Document ID: 41655926

DX-D 400
X-Ray Generator

► Purpose of this document

This document contains the manufacturers' service documentation for the X-Ray Generator. The service documentation is only applicable for DX-D 400.

► Changes compared to previous revision

The following modifications have been implemented:

- Added Disassembly / Reassembly Procedures
(ASM Technical Publication Rev. 2)

LIST OF DOCUMENTS

This Service Manual comprises the following documents:

CODE / REVISION	DOCUMENT	Date
PI-1005R8	Pre-Installation	DEC 13, 2019
IN-1005R16	Installation	DEC 12, 2019
DB-1004R5	Data book	JUL 20, 2016
DB-1021R5	Data book	JUL 20, 2016
CF-1018R5 (+K_TB54)	Configuration	JUL 05, 2019
CF-1004R6 (+K_TB54)	Configuration for Push-button Console	JUL 05, 2019
CF-1054R2 (+K_TB54)	Configuration for Touch Screen Console	JUL 05, 2019
DR-1004R21	LV-DRAC Configuration including Wiring Diagrams	JUN 04, 2020
CA-1036R4	Calibration	JUN 30, 2019
CA-1004R8	Calibration	JUN 30, 2019
CA-1054R2	Calibration	JUN 30, 2019
TR-1101R2	Troubleshooting	OCT 26, 2017
ASM Technical Publication Rev. 2	Disassembly / Reassembly Procedures	OCT 25, 2007
MA-1004R6	Maintenance	OCT 30, 2017
SC-1101R4	Schematics	--
RP-xxxx	Spare Parts List	--
AP-0005R10	Appendix - Adaptation of the Radiation Measuring System	DEC 13, 2019
AP-0073R0i	Appendix - CTSC Touch Screen Console for HF Series Generators	MAY 25, 2016

Technical Publication
PI-1005R8

Pre-Installation

HF Series Generators

REVISION HISTORY

REVISION	DATE	REASON FOR CHANGE
0	JUL 15, 2002	First edition
1	SEP 20, 2003	kW correction for SHF-5xx model
2	FEB 17, 2004	New equipments
3	SEP 15, 2005	Revision of environmental and electrical requirements
4	NOV 24, 2009	Information update
5	SEP 13, 2012	IEC Standards update
6	JUN 28, 2016	Replacement of Console TPC with CTSC. Removed information using an auxiliary boost transformer with 80 kW Generator in 400 / 415 / 440 VAC lines.
7	JUL 04, 2019	Cable outlets in Line Powered Generator with Cover divided in two parts.
8	DEC 13, 2019	New Safety Symbols and new PC Interface Box.

This Document is the english original version, edited and supplied by the manufacturer.

The Revision state of this Document is indicated in the code number shown at the bottom of this page.

ADVISORY SYMBOLS

The following advisory symbols will be used throughout this manual. Their application and meaning are described below.

DANGERS ADVISE OF CONDITIONS OR SITUATIONS THAT IF NOT HEEDED OR AVOIDED WILL CAUSE SERIOUS PERSONAL INJURY OR DEATH.

ADVISE OF CONDITIONS OR SITUATIONS THAT IF NOT HEEDED OR AVOIDED COULD CAUSE SERIOUS PERSONAL INJURY, OR CATASTROPHIC DAMAGE OF EQUIPMENT OR DATA.

Advise of conditions or situations that if not heeded or avoided could cause personal injury or damage to equipment or data.

Note ☞

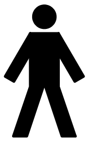
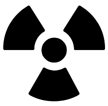
Alert readers to pertinent facts and conditions. Notes represent information that is important to know but which do not necessarily relate to possible injury or damage to equipment.

SAFETY SYMBOLS

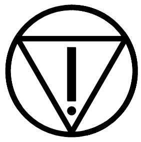
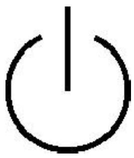
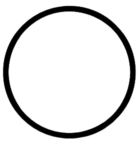
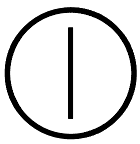
The following safety symbols may appear in the equipment.

Their meaning are described below.

	**Caution. Consult accompanying documents.**
	**Safety Symbol. Follow instructions for use, especially those instructions identified with Advisory Symbols to avoid any risk for the Patient or Operator.** *(Only applies to Standard IEC 60601–1:2005 and IEC 60601-1:2005+AMD1:2012)*
	**Manufacturer.**
	**Date of Manufacture.**
MD	**Medical Device.**
REF	**Catalogue Number (Model reference).**
SN	**Serial Number.**
TYPE	**Model Configuration.**

	**General Mandatory action.**
	**Type B applied part.**
IPx0	**Protection against harmful ingress of water or particulate matter.** **IP Classification: Ordinary.**
	**Ionizing radiation.**
	**Non-ionizing electromagnetic radiation.**
	**Radiation of Laser apparatus.** Do not stare into beam. *(Only applicable to equipment with Laser Pointer)*
	**Dangerous voltage.**
	**General warning, caution, risk of danger.**
	**Warning: Ionizing radiation.**

	**Warning: Non-ionizing radiation.**
	**Warning: Laser beam.**
	**Warning: Electricity.**
	**Warning: Do not place fingers between mobile and fixed parts of the equipment, it may cause serious injuries to patient or operator. As well, make sure the patient extremities are correctly positioned into limit areas during operation, movement of parts may cause serious damages to patient.**
	**Electrostatic sensitive devices.**
	**No pushing.**
	**No sitting.**
	**No stepping on surface.**
	**Do not handle.**

	**Emergency stop.**
	**“Stand-by” power.** *(Only applies to IEC 60601-1:2005 and IEC 60601-1:2005+AMD1:2012)*
	“ON” power.
	**“OFF” power.**
	**“ON” / “OFF” (push-push).** *Each position, “ON” or “OFF”, is a stable position.*
~	**Alternating current.**
3~	**Three-phase alternating current.**
3N~	**Three-phase alternating current with neutral conductor.**
N	**Connection point for the neutral conductor on Permanently Installed equipment.**

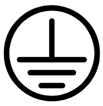
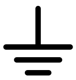
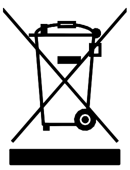
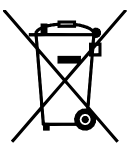
	**Direct current.**
	**Both direct and alternating current.**
	**Protective Earth (Ground).**
	**Earth (Ground).**
	**This symbol according to the European Directive indicates that the Waste of Electrical and Electronic Equipment (WEEE) must not be disposed of as unsorted municipal waste and must be collected separately. Please contact an authorized representative of the manufacturer or an authorized waste management company for information concerning the decommissioning of your equipment.**
 **Li/Pb/Cd/Hg**	**This separate collection symbol is affixed to a battery or its packing, to advise that the battery must be recycled or disposed of in accordance with local or country laws. The letters below the symbol indicate whether certain elements (Li=Lithium, PB=Lead, CD=Cadmium, Hg=Mercury) are contained in the battery. All batteries removed from the equipment must be properly recycled or disposed. Please contact an authorized representative of the manufacturer or an authorized waste management company for information concerning the decommissioning of your equipment.**
	**Pollution Control.** *(Only applicable to People's Republic of China (PRC)).* **This symbol indicates the product contains hazardous materials in excess of the limits established by the Chinese Standards. It must not be disposed of as unsorted municipal waste and must be collected separately. Please contact an authorized representative of the manufacturer or an authorized waste management company for information concerning the decommissioning of your equipment.**

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TABLE OF CONTENTS

SECTION 1 INTRODUCTION

1.1 OBJECTIVE OF THIS MANUAL

This Pre-Installation document provides the information and data needed to plan and qualify the customer site prior to equipment delivery and installation.

This document considers only the X-ray Generator and its associated components. Product information, environmental and electrical requirements are specified.

Note ☞ *For system-related requirements, such as room layout and system interconnections, refer to documentation provided with other subsystems.*

1.2 AVOIDING UNNECESSARY EXPENSES AND DELAYS

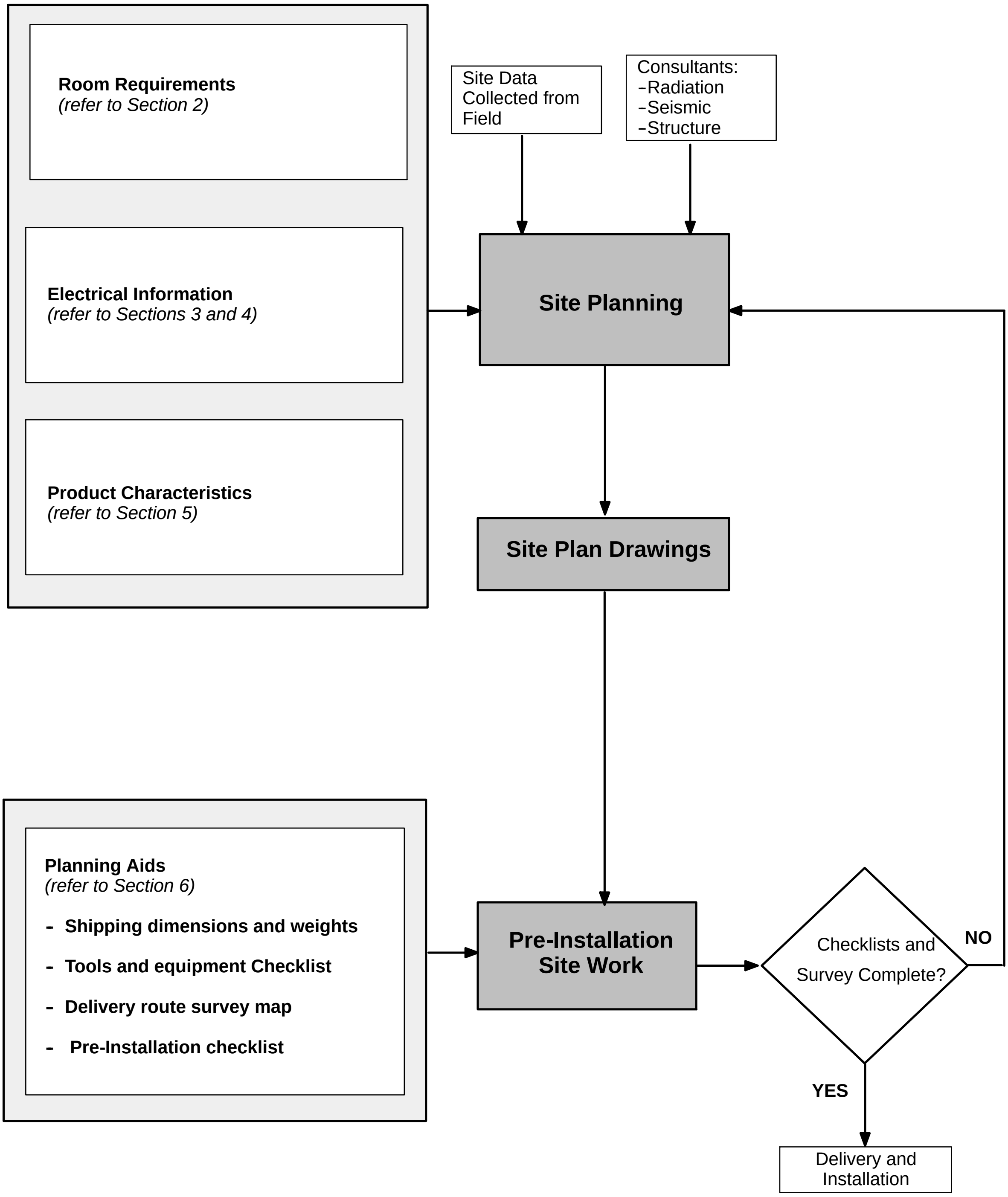
To avoid unnecessary expenses and delays use the "*Pre-installation Checklist*", located in Section 6.4, to determine if you are ready for the installation to begin. Once you believe that the room/location is ready for installation to begin, complete the "*Pre-installation Checklist*". The checklist is an important tool that helps verify that nothing has been missed. The checklist summarizes the preparations and allows you to permanently record the activities that have taken place.

1.3 AN OVERVIEW OF THE PRE-INSTALLATION PROCESS

Complete the checklists contained in this manual. They are an important part of the Pre-Installation process. The checklists summarize the required preparations and verify the completion of the Pre-Installation procedures.

Illustration 1-1 outlines the information in this document and its place in the Pre-Installation process.

Illustration 1-1
Pre-Installation Overview



1.4 RESPONSIBILITY OF PURCHASER / CUSTOMER

To ensure that the installation of the system meets the Purchaser or Customer expectations, it is important to determine who will take responsibility for various items in the course of the system installation process.

To determine these responsibilities, review the following checklists with the customer and assign responsibilities as appropriate:

- Tools and Equipment Checklist (*refer to Section 6.2*)
- Pre-Installation Checklist (*refer to Section 6.4*)

1.5 RESPONSIBILITIES OF THE PURCHASER

The purchaser is responsible for the completion of “*Pre-Installation*”. This includes the procurement and installation of all required materials and services to get the room ready for the installation of the product. This responsibility includes providing:

- A clean and safe work environment for the installation of the product (finished floor, ceiling, walls, and proper room lighting).
- A location suitable for the installation of the product (*refer to Section 2 “Room Requirements”*).
    - Suitable support structures in the floor and walls necessary for the mounting of the product and/or its components (*refer to Section 2.2 “Structural Requirements”*).
    - Installation of conduit, ducts, and/or raceways necessary to route cables safely (*refer to Section 4 “Electrical Requirements,” and Section 5 “Product Characteristics”*).

- Electrical power and grounds of specified quality and reliability (*refer to Section 4, “Electrical Requirements*”).
  - Electrical power of the required voltage output and adequate kVA rating, including the emergency-off safety switch(es) in the room. Power and ground cables to the Room Electrical Cabinet (Main Disconnect).

    Install all safety devices according to this document and Local Codes.
  - Properly installed and sized junction boxes, including covers and fittings, at locations required and called out in architectural drawings.

- A location suitable for operation of the product.
- Installation of non-electric services (if required).
- Current room dimensions plan, including hall way and entry door sizes.

Note ☞ *Complete and proper Pre-Installation will avoid delays and confusion.*

SECTION 2 ROOM REQUIREMENTS

2.1 ENVIRONMENTAL REQUIREMENTS

Note ☞ *STORAGE values only refer to equipment that is still in shipping containers. If the equipment is partially or completely installed, refer to IN USE values.*

2.1.1 RELATIVE HUMIDITY AND TEMPERATURE

<table>
<tr><th rowspan="3">COMPONENT</th><th colspan="4">RELATIVE HUMIDITY
(Non-Condensing)</th><th colspan="4">TEMPERATURE</th></tr>
<tr><th colspan="2">IN USE</th><th colspan="2">STORAGE</th><th colspan="2">IN USE</th><th colspan="2">STORAGE</th></tr>
<tr><th>MIN.</th><th>MAX.</th><th>MIN.</th><th>MAX.</th><th>MIN.</th><th>MAX.</th><th>MIN.</th><th>MAX.</th></tr>
<tr><td>Line Powered Generator</td><td>30%</td><td>75%</td><td>10%</td><td>100%</td><td>10° C
(50° F)</td><td>40° C
(104 °F)</td><td>−40° C
(−40° F)</td><td>70°C
(158° F)</td></tr>
<tr><td>Capacitor Assisted Generator</td><td>30%</td><td>75%</td><td>10%</td><td>100%</td><td>10° C
(50° F)</td><td>40° C
(104 °F)</td><td>−40° C
(−40° F)</td><td>70°C
(158° F)</td></tr>
<tr><td rowspan="2">Battery Powered Generator</td><td rowspan="2">30%</td><td rowspan="2">75%</td><td rowspan="2">10%</td><td rowspan="2">100%</td><td>10° C
(50° F)</td><td>40° C
(104 °F)</td><td rowspan="2">−20° C
(−4° F)</td><td rowspan="2">40° C
(104 °F)</td></tr>
<tr><td colspan="2">for a longer life cycle of batteries it is recommended a temperature around 22°C (72°F)</td></tr>
<tr><td>Control Console</td><td>30%</td><td>75%</td><td>10%</td><td>100%</td><td>10° C
(50° F)</td><td>40° C
(104 °F)</td><td>−40° C
(−40° F)</td><td>70°C
(158° F)</td></tr>
</table>

2.1.2 ATMOSPHERIC PRESSURE

<table>
<tr><th rowspan="3">COMPONENT</th><th colspan="4">ATMOSPHERIC PRESSURE</th></tr>
<tr><th colspan="2">IN USE</th><th colspan="2">STORAGE</th></tr>
<tr><th>MIN.</th><th>MAX.</th><th>MIN.</th><th>MAX.</th></tr>
<tr><td>Line Powered Generator</td><td rowspan="4">700 hPa</td><td rowspan="4">1060 hPa</td><td rowspan="4">500 hPa</td><td rowspan="4">1060 hPa</td></tr>
<tr><td>Capacitor Assisted Generator</td></tr>
<tr><td>Battery Powered Generator</td></tr>
<tr><td>Control Console</td></tr>
</table>

2.1.3 HEAT OUTPUT

In normal environmental circumstances the maximum heat output of the equipment can reach:

- for Line Powered Generators 0.16 kW (544 btu/hr)
- for Capacitor Assisted Generators 0.20 kW (682 btu/hr).
- for Battery Powered Generators 0.26 kW (890 btu/hr).

Note ☞ *Overheating of components can cause system malfunction.*

2.1.4 RADIATION PROTECTION

Because X-ray equipment produces radiation, special precautions may need to be taken or special site modifications may be required. The manufacturer does not make recommendations regarding radiation protection. It is the purchasers responsibility to consult a radiation physicist for advice on radiation protection in X-ray rooms.

2.2 STRUCTURAL REQUIREMENTS

Prior to beginning installation, it is recommended to inspect the site and verify that the X-ray room complies with Pre-installation requirements for the X-ray system such as:

- Floor, wall and raceways for equipment installation.
- A plan distribution is strongly recommended prior equipment installation. Take into account dimensions, travels, operation and passing through areas.

2.2.1 DOOR SIZE REQUIREMENTS

Minimum door sizes also apply to the hallway and elevator.

The minimum door height must be 203 cm (80”) and door width must be 90 cm (35.4”) to take delivery and install system.

The elevator door must meet with the above door requirements and the minimum depth of the elevator measured from the back wall to the elevator door must be 140 cm (55”).

Note ☞ *The above dimensions are calculated as per dimensions of the shipping crates. For dimensions and weights of the crated and uncrated components refer to Table 2-1.*

Table 2-1
Component Crated and Uncrated

COMPONENT CRATED	DIMENSIONS			WEIGHT
	Length	Width	Height	
Line Powered Generator (for only 1 Tube (LSS)) with Control Console and Cables	107 cm (42.1”)	62 cm (24.4”)	74 cm (29.1”)	140 kg (308 lb)
Line Powered Generator (for 1 or 2 Tubes (LSS or HSS)) with Control Console and Cables	115 cm (45.3”)	82 cm (32.3”)	74 cm (29.1”)	170 kg (374 lb)
Capacitor Assisted Generator with Control Console and Cables	118 cm (46.5”)	57 cm (22.4”)	114 cm (44.9”)	204 kg (449 lb)
Battery Powered Generator with Control Console and Cables	118 cm (46.5”)	57 cm (22.4”)	114 cm (44.9”)	280 kg (617 lb)

COMPONENT UNCRATED	DIMENSIONS			WEIGHT
	Length	Width	Height	
Line Powered Generator (for only 1 Tube (LSS)) with Control Console and Cables	44.5 cm (17.5”)	36 cm (14.2”)	56.8 cm (22.4”)	72 kg (159 lb)
Line Powered Generator (for 1 or 2 Tubes (LSS or HSS)) with Control Console and Cables	59.2 cm (23.3”)	36 cm (14.2”)	69 cm (27.2”)	95 kg (209 lb)
Capacitor Assisted Generator with Control Console and Cables	50 cm (19.7”)	36 cm (14.2”)	79 cm (31.1”)	108 kg (238 lb)
Battery Powered Generator with Control Console and Cables	81.3 cm (32”)	43.6 cm (17.2”)	94.8 cm (37.3”)	235 kg (518 lb)

2.2.2 FLOOR AND WALL REQUIREMENTS

The method of installing the system is:

COMPONENT	NORMAL METHOD OF MOUNTING
GENERATOR CABINET	Floor freestanding, wall mounted (only for Line Powered Generators), or anchor to floor with four M10 (3/8") bolts.
CONTROL CONSOLES	Desk freestanding, wall mounted or anchor to an optional pedestal.
PC INTERFACE BOX	Desk freestanding or wall mounted.
Note: Anchoring hardware should be field supplied. For seismic areas all components must be anchored, Local Standards should be applied.	

The Drill Templates of the anchoring holes are shown in the next illustrations.

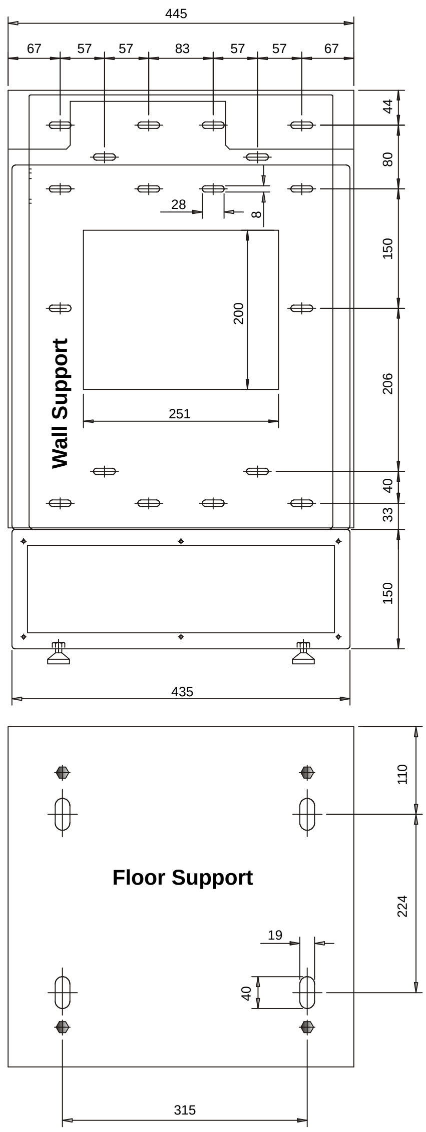
CAUTION

Potential for Injury and/or Equipment Damage: Floor anchors must be a minimum of 150 mm (6") from any concrete edge including ducts and cracks. In addition, the general condition of the concrete in the immediate mounting area should be inspected to ensure that anchors will be set in good quality concrete.

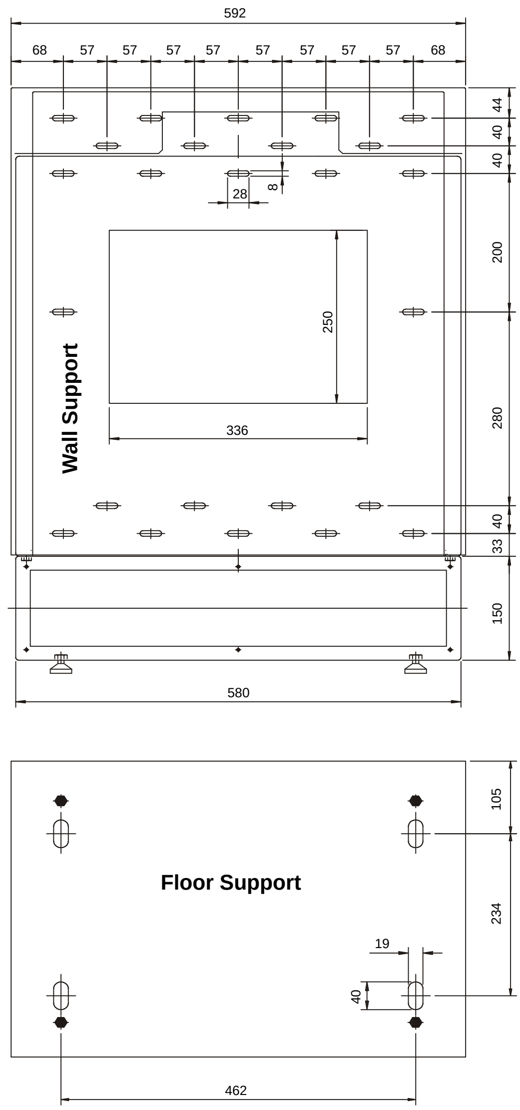
The floor bearing the Rad Room must be concrete and the thickness to be determined by a Structural Engineer to properly support the equipment loads. The anchors require a minimum embedment of 57.2 mm (2 $^1/_4$") into the concrete. If the floor thickness is less than 101.6 mm (4"), it is recommended that the unit be secured using a through-bolt method with a reinforcement plate on the back side.

Illustration 2-1
Drill Template of the optional Generator Supports (only for Line Powered Generators)

OPTIONAL FLOOR AND WALL SUPPORTS
FOR LINE POWERED GENERATORS
(ONLY 1 TUBE – LOW SPEED STARTER)



OPTIONAL FLOOR AND WALL SUPPORTS
FOR LINE POWERED GENERATORS
(1 OR 2 TUBES – HIGH OR LOW SPEED STARTER)



2.3 CLINICAL ACCESS

Make sure that the room is planned with the following clinical access requirements:

- Provide easy access to the equipments.
- Clinicians at the patient examination area must be able to communicate with assistants in the control area.
- Operators in the control area must have easy access to the Operator Console. However, position the controls (including handswitches) so the operator cannot take exposures while looking around or standing outside the control booth's lead glass window.
- Consult customer on the number and location of nonelectrical lines (air, oxygen, vacuum, water, etc.) in the radiographic room.

2.4 FIELD SERVICE ACCESS

Allow appropriate space for service access of the equipment. The minimum recommended free area for service access is:

COMPONENT	SURFACE					
	Left Side	Right Side	Front	Rear	Top	Bottom
GENERATOR CABINET	50 cm (20")	50 cm (20")	100 cm (40")	– *(see note)*	Completely free	–
CONTROL CONSOLE	10 cm (4")	10 cm (4")	Completely free	10 cm (4")	Completely free	–

Note: Ventilation conditions requires to keep a minimum free distance of 15 cm (6") from both lateral sides of the Generator Cabinet and also the same distance from the rear side when the Generator is provided with High Speed Starter (fans for the starter module).

SECTION 3 PLANNING ELECTRICAL CONNECTIONS

3.1 ROUTING CABLES

3.1.1 GENERAL

High voltage and power cables must be separated from other cables. Use a separate through in the duct system or use a separate conduit. Minimize cable length as possible between the Electrical Cabinet (Main Disconnect) and the System Generator Cabinet to reduce voltage regulation problems and wiring costs.

3.1.2 CONDUIT

Separate conduits must be used for power and signal wires. These wires must be kept separated from each other for proper system operation.

Using conduit imposes some important considerations when used with this system. Of primary concern, the majority of cables used are pre-terminated. Pre-termination greatly simplifies interconnection but makes cable-pulling difficult because of the added dimensions of the connectors.

Conduit must be large enough to pass the cable and connector through with all other cables already in the conduit. Also, the size of the conduit chosen must allow for future growth. There is the possibility of additional cables being added later as the system is developed and options are added.

The use of conduit is recommended for cables running overhead between rooms, especially when a diagonal run provides the shortest cable path.

3.1.3 ELECTRICAL DUCTS

It is important that electrical ducts have separate compartments for power and signal wires. These wires must be kept separated from each other for proper system operation.

Electrical ducts have advantages when used with a single room or two (2) adjacent rooms. Electrical ducts combine cabling in a neat and functional appearance, with accessibility and room for expansion.

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SECTION 4 ELECTRICAL REQUIREMENTS

This Generator contains advanced circuitry which will maintain the selected X-ray techniques during adverse line conditions. However, there is a limit to the Generator's ability to correct for inadequate line power.

To ensure proper operation:

- Do not under-size the Distribution Transformer. The secondary of the Distribution Transformer can be a "WYE" ("Star") or "DELTA" wire configuration.
- Size feeder and ground wires as per this document.
- Ensure and maintain input mains voltage to specification. **Ensure that the earth ground resistance of the installation (hospital/clinic) is lower than 10** Ω.

The electrical requirements in this document (wire sizes, etc.) relating to the Generator Cabinet power and the Power Line are the recommended specification.

TO AVOID THE RISK OF ELECTRIC SHOCK, THIS EQUIPMENT MUST ONLY BE CONNECTED TO A SUPPLY MAINS WITH PROTECTIVE EARTH.

ACCORDING TO THE MDD/93/42/EEC, THIS UNIT IS EQUIPPED WITH EMC FILTERS. THE LACK OF THE PROPER GROUNDING MAY PRODUCE ELECTRICAL SHOCK TO THE USER.

The installation should comply with all the electrical requirements indicated in this document. These requirements should be upgraded if Local Standards were more stringent.

4.1 LINE POWERED GENERATORS – POWER LINE REQUIREMENTS

- Factors:

GENERATOR MODEL *(Refer to Identification Label)*	**SINGLE-PHASE GENERATOR**	**THREE-PHASE GENERATOR**	**SINGLE-PHASE GENERATOR**	**THREE-PHASE GENERATOR**
Maximum Power kW	**32 kW**		**40 kW**	
Maximum mA	400 mA		500 mA	
Maximum kVp	125 or 150 kVp		125 or 150 kVp	
Power Line	A	B / C / D	A	B / C / D

GENERATOR MODEL *(Refer to Identification Label)*	**SINGLE-PHASE GENERATOR**	**THREE-PHASE GENERATOR**	**THREE-PHASE GENERATOR**	**THREE-PHASE GENERATOR**
Maximum Power kW	**50 kW**		**64 kW** ***(or 65 kW under special order)***	**80 kW**
Maximum mA	640 mA *(or 630 mA under special order)*		640 mA *(or 650 mA under special order)*	800 mA *(or 1000 mA under special order)*
Maximum kVp	125 or 150 kVp		125 or 150 kVp	150 kVp
Power Line	A	B / C / D	C / D	C / D *(or E for 1000 mA)*

POWER LINE				
A	**B**	**C**	**D**	**E**
230 / 240 V~, Single-Phase, 50 / 60 Hz	230 / 240 V~, Three-Phase, 50 / 60 Hz	400 / 415 / 440 V~, Three-Phase, 50 / 60 Hz	480 V~, Three-Phase, 50 / 60 Hz	530 V~, Three-Phase, 50 / 60 Hz
Line voltage automatic compensation: ±10%.				
Maximum line regulation for maximum kVA demand: 5%.				
NOTES: – For Generators operating with lines at 208 V~ or below an Auxiliary Boost Transformer is required to adequate the line voltage to 230 / 240 V~. – For 1000 mA Generators operating with lines at 400 / 415 / 440 / 480 V~ an auxiliary boost transformer is required to adequate the line voltage to 530 V~.				

- I_{RMS} line current during an X-ray exposure, circuit breaker type and value, differential sensitivity (mA), minimum line power required (kVA), Generator stand-by consumption (W), should be:

	SINGLE-PHASE GENERATOR				THREE-PHASE GENERATOR			
	32 kW (3)				32 kW			
LINE VOLTAGE	I_{RMS} (1)	CIRCUIT BREAKER TYPE (2)			I_{RMS} (1)	CIRCUIT BREAKER TYPE (2)		
		B	C	D		B	C	D
208 V~	192 A	80 A	50 A	25 A	111 A	50 A	25 A	20 A
230 V~	174 A	80 A	40 A	20 A	100 A	40 A	25 A	20 A
240 V~	160 A	63 A	40 A	20 A	96 A	40 A	25 A	20 A
400 V~ (380 V~)	–	–	–	–	58 A	25 A	20 A	20 A
415 V~	–	–	–	–	56 A	25 A	20 A	20 A
440 V~	–	–	–	–	52 A	20 A	20 A	20 A
480 V~	–	–	–	–	48 A	20 A	20 A	20 A
Differential Sensitivity (Earth Leakage / Ground Fault)	30 mA							
Minimum kVA required	40 kVA (*Maximum kW x 1.25*)							
Stand-by Consumption	500 W							

Notes:

(1) $I_{RMS\ (for\ single\text{-}phase)} = (1.25 \times P) / V\sim$ (I_{RMS} *= maximum instantaneous current based on 100 ms X-ray exposure*).
$I_{RMS\ (for\ three\text{-}phase)} = (0.72 \times P) / V\sim$ (I_{RMS} *= maximum instantaneous current based on 100 ms X-ray exposure*).

(2) *Circuit Breaker (Differential, Thermomagnetic, Fuses and/or Contactor).*
The selected circuit breaker type must have a minimum tripping current of 1.1 x I_{RMS} *@ 0.1 seconds.*
For example:
Type "B" breaker: $M_B = (I_{RMS} \times 1.1) / 3$
Type "C" breaker: $M_C = (I_{RMS} \times 1.1) / 5$
Type "D" breaker: $M_D = (I_{RMS} \times 1.1) / 10$

The selected circuit breaker should be equal or bigger than the calculated value. Minimum value should be 20 A.

(3) *For Generators operating with lines at 208 V~ or below an Auxiliary Boost Transformer is required to adequate the line voltage to 230 / 240 V~.*

	SINGLE-PHASE GENERATOR POWER				THREE-PHASE GENERATOR POWER			
	40 kW (3)				40 kW			
LINE VOLTAGE	I_{RMS} (1)	CIRCUIT BREAKER TYPE (2)			I_{RMS} (1)	CIRCUIT BREAKER TYPE (2)		
		B	C	D		B	C	D
208 V~	240 A	100 A	63 A	32 A	138 A	63 A	32 A	20 A
230 V~	217 A	80 A	50 A	25 A	125 A	50 A	32 A	20 A
240 V~	200 A	80 A	50 A	25 A	120 A	50 A	32 A	20 A
400 V~ (380 V~)	–	–	–	–	72 A	32 A	20 A	20 A
415 V~	–	–	–	–	69 A	32 A	20 A	20 A
440 V~	–	–	–	–	65 A	25 A	20 A	20 A
480 V~	–	–	–	–	60 A	25 A	20 A	20 A
Differential Sensitivity (Earth Leakage / Ground Fault)	30 mA							
Minimum kVA required	50 kVA (*Maximum kW x 1.25*)							
Stand-by Consumption	500 W							

Notes:

(1) $I_{RMS\ (for\ single\text{-}phase)} = (1.25 \times P) / V\sim$ (*I_{RMS} = maximum instantaneous current based on 100 ms X-ray exposure*).
$I_{RMS\ (for\ three\text{-}phase)} = (0.72 \times P) / V\sim$ (*I_{RMS} = maximum instantaneous current based on 100 ms X-ray exposure*).

(2) *Circuit Breaker (Differential, Thermomagnetic, Fuses and/or Contactor).*
The selected circuit breaker type must have a minimum tripping current of 1.1 x I_{RMS} @ 0.1 seconds.
For example:

Type "B" breaker: $M_B = (I_{RMS} \times 1.1) / 3$
Type "C" breaker: $M_C = (I_{RMS} \times 1.1) / 5$
Type "D" breaker: $M_D = (I_{RMS} \times 1.1) / 10$

The selected circuit breaker should be equal or bigger than the calculated value. Minimum value should be 20 A.

(3) *For Generators operating with lines at 208 V~ or below an Auxiliary Boost Transformer is required to adequate the line voltage to 230 / 240 V~.*

	SINGLE-PHASE GENERATOR POWER				THREE-PHASE GENERATOR POWER			
	50 kW (3)				**50 kW**			
LINE VOLTAGE	I_{RMS} (1)	CIRCUIT BREAKER TYPE (2)			I_{RMS} (1)	CIRCUIT BREAKER TYPE (2)		
		B	**C**	**D**		**B**	**C**	**D**
208 V~	300 A	125 A	80 A	40 A	173 A	80 A	40 A	20 A
230 V~	272 A	100 A	63 A	32 A	157 A	63 A	40 A	20 A
240 V~	250 A	100 A	63 A	32 A	150 A	63 A	40 A	20 A
400 V~ (380 V~)	–	–	–	–	90 A	40 A	20 A	20 A
415 V~	–	–	–	–	87 A	32 A	20 A	20 A
440 V~	–	–	–	–	82 A	32 A	20 A	20 A
480 V~	–	–	–	–	75 A	32 A	20 A	20 A
Differential Sensitivity (Earth Leakage / Ground Fault)	30 mA							
Minimum kVA required	62.5 kVA (*Maximum kW x 1.25*)							
Stand-by Consumption	500 W							

***Notes**:*

(1) $I_{RMS\ (for\ single\text{-}phase)} = (1.25 \times P) / V\sim$ (I_{RMS} *= maximum instantaneous current based on 100 ms X-ray exposure*).
$I_{RMS\ (for\ three\text{-}phase)} = (0.72 \times P) / V\sim$ (I_{RMS} *= maximum instantaneous current based on 100 ms X-ray exposure*).

(2) *Circuit Breaker (Differential, Thermomagnetic, Fuses and/or Contactor).*
The selected circuit breaker type must have a minimum tripping current of 1.1 x I_{RMS} *@ 0.1 seconds.*
For example:

Type “B” breaker: $M_B = (I_{RMS} \times 1.1) / 3$
Type “C” breaker: $M_C = (I_{RMS} \times 1.1) / 5$
Type “D” breaker: $M_D = (I_{RMS} \times 1.1) / 10$

The selected circuit breaker should be equal or bigger than the calculated value. Minimum value should be 20 A.

(3) *For Generators operating with lines at 208 V~ or below an Auxiliary Boost Transformer is required to adequate the line voltage to 230 / 240 V~.*

	THREE-PHASE GENERATOR POWER							
	64 kW *(or 65 kW)*				**80 kW**			
LINE VOLTAGE	I_{RMS} (1)	CIRCUIT BREAKER TYPE (2)			I_{RMS} (1)	CIRCUIT BREAKER TYPE (2)		
		B	**C**	**D**		**B**	**C**	**D**
400 V~ (380 V~)	115 A	50 A	32 A	20 A	144 A	63 A	32 A	20 A
415 V~	111 A	50 A	25 A	20 A	139 A	63 A	32 A	20 A
440 V~	105 A	40 A	20 A	20 A	131 A	50 A	32 A	20 A
480 V~	96 A	40 A	20 A	20 A	120 A	50 A	32 A	20 A
Differential Sensitivity (Earth Leakage / Ground Fault)	30 mA				30 mA			
Minimum kVA required	80 kVA (*Maximum kW x 1.25*)				100 kVA (*Maximum kW x 1.25*)			
Stand-by Consumption	500 W				500 W			

Notes:

(1) $I_{RMS\ (for\ three\text{-}phase)} = (0.72 \times P) / V\sim$ (I_{RMS} = *maximum instantaneous current based on 100 ms X-ray exposure*).

(2) *Circuit Breaker (Differential, Thermomagnetic, Fuses and/or Contactor).*
The selected circuit breaker type must have a minimum tripping current of 1.1 x I_{RMS} *@ 0.1 seconds.*
For example:

Type "B" breaker: $M_B = (I_{RMS} \times 1.1) / 3$
Type "C" breaker: $M_C = (I_{RMS} \times 1.1) / 5$
Type "D" breaker: $M_D = (I_{RMS} \times 1.1) / 10$

The selected circuit breaker should be equal or bigger than the calculated value. Minimum value should be 20 A.

- The Maximum Impedance must be lower than the value indicated below:

LINE VOLTAGE	SINGLE-PHASE GENERATOR								
	32 kW			40 kW			50 kW		
	Z_L Ω	Z_C Ω	Z_T Ω	Z_L Ω	Z_C Ω	Z_T Ω	Z_L Ω	Z_C Ω	Z_T Ω
208 V~	0.043 Ω	0.012 Ω	0.068 Ω	0.035 Ω	0.010 Ω	0.054 Ω	0.028 Ω	0.008 Ω	0.043 Ω
230 V~	0.053 Ω	0.015 Ω	0.083 Ω	0.042 Ω	0.012 Ω	0.066 Ω	0.034 Ω	0.010 Ω	0.053 Ω
240 V~	0.058 Ω	0.016 Ω	0.090 Ω	0.046 Ω	0.013 Ω	0.072 Ω	0.037 Ω	0.010 Ω	0.058 Ω

Z_L Ω = maximum impedance of the distribution transformer.
Z_C Ω = maximum impedance of every feeder cable.
Z_T Ω = maximum impedance at the generator's input terminals.
NOTE: *The above values comply with the Standards IEC 60601-2-54:2009.*

LINE VOLTAGE	THREE-PHASE GENERATOR								
	32 kW			40 kW			50 kW		
	Z_L Ω	Z_C Ω	Z_T Ω	Z_L Ω	Z_C Ω	Z_T Ω	Z_L Ω	Z_C Ω	Z_T Ω
208 V~	0.074 Ω	0.024 Ω	0.118 Ω	0.060 Ω	0.020 Ω	0.094 Ω	0.048 Ω	0.016 Ω	0.075 Ω
230 V~	0.091 Ω	0.030 Ω	0.144 Ω	0.073 Ω	0.024 Ω	0.115 Ω	0.058 Ω	0.019 Ω	0.092 Ω
240 V~	0.099 Ω	0.032 Ω	0.157 Ω	0.079 Ω	0.026 Ω	0.125 Ω	0.063 Ω	0.021 Ω	0.100 Ω
400 V~ (380 V~)	0.275 Ω	0.090 Ω	0.435 Ω	0.220 Ω	0.072 Ω	0.348 Ω	0.176 Ω	0.058 Ω	0.278 Ω
415 V~	0.296 Ω	0.097 Ω	0.468 Ω	0.237 Ω	0.078 Ω	0.375 Ω	0.189 Ω	0.062 Ω	0.300 Ω
440 V~	0.333 Ω	0.109 Ω	0.526 Ω	0.266 Ω	0.087 Ω	0.421 Ω	0.213 Ω	0.070 Ω	0.337 Ω
480 V~	0.396 Ω	0.130 Ω	0.626 Ω	0.317 Ω	0.104 Ω	0.501 Ω	0.253 Ω	0.083 Ω	0.401 Ω

Z_L Ω = maximum impedance of the distribution transformer.
Z_C Ω = maximum impedance of every feeder cable.
Z_T Ω = maximum impedance at the generator's input terminals.
NOTE: *The above values comply with the Standards IEC 60601-2-54:2009.*

LINE VOLTAGE	THREE-PHASE GENERATOR					
	64 kW *(or 65 kW)*			80 kW		
	Z_L Ω	Z_C Ω	Z_T Ω	Z_L Ω	Z_C Ω	Z_T Ω
400 V~ (380 V~)	0.138 Ω	0.045 Ω	0.218 Ω	0.110 Ω	0.036 Ω	0.174 Ω
415 V~	0.148 Ω	0.048 Ω	0.234 Ω	0.118 Ω	0.039 Ω	0.187 Ω
440 V~	0.166 Ω	0.055 Ω	0.263 Ω	0.133 Ω	0.044 Ω	0.211 Ω
480 V~	0.198 Ω	0.065 Ω	0.313 Ω	0.158 Ω	0.052 Ω	0.251 Ω

Z_L Ω = maximum impedance of the distribution transformer.
Z_C Ω = maximum impedance of every feeder cable.
Z_T Ω = maximum impedance at the generator's input terminals.
NOTE: *The above values comply with the Standards IEC 60601-2-54:2009.*

RECOMMENDED WIRE SIZE

Correct sizing of the feeder wires is critical to proper Generator operation. Wire size is dependent on the Generator power, the line voltage and the distance from the Distribution Transformer to the Generator Cabinet. The maximum voltage drop during an exposure must not exceed 5% of the nominal mains value.

It is recommended that the Distribution Transformer (Hospital / Clinic) used as the power source have at least 25% more power than the maximum power of the X-ray Generator.

The recommended wire sizing is indicated in Table 4-1 and the wire size conversion in Table 4-2. These lengths are measured from the Distribution Transformer to the Room Electrical Cabinet (Main Disconnect). **From the Room Electrical Cabinet to the Generator Cabinet, wire sizes should be consistent with those shown in Table 4-1 and based on the length of wires required to complete the run. The maximum wire size that can be connected to the Generator Cabinet (Input Line Fuse Holder) is 35 mm^2 (AWG 2).**

Table 4-1
Minimum Wire Size from Distribution Transformer to Room Electrical Cabinet

GENERATOR	LINE VOLTAGE	WIRE SIZE AT:							
		15 m (50 ft)		30 m (100 ft)		45 m (150 ft)		60 m (200 ft)	
32 kW, 1ϕ	208 V~	25 mm^2	AWG 2	50 mm^2	AWG 1/0	95 mm^2	AWG 3/0	120 mm^2	AWG 4/0
	230 V~	25 mm^2	AWG 4	50 mm^2	AWG 1	70 mm^2	AWG 2/0	95 mm^2	AWG 3/0
	240 V~	25 mm^2	AWG 4	50 mm^2	AWG 1	70 mm^2	AWG 2/0	95 mm^2	AWG 3/0
32 kW, 3ϕ	208 V~	16 mm^2	AWG 6	25 mm^2	AWG 2	50 mm^2	AWG 1	50 mm^2	AWG 1
	230 V~	10 mm^2	AWG 6	25 mm^2	AWG 4	35 mm^2	AWG 2	50 mm^2	AWG 1
	240 V~	10 mm^2	AWG 6	25 mm^2	AWG 4	35 mm^2	AWG 2	50 mm^2	AWG 1
	400 V~ (380 V~)	4 mm^2	AWG 12	10 mm^2	AWG 8	10 mm^2	AWG 6	16 mm^2	AWG 6
	415 V~	4 mm^2	AWG 12	6 mm^2	AWG 8	10 mm^2	AWG 6	16 mm^2	AWG 6
	440 V~	4 mm^2	AWG 12	6 mm^2	AWG 8	10 mm^2	AWG 8	16 mm^2	AWG 6
	480 V~	4 mm^2	AWG 12	6 mm^2	AWG 10	10 mm^2	AWG 8	10 mm^2	AWG 6

Table 4-1 (cont.)
Minimum Wire Size from Distribution Transformer to Room Electrical Cabinet

GENERATOR	LINE VOLTAGE	WIRE SIZE AT:							
		15 m (50 ft)		30 m (100 ft)		45 m (150 ft)		60 m (200 ft)	
40 kW, 1φ	208 V~	35 mm^2	AWG 2	70 mm^2	AWG 2/0	95 mm^2	AWG 4/0	120 mm^2	AWG 4/0
	230 V~	25 mm^2	AWG 2	50 mm^2	AWG 1/0	95 mm^2	AWG 3/0	120 mm^2	AWG 4/0
	240 V~	25 mm^2	AWG 2	50 mm^2	AWG 1/0	70 mm^2	AWG 3/0	95 mm^2	AWG 4/0
40 kW, 3φ	208 V~	16 mm^2	AWG 4	35 mm^2	AWG 2	50 mm^2	AWG 1/0	70 mm^2	AWG 2/0
	230 V~	16 mm^2	AWG 6	25 mm^2	AWG 2	50 mm^2	AWG 1	50 mm^2	AWG 1/0
	240 V~	16 mm^2	AWG 6	25 mm^2	AWG 2	35 mm^2	AWG 2	50 mm^2	AWG 1/0
	400 V~ (380 V~)	6 mm^2	AWG 10	10 mm^2	AWG 8	16 mm^2	AWG 6	25 mm^2	AWG 4
	415 V~	4 mm^2	AWG 10	10 mm^2	AWG 8	16 mm^2	AWG 6	16 mm^2	AWG 4
	440 V~	4 mm^2	AWG 10	10 mm^2	AWG 8	10 mm^2	AWG 6	16 mm^2	AWG 6
	480 V~	4 mm^2	AWG 12	6 mm^2	AWG 8	10 mm^2	AWG 8	16 mm^2	AWG 6
50 kW, 1φ	208 V~	50 mm^2	AWG 1	95 mm^2	AWG 3/0	N.A.	N.A.	N.A.	N.A.
	230 V~	35 mm^2	AWG 2	70 mm^2	AWG 2/0	95 mm^2	AWG 4/0	N.A.	N.A.
	240 V~	35 mm^2	AWG 2	70 mm^2	AWG 2/0	95 mm^2	AWG 4/0	N.A.	N.A.
50 kW, 3φ	208 V~	25 mm^2	AWG 4	50 mm^2	AWG 1	70 mm^2	AWG 2/0	95 mm^2	AWG 3/0
	230 V~	16 mm^2	AWG 4	35 mm^2	AWG 2	50 mm^2	AWG 1/0	70 mm^2	AWG 2/0
	240 V~	16 mm^2	AWG 4	35 mm^2	AWG 2	50 mm^2	AWG 1	70 mm^2	AWG 2/0
	400 V~ (380 V~)	6 mm^2	AWG 10	10 mm^2	AWG 6	16 mm^2	AWG 4	25 mm^2	AWG 4
	415 V~	6 mm^2	AWG 10	10 mm^2	AWG 6	16 mm^2	AWG 4	25 mm^2	AWG 4
	440 V~	6 mm^2	AWG 10	10 mm^2	AWG 8	16 mm^2	AWG 6	25 mm^2	AWG 4
	480 V~	4 mm^2	AWG 10	10 mm^2	AWG 8	16 mm^2	AWG 6	16 mm^2	AWG 4
64 kW, 3φ *(or 65 kW, 3φ)*	400 V~ (380 V~)	10 mm^2	AWG 8	16 mm^2	AWG 6	25 mm^2	AWG 4	35 mm^2	AWG 2
	415 V~	10 mm^2	AWG 8	16 mm^2	AWG 6	25 mm^2	AWG 4	25 mm^2	AWG 2
	440 V~	6 mm^2	AWG 8	16 mm^2	AWG 6	16 mm^2	AWG 4	25 mm^2	AWG 4
	480 V~	6 mm^2	AWG 10	10 mm^2	AWG 6	16 mm^2	AWG 4	25 mm^2	AWG 4
80 kW, 3φ	400 V~ (380 V~)	10 mm^2	AWG 8	25 mm^2	AWG 4	25 mm^2	AWG 2	35 mm^2	AWG 2
	415 V~	10 mm^2	AWG 8	16 mm^2	AWG 4	25 mm^2	AWG 2	35 mm^2	AWG 2
	440 V~	10 mm^2	AWG 8	16 mm^2	AWG 6	25 mm^2	AWG 4	35 mm^2	AWG 2
	480 V~	6 mm^2	AWG 8	16 mm^2	AWG 6	25 mm^2	AWG 4	25 mm^2	AWG 2

Table 4-2
Wire Size Conversion and Ampacity

Cross Section (mm^2)	AWG	Ampacity (A)
3.31	**12**	20
4		24
5.26	**10**	30
6		39
8.37	**8**	47
10		55
13.3	**6**	61
16		70
21.15	**4**	80
25		90
33.6	**2**	108
35		115
42.4	**1**	122
50		132
53.5	**0 (1/0)**	141
67.4	**00 (2/0)**	164
70		170
85	**000 (3/0)**	188
95		200
107.2	**0000 (4/0)**	216
120		240

The selected cable must have an Ampacity equal or greater than the Circuit Breaker.
The smallest size used is 4 mm^2 or AWG 12.

4.2 CAPACITOR ASSISTED GENERATORS – POWER LINE REQUIREMENTS

Power Line	100 / 110 / 120 / 208 / 230 / 240 V~ – Single-Phase , 50 / 60 Hz Line Voltage Automatic Compensation ±10% V~ Power Line Adaptation for local conditions from 8 to 20 A Connection to line terminals and GND of the Room Electrical Cabinet by using tool and according to local standards.
Circuit Breaker / Thermomagnetic Interruptor minimum rating should be:	20 A for 100 or 110 V~ 16 A for 120 V~ 12.5 A for 208 V~ 10 A for 230 V~ 8 A for 240 V~ (1 Phase + Neutral, Curve Type C)
Differential Sensitivity (Earth Leakage / Ground Fault)	30 mA
Minimum kW required	2.0 kW
Maximum Input Power	4 kVA
Line Impedance	Due to the unit is a Capacitor Assisted Generator, a specific value of Line Impedance is not required.

RECOMMENDED WIRE SIZE

The minimum recommended wire size for the line voltage is:

LINE VOLTAGE	WIRE SIZE	
100 / 110 / 120 V~	4 mm^2	AWG 12
208 / 230 / 240 V~	2.5 mm^2	AWG 14

4.3 BATTERY POWERED GENERATORS – POWER LINE REQUIREMENTS

Power Line	110 / 208 / 230 / 240 V~ – Single-Phase , 50 / 60 Hz Line Voltage Automatic Compensation ±10% V~ Connection to line terminals and GND of the Room Electrical Cabinet by using tool and according to local standards.
Circuit Breaker / Thermomagnetic Interruptor minimum rating should be:	20 A for 110 V~ 12.5 A for 208 V~ 10 A for 230 V~ 8 A for 240 V~ (1 Phase + Neutral, Curve Type C)
Differential Sensitivity (Earth Leakage / Ground Fault)	30 mA
Minimum kW required	0.5 kW for unit with Stand-Alone option 2.2 kW for unit without Stand-Alone option
Maximum Input Power	1 kVA for unit with Stand-Alone option 3.3 kVA for unit without Stand-Alone option
Line Impedance	Due to the unit is a Battery Powered Generator, a specific value of Line Impedance is not required.

RECOMMENDED WIRE SIZE

The minimum recommended wire size for the line voltage is:

LINE VOLTAGE	WIRE SIZE	
110 V~	4 mm^2	AWG 12
208 / 230 / 240 V~	2.5 mm^2	AWG 14

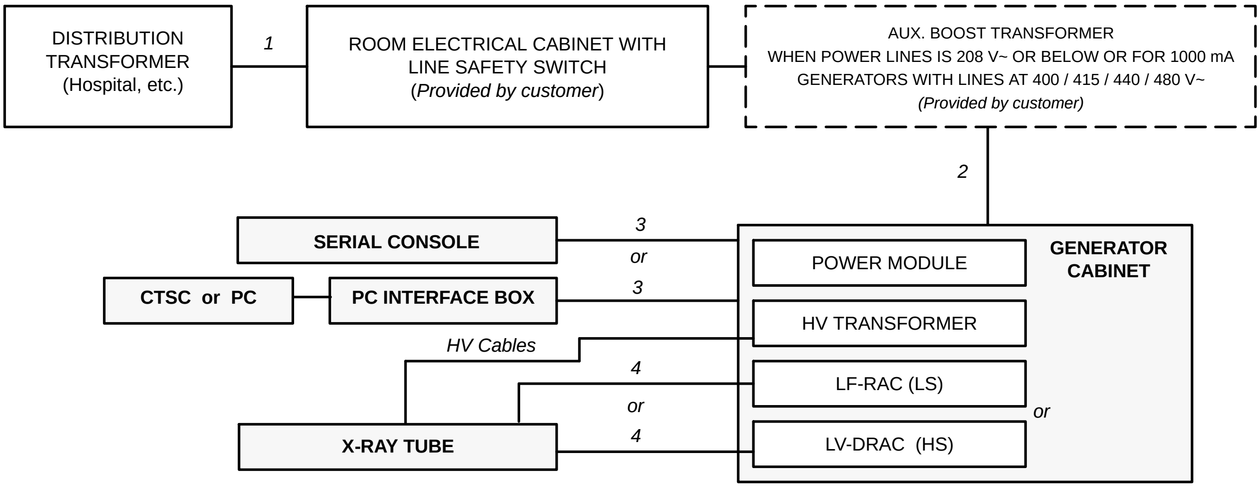
4.4 CTSC POWER LINE REQUIREMENTS

Power Line Operation for CTSC Touch Screen Console	**Input from Line**	Automatic Regulation at 100 – 240 V~ – Single-Phase 50 / 60 Hz Automatic Line Compensation ±10% V~ Input Power 100 VA Connection to standard outlets with GND that complies with local regulations.
	Output to Console	12 V=

4.5 INTERCONNECTION AND GROUNDING REQUIREMENTS

Note ☞ *For more information about interconnection and grounding refer to “Installation” document.*

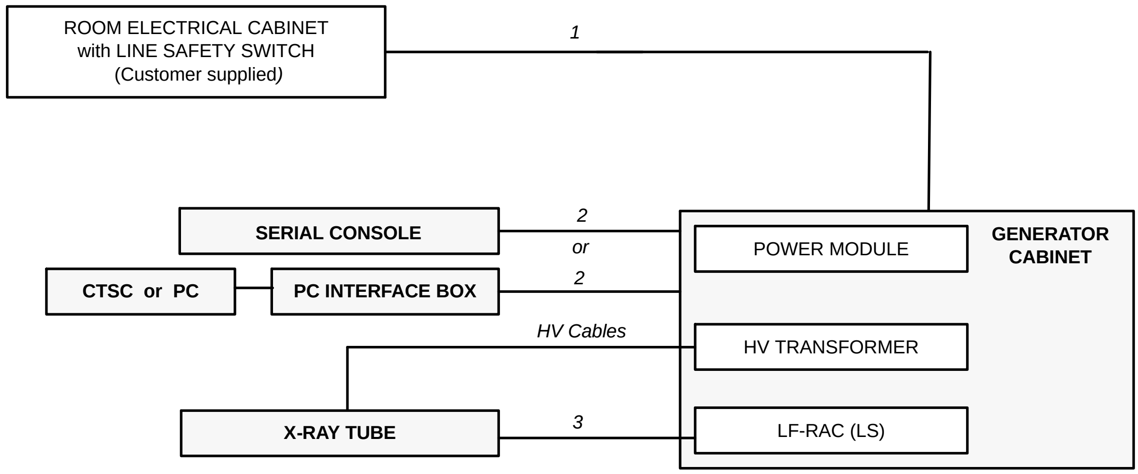
Illustration 4-1
Interconnection Block Diagram for LINE POWERED GENERATORS



CABLE RUN	FUNCTION	REMARKS
1	Single or Three Phase Input Power Line and Ground	Connect to Room Electrical Cabinet according to the indicated electrical requirements. *Customer supplied.*
2	Single or Three Phase Input Power Line and Ground.	Connect to Generator according to the indicated electrical requirements. Install an Auxiliar Boost Transformer when it is required. *Customer supplied.*
3	Serial Communication and Ground.	
4	Stator Supply.	*Provided with X-ray Tube.*
	Generator provided with High Speed Starter requires a shielded stator cable. (*Refer to “Installation” document*).	*Field supplied.*

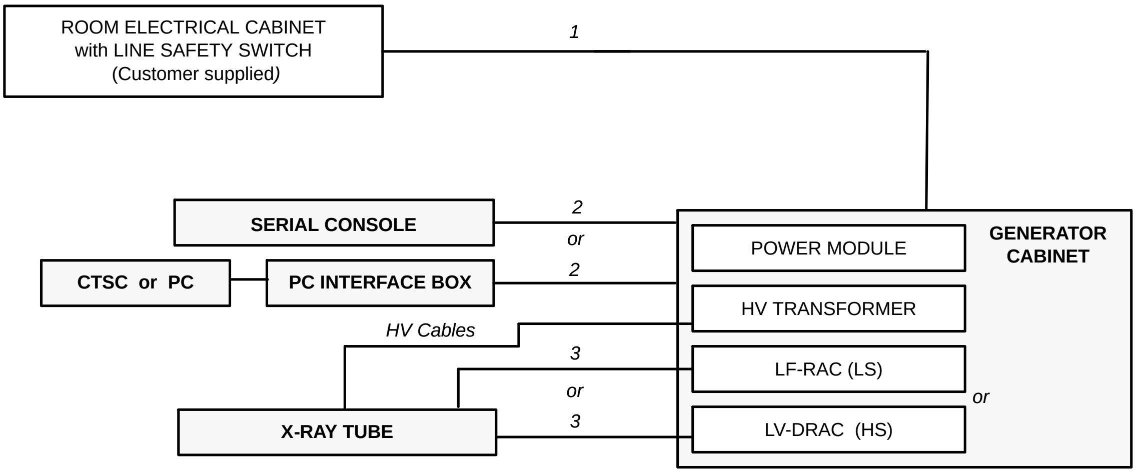
NOTES:
- *For wire size refer to Section 4.1. Consult to Local Standards for feeder and ground wire size requirements.*
- *The system power ground point is located in the Room Electrical Cabinet.*

Illustration 4-2
Interconnection Block Diagram for CAPACITOR ASSISTED GENERATORS



CABLE RUN	FUNCTION	REMARKS
1	Single Phase Input Power Line and Ground	Connect to Room Electrical Cabinet according to the indicated electrical requirements. *Customer supplied.*
2	Serial Communication and Ground.	
3	Stator Supply.	*Provided with X-ray Tube.*
NOTES: – *For wire size refer to Section 4.2. Consult to Local Standards for feeder and ground wire size requirements.* – *The system power ground point is located in the Room Electrical Cabinet.*		

Illustration 4-3
Interconnection Block Diagram for BATTERY POWERED GENERATORS



CABLE RUN	FUNCTION	REMARKS
1	Single Phase Input Power Line. and Ground	Connect to Room Electrical Cabinet according to the indicated electrical requirements. *Customer supplied.*
2	Serial Communication and Ground.	Cable quantity depends on the options installed (AEC, etc.)
3	Stator Supply.	*Provided with X-ray Tube.*
	Generator provided with High Speed Starter requires a shielded stator cable. (*Refer to "Installation" document*).	*Field supplied.*
NOTES: – *For wire size refer to Section 4.3. Consult to Local Standards for feeder and ground wire size requirements.* – *The system power ground point is located in the Electrical Room Cabinet.*		

4.6 SAFETY DEVICES

Every installation must be provided with a main line disconnect device (Circuit Breaker / Thermomagnetic Breaker) and the remote disconnect devices required at all Consoles that are not located next to the line safety switch.

Devices such as Safety Switch / Emergency Switch, Warning Light, and a Door Interlock Switch should be supplied and installed by the customer. (*Refer to Illustration 4-4*).

SAFETY SWITCH / EMERGENCY SWITCH

The main Safety Switch should be installed in the Room Electrical Cabinet (Main Disconnect) close to the Generator Cabinet and provided with light indicators for “Power On / Off”. It should be used for main disconnection of the whole System and located in an accessible place where it can be seen and controlled during operation and service.

Other Emergency Switches should be installed in accessible locations in the room (near the main entrance door or the Control Console) for use in an emergency. They should be connected to the Room Electrical Cabinet (Room Disconnect) so that they cut power to the Generator when they are activated.

The rating of these switches should be: 10 A, 500 V~, NC, and should have at least 3.42 mm as Creepage Distances and Air Clearances in accordance with Standards IEC 60601–1:2005 and IEC 61058–1:2000 requirements.

For Battery Powered Generators, an optional Emergency Stop Button for isolating the Batteries and Power Line of the Generator can also be provided to be installed in the Room Electrical Cabinet or another location in the X-ray Room. (*Refer to Installation Chapter of the Generator Service Manual)*.

The minimum specification for this installation should be:

- Emergency Stop Button: *AC-15 , 240 V, 3 A, Ith 10 A.*
- Cable: *2.5* mm^2 *(AWG 14), 600 V.*

DOOR INTERLOCK SWITCH

The Door Interlock Switch indicates to the operator when Doorways to the X-ray room are open. It inhibits or not the X-ray generation, according to the Local Standards and customer preferences.

This switch should be installed in the entrance door(s) and its connecting cable should be routed to the Generator Cabinet.

WARNING LIGHT

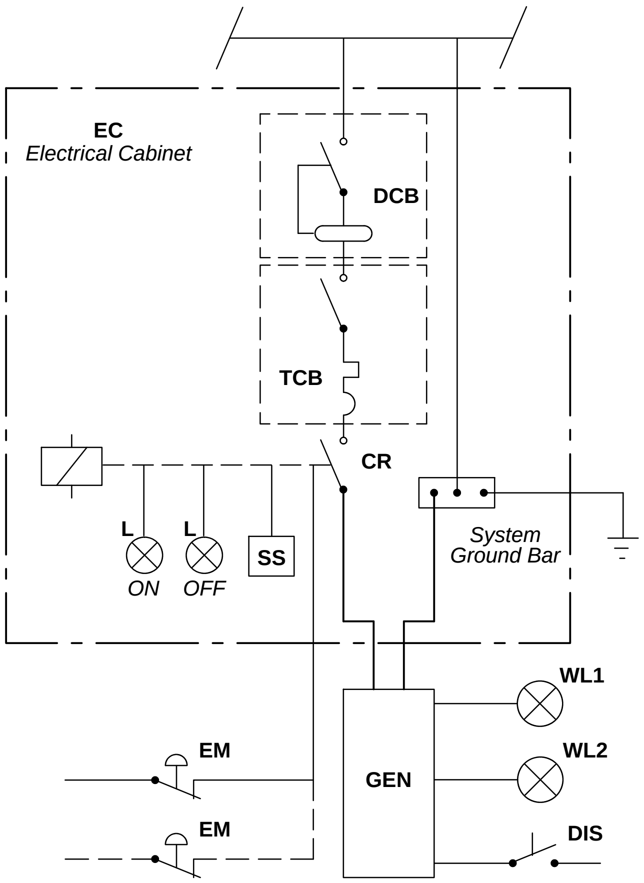
The Warning Lights are signal lamps installed outside of the X-ray room (near of the main entrance) that indicate:

1. The system is under voltage (red lamp “ON”).
2. X-ray exposure in process (yellow lamp “ON”) (*for connection refer to Installation document.*)

The Warning Lights connection cables should be routed to the Generator.

Note ☞ *The installation must be in compliance with all local regulations.*

Illustration 4-4
Room Electrical Cabinet and Mains Connection



LEGEND

EC: Electrical Cabinet (Room Disconnect) for powering X-ray equipment. (*Customer supplied)*

DCB: Differential Circuit Breaker.

TCB: Thermomagnetic (or Fuses) Circuit Breaker.

CR: Contactor controlled by the Safety Switch (**SS**).

SS: Safety Switch used for Generator main disconnection, with ON/OFF positions.

L: ON / OFF Indicator Lamps located on the Electrical Cabinet.

EM: Emergency Switch near to Control Console and/or to the Room main entrance.

GEN: Generator Cabinet.

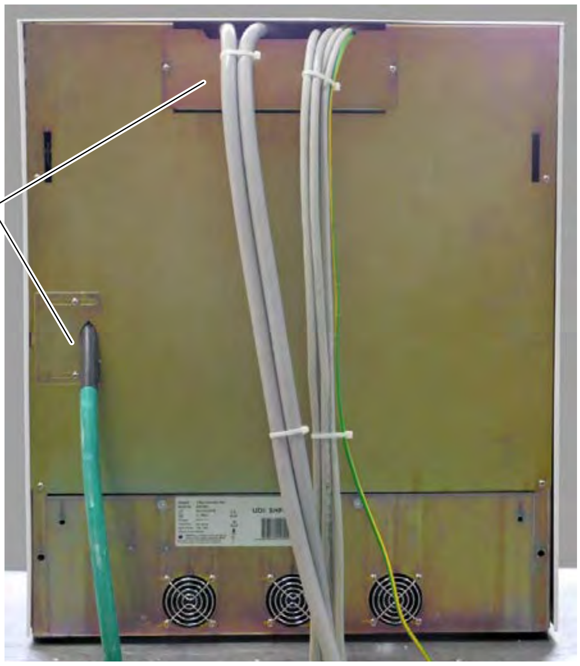
WL1: X-ray Emission Indicator Lamp (yellow lamp) connected to the Generator Cabinet, located outside of the X-ray Room (above the exam room entrance).

WL2: Warning Light (red lamp) located outside of the X-ray Room (above the exam room entrance).

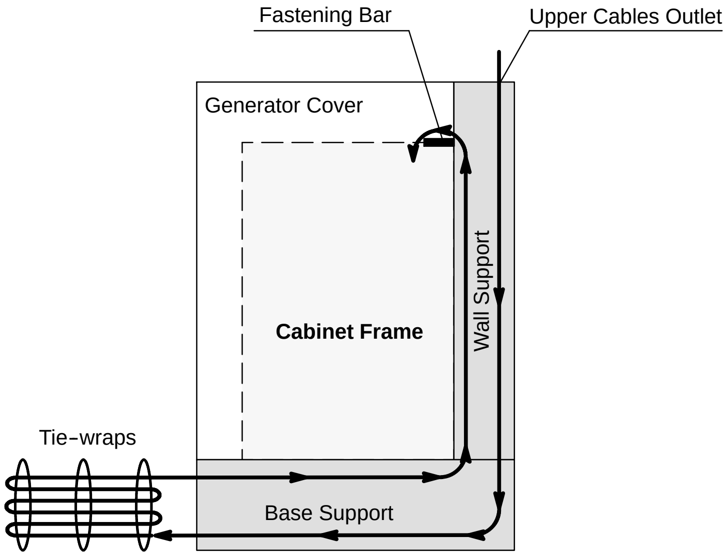
DIS: Door Interlock Switch located on the main entrance(s).

4.7 GENERATOR CABLE ACCESS

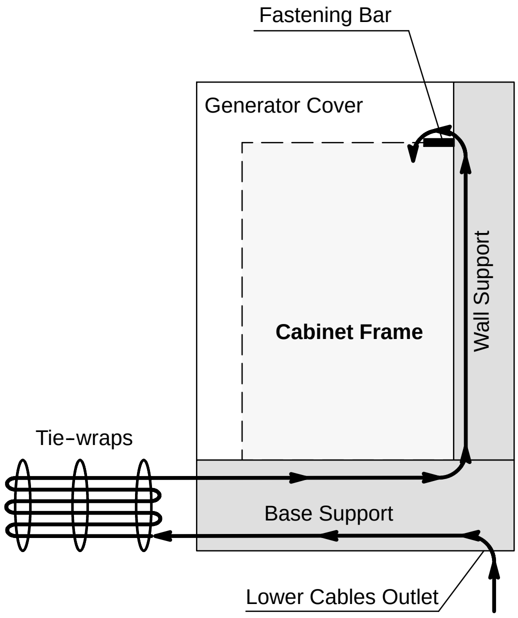
LINE POWERED GENERATOR
(WITHOUT FLOOR OR WALL SUPPORTS)



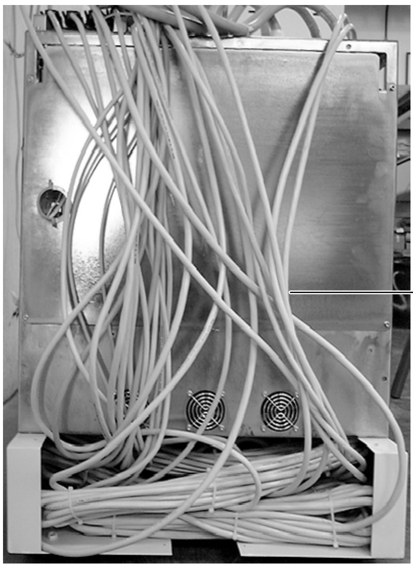
LINE POWERED GENERATOR
(WITH FLOOR AND WALL SUPPORTS)



INTERNAL CABLE ROUTING FROM UPPER CABLES OUTLET



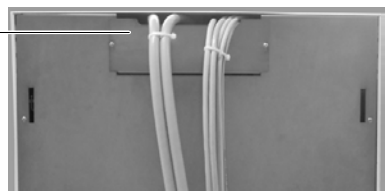
INTERNAL CABLE ROUTING FROM LOWER CABLES OUTLET



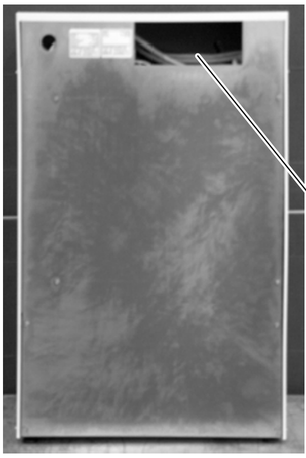
Cables Entrance (upper side of Wall Support)

Cables Routing from Cabinet to Base Support (rear view)

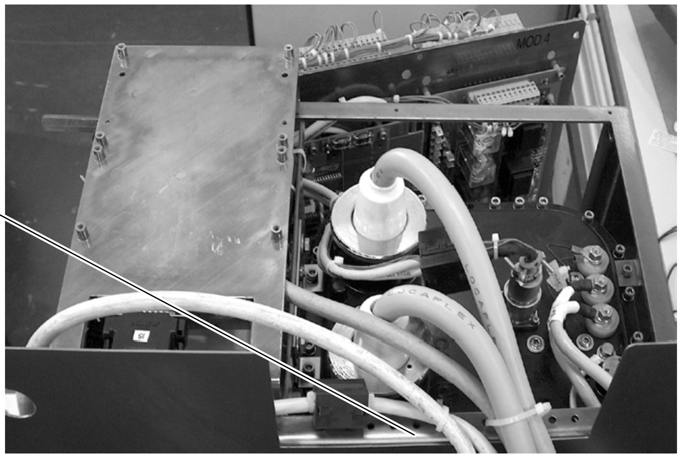
Cables Outlet (rear side of Cabinet Cover)



CAPACITOR ASSISTED GENERATOR



Cable Outlet (rear side)

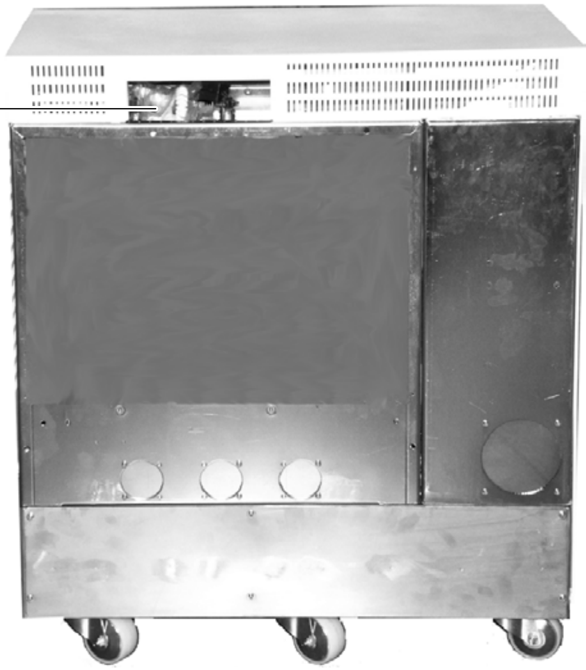


Cable Outlet (rear side)

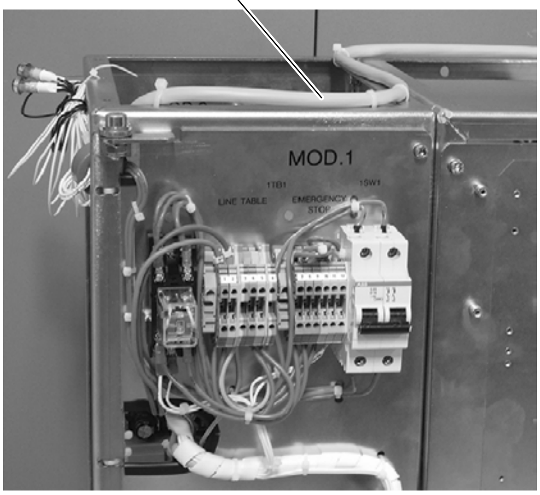
Power Line Cord in Capacitors Generator

BATTERY POWERED GENERATOR

Cable Outlet (rear side)



Power Line Cord in Battery Powered Generator



SECTION 5 PRODUCT CHARACTERISTICS

This section provides product information and illustrations showing physical dimensions, weight, mounting holes and cable access.

5.1 HIGH VOLTAGE CABLES

COMPONENT	STANDARD LENGTH	OPTIONAL LENGTH	OPTIONAL LENGTH
High Voltage Cables	9 m (29.5 ft)	12 m (39.4 ft)	16 m (52.4 ft)

5.2 PHYSICAL CHARACTERISTICS

(Refer to Illustration 5-1)

COMPONENT	DIMENSIONS			WEIGHT
	Length	Width	Height	

LINE POWERED GENERATORS

Compact Generator Cabinet (for only 1 Tube LSS)	445 mm (17.5”)	360 mm (14.2”)	568 mm (22.4”)	72 kg (159 lb)
Compact Generator Cabinet (for 1 or 2 Tubes LSS / HSS)	592 mm (23.3”)	360 mm (14.2”)	690 mm (27.2”)	95 kg (209 lb)

CAPACITOR ASSISTED GENERATORS

Compact Generator Cabinet with Capacitor Module (for only 1 Tube LSS)	500 mm (19.7”)	360 mm (14.2”)	790 mm (31.1”)	108 kg (238 lb)

BATTERY POWERED GENERATORS

Compact Generator Cabinet with Battery Module	813 mm (32”)	436 mm (17.2”)	948 mm (37.3”)	235 kg (518 lb)

COMPONENT	DIMENSIONS			WEIGHT
	Length	Width	Height	

STANDARD CONTROL CONSOLES

RAD Console Graphic Display	430 mm (16.9”)	290 mm (11.4”)	50 mm (1.9”)	6 kg (13.2 lb)
Optional Pedestal for RAD Console Graphic Display	298 mm (11.7”)	236 mm (9.3”)	930 mm (36.6”)	10 kg (22 lb)
Note.– Dimensions for no-standard Consoles are not indicated in this document.				

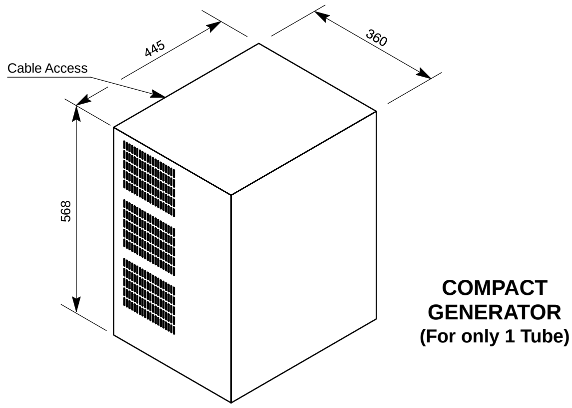
CTSC TOUCH SCREEN CONSOLE

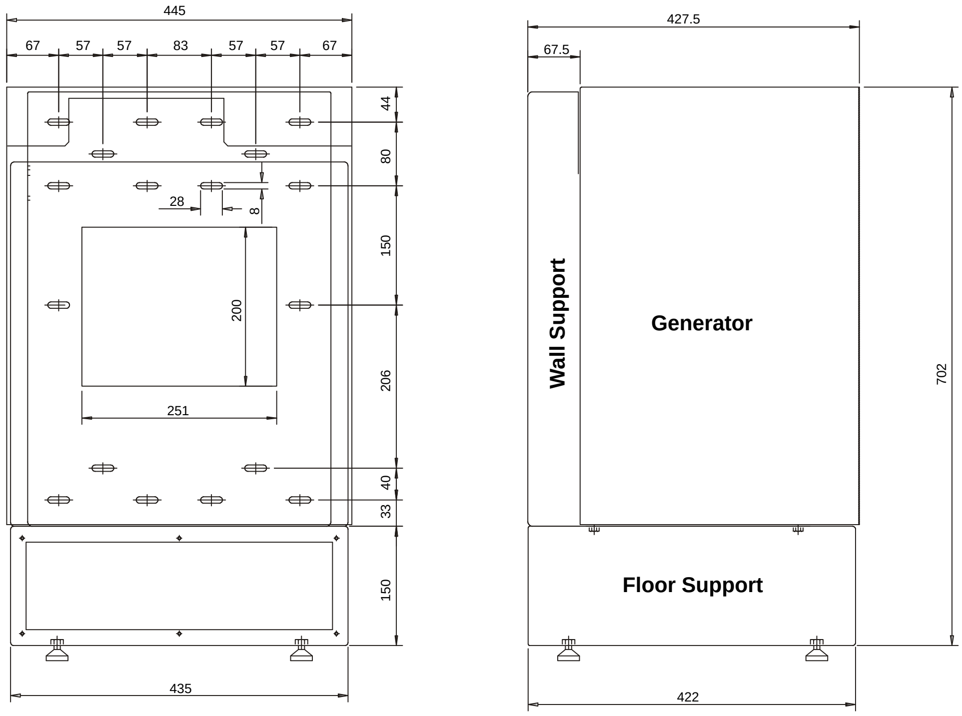
CTSC	323 mm (12.7”)	196 mm (7.7“)	500 mm (19.7”)	8.6 kg (19 lb)

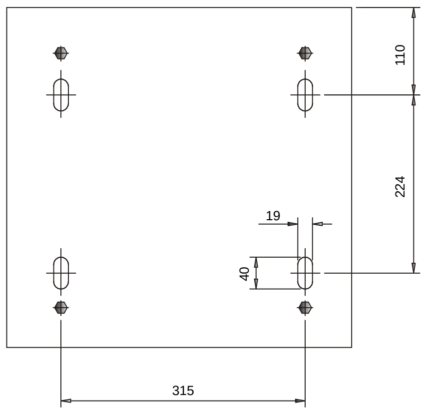
PC INTERFACE BOX

PC Interface Box	131 mm (5.2”)	165 mm (6.5”)	32 mm (1.3”)	0.5 kg (1.1 lb)

Illustration 5-1
Generators

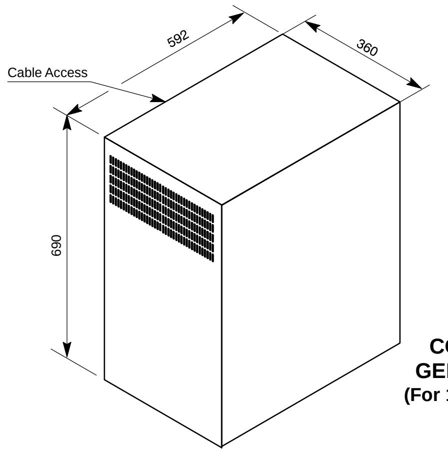




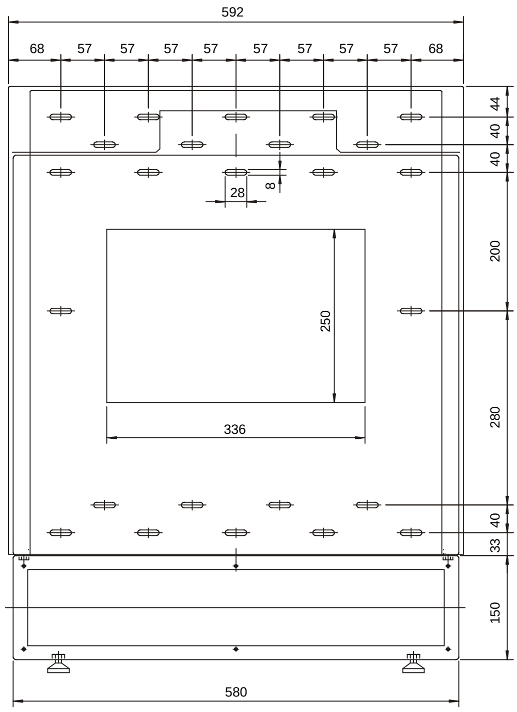


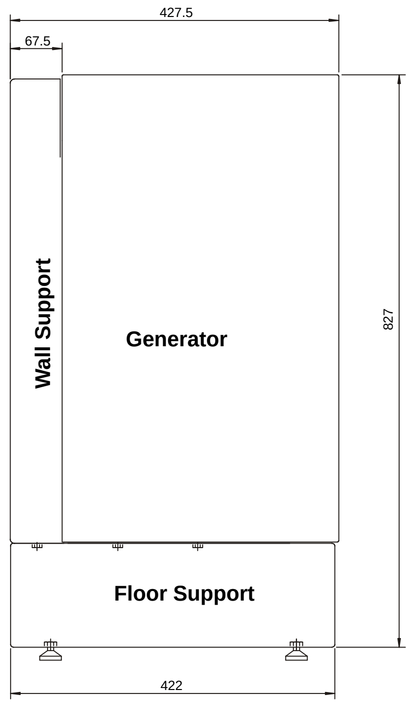
Wall and Floor Supports are options

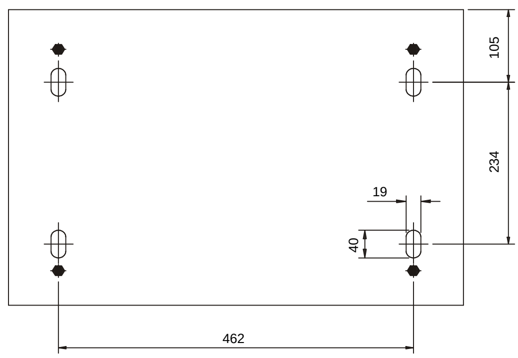
Illustration 5-1 (cont.)
Generators



COMPACT GENERATOR
(For 1 or 2 Tubes)

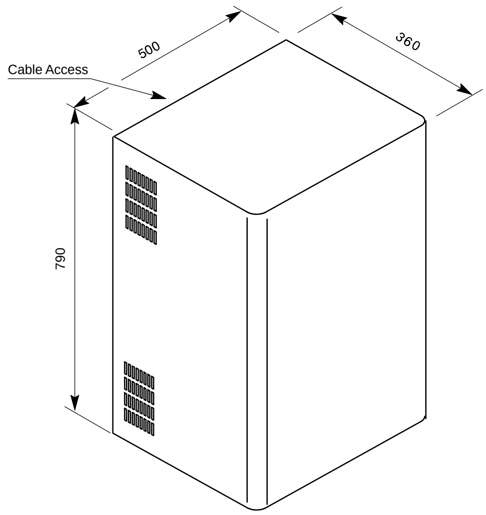






Wall and Floor Supports are options

Illustration 5-1 (cont.)
Generators



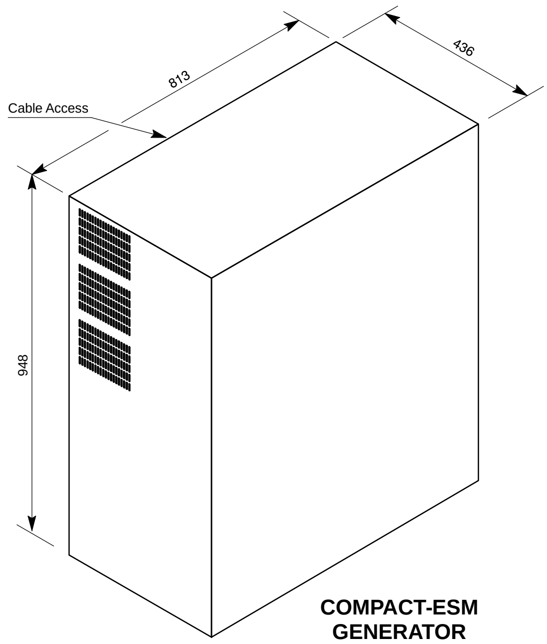
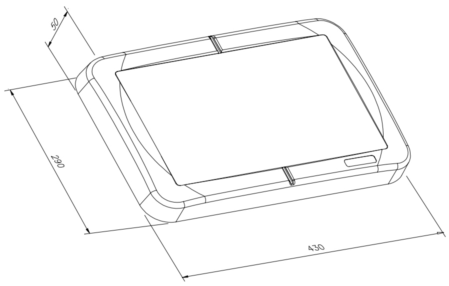


Illustration 5-1 (cont.)
Consoles



RAD CONSOLE – GRAPHIC DISPLAY

THIS CONSOLE CAN BE MOUNTED ON
A TABLE SUPPORT, WALL SUPPORT OR PEDESTAL

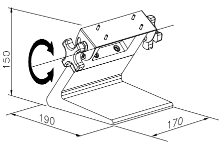
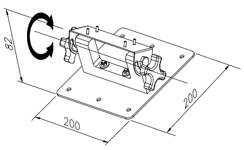
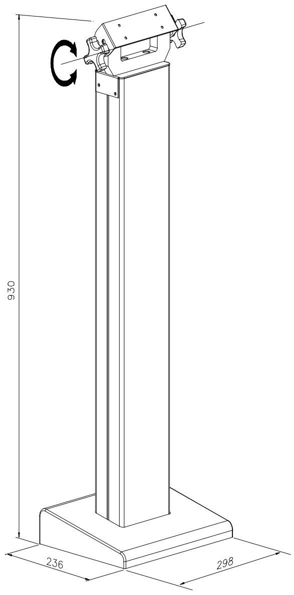


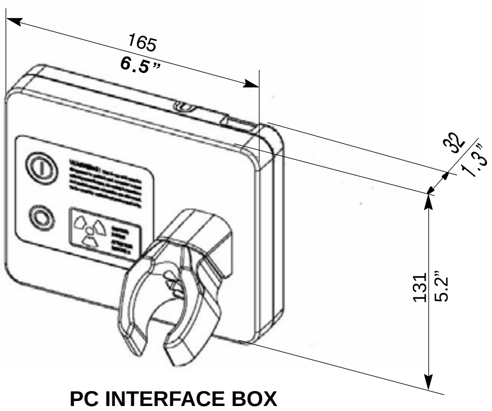
TABLE SUPPORT



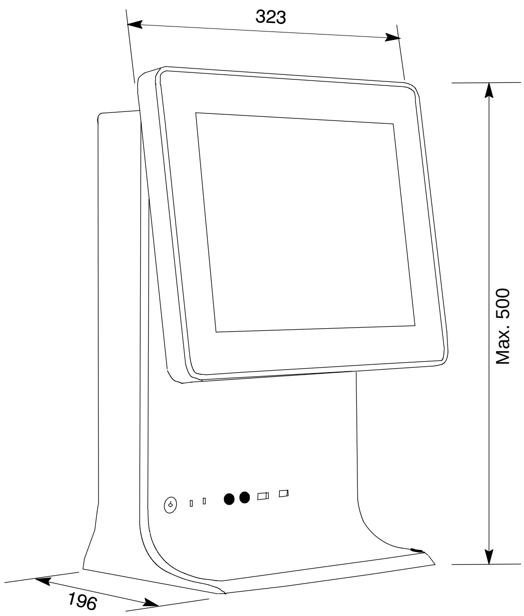
WALL SUPPORT



PEDESTAL



PC INTERFACE BOX



CTSC TOUCH SCREEN CONSOLE

SECTION 6 PLANNING AIDS

6.1 SHIPPING DIMENSIONS AND WEIGHTS

COMPONENT CRATED	DIMENSIONS			WEIGHT
	Length	Width	Height	
Line Powered Generator (for only 1 Tube (LSS)) with Control Console and Cables	107 cm (42.1”)	62 cm (24.4”)	74 cm (29.1”)	140 kg (308 lb)
Line Powered Generator (for 1 or 2 Tubes (LSS or HSS)) with Control Console and Cables	115 cm (45.3”)	82 cm (32.3”)	74 cm (29.1”)	170 kg (374 lb)
Capacitor Assisted Generator with Control Console and Cables	118 cm (46.5”)	57 cm (22.4”)	114 cm (44.9”)	204 kg (449 lb)
Battery Powered Generator with Control Console and Cables	118 cm (46.5”)	57 cm (22.4”)	114 cm (44.9”)	280 kg (617 lb)

6.2 TOOLS AND EQUIPMENT CHECKLIST

TOOLS AND EQUIPMENT CHECKLIST *The following tools and materials are needed for installation but are not shipped with the product.*	**COMPLETED**
Standard service engineer’s tool kit.	
Electric and hammer drill. Assorted masonry and high-speed bits in both metric and SAE sizes	
Assorted sizes of tongue and grove pliers, hammers, hex wrenches (metric and SAE), screw drivers, and metal files	
Wall and Floor anchoring hardware	
Assorted hardware for termination of electrical connections	
Assorted sizes of wire cutters and strippers, ratchet and standard crimpers, and a 75–watt soldering iron	
Tie wraps, heat and electrical tape, and wire markers	
Tags for labeling incomplete work according to regulatory requirements	
Movers, dollies, ladders, shop vacuum, and push-broom	

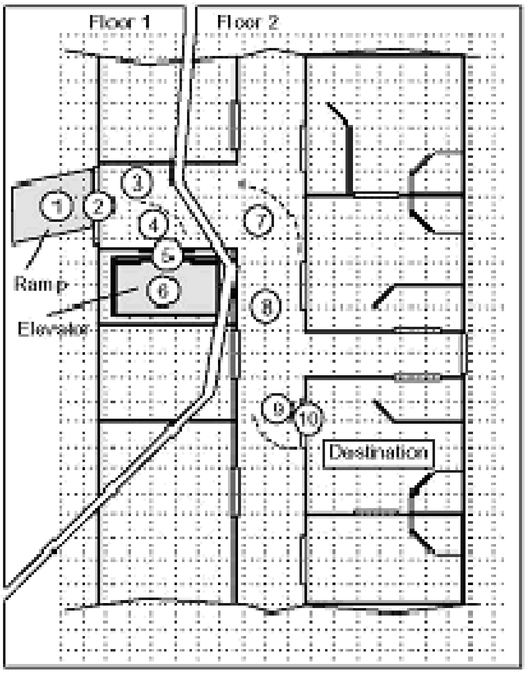
6.3 PREPARING THE DELIVERY ROUTE

Note ☞ *Refer to Section 2.2.1, “Door Size Requirements,” for more information about the crated / uncrated dimensions and weights of the Components.*

1. **Sketch out the Route.**

   Begin preparing a Route Survey by sketching the area of the hospital or clinic which will receive the equipment. Include all areas on the delivery route from outside of the building to destination. See the sample sketch below.

Illustration 6-1
Sample Route



Reference Numbers:
Numbers in circles refer to the Route Survey data.
The Route Survey is a form on which site data is listed (step 2).

2. **Survey the Route.**

   Record all loading capacities, corridor widths, door openings, turning radius, flooring materials, elevator sizes, obstructions, and so on for reference.

3. **Check the Route.**

   Verify that the equipment can actually be transported via the route determined in step 1.

6.4 PRE-INSTALLATION CHECKLIST

Delivery Date:	
Sales Person:	
Customer:	
FDO No.:	
Room #	
Equipment:	

PHYSICAL REQUIREMENTS OF SITE	**COMPLETED**
1. Room size adequate for intended equipment configuration?	
2. Floor and walls are strong enough for intended equipment and mounting methods approved – seismic regulatory codes considered?	
3. Delivery route accommodates all intended equipment?	
4. Radiation physicist consulted?	
5. Necessary alterations made to circumvent obstructions?	
6. Modifications to room finished?	
7. Supports, platforms, wall materials have been provided?	
8. Support structures installed for floor, ceiling, and wall mounted equipment?	
9. Wall – ceiling supports leveled?	
10. Has floor been modified for cable ducts?	
11. Electrical service in place – at the ratings specified in Pre-Installation documentation?	
12. Power available to operate power tools?	
13. All non-electrical lines (air, water, oxygen, vacuum) installed?	

INTERCONNECTIONS	**COMPLETED**
1. Signal cable, power, and grounding plans produced?	
2. Necessary interconnection hardware, such as junction boxes, conduit or raceways, and fittings, provided?	
3. Interconnection hardware installed?	
4. System “feeder” power cables pulled and sufficient length available at disconnect box for connections?	
5. Interconnecting cables continuity checked, and labeled?	
6. All high voltage cable lengths verified?	
7. Interface information available for equipment?	

GENERAL		COMPLETED
1.	Walls and floor clear of all obstructions?	
2.	Walls finished?	
3.	Finished floor installed?	
4.	Room lights installed?	
5.	Dust-creating work completed?	
6.	Old equipment within room removed?	
7.	Component positions clearly marked on floor?	
8.	Space available to store equipment?	
9.	Lock on door, or locked room available?	
10.	Voice phone line connection provided?	
11.	Have all fire/safety inspections for occupancy been completed?	

COMMENTS

INSPECTION DATE(S)

INSTALLATION PROJECT MANAGER SIGNATURE

Technical Publication
IN-1005R16

Installation

HF Series Generators

REVISION HISTORY

REVISION	DATE	REASON FOR CHANGE
9	SEP 13, 2012	IEC Standards update
10	JUL 15, 2013	New Contactors and Terminal Strip 5TS1
11	JUN 30, 2016	New CTSC Touch Screen Console
12	SEP 27, 2016	Installation of Metallic Plates in Line Powered Generators and schematic 54303129 for Rad Console.
13	NOV 03, 2017	Tools for AEC Calibration.
14	MAR 20, 2018	Update of schematic A3514-04.
15	JUL 02, 2019	Cover of Line Powered Generators divided in two parts.
16	DEC 12, 2019	New PC Interface Box

This Document is the english original version, edited and supplied by the manufacturer.

The Revision state of this Document is indicated in the code number shown at the bottom of this page.

ADVISORY SYMBOLS

The following advisory symbols will be used throughout this manual. Their application and meaning are described below.

DANGERS ADVISE OF CONDITIONS OR SITUATIONS THAT IF NOT HEEDED OR AVOIDED WILL CAUSE SERIOUS PERSONAL INJURY OR DEATH.

ADVISE OF CONDITIONS OR SITUATIONS THAT IF NOT HEEDED OR AVOIDED COULD CAUSE SERIOUS PERSONAL INJURY, OR CATASTROPHIC DAMAGE OF EQUIPMENT OR DATA.

Advise of conditions or situations that if not heeded or avoided could cause personal injury or damage to equipment or data.

Note ☞

Alert readers to pertinent facts and conditions. Notes represent information that is important to know but which do not necessarily relate to possible injury or damage to equipment.

TABLE OF CONTENTS

Section **Page**

SECTION 1 INTRODUCTION

The Installation process depends on the Generator and System configuration. Installation must be performed in the order indicated along this document. Perform only the sections required to install this Generator.

1.1 TOOLS AND TEST EQUIPMENT

The following hand tools and products are required for the Installation:

- Standard service engineers tool kit including Allen and Torx key sets.
- Electric drill motor and assorted bits.
- Silicone Insulating Grease (proofing compound).
- Alcohol cleaning agent.

The following test equipment is required for Configuration and Calibration:

- Digital Multimeter.
- Non-invasive kVp Meter.
- Digital mAs Meter.
- Calculator.

- Only for AEC purposes:
  - Sensitometer.
  - Densitometer.
  - Homogeneous Phantom of Aluminium with a purity of not less that 99% and thickness of 21 mm for the Collimator Filter Holder (recommended for AEC calibration).
  - Homogeneous Phantom of PMMA (Polymethylmethacrylate) with a surface of 43 x 43 cm and 15 cm thickness or 3 units of 5 cm thickness.

- Only for Tomo purposes:
  - Tomophantom tool.

- Only for Fluoro purposes:
  - Dosimeter, with R/min and mR/min meters and/or mGy/min and μGy/min meters.
  - Imaging Test Phantom tool.
  - Copper Plates for the Collimator Filter Holder (recommended for ABC calibration):
    2 units of 1 mm thickness,
    1 unit of 0.5 mm thickness,
    2 units of 0.2 mm thickness,
    1 unit of 0.1 mm thickness.

1.2 PRE-INSTALLATION CHECK

Prior to beginning installation, it is recommended to inspect the site and verify that the X-ray room complies with Pre-installation requirements, such as:

- Incoming Line.
- Main Switch and Safety Devices.
- Conduits.
- Space Requirements.

(*Refer to the "Pre-Installation" document.*)

1.3 GENERAL CAUTIONS

OPERATOR AND SERVICE MANUALS SHOULD BE CAREFULLY READ AND UNDERSTOOD BY SERVICE PERSONNEL BEFORE USING AND SERVICING THE EQUIPMENT, ESPECIALLY THE INSTRUCTIONS CONCERNING SAFETY, REGULATORY, DOSAGE AND RADIATION PROTECTION. KEEP THE MANUALS WITH THE EQUIPMENT AT ALL TIMES AND PERIODICALLY REVIEW THE OPERATING AND SAFETY INSTRUCTIONS.

MAKE SURE THAT THE MAIN STORAGE CAPACITORS OF THE HIGH VOLTAGE INVERTER DO NOT CONTAIN ANY RESIDUAL CHARGE. WAIT UNTIL THE LIGHT EMITTING DIODES ON THE CHARGE-DISCHARGE MONITOR BOARDS ARE OFF, APPROXIMATELY 3 MINUTES AFTER THE UNIT IS TURNED OFF.

<u>ALWAYS</u> HAVE THE "IPM DRIVER BOARD" CONNECTED IN THE GENERATOR PREVIOUS TO MAINS POWER IS ACTIVATED IN IT. IF THE "IPM DRIVER BOARD" IS NOT CONNECTED, PERMANENT DAMAGE WILL OCCUR TO IGBTS.

TO AVOID THE RISK OF ELECTRIC SHOCK, THIS EQUIPMENT MUST ONLY BE CONNECTED TO A SUPPLY MAINS WITH PROTECTIVE EARTH. DO NOT TOUCH ANY HEATSINK OF THE CIRCUIT BOARDS EVEN THE GENERATOR IS TURNED OFF. PREVIOUS TO DISASSEMBLE ANY BOARD, REMOVE ALL CONNECTORS PLUGGED TO IT.

<u>LINE POWERED GENERATOR</u>:
THIS GENERATOR IS PERMANENTLY CONNECTED TO THE POWER LINE, AND POWERED ON UNLESS THE SAFETY SWITCH INSTALLED IN THE ROOM ELECTRICAL CABINET IS OFF. WHEN THE GENERATOR IS POWERED, THE NEON LAMP (GREEN) LOCATED ON THE TRANSFORMER 6T2 (GENERATOR CABINET) IS ON.

INTERNAL PARTS OF THE GENERATOR (ALL FUSES, LINE CONTACTOR (6K5), INPUT TRANSFORMER (6T2), ON/OFF RELAY (3K3) AND LF-RAC MODULE) ARE PERMANENTLY POWERED ON THROUGH POWER LINE ALTHOUGH THE CONTROL CONSOLE IS OFF. BE SURE THAT THE SAFETY SWITCH IS OFF BEFORE HANDLING ANY INTERNAL PART OF THE EQUIPMENT.

<u>BATTERY POWERED GENERATOR</u>:
THIS GENERATOR IS PERMANENTLY CONNECTED TO THE POWER LINE THROUGH A LINE PLUG.

WHEN IT DOES NOT WORK WITH STAND-ALONE, IT IS POWERED ON UNLESS THE SAFETY SWITCH INSTALLED IN THE ROOM ELECTRICAL CABINET IS OFF. WHEN THE UNIT IS POWERED, THE NEON LAMP (GREEN) LOCATED ON THE TRANSFORMER 6T2 IS ON.

WHEN IT WORKS WITH OPTIONAL STAND-ALONE IT IS POWERED ON IN ALL SITUATIONS. WHEN THE UNIT IS TURNED ON, THE NEON LAMP (GREEN) LOCATED ON THE TRANSFORMER 6T2 IS ON.

KEEP THE PROTECTION COVERS IN PLACE ALL THE TIME, ONLY REMOVE THE COVERS TO PERFORM SERVICE OPERATIONS. INTERNAL PARTS (CONTACTOR 6K5, LINE FUSES, BATTERY CHARGER BOARD, LINE MONITOR BOARD, BATTERY MONITOR BOARD, ENERGY GUARD BOARD AND STAND-ALONE BOARD) ARE PERMANENTLY POWERED ON AND HAVE THE FULL VOLTAGE POTENTIAL OF THE BATTERIES (APPROX. 400 VDC) ALTHOUGH THE UNIT IS DISCONNECTED FROM THE LINE OR THE CONTROL CONSOLE IS OFF. USE CAUTION WHEN WORKING IN THIS AREA.

SECTION 2 UNPACKING, CABINET INSTALLATION AND POWER LINE CONNECTION

The Generator is shipped in one box to facilitate transport and installation.

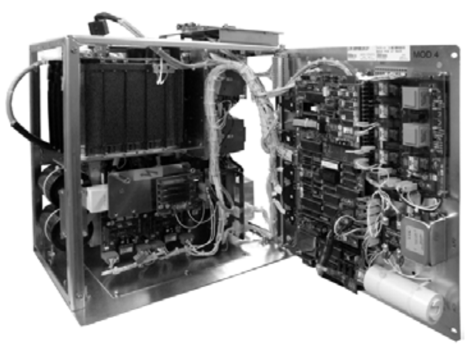
Upon receipt of the X-ray unit and associated equipment, inspect all shipping containers for signs of damage. If damage is found, immediately notify the carrier or their respective agent.

2.1 COMPACT GENERATORS – LINE POWERED

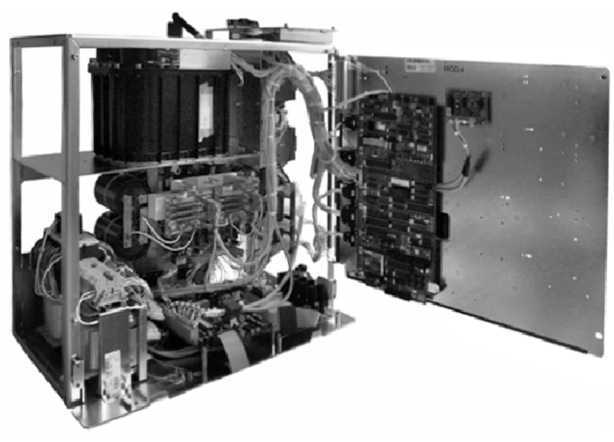
1. Open the shipping box. Take out the Control Console, Interconnection Cables, Cabinet Cover and other furnished parts. Do not discard any packing material such as envelopes, boxes or bags until all parts are accounted for as listed on the packing list.
2. Remove the packing material from the pallet.
3. Remove the Generator Covers and then remove the Generator Cabinet from the shipping pallet, placing it near its chosen room position. This operation requires at least two people.
4. When the equipment is unpacked, verify that all items on the customer order are present, and the hardware and internal wiring is secure.
5. Check the part numbers / serial numbers of each component with its identification labels, and inspect all pieces for visible damage. If any damaged parts are found, repair or order replacements to prevent unnecessary delay in installation.

Illustration 2-1
Compact Generators (two versions)

COMPACT GENERATOR FOR ONLY ONE LS TUBE (MINI)



COMPACT GENERATOR FOR ONE OR TWO LS/HS TUBES



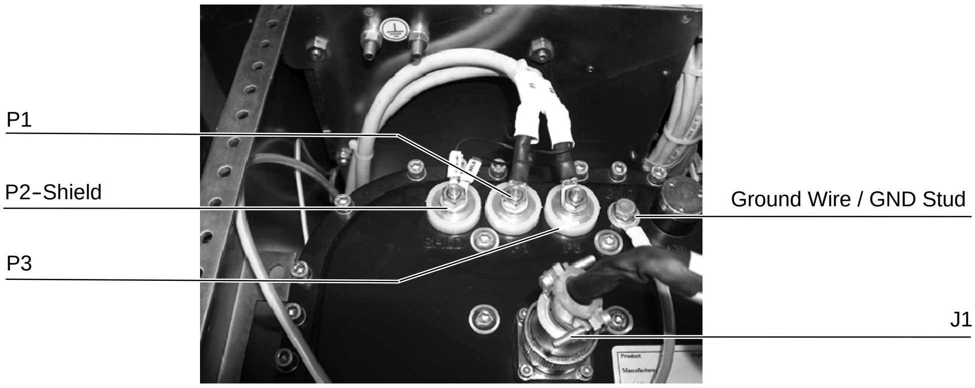
6. In some cases, due to transport safety requirements, the HV Transformer is shipped out of the Generator Cabinet. Install the HV Transformer inside the Cabinet (upper area) and secure it with the respective anchors or plates, then connect the following cables from the Power Module to the corresponding terminals on the HV Transformer:

   - P2-Shield (2 thin wires), P1 and P3. Connect these cables to the stud-brass terminals using two wrenches to tighten the nuts (one to hold the base nut in place and the other to tighten the nut over the cable) and avoiding twisting the studs. Ensure that the connection is secure and properly tightened.
   - Ground wire to Ground stud.
   - Connector J1.

WARNING

THE HV TRANSFORMER HAS TO BE SECURED WITH ITS ANCHORS OR PLATES INSIDE THE CABINET. OTHERWISE P1, P2 AND P3 STUDS MAY BE IN CONTACT WITH THE CABINET FRAME AND PRODUCE A SHORT-CIRCUIT.

Illustration 2-2
Cable Connections to the HV Transformer



7. The Line Powered Generator Cabinet can be installed in one of the following ways:

   - **Using the optional Wall Support only** (*for installation refer to step-8.*)
   - **Using the optional Wall Support and Base Support** (*for installation refer to steps-9.)*
   - **Freestanding** without supports (*for installation refer to steps-12.)*

Note ☞ *Optional Supports must be requested in the customer order.*

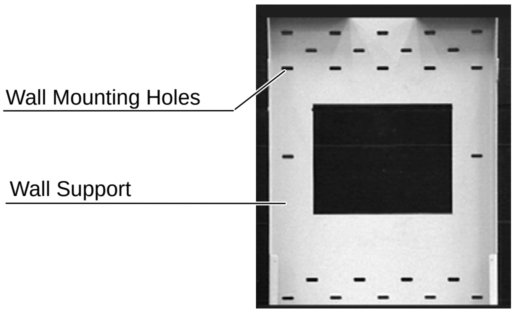
8. **Installation of the Generator Cabinet using a Wall Support Only.**

An optional Wall Support can be provided to hang the Cabinet. The Wall Support must be securely installed on a resistant wall that can hold both the Generator and Cables (keep in mind their weights). (*Refer to the "Pre-Installation" document for more information.*)

a. Place the Wall Support against the wall and level it.

b. Mark the anchoring holes on the wall. Make sure that there is a sufficient number of anchoring points in order to firmly secure the Generator Cabinet to the wall (minimum 4 / 6 anchoring points).

Illustration 2-3
Installation of the Wall Support (optional)

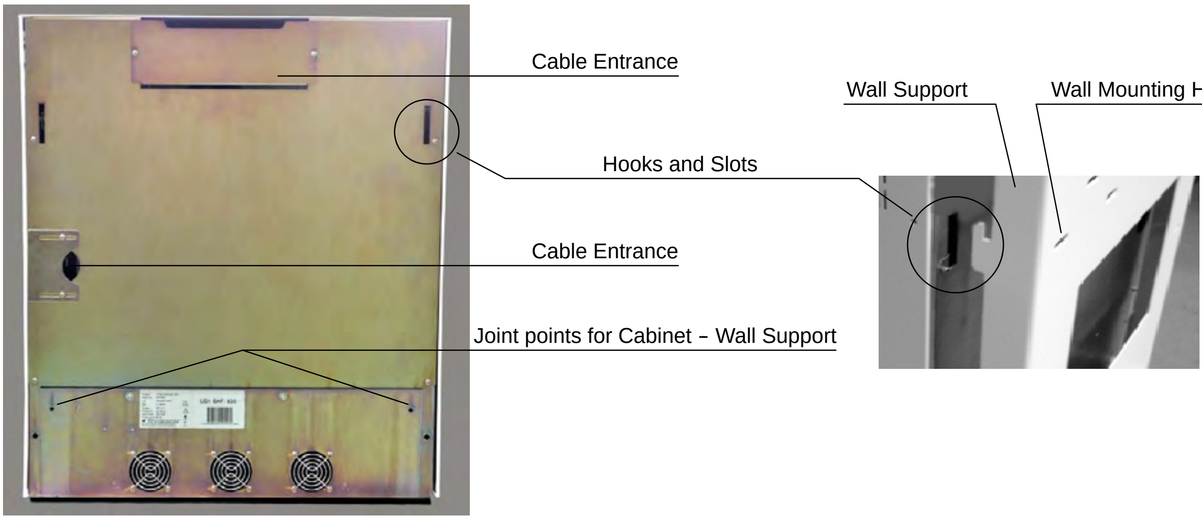


c. Secure the Support firmly to the wall.

d. Hang the Generator, at least two people are required.

e. Fix the two screws that join the rear side of the Cabinet to the Wall Support. Go to step-13.

Illustration 2-4
Installation of the Generator in the Wall Support (optional)

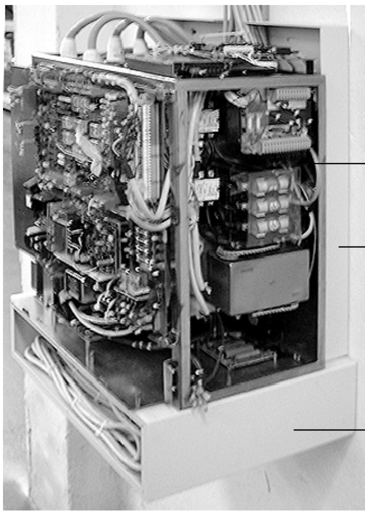


9. **Installation of the Generator Cabinet using a Wall Support and a Base Support.**

   The Generator Cabinet can be assembled over a metallic Base Support (Cable Box) and a Wall Support at the rear side. The final assembly (Generator + Supports) can be hung on the wall (*refer to step 10.*) or left freestanding (*refer to step 11.*).

   (*Refer to the "Pre-Installation" document for more information.*)

Illustration 2-5
Compact Generator with optional Supports

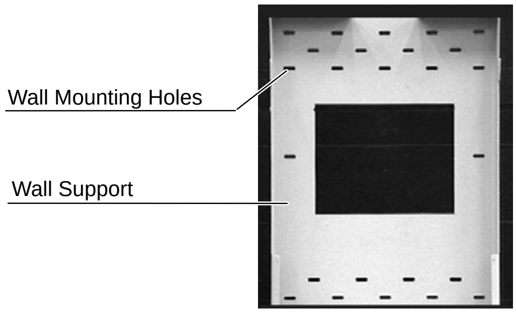


10. *<u>When hanging the Generator on the wall</u>*, the Wall Support must be securely installed on a resistant wall that can hold the Generator with the Supports and Cables (keep in mind their weights). (*Refer to the "Pre-Installation" document for more information.*)

    a. Place the Wall Support against the wall and level it.

    b. Mark the anchoring holes on the wall. Make sure that there is a sufficient number of anchoring points in order to firmly secure the Generator Cabinet to the wall (minimum 4 / 6 anchoring points).

Illustration 2-6
Installation of the Wall Support (optional)

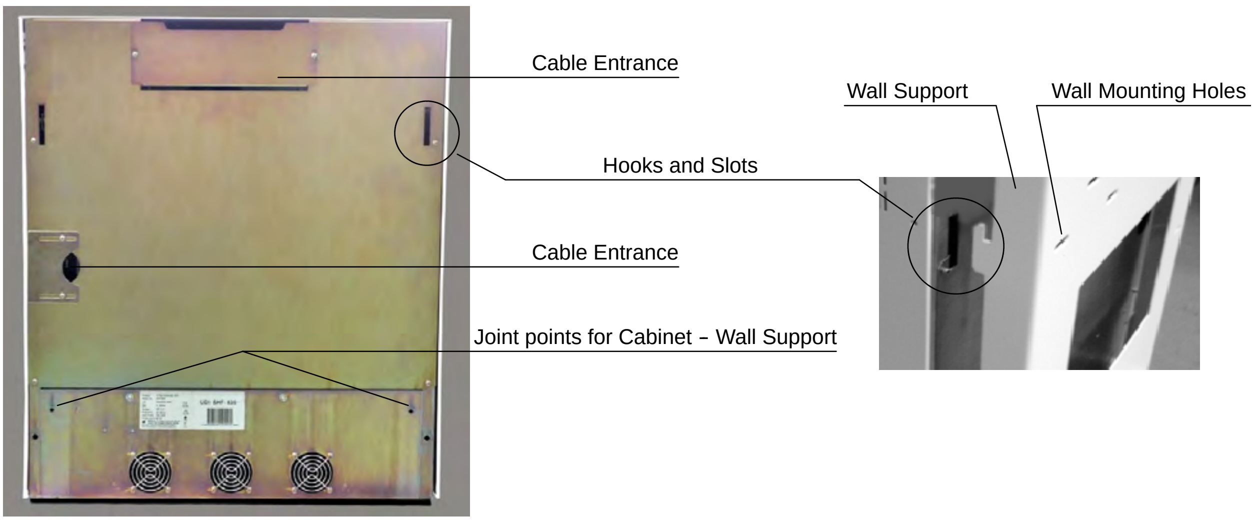


    c. Secure firmly the Support to the wall.

    d. Hang the Generator, at least two people are required.

    e. Fix the two screws that join the rear side of the Cabinet to the Wall Support.

Illustration 2-7
Installation of the Generator in the Wall Support (optional)

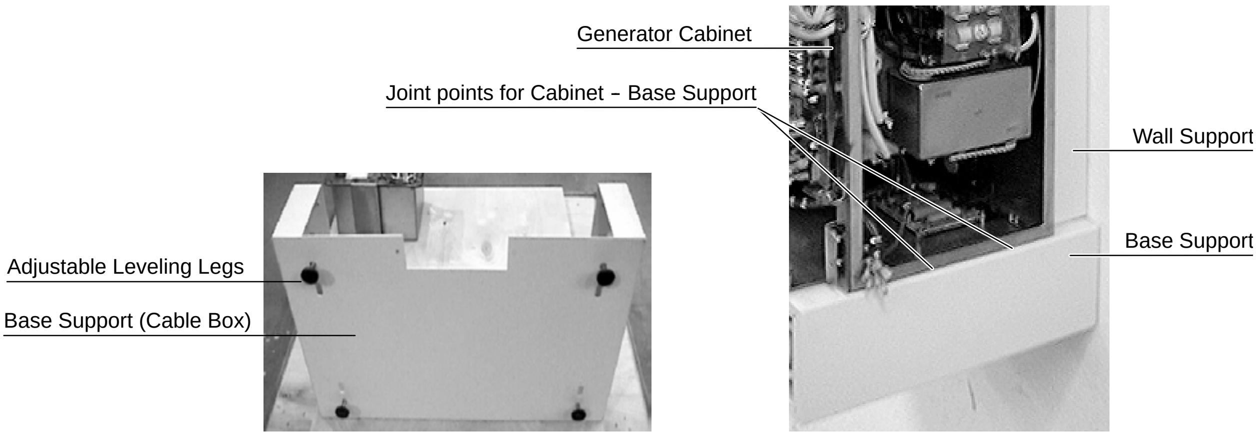


f. Remove the four Adjustable Leveling Legs from the base of the Generator Cabinet and re-install them in the Base Support.

g. Assemble the Base Support under the Generator Cabinet and secure it using four M6x20 screws (supplied). At least two people are required for this operation.

h. Go to step-13.

Illustration 2-8
Installation of the Base Support (optional)



11. *<u>When the Generator is freestanding</u>*, perform the following steps:

a. Remove the four Adjustable Leveling Legs from the Base of the Generator Cabinet and re-install them in the Base Support.

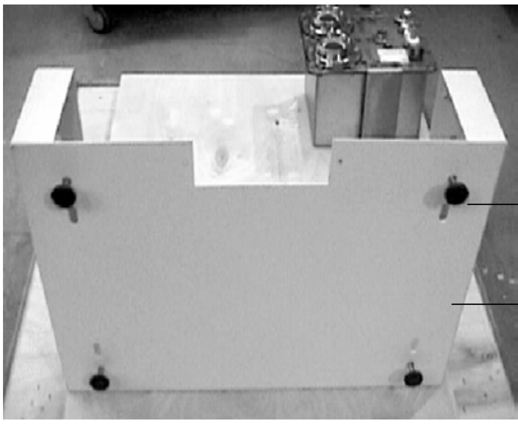
b. Place the Base Support near its chosen place in the room. Level the Base using the Adjustable Leveling Legs. Keep the Base at the maximum distance from the floor.

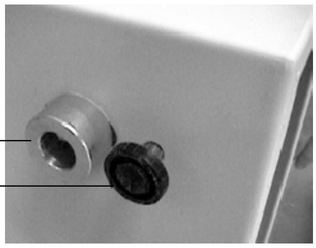
Seismic areas and other conditions require the Generator to be secured to the floor. There are mounting holes on the bottom of the Base Support. Place the four spacers (provided) under the Base and secure them to the floor. Keep the four Leveling Legs at the same height as the spacers (*refer to Illustration 2-9*).

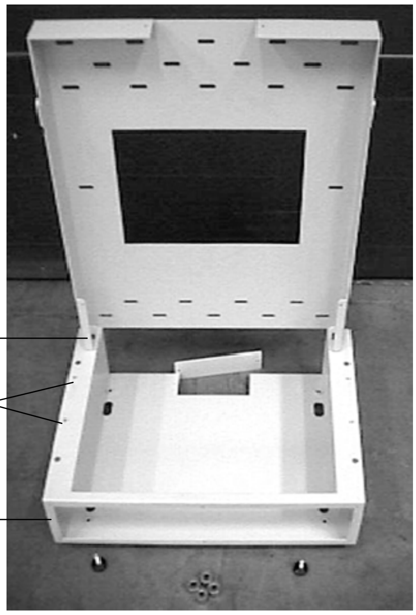
c. Assemble the Wall Support to the Base Support using two M6x20 screws (supplied). Place the Generator Cabinet over the Base Support and secure it using four M6x20 screws (supplied). At least two people are required for this operation.(*refer to Illustration 2-9*).

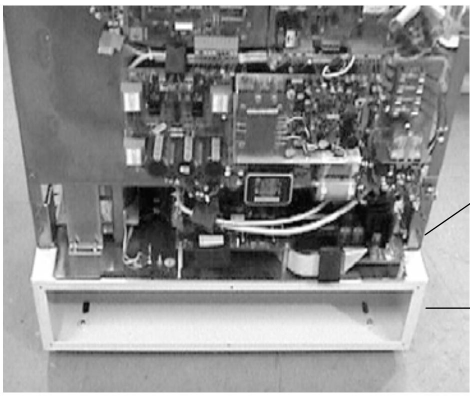
d. Go to step-13.

Illustration 2-9
Installation of the Generator over the Base Support (optional)







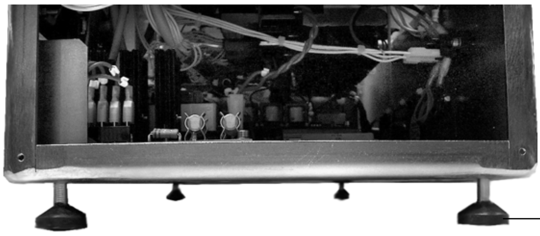


12. **Installation of the Generator Cabinet Freestanding.**

Usually, the Generator Cabinet is freestanding. Place the Cabinet near its chosen place in the room. Level it using the Adjustable Leveling Legs at the bottom of the Cabinet. Keep the Base at the maximum distance from the floor.

Seismic areas and other conditions require the Generator to be secured to the floor. There are mounting holes on the bottom of the Cabinet. Keep the four Leveling Legs at the same height (*refer to Illustration 2-10*).

Illustration 2-10
Adjustable Leveling Legs

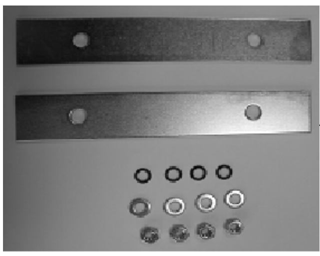


Adjustable Leveling Legs

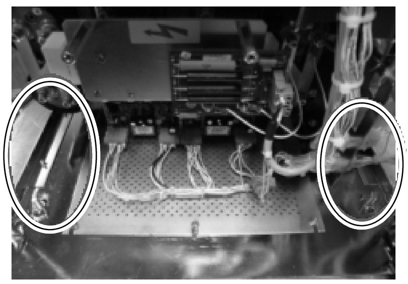
13. Leave a sufficient working area around the equipment that will permit unhindered movements until its final assembly.

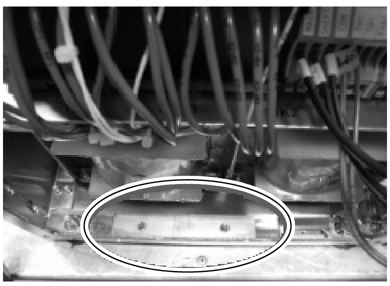
14. Two metallic plates, washers and nuts are supplied in a bag with the Generator for mounting them at both sides of the Generator frame in order to cover the shipping holes. Secure both plates using the bolts in the Generator frame.

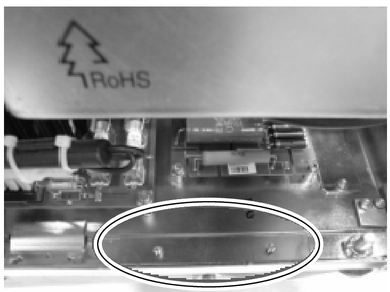
Illustration 2-11
Installation of Metallic Plates



Metallic Plates (2)







COMPACT GENERATOR FOR ONLY ONE LS TUBE (MINI)

COMPACT GENERATOR FOR ONE OR TWO LS/HS TUBES

POWER LINE CONNECTION

KEEP IN MIND THE GENERAL CAUTIONS FOR LINE POWERED GENERATORS INDICATED IN SECTION 1.3.

DO NOT POWER ON THE GENERATOR UNTIL SPECIFICALLY INSTRUCTED IN THIS SERVICE MANUAL.

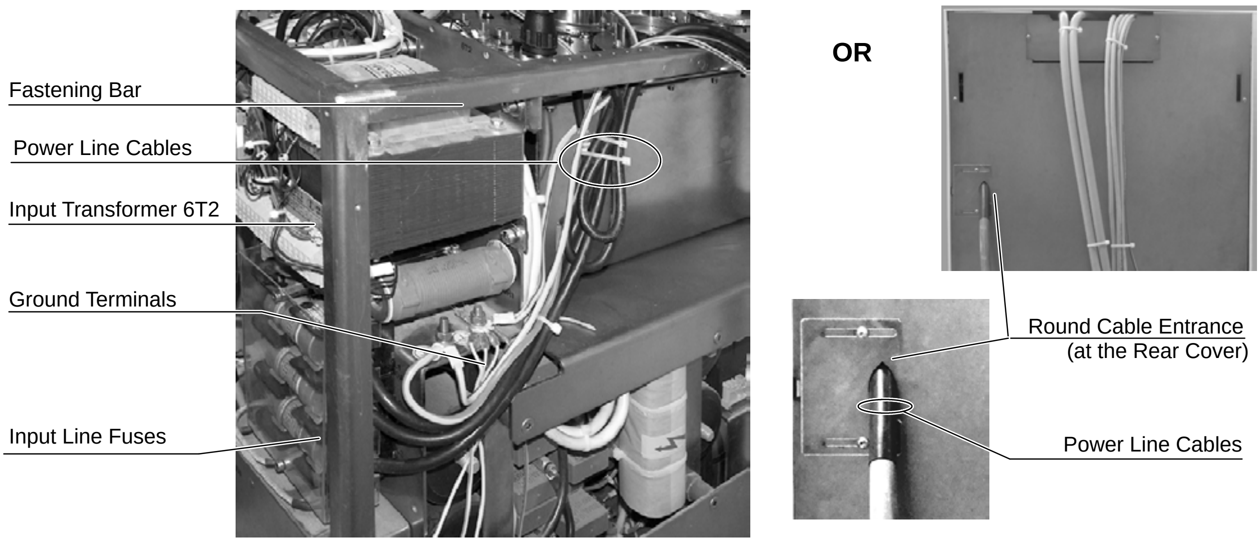
15. Verify that the power supply line is "*OFF*" in the Room Electrical Cabinet. Verify that the power line to the Generator is cut when the Emergency Switch(es) is(are) activated.

16. The power supply line should conform with the Generator model defined in the "*Pre-Installation*" document. Wire sizes indicated in this document are relative to the power supply line and wire length. Verify that the power line voltage and phase of the Generator coincides with the one for Room Electrical Cabinet.

17. Cut the cables to the appropriate length and remove insulation from both ends of the power and ground wires. Connect them to the respective terminals in the Room Electrical Cabinet.

18. Route the Power Line Cables to the Ground Terminal and Input Line Fuses. These cables can be secured to the Fastening Bar of the Cabinet and routed internally along the rear side of the Cabinet; or they can be routed through the Round Cable Outlet on the Rear Cover of the Cabinet (always apply Local Codes for cable routing). (*Refer to Illustration 2-12.*)

Illustration 2-12
Cable Routing in the Line Powered Generator



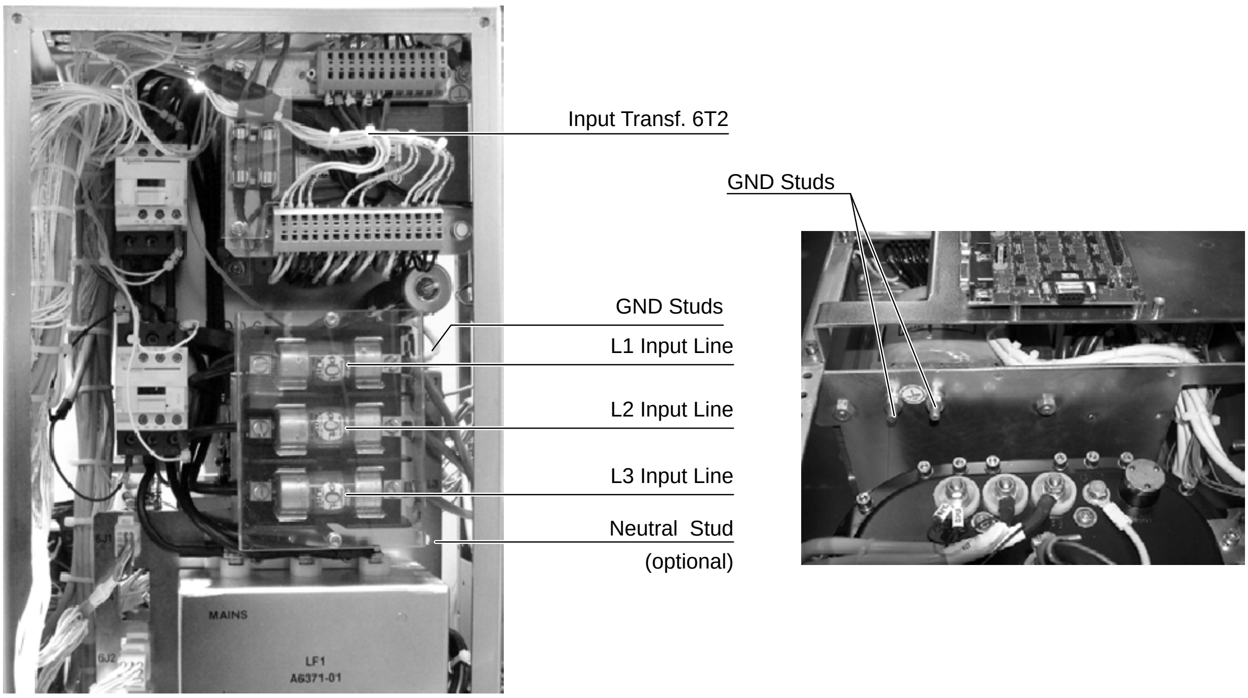
19. For Single Phase Generators, connect the Power wires L1 and N (L2) to the Fuse Holders of F3 and F4 (right side of the Cabinet), and the Ground wire to the Ground stud in the Cabinet Frame (above these fuses or close to the right side of the HV Transformer).

SINGLE PHASE GENERATORS ARE FACTORY DELIVERED TO OPERATE ON PHASE AND NEUTRAL. IN CASE OF CONNECTING THE EQUIPMENT TO A TWO-PHASE LINE, REPLACE THE NEUTRAL CARTRIDGE WITH THE FUSE SUPPLIED WITH THE GENERATOR.

20. For Three Phase Generators, connect the Power wires L1, L2 and L3 to the Fuse Holders of F3, F4 and F5 (right side of the Cabinet), and the Ground wire to the Ground Studs in the Cabinet Frame (located above these fuses or close to the right side of the HV Transformer).

    Three Phase Generators do not need Neutral (N) wire connection from the Line. If the unit is provided with the optional Fuse Module, connect the Neutral (N) wire from the Line to the Neutral Stud below F3 Fuse Holder.

Illustration 2-13
Power Line connections



For 80 kW / 1000 mA Generators, the power supply line must be 530 VAC. If the Generator is supplied with an external step-up autotransformer, it will include the cables to connect the autotransformer to the Generator Cabinet. Power line should be connected to the autotransformer terminals according to the line.

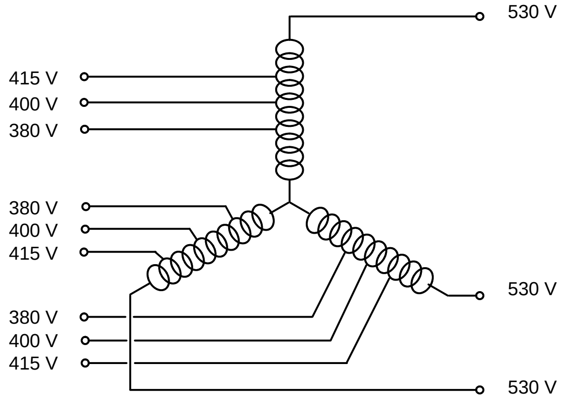
SEP-UP TRANSFORMER

Input: 380 VAC / 400 VAC / 415 VAC, Three-Phase.

Output: 530 VAC, Three-Phase.

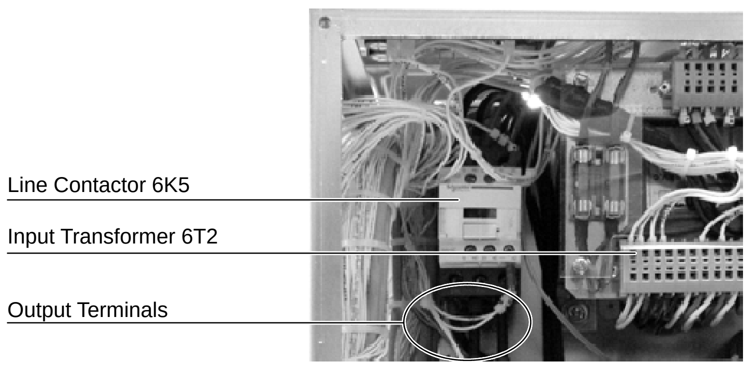
Max Power Output: 80 kW, 10% duty cicle
(approx. 5 seconds / minute)

Rising Temperature: 40ºC



21. The whole System (Tables, Wall Stand, etc.) can be switched ON/OFF when the Generator is switched ON/OFF. For this, power the System through the output terminals of the Line Contactor 6K5 (upper contactor close to the Input Transformer). These terminals are located underneath the Line Contactor 6K5.

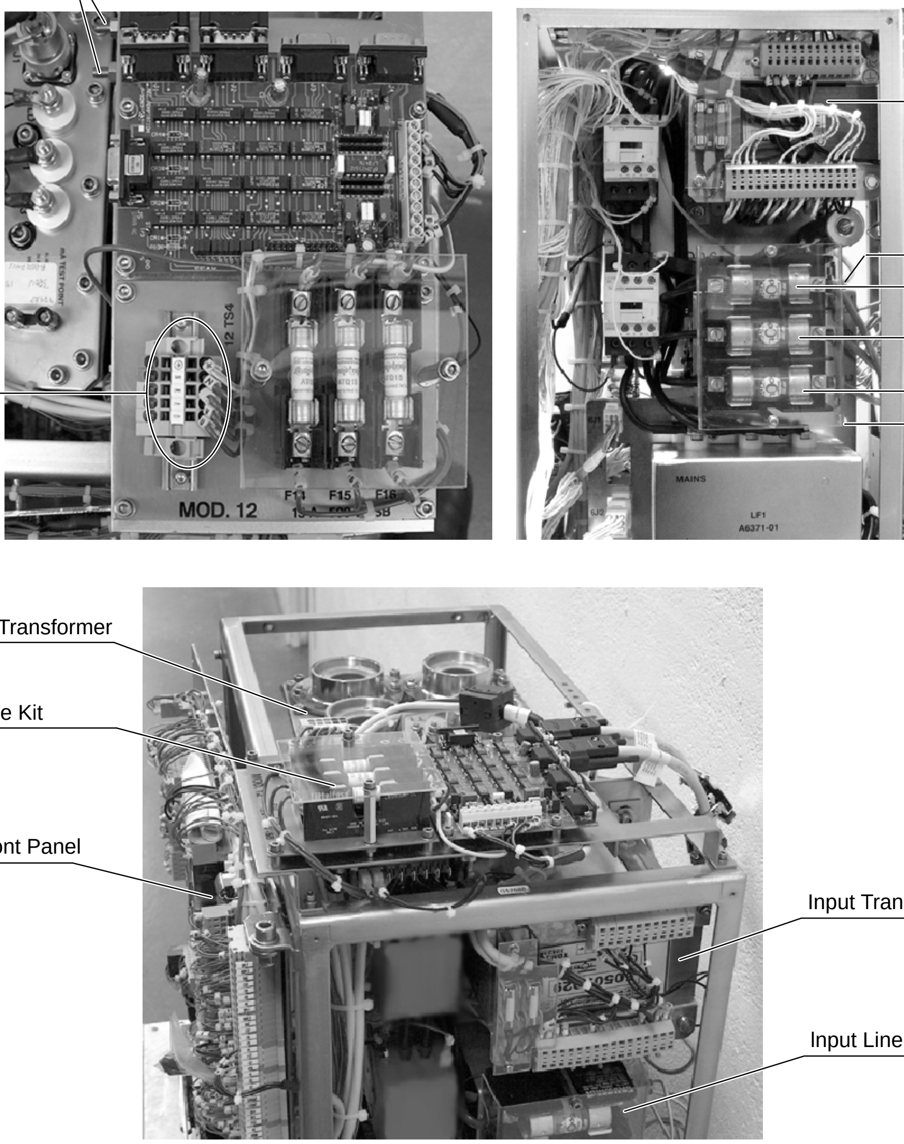
Illustration 2-14
Line Contactor 6K5



22. Three-Phase Generators can be provided with an optional Fuse Module mounted on Module-12, for switching ON/OFF the whole system when the Generator is turned ON/OFF.

    For this, connect the Neutral (N) wire from the Line to the Neutral Stud below F3 Fuse Holder. Power the System through the Output Terminals 12TS4 (U, V, W, N, GND) close to Fuses F14, F15, F16.

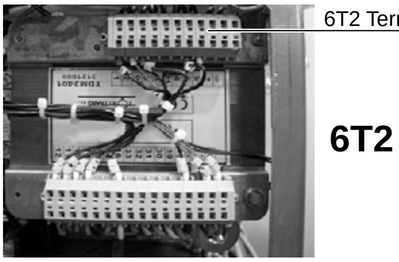
Illustration 2-15
Power Line connections in the optional Fuse Module



23. According to the **nominal voltage** of the line, verify or connect the wire "⁎" to the indicated terminal (TB) of Transformer 6T2. This wire is factory connected to 230 VAC (for 1-Phase), 400 VAC or 480 VAC (for 3-Phase) or 530 VAC (for 80 kW / 1000 mA 3-Phase Generators). (*Refer to Schematic 543020XX*).

Note ☞ *For 220 VAC power line, connect the wire "⁎" to the 230 VAC terminals. For 380 VAC power line, connect the wire "⁎" to the 400 VAC terminals.*

Illustration 2-16
Connections on Transformer 6T2



24. After connecting the Power Line Cables, secure them to the Fastening Bar using cable ties if they are routed over the Fastening Bar, or using a suitable clamp if they are routed through the Round Cable Outlet on the Rear Cover of the Cabinet (always apply Local Codes). (*Refer to Illustration 2-12.*)

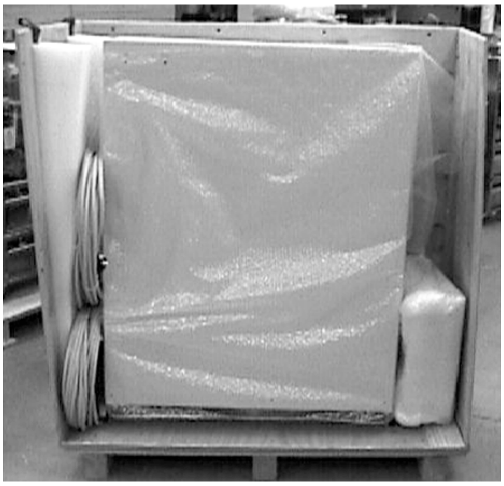
25. Install the Control Console as indicated in Section 2.4.

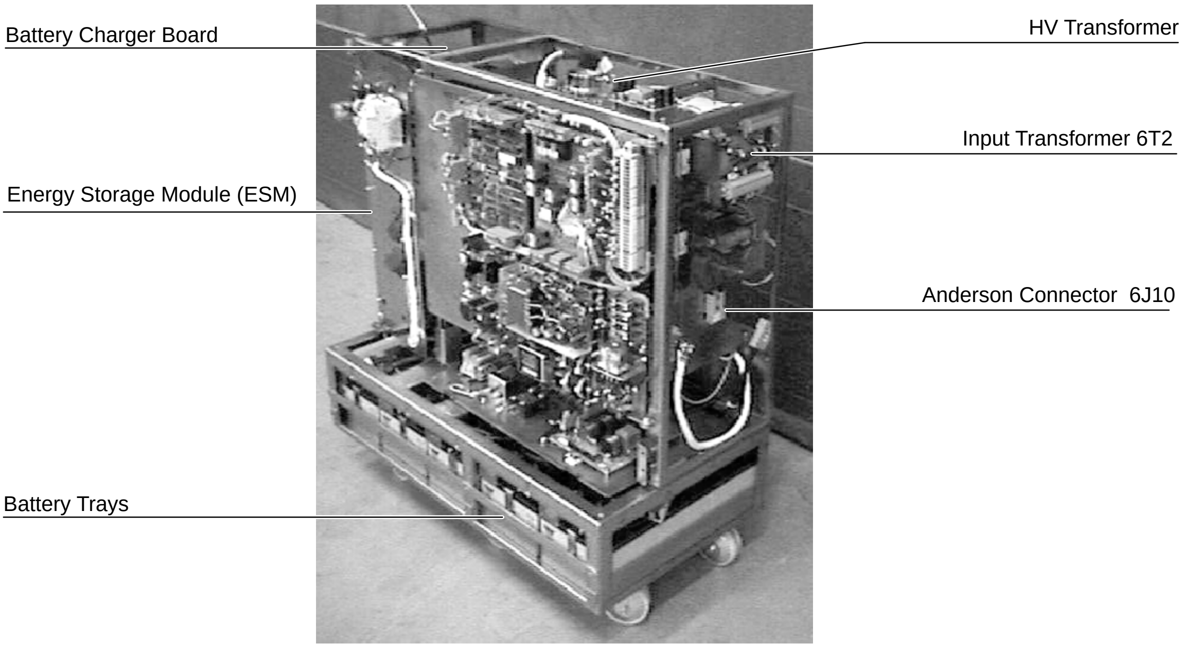
2.2 COMPACT-ESM GENERATORS – BATTERY POWERED

1. Open the shipping box, unpack the Control Console, Interconnection Cables, Cabinet Cover and other furnished parts. Do not discard any packing material such as envelopes, boxes, bags until all parts are accounted for as listed on the packing list.

2. Remove the packing material from the pallet. One of the laterals is adapted to be used as a ramp for unpacking the Generator.

Illustration 2-17
Compact-ESM Generator (unit with batteries)





3. Remove the Generator Cover and then remove both lateral anchoring plates of the Generator Cabinet. Assemble the ramp to the pallet base. Move the Generator from the shipping pallet and place it near its site in the room. At least two people are required for this operation.

THIS GENERATOR IS VERY HEAVY BECAUSE IT IS SHIPPED WITH THE BATTERIES INSTALLED. AT LEAST TWO PEOPLE ARE REQUIRED TO REMOVE THE UNIT FROM THE PALLET. THE EQUIPMENT IS SHIPPED WITH THE BATTERIES CHARGED (APPROX. 400 VDC). CAREFULLY HANDLE THE UNIT DURING ITS UNPACKING AND INSTALLATION.

SOME CONNECTORS ARE UNPLUGGED FOR TRANSPORT, DO NOT PLUG IN THEM UNTIL SPECIFICALLY INSTRUCTED TO DO SO IN THIS DOCUMENT.

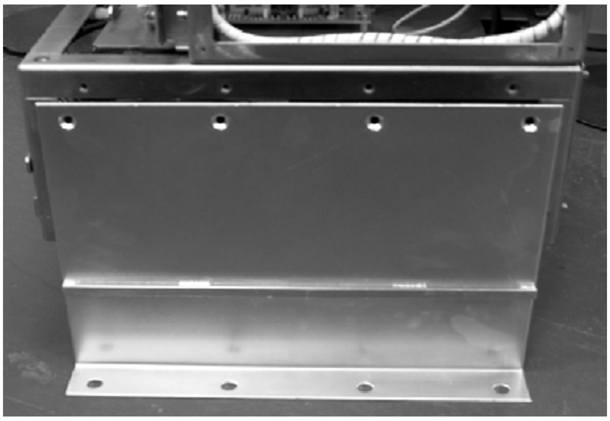
4. When the equipment is unpacked, verify that all items in the customer order are present, and the hardware and internal wiring is secure.

5. Check the part numbers / serial numbers of each component with its identification labels and inspect all pieces for visible damage. If any damaged parts are found, repair or order replacements to prevent unnecessary delay in installation.

6. The Generator Cabinet usually is freestanding. Seismic areas and other conditions require the Generator to be secured to the floor by anchoring plates fixed to both lateral sides of the Cabinet.

7. Leave a sufficient working area around the equipment that will permit unhindered movements until its final assembly.

Illustration 2-18
Anchoring Plates for the Battery Powered Generator



POWER LINE CONNECTION

DANGER !

KEEP IN MIND THE GENERAL CAUTIONS FOR BATTERY POWERED GENERATORS INDICATED IN SECTION 1.3.

DO NOT PLUG THE UNIT INTO THE MAINS SOCKET OR POWER ON THE GENERATOR UNTIL SPECIFICALLY INSTRUCTED TO DO SO IN THIS SERVICE MANUAL.

8. Before connecting the cables, ensure that the power line to the Generator is cut when the Emergency Switch(es) is(are) activated.

9. Measure the line voltage at the Room Electrical Cabinet or at the Wall Socket in case of the Generator will be line powered through a plug. The power supply line should be according to the "*Pre-Installation*" document.

10. If Generator is not provided with a Power Supply cable, obtain a suitable line cord to conform to local standards and requirements.

11. Cut the line cord to the appropriate length. Fasten and route the cable over the top bar of the frame as shown in the Illustration 2-19, using cable ties (tie-wraps) in the holes provided. The cables should be routed through the cable entrance of the Front Panel of Module-1 before connecting the cable to the Terminals in 1TB-1 at the Front Panel. (*Refer to Illustration 2-19.*)

12. The Terminal Block 1TB1 is also provided with connections:

    - to supply power to a Table or another device (1TB1-Table), so the whole system (Tables, etc.) can be switched ON/OFF when the Generator is switched ON/OFF. (*refer to Schematics 543020XX*).

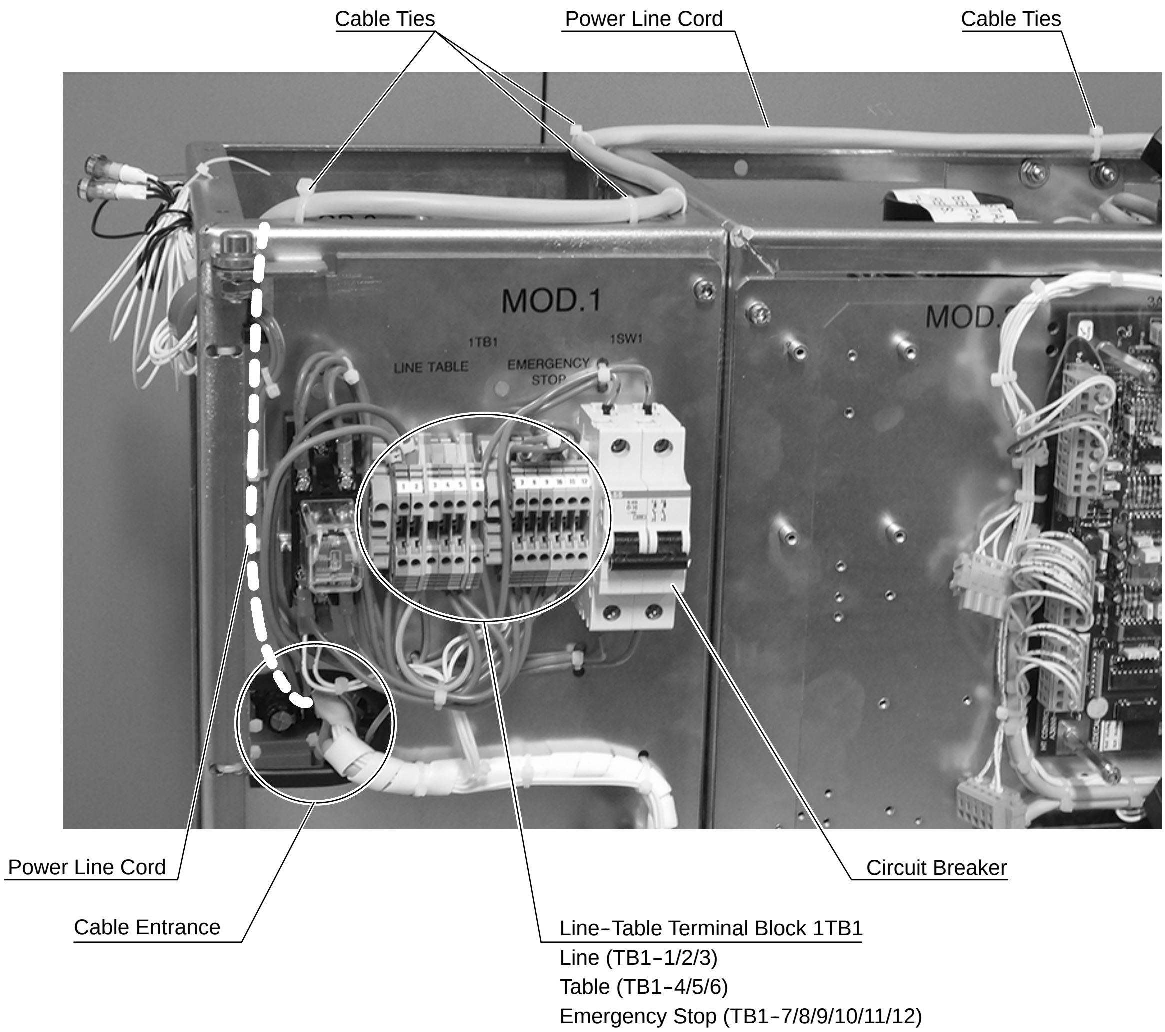
    - to install an optional Emergency Stop Button for isolating the Batteries and Power Line of the Generator. In this case, remove the jumpers installed in the Terminals of 1TB1 (8–9, 7–10, 11–12) and connect the Emergency Stop Button as indicated in *Schematics 543020XX.*

      The minimum specification for this installation should be:
        - Emergency Stop Button: *AC-15 , 240 V, 3 A, Ith 10 A.*
        - Cable: *2.5 mm^2 (AWG 14), 600 V.*

13. Connections of power supply must be made as indicated below:

LINE VOLTAGE			**TABLE SUPPLY (WHOLE SYSTEM)**		
1TB1–1	1TB1–2	1TB1–3	1TB1–4	1TB1–5	1TB1–6
Phase	Neutral	GND	Phase	Neutral	GND

Illustration 2-19
Cable Routing in the Battery Powered Generator

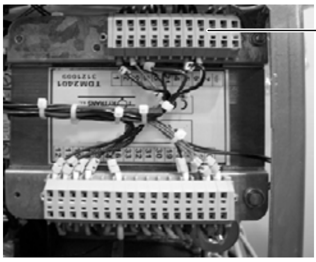


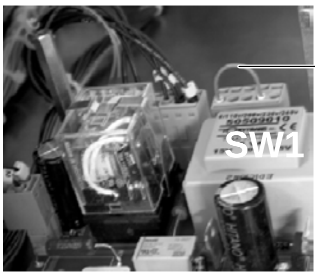
14. The equipment is factory set for a 230 VAC input line. Connect cable "✳" to Transformer 2T1 (close to Battery Charger Board) according to the nominal voltage of the Line.

    Set Jumper in SW1 of Line Monitor Board and connect cable "✳" in Transformer 6T2 (right side of Cabinet), as indicated below.

	POWER SUPPLY LINE (NOMINAL VOLTAGE)				
	Stand-Alone option	**110 VAC**	**208 VAC**	**230 VAC (or 220 VAC)**	**240 VAC**
Cable-✳ in Transformer 6T2	TB-3 or TB-8	TB-3 or TB-8	TB-21	TB-4 or TB-5	TB-6 or TB-7
Jumper in SW1 Line Monitor	Set according to Power Supply Line	SW1-5 with SW1-4	SW1-5 with SW1-3	SW1-5 with SW1-2	SW1-5 with SW1-1

Illustration 2-20
Connections according to Nominal Voltage





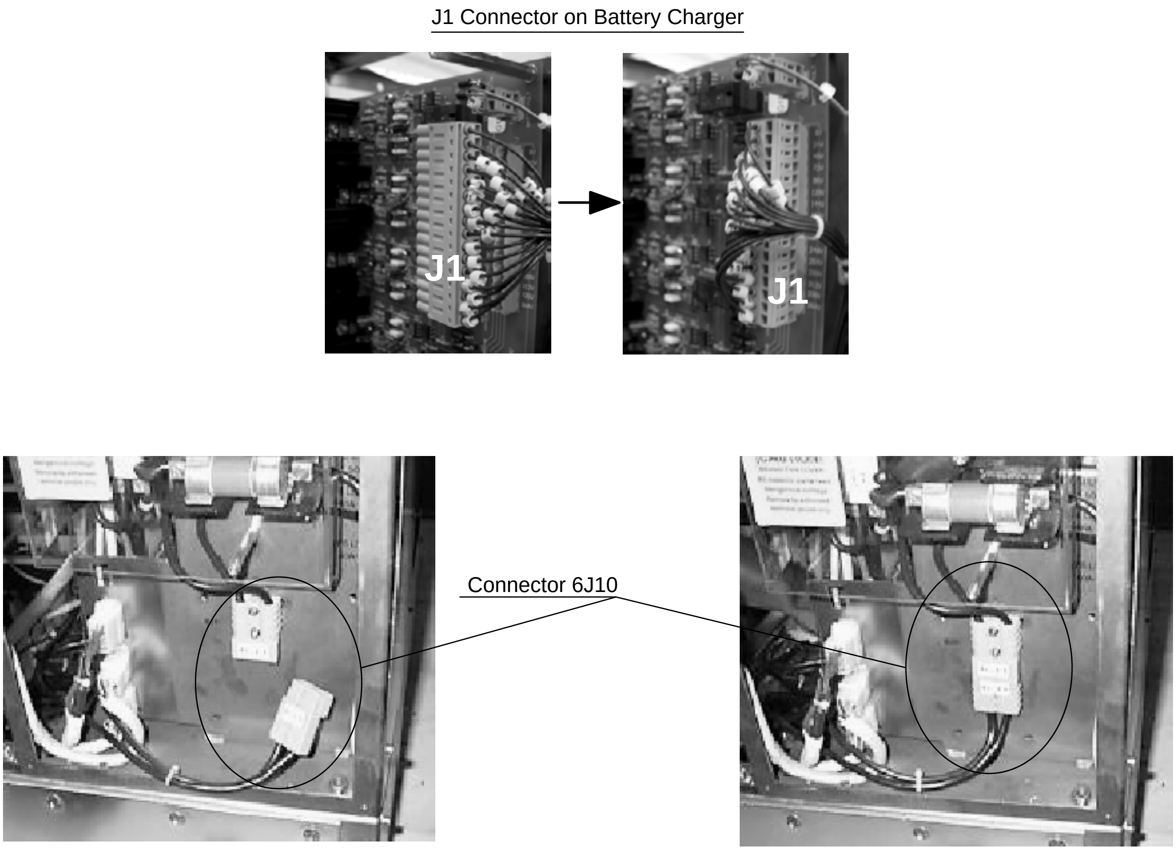
15. **For safety purpose**, the following connectors are unplugged during shipping:

    - Remove the Protective Cover of the Battery Charger Board and carefully plug Connector J1 into the Battery Charger Board. Re-install the Protective Cover.

    - Carefully plug the Anderson Connector 6J10 at the right side of the Cabinet.

WHEN THESE CONNECTORS ARE PLUGGED, FULL BATTERY VOLTAGE IS PRESENT ON THE TERMINALS OF CONTACTOR 6K5 AND ON THE BATTERY CHARGER BOARD, REGARDLESS OF WHETHER THE LINE PLUG IS CONNECTED OR NOT. WHEN THE LINE PLUG IS CONNECTED, THE BATTERIES ARE SUBJECT TO VOLTAGES PRODUCED BY THE CHARGER BOARD.

Illustration 2-21
Connections of J1 on Battery Charger and Anderson 6J10



16. With Cabinet Cover close to the Cabinet, connect the “Line” and “Battery” lamp wires from the Cabinet cover to the respective Molex connectors on the top of the Cabinet (remove the wire tie-wrap).

17. Plug the Generator to the line socket and turn ON the Circuit Breaker. Visually check that:

    - “*Line*” and “*Batteries*” Lamps (on the Cabinet cover) are lit.

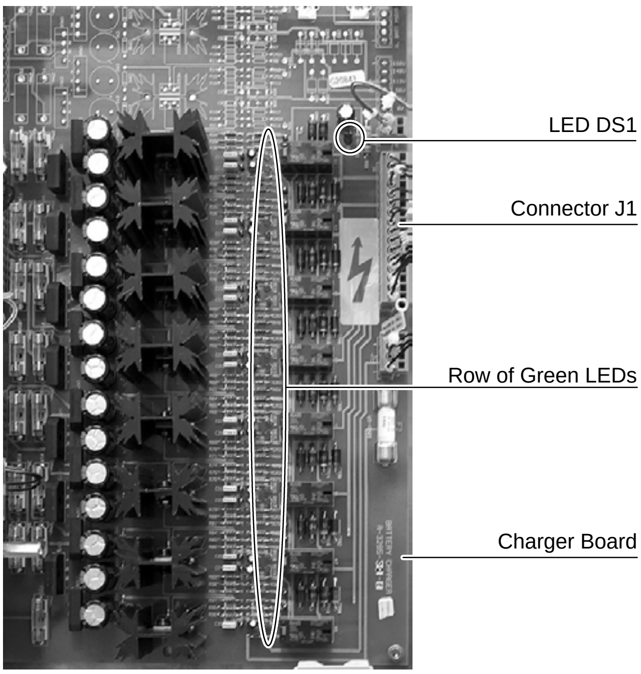
    - LED “*CHECK*” (yellow) is flashing on the Line Monitor Board (2A3). The MAX and MIN LEDs (red) on the Line Monitor Board should be off.

      Perform the **Line Monitor Board Adjustment**:
      - Note the Nominal Line Voltage configured with SW1 at the Line Monitor Board.
      - Measure and note the Power Line Voltage with a Digitalmeter in the mains socket.
      - Adjust VDC on TP2 (positive) and TP1 (negative) with POT1 at the Line Monitor Board as per the following formula:

$$\frac{V_{mains}}{V_{nominal}} \times 2.5 = V_{TP2} \qquad Example: \frac{V_{(mains:220V)}}{V_{(nominal:230V)}} \times 2.5 = V_{TP2}(2.4VDC)$$

      V mains is the line voltage obtained in the mains socket.
      V nominal is the nominal voltage configured with SW1.

    - All of the green LEDs and LED DS1 are lit on the Battery Charger Board.



18. Turn Off the Circuit Breaker and unplug the Generator from the mains socket. Observe the "*Line*" Lamp is switch off.

19. Install the Control Console as indicated in Section 2.4.

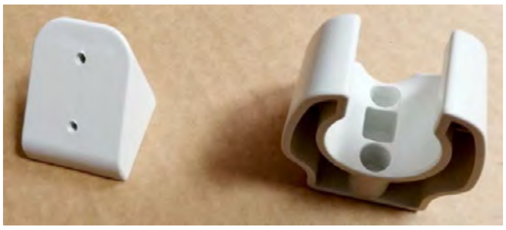
2.3 ON/OFF BOX CONTROL PANEL INSTALLATION

The ON/OFF Box is shipped with the Handswitch, Generator and PC cables already connected. The PC cable can have either a USB connector or two DB9 connectors, depending on the option required. In this last case, it is mandatory to install the A3179-XX Auto ON/OFF board in the computer, to which one of the DB9 connectors has to be connected.

The Handswitch support and the optional sloping support are shipped in a separate box.

Illustration 2-22
ON/OFF Box and Handswitch support

ON/OFF Box



Handswitch Support

The ON/OFF Box can be either wall mounted or freestanding on a table. For the wall mounting option the Handswitch support is mandatory, otherwise it is optional, but recommended.

For wall mounting, it is recommended to install only the Handswitch support in order to place the Handswitch in vertical position.

On the contrary, if the ON/OFF Box is going to be used freestanding on a table, it is recommended to install also the sloping support in order to place the Handswitch with the necessary inclination to avoid it from slipping out of the support.

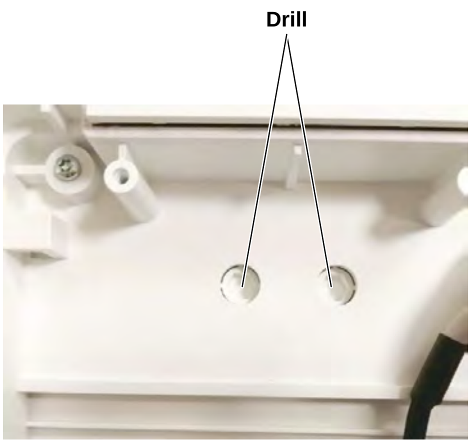
1. Handswitch support installation:

   a. Unscrew both screws from the bottom cover and put it aside.

Illustration 2-23
Bottom cover

   b. Drill two holes for the Handswitch support nuts and screws using a 3.5 mm (9/64”) drill bit.

Illustration 2-24
Drilling points



- To install only the Handswitch support, place two nuts (M3) in the inner hexagonal spaces and screw the Handswitch support from the outer part of the ON/OFF Box using two M3x10 screws.

Illustration 2-25
Handswitch support

- To install the Handswitch support with the sloping support, screw the sloping support from the inner part of the ON/OFF Box and, then, screw the Handswitch support to it. Use four ∅ 3x10 screws for plastic.

Illustration 2-26
Handswitch support with sloping support

2. ON/OFF Box installation.

   - Freestanding: Reinstall the bottom cover using the previously removed screws and place the ON/OFF Box in its final position.

Illustration 2-27
Freestanding installation

- Wall mounting:

a. For wall mounting, the bottom cover is discarded, so it is possible to switch the cables position from the top cable outlet to the bottom cable outlet. In that case, cut the tie-wrap that hold the cables, route them through the opposite outlet and hold them together and to the ON/OFF Box with a new tie-wrap.

Illustration 2-28
Cables outlet

b. Fix the Wall support to the wall using 4 anchor screws.

c. Slide the ON/OFF Box into the Wall support, taking care that it fits in both tracks, and secure it to the support with a screw on the top.

Illustration 2-29
Wall support

Illustration 2-30
Wall mounting installation

3. Proceed with the cable connections *(refer to Section 3.4 and to Section 5.2 – 6070064).*

2.4 CONTROL CONSOLE INSTALLATION

1. Control Console can be freestanding, wall supported or mounted on an optional Pedestal. Console is provided with several mounting holes on the bottom for anchoring to the Pedestal or another support.

2. When a Pedestal is used, secure the Pedestal to the floor through the anchoring holes on its base and place the base cover. Attach the Console to the Pedestal using the mounting holes on the bottom of the Console.

3. When the Console is wall supported, secure the support to the wall and attach the Console to the support using the mounting holes on the bottom of the Console.

4. Leave a sufficient working area around the equipment until its final assembly.

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SECTION 3 CABLE CONNECTIONS

This section provides the information necessary to connect the Generator Cables with the system and options.

Note ☞ *For more information about electrical requirements and cable connections, refer to the "Pre-Installation" document and Section 5 "System Interconnections" at the end of this document.*

Note ☞ *Identification of some terminal connections (TB, TS), boards, etc... along with this document (text and schematics) may have a prefix number which indicates the module number in the equipment. (a.e. TS2 as 4TS2, 10TS2 or 11TS2).*

Some safety devices such as the Safety Switch / Emergency Switch, Warning Light, and Door Interlock Switch are supplied and installed by the customer. Verify that safety devices have been properly installed and routed during the Pre-Installation procedure.

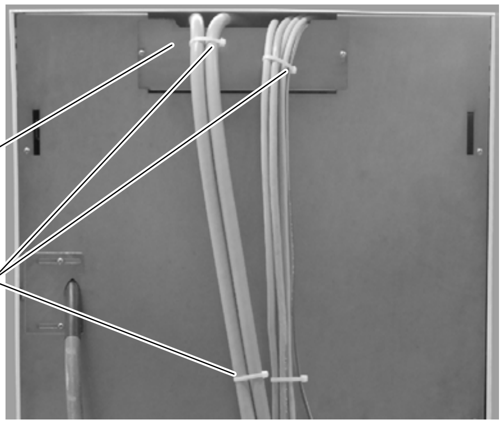
3.1 CABLE ROUTING INSIDE GENERATOR CABINET

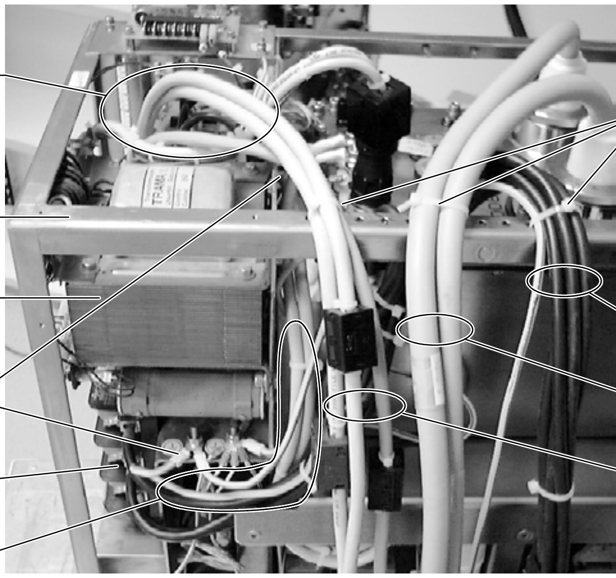
3.1.1 GENERAL CABLE ROUTING

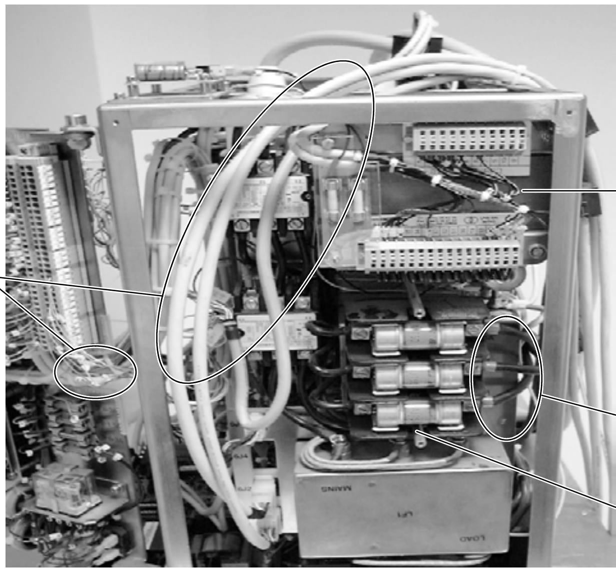
1. Before connecting the Interconnection cables within the Generator Cabinet, cables must be first connected to each Device (Tables, Wall Stands, etc.) and routed through the raceways. Remove the ferrite blocks of the cables (factory clamped) when it is required to carry out a correct routing, then re-install the ferrite blocks where they originally were around cables.

2. Inside the Generator Cabinet, all Interconnection cables must be routed over the Fastening Bar (upper rear bar) of the Cabinet Frame minding the upper Cable Outlet at the rear side of the Cabinet Cover. (*Refer to Illustration 3-1*).

Illustration 3-1
Cable Routing in Compact Generator





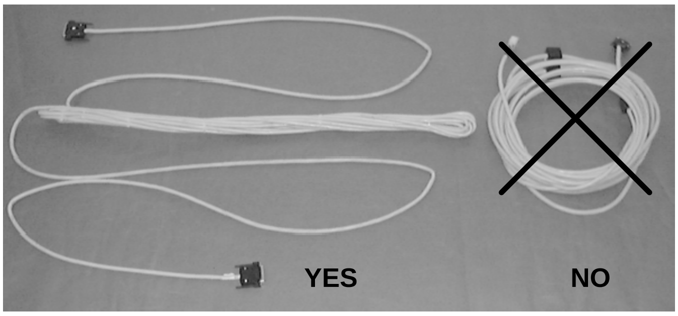


3. For Generators with a Low Speed Starter located behind the Front Panel (Module 4), Stator and Interconnections Cables have to be routed internally through the Cabinet close to the Input Transformer.

4. For Generators with the Low or High Speed Starter located on a shelf (Module 10 or 11), Stator and Interconnections Cables have to be routed internally through the Cabinet close to the HV Transformer.

CAUTION

In order to avoid signal interferences, it is strongly recommended to fold and fasten close to the Generator Cabinet the portion of cables not routed (see picture below). Never wrap in circles.



5. Connect all cables as indicated in Section 3 “*Cable Connections*”.

6. Secure all cables to the Fastening Bar using cable ties after all cable / wire connections are complete.

3.1.2 LINE POWERED GENERATOR WITH OPTIONAL SUPPORTS

1. Before connecting the Interconnection cables within the Generator Cabinet, cables must be first connected to each Device (Tables, Buckys, etc.) and routed through the raceways. Remove the ferrite blocks of the cables (factory clamped) when it is required to carry out a correct routing, then re-install the ferrite blocks where they originally were around cables.

2. Cables can enter into the Generator through the Cable Outlet on the upper side of the Wall Support or through the Cable Outlet at the rear side of the Base Support (according to the raceway position in the room and Local Codes). The non used Cable Outlet has to be closed with the cover supplied. (*Refer to Illustration 3-2*).

3. Route each cable through the Base Support and take out each one to fold and fasten individually the remaining portion of cable that is not used for Generator connections. Then, route the other end of the cable through both Supports. (*Refer to Illustration 3-2*).

4. Inside the Generator Cabinet, all Interconnection cables must be routed over the Fastening Bar (upper rear bar) of the Cabinet Frame minding the upper Cable Outlet at the rear side of the Cabinet Cover. (*Refer to Illustration 3-1*).

5. For Generators with a Low Speed Starter located behind the Front Panel (Module 4), Stator and Interconnections Cables have to be routed internally through the Cabinet close to the Input Transformer.

6. For Generators with the Low or High Speed Starter located on a shelf (Module 10 or 11), Stator and Interconnections Cables have to be routed internally through the Cabinet close to the HV Transformer.

7. All the folded cables should be put into the Base Support. Install the Front Cover of the Base Support.

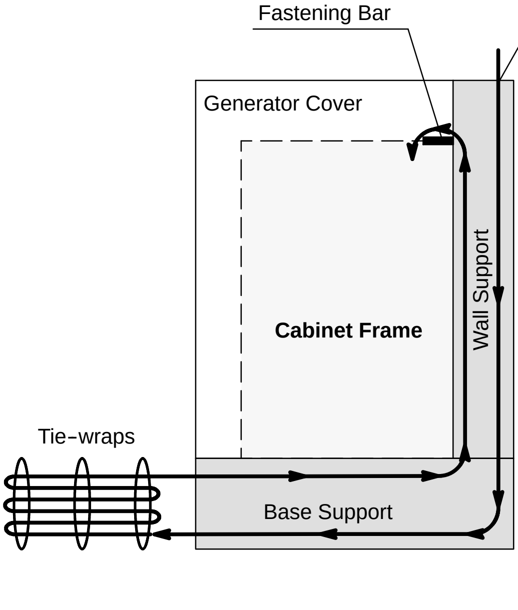
CAUTION

In order to avoid signal interferences, it is strongly recommended to fold and fasten the remaining portion of cables as indicated in Illustration 3-2, before putting them inside the Base Support. Never wrap them in circles.

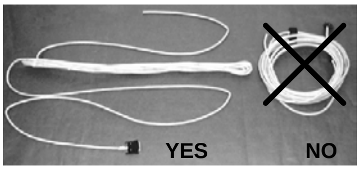
8. Connect all cables as indicated in Section 3 "*Cable Connections*".

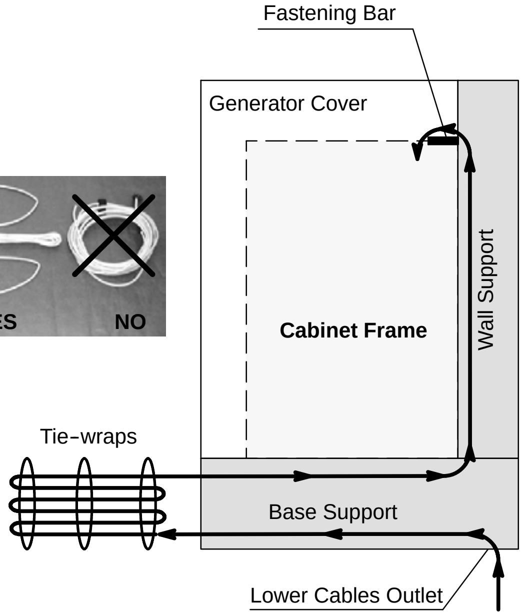
9. Secure all cables to the Fastening Bar using cable ties after all cable / wire connections are complete.

Illustration 3-2
Cable Routing and Outlets

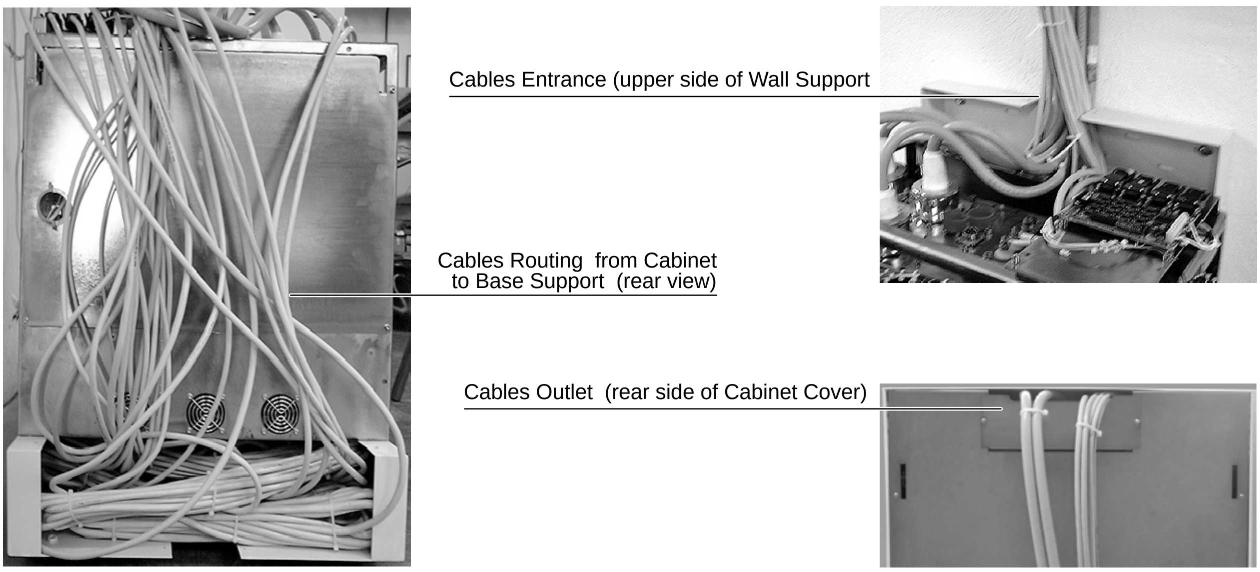


**INTERNAL CABLE ROUTING
FROM UPPER CABLES OUTLET**





**INTERNAL CABLE ROUTING
FROM LOWER CABLES OUTLET**



3.2 HIGH VOLTAGE CABLES CONNECTION

FOR GENERATORS WITH A HV TRANSFORMER WITH X-RAY TUBE RECEPTACLES (ANODE / CATHODE) FOR <u>ONLY ONE X-RAY TUBE</u> CONNECTION AND WHEN THIS TUBE IS BEING USED FOR "FLUOROSCOPY / SPOT FILM": CONNECTIONS OF THE FILAMENT LEADS "FIL-1 RTN" (J4-15) AND "FIL-2 RTN" (J4-16) ON THE INTERFACE CONTROL BOARD HAVE BEEN INVERTED, AND THE "HT INL" (J3-13) IS DISCONNECTED AND INSULATED IN THE CABINET. THESE CONNECTIONS ARE FACTORY SET. (REFER TO SCHEMATIC 543020XX).

FOR GENERATORS WITH A HV TRANSFORMER WITH DOUBLE X-RAY TUBE RECEPTACLES (ANODE / CATHODE TO CONNECT TWO TUBES) AND WHEN ONE OF THE X-RAY TUBES IS BEING USED FOR "FLUOROSCOPY / SPOT FILM", THIS TUBE MUST ALWAYS BE CONNECTED TO THE TUBE-2 RECEPTACLES.

FOR GENERATORS WITH A HV TRANSFORMER WITH DOUBLE X-RAY TUBE RECEPTACLES (ANODE / CATHODE TO CONNECT TWO TUBES): CONNECTIONS OF THE FILAMENT LEADS "FIL-1 RTN" (J4-15) AND "FIL-2 RTN" (J4-16) ON THE INTERFACE CONTROL BOARD HAVE BEEN INVERTED. THESE CONNECTIONS ARE FACTORY SET. (REFER TO SCHEMATIC 543020XX).

3.2.1 HIGH VOLTAGE CABLES

Connect the HV Cables in the HV Transformer (Generator).

These cables must enter into the Generator through the cable outlet on the upper side of the Cabinet and then attached to the fastening bar (upper rear bar) of the Cabinet frame minding the upper cable outlet at the rear side of the Cabinet cover.

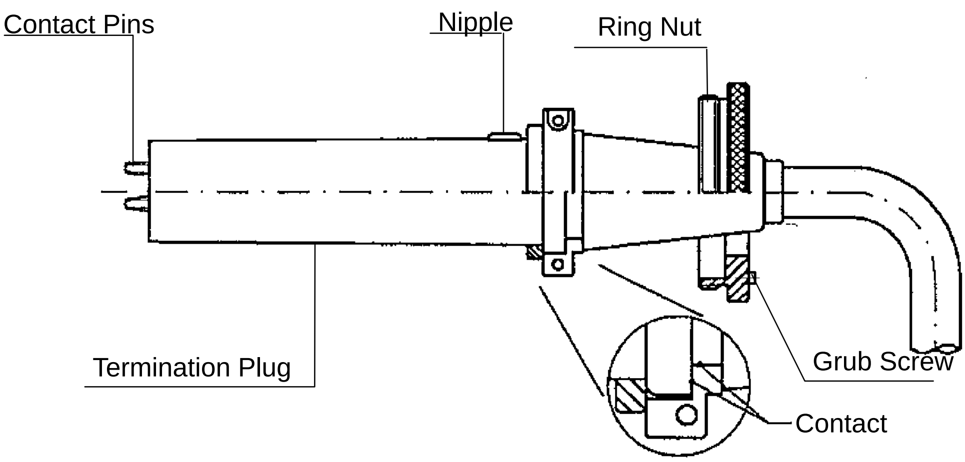
The Terminal Pins of the High Voltage cables are extremely delicate and easily damaged. Therefore they must be handled carefully. Make sure that they are straight and that the splits in the pins are open (parallel to sides).

Anode and Cathode cables are furnished according to the room layout (length of the cables).

1. The mounting accessories of each termination plug are factory assembled. For extended information refer to the HV Cable manufacturer’s instructions located inside the HV Cable package.

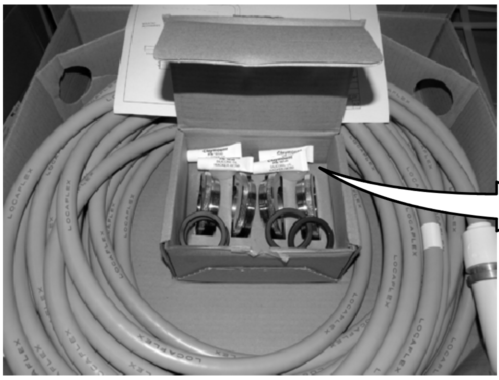
Do not install the Silicone washer supplied with the HV Cables.

2. Unscrew the grub screw of the ring nut. (Refer to the illustration below.)



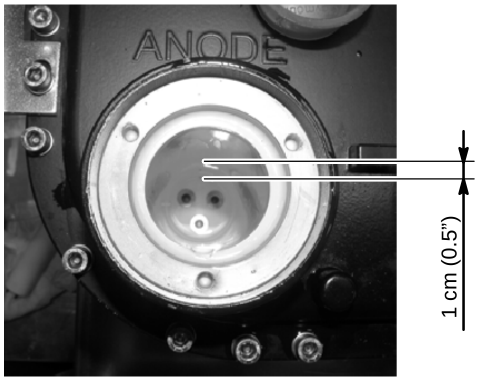
3. Prepare the High Voltage terminals that will be installed in the HV Transformer.

   - Put approximately 1 cm (0.5”) of HV Silicone Oil in the HV Transformer receptacles (included in the HV Cables package).



HV Cables Package

HV Silicone Oil



HV Transformer Receptacle

   - If HV Silicone Oil is not available, fill the receptacles using silicone paste provided with the X-ray Tube.

HV Silicone Paste

HV Cable Terminal with Silicone Paste

4. Carefully insert the Anode and Cathode termination plug into the respective receptacle socket (watch the nipple on the plug to ensure correct positioning of the contact pins).

5. Hand tighten the ring nut. It must be secure. Tighten the grub screw.

6. Prepare the High Voltage terminals that will be installed in the X-ray Tube(s) receptacles as previously described. Apply Silicone Paste over the entire surface of the Plug including the Pins.
7. Carefully connect the Anode and Cathode cables from the HV Transformer to the respective X-ray Tube(s) receptacles. Ensure that all connections are made correctly, maintaining correct Anode and Cathode orientation.
8. Hand tighten the ring nut. It must be secure. Tighten the grub screw.

3.2.2 X-RAY TUBES WITH METALLIC INSERT ENVELOPE

In case of X-ray Tubes with a Metallic Insert Envelope, it is required to connect the wire from the Metallic Insert Envelope to the Black Banana Plug connection on the HV Transformer to obtain a correct mA measures. For these X-ray Tubes the part number of the HV Transformer has to be coded in revision A or higher (a.e. A6094–16A). (*Refer to Section 5.2 – Map 54302035).*

3.3 X-RAY TUBE CONNECTION

3.3.1 STATOR CABLE

X-ray Tubes are equipped with the Stator cable installed.

Note ☞ *For Generators with a “Single X-ray Tube for Fluoroscopy / Spot Film”, connect the Stator wires as indicated for Tube-2, except for Generators with the Low Speed Starter LF-RAC located behind the Front Panel (module-4), in this case connect wires as Tube-1.*

A LV-DRAC (Low Voltage - Digital Rotatory Anode Controller) is required for High Speed X-ray Tubes. Connections between LV-DRAC and Power Module are factory made.

Route the Stator cable together with the HV cables to the Generator Cabinet. Connect the Stator cable terminals to the indicated Terminal Block TS2:

STATOR WIRES	TERMINAL TS2	
	TUBE-1	TUBE-2
MAIN	TS2-1	TS2-9
AUX (Shift)	TS2-2	TS2-10
COMMON	TS2-3	TS2-11

Note ☞ *Terminal Block TS2 may be marked as 4TS2, 10TS2 or 11TS2 depending on the Generator model.*

Note ☞ *For Philips or Siemens X-ray Tubes refer to Interconnection Maps I/F-w021 or I/F-024.*

WARNING

MAKE SURE THAT STATOR WIRES ARE PROPERLY CONNECTED. BEFORE MAKING ANY EXPOSURE, CHECK THAT THE ANODE ROTATES CORRECTLY.

DANGER !

IN GENERATORS EQUIPPED WITH LV-DRAC: THE LV-DRAC OUTPUT CAN BE AS HIGH AS 1000 VRMS. FOR SAFETY REASONS (TO AVOID ELECTRIC SHOCKS), THE STATOR CABLE MUST BE SHIELDED AND BOTH ENDS OF THE SHIELD MUST BE CONNECTED TO GROUND.

DUE TO ELECTROMAGNETIC INTERFERENCE (EMC) PROBLEMS, THE IGBT'S HEATSINK IS NOT GROUNDED. IT IS CONNECTED TO THE NEGATIVE TERMINAL OF THE INPUT RECTIFIER. TO AVOID ELECTRIC SHOCK, BE SURE THAT THE INPUT LINE IS DISCONNECTED AND THE CAPACITOR BANK IS PROPERLY DISCHARGED BEFORE MANIPULATING THE LV-DRAC.

FANS

Wires from fans should be routed with the Stator Cables, and connected to the indicated terminal of the Generator Cabinet. Depending on the model of X-ray Tube, the fans are powered at 115 VAC or 220 VAC. Make the following connections to select the fan voltage.

For Compact Generators (for only one LS Tube) with the Low Speed Starter LF-RAC located behind the Front Panel (module-4), connect wires from fans to:

0 VAC	115 VAC	220 VAC
3TS1-3 or 3TS1-10	3TS1-27	3TS1-26

For Compact Generators (for one or two LS Tubes) with the Low Speed Starter LF-RAC located on a shelf at the bottom of the Generator (module-10), connect wires from fans to:

TUBE CONNECTION	GENERATOR WITH LOW SPEED STARTER		
	WIRES FROM FANS	115 VAC	220 VAC
AS TUBE-1	10TS2-6 and 10TS2-7 on the Generator Cabinet	TB4-T1 with TB1-22 or TB1-23 on the LF-RAC Board	TB4-T1 with TB1-25 or TB1-26 on the LF-RAC Board
AS TUBE-2	10TS2-14 and 10TS2-15 on the Generator Cabinet	TB4-T2 with TB1-22 or TB1-23 on the LF-RAC Board	TB4-T2 with TB1-25 or TB1-26 on the LF-RAC Board

Note ☞ *For Generators with a "Single X-ray Tube for Fluoroscopy / Spot Film" connect the Fan wires as indicated for Tube-2.*

For Compact Generators (for one or two HS Tubes) with the High Speed Starter LV-DRAC located on a shelf at the bottom of the Generator (module-11), connect wires from fans to:

TUBE CONNECTION	GENERATOR WITH HV TRANSFORMER AND HIGH SPEED STARTER FOR ONLY ONE X-RAY TUBE		
	WIRES TO FANS	115 VAC	220 VAC
AS TUBE-1	11TS2-6 and 11TS2-7 on the LV-DRAC Module	Jump 11TS2-6 with 11TS2-17 on the LV-DRAC Module	Jump 11TS2-6 with 11TS2-18 on the LV-DRAC Module
AS TUBE-2	11TS2-14 and 11TS2-15 on the LV-DRAC Module	Jump 11TS2-14 with 11TS2-17 on the LV-DRAC Module	Jump 11TS2-14 with 11TS2-18 on the LV-DRAC Module

TUBE CONNECTION	GENERATOR WITH HV TRANSFORMER AND HIGH SPEED STARTER FOR TWO X-RAY TUBES		
	WIRES TO FANS	115 VAC	220 VAC
AS TUBE-1	11TS2-6 and 11TS2-7 on the LV-DRAC Module	wire marked "T1" with 11TS2-17 on the LV-DRAC Module	wire marked "T1" with 11TS2-18 on the LV-DRAC Module
AS TUBE-2	11TS2-14 and 11TS2-15 on the LV-DRAC Module	wire marked "T2" with 11TS2-17 on the LV-DRAC Module	wire marked "T2" with 11TS2-18 on the LV-DRAC Module

Note ☞ *For Generators with a "Single X-ray Tube for Fluoroscopy / Spot Film" connect the Fan wires as indicated for Tube-2.*

THERMOSTAT OR PRESSURE SWITCH SIGNAL

If the X-ray Tube is provided with a Safety Thermostat (approx. 65^{o}C) or Pressure Switch (must be NC Contact), the two wires should be routed to the Terminal Block TS2 in the Generator Cabinet and connected to the following Terminals.

In case that the X-ray Tube is provided with a Safety Thermostat (approx. 65^{o}C) and a Pressure Switch (both must be NC Contacts), connect them in series before routing, connecting both wire-ends to their respective Terminals in TS2.

THERMOSTAT WIRES	TUBE-1	TUBE-2
THERMOSTAT SIGNAL	TS2-4	TS2-12
THERMOSTAT COMMON	TS2-5	TS2-13

Note ☞ *Terminal Block TS2 may be marked as 4TS2, 10TS2 or 11TS2 depending on the Generator model.*

Note ☞ *For Generators with a "Single X-ray Tube for Fluoroscopy / Spot Film", connect the Stator wires as indicated for Tube-2, except for Generators with the Low Speed Starter LF-RAC located behind the Front Panel (module-4), in this case connect wires as Tube-1.*

If an X-ray Tube is not provided with Thermostat signal, jump both connections in the Terminal Block TS2 (*refer to above table).*

GND AND/OR SHIELD

The connection of the GND and/or Shield wire of the Stator cables depend on the Generator model.

GENERATOR MODEL		CONNECTION OF GND and/or SHIELD WIRE
Number of X-ray Tubes	**Starter type and Location**	
ONLY 1 Tube	LF-RAC (Low Speed) behind the Front Panel (Module 4)	4TS2–6
1 or 2 Tubes	LF-RAC (Low Speed) Lower Cabinet Shelf (Module 10)	10TS2–8 or 10TS2–16
1 or 2 Tubes	LV-DRAC (High Speed) Lower Cabinet Shelf (Module 11)	11TS2–8 (for Tube-1) 11TS2–16 (for Tube-2)

3.3.2 TUBE SELECTION SIGNALS

Note ☞ *This section only applies to Generators with two X-ray Tubes.*

The Tube Selection signals are available through two contacts free of voltage located on the starter.

	TUBE-1 SELECTION	TUBE-2 SELECTION	SELECTION COMMON
on the LF-RAC Board	J1-10	J1-11	J1-12
on the LV-DRAC Module	11KT1-84	11KT1-72	11KT1-83 and 11KT1-71 (connect both)

3.4 INTERCONNECTION CABLES

This section identifies the cables and runs needed for Generator and System Interconnection. Route and connect the interconnection cables from each component installed in the system to the Generator Cabinet as indicated in Illustration 3-3 and Section 5.2 – Interconnection Maps *"543010XX"*.

CAUTION

Interconnection cables should not be routed into the same conduit or cable raceway as the Power or High Voltage cables.

Note ☞ *Console ATP CPU Board is located inside the Generator Cabinet. Only one cable (serial communication RS232 or RS422) from J5 of the Generator Cabinet should be connected to the Serial Console, Control Box or PC Interface Box.*

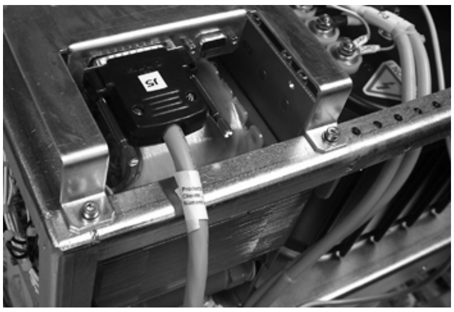
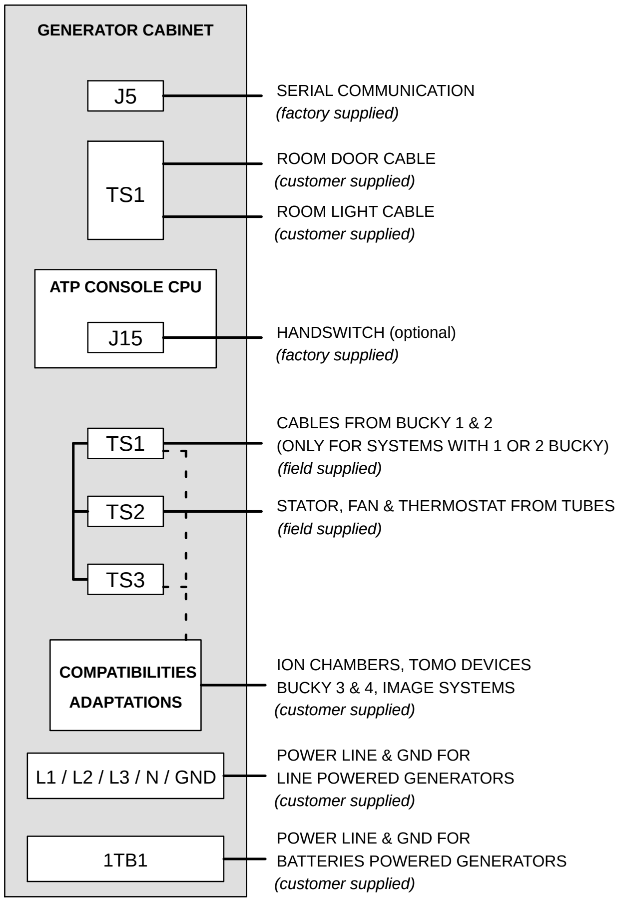


Illustration 3-3
Interconnection Cables



3.4.1 SERIAL CONSOLE

For systems using a Serial Console, only a Serial Interconnection Cable (A7066-xx) from J5 of the Generator Cabinet must be connected to the J1 of the Serial Console. (*Refer to Section 5.2 - Maps 54301052, A6188-03, 54303129).*

3.4.2 CTSC TOUCH SCREEN CONSOLE

This Console is freestanding and it contains the Power Supply inside. Power Cable and ON/OFF Kit, that comprises the PC Interface Box and the communication cables, are also supplied with the Touch Screen Console.

CTSC Touch Screen Console

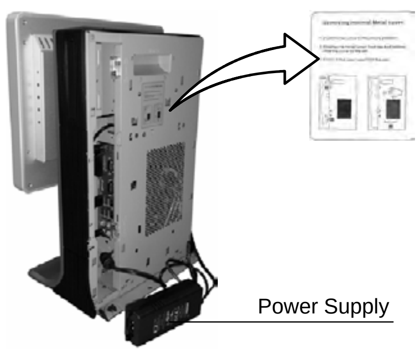
Power Line Cable

ON / OFF Kit

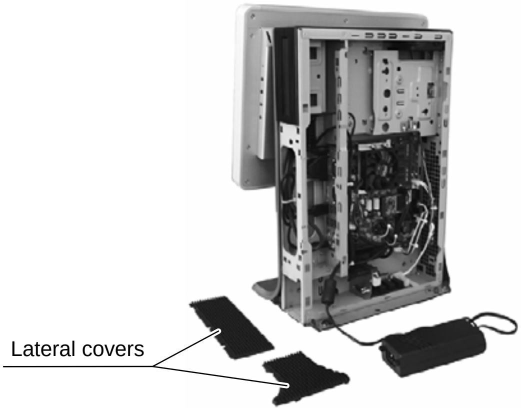
1. Remove the back cover of the PC. Follow the instructions of the label of the cover.
   a. Push the switch to the unlock position to release the cable cover.
   b. Push the release latch.
   c. Slide the back cover upwards to remove.

2. Extract the Power Supply (AC/DC Adapter).

3. Remove both back covers as indicated by label of inside cover.

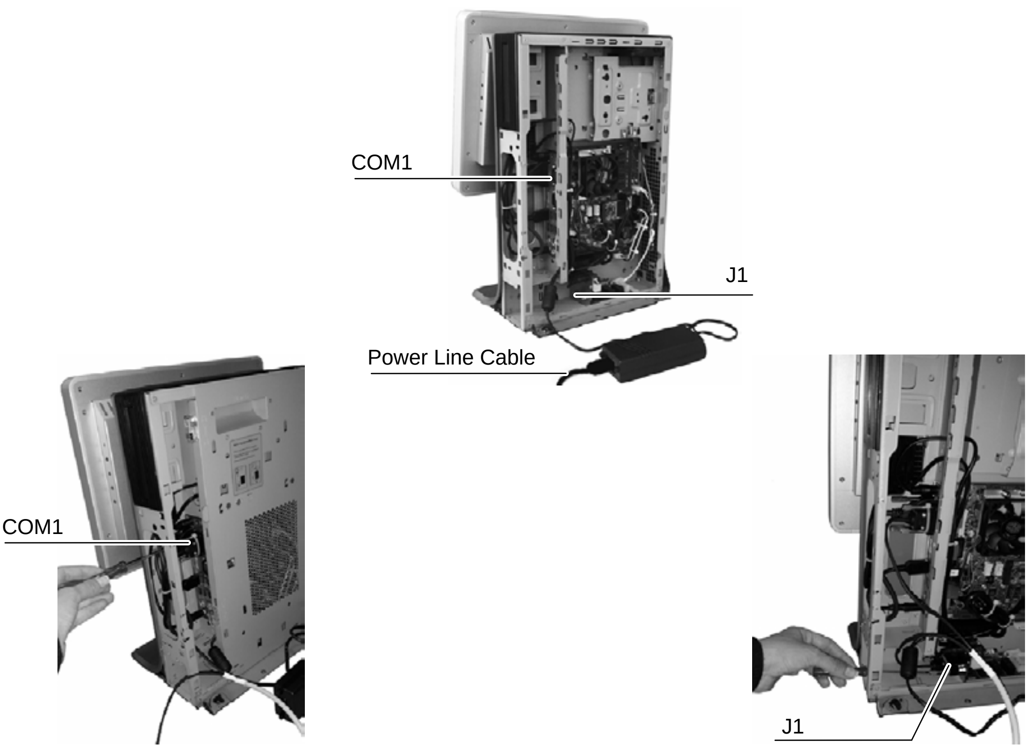


4. Remove both lateral covers to facilitate the access to the connectors and allow the fixation of the cables.



Note ☞ *For cable connections refer to Section 5.2 – 6070064.*

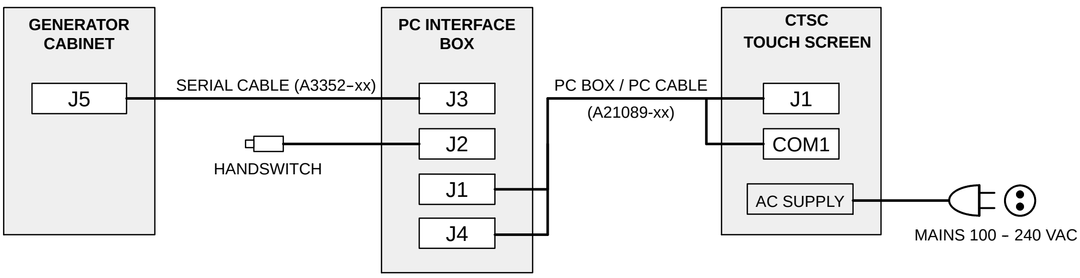
5. Connect the Interface Box–Computer Cable (A21089-XX) to COM1 (Communication) and J1 (Auto ON/OFF) of the CTSC Touch Screen Console connectors. Connect the Power Line Cable to the Power Supply (AC/DC Adapter).



6. Mount back all covers of the Touch Screen Console. The Power Supply can be mounted inside the Console or placed outside as desired.

7. Remove the Back Cover of the PC Interface Box.

8. Connect the Serial Interconnection Cable (A3352-xx) from J5 of the Generator Cabinet to J3 of the PC Interface Box.



9. Connect the Handswitch Cable to J2 of the PC Interface Box.

10. Connect the Interface Box–Computer Cable (A21089-XX) to J1 and J4 of the PC Interface Box and the other end (connectors J1 and COM1) to the CTSC Touch Screen Console.

11. Re-install the Back Cover of the PC Interface Box.

12. Connect the Power Line Cable to the mains (100 – 240 VAC).

3.4.3 VIRTUAL CONSOLE (PC)

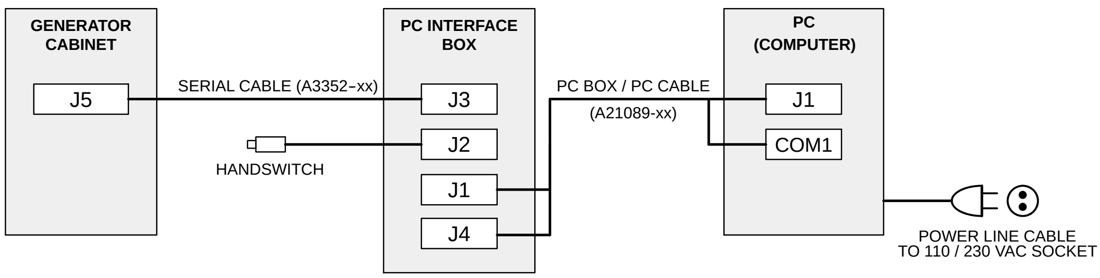
Systems using a Virtual Console running on a PC usually must have a PC Interface Box installed between the PC and Generator. *(Refer to Section 5.2 – Map 6070064.)*

Perform the following connections:

1. Remove the Back Cover of the PC Interface Box.
2. Connect the Serial Interconnection Cable (A3352-xx) from J5 of the Generator Cabinet to J3 of the PC Interface Box.
3. Connect the Handswitch Cable to J2 of the PC Interface Box.
4. Connect the Interface Box–Computer Cable (A21089-XX) to J1 and J4 of the PC Interface Box and the other end (2 connectors) to COM1 (Communication) and J1 (Auto ON/OFF) of the Computer connectors.

Note ☞ *J1 connector is only available in Computers provided with Auto ON/OFF Board inside (factory installed).*

5. Re-install the Back Cover of the PC Interface Box.
6. Check to set proper Line Voltage on PC. Plug the Power Line cable for the Computer to a 110 VAC or 230 VAC socket.



3.4.4 COLLIMATOR ERROR SIGNAL (OPTIONAL)

This option must be requested on the customer order. For systems using an Automatic Collimator, the X-ray exposure can be inhibited due to a Collimator Error. This signal can be used only for one Automatic Collimator in the system, special interconnection should be required when two Collimators are present.

Connect two wires from the Collimator to Terminal Block 4TS3-20 (Collimator Error signal) and 3TS1-18 (or another GND in this Terminal Block). Collimator Error signal goes (through the Interface Cable) from 4TS3-20 in the Generator Cabinet to terminal J2-6 in Connector J2 of the ATP Console CPU Board. If the system is not provided with Automatic Collimator connect 4TS3–20 to GND (3TS1–18).

3.4.5 DOOR INTERLOCK SIGNAL

Connect two wires from the Room Door Interlock Switch(es) to Terminal Block 3TS1-22 (Door signal) and 3TS1-23 (Door Rtn - gnd). If the X-ray Room is not provided with a Door signal, place a jumper between both connections in Terminal Block 3TS1.

3.4.6 WARNING LIGHT SIGNAL

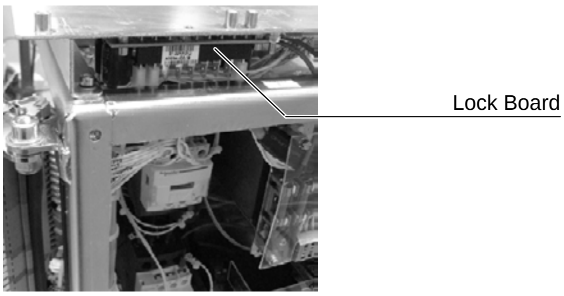
Room Warning Lamp(s) for "*X-ray ON*" indication can be externally powered, or internally by the Terminal Block 3TS1. Room Lamp(s) must be connected through the Terminal Block 3TS1-47 and 3TS1-48 (internal relay on Interface Control Board) to enable the Generator switches On/Off the Room Warning Lamps. (*Refer to Section 5.2 – I/F-008*).

3.4.7 COLLIMATOR LAMP AND SYSTEM LOCKS

The Generator can supply power to the Collimator Lamp and System Locks (Table, Vertical Bucky, etc.)

Connect wires from the Collimator Lamp to Terminal Block TB7-3 (24 VAC) and TB7-4 (0 VAC) of the Lock Board.

Connect wires from the Locks to Terminal Block TB7-5 (+24 VDC) and TB7-6 (0 VDC) of the Lock Board.



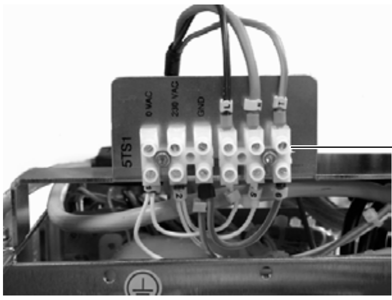
Note ☞ *When required, voltages (VAC and VDC) on TB7 can be changed by connecting their respective wires to the other available terminals on the Input Transformer 6T2. (Refer to Schematics 543020XX*).

CAUTION

At this point, proceed to perform the complete Configuration and the Calibration procedures except for AEC, Fluoro and ABC procedures. Once Configuration and Calibration tasks have been performed, proceed with the rest of the Installation and Calibration tasks.

3.4.8 230 VAC POWER SUPPLY FOR TWO EXTERNAL DEVICES (OPTIONAL)

Optionally the Generator can be provided with a Terminal Strip 5TS1 at the top of the cabinet in order to make easy the connection to supply 230 VAC for two external devices such as two Detector Power Supplies.



3.4.9 BUCKYS

Connect the Bucky as indicated in the Section 5.2 (*Interconnections Maps for Buckys*), and test them before connecting the Ion Chambers.

The following table represents the standard Bucky cable connections:

SYSTEM	CABLE FROM BUCKY IS CONNECTED TO
Systems with 1 or 2 Bucky	Terminal Block 3TS1 of the Generator Cabinet *(Refer to Section 5.2 – Bucky)*
Systems with 3 or 4 Bucky	Terminal Block TB2 of the optional "*Tomo / Bucky Adaptation Board*", located in the Generator Cabinet (*Refer to* "*Tomo / Bucky Adaptation Board*" and *Section 5.2 – Buckys).*
The Bucky of a RAD only Table with Tomo Device	Terminal Block TB1 of the optional "*Tomo / Bucky Adaptation Board*", located in the Generator Cabinet (*Refer to* "*Tomo / Bucky Adaptation Board*" and *Section 5.2 – Buckys).*

Note ☞ *Optional "Tomo / Bucky Adaptation Board" is required to install more than two Buckys in the System. (Refer to the "Tomo / Bucky Adaptation Board" and the Manual for the Bucky).*

If the "Bucky Start" signal enters the Bucky through a relay or another inductive device (a.e. a motor), it is mandatory to add the supplied R2–C2 close to each Bucky, so they have to be connected on the terminal output of the Bucky assembly. The R-Cs are attached to the Generator harness in a bag.

If "Bucky Start" signal enters the Bucky through an optocoupler, do not add the supplied R2–C2 for the Bucky.

Note ☞ *The operations described above will prevent noises and uncontrolled Bucky movements that can cause exposure cutting or console blocking.*

HOW TO INTERFACE NON STANDARD BUCKYS

Note ☞ *Perform this section only if the interconnections for the Bucky are not indicated in Section 5.2 (Interconnections Maps for Buckys).*

<u>Connection of Bucky-1:</u>

1. TS1-1 in the generator is to connect one of the wires to provide the power supply for the Bucky. In the Generator, TS1-1 is “free of voltage” (there is no wire connected) and therefore a jumper needs to be made to supply power for the Bucky: add a jumper between TS1-1 and TS1-26 for a voltage of 220-240 VAC or add a jumper between TS1-1 and TS1-27 for a voltage of 115 VAC.
2. TS1-3 is the return of this power supply (0 VAC).
3. TS1-2 is the voltage reference of the signal that will be sent to the Bucky to start. If the Bucky needs to send 0 VAC as “Bucky Start” (Bucky-1 Drive) make a jumper between TS1-2 and TS1-3, if the Bucky needs to send the power supply voltage as “Bucky Start” (Bucky-1 Drive) make a jumper between TS1-2 and TS1-26 or 27 as required.
4. TS1-4 is the connecting point of the “Bucky Start” signal for the Bucky (Bucky-1 Drive).
5. TS1-5 and TS1-6 is the signal to know if the Bucky is moving. TS1-6 is already connected to ground inside the Generator and provides this reference voltage to the contact inside the Bucky. TS1-5 is the “Bucky moving” signal (Bucky Motion) that is referenced to ground when the Bucky is ready for an exposure.

<u>Connection of Bucky-2:</u>

1. TS1-8 in the generator is to connect one of the wires to provide the power supply for the Bucky. In the Generator, TS1-8 is “free of voltage” (there is no wire connected) and therefore a jumper needs to be made to supply power for the Bucky: add a jumper between TS1-8 and TS1-26 for a voltage of 220-240 VAC or add a jumper between TS1-8 and TS1-27 for a voltage of 115 VAC.
2. TS1-10 is the return of this power supply (0 VAC).
3. TS1-9 is the voltage reference of the signal that will be sent to the Bucky to start. If the Bucky needs to send 0 VAC as “Bucky Start” (Bucky-2 Drive) make a jumper between TS1-9 and TS1-10, if the Bucky needs to send the power supply voltage as “Bucky Start” (Bucky-2 Drive) make a jumper between TS1-9 and TS1-26 or 27 as required.
4. TS1-11 is the connecting point of the “Bucky Start” signal for the Bucky (Bucky-1 Drive).
5. TS1-12 and TS1-13 is the signal to know if the Bucky is moving. TS1-13 is already connected to ground in the Generator and provides this reference voltage to the contact inside the Bucky. TS1-12 is the “Bucky moving” signal (Bucky Motion) that is referenced to ground when the Bucky is ready for an exposure.

3.4.10 TOMO DEVICE

RAD Only Table

The Tomo cable (A3083-01) from connector J13 of the "*ATP Console CPU Board*" has to be connected to the Terminal Blocks TB1 and TB2 of the optional "*Tomo / Bucky Adaptation Board*", located in the Generator Cabinet.

The cables from the Tomo Device are also connected to the Terminal Blocks TB1 and TB2 of the optional "*Tomo / Bucky Adaptation Board*". Refer to the "*Tomo / Bucky Adaptation Board*" for more detailed information and interface. (*Refer also to the Manuals of the Tomo Device).*

Note ☞ *RAD only Table requires the optional "Tomo / Bucky Adaptation Board".*

RF Table

The Tomo cable (A6742–01) from connector J13 of the "*ATP Console CPU Board*" has to be connected to the "*RF Adaptation Board*".

Some RF Tables with Tomo send Tomo Time information (binary code) to the Generator. Each Table has a specific codification of this binary code. In order to ensure proper functioning, the Table type has to be specified for interfacing it with the Generator.

3.4.11 ION CHAMBERS (OPTIONAL)

The "*AEC Control Board*" (A3012-XX) must be installed on the ATP Console CPU Board before installing the Ion Chamber(s). The optional "*AEC Adaptation Board*" (A3263-03) is also required except for Systems with **only one** AID or Vacutec Ion Chamber type. (*Refer to the "Ion Chamber" Service Manuals*).

Systems with only one AID or Vacutec Ion Chamber type:

Connect the Ion Chamber cable to the Terminal Block 3TS1 of the Generator Cabinet and Connector J5 of the ATP Console CPU Board, as indicated in *Section 5.2 – AEC / Ion Chambers.*

Systems that require the optional "AEC Adaptation Board":

For Systems with more than one Vacutec, AID or similar (Comet) Ion Chamber type, or with another type of Ion Chamber (even if it is only one), perform the following tasks in the order described:

Note ☞ *The Generator is only compatible with Ion Chambers that output a positive ramp.*

1. If an Ion Chamber requires High Voltage (200 to 500 VDC), the Generator must include an Interface Control Board (version A3009-09/12) that supplies this voltage.

   The Interface Control Board must have Jumpers from W3 to W8 in “A” position. This High Voltage is supplied through Terminal Block 3TS1-39 “*PT SPLY*” of the Generator Cabinet and sent with a wire to TB1-9 of the “*AEC Adaptation Board*”.

ION CHAMBERS WITH HIGH VOLTAGE			
GE	BVM-CGR	PHILIPS AMPLIMAT	
		AMP-Phenolic Connector	DB 15 Connector
300 VDC	230 VDC	500 VDC	400 VDC

Notes: – If the System included both GE and BVM-CGR Ion Chambers, Terminal TB1-9 must supply 270 VDC.
– Philips Amplimat Ion Chambers can not be installed with GE or BVM-CGR Ion Chambers.

WARNING

DO NOT CONNECT ANY ION CHAMBER TO THE GENERATOR CABINET UNTIL HIGH VOLTAGE IS EITHER VERIFIED OR ADJUSTED TO THE VALUES REQUIRED. OTHER VOLTAGE COULD DAMAGE THE ION CHAMBERS.

Turn the Generator ON and verify voltage in TB1-9 according to the Ion Chambers to be installed. If necessary, adjust the High Voltage at Potentiometer R20 of the Interface Control Board. Turn the Generator OFF after adjustment.

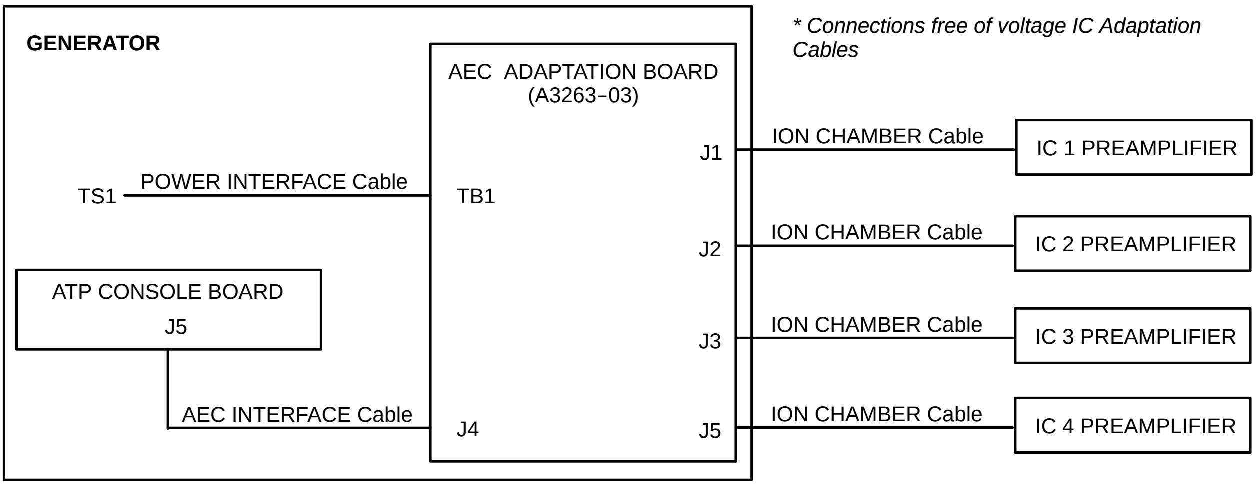
2. Connect each Ion Chamber cable to J1 (IC1), J2 (IC2), J3 (IC3) or J5 (IC4) of the “*AEC Adaptation Board*”. The code for the Ion Chamber cable supplied by the Generator manufacturer is A3253–01.

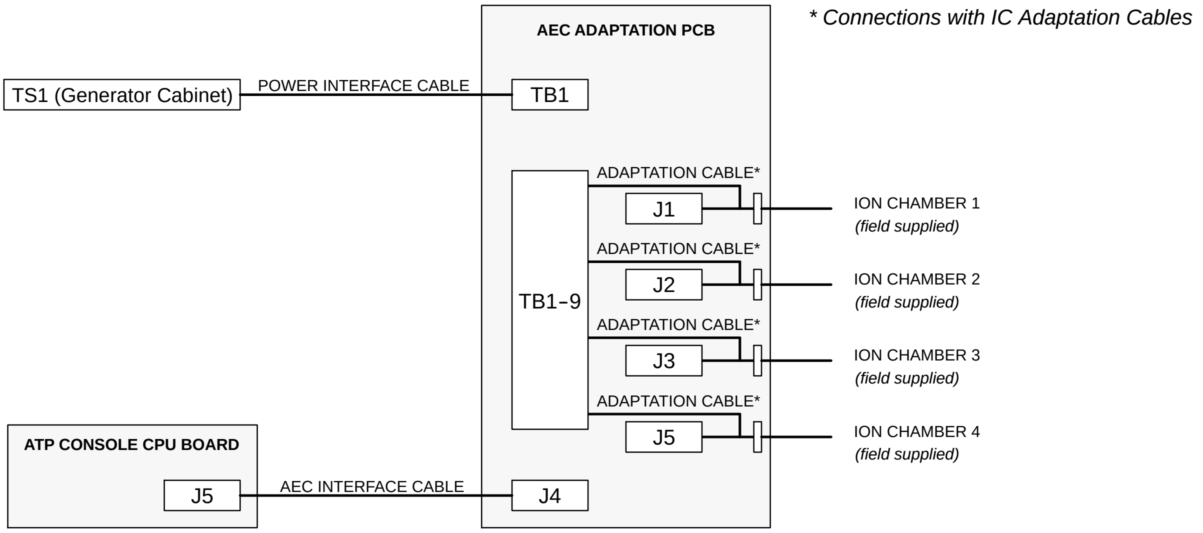
Note ☞ *Same Ion Chamber types have to be installed in consecutive order starting at J1 (IC1). In the case of using four Ion Chambers, IC3 and IC4 must have the same film/cassette combination.*

Note ☞ *The Vacutec, AID or similar Ion Chamber type is directly connected to the “AEC Adaptation Board”. For Comet Ion Chambers, cable connection has to be made previously through the Comet Preamplifier PA-021 and then directly to the “AEC Adaptation Board”.*

For other cases, a cable adapter is required. The Generator manufacturer has the following cable adapters available: GE (A3082–01), CGR-BVM (A3081–01), Philips Amplimat (A3080–01/02 with DB-15 or A6727-01/02 with Phenolic connector) and MEDYS (A6715–01).

Illustration 3-4
Four Ion Chamber Connection





3. Configure Jumpers from JP1 to JP8 and from JP13 to JP16 according to the group of Ion Chamber type:

ION CHAMBER TYPE	JUMPERS POSITION		
	JP3, JP4, JP7, JP8	JP1, JP2, JP5, JP6	JP13, JP14, JP15, JP16
IC1 = IC2 = IC3 = IC4	B	B	B
IC1 = IC2 = IC3	B	B	A
IC1 = IC2	B	A	A
IC1 ≠ IC2 ≠ IC3 ≠ IC4	A	A	A

4. Each type of Ion Chamber requires a specified reference voltage for "*Area Selections*" and "*AEC Reset*" signals:

   - Vacutec, Claymount, AID and Comet Ion Chambers require GND (TB1-10).
   - MEDYS, CGR-BVM, GE and Philips Amplimat Ion Chambers require +24 VDC (TB1-4).

   The reference voltage is provided from: TB1-7 "*Relay 1*" for IC1; TB1-6 "*Relay 2*" for IC2; TB1-5 "*Relay 3*" for IC3; and TB1-8 "*Relay 4*" for IC4.

   For each group of Ion Chambers of the same type, connect a wire between each of the above mentioned terminals to TB1-10 (GND), TB1-4 (+24 VDC) or TB1-3 (+12 VDC) depending on the voltage required (*examples: for four MEDYS Ion Chambers add only a wire-jumper between TB1-7 and TB1-4; or for one MEDYS Ion Chamber as IC-1 and one COMET Ion Chamber as IC-2 add a wire-jumper between TB1-7 and TB1-4, and another wire between TB1-6 and TB1-10*).

DO NOT TURN ON THE GENERATOR UNTIL THE INPUT SIGNALS OF ALL THE ION CHAMBERS ARE CONNECTED TO THE REQUIRED VOLTAGE. OTHER VOLTAGE MIGHT DAMAGE THE ION CHAMBERS.

5. Ion Chambers output must be 0 VDC when there is no-radiation (No-Offset adjustment). If an Ion Chamber output has an offset, it must be adjusted to 0 VDC with the respective Potentiometer.

   Configure Jumpers from JP9 to JP12 and turn ON the Generator only to adjust the following Potentiometers (if needed) according to the Ion Chamber output:

ION CHAMBER OUTPUT	**JUMPERS POSITION**			
	JP9 (IC1)	**JP10 (IC2)**	**JP11 (IC3)**	**JP12 (IC4)**
NO-OFFSET ADJUSTMENT	A	A	A	A
OFFSET ADJUSTMENT	B	B	B	B
TEST POINT AND POTENTIOMETER (ONLY IF JUMPER IS IN "B" POSITION)	TP1 – R11	TP2 – R8	TP4 – R2	TP12 – R5

6. Turn OFF the Generator and connect the AEC Interface cable (A3251–01) between Connector J5 of the ATP Console CPU Board and Connector J4 of the "*AEC Adaptation Board*".

3.4.12 PHOTOMULTIPLIER (OPTIONAL)

Connect the optional Photomultiplier as indicated in the schematic “*Section 5.2 – Photomultiplier (IF-011) and RF System (IM-300)”.*

Note ☞

“*AEC Control Board*” version A3012-06/07/09 is factory installed when the Photomultiplier option is ordered. It can be used for AEC with up to four Ion Chambers, AEC controlled by the Photomultiplier, and ABC performed with the Photomultiplier or the TV Camera.

The Photomultiplier requires negative High Voltage controlled by the Generator. The “*Interface Control Board*” (version A3009-09 or A3009-12) in the Generator Cabinet supplies this type of voltage. Check on this board that Jumpers from W3 to W8 are in “B” position. High Voltage is supplied through Terminal Block 3TS1-39 “*PT SPLY*” and 3TS1-42 “*IC GND*” of the Generator Cabinet.

CAUTION

The High Voltage Power Supply of the Generator can be used to provide either Positive High Voltage to the Ion Chambers or Negative High Voltage to the Photomultiplier, not both. Never connect the Photomultiplier if the Jumpers W3 to W8 in the “Interface Control Board” are in “A” position (positive voltage).

In order to have the Photomultiplier working with AEC, it has to be externally selected by using the “–PT SEL (–SFC)” signal in terminal 4TS3-7 of the Generator Cabinet.

If the System always uses the Photomultiplier for AEC, connect a wire between 4TS3-7 and GND (from 3TS1) in the Generator Cabinet.

If the System is provided with a Photomultiplier Selection signal, use one of the Spare signals in the “*RF Adaptation Board*” (*refer to Section 3.4.15).*

3.4.13 RAD & FLUORO TABLE (SPOT FILM DEVICE)

The "*RF Adaptation Board*" is installed in all Conventional RF Generators. It provides circuitry to induce compatibility between numerous Rad and Fluoro Tables with the Generator. Connections between the "*RF Adaptation Board*" and the Generator are factory performed.

The Fluoro cable (A3267-01) from connector J1 of the "*Fluoro CPU Board*" must be connected to J1 of the "*RF Adaptation Board*".

INTERFACE OF RF SYSTEMS

The Generator can be interfaced with the main RF Systems. Additional Interface Schematics can be provided with this Service Manual whenever the RF System is indicated in the Generator order. Perform all the connections and set all the jumpers according to the respective interface as detailed in each Schematic.

If Interface Schematics are not available, refer to the Manuals of the Table and/or Spot Film Device for the interface signals required as well as the schematics in *Section 5.2 - RF System*. Perform connections as described in the points below:

- The "*PREP*", "*FLUORO*" and "*RAD EXPOSURE*" orders from the Table to the "*RF Adaptation Board*" are adapted to give the "*-SF PREP*", "*-FT SW CMD*" and "*-FL EXP* (*RAD EXPOSURE)*" signals of the Generator. Each one has three jumpers for its configuration according to the type of voltage given by the Table. They share the same Return to the Table.

  Insert or remove the following Jumpers on the "*RF Adaptation Board*" according to the type of signals given from the Table for PREP, RAD EXPOSURE and FLUORO.

TABLE SIGNAL TYPE	CONNECTION ON RF ADAPTATION BOARD
FREE OF VOLTAGE (DRY CONTACT)	INSERT Jumpers: JP1, JP2, JP3, JP4, JP8, JP9, JP10, JP12, JP13 and JP14.
24 VDC	INSERT Jumpers: JP1, JP3, JP4, JP8, JP9, JP10, JP12, JP13 and JP14.
	REMOVE Jumper: JP2
230 VAC	REMOVE Jumpers: JP1, JP2, JP3, JP4, JP8, JP9, JP10, JP12, JP13 and JP14.
115 VAC	INSERT Jumpers: JP1, JP8 and JP12.
	REMOVE Jumper: JP2, JP3, JP4, JP9, JP10, JP13 and JP14.

- The "*READY*" output of the Generator is sent through a N.O. (Normally Open) contact as "*GEN READY*" to the Table to inform that the Generator is ready for a RAD Exposure.
- The "*ALOE*" output of the Generator is sent through a N.O. contact to the Table as "*EXPOSURE ON"* to acknowledge the RAD exposure, or as "*EXPOSURE END"* to advance the film to the next position. Set Jumper JP17 in position A for "*EXPOSURE ON"* or in position B for "*EXPOSURE END*" (50 ms pulse at the end of the RAD exposure). Any of these signals can also be configured for "*NO FLUORO ACKNOWLEDGE"* by setting Jumper JP16 in position A or for "*FLUORO ACKNOWLEDGE*" by setting Jumper JP16 in position B.
- "*GEN READY*" and "*EXPOSURE ON / EXPOSURE END*" share the same return to the Table which is common for both N.O. contacts.

TABLE SIGNALS	CONNECTION ON RF ADAPTATION BOARD
PREP order	TB4-2
RAD EXPOSURE order	TB4-3
FLUORO order	TB4-4
RETURN of PREP, RAD EXPOSURE and FLUORO	TB4-20 *GND* (Jumper JP2 is inserted – *free of voltage*) or TB4-1 (Jumper JP2 is removed)
GENERATOR READY	TB4-9
EXPOSURE ON / EXPOSURE END	TB4-7
NO FLUORO ACKNOWLEDGE / FLUORO ACKNOWLEDGE	
COMMON of GENERATOR READY and EXPOSURE ON / END	TB4-8

- An independent "*FLUORO FOOT SWITCH*" can be connected directly to TB1-1 and TB1-2 of the "*RF Adaptation Board*" .

SELECTION OF TABLE OPERATION MODE FROM THE GENERATOR (OPTIONAL)

Some RF Tables (Prestige, Prestilix, Televix, Telegem, etc) need a selection of Table Operation Mode from the Generator.

A binary code from the Generator (WS1 and WS2) is sent to the "*RF Adaptation Board*". It is decoded and sent to the Table through N.O. contacts as "*SFD SELECT*", "*DIRECT SELECT*", "*DIGITAL SELECT (DSI)*" and "*SPECIAL SELECT*" to select the operating mode. These signals share the same return to the Table which is common for all the N.O. contacts.

Connect the wire marked “*Tomo*” (WS2) of the “*Tomo Cable*” (A6742-xx) to TB3-5 of the “*RF Adaptation Board*”.

Connect the wires from the Table as indicated below:

WIRE FROM TABLE SIGNAL	CONNECTION ON RF ADAPTATION BOARD
SFD SELECT	TB4-5
DIRECT SELECT	TB1-7
DIGITAL SELECT (DSI)	TB1-6
SPECIAL SELECT	TB1-8
SEL RETURN (common)	TB4-6

3.4.14 IMAGE SYSTEM

The “*RF Adaptation Board*” is the interface of the Generator with an Image System and, if needed, with the Image Intensifier. (*Refer to schematics in Section 5.2 – RF System).*

FLUORO PULSES SYNCHRONISM

Fluoro pulses must be synchronized with the Vertical Synchronism of the TV Camera. Connect the signals according to the following situations:

- If the Imaging System provides a Digital output signal for Vertical Synchronism, connect it as “EXP SYNC+” to J2-4, its return as “EXP SYNC–” to J2-9, and set Jumper JP19 in C position, on the “*RF Adaptation Board*”.
- If the Imaging System does not provide the Vertical Synchronism signal, connect the Video Cables as indicated below:

<table>
<tr><th>VIDEO CABLES OF IMAGING SYSTEM</th><th colspan="2">CONNECTION ON RF ADAPTATION BOARD</th></tr>
<tr><td>FROM IMAGING SYSTEM CONTROL</td><td colspan="2">VID IN (BNC)</td></tr>
<tr><td>TO TV MONITOR</td><td colspan="2">VID OUT (BNC)</td></tr>
<tr><td>–</td><td colspan="2">Jumper JP19 in B position</td></tr>
<tr><td rowspan="2">–</td><td rowspan="2">Jumper JP23 to connect or to isolate the shield of the Video Cable (BNC) to Generator GND</td><td>Inserted = Connected</td></tr>
<tr><td>Removed = Isolated</td></tr>
</table>

Note

Some TV Monitors provide a Video output connector (BNC).
In this case, to avoid noises on the Image, connect directly:
– The Video signal from the Imaging System to the Monitor
– The Video output of the TV Monitor to the VID IN of the “RF Adaptation Board”.
– Set Jumper JP19 in B position.

ABC INTERFACE

Connect the signals according to the following situations:

- If the Imaging System provides an ABC output signal proportional to the brightness, connect the “ABC SIGNAL” to TB2-12, its return as “GND” to TB2-14, set Jumper JP21 in B position and remove Jumper JP22, on the “*RF Adaptation Board*”.
- If the Imaging System does not provide an ABC output signal proportional to the brightness, connect Video Cables as indicated below:

<table>
<tr><th>VIDEO CABLES OF TV SYSTEM</th><th colspan="2">CONNECTION ON RF ADAPTATION BOARD</th></tr>
<tr><td>FROM IMAGING SYSTEM CONTROL</td><td colspan="2">VID IN (BNC)</td></tr>
<tr><td>TO TV MONITOR</td><td colspan="2">VID OUT (BNC)</td></tr>
<tr><td>–</td><td colspan="2">Jumpers JP20 and JP21 in A position</td></tr>
<tr><td>–</td><td colspan="2">Insert Jumper JP22</td></tr>
<tr><td rowspan="2">–</td><td rowspan="2">Jumper JP23 to connect or to isolate the shield of the Video Cable (BNC) to Generator GND</td><td>Inserted = Connected</td></tr>
<tr><td>Removed = Isolated</td></tr>
</table>

According to the type of “*AEC Control Board*” (A3012–xx) installed, check that the ABC output signal is correctly routed between J3–9 on the “*RF Adaptation Board*” and the terminal in the Generator Cabinet indicated in the table below (*for more details, refer to Section 5.2 – RF System (IM-300)”.*

RF ADAPTATION BOARD	with AEC Control Board A3012–02	with AEC Control Board A3012–06/07
J3–9 (ABC OUT)	3TS1–51 (PT INPUT)	4TS3-18 (ABC OUT)

INTERFACE OF RF SYSTEMS

Additional Interface Schematics can be provided with this Service Manual whenever the RF System is indicated in the Generator order. Perform all the connections and set all the jumpers according to the respective interface as detailed in each Schematic.

If Interface Schematics are not available, refer to the Manuals of the Image System and Image Intensifier for the interface signals required as well as to schematics in *Section 5.2 – RF System*. Perform the connections as indicated in the following points.

Imaging System Interface

The “VIDEO UNBLANK” output is activated with RAD preparation (PREP ACTIVE), the full Image Blanking on the TV Monitor is obtained. This prevents a flash on the TV Monitor during radiographic exposures. The following connection is provided through a “dry contact” (free of voltage):

SIGNALS TO IMAGING SYSTEM	CONNECTION ON RF ADAPTATION BOARD
VIDEO UNBLANK	TB2-10
VIDEO UNBLANK RETURN	TB2-11

The “LAST IMAGE HOLD (LIH)” output is activated at the same time that the X-rays are switched-off (Fluoro not active). The last full image is maintained on the TV Monitor until the X-rays are switched-on again. Set Jumpers JP11 and JP15 in B position for “LIH” function. The following connection is provided through a “dry contact” (free of voltage):

SIGNALS TO IMAGING SYSTEM	CONNECTION ON RF ADAPTATION BOARD
LAST IMAGE HOLD (LIH)	TB2-8
LAST IMAGE HOLD RETURN (LIH RTN)	TB2-9

It is recommended to connect the 24 VDC from the Imaging System to TB2-13 “LIH ENABLE” on the “*RF Adaptation Board*”.

Pulsed Fluoro at variable rate (a.e. from 30 PPS to 1 PPS) needs an interface from the Generator to the Imaging System in order to freeze or capture a new image. This interface is achieved with the connections indicated in the table below, with each signal passing through the Open Collectors and Emitters to Ground of the corresponding transistor.

SIGNALS FROM GENERATOR	CONNECTION ON RF ADAPTATION BOARD		IMAGING SYSTEM
	INPUT	OUTPUT	
MEMORY ENABLE	J1-13	J2-8	VID MEM ENABLE –
–	24 VDC	J2-3	VID MEM ENABLE +
MEMORY GATE	J1-14	J2-7	MAINGATE –
–	24 VDC	J2-2	MAINGATE +

Image Intensifier Field Selection (Zoom)

Normally, the Image Intensifier Field Selections are connected directly from the Table to the Image Intensifier. If the outputs from the Table are not compatible with the inputs on the Image Intensifier, adapt these selections on the "*RF Adaptation Board*" as indicated below:

SELECTIONS FROM TABLE	CONNECTION ON RF ADAPTATION BOARD		IMAGE INTENSIFIER
	INPUT	OUTPUT	
I.I. MINIMUM	TB4-11	TB2-1	ZOOM 1
I.I. MEDIUM	TB4-12	TB2-2	ZOOM 2
I.I. MAXIMUM	TB4-13	TB2-3	ZOOM 3
-	TB4-20 (Generator GND)	TB2-4	ZOOM COMMON
Set Jumpers JP5, JP6 and JP7 in B position			

The Selections from the Table have to send Ground (from the Generator) when they are activated. The outputs to the Image Intensifier (ZOOM 1, 2, 3) are sent as "dry contacts" (free of voltage). The Common is sent as "ZOOM COMMON".

TV MONITOR IMAGE REVERSE SELECTION

Image Reversal Selections are normally connected directly from the Table to the Imaging System. If the outputs from the Table are not compatible with the inputs on the Imaging System, adapt these selections on the "*RF Adaptation Board*" as indicated below:

SELECTIONS FROM TABLE	CONNECTION ON RF ADAPTATION BOARD		IMAGING SYSTEM
	INPUT	OUTPUT	
HORZ REVERSE	TB4-14	TB2-6	H REV
VERT REVERSE	TB4-15	TB2-7	V REV
-	TB4-20 (Generator GND)	TB2-5	REV COMMON

The Selections from the Table have to send Ground (from the Generator) when they are activated. The outputs to the Image Intensifier (H REV and V REV) are sent as "dry contacts" (free of voltage). The Common is sent as "REV COMMON".

3.4.15 SPARE SIGNALS ON RF ADAPTATION BOARD

Note ☞ *If the RF System has been interfaced using Additional Interface Schematics, some Spare signals may have already been used.*

Spare Signals for direct connections:

SIGNAL NAME	CONNECTIONS ON RF ADAPTATION BOARD	
SPARE 1	J3-12	TB3-1
SPARE 2	J3-13	TB3-2
SPARE 3	J3-14	TB3-3
SPARE 4	J3-15	TB3-4
SPARE 5	J3-10	TB2-16

Spare Signals through Optocouplers, all inputs have to be 24 VDC:

CONNECTIONS ON RF ADAPTATION BOARD			
INPUT		OUTPUT	
IN 1	TB4-16	OUT 1	TB2-17
IN 2	TB4-17	OUT 2	TB2-18
IN 3	TB4-18	OUT 3	TB2-19
IN 4	TB4-19	OUT 4	TB2-20
IN COMMON	TB4-10	GND	TB2-14

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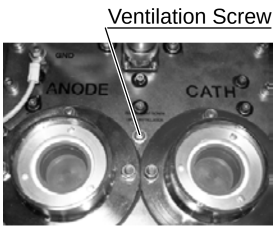
SECTION 4 FINAL INSTALLATION AND CHECKS

4.1 HV TRANSFORMER

CAUTION

This point does not apply to the hermetic HV Transformers (black aluminium HV Transformers).



The HV Transformer contains “Shell Diala AX” oil. Check that there is no oil leakage. If leakage is found, remove the oil fill plug from the top of the HV Transformer and verify that the oil level is within 20 mm (3/4”) from the top of the HV Transformer. Add “Shell Diala AX” oil if necessary.

Unscrew the Ventilation Screw from the top of the HV Transformer.

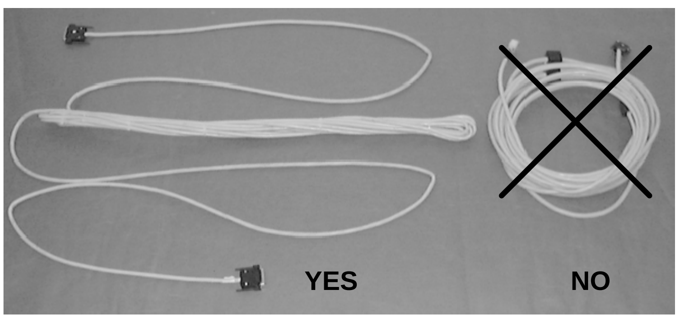
4.2 CABLE FASTENING AND COVERS

Note ☞ *Before re-installing cabinet covers, perform the rest of the required Calibration procedures (i.e. AEC, Fluoro, ABC).*

Check that all electrical connections are firm and secure. Cables should be correctly routed. *(Refer to Section 3.1)*

CAUTION

In order to avoid signal interferences, it is strongly recommended to fold and fasten close to the Generator Cabinet the portion of cables not routed (see picture below). Never wrap in circles.



Assemble both parts of the Cabinet Cover using the screws. Position the Cover over the Generator Cabinet connecting the internal ground wires to the Cover. Finally secure the Cover to the Generator Cabinet with the screws on both sides.

The Power Line, High Voltage and Interconnections cables must pass through the corresponding cable outlets and be fixed with their fastening plates.

Cover Assembly

Cable Outlets and Fastening Plates

SECTION 5 SYSTEM INTERCONNECTIONS

5.1 SYSTEM INTERCONNECTION SIGNALS

All input signals are active low. This means the inputs must be pulled to ground (chassis ground of the Generator) thru relay contacts, by a transistor or other switching device. The current requirement of the switch is less than 10 mA.

CAUTION

Do not apply 115 / 220 VAC logic signals to any of the logic inputs. If 115 / 220 VAC logic signals are used in the X-ray table (i.e. fluoro command), these signals must be converted to a contact closure by a relay.

The outputs signals from the Generator to the subsystem devices are usually active low (switched to chassis ground of the Generator). The outputs are open collector transistor drivers with a maximum current of 0.5 Amperes.

Table 5-1
System Interconnection Signals

SIGNAL NAME	SIGNAL DESCRIPTION
ABC OUT	This analog input is the output from the RF Adaptation Board or from Imaging System. A DC level signal is used for systems that uses a Imaging Systems for the Brightness level. When a DC level is used, an input range of 0 to 10 volts is required. The stabilized value of the input will be between 5 and 7 volts.
–ABC	This signal selects the Fluoro operation mode: a low signal selects Automatic Brightness Control, a high signal selects Manual Mode.
ALOE	This high going signal indicates the Actual Length Of Exposure. This signal is used to interface to some Spot Film system and is used to advance the Spot Film device to the next position when multi-exposures are made on the same film.
–ALOE	This low going signal indicates the Actual Length Of Exposure. This signal is used to interface to some Spot Film system and is used to advance the Spot Film device to the next position when multi-exposures are made on the same film.
–AUTO OFF	This signal only applies to Generator systems with the Stand-alone option.
AUX BUCKY SPLY	External voltage supply required for the Bucky motion, when this voltage is not +24 VDC.
–BEEP	A low signal energizes the Fluoro buzzer.
–BUCKY 1 DR CMD	A low signal to the Interface Control Board as a command to output a Bucky-1 (normally the Table Bucky) drive signal.
–BUCKY 1 MOTION	This low going signal from Bucky-1 indicates Bucky-1 motion, and therefore the exposure is enabled.
BUCKY 1 DR	This signal is originated from the Bucky supply of the Power Module when an exposure order. It starts the Bucky.
–BUCKY 2 DR CMD	A low signal to the Interface Control Board as a command to output a Bucky-2 (normally the Vertical Bucky Stand) drive signal.
–BUCKY 2 MOTION	This low going signal from Bucky-2 indicates Bucky-2 in motion, and therefore the exposure is enabled.

Table 5-1 (cont.)
System Interconnection Signals

SIGNAL NAME	SIGNAL DESCRIPTION
BUCKY 2 DR	This signal is originated from the Bucky supply of the Power Module when an exposure order. It starts the Bucky.
–BUCKY EXP	This low going (0 volts) signal starts the Bucky exposure. The signal originates on the Interface Board
BUCKY SPLY	Voltage supply required for the Bucky drive command.
CAM SYNC	Sync. signal from Imaging System. This signal is used for timing in the Generator.
–CAM FL EXP	This signal interfaces to any Video Camera. A low signal tells the camera that the Generator is making a Fluoro exposure and the Camera should unblank.
C–HT CLK	Serial data clock to the HT Control Board. This clock synchronizes the C–HT DATA signal.
C–HT DATA	Serial data to the HT Control Board. This data is synchronous with the C–HT CLK signal.
–COLLIMATOR	This active low signal indicates that NO EXPOSURE HOLD condition exists at the Collimator. This input is read only when the Radiographic Tube is selected.
–COMP	This low signal indicates that a Compression Device has been selected. This input changes the original density to the appropriate density for Compression selection.
–DOOR	This low signal is the interlock for the Door of the X-ray room.
–DSI SEL	This low going signal from a DSI device indicates that the DSI has been selected and will be used for the next exposure.
–EXP	Low going Expose signal to the HT Control Board. If –PREP is low then a Spot Film or RAD exposure is made, else a Fluoro exposure is made.
FL DSI	Sync. signal from the DSI device. This signal is used for timing in the Generator.
–FL EXP	This is the EXPOSURE COMMAND input when the Tube-2 (Fluoro / Spot Film) is selected. If the –SF PREP input is open then a Fluoro exposure is started, and if the –SF PREP input is low then a Spot Film exposure is made.
–FLD1 DR	A low signal to select the right field in the Ion Chamber.
–FLD2 DR	A low signal to select the left field in the Ion Chamber.
–FLD3 DR	A low signal to select the center field in the Ion Chamber.
–FT SW CMD	This low going signal indicates the Fluoro exposure command. It is needed for Pulsed Fluoro at variable rate.
HT–C CLK	Serial data clock from the HT Control Board. This clock synchronizes the HT–C DATA signal.
HT–C DAT	Serial data from the HT Control Board. This data is synchronous with the HT–C CLK signal.
–HT INL	This signal is low when the switch in the high voltage transformer is in the RAD position. This is a safety interlock which prevents an exposure if the high voltage switch (in the HV Transformer) is in the wrong position.
HV PT CRL	This analogic signal (originates in the optional AEC Control Board) controls the output of the HV Power Supply on the Interface Control Board. +5 volts programs the output to be 0 volts, and 0 volts programs the output to approximately –1200 volts.
IC GND	GND for the IC SPLY.
IC1 INPUT	This input is the output of the Bucky 1 Ion Chamber (normally the Table Ion Chamber).
IC2 INPUT	This input is the output of the Bucky 2 Ion Chamber (normally the Vertical Bucky Stand Ion Chamber).
IC3 INPUT	This input is the output of the Spot Film Ion Chamber.
IC SPLY	Power supply for the Ion Chamber. This output should be within the range of 500 to 800 volts.
–kV DWN	A low signal is a command for the HT Control Board to drive the Fluoro kVp DOWN during a Fluoro exposure in ABC mode.
–kV UP	A low signal is a command for the HT Control Board to drive the Fluoro kVp UP during a Fluoro exposure in ABC mode.

Table 5-1 (cont.)
System Interconnection Signals

SIGNAL NAME	SIGNAL DESCRIPTION
−LINE CONT	A low signal energizes the main line contactor K5 in the Power Module.
LINE SYNC	Signal synchronous with the AC line. This signal originates in the Interface Board and is used to synchronize Fluoro exposures with the AC line.
−MAG 1	A low signal selects Magnification-1 mode on the Image Tube.
−MAG 2	A low signal selects Magnification-2 mode on the Image Tube.
−MEM EN	A low signal enables a frame grabber function in some Video Camera.
−MEM GATE	A low signal enables a record function in some Video Camera. Sometime it can be used to start a VCR or other recording device not integrated into the Video Camera.
−NORM	A low signal selects Normal mode on the Image Tube.
−PREP	Commands to the HT Control Board to boost X-ray Tube Filament to the value of mA selected and to start the X-ray Tube Rotor is RAD Tube is selected.
PT INPUT	This analog input is normally the output of the Photo Multiplier Tube in the Image System and is used for Automatic Brightness Control. A DC level signal can be used for systems with solid state pick-up device or the TV Camera for the Brightness level. When a DC level is used, an input range of 0 to 10 volts is required. The stabilized value of the input will be between 5 and 7 volts.
PT SPLY	Power supply output for the Photomultiplier. The level of this signal is controlled by the HV PT CRL.
−READY	This low going signal indicates the system is ready to make an exposure (Prep cycle complete). This signal is used to interface to certain peripheral devices such as Film Changers, etc.
−ROOM LIGHT	This low going signal indicates the X-ray preparation or exposure. This signal is used to interface to the Room X-ray warning light.
−SFC	This low going signal from a Spot Film camera indicates that the Spot Film camera has been selected and will be used for the next exposure.
−SF PREP	This low going signal indicates the system to boost the filament to the level required for the mA selected on the Control Console and prepares the system for a Spot Film. This input is read only when the Tube-2 (Fluoro / Spot Film) is selected.
−STRT DR	A low signal to indicate the start of an exposure to the Ion Chamber.
−THERMOSTAT-1	This signal from X-ray Tube indicates the overheat of the Tube-1.
−THERMOSTAT-2	This signal from X-ray Tube indicates the overheat of the Tube-2.
V SYNC	Vertical Sync pulses from the TV Camera. In Fixed Rate Pulsed Fluoro the X-ray tube is pulsed at line rate. However, with the Variable Rate Pulsed Fluoroscopy option the X-ray tube is pulsed at rate selected by the operator, the rate is driven from the V Sync signal (it is obtained by dividing the timing frequency of the V sync).

5.2 SYSTEM INTERCONNECTION MAPS

Refer to the following maps for details of the wire connections.

SYSTEM INTERCONNECTION

STATOR INTERFACE

ROOM LAMPS

BUCKYS

AEC – ION CHAMBERS

- AEC Compatibility for only one Ion Chamber I/F-003
- AEC Compatibility with AID / VACUTEC / COMET / CLAYMOUNT for more than one Ion Chamber I/M-015
- AEC – Philips Compatibility I/M-014
- AEC – GE Compatibility I/M-018
- AEC – BVM Compatibility I/M-019
- AEC – MEDYS Compatibility I/M-081
- AEC Adaptation A3263–03

RF SYSTEMS (RF TABLE / IMAGE SYSTEM)

- RF Adaptation Interface A3514–04S
- RF Adaptation Board A3514–04
- ABC Interface (jumper setting) IM–300
- Standard System with CC TV Interface IM–302

PHOTOMULTIPLIER

- Photomultiplier Interface I/F-011
- Photomultiplier Amplifier A3168–02

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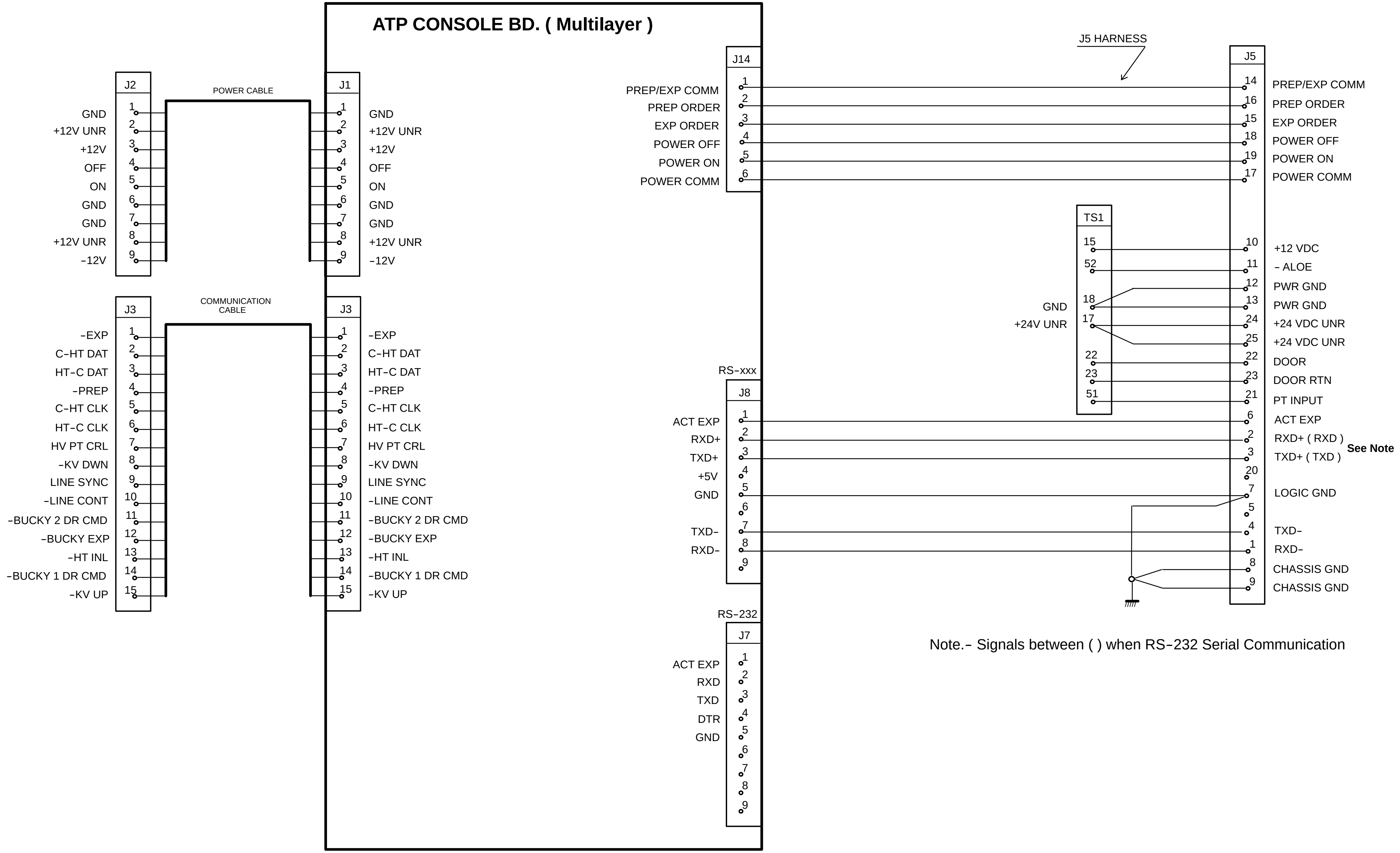
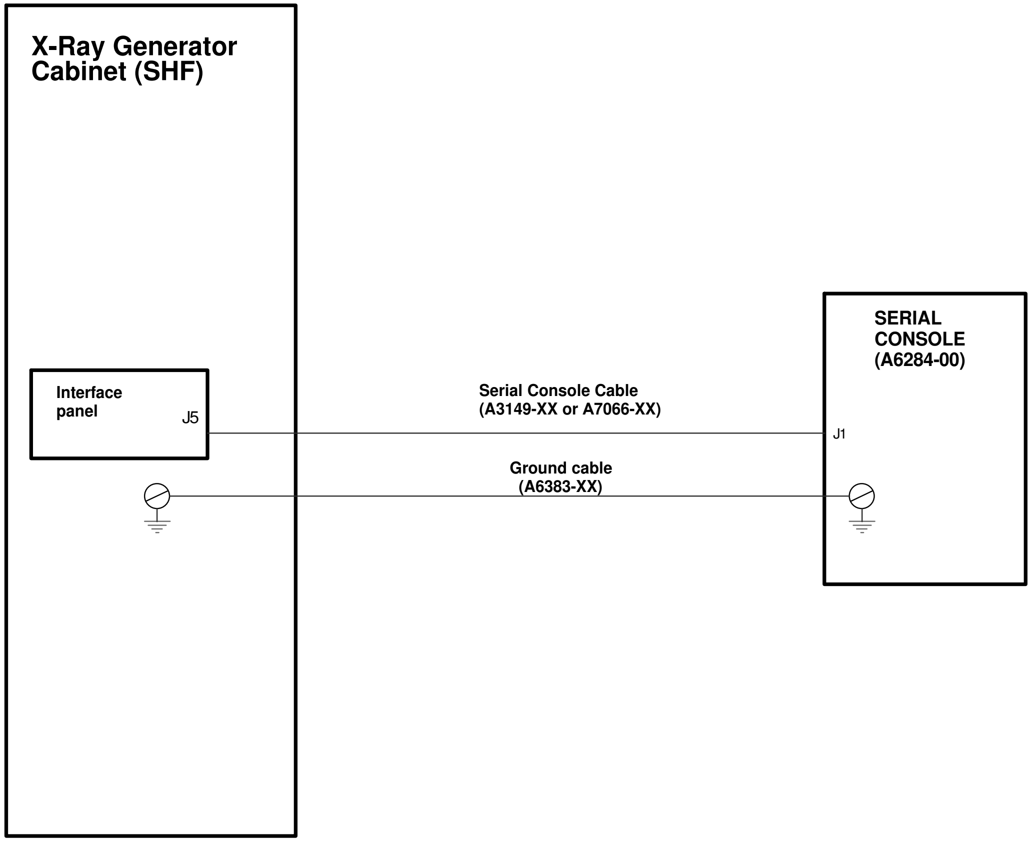


					NAME	DATE	SHEET / OF	DWG: A6188-03
				DRAWING	F. GARCIA	04/04/04	1 / 1	A REV
				REVISED	A. DIAZ	04/04/04		
A	CN 04/148	F. GARCIA	09/09/04	SEDECAL				RS-232/422/485 SERIAL COMMUNICATION
REV	DESCRIPTION	ISSUED BY	DATE					



ROOM DIAGRAM

REV	DESCRIPTION	ISSUED BY	DATE
A	First Release	M.González	04/07/14

	NAME	DATE	SHEET/OF
DRAWING	M.González	04/07/14	1/2
REVISED	A.DIAZ	04/07/14	

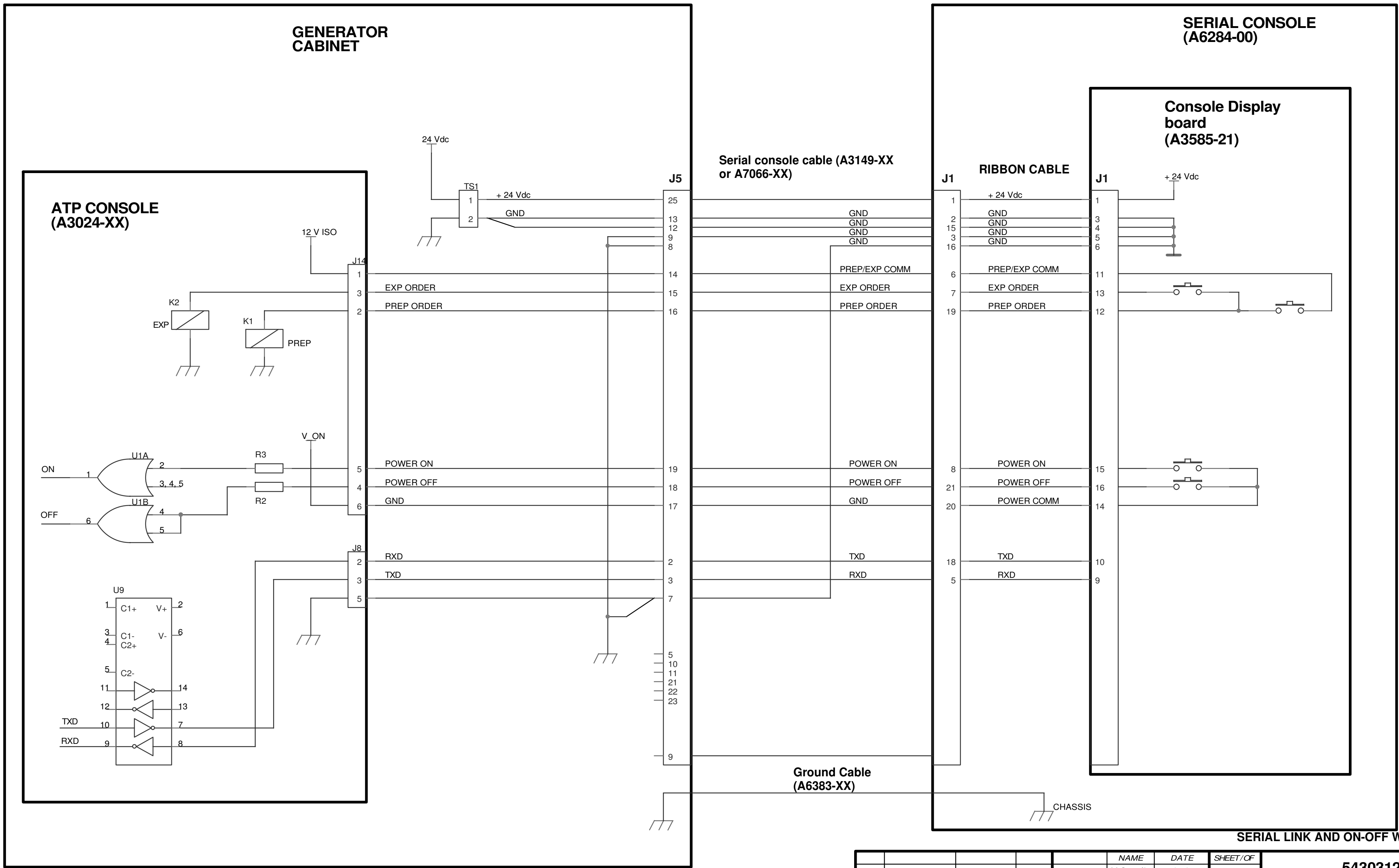
SEDECAL

54303129

A ← REV

Device Interconnection (DI)

SERIAL CONSOLE - SHF INTERCONNECTION



SERIAL LINK AND ON-OFF WIRING

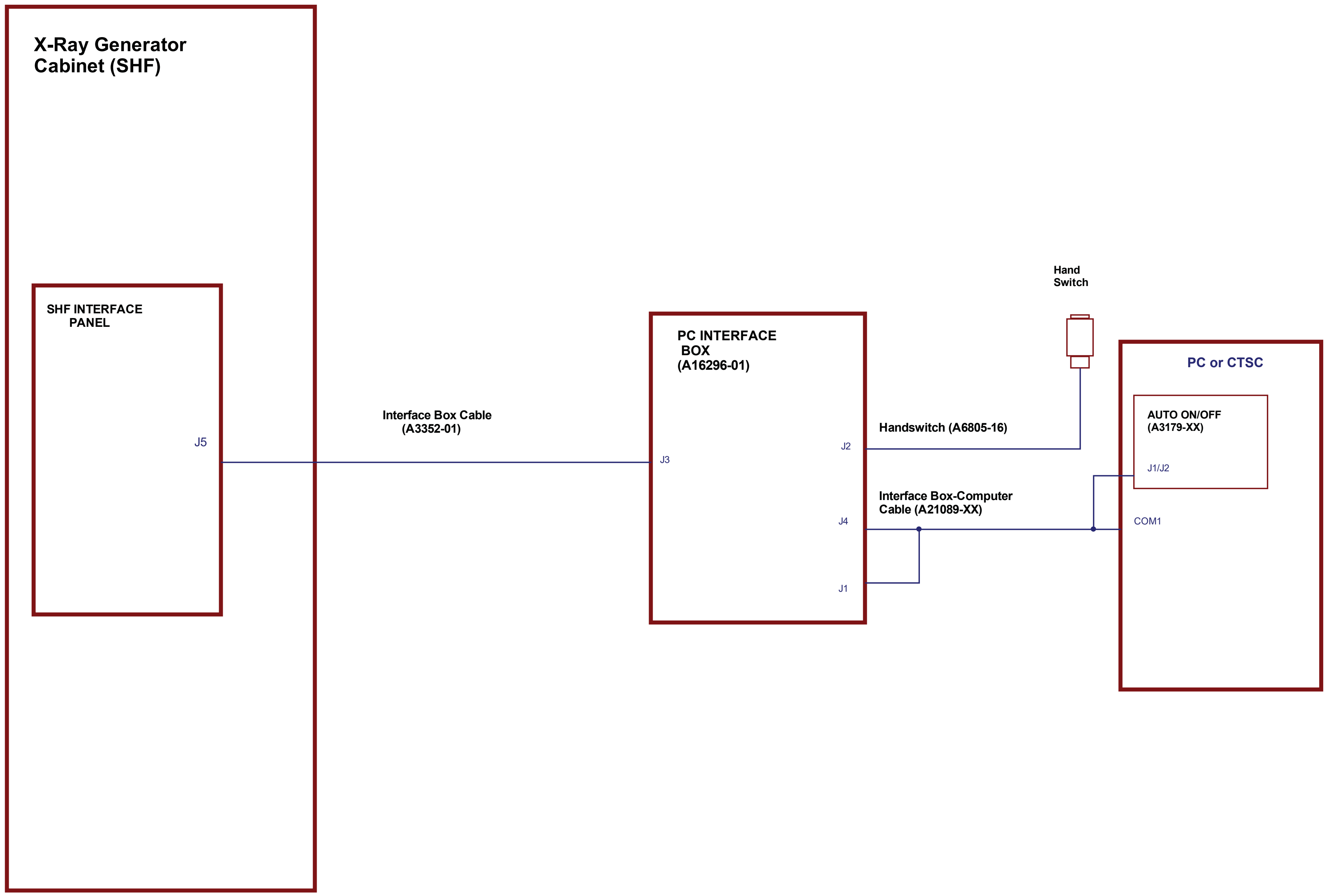
	NAME	DATE	SHEET/OF	
DRAWING	M.González	04/07/14	2/2	54303129
REVISED	A.DIAZ	04/07/14		A ◄REV

REV	DESCRIPTION	ISSUED BY	DATE
A	First Release	M.González	04/07/14

SEDECAL

Device Interconnection (DI)

SERIAL CONSOLE - SHF INTERCONNECTION



SYSTEM INTERCONNECTION

REV	DESCRIPTION	ISSUED BY	DATE
A	Frist release	M.González	2019-07-08

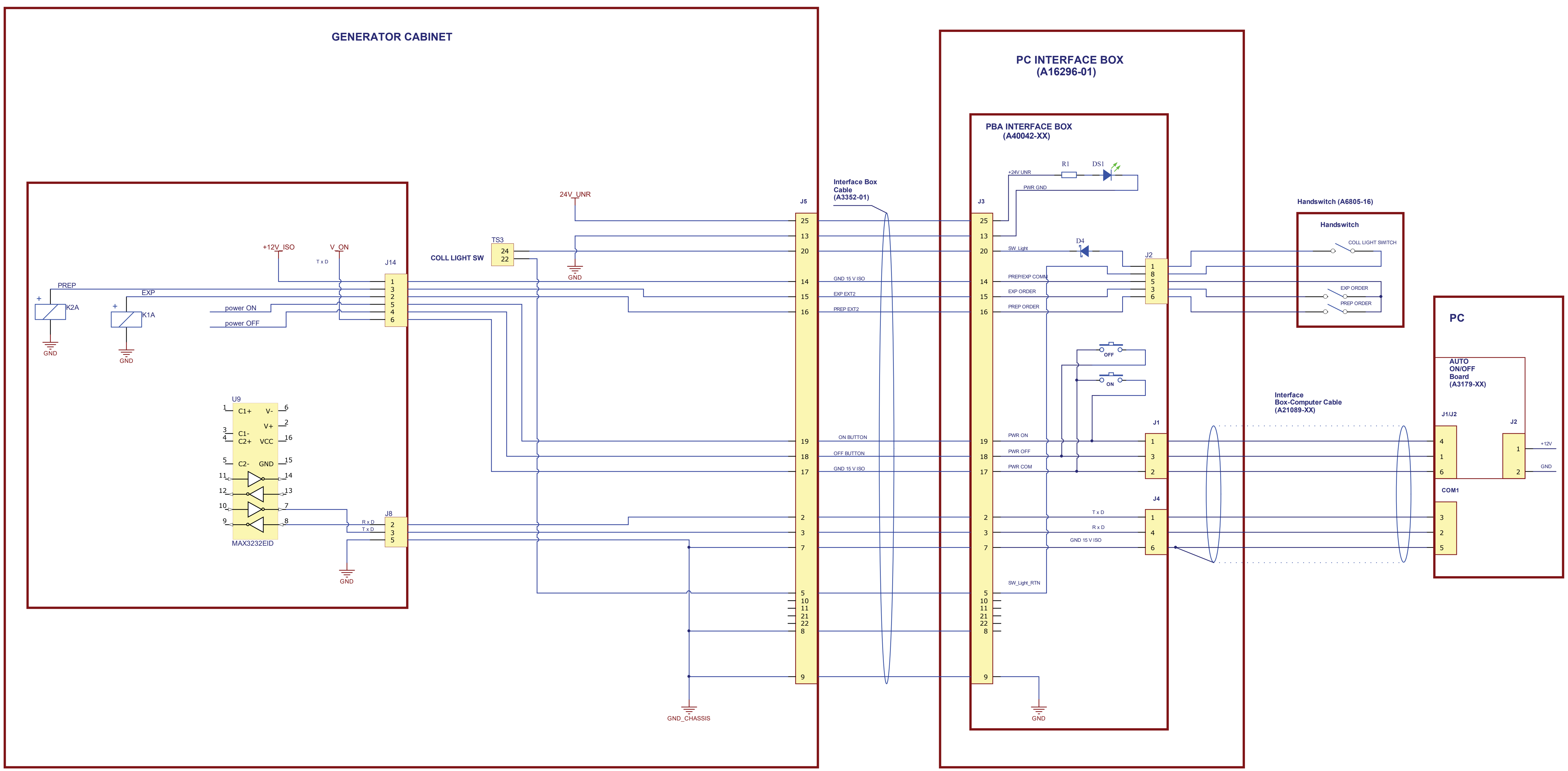
	NAME	DATE	SHEET / OF
DRAWING	M.González	2019-07-08	1 / 3
REVISED	Sonia Perez	2019-07-08	

SEDECAL CONFIDENTIAL

PBA: PCB: A ← REV

6070064 DI

PC-CTSC - ON-OFF BOX - SHF



PC WIRING INTERCONNECTION

A	Frist release	M.González	2019-07-08	
REV	DESCRIPTION	ISSUED BY	DATE	

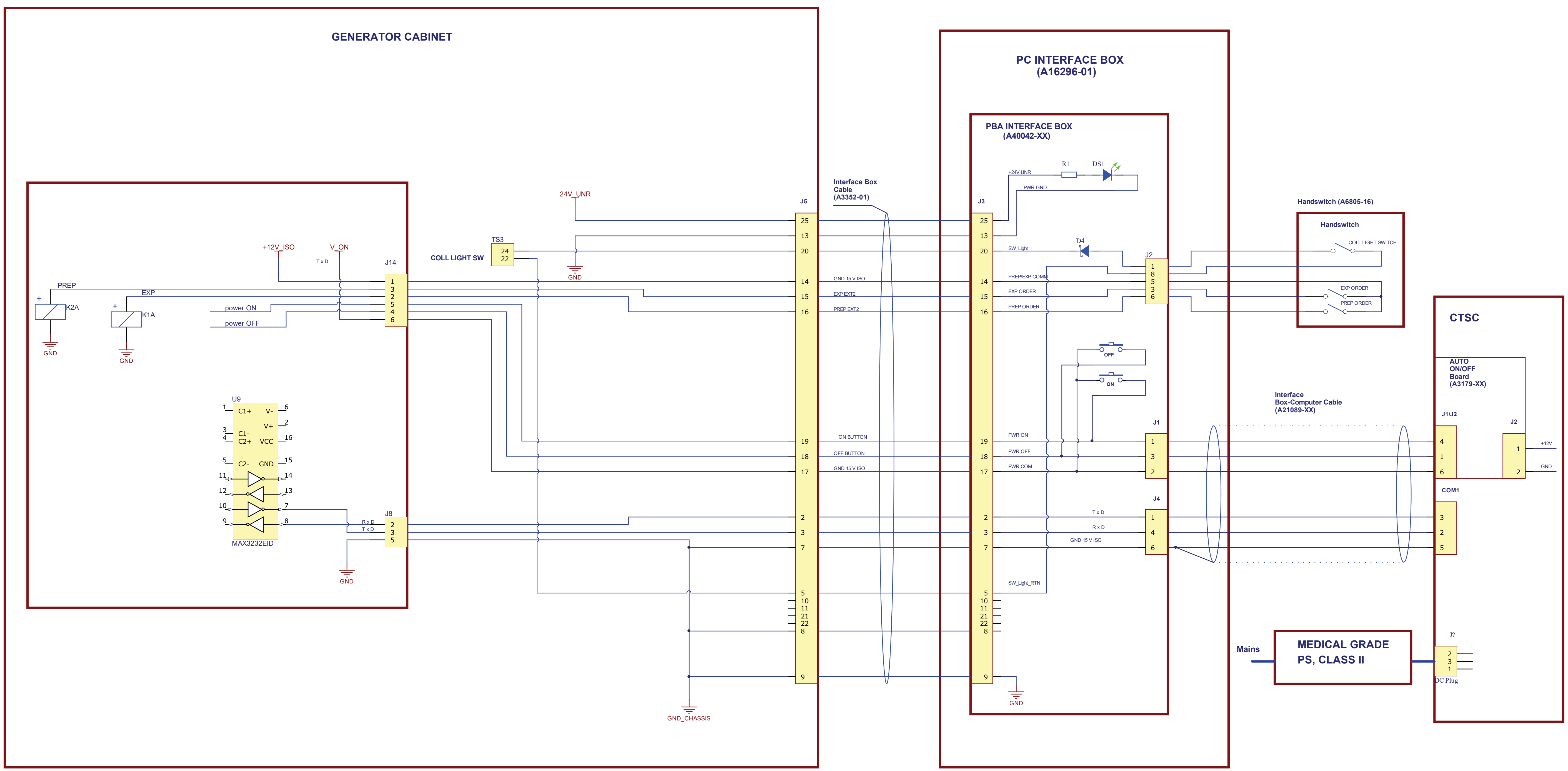
	NAME	DATE	SHEET / OF
DRAWING	M.González	2019-07-08	2 / 3
REVISED	Sonia Perez	2019-07-08	

SEDECAL — CONFIDENTIAL

PBA: PCB: A REV

6070064 DI

PC-CTSC - ON-OFF BOX - SHF



CTSC WIRING INTERCONNECTION

REV	DESCRIPTION	ISSUED BY	DATE
A	Frist release	M.González	2019-07-08

	NAME	DATE	SHEET / OF
DRAWING	M.González	2019-07-08	3 / 3
REVISED	Sonia Perez	2019-07-08	

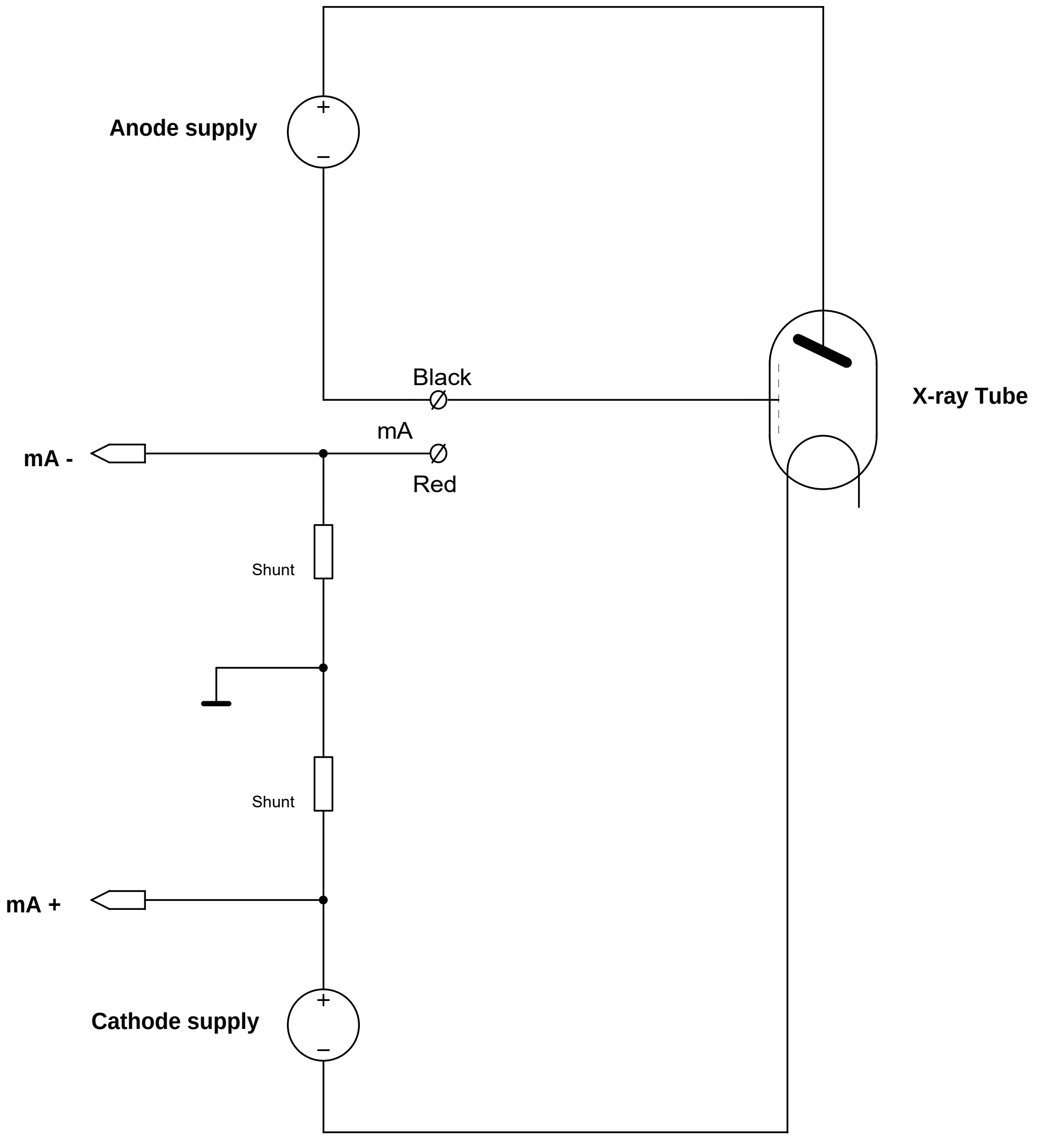
SEDECAL CONFIDENTIAL

PBA: PCB:

REV A

6070064 DI

PC-CTSC - ON-OFF BOX - SHF

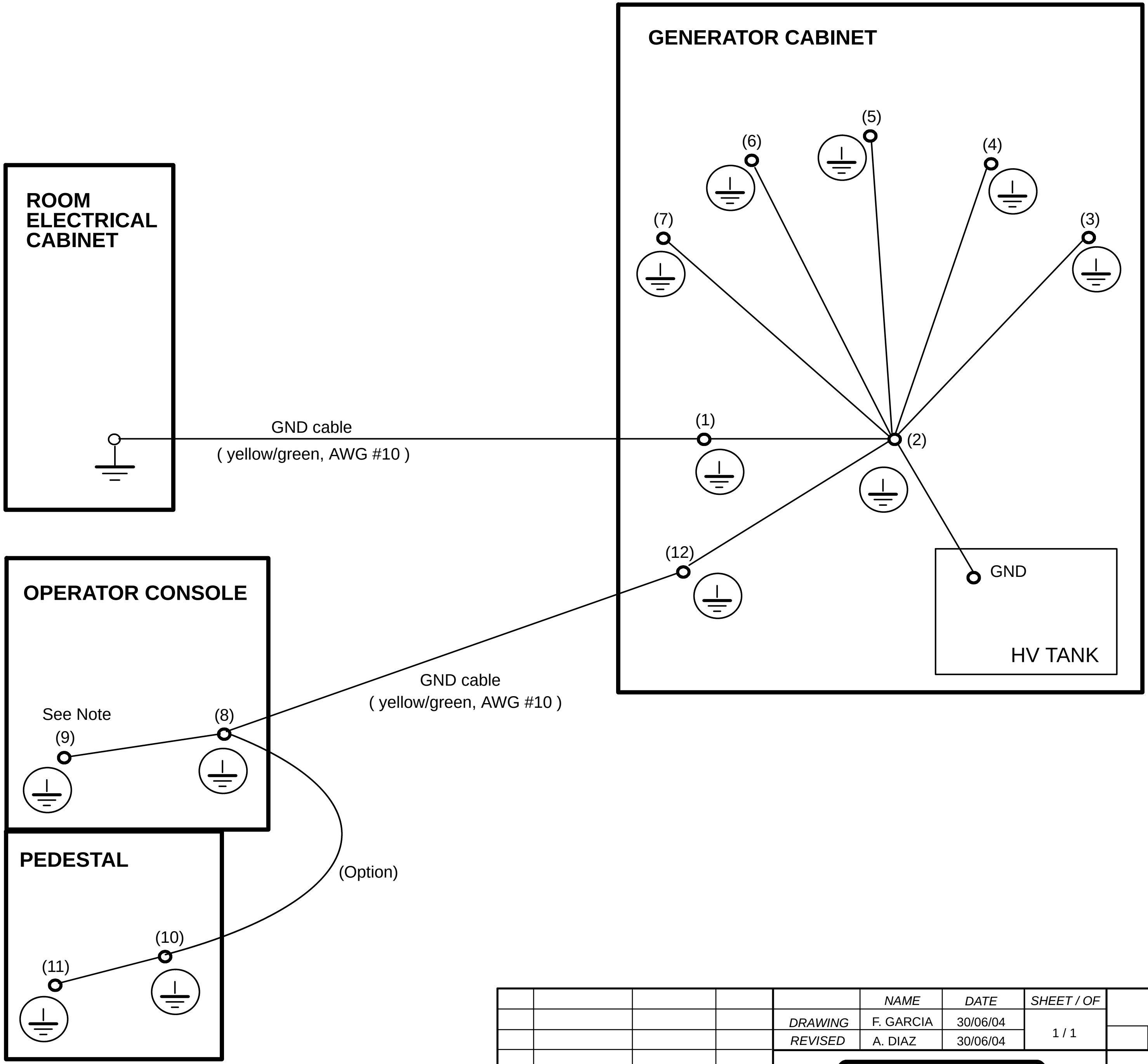


	NAME	DATE	SHEET / OF	54302035
DRAWING	F. Díaz	11/02/03	1/1	REV
REVISED	A. Díaz	11/02/03		

REV	DESCRIPTION	ISSUED BY	DATE

SEDECAL

METALLIC CASE X-RAY TUBE CONN.



(1)	Central Ground
(2)	GND Stud
(3)	Cabinet Cover GND
(4)	Back Panel GND
(5)	Front Panel GND
(6)	Filter LF1 Cover GND
(7)	Adaptations Panel GND
(8)	Console GND (Bottom Panel)
(9)	Console Support GND
(10)	Pedestal Tube GND
(11)	Pedestal Cover GND
(12)	GND STUD

Note.– (9) applicable only for metallical Box Console

REV	DESCRIPTION	ISSUED BY	DATE

	NAME	DATE	SHEET / OF
DRAWING	F. GARCIA	30/06/04	1 / 1
REVISED	A. DIAZ	30/06/04	

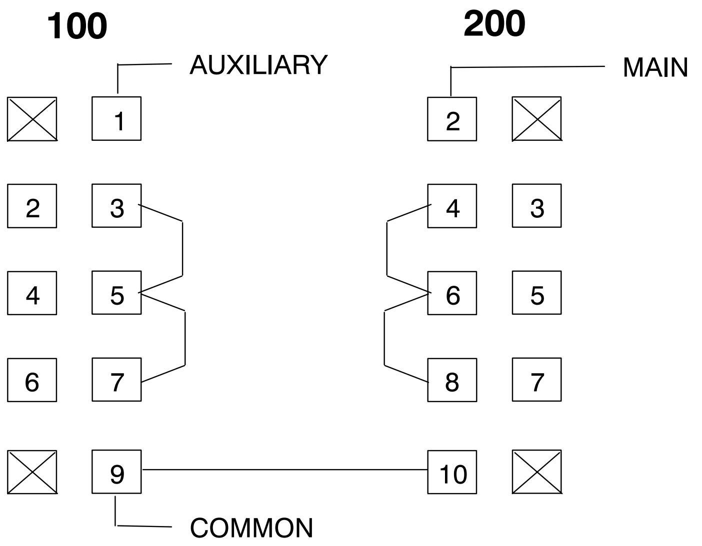
SEDECAL

I/F–103

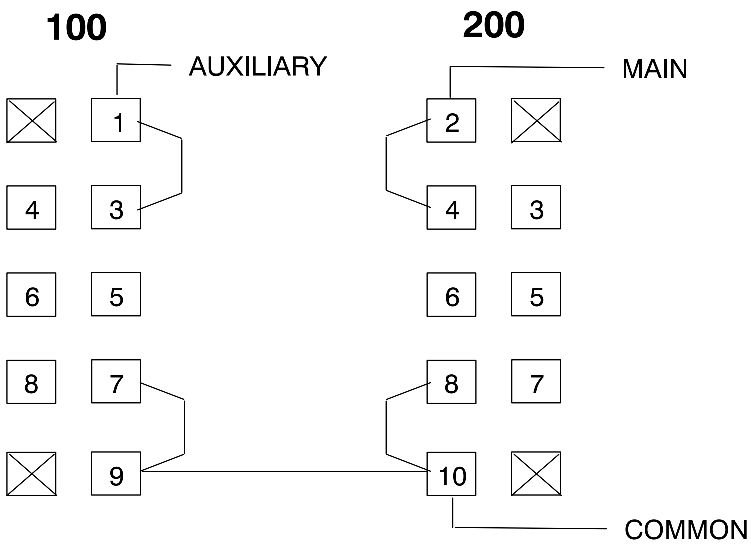
REV

EARTHING DIAGRAM

STATOR ROTALIX 350/351 CONNECTIONS

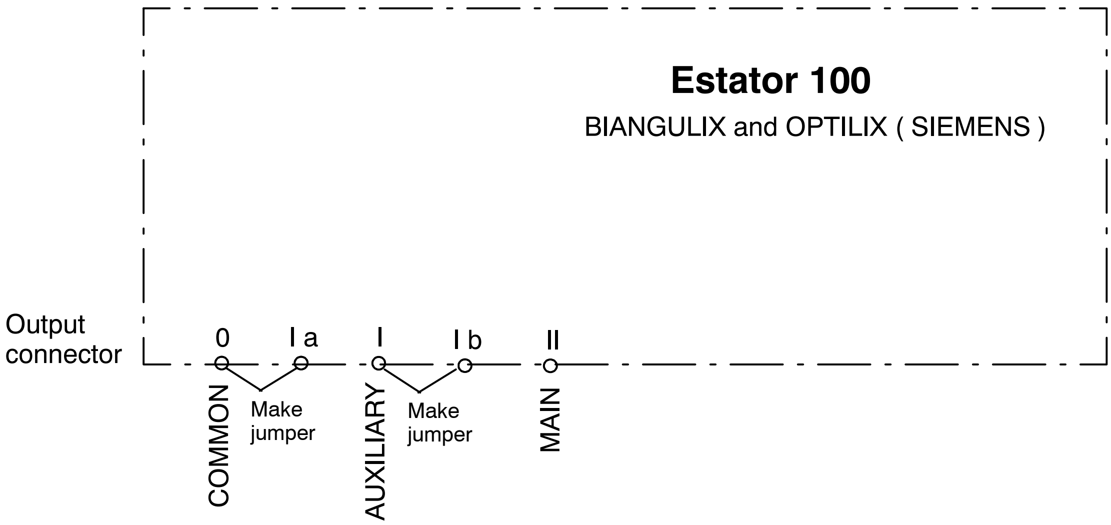


STATOR SUPER ROTALIX 350 CONNECTIONS



					NAME	DATE	SHEET / OF	Interconnection *Interconexión*	I/F–021
				DRAWING	F. GARCIA	09/09/98	1 / 1		
				REVISED	A. DIAZ	09/09/98			REV
				SEDECAL				PHILIPS TUBES–STATOR INTERFACE	
REV	*DESCRIPTION*	*ISSUED BY*	*DATE*						

STATOR 100 CONNECTIONS (BIANGULIX and OPTILILIX TUBES)



NOTE

CONNECT THE STATOR CABLE AS SHOWN.
CHECK THE CABLE SUPPLIED WITH THE TUBE.

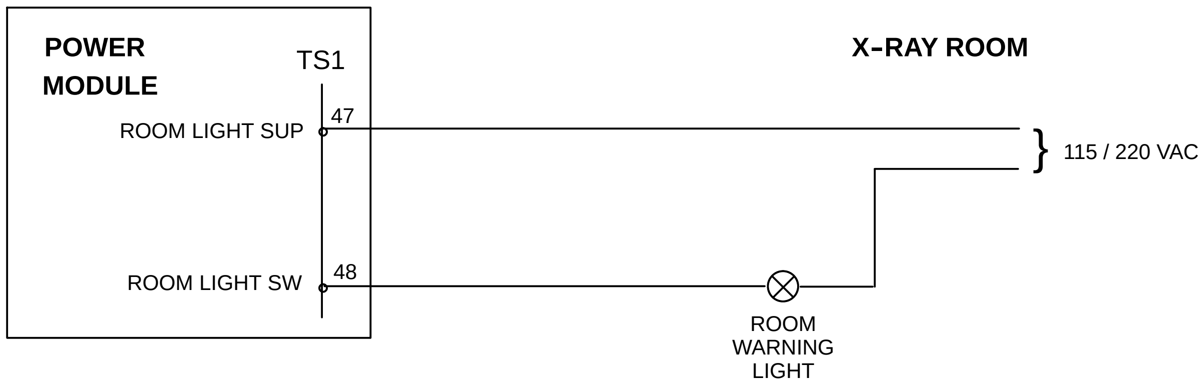
	NAME	DATE	SHEET / OF	Interconnection *Interconexión*	I/F–024
DRAWING	F. GARCIA	09/09/98	1 / 1		REV
REVISED	A. DIAZ	09/09/98			

REV	DESCRIPTION	ISSUED BY	DATE

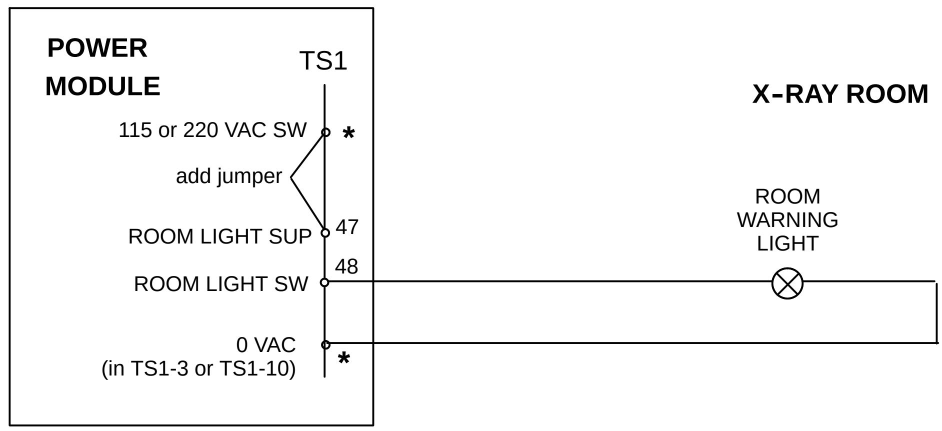
SEDECAL

SIEMENS TUBES–STATOR INTERFACE

Interconnection 1.- For Generator Interface with control relay and externally powered

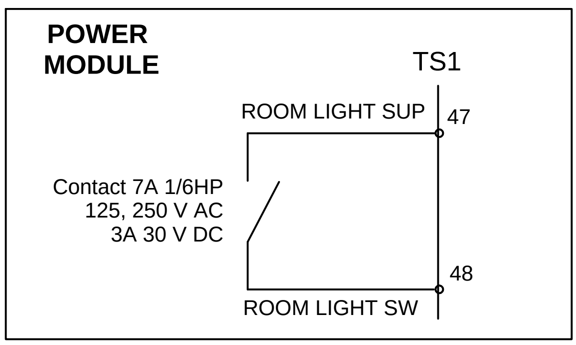


Interconnection 2.- For Generator Interface with control relay and internally powered



* Select the power supply on TS1 according to the lamp voltage.
Add jumper to TS1-26 for 220 VAC or to TS1-27 for 115 VAC.

Interconnection 3,- Additional option to meet some Local Electrical Codes



REV	DESCRIPTION	ISSUED BY	DATE
E	I/F update	F. GARCIA	20/06/04
D	I/F update	F. GARCIA	02/02/02
C	I/F changing	F. GARCIA	05/05/99
B	TS1 changing	F. GARCIA	24/05/96
A	EMC	F. GARCIA	29/03/96

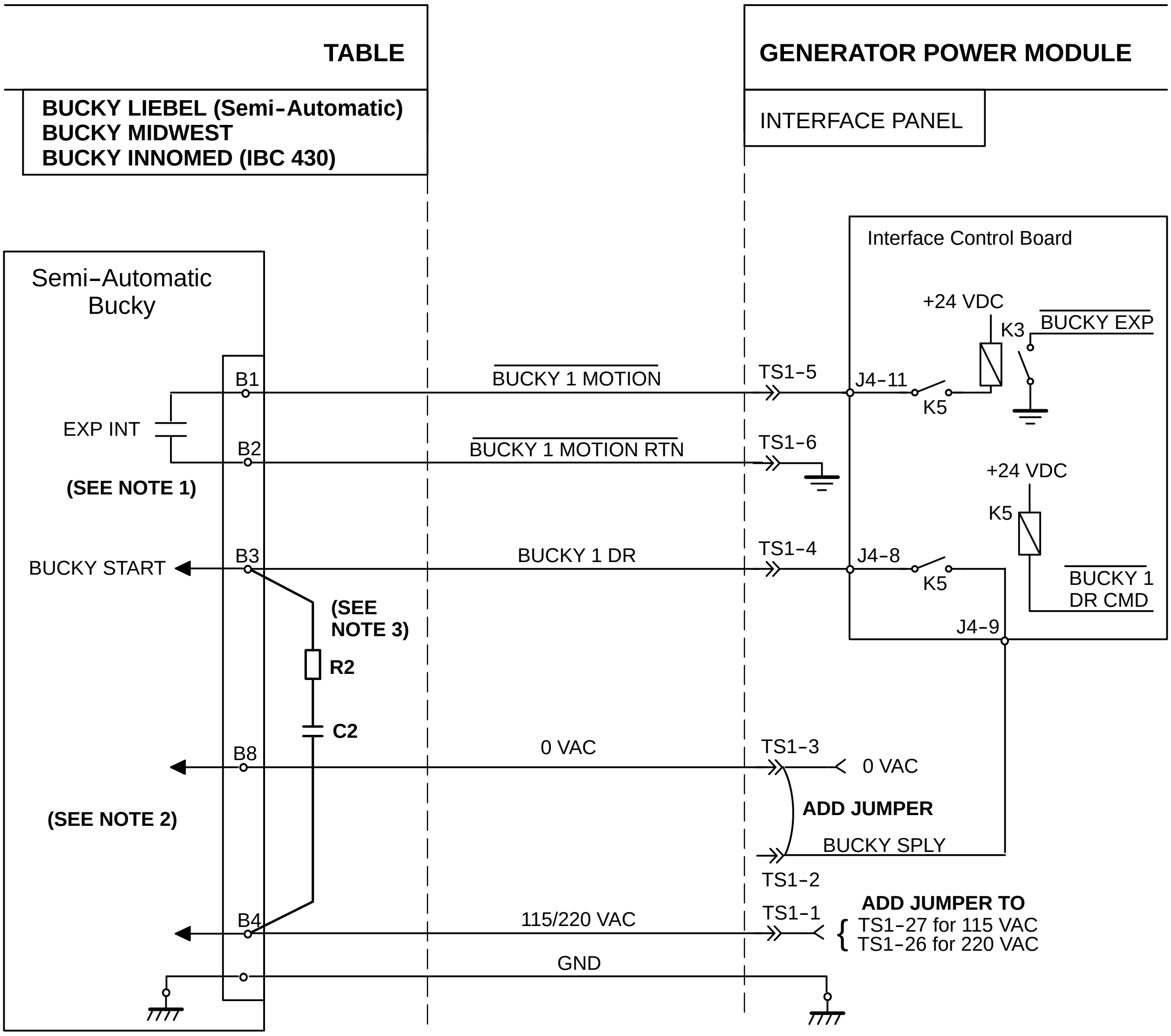
	NAME	DATE	SHEET / OF
DRAWING	F. GARCIA	04/19/95	1 / 1
REVISED	A. DIAZ	04/19/95	

SEDECAL

I/F-008

			E	D	C	B	A	REV

ROOM WARNING LIGHT INTERFACE
INTERFAZ LAMPARA RAYOS-X SALA



NOTE 1: Be sure that B2 terminal is not connected to B3 terminal.

NOTE 2: Select correct voltage in the bucky according to AC input

NOTE 3: In the case of noise due to Bucky, add R2=22 ohm, 1/2w, 5%; and C2=470 nF, 250 VAC as shown.
Don't add that R2-C2 for Liebel-Flarsheim 8000 Series Bucky, and remove resistor R36 and R37 in the INTERFACE CONTROL board.

NOTA 1: Asegurarse que el terminal B2 no está conectado al B3.

NOTA 2: Seleccionar la tensión del bucky según la entrada AC

NOTA 3: En caso de ruidos debido al Bucky, añadir R2=22 ohm, 1/2w, 5%, y C2=470 nF, 250 VAC según se muestra.
Para Bucky Liebel-Flarsheim Series 8000, no añadir esa R2-C2, y quitar las resistencias R36 y R37 en la tarjeta INTERFACE CONTROL.

REV	DESCRIPTION	ISSUED BY	DATE
8	Interf. board revised	F. GARCIA	14/03/08
7	Innomed added	F. GARCIA	09/09/02

	NAME	DATE	SHEET / OF
DRAWING	F. GARCIA	15/03/95	1 / 4
REVISED	A. DIAZ	15/03/95	

SEDECAL

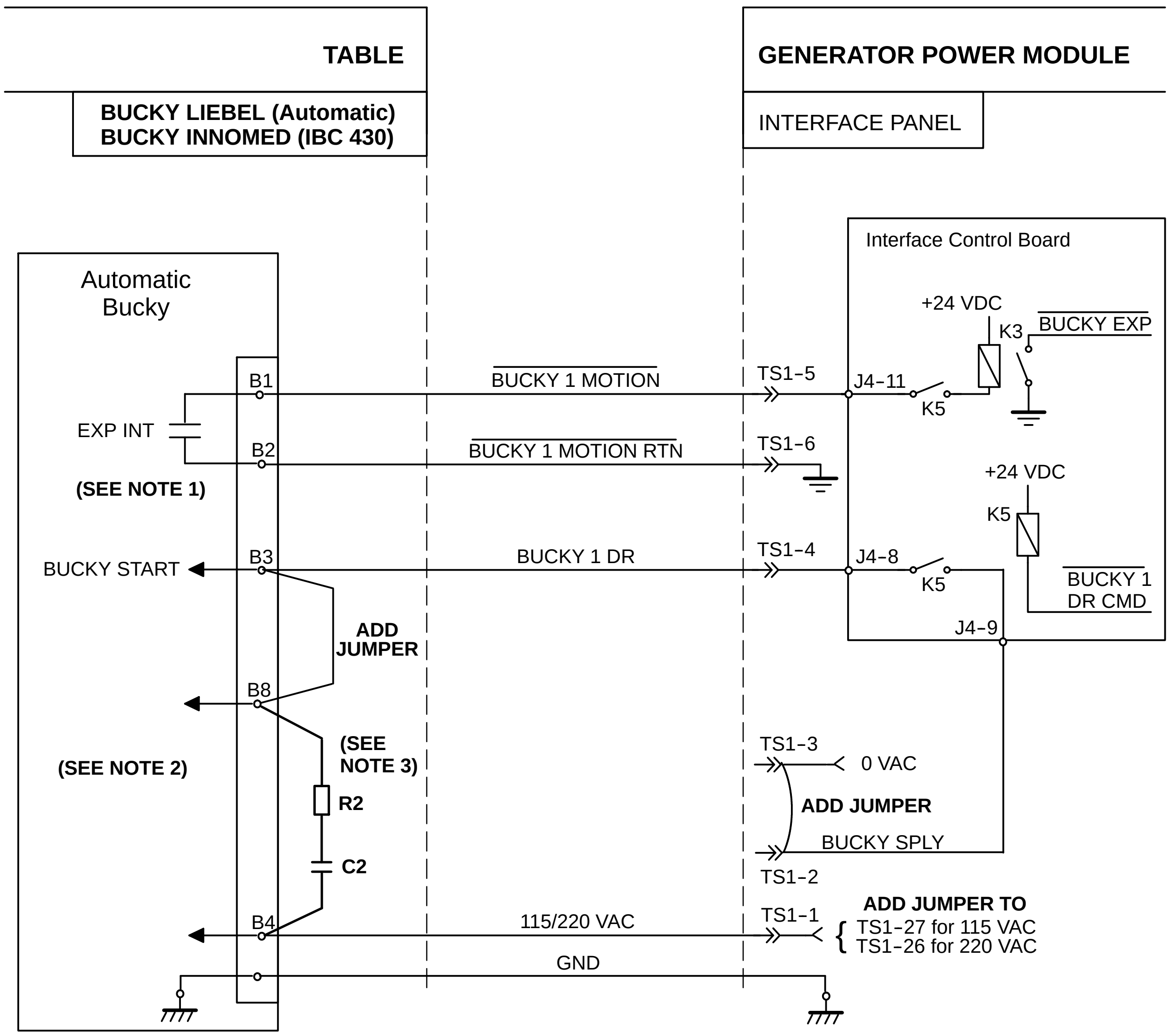
Interconnection Cable
Cable de Inerconexión

I/F-001

8	7	REV

TABLE BUCKY INTERFACE

INTERFAZ BUCKY MESA



NOTE 1: Be sure that B2 terminal is not connected to B3 terminal.

NOTE 2: Select correct voltage in the bucky according to AC input

NOTE 3: In the case of noise due to Bucky, add R2=22 ohm, 1/2w, 5%; and C2=470 nF, 250 VAC as shown.
Don't add that R2-C2 for Liebel-Flarsheim 8000 Series Bucky, and remove resistor R36 and R37 in the INTERFACE CONTROL board.

NOTA 1: Asegurarse que el terminal B2 no está conectado al B3.

NOTA 2: Seleccionar la tensión del bucky según la entrada AC

NOTA 3: En caso de ruidos debido al Bucky, añadir R2=22 ohm, 1/2w, 5%, y C2=470 nF, 250 VAC según se muestra.
Para Bucky Liebel-Flarsheim Series 8000, no añadir esa R2-C2, y quitar las resistencias R36 y R37 en la tarjeta INTERFACE CONTROL.

REV	DESCRIPTION	ISSUED BY	DATE
8	Interf. board revised	F. GARCIA	14/03/08
7	Innomed added	F. GARCIA	09/09/02

	NAME	DATE	SHEET / OF
DRAWING	F. GARCIA	15/03/95	2 / 4
REVISED	A. DIAZ	15/03/95	

SEDECAL

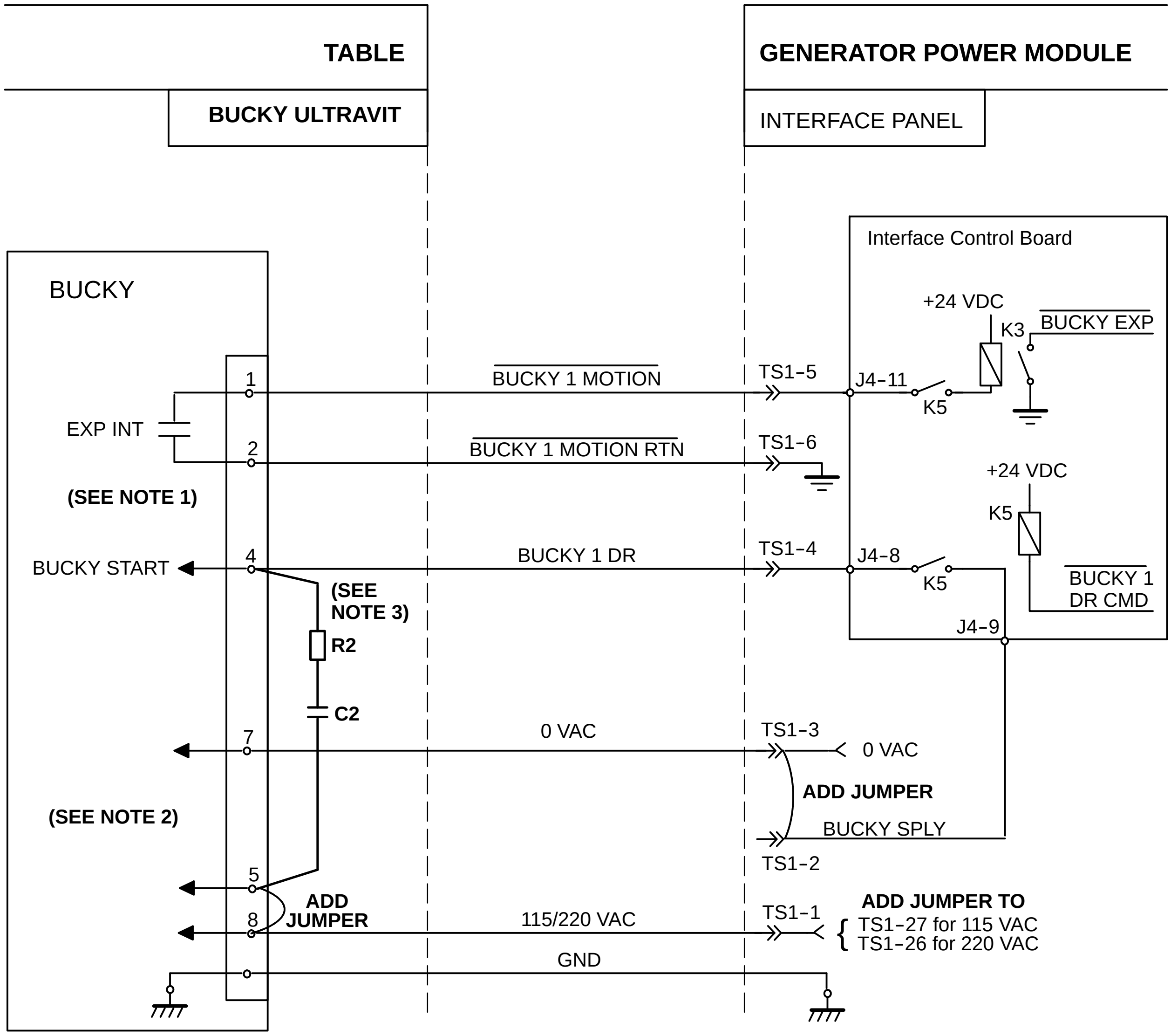
Interconnection Cable
Cable de Inerconexión

I/F-001

REV: 8 | 7

TABLE BUCKY INTERFACE

INTERFAZ BUCKY MESA



NOTE 1: Be sure that 2 terminal is
not connected to 4 terminal.

NOTE 2: Select correct voltage in the
bucky according to AC input

NOTE 3: In the case of noise due to Bucky, add R2=22 ohm, 1/2w, 5%;
and C2=470 nF, 250 VAC as shown.

NOTA 1: Asegurarse que el terminal 2
no está conectado al 4.

NOTA 2: Seleccionar la tensión del
bucky según la entrada AC

NOTA 3: En caso de ruidos debido al Bucky, añadir R2=22 ohm, 1/2w, 5%;
y C2=470 nF, 250 VAC según se muestra.

REV	DESCRIPTION	ISSUED BY	DATE
8	Interf. board revised	F. GARCIA	14/03/08
7	Innomed added	F. GARCIA	09/09/02

	NAME	DATE	SHEET / OF
DRAWING	F. GARCIA	15/03/95	3 / 4
REVISED	A. DIAZ	15/03/95	

SEDECAL

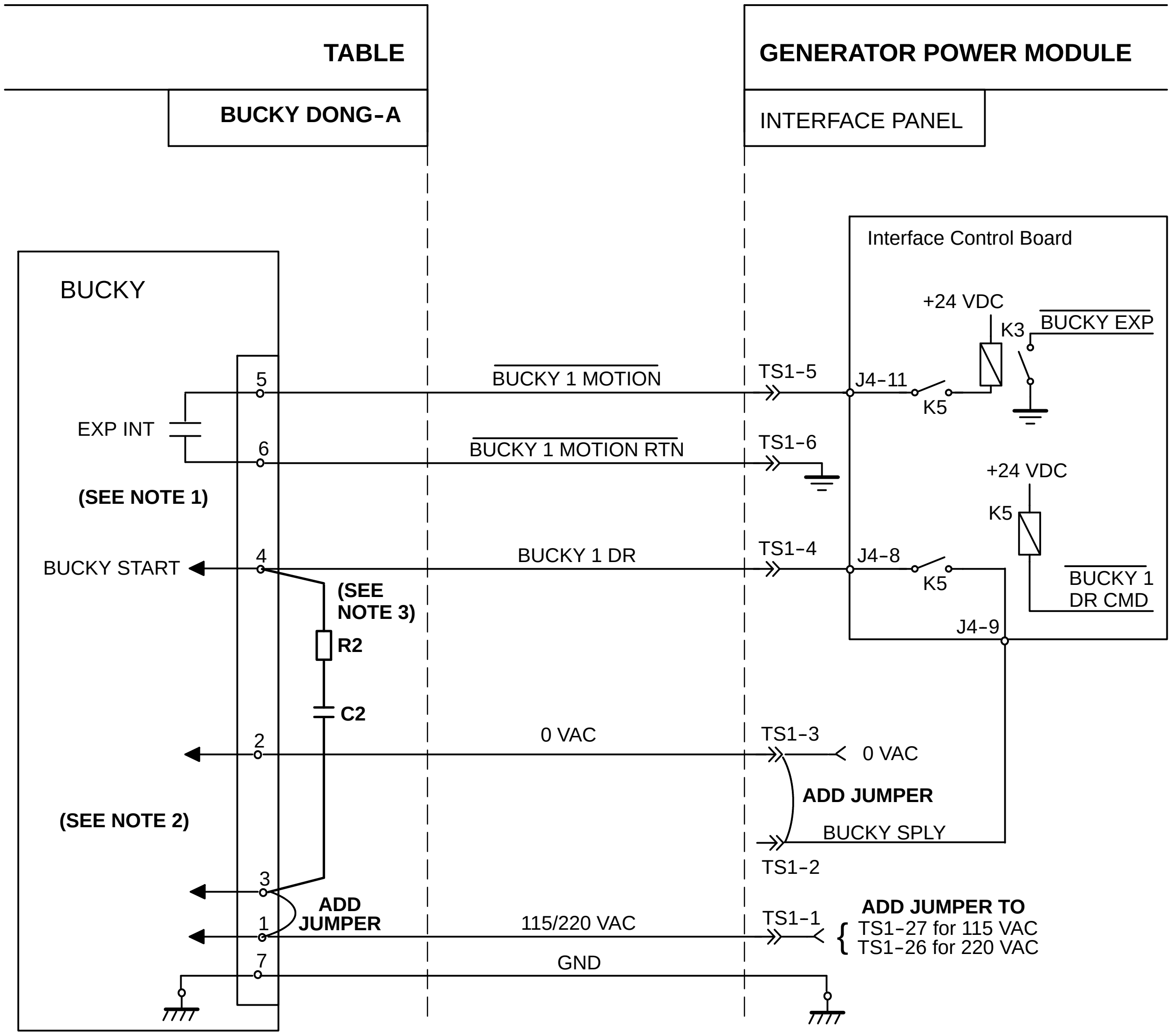
Interconnection Cable
Cable de Inerconexión

I/F-001

8 | 7 | REV

TABLE BUCKY INTERFACE

INTERFAZ BUCKY MESA



NOTE 1: Be sure that 6 terminal is
not connected to 4 terminal.

NOTE 2: Select correct voltage in the
bucky according to AC input

NOTE 3: In the case of noise due to Bucky, add R2=22 ohm, 1/2w, 5%;
and C2=470 nF, 250 VAC as shown.

NOTA 1: Asegurarse que el terminal 6
no está conectado al 4.

NOTA 2: Seleccionar la tensión del
bucky según la entrada AC

NOTA 3: En caso de ruidos debido al Bucky, añadir R2=22 ohm, 1/2w, 5%;
y C2=470 nF, 250 VAC según se muestra.

REV	DESCRIPTION	ISSUED BY	DATE
8	Interf. board revised	F. GARCIA	14/03/08
7	Innomed added	F. GARCIA	09/09/02

	NAME	DATE	SHEET / OF
DRAWING	F. GARCIA	15/03/95	4 / 4
REVISED	A. DIAZ	15/03/95	

SEDECAL

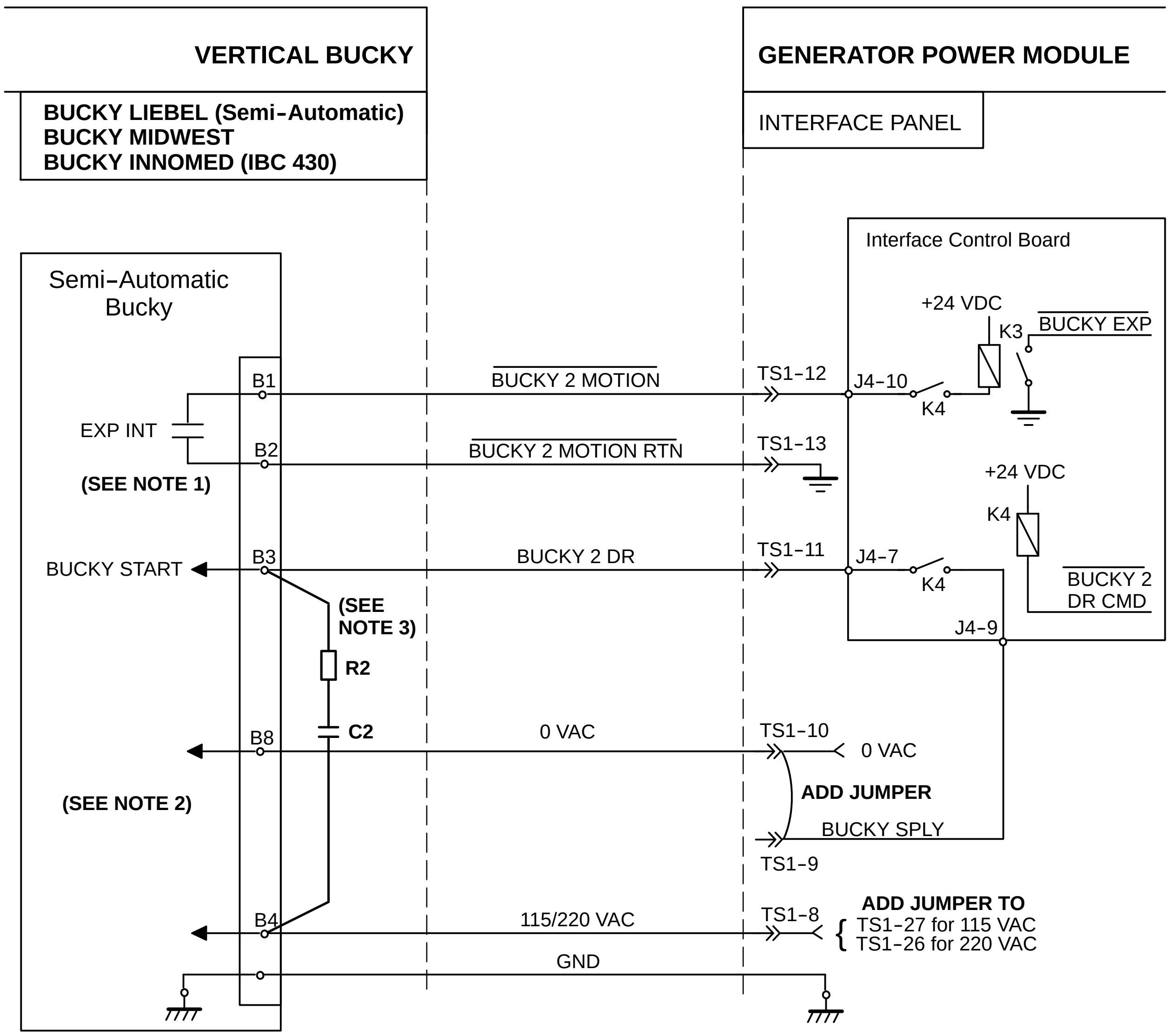
Interconnection Cable
Cable de Inerconexión

I/F-001

8 | 7 | REV

TABLE BUCKY INTERFACE

INTERFAZ BUCKY MESA



NOTE 1: Be sure that B2 terminal is not connected to B3 terminal.

NOTE 2: Select correct voltage in the bucky according to AC input

NOTE 3: In the case of noise due to Bucky, add R2=22 ohm, 1/2w, 5%; and C2=470 nF, 250 VAC as shown.
Don’t add that R2-C2 for Liebel-Flarsheim 8000 Series Bucky, and remove resistor R36 and R37 in the INTERFACE CONTROL board.

NOTA 1: Asegurarse que el terminal B2 no está conectado al B3.

NOTA 2: Seleccionar la tensión del bucky según la entrada AC

NOTA 3: En caso de ruidos debido al Bucky, añadir R2=22 ohm, 1/2w, 5%, y C2=470 nF, 250 VAC según se muestra.
Para Bucky Liebel-Flarsheim Series 8000, no añadir esa R2-C2, y quitar las resistencias R36 y R37 en la tarjeta INTERFACE CONTROL.

REV	DESCRIPTION	ISSUED BY	DATE
8	Interf board revised	F. GARCIA	14/03/08
7	Innomed added	F. GARCIA	09/09/02

	NAME	DATE	SHEET / OF
DRAWING	F. GARCIA	15/03/95	1 / 4
REVISED	A. DIAZ	15/03/95	

SEDECAL

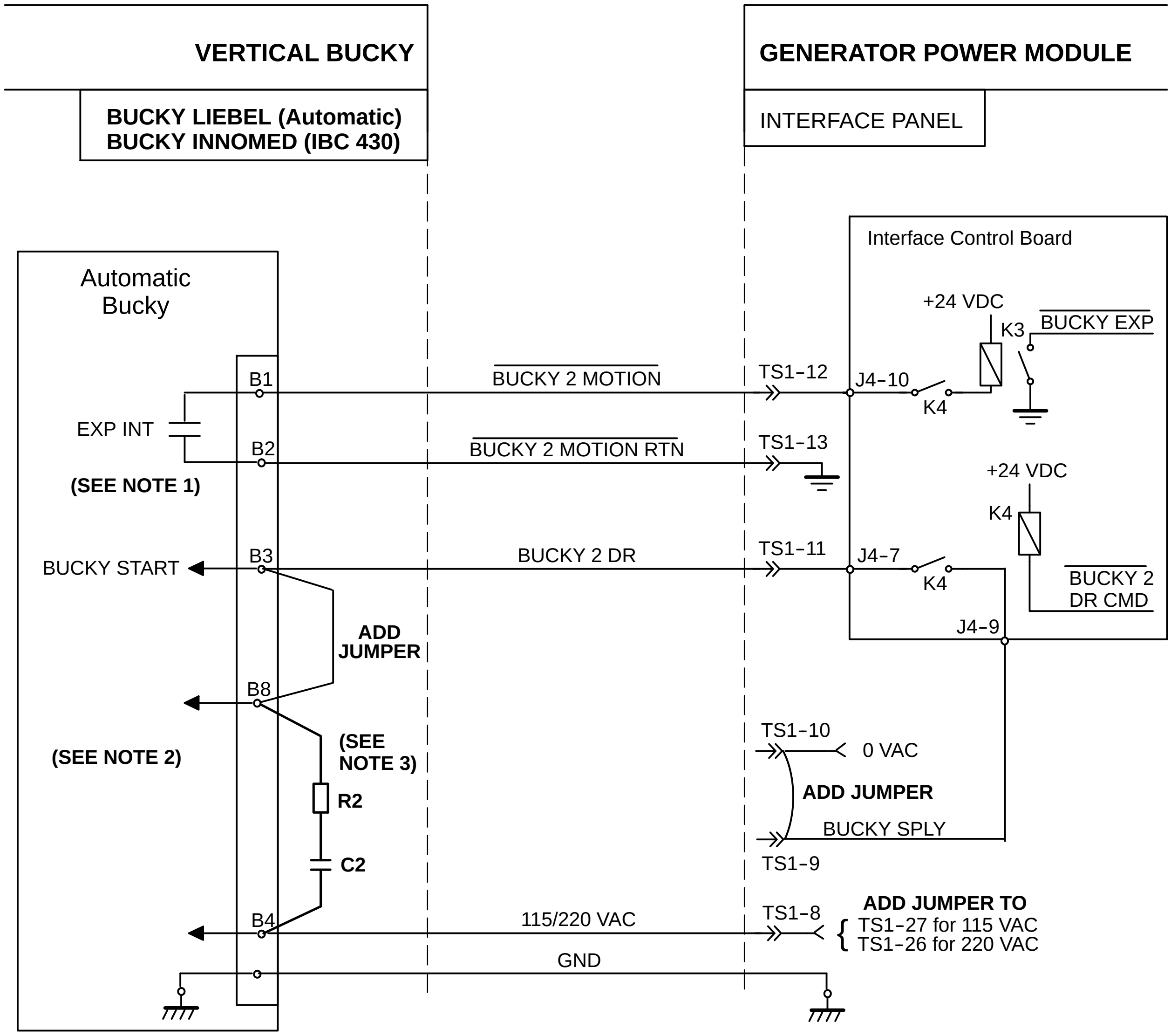
Interconnection Cable
Cable de Inerconexión

I/F-002

REV: 8, 7

VERTICAL BUCKY INTERFACE

INTERFAZ BUCKY VERTICAL



NOTE 1: Be sure that B2 terminal is not connected to B3 terminal.

NOTE 2: Select correct voltage in the bucky according to AC input

NOTE 3: In the case of noise due to Bucky, add R2=22 ohm, 1/2w, 5%; and C2=470 nF, 250 VAC as shown.
Don't add that R2-C2 for Liebel-Flarsheim 8000 Series Bucky, and remove resistor R36 and R37 in the INTERFACE CONTROL board.

NOTA 1: Asegurarse que el terminal B2 no está conectado al B3.

NOTA 2: Seleccionar la tensión del bucky según la entrada AC

NOTA 3: En caso de ruidos debido al Bucky, añadir R2=22 ohm, 1/2w, 5%, y C2=470 nF, 250 VAC según se muestra.
Para Bucky Liebel-Flarsheim Series 8000, no añadir esa R2-C2, y quitar las resistencias R36 y R37 en la tarjeta INTERFACE CONTROL.

REV	DESCRIPTION	ISSUED BY	DATE
8	Interf board revised	F. GARCIA	14/03/08
7	Innomed added	F. GARCIA	09/09/02

	NAME	DATE	SHEET / OF
DRAWING	F. GARCIA	15/03/95	2 / 4
REVISED	A. DIAZ	15/03/95	

SEDECAL

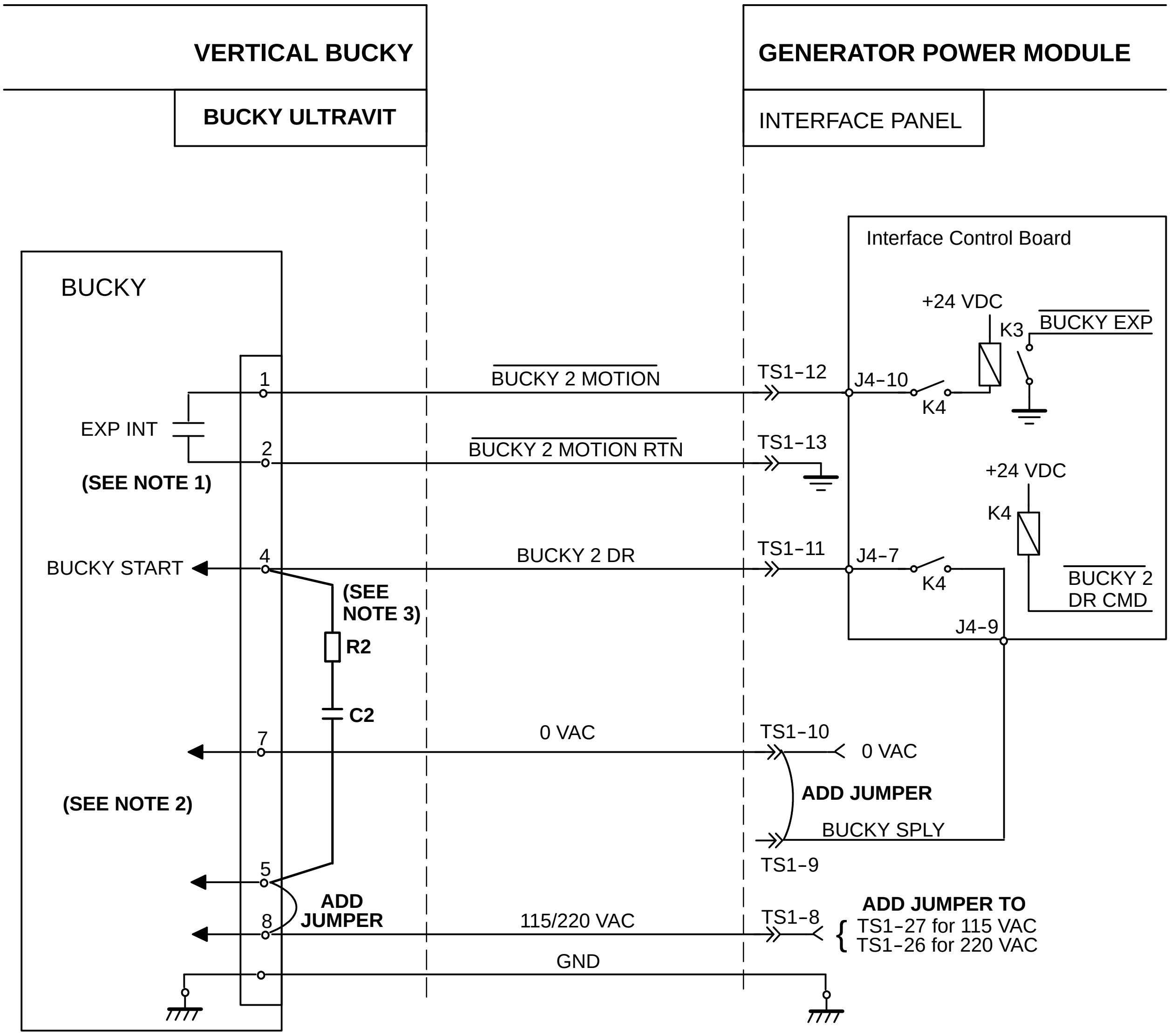
Interconnection Cable
Cable de Inerconexión

I/F-002

8 | 7 | REV

VERTICAL BUCKY INTERFACE

INTERFAZ BUCKY VERTICAL



NOTE 1: Be sure that 2 terminal is not connected to 4 terminal.

NOTE 2: Select correct voltage in the bucky according to AC input

NOTE 3: In the case of noise due to Bucky, add R2=22 ohm, 1/2w, 5%; and C2=470 nF, 250 VAC as shown.

NOTA 1: Asegurarse que el terminal 2 no está conectado al 4.

NOTA 2: Seleccionar la tensión del bucky según la entrada AC

NOTA 3: En caso de ruidos debido al Bucky, añadir R2=22 ohm, 1/2w, 5%; y C2=470 nF, 250 VAC según se muestra.

	NAME	DATE	SHEET / OF
DRAWING	F. GARCIA	15/03/95	3 / 4
REVISED	A. DIAZ	15/03/95	

Interconnection Cable
Cable de Inerconexión

I/F-002

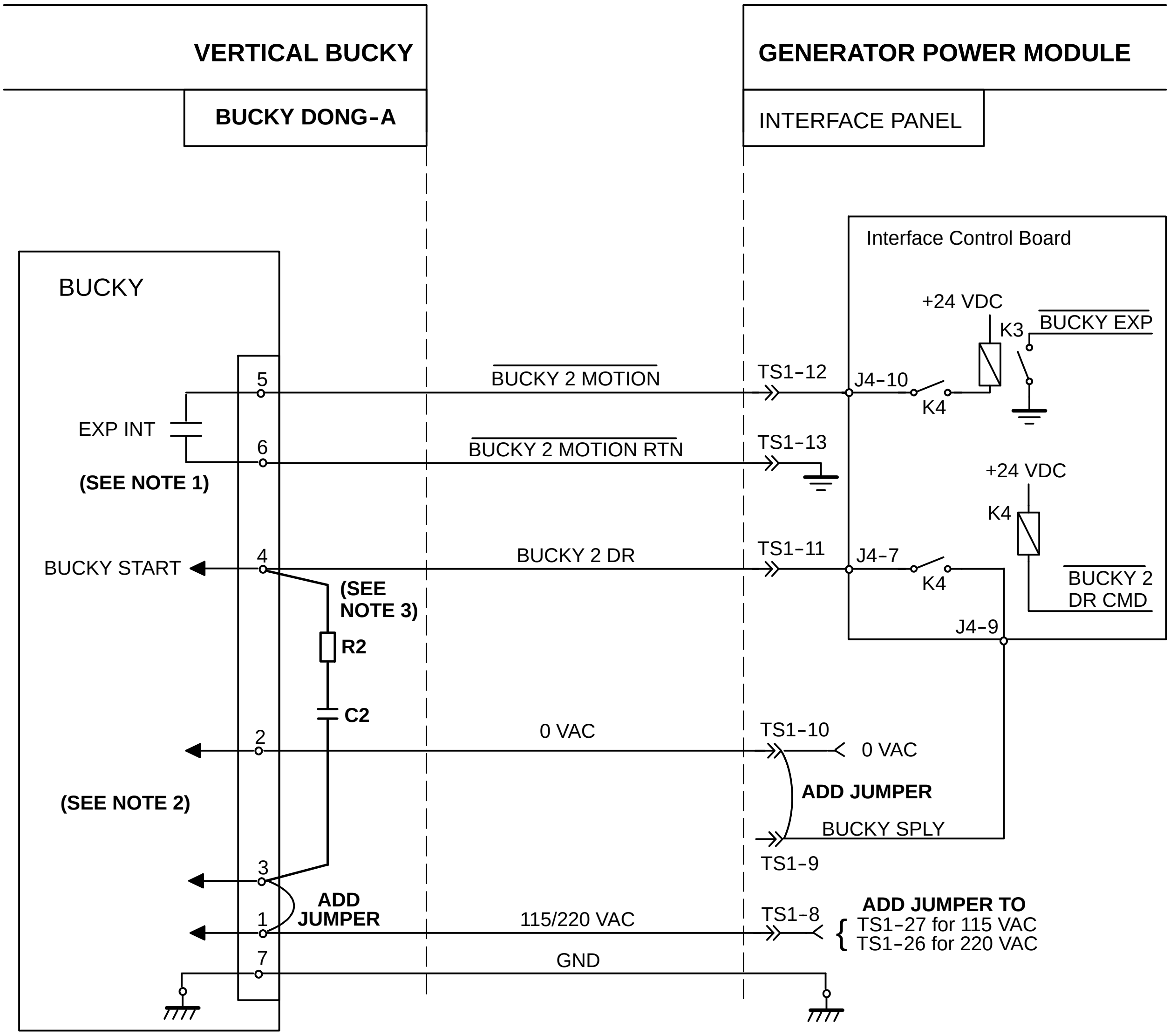
8	7	REV

REV	DESCRIPTION	ISSUED BY	DATE
8	Interf board revised	F. GARCIA	14/03/08
7	Innomed added	F. GARCIA	09/09/02

SEDECAL

VERTICAL BUCKY INTERFACE

INTERFAZ BUCKY VERTICAL



NOTE 1: Be sure that 6 terminal is not connected to 4 terminal.

NOTE 2: Select correct voltage in the bucky according to AC input

NOTE 3: In the case of noise due to Bucky, add R2=22 ohm, 1/2w, 5%; and C2=470 nF, 250 VAC as shown.

NOTA 1: Asegurarse que el terminal 6 no está conectado al 4.

NOTA 2: Seleccionar la tensión del bucky según la entrada AC

NOTA 3: En caso de ruidos debido al Bucky, añadir R2=22 ohm, 1/2w, 5%; y C2=470 nF, 250 VAC según se muestra.

REV	DESCRIPTION	ISSUED BY	DATE
8	Interf board revised	F. GARCIA	14/03/08
7	Innomed added	F. GARCIA	09/09/02

	NAME	DATE	SHEET / OF
DRAWING	F. GARCIA	15/03/95	4 / 4
REVISED	A. DIAZ	15/03/95	

SEDECAL

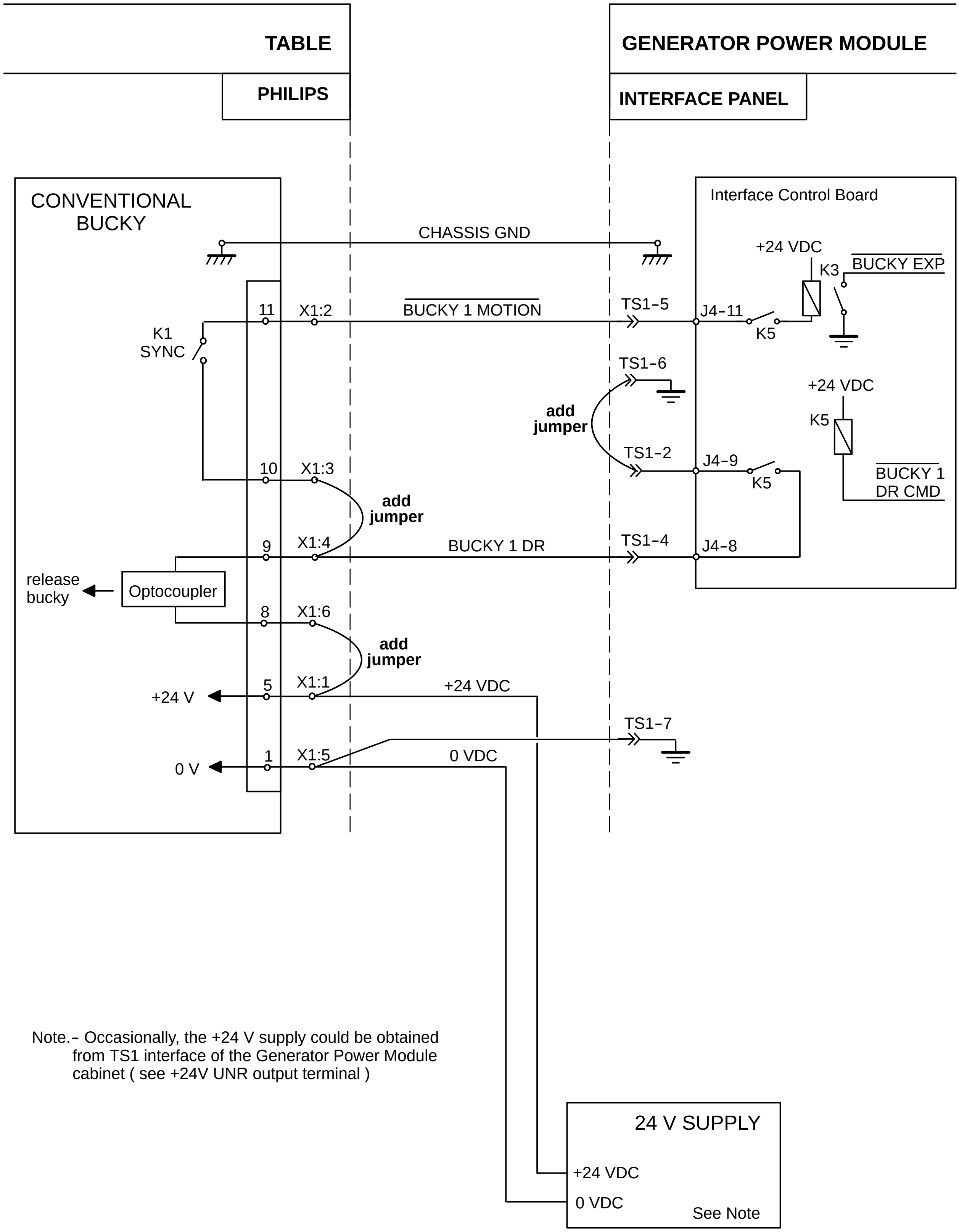
Interconnection Cable
Cable de Inerconexión

I/F-002

8 | 7 | REV

VERTICAL BUCKY INTERFACE

INTERFAZ BUCKY VERTICAL



Note.- Occasionally, the +24 V supply could be obtained from TS1 interface of the Generator Power Module cabinet (see +24V UNR output terminal)

REV	DESCRIPTION	ISSUED BY	DATE
A	Interf board revised	F. García	14/03/08

	NAME	DATE	SHEET / OF
DRAWING	F. GARCIA	22/04/97	1 / 1
REVISED	A. DIAZ	22/04/97	

SEDECAL INNERSCAN

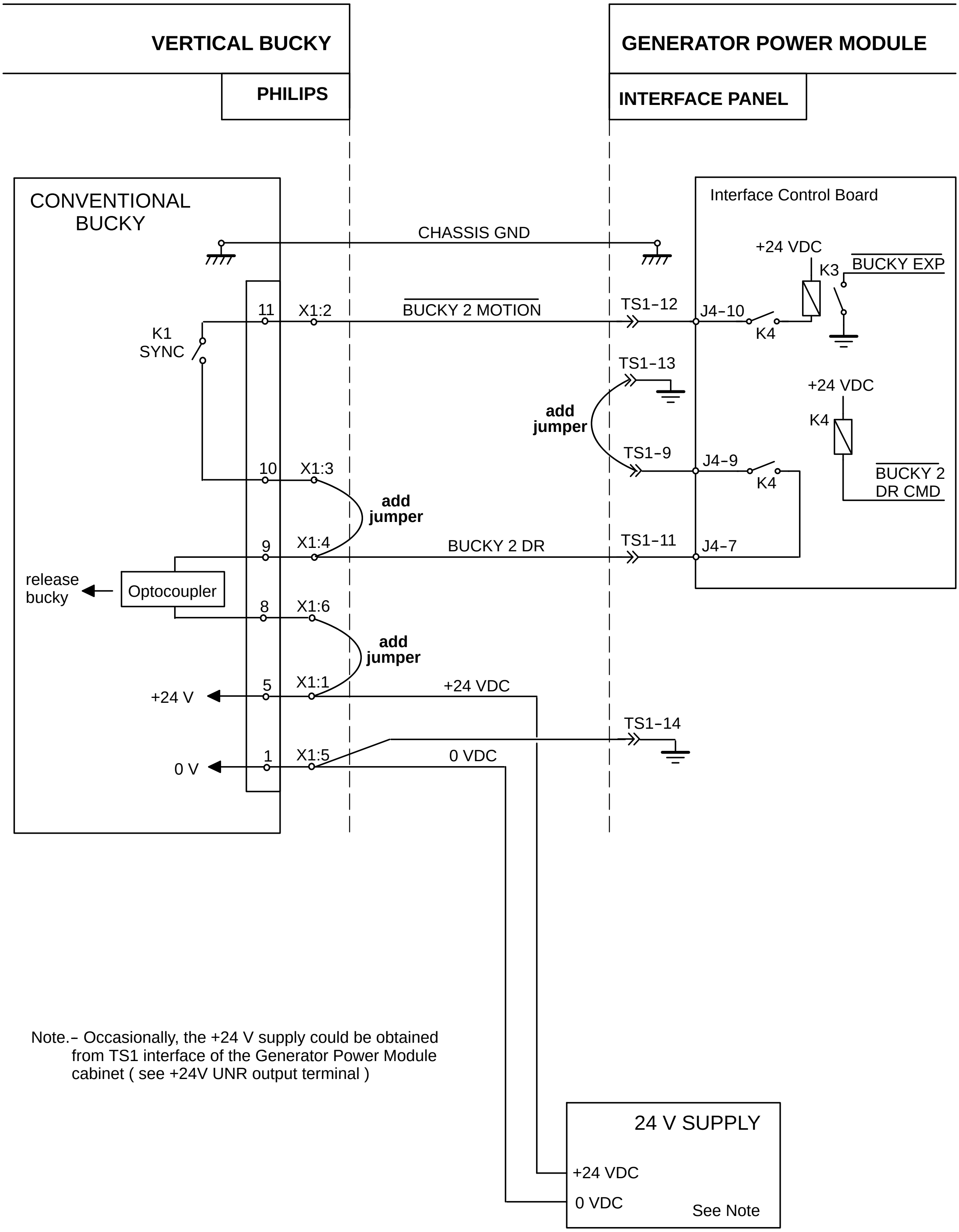
Interconnection Cable
Cable de Inerconexión

I/F-005

A REV

TABLE BUCKY INTERFACE

INTERFAZ BUCKY MESA



Note.- Occasionally, the +24 V supply could be obtained from TS1 interface of the Generator Power Module cabinet (see +24V UNR output terminal)

	NAME	DATE	SHEET / OF
DRAWING	F. GARCIA	22/04/97	1 / 1
REVISED	A. DIAZ	22/04/97	

REV	DESCRIPTION	ISSUED BY	DATE
A	Interf board revised	F. García	14/03/08

SEDECAL INNERSCAN

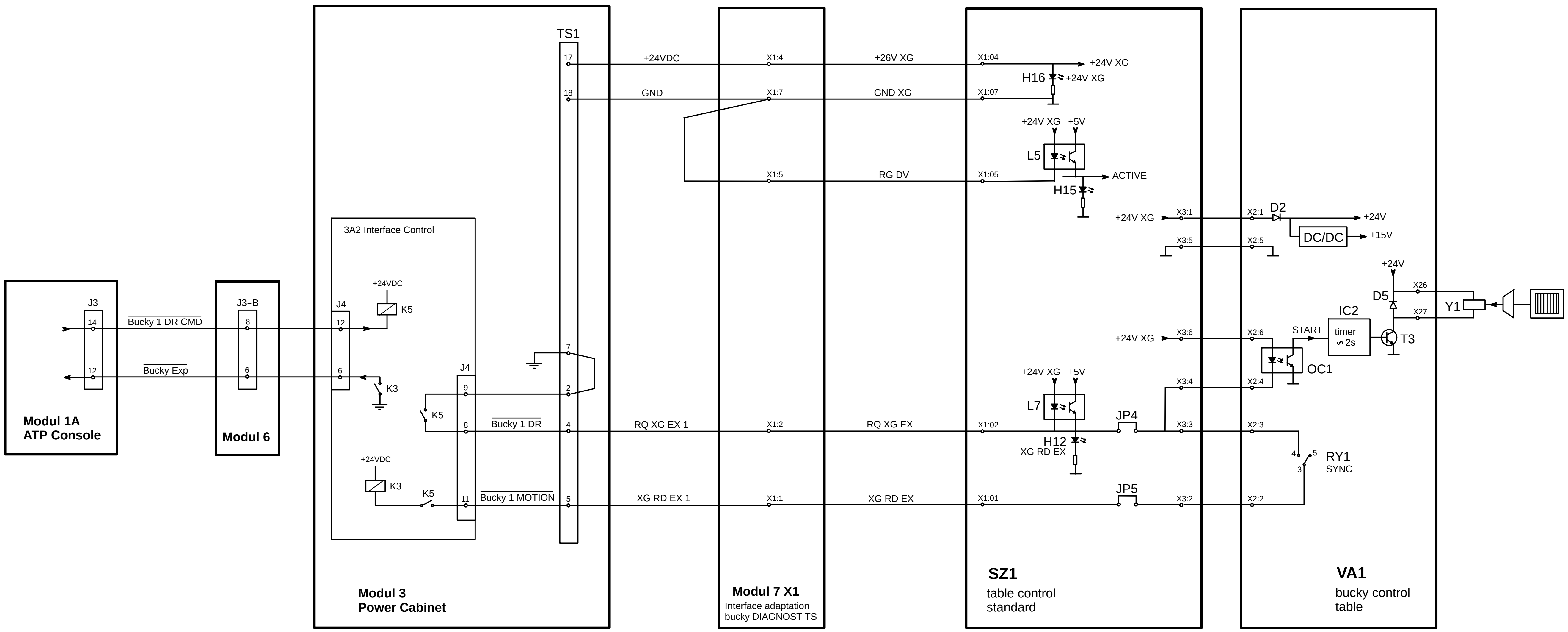
Interconnection Cable
Cable de Inerconexión

I/F-006

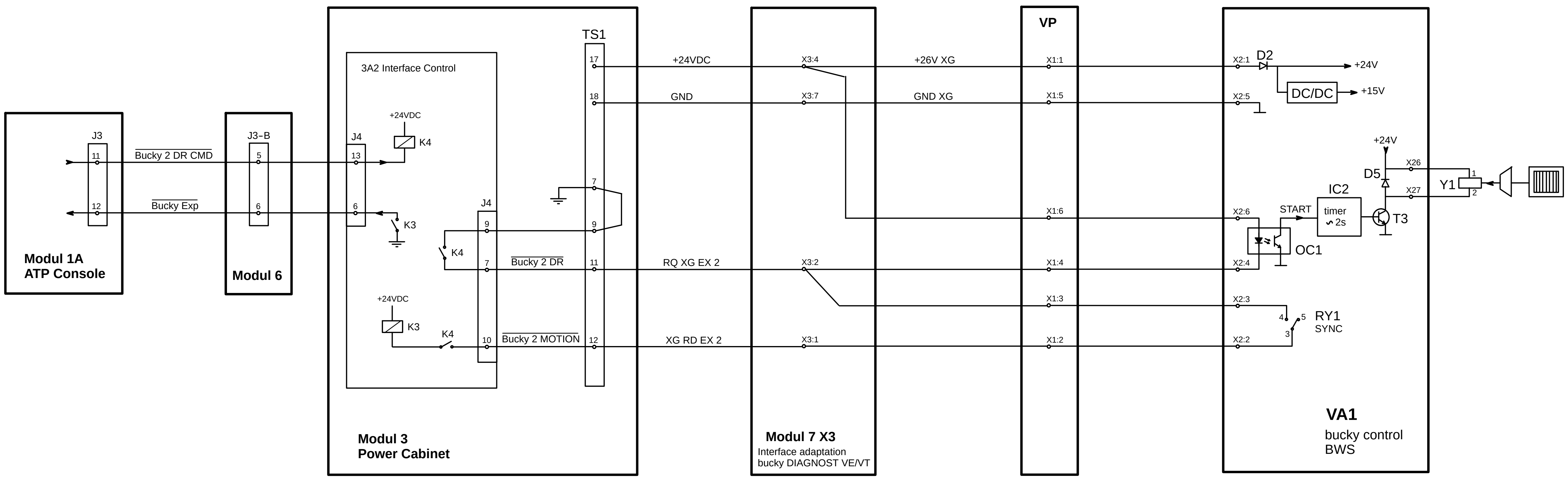
A REV

VERTICAL BUCKY INTERFACE

INTERFAZ BUCKY VERTICAL



					NAME	DATE	SHEET / OF	DWG: I/F – 041
				DRAWING	F. GARCIA	25/09/00	1 / 1	
				REVISED	A. DIAZ	25/09/00		A REV
A	Interf board revised	F. García	14/03/08	SEDECAL				Bucky TS Table (PHILIPS) Interface Adaptation
REV	DESCRIPTION	ISSUED BY	DATE					



A	Interf board revised	F. García	14/03/08
REV	DESCRIPTION	ISSUED BY	DATE

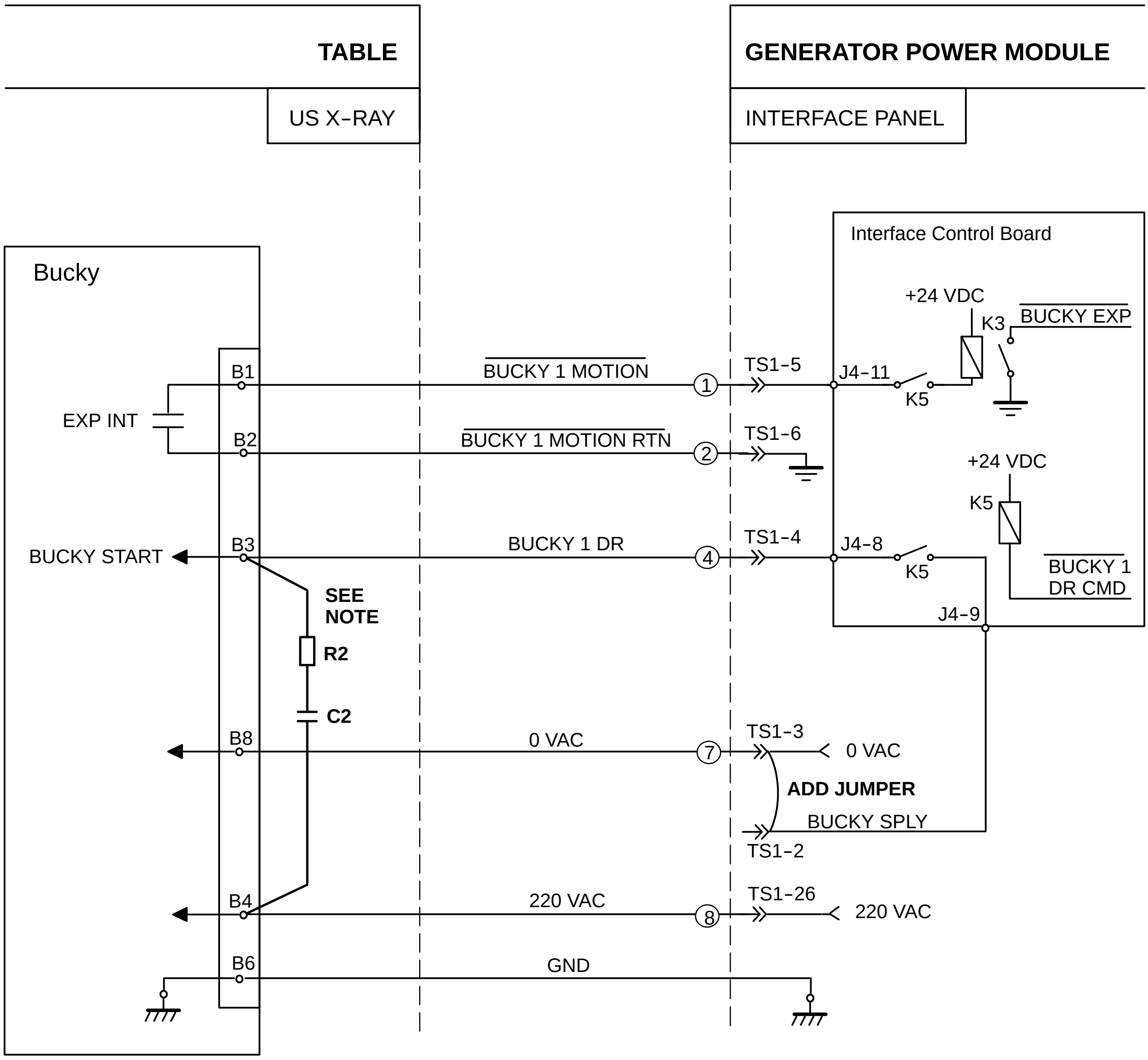
	NAME	DATE	SHEET / OF
DRAWING	F. GARCIA	25/09/00	1 / 1
REVISED	A. DIAZ	25/09/00	

SEDECAL

DWG: I/F – 042

A REV

Bucky VE/VT (PHILIPS)
Interface Adaptation



NOTE : In the case of noise due to Bucky, add R2=22 ohm, 1/2w, 5%; and C2=470 nF, 250 VAC as shown.

NOTA : En caso de ruidos debido al Bucky, añadir R2=22 ohm, 1/2w, 5%, y C2=470 nF, 250 VAC según se muestra.

A	Interf bd. revised	F. García	14/03/08
REV	*DESCRIPTION*	*ISSUED BY*	*DATE*

	NAME	*DATE*	*SHEET / OF*
DRAWING	F. GARCIA	08/08/01	1 / 2
REVISED	A. DIAZ	08/08/01	

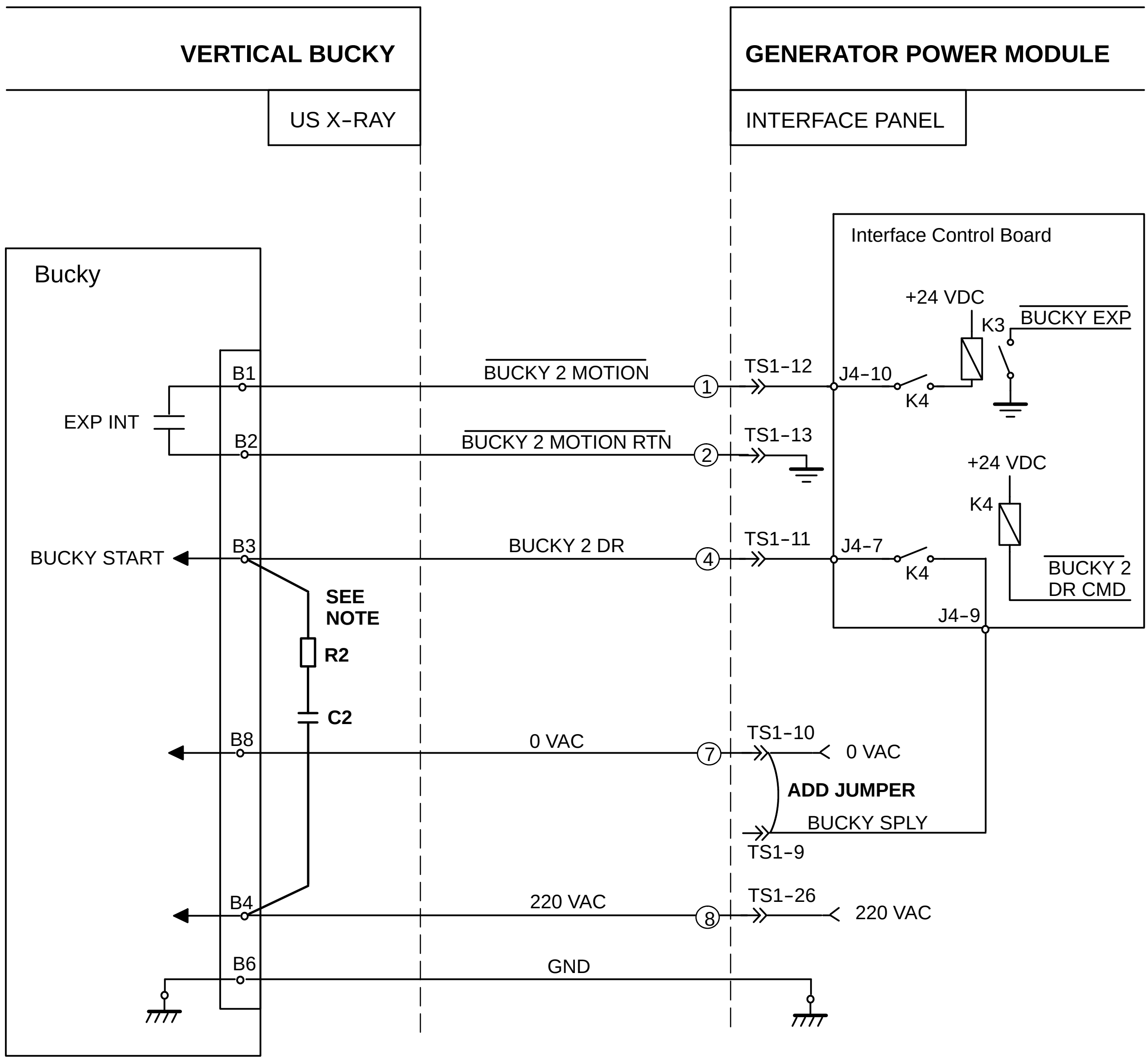
SEDECAL

Interconnection Cable
Cable de Inerconexión

I/F-045

A REV

US X-RAY BUCKY INTERFACE



NOTE : In the case of noise due to Bucky, add R2=22 ohm, 1/2w, 5%; and C2=470 nF, 250 VAC as shown.

NOTA : En caso de ruidos debido al Bucky, añadir R2=22 ohm, 1/2w, 5%, y C2=470 nF, 250 VAC según se muestra.

REV	DESCRIPTION	ISSUED BY	DATE
A	Interf bd. revised	F. García	14/03/08

	NAME	DATE	SHEET / OF
DRAWING	F. GARCIA	08/08/01	2 / 2
REVISED	A. DIAZ	08/08/01	

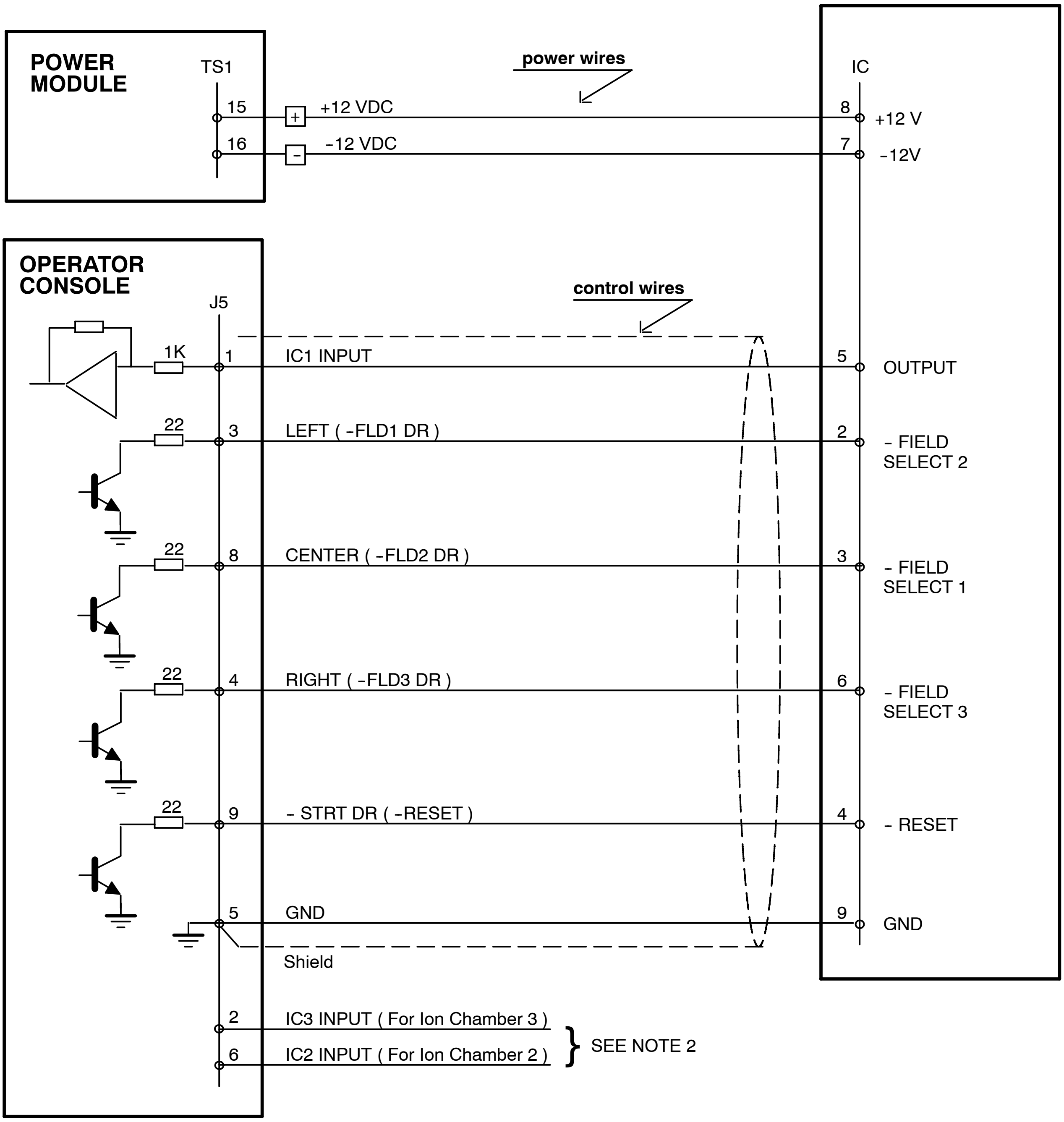
SEDECAL

Interconnection Cable
Cable de Inerconexión

I/F-045

A REV

US X-RAY BUCKY INTERFACE



NOTE 1.- CABLE COMPATIBLE FOR ONE ION CHAMBER (STANDARD COMMUNICATION).
THE CABLE HAS TWO SEPARATED PARTS : CONTROL AND POWER.

NOTE 2.- THE A.E.C. CABLE IS FACTORY CONNECTED FOR ION CHAMBER 1 (J5-1). IF ION CHAMBER 2 OR ION CHAMBER 3 IS USED, REMOVE THE CONNECTION TO J5-1 AND CONNECT TO J5-6 OR J5-2 RESPECTIVELY.

NOTE 3.- THE ASSOCIATION BETWEEN FIELD SELECTION AND AREA DEPENDS ON TYPE OF ION CHAMBER. CHECK THAT THE FIELD SELECTION IN THE ION CHAMBER IS ACCORDING TO THE AREA SELECTION ON THE OPERATOR CONSOLE.

REV	DESCRIPTION	ISSUED BY	DATE
E	*Notes*	F. GARCIA	24/05/96
D	*EMC*	F. GARCIA	29/03/96
C	*s/NC 95/181*	F. GARCIA	02/01/96
B		F. GARCIA	12/12/95
A	*s/NC 95/098*	F. GARCIA	30/06/95

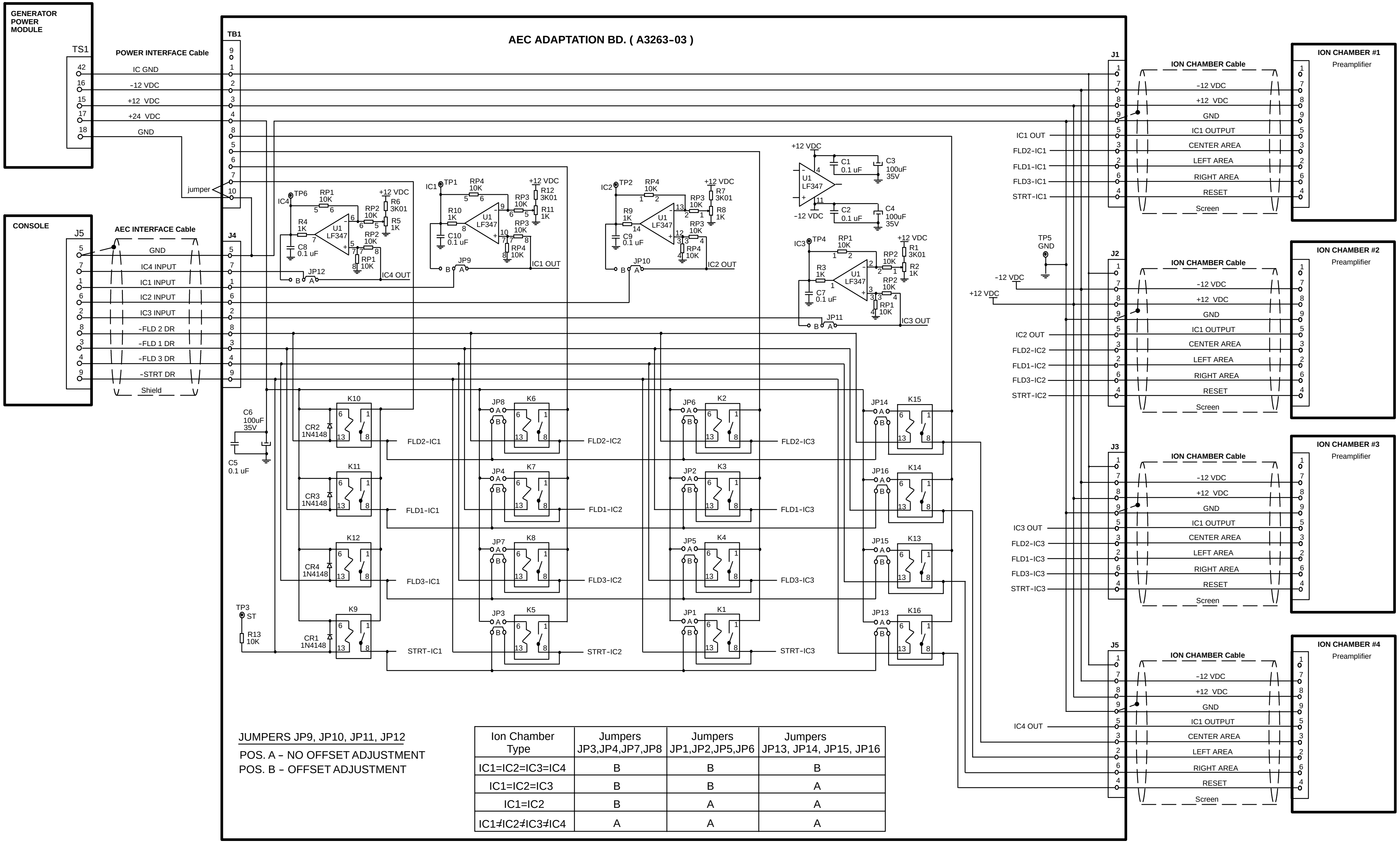
	NAME	DATE	SHEET / OF
DRAWING	F. GARCIA	04/19/95	1 / 1
REVISED	A. DIAZ	04/19/95	

SEDECAL

I/F-003

E D C B A REV

AEC COMPATIBILITY
(for ONLY ONE IonChamber)
COMPATIBILIDAD AEC
(para SOLO UNA Cámara de Ionización)



JUMPERS JP9, JP10, JP11, JP12

POS. A - NO OFFSET ADJUSTMENT
POS. B - OFFSET ADJUSTMENT

Ion Chamber Type	Jumpers JP3,JP4,JP7,JP8	Jumpers JP1,JP2,JP5,JP6	Jumpers JP13, JP14, JP15, JP16
IC1=IC2=IC3=IC4	B	B	B
IC1=IC2=IC3	B	B	A
IC1=IC2	B	A	A
IC1≠IC2≠IC3≠IC4	A	A	A

Note.- Compatible interface with preamplifier for Ion Chamber types :

- Expos-AID
- Vacutec 70145/70151
- Comet Ion Chambers with PA-021 Preamplifier
- Claymount with preamplifier SSMC1006

REV	DESCRIPTION	ISSUED BY	DATE
B	new interface	F. García	30/09/10
A	Version 03	F. GARCIA	10/10/99

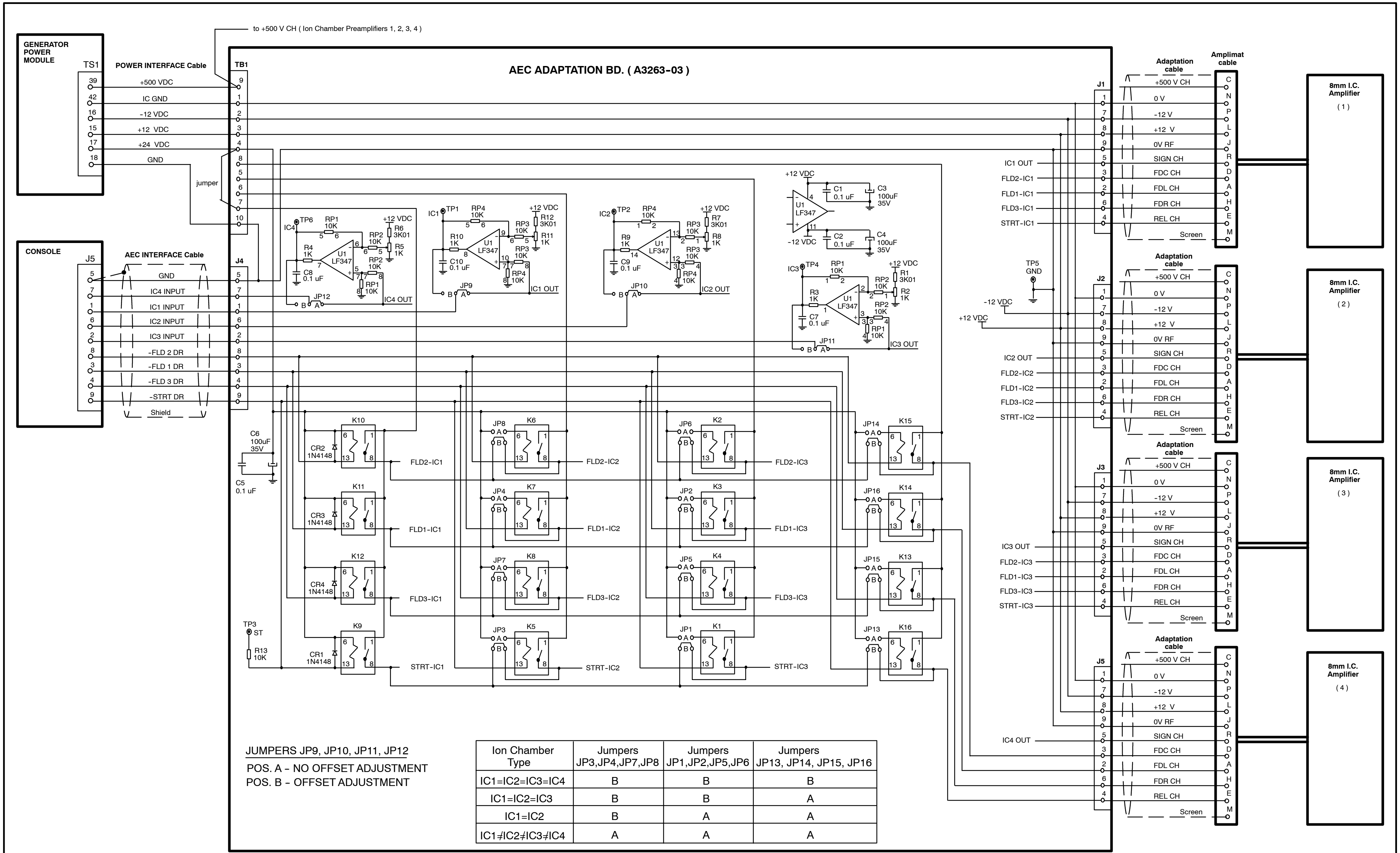
	NAME	DATE	SHEET / OF
DRAWING	F. GARCIA	07/08/96	1 / 1
REVISED	A. DIAZ	10/10/96	

DWG: IM-015

B A REV

SEDECAL

AEC COMPATIBILITY with AID / VACUTEC / COMET / CLAYMOUNT



JUMPERS JP9, JP10, JP11, JP12

POS. A - NO OFFSET ADJUSTMENT
POS. B - OFFSET ADJUSTMENT

Ion Chamber Type	Jumpers JP3,JP4,JP7,JP8	Jumpers JP1,JP2,JP5,JP6	Jumpers JP13, JP14, JP15, JP16
IC1=IC2=IC3=IC4	B	B	B
IC1=IC2=IC3	B	B	A
IC1=IC2	B	A	A
IC1≠IC2≠IC3≠IC4	A	A	A

NOTE.- Adaptation cable required A6727-XX

NOTE

Compatible interface with amplifier of 8mm measuring chamber.

REV	DESCRIPTION	ISSUED BY	DATE
C	I/F - 2 sheets	F. GARCIA	10/10/01
B	Adaptation cable	F. GARCIA	03/03/00
A	VERSION 03	F. GARCIA	10/10/99

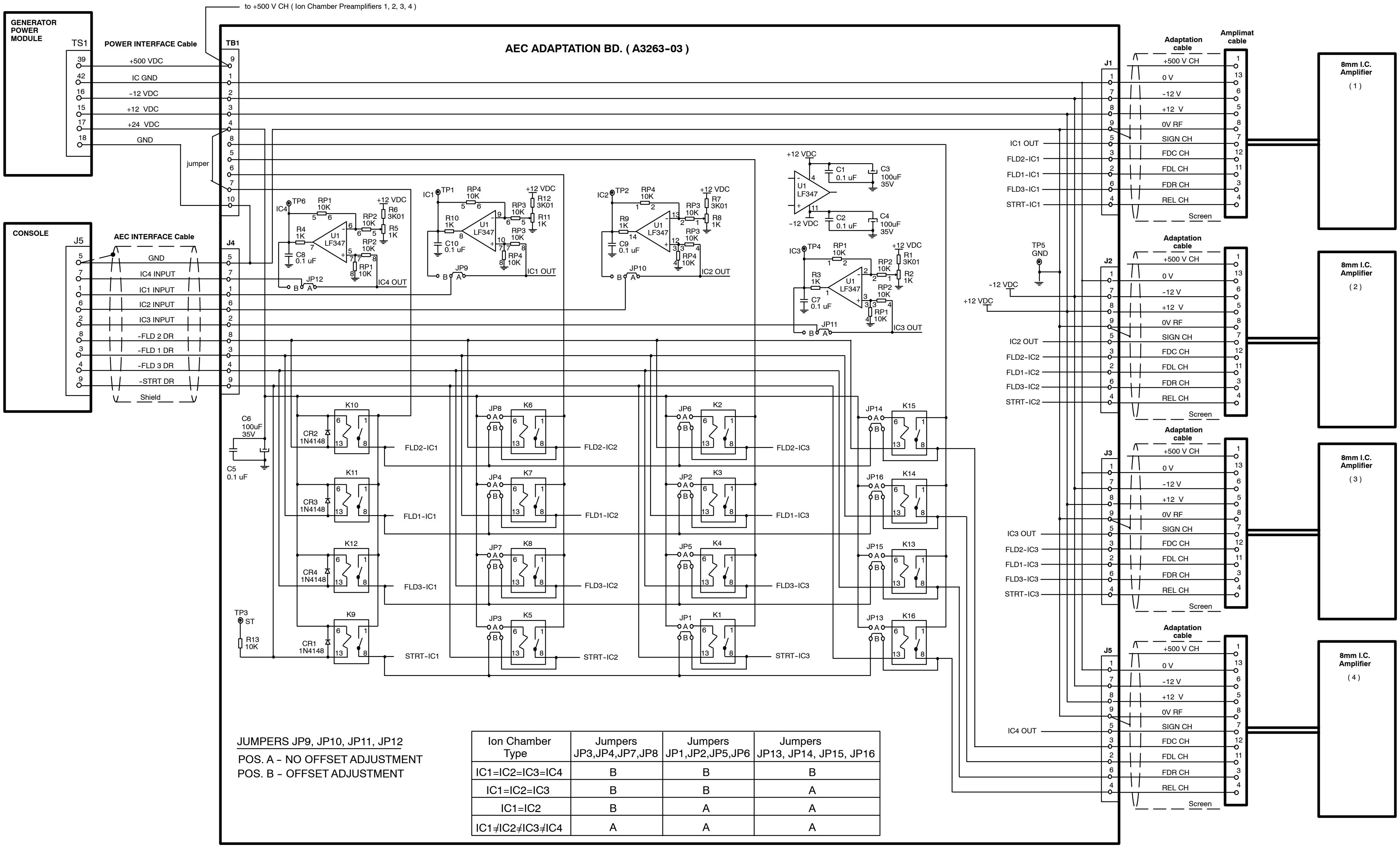
	NAME	DATE	SHEET / OF
DRAWING	F. GARCIA	09/09/98	1 / 2
REVISED	A. DIAZ	09/09/98	

SEDECAL

DWG: IM-014

C B A REV

AEC-PHILIPS COMPATIBILITY
(FOUR ION CHAMBERS)



JUMPERS JP9, JP10, JP11, JP12

POS. A - NO OFFSET ADJUSTMENT
POS. B - OFFSET ADJUSTMENT

Ion Chamber Type	Jumpers JP3,JP4,JP7,JP8	Jumpers JP1,JP2,JP5,JP6	Jumpers JP13, JP14, JP15, JP16
IC1=IC2=IC3=IC4	B	B	B
IC1=IC2=IC3	B	B	A
IC1=IC2	B	A	A
IC1≠IC2≠IC3≠IC4	A	A	A

NOTE.- Adaptation cable required A3080-XX

NOTE

Compatible interface with amplifier of 8mm measuring chamber.

REV	DESCRIPTION	ISSUED BY	DATE
C	I/F - 2 sheets	F. GARCIA	10/10/01
B	Adaptation cable modified	F. GARCIA	03/03/00
A	VERSION 03	F. GARCIA	10/10/99

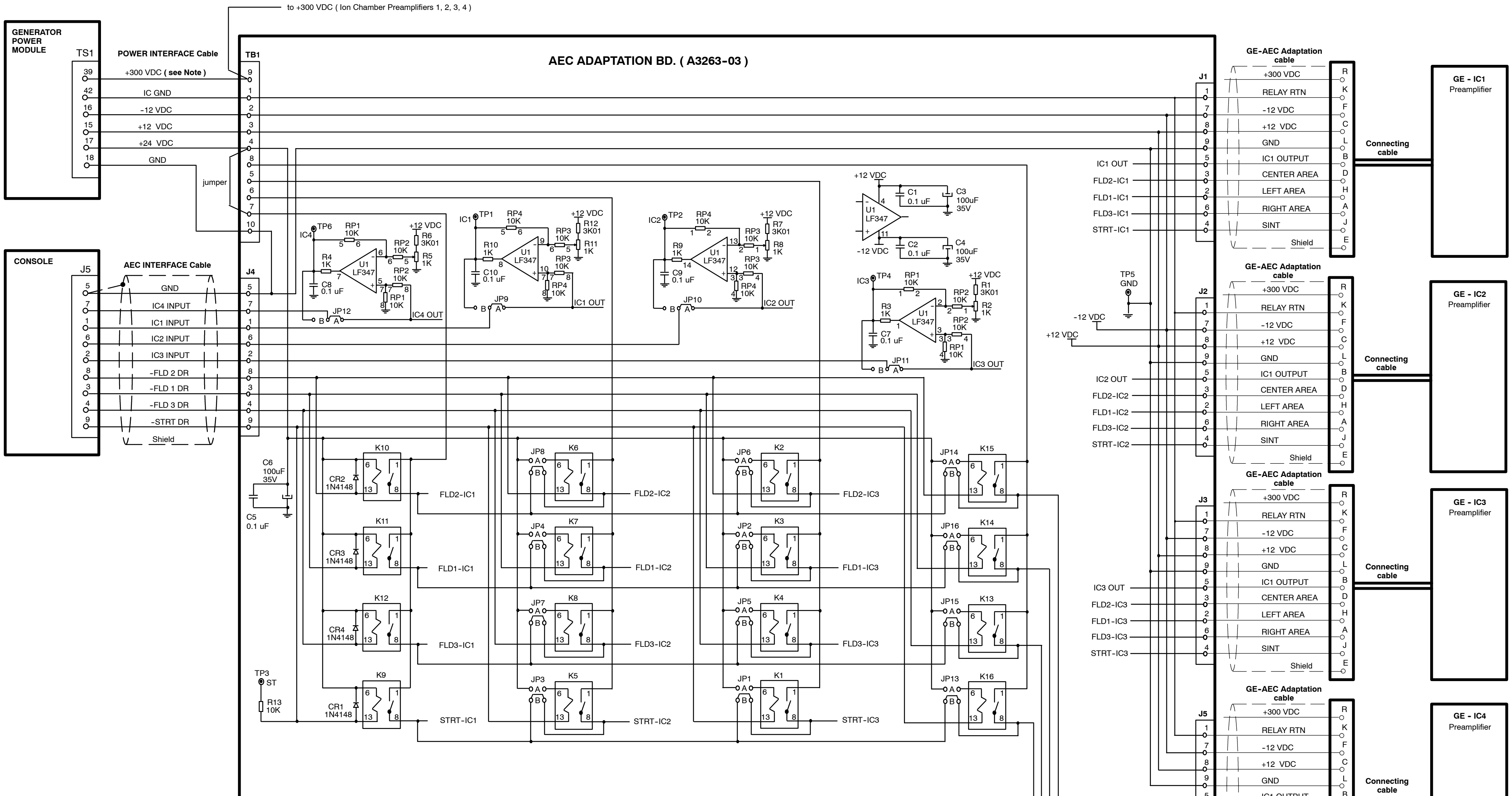
	NAME	DATE	SHEET / OF
DRAWING	F. GARCIA	09/09/98	2 / 2
REVISED	A. DIAZ	09/09/98	

SEDECAL

DWG: IM-014

C B A REV

AEC-PHILIPS COMPATIBILITY (FOUR ION CHAMBERS)



JUMPERS JP9, JP10, JP11, JP12

POS. A - NO OFFSET ADJUSTMENT
POS. B - OFFSET ADJUSTMENT

Ion Chamber Type	Jumpers JP3,JP4,JP7,JP8	Jumpers JP1,JP2,JP5,JP6	Jumpers JP13, JP14, JP15, JP16
IC1=IC2=IC3=IC4	B	B	B
IC1=IC2=IC3	B	B	A
IC1=IC2	B	A	A
IC1≠IC2≠IC3≠IC4	A	A	A

NOTE :
The +300 VDC only required for old GE Ion Chambers (not generated on preamplifier board)

REV	DESCRIPTION	ISSUED BY	DATE
A	Version 03	F. GARCIA	10/10/99

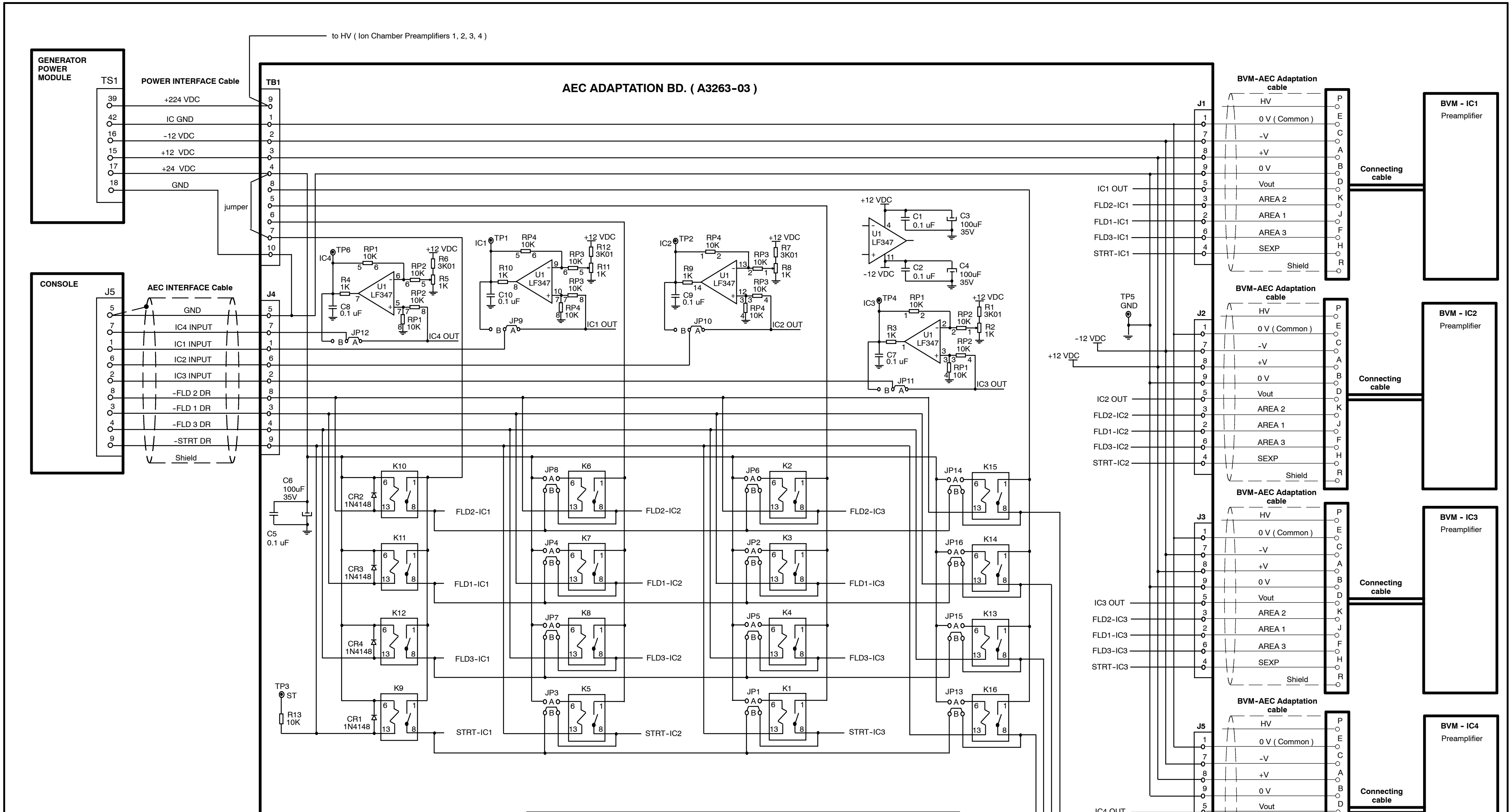
	NAME	DATE	SHEET / OF
DRAWING	F. GARCIA	10/10/97	1 / 1
REVISED	A. DIAZ	10/10/97	

SEDECAL

DWG: IM-018

A REV

AEC - GE COMPATIBILITY
(FOUR ION CHAMBERS)



JUMPERS JP9, JP10, JP11, JP12

POS. A - NO OFFSET ADJUSTMENT

POS. B - OFFSET ADJUSTMENT

Ion Chamber Type	Jumpers JP3,JP4,JP7,JP8	Jumpers JP1,JP2,JP5,JP6	Jumpers JP13, JP14, JP15, JP16
IC1=IC2=IC3=IC4	B	B	B
IC1=IC2=IC3	B	B	A
IC1=IC2	B	A	A
IC1≠IC2≠IC3≠IC4	A	A	A

REV	DESCRIPTION	ISSUED BY	DATE
A	Version 03	F. GARCIA	10/10/99

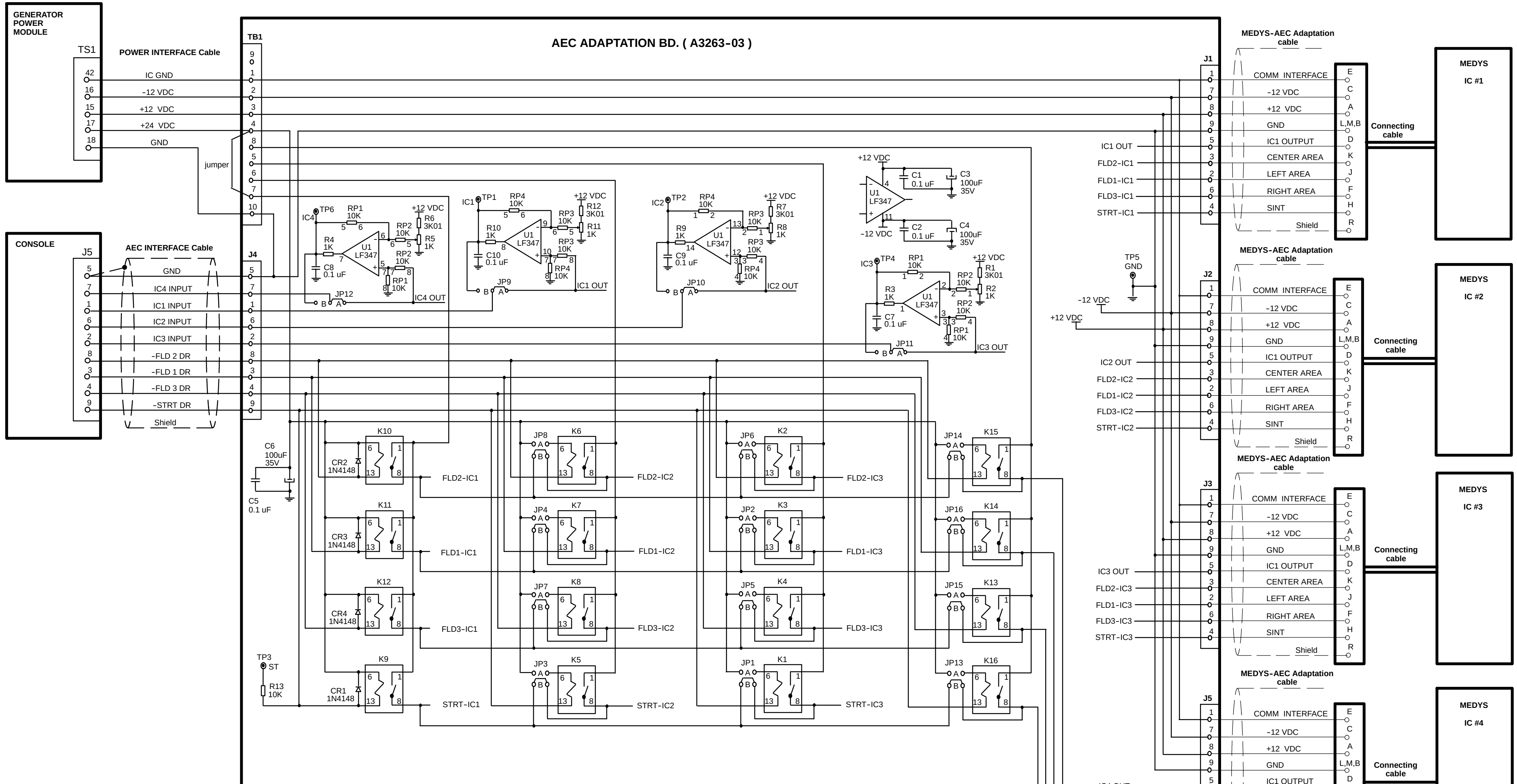
	NAME	DATE	SHEET / OF
DRAWING	F. GARCIA	10/10/97	1 / 1
REVISED	A. DIAZ	10/10/97	

DWG: IM-019

A REV

SEDECAL

AEC - BVM COMPATIBILITY
(FOUR ION CHAMBERS)



JUMPERS JP9, JP10, JP11, JP12

POS. A - NO OFFSET ADJUSTMENT

POS. B - OFFSET ADJUSTMENT

Ion Chamber Type	Jumpers JP3,JP4,JP7,JP8	Jumpers JP1,JP2,JP5,JP6	Jumpers JP13, JP14, JP15, JP16
IC1=IC2=IC3=IC4	B	B	B
IC1=IC2=IC3	B	B	A
IC1=IC2	B	A	A
IC1≠IC2≠IC3≠IC4	A	A	A

					NAME	DATE	SHEET / OF
				DRAWING	F. GARCIA	08/08/01	1 / 1
				REVISED	A. DIAZ	10/10/01	
A	CN 03/211	F. García	09/12/03				
REV	DESCRIPTION	ISSUED BY	DATE				

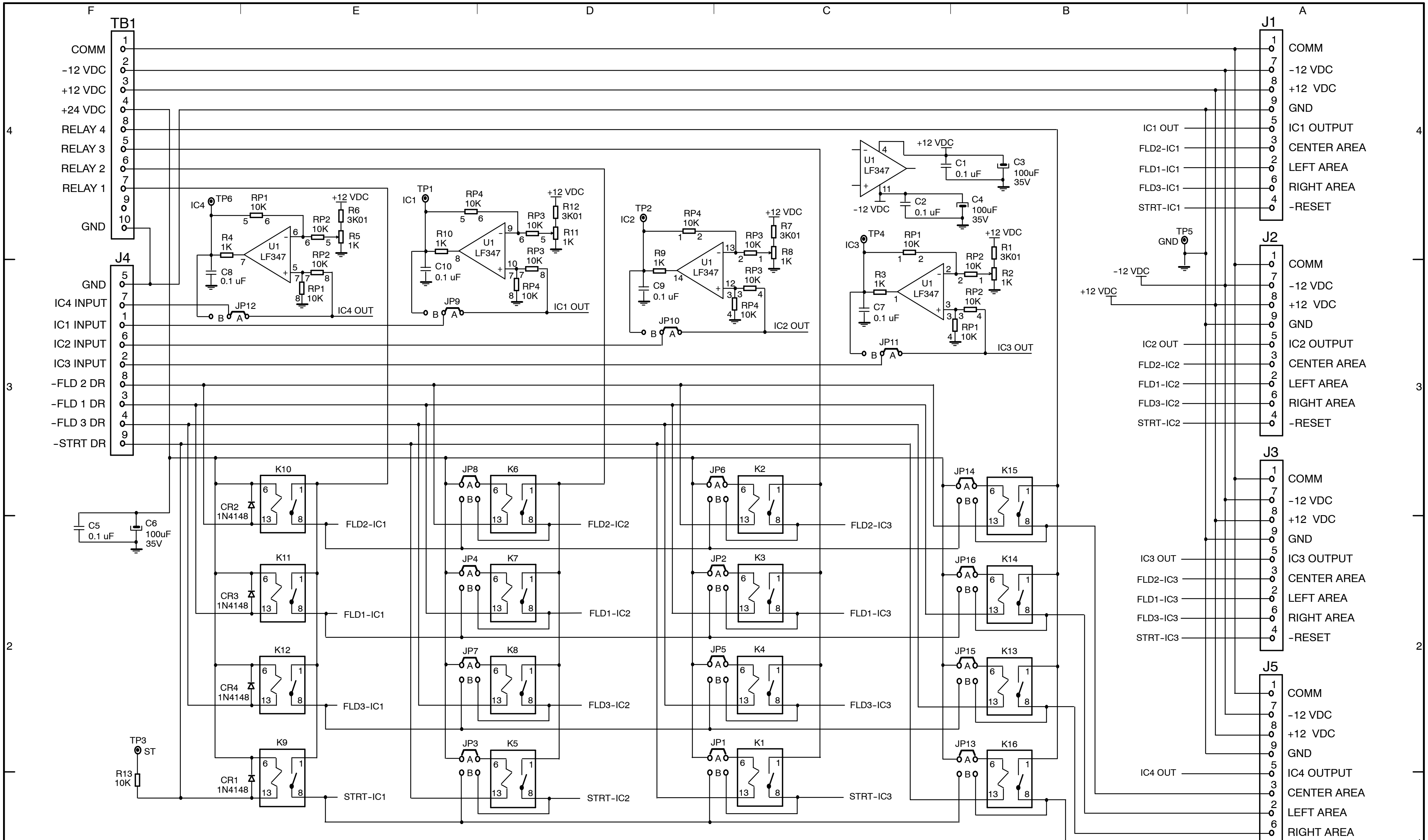
SEDECAL

DWG: IM-081

A REV

MEDYS ION CHAMBER ADAPTATION

–FIELD SEL 3



JUMPERS JP9, JP10, JP11, JP12

POS. A - NO OFFSET ADJUSTMENT
POS. B - OFFSET ADJUSTMENT

Note.- Version 03 as CN 99/45

Ion Chamber Type	Jumpers JP3,JP4,JP7,JP8	Jumpers JP1,JP2,JP5,JP6	Jumpers JP13, JP14, JP15, JP16
IC1=IC2=IC3=IC4	B	B	B
IC1=IC2=IC3	B	B	A
IC1=IC2	B	A	A
IC1≠IC2≠IC3≠IC4	A	A	A

	NAME	DATE	SHEET / OF
DRAWING	F. GARCIA	07/07/99	1 / 1
REVISED	A. DIAZ	07/07/99	

REV	DESCRIPTION	ISSUED BY	DATE

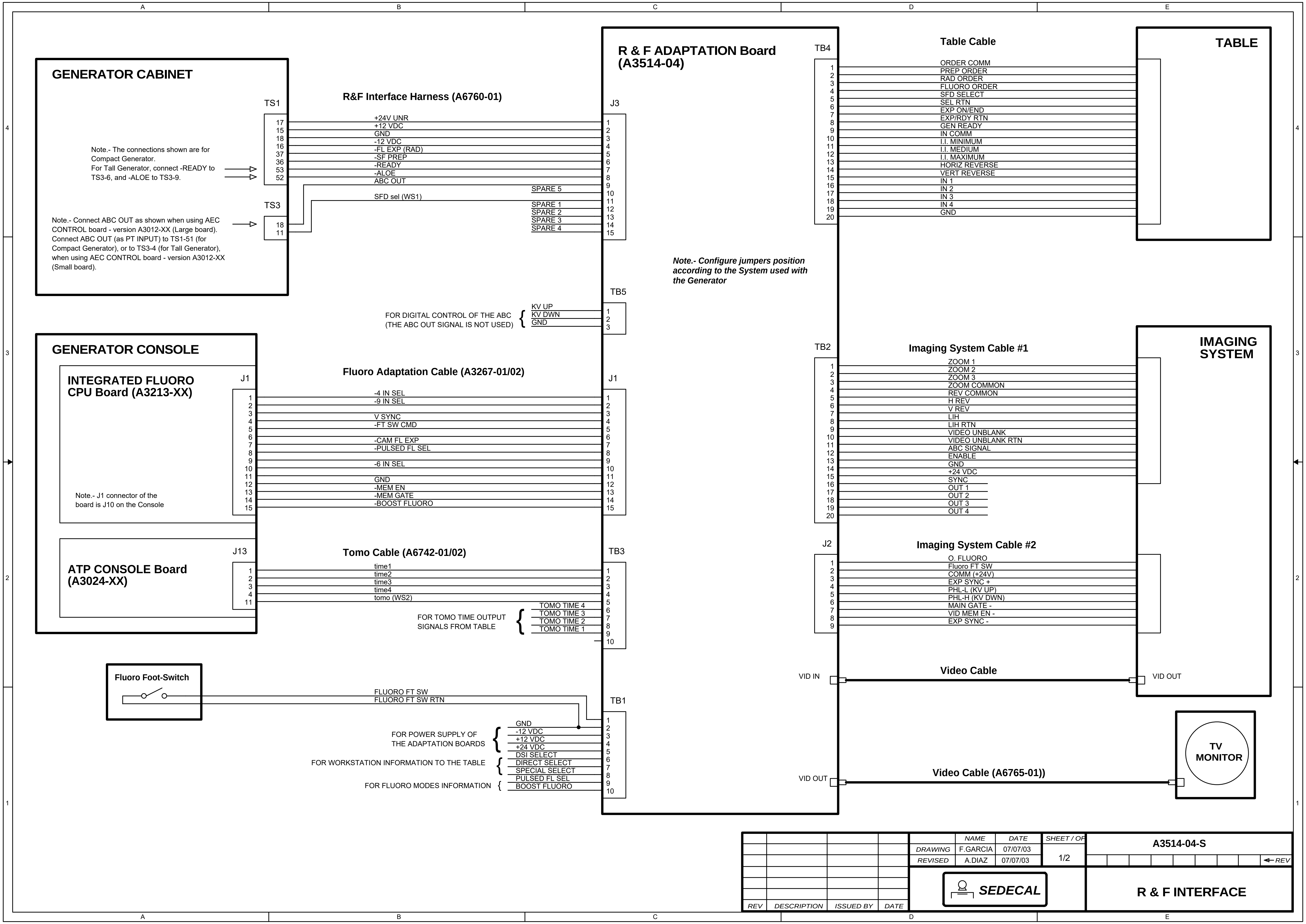
DWG: A3263-03

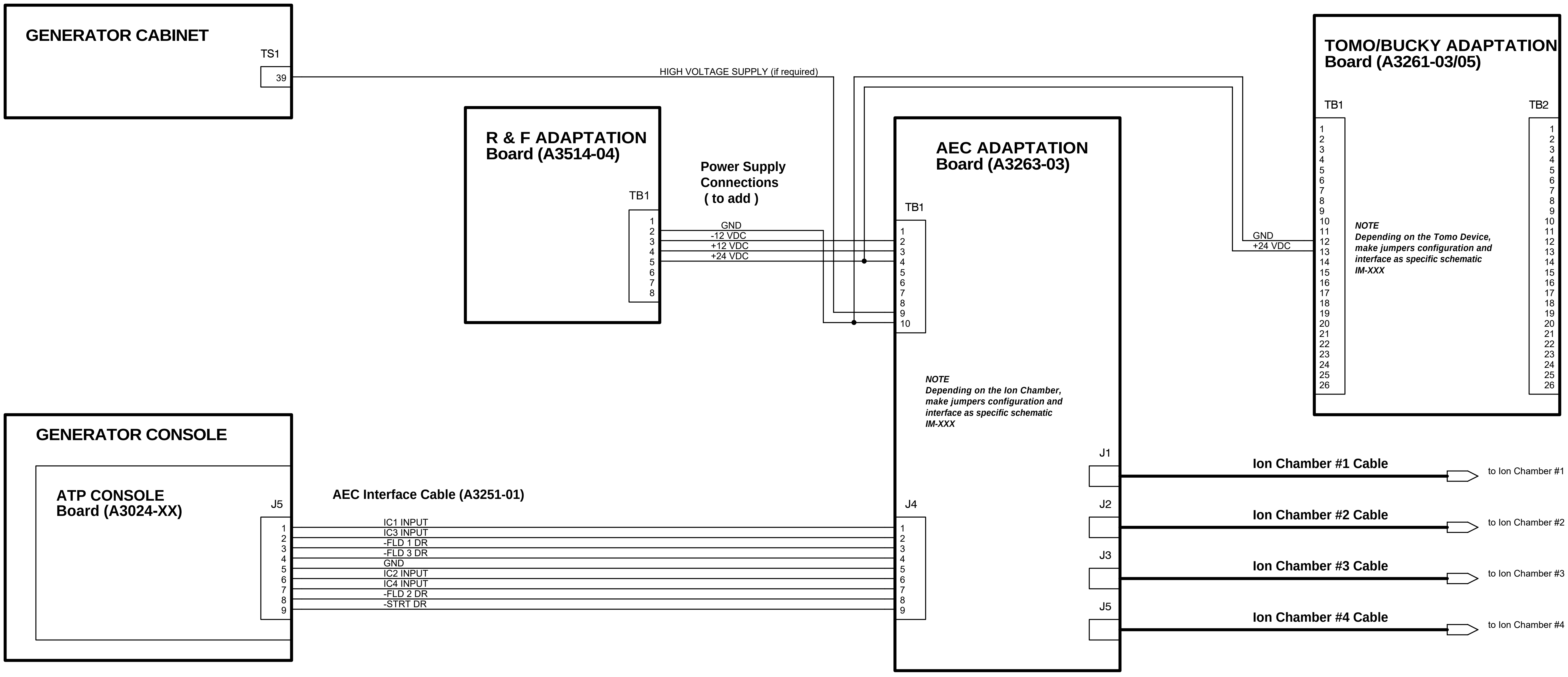
REV

SEDECAL

AEC ADAPTATION

ADAPTACION AEC


GENERATOR CABINET
TS1
17
15
18
16
37
36
53
52
Note.- The connections shown are for Compact Generator.
For Tall Generator, connect -READY to TS3-6, and -ALOE to TS3-9.
TS3
18
11
Note.- Connect ABC OUT as shown when using AEC CONTROL board - version A3012-XX (Large board). Connect ABC OUT (as PT INPUT) to TS1-51 (for Compact Generator), or to TS3-4 (for Tall Generator), when using AEC CONTROL board - version A3012-XX (Small board).
R&F Interface Harness (A6760-01)
+24V UNR
+12 VDC
GND
-12 VDC
-FL EXP (RAD)
-SF PREP
-READY
-ALOE
ABC OUT
SPARE 5
SFD sel (WS1)
SPARE 1
SPARE 2
SPARE 3
SPARE 4
R & F ADAPTATION Board
(A3514-04)
J3
TB4
Table Cable
TABLE
ORDER COMM
PREP ORDER
RAD ORDER
FLUORO ORDER
SFD SELECT
SEL RTN
EXP ON/END
EXP/RDY RTN
GEN READY
IN COMM
I.I. MINIMUM
I.I. MEDIUM
I.I. MAXIMUM
HORIZ REVERSE
VERT REVERSE
IN 1
IN 2
IN 3
IN 4
GND
Note.- Configure jumpers position according to the System used with the Generator
TB5
FOR DIGITAL CONTROL OF THE ABC
(THE ABC OUT SIGNAL IS NOT USED)
KV UP
KV DWN
GND
GENERATOR CONSOLE
INTEGRATED FLUORO
CPU Board (A3213-XX)
J1
Fluoro Adaptation Cable (A3267-01/02)
-4 IN SEL
-9 IN SEL
V SYNC
-FT SW CMD
-CAM FL EXP
-PULSED FL SEL
-6 IN SEL
GND
-MEM EN
-MEM GATE
-BOOST FLUORO
Note.- J1 connector of the board is J10 on the Console
TB2
Imaging System Cable #1
IMAGING
SYSTEM
ZOOM 1
ZOOM 2
ZOOM 3
ZOOM COMMON
REV COMMON
H REV
V REV
LIH
LIH RTN
VIDEO UNBLANK
VIDEO UNBLANK RTN
ABC SIGNAL
ENABLE
GND
+24 VDC
SYNC
OUT 1
OUT 2
OUT 3
OUT 4
ATP CONSOLE Board
(A3024-XX)
J13
Tomo Cable (A6742-01/02)
time1
time2
time3
time4
tomo (WS2)
TB3
FOR TOMO TIME OUTPUT
SIGNALS FROM TABLE
TOMO TIME 4
TOMO TIME 3
TOMO TIME 2
TOMO TIME 1
J2
Imaging System Cable #2
O. FLUORO
Fluoro FT SW
COMM (+24V)
EXP SYNC +
PHL-L (KV UP)
PHL-H (KV DWN)
MAIN GATE -
VID MEM EN -
EXP SYNC -
VID IN
Video Cable
VID OUT
Fluoro Foot-Switch
FLUORO FT SW
FLUORO FT SW RTN
TB1
FOR POWER SUPPLY OF
THE ADAPTATION BOARDS
GND
-12 VDC
+12 VDC
+24 VDC
FOR WORKSTATION INFORMATION TO THE TABLE
DSI SELECT
DIRECT SELECT
SPECIAL SELECT
PULSED FL SEL
FOR FLUORO MODES INFORMATION
BOOST FLUORO
VID OUT
Video Cable (A6765-01))
TV
MONITOR
NAME
DATE
SHEET / OF
DRAWING F.GARCIA 07/07/03
REVISED A.DIAZ 07/07/03
1/2
A3514-04-S
REV
SEDECAL
R & F INTERFACE
REV
DESCRIPTION
ISSUED BY
DATE



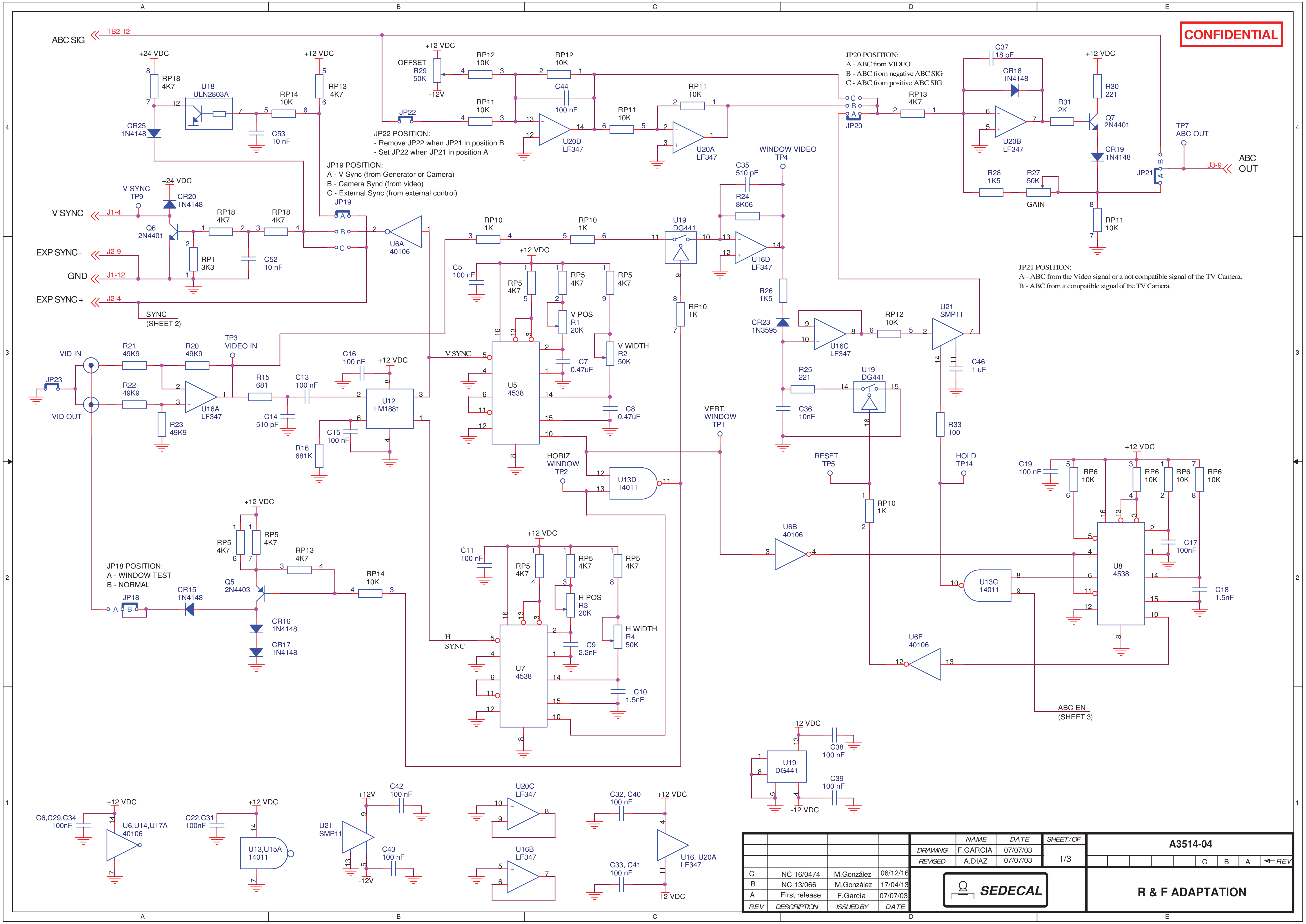
THIS SHEET ONLY APPLIES WHEN AEC ADAPTATION BOARD AND/OR TOMO/BUCKY ADAPTATION BOARD ARE REQUIRED

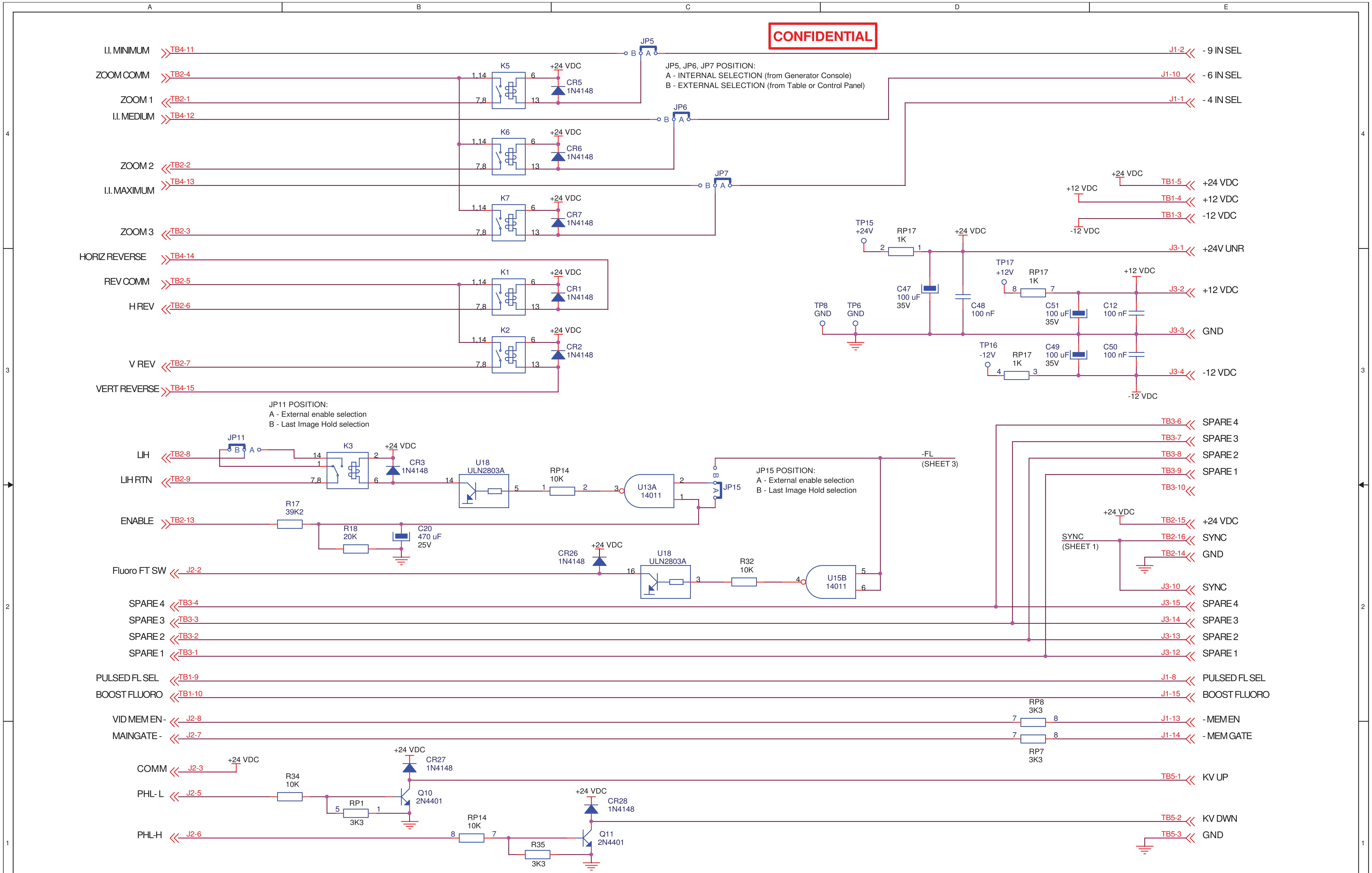
	NAME	DATE	SHEET / OF	A3514-04-S
DRAWING	F.GARCIA	07/07/03	2/2	
REVISED	A.DIAZ	07/07/03		REV

REV	DESCRIPTION	ISSUED BY	DATE

SEDECAL

R & F INTERFACE


CONFIDENTIAL
ABC SIG
TB2-12
V SYNC
J1-4
EXP SYNC -
J2-9
GND
J1-12
EXP SYNC +
J2-4
SYNC
(SHEET 2)
VID IN
VID OUT
JP23
ABC OUT
J3-9
TP7
ABC OUT
WINDOW VIDEO
TP4
VERT. WINDOW
TP1
HORIZ. WINDOW
TP2
RESET
TP5
HOLD
TP14
GAIN
OFFSET
V POS
V WIDTH
H POS
H WIDTH
ABC EN
(SHEET 3)
JP22 POSITION:
- Remove JP22 when JP21 in position B
- Set JP22 when JP21 in position A
JP19 POSITION:
A - V Sync (from Generator or Camera)
B - Camera Sync (from video)
C - External Sync (from external control)
JP20 POSITION:
A - ABC from VIDEO
B - ABC from negative ABC SIG
C - ABC from positive ABC SIG
JP21 POSITION:
A - ABC from the Video signal or a not compatible signal of the TV Camera.
B - ABC from a compatible signal of the TV Camera.
JP18 POSITION:
A - WINDOW TEST
B - NORMAL
U5
4538
U7
4538
U8
4538
U12
LM1881
U19
DG441
U21
SMP11
U18
ULN2803A
U6,U14,U17A
40106
U13,U15A
14011
U16, U20A
LF347
C6,C29,C34
100nF
C22,C31
100nF
C32, C40
100 nF
C33, C41
100 nF
+12 VDC
-12 VDC
+24 VDC
	NAME	DATE	SHEET/OF
DRAWING	F.GARCIA	07/07/03	1/3
REVISED	A.DIAZ	07/07/03	
C | NC 16/0474 | M.González | 06/12/16
B | NC 13/066 | M.González | 17/04/13
A | First release | F.García | 07/07/03
REV | DESCRIPTION | ISSUED BY | DATE
SEDECAL
A3514-04
C B A REV
R & F ADAPTATION



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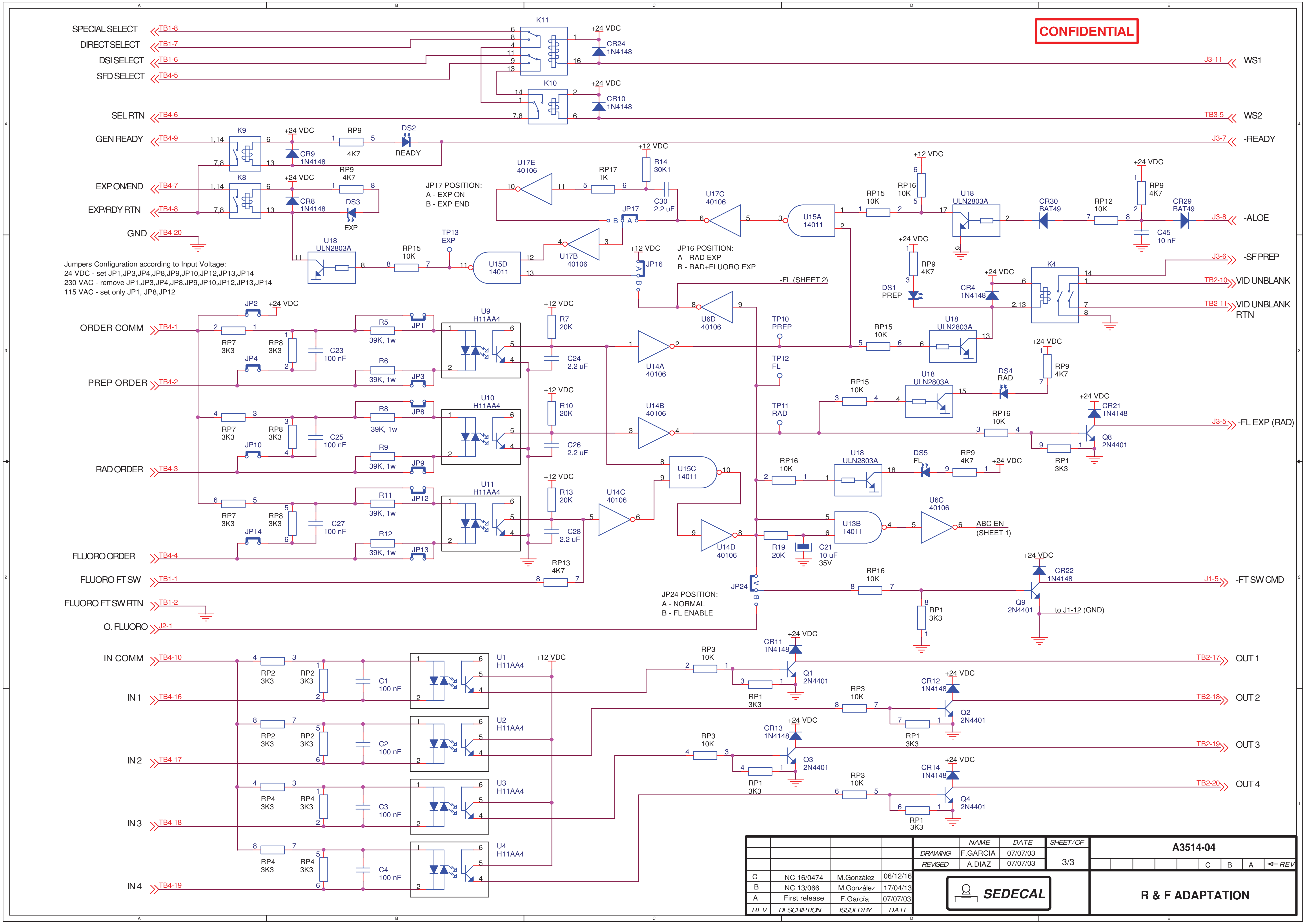
				DRAWING	F.GARCIA	07/07/03	2/3	
				REVISED	A.DIAZ	07/07/03		C B A ← REV
C	NC 16/0474	M.González	06/12/16	SEDECAL				R & F ADAPTATION
B	NC 13/066	M.González	17/04/13					
A	First release	F.García	07/07/03					
REV	DESCRIPTION	ISSUED BY	DATE					


CONFIDENTIAL
SPECIAL SELECT TB1-8
DIRECT SELECT TB1-7
DSI SELECT TB1-6
SFD SELECT TB4-5
SEL RTN TB4-6
GEN READY TB4-9
EXP ON/END TB4-7
EXP/RDY RTN TB4-8
GND TB4-20
ORDER COMM TB4-1
PREP ORDER TB4-2
RAD ORDER TB4-3
FLUORO ORDER TB4-4
FLUORO FT SW TB1-1
FLUORO FT SW RTN TB1-2
O. FLUORO J2-1
IN COMM TB4-10
IN 1 TB4-16
IN 2 TB4-17
IN 3 TB4-18
IN 4 TB4-19
J3-11 WS1
TB3-5 WS2
J3-7 -READY
J3-8 -ALOE
J3-6 -SF PREP
TB2-10 VID UNBLANK
TB2-11 VID UNBLANK RTN
J3-5 -FL EXP (RAD)
J1-5 -FT SW CMD
TB2-17 OUT 1
TB2-18 OUT 2
TB2-19 OUT 3
TB2-20 OUT 4
K11
K10
K9
K8
K4
+24 VDC
+12 VDC
CR24 1N4148
CR10 1N4148
CR9 1N4148
CR8 1N4148
RP9 4K7
DS2 READY
DS3 EXP
U17E 40106
RP17 1K
R14 30K1
C30 2.2 uF
JP17 POSITION:
A - EXP ON
B - EXP END
U17C 40106
U15A 14011
RP15 10K
RP16 10K
U18 ULN2803A
CR30 BAT49
RP12 10K
CR29 BAT49
C45 10 nF
TP13 EXP
U15D 14011
U17B 40106
JP16
JP16 POSITION:
A - RAD EXP
B - RAD+FLUORO EXP
-FL (SHEET 2)
Jumpers Configuration according to Input Voltage:
24 VDC - set JP1,JP3,JP4,JP8,JP9,JP10,JP12,JP13,JP14
230 VAC - remove JP1,JP3,JP4,JP8,JP9,JP10,JP12,JP13,JP14
115 VAC - set only JP1, JP8,JP12
DS1 PREP
CR4 1N4148
U6D 40106
TP10 PREP
TP12 FL
TP11 RAD
U9 H11AA4
U10 H11AA4
U11 H11AA4
RP7 3K3
RP8 3K3
C23 100 nF
C25 100 nF
C27 100 nF
R5 39K, 1w
R6 39K, 1w
R8 39K, 1w
R9 39K, 1w
R11 39K, 1w
R12 39K, 1w
R7 20K
R10 20K
R13 20K
C24 2.2 uF
C26 2.2 uF
C28 2.2 uF
U14A 40106
U14B 40106
U14C 40106
U15C 14011
U14D 40106
U13B 14011
U6C 40106
ABC EN (SHEET 1)
R19 20K
C21 10 uF 35V
DS4 RAD
DS5 FL
CR21 1N4148
Q8 2N4401
RP1 3K3
RP13 4K7
JP24
JP24 POSITION:
A - NORMAL
B - FL ENABLE
CR22 1N4148
Q9 2N4401
to J1-12 (GND)
U1 H11AA4
U2 H11AA4
U3 H11AA4
U4 H11AA4
RP2 3K3
RP4 3K3
C1 100 nF
C2 100 nF
C3 100 nF
C4 100 nF
RP3 10K
CR11 1N4148
CR12 1N4148
CR13 1N4148
CR14 1N4148
Q1 2N4401
Q2 2N4401
Q3 2N4401
Q4 2N4401
NAME DATE SHEET/OF
DRAWING F.GARCIA 07/07/03
REVISED A.DIAZ 07/07/03
3/3
A3514-04
C B A REV
C NC 16/0474 M.González 06/12/16
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A First release F.García 07/07/03
REV DESCRIPTION ISSUED BY DATE
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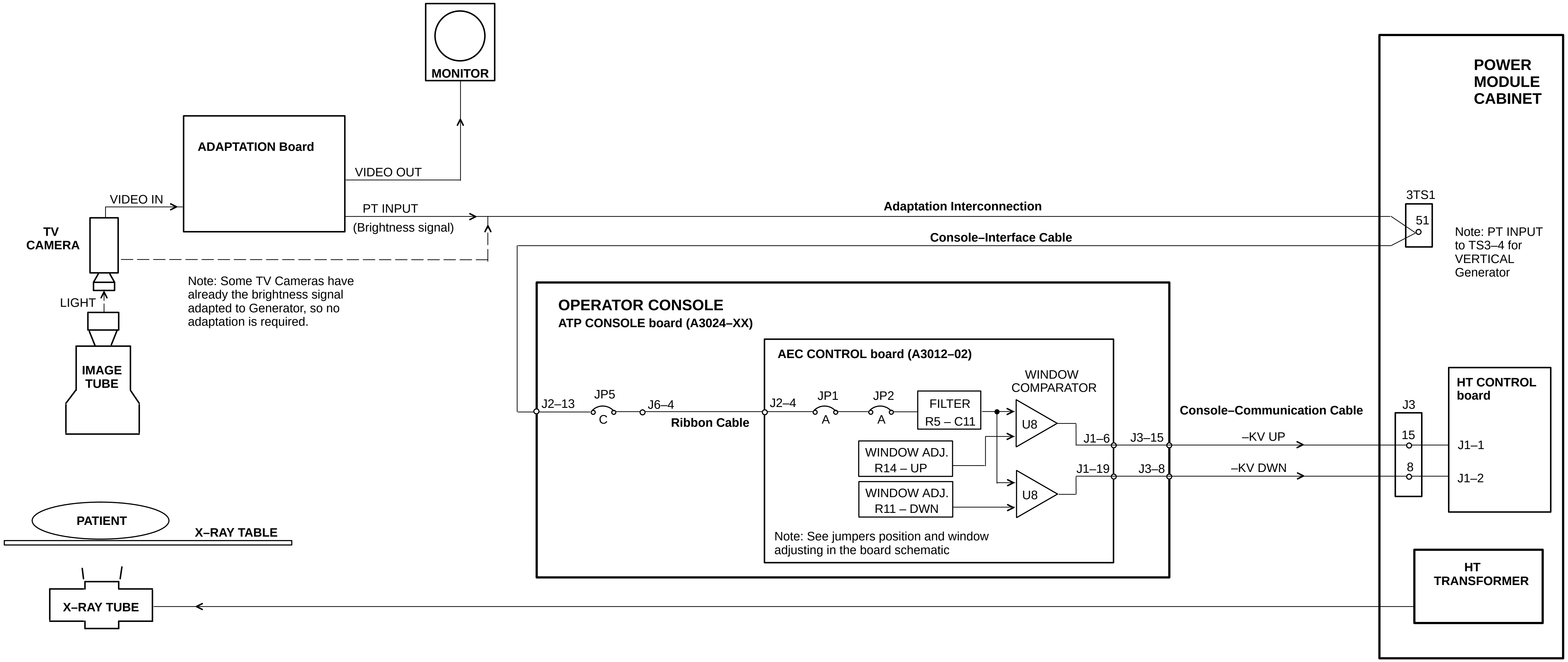
R & F ADAPTATION

Illustration 1.– ABC System for TV Camera
(with AEC CONTROL board A3012–02)



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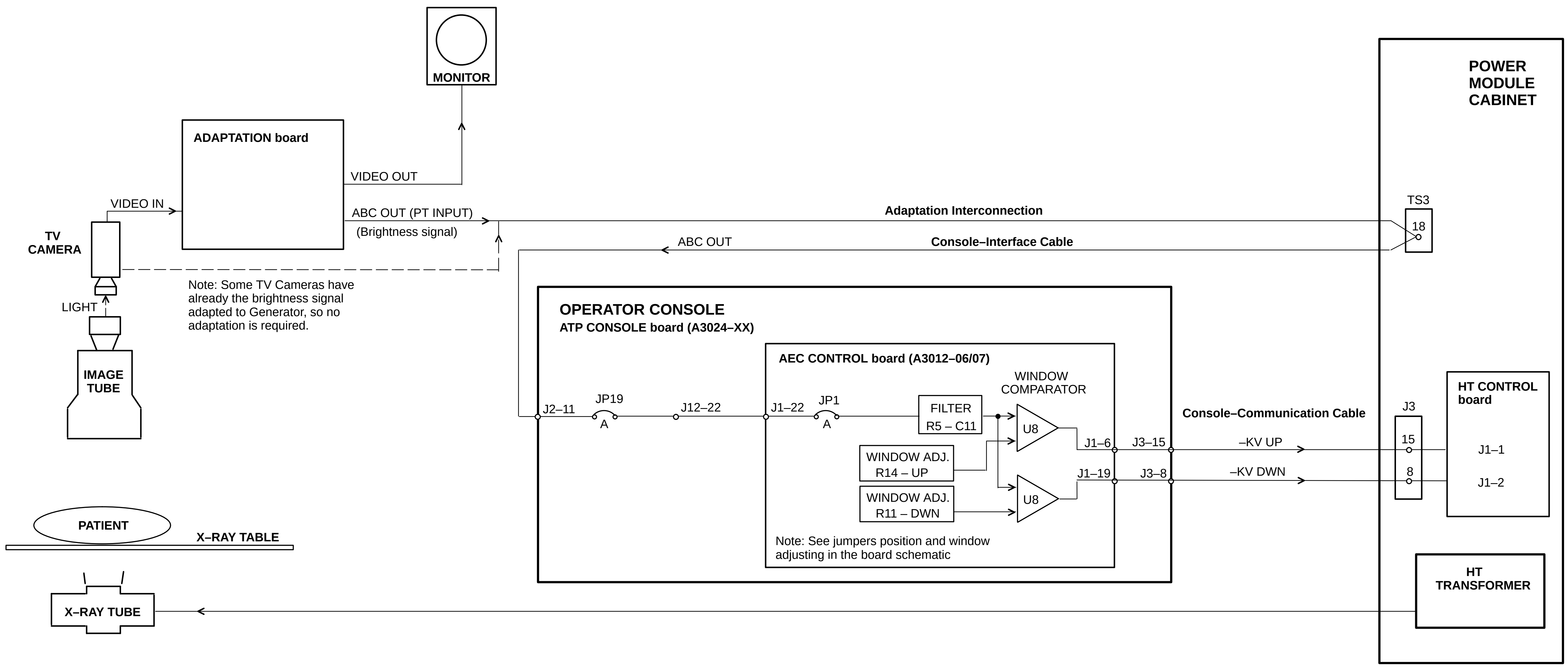
			DRAWING	F. GARCIA	03/03/01	1 / 3	REV
			REVISED	A. DIAZ	24/06/03		
REV	DESCRIPTION	ISSUED BY	DATE	SEDECAL			ABC Interface Diagram

–FIELD SEL 3

F E D C B A

Illustration 2.– ABC System for TV Camera (with AEC CONTROL board A3012–06/07)



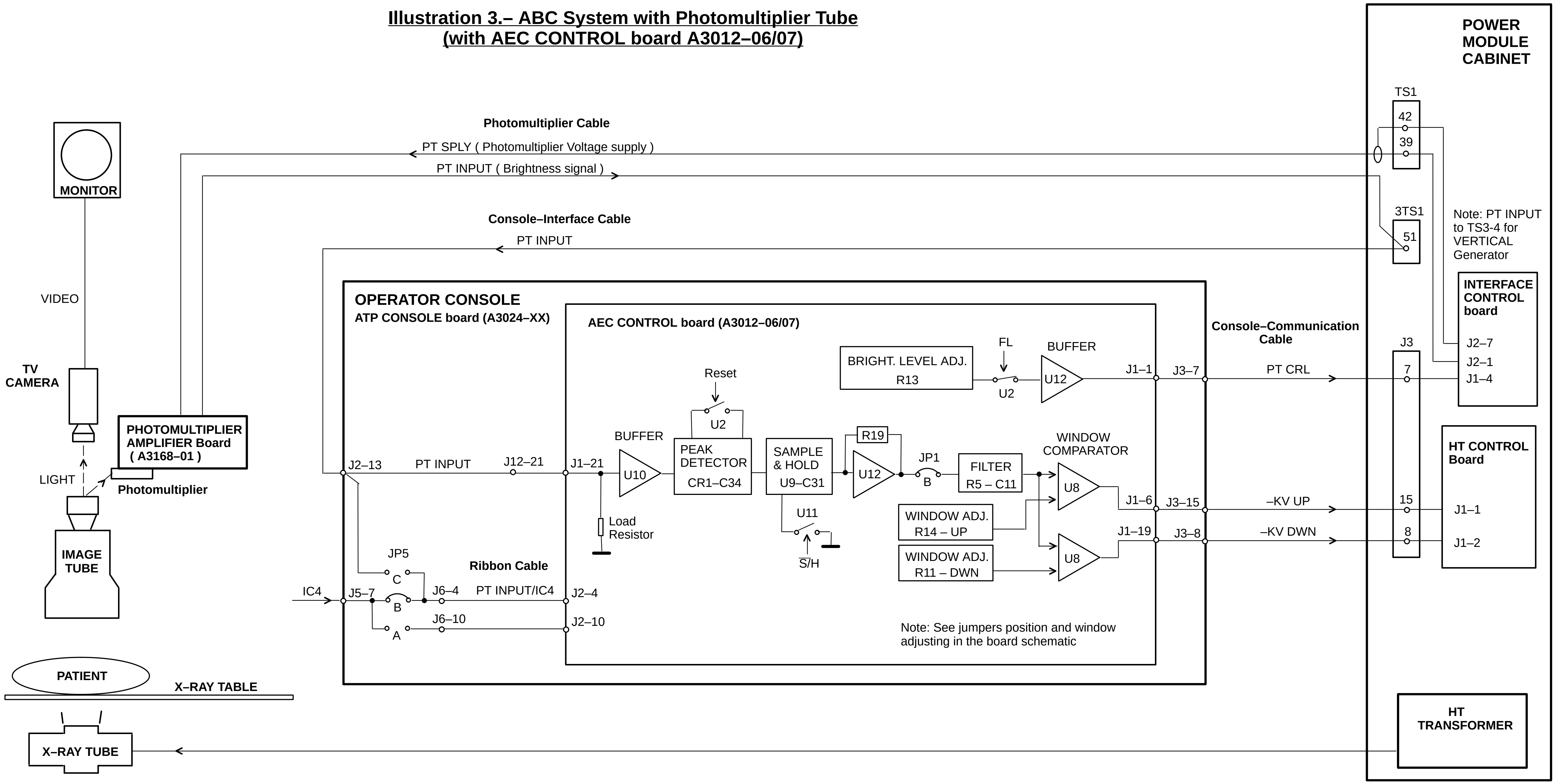
REV	DESCRIPTION	ISSUED BY	DATE		NAME	DATE	SHEET / OF	DWG: IM–300
				DRAWING	F. GARCIA	03/03/01	2 / 3	REV
				REVISED	A. DIAZ	24/06/03		

SEDECAL

ABC Interface Diagram

F E D

Illustration 3.– ABC System with Photomultiplier Tube (with AEC CONTROL board A3012–06/07)



					NAME	DATE	SHEET / OF	DWG: IM–300
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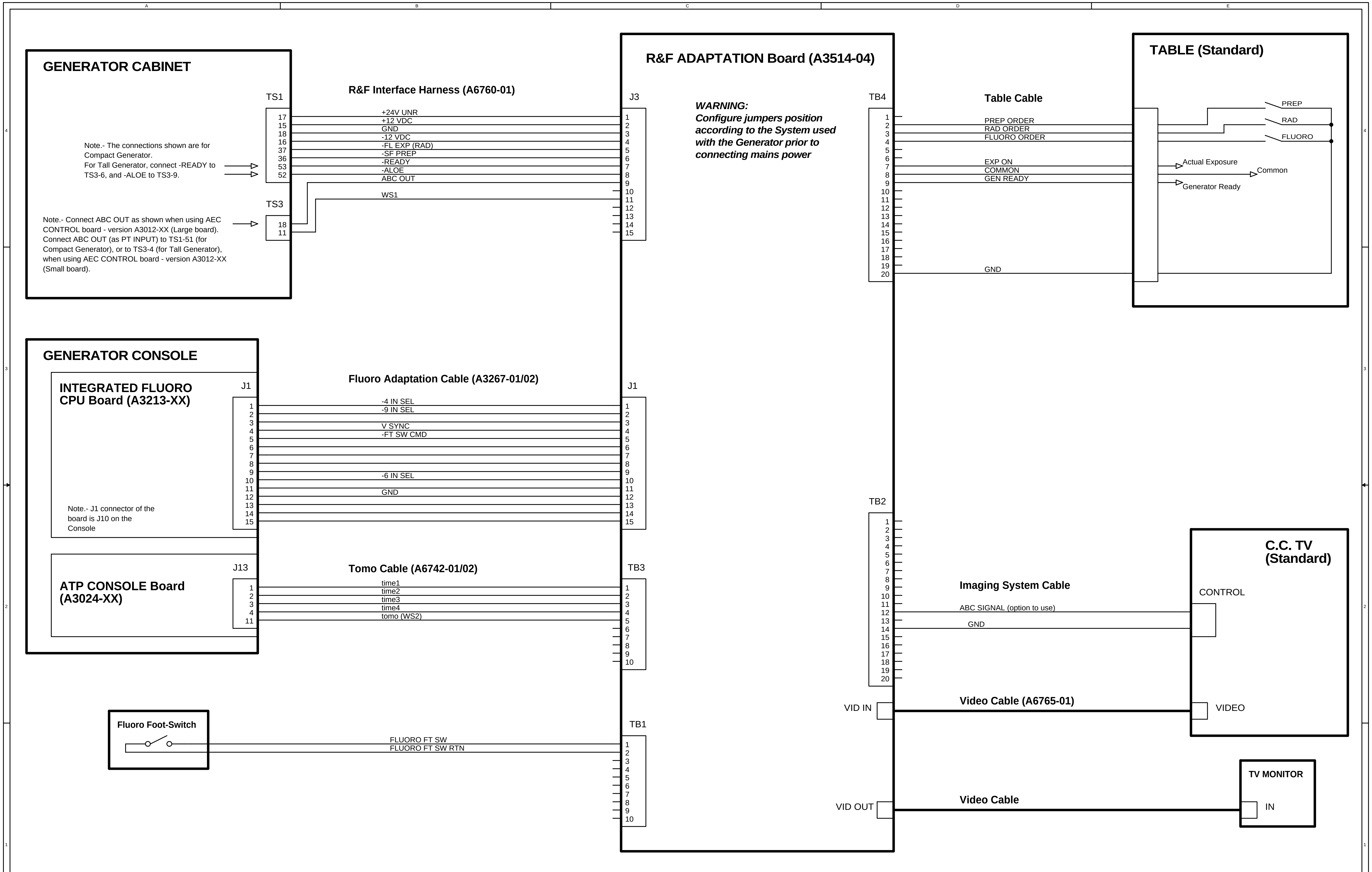
				REVISED	A. DIAZ	24/06/03		
REV	DESCRIPTION	ISSUED BY	DATE	SEDECAL				ABC Interface Diagram

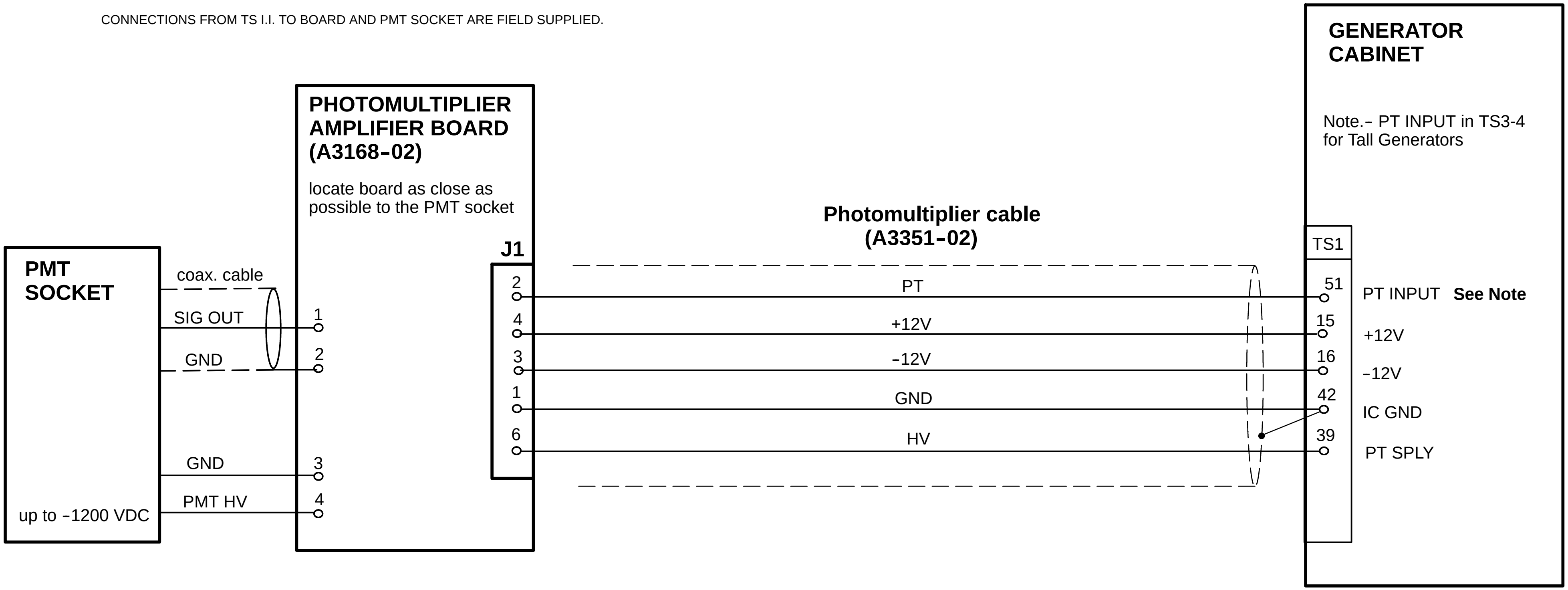


					NAME	DATE	SHEET / OF	IM - 302
				DRAWING	F.GARCIA	13/01/03	1/1	
				REVISED	A.DIAZ	13/01/03		A ◄ REV
A	board version 04	F. Garcia	10/10/03	SEDECAL				STANDARD SYSTEM with C.C. TV Interface
REV	DESCRIPTION	ISSUED BY	DATE					

NOTES

PHOTOMULTIPLIER AMPLIFIER BOARD (A3168–02) REQUIRES AEC CONTROL BOARD (A3012–06), FOR ADECUATE OPERATION WITH PHOTOMULTIPLIER TUBE.

CONNECTIONS FROM TS I.I. TO BOARD AND PMT SOCKET ARE FIELD SUPPLIED.



E	CN 04/169	F. GARCIA	10/10/04
D	CN 02/115	F. GARCIA	20/07/02
C	CN 02/067	F. GARCIA	20/05/01
B	TS I.I. added	F. GARCIA	01/01/01
A	Sheet 2 added	F. GARCIA	25/04/00
REV	*DESCRIPTION*	*ISSUED BY*	*DATE*

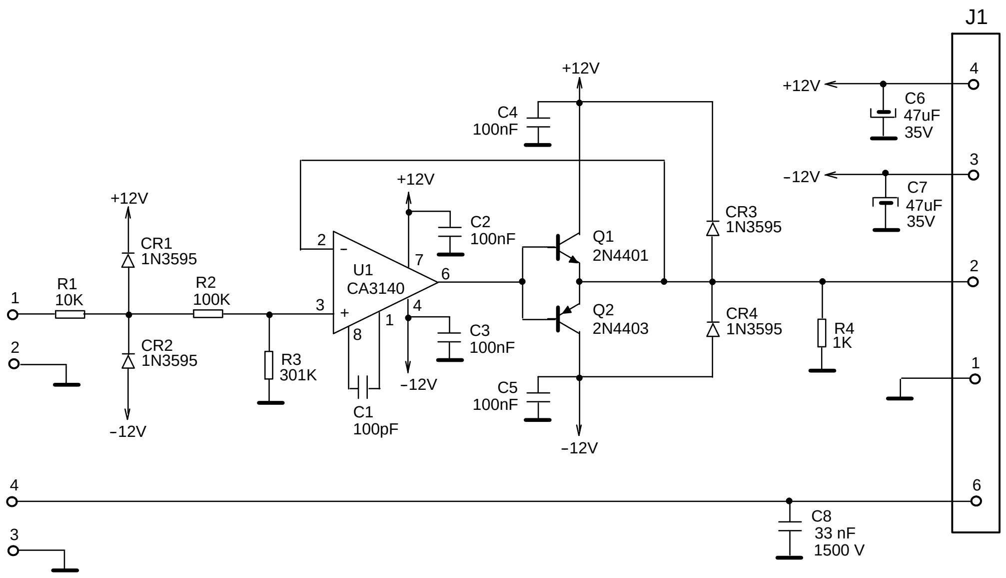
	NAME	*DATE*	*SHEET / OF*
DRAWING	F. GARCIA	03/03/98	1 / 1
REVISED	A. DIAZ	03/03/98	

SEDECAL

I/F–011

			E	D	C	B	A	REV

PHOTOMULTIPLIER INTERFACE



Note.- Version as per CN 04/169

REV	DESCRIPTION	ISSUED BY	DATE

	NAME	DATE	SHEET / OF
DRAWING	F. GARCIA	10/10/04	1 / 1
REVISED	A. DIAZ	10/10/04	

DWG: A3168-02

REV

SEDECAL

PHOTOMULTIPLIER AMPLIFIER

Technical Publication
DB-1004R5

Data Book

HF Series Generators

REVISION HISTORY

REVISION	DATE	REASON FOR CHANGE
0	APR 1, 2001	First edition
1	FEB 10, 2003	Documentation update
2	JAN 25, 2005	Documentation update
3	NOV 2, 2004	Documentation update
4	OCT 26, 2006	Extended Memory Locations
5	JUL 20, 2016	Configuration values using TechService

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TABLE OF CONTENTS

Section **Page**

SECTION 1 INTRODUCTION

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Also, make some exposures using different techniques and Focal Spot and check that mA stations are calibrated correctly, if not perform Calibration procedures.

Note ☞ *Verify that "Configuration Control Sheet" and "Final Test Results" pages from factory have been included with the equipment.*

1.1 INSTALLATION DATA

Enter the following information.

HOSPITAL			
INSTALLED AND TESTED BY		**DATE**	

1.2 MAINTENANCE HISTORY

Enter the following information after each data modification in this book or Periodic Maintenance Service.

DATE	PERFORMED BY	SERVICE NOTES

SECTION 2 DATA TABLES

Table 2-1
3024SW1 - ATP Console CPU Board

3024SW1 POSITION	OPEN (OFF)	CLOSED (ON)
1		
2		
3		
4		

Table 2-2
3024SW2 - ATP Console CPU Board

3024SW2 POSITION	OPEN (OFF)	CLOSED (ON)
1		
2		
3		
4		

Table 2-3
3024SW3 and 3024SW4 - ATP Console CPU Board

Note ☞ *Dip switch 3024SW3 and 3024SW4 is not used for configuration but all their switches must be set in **“Off”** position.*

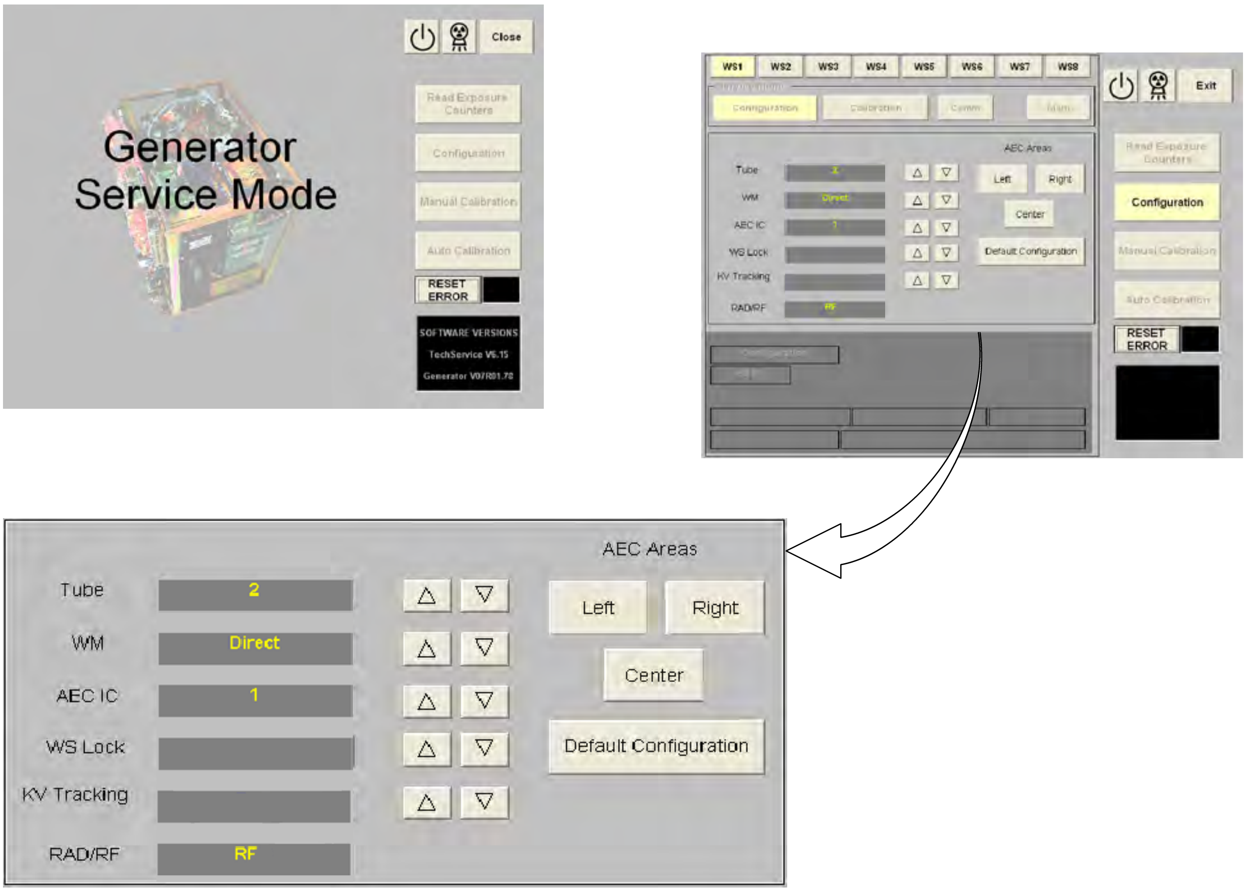
Table 2-4
3000SW2 - HT Controller Board

3000SW2 POSITION	OPEN (OFF)	CLOSED (ON)
1		
2		
3		
4		
5		
6		
7		
8		

Table 2-5
Configured Workstations using a Push-buttons Console

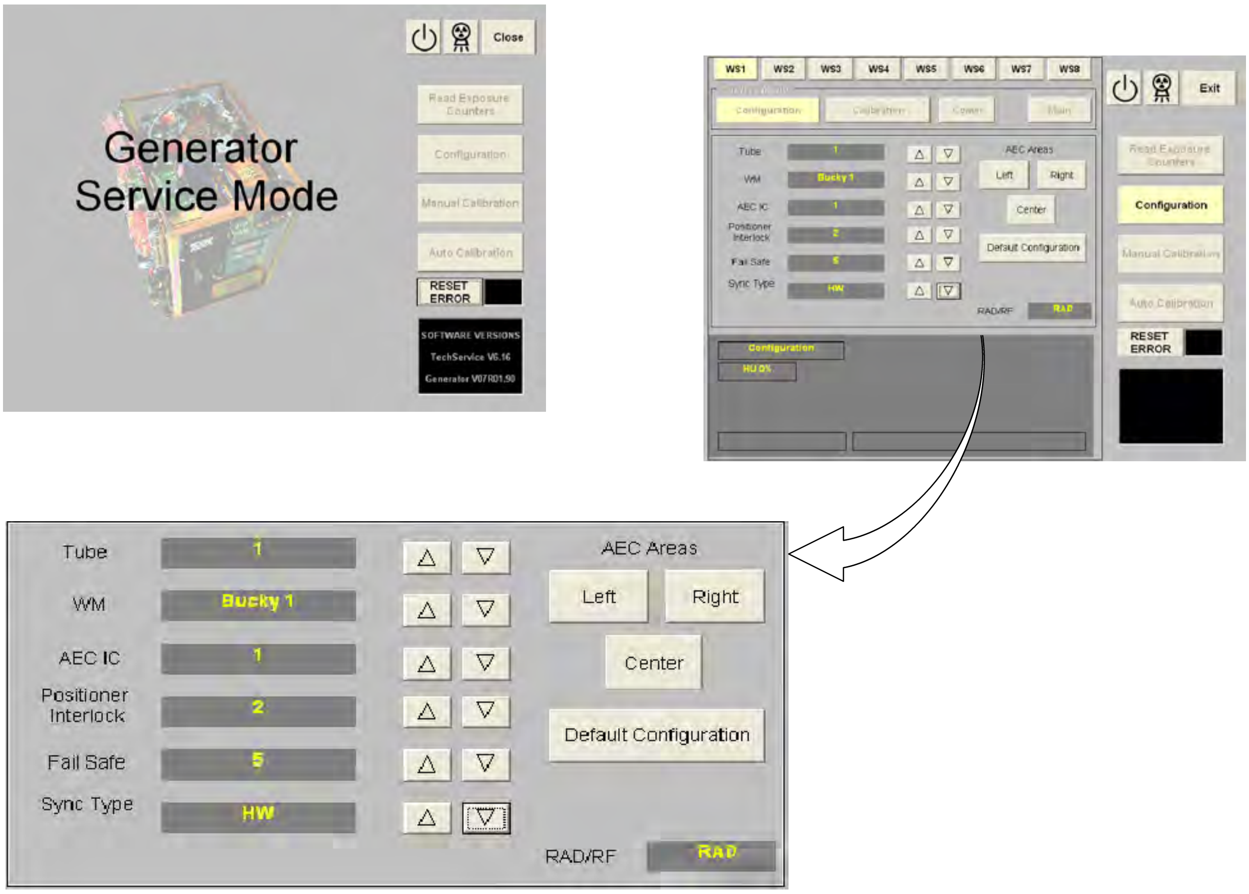
WORKSTATION PUSH-BUTTONS *(Draw the push-buttons or combinations in the cells)*		VALUE ON DISPLAYS				AVAILABLE AEC AREAS
		kV (Tube)	mAs (Device-WM)	mA (AEC-IC)	ms (kV Tracking) (option)	
WS1						
WS2						
WS3						
WS4						
WS5						
WS6						
WS7						
WS8						
WS9						
WS10						

Table 2-6
Configured Workstations using the GSM with TechService V6.15



CONFIGURATION OF WORKSTATIONS USING TECHSERVICE V6.15								
WORKSTATION	**WS1**	**WS2**	**WS3**	**WS4**	**WS5**	**WS6**	**WS7**	**WS8**
TUBE								
WM								
AEC IC								
WS LOCK								
kV TRACKING								
RAD/RF								

Table 2-7
Configured Workstations using the GSM with TechService V6.16



CONFIGURATION OF WORKSTATIONS USING TECHSERVICE V6.16								
WORKSTATION	**WS1**	**WS2**	**WS3**	**WS4**	**WS5**	**WS6**	**WS7**	**WS8**
TUBE								0
WM								
AEC IC								
POSITIONER INTERLOCK								
FAIL SAFE								
SYNC TYPE								
RAD/RF								

Table 2-8
Jumpers in other Generator Boards

GENERATOR BOARDS	JUMPERS POSITION	
HT CONTROLLER	JP1 and JP2	
	JP3, JP5 and JP6	
	JP4	
FILAMENT CONTROL	JP1	
INTERFACE CONTROL	W1	
	W2	
	W3 to W8	
ATP CONSOLE CPU	JP1, JP2 and JP3	
	JP4	
	JP5	
	JP6	
	Connector J8 configured for RS232 so: JP9, JP10 and JP11 in “A”. JP7, JP8, JP21 and JP22 do not matter jumpers position	
	Connector J8 configured for RS422 so: JP7, JP8, JP9, JP10 and JP11 in “B”. JP21 and JP22 do not affect jumpers position	
	JP12	
	JP13	
	JP14	
	JP15, JP16, JP17 and JP18	
	JP19	

Table 2-9
AEC Configuration

JUMPERS POSITION	
AEC Control Board	A3012-_____
JP1	
JP2	
JP3	
JP4	

JUMPERS POSITION	
AEC Adaptation Board	A3263-03
JP3, JP4, JP7, JP8	
JP1, JP2, JP5, JP6	
JP13, JP14, JP15, JP16	
JP9 (IC1)	
JP10 (IC2)	
JP11 (IC3)	
JP12 (IC4)	

Table 2-10
Fluoro Configuration

OPERATION MODE		
FIXED RATE PULSED FLUORO	**VARIABLE RATE PULSED FLUORO**	**ABC**

JUMPERS IN FLUORO CPU BOARD (A3213-XX)	INSERTED	REMOVED
W1		
W2	Always inserted (installed)	

JUMPERS IN ATP CONSOLE CPU BOARD (A3024-XX)	
JP4	Always in “B” position – Camera

JUMPERS POSITION	
RF Adaptation Board	A3514–_____
JP1, JP3, JP4, JP8, JP9, JP10, JP12, JP13, JP14	
JP2	
JP5	
JP6	
JP7	
JP11	
JP15	
JP16	
JP17	
JP18	
JP19	
JP20	
JP21	
JP22	
JP23	
JP24	

Table 2-11
Extended Memory Locations

MEMORY LOCATION	VALUE		MEMORY LOCATION	VALUE
E01			E17	
E02			E18	
E03			E19	
E04			E20	
E05			E21	
E06			E22	
E07			E23	
E08			E24	
E09			E25	
E10			E26	
E11			E27	
E12			E28	
E13			E29	
E14			E30	
E15			E31	
E16			E32	

MEMORY LOCATION *(only for Capacitor Discharge Generator)*	VALUE
E67	
E68	
E69	

Table 2-12
Rotor Acceleration Time Configuration

OPERATION MODE	3000SW2-2	
	OPEN (OFF)	CLOSED (ON)
Rotor Speed	Low Speed	High Speed

TUBE-1 ROTOR ACCELERATION TIME AND FILAMENT SETTING TIME	3000SW2-7		3000SW2-8	
	OPEN (OFF)	CLOSED (ON)	OPEN (OFF)	CLOSED (ON)
_____ seconds				

TUBE-2 ROTOR ACCELERATION TIME AND FILAMENT SETTING TIME	3000SW2-5		3000SW2-6	
	OPEN (OFF)	CLOSED (ON)	OPEN (OFF)	CLOSED (ON)
_____ seconds				

FLUORO ROTOR HOLD-OVER TIME	3000SW2-4	
	OPEN (OFF)	CLOSED (ON)
Status: ______		

Table 2-13
LV-DRAC Configuration

3243SW1		3243SW2		3243SW3		3243SW4	
1		1		1		1	
2		2		2		2	
3		3		3		3	
4		4		4		4	
5		5		5		5	
6		6		6		6	
7		7		7		7	
8		8		8		8	

Table 2-14
mA Calibration Numbers

TUBE-1				
mA STATION	FILAMENT CURRENT NUMBERS AT kVp BREAK POINT			
	40	50	80	120
10				
12.5				
16				
20				
25				
32				
40				
50				
64 (or 63 or 65)				
80				
100				
125				
160				
200				
250				
320				
400				
500				
640 (or 630 or 650)				
800				
1000				
Note.– The mA station values depend on the Generator model. Some models do not contain all the mA stations listed above.				

Table 2-14 (Cont.)
mA Calibration Numbers

TUBE-2				
mA STATION	FILAMENT CURRENT NUMBERS AT kVp BREAK POINT			
	40	50	80	120
10				
12.5				
16				
20				
25				
32				
40				
50				
64 (or 63 or 65)				
80				
100				
125				
160				
200				
250				
320				
400				
500				
640 (or 630 or 650)				
800				
1000				

Note.– The mA station values depend on the Generator model. Some models do not contain all the mA stations listed above.

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Technical Publication
DB-1021R5

Data Book

HF Series Generators

REVISION HISTORY

REVISION	DATE	REASON FOR CHANGE
4	FEB 27, 2006	Extended Memory Locations for Continuous Fluoro
5	JUL 20, 2016	Configuration values using TechService

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1		
2		
3		
4		

Table 2-2
3024SW2 - ATP Console CPU Board

3024SW2 POSITION	OPEN (OFF)	CLOSED (ON)
1		
2		
3		
4		

Table 2-3
3024SW3 and 3024SW4 - ATP Console CPU Board

Note ☞ *Dip switches 3024SW3 and 3024SW4 are not used for configuration but all their switches must be set in **"Off"** position.*

Table 2-4
3000SW2 - HT Controller Board

3000SW2 POSITION	OPEN (OFF)	CLOSED (ON)
1		
2		
3		
4		
5		
6		
7		
8		

Table 2-5
Basic Configuration of Generator Boards

GENERATOR BOARDS	JUMPERS POSITION	
HT CONTROLLER	JP1 and JP2	
	JP3, JP5 and JP6	
	JP4	
FILAMENT CONTROL	JP1	
INTERFACE CONTROL	W1	
	W2	
	W3 to W10	
ATP CONSOLE CPU	JP1, JP2 and JP3	
	JP4	
	JP5	
	JP6	
	Connector J8 configured for RS232 so: JP9, JP10 and JP11 in “A”. JP7, JP8, JP21 and JP22 do not matter jumpers position	
	JP12	
	JP13	
	JP14	
	JP15, JP16, JP17 and JP18	
	JP19	

Table 2-6
AEC Configuration

JUMPERS POSITION	
AEC Control Board	A3012-_____
JP1	
JP2	
JP3	
JP4	

JUMPERS POSITION	
AEC Adaptation Board	A3263-03
JP3, JP4, JP7, JP8	
JP1, JP2, JP5, JP6	
JP13, JP14, JP15, JP16	
JP9 (IC1) (IC5)	
JP10 (IC2) (IC6)	
JP11 (IC3) (IC7)	
JP12 (IC4)	

Table 2-7
Fluoro Configuration

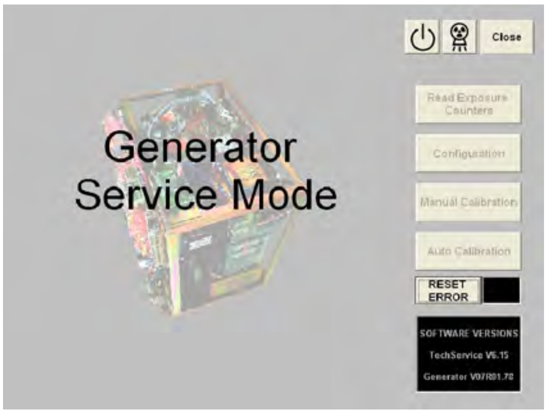
OPERATION MODE		
FIXED RATE PULSED FLUORO	**VARIABLE RATE PULSED FLUORO**	**ABC**

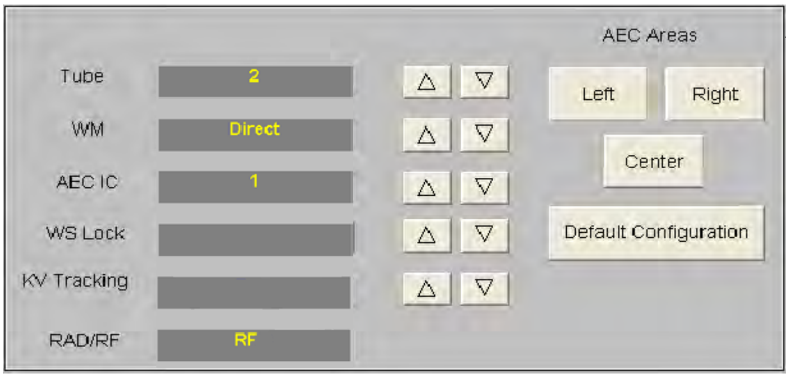
JUMPERS IN FLUORO CPU BOARD (A3213-XX)	INSERTED	REMOVED
W1		
W2	Always inserted (installed)	

JUMPERS IN ATP CONSOLE CPU BOARD (A3024-XX)	
JP4	Always in “B” position – Camera

JUMPERS POSITION	
RF Adaptation Board	A3514–_____
JP1, JP3, JP4, JP8, JP9, JP10, JP12, JP13, JP14	
JP2	
JP5	
JP6	
JP7	
JP11	
JP15	
JP16	
JP17	
JP18	
JP19	
JP20	
JP21	
JP22	
JP23	
JP24	

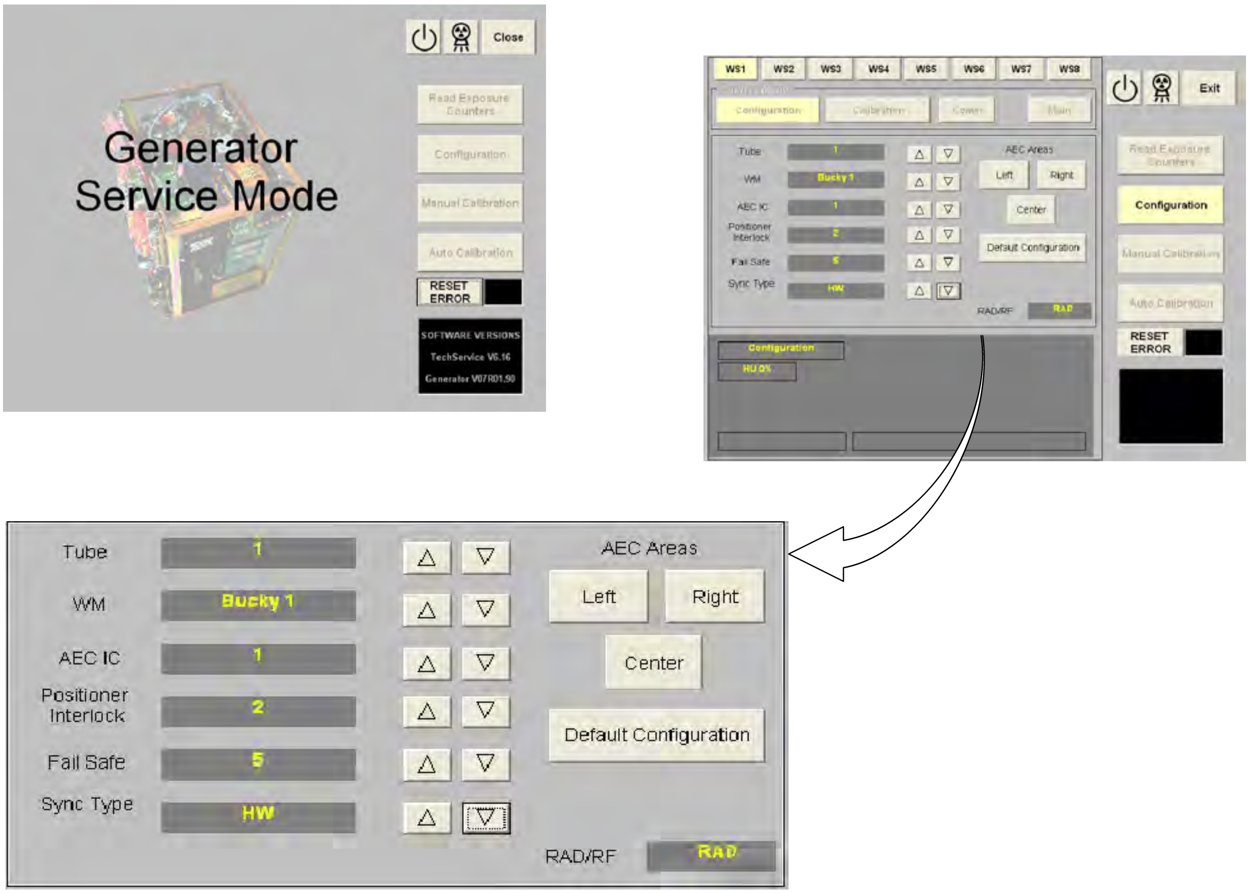
Table 2-8
Configured Workstations using the GSM with TechService V6.15





CONFIGURATION OF WORKSTATIONS USING TECHSERVICE V6.15								
WORKSTATION	WS1	WS2	WS3	WS4	WS5	WS6	WS7	WS8
TUBE								
WM								
AEC IC								
WS LOCK								
kV TRACKING								
RAD/RF								

Table 2-9
Configured Workstations using the GSM with TechService V6.16



CONFIGURATION OF WORKSTATIONS USING TECHSERVICE V6.16								
WORKSTATION	WS1	WS2	WS3	WS4	WS5	WS6	WS7	WS8
TUBE								0
WM								
AEC IC								
POSITIONER INTERLOCK								
FAIL SAFE								
SYNC TYPE								
RAD/RF								

Table 2-10
Extended Memory Locations

MEMORY LOCATION	VALUE		MEMORY LOCATION	VALUE
E01			E34	
E02			E35	
E03			E36	
E04			E37	
E05			E38	
E06			E39	
E07			E40	
E08			E41	
E09			E42	
E10			E43	
E11			E44	
E12			E45	
E13			E46	
E14			E47	
E15			E48	
E16			E49	
E17			E50	
E18			E51	
E19			E52	
E20			E53	
E21			E54	
E22			E55	
E23			E56	
E24			E57	
E25			E58	
E26			E59	
E27			E60	
E28			E61	
E29			E62	
E30			E63	
E31			E64	
E32			E65	
E33			E66	

Table 2-11
Low Speed: Configuration of Rotor and Filament Setting Times

OPERATION MODE	3000SW2-2	
	OPEN (OFF)	CLOSED (ON)
Rotor Speed	Low Speed	High Speed

TUBE-1 ROTOR ACCELERATION TIME AND FILAMENT SETTING TIME	3000SW2-7		3000SW2-8	
	OPEN (OFF)	CLOSED (ON)	OPEN (OFF)	CLOSED (ON)
_____ seconds				

TUBE-2 ROTOR ACCELERATION TIME AND FILAMENT SETTING TIME	3000SW2-5		3000SW2-6	
	OPEN (OFF)	CLOSED (ON)	OPEN (OFF)	CLOSED (ON)
_____ seconds				

FLUORO ROTOR HOLD-OVER TIME AND FILAMENT HOLD-OVER TIME	3000SW2-4	
	OPEN (OFF)	CLOSED (ON)
Status: ______		

Table 2-12
High Speed: Configuration of Filament Setting Times

OPERATION MODE	3000SW2-2	
	OPEN (OFF)	CLOSED (ON)
Rotor Speed	Low Speed	High Speed

TUBE-1 FILAMENT SETTING TIME	3000SW2-7		3000SW2-8	
	OPEN (OFF)	CLOSED (ON)	OPEN (OFF)	CLOSED (ON)
_____ seconds				

TUBE-2 FILAMENT SETTING TIME	3000SW2-5		3000SW2-6	
	OPEN (OFF)	CLOSED (ON)	OPEN (OFF)	CLOSED (ON)
_____ seconds				

FLUORO FILAMENT HOLD-OVER TIME	3000SW2-4	
	OPEN (OFF)	CLOSED (ON)
Status: ______		

Table 2-13
LV-DRAC Configuration

3243SW1		**3243SW2**		**3243SW3**		**3243SW4**	
1		1		1		1	
2		2		2		2	
3		3		3		3	
4		4		4		4	
5		5		5		5	
6		6		6		6	
7		7		7		7	
8		8		8		8	

Table 2-14
mA Calibration Numbers

TUBE-1				
mA STATION	FILAMENT CURRENT NUMBERS AT kVp BREAK POINT			
	40	50	80	120
10				
12.5				
16				
20				
25				
32				
40				
50				
64 (or 63 or 65)				
80				
100				
125				
160				
200				
250				
320				
400				
500				
640 (or 630 or 650)				
800				
1000				
Note.- The mA station values depend on the Generator model. Some models do not contain all the mA station listed above.				

Table 2-14 (Cont.)
mA Calibration Numbers

TUBE-2				
mA STATION	FILAMENT CURRENT NUMBERS AT kVp BREAK POINT			
	40	50	80	120
10				
12.5				
16				
20				
25				
32				
40				
50				
64 (or 63 or 65)				
80				
100				
125				
160				
200				
250				
320				
400				
500				
640 (or 630 or 650)				
800				
1000				
Note.- *The mA station values depend on the Generator model. Some models do not contain all the mA station listed above.*				

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Technical Publication
CF-1018R5

Configuration

HF Series Generators

REVISION HISTORY

REVISION	DATE	REASON FOR CHANGE
1	APR 1, 2005	Documentation upgrade
2	AUG 1, 2005	Anode Stator Configuration
3	OCT 10, 2005	Documentation upgrade
4	JUL 07, 2016	Configuration of Positioner Interlock, Fail Safe, Synchronization Type using Tech Service $\geq$ V6.16
5	JUL 05, 2019	Identification of Tubes as “Toshiba or Canon”

This Document is the English original version, edited and supplied by the manufacturer.

The Revision state of this Document is indicated in the code number shown at the bottom of this page.

ADVISORY SYMBOLS

The following advisory symbols will be used throughout this manual. Their application and meaning are described below.

DANGERS ADVISE OF CONDITIONS OR SITUATIONS THAT IF NOT HEEDED OR AVOIDED WILL CAUSE SERIOUS PERSONAL INJURY OR DEATH.

ADVISE OF CONDITIONS OR SITUATIONS THAT IF NOT HEEDED OR AVOIDED COULD CAUSE SERIOUS PERSONAL INJURY, OR CATASTROPHIC DAMAGE OF EQUIPMENT OR DATA.

Advise of conditions or situations that if not heeded or avoided could cause personal injury or damage to equipment or data.

Note ☞

Alert readers to pertinent facts and conditions. Notes represent information that is important to know but which do not necessarily relate to possible injury or damage to equipment.

TABLE OF CONTENTS

SECTION 1 INITIAL CONFIGURATION PROCEDURE

Configuration provides the initial settings for extended memory and checkout procedures that must be carried out before making X-ray exposures. Functional characteristics of this Generator are defined at the time of installation.

Calibration and some configuration data are stored in a non-volatile memory chip (U3-EEPROM) located on the HT Controller Board in the Power Cabinet.

When the initial setup and checkout has been completed the Generator will be ready for Calibration.

Note ☞ *Record all the configuration settings in the Data Book.*

WARNING

DO NOT SUPPLY THE MAIN POWER UNTIL SPECIFICALLY INSTRUCTED TO DO SO IN THIS DOCUMENT.

THE MAIN CAPACITORS OF THE HIGH VOLTAGE INVERTER RETAIN A LARGE PORTION OF THEIR CHARGE FOR APPROX. 3 MINUTES AFTER THE UNIT IS TURNED OFF.

The Generator configuration is determined by:

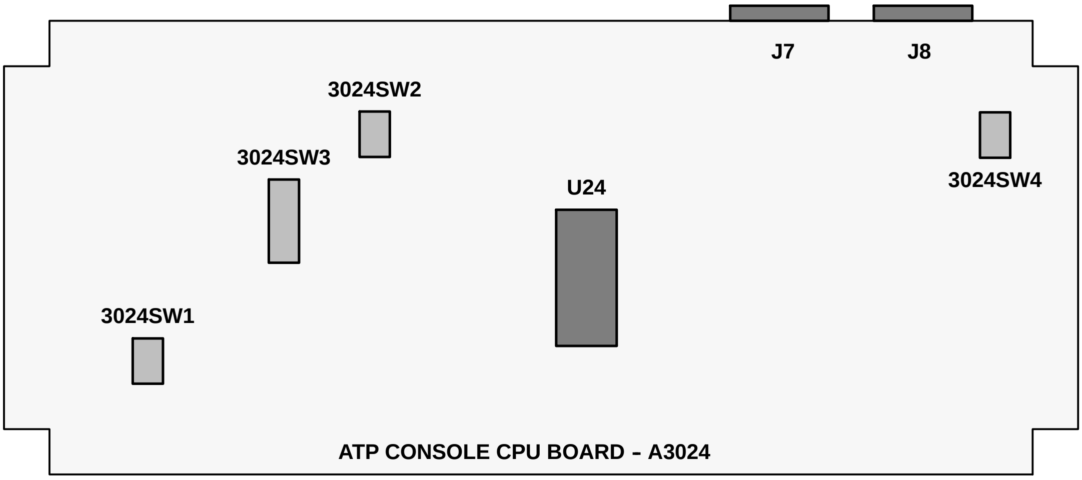
- X-ray tube(s) number, model and use.
- System requirements (Bucky, Tomo, AEC, ...)
- Maximum kV, kW.

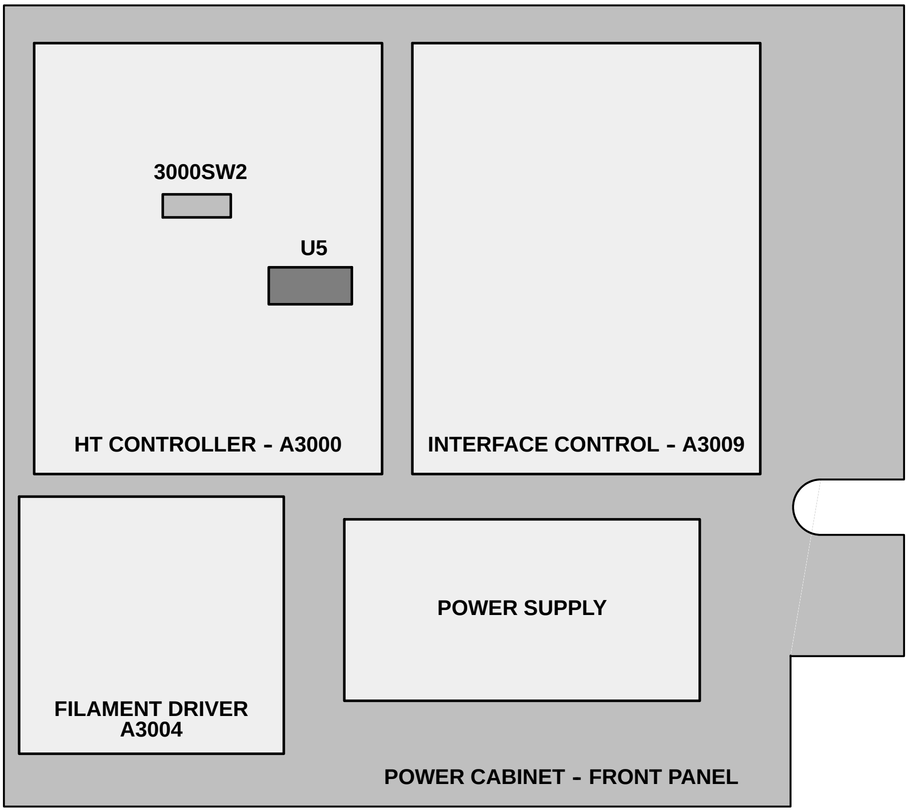
Specific versions of U24-EPROM on the ATP Console CPU Board and U5 on the HT Controller Board are based on the Generator configuration. (*Refer to Illustration 1-1*).

The system configuration and test switches are:

DIP SWITCH LOCATION	FUNCTION
3024SW1 - ATP Console CPU Board	System Configuration
3024SW2 - ATP Console CPU Board	Test
3024SW3 - ATP Console CPU Board	No used for Configuration
3000SW2 - HT Controller Board	System Configuration and Test

Illustration 1-1
EPROM and Switch locations





1.1 CONFIGURATION AND TEST SWITCHES

ATP Console Dip Switches must be configured with the Generator turned OFF, and they are read when the Generator is turned ON again.

1.1.1 3024SW1 - ATP CONSOLE CPU BOARD

Set dip switch 3024SW1 in accordance with the Table 1-1.

Table 1-1
System Configuration Dip Switch 3024SW1 on the ATP Console CPU Board

3024SW1 POSITION	OPEN (OFF)	CLOSED (ON)
1	60 Hz *1)	50 Hz *1)
2	–	**Normal** – Application mode. Exposures are inhibited when Door Interlock Switch is opened.
3	Not used. *Set in "OFF" position.*	Not used.
4	Not used. *Set in "OFF" position.*	Not used.
*Note.– *1) This switch is related with the frequency of the Rotor Controller. For Generators with High Speed Starter (LV-DRAC) or Generators Powered through Batteries with Stand-Alone set always SW1-1 to 60 Hz, in the rest of Generators set SW1-1 in accordance with the Power Line Frequency.*		

1.1.2 3024SW2 - ATP CONSOLE CPU BOARD

Set dip switch 3024SW2 verifying that each position is set as Table 1-2.

Table 1-2
Test Dip Switch 3024SW2 on the ATP Console CPU Board

3024SW2 POSITION	OPEN (OFF)	CLOSED (ON)
1	Skips reception with the HT Controller. Use only for display purposes, troubleshooting or Demo Consoles when there is no Power Module. Be sure that J3 connector is not plugged to the ATP Console CPU Board.	**Normal** – Application mode.
2	Tick Sound (button / command acknowledge) is not emitted by the ATP Console CPU Board.	Tick Sound (button / command acknowledge) is emitted by the ATP Console CPU Board.
3	**Normal** – Application mode.	**Service Mode .**
4	kV Log (Renard) Scale Mode for kV variation (kV changes in logarithmic steps) (*if available*).	kV Lineal Scale Mode for kV variation (**Normal mode**) (kV changes one by one).

1.1.3 3024SW3 - ATP CONSOLE CPU BOARD

Dip switch 3024SW3 is not used for configuration but all their switches must be set in “***Off***” position.

1.1.4 3024SW4 - ATP CONSOLE CPU BOARD

Dip Switch 3024SW4 is not used for configuration but all their switches must be set in “***Off***” position.

1.1.5 3000SW2 - HT CONTROLLER BOARD

HT Controller Dip Switches can be configured while the Generator is ON except Dip Switch 3000SW2-1.

Set dip switch 3000SW2 as indicated in Table 1-3.

Table 1-3
Test Dip Switch 3000SW2 on the HT Controller Board in the Power Module

3000SW2 POSITION	OPEN (OFF)	CLOSED (ON)
1	Normal.	Programming of Rotor Acceleration Time, RAD Filament Setting Time, Fluoro Rotor and Filament Hold-over Time *1) *2)
2	Normal.	Bypasses: Filament, Rotor Ready, Error E11. *1) *3)
3	Normal – Not used.	Not used.
4	Normal – Digital mA Loop Closed	Digital mA Loop Open / Filament Current Constant *1)
5	125 kV *4)	150 kV *4)
6	All Generators except Tube-2 for RAD	Generators with Tube-2 for RAD only.
7	Filament Boosting for Tube–1	No Filament Boosting for Tube–1 *5)
8	Filament Boosting for Tube–2	No Filament Boosting for Tube–2 *5)

*Notes.– *1) Set in Closed (On) position only when indicated in the Service Manual.*

**2) Note that SW2-1 in Closed (On) position is only set to program the Rotor Acceleration Time, Rad Filament Setting Time, Fluoro Rotor and Filament Hold-over Time, therefore it changes the functions of Switches SW2-2 and SW2-4 to SW2-8. Refer to Section 3.*

**3) This turns off the filaments so no radiation will be produced during the exposure.*

WARNING: THE kV OUTPUT OF THE HV TRANSFORMER WILL BE WHATEVER IS SET BY THE CONSOLE. IF THE X-RAY TUBE HV CABLES ARE NOT CONNECTED INTO THE HV TRANSFORMER, FILL COMPLETELY BOTH HV RECEPTACLES WITH HV OIL.

**4) Set SW2-5 according to the Generator kV rating (refer to the Generator model and/or specifications).*

5)* ***Set to “No Filament Boosting” when using X-ray Tubes with Small Focal Spot smaller than 0.6 .*

1.2 BASIC CONFIGURATION OF GENERATOR BOARDS

The following Jumpers are factory set or removed to configure the Generator Boards according to the customer order. Check the jumper positions in the Generator Boards.

GENERATOR BOARDS	JUMPERS POSITION
HT CONTROLLER	JP1 and JP2 in “2”
	JP3, JP5 and JP6 in “2” and JP4 in “1” : for Compact Generators.
FILAMENT CONTROL	W1 in “A”
INTERFACE CONTROL	W1 in “2–3”
	W2 in “1–2”
	W3 to W10 in “A” : for positive High Voltage supply for Ion Chamber W3 to W10 in “B” : for negative High Voltage supply for Photomultiplier Tube
ATP CONSOLE CPU	JP1, JP2 and JP3 in “B” (soldered)
	JP4 in “B” (Cam-Sync)
	JP5 in “B” : Standard JP5 in “C” : for R&F / DSI Generators with AEC Control Board A3012–02/05
	JP6 in “A” (soldered)
	Connector J8 configured for RS232 so: JP9, JP10 and JP11 in “A”. JP7, JP8, JP21 and JP22 do not matter jumpers position
	JP12 removed
	JP13 installed (set) : if AEC Control Board A3012–xx is installed JP13 removed : if AEC Control Board A3012–xx is not installed
	JP14 installed (soldered)
	JP15, JP16, JP17 and JP18 removed
	JP19 in “A” (soldered)

1.3 AEC CONFIGURATION

Configure the following Jumpers on the "*AEC Control Board*" (located over the "*ATP Console CPU Board*") and on the "*AEC Adaptation Board*" when this option is installed in the Generator Cabinet.

AEC CONTROL BOARD (A3012–01/02/05)

JUMPER			DESCRIPTION
JP1	A B C	FOR TV CAMERA FOR PHOTOMULTIPLIER FOURTH ION CHAMBER & ATS–DIG	A3012-05: JP1-C, JP2-A AND JP4-B FOR FOURTH ION CHAMBER & ATS–DIG A3012-02: JP1-A, JP2-A AND JP4-A FOR ABC WITH TV CAMERA A3012-01: JP1-B, JP2-B AND JP4-A FOR ABC WITH PHOTOMULTIPLIER
JP2	A B	FOR TV CAMERA FOR PHOTOMULTIPLIER	
JP4	A B	FOR PHOTOMULTIPLIER – AEC FOR ION CHAMBER – AEC & ATS–DIG	
JP3	A B	FOR HIGH SENSITIVITY FOR LOW SENSITIVITY	JP3-A FOR AEC WHEN USING ION CHAMBER WITH HIGH SENSITIVITY JP3-B FOR AEC WHEN USING ION CHAMBER WITH LOW SENSITIVITY
NOTE:		*HIGH SENSITIVITY IS > 2 V / mR (> 0.223 V / µGy) (a.e. Vacutec Ion Chamber)* *LOW SENSITIVITY IS < 2 V / mR (< 0.223 V / µGy) (refer to Ion Chamber documentation)*	

AEC CONTROL BOARD (A3012–06/07/09)

JUMPER			DESCRIPTION
JP1	A B C	FOR TV CAMERA FOR PHOTOMULTIPLIER EXTERNAL kV CONTROL	JP1-A FOR ABC WITH TV CAMERA JP1-B FOR ABC WITH PHOTOMULTIPLIER JP1-C FOR ABC WITH EXTERNAL kV UP & DOWN CONTROL
JP2	A B	FOR HIGH SENSITIVITY FOR LOW SENSITIVITY	JP2-A FOR AEC WHEN USING ION CHAMBER WITH HIGH SENSITIVITY JP2-B FOR AEC WHEN USING ION CHAMBER WITH LOW SENSITIVITY
JP3	B	FOR NORMAL OPERATION	JP3-B FOR NORMAL OPERATION
JP4	A	FOR NORMAL OPERATION	JP4-A FOR NORMAL OPERATION (Only in A3012-06)
NOTE:		*HIGH SENSITIVITY IS > 2 V / mR (> 0.223 V / µGy) (a.e. Vacutec Ion Chamber)* *LOW SENSITIVITY IS < 2 V / mR (< 0.223 V / µGy) (refer to Ion Chamber documentation)*	

AEC ADAPTATION BOARD (A3263-03)

ION CHAMBER TYPE	JUMPERS POSITION		
	JP3, JP4, JP7, JP8	**JP1, JP2, JP5, JP6**	**JP13, JP14, JP15, JP16**
IC1 = IC2 = IC3 = IC4 *(Default)*	B	B	B
IC1 = IC2 = IC3	B	B	A
IC1 = IC2	B	A	A
IC1 ≠ IC2 ≠ IC3 ≠ IC4	A	A	A

ION CHAMBER OUTPUT	JUMPERS POSITION			
	JP9 (IC1)	**JP10 (IC2)**	**JP11 (IC3)**	**JP12 (IC4)**
NO-OFFSET ADJUSTMENT *(Default)*	A	A	A	A
OFFSET ADJUSTMENT	B	B	B	B
TEST POINT AND POTENTIOMETER (ONLY IF JUMPER IS IN "B" POSITION)	TP1 – R11	TP2 – R8	TP4 – R2	TP12 – R5

1.4 FLUORO CONFIGURATION

Fluoro configuration depends on position of jumpers W1 and W2 in the "*Fluoro CPU Board*" and jumper JP4 in the "*Console CPU Board*", as indicated below:

JUMPERS IN FLUORO CPU BOARD (A3213-XX)	INSERTED	REMOVED
W1	ABC not enable	ABC enable
W2	Always inserted (installed)	

JUMPERS IN ATP CONSOLE CPU BOARD (A3024-XX)	
JP4	Always in "B" position – Camera

Also, configure the following Jumpers on the optional “*RF Adaptation Board*”.

RF ADAPTATION BOARD (A3514–04)

JUMPER	POSITION	FUNCTION
JP1, JP3, JP4, JP8, JP9, JP10, JP12, JP13, JP14	Set all jumpers	+24 VDC for the inputs PREP ORDER, RAD ORDER, and FLUORO ORDER
	Remove all jumpers	230 VAC for the inputs PREP ORDER, RAD ORDER, and FLUORO ORDER
	Set only JP1, JP8 and JP12	115 VAC for the inputs PREP ORDER, RAD ORDER, and FLUORO ORDER
JP2	Set	Generator +24 VDC for PREP / RAD / FLUORO ORDER
	Removed	External supply for PREP / RAD / FLUORO ORDER
JP5	A	ZOOM 1 output selected from Generator (–9 IN SEL)
	B	ZOOM 1 output selected from Table or external control
JP6	A	ZOOM 2 output selected from Generator (–6 IN SEL)
	B	ZOOM 2 output selected from Table or external control
JP7	A	ZOOM 3 output selected from Generator (–4 IN SEL)
	B	ZOOM 3 output selected from Table or external control
JP11	A	LIH output through a N.O. contact
	B	LIH output through a N.C. contact
JP15	A	LIH output selected from an external enable signal
	B	LIH output selected for Last Image Hold function
JP16	A	EXP ON/END output active for only RAD exposure
	B	EXP ON/END output active for Fluoro and RAD exposure
JP17	A	For EXP ON output active along the RAD exposure
	B	For EXP END output active about 50 ms pulse at the end of the RAD exposure
JP18	A	For ABC Window adjustment
	B	For normal operation
JP19	A	Pulsed Fluoro sync. activated with the negative edge of Exp. Sync+
	B	Pulsed Fluoro sync. from composite video signal (video in)
	C	Pulsed Fluoro sync. activated with the positive edge of Exp. Sync+
JP20	A	For ABC OUT signal from composite video signal (video in)
	B	For ABC OUT signal from a negative external ABC signal
	C	For ABC OUT signal from a positive external ABC signal
JP21	A	ABC OUT signal generated from composite video signal or external ABC signal
	B	ABC OUT signal coming directly from the Image System
JP22	Set	ABC OUT signal generated from composite video signal or external ABC signal
	Removed	ABC OUT signal coming directly from the Image System
JP23	Set	Normal position (composite video signal referenced to the Generator ground)
	Removed	To reduce noise (composite video signal isolate from Generator ground)
JP24	A	Normal position (Fluoro order from the Table sent directly to the Generator)
	B	For Fluoro order enable (Fluoro order from the Table sent to the Image System)

1.5 GENERATOR SERVICE MODE

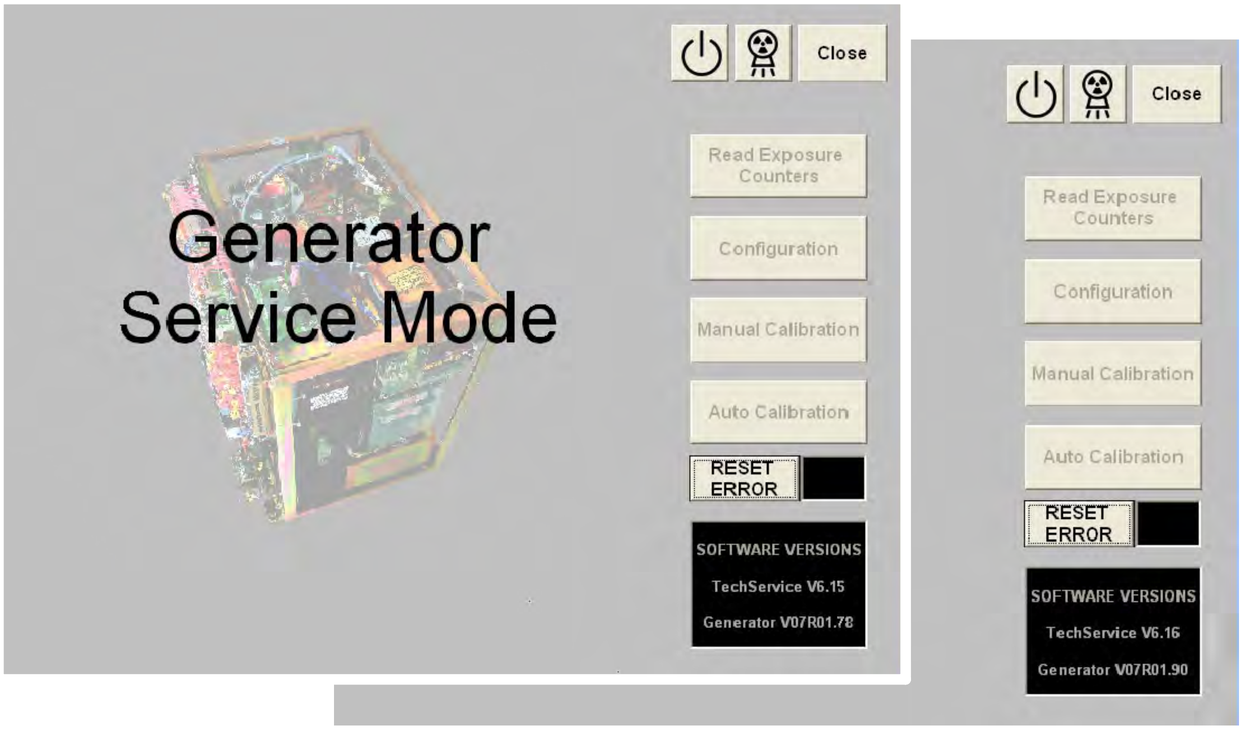
The Generator Service Mode (GSM) program allows the access to the service screens for Reading the Exposure Counters, Configuration and Calibration procedures.

Start the GSM program by clicking on the "*TechService*" icon in the path: "*StartMenu / Programs / Tech Service / TechService". (This is the path by default after installing the program from the CD-Rom).*

After accessing to the GSM program, a black Information Area appears at the lower right corner of the screen to show some messages related with the process (a.e. "*Power Up the Generator*").

If after pressing the "*Configuration*", "*Calibration*" or *Auto Calibration*" buttons, the GSM program prompts an error message: *"Please check calibration dip switch and toggle with power off"*; it means that these functions are disabled because position of dip switch 3024SW2-3 on the "*ATP Console CPU Board*" is not in "*Service Mode Allowed*". Turn OFF the generator, change the dip switch 3024SW2-3 to Closed (ON) position, turn ON the generator and start the GSM program again.

Illustration 1-2
Example of GSM Menu depending on software versions



The screens to "*Read Exposure Counters*", to enter in "*Configuration*", "*Manual Calibration*" or "*Auto Calibration*" are displayed after selecting the respective button on the right side. Press again the selected button (in yellow on the right side) to return to the GSM menu.

The "*Exit*" button can also be used to return to the GSM menu, specially if the others buttons are disable.

The "Configuration" screen can displays different buttons depending on the version of the "*TechService*" supplied for the Generator, refer to *Illustration 1-3* see as example of "*Configuration*" screens.

Note ☞ *Whenever the "Configuration" menu is closed (by pressing any of "Configuration" or "Exit" buttons) a double-beep will sound confirming the storage of the values set for each workstation.*

During operation, the color of the selected buttons changes to yellow when they are selected.

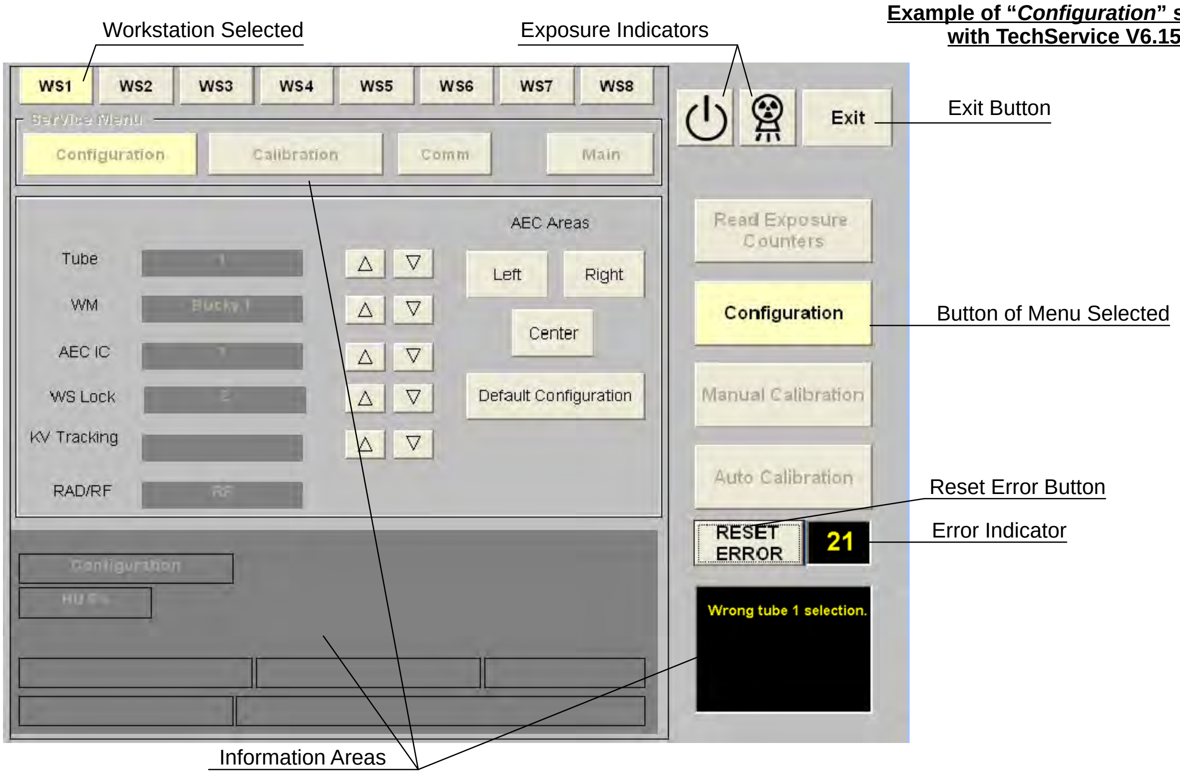
Press the "*Close*" button to exit from the GSM program.

Exposure status indicators for "*Ready*" and "*X-ray On*" are located on the upper right area of the GSM screens. The "*Information Area*" displays data related to the service mode, remaining heat units, working mode, errors indicators, etc.

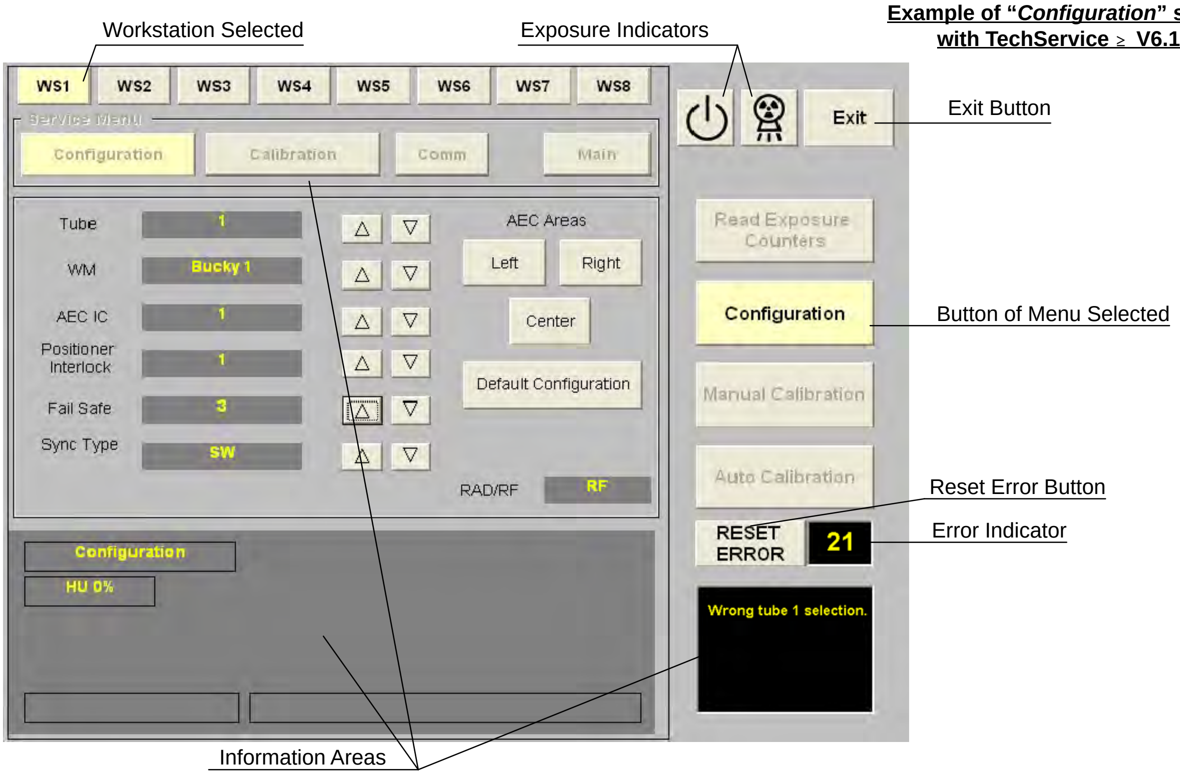
When an error code or message is displayed on the GSM program press the "*Reset Error*" button to reset the error indication.

Illustration 1-3
Status and Error Indicators

Example of "*Configuration*" screen with TechService V6.15



Example of "*Configuration*" screen with TechService ≥ V6.16



1.6 EXPOSURE COUNTERS

The Exposure Counters display the number of Rad exposures made with any of the X-ray Tubes and the accumulated Fluoro exposure time (in hours and minutes) made with the Tube-2.

1. Enter in the GSM program and select the “*Read Exposure Counters*” button.
2. This screen shows the Exposure Counters.
3. Exit from this screen by pressing the “*Read Exposure Counters*” button or the “*Exit*” button again.

Illustration 1-4
Exposure Counters

1.7 WORKSTATIONS CONFIGURATION

This screen is used to view the configuration of the Workstations (Tube, WM, Ion Chamber, etc.) and the AEC Areas selected by default for each Workstation in the system (optional). The different displays/buttons related to the Workstation configuration that appear on the "Configuration" screen depend on the version of the "*TechService*" supplied for the Generator (*refer to Illustration 1-5).*

The workstations can be configured according to the customer preferences or default. If a workstation is configured with the value "*Tube – 0*", its button can not be selected during operation.

CUSTOMIZED CONFIGURATION

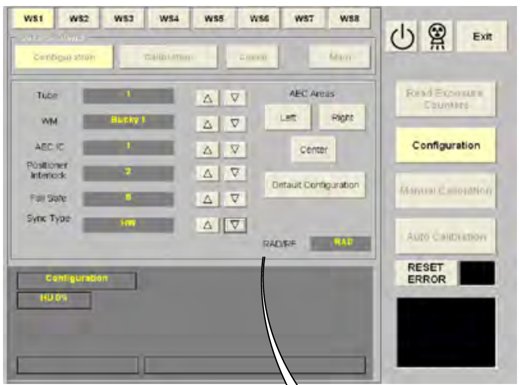
Note ☞ *This procedure has to be performed always that "ATP Console CPU Board" is replaced by a new one.*

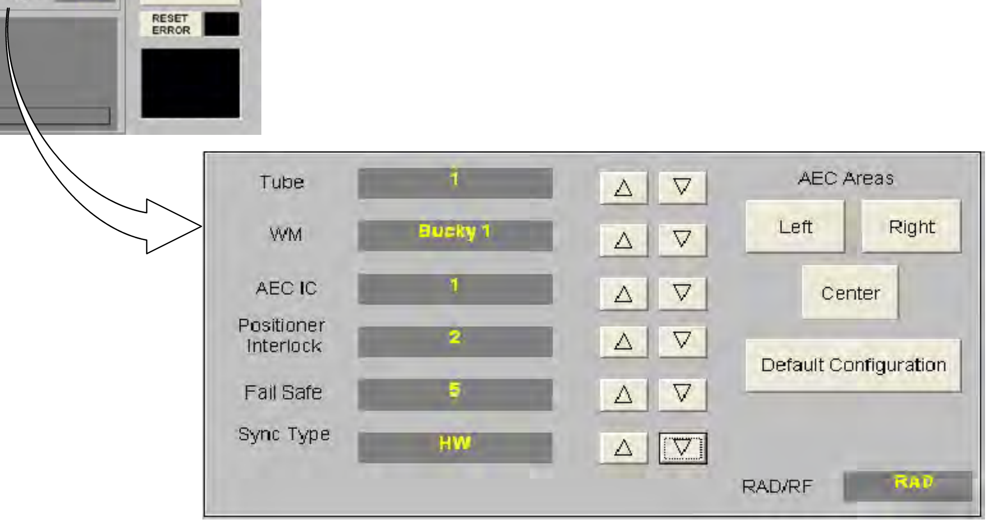
1. Enter in the GSM program and select the "*Configuration*" button.
2. Once in Configuration mode, if the Generator has installed the "*Fluoro CPU Board*" the program has to indicate "*RF*" on the RAD/RF window. This means that Fluoro functions are enabled. If not, it indicates "*RAD*".

Note ☞ *If the Fluoro functions are not enabled ("RF" does not appear) the Fluoro Display and functions will be deactivated after selecting a workstation for Tube-2. In this case, exit, check connection between the Fluoro CPU and ATP Console CPU Board and enter in Configuration again until the "RF" indication appears.*

Illustration 1-5
Configuration screen depending on TechService version

<u>**Example of “*Configuration*” screen with TechService V6.15**</u>





<u>**Example of “*Configuration*” screen with TechService ≥ V6.16**</u>

3. Select the first workstation to be configured, by pressing the respective button (only the icon of the selected workstation has different color). The following values can be shown on the "*Configuration*" screen:

CONFIGURATION VALUES WITH TECHSERVICE V6.15			
DISPLAY	**FUNCTION**	**VALUE**	**DESCRIPTION**
TUBE	**Tubes**	0	No-configured workstation (Not selectable by the operator)
		1	Tube-1
		2	Tube-2
WM	**Devices - Working Modes**	0 – Direct	Direct
		1 – Bucky 1	First Receptor, usually in the Table or for Systems (URS / LP) with only one receptor: CR-Film inserted in the Tray/Bucky or DR (Direct DR or DR inserted in the Receptor cabinet).
		2 – Bucky 2	Second Receptor, usually in the Wall Stand: CR-Film inserted in the Tray/Bucky or DR (Direct DR or DR inserted in the Receptor cabinet).
		3 – STD Tomo	Standard Tomo *1)
		4 – STD RF	Standard RF (Spot Film Device)
		5 – DSI	Digital RAD and Fluoro *2)
		6 – Cine	Cine *2)
		7 – DSA	DSA *2)
AEC IC	**AEC Ion Chambers**	0	No AEC
		1	Ion Chamber-1 (IC-1)
		2	Ion Chamber-2 (IC-2)
		3	Ion Chamber-3 (IC-3)
		4	Ion Chamber-4 (IC-4)
		5	Photomultiplier (PT-INPUT)

Notes:

– Some of listed values are not configurable depending on the Positioners / Generator model .

**1) Only when the Tomo is controlled from the Generator. In this case, the workstation has to be configured as Tube "1" or "2", Device "STD Tomo" and Ion Chamber "0".*
If the Tomo is controlled from the Table, the workstation has to be configured as Tube "2", Device "STD RF" and Ion Chamber "0".

**2) These Devices are only available for Generators provided with interface option for Digital Systems. These workstations has to be configured as Tube "2".*

CONFIGURATION VALUES WITH TECHSERVICE V6.15 (cont.)			
DISPLAY	**FUNCTION**	**VALUE**	**DESCRIPTION**
WS LOCK *3)	**Configuration of Positioner SID Reading exclusive for some RAD Room Systems** *3) **(optional)**	0	No Interlocks, or Interlocks for the Tilting Wall Stand whenever "*Bucky 2*" is configured
		1	Interlocks for the Table
		2	Interlocks for the Wall Stand (No Tilting)
WS LOCK *4)	**Alignment Interlocks and Receptor Detection** *4) **(optional)**	0	No Interlocks for Direct Mode **DR**
		1	Interlocks for the First Receptor **DR**, usually in the Table or for Systems (URS/LP) with only one Receptor
		2	Interlocks for the Second Receptor **DR**, usually in the Wall Stand
		3	No Interlocks for Direct Mode **CR-Film**
		4	Interlocks for the First Receptor **CR-Film**, usually in the Table or for Systems (URS/LP) with only one Receptor
		5	Interlocks for the Second Receptor **CR-Film**, usually in the Wall Stand

Notes:

– Some of listed values are not configurable depending on the Positioners / Generator model .

**3) Only when the RAD Room is a Millennium Plus / Polyrad Premium Advanced (or similar) RAD Rooms with Table and Wall Stand, the value set as "WS Lock" is related to the SID reading in the Tube Stand Console for each positioner.*
Possible values: 0, 1, 2.

**4) For the rest of RAD Rooms (no Millennium Plus / Polyrad Premium Advanced (or similar)), this function requires that the Positioners are supplied with the corresponding Kits for Alignment Interlocks and Receptor Detection installed. If not, configure the "0" value. Possible values: 0, 1, 2, 3, 4, 5.*

When the Receptor is DR, check the following jumpers:
- *On A3656-01 Fail Safe Board, JP1 and JP2 are set in OFF position.*

When the Receptor is CR-Film, check the following jumpers:
- *There is a wire-jumper between Generator TS1-5 and TS1-6 in case of CR-Film Type on Bucky 1 (Table).*
- *There is a wire-jumper between Generator TS1-12 and TS1-13 in case of CR-Film Type on Bucky 2 (Wall Stand).*
- *On A3656-01 Fail Safe Board, JP1 and JP2 are set in ON position.*

CONFIGURATION VALUES WITH TECHSERVICE V6.15 (cont.)			
DISPLAY	**FUNCTION**	**VALUE**	**DESCRIPTION**
kV TRACKING	**RAD kVp Auto-Tracking Formula** **5)* **(optional)**	1	Formula-1
		2	Formula-2
		3	Formula-3
		4	Formula-4
		5	Formula-5
		6	Formula-6
		7	Formula-7
		8	Formula-8
RAD/RF	**Generator Type**	RAD	Only for RAD
		RF	RAD and Fluoro

Notes:

- Some of listed values are not configurable depending on the Positioners / Generator model .

**5) Value on “KV Tracking” (optional) assigns by default one Formula for “Zero Point” operation mode to the selected RF workstation.*

Note ☞ *Refer to Section 1.7.1 for some examples of Workstation configuration using the TechService V6.15.*

CONFIGURATION VALUES WITH TECHSERVICE ≥ V6.16			
DISPLAY	**FUNCTION**	**VALUE**	**DESCRIPTION**
TUBE	**Tubes**	0	No-configured workstation (Not selectable by the operator)
		1	Tube-1
		2	Tube-2
WM	**Devices - Working Modes**	0 – Direct	Direct
		1 – Bucky 1	First Receptor, usually in the Table or for Systems (URS / LP) with only one receptor: CR-Film inserted in the Tray/Bucky or DR (Direct DR or DR inserted in the Receptor cabinet).
		2 – Bucky 2	Second Receptor, usually in the Wall Stand: CR-Film inserted in the Tray/Bucky or DR (Direct DR or DR inserted in the Receptor cabinet).
		3 – STD Tomo	Standard Tomo *1)
		4 – STD RF	Standard RF (Spot Film Device)
		5 – DSI	Digital RAD and Fluoro *2)
		6 – Cine	Cine *2)
		7 – DSA	DSA *2)
AEC IC	**AEC Ion Chambers**	0	No AEC
		1	Ion Chamber-1 (IC-1)
		2	Ion Chamber-2 (IC-2)
		3	Ion Chamber-3 (IC-3)
		4	Ion Chamber-4 (IC-4)
		5	Photomultiplier (PT-INPUT)
POSITIONER INTERLOCK	**Configuration of Positioner SID Reading exclusive for some RAD Room Systems** *3) **(optional)**	0	No Interlocks, or Interlocks for the Tilting Wall Stand whenever "*Bucky 2*" is configured
		1	Interlocks for the Table
		2	Interlocks for the Wall Stand (No Tilting)

Notes:

– Some of listed values are not configurable depending on the Positioners / Generator model .

**1) Only when the Tomo is controlled from the Generator. In this case, the workstation has to be configured as Tube "1" or "2", Device "STD Tomo" and Ion Chamber "0".*
If the Tomo is controlled from the Table, the workstation has to be configured as Tube "2", Device "STD RF" and Ion Chamber "0".

**2) These Devices are only available for Generators provided with interface option for Digital Systems. These workstations has to be configured as Tube "2".*

**3) The configuration of "Positioner Interlocks" only applies to Millennium Plus / Polyrad Premium Advanced (or similar) RAD Rooms with Table and Wall Stand. The value is related to the SID reading in the Tube Stand Console for each positioner.*

CONFIGURATION VALUES WITH TECHSERVICE ≥ V6.16 (cont.)			
DISPLAY	**FUNCTION**	**VALUE**	**DESCRIPTION**
FAIL SAFE	**Alignment Interlocks and Receptor Detection** *4) **(optional)**	0	No Interlocks for Direct Mode **DR**
		1	Interlocks for the First Receptor **DR**, usually in the Table or for Systems (URS/LP) with only one Receptor
		2	Interlocks for the Second Receptor **DR**, usually in the Wall Stand
		3	No Interlocks for Direct Mode **CR-Film**
		4	Interlocks for the First Receptor **CR-Film**, usually in the Table or for Systems (URS/LP) with only one Receptor
		5	Interlocks for the Second Receptor **CR-Film**, usually in the Wall Stand
SYNC TYPE	**Generator - DR Synchronization Type** *5) **(optional)**	HW	DR Synchronization by Hardware
		SW	DR Synchronization by Software
RAD/RF	**Generator Type**	RAD	Only for RAD
		RF	RAD and Fluoro

Notes:

– Some of listed values are not configurable depending on the Positioners / Generator model .

***4) This function requires that the Positioners are supplied with the corresponding Kits for Alignment Interlocks and Receptor Detection installed.*

When the Receptor is DR, check the following jumpers:
- *On A3656–01 Fail Safe Board, JP1 and JP2 are set in OFF position.*

When the Receptor is CR-Film, check the following jumpers:
- *There is a wire-jumper between Generator TS1-5 and TS1-6 in case of CR-Film Type on Bucky 1 (Table).*
- *There is a wire-jumper between Generator TS1-12 and TS1-13 in case of CR-Film Type on Bucky 2 (Wall Stand).*
- *On A3656–01 Fail Safe Board, JP1 and JP2 are set in ON position.*

**5) Consult the documentation of the Acquisition Software and the System Interface schematics in order to set the Synchronization type between the Generator and DR (Detector Power Box).*

Note ☞ *Refer to Section 1.7.1 for some examples of Workstation configuration using the TechService ≥ V6.16.*

4. Set the new value by pressing the corresponding "*Increase*" or "*Decrease*" buttons. Set also the selected AEC Areas by default for each Workstation in the system (optional).

5. Select the next workstations to be configured and set the respective values of each one.

6. Exit from configuration mode by pressing the "*Configuration*" button, then a double-bip will sound confirming the process.

7. Exposures made from workstations configured with:

   - Device "*Direct (No Bucky), Bucky-1, Bucky-2* and *Standard Tomo*" are **only enabled** with the internal "*Preparation*" and "*Exposure*" signals controlled by the Handswitch or Rad Footswitch.

   - Device "*Standard RF*" and "*DSI*" are **only enabled** with the external signals for "*Preparation*", "*RAD Exposure*" and "*Fluoro Exposure*". **Fluoro can only be made from this Device selection.**

   - Device "*Infimed: DSI, Cine, DSA*" are **only enabled** with the external "*Digital Preparation*" and "*Exposure*" signals connected to Terminal Block 4TS3 of the Generator Cabinet.

Note ☞

1) Optional "Tomo / Bucky Adaptation Board" (in the Power Cabinet) is required to configure more than two Buckys or one Tomo Device in the system.

For system without the optional "Tomo / Bucky Adaptation Board", it can only work directly with two Buckys, and the value assigned to them must be "1" and "2" in the second value.

2) TOMO must be always related to Bucky-1. Only one TOMO can be used in the system, so only one of the workstations should be configured with the value "3" in the second value.

3) Optional "AEC Control Board" (connected to the Console CPU Board) is required to work with AEC.

Optional "AEC Adaptation Board" is required to configure any no-standard or more than one Ion Chambers in the system.

DEFAULT CONFIGURATION

Default configuration sets some default values to each workstation. It only should be used to re-initialize the workstation configuration when the complete configuration has been lost or it is not possible to select any workstation.

1. Enter in the GSM program and select the “*Configuration*” button.

2. Press the “*Default Configuration*” button.

3. Exit from configuration mode by pressing the “*Configuration*” button, then a double-bip will sound confirming the process.

4. It is recommended to perform a proper configuration of each workstation in the system after a default configuration.

1.7.1 WORKSTATION CONFIGURATION EXAMPLES

RAD ROOM with TABLE and WALL STAND
RECEPTORS = CR or Film

WS1 = CR or Film in the Table Receptor Cabinet
with AEC Ion Chamber
and Alignment Interlocks / Receptor Detection

WS2 = CR or Film in the Wall Stand Receptor Cabinet
with AEC Ion Chamber and
and Alignment Interlocks / Receptor Detection

WS3 = CR or Film out of the Receptor Cabinet (Direct mode)
with no AEC Ion Chamber
and no Alignment Interlocks / Receptor Detection

CONFIGURATION OF WORKSTATIONS USING TECHSERVICE V6.15				
WORKSTATION	**WS1**	**WS2**	**WS3**	**WS4 / WS5 / WS6 / WS7 / WS8**
TUBE	1	1	1	0
WM	1 – Bucky 1 *(Receptor in Table)*	2 – Bucky 2 *(Receptor in Wall Stand)*	0 – Direct *(Direct)*	
AEC IC	1	2	0	
WS LOCK	4	5	3	
WS LOCK *(only for Millennium Plus / Polyrad Premium Advanced or similar)*	1	2	0	
kV TRACKING				
RAD/RF	RAD	RAD	RAD	

CONFIGURATION OF WORKSTATIONS USING TECHSERVICE ≥ V6.16				
WORKSTATION	**WS1**	**WS2**	**WS3**	**WS4 / WS5 / WS6 / WS7 / WS8**
TUBE	1	1	1	0
WM	1 – Bucky 1 *(Receptor in Table)*	2 – Bucky 2 *(Receptor in Wall Stand)*	0 – Direct *(Direct)*	
AEC IC	1	2	0	
POSITIONER INT *(only for Millennium Plus / Polyrad Premium Advanced or similar)*	1	2	0	
FAIL SAFE	4	5	3	
SYNC TYPE				
RAD/RF	RAD	RAD	RAD	

RAD ROOM with TABLE and WALL STAND
RECEPTOR = DR (SINGLE PANEL)

WS1 =	DR1 in the Table Receptor Cabinet with AEC Ion Chamber and Alignment Interlocks / Receptor Detection
WS2 =	DR1 in the Wall Stand Receptor Cabinet with AEC Ion Chamber and and Alignment Interlocks / Receptor Detection
WS3 =	DR1 out of the Receptor Cabinet (Direct mode) with no AEC Ion Chamber and no Alignment Interlocks / Receptor Detection

CONFIGURATION OF WORKSTATIONS USING TECHSERVICE V6.15				
WORKSTATION	**WS1**	**WS2**	**WS3**	**WS4 / WS5 / WS6 / WS7 / WS8**
TUBE	1	1	1	0
WM	1 – Bucky 1 *(Receptor in Table)*	2 – Bucky 2 *(Receptor in Wall Stand)*	1 – Bucky 1 *(DR in Direct)*	
AEC IC	1	2	0	
WS LOCK	1	2	0	
WS LOCK *(only for Millennium Plus / Polyrad Premium Advanced or similar)*	1	2	0	
kV TRACKING				
RAD/RF	RAD	RAD	RAD	

CONFIGURATION OF WORKSTATIONS USING TECHSERVICE ≥ V6.16				
WORKSTATION	**WS1**	**WS2**	**WS3**	**WS4 / WS5 / WS6 / WS7 / WS8**
TUBE	1	1	1	0
WM	1 – Bucky 1 *(Receptor in Table)*	2 – Bucky 2 *(Receptor in Wall Stand)*	1 – Bucky 1 *(DR in Direct)*	
AEC IC	1	2	0	
POSITIONER INT *(only for Millennium Plus / Polyrad Premium Advanced or similar)*	1	2	0	
FAIL SAFE	1	2	0	
SYNC TYPE	HW or SW	HW or SW	HW or SW	
RAD/RF	RAD	RAD	RAD	

RAD ROOM with TABLE and WALL STAND RECEPTORS = DR (DUAL PANEL)

WS1 = DR1 in the Table Receptor Cabinet
with AEC Ion Chamber
and Alignment Interlocks / Receptor Detection

WS2 = DR2 in the Wall Stand Receptor Cabinet
with AEC Ion Chamber and
and Alignment Interlocks / Receptor Detection

WS3 = DR1 out of the Table Receptor Cabinet (Direct mode)
with no AEC Ion Chamber
and no Alignment Interlocks / Receptor Detection

WS4 = DR2 out of the Wall Stand Receptor Cabinet (Direct mode)
with no AEC Ion Chamber
and no Alignment Interlocks / Receptor Detection

CONFIGURATION OF WORKSTATIONS USING TECHSERVICE V6.15					
WORKSTATION	**WS1**	**WS2**	**WS3**	**WS4**	**WS5 / WS6 / WS7 / WS8**
TUBE	1	1	1	1	0
WM	1 – Bucky 1 *(Receptor in Table)*	2 – Bucky 2 *(Receptor in Wall Stand)*	1 – Bucky 1 *(Table DR in Direct)*	2 – Bucky 2 *(Wall Stand DR in Direct)*	
AEC IC	1	2	0	0	
WS LOCK	1	2	0	0	
WS LOCK *(only for Millennium Plus / Polyrad Premium Advanced or similar)*	1	2	0	0	
kV TRACKING					
RAD/RF	RAD	RAD	RAD	RAD	

CONFIGURATION OF WORKSTATIONS USING TECHSERVICE ≥ V6.16					
WORKSTATION	**WS1**	**WS2**	**WS3**	**WS4**	**WS5 / WS6 / WS7 / WS8**
TUBE	1	1	1	1	0
WM	1 – Bucky 1 *(Receptor in Table)*	2 – Bucky 2 *(Receptor in Wall Stand)*	1 – Bucky 1 *(Table DR in Direct)*	2 – Bucky 2 *(Wall Stand DR in Direct)*	
AEC IC	1	2	0	0	
POSITIONER INT *(only for Millennium Plus / Polyrad Premium Advanced or similar)*	1	2	0	0	
FAIL SAFE	1	2	0	0	
SYNC TYPE	HW or SW	HW or SW	HW or SW	HW or SW	
RAD/RF	RAD	RAD	RAD	RAD	

RAD ROOM with only ONE RECEPTOR (Universal Radiographic System / Lateral Positioner) RECEPTOR = CR or Film

WS1 = CR or Film in the Receptor Cabinet
with AEC Ion Chamber
and Alignment Interlocks / Receptor Detection

WS2 = CR or Film out of the Receptor Cabinet (Direct mode)
with no AEC Ion Chamber
and no Alignment Interlocks / Receptor Detection

CONFIGURATION OF WORKSTATIONS USING TECHSERVICE V6.15			
WORKSTATION	**WS1**	**WS2**	**WS3 / WS4 / WS5 / WS6 / WS7 / WS8**
TUBE	1	1	0
WM	1 – Bucky 1 *(Receptor)*	0 – Direct *(Direct)*	
AEC IC	1	0	
WS LOCK	4	3	
kV TRACKING			
RAD/RF	RAD	RAD	

CONFIGURATION OF WORKSTATIONS USING TECHSERVICE ≥ V6.16			
WORKSTATION	**WS1**	**WS2**	**WS3 / WS4 / WS5 / WS6 / WS7 / WS8**
TUBE	1	1	0
WM	1 – Bucky 1 *(Receptor)*	0 – Direct *(Direct)*	
AEC IC	1	0	
POSITIONER INT			
FAIL SAFE	4	3	
SYNC TYPE			
RAD/RF	RAD	RAD	

RAD ROOM with only ONE RECEPTOR (Universal Radiographic System / Lateral Positioner) RECEPTOR = DR

WS1 = DR in the Receptor Cabinet
with AEC Ion Chamber
and Alignment Interlocks / Receptor Detection

WS2 = DR out of the Receptor Cabinet (Direct mode)
with no AEC Ion Chamber
and no Alignment Interlocks / Receptor Detection

CONFIGURATION OF WORKSTATIONS USING TECHSERVICE V6.15			
WORKSTATION	**WS1**	**WS2**	**WS3 / WS4 / WS5 / WS6 / WS7 / WS8**
TUBE	1	1	0
WM	1 – Bucky 1 (*Receptor*)	1 – Bucky 1 *(Direct)*	
AEC IC	1	0	
WS LOCK	1	0	
kV TRACKING			
RAD/RF	RAD	RAD	

CONFIGURATION OF WORKSTATIONS USING TECHSERVICE ≥ V6.16			
WORKSTATION	**WS1**	**WS2**	**WS3 / WS4 / WS5 / WS6 / WS7 / WS8**
TUBE	1	1	0
WM	1 – Bucky 1 *(Receptor)*	1 – Bucky 1 *(Direct)*	
AEC IC	1	0	
POSITIONER INT			
FAIL SAFE	1	0	
SYNC TYPE	HW or SW	HW or SW	
RAD/RF	RAD	RAD	

SECTION 2 EXTENDED MEMORY SETTING

2.1 EXTENDED MEMORY LOCATIONS

Miscellaneous configuration and calibration data are stored in the Extended Memory Locations. It is recommended to note the values factory stored in each Memory Location. (*Refer to Table 2-1*)

Note ☞ *For generators with only one Radiographic X-ray Tube, this tube have to be configured, calibrated and used as Tube-1.*

Note ☞ *For generators with a Fluoroscopic X-ray Tube or DSI (Digital RAD), this tube have to be configured, calibrated and used as Tube-2.*

For these generators, the value of the E17 Memory Location is not readable as “Tube-2 – Filament stand-by (Autocalibrated)”.

Note ☞ *Generators with a single X-ray Tube for Fluoroscopy / Spot Film / DSI (Digital RAD) require to store the respective values of the Memory Locations:*

- *E17: Tube-2 – Fluoro filament setting.*
- *E18: Tube-2 – Fluoro tube type.*
- *E29 and E31: Tube-2 – Exposure Time adjustments.*
- *Other required Memory Locations.*

Table 2-1
Extended Memory Locations

MEMORY LOCATION	FUNCTION	VALUE
E01	TUBE-1 – RAD filament stand-by (*Autocalibrated. Not field changeable*)	
E02	TUBE-1 – RAD tube type	
E03	Low Digital mA Loop Closed (from 10 mA to 80 mA)	
E04	AEC-1 calibration	
E05	High Digital mA Loop Closed (from 100 mA)	
E06	kV Loop	
E07	Maximum kW *(Factory set. Only field changeable to lower value)*	
E08	AEC-1 tracking	
E09	AEC-2 calibration	
E10	AEC-2 tracking	
E11	Not used.	
E12	AEC Density Scale	
E13	TUBE-1 – Exposure Time adjustment - Delay	
E14	Not used.	
E15	TUBE-1 – Exposure Time adjustment - Ceq kV	
E16	Not used.	
E17*	TUBE-2 – RAD filament stand-by (*Autocalibrated. Not field changeable*)	
	TUBE-2 – FLUORO filament setting	
E18	TUBE-2 – RAD or FLUORO tube type	
E19	Maximum FLUORO kV	
E20	AEC-3 calibration	
E21	Not used.	
E22	Not used.	
E23	AEC-4 calibration / Photomultiplier AEC calibration (SF camera)	
E24	AEC-3 tracking / AEC-4 tracking (equal value for both)	
E25	FLUORO mA display calibration at 50 kV	
E26	FLUORO mA display calibration at 80 kV	
E27	FLUORO mA display calibration at 120 kV	
E28	Not used.	
E29	TUBE-2 – Exposure Time adjustment - Delay	
E30	Not used.	
E31	TUBE-2 – Exposure Time adjustment - Ceq kV	
E32	Not used.	

** Note.– For Fluoroscopic use, value in E17 means “Fluoro filament setting” and must be manually set*

2.2 HOW TO ENTER AND STORE DATA IN THE EXTENDED MEMORY

The Extended Memory data are entered from the Console when the unit is in service mode. Access to memory locations as indicated below:

1. Turn the Generator OFF and set the Test dip switch 3024SW2-3 on the ATP Console CPU Board in *"**On**"* position to permit the service mode.

2. Power ON the System and select the "*Manual Calibration*" button on the GSM program.

3. Select the needed Workstation (WS) using the "*Up*" and "*Down*" buttons, then press the "*OK*" button to enter in calibration mode.

Note ☞ *In calibration mode, only the kV and mA parameters can be modified, values for Time and mAs are factory programmed.*

4. Increase the mA value beyond the maximum mA position. The mA Display will show the first Extended Memory location (E01), they will continue sequentially as the "*Increase mA*" button is pressed.

   The values stored in each location are shown on the "*Calibration Value*" Display after pressing the "*Read*" button or after pressing the "*Increase*" or "*Decrease*" buttons of this panel. Since these buttons are also used to increase or decrease the stored values, one number should be added or subtracted from the reading, to obtain the current stored value.

5. Select the new value by pressing the *"Increase" and "Decrease"* buttons. Each time these buttons are pressed the value displayed on the calibration panel is increased or decreased one step.

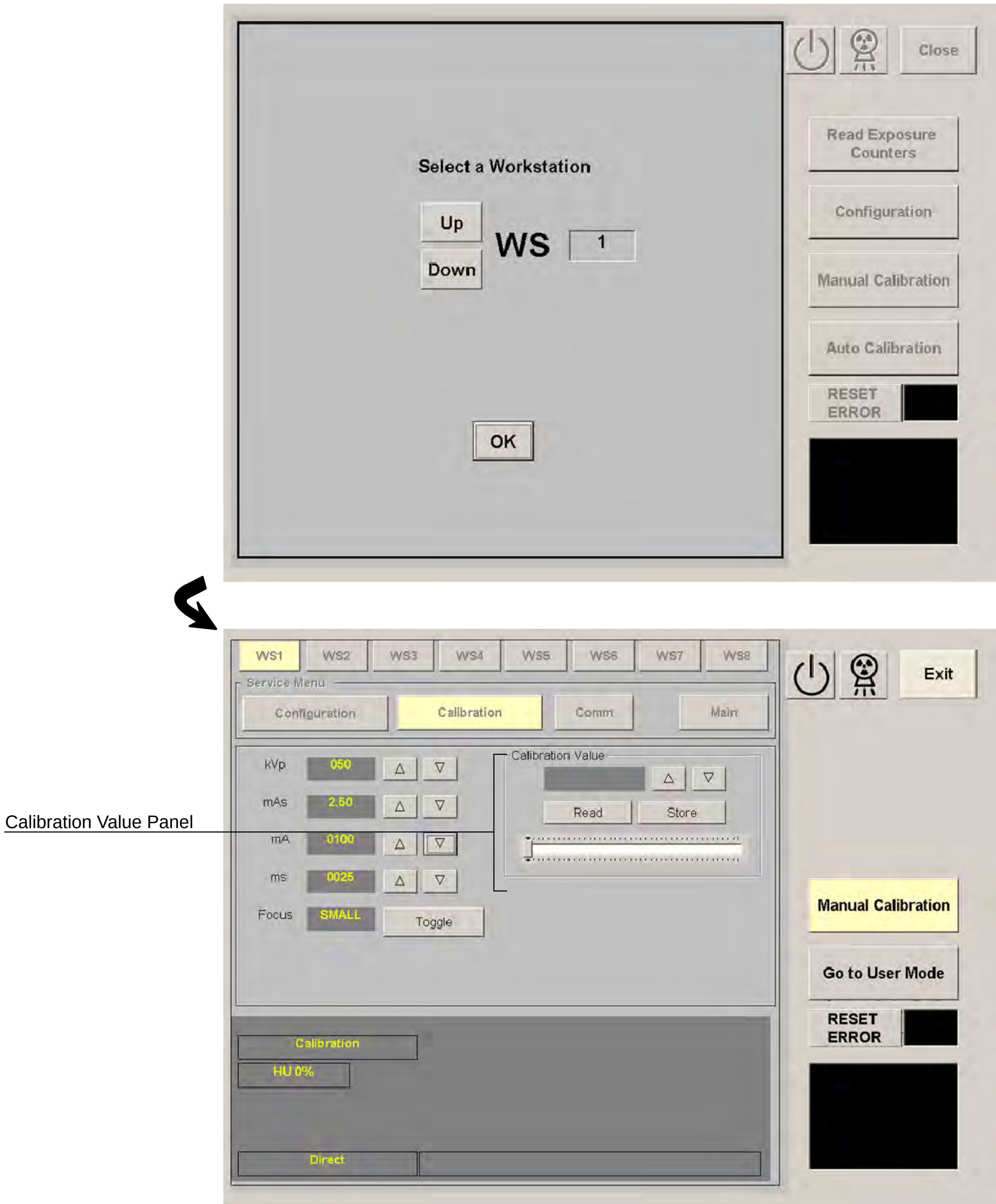
6. Store the new value by pressing the "*Store*" button (Check-summ function).

Note ☞ *If the "Store" button is not pressed after a new value is selected, no modified data will be retained.*

7. Exit from calibration mode by pressing the "*Manual Calibration*" button again.

8. Turn the Generator OFF and set dip switch 3024SW2-3 on the ATP Console CPU Board in *"**Off**"* position to place the Generator in normal mode.

Illustration 2-1
Calibration



2.3 LIMIT OF MAXIMUM kW

The Maximum kW of the Generator is factory set according to the Generator performance. Generator kW can be limited to a lower value.

Note ☞ *This limit can be set to a lower value to match the maximum Generator power to the Line power, due to a high line impedance (refer to Pre-installation document).*

1. Enter in calibration mode by pressing the "*Manual Calibration*" button on the GSM program. Select any workstation (WS) and press the "*OK*" button.
2. Select the E07 Memory Location (memory location is shown on the mA Display).
3. Set the new limit of Maximum kW by pressing the *"Increase" or "Decrease"* calibration buttons and store the value by pressing the "*Store*" button.
4. Exit from calibration mode.

Note ☞ *Record configuration data for E07 in the Data Book.*

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SECTION 3 X-RAY TUBE SELECTION

3.1 X-RAY TUBE INSERT PROTECTION CURVES

In order to properly select the X-ray Tube Insert Protection Curves for the Tubes connected to the Generator, perform the following procedure:

1. Enter in calibration mode by pressing the "*Manual Calibration*" button on the GSM program. Select one of the workstation (WS) related to the X-ray Tube to be configured. Then press the "*OK*" button.
2. Select the respective memory location, E02 for Tube-1 or E18 for Tube-2 (memory location is shown on the mA Display).
3. Identify in Section 4 "*X-ray Tube Data*", the X-ray tube that is being installed and note its tube type number.
4. Set the tube number by pressing the *"Increase" or "Decrease"* calibration buttons until the correct number is showed on the "*Calibration Value*" panel.
5. Store the value by pressing the "*Store*" button.
6. Verify that the tube code (ID) shown in the mAs Display is the same of the tube code listed in Section 4 "*X-ray Tube Data*". The tube code (ID) can be only read for the selected X-ray Tube after pressing the "*Store*" button.
7. If required, repeat this procedure for the other X-ray Tube.
8. Exit from calibration mode.

Note ☞ *Record configuration data for E02 and E18 in the Data Book.*

3.2 GENERATORS WITH LF-RAC (LOW SPEED STARTER)

3.2.1 STATOR VOLTAGE AND CAPACITOR SELECTION

CAUTION

Check that the capacitor value of the Low Speed Starter corresponds to the value recommended by the X-ray Tube manufacturer. If needed replace the capacitor. Also, the Rotor speed must be indicated by the manufacturer.

The DC Brake of the Low Speed Starter (LF-RAC) can be removed by desoldering CR6 on the LF-RAC Board (*refer to schematic 543020xx*). In this case, the Tube will remain coasting after releasing the "*Prep*" or the "*Fluoro*" order.

3.2.1.1 CONFIGURATION FOR ONE OR TWO TUBES WITH STANDARD STATOR

Voltage and capacitor is factory set to 220 VAC, 30 μF. In all cases, refer to X-ray Tube Product Data.

3.2.1.2 CONFIGURATION FOR ONE OR TWO TUBES WITH THE SAME STARTING VOLTAGE AT 110 VAC

When the stator requires a starting voltage of 110 VAC (a.e. X-ray Tube Toshiba or Canon E7239 / E7240 / E7242 / E7252 / E7299 / E7813 / E7865) perform the following modifications:

- If the Power Input Transformer 6T2 is for using with power lines up to 240 VAC (part number 50509030), remove the wire labelled as "4" that is connected to Terminal 4 (230 VAC RTR) and connect it to Terminal 3 or 8 (110 VAC).

- If the Power Input Transformer 6T2 is for using with power lines up to 530 VAC (part number 50509029), remove the wire labelled as "4" that is connected to Terminal 4 (230 VAC RTR) and connect it to Terminal 40 (110 VAC).

- For X-ray Tube Toshiba or Canon E7252 or E7813 (or when it is required) replace also the Fuse F1 (6A) on the LF-RAC Board by another fuse of 10 A.

CAUTION

These changes affect to all the Tubes connected to Generator.

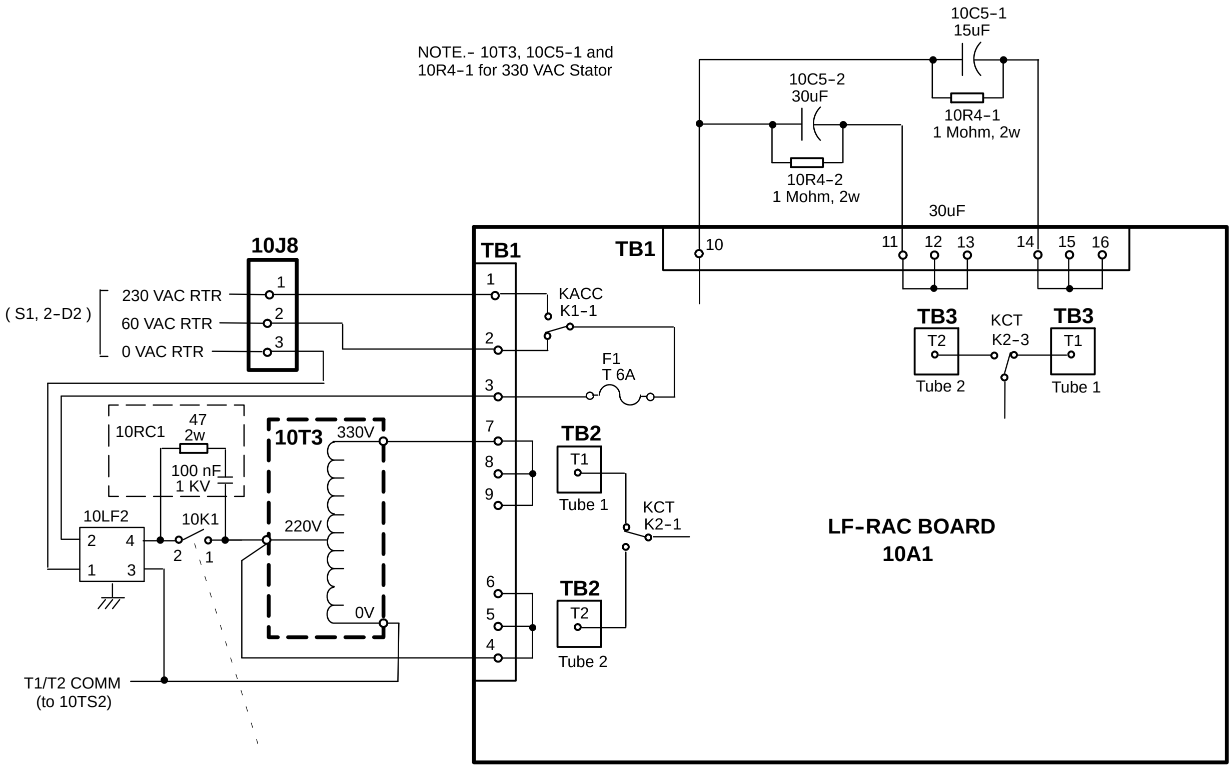
3.2.1.3 CONFIGURATION FOR TWO TUBES WITH DIFFERENT STARTING VOLTAGE AND CAPACITOR OR ONE TUBE WITH STARTING VOLTAGE AT 330 VAC

For Generators equipped with a LF-RAC module for two X-ray Tubes, with possible selection of voltage and capacitor jumpers on the LF-RAC Board, set jumpers according to the respective X-ray Tube(s) as indicated below.

TWO TUBES WITH STARTING VOLTAGE AT 220 VAC AND 330 VAC OR ONE TUBE WITH STARTING VOLTAGE AT 330 VAC

(A "Kit of 330 VAC" is required with this configuration).

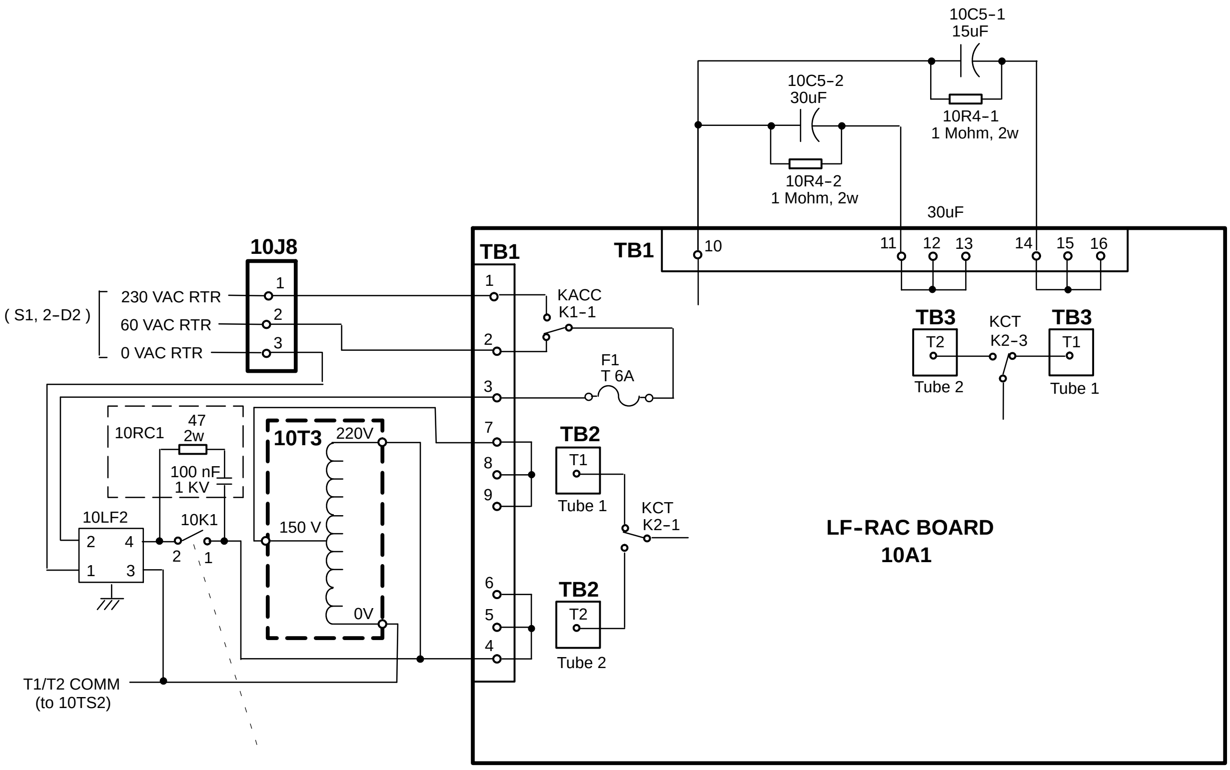
		TUBE-1	TUBE-2
VOLTAGE	220 VAC	TB2-T1 with TB1-5 or TB1-6	TB2-T2 with TB1-5 or TB1-6
	330 VAC	TB2-T1 with TB1-8 or TB1-9	TB2-T2 with TB1-8 or TB1-9
CAPACITOR	30 µF	TB3-T1 with TB1-12 or TB1-13	TB3-T2 with TB1-12 or TB1-13
	15 µF	TB3-T1 with TB1-15 or TB1-16	TB3-T2 with TB1-15 or TB1-16



TWO TUBES WITH STARTING VOLTAGE AT 220 VAC AND 110 VAC

(A “Kit of 110 VAC” is required with this configuration).

		TUBE-1	TUBE-2
VOLTAGE	**220 VAC**	TB2-T1 with TB1-5 or TB1-6	TB2-T2 with TB1-5 or TB1-6
	150 VAC	TB2-T1 with TB1-8 or TB1-9	TB2-T2 with TB1-8 or TB1–9
CAPACITOR	**30 µF**	TB3-T1 with TB1-12 or TB1-13	TB3-T2 with TB1-12 or TB1-13
	15 µF	TB3-T1 with TB1-15 or TB1-16	TB3-T2 with TB1-15 or TB1-16



3.2.2 PROGRAMMING OF ROTOR ACCELERATION TIME, RAD FILAMENT SETTING TIME, FLUORO ROTOR AND FILAMENT HOLD-OVER TIME

CAUTION

Rotor Acceleration Time is determined by the X-ray Tube and Rotor characteristics and it must be considered when the Generator is about to be configured. X-ray Tube could be permanently damaged unless the required RPM are reached before an exposure. (Refer to technical information of the X-ray Tube).

Dip Switch 3000SW2 on the HT Controller Board is used to program:

- *Rotor Acceleration Time*. That depends on Stator voltage, Stator frequency, Stator type, quality of X-ray tube bearings, and X-ray tube anode size. A reed tachometer or a stroboscope can be used to determine the anode RPM. Be sure that the Rotor Acceleration Times meet all requirements for anticipated customer applications.

  This value is programmable from 0.8 to 2.7 seconds. After this time the Rotor is hold running in maintaining mode as long as “*Prep*” is active.

- *Rad Filament Setting Time*. This parameter has the same configuration value than the Rotor Acceleration Time. Sometimes, if it is required to increase the Rad Filament Setting Time to the next value, configure the respective switches again. This adjustment avoids Error-12.

- *Fluoro Rotor Hold-over Time and Fluoro Filament Hold-over Time*. This value can be programmed to run for 1 minute or not at all, after releasing the Fluoro Pedal.

Note ☞ *The Rotor Acceleration Time and Rad Filament Setting Time is factory set to 1.8 seconds. The Fluoro Rotor Hold-over Time and Fluoro Filament Hold-over Time is factory set to 1 minute. Maintain this value when it is unknown or not provided with the X-ray Tube documentation.*

1. Turn the Generator OFF and note current settings of the dip switch 3000SW2 on the HT Controller Board.

Note ☞ *Configuration of these times are only allowed when dip switch 3000SW2-1 is in “Closed” (On) position after power the Generator OFF and back ON again.*

2. Set dip switches 3000SW2-1 and 3000SW2-2 as indicated below, in order to enable the selection of times with the Low Speed Starter. ***Dip switch3000SW2-1 has to be switched ONLY with the Generator powered OFF.***

3000SW2-1 (selection enable)	3000SW2-2 (Low Speed Starter)
ON	OFF

3. Configure the Rotor and Filament Times by setting the dip switches 3000SW2-4 through 3000SW2-8 per Table 3-1.

Table 3-1
Low Speed: Configuration of Rotor and Filament Times

TUBE-1 ROTOR ACCELERATION TIME AND FILAMENT SETTING TIME	3000SW2-7		3000SW2-8	
	OPEN (OFF)	CLOSED (ON)	OPEN (OFF)	CLOSED (ON)
0.8 seconds		❏		❏
1.2 seconds	❏			❏
1.8 seconds		❏	❏	
2.7 seconds	❏		❏	

TUBE-2 ROTOR ACCELERATION TIME AND FILAMENT SETTING TIME	3000SW2-5		3000SW2-6	
	OPEN (OFF)	CLOSED (ON)	OPEN (OFF)	CLOSED (ON)
0.8 seconds		❏		❏
1.2 seconds	❏			❏
1.8 seconds		❏	❏	
2.7 seconds	❏		❏	

FLUORO ROTOR AND FILAMENT HOLD-OVER TIME	3000SW2-4	
	OPEN (OFF)	CLOSED (ON)
After releasing the Fluoro Pedal, the Rotor stops and the Filament Current goes back to stand-by.		❏
After releasing the Fluoro Pedal, 1 minutes passes before the Rotor stops and the Filament Current goes back to stand-by.	❏	

Note ☞ *Record the switch configuration in the Data Book.*

4. To validate previous configuration, turn the Generator ON, wait until Error–01 (E01) appears on the Console and turn the Generator OFF.

5. Set dip switch 3000SW2 to the original settings as noted in step-1. (*Refer to Section 1.1.5 for the normal settings of Dip Switch 3000SW2*).

3.3 GENERATORS WITH LV-DRAC (HIGH SPEED STARTER)

3.3.1 ANODE STATOR SELECTION

For Generators with High Speed Starter, **configure NOW** the X-ray Tube Family (Anode Stator + Insert) by setting the respective dip switches 3243SW1 (pos. 4 to 8) and / or 3243SW2 (pos. 4 to 8) on the Control DRAC Board. (*Refer to "LV-DRAC - Digital Rotating Anode Controller" document*).

Configuration of these dip switches automatically determines the appropriate Starting and Running Stator Voltage and Rotor Acceleration Time of the selected Tube Family.

3.3.2 PROGRAMMING OF RAD FILAMENT SETTING TIME AND FLUORO FILAMENT HOLD-OVER TIME

Note ☞

With High Speed operation:

– Rotor Acceleration Time is related to the X-ray Tube Family configured on the Control DRAC Board (LV-DRAC).

– Fluoro and Spot Film Rotor Hold-over Times are configured on the Control DRAC Board (LV-DRAC).

– Rad Filament Setting Time and Fluoro Filament Hold-over Time are configured with dip switch 3000SW2 per this instruction.

Dip Switch 3000SW2 on the HT Controller Board is used to program:

- *Rad Filament Setting Time*. This value is programmable from 0.8 to 2.7 seconds. It can be initially set as the same value assigned for the Rotor Acceleration Time *(refer to technical information of the X-ray Tube)*

  Sometimes, if it is required to increase the Rad Filament Setting Time to the next value, configure the respective switches again. This adjustment avoids Error-12.

- *Fluoro Rotor Hold-over Time and Fluoro Filament Hold-over Time*. This value can be programmed to run for 1 minute or not at all, after releasing the Fluoro Pedal.

Note ☞ *The Rad Filament Setting Time is factory set to 1.8 seconds. The Fluoro Filament Hold-over Time is factory set to 1 minute. Maintain this value when it is unknown or not provided with the X-ray Tube documentation.*

1. Turn the Generator OFF and note current settings of the dip switch 3000SW2 on the HT Controller Board.

Note ☞ *Configuration of these times are only allowed when dip switch 3000SW2-1 is in "Closed" (On) position after power the Generator OFF and back ON again.*

2. Set dip switches 3000SW2-1 and 3000SW2-2 as indicated below, in order to enable the selection of times with the High Speed Starter. ***Dip switch3000SW2-1 has to be switched ONLY with the Generator powered OFF.***

3000SW2-1 (selection enable)	3000SW2-2 (High Speed Starter)
ON	ON

3. Configure the Filament Setting Times by setting the dip switches 3000SW2-4 through 3000SW2-8 per Table 3-2. The Filament Setting Time should be configured in accordance to Rotor Acceleration Time of the X-ray Tube.

Table 3-2
High Speed: Configuration of Filament Setting Time

TUBE-1 FILAMENT SETTING TIME	3000SW2-7		3000SW2-8	
	OPEN (OFF)	CLOSED (ON)	OPEN (OFF)	CLOSED (ON)
0.8 seconds		❑		❑
1.2 seconds	❑			❑
1.8 seconds		❑	❑	
2.7 seconds	❑		❑	

TUBE-2 FILAMENT SETTING TIME	3000SW2-5		3000SW2-6	
	OPEN (OFF)	CLOSED (ON)	OPEN (OFF)	CLOSED (ON)
0.8 seconds		❑		❑
1.2 seconds	❑			❑
1.8 seconds		❑	❑	
2.7 seconds	❑		❑	

FLUORO FILAMENT HOLD-OVER TIME	3000SW2-4	
	OPEN (OFF)	CLOSED (ON)
After releasing the Fluoro Pedal, the Filament Current goes back to stand-by.		❑
After releasing the Fluoro Pedal, 1 minutes passes before the Filament Current goes back to stand-by.	❑	

Note ☞ *Record the switch configuration in the Data Book.*

4. To validate previous configuration, turn the Generator ON, wait until Error–01 (E01) appears on the Console and turn the Generator OFF.

5. Set dip switch 3000SW2 to the original settings as noted in step-1. (*Refer to Section 1.1.5 for the normal settings of Dip Switch 3000SW2*).

3.4 ANODE ROTATION TEST

Perform the following tests for each X-ray Tube in the installation, checking the low and high speed when it is required.

Note ☞ *Two people are needed for these tests, one at the Console and the service engineer looking at the anode of the X-ray Tube. These tests also can be done by hearing the sound of the anode rotating.*

WARNING

NEVER MAKE EXPOSURES DURING THE TESTS, THE PERSON CLOSE TO THE X-RAY TUBE WILL BE EXPOSED.

1. With the switch 3024SW2-3 on the ATP Console CPU Board in "***On***" position (service mode), turn the Console ON and select the corresponding X-ray Tube.

2. Select a low value for kVp and mAs for checking the Anode Rotation at Low Speed.

3. Press the "*Prep*" push-button and visually check that the Tube anode rotates in the proper way. (*Refer to the X-ray Tube documentation*).

4. Hold pressed the "*Prep*" push-button and check that the rotation speed of the Tube anode is in compliance with the X-ray Tube specifications.

   For this test is recommended to turn off the Tube filaments (switch 3000SW2-2 on the HT Controller in "***On***" position) and use a stroboscope to measure the anode speed.

5. Release the "*Prep*" push-button.

6. For Generators with LV-DRAC, select a high value for kVp and mAs for checking the Anode Rotation at High Speed. Repeat steps 3, 4 and 5.

7. If required for the second Tube, repeat this procedure.

3.5 FOCAL SPOTS CONFIGURATION

This configuration determines which mA station will be the smallest mA station for the Large Focal Spot. It is possible to configure all the mA stations for the Small Focal Spot or for the Large Focal Spot.

The smallest mA station for the Large Focal Spot must be selected according to the Tube ratings for the Small Filament and the customer preference.

WARNING

IF THE mA STATION FOR FOCAL SPOT CHANGE IS NOT CONFIGURED ACCORDING TO THE X-RAY TUBE RATINGS, THE TUBE FILAMENTS MAY BE PERMANENTLY DAMAGED.

1. With the generator OFF, set dip switch 3024SW2-3 on the ATP Console CPU Board in *“**On**”* position to permit the service mode.
2. Power ON the System. Enter in calibration mode by pressing the “*Manual Calibration*” button on the GSM program. Select any workstation (WS) of the corresponding X-ray Tube and press the “*OK*” button.
3. Select the smallest mA station for the Large Focal Spot using the “*Increase*” or “*Decrease*” mA buttons. When is required to configure all mA stations for the Small Focal Spot, select “*E01*” Memory Location.

Note ☞ *Default value is factory set at 200 mA except when using X-ray Tubes with Small Focal Spot smaller than 0.6 .*

4. Press the “*Toggle*” button to store the select mA station and then press the “*Confirm*” or “*Dismiss*” buttons to confirm or cancel the process. When it is confirmed, the ATP Console CPU Board emits a “double-beep”.

WARNING

IF THE FOCAL SPOT SWITCH-OVER POINT IS CHANGED AFTER mA CALIBRATION, THE mA STATIONS AFFECTED MUST BE RE-CALIBRATED.

5. Exit from calibration mode.

Perform the following test (*it is not mandatory*).

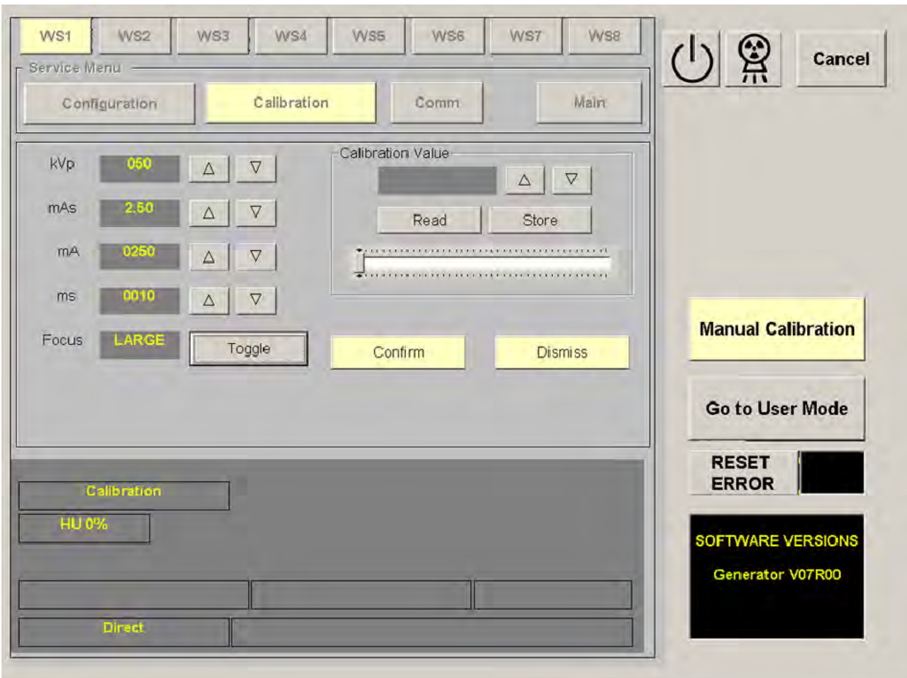
Note ☞

The test described only applies to RAD Tubes.

In case of a R&F Tube (Tube-2) both filament are always ON (lit). Select a "Direct" workstation and a mA station for the Small Filament. Press "Prep" for RAD and observe through the X-ray Tube window that the Small Filament lights more than the Large Filament.

1. Select the highest mA station for the Small Focal Spot. Verify that effectively the Small Filament is ON (lighted) and the Large Filament is OFF. Observe filaments through the X-ray tube window.
2. Select the lowest mA station for the Large Focal Spot. Verify that effectively the Large Filament is ON (lighted) and the Small Filament is OFF. Observe filaments through the X-ray tube window.
3. If required for the second tube, repeat this procedure.

Illustration 3-1
Focal Spots Configuration



SECTION 4 X-RAY TUBE DATA

The following table lists several common X-ray tubes and their corresponding number. If a specific tube is not listed, tube specifications are given to enable you chose a similar tube type. If none of the listed tubes are satisfactory, contact your generator supplier to obtain special software.

Table 4-1
X-ray Tube Numbers

TUBE NUMBER	TUBE CODE (ID)	MODEL	FOCAL SPOT	POWER RATINGS		KHU
				LS (kW)	HS (kW)	
001	139	TOSHIBA or CANON E7239X	1.0 / 2.0	22 / 45	–	133
002	201	TOSHIBA or CANON E7240X	0.6 / 1.2	15 / 30	–	140
003	140	TOSHIBA or CANON E7242X	0.6 / 1.5	18 / 49	–	187
004	090	TOSHIBA or CANON E7252X	0.6 / 1.2	15 / 42	26 / 73	300
005	412	TOSHIBA or CANON E7254FX	0.6 / 1.2	23 / 60	40 / 102	400
006	407	TOSHIBA or CANON E7884X	0.6 / 1.2	21 / 52		300
007	310	TOSHIBA or CANON E7843X	0.6 / 1.2	22 / 49	–	150
008	344	TOSHIBA or CANON E7865X	0.3 / 1.0	3 / 40	–	140
009	402	TOSHIBA or CANON E7876X	0.6 / 1.2	22 / 53		230
010	260	IAE RTM 101 HS	0.6 / 1.2	22 / 55	37 / 99	400
011	411	TOSHIBA or CANON E7886X	0.7 / 1.3	17 / 39		300
012	381	TOSHIBA or CANON E7869 X	0.6 / 1.2	21 / 55	36 / 96	600
013	404	VARIAN RAD 14	0.6 / 1.2	21 / 54	32 / 77	300
014	161	VARIAN RAD 21	0.6 / 1.2	21 / 64	36 / 100	300
015	265	VARIAN RAD 60	0.6 / 1.2	26 / 67	39 / 100	400
016	238	VARIAN RAD 74	0.6 / 1.5	20 / 52	–	200
017	252	VARIAN RAD 92	0.6 / 1.2	26 / 62	40 / 99	600
018	092	VARIAN A-192	0.6 / 1.2	25 / 63	40 / 96	300
019	309	VARIAN A196	0.6 / 1.0	20 / 47	32 / 72	350
020	094	VARIAN A-292	0.6 / 1.2	25 / 62	39 / 96	400
021	208	VARIAN G 292	0.6 / 1.2	25 / 63	39 / 95	600
022	051	GE-CGR MN 640	1.0 / 1.8	23 / 46	–	150
023	064	GE MAXIRAY-75	0.6 / 1.5	12 / 37	21 / 62	300
024	062	GE MAXIRAY-100	0.6 / 1.25	18 / 55	31 / 100	350
025	261	SIEMENS DR 154/30/50	1.2 / 1.8	31 / 53	–	200
026						
027						

Note .– Power Ratings are for 60 Hz. To calculate Power Ratings for 50 Hz multiply the values by 0.91 *TB54 (+K)*

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Technical Publication
CF-1004R6

Configuration

HF Series Generators

REVISION HISTORY

REVISION	DATE	REASON FOR CHANGE
0	APR 1, 2001	First edition
1	FEB 10, 2003	Documentation update
2	MAY 20, 2004	Documentation update
3	APR 1, 2005	Text revision
4	AUG 1, 2005	Anode Stator Configuration
5	NOV 15, 2006	Extended Memory Locations related to the Capacitor Discharge Generators
6	JUL 05, 2019	Identification of Tubes as “Toshiba or Canon”

This Document is the English original version, edited and supplied by the manufacturer.

The Revision state of this Document is indicated in the code number shown at the bottom of this page.

ADVISORY SYMBOLS

The following advisory symbols will be used throughout this manual. Their application and meaning are described below.

DANGERS ADVISE OF CONDITIONS OR SITUATIONS THAT IF NOT HEEDED OR AVOIDED WILL CAUSE SERIOUS PERSONAL INJURY OR DEATH.

ADVISE OF CONDITIONS OR SITUATIONS THAT IF NOT HEEDED OR AVOIDED COULD CAUSE SERIOUS PERSONAL INJURY, OR CATASTROPHIC DAMAGE OF EQUIPMENT OR DATA.

Advise of conditions or situations that if not heeded or avoided could cause personal injury or damage to equipment or data.

Note ☞

Alert readers to pertinent facts and conditions. Notes represent information that is important to know but which do not necessarily relate to possible injury or damage to equipment.

TABLE OF CONTENTS

SECTION 1 INITIAL CONFIGURATION PROCEDURE

Configuration provides the initial settings for extended memory and checkout procedures that must be carried out prior to making X-ray exposures. Functional characteristics of this Generator are defined at the time of installation.

Calibration and some configuration data are stored in a non-volatile memory chip (U3-EEPROM) located on the HT Controller Board in the Power Cabinet.

When the initial setup and checkout has been completed the Generator will be ready for Calibration.

Note ☞ *Record all the configuration settings in the Data Book.*

WARNING

DO NOT SUPPLY THE MAIN POWER UNTIL SPECIFICALLY INSTRUCTED TO DO SO IN THIS DOCUMENT.

THE MAIN CAPACITORS OF THE HIGH VOLTAGE INVERTER RETAIN A LARGE PORTION OF THEIR CHARGE FOR APPROX. 3 MINUTES AFTER THE UNIT IS TURNED OFF.

The Generator configuration is determined by:

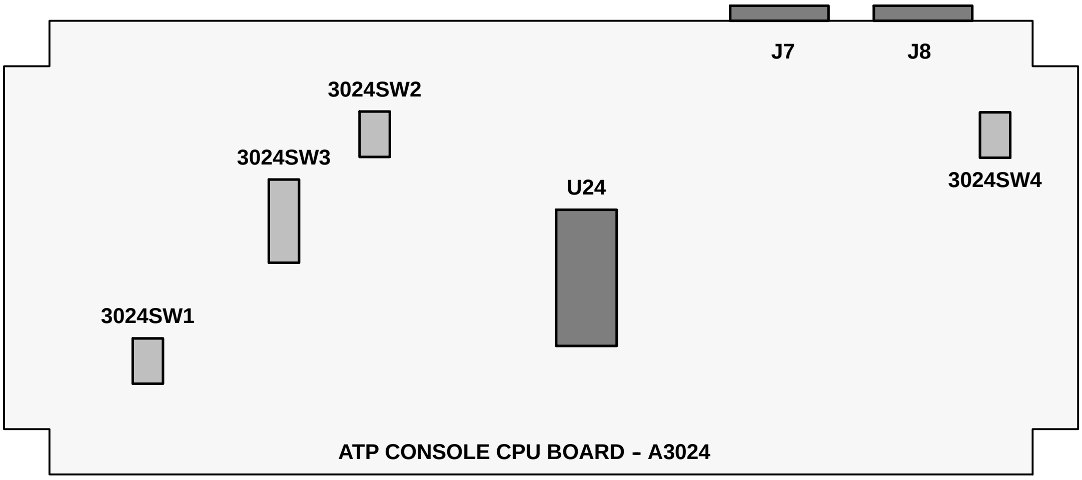
- X-ray Tube(s) number, model and use.
- System requirements (Bucky, Tomo, AEC, ...)
- Maximum kV, kW.

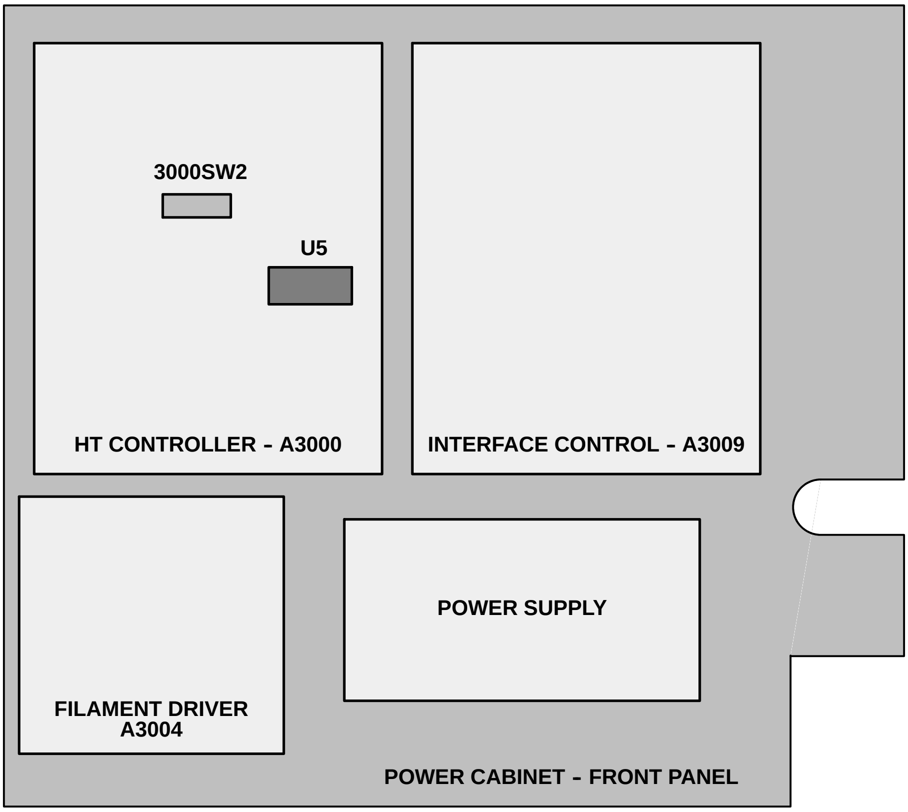
Specific versions of U24-EPROM on the ATP Console CPU Board and U5 on the HT Controller Board are based on the Generator configuration. (*Refer to Illustration 1-1*).

The system configuration and test switches are:

DIP SWITCH LOCATION	FUNCTION
3024SW1 - ATP Console CPU Board	System Configuration
3024SW2 - ATP Console CPU Board	Test
3024SW3 - ATP Console CPU Board	No used for Configuration
3000SW2 - HT Controller Board	System Configuration and Test

Illustration 1-1
EPROM and Switch locations





1.1 CONFIGURATION AND TEST SWITCHES

ATP Console Dip Switches must be configured with the Generator turned OFF, and they are read when the Generator is turned ON again.

1.1.1 3024SW1 - ATP CONSOLE CPU BOARD

Set dip switch 3024SW1 in accordance with the Table 1-1.

Table 1-1
System Configuration Dip Switch 3024SW1 on the ATP Console CPU Board

3024SW1 POSITION	OPEN (OFF)	CLOSED (ON)
1	60 Hz *1)	50 Hz *1)
2	–	**Normal** – Application mode. Exposures are inhibited when Door Interlock Switch is opened.
3	Not used. *Set in "OFF" position.*	Not used.
4	Not used. *Set in "OFF" position.*	Not used.
*Note.– *1) This switch is related with the frequency of the Rotor Controller. For Generators with High Speed Starter (LV-DRAC) or Generators Powered through Batteries with Stand-Alone set always SW1-1 to 60 Hz, in the rest of Generators set SW1-1 in accordance with the Power Line Frequency.*		

1.1.2 3024SW2 - ATP CONSOLE CPU BOARD

Set dip switch 3024SW2 verifying that each position is set as Table 1-2.

Table 1-2
Test Dip Switch 3024SW2 on the ATP Console CPU Board

3024SW2 POSITION	OPEN (OFF)	CLOSED (ON)
1	Skips reception with the HT Controller. Use only for display purposes, troubleshooting or Demo Consoles when there is no Power Module. Be sure that J3 connector is not plugged to the ATP Console CPU Board.	**Normal** – Application mode.
2	Tick Sound (button / command acknowledge) is not emitted by the ATP Console CPU Board.	Tick Sound (button / command acknowledge) is emitted by the ATP Console CPU Board.
3	**Normal** – Application mode.	**Service Mode .** In this mode and some Consoles, if the selected Focal Spot indicator is blinking it means that Generator is operating in High Speed. It will help to service engineer during Configuration and Calibration procedures.
4	kV Log (Renard) Scale Mode for kV variation (kV changes in logarithmic steps) (*if available*).	kV Lineal Scale Mode for kV variation (**Normal mode**) (kV changes one by one).

1.1.3 3024SW3 - ATP CONSOLE CPU BOARD

Dip Switch 3024SW3 is not used for configuration but all their switches must be set in "***Off***" position.

1.1.4 3024SW4 - ATP CONSOLE CPU BOARD

Dip Switch 3024SW4 is not used for configuration but all their switches must be set in "***Off***" position.

1.1.5 3000SW2 - HT CONTROLLER BOARD

HT Controller Dip Switches can be configured while the Generator is ON except Dip Switch 3000SW2-1.

Set dip switch 3000SW2 as indicated in Table 1-3.

Table 1-3
Test Dip Switch 3000SW2 on the HT Controller Board in the Power Module

3000SW2 POSITION	OPEN (OFF)	CLOSED (ON)
1	Normal.	Programming of Rotor Acceleration Time, RAD Filament Setting Time, Fluoro Rotor and Filament Hold-over Time *1) *2)
2	Normal.	Bypasses: Filament, Rotor Ready, Error E11. *1) *3)
3	Normal – Not used.	Not used.
4	Normal – Digital mA Loop Closed	Digital mA Loop Open / Filament Current Constant *1)
5	125 kV *4)	150 kV *4)
6	All Generators except Tube-2 for RAD	Generators with Tube-2 for RAD only.
7	Filament Boosting for Tube–1	No Filament Boosting for Tube–1 *5)
8	Filament Boosting for Tube–2	No Filament Boosting for Tube–2 *5)

*Notes.– *1) Set in Closed (On) position only when indicated in the Service Manual.*

**2) Note that SW2-1 in Closed (On) position is only set to program the Rotor Acceleration Time, Rad Filament Setting Time, Fluoro Rotor and Filament Hold-over Time, therefore it changes the functions of Switches SW2-2 and SW2-4 to SW2-8. Refer to Section 3.*

**3) This turns off the filaments so no radiation will be produced during the exposure.*

WARNING: THE kV OUTPUT OF THE HV TRANSFORMER WILL BE WHATEVER IS SET BY THE CONSOLE. IF THE X-RAY TUBE HV CABLES ARE NOT CONNECTED INTO THE HV TRANSFORMER, FILL COMPLETELY BOTH HV RECEPTACLES WITH HV OIL.

**4) Set SW2-5 according to the Generator kV rating (refer to the Generator model and/or specifications).*

5)* ***Set to "No Filament Boosting" when using X-ray Tubes with Small Focal Spot smaller than 0.6 .*

1.2 BASIC CONFIGURATION OF GENERATOR BOARDS

The following Jumpers are factory set or removed to configure the Generator Boards according to the customer order. Check the jumper positions in the Generator Boards.

GENERATOR BOARDS	JUMPERS POSITION
HT CONTROLLER	JP1 and JP2 in “2”
	JP3, JP5 and JP6 in “2” and JP4 in “1” : for Compact Generators. JP3, JP5 and JP6 in “1” and JP4 in “2” : for Vertical Generators.
FILAMENT CONTROL	W1 in “A”
INTERFACE CONTROL	W1 in “2–3”
	W2 in “1–2”
	W3 to W10 in “A” : for positive High Voltage supply for Ion Chamber W3 to W10 in “B” : for negative High Voltage supply for Photomultiplier Tube
ATP CONSOLE CPU	JP1, JP2 and JP3 in “B” (soldered)
	JP4 in “B” (Cam-Sync)
	JP5 in “B” : Standard JP5 in “C” : for R&F / DSI Generators with AEC Control Board A3012–02/05
	JP6 in “A” (soldered)
	Connector J8 configured for RS232 so: JP9, JP10 and JP11 in “A”. JP7, JP8, JP21 and JP22 do not matter jumpers position
	JP12 removed
	JP13 installed (set) : if AEC Control Board A3012–xx is installed JP13 removed : if AEC Control Board A3012–xx is not installed
	JP14 installed (soldered)
	JP15, JP16, JP17 and JP18 removed
	JP19 in “A” (soldered)

1.3 AEC CONFIGURATION

Configure the following Jumpers on the "*AEC Control Board*" (located over the "*ATP Console CPU Board*") and on the "*AEC Adaptation Board*" when this option is installed in the Generator Cabinet.

AEC CONTROL BOARD (A3012–01/02/05)

JUMPER			DESCRIPTION
JP1	A B C	FOR TV CAMERA FOR PHOTOMULTIPLIER FOURTH ION CHAMBER & ATS–DIG	A3012-05: JP1-C, JP2-A AND JP4-B FOR FOURTH ION CHAMBER & ATS–DIG A3012-02: JP1-A, JP2-A AND JP4-A FOR ABC WITH TV CAMERA A3012-01: JP1-B, JP2-B AND JP4-A FOR ABC WITH PHOTOMULTIPLIER
JP2	A B	FOR TV CAMERA FOR PHOTOMULTIPLIER	
JP4	A B	FOR PHOTOMULTIPLIER – AEC FOR ION CHAMBER – AEC & ATS–DIG	
JP3	A B	FOR HIGH SENSITIVITY FOR LOW SENSITIVITY	JP3-A FOR AEC WHEN USING ION CHAMBER WITH HIGH SENSITIVITY JP3-B FOR AEC WHEN USING ION CHAMBER WITH LOW SENSITIVITY
NOTE:		*HIGH SENSITIVITY IS > 2 V / mR (> 0.223 V / μGy) (a.e. Vacutec Ion Chamber)* *LOW SENSITIVITY IS < 2 V / mR (< 0.223 V / μGy) (refer to Ion Chamber documentation)*	

AEC CONTROL BOARD (A3012–06/07/09)

JUMPER			DESCRIPTION
JP1	A B C	FOR TV CAMERA FOR PHOTOMULTIPLIER EXTERNAL kV CONTROL	JP1-A FOR ABC WITH TV CAMERA JP1-B FOR ABC WITH PHOTOMULTIPLIER JP1-C FOR ABC WITH EXTERNAL kV UP & DOWN CONTROL
JP2	A B	FOR HIGH SENSITIVITY FOR LOW SENSITIVITY	JP2-A FOR AEC WHEN USING ION CHAMBER WITH HIGH SENSITIVITY JP2-B FOR AEC WHEN USING ION CHAMBER WITH LOW SENSITIVITY
JP3	B	FOR NORMAL OPERATION	JP3-B FOR NORMAL OPERATION
JP4	A	FOR NORMAL OPERATION	JP4-A FOR NORMAL OPERATION (Only in A3012-06)
NOTE:		*HIGH SENSITIVITY IS > 2 V / mR (> 0.223 V / μGy) (a.e. Vacutec Ion Chamber)* *LOW SENSITIVITY IS < 2 V / mR (< 0.223 V / μGy) (refer to Ion Chamber documentation)*	

AEC ADAPTATION BOARD (A3263-03)

ION CHAMBER TYPE	JUMPERS POSITION		
	JP3, JP4, JP7, JP8	JP1, JP2, JP5, JP6	JP13, JP14, JP15, JP16
IC1 = IC2 = IC3 = IC4 *(Default)*	B	B	B
IC1 = IC2 = IC3	B	B	A
IC1 = IC2	B	A	A
IC1 ≠ IC2 ≠ IC3 ≠ IC4	A	A	A

ION CHAMBER OUTPUT	JUMPERS POSITION			
	JP9 (IC1)	JP10 (IC2)	JP11 (IC3)	JP12 (IC4)
NO-OFFSET ADJUSTMENT *(Default)*	A	A	A	A
OFFSET ADJUSTMENT	B	B	B	B
TEST POINT AND POTENTIOMETER (ONLY IF JUMPER IS IN "B" POSITION)	TP1 – R11	TP2 – R8	TP4 – R2	TP12 – R5

1.4 FLUORO CONFIGURATION

Fluoro configuration depends on position of jumpers W1 and W2 in the "*Fluoro CPU Board*" and jumper JP4 in the "*Console CPU Board*", as indicated below:

JUMPERS IN FLUORO CPU BOARD (A3213-XX)	INSERTED	REMOVED
W1	ABC not enable	ABC enable
W2	Always inserted (installed)	

JUMPERS IN ATP CONSOLE CPU BOARD (A3024-XX)	
JP4	Always in "B" position – Camera

Also, configure the following Jumpers on the optional "*RF Adaptation Board*".

RF ADAPTATION BOARD (A3514-04)

JUMPER	POSITION	FUNCTION
JP1, JP3, JP4, JP8, JP9, JP10, JP12, JP13, JP14	Set all jumpers	+24 VDC for the inputs PREP ORDER, RAD ORDER, and FLUORO ORDER
	Remove all jumpers	230 VAC for the inputs PREP ORDER, RAD ORDER, and FLUORO ORDER
	Set only JP1, JP8 and JP12	115 VAC for the inputs PREP ORDER, RAD ORDER, and FLUORO ORDER
JP2	Set	Generator +24 VDC for PREP / RAD / FLUORO ORDER
	Removed	External supply for PREP / RAD / FLUORO ORDER
JP5	A	ZOOM 1 output selected from Generator (-9 IN SEL)
	B	ZOOM 1 output selected from Table or external control
JP6	A	ZOOM 2 output selected from Generator (-6 IN SEL)
	B	ZOOM 2 output selected from Table or external control
JP7	A	ZOOM 3 output selected from Generator (-4 IN SEL)
	B	ZOOM 3 output selected from Table or external control
JP11	A	LIH output through a N.O. contact
	B	LIH output through a N.C. contact
JP15	A	LIH output selected from an external enable signal
	B	LIH output selected for Last Image Hold function
JP16	A	EXP ON/END output active for only RAD exposure
	B	EXP ON/END output active for Fluoro and RAD exposure
JP17	A	For EXP ON output active along the RAD exposure
	B	For EXP END output active about 50 ms pulse at the end of the RAD exposure
JP18	A	For ABC Window adjustment
	B	For normal operation
JP19	A	Pulsed Fluoro sync. activated with the negative edge of Exp. Sync+
	B	Pulsed Fluoro sync. from composite video signal (video in)
	C	Pulsed Fluoro sync. activated with the positive edge of Exp. Sync+
JP20	A	For ABC OUT signal from composite video signal (video in)
	B	For ABC OUT signal from a negative external ABC signal
	C	For ABC OUT signal from a positive external ABC signal
JP21	A	ABC OUT signal generated from composite video signal or external ABC signal
	B	ABC OUT signal coming directly from the Image System
JP22	Set	ABC OUT signal generated from composite video signal or external ABC signal
	Removed	ABC OUT signal coming directly from the Image System
JP23	Set	Normal position (composite video signal referenced to the Generator ground)
	Removed	To reduce noise (composite video signal isolate from Generator ground)
JP24	A	Normal position (Fluoro order from the Table sent directly to the Generator)
	B	For Fluoro order enable (Fluoro order from the Table sent to the Image System)

1.5 WORKSTATIONS CONFIGURATION

The workstations can be configured according to the customer preferences or default.

Each combination of Tube / Device / Ion Chamber is associated to one workstation in the system. If during the system configuration some push-button has not been related to one workstation (*value "Tube – 0"*), these push-buttons won't be able to be selected during operation.

The different combinations of X-ray Tubes, Devices, Ion Chambers and kV Tracking (optional) are configured from the Console as described below:

CUSTOMIZED CONFIGURATION

Note — *This procedure has to be performed always that "ATP Console CPU Board" is replaced by a new one.*

1. With the Generator OFF, set dip switch 3024SW2-3 on the ATP Console CPU Board in *"**On**"* position to permit the service mode.

2. In accordance with the Console model, enter in configuration mode by holding pressed the "*ON*" push-button and then simultaneously press "*+2*" and "*–2*" density (*or "Slow" and "Fast" Film/Screen*) push-buttons, until all the workstations push-buttons are illuminated.

3. Select the first workstation to be configured, by pressing the respective push-button or combination of push-buttons, only these push-buttons blink and the Console shows one of the following values:

DISPLAY	FUNCTION	VALUE	DESCRIPTION
1st Value	**TUBES**	0	No-configured workstation
		1	Tube-1
		2	Tube-2
2nd Value	**DEVICES – WORKING MODE**	0 – Direct	Direct (No Bucky)
		1 – Bucky 1	Bucky-1
		2 – Bucky 2	Bucky-2
		3 – STD Tomo	Standard Tomo *1)
		4 – STD RF	Standard RF (Spot Film Device)
		5 – DSI	Digital RAD and Fluoro *2)
		6 – Cine	Cine *2)
		7 – DSA	DSA *2)
3rd Value	**ION CHAMBERS**	0	No AEC
		1	Ion Chamber-1 (IC-1)
		2	Ion Chamber-2 (IC-2)
		3	Ion Chamber-3 (IC-3)
		4	Ion Chamber-4 (IC-4)
		5	Photomultiplier (PT-INPUT)
4th Value	**kV TRACKING (OPTIONAL)**	1	Formula-1
		2	Formula-2
		3	Formula-3
		4	Formula-4
		5	Formula-5
		6	Formula-6
		7	Formula-7
		8	Formula-8

Notes:

– Some of listed values are not configurable depending on the Generator model .

**1) Only when the Tomo is controlled from the Generator. In this case, the workstation has to be configured as Tube “1” or “2”, Device “STD Tomo” and Ion Chamber “0”.*
If the Tomo is controlled from the Table, the workstation has to be configured as Tube “2”, Device “STD RF” and Ion Chamber “0”.

**2) These Devices are only available for Generators provide with interface option for Digital Systems. These workstations has to be configured as Tube “2”.*

4. Set the new value by pressing the corresponding “*Increase*” or “*Decrease*” push-buttons.

Note ☞ *In some Consoles, “No Bucky” is selected when neither of the “Bucky” nor “Tomo” push-buttons are selected.*

5. Select the next workstations to be configured and set the respective values of each one.

6. Exposures made from workstations configured with:

   - Device "*Direct (No Bucky), Bucky-1, Bucky-2* and *Standard Tomo*" are **only enabled** with the internal "*Preparation*" and "*Exposure*" signals controlled by the Handswitch or Rad Footswitch.

   - Device "*Standard RF*" and "*DSI*" are **only enabled** with the external signals for "*Preparation*", "*RAD Exposure*" and "*Fluoro Exposure*". **Fluoro can only be made from this Device selection.**

   - Device "*Infimed: DSI, Cine, DSA*" are **only enabled** with the external "*Digital Preparation*" and "*Exposure*" signals connected to Terminal Block 4TS3 of the Generator Cabinet.

7. Select one of the workstation configured as available and in accordance with the Console model exit configuration mode by simultaneously pressing "*+2*" and "*–2*" (*or "Slow" and "Fast" Film/Screen*) push-buttons, then a double-bip will sound and the Console go on with the starting process.

Note ☞

1) Optional "Tomo / Bucky Adaptation Board" (in the Power Cabinet) is required to configure more than two Buckys or one Tomo Device in the system.

For system without the optional "Tomo / Bucky Adaptation Board", it can only work directly with two Buckys, and the value assigned to them must be "1" and "2" in the second value.

2) TOMO must be always related to Bucky-1. Only one TOMO can be used in the system, so only one of the workstations should be configured with the value "3" in the second value.

3) Optional "AEC Control Board" (connected to the Console CPU Board) is required to configure any Ion Chamber.

Optional "AEC Adaptation Board" is required to configure any no-standard or more than one Ion Chambers in the system.

DEFAULT CONFIGURATION

Default configuration sets some default values to each workstation. It only should be used to re-initialize the workstation configuration when the complete configuration has been lost or it is not possible to select any workstation.

1. With the Generator OFF, set dip switch 3024SW2-3 on the ATP Console CPU Board in *“**On**”* position to permit the service mode.

2. In accordance with the Console model, enter in configuration mode by holding pressed the “*ON*” push-button and then simultaneously press “*+2*” and “*-2*” density (*or “Slow” and “Fast” Film/Screen*) push-buttons, until all the workstations push-buttons are illuminated.

3. Press the “*AEC Reset*” push-button once, and in accordance with the Console model exit configuration mode by simultaneously pressing “*+2*” and “*-2*” (*or “Slow” and “Fast” Film/Screen*) push-buttons, then a double-bip will sound and the console go on with the starting process.

4. It is recommended to perform a proper configuration of each workstation in the system after a default configuration.

SECTION 2 EXTENDED MEMORY SETTING

2.1 EXTENDED MEMORY LOCATIONS

Miscellaneous configuration and calibration data are stored in the Extended Memory Locations. It is recommended to note the values factory stored in each Memory Location. (*Refer to Table 2-1*)

Note ☞ *For generators with only one Radiographic X-ray Tube, this tube have to be configured, calibrated and used as Tube-1.*

Note ☞ *For generators with a Fluoroscopic X-ray Tube or DSI (Digital RAD), this tube have to be configured, calibrated and used as Tube-2.*

For these generators, the value of the E17 Memory Location is not readable as "Tube-2 – Filament stand-by (Autocalibrated)".

Note ☞ *Generators with a single X-ray Tube for Fluoroscopy / Spot Film / DSI (Digital RAD) require to store the respective values of the Memory Locations:*

- *E17: Tube-2 – Fluoro filament setting.*
- *E18: Tube-2 – Fluoro tube type.*
- *E29 and E31: Tube-2 – Exposure Time adjustments.*
- *Other required Memory Locations.*

Table 2-1
Extended Memory Locations

MEMORY LOCATION	FUNCTION	VALUE
E01	TUBE-1 – RAD filament stand-by (*Autocalibrated. Not field changeable*)	
E02	TUBE-1 – RAD Tube type	
E03	Low Digital mA Loop Closed (from 10 mA to 80 mA)	
E04	AEC-1 calibration	
E05	High Digital mA Loop Closed (from 100 mA)	
E06	kV Loop	
E07	Maximum kW *(Factory set. Only field changeable to lower value)*	
E08	AEC-1 tracking	
E09	AEC-2 calibration	
E10	AEC-2 tracking	
E11	AEC Compression Device - Time adjustment	
E12	AEC Density Scale	
E13	TUBE-1 – Exposure Time adjustment - Delay	
E15	TUBE-1 – Exposure Time adjustment - Ceq kV	
E17	TUBE-2 – RAD filament stand-by (*Autocalibrated. Not field changeable*)	
	TUBE-2 – FLUORO filament setting *1)*	
E18	TUBE-2 – RAD or FLUORO Tube type	
E19	Maximum FLUORO kV	
E20	AEC-3 calibration	
E23	AEC-4 calibration / Photomultiplier AEC calibration (SF camera)	
E24	AEC-3 tracking / AEC-4 tracking (equal value for both)	
E25	FLUORO mA display calibration at 50 kV	
E26	FLUORO mA display calibration at 80 kV	
E27	FLUORO mA display calibration at 120 kV	
E29	TUBE-2 – Exposure Time adjustment - Delay	
E31	TUBE-2 – Exposure Time adjustment - Ceq kV	
E67	Number of Storage Capacitors *2)*	
E68	Nominal Line Voltage *2)*	
E69	Maximum Line Current *2)*	

** Notes: Memory Locations not listed are not used.*
1) For Fluoroscopic use, value in E17 means “Fluoro filament setting” and must be manually set
2) This Extended Memory Location only applies to the Capacitor Discharge Generator.

2.2 HOW TO ENTER AND STORE DATA IN THE EXTENDED MEMORY

The Extended Memory data are entered from the Console when the unit is in service mode. Access to memory locations as indicated below:

1. Turn the Generator OFF and set the Test dip switch 3024SW2-3 on the ATP Console CPU Board in *"**On**"* position to permit the service mode.

2. Turn the Generator ON by pressing the *"Power On"* push-button on the Console.

3. In accordance with the Console model, enter calibration mode by simultaneously pressing "*+2*" and "*–2*" density *(or "Slow" and "Fast" Film/Screen)* push-buttons. The indicator lamp for the selected workstation will be flash confirming that the Generator is in the calibration mode.

Note ☞ *In calibration mode, only the kV and mA parameters can be modified, values for Time and mAs are factory programmed.*

4. Increase the mA value beyond the maximum mA position, one step for each of the memory locations. The mA Display will show the first Extended Memory location (E01), they will continue sequentially as the "*Increase mA*" push-button is pressed.

   The values stored in each location are displayed on the kV Display after pressing the "*AEC Reset*" push-button or after pressing the "*+1*" or "*–1*" *(or "Increase" and "Decrease")* density push-buttons. Since these push-buttons are also used to increase or decrease the stored values one number should be added or subtracted from the reading to obtain the stored value.

5. Select the new value by pressing "*+1*" or "*–1*" *(or "Increase" and "Decrease")* density push-buttons. Each time these push-buttons are depressed the displayed value (on the kV Display) is increased or decreased one step.

6. Store the new value by pressing the "*AEC Reset*" push-button (Check-summ function).

Note ☞ *If the "AEC Reset" push-button is not pressed after a new value is selected, no modified data will be retained and the kV Display reverts to either the selected kV value or the original data.*

7. Exit calibration mode by simultaneously pressing "*+2*" and "*–2*" *(or "Slow" and "Fast" Film/Screen)* push-buttons.

8. Turn the Generator OFF and set Test dip switch 3024SW2-3 on the ATP Console CPU Board in *"**Off**"* position to place the Generator in normal mode.

2.3 LIMIT OF MAXIMUM kW

The Maximum kW of the Generator is factory set according to the Generator performance. Generator kW can be limited to a lower value.

Note ☞ *This limit can be set to a lower value to match the maximum Generator power to the Line power, due to a high line impedance (refer to Pre-installation document).*

1. Enter calibration mode.
2. Select the E07 Memory Location (memory location is shown on the mA Display).
3. Set the new limit of Maximum kW by pressing the "*+1*" or "*–1*" *(or "Increase" and "Decrease")* density push-buttons until the correct number is showed in the kV Display.
4. Store the new value by pressing the "*AEC Reset*" push-button.
5. Exit from calibration mode.

Note ☞ *Record configuration data for E07 in the Data Book.*

2.4 EXTENDED MEMORY LOCATIONS RELATED TO THE CAPACITOR DISCHARGE GENERATOR

The values entered into the Extended Memory Locations **E67**, **E68** and **E69** ensure optimal performance of the Capacitor Discharge Generator. These values are factory set, but they must be checked by the field engineer during installation / configuration of the Generator according to the Line Voltage (E68) and Line Current (E69) of the installation site.

The correct configuration of these Extended Memory Locations and the Jumper set on the Capacitor Charger Board (A3517–xx) will prevent that the Error Code "*E13*" from appearing during operation.

EXTENDED MEMORY LOCATION E67: NUMBER OF CAPACITORS

The value entered into the Extended Memory Location **E67** must be the same as the physical count of the Capacitors in the equipment: **6 , 8 or 10.**

EXTENDED MEMORY LOCATION E68: NOMINAL LINE VOLTAGE

The value entered into the Extended Memory Location **E68** must be set according to the Nominal Line Voltage from the Room Electrical Supply to which the equipment is connected: **100 , 110 , 120 , 208 , 230 or 240 VAC.**

EXTENDED MEMORY LOCATION E69: MAXIMUM LINE CURRENT

The value entered into the Extended Memory Location **E69** must coincide with the value of the Jumper (J2 / J3 / J4 / J5 / J6) set on the Capacitor Charger Board (A3517–xx) during the installation of the Generator: **20 , 16 , 12 , 10 or 8 A.**

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SECTION 3 X-RAY TUBE SELECTION

3.1 X-RAY TUBE INSERT PROTECTION CURVES

In order to properly select the X-ray Tube Insert Protection Curves for the Tubes connected to the Generator, perform the following procedure:

1. Select one workstation of the corresponding X-ray Tube to be configured.
2. Enter in calibration mode.
3. Select the respective memory location, E02 for Tube-1 or E18 for Tube-2 (memory location is shown on the mA Display).
4. Identify in Section 4 "*X-ray Tube Data*", the X-ray Tube that is being installed and note its Tube type number.
5. Set the Tube number by pressing "*+1*" or "*–1*" *(or "Increase" and "Decrease")* density push-buttons until the correct number is showed in the kV Display.
6. Store the value by pressing the "*AEC Reset*" push-button.
7. Verify that the Tube code (ID) showed in the mAs Display is the same of the Tube code listed in Section 4 "*X-ray Tube Data*". The Tube code (ID) can be only read for the selected X-ray Tube after pressing the "*AEC Reset*" push-button.
8. If required, repeat this procedure for the other X-ray Tube.
9. Exit calibration mode.

Note ☞ *Record configuration data for E02 and E18 in the Data Book.*

3.2 GENERATORS WITH LF-RAC (LOW SPEED STARTER)

3.2.1 STATOR VOLTAGE AND CAPACITOR SELECTION

Check that the capacitor value of the Low Speed Starter corresponds to the value recommended by the X-ray Tube manufacturer. If needed replace the capacitor. Also, the Rotor speed must be indicated by the manufacturer.

The DC Brake of the Low Speed Starter (LF-RAC) can be removed by desoldering CR6 on the LF-RAC Board (*refer to schematic 543020xx*). In this case, the Tube will remain coasting after releasing the "*Prep*" or the "*Fluoro*" order.

3.2.1.1 CONFIGURATION FOR ONE OR TWO TUBES WITH STANDARD STATOR

Voltage and capacitor is factory set to 220 VAC, 30 μF. In all cases, refer to X-ray Tube Product Data.

3.2.1.2 CONFIGURATION FOR ONE OR TWO TUBES WITH THE SAME STARTING VOLTAGE AT 110 VAC

When the stator requires a starting voltage of 110 VAC (a.e. X-ray Tube Toshiba or Canon E7239 / E7240 / E7242 / E7252 / E7299 / E7813 / E7865) perform the following modifications:

- If the Power Input Transformer 6T2 is for using with power lines up to 240 VAC (part number 50509030), remove the wire labelled as "4" that is connected to Terminal 4 (230 VAC RTR) and connect it to Terminal 3 or 8 (110 VAC).
- If the Power Input Transformer 6T2 is for using with power lines up to 530 VAC (part number 50509029), remove the wire labelled as "4" that is connected to Terminal 4 (230 VAC RTR) and connect it to Terminal 40 (110 VAC).
- For X-ray Tube Toshiba or Canon E7252 or E7813 (or when it is required) replace also the Fuse F1 (6A) on the LF-RAC Board by another fuse of 10 A.

These changes affect to all the Tubes connected to Generator.

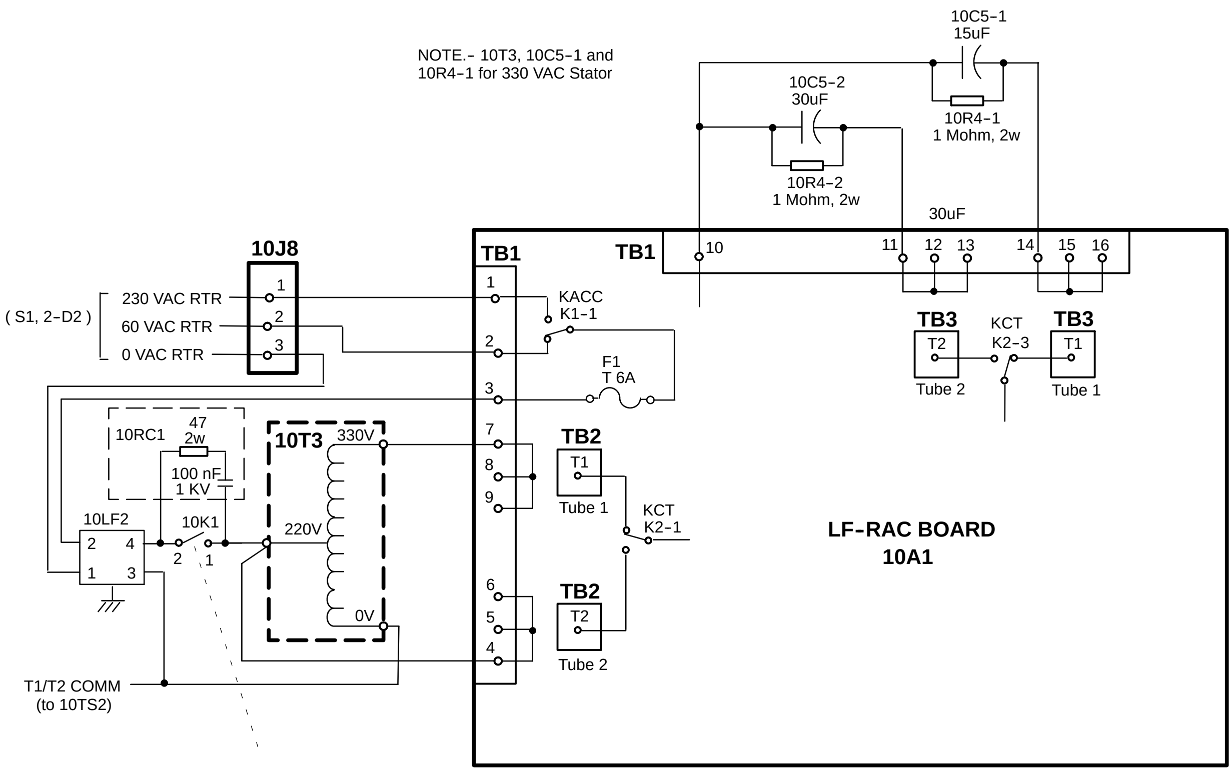
3.2.1.3 CONFIGURATION FOR TWO TUBES WITH DIFFERENT STARTING VOLTAGE AND CAPACITOR OR ONE TUBE WITH STARTING VOLTAGE AT 330 VAC

For Generators equipped with a LF-RAC module for two X-ray Tubes, with possible selection of voltage and capacitor jumpers on the LF-RAC Board, set jumpers according to the respective X-ray Tube(s) as indicated below.

TWO TUBES WITH STARTING VOLTAGE AT 220 VAC AND 330 VAC OR ONE TUBE WITH STARTING VOLTAGE AT 330 VAC

(A "Kit of 330 VAC" is required with this configuration).

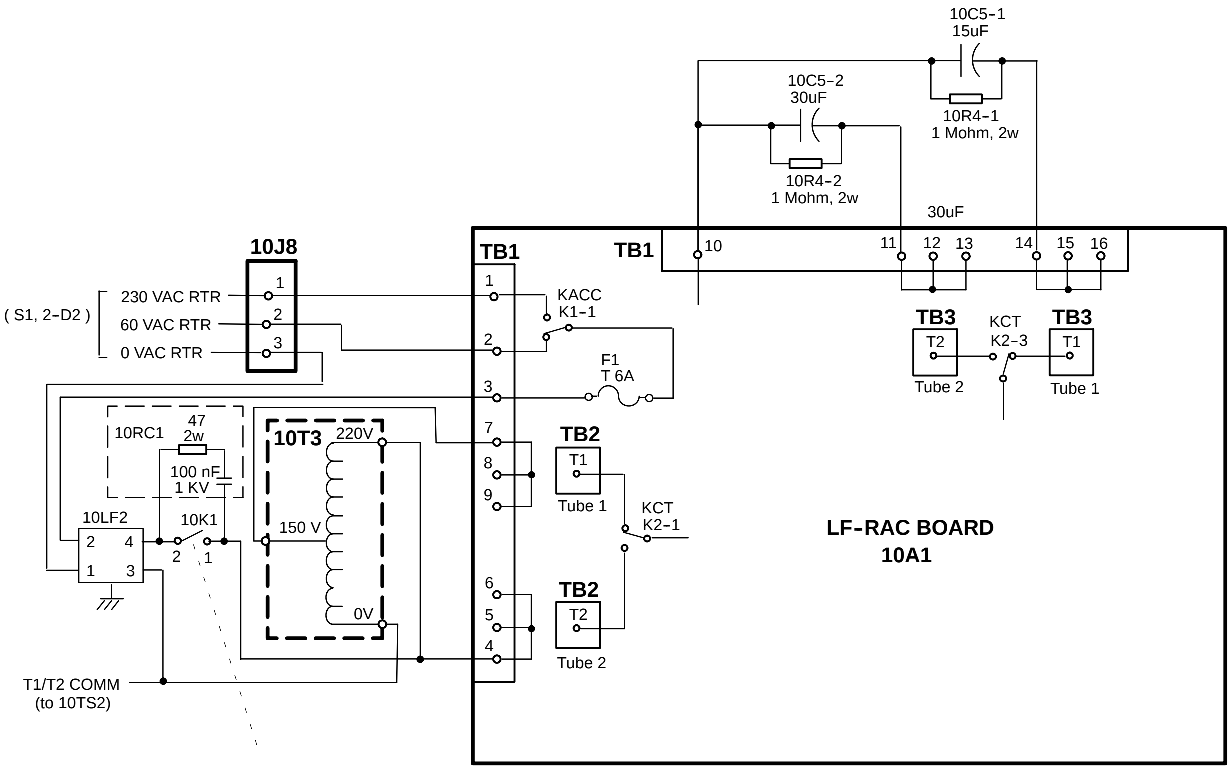
		TUBE-1	TUBE-2
VOLTAGE	220 VAC	TB2-T1 with TB1-5 or TB1-6	TB2-T2 with TB1-5 or TB1-6
	330 VAC	TB2-T1 with TB1-8 or TB1-9	TB2-T2 with TB1-8 or TB1-9
CAPACITOR	30 µF	TB3-T1 with TB1-12 or TB1-13	TB3-T2 with TB1-12 or TB1-13
	15 µF	TB3-T1 with TB1-15 or TB1-16	TB3-T2 with TB1-15 or TB1-16



TWO TUBES WITH STARTING VOLTAGE AT 220 VAC AND 110 VAC

(A "Kit of 110 VAC" is required with this configuration).

		TUBE-1	TUBE-2
VOLTAGE	**220 VAC**	TB2-T1 with TB1-5 or TB1-6	TB2-T2 with TB1-5 or TB1-6
	150 VAC	TB2-T1 with TB1-8 or TB1-9	TB2-T2 with TB1-8 or TB1–9
CAPACITOR	**30 µF**	TB3-T1 with TB1-12 or TB1-13	TB3-T2 with TB1-12 or TB1-13
	15 µF	TB3-T1 with TB1-15 or TB1-16	TB3-T2 with TB1-15 or TB1-16



3.2.2 PROGRAMMING OF ROTOR ACCELERATION TIME, RAD FILAMENT SETTING TIME, FLUORO ROTOR AND FILAMENT HOLD-OVER TIME

CAUTION

Rotor Acceleration Time is determined by the X-ray Tube and Rotor characteristics and it must be considered when the Generator is about to be configured. X-ray Tube could be permanently damaged unless the required RPM are reached before an exposure. (Refer to technical information of the X-ray Tube).

Dip Switch 3000SW2 on the HT Controller Board is used to program:

- *Rotor Acceleration Time*. That depends on stator voltage, stator frequency, stator type, quality of X-ray tube bearings, and X-ray tube anode size. A reed tachometer or a stroboscope can be used to determine the anode RPM. Be sure that the Rotor Acceleration Times meet all requirements for anticipated customer applications.

  This value is programmable from 0.8 to 2.7 seconds. After this time the Rotor is hold running in maintaining mode as long as "*Prep*" is active.

- *Rad Filament Setting Time*. This parameter has the same configuration value than the Rotor Acceleration Time. Sometimes, if it is required to increase the Rad Filament Setting Time to the next value, configure the respective switches again. This adjustment avoids Error-12.

- *Fluoro Rotor Hold-over Time and Fluoro Filament Hold-over Time*. This value can be programmed to run for 1 minute or not at all, after releasing the Fluoro Pedal.

Note ☞

The Rotor Acceleration Time and Rad Filament Setting Time is factory set to 1.8 seconds. The Fluoro Rotor Hold-over Time and Fluoro Filament Hold-over Time is factory set to 1 minute. Maintain this value when it is unknown or not provided with the X-ray Tube documentation.

1. Turn the Generator OFF and note current settings of the dip switch 3000SW2 on the HT Controller Board.

Note ☞

Configuration of these times are only allowed when dip switch 3000SW2-1 is in "Closed" (On) position after power the Generator OFF and back ON again.

2. Set dip switches 3000SW2-1 and 3000SW2-2 as indicated below, in order to enable the selection of times with the Low Speed Starter. ***Dip switch3000SW2-1 has to be switched ONLY with the Generator powered OFF.***

3000SW2-1 (selection enable)	3000SW2-2 (Low Speed Starter)
ON	OFF

3. Configure the Rotor and Filament Times by setting the dip switches 3000SW2-4 through 3000SW2-8 per Table 3-1.

Table 3-1
Low Speed: Configuration of Rotor and Filament Times

TUBE-1 ROTOR ACCELERATION TIME AND FILAMENT SETTING TIME	3000SW2-7		3000SW2-8	
	OPEN (OFF)	CLOSED (ON)	OPEN (OFF)	CLOSED (ON)
0.8 seconds		❑		❑
1.2 seconds	❑			❑
1.8 seconds		❑	❑	
2.7 seconds	❑		❑	

TUBE-2 ROTOR ACCELERATION TIME AND FILAMENT SETTING TIME	3000SW2-5		3000SW2-6	
	OPEN (OFF)	CLOSED (ON)	OPEN (OFF)	CLOSED (ON)
0.8 seconds		❑		❑
1.2 seconds	❑			❑
1.8 seconds		❑	❑	
2.7 seconds	❑		❑	

FLUORO ROTOR AND FILAMENT HOLD-OVER TIME	3000SW2-4	
	OPEN (OFF)	CLOSED (ON)
After releasing the Fluoro Pedal, the Rotor stops and the Filament Current goes back to stand-by.		❑
After releasing the Fluoro Pedal, 1 minutes passes before the Rotor stops and the Filament Current goes back to stand-by.	❑	

Note ☞ *Record the switch configuration in the Data Book.*

4. To validate previous configuration, turn the Generator ON, wait until Error–01 (E01) appears on the Console and turn the Generator OFF.

5. Set dip switch 3000SW2 to the original settings as noted in step-1. (*Refer to Section 1.1.5 for the normal settings of Dip Switch 3000SW2*).

3.3 GENERATORS WITH LV-DRAC (HIGH SPEED STARTER)

3.3.1 ANODE STATOR SELECTION

For Generators with High Speed Starter, **configure NOW** the X-ray Tube Family (anode stator + insert) by setting the respective dip switches 3243SW1 (pos. 4 to 8) and / or 3243SW2 (pos. 4 to 8) on the Control DRAC Board. (*Refer to "LV-DRAC - Digital Rotating Anode Controller" document*).

Configuration of these dip switches automatically determines the appropriate Starting and Running Stator Voltage and Rotor Acceleration Time of the selected Tube Family.

3.3.2 PROGRAMMING OF RAD FILAMENT SETTING TIME AND FLUORO FILAMENT HOLD-OVER TIME

Note ☞

With High Speed operation:

– Rotor Acceleration Time is related to the X-ray Tube Family configured on the Control DRAC Board (LV-DRAC).

– Fluoro and Spot Film Rotor Hold-over Times are configured on the Control DRAC Board (LV-DRAC).

– Rad Filament Setting Time and Fluoro Filament Hold-over Time are configured with dip switch 3000SW2 per this instruction.

Dip Switch 3000SW2 on the HT Controller Board is used to program:

- *Rad Filament Setting Time*. This value is programmable from 0.8 to 2.7 seconds. It can be initially set as the same value assigned for the Rotor Acceleration Time *(refer to technical information of the X-ray Tube)*

  Sometimes, if it is required to increase the Rad Filament Setting Time to the next value, configure the respective switches again. This adjustment avoids Error-12.

- *Fluoro Rotor Hold-over Time and Fluoro Filament Hold-over Time*. This value can be programmed to run for 1 minute or not at all, after releasing the Fluoro Pedal.

Note ☞ *The Rad Filament Setting Time is factory set to 1.8 seconds. The Fluoro Filament Hold-over Time is factory set to 1 minute. Maintain this value when it is unknown or not provided with the X-ray Tube documentation.*

1. Turn the Generator OFF and note current settings of the dip switch 3000SW2 on the HT Controller Board.

Note ☞ *Configuration of these times are only allowed when dip switch 3000SW2-1 is in "Closed" (On) position after power the Generator OFF and back ON again.*

2. Set dip switches 3000SW2-1 and 3000SW2-2 as indicated below, in order to enable the selection of times with the High Speed Starter. ***Dip switch3000SW2-1 has to be switched ONLY with the Generator powered OFF.***

3000SW2-1 (selection enable)	3000SW2-2 (High Speed Starter)
ON	ON

3. Configure the Filament Setting Times by setting the dip switches 3000SW2-4 through 3000SW2-8 per Table 3-2. The Filament Setting Time should be configured in accordance to Rotor Acceleration Time of the X-ray Tube.

Table 3-2
High Speed: Configuration of Filament Setting Time

TUBE-1 FILAMENT SETTING TIME	3000SW2-7		3000SW2-8	
	OPEN (OFF)	CLOSED (ON)	OPEN (OFF)	CLOSED (ON)
0.8 seconds		❑		❑
1.2 seconds	❑			❑
1.8 seconds		❑	❑	
2.7 seconds	❑		❑	

TUBE-2 FILAMENT SETTING TIME	3000SW2-5		3000SW2-6	
	OPEN (OFF)	CLOSED (ON)	OPEN (OFF)	CLOSED (ON)
0.8 seconds		❑		❑
1.2 seconds	❑			❑
1.8 seconds		❑	❑	
2.7 seconds	❑		❑	

FLUORO FILAMENT HOLD-OVER TIME	3000SW2-4	
	OPEN (OFF)	CLOSED (ON)
After releasing the Fluoro Pedal, the Filament Current goes back to stand-by.		❑
After releasing the Fluoro Pedal, 1 minutes passes before the Filament Current goes back to stand-by.	❑	

Note ☞ *Record the switch configuration in the Data Book.*

4. To validate previous configuration, turn the Generator ON, wait until Error–01 (E01) appears on the Console and turn the Generator OFF.

5. Set dip switch 3000SW2 to the original settings as noted in step-1. (*Refer to Section 1.1.5 for the normal settings of Dip Switch 3000SW2*).

3.4 ANODE ROTATION TEST

Perform the following tests for each X-ray Tube in the installation, checking the low and high speed when it is required.

Note ☞ *Two people are needed for these tests, one at the Console and the service engineer looking at the anode of the X-ray Tube. These tests also can be done by hearing the sound of the anode rotating.*

WARNING

NEVER MAKE EXPOSURES DURING THE TESTS, THE PERSON CLOSE TO THE X-RAY TUBE WILL BE EXPOSED.

1. With the switch 3024SW2-3 on the ATP Console CPU Board in "***On***" position (service mode), turn the Console ON and select the corresponding X-ray Tube.

2. Select a low value for kVp and mAs for checking the Anode Rotation at Low Speed.

3. Press the "*Prep*" push-button and visually check that the Tube anode rotates in the proper way. (*Refer to the X-ray Tube documentation*).

4. Hold pressed the "*Prep*" push-button and check that the rotation speed of the Tube anode is in compliance with the X-ray Tube specifications.

   For this test is recommended to turn off the Tube filaments (switch 3000SW2-2 on the HT Controller in "***On***" position) and use a stroboscope to measure the anode speed.

5. Release the "*Prep*" push-button.

6. For Generators with LV-DRAC, select a high value for kVp and mAs for checking the Anode Rotation at High Speed. Repeat steps 3, 4 and 5.

7. If required for the second Tube, repeat this procedure.

3.5 FOCAL SPOTS CONFIGURATION

This configuration determines which mA station will be the smallest mA station for the Large Focal Spot. It is possible to configure all the mA stations for the Small Focal Spot or for the Large Focal Spot.

The smallest mA station for the Large Focal Spot must be selected according to the Tube ratings for the Small Filament and the customer preference.

IF THE mA STATION FOR FOCAL SPOT CHANGE IS NOT CONFIGURED ACCORDING TO THE X-RAY TUBE RATINGS, THE TUBE FILAMENTS MAY BE PERMANENTLY DAMAGED.

1. With the generator OFF, set dip switch 3024SW2-3 on the ATP Console CPU Board in *"**On**"* position to permit the service mode.
2. Power ON the System. Enter in calibration mode.
3. Select the smallest mA for the Large Focal Spot by using the "*mA Increase / Decrease*" push-buttons. When is required to configure all mA stations for the Small Focal Spot, select "*E01*" Memory Location.

Note ☞ *Default value is factory set at 200 mA except when using X-ray Tubes with Small Focal Spot smaller than 0.6 .*

4. Store the selected mA station by pressing the "*Power On*" and "*AEC Reset*" push-buttons on the Console. This stores the switch-over point for the focal spot selection. When it is confirmed, the ATP Console CPU Board emits a "double-beep".

IF THE FOCAL SPOT SWITCH-OVER POINT IS CHANGED AFTER mA CALIBRATION, THE mA STATIONS AFFECTED MUST BE RE-CALIBRATED.

5. Exit from calibration mode.

Perform the following test (*it is not mandatory*).

Note ☞

The test described only applies to RAD Tubes.

In case of a R&F Tube (Tube-2) both filament are always ON (lit). Select a "Direct" workstation and a mA station for the Small Filament. Press "Prep" for RAD and observe through the X-ray Tube window that the Small Filament lights more than the Large Filament.

1. Select the highest mA station for the Small Focal Spot. Verify that effectively the Small Filament is ON (lighted) and the Large Filament is OFF. Observe filaments through the X-ray tube window.

2. Select the lowest mA station for the Large Focal Spot. Verify that effectively the Large Filament is ON (lighted) and the Small Filament is OFF. Observe filaments through the X-ray tube window.

3. If required for the second tube, repeat this procedure.

SECTION 4 X-RAY TUBE DATA

The following table lists several common X-ray Tubes and their corresponding number. If a specific Tube is not listed, Tube specifications are given to enable you chose a similar Tube type. If none of the listed Tubes are satisfactory, contact your Generator supplier to obtain special software.

Table 4-1
X-ray Tube Type Numbers

TUBE NUMBER	TUBE CODE (ID)	MODEL	FOCAL SPOT	POWER RATINGS		KHU
				LS (kW)	HS (kW)	
001	139	TOSHIBA or CANON E7239X	1.0 / 2.0	22 / 45	–	133
002	201	TOSHIBA or CANON E7240X	0.6 / 1.2	15 / 30	–	140
003	140	TOSHIBA or CANON E7242X	0.6 / 1.5	18 / 49	–	187
004	090	TOSHIBA or CANON E7252X	0.6 / 1.2	15 / 42	26 / 73	300
005	412	TOSHIBA or CANON E7254FX	0.6 / 1.2	23 / 60	40 / 102	400
006	407	TOSHIBA or CANON E7884X	0.6 / 1.2	21 / 52		300
007	310	TOSHIBA or CANON E7843X	0.6 / 1.2	22 / 49	–	150
008	344	TOSHIBA or CANON E7865X	0.3 / 1.0	3 / 40	–	140
009	402	TOSHIBA or CANON E7876X	0.6 / 1.2	22 / 53		230
010	260	IAE RTM 101 HS	0.6 / 1.2	22 / 55	37 / 99	400
011	411	TOSHIBA or CANON E7886X	0.7 / 1.3	17 / 39		300
012	381	TOSHIBA or CANON E7869 X	0.6 / 1.2	21 / 55	36 / 96	600
013	404	VARIAN RAD 14	0.6 / 1.2	21 / 54	32 / 77	300
014	161	VARIAN RAD 21	0.6 / 1.2	21 / 64	36 / 100	300
015	265	VARIAN RAD 60	0.6 / 1.2	26 / 67	39 / 100	400
016	238	VARIAN RAD 74	0.6 / 1.5	20 / 52	–	200
017	252	VARIAN RAD 92	0.6 / 1.2	26 / 62	40 / 99	600
018	092	VARIAN A-192	0.6 / 1.2	25 / 63	40 / 96	300
019	309	VARIAN A196	0.6 / 1.0	20 / 47	32 / 72	350
020	094	VARIAN A-292	0.6 / 1.2	25 / 62	39 / 96	400
021	208	VARIAN G 292	0.6 / 1.2	25 / 63	39 / 95	600
022	051	GE-CGR MN 640	1.0 / 1.8	23 / 46	–	150
023	064	GE MAXIRAY-75	0.6 / 1.5	12 / 37	21 / 62	300
024	062	GE MAXIRAY-100	0.6 / 1.25	18 / 55	31 / 100	350
025	261	SIEMENS DR 154/30/50	1.2 / 1.8	31 / 53	–	200
026						
027						
Note .– Power Ratings are for 60 Hz. To calculate Power Ratings for 50 Hz multiply the values by 0.91						*TB54 (+K)*

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Technical Publication
CF-1054R2

Configuration

HF Series Generators

REVISION HISTORY

REVISION	DATE	REASON FOR CHANGE
0	MAR 27, 2007	First edition
1	JUL 07, 2016	Configuration of Positioner Interlock, Fail Safe, Synchronization Type using Tech Service V6.16
2	JUL 05, 2019	Identification of Tubes as “Toshiba or Canon”

This Document is the English original version, edited and supplied by the manufacturer.

The Revision state of this Document is indicated in the code number shown at the bottom of this page.

ADVISORY SYMBOLS

The following advisory symbols will be used throughout this manual. Their application and meaning are described below.

DANGERS ADVISE OF CONDITIONS OR SITUATIONS THAT IF NOT HEEDED OR AVOIDED WILL CAUSE SERIOUS PERSONAL INJURY OR DEATH.

ADVISE OF CONDITIONS OR SITUATIONS THAT IF NOT HEEDED OR AVOIDED COULD CAUSE SERIOUS PERSONAL INJURY, OR CATASTROPHIC DAMAGE OF EQUIPMENT OR DATA.

Advise of conditions or situations that if not heeded or avoided could cause personal injury or damage to equipment or data.

Note ☞

Alert readers to pertinent facts and conditions. Notes represent information that is important to know but which do not necessarily relate to possible injury or damage to equipment.

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SECTION 1 INITIAL CONFIGURATION PROCEDURE

Configuration provides the initial settings for extended memory and checkout procedures that must be carried out before making X-ray exposures. Functional characteristics of this Generator are defined at the time of installation.

Calibration and some configuration data are stored in a non-volatile memory chip (U3-EEPROM) located on the HT Controller Board in the Power Cabinet.

When the initial setup and checkout has been completed the Generator will be ready for Calibration.

Note ☞ *Record all the configuration settings in the Data Book.*

WARNING

DO NOT SUPPLY THE MAIN POWER UNTIL SPECIFICALLY INSTRUCTED TO DO SO IN THIS DOCUMENT.

THE MAIN CAPACITORS OF THE HIGH VOLTAGE INVERTER RETAIN A LARGE PORTION OF THEIR CHARGE FOR APPROX. 3 MINUTES AFTER THE UNIT IS TURNED OFF.

The Generator configuration is determined by:

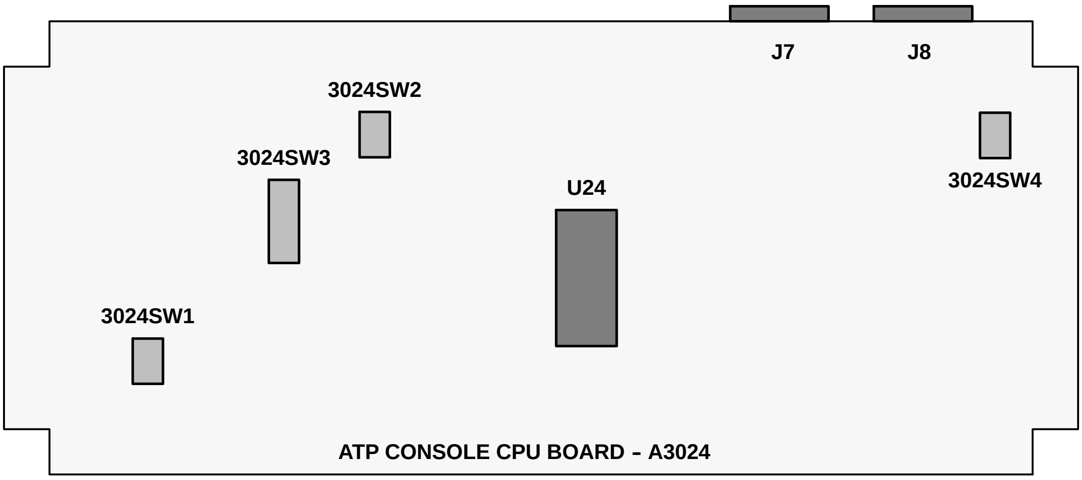
- X-ray tube(s) number, model and use.
- System requirements (Bucky, Tomo, AEC, ...)
- Maximum kV, kW.

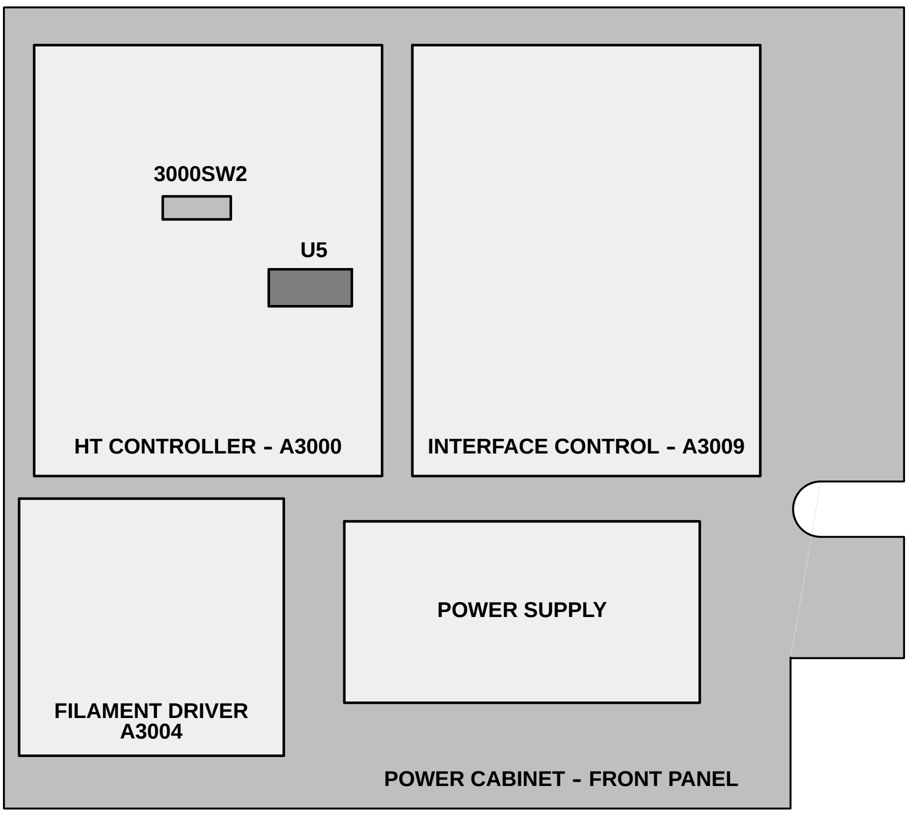
Specific versions of U24-EPROM on the ATP Console CPU Board and U5 on the HT Controller Board are based on the Generator configuration. (*Refer to Illustration 1-1*).

The system configuration and test switches are:

DIP SWITCH LOCATION	FUNCTION
3024SW1 - ATP Console CPU Board	System Configuration
3024SW2 - ATP Console CPU Board	Test
3024SW3 - ATP Console CPU Board	No used for Configuration
3000SW2 - HT Controller Board	System Configuration and Test

Illustration 1-1
EPROM and Switch locations





1.1 CONFIGURATION AND TEST SWITCHES

ATP Console Dip Switches must be configured with the Generator turned OFF, and they are read when the Generator is turned ON again.

1.1.1 3024SW1 - ATP CONSOLE CPU BOARD

Set dip switch 3024SW1 in accordance with the Table 1-1.

Table 1-1
System Configuration Dip Switch 3024SW1 on the ATP Console CPU Board

3024SW1 POSITION	OPEN (OFF)	CLOSED (ON)
1	60 Hz *1)	50 Hz *1)
2	–	**Normal** – Application mode. Exposures are inhibited when Door Interlock Switch is opened.
3	Not used. *Set in “OFF” position.*	Not used.
4	Not used. *Set in “OFF” position.*	Not used.
*Note.– *1) This switch is related with the frequency of the Rotor Controller. For Generators with High Speed Starter (LV-DRAC) or Generators Powered through Batteries with Stand-Alone set always SW1-1 to 60 Hz, in the rest of Generators set SW1-1 in accordance with the Power Line Frequency.*		

1.1.2 3024SW2 - ATP CONSOLE CPU BOARD

Set dip switch 3024SW2 verifying that each position is set as Table 1-2.

Table 1-2
Test Dip Switch 3024SW2 on the ATP Console CPU Board

3024SW2 POSITION	OPEN (OFF)	CLOSED (ON)
1	Skips reception with the HT Controller. Use only for display purposes, troubleshooting or Demo Consoles when there is no Power Module. Be sure that J3 connector is not plugged to the ATP Console CPU Board.	**Normal** – Application mode.
2	Tick Sound (button / command acknowledge) is not emitted by the ATP Console CPU Board.	Tick Sound (button / command acknowledge) is emitted by the ATP Console CPU Board.
3	**Normal** – Application mode.	**Service Mode .**
4	kV Log (Renard) Scale Mode for kV variation (kV changes in logarithmic steps) (*if available*).	kV Lineal Scale Mode for kV variation (**Normal mode**) (kV changes one by one).

1.1.3 3024SW3 - ATP CONSOLE CPU BOARD

Dip switch 3024SW3 is not used for configuration but all their switches must be set in "***Off***" position.

1.1.4 3024SW4 - ATP CONSOLE CPU BOARD

Dip Switch 3024SW4 is not used for configuration but all their switches must be set in "***Off***" position.

1.1.5 3000SW2 - HT CONTROLLER BOARD

HT Controller Dip Switches can be configured while the Generator is ON except Dip Switch 3000SW2-1.

Set dip switch 3000SW2 as indicated in Table 1-3.

Table 1-3
Test Dip Switch 3000SW2 on the HT Controller Board in the Power Module

3000SW2 POSITION	OPEN (OFF)	CLOSED (ON)
1	Normal.	Programming of Rotor Acceleration Time, RAD Filament Setting Time, Fluoro Rotor and Filament Hold-over Time *1) *2)
2	Normal.	Bypasses: Filament, Rotor Ready, Error E11. *1) *3)
3	Normal – Not used.	Not used.
4	Normal – Digital mA Loop Closed	Digital mA Loop Open / Filament Current Constant *1)
5	125 kV *4)	150 kV *4)
6	All Generators except Tube-2 for RAD	Generators with Tube-2 for RAD only.
7	Filament Boosting for Tube–1	No Filament Boosting for Tube–1 *5)
8	Filament Boosting for Tube–2	No Filament Boosting for Tube–2 *5)

Notes.– **1) Set in Closed (On) position only when indicated in the Service Manual.*

**2) Note that SW2-1 in Closed (On) position is only set to program the Rotor Acceleration Time, Rad Filament Setting Time, Fluoro Rotor and Filament Hold-over Time, therefore it changes the functions of Switches SW2-2 and SW2-4 to SW2-8. Refer to Section 3.*

**3) This turns off the filaments so no radiation will be produced during the exposure.*

WARNING: THE kV OUTPUT OF THE HV TRANSFORMER WILL BE WHATEVER IS SET BY THE CONSOLE. IF THE X-RAY TUBE HV CABLES ARE NOT CONNECTED INTO THE HV TRANSFORMER, FILL COMPLETELY BOTH HV RECEPTACLES WITH HV OIL.

**4) Set SW2-5 according to the Generator kV rating (refer to the Generator model and/or specifications).*

5)* ***Set to "No Filament Boosting" when using X-ray Tubes with Small Focal Spot smaller than 0.6 .*

1.2 BASIC CONFIGURATION OF GENERATOR BOARDS

The following Jumpers are factory set or removed to configure the Generator Boards according to the customer order. Check the jumper positions in the Generator Boards.

GENERATOR BOARDS	JUMPERS POSITION
HT CONTROLLER	JP1 and JP2 in “2”
	JP3, JP5 and JP6 in “2” and JP4 in “1” : for Compact Generators.
FILAMENT CONTROL	W1 in “A”
INTERFACE CONTROL	W1 in “2–3”
	W2 in “1–2”
	W3 to W10 in “A” : for positive High Voltage supply for Ion Chamber W3 to W10 in “B” : for negative High Voltage supply for Photomultiplier Tube
ATP CONSOLE CPU	JP1, JP2 and JP3 in “B” (soldered)
	JP4 in “B” (Cam-Sync)
	JP5 in “B” : Standard JP5 in “C” : for R&F / DSI Generators with AEC Control Board A3012–02/05
	JP6 in “A” (soldered)
	Connector J8 configured for RS232 so: JP9, JP10 and JP11 in “A”. JP7, JP8, JP21 and JP22 do not matter jumpers position
	JP12 removed
	JP13 installed (set) : if AEC Control Board A3012–xx is installed JP13 removed : if AEC Control Board A3012–xx is not installed
	JP14 installed (soldered)
	JP15, JP16, JP17 and JP18 removed
	JP19 in “A” (soldered)

1.3 AEC CONFIGURATION

Configure the following Jumpers on the "*AEC Control Board*" (located over the "*ATP Console CPU Board*") and on the "*AEC Adaptation Board*" when this option is installed in the Generator Cabinet.

AEC CONTROL BOARD (A3012–01/02/05)

JUMPER			DESCRIPTION
JP1	A B C	FOR TV CAMERA FOR PHOTOMULTIPLIER FOURTH ION CHAMBER & ATS–DIG	A3012-05: JP1-C, JP2-A AND JP4-B FOR FOURTH ION CHAMBER & ATS–DIG A3012-02: JP1-A, JP2-A AND JP4-A FOR ABC WITH TV CAMERA A3012-01: JP1-B, JP2-B AND JP4-A FOR ABC WITH PHOTOMULTIPLIER
JP2	A B	FOR TV CAMERA FOR PHOTOMULTIPLIER	
JP4	A B	FOR PHOTOMULTIPLIER – AEC FOR ION CHAMBER – AEC & ATS–DIG	
JP3	A B	FOR HIGH SENSITIVITY FOR LOW SENSITIVITY	JP3-A FOR AEC WHEN USING ION CHAMBER WITH HIGH SENSITIVITY JP3-B FOR AEC WHEN USING ION CHAMBER WITH LOW SENSITIVITY
NOTE:		*HIGH SENSITIVITY IS > 2 V / mR (> 0.223 V / µGy) (a.e. Vacutec Ion Chamber)* *LOW SENSITIVITY IS < 2 V / mR (< 0.223 V / µGy) (refer to Ion Chamber documentation)*	

AEC CONTROL BOARD (A3012–06/07/09)

JUMPER			DESCRIPTION
JP1	A B C	FOR TV CAMERA FOR PHOTOMULTIPLIER EXTERNAL kV CONTROL	JP1-A FOR ABC WITH TV CAMERA JP1-B FOR ABC WITH PHOTOMULTIPLIER JP1-C FOR ABC WITH EXTERNAL kV UP & DOWN CONTROL
JP2	A B	FOR HIGH SENSITIVITY FOR LOW SENSITIVITY	JP2-A FOR AEC WHEN USING ION CHAMBER WITH HIGH SENSITIVITY JP2-B FOR AEC WHEN USING ION CHAMBER WITH LOW SENSITIVITY
JP3	B	FOR NORMAL OPERATION	JP3-B FOR NORMAL OPERATION
JP4	A	FOR NORMAL OPERATION	JP4-A FOR NORMAL OPERATION (Only in A3012-06)
NOTE:		*HIGH SENSITIVITY IS > 2 V / mR (> 0.223 V / µGy) (a.e. Vacutec Ion Chamber)* *LOW SENSITIVITY IS < 2 V / mR (< 0.223 V / µGy) (refer to Ion Chamber documentation)*	

AEC ADAPTATION BOARD (A3263-03)

ION CHAMBER TYPE	JUMPERS POSITION		
	JP3, JP4, JP7, JP8	JP1, JP2, JP5, JP6	JP13, JP14, JP15, JP16
IC1 = IC2 = IC3 = IC4 *(Default)*	B	B	B
IC1 = IC2 = IC3	B	B	A
IC1 = IC2	B	A	A
IC1 ≠ IC2 ≠ IC3 ≠ IC4	A	A	A

ION CHAMBER OUTPUT	JUMPERS POSITION			
	JP9 (IC1)	JP10 (IC2)	JP11 (IC3)	JP12 (IC4)
NO-OFFSET ADJUSTMENT *(Default)*	A	A	A	A
OFFSET ADJUSTMENT	B	B	B	B
TEST POINT AND POTENTIOMETER (ONLY IF JUMPER IS IN “B” POSITION)	TP1 – R11	TP2 – R8	TP4 – R2	TP12 – R5

1.4 FLUORO CONFIGURATION

Fluoro configuration depends on position of jumpers W1 and W2 in the “*Fluoro CPU Board*” and jumper JP4 in the “*Console CPU Board*”, as indicated below:

JUMPERS IN FLUORO CPU BOARD (A3213-XX)	INSERTED	REMOVED
W1	ABC not enable	ABC enable
W2	Always inserted (installed)	

JUMPERS IN ATP CONSOLE CPU BOARD (A3024-XX)	
JP4	Always in “B” position – Camera

Also, configure the following Jumpers on the optional “*RF Adaptation Board*”.

RF ADAPTATION BOARD (A3514-04)

JUMPER	POSITION	FUNCTION
JP1, JP3, JP4, JP8, JP9, JP10, JP12, JP13, JP14	Set all jumpers	+24 VDC for the inputs PREP ORDER, RAD ORDER, and FLUORO ORDER
	Remove all jumpers	230 VAC for the inputs PREP ORDER, RAD ORDER, and FLUORO ORDER
	Set only JP1, JP8 and JP12	115 VAC for the inputs PREP ORDER, RAD ORDER, and FLUORO ORDER
JP2	Set	Generator +24 VDC for PREP / RAD / FLUORO ORDER
	Removed	External supply for PREP / RAD / FLUORO ORDER
JP5	A	ZOOM 1 output selected from Generator (-9 IN SEL)
	B	ZOOM 1 output selected from Table or external control
JP6	A	ZOOM 2 output selected from Generator (-6 IN SEL)
	B	ZOOM 2 output selected from Table or external control
JP7	A	ZOOM 3 output selected from Generator (-4 IN SEL)
	B	ZOOM 3 output selected from Table or external control
JP11	A	LIH output through a N.O. contact
	B	LIH output through a N.C. contact
JP15	A	LIH output selected from an external enable signal
	B	LIH output selected for Last Image Hold function
JP16	A	EXP ON/END output active for only RAD exposure
	B	EXP ON/END output active for Fluoro and RAD exposure
JP17	A	For EXP ON output active along the RAD exposure
	B	For EXP END output active about 50 ms pulse at the end of the RAD exposure
JP18	A	For ABC Window adjustment
	B	For normal operation
JP19	A	Pulsed Fluoro sync. activated with the negative edge of Exp. Sync+
	B	Pulsed Fluoro sync. from composite video signal (video in)
	C	Pulsed Fluoro sync. activated with the positive edge of Exp. Sync+
JP20	A	For ABC OUT signal from composite video signal (video in)
	B	For ABC OUT signal from a negative external ABC signal
	C	For ABC OUT signal from a positive external ABC signal
JP21	A	ABC OUT signal generated from composite video signal or external ABC signal
	B	ABC OUT signal coming directly from the Image System
JP22	Set	ABC OUT signal generated from composite video signal or external ABC signal
	Removed	ABC OUT signal coming directly from the Image System
JP23	Set	Normal position (composite video signal referenced to the Generator ground)
	Removed	To reduce noise (composite video signal isolate from Generator ground)
JP24	A	Normal position (Fluoro order from the Table sent directly to the Generator)
	B	For Fluoro order enable (Fluoro order from the Table sent to the Image System)

1.5 GENERATOR SERVICE MODE

Service Menu includes the buttons to access to “*Software Upgrade*”, “*Error Log*”, “*Settings*” and “*Generator Service*” menus.

Access to the Service menus as follow:

1. Switch ON the System (Console + Generator) by pressing the “*ON/OFF*” button of the Touch Screen Console. It directly starts application and shows the Main Menu.

2. Select the “*Service Mode*” button on the Main menu.

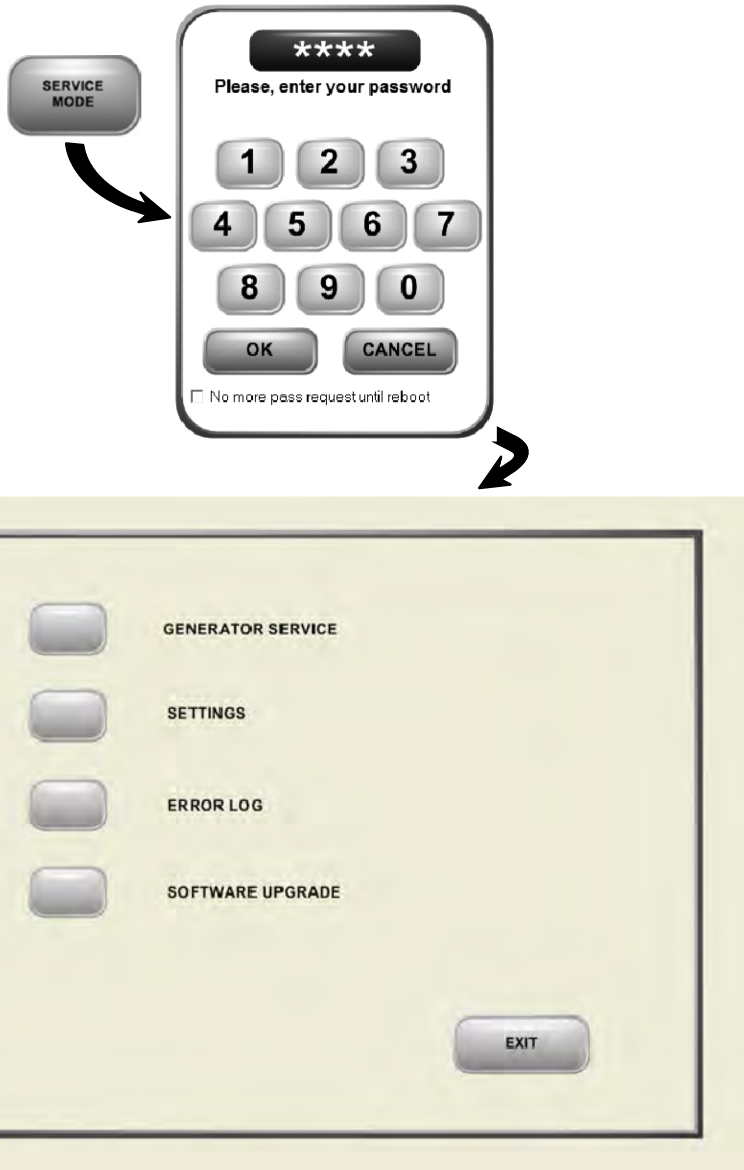
3. Enter the Service Password (code 2434) on the Service Access Panel.

4. Access to the different menus by selecting its respective button or go back to the Main Menu by pressing the “*Exit*” button.

Illustration 1-2
Service Tab

Access Screen from Main Menu

Service Mode Menu



1.5.1 SOFTWARE UPGRADE

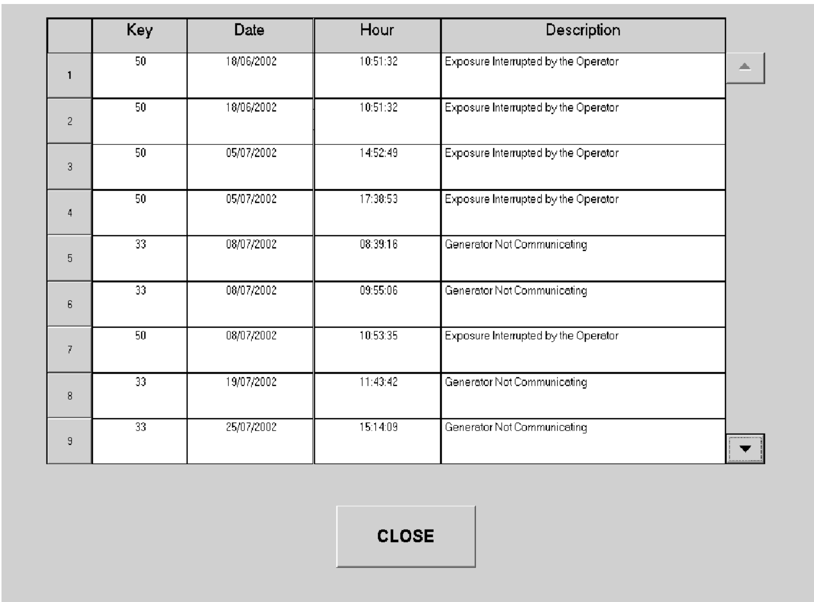
The "***Software Upgrade***" button on the Service Mode Menu is used to close the Application Program without turning OFF the System. After pressing this button, the Console shows the PC Desktop to enable the Application Software Upgrade, PC Operating System or perform an APR Backup. (*Also refer to Troubleshooting document in the Service Manual*).

Note ☞ *To perform any of these operations, it is recommended to connect a Keyboard to any of the USB ports of the CTSC Touch Screen Console.*

1.5.2 ERROR LOG

The Error Log Menu shows a list of the latest fifty (50) Errors with indication of: code, date, hour and error description.

Illustration 1-3
Error Log Menu



	Key	Date	Hour	Description
1	50	18/06/2002	10:51:32	Exposure Interrupted by the Operator
2	50	18/06/2002	10:51:32	Exposure Interrupted by the Operator
3	50	05/07/2002	14:52:49	Exposure Interrupted by the Operator
4	50	05/07/2002	17:38:53	Exposure Interrupted by the Operator
5	33	08/07/2002	08:39:16	Generator Not Communicating
6	33	08/07/2002	09:55:06	Generator Not Communicating
7	50	08/07/2002	10:53:35	Exposure Interrupted by the Operator
8	33	19/07/2002	11:43:42	Generator Not Communicating
9	33	25/07/2002	15:14:09	Generator Not Communicating

CLOSE

1.5.3 SETTINGS

Settings Menu is comprised of Configuration of the Workstation Icons, Communications, Generator Options and Printer screens.

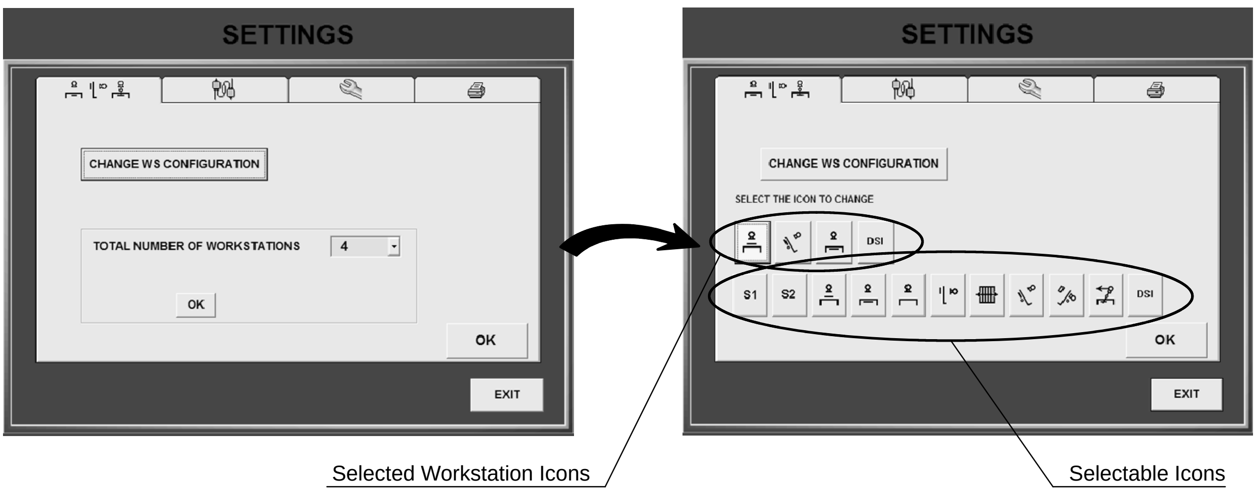
Access to these screens by selecting the respective Tab on the "*Settings*" menu. Press the "*OK*" button to apply the new selections or press "*Exit*" to go back to the Service menu.

The **Workstation Icon Menu** is used for selecting the most suitable Icon for each workstation button in the System.

Note ☞ *Note in the "Data Book" the Icons configured for each Workstation. Values configured in Section 1.7 must be set according to the selected icons.*

Press the "*Change WS Configuration*" button and set the total number of workstations to be used. Then press the "*OK*" button and select the Icon for each workstation. In the new screen, Icons in the upper line corresponds with the Icons that will appear for each workstation on the Application Program (operation mode).

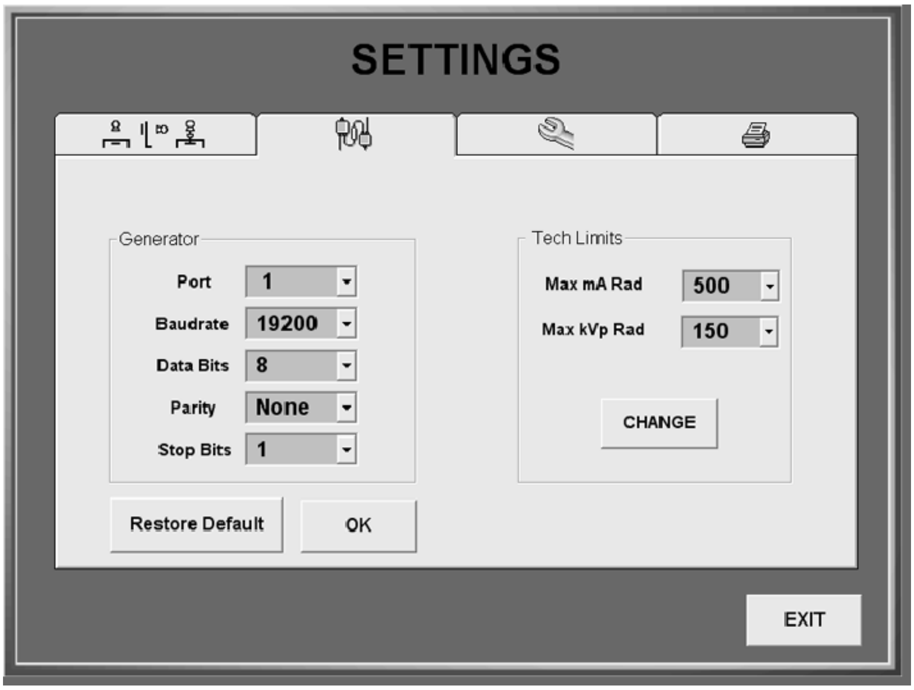
Illustration 2-1
Settings – Workstations Menu



The **Communications Menu** is used to configure the speed and communication port of the PC unit (inside Touch Screen Console) where the link of the Generator Cabinet is connected, and the Technical Limits for the maximum selectable value of each parameter in the Slider of the Application Program (operation mode).

Press "*Restore Default*" to set the default values or modify them and press "*OK*" to set the new values.

Illustration 2-2
Settings – Communications Menu



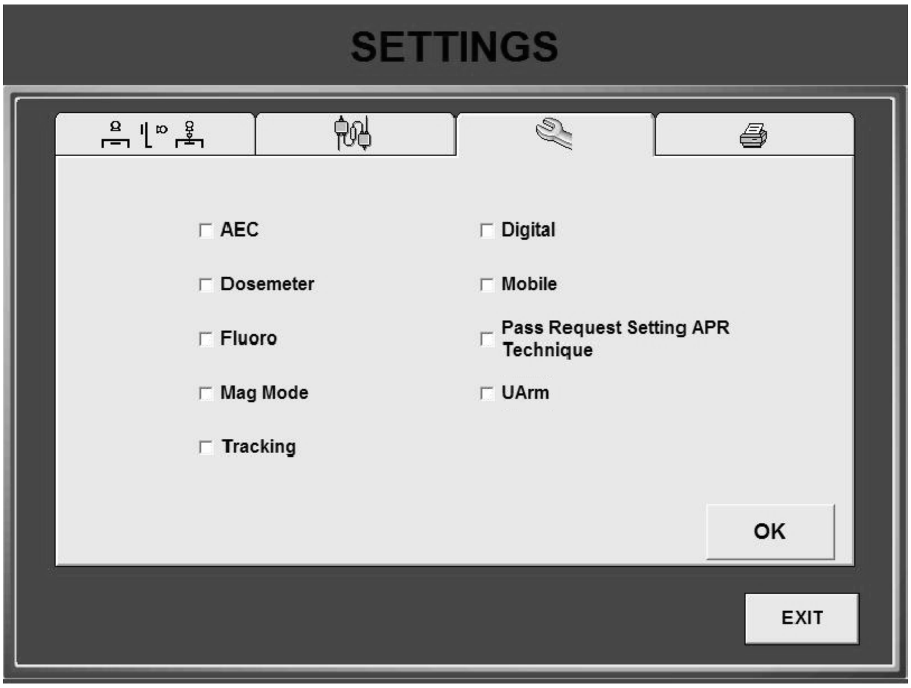
Serial communication have to be connected to the following ports of the Console (PC Unit):

COM PORT	CONNECTION
COM 1	Generator Cabinet.
COM 2	Touch Screen (internal connection).
COM 3	Printer (optional)
COM 4	Laptop (PC)

Note ☞ *Verify that Serial Communication is properly connected to respective Serial Ports of the Console (PC unit). If during start-up, these connections are wrong the Application Program can not work correctly.*

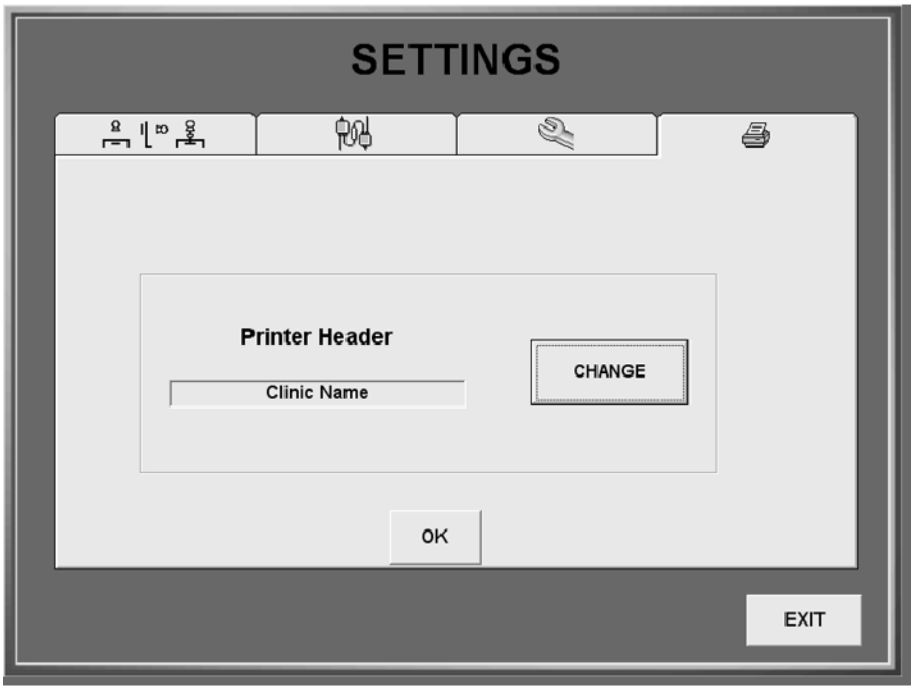
The **Generator Options Menu** is used to configure and enable / disable the controls of the indicated options on the Application Program (operation mode).

Illustration 2-3
Settings – Options Menu



The **Printer Menu** is used for entering the Hospital or Clinic Name which is shown in all printed information. This name can be modify through the keyboard that appears after pressing the "*Change*" button.

Illustration 2-4
Settings – Printer Menu



1.5.4 GSM PROGRAM MENU

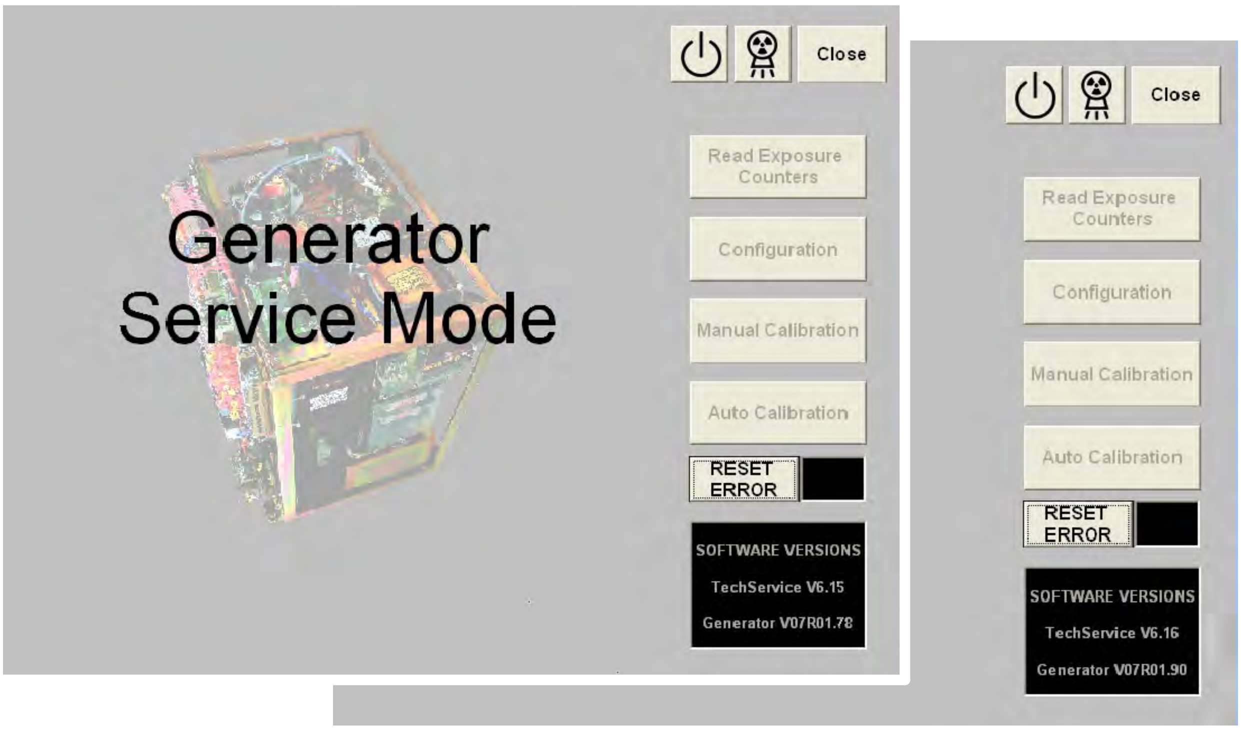
The Generator Service Mode (GSM) program allows the access to the service screens for Reading the Exposure Counters, Configuration and Calibration procedures.

Access to the GSM program by selecting the “*Generator Service*” button on the Service Mode Menu.

After accessing to the GSM program, a black Information Area appears at the lower right corner of the screen to show some messages related with the process (a.e. “*Power Up the Generator*”).

If after pressing the “*Configuration*”, “*Calibration*” or *Auto Calibration*” buttons, the GSM program prompts an error message: *“Please check calibration dip switch and toggle with power off”*; it means that these functions are disabled because position of dip switch 3024SW2-3 on the “*ATP Console CPU Board*” is not in “*Service Mode Allowed*”. Turn OFF the generator, change the dip switch 3024SW2-3 to Closed (ON) position, turn ON the generator and start the GSM program again.

Illustration 1-4
Example of GSM Menu depending on software versions



The screens to “*Read Exposure Counters*”, to enter in “*Configuration*”, “*Manual Calibration*” or “*Auto Calibration*” are displayed after selecting the respective button on the right side. Press again the selected button (in yellow on the right side) to return to the GSM menu.

The “*Exit*” button can also be used to return to the GSM menu, specially if the others buttons are disable.

The “Configuration” screen can displays different buttons depending on the version of the “*TechService*” supplied for the Generator, refer to *Illustration 1-5* see as example of “*Configuration*” screens.

Note ☞ *Whenever the “Configuration” menu is closed (by pressing any of “Configuration” or “Exit” buttons) a double-beep will sound confirming the storage of the values set for each workstation.*

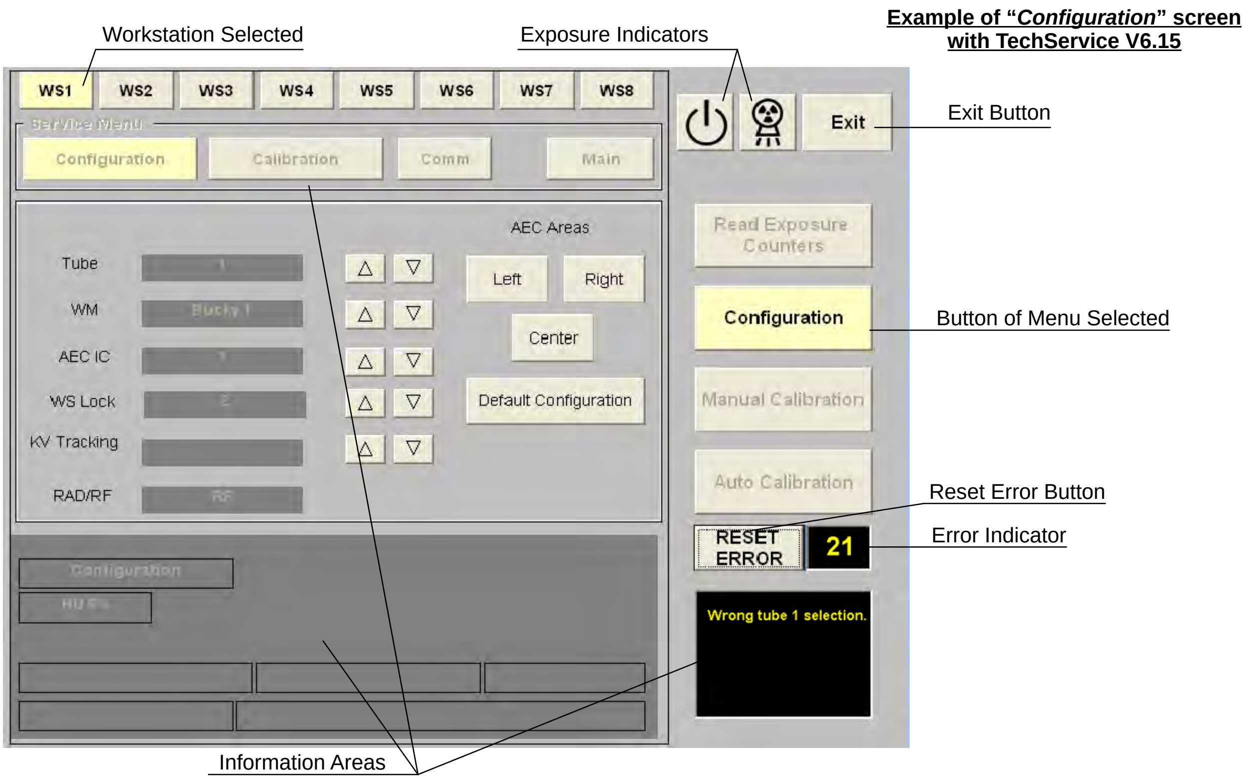
During operation, the color of the selected buttons changes to yellow when they are selected.

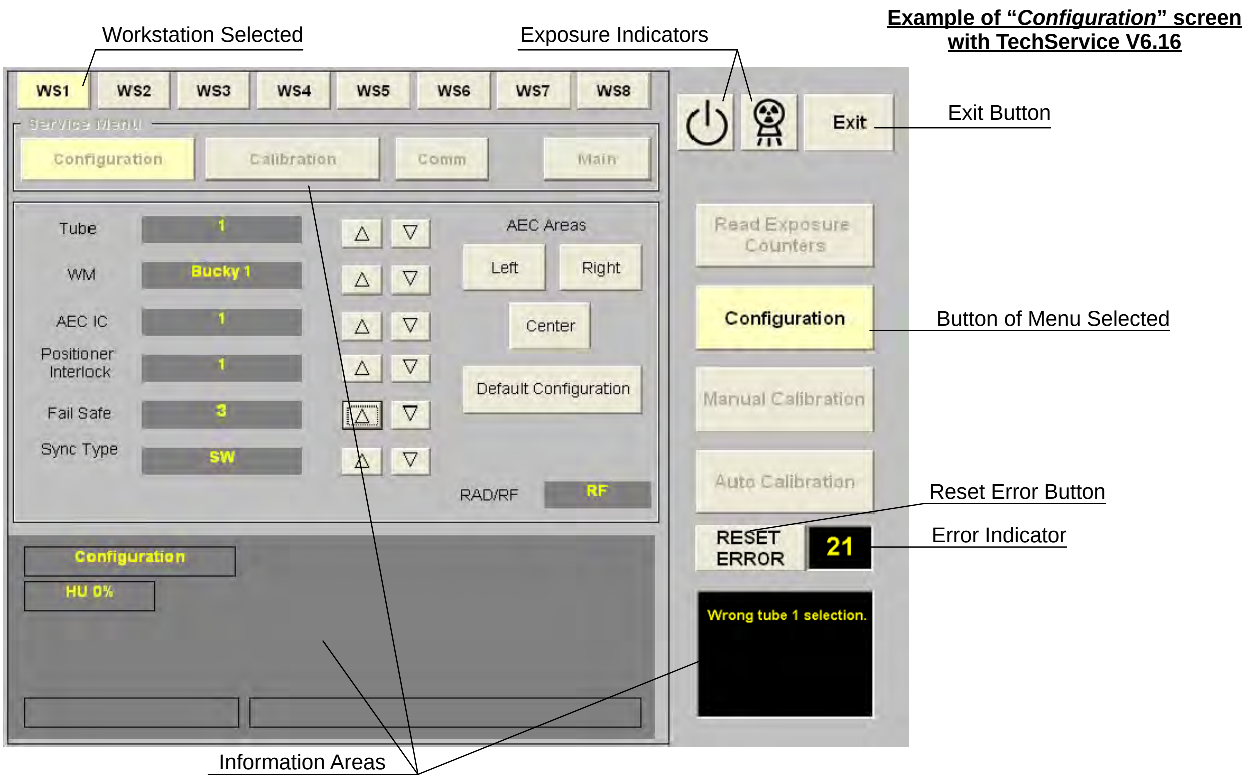
Press the “*Close*” button to exit from the GSM program.

Exposure status indicators for “*Ready*” and “*X-ray On*” are located on the upper right area of the GSM screens. The “*Information Area*” displays data related to the service mode, remaining heat units, working mode, errors indicators, etc.

When an error code or message is displayed on the GSM program press the “*Reset Error*” button to reset the error indication.

Illustration 1-5
Status and Error Indicators





1.6 EXPOSURE COUNTERS

The Exposure Counters display the number of Rad exposures made with any of the X-ray Tubes and the accumulated Fluoro exposure time (in hours and minutes) made with the Tube-2.

1. Enter in the GSM program and select the "*Read Exposure Counters*" button.
2. This screen shows the Exposure Counters.
3. Exit from this screen by pressing the "*Read Exposure Counters*" button or the "*Exit*" button again.

Illustration 1-6
Exposure Counters

1.7 WORKSTATIONS CONFIGURATION

This screen is used to view the configuration of the Workstations (Tube, WM, Ion Chamber, etc.) and the AEC Areas selected by default for each Workstation in the system (optional). The different displays/buttons related to the Workstation configuration that appear on the “Configuration” screen depend on the version of the “*TechService*” supplied for the Generator (*refer to Illustration 1-7).*

The workstations can be configured according to the customer preferences or default. If a workstation is configured with the value “*Tube – 0*”, its button can not be selected during operation.

Note ☞ *The Workstations to be configured are related to their icons previously set (following the same order). All of them have to be set for “Tube-1” or “Tube-2”.*

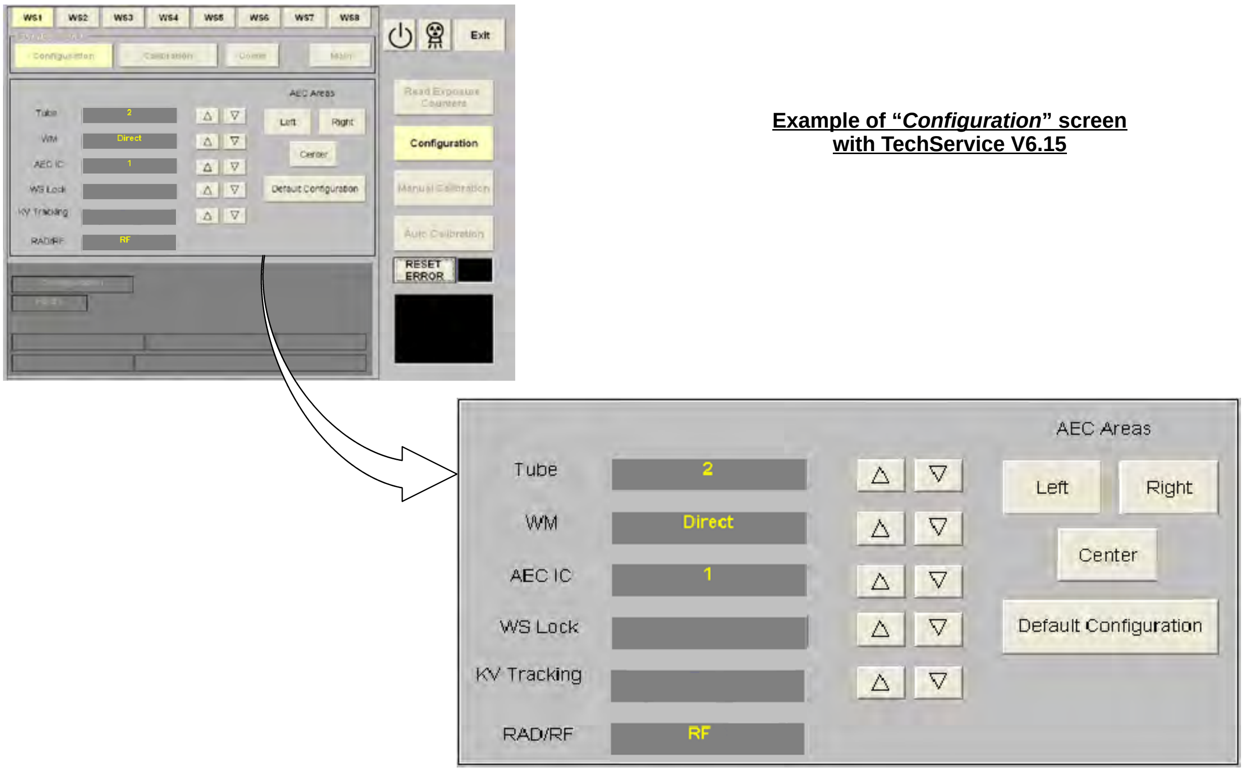
CUSTOMIZED CONFIGURATION

Note ☞ *This procedure has to be performed always that “ATP Console CPU Board” is replaced by a new one.*

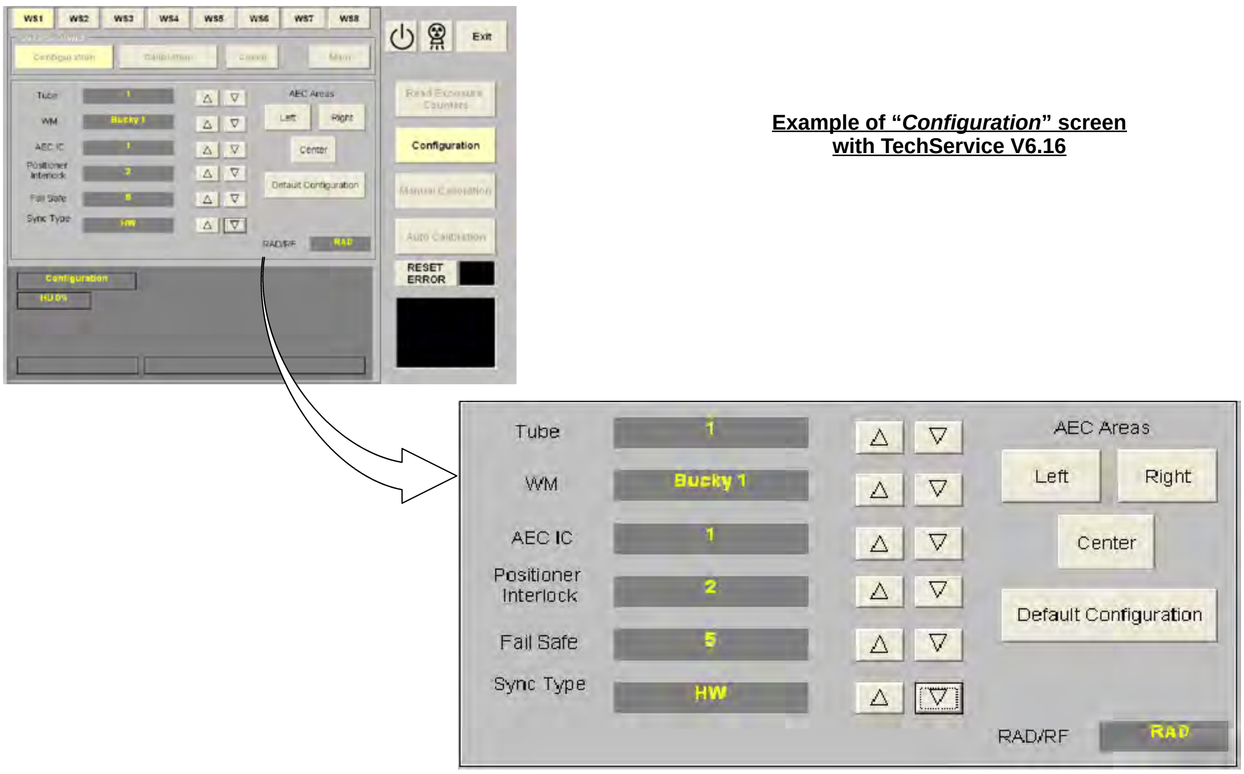
1. Enter in the GSM program and select the “*Configuration*” button.
2. Once in Configuration mode, if the Generator has installed the “*Fluoro CPU Board*” the program has to indicate “*RF*” on the RAD/RF window. This means that Fluoro functions are enabled. If not, it indicates “*RAD*”.

Note ☞ *If the Fluoro functions are not enabled (“RF” does not appear) the Fluoro Display and functions will be deactivated after selecting a workstation for Tube-2. In this case, exit, check connection between the Fluoro CPU and ATP Console CPU Board and enter in Configuration again until the “RF” indication appears.*

Illustration 1-7
Configuration screen depending on TechService version



Example of "*Configuration*" screen with TechService V6.15



Example of "*Configuration*" screen with TechService V6.16

3. Select the first workstation to be configured, by pressing the respective button (only the icon of the selected workstation has different color). The following values can be shown on the "*Configuration*" screen:

CONFIGURATION VALUES WITH TECHSERVICE V6.15			
DISPLAY	**FUNCTION**	**VALUE**	**DESCRIPTION**
TUBE	**Tubes**	0	No-configured workstation (Not selectable by the operator)
		1	Tube-1
		2	Tube-2
WM	**Devices - Working Modes**	0 – Direct	Direct
		1 – Bucky 1	First Receptor, usually in the Table or for Systems (URS / LP) with only one receptor: CR-Film inserted in the Tray/Bucky or DR (Direct DR or DR inserted in the Receptor cabinet).
		2 – Bucky 2	Second Receptor, usually in the Wall Stand: CR-Film inserted in the Tray/Bucky or DR (Direct DR or DR inserted in the Receptor cabinet).
		3 – STD Tomo	Standard Tomo *1)
		4 – STD RF	Standard RF (Spot Film Device)
		5 – DSI	Digital RAD and Fluoro *2)
		6 – Cine	Cine *2)
		7 – DSA	DSA *2)
AEC IC	**AEC Ion Chambers**	0	No AEC
		1	Ion Chamber-1 (IC-1)
		2	Ion Chamber-2 (IC-2)
		3	Ion Chamber-3 (IC-3)
		4	Ion Chamber-4 (IC-4)
		5	Photomultiplier (PT-INPUT)

Notes:

– Some of listed values are not configurable depending on the Positioners / Generator model .

**1) Only when the Tomo is controlled from the Generator. In this case, the workstation has to be configured as Tube "1" or "2", Device "STD Tomo" and Ion Chamber "0".*
If the Tomo is controlled from the Table, the workstation has to be configured as Tube "2", Device "STD RF" and Ion Chamber "0".

**2) These Devices are only available for Generators provided with interface option for Digital Systems. These workstations has to be configured as Tube "2".*

CONFIGURATION VALUES WITH TECHSERVICE V6.15 (cont.)			
DISPLAY	**FUNCTION**	**VALUE**	**DESCRIPTION**
WS LOCK *3)	**Configuration of Positioner SID Reading exclusive for some RAD Room Systems** *3) **(optional)**	0	No Interlocks, or Interlocks for the Tilting Wall Stand whenever "*Bucky 2*" is configured
		1	Interlocks for the Table
		2	Interlocks for the Wall Stand (No Tilting)
WS LOCK *4)	**Alignment Interlocks and Receptor Detection** *4) **(optional)**	0	No Interlocks for Direct Mode **DR**
		1	Interlocks for the First Receptor **DR**, usually in the Table or for Systems (URS/LP) with only one Receptor
		2	Interlocks for the Second Receptor **DR**, usually in the Wall Stand
		3	No Interlocks for Direct Mode **CR-Film**
		4	Interlocks for the First Receptor **CR-Film**, usually in the Table or for Systems (URS/LP) with only one Receptor
		5	Interlocks for the Second Receptor **CR-Film**, usually in the Wall Stand

Notes:

– Some of listed values are not configurable depending on the Positioners / Generator model .

**3) Only when the RAD Room is a Millennium Plus / Polyrad Premium Advanced (or similar) RAD Rooms with Table and Wall Stand, the value set as "WS Lock" is related to the SID reading in the Tube Stand Console for each positioner.*
Possible values: 0, 1, 2.

**4) For the rest of RAD Rooms (no Millennium Plus / Polyrad Premium Advanced (or similar)), this function requires that the Positioners are supplied with the corresponding Kits for Alignment Interlocks and Receptor Detection installed. If not, configure the "0" value. Possible values: 0, 1, 2, 3, 4, 5.*

When the Receptor is DR, check the following jumpers:
– On A3656–01 Fail Safe Board, JP1 and JP2 are set in OFF position.

When the Receptor is CR-Film, check the following jumpers:
– There is a wire-jumper between Generator TS1-5 and TS1-6 in case of CR-Film Type on Bucky 1 (Table).
– There is a wire-jumper between Generator TS1-12 and TS1-13 in case of CR-Film Type on Bucky 2 (Wall Stand).
– On A3656–01 Fail Safe Board, JP1 and JP2 are set in ON position.

CONFIGURATION VALUES WITH TECHSERVICE V6.15 (cont.)			
DISPLAY	**FUNCTION**	**VALUE**	**DESCRIPTION**
kV TRACKING	**RAD kVp Auto-Tracking Formula** **5)* **(optional)**	1	Formula-1
		2	Formula-2
		3	Formula-3
		4	Formula-4
		5	Formula-5
		6	Formula-6
		7	Formula-7
		8	Formula-8
RAD/RF	**Generator Type**	RAD	Only for RAD
		RF	RAD and Fluoro

Notes:

- *Some of listed values are not configurable depending on the Positioners / Generator model .*

**5) Value on “KV Tracking” (optional) assigns by default one Formula for “Zero Point” operation mode to the selected RF workstation.*

Note ☞ *Refer to Section 1.7.1 for some examples of Workstation configuration using the TechService V6.15.*

CONFIGURATION VALUES WITH TECHSERVICE V6.16			
DISPLAY	**FUNCTION**	**VALUE**	**DESCRIPTION**
TUBE	**Tubes**	0	No-configured workstation (Not selectable by the operator)
		1	Tube-1
		2	Tube-2
WM	**Devices - Working Modes**	0 – Direct	Direct
		1 – Bucky 1	First Receptor, usually in the Table or for Systems (URS / LP) with only one receptor: CR-Film inserted in the Tray/Bucky or DR (Direct DR or DR inserted in the Receptor cabinet).
		2 – Bucky 2	Second Receptor, usually in the Wall Stand: CR-Film inserted in the Tray/Bucky or DR (Direct DR or DR inserted in the Receptor cabinet).
		3 – STD Tomo	Standard Tomo *1)
		4 – STD RF	Standard RF (Spot Film Device)
		5 – DSI	Digital RAD and Fluoro *2)
		6 – Cine	Cine *2)
		7 – DSA	DSA *2)
AEC IC	**AEC Ion Chambers**	0	No AEC
		1	Ion Chamber-1 (IC-1)
		2	Ion Chamber-2 (IC-2)
		3	Ion Chamber-3 (IC-3)
		4	Ion Chamber-4 (IC-4)
		5	Photomultiplier (PT-INPUT)
POSITIONER INTERLOCK	**Configuration of Positioner SID Reading exclusive for some RAD Room Systems** *3) **(optional)**	0	No Interlocks, or Interlocks for the Tilting Wall Stand whenever "*Bucky 2*" is configured
		1	Interlocks for the Table
		2	Interlocks for the Wall Stand (No Tilting)

Notes:

– Some of listed values are not configurable depending on the Positioners / Generator model .

**1) Only when the Tomo is controlled from the Generator. In this case, the workstation has to be configured as Tube "1" or "2", Device "STD Tomo" and Ion Chamber "0".*
If the Tomo is controlled from the Table, the workstation has to be configured as Tube "2", Device "STD RF" and Ion Chamber "0".

**2) These Devices are only available for Generators provided with interface option for Digital Systems. These workstations has to be configured as Tube "2".*

**3) The configuration of "Positioner Interlocks" only applies to Millennium Plus / Polyrad Premium Advanced (or similar) RAD Rooms with Table and Wall Stand. The value is related to the SID reading in the Tube Stand Console for each positioner.*

CONFIGURATION VALUES WITH TECHSERVICE V6.16 (cont.)			
DISPLAY	**FUNCTION**	**VALUE**	**DESCRIPTION**
FAIL SAFE	**Alignment Interlocks and Receptor Detection** *4) **(optional)**	0	No Interlocks for Direct Mode **DR**
		1	Interlocks for the First Receptor **DR**, usually in the Table or for Systems (URS/LP) with only one Receptor
		2	Interlocks for the Second Receptor **DR**, usually in the Wall Stand
		3	No Interlocks for Direct Mode **CR-Film**
		4	Interlocks for the First Receptor **CR-Film**, usually in the Table or for Systems (URS/LP) with only one Receptor
		5	Interlocks for the Second Receptor **CR-Film**, usually in the Wall Stand
SYNC TYPE	**Generator - DR Synchronization Type** *5) **(optional)**	HW	DR Synchronization by Hardware
		SW	DR Synchronization by Software
RAD/RF	**Generator Type**	RAD	Only for RAD
		RF	RAD and Fluoro

Notes:

– Some of listed values are not configurable depending on the Positioners / Generator model .

***4) This function requires that the Positioners are supplied with the corresponding Kits for Alignment Interlocks and Receptor Detection installed.*

When the Receptor is DR, check the following jumpers:
– On A3656–01 Fail Safe Board, JP1 and JP2 are set in OFF position.

When the Receptor is CR-Film, check the following jumpers:
– There is a wire-jumper between Generator TS1-5 and TS1-6 in case of CR-Film Type on Bucky 1 (Table).
– There is a wire-jumper between Generator TS1-12 and TS1-13 in case of CR-Film Type on Bucky 2 (Wall Stand).
– On A3656–01 Fail Safe Board, JP1 and JP2 are set in ON position.

**5) Consult the documentation of the Acquisition Software and the System Interface schematics in order to set the Synchronization type between the Generator and DR (Detector Power Box).*

Note ☞ *Refer to Section 1.7.1 for some examples of Workstation configuration using the TechService V6.16.*

4. Set the new value by pressing the corresponding "*Increase*" or "*Decrease*" buttons. Set also the selected AEC Areas by default for each Workstation in the system (optional).

5. Select the next workstations to be configured and set the respective values of each one.

6. Exit from configuration mode by pressing the "*Configuration*" button, then a double-bip will sound confirming the process.

7. Exposures made from workstations configured with:

   - Device "*Direct (No Bucky), Bucky-1, Bucky-2* and *Standard Tomo*" are **only enabled** with the internal "*Preparation*" and "*Exposure*" signals controlled by the Handswitch or Rad Footswitch.

   - Device "*Standard RF*" and "*DSI*" are **only enabled** with the external signals for "*Preparation*", "*RAD Exposure*" and "*Fluoro Exposure*". **Fluoro can only be made from this Device selection.**

   - Device "*Infimed: DSI, Cine, DSA*" are **only enabled** with the external "*Digital Preparation*" and "*Exposure*" signals connected to Terminal Block 4TS3 of the Generator Cabinet.

Note ☞

1) Optional "Tomo / Bucky Adaptation Board" (in the Power Cabinet) is required to configure more than two Buckys or one Tomo Device in the system.

For system without the optional "Tomo / Bucky Adaptation Board", it can only work directly with two Buckys, and the value assigned to them must be "1" and "2" in the second value.

2) TOMO must be always related to Bucky-1. Only one TOMO can be used in the system, so only one of the workstations should be configured with the value "3" in the second value.

3) Optional "AEC Control Board" (connected to the Console CPU Board) is required to work with AEC.

Optional "AEC Adaptation Board" is required to configure any no-standard or more than one Ion Chambers in the system.

DEFAULT CONFIGURATION

Default configuration sets some default values to each workstation. It only should be used to re-initialize the workstation configuration when the complete configuration has been lost or it is not possible to select any workstation.

1. Enter in the GSM program and select the “*Configuration*” button.
2. Press the “*Default Configuration*” button.
3. Exit from configuration mode by pressing the “*Configuration*” button, then a double-bip will sound confirming the process.
4. It is recommended to perform a proper configuration of each workstation in the system after a default configuration.

1.7.1 WORKSTATION CONFIGURATION EXAMPLES

RAD ROOM with TABLE and WALL STAND
RECEPTORS = CR or Film

WS1 = CR or Film in the Table Receptor Cabinet
with AEC Ion Chamber
and Alignment Interlocks / Receptor Detection

WS2 = CR or Film in the Wall Stand Receptor Cabinet
with AEC Ion Chamber and
and Alignment Interlocks / Receptor Detection

WS3 = CR or Film out of the Receptor Cabinet (Direct mode)
with no AEC Ion Chamber
and no Alignment Interlocks / Receptor Detection

CONFIGURATION OF WORKSTATIONS USING TECHSERVICE V6.15				
WORKSTATION	**WS1**	**WS2**	**WS3**	**WS4 / WS5 / WS6 / WS7 / WS8**
TUBE	1	1	1	0
WM	1 – Bucky 1 *(Receptor in Table)*	2 – Bucky 2 *(Receptor in Wall Stand)*	0 – Direct *(Direct)*	
AEC IC	1	2	0	
WS LOCK	4	5	3	
WS LOCK *(only for Millennium Plus / Polyrad Premium Advanced or similar)*	1	2	0	
kV TRACKING				
RAD/RF	RAD	RAD	RAD	

CONFIGURATION OF WORKSTATIONS USING TECHSERVICE V6.16				
WORKSTATION	**WS1**	**WS2**	**WS3**	**WS4 / WS5 / WS6 / WS7 / WS8**
TUBE	1	1	1	0
WM	1 – Bucky 1 *(Receptor in Table)*	2 – Bucky 2 *(Receptor in Wall Stand)*	0 – Direct *(Direct)*	
AEC IC	1	2	0	
POSITIONER INT *(only for Millennium Plus / Polyrad Premium Advanced or similar)*	1	2	0	
FAIL SAFE	4	5	3	
SYNC TYPE				
RAD/RF	RAD	RAD	RAD	

RAD ROOM with TABLE and WALL STAND
RECEPTOR = DR (SINGLE PANEL)

WS1 = DR1 in the Table Receptor Cabinet
with AEC Ion Chamber
and Alignment Interlocks / Receptor Detection

WS2 = DR1 in the Wall Stand Receptor Cabinet
with AEC Ion Chamber and
and Alignment Interlocks / Receptor Detection

WS3 = DR1 out of the Receptor Cabinet (Direct mode)
with no AEC Ion Chamber
and no Alignment Interlocks / Receptor Detection

CONFIGURATION OF WORKSTATIONS USING TECHSERVICE V6.15				
WORKSTATION	**WS1**	**WS2**	**WS3**	**WS4 / WS5 / WS6 / WS7 / WS8**
TUBE	1	1	1	0
WM	1 – Bucky 1 *(Receptor in Table)*	2 – Bucky 2 *(Receptor in Wall Stand)*	1 – Bucky 1 *(DR in Direct)*	
AEC IC	1	2	0	
WS LOCK	1	2	0	
WS LOCK *(only for Millennium Plus / Polyrad Premium Advanced or similar)*	1	2	0	
kV TRACKING				
RAD/RF	RAD	RAD	RAD	

CONFIGURATION OF WORKSTATIONS USING TECHSERVICE V6.16				
WORKSTATION	**WS1**	**WS2**	**WS3**	**WS4 / WS5 / WS6 / WS7 / WS8**
TUBE	1	1	1	0
WM	1 – Bucky 1 *(Receptor in Table)*	2 – Bucky 2 *(Receptor in Wall Stand)*	1 – Bucky 1 *(DR in Direct)*	
AEC IC	1	2	0	
POSITIONER INT *(only for Millennium Plus / Polyrad Premium Advanced or similar)*	1	2	0	
FAIL SAFE	1	2	0	
SYNC TYPE	HW or SW	HW or SW	HW or SW	
RAD/RF	RAD	RAD	RAD	

RAD ROOM with TABLE and WALL STAND RECEPTORS = DR (DUAL PANEL)

WS1 = DR1 in the Table Receptor Cabinet
with AEC Ion Chamber
and Alignment Interlocks / Receptor Detection

WS2 = DR2 in the Wall Stand Receptor Cabinet
with AEC Ion Chamber and
and Alignment Interlocks / Receptor Detection

WS3 = DR1 out of the Table Receptor Cabinet (Direct mode)
with no AEC Ion Chamber
and no Alignment Interlocks / Receptor Detection

WS4 = DR2 out of the Wall Stand Receptor Cabinet (Direct mode)
with no AEC Ion Chamber
and no Alignment Interlocks / Receptor Detection

CONFIGURATION OF WORKSTATIONS USING TECHSERVICE V6.15					
WORKSTATION	**WS1**	**WS2**	**WS3**	**WS4**	**WS5 / WS6 / WS7 / WS8**
TUBE	1	1	1	1	0
WM	1 – Bucky 1 *(Receptor in Table)*	2 – Bucky 2 *(Receptor in Wall Stand)*	1 – Bucky 1 *(Table DR in Direct)*	2 – Bucky 2 *(Wall Stand DR in Direct)*	
AEC IC	1	2	0	0	
WS LOCK	1	2	0	0	
WS LOCK *(only for Millennium Plus / Polyrad Premium Advanced or similar)*	1	2	0	0	
kV TRACKING					
RAD/RF	RAD	RAD	RAD	RAD	

CONFIGURATION OF WORKSTATIONS USING TECHSERVICE V6.16					
WORKSTATION	**WS1**	**WS2**	**WS3**	**WS4**	**WS5 / WS6 / WS7 / WS8**
TUBE	1	1	1	1	0
WM	1 – Bucky 1 *(Receptor in Table)*	2 – Bucky 2 *(Receptor in Wall Stand)*	1 – Bucky 1 *(Table DR in Direct)*	2 – Bucky 2 *(Wall Stand DR in Direct)*	
AEC IC	1	2	0	0	
POSITIONER INT *(only for Millennium Plus / Polyrad Premium Advanced or similar)*	1	2	0	0	
FAIL SAFE	1	2	0	0	
SYNC TYPE	HW or SW	HW or SW	HW or SW	HW or SW	
RAD/RF	RAD	RAD	RAD	RAD	

RAD ROOM with only ONE RECEPTOR
(Universal Radiographic System / Lateral Positioner)
RECEPTOR = CR or Film

WS1 = CR or Film in the Receptor Cabinet
with AEC Ion Chamber
and Alignment Interlocks / Receptor Detection

WS2 = CR or Film out of the Receptor Cabinet (Direct mode)
with no AEC Ion Chamber
and no Alignment Interlocks / Receptor Detection

CONFIGURATION OF WORKSTATIONS USING TECHSERVICE V6.15			
WORKSTATION	**WS1**	**WS2**	**WS3 / WS4 / WS5 / WS6 / WS7 / WS8**
TUBE	1	1	0
WM	1 – Bucky 1 (*Receptor*)	0 – Direct *(Direct)*	
AEC IC	1	0	
WS LOCK	4	3	
kV TRACKING			
RAD/RF	RAD	RAD	

CONFIGURATION OF WORKSTATIONS USING TECHSERVICE V6.16			
WORKSTATION	**WS1**	**WS2**	**WS3 / WS4 / WS5 / WS6 / WS7 / WS8**
TUBE	1	1	0
WM	1 – Bucky 1 *(Receptor)*	0 – Direct *(Direct)*	
AEC IC	1	0	
POSITIONER INT			
FAIL SAFE	4	3	
SYNC TYPE			
RAD/RF	RAD	RAD	

RAD ROOM with only ONE RECEPTOR (Universal Radiographic System / Lateral Positioner) RECEPTOR = DR

WS1 = DR in the Receptor Cabinet
with AEC Ion Chamber
and Alignment Interlocks / Receptor Detection

WS2 = DR out of the Receptor Cabinet (Direct mode)
with no AEC Ion Chamber
and no Alignment Interlocks / Receptor Detection

CONFIGURATION OF WORKSTATIONS USING TECHSERVICE V6.15			
WORKSTATION	**WS1**	**WS2**	**WS3 / WS4 / WS5 / WS6 / WS7 / WS8**
TUBE	1	1	0
WM	1 – Bucky 1 (*Receptor*)	1 – Bucky 1 *(Direct)*	
AEC IC	1	0	
WS LOCK	1	0	
kV TRACKING			
RAD/RF	RAD	RAD	

CONFIGURATION OF WORKSTATIONS USING TECHSERVICE V6.16			
WORKSTATION	**WS1**	**WS2**	**WS3 / WS4 / WS5 / WS6 / WS7 / WS8**
TUBE	1	1	0
WM	1 – Bucky 1 *(Receptor)*	1 – Bucky 1 *(Direct)*	
AEC IC	1	0	
POSITIONER INT			
FAIL SAFE	1	0	
SYNC TYPE	HW or SW	HW or SW	
RAD/RF	RAD	RAD	

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SECTION 2 EXTENDED MEMORY SETTING

2.1 EXTENDED MEMORY LOCATIONS

Miscellaneous configuration and calibration data are stored in the Extended Memory Locations. It is recommended to note the values factory stored in each Memory Location. (*Refer to Table 2-1*)

Note ☞ *For generators with only one Radiographic X-ray Tube, this tube have to be configured, calibrated and used as Tube-1.*

Note ☞ *For generators with a Fluoroscopic X-ray Tube or DSI (Digital RAD), this tube have to be configured, calibrated and used as Tube-2.*

Table 2-1
Extended Memory Locations

MEMORY LOCATION	FUNCTION	VALUE
E01	TUBE-1 – RAD filament stand-by (*Autocalibrated. Not field changeable*)	
E02	TUBE-1 – RAD tube type	
E03	Low Digital mA Loop Closed (from 10 mA to 80 mA)	
E04	AEC-1 calibration	
E05	High Digital mA Loop Closed (from 100 mA)	
E06	kV Loop	
E07	Maximum kW *(Factory set. Only field changeable to lower value)*	
E08	AEC-1 tracking	
E09	AEC-2 calibration	
E10	AEC-2 AEC tracking	
E11	Not used.	
E12	AEC Density Scale	
E13	TUBE-1 – Exposure Time adjustment - Delay	
E14	Not used.	
E15	TUBE-1 – Exposure Time adjustment - Ceq kV	
E16	Not used.	
E17	Not used.	
E18	TUBE-2 – FLUORO tube type	
E19	Maximum FLUORO kV	
E20	AEC-3 calibration	
E21	Not used.	
E22	TUBE-2 – Filament setting for Pulsed Fluoro and Automatic Mode (ABC) at 10 R/min	
E23	AEC-4 calibration / Photomultiplier AEC calibration (SF Camera)	
E24	AEC-3 tracking / AEC-4 tracking (equal value for both)	
E25	Not used.	
E26	Not used.	
E27	Not used.	
E28	Not used.	
E29	TUBE-2 – Exposure Time adjustment - Delay	
E30	Not used.	
E31	TUBE-2 – Exposure Time adjustment - Ceq kV	
E32	Not used.	
E33	TUBE-2 – Filament setting for Continuous Fluoro and Automatic Mode (ABC) at 10 R/min	
E34	Not used.	

Table 2-1 (cont.)
Extended Memory Locations

MEMORY LOCATION	FUNCTION	VALUE
E35	FLUORO mA Display calibration at 50 kV related to E22 Memory Location	
E36	FLUORO mA display calibration at 80 kV related to E22 Memory Location	
E37	FLUORO mA display calibration at 110 kV related to E22 Memory Location	
E38	FLUORO mA Display calibration at 50 kV related to E33 Memory Location	
E39	FLUORO mA display calibration at 80 kV related to E33 Memory Location	
E40	FLUORO mA display calibration at 110 kV related to E33 Memory Location	
E41	Not used.	
E42	TUBE-2 – Filament setting for Continuous Fluoro and High Dose in Automatic Mode (ABC) at 20 R/min	
E43	FLUORO mA Display calibration at 50 kV related to E42 Memory Location	
E44	FLUORO mA display calibration at 80 kV related to E42 Memory Location	
E45	FLUORO mA display calibration at 110 kV related to E42 Memory Location	
E46	Fluoro selection: Continuous Fluoro only (0), Continuous and Pulsed Fluoro (1), or Pulsed Fluoro only (2).	
E47	Not used.	
E48	Not used.	
E49	Not used.	
E50	Not used.	
E51	TUBE-2 – Filament setting for Continuous Fluoro and Manual Mode (Non-ABC) at 5 R/min	
E52	FLUORO mA Display calibration at 50 kV related to E51 Memory Location	
E53	FLUORO mA display calibration at 80 kV related to E51 Memory Location	
E54	FLUORO mA display calibration at 110 kV related to E51 Memory Location	
E55	Not used.	
E56	Not used.	
E57	Not used.	
E58	Not used.	
E59	TUBE-2 – Filament setting for Pulsed Fluoro and Manual Mode (Non-ABC) at 5 R/min	
E60	FLUORO mA Display calibration at 50 kV related to E59 Memory Location	
E61	FLUORO mA display calibration at 80 kV related to E59 Memory Location	
E62	FLUORO mA display calibration at 110 kV related to E59 Memory Location	
E63	Not used.	
E64	Not used.	
E65	Not used.	
E66	Not used.	

2.2 HOW TO ENTER AND STORE DATA IN THE EXTENDED MEMORY

The Extended Memory data are entered from the Console when the unit is in service mode. Access to memory locations as indicated below:

1. Turn the Generator OFF and set the Test dip switch 3024SW2-3 on the ATP Console CPU Board in *"**On**"* position to permit the service mode.

2. Power ON the System and select the "*Manual Calibration*" button on the GSM program.

3. Select the needed Workstation (WS) using the "*Up*" and "*Down*" buttons, then press the "*OK*" button to enter in calibration mode.

Note ☞ *In calibration mode, only the kV and mA parameters can be modified, values for Time and mAs are factory programmed.*

4. Increase the mA value beyond the maximum mA position. The mA Display will show the first Extended Memory location (E01), they will continue sequentially as the "*Increase mA*" button is pressed.

   The values stored in each location are shown on the "*Calibration Value*" Display after pressing the "*Read*" button or after pressing the "*Increase*" or "*Decrease*" buttons of this panel. Since these buttons are also used to increase or decrease the stored values, one number should be added or subtracted from the reading, to obtain the current stored value.

5. Select the new value by pressing the *"Increase" and "Decrease"* buttons. Each time these buttons are pressed the value displayed on the calibration panel is increased or decreased one step.

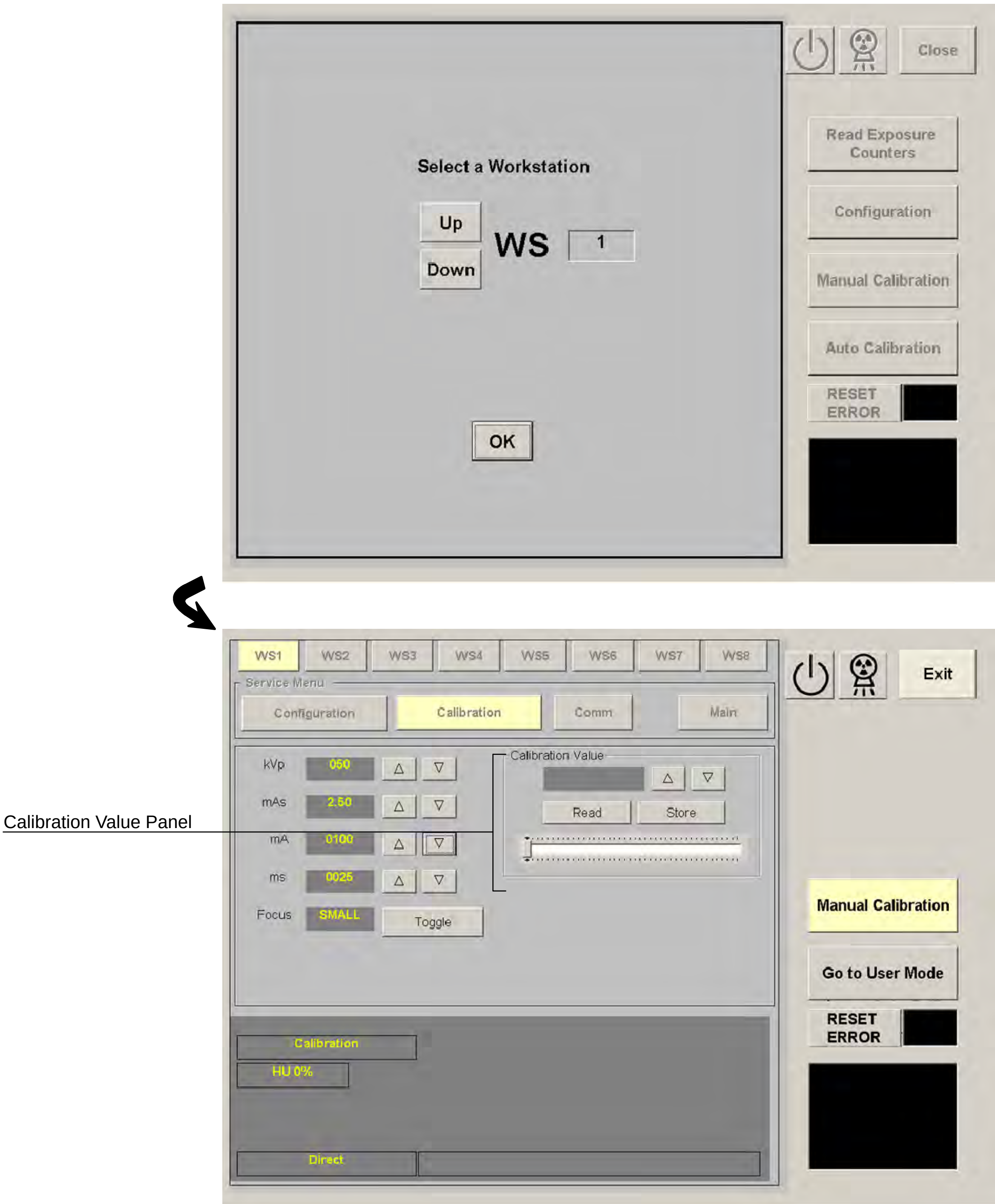
6. Store the new value by pressing the "*Store*" button (Check-summ function).

Note ☞ *If the "Store" button is not pressed after a new value is selected, no modified data will be retained.*

7. Exit from calibration mode by pressing the "*Manual Calibration*" button again.

8. Turn the Generator OFF and set dip switch 3024SW2-3 on the ATP Console CPU Board in *"**Off**"* position to place the Generator in normal mode.

Illustration 2-1
Calibration



2.3 LIMIT OF MAXIMUM kW

The Maximum kW of the Generator is factory set according to the Generator performance. Generator kW can be limited to a lower value.

Note ☞ *This limit can be set to a lower value to match the maximum Generator power to the Line power, due to a high line impedance (refer to Pre-installation document).*

1. Enter in calibration mode by pressing the "*Manual Calibration*" button on the GSM program. Select any workstation (WS) and press the "*OK*" button.
2. Select the E07 Memory Location (memory location is shown on the mA Display).
3. Set the new limit of Maximum kW by pressing the *"Increase" or "Decrease"* calibration buttons and store the value by pressing the "*Store*" button.
4. Exit from calibration mode.

Note ☞ *Record configuration data for E07 in the Data Book.*

SECTION 3 X-RAY TUBE SELECTION

3.1 X-RAY TUBE INSERT PROTECTION CURVES

In order to properly select the X-ray Tube Insert Protection Curves for the Tubes connected to the Generator, perform the following procedure:

1. Enter in calibration mode by pressing the "*Manual Calibration*" button on the GSM program. Select one of the workstation (WS) related to the X-ray Tube to be configured. Then press the "*OK*" button.
2. Select the respective memory location, E02 for Tube-1 or E18 for Tube-2 (memory location is shown on the mA Display).
3. Identify in Section 4 "*X-ray Tube Data*", the X-ray tube that is being installed and note its tube type number.
4. Set the tube number by pressing the *"Increase" or "Decrease"* calibration buttons until the correct number is showed on the "*Calibration Value*" panel.
5. Store the value by pressing the "*Store*" button.
6. Verify that the tube code (ID) shown in the mAs Display is the same of the tube code listed in Section 4 "*X-ray Tube Data*". The tube code (ID) can be only read for the selected X-ray Tube after pressing the "*Store*" button.
7. If required, repeat this procedure for the other X-ray Tube.
8. Exit from calibration mode.

Note ☞ *Record configuration data for E02 and E18 in the Data Book.*

3.2 GENERATORS WITH LF-RAC (LOW SPEED STARTER)

3.2.1 STATOR VOLTAGE AND CAPACITOR SELECTION

Check that the capacitor value of the Low Speed Starter corresponds to the value recommended by the X-ray Tube manufacturer. If needed replace the capacitor. Also, the Rotor speed must be indicated by the manufacturer.

The DC Brake of the Low Speed Starter (LF-RAC) can be removed by desoldering CR6 on the LF-RAC Board (*refer to schematic 543020xx*). In this case, the Tube will remain coasting after releasing the "*Prep*" or the "*Fluoro*" order.

3.2.1.1 CONFIGURATION FOR ONE OR TWO TUBES WITH STANDARD STATOR

Voltage and capacitor is factory set to 220 VAC, 30 μF. In all cases, refer to X-ray Tube Product Data.

3.2.1.2 CONFIGURATION FOR ONE OR TWO TUBES WITH THE SAME STARTING VOLTAGE AT 110 VAC

When the stator requires a starting voltage of 110 VAC (a.e. X-ray Tube Toshiba or Canon E7239 / E7240 / E7242 / E7252 / E7299 / E7813 / E7865) perform the following modifications:

- If the Power Input Transformer 6T2 is for using with power lines up to 240 VAC (part number 50509030), remove the wire labelled as "4" that is connected to Terminal 4 (230 VAC RTR) and connect it to Terminal 3 or 8 (110 VAC).
- If the Power Input Transformer 6T2 is for using with power lines up to 530 VAC (part number 50509029), remove the wire labelled as "4" that is connected to Terminal 4 (230 VAC RTR) and connect it to Terminal 40 (110 VAC).
- For X-ray Tube Toshiba or Canon E7252 or E7813 (or when it is required) replace also the Fuse F1 (6A) on the LF-RAC Board by another fuse of 10 A.

These changes affect to all the Tubes connected to Generator.

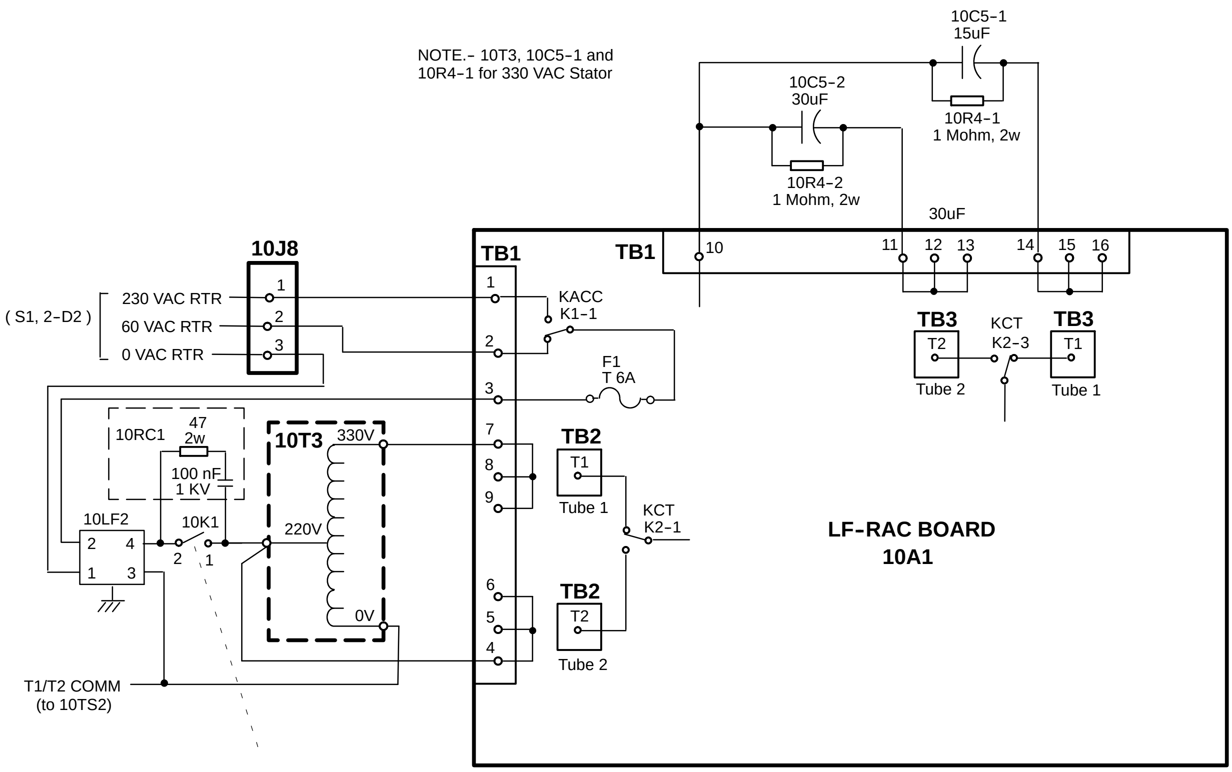
3.2.1.3 CONFIGURATION FOR TWO TUBES WITH DIFFERENT STARTING VOLTAGE AND CAPACITOR OR ONE TUBE WITH STARTING VOLTAGE AT 330 VAC

For Generators equipped with a LF-RAC module for two X-ray Tubes, with possible selection of voltage and capacitor jumpers on the LF-RAC Board, set jumpers according to the respective X-ray Tube(s) as indicated below.

TWO TUBES WITH STARTING VOLTAGE AT 220 VAC AND 330 VAC OR ONE TUBE WITH STARTING VOLTAGE AT 330 VAC

(A "Kit of 330 VAC" is required with this configuration).

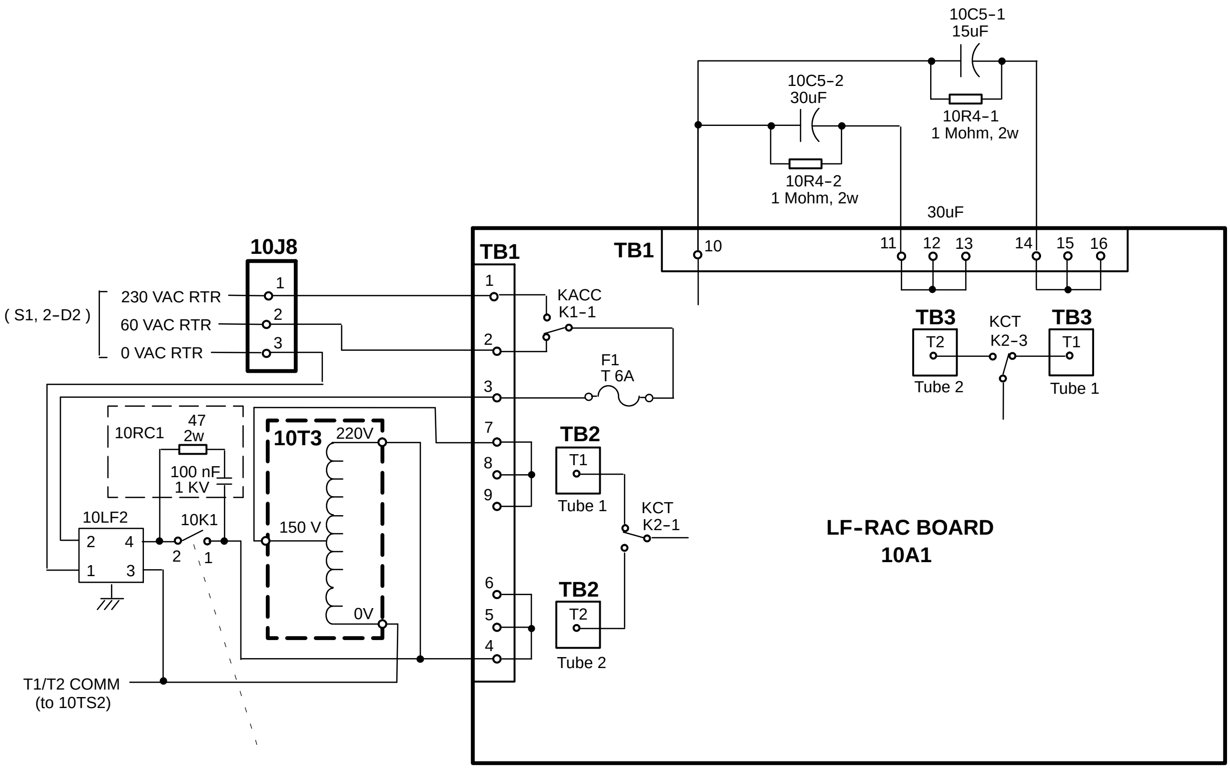
		TUBE-1	TUBE-2
VOLTAGE	220 VAC	TB2-T1 with TB1-5 or TB1-6	TB2-T2 with TB1-5 or TB1-6
	330 VAC	TB2-T1 with TB1-8 or TB1-9	TB2-T2 with TB1-8 or TB1-9
CAPACITOR	30 µF	TB3-T1 with TB1-12 or TB1-13	TB3-T2 with TB1-12 or TB1-13
	15 µF	TB3-T1 with TB1-15 or TB1-16	TB3-T2 with TB1-15 or TB1-16



TWO TUBES WITH STARTING VOLTAGE AT 220 VAC AND 110 VAC

(A “Kit of 110 VAC” is required with this configuration).

		TUBE-1	TUBE-2
VOLTAGE	**220 VAC**	TB2-T1 with TB1-5 or TB1-6	TB2-T2 with TB1-5 or TB1-6
	150 VAC	TB2-T1 with TB1-8 or TB1-9	TB2-T2 with TB1-8 or TB1–9
CAPACITOR	**30 μF**	TB3-T1 with TB1-12 or TB1-13	TB3-T2 with TB1-12 or TB1-13
	15 μF	TB3-T1 with TB1-15 or TB1-16	TB3-T2 with TB1-15 or TB1-16



3.2.2 PROGRAMMING OF ROTOR ACCELERATION TIME, RAD FILAMENT SETTING TIME, FLUORO ROTOR AND FILAMENT HOLD-OVER TIME

CAUTION

Rotor Acceleration Time is determined by the X-ray Tube and Rotor characteristics and it must be considered when the Generator is about to be configured. X-ray Tube could be permanently damaged unless the required RPM are reached before an exposure. (Refer to technical information of the X-ray Tube).

Dip Switch 3000SW2 on the HT Controller Board is used to program:

- *Rotor Acceleration Time*. That depends on stator voltage, stator frequency, stator type, quality of X-ray tube bearings, and X-ray tube anode size. A reed tachometer or a stroboscope can be used to determine the anode RPM. Be sure that the Rotor Acceleration Times meet all requirements for anticipated customer applications.

  This value is programmable from 0.8 to 2.7 seconds. After this time the Rotor is hold running in maintaining mode as long as “*Prep*” is active.

- *Rad Filament Setting Time*. This parameter has the same configuration value than the Rotor Acceleration Time. Sometimes, if it is required to increase the Rad Filament Setting Time to the next value, configure the respective switches again. This adjustment avoids Error-12.

- *Fluoro Rotor Hold-over Time and Fluoro Filament Hold-over Time*. This value can be programmed to run for 1 minute or not at all, after releasing the Fluoro Pedal.

Note ☞ *The Rotor Acceleration Time and Rad Filament Setting Time is factory set to 1.8 seconds. The Fluoro Rotor Hold-over Time and Fluoro Filament Hold-over Time is factory set to 1 minute. Maintain this value when it is unknown or not provided with the X-ray Tube documentation.*

1. Turn the Generator OFF and note current settings of the dip switch 3000SW2 on the HT Controller Board.

Note ☞ *Configuration of these times are only allowed when dip switch 3000SW2-1 is in “Closed” (On) position after power the Generator OFF and back ON again.*

2. Set dip switches 3000SW2-1 and 3000SW2-2 as indicated below, in order to enable the selection of times with the Low Speed Starter. ***Dip switch3000SW2-1 has to be switched ONLY with the Generator powered OFF.***

3000SW2-1 (selection enable)	3000SW2-2 (Low Speed Starter)
ON	OFF

3. Configure the Rotor and Filament Times by setting the dip switches 3000SW2-4 through 3000SW2-8 per Table 3-1.

Table 3-1
Low Speed: Configuration of Rotor and Filament Times

TUBE-1 ROTOR ACCELERATION TIME AND FILAMENT SETTING TIME	3000SW2-7		3000SW2-8	
	OPEN (OFF)	CLOSED (ON)	OPEN (OFF)	CLOSED (ON)
0.8 seconds		❑		❑
1.2 seconds	❑			❑
1.8 seconds		❑	❑	
2.7 seconds	❑		❑	

TUBE-2 ROTOR ACCELERATION TIME AND FILAMENT SETTING TIME	3000SW2-5		3000SW2-6	
	OPEN (OFF)	CLOSED (ON)	OPEN (OFF)	CLOSED (ON)
0.8 seconds		❑		❑
1.2 seconds	❑			❑
1.8 seconds		❑	❑	
2.7 seconds	❑		❑	

FLUORO ROTOR AND FILAMENT HOLD-OVER TIME	3000SW2-4	
	OPEN (OFF)	CLOSED (ON)
After releasing the Fluoro Pedal, the Rotor stops and the Filament Current goes back to stand-by.		❑
After releasing the Fluoro Pedal, 1 minutes passes before the Rotor stops and the Filament Current goes back to stand-by.	❑	

Note ☞ *Record the switch configuration in the Data Book.*

4. To validate previous configuration, turn the Generator ON, wait until Error–01 (E01) appears on the Console and turn the Generator OFF.

5. Set dip switch 3000SW2 to the original settings as noted in step-1. (*Refer to Section 1.1.5 for the normal settings of Dip Switch 3000SW2*).

3.3 GENERATORS WITH LV-DRAC (HIGH SPEED STARTER)

3.3.1 ANODE STATOR SELECTION

For Generators with High Speed Starter, **configure NOW** the X-ray Tube Family (anode stator + insert) by setting the respective dip switches 3243SW1 (pos. 4 to 8) and / or 3243SW2 (pos. 4 to 8) on the Control DRAC Board. (*Refer to "LV-DRAC - Digital Rotating Anode Controller" document*).

Configuration of these dip switches automatically determines the appropriate Starting and Running Stator Voltage and Rotor Acceleration Time of the selected Tube Family.

3.3.2 PROGRAMMING OF RAD FILAMENT SETTING TIME AND FLUORO FILAMENT HOLD-OVER TIME

Note ☞

With High Speed operation:

– Rotor Acceleration Time is related to the X-ray Tube Family configured on the Control DRAC Board (LV-DRAC).

– Fluoro and Spot Film Rotor Hold-over Times are configured on the Control DRAC Board (LV-DRAC).

– Rad Filament Setting Time and Fluoro Filament Hold-over Time are configured with dip switch 3000SW2 per this instruction.

Dip Switch 3000SW2 on the HT Controller Board is used to program:

- *Rad Filament Setting Time*. This value is programmable from 0.8 to 2.7 seconds. It can be initially set as the same value assigned for the Rotor Acceleration Time *(refer to technical information of the X-ray Tube)*

  Sometimes, if it is required to increase the Rad Filament Setting Time to the next value, configure the respective switches again. This adjustment avoids Error-12.

- *Fluoro Rotor Hold-over Time and Fluoro Filament Hold-over Time*. This value can be programmed to run for 1 minute or not at all, after releasing the Fluoro Pedal.

Note ☞ *The Rad Filament Setting Time is factory set to 1.8 seconds. The Fluoro Filament Hold-over Time is factory set to 1 minute. Maintain this value when it is unknown or not provided with the X-ray Tube documentation.*

1. Turn the Generator OFF and note current settings of the dip switch 3000SW2 on the HT Controller Board.

Note ☞ *Configuration of these times are only allowed when dip switch 3000SW2-1 is in "Closed" (On) position after power the Generator OFF and back ON again.*

2. Set dip switches 3000SW2-1 and 3000SW2-2 as indicated below, in order to enable the selection of times with the High Speed Starter. ***Dip switch3000SW2-1 has to be switched ONLY with the Generator powered OFF.***

3000SW2-1 (selection enable)	**3000SW2-2 (High Speed Starter)**
ON	ON

3. Configure the Filament Setting Times by setting the dip switches 3000SW2-4 through 3000SW2-8 per Table 3-2. The Filament Setting Time should be configured in accordance to Rotor Acceleration Time of the X-ray Tube.

Table 3-2
High Speed: Configuration of Filament Setting Time

TUBE-1 FILAMENT SETTING TIME	3000SW2-7		3000SW2-8	
	OPEN (OFF)	CLOSED (ON)	OPEN (OFF)	CLOSED (ON)
0.8 seconds		❑		❑
1.2 seconds	❑			❑
1.8 seconds		❑	❑	
2.7 seconds	❑		❑	

TUBE-2 FILAMENT SETTING TIME	3000SW2-5		3000SW2-6	
	OPEN (OFF)	CLOSED (ON)	OPEN (OFF)	CLOSED (ON)
0.8 seconds		❑		❑
1.2 seconds	❑			❑
1.8 seconds		❑	❑	
2.7 seconds	❑		❑	

FLUORO FILAMENT HOLD-OVER TIME	3000SW2-4	
	OPEN (OFF)	CLOSED (ON)
After releasing the Fluoro Pedal, the Filament Current goes back to stand-by.		❑
After releasing the Fluoro Pedal, 1 minutes passes before the Filament Current goes back to stand-by.	❑	

Note ☞ *Record the switch configuration in the Data Book.*

4. To validate previous configuration, turn the Generator ON, wait until Error–01 (E01) appears on the Console and turn the Generator OFF.

5. Set dip switch 3000SW2 to the original settings as noted in step-1. (*Refer to Section 1.1.5 for the normal settings of Dip Switch 3000SW2*).

3.4 ANODE ROTATION TEST

Perform the following tests for each X-ray Tube in the installation, checking the low and high speed when it is required.

Note ☞

Two people are needed for these tests, one at the Console and the service engineer looking at the anode of the X-ray Tube. These tests also can be done by hearing the sound of the anode rotating.

WARNING

NEVER MAKE EXPOSURES DURING THE TESTS, THE PERSON CLOSE TO THE X-RAY TUBE WILL BE EXPOSED.

1. With the switch 3024SW2-3 on the ATP Console CPU Board in "***On***" position (service mode), turn the Console ON and select the corresponding X-ray Tube.

2. Select a low value for kVp and mAs for checking the Anode Rotation at Low Speed.

3. Press the "*Prep*" push-button and visually check that the Tube anode rotates in the proper way. (*Refer to the X-ray Tube documentation*).

4. Hold pressed the "*Prep*" push-button and check that the rotation speed of the Tube anode is in compliance with the X-ray Tube specifications.

   For this test is recommended to turn off the Tube filaments (switch 3000SW2-2 on the HT Controller in "***On***" position) and use a stroboscope to measure the anode speed.

5. Release the "*Prep*" push-button.

6. For Generators with LV-DRAC, select a high value for kVp and mAs for checking the Anode Rotation at High Speed. Repeat steps 3, 4 and 5.

7. If required for the second Tube, repeat this procedure.

3.5 FOCAL SPOTS CONFIGURATION

This configuration determines which mA station will be the smallest mA station for the Large Focal Spot. It is possible to configure all the mA stations for the Small Focal Spot or for the Large Focal Spot.

The smallest mA station for the Large Focal Spot must be selected according to the Tube ratings for the Small Filament and the customer preference.

WARNING

IF THE mA STATION FOR FOCAL SPOT CHANGE IS NOT CONFIGURED ACCORDING TO THE X-RAY TUBE RATINGS, THE TUBE FILAMENTS MAY BE PERMANENTLY DAMAGED.

1. With the generator OFF, set dip switch 3024SW2-3 on the ATP Console CPU Board in *"**On**"* position to permit the service mode.
2. Power ON the System. Enter in calibration mode by pressing the "*Manual Calibration*" button on the GSM program. Select any workstation (WS) of the corresponding X-ray Tube and press the "*OK*" button.
3. Select the smallest mA station for the Large Focal Spot using the "*Increase*" or "*Decrease*" mA buttons. When is required to configure all mA stations for the Small Focal Spot, select "*E01*" Memory Location.

Note ☞ *Default value is factory set at 200 mA except when using X-ray Tubes with Small Focal Spot smaller than 0.6 .*

4. Press the "*Toggle*" button to store the select mA station and then press the "*Confirm*" or "*Dismiss*" buttons to confirm or cancel the process. When it is confirmed, the ATP Console CPU Board emits a "double-beep".

WARNING

IF THE FOCAL SPOT SWITCH-OVER POINT IS CHANGED AFTER mA CALIBRATION, THE mA STATIONS AFFECTED MUST BE RE-CALIBRATED.

5. Exit from calibration mode.

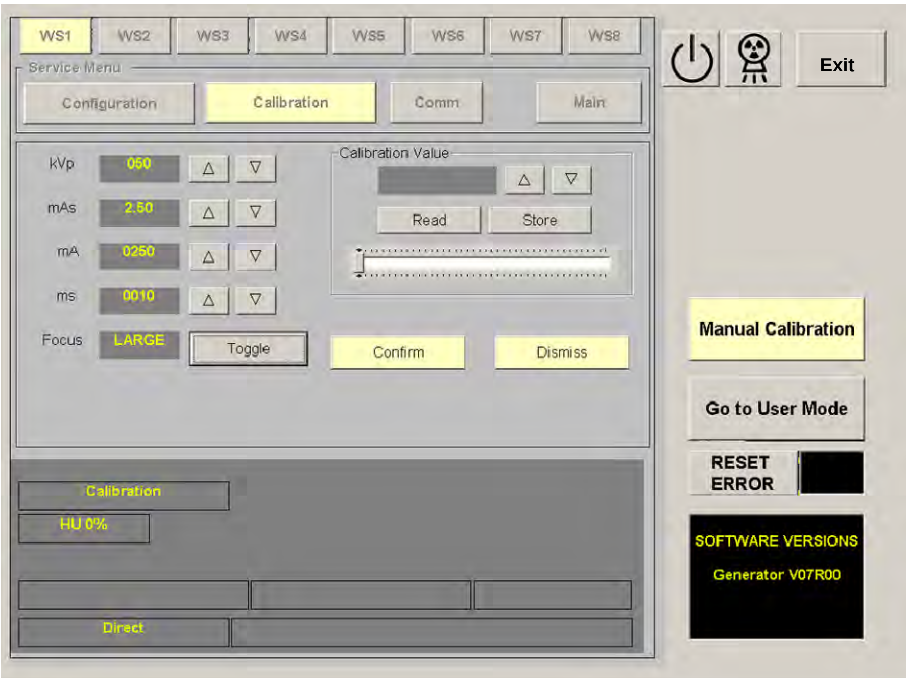
Perform the following test (*it is not mandatory*).

Note ☞ *The test described only applies to RAD Tubes.*

In case of a R&F Tube (Tube-2) both filament are always ON (lit). Select a "Direct" workstation and a mA station for the Small Filament. Press "Prep" for RAD and observe through the X-ray Tube window that the Small Filament lights more than the Large Filament.

1. Select the highest mA station for the Small Focal Spot. Verify that effectively the Small Filament is ON (lighted) and the Large Filament is OFF. Observe filaments through the X-ray tube window.
2. Select the lowest mA station for the Large Focal Spot. Verify that effectively the Large Filament is ON (lighted) and the Small Filament is OFF. Observe filaments through the X-ray tube window.
3. If required for the second tube, repeat this procedure.

Illustration 3-1
Focal Spots Configuration



SECTION 4 X-RAY TUBE DATA

The following table lists several common X-ray tubes and their corresponding number. If a specific tube is not listed, tube specifications are given to enable you chose a similar tube type. If none of the listed tubes are satisfactory, contact your generator supplier to obtain special software.

Table 4-1
X-ray Tube Numbers

TUBE NUMBER	TUBE CODE (ID)	MODEL	FOCAL SPOT	POWER RATINGS		KHU
				LS (kW)	HS (kW)	
001	139	TOSHIBA or CANON E7239X	1.0 / 2.0	22 / 45	–	133
002	201	TOSHIBA or CANON E7240X	0.6 / 1.2	15 / 30	–	140
003	140	TOSHIBA or CANON E7242X	0.6 / 1.5	18 / 49	–	187
004	090	TOSHIBA or CANON E7252X	0.6 / 1.2	15 / 42	26 / 73	300
005	412	TOSHIBA or CANON E7254FX	0.6 / 1.2	23 / 60	40 / 102	400
006	407	TOSHIBA or CANON E7884X	0.6 / 1.2	21 / 52		300
007	310	TOSHIBA or CANON E7843X	0.6 / 1.2	22 / 49	–	150
008	344	TOSHIBA or CANON E7865X	0.3 / 1.0	3 / 40	–	140
009	402	TOSHIBA or CANON E7876X	0.6 / 1.2	22 / 53		230
010	260	IAE RTM 101 HS	0.6 / 1.2	22 / 55	37 / 99	400
011	411	TOSHIBA or CANON E7886X	0.7 / 1.3	17 / 39		300
012	381	TOSHIBA or CANON E7869 X	0.6 / 1.2	21 / 55	36 / 96	600
013	404	VARIAN RAD 14	0.6 / 1.2	21 / 54	32 / 77	300
014	161	VARIAN RAD 21	0.6 / 1.2	21 / 64	36 / 100	300
015	265	VARIAN RAD 60	0.6 / 1.2	26 / 67	39 / 100	400
016	238	VARIAN RAD 74	0.6 / 1.5	20 / 52	–	200
017	252	VARIAN RAD 92	0.6 / 1.2	26 / 62	40 / 99	600
018	092	VARIAN A-192	0.6 / 1.2	25 / 63	40 / 96	300
019	309	VARIAN A196	0.6 / 1.0	20 / 47	32 / 72	350
020	094	VARIAN A-292	0.6 / 1.2	25 / 62	39 / 96	400
021	208	VARIAN G 292	0.6 / 1.2	25 / 63	39 / 95	600
022	051	GE-CGR MN 640	1.0 / 1.8	23 / 46	–	150
023	064	GE MAXIRAY-75	0.6 / 1.5	12 / 37	21 / 62	300
024	062	GE MAXIRAY-100	0.6 / 1.25	18 / 55	31 / 100	350
025	261	SIEMENS DR 154/30/50	1.2 / 1.8	31 / 53	–	200
026						
027						

Note .– Power Ratings are for 60 Hz. To calculate Power Ratings for 50 Hz multiply the values by 0.91 *TB54 (+K)*

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Technical Publication
DR-1004R21

LV-DRAC

Low Voltage - Digital Rotating Anode Controller

HF Series Generators

REVISION HISTORY

REVISION	DATE	REASON FOR CHANGE
18	OCT 16, 2017	Update of Tube list (soft V10R3.10.2) and schematic A3243-04I
19	JUL 13, 2018	Self-Running Mode selection with Switch 3243SW3-2 and Anode Rotation during Fluoro with Switch 3243SW3-4 (soft V10R3.10.3)
20	JUL 05, 2019	Document update with information for both software versions (V10R3.10.2 and V10R3.10.3) and schematic A3243–04J. Identification of Tubes as “Toshiba or Canon”
21	JUN 04, 2020	Schematic A3243–04K.

This Document is the English original version, edited and supplied by the manufacturer.

The Revision state of this Document is indicated in the code number shown at the bottom of this page.

ADVISORY SYMBOLS

The following advisory symbols will be used throughout this manual. Their application and meaning are described below.

DANGERS ADVISE OF CONDITIONS OR SITUATIONS THAT IF NOT HEEDED OR AVOIDED WILL CAUSE SERIOUS PERSONAL INJURY OR DEATH.

ADVISE OF CONDITIONS OR SITUATIONS THAT IF NOT HEEDED OR AVOIDED COULD CAUSE SERIOUS PERSONAL INJURY, OR CATASTROPHIC DAMAGE OF EQUIPMENT OR DATA.

Advise of conditions or situations that if not heeded or avoided could cause personal injury or damage to equipment or data.

Note ☞

Alert readers to pertinent facts and conditions. Notes represent information that is important to know but which do not necessarily relate to possible injury or damage to equipment.

TABLE OF CONTENTS

SECTION 1 CONFIGURATION

Note ☞

This document ONLY applies to High Speed Generators supplied with the LV-DRAC (Low Voltage - Digital Rotating Anode Controller).

The LV-DRAC is a High Speed Rotor Controller located on the Generator Cabinet. Its configuration is made through dip switches 3243SW1 to 3243SW4 on the Control DRAC Board.

WARNING

DEPENDING ON THE SOFTWARE VERSION INSTALLED IN THE LV-DRAC CONTROL BOARD (V10R3.10.2 AND V10R3.10.3), THE FUNCTION OF SOME SWITCHES IS DIFFERENT. PAY SPECIAL ATTENTION TO THE INDICATED VERSIONS AND CONFIGURE EACH SWITCH CORRECTLY.

DANGER !

BEFORE MANIPULATING THE LV-DRAC, MAKE SURE THAT THE INPUT LINE IS DISCONNECTED AND THE CAPACITOR BANK IS PROPERLY DISCHARGED. WAIT UNTIL LEDS DL7 AND DL8 ON THE CONTROL DRAC BOARD ARE OFF.

1.1 SWITCH CONFIGURATION WITH SOFTWARE V10R3.10.2

The Function of these switches is the following:

3243SW1-x	FUNCTION	REMARKS
1	MINIMUM TIME FOR READY (DELAY)	*For further information about these switches refer to Section 1.5*
2		
3		
4	TUBE TYPE SELECTION FOR TUBE-1	**Set dip switches in accordance with the tables for Conventional or Mammographic use.** Also refer to position of dip switches: 3243SW3-5, 3243SW3-7, 3243SW3-8 *For further information about these switches refer to Section 1.3*
5		
6		
7		
8		

3243SW2-x	FUNCTION	REMARKS
1	FLUORO HOLD-OVER TIME	*For further information about these switches refer to Section 1.6*
2		
3		
4	TUBE TYPE SELECTION FOR TUBE-2	**Set dip switches in accordance with the tables for Conventional or Mammographic use.** Also refer to position of dip switches: 3243SW4-5, 3243SW3-7, 3243SW3-8 *For further information about these switches refer to Section 1.4*
5		
6		
7		
8		

3243SW3-x	FUNCTION	REMARKS
1	LOW SPEED ROTATION BRAKE MODE (3300 rpm to 0 rpm)	ON = INHIBITED OFF = ACTIVATED
2	NOT USED*	
3	SPOT FILM HIGH SPEED START MODE	ON = SPOT FILM ALWAYS STARTS IN HIGH SPEED (10000 RPM) OFF = SPOT FILM STARTS AT REQUIRED SPEED
4	ANODE ROTATION DURING FLUORO	ON = HIGH SPEED ANODE ROTATION DURING FLUORO. FLUORO STARTS IN HIGH SPEED. OFF = LOW SPEED ANODE ROTATION DURING FLUORO. FLUORO STARTS IN LOW SPEED. *Usually Fluoro starts in Low Speed, so It is recommended to set this switch in “OFF”.*
5	TUBE-1 SELECTION DEPENDING ON THE TUBE LIST	ON = WHEN THE TUBE CONFIGURED AS TUBE-1 IS LISTED ON TUBE TABLE-1 OFF = WHEN THE TUBE CONFIGURED AS TUBE-1 IS LISTED ON TUBE TABLE-2 *For further information about these switches refer to Section 1.3*
6	PORT FLUORO MODE	ON = ENABLED PORT FLUORO. USED FOR GENERATORS WITH FLUORO. OFF = DISABLED PORT FLUORO. USED FOR GENERATORS WITH ONLY RAD.
7 8	TUBE TYPE SELECTION	ON = ALWAYS SET IN “ON” *For further information about these switches refer to Sections 1.3 and 1.4*

** Note: Set switches not used in “ON” position.*

3243SW4-x	FUNCTION	REMARKS
1	SPOT FILM HOLD TIME	*For further information about these switches refer to Section 1.7*
2		
3		
4		
5	TUBE-2 SELECTION DEPENDING ON THE TUBE LIST	ON = WHEN THE TUBE CONFIGURED AS TUBE-2 IS LISTED ON TUBE TABLE-1 OFF = WHEN THE TUBE CONFIGURED AS TUBE-2 IS LISTED ON TUBE TABLE-2 *For further information about these switches refer to Section 1.4*
6	SELF RUNNING MODE	ON = ENABLED SELF-RUNNING OFF = DISABLED SELF-RUNNING *For further information about these switches refer to Section 1.8*
7	PROTECTIONS – ERRORS	ON = INHIBITED OFF = ACTIVATED (NORMAL OPERATION MODE) *For further information about these switches refer to Section 1.9*
8	DC BRAKE MODE (FOR LOW AND HIGH SPEED)	ON = ACTIVATED OFF = INHIBITED

** Note: Set switches not used in "ON" position.*

1.2 SWITCH CONFIGURATION WITH SOFTWARE V10R3.10.3

The Function of these switches is the following:

3243SW1-x	FUNCTION	REMARKS
1	MINIMUM TIME FOR READY (DELAY)	*For further information about these switches refer to Section 1.5*
2		
3		
4	TUBE TYPE SELECTION FOR TUBE-1	**Set dip switches in accordance with the tables for Conventional or Mammographic use.** Also refer to position of dip switches: 3243SW3-5, 3243SW3-7, 3243SW3-8 *For further information about these switches refer to Section 1.3*
5		
6		
7		
8		

3243SW2-x	FUNCTION	REMARKS
1	FLUORO HOLD-OVER TIME	*For further information about these switches refer to Section 1.6*
2		
3		
4	TUBE TYPE SELECTION FOR TUBE-2	**Set dip switches in accordance with the tables for Conventional or Mammographic use.** Also refer to position of dip switches: 3243SW4-5, 3243SW3-7, 3243SW3-8 *For further information about these switches refer to Section 1.4*
5		
6		
7		
8		

3243SW3-x	FUNCTION	REMARKS
1	LOW SPEED ROTATION BRAKE MODE (3300 rpm to 0 rpm)	ON = INHIBITED OFF = ACTIVATED
2	CONFIGURATION OF THE “SELF RUNNING MODE”	ON = “SELF RUNNING MODE” STARTS EVERY TIME “PREPARATION” IS ACTIVATED OFF = “SELF RUNNING MODE” STARTS AFTER ACTIVATION OF “PREPARATION” IN THREE CONSECUTIVE TIMES *For further information about these switches refer to Section 1.8*
3	SPOT FILM HIGH SPEED START MODE	ON = SPOT FILM ALWAYS STARTS IN HIGH SPEED (10000 RPM) OFF = SPOT FILM STARTS AT REQUIRED SPEED
4	ANODE ROTATION DURING FLUORO	ON = LOW OR HIGH SPEED ANODE ROTATION DURING FLUORO, THAT IS, FLUORO STARTS AT THE SAME SPEED OF THE SELECTED SPEED FOR RAD. OFF = LOW SPEED ANODE ROTATION DURING FLUORO. FLUORO STARTS IN LOW SPEED. *Usually Fluoro starts in Low Speed, so it is recommended to set this switch in “OFF”.*
5	TUBE-1 SELECTION DEPENDING ON THE TUBE LIST	ON = WHEN THE TUBE CONFIGURED AS TUBE-1 IS LISTED ON TUBE TABLE-1 OFF = WHEN THE TUBE CONFIGURED AS TUBE-1 IS LISTED ON TUBE TABLE-2 *For further information about these switches refer to Section 1.3*
6	PORT FLUORO MODE	ON = ENABLED PORT FLUORO. USED FOR GENERATORS WITH FLUORO. OFF = DISABLED PORT FLUORO. USED FOR GENERATORS WITH ONLY RAD.
7 8	TUBE TYPE SELECTION	ON = ALWAYS SET IN “ON” *For further information about these switches refer to Sections 1.3 and 1.4*

** Note: Set switches not used in “ON” position.*

3243SW4-x	FUNCTION	REMARKS
1	SPOT FILM HOLD TIME	*For further information about these switches refer to Section 1.7*
2		
3		
4		
5	TUBE-2 SELECTION DEPENDING ON THE TUBE LIST	ON = WHEN THE TUBE CONFIGURED AS TUBE-2 IS LISTED ON TUBE TABLE-1 OFF = WHEN THE TUBE CONFIGURED AS TUBE-2 IS LISTED ON TUBE TABLE-2 *For further information about these switches refer to Section 1.4*
6	"SELF RUNNING MODE"	ON = ENABLED OFF = DISABLED *For further information about these switches refer to Section 1.8*
7	PROTECTIONS – ERRORS	ON = INHIBITED OFF = ACTIVATED (NORMAL OPERATION MODE) *For further information about these switches refer to Section 1.9*
8	DC BRAKE MODE (FOR LOW AND HIGH SPEED)	ON = ACTIVATED OFF = INHIBITED

** Note: Set switches not used in "ON" position.*

1.3 TUBE TYPE SELECTION FOR TUBE-1

<u>TUBE-1 for CONVENTIONAL USE in TUBE TABLE-1</u>

<table>
<tr><th rowspan="2">Pos</th><th rowspan="2">TUBE FAMILY
(Stator - ∅ Anode)</th><th colspan="8">SWITCH 3243SWx-x</th></tr>
<tr><th>SW1-4</th><th>SW1-5</th><th>SW1-6</th><th>SW1-7</th><th>SW1-8</th><th>SW3-5</th><th>SW3-7</th><th>SW3-8</th></tr>
<tr><td>0</td><td>GE MAXIRAY 75</td><td>ON</td><td>ON</td><td>ON</td><td>ON</td><td>ON</td><td rowspan="36">ON</td><td rowspan="36">ON</td><td rowspan="36">ON</td></tr>
<tr><td>1</td><td>GE MAXIRAY 100</td><td>OFF</td><td>ON</td><td>ON</td><td>ON</td><td>ON</td></tr>
<tr><td>2</td><td>VARIAN G-1582</td><td>ON</td><td>OFF</td><td>ON</td><td>ON</td><td>ON</td></tr>
<tr><td rowspan="2">3</td><td>VARIAN RAD-XX or EUREKA RAD-XX (3” Anode,
Emerald or Diamond Housing, R Stator, 20/50 ohm, 300 KHU)</td><td rowspan="2">OFF</td><td rowspan="2">OFF</td><td rowspan="2">ON</td><td rowspan="2">ON</td><td rowspan="2">ON</td></tr>
<tr><td>VARIAN A132 (3” Anode, 300 KHU)</td></tr>
<tr><td rowspan="4">4</td><td>VARIAN RAD-XX or EUREKA RAD-XX (4” Anode,
Sapphire Housing, R Stator (16/50 ohm or 20/50 ohm), 400 KHU)</td><td rowspan="4">ON</td><td rowspan="4">ON</td><td rowspan="4">OFF</td><td rowspan="4">ON</td><td rowspan="4">ON</td></tr>
<tr><td>VARIAN RAD-56 (4” Anode, Sapphire Housing,
R Stator (20/50 ohm), 400 KHU)</td></tr>
<tr><td>VARIAN A256 / A282 / A292 (4” Anode, B130 or B150 Housing,
R Stator (16/50 ohm or 20/50 ohm), 400 KHU)</td></tr>
<tr><td>TOSHIBA or CANON 7254X / 7255X / 7823 (4” Anode,
XS-RB Stator (20/38 ohm), 400 KHU)</td></tr>
<tr><td>5</td><td>VARIAN GS-2075 with B220 Housing</td><td>OFF</td><td>ON</td><td>OFF</td><td>ON</td><td>ON</td></tr>
<tr><td>6</td><td>SIEMENS 100 L BIANGULIX
SIEMENS 100 L OPTILIX</td><td>ON</td><td>OFF</td><td>OFF</td><td>ON</td><td>ON</td></tr>
<tr><td>7</td><td>PHILIPS SUPEROTALIX / PHILIPS SRO</td><td>OFF</td><td>OFF</td><td>OFF</td><td>ON</td><td>ON</td></tr>
<tr><td>8</td><td>DUNLEE PX-1302</td><td>ON</td><td>ON</td><td>ON</td><td>OFF</td><td>ON</td></tr>
<tr><td>9</td><td>CGR STATORIX 260 with RSN 742 / MSN 740</td><td>OFF</td><td>ON</td><td>ON</td><td>OFF</td><td>ON</td></tr>
<tr><td>10</td><td>CGR STATORIX 550 with RSN 722 / MSN 722
CGR STATORIX 550/240 with RN 620</td><td>ON</td><td>OFF</td><td>ON</td><td>OFF</td><td>ON</td></tr>
<tr><td>11</td><td>SIEMENS 100 G</td><td>OFF</td><td>OFF</td><td>ON</td><td>OFF</td><td>ON</td></tr>
<tr><td>12</td><td>SIEMENS RH 150/100</td><td>ON</td><td>ON</td><td>OFF</td><td>OFF</td><td>ON</td></tr>
<tr><td>13</td><td>COMET DO-10 (4” Anode)</td><td>OFF</td><td>ON</td><td>OFF</td><td>OFF</td><td>ON</td></tr>
<tr><td>14</td><td>COMET DO-9 (4” Anode)</td><td>ON</td><td>OFF</td><td>OFF</td><td>OFF</td><td>ON</td></tr>
<tr><td>15</td><td>CGR STATORIX 240 with MN 620 / M 641 / RN 620
CGR STATORIX 240/260 with MN 640</td><td>OFF</td><td>OFF</td><td>OFF</td><td>OFF</td><td>ON</td></tr>
<tr><td>16</td><td>PICKER PX-307</td><td>ON</td><td>ON</td><td>ON</td><td>ON</td><td>OFF</td></tr>
<tr><td>17</td><td>HANGZHOU XD-52-30, 50/150</td><td>OFF</td><td>ON</td><td>ON</td><td>ON</td><td>OFF</td></tr>
<tr><td>18</td><td>DUNLEE PX-1312</td><td>ON</td><td>OFF</td><td>ON</td><td>ON</td><td>OFF</td></tr>
<tr><td>19</td><td>DUNLEE PX-1456 / PX-1436 / PX-1400 (Q Stator)</td><td>OFF</td><td>OFF</td><td>ON</td><td>ON</td><td>OFF</td></tr>
<tr><td>20</td><td>COMET DX-1000</td><td>ON</td><td>ON</td><td>OFF</td><td>ON</td><td>OFF</td></tr>
<tr><td>21</td><td>COMET DX-81 / COMET XSTAR-14</td><td>OFF</td><td>ON</td><td>OFF</td><td>ON</td><td>OFF</td></tr>
<tr><td>22</td><td>PHILIPS ROTALIX 350/351</td><td>ON</td><td>OFF</td><td>OFF</td><td>ON</td><td>OFF</td></tr>
<tr><td>23</td><td>VARIAN G892/G896 (with B147 Housing) (4” Anode, 16/50 ohm, 837 KHU)</td><td>OFF</td><td>OFF</td><td>OFF</td><td>ON</td><td>OFF</td></tr>
<tr><td>24</td><td>TOSHIBA or CANON XRR-3331-X (XR-AL, 3” Anode, 300 KHU)</td><td>ON</td><td>ON</td><td>ON</td><td>OFF</td><td>OFF</td></tr>
<tr><td>25</td><td>VARIAN with B160 / B165 Housing</td><td>OFF</td><td>ON</td><td>ON</td><td>OFF</td><td>OFF</td></tr>
<tr><td>26</td><td>TOSHIBA or CANON E7252X (XS-AL Stator)</td><td>ON</td><td>OFF</td><td>ON</td><td>OFF</td><td>OFF</td></tr>
<tr><td>27</td><td>COMET DX 700 HS</td><td>OFF</td><td>OFF</td><td>ON</td><td>OFF</td><td>OFF</td></tr>
<tr><td>28</td><td>VARIAN A182 / A192 / A196 / A197 (with B130 Housing)</td><td>ON</td><td>ON</td><td>OFF</td><td>OFF</td><td>OFF</td></tr>
<tr><td>29</td><td>VARIAN G 1592</td><td>OFF</td><td>ON</td><td>OFF</td><td>OFF</td><td>OFF</td></tr>
<tr><td>30</td><td>PICKER PX400P + PX457P</td><td>ON</td><td>OFF</td><td>OFF</td><td>OFF</td><td>OFF</td></tr>
<tr><td>31</td><td>JUGORENDGEN RX 150/30 - 50</td><td>OFF</td><td>OFF</td><td>OFF</td><td>OFF</td><td>OFF</td></tr>
</table>

TUBE-1 for CONVENTIONAL USE in TUBE TABLE-2

Pos	TUBE FAMILY (Stator - ∅ Anode)	SWITCH 3243SWx-x							
		SW1-4	SW1-5	SW1-6	SW1-7	SW1-8	SW3-5	SW3-7	SW3-8
0	VARIAN GS-20711 (B220H Housing, R Stator)	ON	ON	ON	ON	ON			
1	SIEMENS 100 L-W	OFF	ON	ON	ON	ON			
2	SIEMENS SV 125/15/82	ON	OFF	ON	ON	ON			
3	IAE RTM90 / IAE RTM92 (C52 / C352 Housing)	OFF	OFF	ON	ON	ON			
4	IAE RTM101HS / IAE RTM102HS (C100 Housing)	ON	ON	OFF	ON	ON			
5	DUNLEE DA 1036 - DU 404	OFF	ON	OFF	ON	ON			
6	DUNLEE DA 1094 - DU 694 / DU 692	ON	OFF	OFF	ON	ON			
7	DUNLEE DR 1817 / 1825 (High Impedance Stator)	OFF	OFF	OFF	ON	ON			
8	CGR STATORIX 240 / 260 with MSN 740 / MSN 742	ON	ON	ON	OFF	ON			
9	IAE RTC 700 HS (C52S or C100XT Housing)	OFF	ON	ON	OFF	ON			
10	VARIAN GS 30711	ON	OFF	ON	OFF	ON			
11	VARIAN G292 / G294 / G256 / G297 (B130 Housing)	OFF	OFF	ON	OFF	ON			
12	IAE RTM101HS / RTM102HS (C52S Housing)	ON	ON	OFF	OFF	ON			
13	IAE RTC1000HS (C52S or C100XT Housing)	OFF	ON	OFF	OFF	ON			
14	TOSHIBA or CANON ROTANODE E7100X (4” Anode, 9/28 ohm, RTM, 300 kHU)	ON	OFF	OFF	OFF	ON			
15	DUNLEE DA 1083 / PX 1483 (DU 404 / DA10 Housing, C Stator)	OFF	OFF	OFF	OFF	ON			
16	VARIAN A277 / A288 (B130H and B150H Housing, R Stator)	ON	ON	ON	ON	OFF			
17	VARIAN G1092 (B160 / B165 Housing, R Stator)	OFF	ON	ON	ON	OFF	OFF	ON	ON
18	DUNLEE PX1473Q - DU 604	ON	OFF	ON	ON	OFF			
19	TOSHIBA or CANON E7260DX	OFF	OFF	ON	ON	OFF			
20	VARIAN HE100 (B180 / B185 Housing, R Stator)	ON	ON	OFF	ON	OFF			
21	IAE RTC 137 (CT 180 Housing)	OFF	ON	OFF	ON	OFF			
22	VARIAN A102 (B100 Housing)	ON	OFF	OFF	ON	OFF			
23	IAE X40 (C352 Housing (only Low Speed)) IAE RTM78HS (C352 Housing)	OFF	OFF	OFF	ON	OFF			
24	VARIAN RAD-92 / RAD-94 (4” Anode, Sapphire Housing, R Stator, 20/50 ohm, 600 KHU) VARIAN SG296B (B199-R Housing) VARIAN G296 (B130 Housing) IAE RTC600 HS (4” Anode, C100 Housing, 20/40 ohm, 600 KHU)	ON	ON	ON	OFF	OFF			
25	TOSHIBA or CANON ROTANODE E7867X / E7869X	OFF	ON	ON	OFF	OFF			
26	TOSHIBA or CANON ROTANODE E7239X / E7240X / E7242X / E7865X	ON	OFF	ON	OFF	OFF			
27	TOSHIBA or CANON ROTANODE E7864X (4” Anode, 9/28 ohm, 400 KHU)	OFF	OFF	ON	OFF	OFF			
28	SIEMENS RAY-14_1 (SV150/33/78S Insert)	ON	ON	OFF	OFF	OFF			
29	TOSHIBA or CANON ROTANODE E7252X (XS-R Stator) TOSHIBA or CANON ROTANODE E7886X (27/58 ohm Stator)	OFF	ON	OFF	OFF	OFF			
30	ATX 10WX-692 / 1463 (ATI692) (4” Anode, C Stator, 47/60 ohm, 600 KHU)	ON	OFF	OFF	OFF	OFF			
31	PHILIPS SRM 1551 ROT500	OFF	OFF	OFF	OFF	OFF			

TUBE-1 for MAMMOGRAPHIC USE in TUBE TABLE-1

<table>
<tr><th rowspan="2">Pos</th><th rowspan="2">TUBE FAMILY
(Stator - ∅ Anode)</th><th colspan="8">SWITCH 3243SWx-x</th></tr>
<tr><th>SW1-4</th><th>SW1-5</th><th>SW1-6</th><th>SW1-7</th><th>SW1-8</th><th>SW3-5</th><th>SW3-7</th><th>SW3-8</th></tr>
<tr><td>0</td><td></td><td>ON</td><td>ON</td><td>ON</td><td>ON</td><td>ON</td><td rowspan="32">ON</td><td rowspan="32">ON</td><td rowspan="32">ON</td></tr>
<tr><td>1</td><td></td><td>OFF</td><td>ON</td><td>ON</td><td>ON</td><td>ON</td></tr>
<tr><td>2</td><td></td><td>ON</td><td>OFF</td><td>ON</td><td>ON</td><td>ON</td></tr>
<tr><td>3</td><td>IAE XM1016T (3” Anode, 20/40 ohm, 300 KHU) (MAMMO)</td><td>OFF</td><td>OFF</td><td>ON</td><td>ON</td><td>ON</td></tr>
<tr><td>4</td><td></td><td>ON</td><td>ON</td><td>OFF</td><td>ON</td><td>ON</td></tr>
<tr><td>5</td><td>CGR STATORIX M50 (MAMMO)</td><td>OFF</td><td>ON</td><td>OFF</td><td>ON</td><td>ON</td></tr>
<tr><td>6</td><td></td><td>ON</td><td>OFF</td><td>OFF</td><td>ON</td><td>ON</td></tr>
<tr><td>7</td><td></td><td>OFF</td><td>OFF</td><td>OFF</td><td>ON</td><td>ON</td></tr>
<tr><td>8</td><td></td><td>ON</td><td>ON</td><td>ON</td><td>OFF</td><td>ON</td></tr>
<tr><td>9</td><td></td><td>OFF</td><td>ON</td><td>ON</td><td>OFF</td><td>ON</td></tr>
<tr><td>10</td><td></td><td>ON</td><td>OFF</td><td>ON</td><td>OFF</td><td>ON</td></tr>
<tr><td>11</td><td></td><td>OFF</td><td>OFF</td><td>ON</td><td>OFF</td><td>ON</td></tr>
<tr><td>12</td><td></td><td>ON</td><td>ON</td><td>OFF</td><td>OFF</td><td>ON</td></tr>
<tr><td>13</td><td></td><td>OFF</td><td>ON</td><td>OFF</td><td>OFF</td><td>ON</td></tr>
<tr><td>14</td><td></td><td>ON</td><td>OFF</td><td>OFF</td><td>OFF</td><td>ON</td></tr>
<tr><td>15</td><td></td><td>OFF</td><td>OFF</td><td>OFF</td><td>OFF</td><td>ON</td></tr>
<tr><td>16</td><td></td><td>ON</td><td>ON</td><td>ON</td><td>ON</td><td>OFF</td></tr>
<tr><td>17</td><td></td><td>OFF</td><td>ON</td><td>ON</td><td>ON</td><td>OFF</td></tr>
<tr><td>18</td><td></td><td>ON</td><td>OFF</td><td>ON</td><td>ON</td><td>OFF</td></tr>
<tr><td>19</td><td></td><td>OFF</td><td>OFF</td><td>ON</td><td>ON</td><td>OFF</td></tr>
<tr><td>20</td><td></td><td>ON</td><td>ON</td><td>OFF</td><td>ON</td><td>OFF</td></tr>
<tr><td>21</td><td></td><td>OFF</td><td>ON</td><td>OFF</td><td>ON</td><td>OFF</td></tr>
<tr><td>22</td><td></td><td>ON</td><td>OFF</td><td>OFF</td><td>ON</td><td>OFF</td></tr>
<tr><td>23</td><td>COMET MOS-50 (MAMMO)</td><td>OFF</td><td>OFF</td><td>OFF</td><td>ON</td><td>OFF</td></tr>
<tr><td>24</td><td>VARIAN M103T with B115 Housing (MAMMO)
VARIAN M113 with B115 Housing (MAMMO)
VARIAN IM113T (MAMMO)
VARIAN RAD 85S with B112 Housing (3”, 16/50 ohm, 300 kHU) (MAMMO)</td><td>ON</td><td>ON</td><td>ON</td><td>OFF</td><td>OFF</td></tr>
<tr><td>25</td><td></td><td>OFF</td><td>ON</td><td>ON</td><td>OFF</td><td>OFF</td></tr>
<tr><td>26</td><td></td><td>ON</td><td>OFF</td><td>ON</td><td>OFF</td><td>OFF</td></tr>
<tr><td>27</td><td></td><td>OFF</td><td>OFF</td><td>ON</td><td>OFF</td><td>OFF</td></tr>
<tr><td>28</td><td></td><td>ON</td><td>ON</td><td>OFF</td><td>OFF</td><td>OFF</td></tr>
<tr><td>29</td><td></td><td>OFF</td><td>ON</td><td>OFF</td><td>OFF</td><td>OFF</td></tr>
<tr><td>30</td><td></td><td>ON</td><td>OFF</td><td>OFF</td><td>OFF</td><td>OFF</td></tr>
<tr><td>31</td><td></td><td>OFF</td><td>OFF</td><td>OFF</td><td>OFF</td><td>OFF</td></tr>
</table>

TUBE-1 for MAMMOGRAPHIC USE in TUBE TABLE-2

Pos	TUBE FAMILY (Stator - ∅ Anode)	SWITCH 3243SWx-x							
		SW1-4	SW1-5	SW1-6	SW1-7	SW1-8	SW3-5	SW3-7	SW3-8
0		ON	ON	ON	ON	ON			
1		OFF	ON	ON	ON	ON			
2		ON	OFF	ON	ON	ON			
3		OFF	OFF	ON	ON	ON			
4		ON	ON	OFF	ON	ON			
5		OFF	ON	OFF	ON	ON			
6		ON	OFF	OFF	ON	ON			
7		OFF	OFF	OFF	ON	ON			
8		ON	ON	ON	OFF	ON			
9		OFF	ON	ON	OFF	ON			
10		ON	OFF	ON	OFF	ON			
11		OFF	OFF	ON	OFF	ON			
12		ON	ON	OFF	OFF	ON			
13		OFF	ON	OFF	OFF	ON			
14		ON	OFF	OFF	OFF	ON			
15		OFF	OFF	OFF	OFF	ON			
16		ON	ON	ON	ON	OFF	OFF	ON	ON
17		OFF	ON	ON	ON	OFF			
18		ON	OFF	ON	ON	OFF			
19		OFF	OFF	ON	ON	OFF			
20		ON	ON	OFF	ON	OFF			
21		OFF	ON	OFF	ON	OFF			
22		ON	OFF	OFF	ON	OFF			
23		OFF	OFF	OFF	ON	OFF			
24	VARIAN RAD 70 (MAM-RAD 105 H Housing, R Stator) (MAMMO) VARIAN RAD 70B (MAM-RAD 105 H Housing, R Stator) (MAMMO) VARIAN RAD 70SP (MAM-RAD 100 H Housing, R Stator) (MAMMO)	ON	ON	ON	OFF	OFF			
25		OFF	ON	ON	OFF	OFF			
26		ON	OFF	ON	OFF	OFF			
27		OFF	OFF	ON	OFF	OFF			
28		ON	ON	OFF	OFF	OFF			
29		OFF	ON	OFF	OFF	OFF			
30		ON	OFF	OFF	OFF	OFF			
31		OFF	OFF	OFF	OFF	OFF			

1.4 TUBE TYPE SELECTION FOR TUBE-2

TUBE-2 for CONVENTIONAL USE in TUBE TABLE-1

<table>
<tr><th rowspan="2">Pos</th><th rowspan="2">TUBE FAMILY
(Stator - ∅ Anode)</th><th colspan="8">SWITCH 3243SWx-x</th></tr>
<tr><th>SW2-4</th><th>SW2-5</th><th>SW2-6</th><th>SW2-7</th><th>SW2-8</th><th>SW4-5</th><th>SW3-7</th><th>SW3-8</th></tr>
<tr><td>0</td><td>GE MAXIRAY 75</td><td>ON</td><td>ON</td><td>ON</td><td>ON</td><td>ON</td><td rowspan="36">ON</td><td rowspan="36">ON</td><td rowspan="36">ON</td></tr>
<tr><td>1</td><td>GE MAXIRAY 100</td><td>OFF</td><td>ON</td><td>ON</td><td>ON</td><td>ON</td></tr>
<tr><td>2</td><td>VARIAN G-1582</td><td>ON</td><td>OFF</td><td>ON</td><td>ON</td><td>ON</td></tr>
<tr><td rowspan="2">3</td><td>VARIAN RAD-XX or EUREKA RAD-XX (3” Anode,
Emerald or Diamond Housing, R Stator, 20/50 ohm, 300 KHU)</td><td rowspan="2">OFF</td><td rowspan="2">OFF</td><td rowspan="2">ON</td><td rowspan="2">ON</td><td rowspan="2">ON</td></tr>
<tr><td>VARIAN A132 (3” Anode, 300 KHU)</td></tr>
<tr><td rowspan="4">4</td><td>VARIAN RAD-XX or EUREKA RAD-XX (4” Anode,
Sapphire Housing, R Stator (16/50 ohm or 20/50 ohm), 400 KHU)</td><td rowspan="4">ON</td><td rowspan="4">ON</td><td rowspan="4">OFF</td><td rowspan="4">ON</td><td rowspan="4">ON</td></tr>
<tr><td>VARIAN RAD-56 (4” Anode, Sapphire Housing,
R Stator (20/50 ohm), 400 KHU)</td></tr>
<tr><td>VARIAN A256 / A282 / A292 (4” Anode, B130 or B150 Housing,
R Stator (16/50 ohm or 20/50 ohm), 400 KHU)</td></tr>
<tr><td>TOSHIBA or CANON 7254X / 7255X / 7823 (4” Anode,
XS-RB Stator (20/38 ohm), 400 KHU)</td></tr>
<tr><td>5</td><td>VARIAN GS-2075 with B220 Housing</td><td>OFF</td><td>ON</td><td>OFF</td><td>ON</td><td>ON</td></tr>
<tr><td>6</td><td>SIEMENS 100 L BIANGULIX
SIEMENS 100 L OPTILIX</td><td>ON</td><td>OFF</td><td>OFF</td><td>ON</td><td>ON</td></tr>
<tr><td>7</td><td>PHILIPS SUPEROTALIX / SRO</td><td>OFF</td><td>OFF</td><td>OFF</td><td>ON</td><td>ON</td></tr>
<tr><td>8</td><td>DUNLEE PX-1302</td><td>ON</td><td>ON</td><td>ON</td><td>OFF</td><td>ON</td></tr>
<tr><td>9</td><td>CGR STATORIX 260 with RSN 742 / MSN 740</td><td>OFF</td><td>ON</td><td>ON</td><td>OFF</td><td>ON</td></tr>
<tr><td>10</td><td>CGR STATORIX 550 with RSN 722 / MSN 722
CGR STATORIX 550/240 with RN 620</td><td>ON</td><td>OFF</td><td>ON</td><td>OFF</td><td>ON</td></tr>
<tr><td>11</td><td>SIEMENS 100 G</td><td>OFF</td><td>OFF</td><td>ON</td><td>OFF</td><td>ON</td></tr>
<tr><td>12</td><td>SIEMENS RH 150/100</td><td>ON</td><td>ON</td><td>OFF</td><td>OFF</td><td>ON</td></tr>
<tr><td>13</td><td>COMET DO-10 (4” Anode)</td><td>OFF</td><td>ON</td><td>OFF</td><td>OFF</td><td>ON</td></tr>
<tr><td>14</td><td>COMET DO-9 (4” Anode)</td><td>ON</td><td>OFF</td><td>OFF</td><td>OFF</td><td>ON</td></tr>
<tr><td>15</td><td>CGR STATORIX 240 with MN 620 / M 641
CGR STATORIX 240/260 with MN 640</td><td>OFF</td><td>OFF</td><td>OFF</td><td>OFF</td><td>ON</td></tr>
<tr><td>16</td><td>PICKER PX-307</td><td>ON</td><td>ON</td><td>ON</td><td>ON</td><td>OFF</td></tr>
<tr><td>17</td><td>HANGZHOU XD-52-30, 50/150</td><td>OFF</td><td>ON</td><td>ON</td><td>ON</td><td>OFF</td></tr>
<tr><td>18</td><td>DUNLEE PX-1312</td><td>ON</td><td>OFF</td><td>ON</td><td>ON</td><td>OFF</td></tr>
<tr><td>19</td><td>DUNLEE PX-1456 / PX-1436 / PX-1400 (Q Stator)</td><td>OFF</td><td>OFF</td><td>ON</td><td>ON</td><td>OFF</td></tr>
<tr><td>20</td><td>COMET DX-1000</td><td>ON</td><td>ON</td><td>OFF</td><td>ON</td><td>OFF</td></tr>
<tr><td>21</td><td>COMET DX-81 / COMET XSTAR-14</td><td>OFF</td><td>ON</td><td>OFF</td><td>ON</td><td>OFF</td></tr>
<tr><td>22</td><td>PHILIPS ROTALIX 350/351</td><td>ON</td><td>OFF</td><td>OFF</td><td>ON</td><td>OFF</td></tr>
<tr><td>23</td><td>VARIAN G892/G896 (with B147 Housing) (4” Anode, 16/50 ohm, 837 KHU)</td><td>OFF</td><td>OFF</td><td>OFF</td><td>ON</td><td>OFF</td></tr>
<tr><td>24</td><td>TOSHIBA or CANON XRR-3331-X (XR-AL, 3” Anode, 300 KHU)</td><td>ON</td><td>ON</td><td>ON</td><td>OFF</td><td>OFF</td></tr>
<tr><td>25</td><td>VARIAN with B160 / B165 Housing</td><td>OFF</td><td>ON</td><td>ON</td><td>OFF</td><td>OFF</td></tr>
<tr><td>26</td><td>TOSHIBA or CANON E7252X (XS-AL Stator)</td><td>ON</td><td>OFF</td><td>ON</td><td>OFF</td><td>OFF</td></tr>
<tr><td>27</td><td>COMET DX 700 HS</td><td>OFF</td><td>OFF</td><td>ON</td><td>OFF</td><td>OFF</td></tr>
<tr><td>28</td><td>VARIAN A182 / A192 / A196 / A197 (with B130 Housing)</td><td>ON</td><td>ON</td><td>OFF</td><td>OFF</td><td>OFF</td></tr>
<tr><td>29</td><td>VARIAN G 1592</td><td>OFF</td><td>ON</td><td>OFF</td><td>OFF</td><td>OFF</td></tr>
<tr><td>30</td><td>PICKER PX400P + PX457P</td><td>ON</td><td>OFF</td><td>OFF</td><td>OFF</td><td>OFF</td></tr>
<tr><td>31</td><td>JUGORENDGEN RX 150/30 - 50</td><td>OFF</td><td>OFF</td><td>OFF</td><td>OFF</td><td>OFF</td></tr>
</table>

TUBE-2 for CONVENTIONAL USE in TUBE TABLE-2

Pos	TUBE FAMILY (Stator - ∅ Anode)	SWITCH 3243SWx-x							
		SW2-4	SW2-5	SW2-6	SW2-7	SW2-8	SW4-5	SW3-7	SW3-8
0	VARIAN GS-20711 (B220H Housing, R Stator)	ON	ON	ON	ON	ON	OFF	ON	ON
1	SIEMENS 100 L-W	OFF	ON	ON	ON	ON			
2	SIEMENS SV 125/15/82	ON	OFF	ON	ON	ON			
3	IAE RTM90 / IAE RTM92 (C52 / C352 Housing)	OFF	OFF	ON	ON	ON			
4	IAE RTM101HS / IAE RTM102HS (C100 Housing)	ON	ON	OFF	ON	ON			
5	DUNLEE DA 1036 – DU 404	OFF	ON	OFF	ON	ON			
6	DUNLEE DA 1094 – DU 694 / DU 692	ON	OFF	OFF	ON	ON			
7	DUNLEE DR 1817 / 1825 (High Impedance Stator)	OFF	OFF	OFF	ON	ON			
8	CGR STATORIX 240 / 260 with MSN 740 / MSN 742	ON	ON	ON	OFF	ON			
9	IAE RTC 700 HS (C52S or C100XT Housing)	OFF	ON	ON	OFF	ON			
10	VARIAN GS 30711	ON	OFF	ON	OFF	ON			
11	VARIAN G292 / G294 / G256 / G297 (B130 Housing)	OFF	OFF	ON	OFF	ON			
12	IAE RTM101HS / RTM102HS (C52S Housing)	ON	ON	OFF	OFF	ON			
13	IAE RTC1000HS (C52S or C100XT Housing)	OFF	ON	OFF	OFF	ON			
14	TOSHIBA or CANON ROTANODE E7100X (4” Anode, 9/28 ohm, RTM, 300 kHU)	ON	OFF	OFF	OFF	ON			
15	DUNLEE DA 1083 / PX 1483 (DU 404 / DA10 Housing, C Stator)	OFF	OFF	OFF	OFF	ON			
16	VARIAN A277 / A288 (B130H and B150H Housing, R Stator)	ON	ON	ON	ON	OFF			
17	VARIAN G1092 (B160 / B165 Housing, R Stator)	OFF	ON	ON	ON	OFF			
18	DUNLEE PX1473Q – DU 604	ON	OFF	ON	ON	OFF			
19	TOSHIBA or CANON E7260DX	OFF	OFF	ON	ON	OFF			
20	VARIAN HE100 (B180 / B185 Housing, R Stator)	ON	ON	OFF	ON	OFF			
21	IAE RTC 137 (CT 180 Housing)	OFF	ON	OFF	ON	OFF			
22	VARIAN A102 (B100 Housing)	ON	OFF	OFF	ON	OFF			
23	IAE X40 (C352 Housing (only Low Speed)) IAE RTM78HS (C352 Housing)	OFF	OFF	OFF	ON	OFF			
24	VARIAN RAD-92 / RAD-94 (4” Anode, Sapphire Housing, R Stator, 20/50 ohm, 600 KHU) VARIAN SG296B (B199-R Housing) VARIAN G296 (B130 Housing) IAE RTC600 HS (4” Anode, C100 Housing, 20/40 ohm, 600 KHU)	ON	ON	ON	OFF	OFF			
25	TOSHIBA or CANON ROTANODE E7867X / E7869X	OFF	ON	ON	OFF	OFF			
26	TOSHIBA or CANON ROTANODE E7239X / E7240X / E7242X / E7865X	ON	OFF	ON	OFF	OFF			
27	TOSHIBA or CANON ROTANODE E7864X (4” Anode, 9/28 ohm, 400 KHU)	OFF	OFF	ON	OFF	OFF			
28	SIEMENS RAY-14_1 (SV150/33/78S Insert)	ON	ON	OFF	OFF	OFF			
29	TOSHIBA or CANON ROTANODE E7252X (XS-R Stator) TOSHIBA or CANON ROTANODE E7886X (27/58 ohm Stator)	OFF	ON	OFF	OFF	OFF			
30	ATX 10WX-692 / 1463 (ATI692) (4” Anode, C Stator, 47/60 ohm, 600 KHU)	ON	OFF	OFF	OFF	OFF			
31	PHILIPS SRM 1551 ROT500	OFF	OFF	OFF	OFF	OFF			

TUBE-2 for MAMMOGRAPHIC USE in TUBE TABLE-1

<table>
<tr><th rowspan="2">Pos</th><th rowspan="2">TUBE FAMILY
(Stator - ∅ Anode)</th><th colspan="8">SWITCH 3243SWx-x</th></tr>
<tr><th>SW2-4</th><th>SW2-5</th><th>SW2-6</th><th>SW2-7</th><th>SW2-8</th><th>SW4-5</th><th>SW3-7</th><th>SW3-8</th></tr>
<tr><td>0</td><td></td><td>ON</td><td>ON</td><td>ON</td><td>ON</td><td>ON</td><td rowspan="32">ON</td><td rowspan="32">ON</td><td rowspan="32">ON</td></tr>
<tr><td>1</td><td></td><td>OFF</td><td>ON</td><td>ON</td><td>ON</td><td>ON</td></tr>
<tr><td>2</td><td></td><td>ON</td><td>OFF</td><td>ON</td><td>ON</td><td>ON</td></tr>
<tr><td>3</td><td>IAE XM1016T (3” Anode, 20/40 ohm, 300 KHU) (MAMMO)</td><td>OFF</td><td>OFF</td><td>ON</td><td>ON</td><td>ON</td></tr>
<tr><td>4</td><td></td><td>ON</td><td>ON</td><td>OFF</td><td>ON</td><td>ON</td></tr>
<tr><td>5</td><td>CGR STATORIX M50 (MAMMO)</td><td>OFF</td><td>ON</td><td>OFF</td><td>ON</td><td>ON</td></tr>
<tr><td>6</td><td></td><td>ON</td><td>OFF</td><td>OFF</td><td>ON</td><td>ON</td></tr>
<tr><td>7</td><td></td><td>OFF</td><td>OFF</td><td>OFF</td><td>ON</td><td>ON</td></tr>
<tr><td>8</td><td></td><td>ON</td><td>ON</td><td>ON</td><td>OFF</td><td>ON</td></tr>
<tr><td>9</td><td></td><td>OFF</td><td>ON</td><td>ON</td><td>OFF</td><td>ON</td></tr>
<tr><td>10</td><td></td><td>ON</td><td>OFF</td><td>ON</td><td>OFF</td><td>ON</td></tr>
<tr><td>11</td><td></td><td>OFF</td><td>OFF</td><td>ON</td><td>OFF</td><td>ON</td></tr>
<tr><td>12</td><td></td><td>ON</td><td>ON</td><td>OFF</td><td>OFF</td><td>ON</td></tr>
<tr><td>13</td><td></td><td>OFF</td><td>ON</td><td>OFF</td><td>OFF</td><td>ON</td></tr>
<tr><td>14</td><td></td><td>ON</td><td>OFF</td><td>OFF</td><td>OFF</td><td>ON</td></tr>
<tr><td>15</td><td></td><td>OFF</td><td>OFF</td><td>OFF</td><td>OFF</td><td>ON</td></tr>
<tr><td>16</td><td></td><td>ON</td><td>ON</td><td>ON</td><td>ON</td><td>OFF</td></tr>
<tr><td>17</td><td></td><td>OFF</td><td>ON</td><td>ON</td><td>ON</td><td>OFF</td></tr>
<tr><td>18</td><td></td><td>ON</td><td>OFF</td><td>ON</td><td>ON</td><td>OFF</td></tr>
<tr><td>19</td><td></td><td>OFF</td><td>OFF</td><td>ON</td><td>ON</td><td>OFF</td></tr>
<tr><td>20</td><td></td><td>ON</td><td>ON</td><td>OFF</td><td>ON</td><td>OFF</td></tr>
<tr><td>21</td><td></td><td>OFF</td><td>ON</td><td>OFF</td><td>ON</td><td>OFF</td></tr>
<tr><td>22</td><td></td><td>ON</td><td>OFF</td><td>OFF</td><td>ON</td><td>OFF</td></tr>
<tr><td>23</td><td>COMET MOS-50 (MAMMO)</td><td>OFF</td><td>OFF</td><td>OFF</td><td>ON</td><td>OFF</td></tr>
<tr><td>24</td><td>VARIAN M103T with B115 Housing (MAMMO)
VARIAN M113 with B115 Housing (MAMMO)
VARIAN IM113T (MAMMO)
VARIAN RAD 85S with B112 Housing (3”, 16/50 ohm, 300 kHU) (MAMMO)</td><td>ON</td><td>ON</td><td>ON</td><td>OFF</td><td>OFF</td></tr>
<tr><td>25</td><td></td><td>OFF</td><td>ON</td><td>ON</td><td>OFF</td><td>OFF</td></tr>
<tr><td>26</td><td></td><td>ON</td><td>OFF</td><td>ON</td><td>OFF</td><td>OFF</td></tr>
<tr><td>27</td><td></td><td>OFF</td><td>OFF</td><td>ON</td><td>OFF</td><td>OFF</td></tr>
<tr><td>28</td><td></td><td>ON</td><td>ON</td><td>OFF</td><td>OFF</td><td>OFF</td></tr>
<tr><td>29</td><td></td><td>OFF</td><td>ON</td><td>OFF</td><td>OFF</td><td>OFF</td></tr>
<tr><td>30</td><td></td><td>ON</td><td>OFF</td><td>OFF</td><td>OFF</td><td>OFF</td></tr>
<tr><td>31</td><td></td><td>OFF</td><td>OFF</td><td>OFF</td><td>OFF</td><td>OFF</td></tr>
</table>

TUBE-2 for MAMMOGRAPHIC USE in TUBE TABLE-2

Pos	TUBE FAMILY (Stator - ∅ Anode)	SWITCH 3243SWx-x							
		SW2-4	SW2-5	SW2-6	SW2-7	SW2-8	SW4-5	SW3-7	SW3-8
0		ON	ON	ON	ON	ON			
1		OFF	ON	ON	ON	ON			
2		ON	OFF	ON	ON	ON			
3		OFF	OFF	ON	ON	ON			
4		ON	ON	OFF	ON	ON			
5		OFF	ON	OFF	ON	ON			
6		ON	OFF	OFF	ON	ON			
7		OFF	OFF	OFF	ON	ON			
8		ON	ON	ON	OFF	ON			
9		OFF	ON	ON	OFF	ON			
10		ON	OFF	ON	OFF	ON			
11		OFF	OFF	ON	OFF	ON			
12		ON	ON	OFF	OFF	ON			
13		OFF	ON	OFF	OFF	ON			
14		ON	OFF	OFF	OFF	ON			
15		OFF	OFF	OFF	OFF	ON			
16		ON	ON	ON	ON	OFF	OFF	ON	ON
17		OFF	ON	ON	ON	OFF			
18		ON	OFF	ON	ON	OFF			
19		OFF	OFF	ON	ON	OFF			
20		ON	ON	OFF	ON	OFF			
21		OFF	ON	OFF	ON	OFF			
22		ON	OFF	OFF	ON	OFF			
23		OFF	OFF	OFF	ON	OFF			
24	VARIAN RAD 70 (MAM-RAD 105 H Housing, R Stator) (MAMMO) VARIAN RAD 70B (MAM-RAD 105 H Housing, R Stator) (MAMMO) VARIAN RAD 70SP (MAM-RAD 100 H Housing, R Stator) (MAMMO)	ON	ON	ON	OFF	OFF			
25		OFF	ON	ON	OFF	OFF			
26		ON	OFF	ON	OFF	OFF			
27		OFF	OFF	ON	OFF	OFF			
28		ON	ON	OFF	OFF	OFF			
29		OFF	ON	OFF	OFF	OFF			
30		ON	OFF	OFF	OFF	OFF			
31		OFF	OFF	OFF	OFF	OFF			

1.5 MINIMUM TIME FOR READY (DELAY)

MINIMUM TIME (SECONDS)	3243SW1-x		
	1	2	3
0 *	ON	ON	ON
0.6	OFF	ON	ON
0.8	ON	OFF	ON
1.0	OFF	OFF	ON
1.2	ON	ON	OFF
1.5	OFF	ON	OFF
2.0	ON	OFF	OFF
3.0	OFF	OFF	OFF
** Note: It is recommended to set these switches at “0 seconds”.*			

1.6 FLUORO HOLD TIME

FLUORO HOLD TIME (SECONDS)	3243SW2-x		
	1	2	3
0	ON	ON	ON
10	OFF	ON	ON
20	ON	OFF	ON
30	OFF	OFF	ON
40	ON	ON	OFF
60	OFF	ON	OFF
90	ON	OFF	OFF
120	OFF	OFF	OFF

1.7 SPOT FILM HOLD TIME

SPOT FILM HOLD TIME		3243SW4-x 1	2	3	4
SECONDS	0	ON	ON	ON	ON
	5	OFF	ON	ON	ON
	10	ON	OFF	ON	ON
	15	OFF	OFF	ON	ON
	20	ON	ON	OFF	ON
	30	OFF	ON	OFF	ON
	45	ON	OFF	OFF	ON
	60	OFF	OFF	OFF	ON
MINUTES	2	ON	ON	ON	OFF
	5	OFF	ON	ON	OFF
	10	ON	OFF	ON	OFF
	15	OFF	OFF	ON	OFF
	20	ON	ON	OFF	OFF
	25	OFF	ON	OFF	OFF
	30	ON	OFF	OFF	OFF
	40	OFF	OFF	OFF	OFF

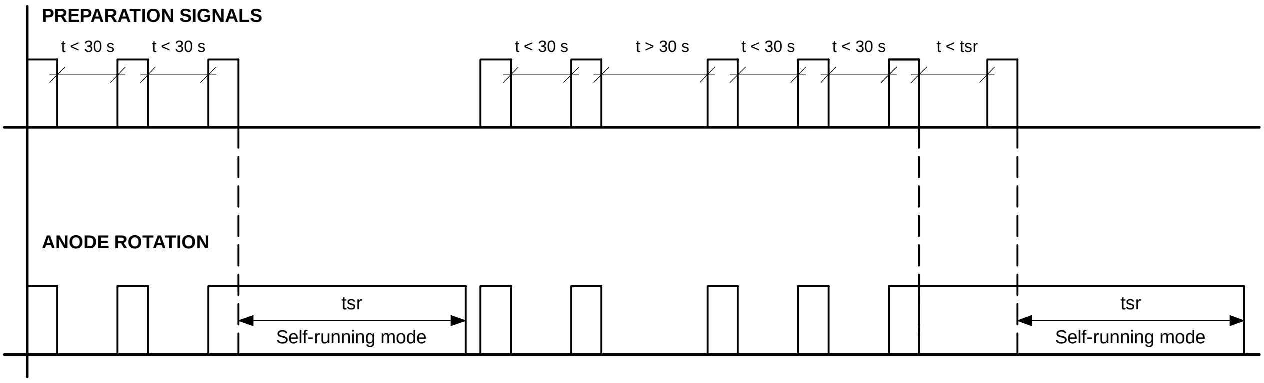
1.8 "SELF-RUNNING MODE"

The continuous starting and braking of the anode produces an overheating in the X-ray Tube Stator (e.g. during calibration procedure). The "Self-running mode" avoids this overheating.

1.8.1 "SELF-RUNNING MODE" OPERATION WITH SOFTWARE V10R3.10.2

In the "Self-running mode" (switch 3243SW4-6 in the "ON" position), the anode remains running for approximately 1 minute when rotates at 3300 rpm or 10000 rpm.

The LV-DRAC enters in the "Self-running mode" when "*Preparation*" is selected three consecutive times **only from the Console buttons or Handswitch**, and the time between two of the consecutive accelerations is shorter than 30 seconds (*refer to illustration below*).



tsr (time for self-running mode) = approx. 1 minute at 3300 rpm or 10000 rpm.

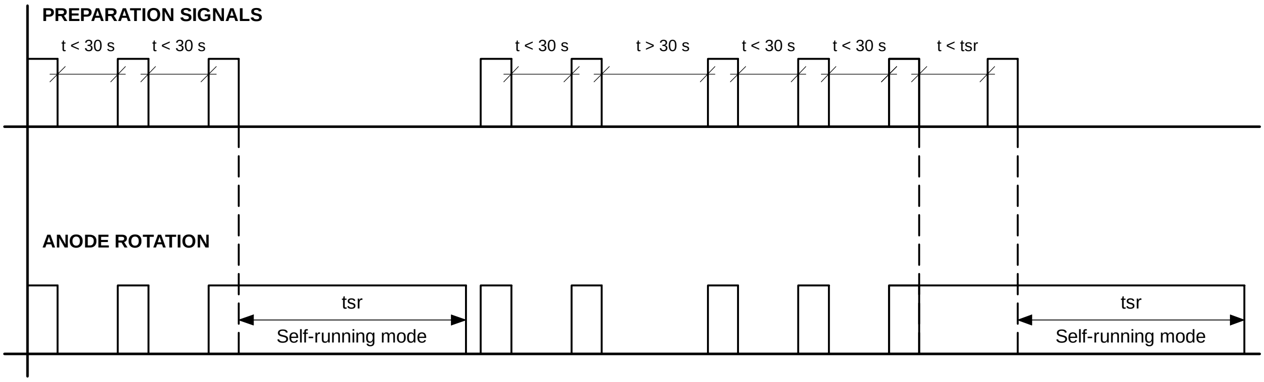
1.8.2 "SELF-RUNNING MODE" OPERATION WITH SOFTWARE V10R3.10.3

The "Self-running mode" is enabled when switch 3243SW4-6 in the "ON" position. The activation moment depends on the configuration set with switch 3243SW3-2.

With the "Self-running mode" enable, the anode remains running for approximately 1 minute when rotates at 3300 rpm or 10000 rpm.

The LV-DRAC enters in the "Self-running mode" when:

- every time "*Preparation*" is selected **from the Console buttons or Handswitch.** It is configured with switch 3243SW3-2 in the "*ON*" position.
- "*Preparation*" is selected three consecutive times **only from the Console buttons or Handswitch**, and the time between two of the consecutive accelerations is shorter than 30 seconds (*refer to illustration below*). It is configured with switch 3243SW3-2 in the "*OFF*" position.



tsr (time for self-running mode) = approx. 1 minute at 3300 rpm or 10000 rpm.

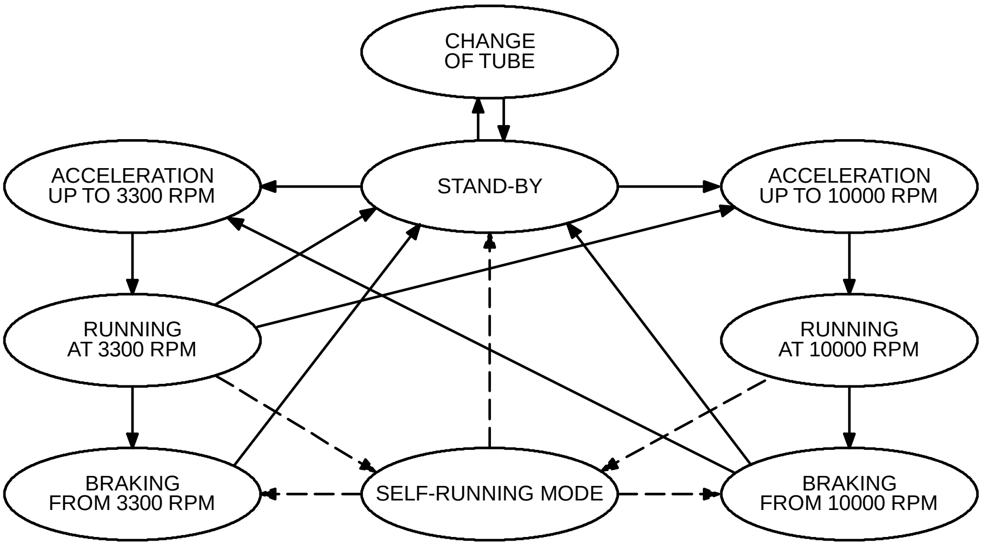
1.9 PROTECTIONS – ERRORS

PROTECTIONS – ERRORS	3243SW4-7
INHIBITED (LED DL1 on the Control DRAC Board is always illuminated)	ON
ACTIVATED (Normal Operation mode) (LED DL1 on the Control DRAC Board is non-illuminated indicating that the DRAC is working properly).	OFF
Note: The Error Codes are usually shown on the Console preceded by the letter "E" (e.g. E51) (For Error Codes refer to the Troubleshooting document).	

WARNING

WHEN SWITCH 3243SW4-7 IS IN THE "ON" POSITION, THE ERROR PROTECTIONS OF THE LV-DRAC ARE INHIBITED.

SECTION 2 LV-DRAC STATUS DIAGRAM



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SECTION 3 SCHEMATICS

Sch. No.	Scheme
	LV-DRAC MODULE BLOCK DIAGRAM
A3243−04	CONTROL DRAC PCB
A3240−05	INTERFACE DRAC PCB
A3109−01	CLAMPING PCB

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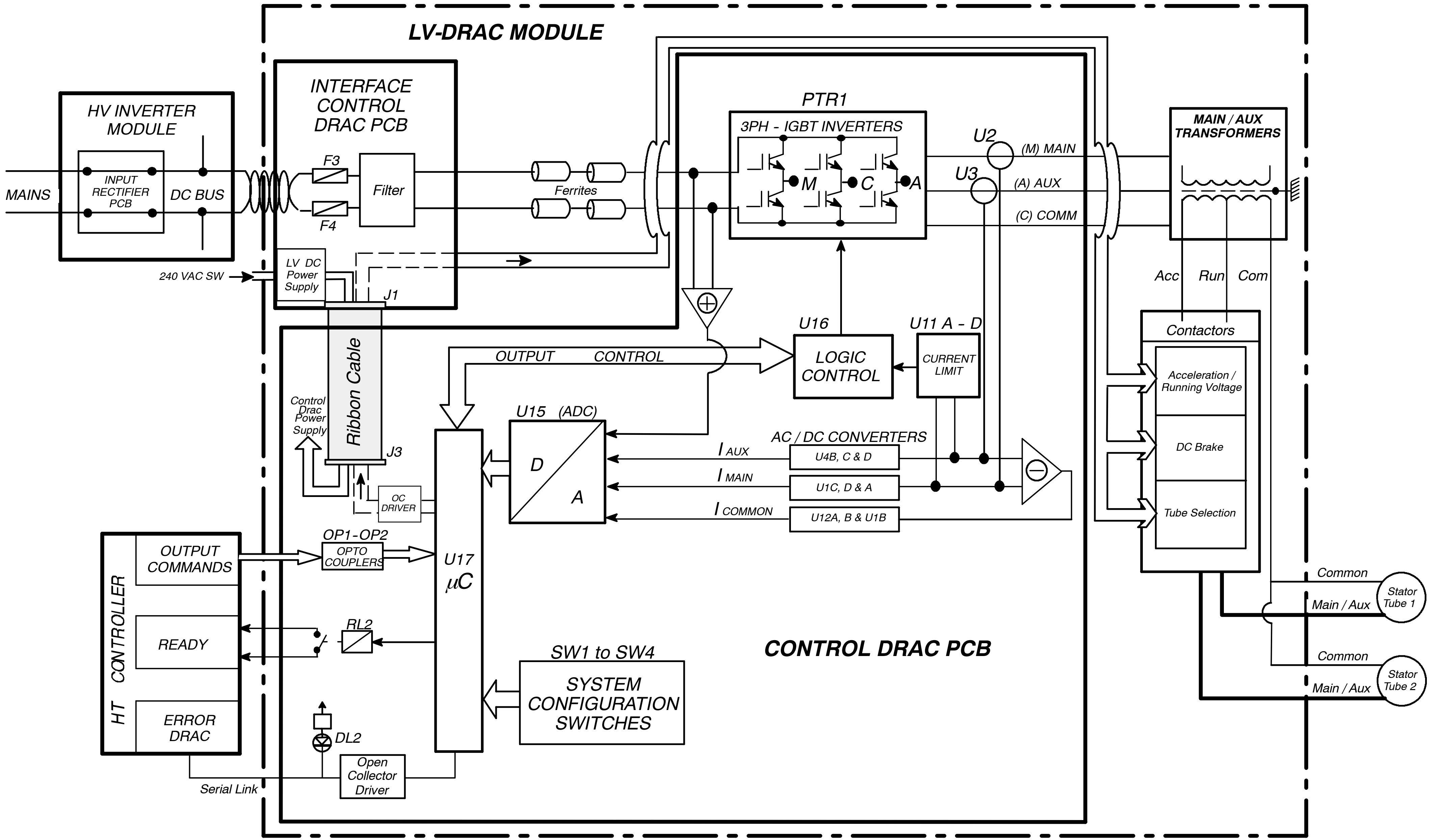
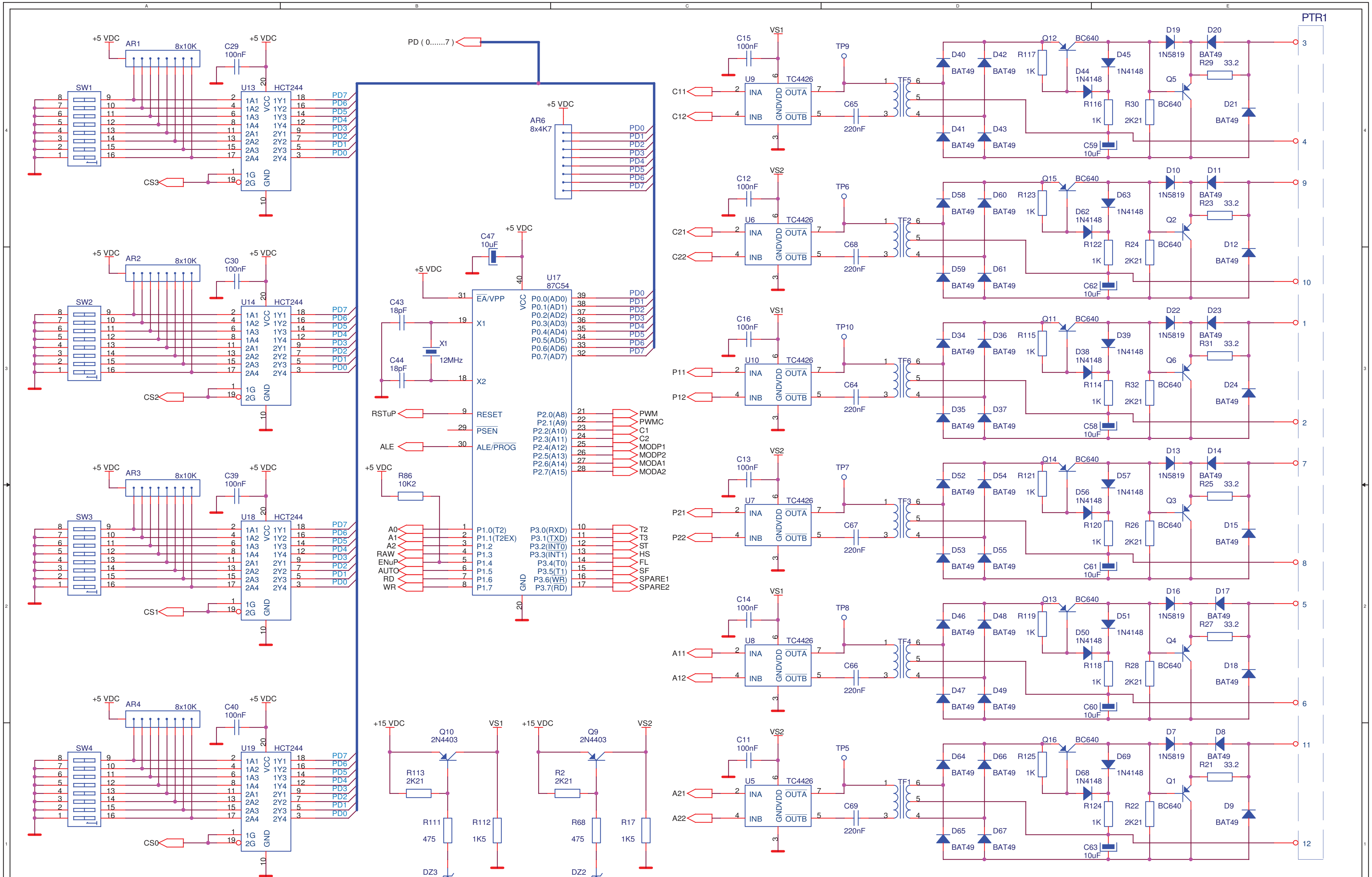


LV-DRAC Module Block Diagram



J	NC 18/148	J.Mingo	30/10/18
I	NC 17/0131	Carlos R.	30/03/17
H	NC 14/0356	R. Hermosilla	24/11/15
G	NC 14/0356	Carlos R.	16/10/15
K	NC20/0169	R. Hermosilla	20/03/20
REV	DESCRIPTION	ISSUED BY	DATE

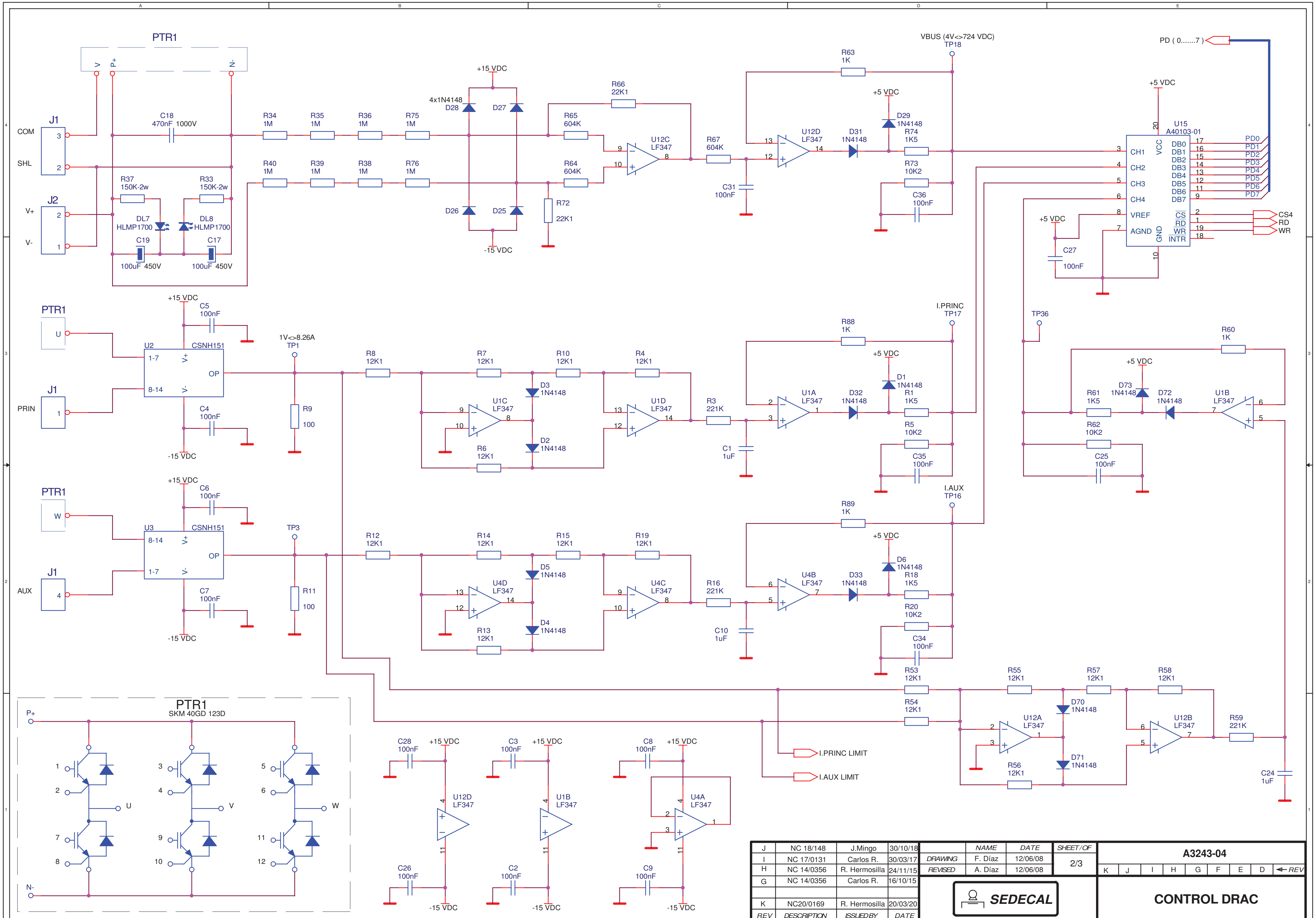
	NAME	DATE	SHEET/OF
DRAWING	F. Díaz	12/06/08	1/3
REVISED	A. Díaz	12/06/08	

A3243-04

K J I H G F E D ← REV

SEDECAL

CONTROL DRAC



J	NC 18/148	J.Mingo	30/10/18
I	NC 17/0131	Carlos R.	30/03/17
H	NC 14/0356	R. Hermosilla	24/11/15
G	NC 14/0356	Carlos R.	16/10/15
K	NC20/0169	R. Hermosilla	20/03/20
REV	DESCRIPTION	ISSUED BY	DATE

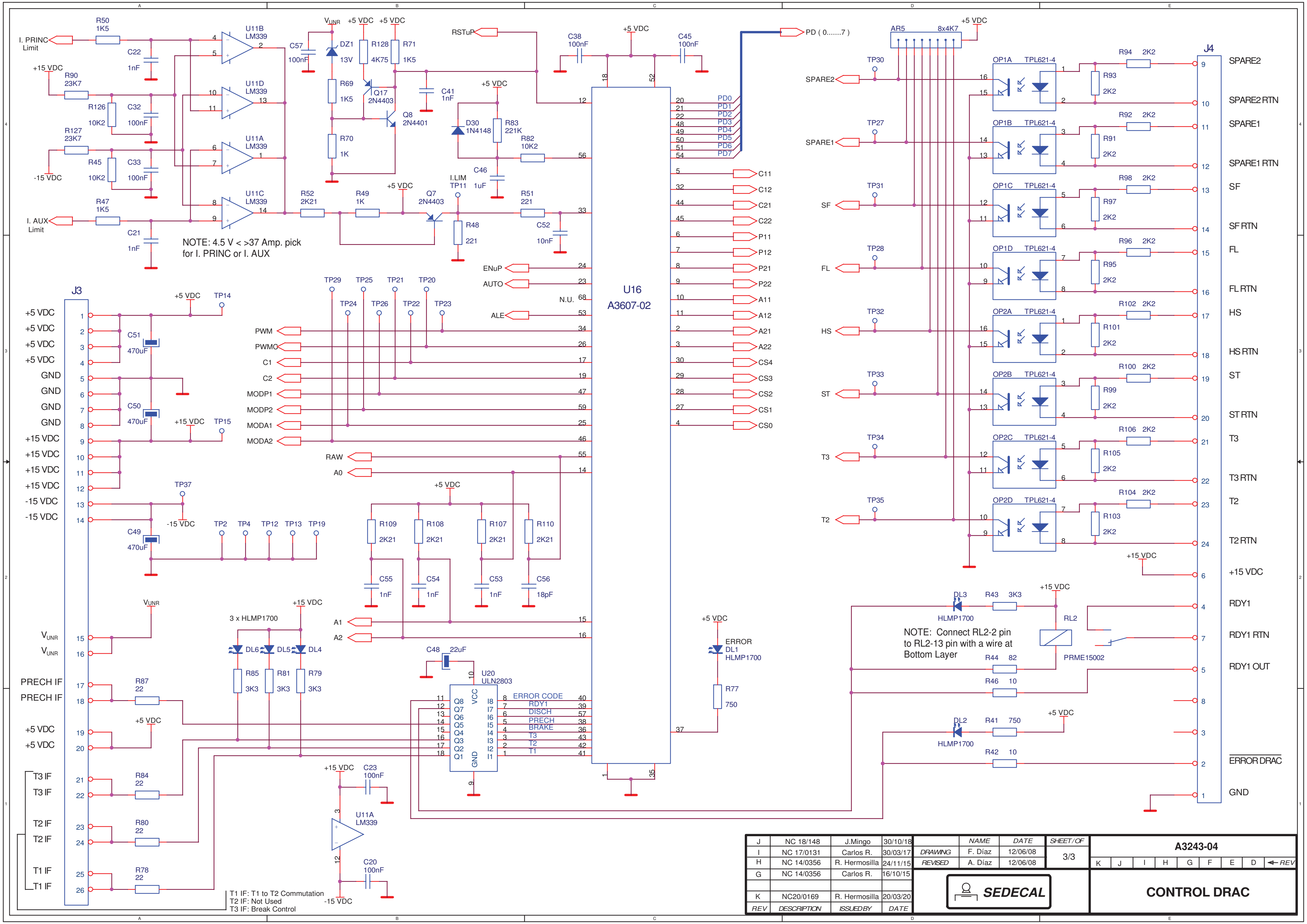
	NAME	DATE	SHEET/OF
DRAWING	F. Díaz	12/06/08	2/3
REVISED	A. Díaz	12/06/08	

A3243-04

K J I H G F E D ◄REV

SEDECAL

CONTROL DRAC



J	NC 18/148	J.Mingo	30/10/18
I	NC 17/0131	Carlos R.	30/03/17
H	NC 14/0356	R. Hermosilla	24/11/15
G	NC 14/0356	Carlos R.	16/10/15
K	NC20/0169	R. Hermosilla	20/03/20
REV	DESCRIPTION	ISSUED BY	DATE

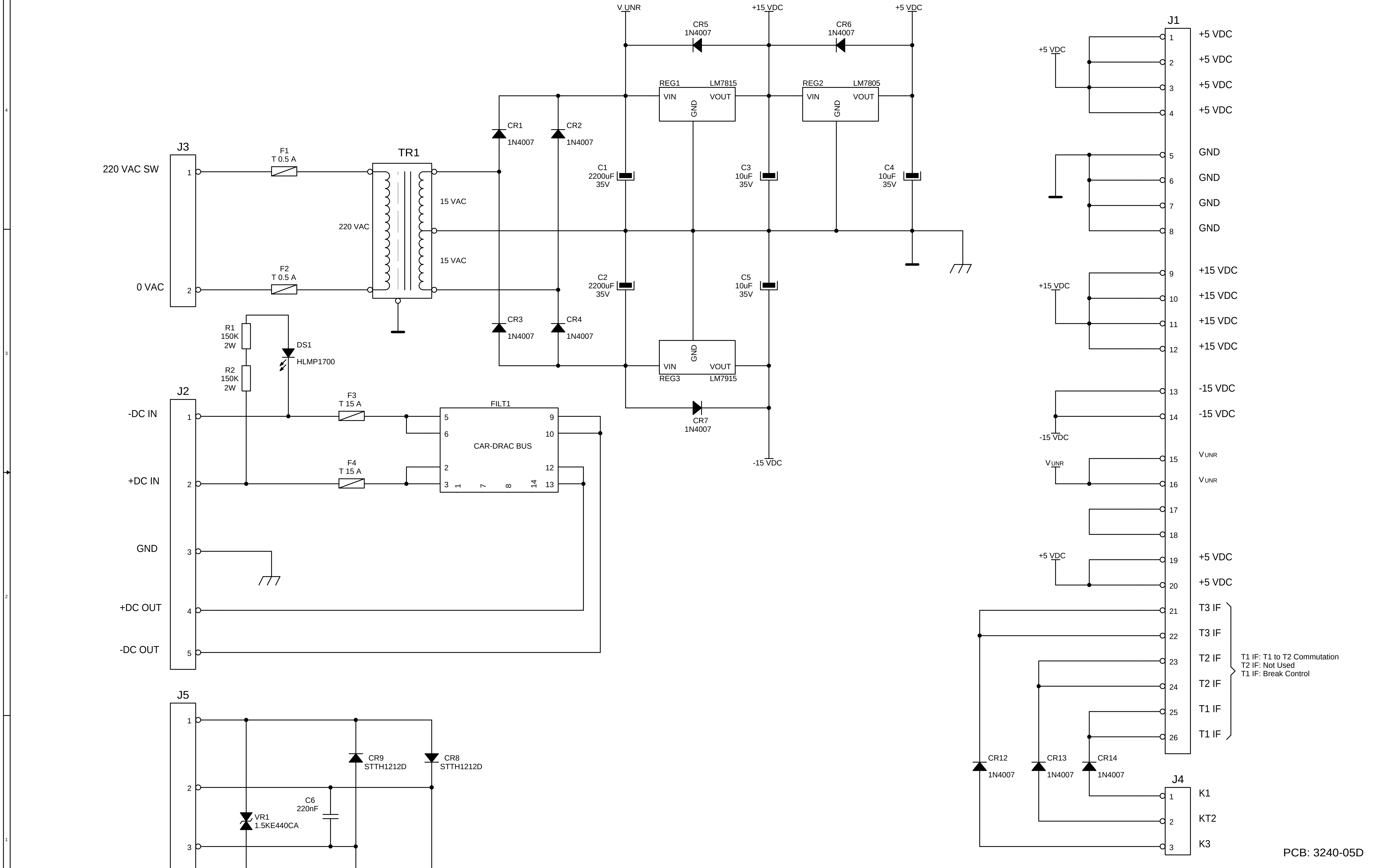
	NAME	DATE	SHEET/OF
DRAWING	F. Díaz	12/06/08	3/3
REVISED	A. Díaz	12/06/08	

A3243-04

K J I H G F E D ← REV

SEDECAL

CONTROL DRAC



PCB: 3240-05D

REV	DESCRIPTION	ISSUED BY	DATE
G	NC 09/301	F. Díaz	16/11/09
F	NC 09/178	F. Díaz	09/06/09
E	CN 01/075	F. GARCIA	03-05-01
C, D	CN 98/090, 99/94	F. GARCIA	15-02-00
H	NC 10/252	F. Díaz	28/05/10

	NAME	DATE
DRAWING	F. GARCIA	27-09-97
REVISED	A. DIAZ	27-09-97

SHEET / OF: 1/1

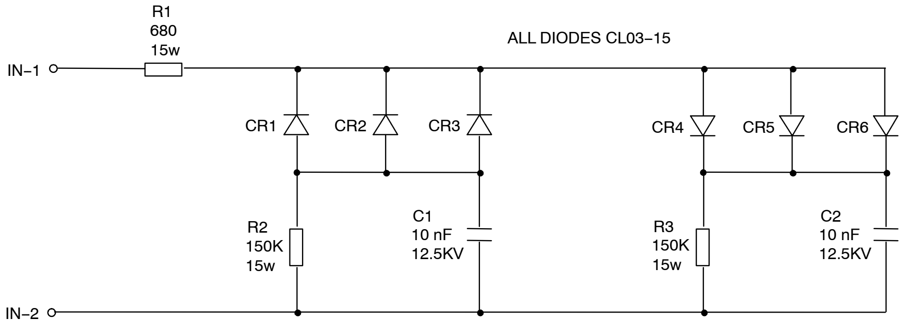
SEDECAL

A3240-05

H G F E D C B A ← REV

INTERFACE DRAC-HF

F E D C B A



REV	DESCRIPTION	ISSUED BY	DATE

	NAME	DATE	SHEET / OF
DRAWING	F. GARCIA	12/01/99	1 / 1
REVISED	A. DIAZ	16/03/99	

SEDECAL INNERSCAN

DWG: A3109-01

REV

CLAMPING

F E D

Technical Publication
CA-1036R4

Calibration

HF Series Generators

REVISION HISTORY

REVISION	DATE	REASON FOR CHANGE
0	JAN 23, 2004	First edition
1	APR 1, 2005	Documentation upgrade
2	FEB 29, 2007	Calibration of optional 1000 mA station
3	OCT 25, 2017	Improvement of AEC Calibration procedure
4	JUN 30, 2019	References for HT Controller Board A3000-8x

This Document is the english original version, edited and supplied by the manufacturer.

The Revision state of this Document is indicated in the code number shown at the bottom of this page.

ADVISORY SYMBOLS

The following advisory symbols will be used throughout this manual. Their application and meaning are described below.

DANGERS ADVISE OF CONDITIONS OR SITUATIONS THAT IF NOT HEEDED OR AVOIDED WILL CAUSE SERIOUS PERSONAL INJURY OR DEATH.

ADVISE OF CONDITIONS OR SITUATIONS THAT IF NOT HEEDED OR AVOIDED COULD CAUSE SERIOUS PERSONAL INJURY, OR CATASTROPHIC DAMAGE OF EQUIPMENT OR DATA.

Advise of conditions or situations that if not heeded or avoided could cause personal injury or damage to equipment or data.

Note ☞

Alert readers to pertinent facts and conditions. Notes represent information that is important to know but which do not necessarily relate to possible injury or damage to equipment.

TABLE OF CONTENTS

SECTION 1 INTRODUCTION

This Calibration document provides information and procedures to perform all the adjustments required to establish an optimal performance of this Generator.

CAUTION

Calibrate the Generator immediately after Configuration is completed.

WARNING

DO NOT SUPPLY THE MAIN POWER UNTIL SPECIFICALLY INSTRUCTED TO DO SO IN THIS DOCUMENT.

THE MAIN CAPACITORS OF THE HIGH VOLTAGE INVERTER RETAIN A LARGE PORTION OF THEIR CHARGE FOR APPROX. 3 MINUTES AFTER THE UNIT IS TURNED OFF.

Calibration data is entered in digital form and stored in a non-volatile memory chip (U3-EEPROM) located on the HT Controller Board, thus no battery back-up is required.

Note ☞

Calibration procedures <u>must be</u> performed in the order listed in this document. Perform only the sections required to calibrate this unit.

1.1 GENERATOR SPECIFICATIONS

1.1.1 MINIMUM CURRENT TIME PRODUCT (mAs)

- Minimum Current Time Product obtained at 0.1 s is 1 mAs.
- Minimum Current Time Product within the specified ranges of compliance for linearity and constancy is 0.1 mAs.

1.1.2 ACCURACY OF RADIOGRAPHIC AND FLUOROSCOPIC PARAMETERS

Note ☞ *Specified accuracy does not include test equipment accuracy.*

PARAMETERS		ACCURACY (with 12 BITS HT Controller)
RAD	kV	± (3% + 1 kV)
	mA	± (4% + 1 mA)
	Exposure Time	± (2% + 0.1 ms)
FLUORO	kV	± (3% + 1 kV)
	mA	± 10%
	Exposure Time	± (1% + 20 ms)

1.1.3 HV FREQUENCY

The operating HV Frequency of this Generator is 25 kHz / 30 kHz.

1.1.4 DUTY CYCLE

The Generator duty cycle is continuous, but limits should be set during installation depending on the capacity of the X-ray tube.

SECTION 2 CALIBRATION PROCEDURES

Note ☞ *Enter in GSM Program for Calibration procedures as described in the "Configuration" document.*

Enter and store calibration data in the Extended Memory Locations as described in Section 2.2 of the "Configuration" document.

Record all the calibration data in the Data Book.

Before calibration, bear in mind that:

- For calibration and measure the kVp it is needed a Non-Invasive kVp Meter.
- For calibration and measure mA or mAs it is needed a mAs Meter plugged to the banana connections on the HV Transformer (connect the mAs Meter for Digital mA Loops calibration).

Note ☞ *Test points on the HT Controller Board can also be used to monitor the kV and mA readings but **should not be used** to calibrate the unit. These test points must be checked with scope:*

- mA test point is TP-5 and the scale factor is:

with HT Controller Board A3000-xx (except -44 or -85) (<1000 mA Generator)
- from 10 to 80 mA, 1 volt = 10 mA
- from 100 mA, 1 volt = 100 mA

with HT Controller Board A3000-44 or -85 (1000 mA Generator)
- from 10 to 80 mA, 1 volt = 20 mA
- from 100 mA, 1 volt = 200 mA

- kV test point is TP-7 and the scale factor is 1 volt = 33.3 kV (0.3 volt = 10 kV)

- Verify that dip switch 3024SW2-3 on the ATP Console CPU Board is in "***On***" position to permit the service mode.

- Verify position of dip switches on the HT Controller Board during every calibration procedure:

DIP SWITCH	OPEN (OFF)	CLOSED (ON)
3000SW2-2	Position during operation – Enables Filament and Rotor Interlocks	Disables Filament and Rotor Interlocks (this turns off the filament so no radiation will be produced during the exposure).
3000SW2-4	Position during operation – Digital mA Loop Closed	Digital mA Loop Open / Filament Current Constant

Note ☞ *Only for Generators with Low Speed Starter (LF-RAC) (it does not apply to Generators with High Speed Starter - LV-DRAC):*

*– When the Digital mA Loop is open (dip switch 3000SW2-4 in “**On**”), the rotor runs for two minutes after releasing the handswitch button from “Preparation” position. After this time the rotor will brake (unless DC Brake is removed).*

*– When the Digital mA Loop is closed (dip switch 3000SW2-4 in “**Off**”), the rotor will brake after releasing the handswitch button from “Preparation” position (unless DC Brake is removed).*

- Be sure that X-ray Tubes configured in E02 and E18 Memory Locations correspond to X-ray Tubes installed (*refer to Configuration document*).

2.1 FILAMENT STAND-BY CURRENT

Note ☞ *For RAD Only Generators, the Filament Stand-by value is auto-calibrated by the Generator and automatically stored into the respective Memory Locations (E01 and E17). Filament Stand-by values are not field changeable.*

Note ☞ *For RAD and Fluoro Generators, E17 Memory Location (”Fluoro Filament Setting”) sets maximum patient Entrance Skin Exposure Dose Rate. (Refer to Section 2.7 “Fluoro Calibration”).*

2.2 EXPOSURE TIME ADJUSTMENT

The values stored in these Extended Memory Locations only affect to Exposure Times for techniques below 20 ms. The Memory Locations which affect short exposure times are:

FUNCTION	MEMORY LOCATION	
	TUBE-1	TUBE-2
EXPOSURE TIME ADJUSTMENT - DELAY	E13	E29
EXPOSURE TIME ADJUSTMENT - Ceq kV	E15	E31

The generator has been optimized at the factory to produce correct exposures at the lower times (<20 ms.) Therefore **do not change** the value factory set for E13 and E29 Memory Locations and only adjust the value for E15 and E31 Memory Location according to the HV Cables length.

The Exposure Time adjustment is calibrated by performing the following steps:

1. Enter in calibration mode by pressing the "*Manual Calibration*" button on the GSM Program. Select an available workstation (WS) and press the "*OK*" button.

2. Select the E13 (or E29) Memory Location. Value in this Memory Location adjusts the time delay of the exposure. It is factory set for a value of 17, 18 or 19 (*default value is "**18**"*). Only read this value, **do not change it**.

3. Select the E15 (or 31) Memory Location. Value in this Memory Location is set in relation to the length in meters of one of the HV Cables (1 ft = 0.3048 m). Verify the HV Cable length in meters and set the following value:

HV CABLE LENGTH	VALUE TO SET IN MEMORY
4 m	27
6 m	31
9 m	38
12 m	45
14 m	49
16 m	54
For another HV Cable length	value = (2.2711 x cables length) + 17.744

4. Store the value of each Memory Location by pressing the "*Store*" button of the calibration panel.

5. Exit from calibration mode and record the new values in the Data Book.

6. Repeat the above calibration process for the second tube (memory locations E29 and E31).

2.3 KV LOOP

Extended Memory Location E06 contains the calibration factor for kV Loop. Each number above or below of the indicated in the E06 memory location increases or decreases respectively the kV gain value.

Note ☞ *Value in E06 Memory Location is only related to the Generator performance (it is not related to the X-ray Tube(s) or another components installed), so value in* ***this Memory Location is factory adjusted****. Only perform this procedure if the HT Controller Board and/or HV Transformer have been replaced in the unit.*

The kV Gain for kV Loop can be manually calibrated with a Non-Invasive kV Meter (recommended procedure) or Auto-calibrated with HV Bleeder.

Manual Calibration of E06 Memory Location

1. With the Generator power OFF:

   ▪ Set Dip switch 3000SW2-2 on the HT Controller Board in *"**Off**"* position (enables Filament and Rotor Interlocks).

   ▪ Set Dip switch 3000SW2-4 on the HT Controller Board in *"**On**"* position (Digital mA Loop Open / Filament Current Constant).

   ▪ Remove the link between the banana plug connections on the HV Transformer. Connect the mAs Meter to the banana plug connections to measure mA or mAs.

   ▪ Place and center a Non-Invasive kVp Meter on the X-ray Tube output at the required SID (*refer to the Non-Invasive kVp Meter documentation*).

2. Enter in calibration mode by pressing the "*Manual Calibration*" button on the GSM Program. Select an available workstation (WS) and press the "*OK*" button.

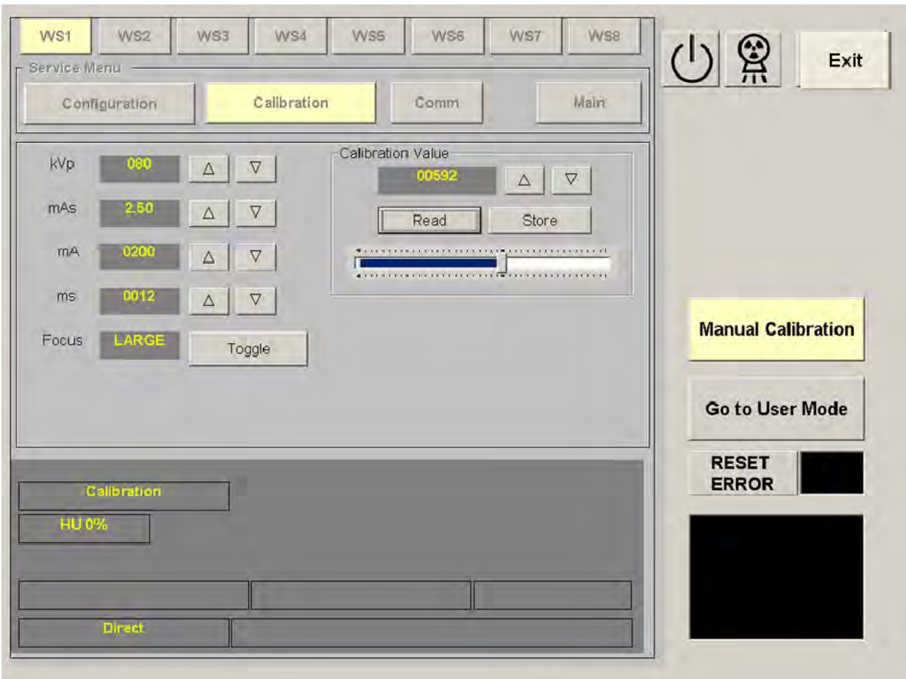
3. Select the E06 Memory Location and read the calibration value by pressing the "*Read*" button. Enter the value "***200***" and store it by pressing the "*Store*" button.

4. Calibrate manually the Filament Current Number for 80 kV / 200 mA combination, as indicated in the following steps (*if it has not been previously calibrated*).

   In calibration mode, Filament Current Numbers are shown on the calibration panel by pressing the "*Read*" button after selecting the respective kV / mA combination. They can be changed by pressing the *"Increase"* and *"Decrease"* buttons and stored by pressing the "*Store*" button of the calibration panel.

   Select 80 kV, 200 mA, Large Focus. Enter the value "*344*" as Filament Current Number (calibration value) and press the "*Store*" button. Make an exposure with these parameters. The mAs read on the mAs Meter must be the same mAs displayed on the calibration screen with a tolerance of ±0.1 mAs (tolerance of the parameter and mAs Meter).

   If the mAs is low, increase the filament number. If the mA is high (or "*Generator Overload*" Error is shown), decrease the filament number. Press the "*Store*" button before making a new exposure. Repeat until the mAs read is correct and the mA station is calibrated.



5. Enter in user mode inside calibration mode by pressing the "*Go to User Mode*" button.

6. Select: RAD Menu, 80 kV, 200 mA, 100 ms and Large Focus. Make an exposure and note the kV value at the end of the exposure.

7. If calibration of the kV Loop is correct (80 ±1 kV), record value "***200***" in the Data Book.

8. If calibration of the kV Loop is not correct:

   a. Exit from the "*User Mode*" screen by pressing the "*Manual Calibration*" button. Select the E06 Memory Location. Press the "*Read*" button to read the value stored.

   b. Increase or decrease the value to increase or decrease the kV respectively. Enter the new value and store it by pressing the "*Store*" button.

   c. Exit calibration mode and repeat the exposure (*steps 5 and 6*) to determine if the new value has had the proper effect, if not repeat step-8.

   d. When it is correct, record the new value for E06 Memory Location in the Data Book.

9. After calibration of E06 Memory Location, remove the Non-Invasive kVp Meter.

Auto-Calibration of E06 Memory Location

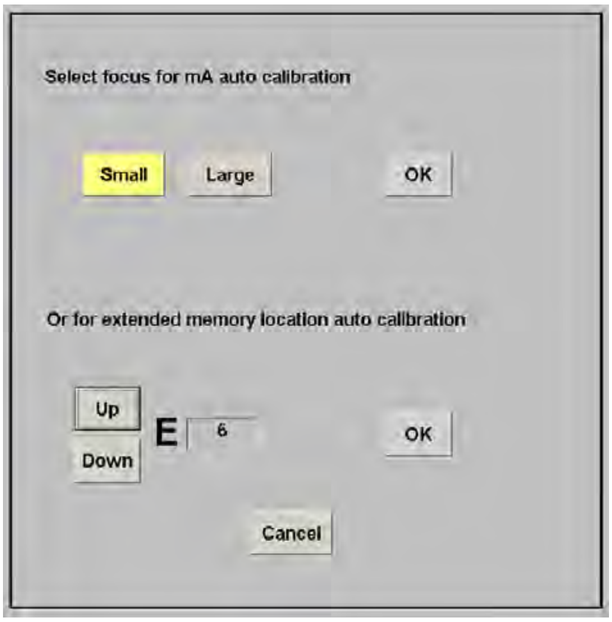
1. With the Generator power OFF:

   - Set Dip switch 3000SW2-2 on the HT Controller Board in *"**On**"* position (disables Filament and Rotor Interlocks).

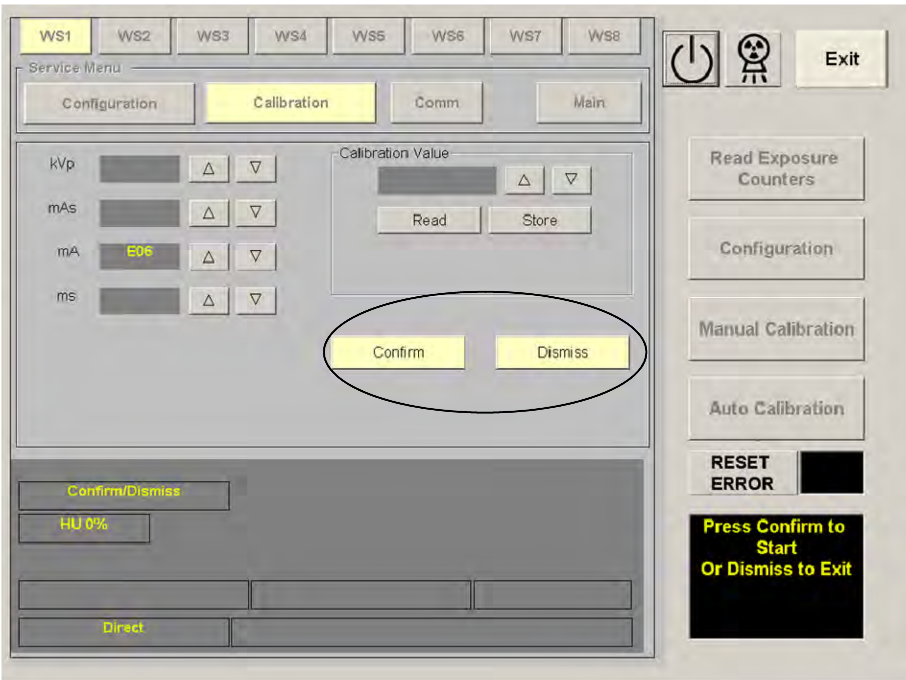
   - Remove the HV Cables from the X-ray Tube and connect them to the HV Bleeder, then connect a short couple of HV Cables from the HV Bleeder to the X-ray Tube.

2. Enter in Auto-calibration mode by pressing the "*Auto Calibration*" button on the GSM menu. Select an available workstation (WS) and press the "*OK*" button. Then, select the E06 Memory Location and press the "*OK*" button.

   Confirm or leave the Auto-calibration by pressing the respective button ("*Yes*" or "*No*") on the new screen.



Confirm or leave the Auto-calibration (second confirmation) by pressing the respective button ("*Confirm*" or "*Dismiss*") on the calibration screen.



Auto-calibration is activated when the "*Auto Calibration*" button is lighted and the "*Press Prep and Expose*" message appears on the screen.

3. Make an exposure (technique parameters are pre-programmed at 100 kV, 200 mA and 32 ms and they can be shown when pressing the "*Prep*" button).

4. Read the kVp measured with the HV Bleeder and enter this value on the kV Display by pressing the *"kV Increase"* or *"kV Decrease"* buttons.

5. Exit from Auto-calibration mode pressing the "*Auto Calibration*" button. At this moment, the Generator will calculate and store the new value in E06 Memory Location. Auto-calibration is deactivated and the process is finished when the screen shows the GSM menu.

6. Press the "*Manual Calibration*" button. Select an available workstation (WS) and press the "*OK*" button. Then, select the E06 Memory Location and read its new value on the Calibration Display. Record this value in the Data Book.

7. Exit calibration mode.

8. After calibration of E06 Memory Location:

   - Switch the Generator power OFF.

   - Remove the HV Bleeder and connect the HV Cables from the Generator directly to the X-ray Tube.

2.4 DIGITAL mA LOOP CLOSED

Extended Memory Locations E03 and E05 contain the calibration factor for Digital mA Loop Closed. Each number above or below the indicated in the Memory Locations increases or decreases respectively the mA gain value.

Note ☞

*Values in E03 and E05 Memory Locations are only related to the Generator performance (they are not related to the X-ray Tube installed), so values in **these Memory Locations are factory adjusted**. Only perform this procedure if the HT Controller Board and/or HV Transformer have been replaced in the unit.*

The mA Gain for Digital mA Loop Closed is calibrated by performing the following steps:

1. With the Generator power OFF, set:

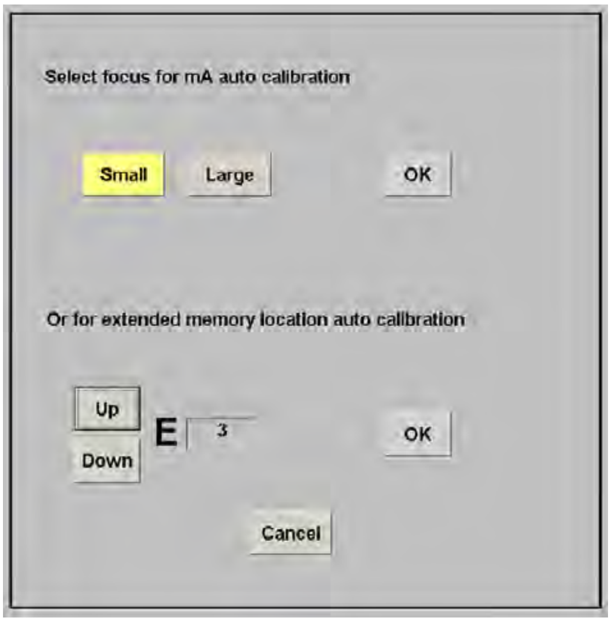
   - Dip switch 3000SW2-2 on the HT Controller Board in "***Off***" position (enables Filament and Rotor Interlocks).
   - Dip switch 3000SW2-4 on the HT Controller Board in "***On***" position (Digital mA Loop Open / Filament Current Constant).
   - Remove the link between the banana plug connections on the HV Transformer. Connect the mAs Meter to the banana plug connections to measure mA or mAs.

2. Calibration of E03 and E05 Memory Locations is performed by means of the "*Auto Calibration*" menu.

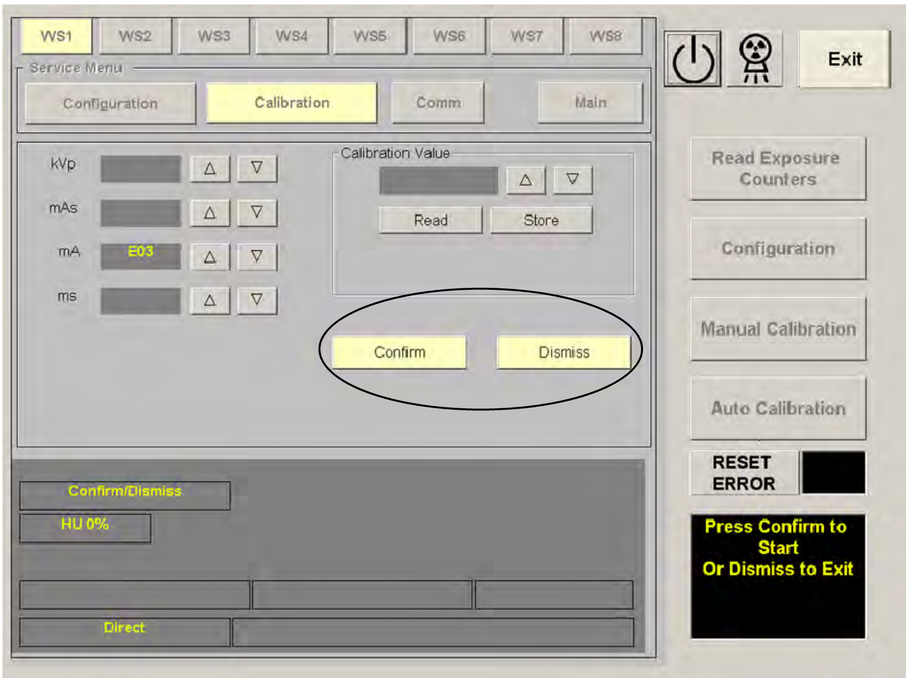
EACH TIME THAT AUTO-CALIBRATION IS ACTIVATED IN ONE OF THESE MEMORY LOCATIONS, CALIBRATION DATA STORED FOR THIS MEMORY LOCATION IS DELETED AND A NEW CALIBRATION FOR IT WILL BE REQUIRED.

3. Enter in Auto-calibration mode by pressing the "*Auto Calibration*" button on the GSM menu. Select an available workstation (WS) and press the "*OK*" button. Then, select the respective Memory Location (E03 or E05) and press the "*OK*" button.

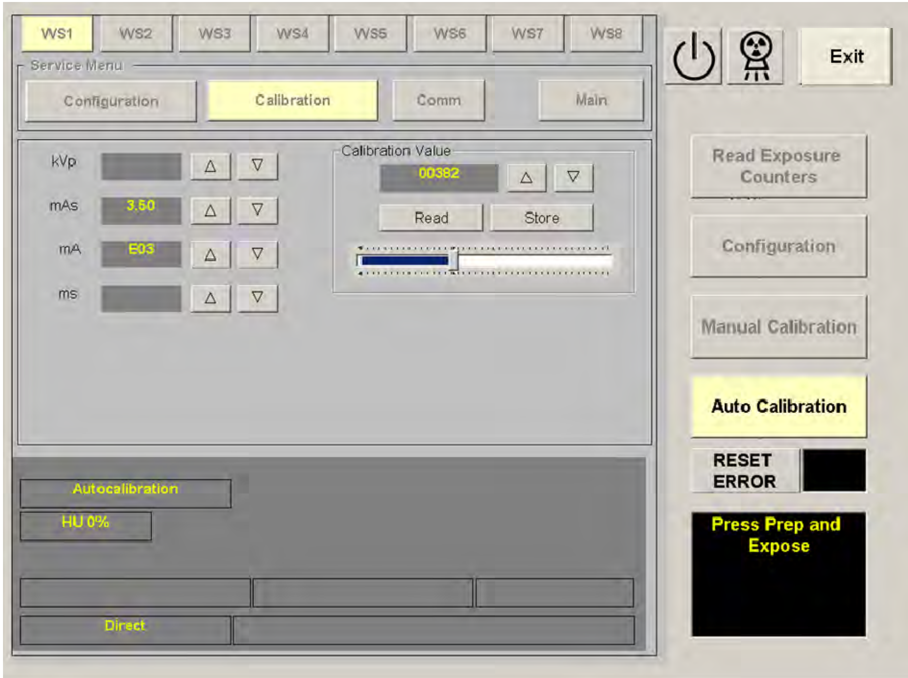
   Confirm or leave the Auto-calibration by pressing the respective button ("*Yes*" or "*No*") on the new screen.



Confirm or leave the Auto-calibration (second confirmation) by pressing the respective button ("*Confirm*" or "*Dismiss*") on the calibration screen.



Auto-calibration is activated when the "*Auto Calibration*" button is lighted and the "*Press Prep and Expose*" message appears on the screen.



4. Calibrate E03 and E05 Memory Locations as described in the following pages.

For Low mA stations (from 10 mA to 80 mA) (E03 Memory Location):

1. Enter in Auto-calibration mode by pressing the "*Auto Calibration*" button on the GSM menu and select the E03 Memory Location. Confirm all the following screens.

2. When Auto-calibration is activated, "*Auto Calibration*" button is lighted and the mAs value is shown on the screen (3.5 mAs or 35 mAs depending on the Generator software).

3. Perform the following steps:

   a. Make an exposure (technique parameters are pre-programmed at 80 kV, 32 mA and the respective time (0.1 s or 1 s) and they can be shown when pressing the "*Prep*" button).

   b. Read the mAs measured on the mAs Meter.

   c. Read the Filament Current Number shown on the calibration panel.

   d. Increase or decrease the Filament Current Number (by pressing the *"Increase"* or *"Decrease"* buttons) to determine the correction needed to obtain a value between 3.0 and 4.0 mAs (for 3.5 mAs) or a value between 30 and 40 mAs (for 35 mAs) in the mAs Meter after making a new exposure.

   e. Repeat the above steps until a proper mAs value is obtained in the mAs Meter.

4. Enter the mAs value read in the mAs Meter (step 3.) in the mAs Display pressing the "*mAs Increase*" or "*mAs Decrease*" buttons.

5. Exit from Auto-calibration mode pressing the "*Auto Calibration*" button. At this moment, the Generator will calculate and store the new value in E03 Memory Location. Auto-calibration is deactivated and the process is finished when the screen shows the GSM menu.

6. Press the "*Manual Calibration*" button. Select an available workstation (WS) and press the "*OK*" button. Then, select the E03 Memory Location and read its new value on the Calibration Display. Record this value in the Data Book.

7. Exit calibration mode.

For High mA stations (from 100 mA) (E05 Memory Location):

1. Enter in Auto-calibration mode by pressing the “*Auto Calibration*” button on the GSM menu and select the E05 Memory Location. Confirm all the following screens.

2. When Auto-calibration is activated, “*Auto Calibration*” button is lighted and the mAs value is shown on the screen (7.75 mAs or 77.5 mAs depending on the Generator software).

3. Perform the following steps:

   a. Make an exposure (technique parameters are pre-programmed at 80 kV, 125 mA and the respective time and they can be shown when pressing the “*Prep*” button).

   b. Read the mAs measured on the mAs Meter.

   c. Read the Filament Current Number shown on the calibration panel.

   d. Increase or decrease the Filament Current Number (by pressing the *“Increase”* or *“Decrease”* buttons) to determine the correction needed to obtain a value between 7.00 and 8.50 mAs (for 7.75 mAs) or a value between 70 and 85 mAs (for 77.5 mAs) in the mAs Meter after making a new exposure.

   e. Repeat the above steps until a proper mAs value is obtained in the mAs Meter.

4. Enter the mAs value read in the mAs Meter (step 3.) in the mAs Display pressing the “*mAs Increase*” or “*mAs Decrease*” buttons.

5. Exit from Auto-calibration mode pressing the “*Auto Calibration*” button. At this moment, the Generator will calculate and store the new value in E05 Memory Location. Auto-calibration is deactivated and the process is finished when the screen shows the GSM menu.

6. Press the “*Manual Calibration*” button. Select an available workstation (WS) and press the “*OK*” button. Then, select the E05 Memory Location and read its new value on the Calibration Display. Record this value in the Data Book.

7. Exit calibration mode.

8. After calibration of E03 and E05 Memory Locations:

   - Switch the Generator power OFF.

   - Disconnect the mAs Meter to the banana plug connections.

   - Re-install the link between the banana plug connections on the HV Transformer.

2.5 DIGITAL mA LOOP OPEN (X-RAY TUBE CALIBRATION)

To achieve the most accurate calibration, **this procedure has to be automatically performed by the Generator (Auto-calibration).** Calibration procedure will be manually performed by the field engineer only if Auto-calibration is not possible.

Two different methods are described in this section: Auto-calibration and Manual Calibration.

Digital mA Loop Open is calibrated by performing the following steps:

1. With the Generator power OFF, set:
   - Dip switch 3000SW2-2 on the HT Controller Board in *“**Off**”* position (enables Filament and Rotor Interlocks).
   - Dip switch 3000SW2-4 on the HT Controller Board in *“**On**”* position (Digital mA Loop Open / Filament Current Constant).
2. Turn the Generator ON.
3. Perform the Auto-calibration procedure as described in Section 2.5.1 for each X-ray Tube in the system.

2.5.1 AUTO-CALIBRATION OF DIGITAL mA LOOP OPEN

Auto-calibration of the Filament Current Numbers is divided in two separated procedures related to the mA stations configured for the Small or Large Focal Spots.

It is recommended to start with the Small Focal Spot (first group) and continue with the Large Focal Spot (second group).

WARNING

EACH TIME THAT AUTO-CALIBRATION IS ACTIVATED IN A mA STATION (OR IN “E01” MEMORY LOCATION), ALL THE FILAMENT CURRENT NUMBERS OF THE SELECTED FOCAL SPOT ARE AUTOMATICALLY SET TO “344”. SO A NEW COMPLETE CALIBRATION OF THE FILAMENT CURRENT NUMBERS FOR THIS FOCAL SPOT WILL BE REQUIRED.

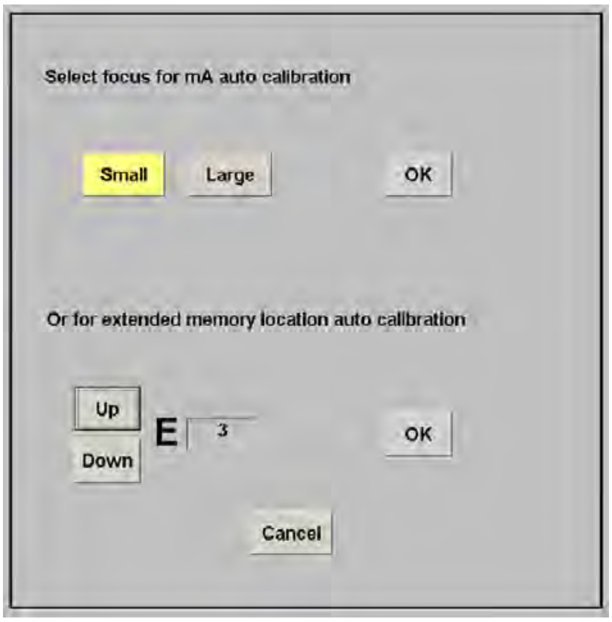
Auto-calibration starts with the minimum available mA station for the selected Focal Spot at 50 kV and follows with the other combinations of mA stations for the selected Focal Spot at 80 kV, 120 kV and 40 kV.

1. Enter in Auto-calibration mode by pressing the "*Auto Calibration*" button on the GSM menu.

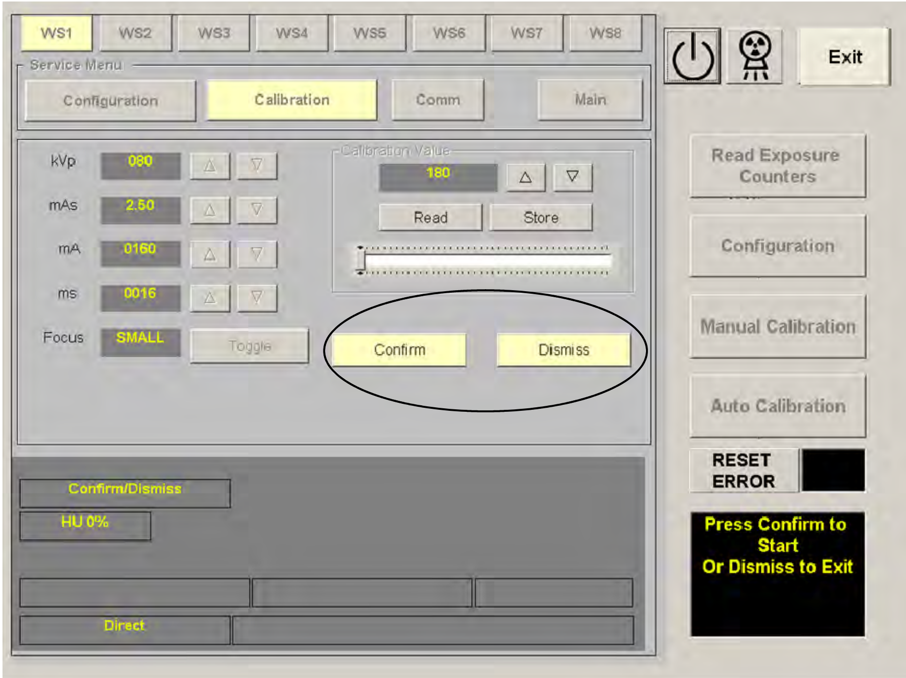
2. Select an available workstation (WS) of the X-ray Tube to be calibrated and press the "*OK*" button. This workstation has to be one of the previously configured as "*Direct*".

3. Select the **Small Focal Spot** by pressing the "*Small*" button and then press the "*OK*" button.

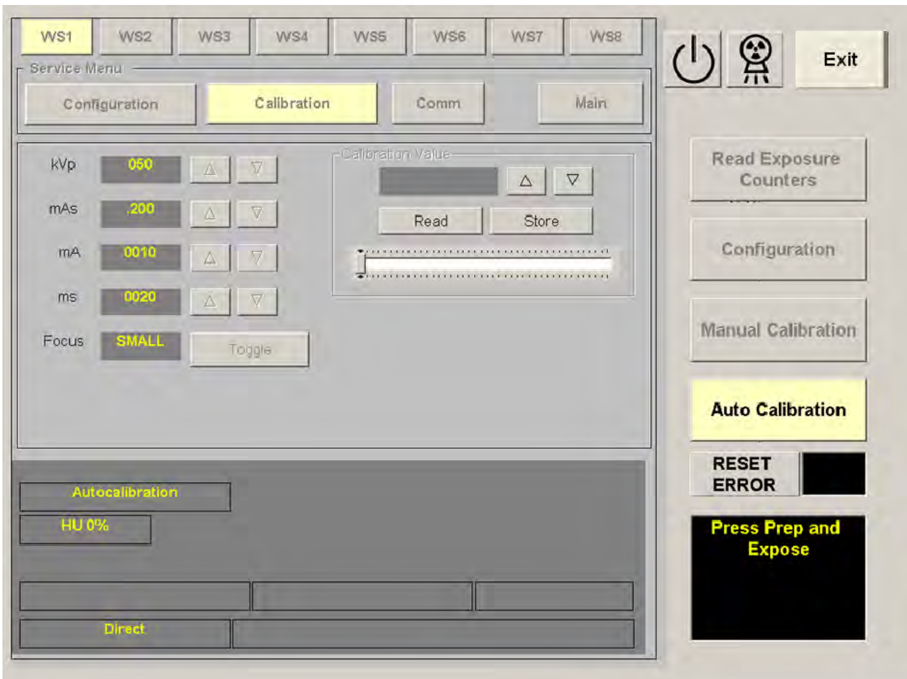
   Confirm or leave the Auto-calibration by pressing the respective button ("*Yes*" or "*No*") on the new screen.



4. Confirm or leave the Auto-calibration (second confirmation) by pressing the respective button ("*Confirm*" or "*Dismiss*") on the calibration screen.



5. Auto-calibration is activated when the "*Auto Calibration*" button is lighted and the "*Press Prep and Expose*" message appears on the screen. At this moment, the Generator has checked the mA stations available for the **Small Focal Spot**.



6. Check that the Heat Units capacity available for the X-ray Tube is 100% or nearly (HU 0% displayed on the screen).

WARNING

BEFORE MAKING ANY EXPOSURE IN AUTO-CALIBRATION, VERIFY THAT THE LINK BETWEEN THE BANANA PLUG CONNECTIONS ON THE HV TRANSFORMER IS INSTALLED.

7. Keep fully pressed the Handswitch button to perform continuous exposures.

Note ☞

In Auto-calibration mode, all technique parameters are factory pre-programmed and they can not be changed.

CAUTION

Auto-calibration can be paused momentarily releasing the Handswitch button, whenever there is not an exposure in process. Do not exit from Auto-calibration before the procedure has been completed.

Note ☞

Auto-calibration can be cancelled by pressing the "Auto Calibration" button. A message on the screen informs that Auto-calibration has been cancelled and after a while the screen shows the GSM menu.

If during Auto-calibration process, any error indication is shown momentarily (such as "*Tube Overload*", etc.), it means that Generator can not calibrate in this moment the selected kV / mA combination (because anode overheated, space charge, Generator power limit, etc.). In this case, the Generator will continue with Auto-calibration of the following available kV / mA combinations for the selected Focal Spot. At the end of the process it will try to calibrate or calculate the combinations previously uncalibrated.

If the Heat Units value displayed is more than 60%, exposures are inhibited momentarily and message *"Tube too hot"* is shown on the screen. This message will disappear and exposures can be made again when the X-ray Tube begins to cool and recovers the Heat Units capacity.

At this point, it is recommended to wait until the Heat Units value displayed are close to the 20% before making any exposure.

Generator tries to calibrate each kV / mA combination for ten (10) attempts (maximum). If calibration is cancelled (after ten attempts), message “*Auto calibration failure*” is shown on the screen until press the “*Auto Calibration*” button to exit from Auto-calibration mode and go back to the GSM menu. Calibration can be also cancelled due to space charge during calibration of the lowest kV at the highest mA stations for the Focal Spot selected, so message “*Auto calibration failure*” is also shown on the screen until press the “*Auto Calibration*” button to exit from Auto-calibration mode and go back to the GSM menu.

WARNING

ONLY IF AUTO-CALIBRATION IS CANCELLED DUE TO “*AUTO CALIBRATION FAILURE*”, CONTINUE THE AUTO-CALIBRATION PROCEDURE FOR THE OTHER FOCAL SPOT. CHECK AT THE END OF THE AUTO-CALIBRATION PROCEDURE WHICH kV / mA COMBINATIONS HAVE NOT BEEN AUTO-CALIBRATED FOR EACH FOCAL SPOT (THESE COMBINATIONS HAVE THE FILAMENT CURRENT NUMBER SET TO “344”). MANUALLY CALIBRATE THESE kV / mA COMBINATIONS AS EXPLAIN IN SECTION 2.5.2.

When Auto-calibration is successfully performed, message “*Auto Calibration OK*” is shown on the screen until press the “*Auto Calibration*” button to exit from Auto-calibration mode and go back to the GSM menu.

8. Repeat the same procedure for the **Large Focal Spot.**

   Enter in Auto-calibration mode by pressing the “*Auto Calibration*” button on the GSM menu.

   Select an available workstation (WS) of the X-ray Tube to be calibrated and press the “*OK*” button. This workstation has to be one of the previously configured as “*Direct*”.

   Select the **Large Focal Spot** by pressing the “*Large*” button and then press the “*OK*” button.

   Confirm or leave the Auto-calibration by pressing the respective button on each screen.

   Auto-calibration is activated when the “*Auto Calibration*” button is lighted. At this moment, the Generator has checked the mA stations available for the **Large Focal Spot**.

   Before starting the exposures, it is recommended to wait until the Heat Units value displayed are close to the 20%.

9. After performing both procedures (for Small and Large Focal Spots), enter in "*Manual Calibration*" mode and select each combination of the available mA stations for each Focal Spot at the kV break points (40, 50, 80 and 120 kV). Press the "*Read*" button to read on the calibration panel the new value of the Filament Current Number stored for each combination and record the new values in the Data Book.

   Note that the highest mA station for Small Focal Spot may have numbers larger than the lowest mA station for Large Focal Spot. This is normal.

10. Exit from calibration mode.

11. Perform the Auto-calibration procedure for the second X-ray Tube.

12. **Turn the Generator power OFF and set Dip Switch 3000SW2-4 on the HT Controller Board in *"Off"* position (Digital mA Loop Closed).**

2.5.2 MANUAL CALIBRATION OF DIGITAL mA LOOP OPEN

This procedure describes the Manual calibration of all the Filament Current Numbers. It has to be also used to calibrate the kV / mA combinations not performed during Auto-calibration procedure because it has not been completed. These combinations have the Filament Current Number set to "344", so only these combinations have to be manually calibrated as described in this procedure. If Auto-calibration for one of the Focal Spots has been successful, it is only required to perform the manual calibration of the mA station do not calibrate for the other Focal Spot.

Manual Calibration is initiated at the 80 kV break point by entering the appropriate Filament Current Number for the proper tube current at each selectable mA. Calibration at the other kV break points (40, 50, 80 and 120 kV) are obtained by adding or subtracting values as indicated in Table 2-1.

Although the suggested values (Table 2-1) could change depending on the X-ray tube used, entering those values will approximate accurate calibration without making excessive exposures.

In "*Manual Calibration*" mode, the Filament Current Numbers are shown on the calibration panel by pressing the "*Read*" button after selecting the respective kV / mA combination. The value can be changed by pressing the *"Increase"* or *"Decrease"* buttons of the calibration panel and stored by pressing the "*Store*" button.

Note that in calibration mode, only the mA stations and kV (at the break points) can be selected.

Table 2-1
mA Calibration Numbers Change

mA STATION	FILAMENT CURRENT NUMBERS AT kV BREAK POINT			
	40	50	80	120
10	A_1+7	A_1+6	A_1	A_1–5
12.5	A_2+7	A_2+6	A_2	A_2–5
16	A_3+7	A_3+6	A_3	A_3–5
20	A_4+7	A_4+6	A_4	A_4–5
25	A_5+7	A_5+6	A_5	A_5–5
32	A_6+7	A_6+6	A_6	A_6–5
40	A_7+7	A_7+6	A_7	A_7–5
50	A_8+7	A_8+6	A_8	A_8–5
64 (or 63 or 65)	A_9+7	A_9+6	A_9	A_9–5
80	A_{10}+7	A_{10}+6	A_{10}	A_{10}–5
100	A_{11}+10	A_{11}+8	A_{11}	A_{11}–7
125	A_{12}+10	A_{12}+8	A_{12}	A_{12}–7
160	A_{13}+10	A_{13}+8	A_{13}	A_{13}–7
200	A_{14}+10	A_{14}+8	A_{14}	A_{14}–7
250	A_{15}+10	A_{15}+8	A_{15}	A_{15}–7
320	A_{16}+14	A_{16}+11	A_{16}	A_{16}–9
400	A_{17}+14	A_{17}+11	A_{17}	A_{17}–9
500	A_{18}+14	A_{18}+11	A_{18}	A_{18}–9
640 (or 630 or 650)	A_{19}+14	A_{19}+11	A_{19}	A_{19}–9
800	A_{20}+14	A_{20}+11	A_{20}	A_{20}–9
1000	A_{21}+14	A_{21}+11	A_{21}	A_{21}–9

Note.– The mA station values depends on the Generator model. Some models do not contain all the mA stations listed above.

1. With the Generator power OFF, set:

   - Dip switch 3000SW2-2 on the HT Controller Board in *"**Off**"* position (enables Filament and Rotor Interlocks).

   - Dip switch 3000SW2-4 on the HT Controller Board in *"**On**"* position (Digital mA Loop Open / Filament Current Constant).

   - Remove the link between the banana plug connections on the HV Transformer. Connect the mAs Meter to the banana plug connections to measure mA or mAs.

2. Turn the Generator ON and enter in calibration mode by pressing the "*Manual Calibration*" button on the GSM menu.

3. Select an available workstation (WS) of the X-ray Tube to be calibrated and press the "*OK*" button. This workstation has to be one of the previously configured as "*Direct*".

4. Check that the Heat Units available for the X-ray Tube is 100% or nearly (HU 0% displayed on the screen).

5. Accordingly to X-ray tube ratings or maximum Generator power, check which kV / mA combinations in Table 2-1 are allowed.

   If error "*Tube Overload*" is shown after selection of a kV / mA combination, it means this combination is not allowed for the selected X-ray Tube.

   In calibration mode, if Generator power is exceeded by a kV / mA combination selection, error "*E-16"* is shown after "*Preparation*". Reset this error by pressing the "*Reset Error*" button.

   Note which combinations in Table 2-1 can not be calibrated by making exposures (combinations not allowed due to Tube rating, maximum Generator power, space charge, etc.) and the Exposure Time assigned to these combinations in calibration mode.

6. Enter in user mode inside calibration mode by pressing the "*Go to User Mode*" button. Select the mA station and Exposure Time of each kV / mA combination not allowed. Increase or decrease the kV value as required to determine the kV value allowed nearest to the kV value of the combination. Note the kV value allowed in the respective cell of Table 2-1.

7. Exit from the "*User Mode*" screen by pressing the "Manual Calibration" button. Select 80 kV and lowest mA station available (first combination available). Enter a Filament Number of "344" for this combination.

8. Make an exposure. The mAs read on the mAs Meter must be the same mAs displayed on the calibration screen with a tolerance of ± 0.1 mAs (tolerance of the parameter and mAs Meter). If the mAs read is close to zero, increase the filament number in big steps (a.e. increase values in 40). As the mAs read is close to the mAs displayed on the Console, increase (or reduce) the filament number in smaller steps (a.e. increase value in 30, 20, 10, ...).

   If the mAs is low, increase the filament number. If the mA is high, decrease the filament number. Press the "*Store*" button before making a new exposure. Repeat until the mA station is calibrated.

Note ☞ *Press the "Store" button to store the new data (filament number) before selecting the next kV or mA stations.*

CAUTION

Calibration data (presently in memory) may or may not be close to your requirements. If it is not close, the potential exists to damage the X-ray tube (i.e. too much mA). Thus, as you start the mA calibration procedure note how close or how far off the mA break points are. If a large adjustment (more than 40 points) is required at the low mA stations, make estimated adjustments to the high mA stations <u>before</u> those exposures are made.

9. Select the next mA station at 80 kV. Before making any exposure, enter as filament number the value calibrated for the previous mA station increased in 10.

   If the mAs is low, increase the filament number. If the mA is high, decrease the filament number. Press the "*Store*" button before making a new exposure. Repeat until the mA station is calibrated.

10. Complete the calibration process for all mA stations at 80 kV as described before. When select the first mA station for the Large Focal Spot, enter as a filament number the value calibrated for the first mA station for the Small Focal Spot. Note that the highest mA station for Small Focal Spot may have numbers larger than the lowest mA station for Large Focal Spot. This is normal.

    Press the “*Read*” button to read on the calibration panel the new value of the Filament Current Number stored for each mA station at 80 kV. Record the new values in the Data Book.

Note ☞

When highest mA stations of the Generator can not be calibrated at 80 kV due to insufficient filament current (the filament current number has reached the maximum number (999)), replace on the Filament Board (A3004-09/10) the Resistor R11 for another resistor with 1.4 kΩ / 5 W, and place Jumper JP1 in position “A”. Then rename the Filament Board as A3004-11.

ATTENTION: After doing this modification reduce the value of all the filament current numbers (column for 80 kV) at the 25% and perform the calibration procedure again (from step-5).

11. Complete the calibration process for the remaining kV / mA combinations using Table 2-1 as a guide. It is not necessary to make exposures to do this. Compute the value for all the kV break points of each available mA station although the Generator power can not reach all the kV / mA combinations. Select the corresponding kV / mA combination and enter the computed value.

12. Check calibration at all break points (making exposures) and correct any calibration points as needed.

Note ☞

If “Tube Overload” error is shown directly after selection of an allowed combination (refer to step-5.), wait until the X-ray tube anode cools down to permit the calibration of the mA station.

13. Recalculate the values of the non-allowed combinations in accordance to the new values obtained by exposures. (*Refer to Table 2-1*).

14. Enter in user mode inside calibration mode by pressing the "*Go to User Mode*" button. Select the mA station, Exposure Time and kV value noted for each kV / mA combination not allowed *(refer to step-6.)*. Check calibration at these kV / mA combinations by making exposures. If needed, enter in calibration mode and correct the Filament Current Number of the respective kV / mA combination not allowed.

15. Exit from the "*User Mode*" screen by pressing the "Manual Calibration" button. In calibration mode, select each combination of the available mA stations at the kV break points (40, 50, 80 and 120 kV). Press the "*Read*" button to read on the kV Display the new value of the Filament Current Number stored for each combination. Record the new values in the Data Book.

    Note that the highest mA station for Small Focal Spot may have numbers larger than the lowest mA station for Large Focal Spot. This is normal.

16. Exit calibration mode.

17. If required, perform the calibration procedure for the second X-ray Tube.

18. After calibration of Filament Current Numbers:

    - Switch the Generator power OFF.
    - Disconnect the mAs Meter to the banana plug connections.
    - Re-install the link between the banana plug connections on the HV Transformer.
    - **Set Dip Switch 3000SW2-4 on the HT Controller Board in "*Off*" position (Digital mA Loop Closed).**

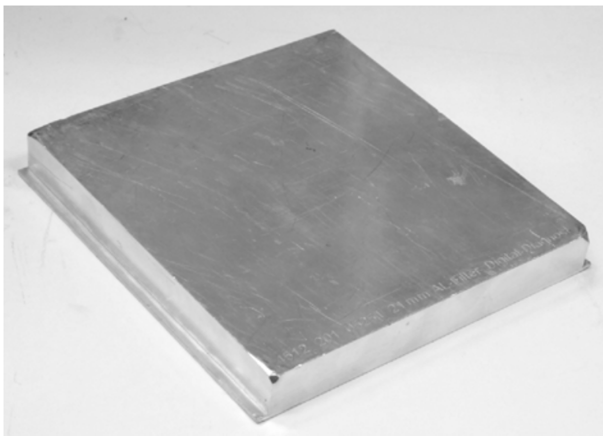
2.6 AEC CALIBRATION

This section describes the adjustments needed to calibrate the AEC in order to achive the correct image at the lowest possible dose.

The Optical Density or Optimum Gray Level is controlled by the values stored in the respective memory locations. For Film, these values are influenced by film speed, screen speed, dark room procedures and customer requirements.

AEC Calibration is carried out using a homogeneous Phantom of Aluminium with a purity of not less that 99% and thickness of 21 mm, to produce an exposure between 50 ms and 300 ms. The AEC will be calibrated to produce a density of 1.0 (or the customer preference Optical Density for Film) or an Optimum Gray Level (for CR or DR) at 70 kV, and then AEC kV Tracking will be adjusted to produce the same density at 55 kV and 90 kV.

Illustration 2-1
Phantom of Aluminium



CAUTION

Before starting with the AEC Calibration, it is necessary that the Alignment of X-Ray Beam and the Alignment of Light Field with X-Ray Field should be performed.

CAUTION

The AEC Calibration must be carried out with the GRID removed whenever possible.

Note ☞

For AEC calibration with Film*, use the same Film and Cassettes used by the customer. AEC calibration must be performed using the Medium Film/Screen speed combination. The Medium Film/Screen speed has to be double of the Slow and half of the Fast (a.e. 200-Slow, 400-Medium, 800-Fast).*

Note ☞

For AEC Calibration with CR (Computer Radiography) or DR (Digital Radiography)*, measure the Image Gray Level or Dose Level by using the needed software tools inside each Acquisition Application.*

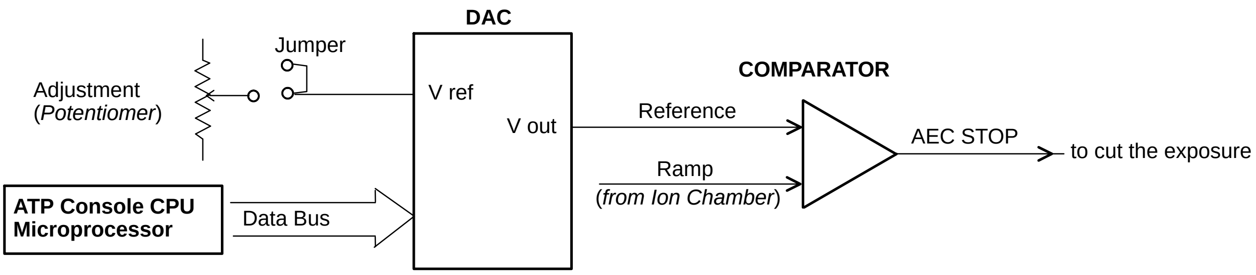
The Dose Level can be also measured by placing a Dosimeter centered on the imaging area of the Receptor (CR or DR) and with the Grid removed.

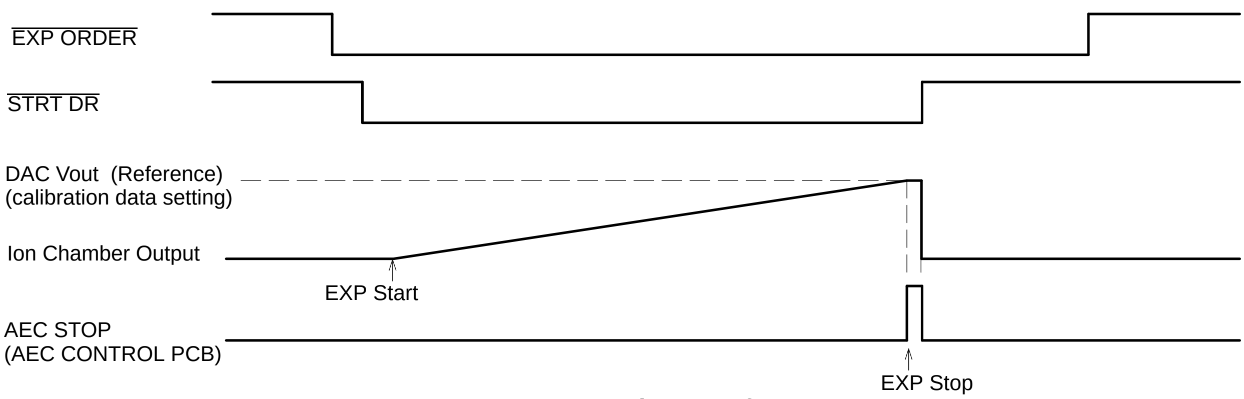
The following table indicates the Memory Locations related to AEC Calibration.

FUNCTION	MEMORY LOCATION
AEC-1 CALIBRATION	E04
AEC-1 TRACKING	E08
AEC-2 CALIBRATION	E09
AEC-2 TRACKING	E10
AEC-3 CALIBRATION	E20
AEC-4 CALIBRATION / PHOTOMULTIPLIER AEC CALIBRATION	E23
AEC-3 and AEC-4 TRACKING (equal value for both)	E24
AEC DENSITY SCALE	E12

Previous to AEC Calibration, identify and note which Memory Locations are assigned / related to each Ion Chamber / Photomultiplier in the system regarding to the configured Workstation / Devices.

Illustration 2-2
Automatic Exposure Control





AEC Function Waveform

2.6.1 PREVIOUS CHECKS FOR AEC CALIBRATION WITH FILM

Make sure the automatic processor works correctly, and the concentration and temperature of the solutions comply with manufacturer specifications.

Obtain a sensitometric curve to determine gamma (γ) of the film and the solution quality. The procedure normally requires a sensitometer, but if it is not available proceed as follows:

1. Make two exposures using the same kV and Film/Screen combination (medium is recommended) but with different mAs settings, mAs(f1) and mAs(f2).

2. Develop and measure the Density (d) of each, d(f1) and d(f2).

3. Determine gamma (γ) by the formula:

$$\gamma = \frac{d(f2) - d(f1)}{\log_{10} \frac{mAs(f2)}{mAs(f1)}}$$

Gamma (γ) must be between 2 and 3, if not change or renew solutions.

2.6.2 OPTICAL DENSITY / IMAGE GRAY LEVEL ADJUSTMENT

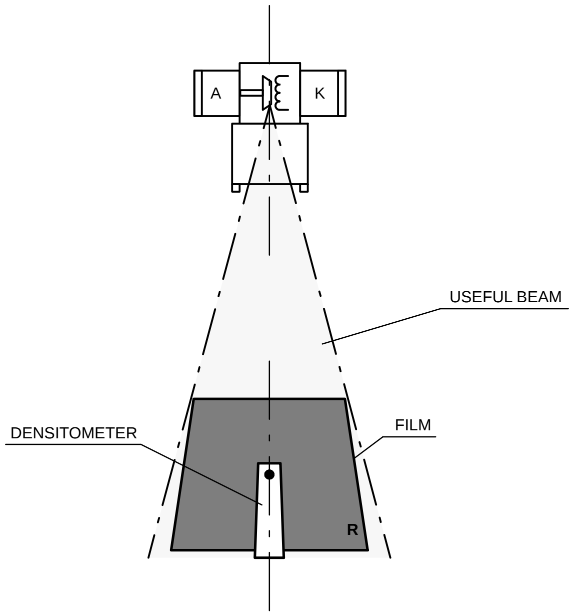
Note ☞ *For Film, the Film Optical Density must be measured always on the same point for all the X-ray Films developed during this procedure.*

The recommended point is on the central axis of the Film with relation of the Anode and Cathode and as close as possible to center of the Film.

Note ☞ *For CR or DR, the Image Gray Level must be measured always on the same area (Region of Interest) for all the RAW images obtained during this procedure.*

The recommended ROI is 4 x 4 cm on the center of the CR or Detector.

Illustration 2-3
How to measure the Film Optical Density (only for Film)



2.6.2.1 ION CHAMBERS WITH GAIN SWITCHES OR WITH GAIN POTENTIOMETER

1. Set the Gain Switches (or Gain Potentiometer) of the Ion Chamber to mid range (*refer to Ion Chamber documentation*).

   The following tables indicate the switch position for the "*Vacutec*" Ion Chamber.

VACUTEC ION CHAMBER – BAK 70 151 with Amplifier 70 901					
SWITCH POSITION		**SW1**	**SW2**	**SW3**	**SW4**
GAIN	0.1 V / µGy (10 V≃ 100 µGy)	OFF	OFF	OFF	
	0.5 V / µGy (10 V≃ 20 µGy)	ON	OFF	OFF	
	1 V / µGy (10 V≃ 10 µGy)	OFF	ON	OFF	
	2 V / µGy (10 V≃ 5 µGy)	OFF	OFF	ON	
OUTPUT SIGNAL	Positive				ON
	Negative				OFF
NORMAL FACTORY SELECTION: 1 V / µGy (10 V≃ 10 µGy) - Positive		***OFF***	***ON***	***OFF***	***ON***

VACUTEC DIGITAL ION CHAMBER – BAK 70 151 with Amplifier 70 902					
SWITCH POSITION		**SW1**	**SW2**	**SW3**	**SW4**
GAIN	0.1 V / µGy (10 V≃ 100 µGy)	OFF	OFF	OFF	OFF
	0.5 V / µGy (10 V≃ 20 µGy)	OFF	OFF	OFF	ON
	1 V / µGy (10 V≃ 10 µGy)	OFF	OFF	ON	OFF
	2 V / µGy (10 V≃ 5 µGy)	OFF	ON	OFF	OFF
	4 V / µGy (10 V≃ 2.5 µGy)	ON	OFF	OFF	OFF
OUTPUT SIGNAL	Positive or Negative polarity of the ramp signal is selected with a switch at the Ramp Module. The Ramp Module is a 9-pin Sub-D connector plugged to the Ion Chamber cable. Positive polarity of the ramp signal is factory set.				
NORMAL FACTORY SELECTION: 1 V / µGy (10 V≃ 10 µGy) - Positive		***OFF***	***OFF***	***ON***	***OFF***

2. Set the following jumper on the AEC Control Board in position A: JP3 for Board A3012–x1/x2/x5 or JP2 for Board A3012–x6/x7/x9.

3. Set SID at the Focal Distance of the Grid to be used in the Table Receptor (usually 100 cm) or in the Vertical Stand Receptor (usually 100 cm and 150 cm or 180 cm).

4. Open the Collimator blades completely.

5. Place in the Collimator guides a Phantom of Aluminium with a purity of not less that 99% .

CAUTION

Any other Phantom material should not be used for AEC Calibration.

6. Enter in calibration mode and verify that AEC Calibration number in E04, E09, E20 and E23 Memory Locations is 70. The useful range for AEC calibration numbers is from 20 to 120. Exit from calibration mode.

7. Enter in calibration mode selecting a Workstation configured for the Ion Chamber to be calibrated. Enter in user mode inside calibration mode by pressing the "*Go to User Mode*" button.

8. Select on the Console:
   - RAD Menu: 70 kV, 100 mA and 1 second back-up time.
   - AEC Menu: "*Central Field*" , "*Density 0*" and "*Medium Film/Screen*".

9. Make an exposure (in case of Film, without film in the cassette, but the cassette inserted in the Receptor housing) (in case of CR or DR, with the CR or DR inserted in the Receptor housing), then note the Exposure Time displayed on the Console, it should be a time between 50 ms and 300 ms. If necessary, change the mA station and make the exposure again (to reduce the time increase the mA value, and viceversa).

Note ☞

The "Actual Exposure Parameters" area shows the last exposure parameters when: exposure is finished by the AEC, exposure is aborted by releasing the exposure control, or after pressing the "Reset Error" button.

CAUTION

The exposure time must be between 50 ms and 300 ms throughout the adjustment procedure. If not, increase or decrease the mA value.

10. **For Film**, insert a cassette with the Medium Film/Screen combination used by the customer. Make an exposure, develop the film and check the Optical Density, it should be 1.0 (or the customer preference O. Density).

    For CR or DR, make an exposure with the CR or DR in the Receptor housing. It is recommended to measure the Image Gray Level or the Dose Level shown on the Acquisition Application.

Note ☞ *The Gray Level and/or Dose reference values are those established by the manufacturer of the CR or DR.*

Note ☞ *When the calibration is carried out measuring the Dose Level, in case the Dose Level is not shown on the Acquisition Application, place a Dosimeter centered on the imaging area of the Receptor (CR or DR) and with the Grid removed.*

If it is not possible due to insufficient space between the Receptor and the Ion Chamber, place the Dosimeter centered in the Receptor housing (tray) and adjust the Gain Switches or Gain Potentiometer (as described in step 11.) until obtain the optimum Dose Level specified by the manufactured of CR or DR. Note the mA and ms resultant values.

After that, remove the Dosimeter and insert the Receptor (CR or DR). Select on the Console: 70 kV, the mA value previously noted and 1 second back-up time. Make an exposure and compare the exposure time now obtained with the previously noted time, then adjust the Gain Potentiometer and repeat the exposure until the previously noted exposure time is achieved.

11. To change the Optical Density, Image Gray Level or received Dose:

    - For Ion Chamber with Gain Switches:

      – If the *Optical Density / Image Gray Level / Dose* obtained is 33% above of the desired one, increase the gain with the switches. Repeat step-10.

      – If the *Optical Density / Image Gray Level / Dose* obtained is 33% below of the desired one, decrease the gain with the switches. Repeat step-10.

      – If the *Optical Density / Image Gray Level / Dose* obtained is in between 33% of the desired one, change the AEC calibration number.

    - For Ion Chamber with Gain Potentiometer, adjust the Gain Potentiometer until the desired *Optical Density / Image Gray Level / Dose* is obtained by repeating step-10. If the adjustment is not achieved with the Gain Potentiometer, change the AEC calibration number.

Note ☞ *As an alternative to the adjustment with the Gain Switches or the Gain Potentiometer is to change the AEC calibration number. It can be done when the Gain Switches or the Gain Potentiometer is not accessible.*

12. Exit from the "*Go to User Mode*" screen by pressing the "*Manual Calibration*" button and in calibration mode set the new AEC calibration number for the respecetive Memory Location (E04, E09, E20 or E23). The *Optical Density / Image Gray Level / Dose* increases / decreases when the calibration number is increased / decreased. Then enter in "*Go to User Mode*" screen and repeat step-10.

Note ☞ *The AEC accuracy is better in all the useful range as the AEC calibration number is closer to 70.*

13. Repeat the above steps for all the Ion Chambers installed with the Generator.

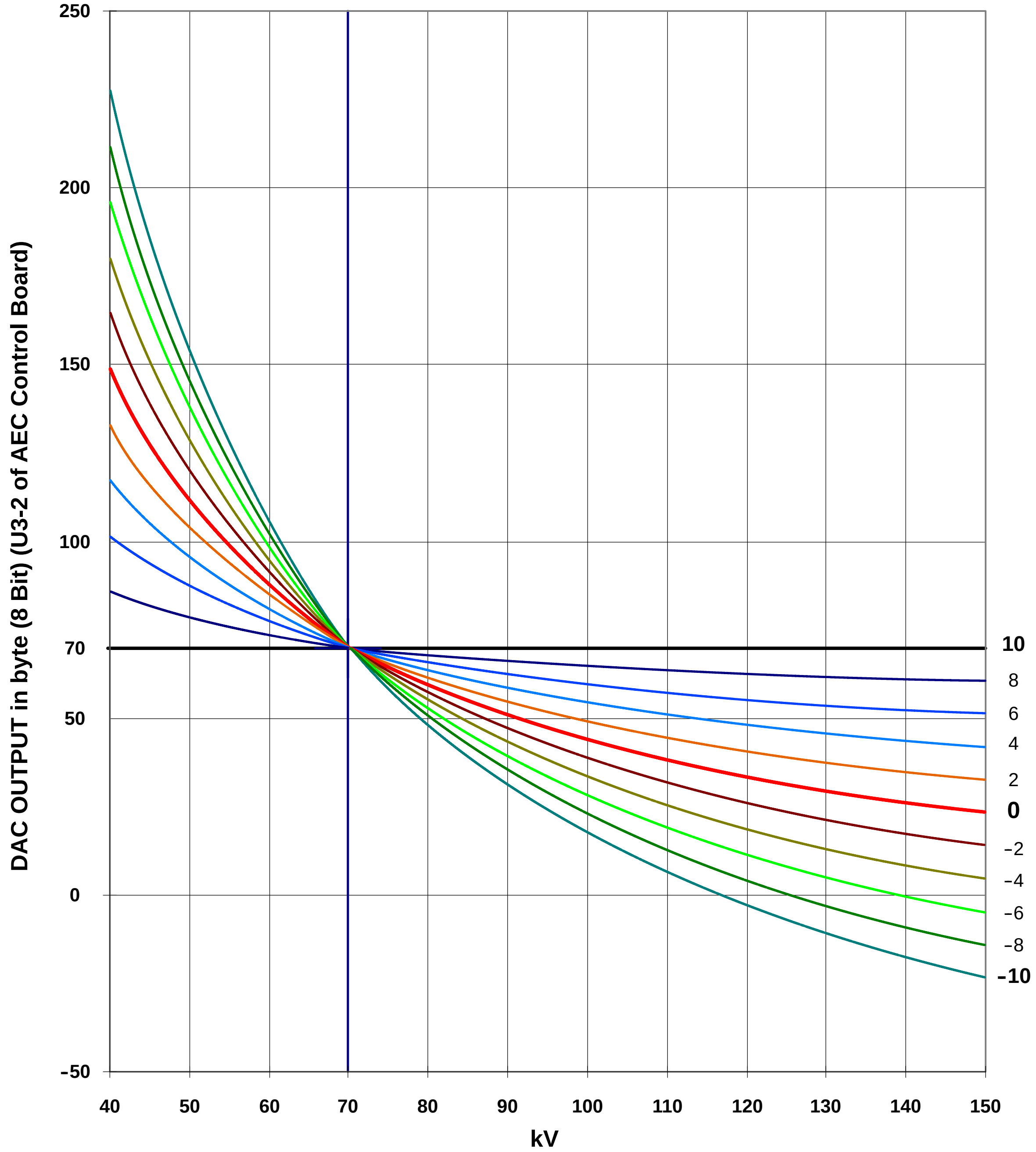
14. Exit from the "*Go to User Mode*" screen by pressing the "*Manual Calibration*" button and exit from calibration mode.

15. Record all the values for the Memory Locations in the Data Book.

2.6.3 kV COMPENSATION

To maintain constant Optical Density (for Film) or Image Gray Level (for CR or DR) regardless of the kV at which a Film, CR or DR is exposed, the Generator provides kV compensation. (*Refer to Illustration 2-4*).

Illustration 2-4
AEC kV Tracking Curve



Perform the following steps to determine whether or not AEC kV Tracking of Optical Density / Image Gray Level must be adjusted.

1. Enter in calibration mode and verify that AEC Tracking number in E08, E10 and E24 Memory Locations is “0”. Exit from calibration mode.

2. Enter in calibration mode selecting a Workstation configured for the Ion Chamber to be calibrated. Enter in user mode inside calibration mode by pressing the “*Go to User Mode*” button.

3. Select on the Console:

   - RAD Menu: 55 kV, 100 mA and 1 second back-up time (or the mA and ms values obtained for the Gain adjustment)

   - AEC Menu: “*Central Field*” , “*Density 0*” and “*Medium Film/Screen*”.

4. Make an exposure (in case of Film, without film in the cassette, but the cassette inserted in the Receptor housing) (in case of CR or DR, with the CR or DR inserted in the Receptor housing) and check that the Exposure Time is between 50 ms and 300 ms. If necessary, change the mA value and make the exposure again. Take note of the final mA station selected for 55 kV.

5. Select 90 kV. Make an exposure (in case of Film, without film in the cassette, but the cassette inserted in the Receptor housing) (in case of CR or DR, with the CR or DR inserted in the Receptor housing) and check that the Exposure Time is between 50 ms and 300 ms. If necessary, change the mA value and make the exposure again. Take note of the final mA station selected for 90 kV.

6. **For Film**, insert a cassette with the Medium Film/Screen combination used by the customer. Make an exposure at 55 kV and 90 kV *(use the selected mA station noted before for each kV)*, develop the film and measure the Optical Density obtained with those exposures. Check that the variation range is the same ±0.2 of the Optical Density obtained before at 70 kV (*Optical Density / Image Gray Level Adjustment – Section 2.6.2*).

   For CR or DR, make an exposure with the CR or DR in the Receptor housing. Make an exposure at 55 kV and 90 kV *(use the selected mA station noted before for each kV)*, note the Image Gray Level obtained with those exposures. Check that the variation range is the same ±20% of Image Gray Level obtained before at 70 kV (*Optical Density / Image Gray Level Adjustment – Section 2.6.2*).

7. If the variation value is not ±0.2 of the Optical Density (for Film) or ±20% of Image Gray Level / Dose Level (for CR or DR) calculate the new value for the AEC Tracking number in each Memory Location as follows:

   - If the Optical Density / Image Gray Level at 55 kV has to be decreased and the Optical Density / Image Gray Level at 90 kV has to be increased then **increase the Tracking value in one**.
   - If the Optical Density / Image Gray Level at 55 kV has to be increased and the Optical Density / Image Gray Level at 90 kV has to be decreased then **decrease the Tracking value in one**.

Note ☞ *A Tracking value of 10 will have no effect on AEC kV compensation.*

   a. Exit from the "*Go to User Mode*" screen by pressing the "*Manual Calibration*" button and in calibration mode select the respective Memory Location (E08, E10 or E24).

   b. Values for AEC Tracking range is from −10 to +10. Determine the correct value for the needed AEC Tracking change.

AEC-kV TRACKING CURVE	+10	+9	+8	+7	+6	+5	+4	+3	+2	+1	**0**	−1	−2	−3	−4	−5	−6	−7	−8	−9	−10
VALUE TO ENTER IN THE MEMORY LOCATION	10	9	8	7	6	5	4	3	2	1	**0**	255	254	253	252	251	250	249	248	247	246

   c. Enter the new value and store it. Enter in user mode inside calibration mode by pressing the "*Go to User Mode*" button and repeat this process from step-6. until the desired compensation of the Optical Density / Image Gray Level is obtained.

8. Repeat the above steps for all the Ion Chambers installed with the Generator.

9. Exit from the "*Go to User Mode*" screen by pressing the "*Manual Calibration*" button and exit from calibration mode.

10. Record all the values for the Memory Locations in the Data Book.

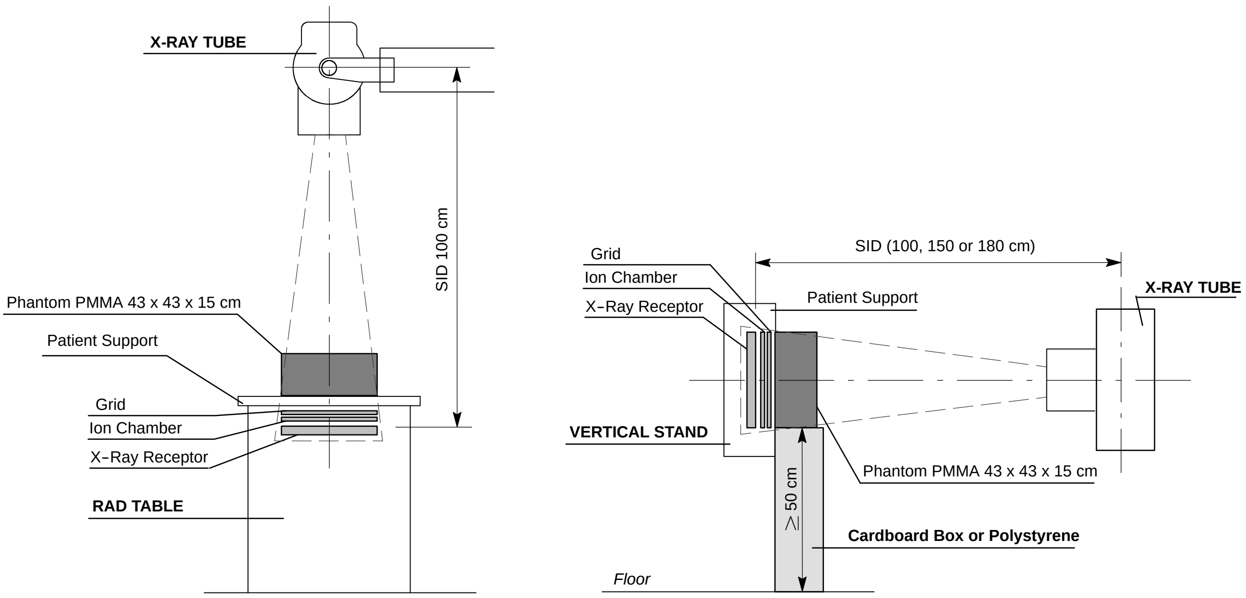
Note ☞ *Once the Gain Adjustment and kV Compensation procedures are finnished, remove from the Collimator guides the Phantom of Aluminium.*

2.6.4 BALANCE ADJUSTMENT / CHECKING FOR THREE FIELD DETECTORS

Note ☞ *Some Ion Chambers does not provide balance potentiometers for Three Field Detectors. In that case, this procedure can be used to check that the Balance adjustment from factory is correct.*

Note ☞ *This checking is carried out using a homogeneous Phantom of PMMA (Polymethylmethacrylate) with a surface of 43 x 43 cm and a thickness of 15 cm so that the Three Field Detectors of the Ion Chamber receive the same amount of scattered radiation. As an alternative to the Phantom of PMMA, the Phantom of Aluminum used for AEC Calibration and placed on the Collimator guides can be used, but it is recommended to use the Phantom of PMMA.*

1. Set SID at the Focal Distance of the Grid to be used in the Table Receptor (usually 100 cm) or in the Vertical Stand Receptor (usually 100 cm, 150 cm and/or 180 cm). Place the Phantom as shown in the next illustration. In the case of the Table, the Tabletop must be completely centered.



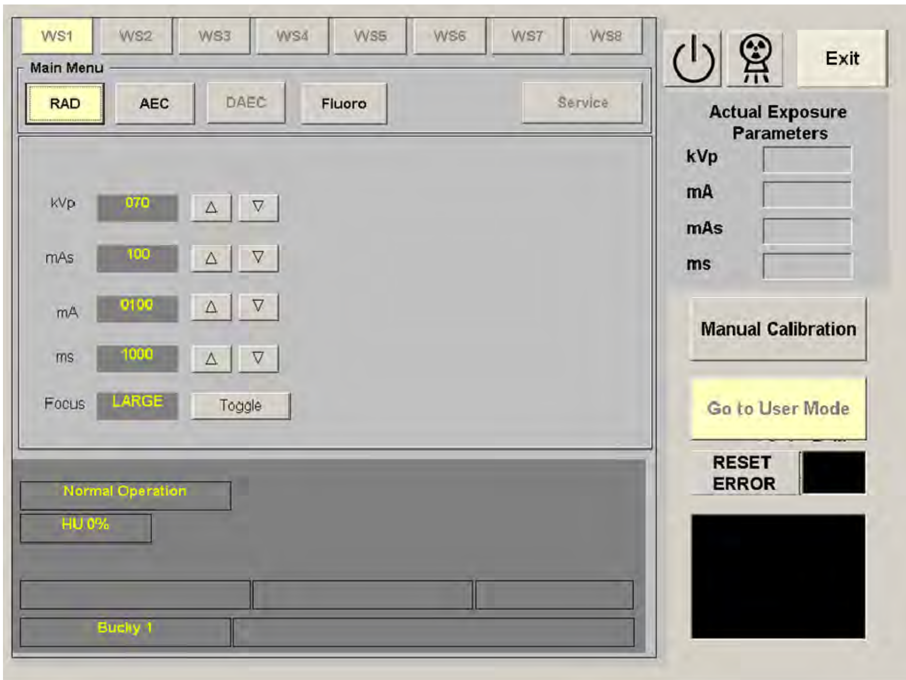
2. If it is present, remove from the Collimator guides the Phantom of Aluminium used for the previous procedures.

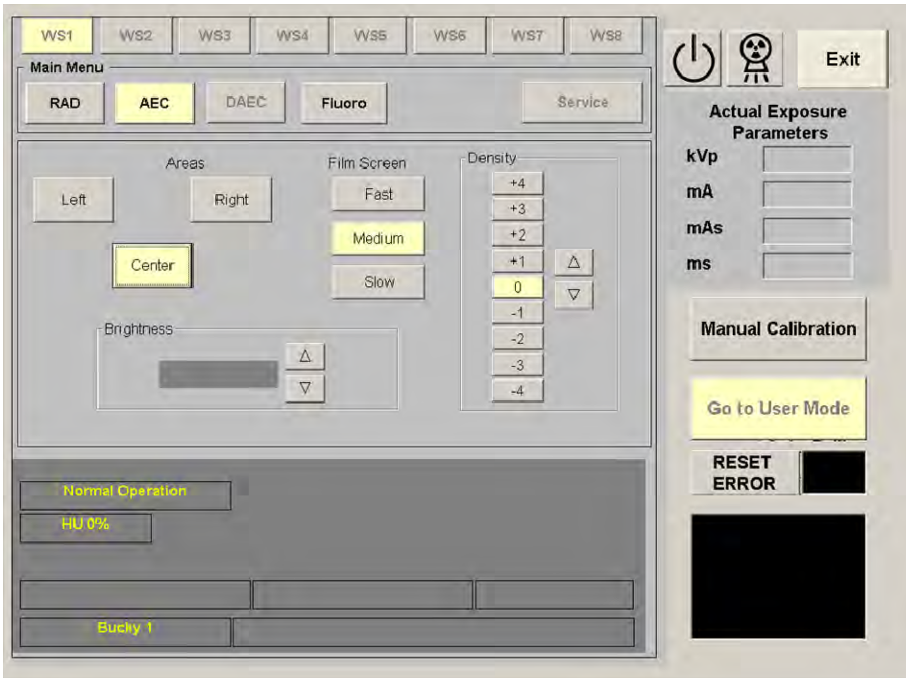
3. Open the Collimator blades up to cover the base of the Phantom.

4. Enter in calibration mode selecting a Workstation configured for the Ion Chamber to be calibrated. Enter in user mode inside calibration mode by pressing the “*Go to User Mode*” button.

5. Select on the Console:

   - RAD Menu: 70 kV, 100 mA and 1 second back-up time.
   - AEC Menu: "*Central Field*" , "*Density 0*" and "*Medium Film/Screen*".





6. Make the following sequence of exposures (in case of Film, without film in the cassette, but the cassette inserted in the Receptor housing) (in case of CR or DR, with the CR or DR inserted in the Receptor housing) and check that the Exposure Time is between 50 ms and 300 ms. If necessary, change the mA value and make the exposure again. Take note of the final mA station selected for each exposure with the Grid removed and with the Grid inserted/installed.

Note ☞ *If the Grid can not be removed from the Receptor housing, perform only the exposures with the Grid installed.*

Note ☞ *The "Actual Exposure Parameters" area shows the last exposure parameters when: exposure is finished by the AEC, exposure is aborted by releasing the exposure control, or after pressing the "Reset Error" button.*

The sequence of exposures are:

- 3 exposures with the Grid removed and the "*Left Field*" of the Ion Chamber selected.
- 3 exposures with the Grid removed and the "*Center Field*" of the Ion Chamber selected.
- 3 exposures with the Grid removed and the "*Right Field*" of the Ion Chamber selected.
- 3 exposures with the Grid inserted / installed and the "*Left Field*" of the Ion Chamber selected.
- 3 exposures with the Grid inserted / installed and the "*Center Field*" of the Ion Chamber selected.
- 3 exposures with the Grid inserted / installed and the "*Right Field*" of the Ion Chamber selected.

Note in Table 2-2 the Exposure Time or the Image Gray Level obtained in each exposure, and the final mA value selected.

Table 2-2
Exposures for Balance Adjustment / Checking of Ion Chamber Fields

TABLE *(SID 100 cm)*	**EXPOSURES WITHOUT GRID** at 70 kV and ___ mA			**EXPOSURES WITH GRID** at 70 kV and ___ mA		
	LEFT Field	**CENTER Field**	**RIGHT Field**	**LEFT Field**	**CENTER Field**	**RIGHT Field**
Exposure #1	t_{L1} =	t_{C1} =	t_{R1} =	t_{L1} =	t_{C1} =	t_{R1} =
Exposure #2	t_{L2} =	t_{C2} =	t_{R2} =	t_{L2} =	t_{C2} =	t_{R2} =
Exposure #3	t_{L3} =	t_{C3} =	t_{R3} =	t_{L3} =	t_{C3} =	t_{R3} =
Average value of the Exposure Time	$\overline{t}_L$ =	$\overline{t}_C$ =	$\overline{t}_R$ =	$\overline{t}_L$ =	$\overline{t}_C$ =	$\overline{t}_R$ =

VERTICAL STAND *(SID 100 cm)*	**EXPOSURES WITHOUT GRID** at 70 kV and ___ mA			**EXPOSURES WITH GRID** at 70 kV and ___ mA		
	LEFT Field	**CENTER Field**	**RIGHT Field**	**LEFT Field**	**CENTER Field**	**RIGHT Field**
Exposure #1	t_{L1} =	t_{C1} =	t_{R1} =	t_{L1} =	t_{C1} =	t_{R1} =
Exposure #2	t_{L2} =	t_{C2} =	t_{R2} =	t_{L2} =	t_{C2} =	t_{R2} =
Exposure #3	t_{L3} =	t_{C3} =	t_{R3} =	t_{L3} =	t_{C3} =	t_{R3} =
Average value of the Exposure Time	$\overline{t}_L$ =	$\overline{t}_C$ =	$\overline{t}_R$ =	$\overline{t}_L$ =	$\overline{t}_C$ =	$\overline{t}_R$ =

VERTICAL STAND *(SID 150 cm or 180 cm)*	**EXPOSURES WITHOUT GRID** at 70 kV and ___ mA			**EXPOSURES WITH GRID** at 70 kV and ___ mA		
	LEFT Field	**CENTER Field**	**RIGHT Field**	**LEFT Field**	**CENTER Field**	**RIGHT Field**
Exposure #1	t_{L1} =	t_{C1} =	t_{R1} =	t_{L1} =	t_{C1} =	t_{R1} =
Exposure #2	t_{L2} =	t_{C2} =	t_{R2} =	t_{L2} =	t_{C2} =	t_{R2} =
Exposure #3	t_{L3} =	t_{C3} =	t_{R3} =	t_{L3} =	t_{C3} =	t_{R3} =
Average value of the Exposure Time	$\overline{t}_L$ =	$\overline{t}_C$ =	$\overline{t}_R$ =	$\overline{t}_L$ =	$\overline{t}_C$ =	$\overline{t}_R$ =

7. Calculate the average exposure time value of the 3 exposures in each Field, without and with Grid in the Receptor housing.
   Note the values in the Table 2-2.

$$\text{Average Value} = \overline{t_x} = \frac{t_{x1} + t_{x2} + t_{x3}}{3}$$

8. Compare the average values of:

   - The "*Center Field*" with the "*Left Field*", without Grid.
   - The "*Center Field*" with the "*Right Field*", without Grid.
   - The "*Center Field*" with the "*Left Field*", with Grid.
   - The "*Center Field*" with the "*Right Field*", with Grid.

% of difference between "*Center*" and "*Left*" Fields = $\dfrac{\overline{t_L} - \overline{t_C}}{\overline{t_C}}$ x 100 = %

% of difference between "*Center*" and "*Right*" Fields = $\dfrac{\overline{t_R} - \overline{t_C}}{\overline{t_C}}$ x 100 = %

The difference of the Exposure Time values between the "*Left Field*" and "*Center Field*" and between the "*Right Field*" and "*Center Field*" must be ± 20%. If not, adjust the corresponding balance potentiometer of the Field to increase or decrease the Exposure Time. Repeat this process from step 6. until the adjustment is complete.

9. Exit from the "*Go to User Mode*" screen by pressing the "*Manual Calibration*" button and exit from calibration mode.

10. Repeat the above steps for all the Ion Chambers installed with the Generator. It is recommended to start with the Table Ion Chamber and then with the Vertical Stand Ion Chamber.

2.6.5 ATS DIGITAL AEC (RAD) ADJUSTMENT (OPTIONAL)

Note ☞ *If the Generator is interfaced with an "ATS Hiris Image System", Digital AEC calibration procedure has to be performed as explained in the "ATS Hiris Image System" documentation.*

2.6.6 PHOTOMULTIPLIER RAD-AEC (DIGITAL RAD) ADJUSTMENT (OPTIONAL)

The Photomultiplier RAD-AEC adjustment can be performed in two ways: one is the value stored in E23 Memory Location and the other is the high voltage applied to the Photomultiplier Tube.

The recommended procedure for this adjustment is to store a constant value in E23 Memory Location and adjust the high voltage applied to the Photomultiplier Tube.

Note ☞ *Value in E23 Memory Location is a common data used for Photomultiplier AEC Calibration or used for the Fourth Ion Chamber Calibration (AEC-4).*

Perform the following procedure:

1. Enter in "*Manual Calibration*" mode selecting a Workstation configured for DSI. Select E23 Memory Location and set a value of "127". Then enter in user mode by pressing the "*Go to User Mode*" button.

2. Set up a Dosimeter as close as possible to the Image Intensifier Radiation Input to measure the Entrance Image Intensifier Exposure Dose Rate. Position the Probe at the center of the primary beam with the entire active volume within the primary beam. Select the Field of View for the Image Intensifier to have 9" FOV.

   Place the Tube-Collimator Assembly at the normal SID (1 meter). Collimate the X-ray beam so it completely covers the Image Intensifier field but does not extend beyond limits of the phantom.

3. Place a homogeneous Phantom of Aluminium with a purity of not less that 99% and thickness of 21 mm in the Collimator Filter Holder.

4. Select on the Console:

    - RAD Menu: 70 kV, 200 mA Large Focus (or the first mA station for Large Focus if 200 mA station is set for Small Focus) and 1 second back-up time.

    - AEC Menu: “*Central Field*” , “*Density 0*” and “*Medium Film/Screen*”.

5. Activate “*Digital Prep*” (–DIGITAL PREP signal = GND on TS3-7 Generator Cabinet). Hold “*Digital Prep*” and adjust the high voltage applied to the Photomultiplier Tube with the potentiometer R12 for Board A3012–x1/x2/x5 or R23 for Board A3012–x6/x7/x9 on the AEC Control Board until measure –400 VDC between TS1–39 and TS1–42 (GND) in the Generator Cabinet.

6. The Dose is affected in the following manner:

    - Increases when the high voltage applied to the Photomultiplier Tube is decreased. (*Example: if 100 μR Dose is obtained with –400 VDC, 200 μR Dose may be obtained decreasing the high voltage to –300 VDC*).

    - Decreases when the high voltage applied to the Photomultiplier Tube is increased. (*Example: if 100 μR Dose is obtained with –400 VDC, 50 μR Dose may be obtained increasing the high voltage to –450 VDC*).

7. Make an exposure and adjust the following potentiometer on the AEC Control Board: R12 for Board A3012–x1/x2/x5 or R23 for Board A3012–x6/x7/x9 on the AEC Control Board; until getting a Dose around 100 μR per frame (*at 9” FOV*) (*for more information refer to the Image System documentation*).

Note ☞ *If the photo tube voltage required is too low, decrease the AEC calibration number in the E23 Memory Location and repeat the process.*

8. Record the E23 Memory Location in the Data Book.

2.6.7 AEC OPTICAL DENSITY SCALE

AEC is calibrated with "*Density 0*" selected (Normal Optical Density). The Optical Density can be increased or decreased in several steps.

The variation percentage of the density scale is factory set at 25%. This variation can be set according to the customer preferences by changing the value stored in E12 Memory Location. This value applies to both tubes.

Depending on the Console model, the range of the scale is "from −2 to +2" or "from −4 to +4" (optional).

The following tables show some examples for the variation percentage of the density scale with reference to the value stored in E12 Memory Location.

E12 VALUE	**DENSITY SCALE FROM −2 TO +2 . VARIATION OVER NORMAL OPTICAL DENSITY (N)**				
	−2	**−1**	**0**	**+1**	**+2**
5	N x 0.90	N x 0.95	**N**	N x 1.05	N x 1.10
10	N x 0.80	N x 0.90	**N**	N x 1.10	N x 1.20
25	N x 0.50	N x 0.75	**N**	N x 1.25	N x 1.50
NOTE: If the value stored in E12 Memory Location is 0, 25 or 255, the variation percentage is 25%.					

E12 VALUE	**DENSITY SCALE FROM −4 TO +4 (*OPTIONAL*) . VARIATION OVER NORMAL OPTICAL DENSITY (N)**								
	−4	**−3**	**−2**	**−1**	**0**	**+1**	**+2**	**+3**	**+4**
5	N x 0.82	N x 0.86	N x 0.91	N x 0.95	**N**	N x 1.05	N x 1.10	N x 1.16	N x 1.22
10	N x 0.68	N x 0.75	N x 0.83	N x 0.91	**N**	N x 1.10	N x 1.21	N x 1.33	N x 1.46
25	N x 0.41	N x 0.51	N x 0.64	N x 0.80	**N**	N x 1.25	N x 1.56	N x 1.95	N x 2.44
NOTE: With scale from "−4 to +4" the useful range for the value stored in E12 Memory Location is from 1 to 25 .									

Record the value for E12 Memory Location in the Data Book.

2.7 FLUORO CALIBRATION

This generator uses Pulsed Fluoro at fixed or variable rate. This technique is a series of short exposures at the TV frame rate (fixed rate) or at the selected PPS (variable rate).

Fluoro exposures are controlled by kV with a constant filament current. The kV values are manually (Manual mode) or automatically (ABC mode) adjusted to obtain the desired brightness (entrance dose rate) on the Image Intensifier.

The Fluoro calibration consists of setting values in the corresponding Extended Memory Locations for Fluoro use. The following table indicates the relationship between Fluoro and Extended Memory Locations.

FUNCTION	MEMORY LOCATIONS
Fluoro Filament Setting	E17
Maximum Fluoro kV	E19
Fluoro mA Display Calibration at 50 kV	E25
Fluoro mA Display Calibration at 80 kV	E26
Fluoro mA Display Calibration at 120 kV	E27

The functions of these extended Memory Locations are:

- E17 is used to store data that controls the Maximum Skin Dose Radiation at the following maximum levels (Regulation limits) (1 Rad = 8.7 mGy).

  - 5 R/min (43.5 mGy/min) for systems working with Manual mode (Non-ABC).

  - 10 R/min (87 mGy/min) for systems working with Automatic mode (ABC).

  Note that in practice, the rejection limits for entrance exposure rate must be somewhat less than the maximum specified due to Dosimeter calibration accuracy. (*Refer to Table 2-3.*)

Table 2-3
Rejection Limits Based on Meter Calibration Accuracy

METER CALIBRATION ACCURACY	REJECTIONS LIMITS	
	FOR 5 R/min (43.5 mGy/min) MAXIMUM	FOR 10 R/min (87 mGy/min) MAXIMUM
±5%	4.75 R/min (41.3 mGy/min)	9.5 R/min (82.7 mGy/min)
±10%	4.50 R/min (39.2 mGy/min)	9.0 R/min (78.3 mGy/min)
±15%	4.25 R/min (37 mGy/min)	8.5 R/min (74 mGy/min)

- E19 is used to set maximum Fluoro kV. This value is determined by the type of TV camera and type of images desired. For general fluoroscopic use with a conventional TV system, 120 kV is recommended. A lower maximum setting will produce more contrast on the TV system but less penetration for large patients.
- E25, E26, E27 are used to calibrate the Fluoro mA Display. These values will be shown on the Fluoro mA Display during Fluoro exposures whenever maximum PPS are selected.

Note ☞

The Fluoro mA Display values entered into the Extended Memory Locations E25, E26 and E27 are also used to calculate Heat Units. It is important to enter accurate values.

Fluoro functions are calibrated by performing the following steps:

1. Turn the generator ON.

CAUTION

Make sure that the Small Filament of the X-ray tube is properly warmed-up (at less 15 minutes).

2. Set up a Dosimeter to measure the Maximum Entrance Skin Exposure Dose Rate. Position the Probe at the center of the primary beam with the entire active volume within the primary beam.

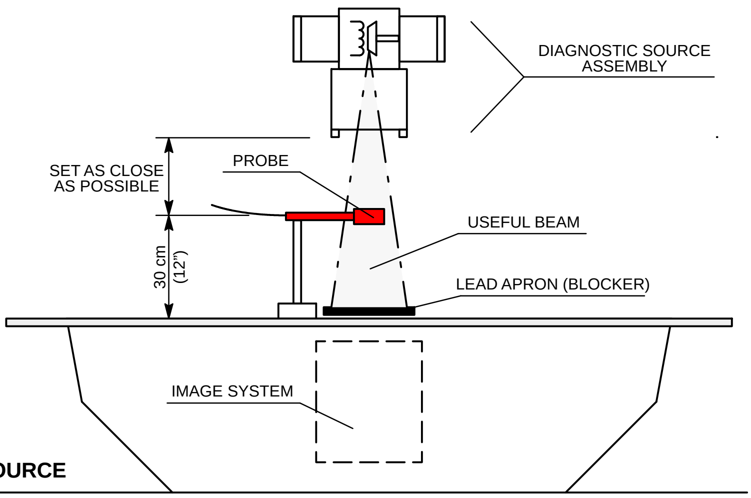
   Place the Tube-Collimator Assembly as close as possible to the Table-Top, fully open the Collimator Blades and align the Image Intensifier with the light beam. Block radiation input to Image Intensifier with a Lead Apron. (*Refer to Illustration 2-5*).

3. Enter in "*Manual Calibration*" mode through a Fluoro workstation and read the Filament Number at 120 kV / 10 mA. Divide this value by four (4) and enter it as starting value for E17 Memory Location (Fluoro Filament Setting).

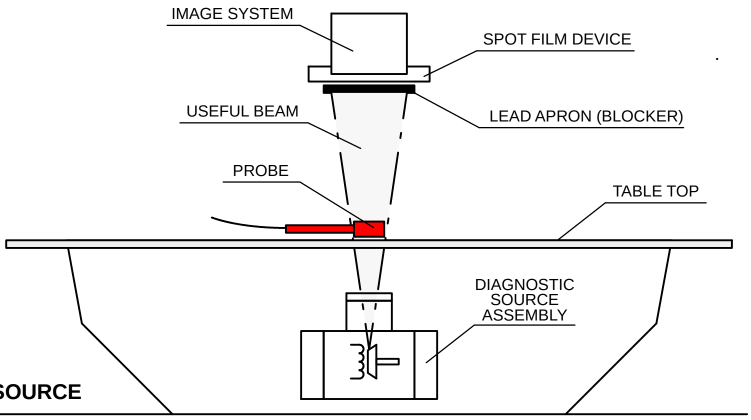
4. Select E19 Memory Location and set the maximum Fluoro kV at 120 kV or more if it is possible.

5. Enter in user mode inside calibration mode by pressing the "*Go to User Mode*" button and select the Fluoro Menu.

Illustration 2-5
Fluoro Entrance Exposure Rate Test Set-up



OVERTABLE SOURCE



UNDERTABLE SOURCE

6. Select the maximum PPS and Non-ABC mode. Make a Fluoro exposure at maximum kV that will be used in the system and measure the dose applied, it should not be over the Rejection Limits for 10 R/min (87 mGy/min) or 5 R/min (43.5 mGy/min) (*refer to Table 2-3.*).

   In case that the value is not acquired, change the Fluoro Filament Setting stored in E17 as required until it is correctly calibrated to that dose. Keep in mind that radiation increases or decreases in accordance to value in E17 is increased or decreased.

7. The mA values displayed during Fluoro exposures are stored in E25, E26 and E27 Memory Locations. The method used to obtain the Fluoro mA values is to measure the average mA using a mA meter in Fluoro.

   During Fluoro exposure, mA values are read directly with a mA Meter in DC connected to the mA Test Points (banana plug connections) on the HV Transformer. Only for this purpose, remove the link between the banana plug connections on the HV Transformer.

   Select the maximum PPS and Non-ABC mode. Make the following Fluoro exposures:

   - Make a Fluoro exposure at 50 kV and take note below the mA reading, this value will be used as Fluoro mA at minimum kV (E25).
   - Make a Fluoro exposure at 80 kV and take note below the mA reading, this value will be used as Fluoro mA at medium kV (E26).
   - Make a Fluoro exposure at 120 kV and take note below the mA reading, this value will be used as Fluoro mA at maximum kV (E27).

FL mA value at 50 kV (E25)	FL mA value at 80 kV (E26)	FL mA value at 120 kV (E27)

8. Remove the Dosimeter and the Lead Apron (Blocker).
9. Exit from the “*User Mode*” screen by pressing “*Manual Calibration*” button.
10. Select E19 Memory Location if it is required to reduce the value for the maximum Fluoro kV in the installation.
11. Select the E25, E26 and E27 Memory Locations and store the respective mA values noted before multiplied by **10** (a.e. if the mA value noted is “3.2”, store the value “32” in the respective Memory Location).
12. Record the new values in the Data Book.
13. Exit calibration mode.

2.8 ABC CALIBRATION

The purpose of the ABC System is to maintain an optimum constant Image Tube Output Brightness by controlling the X-ray kV during Fluoro exams, regardless of changes in the patient opacity viewed on the TV monitor.

The closed-loop ABC System can monitor the Image Tube Output Brightness through two ways: Photomultiplier Tube or TV Camera.

2.8.1 ABC SYSTEM WITH PHOTOMULTIPLIER TUBE

Note ☞ *This operation requires the AEC Control Board A3012-x6/x7/x9 (Digital version).*

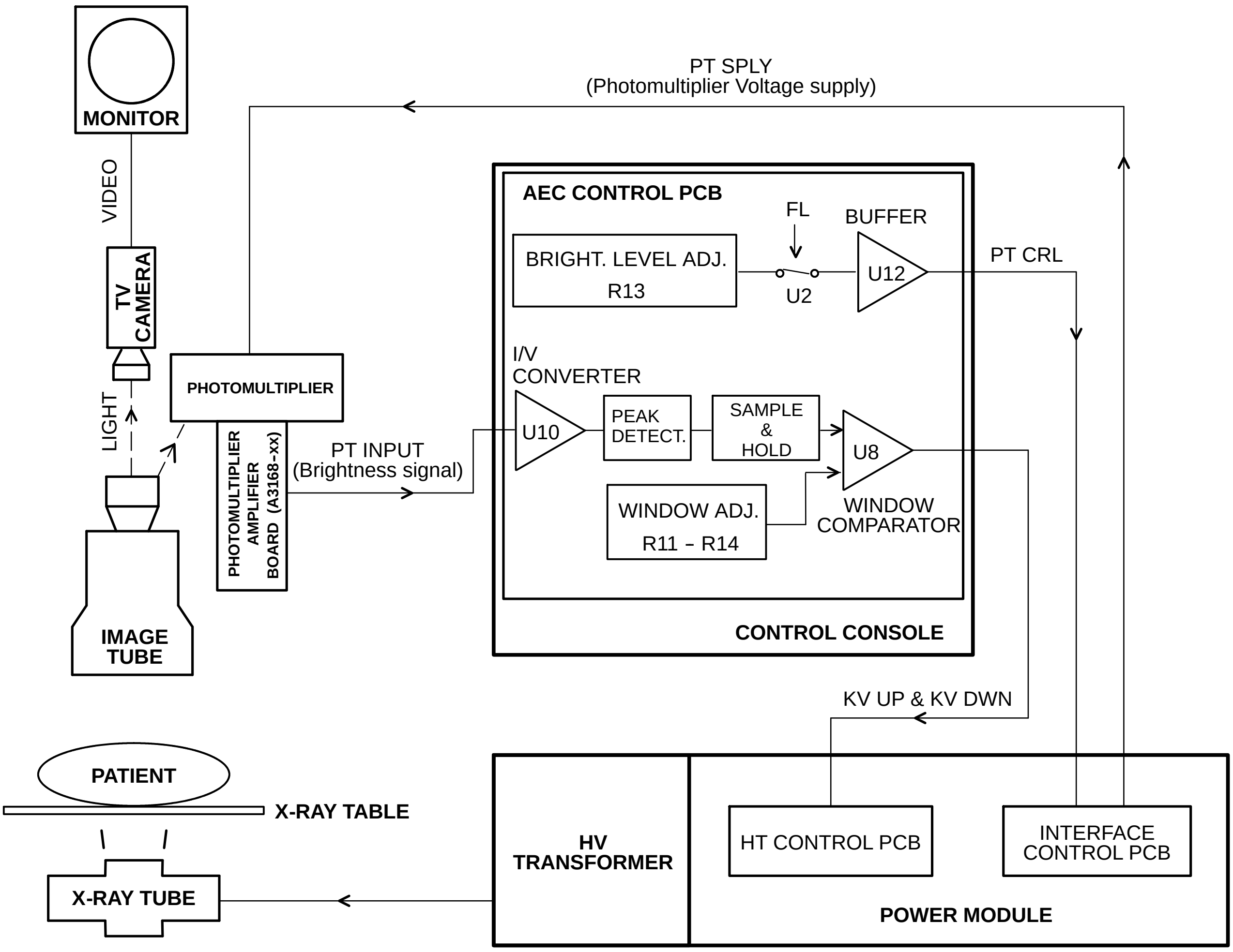
On this system the Photomultiplier current signal, which is proportional to the Image Tube Output Brightness, is used as brightness signal "*PT Input*" for the ABC circuitry of the Generator. (*Refer to Illustration 2-6*).

This analogic signal is converted to a voltage signal in the Photomultiplier Amplifier Board and sent to a peak-detector in the AEC Control Board. The peak signal obtained is then held through a "*Sample and Hold*" circuitry after a synchronism pulse. The peak signal held is adapted to obtain finally the "*ABC IN*" signal which is so the Photomultiplier signal-peak held between synchronism pulses. This signal is then compared to a window reference.

Brightness error at the comparator output is sent as "*kV Up*" and "*kV Down*" to the Generator where is used to drive the Fluoro kV control. The closed-loop operation requires more or less brightness thru "*kV Up*" and "*kV Down*" demand signals respectively. Patient Entrance Dose is automatically varied so that optimum constant Image Tube Output Brightness is maintained.

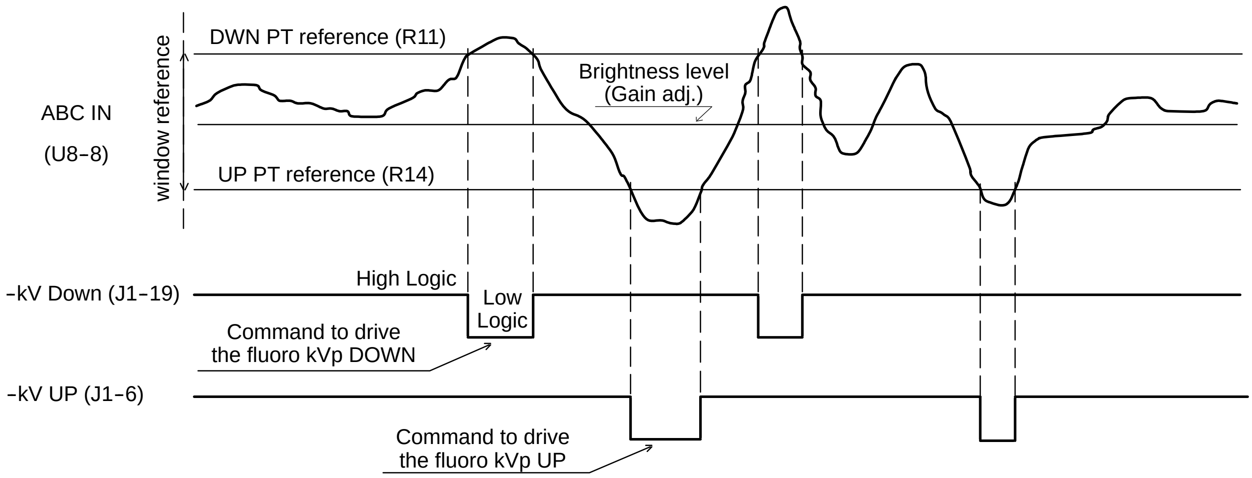
The optimum brightness level in ABC mode is set by adjusting Brightness Control Resistor R13 on the AEC Control Board, which controls the output of the Photomultiplier Tube High Voltage power supply on the Interface Control Board ("*PT CRL*" plus 5 volts programs the output to be 0 volts, and 0 volts programs the output to approximately –1200 volts). The window comparator requires an input range from 0 to +10 VDC for the "*ABC IN*" (the optimum brightness level will be achieved with a value between 5 and 7 VDC).

Illustration 2-6
ABC System for Photomultiplier Tube



Window reference could be adjusted first to set mid-way the brightness level (+5 VDC), and second to increase or decrease the range of response and sensitivity of the kV control to input variations (brightness changes). If oscillation occurs during ABC fluoro exposure, increase the dead zone by adjusting Resistors R11 and R14 on the AEC Control Board. (*Refer to Illustration 2-7 for ABC waveforms*).

Illustration 2-7
ABC Waveforms in AEC Control Board



Adjust the ABC system for Photomultiplier Tube as follow:

1. Be sure that the Video System and the Image Intensifier are powered and operating correctly.

2. Set up a Dosimeter as close as possible to the Image Intensifier Radiation Input to measure the Entrance Image Intensifier Exposure Dose Rate. Position the Probe at the center of the primary beam with the entire active volume within the primary beam.

   Place the Tube-Collimator Assembly at the normal SID (1 meter), fully open the Collimator Blades and align the Image Intensifier with the light beam.

3. Adjust TV Camera gain for 1 volt peak-to-peak composite video output.

4. Select the maximum PPS and Non-ABC mode.

5. Place 2 mm of Copper (or equivalent homogeneous phantom) in the Collimator Filter Holder.

6. Calculate the value of the optimum radiation (that will give optimum brightness) usually is 2μR/frame at 9” FOV (*for more information refer to Image System documentation*).

   Examples:
   For 25 frame/second optimum radiation is 3 mR/min.
   2 μR/frame x 25 frame/s = 50 μR/s.
   50 μR/s x 60 s/min = 3000 μR/min = 3 mR/min.
   For 30 frame/second optimum radiation is 3.6 mR/min.
   2 μR/frame x 30 frame/s = 60 μR/s.
   60 μR/s x 60 s/min = 3600 μR/min = 3.6 mR/min.

   The optimum radiation value should be measured at Image Intensifier Radiation Input. Intensifier grid should be removed, if it can not be removed, this value should be multiplied by two or by the value specified as Grid Absorption Factor.

7. Make a Fluoro exposure at 70 kV and measure the radiation. Optimum radiation is obtained by modifying the Fluoro kV or the Copper thickness in the Collimator Filter Holder. First modify the Fluoro kV, if it is more than 80 kV or less than 60 kV modify the Copper thickness in 0.1 mm (or 0.2 mm). Note the value of Fluoro KV and Copper thickness used to obtain the optimum radiation.

Note ☞ *Radiation increases when kV is increased or Copper thickness is reduced.*

8. Perform the following adjustments in the AEC Control Board:

   a. Adjust R13 in order to obtain 6 VDC on TP3 (ABC IN).

   b. Select 70 kV (or the kV obtained in step-7.) and increase 2 kV and check the increased value of voltage in TP3 (ABC-IN) (if this value has not been increased, increase 1 kV more). Note this value **(consider it as KV-DOWN-SEL)**.

   c. Select 70 kV (or the kV obtained in step-7.) and decrease 2 kV and check the decreased value of voltage in TP3 (ABC-IN) (if this value has not been decreased, decrease 1 kV more). Note this value **(consider it as KV-UP-SEL)**.

   d. Obtain in TP1 the same voltage noted as kV-DOWN-SEL (DOWN PT) by adjusting the Potentiometer R11.

   e. Obtain in TP2 the same voltage noted as kV-UP-SEL (UP PT) by adjusting the Potentiometer R14.

9. Select 70 kV (or the kV obtained in step-7.) and ABC mode.

10. Make a Fluoro exposure and check that the kV does not change.

11. Stop the Fluoro exposure and select 40 kV. Make a Fluoro exposure and check that the kV value goes to 70 kV (or the kV obtained in step-7.) $\pm$2 kV without System problems.

12. Stop the Fluoro exposure and select 100 kV. Make a Fluoro exposure and check that the kV value goes to 70 kV (or the kV obtained in step-7.) $\pm$2 kV without System problems.

2.8.2 ABC SYSTEM WITH TV CAMERA

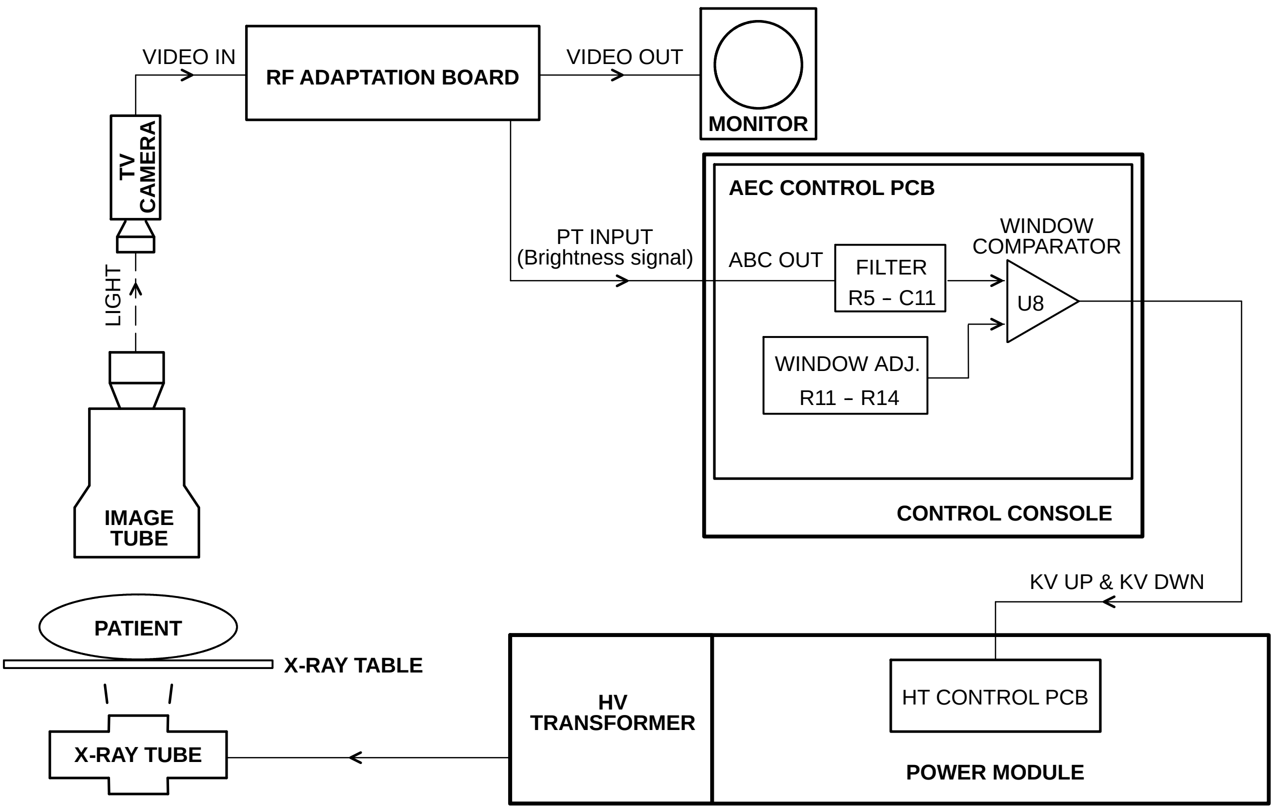
The ABC can be performed with an Analogic Signal Output (*ABC OUT*) proportional to the brightness or with the Composite Video Signal Output from the TV Camera.

The “*ABC OUT*” signal from the TV Camera is compatible with the Generator when the range is from 0 VDC (dark image) to 10 VDC (bright image) and the Optimum Brightness is achieved at around 6 VDC.

When a TV Camera without a direct “*ABC OUT*” signal is used, the Composite Video signal (which amplitude is proportional to the image tube output brightness) is sent to an RF Adaptation Board where it is transformed into an “*ABC OUT*” analogic signal. In this case, the brightness level is taken from a rectangular window from the center of the raster. (*Refer to Illustration 2-8*).

This analogic signal in the AEC Control Board (*“PT Input” in Board A3012-x1/x2/x5 and “ABC OUT” in Board A3012-x6/x7/x9*) is filtered, and compared to a window reference. Brightness error at the comparator output is sent as “*kV Up*” and “*kV Down*” to the Generator where is used to drive the fluoro kV control. The closed-loop operation requires more or less brightness thru “*kV Up*” and “*kV Down*” demand signals respectively. Patient entrance dose is automatically varied so that constant image tube output brightness is maintained.

Illustration 2-8
ABC System for TV Camera

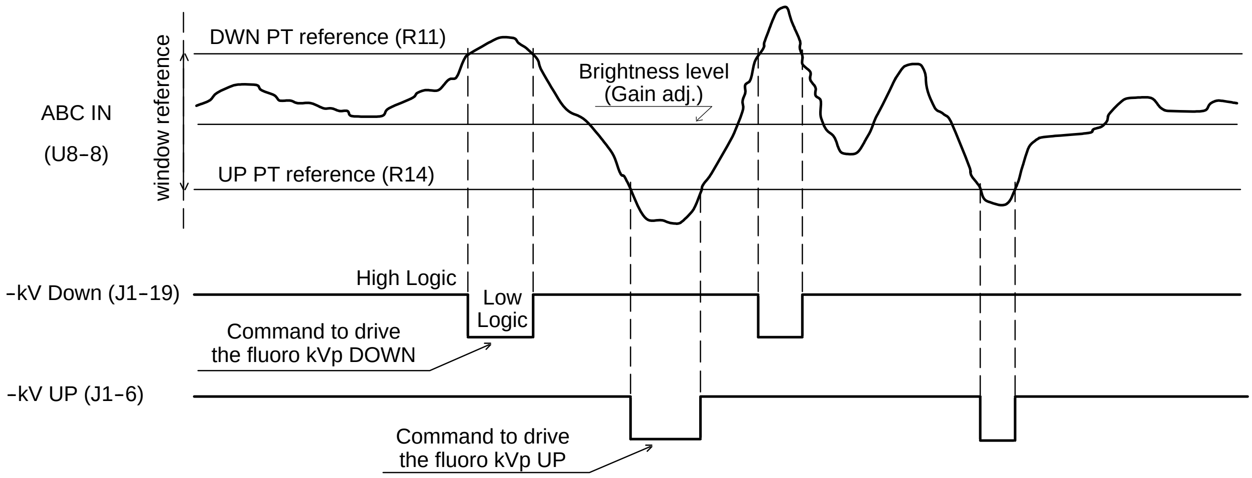


The optimum brightness level in ABC mode is set by adjusting the gain at R27 on the RF Adaptation Board. The "*ABC OUT*" signal requires an input range from 0 to +10 VDC (the stabilized value will be between 5 and 7 VDC).

Window reference could be adjusted first to set mid-way the brightness level (+6 VDC), and second to increase or decrease the range of response and sensitivity of the kV control to input variations (brightness changes). If oscillation occurs during ABC fluoro exposure, increase the dead zone by adjusting R11 and R14 on the AEC Control Board. (*Refer to Illustration 2-9 for ABC waveforms*)

For system interface, refer to RF Adaptation Board. Adjust ABC System according to the following procedures.

Illustration 2-9
ABC Waveforms in AEC Control Board



2.8.2.1 ABC SYSTEM ADJUSTMENT WITH ABC SIGNAL FROM TV CAMERA COMPATIBLE WITH THE GENERATOR

1. Be sure that the Video System and the Image Intensifier are powered and operating correctly.

2. Set up a Dosimeter as close as possible to the Image Intensifier Radiation Input to measure the Entrance Image Intensifier Exposure Dose Rate. Position the Probe at the center of the primary beam with the entire active volume within the primary beam.

   Place the Tube-Collimator Assembly at the normal SID (1 meter), fully open the Collimator Blades and align the Image Intensifier with the light beam.

3. Adjust TV Camera gain for 1 volt peak-to-peak composite video output.

4. Set Jumper JP21 to position B on the RF Adaptation Board.

5. Select the maximum PPS and Non-ABC mode.

6. Place 2 mm of Copper (or equivalent homogeneous phantom) in the Collimator Filter Holder.

7. Calculate the value of the optimum radiation (that will give optimum brightness) usually is 2μR/frame at 9” FOV (*for more information refer to Image System documentation*).

   Examples:

   For 25 frame/second optimum radiation is 3 mR/min.
   2 μR/frame x 25 frame/s = 50 μR/s.
   50 μR/s x 60 s/min = 3000 μR/min = 3 mR/min.

   For 30 frame/second optimum radiation is 3.6 mR/min.
   2 μR/frame x 30 frame/s = 60 μR/s.
   60 μR/s x 60 s/min = 3600 μR/min = 3.6 mR/min.

   The optimum radiation value should be measured at Image Intensifier Radiation Input. Intensifier grid should be removed, if it can not be removed, this value should be multiplied by two or by the value specified as Grid Absorption Factor.

8. Make a Fluoro exposure at 70 kV and measure the radiation. Optimum radiation is obtained by modifying the Fluoro kV or the Copper thickness in the Collimator Filter Holder. First modify the Fluoro kV, if it is more than 80 kV or less than 60 kV modify the Copper thickness in 0.1 mm (or 0.2 mm). Note the value of Fluoro KV and Copper thickness used to obtain the optimum radiation.

Note ☞ *Radiation increases when kV is increased or Copper thickness is reduced.*

9. Perform the adjustment for the window test as specified on the TV Camera manuals. This window defines the area of the image where the brightness will be captured for the ABC and it should be the 25% of the image area.

10. Adjust the TV Camera to obtain +6 VDC (or the voltage supplied by the TV Camera as optimum brightness) on TP3 (ABC IN) on the AEC Control Board (Refer the TV Camera manuals).

11. Perform the following adjustments in the AEC Control Board:

    a. Select 70 kV (or the kV obtained in step-8.) and increase 2 kV and check the increased value of voltage in TP3 (ABC-IN) (if this value has not been increased, increase 1 kV more). Note this value **(consider it as KV-DOWN-SEL)**.

    b. Select 70 kV (or the kV obtained in step-8.) and decrease 2 kV and check the decreased value of voltage in TP3 (ABC-IN) (if this value has not been decreased, decrease 1 kV more). Note this value **(consider it as KV-UP-SEL)**.

    c. Obtain in TP1 the same voltage noted as kV-DOWN-SEL (DOWN PT) by adjusting the Potentiometer R11.

    d. Obtain in TP2 the same voltage noted as kV-UP-SEL (UP PT) by adjusting the Potentiometer R14.

12. Select the 70 kV (or the kV obtained in step-8.) and ABC mode.

13. Make a Fluoro exposure and check that the kV does not change.

14. Stop the Fluoro exposure and select 40 kV. Make a Fluoro exposure and check that the kV value goes to 70 kV (or the kV obtained in step-8.) ±2 kV without System problems.

15. Stop the Fluoro exposure and select 100 kV. Make a Fluoro exposure and check that the kV value goes to 70 kV (or the kV obtained in step-8.) ±2 kV without System problems.

2.8.2.2 ABC SYSTEM ADJUSTMENT WITH AN ABC SIGNAL FROM TV CAMERA NOT COMPATIBLE WITH THE GENERATOR

1. Be sure that the Video System and the Image Intensifier are powered and operating correctly.

2. Set up a Dosimeter as close as possible to the Image Intensifier Radiation Input to measure the Entrance Image Intensifier Exposure Dose Rate. Position the Probe at the center of the primary beam with the entire active volume within the primary beam.

   Place the Tube-Collimator Assembly at the normal SID (1 meter), fully open the Collimator Blades and align the Image Intensifier with the light beam.

3. Adjust TV Camera gain for 1 volt peak-to-peak composite video output.

4. Set on the RF Adaptation Board, Jumpers JP21 to position “A” and JP20 to position “B” (for negative ABC signal) or to position “C” (for positive ABC signal).

5. Select the maximum PPS and Non-ABC mode.

6. Place 2 mm of Copper (or equivalent homogeneous phantom) in the Collimator Filter Holder.

7. Calculate the value of the optimum radiation (that will give optimum brightness) usually is 2μR/frame at 9” FOV (*for more information refer to Image System documentation*).

   Examples:

   For 25 frame/second optimum radiation is 3 mR/min.
   2 μR/frame x 25 frame/s = 50 μR/s.
   50 μR/s x 60 s/min = 3000 μR/min = 3 mR/min.

   For 30 frame/second optimum radiation is 3.6 mR/min.
   2 μR/frame x 30 frame/s = 60 μR/s.
   60 μR/s x 60 s/min = 3600 μR/min = 3.6 mR/min.

   The optimum radiation value should be measured at Image Intensifier Radiation Input. Intensifier grid should be removed, if it can not be removed, this value should be multiplied by two or by the value specified as Grid Absorption Factor.

8. Make a Fluoro exposure at 70 kV and measure the radiation. Optimum radiation is obtained by modifying the Fluoro kV or the Copper thickness in the Collimator Filter Holder. First modify the Fluoro kV, if it is more than 80 kV or less than 60 kV modify the Copper thickness in 0.1 mm (or 0.2 mm). Note the value of Fluoro KV and Copper thickness used to obtain the optimum radiation.

Note ☞ *Radiation increases when kV is increased or Copper thickness is reduced.*

9. Perform the adjustment for the window test as specified on the TV Camera manuals. This window defines the area of the image where the brightness will be captured for the ABC and it should be the 25% of the image area.

10. Select the 70 kV (or the kV obtained in step-8.) and Non-ABC mode.

11. Adjust R29 (OFFSET) on the RF Adaptation Board to have 0 VDC in TP7.

12. Adjust gain at R27 (Gain) on the RF Adaptation Board to make the "*ABC OUT*" signal equal to +6 VDC. Measure "*ABC OUT*" in TP-7 of RF Adaptation Board or in TP3 ("*ABC IN*") of the AEC Control Board.

13. Perform the following adjustments in the AEC Control Board:

    a. Select 70 kV (or the kV obtained in step-8.) and increase 2 kV and check the increased value of voltage in TP3 (ABC-IN). Note this value **(consider it as KV-DOWN-SEL)**.

    b. Select 70 kV (or the kV obtained in step-8.) and decrease 2 kV and check the decreased value of voltage in TP3 (ABC-IN). Note this value **(consider it as KV-UP-SEL)**.

    c. Obtain in TP1 the same voltage noted as kV-DOWN-SEL (DOWN PT) by adjusting the Potentiometer R11.

    d. Obtain in TP2 the same voltage noted as kV-UP-SEL (UP PT) by adjusting the Potentiometer R14.

14. Select the 70 kV (or the kV obtained in step-8.) and ABC mode.

15. Make a Fluoro exposure and check that the kV does not change.

16. Stop the Fluoro exposure and select 40 kV. Make a Fluoro exposure and check that the kV value goes to 70 kV (or the kV obtained in step-8.) $\pm$2 kV without System problems.

17. Stop the Fluoro exposure and select 100 kV. Make a Fluoro exposure and check that the kV value goes to 70 kV (or the kV obtained in step-8.) $\pm$2 kV without System problems.

2.8.2.3 ABC SYSTEM ADJUSTMENT WITH NO ABC SIGNAL FROM TV CAMERA

1. Be sure that the Video System and the Image Intensifier are powered and operating correctly.

2. Set up a Dosimeter as close as possible to the Image Intensifier Radiation Input to measure the Entrance Image Intensifier Exposure Dose Rate. Position the Probe at the center of the primary beam with the entire active volume within the primary beam.

   Place the Tube-Collimator Assembly at the normal SID (1 meter), fully open the Collimator Blades and align the Image Intensifier with the light beam.

3. Adjust TV Camera gain for 1 volt peak-to-peak composite video output.

4. Set on the RF Adaptation Board, Jumpers JP21 to position "A" and JP20 to position "A".

5. Select the maximum PPS and Non-ABC mode.

6. Place 2 mm of Copper (or equivalent homogeneous phantom) in the Collimator Filter Holder.

7. Calculate the value of the optimum radiation (that will give optimum brightness) usually is 2μR/frame at 9" FOV (*for more information refer to Image System documentation*).

   Examples:

   For 25 frame/second optimum radiation is 3 mR/min.
   2 μR/frame x 25 frame/s = 50 μR/s.
   50 μR/s x 60 s/min = 3000 μR/min = 3 mR/min.

   For 30 frame/second optimum radiation is 3.6 mR/min.
   2 μR/frame x 30 frame/s = 60 μR/s.
   60 μR/s x 60 s/min = 3600 μR/min = 3.6 mR/min.

   The optimum radiation value should be measured at Image Intensifier Radiation Input. Intensifier grid should be removed, if it can not be removed, this value should be multiplied by two or by the value specified as Grid Absorption Factor.

8. Make a Fluoro exposure at 70 kV and measure the radiation. Optimum radiation is obtained by modifying the Fluoro kV or the Copper thickness in the Collimator Filter Holder. First modify the Fluoro kV, if it is more than 80 kV or less than 60 kV modify the Copper thickness in 0.1 mm (or 0.2 mm). Note the value of Fluoro KV and Copper thickness used to obtain the optimum radiation.

Note ☞ *Radiation increases when kV is increased or Copper thickness is reduced.*

9. Perform the adjustment for the window test. This window defines the area of the image where the brightness will be captured for the ABC.

   a. Calculate the image area πr^2 (clear circle on the monitor). (r=circle radius).

   b. Calculate the 25% of the image area ($\pi r^2/4$).

   c. Calculate the sides of the window: l = $\sqrt{\pi r^2/4}$ (l= side of square).

   d. Mark the calculated area on the monitor (square).

   e. Position jumper JP18 of RF Adaptation Board in "A". A window will be displayed on the monitor.

   f. Adjust in the RF Adaptation Board the following potentiometers to move the window under the frame marked on the monitor in step-d:

      - R1 potentiometer (vertical position)
      - R2 potentiometer (vertical width)
      - R3 potentiometer (horizontal position)
      - R4 potentiometer (horizontal width)

   g. Once the window is configured, place JP18 in "B" again at RF Adaptation Board.

10. Select the 70 kV (or the kV obtained in step-8.) and Non-ABC mode.

11. Adjust the gain at R27 on the RF Adaptation Board to make the "*ABC OUT*" signal equal to +6 VDC. Measure "*ABC OUT*" in TP7 of RF Adaptation Board or in TP3 ("*ABC IN*") of the AEC Control Board.

12. Perform the following adjustments in the AEC Control Board:

    a. Select 70 kV (or the kV obtained in step-8.) and increase 2 kV and check the increased value of voltage in TP3 (ABC-IN) (if this value has not been increased, increase 1 kV more). Note this value **(consider it as KV-DOWN-SEL)**.

    b. Select 70 kV (or the kV obtained in step-8.) and decrease 2 kV and check the decreased value of voltage in TP3 (ABC-IN) (if this value has not been decreased, decrease 1 kV more). Note this value **(consider it as KV-UP-SEL)**.

    c. Obtain in TP1 the same voltage noted as kV-DOWN-SEL (DOWN PT) by adjusting the Potentiometer R11.

    d. Obtain in TP2 the same voltage noted as kV-UP-SEL (UP PT) by adjusting the Potentiometer R14.

13. Select the 70 kV (or the kV obtained in step-8.) and ABC mode.

14. Make a Fluoro exposure and check that the kV does not change.

15. Stop the Fluoro exposure and select 40 kV. Make a Fluoro exposure and check that the kV value goes to 70 kV (or the kV obtained in step-8.) $\pm$4 kV without System problems.

16. Stop the Fluoro exposure and select 100 kV. Make a Fluoro exposure and check that the kV value goes to 70 kV (or the kV obtained in step-8.) $\pm$4 kV without System problems.

2.9 FINAL CHECKS

Verify that all Configuration and Calibration data have been properly stored in memory.

1. Enter in calibration mode and check that the values noted for the *"Filament Current Numbers"* and *"Extended Memory Locations"* tables of the Data Book are the same that the values displayed and stored in memory. Press the "*Read*" button to read the stored values.

2. Exit from calibration mode and Service mode.

3. Turn the Generator OFF and verify position of dip switches on the HT Controller Board are:

   - Dip switch 3000SW2-2 in *"**Off**"* position (enables Filament and Rotor Interlocks).

   - Dip switch 3000SW2-4 in *"**Off**"* position (Digital mA Loop Closed).

4. Set the Test dip switch 3024SW2-3 on the ATP Console CPU Board in "***Off***" position to place the Generator in normal operating mode.

Technical Publication
CA-1004R8

Calibration

HF Series Generators

REVISION HISTORY

REVISION	DATE	REASON FOR CHANGE
3	NOV 2, 2004	AEC Calibration
4	APR 1, 2005	Text revision
5	FEB 29, 2007	Calibration of optional 1000 mA station
6	JUN12, 2009	Text revision
7	OCT 25, 2017	Improvement of AEC Calibration procedure
8	JUN 30, 2019	References for HT Controller Board A3000-8x

This Document is the english original version, edited and supplied by the manufacturer.

The Revision state of this Document is indicated in the code number shown at the bottom of this page.

ADVISORY SYMBOLS

The following advisory symbols will be used throughout this manual. Their application and meaning are described below.

DANGERS ADVISE OF CONDITIONS OR SITUATIONS THAT IF NOT HEEDED OR AVOIDED WILL CAUSE SERIOUS PERSONAL INJURY OR DEATH.

ADVISE OF CONDITIONS OR SITUATIONS THAT IF NOT HEEDED OR AVOIDED COULD CAUSE SERIOUS PERSONAL INJURY, OR CATASTROPHIC DAMAGE OF EQUIPMENT OR DATA.

Advise of conditions or situations that if not heeded or avoided could cause personal injury or damage to equipment or data.

Note ☞

Alert readers to pertinent facts and conditions. Notes represent information that is important to know but which do not necessarily relate to possible injury or damage to equipment.

TABLE OF CONTENTS

SECTION 1 INTRODUCTION

This Calibration document provides information and procedures to perform all the adjustments required to establish an optimal performance of this Generator.

CAUTION

Calibrate the Generator immediately after Configuration is completed.

WARNING

DO NOT SUPPLY THE MAIN POWER UNTIL SPECIFICALLY INSTRUCTED TO DO SO IN THIS DOCUMENT.

THE MAIN CAPACITORS OF THE HIGH VOLTAGE INVERTER RETAIN A LARGE PORTION OF THEIR CHARGE FOR APPROX. 3 MINUTES AFTER THE UNIT IS TURNED OFF.

Calibration data is entered in digital form and stored in a non-volatile memory chip (U3-EEPROM) located on the HT Controller Board, thus no battery back-up is required.

Note ☞

Calibration procedures must be performed in the order listed in this document. Perform only the sections required to calibrate this unit.

1.1 GENERATOR SPECIFICATIONS

1.1.1 MINIMUM CURRENT TIME PRODUCT (mAs)

- Minimum Current Time Product obtained at 0.1 s is 1 mAs.
- Minimum Current Time Product within the specified ranges of compliance for linearity and constancy is 0.1 mAs.

1.1.2 ACCURACY OF RADIOGRAPHIC AND FLUOROSCOPIC PARAMETERS

Note ☞ *Specified accuracy does not include test equipment accuracy.*

PARAMETERS		ACCURACY (with 12 BITS HT Controller)
RAD	kV	± (3% + 1 kV)
	mA	± (4% + 1 mA)
	Exposure Time	± (2% + 0.1 ms)
FLUORO	kV	± (3% + 1 kV)
	mA	± 10%
	Exposure Time	± (1% + 20 ms)

1.1.3 HV FREQUENCY

The operating HV Frequency of this generator is 25 kHz / 30 kHz.

1.1.4 DUTY CYCLE

The Generator duty cycle is continuous, but limits should be set during installation depending on the capacity of the X-ray tube.

SECTION 2 CALIBRATION PROCEDURES

Note ☞

Enter and store calibration data in the Extended Memory Locations as described in Section 2.2 of the "Configuration" document.

Record all the calibration data in the Data Book.

Before calibration, bear in mind that:

- For calibration and measure the kVp it is needed a Non-Invasive kVp Meter.
- For calibration and measure mA or mAs it is needed a mAs Meter plugged to the banana connections on the HV Transformer (connect the mAs Meter for Digital mA Loops calibration).

Note ☞

Test points on the HT Controller Board can also be used to monitor the kV and mA readings but ***should not be used*** *to calibrate the unit. These test points must be checked with scope:*

- mA test point is TP-5 and the scale factor is:

with HT Controller Board A3000-xx (except -44 or -85) (<1000 mA Generator)
- from 10 to 80 mA, 1 volt = 10 mA
- from 100 mA, 1 volt = 100 mA

with HT Controller Board A3000-44 or -85 (1000 mA Generator)
- from 10 to 80 mA, 1 volt = 20 mA
- from 100 mA, 1 volt = 200 mA

- kV test point is TP-7 and the scale factor is 1 volt = 33.3 kV (0.3 volt = 10 kV)

- Verify that dip switch 3024SW2-3 on the ATP Console CPU Board is in "***On***" position to permit the service mode.

- Verify position of dip switches on the HT Controller Board during every calibration procedure:

DIP SWITCH	OPEN (OFF)	CLOSED (ON)
3000SW2-2	Position during operation – Enables Filament and Rotor Interlocks	Disables Filament and Rotor Interlocks (this turns off the filament so no radiation will be produced during the exposure).
3000SW2-4	Position during operation – Digital mA Loop Closed	Digital mA Loop Open / Filament Current Constant

Note ☞ *Only for Generators with Low Speed Starter (LF-RAC) (it does not apply to Generators with High Speed Starter - LV-DRAC):*

*– When the Digital mA Loop is open (dip switch 3000SW2-4 in "**On**"), the rotor runs for two minutes after releasing the handswitch button from "Preparation" position. After this time the rotor will brake (unless DC Brake is removed).*

*– When the Digital mA Loop is closed (dip switch 3000SW2-4 in "**Off**"), the rotor will brake after releasing the handswitch button from "Preparation" position (unless DC Brake is removed).*

- Be sure that X-ray Tubes configured in E02 and E18 Memory Locations correspond to X-ray Tubes installed (*refer to Configuration document*).

2.1 FILAMENT STAND-BY CURRENT

Note ☞ *For RAD Only Generators, the Filament Stand-by value is auto-calibrated by the Generator and automatically stored into the respective Memory Locations (E01 and E17). Filament Stand-by values are not field changeable.*

Note ☞ *For RAD and Fluoro Generators, E17 Memory Location ("Fluoro Filament Setting") sets maximum patient Entrance Skin Exposure Dose Rate. (Refer to Section 2.7 "Fluoro Calibration").*

2.2 EXPOSURE TIME ADJUSTMENT

The values stored in these Extended Memory Locations only affect to Exposure Times for techniques below 20 ms. The Memory Locations which affect short exposure times are:

FUNCTION	MEMORY LOCATION	
	TUBE-1	TUBE-2
EXPOSURE TIME ADJUSTMENT - DELAY	E13	E29
EXPOSURE TIME ADJUSTMENT - Ceq kV	E15	E31

The Generator has been optimized at the factory to produce correct exposures at the lower times (<20 ms.) Therefore **do not change** the value factory set for E13 and E29 Memory Locations and only adjust the value for E15 and E31 Memory Location according to the HV Cables length.

The Exposure Time adjustment is calibrated by performing the following steps:

1. Enter calibration mode.
2. Select the E13 (or E29) Memory Location. Value in this Memory Location adjusts the time delay of the exposure. It is factory set for a value of 17, 18 or 19 (*default value is "**18**"*). Only read this value, **do not change it**.
3. Select the E15 (or E31) Memory Location. Value in this Memory Location is set in relation to the length in meters of one of the HV Cables (1 ft = 0.3048 m). Verify the HV Cable length in meters and set the following value:

HV CABLE LENGTH	VALUE TO SET IN MEMORY
4 m	27
6 m	31
9 m	38
12 m	45
14 m	49
16 m	54
For another HV Cable length	value = (2.2711 x cable length) + 17.744

4. Store the new value of each Memory Location.
5. Exit from calibration mode and record the new values in the Data Book.
6. Repeat the above calibration process for the second tube (memory locations E29 and E31).

2.3 KV LOOP

Extended Memory Location E06 contains the calibration factor for kV Loop. Each number above or below of the indicated in the E06 memory location increases or decreases respectively the kV gain value.

Note ☞ *Value in E06 Memory Location is only related to the Generator performance (it is not related to the X-ray Tube(s) or another components installed), so value in* ***this Memory Location is factory adjusted****. Only perform this procedure if the HT Controller Board and/or HV Transformer have been replaced in the unit.*

The kV Gain for kV Loop can be manually calibrated with a Non-Invasive kV Meter (recommended procedure) or Auto-calibrated with HV Bleeder.

Manual Calibration of E06 Memory Location

1. With the Generator power OFF:

   - Set Dip switch 3000SW2-2 on the HT Controller Board in *"**Off**"* position (enables Filament and Rotor Interlocks).
   - Set Dip switch 3000SW2-4 on the HT Controller Board in *"**On**"* position (Digital mA Loop Open / Filament Current Constant).
   - Remove the link between the banana plug connections on the HV Transformer. Connect the mAs Meter to the banana plug connections to measure mA or mAs.
   - Place and center a Non-Invasive kVp Meter on the X-ray Tube output at the required SID (*refer to the Non-Invasive kVp Meter documentation*).

2. Enter in calibration mode.

3. Select the E06 Memory Location and read the calibration value by pressing the "*AEC Reset*" push-button. Enter the value "***200***" and store it by pressing the "*AEC Reset*" push-button.

4. Calibrate manually the Filament Current Number for 80 kV / 200 mA combination, as indicated in the following steps (*if it has not been previously calibrated*).

   In calibration mode, Filament Current Numbers are shown on the kV Display by pressing the "*AEC Reset*" push-button after selecting the respective kV / mA combination. They can be changed by pressing the *"Increase"* and *"Decrease"* (or "*+1*" and "*–1*") density push-buttons and stored by pressing the "*AEC Reset*" push-button.

   Select 80 kV, 200 mA and set value "*344*" on Filament Current Number. Make an exposure. The mAs read on the mAs Meter must be the same mAs displayed on the calibration screen with a tolerance of ±0.1 mAs (tolerance of the parameter and mAs Meter).

   If the mAs is low, increase the filament number. If the mA is high (or "*Generator Overload*" Error is shown), decrease the filament number. Press the "*AEC Reset*" push-button before making a new exposure. Repeat until the mAs read is correct and the mA station is calibrated.

5. Exit from Calibration mode.

6. Select: 80 kV, 200 mA, 100 ms. Make an exposure and note the kV value at the end of the exposure.

7. If calibration of the kV Loop is correct (80 ±1 kV), record value "***200***" in the Data Book.

8. If calibration of the kV Loop is not correct:

   a. Enter in Calibration mode and select the E06 Memory Location. Press the "*AEC Reset*" push-button to read the value stored.

   b. Increase or decrease the value to increase or decrease the kV respectively. Enter the new value and store it by pressing the "*AEC Reset*" push-button.

   c. Exit calibration mode and repeat the exposure (*step-6.*) to determine if the new value has had the proper effect, if not repeat step-8.

   d. When it is correct, record the new value for E06 Memory Location in the Data Book.

9. After calibration of E06 Memory Location, remove the Non-Invasive kVp Meter.

Auto-Calibration of E06 Memory Location

1. With the Generator power OFF:

   - Set Dip switch 3000SW2-2 on the HT Controller Board in *"**On**"* position (disables Filament and Rotor Interlocks).

   - Remove the HV Cables from the X-ray Tube and connect them to the HV Bleeder, then connect a short couple of HV Cables from the HV Bleeder to the X-ray Tube.

2. Enter in Calibration mode and select the E06 Memory Location.

EACH TIME THAT AUTO-CALIBRATION IS ACTIVATED IN THIS MEMORY LOCATION, CALIBRATION DATA STORED IS DELETED AND A NEW CALIBRATION FOR IT WILL BE REQUIRED.

3. Enter in Auto-calibration mode pressing the "*Power On*" and "*kV Increase*" push-buttons. After releasing both push-buttons, code "***222***" is shown on the Console accompanied of an alarm waiting confirmation for entering in Auto-calibration mode.

   Keep pressed the "*kV increase*" and "*Power On*" push-buttons again until code "***222***" disappears on the Console to confirm Auto-calibration mode or press only the "*Power On*" push-button to leave Auto-calibration mode and return to manual calibration.

4. Make an exposure (technique parameters are pre-programmed at 100 kV, 200 mA and 32 ms and they can be shown when pressing the "*Prep*" button).

5. Read the kVp measured with the HV Bleeder and enter this value on the kV Display by pressing the *"kV Increase"* or *"kV Decrease"* buttons.

6. Exit from Auto-calibration mode pressing the "*Power ON*" and "*kV Decrease*" push-buttons. At this moment, the Generator will calculate and store the new value in E06 Memory Location. Auto-calibration is deactivated and the process is finished when "*E06*" is indicated on the Console again.

7. Read the new value stored in E06 Memory Location pressing the "*AEC Reset*" push-button. Record this value in the Data Book.

8. Exit calibration mode.

9. After calibration of E06 Memory Location:

   - Switch the Generator power OFF.

   - Remove the HV Bleeder and connect the HV Cables from the Generator directly to the X-ray Tube.

2.4 DIGITAL mA LOOP CLOSED

Extended Memory Locations E03 and E05 contain the calibration factor for Digital mA Loop Closed. Each number above or below the indicated in the memory locations increases or decreases respectively the mA gain value.

Note ☞

Values in E03 and E05 Memory Locations are only related to the Generator performance (they are not related to the X-ray Tube(s) installed), so values in ***these Memory Locations are factory adjusted****. Only perform this procedure if the HT Controller Board and/or HV Transformer have been replaced in the unit.*

The mA Gain for Digital mA Loop Closed is calibrated by performing the following steps:

1. With the Generator power OFF, set:

   - Dip switch 3000SW2-2 on the HT Controller Board in *"**Off**"* position (enables Filament and Rotor Interlocks).

   - Dip switch 3000SW2-4 on the HT Controller Board in *"**On**"* position (Digital mA Loop Open / Filament Current Constant).

   - Remove the link between the banana plug connections on the HV Transformer. Connect the mAs Meter to the banana plug connections to measure mA or mAs.

2. Select one available workstation (eg. "*No Bucky*").

3. Calibrate E03 and E05 Memory Locations as described in the following pages.

WARNING

EACH TIME THAT AUTO-CALIBRATION IS ACTIVATED IN ONE OF THESE MEMORY LOCATIONS, CALIBRATION DATA STORED FOR THAT MEMORY LOCATION IS DELETED AND A NEW CALIBRATION FOR IT WILL BE REQUIRED.

4. After calibration of E03 and E05 Memory Locations:

   - Switch the Generator power OFF.

   - Disconnect the mAs Meter to the banana plug connections.

   - Re-install the link between the banana plug connections on the HV Transformer.

For Low mA stations (from 10 mA to 80 mA) (E03 Memory Location):

1. Enter calibration mode and select the E03 memory location.

2. Enter Auto-calibration mode pressing the "*Power On*" and "*kV increase*" push-buttons. After releasing both push-buttons, code "***222***" is shown on the Console accompanied of an alarm waiting confirmation for entering in Auto-calibration mode.

   Keep pressed the "*kV increase*" and "*Power On*" push-buttons again until code "***222***" disappears on the Console to confirm Auto-calibration mode or press only the "*Power On*" push-button to leave Auto-calibration mode and return to manual calibration.

   Auto-calibration is activated when the Console shows the mAs value (3.5 mAs or 35 mAs depending on the Generator software).

3. Perform the following steps:

   a. Make an exposure (technique parameters are pre-programmed at 80 kV, 32 mA and the respective time (0.1 s or 1 s) and they can be shown when pressing the "*Prep*" button).

   b. Read the mAs measured on the mAs Meter.

   c. Read the Filament Current Number shown on the kV Display by pressing the *"Increase"* and *"Decrease"* (or "*+1*" and "*–1*") density push-buttons. Since these push-buttons are also used to increase or decrease the values one number should be added or subtracted from the reading to obtain the correct value.

   d. Increase or decrease the Filament Current Number to determine the correction needed to obtain a value between 3.0 and 4.0 mAs (for 3.5 mAs) or a value between 30 and 40 mAs (for 35 mAs) in the mAs Meter after making a new exposure.

   e. Repeat the above steps until a proper mAs value is obtained in the mAs Meter.

4. Enter the mAs value read in the mAs Meter (step 3.) in the mAs Display pressing the "*mAs increase*" or "*mAs decrease*" push-buttons.

5. Exit from Auto-calibration mode pressing the "*Power On*" and "*kV decrease*" push-buttons. At this moment, the Generator will calculate and store the new value in E03 memory location. Auto-calibration is deactivated and the process is finished when "*E03*" is indicated on the Console again.

6. Read the new value stored in E03 memory location pressing the "*AEC Reset*" push-button. Record this value in the Data Book.

7. Exit calibration mode.

For High mA stations (from 100 mA) (E05 Memory Location):

1. Enter calibration mode and select the E05 memory location.

2. Enter Auto-calibration mode pressing the "*Power On*" and "*kV increase*" push-buttons. After releasing both push-buttons, code "***222***" is shown on the Console accompanied of an alarm waiting confirmation for entering in Auto-calibration mode.

   Keep pressed the "*kV increase*" and "*Power On*" push-buttons again until code "***222***" disappears on the Console to confirm Auto-calibration mode or press only the "*Power On*" push-button to leave Auto-calibration mode and return to manual calibration.

   Auto-calibration is activated when the Console shows the mAs value (7.75 mAs or 77.5 mAs depending on the Generator software).

3. Perform the following steps:

   a. Make an exposure (technique parameters are pre-programmed at 80 kV, 125 mA and the respective time and they can be shown when pressing the "*Prep*" button).

   b. Read the mAs measured on the mAs Meter.

   c. Read the Filament Current Number shown on the kV Display by pressing the *"Increase"* and *"Decrease"* (or "*+1*" and "*–1*") density push-buttons. Since these push-buttons are also used to increase or decrease the values one number should be added or subtracted from the reading to obtain the correct value.

   d. Increase or decrease the Filament Current Number to determine the correction needed to obtain a value between 7.00 and 8.50 mAs (for 7.75 mAs) or a value between 70 and 85 mAs (for 77.5 mAs) in the mAs Meter after making a new exposure.

   e. Repeat the above steps until a proper mAs value is obtained in the mAs Meter.

4. Enter the mAs value read in the mAs Meter (step 3.) in the mAs Display pressing the "*mAs increase*" or "*mAs decrease*" push-buttons.

5. Exit from Auto-calibration mode pressing the "*Power On*" and "*kV decrease*" push-buttons. At this moment, the Generator will calculate and store the new value in E05 memory location. Auto-calibration is deactivated and the process is finished when "*E05*" is indicated on the Console again.

6. Read the new value stored in E05 memory location pressing the "*AEC Reset*" push-button. Record this value in the Data Book.

7. Exit calibration mode.

2.5 DIGITAL mA LOOP OPEN (X-RAY TUBE CALIBRATION)

To achieve the most accurate calibration, **this procedure has to be automatically performed by the Generator (Auto-calibration).** Calibration procedure will be manually performed by the field engineer only if Auto-calibration is not possible.

Two different methods are described in this section: Auto-calibration and Manual Calibration.

Digital mA Loop Open is calibrated by performing the following steps:

1. With the Generator power OFF, set:
   - Dip switch 3000SW2-2 on the HT Controller Board in *"**Off**"* position (enables Filament and Rotor Interlocks).
   - Dip switch 3000SW2-4 on the HT Controller Board in *"**On**"* position (Digital mA Loop Open / Filament Current Constant).
2. Turn the Generator ON.
3. Enter in Calibration mode. Select the E17 Memory Location and store the value "*086*". Press the "*AEC Reset*" push-button to read the value stored. Exit calibration mode.
4. Perform the Auto-calibration procedure as described in Section 2.5.1 for each X-ray Tube in the system.

2.5.1 AUTO-CALIBRATION OF DIGITAL mA LOOP OPEN

Auto-calibration of the Filament Current Numbers is divided in two separated procedures related to the mA stations configured for the Small or Large Focal Spots.

It is recommended to start with the Small Focal Spot (first group) and continue with the Large Focal Spot (second group).

WARNING

EACH TIME THAT AUTO-CALIBRATION IS ACTIVATED IN A mA STATION (OR IN "E01" MEMORY LOCATION), ALL THE FILAMENT CURRENT NUMBERS OF THE SELECTED FOCAL SPOT ARE AUTOMATICALLY SET TO "344". SO A NEW COMPLETE CALIBRATION OF THE FILAMENT CURRENT NUMBERS FOR THIS FOCAL SPOT WILL BE REQUIRED.

Auto-calibration starts with the minimum available mA station for the selected Focal Spot at 50 kV and follows with the other combinations of mA stations for the selected Focal Spot at 80 kV, 120 kV and 40 kV.

1. Select one available workstation for the X-ray Tube selected. This workstation has to be one of the previously configured as "*Direct*".

2. Enter calibration mode and select one of the configured mA stations for the **Small Focal Spot**.

3. Enter Auto-calibration mode pressing the "*Power On*" and "*kV increase*" push-buttons. After releasing both push-buttons, code "***222***" is shown on the Console accompanied of an alarm waiting confirmation for entering in Auto-calibration mode.

   Keep pressed the "*kV increase*" and "*Power On*" push-buttons again until code "***222***" disappears on the Console to confirm Auto-calibration mode or press only the "*Power On*" push-button to leave Auto-calibration mode and return to manual calibration.

   Auto-calibration is activated after releasing both push-buttons. At this moment, the Generator will check the mA stations available for the **Small Focal Spot**. A "double-beep" will sound when the verification is completed.

4. Check that the Heat Units available for the X-ray Tube are 100% (kV Display shows "H – –" on the Console).

WARNING

BEFORE MAKING ANY EXPOSURE IN AUTO-CALIBRATION, VERIFY THAT THE LINK BETWEEN THE BANANA PLUG CONNECTIONS ON THE HV TRANSFORMER IS INSTALLED.

5. Keep fully pressed the Handswitch push-button or use the Exposure Controls on the Console to perform continuous exposures.

Note ☞

In Auto-calibration mode, all technique parameters are factory pre-programmed and they can not be changed.

CAUTION

Auto-calibration can be paused momentarily by releasing the Handswitch push-button or the Exposure Controls. Do not exit from Auto-calibration before the procedure has been completed.

Note ☞

Auto-calibration can be cancelled by pressing the "Power On" and "kV decrease" push-buttons. A double "double-beep" sound and new values displayed on the Console indicates Auto-calibration is deactivated.

If during Auto-calibration process, any error indication is shown momentarily on the Console (such as “*Tube Overload*”, etc.), it means that Generator can not calibrate in this moment the selected kV / mA combination (because anode overheated, space charge, Generator power limit, etc.). In this case, the Generator will continue with Auto-calibration of the following available kV / mA combinations for the selected Focal Spot. At the end of the process it will try to calibrate or calculate the combinations previously uncalibrated.

If the Heat Units available for the X-ray Tube are less than 40%, exposures are inhibited momentarily and code “***111***” will be flashed on the Console accompanied of an alarm. The alarm will stop when the X-ray Tube begins to cool and recovers the Heat Units capacity, exposures can be performed again even though code “***111***” is shown on the Console.

At this point, it is recommended to wait until the Heat Units available are closed to the 80% of the X-ray Tube capacity without making any exposure.

Generator tries to calibrate each kV / mA combination for ten (10) attempts (maximum). If calibration is aborted (after ten attempts), code “***888***” will be shown on the Console until press the “*Power On*” push-button. Calibration can be also aborted due to space charge during calibration of the lowest kV at the highest mA stations for the Focal Spot selected, so code “***777***” will be shown on the Console until press the “*Power On*” push-button.

WARNING

IF AUTO-CALIBRATION IS ABORTED (CODE “888” OR “777”), CONTINUE THE AUTO-CALIBRATION PROCEDURE FOR THE OTHER FOCAL SPOT. CHECK AT THE END OF THE AUTO-CALIBRATION PROCEDURE WHICH KV / MA COMBINATIONS HAVE NOT BEEN AUTO-CALIBRATED FOR EACH FOCAL SPOT (THESE COMBINATIONS HAVE THE FILAMENT CURRENT NUMBER SET TO “344”). MANUALLY CALIBRATE THESE KV / MA COMBINATIONS AS EXPLAIN IN SECTION 2.5.2.

When Auto-calibration is successfully performed, code “***999***” will be shown on the Console until press the “*Power On*” push-button to exit from Auto-calibration mode. A double “double-beep” sound and new values displayed on the Console indicates Auto-calibration is deactivated.

6. Repeat the same procedure for the **Large Focal Spot** selecting one of the configured mA stations for the Large Focal Spot previous to enter in Auto-calibration mode.

   Before starting the exposures, it is recommended to wait until the Heat Units available are closed to the 80% of the X-ray Tube capacity.

7. After performing both procedures (for Small and Large Focal Spots), select in calibration mode each combination of the available mA stations at the kV break points (40, 50, 80 and 120 kV). Press the "*AEC Reset*" push-button to read on the kV Display the new value of the Filament Current Number stored for each combination and record the new values in the Data Book.

   Note that the highest mA station for Small Focal Spot may have numbers larger than the lowest mA station for Large Focal Spot. This is normal.

8. Exit calibration mode.

9. Repeat the above calibration process for the second tube.

10. **Turn the Generator power OFF and set Dip Switch 3000SW2-4 on the HT Controller Board in *"Off"* position (Digital mA Loop Closed).**

2.5.2 MANUAL CALIBRATION OF DIGITAL mA LOOP OPEN

This procedure describes the Manual calibration of all the Filament Current Numbers. It has to be also used to calibrate the kV / mA combinations not performed during Auto-calibration procedure because it has not been completed. These combinations have the Filament Current Number set to "344", so only these combinations have to be manually calibrated as described in this procedure.

Manual Calibration is initiated at the 80 kV break point by entering the appropriate Filament Current Number for the proper tube current at each selectable mA. Calibration at the other kV break points (40, 50, 80 and 120 kV) are obtained by adding or subtracting values as indicated in Table 2-1.

Although the suggested values (Table 2-1) could change depending on the X-ray tube used, entering those values will approximate accurate calibration without making excessive exposures.

Table 2-1
mA Calibration Numbers Change

mA STATION	FILAMENT CURRENT NUMBERS AT kV BREAK POINT			
	40	50	80	120
10	A_1+7	A_1+6	A_1	A_1–5
12.5	A_2+7	A_2+6	A_2	A_2–5
16	A_3+7	A_3+6	A_3	A_3–5
20	A_4+7	A_4+6	A_4	A_4–5
25	A_5+7	A_5+6	A_5	A_5–5
32	A_6+7	A_6+6	A_6	A_6–5
40	A_7+7	A_7+6	A_7	A_7–5
50	A_8+7	A_8+6	A_8	A_8–5
64 (or 63 or 65)	A_9+7	A_9+6	A_9	A_9–5
80	A_{10}+7	A_{10}+6	A_{10}	A_{10}–5
100	A_{11}+10	A_{11}+8	A_{11}	A_{11}–7
125	A_{12}+10	A_{12}+8	A_{12}	A_{12}–7
160	A_{13}+10	A_{13}+8	A_{13}	A_{13}–7
200	A_{14}+10	A_{14}+8	A_{14}	A_{14}–7
250	A_{15}+10	A_{15}+8	A_{15}	A_{15}–7
320	A_{16}+14	A_{16}+11	A_{16}	A_{16}–9
400	A_{17}+14	A_{17}+11	A_{17}	A_{17}–9
500	A_{18}+14	A_{18}+11	A_{18}	A_{18}–9
640 (or 630 or 650)	A_{19}+14	A_{19}+11	A_{19}	A_{19}–9
800	A_{20}+14	A_{20}+11	A_{20}	A_{20}–9
1000	A_{21}+14	A_{21}+11	A_{21}	A_{21}–9

Note.– The mA station values depends on the Generator model. Some models do not contain all the mA stations listed above.

In calibration mode, Filament Current Numbers are shown on the kV Display by pressing the "*AEC Reset*" push-button after selecting the respective kV / mA combination. They can be changed by pressing the *"Increase"* and *"Decrease"* (or "*+1*" and "*–1*") density push-buttons and stored by pressing the "*AEC Reset*" push-button.

The kV Display shows again the kV when the "*AEC Reset*" push-button is released. Note that in calibration mode, only the mA stations and kV (at the break points) can be selected.

Note ☞ *If an exposure is made while displaying a Filament Current Number, the kV of the exposure is the previously displayed kV.*

1. With the Generator power OFF, set:
   - Dip switch 3000SW2-2 on the HT Controller Board in ***"Off"*** position (enables Filament and Rotor Interlocks).
   - Dip switch 3000SW2-4 on the HT Controller Board in ***"On"*** position (Digital mA Loop Open / Filament Current Constant).
   - Remove the link between the banana plug connections on the HV Transformer. Connect the mAs Meter to the banana plug connections to measure mA or mAs.

2. Turn the Generator ON and select one available workstation for the X-ray Tube selected. This workstation has to be one of the previously configured as "*Direct*".

3. Check that the Heat Units available for the X-ray Tube are 100% (kV Display shows "H – –" on the Console).

4. Enter calibration mode and according to X-ray Tube ratings or maximum Generator power, check which kV / mA combinations in Table 2-1 are allowed.

   If error "*Tube Overload*" is shown on the Console after selection of a kV / mA combination, it means this combination is not allowed for the selected X-ray Tube. In calibration mode, if Generator power is exceeded by a kV / mA combination selection, error "*E-16"* is shown on the Console after "*Preparation*". To reset this error, press "*AEC Reset*" push-button.

   Note which combinations in Table 2-1 can not be calibrated by making exposures (combinations not allowed due to Tube rating, maximum Generator power, space charge, etc.) and the Exposure Time assigned to these combinations in calibration mode.

   Exit calibration mode and select the mA station and Exposure Time of each kV / mA combination not allowed. Increase or decrease the kV value as required to determine the kV value allowed nearest to the kV value of the combination. Note the kV value allowed in the respective cell of Table 2-1.

5. Enter calibration mode and select 80 kV and the lowest mA station available (first combination available). Enter a filament number of "344" for this combination.

6. Make an exposure. The mAs read on the mAs Meter must be the mAs displayed on the Console $\pm$ 0.1 mAs (tolerance of the parameter and mAs Meter). If the mAs read is close to zero, increase the filament number in big steps (a.e. increase values in 40). As the mAs read is close to the mAs displayed on the Console, increase (or reduce) the filament number in smaller steps (a.e. increase value in 30, 20, 10, ...).

   If the mAs is low, increase the filament number. If the mA is high, decrease the filament number. Press the "*AEC Reset*" push-button before making a new exposure. Repeat until the mA station is calibrated.

Note ☞ *Press the "AEC Reset" push-button to store the new data (filament number) before selecting the next kV or mA stations.*

CAUTION

Calibration data (presently in memory) may or may not be close to your requirements. If it is not close, the potential exists to damage the X-ray tube (i.e. too much mA). Thus, as you start the mA calibration procedure note how close or how far off the mA break points are. If a large adjustment (more than 40 points) is required at the low mA stations, make estimated adjustments to the high mA stations <u>before</u> those exposures are made.

7. Select the next mA station at 80 kV. Before making any exposure, enter as filament number the value calibrated for the previous mA station increased in 10.

   If the mAs is low, increase the filament number. If the mA is high, decrease the filament number. Press the "*AEC Reset*" push-button before making a new exposure. Repeat until the mA station is calibrated.

8. Complete the calibration process for all mA stations at 80 kV as described before. When select the first mA station for the Large Focal Spot, enter as a filament number the value calibrated for the first mA station for the Small Focal Spot. Note that the highest mA station for Small Focal Spot may have numbers larger than the lowest mA station for Large Focal Spot. This is normal.

   Press the "*AEC Reset*" push-button to read on the kV Display the new value of the Filament Current Number stored for each mA station at 80 kV. Record the new values in the Data Book.

Note ☞

When highest mA stations of the Generator can not be calibrated at 80 kV due to insufficient filament current (the filament current number has reached the maximum number (999)), replace on the Filament Board (A3004-09/10) the Resistor R11 for another resistor with 1.4 kΩ / 5 W, and place Jumper JP1 in position "A". Then rename the Filament Board as A3004-11.

ATTENTION: After doing this modification reduce the value of all the filament current numbers (column for 80 kV) at the 25% and perform the calibration procedure again (from step-4).

9. Complete the calibration process for the remaining kV / mA combinations using Table 2-1 as a guide. It is not necessary to make exposures to do this. Compute the value for all the kV break points of each available mA station although the Generator power can not reach all the kV / mA combinations. Select the corresponding kV / mA combination and enter the computed value.

10. Check calibration at all allowed kV / mA combinations by making exposures and correct any calibration points as needed.

Note ☞ *If "Tube Overload" error is shown directly on the Console after selection of an allowed combination (refer to step-4.), wait until the X-ray tube anode cools down to permit the calibration of the mA station.*

11. Recalculate the values of the non-allowed combinations in accordance to the new values obtained by the previous exposures. (*Refer to Table 2-1*).
12. Exit calibration mode.
13. Select the mA station, Exposure Time and kV value noted for each kV / mA combination not allowed *(refer to step-4.)*. Check calibration at these kV / mA combinations by making exposures. If needed, enter in calibration mode and correct the Filament Current Number of the respective kV / mA combination not allowed.
14. In calibration mode, select each combination of the available mA stations at the kV break points (40, 50, 80 and 120 kV). Press the "*AEC Reset*" push-button to read on the kV Display the new value of the Filament Current Number stored for each combination. Record the new values in the Data Book.

    Note that the highest mA station for Small Focal Spot may have numbers larger than the lowest mA station for Large Focal Spot. This is normal.
15. Exit calibration mode.
16. Repeat the above calibration process for the second tube.
17. After calibration of Filament Current Numbers:
    - Switch the Generator power OFF.
    - Disconnect the mAs Meter to the banana plug connections.
    - Re-install the link between the banana plug connections on the HV Transformer.
    - **Set Dip Switch 3000SW2-4 on the HT Controller Board in *"Off"* position (Digital mA Loop Closed).**

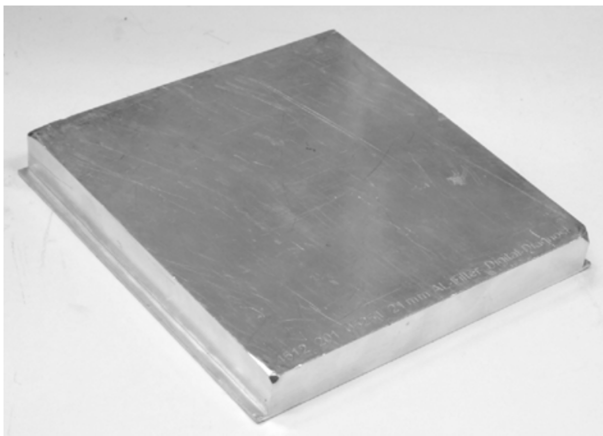
2.6 AEC CALIBRATION

This section describes the adjustments needed to calibrate the AEC in order to achieve the correct image at the lowest possible dose.

The Optical Density or Optimum Gray Level is controlled by the values stored in the respective memory locations. For Film, these values are influenced by film speed, screen speed, dark room procedures and customer requirements.

AEC Calibration is carried out using a homogeneous Phantom of Aluminium with a purity of not less that 99% and thickness of 21 mm, to produce an exposure between 50 ms and 300 ms. The AEC will be calibrated to produce a density of 1.0 (or the customer preference Optical Density for Film) or an Optimum Gray Level (for CR or DR) at 70 kV, and then AEC kV Tracking will be adjusted to produce the same density at 55 kV and 90 kV.

Illustration 2-1
Phantom of Aluminium



CAUTION

Before starting with the AEC Calibration, it is necessary that the Alignment of X-Ray Beam and the Alignment of Light Field with X-Ray Field should be performed.

CAUTION

The AEC Calibration must be carried out with the GRID removed whenever possible.

Note ☞

***For AEC calibration with Film**, use the same Film and Cassettes used by the customer. AEC calibration <u>must be performed</u> using the Medium Film/Screen speed combination. The Medium Film/Screen speed has to be double of the Slow and half of the Fast (a.e. 200-Slow, 400-Medium, 800-Fast).*

Note ☞

***For AEC Calibration with CR (Computer Radiography) or DR (Digital Radiography)**, measure the Image Gray Level or Dose Level by using the needed software tools inside each Acquisition Application.*

The Dose Level can be also measured by placing a Dosimeter centered on the imaging area of the Receptor (CR or DR) and with the Grid removed.

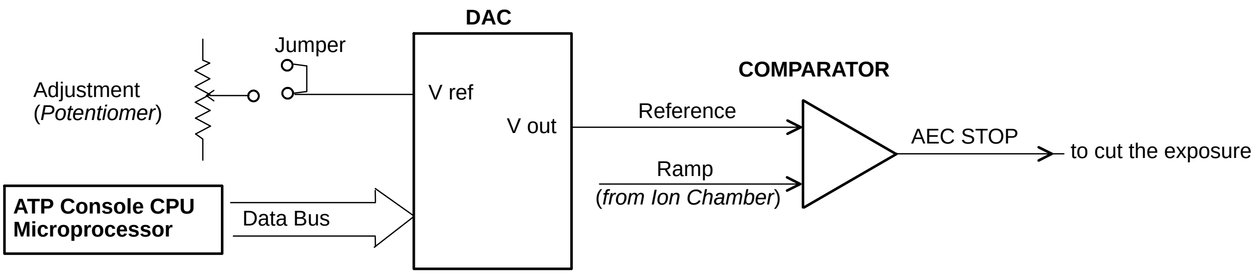
The following table indicates the Memory Locations related to AEC Calibration.

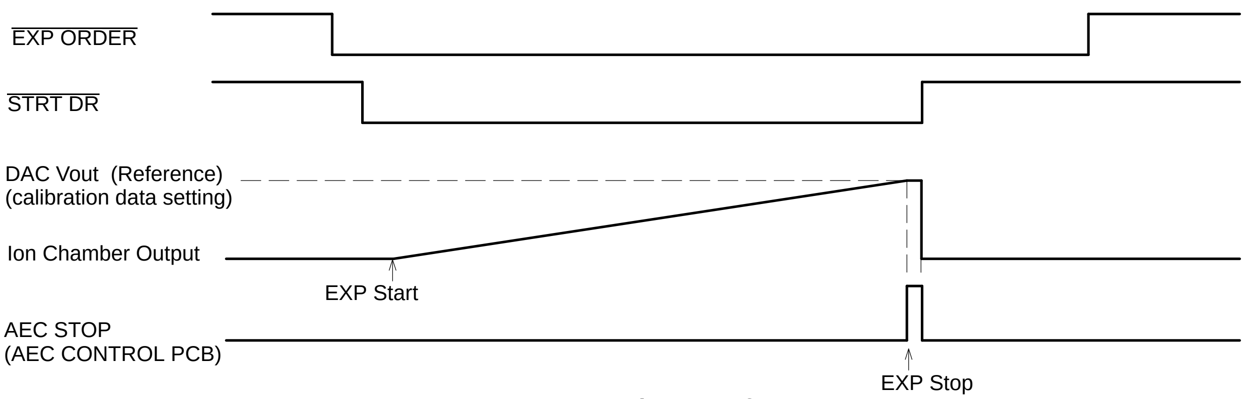
FUNCTION	MEMORY LOCATION
AEC-1 CALIBRATION	E04
AEC-1 TRACKING	E08
AEC-2 CALIBRATION	E09
AEC-2 TRACKING	E10
AEC-3 CALIBRATION	E20
AEC-4 CALIBRATION / PHOTOMULTIPLIER AEC CALIBRATION	E23
AEC-3 and AEC-4 TRACKING (equal value for both)	E24
AEC DENSITY SCALE	E12

CAUTION

Previous to AEC Calibration, identify and note which Memory Locations are assigned / related to each Ion Chamber / Photomultiplier in the system regarding to the configured Workstation / Devices.

Illustration 2-2
Automatic Exposure Control





AEC Function Waveform

2.6.1 PREVIOUS CHECKS FOR AEC CALIBRATION WITH FILM

Make sure the automatic processor works correctly, and the concentration and temperature of the solutions comply with manufacturer specifications.

Obtain a sensitometric curve to determine gamma (γ) of the film and the solution quality. The procedure normally requires a sensitometer, but if it is not available proceed as follows:

1. Make two exposures using the same kV and Film/Screen combination (medium is recommended) but with different mAs settings, mAs(f1) and mAs(f2).

2. Develop and measure the Density (d) of each, d(f1) and d(f2).

3. Determine gamma (γ) by the formula:

$$\gamma = \frac{d(f2) - d(f1)}{log_{10} \frac{mAs(f2)}{mAs(f1)}}$$

Gamma (γ) must be between 2 and 3, if not change or renew solutions.

2.6.2 OPTICAL DENSITY / IMAGE GRAY LEVEL ADJUSTMENT

Note ☞

For Film, the Film Optical Density must be measured always on the same point for all the X-ray Films developed during this procedure.

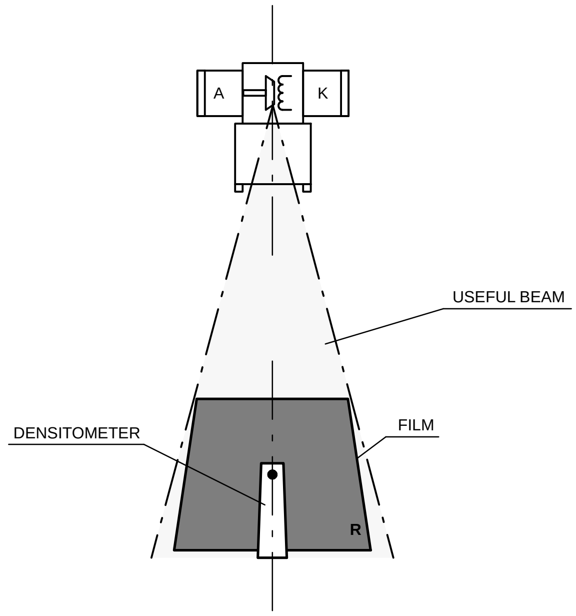
The recommended point is on the central axis of the Film with relation of the Anode and Cathode and as close as possible to center of the Film.

Note ☞

For CR or DR, the Image Gray Level must be measured always on the same area (Region of Interest) for all the RAW images obtained during this procedure.

The recommended ROI is 4 x 4 cm on the center of the CR or Detector.

Illustration 2-3
How to measure the Film Optical Density (only for Film)



2.6.2.1 ION CHAMBERS WITH GAIN SWITCHES OR WITH GAIN POTENTIOMETER

1. Set the Gain Switches (or Gain Potentiometer) of the Ion Chamber to mid range (*refer to Ion Chamber documentation*).

   The following tables indicate the switch position for the "*Vacutec*" Ion Chamber.

<table>
<tr><th colspan="6">VACUTEC ION CHAMBER – BAK 70 151 with Amplifier 70 901</th></tr>
<tr><th colspan="2">SWITCH POSITION</th><th>SW1</th><th>SW2</th><th>SW3</th><th>SW4</th></tr>
<tr><td rowspan="4">GAIN</td><td>0.1 V / μGy (10 V≃ 100 μGy)</td><td>OFF</td><td>OFF</td><td>OFF</td><td></td></tr>
<tr><td>0.5 V / μGy (10 V≃ 20 μGy)</td><td>ON</td><td>OFF</td><td>OFF</td><td></td></tr>
<tr><td>1 V / μGy (10 V≃ 10 μGy)</td><td>OFF</td><td>ON</td><td>OFF</td><td></td></tr>
<tr><td>2 V / μGy (10 V≃ 5 μGy)</td><td>OFF</td><td>OFF</td><td>ON</td><td></td></tr>
<tr><td rowspan="2">OUTPUT SIGNAL</td><td>Positive</td><td></td><td></td><td></td><td>ON</td></tr>
<tr><td>Negative</td><td></td><td></td><td></td><td>OFF</td></tr>
<tr><td colspan="2">NORMAL FACTORY SELECTION: 1 V / μGy (10 V≃ 10 μGy) - Positive</td><td>OFF</td><td>ON</td><td>OFF</td><td>ON</td></tr>
</table>

<table>
<tr><th colspan="6">VACUTEC DIGITAL ION CHAMBER – BAK 70 151 with Amplifier 70 902</th></tr>
<tr><th colspan="2">SWITCH POSITION</th><th>SW1</th><th>SW2</th><th>SW3</th><th>SW4</th></tr>
<tr><td rowspan="5">GAIN</td><td>0.1 V / μGy (10 V≃ 100 μGy)</td><td>OFF</td><td>OFF</td><td>OFF</td><td>OFF</td></tr>
<tr><td>0.5 V / μGy (10 V≃ 20 μGy)</td><td>OFF</td><td>OFF</td><td>OFF</td><td>ON</td></tr>
<tr><td>1 V / μGy (10 V≃ 10 μGy)</td><td>OFF</td><td>OFF</td><td>ON</td><td>OFF</td></tr>
<tr><td>2 V / μGy (10 V≃ 5 μGy)</td><td>OFF</td><td>ON</td><td>OFF</td><td>OFF</td></tr>
<tr><td>4 V / μGy (10 V≃ 2.5 μGy)</td><td>ON</td><td>OFF</td><td>OFF</td><td>OFF</td></tr>
<tr><td>OUTPUT SIGNAL</td><td colspan="5">Positive or Negative polarity of the ramp signal is selected with a switch at the Ramp Module.
The Ramp Module is a 9-pin Sub-D connector plugged to the Ion Chamber cable.
Positive polarity of the ramp signal is factory set.</td></tr>
<tr><td colspan="2">NORMAL FACTORY SELECTION: 1 V / μGy (10 V≃ 10 μGy) - Positive</td><td>OFF</td><td>OFF</td><td>ON</td><td>OFF</td></tr>
</table>

2. Set the following jumper on the AEC Control Board in position A: JP3 for Board A3012–x1/x2/x5 or JP2 for Board A3012–x6/x7/x9.

3. Set SID at the Focal Distance of the Grid to be used in the Table Receptor (usually 100 cm) or in the Vertical Stand Receptor (usually 100 cm and 150 cm or 180 cm).

4. Open the Collimator blades completely.

5. Place in the Collimator guides a Phantom of Aluminium with a purity of not less that 99% .

CAUTION

Any other Phantom material should not be used for AEC Calibration.

6. Enter in calibration mode and verify that AEC Calibration number in E04, E09, E20 and E23 Memory Locations is 70. The useful range for AEC calibration numbers is from 20 to 120. Exit from calibration mode.

7. Select on the Console:

   - A Workstation configured for the Ion Chamber to be calibrated.
   - RAD Menu: 70 kV, 100 mA and 1 second back-up time.
   - AEC Menu: “*Central Field*” , “*Density 0*” and “*Medium Film/Screen*”.

8. Make an exposure (in case of Film, without film in the cassette, but the cassette inserted in the Receptor housing) (in case of CR or DR, with the CR or DR inserted in the Receptor housing), then note the Exposure Time displayed on the Console, it should be a time between 50 ms and 300 ms. If necessary, change the mA station and make the exposure again (to reduce the time increase the mA value, and viceversa).

Note ☞

Last exposure parameters are displayed by pressing the “AEC Reset” button of the Console.

CAUTION

The exposure time must be between 50 ms and 300 ms throughout the adjustment procedure. If not, increase or decrease the mA value.

9. **For Film**, insert a cassette with the Medium Film/Screen combination used by the customer. Make an exposure, develop the film and check the Optical Density, it should be 1.0 (or the customer preference O. Density).

   For CR or DR, make an exposure with the CR or DR in the Receptor housing. It is recommended to measure the Image Gray Level or the Dose Level shown on the Acquisition Application.

Note ☞ *The Gray Level and/or Dose reference values are those established by the manufacturer of the CR or DR.*

Note ☞ *When the calibration is carried out measuring the Dose Level, in case the Dose Level is not shown on the Acquisition Application, place a Dosimeter centered on the imaging area of the Receptor (CR or DR) and with the Grid removed.*

If it is not possible due to insufficient space between the Receptor and the Ion Chamber, place the Dosimeter centered in the Receptor housing (tray) and adjust the Gain Switches or Gain Potentiometer (as described in step 10.) until obtain the optimum Dose Level specified by the manufactured of CR or DR. Note the mA and ms resultant values.

After that, remove the Dosimeter and insert the Receptor (CR or DR). Select on the Console: 70 kV, the mA value previously noted and 1 second back-up time. Make an exposure and compare the exposure time now obtained with the previously noted time, then adjust the Gain Potentiometer and repeat the exposure until the previously noted exposure time is achieved.

10. To change the Optical Density, Image Gray Level or received Dose:

    - For Ion Chamber with Gain Switches:

      – If the *Optical Density / Image Gray Level / Dose* obtained is 33% above of the desired one, increase the gain with the switches. Repeat step-9.

      – If the *Optical Density / Image Gray Level / Dose* obtained is 33% below of the desired one, decrease the gain with the switches. Repeat step-9.

      – If the *Optical Density / Image Gray Level / Dose* obtained is in between 33% of the desired one, change the AEC calibration number.

    - For Ion Chamber with Gain Potentiometer, adjust the Gain Potentiometer until the desired *Optical Density / Image Gray Level / Dose* is obtained by repeating step-9. If the adjustment is not achieved with the Gain Potentiometer, change the AEC calibration number.

Note ☞ *As an alternative to the adjustment with the Gain Switches or the Gain Potentiometer is to change the AEC calibration number. It can be done when the Gain Switches or the Gain Potentiometer is not accessible.*

11. Enter in calibration mode, set the new AEC calibration number for the respective Memory Location (E04, E09, E20 or E23). The *Optical Density / Image Gray Level / Dose* increases / decreases when the calibration number is increased / decreased. Press the "*AEC Reset*" push-button to store the new value, then exit from calibration mode and repeat step-9.

Note ☞ *The AEC accuracy is better in all the useful range as the AEC calibration number is closer to 70.*

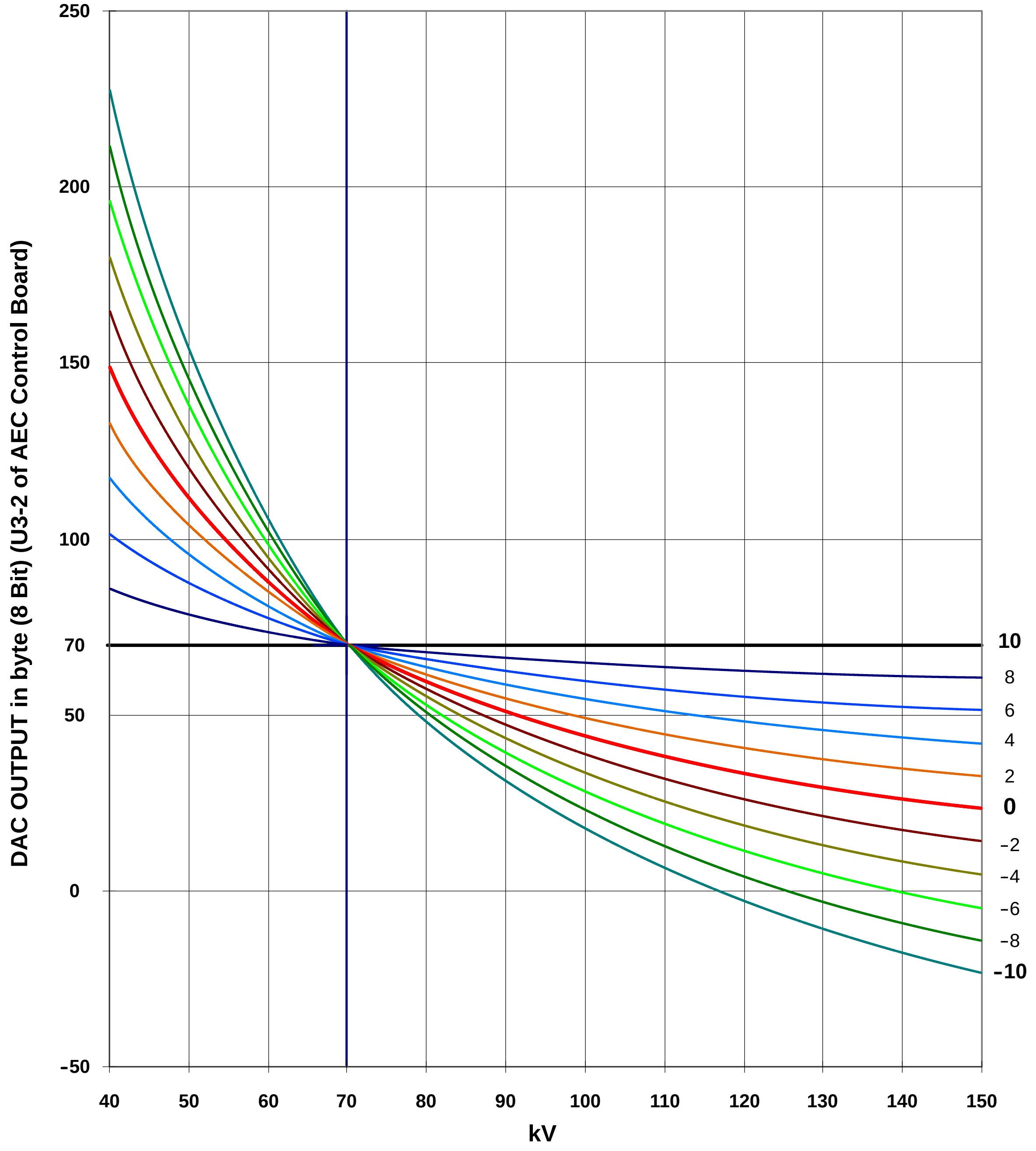
12. Repeat the above steps for all the Ion Chambers installed with the Generator.

13. Record all the values for the Memory Locations in the Data Book.

2.6.3 kV COMPENSATION

To maintain constant Optical Density (for Film) or Image Gray Level (for CR or DR) regardless of the kV at which a Film, CR or DR is exposed, the Generator provides kV compensation. (*Refer to Illustration 2-4*).

Illustration 2-4
AEC kV Tracking Curve



Perform the following steps to determine whether or not AEC kV Tracking of Optical Density / Image Gray Level must be adjusted.

1. Enter in calibration mode and verify that AEC Tracking number in E08, E10 and E24 Memory Locations is “0”. Exit from calibration mode.

2. Select on the Console:

   - A Workstation configured for the Ion Chamber to be calibrated.

   - RAD Menu: 55 kV, 100 mA and 1 second back-up time (or the mA and ms values obtained for the Gain adjustment)

   - AEC Menu: “*Central Field*” , “*Density 0*” and “*Medium Film/Screen*”.

3. Make an exposure (in case of Film, without film in the cassette, but the cassette inserted in the Receptor housing) (in case of CR or DR, with the CR or DR inserted in the Receptor housing) and check that the Exposure Time is between 50 ms and 300 ms. If necessary, change the mA value and make the exposure again. Take note of the final mA station selected for 55 kV.

4. Select 90 kV. Make an exposure (in case of Film, without film in the cassette, but the cassette inserted in the Receptor housing) (in case of CR or DR, with the CR or DR inserted in the Receptor housing) and check that the Exposure Time is between 50 ms and 300 ms. If necessary, change the mA value and make the exposure again. Take note of the final mA station selected for 90 kV.

5. **For Film**, insert a cassette with the Medium Film/Screen combination used by the customer. Make an exposure at 55 kV and 90 kV *(use the selected mA station noted before for each kV)*, develop the film and measure the Optical Density obtained with those exposures. Check that the variation range is the same ±0.2 of the Optical Density obtained before at 70 kV (*Optical Density / Image Gray Level Adjustment – Section 2.6.2*).

   For CR or DR, make an exposure with the CR or DR in the Receptor housing. Make an exposure at 55 kV and 90 kV *(use the selected mA station noted before for each kV)*, note the Image Gray Level obtained with those exposures. Check that the variation range is the same ±20% of Image Gray Level obtained before at 70 kV (*Optical Density / Image Gray Level Adjustment – Section 2.6.2*).

6. If the variation value is not ±0.2 of the Optical Density (for Film) or ±20% of Image Gray Level / Dose Level (for CR or DR) calculate the new value for the AEC Tracking number in each Memory Location as follows:

   - If the Optical Density / Image Gray Level at 55 kV has to be decreased and the Optical Density / Image Gray Level at 90 kV has to be increased then **increase the Tracking value in one**.
   - If the Optical Density / Image Gray Level at 55 kV has to be increased and the Optical Density / Image Gray Level at 90 kV has to be decreased then **decrease the Tracking value in one**.

Note ☞ *A Tracking value of 10 will have no effect on AEC kV compensation.*

   a. Enter in calibration mode, select the respective Memory Location (E08, E10 or E24).

   b. Values for AEC Tracking range is from –10 to +10. Determine the correct value for the needed AEC Tracking change.

AEC-kV TRACKING CURVE	+10	+9	+8	+7	+6	+5	+4	+3	+2	+1	**0**	–1	–2	–3	–4	–5	–6	–7	–8	–9	–10
VALUE TO ENTER IN THE MEMORY LOCATION	10	9	8	7	6	5	4	3	2	1	**0**	255	254	253	252	251	250	249	248	247	246

   c. Press the "*AEC Reset*" push-button to store the new value, then exit from calibration mode.

   d. Repeat this process from step-5. until the desired compensation of the Optical Density / Image Gray Level is obtained.

7. Repeat the above steps for all the Ion Chambers installed with the Generator.

8. Record all the values for the Memory Locations in the Data Book.

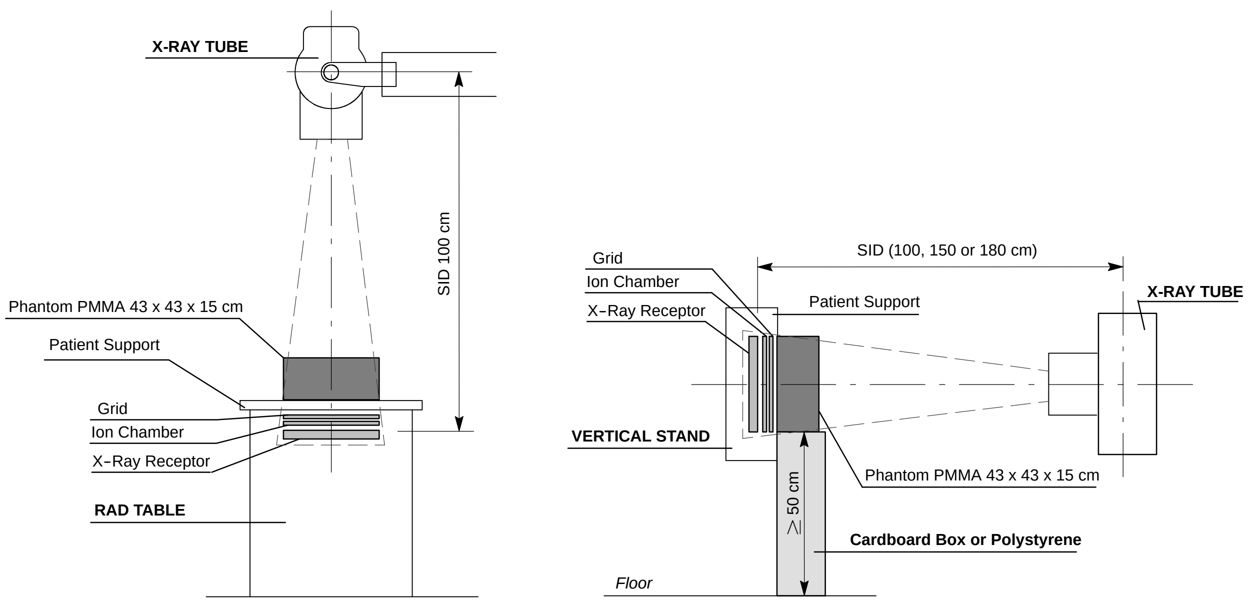
Note ☞ *Once the Gain Adjustment and kV Compensation procedures are finished, remove from the Collimator guides the Phantom of Aluminium.*

2.6.4 BALANCE ADJUSTMENT / CHECKING FOR THREE FIELD DETECTORS

Note ☞ *Some Ion Chambers does not provide balance potentiometers for Three Field Detectors. In that case, this procedure can be used to check that the Balance adjustment from factory is correct.*

Note ☞ *This checking is carried out using a homogeneous Phantom of PMMA (Polymethylmethacrylate) with a surface of 43 x 43 cm and a thickness of 15 cm so that the Three Field Detectors of the Ion Chamber receive the same amount of scattered radiation. As an alternative to the Phantom of PMMA, the Phantom of Aluminum used for AEC Calibration and placed on the Collimator guides can be used, but it is recommended to use the Phantom of PMMA.*

1. Set SID at the Focal Distance of the Grid to be used in the Table Receptor (usually 100 cm) or in the Vertical Stand Receptor (usually 100 cm, 150 cm and/or 180 cm). Place the Phantom as shown in the next illustration. In the case of the Table, the Tabletop must be completely centered.



2. If it is present, remove from the Collimator guides the Phantom of Aluminium used for the previous procedures.

3. Open the Collimator blades up to cover the base of the Phantom.

4. Select on the Console:

   - A Workstation configured for the Ion Chamber to be calibrated.
   - RAD Menu: 70 kV, 100 mA and 1 second back-up time.
   - AEC Menu: "*Central Field*" , "*Density 0*" and "*Medium Film/Screen*".

5. Make the following sequence of exposures (in case of Film, without film in the cassette, but the cassette inserted in the Receptor housing) (in case of CR or DR, with the CR or DR inserted in the Receptor housing) and check that the Exposure Time is between 50 ms and 300 ms. If necessary, change the mA value and make the exposure again. Take note of the final mA station selected for each exposure with the Grid removed and with the Grid inserted/installed.

Note ☞ *If the Grid can not be removed from the Receptor housing, perform only the exposures with the Grid installed.*

Note ☞ *The "Actual Exposure Parameters" area shows the last exposure parameters when: exposure is finished by the AEC, exposure is aborted by releasing the exposure control, or after pressing the "Reset Error" button.*

The sequence of exposures are:

- 3 exposures with the Grid removed and the "*Left Field*" of the Ion Chamber selected.
- 3 exposures with the Grid removed and the "*Center Field*" of the Ion Chamber selected.
- 3 exposures with the Grid removed and the "*Right Field*" of the Ion Chamber selected.
- 3 exposures with the Grid inserted / installed and the "*Left Field*" of the Ion Chamber selected.
- 3 exposures with the Grid inserted / installed and the "*Center Field*" of the Ion Chamber selected.
- 3 exposures with the Grid inserted / installed and the "*Right Field*" of the Ion Chamber selected.

Note in Table 2-2 the Exposure Time or the Image Gray Level obtained in each exposure, and the final mA value selected.

Table 2-2
Exposures for Balance Adjustment / Checking of Ion Chamber Fields

TABLE *(SID 100 cm)*	**EXPOSURES WITHOUT GRID** at 70 kV and ___ mA			**EXPOSURES WITH GRID** at 70 kV and ___ mA		
	LEFT Field	**CENTER Field**	**RIGHT Field**	**LEFT Field**	**CENTER Field**	**RIGHT Field**
Exposure #1	$t_{L1} =$	$t_{C1} =$	$t_{R1} =$	$t_{L1} =$	$t_{C1} =$	$t_{R1} =$
Exposure #2	$t_{L2} =$	$t_{C2} =$	$t_{R2} =$	$t_{L2} =$	$t_{C2} =$	$t_{R2} =$
Exposure #3	$t_{L3} =$	$t_{C3} =$	$t_{R3} =$	$t_{L3} =$	$t_{C3} =$	$t_{R3} =$
Average value of the Exposure Time	$\overline{t}_L =$	$\overline{t}_C =$	$\overline{t}_R =$	$\overline{t}_L =$	$\overline{t}_C =$	$\overline{t}_R =$

VERTICAL STAND *(SID 100 cm)*	**EXPOSURES WITHOUT GRID** at 70 kV and ___ mA			**EXPOSURES WITH GRID** at 70 kV and ___ mA		
	LEFT Field	**CENTER Field**	**RIGHT Field**	**LEFT Field**	**CENTER Field**	**RIGHT Field**
Exposure #1	$t_{L1} =$	$t_{C1} =$	$t_{R1} =$	$t_{L1} =$	$t_{C1} =$	$t_{R1} =$
Exposure #2	$t_{L2} =$	$t_{C2} =$	$t_{R2} =$	$t_{L2} =$	$t_{C2} =$	$t_{R2} =$
Exposure #3	$t_{L3} =$	$t_{C3} =$	$t_{R3} =$	$t_{L3} =$	$t_{C3} =$	$t_{R3} =$
Average value of the Exposure Time	$\overline{t}_L =$	$\overline{t}_C =$	$\overline{t}_R =$	$\overline{t}_L =$	$\overline{t}_C =$	$\overline{t}_R =$

VERTICAL STAND *(SID 150 cm or 180 cm)*	**EXPOSURES WITHOUT GRID** at 70 kV and ___ mA			**EXPOSURES WITH GRID** at 70 kV and ___ mA		
	LEFT Field	**CENTER Field**	**RIGHT Field**	**LEFT Field**	**CENTER Field**	**RIGHT Field**
Exposure #1	$t_{L1} =$	$t_{C1} =$	$t_{R1} =$	$t_{L1} =$	$t_{C1} =$	$t_{R1} =$
Exposure #2	$t_{L2} =$	$t_{C2} =$	$t_{R2} =$	$t_{L2} =$	$t_{C2} =$	$t_{R2} =$
Exposure #3	$t_{L3} =$	$t_{C3} =$	$t_{R3} =$	$t_{L3} =$	$t_{C3} =$	$t_{R3} =$
Average value of the Exposure Time	$\overline{t}_L =$	$\overline{t}_C =$	$\overline{t}_R =$	$\overline{t}_L =$	$\overline{t}_C =$	$\overline{t}_R =$

6. Calculate the average exposure time value of the 3 exposures in each Field, without and with Grid in the Receptor housing.
   Note the values in the Table 2-2.

$$\text{Average Value} = \overline{t_x} = \frac{t_{x1} + t_{x2} + t_{x3}}{3}$$

7. Compare the average values of:

   - The "*Center Field*" with the "*Left Field*", without Grid.
   - The "*Center Field*" with the "*Right Field*", without Grid.
   - The "*Center Field*" with the "*Left Field*", with Grid.
   - The "*Center Field*" with the "*Right Field*", with Grid.

$$\text{\% of difference between "}\textit{Center}\text{" and "}\textit{Left}\text{" Fields} = \frac{\overline{t_L} - \overline{t_C}}{\overline{t_C}} \times 100 = \quad \%$$

$$\text{\% of difference between "}\textit{Center}\text{" and "}\textit{Right}\text{" Fields} = \frac{\overline{t_R} - \overline{t_C}}{\overline{t_C}} \times 100 = \quad \%$$

The difference of the Exposure Time values between the "*Left Field*" and "*Center Field*" and between the "*Right Field*" and "*Center Field*" must be ± 20%. If not, adjust the corresponding balance potentiometer of the Field to increase or decrease the Exposure Time. Repeat this process from step 5. until the adjustment is complete.

8. Repeat the above steps for all the Ion Chambers installed with the Generator. It is recommended to start with the Table Ion Chamber and then with the Vertical Stand Ion Chamber.

2.6.5 PHOTOMULTIPLIER RAD–AEC (DIGITAL RAD) ADJUSTMENT (OPTIONAL)

The Photomultiplier RAD–AEC (Digital RAD) adjustment can be performed in two ways: one is the value stored in E23 Memory Location and the other is the high voltage applied to the Photomultiplier Tube.

The recommended procedure for this adjustment is to store a constant value in E23 Memory Location and adjust the high voltage applied to the Photomultiplier Tube.

Note ☞ *Value in E23 Memory Location is a common data used for Photomultiplier AEC Calibration or used for the Fourth Ion Chamber Calibration (AEC-4).*

Perform the following procedure:

1. Enter in calibration mode. Select E23 Memory Location and set a value of “127”. Then exit from calibration mode and Service mode.

2. Set up a Dosimeter as close as possible to the Image Intensifier Radiation Input to measure the Entrance Image Intensifier Exposure Dose Rate. Position the Probe at the center of the primary beam with the entire active volume within the primary beam. Select the Field of View for the Image Intensifier to have 9” FOV.

   Place the Tube-Collimator Assembly at the normal SID (1 meter). Collimate the X-ray beam so it completely covers the Image Intensifier field but does not extend beyond limits of the phantom.

3. Place a homogeneous Phantom of Aluminium with a purity of not less that 99% and thickness of 21 mm in the Collimator Filter Holder.

4. Select on the Console:

   - RAD: 70 kV, 200 mA Large Focus (or the first mA station for Large Focus if 200 mA station is set for Small Focus) and 1 second back-up time.

   - AEC: “*Central Area*” , “*Density 0*” and “*Medium Film/Screen*”.

5. According to software installed on the ATP Console CPU Board:

    - for software V4Rx or V5Rx: Before "*Prep*" is activated on the Console, select the Photomultiplier (–PT SEL / –SFC signal = GND on TS3-7 Generator Cabinet) and select Digital RAD (–DSI SEL signal = GND on J13–5 ATP Console CPU Board). Hold "*Prep*" and adjust the high voltage applied to the Photomultiplier Tube with the following potentiometer on the AEC Control Board: R12 for Board A3012–x1/x2/x5 or R23 for Board A3012–x6/x7/x9; until measure –400 VDC between TS1–39 and TS1–42 (GND) in the Generator Cabinet.

    - for software V6Rx or greater: Select a Digital Workstation configured for Device = DSI. Activate "*Digital Prep*" (–DIGITAL PREP signal = GND on TS3-7 Generator Cabinet). Hold "*Digital Prep*" and adjust the high voltage applied to the Photomultiplier Tube with the following potentiometer on the AEC Control Board: R12 for Board A3012–x1/x2/x5 or R23 for Board A3012–x6/x7/x9; until measure –400 VDC between TS1–39 and TS1–42 (GND) in the Generator Cabinet.

6. The Dose is affected in the following manner:

    - Increases when the high voltage applied to the Photomultiplier Tube is decreased. (*Example: if 100 μR Dose is obtained with –400 VDC, 200 μR Dose may be obtained decreasing the high voltage to –300 VDC*).

    - Decreases when the high voltage applied to the Photomultiplier Tube is increased. (*Example: if 100 μR Dose is obtained with –400 VDC, 50 μR Dose may be obtained increasing the high voltage to –450 VDC*).

7. Make an exposure and adjust the following potentiometer on the AEC Control Board: R12 for Board A3012–x1/x2/x5 or R23 on for Board A3012–x6/x7/x9; until getting a typical Dose around 100 μR per frame (*at 9" FOV*) (*for more information refer to the Image System documentation*).

Note ☞ *If the photo tube voltage required is too low, decrease the AEC calibration number in the E23 Memory Location and repeat the process.*

8. Record the E23 Memory Location in the Data Book.

2.6.6 AEC OPTICAL DENSITY SCALE

AEC is calibrated with "*Density 0*" selected (Normal Optical Density). The Optical Density can be increased or decreased in several steps.

The variation percentage of the density scale is factory set at 25%. This variation can be set according to the customer preferences by changing the value stored in E12 Memory Location. This value applies to both tubes.

Depending on the Console model, the range of the scale is "from −2 to +2" or "from −4 to +4" (optional).

The following tables show some examples for the variation percentage of the density scale with reference to the value stored in E12 Memory Location.

E12 VALUE	**DENSITY SCALE FROM −2 TO +2 . VARIATION OVER NORMAL OPTICAL DENSITY (N)**				
	−2	**−1**	**0**	**+1**	**+2**
5	N x 0.90	N x 0.95	**N**	N x 1.05	N x 1.10
10	N x 0.80	N x 0.90	**N**	N x 1.10	N x 1.20
25	N x 0.50	N x 0.75	**N**	N x 1.25	N x 1.50
NOTE: If the value stored in E12 Memory Location is 0, 25 or 255, the variation percentage is 25%.					

E12 VALUE	**DENSITY SCALE FROM −4 TO +4 (*OPTIONAL*) . VARIATION OVER NORMAL OPTICAL DENSITY (N)**								
	−4	**−3**	**−2**	**−1**	**0**	**+1**	**+2**	**+3**	**+4**
5	N x 0.82	N x 0.86	N x 0.91	N x 0.95	**N**	N x 1.05	N x 1.10	N x 1.16	N x 1.22
10	N x 0.68	N x 0.75	N x 0.83	N x 0.91	**N**	N x 1.10	N x 1.21	N x 1.33	N x 1.46
25	N x 0.41	N x 0.51	N x 0.64	N x 0.80	**N**	N x 1.25	N x 1.56	N x 1.95	N x 2.44
NOTE: With scale from "−4 to +4" the useful range for the value stored in E12 Memory Location is from 1 to 25 .									

Record the value for E12 Memory Location in the Data Book.

2.7 FLUORO CALIBRATION

This generator uses Pulsed Fluoro at fixed or variable rate. This technique is a series of short exposures at the TV frame rate (fixed rate) or at the selected PPS (variable rate).

Fluoro exposures are controlled by kV with a constant filament current. The kV values are manually (Manual mode) or automatically (ABC mode) adjusted to obtain the desired brightness (entrance dose rate) on the Image Intensifier.

The Fluoro calibration consists of setting values in the corresponding Extended Memory Locations for Fluoro use. The following table indicates the relationship between Fluoro and Extended Memory Locations.

FUNCTION	MEMORY LOCATIONS
Fluoro Filament Setting	E17
Maximum Fluoro kV	E19
Fluoro mA Display Calibration at 50 kV	E25
Fluoro mA Display Calibration at 80 kV	E26
Fluoro mA Display Calibration at 120 kV	E27

The functions of these extended Memory Locations are:

- E17 is used to store data that controls the Maximum Skin Dose Radiation at the following maximum levels (Regulation limits) (1 Rad = 8.7 mGy).
  - 5 R/min (43.5 mGy/min) for systems working with Manual mode (Non-ABC).
  - 10 R/min (87 mGy/min) for systems working with Automatic mode (ABC).

  Note that in practice, the rejection limits for entrance exposure rate must be somewhat less than the maximum specified due to Dosimeter calibration accuracy. (*Refer to Table 2-3.*)

Table 2-3
Rejection Limits Based on Meter Calibration Accuracy

METER CALIBRATION ACCURACY	REJECTIONS LIMITS	
	FOR 5 R/min (43.5 mGy/min) MAXIMUM	FOR 10 R/min (87 mGy/min) MAXIMUM
±5%	4.75 R/min (41.3 mGy/min)	9.5 R/min (82.7 mGy/min)
±10%	4.50 R/min (39.2 mGy/min)	9.0 R/min (78.3 mGy/min)
±15%	4.25 R/min (37 mGy/min)	8.5 R/min (74 mGy/min)

- E19 is used to set maximum Fluoro kV. This value is determined by the type of TV camera and type of images desired. For general fluoroscopic use with a conventional TV system, 120 kV is recommended. A lower maximum setting will produce more contrast on the TV system but less penetration for large patients.

- E25, E26, E27 are used to calibrate the Fluoro mA Display. These values will be shown on the Fluoro mA Display during Fluoro exposures whenever maximum PPS are selected.

Note ☞

The Fluoro mA Display values entered into the Extended Memory Locations E25, E26 and E27 are also used to calculate Heat Units. It is important to enter accurate values.

Fluoro functions are calibrated by performing the following steps:

1. Turn the generator ON.

CAUTION

Make sure that the Small Filament of the X-ray tube is properly warmed-up (at less 15 minutes).

2. Set up a Dosimeter to measure the Maximum Entrance Skin Exposure Dose Rate. Position the Probe at the center of the primary beam with the entire active volume within the primary beam.

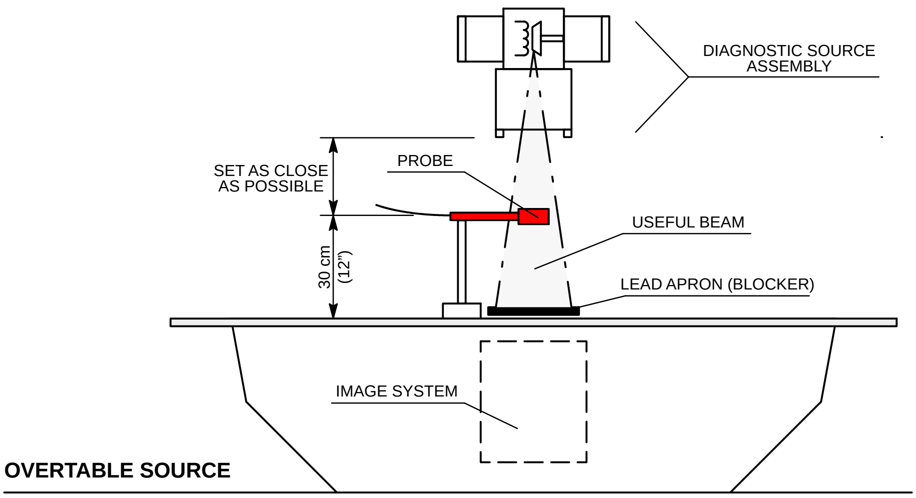
   Place the Tube-Collimator Assembly as close as possible to the Table-Top, fully open the Collimator Blades and align the Image Intensifier with the light beam. Block radiation input to Image Intensifier with a Lead Apron. (*Refer to Illustration 2-5*).

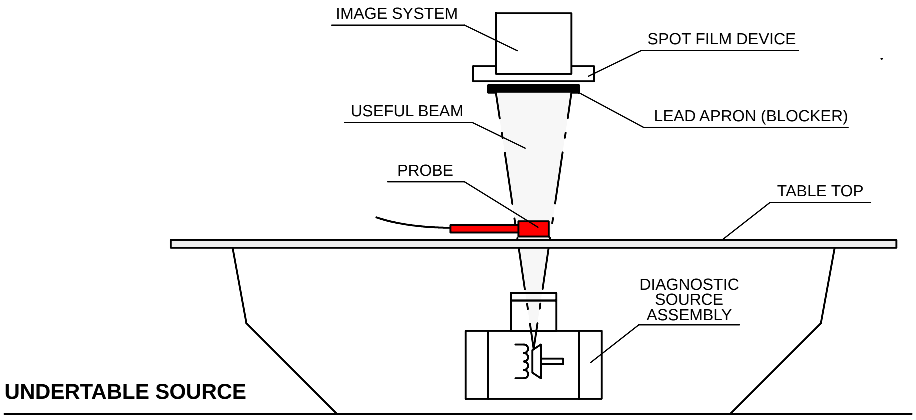
3. Enter in Calibration mode and read the Filament Number at 120 kV / 10 mA. Divide this value by four (4) and enter it as starting value for E17 Memory Location (Fluoro Filament Setting).

4. Select E19 Memory Location and set the maximum Fluoro kV at120 kV or more if it is possible.

5. Exit calibration mode.

Illustration 2-5
Fluoro Entrance Exposure Rate Test Set-up





6. Select the maximum PPS and Non-ABC mode. Make a Fluoro exposure at maximum kV that will be used in the system and measure the dose applied, it should not be over the Rejection Limits for 10 R/min (87 mGy/min) or 5 R/min (43.5 mGy/min) (*refer to Table 2-3.*).

   In case that the value is not acquired, change the Fluoro Filament Setting stored in E17 as required until it is correctly calibrated to that dose. Be in mind that radiation increases or decreases in accordance to value in E17 is increased or decreased.

7. The mA values displayed during Fluoro exposures are stored in E25, E26 and E27 Memory Locations. The method used to obtain the Fluoro mA values is to measure the average mA using a mA meter in Fluoro.

   During Fluoro exposure, mA values are read directly with a mA Meter in DC connected to the mA Test Points (banana plug connections) on the HV Transformer. Only for this purpose, remove the link between the banana plug connections on the HV Transformer.

   Select the maximum PPS and Non-ABC mode. Make the following Fluoro exposures:

   - Make a Fluoro exposure at 50 kV and take note below the mA reading, this value will be used as Fluoro mA at minimum kV (E25).
   - Make a Fluoro exposure at 80 kV and take note below the mA reading, this value will be used as Fluoro mA at medium kV (E26).
   - Make a Fluoro exposure at 120 kV and take note below the mA reading, this value will be used as Fluoro mA at maximum kV (E27).

FL mA value at 50 kV (E25)	FL mA value at 80 kV (E26)	FL mA value at 120 kV (E27)

8. Remove the Dosimeter and the Lead Apron (Blocker).
9. Enter in Calibration mode.
10. Select E19 Memory Location if it is required to reduce the value for the maximum Fluoro kV in the installation.
11. Select the E25, E26 and E27 Memory Locations and store the respective mA values noted before multiplied by **10** (a.e. if the mA value noted is “3.2”, store the value “32” in the respective Memory Location).
12. Record the new values in the Data Book.
13. Exit calibration mode.

2.8 ABC CALIBRATION

The purpose of the ABC System is to maintain an optimum constant Image Tube Output Brightness by controlling the X-ray kV during Fluoro exams, regardless of changes in the patient opacity viewed on the TV monitor.

The closed-loop ABC System can monitor the Image Tube Output Brightness through two ways: Photomultiplier Tube or TV Camera.

2.8.1 ABC SYSTEM WITH PHOTOMULTIPLIER TUBE

Note ☞ *This operation requires the AEC Control Board A3012-x6/x7/x9 (Digital version).*

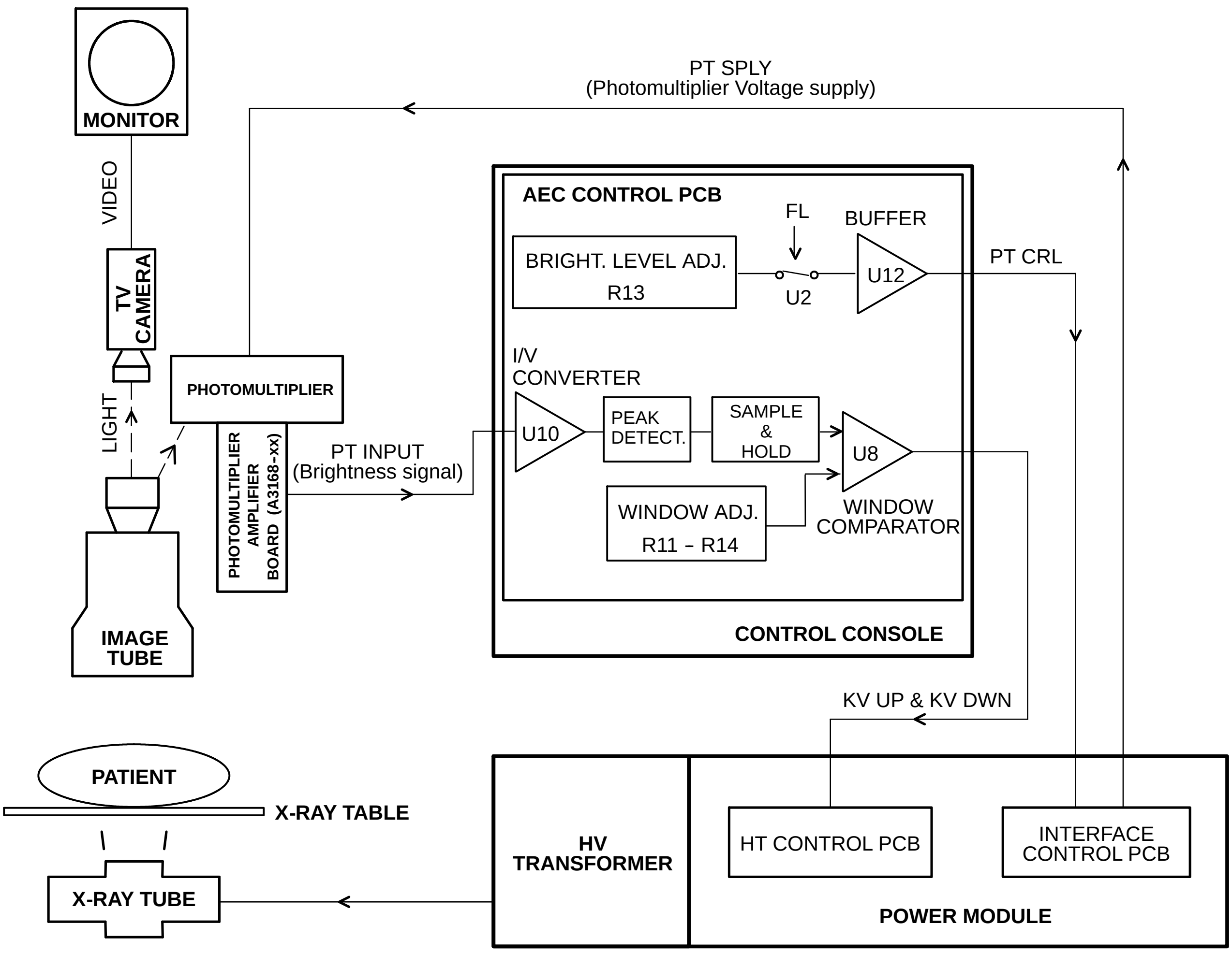
On this system the Photomultiplier current signal, which is proportional to the Image Tube Output Brightness, is used as brightness signal "*PT Input*" for the ABC circuitry of the Generator. (*Refer to Illustration 2-6*).

This analogic signal is converted to a voltage signal in the Photomultiplier Amplifier Board and sent to a peak-detector in the AEC Control Board. The peak signal obtained is then held through a "*Sample and Hold*" circuitry after a synchronism pulse. The peak signal held is adapted to obtain finally the "*ABC IN*" signal which is so the Photomultiplier signal-peak held between synchronism pulses. This signal is then compared to a window reference.

Brightness error at the comparator output is sent as "*kV Up*" and "*kV Down*" to the Generator where is used to drive the Fluoro kV control. The closed-loop operation requires more or less brightness thru "*kV Up*" and "*kV Down*" demand signals respectively. Patient Entrance Dose is automatically varied so that optimum constant Image Tube Output Brightness is maintained.

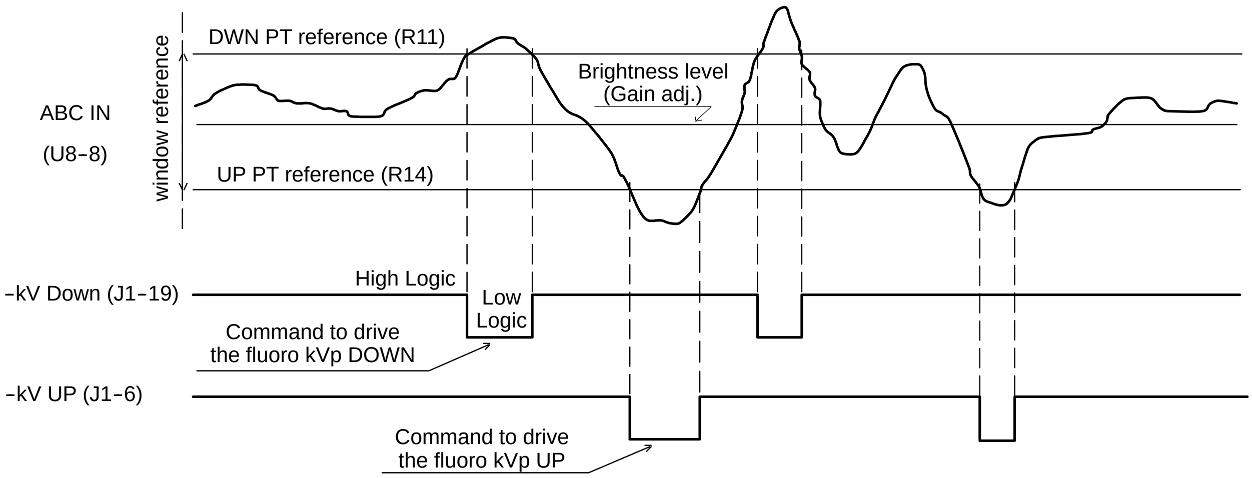
The optimum brightness level in ABC mode is set by adjusting Brightness Control Resistor R13 on the AEC Control Board, which controls the output of the Photomultiplier Tube High Voltage power supply on the Interface Control Board (“*PT CRL*” plus 5 volts programs the output to be 0 volts, and 0 volts programs the output to approximately −1200 volts). The window comparator requires an input range from 0 to +10 VDC for the “*ABC IN*” (the optimum brightness level will be achieved with a value between 5 and 7 VDC).

Illustration 2-6
ABC System for Photomultiplier Tube



Window reference could be adjusted first to set mid-way the brightness level (+5 VDC), and second to increase or decrease the range of response and sensitivity of the kV control to input variations (brightness changes). If oscillation occurs during ABC fluoro exposure, increase the dead zone by adjusting Resistors R11 and R14 on the AEC Control Board. (*Refer to Illustration 2-7 for ABC waveforms*).

Illustration 2-7
ABC Waveforms in AEC Control Board



Adjust the ABC system for Photomultiplier Tube as follow:

1. Be sure that the Video System and the Image Intensifier are powered and operating correctly.

2. Set up a Dosimeter as close as possible to the Image Intensifier Radiation Input to measure the Entrance Image Intensifier Exposure Dose Rate. Position the Probe at the center of the primary beam with the entire active volume within the primary beam.

   Place the Tube-Collimator Assembly at the normal SID (1 meter), fully open the Collimator Blades and align the Image Intensifier with the light beam.

3. Adjust TV Camera gain for 1 volt peak-to-peak composite video output.

4. Select the maximum PPS and Non-ABC mode.

5. Place 2 mm of Copper (or equivalent homogeneous phantom) in the Collimator Filter Holder.

6. Calculate the value of the optimum radiation (that will give optimum brightness) usually is 2μR/frame at 9” FOV (*for more information refer to Image System documentation*).

   Examples:
   For 25 frame/second optimum radiation is 3 mR/min.
   2 μR/frame x 25 frame/s = 50 μR/s.
   50 μR/s x 60 s/min = 3000 μR/min = 3 mR/min.
   For 30 frame/second optimum radiation is 3.6 mR/min.
   2 μR/frame x 30 frame/s = 60 μR/s.
   60 μR/s x 60 s/min = 3600 μR/min = 3.6 mR/min.

   The optimum radiation value should be measured at Image Intensifier Radiation Input. Intensifier grid should be removed, if it can not be removed, this value should be multiplied by two or by the value specified as Grid Absorption Factor.

7. Make a Fluoro exposure at 70 kV and measure the radiation. Optimum radiation is obtained by modifying the Fluoro kV or the Copper thickness in the Collimator Filter Holder. First modify the Fluoro kV, if it is more than 80 kV or less than 60 kV modify the Copper thickness in 0.1 mm (or 0.2 mm). Note the value of Fluoro KV and Copper thickness used to obtain the optimum radiation.

Note ☞ *Radiation increases when kV is increased or Copper thickness is reduced.*

8. Perform the following adjustments in the AEC Control Board:

   a. Adjust R13 in order to obtain 6 VDC on TP3 (ABC IN).

   b. Select 70 kV (or the kV obtained in step-7.) and increase 2 kV and check the increased value of voltage in TP3 (ABC-IN) (if this value has not been increased, increase 1 kV more). Note this value **(consider it as KV-DOWN-SEL)**.

   c. Select 70 kV (or the kV obtained in step-7.) and decrease 2 kV and check the decreased value of voltage in TP3 (ABC-IN) (if this value has not been decreased, decrease 1 kV more). Note this value **(consider it as KV-UP-SEL)**.

   d. Obtain in TP1 the same voltage noted as kV-DOWN-SEL (DOWN PT) by adjusting the Potentiometer R11.

   e. Obtain in TP2 the same voltage noted as kV-UP-SEL (UP PT) by adjusting the Potentiometer R14.

9. Select 70 kV (or the kV obtained in step-7.) and ABC mode.

10. Make a Fluoro exposure and check that the kV does not change.

11. Stop the Fluoro exposure and select 40 kV. Make a Fluoro exposure and check that the kV value goes to 70 kV (or the kV obtained in step-7.) ±2 kV without System problems.

12. Stop the Fluoro exposure and select 100 kV. Make a Fluoro exposure and check that the kV value goes to 70 kV (or the kV obtained in step-7.) ±2 kV without System problems.

2.8.2 ABC SYSTEM WITH TV CAMERA

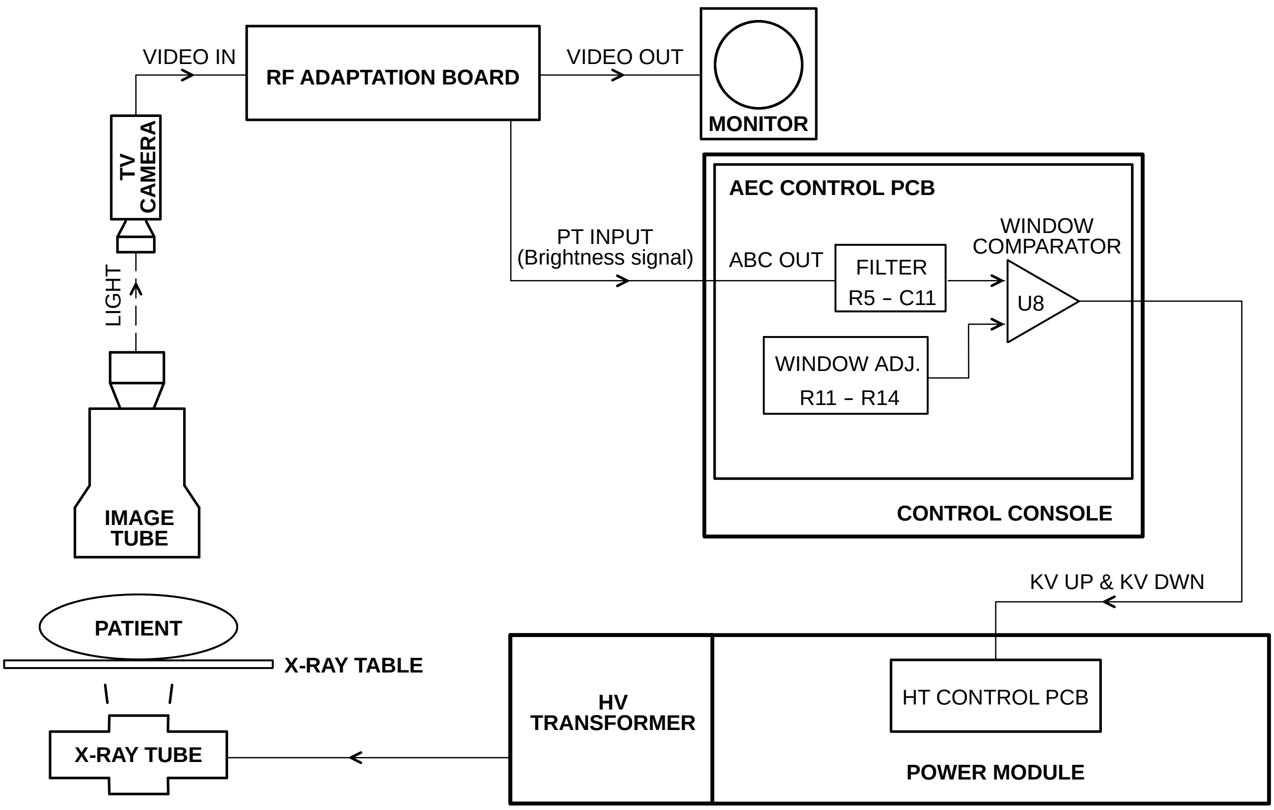
The ABC can be performed with an Analogic Signal Output (*ABC OUT*) proportional to the brightness or with the Composite Video Signal Output from the TV Camera.

The “*ABC OUT*” signal from the TV Camera is compatible with the Generator when the range is from 0 VDC (dark image) to 10 VDC (bright image) and the Optimum Brightness is achieved at around 6 VDC.

When a TV Camera without a direct “*ABC OUT*” signal is used, the Composite Video signal (which amplitude is proportional to the image tube output brightness) is sent to an RF Adaptation Board where it is transformed into an “*ABC OUT*” analogic signal. In this case, the brightness level is taken from a rectangular window from the center of the raster. (*Refer to Illustration 2-8*).

This analogic signal in the AEC Control Board (*“PT Input” in Board A3012-x1/x2/x5 and “ABC OUT” in Board A3012-x6/x7/x9*) is filtered, and compared to a window reference. Brightness error at the comparator output is sent as “*kV Up*” and “*kV Down*” to the Generator where is used to drive the fluoro kV control. The closed-loop operation requires more or less brightness thru “*kV Up*” and “*kV Down*” demand signals respectively. Patient entrance dose is automatically varied so that constant image tube output brightness is maintained.

Illustration 2-8
ABC System for TV Camera

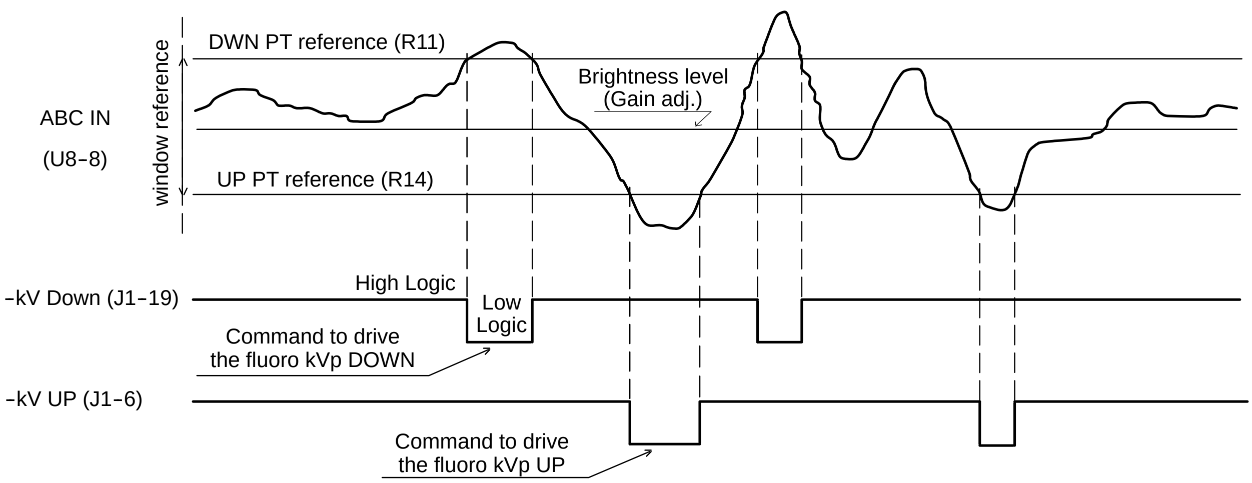


The optimum brightness level in ABC mode is set by adjusting the gain at R27 on the RF Adaptation Board. The "*ABC OUT*" signal requires an input range from 0 to +10 VDC (the stabilized value will be between 5 and 7 VDC).

Window reference could be adjusted first to set mid-way the brightness level (+6 VDC), and second to increase or decrease the range of response and sensitivity of the kV control to input variations (brightness changes). If oscillation occurs during ABC fluoro exposure, increase the dead zone by adjusting R11 and R14 on the AEC Control Board. (*Refer to Illustration 2-9 for ABC waveforms*)

For system interface, refer to RF Adaptation Board. Adjust ABC System according to the following procedures.

Illustration 2-9
ABC Waveforms in AEC Control Board



2.8.2.1 ABC SYSTEM ADJUSTMENT WITH ABC SIGNAL FROM TV CAMERA COMPATIBLE WITH THE GENERATOR

1. Be sure that the Video System and the Image Intensifier are powered and operating correctly.

2. Set up a Dosimeter as close as possible to the Image Intensifier Radiation Input to measure the Entrance Image Intensifier Exposure Dose Rate. Position the Probe at the center of the primary beam with the entire active volume within the primary beam.

   Place the Tube-Collimator Assembly at the normal SID (1 meter), fully open the Collimator Blades and align the Image Intensifier with the light beam.

3. Adjust TV Camera gain for 1 volt peak-to-peak composite video output.

4. Set Jumper JP21 in position B on the RF Adaptation Board.

5. Select the maximum PPS and Non-ABC mode.

6. Place 2 mm of Copper (or equivalent homogeneous phantom) in the Collimator Filter Holder.

7. Calculate the value of the optimum radiation (that will give optimum brightness) usually is 2μR/frame at 9” FOV (*for more information refer to Image System documentation*).

   Examples:

   For 25 frame/second optimum radiation is 3 mR/min.
   2 μR/frame x 25 frame/s = 50 μR/s.
   50 μR/s x 60 s/min = 3000 μR/min = 3 mR/min.

   For 30 frame/second optimum radiation is 3.6 mR/min.
   2 μR/frame x 30 frame/s = 60 μR/s.
   60 μR/s x 60 s/min = 3600 μR/min = 3.6 mR/min.

   The optimum radiation value should be measured at Image Intensifier Radiation Input. Intensifier grid should be removed, if it can not be removed, this value should be multiplied by two or by the value specified as Grid Absorption Factor.

8. Make a Fluoro exposure at 70 kV and measure the radiation. Optimum radiation is obtained by modifying the Fluoro kV or the Copper thickness in the Collimator Filter Holder. First modify the Fluoro kV, if it is more than 80 kV or less than 60 kV modify the Copper thickness in 0.1 mm (or 0.2 mm). Note the value of Fluoro KV and Copper thickness used to obtain the optimum radiation.

Note ☞ *Radiation increases when kV is increased or Copper thickness is reduced.*

9. Perform the adjustment for the window test as specified on the TV Camera manuals. This window defines the area of the image where the brightness will be captured for the ABC and it should be the 25% of the image area.

10. Adjust the TV Camera to obtain +6 VDC (or the voltage supplied by the TV Camera as optimum brightness) on TP3 (ABC IN) on the AEC Control Board (Refer the TV Camera manuals).

11. Perform the following adjustments in the AEC Control Board:

    a. Select 70 kV (or the kV obtained in step-8.) and increase 2 kV and check the increased value of voltage in TP3 (ABC-IN) (if this value has not been increased, increase 1 kV more). Note this value **(consider it as KV-DOWN-SEL)**.

    b. Select 70 kV (or the kV obtained in step-8.) and decrease 2 kV and check the decreased value of voltage in TP3 (ABC-IN) (if this value has not been decreased, decrease 1 kV more). Note this value **(consider it as KV-UP-SEL)**.

    c. Obtain in TP1 the same voltage noted as kV-DOWN-SEL (DOWN PT) by adjusting the Potentiometer R11.

    d. Obtain in TP2 the same voltage noted as kV-UP-SEL (UP PT) by adjusting the Potentiometer R14.

12. Select the 70 kV (or the kV obtained in step-8.) and ABC mode.

13. Make a Fluoro exposure and check that the kV does not change.

14. Stop the Fluoro exposure and select 40 kV. Make a Fluoro exposure and check that the kV value goes to 70 kV (or the kV obtained in step-8.) ±2 kV without System problems.

15. Stop the Fluoro exposure and select 100 kV. Make a Fluoro exposure and check that the kV value goes to 70 kV (or the kV obtained in step-8.) ±2 kV without System problems.

2.8.2.2 ABC SYSTEM ADJUSTMENT WITH ABC SIGNAL FROM TV CAMERA NOT COMPATIBLE WITH THE GENERATOR

1. Be sure that the Video System and the Image Intensifier are powered and operating correctly.

2. Set up a Dosimeter as close as possible to the Image Intensifier Radiation Input to measure the Entrance Image Intensifier Exposure Dose Rate. Position the Probe at the center of the primary beam with the entire active volume within the primary beam.

   Place the Tube-Collimator Assembly at the normal SID (1 meter), fully open the Collimator Blades and align the Image Intensifier with the light beam.

3. Adjust TV Camera gain for 1 volt peak-to-peak composite video output.

4. Set on the RF Adaptation Board, Jumpers JP21 in position “A” and JP20 in position “B” (for negative ABC signal) or in position “C” (for positive ABC signal).

5. Select the maximum PPS and Non-ABC mode.

6. Place 2 mm of Copper (or equivalent homogeneous phantom) in the Collimator Filter Holder.

7. Calculate the value of the optimum radiation (that will give optimum brightness) usually is 2μR/frame at 9” FOV (*for more information refer to Image System documentation*).

   Examples:

   For 25 frame/second optimum radiation is 3 mR/min.
   2 μR/frame x 25 frame/s = 50 μR/s.
   50 μR/s x 60 s/min = 3000 μR/min = 3 mR/min.

   For 30 frame/second optimum radiation is 3.6 mR/min.
   2 μR/frame x 30 frame/s = 60 μR/s.
   60 μR/s x 60 s/min = 3600 μR/min = 3.6 mR/min.

   The optimum radiation value should be measured at Image Intensifier Radiation Input. Intensifier grid should be removed, if it can not be removed, this value should be multiplied by two or by the value specified as Grid Absorption Factor.

8. Make a Fluoro exposure at 70 kV and measure the radiation. Optimum radiation is obtained by modifying the Fluoro kV or the Copper thickness in the Collimator Filter Holder. First modify the Fluoro kV, if it is more than 80 kV or less than 60 kV modify the Copper thickness in 0.1 mm (or 0.2 mm). Note the value of Fluoro KV and Copper thickness used to obtain the optimum radiation.

Note ☞ *Radiation increases when kV is increased or Copper thickness is reduced.*

9. Perform the adjustment for the window test as specified on the TV Camera manuals. This window defines the area of the image where the brightness will be captured for the ABC and it should be the 25% of the image area.

10. Select the 70 kV (or the kV obtained in step-8.) and Non-ABC mode.

11. Adjust R29 (OFFSET) on the RF Adaptation Board to have 0 VDC in TP7.

12. Adjust gain at R27 (Gain) on the RF Adaptation Board to make the “*ABC OUT*” signal equal to +6 VDC. Measure “*ABC OUT*” in TP-7 of RF Adaptation Board or in TP3 (”*ABC IN*”) of the AEC Control Board.

13. Perform the following adjustments in the AEC Control Board:

    a. Select 70 kV (or the kV obtained in step-8.) and increase 2 kV and check the increased value of voltage in TP3 (ABC-IN). Note this value **(consider it as KV-DOWN-SEL)**.

    b. Select 70 kV (or the kV obtained in step-8.) and decrease 2 kV and check the decreased value of voltage in TP3 (ABC-IN). Note this value **(consider it as KV-UP-SEL)**.

    c. Obtain in TP1 the same voltage noted as kV-DOWN-SEL (DOWN PT) by adjusting the Potentiometer R11.

    d. Obtain in TP2 the same voltage noted as kV-UP-SEL (UP PT) by adjusting the Potentiometer R14.

14. Select the 70 kV (or the kV obtained in step-8.) and ABC mode.

15. Make a Fluoro exposure and check that the kV does not change.

16. Stop the Fluoro exposure and select 40 kV. Make a Fluoro exposure and check that the kV value goes to 70 kV (or the kV obtained in step-8.) ±2 kV without System problems.

17. Stop the Fluoro exposure and select 100 kV. Make a Fluoro exposure and check that the kV value goes to 70 kV (or the kV obtained in step-8.) ±2 kV without System problems.

2.8.2.3 ABC SYSTEM ADJUSTMENT WITH NO ABC SIGNAL FROM TV CAMERA

1. Be sure that the Video System and the Image Intensifier are powered and operating correctly.

2. Set up a Dosimeter as close as possible to the Image Intensifier Radiation Input to measure the Entrance Image Intensifier Exposure Dose Rate. Position the Probe at the center of the primary beam with the entire active volume within the primary beam.

   Place the Tube-Collimator Assembly at the normal SID (1 meter), fully open the Collimator Blades and align the Image Intensifier with the light beam.

3. Adjust TV Camera gain for 1 volt peak-to-peak composite video output.

4. Set on the RF Adaptation Board, Jumpers JP21 in position “A” and JP20 in position “A”.

5. Select the maximum PPS and Non-ABC mode.

6. Place 2 mm of Copper (or equivalent homogeneous phantom) in the Collimator Filter Holder.

7. Calculate the value of the optimum radiation (that will give optimum brightness) usually is 2μR/frame at 9” FOV (*for more information refer to Image System documentation*).

   Examples:

   For 25 frame/second optimum radiation is 3 mR/min.
   2 μR/frame x 25 frame/s = 50 μR/s.
   50 μR/s x 60 s/min = 3000 μR/min = 3 mR/min.

   For 30 frame/second optimum radiation is 3.6 mR/min.
   2 μR/frame x 30 frame/s = 60 μR/s.
   60 μR/s x 60 s/min = 3600 μR/min = 3.6 mR/min.

   The optimum radiation value should be measured at Image Intensifier Radiation Input. Intensifier grid should be removed, if it can not be removed, this value should be multiplied by two or by the value specified as Grid Absorption Factor.

8. Make a Fluoro exposure at 70 kV and measure the radiation. Optimum radiation is obtained by modifying the Fluoro kV or the Copper thickness in the Collimator Filter Holder. First modify the Fluoro kV, if it is more than 80 kV or less than 60 kV modify the Copper thickness in 0.1 mm (or 0.2 mm). Note the value of Fluoro KV and Copper thickness used to obtain the optimum radiation.

Note ☞ *Radiation increases when kV is increased or Copper thickness is reduced.*

9. Perform the adjustment for the window test. This window defines the area of the image where the brightness will be captured for the ABC.

   a. Calculate the image area πr^2 (clear circle on the monitor). (r=circle radius).

   b. Calculate the 25% of the image area ($\pi r^2/4$).

   c. Calculate the sides of the window: l = $\sqrt{\pi r^2/4}$ (l= side of square).

   d. Mark the calculated area on the monitor (square).

   e. Position jumper JP18 of RF Adaptation Board in “A”. A window will be displayed on the monitor.

   f. Adjust in the RF Adaptation Board the following potentiometers to move the window under the frame marked on the monitor in step–d:

      – R1 potentiometer (vertical position)
      – R2 potentiometer (vertical width)
      – R3 potentiometer (horizontal position)
      – R4 potentiometer (horizontal width)

   g. Once the window is configured, place JP18 in “B” again at RF Adaptation Board.

10. Select the 70 kV (or the kV obtained in step-8.) and Non-ABC mode.

11. Adjust the gain at R27 on the RF Adaptation Board to make the “*ABC OUT*” signal equal to +6 VDC. Measure “*ABC OUT*” in TP7 of RF Adaptation Board or in TP3 (”*ABC IN*”) of the AEC Control Board.

12. Perform the following adjustments in the AEC Control Board:

    a. Select 70 kV (or the kV obtained in step-8.) and increase 2 kV and check the increased value of voltage in TP3 (ABC-IN) (if this value has not been increased, increase 1 kV more). Note this value **(consider it as KV-DOWN-SEL)**.

    b. Select 70 kV (or the kV obtained in step-8.) and decrease 2 kV and check the decreased value of voltage in TP3 (ABC-IN) (if this value has not been decreased, decrease 1 kV more). Note this value **(consider it as KV-UP-SEL)**.

    c. Obtain in TP1 the same voltage noted as kV-DOWN-SEL (DOWN PT) by adjusting the Potentiometer R11.

    d. Obtain in TP2 the same voltage noted as kV-UP-SEL (UP PT) by adjusting the Potentiometer R14.

13. Select the 70 kV (or the kV obtained in step-8.) and ABC mode.

14. Make a Fluoro exposure and check that the kV does not change.

15. Stop the Fluoro exposure and select 40 kV. Make a Fluoro exposure and check that the kV value goes to 70 kV (or the kV obtained in step-8.) $\pm$4 kV without System problems.

16. Stop the Fluoro exposure and select 100 kV. Make a Fluoro exposure and check that the kV value goes to 70 kV (or the kV obtained in step-8.) $\pm$4 kV without System problems.

2.9 FINAL CHECKS

Verify that all Configuration and Calibration data have been properly stored in memory.

1. Enter in calibration mode and check that the values noted for the *"Filament Current Numbers"* and *"Extended Memory Locations"* tables of the Data Book are the same that the values displayed and stored in memory. Press the "*AEC Reset*" button to read the stored values.

2. Exit from calibration mode and Service mode.

3. Turn the Generator OFF and verify position of dip switches on the HT Controller Board are:

   - Dip switch 3000SW2-2 in "***Off***" position (enables Filament and Rotor Interlocks).

   - Dip switch 3000SW2-4 in "***Off***" position (Digital mA Loop Closed).

4. Set the Test dip switch 3024SW2-3 on the ATP Console CPU Board in "***Off***" position to place the Generator in normal operating mode.

Technical Publication
CA-1054R2

Calibration

HF Series Generators

REVISION HISTORY

REVISION	DATE	REASON FOR CHANGE
0	JUN 18, 2007	First edition
1	OCT 25, 2017	Improvement of AEC Calibration procedure
2	JUN 30, 2019	References for HT Controller Board A3000-8x

This Document is the english original version, edited and supplied by the manufacturer.

The Revision state of this Document is indicated in the code number shown at the bottom of this page.

ADVISORY SYMBOLS

The following advisory symbols will be used throughout this manual. Their application and meaning are described below.

DANGERS ADVISE OF CONDITIONS OR SITUATIONS THAT IF NOT HEEDED OR AVOIDED WILL CAUSE SERIOUS PERSONAL INJURY OR DEATH.

ADVISE OF CONDITIONS OR SITUATIONS THAT IF NOT HEEDED OR AVOIDED COULD CAUSE SERIOUS PERSONAL INJURY, OR CATASTROPHIC DAMAGE OF EQUIPMENT OR DATA.

Advise of conditions or situations that if not heeded or avoided could cause personal injury or damage to equipment or data.

Note ☞

Alert readers to pertinent facts and conditions. Notes represent information that is important to know but which do not necessarily relate to possible injury or damage to equipment.

TABLE OF CONTENTS

Section **Page**

SECTION 1 INTRODUCTION

This Calibration document provides information and procedures to perform all the adjustments required to establish an optimal performance of this Generator.

Calibrate the Generator immediately after Configuration is completed.

DO NOT SUPPLY THE MAIN POWER UNTIL SPECIFICALLY INSTRUCTED TO DO SO IN THIS DOCUMENT.

THE MAIN CAPACITORS OF THE HIGH VOLTAGE INVERTER RETAIN A LARGE PORTION OF THEIR CHARGE FOR APPROX. 3 MINUTES AFTER THE UNIT IS TURNED OFF.

Calibration data is entered in digital form and stored in a non-volatile memory chip (U3-EEPROM) located on the HT Controller Board, thus no battery back-up is required.

Note ☞

Calibration procedures <u>must be</u> performed in the order listed in this document. Perform only the sections required to calibrate this unit.

1.1 GENERATOR SPECIFICATIONS

1.1.1 MINIMUM CURRENT TIME PRODUCT (mAs)

- Minimum Current Time Product obtained at 0.1 s is 1 mAs.
- Minimum Current Time Product within the specified ranges of compliance for linearity and constancy is 0.1 mAs.

1.1.2 ACCURACY OF RADIOGRAPHIC AND FLUOROSCOPIC PARAMETERS

Note ☞ *Specified accuracy does not include test equipment accuracy.*

PARAMETERS		ACCURACY (with 12 BITS HT Controller)
RAD	kV	± (3% + 1 kV)
	mA	± (4% + 1 mA)
	Exposure Time	± (2% + 0.1 ms)
FLUORO	kV	± (3% + 1 kV)
	mA	± 10%
	Exposure Time	± (1% + 20 ms)

1.1.3 HV FREQUENCY

The operating HV Frequency of this Generator is 25 kHz / 30 kHz.

1.1.4 DUTY CYCLE

The Generator duty cycle is continuous, but limits should be set during installation depending on the capacity of the X-ray tube.

SECTION 2 CALIBRATION PROCEDURES

Note ☞

Enter in GSM Program for Calibration procedures as described in the "Configuration" document.

Enter and store calibration data in the Extended Memory Locations as described in Section 2.2 of the "Configuration" document.

Record all the calibration data in the Data Book.

Before calibration, bear in mind that:

- For calibration and measure the kVp it is needed a Non-Invasive kVp Meter.
- For calibration and measure mA or mAs it is needed a mAs Meter plugged to the banana connections on the HV Transformer (connect the mAs Meter for Digital mA Loops calibration).

Note ☞

*Test points on the HT Controller Board can also be used to monitor the kV and mA readings but **should not be used** to calibrate the unit. These test points must be checked with scope:*

- mA test point is TP-5 and the scale factor is:

with HT Controller Board A3000-xx (except -44 or -85) (<1000 mA Generator)
- from 10 to 80 mA, 1 volt = 10 mA
- from 100 mA, 1 volt = 100 mA

with HT Controller Board A3000-44 or -85 (1000 mA Generator)
- from 10 to 80 mA, 1 volt = 20 mA
- from 100 mA, 1 volt = 200 mA

- kV test point is TP-7 and the scale factor is 1 volt = 33.3 kV (0.3 volt = 10 kV)

- Verify that dip switch 3024SW2-3 on the ATP Console CPU Board is in "***On***" position to permit the service mode.

- Verify position of dip switches on the HT Controller Board during every calibration procedure:

DIP SWITCH	OPEN (OFF)	CLOSED (ON)
3000SW2-2	Position during operation – Enables Filament and Rotor Interlocks	Disables Filament and Rotor Interlocks (this turns off the filament so no radiation will be produced during the exposure).
3000SW2-4	Position during operation – Digital mA Loop Closed	Digital mA Loop Open / Filament Current Constant

Note ☞ *Only for Generators with Low Speed Starter (LF-RAC) (it does not apply to Generators with High Speed Starter - LV-DRAC):*

*– When the Digital mA Loop is open (dip switch 3000SW2-4 in "**On**"), the rotor runs for two minutes after releasing the handswitch button from "Preparation" position. After this time the rotor will brake (unless DC Brake is removed).*

*– When the Digital mA Loop is closed (dip switch 3000SW2-4 in "**Off**"), the rotor will brake after releasing the handswitch button from "Preparation" position (unless DC Brake is removed).*

- Be sure that X-ray Tubes configured in E02 and E18 Memory Locations correspond to X-ray Tubes installed (*refer to Configuration document*).

2.1 FILAMENT STAND-BY CURRENT

Note ☞ *For RAD Only Generators, the Filament Stand-by value is auto-calibrated by the Generator and automatically stored into the respective Memory Locations (E01 and E17). Filament Stand-by values are not field changeable.*

2.2 EXPOSURE TIME ADJUSTMENT

The values stored in these Extended Memory Locations only affect to Exposure Times for techniques below 20 ms. The Memory Locations which affect short exposure times are:

FUNCTION	MEMORY LOCATION	
	TUBE-1	**TUBE-2**
EXPOSURE TIME ADJUSTMENT - DELAY	E13	E29
EXPOSURE TIME ADJUSTMENT - Ceq kV	E15	E31

The generator has been optimized at the factory to produce correct exposures at the lower times (<20 ms.) Therefore **do not change** the value factory set for E13 and E29 Memory Locations and only adjust the value for E15 and E31 Memory Location according to the HV Cables length.

The Exposure Time adjustment is calibrated by performing the following steps:

1. Enter in calibration mode by pressing the "*Manual Calibration*" button on the GSM Program. Select an available workstation (WS) and press the "*OK*" button.

2. Select the E13 (or E29) Memory Location. Value in this Memory Location adjusts the time delay of the exposure. It is factory set for a value of 17, 18 or 19 (*default value is "**18**"*). Only read this value, **do not change it**.

3. Select the E15 (or 31) Memory Location. Value in this Memory Location is set in relation to the length in meters of one of the HV Cables (1 ft = 0.3048 m). Verify the HV Cable length in meters and set the following value:

HV CABLE LENGTH	VALUE TO SET IN MEMORY
4 m	27
6 m	31
9 m	38
12 m	45
14 m	49
16 m	54
For another HV Cable length	value = (2.2711 x cables length) + 17.744

4. Store the value of each Memory Location by pressing the "*Store*" button of the calibration panel.

5. Exit from calibration mode and record the new values in the Data Book.

6. Repeat the above calibration process for the second tube (memory locations E29 and E31).

2.3 KV LOOP

Extended Memory Location E06 contains the calibration factor for kV Loop. Each number above or below of the indicated in the E06 memory location increases or decreases respectively the kV gain value.

Note ☞ *Value in E06 Memory Location is only related to the Generator performance (it is not related to the X-ray Tube(s) or another components installed), so value in* ***this Memory Location is factory adjusted****. Only perform this procedure if the HT Controller Board and/or HV Transformer have been replaced in the unit.*

The kV Gain for kV Loop can be manually calibrated with a Non-Invasive kV Meter (recommended procedure) or Auto-calibrated with HV Bleeder.

Manual Calibration of E06 Memory Location

1. With the Generator power OFF:

   - Set Dip switch 3000SW2-2 on the HT Controller Board in *"**Off**"* position (enables Filament and Rotor Interlocks).
   - Set Dip switch 3000SW2-4 on the HT Controller Board in *"**On**"* position (Digital mA Loop Open / Filament Current Constant).
   - Remove the link between the banana plug connections on the HV Transformer. Connect the mAs Meter to the banana plug connections to measure mA or mAs.
   - Place and center a Non-Invasive kVp Meter on the X-ray Tube output at the required SID (*refer to the Non-Invasive kVp Meter documentation*).

2. Enter in calibration mode by pressing the "*Manual Calibration*" button on the GSM Program. Select an available workstation (WS) and press the "*OK*" button.

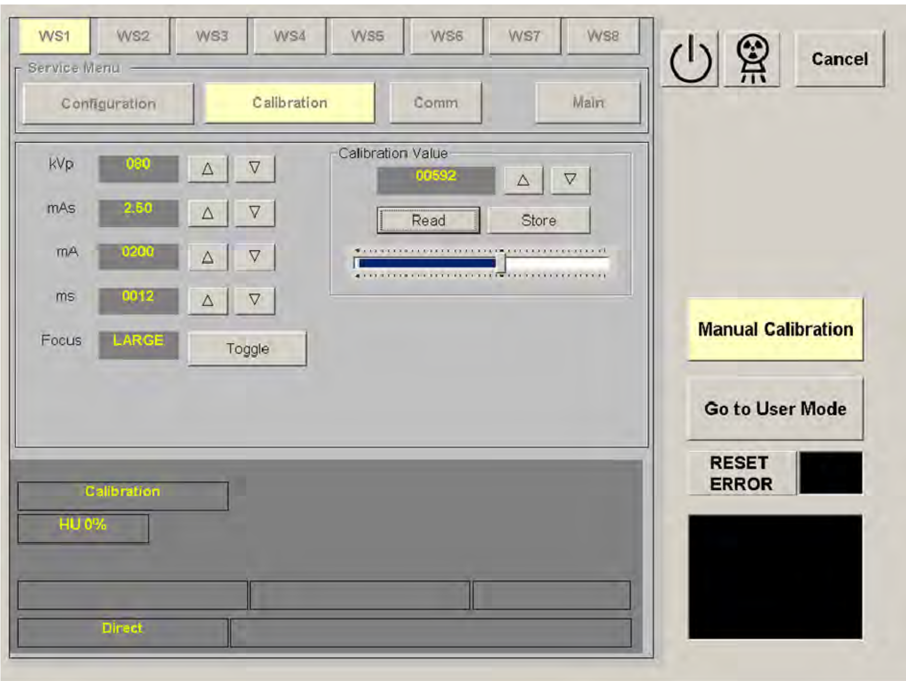
3. Select the E06 Memory Location and read the calibration value by pressing the "*Read*" button. Enter the value "***200***" and store it by pressing the "*Store*" button.

4. Calibrate manually the Filament Current Number for 80 kV / 200 mA combination, as indicated in the following steps (*if it has not been previously calibrated*).

   In calibration mode, Filament Current Numbers are shown on the calibration panel by pressing the "*Read*" button after selecting the respective kV / mA combination. They can be changed by pressing the *"Increase"* and *"Decrease"* buttons and stored by pressing the "*Store*" button of the calibration panel.

   Select 80 kV, 200 mA, Large Focus. Enter the value "*344*" as Filament Current Number (calibration value) and press the "*Store*" button. Make an exposure with these parameters. The mAs read on the mAs Meter must be the same mAs displayed on the calibration screen with a tolerance of ±0.1 mAs (tolerance of the parameter and mAs Meter).

   If the mAs is low, increase the filament number. If the mA is high (or "*Generator Overload*" Error is shown), decrease the filament number. Press the "*Store*" button before making a new exposure. Repeat until the mAs read is correct and the mA station is calibrated.



5. Enter in user mode inside calibration mode by pressing the "*Go to User Mode*" button.

6. Select: RAD Menu, 80 kV, 200 mA, 100 ms and Large Focus. Make an exposure and note the kV value at the end of the exposure.

7. If calibration of the kV Loop is correct (80 ±1 kV), record value "***200***" in the Data Book.

8. If calibration of the kV Loop is not correct:

   a. Exit from the "*User Mode*" screen by pressing the "*Manual Calibration*" button. Select the E06 Memory Location. Press the "*Read*" button to read the value stored.

   b. Increase or decrease the value to increase or decrease the kV respectively. Enter the new value and store it by pressing the "*Store*" button.

   c. Exit calibration mode and repeat the exposure (*steps 5 and 6*) to determine if the new value has had the proper effect, if not repeat step-8.

   d. When it is correct, record the new value for E06 Memory Location in the Data Book.

9. After calibration of E06 Memory Location, remove the Non-Invasive kVp Meter.

Auto-Calibration of E06 Memory Location

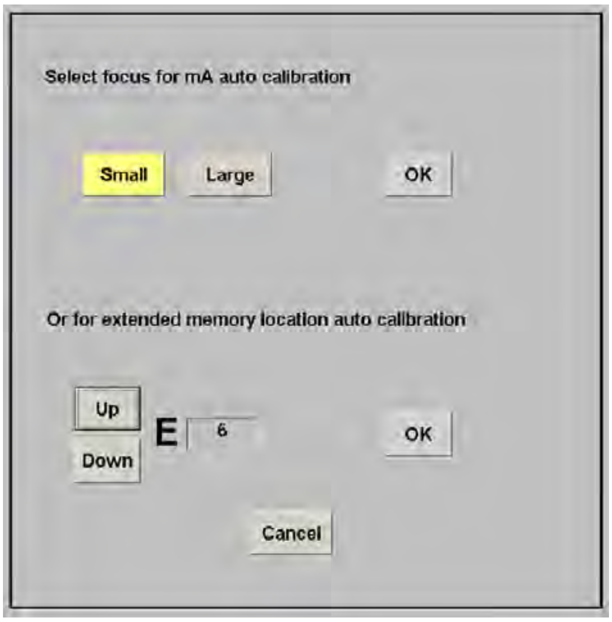
1. With the Generator power OFF:

   - Set Dip switch 3000SW2-2 on the HT Controller Board in *“**On**”* position (disables Filament and Rotor Interlocks).

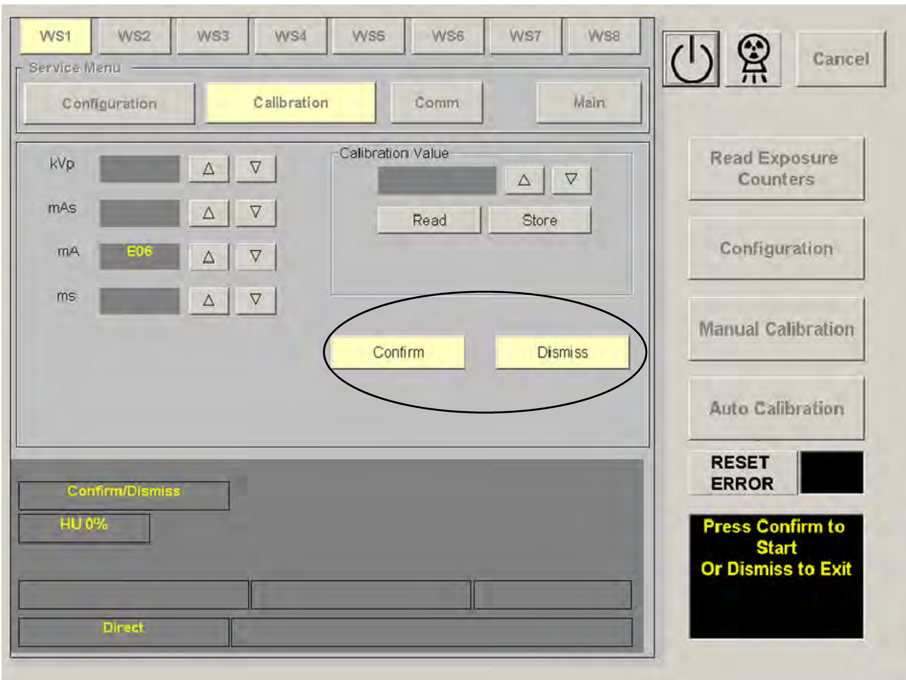
   - Remove the HV Cables from the X-ray Tube and connect them to the HV Bleeder, then connect a short couple of HV Cables from the HV Bleeder to the X-ray Tube.

2. Enter in Auto-calibration mode by pressing the “*Auto Calibration*” button on the GSM menu. Select an available workstation (WS) and press the “*OK*” button. Then, select the E06 Memory Location and press the “*OK*” button.

   Confirm or leave the Auto-calibration by pressing the respective button (“*Yes*” or “*No*”) on the new screen.



Confirm or leave the Auto-calibration (second confirmation) by pressing the respective button ("*Confirm*" or "*Dismiss*") on the calibration screen.



Auto-calibration is activated when the "*Auto Calibration*" button is lighted and the "*Press Prep and Expose*" message appears on the screen.

3. Make an exposure (technique parameters are pre-programmed at 100 kV, 200 mA and 32 ms and they can be shown when pressing the "*Prep*" button).

4. Read the kVp measured with the HV Bleeder and enter this value on the kV Display by pressing the *"kV Increase"* or *"kV Decrease"* buttons.

5. Exit from Auto-calibration mode pressing the "*Auto Calibration*" button. At this moment, the Generator will calculate and store the new value in E06 Memory Location. Auto-calibration is deactivated and the process is finished when the screen shows the GSM menu.

6. Press the "*Manual Calibration*" button. Select an available workstation (WS) and press the "*OK*" button. Then, select the E06 Memory Location and read its new value on the Calibration Display. Record this value in the Data Book.

7. Exit calibration mode.

8. After calibration of E06 Memory Location:

   - Switch the Generator power OFF.

   - Remove the HV Bleeder and connect the HV Cables from the Generator directly to the X-ray Tube.

2.4 DIGITAL mA LOOP CLOSED

Extended Memory Locations E03 and E05 contain the calibration factor for Digital mA Loop Closed. Each number above or below the indicated in the Memory Locations increases or decreases respectively the mA gain value.

Note ☞

*Values in E03 and E05 Memory Locations are only related to the Generator performance (they are not related to the X-ray Tube installed), so values in **these Memory Locations are factory adjusted**. Only perform this procedure if the HT Controller Board and/or HV Transformer have been replaced in the unit.*

The mA Gain for Digital mA Loop Closed is calibrated by performing the following steps:

1. With the Generator power OFF, set:

   ▪ Dip switch 3000SW2-2 on the HT Controller Board in *"**Off**"* position (enables Filament and Rotor Interlocks).

   ▪ Dip switch 3000SW2-4 on the HT Controller Board in *"**On**"* position (Digital mA Loop Open / Filament Current Constant).

   ▪ Remove the link between the banana plug connections on the HV Transformer. Connect the mAs Meter to the banana plug connections to measure mA or mAs.

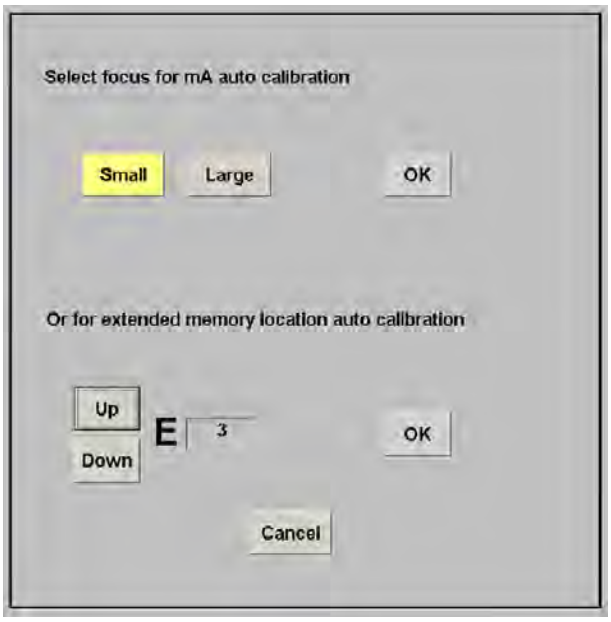
2. Calibration of E03 and E05 Memory Locations is performed by means of the "*Auto Calibration*" menu.

WARNING

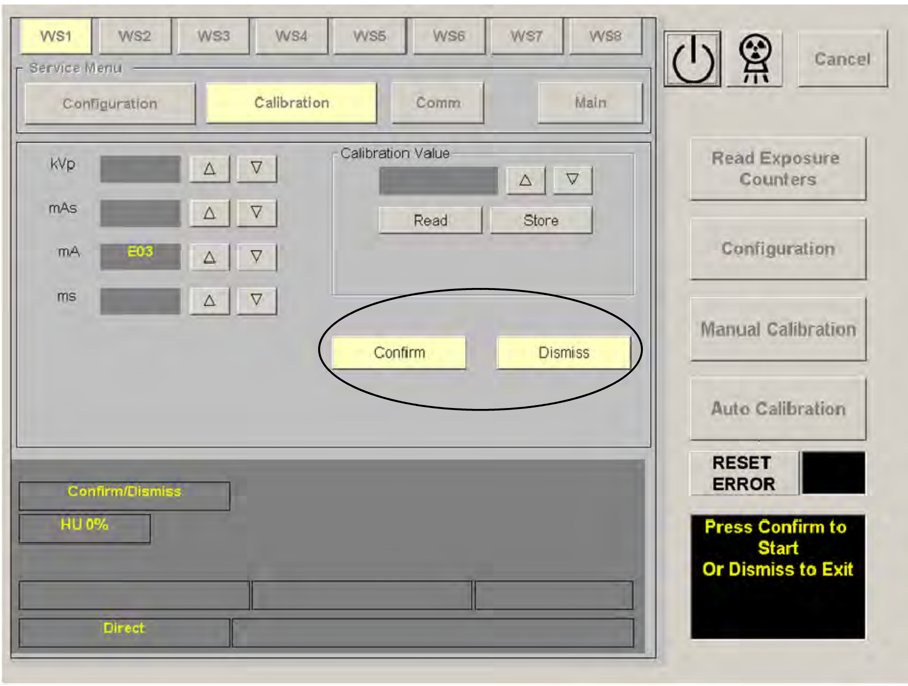
EACH TIME THAT AUTO-CALIBRATION IS ACTIVATED IN ONE OF THESE MEMORY LOCATIONS, CALIBRATION DATA STORED FOR THIS MEMORY LOCATION IS DELETED AND A NEW CALIBRATION FOR IT WILL BE REQUIRED.

3. Enter in Auto-calibration mode by pressing the "*Auto Calibration*" button on the GSM menu. Select an available workstation (WS) and press the "*OK*" button. Then, select the respective Memory Location (E03 or E05) and press the "*OK*" button.

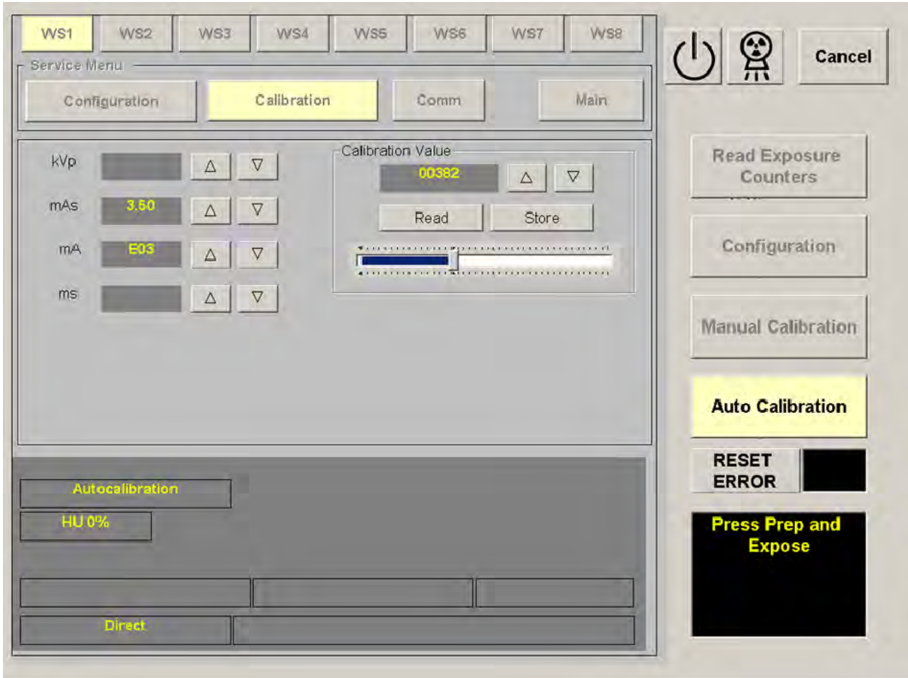
   Confirm or leave the Auto-calibration by pressing the respective button ("*Yes*" or "*No*") on the new screen.



   Confirm or leave the Auto-calibration (second confirmation) by pressing the respective button ("*Confirm*" or "*Dismiss*") on the calibration screen.



Auto-calibration is activated when the "*Auto Calibration*" button is lighted and the "*Press Prep and Expose*" message appears on the screen.



4. Calibrate E03 and E05 Memory Locations as described in the following pages.

For Low mA stations (from 10 mA to 80 mA) (E03 Memory Location):

1. Enter in Auto-calibration mode by pressing the "*Auto Calibration*" button on the GSM menu and select the E03 Memory Location. Confirm all the following screens.

2. When Auto-calibration is activated, "*Auto Calibration*" button is lighted and the mAs value is shown on the screen (3.5 mAs or 35 mAs depending on the Generator software).

3. Perform the following steps:

   a. Make an exposure (technique parameters are pre-programmed at 80 kV, 32 mA and the respective time and they can be shown when pressing the "*Prep*" button).

   b. Read the mAs measured on the mAs Meter.

   c. Read the Filament Current Number shown on the calibration panel.

   d. Increase or decrease the Filament Current Number (by pressing the *"Increase"* or *"Decrease"* buttons) to determine the correction needed to obtain a value between 3.0 and 4.0 mAs (for 3.5 mAs) or a value between 30 and 40 mAs (for 35 mAs) in the mAs Meter after making a new exposure.

   e. Repeat the above steps until a proper mAs value is obtained in the mAs Meter.

4. Enter the mAs value read in the mAs Meter (step 3.) in the mAs Display pressing the "*mAs Increase*" or "*mAs Decrease*" buttons.

5. Exit from Auto-calibration mode pressing the "*Auto Calibration*" button. At this moment, the Generator will calculate and store the new value in E03 Memory Location. Auto-calibration is deactivated and the process is finished when the screen shows the GSM menu.

6. Press the "*Manual Calibration*" button. Select an available workstation (WS) and press the "*OK*" button. Then, select the E03 Memory Location and read its new value on the Calibration Display. Record this value in the Data Book.

7. Exit calibration mode.

For High mA stations (from 100 mA) (E05 Memory Location):

1. Enter in Auto-calibration mode by pressing the "*Auto Calibration*" button on the GSM menu and select the E05 Memory Location. Confirm all the following screens.

2. When Auto-calibration is activated, "*Auto Calibration*" button is lighted and the mAs value is shown on the screen (7.75 mAs or 77.5 mAs depending on the Generator software).

3. Perform the following steps:

    a. Make an exposure (technique parameters are pre-programmed at 80 kV, 125 mA and the respective time and they can be shown when pressing the "*Prep*" button).

    b. Read the mAs measured on the mAs Meter.

    c. Read the Filament Current Number shown on the calibration panel.

    d. Increase or decrease the Filament Current Number (by pressing the *"Increase"* or *"Decrease"* buttons) to determine the correction needed to obtain a value between 7.00 and 8.50 mAs (for 7.75 mAs) or a value between 70 and 85 mAs (for 77.5 mAs) in the mAs Meter after making a new exposure.

    e. Repeat the above steps until a proper mAs value is obtained in the mAs Meter.

4. Enter the mAs value read in the mAs Meter (step 3.) in the mAs Display pressing the "*mAs Increase*" or "*mAs Decrease*" buttons.

5. Exit from Auto-calibration mode pressing the "*Auto Calibration*" button. At this moment, the Generator will calculate and store the new value in E05 Memory Location. Auto-calibration is deactivated and the process is finished when the screen shows the GSM menu.

6. Press the "*Manual Calibration*" button. Select an available workstation (WS) and press the "*OK*" button. Then, select the E05 Memory Location and read its new value on the Calibration Display. Record this value in the Data Book.

7. Exit calibration mode.

8. After calibration of E03 and E05 Memory Locations:

    - Switch the Generator power OFF.

    - Disconnect the mAs Meter to the banana plug connections.

    - Re-install the link between the banana plug connections on the HV Transformer.

2.5 DIGITAL mA LOOP OPEN (X-RAY TUBE CALIBRATION)

To achieve the most accurate calibration, **this procedure has to be automatically performed by the Generator (Auto-calibration).** Calibration procedure will be manually performed by the field engineer only if Auto-calibration is not possible.

Two different methods are described in this section: Auto-calibration and Manual Calibration.

Digital mA Loop Open is calibrated by performing the following steps:

1. With the Generator power OFF, set:
   - Dip switch 3000SW2-2 on the HT Controller Board in "***Off***" position (enables Filament and Rotor Interlocks).
   - Dip switch 3000SW2-4 on the HT Controller Board in "***On***" position (Digital mA Loop Open / Filament Current Constant).
2. Turn the Generator ON.
3. Perform the Auto-calibration procedure as described in Section 2.5.1 for each X-ray Tube in the system.

2.5.1 AUTO-CALIBRATION OF DIGITAL mA LOOP OPEN

Auto-calibration of the Filament Current Numbers is divided in two separated procedures related to the mA stations configured for the Small or Large Focal Spots.

It is recommended to start with the Small Focal Spot (first group) and continue with the Large Focal Spot (second group).

EACH TIME THAT AUTO-CALIBRATION IS ACTIVATED IN A mA STATION (OR IN "E01" MEMORY LOCATION), ALL THE FILAMENT CURRENT NUMBERS OF THE SELECTED FOCAL SPOT ARE AUTOMATICALLY SET TO "344". SO A NEW COMPLETE CALIBRATION OF THE FILAMENT CURRENT NUMBERS FOR THIS FOCAL SPOT WILL BE REQUIRED.

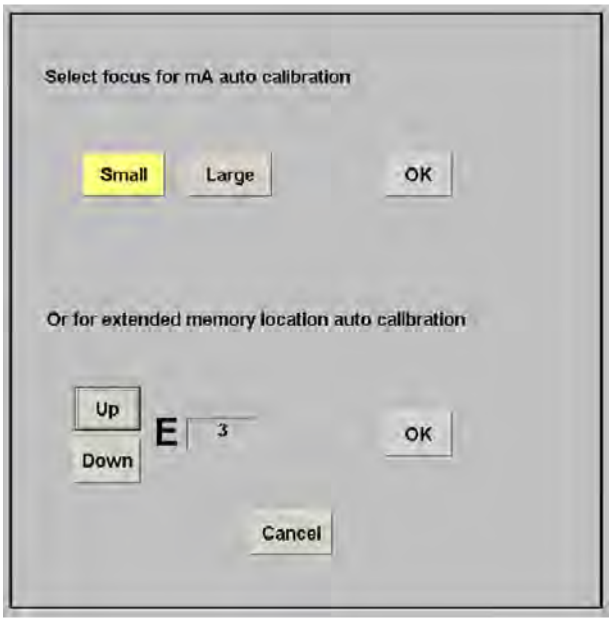
Auto-calibration starts with the minimum available mA station for the selected Focal Spot at 50 kV and follows with the other combinations of mA stations for the selected Focal Spot at 80 kV, 120 kV and 40 kV.

1. Enter in Auto-calibration mode by pressing the “*Auto Calibration*” button on the GSM menu.

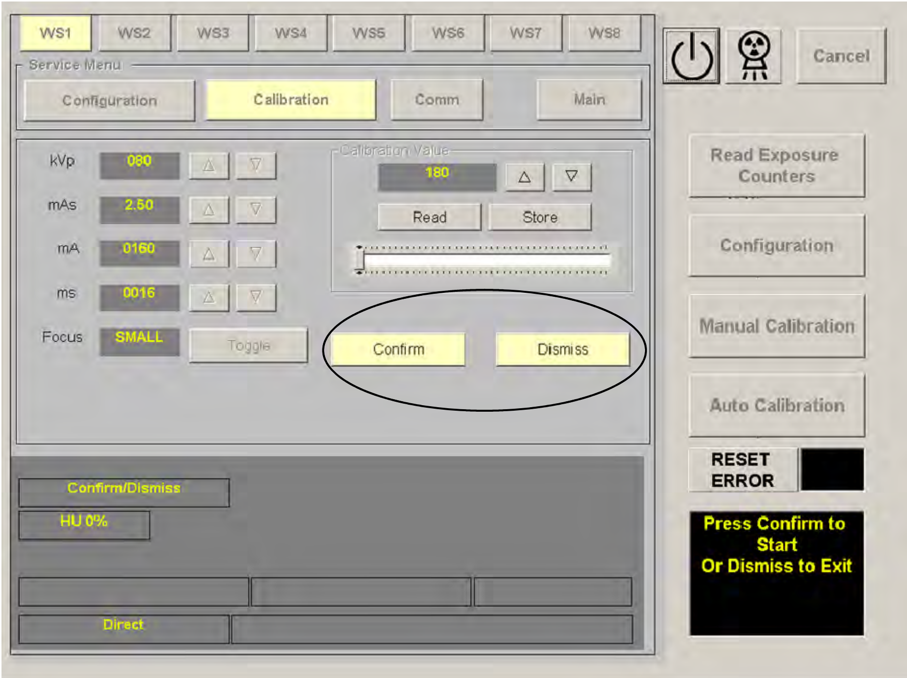
2. Select an available workstation (WS) of the X-ray Tube to be calibrated and press the “*OK*” button. This workstation has to be one of the previously configured as “*Direct*”.

3. Select the **Small Focal Spot** by pressing the “*Small*” button and then press the “*OK*” button.

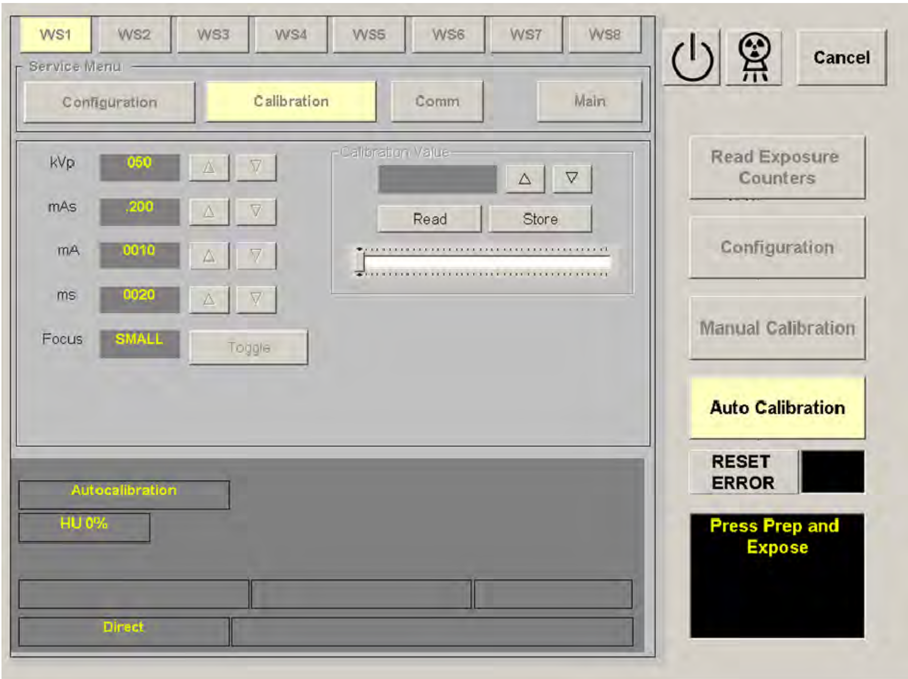
   Confirm or leave the Auto-calibration by pressing the respective button (“*Yes*” or “*No*”) on the new screen.



4. Confirm or leave the Auto-calibration (second confirmation) by pressing the respective button ("*Confirm*" or "*Dismiss*") on the calibration screen.



5. Auto-calibration is activated when the "*Auto Calibration*" button is lighted and the "*Press Prep and Expose*" message appears on the screen. At this moment, the Generator has checked the mA stations available for the **Small Focal Spot**.



6. Check that the Heat Units capacity available for the X-ray Tube is 100% or nearly (HU 0% displayed on the screen).

WARNING

BEFORE MAKING ANY EXPOSURE IN AUTO-CALIBRATION, VERIFY THAT THE LINK BETWEEN THE BANANA PLUG CONNECTIONS ON THE HV TRANSFORMER IS INSTALLED.

7. Keep fully pressed the Handswitch button to perform continuous exposures.

Note ☞

In Auto-calibration mode, all technique parameters are factory pre-programmed and they can not be changed.

CAUTION

Auto-calibration can be paused momentarily releasing the Handswitch button, whenever there is not an exposure in process. Do not exit from Auto-calibration before the procedure has been completed.

Note ☞

Auto-calibration can be cancelled by pressing the "Auto Calibration" button. A message on the screen informs that Auto-calibration has been cancelled and after a while the screen shows the GSM menu.

If during Auto-calibration process, any error indication is shown momentarily (such as "*Tube Overload*", etc.), it means that Generator can not calibrate in this moment the selected kV / mA combination (because anode overheated, space charge, Generator power limit, etc.). In this case, the Generator will continue with Auto-calibration of the following available kV / mA combinations for the selected Focal Spot. At the end of the process it will try to calibrate or calculate the combinations previously uncalibrated.

If the Heat Units value displayed is more than 60%, exposures are inhibited momentarily and message *"Tube too hot"* is shown on the screen. This message will disappear and exposures can be made again when the X-ray Tube begins to cool and recovers the Heat Units capacity.

At this point, it is recommended to wait until the Heat Units value displayed are close to the 20% before making any exposure.

Generator tries to calibrate each kV / mA combination for ten (10) attempts (maximum). If calibration is cancelled (after ten attempts), message "*Auto calibration failure*" is shown on the screen until press the "*Auto Calibration*" button to exit from Auto-calibration mode and go back to the GSM menu. Calibration can be also cancelled due to space charge during calibration of the lowest kV at the highest mA stations for the Focal Spot selected, so message "*Auto calibration failure*" is also shown on the screen until press the "*Auto Calibration*" button to exit from Auto-calibration mode and go back to the GSM menu.

WARNING

ONLY IF AUTO-CALIBRATION IS CANCELLED DUE TO "*AUTO CALIBRATION FAILURE*", CONTINUE THE AUTO-CALIBRATION PROCEDURE FOR THE OTHER FOCAL SPOT. CHECK AT THE END OF THE AUTO-CALIBRATION PROCEDURE WHICH kV / mA COMBINATIONS HAVE NOT BEEN AUTO-CALIBRATED FOR EACH FOCAL SPOT (THESE COMBINATIONS HAVE THE FILAMENT CURRENT NUMBER SET TO "344"). MANUALLY CALIBRATE THESE kV / mA COMBINATIONS AS EXPLAIN IN SECTION 2.5.2.

When Auto-calibration is successfully performed, message "*Auto Calibration OK*" is shown on the screen until press the "*Auto Calibration*" button to exit from Auto-calibration mode and go back to the GSM menu.

8. Repeat the same procedure for the **Large Focal Spot.**

   Enter in Auto-calibration mode by pressing the "*Auto Calibration*" button on the GSM menu.

   Select an available workstation (WS) of the X-ray Tube to be calibrated and press the "*OK*" button. This workstation has to be one of the previously configured as "*Direct*".

   Select the **Large Focal Spot** by pressing the "*Large*" button and then press the "*OK*" button.

   Confirm or leave the Auto-calibration by pressing the respective button on each screen.

   Auto-calibration is activated when the "*Auto Calibration*" button is lighted. At this moment, the Generator has checked the mA stations available for the **Large Focal Spot**.

   Before starting the exposures, it is recommended to wait until the Heat Units value displayed are close to the 20%.

9. After performing both procedures (for Small and Large Focal Spots), enter in "*Manual Calibration*" mode and select each combination of the available mA stations for each Focal Spot at the kV break points (40, 50, 80 and 120 kV). Press the "*Read*" button to read on the calibration panel the new value of the Filament Current Number stored for each combination and record the new values in the Data Book.

   Note that the highest mA station for Small Focal Spot may have numbers larger than the lowest mA station for Large Focal Spot. This is normal.

10. Exit from calibration mode.

11. Perform the Auto-calibration procedure for the second X-ray Tube.

12. **Turn the Generator power OFF and set Dip Switch 3000SW2-4 on the HT Controller Board in *"Off"* position (Digital mA Loop Closed).**

2.5.2 MANUAL CALIBRATION OF DIGITAL mA LOOP OPEN

This procedure describes the Manual calibration of all the Filament Current Numbers. It has to be also used to calibrate the kV / mA combinations not performed during Auto-calibration procedure because it has not been completed. These combinations have the Filament Current Number set to "344", so only these combinations have to be manually calibrated as described in this procedure. If Auto-calibration for one of the Focal Spots has been successful, it is only required to perform the manual calibration of the mA station do not calibrate for the other Focal Spot.

Manual Calibration is initiated at the 80 kV break point by entering the appropriate Filament Current Number for the proper tube current at each selectable mA. Calibration at the other kV break points (40, 50, 80 and 120 kV) are obtained by adding or subtracting values as indicated in Table 2-1.

Although the suggested values (Table 2-1) could change depending on the X-ray tube used, entering those values will approximate accurate calibration without making excessive exposures.

In "*Manual Calibration*" mode, the Filament Current Numbers are shown on the calibration panel by pressing the "*Read*" button after selecting the respective kV / mA combination. The value can be changed by pressing the *"Increase"* or *"Decrease"* buttons of the calibration panel and stored by pressing the "*Store*" button.

Note that in calibration mode, only the mA stations and kV (at the break points) can be selected.

Table 2-1
mA Calibration Numbers Change

mA STATION	FILAMENT CURRENT NUMBERS AT kV BREAK POINT			
	40	50	80	120
10	A_1+7	A_1+6	A_1	A_1–5
12.5	A_2+7	A_2+6	A_2	A_2–5
16	A_3+7	A_3+6	A_3	A_3–5
20	A_4+7	A_4+6	A_4	A_4–5
25	A_5+7	A_5+6	A_5	A_5–5
32	A_6+7	A_6+6	A_6	A_6–5
40	A_7+7	A_7+6	A_7	A_7–5
50	A_8+7	A_8+6	A_8	A_8–5
64 (or 63 or 65)	A_9+7	A_9+6	A_9	A_9–5
80	A_{10}+7	A_{10}+6	A_{10}	A_{10}–5
100	A_{11}+10	A_{11}+8	A_{11}	A_{11}–7
125	A_{12}+10	A_{12}+8	A_{12}	A_{12}–7
160	A_{13}+10	A_{13}+8	A_{13}	A_{13}–7
200	A_{14}+10	A_{14}+8	A_{14}	A_{14}–7
250	A_{15}+10	A_{15}+8	A_{15}	A_{15}–7
320	A_{16}+14	A_{16}+11	A_{16}	A_{16}–9
400	A_{17}+14	A_{17}+11	A_{17}	A_{17}–9
500	A_{18}+14	A_{18}+11	A_{18}	A_{18}–9
640 (or 630 or 650)	A_{19}+14	A_{19}+11	A_{19}	A_{19}–9
800	A_{20}+14	A_{20}+11	A_{20}	A_{20}–9
1000	A_{21}+14	A_{21}+11	A_{21}	A_{21}–9

Note.– The mA station values depends on the Generator model. Some models do not contain all the mA stations listed above.

1. With the Generator power OFF, set:

   - Dip switch 3000SW2-2 on the HT Controller Board in *"**Off**"* position (enables Filament and Rotor Interlocks).
   - Dip switch 3000SW2-4 on the HT Controller Board in *"**On**"* position (Digital mA Loop Open / Filament Current Constant).
   - Remove the link between the banana plug connections on the HV Transformer. Connect the mAs Meter to the banana plug connections to measure mA or mAs.

2. Turn the Generator ON and enter in calibration mode by pressing the "*Manual Calibration*" button on the GSM menu.

3. Select an available workstation (WS) of the X-ray Tube to be calibrated and press the "*OK*" button. This workstation has to be one of the previously configured as "*Direct*".

4. Check that the Heat Units available for the X-ray Tube is 100% or nearly (HU 0% displayed on the screen).

5. Accordingly to X-ray tube ratings or maximum Generator power, check which kV / mA combinations in Table 2-1 are allowed.

   If error "*Tube Overload*" is shown after selection of a kV / mA combination, it means this combination is not allowed for the selected X-ray Tube.

   In calibration mode, if Generator power is exceeded by a kV / mA combination selection, error "*E-16"* is shown after "*Preparation*". Reset this error by pressing the "*Reset Error*" button.

   Note which combinations in Table 2-1 can not be calibrated by making exposures (combinations not allowed due to Tube rating, maximum Generator power, space charge, etc.) and the Exposure Time assigned to these combinations in calibration mode.

6. Enter in user mode inside calibration mode by pressing the "*Go to User Mode*" button. Select the mA station and Exposure Time of each kV / mA combination not allowed. Increase or decrease the kV value as required to determine the kV value allowed nearest to the kV value of the combination. Note the kV value allowed in the respective cell of Table 2-1.

7. Exit from the "*User Mode*" screen by pressing the "Manual Calibration" button. Select 80 kV and lowest mA station available (first combination available). Enter a Filament Number of "344" for this combination.

8. Make an exposure. The mAs read on the mAs Meter must be the same mAs displayed on the calibration screen with a tolerance of $\pm$ 0.1 mAs (tolerance of the parameter and mAs Meter). If the mAs read is close to zero, increase the filament number in big steps (a.e. increase values in 40). As the mAs read is close to the mAs displayed on the Console, increase (or reduce) the filament number in smaller steps (a.e. increase value in 30, 20, 10, ...).

   If the mAs is low, increase the filament number. If the mA is high, decrease the filament number. Press the "*Store*" button before making a new exposure. Repeat until the mA station is calibrated.

Note ☞ *Press the "Store" button to store the new data (filament number) before selecting the next kV or mA stations.*

CAUTION

Calibration data (presently in memory) may or may not be close to your requirements. If it is not close, the potential exists to damage the X-ray tube (i.e. too much mA). Thus, as you start the mA calibration procedure note how close or how far off the mA break points are. If a large adjustment (more than 40 points) is required at the low mA stations, make estimated adjustments to the high mA stations <u>before</u> those exposures are made.

9. Select the next mA station at 80 kV. Before making any exposure, enter as filament number the value calibrated for the previous mA station increased in 10.

   If the mAs is low, increase the filament number. If the mA is high, decrease the filament number. Press the "*Store*" button before making a new exposure. Repeat until the mA station is calibrated.

10. Complete the calibration process for all mA stations at 80 kV as described before. When select the first mA station for the Large Focal Spot, enter as a filament number the value calibrated for the first mA station for the Small Focal Spot. Note that the highest mA station for Small Focal Spot may have numbers larger than the lowest mA station for Large Focal Spot. This is normal.

    Press the "*Read*" button to read on the calibration panel the new value of the Filament Current Number stored for each mA station at 80 kV. Record the new values in the Data Book.

Note ☞

When highest mA stations of the Generator can not be calibrated at 80 kV due to insufficient filament current (the filament current number has reached the maximum number (999)), replace on the Filament Board (A3004-09/10) the Resistor R11 for another resistor with 1.4 kΩ / 5 W, and place Jumper JP1 in position "A". Then rename the Filament Board as A3004-11.

ATTENTION: After doing this modification reduce the value of all the filament current numbers (column for 80 kV) at the 25% and perform the calibration procedure again (from step-5).

11. Complete the calibration process for the remaining kV / mA combinations using Table 2-1 as a guide. It is not necessary to make exposures to do this. Compute the value for all the kV break points of each available mA station although the Generator power can not reach all the kV / mA combinations. Select the corresponding kV / mA combination and enter the computed value.

12. Check calibration at all break points (making exposures) and correct any calibration points as needed.

Note ☞

If "Tube Overload" error is shown directly after selection of an allowed combination (refer to step-5.), wait until the X-ray tube anode cools down to permit the calibration of the mA station.

13. Recalculate the values of the non-allowed combinations in accordance to the new values obtained by exposures. (*Refer to Table 2-1*).

14. Enter in user mode inside calibration mode by pressing the "*Go to User Mode*" button. Select the mA station, Exposure Time and kV value noted for each kV / mA combination not allowed *(refer to step-6.)*. Check calibration at these kV / mA combinations by making exposures. If needed, enter in calibration mode and correct the Filament Current Number of the respective kV / mA combination not allowed.

15. Exit from the "*User Mode*" screen by pressing the "Manual Calibration" button. In calibration mode, select each combination of the available mA stations at the kV break points (40, 50, 80 and 120 kV). Press the "*Read*" button to read on the kV Display the new value of the Filament Current Number stored for each combination. Record the new values in the Data Book.

    Note that the highest mA station for Small Focal Spot may have numbers larger than the lowest mA station for Large Focal Spot. This is normal.

16. Exit calibration mode.

17. If required, perform the calibration procedure for the second X-ray Tube.

18. After calibration of Filament Current Numbers:

    - Switch the Generator power OFF.
    - Disconnect the mAs Meter to the banana plug connections.
    - Re-install the link between the banana plug connections on the HV Transformer.
    - **Set Dip Switch 3000SW2-4 on the HT Controller Board in "*Off*" position (Digital mA Loop Closed).**

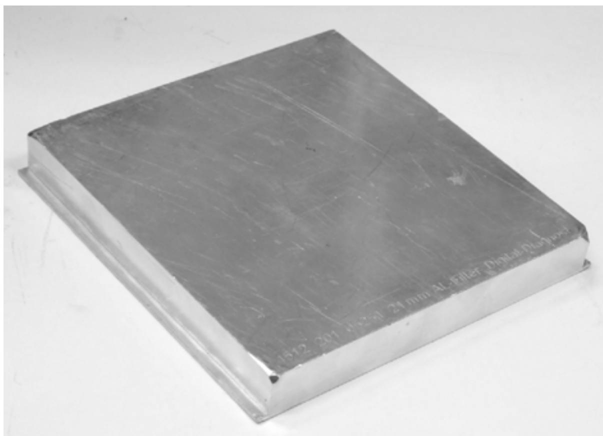
2.6 AEC CALIBRATION

This section describes the adjustments needed to calibrate the AEC in order to achive the correct image at the lowest possible dose.

The Optical Density or Optimum Gray Level is controlled by the values stored in the respective memory locations. For Film, these values are influenced by film speed, screen speed, dark room procedures and customer requirements.

AEC Calibration is carried out using a homogeneous Phantom of Aluminium with a purity of not less that 99% and thickness of 21 mm, to produce an exposure between 50 ms and 300 ms. The AEC will be calibrated to produce a density of 1.0 (or the customer preference Optical Density for Film) or an Optimum Gray Level (for CR or DR) at 70 kV, and then AEC kV Tracking will be adjusted to produce the same density at 55 kV and 90 kV.

Illustration 2-1
Phantom of Aluminium



CAUTION

Before starting with the AEC Calibration, it is necessary that the Alignment of X-Ray Beam and the Alignment of Light Field with X-Ray Field should be performed.

CAUTION

The AEC Calibration must be carried out with the GRID removed whenever possible.

Note ☞

***For AEC calibration with Film**, use the same Film and Cassettes used by the customer. AEC calibration <u>must be performed</u> using the Medium Film/Screen speed combination. The Medium Film/Screen speed has to be double of the Slow and half of the Fast (a.e. 200-Slow, 400-Medium, 800-Fast).*

Note ☞

***For AEC Calibration with CR (Computer Radiography) or DR (Digital Radiography)**, measure the Image Gray Level or Dose Level by using the needed software tools inside each Acquisition Application.*

The Dose Level can be also measured by placing a Dosimeter centered on the imaging area of the Receptor (CR or DR) and with the Grid removed.

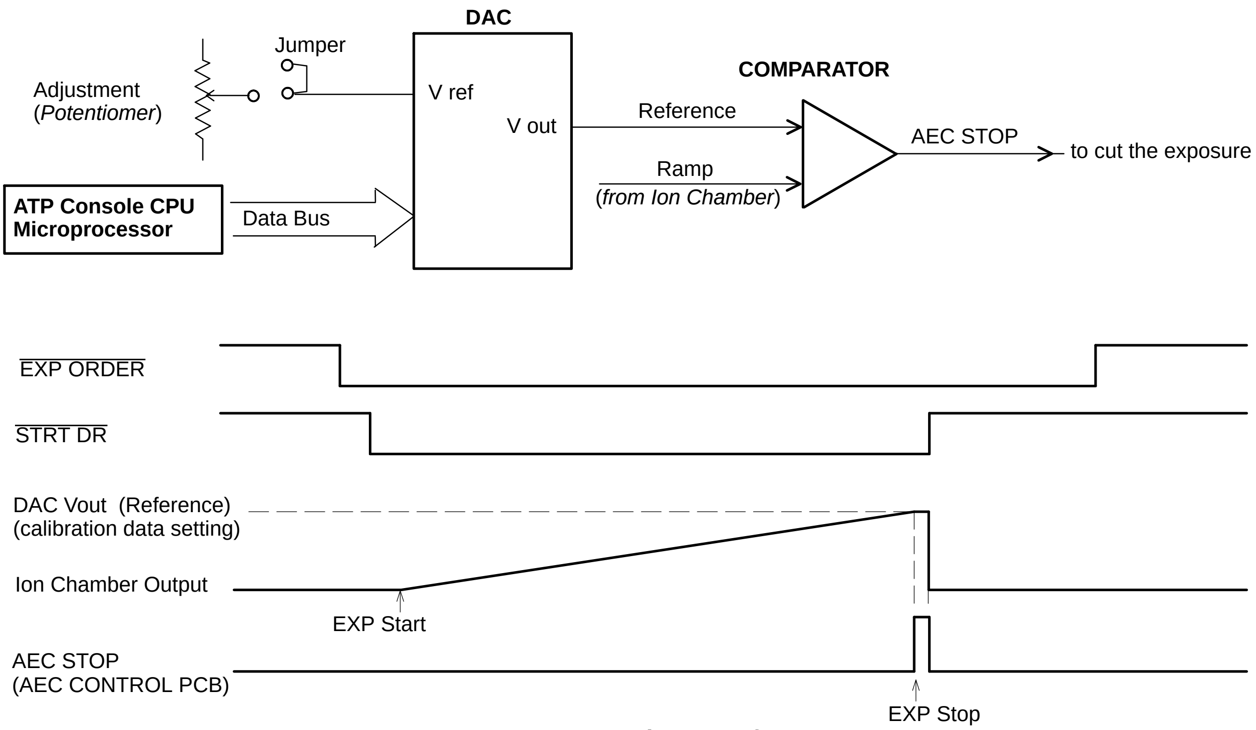
The following table indicates the Memory Locations related to AEC Calibration.

FUNCTION	MEMORY LOCATION
AEC-1 CALIBRATION	E04
AEC-1 TRACKING	E08
AEC-2 CALIBRATION	E09
AEC-2 TRACKING	E10
AEC-3 CALIBRATION	E20
AEC-4 CALIBRATION / PHOTOMULTIPLIER AEC CALIBRATION	E23
AEC-3 and AEC-4 TRACKING (equal value for both)	E24
AEC DENSITY SCALE	E12

CAUTION

Previous to AEC Calibration, identify and note which Memory Locations are assigned / related to each Ion Chamber / Photomultiplier in the system regarding to the configured Workstation / Devices.

Illustration 2-2
Automatic Exposure Control



AEC Function Waveform

2.6.1 PREVIOUS CHECKS FOR AEC CALIBRATION WITH FILM

Make sure the automatic processor works correctly, and the concentration and temperature of the solutions comply with manufacturer specifications.

Obtain a sensitometric curve to determine gamma (γ) of the film and the solution quality. The procedure normally requires a sensitometer, but if it is not available proceed as follows:

1. Make two exposures using the same kV and Film/Screen combination (medium is recommended) but with different mAs settings, mAs(f1) and mAs(f2).

2. Develop and measure the Density (d) of each, d(f1) and d(f2).

3. Determine gamma (γ) by the formula:

$$\gamma = \frac{d(f2) - d(f1)}{log_{10} \frac{mAs(f2)}{mAs(f1)}}$$

Gamma (γ) must be between 2 and 3, if not change or renew solutions.

2.6.2 OPTICAL DENSITY / IMAGE GRAY LEVEL ADJUSTMENT

Note ☞

For Film, the Film Optical Density must be measured always on the same point for all the X-ray Films developed during this procedure.

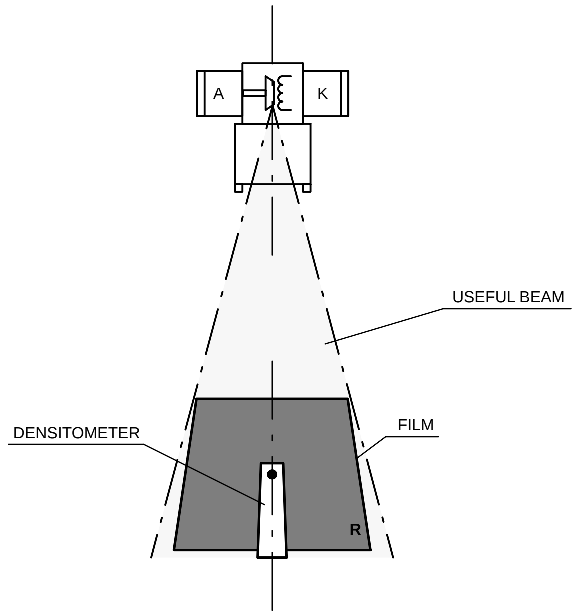
The recommended point is on the central axis of the Film with relation of the Anode and Cathode and as close as possible to center of the Film.

Note ☞

For CR or DR, the Image Gray Level must be measured always on the same area (Region of Interest) for all the RAW images obtained during this procedure.

The recommended ROI is 4 x 4 cm on the center of the CR or Detector.

Illustration 2-3
How to measure the Film Optical Density (only for Film)



2.6.2.1 ION CHAMBERS WITH GAIN SWITCHES OR WITH GAIN POTENTIOMETER

1. Set the Gain Switches (or Gain Potentiometer) of the Ion Chamber to mid range (*refer to Ion Chamber documentation*).

   The following tables indicate the switch position for the "*Vacutec*" Ion Chamber.

VACUTEC ION CHAMBER – BAK 70 151 with Amplifier 70 901					
SWITCH POSITION		**SW1**	**SW2**	**SW3**	**SW4**
GAIN	0.1 V / μGy (10 V≃ 100 μGy)	OFF	OFF	OFF	
	0.5 V / μGy (10 V≃ 20 μGy)	ON	OFF	OFF	
	1 V / μGy (10 V≃ 10 μGy)	OFF	ON	OFF	
	2 V / μGy (10 V≃ 5 μGy)	OFF	OFF	ON	
OUTPUT SIGNAL	Positive				ON
	Negative				OFF
NORMAL FACTORY SELECTION: 1 V / μGy (10 V≃ 10 μGy) - Positive		***OFF***	***ON***	***OFF***	***ON***

VACUTEC DIGITAL ION CHAMBER – BAK 70 151 with Amplifier 70 902					
SWITCH POSITION		**SW1**	**SW2**	**SW3**	**SW4**
GAIN	0.1 V / μGy (10 V≃ 100 μGy)	OFF	OFF	OFF	OFF
	0.5 V / μGy (10 V≃ 20 μGy)	OFF	OFF	OFF	ON
	1 V / μGy (10 V≃ 10 μGy)	OFF	OFF	ON	OFF
	2 V / μGy (10 V≃ 5 μGy)	OFF	ON	OFF	OFF
	4 V / μGy (10 V≃ 2.5 μGy)	ON	OFF	OFF	OFF
OUTPUT SIGNAL	Positive or Negative polarity of the ramp signal is selected with a switch at the Ramp Module. The Ramp Module is a 9-pin Sub-D connector plugged to the Ion Chamber cable. Positive polarity of the ramp signal is factory set.				
NORMAL FACTORY SELECTION: 1 V / μGy (10 V≃ 10 μGy) - Positive		***OFF***	***OFF***	***ON***	***OFF***

2. Set the following jumper on the AEC Control Board in position A: JP3 for Board A3012–x1/x2/x5 or JP2 for Board A3012–x6/x7/x9.

3. Set SID at the Focal Distance of the Grid to be used in the Table Receptor (usually 100 cm) or in the Vertical Stand Receptor (usually 100 cm and 150 cm or 180 cm).

4. Open the Collimator blades completely.

5. Place in the Collimator guides a Phantom of Aluminium with a purity of not less that 99% .

CAUTION

Any other Phantom material should not be used for AEC Calibration.

6. Enter in calibration mode and verify that AEC Calibration number in E04, E09, E20 and E23 Memory Locations is 70. The useful range for AEC calibration numbers is from 20 to 120. Exit from calibration mode.

7. Enter in calibration mode selecting a Workstation configured for the Ion Chamber to be calibrated. Enter in user mode inside calibration mode by pressing the "*Go to User Mode*" button.

8. Select on the Console:

   ▪ RAD Menu: 70 kV, 100 mA and 1 second back-up time.

   ▪ AEC Menu: "*Central Field*" , "*Density 0*" and "*Medium Film/Screen*".

9. Make an exposure (in case of Film, without film in the cassette, but the cassette inserted in the Receptor housing) (in case of CR or DR, with the CR or DR inserted in the Receptor housing), then note the Exposure Time displayed on the Console, it should be a time between 50 ms and 300 ms. If necessary, change the mA station and make the exposure again (to reduce the time increase the mA value, and viceversa).

Note ☞

The "Actual Exposure Parameters" area shows the last exposure parameters when: exposure is finished by the AEC, exposure is aborted by releasing the exposure control, or after pressing the "Reset Error" button.

CAUTION

The exposure time must be between 50 ms and 300 ms throughout the adjustment procedure. If not, increase or decrease the mA value.

10. **For Film**, insert a cassette with the Medium Film/Screen combination used by the customer. Make an exposure, develop the film and check the Optical Density, it should be 1.0 (or the customer preference O. Density).

    For CR or DR, make an exposure with the CR or DR in the Receptor housing. It is recommended to measure the Image Gray Level or the Dose Level shown on the Acquisition Application.

Note ☞ *The Gray Level and/or Dose reference values are those established by the manufacturer of the CR or DR.*

Note ☞ *When the calibration is carried out measuring the Dose Level, in case the Dose Level is not shown on the Acquisition Application, place a Dosimeter centered on the imaging area of the Receptor (CR or DR) and with the Grid removed.*

If it is not possible due to insufficient space between the Receptor and the Ion Chamber, place the Dosimeter centered in the Receptor housing (tray) and adjust the Gain Switches or Gain Potentiometer (as described in step 11.) until obtain the optimum Dose Level specified by the manufactured of CR or DR. Note the mA and ms resultant values.

After that, remove the Dosimeter and insert the Receptor (CR or DR). Select on the Console: 70 kV, the mA value previously noted and 1 second back-up time. Make an exposure and compare the exposure time now obtained with the previously noted time, then adjust the Gain Potentiometer and repeat the exposure until the previously noted exposure time is achieved.

11. To change the Optical Density, Image Gray Level or received Dose:

    - <u>For Ion Chamber with Gain Switches</u>:

      – If the *Optical Density / Image Gray Level / Dose* obtained is 33% above of the desired one, increase the gain with the switches. Repeat step-10.

      – If the *Optical Density / Image Gray Level / Dose* obtained is 33% below of the desired one, decrease the gain with the switches. Repeat step-10.

      – If the *Optical Density / Image Gray Level / Dose* obtained is in between 33% of the desired one, change the AEC calibration number.

    - <u>For Ion Chamber with Gain Potentiometer</u>, adjust the Gain Potentiometer until the desired *Optical Density / Image Gray Level / Dose* is obtained by repeating step-10. If the adjustment is not achieved with the Gain Potentiometer, change the AEC calibration number.

Note ☞ *As an alternative to the adjustment with the Gain Switches or the Gain Potentiometer is to change the AEC calibration number. It can be done when the Gain Switches or the Gain Potentiometer is not accessible.*

12. Exit from the "*Go to User Mode*" screen by pressing the "*Manual Calibration*" button and in calibration mode set the new AEC calibration number for the respecetive Memory Location (E04, E09, E20 or E23). The *Optical Density / Image Gray Level / Dose* increases / decreases when the calibration number is increased / decreased. Then enter in "*Go to User Mode*" screen and repeat step-10.

Note ☞ *The AEC accuracy is better in all the useful range as the AEC calibration number is closer to 70.*

13. Repeat the above steps for all the Ion Chambers installed with the Generator.

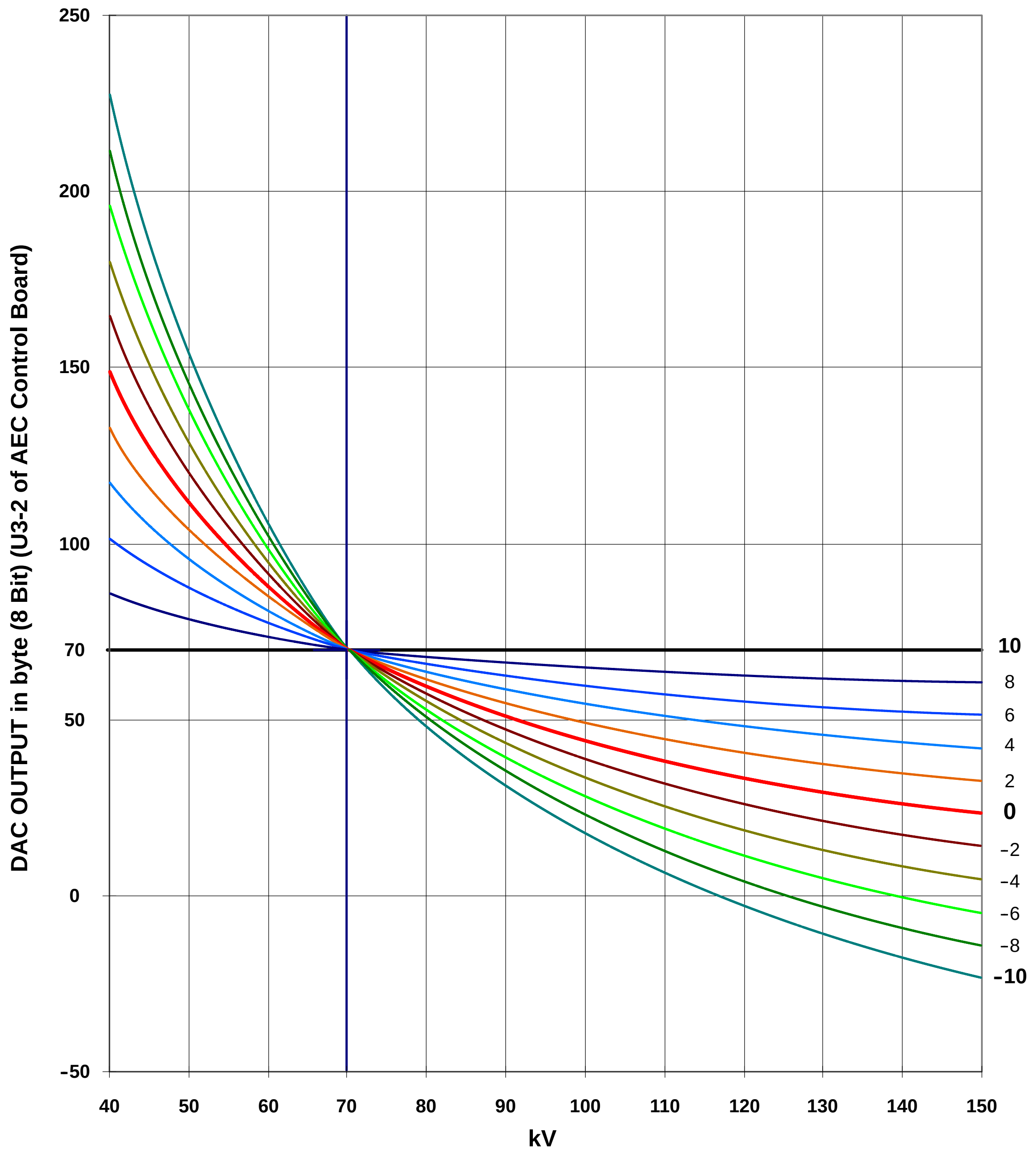
14. Exit from the "*Go to User Mode*" screen by pressing the "*Manual Calibration*" button and exit from calibration mode.

15. Record all the values for the Memory Locations in the Data Book.

2.6.3 kV COMPENSATION

To maintain constant Optical Density (for Film) or Image Gray Level (for CR or DR) regardless of the kV at which a Film, CR or DR is exposed, the Generator provides kV compensation. (*Refer to Illustration 2-4*).

Illustration 2-4
AEC kV Tracking Curve



Perform the following steps to determine whether or not AEC kV Tracking of Optical Density / Image Gray Level must be adjusted.

1. Enter in calibration mode and verify that AEC Tracking number in E08, E10 and E24 Memory Locations is “0”. Exit from calibration mode.
2. Enter in calibration mode selecting a Workstation configured for the Ion Chamber to be calibrated. Enter in user mode inside calibration mode by pressing the “*Go to User Mode*” button.
3. Select on the Console:
   - RAD Menu: 55 kV, 100 mA and 1 second back-up time (or the mA and ms values obtained for the Gain adjustment)
   - AEC Menu: “*Central Field*” , “*Density 0*” and “*Medium Film/Screen*”.
4. Make an exposure (in case of Film, without film in the cassette, but the cassette inserted in the Receptor housing) (in case of CR or DR, with the CR or DR inserted in the Receptor housing) and check that the Exposure Time is between 50 ms and 300 ms. If necessary, change the mA value and make the exposure again. Take note of the final mA station selected for 55 kV.
5. Select 90 kV. Make an exposure (in case of Film, without film in the cassette, but the cassette inserted in the Receptor housing) (in case of CR or DR, with the CR or DR inserted in the Receptor housing) and check that the Exposure Time is between 50 ms and 300 ms. If necessary, change the mA value and make the exposure again. Take note of the final mA station selected for 90 kV.
6. **For Film**, insert a cassette with the Medium Film/Screen combination used by the customer. Make an exposure at 55 kV and 90 kV *(use the selected mA station noted before for each kV)*, develop the film and measure the Optical Density obtained with those exposures. Check that the variation range is the same ±0.2 of the Optical Density obtained before at 70 kV (*Optical Density / Image Gray Level Adjustment – Section 2.6.2*).

   For CR or DR, make an exposure with the CR or DR in the Receptor housing. Make an exposure at 55 kV and 90 kV *(use the selected mA station noted before for each kV)*, note the Image Gray Level obtained with those exposures. Check that the variation range is the same ±20% of Image Gray Level obtained before at 70 kV (*Optical Density / Image Gray Level Adjustment – Section 2.6.2*).

7. If the variation value is not ±0.2 of the Optical Density (for Film) or ±20% of Image Gray Level / Dose Level (for CR or DR) calculate the new value for the AEC Tracking number in each Memory Location as follows:

   - If the Optical Density / Image Gray Level at 55 kV has to be decreased and the Optical Density / Image Gray Level at 90 kV has to be increased then **increase the Tracking value in one**.

   - If the Optical Density / Image Gray Level at 55 kV has to be increased and the Optical Density / Image Gray Level at 90 kV has to be decreased then **decrease the Tracking value in one**.

Note ☞ *A Tracking value of 10 will have no effect on AEC kV compensation.*

   a. Exit from the "*Go to User Mode*" screen by pressing the "*Manual Calibration*" button and in calibration mode select the respective Memory Location (E08, E10 or E24).

   b. Values for AEC Tracking range is from –10 to +10. Determine the correct value for the needed AEC Tracking change.

AEC-kV TRACKING CURVE	+10	+9	+8	+7	+6	+5	+4	+3	+2	+1	**0**	–1	–2	–3	–4	–5	–6	–7	–8	–9	–10
VALUE TO ENTER IN THE MEMORY LOCATION	10	9	8	7	6	5	4	3	2	1	**0**	255	254	253	252	251	250	249	248	247	246

   c. Enter the new value and store it. Enter in user mode inside calibration mode by pressing the "*Go to User Mode*" button and repeat this process from step-6. until the desired compensation of the Optical Density / Image Gray Level is obtained.

8. Repeat the above steps for all the Ion Chambers installed with the Generator.

9. Exit from the "*Go to User Mode*" screen by pressing the "*Manual Calibration*" button and exit from calibration mode.

10. Record all the values for the Memory Locations in the Data Book.

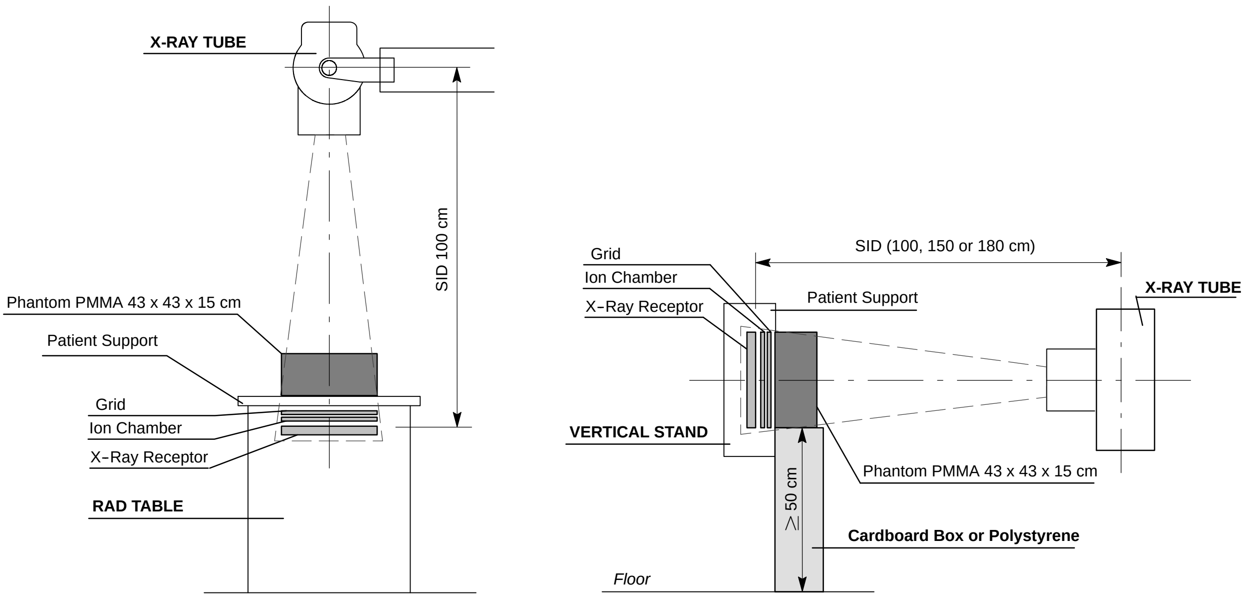
Note ☞ *Once the Gain Adjustment and kV Compensation procedures are finnished, remove from the Collimator guides the Phantom of Aluminium.*

2.6.4 BALANCE ADJUSTMENT / CHECKING FOR THREE FIELD DETECTORS

Note ☞ *Some Ion Chambers does not provide balance potentiometers for Three Field Detectors. In that case, this procedure can be used to check that the Balance adjustment from factory is correct.*

Note ☞ *This checking is carried out using a homogeneous Phantom of PMMA (Polymethylmethacrylate) with a surface of 43 x 43 cm and a thickness of 15 cm so that the Three Field Detectors of the Ion Chamber receive the same amount of scattered radiation. As an alternative to the Phantom of PMMA, the Phantom of Aluminum used for AEC Calibration and placed on the Collimator guides can be used, but it is recommended to use the Phantom of PMMA.*

1. Set SID at the Focal Distance of the Grid to be used in the Table Receptor (usually 100 cm) or in the Vertical Stand Receptor (usually 100 cm, 150 cm and/or 180 cm). Place the Phantom as shown in the next illustration. In the case of the Table, the Tabletop must be completely centered.



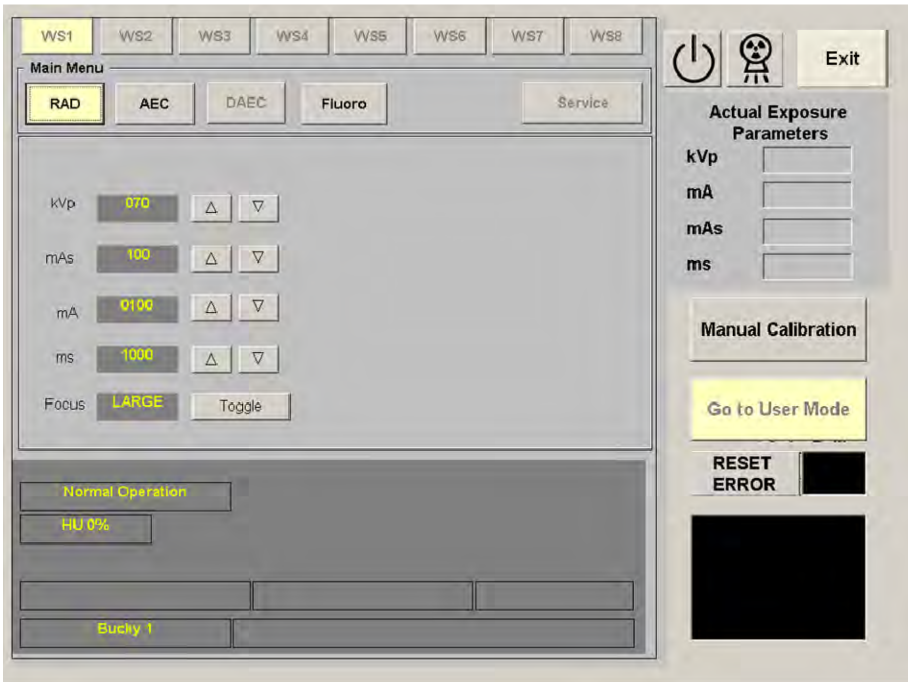
2. If it is present, remove from the Collimator guides the Phantom of Aluminium used for the previous procedures.

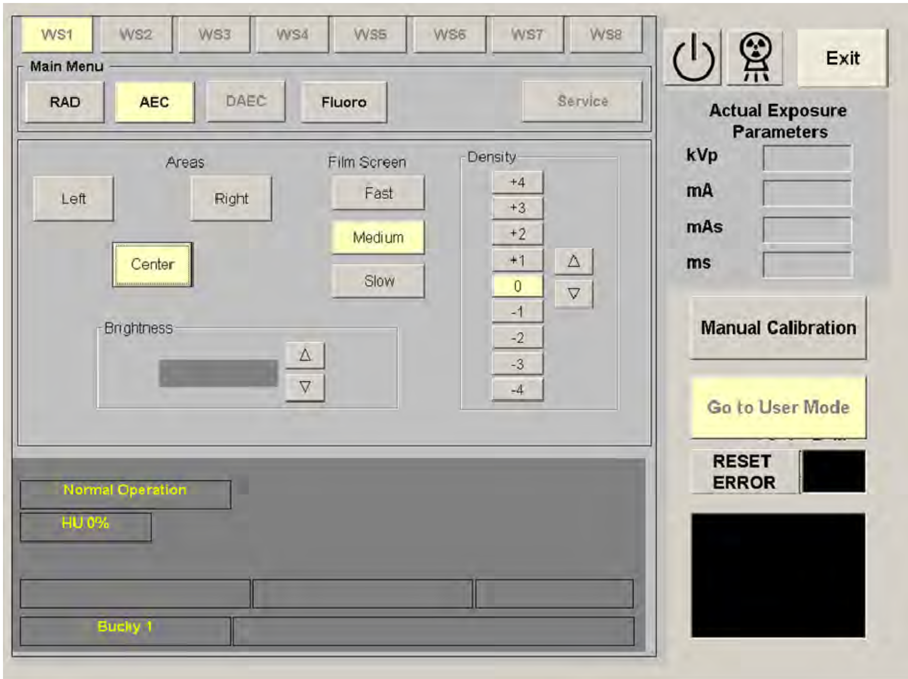
3. Open the Collimator blades up to cover the base of the Phantom.

4. Enter in calibration mode selecting a Workstation configured for the Ion Chamber to be calibrated. Enter in user mode inside calibration mode by pressing the "*Go to User Mode*" button.

5. Select on the Console:

   - RAD Menu: 70 kV, 100 mA and 1 second back-up time.
   - AEC Menu: "*Central Field*" , "*Density 0*" and "*Medium Film/Screen*".





6. Make the following sequence of exposures (in case of Film, without film in the cassette, but the cassette inserted in the Receptor housing) (in case of CR or DR, with the CR or DR inserted in the Receptor housing) and check that the Exposure Time is between 50 ms and 300 ms. If necessary, change the mA value and make the exposure again. Take note of the final mA station selected for each exposure with the Grid removed and with the Grid inserted/installed.

Note ☞ *If the Grid can not be removed from the Receptor housing, perform only the exposures with the Grid installed.*

Note ☞ *The "Actual Exposure Parameters" area shows the last exposure parameters when: exposure is finished by the AEC, exposure is aborted by releasing the exposure control, or after pressing the "Reset Error" button.*

The sequence of exposures are:

- 3 exposures with the Grid removed and the "*Left Field*" of the Ion Chamber selected.
- 3 exposures with the Grid removed and the "*Center Field*" of the Ion Chamber selected.
- 3 exposures with the Grid removed and the "*Right Field*" of the Ion Chamber selected.
- 3 exposures with the Grid inserted / installed and the "*Left Field*" of the Ion Chamber selected.
- 3 exposures with the Grid inserted / installed and the "*Center Field*" of the Ion Chamber selected.
- 3 exposures with the Grid inserted / installed and the "*Right Field*" of the Ion Chamber selected.

Note in Table 2-2 the Exposure Time or the Image Gray Level obtained in each exposure, and the final mA value selected.

Table 2-2
Exposures for Balance Adjustment / Checking of Ion Chamber Fields

TABLE *(SID 100 cm)*	**EXPOSURES WITHOUT GRID at 70 kV and ___ mA**			**EXPOSURES WITH GRID at 70 kV and ___ mA**		
	LEFT Field	**CENTER Field**	**RIGHT Field**	**LEFT Field**	**CENTER Field**	**RIGHT Field**
Exposure #1	$t_{L1} =$	$t_{C1} =$	$t_{R1} =$	$t_{L1} =$	$t_{C1} =$	$t_{R1} =$
Exposure #2	$t_{L2} =$	$t_{C2} =$	$t_{R2} =$	$t_{L2} =$	$t_{C2} =$	$t_{R2} =$
Exposure #3	$t_{L3} =$	$t_{C3} =$	$t_{R3} =$	$t_{L3} =$	$t_{C3} =$	$t_{R3} =$
Average value of the Exposure Time	$\overline{t}_L =$	$\overline{t}_C =$	$\overline{t}_R =$	$\overline{t}_L =$	$\overline{t}_C =$	$\overline{t}_R =$

VERTICAL STAND *(SID 100 cm)*	**EXPOSURES WITHOUT GRID at 70 kV and ___ mA**			**EXPOSURES WITH GRID at 70 kV and ___ mA**		
	LEFT Field	**CENTER Field**	**RIGHT Field**	**LEFT Field**	**CENTER Field**	**RIGHT Field**
Exposure #1	$t_{L1} =$	$t_{C1} =$	$t_{R1} =$	$t_{L1} =$	$t_{C1} =$	$t_{R1} =$
Exposure #2	$t_{L2} =$	$t_{C2} =$	$t_{R2} =$	$t_{L2} =$	$t_{C2} =$	$t_{R2} =$
Exposure #3	$t_{L3} =$	$t_{C3} =$	$t_{R3} =$	$t_{L3} =$	$t_{C3} =$	$t_{R3} =$
Average value of the Exposure Time	$\overline{t}_L =$	$\overline{t}_C =$	$\overline{t}_R =$	$\overline{t}_L =$	$\overline{t}_C =$	$\overline{t}_R =$

VERTICAL STAND *(SID 150 cm or 180 cm)*	**EXPOSURES WITHOUT GRID at 70 kV and ___ mA**			**EXPOSURES WITH GRID at 70 kV and ___ mA**		
	LEFT Field	**CENTER Field**	**RIGHT Field**	**LEFT Field**	**CENTER Field**	**RIGHT Field**
Exposure #1	$t_{L1} =$	$t_{C1} =$	$t_{R1} =$	$t_{L1} =$	$t_{C1} =$	$t_{R1} =$
Exposure #2	$t_{L2} =$	$t_{C2} =$	$t_{R2} =$	$t_{L2} =$	$t_{C2} =$	$t_{R2} =$
Exposure #3	$t_{L3} =$	$t_{C3} =$	$t_{R3} =$	$t_{L3} =$	$t_{C3} =$	$t_{R3} =$
Average value of the Exposure Time	$\overline{t}_L =$	$\overline{t}_C =$	$\overline{t}_R =$	$\overline{t}_L =$	$\overline{t}_C =$	$\overline{t}_R =$

7. Calculate the average exposure time value of the 3 exposures in each Field, without and with Grid in the Receptor housing.
   Note the values in the Table 2-2.

$$\text{Average Value} = \overline{t_x} = \frac{t_{x1} + t_{x2} + t_{x3}}{3}$$

8. Compare the average values of:

   - The "*Center Field*" with the "*Left Field*", without Grid.
   - The "*Center Field*" with the "*Right Field*", without Grid.
   - The "*Center Field*" with the "*Left Field*", with Grid.
   - The "*Center Field*" with the "*Right Field*", with Grid.

$$\text{\% of difference between "}\textit{Center}\text{" and "}\textit{Left}\text{" Fields} = \frac{\overline{t_L} - \overline{t_C}}{\overline{t_C}} \times 100 = \quad \%$$

$$\text{\% of difference between "}\textit{Center}\text{" and "}\textit{Right}\text{" Fields} = \frac{\overline{t_R} - \overline{t_C}}{\overline{t_C}} \times 100 = \quad \%$$

   The difference of the Exposure Time values between the "*Left Field*" and "*Center Field*" and between the "*Right Field*" and "*Center Field*" must be ± 20%. If not, adjust the corresponding balance potentiometer of the Field to increase or decrease the Exposure Time. Repeat this process from step 6. until the adjustment is complete.

9. Exit from the "*Go to User Mode*" screen by pressing the "*Manual Calibration*" button and exit from calibration mode.

10. Repeat the above steps for all the Ion Chambers installed with the Generator. It is recommended to start with the Table Ion Chamber and then with the Vertical Stand Ion Chamber.

2.6.5 ATS DIGITAL AEC (RAD) ADJUSTMENT (OPTIONAL)

Note ☞ *If the Generator is interfaced with an "ATS Hiris Image System", Digital AEC calibration procedure has to be performed as explained in the "ATS Hiris Image System" documentation.*

2.6.6 PHOTOMULTIPLIER RAD-AEC (DIGITAL RAD) ADJUSTMENT (OPTIONAL)

The Photomultiplier RAD-AEC adjustment can be performed in two ways: one is the value stored in E23 Memory Location and the other is the high voltage applied to the Photomultiplier Tube.

The recommended procedure for this adjustment is to store a constant value in E23 Memory Location and adjust the high voltage applied to the Photomultiplier Tube.

Note ☞ *Value in E23 Memory Location is a common data used for Photomultiplier AEC Calibration or used for the Fourth Ion Chamber Calibration (AEC-4).*

Perform the following procedure:

1. Enter in "*Manual Calibration*" mode selecting a Workstation configured for DSI. Select E23 Memory Location and set a value of "127". Then enter in user mode by pressing the "*Go to User Mode*" button.

2. Set up a Dosimeter as close as possible to the Image Intensifier Radiation Input to measure the Entrance Image Intensifier Exposure Dose Rate. Position the Probe at the center of the primary beam with the entire active volume within the primary beam. Select the Field of View for the Image Intensifier to have 9" FOV.

   Place the Tube-Collimator Assembly at the normal SID (1 meter). Collimate the X-ray beam so it completely covers the Image Intensifier field but does not extend beyond limits of the phantom.

3. Place a homogeneous Phantom of Aluminium with a purity of not less that 99% and thickness of 21 mm in the Collimator Filter Holder.

4. Select on the Console:

   - RAD Menu: 70 kV, 200 mA Large Focus (or the first mA station for Large Focus if 200 mA station is set for Small Focus) and 1 second back-up time.

   - AEC Menu: "*Central Field*" , "*Density 0*" and "*Medium Film/Screen*".

5. Activate "*Digital Prep*" (–DIGITAL PREP signal = GND on TS3-7 Generator Cabinet). Hold "*Digital Prep*" and adjust the high voltage applied to the Photomultiplier Tube with the potentiometer R12 for Board A3012–x1/x2/x5 or R23 for Board A3012–x6/x7/x9 on the AEC Control Board until measure –400 VDC between TS1–39 and TS1–42 (GND) in the Generator Cabinet.

6. The Dose is affected in the following manner:

   - Increases when the high voltage applied to the Photomultiplier Tube is decreased. (*Example: if 100 μR Dose is obtained with –400 VDC, 200 μR Dose may be obtained decreasing the high voltage to –300 VDC*).

   - Decreases when the high voltage applied to the Photomultiplier Tube is increased. (*Example: if 100 μR Dose is obtained with –400 VDC, 50 μR Dose may be obtained increasing the high voltage to –450 VDC*).

7. Make an exposure and adjust the following potentiometer on the AEC Control Board: R12 for Board A3012–x1/x2/x5 or R23 for Board A3012–x6/x7/x9 on the AEC Control Board; until getting a Dose around 100 μR per frame (*at 9" FOV*) (*for more information refer to the Image System documentation*).

Note ☞ *If the photo tube voltage required is too low, decrease the AEC calibration number in the E23 Memory Location and repeat the process.*

8. Record the E23 Memory Location in the Data Book.

2.6.7 AEC OPTICAL DENSITY SCALE

AEC is calibrated with "*Density 0*" selected (Normal Optical Density). The Optical Density can be increased or decreased in several steps.

The variation percentage of the density scale is factory set at 25%. This variation can be set according to the customer preferences by changing the value stored in E12 Memory Location. This value applies to both tubes.

Depending on the Console model, the range of the scale is "from –2 to +2" or "from –4 to +4" (optional).

The following tables show some examples for the variation percentage of the density scale with reference to the value stored in E12 Memory Location.

E12 VALUE	**DENSITY SCALE FROM –2 TO +2 . VARIATION OVER NORMAL OPTICAL DENSITY (N)**				
	–2	**–1**	**0**	**+1**	**+2**
5	N x 0.90	N x 0.95	**N**	N x 1.05	N x 1.10
10	N x 0.80	N x 0.90	**N**	N x 1.10	N x 1.20
25	N x 0.50	N x 0.75	**N**	N x 1.25	N x 1.50
NOTE: If the value stored in E12 Memory Location is 0, 25 or 255, the variation percentage is 25%.					

E12 VALUE	**DENSITY SCALE FROM –4 TO +4 (*OPTIONAL*) . VARIATION OVER NORMAL OPTICAL DENSITY (N)**								
	–4	**–3**	**–2**	**–1**	**0**	**+1**	**+2**	**+3**	**+4**
5	N x 0.82	N x 0.86	N x 0.91	N x 0.95	**N**	N x 1.05	N x 1.10	N x 1.16	N x 1.22
10	N x 0.68	N x 0.75	N x 0.83	N x 0.91	**N**	N x 1.10	N x 1.21	N x 1.33	N x 1.46
25	N x 0.41	N x 0.51	N x 0.64	N x 0.80	**N**	N x 1.25	N x 1.56	N x 1.95	N x 2.44
NOTE: With scale from "–4 to +4" the useful range for the value stored in E12 Memory Location is from 1 to 25 .									

Record the value for E12 Memory Location in the Data Book.

2.7 FLUORO CALIBRATION

This generator uses Continuous Fluoro and Pulsed Fluoro (a series of short exposures at the selected PPS).

Fluoro exposures are controlled by kV with a constant filament current. The kV values are manually (Manual mode) or automatically (ABC mode) adjusted to obtain the desired brightness (entrance dose rate) on the Image Intensifier.

The Fluoro calibration consists of setting values in the corresponding Extended Memory Locations for Fluoro use. The following table indicates the relationship between Fluoro and Extended Memory Locations.

MEMORY	FUNCTION
E19	Maximum FLUORO kV
E46	Fluoro selection: Continuous Fluoro only, Continuous and Pulsed Fluoro, or Pulsed Fluoro only

	PULSED FLUORO		
	MANUAL MODE (NON-ABC), 5 R/min	AUTOMATIC MODE (ABC), 10 R/min	HIGH DOSE (ABC), 20 R/min
Fluoro Filament Setting (Demand)	**E59**	**E22**	**-**
Fluoro mA Display calibration at 50 kV	**E60**	**E35**	**-**
Fluoro mA Display calibration at 80 kV	**E61**	**E36**	**-**
Fluoro mA Display calibration at 110 kV	**E62**	**E37**	**-**

	CONTINUOUS FLUORO		
	MANUAL MODE (NON-ABC), 5 R/min	AUTOMATIC MODE (ABC), 10 R/min	HIGH DOSE (ABC), 20 R/min
Fluoro Filament Setting (Demand)	**E51**	**E33**	**E42**
Fluoro mA Display calibration at 50 kV	**E52**	**E38**	**E43**
Fluoro mA Display calibration at 80 kV	**E53**	**E39**	**E44**
Fluoro mA Display calibration at 110 kV	**E54**	**E40**	**E45**

The functions of these Extended Memory Locations are:

- E19 is used to set **maximum Fluoro kV**. This value is determined by the type of TV camera and type of images desired. For general fluoroscopic use with a conventional TV system, **125 kV** is recommended. A lower maximum setting will produce more contrast on the TV system but less penetration for large patients.

- E46 is used to select the Fluoro operation mode in **only Continuous Fluoro only (0), Continuous and Pulsed Fluoro (1), or Pulsed Fluoro only (2).**

The functions of the Extended Memory Locations used for Fluoro Filament Setting (Demand) are:

- E59 is used to store data that controls the Maximum Skin Dose Radiation for **Pulsed Fluoro in Manual Mode (Non-ABC) at 5 R/min** (43.5 mGy/min) (maximum level of regulation limit) with a maximum Fluoro kV at **125 kV**.

- E22 is used to store data that controls the Maximum Skin Dose Radiation for **Pulsed Fluoro in Automatic Mode (ABC) at 10 R/min** (87 mGy/min) (maximum level of regulation limit) with a maximum Fluoro kV at **125 kV**.

- E51 is used to store data that controls the Maximum Skin Dose Radiation for **Continuous Fluoro in Manual Mode (Non-ABC) at 5 R/min** (43.5 mGy/min) (maximum level of regulation limit) with a maximum Fluoro kV at **125 kV**.

- E33 is used to store data that controls the Maximum Skin Dose Radiation for **Continuous Fluoro in Automatic Mode (ABC) at 10 R/min** (87 mGy/min) (maximum level of regulation limit) with a maximum Fluoro kV at **125 kV**.

- E42 is used to store data that controls the Maximum Skin Dose Radiation for **Continuous Fluoro + High Dose in Automatic Mode (ABC) at 20 R/min** (174 mGy/min) (maximum level of regulation limit) with a maximum Fluoro kV at **125 kV**.

Note that in practice, the rejection limits for entrance exposure rate must be somewhat less than the maximum specified due to Radiation Meter calibration accuracy. (*Refer to Table 2-3.*)

Table 2-3
Rejection Limits Based on Meter Calibration Accuracy (1 Rad = 8.7 mGy)

METER CALIBRATION ACCURACY	REJECTIONS LIMITS		
	FOR 5 R/min (43.5 mGy/min) MAXIMUM	FOR 10 R/min (87 mGy/min) MAXIMUM	FOR 20 R/min (174 mGy/min) MAXIMUM
±5%	4.75 R/min (41.3 mGy/min)	9.5 R/min (82.7 mGy/min)	19 R/min (165.4 mGy/min)
±10%	4.50 R/min (39.2 mGy/min)	9.0 R/min (78.3 mGy/min)	18 R/min (156.6 mGy/min)
±15%	4.25 R/min (37.0 mGy/min)	8.5 R/min (74.0 mGy/min)	17 R/min (148.0 mGy/min)

The functions of the Extended Memory Locations used to calibrate the Fluoro mA Display are:

Note ☞ *The Fluoro mA Display values entered in the following Extended Memory Locations are also used to calculate Heat Units. It is important to enter accurate values.*

- E60, E61, E62 are used to calibrate the Fluoro mA Display for **Pulsed Fluoro in Manual Mode (Non-ABC) at 5 R/min** (43.5 mGy/min). These values will be shown on the Fluoro mA Display during Fluoro exposures whenever maximum PPS are selected.
- E35, E36, E37 are used to calibrate the Fluoro mA Display for **Pulsed Fluoro in Automatic Mode (ABC) at 10 R/min** (87 mGy/min). These values will be shown on the Fluoro mA Display during Fluoro exposures whenever maximum PPS are selected.
- E52, E53, E54 are used to calibrate the Fluoro mA Display for **Continuous Fluoro in Manual Mode (Non-ABC) at 5 R/min** (43.5 mGy/min). These values will be shown on the Fluoro mA Display during Fluoro exposures whenever Continuous Fluoro is selected.
- E38, E39, E40 are used to calibrate the Fluoro mA Display for **Continuous Fluoro in Automatic Mode (ABC) at 10 R/min** (87 mGy/min). These values will be shown on the Fluoro mA Display during Fluoro exposures whenever Continuous Fluoro is selected.
- E43, E44, E45 are used to calibrate the Fluoro mA Display for **Continuous Fluoro + High Dose in Automatic Mode (ABC) at 20 R/min** (174 mGy/min). These values will be shown on the Fluoro mA Display during Fluoro exposures whenever Continuous Fluoro and High Dose are selected.

Fluoro functions are calibrated by performing the following steps:

1. With the Generator OFF, disconnect wires P1-1 and P1-2 on the HT Controller Board.

2. Turn the generator ON.

Make sure that the Small Filament of the X-ray tube is properly warmed-up (at less 15 minutes).

3. Set up a Radiation Meter to measure the Maximum Skin Dose Radiation. Position the Probe at the center of the primary beam with the entire active volume within the primary beam.

   Place the Tube-Collimator Assembly as close as possible to the Table-Top, fully open the Collimator Blades and align the Image Intensifier with the light beam. Block radiation input to Image Intensifier with a Lead Apron. (*Refer to Illustration 2-5*).

4. Enter in "*Manual Calibration*" mode through a Fluoro workstation and read the Filament Number at 120 kV / 10 mA. Divide this value by four (4) and enter it as starting value for **E22**, **E33**, **E42**, **E51** and **E59** Memory Location (Fluoro Filament Setting).

5. Select **E19** Memory Location and set the maximum Fluoro kV at125 kV or more if it is possible.

6. Select **E46** Memory Location and select the Fluoro operation mode by entering value: "0" for Continuous Fluoro Only, "1" for Continuous and Pulsed Fluoro, or "2" for Pulsed Fluoro Only.

7. Enter in user mode inside calibration mode by pressing the "*Go to User Mode*" button and select the Fluoro Menu.

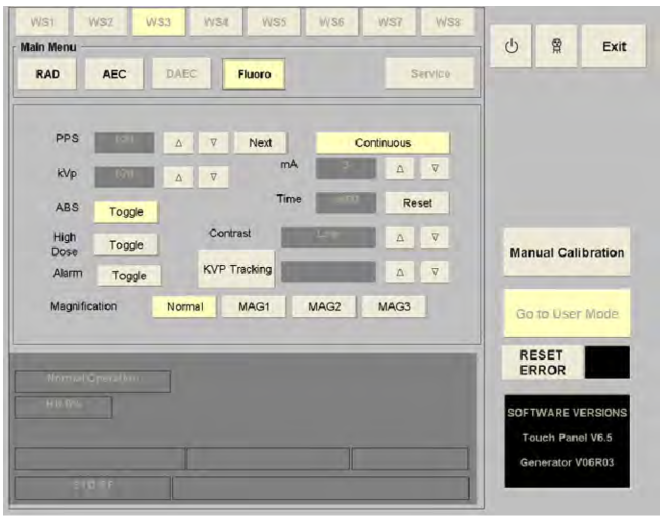
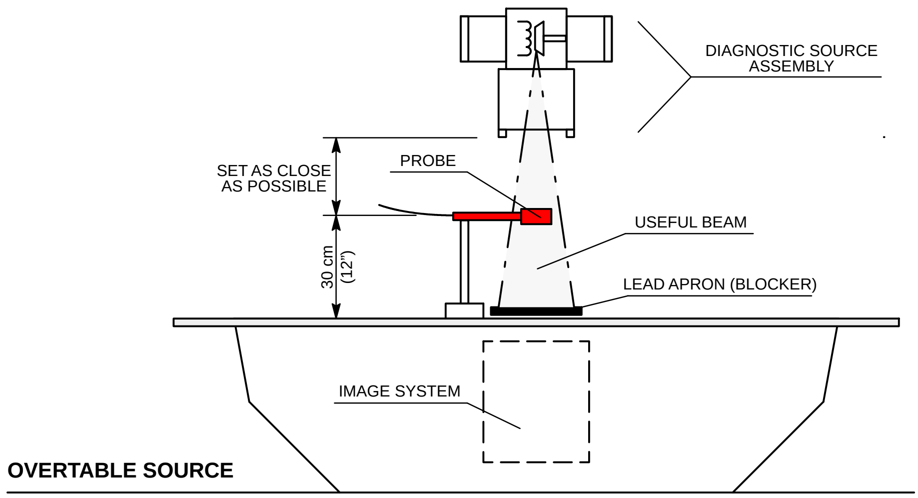
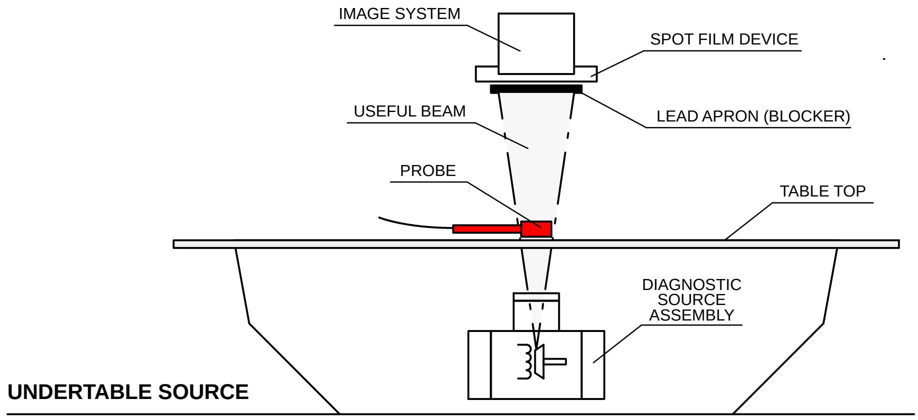


Illustration 2-5
Fluoro Entrance Exposure Rate Test Set-up





8. For calibration of **E59** Memory Location select:

   - Maximum PPS (Pulsed Fluoro).
   - Non-ABC mode (ABC button deselected)
   - Maximum Fluoro kV (125 kV).

   Make a Fluoro exposure at maximum kV and measure the dose applied, it should not be over the Rejection Limits for 5 R/min (43.5 mGy/min) (*refer to Table 2-3.*).

   In case that the value is not acquired, change the Fluoro Filament Setting stored in **E59** as required until it is correctly calibrated to that dose. Keep in mind that radiation increases or decreases in accordance to value in **E59** is increased or decreased.

9. For calibration of **E22** Memory Location select:

   - Maximum PPS (Pulsed Fluoro).
   - ABC mode (ABC button selected)
   - Maximum Fluoro kV (125 kV).

   Make a Fluoro exposure at maximum kV and measure the dose applied, it should not be over the Rejection Limits for 10 R/min (87 mGy/min) (*refer to Table 2-3.*).

   In case that the value is not acquired, change the Fluoro Filament Setting stored in **E22** as required until it is correctly calibrated to that dose. Keep in mind that radiation increases or decreases in accordance to value in **E22** is increased or decreased.

10. For calibration of **E51** Memory Location select:

    - Continuous Fluoro.
    - Non-ABC mode (ABC button deselected)
    - Maximum Fluoro kV (125 kV).

    Make a Fluoro exposure at maximum kV and measure the dose applied, it should not be over the Rejection Limits for 5 R/min (43.5 mGy/min) (*refer to Table 2-3.*).

    In case that the value is not acquired, change the Fluoro Filament Setting stored in **E51** as required until it is correctly calibrated to that dose. Keep in mind that radiation increases or decreases in accordance to value in **E51** is increased or decreased.

11. For calibration of **E33** Memory Location select:

    - Continuous Fluoro.
    - ABC mode (ABC button selected)
    - Maximum Fluoro kV (125 kV).

    Make a Fluoro exposure at maximum kV and measure the dose applied, it should not be over the Rejection Limits for 10 R/min (87 mGy/min) (*refer to Table 2-3.*).

    In case that the value is not acquired, change the Fluoro Filament Setting stored in **E33** as required until it is correctly calibrated to that dose. Keep in mind that radiation increases or decreases in accordance to value in **E33** is increased or decreased.

12. For calibration of **E42** Memory Location select:

    - Continuous Fluoro.
    - High Dose (High Dose button selected).
    - ABC mode (ABC button selected)
    - Maximum Fluoro kV (125 kV).

    Make a Fluoro exposure at maximum kV and measure the dose applied, it should not be over the Rejection Limits for 20 R/min (147 mGy/min) (*refer to Table 2-3.*).

    In case that the value is not acquired, change the Fluoro Filament Setting stored in **E42** as required until it is correctly calibrated to that dose. Keep in mind that radiation increases or decreases in accordance to value in **E42** is increased or decreased.

13. The mA values displayed during Fluoro exposures are stored in the following Memory Locations:

FOR FILAMENT DEMAND RELATED TO	**FLUORO mA VALUE DISPLAYED AT**		
	50 kV	**80 kV**	**110 kV**
E59	E60	E61	E62
E22	E35	E36	E37
E51	E52	E53	E54
E33	E38	E39	E40
E42	E43	E44	E45

    The Fluoro mA values are obtained by measuring the average mA using a mA meter in Fluoro.

    During Fluoro exposure, mA values are read directly with a mA Meter in DC connected to the mA Test Points (banana plug connections) on the HV Transformer. Only for this purpose, remove the link between the banana plug connections on the HV Transformer.

14. For calibration of **E60**, **E61** and **E62** Memory Locations, select:

    - Maximum PPS (Pulsed Fluoro).
    - Non-ABC mode (ABC button deselected)

    Make the following Fluoro exposures:

    - Make a Fluoro exposure at 50 kV and take note below the mA reading, this value will be used as Fluoro mA at minimum kV (**E60**).
    - Make a Fluoro exposure at 80 kV and take note below the mA reading, this value will be used as Fluoro mA at medium kV (**E61**).
    - Make a Fluoro exposure at 110 kV and take note below the mA reading, this value will be used as Fluoro mA at maximum kV (**E62**).

FL mA value at 50 kV (E60)	FL mA value at 80 kV (E61)	FL mA value at 110 kV (E62)

15. For calibration of **E35**, **E36** and **E37** Memory Locations, select:

    - Maximum PPS (Pulsed Fluoro).
    - ABC mode (ABC button selected)

    Make the following Fluoro exposures:

    - Make a Fluoro exposure at 50 kV and take note below the mA reading, this value will be used as Fluoro mA at minimum kV (**E35**).
    - Make a Fluoro exposure at 80 kV and take note below the mA reading, this value will be used as Fluoro mA at medium kV (**E36**).
    - Make a Fluoro exposure at 110 kV and take note below the mA reading, this value will be used as Fluoro mA at maximum kV (**E37**).

FL mA value at 50 kV (E35)	FL mA value at 80 kV (E36)	FL mA value at 110 kV (E37)

16. For calibration of **E52**, **E53** and **E54** Memory Locations, select:

    - Continuous Fluoro.
    - Non-ABC mode (ABC button deselected)

    Make the following Fluoro exposures:

    - Make a Fluoro exposure at 50 kV and take note below the mA reading, this value will be used as Fluoro mA at minimum kV (**E52**).
    - Make a Fluoro exposure at 80 kV and take note below the mA reading, this value will be used as Fluoro mA at medium kV (**E53**).
    - Make a Fluoro exposure at 110 kV and take note below the mA reading, this value will be used as Fluoro mA at maximum kV (**E54**).

FL mA value at 50 kV (E52)	**FL mA value at 80 kV (E53)**	**FL mA value at 110 kV (E54)**

17. For calibration of **E38**, **E39** and **E40** Memory Locations, select:

    - Continuous Fluoro.
    - ABC mode (ABC button selected)

    Make the following Fluoro exposures:

    - Make a Fluoro exposure at 50 kV and take note below the mA reading, this value will be used as Fluoro mA at minimum kV (**E38**).
    - Make a Fluoro exposure at 80 kV and take note below the mA reading, this value will be used as Fluoro mA at medium kV (**E39**).
    - Make a Fluoro exposure at 110 kV and take note below the mA reading, this value will be used as Fluoro mA at maximum kV (**E40**).

FL mA value at 50 kV (E38)	**FL mA value at 80 kV (E39)**	**FL mA value at 110 kV (E40)**

18. For calibration of **E43**, **E44** and **E45** Memory Locations, select:

    - Continuous Fluoro.
    - High Dose (High Dose button selected).
    - ABC mode (ABC button selected)

    Make the following Fluoro exposures:

    - Make a Fluoro exposure at 50 kV and take note below the mA reading, this value will be used as Fluoro mA at minimum kV (**E43**).
    - Make a Fluoro exposure at 80 kV and take note below the mA reading, this value will be used as Fluoro mA at medium kV (**E44**).
    - Make a Fluoro exposure at 110 kV and take note below the mA reading, this value will be used as Fluoro mA at maximum kV (**E45**).

FL mA value at 50 kV (E43)	FL mA value at 80 kV (E44)	FL mA value at 110 kV (E45)

19. Remove the Radiation Meter and the Lead Apron (Blocker).
20. Exit from the "*User Mode*" screen by pressing "*Manual Calibration*" button.
21. Select **E19** Memory Location if it is required to reduce the value for the maximum Fluoro kV in the installation.
22. Select the Memory Locations for each mA Fluoro Display (**E35**, **E36**, **E37**, **E38**, **E39**, **E40**, **E43**, **E44, E45, E52, E53, E54, E60, E61** and **E62**) and store the respective mA values noted before multiplied by **10** (a.e. if the mA value noted is "3.2", store the value "32" in the respective Memory Location).
23. Record the new values in the Data Book.
24. Exit calibration mode.
25. **Turn the Generator OFF and connect wires P1-1 and P1-2 on the HT Controller Board.**

2.8 ABC CALIBRATION

Note ☞ *If the Generator is interfaced with an ATS Image System, ABC calibration procedure has to be performed as explained in the Image System documentation.*

The purpose of the ABC System is to maintain an optimum constant Image Tube Output Brightness by controlling the X-ray kV during Fluoro exams, regardless of changes in the patient opacity viewed on the TV monitor.

The closed-loop ABC System can monitor the Image Tube Output Brightness through two ways: Photomultiplier Tube or TV Camera.

2.8.1 ABC SYSTEM WITH PHOTOMULTIPLIER TUBE

Note ☞ *This operation requires the AEC Control Board A3012-x6/x7/x9 (Digital version).*

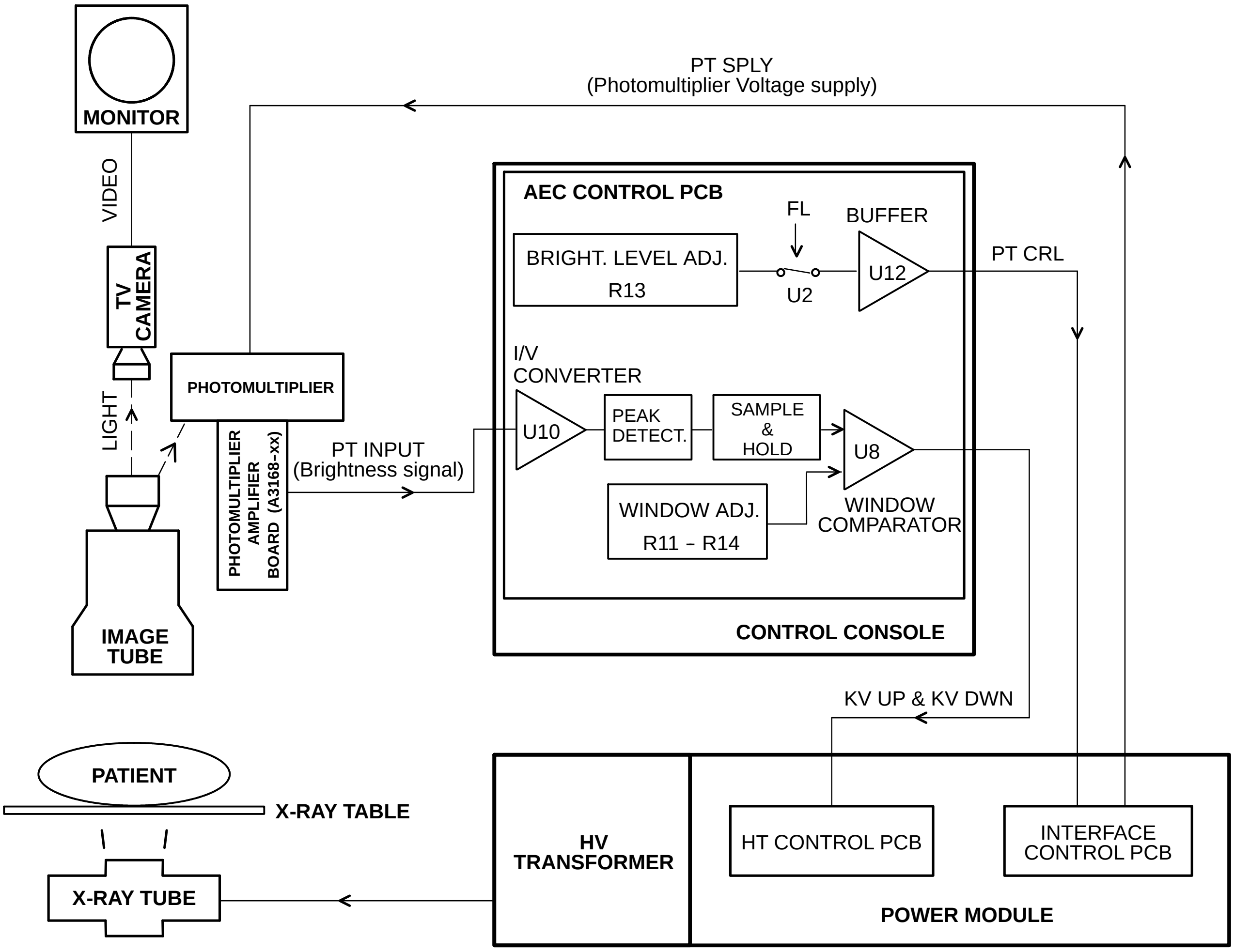
On this system the Photomultiplier current signal, which is proportional to the Image Tube Output Brightness, is used as brightness signal "*PT Input*" for the ABC circuitry of the Generator. (*Refer to Illustration 2-6*).

This analogic signal is converted to a voltage signal in the Photomultiplier Amplifier Board and sent to a peak-detector in the AEC Control Board. The peak signal obtained is then held through a "*Sample and Hold*" circuitry after a synchronism pulse. The peak signal held is adapted to obtain finally the "*ABC IN*" signal which is so the Photomultiplier signal-peak held between synchronism pulses. This signal is then compared to a window reference.

Brightness error at the comparator output is sent as "*kV Up*" and "*kV Down*" to the Generator where is used to drive the Fluoro kV control. The closed-loop operation requires more or less brightness thru "*kV Up*" and "*kV Down*" demand signals respectively. Patient Entrance Dose is automatically varied so that optimum constant Image Tube Output Brightness is maintained.

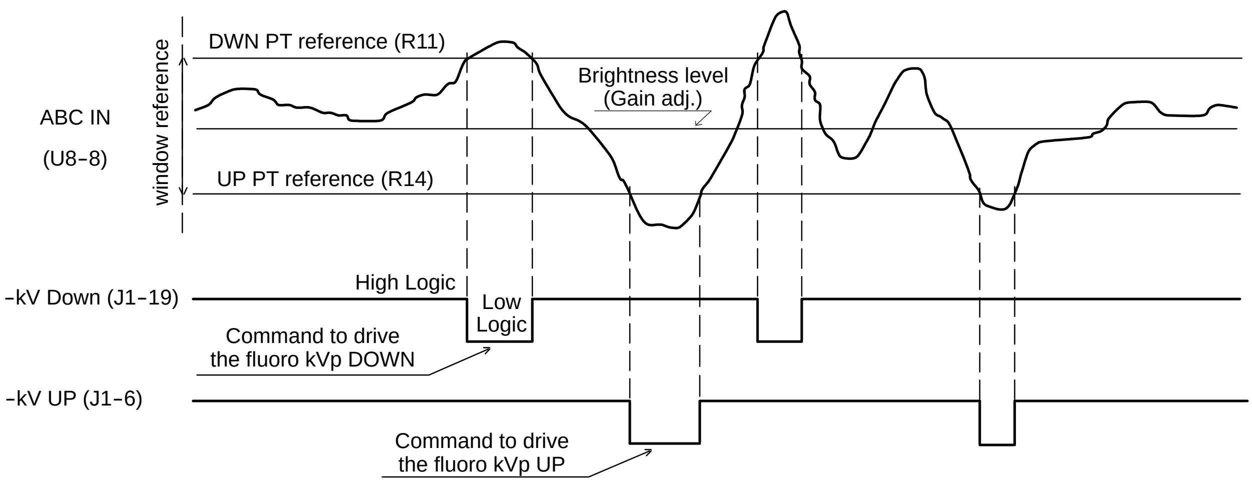
The optimum brightness level in ABC mode is set by adjusting Brightness Control Resistor R13 on the AEC Control Board, which controls the output of the Photomultiplier Tube High Voltage power supply on the Interface Control Board ("*PT CRL*" plus 5 volts programs the output to be 0 volts, and 0 volts programs the output to approximately −1200 volts). The window comparator requires an input range from 0 to +10 VDC for the "*ABC IN*" (the optimum brightness level will be achieved with a value between 5 and 7 VDC).

Illustration 2-6
ABC System for Photomultiplier Tube



Window reference could be adjusted first to set mid-way the brightness level (+5 VDC), and second to increase or decrease the range of response and sensitivity of the kV control to input variations (brightness changes). If oscillation occurs during ABC fluoro exposure, increase the dead zone by adjusting Resistors R11 and R14 on the AEC Control Board. (*Refer to Illustration 2-7 for ABC waveforms*).

Illustration 2-7
ABC Waveforms in AEC Control Board



Adjust the ABC system for Photomultiplier Tube as follow:

1. Be sure that the Video System and the Image Intensifier are powered and operating correctly.

2. Set up a Dosimeter as close as possible to the Image Intensifier Radiation Input to measure the Entrance Image Intensifier Exposure Dose Rate. Position the Probe at the center of the primary beam with the entire active volume within the primary beam.

   Place the Tube-Collimator Assembly at the normal SID (1 meter), fully open the Collimator Blades and align the Image Intensifier with the light beam.

3. Adjust TV Camera gain for 1 volt peak-to-peak composite video output.

4. Select: Non-ABC mode and Maximum PPS (if Pulsed Fluoro is allowed).

5. Place 2 mm of Copper (or equivalent homogeneous phantom) in the Collimator Filter Holder.

6. Calculate the value of the optimum radiation (that will give optimum brightness) to obtain for Pulsed Fluoro 2µR/frame at 9” FOV or to obtain for Continuous Fluoro 50µR/second at 9” FOV.

   Examples:

   For Continuous Fluoro, optimum radiation is 3 mR/min.
   50 µR/s x 60 s/min = 3000 µR/min = 3 mR/min.

   For Pulsed Fluoro at 25 frame/second, optimum radiation is 3 mR/min.
   2 µR/frame x 25 frame/s = 50 µR/s.
   50 µR/s x 60 s/min = 3000 µR/min = 3 mR/min.

   For Pulsed Fluoro at 30 frame/second, optimum radiation is 3.6 mR/min.
   2 µR/frame x 30 frame/s = 60 µR/s.
   60 µR/s x 60 s/min = 3600 µR/min = 3.6 mR/min.

   The optimum radiation value should be measured at Image Intensifier Radiation Input. Intensifier grid should be removed, if it can not be removed, this value should be multiplied by two or by the value specified as Grid Absorption Factor.

7. Make a Fluoro exposure at 70 kV and measure the radiation. Optimum radiation is obtained by modifying the Fluoro kV or the Copper thickness in the Collimator Filter Holder. First modify the Fluoro kV, if it is more than 80 kV or less than 60 kV modify the Copper thickness in 0.1 mm (or 0.2 mm). Note the value of Fluoro KV and Copper thickness used to obtain the optimum radiation.

Note ☞ *Radiation increases when kV is increased or Copper thickness is reduced.*

8. Perform the following adjustments in the AEC Control Board:

   a. Adjust R13 in order to obtain 6 VDC on TP3 (ABC IN).

   b. Select 70 kV (or the kV obtained in step-7.) and increase 2 kV and check the increased value of voltage in TP3 (ABC-IN) (if this value has not been increased, increase 1 kV more). Note this value **(consider it as KV-DOWN-SEL)**.

   c. Select 70 kV (or the kV obtained in step-7.) and decrease 2 kV and check the decreased value of voltage in TP3 (ABC-IN) (if this value has not been decreased, decrease 1 kV more). Note this value **(consider it as KV-UP-SEL)**.

   d. Obtain in TP1 the same voltage noted as kV-DOWN-SEL (DOWN PT) by adjusting the Potentiometer R11.

   e. Obtain in TP2 the same voltage noted as kV-UP-SEL (UP PT) by adjusting the Potentiometer R14.

9. Select 70 kV (or the kV obtained in step-7.) and ABC mode.

10. Make a Fluoro exposure and check that the kV does not change.

11. Stop the Fluoro exposure and select 40 kV. Make a Fluoro exposure and check that the kV value goes to 70 kV (or the kV obtained in step-7.) ±2 kV without System problems.

12. Stop the Fluoro exposure and select 100 kV. Make a Fluoro exposure and check that the kV value goes to 70 kV (or the kV obtained in step-7.) ±2 kV without System problems.

2.8.2 ABC SYSTEM WITH TV CAMERA

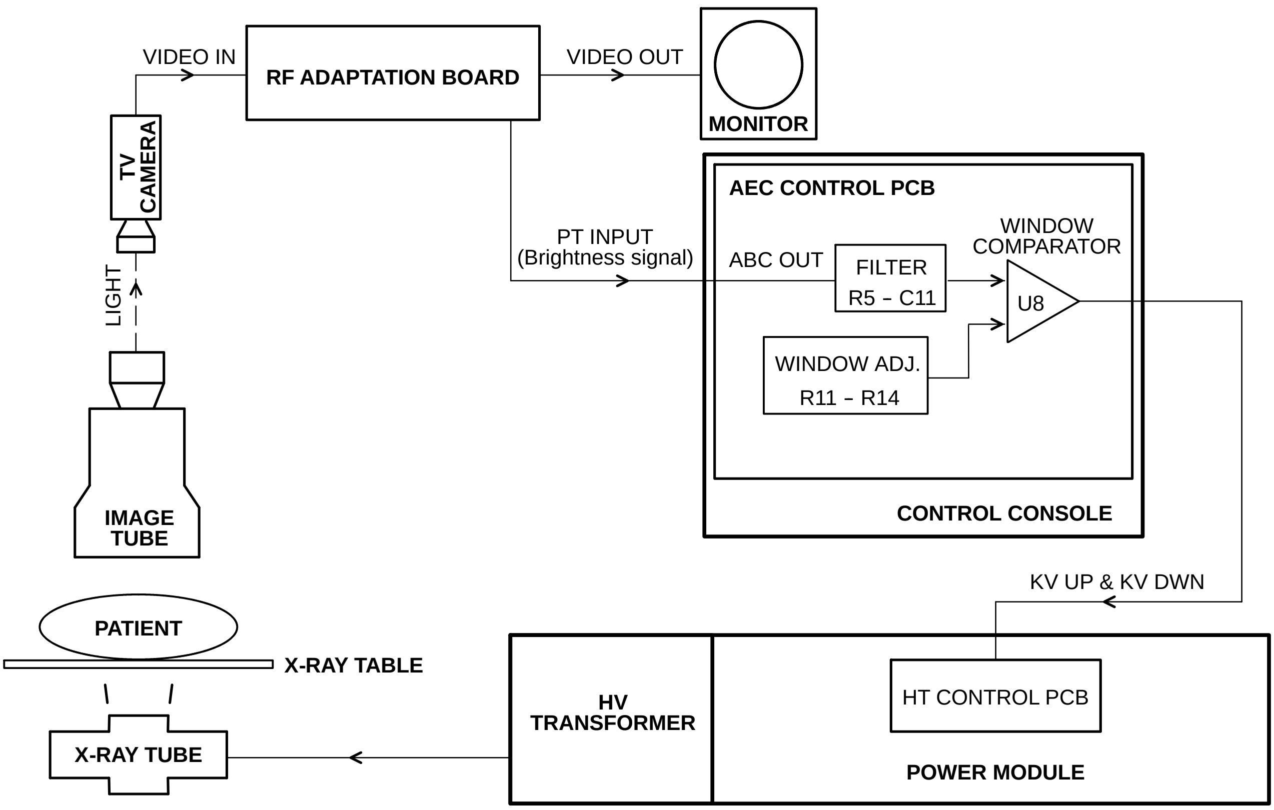
The ABC can be performed with an Analogic Signal Output (*ABC OUT*) proportional to the brightness or with the Composite Video Signal Output from the TV Camera.

The "*ABC OUT*" signal from the TV Camera is compatible with the Generator when the range is from 0 VDC (dark image) to 10 VDC (bright image) and the Optimum Brightness is achieved at around 6 VDC.

When a TV Camera without a direct "*ABC OUT*" signal is used, the Composite Video signal (which amplitude is proportional to the image tube output brightness) is sent to an RF Adaptation Board where it is transformed into an "*ABC OUT*" analogic signal. In this case, the brightness level is taken from a rectangular window from the center of the raster. (*Refer to Illustration 2-8*).

This analogic signal in the AEC Control Board (*"PT Input" in Board A3012-x1/x2/x5 and "ABC OUT" in Board A3012-x6/x7/x9*) is filtered, and compared to a window reference. Brightness error at the comparator output is sent as "*kV Up*" and "*kV Down*" to the Generator where is used to drive the fluoro kV control. The closed-loop operation requires more or less brightness thru "*kV Up*" and "*kV Down*" demand signals respectively. Patient entrance dose is automatically varied so that constant image tube output brightness is maintained.

Illustration 2-8
ABC System for TV Camera

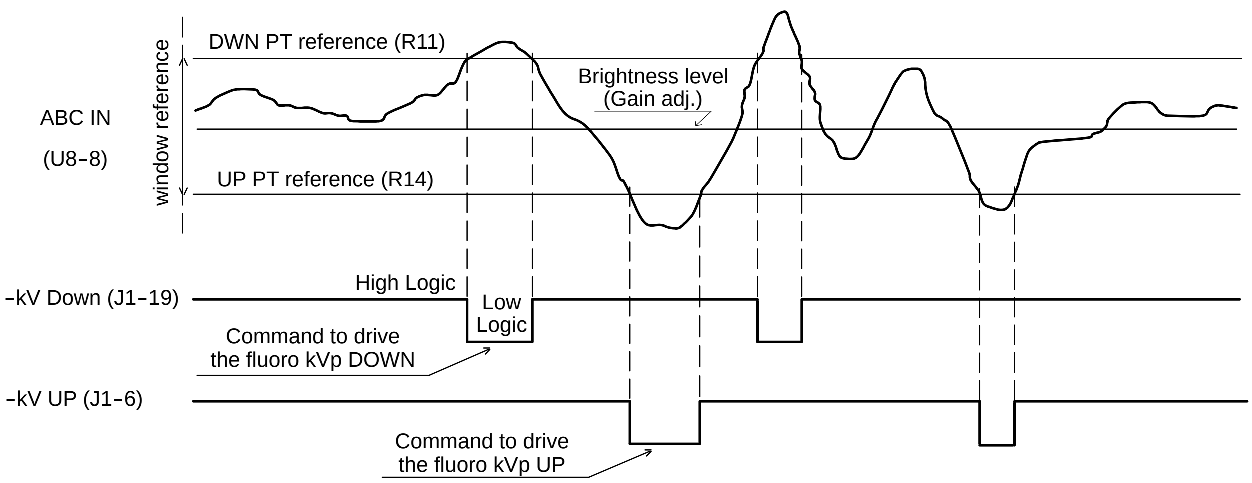


The optimum brightness level in ABC mode is set by adjusting the gain at R27 on the RF Adaptation Board. The "*ABC OUT*" signal requires an input range from 0 to +10 VDC (the stabilized value will be between 5 and 7 VDC).

Window reference could be adjusted first to set mid-way the brightness level (+6 VDC), and second to increase or decrease the range of response and sensitivity of the kV control to input variations (brightness changes). If oscillation occurs during ABC fluoro exposure, increase the dead zone by adjusting R11 and R14 on the AEC Control Board. (*Refer to Illustration 2-9 for ABC waveforms*)

For system interface, refer to RF Adaptation Board. Adjust ABC System according to the following procedures.

Illustration 2-9
ABC Waveforms in AEC Control Board



2.8.2.1 ABC SYSTEM ADJUSTMENT WITH ABC SIGNAL FROM TV CAMERA COMPATIBLE WITH THE GENERATOR

1. Be sure that the Video System and the Image Intensifier are powered and operating correctly.

2. Set up a Dosimeter as close as possible to the Image Intensifier Radiation Input to measure the Entrance Image Intensifier Exposure Dose Rate. Position the Probe at the center of the primary beam with the entire active volume within the primary beam.

   Place the Tube-Collimator Assembly at the normal SID (1 meter), fully open the Collimator Blades and align the Image Intensifier with the light beam.

3. Adjust TV Camera gain for 1 volt peak-to-peak composite video output.

4. Set Jumper JP21 in position B on the RF Adaptation Board.

5. Select: Non-ABC mode and Maximum PPS (if Pulsed Fluoro is allowed).

6. Place 2 mm of Copper (or equivalent homogeneous phantom) in the Collimator Filter Holder.

7. Calculate the value of the optimum radiation (that will give optimum brightness) to obtain for Pulsed Fluoro 2μR/frame at 9” FOV or to obtain for Continuous Fluoro 50μR/second at 9” FOV (*for more information refer to Image System documentation*).

   Examples:

   For Continuous Fluoro, optimum radiation is 3 mR/min.
   50 μR/s x 60 s/min = 3000 μR/min = 3 mR/min.

   For Pulsed Fluoro at 25 frame/second, optimum radiation is 3 mR/min.
   2 μR/frame x 25 frame/s = 50 μR/s.
   50 μR/s x 60 s/min = 3000 μR/min = 3 mR/min.

   For Pulsed Fluoro at 30 frame/second, optimum radiation is 3.6 mR/min.
   2 μR/frame x 30 frame/s = 60 μR/s.
   60 μR/s x 60 s/min = 3600 μR/min = 3.6 mR/min.

   The optimum radiation value should be measured at Image Intensifier Radiation Input. Intensifier grid should be removed, if it can not be removed, this value should be multiplied by two or by the value specified as Grid Absorption Factor.

8. Make a Fluoro exposure at 70 kV and measure the radiation. Optimum radiation is obtained by modifying the Fluoro kV or the Copper thickness in the Collimator Filter Holder. First modify the Fluoro kV, if it is more than 80 kV or less than 60 kV modify the Copper thickness in 0.1 mm (or 0.2 mm). Note the value of Fluoro KV and Copper thickness used to obtain the optimum radiation.

Note ☞ *Radiation increases when kV is increased or Copper thickness is reduced.*

9. Perform the adjustment for the window test as specified on the TV Camera manuals. This window defines the area of the image where the brightness will be captured for the ABC and it should be the 25% of the image area.

10. Adjust the TV Camera to obtain +6 VDC (or the voltage supplied by the TV Camera as optimum brightness) on TP3 (ABC IN) on the AEC Control Board (Refer the TV Camera manuals).

11. Perform the following adjustments in the AEC Control Board:

    a. Select 70 kV (or the kV obtained in step-8.) and increase 2 kV and check the increased value of voltage in TP3 (ABC-IN) (if this value has not been increased, increase 1 kV more). Note this value **(consider it as KV-DOWN-SEL)**.

    b. Select 70 kV (or the kV obtained in step-8.) and decrease 2 kV and check the decreased value of voltage in TP3 (ABC-IN) (if this value has not been decreased, decrease 1 kV more). Note this value **(consider it as KV-UP-SEL)**.

    c. Obtain in TP1 the same voltage noted as kV-DOWN-SEL (DOWN PT) by adjusting the Potentiometer R11.

    d. Obtain in TP2 the same voltage noted as kV-UP-SEL (UP PT) by adjusting the Potentiometer R14.

12. Select the 70 kV (or the kV obtained in step-8.) and ABC mode.

13. Make a Fluoro exposure and check that the kV does not change.

14. Stop the Fluoro exposure and select 40 kV. Make a Fluoro exposure and check that the kV value goes to 70 kV (or the kV obtained in step-8.) ±2 kV without System problems.

15. Stop the Fluoro exposure and select 100 kV. Make a Fluoro exposure and check that the kV value goes to 70 kV (or the kV obtained in step-8.) ±2 kV without System problems.

2.8.2.2 ABC SYSTEM ADJUSTMENT WITH AN ABC SIGNAL FROM TV CAMERA NOT COMPATIBLE WITH THE GENERATOR

1. Be sure that the Video System and the Image Intensifier are powered and operating correctly.

2. Set up a Dosimeter as close as possible to the Image Intensifier Radiation Input to measure the Entrance Image Intensifier Exposure Dose Rate. Position the Probe at the center of the primary beam with the entire active volume within the primary beam.

   Place the Tube-Collimator Assembly at the normal SID (1 meter), fully open the Collimator Blades and align the Image Intensifier with the light beam.

3. Adjust TV Camera gain for 1 volt peak-to-peak composite video output.

4. Set on the RF Adaptation Board, Jumpers JP21 in position “A” and JP20 in position “B” (for negative ABC signal) or in position “C” (for positive ABC signal).

5. Select: Non-ABC mode and Maximum PPS (if Pulsed Fluoro is allowed).

6. Place 2 mm of Copper (or equivalent homogeneous phantom) in the Collimator Filter Holder.

7. Calculate the value of the optimum radiation (that will give optimum brightness) to obtain for Pulsed Fluoro 2μR/frame at 9” FOV or to obtain for Continuous Fluoro 50μR/second at 9” FOV (*for more information refer to Image System documentation*).

   Examples:

   For Continuous Fluoro, optimum radiation is 3 mR/min.
   50 μR/s x 60 s/min = 3000 μR/min = 3 mR/min.

   For Pulsed Fluoro at 25 frame/second, optimum radiation is 3 mR/min.
   2 μR/frame x 25 frame/s = 50 μR/s.
   50 μR/s x 60 s/min = 3000 μR/min = 3 mR/min.

   For Pulsed Fluoro at 30 frame/second, optimum radiation is 3.6 mR/min.
   2 μR/frame x 30 frame/s = 60 μR/s.
   60 μR/s x 60 s/min = 3600 μR/min = 3.6 mR/min.

   The optimum radiation value should be measured at Image Intensifier Radiation Input. Intensifier grid should be removed, if it can not be removed, this value should be multiplied by two or by the value specified as Grid Absorption Factor.

8. Make a Fluoro exposure at 70 kV and measure the radiation. Optimum radiation is obtained by modifying the Fluoro kV or the Copper thickness in the Collimator Filter Holder. First modify the Fluoro kV, if it is more than 80 kV or less than 60 kV modify the Copper thickness in 0.1 mm (or 0.2 mm). Note the value of Fluoro KV and Copper thickness used to obtain the optimum radiation.

Note ☞ *Radiation increases when kV is increased or Copper thickness is reduced.*

9. Perform the adjustment for the window test as specified on the TV Camera manuals. This window defines the area of the image where the brightness will be captured for the ABC and it should be the 25% of the image area.

10. Select the 70 kV (or the kV obtained in step-8.) and Non-ABC mode.

11. Adjust R29 (OFFSET) on the RF Adaptation Board to have 0 VDC in TP7.

12. Adjust gain at R27 (Gain) on the RF Adaptation Board to make the "*ABC OUT*" signal equal to +6 VDC. Measure "*ABC OUT*" in TP-7 of RF Adaptation Board or in TP3 ("*ABC IN*") of the AEC Control Board.

13. Perform the following adjustments in the AEC Control Board:

    a. Select 70 kV (or the kV obtained in step-8.) and increase 2 kV and check the increased value of voltage in TP3 (ABC-IN). Note this value **(consider it as KV-DOWN-SEL)**.

    b. Select 70 kV (or the kV obtained in step-8.) and decrease 2 kV and check the decreased value of voltage in TP3 (ABC-IN). Note this value **(consider it as KV-UP-SEL)**.

    c. Obtain in TP1 the same voltage noted as kV-DOWN-SEL (DOWN PT) by adjusting the Potentiometer R11.

    d. Obtain in TP2 the same voltage noted as kV-UP-SEL (UP PT) by adjusting the Potentiometer R14.

14. Select the 70 kV (or the kV obtained in step-8.) and ABC mode.

15. Make a Fluoro exposure and check that the kV does not change.

16. Stop the Fluoro exposure and select 40 kV. Make a Fluoro exposure and check that the kV value goes to 70 kV (or the kV obtained in step-8.) ±2 kV without System problems.

17. Stop the Fluoro exposure and select 100 kV. Make a Fluoro exposure and check that the kV value goes to 70 kV (or the kV obtained in step-8.) ±2 kV without System problems.

2.8.2.3 ABC SYSTEM ADJUSTMENT WITH NO ABC SIGNAL FROM TV CAMERA

1. Be sure that the Video System and the Image Intensifier are powered and operating correctly.

2. Set up a Dosimeter as close as possible to the Image Intensifier Radiation Input to measure the Entrance Image Intensifier Exposure Dose Rate. Position the Probe at the center of the primary beam with the entire active volume within the primary beam.

   Place the Tube-Collimator Assembly at the normal SID (1 meter), fully open the Collimator Blades and align the Image Intensifier with the light beam.

3. Adjust TV Camera gain for 1 volt peak-to-peak composite video output.

4. Set on the RF Adaptation Board, Jumpers JP21 in position “A” and JP20 in position “A”.

5. Select: Non-ABC mode and Maximum PPS (if Pulsed Fluoro is allowed).

6. Place 2 mm of Copper (or equivalent homogeneous phantom) in the Collimator Filter Holder.

7. Calculate the value of the optimum radiation (that will give optimum brightness) to obtain for Pulsed Fluoro 2µR/frame at 9” FOV or to obtain for Continuous Fluoro 50µR/second at 9” FOV.

   Examples:

   For Continuous Fluoro, optimum radiation is 3 mR/min.
   50 µR/s x 60 s/min = 3000 µR/min = 3 mR/min.

   For Pulsed Fluoro at 25 frame/second, optimum radiation is 3 mR/min.
   2 µR/frame x 25 frame/s = 50 µR/s.
   50 µR/s x 60 s/min = 3000 µR/min = 3 mR/min.

   For Pulsed Fluoro at 30 frame/second, optimum radiation is 3.6 mR/min.
   2 µR/frame x 30 frame/s = 60 µR/s.
   60 µR/s x 60 s/min = 3600 µR/min = 3.6 mR/min.

   The optimum radiation value should be measured at Image Intensifier Radiation Input. Intensifier grid should be removed, if it can not be removed, this value should be multiplied by two or by the value specified as Grid Absorption Factor.

8. Make a Fluoro exposure at 70 kV and measure the radiation. Optimum radiation is obtained by modifying the Fluoro kV or the Copper thickness in the Collimator Filter Holder. First modify the Fluoro kV, if it is more than 80 kV or less than 60 kV modify the Copper thickness in 0.1 mm (or 0.2 mm). Note the value of Fluoro KV and Copper thickness used to obtain the optimum radiation.

Note ☞ *Radiation increases when kV is increased or Copper thickness is reduced.*

9. Perform the adjustment for the window test. This window defines the area of the image where the brightness will be captured for the ABC.

   a. Calculate the image area πr^2 (clear circle on the monitor). (r=circle radius).

   b. Calculate the 25% of the image area ($\pi r^2/4$).

   c. Calculate the sides of the window: l = $\sqrt{\pi r^2 / 4}$ (l= side of square).

   d. Mark the calculated area on the monitor (square).

   e. Position jumper JP18 of RF Adaptation Board in “A”. A window will be displayed on the monitor.

   f. Adjust in the RF Adaptation Board the following potentiometers to move the window under the frame marked on the monitor in step-d:

      - R1 potentiometer (vertical position)
      - R2 potentiometer (vertical width)
      - R3 potentiometer (horizontal position)
      - R4 potentiometer (horizontal width)

   g. Once the window is configured, place JP18 in “B” again at RF Adaptation Board.

10. Select the 70 kV (or the kV obtained in step-8.) and Non-ABC mode.

11. Adjust the gain at R27 on the RF Adaptation Board to make the “*ABC OUT*” signal equal to +6 VDC. Measure “*ABC OUT*” in TP7 of RF Adaptation Board or in TP3 (”*ABC IN*”) of the AEC Control Board.

12. Perform the following adjustments in the AEC Control Board:

    a. Select 70 kV (or the kV obtained in step-8.) and increase 2 kV and check the increased value of voltage in TP3 (ABC-IN) (if this value has not been increased, increase 1 kV more). Note this value **(consider it as KV-DOWN-SEL)**.

    b. Select 70 kV (or the kV obtained in step-8.) and decrease 2 kV and check the decreased value of voltage in TP3 (ABC-IN) (if this value has not been decreased, decrease 1 kV more). Note this value **(consider it as KV-UP-SEL)**.

    c. Obtain in TP1 the same voltage noted as kV-DOWN-SEL (DOWN PT) by adjusting the Potentiometer R11.

    d. Obtain in TP2 the same voltage noted as kV-UP-SEL (UP PT) by adjusting the Potentiometer R14.

13. Select the 70 kV (or the kV obtained in step-8.) and ABC mode.

14. Make a Fluoro exposure and check that the kV does not change.

15. Stop the Fluoro exposure and select 40 kV. Make a Fluoro exposure and check that the kV value goes to 70 kV (or the kV obtained in step-8.) $\pm$4 kV without System problems.

16. Stop the Fluoro exposure and select 100 kV. Make a Fluoro exposure and check that the kV value goes to 70 kV (or the kV obtained in step-8.) $\pm$4 kV without System problems.

2.9 FINAL CHECKS

Verify that all Configuration and Calibration data have been properly stored in memory.

1. Enter in calibration mode and check that the values noted for the *“Filament Current Numbers”* and *“Extended Memory Locations”* tables of the Data Book are the same that the values displayed and stored in memory. Press the “*Read*” button to read the stored values.

2. Exit from calibration mode and Service mode.

3. Turn the Generator OFF and verify position of dip switches on the HT Controller Board are:

   - Dip switch 3000SW2-2 in “***Off***” position (enables Filament and Rotor Interlocks).

   - Dip switch 3000SW2-4 in “***Off***” position (Digital mA Loop Closed).

4. Set the Test dip switch 3024SW2-3 on the ATP Console CPU Board in “***Off***” position to place the Generator in normal operating mode.

Technical Publication
TR-1101R2

Troubleshooting

HF Series Generators
with Low or High Speed Starter

REVISION HISTORY

REVISION	DATE	REASON FOR CHANGE
0	JUN 29, 2015	First edition
1	JUN 28, 2016	Information about CTSC Console, Error E32 (Fail-Safe) and Error E82 (LV-DRAC)
2	OCT 26, 2017	Update of Errors E13 and E27

This Document is the English original version, edited and supplied by the manufacturer.
The Revision state of this Document is indicated in the code number shown at the bottom of this page.

ADVISORY SYMBOLS

The following advisory symbols will be used throughout this manual. Their application and meaning are described below.

DANGER !

DANGERS ADVISE OF CONDITIONS OR SITUATIONS THAT IF NOT HEEDED OR AVOIDED WILL CAUSE SERIOUS PERSONAL INJURY OR DEATH.

WARNING

ADVISE OF CONDITIONS OR SITUATIONS THAT IF NOT HEEDED OR AVOIDED COULD CAUSE SERIOUS PERSONAL INJURY, OR CATASTROPHIC DAMAGE OF EQUIPMENT OR DATA.

CAUTION

Advise of conditions or situations that if not heeded or avoided could cause personal injury or damage to equipment or data.

Note ☞

Alert readers on pertinent facts and conditions. Notes represent information that is important to know but which do not necessarily relate to possible injury or damage to equipment.

TABLE OF CONTENTS

SECTION 1 INTRODUCTION

The Generator contains many self-diagnostic routines which greatly facilitate troubleshooting. Self-diagnostic functions require a proper performance of all microprocessors. Each microprocessor contains LEDs that indicate correct operation.

As a general rule, the first step in any troubleshooting procedure is to verify correct Power Supply Voltages and perform a visual inspection of all Boards and Cable connections.

Upon arrival at the X-ray Room, the Service Engineer should carry out the following operations:

- If the Generator cannot be Powered up, run the troubleshooting for Error Code E01.
- If the Generator can be Powered up:
  - Check which Error Code is displayed on the Console and run the troubleshooting routines for the last Error Code displayed.
  - If there is no error code displayed, try to reproduce the failure in the conditions reported by the Operator. The Error Code displayed might be different from the one reported. In all cases, run the troubleshooting routines for the last Error Code displayed.

CAUTION

Whenever the HV Transformer, X-ray Tube, ATP Console CPU Board, HT Controller Board, or Filament Control Board is replaced in the Generator, the respective Configuration and Calibration procedures must be performed.

If the HT Controller Board or the ATP Console CPU Board are replaced, check that the Extended Memory data have not been lost or modified with the Board change. Compare Extended Memory data displayed on the Console with the values noted in the Data Book.

If the HT Controller Board is replaced in the Power Module, transfer U3-EEPROM from the old Board to the new Board. U3-EEPROM contains calibration data.

If U3-EEPROM is not transferred, a complete Calibration must be performed.

Make various exposures, using different techniques and Focal Spots, to verify that mA stations are calibrated correctly. If they are not, perform Calibration procedures.

Update and record in the Data Book any new data entered in the Extended Memory Locations.

1.1 TOOLS AND TEST EQUIPMENT

The following hand tools and products are required for the Troubleshooting:

- Standard service engineer's tool kit, including a reversible ratchet with socket set.
- Silicone Insulating Grease (proofing compound) (included in the X-ray Tube package).
- HV Oil (included in the HV Cables package).
- Alcohol cleaning agent.

The following test equipment is required for some Configuration and Calibration procedures carried out during Troubleshooting:

- Calculator.
- Anti-static Kit.
- Digital Multimeter.
- Non-invasive kVp Meter.
- Digital mAs Meter.
- Oscilloscope (Tektronics 486 or similar).
- *Only for AEC purposes:*
  - Sensitometer.
  - Densitometer.
  - Copper Plates for the Collimator Filter Holder (recommended for AEC calibration):
    2 units of 1 mm thickness,
    1 unit of 0.5 mm thickness,
    2 units of 0.2 mm thickness,
    1 unit of 0.1 mm thickness.
  - Acrylic Plastic Plates can be used Instead of Copper Plates:
    6 units of 5 cm. thickness,
    5 units of 1cm. thickness.
- *Only for Tomo purposes:*
  - Tomophantom tool.

1.2 GENERAL CAUTIONS

MAKE SURE THAT THE MAIN STORAGE CAPACITORS OF THE HIGH VOLTAGE INVERTER DO NOT CONTAIN ANY RESIDUAL CHARGE. WAIT UNTIL THE LIGHT EMITTING DIODES (LEDS) ON THE CHARGE-DISCHARGE MONITOR BOARDS ARE OFF (APPROXIMATELY THREE (3) MINUTES AFTER THE UNIT IS TURNED OFF).

TO AVOID ELECTRIC SHOCK, DO NOT TOUCH ANY HEATSINK OF THE CIRCUIT BOARDS EVEN THE GENERATOR IS TURNED OFF. PREVIOUS TO DISASSEMBLE ANY BOARD, REMOVE ALL CONNECTORS PLUGGED TO IT.

DO NOT SUPPLY THE MAIN POWER FROM THE ELECTRICAL ROOM CABINET (MAIN DISCONNECT) OR TURN ON THE SYSTEM UNTIL SPECIFICALLY INSTRUCTED IN THIS DOCUMENT.

<u>ALWAYS</u> HAVE THE "IPM DRIVER BOARD" CONNECTED IN THE GENERATOR PREVIOUS TO ACTIVATING MAINS POWER. IF THE "IPM DRIVER BOARD" IS NOT CONNECTED, IRREVERSIBLE DAMAGE WILL OCCUR TO THE IGBTS.

<u>LINE POWERED GENERATOR</u>:
THIS GENERATOR IS PERMANENTLY CONNECTED TO THE POWER LINE AND POWERED ON UNLESS THE SAFETY SWITCH INSTALLED IN THE ROOM ELECTRICAL CABINET IS OFF. WHEN THE GENERATOR IS POWERED ON, THE NEON LAMP (GREEN) LOCATED ON THE TRANSFORMER 6T2 (GENERATOR CABINET) IS ON.

INTERNAL PARTS OF THE GENERATOR (ALL FUSES, LINE CONTACTOR (6K5), INPUT TRANSFORMER (6T2), ON/OFF RELAY (3K3) AND LF-RAC MODULE) RECEIVE CONTINUOUS POWER THROUGH THE POWER LINE ALTHOUGH THE CONTROL CONSOLE IS OFF. BE SURE THAT THE SAFETY SWITCH IS OFF BEFORE HANDLING ANY INTERNAL PART OF THE EQUIPMENT.

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SECTION 2 GENERAL PROCEDURES

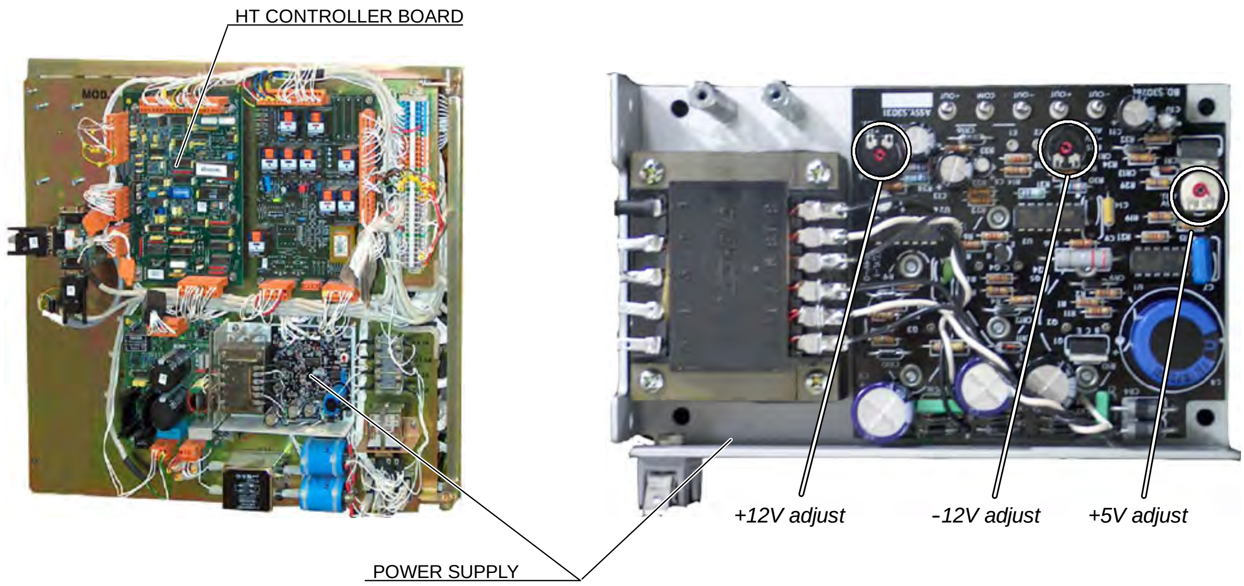
2.1 LOW DC VOLTAGE POWER SUPPLY TEST

The Generator operates from a Low DC Voltage Power Supply located in the Front Panel (MOD. 3) of the Generator Cabinet. (*Refer to Illustration 2-1*).

Turn the Generator ON and with a Digital Multimeter measure between:

- P2-3 (+) and P2-4 on the HT Controller Board. Check that the voltage at this point is +5 (±0.2 VDC). If required, adjust voltage with the +5 VDC Adjustment Potentiometer on the Power Supply Board.
- P2-2 (+) and P2-4 on the HT Controller Board. Check that the voltage at this point is +12 (±0.1 VDC). If required, adjust voltage with the +12 VDC Adjustment Potentiometer on the Power Supply Board.
- P2-1 (–) and P2-4 on the HT Controller Board. Check that the voltage at this point is –12 (±0.1 VDC) (this voltage must be –12.7 (±0.1 VDC) if the Console is provided with a Graphic Display). If required, adjust voltage with the –12 VDC Adjustment Potentiometer on the Power Supply Board.

Illustration 2-1
Power Supply and HT Controller Board in the Front Panel



The ATP Console CPU Board operates from a 12 VDC Unregulated Supply located in the Generator Cabinet that supplies to a 5 VDC switching regulator located in the ATP Console CPU Board.

The ATP Console CPU Board is located in the Back Panel (MOD.4) of the Generator Cabinet.

Turn the generator ON and with a Digital Multimeter measure between:

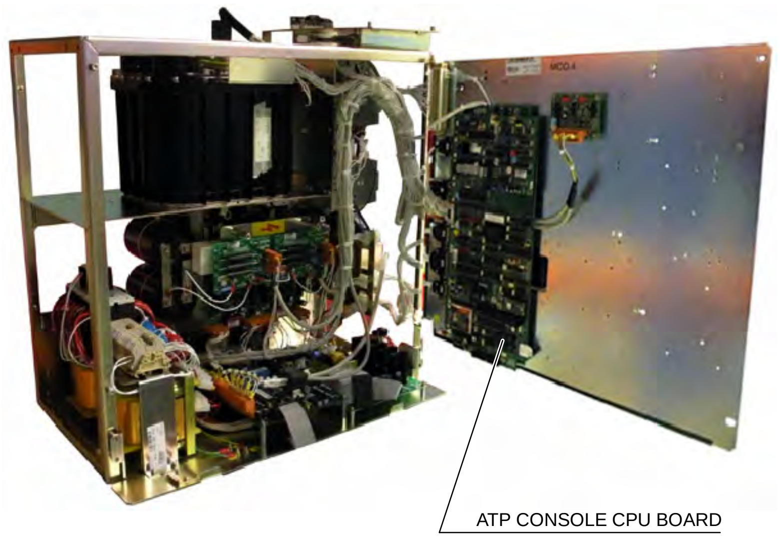
- J1-2 or J1-8 (12V UNR) with J1-6 or J1-1 (GND) on the ATP Console CPU Board; likewise, TP11 (GND UNR) with TP9 (12V UNR) on the ATP Console CPU Board. Check that the voltage at this point is +12 (±1.5 VDC).

  If the measured voltage is not +12 (±1.5 VDC), check the 12 VDC Unregulated Supply of the generator, that is, between terminals 11 and 12 of the Input Transformer 6T2, Fuse 3F7 (3A, 250 V), Contactor 3K3, Rectifier 3BR4, and Capacitor 3C7. (*Refer to schematic 543020xx*).

- TP1 GND and TP3 +5 V on the ATP Console CPU Board. Check that the voltage at this point is +5 (±0.2 VDC). If not, replace the ATP Console CPU Board.

Note ☞ *No adjustments are required for both voltage measurements.*

Illustration 2-2
ATP Console CPU Board in the Back Panel



2.2 MICROPROCESSORS AND GENERAL OPERATION

The following LEDs indicate the proper operation of each Microprocessor in the Generator:

- The LED DS1 located on the HT Controller Board blinks fast during power up, then slows to a steady blink of about two (2) per second, indicating that the Microprocessor U5 is operating normally.

- The LED DS2 located on the ATP Console CPU Board normally blinks at the same rate as LED DS1 on the HT Controller Board, indicating that communication between both Boards is correct.

Also observe the following LEDs to facilitate general troubleshooting:

- When LED DS1 located on the Interface Control Board is ON (lit), it indicates that the Generator is ON.

- The LED DS1 located on the ATP Console CPU Board is normally ON (lit), indicating that the Watch-Dog Timer of the Console is operating and insuring the correct timing of data communications with the HT Controller Board.

2.3 REPLACEMENT OF MEMORY IN ATP CONSOLE CPU BOARD AND/OR HT CONTROLLER BOARD

Before starting up the system, you have to set ON the switch A3024SW2–3 at the ATP Console CPU Board to enable Service Mode. A few seconds after pressing the ON button on the Console, you will see E10 (this is shown because the EPROM U24 has been replaced).

Reset the error indication by pressing the respective button on the Console and keep it pressed until Error 10 disappears.

After this, the normal start up will take place.

It is recommended to set this switch back to OFF once the installation has been completed, so the operator will not have access to Configuration or Calibration Modes (Service Modes).

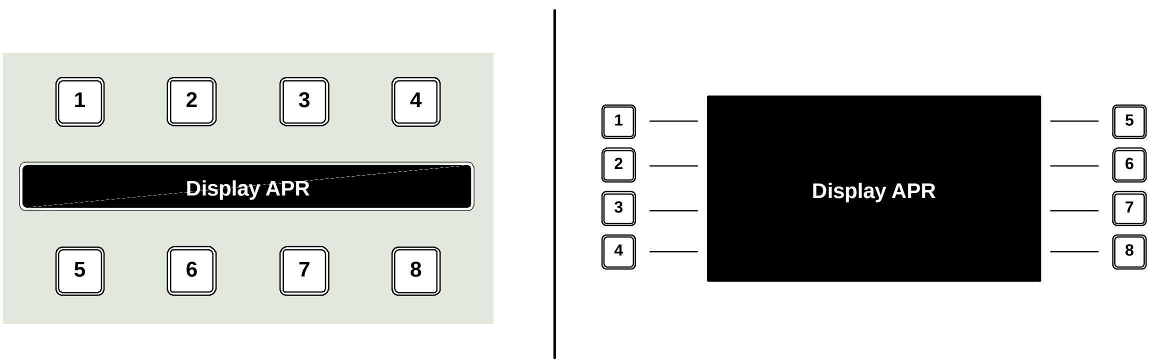
2.4 PROCEDURES RELATED TO THE PUSH-BUTTON CONSOLE

2.4.1 APR OPERATION

APR techniques are factory pre-programmed to standard techniques sets. All parameters of APR techniques may be manually rewritten as required by the operator and stored in the ”*APR working file*” for later use (*refer to the respective Operator Manua*l).

Note ☞ *This section only applies to Push-button Consoles equipped with Anatomical Programmer (APR).*

Illustration 2-3
APR Module version in Push-buttons Consoles



2.4.2 APR RE-INITIALIZATION

The APR re-initialization makes a new copy of the factory pre-programmed parameters of the APR techniques in the U23-NVRAM of the ATP Console CPU Board.

APR re-initialization sets the APR techniques for the selected workstation.

To re-initialize the APR techniques, exit the APR mode and simultaneously press the push-buttons 5-6-7-8 on the APR module. (*Refer to Illustration 2-3)*.

CAUTION

The APR re-initialization deletes all the APR parameters and related selections previously modified and stored by the operator for both X-ray Tubes.

2.4.3 APR BACKUP

The APR Backup copies parameters and selections of the APR techniques stored in the U23-NVRAM and transfers this information to the U18-E2PROM of the ATP Console CPU Board. This procedure copies all APR techniques stored in the "*APR working file*" and stores them in the "*APR backup file*" .

The APR backup is automatically performed when the equipment is turned OFF/ON, whenever any APR technique has been modified and stored in the U23-NVRAM by the operator.

To backup the APR techniques, exit the APR mode and simultaneously press push-buttons 1-5-6 of the APR module. (*Refer to Illustration 2-3*).

2.4.4 APR RESTORE

The APR Restore copies the parameters and selections of the APR techniques stored in the U18-E2PROM and transfers this information to the U23-NVRAM of the ATP Console CPU Board. This action replaces the data stored in the "*APR working file*" with the data in the "*APR backup file*" for all APR techniques.

The APR Restore is automatically performed when the Console is turned OFF-ON, whenever any problem had been detected during the U23-NVRAM checksum.

To restore the APR techniques, turn the Console ON and with the APR mode OFF press simultaneously the push-buttons 4-7-8 of the APR module. (*Refer to Illustration 2-3*).

2.5 PROCEDURES RELATED TO THE TPC TOUCH SCREEN CONSOLE

2.5.1 TROUBLESHOOTING THE TOUCH SCREEN CONSOLE

POSSIBLE CONDITIONS	
PROBLEM NUMBER	**DESCRIPTION / CIRCUMSTANCE**
1	CONSOLE AND GENERATOR DO NOT START-UP
2	CONSOLE STARTS-UP / GENERATOR DOES NOT START-UP.
3	CONSOLE BEEPS BEFORE START-UP
4	NO IMAGE ON THE SCREEN
5	OPERATING SYSTEM NOT LAUNCHED (START-UP ANOMALIES)
6	UPPER FANS HAVE STOPPED
7	TOUCH SCREEN NOT RESPONDING OR MISCALIBRATION

Note ☞

Ensure that the system is connected to the power source and that there is a power supply from the Generator to the Touch Screen Console. In some cases, the Touch Screen Console can be powered directly from the Mains.

Certain problems described below are circumstantial and assume a correct functioning of the equipment.

PROBLEM 1: THE CONSOLE AND GENERATOR DO NOT START-UP

Theory:

The ON signal is sent to J9 on the Interface Console TPC Board (A3515-xx) and turns on the PC (TPC). The OFF signal is sent to JP4 on the TPC Motherboard and turns off the PC (TPC). See schematic A3515-xx for more details. An External ON Connector is provided for a remote ON device and only used in certain setups.

J9 triggers K4 which activates /PS_ON, turning on the TPC Power Supply. When the TPC Motherboard has start-up, it sends a signal through the primary IDE port, latching the /PS_ON signal to GND. If the TPC Motherboard does not start-up the Power Supply will turn OFF as soon as the ON Button is released.

Possible Causes:

A malfunctioning ON button, cable connections or incorrect power supply may impede Start-up of the Console and Generator. Follow the steps below and see schematic 54302032 for more details.

1. Check connections and continuity (Ω) detailed below, replacing or repairing where necessary:

   - Switch pin 3 (ON SIGNAL) with J9-1 (also Pin 3 of the External ON Connector).

   - Switch pin 2 (Common) with J9-2 and JP4-1 (also Pin 1 of the External ON Connector).

   - Check Switch pin 1 (OFF) with JP4-2.

   If there is continuity in all the cables, the problem may be in the Kit Power Supply or the Interface Control TPC Board, proceed to the next step.

2. The connection behind the TPC Console cover ON button contains three pins. Their corresponding wires are 1 (OFF), 2 (Common / GND), 3 (ON). Disconnect 2 and 3. Make a short-circuit between 2 and 3 on the cable. If the TPC Console turns on then the ON button is defective and must be replaced. If the TPC Console does not turn on, the problem may be in the harness, proceed to the next step.

3. Check for 5V between J10-2 and J10-4. If 5V is not present, replace the Kit Power Supply. If 5V is present, replace the Interface Console TPC Board (A3515-xx).

PROBLEM 2: THE CONSOLE STARTS-UP BUT THE GENERATOR DOES NOT START-UP

Possible Causes:

This may be do to an error in the Interface Control Board (A3009-xx) in the Generator, an incorrect cable connection (Cable A7067-xx) or a malfunction in the A3515-xx Interface Console TPC board. Follow the steps below and see the schematic A3515-xx for more details.

1. Ensure that the Generator can be turned on independently. If the Generator does not turn on, see Error 33 in the Troubleshooting documentation. If the Generator turns on, proceed to the next step.

2. Check Continuity in the pins of A7067-xx replacing the cable where necessary. If there is continuity in the cable, proceed to the next step.

3. Open the Console and visually check the A6796-xx connection at J6 on the A3515-xx board replacing the connection if necessary. If there is a proper connection, replace the Interface Console TPC Board (A3515-xx).

PROBLEM 3: THE CONSOLE BEEPS BEFORE START-UP

Note ☞ *This may be a temporal corruption during the start-up dialogue, restart the console to confirm fault before attempting service.*

The Video Chip Set or DRAM will be at fault when the console, during start-up, emits either a single long beep followed by three short beeps (— · · ·), or a continuous series of long beeps (— — —).

Possible Causes:

These are BIOS errors and may be caused by either a corrupt power or DRAM connection; or a malfunctioning TPC Motherboard. See schematic 54302032 for more details.

Visually check and ensure a proper connection not only on the TPC Motherboard Processor and its ventilator but also on the DRAM board (repairing or replacing if necessary). If there is a proper connection, replace the TPC Motherboard.

PROBLEM 4: THERE IS NO IMAGE ON THE SCREEN

Possible Causes:

The most probable cause is a faulty or damaged TFT Inverter; however, a replacement of the other three main components (TFT screen, Cable 55001042 and Motherboard) may be necessary, even if the cause is in only one of them. Follow the steps below and see schematic 54302032 for more details.

1. Fans begin rotating when the Console is turned ON. Follow Troubleshooting steps for Problem 1 if fans do not begin rotating after having pressed the On button of the Console. If fans rotate when Console is turned ON, go to the next step.

2. Ensure a correct connection of the 55001042 cable at the TFT and the KIT PC at TFT LCD-1. Replace the cable in the event of visible damage. If no damage is present and the connections are correct, go to the next step.

3. The fluorescent lights used in the TFT are visible from the backside of the TFT Screen. If the lights are not visible from the backside of the screen, go to the next step. If the lights are visible, then the problem may be due to either the TFT Controller on the TPC Motherboard (A6671-xx) or the TFT Screen. Carry out the following tests. If all signals are correctly present, replace the TFT Screen.

   - Verify an active color range for Blue, Green and Red signals located at LCD1 pins 12, 20 and 19 respectively.

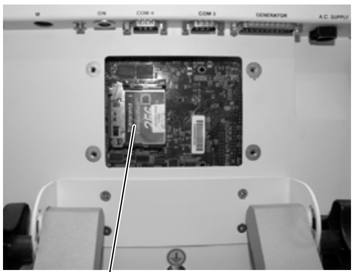
   - Ensure +3.3 V at LCD1 pins 5 & 6.

   If any of the signals are not correctly present, replace the Motherboard.

4. Check for +12 V (power supply from the TPC Motherboard to the Inverter Board) on the Connector LCD1, Pins 1 & 2. GND is located at Pins 3 & 4. If +12 V is not properly present, replace the Motherboard. If +12 V is present, replace the Inverter Board.

PROBLEM 5: OPERATING SYSTEM NOT LAUNCHED OR START-UP ANOMALIES

Note ☞ *This may be a temporary corruption or communication failure during the start-up dialogue, restart the console to confirm problem before attempting service.*



Compact Flash Memory

The Compact Flash Card located on the underside of the Console should contain all software necessary for the proper functioning of the Operating Application. Notwithstanding, it may be damaged or incorrectly formatted.

Troubleshooting for the Compact Flash Card must be performed with a properly trained Service Engineer to ensures correct and up-to-date formatting and operating system corrections. Messages during the start-up routine such as "*Disk Boot Failure*" appear with Compact Flash Card problems.

PROBLEM 6: UPPER FANS HAVE STOPPED

The Ventilation Fan and the Cooling Fan cool the Console and the Microprocessor on the Motherboard respectively. Follow the steps below and see schematics in the Service Manual for more details.

Note ☞ *The Unit may suffer irreversible damage if the ventilation fans are not functioning properly. Nevertheless, ensure that the Console functions properly before troubleshooting the fans.*

Ventilation Fans

1. Visually check for proper power supply cable connections to the fans: Check for 12 VDC on the Power Supply (Console side) of the ensemble. The 2 black wires are Common, Yellow is 12 VDC and red is 5V. The Power Supply to the Fans connects to a black and a yellow wire. If there is 12 V, replace Ventilation Fans. With a lack of 12 VDC, replace the Power Cable.

Cooling Fans

1. If the Cooling Fan is not functioning, the microprocessor on the Motherboard will heat up and eventually freeze the Touch Screen controls and processes. If the system freezes, first try to restart the system. If the condition consists, proceed to the next step.

2. Open the TPC and see if the Cooling Fan is rotating. Visually check connections for broken wires and proper connections. If connections and wires are ok, replace the Cooling Fan.

<u>PROBLEM 7: TOUCH SCREEN NOT RESPONDING OR TOUCH SCREEN MISCALIBRATION</u>

<u>Theory</u>:

The Touch Screen Control Board LED blinks when there is no pressure on the Touch Screen (when no selection is made). As soon as a selection is made on the Screen, the LED stops blinking and remains illuminated. The LED blinks again as soon as pressure is removed from the screen.

Communication between the Touch Screen Control Board (Connector JP2) and the Motherboard should have signals of RS232 at 9600 bps.

<u>Possible Causes</u>:

If calibration has been correctly performed, the problem could be in the Touch Panel Controller (Touch Screen Control Board) and may also involve replacing either Kit TFT Screen TPC (12”) or Kit PC TPC.

Note ☞ *Follow the instructions in the section entitled Touch Screen Sensor Calibration in this document.*

<u>LED STATUS</u>: LED IS BLINKING AND ILLUMINATED STATES CORRECT WHEN PRESSED.

Check the communication between the Motherboard and the Touch Screen Control Board by measuring at JP2 between Pin 2 and Pin 5 (GND) and Pin 3 and Pin 5. If there is a communication error, visually check the Motherboard (must be dismounted to check the underside). If no damage can be seen, replace the Touch Screen Control Board and communication cable.

If the error persists, replace the Motherboard (Kit PC TPC in Replacement Parts).

<u>LED STATUS</u>: LED IS BLINKING BUT DOES NOT CHANGE WHEN PRESSED.

If LED blinks and does not change when the Touch Screen is pressed, the problem is in the Touch Screen Sensor. Replace the Kit TFT Screen TPC (12”).

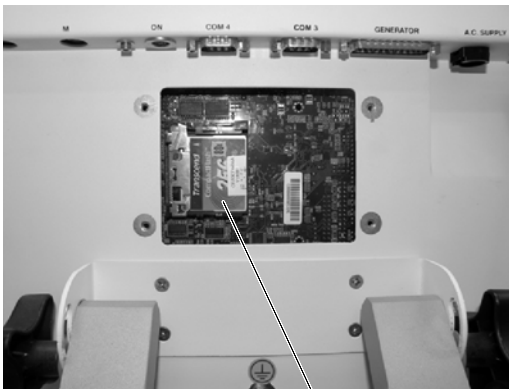
<u>LED STATUS</u>: LED IS NOT BLINKING NOR ILLUMINATED WHEN PRESSED.

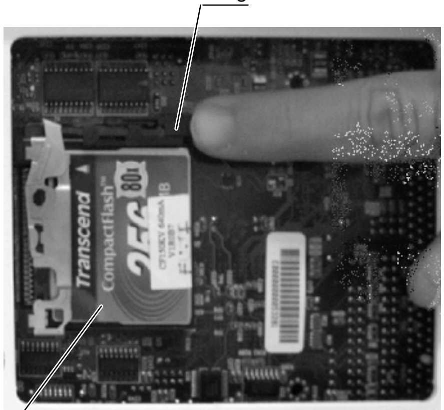
Check for 12 VDC between pins JP4-3 and JP4-2. If 12 VDC is present, replace Touch Screen Control Board. If 12 VDC is not present, check the continuity on A6766-xx from JP4 to J7 on the A3515-xx board. Replace the A6766-xx cable if there is no continuity. Replace the Interface Console TPC Board (A3515-xx). if there is continuity.

2.5.2 REPLACEMENT OF COMPÀCT FLASH MEMORY INSIDE THE TOUCH SCREEN CONSOLE

1. Turn OFF the Generator and Console.
2. Disconnect the Serial Communication (COM1), COM3 and COM4 cables at the rear side of the Touch Screen Console.

3. Remove the Cover at the rear side of the Console.
4. Remove the Compact Flash Memory by pushing its housing leg. Insert the new Compact Flash Memory and verify the correct connection of the Compact Flash terminals.





5. Re-install the cover and connect the cables.

2.5.3 SOFTWARE UPGRADE

If the Touch Screen Application is provided with a "*Software Upgrade*" button on the Service Mode Menu, it is used to close the Application Program without turning OFF the System. After pressing this button, the Console shows the PC Desktop to enable the Application Software Upgrade, Language Configuration of the PC Operating System or Touch Screen Sensor Calibration.

Note ☞ *To perform any of these operations, it is necessary to connect a Keyboard to the connector labelled "Kb" on the back side of the Touch Screen Console.*

Ensure that the Keyboard connector is suitable (MiniDin type).

2.5.4 TOUCH SCREEN SENSOR CALIBRATION

The Sensor of the Touch Screen needs calibration when the buttons can not be properly selected or when the Compact Flash has been changed.

CALIBRATION FOR AN "ELO" TOUCH SCREEN SENSOR

1. Enter in "*Service Mode*" and press the "*Software Upgrade*" button.
2. Press the "*Start-Windows*" button on the keyboard connected to the Touch Screen Console, then select (double-click): "*Settings / Control Panel / EloTouchscreen*".
3. Execute the "*Align*" program and follow the process touching on the indicated places. Click on "Yes" and "OK", then close the "Control Panel".
4. Return to the Application through "*Start*" and select: "*Programs / Start up (select the first one) / Console*".

2.5.5 TOUCH SCREEN BRIGHTNESS ADJUSTMENT

1. Connect a Keyboard and Mouse to the Touch Screen Console.
2. Press CTRL+ALT+SUPR to launch the Task Manager. Click on "*End Task*" to stop the application.
3. Press "Windows" key and launch "Start/Settings/Control Panel/Display/S3 Gamma Plus/Brightness".
4. Adjust the brightness at your convenience by the corresponding control and click on "*Apply*".
5. Close all windows and launch the "SEDECAL" application by "Start/Programs/Startup/Sedecal" (*the last name can be different depending on the application*).

2.5.6 EXTERNAL BACKUP OF THE APR TECHNIQUES

1. Connect a Laptop (PC) to the Touch Screen Console with a serial cable (*DB9 with female pins on both ends; on one end Pin 2 connects with Pin 3; on the other end Pin 2 connects with Pin 3; Pin 5 connects with Pin 5*). Connect the serial cable to port "**COM4**" of the Touch Screen Console and any free port on the Laptop (PC).

2. On the Laptop (PC):

   a. Select: "*StartMenu* / *Programs / Accessories / Communications / Hyperterminal / hypertrm.exe*".

   b. Once the Hyperterminal is opened on the Laptop (PC), configure the connection. For that select on the Menu bar:

      File -> Properties -> Connect using: ***COM * (selected free port)***

      Configure -> *Bits per second:* ***115200***
      Data Bits: ***8***
      Parity: ***None***
      StopBits: ***1***
      Flow Control: ***None***

   c. Press "*OK*" on the two windows to save and close.

   d. Select on the Menu bar: *Transfer ->* ***Receive File***

      on this window select:

      Place received file in the following folder:
      (choose a folder in the Laptop)

      Use receiving protocol:
      Xmodem

   e. A window will emerge, do not press "***Receive***". Go to step 3

3. On the Touch Screen Console:

   a. Enter in "*Service Mode*" and press the "*Software Upgrade*" button.

   b. Press the "*Start-Windows*" button on the keyboard connected to the Touch Screen Console, then select: "*Programs / accessories / hyperterminal / PORT4.ht*".

c. With the Hyperterminal open on the Touch Screen Console, the connection configuration is made by selecting the following from the Menu bar:

File -> Properties -> Connect using: ***COM4***

Configure -> *Bits per second:* ***115200***
Data Bits: ***8***
Parity: ***None***
StopBits: ***1***
Flow Control: ***None***

d. Press "*OK*" on the two windows to save and close.

e. Select on the Menu bar: *Transfer ->* ***Send File***

and on the emerging window select:

Filename:
C:\ program files \ Rad_Console *(this name may be different)* ***\ APR_English.ini*** *(or* ***APR_French.ini, APR_Spanish.ini, APR_German.ini, APR_Italian.ini, or APR_Portuguese.ini*** *according to the APR language previously selected in the Settings / Settings Menu)*.

For the prompt "Use sending protocol" enter:
Xmodem

f. A window will emerge, do not press "***Send***". Go to step 4.

4. Press "***Receive***" on the emerging window on the Laptop (PC). The computer will prompt for a new filename for the file to be saved: Enter a filename according to the APR language previously selected in the Settings / Settings Menu: ***"APR_English.ini" (APR_French.ini, APR_Spanish.ini, APR_German.ini, APR_Italian.ini, or APR_Portuguese.ini)***

5. Press "***Send***" on the Touch Screen window.

6. Wait until the transfer is complete (this may take a few minutes)

7. When the transfer is complete, close the Hyperterminal application in the Laptop and Touch Screen Console. Disconnect the serial cable.

8. On the Touch Screen, press the"*Start-Windows*" button on the keyboard and select: "*Programs / Start up (select the first one) / Console*", to return to the Application.

2.6 PROCEDURES RELATED TO THE CTSC TOUCH SCREEN CONSOLE

2.6.1 TROUBLESHOOTING THE CTSC TOUCH SCREEN CONSOLE

POSSIBLE CONDITIONS	
PROBLEM NUMBER	**DESCRIPTION / CIRCUMSTANCE**
1	THE CONSOLE AND GENERATOR DO NOT START-UP
2	THE CONSOLE STARTS-UP BUT THE GENERATOR DOES NOT START-UP.
3	THE CONSOLE BEEPS BEFORE START-UP
4	THERE IS NO IMAGE ON THE SCREEN
5	OPERATING SYSTEM NOT LAUNCHED OR START-UP ANOMALIES
6	CTSC CONSOLE FANS HAVE STOPPED
7	THE TOUCH SCREEN DOES NOT RESPOND TO THE TOUCH

Note ☞ *Ensure that the Generator and CTSC Touch Screen Console are powered ON.*

Certain problems described below are circumstantial and assume a correct functioning of the equipment.

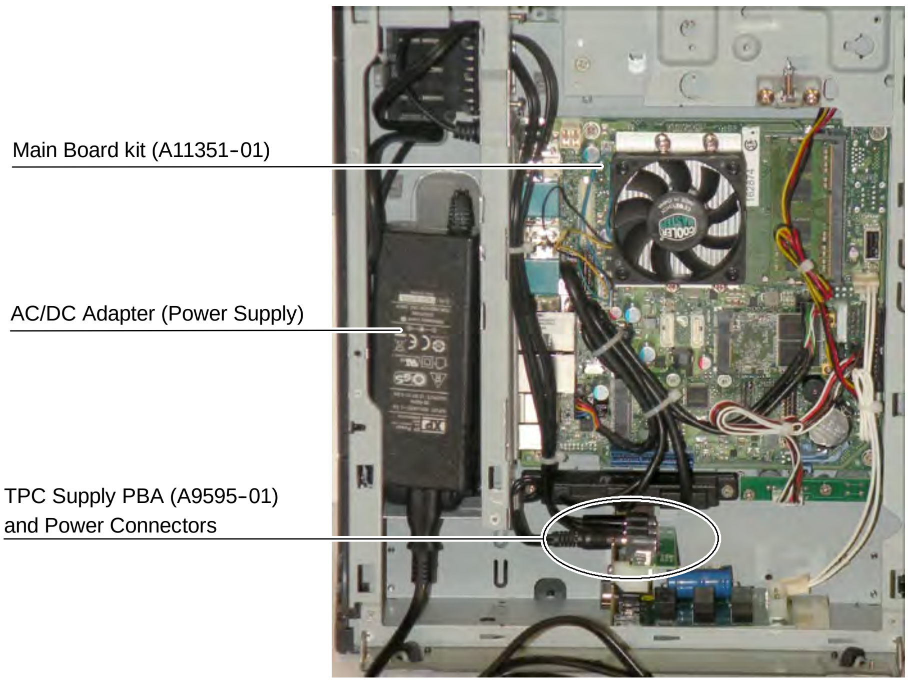
PROBLEM 1: THE CONSOLE AND GENERATOR DO NOT START-UP

Theory:

The CTSC Console controls its start-up procedure and also of the X-ray Generator, if it is not properly powered, it will not be able to start nor the operating software, nor the X-ray Generator.

Possible Causes:

The AC/DC Adapter could be damaged, but it could be also a problem with the power connectors, the TPC Supply PBA (A9595-01) or the Main Board Kit (A11351-01) which would be damaged. Follow the steps below:



1. Check that the AC/DC Adapter (Power Supply) is correctly connected to the mains and its LED is green lighted. If the LED is green lighted, proceed to verify that the connection with the Console is correct.

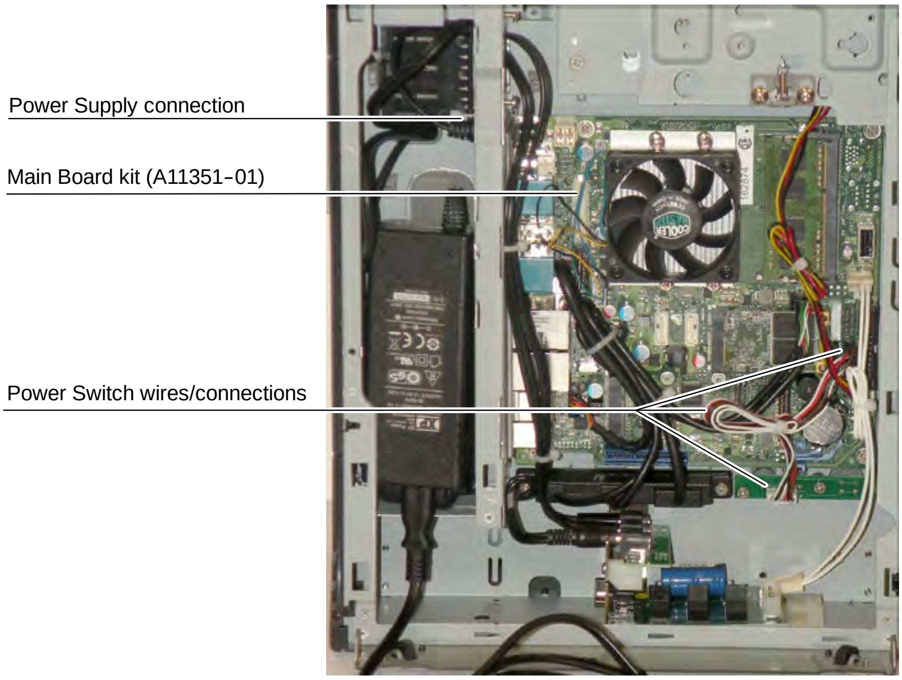
2. Open the back covers of the Console as indicated in the Installation procedure.

3. Check in TPC Supply PBA (A9595-01) that the power supply is correct and connectors/cables are not damaged or disconnected:

   a. Check for 12 VDC with a multimeter in the DC Power connector of the cable from the AC/DC Adapter. Replace the Power Supply if the reading is not correct.

   b. Check for 12 VDC in all connectors of TPC Supply PBA (A9595-01) and the cables are properly connected.

4. Once previous step is completed, check that the following connectors/wires in the Main Board (A11351-01) are correctly connected: Power Supply and Power Switch.



5. If the connection is correct, it might be a problem of the Main Board Kit (A11351-01), it must be replaced. The Main Board Kit includes the operation software, so it is highly recommended to complete a backup of the APR whenever it has been previously modified *(refer to Section 2.6.3).*

PROBLEM 2: THE CONSOLE STARTS-UP BUT THE GENERATOR DOES NOT START-UP

Theory:

This may be an error due to a incorrect connection of CTSC Console with the Generator, which may be not properly powered.

Possible Causes:

This may be due to an error in the Interface Control Board (A3009-xx) in SHF Generators or Interface Board (A3674-xx) in SHFR Generators, an incorrect cable connection (Cable A3352-xx) or a malfunction in the Auto ON/OFF Board (A3179-xx).

1. Ensure that the Generator can be turned on independently using the PC Interface Box. If the Generator does not turn on, follow steps 2. and 3. If the Generator turns on, proceed with steps 4. and 5.

2. Check that Generator is correctly powered and see Error 33 in the Troubleshooting documentation.

3. Check if there is present any damage in the PC Interface Box and in the Interface Box Cable (A3352-xx) and if it is properly connected. Replace it in case that it is damaged.

4. Check that the A3363-xx Cable is correctly connected to CTSC Console and to the PC Interface Box (*refer to the general wiring schematic 54302351*).

5. Check for 12 VDC the J4 connector in Auto ON/OFF Board (A3179-xx). Replace the Main Board (A11351-01) if the reading is not correct or replace the Auto ON/OFF Board (A3179-xx) if the reading is correct.

PROBLEM 3: THE CONSOLE BEEPS BEFORE START-UP

Note ☞ *This may be a temporal corruption during the start-up dialogue, restart the console to confirm fault before attempting service.*

Theory:

The Video Chip Set or DRAM will be at fault when the console, during start-up, emits either a single long beep followed by three short beeps (— · · ·), or a continuous series of long beeps (— — —).

Possible Causes:

These are BIOS errors and may be caused by either a corrupt power or DRAM connection; or a malfunctioning CTSC Main Board Kit (A11351-01).

Visually check and ensure the proper connections on the CTSC Main Board (A11351-01), not only on the Main Board Processor and its ventilator but also on the DRAM board. If there is a proper connection, replace the CTSC Main Board Kit (A11351-01).

PROBLEM 4: THERE IS NO IMAGE ON THE SCREEN

Theory:

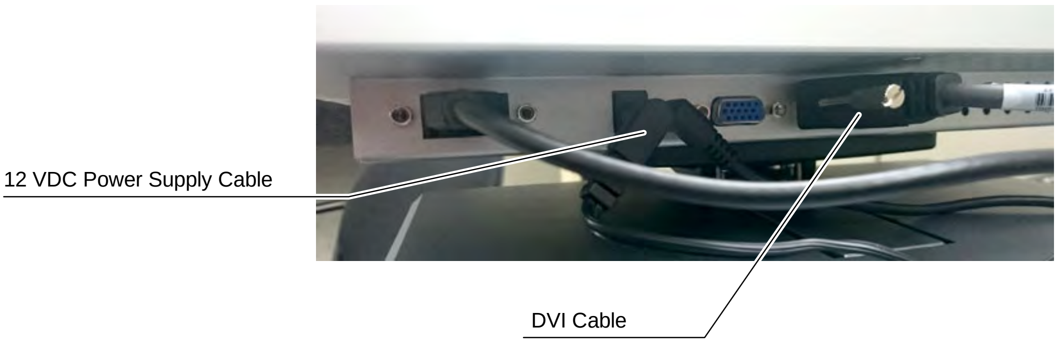
The CTSC Console Monitor is powered by TPC Supply PBA (A9595-01), when the connection is correct the Monitor must be lighted and display the operating software.

The image/data is supplied by the Main Board Kit (A11351-01) using a DVI Cable.

Possible Causes:

The most probable cause is an incorrect connection or damaged DVI Cable; however, a replacement of the other two main components (Monitor and Main Board Kit) may be necessary. Follow the steps below:

1. Turn the CTSC Console ON and check if the "*Status*" indicator is powered (on the lateral of the CTSC Console). If not, check connections for +12 V power supply cable from the TPC Supply PBA (A9595-01). Replace the cable in the event of visible damage.



2. If the previous step is correct, ensure a correct connection of the DVI cable of the monitor. Replace the cable in the event of visible damage.

3. If both cables/connections are correct, then the problem could be the Monitor or the Main Board (A11351–01). Check the Monitor with the cables connected to another PC of a CTSC Console. If the Monitor displays the image, then replace the Main Board Kit (A11351–01). Otherwise, replace the Monitor.

PROBLEM 5: OPERATING SYSTEM NOT LAUNCHED OR START-UP ANOMALIES

Note ☞ *This may be a temporary corruption or communication failure during the start-up dialogue, restart the Console to confirm problem before attempting service.*

Theory:

This problem is caused by a damaged SSD Disk of the CTSC Console or when there is a malfunction in it.

Possible Causes:

The CTSC Console turns on but the operating software does not complete the start up procedure. It unsuccessfully searches for the SSD Disk and, then, tries to use other starting devices. Messages during the start-up routine such as "*Reboot and select proper boot device*" appear with SSD Disk problems.

The SSD Disk is a part of the Main Board Kit (A11351-01), it should contain all software necessary for the proper functioning of the Operating Application.

If the problem persists after starting-up the Console several times, replace the Main Board Kit (A11351-01).

PROBLEM 6: CTSC CONSOLE FANS HAVE STOPPED

The Console Ventilation Fan and the CPU Cooler cool the Console and the Microprocessor on the Main Board Kit respectively.

Note ☞ *The CTSC Console may suffer irreversible damage if the Console Ventilation Fan is not functioning properly. Nevertheless, ensure that the Console functions properly before troubleshooting the fan.*

Console Ventilation Fan

1. Visually check for proper Fan Power Supply Cable connection in the Main Board. Check for 12 VDC in the corresponding connector of the Main Board (A11351–01), if it is not present, replaces the Main Board kit (A11351–01).

CPU Cooler

1. If the CPU Cooler is not functioning, the microprocessor on the Main Board Kit (A11351-01) will heat up and eventually freeze the Touch Screen controls and processes. If the Main Board freezes, first try to restart the Console. If the condition persists, proceed to the next step.

2. Open the CTSC Console, power the Console ON and check if the CPU cooler is rotating. Visually check connections for broken wires and proper connections. If connections and wires are ok, replace the Main Board Kit (A11351-01) which includes the CPU Cooler.

PROBLEM 7: THE TOUCH SCREEN DOES NOT RESPOND TO THE TOUCH

Note ☞ *This may be a temporary corruption or communication failure during the start-up dialogue, restart the Console to confirm problem before attempting service.*

Make sure hands and screen are clean and dry, then try these steps:

1. With the CTSC Console OFF disconnect the USB Cable of the Monitor.

USB Cable

2. Switch ON the CTSC Console and wait until the operating system is running.
3. Connect the USB Cable to the Monitor and check its connections to the Main Board. Verify that now the Touch Screen is working properly.
4. If it does not work properly yet, connect an USB keyboard to the CSTC Console.
5. Press the "*Windows*" key and launch "*Control Panel/Device Manager/Mice and Other Pointing Devices*".
6. Check that the "*HID Compliant Mouse*" is listed, if not replace the USB Cable or connect it to another USB connector in the Main Board.
7. In both cases if the Monitor does not respond correctly it must be necessary to replace the Monitor.

2.6.2 SOFTWARE UPGRADE

If the Touch Screen Application is provided with a "*Software Upgrade*" button on the Service Mode Menu, it is used to close the Application Program without turning OFF the Console. After pressing this button, the Console shows the PC Desktop to enable the Application Software Upgrade.

Note ☞ *To perform any of these operations, it is necessary to connect an USB Keyboard at the bottom of the CTSC Console.*

2.6.3 EXTERNAL BACKUP OF THE APR TECHNIQUES AND ERROR LOG

WARNING

DURING THE BACKUP PROCESS IT IS NECESSARY TO ACCESS TO THE OPERATING SOFTWARE MAIN FOLDER. IT IS ABSOLUTELY MANDATORY NOT TO DELETE OR MODIFY ANY FILE IN THIS FOLDER, EXCEPT WHEN INDICATED, IN ORDER TO NOT CORRUPT THE CORRECT PERFORMANCE OF THE SOFTWARE.

1. Connect a USB keyboard to the CTSC Console.
2. Connect the external device where the backup will be recorded to the other USB port of the CTSC Console.
3. Press the *"Windows"* key, select *"Computer"* and browse to the following folder: *"\\Computer\Local Disk (C:)\Program Files (x86)\Sedecal".*
4. Copy *"APRBckUp"* and *"Fichero"* files to the external device.
5. Close the "*Windows Explorer*" and disconnect the keyboard and the storage external device from the USB ports of the CTSC Console.

To restore the APR techniques and Error log backup files just copy and rewrite the current files in the "*Sedecal*" folder of the CTSC Console.

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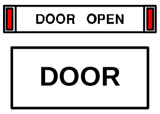
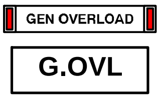
SECTION 3 SELF-DIAGNOSIS INDICATORS

Some Consoles are provided with Self-Diagnosis indicators that identify a malfunctions in the system, alerting the operator about any error existence that may inhibit exposure. During normal system operation, these indicators are directly shown on the Console (depending on the Console model they can be shown on the APR Display, Console Indicators, Warning Messages Area, etc).

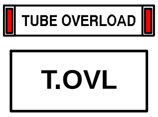


DOOR OPEN: Indicates the X-ray room door is open when the X-ray equipment is in use. (*Also refer to Error Code "E35"*).



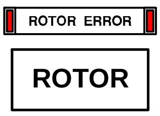
GENERATOR OVERLOAD: Indicates that the exposure has been interrupted during exposure due to an arcing or malfunction in the HV circuitry (X-ray Tube, HV Transformer and/or HV Cables) or a failure of IGBT module (overheated or defective IGBTs) has been detected. (*Also refer to Error Code "E09"*).

Generator Overload may also appear when attempting a high power and lengthy exposure with the X-ray Tube not sufficiently warmed-up.

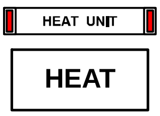


TUBE OVERLOAD: Indicates that either the technique selected is beyond the X-ray tube ratings or the present conditions of the X-ray tube inhibit the exposure (anode overheated). Parameters for next exposure may be temporally limited by the Generator (change the exposure values or wait for the X-ray tube to cool). (*Also refer to Error Code "E37"*).

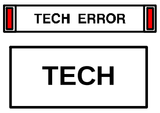
Check that available heat units are lower than calculated for the next exposure. Reduce exposure factors or wait for the X-ray tube to cool.



ROTOR ERROR: Indicates that the X-ray tube anode is not rotating while "*Prep*" is active, then exposures are inhibited. (*Also refer to Error Code "E18"*).



HEAT: Indicates that the X-ray Tube thermostat / pressurestat is open due to overheating of the tube housing (housing is too hot, wait for the housing to cool) or to a thermostat / pressurestat mal-function (housing is cool). Heat units may raise to any value. (*Also refer to Error Code "E36"*).



TECHNIQUE ERROR: If it activates during exposure it means that:

The exposure has been interrupted by the "Security Timer" because of a system failure. Call Field Service. (Also refer to Error Code "E34").

This error can also be shown:

- after an APR technique selection to advise that exposure parameters displayed on the Console are not the values stored for this APR technique. Exposure parameters are adapted by the Generator. (R*efer to Error Code "E34"*).
- if a failure on the Automatic Collimator has been detected (blades are fully open or in movement during exposure, etc.). In this case the indicator light is constantly lit (not blinking). (*Also refer to Error Code "E48"*).

SECTION 4 ERROR CODES

ERROR CODE LIST	
ERROR CODE	**DESCRIPTION**
E01	Failure in power up routine. No communication link between HT Controller Board and ATP Console CPU Board.
E02	Failure in power up routine. RAD Generator configured as R&F Generator. No communication link between ATP Console CPU Board and Fluoro CPU Board.
E03	Failure in power up routine. Workstations are not configured.
E04	"*Prep*" signal received without Console order.
E05	"*Fluoro*" signal active without request.
E06	"*Prep*" and/or "*Exposure*" orders activated during power-up routine.
E07	Wrong data for X-ray Tube-2.
E08	Wrong data for X-ray Tube-1.
E09	Generator overload. Arcing or IGBT fault.
E10	EEPROM corrupted or not initialized on ATP Console CPU Board or on HT Controller Board. Wrong data calibration.
E11	No voltage in the Main Storage Capacitors of the Generator (Inverter Module).
E12	No mA during exposure or mA out of tolerance. Wrong filament current.
E13	No kVp during exposure, kVp out of tolerance ($\pm$33%) or insufficient time parameters during AEC operation.
E14	Exposure signal without X-ray Exposure Console command.
E15	Filament Driver Circuit Open, No current on Filament. Wrong selection of Focal Spot detected during "*Prep*".
E16	Invalid value of : kVp, mA or kW.
E17	Communication error among ATP Console, CPU Board and HT Controller Board.
E18	Rotor error or Rotor running without order (only with Low Speed Starter).
E19	mA detected without "*Exp*" command.
E20	kVp detected without *"Exp"* command.
E21	Wrong Tube-1 selection.
E22	Wrong Tube-2 selection.
E23	Calibration data not stored
E24	Bucky Movement Signal has not been detected or DR Device is not ready for exposure.
E27	Failure in EPROM U24 of the ATP Console CPU Board. Bad checksum.
E28	AEC Reference set failure.
E32	Operator safety alert: the Receptor has not been replaced or inserted.
E33	No communication link between the Generator and the Operator Console or PC Unit.

ERROR CODE LIST	
ERROR CODE	**DESCRIPTION**
E34	Technique error.
E35	Door Open. For Generators with HV Transformer equipped with a Security Pressure Switch, the HV Transformer surpasses the maximum internal pressure capacity.
E36	Safety Thermostat Open. Overheating.
E37	Tube Overload.
E38	Operator safety alert: Wrong X-ray Tube orientation for Alignment Interlock-1 (usually Table Workstation).
E39	Operator safety alert: Wrong X-ray Tube orientation for Alignment Interlock-2 (usually Wall Stand Workstation).
E40	Operator safety alert: more than one Workstation Interlock is active at the same time.
E41	Dosimeter failure. Communication failure between Tube-1 Dosimeter and Generator.
E42	Dosimeter failure. Autotest error on Tube-1 Dosimeter.
E43	Dosimeter failure. Tube-1 DAP Ion Chamber status check error.
E44	Dosimeter failure. Communication failure between Tube-2 Dosimeter and Generator.
E45	Dosimeter failure. Autotest error on Tube-2 Dosimeter.
E46	Dosimeter failure. Tube-2 DAP Ion Chamber status check error.
E48	Collimator Error.
E50	Interrupted Exposure.
E51	LV-DRAC: Checksum failure or Microcontroller U17 corrupted in Control DRAC Board.
E52	LV-DRAC: Microcontroller RAM failure.
E53	LV-DRAC: Insufficient DC BUS voltage at low level voltage (220 VAC).
E54	LV-DRAC: Insufficient DC BUS voltage at high level voltage (400 / 480 VAC).
E55	LV-DRAC: Excessive DC BUS voltage at 480 VAC.
E58	LV-DRAC: Excessive current in the main winding during acceleration up to 3300 RPM
E59	LV-DRAC: Excessive current in the auxiliary winding during acceleration up to 3300 RPM
E60	LV-DRAC: Insufficient current in the auxiliary winding during acceleration up to 3300 RPM
E61	LV-DRAC: Insufficient current in the main winding during acceleration up to 3300 RPM
E62	LV-DRAC: Excessive current in the main winding during acceleration up to 10000 RPM
E63	LV-DRAC: Excessive current in the auxiliary winding during acceleration up to 10000 RPM
E64	LV-DRAC: Insufficient current in the auxiliary winding during acceleration up to 10000 RPM
E65	LV-DRAC: Insufficient current in the main winding during acceleration up to 10000 RPM
E66	LV-DRAC: Excessive current in the main winding running at 3300 RPM
E67	LV-DRAC: Excessive current in the auxiliary winding running at 3300 RPM
E68	LV-DRAC: Insufficient current in the auxiliary winding running at 3300 RPM
E69	LV-DRAC: Insufficient current in the main winding running at 3300 RPM

ERROR CODE LIST	
ERROR CODE	**DESCRIPTION**
E70	LV-DRAC: Excessive current in the main winding running at 10000 RPM
E71	LV-DRAC: Excessive current in the auxiliary winding running at 10000 RPM
E72	LV-DRAC: Insufficient current in the auxiliary winding running at 10000 RPM
E73	LV-DRAC: Insufficient current in the main winding running at 10000 RPM
E74	LV-DRAC: Excessive current in the main winding braking at 3300 RPM
E75	LV-DRAC: Excessive current in the auxiliary winding braking at 3300 RPM
E76	LV-DRAC: Insufficient current in the auxiliary winding braking at 3300 RPM
E77	LV-DRAC: Insufficient current in the main winding braking at 3300 RPM
E78	LV-DRAC: Excessive current in the main winding braking at 10000 RPM
E79	LV-DRAC: Excessive current in the auxiliary winding braking at 10000 RPM
E80	LV-DRAC: Insufficient current in the auxiliary winding braking at 10000 RPM
E81	LV-DRAC: Insufficient current in the main winding braking at 10000 RPM
E82	LV-DRAC: Wrong X-ray Tube selection.
E83	LV-DRAC: Excessive current in DC Brake.
E87	LV-DRAC: Insufficient current in common wire during acceleration up to 3300 RPM
E88	LV-DRAC: Insufficient current in common wire running at 3300 RPM.
E89	LV-DRAC: Insufficient current in common wire during acceleration up to 10000 RPM.
E90	LV-DRAC: Insufficient current in common wire running at 10000 RPM.
E91	LV-DRAC: Incorrect signal measure in IPRINC (CH2).
E92	LV-DRAC: Incorrect signal measure in IAUX (CH3).
E93	LV-DRAC: Incorrect signal measure in ICOM (CH4).
E95	Rapid Termination
E97	Exposure Switch (Handswitch) released before starting the exposure,
E98	DIP Switch 3024SW2-3 on ATP Console Board set for Configuration and Calibration Mode Active.

ERROR CODE : E01

DESCRIPTION : Failure in power up routine.
No communication link between HT Controller Board and ATP Console CPU Board.

ERROR TYPE : Fatal error. Generator can not continue with power up.

APPLICABLE TO : All Generators

APPEARS WHEN : Only during initialization phase. If it appears during normal functioning of equipment, it means that a problem has caused a power off in the unit.

INFORMATION / SYMPTOM : This Error Code requires that the Generator be turned OFF/ON before it can be fixed.

POSSIBLE CAUSES

Dipswitch 3000SW2-1 is in “ON” position at the HT Controller Board.

It has not been possible to establish a correct communication link between the ATP Console CPU Board and the HT Controller Board during power ON.

The communication link between the ATP Console Board and the HT Controller Board is not reliable.

The Microprocessor U5 on the HT Controller Board has not started-up.

The Generator has been affected by a loss of the main power.

Faulty DC power supply.

ACTIONS

1. With the Generator switched OFF, check that Dipswitch 3000SW2-1 is in “OFF” position at the HT Controller Board.

   This switch is set in “ON” position only for programming the Rotor Acceleration Time, Rad Filament Setting Time, Fluoro Rotor and Filament Hold-over Time, therefore it changes the functions of Switches SW2-2 and SW2-4 to SW2-8. For normal operation it must set in “OFF” position.

2. Turn OFF/ON the Generator to verify that the initialization procedure has been established correctly. Check that connections of the ATP Console CPU Board and HT Controller Board are secure.

3. If the error appears just after EPROM U24 on the ATP Console Board (A3024-xx) or Microprocessor U5 on the HT Controller Board (A3000-xx) have been replaced or updated, then check the software version compatibility. If necessary, replace or update again .

4. Visually check the performance of DS1 on the HT Controller Board during start-up.

   - If DS1 *remains illuminated* (not blinking), replace the HT Controller Board (A3000-xx).
   - If DS1 *blinks*, go to step-6.
   - If DS1 *remains OFF*, go to step-5.

5. The DC supply may be faulty either at the source or at the Boards themselves.

   - On the HT Controller Board, check for DC at TP3 (+12V), TP4 (-12V) and TP2 (+5V) with GND connection at either TP1, TP9 & TP10.

   - On the ATP Console Board, measure between TP9 (+12V UNREG) with TP11 (GND UNREG); TP10 (+12V ISO), TP3 (+5V), TP7 (+12V) and TP8 (-12V) with TP1 (GND).

     - If DC supply is *not present*, there might be a faulty fuse: shutdown the Generator and test Fuse 3F9 on the Generator with an Multimeter (replacing if necessary). Fuse 3F9 is located below the Power Supply 3PS1 in the Generator Front Panel.

     - If DC supply *is present* (or error persists with correct DC), proceed to the next step.

6. Check continuity between J3 terminals 2, 3, 5 and 6 on the ATP Console CPU Board with P1 terminals 4, 11, 5 and 10 on the HT Controller Board respectively. Connector 6J3 terminals 2, 3, 5 and 6 on the Generator should also be checked. Repair or replace if necessary.

   If there is continuity in these connections, proceed to the next step.

7. Verify with an oscilloscope the signal presence (pulses) for C-HT CLK (J3-5) and C-HT DAT (J3-2) from the ATP Console Board to the HT Controller Board (P1-5 and P1-4 respectively).

   - If any signal is *not present*, replace the ATP Console CPU Board.

   - If the signals *are present*, proceed to the next step.

8. Verify with an oscilloscope the signal presence (pulses) for HT-C CLK (P1-10) and HT-C DAT (P1-11) from the HT Controller Board to the ATP Console CPU Board (J3-6 and J3-3 respectively). If any signal is not present, replace the HT Controller Board. If the problem persists, replace Microprocessor U5 on the HT Controller Board.

ERROR CODE : E02

DESCRIPTION : Failure in power up routine. RAD Generator configured as R&F Generator.
No communication link between ATP Console CPU Board and Fluoro CPU Board.

ERROR TYPE : Fatal error. Generator can not continue with power up.

APPLICABLE TO : R&F Generators or Generators configured by mistake as R&F.

APPEARS WHEN : Only during initialization phase. If it appears during normal functioning of equipment, it means that a problem has caused a power-off in the unit.

INFORMATION / SYMPTOM : This Error Code requires that the Generator be turned OFF/ON before it can be fixed.

An incorrect or corrupt communication link occurred between the ATP Console and the Fluoro CPU Boards during power ON and the Generator is not able to make exposures.

POSSIBLE CAUSES

A RAD Generator has been configured by mistake as a R&F Generator. See Configuration Section.

The communication link between ATP Console CPU Board and Fluoro CPU Board is not reliable.

The Fluoro CPU Board does not work properly.

The Microprocessor U9 on the Fluoro CPU Board did not start-up.

An incorrect communication between the ATP Console and Fluoro CPU Board has been established during power ON.

After changing the ATP Console CPU Board or U18 / U23. The error is removed by entering and then exiting from Workstation configuration.

ACTIONS

1. Turn OFF/ON the Generator to verify that the initialization procedure has been established correctly. Check that connections of the ATP Console CPU Board and Fluoro CPU Board are secure.

2. If the error appears just after EPROM U24 on the ATP Console Board (A3024-xx) or Microprocessor U9 on the Fluoro CPU Board (A3213-xx) have been replaced or updated, then check the software version compatibility. If necessary, replace or update again .

3. Visually check the performance of DS1 on the Fluoro CPU Board during startup.
   - If DS1 *remains illuminated* (not blinking), replace Microcontroller U9 on the Fluoro CPU Board.
   - If DS1 *blinks*, go to step-6.
   - If DS1 *remains OFF*, go to step-5.

4. The DC supply may be faulty either at the source or at the Boards themselves. On the Fluoro CPU Board, check for DC at TP5 (+12V), TP3 (+5V) with GND connection at TP4. If <u>DC supply</u> *is present* (or error persists with correct DC), proceed to the next step.

5. Check continuity between J4 terminals 1, 7, 3 and 4 on the ATP Console CPU Board with J4 terminals 1, 4, 5 and 7 on the Fluoro CPU Board respectively. Repair or replace if necessary.

   If there is continuity in these connections, proceed to the next step.

6. Verify signal presence for C-FL CLK (J4-7) and C-FL DAT (J4-1) from the ATP Console CPU Board to the Fluoro CPU Board (J4-4 & J4-1 respectively).

    - If any signal is *not present*, replace the ATP Console CPU Board.
    - If the signals *are present*, proceed to the next step.

7. Verify signal presence for FL-C CLK (J4-7) and FL-C DAT (J4-5) from the Fluoro CPU Board to the ATP Console CPU Board (J4-4 and J4-3 respectively). If any signal is not present, replace the Fluoro CPU Board . If the problem persists, replace Microcontroller U9 on the Fluoro CPU Board.

ERROR CODE : E03

DESCRIPTION :	Failure in power up routine. Workstations are not configured.
ERROR TYPE :	Fatal error. Generator can not continue with power up.
APPLICABLE TO :	All Generators.
APPEARS WHEN :	Only during initialization phase. If it appears during normal functioning of equipment, it means that a problem has caused a power off in the unit.
INFORMATION / SYMPTOM :	This Error Code requires that the Generator be turned OFF/ON before it can be fixed. It has not been possible to establish a correct communication link between the ATP Console CPU Board and the HT Controller Board during power ON and the Generator is not able to make Exposures.

POSSIBLE CAUSES

All workstations have been configured as Tube = 0.

The EEPROM (U18) on the ATP Console CPU Board is defective.

ACTIONS

1. Configure workstations according to the Service Manual.

2. If not fixed after the previous steps, replace the ATP Console CPU Board and configure workstations again.

ERROR CODE : E04

DESCRIPTION :	"*Prep*" signal received without Console order.
ERROR TYPE :	Fatal error. Generator re-start automatically once error is solved.
APPLICABLE TO :	All Generators.
APPEARS WHEN :	At any moment once initialization phase is over.
INFORMATION / SYMPTOM :	This Error Code requires that the Generator be turned OFF/ON before it can be fixed.
	An incorrect or corrupt communication link has been established between the ATP Console CPU Board and the HT Controller Board.

POSSIBLE CAUSES

The Generator receives the *"Prep"* signal without a Console command.

ACTIONS

1. Check continuity between P1-3 on HT Controller Board and J3-4 on ATP Console CPU Board. Check with special care connector 6J3 of the Generator (6J3-4 of the Generator connects with P2-3 on the HT Control Board).
2. If all is correct, check signal from P1-3 to U5 on HT Controller Board.
3. If the signal is OK, replace the HT Controller Board .

ERROR CODE : E05

DESCRIPTION :	"*Fluoro*" signal active without request.
ERROR TYPE :	Fatal error. Generator cannot continue with Power up.
APPLICABLE TO :	R&F Generators or Generators configured by mistake as R&F.
APPEARS WHEN :	Only during initialization phase.
INFORMATION / SYMPTOM :	This Error Code requires that the Generator be turned OFF/ON before it can be fixed.

POSSIBLE CAUSES

The Generator receives the "*Fluoro*" signal without a Console command.

"Exp" has been pressed in a Workstation not configured for standard R&F.

An incorrect or corrupt communication link has been established between the ATP Console CPU Board and the Fluoro CPU Board during power ON and the Generator is not able to make exposures.

Absence of 24 VDC in the Power Cabinet due to a blown fuse (3F6 in the Front Panel)

ACTIONS

1. Check for an accidental press on the Fluoro pedal.
2. Ensure that there is 24 V between 3TS1-17 and GND. If not present, Check Fuse 3F6 and replace if necessary. If 24 VDC is present, proceed to the next step.
3. Measure the Voltage (DC) between the Anode of Diode CR13 on the ATP Console CPU Board and GND. If the measurement is exactly 4.3 VDC: change the ATP Console. If the Voltage is appreciably different from 4.3 VDC, disconnect Connector J2 from the ATP Console CPU Board and go to the next step.
4. Restart the equipment. <u>If the error disappears</u>, check for a short circuit between J2-17 (-FL EXP) and other signals on the cable, repairing or replacing as necessary (*see diagram 54301045 in the Installation chapter in the Service Manual*). This signal may also be present at 3TS1-37 and 6J1-7 as well as J4-16 of the Control DRAC for systems with High Speed Starters (*see Block Diagram Schematic 543020xx in the Service Manual for the -FI EXP signal)*. <u>If the error persists</u>, reconnect J2 to the ATP Console CPU Board and proceed to the next step.
5. Remove Jumper W2 from the Fluoro CPU and restart the equipment. <u>If the error persists</u>, check for a short circuit in the flat cable that unites the Fluoro CPU with the ATP Console CPU Board. <u>If the error disappears</u>, put Jumper W2 back to its original position and proceed to the next step.
6. Disconnect J1 from the Fluoro CPU and restart the equipment. If the error persists, Change the Fluoro CPU. If the error disappears, reconnect J1 to the Fluoro CPU and go to the next step.
7. Disconnect J1 from the R/F Adaptation Board and restart the equipment. <u>If the error persists</u>, check for a short circuit in the cable between the Fluoro CPU and the R/F Adaptation Board. <u>If the error disappears</u>, reconnect J1 to the R/F Adaptation Board and proceed to the next step.
8. Disconnect TB4 and TB1 from the R/F Adaptation Board and restart the equipment, <u>if the error persists</u>, change the R/F Adaptation Board. <u>If the error disappears</u>, check for activity which may have produced the signal coming from either the R/F system or the Footswitch itself, repairing or replacing as necessary.

Note ☞ *If the system does not have an R/F Adaptation Board, refer to the schematics of the Boards which correspond to its functionalities.*

ERROR CODE : E06

DESCRIPTION : "*Prep*" and/or "*Exposure*" orders activated during power-up routine.

ERROR TYPE : Informative.

APPLICABLE TO : All Generators

APPEARS WHEN : At any moment once initialization phase is over.

INFORMATION / SYMPTOM : This Error Code requires that the Generator be turned OFF/ON before it can be fixed.

POSSIBLE CAUSES

The Generator has detected "*Prep*" or "*Exposure*" signals during initialization.

ACTIONS

1. In Generators equipped with *"Prep*" and *"Exposure"* keys on the Console, check that no object has accidentally activated the function. Also check for possible damages on keys. Check for damages on flat cables to connector J9 on the ATP Console CPU Board.

2. In Generators with external Handswitch, check contacts, cable and connectors.

3. If the error persists, check for continuity between TS1-37 and J2-17 on the ATP Console CPU Board and TS1-36 and J2-4 also on the ATP Console CPU Board.

4. If the error persists, replace the ATP Console CPU Board.

ERROR CODE : E07

DESCRIPTION :	Wrong data for X-ray Tube-2.
ERROR TYPE :	Fatal error. Generator can not continue with power up.
APPLICABLE TO :	All Generators
APPEARS WHEN :	Only during initialization phase.
INFORMATION / SYMPTOM :	This Error Code requires that the Generator be turned OFF/ON before it can be fixed. An incorrect or corrupt communication link has been established between the ATP Console CPU Board and the HT Controller Board during power ON.

POSSIBLE CAUSES

Data on Extended Memory Location “E18” are larger than the maximum allowed.

ACTIONS

1. Replace the HT Controller Board.

ERROR CODE : E08

DESCRIPTION : Wrong data for X-ray Tube-1.

ERROR TYPE : Fatal error. Generator can not continue with power up.

APPLICABLE TO : All Generators

APPEARS WHEN : Only during initialization phase.

INFORMATION / SYMPTOM : This Error Code requires that the Generator be turned OFF/ON before it can be fixed.

An incorrect or corrupt communication link has been established between the ATP Console CPU Board and the HT Controller Board during power ON.

POSSIBLE CAUSES

Data on Extended Memory Location “E02” are larger than the maximum allowed.

ACTIONS

1. Replace the HT Controller Board.

ERROR CODE : E09 - GENERATOR OVERLOAD

DESCRIPTION : Generator overload. Arcing or IGBT fault.

ERROR TYPE : Informative.

APPLICABLE TO : All Generators

APPEARS WHEN : During the exposure and In Stand-by,

INFORMATION / SYMPTOM : This error may appear at the Console as “E09” Error Code or as a “Generator Overload” indication.

During exposure an over current on the IGBTs of the HV Inverter Module has been detected. This may be produced by an arc or malfunction on the HV Circuitry.

In stand-by, the Console is continuously displaying “E09” or “Generator Overload” due to a defective or overheated IGBT Module.

POSSIBLE CAUSES

Symptom-1:

- Defective X-ray Tube.
- Defective HV Transformer or HV Cable.
- Defective Inverter Module.
- Defective HT Controller Board.

Symptom-2:

- Extremely high Duty Cycle on Rad and Fluoro operation.

ACTIONS

A. PRELIMINARY

1. Select minimum kVp , minimum mA, and 80 ms (for example 40 kVp, 10mA, and 80 ms). Make preparation and check that anode rotates in the X-ray Tube. If the anode is not rotating correctly, check the starter and the Stator connections.

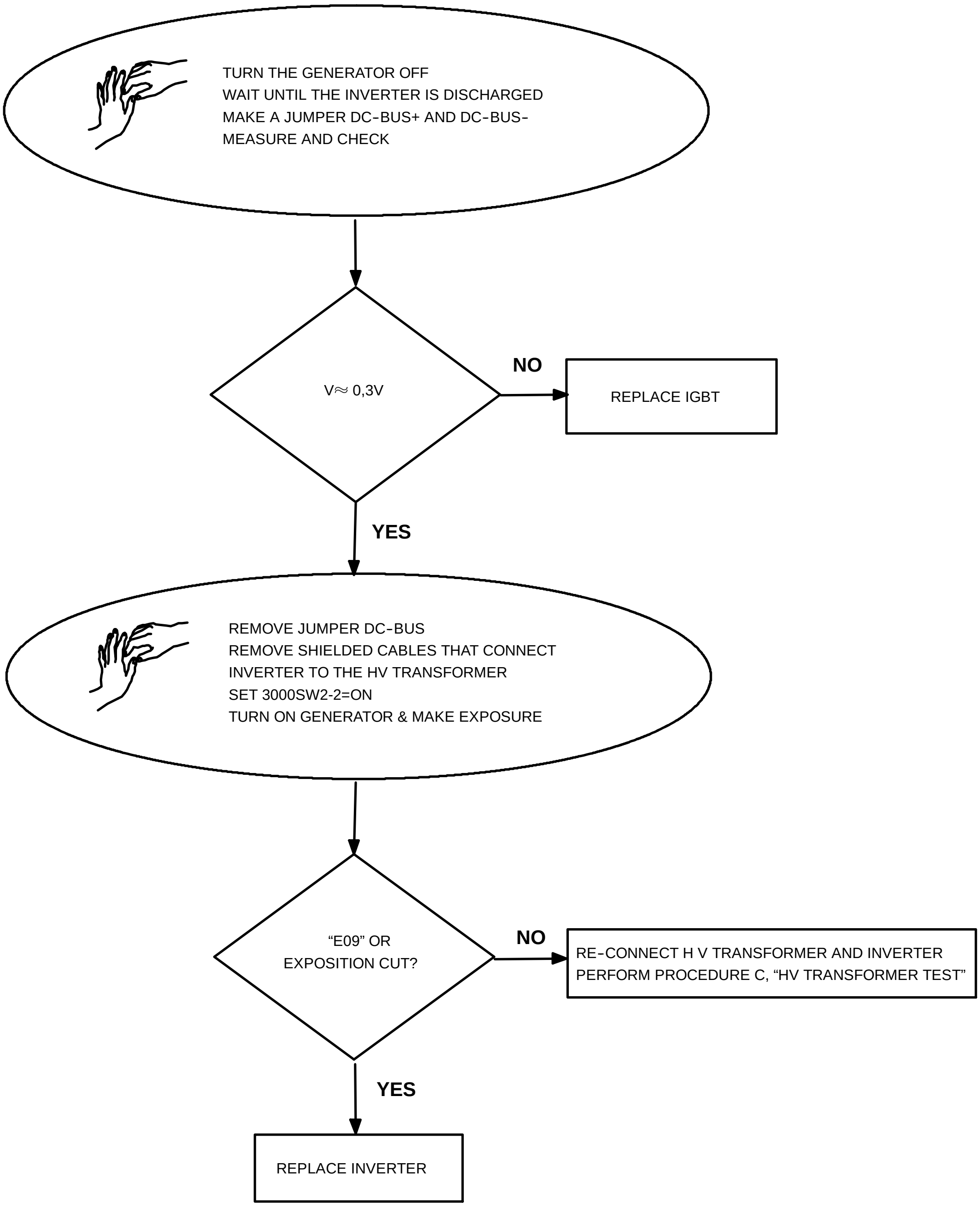
2. In case the anode is rotating correctly, make an exposure:
   - If “09” or “Generator Overload” appears, follow the procedure in paragraph B, “Inverter Module Test.”
   - If not, follow step 3.

3. Increment kVp in 10 kVp steps, select the same mA and time. Make an exposure:
   - If “E09” or “Generator Overload” appears, or the exposure is cut before 80 ms, then follow Procedure C, “HV Transformer Test.”
   - If not, keep on increasing the kVp in 10 kVp steps (60, 70, 80, 90, 100, 110, 120, and 125 kVp for 125 kVp HV Transformers; and 130, 140, 150 kVp for 150 kVp HV Transformers) making Exposures at each kVp selected.
     - If “E09” or “Generator Overload” appears or the exposure is cut before 80 ms at any kVp selected, follow Procedure C, “HV Transformer Test.”
     - If “E09” or “Generator Overload” has not appeared at the maximum kVp or the exposure was not cut before 80 ms, it means that the HV Transformer and the HV Cables are OK. Then follow Procedure F, “RANDOM “E09” or “Generator Overload”.” In this case high mA causes “E09” or “Generator Overload”.

B. INVERTER MODULE TEST

Illustration 4-1 shows a Flowchart for Procedure “B.”

Illustration 4-1
Flowchart for B: Inverter Module Test



1. Turn the Generator and Electrical Room Cabinet (Main Disconnect) OFF.

2. Remove the cover from the Generator Cabinet.

3. Wait for the DC Bus of the Inverter to be fully discharged. When it is fully discharged the LEDs on the Charge-Discharge Monitor Board will be completely turned off.

DANGER !

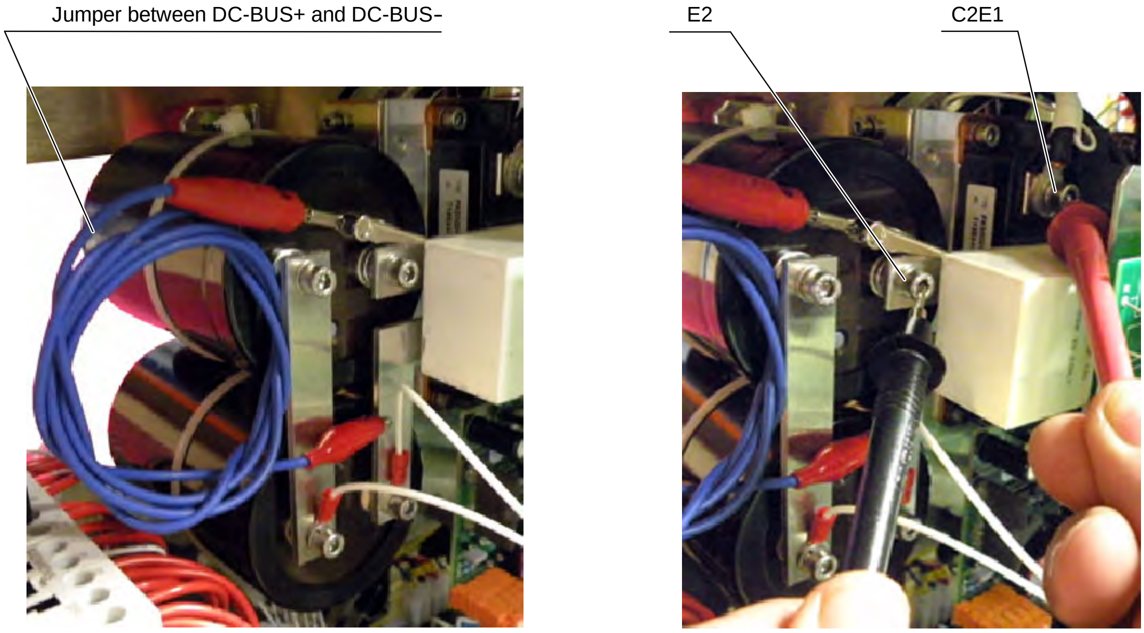
MAKE SURE THAT THE MAIN STORAGE CAPACITORS OF THE HIGH VOLTAGE INVERTER DO NOT CONTAIN ANY RESIDUAL CHARGE. WAIT UNTIL THE LIGHT EMITTING DIODES ON THE CHARGE-DISCHARGE MONITOR BOARDS ARE OFF, APPROXIMATELY THREE (3) MINUTES AFTER THE UNIT IS TURNED OFF.

4. When LEDs are off make a jumper between DC-BUS+ and DC–BUS– (use a wire AWG 22 (0.5 mm^2) or higher). Make sure that there is less than 10 VDC across the BUS. (Refer to Illustration 4-2 to see where to make the jumper.)

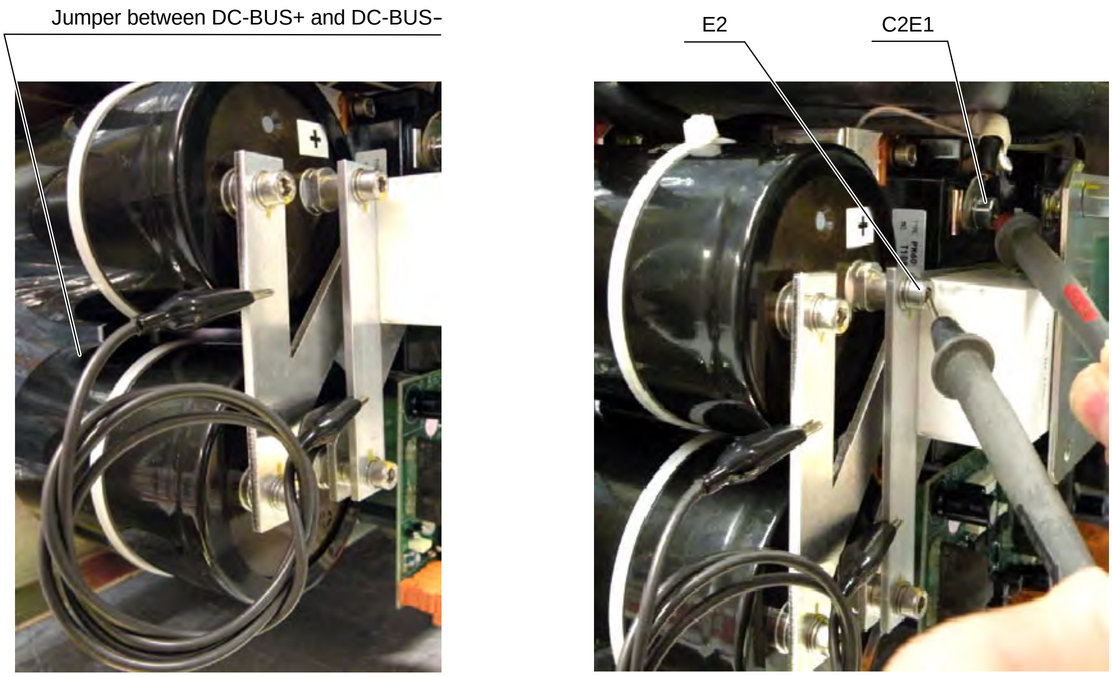
5. Measure with a Multimeter in Diode (or ohms) between C2E1 (positive polarity) and E2 or C1 (negative polarity) in both IGBTs (refer to Illustration 4-2 for more details). Repeat the measure with different polarity between C2E1 (negative polarity) and E2 or C1 (positive polarity).

   Voltage should be around 0.3 V (or the resistance must be a high impedance) for the IGBT to be OK. Normally when an IGBT is broken the voltage is = 0 volts (or the resistance is zero [0] Ohms) or very close.

Illustration 4-2
Jumper and Measurement Points



3–PHASE LINE POWERED GENERATOR



1–PHASE LINE POWERED GENERATOR

6. Repeat the measurements done in step 5 for the other IGBT.

WARNING

DON'T FORGET TO REMOVE THE JUMPER ACROSS THE DC BUS AFTER ALL MEASUREMENTS ARE MADE, OTHERWISE THE INVERTER WILL SUFFER SERIOUS DAMAGE.

7. If any of the IGBTs are short-circuited, replace the IGBT.

8. If both IGBTs are OK, remove both shielded cables that connect the Inverter to the HV Transformer: P1, P3, and SHLD (P2). Isolate the three (3) wires completely from each other and from the metal sheet or ground.

WARNING

MAKE SURE THE WIRES ARE PERFECTLY ISOLATED AND THAT NO SHORT-CIRCUIT IS MADE, OTHERWISE SERIOUS DAMAGES COULD RESULT.

9. Set DIP switch 3000SW2-2 in the ON position at the HT Controller Board.

10. Turn the Room Electrical Cabinet (Mains Disconnect) and Generator ON.

11. Make an exposure:

   - If "E09" or "Generator Overload" does not appear and the exposure has not been cut before 80 ms, re-connect both shielded cables to the HV Transformer (P1, P2, and P3). Follow Procedure C, "HV Transformer Test."
   - If "E09" or "Generator Overload" appears or the exposure has been cut before 80 ms, replace the whole Inverter Module.

Note ☞

At the end of an Exposure and right after releasing the Handswitch, error "E13" is shown on the Console. This is normal. Reset and continue.

12. Turn the Electrical Room Cabinet (Main Disconnect) and generator OFF. Wait three (3) minutes for the Main Storage Capacitors to discharge.

13. Set DIP switch 3000SW2-2 in the OFF position at the HT Controller Board. Re-connect both shielded cables that connect the Inverter to the HV Transformer P1, P3, and SHLD (P2).

C. HV TRANSFORMER TEST

1. Make these connections with the Oscilloscope:
   - CH.1 on + mA (TP14) on the HT Controller Board.
   - CH.2 on - mA (TP13) on the HT Controller Board.
   - Base Time in 10 ms per division and 1 V per division

2. Turn the mains and Generator ON. Set DIP switch 3000SW2-4 to the ON position at the HV Controller Board.

3. Select 40 kVp, 10mA, and 80 ms. Make an exposure and check that both waveforms are almost symmetric (a difference of 12% is normal).
   - If it is OK, follow the procedure in step 4.
   - If it is not OK, check:
     - that in the mA Test Point of the HV Transformer the jumper is correctly placed and secure.
     - that connector J1 is correctly placed and secure in the HV Transformer.
     - continuity between J1-D and P4-7, J1-E and P4-6, J1-B and P4-2, and J1-C and P4-1. Check that they are correctly connected and secure.
     - if after these actions the waveform is not OK, replace the HV Transformer.

4. Turn the Generator and Electrical Room Cabinet (Main Disconnect) OFF. Wait three (3) minutes for the Main Storage Capacitors to discharge.

5. Remove the HV Cables from the HV Transformer (anode and cathode) and fill the HV Receptacles with oil.

6. On the HT Controller Board, make a jumper FIL (TP8) and + 5 V (TP2).

7. Turn the Electrical Room Cabinet (Main Disconnect) and Generator ON.

8. Make these connections with the Oscilloscope:
   - CH.1 on + kV (TP11) on the HT Controller Board.
   - CH.2 on –kV (TP12) on the HT Controller Board.
   - Base time in 10 msec. per division and 2 V per division.

9. Select 40 kVp, 10 mA, and 80 ms. Make an Exposure and check that both waveforms are symmetric. A difference of 12% is normal.

Note ☞ *If error code “E15” appears after pressing PREP, reset the Error and select the lowest mA for Large Focus. Repeat the exposure.*

   - If it is OK, follow procedure in step 10.
   - If it is not OK, follow Procedure D, “Asymmetry on the kVp Loop.”

10. Make exposures from 40 kVp to 150 kVp with the same Exposure Time and check that all kVp waveforms are symmetric and the values are similar according the table below.

Select	TP11 & TP12 on the HT Controller
50 kVp	2.1 V
70 kVp	2.9 V
90 kVp	3.7 V
110 kVp	4.5 V
130 kVp	5.3 V
150 kVp	6.1 V

11. If the waveforms are not symmetric (within 12% at any point), follow Procedure D, “Asymmetry on the kVp Loop.”

12. If everything is OK, it means that HV Transformer is OK and the problem could be in the X-ray Tube or in the HV Cables. In order to determine exactly what part must be replaced (the X-ray Tube or the HV Cables) it is necessary to replace one of both components and perform the procedure again. In most of the cases the part to be replaced usually is the X-ray Tube. To know when the Tube begins to arc follow Procedure E, “X-ray Tube Test.”

13. Turn the Generator and Electrical Room Cabinet (Main Disconnect) OFF and wait three (3) minutes for the Main Storage Capacitors to discharge. Set DIP switch 3000SW2-4 in the OFF position at the HV Controller Board and remove the jumper between FIL (TP8) and + 5 V (TP2).

D. ASYMMETRY ON THE kVp LOOP

This procedure determines what part should be replaced due to asymmetry on the kVp Loop: the High Voltage Transformer or the HT Controller Board.

1. Turn the generator and Electrical Room Cabinet (Main Disconnect) OFF and wait three (3) minutes for the Main Storage Capacitors to discharge.

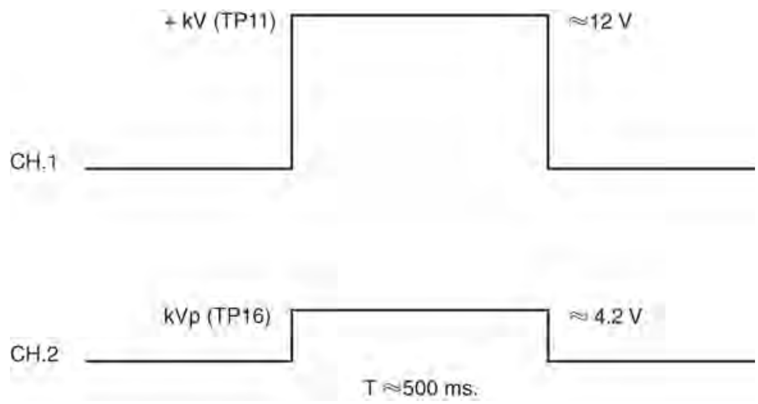
2. Set DIP Switch 3000SW2-2 to the “ON” position at the HV Controller Board.

3. Turn the Room Electrical Cabinet (Main Disconnect) and generator ON.

4. Make these connections with the Oscilloscope:
   - CH.1 on +kV (TP11) on the HT Controller Board.
   - CH.2 on kVp (TP16) on the HT Controller Board.

5. Apply +12VDC (P2-2) to +kV (P4-2) for 500 ms. This operation may cause Error “20” if the voltage is applied for more than 500 ms; in this case turn the generator OFF and ON to reset the error.

6. Check the waveform's result:

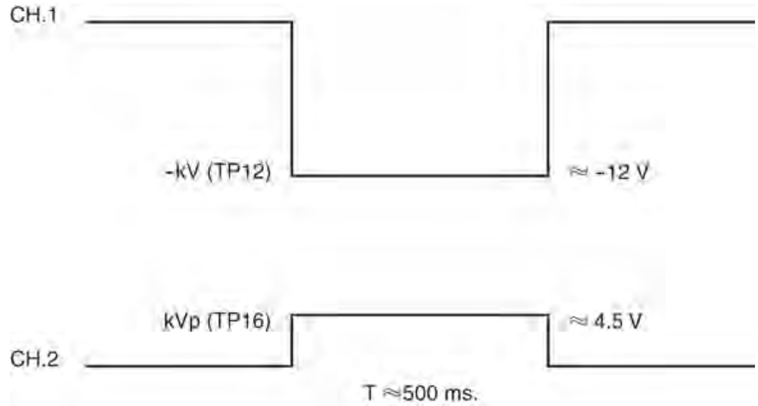


- If it is OK, follow the procedure in step 7.
- If it is not OK, replace the HT Controller Board. It is recommended to perform Procedure C, "HV Transformer Test," again.

7. Make these connections with the Oscilloscope:
   - CH.1 on –kV (TP12) on HT the Controller Board.
   - CH.2 on kVp (TP16) on HT the Controller Board.

8. Apply –12VDC (P2–1) to –kV (P4–1) for 500 ms. This operation may cause Error "20" if the voltage is applied for more than 500 ms. In this case turn the generator OFF and ON to reset the error.

9. Check the waveform's result:



- If it is OK, replace the HV Transformer.
- If it is not OK, replace the HT Controller Board. It is recommended to perform Procedure C, "HV Transformer Test," again.

10. Turn the Generator and Electrical Room Cabinet (Main Disconnect) OFF and wait three (3) minutes for the Main Storage Capacitors to discharge.

11. Set DIP Switch 3000SW2–2 in the OFF position at the HV Controller Board.

E. X-RAY TUBE TEST

After the performance of the above referred test everything is found OK, the Service (Field) Engineer may want to know the actual status of the Tube. Perform the following procedure in order to determine the point in which the X-ray Tube begins to arc.

CAUTION

It is strongly recommended to replace the Tube as soon as possible to prevent potential damage to the Generator.

1. Select 40kVp, 10mA, and 100 ms.

2. Make an exposure.

3. Increment kVp in 10 kVp steps, select same mA and time. Make an exposure.
   - If “E09” or “Generator Overload” appears follow Procedure C, “HV Transformer Test,” if it has not been performed before. If Procedure C has been already performed follow the procedure in step 4.
   - If “E09” or “Generator Overload” does not appear, keep on incrementing the kVp in steps of 10 kVp (up to the maximum kVp), making exposures at each kVp selected.
     - If “E09” or “Generator Overload” appears at any kVp selected it means that the Tube has dielectric problems above the selected kVp.
     - If “E09” or “Generator Overload“ does not appear (up to maximum kVp), it means that arcing may be due to mA or kW. Follow the procedure in step 4.

4. Select 40 kVp and 10 mA. Increment the mA one station and make an Exposure. Keep on incrementing the mA station (making exposures) until “E09” or “Generator Overload” appears. This will give an idea of the maximum mA allowed by the Tube without arcing. If “E09” or “Generator Overload” does not appear follow step 5.

5. If the Tube still does not arc, the problem is related to kW = KV*mA. Make selections on the Console at 100 ms incrementing kV and mA. A point will be reached in which “E09” or “Generator Overload” will appear. This will give an idea on the approximate value of kVp and mA that can be handled by the X-ray Tube. Also, this value may change when the Tube heats up.

F. RANDOM “E09” OR “GENERATOR OVERLOAD”

If everything is OK and random “E09” or “Generator Overload” appears, check:

1. That the signal IGBT FAULT on Pin 3 of P5 on the HT Controller Board is not low (logic 0) in stand-by and during the exposure. If there is noise, check for a loose connection between Pin 3 of P5 on HT Controller Board and Pin 4 of J2 in both IPM Driver Boards

2. If IGBT FAULT is active during an exposure, try to isolate when it occurs. It may be due to noise coming from any device outside the Generator. Or it may occur when selecting a high power Exposure and the voltage of the main line goes down more than 10%.

ERROR CODE : E10

DESCRIPTION :	EEPROM corrupted or not initialized on ATP Console CPU Board or on HT Controller Board. Wrong data calibration.
ERROR TYPE :	Fatal Error during power up (when EEPROM U3 on HT Controller Board is corrupted or not initialized). Informative error during power up (when EEPROM U18 on ATP Console CPU Board is corrupted or not initialized or when EPROM U24 on ATP Console CPU Board has been changed). In both cases, "E10" appears together with "E34" Error Code or "Technique Error" indication.
APPLICABLE TO :	All Generators.
APPEARS WHEN :	Only during initialization phase.
INFORMATION / SYMPTOM :	Generator does not continue with start up.

POSSIBLE CAUSES

EEPROM U3 on the HT Controller Board corrupted or not initialized.

EEPROM U18 on the ATP Console CPU Board corrupted or not initialized.

EPROM U24 on the ATP Console CPU Board has been changed.

ACTIONS

1. If EPROM U24 in the ATP Console CPU Board has been replaced, reset the Error Code to acknowledge that the NVRAM has been initialized.
2. If the error does not reset, turn the Generator OFF and set Dip-switch A3024SW2-3 in the ON position to allow Service Mode.
3. Turn the Generator ON and enter into Workstations Configuration and follow the checks as indicated in the Service Manual (do not forget to exit from Configuration mode to store the Workstation Configuration).
4. If the problem persists and "E10" appears together with the "E34" Error Code or "Technique Error" indication, replace the ATP Console CPU Board.
5. If the problem persists and only "E10" appears on the Console, replace the HT Controller Board.

ERROR CODE : E11

DESCRIPTION : No voltage in the Main Storage Capacitors of the Generator (Inverter Module).

ERROR TYPE : Informative. “*Prep*” is not allowed.

APPLICABLE TO : All Line Powered Generators

APPEARS WHEN : Only during initialization phase or when pressing “*PREP*”.

INFORMATION / SYMPTOM : –

POSSIBLE CAUSES

No voltage in the Main Storage Capacitors (5C1, 5C2, 5C3, 5C4) of the Generator (Inverter Module).

Defective Charge/Discharge Monitor Board.

Precharge 6K5 contactor located inside the Generator Cabinet is not energized.

Main line fuses F3 and/or F4 are blown.

“–CHRG” signal of Pin 7 on connector P1 on the HT Controller Board is not present.

Cables disconnected accidentally or damaged connectors.

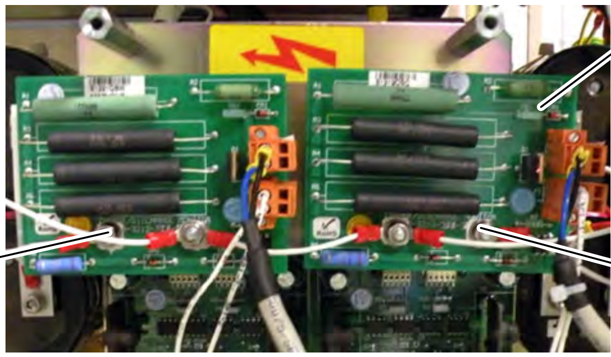
ACTIONS

A. IF LED DS1 IN CHARGE/DISCHARGE MONITOR IS ILLUMINATED

Check the voltage at the Main Storage Capacitors (5C1, 5C2, 5C3, 5C4) (Inverter Module) measuring the voltage between DC BUS (+) and DC BUS (–) as indicated in the illustration below.

1–PHASE LINE POWERED GENERATOR

3–PHASE LINE POWERED GENERATOR



Voltage at the Main Storage Capacitors should be the voltage of the Input Power Line multiply by 1.4142 for Line Powered Generators (not in "Prep") (±10%). See the following examples:

Input Power Line	Voltage at the Main Storage Capacitors
Line Powered Generator at 230 VAC	230 x 1.4142 = 325 VDC (±10%)
Line Powered Generator at 400 VAC	400 x 1.4142 = 566 VDC (±10%)
Line Powered Generator at 480 VAC	480 x 1.4142 = 679 VDC (±10%)

- If the voltage is OK, check that P1-7 on the HT Controller is at logic level "0". (0.75 V for Generators with 1 Charge/ Discharge Monitor Board and 1.5 V for Generators with 2 Charge/Discharge Monitor Boards).
  - If logic level is OK (logic level 0), replace the HT Controller Board.
  - If logic level is not OK, check the links between P1-7 on the HT Controller Board and P1-2 on Charge/Discharge Monitor Board #1 and P1-1 on Charge/Discharge Monitor Board #1 and P1-2 on Charge/Discharge Monitor Board #2,
    - If these links are OK, replace defective Charge/Discharge Monitor Board.
    - If they are not OK, repair connection.

- If the voltage in capacitors is not OK, check VAC on AC1, AC2 and AC3 at the Input Rectifier Board.
  - If VAC is not OK, verify input connections and input fuses.
  - If VAC is OK, disconnect BUS+ and BUS– at the Input Rectifier Board and check the VDC.
    - If VDC is not OK, replace any defective components (CR1, CR2, CR3) at the Input Rectifier Board.
    - If VDC is OK, check for and replace any defective components at the Generator Cabinet.

B. IF LED DS1 IS NOT ILLUMINATED

- Check input VAC on 6LF1,
  - If VAC is OK, replace any defective components at the Input Rectifier Board (CR2, CR3 or CR1).
  - If VAC on 6LF1 is not OK, check that contactor 6K5 is ON.
    - If 6K5 is ON, check VAC on T1,T2 and T3 (in 6K5).
      - If voltage is OK, replace the defective 6R1.
      - If voltage is not OK, replace the defective fuse (F3, F4 or F5).

- If Contactor 6K5 is not ON, check if signal +24VPSU is OK.
  - If the signal is not OK, check and/or replace 3F6 and 6T2.
  - If +24VPSU is OK, check that signal –LINE CONT is at 0 VDC,
    - if –LINE CONT is OK (0 VDC), replace 6K5.
    - If –LINE CONT is not OK, check continuity in J3-10 at the ATP Console CPU Board.
      - If –LINE CONT is OK, repair the connection between J3-10 and "A" in 6K5, at the ATP Console CPU Board.
      - If –LINE CONT is not OK at the ATP Console CPU Board, replace the ATP Console CPU Board.

ERROR CODE : E12

DESCRIPTION : No mA during exposure or mA out of tolerance. Wrong filament current.

ERROR TYPE : Informative.

APPLICABLE TO : All Generators

APPEARS WHEN : After exposition.

INFORMATION / SYMPTOM : Error 12 appears after the Exposure to alert the operator that the mA at the start of the exposure has not been correct. During the first 10 ms the Generator applies constant filament current to the Tube. This current is proportional to the current already calibrated for that mA station at the kVp selected for that Exposure (filament numbers). Near the end of these 10 ms, the HT Controller Board reads the mA and if they are found to be 30% under or over what has been selected, it sends error “12” to the Console.

POSSIBLE CAUSES

Calibration data for kVp and mA is not correct causing error E12.

The mA jumper on the HV Transformer is open, or it is not making good contact. The mA read at the beginning of the exposure is 50% of the correct value (because one branch is open).

There is a problem on the reading of the mA.

No correct heating prior to the Exposure. The filament has not reached its correct temperature and the mA at the start of the exposure is low. It usually occurs when the *“Prep”* and *“Exp”* buttons are pressed down at the same time.

Making an exposure immediately after getting out of Calibration mode in Extended Memory.

+5 VDC , +12 VDC or –12 VDC Power Supplies of HT Control Board (measured at TP2, TP3 and TP4 of this Board) have excessive ripple or VDC measured is not correct.

ACTIONS

1. Connect a Oscilloscope to the following Test Points on the HT Controller Board and check that the voltage is correct. Adjust an incorrect voltage with the respective Potentiometer in the Power Supply Board (*refer to Section 2.1 – Low DC Voltage Power Supply Test*):
   - TP2 (+5 VDC) on HT Control Board is adjusted with R12 Pot. in the Power Supply Board.
   - TP3 (+12 VDC) on HT Control Board is adjusted with R26 Pot. in the Power Supply Board.
   - TP4 (–12 VDC) on HT Control Board is adjusted with R25 Pot. in the Power Supply Board.

2. Check calibration data for the mA Open Loop (filament numbers) as described in the Service Manual for all combinations of kVp and mA when this error appears.

   With a Oscilloscope connected to Test Point TP5 (mA) on the HT Controller Board, check that the mA reading is within a ratio of 1V=100 mA (± 5%) for software V2 and V3. For later versions (V4 and up), the ratio is 1V=10mA from the min. mA to 80 mA and 1V=100mA from 100 mA to maximum rating.

   If it is not, the cause could be that the mA second test is not measuring correctly, or a wrong measurement performed in the Generator. *(Refer to step 3).*

3. Check that the jumper in the mA Test Point of the HV Transformer is correctly placed and secure.

4. With a Oscilloscope check that during the entire Exposure signals on Test Points TP13 (-mA) and TP14 (+mA) on the HT Control Board connectors are symmetrical (12%).
   - If one is found missing or not symmetrical, measure on Pin 6 and 7 of J4 on the HT Control Board.
   - If they are symmetrical on both Points, the problem could be on the HT Control Board.
   - If they are not correct, check that the connections made on the HV Transformer in J1-E, D, K terminals are correctly connected and secure. Also check that the GND wire is connected to GND stud.
   - If connections are correct the problem is in the HV Transformer.

5. Connect an Oscilloscope to Test Point TP5 (mA) on the HT Controller Board.

Note ☞ *For the following test with a High Speed Generator, the self-running mode has not been active. DIP switch 3243SW4-6 on the Control DRAC Board must be in the "OFF" position (only High Speed Generator).*

Check that:

- when the exposure is made by pressing first the PREP control and then the EXP control, the mA reading at the beginning of exposure is correct.
- and when an exposure is made by pressing at the same time the PREP and EXP controls, the mA reading at the beginning of exposure is low.

6. For Low Speed Generators:
   - Reprogram the "*Rotor Acceleration and Filament Setting Time*" as stated in the Service Manual (Configuration chapter) : one (1) step over the previously configured time (e.g.: if it was 1.2 seconds, reprogram for 1.8 seconds) and check if boosting is correctly configured.

     If it is not correct, reprogram the "*Rotor Acceleration and Filament Setting Time*" one (1) step over the previously configured time and test again.

7. For High Speed Generators:
   - Reprogram the "*RAD Filament Setting Time*" as stated in the Service Manual (Configuration chapter) : one (1) step over the previously configured time (e.g.: if the Filament Setting Time programmed was 1.8 seconds, reprogram it for 2.7 seconds).

In order to verify that the problem has disappeared:

- select the highest mA station for Small Focus and the lowest kVp allowed for this mA station. Make an Exposure by pressing at the same time the PREP and EXP controls; check that the mA reading at the beginning of the Exposure is correct.
- select the highest mA station for Large Focus and the lowest kVp allowed for this mA station. Make an Exposure by pressing at the same time the PREP and EXP controls; check that the mA reading at the beginning of the Exposure is correct.

  If it is not correct, reprogram the "RAD Filament Setting Time" one (1) step over the previously configured time and test again.

ERROR CODE : E13

DESCRIPTION : No kVp during exposure, kVp out of tolerance (±33%) or insufficient time parameters during AEC operation.

ERROR TYPE : Informative. May abort exposition.

APPLICABLE TO : All Generators

APPEARS WHEN : During and after exposures.

INFORMATION / SYMPTOM : No kVp during exposure.

POSSIBLE CAUSES

Note ☞ *This error assumes that the fault is not due to arcing in the X-ray Tube.*

Connection between the ATP Console CPU Board and HT Controller Board (–EXP signal)

Connection on the IPM Driver Boards

Faulty HT Controller

Faulty IPM Driver Board

Faulty IGBT

Open Serial Capacitor (5C9)

5V OUT during exposure

Power to IPM Drivers is not supplied from the Interface Control Board

ACTIONS

1. With an Oscilloscope, measure between TP-12 & TP-11 on the HT Controller. These signals should be incomplete and/or irregular.

2. Assure that the power supply to the *HT Controller Board* and the two *IPM Drivers* are correct.

   HT Controller: Schematic A3000-xx – Check for 5V, –12VAC and +12VAC.

   IPM Driver: Schematic A3063-06 – Check for +24 VDC ±10 % (ROHS Generator) and check for 5 V (both voltages are supplied from the Interface Control Board). 5V should be constant (not presenting any variation), *including during the entire Exposure.*

3. Measure the pulses at P3-1 (KV DR1) and P3-2 (KV DR2) on the HT Controller. If these pulses are not present during the Exposure, change the HT Controller. If they are present, proceed to the next step.

The following procedures involve the IPM Driver Boards which are connected to the IGBTs. This area has dangerous HIGH VOLTAGE and must be treated with great care.

4. Ensure that KV DR1 and KV DR2 reach the IPM Drivers at J1-1 & J1-2. If these signals are not present at the connection points, revise the connection or cables. If these signals are present, proceed to the next step.

5. Turn OFF the equipment. Dismount one of the IPM Drivers from the IGBT disconnecting the terminals to IGBT side but keeping J1 & J2 connected.

   Turn ON the equipment and ensure the power supply by measuring at J3-1 (+15 V OUTPUT 1) & J3-4 (GND 1), and by measuring at J4-1 (+15 V OUTPUT 2) & J4-4 (GND 2).

   Turn OFF the equipment. If +15 V OUTPUT is not present, repair or replace if necessary. Return the first IPM Driver to its original position connected to the IGBT. Then dismount the second IPM Driver and repeat this step.

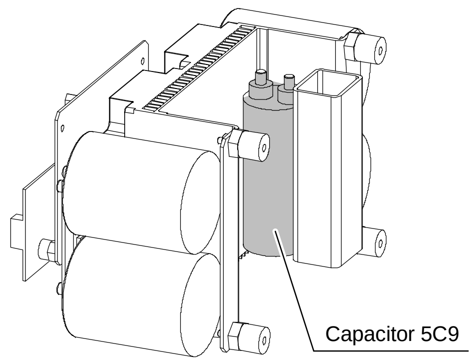
   If +15 V OUTPUT is present in both IPM Drivers. proceed to the next step.

6. Turn OFF the equipment and ***wait a few moments for the equipment to fully discharge***. Remove the rear cover of the Generator Cabinet for accessing to Capacitor 5C9 located at the back side of the HV Inverter. Check the Capacitor 5C9 as follows:

   - by using a meter (e.g. Fluke 87) in “capacitor” mode
     - If Capacitor 5C9 is in good condition, the meter shows: “O.L μf (out of limit)” .
     - If Capacitor 5C9 is defective, the meter shows an abnormally low value (e.g: 0.19 μf).

   - or, by using a meter in “ohms” mode
     - If Capacitor 5C9 is in good condition, the meter shows the resistance changing. If the polarity of the probes is reversed, the meter shows a negative resistance.
     - If Capacitor 5C9 is defective, the meter shows a very high Impedance (1 MOhms) or Open circuit.

   If Capacitor 5C9 is defective, replace it. If not, proceed to the next step.



7. Refer to Schematic 543020xx for the connections between the HV Transformer and the IGBTs. Measure the resistance (continuity) of the following cables from the IGBTs to the HV Transformer, replacing or repairing where necessary:
   - Capacitor 5C9 (Transformer side terminal) and P1 of the HV Transformer.
   - C2E1 and P2

8. Disconnect P1 & P2 on the HV Transformer. Check that the resistance at P1 & P2 is low (approximately 0.2 Ω). If the resistance is too high, replace the HV Transformer. If the resistance is correct, proceed to the next step.

9. On the HT Controller Board, place SW2-2 to ON. Disconnect A2(B) +24V PSU (Faston Terminal) at the 6K5 contactor (some are simply marked as K5).

10. Turn ON the equipment and verify that 6K5 does not activate and that there is NO TENSION on the DC Bus (± 300 VDC), Charge / Discharge Screws or Capacitor Bars.

Note ☞ *The following action requires the Inverter Module (L2), to which the Charge/Discharge Boards are mounted, to be dismounted in order to gain access to the IPM Driver Boards. Do not disconnect the Charge/Discharge Boards.*

11. With an Oscilloscope at one of the IPM Driver boards, measure pulses between J3-4 (GND 1) & J3-3 (CP1 KVDR1) and pulses between J4-4 (GND 2) & J4-3 (CN1 KVDR2). Repeat the test on the other IPM Driver board. If the pulses are not present, replace the respective IPM Driver Board.

ERROR CODE : E14

DESCRIPTION : Exposure signal without X-ray Exposure Console command.

ERROR TYPE : Informative.

APPLICABLE TO : All Generators

APPEARS WHEN : During and after exposition.

INFORMATION / SYMPTOM : Exposure signal without X-ray Exposure Console command.

POSSIBLE CAUSES

The *"Exp"* signal is active on the HT Controller Board.

ACTIONS

1. Remove the connector J1 on HT Controller Board and check grounding of Pin 6 of P1.
2. If Pin 6 of P1 is grounded, replace the HT Controller Board.
3. If Pin 6 of P1 on the HT Controller Board is not grounded, then check grounding of Pin 6 of Connector J1.
4. If it is grounded, remove the connector J3 on the ATP Console CPU Board and check grounding of Pin 6 of Connector J1 again. If it is grounded, repair the wire short-circuit.
5. If it is not grounded, replace the ATP Console CPU Board.

Note ☞ *The resistance value between Pin 6 of P1 on HT Controller Board and Ground (with all cables connected) should be around 900 Ω.*

ERROR CODE : E15

DESCRIPTION : Filament Driver Circuit Open, No current on Filament. Wrong selection of Focal Spot detected during “*Prep*”.

ERROR TYPE : Informative. Does not allow “*Prep*”. Requires to be reset twice.

APPLICABLE TO : All Generators

APPEARS WHEN : At any moment.

INFORMATION / SYMPTOM : No current detected on Focal Spot (Filaments Off). After resetting the Error Code, the filament driver will be shut off.

POSSIBLE CAUSES

Absence of −12 V Power Supply at the HT Controller

A There is no power supplied to the Filament Board
Poor connection at the Cathode HV Cable
Defective Filament Transformer inside the HV Transformer
Defective HV Switch inside the HV Transformer (if the system is equipped with two Tubes)

B Wrong signal −FIL1 ACK

ACTIONS

Note ☞ *“E15” may be provoked by an absence of −12 V (power supply) to the HT Controller at P2-1 or from the Low Voltage Power Supply (LVDC Power Supply 3PS1) at 3TS1-16. See schematics 543020xx and HT Controller 3000-xx for further information.*

Before Troubleshooting for the Possible Causes listed above, proceed with the following steps.

1. Verify -12V from the Low Voltage Power Supply to the HT Controller, identifying and correcting any possible short circuit. If -12V is present, Troubleshoot for the causes listed in the Possible Causes section above (Causes A and B). It -12V is not present, proceed to the next step.

2. There is a possibility of a short circuit at the Ion Chamber connections. If the system has AEC and doesn’t have an AEC Adaptation Board, proceed to the next step. If the system has an AEC Adaptation Board, proceed to step 4.

3. It is likely that there is a short circuit in 3TS1, most probably at 3TS1-16.

4. Disconnect J1, J2, J3 & J5 at the AEC Adaptation Board that go to the Ion Chambers and test for a short circuit in one of these aforementioned connections.

A. THERE IS NO SUPPLY TO THE FILAMENT BOARD, A POOR CONNECTION ON THE CATHODE HV CABLE, A DEFECTIVE FILAMENT TRANSFORMER OR A DEFECTIVE HV SWITCH.

Note ☞

For Generators with two Tubes:

- if the error appears in both Tubes, go to step 1.

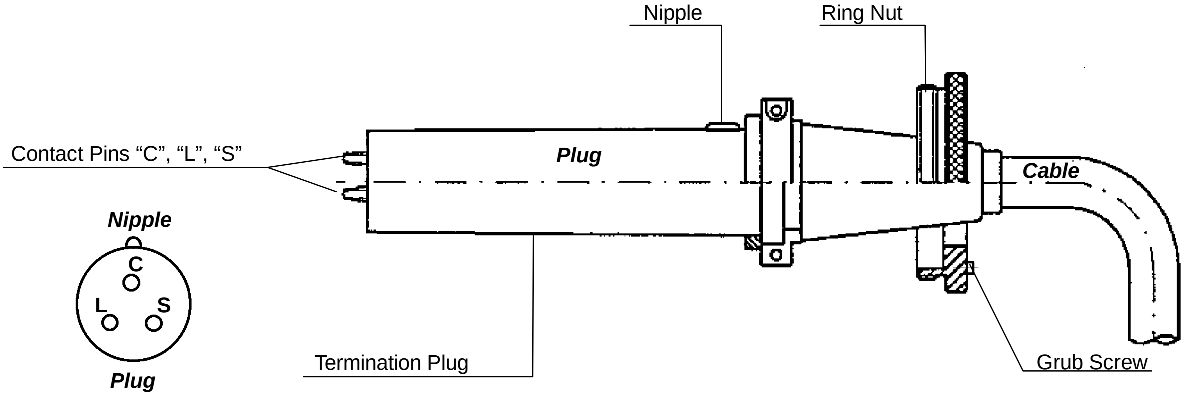
- if the error appears in only one Tube, interchange HV Cables. Then, if error remains when selecting the same Tube from Console, replace HV Transformer.

1. Visual Check for Unplugged Connectors:
With the Generator turned OFF, first of all take a visual inspection at all the connectors in the Front Panel of the Generator (HT Controller Board, Filament Driver Board, Interface Control Board and the High Voltage Switch Control Board). It could have happened that by an accident some connector has been unplugged when removing or placing the generator cover. Take a close inspection because sometimes a connector is disconnected a little bit from one of the sides but not totally disconnected from the connector of the board. Please take a close look with a flash light.

2. X-Ray Tube Filaments Resistance Test:
With the Generator turned OFF, measure the Filaments of each Tube by disconnecting the Cathode High Voltage Cable from the HV Transformer (Generator side)

There are three pins located at the male end of the Plug: "C" (Common), "L" (Large) and "S" (Small). With an Ohm meter, measure between "C" and "S". If the filaments are OK (not opened), the reading should be close to zero Ohms. Also measure between "C" and "L" and between "L" and "S".

If there is an open circuit in any of the Tube filaments, measure the resistance on the Tube side. Remove the Cable from the Tube and test the ohms in the female plug (Tube side) with an Ohm meter that has sufficiently long probes.



3. Primary Filament Resistance Test (1):
With the Generator turned off, measure the resistance of the primary of the Filament Transformer for the Small Focus by removing connector J1 on the HV Transformer and measuring on the Connector of the HV Transformer between the pin marked G (FIL SUP) and H (FIL 2 RTN). Also measure between G (FIL SUP) and F (FIL 1 RTN). These readings should be about 5 ohms each primary.

4. Primary Filament Resistance Test (2):
   Reconnect J1 to the HV Transformer and ensure that it is securely connected and “locked” into position by twisting the outside cover until a “click” is heard. Measure the Ohms between the following points (Each one should read about 5 Ohms):

   - FIL 1 RTN (Large Focus) P3-4 on the Filament Driver Board and P4-15 on the Interface Control Board.
   - FIL 2 RTN (Small Focus) P3-4 on the Filament Driver Board and P4-16 on the Interface Control Board.

   Move around the J1 cable that goes into the HV Transformer looking for a possible wrong connection.

5. High Voltage Switch Connection:

   a. If the primary resistance tests do not reveal the source of the error, remove the Cathode High Voltage Cable from the HV Transformer for both X-ray Tubes.
   b. Set dipswitch “SW2-2” of the HT Controller Board in “ON” position to turn OFF the Filament Circuit (No Error 15) .
   c. Turn the Generator “ON” and select “Tube 1” (or “Tube 2”).
   d. Measure with an Ohm Meter the pins inside the HV Transformer receptacle for “Tube 1” . For this, use long probes to be able to access to the pins of the “Female” High Voltage Connector of the HV Transformer. Measure between Common (this is the pin in line with

      the “Nipple”) and Small (it is the pin to the left). Measure also between Common and Large (it is the pin to the right) . The resistance should be around 0.5 Ohms for each Filament.
   e. Select “Tube 2”, if it is present, and repeat the measurement done in step-d. for “Tube 2”.

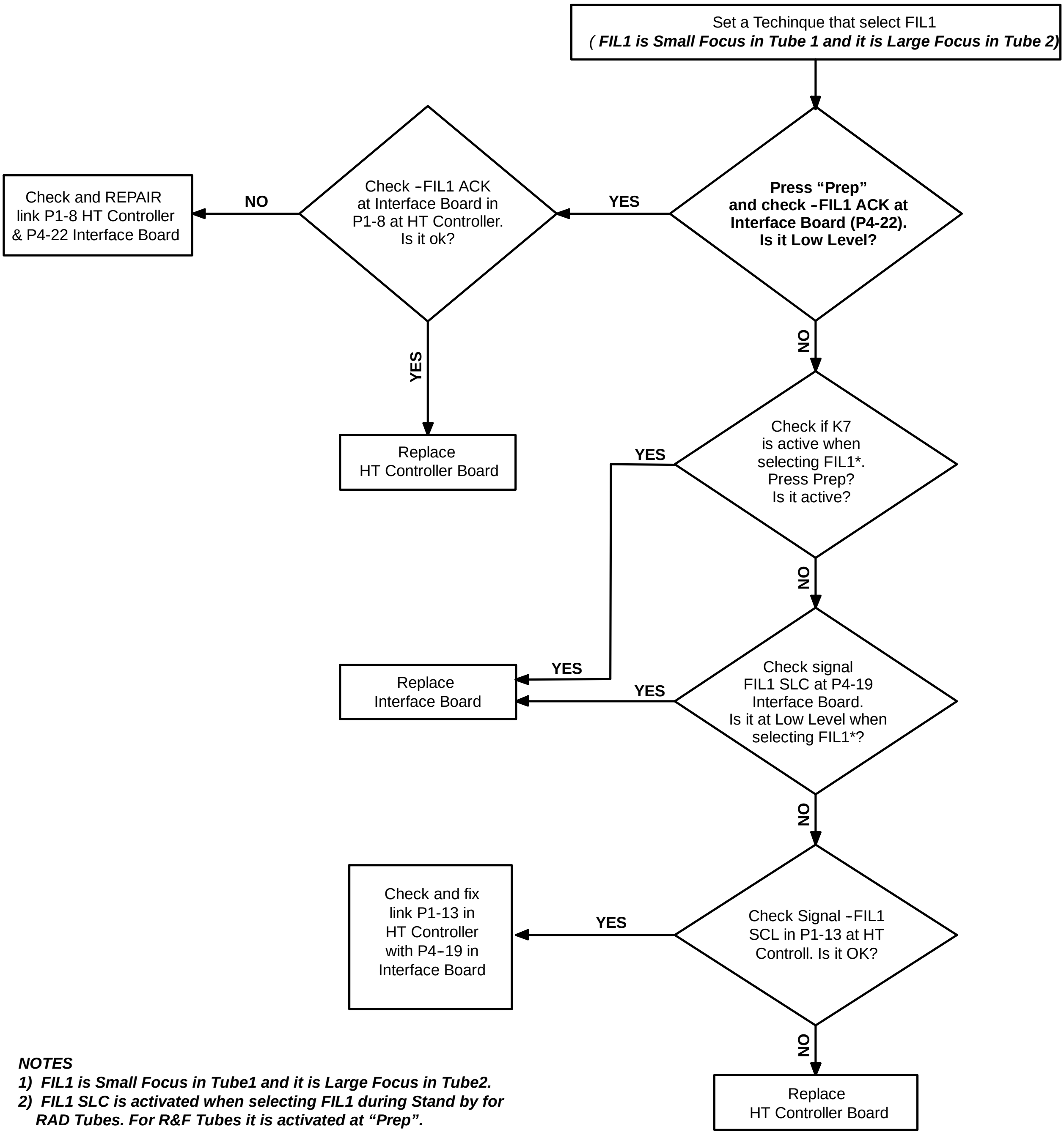
6. Once the test is finished, reconnect the Cathode HV cable for “Tube 1” in its position of the HV Transformer (it is marked in the Cable and in the HV Transformer). Clean the cable with a piece of clean dry paper before placing it inside the HV Transformer. Make sure you tighten the big washer of the HV Cable into the HV Transformer.

7. Repeat the previous step for “Tube 2”.

8. Set dipswitch “SW2-2” of the HT Controller Board in “OFF” position to turn ON the Filament Circuit.

B. WRONG SIGNAL –FIL1 ACK

Perform the following diagnosis if after pressing “*Prep*” the Error Code “E15” appears on the Console.



NOTES
1) FIL1 is Small Focus in Tube1 and it is Large Focus in Tube2.
2) FIL1 SLC is activated when selecting FIL1 during Stand by for RAD Tubes. For R&F Tubes it is activated at “Prep”.

ERROR CODE : E16

DESCRIPTION : Invalid value of : kVp, mA or kW.

ERROR TYPE : Informative. Does not allow “*Prep*” or “*Exp*”.

APPLICABLE TO : All Generators

APPEARS WHEN : In “Prep”

INFORMATION / SYMPTOM : Selected mA or kVp are not correct.

POSSIBLE CAUSES

Wrong maximum kVp configuration.

Wrong software compatibility on the Generator Cabinet and Console.

When pressing “Prep” during the calibration of “Digital mA Loop Open” with a technique that overpasses the Generator power kVp/mA.

ACTIONS

1. Check dipswitch-5 of SW2 on the HT Controller Board , it must be set in accordance with the Generator configuration (maximum kVp of Generator) (dipswitch-5 must be in “open” position for 125 kVp Generator, / dipswitch-5 must be in “closed” position for 150 kVp Generator).

2. When “Digital mA Loop Open” is manually calibrated (in calibration mode), this error may appears if the Generator power is exceeded by a kVp / mA combination selection. Reset the error indication and enter manually the Filament Current number following the instructions described in the Calibration chapter without make any exposure for that combination (kVp / mA).

ERROR CODE : E17

DESCRIPTION : Communication error among ATP Console CPU Board and HT Controller Board.

ERROR TYPE : Fatal Error. Generator opens line contactor.

APPLICABLE TO : All Generators

APPEARS WHEN : Once initialization phase is over at any moment.

INFORMATION / SYMPTOM : No communication link between HT Controller Board and ATP Console CPU Board.
This Error Code requires that the Generator be turned OFF/ON before it can be fixed.

POSSIBLE CAUSES

The communication link between the ATP Console Board and the HT Controller Board is not reliable.

The Generator has been affected by a loss of the main power.

Faulty DC power supply.

Noise on the bucky circuitry.

Defective HT Controller Board or defective ATP Console CPU Board.

ACTIONS

1. Turn Generator OFF/ON.
2. If “E01” appears, follow the same procedure as for “E01”.
3. If “E01” does not appear, error “E17” can be due:
   - a loss of the main power.
   - an intermittent error produced by an external device, install a R-C filter in the power supply and at Bucky start circuitry.

ERROR CODE : E18 OR ROTOR ERROR

DESCRIPTION : Rotor error or Rotor running without order (only with Low Speed Starter).

ERROR TYPE : Fatal Error when the Rotor is running without order. Exposure is not allowed.
Informative Error when the Rotor is not running while “Prep” is active. Exposure is not allowed.

APPLICABLE TO : All Generators.

APPEARS WHEN : At any moment.

INFORMATION / SYMPTOM : The X-ray Tube is not detected to be rotating while “Prep” is active, then exposure is inhibited. For Generators with Low Speed Starter, it can be due to the X-ray Tube anode is rotating without a command from the Console.

POSSIBLE CAUSES

For all Generators:

“-PREP” signal is not going low in the HT Controller Board when “Prep” is pressed.

Only for Generators with High Speed Starter:

HT Controller Board is not receiving the “RTR Ready” signal back from the Control DRAC Board.

Only for Generators with Low Speed Starter:

“–RTR” signal on HT Controller Board is active.

Defective relay K1 (solid State) on the low speed module.

±12 VDC power supply missing on the HT Controller Board.

Defective Low Speed Control or HT Controller Boards.

ACTIONS

A. PREVIOUS CHECK FOR ALL GENERATORS (LOW OR HIGH SPEED STARTER)

Check that the “-PREP” signal is going low in the HT Controller Board when “Prep” is active.

- “-PREP” signal can be measured in connector P1-3 of the HT Controller Board or by looking at the LED DS2 in the HT Controller Board (it must be ON when “Prep” is active).
- If not, check the communication cable (J3) between the ATP console CPU Board and the Generator connector 6J3 and then to the HT Controller Board (P1-3). Make sure it is properly connected and that all the pins are well inserted on both sides (especially 6J3-4 on both sides).
  - If there is not signal continuity between the ATP Console CPU Board (J3-4) and the HT Controller Board (P1-3), repair or replace the communication cable.
  - If the “-PREP” signal is going low and there is signal continuity between the ATP Console CPU Board (J3-4) and the HT Controller Board (P1-3) and LED DS2 in the HT Controller Board is OFF when “Prep” is active, replace the ATP Console CPU Board.
  - If the “-PREP” signal is going low and there is signal continuity between the ATP Console CPU Board (J3-4) and the HT Controller Board (P1-3) and LED DS2 in the HT Controller Board is ON when “Prep” is active, perform procedure B for Generators with High Speed Starter or procedure C for Generators with Low Speed Starter.

B. ONLY FOR GENERATORS WITH HIGH SPEED STARTER (LV-DRAC)

In "Prep" (the Rotor is not running while "Prep" is active)

"Rotor Error" means that the ATP Console CPU Board is not receiving the "Ready" communication signal back from the HT Controller Board. This could be also because the HT Controller Board is not receiving the "Ready" (-RTR RDY) signal from the High Speed Starter (LV-DRAC).

1. Perform the Programming of the High Speed Starter and RAD Filament Setting Time as explained in the Configuration Chapter of the Generator Service Manual. Perform the following sequence:

    - Turn OFF the Generator and take note of the setting of Dipswitch 3000SW2 on the HT Controller Board.
    - Set all Dipswitch positions to OFF.
    - Set Dipswitch of positions 1, 2, 5 and 7 to ON (position 2 to ON informs to the HT Controller Board that it has a LV-DRAC connected).
    - Turn ON the Generator and wait of E01. If E01 is not displayed leave the Generator for 1 minute and then proceed to turn it off.
    - Set all Dipswitch positions as they were originally.

2. If after this, the "Rotor Error" is still present check that the "-RTR RUN" signal is going low in the Control DRAC Board by measuring J4-20 in the Control DRAC Board when "Prep" is active. Normally, if this signal is received by the Control DRAC Board a noise can be heard on the LV-DRAC Transformers because the starter is trying to start the Tube.

    - If there is no signal, check the signal continuity between the HT Controller Board (P5-5), connector 6J1 of the Generator Cabinet (6J1-1) and Control DRAC Board (J4-20). If the continuity is correct but there is no signal in the Control DRAC Board (J4-20), replace the HT Controller Board.
    - If this signal is arriving to the Control DRAC Board then most probably is that the LV-DRAC (High Speed Starter) is accelerating the Tube and therefore the "-RTR RDY" signal is not being received in the HT Controller Board.

        - Measure the signal "-RTR RDY" (active-low) in J4-4 of the Control DRAC Board. Also the LED DL3 must be ON on the Control DRAC Board. If either is not correct:

            - Set Dipswitches for "Minimum Time for Ready (Delay)" on the Control DRAC Board are set for "0" seconds (Dipswitches 3243SW1-1, SW1-2 and SW1-3 in ON position).

            - Check the voltage at the following Test Points on the Control DRAC Board: +5 VDC at TP14, +15 VDC at TP15, -15 VDC at TP37, using for GND reference the following Test Points on the Control DRAC Board: TP2, TP4, TP12, TP13, or TP19. If they are correct, replace the Control DRAC Board.

            - If voltages at the above points are correct, turn the generator OFF and wait three (3) minutes for the Main Storage Capacitors to discharge. Remove the Ribbon Cable from Connector J3 at the Control DRAC Board.Turn the generator ON.

              Check the voltage at the following points on the Interface DRAC Board:
              +5 VDC at Anode of diode CR6,
              +15 VDC at Anode of diode CR5 or at Cathode of diode CR6,
              -15 VDC at Cathode of diode CR7.
              For GND reference use the Terminal J2-3 on the Interface DRAC Board.

              If voltages at the above points are correct, replace the Control DRAC Board. If any voltage at the above points are not correct, verify at the Interface DRAC Board that there is 220 VAC between J3-1 and J3-2, and fuse F1 and F2 are correct, if 220 VAC is present and the fuses are correct replace the Interface DRAC Board.

        - If the signal "-RTR RDY" (active-low) in J4-4 of the Control DRAC Board is correct and the LED DL3 is ON on the Control DRAC Board, check the signal continuity between the Control DRAC Board (J4-4), connector 6J1 of the Generator Cabinet (6J1-5) and HT Controller Board (P5-4). If the continuity is correct but there is no signal in the HT Controller Board (P5-4), replace the HT Controller Board.

CAUTION

Connect all the wires / cables removed during the procedure back to the original connections.

C. ONLY FOR GENERATORS WITH LOW SPEED STARTER (LF-RAC)

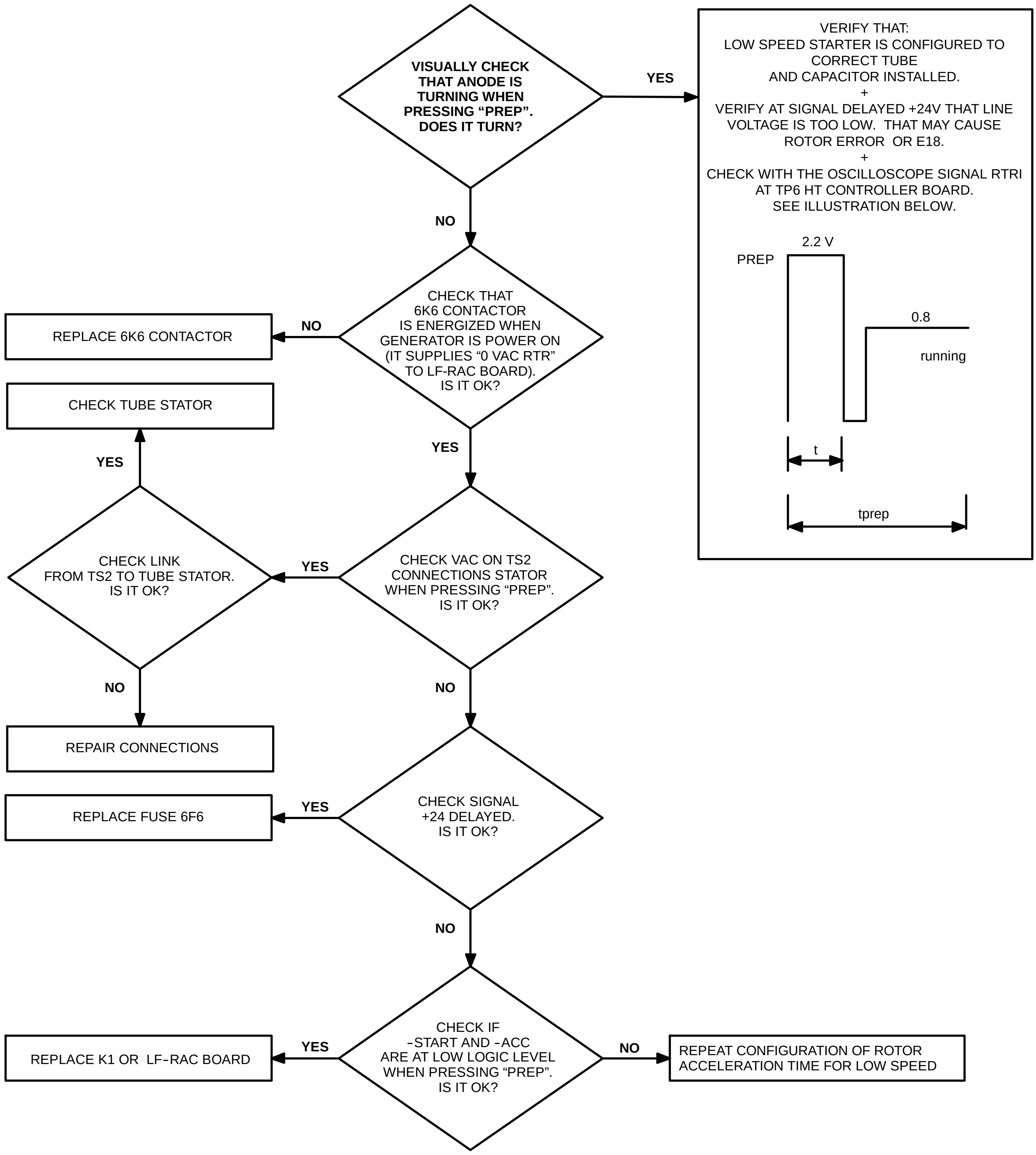
In Stand-by (the Rotor is running without order)

1. Check if the signal "RTR I" Test Point (TP6 on HT Controller) is 0 VDC.
   - If it is 0 VDC, replace the HT Controller Board.
   - If it is not 0 VDC, remove wire P4-3 "RTR I2" on the HT Controller Board and check again the voltage at TP6.
     - If it is not 0 VDC, replace the HT Controller Board.
     - If it is 0 VDC, connect wire P4-3 "RTR I2" on the HT Controller Board and then ensure that Solid Relay K1 (4K1 or 10K1) in the Low Speed Starter Module works properly. For that, check the voltage between terminals 3 and 4 of the Solid Relay K1 is 0 VDC.
2. If the voltage between terminals 3 and 4 of the Solid Relay K1 it is not 0 VDC, replace the HT Controller Board.
3. If the voltage between terminals 3 and 4 of the Solid Relay K1 is 0 VDC, check the voltage between terminal 1 and 2 of the Solid Relay K1 is 60 VAC.
   - If it is 60 VAC replace the LF-RAC Board.
   - If it is not 60 VAC replace the Solid Relay K1 (4K1 or 10K1).

In "Prep" (the Rotor is not running while "Prep" is active)

Refer to the following Flowchart for procedure in "Prep".

IF “E18” OR ROTOR ERROR APPEARS IN “PREP” (ONLY FOR LF-RAC)



ERROR CODE : E19

DESCRIPTION :	mA detected without "*Exp*" command.
ERROR TYPE :	Fatal Error. Generator has opened a line contactor that remains in an endless loop. It is necessary to turn off the equipment.
APPLICABLE TO :	All Generators
APPEARS WHEN :	In stand-by or during initialization.
INFORMATION / SYMPTOM :	Current in tube without *"Prep"* command.

POSSIBLE CAUSES

± 12 VDC power supplies missing on the HT Controller Board.

Defective HT Controller.

mA signal on H T Controller is active.

ACTIONS

1. Check ± 12 VDC power supplies.
2. In stand-by mode (no exposure), check for 0 VDC in TP5, TP13, TP14 as well as in connector P4-6 and P4-7 of the HT Controller Board.
3. If voltage V $\neq$ 0 VDC in P4-6 and P4-7, check connections between P4-6 / P4-7 and J1 of the HV Transformer.
4. If it is OK, replace HT Controller Board.

Note ☞

As reference values:

- the resistance measured between P4-6 or P4-7 on the HT Controller Board and Ground (with all cables connected) should be around 900 Ω.

- the resistance measured between P4-6 or P4-7 on the HT Controller Board and Ground (with cable of J4 connector removed from the HT Controller Board) should be around 200 KΩ.

ERROR CODE : E20

DESCRIPTION :	kVp detected without *"Exp"* command.
ERROR TYPE :	Fatal Error. Generator has opened a line contactor that remains in an endless loop.
APPLICABLE TO :	All Generators.
APPEARS WHEN :	In stand-by or during initialization.
INFORMATION / SYMPTOM :	kVp detected without *"Exp"* command. "E20" on the Console indicates that the error must be solved with the equipment OFF.

POSSIBLE CAUSES

−12 VDC power supply missing.

Defective HT Controller Board.

ACTIONS

1. Check −12 VDC power supply.
2. In stand-by mode (no exposure), check for 0 VDC in TP7, TP11, TP12, as well as in connector P4-1 and P4-2 of the HT Controller Board.
3. If voltage V $\neq$ 0 VDC in P4-1 and P4-2, check connections between P4-1 / P4-2 and J1 of the HV Transformer.
4. If it is OK, replace HT Controller Board.

Note ☞

As reference values:

- the resistance measured between P4-1 on the HT Controller Board and Ground (with all cables connected) should be around 18.5 KΩ.

- the resistance measured between P4-2 on the HT Controller Board and Ground (with all cables connected) should be around 17.5 KΩ.

- the resistance measured between P4-1 or P4-2 on the HT Controller Board and Ground (with cable of J4 connector removed from the HT Controller Board) should be around 20 KΩ.

ERROR CODE : E21

DESCRIPTION : Wrong Tube-1 selection.

ERROR TYPE : Informative. Does not allow operation until the error is solved or another Tube is selected.

APPLICABLE TO : All Generators.

APPEARS WHEN : Principally after initialization, at any moment or when changing Tube selection.

INFORMATION / SYMPTOM : Wrong Tube 1 selection.

POSSIBLE CAUSES

The –HT INTLK is not grounding (Tube 1 selection).

Defective HV Switch inside the HV Transformer (two Tubes option).

The –HT INTLK is missing.

ACTIONS

Note ☞ *Before performing any action, check the Workstation configuration for each Tube.*

Only for one (1) Tube option:

1. Check the –HT INTLK in 6J3-13 (Generator Cabinet), it should be 0 VDC with Tube-1 selected.
2. If it is not 0 VDC, check the Jumper between 6J3-13 and 6J3-16 (GND).
3. If 6J3-13 = 0 VDC, check J3–13 on the ATP Console CPU Board.
4. If not 0 VDC in J3-13, check link between 6J3–13 of the Generator Cabinet and J3-13 on the ATP Console CPU Board.
5. If voltage is 0 VDC and “E21” appears, replace the ATP Console CPU Board.

Only for two (2) Tubes option:

1. Check J3-13 on the ATP Console CPU Board. If it is 0 VDC, replace the ATP Console CPU Board. If it is 5 VDC, proceed to the second step.
2. Turn off the equipment, disconnect J1 from the HV Transformer and check continuity between J1-J and J3-13 on the ATP Console CPU Board.
3. If the continuity is not OK, check cable and replace if necessary.
4. If connection is OK, replace the HV Transformer.

ERROR CODE : E22

DESCRIPTION : Wrong Tube-2 selection.

ERROR TYPE : Informative. Does not allow operation until the error is solved or another Tube is selected.

APPLICABLE TO : All Generators.

APPEARS WHEN : At any moment mainly after initialization or when changing Tube selection.

INFORMATION / SYMPTOM : Wrong Tube 2 selection.

POSSIBLE CAUSES

The –HT INTLK is not at high logic level 5V (Tube 2 selected).

Defective HV Switch inside the HV Transformer (two Tubes option).

The -HT INTLK is grounding.

ACTIONS

Note ☞ *Before performing any action, check the Workstation configuration for each Tube.*

Only for one (1) Tube option:

1. Check the –HT INTLK in 6J3-13 (Generator Cabinet), it should be 5 VDC with Tube 2 selected.
2. If it is not 5 VDC, check that 6J3-13 is not grounding.
3. If 6J3-13 = 5 VDC, check J3-13 on the ATP Console CPU Board.
4. If not 5 VDC in J3-13, disconnect J3-13 on the ATP Console CPU Board and check for short-circuits between J3-13 and ground or others signals.
5. If voltage is 5 VDC and “E22” appears, replace the ATP Console CPU Board.

Only for two (2) Tubes option:

1. Check J3-13 on the ATP Console CPU Board. If it is 5 VDC, replace the ATP Console CPU Board. If it is 0 VDC, proceed to the second step.
2. Turn off the equipment, disconnect J1 from the HV Transformer and check for short-circuits between J1-J and ground or others signals.
3. If previous steps are correct, replace the HV Transformer.

ERROR CODE : E23

DESCRIPTION : Calibration data not stored

ERROR TYPE : Indicative although it is almost impossible to find if not provoked.

APPLICABLE TO : All Generators.

APPEARS WHEN : When trying to save calibration data.

INFORMATION / SYMPTOM : Calibration data not stored. Calibration value intended to be stored has not been properly recorded.

POSSIBLE CAUSES

This problem may be shown randomly.

This problem is continuos or occurs frequently and the communication link between the Generator Cabinet and the Console is too noisy.

ACTIONS

1. Check calibration data and enter them manually if required.
2. Check communication cable (J3) between ATP Console CPU Board and HT Controller Board.
3. Route communication cables in a different way.

ERROR CODE : E24

DESCRIPTION : Bucky Movement Signal has not been detected or DR Device is not ready for exposure.

ERROR TYPE : Indicative. Does not allow exposition.

APPLICABLE TO : All Generators.

APPEARS WHEN : At the beginning of the exposition.

INFORMATION / SYMPTOM : Wrong Exposure signal from Bucky or DR Devices.

POSSIBLE CAUSES

Wrong Workstation configuration or selection.

Wrong wiring of the Bucky.

Malfunction of the Bucky / DR Device / Standard Tomo Device.

ACTIONS

1. Check the configuration of the selected Workstation corresponds to the device (Bucky / DR / Standard Tomo) connected to the Generator (*refer to the Installation / Configuration chapters of the Generator Service Manual*).

2. If none of these devices (Bucky / DR / Standard Tomo) have to be connected to the Generator and "E24" Error Code is present, check if the Workstation configuration is correct, that is, "Device value" $\neq$ 1 (Bucky-1), or $\neq$ 2 (Bucky-2), or $\neq$ 3 (Standard Tomo) (*refer to the Configuration chapter of the Generator Service Manual*).

3. If the error is present selecting a Workstation configured as Bucky-1 (1) or Standard Tomo (3), proceed with step 4.

   If the error is present selecting a Workstation configured as Bucky-2 (2), proceed with step 5.

4. **The error is present selecting a Workstation configured as Bucky-1 (1) or Standard Tomo (3)**, make a provisional jumper between 3TS1-5 and 3TS1-6 of the Generator. Then, make an exposure.

   a. If the exposure is finished and "E24" Error Code is not present, check cable connection between 3TS1 of the Generator and the respective Device (Bucky or DR). *(Refer to the Interconnection Map at the end of the Installation chapter of the Generator Service Manual).*

   b. If "E24" Error Code is present, check if Relay K5 of the Interface Control Board (A3009-xx) is activated.

   c. If Relay K5 is not activated, check if signal $\overline{\text{BUCKY1 DRCMD}}$ is active ("Low Level") in P4-12 of the Interface Control Board when making an exposure.

      - If signal $\overline{\text{BUCKY1 DRCMD}}$ is active, replace the Interface Control Board (A3009-xx).
      - If it is not active, check this signal ($\overline{\text{BUCKY1 DRCMD}}$) is active ("Low Level") in J3-14 of the ATP Console CPU Board (A3024-xx) when making an exposure.

        If it is active, check connection between J3-14 of the ATP Console CPU Board (A3024-xx) and P4-12 of the Interface Control Board.

        If it is not active, replace the ATP Console CPU Board (A3024-xx).

d. If Relay K5 is activated, check if Relay K3 is activated when making an exposure.

- If Relay K3 is activated, check if signal $\overline{\text{BUCKY EXP}}$ is active (“Low Level”) in P4-6 of the Interface Control Board when making an exposure.
- If signal $\overline{\text{BUCKY EXP}}$ is not active, replace the Interface Control Board (A3009-xx).
- If signal $\overline{\text{BUCKY EXP}}$ is active, check for this signal active in J3-12 of the ATP Console CPU Board (A3024-xx) when making an exposure.

  If it is active, replace the ATP Console CPU Board (A3024-xx).

  If it is not active, check connection between J3-12 of the ATP Console CPU Board (A3024-xx) and P4-6 of the Interface Control Board.

5. **The error is present selecting a Workstation configured as Bucky-2**, Make a provisional jumper between 3TS1-12 and 3TS1-13 of the Generator. Then make an exposure.

a. If the exposure is finished and “E24” Error Code is not present, check cable connection between 3TS1 of the Generator and the respective Device (Bucky or DR). *(Refer to the Interconnection Map at the end of the Installation chapter of the Generator Service Manual).*

b. If “E24” Error Code is present, check if Relay K4 of the Interface Control Board (A3009-xx) is activated.

c. If Relay K4 is not activated, check if signal $\overline{\text{BUCKY2 DRCMD}}$ is active (“Low Level”) in P4-13 of the Interface Control Board when making an exposure.

- If signal $\overline{\text{BUCKY2 DRCMD}}$ is active, replace the Interface Control Board (A3009-xx).
- If it is not active, check this signal ($\overline{\text{BUCKY2 DRCMD}}$) is active (“Low Level”) in J3-11 of the ATP Console CPU Board (A3024-xx) when making an exposure.

  If it is active, check connection between J3-11 of the ATP Console CPU Board (A3024-xx) and P4-13 of the Interface Control Board.

  If it is not active, replace the ATP Console CPU Board (A3024-xx).

d. If Relay K4 is activated, check if Relay K3 is activated when making an exposure.

- If Relay K3 is activated, check if signal $\overline{\text{BUCKY EXP}}$ is active (“Low Level”) in P4-6 of the Interface Control Board when making an exposure.
- If signal $\overline{\text{BUCKY EXP}}$ is not active, replace the Interface Control Board (A3009-xx).
- If signal $\overline{\text{BUCKY EXP}}$ is active, check for this signal active in J3-12 of the ATP Console CPU Board (A3024-xx) when making an exposure.

  If it is active, replace the ATP Console CPU Board (A3024-xx).

  If it is not active, check connection between J3-12 of the ATP Console CPU Board (A3024-xx) and P4-6 of the Interface Control Board.

6. Finally, remove the provisional jumpers in 3TS1 of the Generator.

ERROR CODE : E27

DESCRIPTION :	Failure in EPROM U24 of the ATP Console CPU Board. Bad checksum.
ERROR TYPE :	Fatal Error. Generator does not start.
APPLICABLE TO :	All Generators
APPEARS WHEN :	During Generator initialization.
INFORMATION / SYMPTOM :	The ATP Console CPU Board performs a checksum procedure of EPROM U24 when it has been configured to a non-allowed calibration and it has found this value to be incorrect.

POSSIBLE CAUSES

The ATP Console CPU Board has been configured in a non communication mode.

The non volatile RAM does not calculate and compare the ATP Console CPU Board checksum.

The EPROM U24 has been corrupted.

ACTIONS

1. Check if dip-switch 3024SW2 on ATP Console CPU Board is correctly configured (*refer to Configuration Chapter - "Configuration and Test Switches" of the Service Manual).*

2. If error remains, replace the ATP Console CPU Board installing the EPROM U24 from the previous board that has been removed.

3. If error remains, replace the EPROM U24 on ATP Console CPU Board.

ERROR CODE : E28

DESCRIPTION :	AEC Reference set failure.
ERROR TYPE :	Informative. Does not allow “*Prep*” or “*Exp*”.
APPLICABLE TO :	All Generators
APPEARS WHEN :	Before the exposure, during operation with AEC.
INFORMATION / SYMPTOM :	Indicated as Error Code “E28” during AEC selection. Some Consoles show the message “Wrong AEC Selection”.

POSSIBLE CAUSES

AEC Reference out of range. The selected kVp value, AEC Density and/or Film/Screen Combination set a technique that is out of the operative range with AEC.

ACTIONS

1. Change any parameter (kVp value, AEC Density or Film / Screen Combination) in order to obtain a technique enabled for AEC.

ERROR CODE : E32

DESCRIPTION : Operator safety alert: the Receptor has not been replaced or inserted.

ERROR TYPE : Preventive. The error must be reset and the receptor replaced (new Cassette Film or CR).

APPLICABLE TO : Any Positioner with Receptor Detection Kit installed.

APPEARS WHEN : Just after “Prep” is pressed.

INFORMATION / SYMPTOM : Error Code “E32” is displayed along with an audible alarm and it is not possible to make Exposures.

POSSIBLE CAUSES

The Receptor (Cassette Film, CR or Portable Digital Detector) has not been replaced after exposure.

ACTIONS

PRELIMINARY CHECKS (ALL TYPES OF POSITIONERS)

1. Checking the Interlock selecting signals: Verify the status of the Interlock Selection Signals in A3656-01 PBA depending on the configuration of the selected workstation:

WS Lock (Alignment Interlock and Receptor Detection)	A3656-01 PBA (GND=TB1-5&6)		
	TB1-8	TB1-9	TB1-14
0	5V (1)	0.6 V (0)	5V (1)
1	0.6V	5V	5V
2	5V	5V	5V
3	0.6V	0.6V	0.6V
4	0.6V	5V	0.6V
5	5	5	0.6V

a. If the signals are correct, continue in step 2.

b. Verify the continuity in the Interlock Selection Signals between the ATP console of the Generator and A3656-01 PBA.

ATP Console PCB (A3024-XX)	Generator Cabin	A3656-01 PBA
J2-1	4TS3-10	TB1-8
J2-12	4TS3-12	TB1-9
J2-2	4TS3-11	TB1-14

c. If the continuity of any signal is not correct, repair the corresponding connection.

d. If the connections are ok, replace the ATP Console PCB.

2. In case that the error appears when selecting a “CR” configuration (and the system works well when selecting a “DR” configuration:

   a. Connect the oscilloscope to TB1-15 in A3656-01 PBA. Select a workstation configured as Direct, No AEC, minimum kVp, minimum mA and any exposure time (a.e. 80 ms).

Note ☞ *It is suggested to set the HT Controller PCB switch SW2-2 in “ON” position to inhibit radiation during this test.*

   b. Perform an exposure and verify that the signal goes from 5V to 0V during the selected exposure time (a.e. 80 ms).

Note ☞ *If an oscilloscope is not available, a multimeter can also be used. Perform the same configuration as explained above but select an exposure time greater than 1 second in order to register the change of voltage from 5V to 0V during the exposure.*

   c. If the signal is correct, replace A3656-01 PBA.

   d. If the signal is not correct, check continuity in:

ATP Console PCB (A3024-XX)	Generator Cabin	A3656-01 PBA
J2-23	3TS1-52	J2-23

   e. If the continuity is ok, replace ATP Console and A3656-01 PBA.

TABLE WORKSTATION

1. If the error appears when the Table Workstation is selected, check continuity between TB1-3/5 and TB1-11 and between TB1-3/5 and TB1-10 in the A3656-01 PBA. *Refer to Schematic 54303070.*
2. If the electrical continuity fails at any point, check the cables between A3650-01 PBA to the Receptor Cabinet and check also the corresponding Switches.
3. If the Electrical continuity is correct, check LED D21 in A3656-01 PBA. If D21 if OFF, check the supply of the PBA A3656-01 at TB1-13&12. If the supply (+24V) is ok, replace the PBA A3656-01.
4. If the LED D21 in A3656-01 PBA is ON, check Leds D8 and D9 in the same PBA. If any of the LEDs is OFF, replace the PBA A3656-01.
5. If Leds D8 and D9 are ON, check voltage at TB2-1 of the PBA A3650-01. If the voltage in TB2-1 ≈ 5V, replace the PBA A3656-01.
6. If TB2-1= 0V, check the following connections: TB2-1 to 4TS3-20 to J2-15 (at the ATP Console Board). If the connections are ok, replace the Generator ATP Console Board (A3024-XX).

WALL STAND WORKSTATION

1. If the error appears when the Wall Stand Workstation is selected, check continuity between TB1-4/6 and TB1-17 and between TB1-4/6 and TB1-16 in the A3656-01 PBA. *Refer to Schematic 54303070.*

2. If the electrical continuity fails at any point, check the cables between A3650-01 PBA to the Receptor Cabinet and check also the corresponding Switches.

3. If the Electrical continuity is correct, check LED D21 in A3656-01 PBA. If D21 if OFF, check the supply of the PBA A3656-01 at TB1-13&12. If the supply (+24V) is ok, replace the PBA A3656-01.

4. If the LED D21 in A3656-01 PBA is ON, check Leds D8 and D9 in the same PBA. If any of the LEDs is OFF, replace the PBA A3656-01.

5. If Leds D8 and D9 are ON, check voltage at TB2-1 of the PBA A3650-01. If the voltage in TB2-1 $\approx$ 5V, replace the PBA A3656-01.

6. If TB2-1= 0V, check the following connections: TB2-1 to 4TS3-20 to J2-15 (at the ATP Console Board). If the connections are ok, replace the Generator ATP Console Board (A3024-XX).

SINGLE PANEL SYSTEMS (U-ARM)

1. With the System On, the receptor inside the tray and the tray fully inserted, check continuity between TB1-5 and TB1-11 and also between TB1-5 and TB1-10 in the A3656-01 PBA. Refer to schematic 54303157.
   If the continuity is OK go to Step 11.
2. If the continuity is not ok, verify 5 VDC in diodes D1 and D2 of the A3677-01 Rotation interface PBA.
3. If 5VDC in D1 and D2 is ok, verify the following connections:

A3677-01 PBA	A3656-01 PBA
from K1-3	to TB1-5
from K2-4	to TB1-10
from K2-3	to TB1-5
from K2-4	to TB1-11

If the connections are ok, replace A3677-01 PBA also known as A13050-403.

4. If 5 VDC in D1 and D2 is not ok, verify 5 VDC between J1-1 in A3677-01 and GND (J1-6).
   If 5VDC are ok, go to step 9.
5. If 5 VDC is not ok, verify 5 VDC between TB1-2 and TB1-5 in A3656-01. If 5 VDC is ok, verify the following connections:

A3677-01 PBA	A3656-01 PBA
from J1-1	to TB1-2
from J1-6	to TB1-5

6. If 5 VDC is not ok in step 5., check LED D21 in A3656-01 PBA. If D21 if OFF, check the supply of the PBA A3656-01 at TB1-13&12. If the supply (+24V) is ok, replace the A3656-01 PBA. If D21 is ON, go to step 8.

7. If the supply (+24V) is not present, verify/repair the following connections:

3TS1 (Generator)	A3656-01 PBA
from 3TS1-7	to TB1-12 (GND)
from 3TS1-17	to TB1-13

8. If D21 is ON in step 6., check that Jumper 2 in A3656-01 is correctly inserted, if the Jumper 2 is correctly inserted, replace A3656-01 PBA.

9. Check continuity between J1-6 & 5 and J1-6 & 4, ok replace A3677-01 (also known as A13050-403).

10. if continuity in any point of step 9. is not ok, verify connections from J1 of A3677-01 to the Detector “IN” and “Tray” switches located at the BDC tray at the U-arm, refer to schematics 54303157. Verify that the previously mentioned switches provide correct signals when inserting the tray with the Receptor in place.

11. Check Leds D8 and D9 in PBA A3656-01. If any of the LEDs is OFF, replace the PBA A3656-01.

12. If Leds D8 and D9 are ON, check voltage at TB2-1 of the PBA A3650-01. If the voltage in TB2-1 $\approx$ 5V, replace the PBA A3656-01.

13. If TB2-1= 0V, check the following connections: TB2-1 to 4TS3-20 to J2-15 (at the ATP Console Board). If the connections are ok, replace the Generator ATP Console Board (A3024-XX).

ERROR CODE : E33

DESCRIPTION : No communication link between the Generator and the Operator Console or PC Unit.

ERROR TYPE : Indicative.

APPLICABLE TO : All Generators with Operator Console.

APPEARS WHEN : At any moment.

INFORMATION / SYMPTOM : Serial Communication Error.

POSSIBLE CAUSES

Connecting cable between Console and Generator is loose or damaged.

ATP Console CPU Board, or Operator Console, or Serial Port of the PC is damaged.

The Generator is turned OFF and PC is ON.

ACTIONS

This error means that there is NO serial communication (RS232) between the ATP Console CPU Board and the Operator Console or PC (depends on the installation).

Note ☞ *The ATP Console CPU Board (for serial communication) is located at the back side of the Front Panel the Generator cabinet.*

1. Check the connection cable between connector J8 (or J7 depends on the Generator configuration) from the ATP Console CPU Board to connector J5 of the Generator cabinet. Then check the serial communication cable and connections from J5 to the Operator Console or to the ON/OFF Interface Box (when a PC is used). *(Refer to schematics 54301052 and A6188-03 of the Installation chapter in the Service Manual).*

2. In order to isolate the problem, turn the Generator ON and measure if any of the following voltages are present in order to know if the Generator is really turned ON.
   - 240 VAC SW: between 3TS1-26 and 3TS1-10.
   - 115 VAC SW: between 3TS1-27 and 3TS1-10.
   - Relay 3K3 (located on the front door of the generator) is energized.
   - LED DS1 in the Interface Control Board is ON.

3. If the Generator is turned ON, check the following points:
   a. 12 VDC UNR: In the ATP Console CPU Board between TP9 and TP11.

      If 12 VDC UNR is not present in the ATP Console CPU Board, check Fuse 3F7. If Fuse 3F7 is OK, check the presence of 11 VAC at the input of Rectifier 3BR4.
      - If 11VAC is not present, check for 11 VAC between terminals 11 and 12 of Transformer 6T2 and check Relay 3K3 works properly.
      - If 11 VAC is present at the input of Rectifier 3BR4, check for 12 VDC UNR measuring in Capacitor 3C7. If 12 VDC UNR is not present, replace the Rectifier 3BR4. If 12 VDC UNR is present, check the wire connections.

b. If 12 VDC UNR is present between TP9 and TP11 of the ATP Console CPU Board, check for:

- 12 VDC ISO: In the ATP Console CPU Board between TP10 and TP1.
- 5 VDC of the ATP: In the ATP Console CPU Board between TP3 and TP1.
- DS1 of the ATP Console CPU Board (normally ON).

  If any of the voltages is not present or correct, or if LED DS1 is OFF, replace the ATP Console CPU Board.

c. If previous steps are correct, the problem is isolated in the RS232 connection between the ATP Console CPU Board and the Operator Console or PC (depends on the installation).

   Check the Serial Port on the PC and if possible the RxD and TxD signal between the ATP Console CPU Board and the PC. *(Refer to schematics 54301052 and A6188-03 of the Installation chapter in the Service Manual).* Replace any defective part found.

   To check the Serial Communication using an Oscilloscope measure the following signal:

- On the ATP Console CPU Board, measure and check that there is a wave form on the connector J8-3, if some RS232 signal is present that means the ATP Console CPU Board is sending some information to the Operator Console, in case that no signal is present on this pin replace the ATP Console CPU Board.
- On the ATP Console CPU Board, measure and check that there is a wave form on the connector J8-2, if some RS232 signal is present that means the ATP Console CPU Board is receiving some information from the Operator Console, in case that no signal is present check the following points:

  - For Push-button Console, check that all VDC are present on the Operator Console and all internal connections are secure inside the Console.

  - For Touch Screen Console, check that all internal connections are secure inside the Console.

  - If after the previous checking the wave form is present on the connector J8-2 but the “E33” Error Code persists, then replace the ATP Console CPU Board.

ERROR CODE : E34 – TECHNIQUE ERROR

DESCRIPTION :	Technique error.
ERROR TYPE :	Informative without acoustic alarm or Fatal error after exposition. It does not allow exposure.
APPLICABLE TO :	All Generators.
APPEARS WHEN :	At any moment after parameter selection or after exposure.
INFORMATION / SYMPTOM :	Warning Indication: “Technique error” on Consoles with written indicators. For other Consoles, “E34” appears on the display.

POSSIBLE CAUSES

Calibration for specific parameters is incorrect.

ACTIONS

1. <u>If this error occurs with time parameters close to 1ms</u> – The cable capacity is excessive for a short exposure. Also the calibration for that parameters is wrong. Check the Calibration section of the Service Manual: “*Exposure Time Adjustment”*.

2. If this error occurs in Fluoroscopy mode with ABC, it means that the equipment is not able to perform the intended operation. Perform Jumper W1 in Fluoro CPU.

3. **DANGER: If it happens after an exposition, it indicates a failure in the exposition timer; backup timer has been cut.** Reset APR and reconfigure values.

ERROR CODE : E35 – DOOR OPEN

DESCRIPTION : Door Open.
For Generators with HV Transformer equipped with a Security Pressure Switch, the HV Transformer surpasses the maximum internal pressure capacity.

ERROR TYPE : Informative. It may inhibit Exposition depending on the configuration of Dipswitch 3024SW1–2 on the ATP Console CPU Board.

APPLICABLE TO : All Generators.

APPEARS WHEN : At any moment.

INFORMATION / SYMPTOM : Indicated with warning “Door Open” or error code “E35”. Does not allow “Prep” and “Exp”.

POSSIBLE CAUSES

“Door Open” Circuit is open (X-Ray Room Door open, cable disconnected or jumper cable not installed).

When the HV Transformer is equipped with a Pressure Switch: Could indicate a need to replace the HV Transformer because it has surpassed its maximum internal pressure capacity and is close to deforming.

Fault at the ATP Console CPU Board.

ACTIONS

1. If the X-Ray Door signal is setup, ensure continuity in the *Door Interlock Signal* from the X-Ray Room Door through 3TS1 (3TS1-22 & 3TS1-23) and J2 (J2-19 & J2-18) on the ATP Console CPU Board (*see the Installation Chapter of the Service Manual: “Door Interlock Signal”*), correcting continuity where necessary.

   If the X-Ray Door signal is not setup, ensure the same continuity as above from the Jumper at 3TS1 (3TS1-22 & 3TS1-23).

2. If the error persists and the HV Transformer is equipped with a Security Pressure Switch, this error may appear when the HV Transformer surpasses its maximum internal pressure capacity and is close to deforming. In this case, the HV Transformer must be replaced.

3. If the error persists and the HV Transformer has been replaced or is not equipped with a Security Pressure Switch, replace the ATP Console CPU Board.

ERROR CODE : E36 - HEAT UNITS

DESCRIPTION :	Safety Thermostat Open. Overheating.
ERROR TYPE :	Informative without acoustic alarm. Does not allow expositions.
APPLICABLE TO :	All Generators.
APPEARS WHEN :	At any moment.
INFORMATION / SYMPTOM :	Indicated with "*Heat Unit*" warning in Consoles with written indicators. For the rest of Consoles "E36" appears in display. Does not allow "*Prep*" and "*Exp*".

POSSIBLE CAUSES

The thermostat of the selected Tube is open due to an overheated Tube Housing (temperature > 60ºC), a defective thermostat connection, or a faulty thermostat.

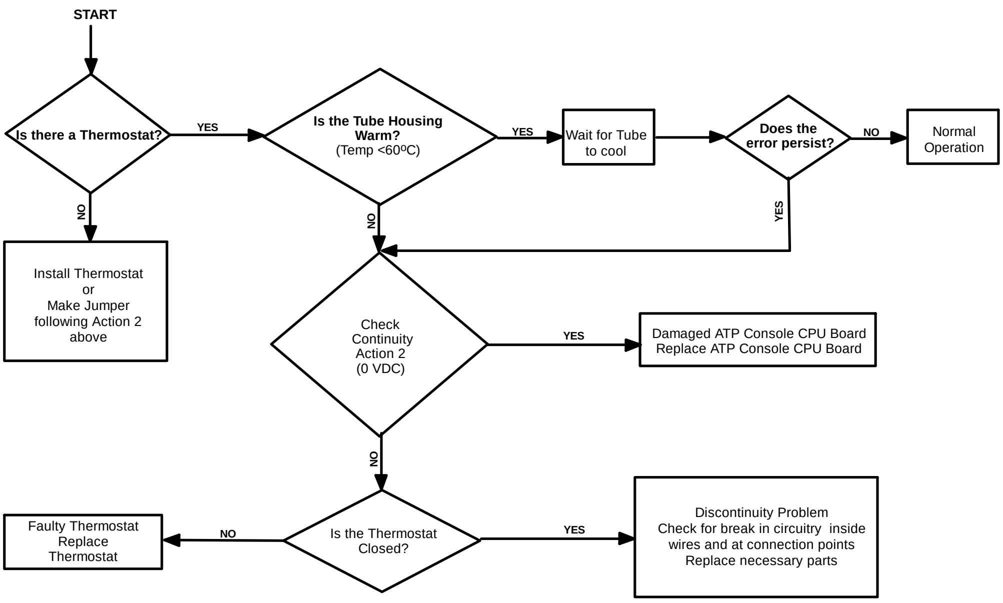
Discontinuity problem inside the wires or at connection points.

If the Tube Housing is cool (temperature < 60ºC) and there is a closed circuit (connections are not faulty and Voltmeter reading for Tube-1/2 is 0 VDC), there is a damaged ATP.

It may also appear during calibration due to the high volume of exposures (starting, braking and Anode heating)

ACTIONS

1. If the error is due to overheating, wait until the temperature is lower than 60ºC, the thermostat will be closed.
2. When there is no thermostat on the X-ray Tubes, the respective thermostat signals have to be connected to ground (For Tube-1: TS2-4 & TS2-5 / For Tube-2: TS2-12 & TS2-13)
3. Check for a correct installation of the Thermostat/Presostat (connections for Tube-1: TS2-4 & TS2-5 / For Tube-2: TS2-12 & TS2-13).
   - If the Tube does not have this signal, make the Jumpers as indicated above.
   - If the Tube has this signal, check for a faulty ATP Console CPU Board.



ERROR CODE : E37 - TUBE OVERLOAD

DESCRIPTION :	Tube Overload.
ERROR TYPE :	Informative without acoustic alarm. Does not allow Exposition.
APPLICABLE TO :	All Generators.
APPEARS WHEN :	After “Exp” due to Tube overheating. After changing radiographic parameters. In some Consoles this error may not appear as they are provided with an automatic blocking that disables parameters above Tube capacity.
INFORMATION / SYMPTOM :	Indicated with warning “Tube Overload” in Consoles with written indicators. For the rest of the Consoles “E37” appears in the display. Exposures are not allowed.

POSSIBLE CAUSES

Parameters selected for a new exposition are above Tube capacity. (Heat Units or Rating).

The Capacity Line frequency is wrong or the Tube selected in the extended position “E02” or “E18” is not correct.

ACTIONS

1. Wait until X-ray Tube temperature is lowered, so capacity of available Heat Units increase, or modify Exposition parameters.

2. If Heat Units of the Tube are 100% and “E37” or “Tube Overload” warning appear, check that Dip-switch 3024SW1-1 on ATP Console CPU Board is properly configured (Dip-switch 3024SW1-1 in “OFF” position for High Speed generators). (*Refer to the Configuration Chapter in the Service Manual*).

3. Check the X-Ray Tube configured in the Extended Memory Location “E02” for Tube-1 and “E18” for Tube-2 (*refer to Section“X-ray Tube Selection” of the Configuration Chapter of the Service Manual*).

ERROR CODE : E38 - E39

DESCRIPTION : Operator safety alert: X-ray Tube orientation is incorrect for the selected Workstation.
E38 configured for Alignment Interlock-1 (usually the Table).
E39 configured for Alignment Interlock-2 (usually the Wall Stand).

ERROR TYPE : Preventive.

APPLICABLE TO : All Generators with an X-ray Tube Alignment Safety Kit

APPEARS WHEN : Just after “Prep” is pressed.

INFORMATION / SYMPTOM : “E38” or “E39” appears on the Console while an alarm sounds.

POSSIBLE CAUSES

The X-ray Tube orientation is not aligned for the selected Workstation (out of an acceptable alignment range).

ACTIONS

1. Align the X-ray Tube with the selected workstation (usually Interlock-1 (E38) for the Table and Interlock-2 (E39) for the Wall Stand) and then keep pressed the respective button (“Reset”) until the error indication disappears.
2. If the error persists, check the Workstation Lock (Alignment Interlock) configuration and cable connections according to Appendix “X-ray Tube Alignment Kit”.

ERROR CODE : E40

DESCRIPTION :	Operator safety alert: more than one Workstation Interlock is active at the same time.
ERROR TYPE :	Preventive. The error must be reset and the alignment corrected.
APPLICABLE TO :	All Generators with an X-ray Tube Alignment Safety Kit
APPEARS WHEN :	Just after “Prep” is pressed.
INFORMATION / SYMPTOM :	Error Code “E40” is displayed along with an audible alarm and it is not possible to make Exposures.

POSSIBLE CAUSES

More than one Workstation Interlock is active at the same time.

ACTIONS

1. Keep pressed the respective button (“Reset”) until the error indication disappears.
2. Check the Workstation Lock (Alignment Interlock) configuration and cable connections.
3. If the error persists, replace the Alignment Board (A3540-01).

ERROR CODE : E41

DESCRIPTION : Dosimeter failure. Communication failure between the Tube-1 Dosimeter and Generator.

ERROR TYPE : Indicative.

APPLICABLE TO : All Generators with Dosimeter.

APPEARS WHEN : Communication error starting the measuring.

INFORMATION / SYMPTOM : Indicated as Error Code "E41".

POSSIBLE CAUSES

Wrong Physical connection between Dosimeter and Generator for Tube-1.

Defective Radiation Meter Board (A3170-01) or defective ATP Console CPU Board (A3024-xx).

ACTIONS

1. Turn OFF/ON the Generator to reset the Radiation Measuring System.
2. Check the cable connections between the Dosimeter Ion Chamber for Tube-1 (located under the Collimator) and the Connector IC-1 located on the Front Panel (Module-3) of the Generator Cabinet (*for more information, refer to Appendix "Adaptation of the Radiation Measuring System*).
3. Check the cable connections between Connector IC-1 and Connector P2 of the Radiation Meter Board (A3170-01).
4. Check the cable connections between Connector P3 of the Radiation Meter Board (A3170-01) to Connector J7 of the ATP Console CPU Board (A3024-xx) or to Connector COM4 of the TPC (if ATP Console CPU Board is not used for the Dosimeter System).
5. Verify +24VDC is present between J1-2 and J1-3 of the Radiation Meter Board (A3170-01).
   - If +24VDC is not present, check wire connections between J1 of the Radiation Meter Board and 3TS1-17/18 in the Generator Cabinet.
   - If +24VDC is present, disconnect the JACK connector next to Connector IC1 and check if verify 23 VDC is present on the JACK connector (Generator side).
     - If 23 VDC is not present, check wire connection between P2 of the Radiation Meter Board and JACK Connector, and if the connection is correct replace the Radiation Meter Board (A3170-01).
     - If 23 VDC is present, follow next step.
6. On the Radiation Meter Board, verify between both ends of Diode D1 is 0 VDC present.
   - If the voltage in Diode D1 is 24 VDC, check if there is a short-circuit between J1-1 and GND.
   - If the voltage in Diode D1 is 0 VDC, disconnect P2 and P3 of the Radiation Meter Board. Maintain the Unit switched ON, measure continuity between P3-2 and P2-2, and between P3-3 and P2-3. If there is not continuity between the mentioned points, replace the Radiation Meter Board (A3170-01).
7. Only for Radiation Measuring Systems with connections through the ATP Console CPU Board.

   Using an Oscilloscope, measure on the ATP Console CPU Board the presence of pulses between connector J7-2 (reception) and GND, and between J7-3 (transmission) and GND.
   - If pulses are present in J7-3 but pulses are not present in J7-2 , replace the DAP Ion Chamber.
   - If pulses are not present in J7-3, replace the ATP Console CPU Board (A3024-xx).
   - If pulses are present in both mentioned points, replace the ATP Console CPU Board (A3024-xx).

ERROR CODE : E42

DESCRIPTION : Dosimeter failure. Auto test error on Tube-1 Dosimeter.

ERROR TYPE : Indicative.

APPLICABLE TO : All Generators with Dosimeter.

APPEARS WHEN : Communication error starting the measuring for Tube-1 or during regular operation.

INFORMATION / SYMPTOM : Indicated as Error Code “E42”. Failure test in Dosimeter.

POSSIBLE CAUSES

Error during electronic checking of DAP Ion Chamber for Tube-1.

ACTIONS

1. Turn OFF/ON the Generator to reset the Radiation Measuring System.

2. If the error persists, replace the DAP Ion Chamber.

ERROR CODE : E43

DESCRIPTION :	Dosimeter failure. Tube-1 DAP Ion Chamber status check error.
ERROR TYPE :	Indicative.
APPLICABLE TO :	All Generators with Dosimeter.
APPEARS WHEN :	Communication error starting the measuring for Tube-1 or during regular operation.
INFORMATION / SYMPTOM :	Indicated as Error Code “E43”. Wrong DAP Ion Chamber status request.

POSSIBLE CAUSES

Error during DAP Ion Chamber checking. DAP Ion Chamber not operative.

ACTIONS

1. Turn OFF/ON the Generator to reset the Radiation Measuring System.

2. If the error persists, it is necessary to recalibrate the DAP Ion Chamber.

ERROR CODE : E44

DESCRIPTION : Dosimeter failure. Communication failure between the Tube-2 Dosimeter and Generator.

ERROR TYPE : Indicative.

APPLICABLE TO : All Generators with Dosimeter.

APPEARS WHEN : Communication error starting the measuring.

INFORMATION / SYMPTOM : Indicated as Error Code "E44".

POSSIBLE CAUSES

Wrong Physical connection between Dosimeter and Generator for Tube-2.

Defective Radiation Meter Board (A3170-01) or defective ATP Console CPU Board (A3024-xx).

ACTIONS

1. Turn OFF/ON the Generator to reset the Radiation Measuring System.
2. Check the cable connections between the Dosimeter Ion Chamber for Tube-2 (located under the Collimator) and the Connector IC-2 located on the Front Panel (Module-3) of the Generator Cabinet (*for more information, refer to Appendix "Adaptation of the Radiation Measuring System*).
3. Check the cable connections between Connector IC-2 and Connector P1 of the Radiation Meter Board (A3170-01).
4. Check the cable connections between Connector P3 of the Radiation Meter Board (A3170-01) to Connector J7 of the ATP Console CPU Board (A3024-xx) or to Connector COM4 of the TPC (if ATP Console CPU Board is not used for the Dosimeter System).
5. Verify +24VDC is present between J1-2 and J1-3 of the Radiation Meter Board (A3170-01).
   - If +24VDC is not present, check wire connections between J1 of the Radiation Meter Board and 3TS1-17/18 in the Generator Cabinet.
   - If +24VDC is present, disconnect the JACK connector next to Connector IC1 and check if verify 23 VDC is present on the JACK connector (Generator side).
     - If 23 VDC is not present, check wire connection between P1 of the Radiation Meter Board and JACK Connector, and if the connection is correct replace the Radiation Meter Board (A3170-01).
     - If 23 VDC is present, follow next step.
6. On the Radiation Meter Board , verify between both ends of Diode D1 is 24 VDC present.
   - If the voltage in Diode D1 is 0 VDC, check wire connection between J1-1 of the Radiation Meter Board and J1-12 of the HT Controller Board.
   - If the voltage in Diode D1 is 24 VDC, disconnect P1 and P3 of the Radiation Meter Board. Maintain the Unit switched ON, measure continuity between P1-2 and P3-2, and between P1-3 and P3-3. If there is not continuity between the mentioned points, replace the Radiation Meter Board (A3170-01).
7. Only for Radiation Measuring Systems with connections through the ATP Console CPU Board. Using an Oscilloscope, measure on the ATP Console CPU Board the presence of pulses between connector J7-2 (reception) and GND, and between J7-3 (transmission) and GND.
   - If pulses are present in J7-3 but pulses are not present in J7-2 , replace the DAP Ion Chamber.
   - If pulses are not present in J7-3, replace the ATP Console CPU Board (A3024-xx).
   - If pulses are present in both mentioned points, replace the ATP Console CPU Board (A3024-xx).

ERROR CODE : E45

DESCRIPTION : Dosimeter failure. Auto test error on Tube-2 Dosimeter.

ERROR TYPE : Indicative.

APPLICABLE TO : All Generators with Dosimeter.

APPEARS WHEN : Communication error starting the measuring for Tube-2 or during regular operation.

INFORMATION / SYMPTOM : Indicated as Error Code “E45”. Failure test in Dosimeter.

POSSIBLE CAUSES

Error during electronic checking of DAP Ion Chamber for Tube-2.

ACTIONS

1. Turn OFF/ON the Generator to reset the Radiation Measuring System.
2. If the error persists, replace the DAP Ion Chamber.

ERROR CODE : E46

DESCRIPTION : Dosimeter failure. Tube-2 DAP Ion Chamber status check error.

ERROR TYPE : Indicative.

APPLICABLE TO : All Generators with Dosimeter.

APPEARS WHEN : Communication error starting the measuring for Tube-2 or during regular operation.

INFORMATION / SYMPTOM : Indicated as Error Code “E46”. Wrong DAP Ion Chamber status request.

POSSIBLE CAUSES

Error during DAP Ion Chamber checking. DAP Ion Chamber not operative.

ACTIONS

1. Turn OFF/ON the Generator to reset the Radiation Measuring System.

2. If the error persists, it is necessary to recalibrate the DAP Ion Chamber.

ERROR CODE : E48

DESCRIPTION : Collimator Error.

ERROR TYPE : Informative. Does not allow exposure.

APPLICABLE TO : All Generators.

APPEARS WHEN : At any moment.

INFORMATION / SYMPTOM : Showed as “Technique Error” in Consoles with this light indicator. On other Consoles, “E48” is displayed.

POSSIBLE CAUSES

Collimator blades closed or in motion during exposure.

Defective Collimator.

ACTIONS

1. Check collimator blades.

2. If they are OK, check that the TS3-20 is at “Low level”
   - If it is not at “Low level”: The problem is in the Collimator.
   - If the signal is at “Low level”, check J2-6 on ATP Console.
     - if it is at “Low level”, replace ATP Console CPU Board
     - If is at “High level”, check and fix the link between J2-6 and TS3-20.

ERROR CODE : E50

DESCRIPTION : Interrupted Exposure.

ERROR TYPE : Indicative.

APPLICABLE TO : All Generators.

APPEARS WHEN : When operator releases “*Exp*” control before exposure time has finished.

INFORMATION / SYMPTOM : Indicated as Error Code “E50” or “Exposure Aborted by the Operator”.

POSSIBLE CAUSES

Operator releases “*Exp*” button before exposure time has finished.

ACTIONS

1. Reset the Error indication.
2. Repeat the exposure.
3. If the error persists, check:
   - Handswitch condition and connections, replace if needed.
   - “EXP” button on the Console, Console condition and connections, replace the respective parts if needed.

ERROR CODE : E51

DESCRIPTION :	LV-DRAC: Checksum failure or Microcontroller U17 corrupted in Control DRAC Board.
ERROR TYPE :	Indicative. System does not allow exposition.
APPLICABLE TO :	Generators with High Speed Starter
APPEARS WHEN :	After self-test.
INFORMATION / SYMPTOM :	At power On, after the Generator autocheck, Error Code "E51 is displayed and it is not possible to make Exposures.

POSSIBLE CAUSES

DRAC program memory corrupted.

ACTIONS

1. Replace Microcontroller U17 on the Control DRAC Board.

ERROR CODE : E52

DESCRIPTION : LV-DRAC: Microcontroller RAM failure.

ERROR TYPE : Indicative. Exposure is not allowed.

APPLICABLE TO : Generators with High Speed Starter

APPEARS WHEN : After self-test.

INFORMATION / SYMPTOM : At power On, after the Generator autocheck, Error Code “E52” is displayed and it is not possible to make Exposures.

POSSIBLE CAUSES

U17 on the Control DRAC Board is defective.

ACTIONS

1. Replace Microcontroller U17 on Control DRAC Board.

ERROR CODE : E53

DESCRIPTION :	LV-DRAC: Insufficient DC BUS voltage at low level voltage (220 VAC).
ERROR TYPE :	Indicative. Exposure is not allowed.
APPLICABLE TO :	Generators with High Speed Starter
APPEARS WHEN :	At any moment.
INFORMATION / SYMPTOM :	Error Code “E53” is displayed and it is not possible to make *Prep*.

POSSIBLE CAUSES

Low or no DC BUS Voltage on the Control DRAC Board.

Voltage at TP18 on the Control DRAC is <1.1VDC.

ACTIONS

1. Turn the generator ON.

TO AVOID ELECTRIC SHOCK, DO NOT TOUCH ANY HEATSINK OR ANY COMPONENT IN THE LV-DRAC MODULE.

2. On the Interface DRAC Board check that the voltage between J2-1 (-) and J2-2 (+) is higher than 200 VDC.
   - If it is not, perform Error Code “E11” checking.
   - If it is higher than 200 VDC, go to next step.

3. On the Interface DRAC Board check that there is the same voltage between J2-5 (-) and J2-4 (+) than the voltage measured before between J2-1 (-) and J2-2 (+).
   - If VDC is OK, go to step 8.
   - If VDC is not OK, go to next step.

4. Turn the generator OFF and wait three (3) minutes for Main Storage Capacitors to discharge.

5. Check Fuses F3 and F4 on the Interface DRAC Board and that the Fuse Holders are making contact with the Fuses. If necessary, replace the Fuses and close the contacts of the Fuse Holders.

6. Turn the generator ON.

7. If the error persists, check on the Interface DRAC Board that there is the same voltage between J2-5 (-) and J2-4 (+) than the VDC measured before between J2-1 (-) and J2-2 (+).
   - If VDC is OK, go to step 8.
   - If VDC is not OK, turn the generator OFF and wait three (3) minutes for the Main Storage Capacitors to discharge.
     - If any of the Fuses are blown again, replace the Fuse(s) and replace the Control DRAC Board.
     - If both Fuses are OK, replace the Interface DRAC Board.

8. On the Control DRAC Board, check that the voltage between J2–1 (–) and J2–2 (+) is the same than the voltage measured before between J2–1 (–) and J2–2 (+) on the Interface DRAC Board.
   - If VDC is not OK:
     - Turn the generator OFF and wait three (3) minutes for the Main Storage Capacitors to discharge.
     - Check the Faston terminals of the DC BUS Cable on both Boards (Control and Interface DRAC Boards). If necessary, close the Faston terminals.
     - Check the continuity of the DC BUS Cable. If necessary, replace the DC BUS Cable.
   - If VDC is OK, but the error persists, check that the voltage at TP18 on Control DRAC Board is < 1.1 VDC.

Note ☞ *For GND reference use the following Test Points on the Control DRAC Board: TP2, TP4, TP12, TP13, or TP19.*

   - If VDC is higher than 1.1 VDC, replace the Control DRAC Board.
   - If VDC is lower than 1.1 VDC, check the voltage at the following Test Points on the Control DRAC Board:
     - +5 VDC at TP14
     - +15 VDC at TP15
     - –15 VDC at TP37

Note ☞ *For GND reference use the following Test Points on the Control DRAC Board: TP2, TP4, TP12, TP13, or TP19.*

   - If voltages at the above Test Points are correct, replace the Control DRAC Board.
   - If any voltage at the above Test Points are not correct, go to next step.

9. Turn the generator OFF and wait three (3) minutes for the Main Storage Capacitors to discharge.

10. Remove the Ribbon Cable from Connector J3 at the Control DRAC Board.

11. Turn the generator ON.

12. Check the voltage at the following points on the Interface DRAC Board:
    - +5 VDC at Anode of diode CR6
    - +15 VDC at Anode of diode CR5 or at Cathode of diode CR6
    - –15 VDC at Cathode of diode CR7

Note ☞ *For GND reference use the Terminal J2–3 on the Interface DRAC Board.*

   - If voltages at the above points are correct, replace the Control DRAC Board.
   - If any voltage at the above points are not correct, replace the Interface DRAC Board.

CAUTION ***Connect all the wires / cables removed during the procedure back to the original connections.***

ERROR CODE : E54

DESCRIPTION : LV-DRAC: Insufficient DC BUS voltage at high level voltage (400 / 480 VAC).

ERROR TYPE : Indicative. Exposure is not allowed.

APPLICABLE TO : Generators with High Speed Starter

APPEARS WHEN : At any moment

INFORMATION / SYMPTOM : Error Code “E54” is displayed and it is not possible to make *Prep*.

POSSIBLE CAUSES

Low or no DC BUS Voltage on the Control DRAC Board.

Voltage at TP18 on the Control DRAC is <2.48VDC.

ACTIONS

1. Turn the generator ON.

TO AVOID ELECTRIC SHOCK, DO NOT TOUCH ANY HEATSINK OR ANY COMPONENT IN THE LV-DRAC MODULE.

2. On the Interface DRAC Board check that the voltage between J2-1 (-) and J2-2 (+) is higher than 447 VDC.
   - If it is not, perform Error Code “E11” checking.
   - If it is higher than 447 VDC, go to next step.

3. On the Interface DRAC Board, check that there is the same voltage between J2-5 (-) and J2-4 (+) than the voltage measured before between J2-1 (-) and J2-2 (+).
   - If VDC is OK, go to step 8.
   - If VDC is not OK, go to next step.

4. Turn the generator OFF and wait three (3) minutes for the Main Storage Capacitors to discharge.

5. Check Fuses F3 and F4 on the Interface DRAC Board and that the Fuse Holders are making contact with the Fuses. If necessary, replace the Fuses and close the contacts of the Fuse Holders.

6. Turn the generator ON.

7. If the error persists, check on the Interface DRAC Board that there is the same voltage between J2-5 (-) and J2-4 (+) than the voltage measured before between J2-1 (-) and J2-2 (+).
   - If VDC is OK, go to step 8.
   - If VDC is not OK, turn the generator OFF and wait three (3) minutes for the Main Storage Capacitors to discharge.
     - If any of the Fuses are blown again, replace the Fuse(s) and replace the Control DRAC Board.
     - If both Fuses are OK, replace the Interface DRAC Board.

8. On the Control DRAC Board, check that the voltage between J2-1 (-) and J2-2 (+) is the same than the voltage measured before between J2-1 (-) and J2-2 (+) on the Interface DRAC Board.
   - If VDC is not OK:
     - Turn the generator OFF and wait three (3) minutes for the Main Storage Capacitors to discharge.
     - Check the Faston terminals of the DC BUS Cable on both Boards (Control and Interface DRAC Boards). If necessary, close the Faston terminals.
     - Check the continuity of the DC BUS Cable. If necessary, replace the DC BUS Cable.
   - If VDC is OK, but the error persists, check that the voltage at TP18 on the Control DRAC Board is < 2.48 VDC.

Note ☞ *For GND reference use the following Test Points on the Control DRAC Board: TP2, TP4, TP12, TP13, or TP19.*

- If VDC is higher than 2.48 VDC, replace the Control DRAC Board.
- If VDC is lower than 2.48 VDC, check the voltage at the following Test Points on the Control DRAC Board:
  - +5 VDC at TP14
  - +15 VDC at TP15
  - -15 VDC at TP37

Note ☞ *For GND reference use the following Test Points on the Control DRAC Board: TP2, TP4, TP12, TP13, or TP19.*

- If voltages at the above Test Points are correct, replace the Control DRAC Board.
- If any voltage at the above Test Points are not correct, go to next step.

9. Turn the generator OFF and wait three (3) minutes for the Main Storage Capacitors to discharge.

10. Remove the Ribbon Cable from Connector J3 at the Control DRAC Board.

11. Turn the generator ON.

12. Check the voltage at the following points on the Interface DRAC Board:
    - +5 VDC at Anode of diode CR6
    - +15 VDC at Anode of diode CR5 or at Cathode of diode CR6
    - -15 VDC at Cathode of diode CR7

Note ☞ *For GND reference use the Terminal J2-3 on the Interface DRAC Board.*

- If voltages at the above points are correct, replace the Control DRAC Board.
- If any voltage at the above points are not correct, replace the Interface DRAC Board.

CAUTION ***Connect all the wires / cables removed during the procedure back to the original connections.***

ERROR CODE : E55

DESCRIPTION :	LV-DRAC: Excessive DC BUS voltage at 480 VAC.
ERROR TYPE :	Indicative. Exposure is not allowed.
APPLICABLE TO :	Generators with High Speed Starter.
APPEARS WHEN :	At any moment
INFORMATION / SYMPTOM :	Error Code “E55” is displayed and it is not possible to make *Prep*.

POSSIBLE CAUSES

DC BUS Voltage out of range on the Control DRAC Board.

Voltage at TP18 on the Control DRAC is > 4.92 VDC.

ACTIONS

1. Turn the generator ON.

DANGER !

TO AVOID ELECTRIC SHOCK, DO NOT TOUCH ANY HEATSINK OR ANY COMPONENT IN THE LV-DRAC MODULE.

2. Check that the input voltage to the Generator (at Input Line Fuses) is according to specifications (480 VAC, ±10%). If it is not, check the Input Power Line.

Note ☞

For a three-phase Generator, the DC BUS voltage should be approximately the RMS voltage value between phases times 1.5, when the generator is ON and not making exposures.

- The following steps are a few recommendations to check the Input Power Line. These steps are not related with the Generator.
- Measure the voltage between all the phases: L1 and L2; L2 and L3; L3 and L1. They may have a big disequilibrium in one (1) of them.
- If the three (3) measurements are equal, maybe the input voltage in the installation is not sinusoidal and the peek between any of the phases is too higher.

  Use an Oscilloscope with the shield of the probe isolated from ground. Both the probe and the scope have to be able to handle and insulation voltage of 480 VAC (±10%) between the active of the probe and the shield.

  Connect the probe between all the phases: L1 and L2; L2 and L3; L3 and L1. Check the peek between any of the phases.

3. If the input voltage is OK, check on the Control DRAC Board that the voltage between J2-1 (-) and J2-2 (+) is < 800 VDC. Take note of the measured VDC.
   - If VDC is > 800 VDC, go to step 8.
   - If VDC is < 800 VDC, but the error persists, measure on the Control DRAC Board the voltage between TP18 and a GND Test Point (TP2, TP4, TP12, TP13 or TP19).

     Check that VDC measured at TP18 complies with the following scale factor:
     181 VDC measured between J2-1 and J2-2 = 1 VDC measured at TP18.
     - If VDC ratio is OK, but the error persists, replace the Control DRAC Board.
     - If VDC ratio is not OK, check the voltage at the following Test Points on the Control DRAC Board:
       - +5 VDC at TP14
       - +15 VDC at TP15
       - -15 VDC at TP37

Note ☞ *For GND reference use the following Test Points on the Control DRAC Board: TP2, TP4, TP12, TP13, or TP19.*

- If voltages at the above Test Points are correct, replace the Control DRAC Board.
- If any voltage at the above Test Points are not correct, go to next step.

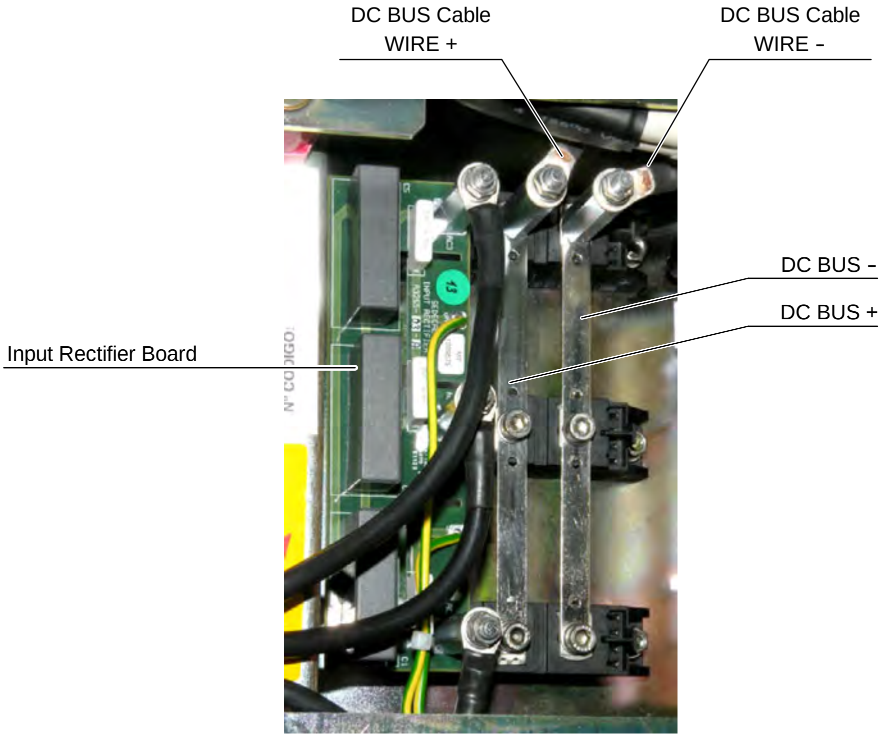
4. Turn the generator OFF and wait three (3) minutes for the Main Storage Capacitors to discharge.
5. Remove the Ribbon Cable from Connector J3 at the Control DRAC Board.
6. Turn the generator ON.
7. Check the voltage at the following points on the Interface DRAC Board:
   - +5 VDC at Anode of diode CR6
   - +15 VDC at Anode of diode CR5 or at Cathode of diode CR6
   - -15 VDC at Cathode of diode CR7

Note ☞ *For GND reference use the Terminal J2-3 on the Interface DRAC Board.*

- If voltages at the above points are correct, replace the Control DRAC Board.
- If any voltage at the above points are not correct, replace the Interface DRAC Board.

8. Turn the generator OFF and wait three (3) minutes for the Main Storage Capacitors to discharge.
9. Disconnect the DC BUS Cable from J2-5 (-) and J2-4 (+) on the Interface DRAC Board.
10. Turn the generator ON.
11. Check on the Interface DRAC Board that the voltage between J2-1 (-) and J2-2 (+) is < 800 VDC.
    - If VDC is < 800 VDC, replace the Control DRAC Board.
    - If VDC is > 800 VDC, go to the next step.
12. Turn the generator OFF and wait three (3) minutes for the Main Storage Capacitors to discharge.
13. Disconnect the DC BUS Cable from J2-1 (-) and J2-2 (+) on the Interface DRAC Board.

14. Turn the generator ON.
15. At the wire ends (–) and (+) of the DC BUS Cable disconnected before from the Interface DRAC Board, check that the voltage is < 800 VDC.
    - If VDC is < 800 VDC, replace the Interface DRAC Board.
    - If VDC is > 800 VDC, go to the next step.
16. Turn the generator OFF and wait three (3) minutes for the Main Storage Capacitors to discharge.
17. Disconnect the wires (–) and (+) of the DC BUS Cable from the Input Rectifier Board.



18. Turn the generator ON.
19. Check if the voltage is < 800 VDC between BUS+ and BUS– on the Input Rectifier Board (Inverter Module).
    - If VDC is > 800 VDC, replace the Input Rectifier Board.
    - If VDC is < 800 VDC, at least one of the Main Storage Capacitors (Inverter Module) is defective. Replace the Main Storage Capacitors.
20. Turn the generator OFF and wait three (3) minutes for the Main Storage Capacitors to discharge.

CAUTION

Connect all the wires / cables removed during the procedure back to the original connections.

ERROR CODE : E58

DESCRIPTION :	LV-DRAC: Excessive current in the main winding during acceleration up to 3300 RPM
ERROR TYPE :	Indicative. Exposure is not allowed.
APPLICABLE TO :	Generators with High Speed Starter.
APPEARS WHEN :	During Anode acceleration at Low Speed.
INFORMATION / SYMPTOM :	Error Code “E58” is displayed and it is not possible to make exposures.

POSSIBLE CAUSES

Excessive current in the main winding up to 3300 RPM is detected.

Defective: Interface DRAC Board, or Control DRAC Board, or Tube Stator, or Stator Cable, or Clamping Board, or Transformers, or Contactors in LV-DRAC Module.

ACTIONS

CAUTION

All the wires / cables removed during the procedure have to be isolated to avoid contact with any other wire or ground.

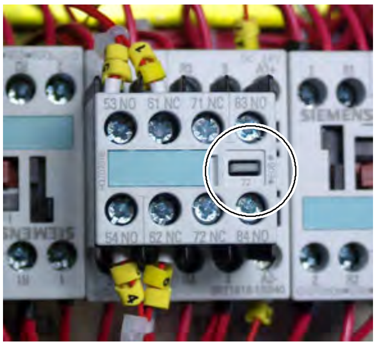
1. Verify the Generator is turned OFF.

2. Check that the DIP switches on the Control DRAC Board are set in the correct position. *(Refer to the LV -DRAC Documentation in this Service Manual, especially check that DIP-switches 3243SW3-5 and 3243SW4-5 are in the correct position according to the Tube Family Selection.)*

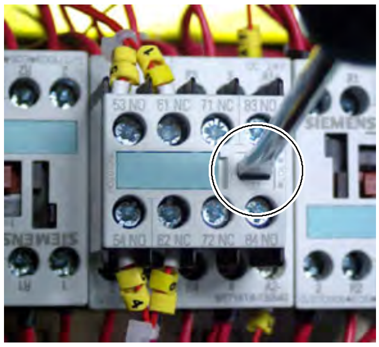
3. Check each wire connection of the Stator Cable on the Tube side and on 11TS2 on the LV-DRAC Module are correct and secured (good contact), connect properly, and tighten each wire if necessary. Check if the error has been corrected. If not, go to the next step.

4. With the Generator turned OFF, measure the Stator Tube Winding impedances on 11TS2 on the LV-DRAC Module.

Note ☞ *The Contactor 11KT1 on the LV-DRAC Module have to be not energized (contactor indicator is visible) when measuring the Stator impedances of Tube-1 and have to be energized (by manually pressing the contactor indicator) when measuring the Stator impedances of Tube-2.*



Contactor 11KT1 measuring Stator impedances of Tube-1



Contactor 11KT1 measuring Stator impedances of Tube-2

- For Tube-1 measure:
  - between Main (11TS2-1) and Common (11TS2-3).
  - between Auxiliary (11TS2-2) and Common (11TS2-3).
  - between Main (11TS2-1) and Auxiliary (11TS2-2), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
- For Tube-2 measure:
  - between Main (11TS2-9) and Common (11TS2-11).
  - between Auxiliary (11TS2-10) and Common (11TS2-11).
  - between Main (11TS2-9) and Auxiliary (11TS2-10), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.

Note ☞ *Impedance must be as stated in the X-ray Tube Stator specifications. (Refer to the Manufacturer X-ray Tube Data Sheet.)*

- If the impedance is OK, go to the next step.
- If the impedance is not correct:
  - Measure the Stator Tube Winding impedances on the Tube side:
    - Between Main and Common.
    - Between Auxiliary and Common.
    - Between Main and Auxiliary, it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
    - If the impedance is correct on the Tube, replace the Stator Cable.
    - If the impedance is not correct on the Tube, replace the X-ray Tube.

5. Check for correct isolation between the connections for the Main winding and Auxiliary winding in 11TS2 on the LV-DRAC Module. Measure the impedance between Main and Ground, Auxiliary and Ground, Common and Ground; in all cases it must be high impedance (mega-ohms).

    - If the impedance is OK, go to the next step.
    - If the impedance is not correct, it can be due to:
        - a wrong connection of the Stator Cable on the Tube side or on the Generator side. Check the connection of the Stator Cable and connect it properly if necessary.
        - or the Stator Cable is short-circuited, then disconnect the Stator Cable on the Tube side and measure impedance in the Tube. If the problem persists replace the X-ray Tube.

6. Turn the Generator ON.

CAUTION

To perform each one of the following checks it is necessary:

- ***Turn the Generator OFF and wait three (3) minutes to discharge the Main Storage Capacitors.***
- ***Remove the wire indicated in each step below.***
- ***Turn the Generator ON. Press PREP and note the error code and reset it.***

7. On the Tube side, remove the Main wire. Check:

    - If an "Excessive Current" code appears, go to the next step.
    - If an "Insufficient Current" code appears, the problem is in the Tube Stator. Replace the X-ray Tube.

8. On the Generator side, remove the Main wire (11TS2-1 for Tube-1 or 11TS2-9 for Tube-2). Check:

    - If an "Excessive Current" code appears, go to the next step.
    - If an "Insufficient Current" code appears, the problem is in the Stator Cable. Replace the Stator Cable.

9. Desolder the wire marked as "12" on the Main Transformer of the LV-DRAC Module. Check:

    - If an "Excessive Current" code appears, go to the next step.
    - If an "Insufficient Current" code appears, there is a bad contact from 11TS2 to Terminal "12" in the Transformer on the Contactor's Terminals 11KT1, 11K2, and/or 11K3 (*refer to Schematic "543020xx" in the Service Manual*). Identify faulty connections, clean the contacts, tighten each wire connection, and/or replace Contactors if necessary.

10. On the Control DRAC Board, remove wire J1-1 (Main). Check:

    - If an "Excessive Current" code appears, go to the next step.
    - If an "Insufficient Current" code appears, replace the Main Transformer at the LV-DRAC Module.

11. On the Control DRAC Board, remove wire J1-3 (Shield). Check:

    - If an "Excessive Current" code appears, replace the Control DRAC Board.
    - If an "Insufficient Current" code appears, replace the Main Transformer at the LV-DRAC Module.

CAUTION

Connect all the wires / cables removed during the procedure back to the original connections.

ERROR CODE : E59

DESCRIPTION : LV-DRAC: Excessive current in the auxiliary winding during acceleration up to 3300 RPM

ERROR TYPE : Indicative. Exposure is not allowed.

APPLICABLE TO : All Generators with High Speed Starter.

APPEARS WHEN : During Anode acceleration at Low Speed.

INFORMATION / SYMPTOM : Error Code “E59” is displayed and it is not possible to make Exposures.

POSSIBLE CAUSES

Excessive current in the auxiliary winding up to 3300 RPM is detected.

Defective: Interface DRAC Board, or Control DRAC Board, or Tube Stator, or Stator Cable, or Clamping Board, or Transformers, or Contactors in LV-DRAC Module.

ACTIONS

All the wires / cables removed during the procedure have to be isolated to avoid contact with any other wire or ground.

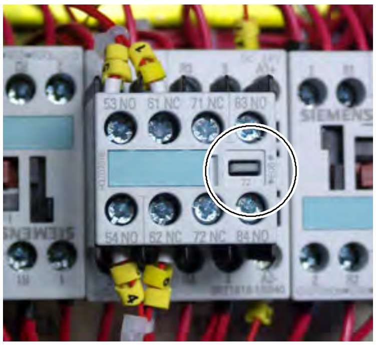
1. Verify the Generator is turned OFF.

2. Check that the DIP switches on the Control DRAC Board are set in the correct position. *(Refer to the LV -DRAC Documentation in this Service Manual, especially check that DIP-switches 3243SW3-5 and 3243SW4-5 are in the correct position according to the Tube Family Selection.)*

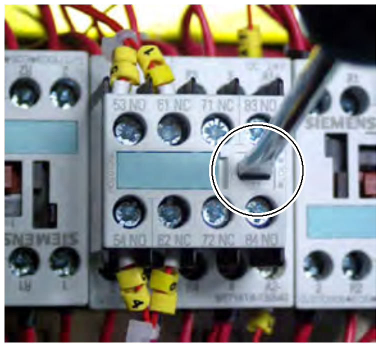
3. Check each wire connection of the Stator Cable on the Tube side and on 11TS2 on the LV-DRAC Module are correct and secured (good contact), connect properly, and tighten each wire if necessary. Check if the error has been corrected. If not, go to the next step.

4. With the Generator turned OFF, measure the Stator Tube Winding impedances on 11TS2 on the LV-DRAC Module.

Note ☞ *The Contactor 11KT1 on the LV-DRAC Module have to be not energized (contactor indicator is visible) when measuring the Stator impedances of Tube-1 and have to be energized (by manually pressing the contactor indicator) when measuring the Stator impedances of Tube-2.*



Contactor 11KT1 measuring Stator impedances of Tube-1



Contactor 11KT1 measuring Stator impedances of Tube-2

- For Tube-1 measure:
  - between Main (11TS2-1) and Common (11TS2-3).
  - between Auxiliary (11TS2-2) and Common (11TS2-3).
  - between Main (11TS2-1) and Auxiliary (11TS2-2), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
- For Tube-2 measure:
  - between Main (11TS2-9) and Common (11TS2-11).
  - between Auxiliary (11TS2-10) and Common (11TS2-11).
  - between Main (11TS2-9) and Auxiliary (11TS2-10), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.

Note ☞ *Impedance must be as stated in the X-ray Tube Stator specifications. (Refer to the Manufacturer X-ray Tube Data Sheet.)*

- If the impedance is OK, go to the next step.
- If the impedance is not correct:
  - Measure the Stator Tube Winding impedances on the Tube side:
    - Between Main and Common.
    - Between Auxiliary and Common.
    - Between Main and Auxiliary, it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
    - If the impedance is correct on the Tube, replace the Stator Cable.
    - If the impedance is not correct on the Tube, replace the X-ray Tube.

5. Check for correct isolation between the connections for the Main winding and Auxiliary winding in 11TS2 on the LV-DRAC Module. Measure the impedance between Main and Ground, Auxiliary and Ground, Common and Ground; in all cases it must be high impedance (mega-ohms).
   - If the impedance is OK, go to the next step.
   - If the impedance is not correct, it can be due to:
     - a wrong connection of the Stator Cable on the Tube side or on the Generator side. Check the connection of the Stator Cable and connect it properly if necessary.
     - or the Stator Cable is short-circuited, then disconnect the Stator Cable on the Tube side and measure impedance in the Tube. If the problem persists replace the X-ray Tube.
6. Turn the Generator ON.

CAUTION

To perform each one of the following checks it is necessary:

- Turn the Generator OFF and wait three (3) minutes to discharge the Main Storage Capacitors.

- Remove the wire indicated in each step below.

- Turn the Generator ON. Press PREP and note the error code and reset it.

7. On the Tube side, remove the Auxiliary wire. Check:
   - If an “Excessive Current” code appears, go to the next step.
   - If an “Insufficient Current” code appears, the problem is in the Tube Stator. Replace the X-ray Tube.
8. On the Generator side, remove the Auxiliary wire (11TS2-2 for Tube-1 or 11TS2-10 for Tube-2). Check:
   - If an “Excessive Current” code appears, go to the next step.
   - If an “Insufficient Current” code appears, the problem is in the Stator Cable. Replace the Stator Cable.
9. On the Interface DRAC Board, remove J5-1 and J5-4 wires. Check:
   - If an “Excessive Current” code appears, go to the next step.
   - If an “Insufficient Current” code appears, replace the Interface DRAC Board.
10. Remove the two (2) wires connected to the Clamping Board. Check:
    - If an “Excessive Current” code appears, go to the next step.
    - If an “Insufficient Current” code appears, replace the Clamping Board.
11. Desolder the wire marked as “12” on the auxiliary Transformer of the LV-DRAC Module. Check:
    - If an “Excessive Current” code appears, go to the next step.
    - If an “Insufficient Current” code appears, there is a bad contact from 11TS2 to Terminal “12” in the Transformer on the Contactor’s Terminals 11KT1, 11K2, and/or 11K3 (*refer to Schematic “543020xx” in the Service Manual*). Identify faulty connections, clean the contacts, tighten each wire connection, and/or replace Contactors if necessary.
12. On the Control DRAC Board, remove wire J1-4 (Auxiliary). Check:
    - If an “Excessive Current” code appears, go to the next step.
    - If an “Insufficient Current” code appears, replace the Main Transformer at the LV-DRAC Module.
13. On the Control DRAC Board, remove wire J1-3 (Shield). Check:
    - If an “Excessive Current” code appears, replace the Control DRAC Board.
    - If an “Insufficient Current” code appears, replace the Main Transformer at the LV-DRAC Module.

CAUTION

Connect all the wires / cables removed during the procedure back to the original connections.

ERROR CODE : E60

DESCRIPTION : LV-DRAC: Insufficient current in the auxiliary winding during acceleration up to 3300 RPM

ERROR TYPE : Indicative. Exposure is not allowed.

APPLICABLE TO : All Generators with High Speed Starter.

APPEARS WHEN : During Anode acceleration at Low Speed.

INFORMATION / SYMPTOM : Error Code "E60" is displayed and it is not possible to make Exposures.

POSSIBLE CAUSES

Insufficient current in the auxiliary winding up to 3300 RPM is detected.

Defective: Interface DRAC Board, or Control DRAC Board, or Tube Stator, or Stator Cable, or Clamping Board, or Transformers, or Contactors in LV-DRAC Module.

ACTIONS

All the wires / cables removed during the procedure have to be isolated to avoid contact with any other wire or ground.

1. Verify the Generator is turned OFF.

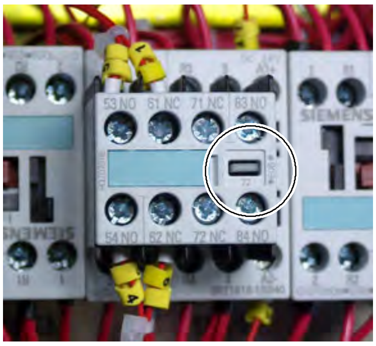
2. Check that the DIP switches on the Control DRAC Board are set in the correct position. *(Refer to the LV -DRAC Documentation in this Service Manual, especially check that DIP-switches 3243SW3-5 and 3243SW4-5 are in the correct position according to the Tube Family Selection.)*

3. Check each wire connection of the Stator Cable on the Tube side and on 11TS2 on the LV-DRAC Module are correct and secured (good contact), connect properly, and tighten each wire if necessary. Check if the error has been corrected. If not, go to the next step.

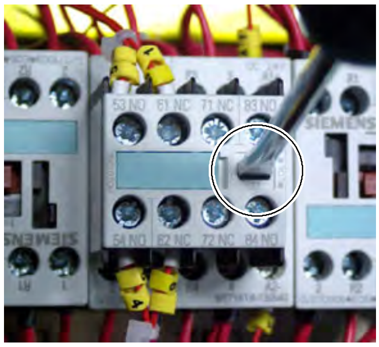
4. With the Generator turned OFF, measure the Stator Tube Winding impedances on 11TS2 on the LV-DRAC Module.

Note ☞

The Contactor 11KT1 on the LV-DRAC Module have to be not energized (contactor indicator is visible) when measuring the Stator impedances of Tube-1 and have to be energized (by manually pressing the contactor indicator) when measuring the Stator impedances of Tube-2.



Contactor 11KT1 measuring Stator impedances of Tube-1



Contactor 11KT1 measuring Stator impedances of Tube-2

- For Tube-1 measure:
  - between Main (11TS2-1) and Common (11TS2-3).
  - between Auxiliary (11TS2-2) and Common (11TS2-3).
  - between Main (11TS2-1) and Auxiliary (11TS2-2), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
- For Tube-2 measure:
  - between Main (11TS2-9) and Common (11TS2-11).
  - between Auxiliary (11TS2-10) and Common (11TS2-11).
  - between Main (11TS2-9) and Auxiliary (11TS2-10), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.

Note ☞

Impedance must be as stated in the X-ray Tube Stator specifications. (Refer to the Manufacturer X-ray Tube Data Sheet.)

- If the impedance is OK, go to the next step.
- If the impedance is not correct:
  - Measure the Stator Tube Winding impedances on the Tube side:
    - Between Main and Common.
    - Between Auxiliary and Common.
    - Between Main and Auxiliary, it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.

    - If the impedance is correct on the Tube, replace the Stator Cable.
    - If the impedance is not correct on the Tube, replace the X-ray Tube.

5. Check that there is a low resistance (ohms) on the primary and secondary side of either the Main or Auxiliary Transformer (depending if the error is in the Main or Auxiliary winding):
   - For Primary measure between terminals 1-7 of the Transformer.
   - For Secondary measure between terminals 8-10 and 10-12 of the Transformer.
   - ▪ If the low resistance is OK, go to the next step.
   - ▪ If the low resistance is not correct, replace the Transformer.

6. On the Control DRAC Board, check that there is a continuity between the following points:
   - For Main measure between J1-1 and J1-3.
   - For Auxiliary measure between J1-3 and J1-4.
   - ▪ If the continuity is OK, go to the next step.
   - ▪ If the continuity is not correct, check cable connections in J1 of the Control DRAC Board and in Primary side of the Transformers.

7. With the Generator turned OFF, check that Contactors 11KT1, 11K2, and 11K3 are not energized (OFF) on the LV-DRAC Module.
   - ▪ If it is OK, go to the next step.
   - ▪ If any Contactor is energized (ON), replace the Contactor.

8. Turn the Generator ON, check on the LV-DRAC Module that ten (10) seconds after power-up Contactors 11K2 and 11K3 are not energized (OFF) and Contactor 11KT1 is energized (ON) when Tube-1 is selected (Contactor 11KT1 is not energized (OFF) when Tube-2 is selected).
   - ▪ If it is OK, go to the next step.
   - ▪ If Contactor 11K2 or 11K3 is energized (ON), replace the Control DRAC Board.
   - ▪ If Contactor 11KT1 is not energized (OFF) (when Tube-1 is selected), turn the Generator OFF and wait three (3) minutes for the Main Storage Capacitors to discharge. Check that Diode CR14 is OK on the Interface DRAC Board.
     - Diode CR14 is OK, replace the Control DRAC Board.
     - Diode CR14 is not OK, replace the Interface DRAC Board.

9. Turn the Generator ON.

DANGER !

TO AVOID ELECTRIC SHOCK, DO NOT TOUCH ANY HEATSINK OR ANY COMPONENT IN THE LV-DRAC MODULE.

10. Check that there is a continuity between the following points:
    - For Main measure between terminal 12 of the Main Transformer and 11TS2-1 (for Tube-1) or 11TS2-9 (for Tube-2).
    - For Auxiliary measure between terminal 12 of the Auxiliary Transformer and 11TS2-2 (for Tube-1) or 11TS2-10 (for Tube-2).
    - For Common measure between terminal 8 of each Transformer (Main and Auxiliary) and then between terminal 8 of the Main Transformer and 11TS2-3 (for Tube-1) or 11TS2-11 (for Tube-2).
    - ▪ If the continuity is OK, go to the next step.
    - ▪ If the continuity is not correct, there is a bad contact on the Transformer Terminals or on the Contactor's Terminals 11KT1, 11K2, and/or 11K3 (*refer to Schematic "543020xx" in the Service Manual*). Identify faulty connections, clean the contacts, and/or tighten each wire connection.

11. Check the proper operation of the Control DRAC Board. For that:
    - Set DIP switch 3243SW4-7 in the “ON” position to inhibit errors.
    - Select: 40 kVp, 10 mA and 10 ms (low speed) and Direct Workstation. Check the X-ray Tube is starting properly by performing an Anode Rotation Test (*refer to “Configuration” chapter in the Service Manual*).
      - If the Tube does not start, replace the Control DRAC Board.
      - If the Tube starts, the Control DRAC Board has to be replaced but the unit can work (for a short period of days) whenever DIP switch 3243SW4-7 is in the “ON” position to inhibit errors.
      - In both cases, set DIP switch 3243SW4-7 in the “OFF” position after replacing the Control DRAC Board.

CAUTION

Connect all the wires / cables removed during the procedure back to the original connections.

ERROR CODE : E61

DESCRIPTION : LV-DRAC: Insufficient current in the main winding during acceleration up to 3300 RPM

ERROR TYPE : Indicative. Exposure is not allowed.

APPLICABLE TO : All Generators with High Speed Starter.

APPEARS WHEN : During Anode acceleration at Low Speed.

INFORMATION / SYMPTOM : Error Code “E61” is displayed and it is not possible to make Exposures.

POSSIBLE CAUSES

Insufficient current in the main winding up to 3300 RPM is detected.

Defective: Interface DRAC Board, or Control DRAC Board, or Tube Stator, or Stator Cable, or Clamping Board, or Transformers, or Contactors in LV-DRAC Module.

ACTIONS

All the wires / cables removed during the procedure have to be isolated to avoid contact with any other wire or ground.

1. Verify the Generator is turned OFF.

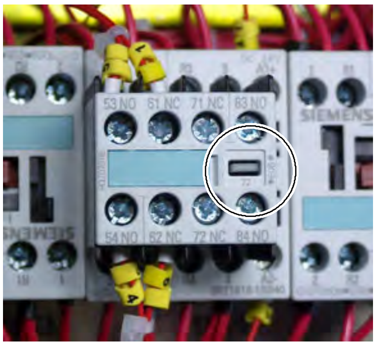
2. Check that the DIP switches on the Control DRAC Board are set in the correct position. *(Refer to the LV -DRAC Documentation in this Service Manual, especially check that DIP-switches 3243SW3-5 and 3243SW4-5 are in the correct position according to the Tube Family Selection.)*

3. Check each wire connection of the Stator Cable on the Tube side and on 11TS2 on the LV-DRAC Module are correct and secured (good contact), connect properly, and tighten each wire if necessary. Check if the error has been corrected. If not, go to the next step.

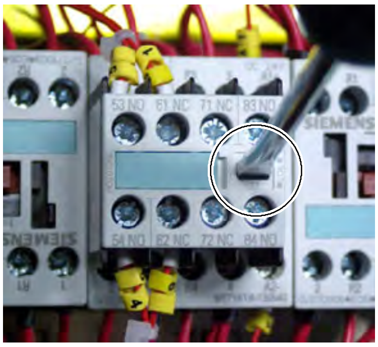
4. With the Generator turned OFF, measure the Stator Tube Winding impedances on 11TS2 on the LV-DRAC Module.

Note ☞

The Contactor 11KT1 on the LV-DRAC Module have to be not energized (contactor indicator is visible) when measuring the Stator impedances of Tube-1 and have to be energized (by manually pressing the contactor indicator) when measuring the Stator impedances of Tube-2.



Contactor 11KT1 measuring Stator impedances of Tube-1



Contactor 11KT1 measuring Stator impedances of Tube-2

- For Tube-1 measure:
  - between Main (11TS2-1) and Common (11TS2-3).
  - between Auxiliary (11TS2-2) and Common (11TS2-3).
  - between Main (11TS2-1) and Auxiliary (11TS2-2), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
- For Tube-2 measure:
  - between Main (11TS2-9) and Common (11TS2-11).
  - between Auxiliary (11TS2-10) and Common (11TS2-11).
  - between Main (11TS2-9) and Auxiliary (11TS2-10), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.

Note ☞

Impedance must be as stated in the X-ray Tube Stator specifications. (Refer to the Manufacturer X-ray Tube Data Sheet.)

- If the impedance is OK, go to the next step.
- If the impedance is not correct:
  - Measure the Stator Tube Winding impedances on the Tube side:
    - Between Main and Common.
    - Between Auxiliary and Common.
    - Between Main and Auxiliary, it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
    - If the impedance is correct on the Tube, replace the Stator Cable.
    - If the impedance is not correct on the Tube, replace the X-ray Tube.

5. Check that there is a low resistance (ohms) on the primary and secondary side of either the Main or Auxiliary Transformer (depending if the error is in the Main or Auxiliary winding):
   - For Primary measure between terminals 1-7 of the Transformer.
   - For Secondary measure between terminals 8-10 and 10-12 of the Transformer.
   - ▪ If the low resistance is OK, go to the next step.
   - ▪ If the low resistance is not correct, replace the Transformer.

6. On the Control DRAC Board, check that there is a continuity between the following points:
   - For Main measure between J1-1 and J1-3.
   - For Auxiliary measure between J1-3 and J1-4.
   - ▪ If the continuity is OK, go to the next step.
   - ▪ If the continuity is not correct, check cable connections in J1 of the Control DRAC Board and in Primary side of the Transformers.

7. With the Generator turned OFF, check that Contactors 11KT1, 11K2, and 11K3 are not energized (OFF) on the LV-DRAC Module.
   - ▪ If it is OK, go to the next step.
   - ▪ If any Contactor is energized (ON), replace the Contactor.

8. Turn the Generator ON, check on the LV-DRAC Module that ten (10) seconds after power-up Contactors 11K2 and 11K3 are not energized (OFF) and Contactor 11KT1 is energized (ON) when Tube-1 is selected (Contactor 11KT1 is not energized (OFF) when Tube-2 is selected).
   - ▪ If it is OK, go to the next step.
   - ▪ If Contactor 11K2 or 11K3 is energized (ON), replace the Control DRAC Board.
   - ▪ If Contactor 11KT1 is not energized (OFF) (when Tube-1 is selected), turn the Generator OFF and wait three (3) minutes for the Main Storage Capacitors to discharge. Check that Diode CR14 is OK on the Interface DRAC Board.
     - Diode CR14 is OK, replace the Control DRAC Board.
     - Diode CR14 is not OK, replace the Interface DRAC Board.

9. Turn the Generator ON.

TO AVOID ELECTRIC SHOCK, DO NOT TOUCH ANY HEATSINK OR ANY COMPONENT IN THE LV-DRAC MODULE.

10. Check that there is a continuity between the following points:
    - For Main measure between terminal 12 of the Main Transformer and 11TS2-1 (for Tube-1) or 11TS2-9 (for Tube-2).
    - For Auxiliary measure between terminal 12 of the Auxiliary Transformer and 11TS2-2 (for Tube-1) or 11TS2-10 (for Tube-2).
    - For Common measure between terminal 8 of each Transformer (Main and Auxiliary) and then between terminal 8 of the Main Transformer and 11TS2-3 (for Tube-1) or 11TS2-11 (for Tube-2).
    - ▪ If the continuity is OK, go to the next step.
    - ▪ If the continuity is not correct, there is a bad contact on the Transformer Terminals or on the Contactor's Terminals 11KT1, 11K2, and/or 11K3 (*refer to Schematic "543020xx" in the Service Manual*). Identify faulty connections, clean the contacts, and/or tighten each wire connection.

11. Check the proper operation of the Control DRAC Board. For that:
    - Set DIP switch 3243SW4-7 in the “ON” position to inhibit errors.
    - Select: 40 kVp, 10 mA and 10 ms (low speed) and Direct Workstation. Check the X-ray Tube is starting properly by performing an Anode Rotation Test (*refer to “Configuration” chapter in the Service Manual*).
        - If the Tube does not start, replace the Control DRAC Board.
        - If the Tube starts, the Control DRAC Board has to be replaced but the unit can work (for a short period of days) whenever DIP switch 3243SW4-7 is in the “ON” position to inhibit errors.
        - In both cases, set DIP switch 3243SW4-7 in the “OFF” position after replacing the Control DRAC Board.

CAUTION

Connect all the wires / cables removed during the procedure back to the original connections.

ERROR CODE : E62

DESCRIPTION : LV-DRAC: Excessive current in the main winding during acceleration up to 10000 RPM

ERROR TYPE : Indicative. Exposure is not allowed.

APPLICABLE TO : Generators with High Speed Starter.

APPEARS WHEN : During Anode acceleration at High Speed.

INFORMATION / SYMPTOM : Error Code “E62” is displayed and it is not possible to make exposures.

POSSIBLE CAUSES

Excessive current in the main winding up to 10000 RPM is detected.

Defective: Interface DRAC Board, or Control DRAC Board, or Tube Stator, or Stator Cable, or Clamping Board, or Transformers, or Contactors in LV-DRAC Module.

ACTIONS

CAUTION

All the wires / cables removed during the procedure have to be isolated to avoid contact with any other wire or ground.

1. Verify the Generator is turned OFF.

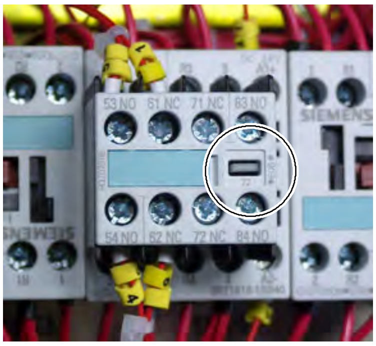
2. Check that the DIP switches on the Control DRAC Board are set in the correct position. *(Refer to the LV -DRAC Documentation in this Service Manual, especially check that DIP-switches 3243SW3-5 and 3243SW4-5 are in the correct position according to the Tube Family Selection.)*

3. Check each wire connection of the Stator Cable on the Tube side and on 11TS2 on the LV-DRAC Module are correct and secured (good contact), connect properly, and tighten each wire if necessary. Check if the error has been corrected. If not, go to the next step.

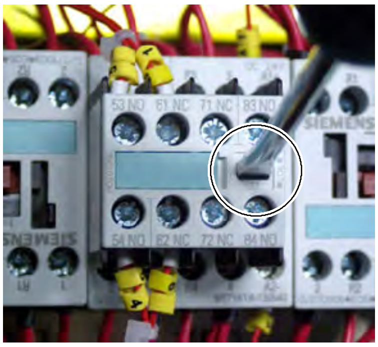
4. With the Generator turned OFF, measure the Stator Tube Winding impedances on 11TS2 on the LV-DRAC Module.

Note ☞

The Contactor 11KT1 on the LV-DRAC Module have to be not energized (contactor indicator is visible) when measuring the Stator impedances of Tube-1 and have to be energized (by manually pressing the contactor indicator) when measuring the Stator impedances of Tube-2.



Contactor 11KT1 measuring Stator impedances of Tube-1



Contactor 11KT1 measuring Stator impedances of Tube-2

- For Tube-1 measure:
  - between Main (11TS2-1) and Common (11TS2-3).
  - between Auxiliary (11TS2-2) and Common (11TS2-3).
  - between Main (11TS2-1) and Auxiliary (11TS2-2), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
- For Tube-2 measure:
  - between Main (11TS2-9) and Common (11TS2-11).
  - between Auxiliary (11TS2-10) and Common (11TS2-11).
  - between Main (11TS2-9) and Auxiliary (11TS2-10), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.

Note ☞

Impedance must be as stated in the X-ray Tube Stator specifications. (Refer to the Manufacturer X-ray Tube Data Sheet.)

- If the impedance is OK, go to the next step.
- If the impedance is not correct:
  - Measure the Stator Tube Winding impedances on the Tube side:
    - Between Main and Common.
    - Between Auxiliary and Common.
    - Between Main and Auxiliary, it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.

    - If the impedance is correct on the Tube, replace the Stator Cable.
    - If the impedance is not correct on the Tube, replace the X-ray Tube.

5. Check for correct isolation between the connections for the Main winding and Auxiliary winding in 11TS2 on the LV-DRAC Module. Measure the impedance between Main and Ground, Auxiliary and Ground, Common and Ground; in all cases it must be high impedance (mega-ohms).
   - If the impedance is OK, go to the next step.
   - If the impedance is not correct, it can be due to:
     - a wrong connection of the Stator Cable on the Tube side or on the Generator side. Check the connection of the Stator Cable and connect it properly if necessary.
     - or the Stator Cable is short-circuited, then disconnect the Stator Cable on the Tube side and measure impedance in the Tube. If the problem persists replace the X-ray Tube.
6. Turn the Generator ON.

To perform each one of the following checks it is necessary:

- Turn the Generator OFF and wait three (3) minutes to discharge the Main Storage Capacitors.

- Remove the wire indicated in each step below.

- Turn the Generator ON. Press PREP and note the error code and reset it.

7. On the Tube side, remove the Main wire. Check:
   - If an "Excessive Current" code appears, go to the next step.
   - If an "Insufficient Current" code appears, the problem is in the Tube Stator. Replace the X-ray Tube.
8. On the Generator side, remove the Main wire (11TS2-1 for Tube-1 or 11TS2-9 for Tube-2). Check:
   - If an "Excessive Current" code appears, go to the next step.
   - If an "Insufficient Current" code appears, the problem is in the Stator Cable. Replace the Stator Cable.
9. Desolder the wire marked as "12" on the Main Transformer of the LV-DRAC Module. Check:
   - If an "Excessive Current" code appears, go to the next step.
   - If an "Insufficient Current" code appears, there is a bad contact from 11TS2 to Terminal "12" in the Transformer on the Contactor's Terminals 11KT1, 11K2, and/or 11K3 (*refer to Schematic "543020xx" in the Service Manual*). Identify faulty connections, clean the contacts, tighten each wire connection, and/or replace Contactors if necessary.
10. On the Control DRAC Board, remove wire J1-1 (Main). Check:
    - If an "Excessive Current" code appears, go to the next step.
    - If an "Insufficient Current" code appears, replace the Main Transformer at the LV-DRAC Module.
11. On the Control DRAC Board, remove wire J1-3 (Shield). Check:
    - If an "Excessive Current" code appears, replace the Control DRAC Board.
    - If an "Insufficient Current" code appears, replace the Main Transformer at the LV-DRAC Module.

Connect all the wires / cables removed during the procedure back to the original connections.

ERROR CODE : E63

DESCRIPTION :	LV-DRAC: Excessive current in the auxiliary winding during acceleration up to 10000 RPM
ERROR TYPE :	Indicative. Exposure is not allowed.
APPLICABLE TO :	All Generators with High Speed Starter.
APPEARS WHEN :	During Anode acceleration at High Speed.
INFORMATION / SYMPTOM :	Error Code “E63” is displayed and it is not possible to make Exposures.

POSSIBLE CAUSES

Excessive current in the auxiliary winding up to 10000 RPM is detected.

Defective: Interface DRAC Board, or Control DRAC Board, or Tube Stator, or Stator Cable, or Clamping Board, or Transformers, or Contactors in LV-DRAC Module.

ACTIONS

All the wires / cables removed during the procedure have to be isolated to avoid contact with any other wire or ground.

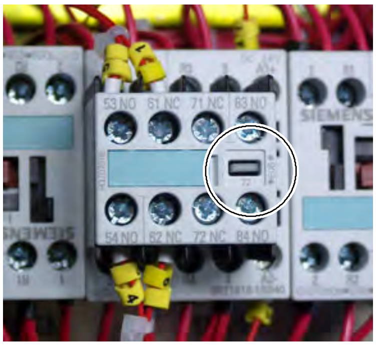
1. Verify the Generator is turned OFF.

2. Check that the DIP switches on the Control DRAC Board are set in the correct position. *(Refer to the LV -DRAC Documentation in this Service Manual, especially check that DIP-switches 3243SW3-5 and 3243SW4-5 are in the correct position according to the Tube Family Selection.)*

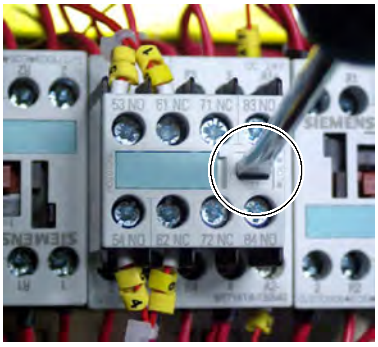
3. Check each wire connection of the Stator Cable on the Tube side and on 11TS2 on the LV-DRAC Module are correct and secured (good contact), connect properly, and tighten each wire if necessary. Check if the error has been corrected. If not, go to the next step.

4. With the Generator turned OFF, measure the Stator Tube Winding impedances on 11TS2 on the LV-DRAC Module.

Note ☞ *The Contactor 11KT1 on the LV-DRAC Module have to be not energized (contactor indicator is visible) when measuring the Stator impedances of Tube-1 and have to be energized (by manually pressing the contactor indicator) when measuring the Stator impedances of Tube-2.*



Contactor 11KT1 measuring Stator impedances of Tube-1



Contactor 11KT1 measuring Stator impedances of Tube-2

- For Tube-1 measure:
  - between Main (11TS2-1) and Common (11TS2-3).
  - between Auxiliary (11TS2-2) and Common (11TS2-3).
  - between Main (11TS2-1) and Auxiliary (11TS2-2), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
- For Tube-2 measure:
  - between Main (11TS2-9) and Common (11TS2-11).
  - between Auxiliary (11TS2-10) and Common (11TS2-11).
  - between Main (11TS2-9) and Auxiliary (11TS2-10), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.

Note ☞ *Impedance must be as stated in the X-ray Tube Stator specifications. (Refer to the Manufacturer X-ray Tube Data Sheet.)*

- If the impedance is OK, go to the next step.
- If the impedance is not correct:
  - Measure the Stator Tube Winding impedances on the Tube side:
    - Between Main and Common.
    - Between Auxiliary and Common.
    - Between Main and Auxiliary, it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
    - If the impedance is correct on the Tube, replace the Stator Cable.
    - If the impedance is not correct on the Tube, replace the X-ray Tube.

5. Check for correct isolation between the connections for the Main winding and Auxiliary winding in 11TS2 on the LV-DRAC Module. Measure the impedance between Main and Ground, Auxiliary and Ground, Common and Ground; in all cases it must be high impedance (mega-ohms).
   - If the impedance is OK, go to the next step.
   - If the impedance is not correct, it can be due to:
     - a wrong connection of the Stator Cable on the Tube side or on the Generator side. Check the connection of the Stator Cable and connect it properly if necessary.
     - or the Stator Cable is short-circuited, then disconnect the Stator Cable on the Tube side and measure impedance in the Tube. If the problem persists, replace the X-ray Tube.
6. Turn the Generator ON.

CAUTION

To perform each one of the following checks it is necessary:

- Turn the Generator OFF and wait three (3) minutes to discharge the Main Storage Capacitors.

- Remove the wire indicated in each step below.

- Turn the Generator ON. Press PREP and note the error code and reset it.

7. On the Tube side, remove the Auxiliary wire. Check:
   - If an “Excessive Current” code appears, go to the next step.
   - If an “Insufficient Current” code appears, the problem is in the Tube Stator. Replace the X-ray Tube.
8. On the Generator side, remove the Auxiliary wire (11TS2-2 for Tube-1 or 11TS2-10 for Tube-2). Check:
   - If an “Excessive Current” code appears, go to the next step.
   - If an “Insufficient Current” code appears, the problem is in the Stator Cable. Replace the Stator Cable.
9. On the Interface DRAC Board, remove J5-1 and J5-4 wires. Check:
   - If an “Excessive Current” code appears, go to the next step.
   - If an “Insufficient Current” code appears, replace the Interface DRAC Board.
10. Remove the two (2) wires connected to the Clamping Board. Check:
    - If an “Excessive Current” code appears, go to the next step.
    - If an “Insufficient Current” code appears, replace the Clamping Board.
11. Desolder the wire marked as “12” on the auxiliary Transformer of the LV-DRAC Module. Check:
    - If an “Excessive Current” code appears, go to the next step.
    - If an “Insufficient Current” code appears, there is a bad contact from 11TS2 to Terminal “12” in the Transformer on the Contactor’s Terminals 11KT1, 11K2, and/or 11K3 (*refer to Schematic “543020xx” in the Service Manual*). Identify faulty connections, clean the contacts, tighten each wire connection, and/or replace Contactors if necessary.
12. On the Control DRAC Board, remove wire J1-4 (Auxiliary). Check:
    - If an “Excessive Current” code appears, go to the next step.
    - If an “Insufficient Current” code appears, replace the Main Transformer at the LV-DRAC Module.
13. On the Control DRAC Board, remove wire J1-3 (Shield). Check:
    - If an “Excessive Current” code appears, replace the Control DRAC Board.
    - If an “Insufficient Current” code appears, replace the Main Transformer at the LV-DRAC Module.

CAUTION

Connect all the wires / cables removed during the procedure back to the original connections.

ERROR CODE : E64

DESCRIPTION :	LV-DRAC: Insufficient current in the auxiliary winding during acceleration up to 10000 RPM
ERROR TYPE :	Indicative. Exposure is not allowed.
APPLICABLE TO :	All Generators with High Speed Starter.
APPEARS WHEN :	During Anode acceleration at High Speed.
INFORMATION / SYMPTOM :	Error Code “E64” is displayed and it is not possible to make Exposures.

POSSIBLE CAUSES

Insufficient current in the auxiliary winding up to 10000 RPM is detected.

Defective: Interface DRAC Board, or Control DRAC Board, or Tube Stator, or Stator Cable, or Clamping Board, or Transformers, or Contactors in LV-DRAC Module.

ACTIONS

All the wires / cables removed during the procedure have to be isolated to avoid contact with any other wire or ground.

1. Verify the Generator is turned OFF.

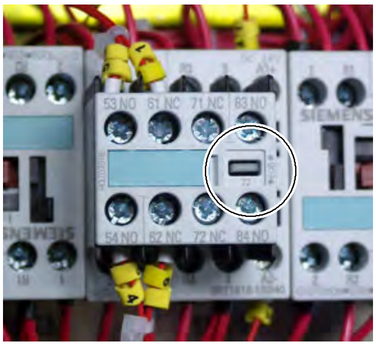
2. Check that the DIP switches on the Control DRAC Board are set in the correct position. *(Refer to the LV -DRAC Documentation in this Service Manual, especially check that DIP-switches 3243SW3-5 and 3243SW4-5 are in the correct position according to the Tube Family Selection.)*

3. Check each wire connection of the Stator Cable on the Tube side and on 11TS2 on the LV-DRAC Module are correct and secured (good contact), connect properly, and tighten each wire if necessary. Check if the error has been corrected. If not, go to the next step.

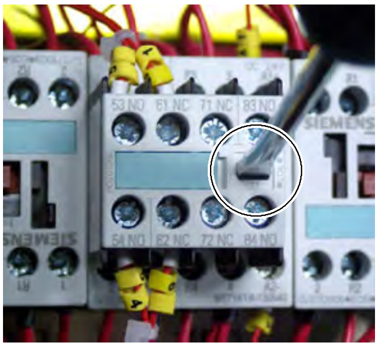
4. With the Generator turned OFF, measure the Stator Tube Winding impedances on 11TS2 on the LV-DRAC Module.

Note ☞

The Contactor 11KT1 on the LV-DRAC Module have to be not energized (contactor indicator is visible) when measuring the Stator impedances of Tube-1 and have to be energized (by manually pressing the contactor indicator) when measuring the Stator impedances of Tube-2.



Contactor 11KT1 measuring Stator impedances of Tube-1



Contactor 11KT1 measuring Stator impedances of Tube-2

- For Tube-1 measure:
  - between Main (11TS2-1) and Common (11TS2-3).
  - between Auxiliary (11TS2-2) and Common (11TS2-3).
  - between Main (11TS2-1) and Auxiliary (11TS2-2), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
- For Tube-2 measure:
  - between Main (11TS2-9) and Common (11TS2-11).
  - between Auxiliary (11TS2-10) and Common (11TS2-11).
  - between Main (11TS2-9) and Auxiliary (11TS2-10), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.

Note ☞

Impedance must be as stated in the X-ray Tube Stator specifications. (Refer to the Manufacturer X-ray Tube Data Sheet.)

- If the impedance is OK, go to the next step.
- If the impedance is not correct:
  - Measure the Stator Tube Winding impedances on the Tube side:
  - Between Main and Common.
  - Between Auxiliary and Common.
  - Between Main and Auxiliary, it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
  - If the impedance is correct on the Tube, replace the Stator Cable.
  - If the impedance is not correct on the Tube, replace the X-ray Tube.

5. Check that there is a low resistance (ohms) on the primary and secondary side of either the Main or Auxiliary Transformer (depending if the error is in the Main or Auxiliary winding):
   - For Primary measure between terminals 1–7 of the Transformer.
   - For Secondary measure between terminals 8–10 and 10–12 of the Transformer.
   - ▪ If the low resistance is OK, go to the next step.
   - ▪ If the low resistance is not correct, replace the Transformer.

6. On the Control DRAC Board, check that there is a continuity between the following points:
   - For Main measure between J1–1 and J1–3.
   - For Auxiliary measure between J1–3 and J1–4.
   - ▪ If the continuity is OK, go to the next step.
   - ▪ If the continuity is not correct, check cable connections in J1 of the Control DRAC Board and in Primary side of the Transformers.

7. With the Generator turned OFF, check that Contactors 11KT1, 11K2, and 11K3 are not energized (OFF) on the LV–DRAC Module.
   - ▪ If it is OK, go to the next step.
   - ▪ If any Contactor is energized (ON), replace the Contactor.

8. Turn the Generator ON, check on the LV–DRAC Module that ten (10) seconds after power–up Contactors 11K2 and 11K3 are not energized (OFF) and Contactor 11KT1 is energized (ON) when Tube-1 is selected (Contactor 11KT1 is not energized (OFF) when Tube-2 is selected).
   - ▪ If it is OK, go to the next step.
   - ▪ If Contactor 11K2 or 11K3 is energized (ON), replace the Control DRAC Board.
   - ▪ If Contactor 11KT1 is not energized (OFF) (when Tube–1 is selected), turn the Generator OFF and wait three (3) minutes for the Main Storage Capacitors to discharge. Check that Diode CR14 is OK on the Interface DRAC Board.
     - Diode CR14 is OK, replace the Control DRAC Board.
     - Diode CR14 is not OK, replace the Interface DRAC Board.

9. Turn the Generator ON.

TO AVOID ELECTRIC SHOCK, DO NOT TOUCH ANY HEATSINK OR ANY COMPONENT IN THE LV-DRAC MODULE.

10. Check that there is a continuity between the following points:
    - For Main measure between terminal 12 of the Main Transformer and 11TS2–1 (for Tube-1) or 11TS2–9 (for Tube-2).
    - For Auxiliary measure between terminal 12 of the Auxiliary Transformer and 11TS2–2 (for Tube-1) or 11TS2–10 (for Tube-2).
    - For Common measure between terminal 8 of each Transformer (Main and Auxiliary) and then between terminal 8 of the Main Transformer and 11TS2–3 (for Tube-1) or 11TS2–11 (for Tube-2).
    - ▪ If the continuity is OK, go to the next step.
    - ▪ If the continuity is not correct, there is a bad contact on the Transformer Terminals or on the Contactor's Terminals 11KT1, 11K2, and/or 11K3 (*refer to Schematic "543020xx" in the Service Manual*). Identify faulty connections, clean the contacts, and/or tighten each wire connection.

11. Check the proper operation of the Control DRAC Board. For that:
    - Set DIP switch 3243SW4-7 in the “ON” position to inhibit errors.
    - Select: 40 kVp, 10 mA and 10 ms (low speed) and Direct Workstation. Check the X-ray Tube is starting properly by performing an Anode Rotation Test (*refer to “Configuration” chapter in the Service Manual*).
        - If the Tube does not start, replace the Control DRAC Board.
        - If the Tube starts, the Control DRAC Board has to be replaced but the unit can work (for a short period of days) whenever DIP switch 3243SW4-7 is in the “ON” position to inhibit errors.
        - In both cases, set DIP switch 3243SW4-7 in the “OFF” position after replacing the Control DRAC Board.

CAUTION

Connect all the wires / cables removed during the procedure back to the original connections.

ERROR CODE : E65

DESCRIPTION : LV-DRAC: Insufficient current in the main winding during acceleration up to 10000 RPM

ERROR TYPE : Indicative. Exposure is not allowed.

APPLICABLE TO : All Generators with High Speed Starter.

APPEARS WHEN : During Anode acceleration at High Speed.

INFORMATION / SYMPTOM : Error Code “E65” is displayed and it is not possible to make Exposures.

POSSIBLE CAUSES

Insufficient current in the main winding up to 10000 RPM is detected.

Defective: Interface DRAC Board, or Control DRAC Board, or Tube Stator, or Stator Cable, or Clamping Board, or Transformers, or Contactors in LV-DRAC Module.

ACTIONS

CAUTION

All the wires / cables removed during the procedure have to be isolated to avoid contact with any other wire or ground.

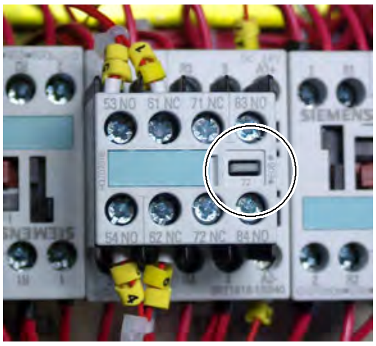
1. Verify the Generator is turned OFF.

2. Check that the DIP switches on the Control DRAC Board are set in the correct position. *(Refer to the LV -DRAC Documentation in this Service Manual, especially check that DIP-switches 3243SW3-5 and 3243SW4-5 are in the correct position according to the Tube Family Selection.)*

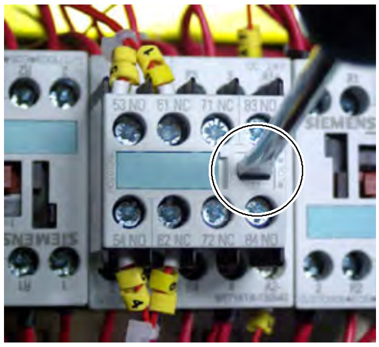
3. Check each wire connection of the Stator Cable on the Tube side and on 11TS2 on the LV-DRAC Module are correct and secured (good contact), connect properly, and tighten each wire if necessary. Check if the error has been corrected. If not, go to the next step.

4. With the Generator turned OFF, measure the Stator Tube Winding impedances on 11TS2 on the LV-DRAC Module.

Note ☞ *The Contactor 11KT1 on the LV-DRAC Module have to be not energized (contactor indicator is visible) when measuring the Stator impedances of Tube-1 and have to be energized (by manually pressing the contactor indicator) when measuring the Stator impedances of Tube-2.*



Contactor 11KT1 measuring Stator impedances of Tube-1



Contactor 11KT1 measuring Stator impedances of Tube-2

- For Tube-1 measure:
  - between Main (11TS2-1) and Common (11TS2-3).
  - between Auxiliary (11TS2-2) and Common (11TS2-3).
  - between Main (11TS2-1) and Auxiliary (11TS2-2), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
- For Tube-2 measure:
  - between Main (11TS2-9) and Common (11TS2-11).
  - between Auxiliary (11TS2-10) and Common (11TS2-11).
  - between Main (11TS2-9) and Auxiliary (11TS2-10), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.

Note ☞ *Impedance must be as stated in the X-ray Tube Stator specifications. (Refer to the Manufacturer X-ray Tube Data Sheet.)*

- If the impedance is OK, go to the next step.
- If the impedance is not correct:
  - Measure the Stator Tube Winding impedances on the Tube side:
    - Between Main and Common.
    - Between Auxiliary and Common.
    - Between Main and Auxiliary, it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
    - If the impedance is correct on the Tube, replace the Stator Cable.
    - If the impedance is not correct on the Tube, replace the X-ray Tube.

5. Check that there is a low resistance (ohms) on the primary and secondary side of either the Main or Auxiliary Transformer (depending if the error is in the Main or Auxiliary winding):
   - For Primary measure between terminals 1-7 of the Transformer.
   - For Secondary measure between terminals 8-10 and 10-12 of the Transformer.
   ▪ If the low resistance is OK, go to the next step.
   ▪ If the low resistance is not correct, replace the Transformer.

6. On the Control DRAC Board, check that there is a continuity between the following points:
   - For Main measure between J1-1 and J1-3.
   - For Auxiliary measure between J1-3 and J1-4.
   ▪ If the continuity is OK, go to the next step.
   ▪ If the continuity is not correct, check cable connections in J1 of the Control DRAC Board and in Primary side of the Transformers.

7. With the Generator turned OFF, check that Contactors 11KT1, 11K2, and 11K3 are not energized (OFF) on the LV-DRAC Module.
   ▪ If it is OK, go to the next step.
   ▪ If any Contactor is energized (ON), replace the Contactor.

8. Turn the Generator ON, check on the LV-DRAC Module that ten (10) seconds after power-up Contactors 11K2 and 11K3 are not energized (OFF) and Contactor 11KT1 is energized (ON) when Tube-1 is selected (Contactor 11KT1 is not energized (OFF) when Tube-2 is selected).
   ▪ If it is OK, go to the next step.
   ▪ If Contactor 11K2 or 11K3 is energized (ON), replace the Control DRAC Board.
   ▪ If Contactor 11KT1 is not energized (OFF) (when Tube-1 is selected), turn the Generator OFF and wait three (3) minutes for the Main Storage Capacitors to discharge. Check that Diode CR14 is OK on the Interface DRAC Board.
     - Diode CR14 is OK, replace the Control DRAC Board.
     - Diode CR14 is not OK, replace the Interface DRAC Board.

9. Turn the Generator ON.

DANGER !

TO AVOID ELECTRIC SHOCK, DO NOT TOUCH ANY HEATSINK OR ANY COMPONENT IN THE LV-DRAC MODULE.

10. Check that there is a continuity between the following points:
    - For Main measure between terminal 12 of the Main Transformer and 11TS2-1 (for Tube-1) or 11TS2-9 (for Tube-2).
    - For Auxiliary measure between terminal 12 of the Auxiliary Transformer and 11TS2-2 (for Tube-1) or 11TS2-10 (for Tube-2).
    - For Common measure between terminal 8 of each Transformer (Main and Auxiliary) and then between terminal 8 of the Main Transformer and 11TS2-3 (for Tube-1) or 11TS2-11 (for Tube-2).
    ▪ If the continuity is OK, go to the next step.
    ▪ If the continuity is not correct, there is a bad contact on the Transformer Terminals or on the Contactor's Terminals 11KT1, 11K2, and/or 11K3 (*refer to Schematic "543020xx" in the Service Manual*). Identify faulty connections, clean the contacts, and/or tighten each wire connection.

11. Check the proper operation of the Control DRAC Board. For that:
    - Set DIP switch 3243SW4-7 in the “ON” position to inhibit errors.
    - Select: 40 kVp, 10 mA and 10 ms (low speed) and Direct Workstation. Check the X-ray Tube is starting properly by performing an Anode Rotation Test (*refer to “Configuration” chapter in the Service Manual*).
        - If the Tube does not start, replace the Control DRAC Board.
        - If the Tube starts, the Control DRAC Board has to be replaced but the unit can work (for a short period of days) whenever DIP switch 3243SW4-7 is in the “ON” position to inhibit errors.
        - In both cases, set DIP switch 3243SW4-7 in the “OFF” position after replacing the Control DRAC Board.

CAUTION

Connect all the wires / cables removed during the procedure back to the original connections.

ERROR CODE : E66

DESCRIPTION : LV-DRAC: Excessive current in the main winding running at 3300 RPM

ERROR TYPE : Indicative. Exposure is not allowed.

APPLICABLE TO : Generators with High Speed Starter.

APPEARS WHEN : During Anode acceleration at Low Speed.

INFORMATION / SYMPTOM : Error Code “E66” is displayed and it is not possible to make exposures.

POSSIBLE CAUSES

Excessive current in the main winding running at 3300 RPM is detected.

During the acceleration time the Contactor 11K2 remains OFF. Once the acceleration time has been completed the Contactor 11K2 must be energized to apply to the Stator a lower voltage (running voltage). This is the step where the errors are appearing (excessive current in running mode). For any reason, Contactor 11K2 is not energized so that the voltage applied to the Stator is higher than should be and this is causing the excessive current.

Defective: cable connections, or Contactor 11K2, or Control DRAC Board, or Stator Cable, or Tube Stator.

ACTIONS

CAUTION

All the wires / cables removed during the procedure have to be isolated to avoid contact with any other wire or ground.

1. Verify the Generator is turned OFF.

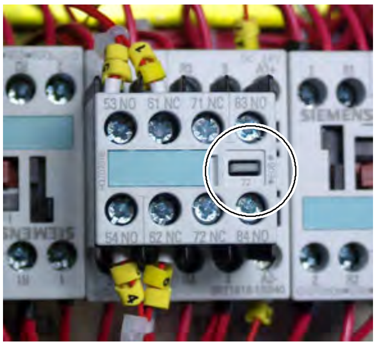
2. Check that the DIP switches on the Control DRAC Board are set in the correct position. *(Refer to the LV -DRAC Documentation in this Service Manual, especially check that DIP-switches 3243SW3-5 and 3243SW4-5 are in the correct position according to the Tube Family Selection.)*

3. Check each wire connection of the Stator Cable on the Tube side and on 11TS2 on the LV-DRAC Module are correct and secured (good contact), connect properly, and tighten each wire if necessary. Check if the error has been corrected. If not, go to the next step.

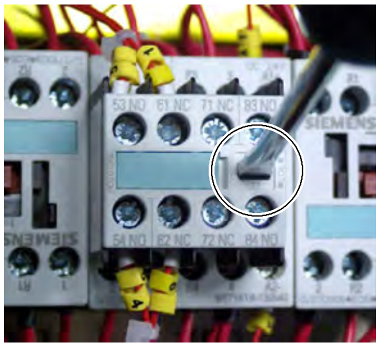
4. With the Generator turned OFF, measure the Stator Tube Winding impedances on 11TS2 on the LV-DRAC Module.

Note

The Contactor 11KT1 on the LV-DRAC Module have to be not energized (contactor indicator is visible) when measuring the Stator impedances of Tube-1 and have to be energized (by manually pressing the contactor indicator) when measuring the Stator impedances of Tube-2.



Contactor 11KT1 measuring Stator impedances of Tube-1



Contactor 11KT1 measuring Stator impedances of Tube-2

- For Tube-1 measure:
  - between Main (11TS2-1) and Common (11TS2-3).
  - between Auxiliary (11TS2-2) and Common (11TS2-3).
  - between Main (11TS2-1) and Auxiliary (11TS2-2), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
- For Tube-2 measure:
  - between Main (11TS2-9) and Common (11TS2-11).
  - between Auxiliary (11TS2-10) and Common (11TS2-11).
  - between Main (11TS2-9) and Auxiliary (11TS2-10), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.

Note

Impedance must be as stated in the X-ray Tube Stator specifications. (Refer to the Manufacturer X-ray Tube Data Sheet.)

- If the impedance is OK, go to the next step.
- If the impedance is not correct:
  - Measure the Stator Tube Winding impedances on the Tube side:
    - Between Main and Common.
    - Between Auxiliary and Common.
    - Between Main and Auxiliary, it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
  - If the impedance is correct on the Tube, replace the Stator Cable.
  - If the impedance is not correct on the Tube, replace the X-ray Tube.

5. Check for correct isolation between the connections for the Main winding and Auxiliary winding in 11TS2 on the LV-DRAC Module. Measure the impedance between Main and Ground, Auxiliary and Ground, Common and Ground; in all cases it must be high impedance (mega-ohms).

   - If the impedance is OK, go to the next step.
   - If the impedance is not correct, it can be due to:
     - a wrong connection of the Stator Cable on the Tube side or on the Generator side. Check the connection of the Stator Cable and connect it properly if necessary.
     - or the Stator Cable is short-circuited, then disconnect the Stator Cable on the Tube side and measure impedance in the Tube. If the problem persists replace the X-ray Tube.

6. Turn the Generator ON.

7. Check that the Contactor 11K2 is energized few moments after the “Prep” order.

   - If it is OK, check if Contactor 11K2 is providing a good contact, if needed replace Contactor 11K2.
   - If Contactor 11K2 is not energized, check +24 VDC at the coil of 11K2 (between A1 and A2).

Note ☞ *The voltage must be verified when the Contactor is supposed to be ON (after the acceleration time)*

- If the voltage is OK, check the coil of the Contactor by an ohmmeter. It must be around 160 Ohms. If it is not correct replace the Contactor.
- If the voltage is not present, check 24 VDC (Delayed) between A1 of Contactor 11K2 and ground (this voltage must be present at any time).
  - If 24 VDC is not present between A1 of Contactor 11K2 and ground, check continuity between the Interface Control Board (J5-2) and A1 of Contactor 11K2, checking it also in the aerial connector 11J7-1. Repair defective connections..
  - If 24 VDC is present between A1 of Contactor 11K2 and ground, check the link between A2 of Contactor 11K2 and J4-2 of the Interface DRAC Board.

    If the link is not correct, repair or replace it.

    If the link is correct, check low logic level at the cathode of CR13 when Contactor 11K2 is supposed to be ON. If the low level is present check the diode CR13, and if diode CR13 is defective replace this diode or the Interface DRAC Board. Check also the flat cable between Interface DRAC Board (J1) and Control DRAC Board, if the flat cable is not correct, replace this cable.

    If the flat cable is correct but you have +24 VDC between cathode of CR13 and ground, replace the Control DRAC Board.

CAUTION ***Connect all the wires / cables removed during the procedure back to the original connections.***

ERROR CODE : E67

DESCRIPTION : LV-DRAC: Excessive current in the auxiliary winding running at 3300 RPM

ERROR TYPE : Indicative. Exposure is not allowed.

APPLICABLE TO : All Generators with High Speed Starter.

APPEARS WHEN : During Anode acceleration at Low Speed.

INFORMATION / SYMPTOM : Error Code "E67" is displayed and it is not possible to make Exposures.

POSSIBLE CAUSES

Excessive current in the auxiliary winding running at 3300 RPM is detected.

During the acceleration time the Contactor 11K2 remains OFF. Once the acceleration time has been completed the Contactor 11K2 must be energized to apply to the Stator a lower voltage (running voltage). This is the step where the errors are appearing (excessive current in running mode). For any reason, Contactor 11K2 is not energized so that the voltage applied to the Stator is higher than should be and this is causing the excessive current.

Defective: cable connections, or Contactor 11K2, or Control DRAC Board, or Stator Cable, or Tube Stator.

ACTIONS

CAUTION

All the wires / cables removed during the procedure have to be isolated to avoid contact with any other wire or ground.

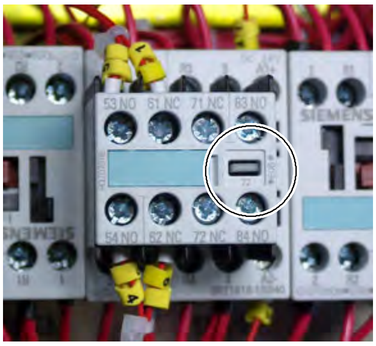
1. Verify the Generator is turned OFF.

2. Check that the DIP switches on the Control DRAC Board are set in the correct position. *(Refer to the LV -DRAC Documentation in this Service Manual, especially check that DIP-switches 3243SW3-5 and 3243SW4-5 are in the correct position according to the Tube Family Selection.)*

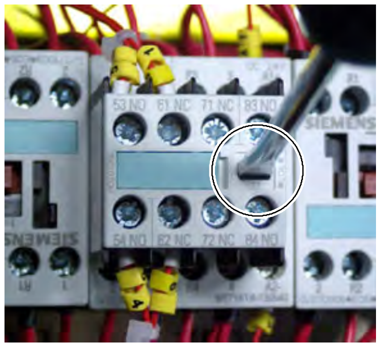
3. Check each wire connection of the Stator Cable on the Tube side and on 11TS2 on the LV-DRAC Module are correct and secured (good contact), connect properly, and tighten each wire if necessary. Check if the error has been corrected. If not, go to the next step.

4. With the Generator turned OFF, measure the Stator Tube Winding impedances on 11TS2 on the LV-DRAC Module.

Note ☞ *The Contactor 11KT1 on the LV-DRAC Module have to be not energized (contactor indicator is visible) when measuring the Stator impedances of Tube-1 and have to be energized (by manually pressing the contactor indicator) when measuring the Stator impedances of Tube-2.*



Contactor 11KT1 measuring
Stator impedances of Tube-1



Contactor 11KT1 measuring
Stator impedances of Tube-2

- For Tube-1 measure:
  - between Main (11TS2-1) and Common (11TS2-3).
  - between Auxiliary (11TS2-2) and Common (11TS2-3).
  - between Main (11TS2-1) and Auxiliary (11TS2-2), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
- For Tube-2 measure:
  - between Main (11TS2-9) and Common (11TS2-11).
  - between Auxiliary (11TS2-10) and Common (11TS2-11).
  - between Main (11TS2-9) and Auxiliary (11TS2-10), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.

Note ☞ *Impedance must be as stated in the X-ray Tube Stator specifications. (Refer to the Manufacturer X-ray Tube Data Sheet.)*

- If the impedance is OK, go to the next step.
- If the impedance is not correct:
  - Measure the Stator Tube Winding impedances on the Tube side:
    - Between Main and Common.
    - Between Auxiliary and Common.
    - Between Main and Auxiliary, it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.

    - If the impedance is correct on the Tube, replace the Stator Cable.
    - If the impedance is not correct on the Tube, replace the X-ray Tube.

5. Check for correct isolation between the connections for the Main winding and Auxiliary winding in 11TS2 on the LV-DRAC Module. Measure the impedance between Main and Ground, Auxiliary and Ground, Common and Ground; in all cases it must be high impedance (mega-ohms).

   - If the impedance is OK, go to the next step.
   - If the impedance is not correct, it can be due to:
     - a wrong connection of the Stator Cable on the Tube side or on the Generator side. Check the connection of the Stator Cable and connect it properly if necessary.
     - or the Stator Cable is short-circuited, then disconnect the Stator Cable on the Tube side and measure impedance in the Tube. If the problem persists replace the X-ray Tube.

6. Turn the Generator ON.

7. Check that the Contactor 11K2 is energized few moments after the “Prep” order.

   - If it is OK, check if Contactor 11K2 is providing a good contact, if needed replace Contactor 11K2.
   - If Contactor 11K2 is not energized, check +24 VDC at the coil of 11K2 (between A1 and A2).

Note ☞ *The voltage must be verified when the Contactor is supposed to be ON (after the acceleration time)*

- If the voltage is OK, check the coil of the Contactor by an ohmmeter. It must be around 160 Ohms. If it is not correct replace the Contactor.
- If the voltage is not present, check 24 VDC (Delayed) between A1 of Contactor 11K2 and ground (this voltage must be present at any time).
  - If 24 VDC is not present between A1 of Contactor 11K2 and ground, check continuity between the Interface Control Board (J5-2) and A1 of Contactor 11K2, checking it also in the aerial connector 11J7-1. Repair defective connections..
  - If 24 VDC is present between A1 of Contactor 11K2 and ground, check the link between A2 of Contactor 11K2 and J4-2 of the Interface DRAC Board.

    If the link is not correct, repair or replace it.

    If the link is correct, check low logic level at the cathode of CR13 when Contactor 11K2 is supposed to be ON. If the low level is present check the diode CR13, and if diode CR13 is defective replace this diode or the Interface DRAC Board. Check also the flat cable between Interface DRAC Board (J1) and Control DRAC Board, if the flat cable is not correct, replace this cable.

    If the flat cable is correct but you have +24 VDC between cathode of CR13 and ground, replace the Control DRAC Board.

CAUTION ***Connect all the wires / cables removed during the procedure back to the original connections.***

ERROR CODE : E68

DESCRIPTION : LV-DRAC: Insufficient current in the auxiliary winding running at 3300 RPM

ERROR TYPE : Indicative. Exposure is not allowed.

APPLICABLE TO : All Generators with High Speed Starter.

APPEARS WHEN : During Anode acceleration at Low Speed.

INFORMATION / SYMPTOM : Error Code “E68” is displayed and it is not possible to make Exposures.

POSSIBLE CAUSES

Insufficient current in the auxiliary winding running at 3300 RPM is detected.

Defective: Interface DRAC Board, or Control DRAC Board, or Tube Stator, or Stator Cable, or Clamping Board, or Transformers, or Contactors in LV-DRAC Module.

ACTIONS

All the wires / cables removed during the procedure have to be isolated to avoid contact with any other wire or ground.

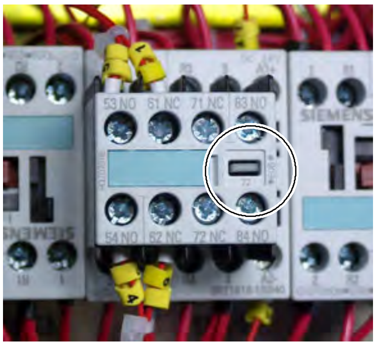
1. Verify the Generator is turned OFF.

2. Check that the DIP switches on the Control DRAC Board are set in the correct position. *(Refer to the LV -DRAC Documentation in this Service Manual, especially check that DIP-switches 3243SW3-5 and 3243SW4-5 are in the correct position according to the Tube Family Selection.)*

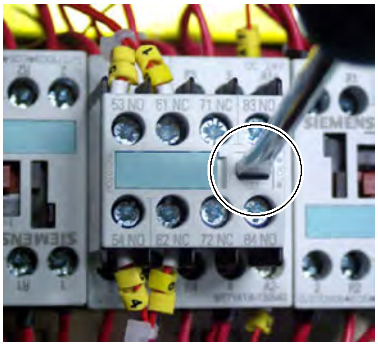
3. Check each wire connection of the Stator Cable on the Tube side and on 11TS2 on the LV-DRAC Module are correct and secured (good contact), connect properly, and tighten each wire if necessary. Check if the error has been corrected. If not, go to the next step.

4. With the Generator turned OFF, measure the Stator Tube Winding impedances on 11TS2 on the LV-DRAC Module.

Note ☞ *The Contactor 11KT1 on the LV-DRAC Module have to be not energized (contactor indicator is visible) when measuring the Stator impedances of Tube-1 and have to be energized (by manually pressing the contactor indicator) when measuring the Stator impedances of Tube-2.*



Contactor 11KT1 measuring Stator impedances of Tube-1



Contactor 11KT1 measuring Stator impedances of Tube-2

- For Tube-1 measure:
  - between Main (11TS2-1) and Common (11TS2-3).
  - between Auxiliary (11TS2-2) and Common (11TS2-3).
  - between Main (11TS2-1) and Auxiliary (11TS2-2), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
- For Tube-2 measure:
  - between Main (11TS2-9) and Common (11TS2-11).
  - between Auxiliary (11TS2-10) and Common (11TS2-11).
  - between Main (11TS2-9) and Auxiliary (11TS2-10), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.

Note ☞ *Impedance must be as stated in the X-ray Tube Stator specifications. (Refer to the Manufacturer X-ray Tube Data Sheet.)*

- If the impedance is OK, go to the next step.
- If the impedance is not correct:
  - Measure the Stator Tube Winding impedances on the Tube side:
    - Between Main and Common.
    - Between Auxiliary and Common.
    - Between Main and Auxiliary, it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.

    - If the impedance is correct on the Tube, replace the Stator Cable.
    - If the impedance is not correct on the Tube, replace the X-ray Tube.

5. Check that there is a low resistance (ohms) on the primary and secondary side of either the Main or Auxiliary Transformer (depending if the error is in the Main or Auxiliary winding):
   - For Primary measure between terminals 1-7 of the Transformer.
   - For Secondary measure between terminals 8-10 and 10-12 of the Transformer.
   - ▪ If the low resistance is OK, go to the next step.
   - ▪ If the low resistance is not correct, replace the Transformer.

6. On the Control DRAC Board, check that there is a continuity between the following points:
   - For Main measure between J1-1 and J1-3.
   - For Auxiliary measure between J1-3 and J1-4.
   - ▪ If the continuity is OK, go to the next step.
   - ▪ If the continuity is not correct, check cable connections in J1 of the Control DRAC Board and in Primary side of the Transformers.

7. With the Generator turned OFF, check that Contactors 11KT1, 11K2, and 11K3 are not energized (OFF) on the LV-DRAC Module.
   - ▪ If it is OK, go to the next step.
   - ▪ If any Contactor is energized (ON), replace the Contactor.

8. Turn the Generator ON, check on the LV-DRAC Module that ten (10) seconds after power-up Contactors 11K2 and 11K3 are not energized (OFF) and Contactor 11KT1 is energized (ON) when Tube-1 is selected (Contactor 11KT1 is not energized (OFF) when Tube-2 is selected).
   - ▪ If it is OK, go to the next step.
   - ▪ If Contactor 11K2 or 11K3 is energized (ON), replace the Control DRAC Board.
   - ▪ If Contactor 11KT1 is not energized (OFF) (when Tube-1 is selected), turn the Generator OFF and wait three (3) minutes for the Main Storage Capacitors to discharge. Check that Diode CR14 is OK on the Interface DRAC Board.
     - Diode CR14 is OK, replace the Control DRAC Board.
     - Diode CR14 is not OK, replace the Interface DRAC Board.

9. Turn the Generator ON.

TO AVOID ELECTRIC SHOCK, DO NOT TOUCH ANY HEATSINK OR ANY COMPONENT IN THE LV-DRAC MODULE.

10. Check that there is a continuity between the following points:
    - For Main measure between terminal 12 of the Main Transformer and 11TS2-1 (for Tube-1) or 11TS2-9 (for Tube-2).
    - For Auxiliary measure between terminal 12 of the Auxiliary Transformer and 11TS2-2 (for Tube-1) or 11TS2-10 (for Tube-2).
    - For Common measure between terminal 8 of each Transformer (Main and Auxiliary) and then between terminal 8 of the Main Transformer and 11TS2-3 (for Tube-1) or 11TS2-11 (for Tube-2).
    - ▪ If the continuity is OK, go to the next step.
    - ▪ If the continuity is not correct, there is a bad contact on the Transformer Terminals or on the Contactor's Terminals 11KT1, 11K2, and/or 11K3 (*refer to Schematic "543020xx" in the Service Manual*). Identify faulty connections, clean the contacts, and/or tighten each wire connection.

11. Check the proper operation of the Control DRAC Board. For that:
    - Set DIP switch 3243SW4-7 in the “ON” position to inhibit errors.
    - Select: 40 kVp, 10 mA and 10 ms (low speed) and Direct Workstation. Check the X-ray Tube is starting properly by performing an Anode Rotation Test (*refer to “Configuration” chapter in the Service Manual*).
      - If the Tube does not start, replace the Control DRAC Board.
      - If the Tube starts, the Control DRAC Board has to be replaced but the unit can work (for a short period of days) whenever DIP switch 3243SW4-7 is in the “ON” position to inhibit errors.
      - In both cases, set DIP switch 3243SW4-7 in the “OFF” position after replacing the Control DRAC Board.

CAUTION

Connect all the wires / cables removed during the procedure back to the original connections.

ERROR CODE : E69

DESCRIPTION : LV-DRAC: Insufficient current in the main winding running at 3300 RPM

ERROR TYPE : Indicative. Exposure is not allowed.

APPLICABLE TO : All Generators with High Speed Starter.

APPEARS WHEN : During Anode acceleration at Low Speed.

INFORMATION / SYMPTOM : Error Code “E69” is displayed and it is not possible to make Exposures.

POSSIBLE CAUSES

Insufficient current in the main winding running at 3300 RPM is detected.

Defective: Interface DRAC Board, or Control DRAC Board, or Tube Stator, or Stator Cable, or Clamping Board, or Transformers, or Contactors in LV-DRAC Module.

ACTIONS

All the wires / cables removed during the procedure have to be isolated to avoid contact with any other wire or ground.

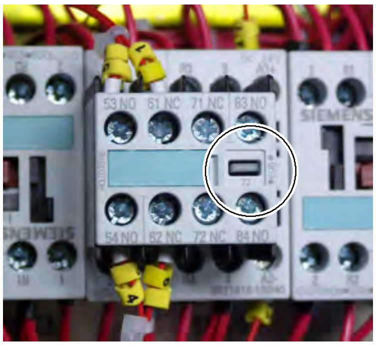
1. Verify the Generator is turned OFF.

2. Check that the DIP switches on the Control DRAC Board are set in the correct position. *(Refer to the LV -DRAC Documentation in this Service Manual, especially check that DIP-switches 3243SW3-5 and 3243SW4-5 are in the correct position according to the Tube Family Selection.)*

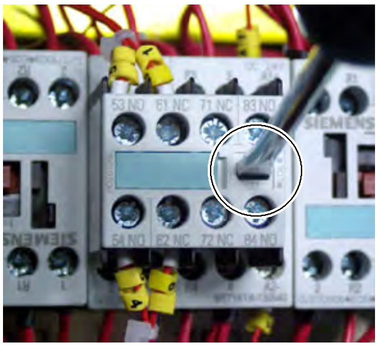
3. Check each wire connection of the Stator Cable on the Tube side and on 11TS2 on the LV-DRAC Module are correct and secured (good contact), connect properly, and tighten each wire if necessary. Check if the error has been corrected. If not, go to the next step.

4. With the Generator turned OFF, measure the Stator Tube Winding impedances on 11TS2 on the LV-DRAC Module.

Note ☞ *The Contactor 11KT1 on the LV-DRAC Module have to be not energized (contactor indicator is visible) when measuring the Stator impedances of Tube-1 and have to be energized (by manually pressing the contactor indicator) when measuring the Stator impedances of Tube-2.*



Contactor 11KT1 measuring Stator impedances of Tube-1



Contactor 11KT1 measuring Stator impedances of Tube-2

- For Tube-1 measure:
  - between Main (11TS2-1) and Common (11TS2-3).
  - between Auxiliary (11TS2-2) and Common (11TS2-3).
  - between Main (11TS2-1) and Auxiliary (11TS2-2), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
- For Tube-2 measure:
  - between Main (11TS2-9) and Common (11TS2-11).
  - between Auxiliary (11TS2-10) and Common (11TS2-11).
  - between Main (11TS2-9) and Auxiliary (11TS2-10), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.

Note ☞ *Impedance must be as stated in the X-ray Tube Stator specifications. (Refer to the Manufacturer X-ray Tube Data Sheet.)*

- If the impedance is OK, go to the next step.
- If the impedance is not correct:
  - Measure the Stator Tube Winding impedances on the Tube side:
    - Between Main and Common.
    - Between Auxiliary and Common.
    - Between Main and Auxiliary, it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
    - If the impedance is correct on the Tube, replace the Stator Cable.
    - If the impedance is not correct on the Tube, replace the X-ray Tube.

5. Check that there is a low resistance (ohms) on the primary and secondary side of either the Main or Auxiliary Transformer (depending if the error is in the Main or Auxiliary winding):
   - For Primary measure between terminals 1–7 of the Transformer.
   - For Secondary measure between terminals 8–10 and 10–12 of the Transformer.

   ▪ If the low resistance is OK, go to the next step.

   ▪ If the low resistance is not correct, replace the Transformer.

6. On the Control DRAC Board, check that there is a continuity between the following points:
   - For Main measure between J1–1 and J1–3.
   - For Auxiliary measure between J1–3 and J1–4.

   ▪ If the continuity is OK, go to the next step.

   ▪ If the continuity is not correct, check cable connections in J1 of the Control DRAC Board and in Primary side of the Transformers.

7. With the Generator turned OFF, check that Contactors 11KT1, 11K2, and 11K3 are not energized (OFF) on the LV–DRAC Module.

   ▪ If it is OK, go to the next step.

   ▪ If any Contactor is energized (ON), replace the Contactor.

8. Turn the Generator ON, check on the LV–DRAC Module that ten (10) seconds after power–up Contactors 11K2 and 11K3 are not energized (OFF) and Contactor 11KT1 is energized (ON) when Tube-1 is selected (Contactor 11KT1 is not energized (OFF) when Tube-2 is selected).

   ▪ If it is OK, go to the next step.

   ▪ If Contactor 11K2 or 11K3 is energized (ON), replace the Control DRAC Board.

   ▪ If Contactor 11KT1 is not energized (OFF) (when Tube–1 is selected), turn the Generator OFF and wait three (3) minutes for the Main Storage Capacitors to discharge. Check that Diode CR14 is OK on the Interface DRAC Board.
     - Diode CR14 is OK, replace the Control DRAC Board.
     - Diode CR14 is not OK, replace the Interface DRAC Board.

9. Turn the Generator ON.

TO AVOID ELECTRIC SHOCK, DO NOT TOUCH ANY HEATSINK OR ANY COMPONENT IN THE LV-DRAC MODULE.

10. Check that there is a continuity between the following points:
    - For Main measure between terminal 12 of the Main Transformer and 11TS2–1 (for Tube-1) or 11TS2–9 (for Tube-2).
    - For Auxiliary measure between terminal 12 of the Auxiliary Transformer and 11TS2–2 (for Tube-1) or 11TS2–10 (for Tube-2).
    - For Common measure between terminal 8 of each Transformer (Main and Auxiliary) and then between terminal 8 of the Main Transformer and 11TS2–3 (for Tube-1) or 11TS2–11 (for Tube-2).

    ▪ If the continuity is OK, go to the next step.

    ▪ If the continuity is not correct, there is a bad contact on the Transformer Terminals or on the Contactor's Terminals 11KT1, 11K2, and/or 11K3 (*refer to Schematic "543020xx" in the Service Manual*). Identify faulty connections, clean the contacts, and/or tighten each wire connection.

11. Check the proper operation of the Control DRAC Board. For that:
    - Set DIP switch 3243SW4-7 in the “ON” position to inhibit errors.
    - Select: 40 kVp, 10 mA and 10 ms (low speed) and Direct Workstation. Check the X-ray Tube is starting properly by performing an Anode Rotation Test (*refer to “Configuration” chapter in the Service Manual*).
      - If the Tube does not start, replace the Control DRAC Board.
      - If the Tube starts, the Control DRAC Board has to be replaced but the unit can work (for a short period of days) whenever DIP switch 3243SW4-7 is in the “ON” position to inhibit errors.
      - In both cases, set DIP switch 3243SW4-7 in the “OFF” position after replacing the Control DRAC Board.

CAUTION

Connect all the wires / cables removed during the procedure back to the original connections.

ERROR CODE : E70

DESCRIPTION : LV-DRAC: Excessive current in the main winding running at 10000 RPM

ERROR TYPE : Indicative. Exposure is not allowed.

APPLICABLE TO : Generators with High Speed Starter.

APPEARS WHEN : During Anode acceleration at High Speed.

INFORMATION / SYMPTOM : Error Code “E70” is displayed and it is not possible to make exposures.

POSSIBLE CAUSES

Excessive current in the main winding running at 10000 RPM is detected.

During the acceleration time the Contactor 11K2 remains OFF. Once the acceleration time has been completed the Contactor 11K2 must be energized to apply to the Stator a lower voltage (running voltage). This is the step where the errors are appearing (excessive current in running mode). For any reason, Contactor 11K2 is not energized so that the voltage applied to the Stator is higher than should be and this is causing the excessive current.

Defective: cable connections, or Contactor 11K2, or Control DRAC Board, or Stator Cable, or Tube Stator.

ACTIONS

All the wires / cables removed during the procedure have to be isolated to avoid contact with any other wire or ground.

1. Verify the Generator is turned OFF.

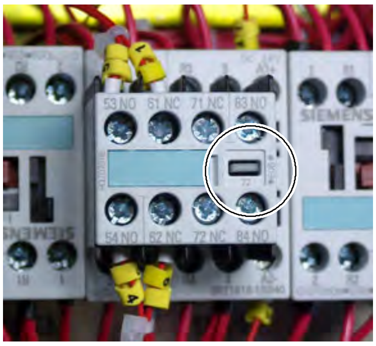
2. Check that the DIP switches on the Control DRAC Board are set in the correct position. *(Refer to the LV -DRAC Documentation in this Service Manual, especially check that DIP-switches 3243SW3-5 and 3243SW4-5 are in the correct position according to the Tube Family Selection.)*

3. Check each wire connection of the Stator Cable on the Tube side and on 11TS2 on the LV-DRAC Module are correct and secured (good contact), connect properly, and tighten each wire if necessary. Check if the error has been corrected. If not, go to the next step.

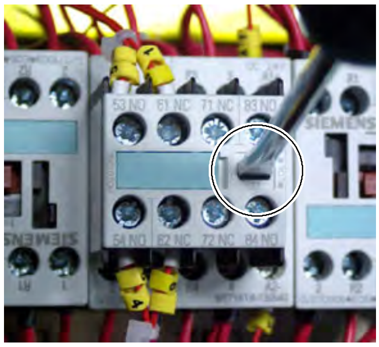
4. With the Generator turned OFF, measure the Stator Tube Winding impedances on 11TS2 on the LV-DRAC Module.

Note ☞

The Contactor 11KT1 on the LV-DRAC Module have to be not energized (contactor indicator is visible) when measuring the Stator impedances of Tube-1 and have to be energized (by manually pressing the contactor indicator) when measuring the Stator impedances of Tube-2.



Contactor 11KT1 measuring Stator impedances of Tube-1



Contactor 11KT1 measuring Stator impedances of Tube-2

- For Tube-1 measure:
  - between Main (11TS2-1) and Common (11TS2-3).
  - between Auxiliary (11TS2-2) and Common (11TS2-3).
  - between Main (11TS2-1) and Auxiliary (11TS2-2), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
- For Tube-2 measure:
  - between Main (11TS2-9) and Common (11TS2-11).
  - between Auxiliary (11TS2-10) and Common (11TS2-11).
  - between Main (11TS2-9) and Auxiliary (11TS2-10), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.

Note ☞

Impedance must be as stated in the X-ray Tube Stator specifications. (Refer to the Manufacturer X-ray Tube Data Sheet.)

- If the impedance is OK, go to the next step.
- If the impedance is not correct:
  - Measure the Stator Tube Winding impedances on the Tube side:
    - Between Main and Common.
    - Between Auxiliary and Common.
    - Between Main and Auxiliary, it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.

    - If the impedance is correct on the Tube, replace the Stator Cable.
    - If the impedance is not correct on the Tube, replace the X-ray Tube.

5. Check for correct isolation between the connections for the Main winding and Auxiliary winding in 11TS2 on the LV-DRAC Module. Measure the impedance between Main and Ground, Auxiliary and Ground, Common and Ground; in all cases it must be high impedance (mega-ohms).

    - If the impedance is OK, go to the next step.
    - If the impedance is not correct, it can be due to:
        - a wrong connection of the Stator Cable on the Tube side or on the Generator side. Check the connection of the Stator Cable and connect it properly if necessary.
        - or the Stator Cable is short-circuited, then disconnect the Stator Cable on the Tube side and measure impedance in the Tube. If the problem persists replace the X-ray Tube.

6. Turn the Generator ON.

7. Check that the Contactor 11K2 is energized few moments after the “Prep” order.

    - If it is OK, check if Contactor 11K2 is providing a good contact, if needed replace Contactor 11K2.
    - If Contactor 11K2 is not energized, check +24 VDC at the coil of 11K2 (between A1 and A2).

Note ☞ *The voltage must be verified when the Contactor is supposed to be ON (after the acceleration time)*

- If the voltage is OK, check the coil of the Contactor by an ohmmeter. It must be around 160 Ohms. If it is not correct replace the Contactor.
- If the voltage is not present, check 24 VDC (Delayed) between A1 of Contactor 11K2 and ground (this voltage must be present at any time).
    - If 24 VDC is not present between A1 of Contactor 11K2 and ground, check continuity between the Interface Control Board (J5-2) and A1 of Contactor 11K2, checking it also in the aerial connector 11J7-1. Repair defective connections..
    - If 24 VDC is present between A1 of Contactor 11K2 and ground, check the link between A2 of Contactor 11K2 and J4-2 of the Interface DRAC Board.

      If the link is not correct, repair or replace it.

      If the link is correct, check low logic level at the cathode of CR13 when Contactor 11K2 is supposed to be ON. If the low level is present check the diode CR13, and if diode CR13 is defective replace this diode or the Interface DRAC Board. Check also the flat cable between Interface DRAC Board (J1) and Control DRAC Board, if the flat cable is not correct, replace this cable.

      If the flat cable is correct but you have +24 VDC between cathode of CR13 and ground, replace the Control DRAC Board.

CAUTION ***Connect all the wires / cables removed during the procedure back to the original connections.***

ERROR CODE : E71

DESCRIPTION : LV-DRAC: Excessive current in the auxiliary winding running at 10000 RPM

ERROR TYPE : Indicative. Exposure is not allowed.

APPLICABLE TO : All Generators with High Speed Starter.

APPEARS WHEN : During Anode acceleration at High Speed.

INFORMATION / SYMPTOM : Error Code “E71” is displayed and it is not possible to make Exposures.

POSSIBLE CAUSES

Excessive current in the auxiliary winding running at 10000 RPM is detected.

During the acceleration time the Contactor 11K2 remains OFF. Once the acceleration time has been completed the Contactor 11K2 must be energized to apply to the Stator a lower voltage (running voltage). This is the step where the errors are appearing (excessive current in running mode). For any reason, Contactor 11K2 is not energized so that the voltage applied to the Stator is higher than should be and this is causing the excessive current.

Defective: cable connections, or Contactor 11K2, or Control DRAC Board, or Stator Cable, or Tube Stator.

ACTIONS

CAUTION

All the wires / cables removed during the procedure have to be isolated to avoid contact with any other wire or ground.

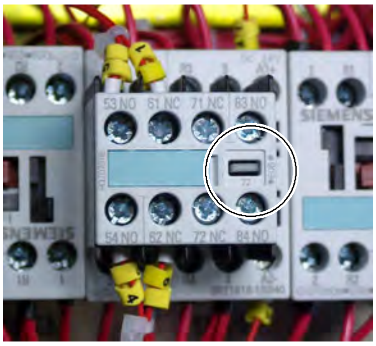
1. Verify the Generator is turned OFF.

2. Check that the DIP switches on the Control DRAC Board are set in the correct position. *(Refer to the LV -DRAC Documentation in this Service Manual, especially check that DIP-switches 3243SW3-5 and 3243SW4-5 are in the correct position according to the Tube Family Selection.)*

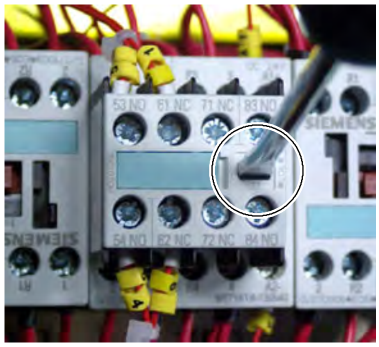
3. Check each wire connection of the Stator Cable on the Tube side and on 11TS2 on the LV-DRAC Module are correct and secured (good contact), connect properly, and tighten each wire if necessary. Check if the error has been corrected. If not, go to the next step.

4. With the Generator turned OFF, measure the Stator Tube Winding impedances on 11TS2 on the LV-DRAC Module.

Note ☞ *The Contactor 11KT1 on the LV-DRAC Module have to be not energized (contactor indicator is visible) when measuring the Stator impedances of Tube-1 and have to be energized (by manually pressing the contactor indicator) when measuring the Stator impedances of Tube-2.*



Contactor 11KT1 measuring Stator impedances of Tube-1



Contactor 11KT1 measuring Stator impedances of Tube-2

- For Tube-1 measure:
  - between Main (11TS2-1) and Common (11TS2-3).
  - between Auxiliary (11TS2-2) and Common (11TS2-3).
  - between Main (11TS2-1) and Auxiliary (11TS2-2), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
- For Tube-2 measure:
  - between Main (11TS2-9) and Common (11TS2-11).
  - between Auxiliary (11TS2-10) and Common (11TS2-11).
  - between Main (11TS2-9) and Auxiliary (11TS2-10), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.

Note ☞ *Impedance must be as stated in the X-ray Tube Stator specifications. (Refer to the Manufacturer X-ray Tube Data Sheet.)*

- If the impedance is OK, go to the next step.
- If the impedance is not correct:
  - Measure the Stator Tube Winding impedances on the Tube side:
    - Between Main and Common.
    - Between Auxiliary and Common.
    - Between Main and Auxiliary, it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.

    - If the impedance is correct on the Tube, replace the Stator Cable.
    - If the impedance is not correct on the Tube, replace the X-ray Tube.

5. Check for correct isolation between the connections for the Main winding and Auxiliary winding in 11TS2 on the LV-DRAC Module. Measure the impedance between Main and Ground, Auxiliary and Ground, Common and Ground; in all cases it must be high impedance (mega-ohms).

   - If the impedance is OK, go to the next step.
   - If the impedance is not correct, it can be due to:
     - a wrong connection of the Stator Cable on the Tube side or on the Generator side. Check the connection of the Stator Cable and connect it properly if necessary.
     - or the Stator Cable is short-circuited, then disconnect the Stator Cable on the Tube side and measure impedance in the Tube. If the problem persists replace the X-ray Tube.

6. Turn the Generator ON.

7. Check that the Contactor 11K2 is energized few moments after the “Prep” order.

   - If it is OK, check if Contactor 11K2 is providing a good contact, if needed replace Contactor 11K2.
   - If Contactor 11K2 is not energized, check +24 VDC at the coil of 11K2 (between A1 and A2).

Note ☞ *The voltage must be verified when the Contactor is supposed to be ON (after the acceleration time)*

- If the voltage is OK, check the coil of the Contactor by an ohmmeter. It must be around 160 Ohms. If it is not correct replace the Contactor.
- If the voltage is not present, check 24 VDC (Delayed) between A1 of Contactor 11K2 and ground (this voltage must be present at any time).
  - If 24 VDC is not present between A1 of Contactor 11K2 and ground, check continuity between the Interface Control Board (J5-2) and A1 of Contactor 11K2, checking it also in the aerial connector 11J7-1. Repair defective connections..
  - If 24 VDC is present between A1 of Contactor 11K2 and ground, check the link between A2 of Contactor 11K2 and J4-2 of the Interface DRAC Board.

    If the link is not correct, repair or replace it.

    If the link is correct, check low logic level at the cathode of CR13 when Contactor 11K2 is supposed to be ON. If the low level is present check the diode CR13, and if diode CR13 is defective replace this diode or the Interface DRAC Board. Check also the flat cable between Interface DRAC Board (J1) and Control DRAC Board, if the flat cable is not correct, replace this cable.

    If the flat cable is correct but you have +24 VDC between cathode of CR13 and ground, replace the Control DRAC Board.

CAUTION

Connect all the wires / cables removed during the procedure back to the original connections.

ERROR CODE : E72

DESCRIPTION : LV-DRAC: Insufficient current in the auxiliary winding running at 10000 RPM

ERROR TYPE : Indicative. Exposure is not allowed.

APPLICABLE TO : All Generators with High Speed Starter.

APPEARS WHEN : During Anode acceleration at High Speed.

INFORMATION / SYMPTOM : Error Code “E72” is displayed and it is not possible to make Exposures.

POSSIBLE CAUSES

Insufficient current in the auxiliary winding running at 10000 RPM is detected.

Defective: Interface DRAC Board, or Control DRAC Board, or Tube Stator, or Stator Cable, or Clamping Board, or Transformers, or Contactors in LV-DRAC Module.

ACTIONS

CAUTION

All the wires / cables removed during the procedure have to be isolated to avoid contact with any other wire or ground.

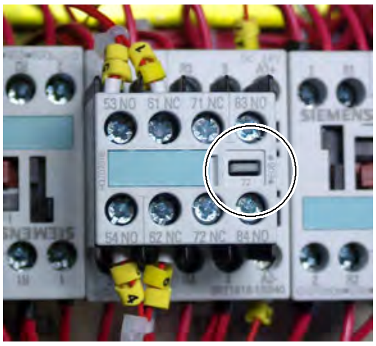
1. Verify the Generator is turned OFF.

2. Check that the DIP switches on the Control DRAC Board are set in the correct position. *(Refer to the LV -DRAC Documentation in this Service Manual, especially check that DIP-switches 3243SW3-5 and 3243SW4-5 are in the correct position according to the Tube Family Selection.)*

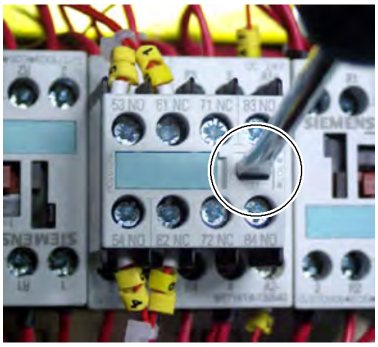
3. Check each wire connection of the Stator Cable on the Tube side and on 11TS2 on the LV-DRAC Module are correct and secured (good contact), connect properly, and tighten each wire if necessary. Check if the error has been corrected. If not, go to the next step.

4. With the Generator turned OFF, measure the Stator Tube Winding impedances on 11TS2 on the LV-DRAC Module.

Note ☞ *The Contactor 11KT1 on the LV-DRAC Module have to be not energized (contactor indicator is visible) when measuring the Stator impedances of Tube-1 and have to be energized (by manually pressing the contactor indicator) when measuring the Stator impedances of Tube-2.*



Contactor 11KT1 measuring Stator impedances of Tube-1



Contactor 11KT1 measuring Stator impedances of Tube-2

- For Tube-1 measure:
  - between Main (11TS2-1) and Common (11TS2-3).
  - between Auxiliary (11TS2-2) and Common (11TS2-3).
  - between Main (11TS2-1) and Auxiliary (11TS2-2), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
- For Tube-2 measure:
  - between Main (11TS2-9) and Common (11TS2-11).
  - between Auxiliary (11TS2-10) and Common (11TS2-11).
  - between Main (11TS2-9) and Auxiliary (11TS2-10), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.

Note ☞ *Impedance must be as stated in the X-ray Tube Stator specifications. (Refer to the Manufacturer X-ray Tube Data Sheet.)*

- If the impedance is OK, go to the next step.
- If the impedance is not correct:
  - Measure the Stator Tube Winding impedances on the Tube side:
    - Between Main and Common.
    - Between Auxiliary and Common.
    - Between Main and Auxiliary, it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
    - If the impedance is correct on the Tube, replace the Stator Cable.
    - If the impedance is not correct on the Tube, replace the X-ray Tube.

5. Check that there is a low resistance (ohms) on the primary and secondary side of either the Main or Auxiliary Transformer (depending if the error is in the Main or Auxiliary winding):
   - For Primary measure between terminals 1-7 of the Transformer.
   - For Secondary measure between terminals 8-10 and 10-12 of the Transformer.
   - ▪ If the low resistance is OK, go to the next step.
   - ▪ If the low resistance is not correct, replace the Transformer.

6. On the Control DRAC Board, check that there is a continuity between the following points:
   - For Main measure between J1-1 and J1-3.
   - For Auxiliary measure between J1-3 and J1-4.
   - ▪ If the continuity is OK, go to the next step.
   - ▪ If the continuity is not correct, check cable connections in J1 of the Control DRAC Board and in Primary side of the Transformers.

7. With the Generator turned OFF, check that Contactors 11KT1, 11K2, and 11K3 are not energized (OFF) on the LV-DRAC Module.
   - ▪ If it is OK, go to the next step.
   - ▪ If any Contactor is energized (ON), replace the Contactor.

8. Turn the Generator ON, check on the LV-DRAC Module that ten (10) seconds after power-up Contactors 11K2 and 11K3 are not energized (OFF) and Contactor 11KT1 is energized (ON) when Tube-1 is selected (Contactor 11KT1 is not energized (OFF) when Tube-2 is selected).
   - ▪ If it is OK, go to the next step.
   - ▪ If Contactor 11K2 or 11K3 is energized (ON), replace the Control DRAC Board.
   - ▪ If Contactor 11KT1 is not energized (OFF) (when Tube-1 is selected), turn the Generator OFF and wait three (3) minutes for the Main Storage Capacitors to discharge. Check that Diode CR14 is OK on the Interface DRAC Board.
     - Diode CR14 is OK, replace the Control DRAC Board.
     - Diode CR14 is not OK, replace the Interface DRAC Board.

9. Turn the Generator ON.

DANGER !

TO AVOID ELECTRIC SHOCK, DO NOT TOUCH ANY HEATSINK OR ANY COMPONENT IN THE LV-DRAC MODULE.

10. Check that there is a continuity between the following points:
    - For Main measure between terminal 12 of the Main Transformer and 11TS2-1 (for Tube-1) or 11TS2-9 (for Tube-2).
    - For Auxiliary measure between terminal 12 of the Auxiliary Transformer and 11TS2-2 (for Tube-1) or 11TS2-10 (for Tube-2).
    - For Common measure between terminal 8 of each Transformer (Main and Auxiliary) and then between terminal 8 of the Main Transformer and 11TS2-3 (for Tube-1) or 11TS2-11 (for Tube-2).
    - ▪ If the continuity is OK, go to the next step.
    - ▪ If the continuity is not correct, there is a bad contact on the Transformer Terminals or on the Contactor's Terminals 11KT1, 11K2, and/or 11K3 (*refer to Schematic "543020xx" in the Service Manual*). Identify faulty connections, clean the contacts, and/or tighten each wire connection.

11. Check the proper operation of the Control DRAC Board. For that:
    - Set DIP switch 3243SW4-7 in the “ON” position to inhibit errors.
    - Select: 40 kVp, 10 mA and 10 ms (low speed) and Direct Workstation. Check the X-ray Tube is starting properly by performing an Anode Rotation Test (*refer to “Configuration” chapter in the Service Manual*).
      - If the Tube does not start, replace the Control DRAC Board.
      - If the Tube starts, the Control DRAC Board has to be replaced but the unit can work (for a short period of days) whenever DIP switch 3243SW4-7 is in the “ON” position to inhibit errors.
      - In both cases, set DIP switch 3243SW4-7 in the “OFF” position after replacing the Control DRAC Board.

CAUTION

Connect all the wires / cables removed during the procedure back to the original connections.

ERROR CODE : E73

DESCRIPTION : LV-DRAC: Insufficient current in the main winding running at 10000 RPM

ERROR TYPE : Indicative. Exposure is not allowed.

APPLICABLE TO : All Generators with High Speed Starter.

APPEARS WHEN : During Anode acceleration at High Speed.

INFORMATION / SYMPTOM : Error Code "E73" is displayed and it is not possible to make Exposures.

POSSIBLE CAUSES

Insufficient current in the main winding running at 10000 RPM is detected.

Defective: Interface DRAC Board, or Control DRAC Board, or Tube Stator, or Stator Cable, or Clamping Board, or Transformers, or Contactors in LV-DRAC Module.

ACTIONS

All the wires / cables removed during the procedure have to be isolated to avoid contact with any other wire or ground.

1. Verify the Generator is turned OFF.

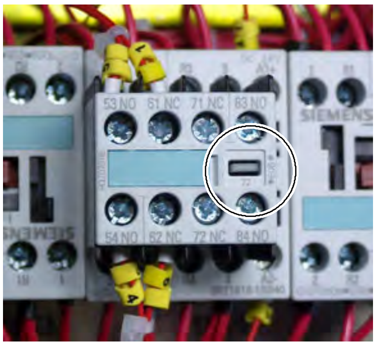
2. Check that the DIP switches on the Control DRAC Board are set in the correct position. *(Refer to the LV -DRAC Documentation in this Service Manual, especially check that DIP-switches 3243SW3-5 and 3243SW4-5 are in the correct position according to the Tube Family Selection.)*

3. Check each wire connection of the Stator Cable on the Tube side and on 11TS2 on the LV-DRAC Module are correct and secured (good contact), connect properly, and tighten each wire if necessary. Check if the error has been corrected. If not, go to the next step.

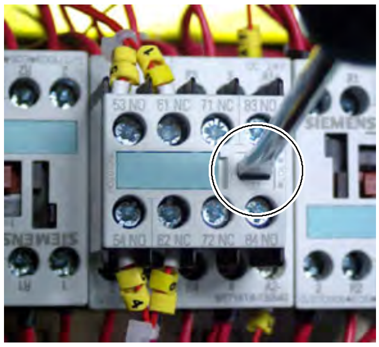
4. With the Generator turned OFF, measure the Stator Tube Winding impedances on 11TS2 on the LV-DRAC Module.

Note ☞

The Contactor 11KT1 on the LV-DRAC Module have to be not energized (contactor indicator is visible) when measuring the Stator impedances of Tube-1 and have to be energized (by manually pressing the contactor indicator) when measuring the Stator impedances of Tube-2.



Contactor 11KT1 measuring Stator impedances of Tube-1



Contactor 11KT1 measuring Stator impedances of Tube-2

- For Tube-1 measure:
  - between Main (11TS2-1) and Common (11TS2-3).
  - between Auxiliary (11TS2-2) and Common (11TS2-3).
  - between Main (11TS2-1) and Auxiliary (11TS2-2), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
- For Tube-2 measure:
  - between Main (11TS2-9) and Common (11TS2-11).
  - between Auxiliary (11TS2-10) and Common (11TS2-11).
  - between Main (11TS2-9) and Auxiliary (11TS2-10), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.

Note ☞

Impedance must be as stated in the X-ray Tube Stator specifications. (Refer to the Manufacturer X-ray Tube Data Sheet.)

- If the impedance is OK, go to the next step.
- If the impedance is not correct:
  - Measure the Stator Tube Winding impedances on the Tube side:
    - Between Main and Common.
    - Between Auxiliary and Common.
    - Between Main and Auxiliary, it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
    - If the impedance is correct on the Tube, replace the Stator Cable.
    - If the impedance is not correct on the Tube, replace the X-ray Tube.

5. Check that there is a low resistance (ohms) on the primary and secondary side of either the Main or Auxiliary Transformer (depending if the error is in the Main or Auxiliary winding):
    - For Primary measure between terminals 1-7 of the Transformer.
    - For Secondary measure between terminals 8-10 and 10-12 of the Transformer.
   - ▪ If the low resistance is OK, go to the next step.
   - ▪ If the low resistance is not correct, replace the Transformer.

6. On the Control DRAC Board, check that there is a continuity between the following points:
    - For Main measure between J1-1 and J1-3.
    - For Auxiliary measure between J1-3 and J1-4.
   - ▪ If the continuity is OK, go to the next step.
   - ▪ If the continuity is not correct, check cable connections in J1 of the Control DRAC Board and in Primary side of the Transformers.

7. With the Generator turned OFF, check that Contactors 11KT1, 11K2, and 11K3 are not energized (OFF) on the LV-DRAC Module.
   - ▪ If it is OK, go to the next step.
   - ▪ If any Contactor is energized (ON), replace the Contactor.

8. Turn the Generator ON, check on the LV-DRAC Module that ten (10) seconds after power-up Contactors 11K2 and 11K3 are not energized (OFF) and Contactor 11KT1 is energized (ON) when Tube-1 is selected (Contactor 11KT1 is not energized (OFF) when Tube-2 is selected).
   - ▪ If it is OK, go to the next step.
   - ▪ If Contactor 11K2 or 11K3 is energized (ON), replace the Control DRAC Board.
   - ▪ If Contactor 11KT1 is not energized (OFF) (when Tube-1 is selected), turn the Generator OFF and wait three (3) minutes for the Main Storage Capacitors to discharge. Check that Diode CR14 is OK on the Interface DRAC Board.
      - Diode CR14 is OK, replace the Control DRAC Board.
      - Diode CR14 is not OK, replace the Interface DRAC Board.

9. Turn the Generator ON.

TO AVOID ELECTRIC SHOCK, DO NOT TOUCH ANY HEATSINK OR ANY COMPONENT IN THE LV-DRAC MODULE.

10. Check that there is a continuity between the following points:
    - For Main measure between terminal 12 of the Main Transformer and 11TS2-1 (for Tube-1) or 11TS2-9 (for Tube-2).
    - For Auxiliary measure between terminal 12 of the Auxiliary Transformer and 11TS2-2 (for Tube-1) or 11TS2-10 (for Tube-2).
    - For Common measure between terminal 8 of each Transformer (Main and Auxiliary) and then between terminal 8 of the Main Transformer and 11TS2-3 (for Tube-1) or 11TS2-11 (for Tube-2).
   - ▪ If the continuity is OK, go to the next step.
   - ▪ If the continuity is not correct, there is a bad contact on the Transformer Terminals or on the Contactor's Terminals 11KT1, 11K2, and/or 11K3 (*refer to Schematic "543020xx" in the Service Manual*). Identify faulty connections, clean the contacts, and/or tighten each wire connection.

11. Check the proper operation of the Control DRAC Board. For that:
    - Set DIP switch 3243SW4-7 in the “ON” position to inhibit errors.
    - Select: 40 kVp, 10 mA and 10 ms (low speed) and Direct Workstation. Check the X-ray Tube is starting properly by performing an Anode Rotation Test (*refer to “Configuration” chapter in the Service Manual*).
        - If the Tube does not start, replace the Control DRAC Board.
        - If the Tube starts, the Control DRAC Board has to be replaced but the unit can work (for a short period of days) whenever DIP switch 3243SW4-7 is in the “ON” position to inhibit errors.
        - In both cases, set DIP switch 3243SW4-7 in the “OFF” position after replacing the Control DRAC Board.

CAUTION

Connect all the wires / cables removed during the procedure back to the original connections.

ERROR CODE : E74

DESCRIPTION :	LV-DRAC: Excessive current in the main winding braking at 3300 RPM
ERROR TYPE :	Indicative. Exposure is not allowed.
APPLICABLE TO :	Generators with High Speed Starter.
APPEARS WHEN :	During Anode acceleration at Low Speed.
INFORMATION / SYMPTOM :	Error Code “E74” is displayed and it is not possible to make exposures.

POSSIBLE CAUSES

Excessive current in the main winding braking at 3300 RPM is detected.

Defective: Interface DRAC Board, or Control DRAC Board, or Tube Stator, or Stator Cable, or Clamping Board, or Transformers, or Contactors in LV-DRAC Module.

ACTIONS

CAUTION

All the wires / cables removed during the procedure have to be isolated to avoid contact with any other wire or ground.

1. Verify the Generator is turned OFF.

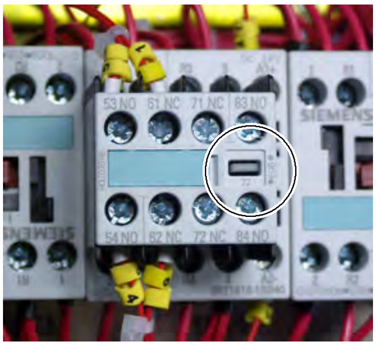
2. Check that the DIP switches on the Control DRAC Board are set in the correct position. *(Refer to the LV -DRAC Documentation in this Service Manual, especially check that DIP-switches 3243SW3-5 and 3243SW4-5 are in the correct position according to the Tube Family Selection.)*

3. Check each wire connection of the Stator Cable on the Tube side and on 11TS2 on the LV-DRAC Module are correct and secured (good contact), connect properly, and tighten each wire if necessary. Check if the error has been corrected. If not, go to the next step.

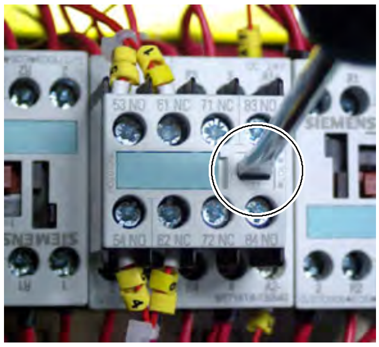
4. With the Generator turned OFF, measure the Stator Tube Winding impedances on 11TS2 on the LV-DRAC Module.

Note ☞

The Contactor 11KT1 on the LV-DRAC Module have to be not energized (contactor indicator is visible) when measuring the Stator impedances of Tube-1 and have to be energized (by manually pressing the contactor indicator) when measuring the Stator impedances of Tube-2.



Contactor 11KT1 measuring
Stator impedances of Tube-1



Contactor 11KT1 measuring
Stator impedances of Tube-2

- For Tube-1 measure:
  - between Main (11TS2-1) and Common (11TS2-3).
  - between Auxiliary (11TS2-2) and Common (11TS2-3).
  - between Main (11TS2-1) and Auxiliary (11TS2-2), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
- For Tube-2 measure:
  - between Main (11TS2-9) and Common (11TS2-11).
  - between Auxiliary (11TS2-10) and Common (11TS2-11).
  - between Main (11TS2-9) and Auxiliary (11TS2-10), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.

Note ☞

Impedance must be as stated in the X-ray Tube Stator specifications. (Refer to the Manufacturer X-ray Tube Data Sheet.)

- If the impedance is OK, go to the next step.
- If the impedance is not correct:
  - Measure the Stator Tube Winding impedances on the Tube side:
    - Between Main and Common.
    - Between Auxiliary and Common.
    - Between Main and Auxiliary, it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
  - If the impedance is correct on the Tube, replace the Stator Cable.
  - If the impedance is not correct on the Tube, replace the X-ray Tube.

5. Check for correct isolation between the connections for the Main winding and Auxiliary winding in 11TS2 on the LV-DRAC Module. Measure the impedance between Main and Ground, Auxiliary and Ground, Common and Ground; in all cases it must be high impedance (mega-ohms).
   - If the impedance is OK, go to the next step.
   - If the impedance is not correct, it can be due to:
     - a wrong connection of the Stator Cable on the Tube side or on the Generator side. Check the connection of the Stator Cable and connect it properly if necessary.
     - or the Stator Cable is short-circuited, then disconnect the Stator Cable on the Tube side and measure impedance in the Tube. If the problem persists replace the X-ray Tube.
6. Turn the Generator ON.

CAUTION

To perform each one of the following checks it is necessary:

- Turn the Generator OFF and wait three (3) minutes to discharge the Main Storage Capacitors.

- Remove the wire indicated in each step below.

- Turn the Generator ON. Press PREP and note the error code and reset it.

7. On the Tube side, remove the Main wire. Check:
   - If an “Excessive Current” code appears, go to the next step.
   - If an “Insufficient Current” code appears, the problem is in the Tube Stator. Replace the X-ray Tube.
8. On the Generator side, remove the Main wire (11TS2-1 for Tube-1 or 11TS2-9 for Tube-2). Check:
   - If an “Excessive Current” code appears, go to the next step.
   - If an “Insufficient Current” code appears, the problem is in the Stator Cable. Replace the Stator Cable.
9. Desolder the wire marked as “12” on the Main Transformer of the LV-DRAC Module. Check:
   - If an “Excessive Current” code appears, go to the next step.
   - If an “Insufficient Current” code appears, there is a bad contact from 11TS2 to Terminal “12” in the Transformer on the Contactor’s Terminals 11KT1, 11K2, and/or 11K3 (*refer to Schematic “543020xx” in the Service Manual*). Identify faulty connections, clean the contacts, tighten each wire connection, and/or replace Contactors if necessary.
10. On the Control DRAC Board, remove wire J1-1 (Main). Check:
    - If an “Excessive Current” code appears, go to the next step.
    - If an “Insufficient Current” code appears, replace the Main Transformer at the LV-DRAC Module.
11. On the Control DRAC Board, remove wire J1-3 (Shield). Check:
    - If an “Excessive Current” code appears, replace the Control DRAC Board.
    - If an “Insufficient Current” code appears, replace the Main Transformer at the LV-DRAC Module.

CAUTION

Connect all the wires / cables removed during the procedure back to the original connections.

ERROR CODE : E75

DESCRIPTION : LV-DRAC: Excessive current in the auxiliary winding braking at 3300 RPM

ERROR TYPE : Indicative. Exposure is not allowed.

APPLICABLE TO : All Generators with High Speed Starter.

APPEARS WHEN : During Anode acceleration at Low Speed.

INFORMATION / SYMPTOM : Error Code “E75” is displayed and it is not possible to make Exposures.

POSSIBLE CAUSES

Excessive current in the auxiliary winding braking at 3300 RPM is detected.

Defective: Interface DRAC Board, or Control DRAC Board, or Tube Stator, or Stator Cable, or Clamping Board, or Transformers, or Contactors in LV-DRAC Module.

ACTIONS

All the wires / cables removed during the procedure have to be isolated to avoid contact with any other wire or ground.

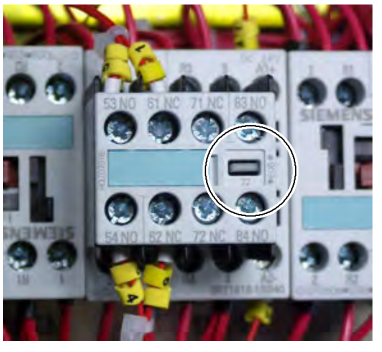
1. Verify the Generator is turned OFF.

2. Check that the DIP switches on the Control DRAC Board are set in the correct position. *(Refer to the LV -DRAC Documentation in this Service Manual, especially check that DIP-switches 3243SW3-5 and 3243SW4-5 are in the correct position according to the Tube Family Selection.)*

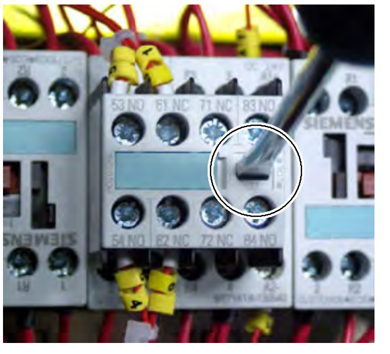
3. Check each wire connection of the Stator Cable on the Tube side and on 11TS2 on the LV-DRAC Module are correct and secured (good contact), connect properly, and tighten each wire if necessary. Check if the error has been corrected. If not, go to the next step.

4. With the Generator turned OFF, measure the Stator Tube Winding impedances on 11TS2 on the LV-DRAC Module.

Note ☞ *The Contactor 11KT1 on the LV-DRAC Module have to be not energized (contactor indicator is visible) when measuring the Stator impedances of Tube-1 and have to be energized (by manually pressing the contactor indicator) when measuring the Stator impedances of Tube-2.*



Contactor 11KT1 measuring Stator impedances of Tube-1



Contactor 11KT1 measuring Stator impedances of Tube-2

- For Tube-1 measure:
  - between Main (11TS2-1) and Common (11TS2-3).
  - between Auxiliary (11TS2-2) and Common (11TS2-3).
  - between Main (11TS2-1) and Auxiliary (11TS2-2), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
- For Tube-2 measure:
  - between Main (11TS2-9) and Common (11TS2-11).
  - between Auxiliary (11TS2-10) and Common (11TS2-11).
  - between Main (11TS2-9) and Auxiliary (11TS2-10), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.

Note ☞ *Impedance must be as stated in the X-ray Tube Stator specifications. (Refer to the Manufacturer X-ray Tube Data Sheet.)*

- If the impedance is OK, go to the next step.
- If the impedance is not correct:
  - Measure the Stator Tube Winding impedances on the Tube side:
    - Between Main and Common.
    - Between Auxiliary and Common.
    - Between Main and Auxiliary, it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
    - If the impedance is correct on the Tube, replace the Stator Cable.
    - If the impedance is not correct on the Tube, replace the X-ray Tube.

5. Check for correct isolation between the connections for the Main winding and Auxiliary winding in 11TS2 on the LV-DRAC Module. Measure the impedance between Main and Ground, Auxiliary and Ground, Common and Ground; in all cases it must be high impedance (mega-ohms).

   - If the impedance is OK, go to the next step.
   - If the impedance is not correct, it can be due to:
     - a wrong connection of the Stator Cable on the Tube side or on the Generator side. Check the connection of the Stator Cable and connect it properly if necessary.
     - or the Stator Cable is short-circuited, then disconnect the Stator Cable on the Tube side and measure impedance in the Tube. If the problem persists replace the X-ray Tube.

6. Turn the Generator ON.

To perform each one of the following checks it is necessary:

- Turn the Generator OFF and wait three (3) minutes to discharge the Main Storage Capacitors.

- Remove the wire indicated in each step below.

- Turn the Generator ON. Press PREP and note the error code and reset it.

7. On the Tube side, remove the Auxiliary wire. Check:

   - If an “Excessive Current” code appears, go to the next step.
   - If an “Insufficient Current” code appears, the problem is in the Tube Stator. Replace the X-ray Tube.

8. On the Generator side, remove the Auxiliary wire (11TS2-2 for Tube-1 or 11TS2-10 for Tube-2). Check:

   - If an “Excessive Current” code appears, go to the next step.
   - If an “Insufficient Current” code appears, the problem is in the Stator Cable. Replace the Stator Cable.

9. On the Interface DRAC Board, remove J5-1 and J5-4 wires. Check:

   - If an “Excessive Current” code appears, go to the next step.
   - If an “Insufficient Current” code appears, replace the Interface DRAC Board.

10. Remove the two (2) wires connected to the Clamping Board. Check:

    - If an “Excessive Current” code appears, go to the next step.
    - If an “Insufficient Current” code appears, replace the Clamping Board.

11. Desolder the wire marked as “12” on the Auxiliary Transformer of the LV-DRAC Module. Check:

    - If an “Excessive Current” code appears, go to the next step.
    - If an “Insufficient Current” code appears, there is a bad contact from 11TS2 to Terminal “12” in the Transformer on the Contactor’s Terminals 11KT1, 11K2, and/or 11K3 (*refer to Schematic “543020xx” in the Service Manual*). Identify faulty connections, clean the contacts, tighten each wire connection, and/or replace Contactors if necessary.

12. On the Control DRAC Board, remove wire J1-4 (Auxiliary). Check:

    - If an “Excessive Current” code appears, go to the next step.
    - If an “Insufficient Current” code appears, replace the Main Transformer at the LV-DRAC Module.

13. On the Control DRAC Board, remove wire J1-3 (Shield). Check:

    - If an “Excessive Current” code appears, replace the Control DRAC Board.
    - If an “Insufficient Current” code appears, replace the Main Transformer at the LV-DRAC Module.

Connect all the wires / cables removed during the procedure back to the original connections.

ERROR CODE : E76

DESCRIPTION : LV-DRAC: Insufficient current in the auxiliary winding braking at 3300 RPM

ERROR TYPE : Indicative. Exposure is not allowed.

APPLICABLE TO : All Generators with High Speed Starter.

APPEARS WHEN : During Anode acceleration at Low Speed.

INFORMATION / SYMPTOM : Error Code “E76” is displayed and it is not possible to make Exposures.

POSSIBLE CAUSES

Insufficient current in the auxiliary winding braking at 3300 RPM is detected.

Defective: Interface DRAC Board, or Control DRAC Board, or Tube Stator, or Stator Cable, or Clamping Board, or Transformers, or Contactors in LV-DRAC Module.

ACTIONS

CAUTION

All the wires / cables removed during the procedure have to be isolated to avoid contact with any other wire or ground.

1. Verify the Generator is turned OFF.

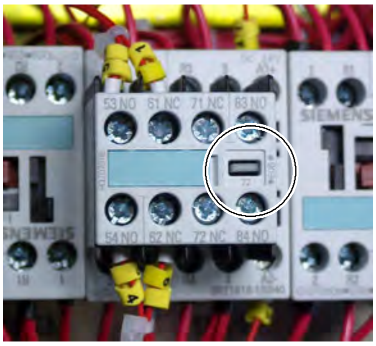
2. Check that the DIP switches on the Control DRAC Board are set in the correct position. *(Refer to the LV -DRAC Documentation in this Service Manual, especially check that DIP-switches 3243SW3-5 and 3243SW4-5 are in the correct position according to the Tube Family Selection.)*

3. Check each wire connection of the Stator Cable on the Tube side and on 11TS2 on the LV-DRAC Module are correct and secured (good contact), connect properly, and tighten each wire if necessary. Check if the error has been corrected. If not, go to the next step.

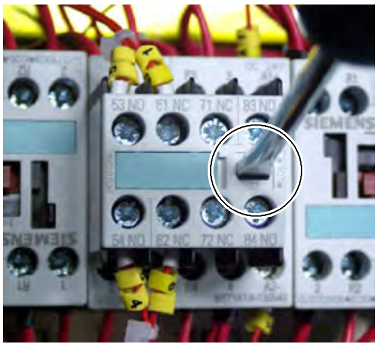
4. With the Generator turned OFF, measure the Stator Tube Winding impedances on 11TS2 on the LV-DRAC Module.

Note ☞

The Contactor 11KT1 on the LV-DRAC Module have to be not energized (contactor indicator is visible) when measuring the Stator impedances of Tube-1 and have to be energized (by manually pressing the contactor indicator) when measuring the Stator impedances of Tube-2.



Contactor 11KT1 measuring Stator impedances of Tube-1



Contactor 11KT1 measuring Stator impedances of Tube-2

- For Tube-1 measure:
  - between Main (11TS2-1) and Common (11TS2-3).
  - between Auxiliary (11TS2-2) and Common (11TS2-3).
  - between Main (11TS2-1) and Auxiliary (11TS2-2), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
- For Tube-2 measure:
  - between Main (11TS2-9) and Common (11TS2-11).
  - between Auxiliary (11TS2-10) and Common (11TS2-11).
  - between Main (11TS2-9) and Auxiliary (11TS2-10), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.

Note ☞

Impedance must be as stated in the X-ray Tube Stator specifications. (Refer to the Manufacturer X-ray Tube Data Sheet.)

- If the impedance is OK, go to the next step.
- If the impedance is not correct:
  - Measure the Stator Tube Winding impedances on the Tube side:
    - Between Main and Common.
    - Between Auxiliary and Common.
    - Between Main and Auxiliary, it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
    - If the impedance is correct on the Tube, replace the Stator Cable.
    - If the impedance is not correct on the Tube, replace the X-ray Tube.

5. Check that there is a low resistance (ohms) on the primary and secondary side of either the Main or Auxiliary Transformer (depending if the error is in the Main or Auxiliary winding):
   - For Primary measure between terminals 1-7 of the Transformer.
   - For Secondary measure between terminals 8-10 and 10-12 of the Transformer.

   ▪ If the low resistance is OK, go to the next step.

   ▪ If the low resistance is not correct, replace the Transformer.

6. On the Control DRAC Board, check that there is a continuity between the following points:
   - For Main measure between J1-1 and J1-3.
   - For Auxiliary measure between J1-3 and J1-4.

   ▪ If the continuity is OK, go to the next step.

   ▪ If the continuity is not correct, check cable connections in J1 of the Control DRAC Board and in Primary side of the Transformers.

7. With the Generator turned OFF, check that Contactors 11KT1, 11K2, and 11K3 are not energized (OFF) on the LV-DRAC Module.

   ▪ If it is OK, go to the next step.

   ▪ If any Contactor is energized (ON), replace the Contactor.

8. Turn the Generator ON, check on the LV-DRAC Module that ten (10) seconds after power-up Contactors 11K2 and 11K3 are not energized (OFF) and Contactor 11KT1 is energized (ON) when Tube-1 is selected (Contactor 11KT1 is not energized (OFF) when Tube-2 is selected).

   ▪ If it is OK, go to the next step.

   ▪ If Contactor 11K2 or 11K3 is energized (ON), replace the Control DRAC Board.

   ▪ If Contactor 11KT1 is not energized (OFF) (when Tube-1 is selected), turn the Generator OFF and wait three (3) minutes for the Main Storage Capacitors to discharge. Check that Diode CR14 is OK on the Interface DRAC Board.
     - Diode CR14 is OK, replace the Control DRAC Board.
     - Diode CR14 is not OK, replace the Interface DRAC Board.

9. Turn the Generator ON.

DANGER !

TO AVOID ELECTRIC SHOCK, DO NOT TOUCH ANY HEATSINK OR ANY COMPONENT IN THE LV-DRAC MODULE.

10. Check that there is a continuity between the following points:
    - For Main measure between terminal 12 of the Main Transformer and 11TS2-1 (for Tube-1) or 11TS2-9 (for Tube-2).
    - For Auxiliary measure between terminal 12 of the Auxiliary Transformer and 11TS2-2 (for Tube-1) or 11TS2-10 (for Tube-2).
    - For Common measure between terminal 8 of each Transformer (Main and Auxiliary) and then between terminal 8 of the Main Transformer and 11TS2-3 (for Tube-1) or 11TS2-11 (for Tube-2).

    ▪ If the continuity is OK, go to the next step.

    ▪ If the continuity is not correct, there is a bad contact on the Transformer Terminals or on the Contactor's Terminals 11KT1, 11K2, and/or 11K3 (*refer to Schematic "543020xx" in the Service Manual*). Identify faulty connections, clean the contacts, and/or tighten each wire connection.

11. Check the proper operation of the Control DRAC Board. For that:
    - Set DIP switch 3243SW4-7 in the “ON” position to inhibit errors.
    - Select: 40 kVp, 10 mA and 10 ms (low speed) and Direct Workstation. Check the X-ray Tube is starting properly by performing an Anode Rotation Test (*refer to “Configuration” chapter in the Service Manual*).
        - If the Tube does not start, replace the Control DRAC Board.
        - If the Tube starts, the Control DRAC Board has to be replaced but the unit can work (for a short period of days) whenever DIP switch 3243SW4-7 is in the “ON” position to inhibit errors.
        - In both cases, set DIP switch 3243SW4-7 in the “OFF” position after replacing the Control DRAC Board.

CAUTION

Connect all the wires / cables removed during the procedure back to the original connections.

ERROR CODE : E77

DESCRIPTION :	LV-DRAC: Insufficient current in the main winding braking at 3300 RPM
ERROR TYPE :	Indicative. Exposure is not allowed.
APPLICABLE TO :	All Generators with High Speed Starter.
APPEARS WHEN :	During Anode acceleration at Low Speed.
INFORMATION / SYMPTOM :	Error Code “E77” is displayed and it is not possible to make Exposures.

POSSIBLE CAUSES

Insufficient current in the main winding braking at 3300 RPM is detected.

Defective: Interface DRAC Board, or Control DRAC Board, or Tube Stator, or Stator Cable, or Clamping Board, or Transformers, or Contactors in LV-DRAC Module.

ACTIONS

CAUTION

All the wires / cables removed during the procedure have to be isolated to avoid contact with any other wire or ground.

1. Verify the Generator is turned OFF.

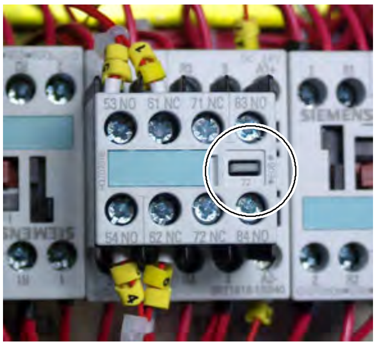
2. Check that the DIP switches on the Control DRAC Board are set in the correct position. *(Refer to the LV -DRAC Documentation in this Service Manual, especially check that DIP-switches 3243SW3-5 and 3243SW4-5 are in the correct position according to the Tube Family Selection.)*

3. Check each wire connection of the Stator Cable on the Tube side and on 11TS2 on the LV-DRAC Module are correct and secured (good contact), connect properly, and tighten each wire if necessary. Check if the error has been corrected. If not, go to the next step.

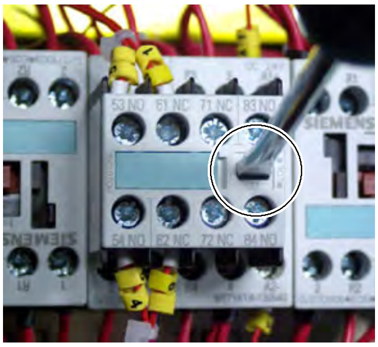
4. With the Generator turned OFF, measure the Stator Tube Winding impedances on 11TS2 on the LV-DRAC Module.

Note ☞

The Contactor 11KT1 on the LV-DRAC Module have to be not energized (contactor indicator is visible) when measuring the Stator impedances of Tube-1 and have to be energized (by manually pressing the contactor indicator) when measuring the Stator impedances of Tube-2.



Contactor 11KT1 measuring Stator impedances of Tube-1



Contactor 11KT1 measuring Stator impedances of Tube-2

- For Tube-1 measure:
  - between Main (11TS2-1) and Common (11TS2-3).
  - between Auxiliary (11TS2-2) and Common (11TS2-3).
  - between Main (11TS2-1) and Auxiliary (11TS2-2), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
- For Tube-2 measure:
  - between Main (11TS2-9) and Common (11TS2-11).
  - between Auxiliary (11TS2-10) and Common (11TS2-11).
  - between Main (11TS2-9) and Auxiliary (11TS2-10), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.

Note ☞

Impedance must be as stated in the X-ray Tube Stator specifications. (Refer to the Manufacturer X-ray Tube Data Sheet.)

- If the impedance is OK, go to the next step.
- If the impedance is not correct:
  - Measure the Stator Tube Winding impedances on the Tube side:
    - Between Main and Common.
    - Between Auxiliary and Common.
    - Between Main and Auxiliary, it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
    - If the impedance is correct on the Tube, replace the Stator Cable.
    - If the impedance is not correct on the Tube, replace the X-ray Tube.

5. Check that there is a low resistance (ohms) on the primary and secondary side of either the Main or Auxiliary Transformer (depending if the error is in the Main or Auxiliary winding):
   - For Primary measure between terminals 1-7 of the Transformer.
   - For Secondary measure between terminals 8-10 and 10-12 of the Transformer.

   ▪ If the low resistance is OK, go to the next step.

   ▪ If the low resistance is not correct, replace the Transformer.

6. On the Control DRAC Board, check that there is a continuity between the following points:
   - For Main measure between J1-1 and J1-3.
   - For Auxiliary measure between J1-3 and J1-4.

   ▪ If the continuity is OK, go to the next step.

   ▪ If the continuity is not correct, check cable connections in J1 of the Control DRAC Board and in Primary side of the Transformers.

7. With the Generator turned OFF, check that Contactors 11KT1, 11K2, and 11K3 are not energized (OFF) on the LV-DRAC Module.

   ▪ If it is OK, go to the next step.

   ▪ If any Contactor is energized (ON), replace the Contactor.

8. Turn the Generator ON, check on the LV-DRAC Module that ten (10) seconds after power-up Contactors 11K2 and 11K3 are not energized (OFF) and Contactor 11KT1 is energized (ON) when Tube-1 is selected (Contactor 11KT1 is not energized (OFF) when Tube-2 is selected).

   ▪ If it is OK, go to the next step.

   ▪ If Contactor 11K2 or 11K3 is energized (ON), replace the Control DRAC Board.

   ▪ If Contactor 11KT1 is not energized (OFF) (when Tube-1 is selected), turn the Generator OFF and wait three (3) minutes for the Main Storage Capacitors to discharge. Check that Diode CR14 is OK on the Interface DRAC Board.
     - Diode CR14 is OK, replace the Control DRAC Board.
     - Diode CR14 is not OK, replace the Interface DRAC Board.

9. Turn the Generator ON.

TO AVOID ELECTRIC SHOCK, DO NOT TOUCH ANY HEATSINK OR ANY COMPONENT IN THE LV-DRAC MODULE.

10. Check that there is a continuity between the following points:
    - For Main measure between terminal 12 of the Main Transformer and 11TS2-1 (for Tube-1) or 11TS2-9 (for Tube-2).
    - For Auxiliary measure between terminal 12 of the Auxiliary Transformer and 11TS2-2 (for Tube-1) or 11TS2-10 (for Tube-2).
    - For Common measure between terminal 8 of each Transformer (Main and Auxiliary) and then between terminal 8 of the Main Transformer and 11TS2-3 (for Tube-1) or 11TS2-11 (for Tube-2).

    ▪ If the continuity is OK, go to the next step.

    ▪ If the continuity is not correct, there is a bad contact on the Transformer Terminals or on the Contactor's Terminals 11KT1, 11K2, and/or 11K3 (*refer to Schematic "543020xx" in the Service Manual*). Identify faulty connections, clean the contacts, and/or tighten each wire connection.

11. Check the proper operation of the Control DRAC Board. For that:
    - Set DIP switch 3243SW4-7 in the “ON” position to inhibit errors.
    - Select: 40 kVp, 10 mA and 10 ms (low speed) and Direct Workstation. Check the X-ray Tube is starting properly by performing an Anode Rotation Test (*refer to “Configuration” chapter in the Service Manual*).
        - If the Tube does not start, replace the Control DRAC Board.
        - If the Tube starts, the Control DRAC Board has to be replaced but the unit can work (for a short period of days) whenever DIP switch 3243SW4-7 is in the “ON” position to inhibit errors.
        - In both cases, set DIP switch 3243SW4-7 in the “OFF” position after replacing the Control DRAC Board.

CAUTION

Connect all the wires / cables removed during the procedure back to the original connections.

ERROR CODE : E78

DESCRIPTION :	LV-DRAC: Excessive current in the main winding braking at 10000 RPM
ERROR TYPE :	Indicative. Exposure is not allowed.
APPLICABLE TO :	Generators with High Speed Starter.
APPEARS WHEN :	During Anode acceleration at High Speed.
INFORMATION / SYMPTOM :	Error Code “E78” is displayed and it is not possible to make exposures.

POSSIBLE CAUSES

Excessive current in the main winding braking at 10000 RPM is detected.

Defective: Interface DRAC Board, or Control DRAC Board, or Tube Stator, or Stator Cable, or Clamping Board, or Transformers, or Contactors in LV-DRAC Module.

ACTIONS

All the wires / cables removed during the procedure have to be isolated to avoid contact with any other wire or ground.

1. Verify the Generator is turned OFF.

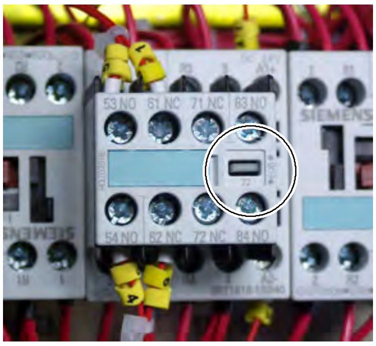
2. Check that the DIP switches on the Control DRAC Board are set in the correct position. *(Refer to the LV -DRAC Documentation in this Service Manual, especially check that DIP-switches 3243SW3-5 and 3243SW4-5 are in the correct position according to the Tube Family Selection.)*

3. Check each wire connection of the Stator Cable on the Tube side and on 11TS2 on the LV-DRAC Module are correct and secured (good contact), connect properly, and tighten each wire if necessary. Check if the error has been corrected. If not, go to the next step.

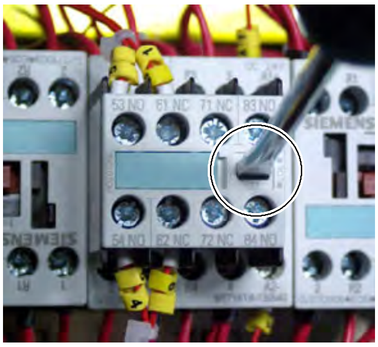
4. With the Generator turned OFF, measure the Stator Tube Winding impedances on 11TS2 on the LV-DRAC Module.

Note ☞

The Contactor 11KT1 on the LV-DRAC Module have to be not energized (contactor indicator is visible) when measuring the Stator impedances of Tube-1 and have to be energized (by manually pressing the contactor indicator) when measuring the Stator impedances of Tube-2.



Contactor 11KT1 measuring Stator impedances of Tube-1



Contactor 11KT1 measuring Stator impedances of Tube-2

- For Tube-1 measure:
  - between Main (11TS2-1) and Common (11TS2-3).
  - between Auxiliary (11TS2-2) and Common (11TS2-3).
  - between Main (11TS2-1) and Auxiliary (11TS2-2), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
- For Tube-2 measure:
  - between Main (11TS2-9) and Common (11TS2-11).
  - between Auxiliary (11TS2-10) and Common (11TS2-11).
  - between Main (11TS2-9) and Auxiliary (11TS2-10), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.

Note ☞

Impedance must be as stated in the X-ray Tube Stator specifications. (Refer to the Manufacturer X-ray Tube Data Sheet.)

- If the impedance is OK, go to the next step.
- If the impedance is not correct:
  - Measure the Stator Tube Winding impedances on the Tube side:
  - Between Main and Common.
  - Between Auxiliary and Common.
  - Between Main and Auxiliary, it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.

  - If the impedance is correct on the Tube, replace the Stator Cable.
  - If the impedance is not correct on the Tube, replace the X-ray Tube.

5. Check for correct isolation between the connections for the Main winding and Auxiliary winding in 11TS2 on the LV-DRAC Module. Measure the impedance between Main and Ground, Auxiliary and Ground, Common and Ground; in all cases it must be high impedance (mega-ohms).

   - If the impedance is OK, go to the next step.
   - If the impedance is not correct, it can be due to:
     - a wrong connection of the Stator Cable on the Tube side or on the Generator side. Check the connection of the Stator Cable and connect it properly if necessary.
     - or the Stator Cable is short-circuited, then disconnect the Stator Cable on the Tube side and measure impedance in the Tube. If the problem persists replace the X-ray Tube.

6. Turn the Generator ON.

CAUTION

To perform each one of the following checks it is necessary:

- Turn the Generator OFF and wait three (3) minutes to discharge the Main Storage Capacitors.

- Remove the wire indicated in each step below.

- Turn the Generator ON. Press PREP and note the error code and reset it.

7. On the Tube side, remove the Main wire. Check:
   - If an “Excessive Current” code appears, go to the next step.
   - If an “Insufficient Current” code appears, the problem is in the Tube Stator. Replace the X-ray Tube.
8. On the Generator side, remove the Main wire (11TS2-1 for Tube-1 or 11TS2-9 for Tube-2). Check:
   - If an “Excessive Current” code appears, go to the next step.
   - If an “Insufficient Current” code appears, the problem is in the Stator Cable. Replace the Stator Cable.
9. Desolder the wire marked as “12” on the Main Transformer of the LV-DRAC Module. Check:
   - If an “Excessive Current” code appears, go to the next step.
   - If an “Insufficient Current” code appears, there is a bad contact from 11TS2 to Terminal “12” in the Transformer on the Contactor’s Terminals 11KT1, 11K2, and/or 11K3 (*refer to Schematic “543020xx” in the Service Manual*). Identify faulty connections, clean the contacts, tighten each wire connection, and/or replace Contactors if necessary.
10. On the Control DRAC Board, remove wire J1-1 (Main). Check:
    - If an “Excessive Current” code appears, go to the next step.
    - If an “Insufficient Current” code appears, replace the Main Transformer at the LV-DRAC Module.
11. On the Control DRAC Board, remove wire J1-3 (Shield). Check:
    - If an “Excessive Current” code appears, replace the Control DRAC Board.
    - If an “Insufficient Current” code appears, replace the Main Transformer at the LV-DRAC Module.

CAUTION

Connect all the wires / cables removed during the procedure back to the original connections.

ERROR CODE : E79

DESCRIPTION : LV-DRAC: Excessive current in the auxiliary winding braking at 10000 RPM

ERROR TYPE : Indicative. Exposure is not allowed.

APPLICABLE TO : All Generators with High Speed Starter.

APPEARS WHEN : During Anode acceleration at High Speed.

INFORMATION / SYMPTOM : Error Code “E79” is displayed and it is not possible to make Exposures.

POSSIBLE CAUSES

Excessive current in the auxiliary winding braking at 10000 RPM is detected.

Defective: Interface DRAC Board, or Control DRAC Board, or Tube Stator, or Stator Cable, or Clamping Board, or Transformers, or Contactors in LV-DRAC Module.

ACTIONS

CAUTION

All the wires / cables removed during the procedure have to be isolated to avoid contact with any other wire or ground.

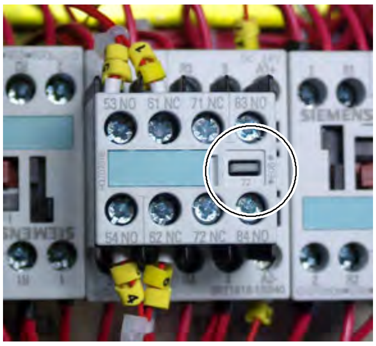
1. Verify the Generator is turned OFF.

2. Check that the DIP switches on the Control DRAC Board are set in the correct position. *(Refer to the LV -DRAC Documentation in this Service Manual, especially check that DIP-switches 3243SW3-5 and 3243SW4-5 are in the correct position according to the Tube Family Selection.)*

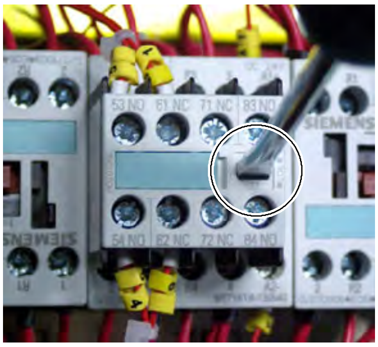
3. Check each wire connection of the Stator Cable on the Tube side and on 11TS2 on the LV-DRAC Module are correct and secured (good contact), connect properly, and tighten each wire if necessary. Check if the error has been corrected. If not, go to the next step.

4. With the Generator turned OFF, measure the Stator Tube Winding impedances on 11TS2 on the LV-DRAC Module.

Note ☞ *The Contactor 11KT1 on the LV-DRAC Module have to be not energized (contactor indicator is visible) when measuring the Stator impedances of Tube-1 and have to be energized (by manually pressing the contactor indicator) when measuring the Stator impedances of Tube-2.*



Contactor 11KT1 measuring Stator impedances of Tube-1



Contactor 11KT1 measuring Stator impedances of Tube-2

- For Tube-1 measure:
  - between Main (11TS2-1) and Common (11TS2-3).
  - between Auxiliary (11TS2-2) and Common (11TS2-3).
  - between Main (11TS2-1) and Auxiliary (11TS2-2), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
- For Tube-2 measure:
  - between Main (11TS2-9) and Common (11TS2-11).
  - between Auxiliary (11TS2-10) and Common (11TS2-11).
  - between Main (11TS2-9) and Auxiliary (11TS2-10), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.

Note ☞ *Impedance must be as stated in the X-ray Tube Stator specifications. (Refer to the Manufacturer X-ray Tube Data Sheet.)*

- If the impedance is OK, go to the next step.
- If the impedance is not correct:
  - Measure the Stator Tube Winding impedances on the Tube side:
    - Between Main and Common.
    - Between Auxiliary and Common.
    - Between Main and Auxiliary, it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
    - If the impedance is correct on the Tube, replace the Stator Cable.
    - If the impedance is not correct on the Tube, replace the X-ray Tube.

5. Check for correct isolation between the connections for the Main winding and Auxiliary winding in 11TS2 on the LV-DRAC Module. Measure the impedance between Main and Ground, Auxiliary and Ground, Common and Ground; in all cases it must be high impedance (mega-ohms).
   - If the impedance is OK, go to the next step.
   - If the impedance is not correct, it can be due to:
     - a wrong connection of the Stator Cable on the Tube side or on the Generator side. Check the connection of the Stator Cable and connect it properly if necessary.
     - or the Stator Cable is short-circuited, then disconnect the Stator Cable on the Tube side and measure impedance in the Tube. If the problem persists replace the X-ray Tube.
6. Turn the Generator ON.

To perform each one of the following checks it is necessary:

- Turn the Generator OFF and wait three (3) minutes to discharge the Main Storage Capacitors.

- Remove the wire indicated in each step below.

- Turn the Generator ON. Press PREP and note the error code and reset it.

7. On the Tube side, remove the Auxiliary wire. Check:
   - If an “Excessive Current” code appears, go to the next step.
   - If an “Insufficient Current” code appears, the problem is in the Tube Stator. Replace the X-ray Tube.
8. On the Generator side, remove the Auxiliary wire (11TS2-2 for Tube-1 or 11TS2-10 for Tube-2). Check:
   - If an “Excessive Current” code appears, go to the next step.
   - If an “Insufficient Current” code appears, the problem is in the Stator Cable. Replace the Stator Cable.
9. On the Interface DRAC Board, remove J5-1 and J5-4 wires. Check:
   - If an “Excessive Current” code appears, go to the next step.
   - If an “Insufficient Current” code appears, replace the Interface DRAC Board.
10. Remove the two (2) wires connected to the Clamping Board. Check:
    - If an “Excessive Current” code appears, go to the next step.
    - If an “Insufficient Current” code appears, replace the Clamping Board.
11. Desolder the wire marked as “12” on the Auxiliary Transformer of the LV-DRAC Module. Check:
    - If an “Excessive Current” code appears, go to the next step.
    - If an “Insufficient Current” code appears, there is a bad contact from 11TS2 to Terminal “12” in the Transformer on the Contactor’s Terminals 11KT1, 11K2, and/or 11K3 (*refer to Schematic “543020xx” in the Service Manual*). Identify faulty connections, clean the contacts, tighten each wire connection, and/or replace Contactors if necessary.
12. On the Control DRAC Board, remove wire J1-4 (Auxiliary). Check:
    - If an “Excessive Current” code appears, go to the next step.
    - If an “Insufficient Current” code appears, replace the Main Transformer at the LV-DRAC Module.
13. On the Control DRAC Board, remove wire J1-3 (Shield). Check:
    - If an “Excessive Current” code appears, replace the Control DRAC Board.
    - If an “Insufficient Current” code appears, replace the Main Transformer at the LV-DRAC Module.

Connect all the wires / cables removed during the procedure back to the original connections.

ERROR CODE : E80

DESCRIPTION : LV-DRAC: Insufficient current in the auxiliary winding braking at 10000 RPM

ERROR TYPE : Indicative. Exposure is not allowed.

APPLICABLE TO : All Generators with High Speed Starter.

APPEARS WHEN : During Anode acceleration at High Speed.

INFORMATION / SYMPTOM : Error Code "E80" is displayed and it is not possible to make Exposures.

POSSIBLE CAUSES

Insufficient current in the auxiliary winding braking at 10000 RPM is detected.

Defective: Interface DRAC Board, or Control DRAC Board, or Tube Stator, or Stator Cable, or Clamping Board, or Transformers, or Contactors in LV-DRAC Module.

ACTIONS

CAUTION

All the wires / cables removed during the procedure have to be isolated to avoid contact with any other wire or ground.

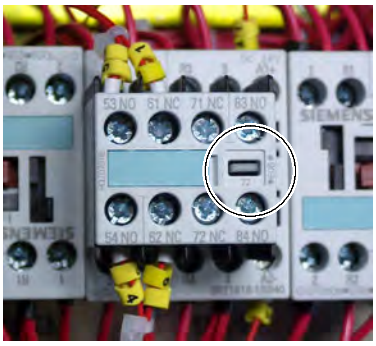
1. Verify the Generator is turned OFF.

2. Check that the DIP switches on the Control DRAC Board are set in the correct position. *(Refer to the LV -DRAC Documentation in this Service Manual, especially check that DIP-switches 3243SW3-5 and 3243SW4-5 are in the correct position according to the Tube Family Selection.)*

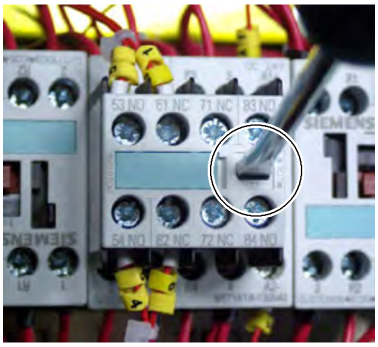
3. Check each wire connection of the Stator Cable on the Tube side and on 11TS2 on the LV-DRAC Module are correct and secured (good contact), connect properly, and tighten each wire if necessary. Check if the error has been corrected. If not, go to the next step.

4. With the Generator turned OFF, measure the Stator Tube Winding impedances on 11TS2 on the LV-DRAC Module.

Note ☞ *The Contactor 11KT1 on the LV-DRAC Module have to be not energized (contactor indicator is visible) when measuring the Stator impedances of Tube-1 and have to be energized (by manually pressing the contactor indicator) when measuring the Stator impedances of Tube-2.*



Contactor 11KT1 measuring Stator impedances of Tube-1



Contactor 11KT1 measuring Stator impedances of Tube-2

- For Tube-1 measure:
  - between Main (11TS2-1) and Common (11TS2-3).
  - between Auxiliary (11TS2-2) and Common (11TS2-3).
  - between Main (11TS2-1) and Auxiliary (11TS2-2), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
- For Tube-2 measure:
  - between Main (11TS2-9) and Common (11TS2-11).
  - between Auxiliary (11TS2-10) and Common (11TS2-11).
  - between Main (11TS2-9) and Auxiliary (11TS2-10), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.

Note ☞ *Impedance must be as stated in the X-ray Tube Stator specifications. (Refer to the Manufacturer X-ray Tube Data Sheet.)*

- If the impedance is OK, go to the next step.
- If the impedance is not correct:
  - Measure the Stator Tube Winding impedances on the Tube side:
    - Between Main and Common.
    - Between Auxiliary and Common.
    - Between Main and Auxiliary, it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
    - If the impedance is correct on the Tube, replace the Stator Cable.
    - If the impedance is not correct on the Tube, replace the X-ray Tube.

5. Check that there is a low resistance (ohms) on the primary and secondary side of either the Main or Auxiliary Transformer (depending if the error is in the Main or Auxiliary winding):

   - For Primary measure between terminals 1-7 of the Transformer.
   - For Secondary measure between terminals 8-10 and 10-12 of the Transformer.

   ▪ If the low resistance is OK, go to the next step.

   ▪ If the low resistance is not correct, replace the Transformer.

6. On the Control DRAC Board, check that there is a continuity between the following points:

   - For Main measure between J1-1 and J1-3.
   - For Auxiliary measure between J1-3 and J1-4.

   ▪ If the continuity is OK, go to the next step.

   ▪ If the continuity is not correct, check cable connections in J1 of the Control DRAC Board and in Primary side of the Transformers.

7. With the Generator turned OFF, check that Contactors 11KT1, 11K2, and 11K3 are not energized (OFF) on the LV-DRAC Module.

   ▪ If it is OK, go to the next step.

   ▪ If any Contactor is energized (ON), replace the Contactor.

8. Turn the Generator ON, check on the LV-DRAC Module that ten (10) seconds after power-up Contactors 11K2 and 11K3 are not energized (OFF) and Contactor 11KT1 is energized (ON) when Tube-1 is selected (Contactor 11KT1 is not energized (OFF) when Tube-2 is selected).

   ▪ If it is OK, go to the next step.

   ▪ If Contactor 11K2 or 11K3 is energized (ON), replace the Control DRAC Board.

   ▪ If Contactor 11KT1 is not energized (OFF) (when Tube-1 is selected), turn the Generator OFF and wait three (3) minutes for the Main Storage Capacitors to discharge. Check that Diode CR14 is OK on the Interface DRAC Board.

     - Diode CR14 is OK, replace the Control DRAC Board.
     - Diode CR14 is not OK, replace the Interface DRAC Board.

9. Turn the Generator ON.

DANGER !

TO AVOID ELECTRIC SHOCK, DO NOT TOUCH ANY HEATSINK OR ANY COMPONENT IN THE LV-DRAC MODULE.

10. Check that there is a continuity between the following points:

    - For Main measure between terminal 12 of the Main Transformer and 11TS2-1 (for Tube-1) or 11TS2-9 (for Tube-2).
    - For Auxiliary measure between terminal 12 of the Auxiliary Transformer and 11TS2-2 (for Tube-1) or 11TS2-10 (for Tube-2).
    - For Common measure between terminal 8 of each Transformer (Main and Auxiliary) and then between terminal 8 of the Main Transformer and 11TS2-3 (for Tube-1) or 11TS2-11 (for Tube-2).

    ▪ If the continuity is OK, go to the next step.

    ▪ If the continuity is not correct, there is a bad contact on the Transformer Terminals or on the Contactor's Terminals 11KT1, 11K2, and/or 11K3 (*refer to Schematic "543020xx" in the Service Manual*). Identify faulty connections, clean the contacts, and/or tighten each wire connection.

11. Check the proper operation of the Control DRAC Board. For that:

   - Set DIP switch 3243SW4-7 in the “ON” position to inhibit errors.

   - Select: 40 kVp, 10 mA and 10 ms (low speed) and Direct Workstation. Check the X-ray Tube is starting properly by performing an Anode Rotation Test (*refer to “Configuration” chapter in the Service Manual*).

     – If the Tube does not start, replace the Control DRAC Board.

     – If the Tube starts, the Control DRAC Board has to be replaced but the unit can work (for a short period of days) whenever DIP switch 3243SW4-7 is in the “ON” position to inhibit errors.

     – In both cases, set DIP switch 3243SW4-7 in the “OFF” position after replacing the Control DRAC Board.

CAUTION

Connect all the wires / cables removed during the procedure back to the original connections.

ERROR CODE : E81

DESCRIPTION : LV-DRAC: Insufficient current in the main winding braking at 10000 RPM

ERROR TYPE : Indicative. Exposure is not allowed.

APPLICABLE TO : All Generators with High Speed Starter.

APPEARS WHEN : During Anode acceleration at High Speed.

INFORMATION / SYMPTOM : Error Code “E81” is displayed and it is not possible to make Exposures.

POSSIBLE CAUSES

Insufficient current in the main winding braking at 10000 RPM is detected.

Defective: Interface DRAC Board, or Control DRAC Board, or Tube Stator, or Stator Cable, or Clamping Board, or Transformers, or Contactors in LV-DRAC Module.

ACTIONS

All the wires / cables removed during the procedure have to be isolated to avoid contact with any other wire or ground.

1. Verify the Generator is turned OFF.

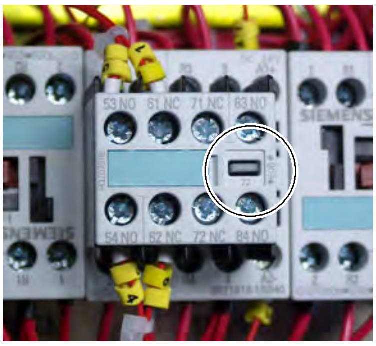
2. Check that the DIP switches on the Control DRAC Board are set in the correct position. *(Refer to the LV -DRAC Documentation in this Service Manual, especially check that DIP-switches 3243SW3-5 and 3243SW4-5 are in the correct position according to the Tube Family Selection.)*

3. Check each wire connection of the Stator Cable on the Tube side and on 11TS2 on the LV-DRAC Module are correct and secured (good contact), connect properly, and tighten each wire if necessary. Check if the error has been corrected. If not, go to the next step.

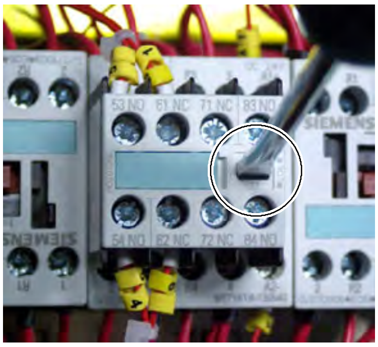
4. With the Generator turned OFF, measure the Stator Tube Winding impedances on 11TS2 on the LV-DRAC Module.

Note ☞

The Contactor 11KT1 on the LV-DRAC Module have to be not energized (contactor indicator is visible) when measuring the Stator impedances of Tube-1 and have to be energized (by manually pressing the contactor indicator) when measuring the Stator impedances of Tube-2.



Contactor 11KT1 measuring Stator impedances of Tube-1



Contactor 11KT1 measuring Stator impedances of Tube-2

- For Tube-1 measure:
  - between Main (11TS2-1) and Common (11TS2-3).
  - between Auxiliary (11TS2-2) and Common (11TS2-3).
  - between Main (11TS2-1) and Auxiliary (11TS2-2), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
- For Tube-2 measure:
  - between Main (11TS2-9) and Common (11TS2-11).
  - between Auxiliary (11TS2-10) and Common (11TS2-11).
  - between Main (11TS2-9) and Auxiliary (11TS2-10), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.

Note ☞

Impedance must be as stated in the X-ray Tube Stator specifications. (Refer to the Manufacturer X-ray Tube Data Sheet.)

- If the impedance is OK, go to the next step.
- If the impedance is not correct:
  - Measure the Stator Tube Winding impedances on the Tube side:
    - Between Main and Common.
    - Between Auxiliary and Common.
    - Between Main and Auxiliary, it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
    - If the impedance is correct on the Tube, replace the Stator Cable.
    - If the impedance is not correct on the Tube, replace the X-ray Tube.

5. Check that there is a low resistance (ohms) on the primary and secondary side of either the Main or Auxiliary Transformer (depending if the error is in the Main or Auxiliary winding):
   - For Primary measure between terminals 1-7 of the Transformer.
   - For Secondary measure between terminals 8-10 and 10-12 of the Transformer.
   ▪ If the low resistance is OK, go to the next step.
   ▪ If the low resistance is not correct, replace the Transformer.

6. On the Control DRAC Board, check that there is a continuity between the following points:
   - For Main measure between J1-1 and J1-3.
   - For Auxiliary measure between J1-3 and J1-4.
   ▪ If the continuity is OK, go to the next step.
   ▪ If the continuity is not correct, check cable connections in J1 of the Control DRAC Board and in Primary side of the Transformers.

7. With the Generator turned OFF, check that Contactors 11KT1, 11K2, and 11K3 are not energized (OFF) on the LV-DRAC Module.
   ▪ If it is OK, go to the next step.
   ▪ If any Contactor is energized (ON), replace the Contactor.

8. Turn the Generator ON, check on the LV-DRAC Module that ten (10) seconds after power-up Contactors 11K2 and 11K3 are not energized (OFF) and Contactor 11KT1 is energized (ON) when Tube-1 is selected (Contactor 11KT1 is not energized (OFF) when Tube-2 is selected).
   ▪ If it is OK, go to the next step.
   ▪ If Contactor 11K2 or 11K3 is energized (ON), replace the Control DRAC Board.
   ▪ If Contactor 11KT1 is not energized (OFF) (when Tube-1 is selected), turn the Generator OFF and wait three (3) minutes for the Main Storage Capacitors to discharge. Check that Diode CR14 is OK on the Interface DRAC Board.
     - Diode CR14 is OK, replace the Control DRAC Board.
     - Diode CR14 is not OK, replace the Interface DRAC Board.

9. Turn the Generator ON.

DANGER !

TO AVOID ELECTRIC SHOCK, DO NOT TOUCH ANY HEATSINK OR ANY COMPONENT IN THE LV-DRAC MODULE.

10. Check that there is a continuity between the following points:
    - For Main measure between terminal 12 of the Main Transformer and 11TS2-1 (for Tube-1) or 11TS2-9 (for Tube-2).
    - For Auxiliary measure between terminal 12 of the Auxiliary Transformer and 11TS2-2 (for Tube-1) or 11TS2-10 (for Tube-2).
    - For Common measure between terminal 8 of each Transformer (Main and Auxiliary) and then between terminal 8 of the Main Transformer and 11TS2-3 (for Tube-1) or 11TS2-11 (for Tube-2).
    ▪ If the continuity is OK, go to the next step.
    ▪ If the continuity is not correct, there is a bad contact on the Transformer Terminals or on the Contactor's Terminals 11KT1, 11K2, and/or 11K3 (*refer to Schematic "543020xx" in the Service Manual*). Identify faulty connections, clean the contacts, and/or tighten each wire connection.

11. Check the proper operation of the Control DRAC Board. For that:
    - Set DIP switch 3243SW4-7 in the “ON” position to inhibit errors.
    - Select: 40 kVp, 10 mA and 10 ms (low speed) and Direct Workstation. Check the X-ray Tube is starting properly by performing an Anode Rotation Test (*refer to “Configuration” chapter in the Service Manual*).
        - If the Tube does not start, replace the Control DRAC Board.
        - If the Tube starts, the Control DRAC Board has to be replaced but the unit can work (for a short period of days) whenever DIP switch 3243SW4-7 is in the “ON” position to inhibit errors.
        - In both cases, set DIP switch 3243SW4-7 in the “OFF” position after replacing the Control DRAC Board.

Connect all the wires / cables removed during the procedure back to the original connections.

ERROR CODE : E82

DESCRIPTION :	LV-DRAC: Wrong X-ray Tube selection.
ERROR TYPE :	Indicative. Does not allow exposures.
APPLICABLE TO :	All Generators with High Speed Starter (LV-Drac).
APPEARS WHEN :	During POWER OFF or in stand by.
INFORMATION / SYMPTOM :	E82 appears on display

POSSIBLE CAUSES

Incorrect turning off routine.

Incorrect signals of tube selection in the LV-DRAC.

Defective Delayed Switch Off PCB.

Defective Control DRAC PCB.

ACTIONS

1. With the Generator off, disconnect J12 from A3274 Delayed Switch Off PCB and jumper the aerial connector J1-1 & 8. Turn the Generator ON, if the error persists, replace A3243 Control DRAC PCB.
2. If the error dissapears, verify that the generator performs the turning off routines in a correct way. if ok, replace the Delayed Switch OFF PCB A3274-XX.
3. If the Generator turning off routines are not correct, verify the connections between 6J2 in the Generator Cabinet and J1-8 in the Delayed Switch OFF PCB as well verify connection between J1-8 in the Interface Control PCB and J1-1 in the Delayed Switch OFF PCB.
4. If the connections are not ok, repair accordingly, if the connections are ok, verify the components related to the Turning OFF function of the Generator according to the system configuration.

ERROR CODE : E83

DESCRIPTION : LV-DRAC: Excessive current in DC Brake.

ERROR TYPE : Indicative. Exposure is not allowed.

APPLICABLE TO : All Generators with High Speed Starter.

APPEARS WHEN : During Anode braking in DC voltage.

INFORMATION / SYMPTOM : Error Code “E83” is displayed and it is not possible to make Exposures.

POSSIBLE CAUSES

Excessive current in the main or auxiliary winding is detected.

ACTIONS

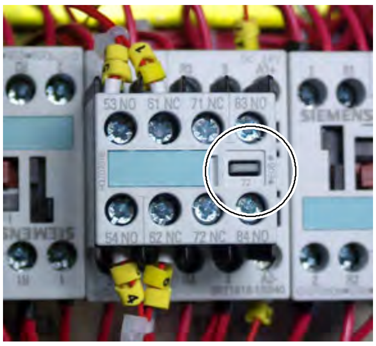
CAUTION

All the wires / cables removed during the procedure have to be isolated to avoid contact with any other wire or ground.

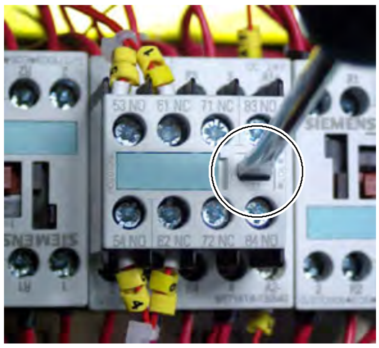
1. Verify the Generator is turned OFF.
2. Check that the DIP switches on the Control DRAC Board are set in the correct position. *(Refer to the LV -DRAC Documentation in this Service Manual, especially check that DIP-switches 3243SW3-5 and 3243SW4-5 are in the correct position according to the Tube Family Selection.)*
3. Check each wire connection of the Stator Cable on the Tube side and on 11TS2 on the LV-DRAC Module are correct and secured (good contact), connect properly, and tighten each wire if necessary. Check if the error has been corrected. If not, go to the next step.
4. With the Generator turned OFF, measure the Stator Tube Winding impedances on 11TS2 on the LV-DRAC Module.

Note

The Contactor 11KT1 on the LV-DRAC Module have to be not energized (contactor indicator is visible) when measuring the Stator impedances of Tube-1 and have to be energized (by manually pressing the contactor indicator) when measuring the Stator impedances of Tube-2.



Contactor 11KT1 measuring Stator impedances of Tube-1



Contactor 11KT1 measuring Stator impedances of Tube-2

- For Tube-1 measure:
  - between Main (11TS2-1) and Common (11TS2-3).
  - between Auxiliary (11TS2-2) and Common (11TS2-3).
  - between Main (11TS2-1) and Auxiliary (11TS2-2), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
- For Tube-2 measure:
  - between Main (11TS2-9) and Common (11TS2-11).
  - between Auxiliary (11TS2-10) and Common (11TS2-11).
  - between Main (11TS2-9) and Auxiliary (11TS2-10), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.

Note ☞ *Impedance must be as stated in the X-ray Tube Stator specifications. (Refer to the Manufacturer X-ray Tube Data Sheet.)*

- If the impedance is OK, go to the next step.
- If the impedance is not correct:
  - Measure the Stator Tube Winding impedances on the Tube side:
    - Between Main and Common.
    - Between Auxiliary and Common.
    - Between Main and Auxiliary, it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
    - If the impedance is correct on the Tube, replace the Stator Cable.
    - If the impedance is not correct on the Tube, replace the X-ray Tube.

5. Check for correct isolation between the connections for the Main winding and Auxiliary winding in 11TS2 on the LV-DRAC Module. Measure the impedance between Main and Ground, Auxiliary and Ground, Common and Ground; in all cases it must be high impedance (mega-ohms).
   - If the impedance is OK, go to the next step.
   - If the impedance is not correct, it can be due to:
     - a wrong connection of the Stator Cable on the Tube side or on the Generator side. Check the connection of the Stator Cable and connect it properly if necessary.
     - or the Stator Cable is short-circuited, then disconnect the Stator Cable on the Tube side and measure impedance in the Tube. If the problem persists replace the X-ray Tube.
6. Turn the Generator ON.

CAUTION

To perform each one of the following checks it is necessary:

- ***Turn the Generator OFF and wait three (3) minutes to discharge the Main Storage Capacitors.***
- ***Remove the wire indicated in each step below.***
- ***Turn the Generator ON. Press PREP and note the error code and reset it.***

7. On the Tube side, remove the Auxiliary wire. Check:
   - If an “Excessive Current” code appears, go to the next step.
   - If an “Insufficient Current” code appears, the problem is in the Tube Stator. Replace the X-ray Tube.

8. On the Generator side, remove the Auxiliary wire (11TS2-2 for Tube-1 or 11TS2-10 for Tube-2). Check:
   - If an “Excessive Current” code appears, go to the next step.
   - If an “Insufficient Current” code appears, the problem is in the Stator Cable. Replace the Stator Cable.

9. On the Interface DRAC Board, remove J5-1 and J5-4 wires. Check:
   - If an “Excessive Current” code appears, go to the next step.
   - If an “Insufficient Current” code appears, replace the Interface DRAC Board.

10. Remove the two (2) wires connected to the Clamping Board. Check:
    - If an “Excessive Current” code appears, go to the next step.
    - If an “Insufficient Current” code appears, replace the Clamping Board.

11. Desolder the wire marked as “12” on the Auxiliary Transformer of the LV-DRAC Module. Check:
    - If an “Excessive Current” code appears, go to the next step.
    - If an “Insufficient Current” code appears, there is a bad contact from 11TS2 to Terminal “12” in the Transformer on the Contactor’s Terminals 11KT1, 11K2, and/or 11K3 (*refer to Schematic “543020xx” in the Service Manual*). Identify faulty connections, clean the contacts, tighten each wire connection, and/or replace Contactors if necessary.

12. On the Control DRAC Board, remove wire J1-1 (Main) and J1-4 (Auxiliary). Check:
    - If an “Excessive Current” code appears, go to the next step.
    - If an “Insufficient Current” code appears, replace the Main Transformer at the LV-DRAC Module.

13. On the Control DRAC Board, remove wire J1-3 (Shield). Check:
    - If an “Excessive Current” code appears, replace the Control DRAC Board.
    - If an “Insufficient Current” code appears, replace the Main Transformer at the LV-DRAC Module.

CAUTION

Connect all the wires / cables removed during the procedure back to the original connections.

ERROR CODE : E87

DESCRIPTION : LV-DRAC: Insufficient current in common wire during acceleration up to 3300 RPM

ERROR TYPE : Indicative. Exposure is not allowed.

APPLICABLE TO : All Generators with High Speed Starter.

APPEARS WHEN : During Anode acceleration at Low Speed.

INFORMATION / SYMPTOM : Error Code “E87” is displayed and it is not possible to make Exposures.

POSSIBLE CAUSES

Insufficient current in the common wire up to 3300 RPM is detected.

ACTIONS

CAUTION

All the wires / cables removed during the procedure have to be isolated to avoid contact with any other wire or ground.

1. Verify the Generator is turned OFF.

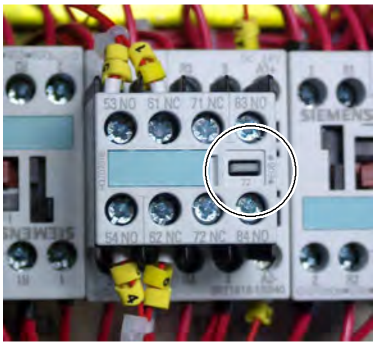
2. Check that the DIP switches on the Control DRAC Board are set in the correct position. *(Refer to the LV -DRAC Documentation in this Service Manual, especially check that DIP-switches 3243SW3-5 and 3243SW4-5 are in the correct position according to the Tube Family Selection.)*

3. Check each wire connection of the Stator Cable on the Tube side and on 11TS2 on the LV-DRAC Module are correct and secured (good contact), connect properly, and tighten each wire if necessary. Check if the error has been corrected. If not, go to the next step.

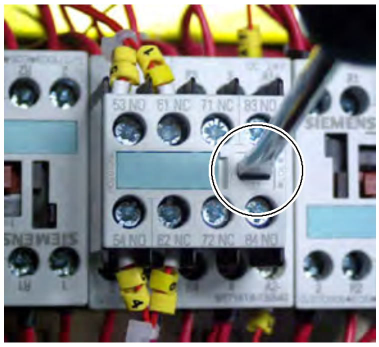
4. With the Generator turned OFF, measure the Stator Tube Winding impedances on 11TS2 on the LV-DRAC Module.

Note ☞

The Contactor 11KT1 on the LV-DRAC Module have to be not energized (contactor indicator is visible) when measuring the Stator impedances of Tube-1 and have to be energized (by manually pressing the contactor indicator) when measuring the Stator impedances of Tube-2.



Contactor 11KT1 measuring Stator impedances of Tube-1



Contactor 11KT1 measuring Stator impedances of Tube-2

- For Tube-1 measure:
  - between Main (11TS2-1) and Common (11TS2-3).
  - between Auxiliary (11TS2-2) and Common (11TS2-3).
  - between Main (11TS2-1) and Auxiliary (11TS2-2), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
- For Tube-2 measure:
  - between Main (11TS2-9) and Common (11TS2-11).
  - between Auxiliary (11TS2-10) and Common (11TS2-11).
  - between Main (11TS2-9) and Auxiliary (11TS2-10), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.

Note ☞

Impedance must be as stated in the X-ray Tube Stator specifications. (Refer to the Manufacturer X-ray Tube Data Sheet.)

- If the impedance is OK, go to the next step.
- If the impedance is not correct:
  - Measure the Stator Tube Winding impedances on the Tube side:
    - Between Main and Common.
    - Between Auxiliary and Common.
    - Between Main and Auxiliary, it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
    - If the impedance is correct on the Tube, replace the Stator Cable.
    - If the impedance is not correct on the Tube, replace the X-ray Tube.

5. Check that there is a low resistance (ohms) on the primary and secondary side of either the Main or Auxiliary Transformer (depending if the error is in the Main or Auxiliary winding):
   - For Primary measure between terminals 1-7 of the Transformer.
   - For Secondary measure between terminals 8-10 and 10-12 of the Transformer.
   - ▪ If the low resistance is OK, go to the next step.
   - ▪ If the low resistance is not correct, replace the Transformer.

6. On the Control DRAC Board, check that there is a continuity between the following points:
   - For Main measure between J1-1 and J1-3.
   - For Auxiliary measure between J1-3 and J1-4.
   - ▪ If the continuity is OK, go to the next step.
   - ▪ If the continuity is not correct, check cable connections in J1 of the Control DRAC Board and in Primary side of the Transformers.

7. With the Generator turned OFF, check that Contactors 11KT1, 11K2, and 11K3 are not energized (OFF) on the LV-DRAC Module.
   - ▪ If it is OK, go to the next step.
   - ▪ If any Contactor is energized (ON), replace the Contactor.

8. Turn the Generator ON, check on the LV-DRAC Module that ten (10) seconds after power-up Contactors 11K2 and 11K3 are not energized (OFF) and Contactor 11KT1 is energized (ON) when Tube-1 is selected (Contactor 11KT1 is not energized (OFF) when Tube-2 is selected).
   - ▪ If it is OK, go to the next step.
   - ▪ If Contactor 11K2 or 11K3 is energized (ON), replace the Control DRAC Board.
   - ▪ If Contactor 11KT1 is not energized (OFF) (when Tube-1 is selected), turn the Generator OFF and wait three (3) minutes for the Main Storage Capacitors to discharge. Check that Diode CR14 is OK on the Interface DRAC Board.
     - Diode CR14 is OK, replace the Control DRAC Board.
     - Diode CR14 is not OK, replace the Interface DRAC Board.

9. Turn the Generator ON.

DANGER !

TO AVOID ELECTRIC SHOCK, DO NOT TOUCH ANY HEATSINK OR ANY COMPONENT IN THE LV-DRAC MODULE.

10. Check that there is a continuity between the following points:
    - For Main measure between terminal 12 of the Main Transformer and 11TS2-1 (for Tube-1) or 11TS2-9 (for Tube-2).
    - For Auxiliary measure between terminal 12 of the Auxiliary Transformer and 11TS2-2 (for Tube-1) or 11TS2-10 (for Tube-2).
    - For Common measure between terminal 8 of each Transformer (Main and Auxiliary) and then between terminal 8 of the Main Transformer and 11TS2-3 (for Tube-1) or 11TS2-11 (for Tube-2).
    - ▪ If the continuity is OK, go to the next step.
    - ▪ If the continuity is not correct, there is a bad contact on the Transformer Terminals or on the Contactor's Terminals 11KT1, 11K2, and/or 11K3 (*refer to Schematic "543020xx" in the Service Manual*). Identify faulty connections, clean the contacts, and/or tighten each wire connection.

11. Check the proper operation of the Control DRAC Board. For that:
    - Set DIP switch 3243SW4-7 in the “ON” position to inhibit errors.
    - Select: 40 kVp, 10 mA and 10 ms (low speed) and Direct Workstation. Check the X-ray Tube is starting properly by performing an Anode Rotation Test (*refer to “Configuration” chapter in the Service Manual*).
        - If the Tube does not start, replace the Control DRAC Board.
        - If the Tube starts, the Control DRAC Board has to be replaced but the unit can work (for a short period of days) whenever DIP switch 3243SW4-7 is in the “ON” position to inhibit errors.
        - In both cases, set DIP switch 3243SW4-7 in the “OFF” position after replacing the Control DRAC Board.

CAUTION

Connect all the wires / cables removed during the procedure back to the original connections.

ERROR CODE : E88

DESCRIPTION : LV-DRAC: Insufficient current in common wire running at 3300 RPM.

ERROR TYPE : Indicative. Exposure is not allowed.

APPLICABLE TO : All Generators with High Speed Starter.

APPEARS WHEN : During Anode acceleration at Low Speed.

INFORMATION / SYMPTOM : Error Code “E88” is displayed and it is not possible to make Exposures.

POSSIBLE CAUSES

Insufficient current in the common wire running at 3300 RPM is detected.

ACTIONS

All the wires / cables removed during the procedure have to be isolated to avoid contact with any other wire or ground.

1. Verify the Generator is turned OFF.

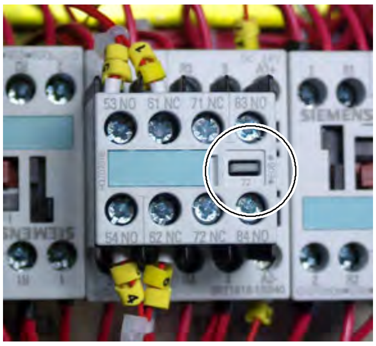
2. Check that the DIP switches on the Control DRAC Board are set in the correct position. *(Refer to the LV -DRAC Documentation in this Service Manual, especially check that DIP-switches 3243SW3-5 and 3243SW4-5 are in the correct position according to the Tube Family Selection.)*

3. Check each wire connection of the Stator Cable on the Tube side and on 11TS2 on the LV-DRAC Module are correct and secured (good contact), connect properly, and tighten each wire if necessary. Check if the error has been corrected. If not, go to the next step.

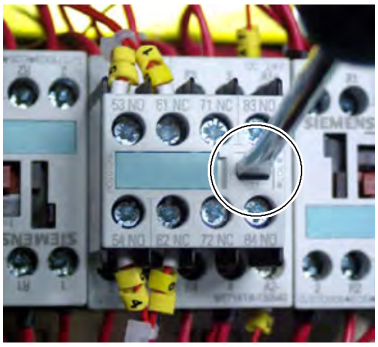
4. With the Generator turned OFF, measure the Stator Tube Winding impedances on 11TS2 on the LV-DRAC Module.

Note ☞

The Contactor 11KT1 on the LV-DRAC Module have to be not energized (contactor indicator is visible) when measuring the Stator impedances of Tube-1 and have to be energized (by manually pressing the contactor indicator) when measuring the Stator impedances of Tube-2.



Contactor 11KT1 measuring Stator impedances of Tube-1



Contactor 11KT1 measuring Stator impedances of Tube-2

- For Tube-1 measure:
  - between Main (11TS2-1) and Common (11TS2-3).
  - between Auxiliary (11TS2-2) and Common (11TS2-3).
  - between Main (11TS2-1) and Auxiliary (11TS2-2), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
- For Tube-2 measure:
  - between Main (11TS2-9) and Common (11TS2-11).
  - between Auxiliary (11TS2-10) and Common (11TS2-11).
  - between Main (11TS2-9) and Auxiliary (11TS2-10), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.

Note ☞

Impedance must be as stated in the X-ray Tube Stator specifications. (Refer to the Manufacturer X-ray Tube Data Sheet.)

- If the impedance is OK, go to the next step.
- If the impedance is not correct:
  - Measure the Stator Tube Winding impedances on the Tube side:
    - Between Main and Common.
    - Between Auxiliary and Common.
    - Between Main and Auxiliary, it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
    - If the impedance is correct on the Tube, replace the Stator Cable.
    - If the impedance is not correct on the Tube, replace the X-ray Tube.

5. Check that there is a low resistance (ohms) on the primary and secondary side of either the Main or Auxiliary Transformer (depending if the error is in the Main or Auxiliary winding):
   - For Primary measure between terminals 1-7 of the Transformer.
   - For Secondary measure between terminals 8-10 and 10-12 of the Transformer.
   - ▪ If the low resistance is OK, go to the next step.
   - ▪ If the low resistance is not correct, replace the Transformer.

6. On the Control DRAC Board, check that there is a continuity between the following points:
   - For Main measure between J1-1 and J1-3.
   - For Auxiliary measure between J1-3 and J1-4.
   - ▪ If the continuity is OK, go to the next step.
   - ▪ If the continuity is not correct, check cable connections in J1 of the Control DRAC Board and in Primary side of the Transformers.

7. With the Generator turned OFF, check that Contactors 11KT1, 11K2, and 11K3 are not energized (OFF) on the LV-DRAC Module.
   - ▪ If it is OK, go to the next step.
   - ▪ If any Contactor is energized (ON), replace the Contactor.

8. Turn the Generator ON, check on the LV-DRAC Module that ten (10) seconds after power-up Contactors 11K2 and 11K3 are not energized (OFF) and Contactor 11KT1 is energized (ON) when Tube-1 is selected (Contactor 11KT1 is not energized (OFF) when Tube-2 is selected).
   - ▪ If it is OK, go to the next step.
   - ▪ If Contactor 11K2 or 11K3 is energized (ON), replace the Control DRAC Board.
   - ▪ If Contactor 11KT1 is not energized (OFF) (when Tube-1 is selected), turn the Generator OFF and wait three (3) minutes for the Main Storage Capacitors to discharge. Check that Diode CR14 is OK on the Interface DRAC Board.
     - Diode CR14 is OK, replace the Control DRAC Board.
     - Diode CR14 is not OK, replace the Interface DRAC Board.

9. Turn the Generator ON.

DANGER !

TO AVOID ELECTRIC SHOCK, DO NOT TOUCH ANY HEATSINK OR ANY COMPONENT IN THE LV-DRAC MODULE.

10. Check that there is a continuity between the following points:
    - For Main measure between terminal 12 of the Main Transformer and 11TS2-1 (for Tube-1) or 11TS2-9 (for Tube-2).
    - For Auxiliary measure between terminal 12 of the Auxiliary Transformer and 11TS2-2 (for Tube-1) or 11TS2-10 (for Tube-2).
    - For Common measure between terminal 8 of each Transformer (Main and Auxiliary) and then between terminal 8 of the Main Transformer and 11TS2-3 (for Tube-1) or 11TS2-11 (for Tube-2).
    - ▪ If the continuity is OK, go to the next step.
    - ▪ If the continuity is not correct, there is a bad contact on the Transformer Terminals or on the Contactor's Terminals 11KT1, 11K2, and/or 11K3 (*refer to Schematic "543020xx" in the Service Manual*). Identify faulty connections, clean the contacts, and/or tighten each wire connection.

11. Check the proper operation of the Control DRAC Board. For that:
    - Set DIP switch 3243SW4-7 in the “ON” position to inhibit errors.
    - Select: 40 kVp, 10 mA and 10 ms (low speed) and Direct Workstation. Check the X-ray Tube is starting properly by performing an Anode Rotation Test (*refer to “Configuration” chapter in the Service Manual*).
        - If the Tube does not start, replace the Control DRAC Board.
        - If the Tube starts, the Control DRAC Board has to be replaced but the unit can work (for a short period of days) whenever DIP switch 3243SW4-7 is in the “ON” position to inhibit errors.
        - In both cases, set DIP switch 3243SW4-7 in the “OFF” position after replacing the Control DRAC Board.

CAUTION

Connect all the wires / cables removed during the procedure back to the original connections.

ERROR CODE : E89

DESCRIPTION : LV-DRAC: Insufficient current in common wire during acceleration up to 10000 RPM.

ERROR TYPE : Indicative. Exposure is not allowed.

APPLICABLE TO : All Generators with High Speed Starter.

APPEARS WHEN : During Anode acceleration at High Speed.

INFORMATION / SYMPTOM : Error Code “E89” is displayed and it is not possible to make Exposures.

POSSIBLE CAUSES

Insufficient current in the common wire during acceleration up to 10000 RPM is detected.

ACTIONS

All the wires / cables removed during the procedure have to be isolated to avoid contact with any other wire or ground.

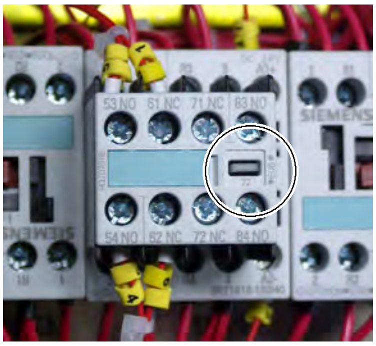
1. Verify the Generator is turned OFF.

2. Check that the DIP switches on the Control DRAC Board are set in the correct position. *(Refer to the LV -DRAC Documentation in this Service Manual, especially check that DIP-switches 3243SW3-5 and 3243SW4-5 are in the correct position according to the Tube Family Selection.)*

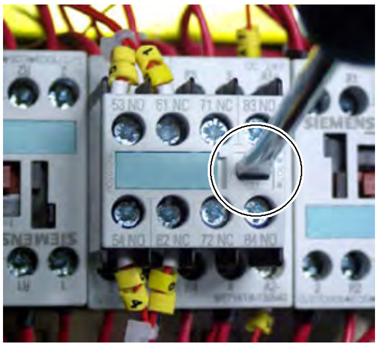
3. Check each wire connection of the Stator Cable on the Tube side and on 11TS2 on the LV-DRAC Module are correct and secured (good contact), connect properly, and tighten each wire if necessary. Check if the error has been corrected. If not, go to the next step.

4. With the Generator turned OFF, measure the Stator Tube Winding impedances on 11TS2 on the LV-DRAC Module.

Note ☞ *The Contactor 11KT1 on the LV-DRAC Module have to be not energized (contactor indicator is visible) when measuring the Stator impedances of Tube-1 and have to be energized (by manually pressing the contactor indicator) when measuring the Stator impedances of Tube-2.*



Contactor 11KT1 measuring Stator impedances of Tube-1



Contactor 11KT1 measuring Stator impedances of Tube-2

- For Tube-1 measure:
  - between Main (11TS2-1) and Common (11TS2-3).
  - between Auxiliary (11TS2-2) and Common (11TS2-3).
  - between Main (11TS2-1) and Auxiliary (11TS2-2), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
- For Tube-2 measure:
  - between Main (11TS2-9) and Common (11TS2-11).
  - between Auxiliary (11TS2-10) and Common (11TS2-11).
  - between Main (11TS2-9) and Auxiliary (11TS2-10), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.

Note ☞ *Impedance must be as stated in the X-ray Tube Stator specifications. (Refer to the Manufacturer X-ray Tube Data Sheet.)*

- If the impedance is OK, go to the next step.
- If the impedance is not correct:
  - Measure the Stator Tube Winding impedances on the Tube side:
    - Between Main and Common.
    - Between Auxiliary and Common.
    - Between Main and Auxiliary, it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
    - If the impedance is correct on the Tube, replace the Stator Cable.
    - If the impedance is not correct on the Tube, replace the X-ray Tube.

5. Check that there is a low resistance (ohms) on the primary and secondary side of either the Main or Auxiliary Transformer (depending if the error is in the Main or Auxiliary winding):
   - For Primary measure between terminals 1-7 of the Transformer.
   - For Secondary measure between terminals 8-10 and 10-12 of the Transformer.
   ▪ If the low resistance is OK, go to the next step.
   ▪ If the low resistance is not correct, replace the Transformer.

6. On the Control DRAC Board, check that there is a continuity between the following points:
   - For Main measure between J1-1 and J1-3.
   - For Auxiliary measure between J1-3 and J1-4.
   ▪ If the continuity is OK, go to the next step.
   ▪ If the continuity is not correct, check cable connections in J1 of the Control DRAC Board and in Primary side of the Transformers.

7. With the Generator turned OFF, check that Contactors 11KT1, 11K2, and 11K3 are not energized (OFF) on the LV-DRAC Module.
   ▪ If it is OK, go to the next step.
   ▪ If any Contactor is energized (ON), replace the Contactor.

8. Turn the Generator ON, check on the LV-DRAC Module that ten (10) seconds after power-up Contactors 11K2 and 11K3 are not energized (OFF) and Contactor 11KT1 is energized (ON) when Tube-1 is selected (Contactor 11KT1 is not energized (OFF) when Tube-2 is selected).
   ▪ If it is OK, go to the next step.
   ▪ If Contactor 11K2 or 11K3 is energized (ON), replace the Control DRAC Board.
   ▪ If Contactor 11KT1 is not energized (OFF) (when Tube-1 is selected), turn the Generator OFF and wait three (3) minutes for the Main Storage Capacitors to discharge. Check that Diode CR14 is OK on the Interface DRAC Board.
     - Diode CR14 is OK, replace the Control DRAC Board.
     - Diode CR14 is not OK, replace the Interface DRAC Board.

9. Turn the Generator ON.

DANGER !

TO AVOID ELECTRIC SHOCK, DO NOT TOUCH ANY HEATSINK OR ANY COMPONENT IN THE LV-DRAC MODULE.

10. Check that there is a continuity between the following points:
    - For Main measure between terminal 12 of the Main Transformer and 11TS2-1 (for Tube-1) or 11TS2-9 (for Tube-2).
    - For Auxiliary measure between terminal 12 of the Auxiliary Transformer and 11TS2-2 (for Tube-1) or 11TS2-10 (for Tube-2).
    - For Common measure between terminal 8 of each Transformer (Main and Auxiliary) and then between terminal 8 of the Main Transformer and 11TS2-3 (for Tube-1) or 11TS2-11 (for Tube-2).
    ▪ If the continuity is OK, go to the next step.
    ▪ If the continuity is not correct, there is a bad contact on the Transformer Terminals or on the Contactor's Terminals 11KT1, 11K2, and/or 11K3 (*refer to Schematic "543020xx" in the Service Manual*). Identify faulty connections, clean the contacts, and/or tighten each wire connection.

11. Check the proper operation of the Control DRAC Board. For that:
    - Set DIP switch 3243SW4-7 in the “ON” position to inhibit errors.
    - Select: 40 kVp, 10 mA and 10 ms (low speed) and Direct Workstation. Check the X-ray Tube is starting properly by performing an Anode Rotation Test (*refer to “Configuration” chapter in the Service Manual*).
      - If the Tube does not start, replace the Control DRAC Board.
      - If the Tube starts, the Control DRAC Board has to be replaced but the unit can work (for a short period of days) whenever DIP switch 3243SW4-7 is in the “ON” position to inhibit errors.
      - In both cases, set DIP switch 3243SW4-7 in the “OFF” position after replacing the Control DRAC Board.

CAUTION

Connect all the wires / cables removed during the procedure back to the original connections.

ERROR CODE : E90

DESCRIPTION : LV-DRAC: Insufficient current in common wire running at 10000 RPM.

ERROR TYPE : Indicative. Exposure is not allowed.

APPLICABLE TO : All Generators with High Speed Starter.

APPEARS WHEN : During Anode acceleration at High Speed.

INFORMATION / SYMPTOM : Error Code “E90” is displayed and it is not possible to make Exposures.

POSSIBLE CAUSES

Insufficient current in common wire running at 10000 RPM is detected.

ACTIONS

All the wires / cables removed during the procedure have to be isolated to avoid contact with any other wire or ground.

1. Verify the Generator is turned OFF.

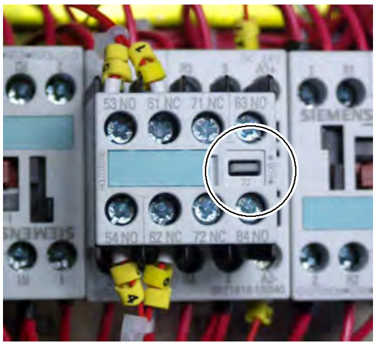
2. Check that the DIP switches on the Control DRAC Board are set in the correct position. *(Refer to the LV -DRAC Documentation in this Service Manual, especially check that DIP-switches 3243SW3-5 and 3243SW4-5 are in the correct position according to the Tube Family Selection.)*

3. Check each wire connection of the Stator Cable on the Tube side and on 11TS2 on the LV-DRAC Module are correct and secured (good contact), connect properly, and tighten each wire if necessary. Check if the error has been corrected. If not, go to the next step.

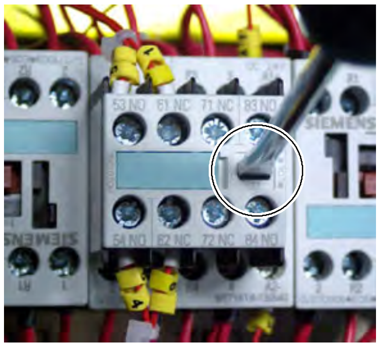
4. With the Generator turned OFF, measure the Stator Tube Winding impedances on 11TS2 on the LV-DRAC Module.

Note ☞

The Contactor 11KT1 on the LV-DRAC Module have to be not energized (contactor indicator is visible) when measuring the Stator impedances of Tube-1 and have to be energized (by manually pressing the contactor indicator) when measuring the Stator impedances of Tube-2.



Contactor 11KT1 measuring Stator impedances of Tube-1



Contactor 11KT1 measuring Stator impedances of Tube-2

- For Tube-1 measure:
  - between Main (11TS2-1) and Common (11TS2-3).
  - between Auxiliary (11TS2-2) and Common (11TS2-3).
  - between Main (11TS2-1) and Auxiliary (11TS2-2), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
- For Tube-2 measure:
  - between Main (11TS2-9) and Common (11TS2-11).
  - between Auxiliary (11TS2-10) and Common (11TS2-11).
  - between Main (11TS2-9) and Auxiliary (11TS2-10), it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.

Note ☞

Impedance must be as stated in the X-ray Tube Stator specifications. (Refer to the Manufacturer X-ray Tube Data Sheet.)

- If the impedance is OK, go to the next step.
- If the impedance is not correct:
  - Measure the Stator Tube Winding impedances on the Tube side:
    - Between Main and Common.
    - Between Auxiliary and Common.
    - Between Main and Auxiliary, it must be the sum of impedance measured between Main and Common plus Auxiliary and Common.
    - If the impedance is correct on the Tube, replace the Stator Cable.
    - If the impedance is not correct on the Tube, replace the X-ray Tube.

5. Check that there is a low resistance (ohms) on the primary and secondary side of either the Main or Auxiliary Transformer (depending if the error is in the Main or Auxiliary winding):
   - For Primary measure between terminals 1-7 of the Transformer.
   - For Secondary measure between terminals 8-10 and 10-12 of the Transformer.
   - ▪ If the low resistance is OK, go to the next step.
   - ▪ If the low resistance is not correct, replace the Transformer.

6. On the Control DRAC Board, check that there is a continuity between the following points:
   - For Main measure between J1-1 and J1-3.
   - For Auxiliary measure between J1-3 and J1-4.
   - ▪ If the continuity is OK, go to the next step.
   - ▪ If the continuity is not correct, check cable connections in J1 of the Control DRAC Board and in Primary side of the Transformers.

7. With the Generator turned OFF, check that Contactors 11KT1, 11K2, and 11K3 are not energized (OFF) on the LV-DRAC Module.
   - ▪ If it is OK, go to the next step.
   - ▪ If any Contactor is energized (ON), replace the Contactor.

8. Turn the Generator ON, check on the LV-DRAC Module that ten (10) seconds after power-up Contactors 11K2 and 11K3 are not energized (OFF) and Contactor 11KT1 is energized (ON) when Tube-1 is selected (Contactor 11KT1 is not energized (OFF) when Tube-2 is selected).
   - ▪ If it is OK, go to the next step.
   - ▪ If Contactor 11K2 or 11K3 is energized (ON), replace the Control DRAC Board.
   - ▪ If Contactor 11KT1 is not energized (OFF) (when Tube-1 is selected), turn the Generator OFF and wait three (3) minutes for the Main Storage Capacitors to discharge. Check that Diode CR14 is OK on the Interface DRAC Board.
     - Diode CR14 is OK, replace the Control DRAC Board.
     - Diode CR14 is not OK, replace the Interface DRAC Board.

9. Turn the Generator ON.

DANGER !

TO AVOID ELECTRIC SHOCK, DO NOT TOUCH ANY HEATSINK OR ANY COMPONENT IN THE LV-DRAC MODULE.

10. Check that there is a continuity between the following points:
    - For Main measure between terminal 12 of the Main Transformer and 11TS2-1 (for Tube-1) or 11TS2-9 (for Tube-2).
    - For Auxiliary measure between terminal 12 of the Auxiliary Transformer and 11TS2-2 (for Tube-1) or 11TS2-10 (for Tube-2).
    - For Common measure between terminal 8 of each Transformer (Main and Auxiliary) and then between terminal 8 of the Main Transformer and 11TS2-3 (for Tube-1) or 11TS2-11 (for Tube-2).
    - ▪ If the continuity is OK, go to the next step.
    - ▪ If the continuity is not correct, there is a bad contact on the Transformer Terminals or on the Contactor's Terminals 11KT1, 11K2, and/or 11K3 (*refer to Schematic "543020xx" in the Service Manual*). Identify faulty connections, clean the contacts, and/or tighten each wire connection.

11. Check the proper operation of the Control DRAC Board. For that:
    - Set DIP switch 3243SW4-7 in the “ON” position to inhibit errors.
    - Select: 40 kVp, 10 mA and 10 ms (low speed) and Direct Workstation. Check the X-ray Tube is starting properly by performing an Anode Rotation Test (*refer to “Configuration” chapter in the Service Manual*).
      - If the Tube does not start, replace the Control DRAC Board.
      - If the Tube starts, the Control DRAC Board has to be replaced but the unit can work (for a short period of days) whenever DIP switch 3243SW4-7 is in the “ON” position to inhibit errors.
      - In both cases, set DIP switch 3243SW4-7 in the “OFF” position after replacing the Control DRAC Board.

CAUTION

Connect all the wires / cables removed during the procedure back to the original connections.

ERROR CODE : E91

DESCRIPTION : LV-DRAC: Incorrect signal measure in IPRINC (CH2).

ERROR TYPE : Indicative. Exposure is not allowed.

APPLICABLE TO : All Generators with High Speed Starter.

APPEARS WHEN : In Stand-by situation.

INFORMATION / SYMPTOM : Error Code “E91” is displayed and it is not possible to make Exposures.

POSSIBLE CAUSES

The Generator is detecting current through the main wire when it should be zero (0).

ACTIONS

1. Turn the Generator ON.

DANGER !

TO AVOID ELECTRIC SHOCK, DO NOT TOUCH ANY HEATSINK OR ANY COMPONENT IN THE LV-DRAC MODULE.

2. Check the voltage at TP1 and TP17 on the Control DRAC Board. Both voltages should be 0 VDC.

Note ☞ *For GND reference use the following Test Points on the Control DRAC Board: TP2, TP4, TP12, TP13, or TP19.*

- If both voltages at TP1 and TP17 are 0 VDC and the Error Code persists, replace the Control DRAC Board.
- If any voltage at TP1 and TP17 is different than 0 VDC, go to the next step.

3. Check the voltage at the following Test Points on the Control DRAC Board:
   - +5 VDC at TP14
   - +15 VDC at TP15
   - −15 VDC at TP37

Note ☞ *For GND reference use the following Test Points on the Control DRAC Board: TP2, TP4, TP12, TP13, or TP19.*

- If voltages at the above Test Points are correct, replace the Control DRAC Board.
- If any voltage at the above Test Points are not correct, go to the next step.

4. Turn the Generator OFF and wait three (3) minutes for the Main Storage Capacitors to discharge.

5. Remove the Ribbon Cable from Connector J3 at the Control DRAC Board.

6. Turn the Generator ON.

7. Check the voltage at the following points on the Interface DRAC Board:
   - +5 VDC at Anode of diode CR6
   - +15 VDC at Anode of diode CR5 or at Cathode of diode CR6
   - −15 VDC at Cathode of diode CR7

Note ☞ *For GND reference use the Terminal J2-3 on the Interface DRAC Board.*

- If voltages at the above points are correct, replace the Control DRAC Board.
- If any voltage at the above points are not correct, replace the Interface DRAC Board.

CAUTION ***Connect all the wires / cables removed during the procedure back to the original connections.***

ERROR CODE : E92

DESCRIPTION : LV-DRAC: Incorrect signal measure in IAUX (CH3).

ERROR TYPE : Indicative. Exposure is not allowed.

APPLICABLE TO : All Generators with High Speed Starter.

APPEARS WHEN : In Stand-by situation.

INFORMATION / SYMPTOM : Error Code “E92” is displayed and it is not possible to make Exposures.

POSSIBLE CAUSES

The Generator is detecting current through the auxiliary wire when it should be zero (0).

ACTIONS

1. Turn the Generator ON.

DANGER !

TO AVOID ELECTRIC SHOCK, DO NOT TOUCH ANY HEATSINK OR ANY COMPONENT IN THE LV-DRAC MODULE.

2. Check the voltage at TP3 and TP16 on the Control DRAC Board. Both voltages should be 0 VDC.

Note ☞ *For GND reference use the following Test Points on the Control DRAC Board: TP2, TP4, TP12, TP13, or TP19.*

- If both voltages at TP3 and TP16 are 0 VDC and the Error Code persists, replace the Control DRAC Board.
- If any voltage at TP3 and TP16 is different than 0 VDC, go to the next step.

3. Check the voltage at the following Test Points on the Control DRAC Board:
   - +5 VDC at TP14
   - +15 VDC at TP15
   - −15 VDC at TP37

Note ☞ *For GND reference use the following Test Points on the Control DRAC Board: TP2, TP4, TP12, TP13, or TP19.*

- If voltages at the above Test Points are correct, replace the Control DRAC Board.
- If any voltage at the above Test Points are not correct, go to the next step.

4. Turn the Generator OFF and wait three (3) minutes for the Main Storage Capacitors to discharge.

5. Remove the Ribbon Cable from Connector J3 at the Control DRAC Board.

6. Turn the Generator ON.

7. Check the voltage at the following points on the Interface DRAC Board:
   - +5 VDC at Anode of diode CR6
   - +15 VDC at Anode of diode CR5 or at Cathode of diode CR6
   - -15 VDC at Cathode of diode CR7

Note ☞ *For GND reference use the Terminal J2-3 on the Interface DRAC Board.*

- If voltages at the above points are correct, replace the Control DRAC Board.
- If any voltage at the above points are not correct, replace the Interface DRAC Board.

CAUTION

Connect all the wires / cables removed during the procedure back to the original connections.

ERROR CODE : E93

DESCRIPTION : LV-DRAC: Incorrect signal measure in ICOM (CH4).

ERROR TYPE : Indicative. Exposure is not allowed.

APPLICABLE TO : All Generators with High Speed Starter.

APPEARS WHEN : In Stand-by situation.

INFORMATION / SYMPTOM : Error Code “E93” is displayed and it is not possible to make Exposures.

POSSIBLE CAUSES

The Generator is detecting current through the main wire when it should be zero (0).

ACTIONS

1. Turn the Generator ON.

DANGER !

TO AVOID ELECTRIC SHOCK, DO NOT TOUCH ANY HEATSINK OR ANY COMPONENT IN THE LV-DRAC MODULE.

2. Check the voltage at TP1, TP3, and TP36 on Control DRAC Board. All voltages should be 0 VDC.

Note ☞ *For GND reference use the following Test Points on the Control DRAC Board: TP2, TP4, TP12, TP13, or TP19.*

- If both voltages at TP1 and TP17 are 0 VDC and the Error Code persists, replace the Control DRAC Board.
- If any voltage at TP1, TP3, or TP36 is different than 0 VDC, go to the next step.

3. Check the voltage at the following Test Points on the Control DRAC Board:
   - +5 VDC at TP14
   - +15 VDC at TP15
   - -15 VDC at TP37

Note ☞ *For GND reference use the following Test Points on the Control DRAC Board: TP2, TP4, TP12, TP13, or TP19.*

- If voltages at the above Test Points are correct, replace the Control DRAC Board.
- If any voltage at the above Test Points are not correct, go to the next step.

4. Turn the Generator OFF and wait three (3) minutes for the Main Storage Capacitors to discharge.

5. Remove the Ribbon Cable from Connector J3 at the Control DRAC Board.

6. Turn the Generator ON.

7. Check the voltage at the following points on the Interface DRAC Board:
   - +5 VDC at Anode of diode CR6
   - +15 VDC at Anode of diode CR5 or at Cathode of diode CR6
   - -15 VDC at Cathode of diode CR7

Note ☞ *For GND reference use the Terminal J2-3 on the Interface DRAC Board.*

- If voltages at the above points are correct, replace the Control DRAC Board.
- If any voltage at the above points are not correct, replace the Interface DRAC Board.

CAUTION ***Connect all the wires / cables removed during the procedure back to the original connections.***

ERROR CODE : E95

DESCRIPTION : Rapid Termination

ERROR TYPE : Indicative. Does not allow exposures.

APPLICABLE TO : Generators with Rapid Termination application Installed.

APPEARS WHEN : While Exposure (after 30% of the exposure back-up time and after 10 ms of exposure, both conditions have to be fulfilled).

INFORMATION / SYMPTOM : Error Code “E95” is displayed and it is not possible to make Exposures.

POSSIBLE CAUSES

No radiation is detected on the Ion Chamber.

The selected parameters are not appropriate for an exposure with AEC (due to a short backup time / mAs Operator selection).

The selected Ion Chamber is not correct.

Dipswitch 3024SW1-3 on the ATP Console CPU Board A3024-XX is in the ON position.

ACTIONS

Rapid Termination is a Safety device that cuts the X-ray exposure in case of an error with the selected Ion Chamber or the selected parameters (short backup time) are not appropriate for an exposure with AEC.

AEC Rapid Termination compares the AEC ramp with a 25% of the final value at the 30% of the Backup Time. It is activated after 30% of the exposure back-up time and after 10 ms of exposure, both conditions have to be fulfilled.

For a proper operation of the Rapid Termination feature, the operator must select an exposure back-up time higher or equal to 100 ms whenever the AEC is ON.

1. Press the respective button on the Console to reset the Error indication.
2. Check the Collimator blades are properly open and no object is blocking the X-ray beam.
3. Increase the backup Time / mAs.
4. Select appropriate Ion Chamber, check the Ion Chamber configured for that Workstation is the same as one physically connected (a.e. IC1 connected to J1 at the AEC Adaptation Board).
5. Check that 3024SW1-3 at the ATP Console CPU Board (A3024-XX) is OFF.

ERROR CODE : E97

DESCRIPTION : Exposure Switch (Handswitch) released before starting the exposure,

ERROR TYPE : Indicative.

APPLICABLE TO : All Generators, when not in “Direct” mode.

APPEARS WHEN : After releasing the “Exp” button of the Exposure Switch before starting the exposure.

INFORMATION / SYMPTOM : Error Code “E97” is displayed.

POSSIBLE CAUSES

User misuse. The Exposure Switch has been pressed and released before starting the X-ray.

Malfunction of the Exposure Switch.

ACTIONS

1. Reset the error condition by touching the respective button on the Console.

2. Repeat the exposure process, ensuring not to release the Exposure Switch until completing the exposure. If no exposure has been performed during the normal time lapse after pressing the Exposure Switch, E97 will appear again after releasing the Exposure Switch; then, continue in the next step.

3. Repeat the complete exposure process, keeping the Exposure Switch fully pressed during 20 seconds approximately and check if Error E24 appears (Bucky Movement Signal has not been detected or DR Device is not ready for exposure); if so, troubleshoot for E24. If Error E24 does not appear, continue in next step.

4. Verify the correct operation of the Exposure Switch buttons and check the corresponding connections from the Exposure Switch to the Generator, ATP CONSOLE PCB A3024-XX (*Refer to the corresponding Schematics),* repairing or replacing as necessary from the Exposure Switch to J14 Connector.

ERROR CODE : E98

DESCRIPTION : DIP Switch 3024SW2-3 on ATP Console Board set for Configuration and Calibration Mode Active.

ERROR TYPE : Informative. It allows normal operation.

APPLICABLE TO : All Generators.

APPEARS WHEN : After turning on the Control Console.

INFORMATION / SYMPTOM : Error Code “E98” is displayed.

POSSIBLE CAUSES

DIP Switch 3024SW2-3 on the ATP Console CPU Board (A3024-xx) set in the ON position.

ACTIONS

1. Reset the error condition by pressing the respective button on the Console.

Note ☞ *Keep in mind that this error will appear each time the Generator is turned OFF/ON during service procedures (configuration, calibration, etc.) whenever Dip-switch 3024SW2-3 on ATP Console CPU Board is in “ON” (closed) position (for Service Mode allowed).*

2. When servicing is finished and the Generator is ready for normal operation, turn the Generator OFF and set DIP Switch 3024SW2-3 on ATP Console CPU Board in the OFF (open) position (operation mode).

ASM Technical Publication
Rev. 2 (071025)

Disassembly / Reassembly Procedures

HF Series Generators

SECTION 1 DISASSEMBLY / REASSEMBLY PROCEDURES

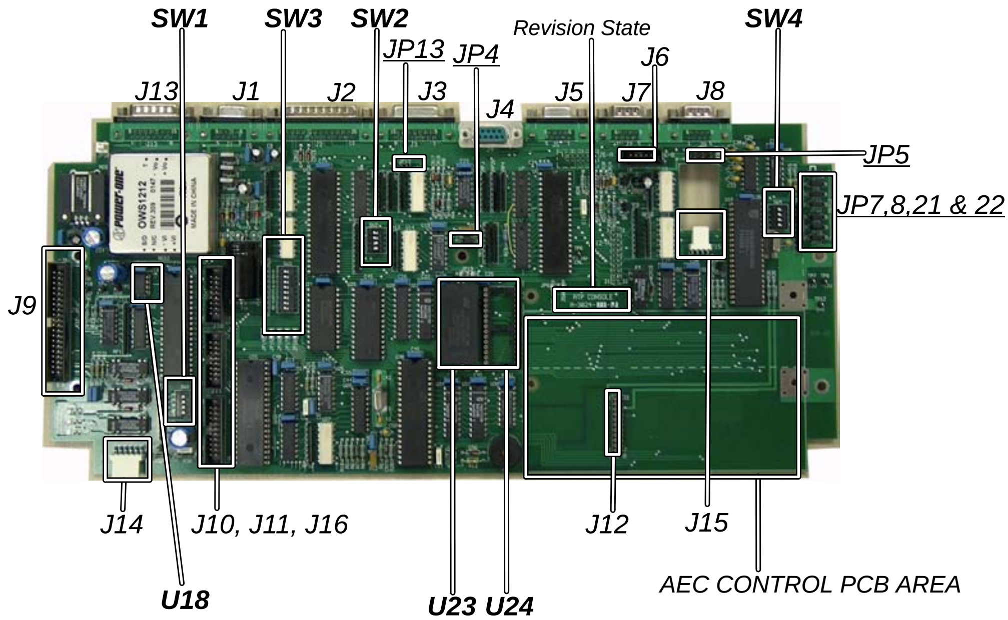
JOB CARD LIST	
JOB CARD	**DESCRIPTION**
CONTROL	
DR001	ATP Console (A3024 - XX)
DR002	AEC Control Board (A3012 - 01 / 02 / 05)
DR003	AEC Control Board (A3012 - 07 / 08 / 11 / 12 / 15 / 17)
FRONT PANEL	
DR004	HT Controller Board (A3000 - XX)
DR005	Filament Driver Boards (3004 - 10 / 8) – Replacements and Upgrade replacement
DR006	Interface Control Board (3009 - XX)
DR007	Power Supply Board
INVERTER MODULE	
DR008	IGBT Module
DR009	Input Rectifier (A3255 - XX)
DR010	Rectifier
DR011	IPM Driver Board (A3063 - 03)
DR012	Charge Discharge (A3212 – XX)
RAC/DRAC STARTERS	
DR013	LF RAC (A3096 - 02)
DR014	High Speed Board – Control DRAC (A3243 - XX)
DR015	Interface DRAC (A3240 – XX)
DR016	Clamping Board (A3109 - XX)
TANKS	
DR017	High Voltage Tanks – One Tube and Two Tubes
OPTIONS AND ADAPTATIONS	
DR018	AEC Adaptation Board (A3263 - XX)
DR019	Tomo / Bucky Interface Board (A3261 - XX)
DR020	R & F Adaptation Board (A3263 - XX)
DR021	Locks Board (A3214 - XX)

JOB CARD DR001: REPLACEMENT OF THE ATP CONSOLE CPU BOARD

SUBASSEMBLY : **ATP CONSOLE CPU BOARD A3024-XX**

TOOLS : Standard Service Tool Kit.

PROCEDURE



CAUTION

TURN OFF THE GENERATOR AND SWITCH OFF THE POWER SUPPLY FROM THE ELECTRICAL CABINET.

Note ☞

For Generators with a Serial Connection (ATP located within the Power Cabinet), Connectors J6, J9, J10, J11 & J16 are not used.

1. Note the actual setting of **all jumpers and switches** on the board. We recommend using the table on the following page for this task. Note the label on EEPROM U24 (Console Program).
2. Remove Memories U18, U23 & U24.
3. Remove all board connectors. Do not forget to note their position.
4. Disconnect and remove the AEC Control Board if this option is present.
5. Remove the five Allen screws used to secure the board.
6. Using the anti-static protection device, replace the old board with the new one. Install the previously removed Memories U18, U23 and U24.
7. Replace the five Allen screws and all previously removed connectors.
8. Set all jumpers and switches to their original positions.

9. Check that RAM U23 and EPROM U18 (APR data) are present. Also check if EPROM U24 is on the new board; if not, remove the old one and put it on the new board (Do not forget to use the anti-static protection).

10. Power ON the Electrical Cabinet and then the Console. Workstation Configuration must be checked for loss or modification. See Configuration Chapter in the Service Manual.

11. Make a functional check of the Equipment. This entails a complete check including all options such as Tomo, AEC, APR, etc.

12. Note on the Data Book the cause and the date of the replacement and fix an adhesive label beside the new board indicating the date and name of the field engineer in order to give maximum information.

Note ☞ *If the error persists after having changed the Board, replace the old components U23 & U18 with the ones supplied with the new Board. Then reset and reconfigure the Workstation following the Configuration Chapter in the Service Manual.*

Note ☞ *If Error 10 (E10) appears during startup, follow the steps below:*
1. Shut down the system
2. Activate Service Mode by placing SW2-3 to the “ON” position
3. Turn ON the system
4. When E10 appears, reset the error
5. Ensure a correct Workstation Configuration
6. Shut down and exit Service mode by placing SW2-3 to “OFF”

Switch Position	Dipswitch SW1			
	1	2	3	4
ON				
OFF				

Switch Position	Dipswitch SW2			
	1	2	3	4
ON				
OFF				

Switch Position	Dipswitch SW3							
	1	2	3	4	5	6	7	8
ON								
OFF								

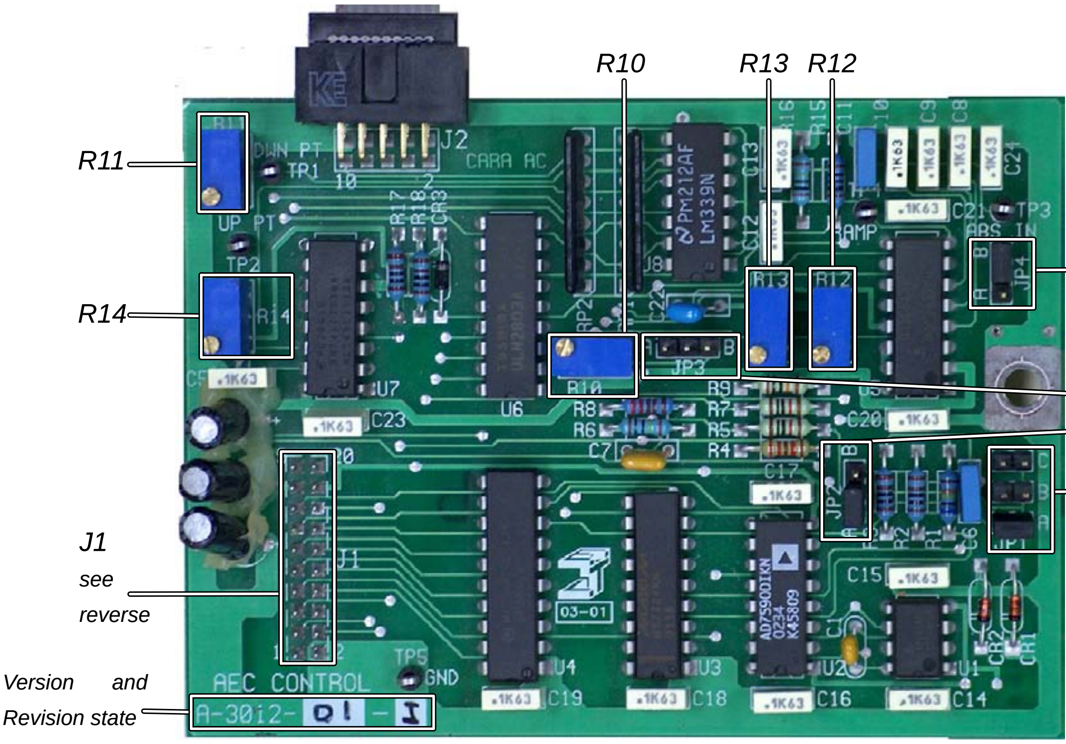
Switch Position	Dipswitch SW4			
	1	2	3	4
ON				
OFF				

JOB CARD DR002: REPLACEMENT OF THE AEC CONTROL BOARD

SUBASSEMBLY : **AEC CONTROL BOARD (A3012-01/02/05)**

TOOLS : Standard Service Tool Kit.

PROCEDURE



TURN OFF THE GENERATOR AND SWITCH OFF THE POWER SUPPLY FROM THE ELECTRICAL CABINET.

The AEC Control Board is always mounted directly onto the ATP Console whether in the Generator Cabinet or the Control Console. For ease of service, it is recommended to remove the ATP Console.

Different versions of the AEC Control are configured for different systems, the table below serves as an orientation when installing the replacement board.

BOARD	VERSION	JP1	JP2	JP4
3012-01	Photomultiplier	B	B	A
3012-02	Image System (TV Camera)	A	A	A
3012-05	4 Ion Chambers	C	A	B

1. Note the positions of JP1, JP2 and JP4 on the table below. JP3 is set to position A only for Ion Chambers with high sensitivity (Gain $>$ 2V / mR).

   If Jumper JP3 is set to B, measure the resistance at R10. Measure and note the values of the resistors indicated in the *Resistor Table.*

JUMPER	A	B	C
JP1			
JP2			
JP4			

Resistor Table

BOARD	RESISTOR	VALUES
***ALL* (JP3=B)**	R10	
A3012-01	R12 & R13	
A3012-02	R11 & R14	
A3012-02	*Does not require adjustment.*	

2. Remove the Allen screw used to secure the AEC Control Board to the ATP CPU Board, holding the nut in place to avoid stripping.

3. Disconnect the flat cable from the AEC Control board. Then disconnect the pin connector of the Control Board, located at the backside of the board, by carefully lifting it perpendicular from the ATP Console.

4. Replace the old board with the new one. Connector J1 on the ATP Console may have more connections than the AEC Control. Ensure that pin 1 (J1) on the AEC Control lines up *perfectly* with pin 1 (J12) on the ATP Console if the size or number of connection points are not the same.

5. Replace the Allen screw, do not forget to replace the spacer

6. Ensure that the jumpers and resistance on the replacement board match the configuration of the original board (see step 1).

7. Power on the electrical cabinet and then the system.

8. Make a functional check of the AEC by testing the Ion Chambers in the system. If necessary, reconfigure the AEC system following the instructions laid out in the Configuration Chapter *(AEC Configuration)* of the Service Manual.

9. Make a functional check of the equipment.

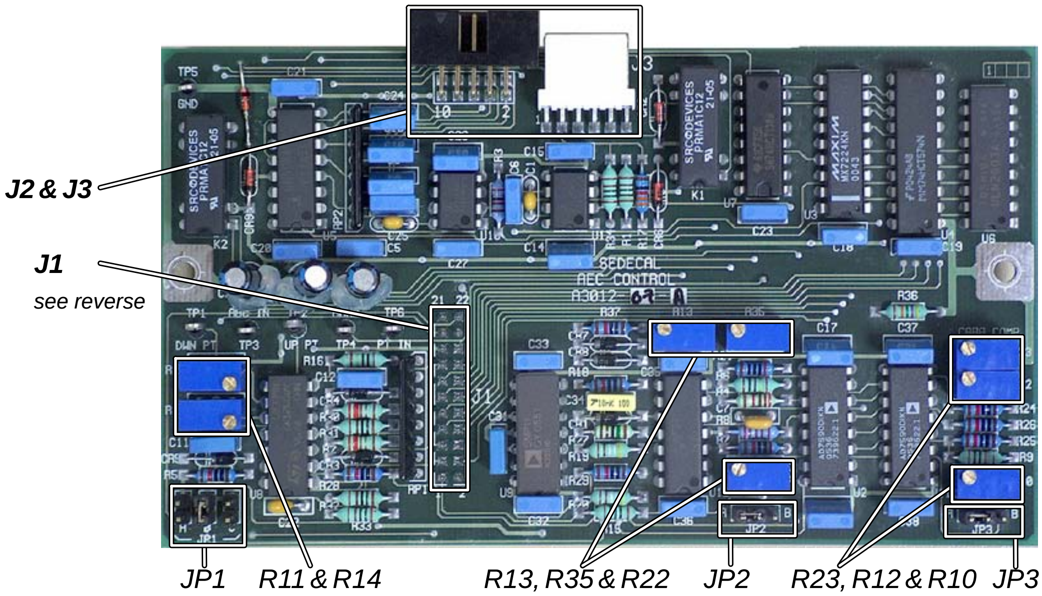
10. Note in the Databook the cause and the date of the replacement and fix an adhesive label beside the new board indicating the date and name of field engineer in order to give maximum information.

JOB CARD DR003: REPLACEMENT OF THE AEC CONTROL BOARD (A3012-07/08/10/11/12/15/17)

SUBASSEMBLY : **AEC CONTROL BOARD A3012-07/08/10/11/12/15/17)**

TOOLS : Standard Service Tool Kit.

PROCEDURE



CAUTION

TURN OFF THE GENERATOR AND SWITCH OFF THE POWER SUPPLY FROM THE ELECTRICAL CABINET.

The AEC Control Board is always mounted directly onto the ATP Console whether in the Generator Cabinet or the Control Console. For ease of service, it is recommended to also remove the ATP Console.

Different versions of the AEC Control are configured for different systems, the table below serves as an orientation when installing the replacement board.

BOARD	VERSION	JP1	JP2	JP4
3012-11	Photomultiplier	B	B	A
3012-12	Image System (TV Camera)	A	A	A
3012-15	4 Ion Chambers	C	A	B

1. Note all Jumper positions and Resistor values in the *Component / Value Table* further below. See the Configuration Chapter (*AEC Configuration*) in the Service Manual for more information.

Components / Value Table

<table>
<tr><th colspan="2">Components</th><th rowspan="2">Value</th></tr>
<tr><th>A3012 - 7 / 8</th><th>A3012 -11 / 12 / 15</th></tr>
<tr><td colspan="2">JP1</td><td></td></tr>
<tr><td colspan="2">JP2</td><td></td></tr>
<tr><td colspan="2">JP3</td><td></td></tr>
<tr><td></td><td>JP4</td><td></td></tr>
<tr><td colspan="2">R13</td><td></td></tr>
<tr><td>R35</td><td></td><td></td></tr>
<tr><td colspan="2">R12</td><td></td></tr>
<tr><td>R23</td><td></td><td></td></tr>
<tr><td colspan="2">R10 (JP3 set to B)</td><td></td></tr>
<tr><td>R22 (JP2 set to B)</td><td></td><td></td></tr>
<tr><td colspan="2">R11</td><td></td></tr>
<tr><td colspan="2">R14</td><td></td></tr>
</table>

2. Remove the Allen screw used to secure the AEC Control Board to the ATP CPU Board holding the nut in place to avoid stripping.

3. Disconnect the flat cable from the AEC Control board. Then disconnect the pin connector of the Control Board, located at the backside of the board, by carefully lifting it perpendicular from the ATP Console.

4. Replace the old board with the new one. Connector J1 on the ATP Console may have more female connections than the AEC Control has males. Ensure that pin 1 (J1) on the AEC Control lines up *perfectly* with pin 1 (J12) on the ATP Console if the size or number of connection points are not the same. AEC Control A3012–07 has 22 pins and A3012 11/12/15 has 24. The first pair and last pair of connection points are numbered on the front side of the board.

5. Replace the Allen screw, do not forget to replace the spacer

6. Ensure that the jumpers and resistance on the replacement board match the configuration of the original board (see step 1).

7. Power on the electrical cabinet and then the system.

8. Make a functional check of the AEC by completely checking the system’s Ion Chambers. If necessary, reconfigure the AEC system following the instructions laid out in the Configuration Chapter *(AEC Configuration)* of the Service Manual.

9. Make a functional check of the equipment.

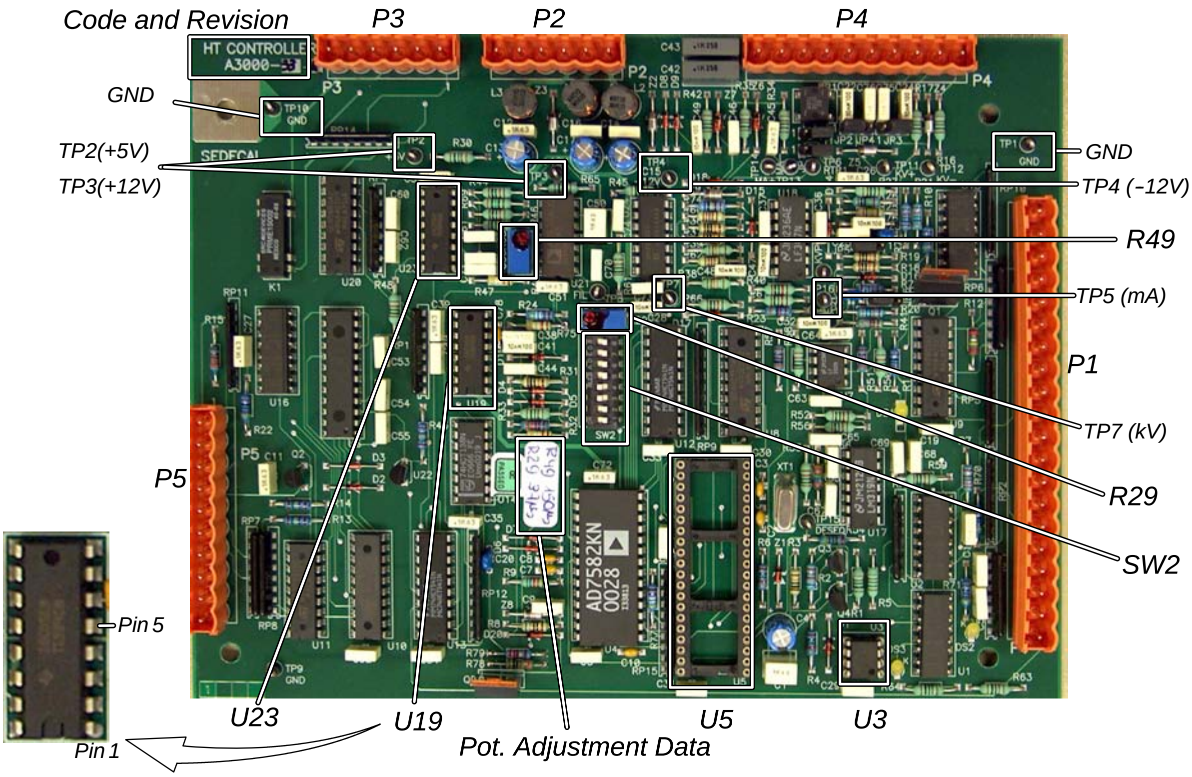
10. Note in the Databook the cause and the date of the replacement and fix an adhesive label beside the new board indicating the date and name of field engineer in order to give maximum information.

JOB CARD DR004: REPLACEMENT OF THE HT CONTROLLER BOARD

SUBASSEMBLY : **HT CONTROLLER BOARD A3000-XX**

TOOLS : Standard Service Tool Kit.

PROCEDURE



1. With the Generator ON and using an Oscilloscope, measure and note the period of the signals on U19-5

FOR THE FOLLOWING STEPS, TURN OFF THE GENERATOR AND SWITCH OFF THE POWER SUPPLY FROM THE ELECTRICAL CABINET.

2. Note the setting for Dipswitch SW2. The table supplied below will help you with this task. Ensure that the new HT Controller is configured for the system (*see note below*).

Switch Position	**Dipswitch SW2**							
	1	2	3	4	5	6	7	8
ON								
OFF								

Note ☞

The following table contains important information on the configuration of the HT Controller for different Generator types. Ensure that the replacement board contains the correct configuration and settings as the board to be replaced. See the HT Controller Schematics in the Service Manual for more information.

HTC 3000 Reference	**Configuration Generator Type**	**Special Note**
–33 ($\leq$rev.K)	Line Powered – Single Phase / Standard Configuration	D19 present
–33 ($\geq$rev.K1)	Line Powered – Triple Phase / Batteries / Capacitors	D19 removed
–34	3 Tube Configuration	Jumpers should be soldered at RP7–3&4 and RP8–5&6
–35	High Voltage Cables > (of more than) 22 meters	Jumpers (*idem* –34), R28=86K6 Ω
–36	Mammography	R16&17=4K02 Ω, R20&21=69K8 Ω, R38&39=226K Ω, R60&62=25K5 Ω
–43	Capacitors / Heavy Duty Cycle Inverters (Triple Phase Generators)	Inverters Board A6362–35
–44 (–41)	$\geq$1000 mA (1000mA or more) /	R36&37=200K Ω, R40=2K21 Ω / Z6 & Z7 removed

3. Remove all connectors from the board and note their position.
4. Remove the four Allen screws (one metallic and three nylon) used to secure the board to the Cabinet.
5. Using the anti–static protection device, replace the old board with the replacement (new) one.
6. Replace the four Allen screws.
7. Replace all the previously removed connectors. *(see Step 3.)*
8. Set the switches on SW2 to their original position. *(see Step 2.)*

WARNING

DO NOT TURN ON THE SYSTEM UNLESS EXPLICITLY TOLD TO DO SO IN THESE INSTRUCTIONS.

9. Ensure that EEPROM U3 (Calibration data) and microprocessor U5 (Cabinet Program) are present on the new board; remove both components and replace them with the old ones on the new board (do not forget to use the anti-static protection). U5 is not normally supplied because it is individual for each system.
10. Set SW2–2 to ON and Turn the equipment ON.

Note ☞ *R29 and R49 are used to adjust the modulator period for the Inverter and Filament, U19-5 and U23-5 respectively. There is a label on the board (shown in photo as "Pot.Adjustment Data") that displays factory-set inverter periods in μseconds for R29 & R49.*

11. Visually check the replaced (old) Board Potentiometer Adjustments, marked on the label (somewhere on the board). If one or both modulator period values are missing, refer to the original Final Test Documentation that came with the system, or refer to Table-1 below as a guideline only.
12. Measuring with an Oscilloscope at U23-5, the period of the signal must be adjusted with Potentiometer R49 if it does not match the period detailed in Table-1 below.
13. Ensure that U19-5 has the same period as measured on the replaced HT Controller in step 1.; adjusting R29 as necessary. Table-1 below details the possible periods that U19-5 may present.

Table-1
Pot. Adjustment Data

Component – Pin	System Configuration	Period
U19-5	Standard / Default Configuration	40μs (37μs ✶)
U19-5	Capacitor Assisted Generators / Heavy Duty Cycle Inverters (Triple Phase Generators)	48μs (45μs ✶)
U23-5	Filament Driver Board 3004-xx 04/05/06/08	150μs
U23-5	Filament Driver Board 3004-xx 10/11/12 and higher	80μs
✶ – During the final system test, certain U19 components are set to 37 or 45μs. As this depends on the system and final site, contact the manufacturer in absence of the correct indication for this value.		

Note ☞ HT Controllers with revision K and lower cannot be adjusted to an 80μs filament period unless Resistor R46 (4K99 Ω) is installed.

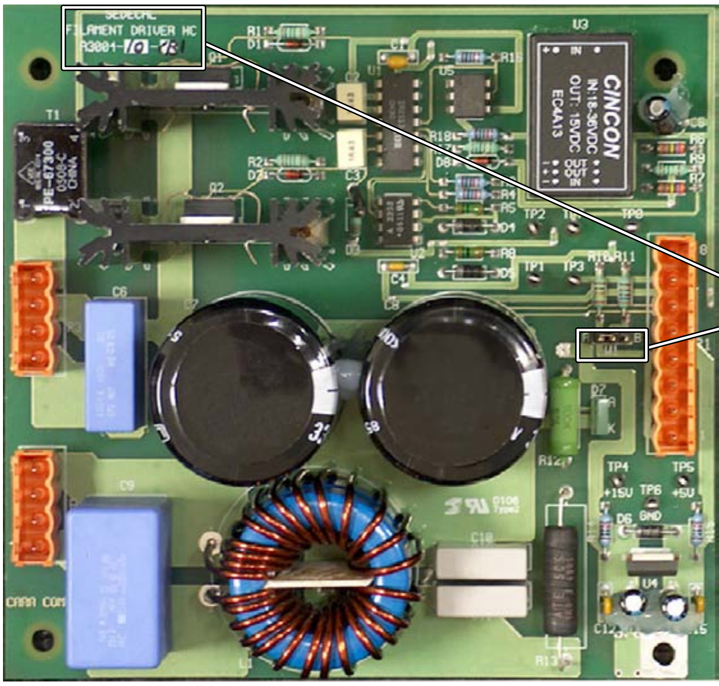
14. Turn OFF the System. Set SW2–2 back to the OFF position.
15. Perform Rotor Programming as detailed in the Configuration Chapter.
16. Power ON the Electrical Cabinet and the System. Check that the Extended Memory Data have not been lost or modified. Use data noted in the *Data Book* during installation. Ensure a proper X–ray Tube selection. In case of doubts and for additional information on carrying out Configuration, check the *Configuration Chapter* in the *Service Manual*.
17. Carry out the procedures as detailed in the *Preventive Maintenance Chapter* of the *Service Manual* (Test for kV Loop, Test for Digital mA Loop Open and Test for Digital mA Loop Closed).
18. Note in the *Data Book* the cause and the date of the replacement and fix an adhesive label with the Board Potentiometer Adjustments beside the new board including the date and name of the service engineer.

JOB CARD DR005A: REPLACEMENT OF THE FILAMENT DRIVER BOARD

SUBASSEMBLY : **FILAMENT DRIVER BOARD A3004–10**

TOOLS : Standard Service Tool Kit.

PROCEDURE



Revision Information and W1

CAUTION

TURN OFF THE GENERATOR AND ISOLATE THE POWER FROM THE ELECTRICAL CABINET.

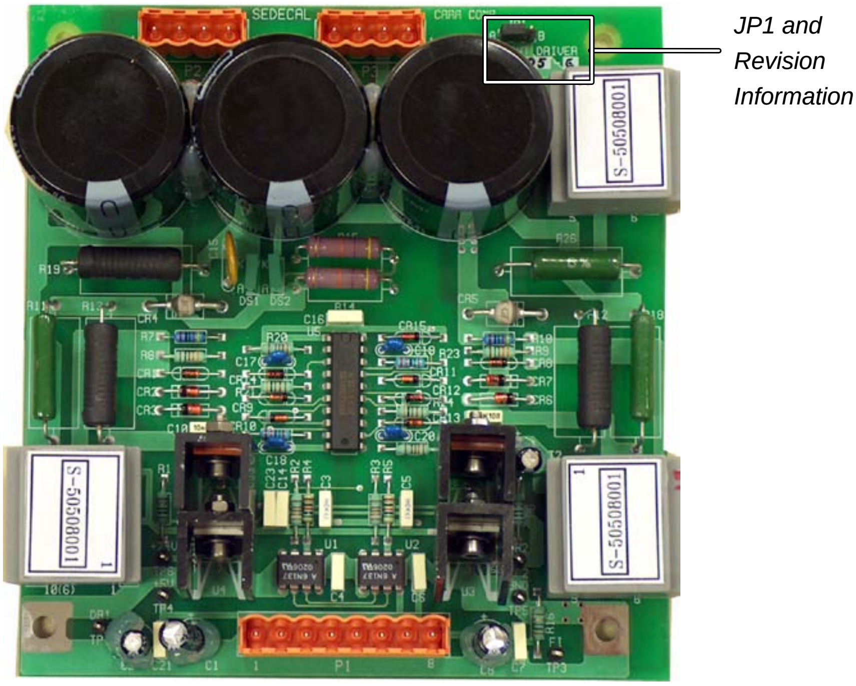
1. Note the actual settings of jumper W1 on the board and remove all connectors of the Board to be replaced and note their position.
2. Remove the four Allen screws used to secure the board to the cabinet.
3. Mount the Replacement Board, securing it with the four Allen screws.
4. Replace all previously removed connectors.
5. Ensure that W1 is in its original position *(see Step 1)*
6. Power ON the Electrical Cabinet and Systems.
7. Connect the mAs meter on the HV Tank and place a non–invasive meter on the table under the X-ray beam.
8. To confirm correct parameters, make several exposures with different technique settings, carrying out a full calibration if not correct.
9. Remove the Test Equipment and note the new memory data.
10. Note in the DataBook the cause and date of replacement and fix an adhesive label beside the new board indicating the date and name of the field engineer in order to give maximum info.

JOB CARD DR005B: REPLACEMENT OF THE FILAMENT DRIVER BOARD

SUBASSEMBLY : **FILAMENT DRIVER BOARD A3004-XX $\leq$ 08**

TOOLS : Standard Service Tool Kit.

PROCEDURE



CAUTION

TURN OFF THE GENERATOR AND THE POWER SUPPLY FROM THE ELECTRICAL CABINET.

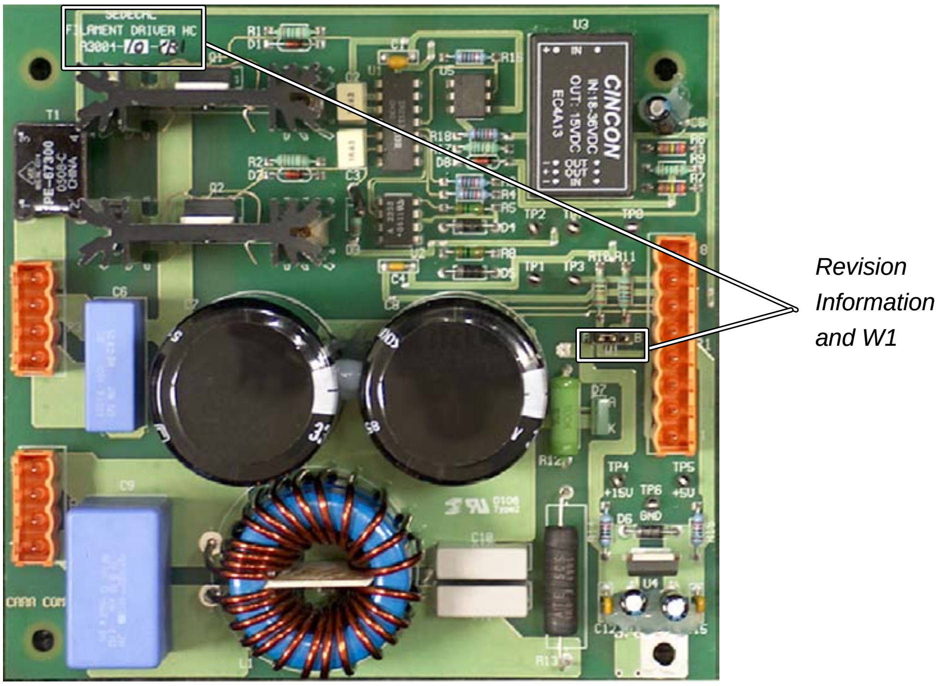
1. Note the actual settings of jumper JP1 on the board and remove all connectors of the Board to be replaced and note their position.
2. Remove the four Allen screws used to secure the board to the cabinet.
3. Mount the Replacement Board, securing it with the four Allen screws.
4. Replace all previously removed connectors.
5. Ensure JP1 is in its original position *(see Step 1)*
6. Power ON the Electrical Cabinet and the System.
7. Connect the mAs meter on the HV Tank and place a non–invasive meter on the table under the X-ray beam.
8. To confirm correct parameters, make several exposures with different technique settings, carrying out a full calibration if not correct.
9. Remove the Test Equipment and note the new memory data.
10. Note in the DataBook the cause and date of replacement and fix an adhesive label beside the new board indicating the date and name of the field engineer in order to give maximum info.

JOB CARD DR005C: REPLACEMENT OF THE FILAMENT DRIVER BOARD

SUBASSEMBLY : **REPLACEMENT / UPGRADE**
TO FILAMENT DRIVER BOARD A3004-XX $\geq$10 [for A3004-xx $\leq$ 08]

TOOLS : Standard Service Tool Kit.

PROCEDURE



TURN OFF THE GENERATOR AND THE POWER SUPPLY FROM THE ELECTRICAL CABINET.

1. Note the actual settings of jumper JP1 on the board and remove all connectors of the Board to be replaced and note their position.
2. Remove the four Allen screws used to secure the board to the cabinet.
3. Mount the Replacement Board, securing it with the four Allen screws.
4. Replace all previously removed connectors.
5. Ensure that jumper W1 is in the same position as JP1 *(see Step 1)*

6. Check the revision state of the HT Controller. If it is at least A3000-xx K, proceed to the next step. If the revision state is less than K, change Resistor R46 on the HT Controller for a resistor with a value of 4K99 Ω.

7. Using an oscilloscope, check the period of the waveform at U23-5 and adjust with potentiometer R49 to 80μs.

8. On the Interface Control Board, verify that Capacitor C6 measures 6μF

9. Recalibrate the *mA Loop Open* and *mA Loop Closed* following the instructions detailed in the relevant section within the Service Manual.

10. Power ON the Electrical Cabinet and System.

11. Connect the mAs meter on the HV Tank and place a non–invasive meter on the table under the X-ray beam.

12. To confirm correct parameters, make several exposures with different technique settings, carrying out a full calibration if not correct.

13. Remove the Test Equipment and note the new memory data.

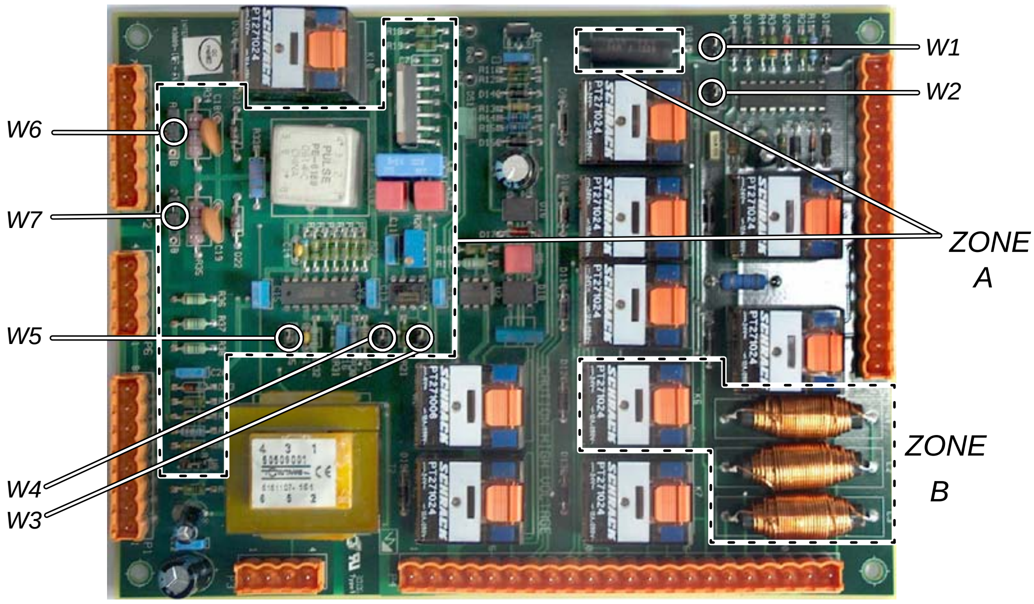
14. Note in the DataBook the cause and date of replacement and fix an adhesive label beside the new board indicating the date and name of the field engineer in order to give maximum info.

JOB CARD DR006: REPLACEMENT OF THE INTERFACE CONTROL BOARD

SUBASSEMBLY : **INTERFACE CONTROL BOARD A3009-XX**

TOOLS : Standard Service Tool Kit.

PROCEDURE



TURN OFF THE GENERATOR AND SHUT DOWN THE POWER SUPPLY FROM THE ELECTRICAL CABINET.

The table below illustrates the possible configurations of an Interface Control Board. The actual components in both zone A and B are detailed in Schematics A3009-xx in the Service Manual. Ensure that the replacement board is properly configured for the actual system type before continuing with the replacement.

VERSION	SYSTEM TYPE	COMPONENTS ZONE A	COMPONENTS ZONE B
A3009-09	RAD + HV	REQUIRED	NOT REQUIRED
A3009-10	RAD + FLUORO	NOT REQUIRED	REQUIRED
A3009-11	RAD ONLY	NOT REQUIRED	NOT REQUIRED
A3009-12	RAD + FLUORO + HV	REQUIRED	REQUIRED
A3009-15	MAMMOGRAPHY	NOT REQUIRED	NOT REQUIRED

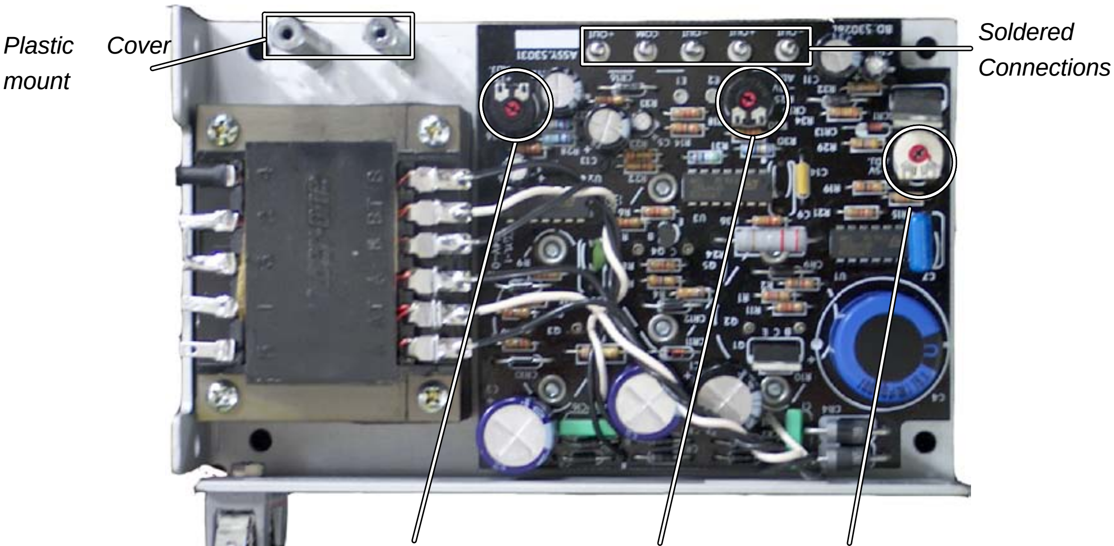
1. Note the actual setting of jumpers on the board.
2. Remove all connectors of the board. Note their position.
3. Remove the four Allen screws used to secure the board to the Cabinet.
4. Replace the old board with the new one.
5. Replace the four Allen screws.
6. Replace all connectors previously removed.
7. Set the jumpers in their original positions *(see Step 1)*
8. Power ON the Electrical Cabinet and Console.
9. Connect the digital Voltmeter on TB1-9 and TB1-1 (GND) and adjust Pot R29 to obtain the required Voltage for the Ion Chamber in use. Certain Ion Chambers require 230 VDC while others require 300 VDC (see Ion Chamber specifications for more information). Do not forget to remove the Voltmeter when finished.
10. Make several exposures with different AEC technique settings in order to check if the density is correct compared with previous results.
11. If density values are not correct, perform a full AEC calibration and note the new memory data.
12. Note in the DataBook the cause and date of the replacement and fix an adhesive label beside the new board indicating the date and name of the field engineer in order to give maximum info.

JOB CARD DR007: REPLACEMENT OF THE POWER SUPPLY BOARD

SUBASSEMBLY : **POWER SUPPLY BOARD**

TOOLS : Standard Service Tool Kit.

PROCEDURE



TURN OFF THE GENERATOR AND ISOLATE THE POWER FROM THE ELECTRICAL CABINET.

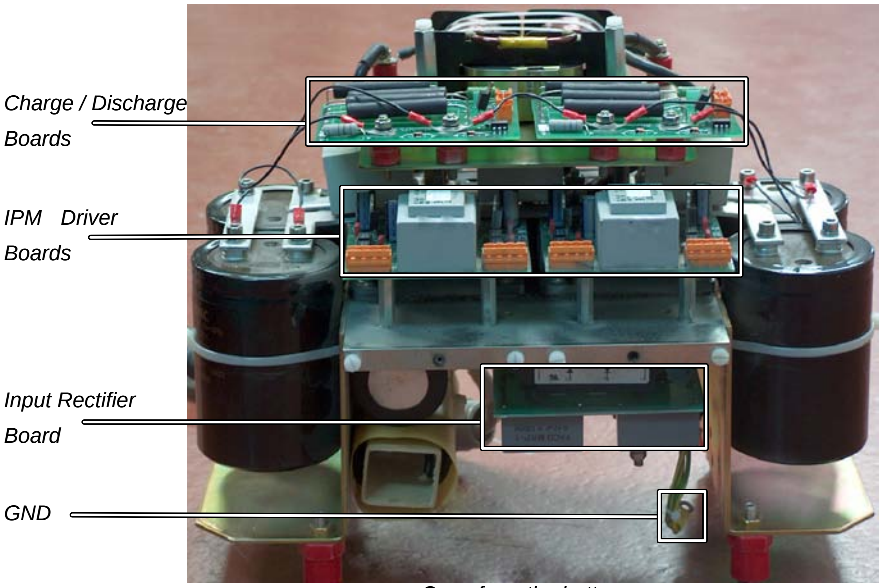
1. After accessing the front panel, remove the two screws from the Plastic Cover Mount and take off the Plastic Cover.
2. Unsolder and note the positions of the wires to the board.
3. Remove the four Allen screws used to secure the board to the cabinet.
4. Replace the old board with the new one and secure the board with the original four Allen screws.
5. Replace all connectors previously removed.
6. Power ON the Electrical Cabinet and System.
7. Connect the digital Voltmeter on the board and check Voltages: If +5 V, +12 V and –12 V are not OK, adjust the corresponding potentiometer.
8. Perform the *Low DC Voltage Power Supply Test* as detailed in the Troubleshooting chapter of the Service Manual. Make a functional check of the equipment.
9. Note in the DataBook the cause and date of replacement and fix an adhesive label beside the new board indicating the date and name of field engineer in order to give maximum info.

JOB CARD DR008: REPLACEMENT OF THE IGBT MODULE

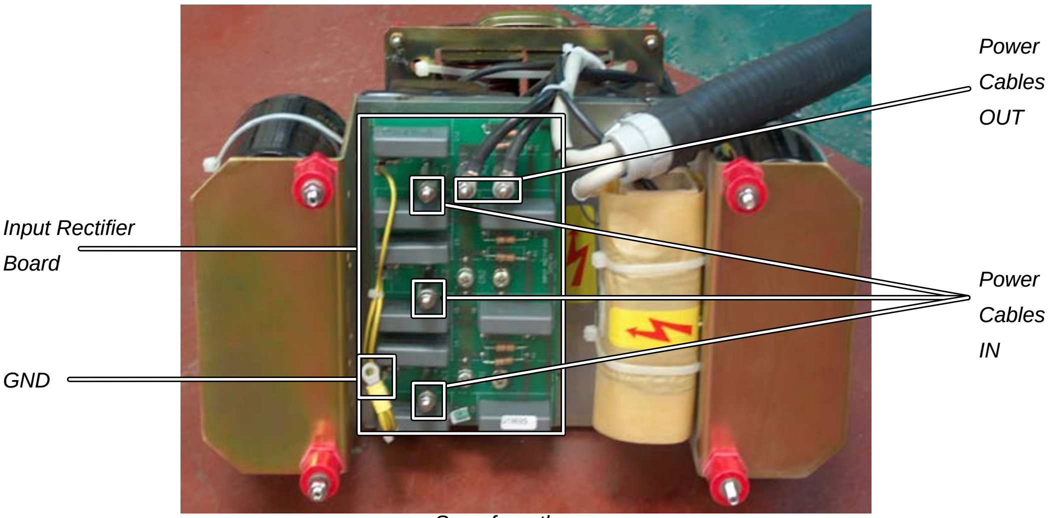
SUBASSEMBLY : **IGBT MODULE**

TOOLS : Standard Service Tool Kit.

PROCEDURE



Seen from the bottom



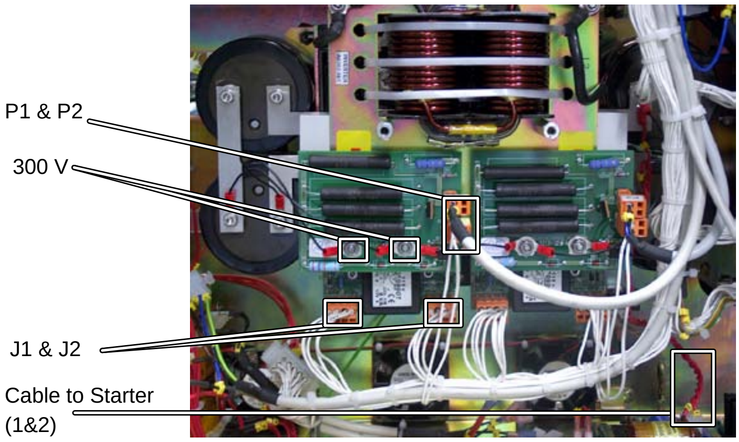
Seen from the rear

SHUT DOWN THE GENERATOR AND ISOLATE THE POWER FROM THE ELECTRICAL CABINET.

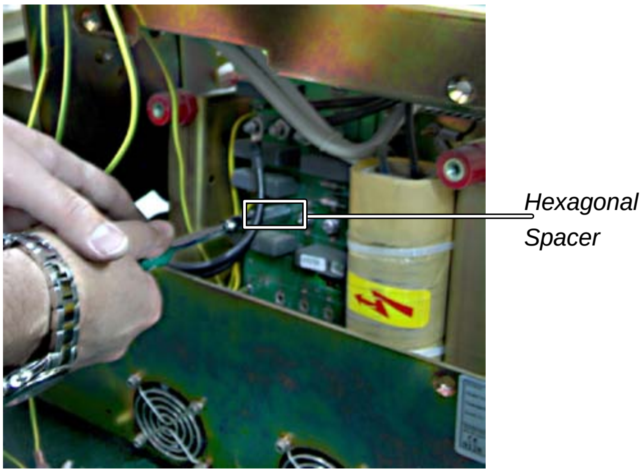
BEFORE MANIPULATING THE BOARD, ENSURE THAT THERE IS NO VOLTAGE IN THE CAPACITORS BANK.

1. Take off the Power Cabinet Cover and place the Generator where the rear panel can be accessed.
2. Open the Front Cover of the Chassis.
3. Remove the protective Plastic Safety Cover from the front of the Module.

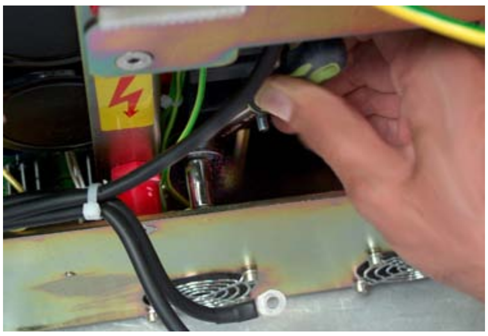
4. If the system is equipped with a High Speed Starter (LV Drac), disconnect the cables to the Starter marked (+ & –) from the inverter that go to 1 & 2 at the Starter (see photo below).



5. Disconnect the Cables from the IPM Drivers (J1 & J2) and the Charge/Discharge Boards (P1 & P2).
6. Remove the four Allen screws and take off the Back Cover. This action may be hampered due to the routing of the Power Line Cables. If this is the case, disconnect the Power Line Cables from the Input Line Fuses.
7. From the Backside of the Generator, disconnect the Power Cables from the Input Rectifier holding the hexagonal spacer in place while unscrewing the connection as shown in the photo below.



8. With a socket wrench, disconnect the GND (yellow and green wires) on the bottom inside of the Chassis as shown in the photo below.

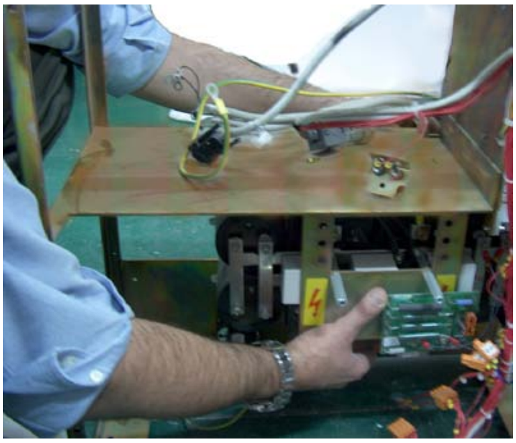


9. Disconnect the HV Tank (Cables for P1, P3 and Shield).

10. The most practical way of dismounting the Inverter Module from the Chassis is by first removing the two lower screws and then <u>loosening</u> the two upper screws.

11. Brace the module with one hand (to keep the module from falling and potentially damaging the components underneath) while removing the already loosened upper screws of the Inverter Module as shown in the photo below.

This Module is heavy and must be removed through the front of the Cabinet.



12. Install the new Module, attaching the screws with the nuts removed. Replace the wires and connectors removed in steps 2 – *10*.

Assure that the connections are not only secure but also correct before switching on the power supply.

13. Turn on the System and measure with a polymeter that $\leq$ 300 V ($\pm$ 10 %) is present in both Charge / Discharge Boards (see photo in step 4).

14. Carry out exposures using various kV stations in order to check that the system has not suffered any variations in Calibration.

15. Replace the Rear Cover, securing it to the Cabinet with the 4 Allen screws. Then replace the Plastic Safety Cover and shut the Front Cover.

16. Return the faulty Module to factory.

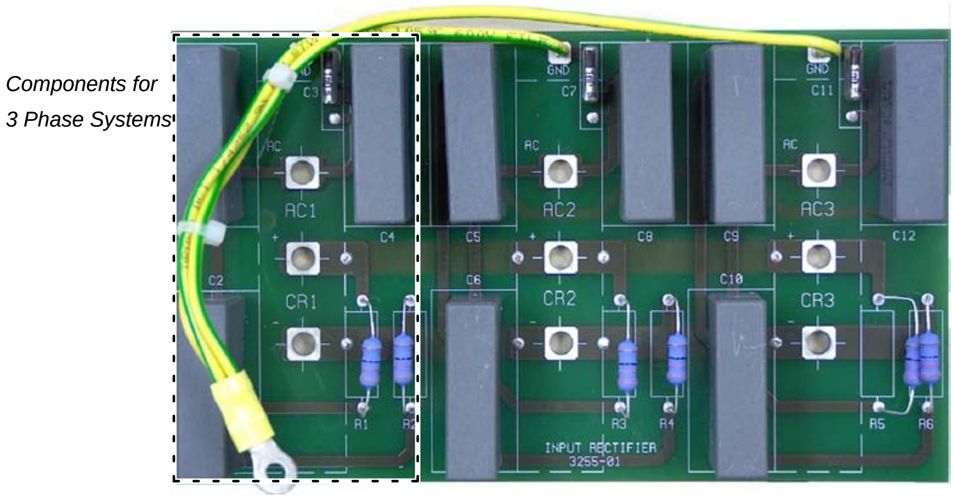
17. Note in the DataBook the cause and date of the replacement and fix an adhesive label beside the new board indicating the date and the name of the field engineer in order to give maximum info.

JOB CARD DR009: REPLACEMENT OF THE INPUT RECTIFIER

SUBASSEMBLY : **INPUT RECTIFIER (A3255-0X).**

TOOLS : Standard Service Tool Kit.

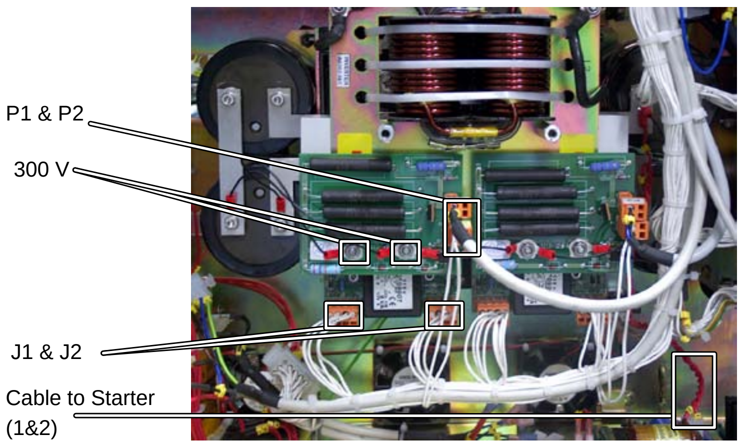
PROCEDURE



SHUT DOWN THE GENERATOR AND ISOLATE THE POWER FROM THE ELECTRICAL CABINET.

BEFORE MANIPULATING THE BOARD, ENSURE THAT THERE IS NO VOLTAGE IN THE CAPACITORS BANK.

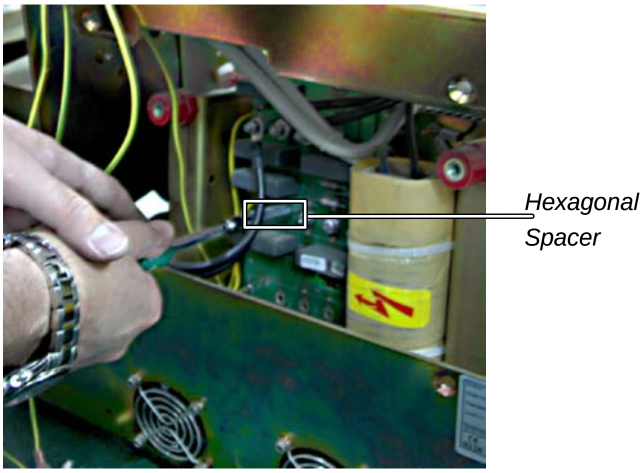
1. Take off the Power Cabinet Cover and place the Generator where the rear panel can be accessed.
2. Open the Front Cover of the Chassis.
3. Remove the protective Plastic Safety Cover from the front of the Module.
4. If the system is equipped with a High Speed Starter (LV Drac), disconnect the cables to the Starter marked (+ & –) from the inverter that go to 1 & 2 at the Starter (see photo below).



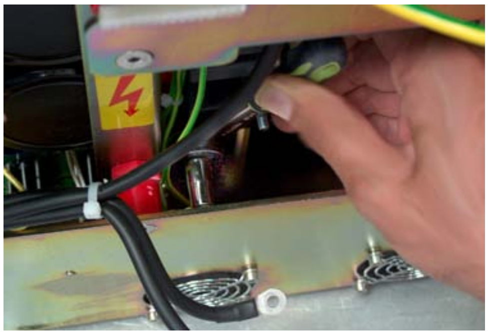
5. Disconnect the Cables from the IPM Drivers (J1 & J2) and the Charge/Discharge Boards (P1 & P2).

6. Remove the four Allen screws and take off the Back Cover. This action may be hampered due to the routing of the Power Line Cables. If this is the case, disconnect the Power Line Cables from the Input Line Fuses.

7. From the Backside of the Generator, disconnect the Power Cables from the Input Rectifier Board, holding the Standoffs (hexagonal spacers) in place while unscrewing the connection as shown in the photo below.



8. With a socket wrench, disconnect the GND (yellow and green wires) on the bottom inside of the Chassis as shown in the photo below.



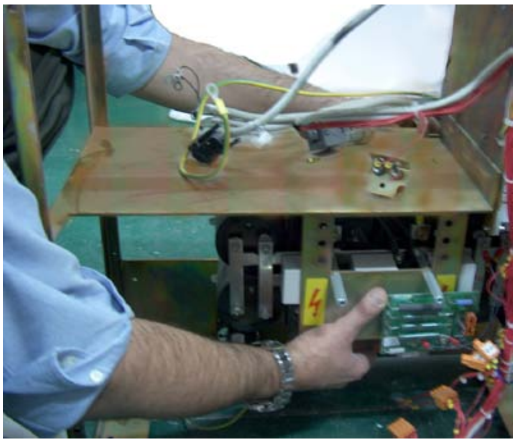
9. Disconnect the HV Tank (Cables for P1, P3 and Shield).

10. The most practical way of dismounting the Inverter Module from the Chassis is by first removing the two lower screws and then <u>loosening</u> the two upper screws.

11. Brace the module with one hand (to keep the module from falling and potentially damaging the components underneath) while removing the already loosened upper screws of the Inverter Module as in the photo below (*Components have been removed in the demonstration below*).

CAUTION

This Module is heavy and must be removed through the front of the Cabinet.



12. Position the Module in order to access the Input Rectifier Board. Remove the four (4) or five (5) Standoffs (hexagon–shaped spacers) and the two (2) or four (4) Allen Screws used to fix the board to the Rectifier behind.
13. Replace the old board with the new one, fixing the Standoffs and Allen Screws in their original positions.
14. Replace all wires and connections removed in steps 2 *– 10*.

CAUTION

Assure that the connections are not only secure but also correct before switching on the power supply.

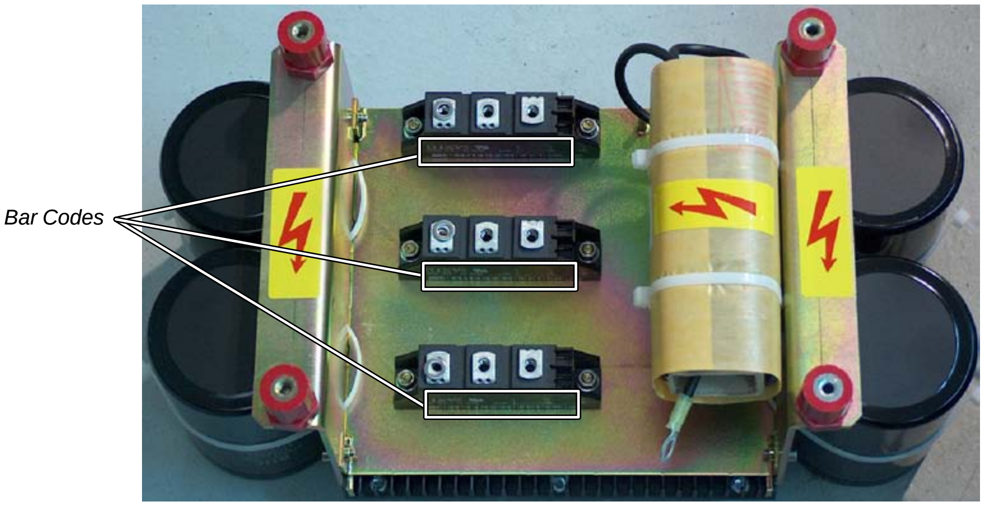
15. Carry out exposures using various kV stations in order to check that the system has not suffered any variations in Calibration.
16. Replace the Rear Cover, securing it to the Cabinet with the 4 Allen screws from the original board. Then replace the Plastic Safety Cover and shut the Front Cover.
17. Run a functionality test for the system.
18. Return the faulty board to the factory.
19. Note in the DataBook the cause and date of the replacement and fix an adhesive label beside the new board indicating the date and the name of the field engineer in order to give maximum info.

JOB CARD DR010: REPLACEMENT OF THE RECTIFIERS

SUBASSEMBLY : **RECTIFIERS ON THE IGBT MODULE.**

TOOLS : Standard Service Tool Kit.

PROCEDURE

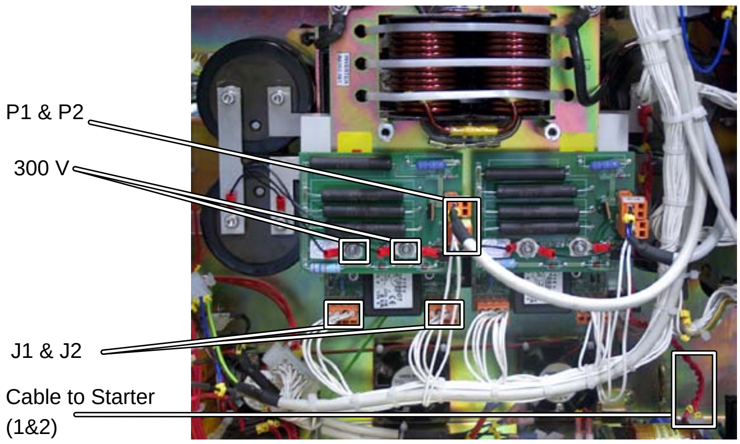


CAUTION

SHUT DOWN THE GENERATOR AND ISOLATE THE POWER FROM THE ELECTRICAL CABINET.

BEFORE MANIPULATING THE BOARD, ENSURE THAT THERE IS NO VOLTAGE IN THE CAPACITORS BANK.

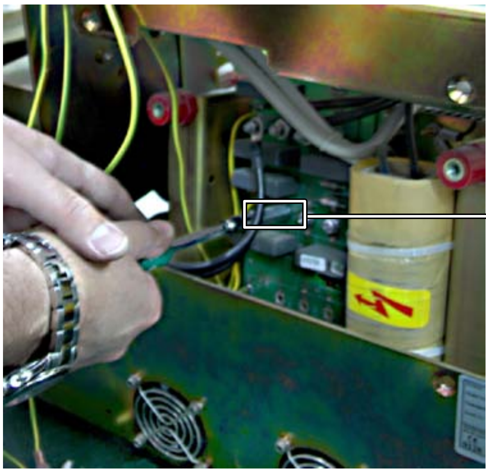
1. Take off the Power Cabinet Cover and place the Generator where the rear panel can be accessed.
2. Open the Front Cover of the Chassis.
3. Remove the protective Plastic Safety Cover from the front of the Module.
4. If the system is equipped with a High Speed Starter (LV Drac), disconnect the cables to the Starter marked (+ & –) from the inverter that go to 1 & 2 at the Starter (see photo below).



5. Disconnect the Cables from the IPM Drivers (J1 & J2) and the Charge/Discharge Boards (P1 & P2).

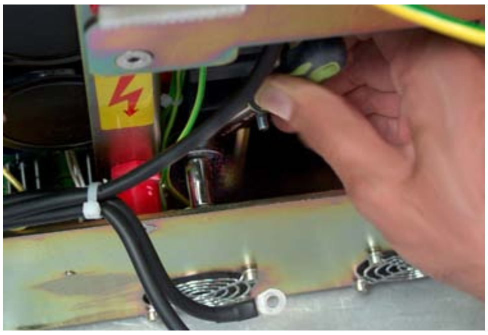
6. Remove the four Allen screws and take off the Back Cover. This action may be hampered due to the routing of the Power Line Cables. If this is the case, disconnect the Power Line Cables from the Input Line Fuses.

7. From the Backside of the Generator, disconnect the Power Cables from the Input Rectifier Board, holding the Standoffs (hexagonal spacers) in place while unscrewing the connection as shown in the photo below.



Hexagonal Spacer

8. With a socket wrench, disconnect the GND (yellow and green wires) on the bottom inside of the Chassis as shown in the photo below.



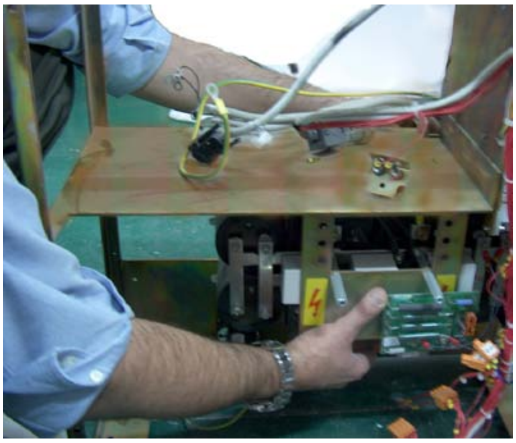
9. Disconnect the HV Tank (Cables for P1, P3 and Shield).

10. The most practical way of dismounting the Inverter Module from the Chassis is by first removing the two lower screws and then <u>loosening</u> the two upper screws.

11. Brace the module with one hand (to keep the module from falling and potentially damaging the components underneath) while removing the already loosened upper screws of the Inverter Module as in the photo below (*Components have been removed in the demonstration below*).

CAUTION

This Module is heavy and must be removed through the front of the Cabinet.



12. Position the Module in order to access the Input Rectifier Board. Remove the four (4) or five (5) Standoffs (hexagon–shaped spacers) and the two (2) or four (4) Allen Screws used to fix the board to the Rectifier behind.
13. Remove the Rectifier Board to gain access to the Rectifiers below, noting the original position of the board for reference.
14. Each Rectifier is fixed to a Standoff on the Module by four washers and two nuts. Note the orientation of the Rectifiers. Remove and replace the Rectifiers, *<u>respecting the original orientation as to not interfere with the Polarity of the Unit</u>*.
15. Replace and fix the Input Rectifier Board, *<u>ensuring that its position matches its original placement</u>*.
16. Replace all wires and connections removed in steps 2 – *10*.

CAUTION

Assure that the connections are not only secure but also correct before switching on the power supply.

17. Test the system to ensure proper functioning.
18. Replace the Rear Cover, securing it to the Cabinet with the 4 Allen screws from the original board. Then replace the Plastic Safety Cover and shut the Front Cover.
19. Return the faulty rectifiers to the factory.
20. Note in the DataBook the cause and date of the replacement and fix an adhesive label beside the new board indicating the date and the name of the field engineer in order to give maximum info.

JOB CARD DR011: REPLACEMENT OF THE IPM DRIVER BOARDS

SUBASSEMBLY : **IPM DRIVER BOARDS (A3063-03).**

TOOLS : Standard Service Tool Kit.

PROCEDURE

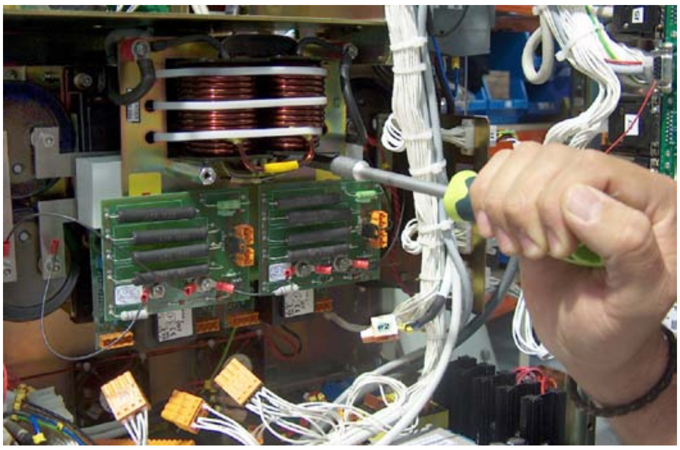
WARNING

TURN OFF THE GENERATOR AND ISOLATE THE POWER FROM THE ELECTRICAL CABINET.

BEFORE MANIPULATING THE BOARDS, ENSURE THAT NO VOLTAGE IS PRESENT AT THE CAPACITORS BANK.

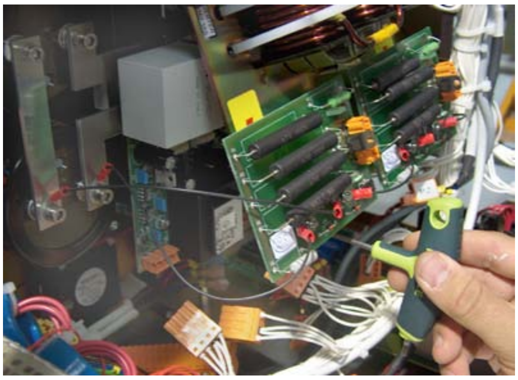
1. After accessing the Front Panel, remove the Plastic Safety Cover from the Inverter Module.

2. Disconnect all main connections to the boards as shown in the photo below. Do not forget to note their positions.



3. Remove the two Standoffs (hexagonal spacers), used to secure the Front Panel to the Cabinet, as shown in the photo above.

4. Prop the Inverter Module Front Panel in the position shown in the photo below.



5. Remove the four screws used to fix the two IPM Boards to the Inverter Module (2 screws on each board).

CAUTION

The connector pins located on the backside of the IPM Boards are fragile: Use care when removing and installing the replacement boards.

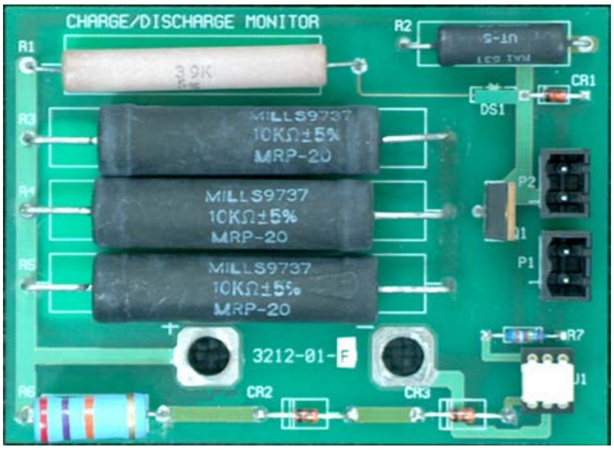
6. Remove the IPM Driver Boards by pulling them gently and perpendicular from the Module.
7. When installing the replacement IPM Driver Boards, ensure that the pins on the Inverter Module line up with the connectors on the Boards.
8. Replace the four Allen screws.
9. Replace all connectors, securing the connection for all affected boards.
10. Power ON the Electrical Cabinet and then the System.
11. Check for a correct operation.
12. Make a functional check of the equipment.
13. Note in the DataBook the cause and date of the replacement and fix an adhesive label of the new board indicating the date and name of the field engineer in order to give maximum info.

JOB CARD DR012:	REPLACEMENT OF THE CHARGE/DISCHARGE MONITOR BOARD

SUBASSEMBLY : **CHARGE/DISCHARGE MONITOR BOARD (A3212-XX).**

TOOLS : Standard Service Tool Kit.

PROCEDURE



TURN OFF THE GENERATOR AND ISOLATE THE POWER FROM THE ELECTRICAL CABINET.

BEFORE ANY MANIPULATION, ENSURE THAT THERE IS NO VOLTAGE PRESENT IN THE CAPACITORS BANK.

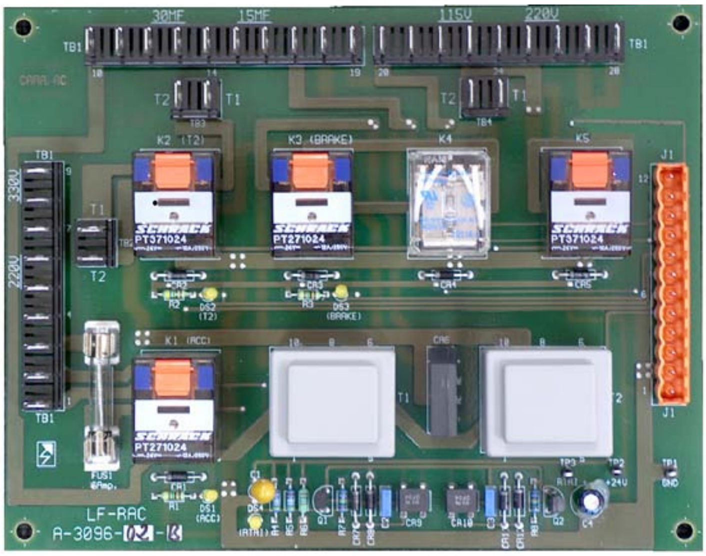
1. Remove All connectors of the board and note their positions.
2. Remove the four Allen screws used to secure the board to the Cabinet.
3. Replace the old board with the new one.
4. Replace the four Allen screws.
5. Replace all the connectors previously removed.
6. Power ON the Electrical Cabinet and System.
7. Check for correct operation (Led ON) and 0 VDC in resistor R4 when the equipment is ON. This should be more than 200 VDC right after the equipment is Powered OFF.
8. Make a functional check of the equipment.
9. Note in the DataBook the cause and date of the replacement and fix an adhesive label beside the new board indicating the date and name of field engineer in order to give maximum info.

JOB CARD DR013: REPLACEMENT OF THE LOW SPEED BOARD

SUBASSEMBLY : **LOW SPEED BOARD / LF RAC (A3096-02)**

TOOLS : Standard Service Tool Kit.

PROCEDURE



CAUTION

TURN OFF THE GENERATOR AND ISOLATE THE POWER FROM THE ELECTRICAL CABINET.

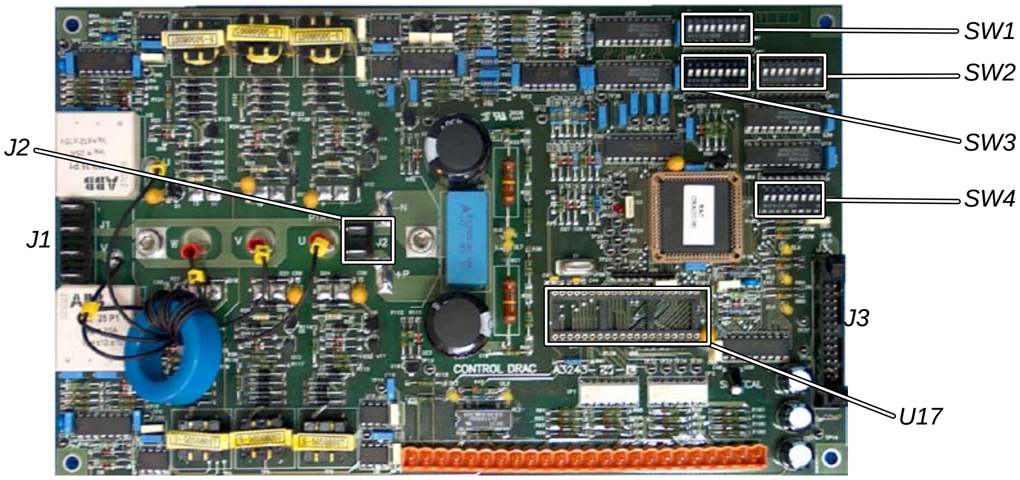
10. Remove all connectors and note their positions.
11. Remove the four Allen screws used to secure the board to the Cabinet.
12. Replace the old board with the new one.
13. Replace the four Allen screws.
14. Reconnect all previously removed connectors.
15. Power ON the Electrical Cabinet and the System.
16. Make a functional check for the acceleration, running and braking times, visually checking the rotation of the anode through the window.
17. Make a functional check of the equipment.
18. Note in the DataBook the cause and date of the replacement and fix an adhesive label beside the new board indicating the date and name of the field engineer in order to give maximum info.

JOB CARD DR014: REPLACEMENT OF THE HIGH SPEED BOARD

SUBASSEMBLY : **HIGH SPEED BOARD (A3243-XX).**

TOOLS : Standard Service Tool Kit.

PROCEDURE



TURN OFF THE GENERATOR AND ISOLATE THE POWER FROM THE ELECTRICAL CABINET.

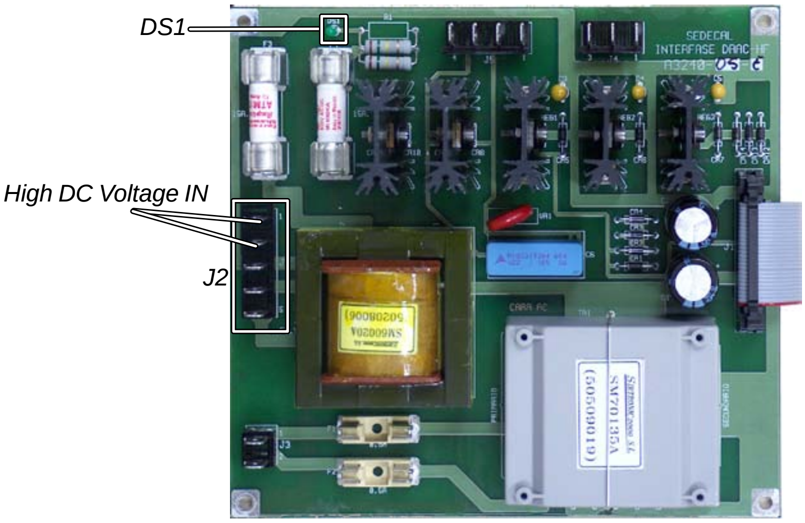
1. Note the actual setting of jumpers on the board.
2. Remove all wires and connectors of the board and note their positions.
3. Remove the four Allen screws used to secure the board to the Cabinet.
4. Replace the old board with the new one.
5. Replace the four Allen screws.
6. Replace all wires and connectors previously removed.
7. Set jumpers to their original position *(see Step 1).*
8. Place the old U17 onto the new board.
9. Power on the Electrical Cabinet and System.
10. Make a functional check of acceleration, running and braking times and visually check the rotation of the anode through the window.
11. Make a functional check of the equipment.
12. Note in the DataBook the cause and the date of the replacement and fix an adhesive label beside the new board indicating the date and name of the field engineer in order to give the maximum info.

JOB CARD DR015: REPLACEMENT OF THE INTERFACE DRAC-HT

SUBASSEMBLY : **INTERFACE DRAC-HF (A3240-XX).**

TOOLS : Standard Service Tool Kit.

PROCEDURE



ENSURE THAT LED DS1 IS ON WHEN THE SYSTEM IS ON.

SHUT DOWN THE GENERATOR AND ISOLATE THE POWER FROM THE ELECTRICAL CABINET, WAITING AT LEAST 3 MINUTES FOR THE POWER MODULE TO DISCHARGE.

THE LED DS1 BEGINS TO DIM DURING DISCHARGE AND IS OFF WHEN COMPLETELY DISCHARGED. NEVERTHELESS, ENSURE THAT DC VOLTAGE IS NOT PRESENT AT J2-1 & J2-2 BEFORE CONTINUING WITH THE REASSEMBLY.

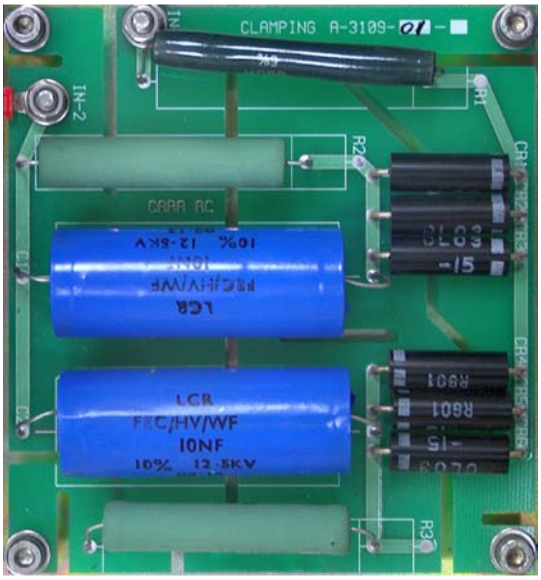
1. Remove all wires and connectors of the board, noting their positions.
2. Remove the four Allen screws used to secure the board to the Cabinet.
3. Replace the old board with the new one and secure it to the Chassis with the four Allen screws.
4. Replace all previously removed connectors. Ensure that Connections line up properly, the first and the last pin are numbered to aid this task.
5. Power on the Electrical Cabinet and the System.
6. Make a functional check of the equipment, acceleration, running and braking times with a visual check of the rotating anode.
7. Note in the DataBook the cause and the date of the replacement and fix an adhesive label beside the new board indicating the date and name of the field engineer in order to give the maximum info.

JOB CARD DR016: REPLACEMENT OF THE CLAMPING BOARD

SUBASSEMBLY : **CLAMPING BOARD (A3109-XX).**

TOOLS : Standard Service Tool Kit.

PROCEDURE



TURN OFF THE GENERATOR AND ISOLATE THE POWER FROM THE ELECTRICAL CABINET.

1. Remove all wires of the board and note their positions.
2. Remove the four screws used to secure the board to the Cabinet.
3. Replace the old board with the new one.
4. Replace the four Allen screws.
5. Replace all wires previously removed.
6. Power ON the Electrical Cabinet and the System.
7. Make a functional check of the equipment.
8. Note in the DataBook the cause and date of the replacement and fix an adhesive label beside the new board indicating the date and name of the field engineer in order to give maximum info.

JOB CARD DR017A: REPLACEMENT OF THE HIGH VOLTAGE TANK

SUBASSEMBLY : **HIGH VOLTAGE TANK (ONE TUBE)**

TOOLS : Standard Service Tool Kit.

PROCEDURE

CAUTION

TURN OFF THE GENERATOR AND ISOLATE THE POWER FROM THE ELECTRICAL CABINET.

1. Remove all wires and cables from the Tank and note their positions. These wires from the Inverter Module are P1, P3 and “Shield” (SHLD). The ground wire (GND) is directly connected to the Chassis.

2. Replace the old tank with the new one and replace all connections previously removed in Step 1.

Note ☞ *Do not open the Oil Cover as the Oil Level does not need to be checked in this type of tank.*

3. Power ON the Electrical Cabinet and then the System.

4. Make a check with a few mA and kV settings and recalibrate the system if necessary following the Calibration Procedures for *kV Loop*, *Digital mA Loop Closed* and *Digital mA Loop* (both Focal Spots) detailed in the Calibration Chapter of the Service Manual.

5. Return the faulty tank to the factory.

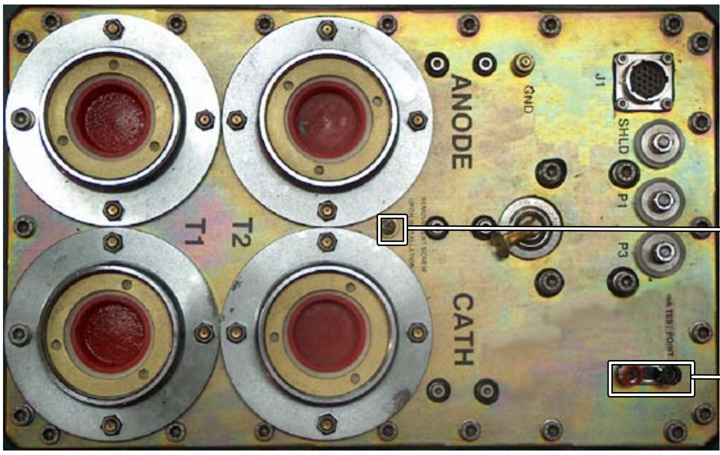
6. Note in the DataBook the cause and date of the replacement and fix an adhesive label beside the new board indicating the date and name of the field engineer in order to give the maximum info.

JOB CARD DR017B: REPLACEMENT OF THE HIGH VOLTAGE TANK

SUBASSEMBLY : **HIGH VOLTAGE TANK (TWO TUBES)**

TOOLS : Standard Service Tool Kit.

PROCEDURE



CAUTION

TURN OFF THE GENERATOR AND ISOLATE THE POWER FROM THE ELECTRICAL CABINET.

1. Remove all wires and cables from the Tank and note their positions. The wires from the Inverter Module are P1, P3 and “Shield” (SHLD). The ground wire (GND) is directly connected to the Chassis.

2. Replace the old tank with the new one and replace the wires and cables previously removed in the previous step.

3. Loosen the ventilation screw (Phillips Head Screw shown in the photo above). There should be no leakage present. Check that the oil is approximately 20mm (3/4”) from the surface of the HV Transformer.

4. Power ON the Electrical Cabinet and then the System.

5. Make a check in a few mA and kV settings for each tube and with both filaments and Recalibrate the system if necessary following the Calibration Procedures for *kV Loop*, *Digital mA Loop Closed* (calibrating one tube is sufficient) and *Digital mA Loop* (both Tubes and Focal Spots) detailed in the Calibration Chapter of the Service Manual.

6. Make a functional check of the equipment.

7. Return the faulty tank to the factory.

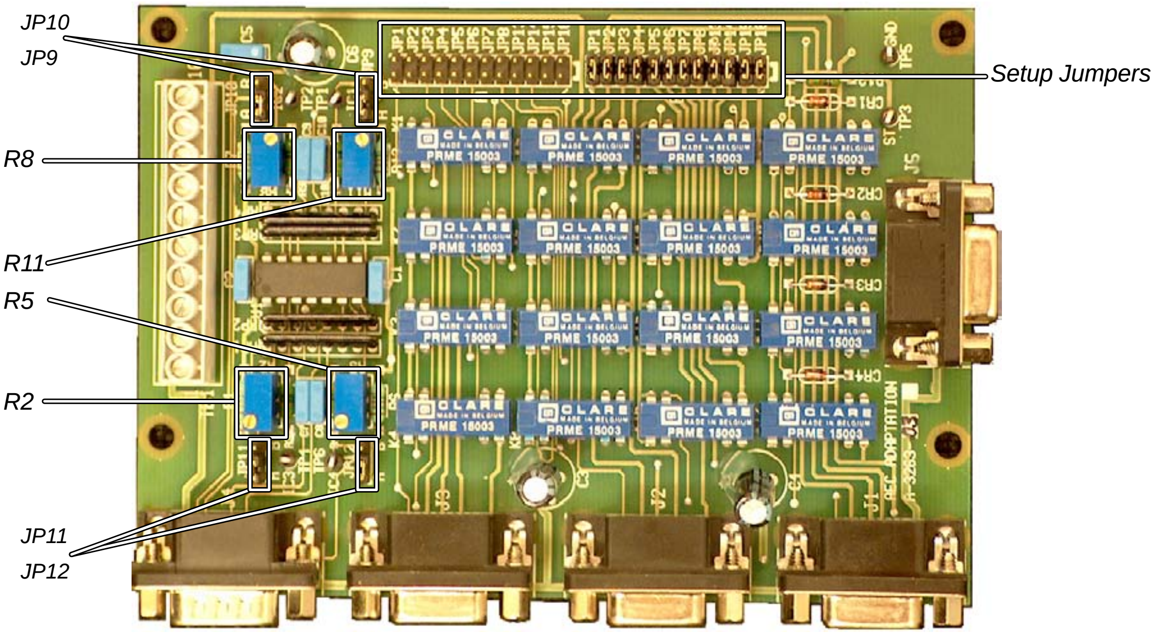
8. Note in the DataBook the cause and date of the replacement and fix an adhesive label beside the new board indicating the date and name of the field engineer in order to give the maximum info.

JOB CARD DR018: REPLACEMENT OF THE AEC ADAPTATION BOARD

SUBASSEMBLY : **AEC ADAPTATION BOARD (A3263-XX)**

TOOLS : Standard Service Tool Kit.

PROCEDURE



TURN OFF THE GENERATOR AND ISOLATE THE POWER FROM THE ELECTRICAL CABINET.

1. Note the actual setting of jumpers on the board. Their configuration depends on the Ion Chamber setup with the system. The table below will help you with this task, this is the same table from the Data Book chapter in the Service Manual. See Schematic A3263-xx in the Service Manual for more information.

JUMPERS POSITION	
JP3, JP4, JP7, JP8	
JP1, JP2, JP5, JP6	
JP13, JP14, JP15, JP16	
JP9 (IC1)	
JP10 (IC2)	
JP11 (IC3)	
JP12 (IC4)	

2. Remove all connectors of the board and note their positions.

3. Remove the four Allen screws used to secure the board to the Cabinet.

4. Replace the old board with the new one.

5. Replace the four Allen screws.

6. Replace all connectors previously removed.

7. Set jumpers to their original positions *(see Step 1).* In case jumpers 9 - 12 have come in different positions to those on the previous board, set them to their necessary positions and ensure a proper Ion Chamber Output according to the table below. If the jumpers are in the same position, proceed to the next step.

   Ion Chambers output has to be 0 VDC when there is no radiation (no-Offset Adjustment). If an Ion Chamber output has an offset, it must be adjusted to 0 VDC with the respective Potentiometer. The table below will aid with any necessary adjustment.

ION CHAMBER OUTPUT	JUMPERS POSITION			
	JP9 (IC1)	**JP10 (IC2)**	**JP11 (IC3)**	**JP12 (IC4)**
NO-OFFSET ADJUSTMENT	A	A	A	A
OFFSET ADJUSTMENT	B	B	B	B
TEST POINT AND POTENTIOMETER (ONLY IF JUMPER IS IN “B” POSITION)	TP1 - R11	TP2 - R8	TP4 - R2	TP12 - R5

8. Power ON the Electrical Cabinet and System.

9. Make several exposures with different AEC technique settings in order to ensure a correct selection.

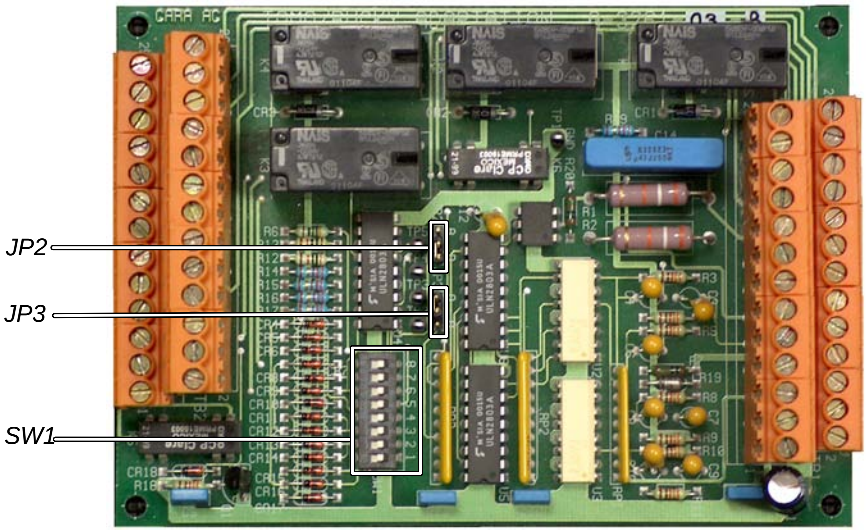
10. Make a functional check of the equipment.

11. Note in the DataBook the cause and date of the replacement and fix an adhesive label beside the new board indicating the date and name of the field engineer to give maximum info.

JOB CARD DR019: REPLACEMENT OF THE TOMO / BUCKY INTERFACE BOARD

SUBASSEMBLY : **TOMO/BUCKY INTERFACE BOARD (A3261-03)**
TOOLS : Standard Service Tool Kit.

PROCEDURE



TURN OFF THE GENERATOR AND ISOLATE THE POWER FROM THE ELECTRICAL CABINET.

1. Note the actual setting of jumpers JP2 & JP3 and Dipswitch SW1.

Positions	JP2	JP3	Switch Position	Dipswitch SW1							
				1	2	3	4	5	6	7	8
A			**ON**								
B			**OFF**								

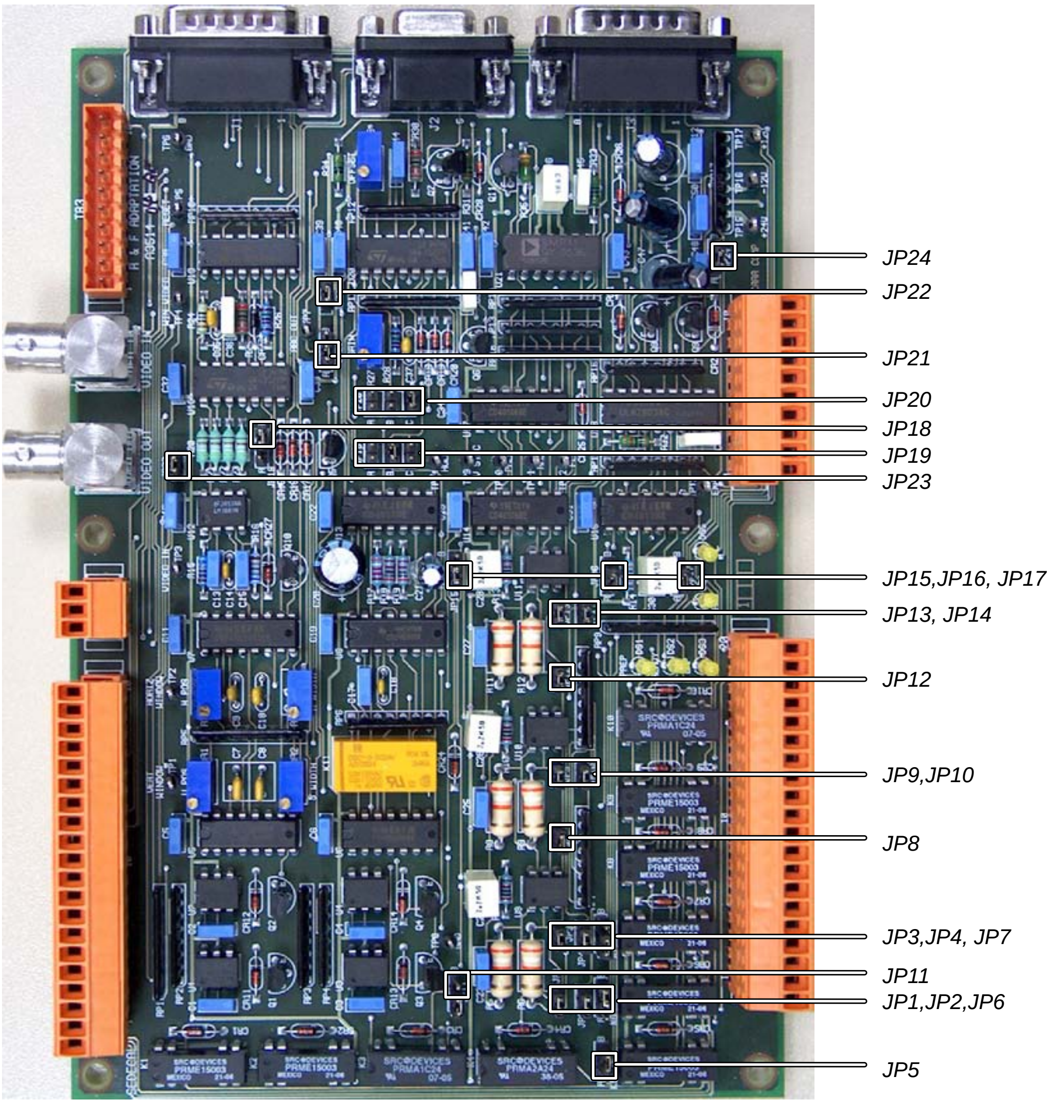
2. Remove all wires from the terminal strips and note their positions.
3. Remove the four Allen screws used to secure the board to the Cabinet.
4. Replace the old board with the new one.
5. Replace the four Allen screws and reconnect wires to the terminal strips.
6. Set jumpers and switches to their original positions *(see Step 1)*
7. Power ON the Electrical Cabinet and System.
8. Make a functional check for the Tomo and Bucky selection, Tomo Times, if available with the application; and the entire equipment.
9. Note in the DataBook the cause and date of the replacement and fix an adhesive label beside the new board indicating the date and name of the field engineer in order to give maximum info.

JOB CARD DR020: REPLACEMENT OF THE RF ADAPTATION BOARD

SUBASSEMBLY : **RF ADAPTATION BOARD (A3514-XX).**

TOOLS : Standard Service Tool Kit.

PROCEDURE



TURN OFF THE GENERATOR AND ISOLATE THE POWER FROM THE ELECTRICAL CABINET.

Note ☞

For additional information on the RF Adaptation board, refer to the respective sections in the Installation and Configuration documents of the Service Manual as well as the corresponding schematics.

1. Remove all wire connections from the board and take note of their positions and markings.

Note ☞ *Although jumpers are set according to the system configuration, the jumpers on the replacement board* ***must be set during the reassembly procedure****. Refer to Fluoro Configuration in the Data Book when confirming a correct jumper position; also refer to the Fluoro Configuration section in the Configuration document for more information about each Jumper for the RF Adaptation board.*

2. It is recommended to set the jumpers on the replacement board exactly as found on the old board before mounting the board. The table below (same as in Data Book) will aid in this task.

JUMPERS POSITION			
RF Adaptation Board A3514-_____			
JP1, JP3, JP4, JP8, JP9, JP10, JP12, JP13, JP14		JP17	
JP2		JP18	
JP5		JP19	
JP6		JP20	
JP7		JP21	
JP11		JP22	
JP15		JP23	
JP16		JP24	

3. Remove the four Allen screws used to secure the board to the Cabinet.

4. Replace the old board with the new one, fixing the replacement board to the Cabinet with the same Allen screws used for the old board.

5. Replace all the connectors previously removed and then Power On the Electrical Cabinet and System.

6. Ensure that all jumpers are in their proper position and then check for a proper Fluoro operation and ABC, if available, by carrying out expositions with various different technical parameters.

   Calibration may be necessary for ABC when the ABC signal from the TV Camera is not compatible with the Generator or there is not ABC signal from the TV Camera (refer to the ABC Calibration in the Calibration document of the Service Manual).

7. Make a functional check of the equipment.

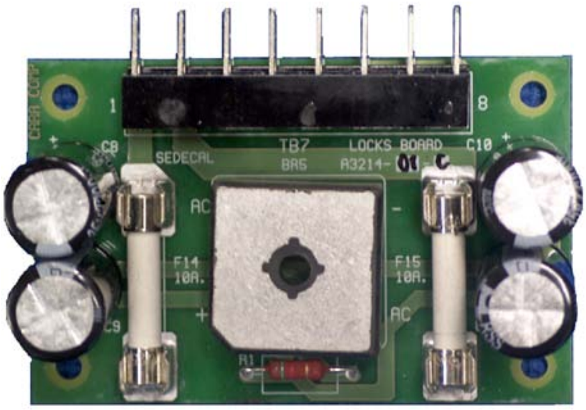
8. Note in the Data Book the cause and date of the replacement and fix an adhesive label beside the new board indicating the date and name of field engineer in order to give maximum info.

JOB CARD DR021A: REPLACEMENT OF THE LOCKS BOARD

SUBASSEMBLY : **LOCKS BOARD (A3214-01).**

TOOLS : Standard Service Tool Kit.

PROCEDURE



TURN OFF THE GENERATOR AND ISOLATE THE POWER FROM THE ELECTRICAL CABINET.

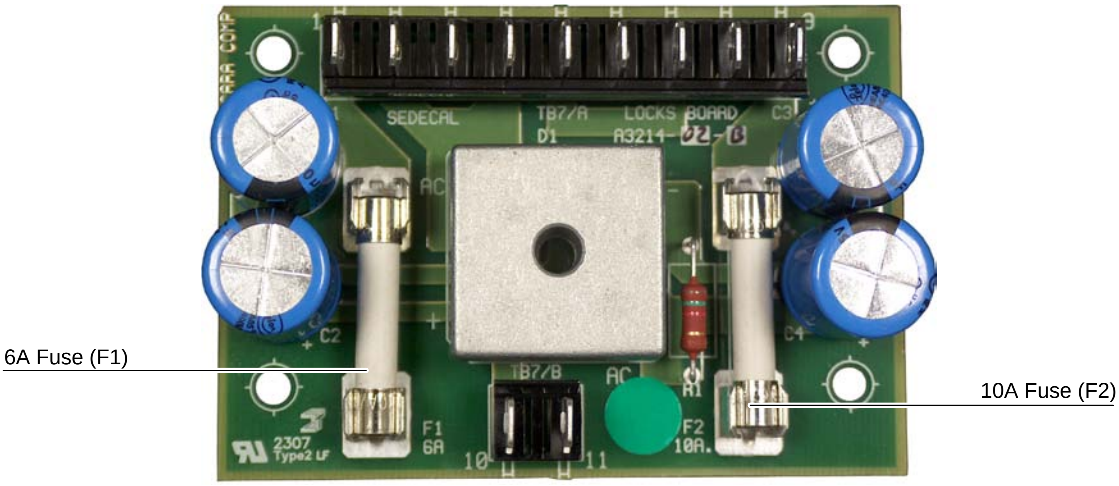
1. Remove all wires of the board and note their positions.
2. Remove the four screws and nuts with washers used to secure the board to the Cabinet.
3. Replace the old board with the new one.
4. Replace the four Allen screws.
5. Replace all wires previously removed.
6. Power ON the Electrical Cabinet and then the System.
7. Check that the Locks, tube stand, colimator light, etc function correctly.
8. Make a functional check of the equipment.
9. Note in the DataBook the cause and date of the replacement and fix an adhesive label beside the new board indicating the date and name of the field engineer in order to give maximum info.

JOB CARD DR021B: REPLACEMENT OF THE LOCKS BOARD

SUBASSEMBLY : **LOCKS BOARD (A3214-$\geq$02).**

TOOLS : Standard Service Tool Kit.

PROCEDURE



CAUTION

TURN OFF THE GENERATOR AND ISOLATE THE POWER FROM THE ELECTRICAL CABINET.

1. Remove all wires of the board and note their positions.
2. Remove the four screws and nuts with washers used to secure the board to the Cabinet.
3. Replace the old board with the new one.
4. Replace the four Allen screws.
5. Replace all wires previously removed.
6. Power ON the Electrical Cabinet and then the System.
7. Check that the Locks, tube stand, colimator light, etc function correctly.
8. Make a functional check of the equipment.
9. Note in the DataBook the cause and date of the replacement and fix an adhesive label beside the new board indicating the date and name of the field engineer in order to give maximum info.

Technical Publication
MA-1004R6

Maintenance

HF Series Generators

REVISION HISTORY

REVISION	DATE	REASON FOR CHANGE
1	DEC 20, 2001	Text revision
2	APR 15, 2005	Review of Maintenance procedures
3	DEC 12, 2005	Reference to Calibration Chapter
4	MAR 26, 2008	Calibration of Touch Screen Sensor
5	JUN 02, 2016	New CTSC Touch Screen Console
6	OCT 30, 2017	AEC Checking

This Document is the English original version, edited and supplied by the manufacturer.

The Revision state of this Document is indicated in the code number shown at the bottom of this page.

ADVISORY SYMBOLS

The following advisory symbols will be used throughout this manual. Their application and meaning are described below.

DANGERS ADVISE OF CONDITIONS OR SITUATIONS THAT IF NOT HEEDED OR AVOIDED WILL CAUSE SERIOUS PERSONAL INJURY OR DEATH.

ADVISE OF CONDITIONS OR SITUATIONS THAT IF NOT HEEDED OR AVOIDED COULD CAUSE SERIOUS PERSONAL INJURY, OR CATASTROPHIC DAMAGE OF EQUIPMENT OR DATA.

Advise of conditions or situations that if not heeded or avoided could cause personal injury or damage to equipment or data.

Note ☞

Alert readers to pertinent facts and conditions. Notes represent information that is important to know but which do not necessarily relate to possible injury or damage to equipment.

TABLE OF CONTENTS

SECTION 1 INTRODUCTION

The purpose of this Periodic Maintenance is to assure continued safe performance of the X-ray Generator, to increase serviceability, to reduce the costs (down time, repairs, etc.) and to assure the safety (personal risk).

The following checks and maintenance procedures, together with the suggested intervals, are the manufacturer's recommendation for the most effective Periodic Maintenance schedule for this Generator.

Service tasks here described must be performed exclusively by service personnel specifically trained on medical X-ray Generators.

The first Periodic Maintenance Service should be performed six (6) months after installation, and the subsequent services every twelve (12) months. Periodic Maintenance Service depends on the working load of the Generator and X-ray Tube.

Note ☞ *Take note in the Data Book all the periodic maintenance services carried out and the data changes made during any maintenance service.*

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SECTION 2 PERIODIC MAINTENANCE PROCEDURES

CAUTION

When any major component, such as a X-ray Tube, HV Transformer or major circuit board, is replaced in the system, perform the respective Configuration and Calibration procedures.

Update and take note in the Data Book any new data entered in memory.

CAUTION

If the HT Control Board or the ATP Console CPU Board is replaced, check specially that Extended Memory data have not been lost or modified with the Board change. Compare Extended Memory data with the values noted in the Data Book.

Also, make some exposures using different techniques and Focal Spot and check that mA stations are calibrated correctly, if not perform Calibration procedures.

Before starting the periodic maintenance procedures, it is recommended to make a test exposure using the same operating factors and conditions as a typical exposure.

Perform the X-ray tube warm-up procedure if the tube has not been in use for approximately one hour. (*Refer to Operator Manual of the Console).*

2.1 TEST EQUIPMENT

The tools and test equipment required to perform the Periodic Maintenance Service are the same as specified in "*Installation*" document.

2.2 GENERAL CAUTIONS

MAKE SURE THAT THE MAIN CAPACITORS OF THE HIGH VOLTAGE INVERTER DO NOT CONTAIN ANY RESIDUAL CHARGE. WAIT UNTIL THE LIGHT EMITTING DIODES ON THE CHARGE-DISCHARGE MONITOR BOARDS ARE OFF, APPROX. 3 MINUTES AFTER THE UNIT IS TURNED OFF.

ALWAYS HAVE THE "IPM DRIVER BOARD" CONNECTED IN THE GENERATOR PREVIOUS TO MAINS POWER IS ACTIVATED IN IT. IF THE "IPM DRIVER BOARD" IS NOT CONNECTED, PERMANENT DAMAGE WILL OCCUR TO IGBTS.

LINE POWERED GENERATOR:
THIS GENERATOR IS PERMANENTLY CONNECTED TO THE POWER LINE, AND POWERED ON UNLESS THE SAFETY SWITCH INSTALLED IN THE ROOM ELECTRICAL CABINET IS OFF. WHEN THE GENERATOR IS POWERED, THE NEON LAMP (GREEN) LOCATED ON THE TRANSFORMER 6T2 (GENERATOR CABINET) IS ON.

INTERNAL PARTS OF THE GENERATOR (ALL FUSES, LINE CONTACTOR (6K5), INPUT TRANSFORMER (6T2), ON/OFF RELAY (3K3) AND LF-RAC MODULE) ARE PERMANENTLY POWERED ON THROUGH POWER LINE ALTHOUGH THE CONTROL CONSOLE IS OFF. BE SURE THAT THE SAFETY SWITCH IS OFF BEFORE HANDLING ANY INTERNAL PART OF THE EQUIPMENT.

DANGER !

<u>BATTERY POWERED GENERATOR</u>:
THIS GENERATOR IS PERMANENTLY CONNECTED TO THE POWER LINE THROUGH A LINE PLUG.

WHEN IT DOES NOT WORK WITH STAND-ALONE, IT IS POWERED ON UNLESS THE SAFETY SWITCH INSTALLED IN THE ROOM ELECTRICAL CABINET IS OFF. WHEN THE UNIT IS POWERED, THE NEON LAMP (GREEN) LOCATED ON THE TRANSFORMER 6T2 IS ON.

WHEN IT WORKS WITH OPTIONAL STAND-ALONE IT IS POWERED ON IN ALL SITUATIONS. WHEN THE UNIT IS TURNED ON, THE NEON LAMP (GREEN) LOCATED ON THE TRANSFORMER 6T2 IS ON.

KEEP THE PROTECTION COVERS IN PLACE ALL THE TIME, ONLY REMOVE THE COVERS TO PERFORM SERVICE OPERATIONS. INTERNAL PARTS (CONTACTOR 6K5, LINE FUSES, BATTERY CHARGER BOARD, LINE MONITOR BOARD, BATTERY MONITOR BOARD, ENERGY GUARD BOARD AND STAND-ALONE BOARD) ARE PERMANENTLY POWERED ON AND HAVE THE FULL VOLTAGE POTENTIAL OF THE BATTERIES (APPROX. 400 VDC) ALTHOUGH THE UNIT IS DISCONNECTED FROM THE LINE OR THE CONTROL CONSOLE IS OFF. USE CAUTION WHEN WORKING IN THIS AREA.

DANGER !

<u>CAPACITOR ASSISTED GENERATOR</u>:
THIS GENERATOR IS PERMANENTLY CONNECTED TO THE POWER LINE THROUGH A LINE PLUG. IT IS POWERED ON UNLESS THE SAFETY SWITCH INSTALLED IN THE ROOM ELECTRICAL CABINET IS OFF. WHEN THE UNIT IS POWERED, THE NEON (GREEN) LOCATED ON THE TRANSFORMER 6T2 IS ON.

KEEP THE PROTECTION COVERS IN PLACE ALL THE TIME, ONLY REMOVE THE COVERS TO PERFORM SERVICE OPERATIONS. INTERNAL PARTS (CAPACITOR OF HV INVERTER, STORAGE CAPACITORS MODULE, LINE FUSES, DC BUS FUSES, ETC.) ARE PERMANENTLY POWERED ON AND HAVE THE FULL VOLTAGE POTENTIAL OF THE CAPACITORS (APPROX. 800 VDC), ALTHOUGH THE UNIT IS DISCONNECTED FROM THE LINE OR THE CONTROL CONSOLE IS OFF. USE CAUTION WHEN WORKING IN THIS AREA.

2.3 GENERAL CLEANING

NEVER ATTEMPT TO CLEAN OR HANDLE ANY PART OF THE GENERATOR WHEN IT IS TURNED ON. SWITCH OFF THE GENERATOR MAIN DISCONNECT BEFORE CLEANING OR INSPECTING.

DO NOT SUPPLY THE MAIN POWER UNTIL SPECIFICALLY INSTRUCTED TO DO SO IN THIS DOCUMENT.

2.3.1 EXTERNAL SURFACES

Clean external covers and surfaces frequently, particularly if corroding chemicals are present and specially parts in contact with the patient, with a soft cloth moistened in warm water with mild soap solution. Rinse wipe with a soft cloth moistened in clean water. Do not use cleaners or solvents of any kind.

Clean Console keyboard and displays with a cloth dampened in warm water. Rinse wipe with a cloth dampened in clean water.

Also check painted surfaces for scratching and touch up as required.

2.3.2 INTERNAL CABINET CLEANING

MAKE SURE THAT THE MAIN CAPACITORS OF THE HIGH VOLTAGE INVERTER DO NOT RETAIN ANY RESIDUAL CHARGE. LED ON THE CHARGE-DISCHARGE MONITOR BOARDS HAVE TO BE OFF.

Remove the external access cover from the Generator Cabinet.

Visually inspect all major components for dust or foreign items. Search carefully to detect objects which might cause short circuits and for loose connections.

If excess dust is present, clean the interior of the Generator Cabinet using a dry brush or vacuum cleaner. Make sure that the fans operate properly and the vent holes of the cabinet are not obstructed.

2.3.3 INTERNAL CLEANING OF THE CTSC TOUCH SCREEN CONSOLE

DANGER !

MAKE SURE THAT THE CTSC TOUCH SCREEN CONSOLE IS POWERED OFF OR UNPLUGGED.

Remove the cover of the CTSC Touch Screen Console.

Visually inspect internally for dust or foreign items. Search carefully to detect objects which might cause short circuits and for loose connections.

If excess dust is present, clean the interior of the CTSC Touch Screen Console using a dry brush or vacuum cleaner. Make sure that the fans operate properly and the vent holes are not obstructed.

Clean the Touch Screen sensor with an isopropyl alcohol and water solution ratio of 50:50 , always damp the lint-free cloth and then clean the screen. Spray the cleaning liquid onto the cloth, never spray directly on the screen.

2.4 CABLE CHECKS

CAREFULLY HANDLE ALL INTERNAL PARTS OF THE UNIT.

Check that all electrical connections are firm and secure and that all cable clamps and strain reliefs are in place. Also check that connectors do not have exposed wire-veins and check cable sheaths (cable cover) for wear and fraying.

Check that all cables are correctly routed.

2.4.1 GROUND CABLE CONNECTIONS

The central reference ground of the X-ray System and Generator is located at the Generator Cabinet.

Check the ground lead interconnections continuity using a multimeter at its lowest ohms range.

2.4.2 AC POWER SUPPLY IN X-RAY ROOM

Measure the value of AC power supply between all phases, neutral and ground. Check that these values comply with the tolerances established at the original installation.

2.4.3 CABLE CONNECTIONS OF THE CTSC TOUCH SCREEN CONSOLE

Check connection and condition of the interconnection cables of the Console.

Check the Handswitch condition. Verify that the Handswitch cable and its connection to the Console are in good condition.

2.5 CONTROL CONSOLE CONDITION

Check the proper connection and condition of the cables connected to the Console.

Check correct operation of the buttons, displays and indicators by performing the following test:

1. Turn the Generator / Console ON.

2. If the Console is a Touch Screen Console, touch on different points of the operator application on the Touch Screen to check that the Touch Screen Sensor is properly calibrated. It is factory calibrated and it does not require any calibration procedure.

3. If applicable, check the Handswitch condition. Verify that the Handswitch cable and its connection to the Console are in good condition.

4. Select a radiographic technique and observe:

   - Indicators of the selected workstation and Focal Spot.

   - Technique parameters are displayed on the Console. Change technique parameters and observe that changes are correctly displayed.

   - Select the parameters for an usual exposure. Press “*Prep*” and verify that the “*Ready*” indicator is activated. Release “*Prep*” and observe that the “*Ready*” indicator is deactivated.

   - Make the exposure, and verify that radiographic exposure signal sounds and the “*Prep*” and “*X-ray On*” indicators are activated during the exposure.

5. If AEC is installed, select a technique with AEC and observe that the indicators of the selected AEC controls are activated.

6. If APR is installed, select an APR technique and observe:

   - Indicators of the selected Patient Size are activated and the Body Region / Anatomical Views are shown on the APR Display and its corresponding parameters are shown on the RAD Display.

   - Change the APR technique and observe that selection and parameters changes on both Displays.

7. If Fluoro is installed, select a workstation for Fluoro operation and observe:

   - Fluoro parameters are displayed on the Fluoro Display.
   - Change the Fluoro kV and observe that changes are correctly displayed.
   - Check selection of another functions related to Fluoro if they are present (ABC, PPS, etc.).

2.6 HV TRANSFORMER CONDITION

The HV Transformer contains “Shell Diala AX” oil.

Check that there is not oil leakage. If found, remove the oil fill plug from the top of the HV Transformer and verify that the oil level is within 20 mm (3/4”) of the top surface of the HV Transformer. If necessary add oil “Shell Diala AX”.

Note ☞ *This point does not apply to the hermetic HV Transfromers (black aluminium HV Transformers).*

Make sure that:

- HV oil in the HV Cable terminals is clean and shows no evidence of arcing.
- HV Cable terminal rings are tight.

2.7 X-RAY TUBE CONDITION

Make sure that:

- All parts are mechanically secure with no oil leaks.
- HV grease on the HV Cable terminals is clean and shows no evidence of arcing.
- HV Cable terminal rings are tight.

2.8 RADIOGRAPHIC PARAMETERS

With the generator power OFF, connect:

- Non-invasive kV Meter to measure kV.
- mAs Meter to the banana plug connections on the HV Transformer to measure mA or mAs (connect the mAs Meter for Digital mA Loops calibration).

Note ☞ *Test points on the HT Controller PCB can also be used to monitor the kV and mA readings but **<u>should not be used</u>** to calibrate the unit. These test points must be checked with scope. (Refer to Calibration chapter – Section 2 "Calibration Procedures", for test points and scale factors).*

2.8.1 TEST FOR kV LOOP

1. Verify that dip switch 3000SW2-2 on the HT Controller Board is in *"**Off**"* position (enables Filament and Rotor Interlocks).
2. Turn the Generator ON and select the "*Direct*" (*No Bucky*) workstation in one of the X-ray Tubes.
3. Select 80 kV, 200 mA (or the first mA station for Large Focus), 100 ms. Make an exposure and note the kV at the end of the exposure.
4. Check that the kV value read on the kV Meter must be 80 ±1 kV.

   If the kV value does not comply with the above value, perform the respective Calibration procedures.

2.8.2 TEST FOR DIGITAL mA LOOP OPEN

1. Set the dip switch 3000SW2-4 on the HT Controller Board in *"**On**"* position (Digital mA Loop Open / Filament Current Constant).

Note ☞ *Only for Generators with LF-RAC (LSS):*

*– When the mA Loop is open (dip switch 3000SW2-4 in "**On**"), the rotor runs for two minutes after release the handswitch push-button from "Preparation" position.*

*– When the mA Loop is closed (dip switch 3000SW2-4 in "**Off**"), the Tube will brake after release the handswitch push-button from "Preparation" position.*

2. Enter in Manual Calibration selecting the "*Direct*" (*No Bucky*) workstation of the corresponding X-ray Tube.

3. Select 80 kV and the following mA stations. Make an exposure and note the mAs values read on the mAs Meter.

   - Minimum mA for Small Focal Spot.
   - Maximum mA for Small Focal Spot.
   - Minimum mA for Large Focal Spot.
   - Maximum mA for Large Focal Spot.

4. Check that the mAs values read on the mAs Meter must be the same mAs displayed on the Console with a tolerance of ±6% mAs.

   If the mAs values do not comply with the above values, perform the respective Auto-Calibration procedures.

5. Repeat this test for the second X-ray Tube.

6. Turn the Generator OFF and set the dip switch 3000SW2-4 on the HT Controller Board in *"**Off**"* position (Digital mA Loop Closed).

2.8.3 TEST FOR DIGITAL mA LOOP CLOSED

1. Turn the Generator ON and select the "*Direct*" (*No Bucky*) workstation in one of the X-ray Tubes.

2. Select the following parameters, make an exposure and note the mAs values read on the mAs Meter.

   - 80 kV, 100 ms, 50 mA.
   - 80 kV, 100 ms, 200 mA.

3. Check that the mAs values read on the mAs Meter must be the same mAs displayed on the Console with a tolerance of ±4% mAs.

4. If the mAs values do not comply with the above values, perform the respective Auto-Calibration procedures.

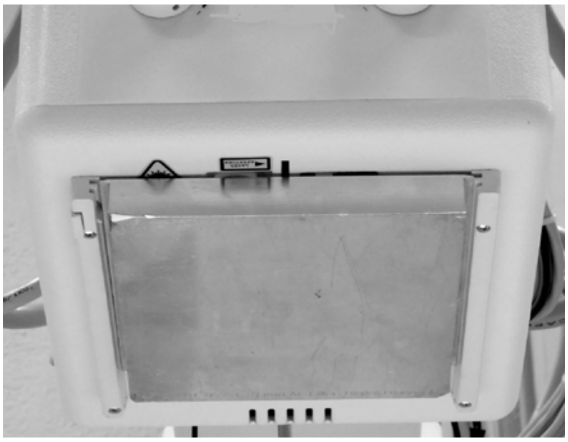
5. Turn the Generator OFF.

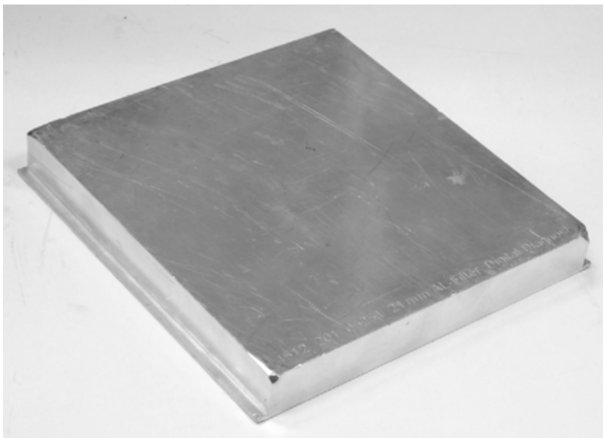
2.9 AEC CHECKS

The AEC is calibrated to produce a density of 1.0 (or the customer preference Optical Density for Film) or an Optimum Gray Level (for CR or DR) at 70 kV, and then AEC kV Tracking is adjusted to produce the same density at 55 kV and 90 kV.

AEC Checks are carried out using a homogeneous Phantom of Aluminium with a purity of not less that 99% and thickness of 21 mm, to produce an exposure between 50 ms and 300 ms. (*Refer to Illustration 2-1)*.

Illustration 2-1
Phantom of Aluminium





Note ☞ ***For AEC with Film**, use the same Film and Cassettes used by the customer. AEC calibration <u>must be performed</u> using the Medium Film/Screen speed combination. The Medium Film/Screen speed has to be double of the Slow and half of the Fast (a.e. 200-Slow, 400-Medium, 800-Fast).*

Note ☞ ***For AEC with CR (Computer Radiography) or DR (Digital Radiography)**, measure the Image Gray Level or Dose Level by using the needed software tools inside each Acquisition Application.*

2.9.1 OPTICAL DENSITY / IMAGE GRAY LEVEL

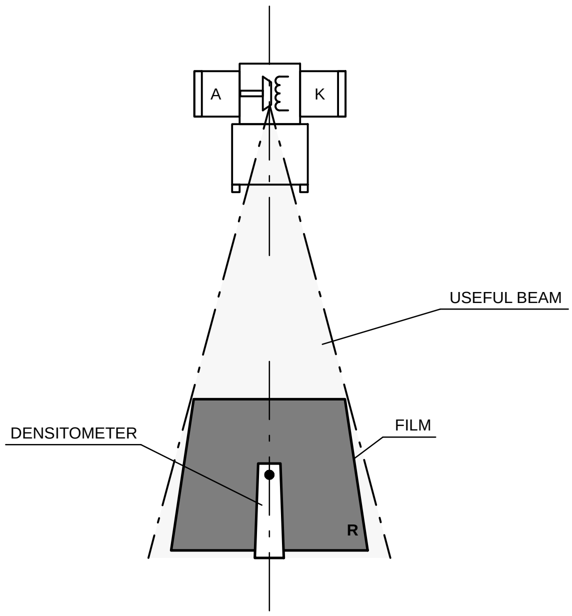
Note ☞ *For Film, the Film Optical Density must be measured always on the same point for all the X-ray Films developed during this procedure.*

The recommended point is on the central axis of the Film with relation of the Anode and Cathode and as close as possible to center of the Film.

Note ☞ *For CR or DR, the Image Gray Level must be measured always on the same area (Region of Interest) for all the RAW images obtained during this procedure.*

The recommended ROI is 4 x 4 cm on the center of the CR or Detector.

Illustration 2-2
How to measure the Film Optical Density (only for Film)



1. Set SID at the Focal Distance of the Grid to be used in the Table Receptor (usually 100 cm) or in the Vertical Stand Receptor (usually 100 cm and 150 cm or 180 cm).

2. Open the Collimator blades completely.

3. Place in the Collimator guides a Phantom of Aluminium with a purity of not less that 99% .

4. Select a workstation for the Ion Chamber to be tested. Select on the Console:

   - RAD Menu: 70 kV, 100 mA and 1 second back-up time.

   - AEC Menu: "*Central Field*" , "*Density 0*" and "*Medium Film/Screen*".

5. **For Film**, insert a cassette with the Medium Film/Screen combination used by the customer. Make an exposure, develop the film and check the Optical Density, it should be 1.0 (or the customer preference O. Density).

   For CR or DR, make an exposure with the CR or DR in the Receptor housing. Check the value of the Image Gray Level or the Dose Level shown on the Acquisition Application, it should be the Gray Level and/or Dose reference values established by the manufacturer of the CR or DR.

CAUTION

The exposure time must be between 50 ms and 300 ms. If not, increase or decrease the mA value, and repeat the exposure.

6. If the Optical Density / Image Gray Level or Dose Level is not as required, perform the respective AEC Calibration procedure.

7. Repeat the above steps for all the Ion Chambers installed with the Generator.

2.9.2 kV COMPENSATION

1. Select a workstation for the Ion Chamber to be tested. Select on the Console:

   - RAD Menu: 55 kV, 100 mA and 1 second back-up time.
   - AEC Menu: “*Central Area*” , “*Density 0*” and “*Medium Film/Screen*”.

2. **For Film**,

   - Make an exposure at 55 kV without film in the cassette, but the cassette inserted in the Receptor housing, and check that the Exposure Time is between 50 ms and 300 ms. If necessary, change the mA value and make the exposure again. Take note of the final mA station selected for 55 kV.
   - Make an exposure at 90 kV without film in the cassette, but the cassette inserted in the Receptor housing, and check that the Exposure Time is between 50 ms and 300 ms. If necessary, change the mA value and make the exposure again. Take note of the final mA station selected for 90 kV.
   - Insert a cassette with the Medium Film/Screen combination used by the customer. Make an exposure at 55 kV and 90 kV *(use the selected mA station noted before for each kV)*, develop the film and measure the Optical Density obtained with those exposures.
   - Check that the variation range is the same ±0.2 of the Optical Density obtained before at 70 kV.

3. **For CR or DR**,

   - Make an exposure at 55 kV with the CR or DR inserted in the Receptor housing and check that the Exposure Time is between 50 ms and 300 ms. If necessary, change the mA value and make the exposure again. Take note of the Image Gray Level obtained at 55 kV.
   - Make an exposure at 90 kV with the CR or DR inserted in the Receptor housing and check that the Exposure Time is between 50 ms and 300 ms. If necessary, change the mA value and make the exposure again. Take note of the Image Gray Level obtained at 90 kV.
   - Check that the variation range is the same ±20% of Image Gray Level obtained before at 70 kV (*Optical Density / Image Gray Level – Section 2.9.1*).

4. If the variation values is not as required, perform the respective AEC Calibration procedure.

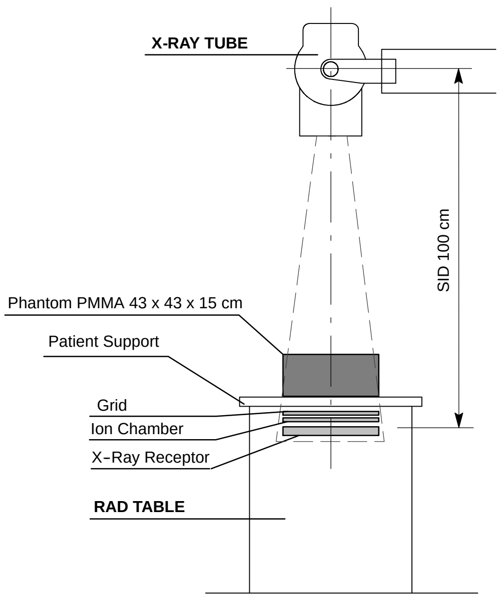
5. Repeat the above steps for all the Ion Chambers installed with the Generator.

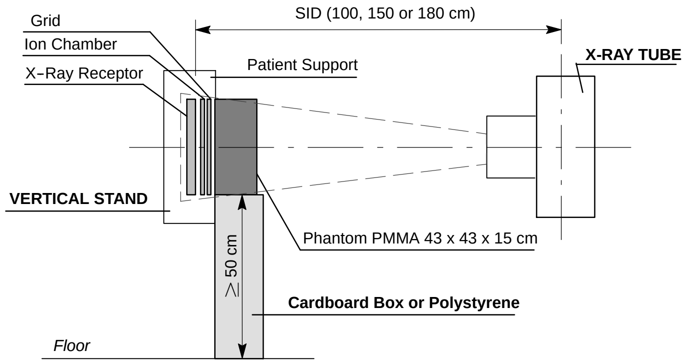
Note ☞ *Once the above checkings are finished, remove from the Collimator guides the Phantom of Aluminium.*

2.9.3 BALANCE CHECKING FOR THREE FIELD DETECTORS

Note ☞ *This checking is carried out using a homogeneous Phantom of PMMA (Polymethylmethacrylate) with a surface of 43 x 43 cm and a thickness of 15 cm so that the Three Field Detectors of the Ion Chamber receive the same amount of scattered radiation. As an alternative to the Phantom of PMMA, the Phantom of Aluminum used for the previous AEC Checks and placed on the Collimator guides can be used, but it is recommended to use the Phantom of PMMA.*

1. Set SID at the Focal Distance of the Grid to be used in the Table Receptor (usually 100 cm) or in the Vertical Stand Receptor (usually 100 cm, 150 cm and/or 180 cm). Place the Phantom as shown in the next illustration. In the case of the Table, the Tabletop must be completely centered.





2. Open the Collimator blades up to cover the base of the Phantom.

3. Select on the Console:

   - RAD Menu: 70 kV, 100 mA and 1 second back-up time.
   - AEC Menu: "*Central Field*" , "*Density 0*" and "*Medium Film/Screen*".

4. Make the following sequence of exposures (in case of Film, without film in the cassette, but the cassette inserted in the Receptor housing) (in case of CR or DR, with the CR or DR inserted in the Receptor housing) and check that the Exposure Time is between 50 ms and 300 ms. If necessary, change the mA value and make the exposure again. Take note of the final mA station selected for each exposure with the Grid removed and with the Grid inserted/installed.

Note ☞ *If the Grid can not be removed from the Receptor housing, perform only the exposures with the Grid installed.*

The sequence of exposures are:

- 3 exposures with the Grid removed and the "*Left Field*" of the Ion Chamber selected.
- 3 exposures with the Grid removed and the "*Center Field*" of the Ion Chamber selected.
- 3 exposures with the Grid removed and the "*Right Field*" of the Ion Chamber selected.
- 3 exposures with the Grid inserted / installed and the "*Left Field*" of the Ion Chamber selected.
- 3 exposures with the Grid inserted / installed and the "*Center Field*" of the Ion Chamber selected.
- 3 exposures with the Grid inserted / installed and the "*Right Field*" of the Ion Chamber selected.

Note in Table 2-1 the Exposure Time or the Image Gray Level obtained in each exposure, and the final mA value selected.

Table 2-1
Exposures for Balance Checking of Ion Chamber Fields

TABLE *(SID 100 cm)*	**EXPOSURES WITHOUT GRID** at 70 kV and ___ mA			**EXPOSURES WITH GRID** at 70 kV and ___ mA		
	LEFT Field	**CENTER Field**	**RIGHT Field**	**LEFT Field**	**CENTER Field**	**RIGHT Field**
Exposure #1	$t_{L1} =$	$t_{C1} =$	$t_{R1} =$	$t_{L1} =$	$t_{C1} =$	$t_{R1} =$
Exposure #2	$t_{L2} =$	$t_{C2} =$	$t_{R2} =$	$t_{L2} =$	$t_{C2} =$	$t_{R2} =$
Exposure #3	$t_{L3} =$	$t_{C3} =$	$t_{R3} =$	$t_{L3} =$	$t_{C3} =$	$t_{R3} =$
Average value of the Exposure Time	$\overline{t}_L =$	$\overline{t}_C =$	$\overline{t}_R =$	$\overline{t}_L =$	$\overline{t}_C =$	$\overline{t}_R =$

VERTICAL STAND *(SID 100 cm)*	**EXPOSURES WITHOUT GRID** at 70 kV and ___ mA			**EXPOSURES WITH GRID** at 70 kV and ___ mA		
	LEFT Field	**CENTER Field**	**RIGHT Field**	**LEFT Field**	**CENTER Field**	**RIGHT Field**
Exposure #1	$t_{L1} =$	$t_{C1} =$	$t_{R1} =$	$t_{L1} =$	$t_{C1} =$	$t_{R1} =$
Exposure #2	$t_{L2} =$	$t_{C2} =$	$t_{R2} =$	$t_{L2} =$	$t_{C2} =$	$t_{R2} =$
Exposure #3	$t_{L3} =$	$t_{C3} =$	$t_{R3} =$	$t_{L3} =$	$t_{C3} =$	$t_{R3} =$
Average value of the Exposure Time	$\overline{t}_L =$	$\overline{t}_C =$	$\overline{t}_R =$	$\overline{t}_L =$	$\overline{t}_C =$	$\overline{t}_R =$

VERTICAL STAND *(SID 150 cm or 180 cm)*	**EXPOSURES WITHOUT GRID** at 70 kV and ___ mA			**EXPOSURES WITH GRID** at 70 kV and ___ mA		
	LEFT Field	**CENTER Field**	**RIGHT Field**	**LEFT Field**	**CENTER Field**	**RIGHT Field**
Exposure #1	$t_{L1} =$	$t_{C1} =$	$t_{R1} =$	$t_{L1} =$	$t_{C1} =$	$t_{R1} =$
Exposure #2	$t_{L2} =$	$t_{C2} =$	$t_{R2} =$	$t_{L2} =$	$t_{C2} =$	$t_{R2} =$
Exposure #3	$t_{L3} =$	$t_{C3} =$	$t_{R3} =$	$t_{L3} =$	$t_{C3} =$	$t_{R3} =$
Average value of the Exposure Time	$\overline{t}_L =$	$\overline{t}_C =$	$\overline{t}_R =$	$\overline{t}_L =$	$\overline{t}_C =$	$\overline{t}_R =$

5. Calculate the average exposure time value of the 3 exposures in each Field, without and with Grid in the Receptor housing.
Note the values in the Table 2-1.

$$\text{Average Value} = \overline{t_x} = \frac{t_{x1} + t_{x2} + t_{x3}}{3}$$

6. Compare the average values of:

- The "*Center Field*" with the "*Left Field*", without Grid.
- The "*Center Field*" with the "*Right Field*", without Grid.
- The "*Center Field*" with the "*Left Field*", with Grid.
- The "*Center Field*" with the "*Right Field*", with Grid.

$$\text{\% of difference between "Center" and "Left" Fields} = \frac{\overline{t_L} - \overline{t_C}}{\overline{t_C}} \times 100 = \quad \%$$

$$\text{\% of difference between "Center" and "Right" Fields} = \frac{\overline{t_R} - \overline{t_C}}{\overline{t_C}} \times 100 = \quad \%$$

The difference of the Exposure Time values between the "*Left Field*" and "*Center Field*" and between the "*Right Field*" and "*Center Field*" must be ± 20%. If not, perform the respective AEC Calibration procedure.

7. Repeat the above steps for all the Ion Chambers installed with the Generator. It is recommended to start with the Table Ion Chamber and then with the Vertical Stand Ion Chamber.

2.10 FLUORO CHECK

Fluoro functions are calibrated by performing the following steps:

1. Turn the Generator ON.

CAUTION

Make sure that the Small Filament of the X-ray tube is properly warmed-up.

2. Set up a Dosimeter to measure the Maximum Entrance Skin Exposure Dose Rate. Position the Probe at the center of the primary beam with the entire active volume within the primary beam. Place the Tube-Collimator Assembly as close as possible to the Table-Top, fully open the Collimator Blades and align the Image Intensifier with the light beam. Block radiation input to Image Intensifier with a Lead Apron. (*Refer to Illustration in Fluoro Calibration).*

Note ☞

Note that in practice, the rejection limits for entrance exposure rate must be somewhat less than the maximum specified due to Dosimeter calibration accuracy.

METER CALIBRATION ACCURACY	**REJECTIONS LIMITS**	
	FOR 5 R/min (43.5 mGy/min) MAXIMUM	**FOR 10 R/min (87 mGy/min) MAXIMUM**
±5%	4.75 R/min (41.3 mGy/min)	9.5 R/min (82.7 mGy/min)
±10%	4.50 R/min (39.2 mGy/min)	9.0 R/min (78.3 mGy/min)
±15%	4.25 R/min (37 mGy/min)	8.5 R/min (74 mGy/min)

3. For testing the Dose, make a Fluoro exposure at maximum kV and measure the dose applied, it should not be over the Rejection Limits for 5 R/min (43.5 mGy/min) or 10 R/min (87 mGy/min) (*refer to the above table*).

   In case that the value is not acquired, perform the respective Fluoro calibration process.

4. The Fluoro mA values are obtained by measuring the average mA using a mA meter in Fluoro.

   During Fluoro exposure, mA values are read directly with a mA Meter in DC connected to the mA Test Points (banana plug connections) on the HV Transformer. Only for this purpose, remove the link between the banana plug connections on the HV Transformer.

5. For testing the mA, make a Fluoro exposure at 50 kV, 80 kV and 110 kV.

   Check that the mA values read on the mAs Meter must be the same mA displayed on the Console with a tolerance of ±10 % mA. If the mA value does not comply with the above values, perform the respective Calibration procedures.

6. Remove the Dosimeter and the Lead Apron (Blocker).

2.11 ABC CHECK

Note ☞ *If the Generator is interfaced with an ATS Image System, ABC testing procedure has to be performed as explained in the Image System documentation.*

1. Be sure that the Video System and the Image Intensifier are powered and operating correctly.

2. Set up a Dosimeter as close as possible to the Image Intensifier Radiation Input to measure the Entrance Image Intensifier Exposure Dose Rate. Position the Probe at the center of the primary beam with the entire active volume within the primary beam.

   Place the Tube-Collimator Assembly at the normal SID (1 meter), fully open the Collimator Blades and align the Image Intensifier with the light beam.

3. Adjust TV Camera gain for 1 volt peak-to-peak composite video output.

4. Select ABC mode.

5. Place 2 mm of Copper (or equivalent homogeneous phantom) in the Collimator Filter Holder.

6. Make a Fluoro exposure and check that Fluoro kVp displayed on the Console is between 80 kVp and 60 kVp. If it is more than 80 kV or less than 60 kV modify the Copper thickness in steps of 0.1 mm (or 0.2 mm) and make Fluoro exposures until the kVp is within the range.

7. Calculate the value of the optimum dose rate (that will give optimum brightness) to obtain 2μR/frame at 9” FOV.

   Examples:
   For 25 frame/second optimum dose rate is 3 mR/min.
   2 μR/frame x 25 frame/s = 50 μR/s.
   50 μR/s x 60 s/min = 3000 μR/min = 3 mR/min.
   For 30 frame/second optimum dose rate is 3.6 mR/min.
   2 μR/frame x 30 frame/s = 60 μR/s.
   60 μR/s x 60 s/min = 3600 μR/min = 3.6 mR/min.

   The optimum dose rate (dose rate) value should be measured at Image Intensifier Radiation Input. Intensifier grid should be removed, if it can not be removed, this value should be multiplied by the value specified as Grid Absorption Factor.

8. Make a Fluoro exposure and measure the dose rate. The dose rate read on the Dosimeter must be the same as the previously calculated with the tolerance specified by the Dosimeter accuracy. If the dose rate does not comply, perform the respective Calibration procedures.

9. Stop the Fluoro exposure and select 40 kV. Make a Fluoro exposure and check that the kV value goes to 70 kV (or the kV obtained in step-6.) ±2 kV without System problems.

10. Stop the Fluoro exposure and select 100 kV. Make a Fluoro exposure and check that the kV value goes to 70 kV (or the kV obtained in step-6.) ±2 kV without System problems.

SECTION 3 SPECIAL MAINTENANCE RELATED TO BATTERY POWERED GENERATORS

Note ☞ *This Section only applies to Battery Powered Generators and must be performed at least once a year.*

3.1 BATTERY STORAGE CONDITIONS

This generator should be stored at a dry environment around 20^{o}C (68^{o}F). The recommended operating temperature is 15^{o}C to 30^{o}C (59^{o}F to 86^{o}F).

During normal storage conditions (dry environment at 20^{o}C (68^{o}F) the internal resistance of the batteries will cause a discharge rate of 15% per six month period. Storage above 30^{o}C (86^{o}F) should be avoided, since it will cause excessive battery voltage loss.

Within the recommended operating temperature and under optimum float conditions, the batteries service life is expected to exceed 5 years.

The batteries of the Unit are fully charged when delivered from the factory. If the Unit is going to be stored or has been stored for a period longer than six months, batteries must be fully charged during eight hours before operation or service tasks.

CAUTION

If the unit has not been used or it has been stored for six months, it should be installed and/or energized to prevent deep discharge of the batteries. A deep discharge will cause permanent damage to the batteries. Perform the following Maintenance Tests.

3.2 BATTERY CHARGER TEST AND BATTERY CONDITION TEST

Refer to *Section 2.6 "Procedures related to the Battery Powered Generators"* of the Troubleshooting document in the Service Manual and perform all the indicated procedures to carry out a correct maintenance of the Battery Charger Board and Batteries.

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Technical Publication
SC-1101R4

Schematics

HF Series Generators
Line Powered Generators

DX-D 300 / DX-D 400 / DX-D 600

REVISION HISTORY

REVISION	DATE	REASON FOR CHANGE
	Refer to each schematic	

This Document is the english original version, edited and supplied by the manufacturer.

The Revision state of this Document is indicated in the code number shown at the bottom of this page.

ADVISORY SYMBOLS

The following advisory symbols will be used throughout this manual. Their application and meaning are described below.

DANGERS ADVISE OF CONDITIONS OR SITUATIONS THAT IF NOT HEEDED OR AVOIDED WILL CAUSE SERIOUS PERSONAL INJURY OR DEATH.

ADVISE OF CONDITIONS OR SITUATIONS THAT IF NOT HEEDED OR AVOIDED COULD CAUSE SERIOUS PERSONAL INJURY, OR CATASTROPHIC DAMAGE OF EQUIPMENT OR DATA.

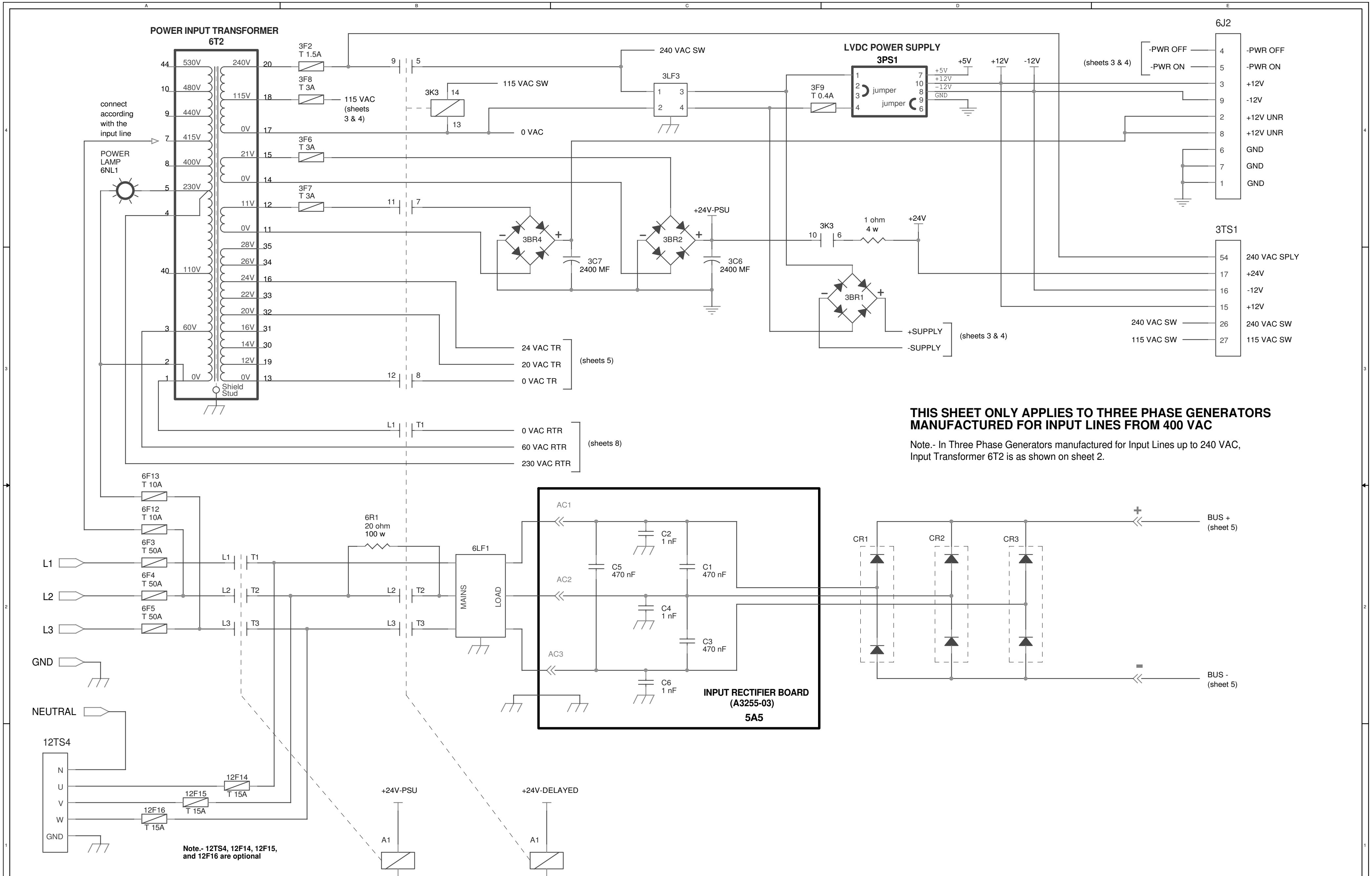
Advise of conditions or situations that if not heeded or avoided could cause personal injury or damage to equipment or data.

Note ☞

Alert readers to pertinent facts and conditions. Notes represent information that is important to know but which do not necessarily relate to possible injury or damage to equipment.

TABLE OF CONTENTS

SCH. No.	SCHEMATIC	DX-D 300	DX-D 400	DX-D 600	REMARKS
A3651–01	Direct Stitching Interface PCB	✓	✓	✓	
A3656–01	Direct Fail Safe – Stitching – Tomo Interface PCB	✓			
A3677–01	Rotation Interface PCB	✓			
OPERATOR CONTROL CONSOLES FOR DX-D 400					
A3553–02	Serial Console Control PCB		✓		*Only used with Analogic Systems and Push-buttton Console*
A3585–21	RAD Multiuse H2 Serial Console Display		✓		
54302351	CTSC to Generator Connection		✓		*Only used with Analogic Systems and CTSC Console*
A3179–10	Low Auto ON/OFF PCB		✓		
54302032	TPC A6264–03/03 Console Connections		✓		*Only used with Analogic Systems and Touch Screen Console*
A3515–02	MT Console Interface		✓		



REV	DESCRIPTION	ISSUED BY	DATE
K	NC16/0390	M.González	30/11/16
J	NC14/0139	R.Hermosilla	24/04/14
I	NC13/0015	R.Asenjo	21/01/13
H	NC12/0466	R.Asenjo	08/11/12
G	NC10/0533	F.García	14/04/11

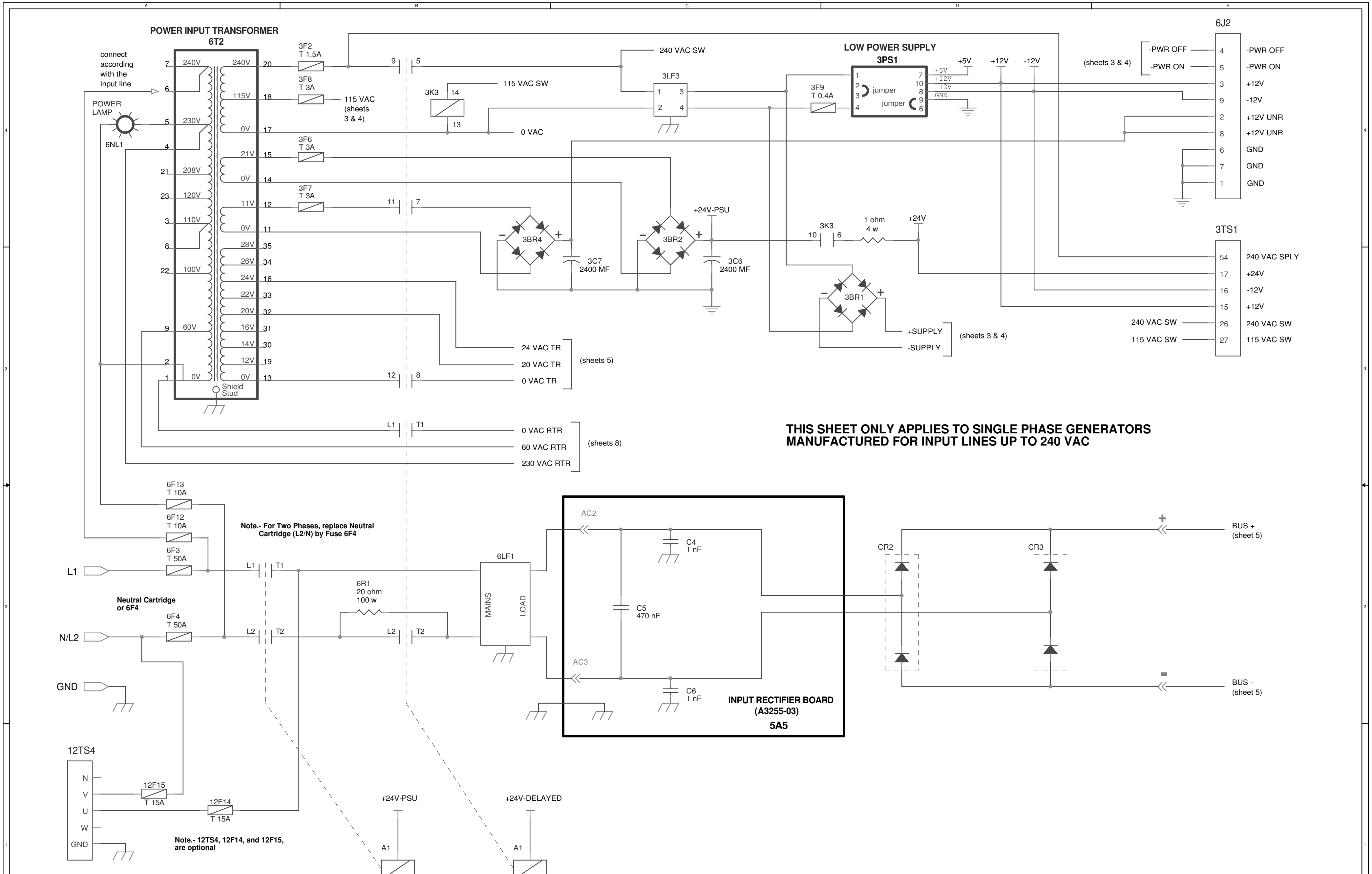
	NAME	DATE	SHEET/OF
DRAWING	F.GARCIA	30/09/02	1/8
REVISED	A.DIAZ	11/11/02	

54302010

K	J	I	H	G	◄REV

SEDECAL

COMPACT-LV DRAC/LF RAC GENERATOR



THIS SHEET ONLY APPLIES TO SINGLE PHASE GENERATORS MANUFACTURED FOR INPUT LINES UP TO 240 VAC

REV	DESCRIPTION	ISSUED BY	DATE
K	NC16/0390	M.González	30/11/16
J	NC14/0139	R.Hermosilla	24/04/14
I	NC13/0015	R.Asenjo	21/01/13
H	NC12/0466	R.Asenjo	08/11/12
G	NC10/0533	F.García	14/04/11

	NAME	DATE	SHEET/OF
DRAWING	F.GARCIA	30/09/02	2/8
REVISED	A.DIAZ	11/11/02	

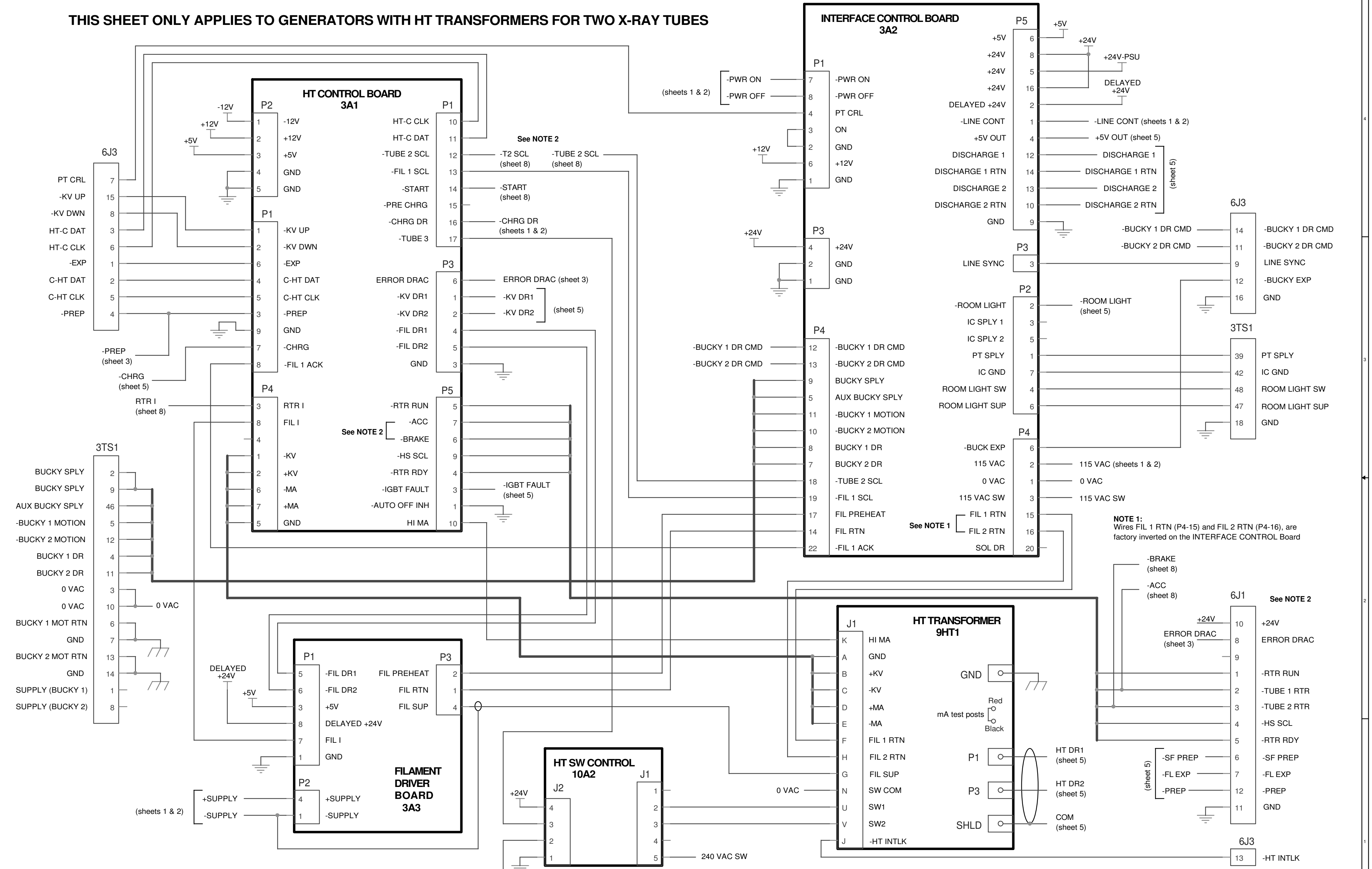
54302010

K	J	I	H	G	◄ REV

SEDECAL

COMPACT-LV DRAC/LF RAC GENERATOR

THIS SHEET ONLY APPLIES TO GENERATORS WITH HT TRANSFORMERS FOR TWO X-RAY TUBES



NOTE 2.- For High Speed Version:

-T2 SCL signal is shortcircuited with -TUBE 2 SCL signal.

-ACC and -BRAKE signals for Low Speed Version becomes -TUBE 1 RTR and -TUBE 2 RTR respectively.

6J1 connector used only for High Speed version (see LV-DRAC documentation).

REV	DESCRIPTION	ISSUED BY	DATE
K	NC16/0390	M.González	30/11/16
J	NC14/0139	R.Hermosilla	24/04/14
I	NC13/0015	R.Asenjo	21/01/13
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G	NC10/0533	F.García	14/04/11

	NAME	DATE	SHEET/OF
DRAWING	F.GARCIA	30/09/02	3/8
REVISED	A.DIAZ	11/11/02	

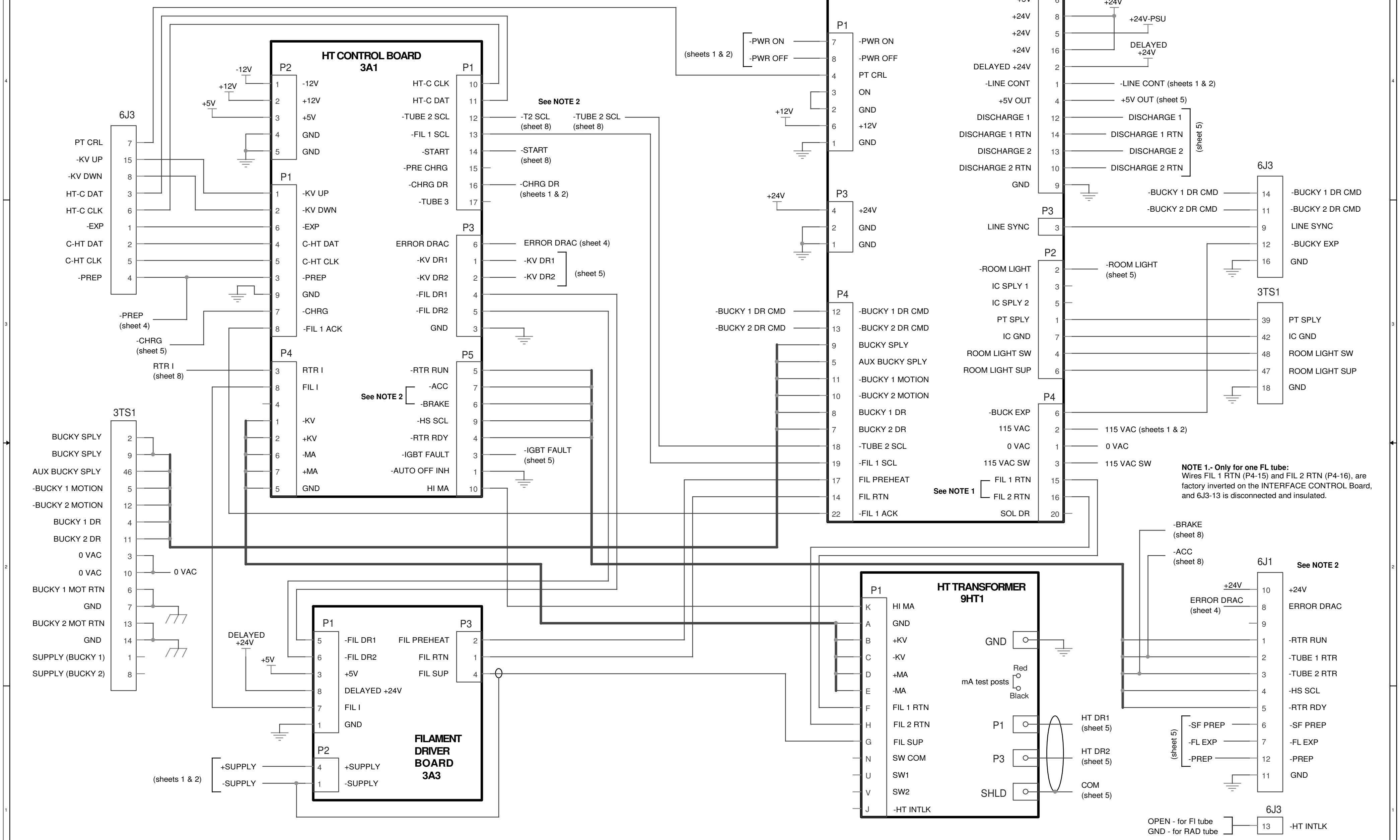
54302010

K J I H G ← REV

SEDECAL

COMPACT-LV DRAC/LF RAC GENERATOR

THIS SHEET ONLY APPLIES TO GENERATORS WITH HT TRANSFORMER FOR ONLY ONE X-RAY TUBE



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H	NC12/0466	R.Asenjo	08/11/12
G	NC10/0533	F.García	14/04/11

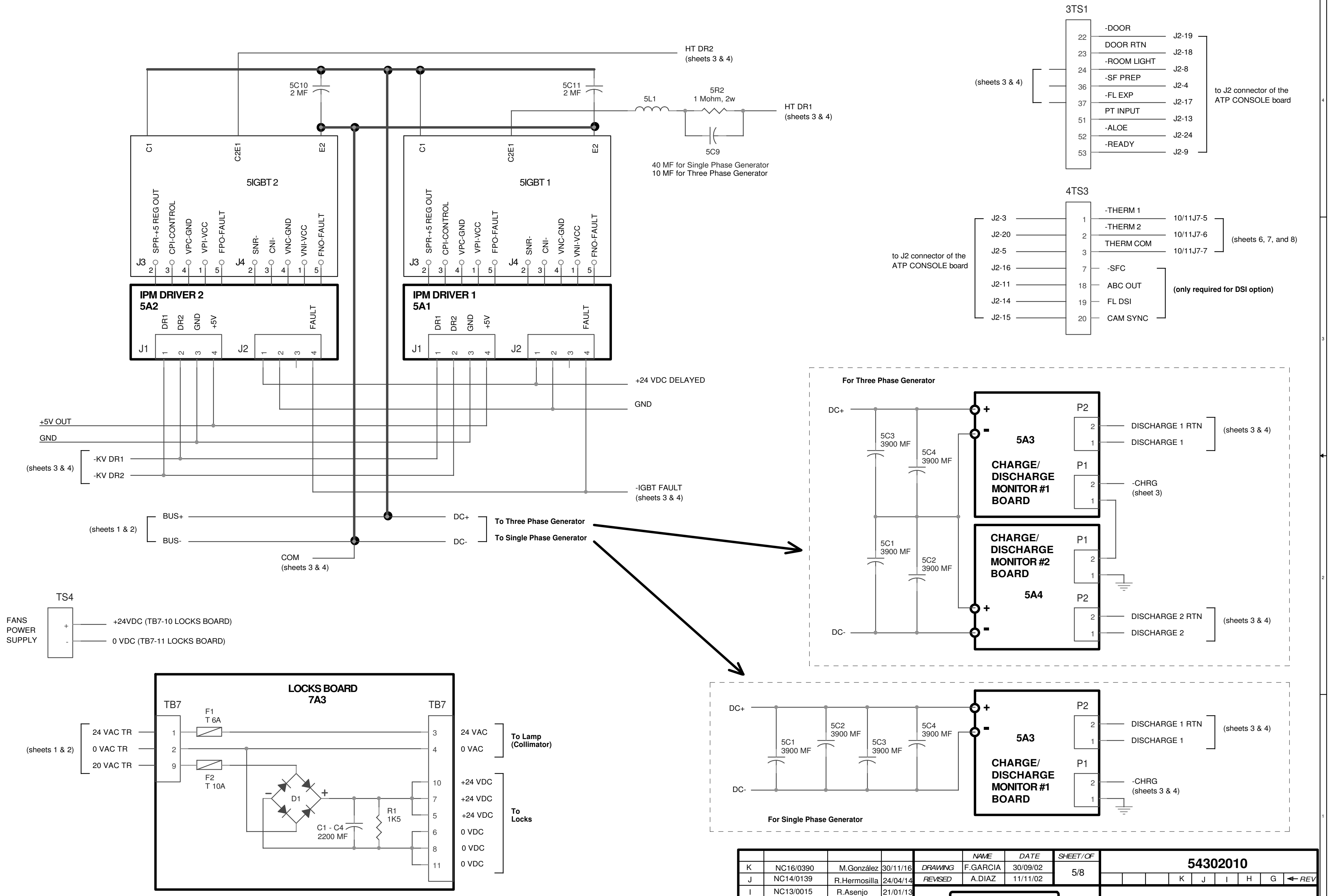
	NAME	DATE	SHEET/OF
DRAWING	F.GARCIA	30/09/02	4/8
REVISED	A.DIAZ	11/11/02	

54302010

K J I H G ← REV

SEDECAL

COMPACT-LV DRAC/LF RAC GENERATOR



REV	DESCRIPTION	ISSUED BY	DATE
K	NC16/0390	M.González	30/11/16
J	NC14/0139	R.Hermosilla	24/04/14
I	NC13/0015	R.Asenjo	21/01/13
H	NC12/0466	R.Asenjo	08/11/12
G	NC10/0533	F.García	14/04/11

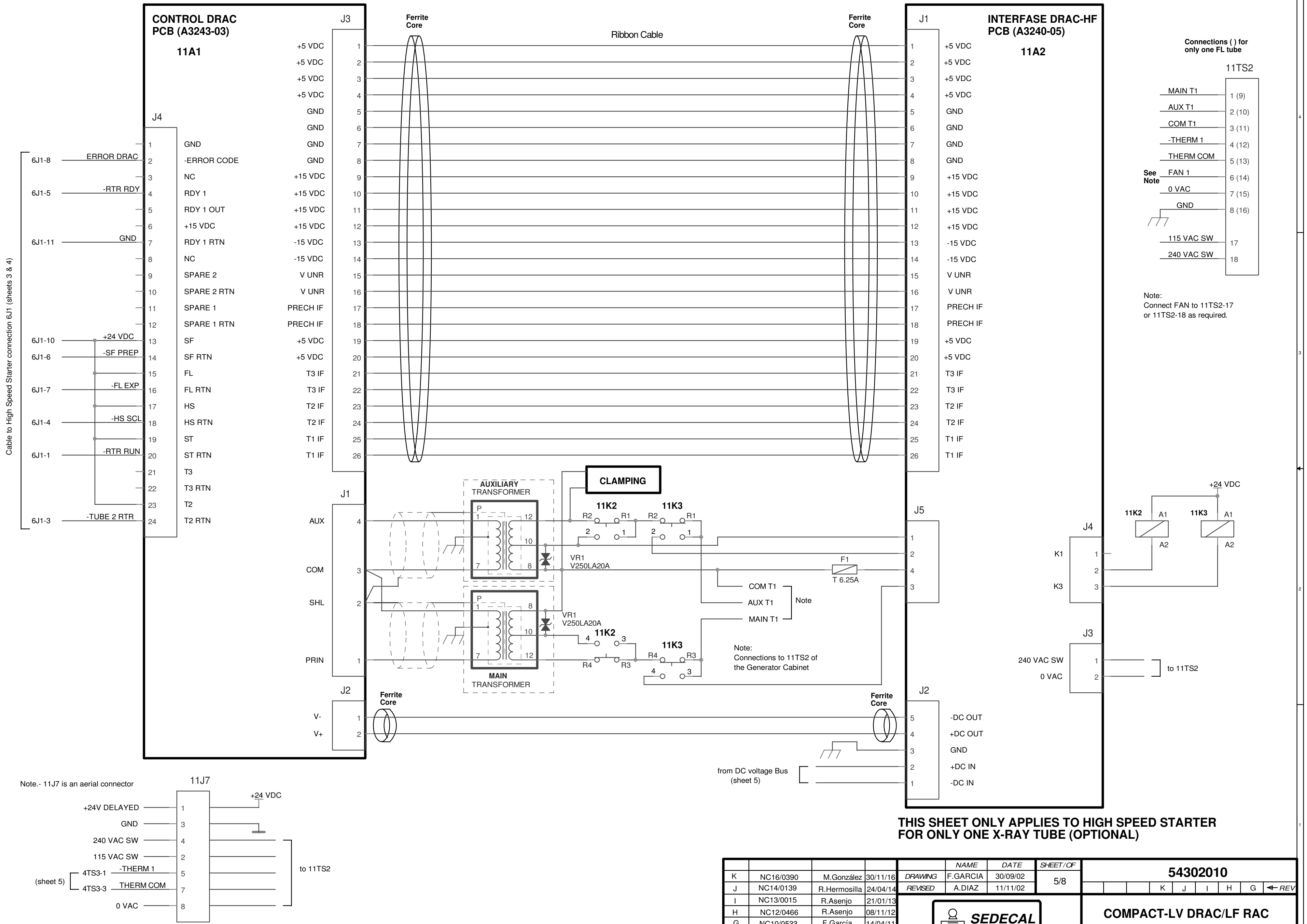
	NAME	DATE	SHEET/OF
DRAWING	F.GARCIA	30/09/02	5/8
REVISED	A.DIAZ	11/11/02	

SEDECAL

54302010

K J I H G ← REV

COMPACT-LV DRAC/LF RAC GENERATOR



THIS SHEET ONLY APPLIES TO HIGH SPEED STARTER FOR ONLY ONE X-RAY TUBE (OPTIONAL)

REV	DESCRIPTION	ISSUED BY	DATE
K	NC16/0390	M.González	30/11/16
J	NC14/0139	R.Hermosilla	24/04/14
I	NC13/0015	R.Asenjo	21/01/13
H	NC12/0466	R.Asenjo	08/11/12
G	NC10/0533	F.García	14/04/11

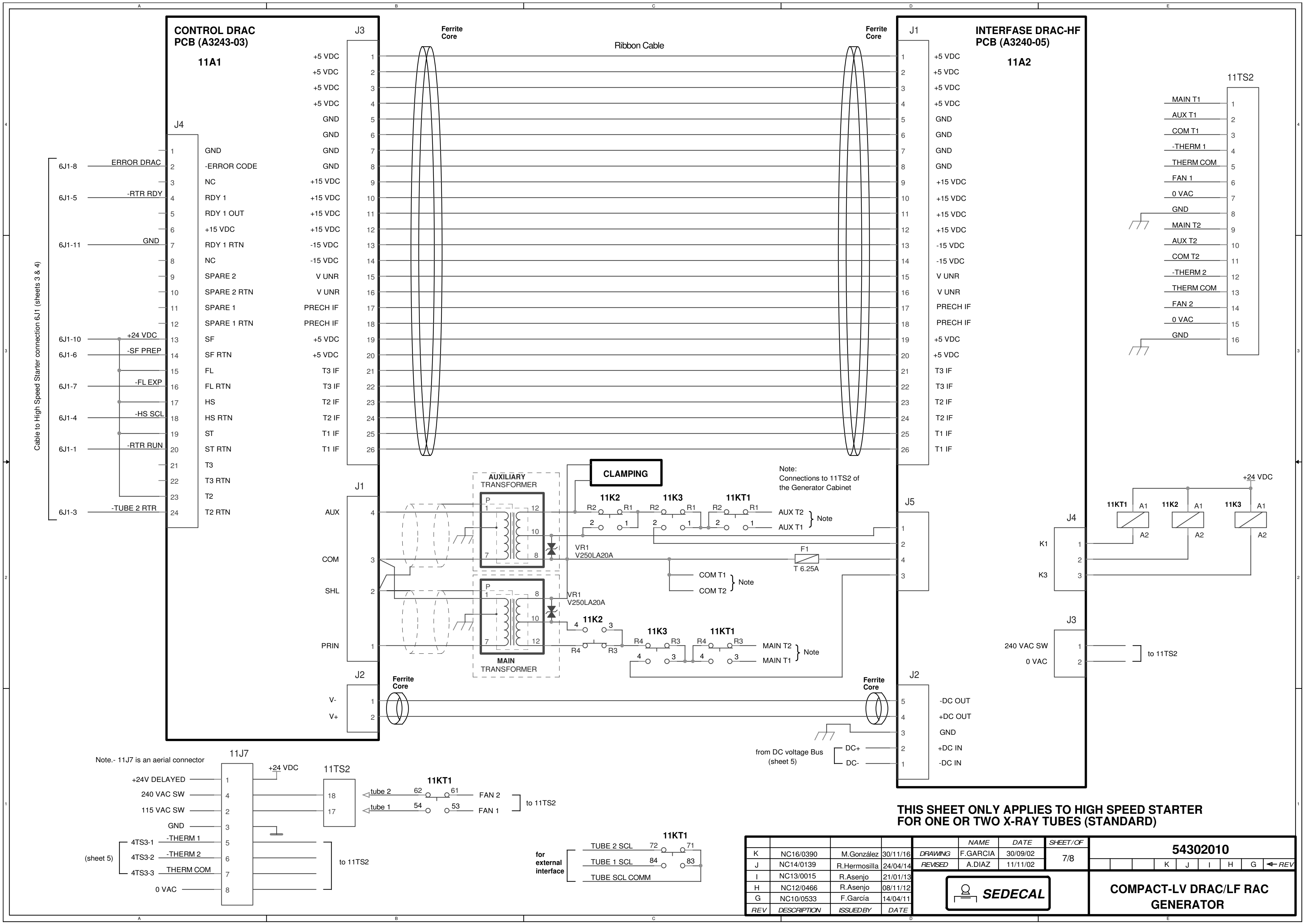
	NAME	DATE	SHEET/OF
DRAWING	F.GARCIA	30/09/02	5/8
REVISED	A.DIAZ	11/11/02	

SEDECAL

54302010

K | J | I | H | G | ← REV

COMPACT-LV DRAC/LF RAC GENERATOR



THIS SHEET ONLY APPLIES TO HIGH SPEED STARTER FOR ONE OR TWO X-RAY TUBES (STANDARD)

REV	DESCRIPTION	ISSUED BY	DATE
K	NC16/0390	M.González	30/11/16
J	NC14/0139	R.Hermosilla	24/04/14
I	NC13/0015	R.Asenjo	21/01/13
H	NC12/0466	R.Asenjo	08/11/12
G	NC10/0533	F.García	14/04/11

	NAME	DATE	SHEET/OF
DRAWING	F.GARCIA	30/09/02	7/8
REVISED	A.DIAZ	11/11/02	

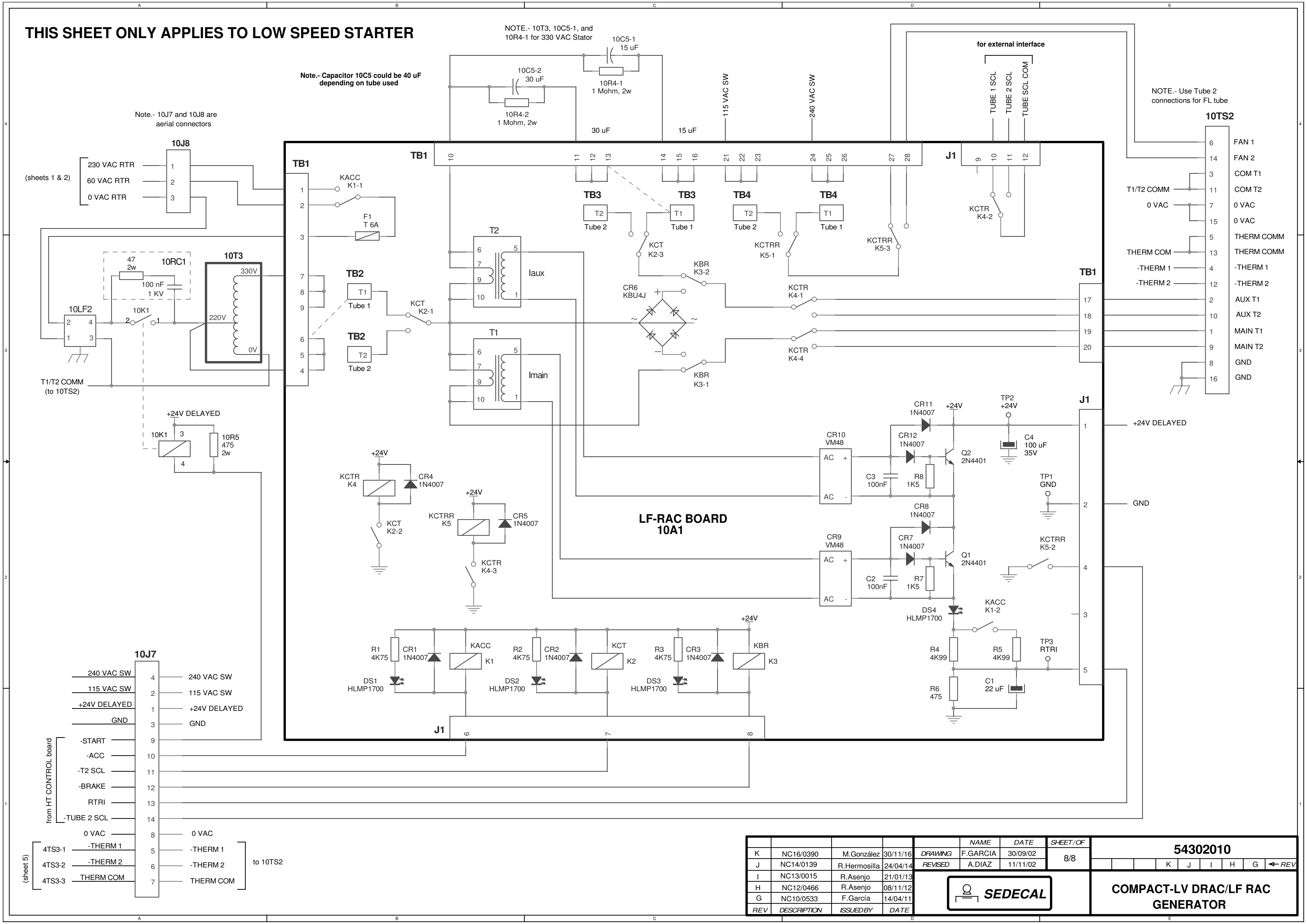
SEDECAL

54302010

K J I H G ← REV

COMPACT-LV DRAC/LF RAC GENERATOR

THIS SHEET ONLY APPLIES TO LOW SPEED STARTER



REV	DESCRIPTION	ISSUED BY	DATE
K	NC16/0390	M.González	30/11/16
J	NC14/0139	R.Hermosilla	24/04/14
I	NC13/0015	R.Asenjo	21/01/13
H	NC12/0466	R.Asenjo	08/11/12
G	NC10/0533	F.García	14/04/11

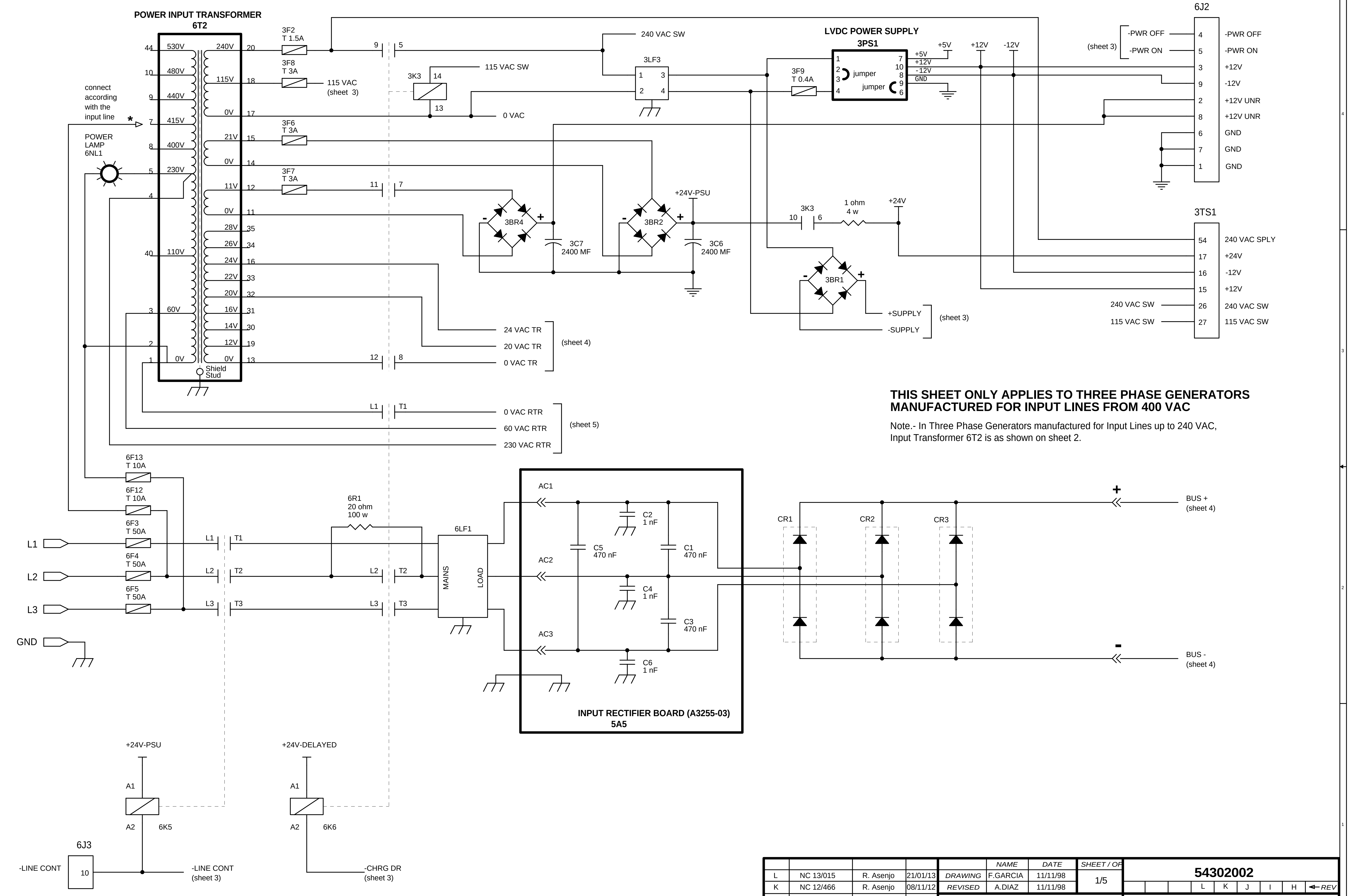
	NAME	DATE	SHEET/OF
DRAWING	F.GARCIA	30/09/02	8/8
REVISED	A.DIAZ	11/11/02	

SEDECAL

54302010

REV: K J I H G

COMPACT-LV DRAC/LF RAC GENERATOR



THIS SHEET ONLY APPLIES TO THREE PHASE GENERATORS MANUFACTURED FOR INPUT LINES FROM 400 VAC

Note.- In Three Phase Generators manufactured for Input Lines up to 240 VAC, Input Transformer 6T2 is as shown on sheet 2.

REV	DESCRIPTION	ISSUED BY	DATE
L	NC 13/015	R. Asenjo	21/01/13
K	NC 12/466	R. Asenjo	08/11/12
J	CN 10/533	F. Díaz	14/04/11
I	CN 09/385	F. García	30/12/09
H	CN 06/159	F. García	08/08/06

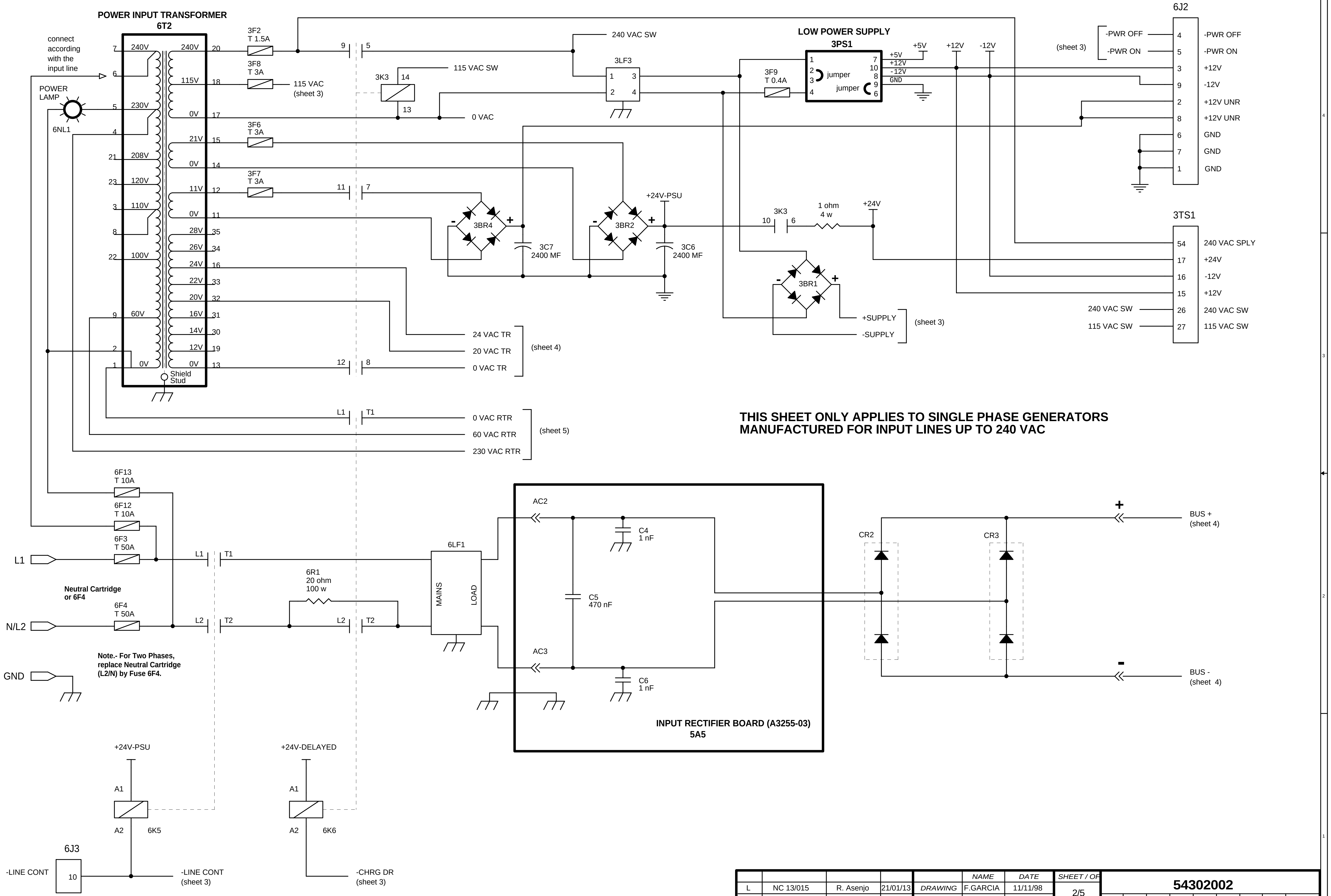
	NAME	DATE	SHEET / OF
DRAWING	F.GARCIA	11/11/98	1/5
REVISED	A.DIAZ	11/11/98	

SEDECAL

54302002

L K J I H ◄ REV

COMPACT GENERATOR (ONLY ONE TUBE)



THIS SHEET ONLY APPLIES TO SINGLE PHASE GENERATORS MANUFACTURED FOR INPUT LINES UP TO 240 VAC

REV	DESCRIPTION	ISSUED BY	DATE
L	NC 13/015	R. Asenjo	21/01/13
K	NC 12/466	R. Asenjo	08/11/12
J	CN 10/533	F. Díaz	14/04/11
I	CN 09/385	F. García	30/12/09
H	CN 06/159	F. García	08/08/06

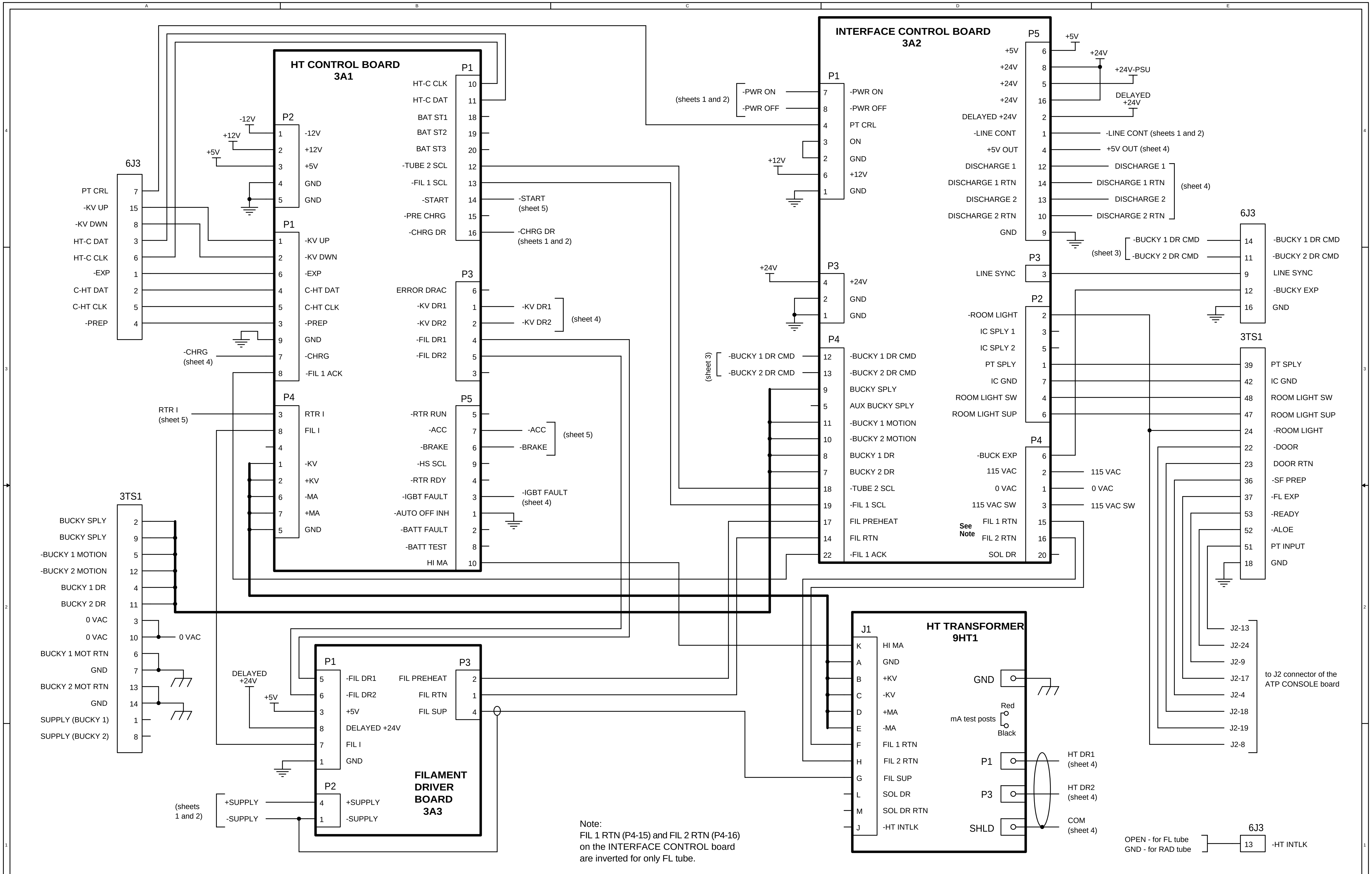
	NAME	DATE	SHEET / OF
DRAWING	F.GARCIA	11/11/98	2/5
REVISED	A.DIAZ	11/11/98	

SEDECAL

54302002

L	K	J	I	H	REV

COMPACT GENERATOR (ONLY ONE TUBE)



REV	DESCRIPTION	ISSUED BY	DATE
L	NC 13/015	R. Asenjo	21/01/13
K	NC 12/466	R. Asenjo	08/11/12
J	CN 10/533	F. Díaz	14/04/11
I	CN 09/385	F. García	30/12/09
H	CN 06/159	F. García	08/08/06

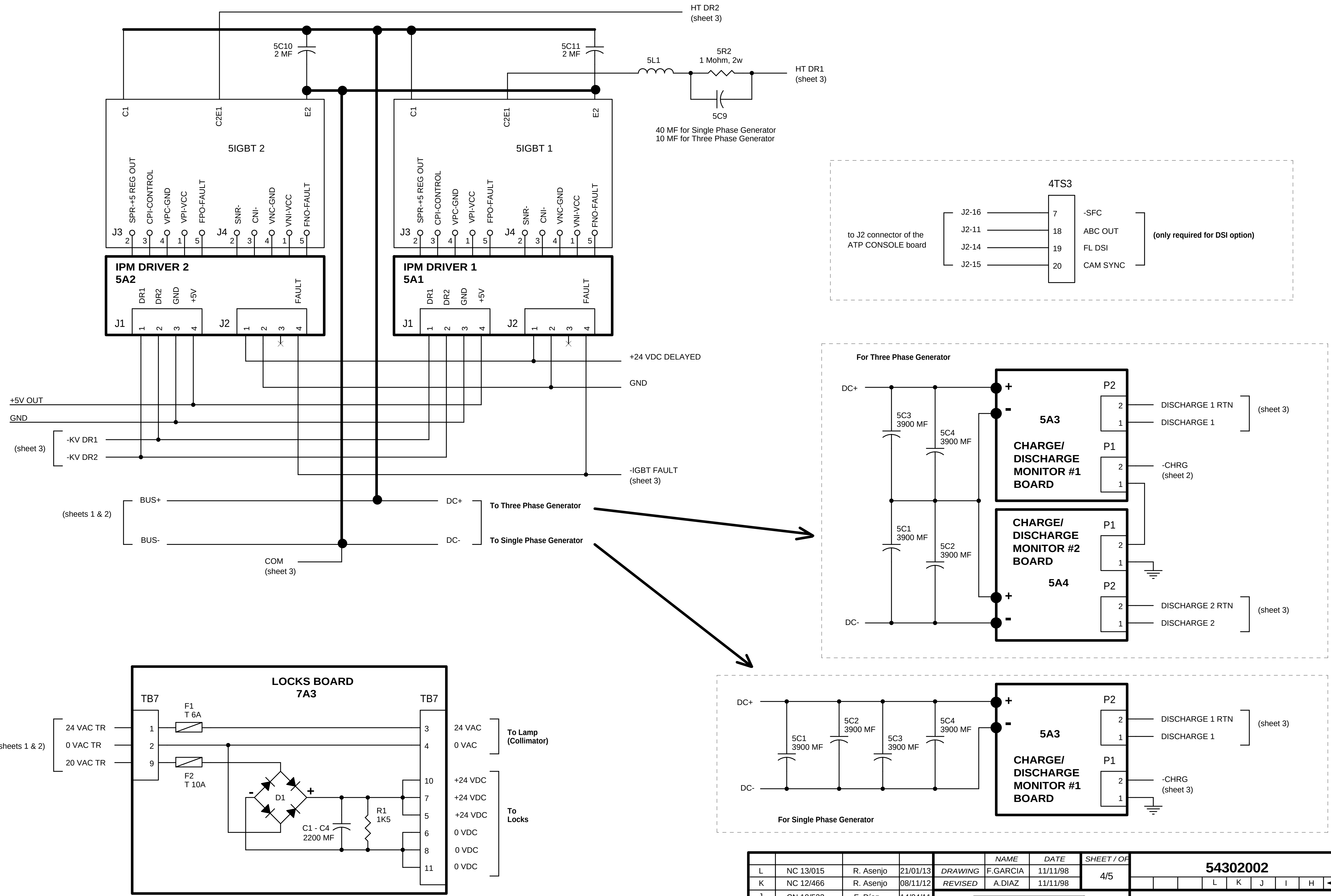
	NAME	DATE	SHEET / OF
DRAWING	F.GARCIA	11/11/98	3/5
REVISED	A.DIAZ	11/11/98	

SEDECAL

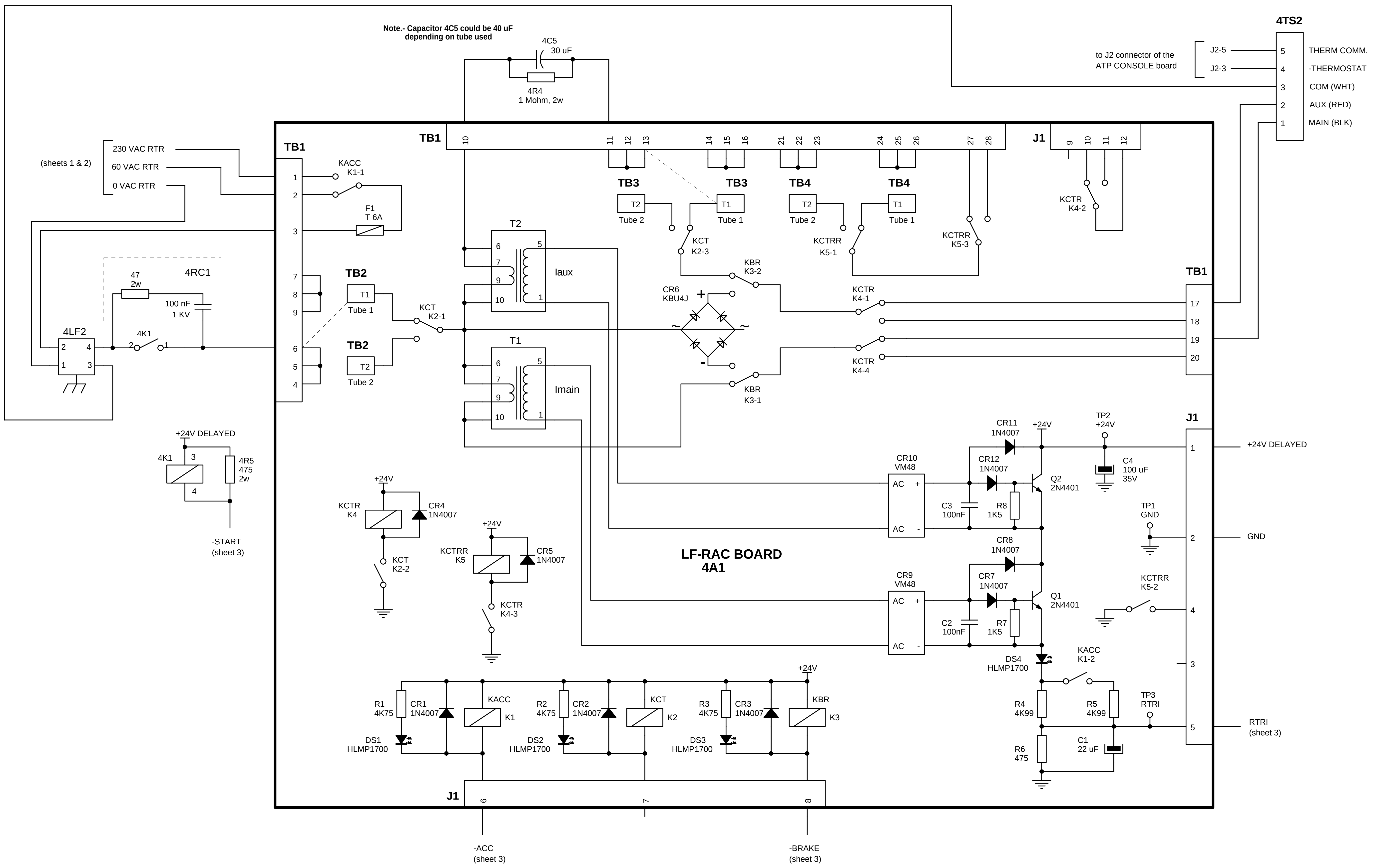
54302002

L K J I H ◄ REV

COMPACT GENERATOR
(ONLY ONE TUBE)



					NAME	DATE	SHEET / OF	54302002
L	NC 13/015	R. Asenjo	21/01/13	DRAWING	F.GARCIA	11/11/98	4/5	L K J I H ◄REV
K	NC 12/466	R. Asenjo	08/11/12	REVISED	A.DIAZ	11/11/98		
J	CN 10/533	F. Díaz	14/04/11	SEDECAL				COMPACT GENERATOR (ONLY ONE TUBE)
I	CN 09/385	F. García	30/12/09					
H	CN 06/159	F. García	08/08/06					
REV	DESCRIPTION	ISSUED BY	DATE					



REV	DESCRIPTION	ISSUED BY	DATE
L	NC 13/015	R. Asenjo	21/01/13
K	NC 12/466	R. Asenjo	08/11/12
J	CN 10/533	F. Díaz	14/04/11
I	CN 09/385	F. García	30/12/09
H	CN 06/159	F. García	08/08/06

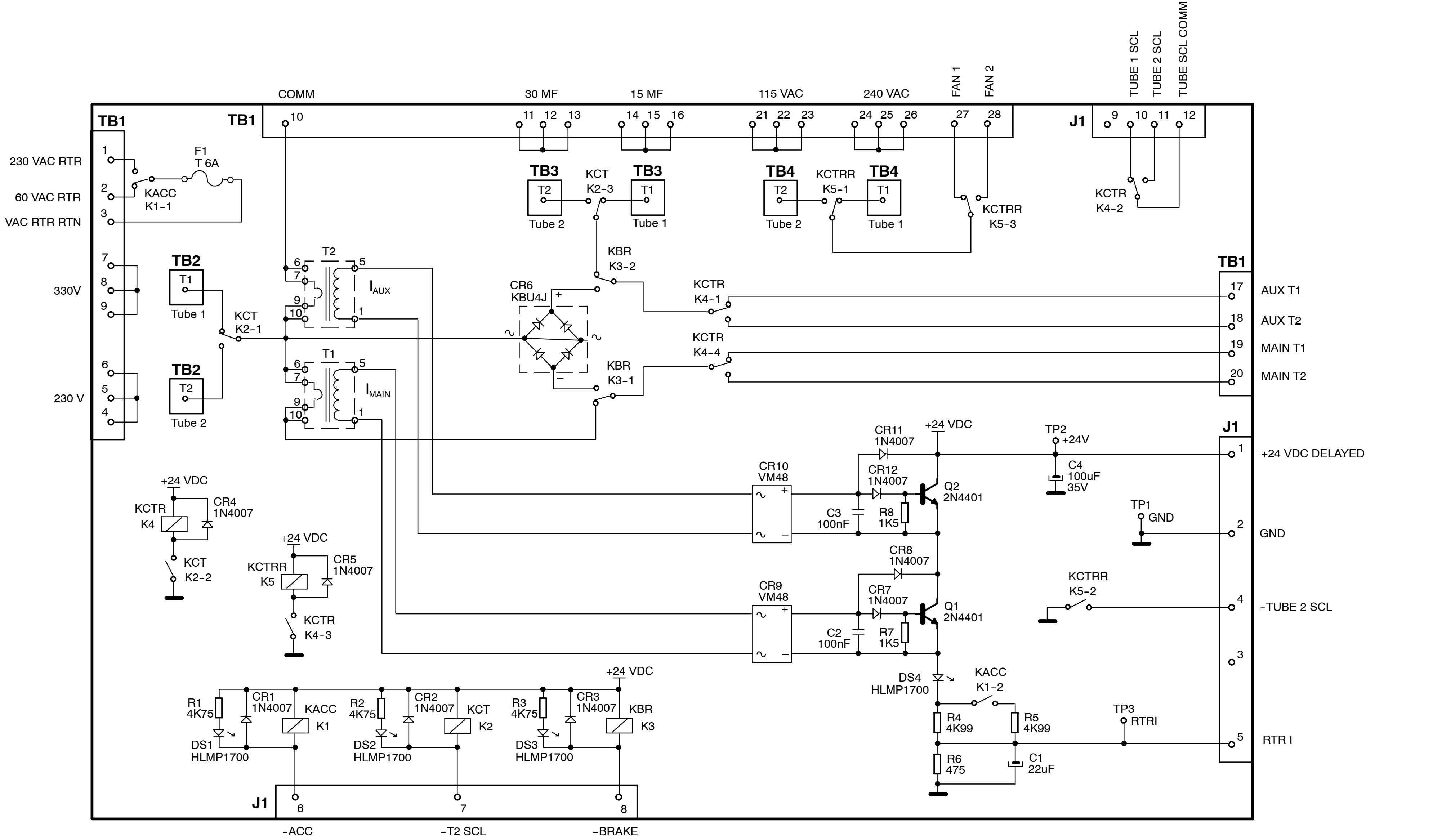
	NAME	DATE	SHEET / OF
DRAWING	F.GARCIA	11/11/98	5/5
REVISED	A.DIAZ	11/11/98	

SEDECAL

54302002

L K J I H ◄ REV

COMPACT GENERATOR (ONLY ONE TUBE)



Note:
The LF-RAC shown in the Generator schematic (543020XX) is a basic documentation, only for interconnection purposes.
Follow this schematic for detailed component information of the LF-RAC board.

061109

	NAME	DATE	SHEET / OF
DRAWING	F. GARCIA	21/09/97	1 / 1
REVISED	A. DIAZ	21/09/97	

REV	DESCRIPTION	ISSUED BY	DATE
B	CN 03/004	F. García	13/01/03

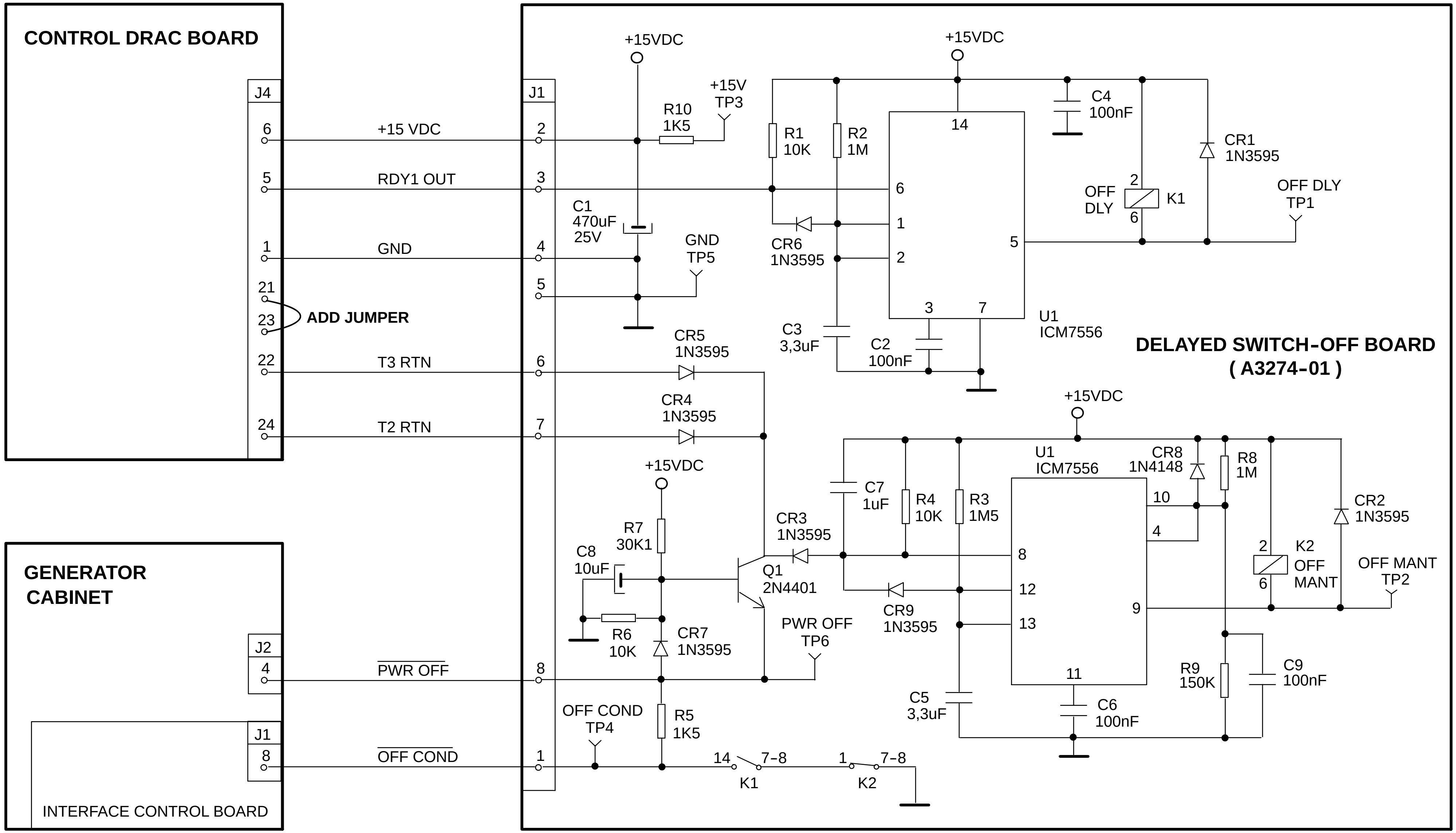
DWG: A3096-02

B ◄ REV

SEDECAL

LF - RAC Board

(Line Frequency Rotatory Anode Controller)



061109

REV	DESCRIPTION	ISSUED BY	DATE
D	CN 14/0337	F. GARCIA	12/12/14
C	CN 00/183	F. GARCIA	06/09/00
B	CN 99/003	F. GARCIA	13/01/99

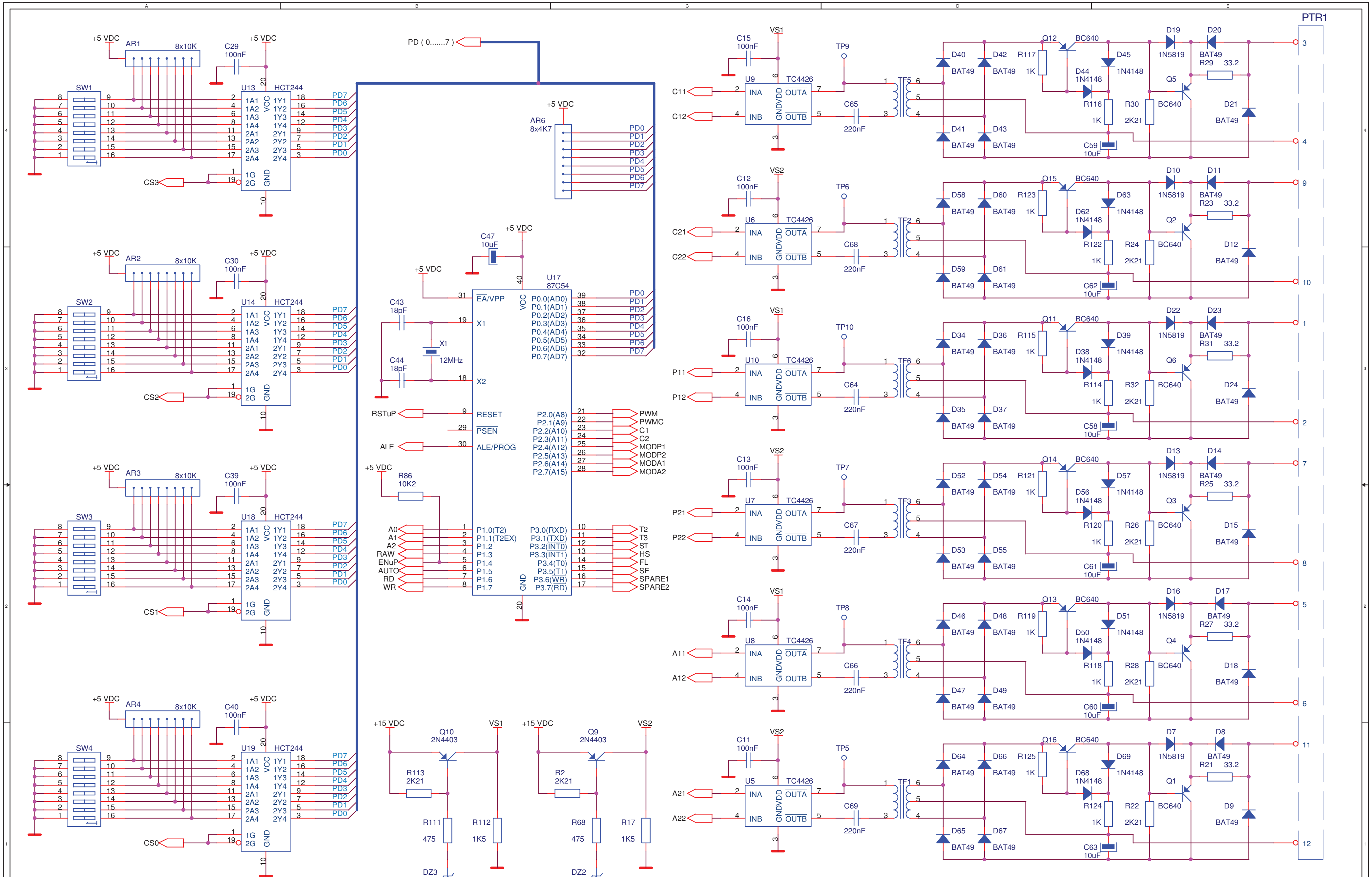
	NAME	DATE	SHEET / OF
DRAWING	F. GARCIA	05/05/98	1 / 1
REVISED	A. DIAZ	05/05/98	

SEDECAL

DWG: A3274-01

					D	C	B	REV

DELAYED SWITCH-OFF



J	NC 18/148	J.Mingo	30/10/18
I	NC 17/0131	Carlos R.	30/03/17
H	NC 14/0356	R. Hermosilla	24/11/15
G	NC 14/0356	Carlos R.	16/10/15
K	NC20/0169	R. Hermosilla	20/03/20
REV	DESCRIPTION	ISSUED BY	DATE

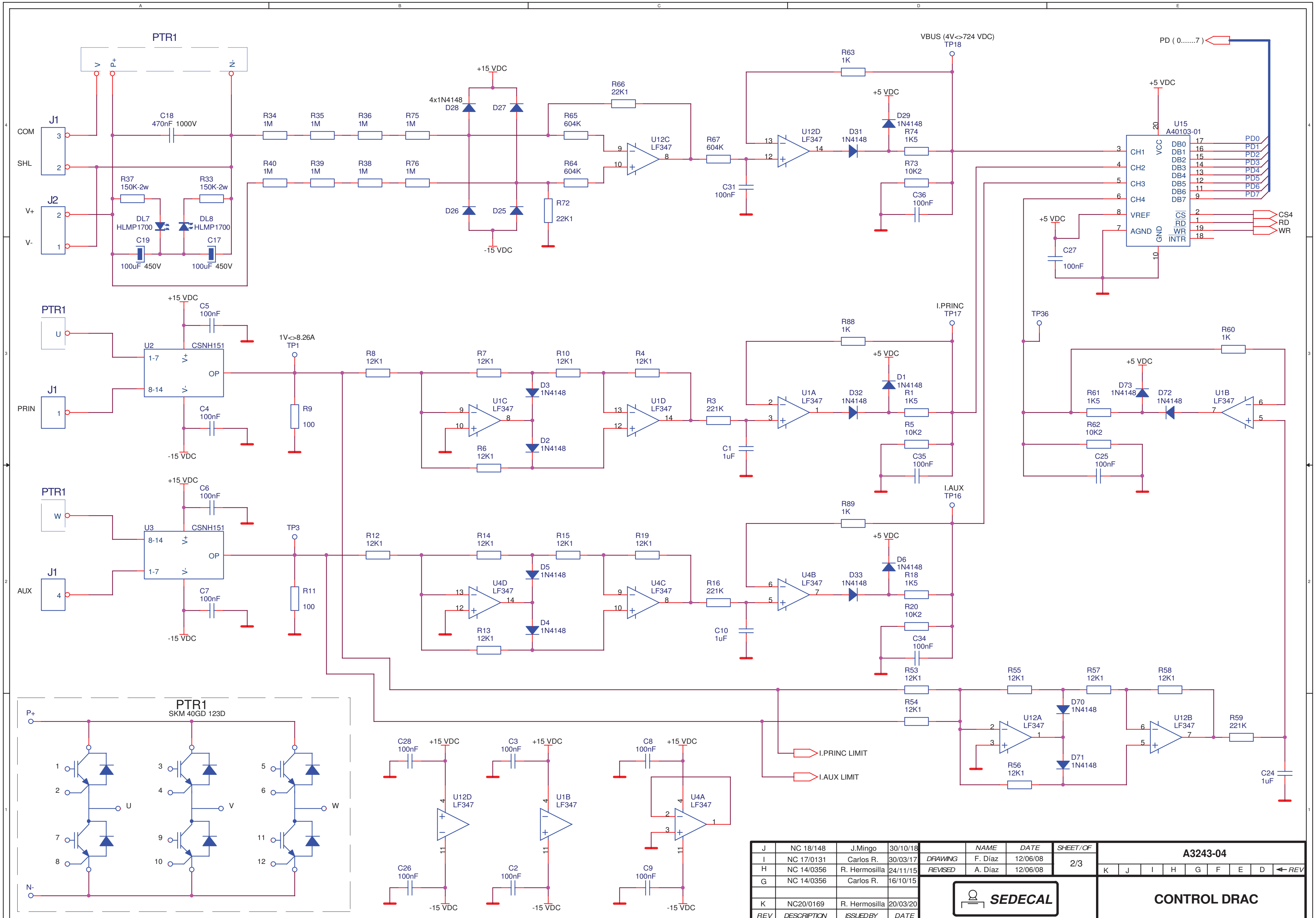
	NAME	DATE	SHEET/OF
DRAWING	F. Díaz	12/06/08	1/3
REVISED	A. Díaz	12/06/08	

A3243-04

K J I H G F E D ← REV

SEDECAL

CONTROL DRAC



REV	DESCRIPTION	ISSUED BY	DATE
J	NC 18/148	J.Mingo	30/10/18
I	NC 17/0131	Carlos R.	30/03/17
H	NC 14/0356	R. Hermosilla	24/11/15
G	NC 14/0356	Carlos R.	16/10/15
K	NC20/0169	R. Hermosilla	20/03/20

	NAME	DATE
DRAWING	F. Díaz	12/06/08
REVISED	A. Díaz	12/06/08

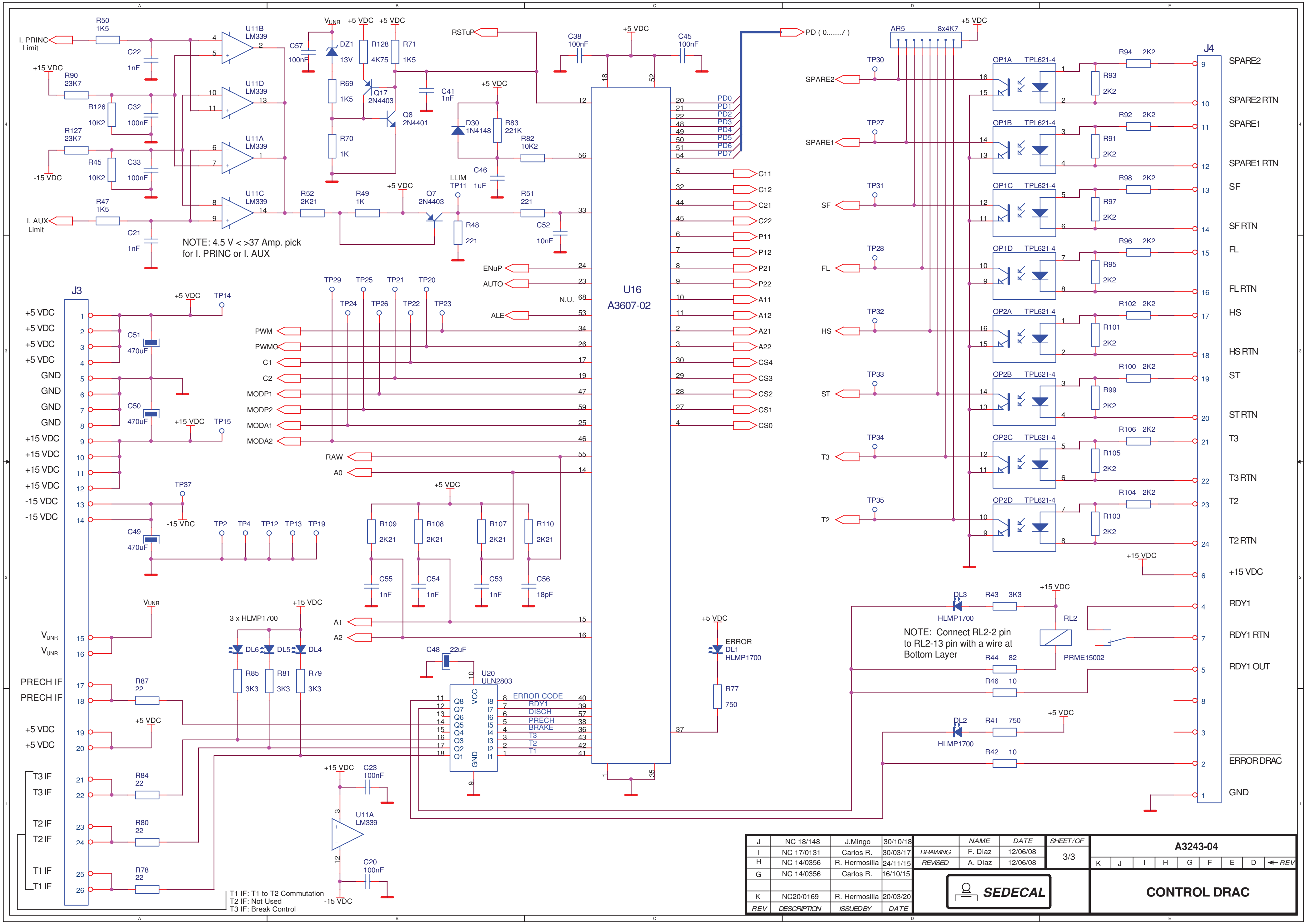
SHEET/OF 2/3

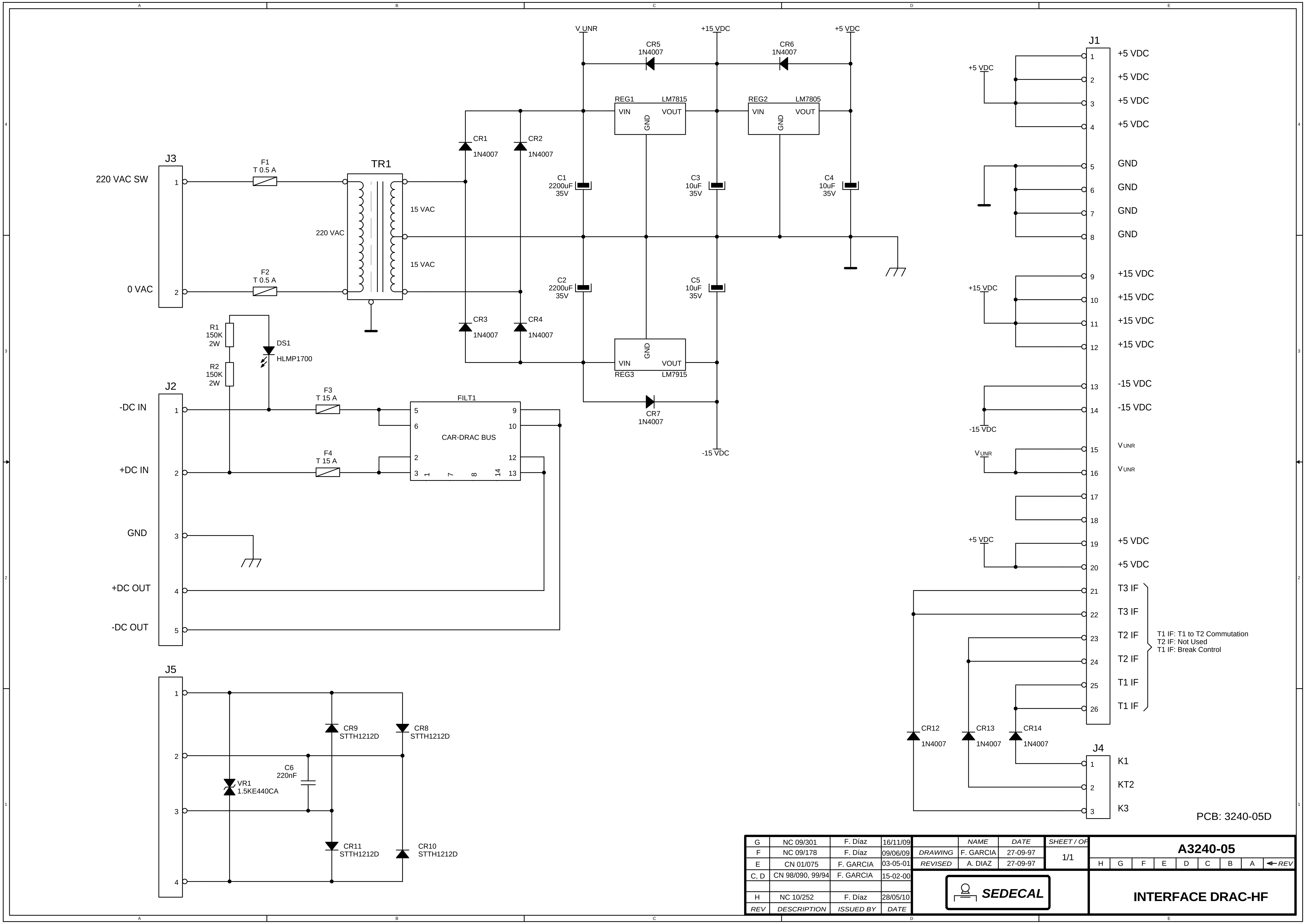
A3243-04

K	J	I	H	G	F	E	D	← REV

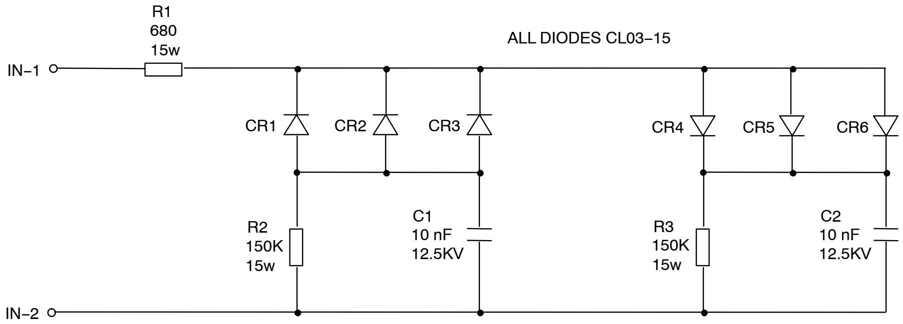
SEDECAL

CONTROL DRAC


NOTE: 4.5 V < >37 Amp. pick
for I. PRINC or I. AUX
U16
A3607-02
U20
ULN2803
NOTE: Connect RL2-2 pin
to RL2-13 pin with a wire at
Bottom Layer
T1 IF: T1 to T2 Commutation
T2 IF: Not Used
T3 IF: Break Control
J3
J4
J NC 18/148 J.Mingo 30/10/18
I NC 17/0131 Carlos R. 30/03/17
H NC 14/0356 R. Hermosilla 24/11/15
G NC 14/0356 Carlos R. 16/10/15
K NC20/0169 R. Hermosilla 20/03/20
REV DESCRIPTION ISSUED BY DATE
NAME DATE
DRAWING F. Díaz 12/06/08
REVISED A. Díaz 12/06/08
SHEET/OF 3/3
A3243-04
SEDECAL
CONTROL DRAC



J3
220 VAC SW
0 VAC
F1
T 0.5 A
F2
T 0.5 A
TR1
220 VAC
15 VAC
15 VAC
CR1
1N4007
CR2
1N4007
CR3
1N4007
CR4
1N4007
V UNR
+15 VDC
+5 VDC
CR5
1N4007
CR6
1N4007
REG1
LM7815
VIN
VOUT
GND
REG2
LM7805
C1
2200uF
35V
C2
2200uF
35V
C3
10uF
35V
C4
10uF
35V
C5
10uF
35V
REG3
LM7915
CR7
1N4007
-15 VDC
R1
150K
2W
R2
150K
2W
DS1
HLMP1700
J2
-DC IN
+DC IN
GND
+DC OUT
-DC OUT
F3
T 15 A
F4
T 15 A
FILT1
CAR-DRAC BUS
J5
CR9
STTH1212D
CR8
STTH1212D
C6
220nF
VR1
1.5KE440CA
CR11
STTH1212D
CR10
STTH1212D
J1
+5 VDC
GND
+15 VDC
-15 VDC
VUNR
T3 IF
T2 IF
T1 IF
T1 IF: T1 to T2 Commutation
T2 IF: Not Used
T1 IF: Break Control
CR12
1N4007
CR13
1N4007
CR14
1N4007
J4
K1
KT2
K3
PCB: 3240-05D
G NC 09/301 F. Díaz 16/11/09
F NC 09/178 F. Díaz 09/06/09
E CN 01/075 F. GARCIA 03-05-01
C, D CN 98/090, 99/94 F. GARCIA 15-02-00
H NC 10/252 F. Díaz 28/05/10
REV DESCRIPTION ISSUED BY DATE
NAME DATE
DRAWING F. GARCIA 27-09-97
REVISED A. DIAZ 27-09-97
SHEET / OF
1/1
SEDECAL
A3240-05
H G F E D C B A REV
INTERFACE DRAC-HF



REV	DESCRIPTION	ISSUED BY	DATE

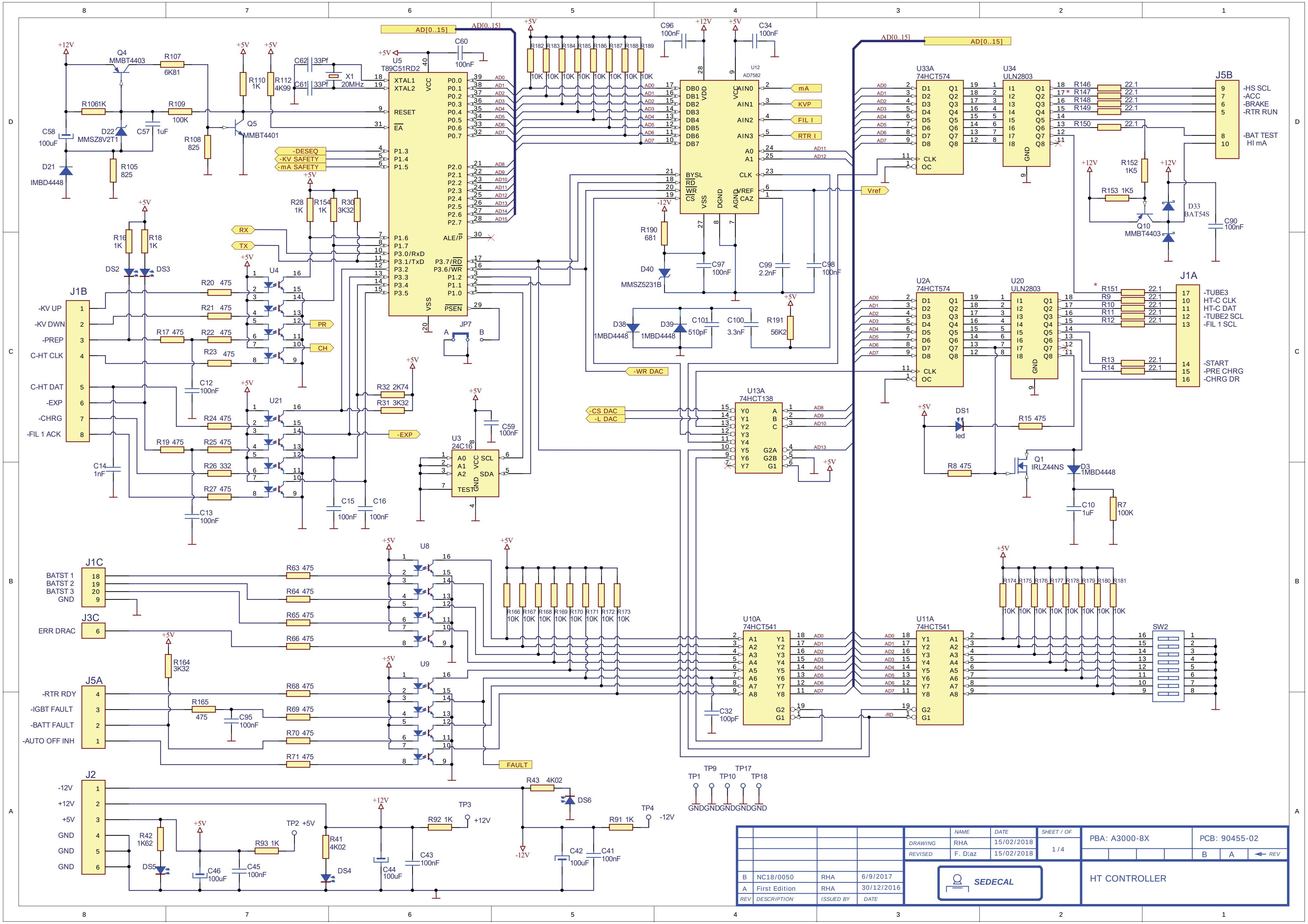
	NAME	DATE	SHEET / OF
DRAWING	F. GARCIA	12/01/99	1 / 1
REVISED	A. DIAZ	16/03/99	

SEDECAL INNERSCAN

DWG: A3109-01

REV

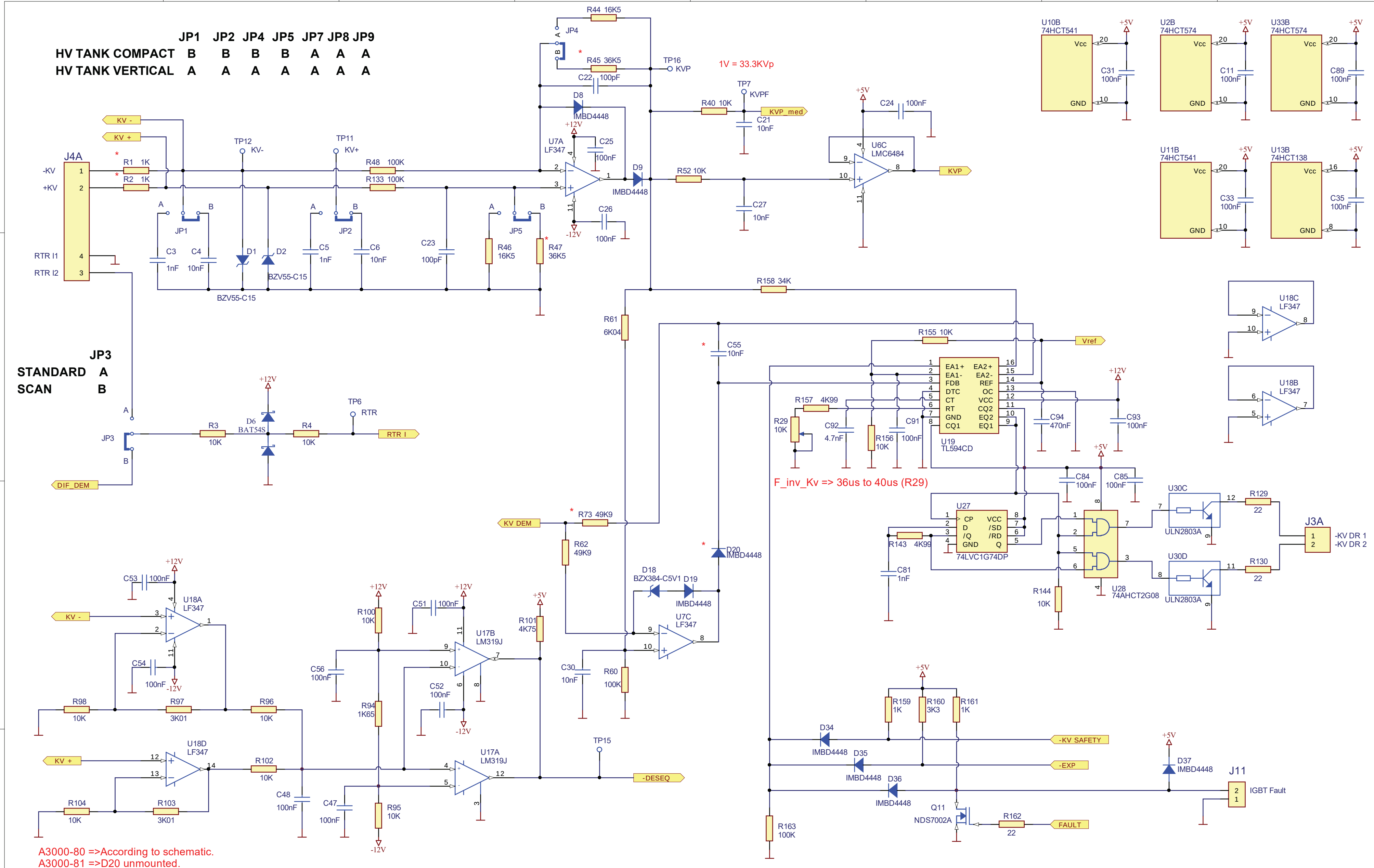
CLAMPING



PBA: A3000-8X
PCB: 90455-02
HT CONTROLLER
SEDECAL
DRAWING RHA 15/02/2018
REVISED F. Díaz 15/02/2018
SHEET / OF 1 / 4
B NC18/0050 RHA 6/9/2017
A First Edition RHA 30/12/2016
REV DESCRIPTION ISSUED BY DATE

	JP1	JP2	JP4	JP5	JP7	JP8	JP9
HV TANK COMPACT	B	B	B	B	A	A	A
HV TANK VERTICAL	A	A	A	A	A	A	A

	JP3
STANDARD	A
SCAN	B



A3000-80 =>According to schematic.
A3000-81 =>D20 unmounted.
A3000-82 =>D20 unmounted, R73 86K6, R147 & R151 0ohm.
A3000-83 =>D20 unmounted, R45 & R47 69K8, R58 & R56 226K, R59 & R54 25K5, R1 & R2 4K02.
A3000-84 =>D20 unmounted, adjust R29 to have a period of 48us.
A3000-85 =>D20 unmounted, R55 & R57 200K, R38 2K21, D4 & D5 unmounted
A3000-86 =>D20 unmounted, adjust R29 to have a period of 48us, C55 100nF.
A3000-87 =>D20 unmounted, adjust R29 to have a period of 45us, C55 100nF.
A3000-88 =>D20 unmounted, R147 & R151 0ohm.

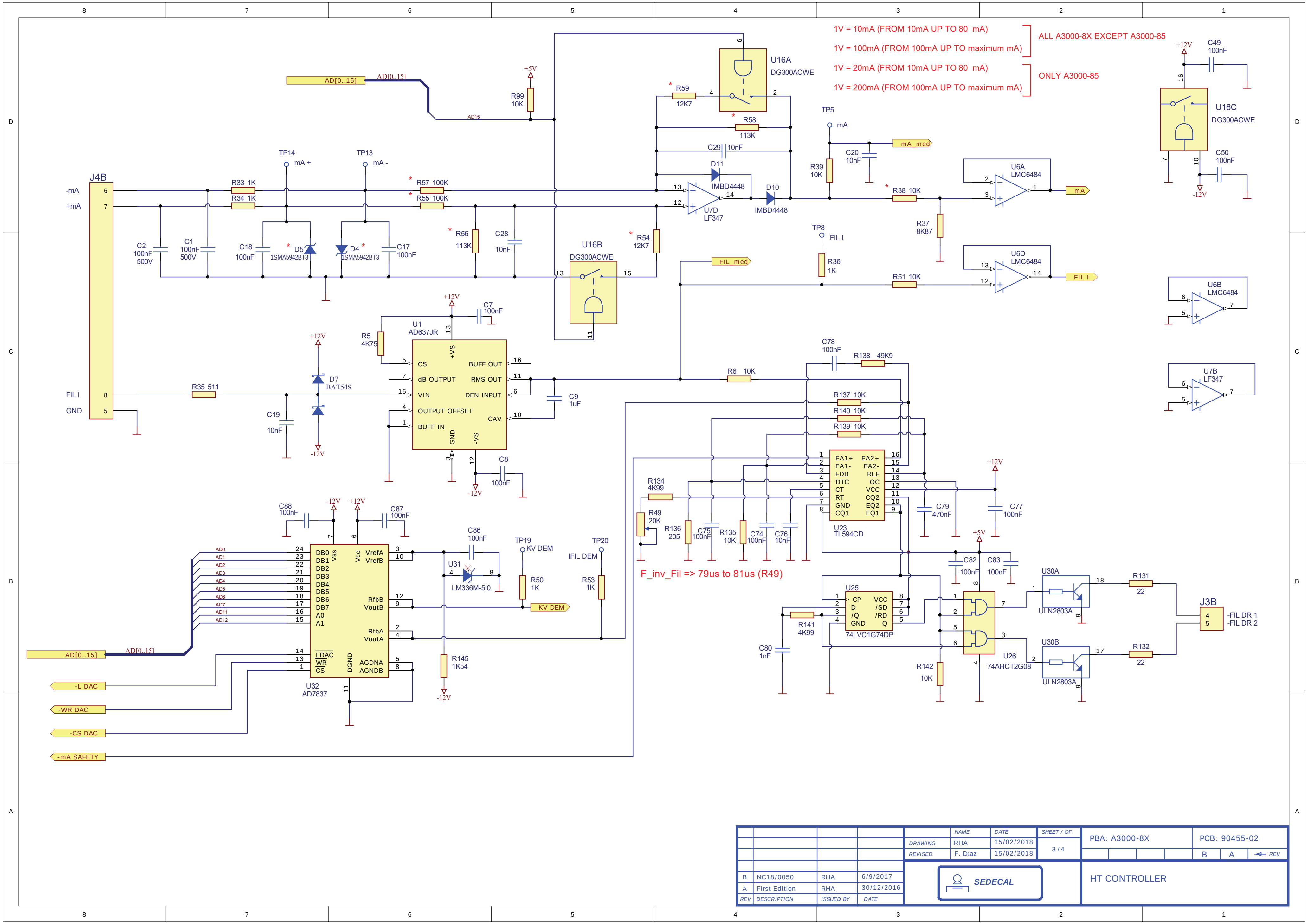
REV	DESCRIPTION	ISSUED BY	DATE
B	NC18/0050	RHA	6/9/2017
A	First Edition	RHA	30/12/2016

	NAME	DATE	SHEET / OF
DRAWING	RHA	15/02/2018	2 / 4
REVISED	F. Díaz	15/02/2018	

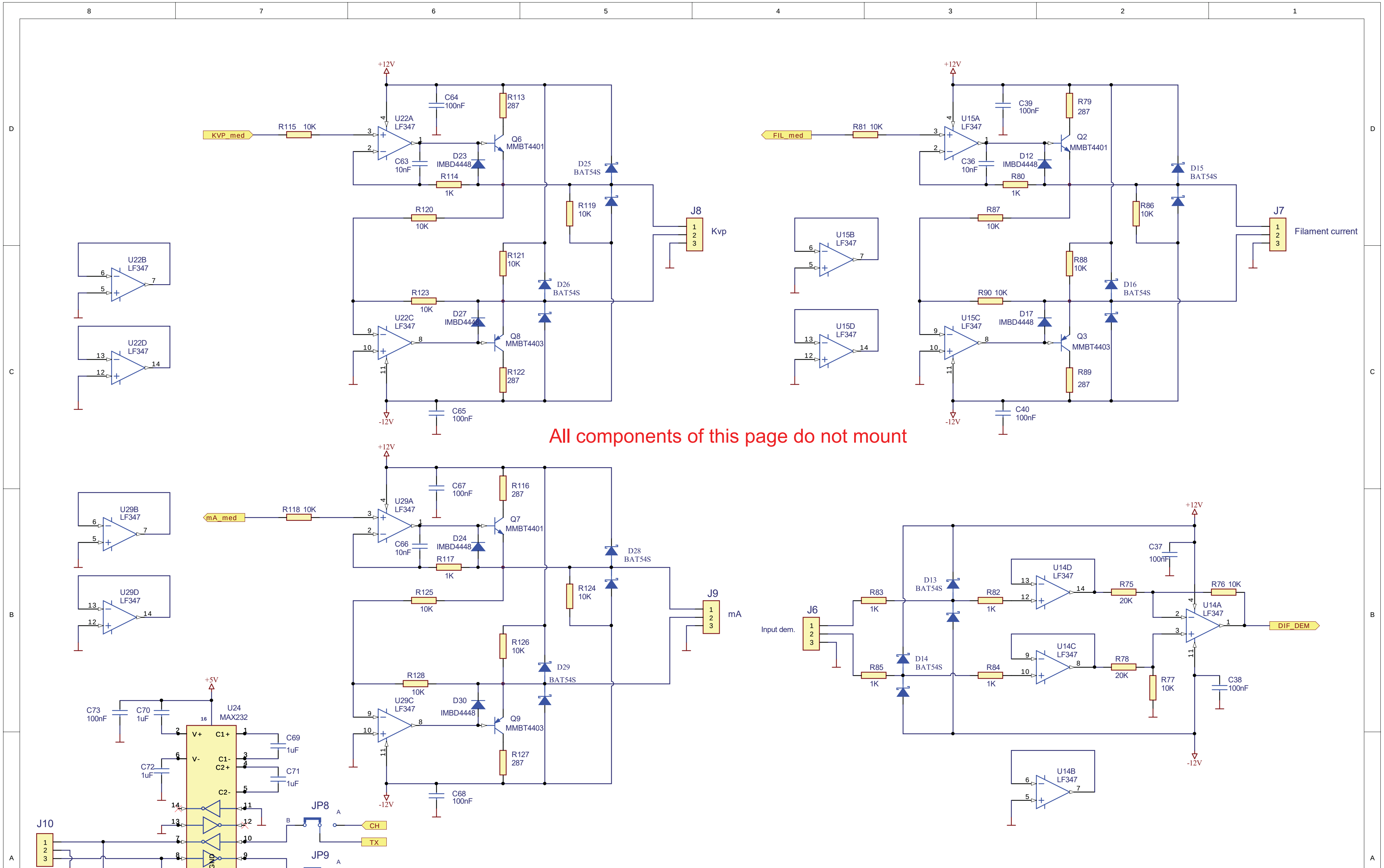
SEDECAL

PBA: A3000-8X
PCB: 90455-02
B A REV

HT CONTROLLER



1V = 10mA (FROM 10mA UP TO 80 mA)
1V = 100mA (FROM 100mA UP TO maximum mA)
ALL A3000-8X EXCEPT A3000-85
1V = 20mA (FROM 10mA UP TO 80 mA)
1V = 200mA (FROM 100mA UP TO maximum mA)
ONLY A3000-85
F_inv_Fil => 79us to 81us (R49)
J4B
U16A DG300ACWE
U16B DG300ACWE
U16C DG300ACWE
U7D LF347
U7B LF347
U6A LMC6484
U6D LMC6484
U6B LMC6484
U1 AD637JR
U23 TL594CD
U25 74LVC1G74DP
U26 74AHCT2G08
U30A ULN2803A
U30B ULN2803A
U31 LM336M-5,0
U32 AD7837
J3B
AD[0..15]
mA_med
mA
FIL_med
FIL I
KV DEM
-L DAC
-WR DAC
-CS DAC
-mA SAFETY
-FIL DR 1
-FIL DR 2
NAME
DATE
SHEET / OF
DRAWING RHA 15/02/2018
REVISED F. Díaz 15/02/2018
3 / 4
PBA: A3000-8X
PCB: 90455-02
B A REV
B NC18/0050 RHA 6/9/2017
A First Edition RHA 30/12/2016
REV DESCRIPTION ISSUED BY DATE
SEDECAL
HT CONTROLLER

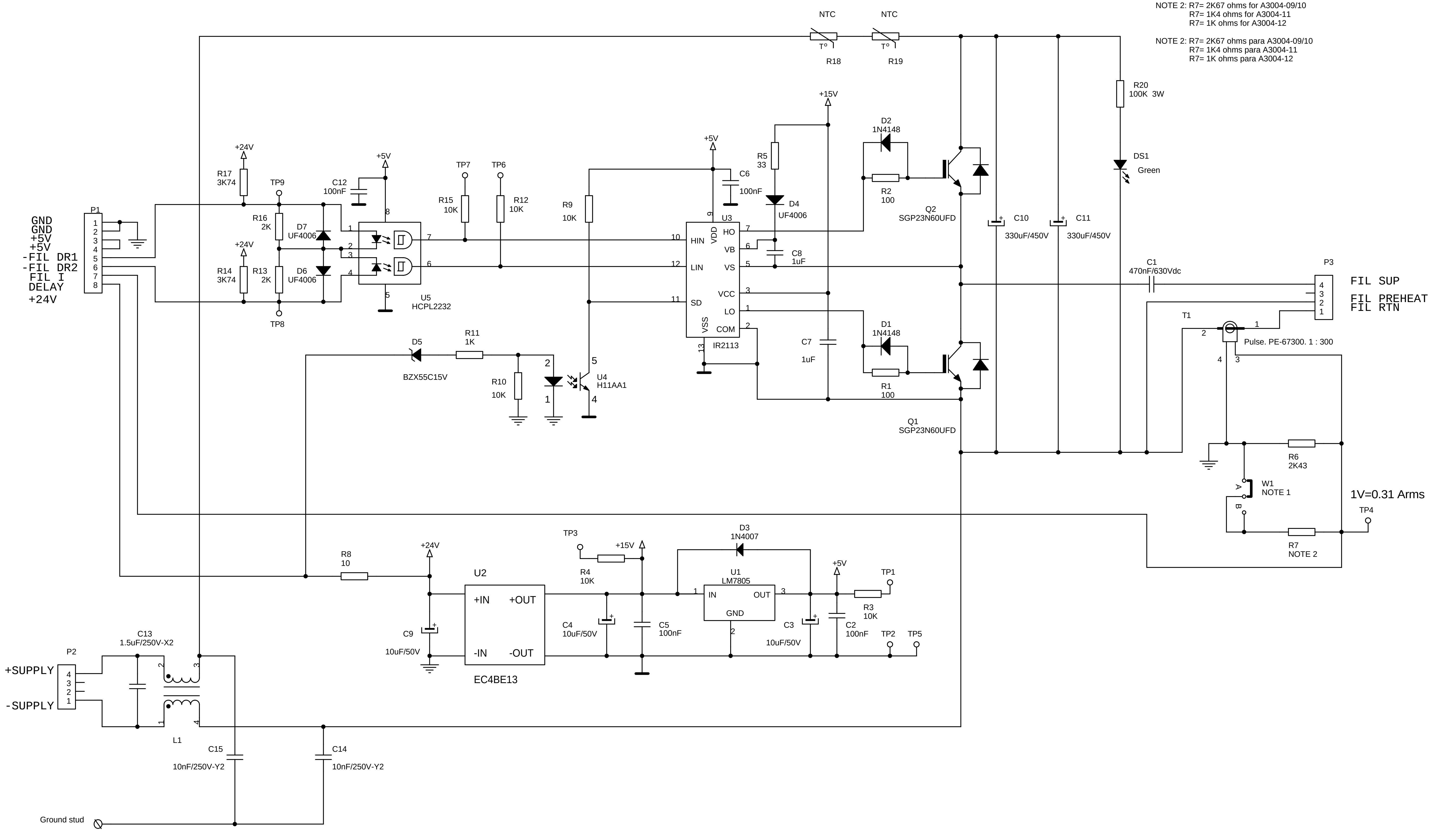


				NAME	DATE	SHEET / OF	PBA: A3000-8X	PCB: 90455-02
			DRAWING	RHA	15/02/2018	4 / 4		B A ← REV
			REVISED	F. Díaz	15/02/2018			
B	NC18/0050	RHA	6/9/2017	SEDECAL			HT CONTROLLER	
A	First Edition	RHA	30/12/2016					
REV	DESCRIPTION	ISSUED BY	DATE					

NOTE 1: W1-A for version A3004-10/11/12, W1-B for version A3004-09
NOTE 1: W1-A para versión A3004-10/11/12, W1-B para versión A3004-09

NOTE 2: R7= 2K67 ohms for A3004-09/10
R7= 1K4 ohms for A3004-11
R7= 1K ohms for A3004-12

NOTE 2: R7= 2K67 ohms para A3004-09/10
R7= 1K4 ohms para A3004-11
R7= 1K ohms para A3004-12



PCB 90068-04

REV	DESCRIPTION	ISSUED BY	DATE
F	NC 09/347	F. Díaz	26/11/09
E	NC 09/162	R. Asenjo	05/06/09
Db1	NC 06/251	F. Díaz	01/12/06
Cb1	NC 05/112		

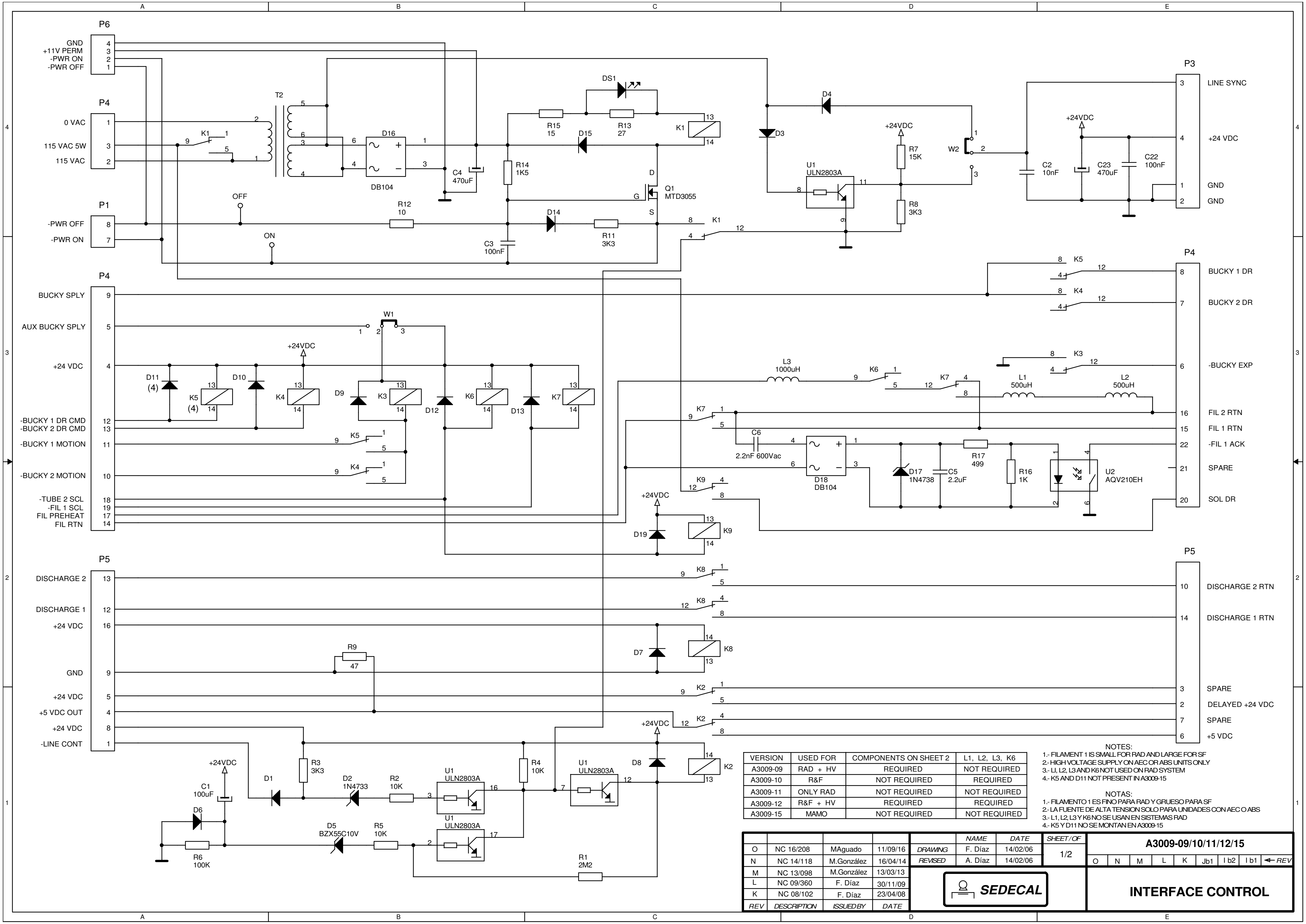
	NAME	DATE	SHEET / OF
DRAWING	F. Díaz	26/10/04	1/1
REVISED	A. Díaz	26/10/04	

SEDECAL

A3004-09/10/11/12

F	E	Db1	Cb1	Bb1	Ab1	b2	b1	◄ REV

Filament Driver HC



VERSION	USED FOR	COMPONENTS ON SHEET 2	L1, L2, L3, K6
A3009-09	RAD + HV	REQUIRED	NOT REQUIRED
A3009-10	R&F	NOT REQUIRED	REQUIRED
A3009-11	ONLY RAD	NOT REQUIRED	NOT REQUIRED
A3009-12	R&F + HV	REQUIRED	REQUIRED
A3009-15	MAMO	NOT REQUIRED	NOT REQUIRED

NOTES:
1.- FILAMENT 1 IS SMALL FOR RAD AND LARGE FOR SF
2.- HIGH VOLTAGE SUPPLY ON AEC OR ABS UNITS ONLY
3.- LI, L2, L3 AND K6 NOT USED ON RAD SYSTEM
4.- K5 AND D11 NOT PRESENT IN A3009-15

NOTAS:
1.- FILAMENTO 1 ES FINO PARA RAD Y GRUESO PARA SF
2.- LA FUENTE DE ALTA TENSION SOLO PARA UNIDADES CON AEC O ABS
3.- L1, L2, L3 Y K6 NO SE USAN EN SISTEMAS RAD
4.- K5 Y D11 NO SE MONTAN EN A3009-15

REV	DESCRIPTION	ISSUED BY	DATE
O	NC 16/208	MAguado	11/09/16
N	NC 14/118	M.González	16/04/14
M	NC 13/098	M.González	13/03/13
L	NC 09/360	F. Díaz	30/11/09
K	NC 08/102	F. Díaz	23/04/08

	NAME	DATE
DRAWING	F. Díaz	14/02/06
REVISED	A. Díaz	14/02/06

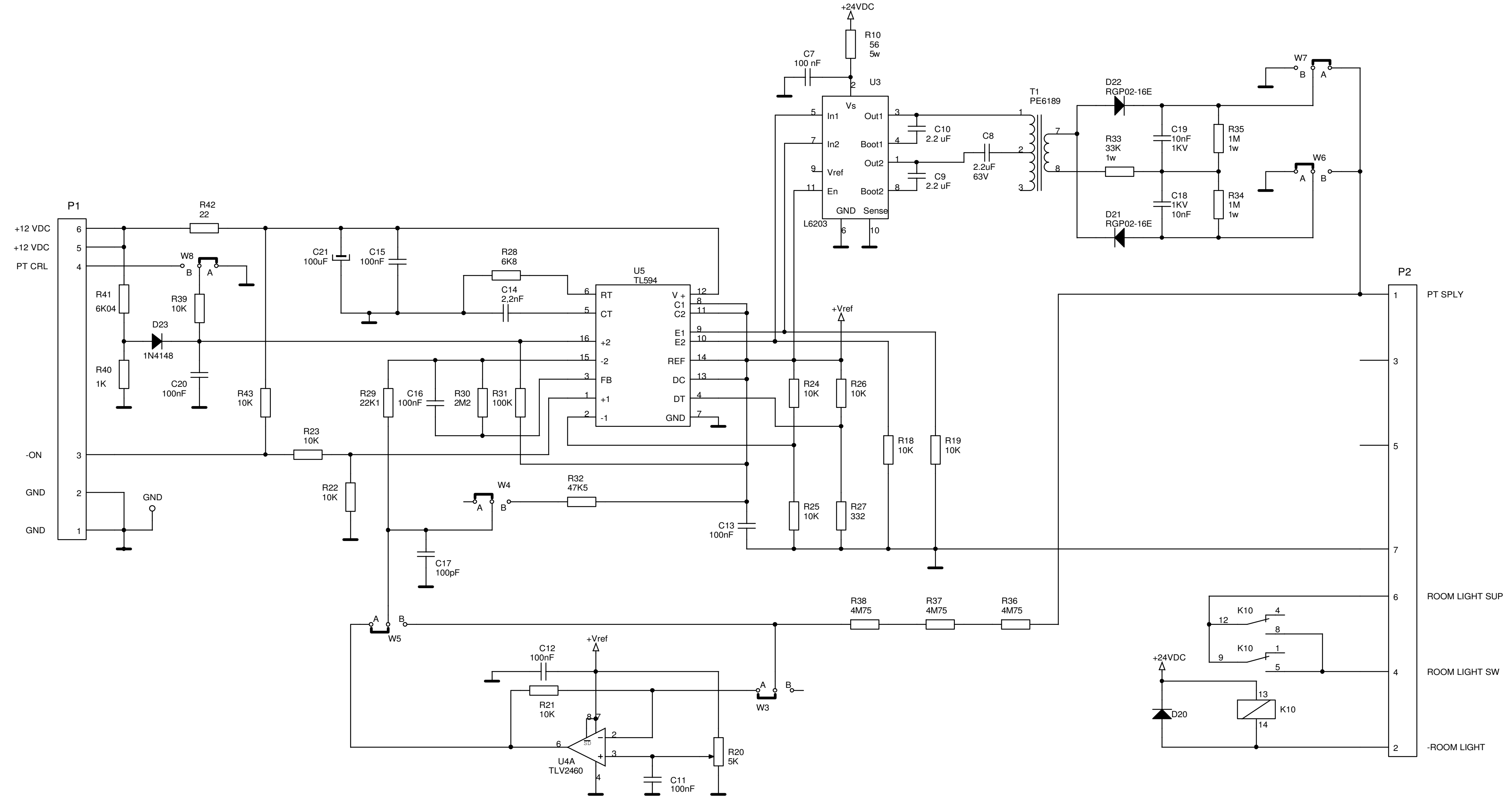
SHEET/OF 1/2

A3009-09/10/11/12/15

O N M L K Jb1 I b2 I b1 ← REV

SEDECAL

INTERFACE CONTROL



NOTE.- BE SURE THAT THE VALUE OF THE PHOTO TUBE SPLY OUTPUT IN P2-1 IS THE REQUIRED BEFORE CONECTING THE SYSTEM INTERFACE

NOTA.- ASEGURESE DE QUE EL VALOR DE LA SALIDA PHOTO TUBE SPLY EN P2-1 ES EL REQUERIDO ANTES DE HACER LA INTERCONEXION DEL SISTEMA

PHOTO TUBE SPLY OUTPUT (P2-1)

+500 VDC OR +300 VDC : JUMPERS W3 TO W8 IN POS "A", AND ADJUSTING WITH R20

VARIABLE NEGATIVE OUTPUT : JUMPERS W3 TO W10 IN POS "B"

SALIDA PHOTO TUBE SPLY (P2-1)

+500 VDC O +300 VDC : PUENTES W3 A W8 EN POS "A",Y AJUSTAR CON R20

SALIDA NEGATIVA VARIABLE : PUENTES W3 A W10 EN POS "B"

REV	DESCRIPTION	ISSUED BY	DATE
O	NC 16/208	MAguado	11/09/16
N	NC 14/118	M.González	16/04/14
M	NC 13/098	M.González	13/03/13
L	NC 09/360	F. Díaz	30/11/09
K	NC 08/102	F. Díaz	23/04/08

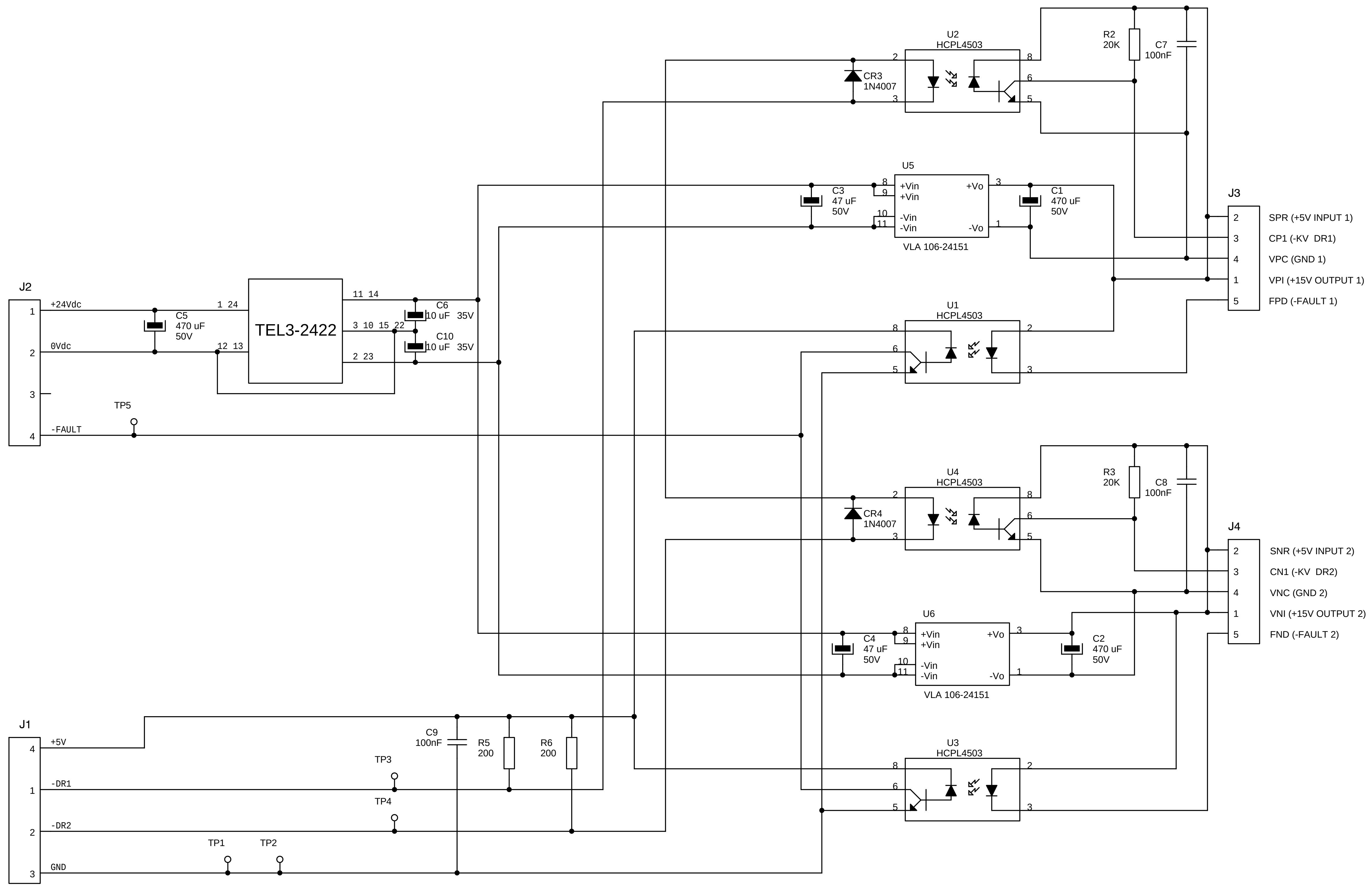
	NAME	DATE	SHEET/OF
DRAWING	F. Díaz	14/02/06	2/2
REVISED	A. Díaz	14/02/06	

SEDECAL

A3009-09/10/11/12/15

O	N	M	L	K	Jb1	I b2	I b1	◄ REV

INTERFACE CONTROL



C.I. 90132-06

REV	DESCRIPTION	ISSUED BY	DATE
B	NC 13/001	F. Díaz	04/01/13

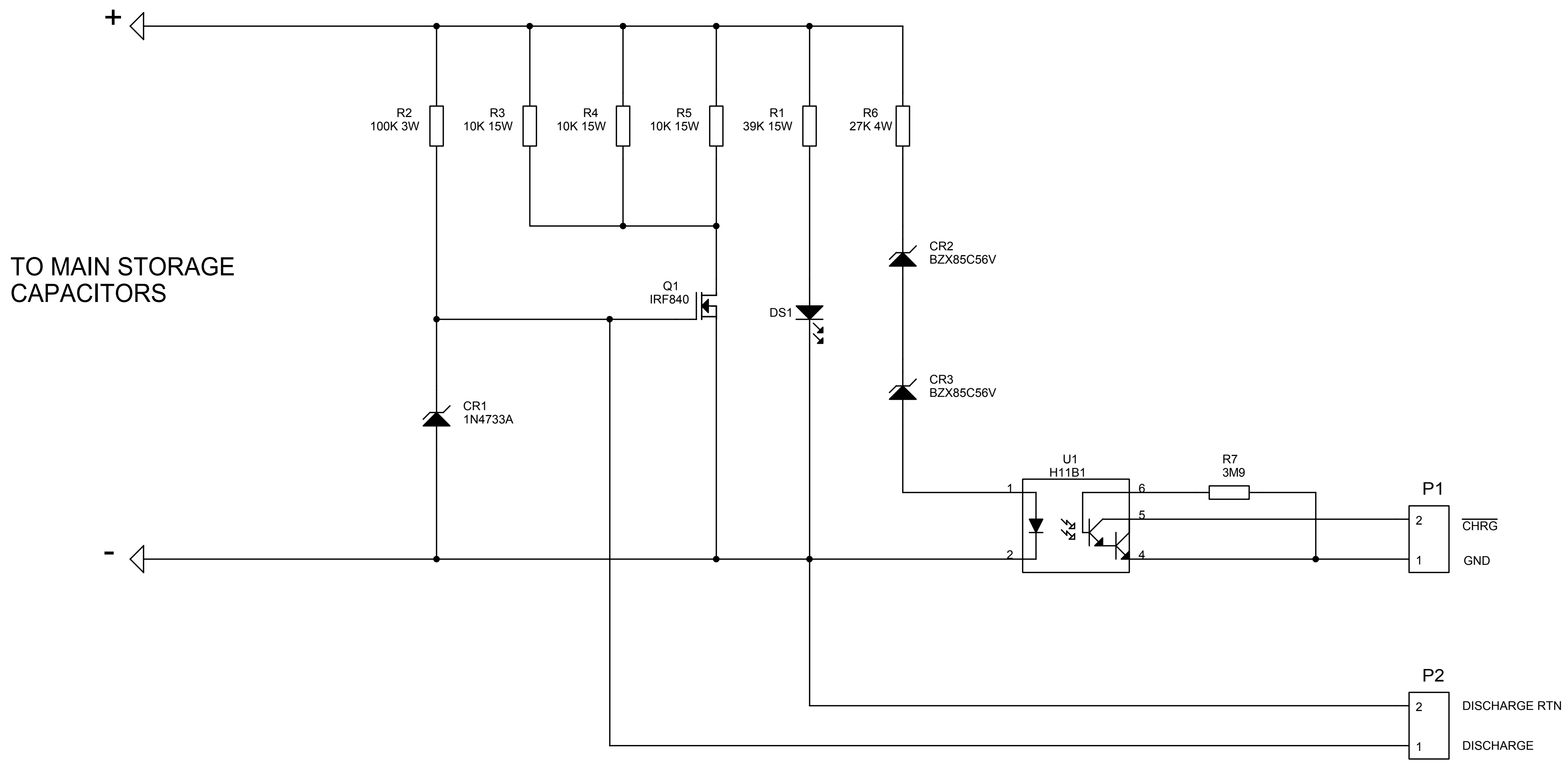
	NAME	DATE	SHEET / OF
DRAWING	F. Díaz	20/06/11	1/1
REVISED	A. Díaz	20/06/11	

SEDECAL

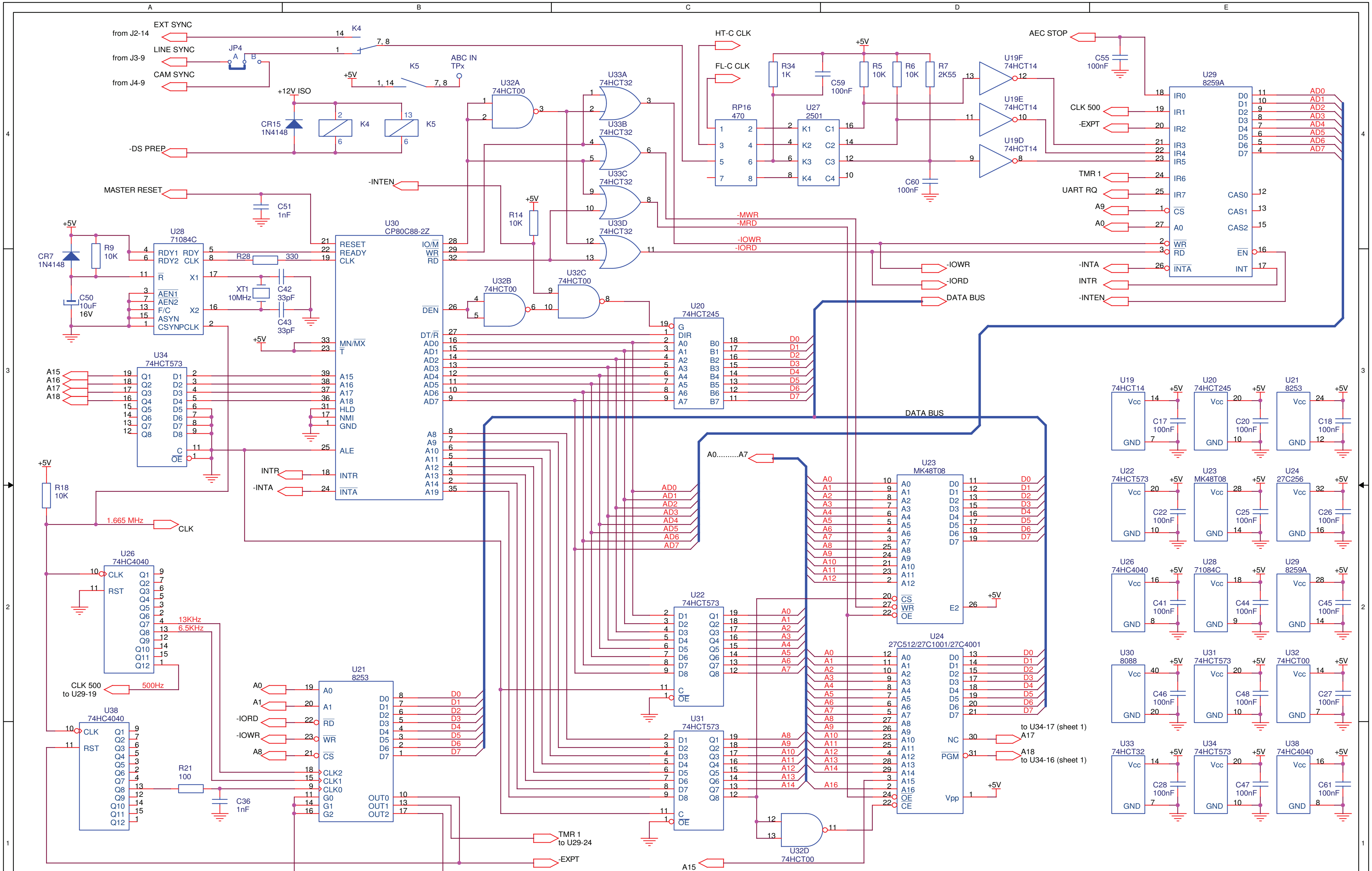
A3063-06

B A ◄REV

IPM DRIVER



E	CN 98/114	F.GARCIA	10/10/98	CHARGE/DISCHARGE MONITOR	ENG	F. GARCIA
D	CN 98/057	F.GARCIA	29/04/98		CHK	A. DIAZ
C	CN 96/033	F.GARCIA	06/03/96		REV	CN99/80 (22/07/99)
B	CN 95/080	F.GARCIA	10/05/95	SEDECAL S.A.	DWG	3212-01 REV. F
A	CN 95/74	F.GARCIA	25/04/95			REV.
REV	DESCRIPTION	ISSUED BY	DATE		DATE	11/01/95



REV	DESCRIPTION	ISSUED BY	DATE
V	NC 18/0119	Carlos R.	28/03/19
U	NC 13/257	R. Hermosilla	19/02/14
T	NC 13/417	R. Hermosilla	21/01/14
S	NC 12/278	F. Díaz	25/06/12
W	NC19/0078	R. Hermosilla	30/07/19

	NAME	DATE
DRAWING	F. Díaz	09/02/11
REVISED	A. Díaz	09/02/11

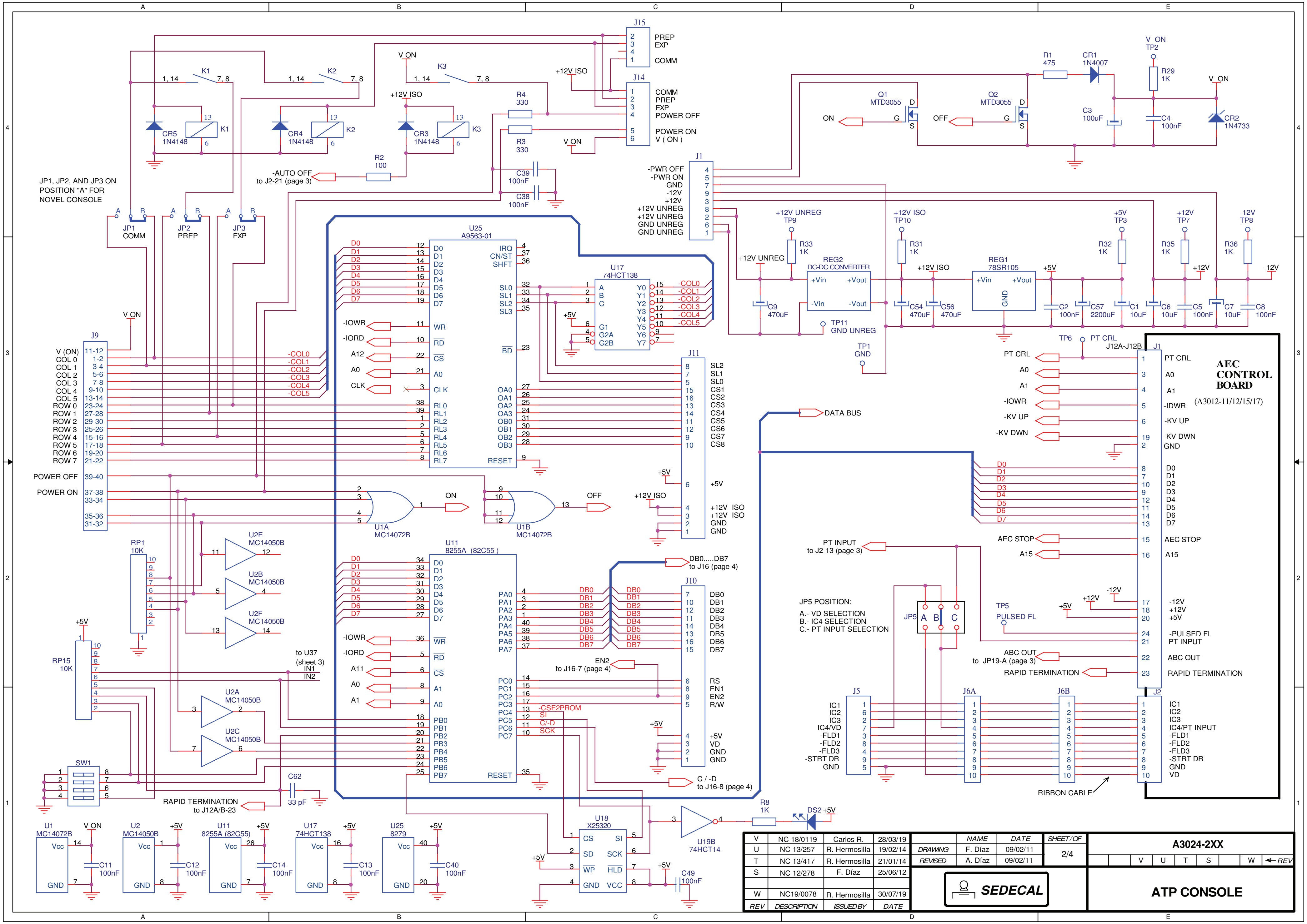
SHEET/OF 1/4

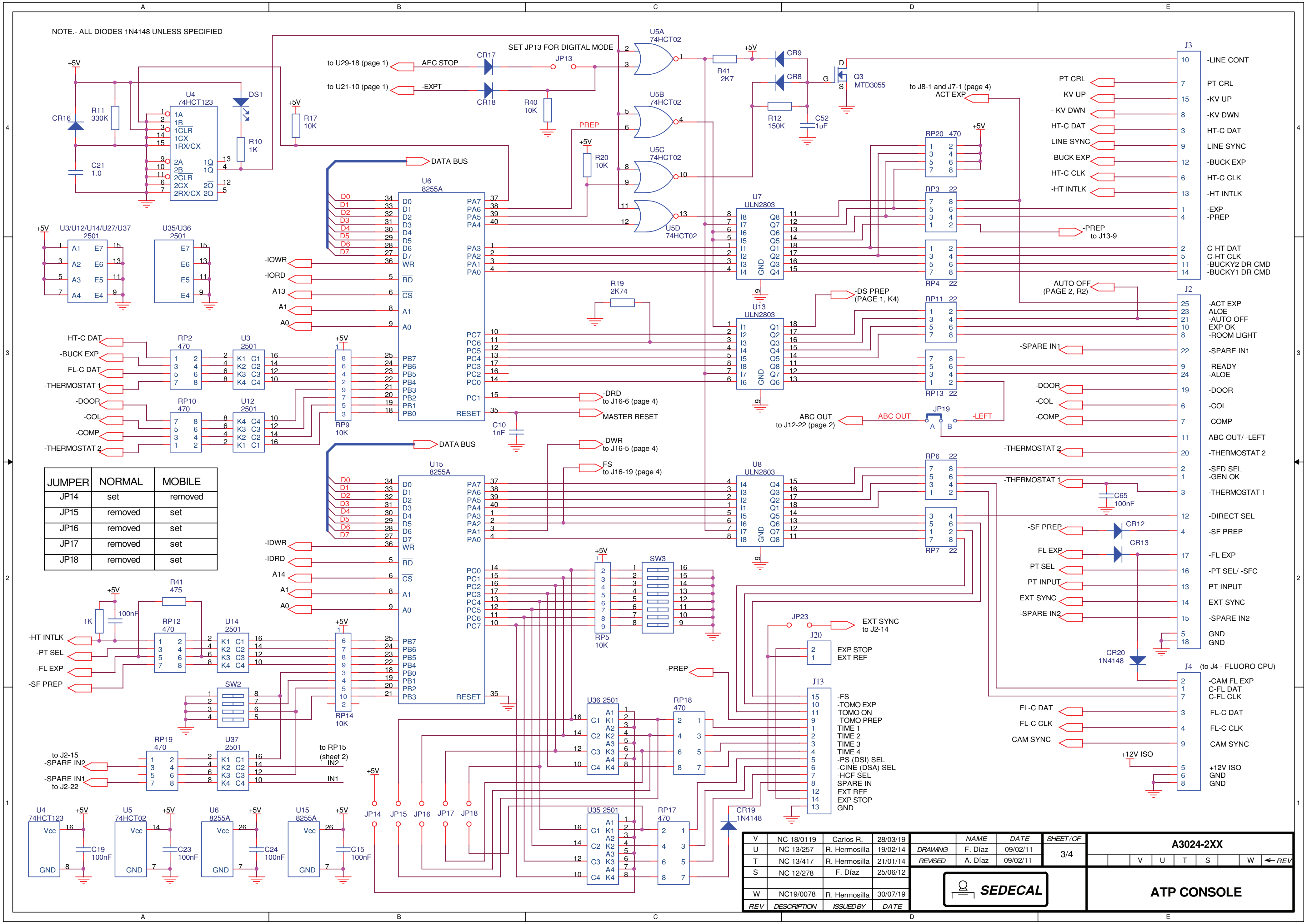
A3024-2XX

V U T S W ← REV

SEDECAL

ATP CONSOLE


J15
PREP
EXP
COMM
J14
COMM
PREP
EXP
POWER OFF
POWER ON
V (ON)
K1
K2
K3
1, 14
7, 8
V ON
+12V ISO
CR5 1N4148
CR4 1N4148
CR3 1N4148
R4 330
R3 330
R2 100
-AUTO OFF
to J2-21 (page 3)
C39 100nF
C38 100nF
JP1, JP2, AND JP3 ON
POSITION "A" FOR
NOVEL CONSOLE
JP1 COMM
JP2 PREP
JP3 EXP
U25 A9563-01
U17 74HCT138
J1
-PWR OFF
-PWR ON
GND
-12V
+12V
+12V UNREG
GND UNREG
R1 475
CR1 1N4007
V ON TP2
R29 1K
Q1 MTD3055
Q2 MTD3055
ON
OFF
C3 100uF
C4 100nF
CR2 1N4733
+12V UNREG TP9
R33 1K
REG2 DC-DC CONVERTER
+12V ISO TP10
R31 1K
C9 470uF
C54 470uF
C56 470uF
TP11 GND UNREG
REG1 78SR105
+5V TP3
R32 1K
+12V TP7
R35 1K
-12V TP8
R36 1K
C2 100nF
C57 2200uF
C1 10uF
C6 10uF
C5 100nF
C7 10uF
C8 100nF
TP1 GND
TP6 PT CRL
J12A-J12B
AEC CONTROL BOARD
(A3012-11/12/15/17)
PT CRL
A0
A1
-IOWR
-KV UP
-KV DWN
GND
D0 D1 D2 D3 D4 D5 D6 D7
AEC STOP
A15
DATA BUS
J9
V (ON)
COL 0 COL 1 COL 2 COL 3 COL 4 COL 5
ROW 0 ROW 1 ROW 2 ROW 3 ROW 4 ROW 5 ROW 6 ROW 7
POWER OFF
POWER ON
J11
SL2 SL1 SL0 CS1 CS2 CS3 CS4 CS5 CS6 CS7 CS8
U1A MC14072B
U1B MC14072B
U11 8255A (82C55)
U2E MC14050B
U2B MC14050B
U2F MC14050B
U2A MC14050B
U2C MC14050B
RP1 10K
RP15 10K
SW1
to U37 (sheet 3)
IN1
IN2
DB0.....DB7
to J16 (page 4)
J10
EN2
to J16-7 (page 4)
RS EN1 EN2 R/W
-CSE2PROM
SI
C/-D
SCK
C / -D
to J16-8 (page 4)
C62 33 pF
RAPID TERMINATION
to J12A/B-23
PT INPUT
to J2-13 (page 3)
JP5 POSITION:
A.- VD SELECTION
B.- IC4 SELECTION
C.- PT INPUT SELECTION
JP5
TP5 PULSED FL
-12V
+12V
+5V
-PULSED FL
PT INPUT
ABC OUT
to JP19-A (page 3)
RAPID TERMINATION
J5
J6A
J6B
J2
IC1 IC2 IC3 IC4/VD -FLD1 -FLD2 -FLD3 -STRT DR GND
IC4/PT INPUT
VD
RIBBON CABLE
U18 X25320
U19B 74HCT14
R8 1K
DS2
C49 100nF
U1 MC14072B
U2 MC14050B
U11 8255A (82C55)
U17 74HCT138
U25 8279
C11 100nF
C12 100nF
C14 100nF
C13 100nF
C40 100nF
V | NC 18/0119 | Carlos R. | 28/03/19
U | NC 13/257 | R. Hermosilla | 19/02/14
T | NC 13/417 | R. Hermosilla | 21/01/14
S | NC 12/278 | F. Díaz | 25/06/12
W | NC19/0078 | R. Hermosilla | 30/07/19
REV | DESCRIPTION | ISSUED BY | DATE
DRAWING | F. Díaz | 09/02/11
REVISED | A. Díaz | 09/02/11
NAME | DATE
SHEET/OF 2/4
A3024-2XX
V U T S W REV
SEDECAL
ATP CONSOLE



JUMPER	NORMAL	MOBILE
JP14	set	removed
JP15	removed	set
JP16	removed	set
JP17	removed	set
JP18	removed	set

REV	DESCRIPTION	ISSUED BY	DATE
V	NC 18/0119	Carlos R.	28/03/19
U	NC 13/257	R. Hermosilla	19/02/14
T	NC 13/417	R. Hermosilla	21/01/14
S	NC 12/278	F. Díaz	25/06/12
W	NC19/0078	R. Hermosilla	30/07/19

	NAME	DATE
DRAWING	F. Díaz	09/02/11
REVISED	A. Díaz	09/02/11

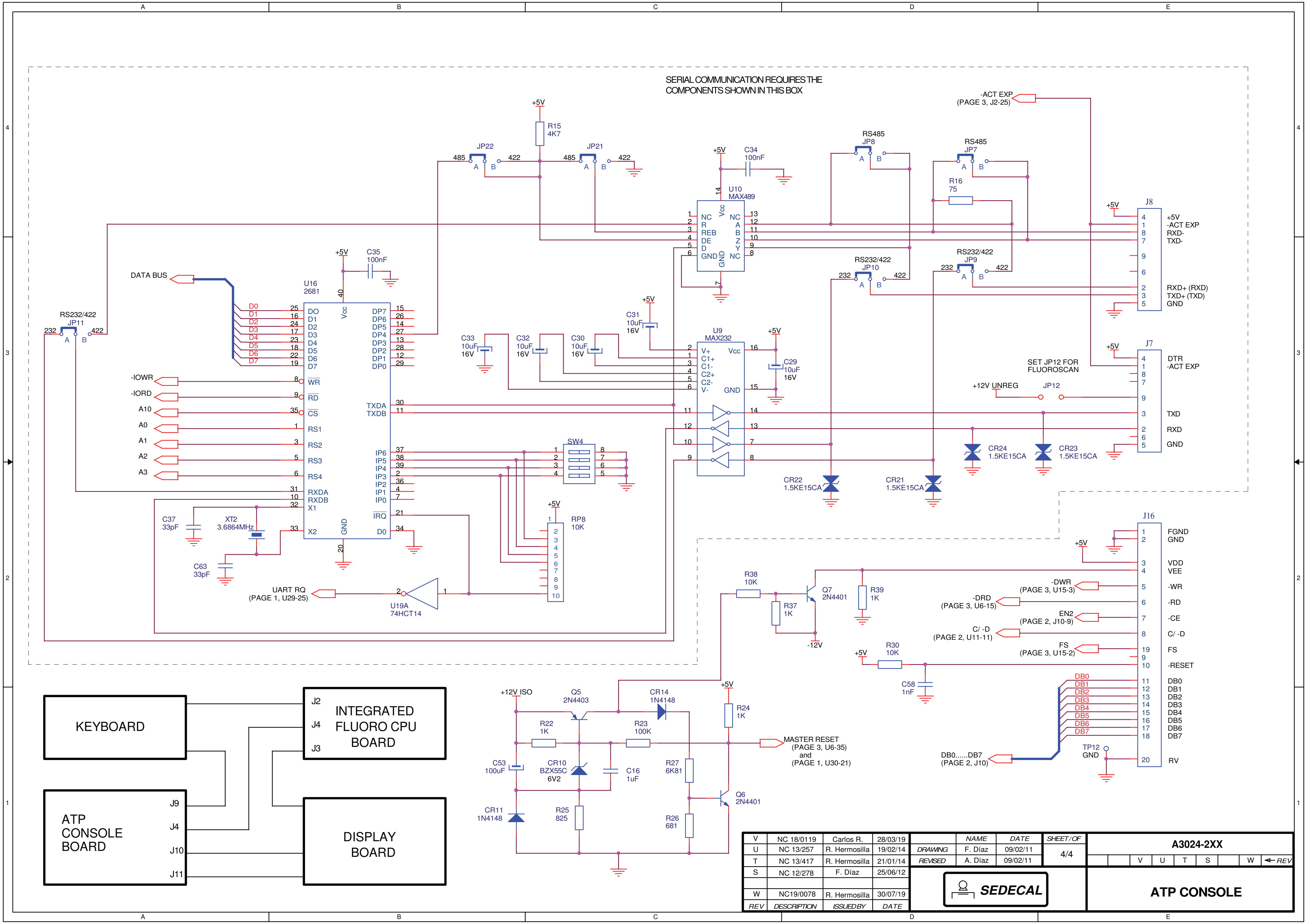
SHEET/OF 3/4

A3024-2XX

V U T S W ← REV

SEDECAL

ATP CONSOLE



REV	DESCRIPTION	ISSUED BY	DATE
V	NC 18/0119	Carlos R.	28/03/19
U	NC 13/257	R. Hermosilla	19/02/14
T	NC 13/417	R. Hermosilla	21/01/14
S	NC 12/278	F. Díaz	25/06/12
W	NC19/0078	R. Hermosilla	30/07/19

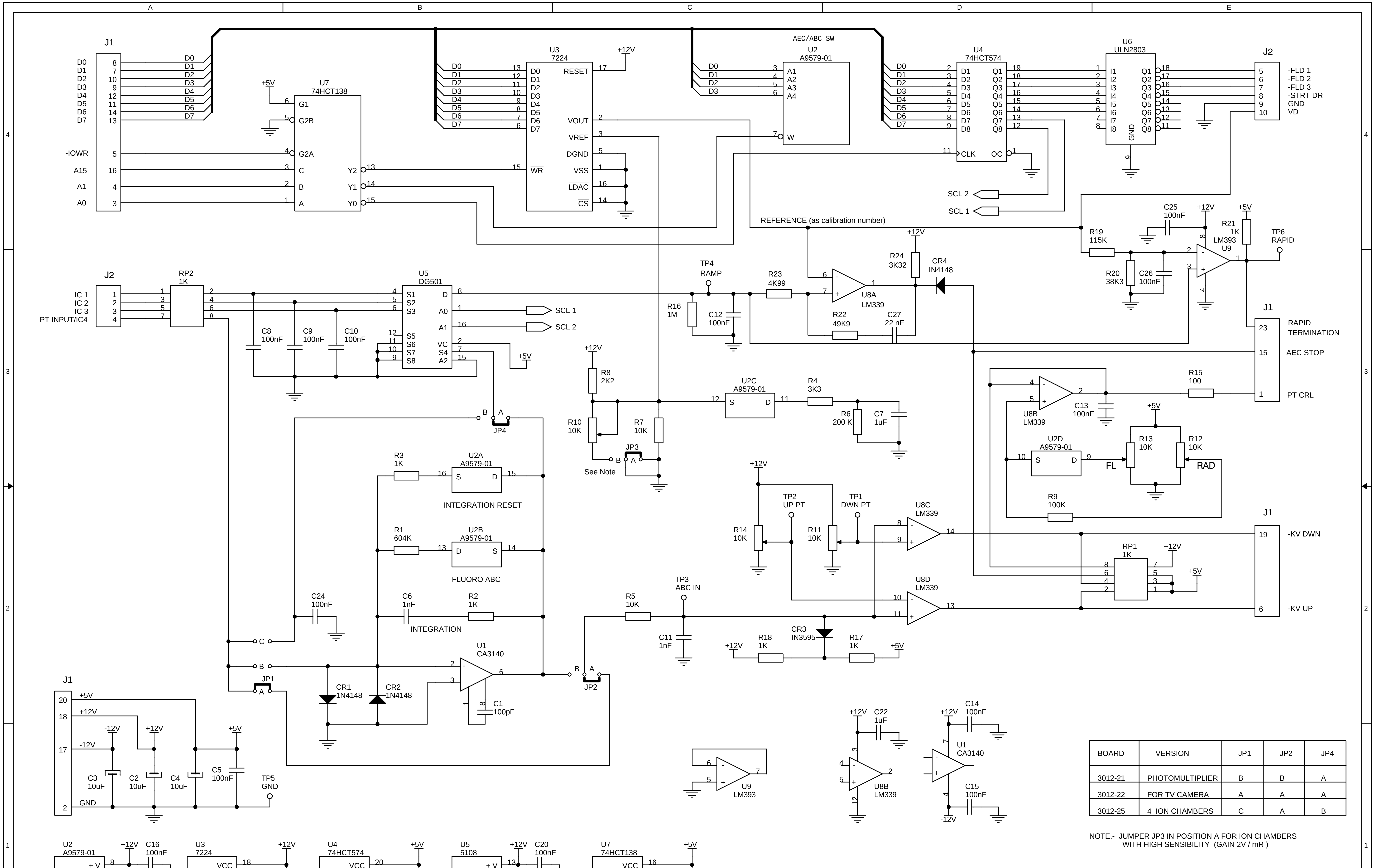
	NAME	DATE
DRAWING	F. Díaz	09/02/11
REVISED	A. Díaz	09/02/11

SHEET/OF 4/4

A3024-2XX

SEDECAL

ATP CONSOLE



BOARD	VERSION	JP1	JP2	JP4
3012-21	PHOTOMULTIPLIER	B	B	A
3012-22	FOR TV CAMERA	A	A	A
3012-25	4 ION CHAMBERS	C	A	B

NOTE.- JUMPER JP3 IN POSITION A FOR ION CHAMBERS
WITH HIGH SENSIBILITY (GAIN 2V / mR)

REV	DESCRIPTION	ISSUED BY	DATE
D	NC 13/228	M.A.González	16/09/13
C	NC 12/378	M.A.González	19/03/13
B	NC 08/137	M.A.González	21/05/08
A	NC 08/105	R. Asenjo	16/04/08

	NAME	DATE
DRAWING	R. Asenjo	16/04/08
REVISED	A. Díaz	16/04/08

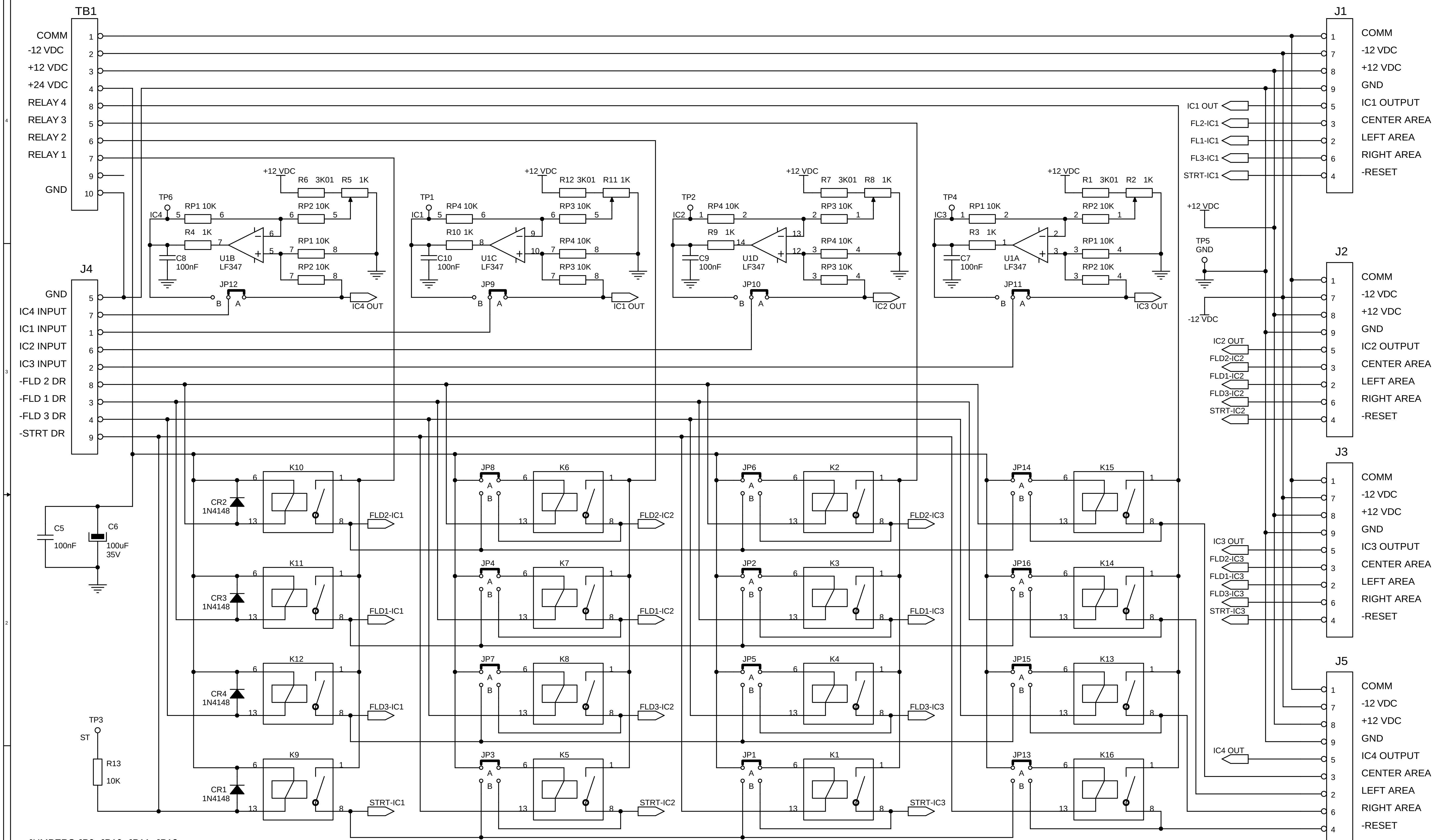
SHEET / OF 1/1

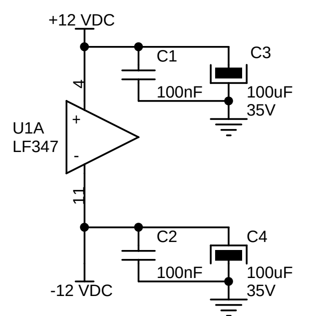
SEDECAL

A3012-21/22/25

D C B A ◄REV

AEC CONTROL





JUMPERS JP9, JP10, JP11, JP12

POS. A.- NO OFFSET ADJUSTMENT

POS. B.- OFFSET ADJUSTMENT

Ion Chamber Type	Jumpers JP3, JP4, JP7, JP8	Jumpers JP1, JP2, JP5, JP6	Jumpers JP13, JP14, JP15, JP16
IC1=IC2=IC3=IC4	B	B	B
IC1=IC2=IC3	B	B	A
IC1=IC2	B	A	A
IC1≠IC2≠IC3≠IC4	A	A	A

Note.- Version 03 as CN 99/45

REV	DESCRIPTION	ISSUED BY	DATE

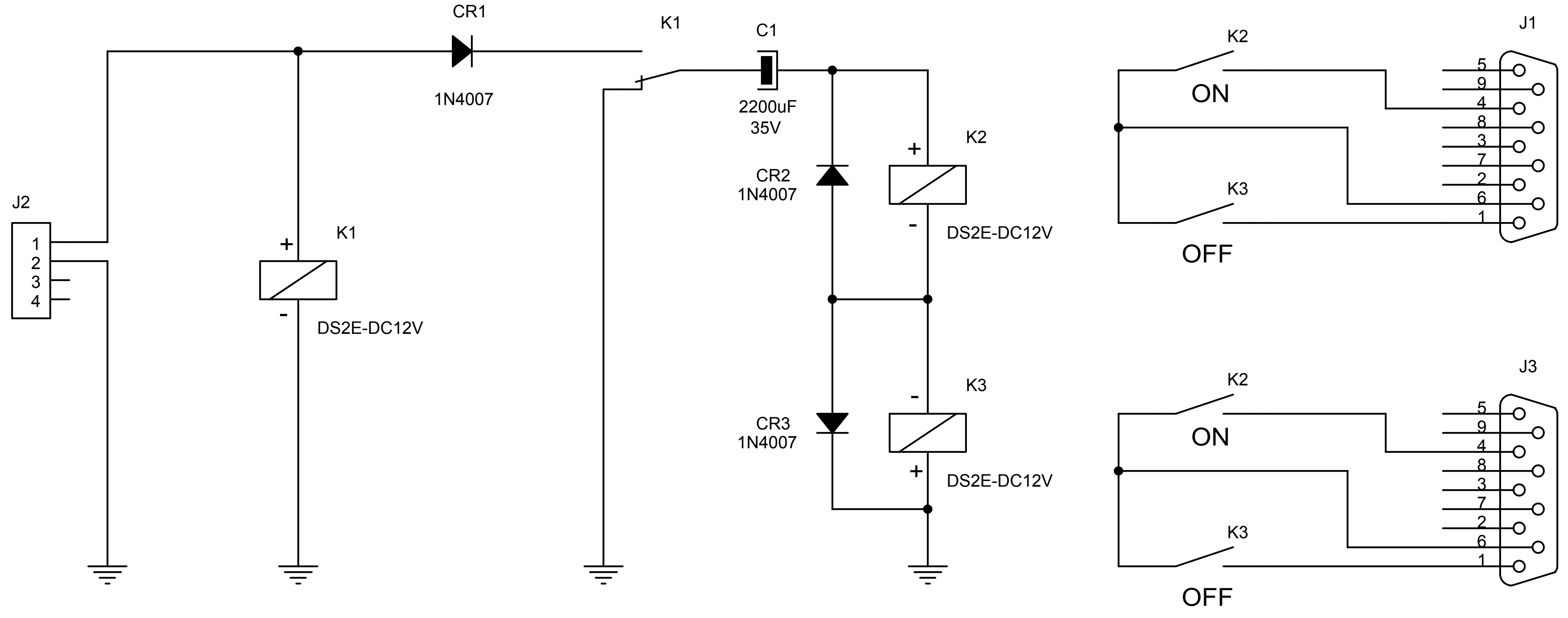
	NAME	DATE	SHEET / OF
DRAWING	F. GARCIA	07-07-99	1/1
REVISED	A. DIAZ	07-07-99	

SEDECAL

A3263-03

REV

AEC ADAPTATION
ADAPTACION AEC



REV	DESCRIPTION	ISSUED BY	DATE

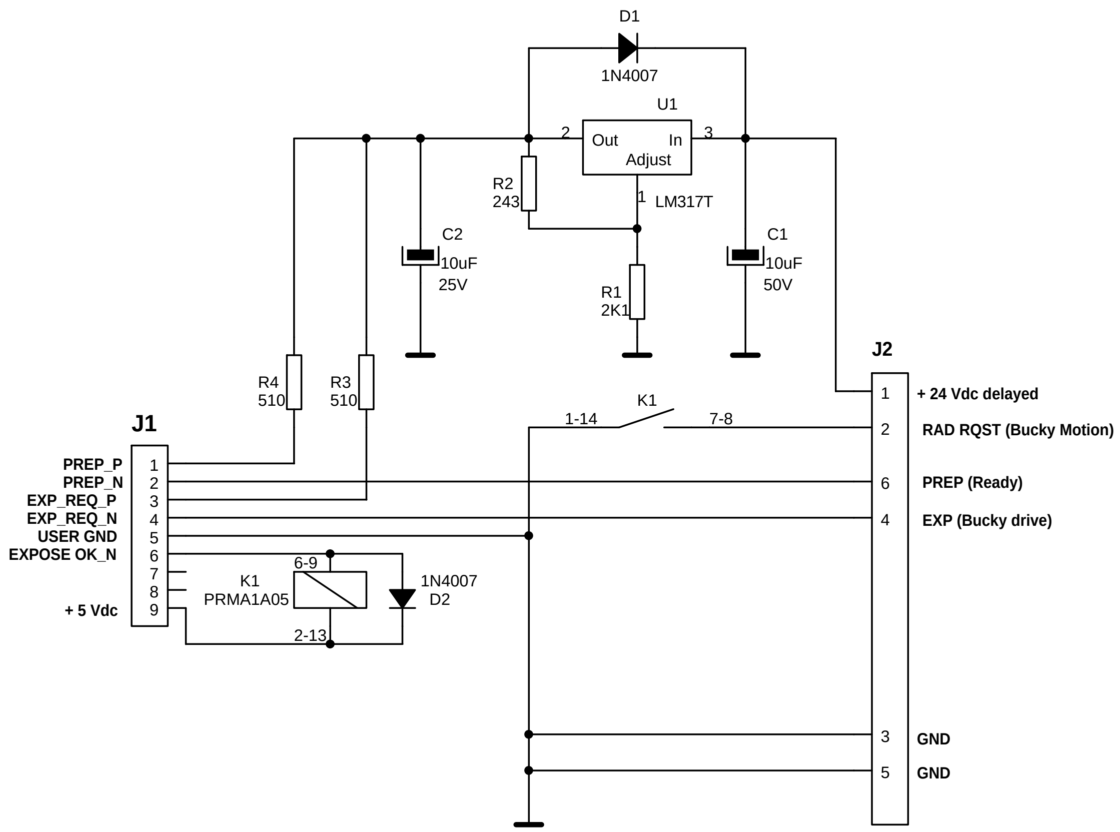
	NAME	DATE	SHEET / OF
DRAWING	F. Díaz	14/12/01	1/1
REVISED	F. Díaz	14/12/01	

SEDECAL

A3179-02

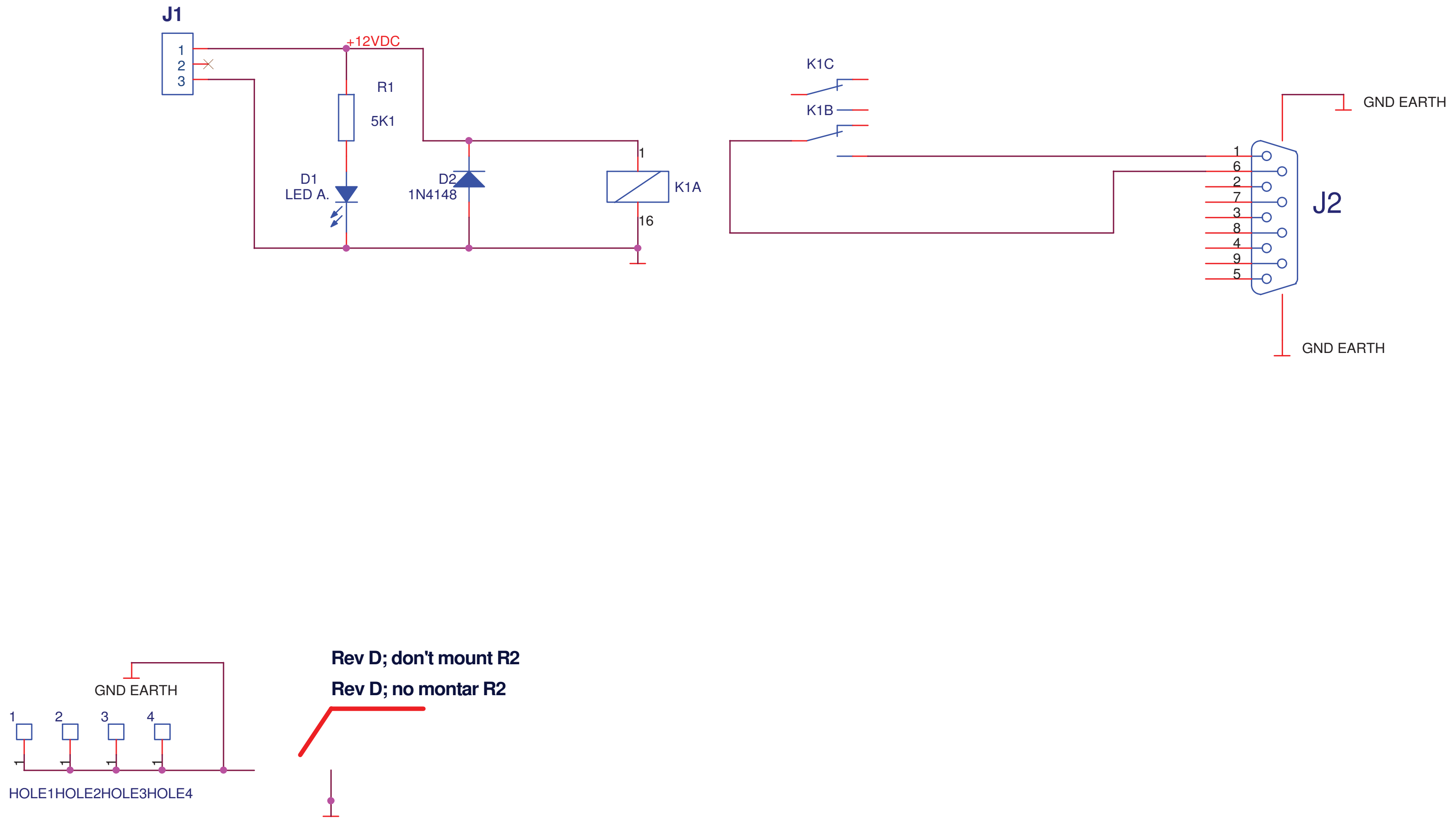
REV

AUTO ON/OFF



PCB: 90200-02

					NAME	DATE	SHEET / OF	A3610-03
				DRAWING	M.González	10/03/09	1/1	B A ◄ REV
				REVISED	A. Díaz	10/03/09		
B	NC 12/269	M.A. González	19/06/12	SEDECAL				INTERFACE VARIAN PCB
A	NE 074/09	M.A. González	10/03/09					
REV	DESCRIPTION	ISSUED BY	DATE					



PCB 90309-02

REV	DESCRIPTION	ISSUED BY	DATE
D	NC 18/0018	M. González	08/03/18
C	NC 12/269	Sonia Pérez	13/07/11
B	NC 11/245	Sonia Pérez	18/06/12
A	Prototype	Sonia Pérez	12/05/20

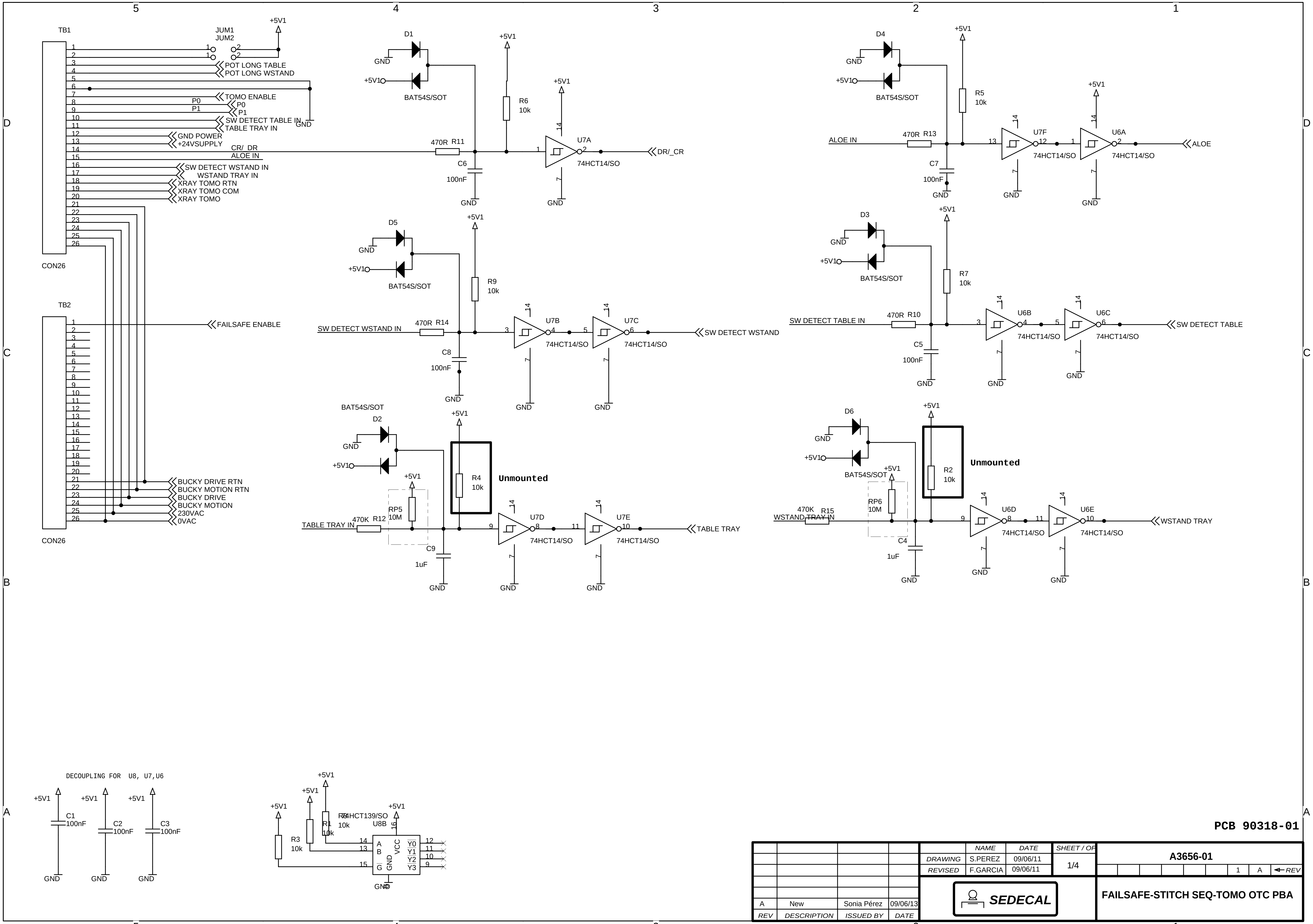
	NAME	DATE	SHEET / OF
DRAWING	S.PEREZ	12/05/11	1/1
REVISED	M.González	12/05/11	

SEDECAL

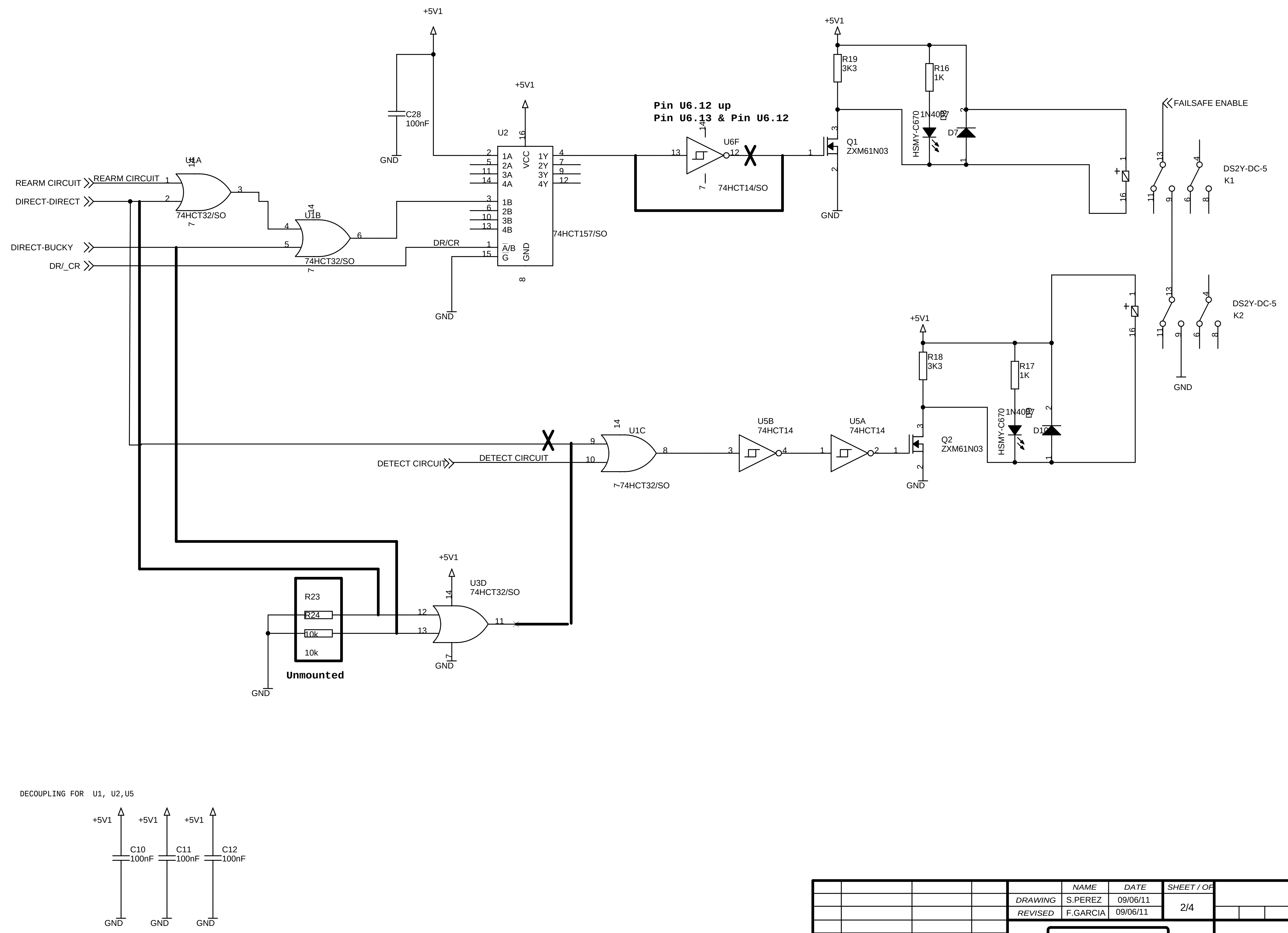
PBA A3651-01

				D	C	B	A	← REV

DIRECT STITCHING INTERFACE PBA

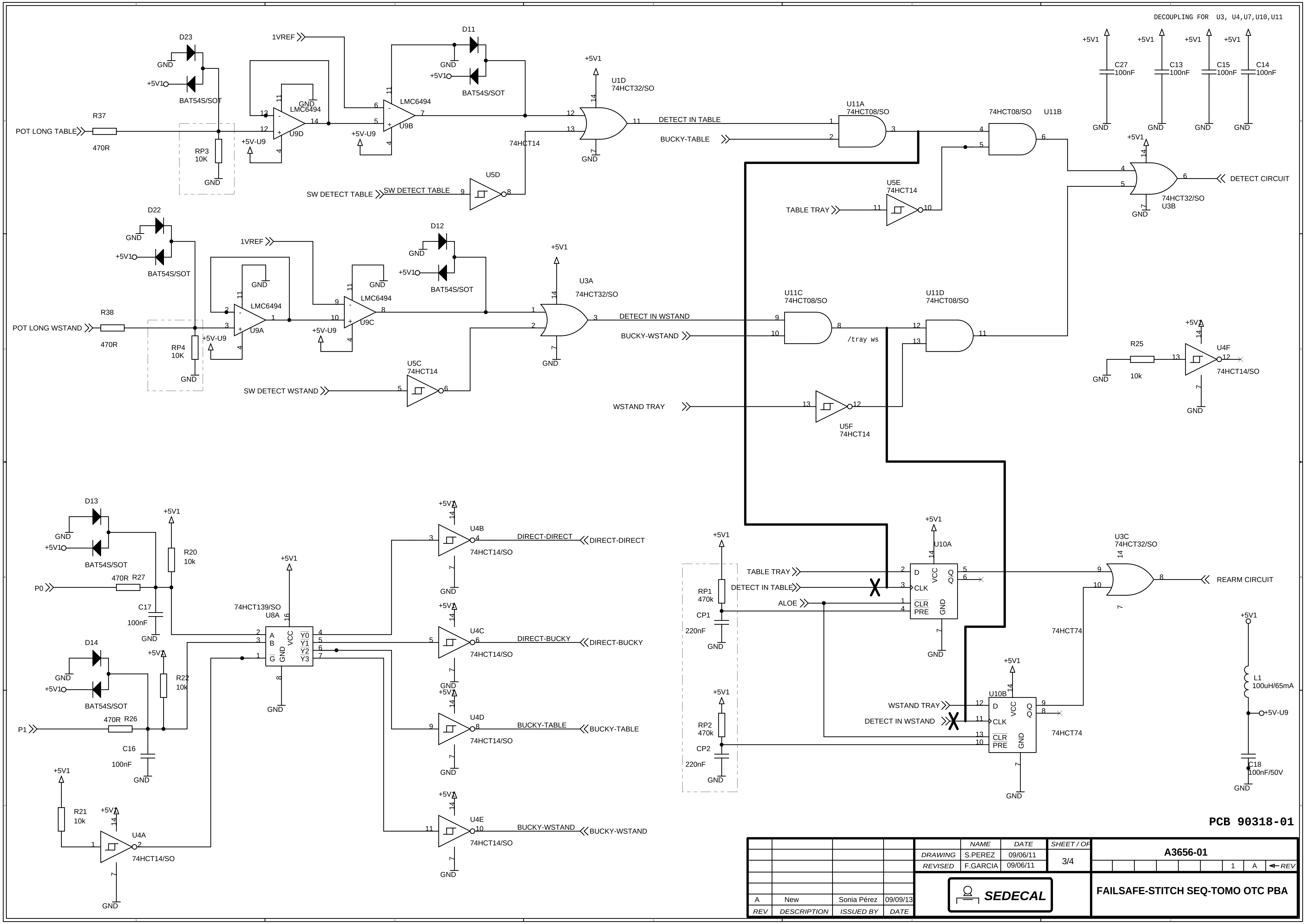


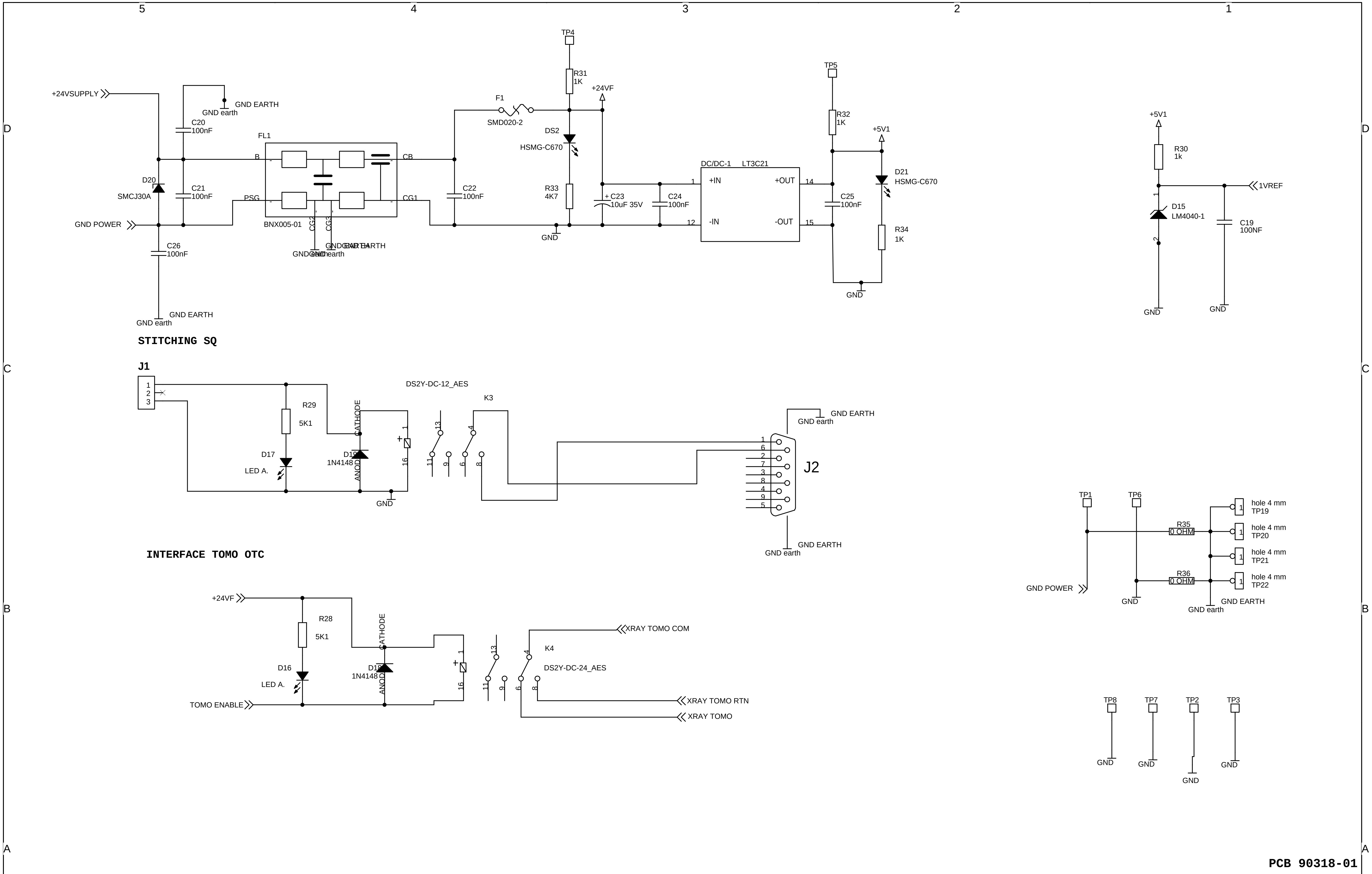
TB1
CON26
JUM1
JUM2
POT LONG TABLE
POT LONG WSTAND
TOMO ENABLE
P0
P1
SW DETECT TABLE IN
TABLE TRAY IN
GND POWER
+24VSUPPLY
CR/_DR
ALOE IN
SW DETECT WSTAND IN
WSTAND TRAY IN
XRAY TOMO RTN
XRAY TOMO COM
XRAY TOMO
TB2
FAILSAFE ENABLE
BUCKY DRIVE RTN
BUCKY MOTION RTN
BUCKY DRIVE
BUCKY MOTION
230VAC
0VAC
D1
BAT54S/SOT
R6 10k
470R R11
C6 100nF
U7A 74HCT14/SO
DR/_CR
D4
R5 10k
470R R13
C7 100nF
U7F 74HCT14/SO
U6A 74HCT14/SO
ALOE
D5
R9 10k
470R R14
C8 100nF
U7B 74HCT14/SO
U7C 74HCT14/SO
SW DETECT WSTAND
D3
R7 10k
470R R10
C5 100nF
U6B 74HCT14/SO
U6C 74HCT14/SO
SW DETECT TABLE
D2
R4 10k
Unmounted
RP5 10M
470K R12
C9 1uF
U7D 74HCT14/SO
U7E 74HCT14/SO
TABLE TRAY
D6
R2 10k
Unmounted
RP6 10M
470K R15
C4 1uF
U6D 74HCT14/SO
U6E 74HCT14/SO
WSTAND TRAY
DECOUPLING FOR U8, U7,U6
C1 100nF
C2 100nF
C3 100nF
R3 10k
R1 10k
R8 10k
74HCT139/SO
U8B
+5V1
GND
PCB 90318-01
NAME
DATE
SHEET / OF
DRAWING S.PEREZ 09/06/11
REVISED F.GARCIA 09/06/11
1/4
A3656-01
1 A REV
SEDECAL
FAILSAFE-STITCH SEQ-TOMO OTC PBA
A New Sonia Pérez 09/06/13
REV DESCRIPTION ISSUED BY DATE



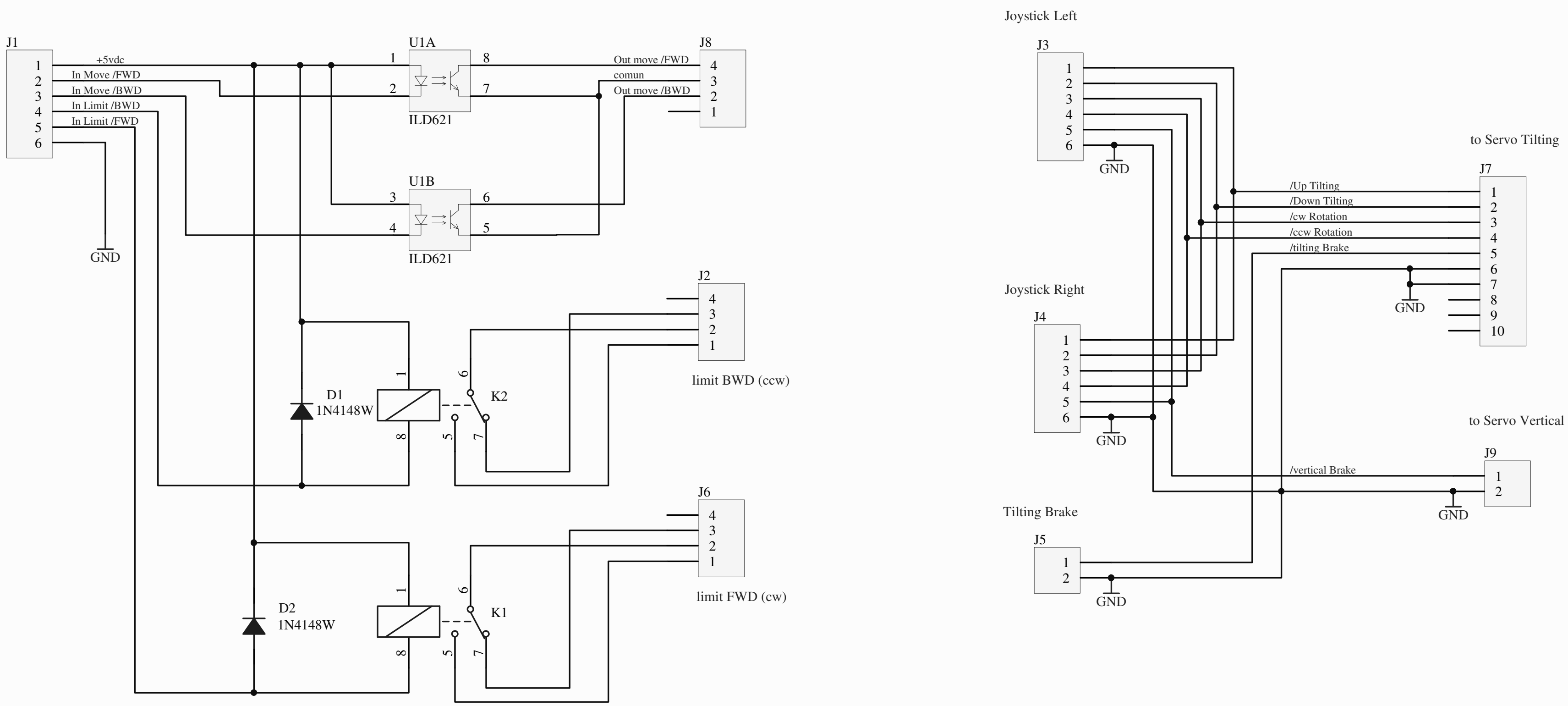
PCB 90318-01

					NAME	DATE	SHEET / OF	A3656-01
				DRAWING	S.PEREZ	09/06/11	2/4	1 A REV
				REVISED	F.GARCIA	09/06/11		
A	New	Sonia Pérez	09/09/13	SEDECAL				FAILSAFE-STITCH SEQ-TOMO OTC PBA
REV	DESCRIPTION	ISSUED BY	DATE					


DECOUPLING FOR U3, U4,U7,U10,U11
POT LONG TABLE
R37
470R
RP3
10K
D23
BAT54S/SOT
1VREF
LMC6494
U9D
U9B
D11
+5V-U9
U1D
74HCT32/SO
DETECT IN TABLE
BUCKY-TABLE
SW DETECT TABLE
U5D
74HCT14
U11A
74HCT08/SO
U11B
U5E
TABLE TRAY
74HCT32/SO
U3B
DETECT CIRCUIT
C27
C13
C15
C14
100nF
+5V1
GND
POT LONG WSTAND
R38
RP4
D22
D12
U9A
U9C
U3A
DETECT IN WSTAND
BUCKY-WSTAND
SW DETECT WSTAND
U5C
U11C
U11D
/tray ws
WSTAND TRAY
U5F
R25
10k
U4F
74HCT14/SO
D13
D14
P0
P1
R27
R26
R20
R22
C17
C16
R21
U4A
74HCT139/SO
U8A
U4B
U4C
U4D
U4E
DIRECT-DIRECT
DIRECT-BUCKY
U10A
U10B
74HCT74
RP1
470k
CP1
220nF
RP2
CP2
ALOE
U3C
REARM CIRCUIT
L1
100uH/65mA
C18
100nF/50V
PCB 90318-01
NAME
DATE
SHEET / OF
DRAWING
S.PEREZ
09/06/11
REVISED
F.GARCIA
3/4
A3656-01
1
A
REV
A
New
Sonia Pérez
09/09/13
REV
DESCRIPTION
ISSUED BY
DATE
SEDECAL
FAILSAFE-STITCH SEQ-TOMO OTC PBA

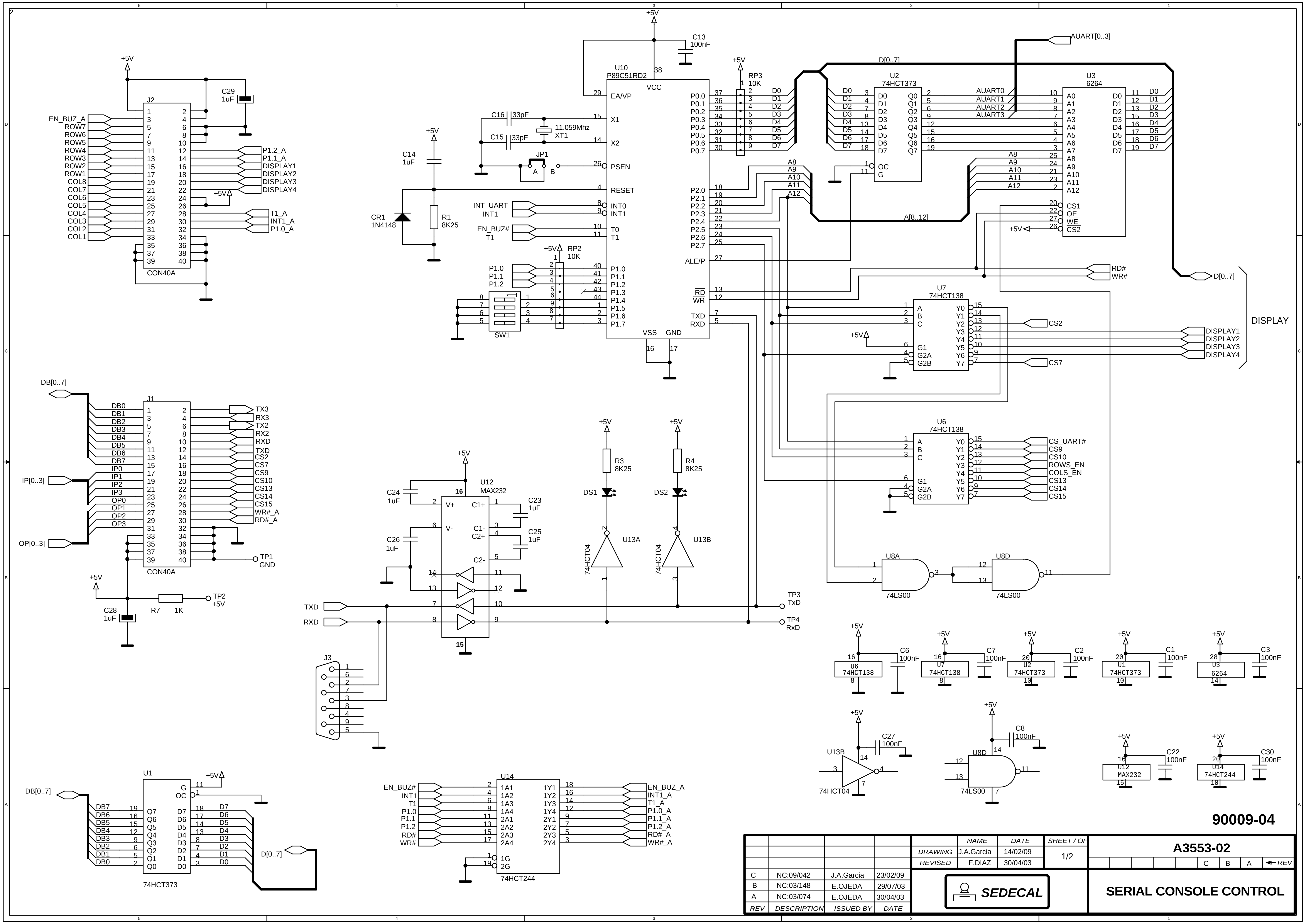


					NAME	DATE	SHEET / OF	A3656-01
				DRAWING	S.PEREZ	09/06/11	4/4	1 A REV
				REVISED	F.GARCIA	09/06/11		
A	New	Sonia Pérez	09/09/13	SEDECAL				FAILSAFE-STITCH SEQ-TOMO OTC PBA
REV	DESCRIPTION	ISSUED BY	DATE					



PCB 90353-02

					NAME	DATE	SHEET / OF	A3677-01
				DRAWING	L.M.Pascual	04-06-2013	1/1	
				REVISED	M.A.Gonz.	04-06-2013		B · A · REV
B	NC 13/398	L.M.Pascual	16-12-2013	SEDECAL				ROTATION INTERFACE PBA
A	New	L.M.Pascual	04-06-2013					
REV	DESCRIPTION	ISSUED BY	DATE					



U10
P89C51RD2
VCC
EA/VP
X1
X2
PSEN
RESET
INT0
INT1
T0
T1
P0.0
P0.1
P0.2
P0.3
P0.4
P0.5
P0.6
P0.7
P2.0
P2.1
P2.2
P2.3
P2.4
P2.5
P2.6
P2.7
ALE/P
RD
WR
TXD
RXD
VSS
GND
P1.0
P1.1
P1.2
P1.3
P1.4
P1.5
P1.6
P1.7
C13
100nF
C16
33pF
C15
33pF
11.059Mhz
XT1
JP1
C14
1uF
CR1
1N4148
R1
8K25
RP2
10K
RP3
10K
SW1
INT_UART
EN_BUZ#
U2
74HCT373
U3
6264
D[0..7]
AUART[0..3]
A[8..12]
RD#
WR#
DISPLAY
U7
74HCT138
CS2
CS7
DISPLAY1
DISPLAY2
DISPLAY3
DISPLAY4
U6
74HCT138
CS_UART#
CS9
CS10
ROWS_EN
COLS_EN
CS13
CS14
CS15
U8A
74LS00
U8D
74LS00
J2
CON40A
EN_BUZ_A
ROW7
ROW6
ROW5
ROW4
ROW3
ROW2
ROW1
COL8
COL7
COL6
COL5
COL4
COL3
COL2
COL1
P1.2_A
P1.1_A
T1_A
INT1_A
P1.0_A
C29
1uF
J1
CON40A
DB[0..7]
IP[0..3]
OP[0..3]
TX3
RX3
TX2
RX2
RXD
TXD
WR#_A
RD#_A
TP1
GND
TP2
+5V
C28
1uF
R7
1K
U12
MAX232
C24
1uF
C23
1uF
C26
1uF
C25
1uF
R3
8K25
R4
8K25
DS1
DS2
U13A
U13B
74HCT04
TP3
TxD
TP4
RxD
J3
U1
74HCT373
U14
74HCT244
C6
C7
C2
C1
C3
100nF
C27
C8
C22
C30
90009-04
NAME
DATE
SHEET / OF
DRAWING
J.A.Garcia
14/02/09
REVISED
F.DIAZ
30/04/03
1/2
A3553-02
C
NC:09/042
J.A.Garcia
23/02/09
B
NC:03/148
E.OJEDA
29/07/03
A
NC:03/074
E.OJEDA
30/04/03
REV
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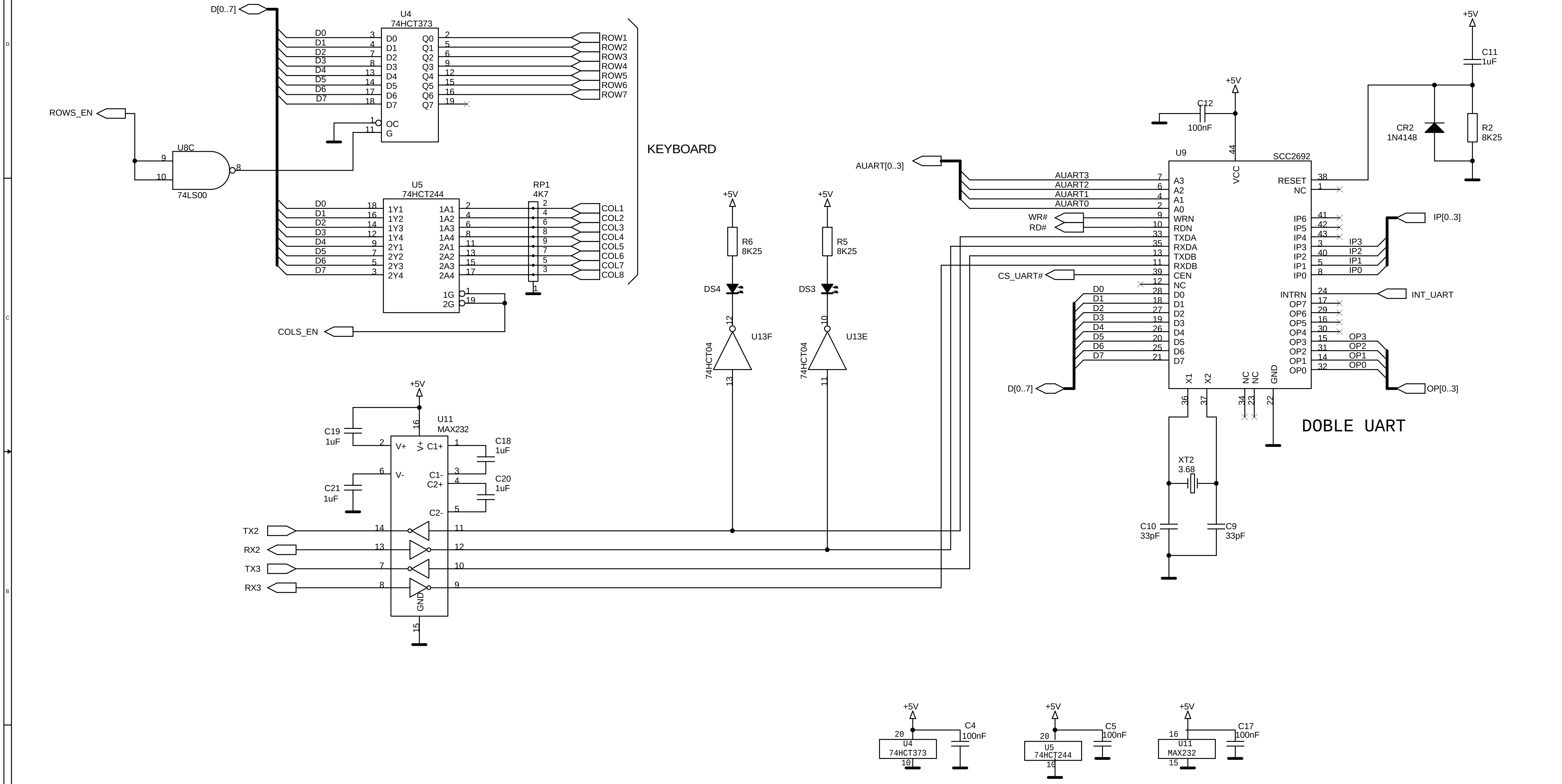
ISSUED BY
DATE
SEDECAL
SERIAL CONSOLE CONTROL



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C	NC:09/042	J.A.Garcia	23/02/09	SEDECAL				SERIAL CONSOLE CONTROL
B	NC:03/148	E.OJEDA	29/07/03					
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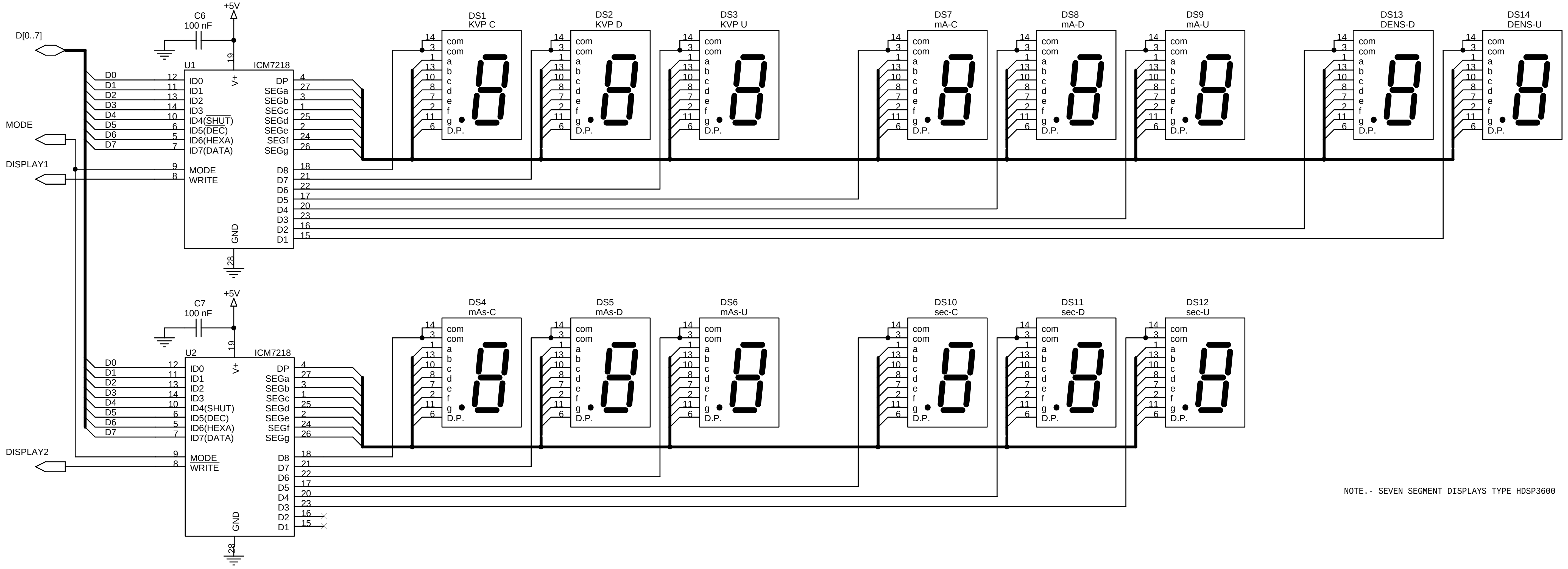
b.0



NOTE.- SEVEN SEGMENT DISPLAYS TYPE HDSP3600

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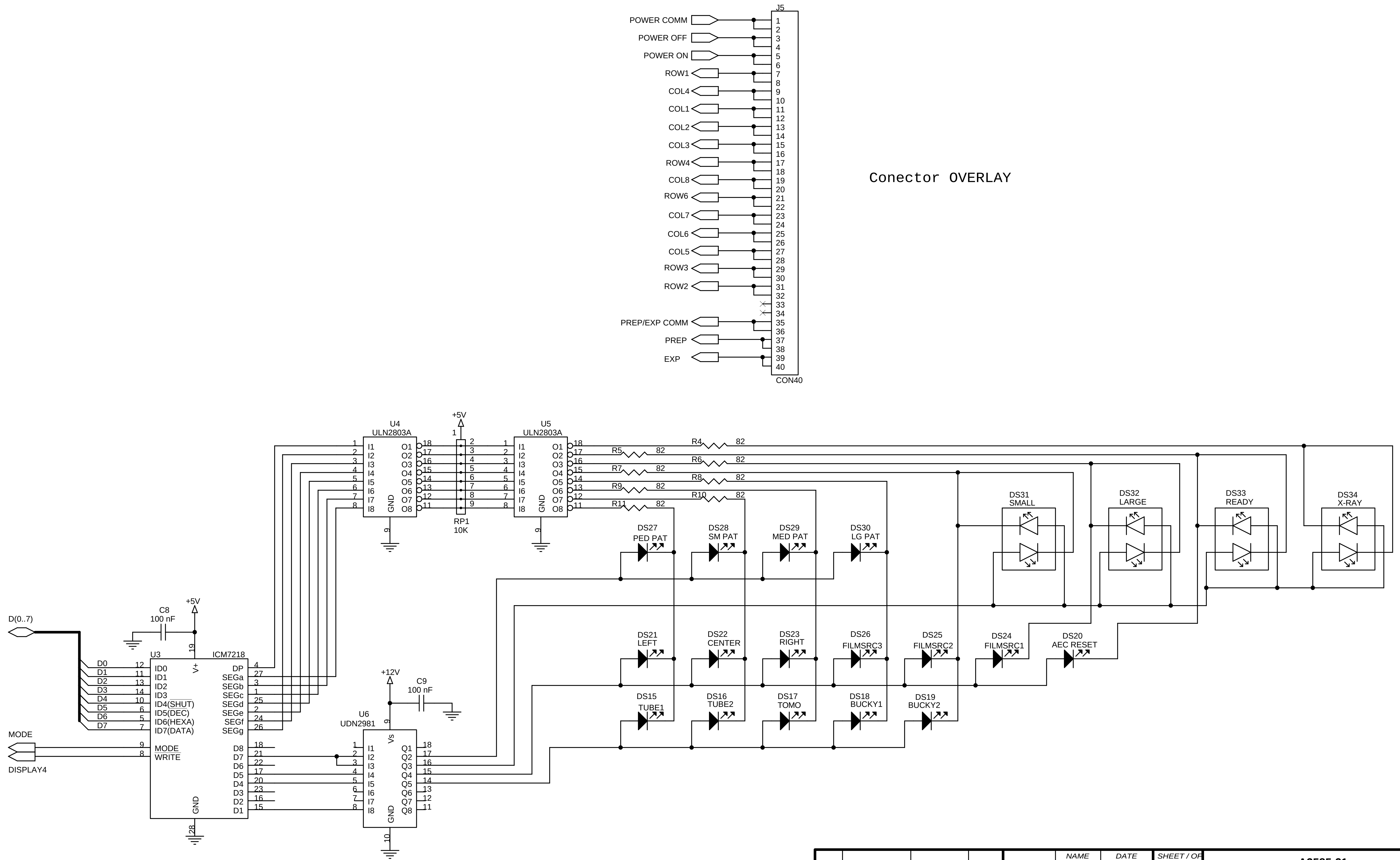

NOTE 1.- ALL LED's HLMP-0400 UNLESS SPECIFIED

NOTE 2.- ALL DIODES 1N4148 UNLESS SPECIFIED

REV	DESCRIPTION	ISSUED BY	DATE
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	NAME	DATE	SHEET / OF
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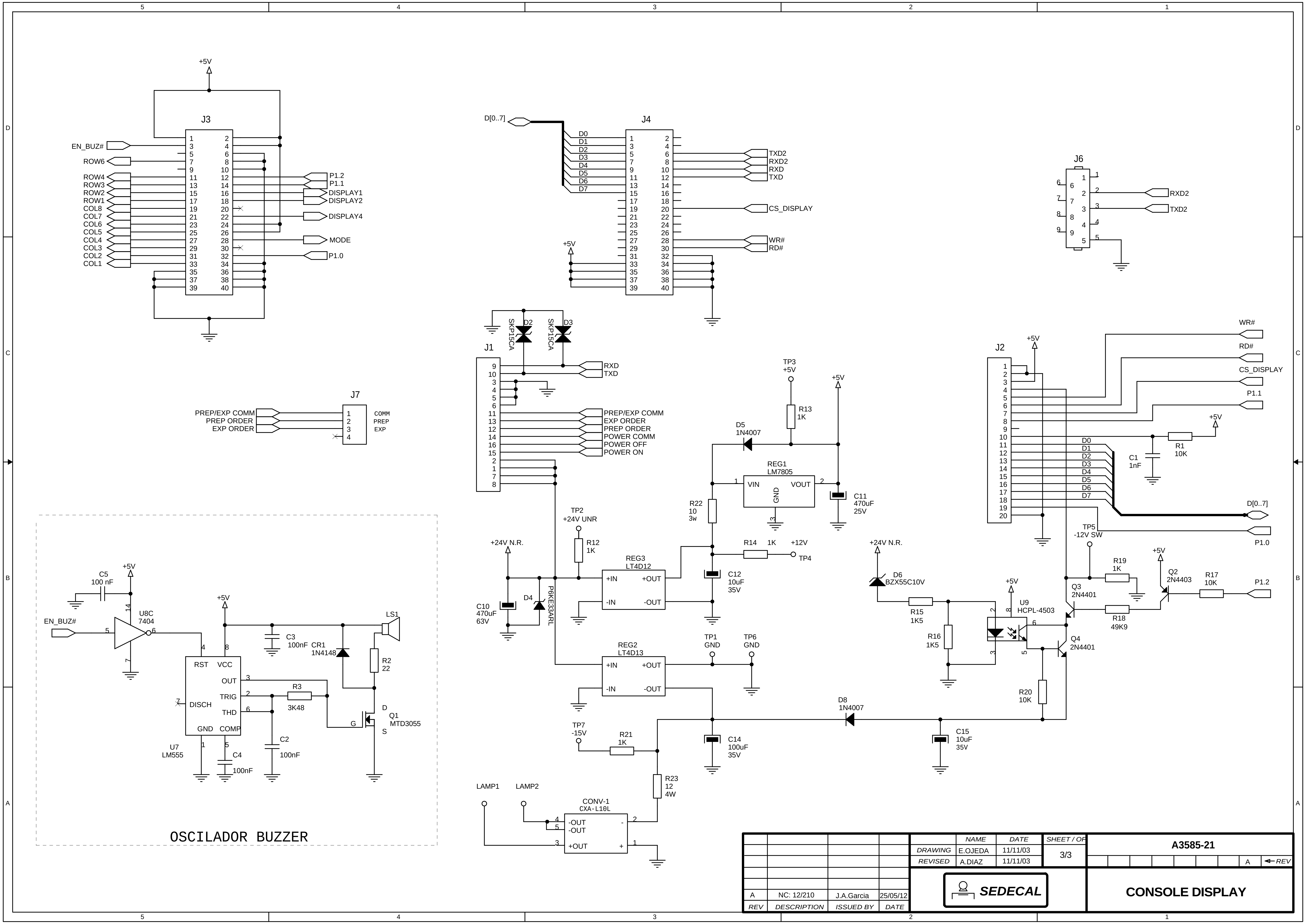
REVISED	A.DIAZ	11/11/03	

SEDECAL

A3585-21

A ◄REV

CONSOLE DISPLAY



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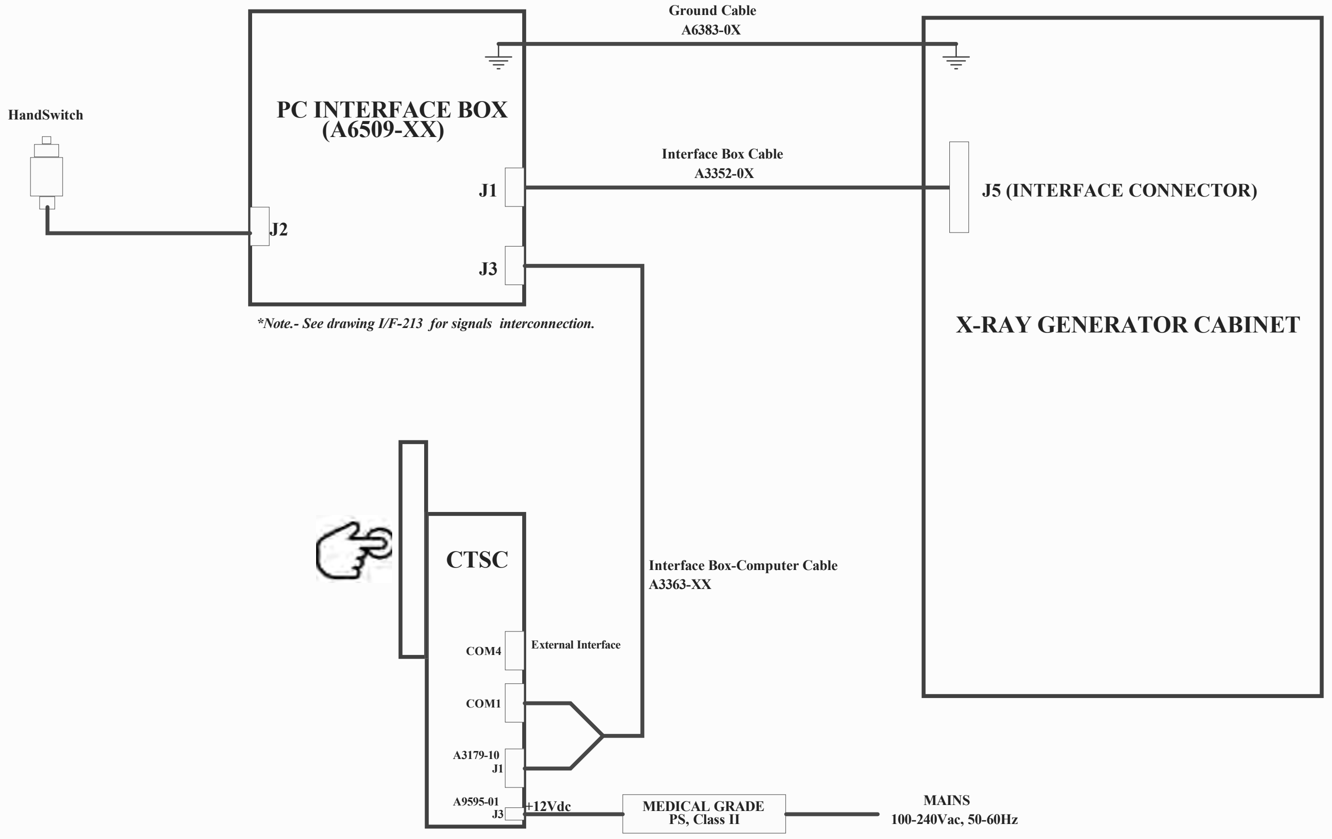

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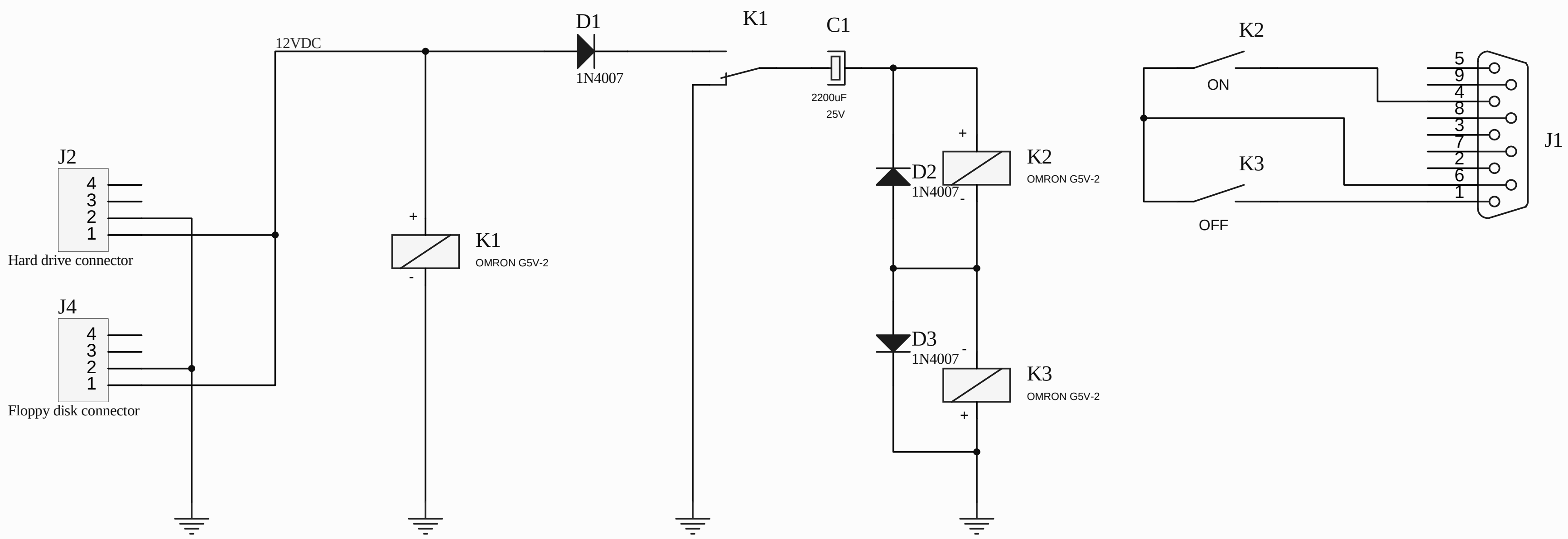
REVISED	FD	04/05/15	

SEDECAL

54302351

REV A

CTSC TO GENERATOR CONNECTION



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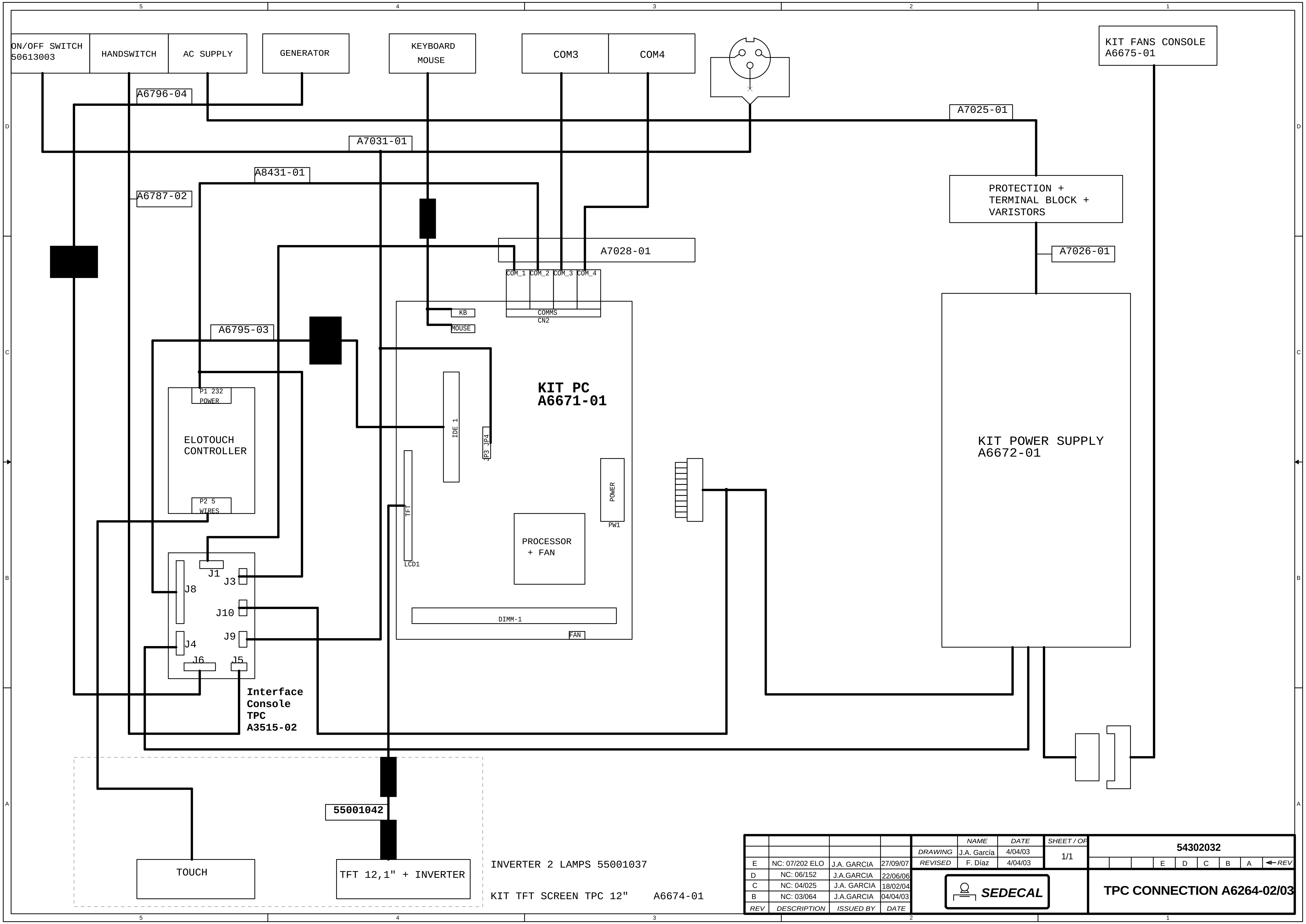

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B	NC: 03/064	J.A.GARCIA	04/04/03
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REVISED	F. Díaz	4/04/03	

SEDECAL

54302032

			E	D	C	B	A	← REV

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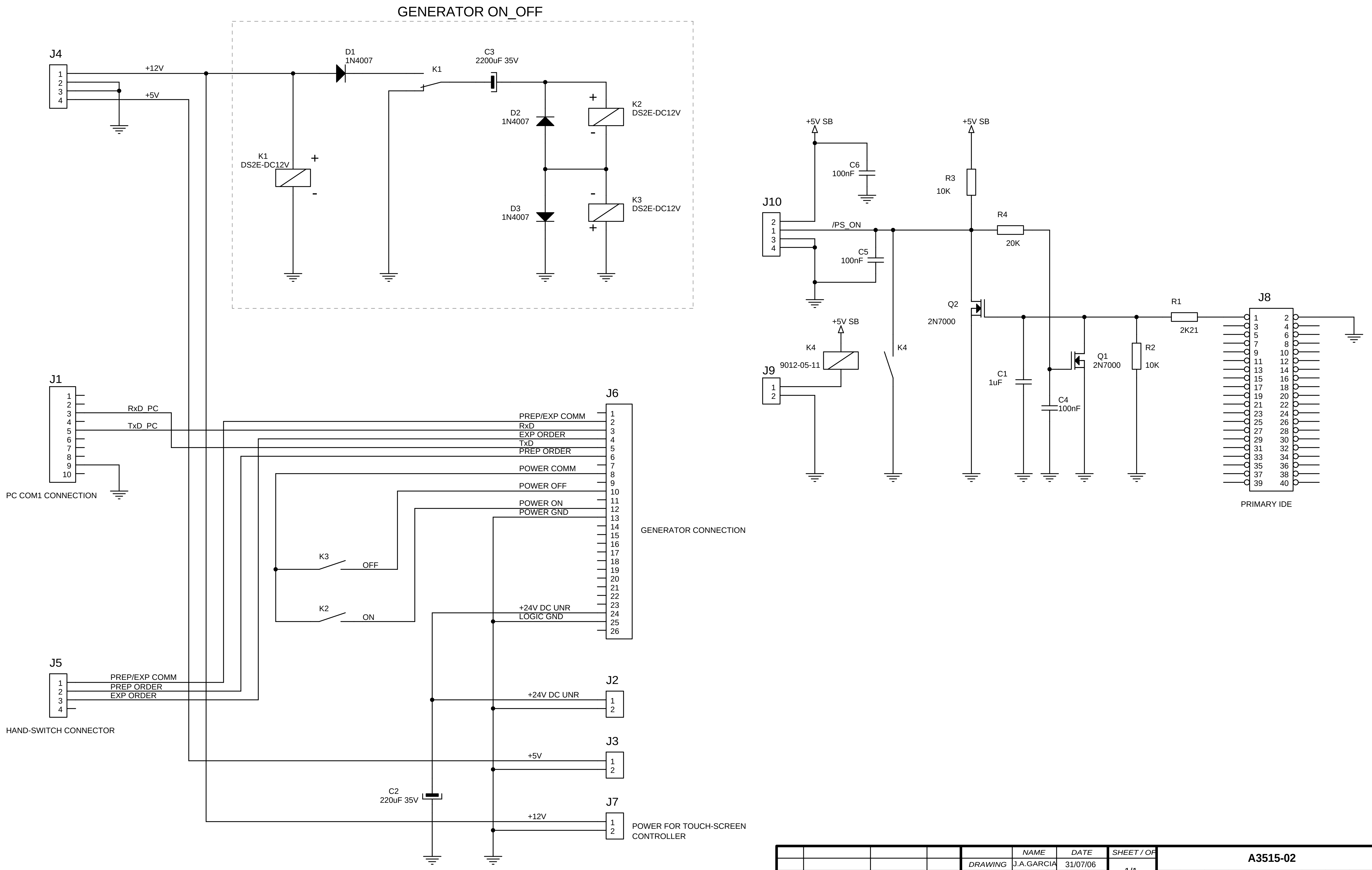

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B	NC: 04/163	J.A.Garcia	29/09/04

	NAME	DATE	SHEET / OF
DRAWING	J.A.GARCIA	31/07/06	1/1
REVISED	A.DIAZ	31/07/06	

SEDECAL

A3515-02

REV: D C B A

INTERFACE CONSOLE TPC

Document ID: 41552308

DX-D 400
X-Ray Generator

► Purpose of this document

The spare parts list is not integrated in this Service Manual.
Refer to the following document:.

Document	Reference
DX-D 400 - X-Ray System - Spare Parts List	Document ID 41587553

Appendix

Technical Publication
AP-0005R10_EN_NLG

Adaptation of the Radiation Measuring System

HF Series Generators

REVISION HISTORY

REVISION	DATE	REASON FOR CHANGE
4	APR 02, 2007	Removed connection for Conventional Console.
5	APR 20, 2007	New Ion Chamber VacuDAP 1580013
6	FEB 08, 2008	Kit of optional measuring system for the second Tube (upgrade)
7	MAY 18, 2010	Information for A9447–09
8	JUL 15, 2016	Schematic update and information for CTSC Console
9	MAY 28, 2018	New Printer
10	DEC 13, 2019	New PC Interface Box

This Document is the English original version, edited and supplied by the manufacturer.

The Revision state of this Document is indicated in the code number shown at the bottom of this page.

ADVISORY SYMBOLS

The following advisory symbols will be used throughout this manual. Their application and meaning are described below.

DANGERS ADVISE OF CONDITIONS OR SITUATIONS THAT IF NOT HEEDED OR AVOIDED WILL CAUSE SERIOUS PERSONAL INJURY OR DEATH.

ADVISE OF CONDITIONS OR SITUATIONS THAT IF NOT HEEDED OR AVOIDED COULD CAUSE SERIOUS PERSONAL INJURY, OR CATASTROPHIC DAMAGE OF EQUIPMENT OR DATA.

Advise of conditions or situations that if not heeded or avoided could cause personal injury or damage to equipment or data.

Note ☞

Alert readers on pertinent facts and conditions. Notes represent information that is important to know but which do not necessarily relate to possible injury or damage to equipment.

TABLE OF CONTENTS

SECTION 1 OPERATION

The Radiation Measuring System consists of an Ionization Chamber installed beneath the Collimator and connected to the Radiation Meter PCB (A3170–01) in the Generator Cabinet.

This system is prepared to measure independently the radiation emitted by two tubes connected to the same Generator. Radiation is measured as a Dose Area Product (DAP) in mGy*cm^2.

Different radiation readings can be made according to the selected workstation (radiographic or fluoroscopic). The reading is shown on a CTSC Touch Screen Console with embedded PC or on a PC Monitor (based on the customer's application).

WARNING

KEEP IN MIND ALL SAFETY REQUIREMENTS DESCRIBED IN THE MANUALS CONCERNING THE GENERATOR AND THE ENTIRE SYSTEM.

Note ☞

Radiation measuring must not be made with accessory items such as filters or diaphragms between the Collimator and the Patient.

Note ☞

Prior to a new patient exam, all radiation measuring values should be set to zero (0).

1.1 RADIATION READING

The Dose Display shows the accumulated radiation value of the X-ray Tube related to the selected Workstation. The radiation value of each exposure is added to the accumulated radiation value for the selected X-ray Tube. The accumulated radiation value is reset by pressing the "*Dose Reset*" button.

Radiation measure is read as a DAP value (Dose Area Product) in mGy*cm^2 (for example: 64.5 $\pm$0.5 mGy*cm^2).

The Accumulated Dose of a patient can be printed whenever a printer is connected to the Console. After pressing the "*Print*" button, a keyboard appears on the Console with which the Patient Name can be entered. Pressing "*OK*" will print the Dose information.

1.2 ERROR CODES

Error codes indicate the potential cause of a system failure. Error codes are shown on the console and are removed in the same way other error codes are removed *(refer to Console Operator Manual).*

All these error codes are preceded by the letter “E” (a.e. E41) and enable the operator to indirectly convey the possible source of error to service personnel. This may prevent the need for a service call or enable service personnel to anticipate corrective actions prior to arriving on site.

There are six Error Codes designated to possible malfunctions of the Radiation Measuring System *(refer to Table 1-1*).

CAUTION

When any of the below Error Codes is displayed, the Radiation Measuring System remains unable for the related X-ray Tube until the equipment is turned On again.

Table 1-1
Error Codes

<table>
<tr><th>ERROR</th><th>DESCRIPTION</th><th>WHAT TO DO</th></tr>
<tr><td>E41</td><td>Communication error starting the measuring.
Physical connection to meter in Tube-1.</td><td rowspan="6">Press the “Reset Error” button to reset the Error Code.
Check cable connection between Radiation Meter PCB & Ion Chamber.
Turn the Generator OFF and ON.

If the error code persists, reset the Error Code indication on the Console. So that the equipment may go on operative even the Radiation Measuring System option is unable in this Tube. (Refer to the “Troubleshooting” chapter in the Generator Service Manual).</td></tr>
<tr><td>E42</td><td>Error during electronics checking for Tube-1.</td></tr>
<tr><td>E43</td><td>Error during Ion Chamber checking in Tube-1.</td></tr>
<tr><td>E44</td><td>Communication error starting the measuring.
Physical connection to meter in Tube-2.</td></tr>
<tr><td>E45</td><td>Error during electronics checking for Tube-2.</td></tr>
<tr><td>E46</td><td>Error during Ion Chamber checking in Tube-2.</td></tr>
</table>

1.3 MAINTENANCE

Due to the High Sensitive Detector the Ion Chamber shall be handled carefully. Never press on the light transparent plates of the Ionization Chamber.

NEVER ATTEMPT TO CLEAN ANY PART OF THE EQUIPMENT WHEN IT IS SWITCHED ON. ALWAYS SWITCH OFF THE EQUIPMENT AND ISOLATE THE MAINS ELECTRICAL SUPPLY BEFORE CLEANING.

The tasks of this periodic maintenance shall include:

1. Switch the equipment OFF.
2. Check externally the proper cable connections between each component.
3. Clean the equipment frequently, particularly if corroding chemicals are present. <u>NEVER</u> use cleaners, alcohol or solvents of any kind. Use only a cloth moistened in warm water and mild soap.

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SECTION 2 INSTALLATION

CAUTION

Installation of the Radiation Measuring System must be made with all power supplies turned off. The System has been factory calibrated and tested.

Note ☞

Verify that the size and characteristics of the supplied Ionization Chamber is suitable for the rail-guides located beneath the Collimator base (147 x 168 or 177 x 178 mm).

1. Unpack the system and check that all components are present and that they do not present any damage.
2. Insert the Ionization Chamber in the Collimator rails-guide.
3. Connect the following cables as indicated in schematic A9447-09, 6070087 or 6070088:
   a. Connect each Ion Chamber cable to the respective contact points at RS232 (IC1 or IC2) in the Generator Cabinet.
   b. Connect or verify that the Radiation Meter cable (A7264-xx) is properly connected at terminals IC1 / IC2 and the Radiation Meter Board as indicated in the next table.

GENERATOR CONFIGURATION	ION CHAMBER TUBE-1	ION CHAMBER TUBE-2	WIRE-1 TO J1 ON THE RADIATION METER PCB (A3170–01)
One Tube for RAD only	Cable A7264-xx to P2	–	J1-1 Inserted
One Tube for R&F (configured as Tube-2)	-	Cable A7264-xx to P2	J1-1 Inserted
Two Tubes for RAD only	Cable A7264-xx to P2	Cable A7264-xx to P1	J1-1 Inserted
One Tube for RAD (configured as Tube-1) + One Tube for R&F (configured as Tube-2)	Cable A7264-xx to P2	Cable A7264-xx to P1	J1-1 Inserted
Two Tubes but only with Radiation Measuring System for Tube-1	Cable A7264-xx to P2	–	J1-1 removed and isolated
Two Tubes but only with Radiation Measuring System for Tube-2	–	Cable A7264-xx to P2	J1-1 removed and isolated

Note ☞ *Radiation Meter Board (A3170-01) is factory installed inside the Generator Cabinet when the Radiation Measuring System is provided with the Generator.*

c. If the connection between the Radiation Meter Board (A3170–01) and the PC / CTSC is through the ATP Console CPU Board (A3024–xx) (*see schematic 6070087 for PC or CTSC and A9447–09 for the U-Arm*), verify / connect:

– Radiation Meter Control cable (A3355–xx) between P3 on the Radiation Meter Board and J7 on the ATP Console CPU Board.

– **For PC**: connections from COM1 and J1 of the PC to J8 of the ATP Console CPU Board are made through the "*PC Interface Box*" (when the PC is equipped with this control device) and from connector J5 of the Generator Cabinet *(see schematic 6070087)*. These cables and their connections are the same as the ones used for a Generator without the Radiation Measuring System.

– **For CTSC**: connections from COM1 (*Generator)* of the CTSC to J8 of the ATP Console CPU Board are made through the "*PC Interface Box*" and from connector J5 of the Generator Cabinet (*see schematic 6070087)*. These cables and their connections are the same as the ones used for a Generator without the Radiation Measuring System.

– **For U-Arm**: connections from "Generator" conector (D–Type 25 Pin) of the system Interface Panel (at the U–Arm Control Box) to J8 of the ATP Console CPU Board are made through connector J5 of the Generator Cabinet (*see schematic 9447–09)*. These cables and their connections are the same as the ones used for a Generator without the Radiation Measuring System.

– Printer cable (A7038–01) from PC / CTSC COM3 to the Printer.

d. If there is a direct connection between the Radiation Meter Board (A3170–01) and the CTSC (*see schematic 6070088*), connect:

– Radiation Meter Control cable (A6757–xx) between P3 on the Radiation Meter Board and COM4 on the CTSC.

– Printer cable (A7038–01) from CTSC COM3 to the Printer.

2.2 SCHEMATICS

Refer to the following schematics for cable connections:

- 6070087 Radiation Meter Interconnection
  (for PC or CTSC – 1 or 2 Tubes)
  connection through the ATP Console CPU Board

- 6070088 Radiation Meter Interconnection
  (for PC or CTSC – 1 or 2 Tubes)
  direct connection to PC or CTSC

- A9447-09 Radiation Meter Interconnection
  (for U–Arm – 1 Tube)
  connection through the ATP Console CPU Board

- A3170-01 Radiation Meter Board

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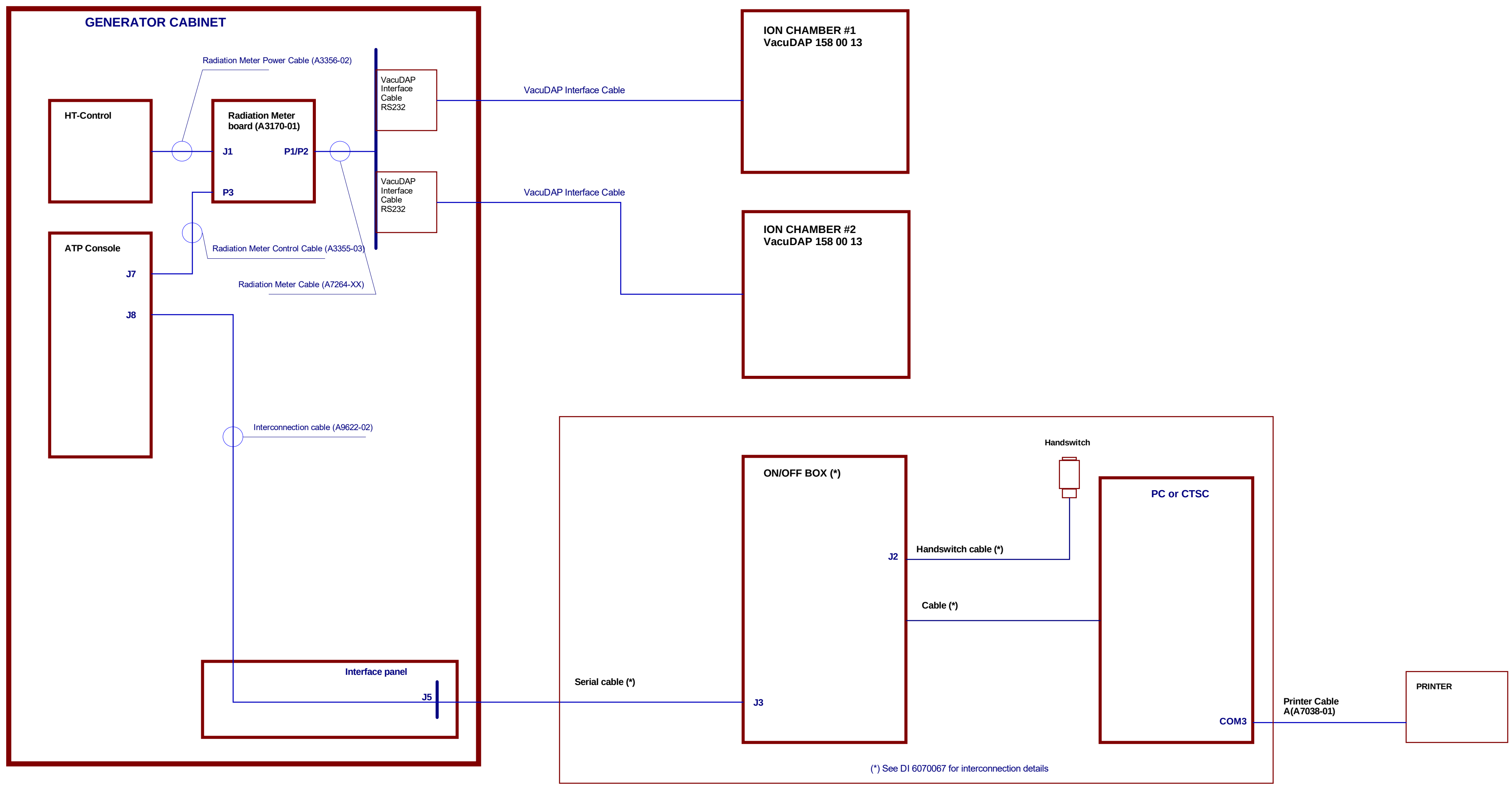

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	NAME	DATE	SHEET / OF
DRAWING	M.González	2019-10-21	1 / 2
REVISED	Sonia Perez	2019-10-21	

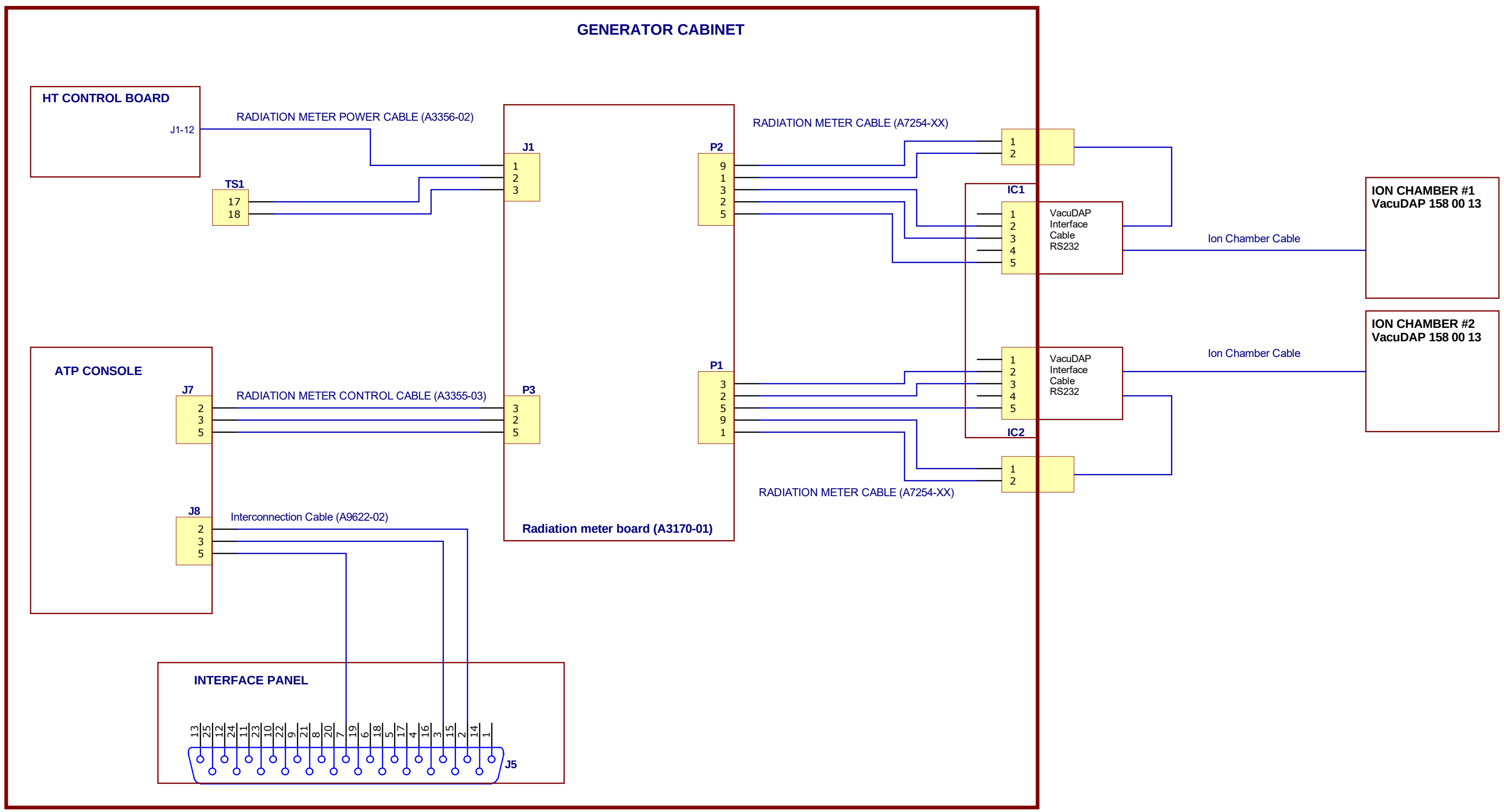
SEDECAL CONFIDENTIAL

PBA: PCB:

A REV

6070087 DI

DAP Meter - VACUDAP - SHF - Internal Conn.



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REVISED	Sonia Perez	2019-10-21	

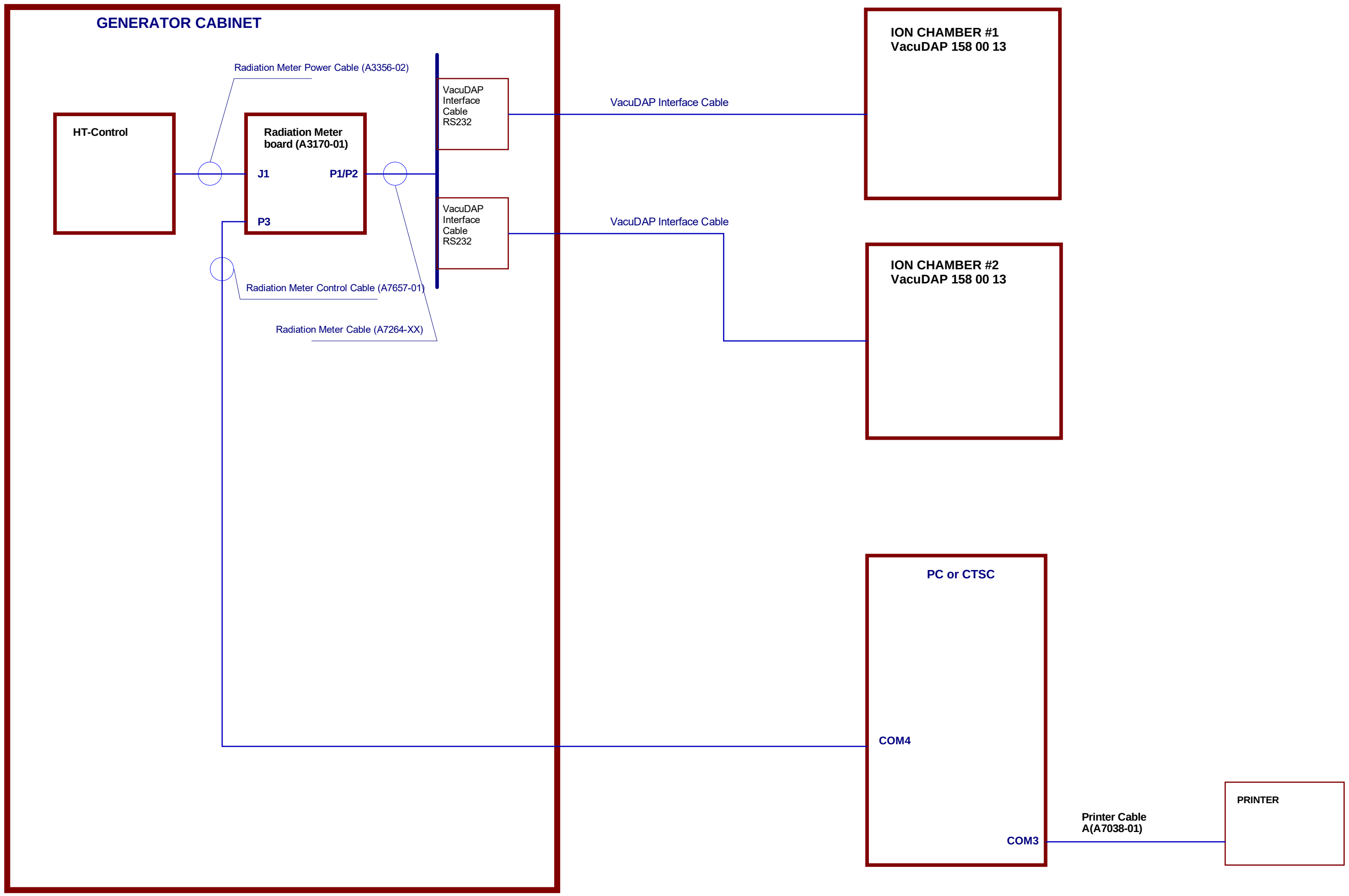
PBA: PCB:

A ← REV

SEDECAL CONFIDENTIAL

6070087 DI

DAP Meter - VACUDAP - SHF - Internal Conn.



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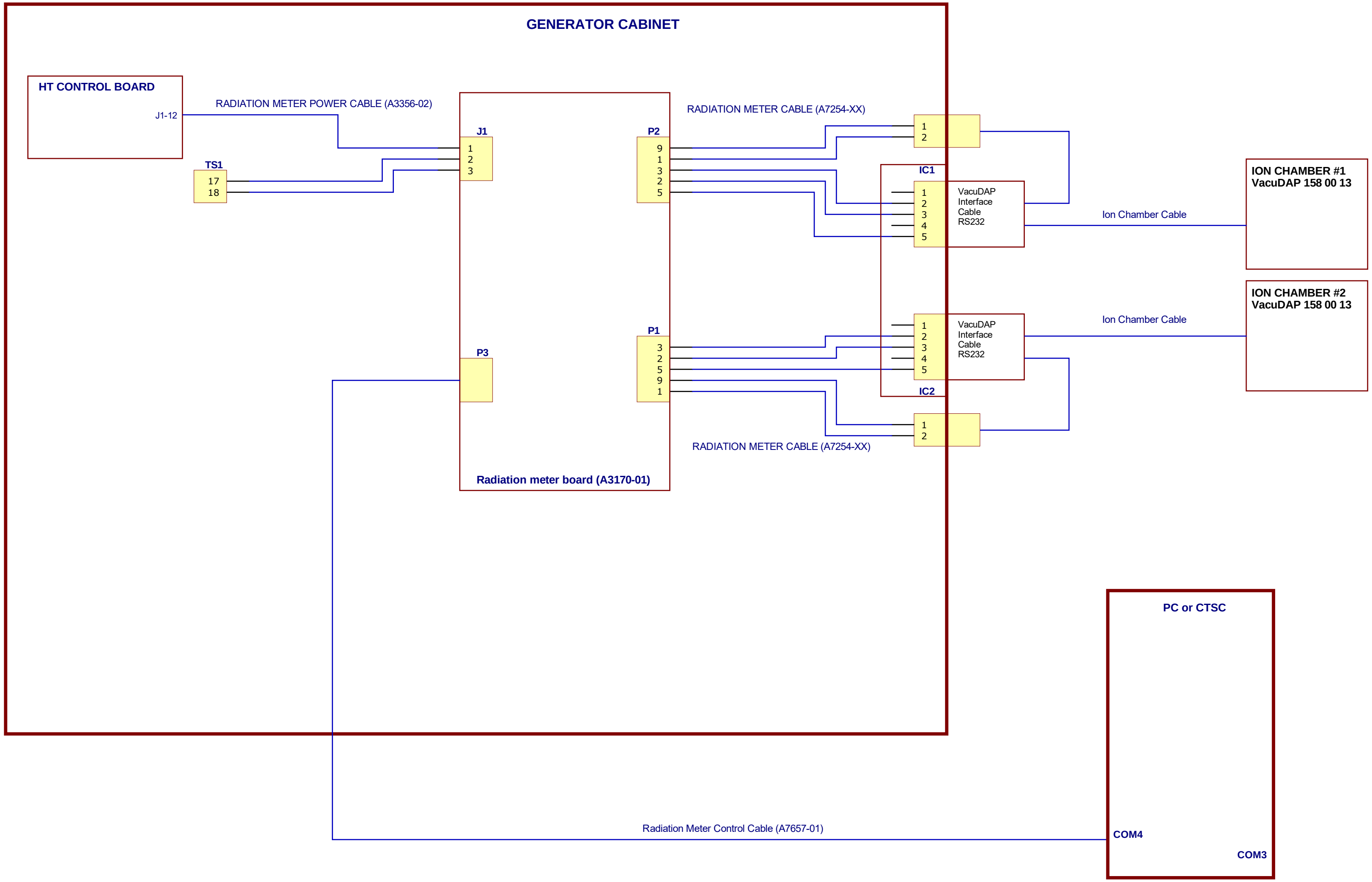
REVISED	Sonia Perez	2019-10-21	

PBA:
PCB:
A REV

SEDECAL CONFIDENTIAL

6070088 DI
DAP Meter - VACUDAP - SHF - External Conn.



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REVISED	Sonia Perez	2019-10-21	

PBA:

PCB:

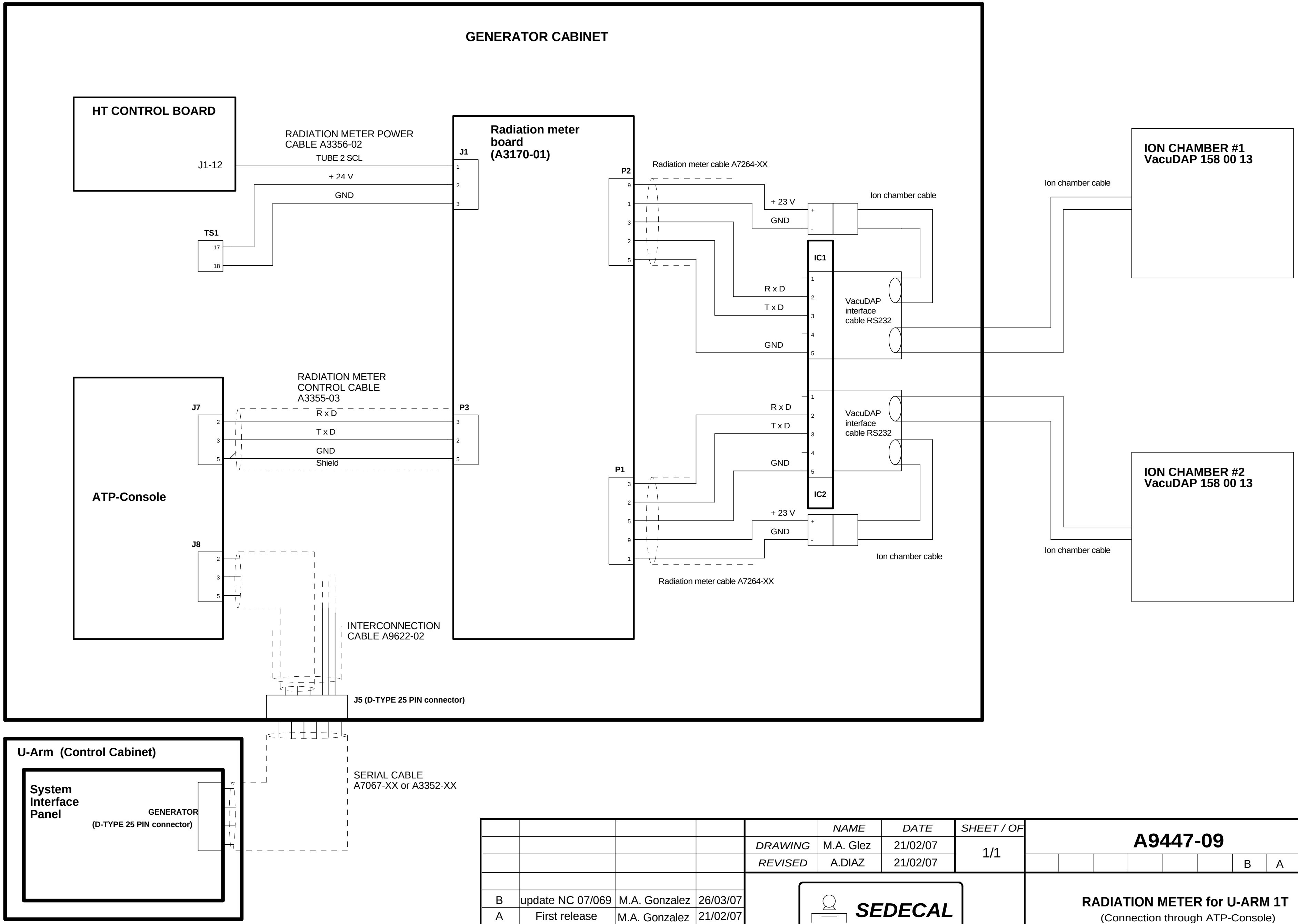
A ← REV

SEDECAL

CONFIDENTIAL

6070088 DI

DAP Meter - VACUDAP - SHF - External Conn.



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				REVISED	A.DIAZ	21/02/07		B A ← REV
B	update NC 07/069	M.A. Gonzalez	26/03/07	SEDECAL				RADIATION METER for U-ARM 1T (Connection through ATP-Console)
A	First release	M.A. Gonzalez	21/02/07					
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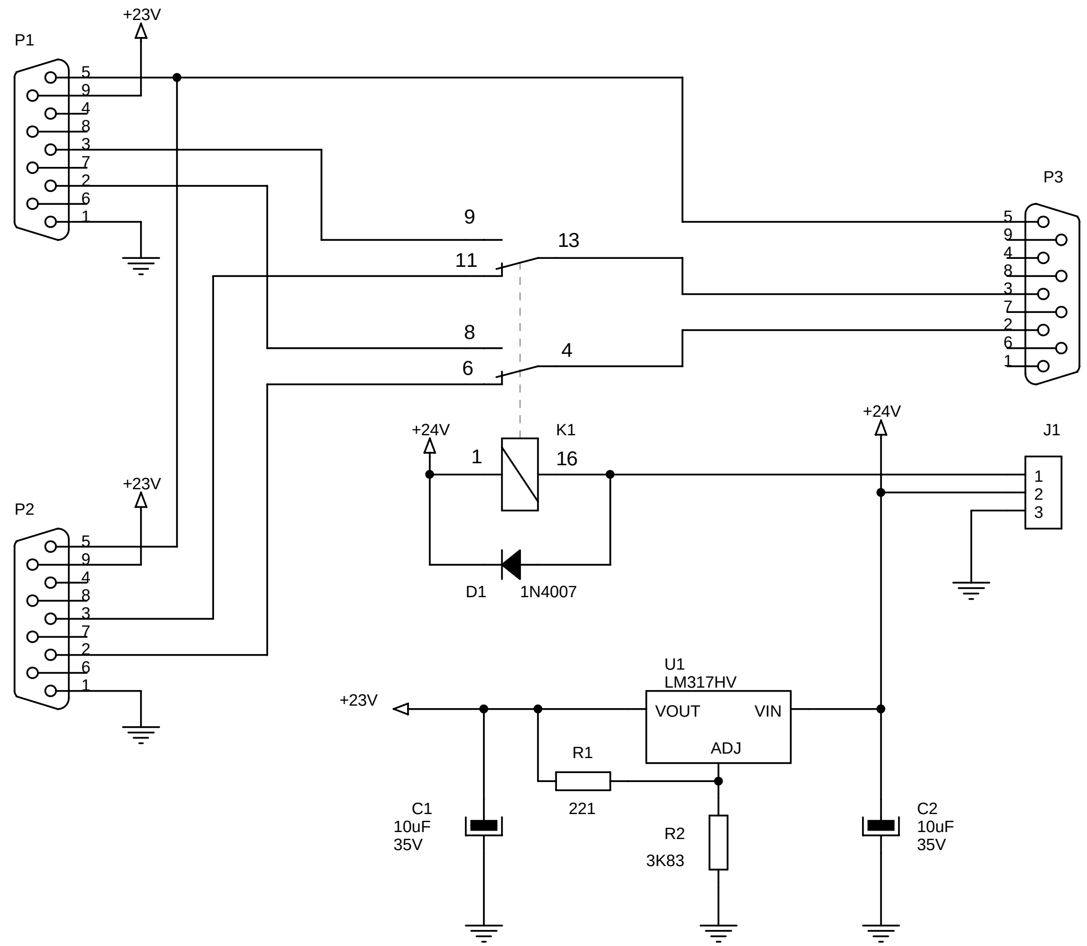

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REVISED	F. Díaz	05/04/00	

SEDECAL

A3170-01

REV A

RADIATION METER

Appendix

Technical Publication
AP-0073R0

CTSC Touch Screen Console for HF Series Generators

Appendix to the Service Manual

0120

This product bears a CE marking in accordance with the provisions of the 93/42/EEC MDD dated June 14, 1993.

Este producto ostenta una marca CE de acuerdo con las disposiciones de la Directiva 93/42/CEE del 14 de Junio de 1993 sobre Productos Médicos.

Ce produit porte la marque CE de conformité aux règlements de la Directive 93/42/CEE du 14 juin 1993 relative aux Produits médicaux.

The information comprised in this manual applies to the following equipments La información contenida en este manual se aplica a los siguientes equipos L'information contenue dans ce manuel est appliquée aux équipements suivants
CTSC Touch Screen Console compatible with: **X-ray Generator SHF** **X-ray Generator SHFR**

Manufactured by:
Fabricado por:

SEDECAL
Sociedad Española de Electromedicina y Calidad S.A.
Pelaya, 9 – 13. Polígono Industrial "Río de Janeiro"
28110 Algete, Madrid – España (Spain)

Phone: +34 916 280 544 Fax: +34 902 190 385 www.sedecal.com

REVISION HISTORY

REVISION	DATE	REASON FOR CHANGE
0	SEPT 30, 2015	First Edition

This Document is the English original version, edited and supplied by the manufacturer.

The Revision state of this Document is indicated in the code number shown at the bottom of this page.

ADVISORY SYMBOLS

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ADVISE OF CONDITIONS OR SITUATIONS THAT IF NOT HEEDED OR AVOIDED COULD CAUSE SERIOUS PERSONAL INJURY, CATASTROPHIC DAMAGE TO EQUIPMENT OR DATA.

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TABLE OF CONTENTS

Section **Page**

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SECTION 1 INTRODUCTION

This Appendix describes the features and specifications related to the **CTSC Touch Screen Console for HF Series Generators that replaces the previous TPC Touch Screen Console.**

It is a complement of the Service Manuals provided with the **HF Series Generators;** for further information about installation and maintenance refer to the corresponding Manual.

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SECTION 2 INSTALLATION

This Console is freestanding and it contains the Power Supply inside. Power Cable and ON/OFF Kit, that comprises the PC Interface Box and the communication cables, are also supplied with the Touch Screen Console.

CTSC Touch Screen Console

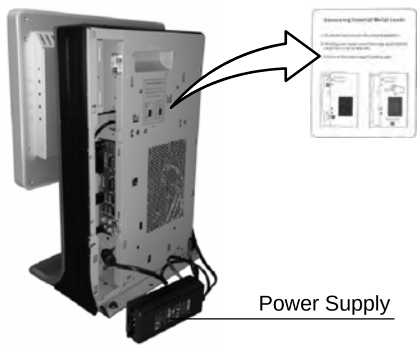
Power Line Cable

ON / OFF Kit

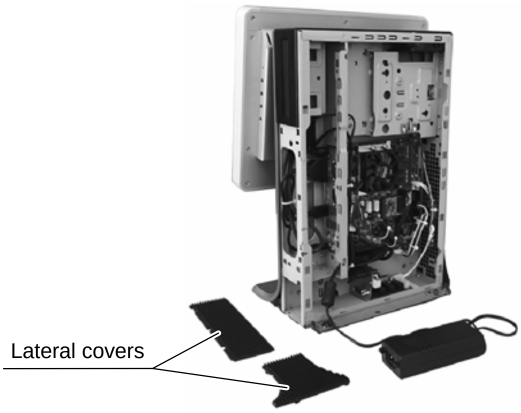
1. Remove the back cover of the PC. Follow the instructions of the label of the cover.
    a. Push the switch to the unlock position to release the cable cover.
    b. Push the release latch.
    c. Slide the back cover upwards to remove.

2. Extract the Power Supply (AC/DC Adapter).

3. Remove both back covers as indicated by label of inside cover.

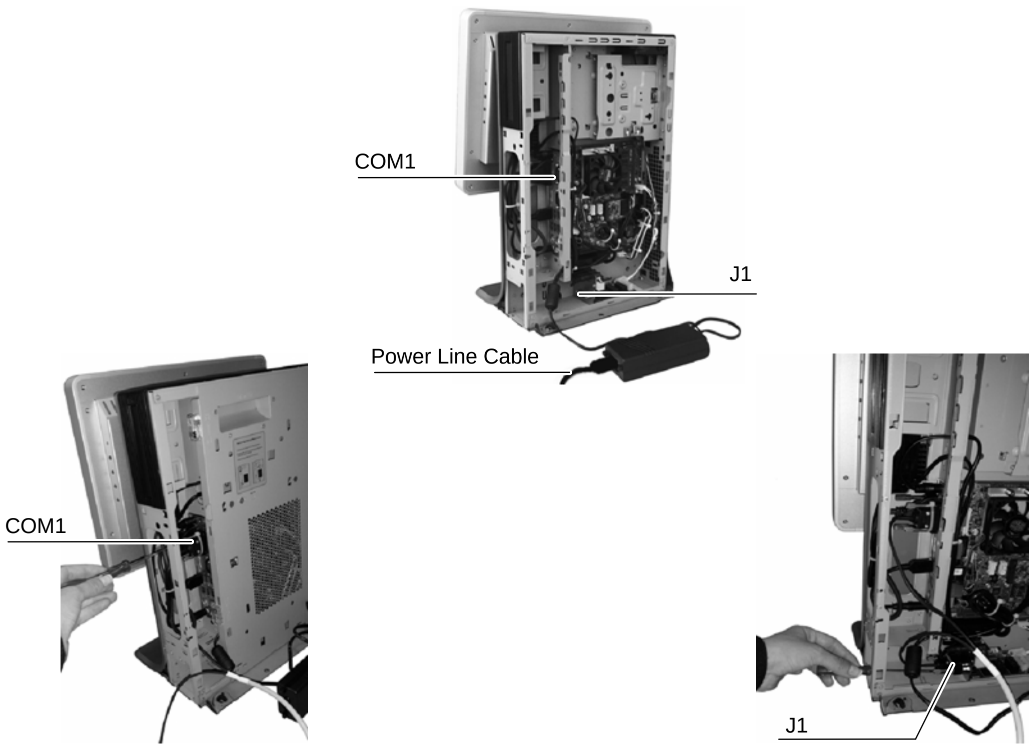


4. Remove both lateral covers to facilitate the access to the connectors and allow the fixation of the cables.



Note ☞ *For cable connections refer to Section 6.1 – 54302351.*

5. Connect the Interface Box–Computer Cable (A3363–xx) to COM1 (Communication) and J1 (Auto ON/OFF) of the CTSC Touch Screen Console connectors. Connect the Power Line Cable to the Power Supply (AC/DC Adapter).



6. Mount back all covers of the Touch Screen Console. The Power Supply can be mounted inside the Console or placed outside as desired.

7. Remove the Back Cover of the PC Interface Box.
8. Connect the Serial Interconnection Cable (A3352–xx) from J5 of the Generator Cabinet to J1 of the PC Interface Box.
9. Connect the Handswitch Cable to J2 of the PC Interface Box.
10. Connect the Interface Box–Computer Cable (A3363–xx) to J3 of the PC Interface Box. The other end (connectors J1 and COM1) was connected to the CTSC Touch Screen Console.
11. Re-install the Back Cover of the PC Interface Box.
12. Connect the Power Line Cable to the mains (100 – 240 VAC).

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SECTION 3 TROUBLESHOOTING

3.1 PROCEDURES FOR THE CTSC TOUCH SCREEN CONSOLE

POSSIBLE CONDITIONS	
PROBLEM NUMBER	**DESCRIPTION / CIRCUMSTANCE**
1	THE CONSOLE AND GENERATOR DO NOT START-UP
2	THE CONSOLE STARTS-UP BUT THE GENERATOR DOES NOT START-UP.
3	THE CONSOLE BEEPS BEFORE START-UP
4	THERE IS NO IMAGE ON THE SCREEN
5	OPERATING SYSTEM NOT LAUNCHED OR START-UP ANOMALIES
6	CTSC CONSOLE FANS HAVE STOPPED
7	THE TOUCH SCREEN DOES NOT RESPOND TO THE TOUCH

Note ☞

Ensure that the Generator and CTSC Touch Screen Console are powered ON.

Certain problems described below are circumstantial and assume a correct functioning of the equipment.

PROBLEM 1: THE CONSOLE AND GENERATOR DO NOT START-UP

Theory:

The CTSC Console controls its start-up procedure and also of the X-ray Generator, if it is not properly powered, it will not be able to start nor the operating software, nor the X-ray Generator.

Possible Causes:

The AC/DC Adapter could be damaged, but it could be also a problem with the power connectors, the TPC Supply PBA (A9595-01) or the Main Board Kit (A11351-01) which would be damaged. Follow the steps below:

1. Check that the AC/DC Adapter (Power Supply) is correctly connected to the mains and its LED is green lighted. If the LED is green lighted, proceed to verify that the connection with the Console is correct.

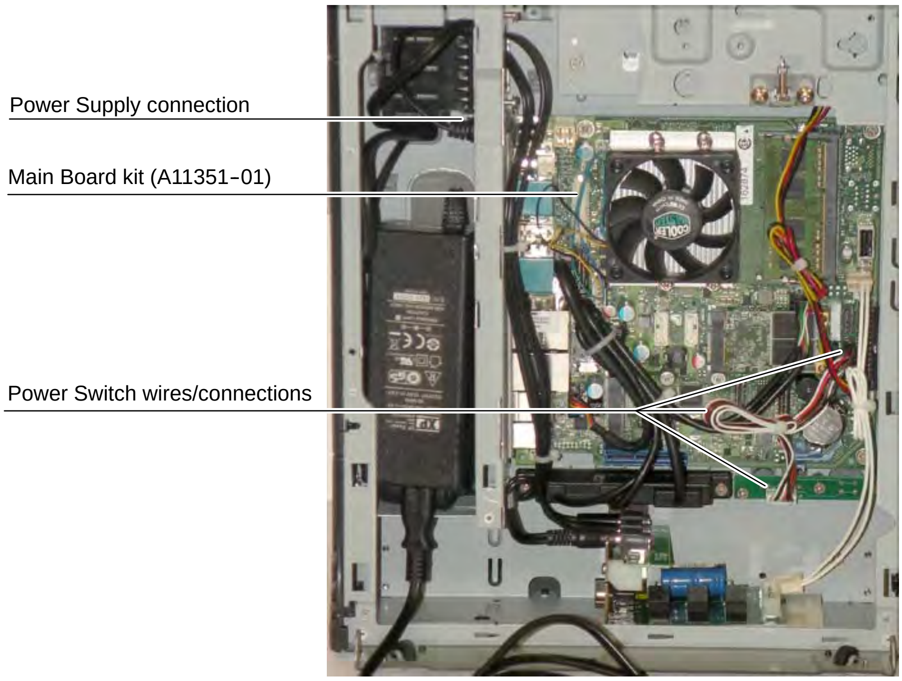
2. Open the back covers of the Console as indicated in the Installation procedure.

3. Check in TPC Supply PBA (A9595-01) that the power supply is correct and connectors/cables are not damaged or disconnected:

    a. Check for 12 VDC with a multimeter in the DC Power connector of the cable from the AC/DC Adapter. Replace the Power Supply if the reading is not correct.

    b. Check for 12 VDC in all connectors of TPC Supply PBA (A9595-01) and the cables are properly connected.

4. Once previous step is completed, check that the following connectors/wires in the Main Board (A11351-01) are correctly connected: Power Supply and Power Switch.



5. If the connection is correct, it might be a problem of the Main Board Kit (A11351-01), it must be replaced. The Main Board Kit includes the operation software, so it is highly recommended to complete a backup of the APR whenever it has been previously modified *(refer to Section 3.3).*

PROBLEM 2: THE CONSOLE STARTS-UP BUT THE GENERATOR DOES NOT START-UP

Theory:

This may be an error due to a incorrect connection of CTSC Console with the Generator, which may be not properly powered.

Possible Causes:

This may be due to an error in the Interface Control Board (A3009-xx) in SHF Generators or Interface Board (A3674-xx) in SHFR Generators, an incorrect cable connection (Cable A3352-xx) or a malfunction in the Auto ON/OFF Board (A3179-xx).

1. Ensure that the Generator can be turned on independently using the PC Interface Box. If the Generator does not turn on, follow steps 2. and 3. If the Generator turns on, proceed with steps 4. and 5.

2. Check that Generator is correctly powered and see Error 33 in the Troubleshooting documentation.

3. Check if there is present any damage in the PC Interface Box and in the Interface Box Cable (A3352-xx) and if it is properly connected. Replace it in case that it is damaged.

4. Check that the A3363-xx Cable is correctly connected to CTSC Console and to the PC Interface Box (*refer to the general wiring schematic 54302351*).

5. Check for 12 VDC the J4 connector in Auto ON/OFF Board (A3179-xx). Replace the Main Board (A11351-01) if the reading is not correct or replace the Auto ON/OFF Board (A3179-xx) if the reading is correct.

PROBLEM 3: THE CONSOLE BEEPS BEFORE START-UP

Note ☞ *This may be a temporal corruption during the start-up dialogue, restart the console to confirm fault before attempting service.*

Theory:

The Video Chip Set or DRAM will be at fault when the console, during start-up, emits either a single long beep followed by three short beeps (— · · ·), or a continuous series of long beeps (— — —).

Possible Causes:

These are BIOS errors and may be caused by either a corrupt power or DRAM connection; or a malfunctioning CTSC Main Board Kit (A11351-01).

Visually check and ensure the proper connections on the CTSC Main Board (A11351-01), not only on the Main Board Processor and its ventilator but also on the DRAM board. If there is a proper connection, replace the CTSC Main Board Kit (A11351-01).

<u>PROBLEM 4: THERE IS NO IMAGE ON THE SCREEN</u>

<u>Theory</u>:

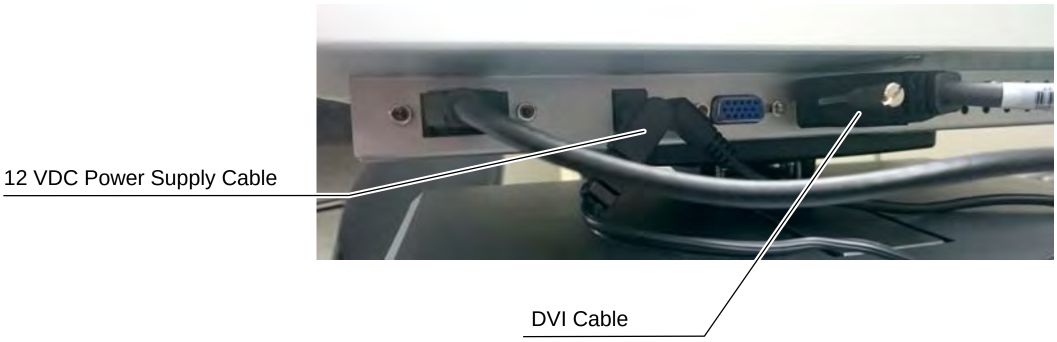
The CTSC Console Monitor is powered by TPC Supply PBA (A9595-01), when the connection is correct the Monitor must be lighted and display the operating software.

The image/data is supplied by the Main Board Kit (A11351-01) using a DVI Cable.

<u>Possible Causes</u>:

The most probable cause is an incorrect connection or damaged DVI Cable; however, a replacement of the other two main components (Monitor and Main Board Kit) may be necessary. Follow the steps below:

1. Turn the CTSC Console ON and check if the "*Status*" indicator is powered (on the lateral of the CTSC Console). If not, check connections for +12 V power supply cable from the TPC Supply PBA (A9595-01). Replace the cable in the event of visible damage.



2. If the previous step is correct, ensure a correct connection of the DVI cable of the monitor. Replace the cable in the event of visible damage.

3. If both cables/connections are correct, then the problem could be the Monitor or the Main Board (A11351–01). Check the Monitor with the cables connected to another PC of a CTSC Console. If the Monitor displays the image, then replace the Main Board Kit (A11351–01). Otherwise, replace the Monitor.

PROBLEM 5: OPERATING SYSTEM NOT LAUNCHED OR START-UP ANOMALIES

Note ☞ *This may be a temporary corruption or communication failure during the start-up dialogue, restart the Console to confirm problem before attempting service.*

Theory:

This problem is caused by a damaged SSD Disk of the CTSC Console or when there is a malfunction in it.

Possible Causes:

The CTSC Console turns on but the operating software does not complete the start up procedure. It unsuccessfully searches for the SSD Disk and, then, tries to use other starting devices. Messages during the start-up routine such as "*Reboot and select proper boot device*" appear with SSD Disk problems.

The SSD Disk is a part of the Main Board Kit (A11351-01), it should contain all software necessary for the proper functioning of the Operating Application.

If the problem persists after starting-up the Console several times, replace the Main Board Kit (A11351-01).

PROBLEM 6: CTSC CONSOLE FANS HAVE STOPPED

The Console Ventilation Fan and the CPU Cooler cool the Console and the Microprocessor on the Main Board Kit respectively.

Note ☞ *The CTSC Console may suffer irreversible damage if the Console Ventilation Fan is not functioning properly. Nevertheless, ensure that the Console functions properly before troubleshooting the fan.*

Console Ventilation Fan

1. Visually check for proper Fan Power Supply Cable connection in the Main Board. Check for 12 VDC in the corresponding connector of the Main Board (A11351–01), if it is not present, replaces the Main Board kit (A11351–01).

CPU Cooler

1. If the CPU Cooler is not functioning, the microprocessor on the Main Board Kit (A11351-01) will heat up and eventually freeze the Touch Screen controls and processes. If the Main Board freezes, first try to restart the Console. If the condition persists, proceed to the next step.

2. Open the CTSC Console, power the Console ON and check if the CPU cooler is rotating. Visually check connections for broken wires and proper connections. If connections and wires are ok, replace the Main Board Kit (A11351-01) which includes the CPU Cooler.

PROBLEM 7: THE TOUCH SCREEN DOES NOT RESPOND TO THE TOUCH

Note ☞ *This may be a temporary corruption or communication failure during the start-up dialogue, restart the Console to confirm problem before attempting service.*

Make sure hands and screen are clean and dry, then try these steps:

1. With the CTSC Console OFF disconnect the USB Cable of the Monitor.

2. Switch ON the CTSC Console and wait until the operating system is running.
3. Connect the USB Cable to the Monitor and check its connections to the Main Board. Verify that now the Touch Screen is working properly.
4. If it does not work properly yet, connect an USB keyboard to the CSTC Console.
5. Press the "*Windows*" key and launch "*Control Panel/Device Manager/Mice and Other Pointing Devices*".
6. Check that the "*HID Compliant Mouse*" is listed, if not replace the USB Cable or connect it to another USB connector in the Main Board.
7. In both cases if the Monitor does not respond correctly it must be necessary to replace the Monitor.

3.2 SOFTWARE UPGRADE

If the Touch Screen Application is provided with a "*Software Upgrade*" button on the Service Mode Menu, it is used to close the Application Program without turning OFF the Console. After pressing this button, the Console shows the PC Desktop to enable the Application Software Upgrade.

Note ☞ *To perform any of these operations, it is necessary to connect an USB Keyboard at the bottom of the CTSC Console.*

3.3 EXTERNAL BACKUP OF THE APR TECHNIQUES AND ERROR LOG

WARNING

DURING THE BACKUP PROCESS IT IS NECESSARY TO ACCESS TO THE OPERATING SOFTWARE MAIN FOLDER. IT IS ABSOLUTELY MANDATORY NOT TO DELETE OR MODIFY ANY FILE IN THIS FOLDER, EXCEPT WHEN INDICATED, IN ORDER TO NOT CORRUPT THE CORRECT PERFORMANCE OF THE SOFTWARE.

1. Connect a USB keyboard to the CTSC Console.
2. Connect the external device where the backup will be recorded to the other USB port of the CTSC Console.
3. Press the *"Windows"* key, select *"Computer"* and browse to the following folder: *"\\Computer\Local Disk (C:)\Program Files (x86)\Sedecal".*
4. Copy *"APRBckUp"* and *"Fichero"* files to the external device.
5. Close the "*Windows Explorer*" and disconnect the keyboard and the storage external device from the USB ports of the CTSC Console.

To restore the APR techniques and Error log backup files just copy and rewrite the current files in the "*Sedecal*" folder of the CTSC Console.

SECTION 4 MAINTENANCE

4.1 CTSC CONSOLE CONDITION

Check the proper connection and condition of the cables connected to the CTSC Console.

Check correct operation of the buttons, displays and indicators by performing the following test:

1. Turn the Generator / Console ON.

2. Touch on different points of the operator application on the Touch Screen to check that the Touch Screen Sensor is properly calibrated. It is factory calibrated and it does not require any calibration procedure.

3. Select a radiographic technique and observe:

   - Indicators of the selected workstation and Focal Spot.

   - Technique parameters are displayed on the Console. Change technique parameters and observe that changes are correctly displayed.

   - Select the parameters for an usual exposure. Press “*Prep*” and verify that the “*Ready*” indicator is activated. Release “*Prep*” and observe that the “*Ready*” indicator is deactivated.

   - Make the exposure, and verify that radiographic exposure signal sounds and the “*Prep*” and “*X-ray On*” indicators are activated during the exposure.

4. If AEC is installed, select a technique with AEC and observe that the indicators of the selected AEC controls are activated.

5. If APR is installed, select an APR technique and observe:

   - Indicators of the selected Patient Size are activated and the Body Region / Anatomical Views are shown on the APR Display and its corresponding parameters are shown on the RAD Display.
   - Change the APR technique and observe that selection and parameters changes on both Displays.

6. If Fluoro is installed, select a workstation for Fluoro operation and observe:

   - Fluoro parameters are displayed on the Fluoro Display.
   - Change the Fluoro kV and observe that changes are correctly displayed.
   - Check selection of another functions related to Fluoro if they are present (ABC, PPS, etc.).

SECTION 6 SCHEMATICS

6.1 SYSTEM INTERCONNECTION MAPS

Refer to the following maps for details of the wire connections.

SYSTEM INTERCONNECTION

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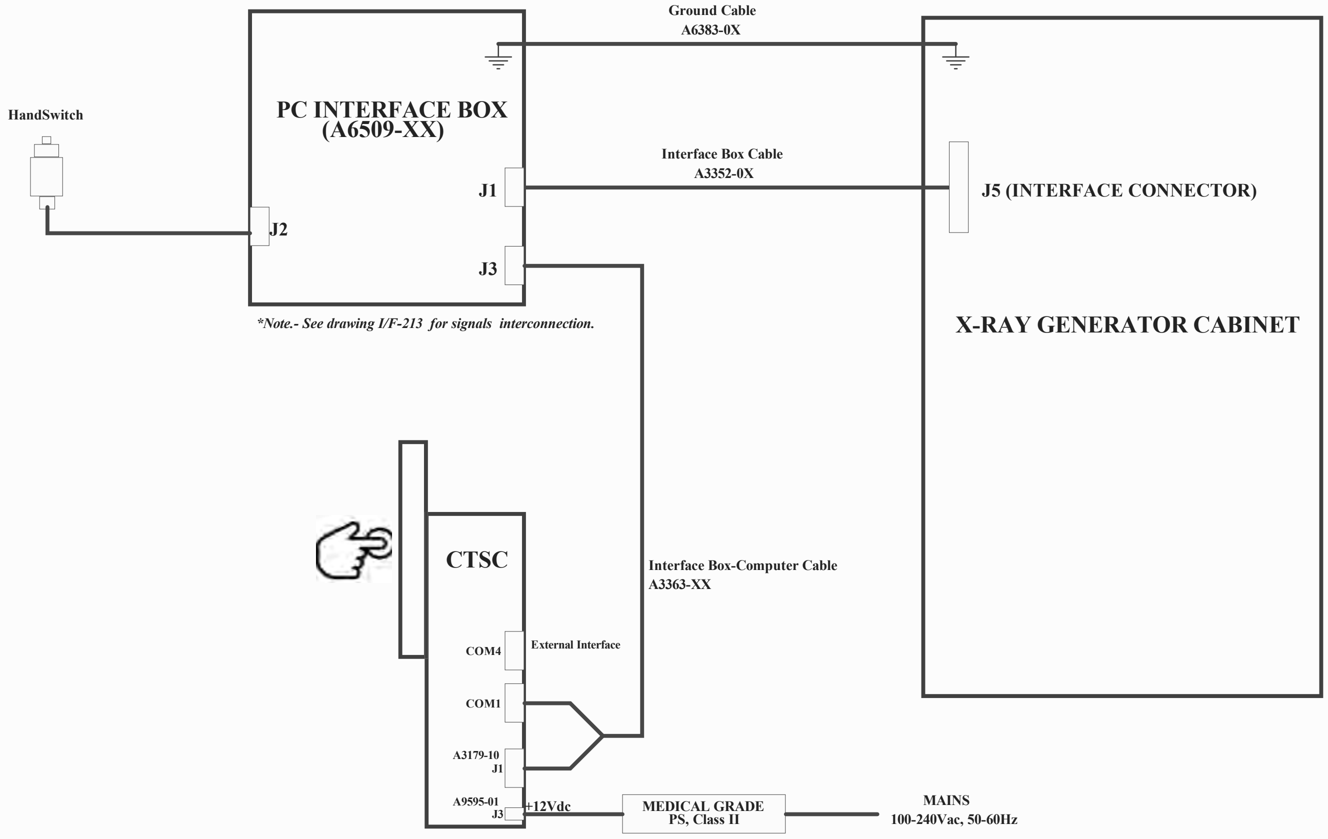


REV	DESCRIPTION	ISSUED BY	DATE
A	First Issue	J.A.Garcia	04/05/15

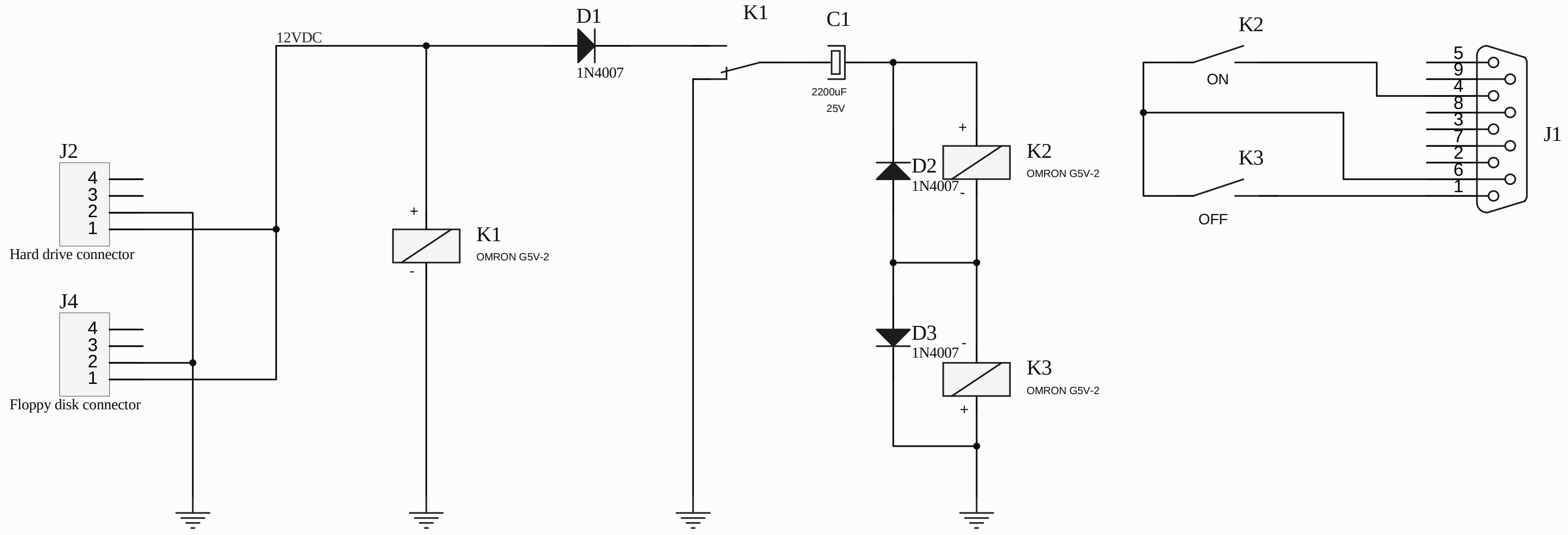
	NAME	DATE	SHEET / OF
DRAWING	J.A.Garcia	04/05/15	1 / 1
REVISED	FD	04/05/15	

54302351

A REV

SEDECAL

CTSC TO GENERATOR CONNECTION



PCB: 90241-01

REV	DESCRIPTION	ISSUED BY	DATE
B	NC 12/102	J.A.Garcia	09/03/12
A	NE 223/10	MC	14/01/10

	NAME	DATE	SHEET / OF
DRAWING	MC	14/01/10	1 / 1
REVISED	F.Díaz	14/01/10	

A3179-10

REV: B A

SEDECAL

LOW PROFILE AUTO ON/OFF