

Portable X-Ray Units

Service Manual

Technical Publication
SM-1076R23_EN_NLG

Service Manual

Portable X-Ray Units

SPL-HF-4.0 / SPL-HF-8.0
SPSL-HF-4.0 / SPSL-HF-8.0
SPSL-HF-4.0-APR / SPSL-HF-8.0-APR

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SPSL-HF-4.0-APR / SPSL-HF-8.0-APR

This manual covers the following equipments / Este manual cubre los siguientes equipos
Ce manuel couvre les équipements suivants / Il presente manuale descrive i seguenti dispositivi

Portable X-Ray Unit SPL:
SPL-HF-4.0, SPL-HF-8.0

Portable X-Ray Unit DRAGON X:
SPSL-HF-4.0, SPSL-HF-8.0,
SPSL-HF-4.0-APR, SPSL-HF-8.0-APR



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REVISION HISTORY

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1	MAR 28, 2011	Diassembly / Reassembly
2	MAY 24, 2011	Diassembly / Reassembly and Renewal Parts
3	NOV 30, 2012	TEST Connector added to measure kVp and mA
4	FEB 25, 2013	New IEC Standards Update & Schematics
5	MAY 6, 2013	New Aluminium Frame
6	JUN 5, 2013	New Overlay Console for Dragon
7	JAN 29, 2014	Exposure and Energy Counters added
8	DEC 03, 2015	Mechanical and Software Updates
9	MAR 01, 2016	Options for X-Ray Units with Trolley
9.2	MAR 28, 2016	Renewal Parts and Schematics
10	JUL 19, 2016	Renewal Parts and Schematics
11	APR 05, 2017	Schematics
12	MAY 03, 2017	Software and Renewal Parts Update
13	FEB 14, 2018	New Overlay
14	JUN 07, 2018	New Leg Locking System
15	OCT 24, 2018	PCB and Software Update
16	DEC 05, 2018	Sound Configuration
17	NOV 25, 2019	General Update II
18	MAR 04, 2020	Schematics
19	DEC 21, 2020	Schematics
20	APR 14, 2021	Technical specifications for 5 kW model.
21	NOV 02, 2021	Collimator cover and Renewal parts update
22	SEP 28, 2022	Renewal parts and Troubleshooting update
23	JAN 26, 2023	Control Driver Board update

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 HEHEDED OR AVOIDED WILL CAUSE SERIOUS PERSONAL INJURY OR DEATH.



ADVISE OF CONDITIONS OR SITUATIONS THAT IF NOT HEHEDED 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.

SERVICE NOTE TO PORTABLE X-RAY UNITS

***THIS PORTABLE UNIT HAS BEEN CONFIGURED,
CALIBRATED AND TESTED BY THE MANUFACTURER.***

***IT IS READY FOR NORMAL OPERATION.
NO SERVICE TASK IS REQUIRED.***

***REFER TO THIS SERVICE MANUAL ONLY
FOR PERIODIC MAINTENANCE OR REPAIRS.***

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SECTION 1 INSTALLATION REQUIREMENTS

1.1 OBJECTIVE AND SCOPE OF THIS MANUAL

This Service Manual is intended to describe the installation, adjustments, configuration, calibration, troubleshooting and periodic maintenance of the Portable X-Ray Unit.



SERVICE PERSONNEL MUST HAVE SUFFICIENT KNOWLEDGE TO COMPETENTLY PERFORM THE SERVICE TASKS RELATED TO X-RAY DEVICES AND PARTICULARLY TO THE EQUIPMENT DESCRIBED IN THIS MANUAL. THIS KNOWLEDGE IS ACQUIRED THROUGH A VARIETY OF EDUCATIONAL METHODS FOR TECHNICIANS IN ACCORDANCE WITH LOCAL LAWS OR REGULATIONS, INCLUDING SPECIFIC TRAINING ON THIS EQUIPMENT.



The Portable Unit has been Configured, Calibrated and Tested by the Manufacturer. It is ready for normal operation. No service task is required. Refer to this Service Manual only for Periodic Maintenance or repairs.

This Service Manual covers the Portable Units for Monoblock and the Monoblock with Trolley versions.

1.2 POWER LINE REQUIREMENTS

Note 

The Unit is factory provided with a Power Cable (6 meters) and a Plug for connection to line voltage (wall socket) according to customer order. If required, change the line cord and plug to conform to local codes and requirements.

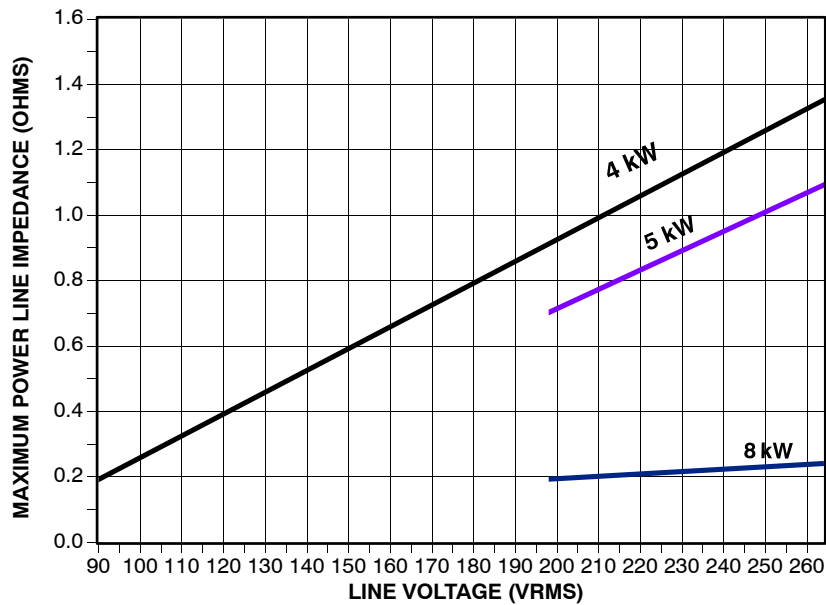


ACCORDING TO MDD/93/42/CEE, THIS UNIT IS EQUIPPED WITH EMC FILTERS. THE LACK OF PROPER GROUNDING MAY PRODUCE ELECTRICAL SHOCK TO THE USER.

Portable X-ray Units power requirements are:

Maximum Power kW	4.0	5.0	8.0
Power Line Operation	Single-Phase, 100 - 240 V~, 50 / 60 Hz.	Single-Phase, 220 - 240 V~, 50 / 60 Hz.	Single-Phase, 220 - 240 V~, 50 / 60 Hz.
	Line voltage automatic compensation: $\pm 10\%$		
	Power line cable of the Portable Unit: 6 meters. Connection to standard outlets with GND that accomplishes local regulations.		
Input Power	6.6 kVA	7.5 kVA	12.5 kVA
Maximum Power Line Impedance	Refer to Illustration 1-1		
Minimum recommended Thermomagnetic / Circuit Breaker	The General Circuit Breaker installed in the Portable Unit is 32 A (curve type C) with a 30 mA Sensitivity Differential.		
	The Power Line Installation should be provided with a 30 mA Sensitivity Differential and with a Thermomagnetic Interruptor / Circuit Breaker of at least:		
	≥ 30 A (curve type C) or ≥ 16 A (curve type D) for 100 - 120 V~ ≥ 16 A (curve type C) or ≥ 10 A (curve type D) for 220 - 240 V~	≥ 16 A (curve type C) or ≥ 13 A (curve type D) for 220 - 240 V~	≥ 30 A (curve type C) or ≥ 16 A (curve type D) for 220 - 240 V~
<i>Momentary Line Current based on 100 ms X-ray exposure (RMS)</i>			

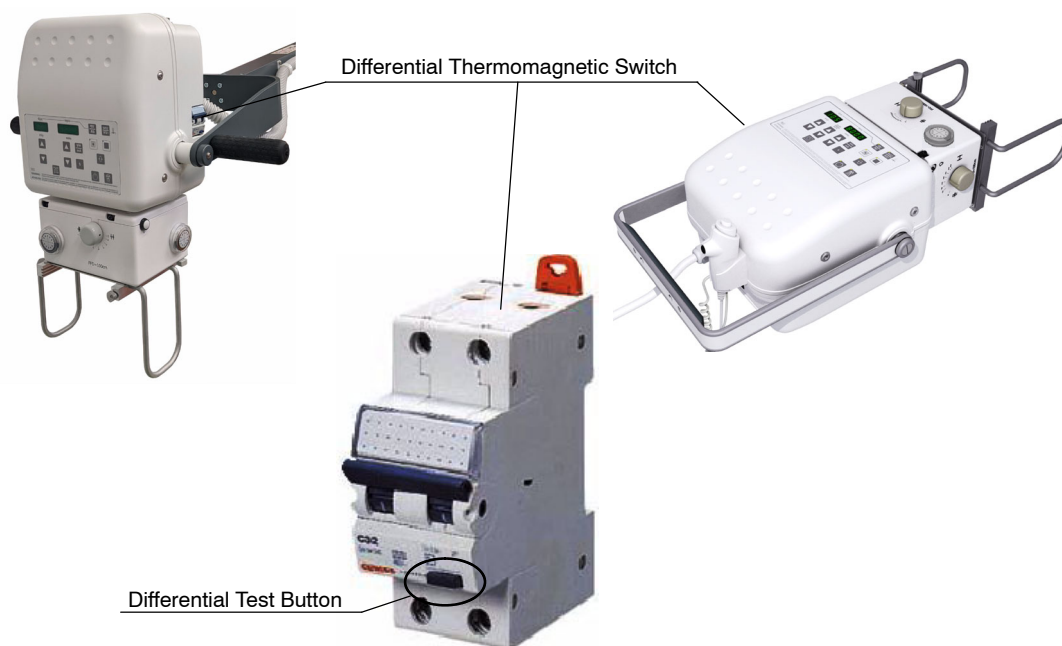
Illustration 1-1
Maximum Power Line Impedance



1.2.1 TEST OF DIFFERENTIAL THERMOMAGNETIC SWITCH

The X-ray Unit is equipped with a Differential Thermomagnetic Switch (Circuit Breaker) with a Differential Test button.

The Test button does not operate when the unit is connected to power lines below 160 V~, but it does not mean that the Differential Thermomagnetic Switch does not work properly.



1.3 TOOLS AND TEST EQUIPMENT

The following test equipment is required in Configuration, Calibration and Troubleshooting and Maintenance:

- Standard service engineers tool kit including Allen and Torx key sets.
- Oscilloscope.
- Non-invasive kVp Meter.
- Digital Multimeter.
- Calculator.
- Torque Wrench to check proper fixation of the screws in the X-ray Unit Support. The tool should be capable to measure 8 Nm and 30 Nm (*refer to Section 7.6 and the corresponding Troubleshooting procedures dismantling the X-ray Unit Support*).

The following Tools are used to adjust the alignment of X-Ray Beam (*refer to Section 4*) and they are not included with the System:

- Collimator Test Tool (Model RMI 161B9).
- Beam Alignment Test Tool (Model RMI 162A).

1.4 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.



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.

SECTION 2

CONFIGURATION PROCEDURE



Configuration and Calibration procedures should only be performed at field if Portable Control Board, Control Driver Board or the High Voltage Transformer are replaced or the EEPROM memory is re-initialized.

All procedures described in this Service Manuals are performed from the Control Panel of the X-ray Unit.

Configuration provides the initial settings and checkout procedures that must be carried out before starting to work with the Unit. Functional characteristics of this Generator are defined during Configuration.

Calibration data and some configuration data are stored in the extended memory area of the non-volatile memory U25-EEPROM Microcontroller. It is located on the Portable Control Board (A3175-05).



Do not supply the main power until specifically instructed in this document.

2.1 CONFIGURATION OF DIP SWITCHES

The Dip Switches located in the Portable Control Board (A3175-05) define the Unit configuration:

Dip Switch SW1	Description
1*	ON = Service mode enabled OFF= Service mode disabled
2	ON = Hardware errors disabled OFF= Hardware errors enabled
3	ON = Demo mode enabled OFF= Demo mode disabled
4	ON = Filaments disabled OFF= Filaments enabled

* NOTE.- Access to Service mode can be also performed using the keyboard as indicated in Section 2.2 while dipswitch is in "OFF" position.

All Dip Switches are Factory set to OFF position for normal operation.

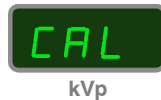
2.2 HOW TO ENTER AND STORE DATA IN CONFIGURATION MODE

Configuration data is entered from the Control Panel when the Unit is in Service Mode. Access and configure data as indicated below:

1. Turn the Unit ON and immediately press and hold "Reset" push-button to enter in Service Mode. The Unit starts its power-up routine and the software version (e.g. P01 0103) is shown on the Display of the Control Panel.



2. When the letters "CAL" appear in the kVp Display, release "Reset" push-button.

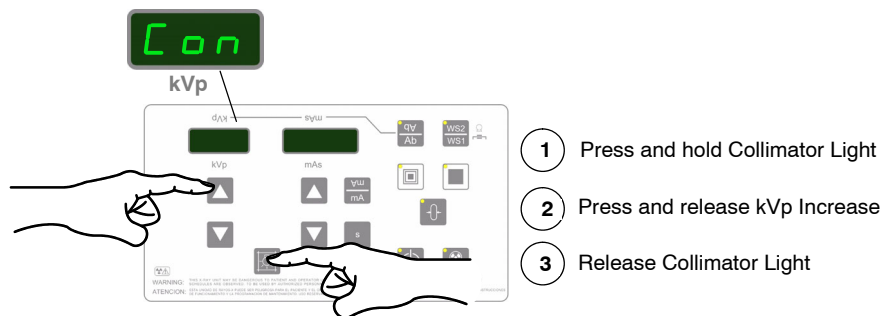


3. Then the Displays show the selected power percentage (e.g. Po = 100) followed by the standard kVp and mAs values.



The Unit is equipped with ten (10) Configuration groups (C01 to C0A) and their subgroups are shown on the kVp Display when they are selected. (Refer to Table 2-1 "Configuration Menus").

4. **To enter or exit the Configuration menu:**
 - a. Press and hold "Collimator Light" push-button and then press and release "kVp Increase" push-button (two beeps sound). (Con) appears on the kVp Display while "Collimator Light" is pressed, then release "Collimator Light" (kVp Display shows C01 and both Focal Spot Leds blink).



- b. Press “kVp Increase” or “kVp Decrease” push-buttons to move through Configuration menus to select any of them (the kVp Display shows menus from C01 to C0A).
- c. Press “Collimator Light” push-button to enter in the sub-menus.
- d. Press “kVp Increase” or “kVp Decrease” to scroll through sub-menus of each menu and select any of them. The desired selection will be shown on the kVp Display.
- e. Press “Collimator Light” push-button to exit the sub-menus.
- f. To exit Configuration Mode, press and hold “Collimator Light” push-button and then press and release “kVp Increase” push-button (two beeps sound). Then release the “Collimator Light” push-button.

**Table 2-1
Configuration Menus**

Value on kVp Display	DESCRIPTION	NOTES
C01	WORKSTATION-1 CONFIGURATION	
	C1.1	X-ray Tube present 0 = WS not used, 1 = Tube 1
	C1.2	Workstation Type: 0 = Direct, 1 = Bucky / Detector, 2 = not used, 3 = not used, 4 = not used
	C1.3	Device selection: 0 = none, 1 = Detector / Standard Bucky (Receptor synchronization by hardware), 2 = Detector / Bucky Com (Receptor synchronization by software)
	C1.4	0 = not used
C02	WORKSTATION-2 CONFIGURATION	
	C2.1	X-ray Tube present 0 = WS not used, 1 = Tube 1
	C2.2	Workstation Type: 0 = Direct, 1 = Bucky / Detector, 2 = not used, 3 = not used, 4 = not used
	C2.3	Device selection: 0 = none, 1 = Detector / Standard Bucky (Receptor synchronization by hardware), 2 = Detector / Bucky Com (Receptor synchronization by software)
	C2.4	0 = not used
C03	mA STATION CONFIGURATION FOR EACH FOCUS	
	C3.1	mA Stations for “Small Focal Spot”: 5.000 mA - 100.0 mA
	C3.2	mA Stations for “Large Focal Spot”: 5.000 mA - 100.0 mA

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**Table 2-1 (cont.)
Configuration Menus**

Value on kVp Display	DESCRIPTION	NOTES
C04	X-RAY TUBE LIST SELECTION / number of Tube in the list	<i>Refer to Section 2.2.3</i>
	C4.1 X-ray Tube Configuration as Tube-1: 1 - 5	
C05	TIME CONFIGURATION FOR "PREP" AND COLLIMATOR LIGHT	<i>Refer to Section 2.2.4</i>
	C5.1 "Prep" Time Configuration: 10 - 50 seconds	Factory Configured at 30 seconds.
	C5.2 "Collimator Light" Time Configuration: 10 - 50 seconds	Factory Configured at 30 seconds.
C06	MAXIMUM X-RAY TUBE POWER	<i>Refer to Section 2.2.5</i>
	C6.1 Maximum percentage limit for X-Ray Tube	Select the maximum power percentage at 100, 90, 80 or 70.
C07	MISCELLANEOUS	<i>Refer to Section 2.2.6</i>
	C7.1 Speaker Sound: OFF / ON / ES OFF / ES ON	OFF = all sounds disabled. ON = all sounds enabled. (Factory set) ES OFF = Exposure sound disabled. Every other sound enabled. ES ON = Exposure sound enabled. Every other sound disabled. <i>C7.1 = OFF and C7.1 = ES OFF are not compatible with C9.4 = NO.</i>
	C7.2 Winter / Summer Automatic Time Update: NO / EU / USA	NO = automatic time update disabled. EU = EU automatic time update enabled (factory set). USA = USA automatic time update enabled.
	C7.3 Collimator Light ON with PREP: OFF / ON	OFF = Collimator Light only enabled with push- button (Factory set). ON = Collimator Light enabled when pressing "PREP".
	C7.4 Protocol Syntax: NO / YES	NO = Standard Protocol. (Factory set) YES = Protocol only compatible with units that require the Tech Service application for configuration / calibration and communication.
	C7.5 ABC input: 0 = None, 1 = kV ±	0 = When the system is not interfaced with an ABC System or to keep the kV constant when calibrating fluoro to make possible the mA reading. (Factory set) 1 = When the Generator is interfaced with an ABC System. The customer's system sends the signals to adjust the kV.

**Table 2-1 (cont.)
Configuration Menus**

Value on kVp Display	DESCRIPTION	NOTES	
C08	DATE AND TIME		
		<i>Factory set at GMT +1.Refer to Section 2.2.7</i>	
	C8.1	Hour	0 - 23
	C8.2	Minutes	0 - 59
	C8.3	Date	1 - 31
	C8.4	Month	1 - 12
C8.5	Year	2000 - 2099	
C09	X-RAY TUBE MISCELLANEOUS		
		<i>Refer to Section 2.2.8</i>	
	C9.1	Tube 1 max kV: 80-125	125 factory set.
	C9.2	Fluoro max kV: 80-125 (only for Fluoro units)	120 factory set (never greater than Tube 1 max kV)
	C9.3	High Dose Auto OFF: NO / YES (only for Fluoro units)	NO = High Dose Button always enabled (Factory set) YES = High Dose Button automatically disabled when not in use.
	C9.4	"RX Enable" Required: NO / YES	NO = X-ray enabled when starting the Unit YES = X-ray disabled when starting the Unit. "RX Enable" comes from RS232, so the Serial Port license must be enabled. <i>When C9.4 = NO, the Exposure sound is always enabled. Configuration of C7.1 = OFF and C7.1 = ES OFF are not compatible with this selection (C9.4 = NO).</i>
	C9.5	mAs Meter Mode: NO / YES	NO = mAs Meter Mode disabled. YES = mAs Meter Mode enabled. (Factory set)
	C9.6	First DSI Exp: E50 Disabled	NO = E50 is displayed when handswitch is released during the first exposure. (Factory set) YES = E50 is not displayed when handswitch is released during the first exposure .
	C.9.7	RAD Sync Timeout	0-60 seconds 2 (Factory set)
C9.8	Fluoro Sync Timeout (only for Fluoro units)	0-60 seconds 2 (Factory set)	

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Value on kVp Display	DESCRIPTION	NOTES
	X-RAY TUBE MISCELLANEOUS	<i>Refer to Section 2.2.8</i>
C09	C9.9 X-Ray Key: NO / YES (optional feature)	NO = X-ray Key feature enabled YES = X-ray Key feature disabled
	C9.A Enable both filaments (only for Fluoro units)	NO = Enable both filaments feature enabled YES = Enable both filaments feature disabled
	MAXIMUM MS FOR DIGITAL WORKSTATION	<i>Refer to Section 2.2.9</i>
C0A	CA.1 Max ms for Digital Workstation	0 = 2.5 seconds (by default) 1 = 3.2 seconds

Note 

If any of the configured values is not consistent with the Unit Parameters, the system will not allow to exit from Configuration mode. Double check the configured values (Refer to Table 2-1).

2.2.1 CONFIGURATION OF WORKSTATIONS (1) - (2)

To select Workstation 1 press the “Direct” Workstation push-button, to select Workstation 2 press the “Receptor” (Bucky or Digital Detector) Workstation push-button.

Note 

In case the Receptor Workstation for the Digital Detector or Bucky is selected and no Digital Detector or Bucky is connected to the Unit or the connection is malfunctioning, error code “E24” appears on the Display. Press “Reset” push-button and check connections and signals of the Digital Detector or Bucky, or select the Workstation for Direct if no Receptor is needed.

Factory Setting					
Workstation 1 Direct		Workstation 2 Bucky or Detector		Workstation 1 or 2 if not Bucky or Detector	
C 1.1	1	C 2.1	1	Set all values 0	
C 1.2	0	C 2.2	1		
C 1.3	0	C 2.3	1		
C 1.4	0	C 2.4	0		
* Note: Select 1 for Receptor synchronization by hardware (e.g. Detector with synchronization box). Select 2 for Receptor synchronization by software (e.g. Wireless Detector without synchronization box).					

In case a Workstation configuration needs to be modified:

1. Enter Configuration Menu C01 (for Workstation-1) or C02 (for Workstation-2).
2. Enter sub-menu C1.X or C2.X, the kVp Display shows (C1.X) or (C2.X) and the mAs Display shows the selectable values.

As example, enter sub-menu C1.1 or C2.1. The kVp Display shows (C1.1) or (C2.1) and the mAs Display shows (0) or (1). “X-ray Tube present” value is “0” for Workstation not used or “1” for X-ray Tube-1 present (Workstation used).

3. Press “mAs Increase” to change the corresponding value from e.g. “0” (Workstation not used) to “1” (Tube present - Workstation used) or viceversa.
4. Press “Reset” push-button to save value.

2.2.2 CONFIGURATION OF mA STATIONS FOR EACH FOCUS

1. Enter Configuration menu C03.
2. Enter sub-menu C3.1. The kVp Display shows (C3.1) and the mAs Display shows (16.00) for 4 kW and 5 kW Units or (12.5) for 8 kW Units (Factory set).
3. To change the corresponding maximum value of mA station for Small Focus, press "mAs Increase" or "mAs Decrease". Factory default value is 16 mA for 4 kW and 5 kW Units or 12.5 mA for 8 kW Units.
4. Press "Reset" push-button to save value.
5. Press "kVp Increase", the kVp Display shows sub-menu (C3.2) and mAs Display shows (5.000) (Factory set).
6. To change the corresponding minimum value of mA station for Large Focus, press "mAs Increase" or "mAs Decrease". Factory default value is 5 mA.
7. Press "Reset" push-button to save value.
8. Press "Collimator Light" push-button to exit the sub-menus. The kVp Display shows (C03).

Note 

Maximum mA station recommended for the "Small Focus" is 16 mA for 4 kW and 5 kW Units or 12.5 mA for 8 kW Units. The minimum mA station for "Large Focus" should be the lowest mA station allowed by the Unit.

2.2.3 X-RAY TUBE SELECTION

1. Select Configuration menu C04.
2. Enter sub-menu C4.1 for Tube-1. The kVp Display shows (C4.1) the Tube identifier.
3. To change the X-ray Tube ID (identifier, shown on the kVp Display for seconds) press “*mAs Increase / Decrease*” and set the ID shown on the “*Inspection Report*” document of the Unit.
4. Press “*Reset*” push-button to save data. The Tube ID is momentarily shown on the kVp Display and a beep sounds.
5. Press “*Collimator Light*” push-button to exit the sub-menus. The kVp Display shows (C04).



Error E08 appear when the Tube ID is a default value.

In case the HV Transformer has been replaced, request the manufacturer the Tube identifier to be configured.

2.2.4 TIME CONFIGURATION FOR “PREP” AND COLLIMATOR LIGHT

1. Select configuration menu C05.
2. Enter sub-menu C5.1 for “*Prep*” Time Configuration. The kVp Display shows (C5.1) and the mAs Display shows (30). Factory set at 30 seconds, within this lapse of time “*Exp*” button should be pressed, otherwise the exposure will not be allowed.
3. Press “*mAs Increase*” or “*mAs Decrease*” to change Preparation Time. Value Factory set at 30 (range from 10 to 50).
4. Press “*Reset*” push-button to save value.
5. Press “*kVp Increase*” to enter sub-menu C5.2 for Collimator Light Time. The kVp Display shows (C5.2) and mAs shows (30) (Factory set).
6. Press “*mAs Increase*” or “*mAs Decrease*” to change Collimator Light Time. Value Factory set at 30 seconds (range from 10 to 50).
7. Press “*Reset*” push-button to save value.
8. Press “*Collimator Light*” push-button to exit sub-menus. The kVp Display shows (C05).

2.2.5 MAXIMUM X-RAY TUBE POWER

Note 

The maximum X-Ray Tube Power (power curves) can be set at 70, 80, 90 or 100% of the maximum rate. This power limitation increases the total life of the Tube.

1. Select Configuration menu C06.
2. Enter sub-menu 6.1. The kVp Display shows (C6.1) and the mAs Display shows (100) (Factory set).
3. To change the Percentage Rating, press “mAs Increase” or “mAs Decrease” push-buttons (70, 80, 90 or 100). Value factory set at 100.
4. Press “Reset” push-button to save the value.
5. Press “Collimator Light” push-button to exit sub-menus. The kVp Display shows (C06).

2.2.6 MISCELLANEOUS

1. Select configuration menu C07.
2. Enter sub-menu C7.1 for Speaker Sound Configuration. The kVp Display shows (C7.1) and the mAs Display shows (ON) (factory set).
3. Press “mAs Increase” or “mAs Decrease” to change Speaker Sound Configuration. Press “Reset” push-button to save value.
4. Press “kVp Increase” to enter sub-menu C7.2 for Winter / Summer Automatic Time Update. The kVp Display shows (C7.2) and mAs shows (EU) (Factory set).
5. Press “mAs Increase” or “mAs Decrease” to change the Winter / Summer Automatic Time Update. Press “Reset” push-button to save value.
6. Press “kVp Increase” to enter sub-menu C7.3 for Collimator Light ON with PREP. The kVp Display shows (C7.3) and mAs shows (OFF) (Factory set).
7. Press “mAs Increase” or “mAs Decrease” to change the Collimator Light ON with PREP. Press “Reset” push-button to save value.

8. Press “*kVp Increase*” to enter sub-menu C7.4 for Protocol Syntax. The kVp Display shows (C7.4) and mAs shows (NO) (Factory set).
9. Press “*mAs Increase*” or “*mAs Decrease*” to change the Protocol Syntax. Press “*Reset*” push-button to save value.
10. Press “*kVp Increase*” to enter sub-menu C7.5 for ABC input. The kVp Display shows (C7.5) and mAs shows (0) (Factory set).
11. Press “*mAs Increase*” or “*mAs Decrease*” to change the ABC input. Press “*Reset*” push-button to save value.
12. Press “*Collimator Light*” push-button to exit sub-menus. The kVp Display shows (C07).

2.2.7 DATE AND TIME (FACTORY SET AT GMT +1)

Note 

When entering the Date and Time data, keep in mind that they are not roll over numbers.

1. Select configuration menu C08 to enter the date/time at the RTC (Real Time Clock).
2. Enter sub-menu:
 - C8.1 for Hour Configuration (range from 0 to 23).
 - C8.2 for Minute Configuration (range from 0 to 59).
 - C8.3 for Date Configuration (range from 1 to 31).
 - C8.4 for Month Configuration (range from 1 to 12).
 - C8.5 for Year Configuration (range from 2000 to 2099).

The kVp Display shows (C8.X) and the mAs Display shows the Factory set values.

3. Press “*mAs Increase*” or “*mAs Decrease*” to change the values.
4. Press “*Reset*” push-button to save values.
5. Press “*Collimator Light*” push-button to exit sub-menus. The kVp Display shows (C08).

2.2.8 X-RAY TUBE MISCELLANEOUS

1. Select configuration menu C09.
2. Enter sub-menu C9.1 for Tube 1 max kV: 80–125. The kVp Display shows (C9.1) and the mAs Display shows (125) (Factory set).
3. Press “*mAs Increase*” or “*mAs Decrease*” to change the value. Press “*Reset*” push-button to save value.
4. Press “*kVp Increase*” to enter sub-menu C9.2 for Fluoro max kV: 80–125. The kVp Display shows (C9.2) and mAs shows (120) (Factory set).
5. Press “*mAs Increase*” or “*mAs Decrease*” to change the value. Press “*Reset*” push-button to save value.
6. Press “*kVp Increase*” to enter sub-menu C9.3 for High Dose Auto OFF. The kVp Display shows (C9.3) and mAs shows (NO) (Factory set).
7. Press “*mAs Increase*” or “*mAs Decrease*” to change the High Dose Auto OFF status. Press “*Reset*” push-button to save it.
8. Press “*kVp Increase*” to enter sub-menu C9.4 for X-Ray Enable Required. The kVp Display shows (C9.4) and mAs shows (NO) (Factory set).
9. Press “*mAs Increase*” or “*mAs Decrease*” to change the X-Ray Enable Required status. Press “*Reset*” push-button to save it.
10. Press “*kVp Increase*” to enter sub-menu C9.5 for mAs Meter Mode. The kVp Display shows (C9.5) and mAs shows (YES) (Factory set).
11. Press “*mAs Increase*” or “*mAs Decrease*” to change the mAs Meter Mode status. Press “*Reset*” push-button to save it.
12. Press “*kVp Increase*” to enter sub-menu C9.6 for First DSI Exposure without E50. The kVp Display shows (C9.6) and mAs shows (NO) (Factory set).
13. Press “*mAs Increase*” or “*mAs Decrease*” to change the First DSI Exposure without E50 status. Press “*Reset*” push-button to save it.
14. Press “*kVp Increase*” to enter sub-menu C9.7 for RAD Sync Timeout. The kVp Display shows (C9.7) and mAs shows (2) seconds (Factory set).
15. Press “*mAs Increase*” or “*mAs Decrease*” to change the value. Press “*Reset*” push-button to save it.

16. Press "*kVp Increase*" to enter sub-menu C9.9 for X-Ray Key option. The kVp Display shows (C9.9) and mAs shows (YES) or (NO).
17. Press "*mAs Increase*" or "*mAs Decrease*" to change the X-Ray Key option status. Press "*Reset*" push-button to save it.
18. Press "*Collimator Light*" push-button to exit sub-menus. The kVp Display shows (C09).
19. Press and hold first "*Collimator Light*" push-button and then press "*kVp Increase*" push-button, release "*kVp Increase*" and then release "*Collimator Light*" in order to exit Configuration Mode.

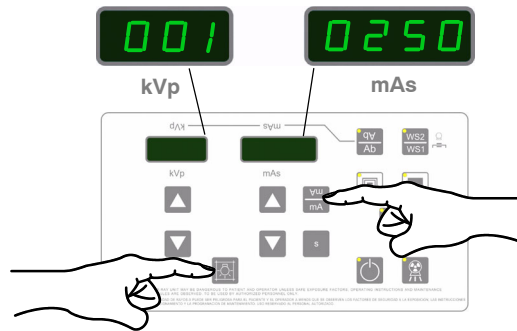
2.2.9 MAXIMUM MS FOR DIGITAL WORKSTATIONS

1. Select configuration menu C0A.
2. Enter sub-menu CA.1. The kVp Display shows (CA.1) and the mAs Display shows (2.5) (Factory set).
3. Press "*mAs Increase*" or "*mAs Decrease*" to change the value. Press "*Reset*" push-button to save value.
4. Press "*Collimator Light*" push-button to exit sub-menus. The kVp Display shows (C0A).
5. Press and hold first "*Collimator Light*" push-button and then press "*kVp Increase*" push-button, release "*kVp Increase*" and then release "*Collimator Light*" in order to exit Configuration Mode.

2.3 COUNTERS FOR SERVICE PURPOSES

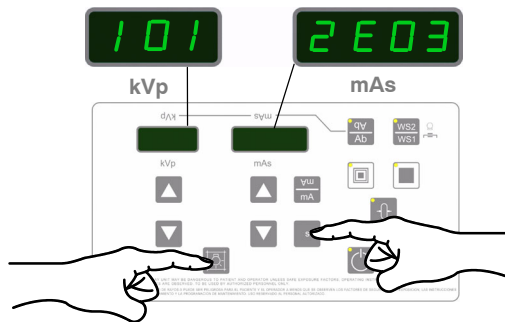
- **Exposure Counter**

To display the totalled number of performed exposures of the selected Focal Spot, press simultaneously “Collimator Light” and “mA” push-buttons, e.g. (001) (0250) = 10.250 exposures.



- **Energy Counter**

To display the totalled Energy of performed exposures of the selected Focal Spot expressed in Joules (J), press simultaneously “Collimator Light” and “s” push-buttons, e.g. (1.01) (2E03) = $1.012 \cdot 10^3$.

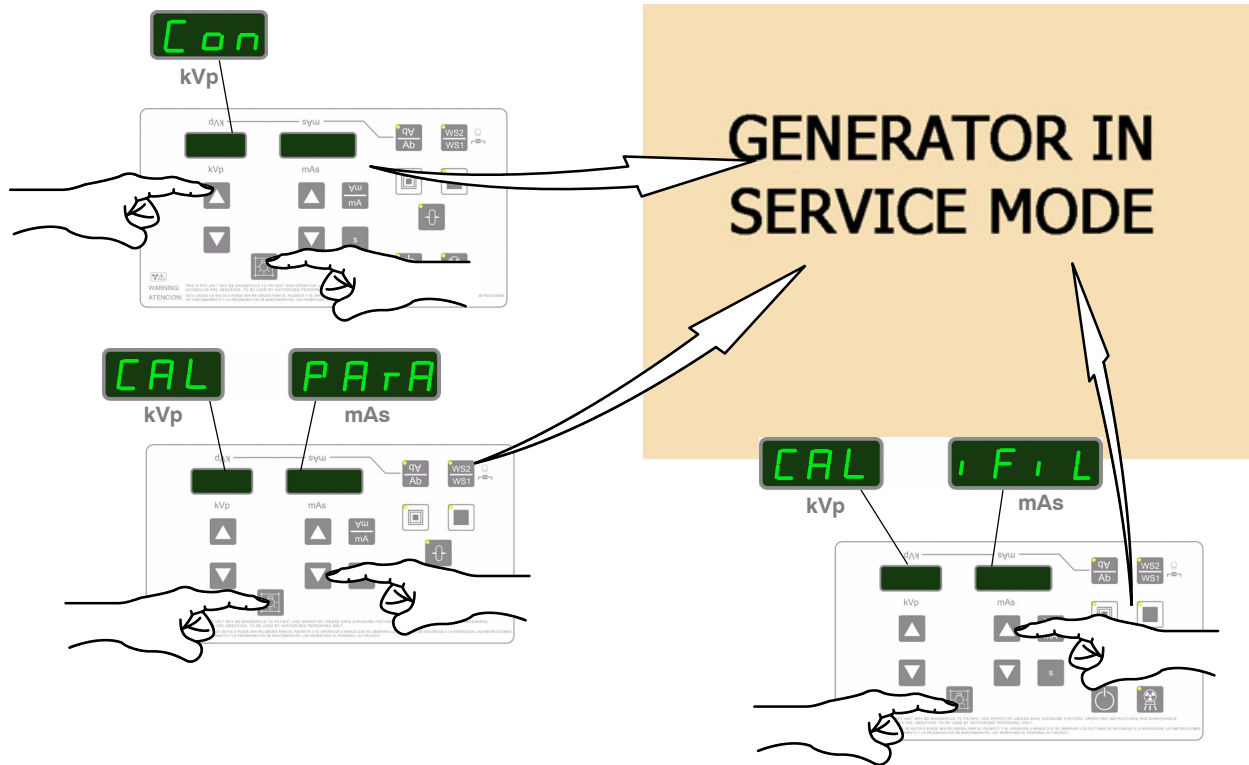


To reset the Exposure Counter value (totalled number of exposures) and the Energy counter (totalled Energy) for both Focal Spots, press and hold simultaneously “Reset”, “Collimator Light” and “mA” or “s”, equally.

2.4 SERVICE APPLICATIONS IN THE TOUCH SCREEN CONSOLE

The configuration and calibration processes are the same for all the Portable X-ray Units but some units with Trolley incorporate a Touch Screen that displays information in a different way.

When the Unit is being configured or calibrated, the touch screen displays:



In order to access to the Service Applications in the touch screen, touch the button "Service Mode" and insert the password "2434".

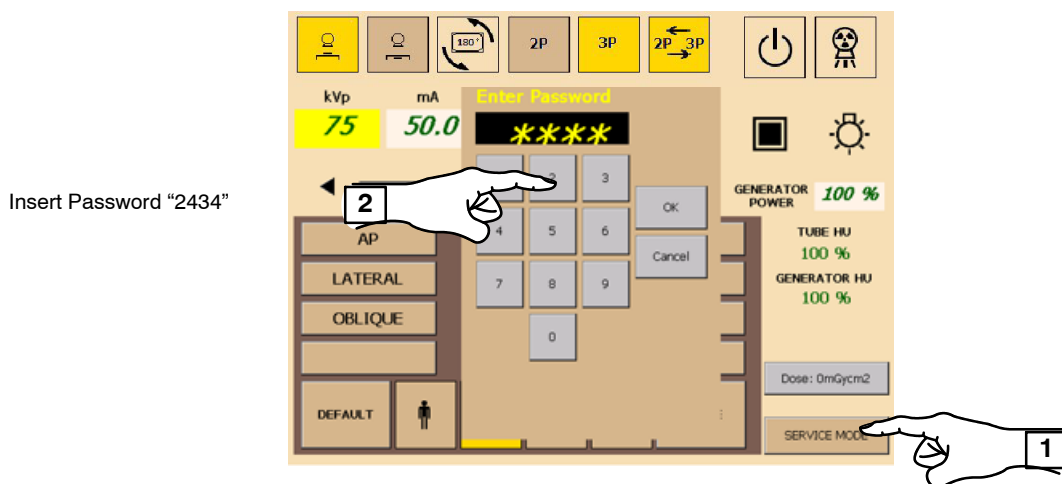


Illustration 2-1

Service Applications in the Touch Screen console

Once inside the Touch Screen Service Mode, the following is displayed:

The screenshot shows the Touch Screen Service Mode interface with the following callouts:

- COUNTERS**: Access to Counters Screen. See below.
- ERROR LOG**: Access to Error Log Screen. See below.
- LANGUAGE**: Selects the language (English, Russian, Spanish).
- BackUp CAL Data**: Performs a Backup copy in the Selected Drive.
- Restore CAL Data**: Restores the calibration data from the FFSDISK (it is like C:/ in a PC).
- BackUp APR Files**: Performs a Backup copy of the APR in the Selected Drive.
- CLOSE APPLICATION**: Closes the RAD program. It is used to access to the OS of the Unit. **ONLY TRAINED STAFF should TOUCH this button. The only way to run the application again is to enter in mydevice/FFSDISK/SEDECAL.EXE**
- EXIT**: Exit from Service Mode.
- Generator type**: HILMAN 8 KW (dropdown menu).
- Dosemeter**: Activates the Dose reading when installed a Dosimeter.
- Buzzer**: Turns ON/OFF the buzzer for errors.
- System Information**: Software Version: VIR3.2, Generator Version: YQ1R01.08, Generator Serial Number: PKL10077.

Counters Screen

The Counters Screen displays the following data:

GENERATOR		TUBE	
RAD Exp. (#)	136	Large	71
		Small	1
RAD Energy (J)	1.643E+05	Large	9.635E+04
		Small	4.176E+01
RAD mAs (mAs)	2.552E+03	Large	1.419E+03
		Small	9.280E-01
Ex. Time (h.m)	Large: 0.09, Small: 0.00	Large	0.03
Col. Time (h.m)	0.15	Small	0.00

Buttons: Refresh, Reset, Exit.

Updates all counters
Resets all counters
Back to Touch Screen Service Mode Screen

Error Log Screen

#	Code	Date	Time	Description
1	039	07-04-2010	17:17:51	Power supply error.
2	041	07-04-2010	17:12:00	Unbalanced mA.
3	033	07-04-2010	10:32:53	Communication error.
4	033	06-04-2010	16:09:36	Communication error.
5	033	06-04-2010	15:57:06	Communication error.
6	033	06-04-2010	15:54:18	Communication error.
7	033	06-04-2010	15:13:32	Communication error.

Buttons: Clear, Export, Exit.

Erases all Error info
Exports a file in CSV format to the SD or FFSDISK
Back to Touch Screen Service Mode Screen

Illustration 2-2
Backup APR files - Backup Calibration Data

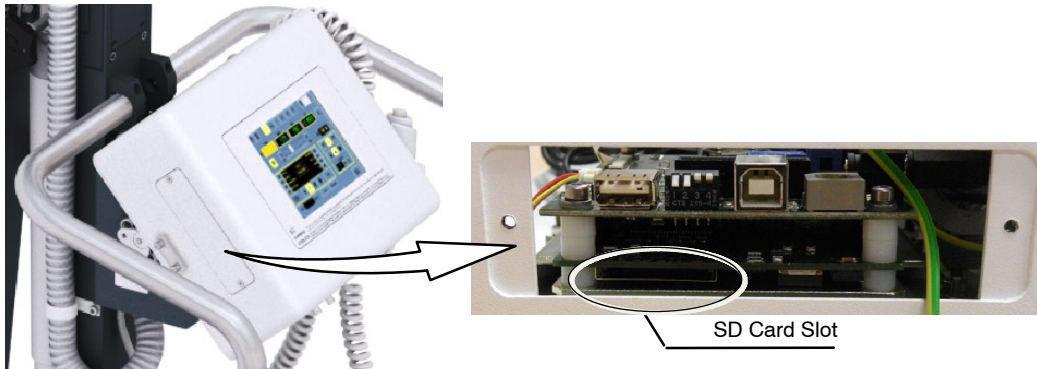
In this case, the first storage device that the unit points is the USB Drive. The User can store the backup file in any drive.

The illustration is divided into three main parts:

- Physical Unit:** A photograph of the portable X-ray unit with callouts for the 'USB drive' and 'SD drive' located inside the front panel.
- Software Interface - Backup APR Files:** A screenshot of the main menu with the 'BackUp APR Files' button highlighted. A 'Sedocal' dialog box is open, displaying a list of files to be copied: EnglishAPR.ini, EnglishAPRbckUp.ini, RussianAPR.ini, RussianAPRbckUp.ini, SpanishAPR.ini, and SpanishAPRbckUp.ini. Buttons for 'Yes' and 'No' are visible.
- Software Interface - Backup CAL Data:** A screenshot of the main menu with the 'BackUp CAL Data' button highlighted. A 'Save As' dialog box is open, showing the file name 'CalData.txt' and the file type 'Archivos de texto (*.txt)'. The save location is 'VStorage Card'.
- Software Interface - Restore CAL Data:** A screenshot of the main menu with the 'Restore CAL Data' button highlighted. An 'Open' dialog box is open, showing the file 'eCalData.txt' in the 'VFFSDISK' location. The file name 'CalData.txt' and type 'Archivos de texto (*.txt)' are also visible.

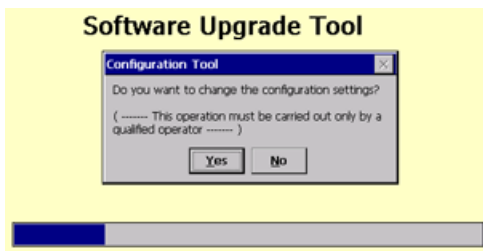
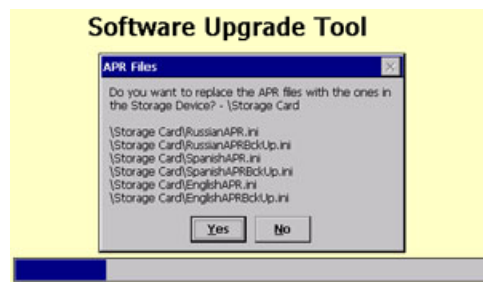
Illustration 2-3
Restoring Data from a SD

Turn the Unit off, insert a SD card in the Slot and turn the Unit ON. The Software Upgrade Screen appears requesting to replace the files found in the SD.



The software will request to replace the files found in the SD in the following order:
(Whenever the SD contains one or all of the following files):

- 1.- Software Upgrade
- 2.- APR files
- 3.- Configuration

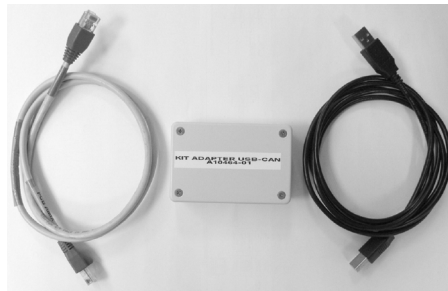


2.5 SERVICE APPLICATIONS IN THE 3P CONSOLE

2.5.1 CONSOLE AND GENERATOR SOFTWARE UPDATE

In order to update the Generator and Console Software, it is required to use a Laptop and a Software update kit, and to follow the steps below.

1. First, install the Downloader, which is an application used to obtain the files to update the Generator and Console Software.
 - a. Connect the USB-CAN Adapter to the USB port of the Computer and wait for it to recognize the hardware.



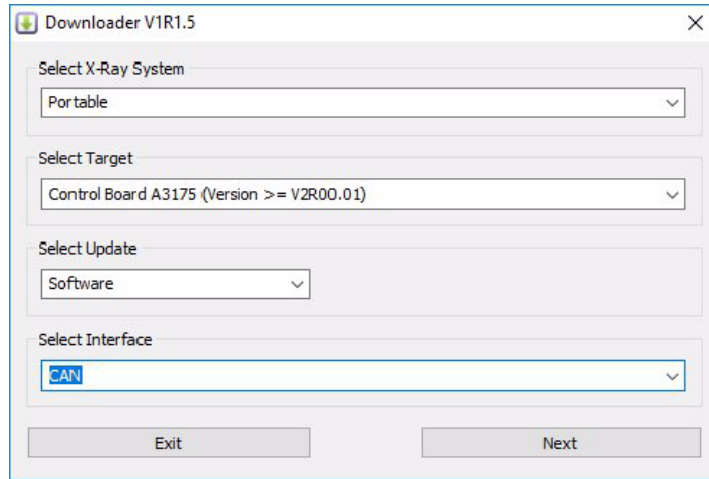
- b. For Windows XP: install the drivers from specific location and choose the folder SEDECAL USB-CAN (Driver) FTDI 2.04.06, for both USB Serial Port drivers.
For Windows 7 and up: the drivers are directly recognized and installed.
 - c. Connect the RJ45 cable from the Adapter to the CAN port located at the bottom front side of the 3P Console.



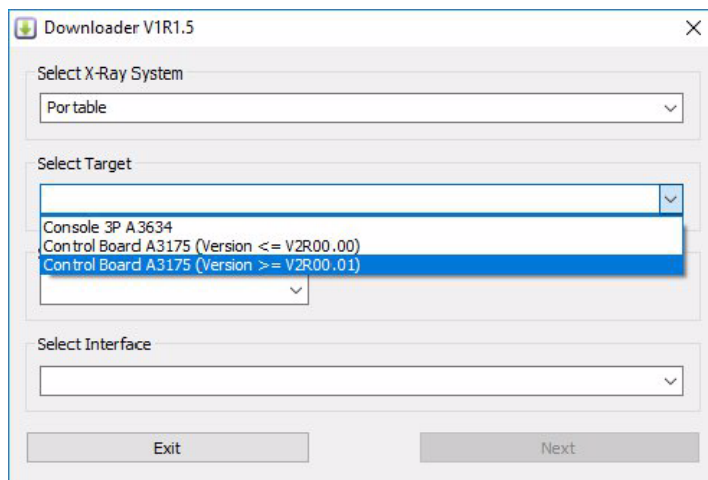
BEFORE INSTALLING THE DOWNLOADER, CHECK ANY PREVIOUS VERSIONS OF THE DOWNLOADER AND UNINSTALL IT.

- d. Then, start the Downloader installation. Execute the Setup.exe; if it cannot be opened, install Framework from the file Dotnetfx40_full_x86_x64.exe, and execute again Setup.exe. It is recommended to install the downloader in the default path.
2. After a successful installation, start the Software Downloader by pressing the “*Software Update*” button.

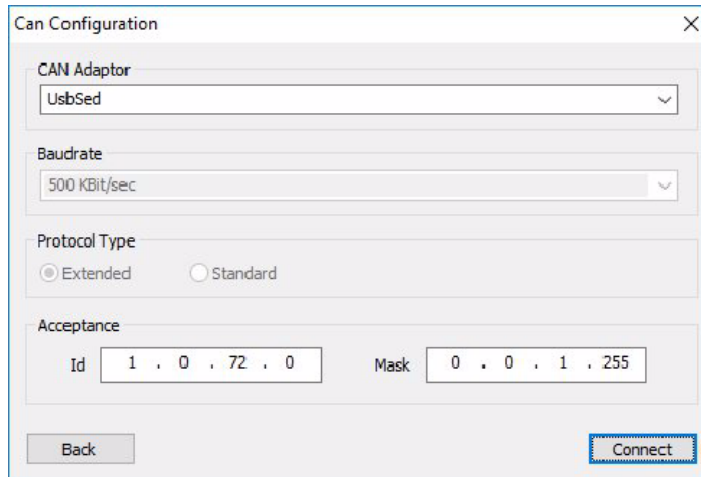
3. Select to update the Portable X-Ray System.



4. Select to update the Control Board (Generator) or the Console, and click on "Next".



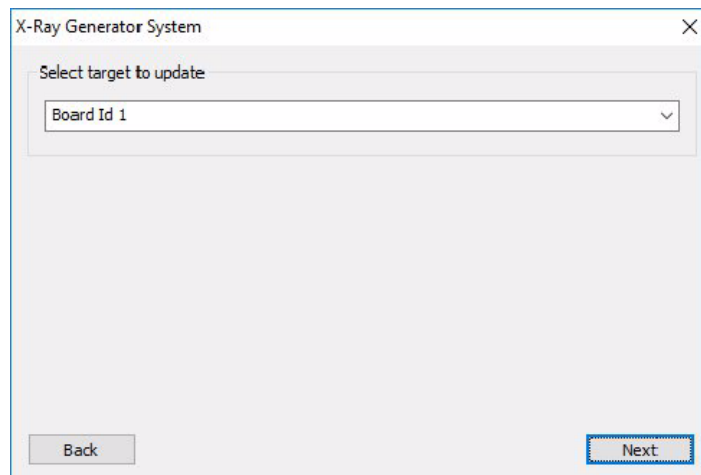
- In the *Can Configuration* screen click on “*Connect*”.



The screenshot shows a dialog box titled "Can Configuration" with a close button (X) in the top right corner. It contains the following fields and controls:

- CAN Adaptor:** A dropdown menu with "UsbSed" selected.
- Baudrate:** A dropdown menu with "500 KBit/sec" selected.
- Protocol Type:** Two radio buttons: "Extended" (selected) and "Standard".
- Acceptance:** Two input fields: "Id" with the value "1 . 0 . 72 . 0" and "Mask" with the value "0 . 0 . 1 . 255".
- Buttons:** "Back" and "Connect" (highlighted with a blue dashed border).

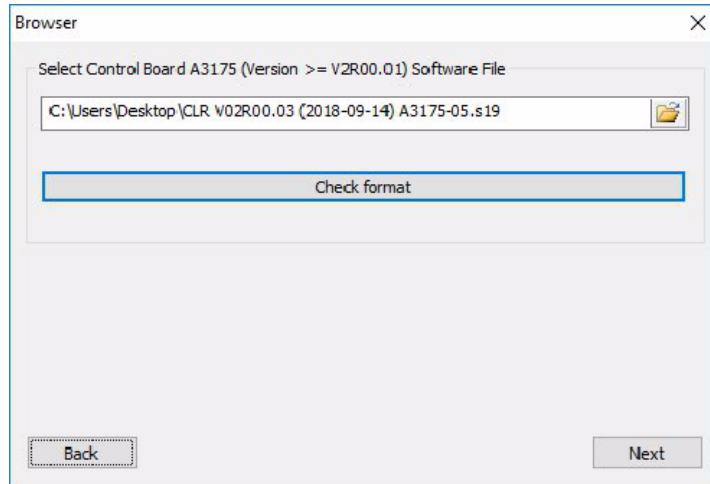
- In case an error window appears on the screen, unplug and plug again the USB cable from the computer to the Adapter, and accept to close the error window. Then, click on “*Connect*”.
- In the *X-Ray Generator System* screen click on “*Next*”.



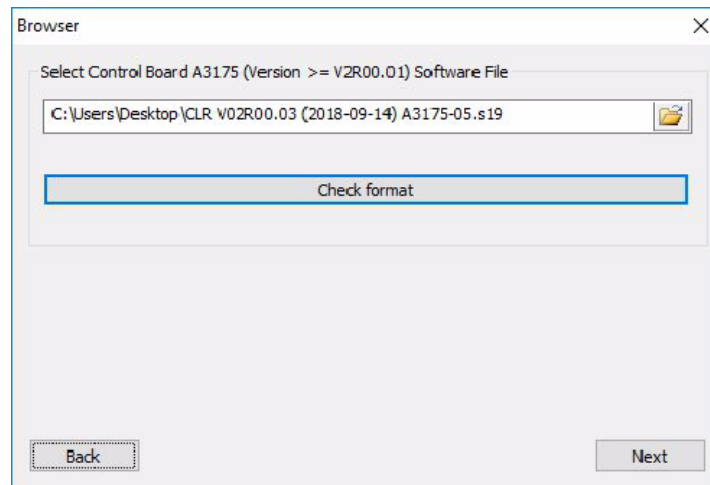
The screenshot shows a dialog box titled "X-Ray Generator System" with a close button (X) in the top right corner. It contains the following fields and controls:

- Select target to update:** A dropdown menu with "Board Id 1" selected.
- Buttons:** "Back" and "Next" (highlighted with a blue dashed border).

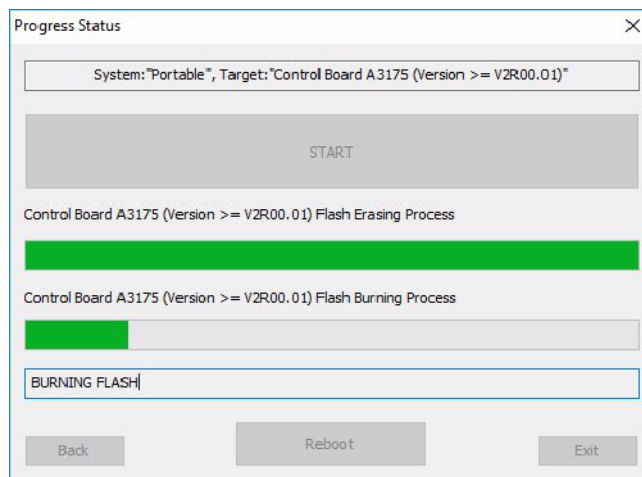
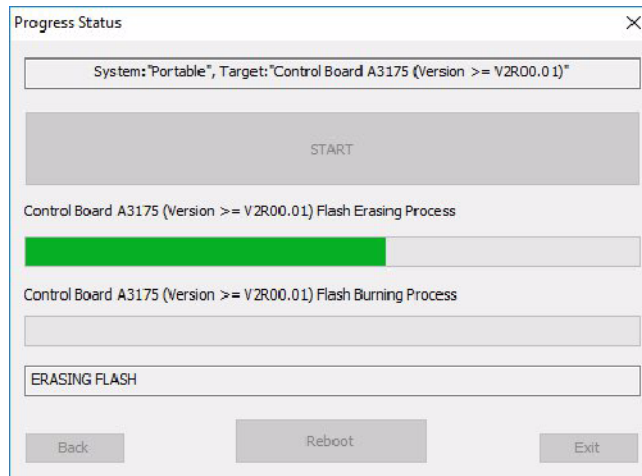
8. To select the file to be downloaded, browse for the .s19 file and open it.



9. Click on "Check Format" and then click on "Next".



- Click on “Start” to begin the software update downloading. Wait until the “SUCCESS!” message is displayed.
If the Generator has been updated and now it is the turn of the Console update (or vice versa), click on “Back” to get the first step of the process and start it again.



Note 

If software update is interrupted before finishing the process, remove the W6 jumper from the A3175-05 PCB and reset the Generator. The equipment will not complete the start up process, as it will be ready for the software update. Then, repeat the whole process. Don't forget to install again the jumper previously removed once the software update is finished.

2.5.2 APR FILES UPDATE

To download the APR Files (.txt), they have to be sent line by line with a 500 ms delay in between. Follow the steps below.

1. Configure the serial port as 19200 8-N-1 (without flow control).
2. Set the ASCII Configuration (File/Properties/Configuration/ASCII Configuration) as follows:
 - a. Send Line Feed with Carriage Return: YES.
 - b. ECO Local characters: YES.
 - c. Line delay: 500 ms.
 - d. Accept the changes.
3. Place a standard Serial Cable (crossed) between the PC or Laptop and the DB9 located on the left side of the 3P Console.
4. Connect the Serial Port of the HyperTerminal.
5. Download the APR file (Transfer / Send Text File => Browse for the file => Click on open).

To extract the APR Files (.txt) present in the unit, follow the steps below.

1. Use the HyperTerminal again (refer to steps 1., 2., 3. and 4. above).
2. Type the command APR? and press ENTER.
3. The unit will answer with all the APR techniques.
4. Copy all the lines and paste them in a NotePad page.
5. Remove the characters appearing before APR line by line. Do not forget to press ENTER after the last line of the document and save the file.

SECTION 3 CALIBRATION



Calibration procedures should only be performed at field if Portable Control Board, Control Driver Board, the High Voltage Transformer are replaced, the EEPROM memory is re-initialized, or otherwise specified.



Previous to starting the Calibration procedure, restore default power values, that is, no restrictions will be set due to the Line Power Detection System (refer to the ending of Section 5.1), and check that the line complies with the Portable X-ray Unit power requirements (refer to Section 1.2).

The Calibration process is as follows:

CALIBRATION PROCESS		
STEP	ACTION	COMMENTS
1	Connection of the Oscilloscope for kVp and mA measurements.	Preliminary Steps (Refer to Section 3.1)
2	Preliminary calibration of Filament Current.	20 mA in Large Focus at 40 kVp and 80 kVp. (Refer to Section 3.2.1).
3	Calibration of kVp Gain.	P01 (Refer to Section 3.2.2).
4	Calibration of mA Gain.	P02 (Refer to Section 3.2.3).
5	Autocalibration.	If the Autocalibration process is done properly, the Calibration is finished. If not, perform the Manual Calibration of the Filament Current (step 6). (Refer to Section 3.2.4).
6	Manual Calibration of Filament Current.	To be performed only when the Autocalibration did not work properly. All mA stations in Small Focus and Large Focus at 80 kVp, 40 kVp and 110 kVp. (Refer to Section 3.2.5).

Note

The kV values to be selected in Calibration Mode are: 40, 80 and 110 kVp depending on the maximum kVp of the Unit.

3.1 PRELIMINARY STEPS



1. Connect Oscilloscope CH1 to measure kVp in the following points:

	TEST Connector (J4) of the X-ray Power Unit	Portable Control Board (A3175-05)	kVp relation
kVp	J4-1	TP22	1 V = 30 kVp
GND	J4-5	TP5	
<i>Note: If the unit is not provided with TEST Connector (J4), kVp has to be measured directly on the Portable Control Board TPs (e.g. upgraded units)</i>			

Oscilloscope CH1 can be also connected on Control Driver Board (A3189-07) but the access is more complicated:

	Control Driver Board (A3189-07)	kVp relation
kVp	TP15	1 V = 30 kVp
GND	TP4 or TP14	

2. Connect Oscilloscope CH2 to measure mA in the following points:

	TEST Connector (J4) of the X-ray Power Unit	Portable Control Board (A3175-05)	mA relation
mA	J4-6	TP21	1 V = 25 mA
GND	J4-5	TP5	
<i>Note: If the unit is not provided with TEST Connector (J4), mA has to be measured directly on the Portable Control Board TPs (e.g. upgraded units)</i>			

Oscilloscope CH2 can be also connected on Control Driver Board (A3189-07) but the access is more complicated:

	Control Driver Board (A3189-07)	mA relation
mA	TP9	1 V = 10 mA
GND	TP4 or TP14	

3. Configure CH1 in 1V/div and CH2 in 0.2V/div. Time base in 5 ms/div; trigger in Normal mode by positive edge of CH1.
4. kVp and mA relation, measured in the Oscilloscope, is indicated in previous tables.



Whenever an exposure is performed during the Calibration procedure (except for Autocalibration), elapse a minimum of 5 seconds between "PREP" and "EXP", this will avoid undesired loss of time.



During Calibration procedure Collimator blades must be fully closed until otherwise instructed in this manual.

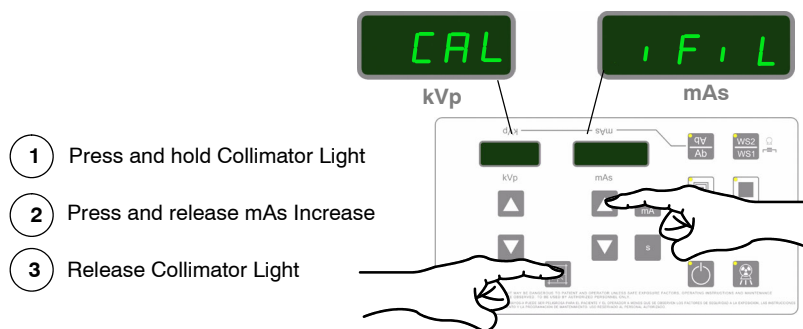
3.2 CALIBRATION OF PARAMETERS



Before calibrating kVp Gain, a calibration of the Filament Current for 20 mA in Large Focus at 40 and 80 must be performed. Refer to Section 3.2.1.

3.2.1 PRELIMINARY CALIBRATION OF FILAMENT CURRENT

1. **To enter Calibration of Filament current** press and hold “Collimator Light” push-button and then press and release “mAs Increase” push-button (two beeps sound). (CAL iFiL) appears on the displays while “Collimator Light” is pressed. Then release “Collimator Light” push-button (the kVp Display shows 40, 80 or 110 and one of the Focal Spot Leds blinks).



2. Select: 40 kVp, “Large Focal Spot” (led blinks), and 20 mA in Large Focal Spot (by pressing the mAs push-buttons). During Calibration the mAs Display shows the mA value.
3. Make an exposure and measure kVp and mA signal values with the Oscilloscope.
 - a. Verify that both signals are flat.
 - b. If the mA value obtained is not the selected, increase or decrease the filament current value (shown on the kVp Display) by pressing “mA” or “S” push-buttons.
4. Make an exposure again to verify that the mA value in the Oscilloscope is the one selected; if it is not, repeat the procedure to increase or decrease the value.

5. Once the correct mA value is reached, save the value pressing “Reset” push-button (one beep will sound and the saved value is shown on the kVp Display). It is important to write down this data for later reference during calibration (Refer to Table 3-1).

Note 

Once a value for filament current is saved, the value remains in memory for the next mA station. This feature helps to save time at entering new data for the next station.

6. Repeat above procedure to calibrate the Filament Current for 80 kVp at 20 mA in Large Focal Spot. The Filament Current value is few steps below the one calibrated for 40 kVp. (Refer to Table 3-1).

Note 

The calibration data for Filament Current should not be repeated at any station.

**Table 3-1
Calibration Data for Reference**

kVp	mA	Value	Example
40	20		810
80	20		800

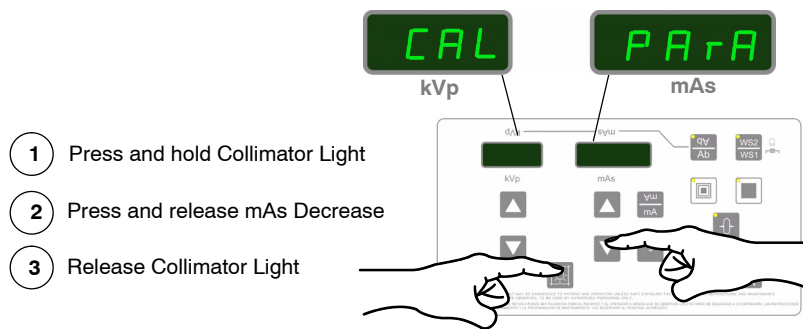
Note 

Values above 999 are shown on kVp display as “= XX”, e.g. “=23” means 1023.

7. To exit Calibration Mode, press and hold “Collimator Light” push-button and then press and release “mAs Increase” push-button (two beeps sound). Then release “Collimator Light” push-button.

3.2.2 CALIBRATION OF kVp GAIN

1. **To enter Calibration Menu**, press and hold “*Collimator Light*” push-button and then press and release “*mAs Decrease*” push-button (two beeps sound). (CAL PArA) appears on the displays while “*Collimator Light*” is pressed. Then release “*Collimator Light*” push-button. The kVp Display shows P01 and one of the Focal Spot Leds blinks.



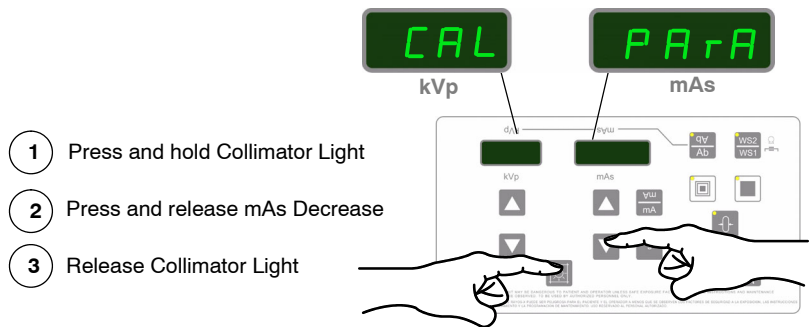
2. Press “*Collimator Light*” to enter calibration of kVp Gain (P01).
3. Place a Non-Invasive kVp meter aligned to the X-ray beam at SID 100 cm. Open the light field to center it with the kVp meter.
4. Make an exposure (parameters are automatically selected: 80 kVp, 20 mA and 100 ms), read kVp and take note of the value. Enter kVp read value in the mAs Display pressing “*mAs Increase*” or “*mAs Decrease*” push-buttons.
5. Save the value by pressing “*Reset*” push-button. The mAs Display shows kVp Gain value during two seconds (this value represents the Gain correction automatically applied, 200 is the reference value).
6. Press “*Collimator Light*” to exit menu P01.
7. To exit Calibration Mode, press and hold “*Collimator Light*” push-button and then press and release “*mAs Decrease*” (two beeps sound). Then release “*Collimator Light*” (kVp and mAs parameters are shown).

3.2.3 CALIBRATION OF mA GAIN



mA Gain should be calibrated before performing the autocalibration process.

1. **To enter Calibration Menu**, press and hold “Collimator Light” push-button and then press and release “mAs Decrease” push-button (two beeps sound). (CAL PArA) appears on the displays while “Collimator Light” is pressed. Then release “Collimator Light” push-button. The kVp Display shows P01 and one of the Focal Spot Leds blinks.

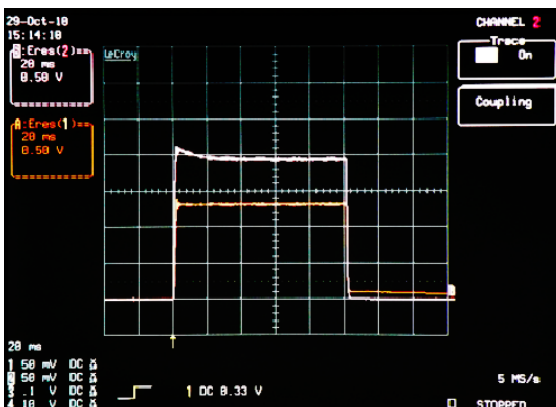


2. Select menu P02 by pressing the “kVp Increase” push-button (kVp Display shows P02).
3. Press “Collimator Light” to enter calibration of mA Gain (P02).
4. The Unit automatically selects: 40 kVp, 20 mA, 2000 ms, and Large focal Spot. Select on the kVp Display the Filament Current value (previously calibrated) by pressing “mA” or “s” push-buttons.

5. Make an exposure and measure mA signal value with the Oscilloscope. Verify that mA signal is flat, make sure that the signal is balanced before it arrives to 20 ms.

Note 

In order to display a noiseless waveform it is necessary to apply a bandwidth filter of 8 KHz when measuring any signals with the oscilloscope. Waveforms captured without the filter may be noisy.



a



b

*In these examples, the white line (upper) represents the mA Signal
The signal in both cases (a and b) is balanced before it arrives to 20 ms*

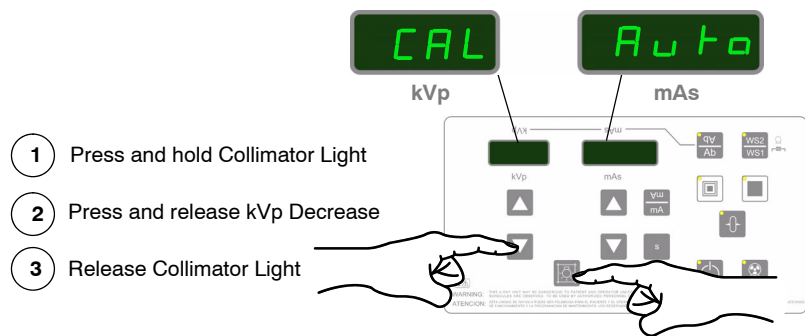
6. If the signal is not balanced before it arrives to 20 ms, change the “Ifil” (Filament Current) value with mA and s and repeat the exposure until the signal is flat before 20ms as shown in the previous picture.
7. Enter mA read value in the mAs Display pressing “mAs Increase” or “mAs Decrease” push-buttons.
8. Save the value by pressing “Reset” push-button. The mAs Display shows mA Gain value during two seconds (this value represents the Gain correction automatically applied, 200 is the reference value).
9. Press “Collimator Light” to exit menu P02.
10. To exit Calibration Mode, press and hold “Collimator Light” push-button and then press and release “mAs Decrease” (two beeps sound). Then release “Collimator Light” (kVp and mAs parameters are shown).

Note 

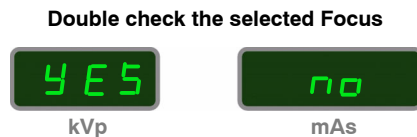
P03 and up are not used menus.

3.2.4 AUTOCALIBRATION

1. Select Large Focal Spot.
2. **To enter Autocalibration**, press and hold “Collimator Light” push-button and then press and release “kVp Decrease” push-button (two beeps sound). The text (CAL Auto) appears on the displays while “Collimator Light” is pressed. Then release “Collimator Light” push-button.



3. Double check that the Large Focal Spot Led is On. The Displays show (YES no). Press “kVp Increase” push-button to select “YES” (to select “no” and exit Autocalibration process, press “mAs Increase” push-button).



4. To start the Autocalibration process, press “Prep” and then press and hold “Exposure” with the Handswitch (or the corresponding push-buttons on the Control Console).

Be prepared to write down the Autocalibration data in Table 3-5.

The Unit starts a series of exposures, a maximum of 20 in order to start the process and a maximum of 10 in order to find each mA Station. The kVp Display shows (n20) in a countdown sequence (e.g. n19, n18, n17...), or (n10) in a countdown sequence (e.g. n9, n8, n7...) until the Unit finds all the mA Stations for that Focal Spot. It may not be needed to perform all the exposures.

Once a Station is found, a long bip sounds and kVp display shows the Calibration value for that mA Station. Then the process is paused after every kVp station calibration, and it is mandatory to release the Handswitch. Wait a few seconds (30 seconds is enough) and then press and hold the Handswitch again in order to continue with the calibration process. When all mA Stations are Autocalibrated, the Displays show (End Auto).

Note 

It is mandatory to release the handswitch and keep it released for quite a while to prevent filament overheat when many stations are to be calibrated.

5. To exit Autocalibration, press and hold "Collimator Light" push-button and then press and release "kVp Decrease" (two beeps sound). Release "Collimator Light".
6. Repeat the process for Small Focal Spot.

Note 

If any error message (e.g. E60) stops the Autocalibration during the process, press "Reset" push-button and continue. If the error persists, exit Autocalibration and repeat the Autocalibration process from the beginning. If the problem persists, contact the Manufacturer.

If the troubles arise at the end of the Autocalibration process (only a few stations to end), press "Reset" push-button and continue. If it does not work, press "Reset" push-button to store the data corresponding to the previously autocalibrated mA stations and start the Manual Calibration process for the remaining stations (Refer to section 3.2.5). If the problem still persists, contact the Manufacturer.



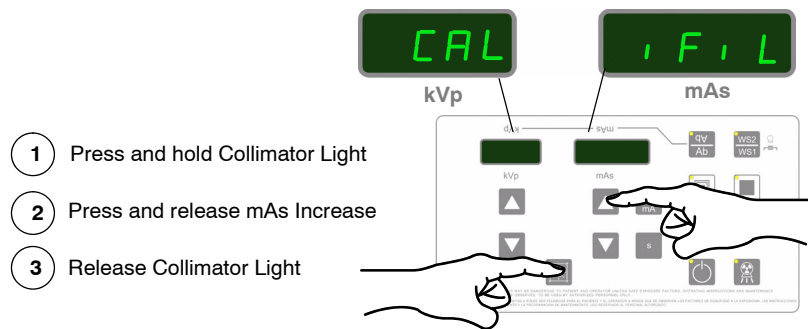
IF THE DIP-SWITCH SW1-1 OF THE PORTABLE CONTROL BOARD HAS BEEN SET IN "ON" POSITION TO ENABLE SERVICE MODE, DO NOT FORGET TO SET IT IN "OFF" POSITION (SERVICE MODE DISABLED) ONCE THE CALIBRATION IS FINISHED.

3.2.5 MANUAL CALIBRATION OF FILAMENT CURRENT (SMALL AND LARGE FOCAL SPOTS)

Note 

Perform this Manual Calibration only when the Autocalibration process has not finished properly.

1. **To enter Calibration of Filament current** press and hold “Collimator Light” push-button and then press and release “mAs Increase” push-button (two beeps sound). (CAL iFiL) appear on the displays while “Collimator Light” is pressed. Then release “Collimator Light” push-button (the kVp Display shows 40, 80 or 110 and the selected Focal Spot Led blinks).



2. Select the corresponding Focal Spot. The Led blinks.
3. Select the corresponding kVp value where the Autocalibration stopped (40, 80 or 110 kVp) pressing “kVp Increase” or “kVp Decrease” push-buttons, and the corresponding mA Station where the Autocalibration stopped by pressing the mAs push-buttons.

Note 

Values above 999 are shown on mAs display as “= XX”, e.g. “=23” means 1023.

4. Make an exposure and measure kVp and mA signal values with the Oscilloscope.
 - a. Verify that both signals are flat.
 - b. If the mA value obtained is not the selected, increase or decrease the filament current value (shown on the kVp Display) by pressing “mA” or “s” push-buttons.

5. Make an exposure again to verify that the mA value in the Oscilloscope is the one selected; if it is not, repeat the procedure from step 4.b. to increase or decrease the value.
6. Once the correct mA value is reached, save the value pressing "Reset" push-button (one beep will sound and the saved value is shown on the kVp Display). It is important to write down this data for later reference during calibration (refer to Table 3-5).

Note 

Once a value for Filament Current is saved, the value remains in memory for the next mA station. This feature helps to save time at entering new data for the next station.

7. Repeat above procedure to calibrate the Filament Current for the following kVp station and the non calibrated mA stations, in the corresponding Focal Spot. The Filament Current value is few steps above the one calibrated before (refer to Table 3-5).

Note 

Values above 999 are shown on mAs display as "=XX", e.g. "=23" means 1023.

8. To exit Calibration Mode, press and hold "Collimator Light" push-button and then press and release "mAs Increase" push-button (two beeps sound). Then release "Collimator Light" push-button.

Note 

At the end of the Filament Current calibration process there are some stations that do not admit exposure, in those cases enter manually the value following the trend. (Refer to Table 3-2 as an example).



KEEP IN MIND THAT ALL FILAMENT CURRENTS SHOULD HAVE A VALUE, EVEN THE ONES OUT OF RANGE (EXPOSURES NOT ALLOWED). IN THOSE CASES A CONTINUOUS BEEP WILL SOUND AND THE VALUES ON THE DISPLAYS BLINK.



IF THE DIP-SWITCH SW1-1 OF THE PORTABLE CONTROL BOARD HAS BEEN SET IN "ON" POSITION TO ENABLE SERVICE MODE, DO NOT FORGET TO SET IT IN "OFF" POSITION (SERVICE MODE DISABLED) ONCE THE CALIBRATION IS FINISHED.

Table 3-2
Example of manual calibrated data for Filament Current in a 4 kW Unit.

	mA Stations	40 kVp	80 kVp	110 kVp
SMALL FOCAL SPOT	5 mA	591	580	577
	6.4 mA	603	592	589
	8 mA	612	603	598
	10 mA	621	613	610*
	12.5 mA	630	623*	-
	16 mA	642	634*	-
LARGE FOCAL SPOT	5 mA	734	726	724
	6.4 mA	748	739	737
	8 mA	760	754	752
	10 mA	772	766	764
	12.5 mA	785	778	776
	16 mA	799	792	790
	20 mA	814	805	802
	25 mA	829	819	816
	32 mA	848	836	829
	40 mA	864	849	842*
	50 mA	881	866	-
	64 mA	902	882*	-
	80 mA	921	900*	-
	100 mA	942	942*	-

*NOTE: Some of the values with * should be entered manually following the numeric trend, the values with - are not calibrated.*

Table 3-3
Example of manual calibrated data for Filament Current in a 5 kW Unit.

	mA Stations	40 kVp	80 kVp	110 kVp
SMALL FOCAL SPOT	5 mA	591	580	577
	6.4 mA	603	592	589
	8 mA	612	603	598
	10 mA	621	613	610*
	12.5 mA	630	623*	-
	16 mA	642	634*	-
LARGE FOCAL SPOT	5 mA	734	726	724
	6.4 mA	748	739	737
	8 mA	760	754	752
	10 mA	772	766	764
	12.5 mA	785	778	776
	16 mA	799	792	790
	20 mA	814	805	802
	25 mA	829	819	816
	32 mA	848	836	829
	40 mA	864	849	842
	50 mA	881	866	873*
	64 mA	902	882*	-
	80 mA	921	900*	-
	100 mA	942	942*	-

*NOTE: Some of the values with * should be entered manually following the numeric trend, the values with - are not calibrated.*

Table 3-4

Example of manual calibrated data for Filament Current in a 8 kW Unit.

	mA Stations	40 kVp	80 kVp	110 kVp
SMALL FOCAL SPOT	5 mA	612	602	598
	6.4 mA	624	613	610
	8 mA	631	622	-
	10 mA	640	630*	-
	12.5 mA	651	640*	-
LARGE FOCAL SPOT	5 mA	751	744	742
	6.4 mA	767	756	752
	8 mA	778	768	767
	10 mA	789	780	780
	12.5 mA	801	793	793
	16 mA	817	809	808
	20 mA	831	825	822
	25 mA	844	838	835
	32 mA	861	853	851
	40 mA	874	867	864
	50 mA	891	883	879
	64 mA	912	900	897
	80 mA	929	917	913*
	100 mA	949	934	-

*NOTE: Some of the values with * should be entered manually following the numeric trend, the values with - are not calibrated.*

Note 

It is suggested to write down the Autocalibration or Manual Calibration data in the table below. Keep in mind that pressing “mA” to check a value, the data will be increased in 1 point.

Example: in order to read the Calibration value for 80 kVp, 25 mA and Large Focal Spot, press “kVp Increase/Decrease” push-buttons to select 80 kVp, press “mAs Increase/Decrease” to select 25 mAs and then press “mA”. If the kVp Display shows 802, the correct value is 801. To check the following mA station, **press twice** “mAs Increase” and once “mA”. If the kVp Display shows 824, the correct value is 823.

**Table 3-5
Filament Current Manual Calibration Data**

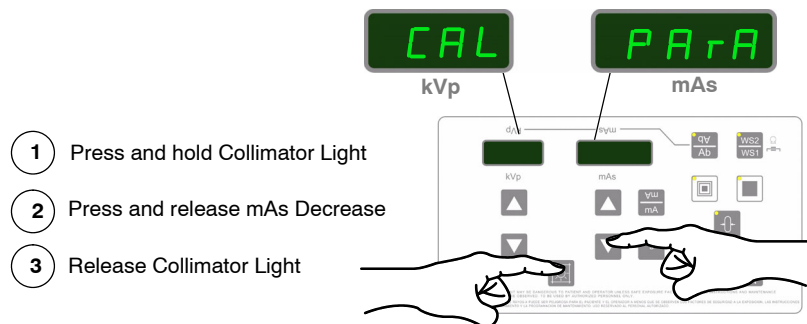
	mA Stations	40 kVp	80 kVp	110 kVp
SMALL FOCAL SPOT	5 mA			
	6.4 mA			
	8 mA			
	10 mA			
	12.5 mA			
	16 mA			
LARGE FOCAL SPOT	5 mA			
	6.4 mA			
	8 mA			
	10 mA			
	12.5 mA			
	16 mA			
	20 mA			
	25 mA			
	32 mA			
	40 mA			
	50 mA			
	64 mA			
	80 mA			
100 mA				
<p><i>NOTE: Based on tables above, some of the values with * should be entered manually following the numeric trend, and values with - are not calibrated.</i></p>				

3.2.6 MANUAL MODIFICATION OF kVp GAIN AND mA GAIN

Note

In some situations in which it is difficult to perform the calibration of kVp Gain and/or mA Gain or when the value is already known, these values can be manually set.

1. **To enter Calibration Menu**, press and hold “Collimator Light” push-button and then press and release “mAs Decrease” push-button (two beeps sound). (CAL PArA) appears on the displays while “Collimator Light” is pressed. Then release “Collimator Light” push-button. The kVp Display shows P01 and one of the Focal Spot Leds blinks.



Note

In case you have to manually modify the mA Gain instead of the kVp Gain, select menu P02 by pressing the “kVp Increase” push-button (kVp Display shows P02).

2. Press any “Focal Spot” push-button to check the current Gain value (kVp or mA Gain), it is displayed on the mAs display for a couple of seconds.
3. Press “mAs Decrease” or “mAs Increase”, to set the new value.
4. Press “Reset” push-button to save the value, a long beep sounds.
5. Exit Calibration by pressing and holding “Collimator Light” push-button and then press and release “mAs Decrease” (two beeps sound). Then release “Collimator Light” (kVp and mAs parameters are shown).

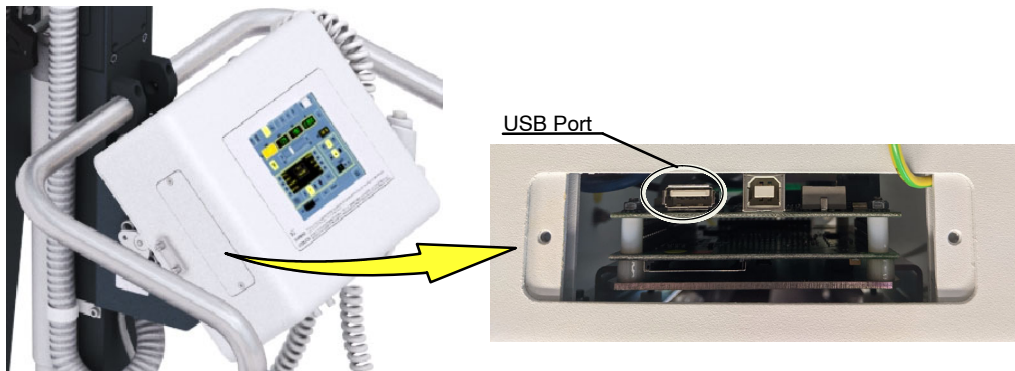


IF THE DIP-SWITCH SW1-1 OF THE PORTABLE CONTROL BOARD HAS BEEN SET IN “ON” POSITION TO ENABLE SERVICE MODE, DO NOT FORGET TO SET IT IN “OFF” POSITION (SERVICE MODE DISABLED) ONCE THE CALIBRATION IS FINISHED.

3.3 TOUCH SCREEN CONSOLE CALIBRATION

Follow the steps below to calibrate the Touch Screen Console.

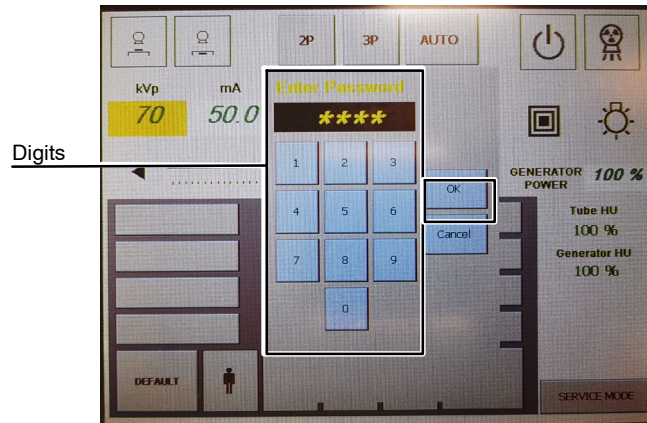
1. Open the lateral window located at the Control Module of the Unit to access the USB port.



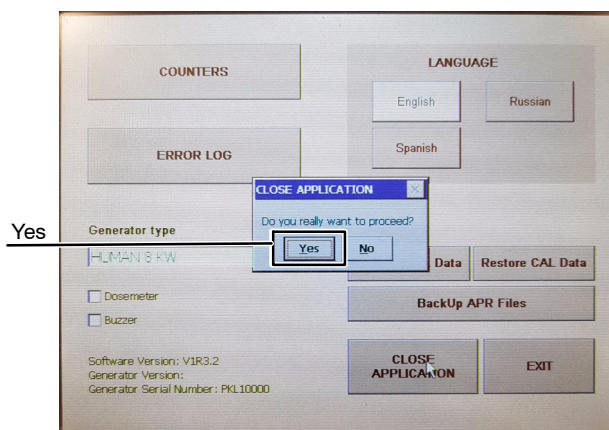
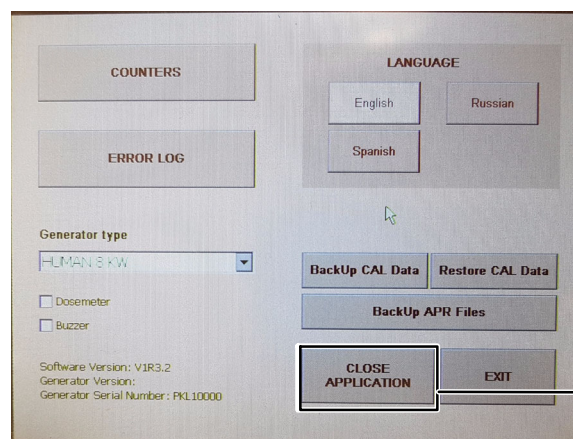
2. Connect a Keyboard to the USB Port.
3. Press the TAB key until a dotted line box appears in the "Service Mode" button, and then press the space bar.



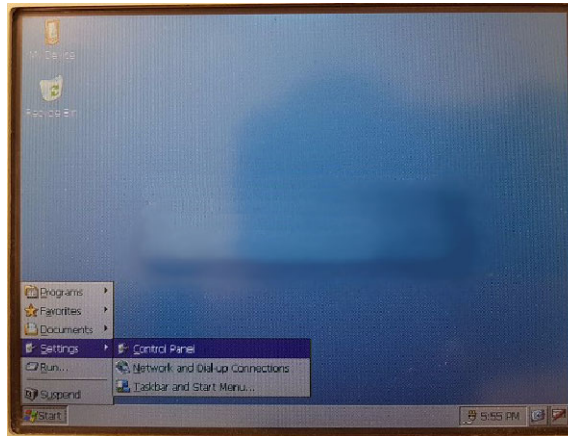
4. Scroll through the digits with the TAB key or the arrow keys, and pressing the space bar, enter the password 2434. Then, press "OK".



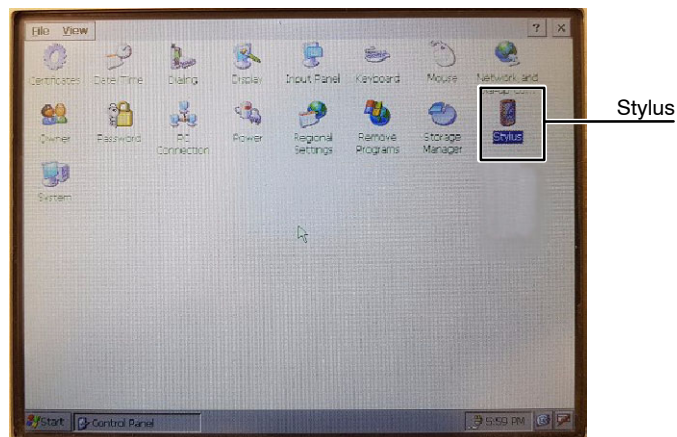
5. Scroll through the Service Mode buttons with the TAB key and pressing the space bar, select "Close Application" (Close Application). Confirm the action in the next window ("Yes").



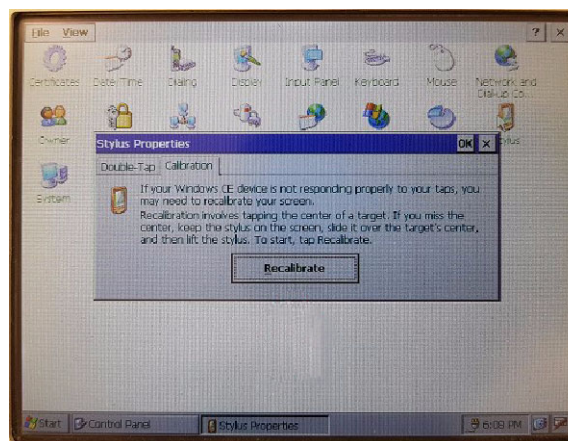
6. Press the Windows key on the keyboard and with the arrow keys select “Control Panel” and press the ENTER key to open the “Control Panel” window.



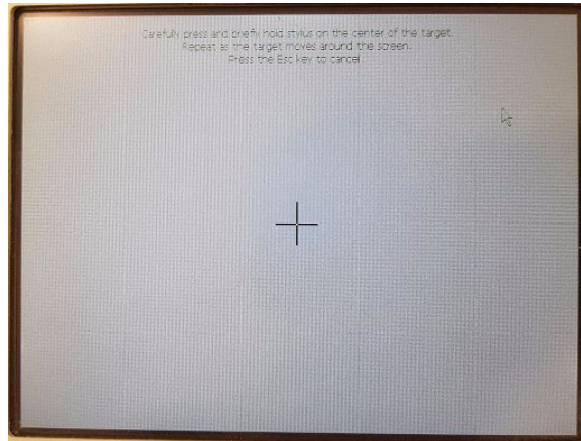
7. Select the “Stylus” icon and press the ENTER key. The application to calibrate the Touch Screen Console will be opened.



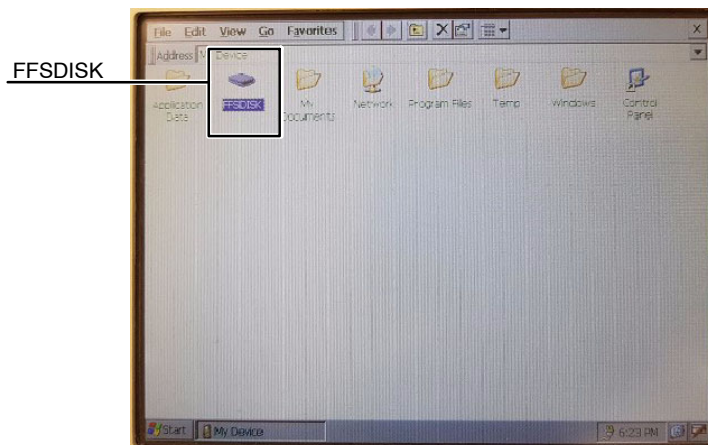
8. Press the TAB key to select the tab “Double-Tap” and press the right arrow key to open the tab “Calibration”. Press the TAB key again to select the option “Recalibrate” and press the ENTER key to run the tool.



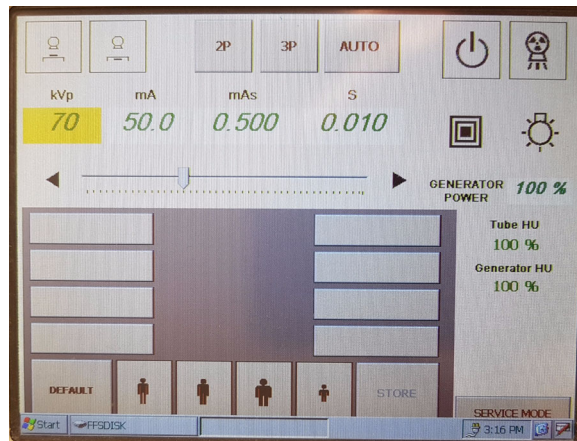
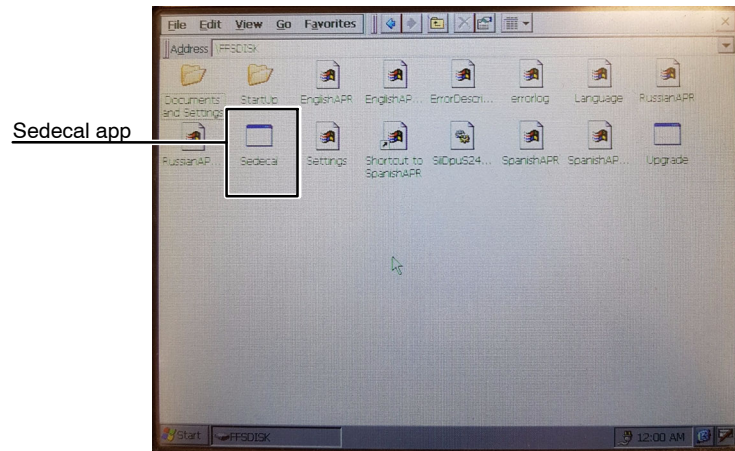
9. Following the instructions shown on the screen, press and hold on the center of the target with the pencil and repeat as the target moves around the screen. Once finished, press the ENTER key to save the new calibration. The Touch Screen is now calibrated.



10. Close the Calibration tool and the "Control Panel". Then, open the folder "My Device" located on the Desktop, and the folder "FFSDISK", by double clicking on the corresponding icons.



11. Open the application “*Sedecal*” with a double click.



12. Once opened, restart the X-Ray Unit in order to restore the correct display of the application.
13. Disconnect the keyboard and install the lateral window cover of the X-Ray Unit Control Module.

SECTION 4 ADJUSTMENTS

4.1 ALIGNMENT OF X-RAY BEAM

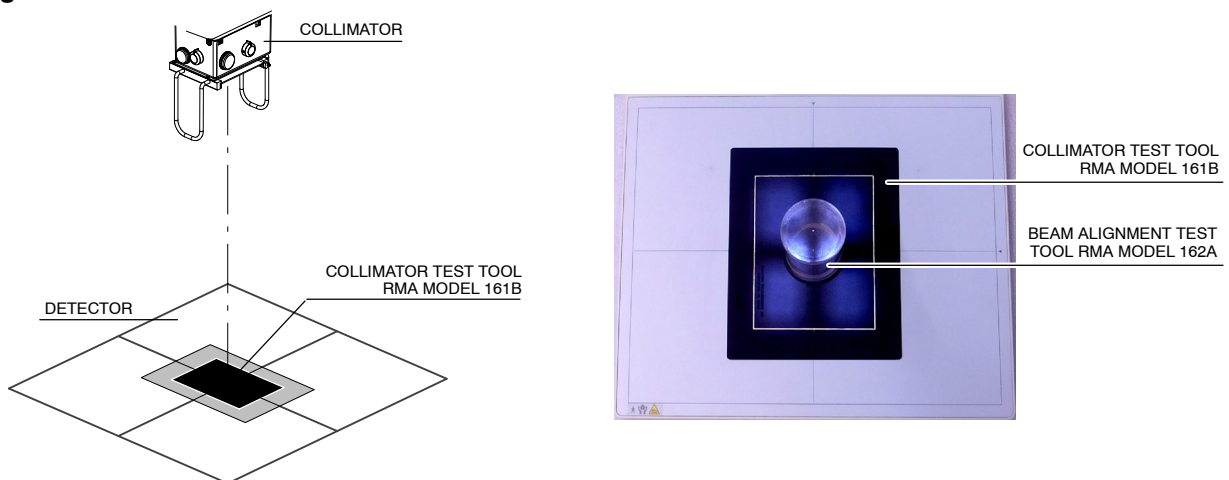
1. Place the Portable Unit in vertical position. The Unit has to be perfectly aligned with the Receptor. With a level, check the correct horizontal position of both parts.

Note 

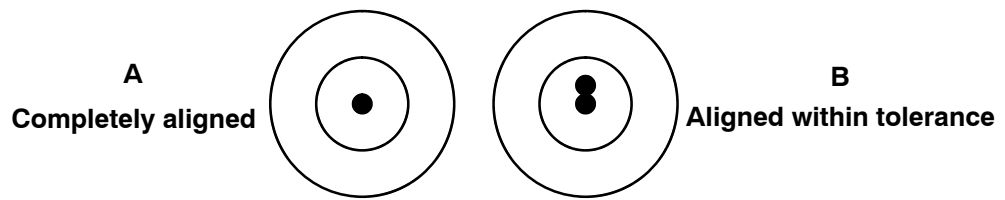
The Receptor used for testing can be located on the floor or a Table.

2. Place SID at 100 cm.
3. Turn on Collimator light and center the Collimator in relation to the Receptor. Horizontal and transverse position of the light axes projected by the Collimator Light must be in line with the Receptor axes.
4. Set the Collimator Test Tool (RMI model 161B) in transversal direction with respect to the Collimator, centered on the Receptor (*refer to Illustration 4-1*).
5. Turn on Collimator light and adjust the Light Field of the Collimator Light to the rectangle drawn inside the Collimator Test Tool.
6. Place centered the Beam Alignment Test Tool (RMI model 162A) on the Collimator Test Tool.

Illustration 4-1
Alignment Test Tools

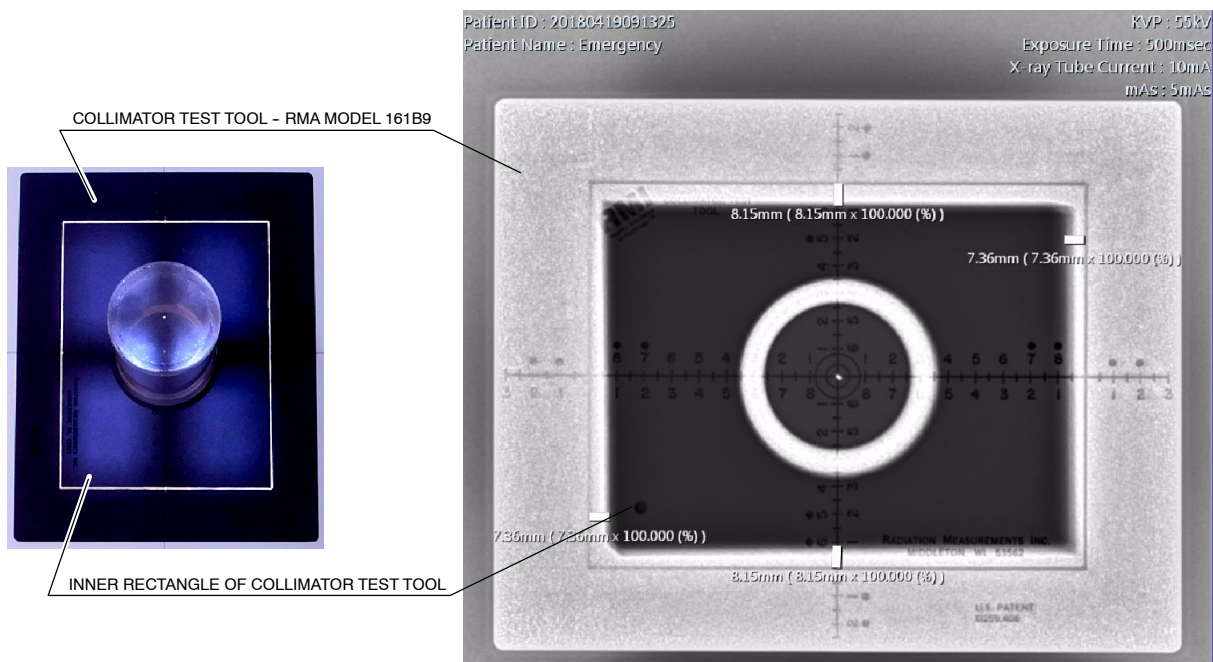


7. Make an exposure at 55 kVp / 5 mAs (10 mA / 0.5 s) and Small Focal Spot.
8. Check in the image that the X-ray Beam is perpendicular to the plane of the Receptor. The perpendicularity of the X-ray Beam can be checked using the Beam Alignment Test Tool. If the image of the two balls coincide as shown in the drawings (A or B), the X-ray Beam is perpendicular; within the allowed tolerance of 0.5° (top ball is within the threshold of the first circle).



If the top ball is outside the first circle, correct the position of the X-Ray Unit. Repeat the process until the perpendicularity is correct.

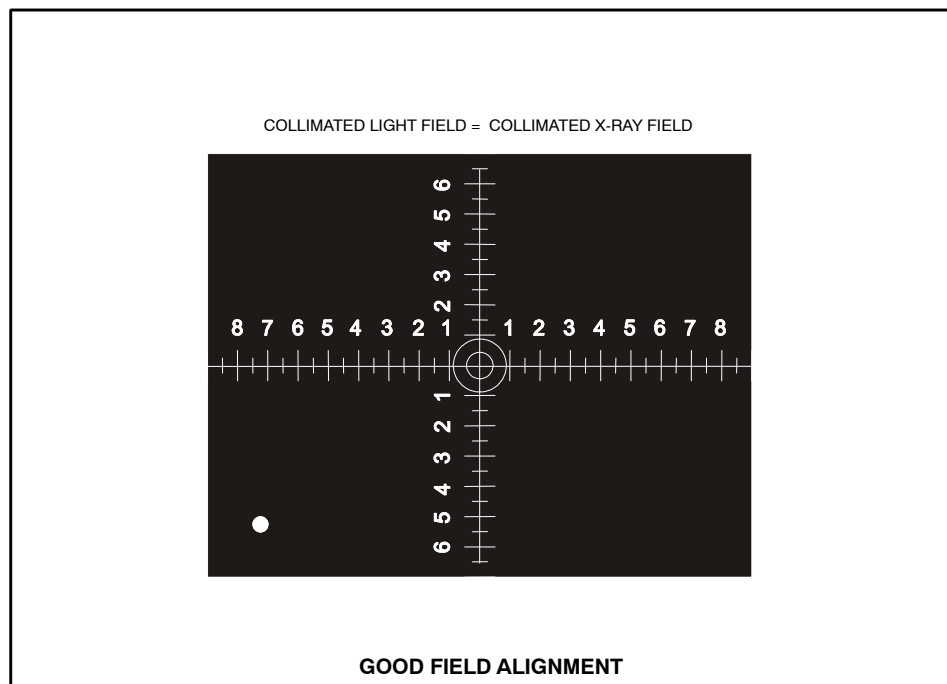
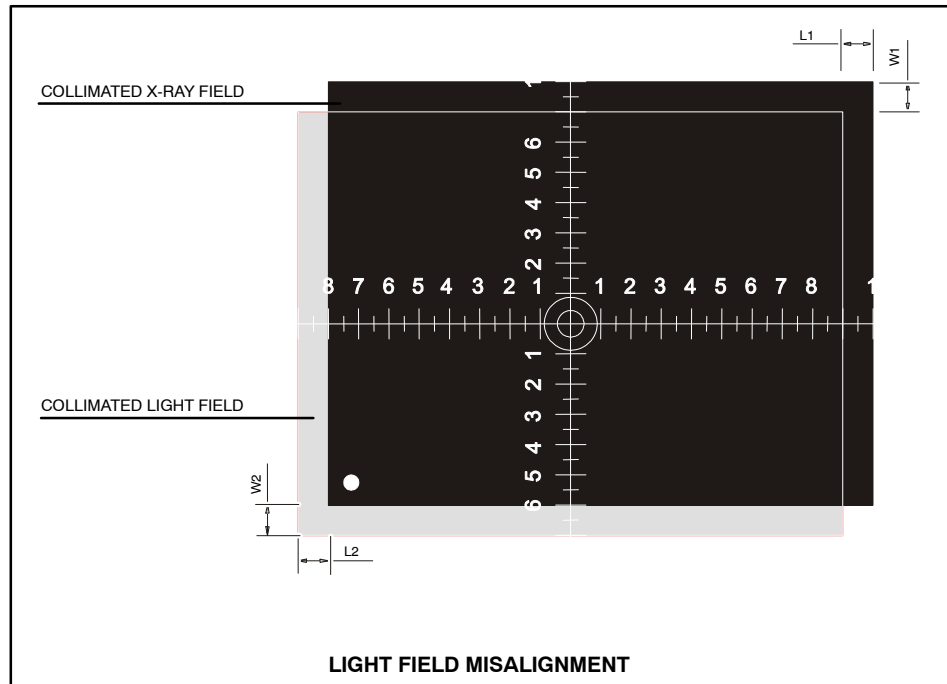
9. Check in the image that the X-ray Field falls just within the image of the inner rectangle of the Collimator Test Tool.



If any edge of the X-ray Field does not coincide with the edge of the inner rectangle means a misalignment of the Light Field with respect to the X-ray Field. The maximum misalignment allowed is 2% of SID (for SID 100 cm = 2 cm tolerance) for both axes.

If case of misalignment, follow with next step.

10. Check on the image the adjustment required to meet the Light Field with the X-ray Field. Identify the deviation on the axes shown on the image.
 Deviation axis X = $L1 + L2$, should be ≤ 2 cm.
 Deviation axis Y = $W1 + W2$, should be ≤ 2 cm.



11. Do not remove the Collimator Test Tool from its original position.
12. Modify Collimator position by carefully unscrewing and screwing the four Centering Adjustment and Security Screws (Allen) until the Light Field coincides with the axes reference imaged (numbers and dots) on the Image.

**Illustration 4-2
Collimator Screws**

CENTERING ADJUSTMENT AND SECURITY SCREWS



13. Repeat exposure and procedure until the result is satisfactory. The maximum misalignment allowed is 2 % of SID (for SID 100 cm = 2 cm of tolerance).

Note 

If adjustment is still necessary, modify position of Collimator Light (refer to the Collimator Manual).

14. Repeat the process making an exposure at 55 kVp / 5 mAs (10 mA / 0.5 s) and Large Focal Spot.



IF THE COLLIMATOR SECURITY SCREWS HAVE BEEN ADJUSTED, VERIFY THAT THE COLLIMATOR IS PROPERLY SEATED AND NO RISK FOR ACCIDENTAL FALL IS POSSIBLE BY TURNING COLLIMATOR AROUND AND PULLING DOWNWARDS FROM IT.

4.2 FIELD SIZE INDICATOR TEST

Note 

Before starting with the Field Size Indicator Test, the Alignment of X-Ray Beam should be performed.

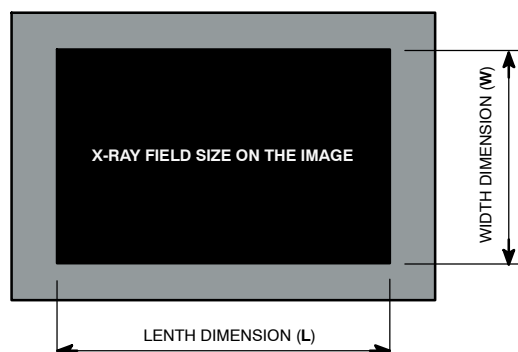
1. Place the Portable Unit in vertical position. The Unit has to be perfectly aligned with the Receptor. Check with a level correct horizontal position of both parts.

Note 

The Receptor used for testing can be located on the floor or a Table.

2. Place SID at 100 cm.
3. Turn on Collimator light and center the Collimator in relation to the Receptor. Horizontal and transverse position of the light axes projected by the Collimator Light must be in line with the Receptor axes.
4. Open the Collimator blades to set a Field Size of 24 x 30 cm for SID 100 cm.
5. Make an exposure at 55 kVp, 1 mAs.
6. Check in the image the following measurements known (*refer to Illustration 4-3*):
 - a. Measure the length of the X-ray Field on the Image (identified as **L**)
 - b. Measure the width of the X-ray Field on the Image (Identified as **W**)

Illustration 4-3
X-ray Field Size



7. With the measurements obtained and according to the field size indication selected, the results should be:
 - Length dimension (**L**) = 300 mm
 - Width dimension (**W**) = 240 mm
8. The difference between the indicated Field Size and the obtained Field Size may not exceed 1.5 % (rejection limit) of the SID in either direction. Therefore the deviation in any direction should not be higher than 15 mm (rejection limit) for SID at 100 cm.
9. If the deviation of Field Size Indication is out acceptance limits, it is necessary to readjust the index of Collimator Blades Control Knobs. For that, loosen each Collimator Control Knob and position it according to deviation. Repeat the complete tests until the X-Ray Field Size selected (24 x 30 cm) is obtained.

SECTION 5 OPERATING POWER ADJUSTMENTS

5.1 AUTOMATIC LINE POWER DETECTION SYSTEM

By means of this System, the Unit detects the maximum operative Power Line adapting the Exposure Parameters to the Power available and avoiding undesired line breakdowns when operating with poor electricity lines.

1. Press and hold the "*Collimator Light*" push-button and then turn the Unit "*ON*". The Display shows "*LPd ACT*" (Line Power Detection Active).
2. Release the "*Collimator Light*" push-button, the Display shows "*LPd P-E*" (Line Power Detection Preparation-Exposition).
3. Press "*Prep*", then press and hold "*X-Ray ON*" to perform consecutive exposures. After each exposure, the display will show "*LPd StP*" for a few seconds. In case the X-Ray tube is too hot, the display will show "*LPd StP*" for a while until the tube cools down; when the display shows "*LPd P-E*" the procedure can be continued.
4. The Display shows "*LPd End*" when the procedure has finished (approximately ten (10) exposures). Release "*X-Ray ON*" button, then the Display shows normal parameters. Now the Unit has detected the Maximum Power Line that can be used during normal operation.

If error code "*E95*" appears at this moment, it means that the line is not good enough and exposures will not be allowed, if possible, change the Unit Plug to another socket (line).

If error code "*E96*" appears during the procedure at any mA station, it means that the corresponding station is not calibrated and power is limited to the previous mA station. The procedure ends and the Unit should be calibrated again.

Once the Line Power Detection Procedure is performed:

- It is **necessary** to perform the Warm Up procedure.
- Perform the procedure every time the Unit is plugged into a different socket as the Unit **applies the data of the last Power Line acknowledged**.
- After finishing the procedure, the remaining thermal capacity (%) is **reduced and certain techniques could be temporarily inhibited**. Wait a few minutes for the Tube to cool.
- This procedure does not take into account the limitations of the **Circuit Breaker (Thermomagnetic Switch) installed at site**. If the Circuit Breaker (Thermomagnetic Switch) installed at site still goes down, perform the Manual Power Reduction procedure below.

Note 

If any error code appears on Display during procedure, press "Reset" push-button.

To restore default values (which means that no restrictions will be set due to the Line Power Detection System):

1. Press and hold the "Collimator Light" push-button and turn the Unit "ON". After a few seconds, the Display will show "LPd ACT" (Line Power Detection Active).
2. At this point press and hold the "Reset" push-button.
3. Release the "Collimator Light" push-button.
4. Release the "Reset" push-button. The values will be set to the maximum range available (no restrictions due to the line) and the "LPd rSt" (Line Power Detection Reset) message will be shown on the displays. When the kVp and mAs parameters are displayed, the X-Ray Unit will be ready for operation.

5.2 mAs-METER MODE

This automatic mode allows the generator to adapt the Exposure Parameters in order to avoid interrupted exposures due to poor electricity lines.

If the Unit detects undesired voltage drops when operating with poor electricity lines, mA are automatically reduced, Exposure Time is increased and the exposure finishes once the mAs selected by the operator are reached.

Note 

Exposure Parameters values selected by the operator may vary when this mode is enabled. In order to visualize time, mA average during exposure and mAs actual values, press the "Reset" button and they will be shown on the displays for a while.

Note 

If the electricity line is so poor that the exposure cannot be completed (e.g. generator time-out (10 seconds) or receptor time-out (2.5), if applicable), E17 or E49 may occur.

Note 

The mAs-Meter Mode is factory set and it can only be disabled by a Service Engineer. The minimum Exposure Time in mAs-Meter Mode is 0.01 seconds.

5.3 MANUAL POWER REDUCTION

The operator may reduce the Unit maximum Power in order to avoid blown fuses or Circuit Breakers down in poor electricity lines. For that, press and hold any "Focal Spot" push-button and increase or decrease the percentage by pressing the "kVp Increase o Decrease" push-buttons respectively.

The kVp Display shows the selected Power Percentage in 10% steps, preceded by the letter "P", from 10% up to 100%. For example, a display of "P80" would indicate that the Power of the Unit will be limited to a maximum of 80%. "P - - " indicates that the Unit will operate at full Power (100% - factory set).

In case a technique exceeds the power required, the kVp and mAs displays will blink, modify the technique or modify Power percentage.

Note 

The Power Percentage selected by the Operator is stored in memory and applied each time the Unit is turned ON.

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SECTION 6 TROUBLESHOOTING

The Generator contains many self-diagnostic routines which greatly facilitates troubleshooting. The self-diagnostic functions require proper operation of the microprocessor.

As a general rule, the first step in any troubleshooting procedure is to verify correct power supply voltage.



If Portable Control Board, Control Driver Board or the High Voltage Transformer are replaced or the EEPROM memory is re-initialized, Configuration and Calibration procedures should be performed.

6.1 GENERAL PROCEDURES

6.1.1 RE-INITIALIZATION OF EEPROM (U25)

Calibration data and some configuration data are stored in the extended memory area of the non-volatile memory U25-EEPROM Microcontroller. It is located on the Portable Control Board (A3175-05).

In case the EEPROM memory has to be re-initialized, perform the following steps:

1. With the Unit power "OFF" and the Dip-switch SW1-1 in "OFF" position on the Portable Control Board, press and hold "Reset", "kVp Increase" and "mAs Increase" push-buttons at the same time.
2. Turn the Unit ON and wait until the message "ini EEP" is shown in the kVp and mAs Displays.



3. Release the "Reset", "kVp Increase" and "mAs Increase" push-buttons.
4. Wait until the message "ini EEP" disappears from the kVp and mAs Displays (it will take 30 seconds approx.).
5. After that, the EEPROM memory has been re-initialized and it is necessary to perform the complete Configuration (refer to Section 2) and Calibration process (refer to Section 3).

6.1.2 PROCEDURES RELATED TO UNITS WITH TOUCH SCREEN CONSOLE

6.1.2.1 MESSAGES IN THE TOUCH SCREEN CONSOLE

If after pressing any of these Rad buttons, the technique value is blocked and an acoustic signal is emitted, one of the messages described in *Table 6-1* may appear on the message areas of the screen.

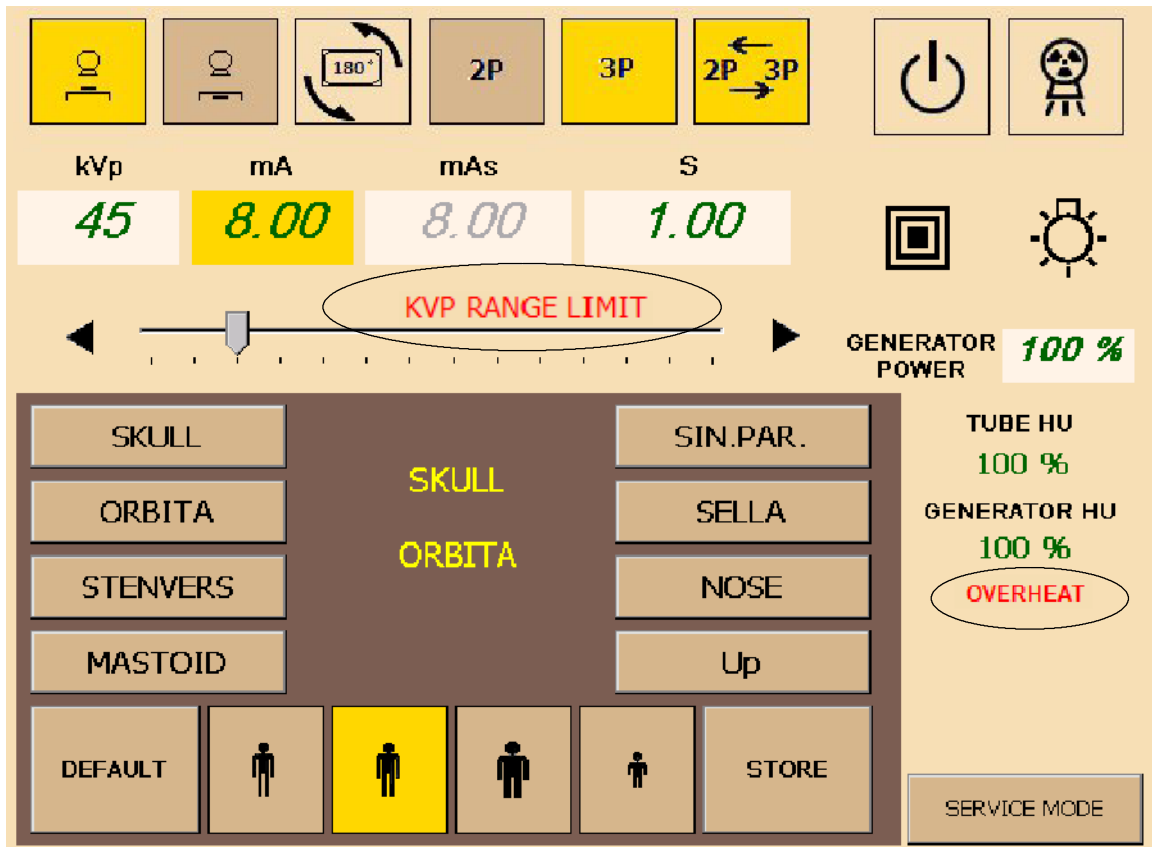
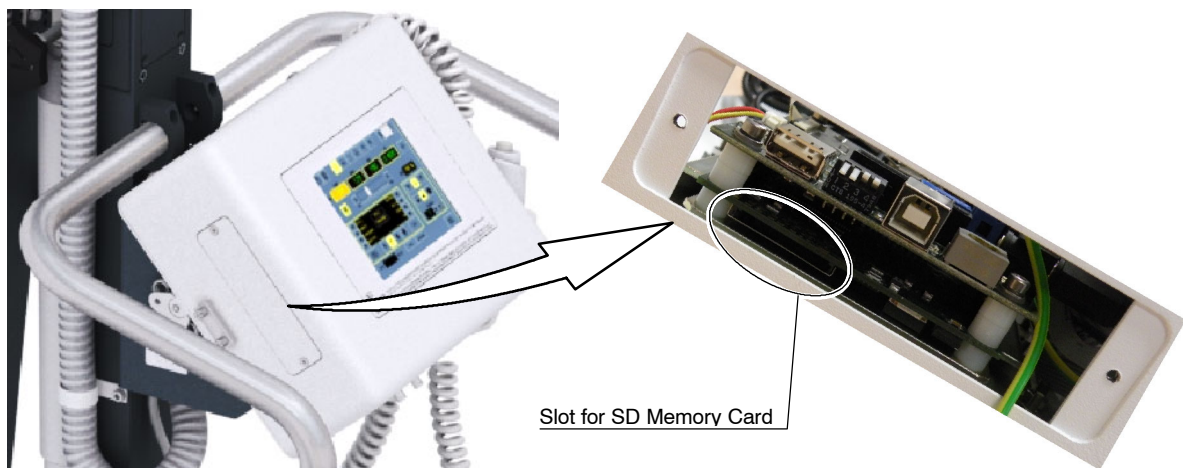


Table 6-1
Messages in the Touch Screen Console

MESSAGE	DESCRIPTION
Messages related to Generator Power Limit: “kVp RANGE LIMIT” “mAs RANGE LIMIT” “mA RANGE LIMIT” “ms RANGE LIMIT”	If the power limit (kVp x mA) is reached by increasing the kVp or mAs up to a maximum possible value, the mAs value is blocked. Flashing values on kVp and mAs displays and an audible signal will alert operator about the situation with one of these messages. If required, kVp could be increased up to its maximum value while mA value may automatically decrease, as long as mAs value is kept the same.
“SPACE CHARGE LIMIT”	If a variation of the kVp or mAs induces to reach space charge limit, the parameter is blocked, and a flashing value on the kVp display and an acoustic signal will alert operator about the situation.
Messages related to X-ray Tube or Heating: “OVERHEAT” “TUBE OVERHEAT” “INVERTER OVERHEAT” “INVERTER LOAD LIMIT”	If a technique reaches the X-ray Tube ratings limit or the X-ray Tube is momentarily overheated, some technique could not be selected. Flashing values on the kVp / mAs displays and an acoustic signal will alert operator about the situation.
“X-RAY KEY”	The X-Ray Key is not in on position. This message only applies to Generators with the “X-Ray Key option”.
“TUBE POWER LIMIT”	The technique overpasses the Tube Power Limit.
“FOCUS CHANGE INHIBIT”	The selected technique does not allow the Focus change.
“LINE POWER TOO LOW”	The Power Line where the unit is connected will bear the usage of the Unit.
“WRONG APR WORKSTATION”	The selected workstation is not allowed for the APR.
“WRONG APR TECHNIQUE”	The APR Technique selected is not allowed.

6.1.2.2 APR SOFTWARE UPDATE

1. Turn the Unit OFF.
2. Open the lateral window located at the Control Module of the Unit.
3. Insert a SD Memory Card with the new software in the slot.
4. Turn the Unit ON.
5. The system automatically detects the *“exe. file”* or a file with an *“APR”* and requests a YES/NO confirmation to overwrite the corresponding files. Press YES.
6. Once finished, turn OFF the Unit, remove the SD Memory Card from the slot and reinstall the Window cover.



6.2 ERROR CODES

Table 6-2
Error Code List

ERROR	DESCRIPTION
No Error Code	System does not Start-up (No indication of Activity) - Precharge Resistors.
E01	Backup Timer I2C error.
E02	Wrong Workstation configuration.
E03	No Workstation configured.
E04	Fluoro Order error.
E05	"Exposure" order is active during power-up.
E06	"Preparation" order is active during power-up.
E08	Wrong identifier for X-ray Tube 1.
E10	EEPROM corrupted or not initialized. Wrong data calibration.
E11	Load Capacitor error.
E12	mA is out of range during exposure.
E13	kVp is out of range during exposure.
E14	kVp ramp error.
E15	Large Filament current is out of range.
E16	Small Filament current is out of range.
E17	DC Bus is out of range.
E19	mA without exposure order.
E20	kVp without exposure order.
E23	EEPROM error.
E24	Bucky / Digital Panel error.
E25	Large Filament current demand is over the limit.
E26	Small Filament current demand is over the limit.
E27	Collimator Light current is out of range.
E28	Collimator Light current is present without order.
E30	Wrong date/time at the RTC (Real Time Clock).
E31	Wrong Time Stamp.
E32	I2C Bus error while accessing the RTC.
E33	Serial Communication error.

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Table 6-2 (cont.)
Error Code List

ERROR	DESCRIPTION
E34	Exposure Timer error.
E35	The acknowledge for X-Rays from the Bucky or Flat Panel Detector has been lost before the end of the exposure.
E36	Presostat / Thermostat error.
E38	System error - Chopper failure.
E39	System error - Power supply error.
E40	System error - kVp Unbalanced.
E41	System error - mA Unbalanced.
E42	Corrupted Counters.
E43	Corrupted Error Log.
E44	I2C Bus error when entering the Potentiometer.
E45	I2C Bus error when entering the Multiplexor.
E46	Busy I2C Bus.
E47	APR Lite check error.
E48	Bucky / Digital Panel interface error.
E49	Exposure Timeout - mAs-Meter Error
E50	Exposure has been aborted by the operator or defective exposure device.
E51	Incorrect Exposure Time.
E53	The timeout for receiving the Fluoro synchronism pulse has elapsed.
E60	The preprogrammed exposures for Autocalibration has finished without complete the Autocalibration process.
E61	There has been an error while trying to access the license data. Default options have been selected.
E74	The generator has been reset because of the COP module.
E75	The generator has been reset because of the CLK module.
E76	The generator has been reset because of an illegal operation code.
E77	The generator has been reset because of a software interrupt.
E78	The generator has been reset because of a memory overflow interrupt.
E95	Power Line not good enough for operation.
E96	Line Power Non Calibrated Technique Error
E97	License - I2C Error.
Err rAn	Defective RAM memory.
Err nrAn	Defective NVRAM memory.
OL	Tube or Generator Overload.

NO ERROR CODE : NO ACTIVITY AT START-UP

DESCRIPTION : System does not start-up. There are no indicators for this error.

POSSIBLE CAUSES

The unit is not connected / powered from mains.

Open Precharge Resistors (R1, R2) during start-up.

Excessive resistance in the Precharge Resistors (R1, R2).

ACTIONS

1. Turn the Unit OFF and ON.
2. Check the unit is powered from mains and the Circuit Breaker of the unit is in "ON" position.
3. Check Resistors R1 and R2 on the EMC Input Filter Board (A3191-04) during start-up, if they are open or if the resistance is too high, replace the EMC Input Filter Board (A3191-04).
4. If the problem persists, contact the manufacturer.

ERROR CODE : E01

DESCRIPTION : Backup Timer I2C error. I2C Bus error while trying to access the external redundant backup timer. "Recoverable" with the "Reset" push-button.

POSSIBLE CAUSES

It is not possible to communicate with the secondary microcontroller (U56) that practises as the redundant backup timer.

ACTIONS

1. Turn the Unit OFF and ON.
2. If the error persists, check on the Control Portable Board (A3175-05):
 - Make sure the secondary microcontroller (U56) has been properly burned (DS29 should be flashing).
 - Review all the hardware connected to the I2C Bus: P89LPC922 (U56), M41T56 (U54).
3. Check on the Control Driver Board (A3189-07) the digital potentiometer AD5245 (U10) and the multiplexer MAX4586 (U12).
4. Check the related components to all of them.
5. Replace the defective hardware.

ERROR CODE : E02

DESCRIPTION : Wrong Workstation configuration. One or more workstations are not properly configured, a default value has been assigned. "Recoverable" with the "Reset" push-button.

POSSIBLE CAUSES

The workstation configuration is invalid, for example a workstation configured as bucky/digital panel (C1.2 or C2.2) has no input selected (C1.3 or C2.3). Or the EEPROM is not initialized, that is very uncommon.

ACTIONS

1. Review the workstation configuration (C01 and C02 menus) and correct the wrong value.
2. Consider initializing the EEPROM (*refer to Section 6.1.1*). If the EEPROM is initialized, the calibration data will be lost and the system configuration will be overwritten with the default values.

ERROR CODE : E03

DESCRIPTION : No Workstation configured. All the workstations have no Tube configured, there is no workstation available, a default value has been assigned. "Recoverable" with the "Reset" push-button.

POSSIBLE CAUSES

The workstation configuration is invalid, or the EEPROM is not initialized, that is very uncommon.

ACTIONS

1. Review the workstation configuration (C1.1 and C2.1 submenus) and configure at least one of them with a value different from "0".
2. Consider initializing the EEPROM (*refer to Section 6.1.1*). If the EEPROM is initialized, the calibration data will be lost and the system configuration will be overwritten with the default values.

ERROR CODE : E04

DESCRIPTION : The “*Fluoro*” order input signal is active during the Start-up sequence. “Unrecoverable”, the system remains lock.

POSSIBLE CAUSES

The “*Fluoro*” order input signal is active and/or defective hardware related to this input.

ACTIONS

1. Make sure that the “*Fluoro*” order input signal in J11.5 of the Portable Control Board (A3175-05) is inactive during the Start-up.
2. Verify the possible defective hardware related to this input.
3. Deactivate the input or replace the defective hardware.

ERROR CODE : E05

DESCRIPTION : “*Exposure*” order input signal is active during the Start-up sequence. “Unrecoverable”, the system remains lock.

POSSIBLE CAUSES

The microprocessor has detected “*Exposure*” during the Start-up sequence.

ACTIONS

1. Make sure that the “*Exposure*” order is inactive during the Start-up by first checking the Handswitch control and Console Overlay.
2. Make sure that the “*Exposure*” order is inactive during the Start-up by checking the signal in:
 - connector J6.2, J8.4, J12.5 and J13.2 on Portable Control Board (A3175-05).
 - connector J2.3 (Handswitch) and J1.8 (RS-232) of the Portable Unit.
 - overlay ribbon cables signal connected to J13.2 on Portable Control Board (A3175-05).
 - connector J4.3 on the Remote Console Connectors (A3632-02) (only for Portable Units with Trolley).
3. Verify the possible defective hardware related to these inputs.
4. Deactivate the input or replace the defective hardware.

ERROR CODE : E06

DESCRIPTION : "Preparation" order input signal is active during the Start-up sequence. "Unrecoverable", the system remains lock.

POSSIBLE CAUSES

The microprocessor has detected "Preparation" during the Start-up sequence.

ACTIONS

1. Make sure that the "Preparation" order is inactive during the Start-up by first checking the Handswitch control and Console Overlay.
2. Make sure that the "Preparation" order is inactive during the Start-up by checking the signal in:
 - connector J6.3, J8.3, J12.2 and J13.3 on Portable Control Board (A3175-05).
 - connector J2.5 (Handswitch) and J1.7 (RS-232) of the Portable Unit.
 - overlay ribbon cables signal connected to J13.3 on Portable Control Board (A3175-05).
 - connector J4.5 on the Remote Console Connectors (A3632-02) (only for Portable Units with Trolley).
3. Verify the possible defective hardware related to these inputs.
4. Deactivate the input or replace the defective hardware.

ERROR CODE : E08

DESCRIPTION : Wrong identifier for X-ray Tube-1.
The Tube identifier (that points a Tube in the Tube list) configured for the Tube-1 is a default value. "Recoverable" with the "Reset" push-button.

POSSIBLE CAUSES

The Tube model configuration is invalid, or the EEPROM is not initialized, that is very uncommon.

ACTIONS

1. Review the workstation configuration (C4.1 submenu) and configure a valid Tube identifier.
2. Consider initializing the EEPROM (*refer to Section 6.1.1*). If the EEPROM is initialized, the calibration data will be lost and the system configuration will be overwritten with the default values.

ERROR CODE : E10

DESCRIPTION : EEPROM corrupted or not initialized. Wrong data calibration in EEPROM. "Unrecoverable", the system remains lock.

POSSIBLE CAUSES

The EEPROM is not initialized, or the EEPROM is defective.

ACTIONS

1. Initialize the EEPROM (*refer to Section 6.1.1*).
2. If the error persists, replace the Portable Control Board (A3175-05) and initialize the new EEPROM (*refer to Section 6.1.1*).

ERROR CODE : E11

DESCRIPTION : Load Capacitor Error - DC Bus error during Start-up. Error while charging the load capacitors. The DC Bus voltage doesn't reach the correct value during Start-up. "Unrecoverable", the system remains lock.

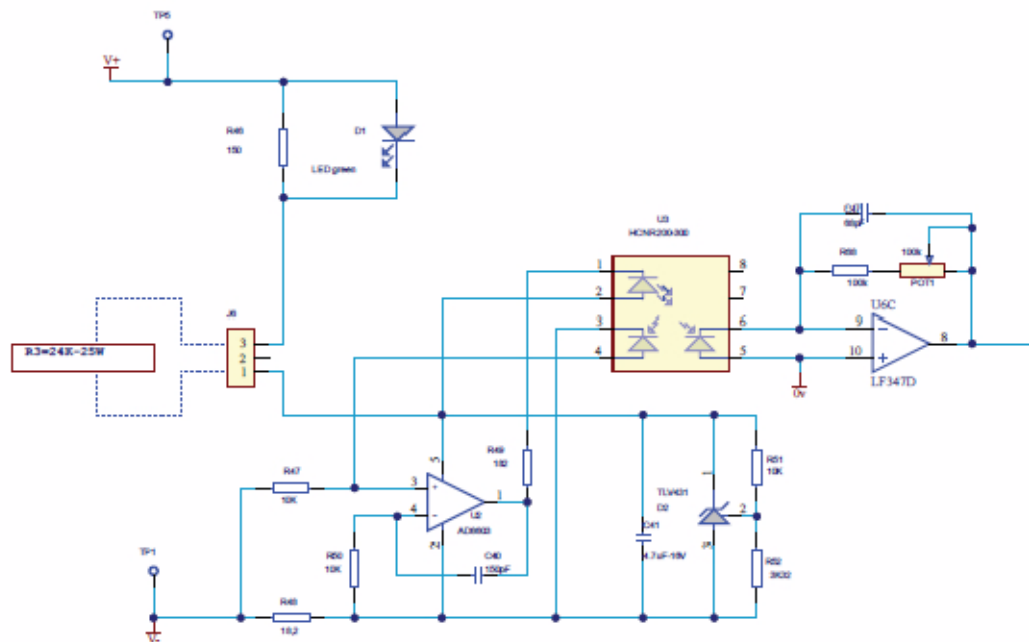
POSSIBLE CAUSES

Defective DC Bus hardware. Fault at the measuring of the DC Bus voltage.

ACTIONS

1. With the generator OFF, verify with ohmmeter the pre-charge resistors R1 & R2 located on the EMC Input Filter A3191-XX. If any of the resistors is damaged (opened) replace the EMC Input Filter A3191-XX. Verify preventively the status of the IGBTs as described in step 8.

2. With the generator OFF, verify with ohmmeter the resistor R3 connected to the control driver board:



Ensure that this resistor is properly connected to the Control Driver board A3189-XX and not damaged.

3. Power ON the unit and measure the DC Bus voltage between TP1 & TP5 of the Control Driver board A3189-XX. In stand-by, you should measure $V_{mains} \times 1.41$ (for example, $230\text{ V} \times 1.41 = 324\text{ V}$). If the voltage is present continue in step 6.
4. If the voltage is not present, check voltage on J4 & J5 of EMC Input Filter A3191-XX. If the DC Bus voltage is present on J4 & J5 of EMC Input Filter A3191-XX, verify connections from J4 & J5 of EMC Input Filter A3191-XX to Control Driver board A3189-XX through the inductance L1.
5. If the DC Bus voltage is not present on J4 & J5 of EMC Input Filter A3191-XX, verify the presence of the line voltage on J2 & J3 of EMC Input Filter A3191-XX. If the line voltage is present, replace the EMC Input Filter A3191-XX. Verify preventively the status of the IGBTs as described in step 8. If the line voltage is not present, check connections between breaker CB1 and J2 & J3 of EMC Input Filter A3191-XX.
6. If DC Bus voltage between TP1 & TP5 of the Control Driver board A3189-XX is present, measure the voltage between TP10 and GND (TP2, TP14, TP17) of the Control Driver board A3189-XX to verify the signal VCarr (Relation of the VCarr and DCBUS is $1\text{V} \sim 100\text{V}$). If signal VCarr is not correct, replace the Control Driver board A3189-XX.

ERROR CODE : E12

DESCRIPTION : mA is out of range during exposure. Tube current out of range during exposure. "Recoverable" with the "Reset" push-button.

POSSIBLE CAUSES

The filament current demand is not calibrated properly.
Defective filament control hardware, noise or fault in the mA measure.

ACTIONS

1. Calibrate the mA stations again.
2. If the error persists, replace the defective hardware.

ERROR CODE : E13

DESCRIPTION : kVp is out of range during exposure. Anode-Cathode voltage is out of range during exposure. "Recoverable" with the "Reset" push-button.

POSSIBLE CAUSES

The DC Bus is going down during exposure.
Defective kVp control hardware, noise or fault in the kVp measure.

ACTIONS

If the error persists, replace the defective hardware.

ERROR CODE : E14

DESCRIPTION : kVp ramp error. Anode-Cathode voltage does not reach the final value in the designated rise time. "Recoverable" with the "Reset" push-button.

POSSIBLE CAUSES

The DC Bus is going down during exposure.
Defective kVp control hardware, noise or fault in the kVp measure.

ACTIONS

If the error persists, replace the defective hardware.

ERROR CODE : E15

DESCRIPTION : Large filament current is out of range. "Recoverable" with the "Reset" push-button.

POSSIBLE CAUSES

Fault in the Tube filament current control hardware.

The Tube filament has blown up or it is not connected.

ACTIONS

If the error persists, replace the defective hardware.

ERROR CODE : E16

DESCRIPTION : Small filament current is out of range. "Recoverable" with the "Reset" push-button.

POSSIBLE CAUSES

Fault in the Tube filament current control hardware.

The Tube filament has blown up or it is not connected.

ACTIONS

If the error persists, replace the defective hardware.

ERROR CODE : E17

DESCRIPTION : DC Bus is out of range. The DC Bus voltage is too high or low during unit operation or the precharge relay is opened. "Recoverable" with the "Reset" push-button.

POSSIBLE CAUSES

Defective DC Bus hardware, noise or fault at the measuring of the DC Bus voltage. The precharge relay can not be activated (if the cause of this error is the precharge relay, it is very important to avoid pressing on the "Collimator Light" or "Preparation" controls as it could blow up the precharge resistors).

ACTIONS

If the error persists, replace the defective hardware.

ERROR CODE : E19

DESCRIPTION : mA without "Exposure" order. Tube current is present without "Exposure" order from the U25-EEPROM Microcontroller. "Recoverable" with the "Reset" push-button.

POSSIBLE CAUSES

Defective hardware or noise in the mA measure.

ACTIONS

If the error persists, replace the defective hardware.

ERROR CODE : E20

DESCRIPTION : kVp without "Exposure" order. Anode-Cathode voltage is present without "Exposure" order from the U25-EEPROM Microcontroller. "Recoverable" with the "Reset" push-button.

POSSIBLE CAUSES

Defective hardware or noise in the kVp measure.

ACTIONS

If the error persists, replace the defective hardware.

ERROR CODE : E23

DESCRIPTION : Error while writing in the EEPROM. "Unrecoverable", the system remains lock.

POSSIBLE CAUSES

The EEPROM is defective.

ACTIONS

1. Initialize the EEPROM (*refer to Section 6.1.1*).
2. If the error persists, replace the Portable Control Board (*A3175-05*) and initialize the new EEPROM (*refer to Section 6.1.1*).

ERROR CODE : E24

DESCRIPTION : Bucky / Digital Panel error. A Workstation configured as Bucky / Digital Panel has elapsed 10 seconds since exposure signal was activated while the equipment was "Ready" without any acknowledge from the Bucky or Digital Panel. "Recoverable" with the "Reset" push-button.

POSSIBLE CAUSES

Defective interconnection cable or hardware related to the signals RX_RQ (Request) or RX_ORDER (Acknowledge). Or the Bucky / Digital Panel is not sending the RX_ORDER signal.

ACTIONS

If the error persists, check the cable connections and signal of the Image Receptor, or replace the defective hardware.

1. Check cable connections and signal from/to the Image Receptor .
2. Check the RX signals in:
 - connector J9.3 (RX_RQ), J9.4 (RX_ACKN) on Portable Control Board (*A3175-05*).
 - connector J1.9 (RX_RQ), J1.4 (RX_ACKN) of RS-232 connector of the Portable Unit.
 - connector J5.2 and J1.10 (RX_RQ), and J5.3 and J1.23 (RX_ACKN) on the Remote Console Connectors (*A3632-02*) (only for Portable Units with Trolley).
3. Verify the possible defective hardware related to these inputs.
4. Replace the defective hardware.

ERROR CODE : E25

DESCRIPTION : Large Filament current demand is over the limit. "Recoverable" with the "Reset" push-button.

POSSIBLE CAUSES

The filament current demand is not calibrated properly.

ACTIONS

Calibrate the mA stations again and check that all the needed data for the interpolation or extrapolation have been entered (*refer to Section 3.2*).

ERROR CODE : E26

DESCRIPTION : Small Filament current demand is over the limit. "Recoverable" with the "Reset" push-button.

POSSIBLE CAUSES

The filament current demand is not calibrated properly.

ACTIONS

Calibrate the mA stations again and check that all the needed data for the interpolation or extrapolation have been entered (*refer to Section 3.2*).

ERROR CODE : E27

DESCRIPTION : Collimator Light current is out of range. "Recoverable" with the "Reset" push-button.

POSSIBLE CAUSES

Fault in the Collimator Light current control hardware.
The Collimator LED circuitry has blown up or it is not connected.

ACTIONS

If the error persists, replace the defective hardware.

ERROR CODE : E28

DESCRIPTION : Collimator Light current is present without order from the U25-EEPROM Microcontroller. "Recoverable" with the "Reset" push-button.

POSSIBLE CAUSES

Defective hardware or noise in the Collimator Light current measure.

ACTIONS

If the error persists, replace the defective hardware.

ERROR CODE : E30

DESCRIPTION : Wrong date/time at the RTC (Real Time Clock). Wrong date stored in the RTC (Real Time Clock) and/or the Time Stamp. "Recoverable" with the "Reset" push-button.

POSSIBLE CAUSES

The RTC has not been configured, the RTC battery is discharged or missed or the RTC is failing.

ACTIONS

1. Check the RTC configuration (*refer to Section 2.2.7*).
2. If the error persists, check the battery BAT1 (model CR 1216, 3V) of the Portable Control Board (A3175-05) and replace if needed.
3. If the error persists, replace the Portable Control Board (A3175-05) and initialize the new EEPROM (*refer to Section 6.1.1*).

ERROR CODE : E31

DESCRIPTION : Wrong Time Stamp. The Time Stamp checksum is wrong. "Recoverable" with the "Reset" push-button.

POSSIBLE CAUSES

The RTC has not been configured, the RTC battery is discharged or missed or the RTC is failing.

ACTIONS

1. Check the RTC configuration (*refer to Section 2.2.7*).
2. If the error persists, check the battery BAT1 (model CR 1216, 3V) of the Portable Control Board (A3175-05) and replace if needed.
3. If the error persists, replace the Portable Control Board (A3175-05) and initialize the new EEPROM (*refer to Section 6.1.1*).

ERROR CODE : E32

DESCRIPTION : I2C Bus error while trying to access the Real Time Clock (RTC).
"Recoverable" with the "Reset" push-button.

POSSIBLE CAUSES

It is not possible to communicate with the RTC.

ACTIONS

1. Check on the Control Portable Board (A3175-05):
 - Review all the hardware connected to the I2C Bus: P89LPC922 (U56), M41T56 (U54).
2. Check on the Control Driver Board (A3189-07) the digital potentiometer AD5245 (U10) and the multiplexer MAX4586 (U12).
3. Check the related components to all of them.
4. Replace the defective hardware.

ERROR CODE : E33

DESCRIPTION : Serial Communication error. This error only applies to Portable Units with Trolley. The Generator has lost the serial communications with the Remote Console (3P Console or Touch Screen Console located in the Trolley) after establishing the link. "Recoverable" with the "Reset" push-button.

POSSIBLE CAUSES

The Generator is not receiving the status requests from the Remote Console at the required rate.

ACTIONS

1. Check the cable and connections between the Generator and the Remote Console.
2. Check the related components to each signal of the communication cables.
3. Replace the defective hardware.

ERROR CODE : E34

DESCRIPTION : Exposure Timer error. The software backup timer has finished the exposure. "Unrecoverable", the system remains lock.

POSSIBLE CAUSES

Fault in the Microcontroller backup timer (U56) of Portable Control Board (A3175-05).

ACTIONS

1. Turn the Unit OFF and ON.
2. If the equipment remains inoperative, replace the Portable Control Board (A3175-05) and initialize the new EEPROM (refer to Section 6.1.1).

ERROR CODE : E35

DESCRIPTION : Flat Panel Detector (FPD)/ Receptor error. The Receptor acknowledge signal has been lost during the exposure so the exposure has been aborted. "Recoverable" with the "Reset" push-button.

POSSIBLE CAUSES

When the FPD (or its power/interface box) is wired to the Generator (the Workstation in use should be Bucky 1), the RX_ACKN signal from the FPD has been lost before the end of the exposure.

When the FPD (or its power/interface box) is not wired to the Generator (the Workstation in use should be Bucky COM), the Host Controller has sent a message to the Generator in order to abort the exposure because it has lost the X-Ray acknowledge from the FPD.

ACTIONS

If the error persists,

- When the FPD (or its power/interface box) is wired to the Generator, check the RX_ACKN signal from the FPD, present at J9.4 in the Portable Control Board (A3175-05).
 - If the signal is OK, replace the Portable Control Board (A3175-05).
 - If the signal is not reaching properly the board or it is noisy, check the cable connections between the FPD (or its power/interface box) and the generator, or the FPD itself.
 - If the signal is clean but it is deactivated before the end of the exposure, check the system configuration or the FPD.
- When the FPD (or its power/interface box) is not wired to the Generator, check the items between the FPD and the System and replace the defective hardware.

ERROR CODE : E36

DESCRIPTION : Presostat / Thermostat error.
This error does not require to press the "Reset" push-button, the error code disappears automatically.

POSSIBLE CAUSES

The housing presostat / thermostat has been opened due to overheat or hardware fault.

ACTIONS

1. Wait for the unit (housing) to cool.
 2. If the error code does not disappear after 15 minutes, turn the Unit OFF and ON.
 3. If the equipment remains inoperative, check the hardware and replace if needed.
-

ERROR CODE : E38

DESCRIPTION : System error - Chopper failure.
The DC Bus voltage and / or the Chopper Coil current is/are too high.
"Recoverable" with the "Reset" push-button.

POSSIBLE CAUSES

Over voltage or over current in the Chopper, noise or fault in the hardware that measure these parameters.

ACTIONS

1. Turn Off/ON the unit.
 2. If the error persists, replace the defective hardware.
-

ERROR CODE : E39

DESCRIPTION : System error - Power supply error.
15 V power supply fault.
"Recoverable" with the "Reset" push-button.

POSSIBLE CAUSES

15 V power supply goes down, noise or fault in the hardware.

ACTIONS

1. Turn Off/ON the unit.
2. If the error persists, replace the defective hardware.

ERROR CODE : E40

DESCRIPTION : System error - kVp unbalanced.
Anode and Cathode branches have different voltage.
"Recoverable" with the "Reset" push-button.

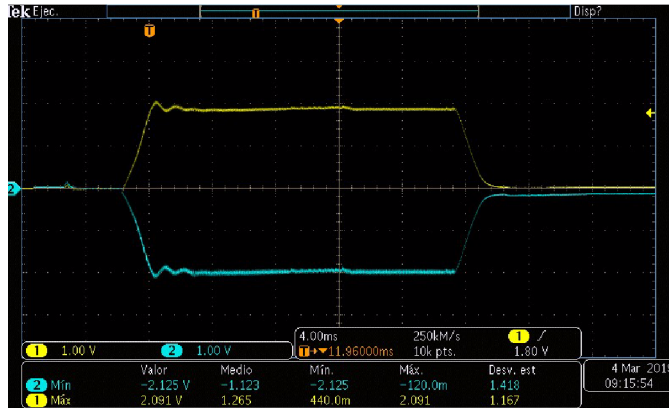
POSSIBLE CAUSES

Defective High Voltage Transformer, Control Driver board A3189-XX or Control Portatil A3175-xx

ACTIONS

1. Connect the oscilloscope to the following test points on Control Driver board A3189-xx:
CH1: TP6 (+kV)
CH2: TP8 (-kV)
GND: TP2, TP4, TP14, TP17, TP21, TP23, TP24, TP25, TP26, TP30

2. Perform an exposure with the parameters that produce the error message and verify the symmetry of the kV signals during the exposure with the oscilloscope. Example of expected signals (no error condition) for a 40kV exposure:



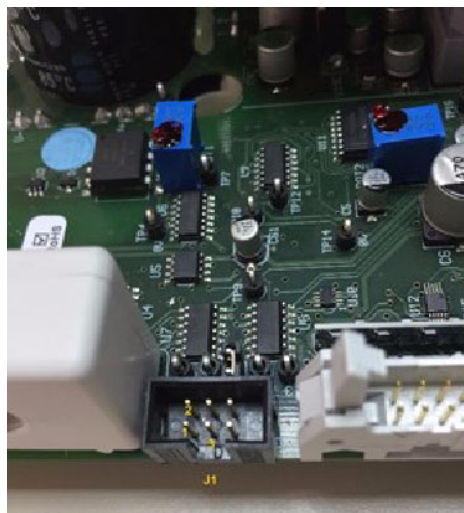
CH1: kV+ & CH2: kV- at 40kVp

3. If the signals +kV and -kV are not symmetrical, verify the ribbon cable between the Control Driver board A3189-xx, and the HV Transformer. If the cable is OK, continue to Step 4.
4. Disconnect the ribbon cable J1 on the Control Driver. Measure the following resistances of the kV feedback inputs in the connector J1 of the Control Driver board:
 - J1-1 (VTK) to J1-3 (GND)
 - J1-2 (VTA) to J1-3 (GND)

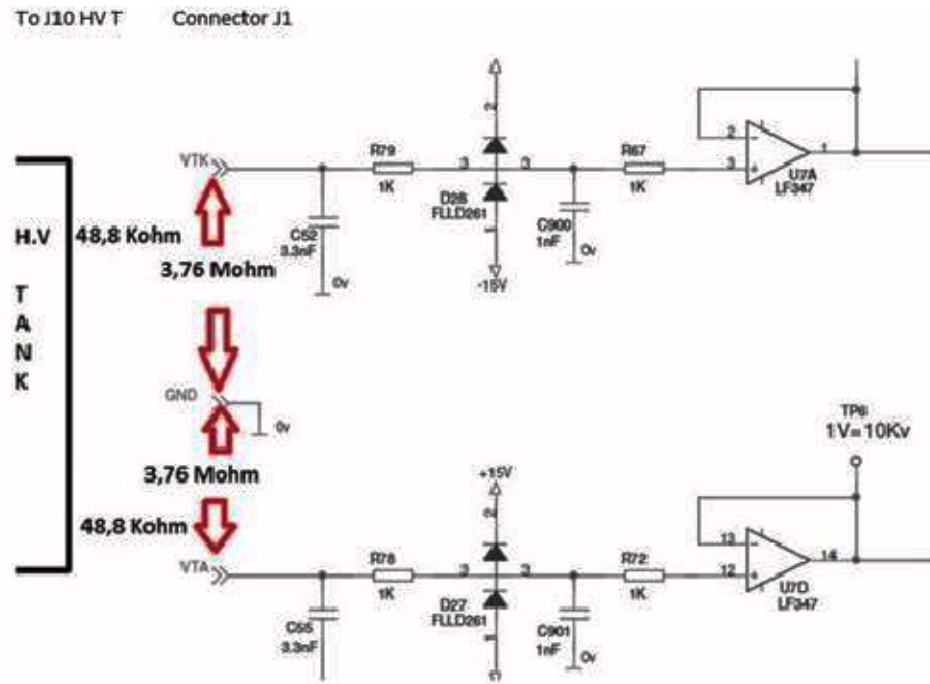
The resistance must be similar in both branches. A significant difference between branches means a defect in the hardware.

Note

Due to the characteristics of the electronic components in the circuit (capacitors, diodes, etc) the measured ohmic value may vary (from $\approx 400\text{kohm}$ to $\approx 4\text{Mohm}$) depending on the tester used for the measurement.



5. If the value of the resistance on the Control Driver are correct, disconnect the ribbon cable from J10 of HV Transformer and measure resistance on the following points of the HV Transformer:
 J10-1 to J10-2 or J10-15 ? 48.8 kohm.
 J10-14 to J10-2 or J10-15 ? 48.8 kohm.



Note: Ohmic values for informative purposes only. Refer to Note in Step 4.

6. If the kV signals in Step 2. are correct but the error E40 appears, verify the ribbon cable between Control Driver board A3189-XX and Control Portatil A3175-xx.
7. If the ribbon cable is not defective, replace Control Driver board A3189-XX and Control Portatil A3175-xx.

ERROR CODE : E41

DESCRIPTION : System error - mA unbalanced.
Anode and Cathode branches have different current.
"Recoverable" with the "Reset" push-button.

POSSIBLE CAUSES

Defective High Voltage Transformer, noise or fault in the measuring hardware.

ACTIONS

1. Turn Off/ON the unit.
2. If the error persists, replace the defective hardware.

ERROR CODE : E42

DESCRIPTION : Corrupted counters. The counters checksum is wrong.
"Recoverable" with the "Reset" push-button.

POSSIBLE CAUSES

Defective Non-Volatile RAM memory in U25-EEPROM Microcontroller (Portable Control Board A3175-05) or it has not been initialized.
Defective Portable Control Board (A3175-05).

ACTIONS

1. Press the "Reset" push-button.
2. If the error persists, turn Off/ON the unit.
3. If the error persists, initialize the EEPROM (*refer to Section 6.1.1*).
4. If the error persists, replace the Portable Control Board (A3175-05) and initialize the new EEPROM (*refer to Section 6.1.1*).

ERROR CODE : E43

DESCRIPTION : Corrupted error log. The error log checksum is wrong.
"Recoverable" with the "Reset" push-button.

POSSIBLE CAUSES

Defective Non-Volatile RAM memory in U25-EEPROM Microcontroller (Portable Control Board A3175-05) or it has not been initialized.
Defective Portable Control Board (A3175-05).

ACTIONS

1. Press the "Reset" push-button.
2. If the error persists, turn Off/ON the unit.
3. If the error persists, initialize the EEPROM (*refer to Section 6.1.1*).
4. If the error persists, replace the Portable Control Board (A3175-05) and initialize the new EEPROM (*refer to Section 6.1.1*).

ERROR CODE : E44

DESCRIPTION : I2C Bus error while trying to access the digital potentiometer.
"Recoverable" with the "Reset" push-button.

POSSIBLE CAUSES

It is not possible to communicate with the digital potentiometer AD5245 (U10) (Control Driver Board A3189-07).

ACTIONS

1. Check on the Control Portable Board (A3175-05):
 - Review all the hardware connected to the I2C Bus: P89LPC922 (U56), M41T56 (U54).
2. Check on the Control Driver Board (A3189-07) the digital potentiometer AD5245 (U10) and the multiplexer MAX4586 (U12).
3. Review the related components to all of them.
4. If the error persists, replace the defective hardware.

ERROR CODE : E45

DESCRIPTION : I2C Bus error while trying to access the multiplexer.
"Recoverable" with the "Reset" push-button.

POSSIBLE CAUSES

It is not possible to communicate with the multiplexer MAX4586 (U12) (Control Driver Board *A3189-07*).

ACTIONS

1. Check on the Control Portable Board (*A3175-05*):
 - Review all the hardware connected to the I2C Bus: P89LPC922 (U56), M41T56 (U54).
2. Check on the Control Driver Board (*A3189-07*) the digital potentiometer AD5245 (U10) and the multiplexer MAX4586 (U12).
3. Review the related components to all of them.
4. If the error persists, replace the defective hardware.

ERROR CODE : E46

DESCRIPTION : Busy I2C bus. I2C Bus error, the Bus remains always busy.
"Recoverable" with the "Reset" push-button.

POSSIBLE CAUSES

It is not possible to communicate as the Bus is always busy.

ACTIONS

1. Check on the Control Portable Board (A3175-05):
 - Review all the hardware connected to the I2C Bus: P89LPC922 (U56), M41T56 (U54).
2. Check on the Control Driver Board (A3189-07) the digital potentiometer AD5245 (U10) and the multiplexer MAX4586 (U12).
3. Review the related components to all of them.
4. If the error persists, replace the defective hardware.

ERROR CODE : E47

DESCRIPTION : The APR Lite checksum is wrong.
"Recoverable" with the "Reset" push-button.

POSSIBLE CAUSES

Defective Non-Volatile RAM memory in U25-EEPROM Microcontroller (Portable Control Board A3175-05) or it has not been initialized.
Defective Portable Control Board (A3175-05).

ACTIONS

1. Press the "Reset" push-button.
2. If the error persists, turn Off/ON the unit.
3. If the error persists, initialize the EEPROM (*refer to Section 6.1.1*).
4. If the error persists, replace the Portable Control Board (A3175-05) and initialize the new EEPROM (*refer to Section 6.1.1*).

ERROR CODE : E48

DESCRIPTION : Bucky / Digital Panel interface error.
The user is trying to perform an exposure with a Bucky or a Digital Panel but this interface is not available.
"Recoverable" with the "Reset" push-button.

POSSIBLE CAUSES

- The workstation configuration is wrong.
 - The unit has not installed the proper software for Bucky / Digital Panel interface.
-

ACTIONS

Configure the workstation without bucky/digital interface or ask for the proper software which supports the bucky/digital interface.

1. If the error is due to a wrong configured Workstation, perform actions described in error codes "E02" and "E03". If a Bucky / Digital Panel is not interfaced to this Workstation, configure it for "Direct" Workstation.
2. If the error is due to a wrong software version, contact to the manufacturer.

ERROR CODE : E49

DESCRIPTION : The programmed exposure time has elapsed but the mAs measured have not reached the expected value.

POSSIBLE CAUSES

The microcontroller is not measuring properly the tube current, there is no tube current (e.g. filaments disabled) or the corresponding exposure time for the selected mAs was close to the maximum and there is not enough margin to compensate the line drop (mA reduction while extending the exposure time).

ACTIONS

1. Press the "Reset" push-button.
Make sure the filaments are enabled and check the selected parameters. Modify them as required.
In case of poor electricity line, reduce the mAs (mA / exposure time) or connect the Unit to a better power line. Try a new exposure.
2. If the error code persists, turn the Unit OFF and ON.
3. If the error persists, verify the possible defective hardware and replace if needed.

ERROR CODE : E50

DESCRIPTION : Exposure has been aborted by the operator or defective exposure device. The user has released the exposure device/s before the end of the exposure (Prep and/or Exp). "Recoverable" with the "Reset" push-button.

POSSIBLE CAUSES

The user has prematurely released the exposure device.

Defective exposure device (Handswitch, Control Panel, ...).

ACTIONS

1. Check the correct status of the exposure device (Handswitch, Control Panel, ...) and their respective cable connections.
2. Verify the possible defective hardware related to these inputs and replace the defective hardware, if needed.

ERROR CODE : E51

DESCRIPTION : Incorrect exposure time. The exposure time is above the maximum (very uncommon) or it is so short that it is not reachable according to the present configuration (rise time and kVp tail / high voltage capacity). "Recoverable" with the "Reset" push-button.

POSSIBLE CAUSES

The exposure time is shorter than the added of the 25% of the rise time plus the kVp tail from the selected kVp to the 75% of that value.

ACTIONS

Change the exposure parameters increasing the exposure time.

ERROR CODE : E53

DESCRIPTION : The timeout for receiving the Fluoro synchronism pulse has elapsed.

POSSIBLE CAUSES

The interconnection cable between the Image System and the Generator is defective.

ACTIONS

1. Check the interconnection cable between the Image System and the Generator. if it is ok,
2. Check the Image System synchronism signal, if it is ok,
3. Replace the Portable Control Board (A3175-05) of the Generator.

ERROR CODE : E60

DESCRIPTION : The preprogrammed exposures for Autocalibration have finished without completing the Autocalibration process. The number of exposures to autocalibrate a mA station have run out. This error can be only shown in Service Mode during Autocalibration process. "Recoverable" with the "Reset" push-button.

POSSIBLE CAUSES

Tube instability, defective filament control hardware, noise or fault in the mA measure.

ACTIONS

If the error persists, replace the defective hardware.

ERROR CODE : E61

DESCRIPTION : There has been an error while trying to access the License data. Default options have been selected. "Recoverable" with the Reset command.

POSSIBLE CAUSES

The License has not been burned or is defective.

ACTIONS

1. If the error persists, dismount the Portable Control Board and the License. Send them to the manufacturer, providing the serial number of the Unit.
2. Mount the new Portable Control Board and the new License.

ERROR CODE : E74

DESCRIPTION : The generator has been reset because of the COP module.

POSSIBLE CAUSES

Unlikely error. Code corruption.

ACTIONS

If the error persists, contact the manufacturer. Factory test self diagnosis. It may be necessary to replace the Portable Control Board Software.

ERROR CODE : E75

DESCRIPTION : The generator has been reset because of the CLK module.

POSSIBLE CAUSES

Unlikely error. Code corruption.

ACTIONS

If the error persists, contact the manufacturer. Factory test self diagnosis. It may be necessary to replace the Portable Control Board Software.

ERROR CODE : E76

DESCRIPTION : The generator has been reset because of an illegal operation code.

POSSIBLE CAUSES

Unlikely error. Code corruption.

ACTIONS

If the error persists, contact the manufacturer. Factory test self diagnosis.
It may be necessary to replace the Portable Control Board Software.

ERROR CODE : E77

DESCRIPTION : The generator has been reset because of a software interrupt.

POSSIBLE CAUSES

Unlikely error. Code corruption.

ACTIONS

If the error persists, contact the manufacturer. Factory test self diagnosis.
It may be necessary to replace the Portable Control Board Software.

ERROR CODE : E78

DESCRIPTION : The generator has been reset because of a memory overflow interrupt.

POSSIBLE CAUSES

Unlikely error. Code corruption.

ACTIONS

If the error persists, contact the manufacturer. Factory test self diagnosis.
It may be necessary to replace the Portable Control Board Software.

ERROR CODE : E95

DESCRIPTION : Power Line not good enough for operation. The Generator could not finish properly the "Automatic Line Power Detection" procedure. No exposure will be allowed until the user performs a successful test. "Unrecoverable", the system remains lock.

POSSIBLE CAUSES

The line impedance is too high.

ACTIONS

1. Repeat the "Automatic Line Power Detection" procedure (*refer to Section 5.1*).
2. If error persists, plug the unit to another socket line and try again.

ERROR CODE : E96

DESCRIPTION : Generator power limited during the Automatic Line Power Detection System due to non calibrated mA station.

POSSIBLE CAUSES

At least one mA Station is not calibrated.

ACTIONS

1. Press the "Reset" push button.
2. Perform the Calibration procedure (*refer to Section 3*).
3. Repeat the "Automatic Line Power Detection" procedure (*refer to Section 5.1*).

ERROR CODE : E97

DESCRIPTION : I2C bus error while trying to access the License. "Recoverable" with the Reset command.

POSSIBLE CAUSES

It is not possible to communicate with the License. Make sure the license is installed and properly plugged in. Check the I2C bus pull-up resistors (RP20 and RP21) and review all the elements connected to the I2C bus: TXS0104E (U68), MKL02Z32VFG4 (U56), M41T56 (U54), License, and the related components to all of them.

ACTIONS

1. Check that the License SD is correctly inserted, remove it and insert it again.
2. If the error persists, dismount the Portable Control Board and the License. Send them to the manufacturer, providing the serial number of the Unit.
3. Mount the new Portable Control Board and the new License.

ERROR CODE : Err rAn

DESCRIPTION : Defective RAM Memory. Memory fault in U25-EEPROM Microcontroller. "Unrecoverable", the system restarts again after 3 seconds.

POSSIBLE CAUSES

Defective RAM memory in U25-EEPROM Microcontroller (Portable Control Board A3175-05).

ACTIONS

1. Turn the Unit OFF and ON.
2. If the equipment remains inoperative, replace the Portable Control Board (A3175-05) and initialize the new EEPROM (*refer to Section 6.1.1*).

ERROR CODE : Err nrAn

DESCRIPTION : Defective NVRAM Memory. Non-Volatile Memory fault in U25-EEPROM Microcontroller. "Unrecoverable", the system restarts again after 3 seconds.

POSSIBLE CAUSES

Defective Non-Volatile RAM memory in U25-EEPROM Microcontroller (Portable Control Board A3175-05).

ACTIONS

1. Turn the Unit OFF and ON.
2. If the equipment remains inoperative, replace the Portable Control Board (A3175-05) and initialize the new EEPROM (*refer to Section 6.1.1*).

ERROR CODE : OL

DESCRIPTION :

Tube or Generator Overload.

The selected technique is beyond the X-ray Tube ratings, the present conditions of the X-ray Tube/Generator inhibit the exposure (anode/inverter overheated) or the calculated remaining thermal capacity (%) for the next exposure is beyond the Generator capacity. Parameters for next exposure may be temporally limited by the Unit.

This error does not require to press the "Reset" push-button, the error code disappears automatically.

POSSIBLE CAUSES

The selected exposure is not possible due to the X-Ray Tube or Generator thermal status.

The selected technique is beyond the X-Ray Tube or Generator ratings, or present conditions of the X-Ray Tube (anode overheated) or Generator (Inverter overheated) inhibit the exposure.

Parameters for next exposure may be temporally limited by the Unit.

ACTIONS

1. Check that the remaining thermal capacity (%) is lower than the calculated for the next exposure (thermal capacity close to 0%).
2. Wait until the Generator cools down.
3. If the error code does not disappear after 15 minutes, turn the Unit OFF and ON.
4. If the equipment remains inoperative, check the hardware and replace if needed.

6.3 PARTS REPLACEMENT OF THE MONOBLOCK UNIT



DO NOT MANIPULATE INSIDE THE UNIT WITHOUT DISCONNECTING IT FROM MAINS, RISK OF ELECTRIC SHOCK.



Configuration and Calibration procedures should only be performed at field if Portable Control Board, Control Driver Board or the High Voltage Transformer are replaced or the EEPROM memory is re-initialized.

Note 

Refer to Renewal Parts Section for further information on parts identification.



6.3.1 ACCESS INSIDE THE UNIT

Note 

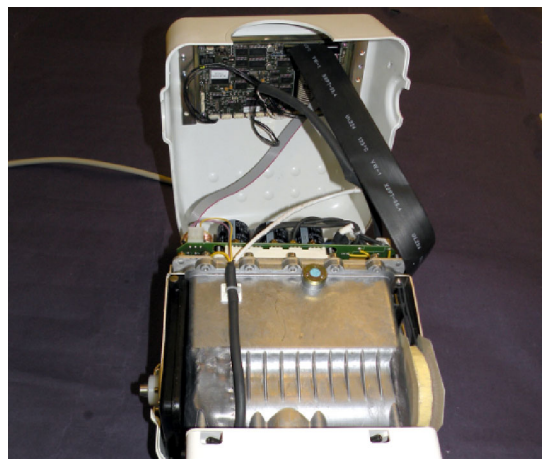
This section only describes the previous steps to carry out the components replacement inside the Unit. For covers replacement refer to Sections 6.3.2 and 6.3.3.

1. Turn the Unit Off and Disconnect it from mains.
2. Place the Unit on a table.

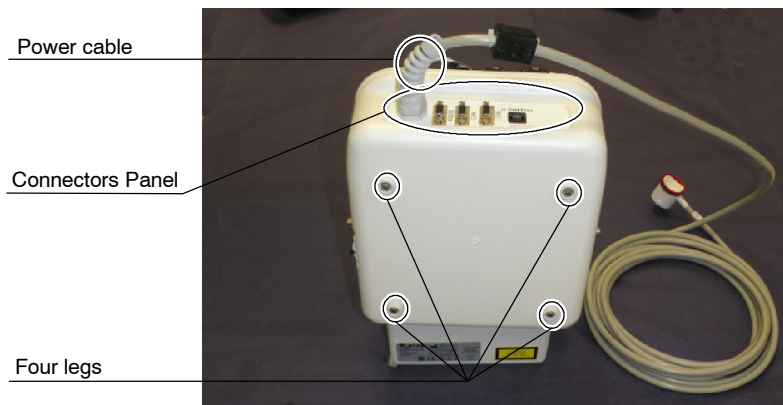
Note 

It is not necessary to remove the Handle to access inside the Unit.

3. Remove the Upper Cover screws and carefully lift the Upper Cover. It is not necessary to unplug any cable.



4. Remove the four legs located at the Lower Cover.

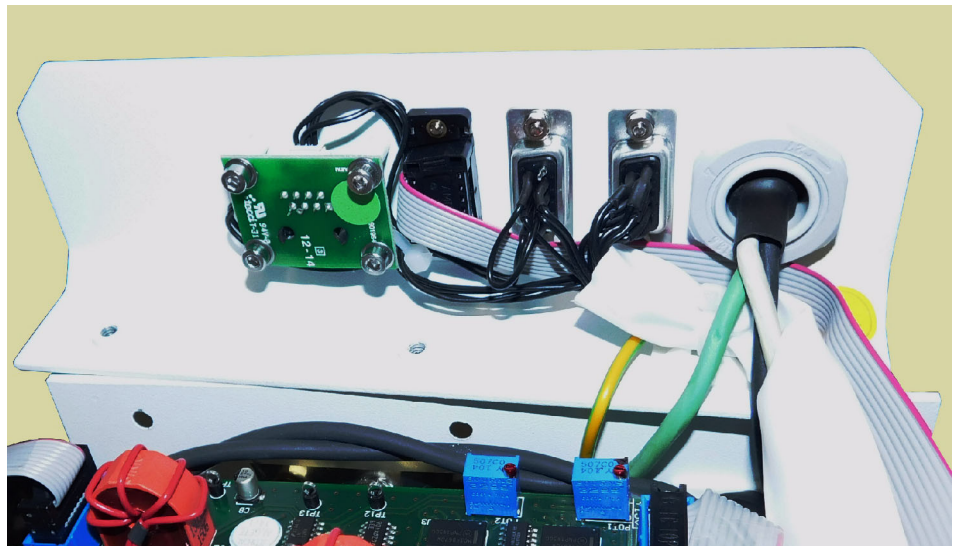


5. Carefully remove the Lower Cover. Pass the Power Line cable through the Connectors Panel window.
6. Unscrew the Connectors Panel.

Connectors Panel



7. Lift the Connectors Panel without unplugging any cable.



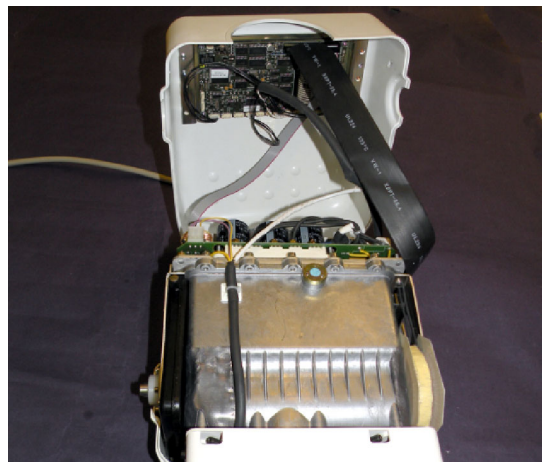
6.3.2 UPPER COVER

1. Turn the Unit Off and Disconnect it from mains.
2. Place the Unit on a table.

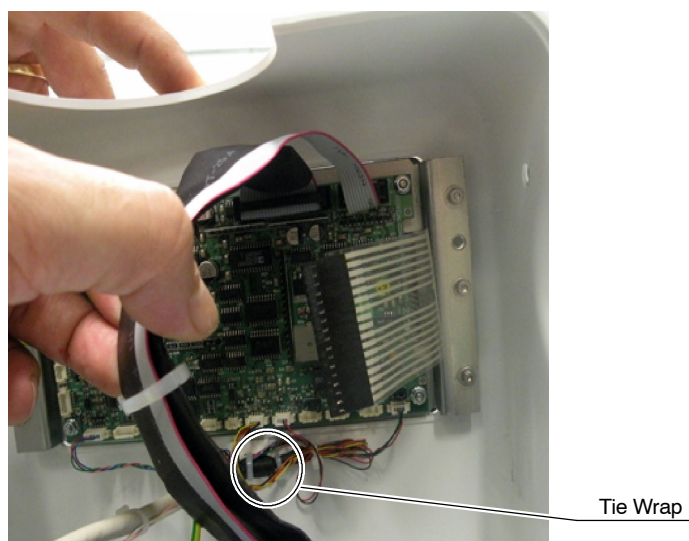
Note 

It is not necessary to remove the Handle for covers replacement.

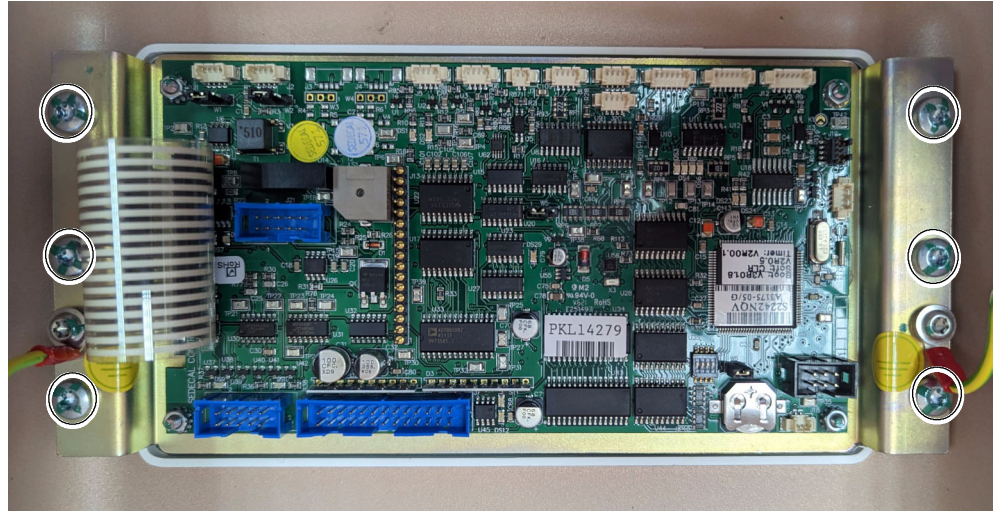
3. Remove the Upper Cover screws and carefully lift the Upper Cover.



4. Cut the tie wrap of the inner part of the Cover. It is not necessary to disconnect any cable from the Portable Control Board (A3175-05) for Upper Cover replacement.



5. Unscrew the screws at both sides of the Portable Control Board support and remove it from the Cover.



6. Re-install the plate support to the new Cover with the screws.
7. Secure the cables connected to Portable Control Board (A3175-05) using a tie wrap with base in the inner part of the Upper Cover.
8. Replace the cover and assemble in reverse order.

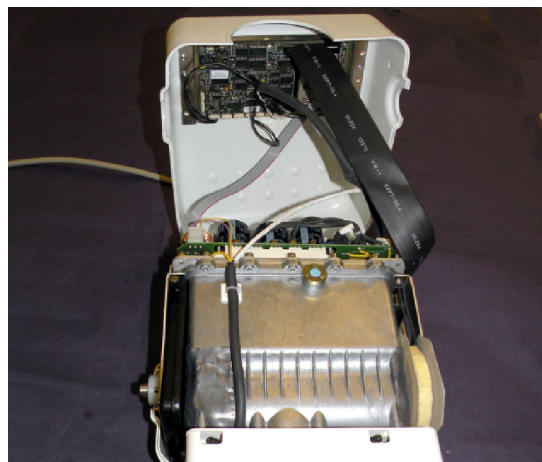
6.3.3 LOWER COVER

1. Turn the Unit Off and Disconnect it from mains.
2. Place the Unit on a table.

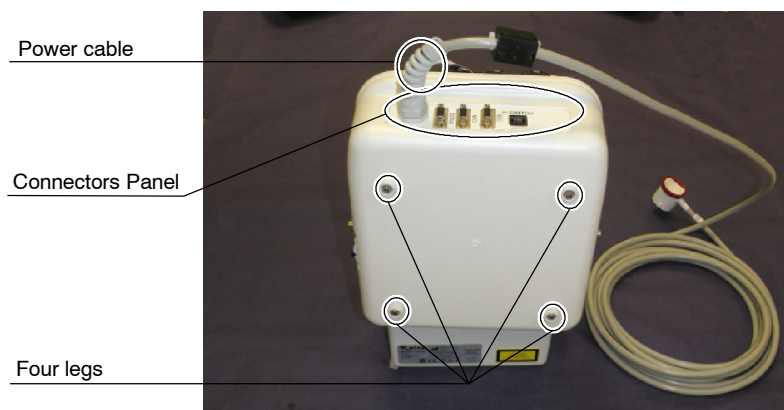
Note 

It is not necessary to remove the Handle for covers replacement.

3. Remove the Upper Cover screws and carefully lift the Upper Cover. It is not necessary to unplug any cable.



4. Remove the four legs located at the Lower Cover.



5. Carefully remove the Lower Cover. Pass the Power cable through the Connectors Panel window.
6. Replace the cover and assemble in reverse order.

6.3.4 HANDLE

1. Remove the shaft assemblies at both sides of the Handle.
2. Replace the Handle carefully (do not scratch the covers). The two (2) shaft assemblies must be installed in the same order that were removed.
3. Tighten strongly the two shaft assemblies of the Handle.



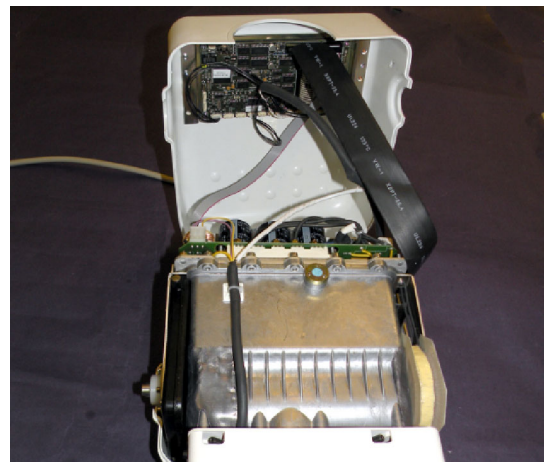
6.3.5 HANDSWITCH SUPPORT

1. Turn the Unit Off and Disconnect it from mains.
2. Place the Unit on a table.

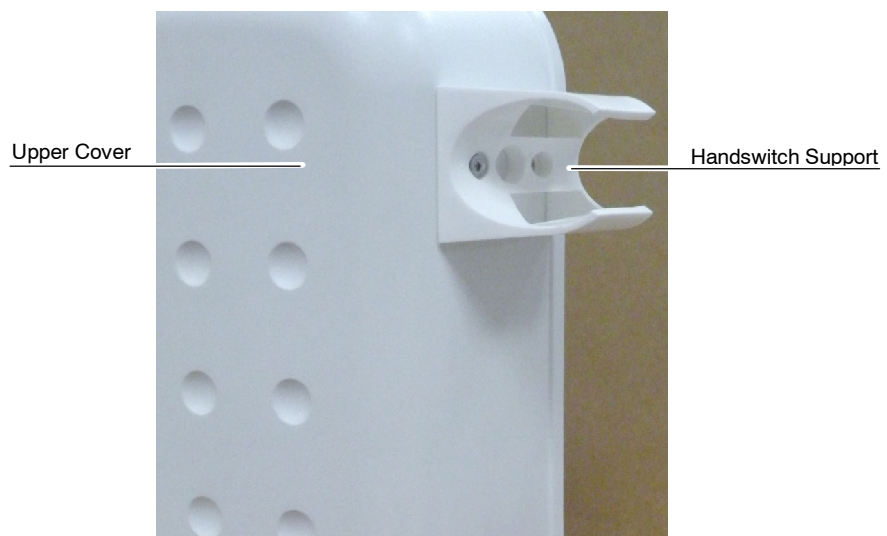
Note 

It is not necessary to remove the Handle to access inside the Unit.

3. Remove the Upper Cover screws and carefully lift the Upper Cover. It is not necessary to unplug any cable.



4. Unscrew the Handswitch Support and replace it.

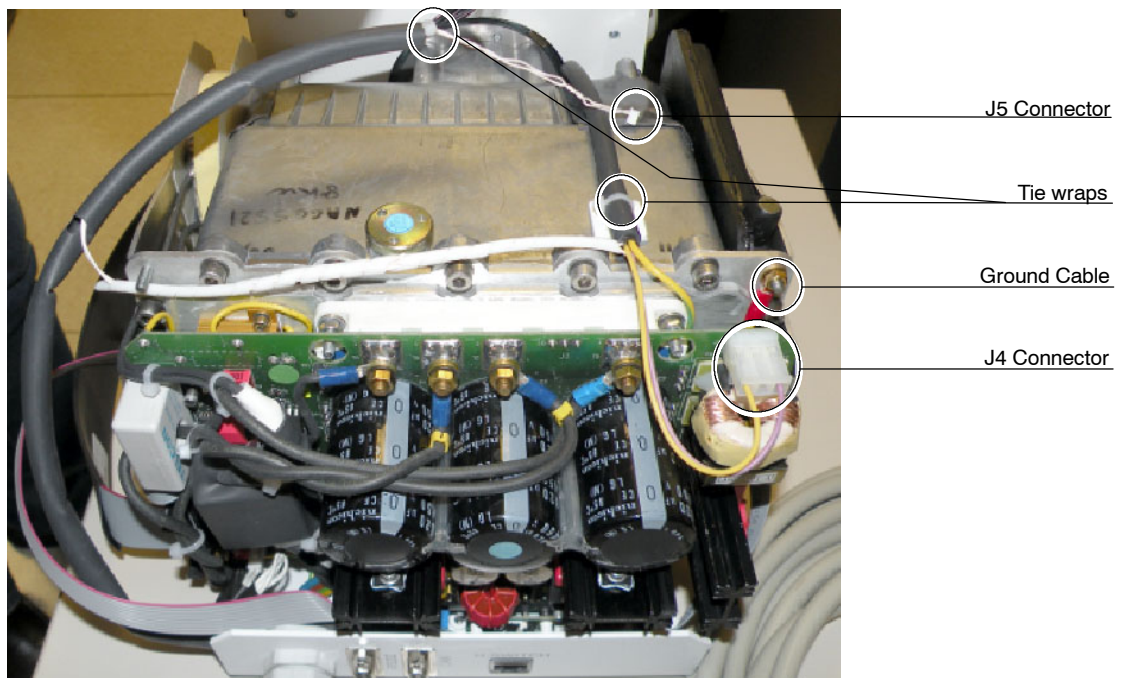


6.3.6 COLLIMATOR

Note 

For replacement of the internal parts of the Collimator included in the Spare Parts List of this Manual, refer to the Collimator Manual.

1. Turn the Unit Off and Disconnect it from mains.
2. Place the Unit on a table.
3. If applicable remove the DAP Rails and SID Guard attached to the Collimator (Refer to Section 6.3.7).
4. Remove the Upper cover screws and carefully lift the cover (refer to Section 6.3.2).
5. Carefully cut the tie wraps.
6. Disconnect the GND cable from the HV Transformer chassis, the J4 connector from the Control Driver Board (A3189-07) and the J5 connector from the Portable Control Board (A3175-05).
7. Take out the cable connected to J5 from the Heat Shrink.



8. Fully unscrew the four (4) Collimator Adjusting Screws and carefully remove the Collimator.



9. Install the new Collimator.



Collimator replacement will affect centering of Collimator light. Screwing may modify position of Collimator and it must be manually centered while tightening the Safety Screws. It is recommended 5 turns to each screw, check parallelism between the Collimator and Unit Chassis, correct position if necessary and finally tighten each Safety Screw with the same number of turns (one by one).

10. Reconnect and assemble in reverse order.



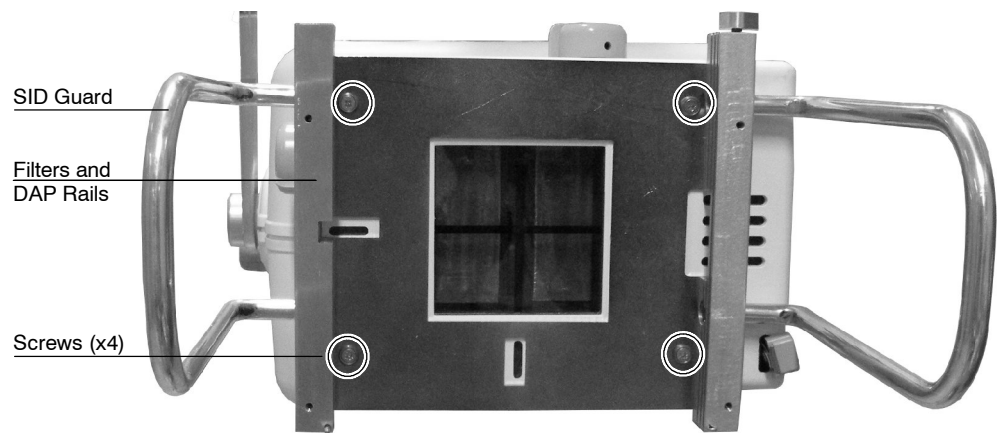
Once the Collimator is replaced, the Unit fully assembled and ready for operation, perform the Adjustments described in Section 4.



VERIFY THAT THE COLLIMATOR IS PROPERLY SEATED AND NO RISK FOR ACCIDENTAL FALL IS POSSIBLE BY TURNING THE COLLIMATOR AROUND AND PULLING DOWNWARDS FROM IT.

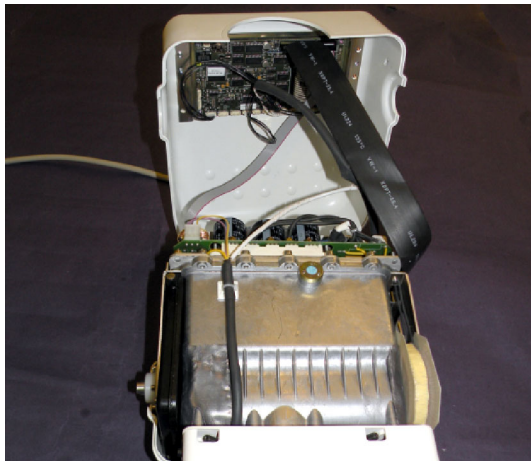
6.3.7 SID GUARD / ALUMINIUM FILTERS AND DAP RAILS

1. Turn the Unit Off and Disconnect it from mains.
2. Disconnect the DAP cable (if applicable) from the Lower Cover of the Power Unit.
3. Remove the aluminium filters (if applicable).
4. Remove the screws (x4) to disassemble the SID Guard / Filters and DAP Rails from the X-Ray Unit.

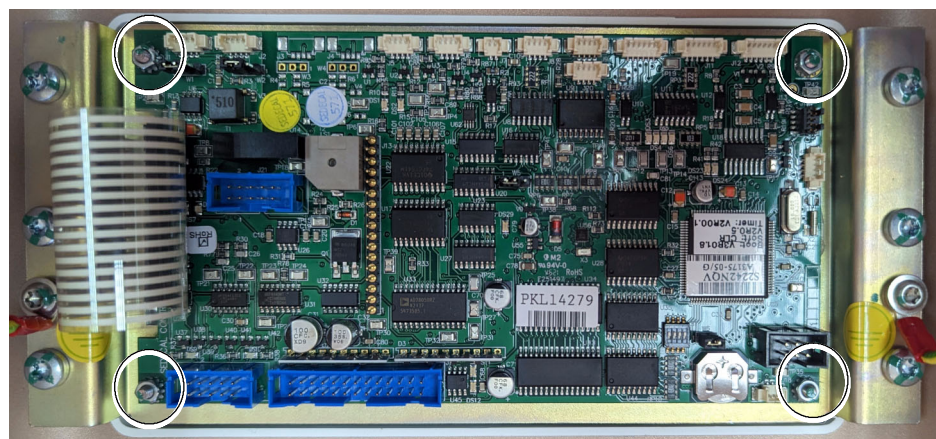


6.3.8 PORTABLE CONTROL BOARD

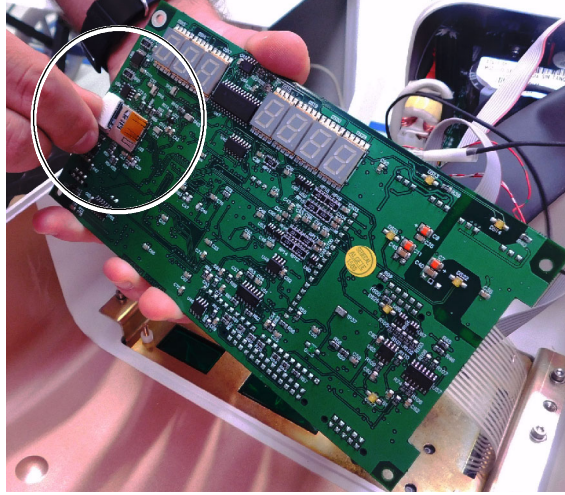
1. Turn the Unit Off and Disconnect it from mains.
2. Place the Unit on a table.
3. Remove the Upper Cover screws and carefully lift the Upper Cover.
4. Unplug all the cables connected to the Portable Control Board (A3175-05).



5. Unscrew the nuts located at each corner of the Portable Control Board and remove it.



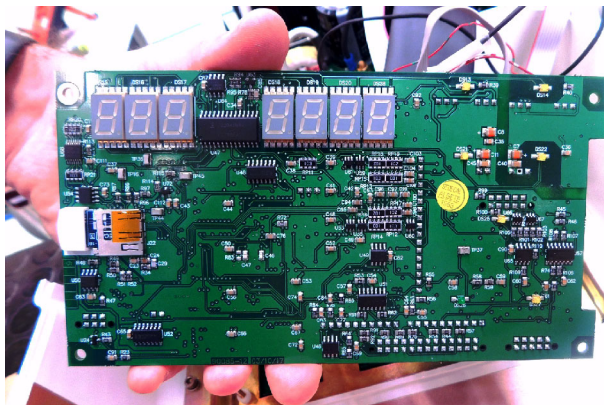
6. Remove the License by pushing and pulling it, and install it in the new Portable Control Board.



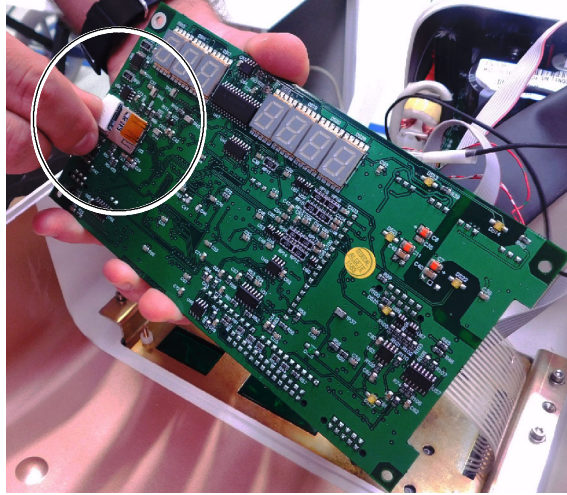
7. Install the new Portable Control Board.
8. Reconnect all the cables and assemble in reverse order.
9. Initialize the new EEPROM (*refer to Section 6.1.1*).

6.3.9 PORTABLE CONTROL BOARD LICENSE

1. Turn the Unit Off and Disconnect it from mains.
2. Place the Unit on a table.
3. Remove the Upper Cover screws and carefully lift the Upper Cover.
4. Unplug the Overlay Flat Flex Cable connected to the Portable Control Board (A3175-05).
5. Unscrew the nuts located at each corner of the Portable Control Board and turn it.



6. Remove the License by pushing and pulling it.



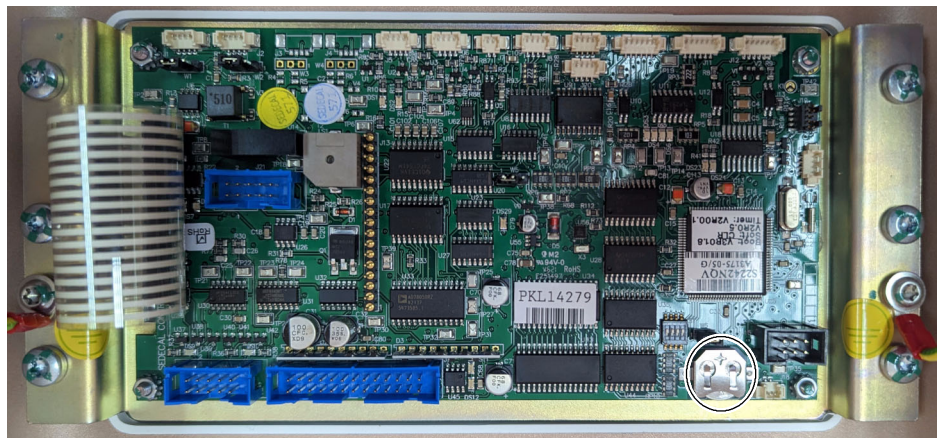
7. Install the new License.
8. Reconnect the Overlay Flat Flex Cable to J3 and assemble in reverse order.
9. Initialize the new EEPROM (*refer to Section 6.1.1*).

6.3.10 REAL TIME CLOCK BATTERY

1. Turn the Unit Off and Disconnect it from mains.
2. Place the Unit on a table.
3. Remove the Upper Cover screws and carefully lift the Upper Cover.



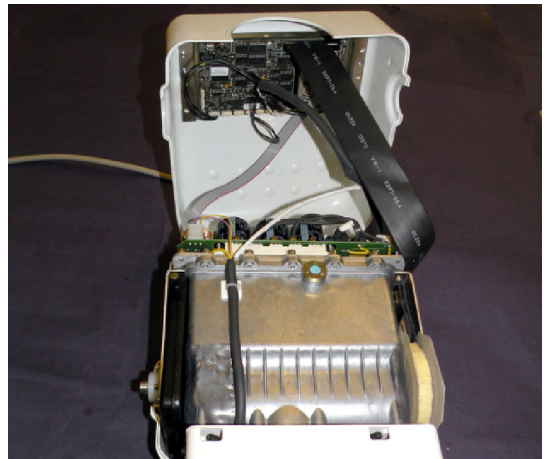
4. Take the battery BAT1 out of the Portable Control Board (A3175-05) and replace it with model "CR1225".



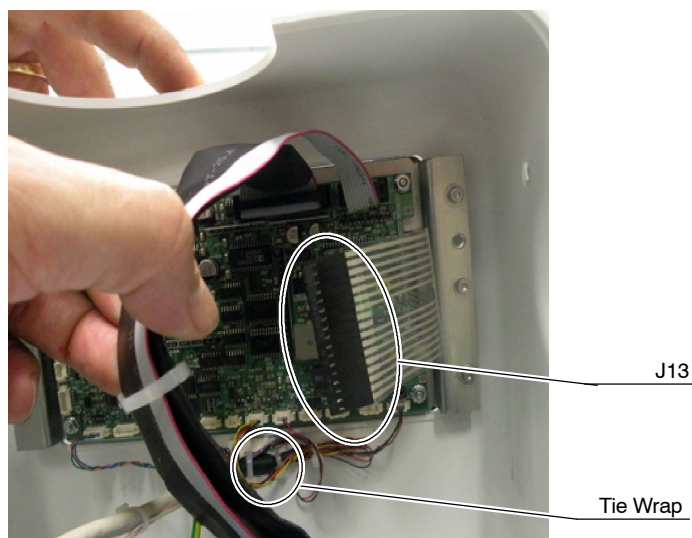
5. Assemble in reverse order.

6.3.11 KEYBOARD

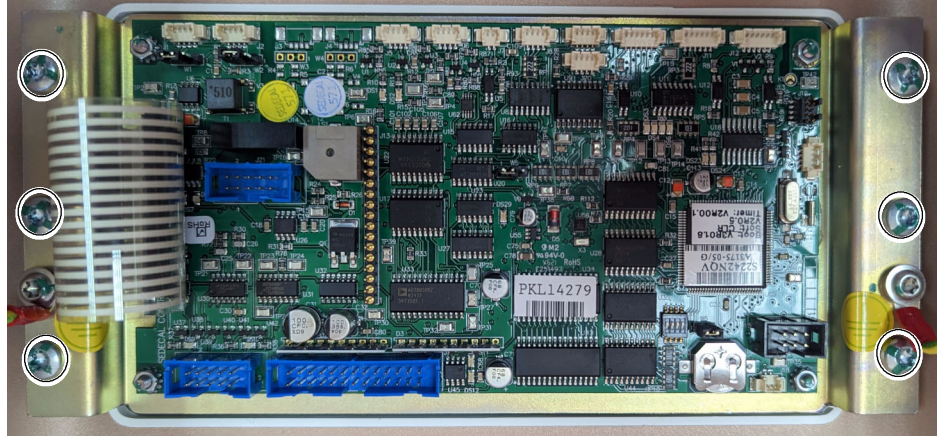
1. Turn the Unit Off and Disconnect it from mains.
2. Place the Unit on a table.
3. Remove the Upper Cover screws and carefully lift the Upper Cover.



4. Disconnect the Keyboard cable (J13) from the Portable Control Board (A3175-05).
5. Cut the tie wrap of the inner part of the Cover. It is not necessary to disconnect the rest of cables from the Portable Control Board for Keyboard replacement.



6. Unscrew the screws at both sides of the Portable Control Board support and remove it.

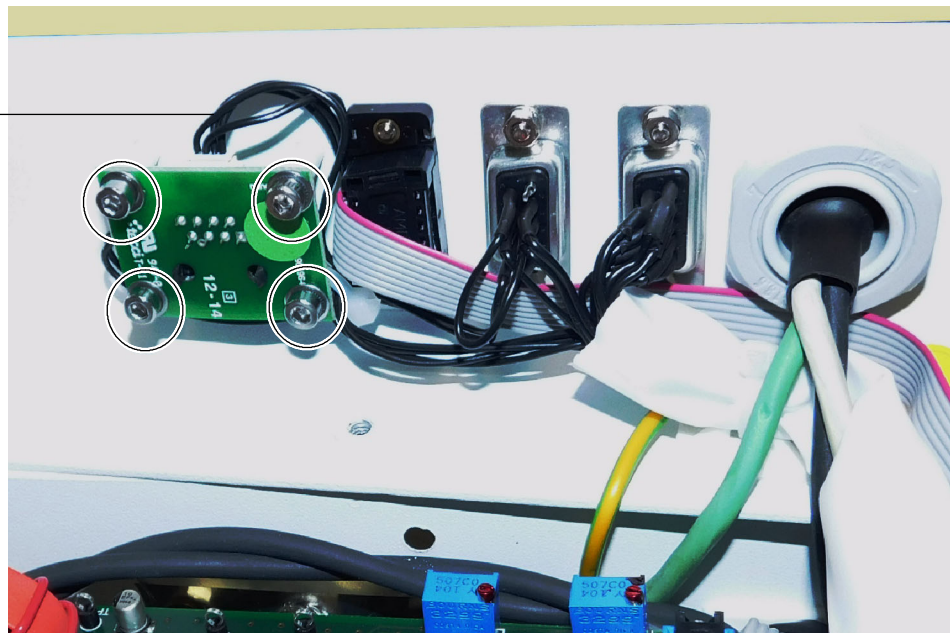


7. Unstick the old Keyboard from the plate support.
8. Clean the remaining glue with alcohol from the support plate and stick the new Keyboard.
9. Reconnect and assemble in reverse order.

6.3.12 HANDSWITCH BOARD

1. Access inside the Unit by removing Upper and Lower Covers and unscrewing the Connectors Panel (refer to Section 6.3.1).
2. Remove the four screws from the Handswitch Board (A9536-02) and disconnect the J6 connector.

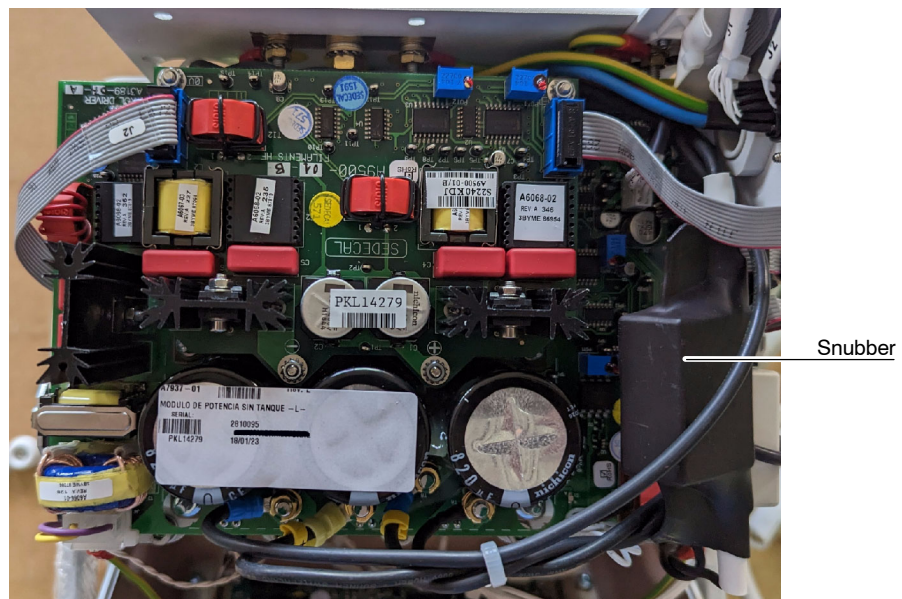
J6 connector



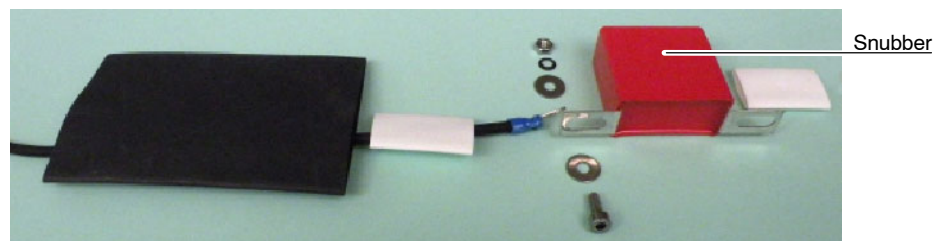
3. Replace the Handswitch Board (A9536-02), reconnect and assemble in reverse order.

6.3.13 SNUBBER

1. Access inside the Unit by removing Upper and Lower Covers and unscrewing the Connectors Panel (refer to Section 6.3.1).
2. Cut the Tie Wraps at both sides of the Snubber and others if needed.
3. Cut the Heat Shrinks (large and small ones) and remove the screws, nuts and washers from the Snubber.



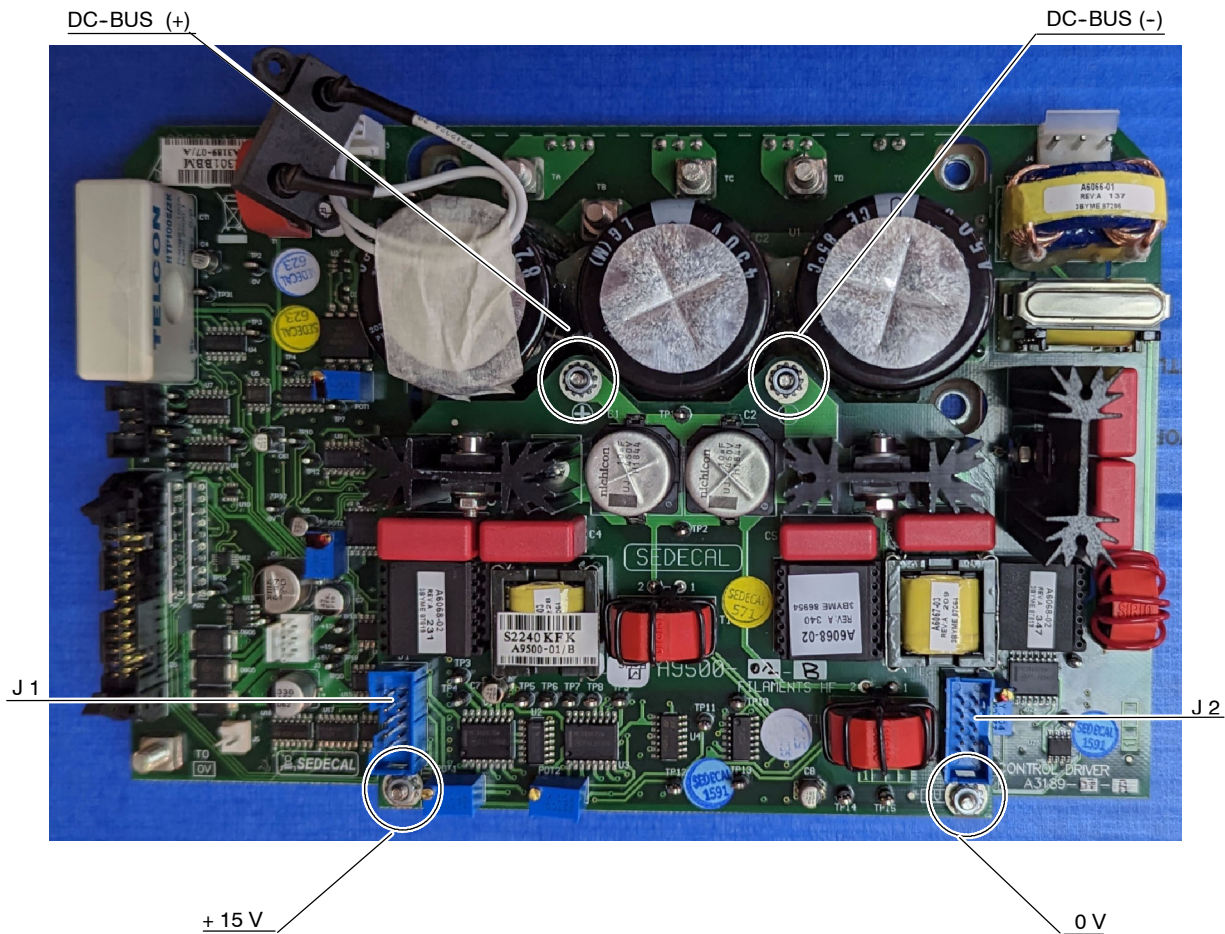
4. Pass the cable through the new large Heat Shrink and then through one of the new small Heat Shrinks.
5. Tighten the screws, nuts and washers previously removed at both sides of the new Snubber, cover both terminals with the small Heat Shrinks and apply heat to reduce the Heat Shrinks.



6. Cover the Snubber and its terminals with the large Heat Shrink, apply heat to reduce the Heat Shrink and fasten it with two Tie Wraps at the ends. Replace the other Tie Wraps previously removed.
7. Reconnect and assemble in reverse order.

6.3.14 FILAMENTS HF BOARD

1. Access inside the Unit by removing Upper and Lower Covers and unscrewing the Connectors Panel (refer to Section 6.3.1).
2. Remove the two Ribbon cables connected to J1 and J2 of the Filaments HF Board (A9500-01).
3. Carefully unscrew the four (4) nuts and washers that assemble the Filaments HF Board (A9500-01) to the Control Driver Board (A3189-07). These screws are the contacts for 0 V, +15 V, DC-BUS (+) and DC-BUS (-). Carefully remove the board.



4. Replace the Filaments HF Board (A9500-01), reconnect and assemble in reverse order.
5. After replacing the Filaments HF Board (A9500-01), follow the next steps in order to verify the large and small focus adjustment.

LARGE FOCUS:

- a. On Filaments HF Board (A9500-01), connect the oscilloscope:
 - CH1: TP11 (V)
 - CH2: TP9 or TP8 (frequency)
 - GND = TP14 / TP15
- b. Select LF, enter in manual calibration, select 40 kVp / 100 mA and enter the data "930".
- c. Press PREP and adjust the POT 2 to see the maximum possible voltage on TP11 (4.5 Volts approx. in PREP; 2.4 Volts in Standby). Once the maximum voltage on TP11 has been reached and the voltage stops increasing, apply two more turns to the potentiometer in the same direction.
- d. Verify that the frequency on TP9 is $106.4 < f < 159.6$ kHz.

SMALL FOCUS:

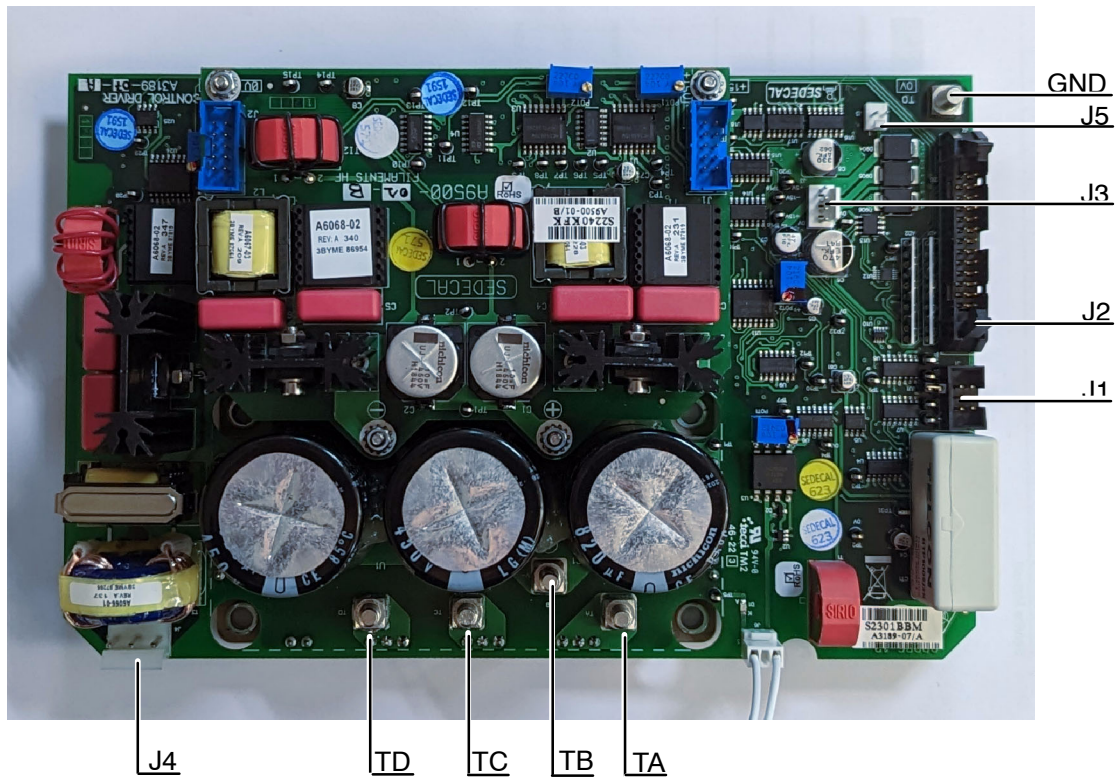
- e. On Filaments HF Board (A9500-01), Connect the oscilloscope:
 - CH1: TP12 (V)
 - CH2: TP3 or TP4 (frequency)
 - GND = TP14 / TP15
 - f. Select SF, enter in manual calibration, select 40 kVp / 20 mA and enter the data "700".
 - g. Press PREP and adjust the POT 1 to see the maximum possible voltage on TP12 (3.4 Volts approx. in PREP; 2.4 Volts in Standby). Once the maximum voltage on TP12 has been reached and the voltage stops increasing, apply two more turns to the potentiometer in the same direction.
 - h. Verify that the frequency on TP3 is $106.4 < f < 159.6$ kHz.
6. Perform Autocalibration (*Refer to Section 3.2.4*).

6.3.15 CONTROL DRIVER BOARD

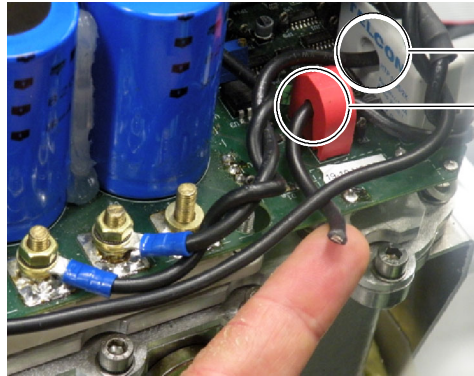
1. Access inside the Unit by removing Upper and Lower Covers and unscrewing the Connectors Panel (refer to Section 6.3.1).
2. Disconnect from the Control Driver Board (A3189-07) the cables connected to J1, J2, J3, J4, J5, GND. Then remove the four (4) nuts attaching the cables connected to TA, TB, TC, TD bolts and take out the cables from the bolts.



Take note of the correspondence of each cable connected to each bolt (TA, TB, TC, TD). It is recommended to mark each cable to avoid any mistakes when replacing the Board.



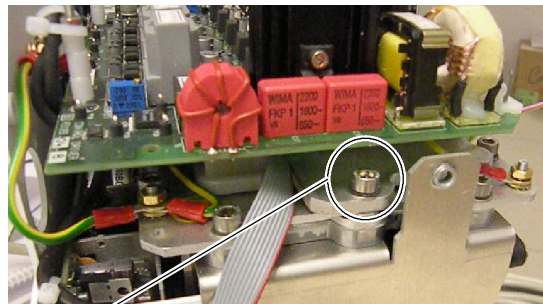
3. Cut the Tie Wraps when needed. Cut the round connector of the TA cable and take it out through the red (round) Current Transformer and take out TB cable (it is not necessary to cut this one) through the grey (square) Voltage Measurer.



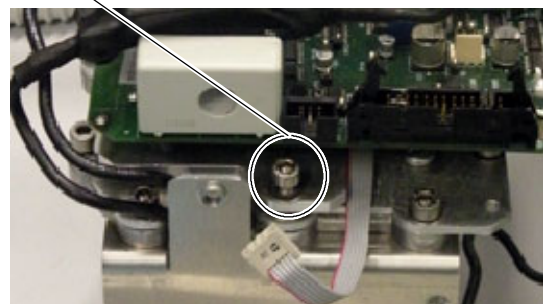
Voltage Measurer

Current Transformer

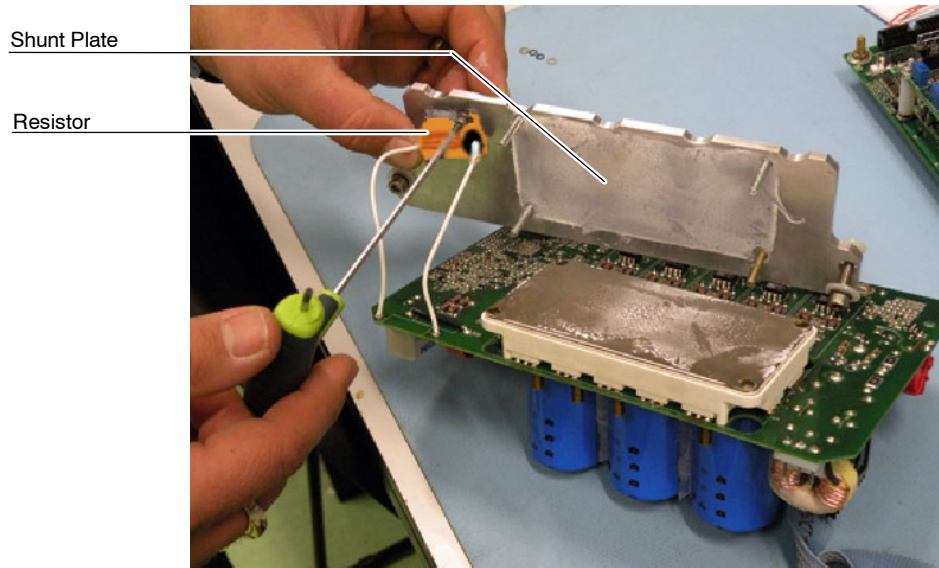
4. The Control Driver Board assembly comprises this Board, the Filaments HF Board, the IGBT, an external Resistor and an aluminium Shunt Plate that is fixed to the HV Transformer with two screws. Unscrew the two (2) allen screws located under both sides of the Control Driver Board and take out the assembly.



Shunt Plate Screws



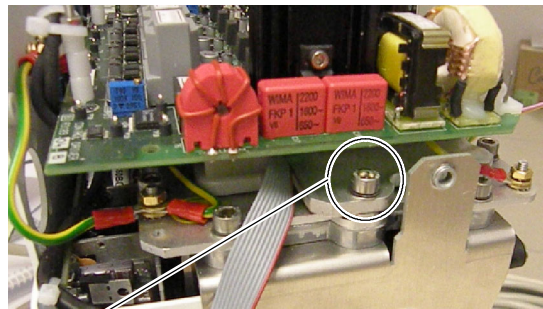
5. Disassemble the Shunt Plate and the Resistor.



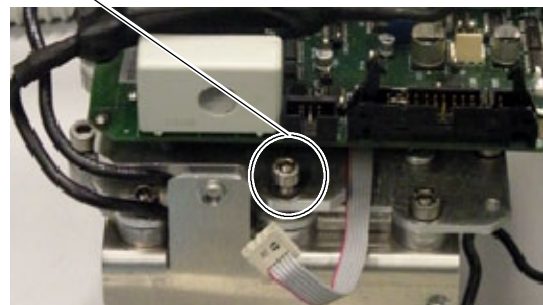
6. Remove old silicone on the Shunt Plate and apply a new layer on its surface. Assemble the new Control Driver Board (A3189-07) to the Shunt Plate by screwing the Resistor and the IGBT screws.



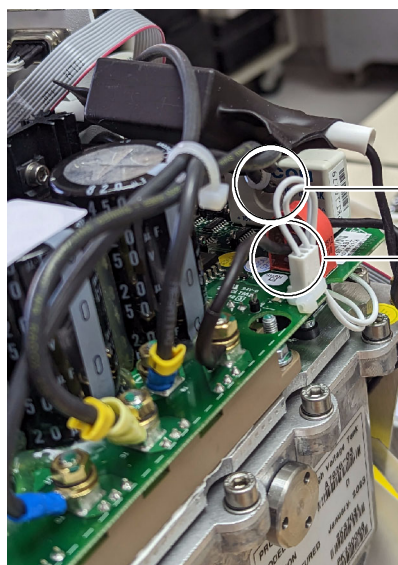
7. Secure the Control Driver Board assembly to the HV Transformer with the two screws removed before.



Shunt Plate Screws



8. Pass the TA cable through the red (round) Current Transformer, crimp the round connector included in the kit. Pass the TB cable through the grey (square) Voltage Measurer. Attach cables with Tie Wraps when needed.



Voltage Measurer

Current Transformer

9. Reconnect and assemble in reverse order.

10. After replacing the Control Driver Board (A3189-07), follow the next steps in order to verify the large and small focus adjustment.

LARGE FOCUS:

- a. On Filaments HF Board (A9500-01), connect the oscilloscope:
 - CH1: TP11 (V)
 - CH2: TP9 or TP8 (frequency)
 - GND = TP14 / TP15
- b. Select LF, enter in manual calibration, select 40 kVp / 100 mA and enter the data "930".
- c. Press PREP and adjust the POT 2 to see the maximum possible voltage on TP11 (4.5 Volts approx. in PREP; 2.4 Volts in Standby). Once the maximum voltage on TP11 has been reached and the voltage stops increasing, apply two more turns to the potentiometer in the same direction.
- d. Verify that the frequency on TP9 is $106.4 < f < 159.6$ kHz.

SMALL FOCUS:

- e. On Filaments HF Board (A9500-01), Connect the oscilloscope:
 - CH1: TP12 (V)
 - CH2: TP3 or TP4 (frequency)
 - GND = TP14 / TP15
 - f. Select SF, enter in manual calibration, select 40 kVp / 20 mA and enter the data "700".
 - g. Press PREP and adjust the POT 1 to see the maximum possible voltage on TP12 (3.4 Volts approx. in PREP; 2.4 Volts in Standby). Once the maximum voltage on TP12 has been reached and the voltage stops increasing, apply two more turns to the potentiometer in the same direction.
 - h. Verify that the frequency on TP3 is $106.4 < f < 159.6$ kHz.
11. Perform Autocalibration (*Refer to Section 3.2.4*).

6.3.16 HV TRANSFORMER

1. Remove the special screws at both sides of the Handle. Take care with the washers.
2. Remove the Handle carefully (do not scratch the covers).

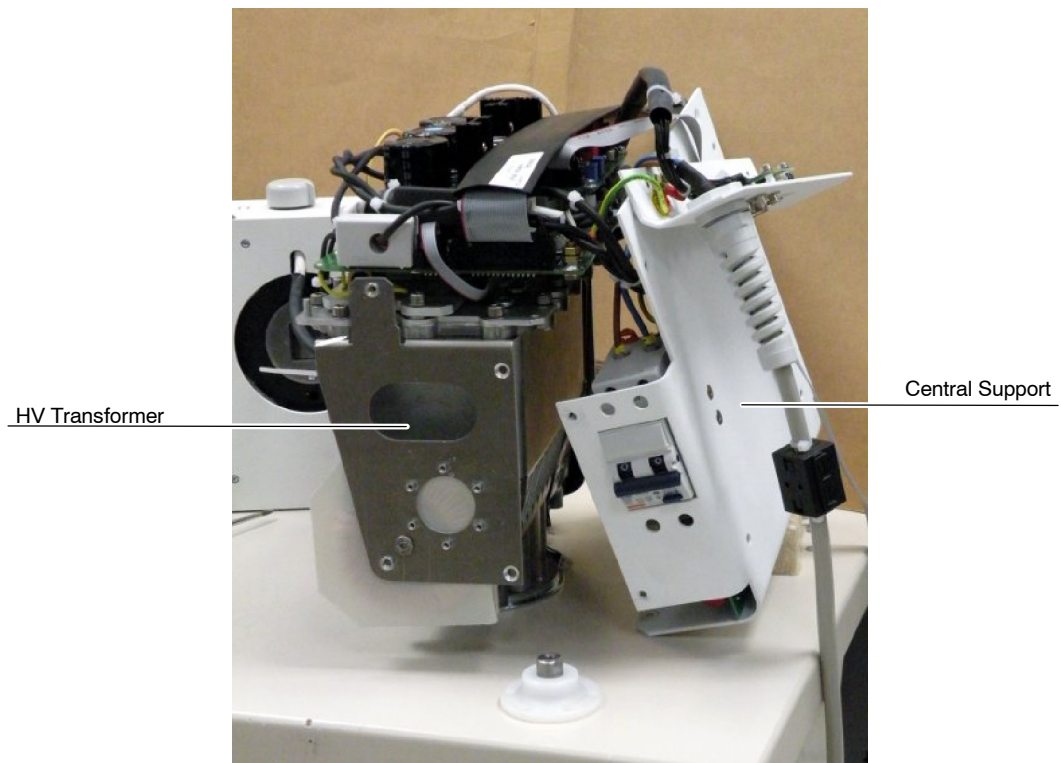
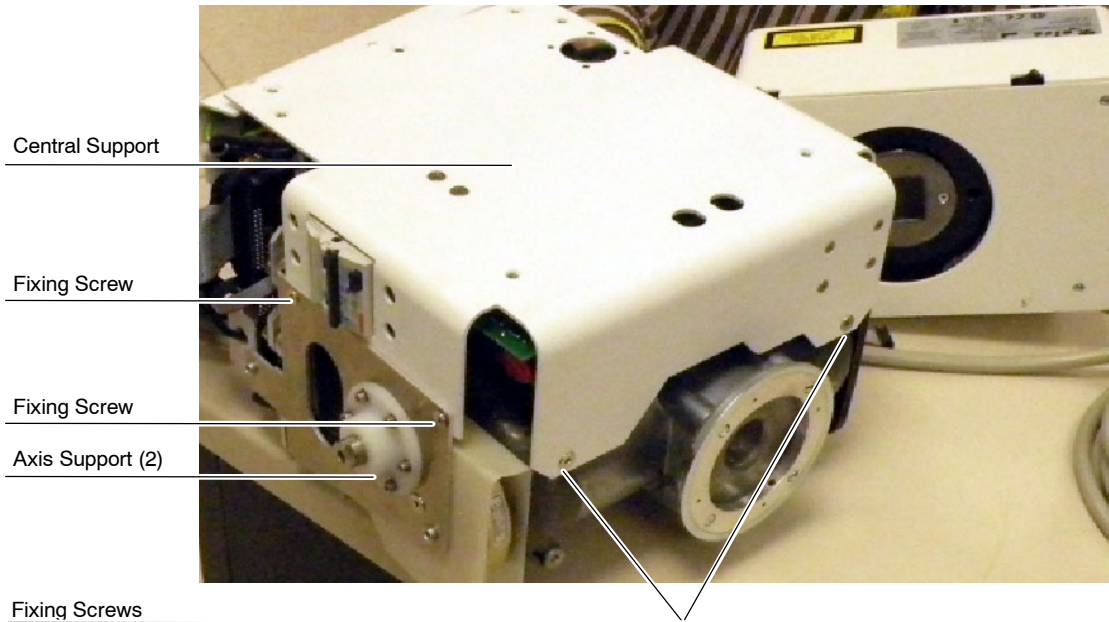


3. If applicable remove the DAP Rails and SID Guard attached to the Collimator (*Refer to Section 6.3.7*).
4. Fully unscrew the four (4) Collimator Adjusting Screws and carefully put the Collimator aside without disconnecting the cables.



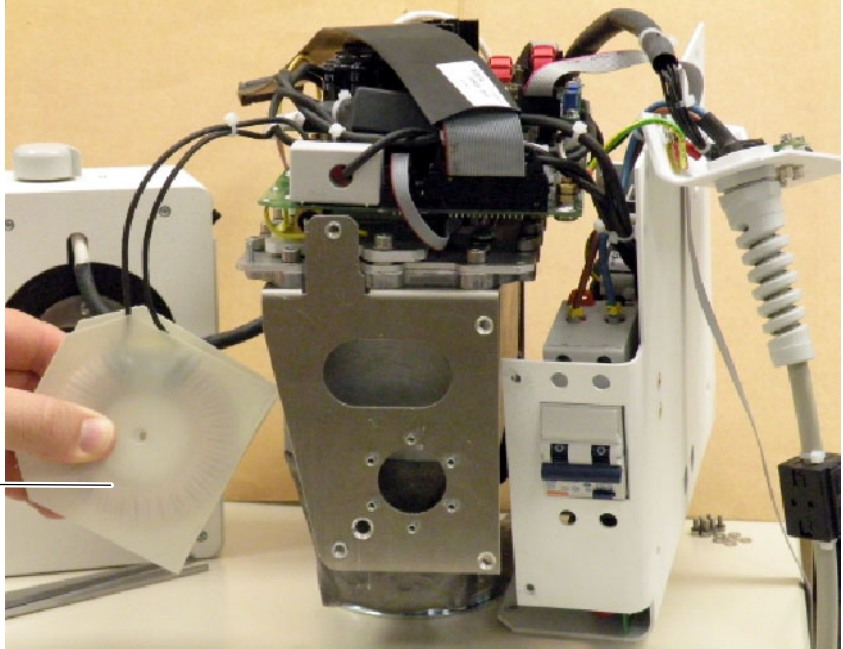
5. Access inside the Unit by removing Upper and Lower Covers and unscrewing the Connectors Panel (*refer to Section 6.3.1*).

- Put aside the Central Support by removing the four (4) fixing screws located at both sides and the two (2) fixing screws located at the front side of the Central Support. Remove the two Handle Axis Supports.



- Put aside the Resonant Inductance cutting the Tie Wrap and removing the screw that fixes it to the HV Transformer Support.

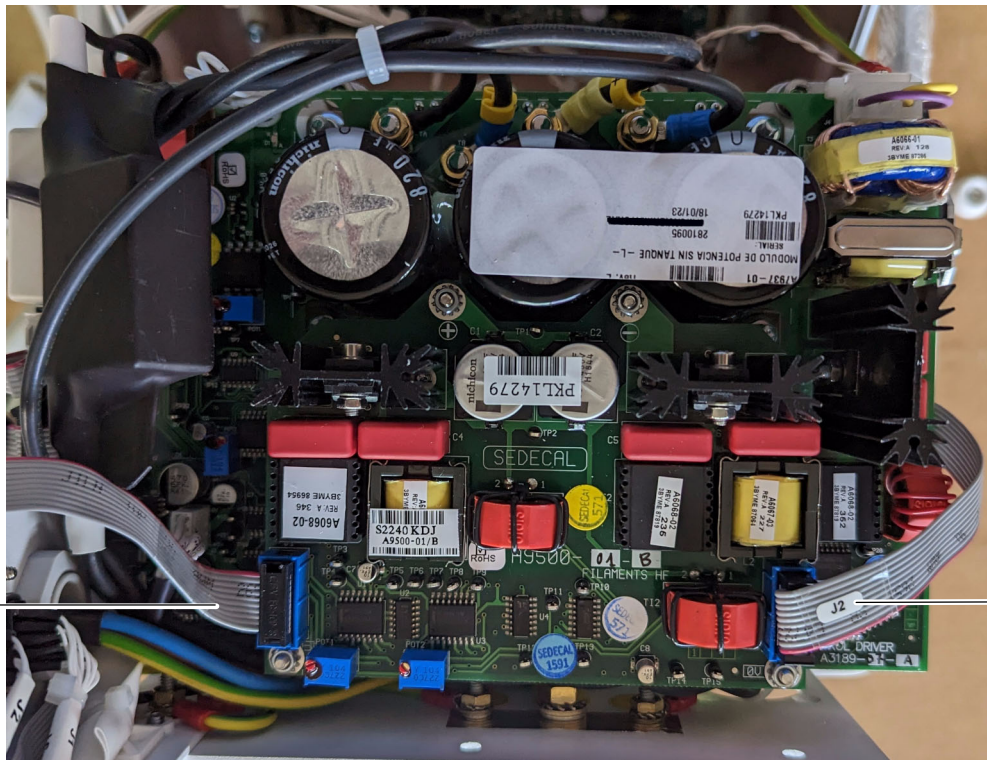
Resonant Inductance



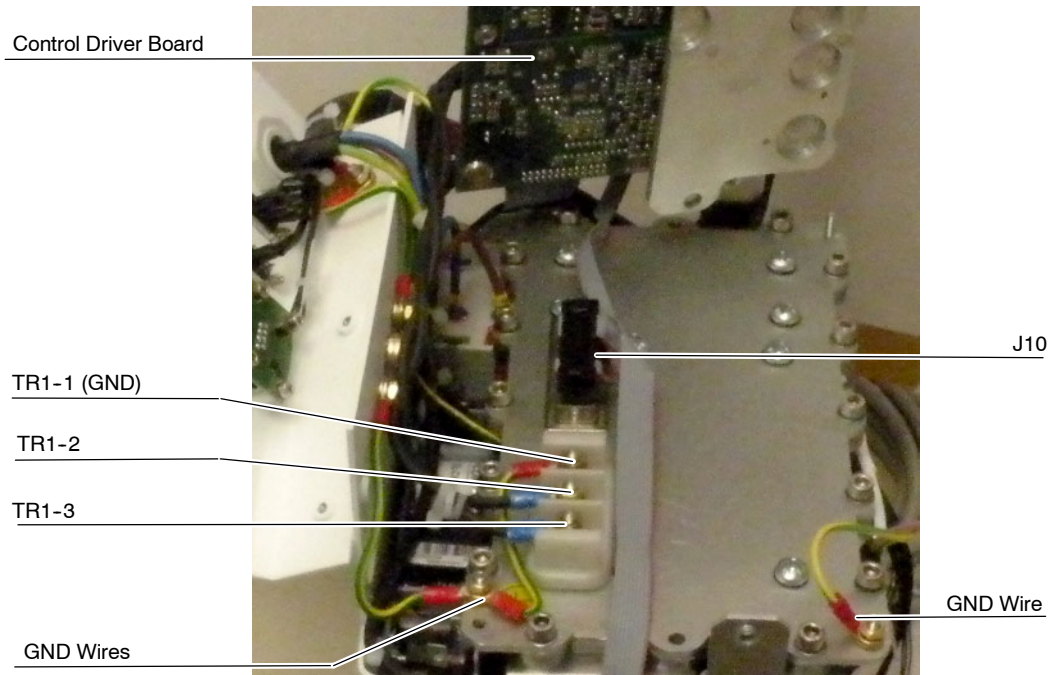
- Remove the two Ribbon cables connected to J1 and J2 of the Filaments HF Board (A9500-01).

J1

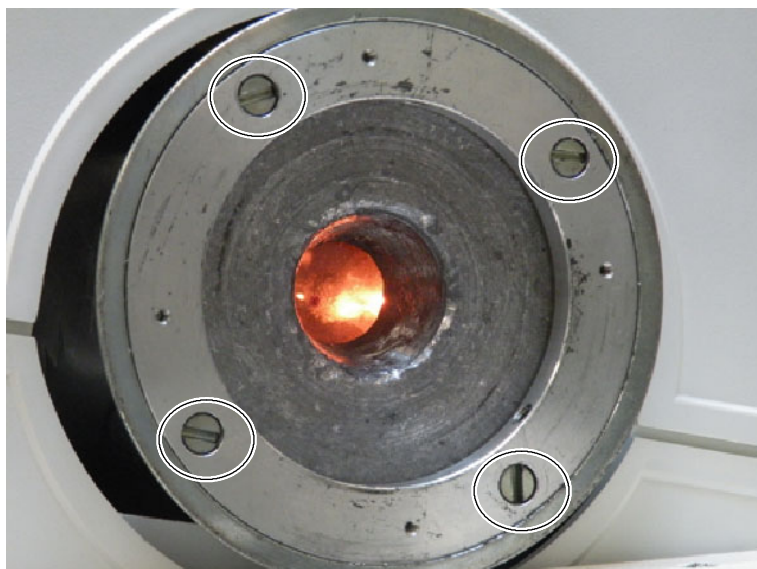
J2



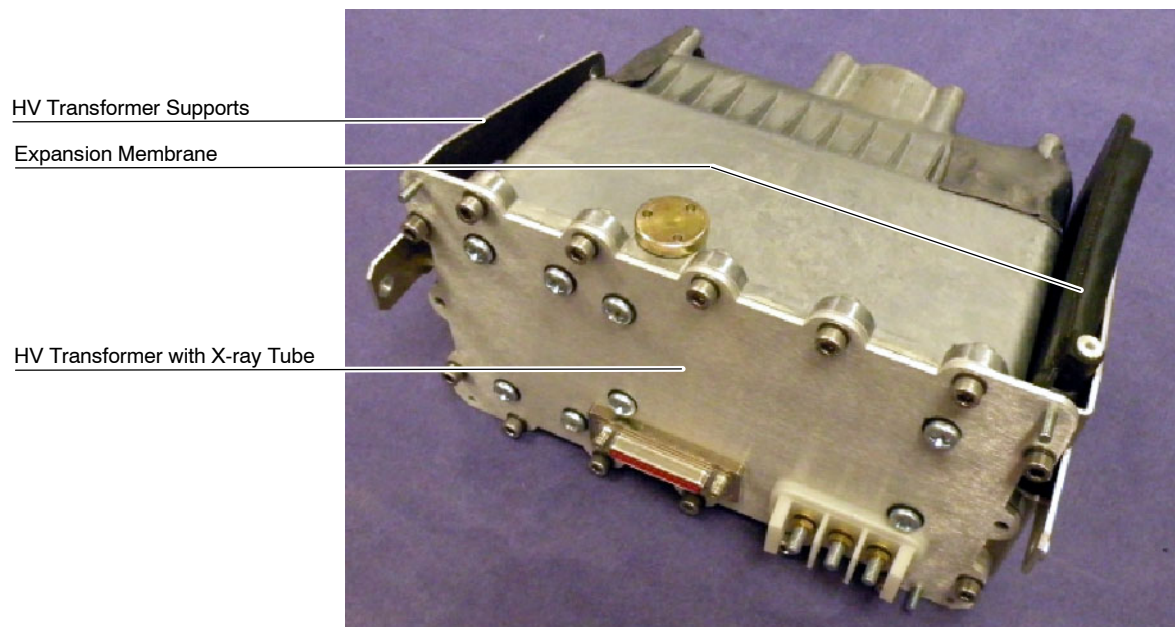
9. Remove the Control Driver Board (A3189-07) as described in *Section 6.3.15* without disassembling the Filaments HF Board (A9500-01).
10. From the HV Transformer, disconnect the J10 Ribbon cable, the wires connected to TR1-2, TR1-3, TR1-1 (GND) and the three GND wires fixed to the HV Transformer screws.



11. Remove the Collimator Adaptation Ring.



12. Replace the HV Transformer. The HV Transformer assembly comprises the HV Transformer with the X-ray Tube, the Expansion Membrane and the two HV Transformer Supports.



13. Re-install the Collimator Adaptation Ring in the new HV Transformer.
14. Connect the J10 Ribbon cable, the wires connected to TR1-2, TR1-3, TR1-1 (GND) and the three GND wires fixed to the HV Transformer screws.
15. Re-install the Control Driver Board (A3189-07) and connect the two Ribbon cables to J1 and J2 of the Filaments HF Board (A9500-01).
16. Mount the Resonant Inductance in HV Transformer fixing its wires with a Tie Wrap.

17. At this point, follow the steps below in order to verify the large and small focus adjustment.

LARGE FOCUS:

- a. On Filaments HF Board (A9500-01), connect the oscilloscope:
 - CH1: TP11 (V)
 - CH2: TP9 or TP8 (frequency)
 - GND = TP14 / TP15
- b. Select LF, enter in manual calibration, select 40 kVp / 100 mA and enter the data "930".
- c. Press PREP and adjust the POT 2 to see the maximum possible voltage on TP11 (4.5 Volts approx. in PREP; 2.4 Volts in Standby). Once the maximum voltage on TP11 has been reached and the voltage stops increasing, apply two more turns to the potentiometer in the same direction.
- d. Verify that the frequency on TP9 is $106.4 < f < 159.6$ kHz.

SMALL FOCUS:

- e. On Filaments HF Board (A9500-01), Connect the oscilloscope:
 - CH1: TP12 (V)
 - CH2: TP3 or TP4 (frequency)
 - GND = TP14 / TP15
- f. Select SF, enter in manual calibration, select 40 kVp / 20 mA and enter the data "700".
- g. Press PREP and adjust the POT 1 to see the maximum possible voltage on TP12 (3.4 Volts approx. in PREP; 2.4 Volts in Standby). Once the maximum voltage on TP12 has been reached and the voltage stops increasing, apply two more turns to the potentiometer in the same direction.
- h. Verify that the frequency on TP3 is $106.4 < f < 159.6$ kHz.

18. Once verified the Filament Adjustment, proceed with the HV Seasoning as follows:
 - a. Close Collimator Blades fully and make sure that no one will be exposed.
 - b. Make sure that X-ray Tube is fully cold (at least 30 minutes without making exposures).
 - c. Reduce the power manually to 20% in case of 4 kW or 5 kW units or 10% in case of 8 kW units. On the X-ray Unit Control Panel, press and hold the "Large Focal Spot" push-button and then press the "kVp Decrease" push-button several times until "P10 or P20" respectively is shown in the kVp display.
 - d. Select 70 kVp, 10 mAs and Large Focus. Perform one exposure per minute increasing 5 kVp in every exposure up to the maximum Tube voltage.
 - e. If there are not signs of instability, the tube is ready for normal use.
 - f. If instability is observed during procedure, reduce 5 kVp of the selected kVp and make two exposures at those kVp, then continue the process.
 - g. Once the seasoning procedure is completed, set the power at 100% again. On the X-ray Unit Control Panel, press and hold the "Large Focal Spot" push-button and then press the "kVp Increase" push-button several times until "P--" is shown in the kVp display.

Note 

Check that the remaining Thermal Capacity of the X-ray Tube is above 80% during this process.

19. Perform Autocalibration (*Refer to Section 3.2.4*).
20. Assemble the Central Support and the two Handle Axis Supports.
21. Assemble the Connectors Panel and the Upper and Lower Covers.

22. Re-install the Collimator.



Collimator replacement will affect centering of Collimator light. Screwing may modify position of Collimator and it must be manually centered while tightening the Safety Screws. It is recommended 5 turns to each screw, check parallelism between the Collimator and Unit Chassis, correct position if necessary and finally tighten each Safety Screw with the same number of turns (one by one).




Once the Collimator is replaced, the Unit fully assembled and ready for operation, perform the Adjustments described in Section 4.


23. If applicable, assemble the DAP Rails and SID Guard attached to the Collimator.
24. Re-install the Handle carefully (do not scratch the covers). The washers must be installed in the same order that were removed. Tighten strongly the two special screws of the Handle.

6.3.17 REPLACEMENT PARTS IN THE CENTRAL SUPPORT

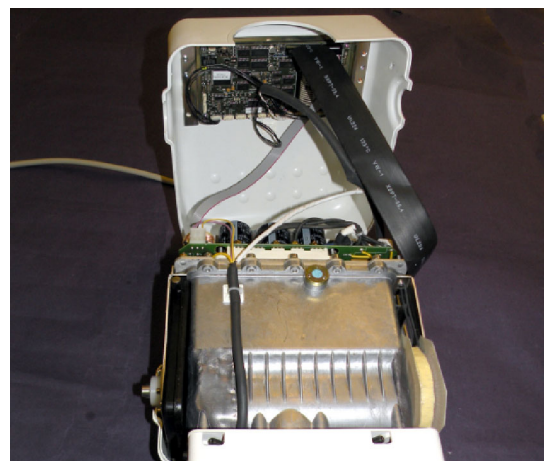
6.3.17.1 ACCESS INSIDE THE CENTRAL SUPPORT

Note  This section only describes the previous steps to carry out the component replacement inside the Central Support.

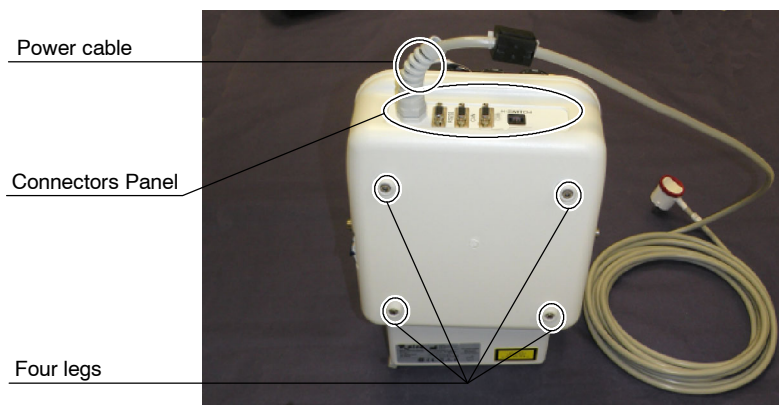
1. Turn the Unit Off and Disconnect it from mains.
2. Place the Unit on a table.

Note  It is not necessary to remove the Handle to access inside the Central Support.

3. Remove the Upper Cover screws and carefully lift the Upper Cover. It is not necessary to unplug any cable.



4. Remove the four legs located at the Lower Cover.



5. Carefully remove the Lower Cover. Pass the Power Line cable through the Connectors Panel window.
6. If applicable remove the DAP Rails and SID Guard attached to the Collimator (*Refer to Section 6.3.7*).
7. Fully unscrew the four (4) Collimator Adjusting Screws and carefully put the Collimator aside without disconnecting the cables.



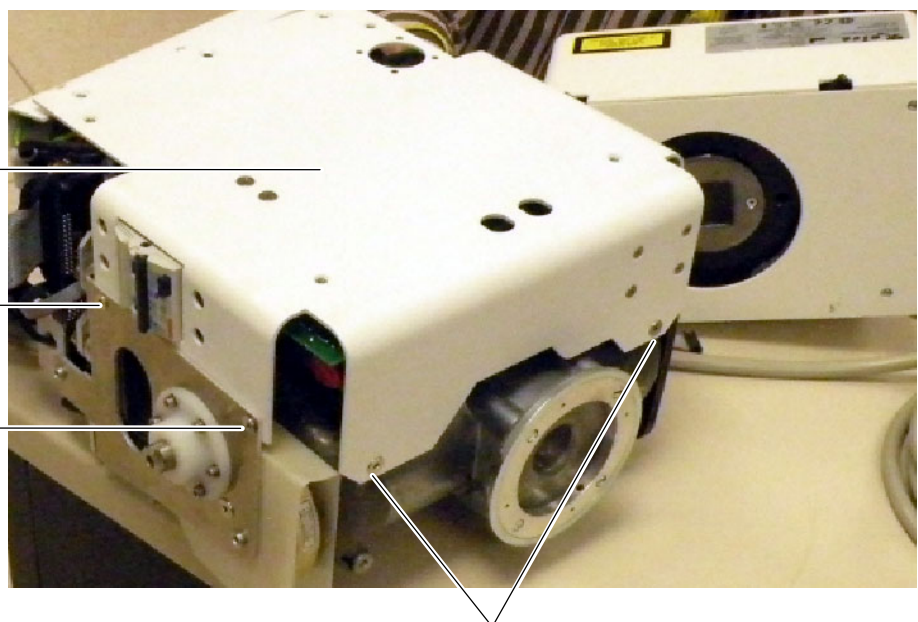
8. Put aside the Central Support by removing the four (4) fixing screws located at both sides and the two (2) fixing screws located at the front side of the Central Support.

Central Support

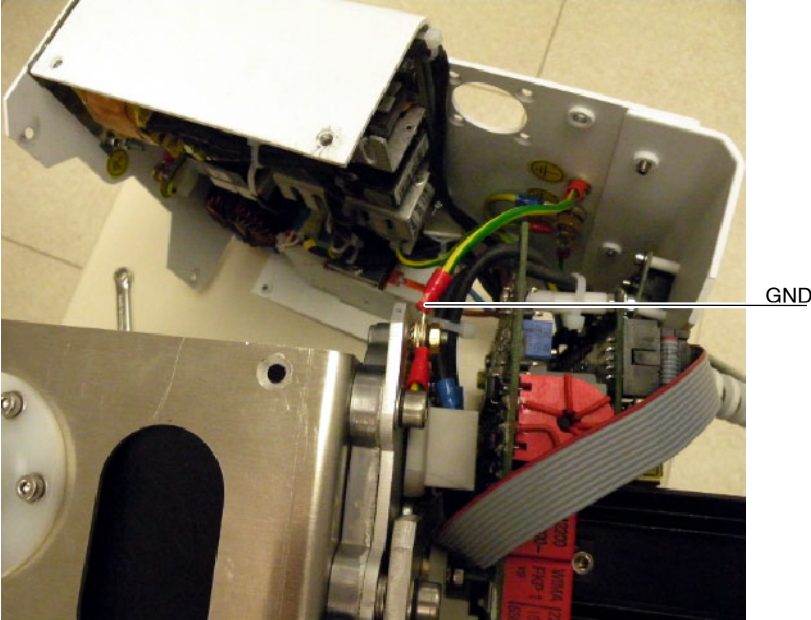
Fixing Screw

Fixing Screw

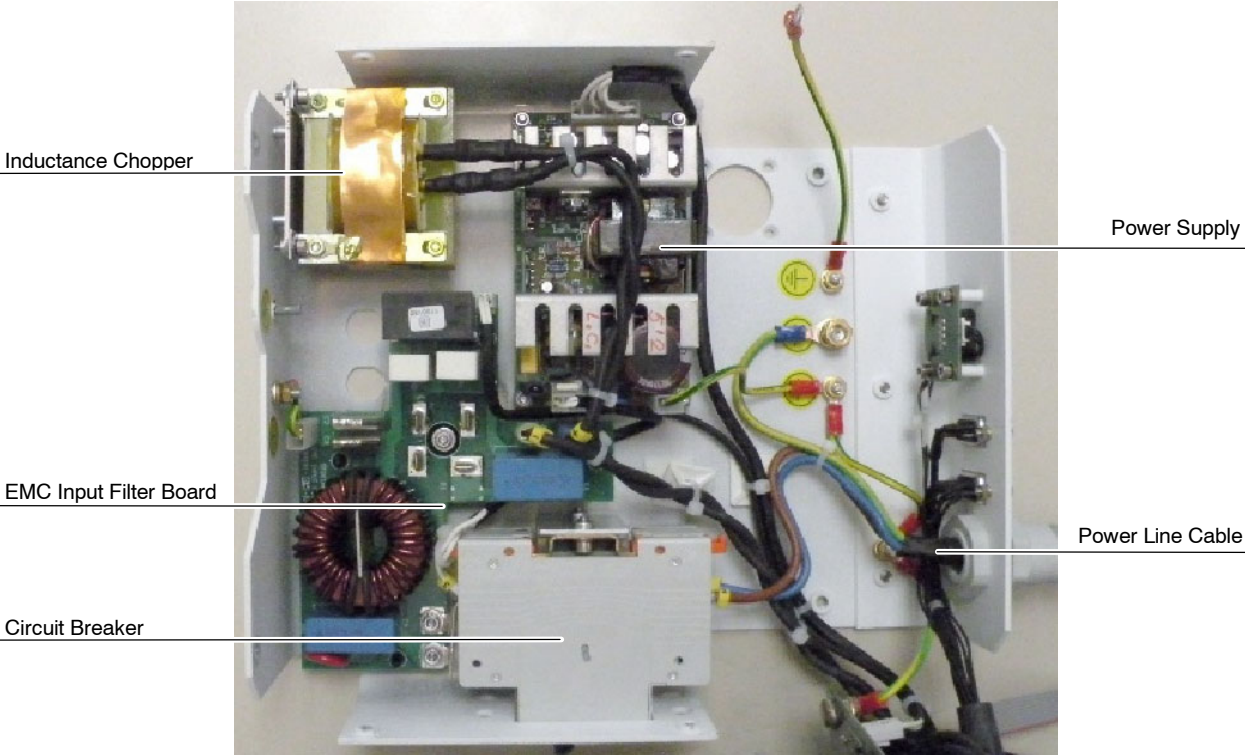
Fixing Screw



9. Disconnect the GND wire from the HV Transformer GND stud.



10. Replace the respective part in the Central Support as described in the next sections.



11. Once the components in the Central Support have been replaced, connect the GND wire previously removed from the HV Transformer GND stud.
12. Assemble the Central Support to HV Transformer.
13. Assemble the Upper and Lower Covers.
14. Re-install the Collimator.



Collimator replacement will affect centering of Collimator light. Screwing may modify position of Collimator and it must be manually centered while tightening the Safety Screws. It is recommended 5 turns to each screw, check parallelism between the Collimator and Unit Chassis, correct position if necessary and finally tighten each Safety Screw with the same number of turns (one by one).

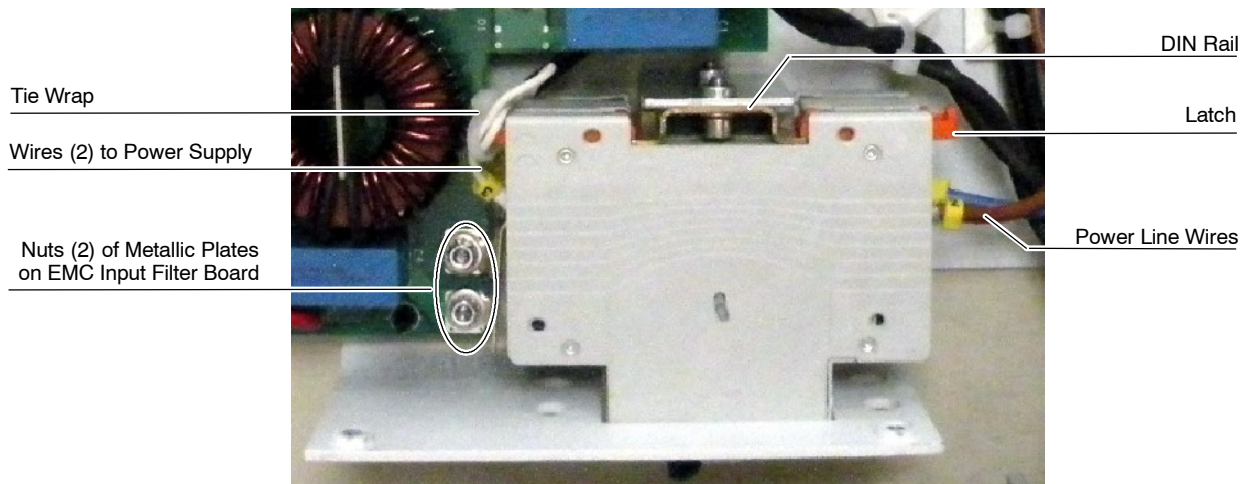


Once the Collimator is replaced, the Unit fully assembled and ready for operation, perform the Adjustments described in Section 4.

15. If applicable, assemble the DAP Rails and SID Guard attached to the Collimator.

6.3.17.2 CIRCUIT BREAKER

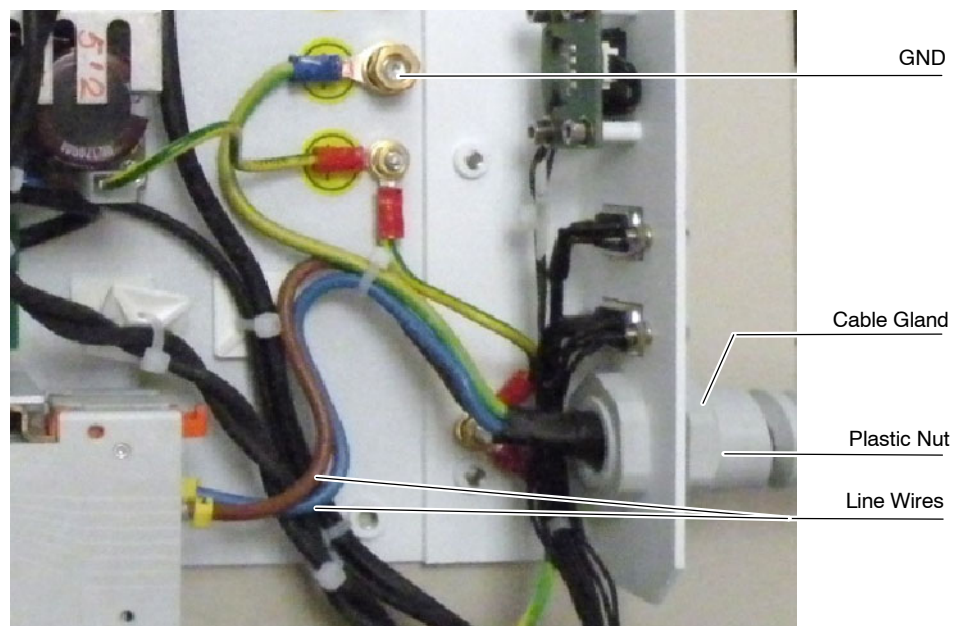
1. Access inside the Central Support as described in *Section 6.3.17.1*.
2. Remove the fixing screws located at the back of the Central Support.
3. Cut the Tie Wrap which secures the two wires connected to the Power Supply. Disconnect the four wires attached keeping in mind the correspondence of each cable.
4. Loosen without removing the two nuts which fixes the two metallic plates in contact with the Circuit Breaker and the EMC Input Filter Board. Disconnect the two metallic plates from the Circuit Breaker, do not remove them from the EMC Input Filter Board.
5. Pull the two Latches and remove the Circuit Breaker from its DIN Rail.



6. Replace the Circuit Breaker, reconnect in reverse order and assemble the Unit as described in *Section 6.3.17.1*.

6.3.17.3 POWER LINE CABLE

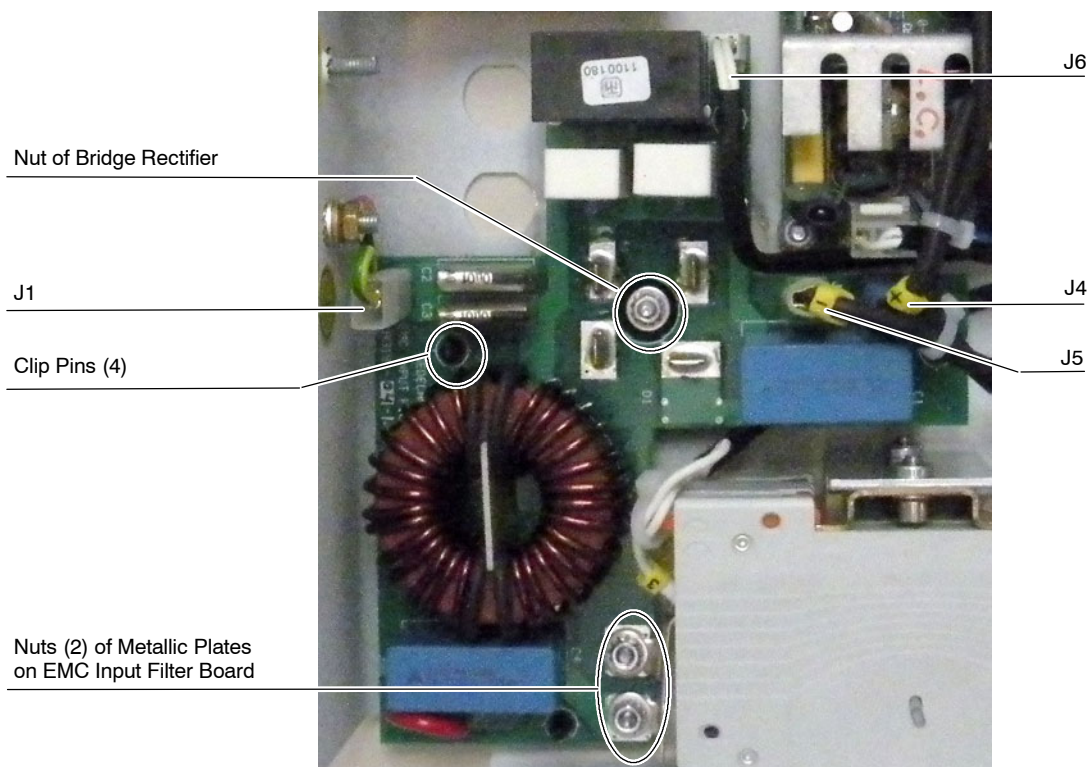
1. Access inside the Central Support as described in *Section 6.3.17.1*.
2. Disconnect the Power Line wires connected to the Circuit Breaker by unscrewing them through the external part of the Central Support.
3. Disconnect the GND wire from the Central Support.
4. Unscrew the Plastic Nut of the Cable Gland.
5. Pass the disconnected Power Line Cable through the Cable Gland.



6. Remove the Plastic Nut and the Ferrite of the Power Line Cable
7. Re-install the Ferrite in the new Power Line Cable and fix it with two Tie Wraps. Then insert the Plastic Nut at the cable end to be connected.
8. Pass the new Power Line Cable through the Cable Gland and screw the Plastic Nut.
9. Connect the line wires to the Circuit Breaker terminals and the GND to the Central Support GND stud.
10. Assemble the Unit as described in *Section 6.3.17.1*.

6.3.17.4 EMC INPUT FILTER BOARD

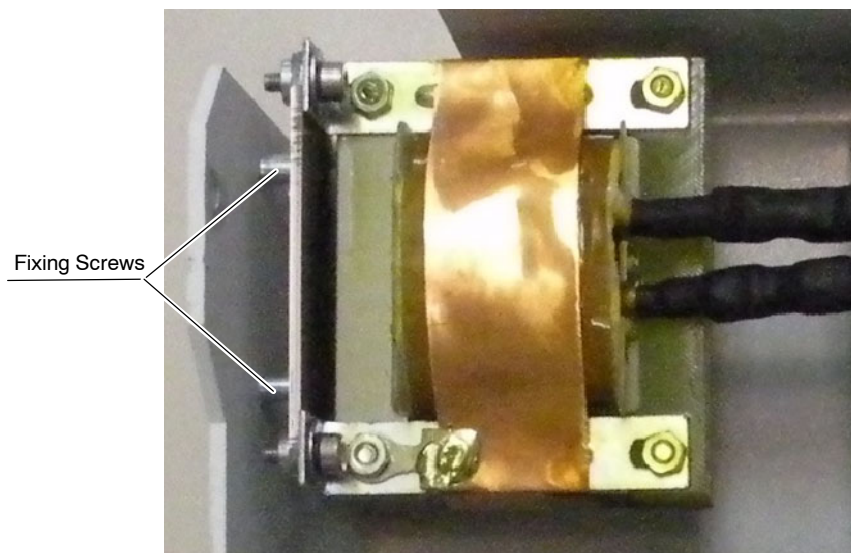
1. Access inside the Central Support as described in *Section 6.3.17.1*.
2. Disconnect the cables connected to J1, J4, J5 and J6. Cut the Tie Wraps if needed.
3. Loosen the two screws of the Circuit Breaker that fixes the two (2) wires from the Power Supply by unscrewing them through the external part of the Central Support. Disconnect both wires.
4. Loosen without removing the two nuts which fixes the two metallic plates in contact with the Circuit Breaker and the EMC Input Filter Board. Disconnect the two metallic plates from the Circuit Breaker, do not remove them from the EMC Input Filter Board.
5. Remove the fixing nut of the Bridge Rectifier (located at the center of the Board).
6. Push one by one the four (4) clip pins and remove the Board.



7. Remove the two (2) metallic Plates from the old Board and install them on the new Board.
8. Clean the silicone paste from the Central Support surface where the Bridge Rectifier was in contact.
9. Apply a thin film of conductive silicone paste on the surface of the Bridge Rectifier.
10. Install the new EMC Input Filter Board securing it with the four (4) clip pins and the fixing nut of the Bridge Rectifier (located at the center of the Board).
11. Connect the wires to the Circuit Breaker terminals and the metallic plates. Tighten the two nuts which fixes the two metallic plates in contact with the Circuit Breaker and the EMC Input Filter Board.
12. Plug the cables connected to J1, J4, J5 and J6.
13. Assemble the Unit as described in *Section 6.3.17.1*.

6.3.17.5 INDUCTANCE CHOPPER

1. Access inside the Central Support as described in *Section 6.3.17.1*.
2. Cut the Tie Wrap if needed.
3. Cut the Heat Shrinks and unsolder the two (2) wires attached keeping in mind the correspondence of each cable.
4. Unscrew the four fixing screws located at the side of the Central Support.
5. Dismount the Inductance Chopper from its support.



6. Assemble the new Inductance Chopper on its support and then in the Central Support.
7. Solder the two (2) wires in the respective terminals covering both cables with the new Heat Shrinks and applying heat to reduce the Heat Shrinks.
8. Assemble the Unit as described in *Section 6.3.17.1*.

6.3.17.6 POWER SUPPLY

1. Access inside the Central Support as described in *Section 6.3.17.1*.
2. Cut the Tie Wrap that secures the cable connected to J2 and disconnect the cables connected to J1, J2 and GND.
3. Remove the four (4) fixing nuts.



4. Replace the Power Supply and assemble in reverse order.
5. Assemble the Unit as described in *Section 6.3.17.1*.

6.4 PARTS REPLACEMENT OF THE MONOBLOCK WITH TROLLEY UNIT



DO NOT MANIPULATE INSIDE THE UNIT WITHOUT DISCONNECTING IT FROM MAINS, RISK OF ELECTRIC SHOCK.



WHENEVER THE REPLACEMENT REQUIRES TO OPEN THE X-RAY POWER UNIT, DISMOUNT IT FROM THE TROLLEY AS DESCRIBED IN SECTION 6.4.1.

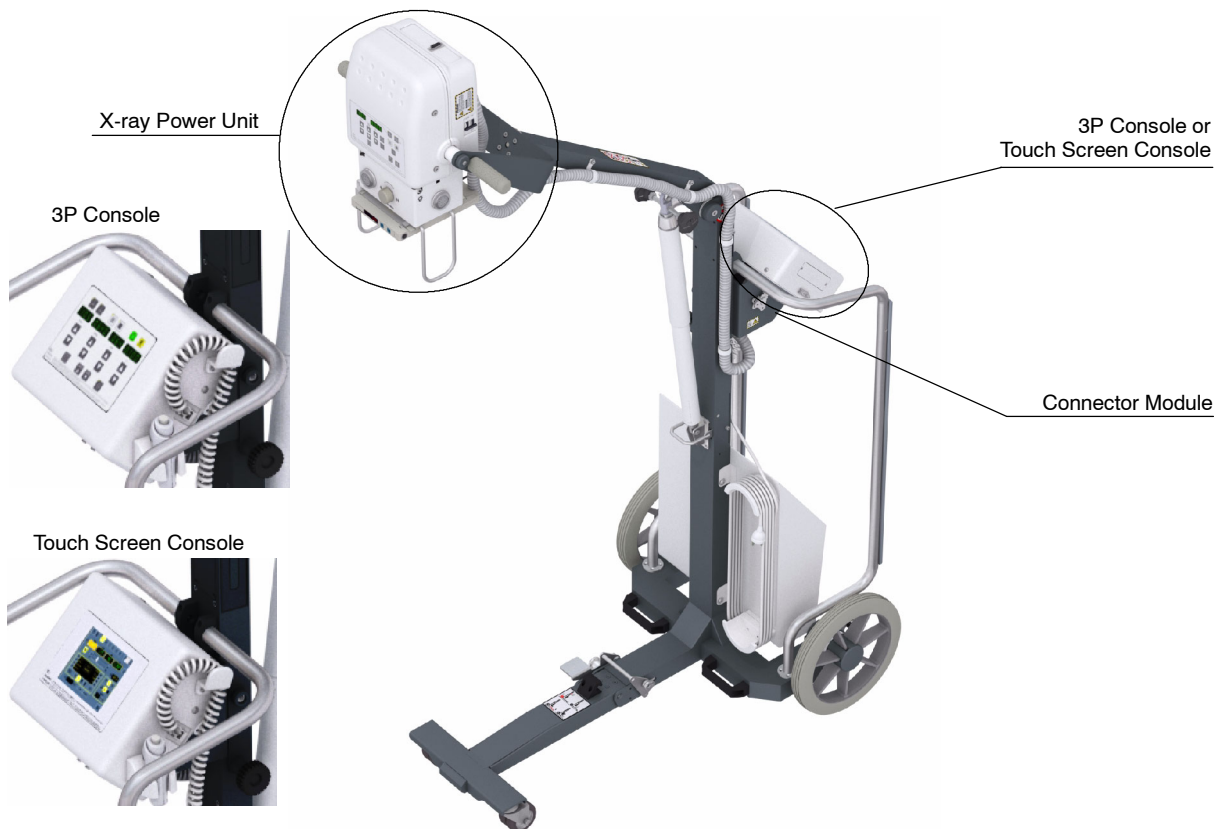
NEVER ATTEMPT TO UNFOLD THE UNIT IN LAYING POSITION. UNFOLD ONLY IN VERTICAL POSITION.



Configuration and Calibration procedures should only be performed at field if Portable Control Board, Control Driver Board or the High Voltage Transformer are replaced or the EEPROM memory is re-initialized.

Note 

Refer to Renewal Parts Section for further information on parts identification.



6.4.1 DISASSEMBLING THE X-RAY POWER UNIT FROM THE ARM

Follow the steps below to dismount the X-Ray Unit from the Arm.

1. Fully extend the Arm, then lay down the Trolley with the handles resting on the floor and leave the Power Unit resting on a table or similar, preventing the Arm from springing up when removing the X-Ray Power Unit.



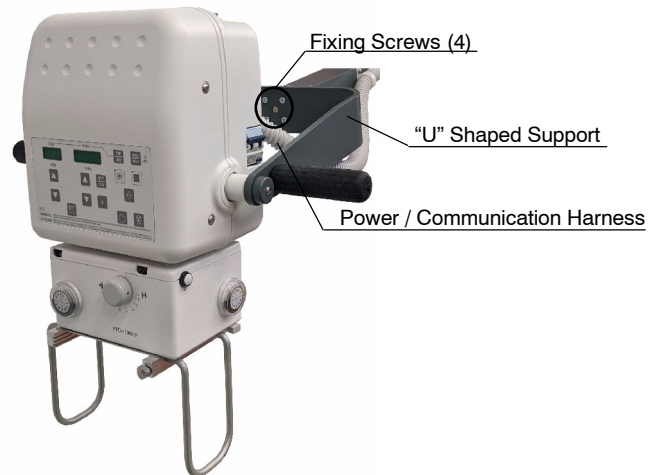
2. Disengage the Power / Communication Harness from the Arm (Cable Clamps).
3. Remove the four (4) fixing screws from the "U" shaped support at the Arm end.



KEEP IN MIND TO USE A 8 Nm TORQUE WRENCH WHEN RE-INSTALLING THE "U" SHAPED SUPPORT WITH THE FOUR (4) FIXING SCREWS.

4. Separate the Power Unit with the Harness from the Arm.

5. Remove the cover from the Connector Module of the Trolley and disconnect the cables of the Power / Communication Harness attached to the Power Unit.



KEEP IN MIND TO USE A 8 Nm TORQUE WRENCH WHEN RE-INSTALLING THE "U" SHAPED SUPPORT WITH THE FOUR (4) FIXING SCREWS.



THE UNIT IS COMPLETELY RELEASED AND ITS WEIGHT IS NOW IN YOUR ARMS. LET IT REST IN A SAFE AREA.

6.4.2 COLLIMATOR

Note 

For replacement of the internal parts of the Collimator included in the Spare Parts List of this Manual, refer to the Collimator Manual.

1. Turn the Unit Off and Disconnect it from mains.
2. To replace the Collimator is not necessary to remove the X-Ray Power Unit from the Trolley, it can be replaced in situ.
If the X-Ray Power Unit is removed from the Arm, follow section 6.4.1 and place it on a table close to the Trolley.
3. If applicable, remove the DAP Rails and SID Guard attached to the Collimator. (*Refer to Section 6.3.7*).
4. Disconnect the Collimator cable from Lower Cover of the Power Unit.
5. Fully Unscrew the four (4) Collimator Adjusting Screws and carefully remove the Collimator.



Collimator replacement will affect centering of Collimator light. Screwing may modify position of Collimator and it must be manually centered while tightening the Safety Screws. It is recommended 5 turns to each screw, check parallelism between the Collimator and Unit Chassis (correct position if necessary) and finally tighten the Safety Screws.

6. Replace the Collimator and re-install the parts step by step.



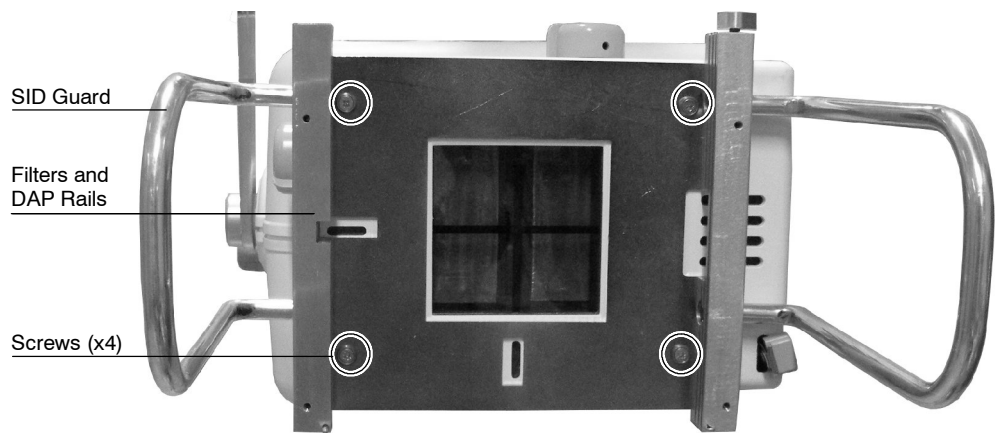
Once the Collimator is replaced, the Unit fully assembled and ready for operation, perform the Adjustments described in Section 4.



VERIFY THAT THE COLLIMATOR IS PROPERLY SEATED AND NO RISK FOR ACCIDENTAL FALL IS POSSIBLE BY TURNING THE COLLIMATOR AROUND AND PULLING DOWNWARDS FROM IT.

6.4.3 SID GUARD / ALUMINIUM FILTERS AND DAP RAILS

1. Turn the Unit Off and Disconnect it from mains.
2. Disconnect the DAP cable (if applicable) from the Lower Cover of the Power Unit.
3. Remove the aluminium filters (if applicable).
4. Remove the screws (x4) to disassemble the SID Guard / Filters and DAP Rails from the X-Ray Unit.



6.4.4 ACCESS INSIDE THE POWER UNIT

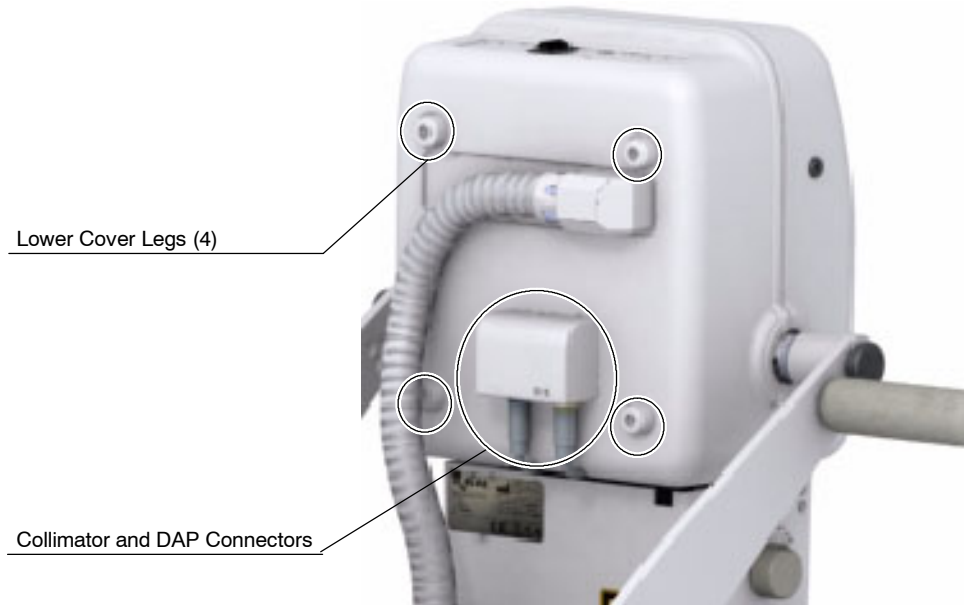
Note 

This section only describes the previous steps to carry out the components replacement inside the Power Unit without removing it from the Trolley. For covers replacement refer to Sections 6.4.5 and 6.4.6.

1. Turn the Unit Off and Disconnect it from mains.
2. Unlock the Arm and raise it so the Power Unit can be close to the surface of a table, to facilitate the Covers disassembly. Lock the Arm in this position.
3. Remove the Upper Cover screws and carefully lift the Upper Cover. It is not necessary to unplug any cable.

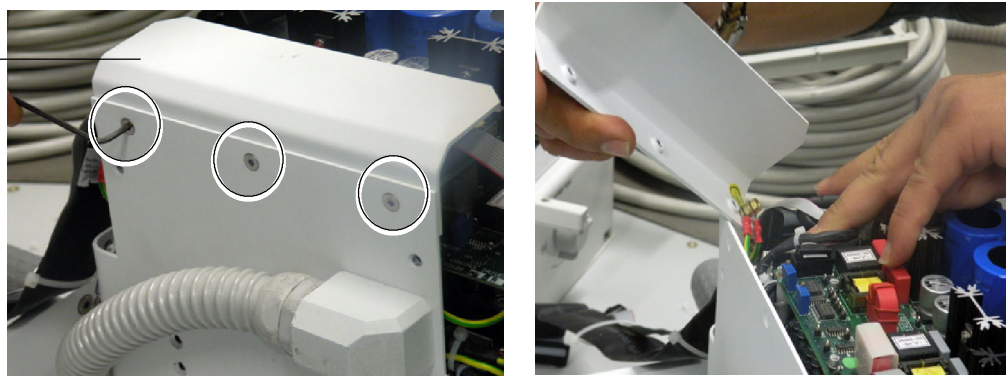


4. Disconnect the Collimator cable from the Lower Cover of the Unit and the DAP cable if connected.
5. Remove the four legs located at the Lower Cover.



6. Carefully remove the Lower Cover. Pass the Power / Communication Harness through the Lower Cover window.
7. Unscrew the Protecting Plate. It is not necessary to disconnect the ground connection.

Protecting Plate



6.4.5 UPPER COVER

Note 

To replace the Upper Cover is not necessary to remove the X-Ray Power Unit from the Trolley, it can be replaced in situ.

Replace the Upper Cover as described in Section 6.3.2.

6.4.6 LOWER COVER

Note 

To replace the Lower Cover is not necessary to remove the X-Ray Power Unit from the Trolley, it can be replaced in situ.

1. Turn the Unit Off and Disconnect it from mains.
2. Unlock the Arm and raise it so the Power Unit can be close to the surface of a table, to facilitate the Covers disassembly. Lock the Arm in this position.

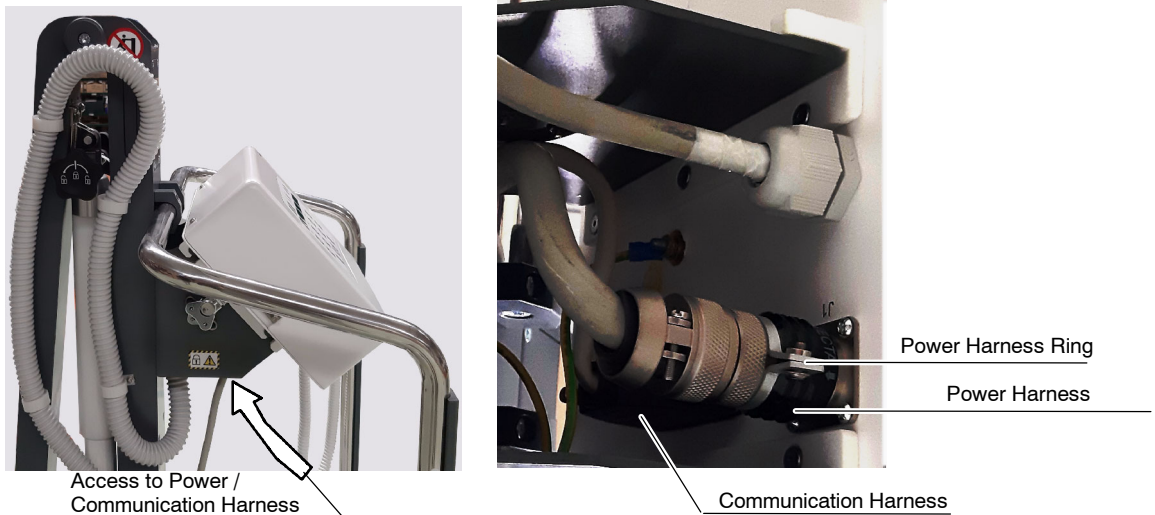
Note 

It is not necessary to remove the Handle for covers replacement.

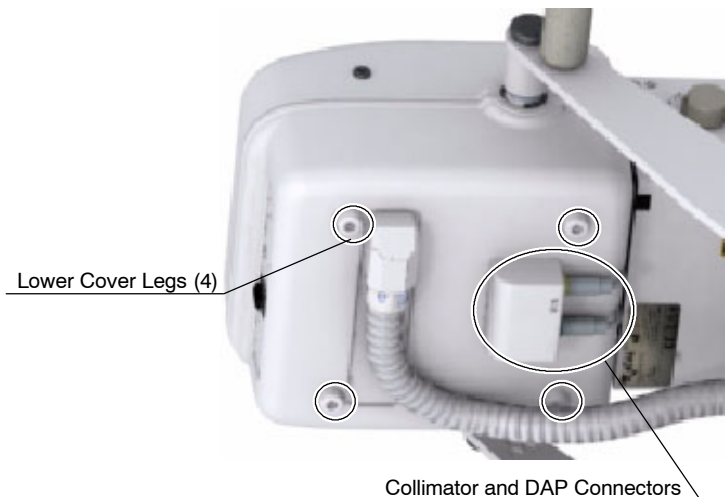
3. Remove the Upper Cover screws and carefully lift the Upper Cover. It is not necessary to unplug any cable.



4. Remove the Power Harness Ring and disconnect the two cables of the Power / Communication Harness attached to the Power Unit.



5. Release the Power / Communication Harness from the Cable Clamps attached to the Arm.
6. Disconnect the Collimator cable from the Lower Cover of the Unit and the DAP cable if connected.
7. Remove the four legs located at the Lower Cover.



8. Carefully remove the Lower Cover. Pass the Power / Communication Harness through the Lower Cover window.
9. Replace the cover and assemble in reverse order.

6.4.7 PORTABLE CONTROL BOARD

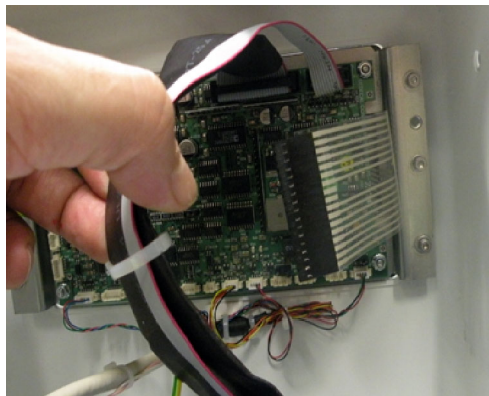
Note 

To replace the Portable Control Board is not necessary to remove the X-Ray Power Unit from the Trolley, it can be replaced in situ.

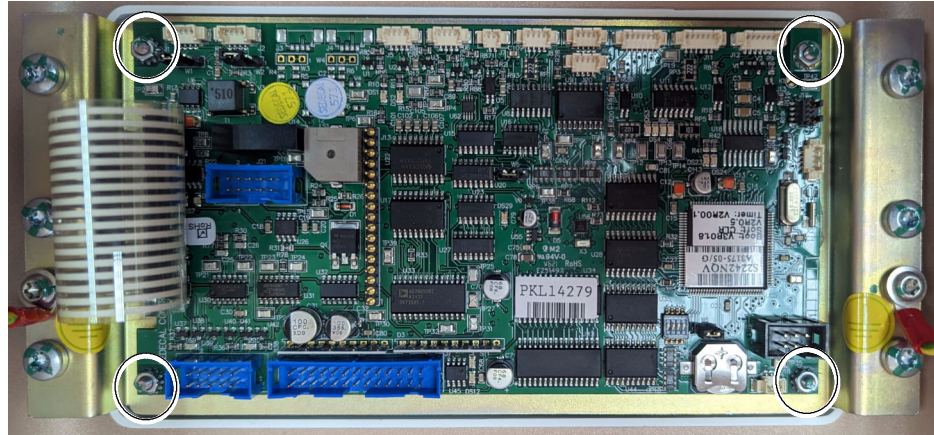
1. Turn the Unit Off and Disconnect it from mains.
2. Unlock the Arm and raise it so the Power Unit can be close to the surface of a table, to facilitate the Covers disassembly. Lock the Arm in this position.
3. Remove the Upper Cover screws and carefully lift the Upper Cover. It is not necessary to unplug any cable.



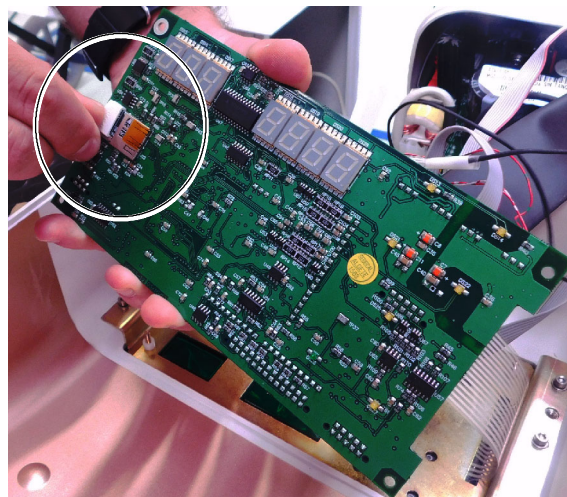
4. Unplug all the cables connected to the Portable Control Board (A3175-05).



5. Unscrew the nuts located at each corner of the Portable Control Board and remove it.



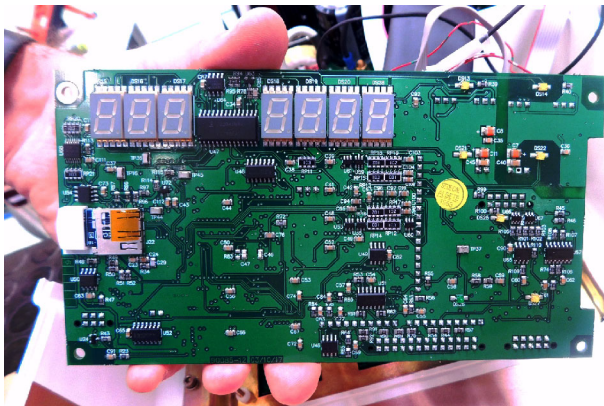
6. Remove the License by pushing and pulling it, and install it in the new Portable Control Board.



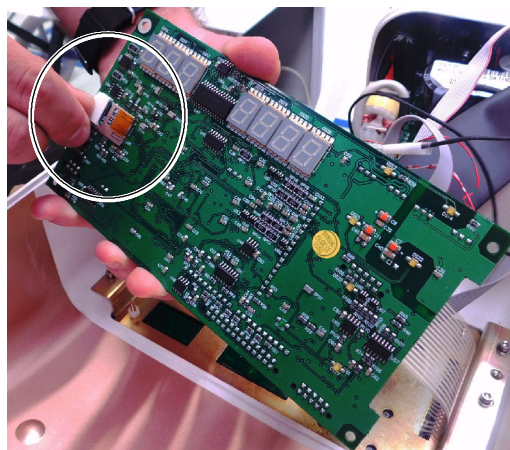
7. Install the new Portable Control Board.
8. Reconnect all the cables and assemble in reverse order.
9. Initialize the new EEPROM (*refer to Section 6.1.1*).

6.4.8 PORTABLE CONTROL BOARD LICENSE

1. Turn the Unit Off and Disconnect it from mains.
2. Place the Unit on a table.
3. Remove the Upper Cover screws and carefully lift the Upper Cover.
4. Unplug the Overlay Flat Flex Cable connected to the Portable Control Board (A3175-05).
5. Unscrew the nuts located at each corner of the Portable Control Board and turn it.



6. Remove the License by pushing and pulling it.



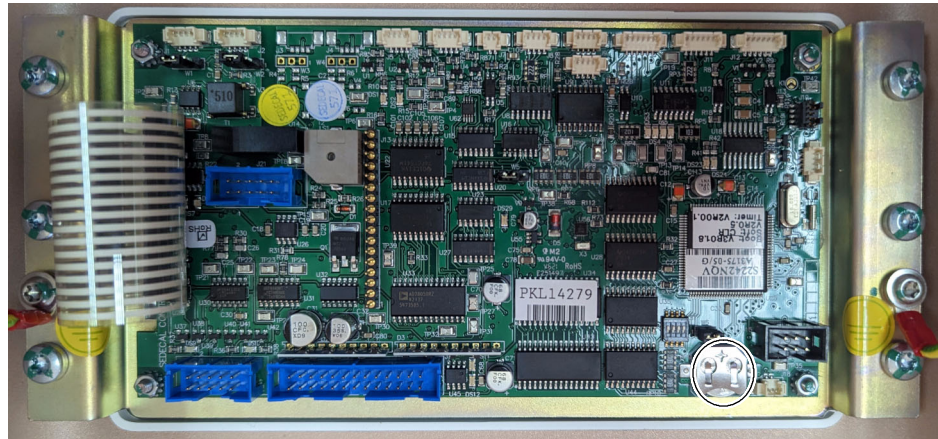
7. Install the new License.
8. Reconnect the Overlay Flat Flex Cable to J3 and assemble in reverse order.
9. Initialize the new EEPROM (*refer to Section 6.1.1*).

6.4.9 REAL TIME CLOCK BATTERY

Note 

To replace the Real Time Clock Battery is not necessary to remove the X-Ray Power Unit from the Trolley, it can be replaced in situ.

1. Access to the Portable Control Board (A3175-05) as described in Section 6.4.7 (steps 1. to 3.).
2. Take the battery BAT1 out of the Portable Control Board (A3175-05) and replace it with model "CR1225".



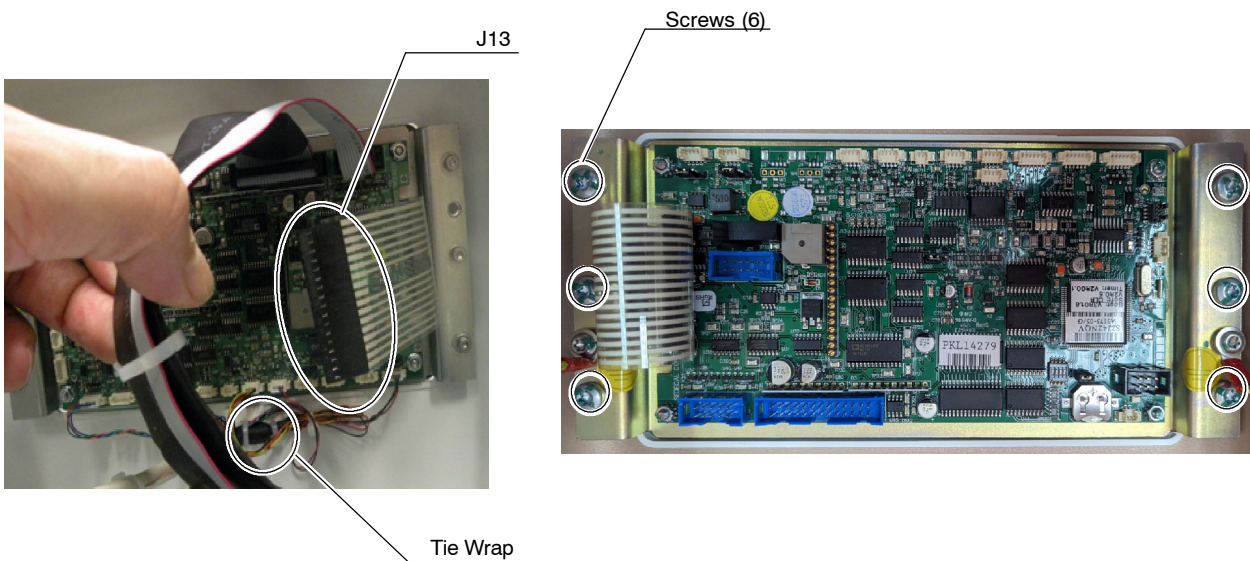
3. Assemble in reverse order.

6.4.10 KEYBOARD

Note 

To replace the Keyboard is not necessary to remove the X-Ray Power Unit from the Trolley, it can be replaced in situ.

1. Access to the Portable Control Board (A3175-05) as described in Section 6.4.7 (steps 1 to 3).
2. Disconnect the Keyboard cable (J13) from the Portable Control Board.
3. Cut the tie wrap of the inner part of the Cover. It is not necessary to disconnect the rest of cables from the Portable Control Board for Keyboard replacement.
4. Unscrew the screws at both sides of the Portable Control Board support and remove it.



5. Unstick the old Keyboard from the plate support.
6. Clean the remaining glue with alcohol from the support plate and stick the new Keyboard.
7. Reconnect and assemble in reverse order.

6.4.11 SNUBBER

1. Access inside the Unit by removing Upper and Lower Covers and unscrewing the Protecting Plate (*refer to Section 6.4.4*).
2. Replace the Snubber as described in *Section 6.3.13 (steps 2. to 7.)*.

6.4.12 FILAMENTS HF BOARD

1. Access inside the Unit by removing Upper and Lower Covers and unscrewing the Protecting Plate (*refer to Section 6.4.4*).
2. Replace the Filaments HF Board, verify the large and small focus adjustment and perform Autocalibration as described in *Section 6.3.14*.

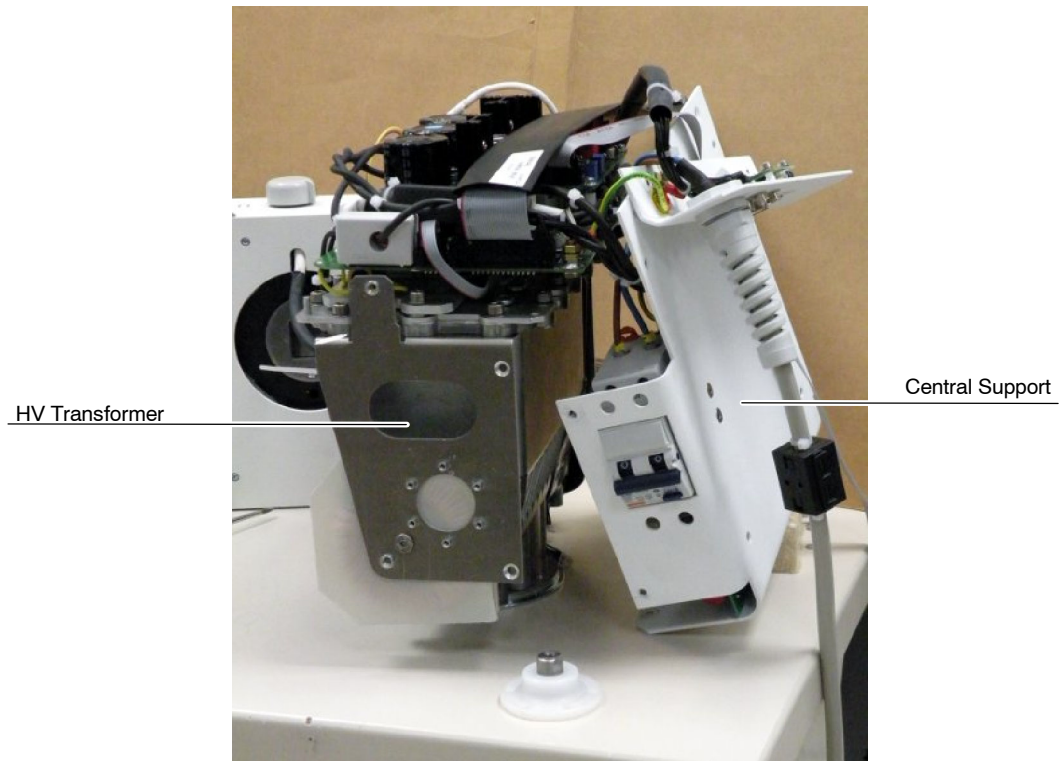
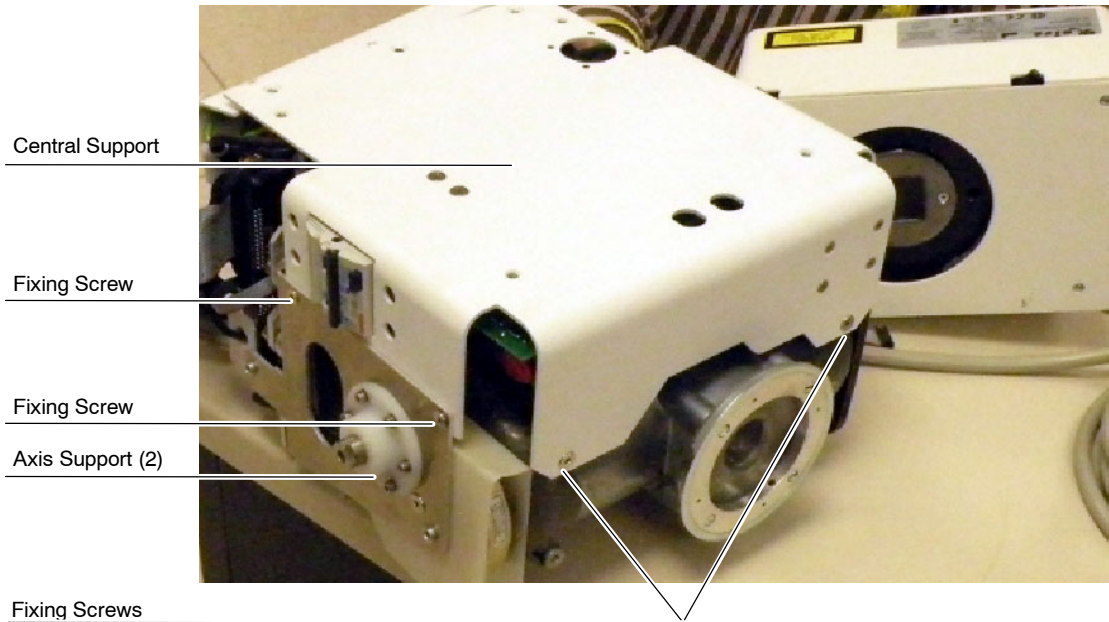
6.4.13 CONTROL DRIVER BOARD

1. Access inside the Unit by removing Upper and Lower Covers and unscrewing the Protecting Plate (*refer to Section 6.4.4*).
2. Replace the Control Driver Board, verify the large and small focus adjustment and perform Autocalibration as described in *Section 6.3.15*.

6.4.14 HV TRANSFORMER

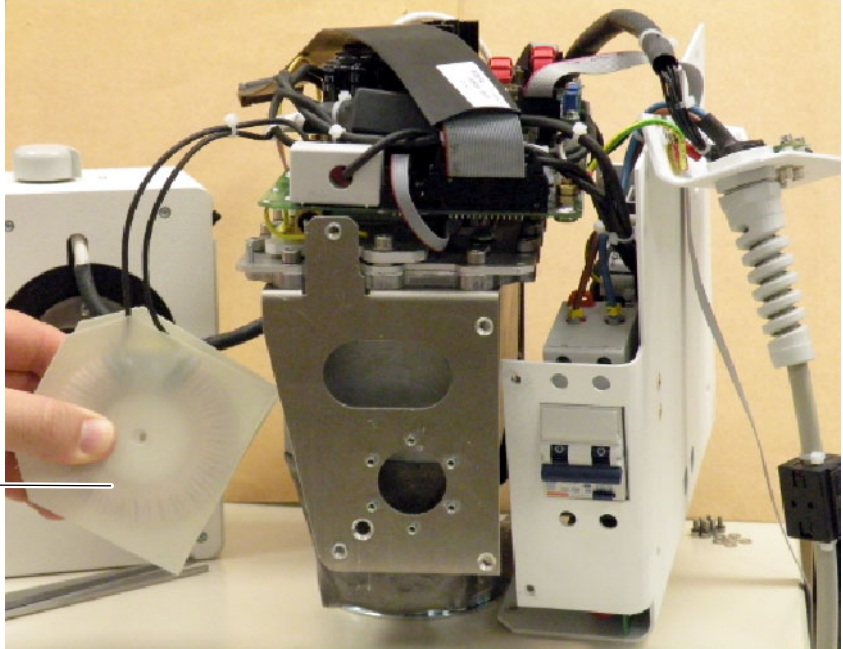
1. Disassemble the X-ray Power Unit from the Arm (*refer to Section 6.4.1*) following Method-2, so the "U" shaped support remains installed in the Arm.
2. Remove the Collimator (*refer to Section 6.4.2*).
3. Access inside the Unit by removing Upper and Lower Covers and unscrewing the Protecting Plate (*refer to Section 6.4.4, steps 3. to 7.*).

4. Put aside the Central Support by removing the four (4) fixing screws located at both sides and the two (2) fixing screws located at the front side of the Central Support. Remove the two Handle Axis Supports.



- Put aside the Resonant Inductance cutting the Tie Wrap and removing the screw that fixes it to the HV Transformer Support.

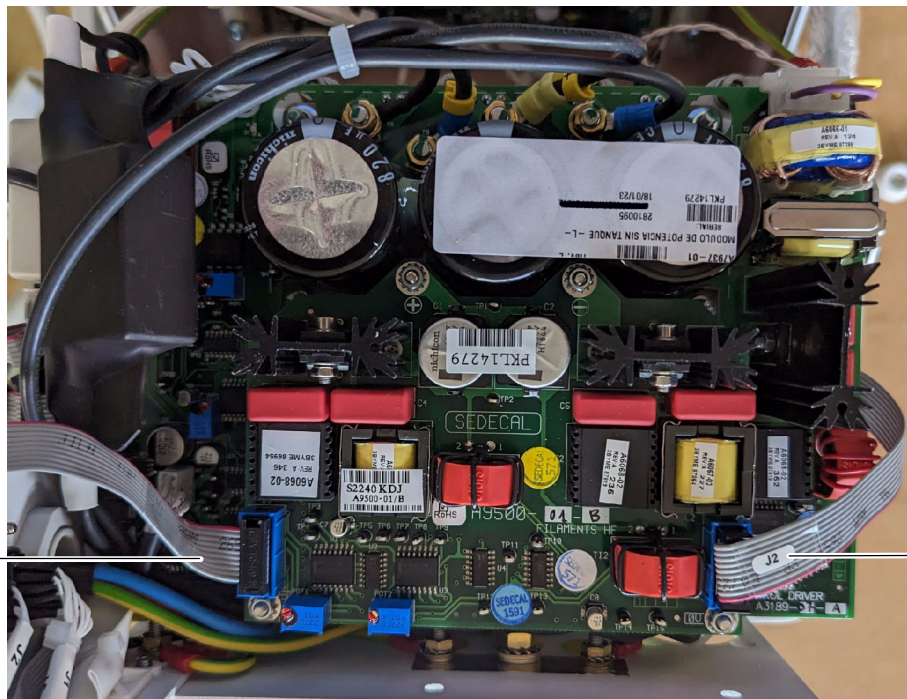
Resonant Inductance



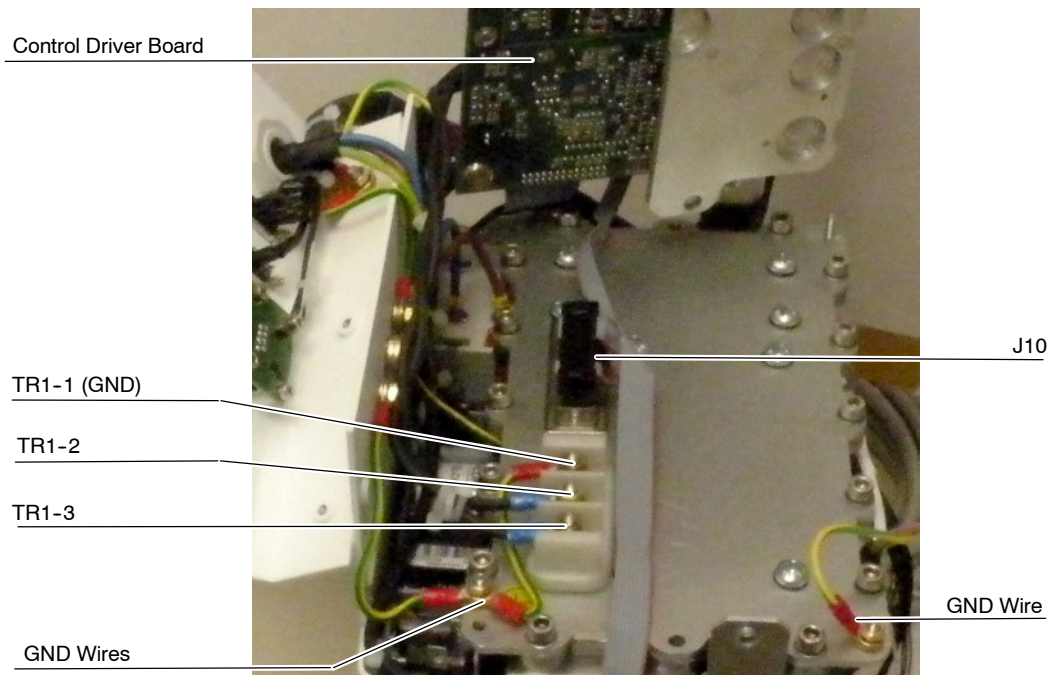
- Remove the two Ribbon cables connected to J1 and J2 of the Filaments HF Board (A9500-01).

J1

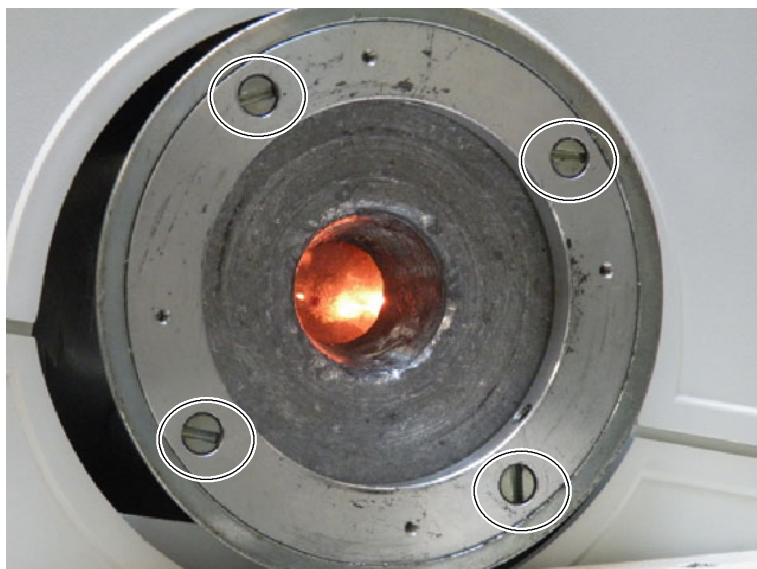
J2



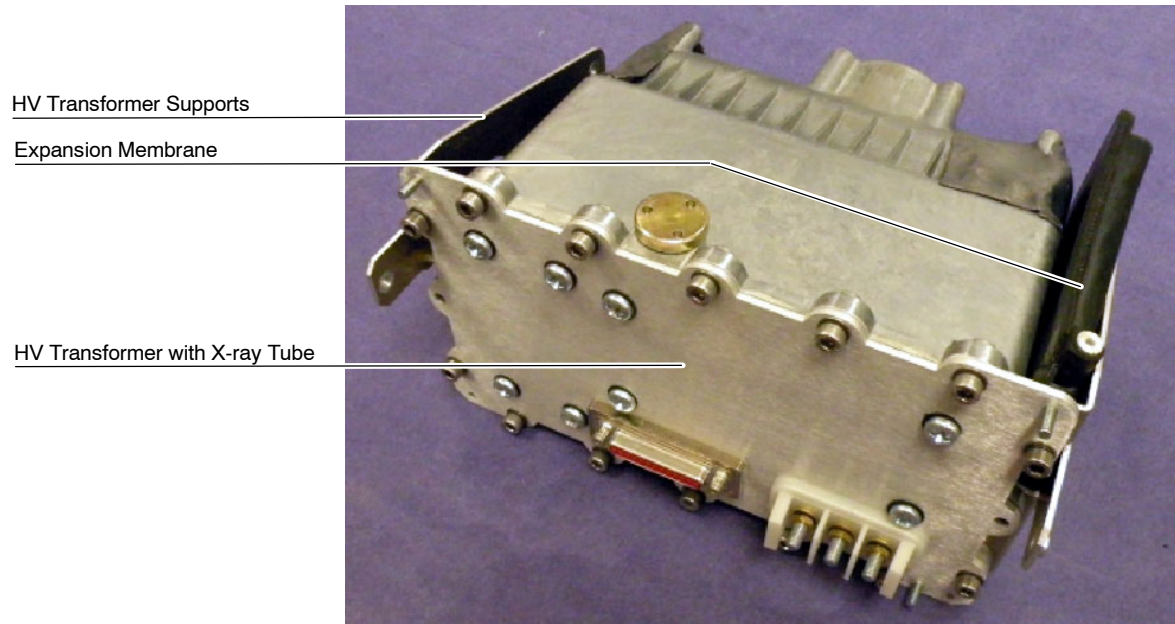
7. Remove the Control Driver Board as described in *Section 6.3.15 (steps 1. to 11.)* without disassembling the Filaments HF Board (A9500-01).
8. From the HV Transformer, disconnect the J10 Ribbon cable, the wires connected to TR1-2, TR1-3, TR1-1 (GND) and the three GND wires fixed to the HV Transformer screws.



9. Remove the Collimator Adaptation Ring.



10. Replace the HV Transformer. The HV Transformer assembly comprises the HV Transformer with the X-ray Tube, the Expansion Membrane and the two HV Transformer Supports.



11. Re-install the Collimator Adaptation Ring in the new HV Transformer.
12. Connect the J10 Ribbon cable, the wires connected to TR1-2, TR1-3, TR1-1 (GND) and the three GND wires fixed to the HV Transformer screws.
13. Re-install the Control the Control Driver Board (*A3189-07*) and connect the two Ribbon cables to J1 and J2 of the Filaments HF Board (*A9500-01*).
14. Mount the Resonant Inductance in HV Transformer fixing its wires with a Tie Wrap.

15. At this point, follow the steps below in order to verify the large and small focus adjustment.

LARGE FOCUS:

- a. On Filaments HF Board (A9500-01), connect the oscilloscope:
 - CH1: TP11 (V)
 - CH2: TP9 or TP8 (frequency)
 - GND = TP14 / TP15
- b. Select LF, enter in manual calibration, select 40 kVp / 100 mA and enter the data "930".
- c. Press PREP and adjust the POT 2 to see the maximum possible voltage on TP11 (4.5 Volts approx. in PREP; 2.4 Volts in Standby). Once the maximum voltage on TP11 has been reached and the voltage stops increasing, apply two more turns to the potentiometer in the same direction.
- d. Verify that the frequency on TP9 is $106.4 < f < 159.6$ kHz.

SMALL FOCUS:

- e. On Filaments HF Board (A9500-01), Connect the oscilloscope:
 - CH1: TP12 (V)
 - CH2: TP3 or TP4 (frequency)
 - GND = TP14 / TP15
- f. Select SF, enter in manual calibration, select 40 kVp / 20 mA and enter the data "700".
- g. Press PREP and adjust the POT 1 to see the maximum possible voltage on TP12 (3.4 Volts approx. in PREP; 2.4 Volts in Standby). Once the maximum voltage on TP12 has been reached and the voltage stops increasing, apply two more turns to the potentiometer in the same direction.
- h. Verify that the frequency on TP3 is $106.4 < f < 159.6$ kHz.

16. Once verified the Filament Adjustment, proceed with the HV Seasoning as follows:
 - a. Close Collimator Blades fully and make sure that no one will be exposed.
 - b. Make sure that X-ray Tube is fully cold (at least 30 minutes without making exposures).
 - c. Reduce the power manually to 20% in case of 4 kW or 5 kW units or 10% in case of 8 kW units. On the X-ray Unit Control Panel, press and hold the "Large Focal Spot" push-button and then press the "kVp Decrease" push-button several times until "P10 or P20" respectively is shown in the kVp display.
 - d. Select 70 kVp, 10 mAs and Large Focus. Perform one exposure per minute increasing 5 kVp in every exposure up to the maximum Tube voltage.
 - e. If there are not signs of instability, the tube is ready for normal use.
 - f. If instability is observed during procedure, reduce 5 kVp of the selected kVp and make two exposures at those kVp, then continue the process.
 - g. Once the seasoning procedure is completed, set the power at 100% again. On the X-ray Unit Control Panel, press and hold the "Large Focal Spot" push-button and then press the "kVp Increase" push-button several times until "P--" is shown in the kVp display.

Note 

Check that the remaining Thermal Capacity of the X-ray Tube is above 80% during this process.

17. Perform Autocalibration (*Refer to Section 3.2.4*).
18. Assemble the Central Support and the two Handle Axis Supports.
19. Assemble the Protecting Plate and the Upper and Lower Covers.

- 20. Re-install the Collimator.



Collimator replacement will affect centering of Collimator light. Screwing may modify position of Collimator and it must be manually centered while tightening the Safety Screws. It is recommended 5 turns to each screw, check parallelism between the Collimator and Unit Chassis, correct position if necessary and finally tighten each Safety Screw with the same number of turns (one by one).

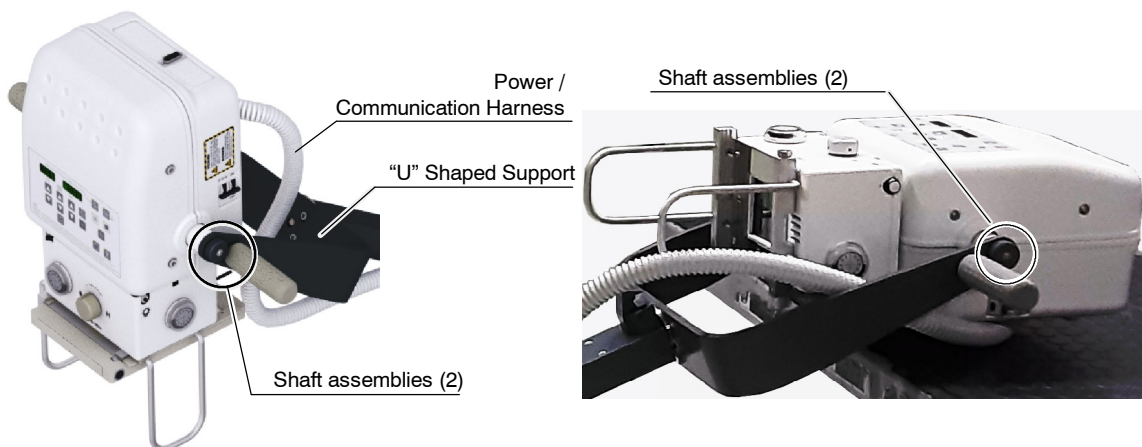


Once the Collimator is replaced, the Unit fully assembled and ready for operation, perform the Adjustments described in Section 4.

- 21. If applicable, assemble the DAP Rails and SID Guard attached to the Collimator.
- 22. Re-install the X-ray Power Unit in the “U” Shaped Support of the Arm (do not scratch the covers). The two (2) shaft assemblies must be installed in the same order that were removed.



KEEP IN MIND TO TIGHTEN THE LOCK NUT ENOUGH FOR THE X-RAY UNIT TO STAY STILL IN A SPECIFIC POSITION, AND ENOUGH FOR THE X-RAY UNIT TO BE EASY TO MOVE. DO NOT FORGET TO LOCK THE NUT WITH THE LOCKING WASHER TOOTH.



6.4.15 REPLACEMENT PARTS IN THE CENTRAL SUPPORT

6.4.15.1 ACCESS INSIDE THE CENTRAL SUPPORT

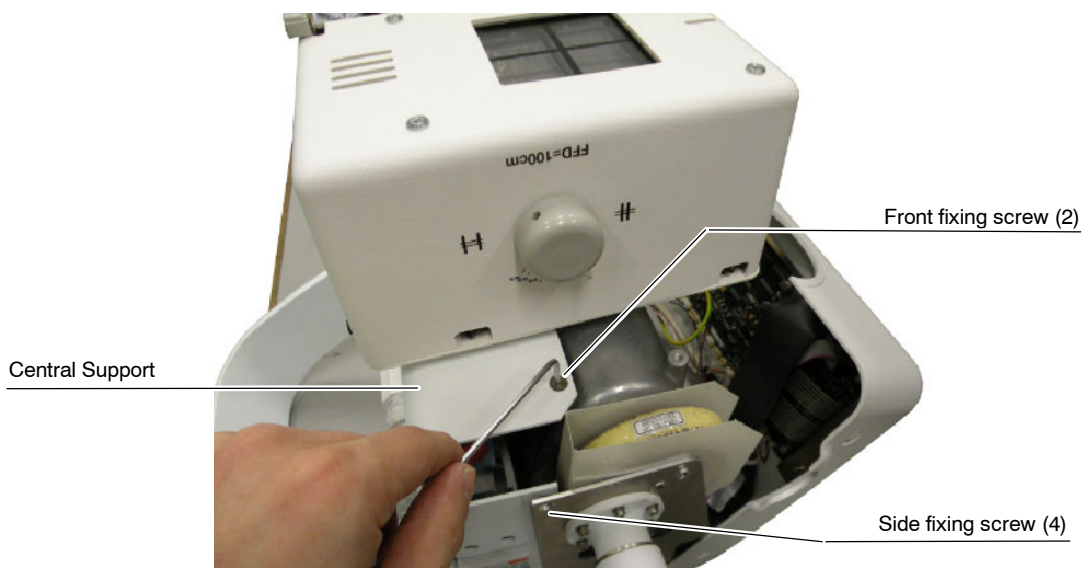
1. Fully extend the Arm, then lay down the Trolley, with the cassettes basket resting on the floor, and leave the Power Unit face up on a table or similar.



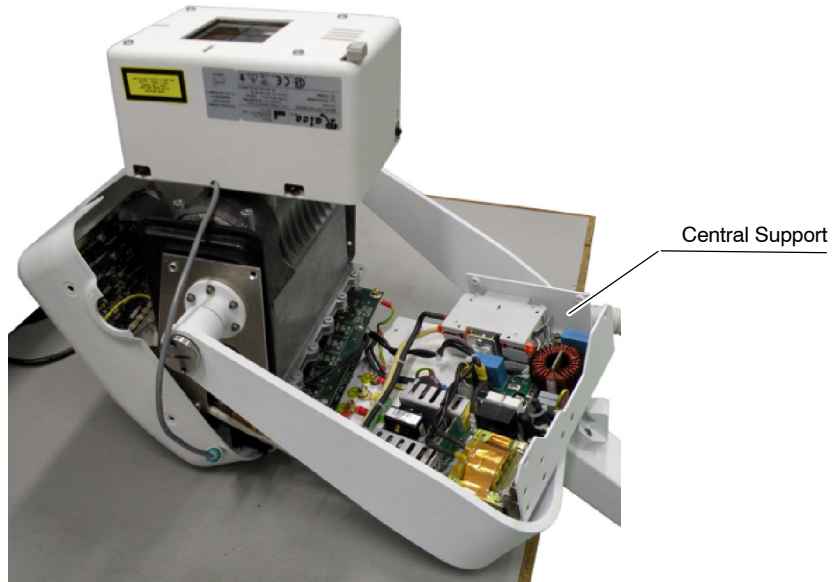
2. Access inside the Unit by removing Upper and Lower Covers and unscrewing the Protecting Plate (refer to Section 6.4.4, steps 3. to 7.).
3. Unscrew the Central Support by removing the four (4) fixing screws located at both sides and the two (2) fixing screws located at the front side of the Central Support.

Note 

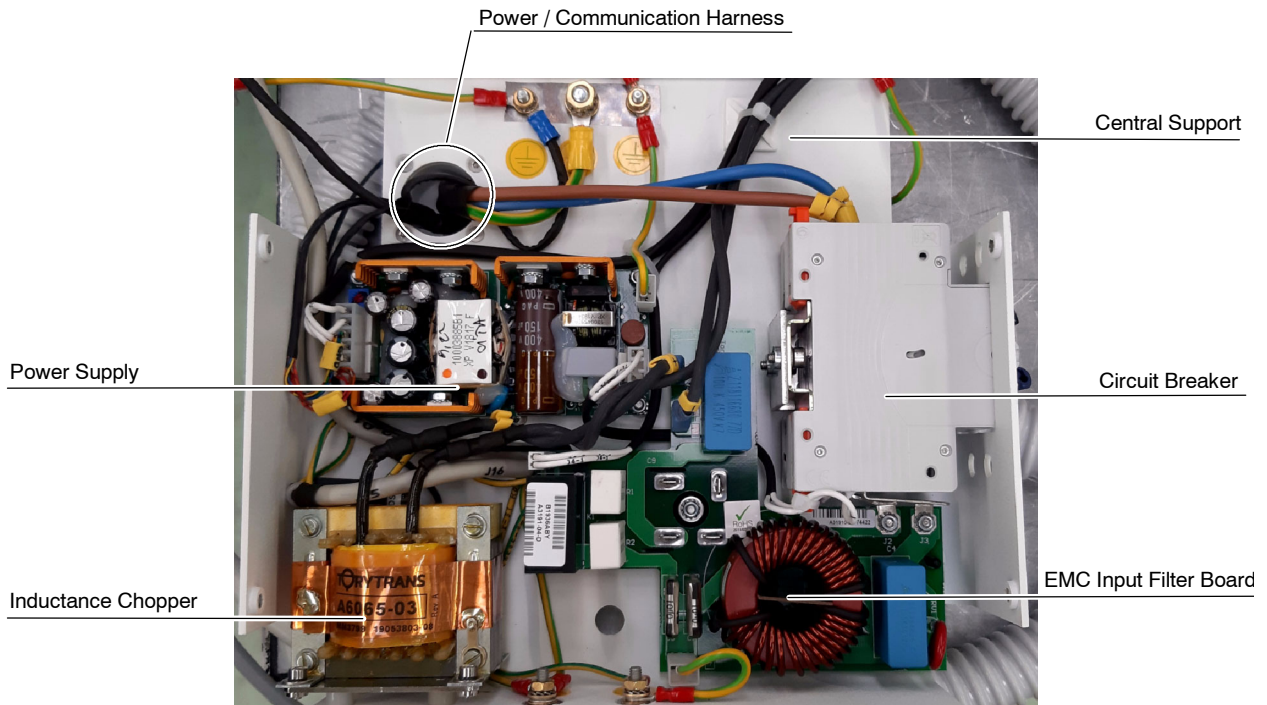
It is not necessary to remove the Collimator to access the front side screws due to the rotatory movement of the Collimator. Accordingly, it is not necessary to perform any Collimator adjustments once the X-ray Power Unit is re-assembled.



- Cut the needed Tie Wraps to facilitate the access to the Central Support components.



- Replace the respective part in the Central Support as described in the next sections.



6. Once the components in the Central Support have been replaced, replace the Tie Wrap previously removed.
7. Screw the Protecting Plate to the Central Support and Assemble it to HV Transformer.
8. Assemble the Upper and Lower Covers.

6.4.15.2 CIRCUIT BREAKER

1. Access inside the Central Support as described in *Section 6.4.15.1*.
2. Remove the old Circuit Breaker as described in *Section 6.3.17.2 (steps 2. to 5.)*.
3. Replace the Circuit Breaker, reconnect in reverse order and assemble the Power Unit as described in *Section 6.4.15.1*.

6.4.15.3 EMC INPUT FILTER BOARD

1. Access inside the Central Support as described in *Section 6.4.15.1*.
2. Replace the EMC Input Filter Board as described in *Section 6.3.17.4 (steps 2. to 12.)*.
3. Assemble the Power Unit as described in *Section 6.4.15.1*.

6.4.15.4 INDUCTANCE CHOPPER

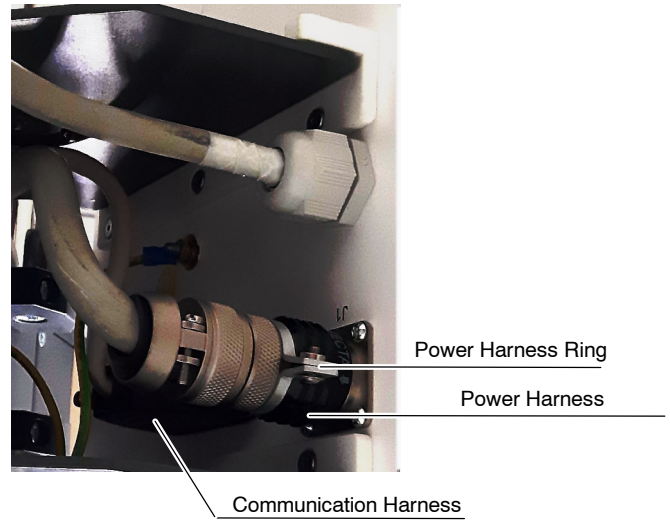
1. Access inside the Central Support as described in *Section 6.4.15.1*.
2. Replace the Inductance Chopper as described in *Section 6.3.17.5 (steps 2. to 7.)*.
3. Assemble the Power Unit as described in *Section 6.4.15.1*.

6.4.15.5 POWER SUPPLY

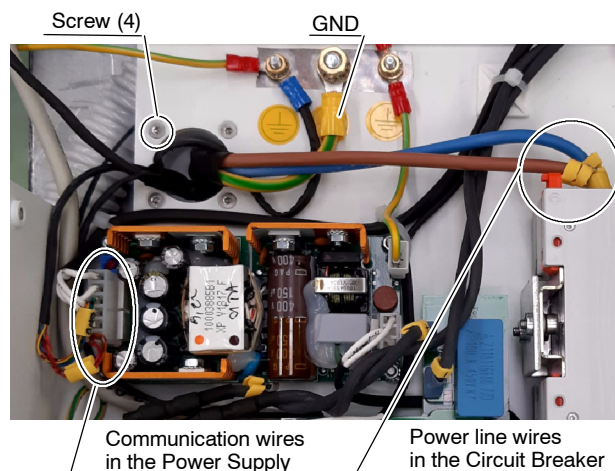
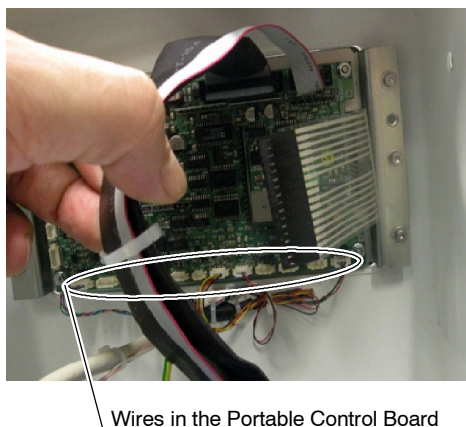
1. Access inside the Central Support as described in *Section 6.4.15.1*.
2. Replace the Power Supply as described in *Section 6.3.17.6 (steps 2. to 4.)*.
3. Assemble the Power Unit as described in *Section 6.4.15.1*.

6.4.15.6 POWER / COMMUNICATION HARNESS

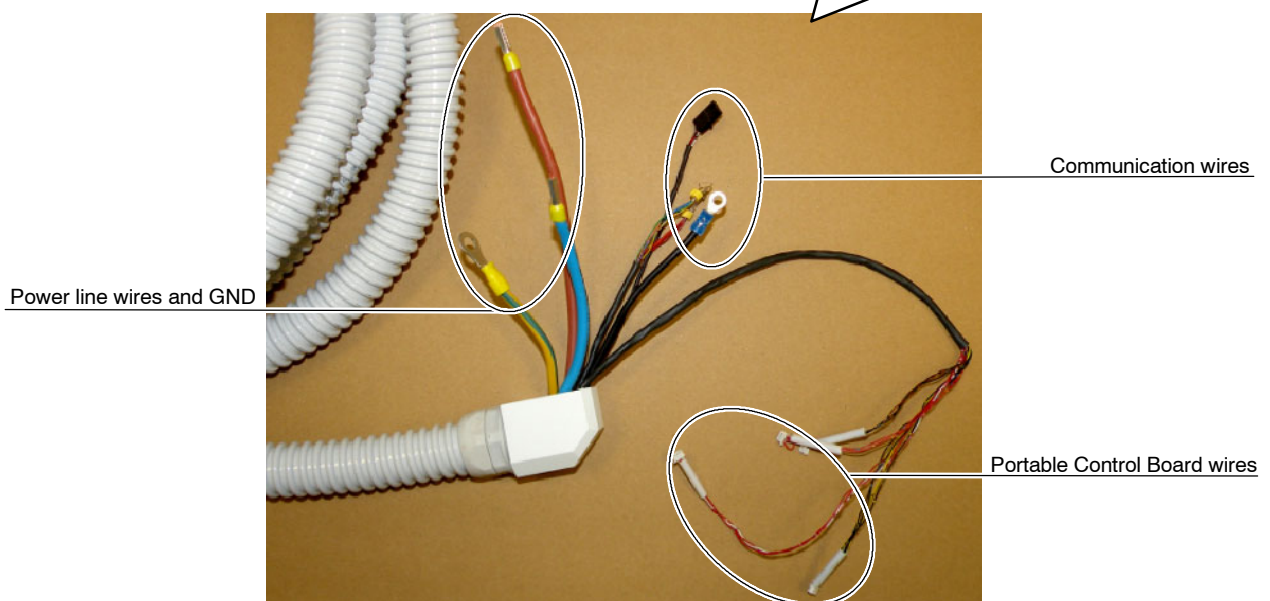
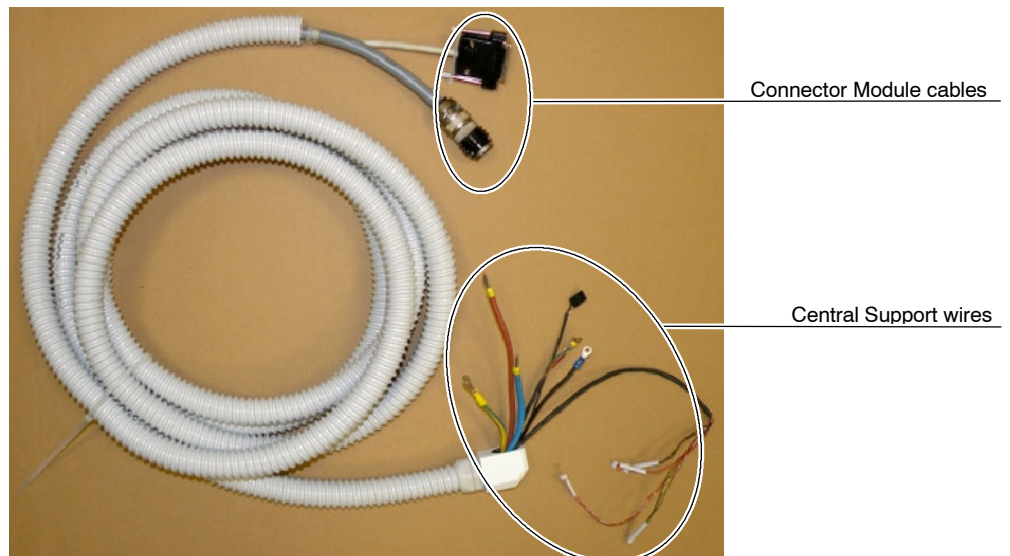
1. Remove the Power Harness Ring and disconnect the two cables of the Power / Communication Harness attached to the Power Unit.



2. Release the Power / Communication Harness from the Cable Clamps attached to the Arm.
3. Access inside the Central Support as described in *Section 6.4.15.1*.
4. Cut the needed Tie Wraps and Heat Shrinks. Disconnect the connectors and wires of the Power / Communication Harness in their respective connectors of the Portable Control Board (J1, J6, J9, J12), Power Supply (J2), Circuit Breaker and GND stud of the Central Support.
5. Remove the four (4) screws of the Power / Communication Harness from the Central Support.



6. Remove the Power / Communication Harness from the Central Support.
7. Install the new Power / Communication Harness by screwing the four (4) screws at the Central Support.
8. Install all the connectors and wires of the Power / Communication Harness in the respective connectors of the Portable Control Board (J1, J6, J9, J12), Power Supply (J2), Circuit Breaker and GND stud of the Central Support. Install the required Tie Wraps.



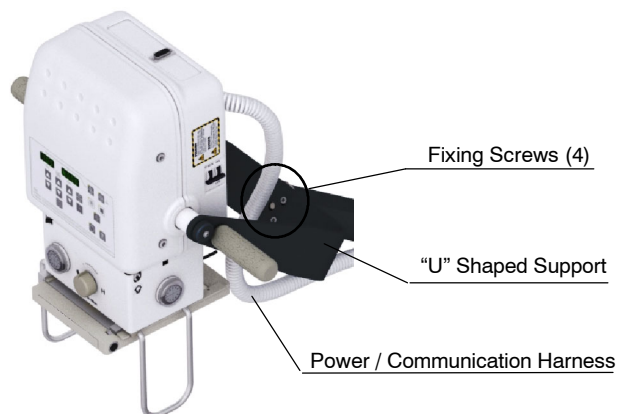
9. Assemble the Power Unit as described in *Section 6.4.15.1*.
10. Attach the Power / Communication Harness to the Arm with the Cable Clamps.
11. Connect the two cables of the Power / Communication Harness in the Connector Module of the Trolley and install its cover.

6.4.16 "U" SHAPED SUPPORT

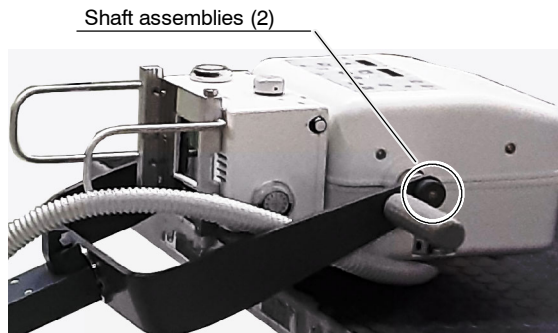
1. Fully extend the Arm, then lay down the Trolley, with the cassettes basket resting on the floor, and leave the Power Unit face up on a table or similar (this will avoid the arm to push up when removing the X-Ray Power Unit).



2. Disengage the Power / Communication Harness from the Arm (Cable Clamps).
3. Remove the four (4) fixing screws from the "U" shaped support at the Arm end.
4. Separate the Power Unit with the "U" shaped support and the Harness from the Arm and leave it on the table.



5. Remove the two (2) shaft assemblies from the “U” shaped support at both sides of the Power Unit.



6. Replace the “U” Shaped Support and assemble in reverse order.
7. Re-install the X-ray Power Unit in the “U” Shaped Support of the Arm (do not scratch the covers). The two (2) shaft assemblies must be installed in the same order that were removed.



KEEP IN MIND TO TIGHTEN THE LOCK NUT ENOUGH FOR THE X-RAY UNIT TO STAY STILL IN A SPECIFIC POSITION, AND ENOUGH FOR THE X-RAY UNIT TO BE EASY TO MOVE. DO NOT FORGET TO LOCK THE NUT WITH THE LOCKING WASHER TOOTH.

8. Re-install the “U” Shaped Support and X-ray Power Unit at the Arm using the four (4) fixing screws.



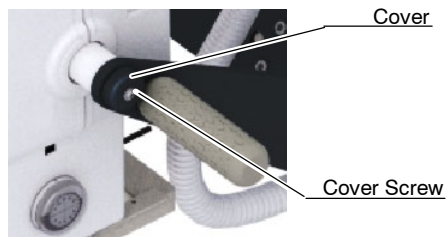
KEEP IN MIND TO USE A 8 Nm TORQUE WRENCH WHEN RE-INSTALLING THE “U” SHAPED SUPPORT WITH THE FOUR (4) FIXING SCREWS.

6.4.17 SHAFT ASSEMBLIES REPLACEMENT

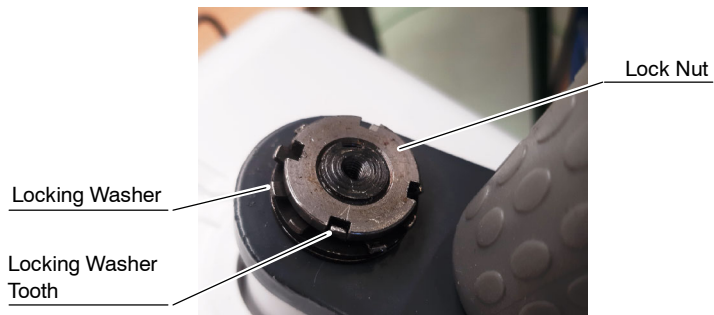
1. Fully extend the Arm, then lay down the Trolley, with the Receptor Basket resting on the floor, and leave the Power Unit face up on a table or similar (this will avoid the arm to push up when removing the X-Ray Power Unit).



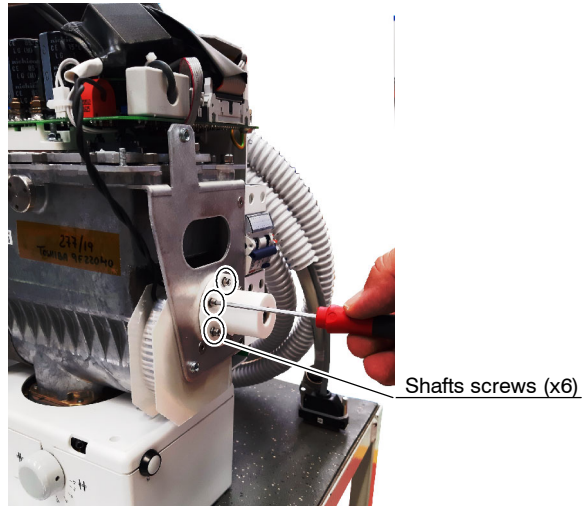
2. Remove the Upper Cover and the Lower Cover as described in their respective Sections 6.4.5 and 6.4.6.
3. Remove the Shaft Assembly to be replaced from the “U” shaped support as follows:
 - a. Remove the Cover Screw and the Cover.



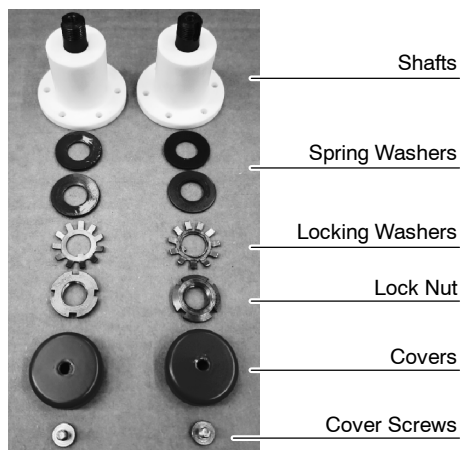
- b. Open the Tooth of the Locking Washer and unscrew the Lock Nut.



- c. Remove the lock nut, the locking washer and the spring washers (x2).
- d. Unscrew the Shaft screws (x6), remove the Shaft and replace it.



- 4. Re-assemble the X-ray Power Unit. Do not forget to install every element that has been disassembled.



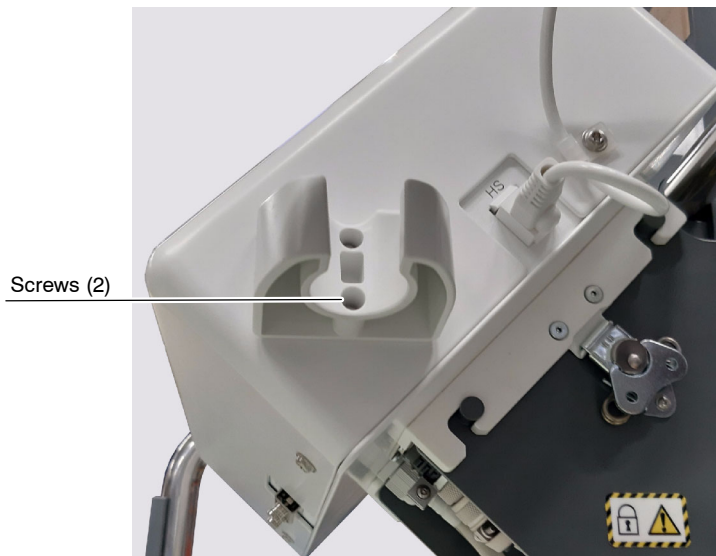
Shaft Assembly



KEEP IN MIND TO TIGHTEN THE LOCK NUT ENOUGH FOR THE X-RAY UNIT TO STAY STILL IN A SPECIFIC POSITION, AND ENOUGH FOR THE X-RAY UNIT TO BE EASY TO MOVE. DO NOT FORGET TO LOCK THE NUT WITH THE LOCKING WASHER TOOTH.

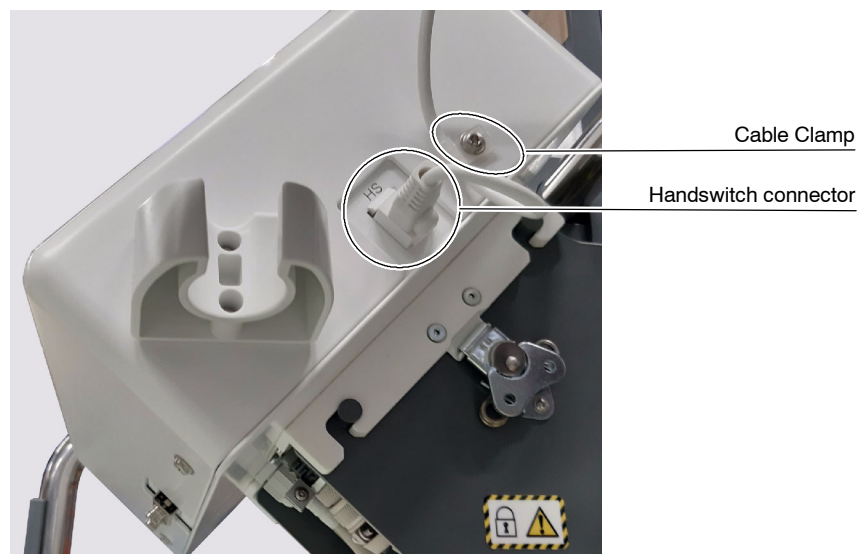
6.4.18 HANDSWITCH SUPPORT

1. Unscrew the Handswitch Support from the Console's cover.
2. Replace the Handswitch Support and tighten the two (2) screws.



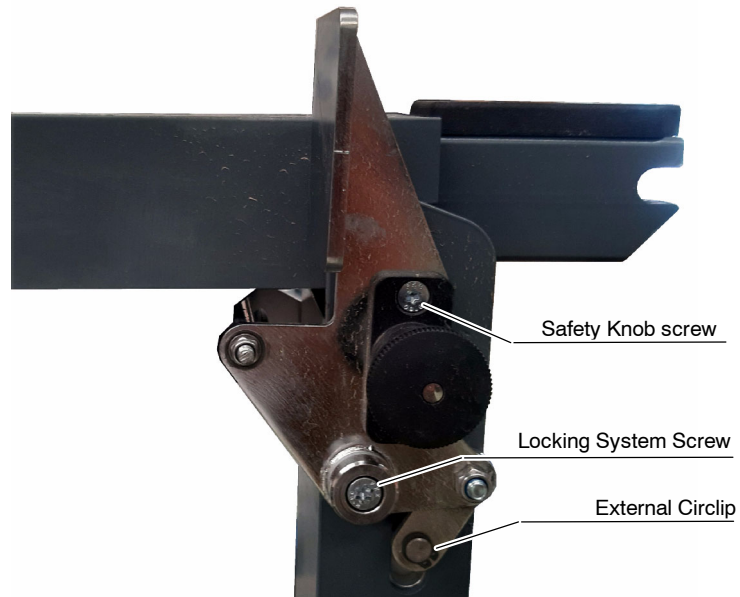
6.4.19 HANDSWITCH

1. Unscrew the Cable Clamp from the Console's cover.
2. Disconnect the Handswitch from its connector on the Console's cover.
3. Attach the new Handswitch to the Console's cover by screwing the Cable Clamp and connect the Handswitch.



6.4.20 LOCKING SYSTEM AND SPRINGS REPLACEMENT OF THE FOLDING LEG

1. With the unit in laying position and the leg folded, remove the Safety Knob screws (x2) and remove the Safety Knob.
2. Remove the external circlips (x2) with external circlip pliers.
3. Remove the Locking System Screws (x2) and the washers (x4).



4. Remove the axis and the Locking System.
5. Install the new Locking System. Firstly, place the axis and the circlip to immobilize the Locking System.

6.4.21 SOLID WHEELS REPLACEMENT

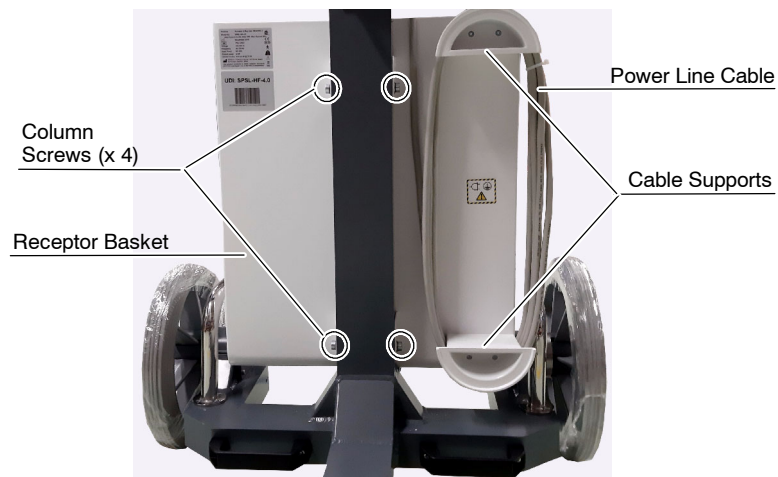
1. Place the Arm in Parking Position. To place the Arm in the Parking Position:



- a. Stand up in front of the Unit.
- b. Position the Power Module in parallel to the Arm.
- c. Unlock the Gas Spring with the Arm Lock Lever.
- d. Push the Power Module downwards with both hands until the parking detent is locked.

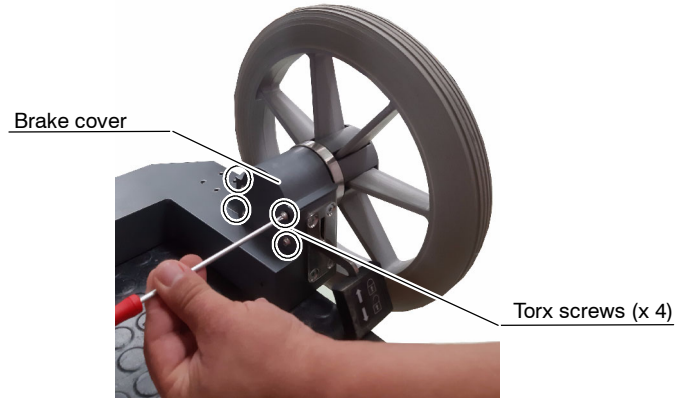
2. Remove the Receptor Basket as follows.

- a. Unwind the Power Line Cable from the Cable Support.
- b. Remove the column screws and the washers while holding the Receptor Basket.
- c. Leave the Receptor Basket aside.

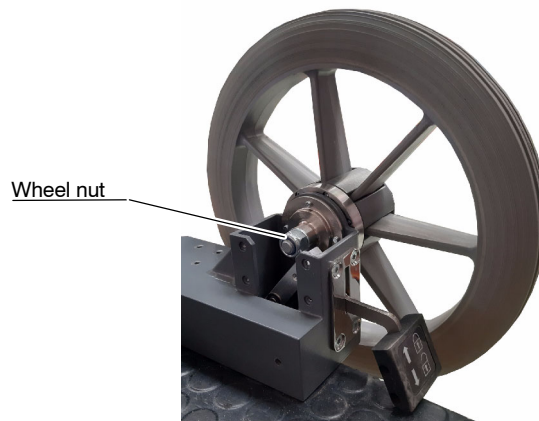


3. Place a block under the Brake so that the wheel to be replaced is raised from the floor.

4. Loosen the four Brake Cover screws in order to remove the Brake Cover of the wheel to be replaced.



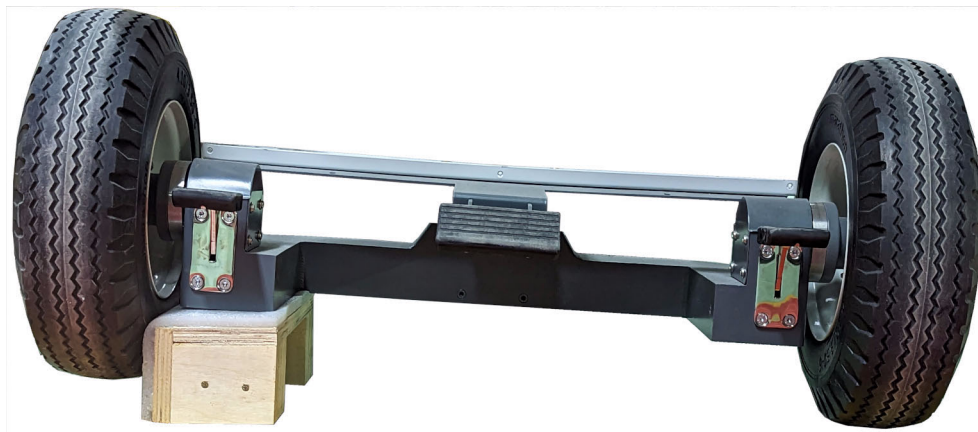
5. Lock the brake and remove the security nut and washer.



6. Release the Brake and replace the Wheel.

6.4.22 ALL-TERRAIN WHEELS REPLACEMENT

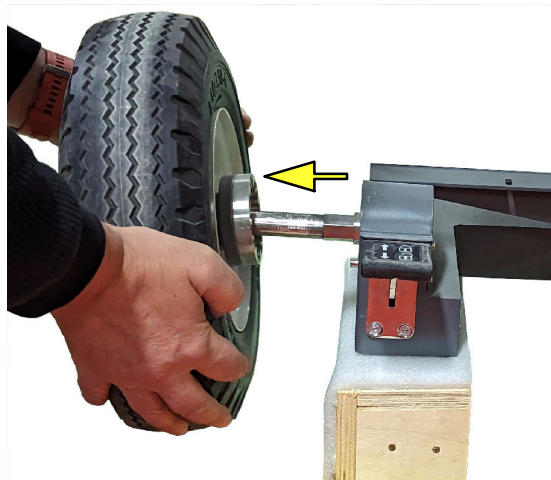
1. Place the arm in parking position.
2. Place a wood block or equivalent under the brake so that the wheel to be replaced is raised from the floor.



3. Open and remove the lock ring that holds the wheel.

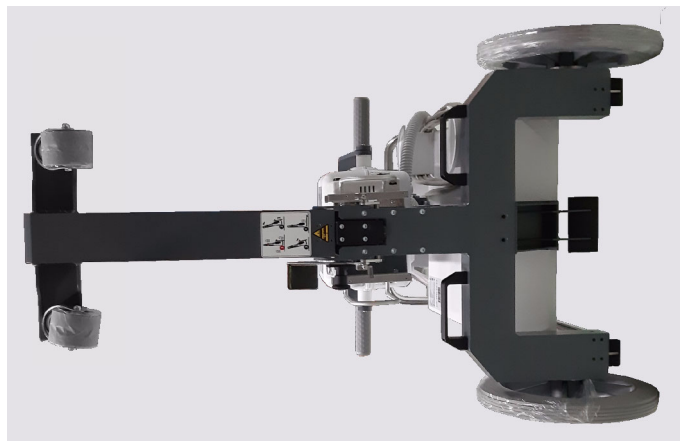


4. Take out the wheel of the shaft, replace it and install the lock ring again.



6.4.23 STEERING WHEELS REPLACEMENT

1. Place the Arm in Parking Position. To place the Arm in the Parking Position:
 - a. Stand up in front of the Unit.
 - b. Position the Power Module in parallel to the Arm.
 - c. Unlock the Gas Spring with the Arm Lock Lever.
 - d. Push the Power Module downwards with both hands until the parking detent is locked.
2. Lay the Trolley down on its side with the leg fully extended.

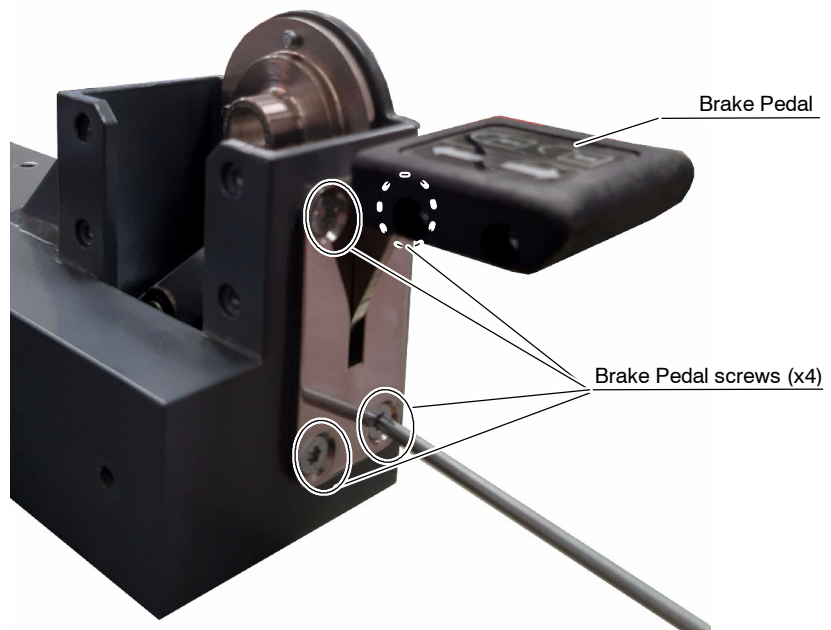


3. Unscrew the Wheel support nut with a box wrench and replace the Steering Wheel.

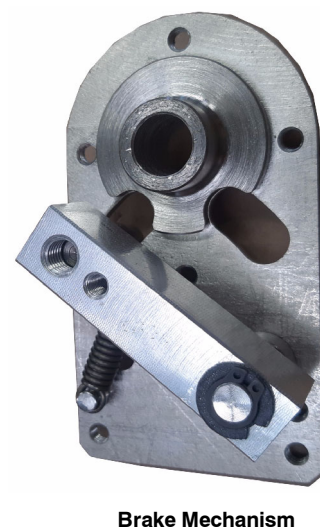
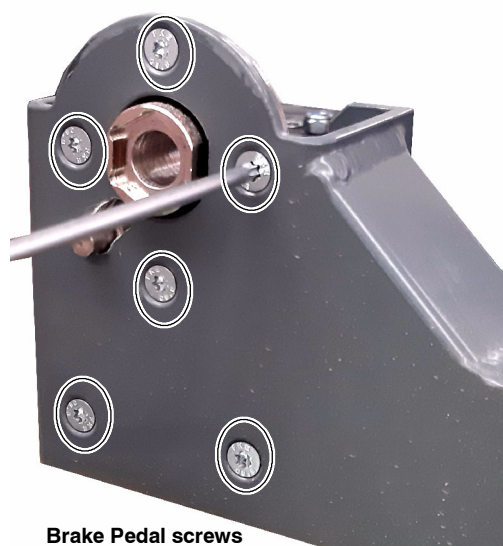


6.4.24 BRAKE MECHANISM AND BRAKE PEDALS

1. Follow the steps in Sections 6.4.21 or *NO TAG*, depending on the type of the wheels to be replaced.
2. Remove the Brake Pedal screws (x4).



3. Replace the Pedal, or leave it aside and continue with next step to replace the Brake Mechanism.
4. Remove the Brake Mechanism screws (x6) and replace the Brake Mechanism.

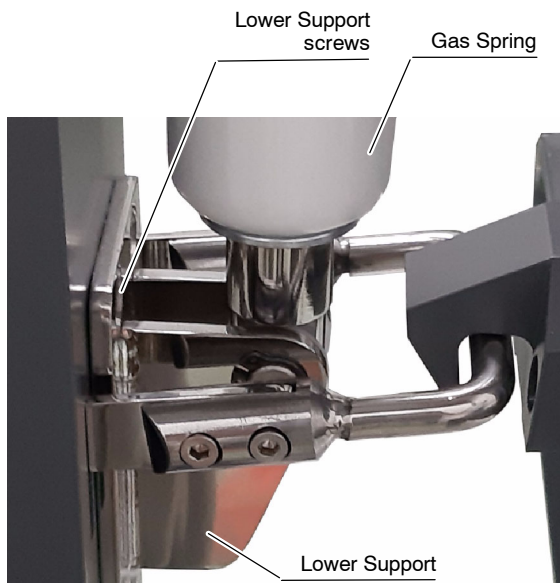


6.4.25 GAS SPRING REPLACEMENT

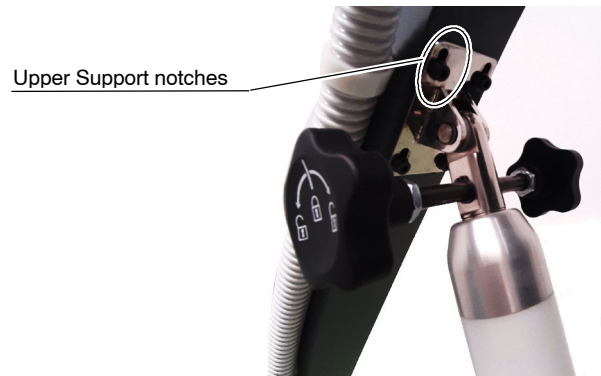
1. Fully extend the Arm, then lay down the Trolley, with the cassettes basket resting on the floor, and leave the Power Unit face up on a table or similar, preventing the Arm from springing up when removing the Gas Spring.



2. Remove the four (4) screws at the Upper Support (Arm) and the four (4) screws of the Lower Support (Column Bracket) of the Gas Spring.



3. Install the new Gas Spring using the same screws to fix the Upper and Lower Supports in the following way:
 - a. Install the Lower Support screws.
 - b. Install the Upper Support screws using the middle notches.
4. Place the Unit in upright position and fully extend the Arm. In case a lack of strength is detected, install the Upper Support screws in the next position notches.



6.4.26 CASSETTE BASKET

1. Unwind the Power Line Cable from the Basket supports.
2. Unscrew 4 Allen screws and take it off.
3. Replace the Cassette Basket.



6.4.27 REPLACEMENT PARTS IN THE 3P CONSOLE BOX

3P Console



6.4.27.1 ACCESS INSIDE THE 3P CONSOLE BOX

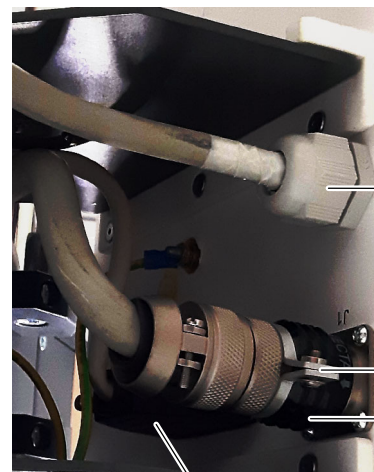
Note 

If the Unit is provided with Isolation Transformer, access inside the Console Box as described in Section 6.4.29.

1. Remove the Power Harness Ring with an Allen wrench and disconnect the two cables of the Power / Communication Harness attached to the Power Unit.



Access to Power /
Communication Harness



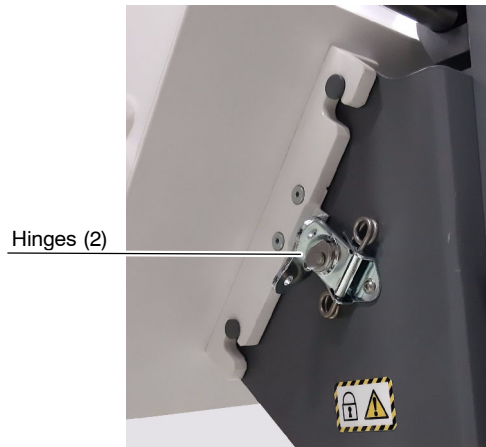
Generator Power Cable

Power Harness Ring

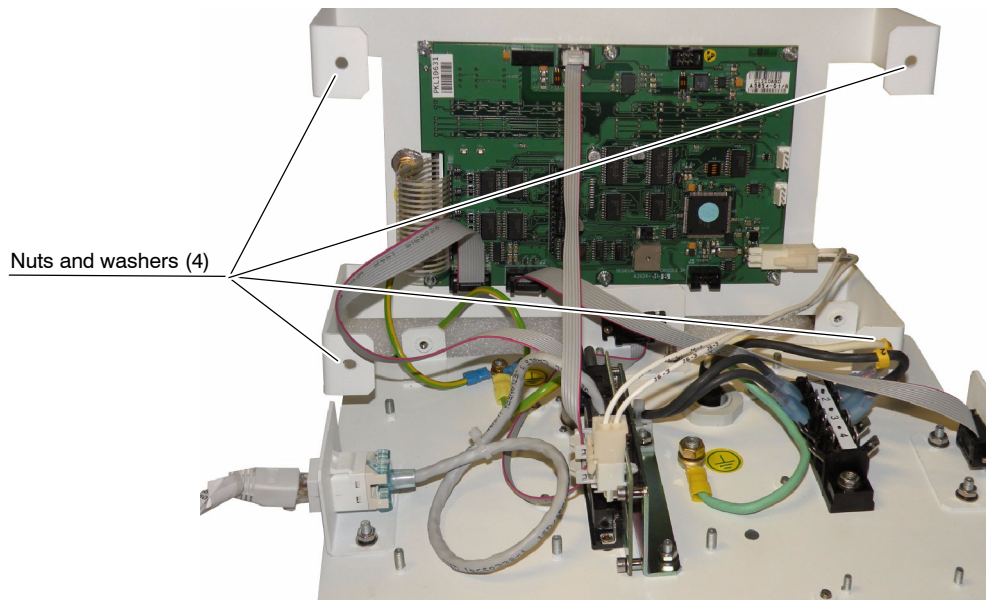
Power Harness

Communication Harness

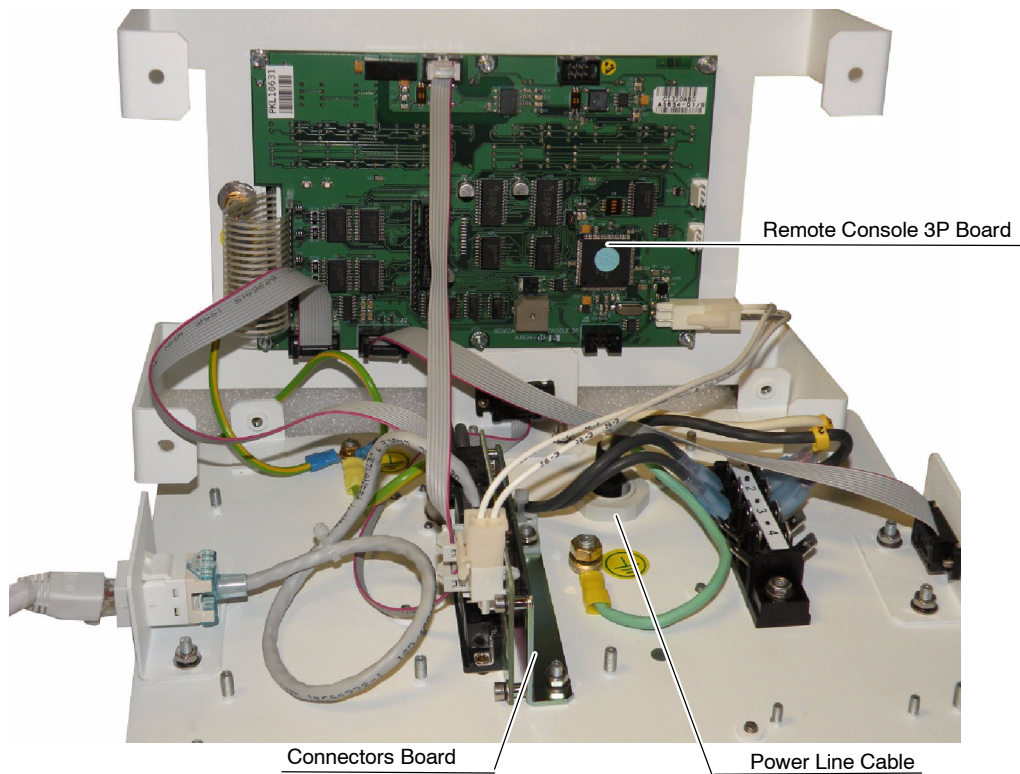
2. Unlock and open the two hinges that attach the 3P Console to the frame. Grab the 3P Console with both hands and move it upwards to the limit. Pull it in order to release it from its bracket and place the 3P Console on a safe place, the 3P Console facing downwards. Do not forget that some cables are still attached to the 3P Console.



3. Remove the four (4) screws at both sides of the cover, lift the cover up and disconnect the Ground cable of the cover.
4. Remove the four (4) nuts and washers and separate the two parts of the Console Box. Be careful with the cables since some of them are connected to both parts of the Console Box.



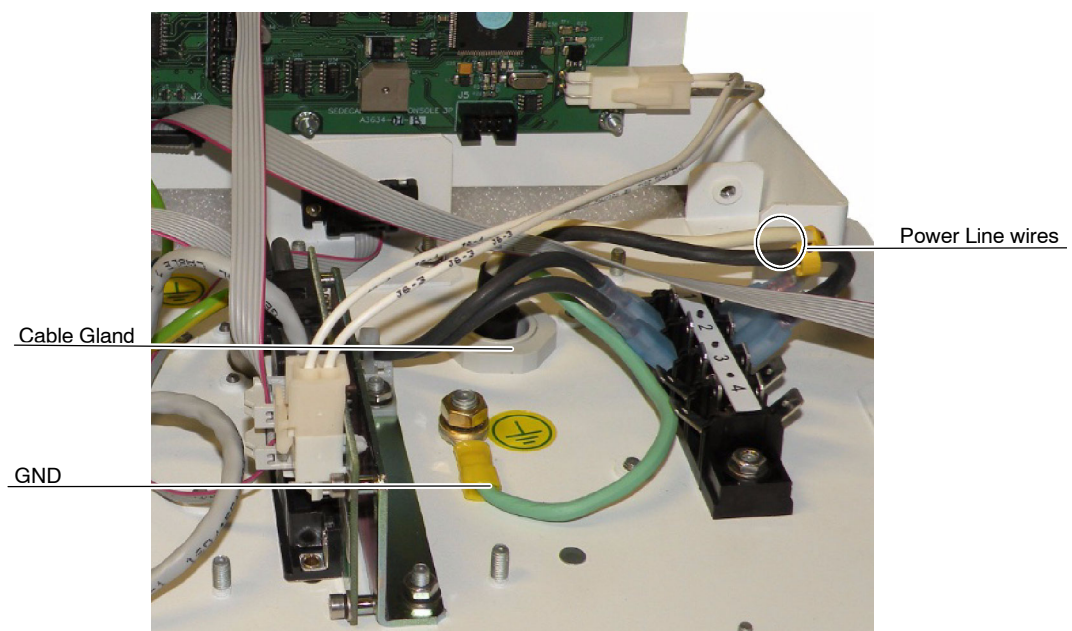
5. Replace the respective part in the Console Box as described in the next sections.



6. Once the components in the Console Box have been replaced, mount the parts with their corresponding screws and assemble the Console Box to the Trolley.
7. Connect the two cables of the Power / Communication Harness previously disconnected to the Power Unit.

6.4.27.2 POWER LINE CABLE

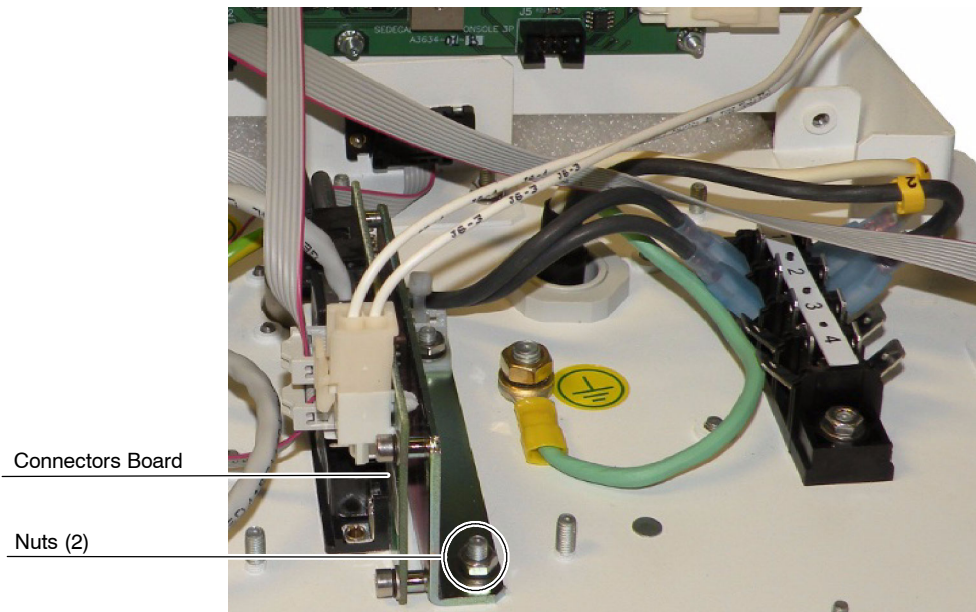
1. Access inside the 3P Console Box as described in *Section 6.4.27.1*.
2. Disconnect the GND from the Console Box GND stud.
3. Disconnect the Power Line wires (Faston connectors) in the rack.
4. Unscrew the Plastic Nut of the Cable Gland.
5. Pass the disconnected Power Line Cable through the Cable Gland.



6. Pass the new Power Line Cable through the Cable Gland and screw the Plastic Nut.
7. Connect the Power Line wires (Faston connectors) in the rack and the GND to the Console Box GND stud.
8. Assemble the Unit as described in *Section 6.4.27.1*.

6.4.27.3 CONNECTORS BOARD

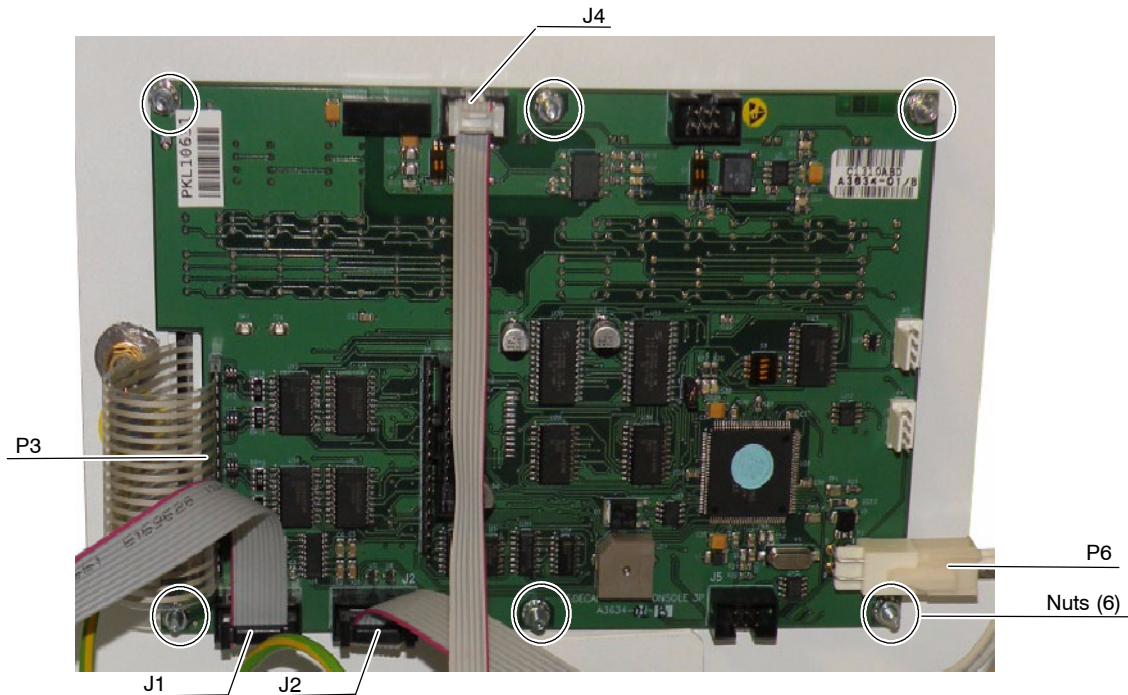
1. Access inside the 3P Console Box as described in *Section 6.4.27.1*.
2. Disconnect the cables connected to J3, J4, J6 and J7.
3. Remove the nuts attaching the support of the Connectors Board (A3632-02) to the 3P Console Box.



4. Install the new Connectors Board.
5. Reconnect all the cables and assemble in reverse order.
6. Assemble the Unit as described in *Section 6.4.27.1*.

6.4.27.4 REMOTE CONSOLE 3P BOARD

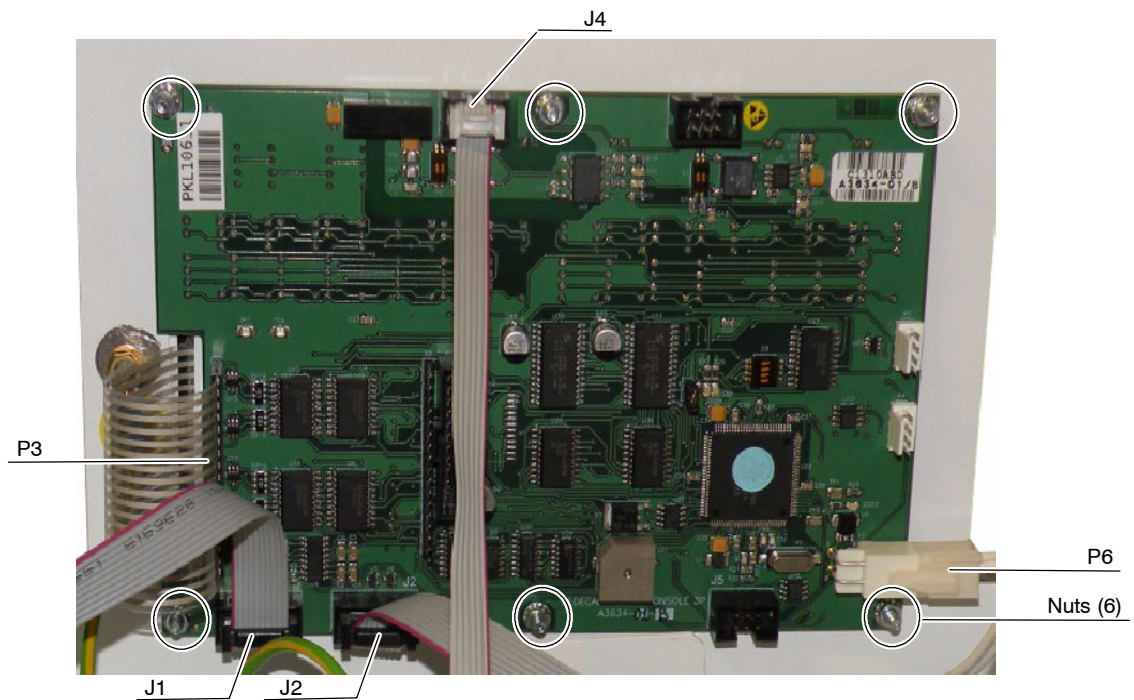
1. Access inside the 3P Console Box as described in *Section 6.4.27.1*.
2. Unplug the cables connected to J1, J2, J4, P6 and P3 (Keyboard cable).
3. Unscrew the six (6) nuts of the Remote Console 3P Board (A3634-01) and remove it.



4. Install the new Remote Console 3P Board.
5. Reconnect all the cables and assemble in reverse order.
6. Assemble the Unit as described in *Section 6.4.27.1*.

6.4.27.5 KEYBOARD

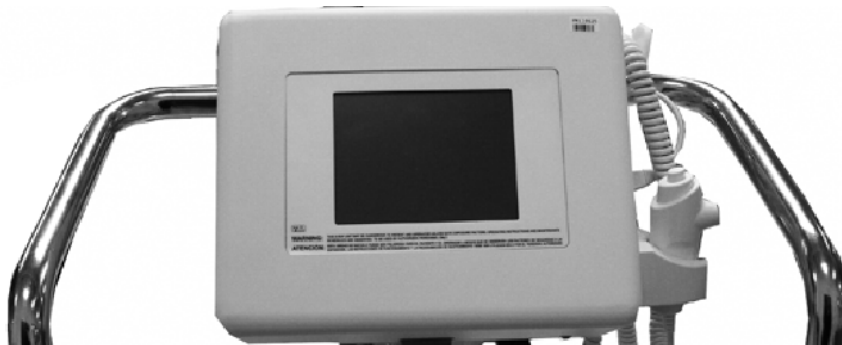
1. Access inside the 3P Console Box as described in *Section 6.4.27.1*.
2. Unplug the cables connected to P6 to facilitate the access to one of the nuts, and P3 (Keyboard cable).
3. Unscrew the six (6) nuts of the Remote Console 3P Board and remove it.



4. Unstick the old Keyboard from the plate support.
5. Clean the remaining glue with alcohol from the support plate and stick the new Keyboard.
6. Reconnect and assemble in reverse order.
7. Assemble the Unit as described in *Section 6.4.27.1*.

6.4.28 PARTS REPLACEMENT IN THE TOUCH SCREEN CONSOLE BOX

Touch Screen Console



6.4.28.1 ACCESS INSIDE THE TOUCH SCREEN CONSOLE BOX

Note 

If the Unit is provided with Isolation Transformer, access inside the Console Box as described in Section 6.4.29.

1. Remove the Power Harness Ring with an Allen wrench and disconnect the two cables of the Power / Communication Harness attached to the Power Unit.



Access to Power /
Communication Harness



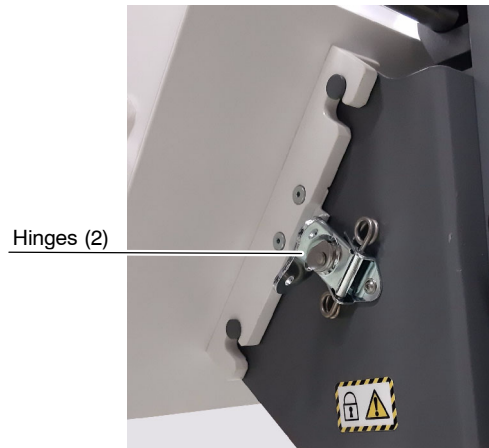
Generator Power Cable

Power Harness Ring

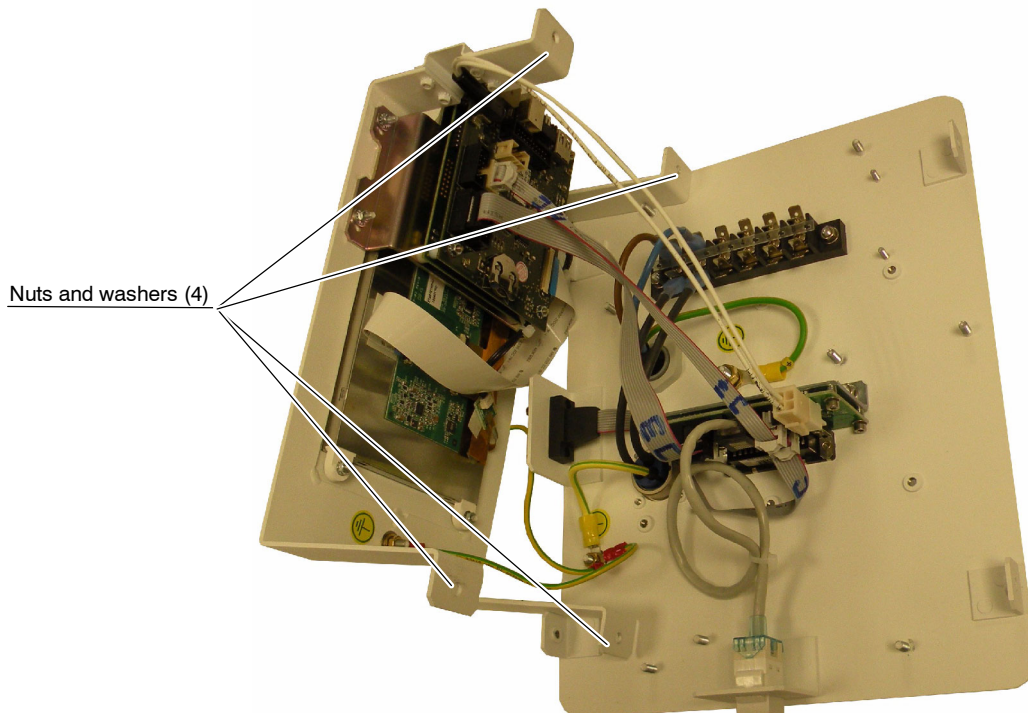
Power Harness

Communication Harness

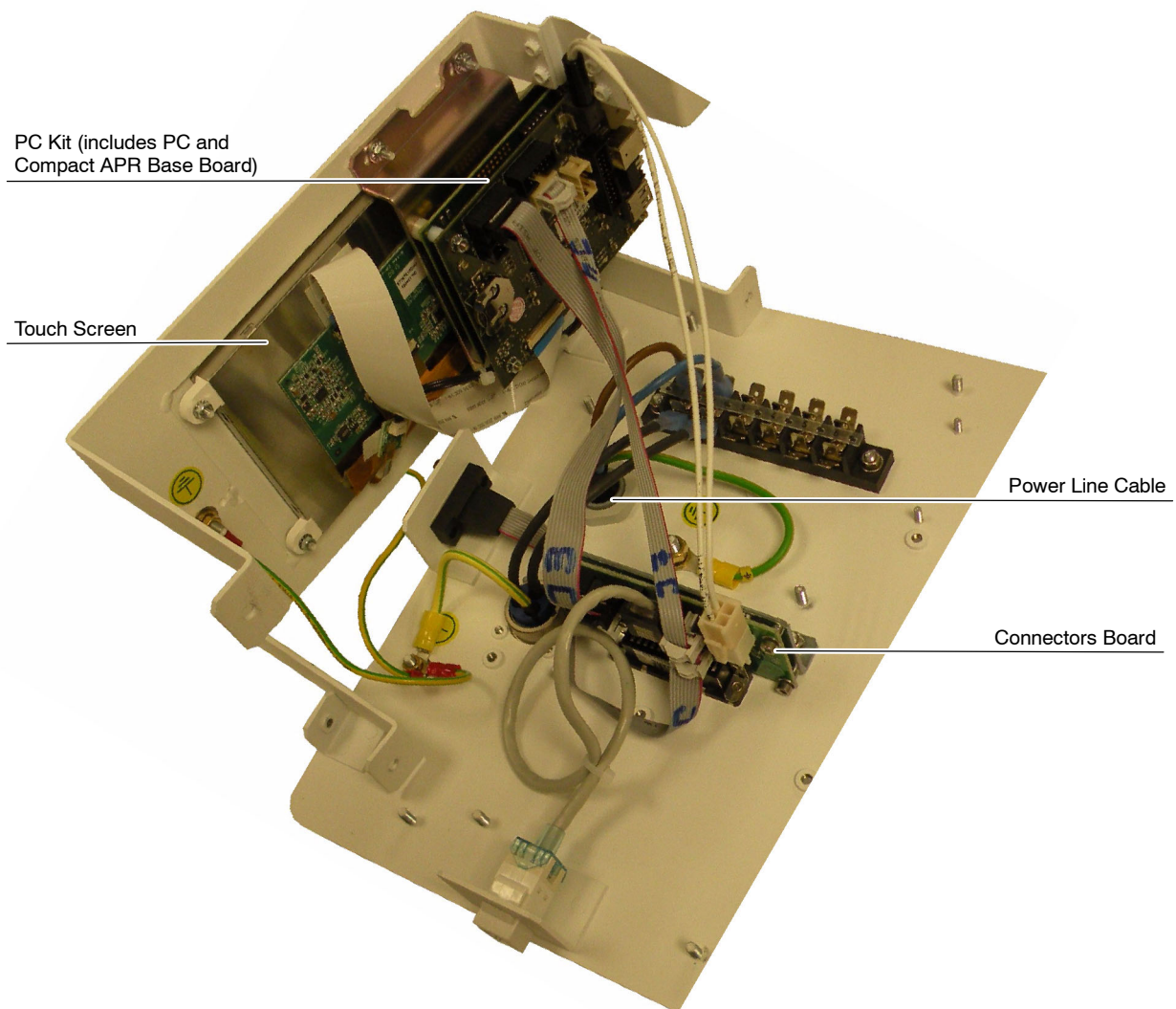
2. Unlock and open the two hinges that attach the Touch Screen to the frame. Grab the Touch Screen with both hands and move the Touch screen upwards to the limit. Pull it in order to release it from its bracket and place the Touch Screen on a safe place, the touch screen facing downwards. Do not forget that some cables are still attached to the touch screen.



3. Remove the four (4) screws at both sides of the cover, lift the cover up and disconnect the Ground cable of the cover.
4. Remove the four (4) nuts and washers and separate the two parts of the Console Box. Be careful with the cables since some of them are connected to both parts of the Console Box.



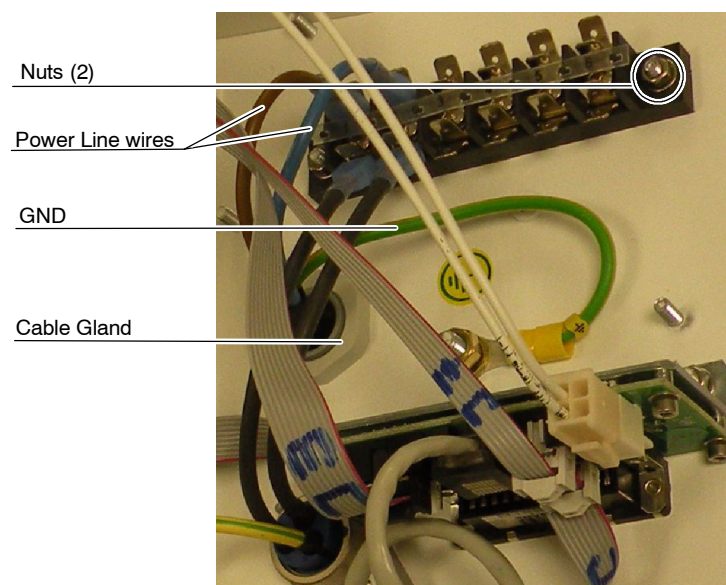
5. Replace the respective part in the Console Box as described in the next sections.



6. Once the components in the Console Box have been replaced, mount the parts with their corresponding screws and assemble the Console Box to the Trolley.
7. Connect the two cables of the Power / Communication Harness previously disconnected to the Power Unit.

6.4.28.2 POWER LINE CABLE

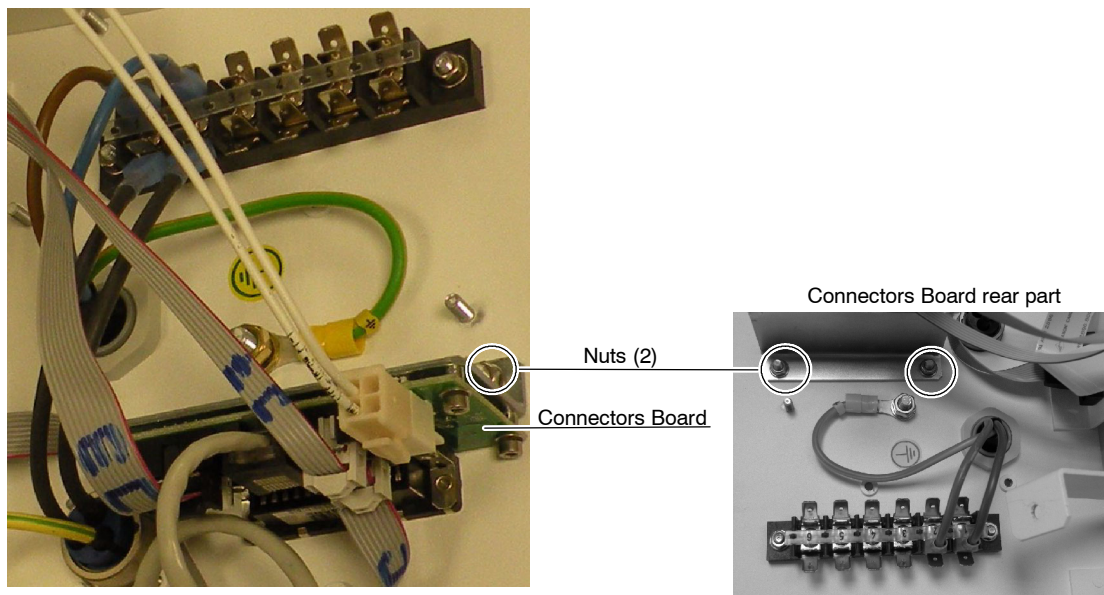
1. Access inside the Touch Screen Console Box as described in *Section 6.4.28.1*.
2. Disconnect the GND from the Console Box GND stud.
3. Disconnect the Power Line wires (Faston connectors) in the rack.
4. Unscrew the Plastic Nut of the Cable Gland.
5. Pass the disconnected Power Line Cables through the Cable Gland.



6. Pass the new Power Line Cable through the Cable Gland and screw the Plastic Nut.
7. Connect the Power Line wires (Faston connectors) in the rack and the GND to the Console Box GND stud.
8. Assemble the Unit as described in *Section 6.4.28.1*.


6.4.28.3 CONNECTORS BOARD

1. Access inside the Touch Screen Console Box as described in *Section 6.4.28.1*.
2. Disconnect the cables connected to J3, J4, J6 and J7.
3. Remove the nuts attaching the support of the Connectors Board (A3632-02) to the Touch Screen Console Box.



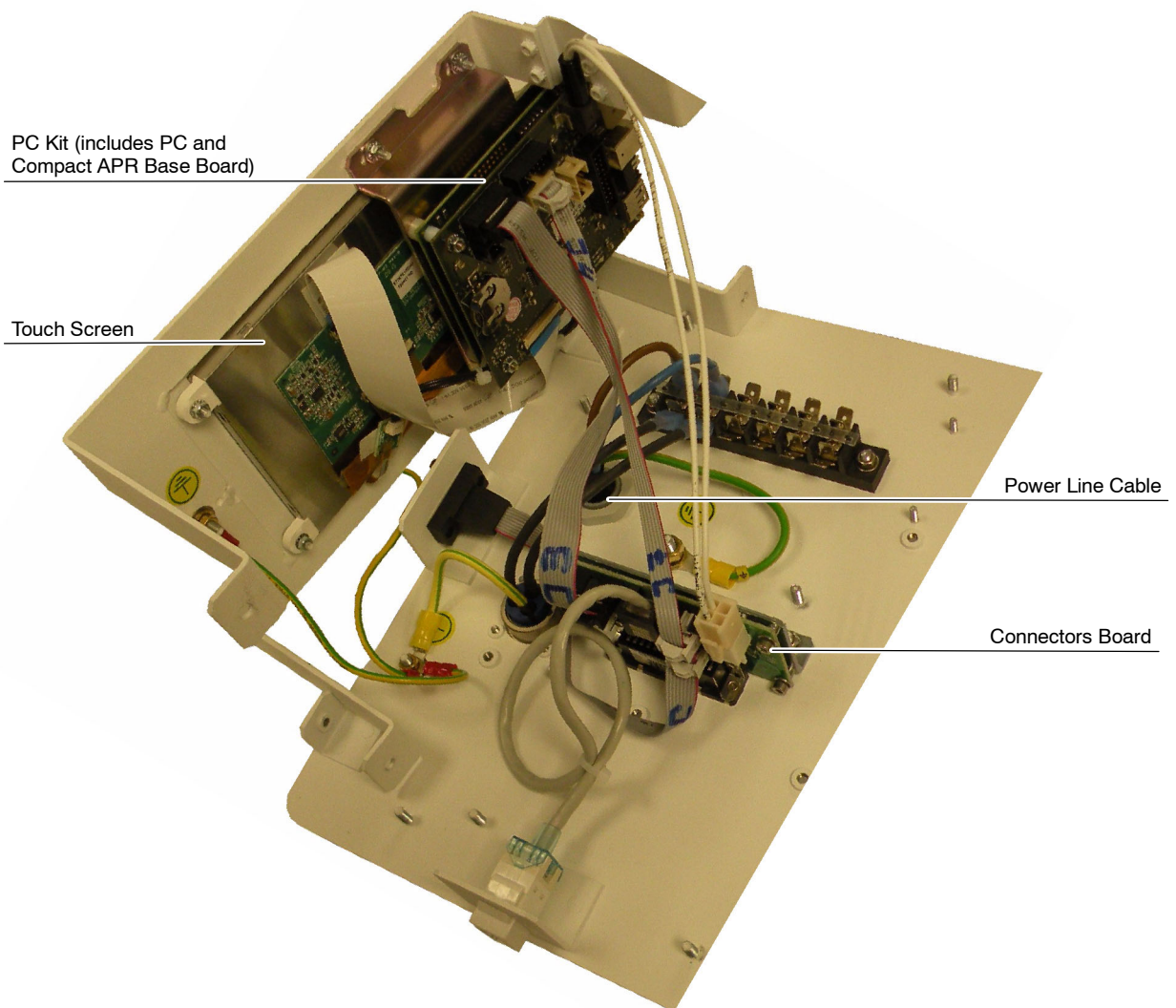
4. Install the new Connectors Board.
5. Reconnect all the cables and assemble in reverse order.
6. Assemble the Unit as described in *Section 6.4.28.1*.

6.4.28.4 PC KIT (PC AND COMPACT APR BASE BOARD)

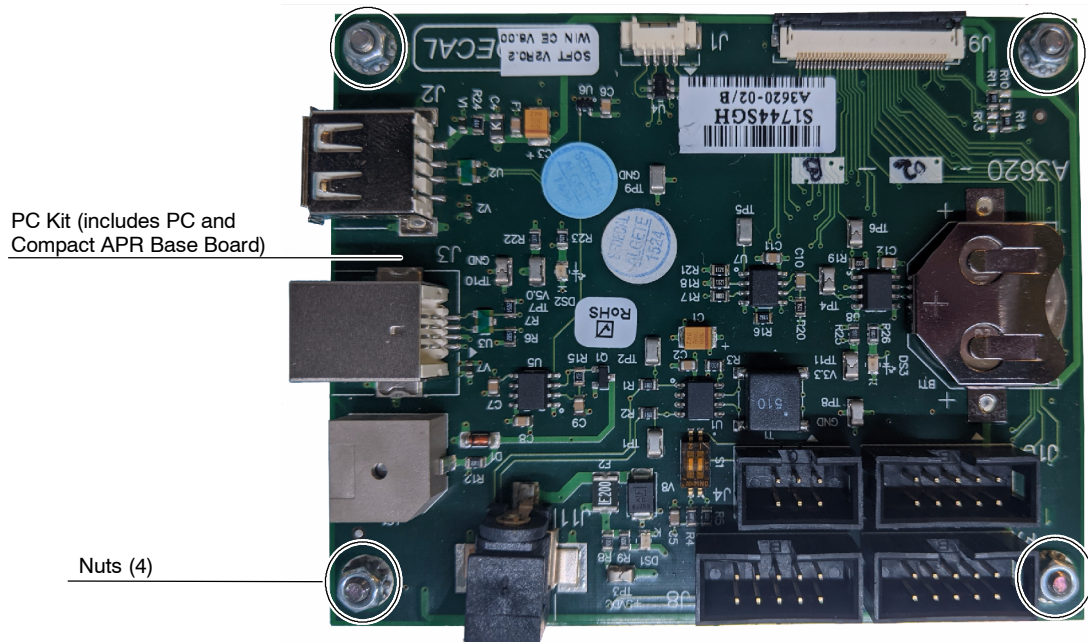
Note 

The PC Kit includes the PC and the Compact APR Base Board (A3620-02).

1. Access inside the Touch Screen Console Box as described in Section 6.4.28.1.



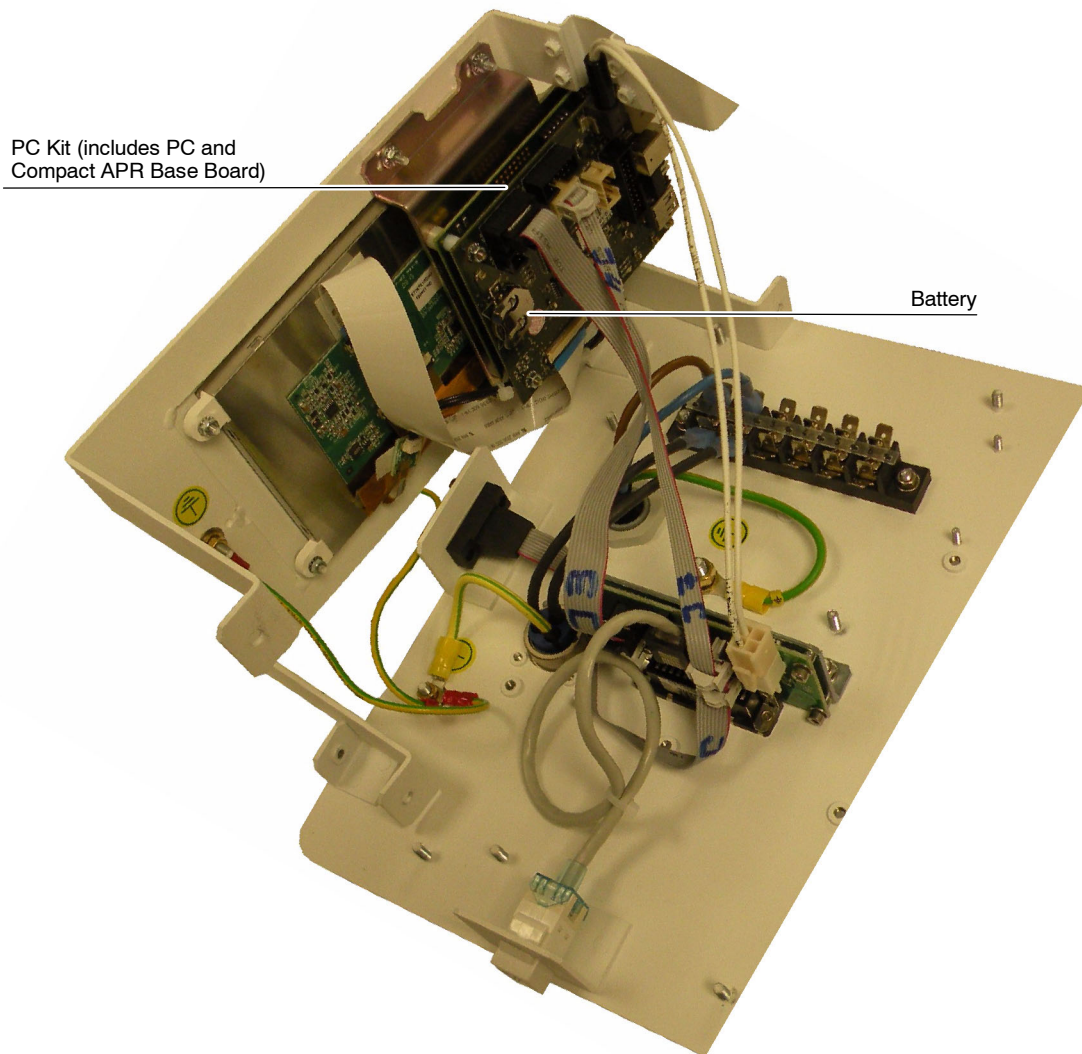
- Carefully, unplug all the cables connected to the removed Compact APR Base Board and re-connect the cables to the new Compact APR Base Board.
- Unscrew the four (4) nuts located at each corner of the PC Kit and remove it. Take care with the washers.



- Carefully, unplug all the cables connected to the removed Compact APR Base Board and re-connect the cables to the new Compact APR Base Board.
- Install the new PC Kit screwing the same washer and nuts removed before. The washers must be installed in the same order that were removed.
- Assemble the Unit as described in *Section 6.4.28.1*.

6.4.28.5 BATTERY OF THE COMPACT APR BASE BOARD

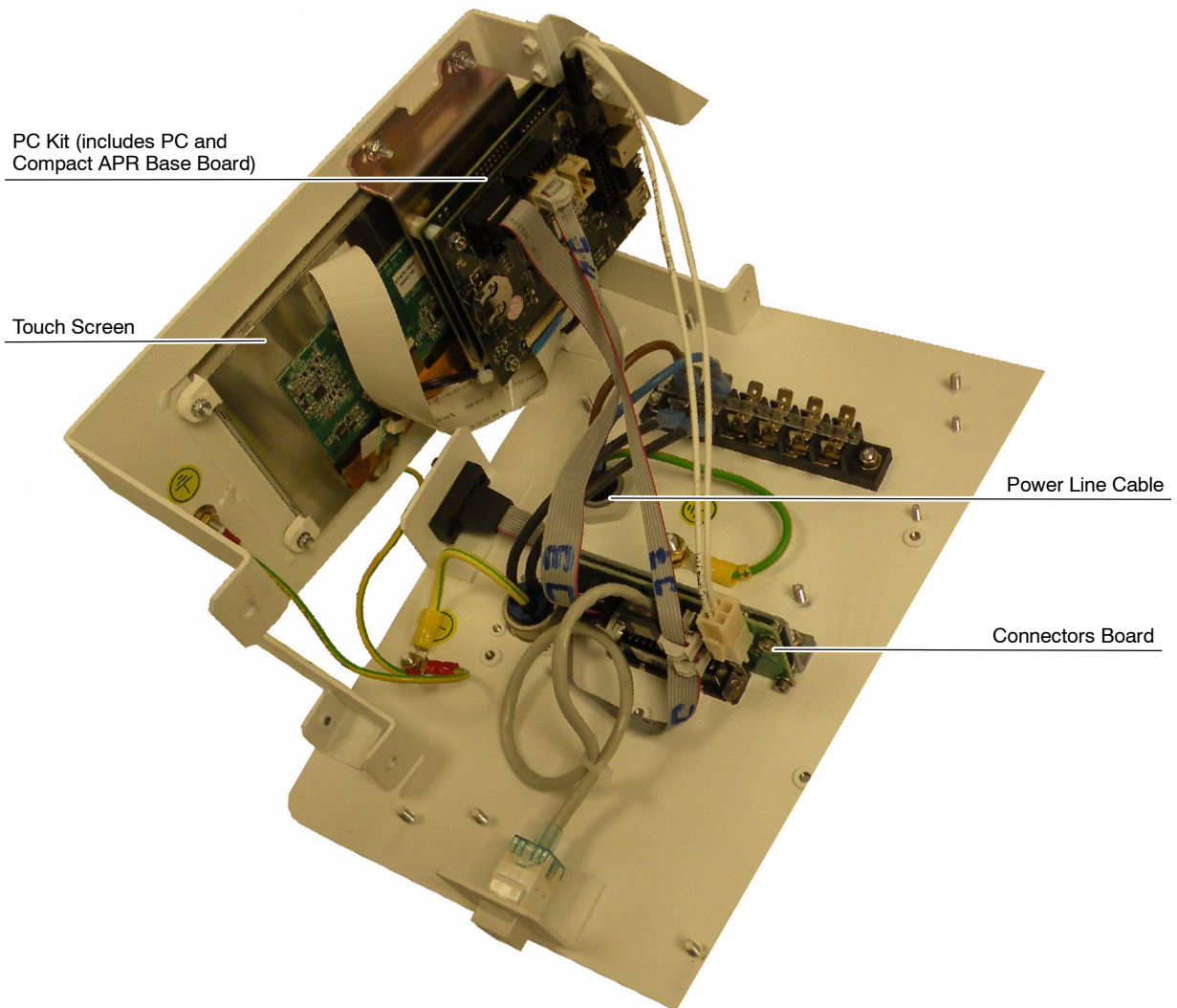
1. Access inside the Touch Screen Console Box as described in *Section 6.4.28.1*.



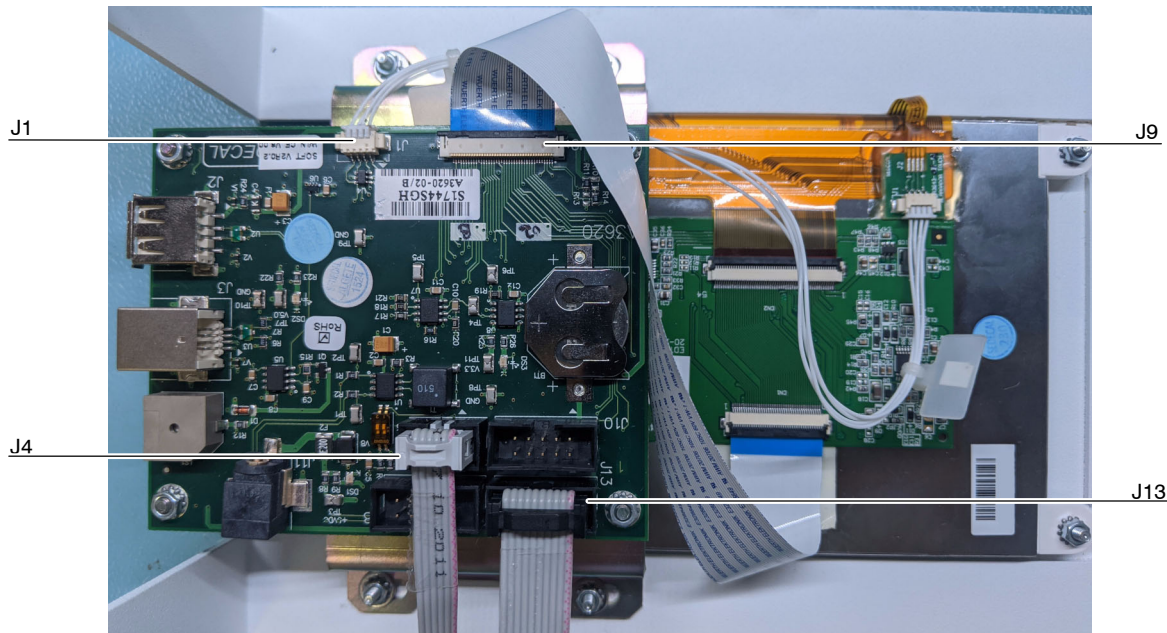
2. Take the battery out of the Compact APR Base Board and replace it.
3. Assemble the Unit as described in *Section 6.4.28.1*.

6.4.28.6 TOUCH SCREEN

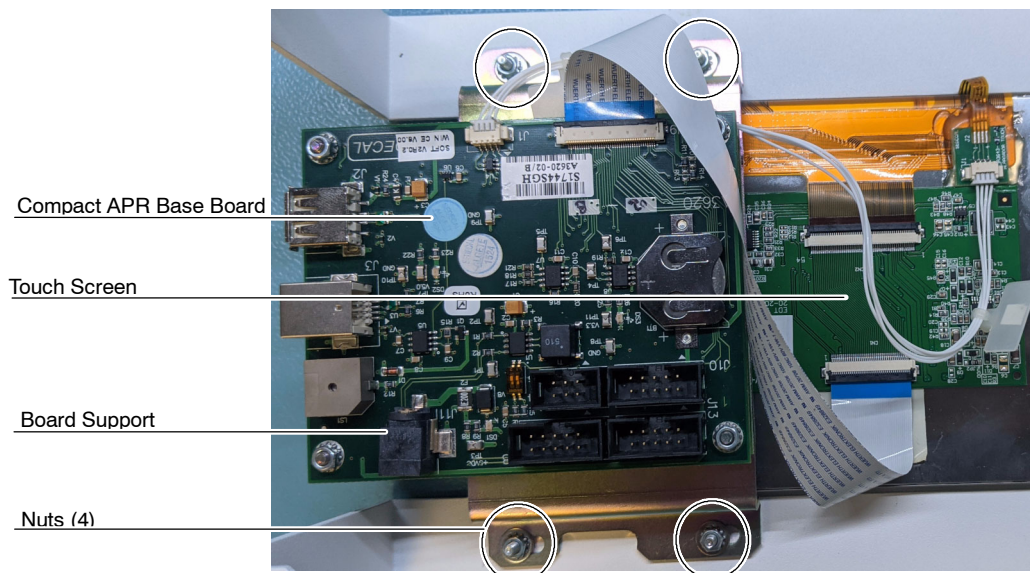
1. Access inside the Touch Screen Console Box as described in *Section 6.4.28.1.*



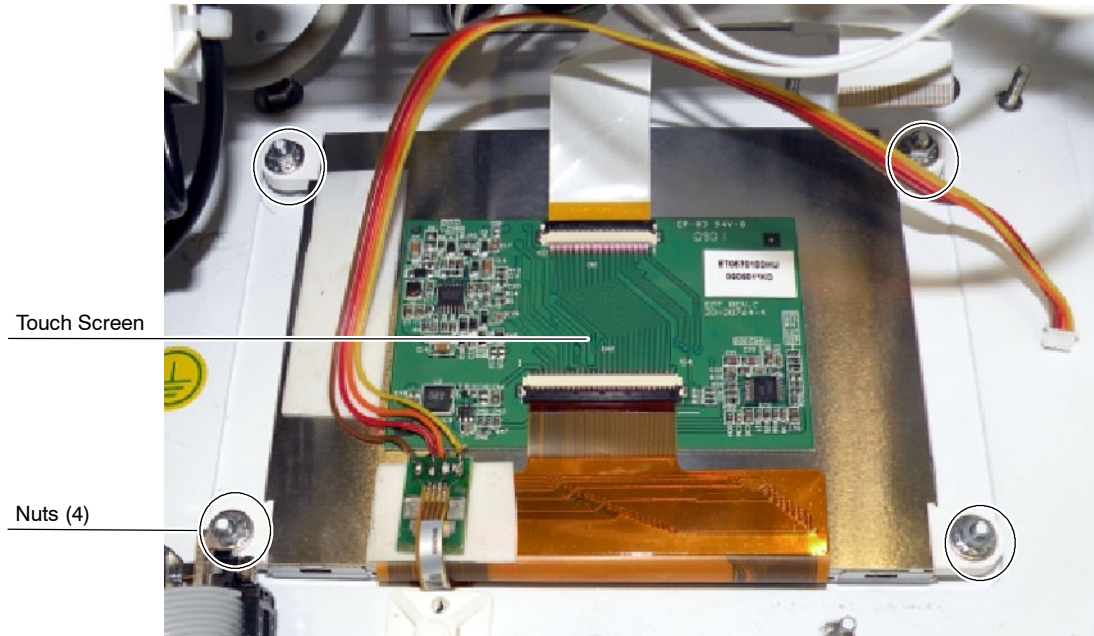
- Unplug the cables connected to J1, J4, J9 and J13 of the Compact APR Base Board to facilitate the access to the Board Support and Touch Screen.



- Unscrew the four (4) nuts located at each corner of the PC Kit Support and remove it. Take care with the washers.



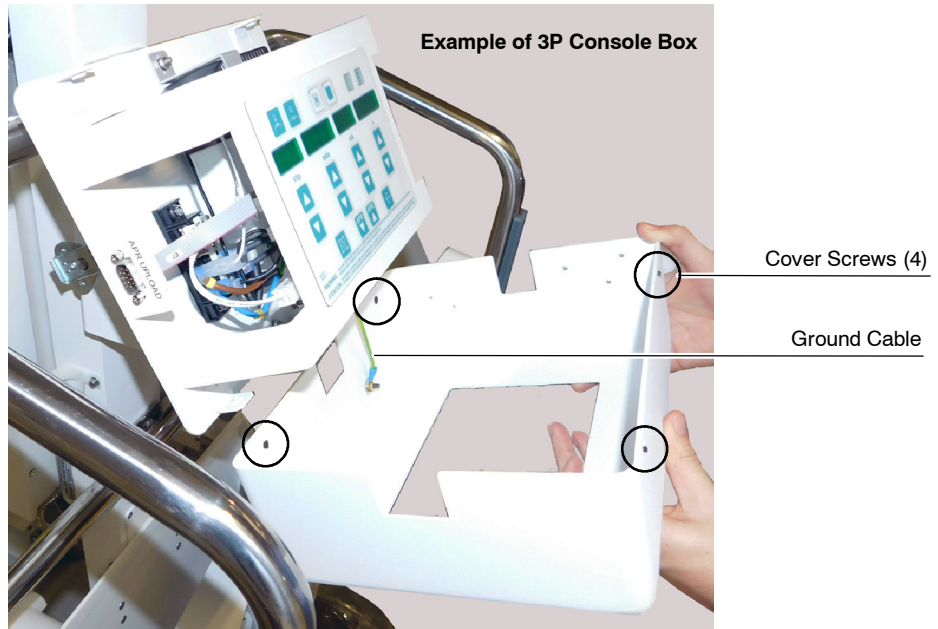
4. Unscrew the four (4) nuts and washers that assemble the Touch Screen to the Console Box and remove it. Take care with the washers.



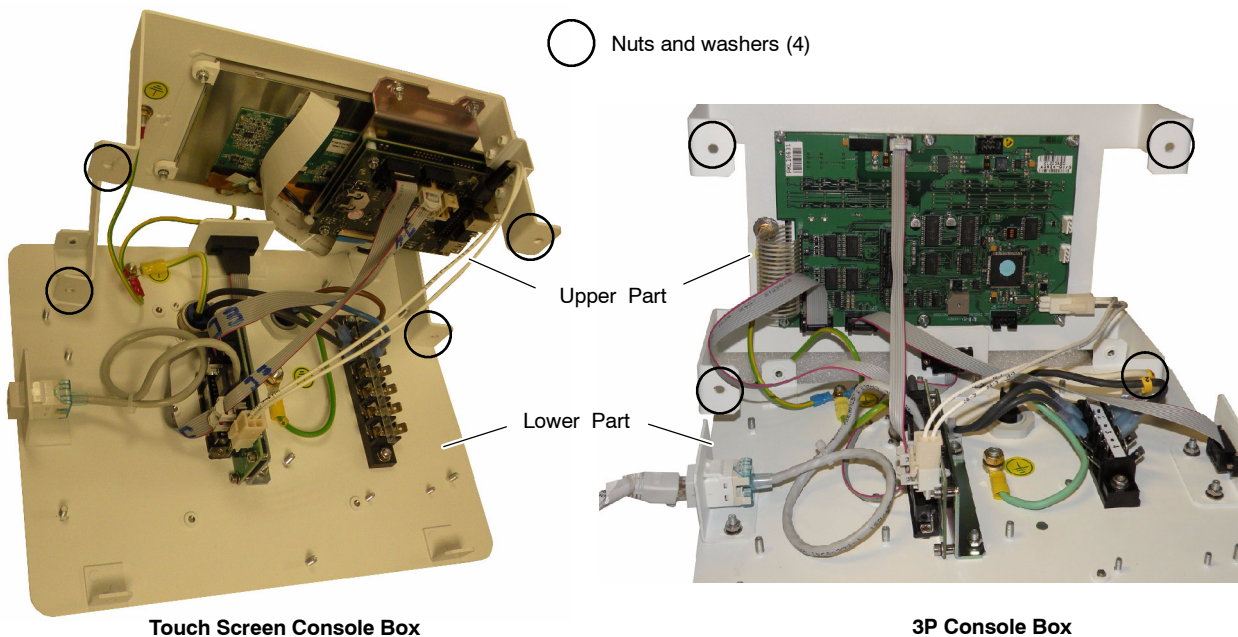
5. Install the new Touch Screen using the same washers and nuts removed before. The washers must be installed in the same order that were removed.
6. Install the PC Kit Support.
7. Connect the cables from the Touch Screen to J1 and J9 and the ribbon cable previously removed to J10 of the Compact APR Base Board. Check that the other cables are properly connected to this board.
8. Assemble the Unit as described in *Section 6.4.28.1*.

6.4.29 ACCESS INSIDE THE CONSOLE BOX FOR UNITS WITH ISOLATION TRANSFORMER

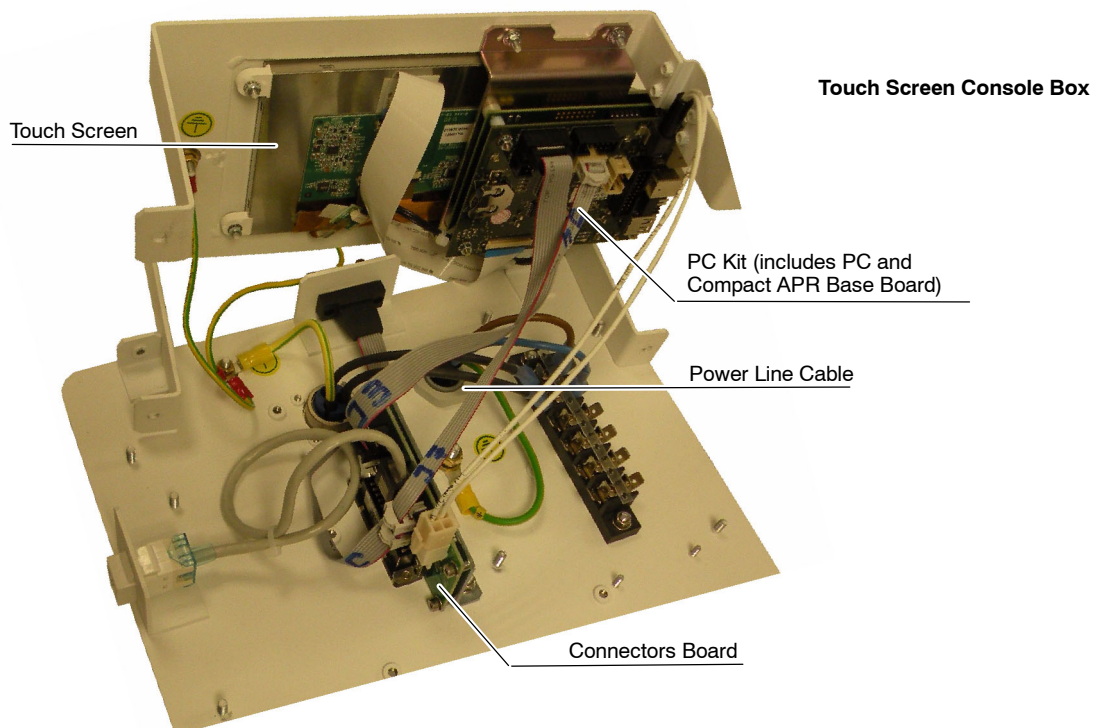
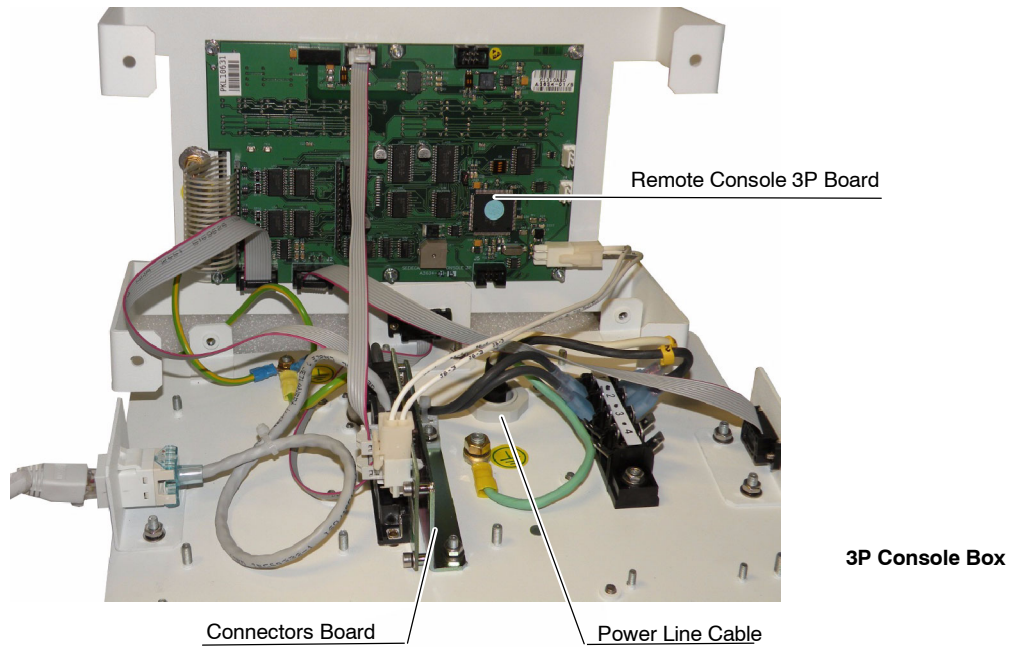
1. Remove the four (4) screws of the cover, lift the cover up and disconnect the Ground cable of the cover. Remove the cover.



2. Remove the four (4) nuts and washers and separate the two parts of the Console Box. Be careful with the cables since some of them are connected to both parts of the Console Box.



3. Replace the respective part in the Console Box as described in the corresponding Sections of the 3P Console Box or Touch Screen Console Box.



4. Once the components in the Console Box have been replaced, assemble both parts of the Console Box, connect the Ground cable and mount the cover.

SECTION 7 MAINTENANCE

The purpose of this Periodic Maintenance is to guaranty a continue safe performance of the Unit, to increase serviceability, to reduce costs (down time, repairs, etc.) and to assure the safety (personal risk).

The following checks and maintenance procedures, at the suggested intervals, are the manufacturer's recommendation for the most effective Periodic Maintenance schedule for this Portable Unit.

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 Unit.

It is the Owner's responsibility to supply or arrange the required tasks to perform the Quality Control procedures according to the frequency and acceptance criteria established by the local regulations.

The manufacturer undertakes to have available spare parts for this equipment at least for ten (10) years after the unit manufacturing.



NEVER ATTEMPT TO PERFORM MAINTENANCE TASKS WHILE THE ME EQUIPMENT IS IN USE WITH A PATIENT.

7.1 PERIODIC MAINTENANCE PROCEDURES

Prior to any periodic maintenance procedure, it is recommended to perform a test exposure using the same operating factors and conditions as for a typical exposure.

Perform the X-ray Tube warm-up procedure when the unit has been off for more than four hours.



Before performing X-ray exposures ensure that the Tube is properly warmed-up. Make sure that no people will be inadvertently exposed to unnecessary X-rays during this procedure.

7.2 GENERAL CLEANING



NEVER ATTEMPT TO CLEAN OR HANDLE ANY PART OF THE UNIT WHEN IT IS ON. SWITCH IT OFF AND DISCONNECT IT FROM THE MAINS BEFORE CLEANING OR INSPECTING.

7.2.1 EXTERNAL SURFACES

Clean external Covers and surfaces frequently, particularly if corroding chemicals are present, with a cloth moistened in warm water with mild soap. Rinse wipe with a 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 with mild soap. Rinse wipe with a cloth dampened in clean water.

Also check painted surfaces for scratching and touch up as required.

7.2.2 INTERNAL CLEANING



NEVER ATTEMPT TO CLEAN INTERNALLY THE UNIT. THE UNIT MUST BE ALWAYS KEPT SHUT UNLESS A SPECIFIC TROUBLESHOOTING PROCEDURE IS TO BE UNDERTAKEN BY HIGHLY QUALIFIED SERVICE PERSONNEL.

7.3 CABLE CHECKS

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.

7.4 GAS SPRING

Check that the X-ray Power Unit can be properly supported by the Gas Spring. To be able to do that, place the Unit in upright position and fully extend the Arm, release the Arm Lock Knob and verify that the X-ray Power Unit remains in position without falling down.

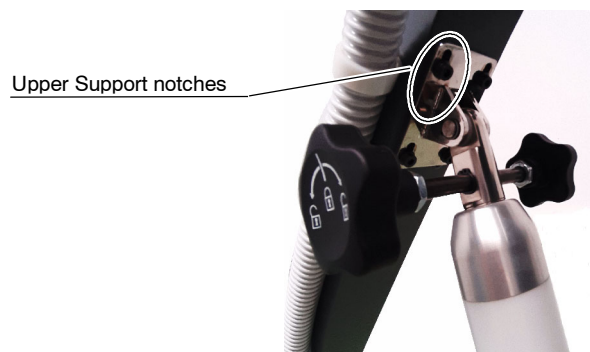


Failure to support the weight of the X-ray Power Unit or failure in the locking handle mechanism will require immediate substitution of the Gas Spring Assembly (refer to Section 6.4.25).

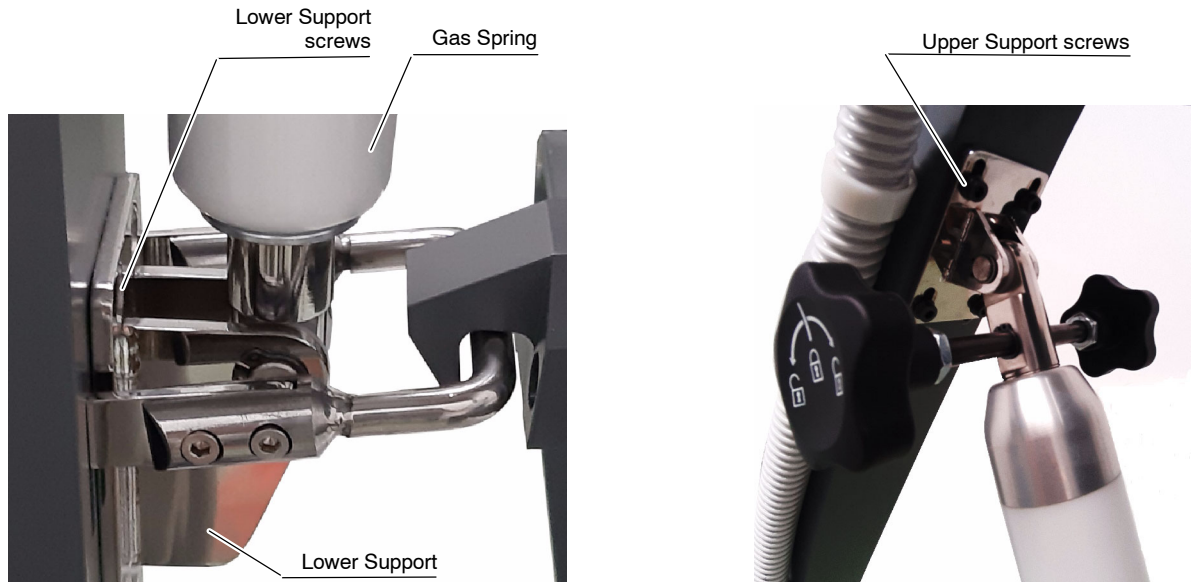


GAS SPRING ASSEMBLY FUNCTIONALITY IS A CRITICAL PART TO THE EQUIPMENT SAFETY. FAILURE IN LOCKING MECHANISM OR IN THE SPRING STRENGTH MAY CAUSE ACCIDENTAL DAMAGE TO USER OR PATIENT.

In case a lack of strength is detected, install the Upper Support screws in the next position notches.



Lock the Gas Spring and verify that all screws at elbow, Upper Support and Lower Support are tightened and present.



7.5 LOCKING SYSTEM AND SPRINGS OF THE FOLDING LEG

Verify that the action of the Locking System to fold the Leg assures that the system locks in place and does not release unless it is released and spring activated.

Failure of the assembly will require immediate substitution of the assembly to assure safety of the unit (*refer to Section 6.4.20*).



LOCKING SYSTEM MISUSE OR FAILURE CAN CAUSE UNIT TO ACCIDENTALLY TIP OVER AND HARM USER OR PATIENT.

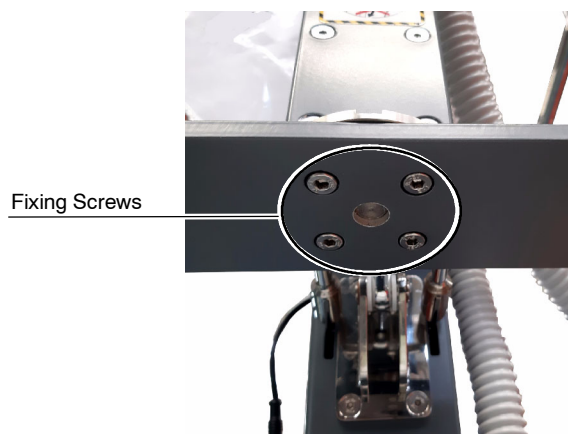
7.6 X-RAY UNIT SUPPORT

Check the correct fixation of the X-ray Power Unit and “U” Shaped Support performing the following steps:

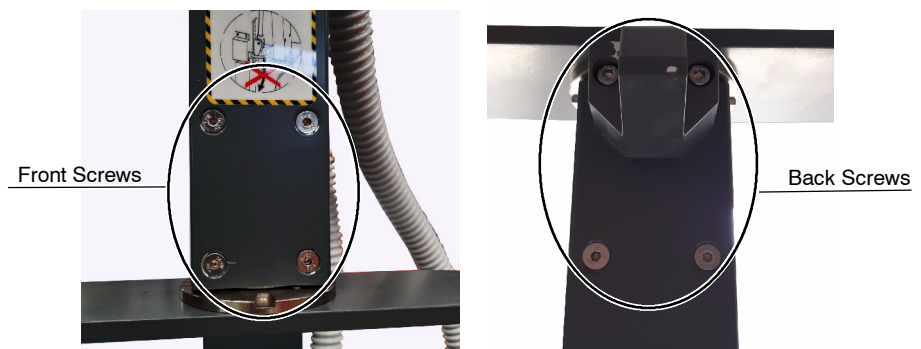
1. Check that the four (4) Fixing Screws are in place and the “U” Shaped Support is fixed to the rotation mechanism of the Trolley using a calibrated torque wrench. The screws are M6 size, A2 steel with a value of 70 Hardness, the torque to the Allen type head is to be tightened using the torque wrench to 8 Nm.



KEEP IN MIND TO USE A 8 Nm TORQUE WRENCH WHEN VERIFYING THE “U” SHAPED SUPPORT FIXATION WITH THE FOUR (4) FIXING SCREWS.



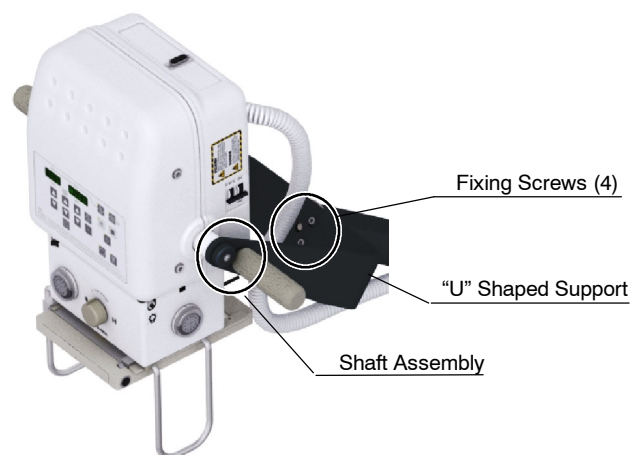
2. Verify that the eight (8) screws attaching rotation mechanism to the chassis are also in place and are properly tightened. There are four (4) screws on the front and four (4) screws on the back side. There is no specification for the torque on these screws as the load is transversal to the screw, but they have to be fully tightened.



1. Check that the X-ray Power Unit is fixed to the “U” Shaped Support and that the Shaft Assembly is in place: Check that the Lock Nut is tightened enough for the X-ray Unit to stay still in a specific position, and enough for the X-Ray Unit to be easy to move, and that the Locking Washer Tooth is securing the Lock Nut.

Note 

Refer to Section 6.4.17 for more information about the Shaft Assembly.



SHOULD ANY SCREW BE MISSING OR NOT PROPERLY TIGHTENED THERE IS A RISK OF THE X-RAY POWER UNIT HEAD FALLING DAMAGING EQUIPMENT AND HARMING USER OR PATIENT.

7.7 COLLIMATOR

Check the Collimator condition performing the following test:

1. Turn the Unit ON.
2. Open fully the Collimator blades using the Collimator Control Knobs and switch On the Collimator Light. Check the Light lights properly.
3. Close fully the Collimator blades using the Collimator Control Knobs and switch On the Collimator Light. Check the Light lights is not emitted out of the Collimator.
4. Open / close the Collimator blades using the Collimator Control Knobs for selecting different “*SID / Image Size References*” (refer to the table on the Operator Manual). Check the final image size in the receptor by switching On the Collimator Light.
5. If any of these tests is not acceptable, remove the Collimator Cover and repair the blades mechanism or the Collimator (*refer to the Collimator manuals*).



VERIFY THAT THE COLLIMATOR IS PROPERLY SEATED AND NO RISK FOR ACCIDENTAL FALL IS POSSIBLE BY TURNING COLLIMATOR AROUND AND PULLING DOWNWARDS FROM IT.

7.8 ALIGNMENT OF THE X-RAY BEAM AND FIELD SIZE INDICATOR TEST

Check the “*Alignment of the X-ray Beam*” and the “*Field Size Indicator Test*” as described in *Section 4*.

7.9 CONTROL PANEL

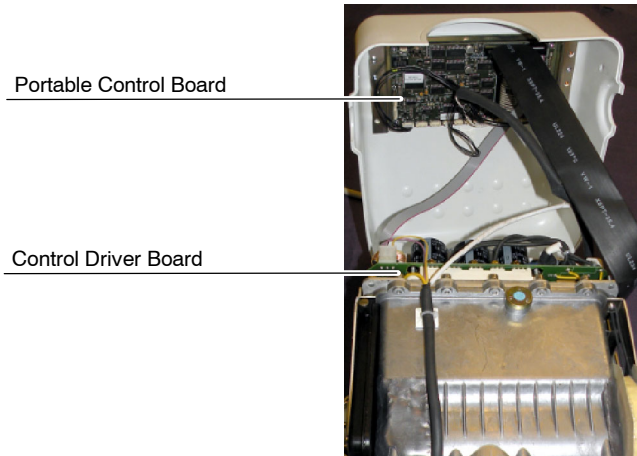
Verify that the Handswitch cable and its connection to the Unit are in good condition. Check the operation of the Handswitch button.

Check correct operation of the push-buttons, displays and indicators of the Control Panel by performing the following test:

1. Turn the Unit ON.
2. Select a radiographic technique and observe:
 - Technique parameters and other selections are displayed on the Control Panel.
 - Change technique parameters and observe that changes are correctly displayed.
 - Select 70 kVp and maximum mAs.
 - Press "*Prep*" and verify that the "*Ready*" indicator is illuminated. Release "*Prep*" and observe that the "*Ready*" indicator is off.
 - Make a typical exposure, and verify that radiographic exposure sound signal and the "*X-ray ON*" indicator function correctly during the X-ray exposure.

7.10 RADIOGRAPHIC PARAMETERS TEST

1. Turn the Unit Off and Disconnect it from mains.
2. Remove the Upper Cover screws and carefully lift the Upper Cover.
Do not unplug any cable.



3. Connect Oscilloscope to the Portable Control Board (A3175-05) as indicated in *Section 3.1*.
4. Turn the Unit ON.
5. kVp Test:
 - Place a Non-Invasive kVp Meter aligned to the X-ray beam at SID 100 cm to measure kVp. Open the light field to center it with the kVp Meter.
 - Select 80 kVp and the lowest mA station in Large Focus. Make an exposure and note the kVp read on the Non-invasive kVp Meter at the end of the exposure.
 - Check that the kVp value read must be the selected on the Control Panel: $80 \pm (3\% + 1 \text{ kVp})$. If the kVp value does not comply with it, perform the respective Calibration procedures (*refer to Section 3*).

6. mA Test:

- Select 80 kVp, Small Focus and the highest mA station in Small Focus (read the mA station on the Control Panel by pressing any “Focal Spot” and “mAs Decrease” push-buttons at the same time).

Make an exposure and measure the mA signal value with the Oscilloscope. Verify that the signal is flat.

Note 

In order to display a noiseless waveform it is necessary to apply a bandwidth filter of 8 KHz when measuring any signals with the oscilloscope. Waveforms captured without the filter may be noisy.

- Select 80 kVp, Large Focus and the lowest mA station in Large Focus (read the mA station on the Control Panel by pressing any “Focal Spot” and “mAs Decrease” push-buttons at the same time).

Make an exposure and measure the mA signal value with the Oscilloscope. Verify that the signal is flat.

- Check that the mA values read must be the selected on the Control Panel $\pm(4\% + 1 \text{ mA})$. If any mA value does not comply with it, perform the respective Calibration procedures (*refer to Section 3*).

7. Turn the Unit OFF. Disconnect the Oscilloscope and re-install the Upper Cover of the Unit.

7.11 OTHER MAINTENANCE PROCEDURES

Note 

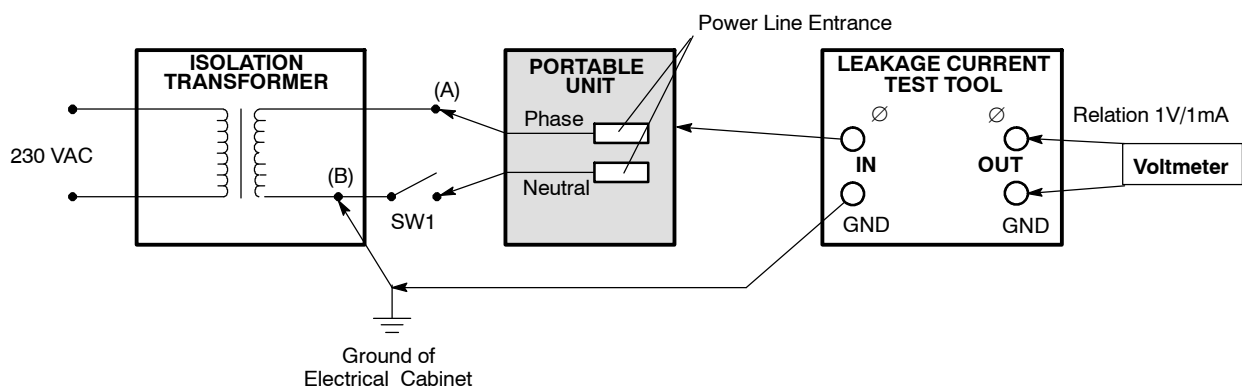
Local Standards may require checking procedures that are not considered Periodic Maintenance by the manufacturer. Below are described some of these procedures and the manufacturer recommendations to perform them.

7.11.1 CHECKING THE LEAKAGE CURRENT

Besides the standard tools and test equipment, this procedure requires the following:

- Leakage Current Test Tool (RC).
 - Isolation Transformer.
 - Voltmeter.
1. Unplug the Unit from the mains. Remove the Ground wire of the AC plug. Remove any external Ground connection to the Portable Unit.
 2. Place the Portable Unit on a surface that is isolated from ground such as wood or non-conductive plastic).
 3. Connect the AC Power Supply Cable to the secondary of the Isolation Transformer and the primary of the Isolation Transformer to 230 V~.
 4. Turn ON the Portable Unit. Connect the Leakage Current Test Tool as follows:

Illustration 7-1
Leakage Current Test Connection

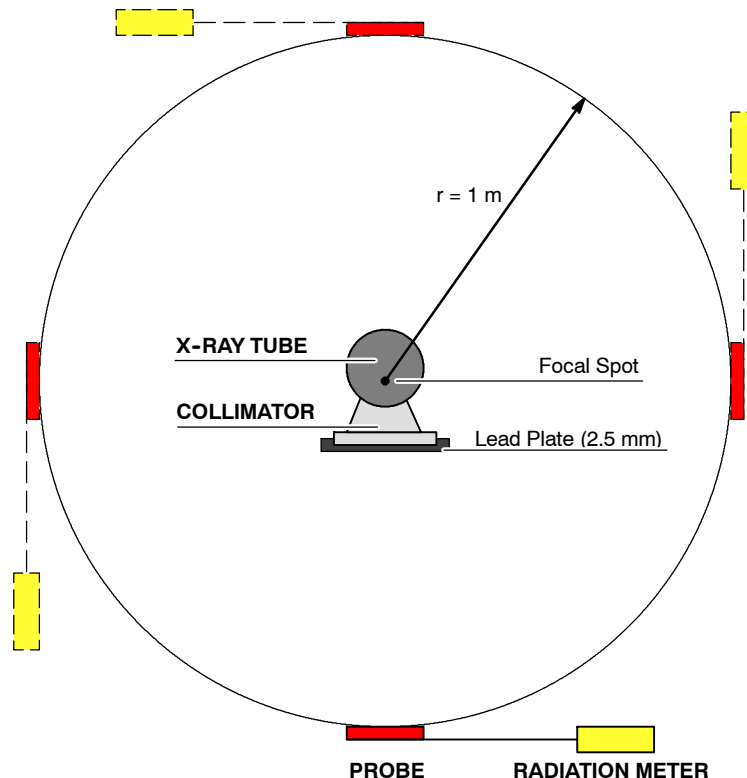


5. As shown in Illustration 7-1, the Voltmeter is set to V_{\sim} and connected to the Test Tool at the **OUT** points. Connect **Ø (IN)** to a metallic part of the Portable Unit. Connect **GND (IN)** to the Ground of the Electrical Cabinet and to an output of the secondary of the Isolation Transformer (B).
6. The reading from the Voltmeter ($1V = 1mA$) gives the leakage current under **normal conditions**. Turn OFF the Portable Unit and disconnect the connection between the secondary of the Isolation Transformer (B) (or with a switch as identified in the illustration). The measurement in the voltmeter gives the leakage current under **fault conditions**.
7. Swap the wires connected from the Isolation Transformer to the Portable Unit (marked as "A" and "B" in the illustration) and repeat the measurement specified before (*step 6.*).
8. The Leakage Current Value should not exceed 5 mA under Normal Conditions or 2.5 mA under Fault Conditions. If the measurements exceed this range, check the Power Supply Cable and Plug (V_{\sim}) for leakage current and replace the "EMC Filter" (line entrance) if required.
9. Disconnect all connections made in the previous steps and return the Portable Unit to operational wiring. Place the ground wire back to the plug and ensure a firm connection.

7.12 CHECKING THE RADIATION LEAKAGE

Besides the standard service tools, a Radiation Meter is necessary for checking Radiation Leakage. Radiation measurement will be setup as indicated in Illustration 7-2.

Illustration 7-2
Radiation Leakage Setup



1. On the Portable Unit Console, select the following parameters:
125 kVp, 50 mAs (20 mA , 2.5 s).
2. Cover the Collimator window with a Lead Plate (\approx 2.5 mm of thickness) with at least 1 cm overlap on all sides and open the Collimator blades.
3. Select *Dose* mode (0.00 μ R) on the Radiation Meter.
4. Make an exposure and note the radiation readout, indicating the position where the probe is placed respect to the Tube-Collimator. Repeat this step with the probe at various positions around the Tube-Collimator (maintaining a radius of 1 meter). Refer to *Illustration 7-2*.
5. Based on the radiation readings, calculate the Radiation Leakage according to the following formula:

$\frac{X}{S}$ Where **X** is the radiation readout (in mR) from the Radiation Meter and **s** is the time in seconds.

The following is an example of the formula stated in Step 5.

- a. If the maximum radiation is “ $X = 5 \text{ mR}$ ” in 2.5 seconds (time selected at the Console), the radiation leakage per second is:

$$\frac{X}{s} = \frac{5\text{mR}}{2.5\text{s}} = 2\text{mR/s}$$

- b. The equivalent current in continuous operating mode for the duty cycle (12 exposures at maximum energy, 125 kVp – 100 mAs during one hour, consisting of four (4) consecutive series of three (3) exposures at 100%, 50% and 25%) of the Portable Unit is **0.19 mA** at 125 kVp.

The dose per second for the equivalent current in continuous operating mode:

$$A = \frac{2\text{mR/s}}{\left(\frac{20\text{mA}}{0.19\text{mA}}\right)} = \frac{2\text{mR/s}}{105.26} = 0.019\text{mR/s}$$

- c. The total dose in one hour (3600 seconds) expressed in mR :

$$A (\text{mR/s}) \times 3600\text{s} = 0.019 \text{ mR/s} \times 3600\text{s} = 68.4 \text{ mR}$$

- d. **The Radiation Leakage limit is 100 mR / h (0.88 mGy / h);** Based on the obtained result, the radiation leakage for this example is:

$$\mathbf{68.4 \text{ mR/h}} \quad (68.4 \text{ mR/h} / 115 = \mathbf{0.59 \text{ mGy/h}})$$

6. Based on the radiation reading at any position, ensure that the Radiation Leakage is lower than the limit of 100 mR/h (0.88 mGy/h). Note the position and value of the maximum radiation reading.

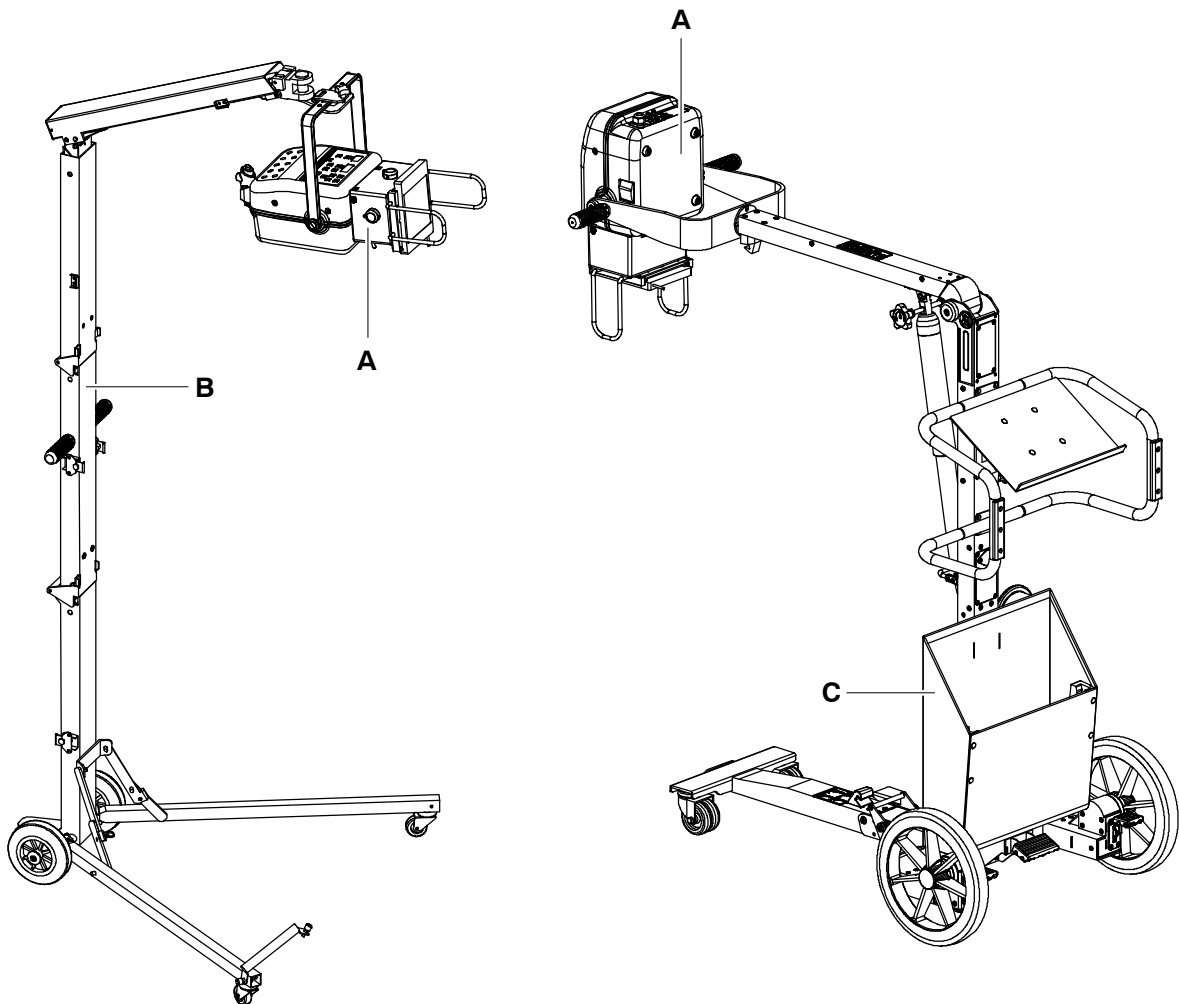
If the Radiation Leakage is over the limit at any position, first replace the Collimator and then repeat this procedure. If leakage is still present, replace the HV Transformer with the X-ray Tube and repeat this section.

When finished, remove the Lead Plate from the Collimator window.

SECTION 8 RENEWAL PARTS

8.1 MONOBLOCK POWER UNIT

- A. MONOBLOCK POWER UNIT
- B. STANDARD PORTABLE STAND (OPTIONAL)
- C. ADVANCED PORTABLE STAND (OPTIONAL)



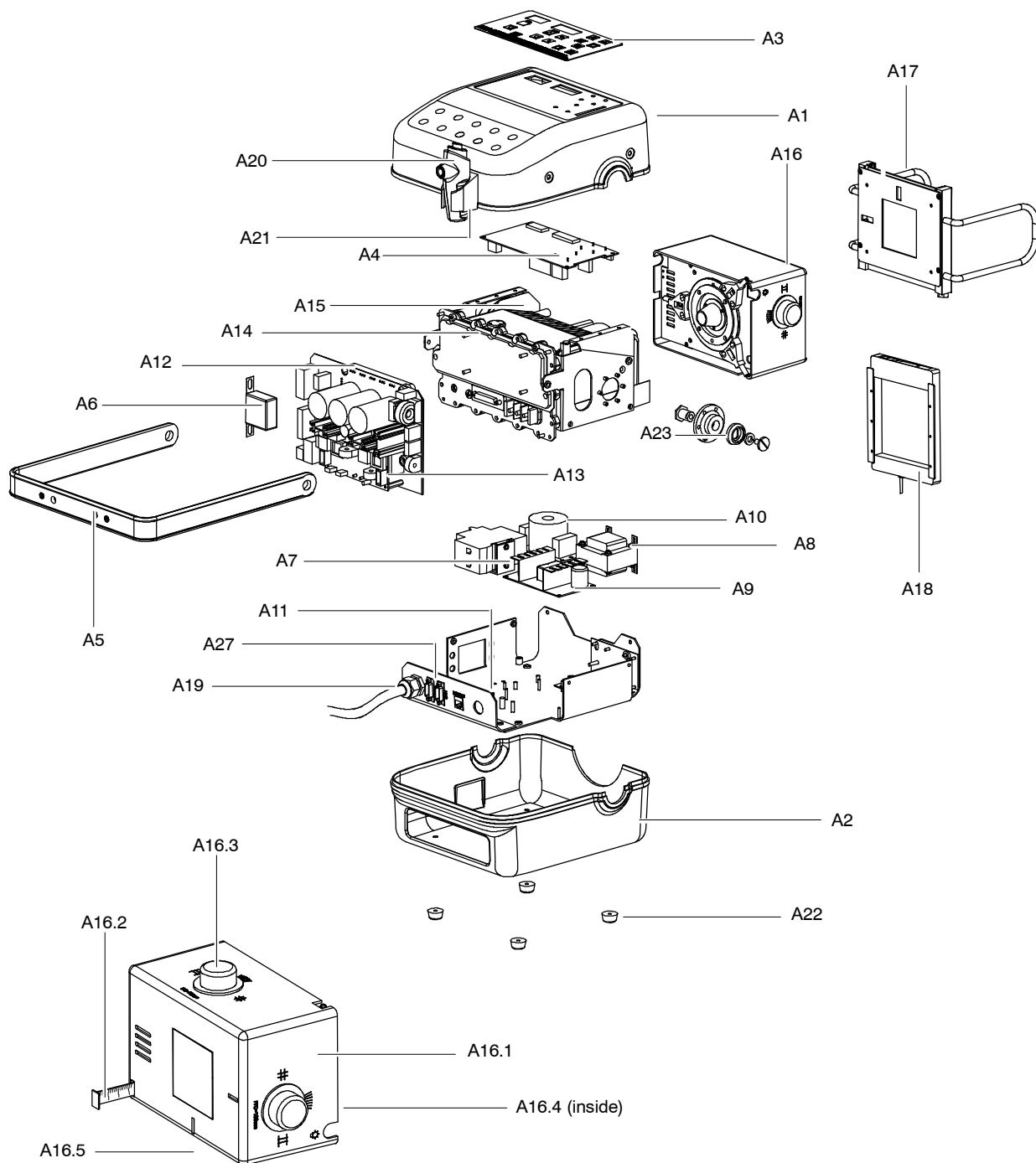
ITEM	DESCRIPTION	QTY	REFERENCE	REMARKS
A	X-RAY POWER UNIT			
A1	Upper Cover	1	SAT-13033-01	
A2	Lower Cover	1	SAT-13034-01	for Monoblock Power Unit (SPL)
	Lower Cover	1	SAT-13034-03	for Power Unit with Trolley (SPSL)
A3	Overlay SPL Without APR	1	SAT-55808384	
	Overlay SPL With APR	1	SAT-55808385	with APR
A4	Portable Control Board	1	SAT-A3175-05	License SD with dedicated software not included, install the License from the replaced PCB. License is exclusive for each Generator.
A4.1	PCB License SD	1	SAT-A40013-01	License is exclusive for each Generator, so the corresponding Generator serial number has to be indicated in the Spare Part Order. This component must not be stored as a stock item.
A5	Handle	1	A520316-01	
A6	Snubber	1	SAT-54003036	
A7	Circuit Breaker	1	SAT-50613122	
A8	Inductance Chopper	1	SAT-A6065-03	
A9	Power Supply	1	SAT-53418052	
A10	EMC Input Filter PCB	1	SAT-A3191-04	
A11	PCB Handswitch	1	SAT-A9536-02	Only for Monoblock Power Unit
A12	Control Driver Board	1	SAT-A3189-07	Includes Item A13 (filament HF PCB)
A13	Filament HF PCB	1	SAT-A9500-01	
A14	HV Tank with X-Ray Tube	1	A520388-XX	XX= 04 for 4 kW and 5 kW XX= 07 for 8 kW
A15	Resonant Inductance	1	SAT-A6077-01	
A16	Collimator	1	A523016-01	without laser and with button
		1	A523014-01	with laser and lamp buttons
A16.1	Collimator Cover	1	A525430-01	
A16.2	Retractable Tape	1	A525129-01	
A16.3	Knob	1	A525128-01	
A16.4	Timer Power Led 3.5 A	1	A525182-01	
A16.5	Led	1	A525412-01	
A16.6	Collimator Cable	1	A7954-01	
A17	SID Guard Dragon	1	SAT-A11921-01	
A18A	Internal Dosimetry (DAP)	1	55902059	Optional
A18B	External Dosimetry (DAP)	1	55902054	
A19	Power Line Cable	1	SAT-A3390-08	with Europe Plug
			SAT-A6725-04	with USA Plug

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ITEM	DESCRIPTION	QTY	REFERENCE	REMARKS
A0	X-RAY POWER UNIT			
A20	Handswitch with Support	1	SAT-A6805-09	Includes Item A21
A21	Support Handswitch	1	SAT-7891-01	
A22	Leg Kit	1	SAT-54402102	Included 4 units
A23	Axis Support Kit	2	A520315-01	Only for Monoblock Power Unit
A24	Aluminium Case	1	SAT-55411001	Optional for Monoblock Power Unit
A25	Foot Switch	1	SAT-A6389-22	
A26	Inclinometer Kit	1	SAT-A11915-02	Optional
A27	Cover DB-9	3	SAT-13078-01	
A28	26-Wires Ribbon Cable	1	A3334-01	Connected to [A3175 Board]-J17 / [A3189 Board]-J2
A29	Control Ribbon Cable	1	A3337-01	Connected to [HV Tank]-J10 / [A3189 Board]-J1 / [A9500 Board]-J2
A30	Test Ribbon Cable	1	A7111-01	Connected to [A3175 Board]-J21 / [Test DB9]
A31	Filaments Ribbon Cable	1	A7113-01	Connected to [A3175 Board]-J16 / [A9500 Board]-J1
A32	Laminated Table-top	1	SAT-8857-01	
A33	Kit Wheels for Laminated Table	1	SAT-A9728-01	Includes 4 wheels (2 + 2 with lock)
A34	Power Cord	1	SAT-CC02424	Israel
		1	SAT-CC02425	Australia / New Zealand
		1	SAT-CC02426	Argentina
		1	SAT-CC02427	Switzerland
		1	SAT-CC02428	Chile
		1	SAT-CC02429	South Africa / India
		1	SAT-CC02430	Brazil
		1	SAT-50613056	UK
		1	SAT-50613032	China

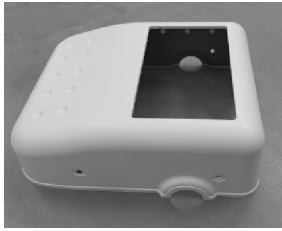
X-RAY POWER UNIT



Portable X-Ray Units

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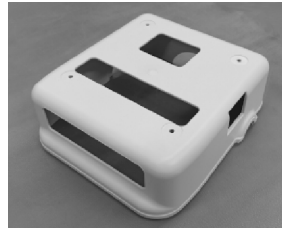
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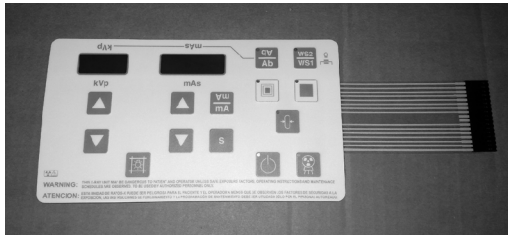
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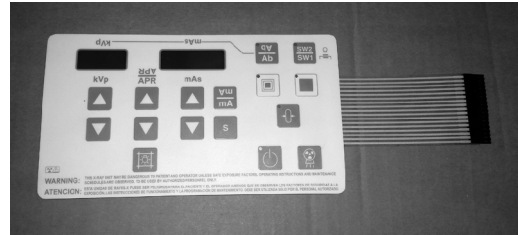
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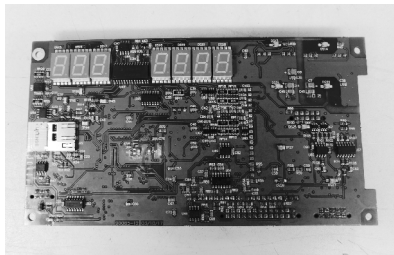
A3



A3



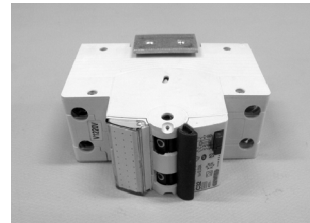
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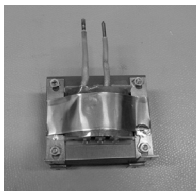
A6



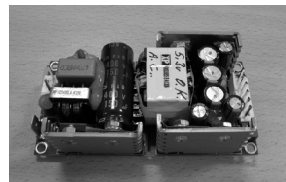
A7



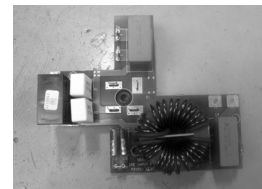
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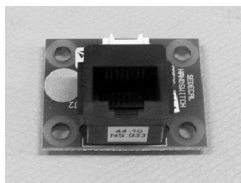
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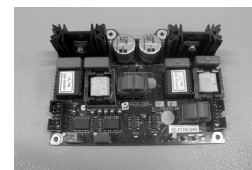
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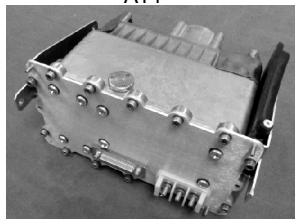
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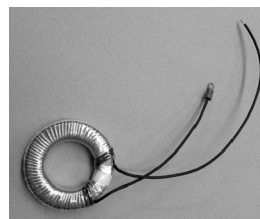
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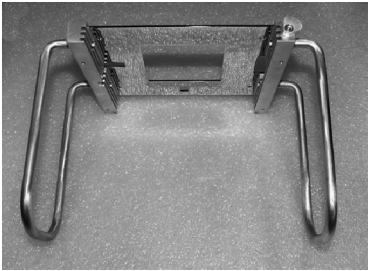
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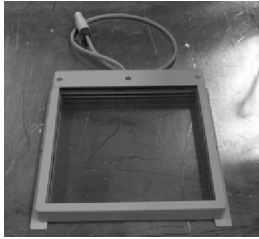
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A17



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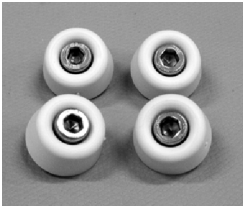
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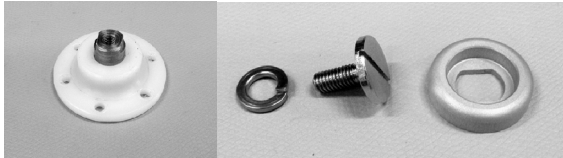
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A22



A23



A24



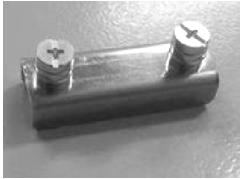
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A27



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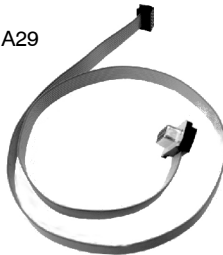
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A29



A32



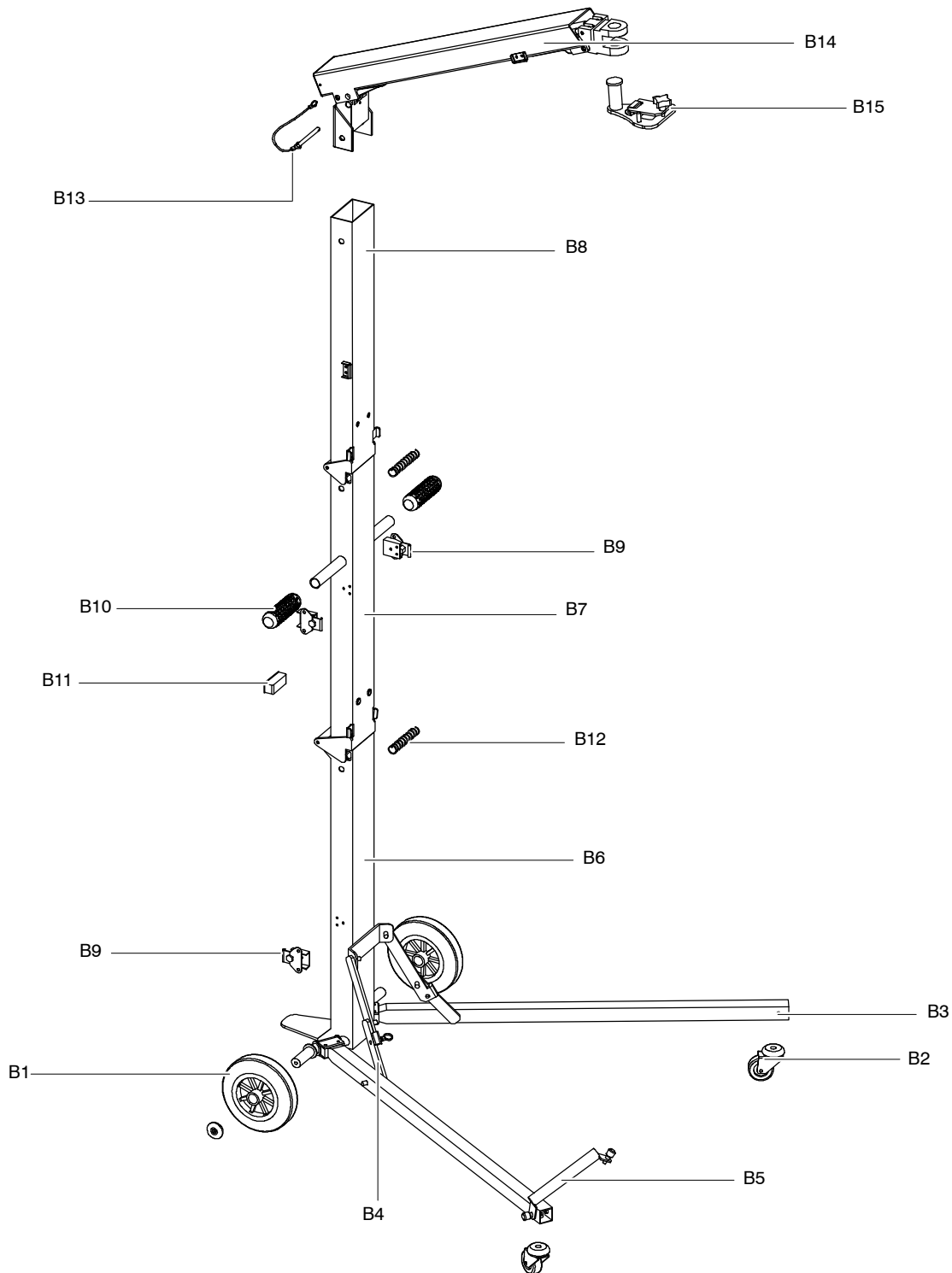
A33

Portable X-Ray Units

Service Manual

ITEM	DESCRIPTION	QTY	REFERENCE	REMARKS
B	STANDARD PORTABLE STAND			
B1	Wheel PVC 160x40e	2	SAT-53810022	
B2	Wheel 2475 PJH 050 P30-11	2	SAT-53810023	
B3	Leg	2	A520244-01	
B4	Hinge	2	A526010-XX	XX= 01 Right XX= 02 Left
B5	Leg Lock	1	SAT-18749-01	
B6	Lower Arm Support	1	A520246-02	
B7	Middle Arm Support	1	A520247-02	
B8	Upper Arm Support	1	A520248-02	
B9	Transport Lock	3	SAT-53830305	
B10	Handle	2	SAT-54505107	
B11	Magnet	1	SAT-53830600	
B12	Lock Spring Kit	1	SAT-9212-01	Included 2 units
B13	Lock Pin	1	SAT-7235-15	
B14	Arm	1	SAT-A7922-01	
B15	Generator Support Kit	1	SAT-A10404-02	

STANDARD PORTABLE STAND



B1



B2



B4



B5



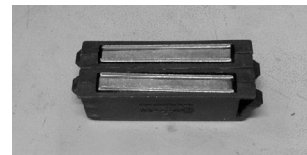
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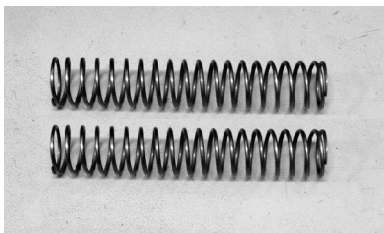
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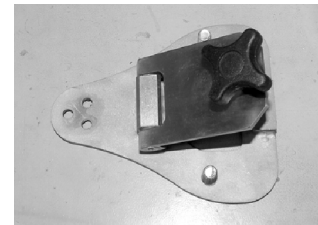
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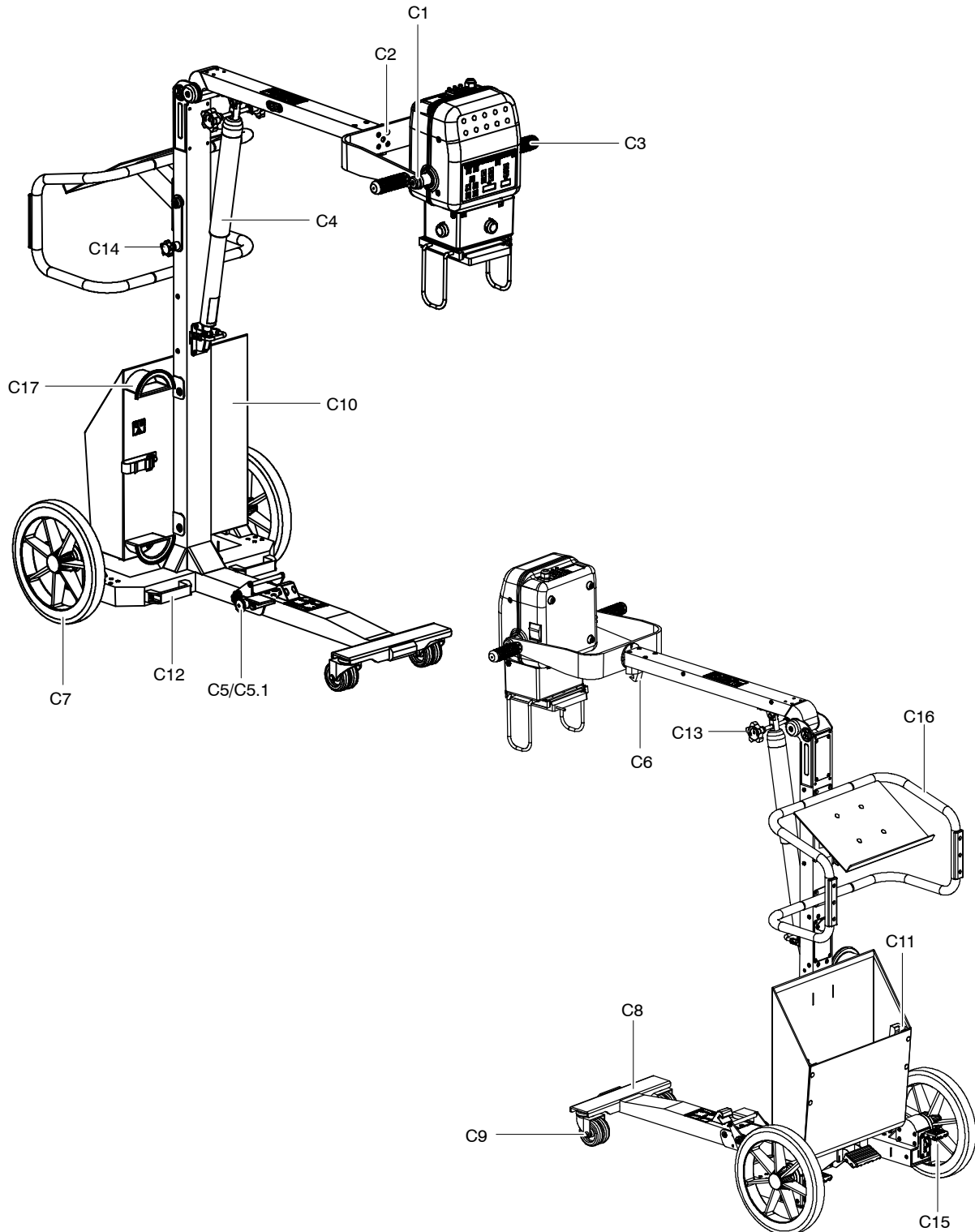


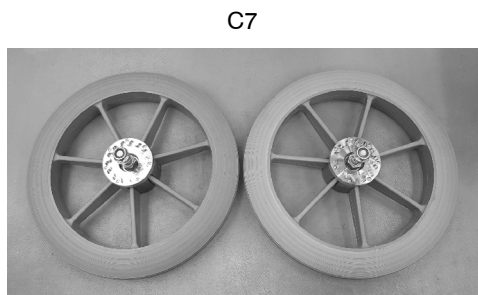
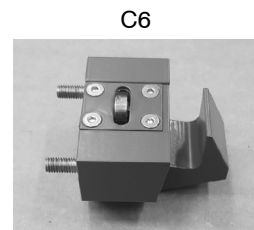
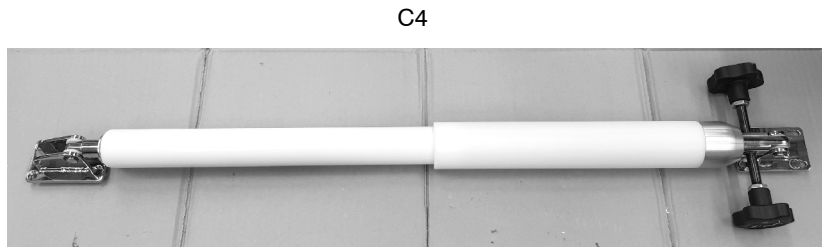
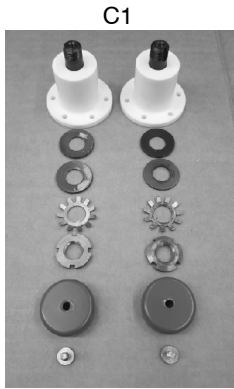
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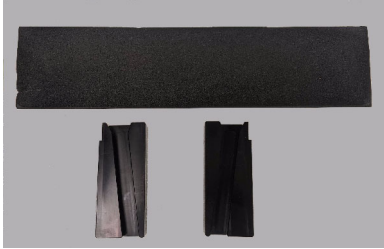
ITEM	DESCRIPTION	QTY	REFERENCE	REMARKS
C	ADVANCED PORTABLE STAND			
C1	Axis Support Kit	1	A520330-02	
C2	Rotation Kit for "U" Shaped Support	1	A520232-01	
C3	Handgrips	2	A520231-02	On Monoblock Support
C4	Gas Spring Kit	1	SAT-A11807-05	Included ITEM C12
C5	Leg Locking System	1	SAT-AS00086	Included ITEM C5.1
C5.1	Safety Knob (Pin)	1	SAT-54404044	
C6	Locking Kit	1	A520234-02	
C7	Standard Wheel	1	SAT-A20220-01	Included 2 wheels
C8	Front Arm T Aluminium	1	SAT-A7969-05	Includes C9
C9	Steering Wheel	2	SAT-53810071	
C10	Cassette Basket	1	SAT-28674-02	
C11	Cassette Basket Guide Kit	1	SAT-AS01809	
C12	Loading Handles	2	SAT-54402037	
C13	Lock Handle	1	A520329-02	
C14	Fixing Arm Kit	1	SAT-A20216-01	
C15	Wheel Lock Lever Kit	1	SAT-A20211-01	Includes 2 units
C16	Short Handles	1	SAT-A11858-01	
C17	Cable Support	1	SAT-10132-01	Included 4 units

ADVANCED PORTABLE STAND





C11



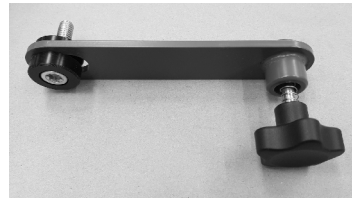
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C13



C14



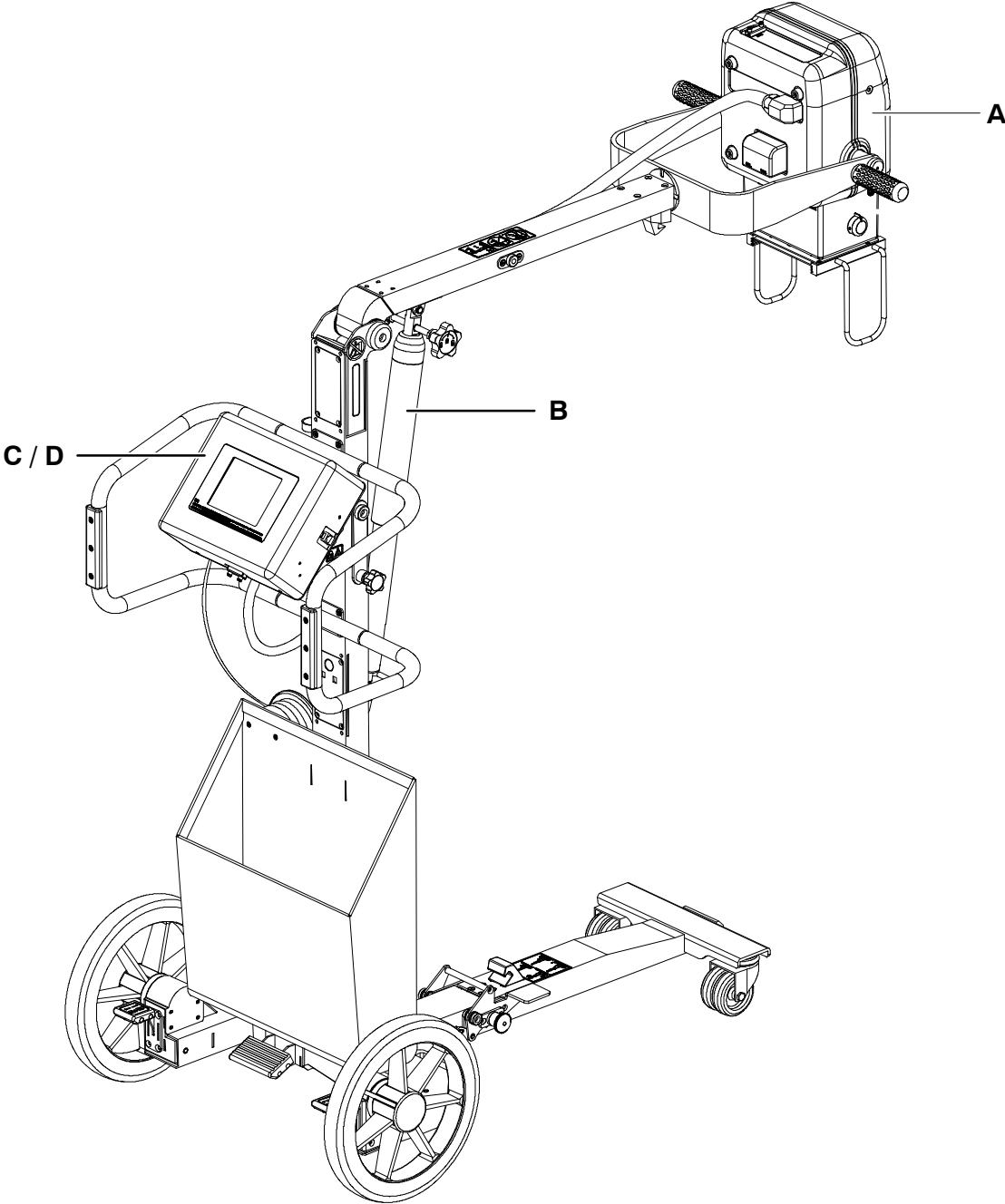
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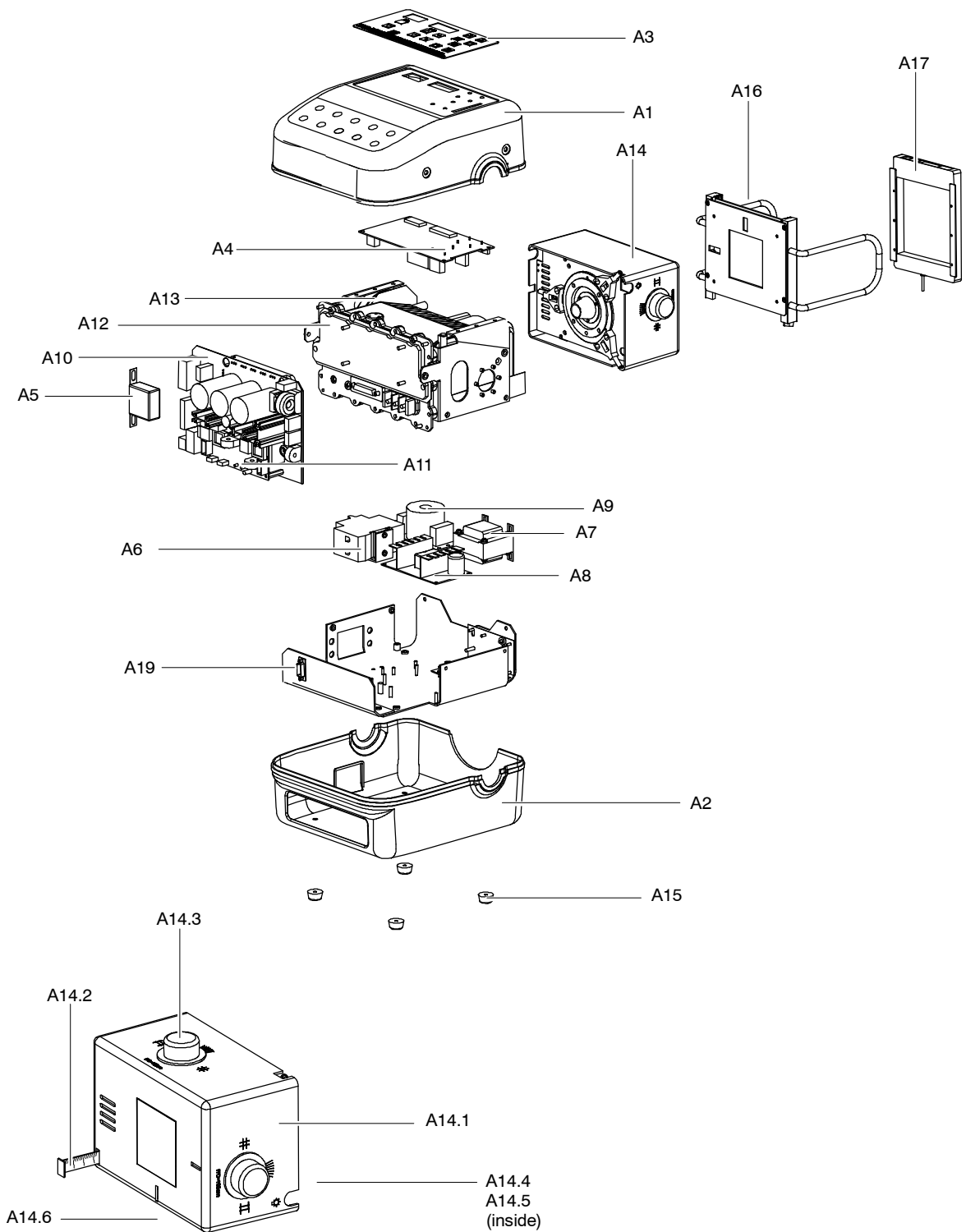
8.2 POWER UNIT WITH TROLLEY AND CONSOLE



Portable X-Ray Units

Service Manual

ITEM	DESCRIPTION	QTY	REFERENCE	REMARKS
A	X-RAY POWER UNIT			
A1	Upper Cover	1	SAT-13033-01	
A2	Lower Cover	1	SAT-13034-03	for Power Unit with Trolley
A3	Overlay	1	SAT-55808384	
A4	Portable Control Board	1	SAT-A3175-05	License SD with dedicated software not included, install the License from the replaced PCB. License is exclusive for each Generator.
A4.1	PCB License SD	1	SAT-A40013-01	License is exclusive for each Generator, so the corresponding Generator serial number has to be indicated in the Spare Part Order. This component must not be stored as a stock item.
A5	Snubber	1	SAT-54003036	
A6	Circuit Breaker	1	SAT-50613122	
A7	Inductance Chopper	1	SAT-A6065-03	
A8	Power Supply	1	SAT-53418052	
A9	EMC Input Filter PCB	1	SAT-A3191-04	
A10	Control Driver Board	1	SAT-A3189-07	Includes Item A11 (filament HF PCB)
A11	Filament HF PCB	1	SAT-A9500-01	
A12	HV Tank with X-Ray Tube	1	A520388-XX	XX= 04 for 4 kW and 5 kW XX= 07 for 8 kW
A13	Resonant Inductance	1	SAT-A6077-01	
A14	Collimator	1	A523016-01	without laser and with button
		1	A523014-01	with laser and lamp buttons
A14.1	Collimator Cover	1	A525430-01	
A14.2	Retractable Tape	1	A525129-01	
A14.3	Knob	1	A525128-01	
A14.4	Timer Power LED 3.5 A	1	A525182-01	
A14.5	LED	1	A525412-01	
A14.6	Collimator Cable	1	A7954-01	
A15	Leg Kit	1	SAT-54402102	Included 4 units
A16	SID Guard Dragon	1	SAT-A11921-01	
A17	Dosimeter	1	55902059	Optional
A18	Inclinometer Kit	1	SAT-A11915-02	Optional
A19	Cover DB-9	3	SAT-13078-01	



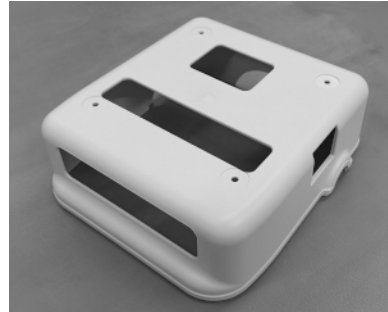
Portable X-Ray Units

Service Manual

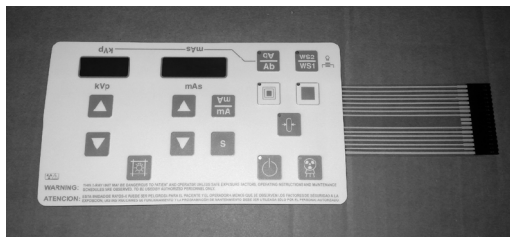
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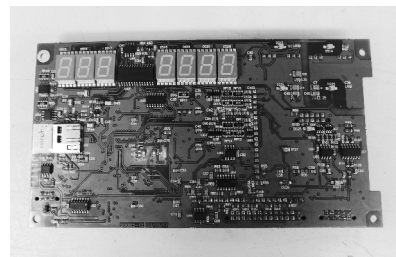
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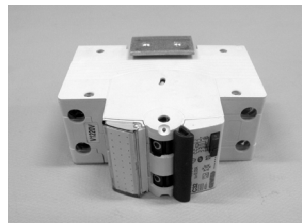
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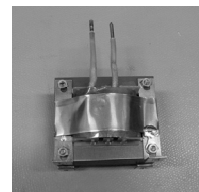
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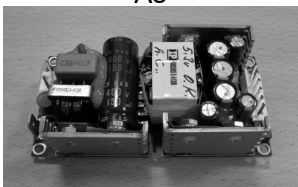
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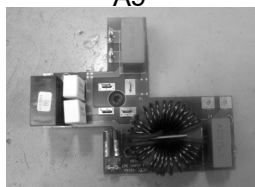
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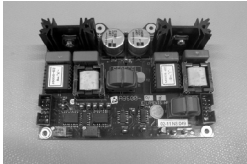
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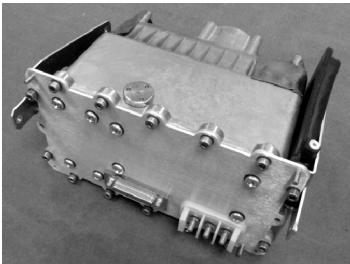
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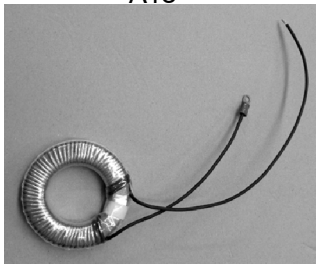
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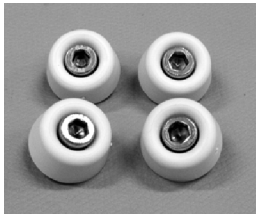
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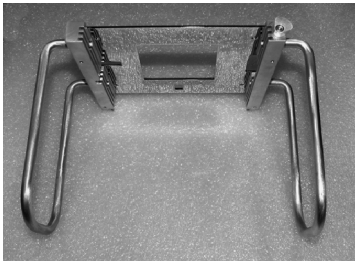
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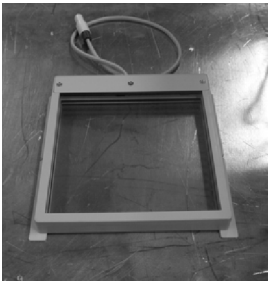
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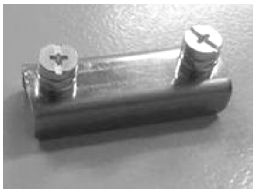
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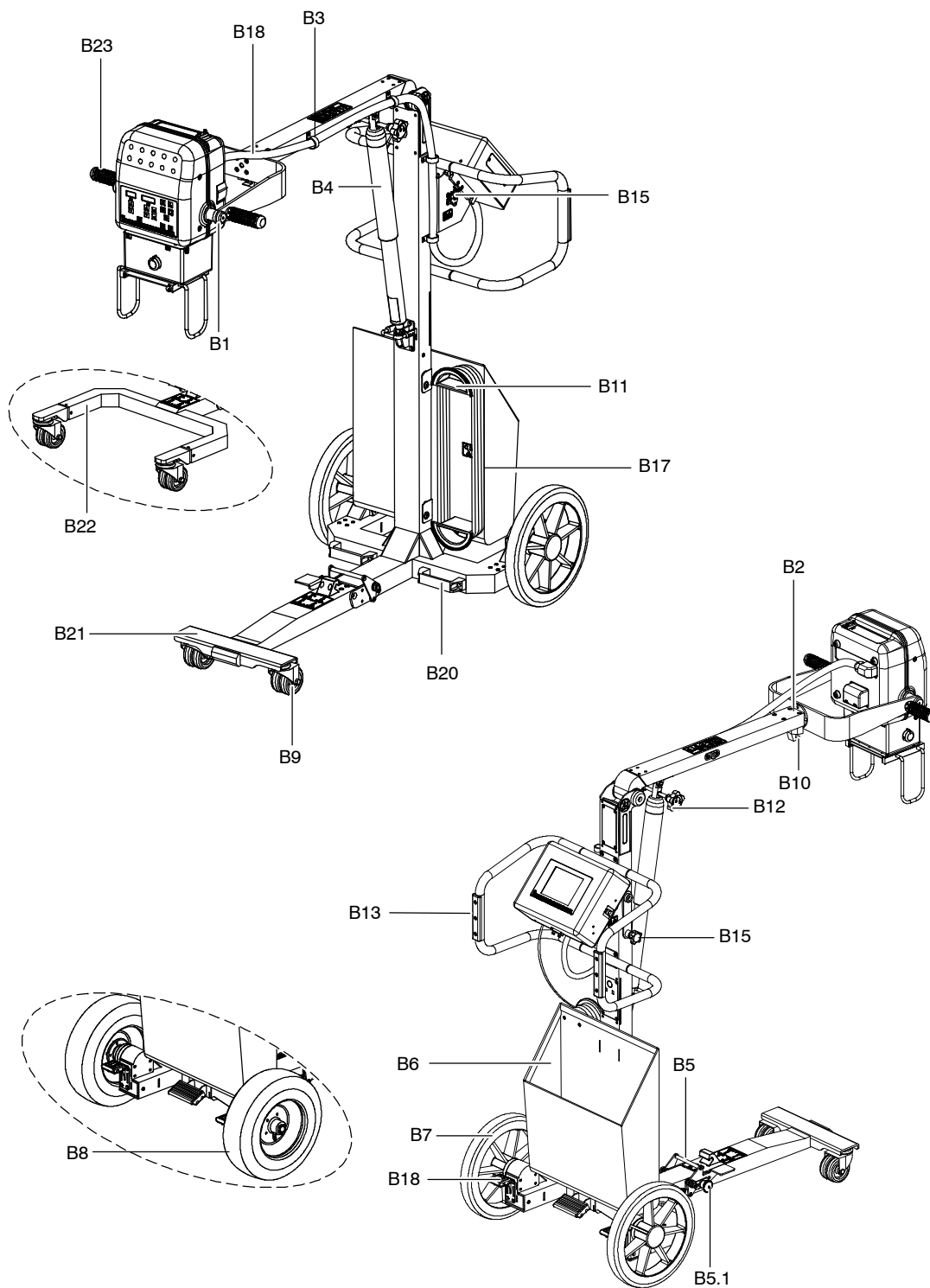
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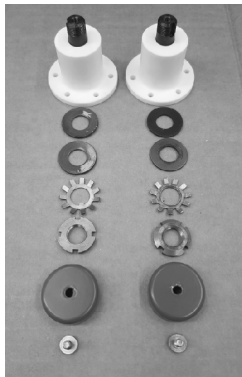
Portable X-Ray Units

Service Manual

ITEM	DESCRIPTION	QTY	REFERENCE	REMARKS
B0	TROLLEY			
B1	Axis Support Kit	1	A520330-02	
B2	Rotation Kit for "U" Shaped Support	1	A520232-01	
B3	Corrugated Cable Clamp	1	SAT-53530106	Included 5 units
B4	Gas Spring Kit	1	SAT-A11807-05	Included ITEM B12
B5	Leg Locking System	1	SAT-AS00086	Included ITEM B5.1
B5.1	Safety Knob (Pin)	1	SAT-54404044	
B6	Cassette Basket	1	SAT-28674-02	
B7	Standard Wheel	1	SAT-A20220-01	Included 2 wheels
B8	All-Terrain Wheel	1	SAT-A20220-02	Included 2 wheels
B9	Steering Wheel	2	SAT-53810071	
B10	Locking Kit	1	A520234-02	
B11	Cable Support	1	SAT-10132-01	Included 4 units
B12	Lock Handle	1	A520329-02	
B13	Short Handles	1	SAT-A11858-01	
	Long Handles	1	SAT-A11858-02	Optional
B14	Handswitch with Support	1	SAT-A6805-08	Includes Item B14.1
B14.1	Handswitch Support	1	SAT-11996-01	
B15	Fixing Arm Kit	1	SAT-A20216-01	
B16	Wheel Lock Lever Kit	1	SAT-A20211-01	Includes 2 units
B17	Power Line Cable	1	A3390-07	with Europe Plug
			A6725-08	with USA Plug
B18	Communication Cable	1	A7910-04	
B19	Collimator Cable	1	A7954-01	
B20	Loading Handles	2	SAT-54402037	
B21	Front Arm T Aluminium	1	SAT-A7969-05	Includes B9
B22	Front Arm Y Aluminium	1	SAT-A7969-06	Optional Includes B9
B23	Head Handle	1	SAT-23846-01	Optional; Includes 2 units
B24	Foot Switch	1	SAT-A6389-22	



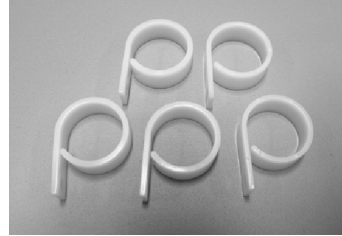
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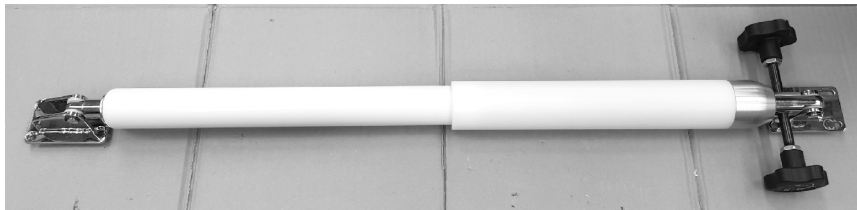
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B3



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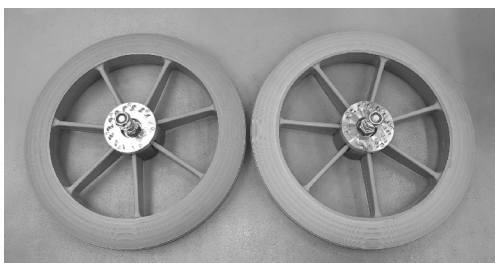
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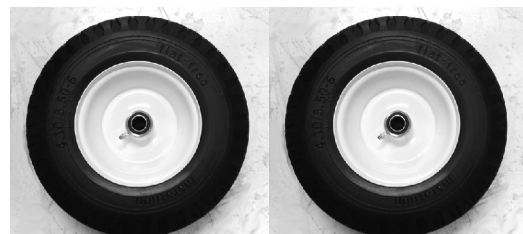
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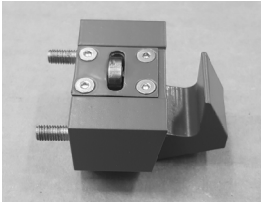
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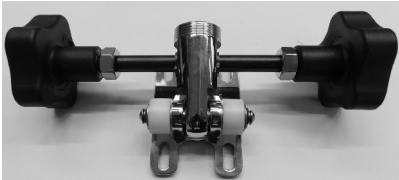
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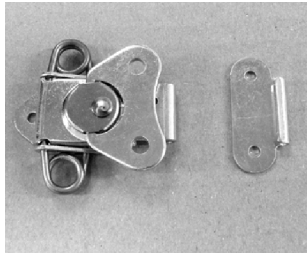
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B14 / B14.1



B17



B18



B20



B23



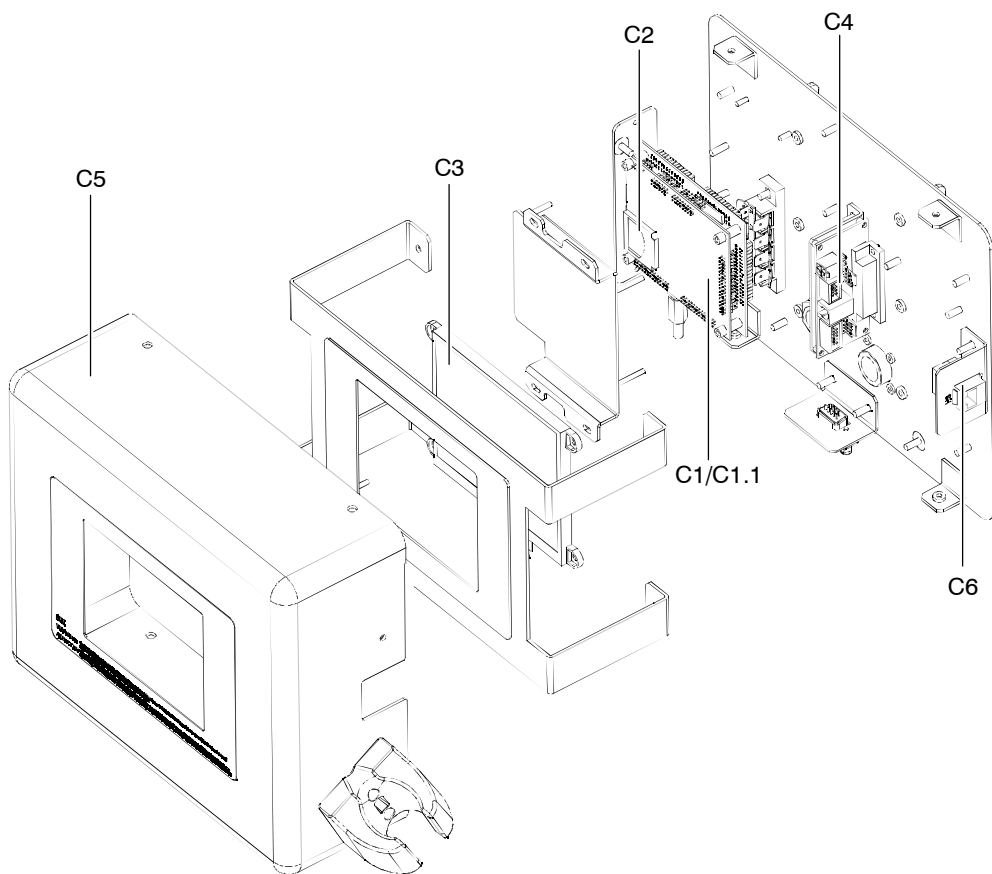
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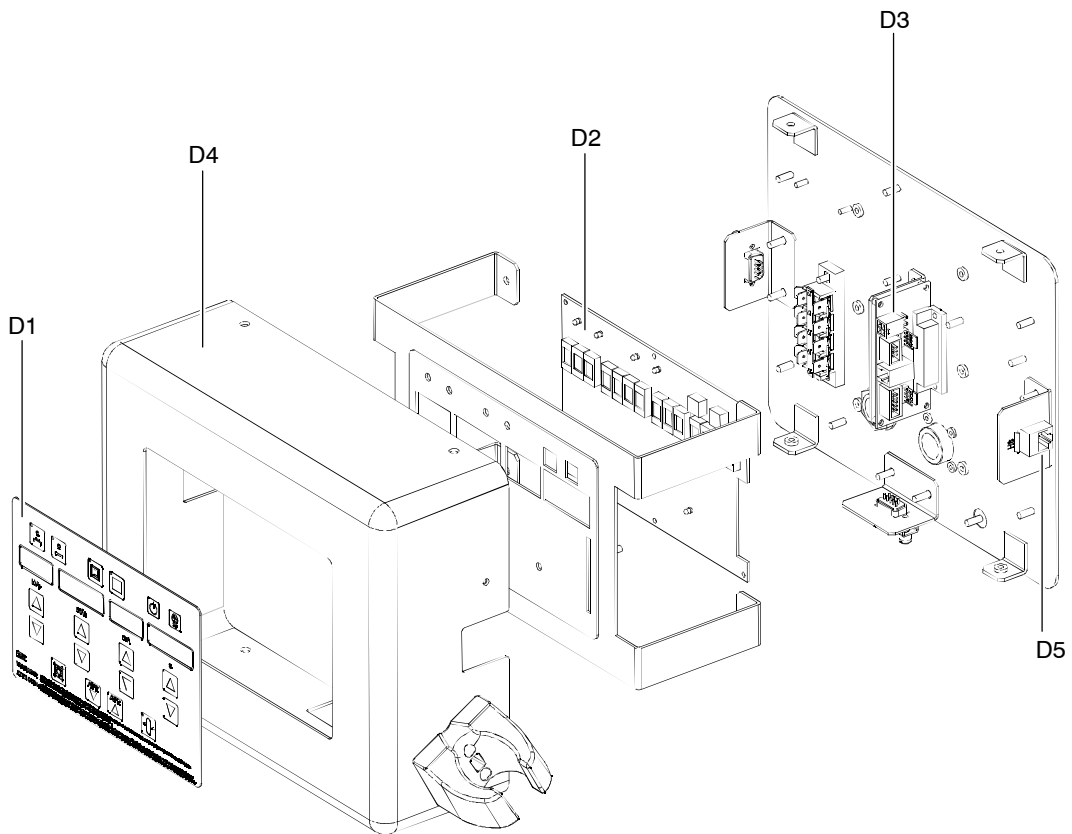
Portable X-Ray Units

Service Manual

ITEM	DESCRIPTION	QTY	REFERENCE	REMARKS
C0	TOUCH SCREEN CONSOLE			
C1	PC Kit	1	A526012-02	
C1.1	Battery PC	1	SAT-50512017	
C2	SD Card	1	SAT-55001168	
C3	Touch Screen TFT	1	SAT-55001167	
C4	PCB Connectors	1	SAT-A3632-02	
C5	Console Cover	1	SAT-28671-01	
C6	Handswitch Plug	1	A526041-01	



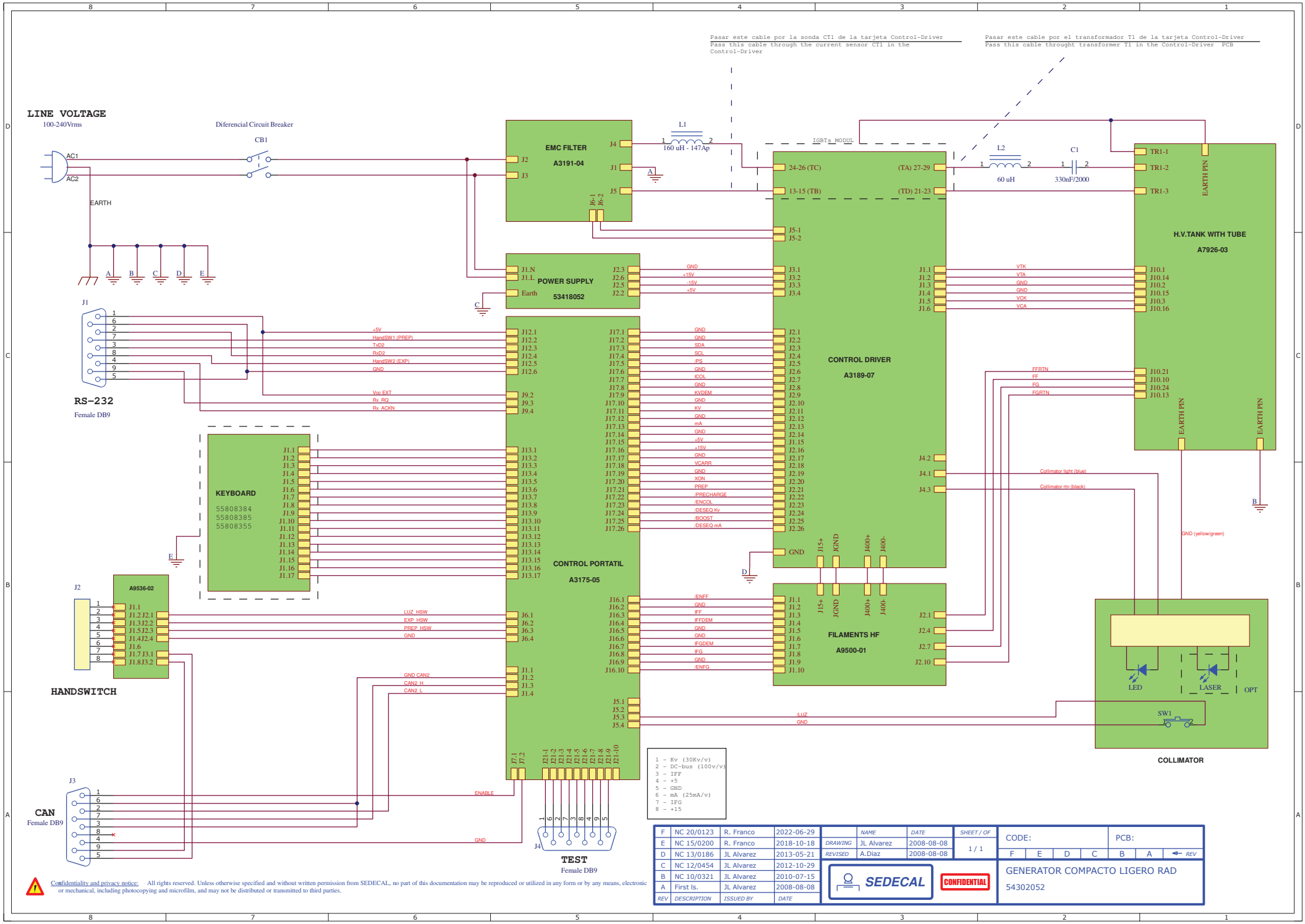
ITEM	DESCRIPTION	QTY	REFERENCE	REMARKS
D0	3P CONSOLE			
D1	Overlay Display	1	SAT-55808383	
D2	Remote Console 3P	1	SAT-A3634-01	
D3	PCB Connectors	1	SAT-A3632-02	
D4	Console Cover	1	SAT-28671-02	
D5	Handswitch Plug	1	A526041-01	



SECTION 9 SCHEMATICS

SCHEMATIC	DESCRIPTION	Portable Unit		
		Monoblock	Monoblock + Trolley with 3P Console	Monoblock + Trolley with Touch Screen Console
54302052	Portable X-ray Unit: Monoblock (<i>Generador Compacto Ligero Rad</i>)	X	X	X
54302220	Portable X-ray Unit: Monoblock + Trolley with 3P Console (<i>SPSL-HF</i>)		X	
54302221	Portable X-ray Unit: Monoblock + Trolley with Touch Screen Console (<i>SPSL-HF-APR</i>)			X
A3175-05	Portable Control Board (<i>Control Portatil PCB</i>)	X	X	X
A3189-07	Control Driver Board (<i>Control Driver PCB</i>)	X	X	X
A3191-04	EMC Input Filter Board	X	X	X
A9500-01	Filaments HF Board	X	X	X
A9536-02	PCB - Handswitch	X		
A3632-02	Remote Console Connectors (<i>Conectores Caja Dragon</i>)		X	X
A3634-01	Remote Console 3P		X	
A3620-02	Compact APR Base Board			X

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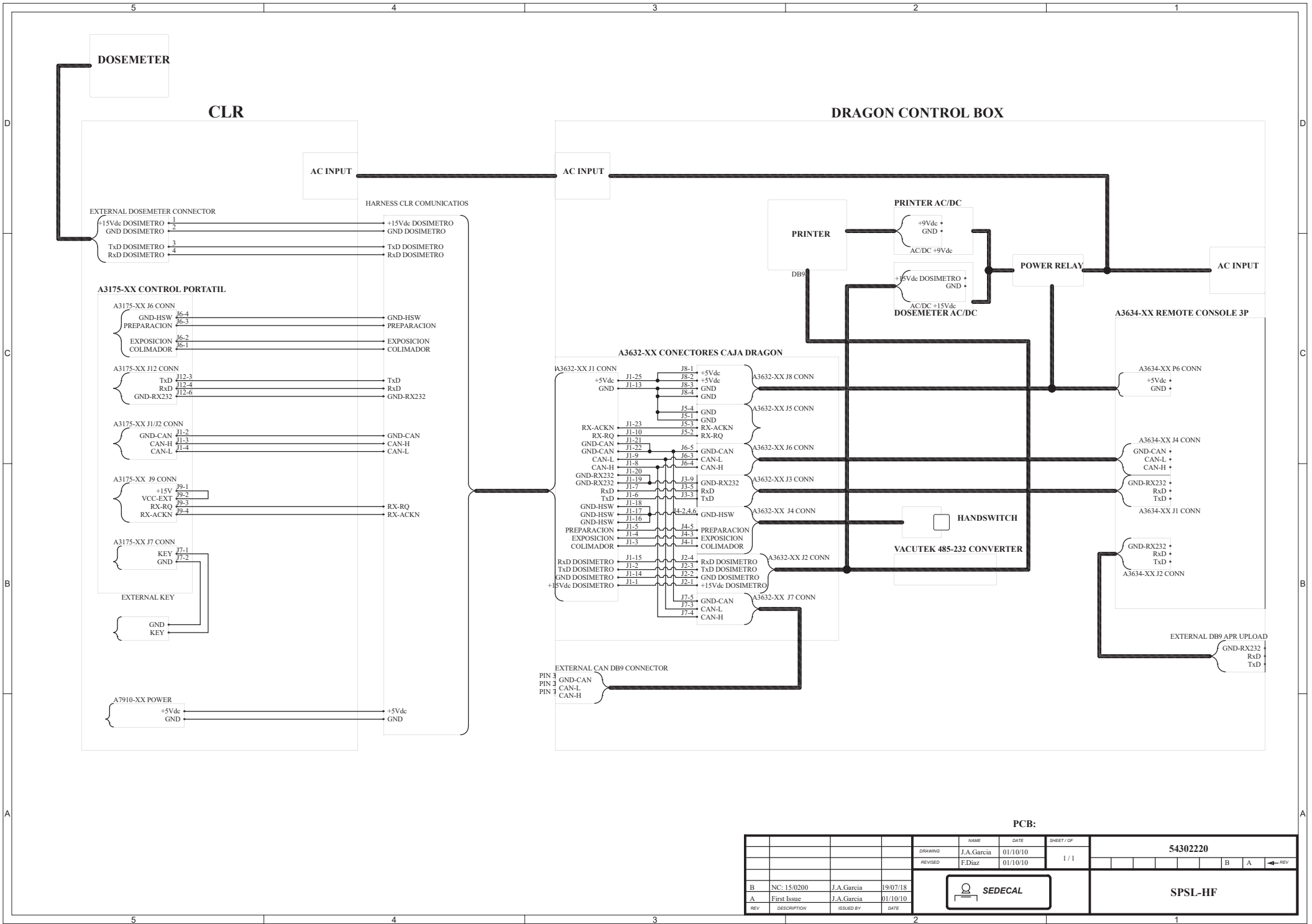
- 1 - Kv (30Kv/v)
- 2 - DC-bus (100v/v)
- 3 - IFF
- 4 - +5
- 5 - GND
- 6 - mA (25mA/v)
- 7 - IFG
- 8 - +15

REV	DESCRIPTION	ISSUED BY	DATE	NAME	DATE	SHEET / OF	CODE:	PCB:
F	NC 20/0123	R. Franco	2022-06-29	JL Alvarez	2008-08-08	1 / 1	F E D C	B A
E	NC 15/0200	R. Franco	2018-10-18	JL Alvarez	2008-08-08			
D	NC 13/0186	JL Alvarez	2013-05-21	A. Diaz	2008-08-08			
C	NC 12/0454	JL Alvarez	2012-10-29					
B	NC 10/0321	JL Alvarez	2010-07-15					
A	First Is.	JL Alvarez	2008-08-08					

SEDECAL **CONFIDENTIAL**

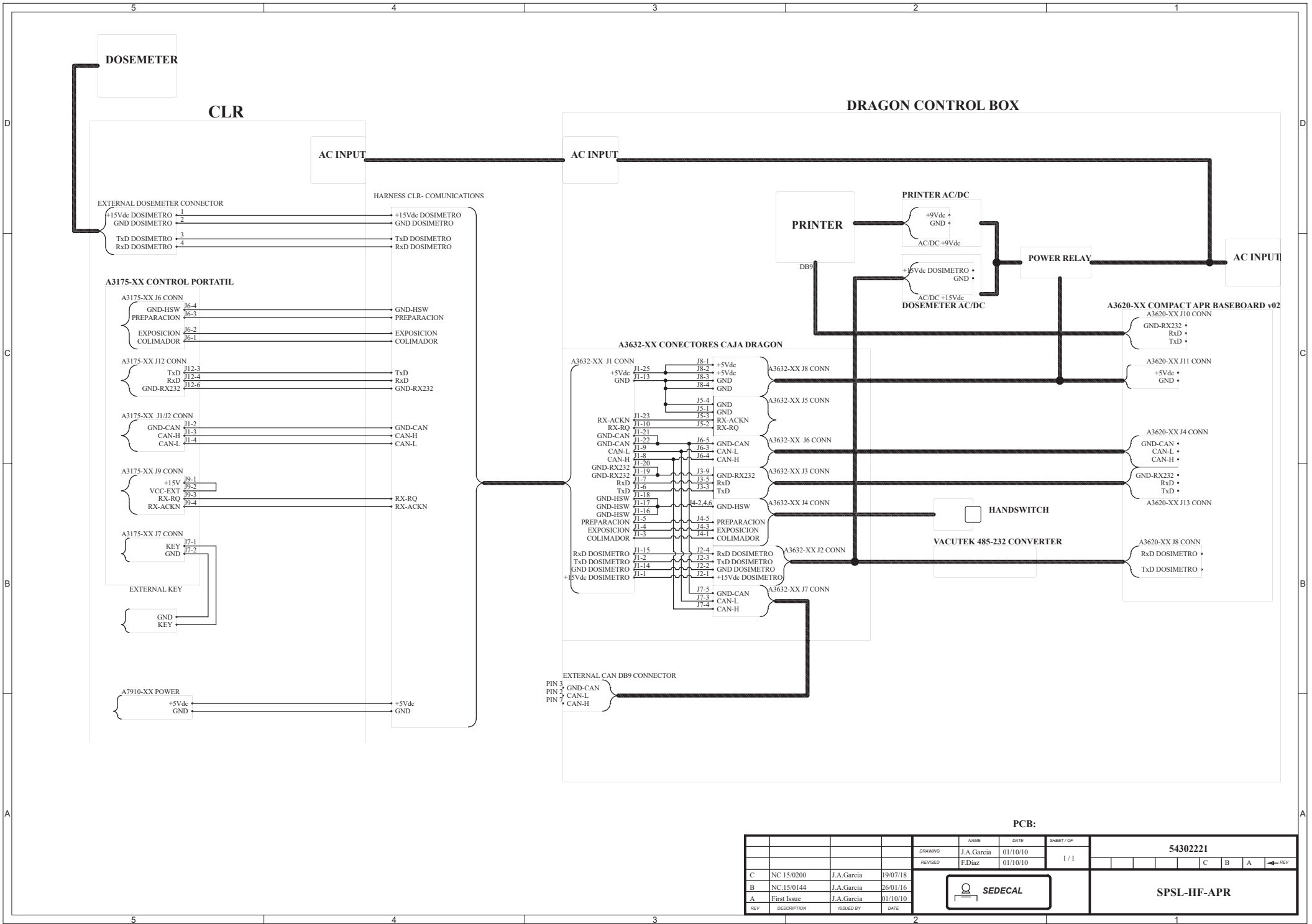
GENERATOR COMPACTO LIGERO RAD
54302052

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PCB:

DRAWING		NAME	DATE	SHEET / OF	54302220					
REVISED		J.A.Garcia	01/10/10	1 / 1						
		F.Diaz	01/10/10		B A ← REV					
B	NC: 15/02/00	J.A.Garcia	19/07/18	SEDECAL					SPSL-HF	
A	First Issue	J.A.Garcia	01/10/10							
REV	DESCRIPTION	ISSUED BY	DATE							

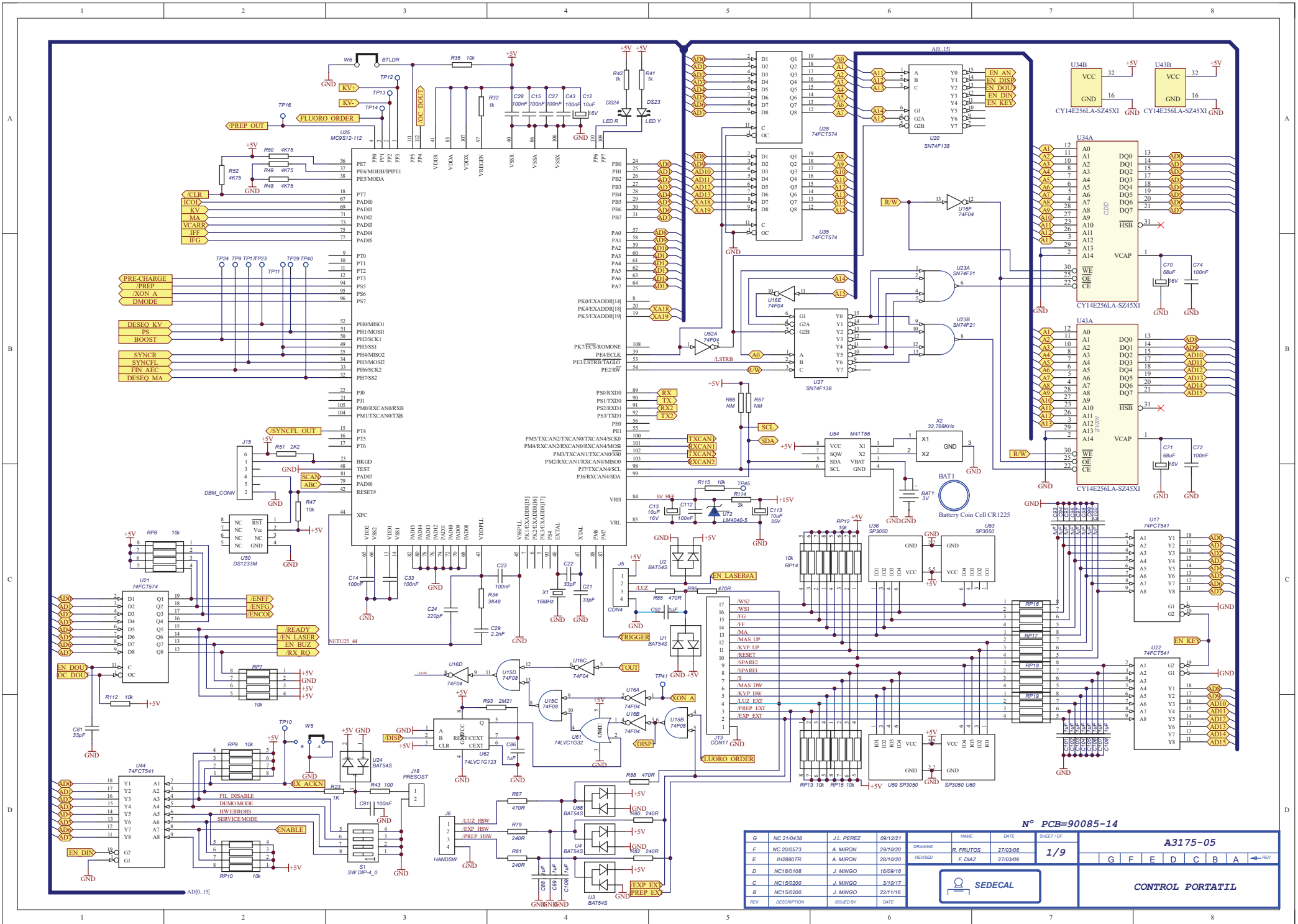


PCB:

DRAWING		NAME		DATE		SHEET / OF		54302221			
REVISED		F.Diaz		01/10/10		1 / 1					
C	NC:15/0200	J.A.Garcia	19/07/18								
B	NC:15/0144	J.A.Garcia	26/01/16								
A	First Issue	J.A.Garcia	01/10/10								
REV	DESCRIPTION	ISSUED BY	DATE								



SPSL-HF-APR

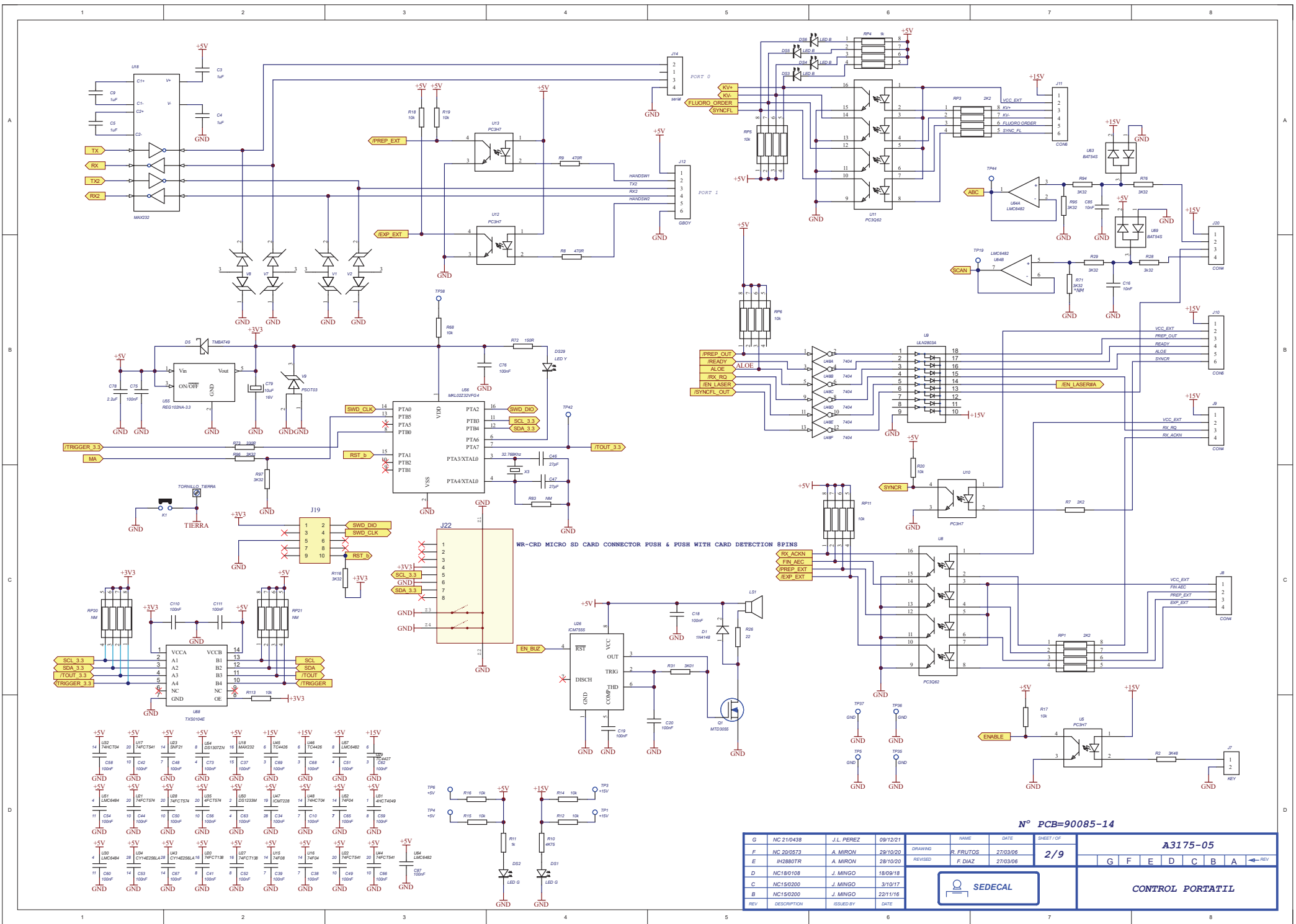


N° PCB=90085-14

G	NC 21/0438	J.L. PEREZ	09/12/21	NAME	DATE	SHEET/OF
F	NC 20/0573	A. MIRON	29/10/20	DRAWING	R. FURTOS	27/03/06
E	IN28807R	A. MIRON	28/10/20	REVISED	F. DIAZ	27/03/06
D	NC18/0108	J. MINGO	18/09/18			
C	NC15/0200	J. MINGO	3/10/17			
B	NC15/0200	J. MINGO	22/1/16			
REV	DESCRIPTION	ISSUED BY	DATE			

A3175-05

CONTROL PORTATIL



Nº PCB=90085-14

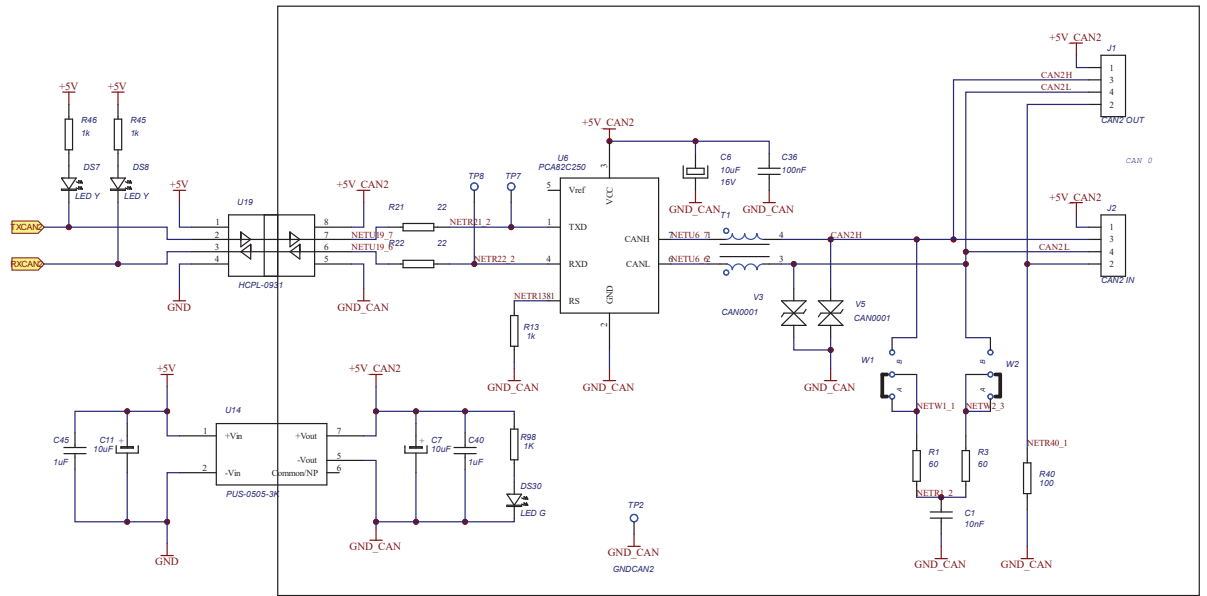
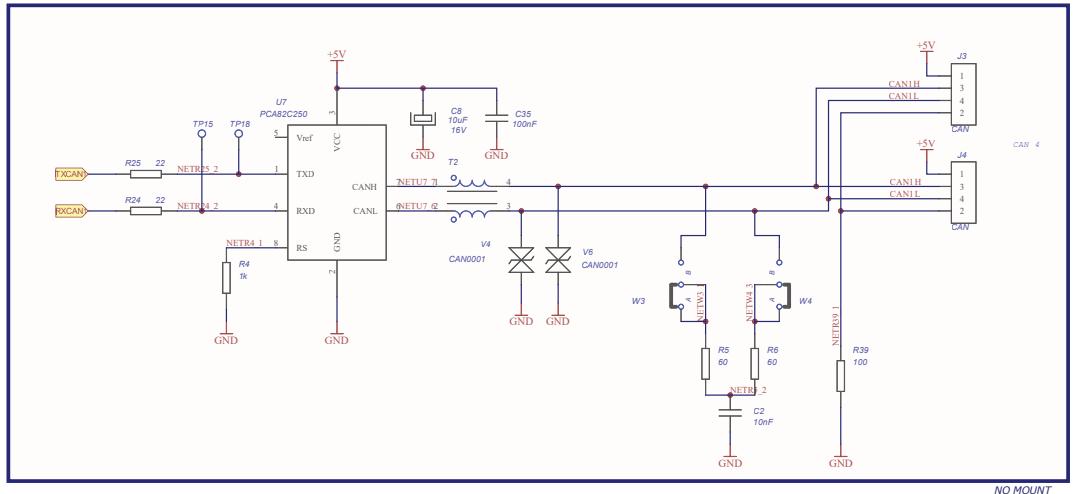
G	NC 210438	J.L. PEREZ	09/12/21	NAME	DATE	SHEET/OP
F	NC 200573	A. MIRON	29/10/20	DRAWING	R. FRITOS	27/03/06
E	4H2880TR	A. MIRON	28/10/20	REVISED	F. DIAZ	27/03/06
D	NC180108	J. MINGO	18/09/18			
C	NC150200	J. MINGO	3/10/17			
B	NC150200	J. MINGO	22/11/16			
REV	DESCRIPTION	ISSUED BY	DATE			

A3175-05



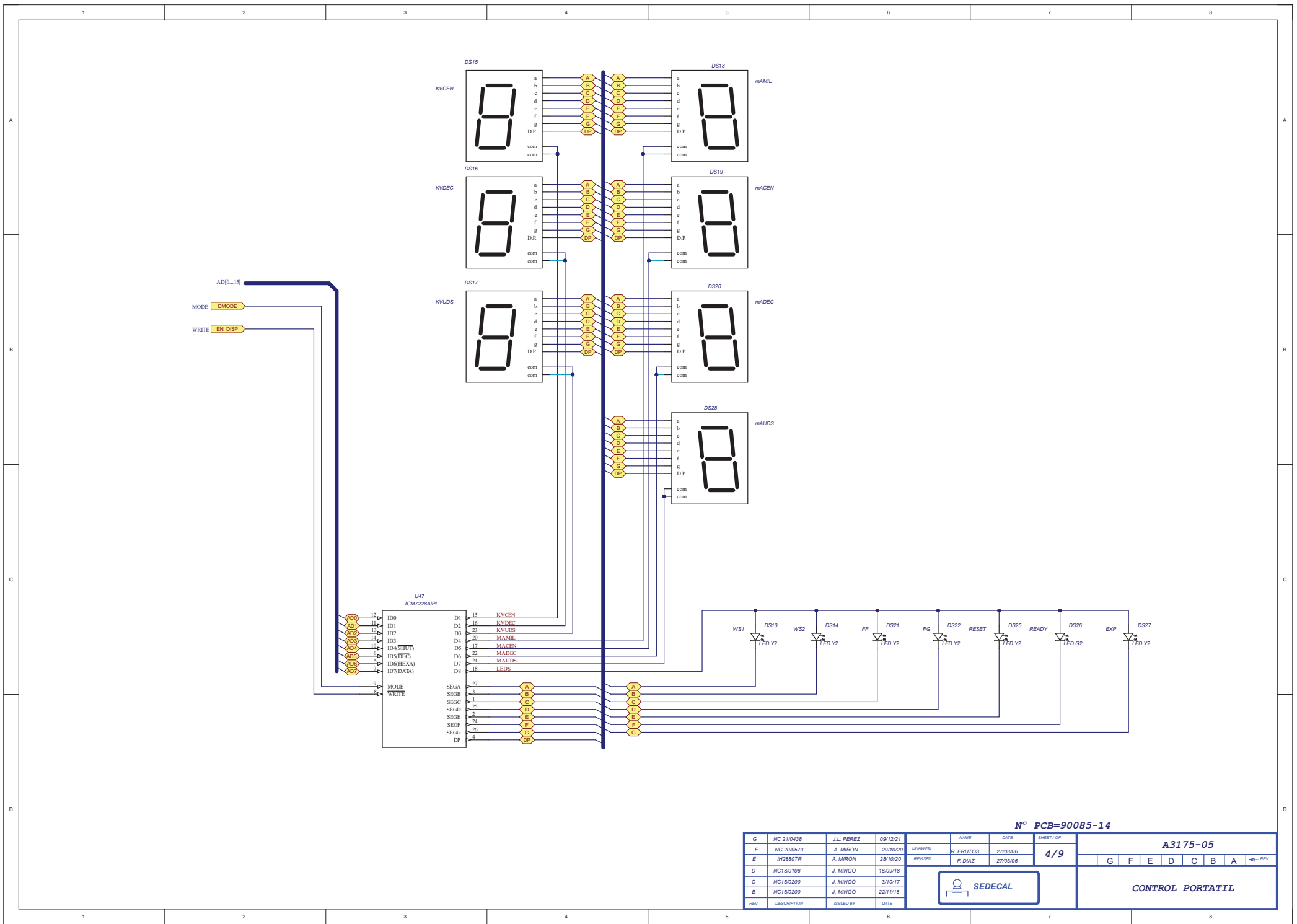
CONTROL PORTATIL

G F E D C B A



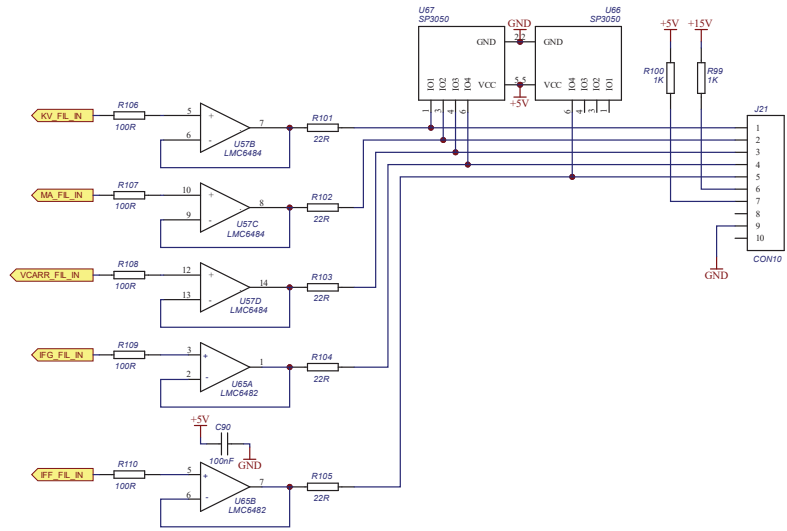
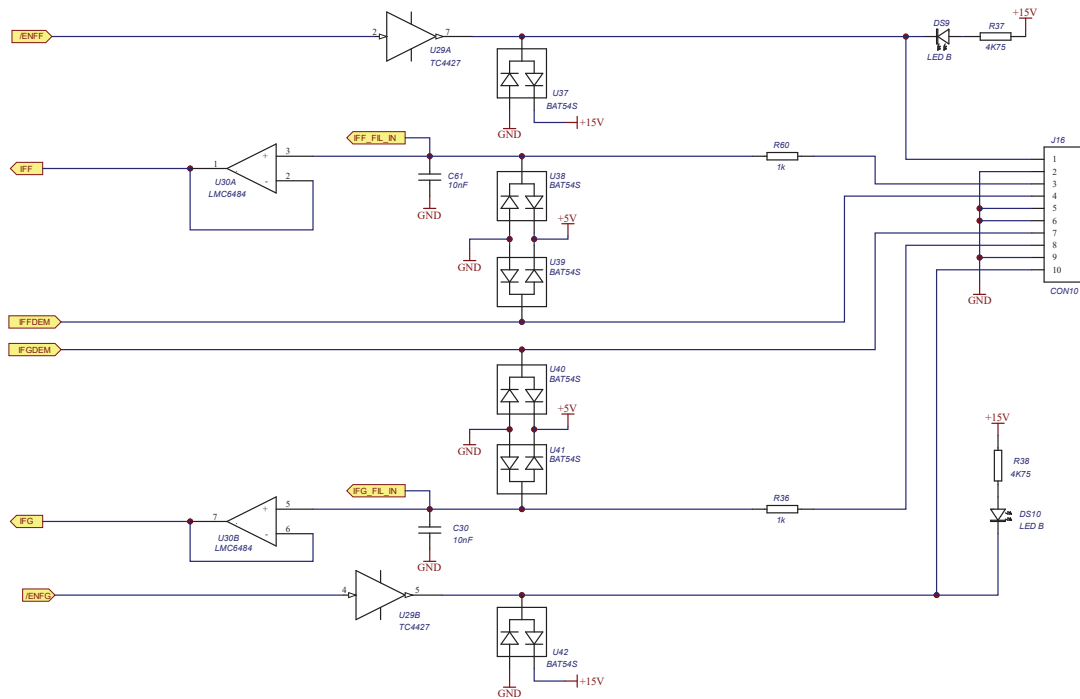
N° PCB=90085-14

REV	DESCRIPTION	ISSUED BY	DATE	NAME	DATE	SHEET/OF	A3175-05										
G	NC 21/0438	J.L. PEREZ	09/12/21														
F	NC 20/0573	A. MIRON	29/10/20	DRAWING	R. FERITOS	27/03/06	3/9										
E	#H2880TR	A. MIRON	28/10/20	REVISED	F. DIAZ	27/03/06		G	F	E	D	C	B	A	← REV		
D	NC18/0108	J. MINGO	18/09/18														
C	NC15/0200	J. MINGO	3/10/17														
B	NC15/0200	J. MINGO	22/11/16														
REV	DESCRIPTION	ISSUED BY	DATE	SEDECAL			CONTROL PORTATIL										



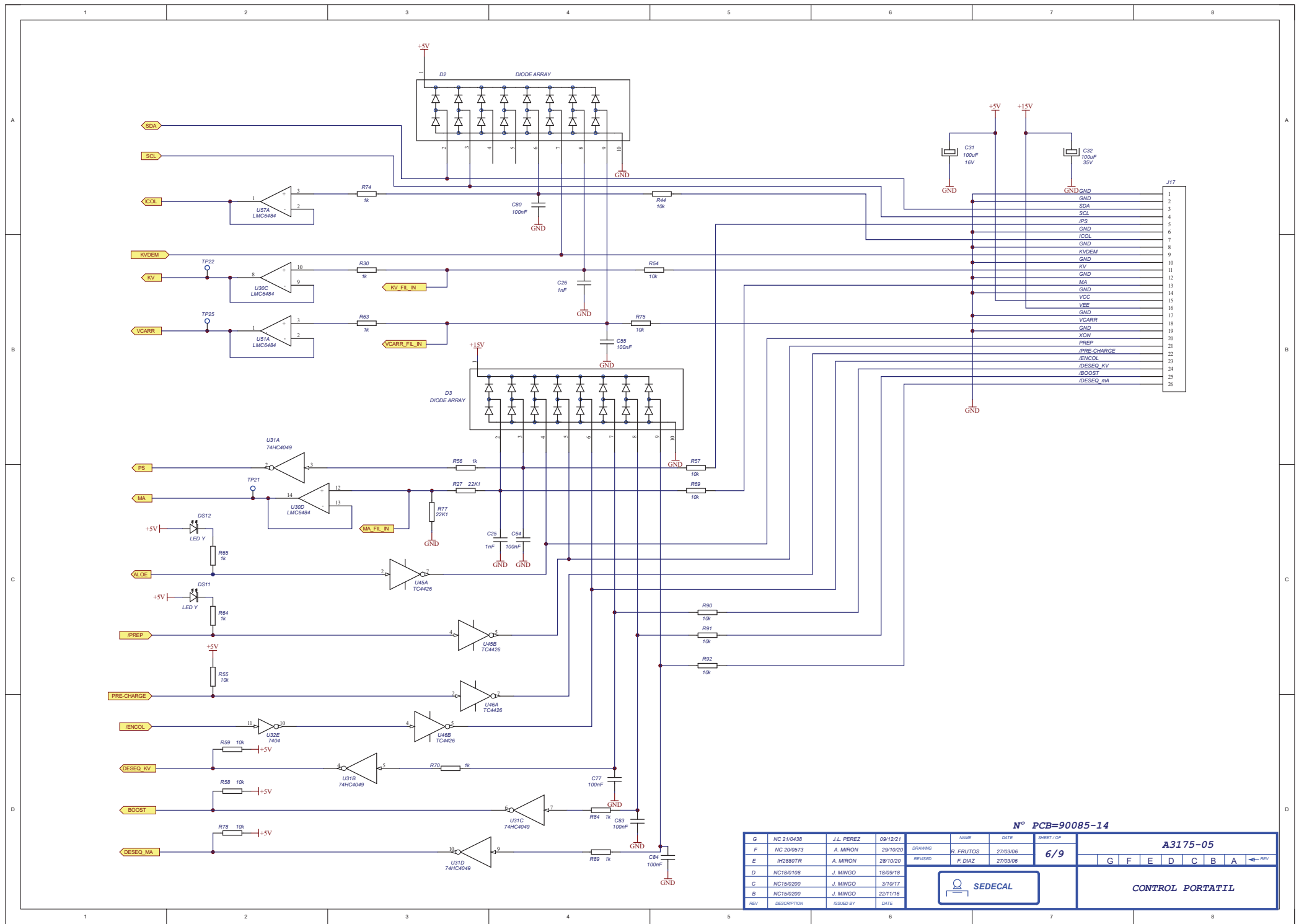
Nº PCB=90085-14

G	NC 210438	J. L. PEREZ	09/12/21	NAME	DATE	SHEET/OP	A3175-05								
F	NC 200573	A. MIRON	29/10/20	DRAWING	R. FRUTOS	27/03/06	4/9	G	F	E	D	C	B	A	←REV
E	9H28807R	A. MIRON	28/10/20	REVISED	F. DIAZ	27/03/06									
D	NC180108	J. MINGO	18/09/18	<div style="display: flex; align-items: center; justify-content: center;"> SEDECAL </div> <div style="text-align: right; margin-top: 5px;">CONTROL PORTATIL</div>											
C	NC150200	J. MINGO	3/10/17												
B	NC150200	J. MINGO	22/1/16												
REV	DESCRIPTION	ISSUED BY	DATE												



N° PCB=90085-14

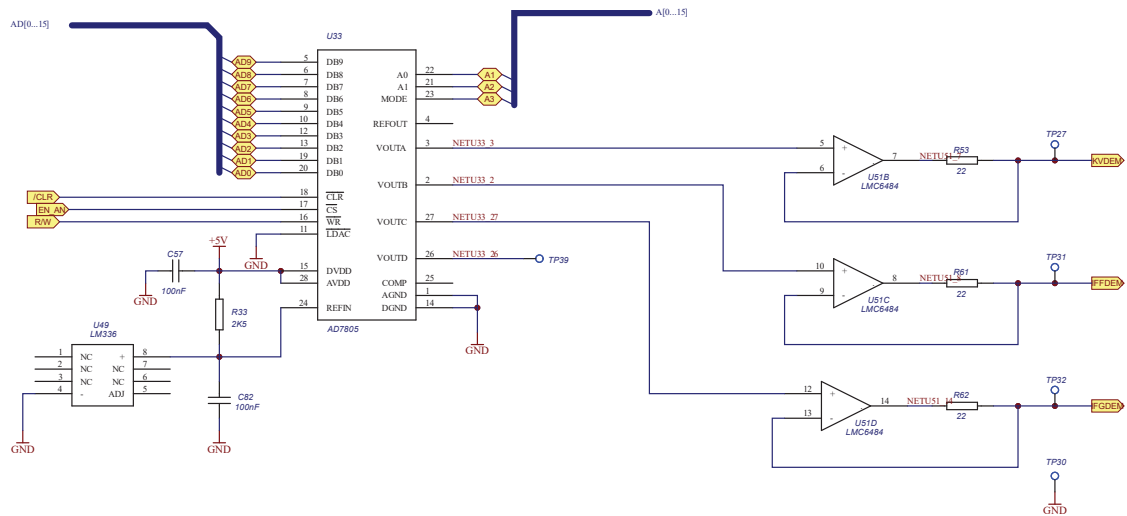
REV	DESCRIPTION	ISSUED BY	DATE	NAME	DATE	SHEET/OP	A3175-05								
G	NC 210438	J. L. PEREZ	09/12/21												
F	NC 200573	A. MIRON	29/10/20	DRAWING:	R. FRUTOS	27/03/06	5/9								
E	I#2880TR	A. MIRON	28/10/20	REVISED:	F. DIAZ	27/03/06		G	F	E	D	C	B	A	
D	NC180108	J. MINGO	18/09/18								CONTROL PORTATIL				
C	NC150200	J. MINGO	3/10/17												
B	NC150200	J. MINGO	22/11/16												
REV	DESCRIPTION	ISSUED BY	DATE												



G			NAME			DATE		SHEET / OP		A3175-05						
F	NC 200573	A. MIRON	29/10/20	DRAWING	R. FERRUTOS	27/03/06	6/9									
E	IH2880TR	A. MIRON	28/10/20	REVISED	F. DIAZ	27/03/06			G	F	E	D	C	B	A	← REV
D	NC18/0108	J. MINGO	18/09/18													
C	NC15/0200	J. MINGO	3/10/17													
B	NC15/0200	J. MINGO	22/11/16													
REV	DESCRIPTION	ISSUED BY	DATE													

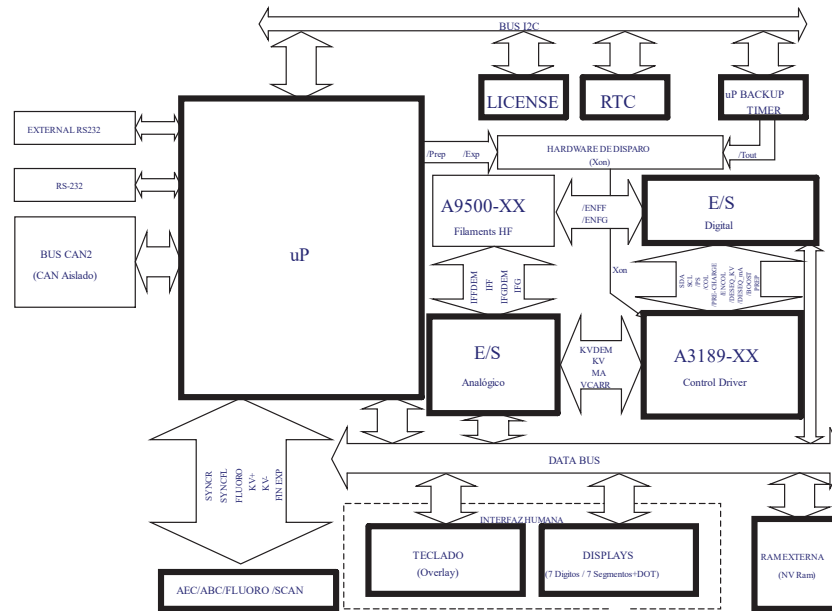


CONTROL PORTATIL



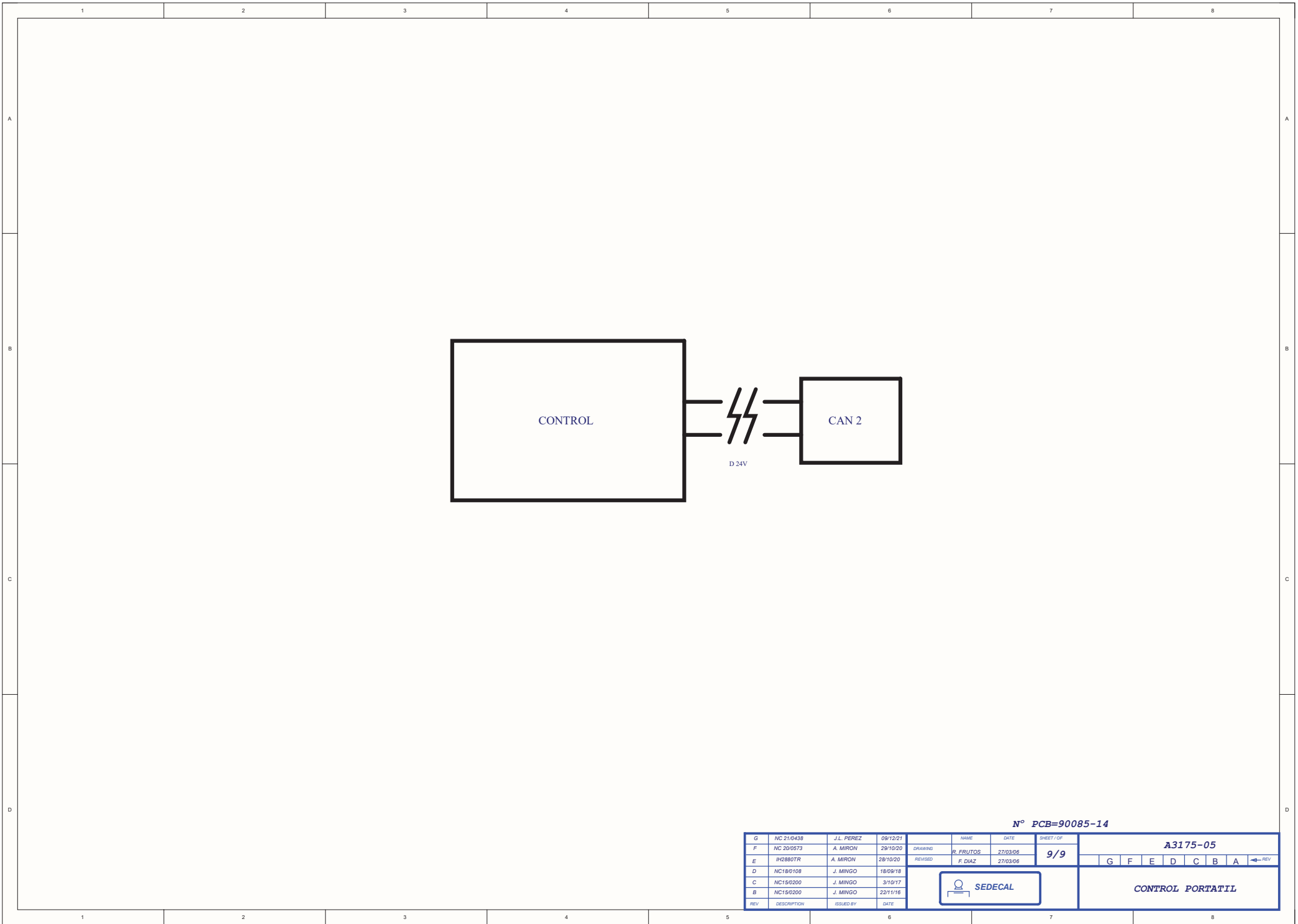
N° PCB=90085-14

REV	DESCRIPTION	ISSUED BY	DATE	NAME	DATE	SHEET / OP	A3175-05												
G	NC 21/04/38	J.L. PEREZ	09/12/21																
F	NC 20/05/73	A. MIRON	29/10/20	DRAWING	R. FIBUTOS	27/03/06	7/9												
E	IP2880TR	A. MIRON	28/10/20	REVISED	F. DIAZ	27/03/06						G	F	E	D	C	B	A	← REV
D	NC18/01/08	J. MINGO	18/09/18						CONTROL PORTATIL										
C	NC15/02/00	J. MINGO	3/10/17																
B	NC15/02/00	J. MINGO	22/11/16																
REV	DESCRIPTION	ISSUED BY	DATE																

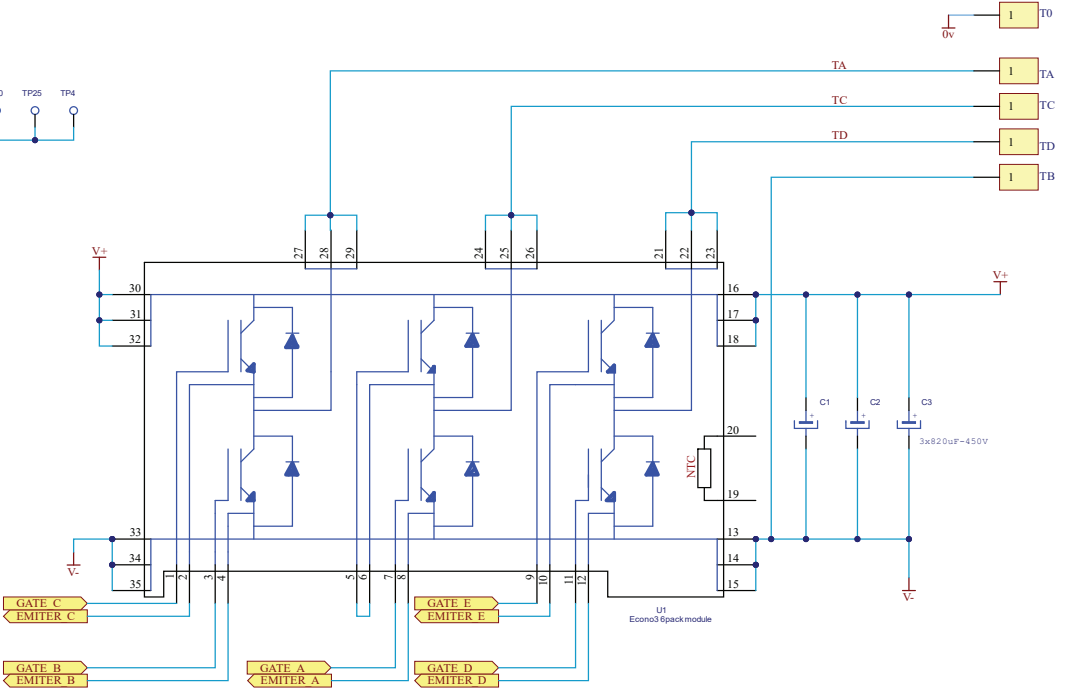
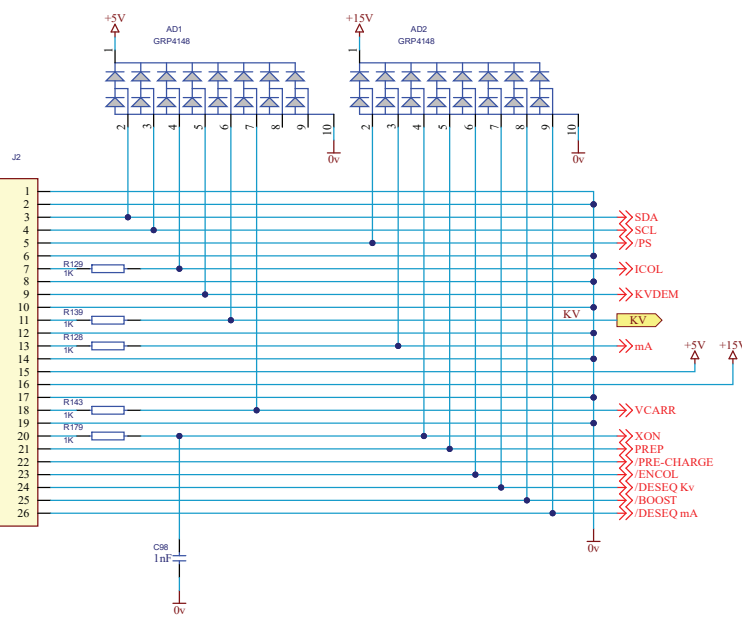
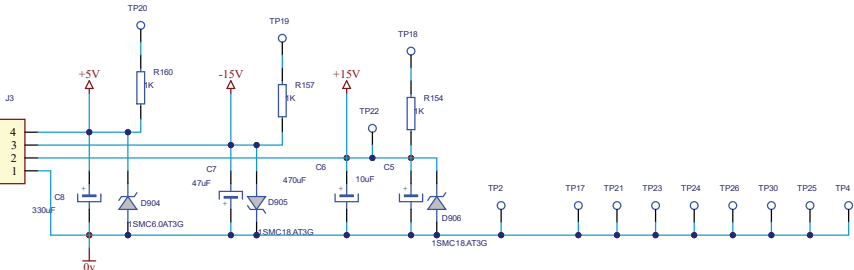
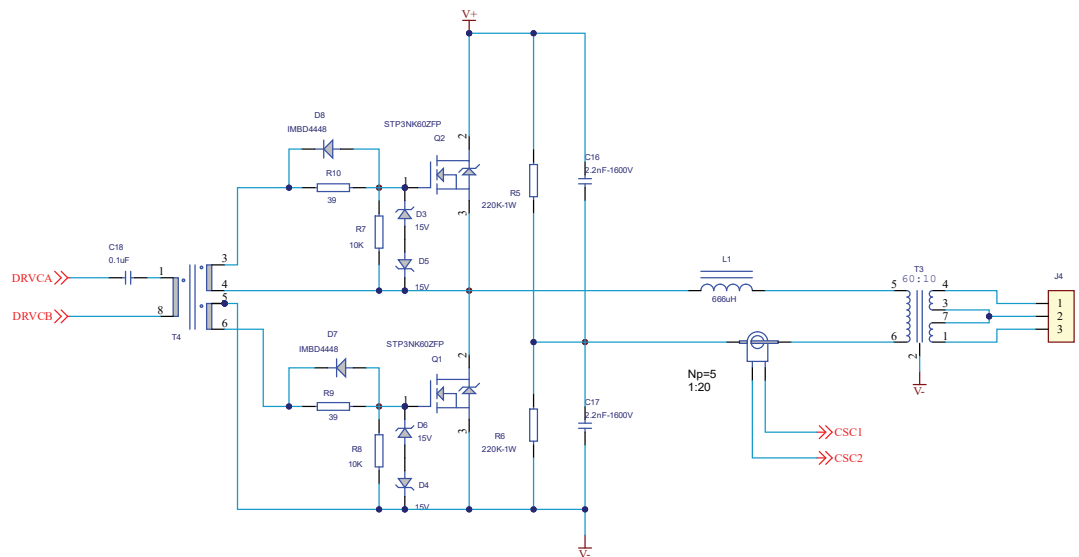
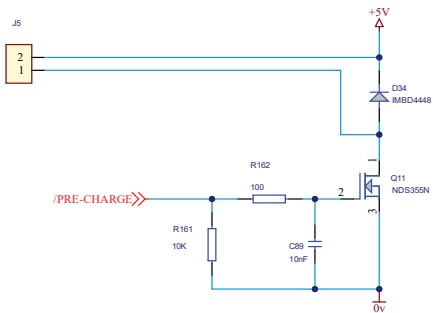


N° PCB=90085-14

REV	DESCRIPTION	ISSUED BY	DATE	NAME	DATE	SHEET / OP	A3175-05						
G	NC 210438	J.L. PEREZ	09/12/21			8 / 9							
F	NC 200573	A. MIRON	28/10/20	DRAWING	R. FERRITOS	27/03/06							
E	#12860TR	A. MIRON	28/10/20	REVISED	F. DIAZ	27/03/06	G	F	E	D	C	B	A
D	NC18/0108	J. MINGO	18/09/18										
C	NC15/0200	J. MINGO	3/10/17										
B	NC15/0200	J. MINGO	22/11/16										
										CONTROL PORTATIL			



				N° PCB=90085-14		
G	NC 21/0438	J.L. PEREZ	09/12/21	NAME	DATE	SHEET/OP
F	NC 20/0573	A. MIRON	29/10/20	DRAWING:	R. FRUTOS	27/03/06
E	#H2880TR	A. MIRON	28/10/20	REVISED:	F. DIAZ	27/03/06
D	NC18/0108	J. MINGO	18/09/18	9/9		
C	NC15/0200	J. MINGO	3/10/17	G F E D C B A ←REV		
B	NC15/0200	J. MINGO	22/1/16	SEDECAL		
REV	DESCRIPTION	ISSUED BY	DATE	CONTROL PORTATIL		

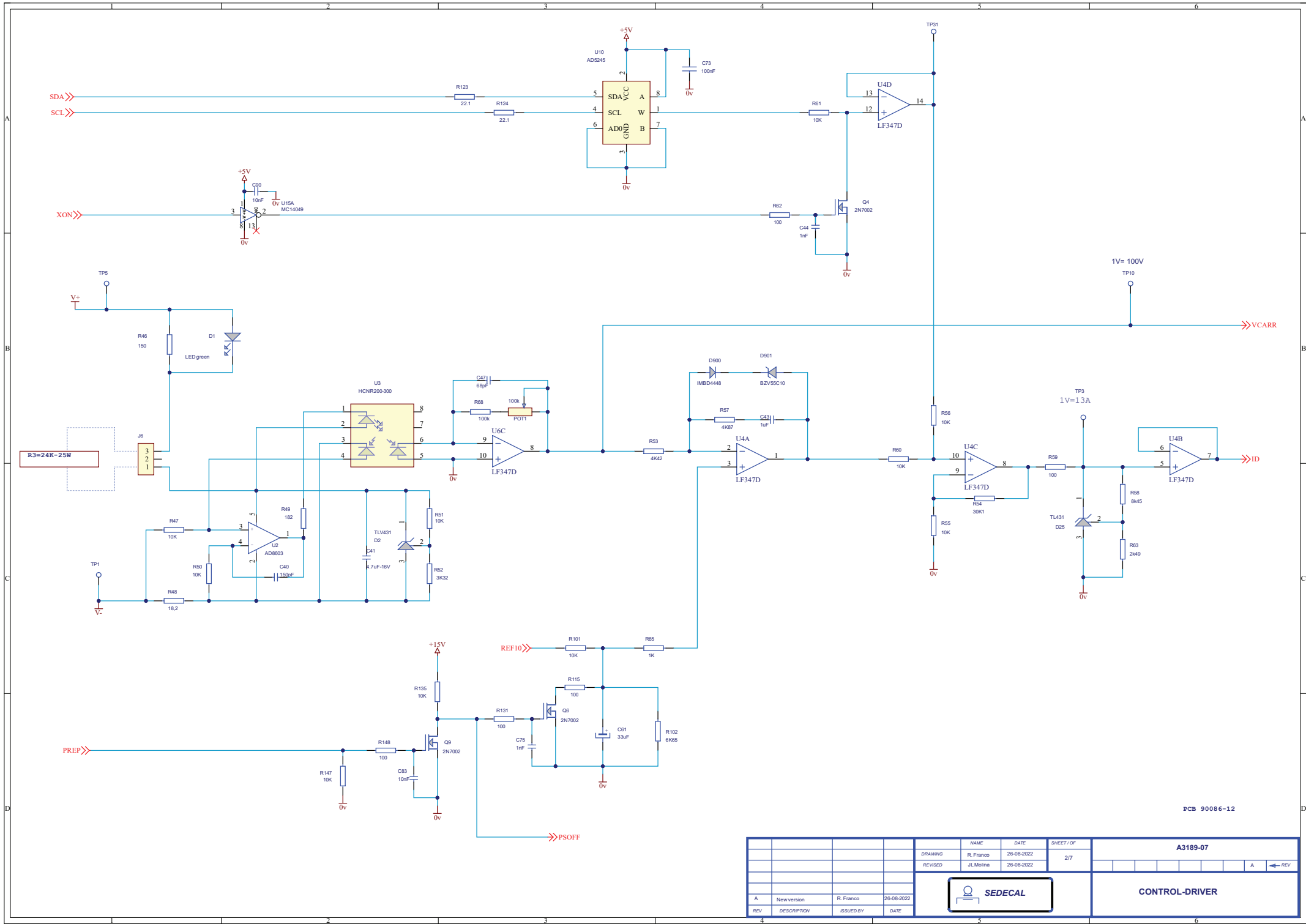


PCB 90086-12

DRAWING		NAME	DATE	SHEET/OF	A3189-07	
REVISED		R. Franco	26-08-2022	1/7		
REV		J.L. Molina	26-08-2022			
A		New version	R. Franco	26-08-2022		
REV		DESCRIPTION	ISSUED BY	DATE		

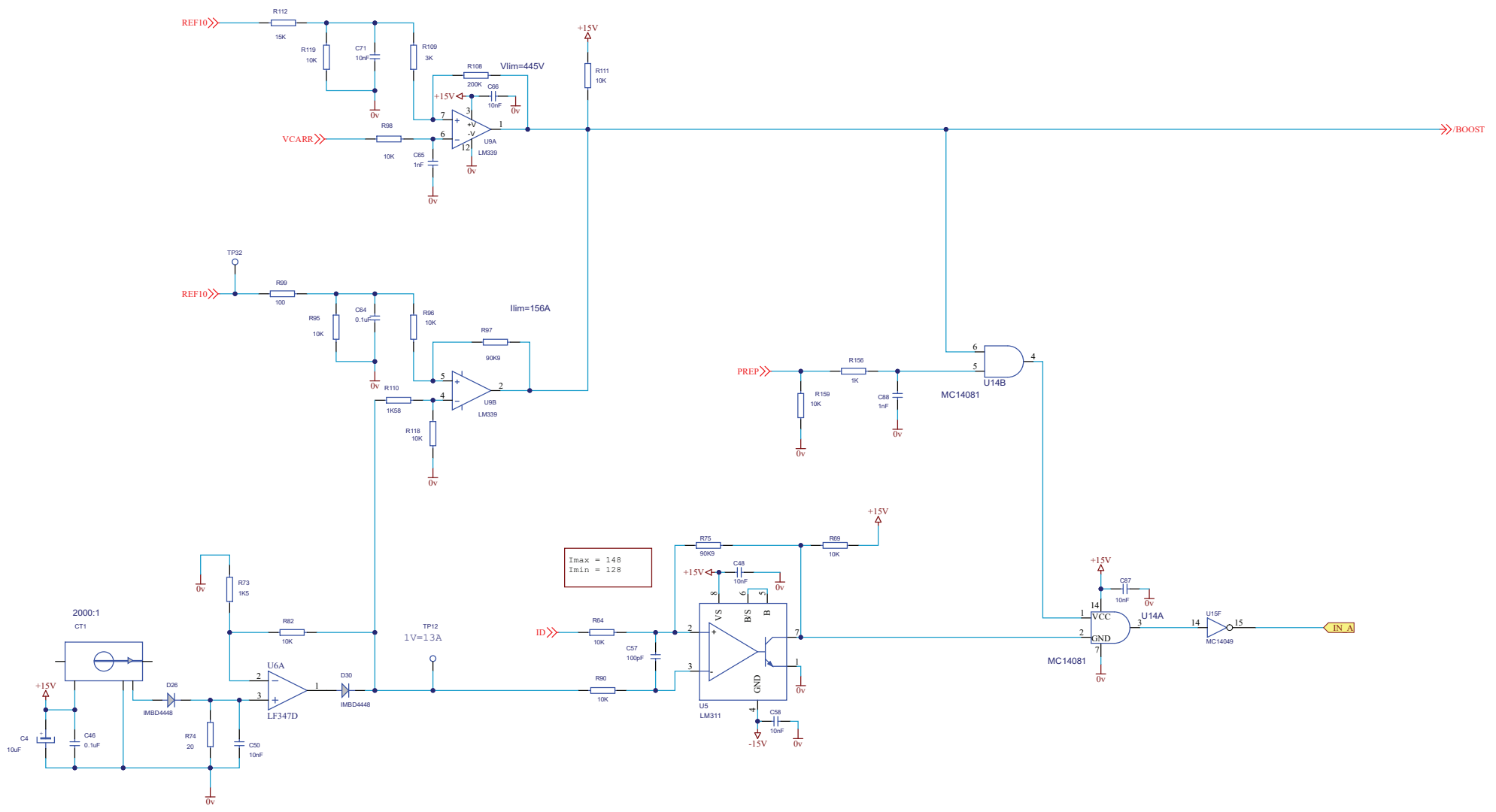
SEDECAL

CONTROL-DRIVER



PCB 90086-12

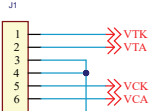
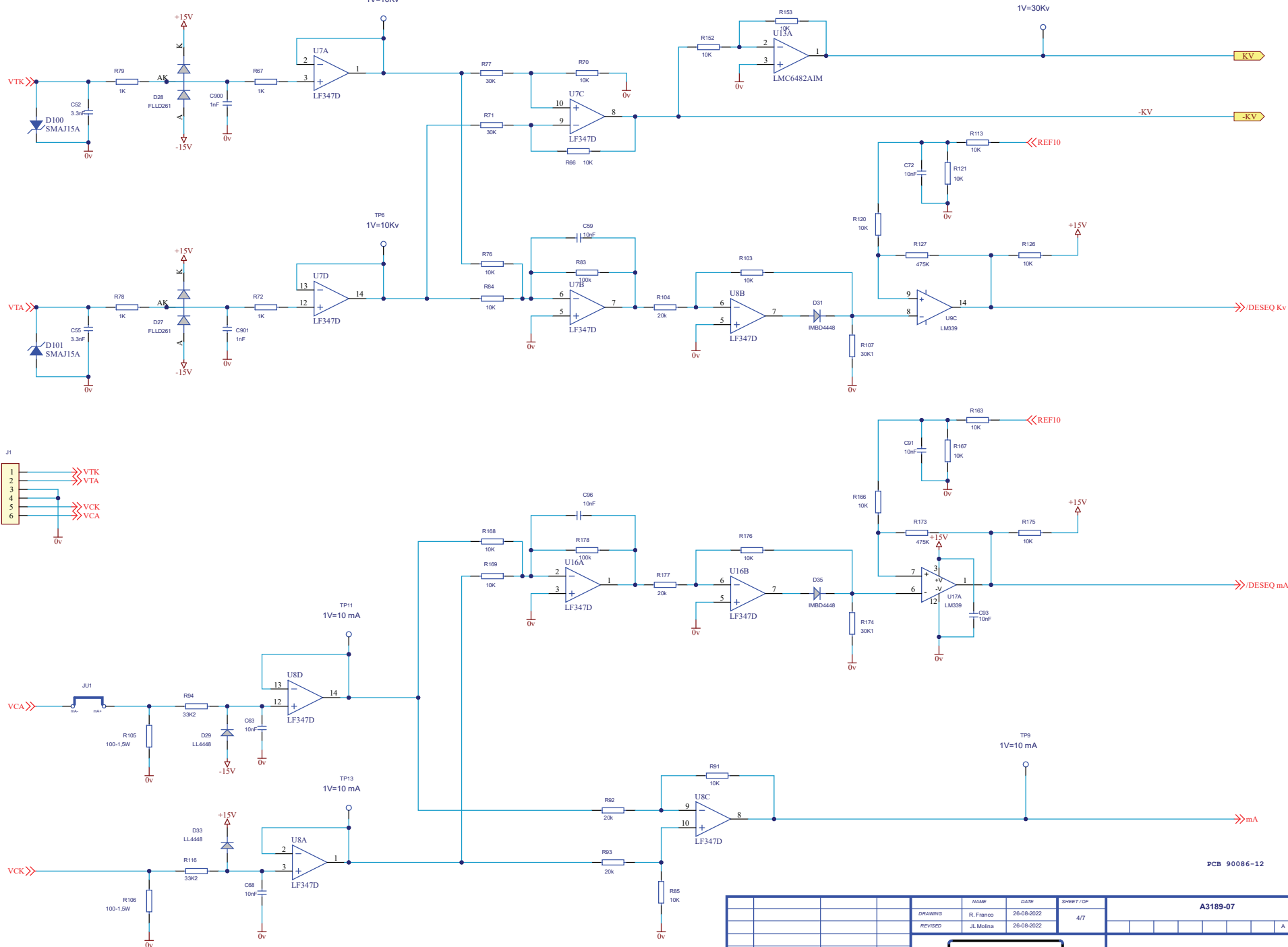
				NAME	DATE	SHEET/OF	A3189-07	
				DRAWING	R. Franco	26-08-2022	2/7	
				REVISED	J.L.Molina	26-08-2022		
						CONTROL-DRIVER		
A	New version	R. Franco	26-08-2022					
REV	DESCRIPTION	ISSUED BY	DATE					



$I_{max} = 148$
 $I_{min} = 128$

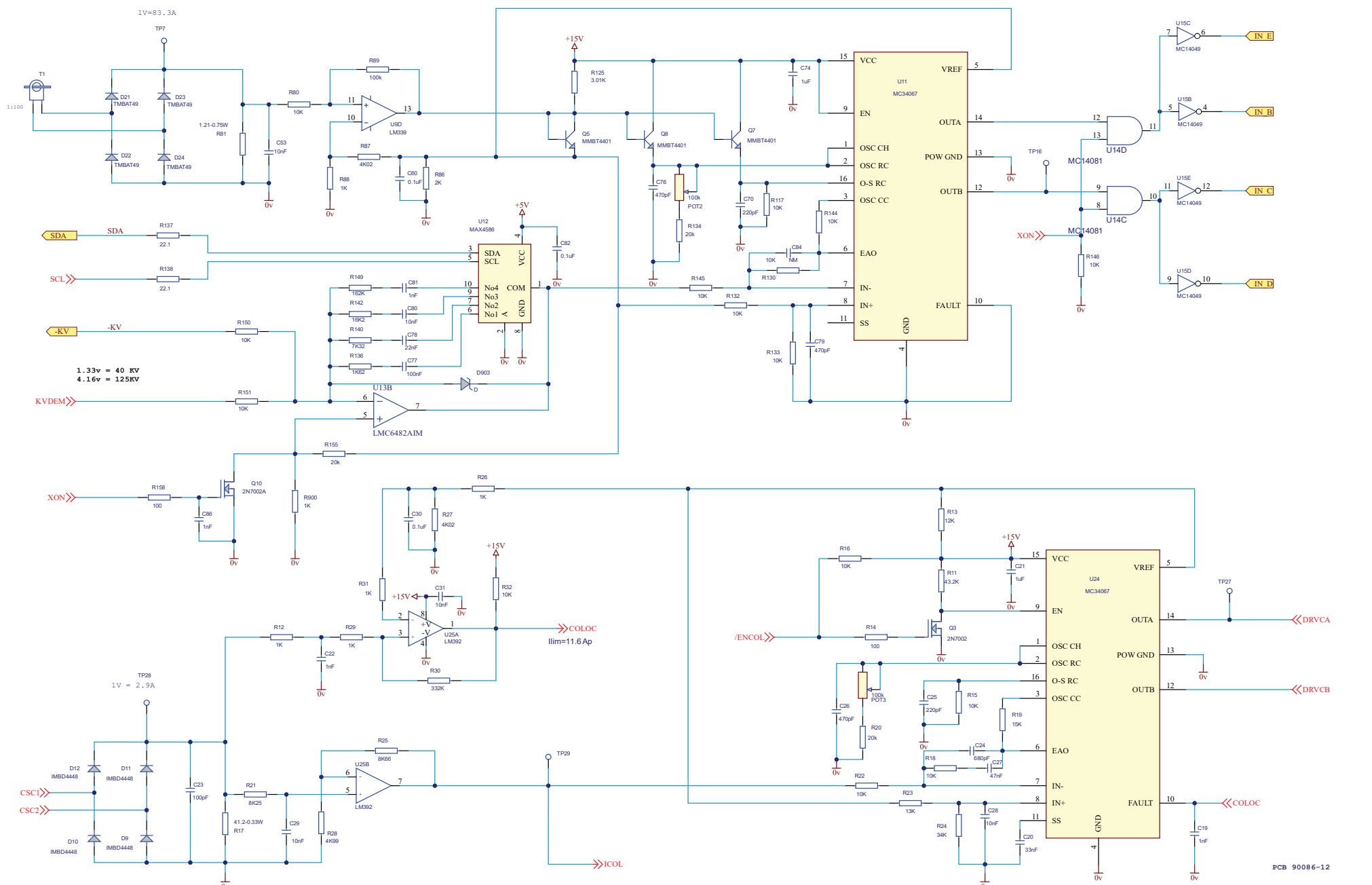
PCB 90086-12

DRAWING		NAME	DATE	SHEET/OF	A3189-07	
REVISED		R. Franco	26-08-2022	3/7		
		J.L. Molins	26-08-2022			
		SEDECAL		CONTROL-DRIVER		
A	New version	R. Franco	26-08-2022			
REV	DESCRIPTION	ISSUED BY	DATE			



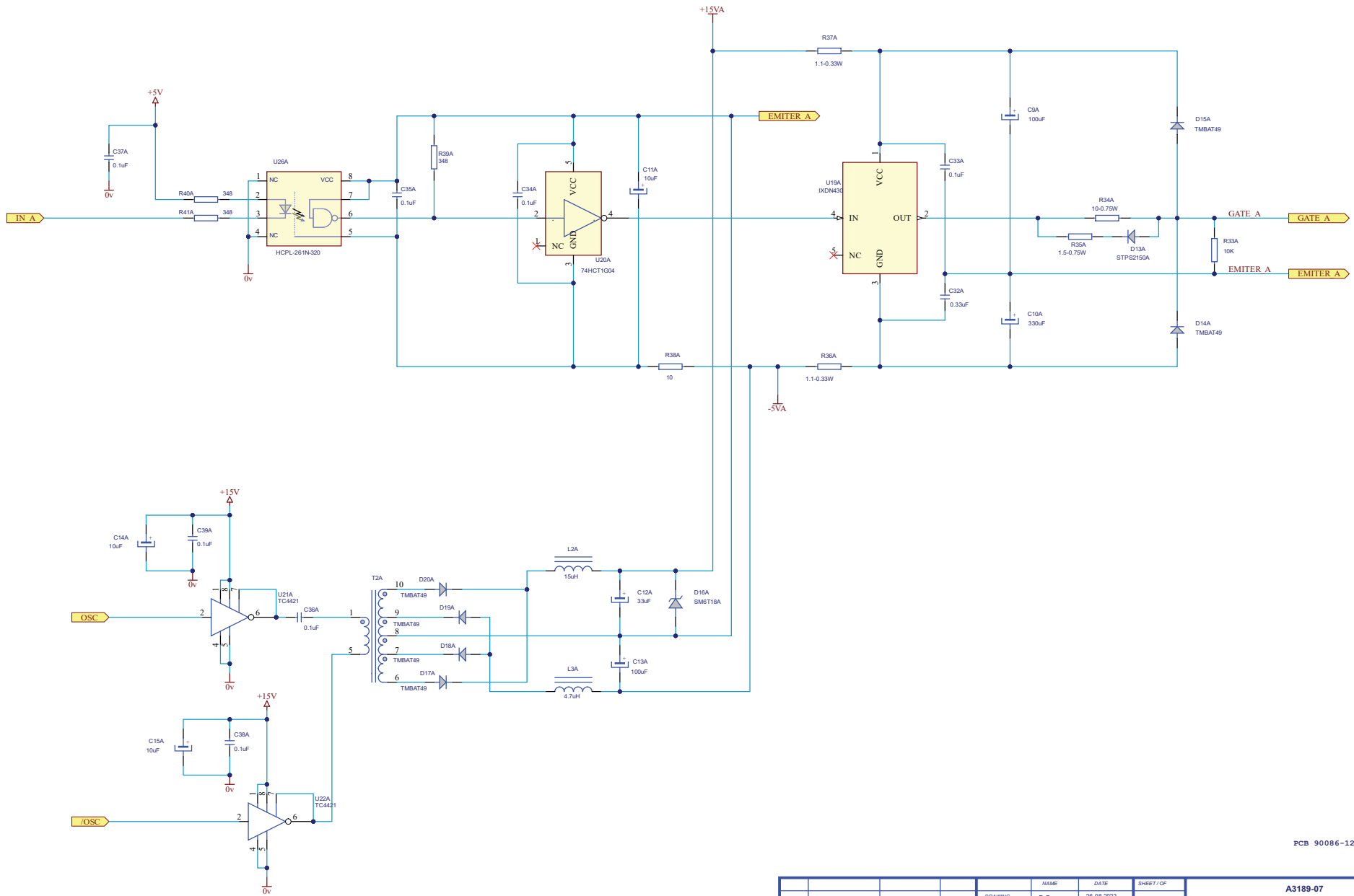
PCB 90086-12

DRAWING		NAME	DATE	SHEET / OF	A3189-07	
REVISED		R. Franco	26-08-2022	4 / 7		
REV		J.L. Molina	26-08-2022			
A		New version	R. Franco	26-08-2022		
REV		DESCRIPTION	ISSUED BY	DATE		
					CONTROL-DRIVER	




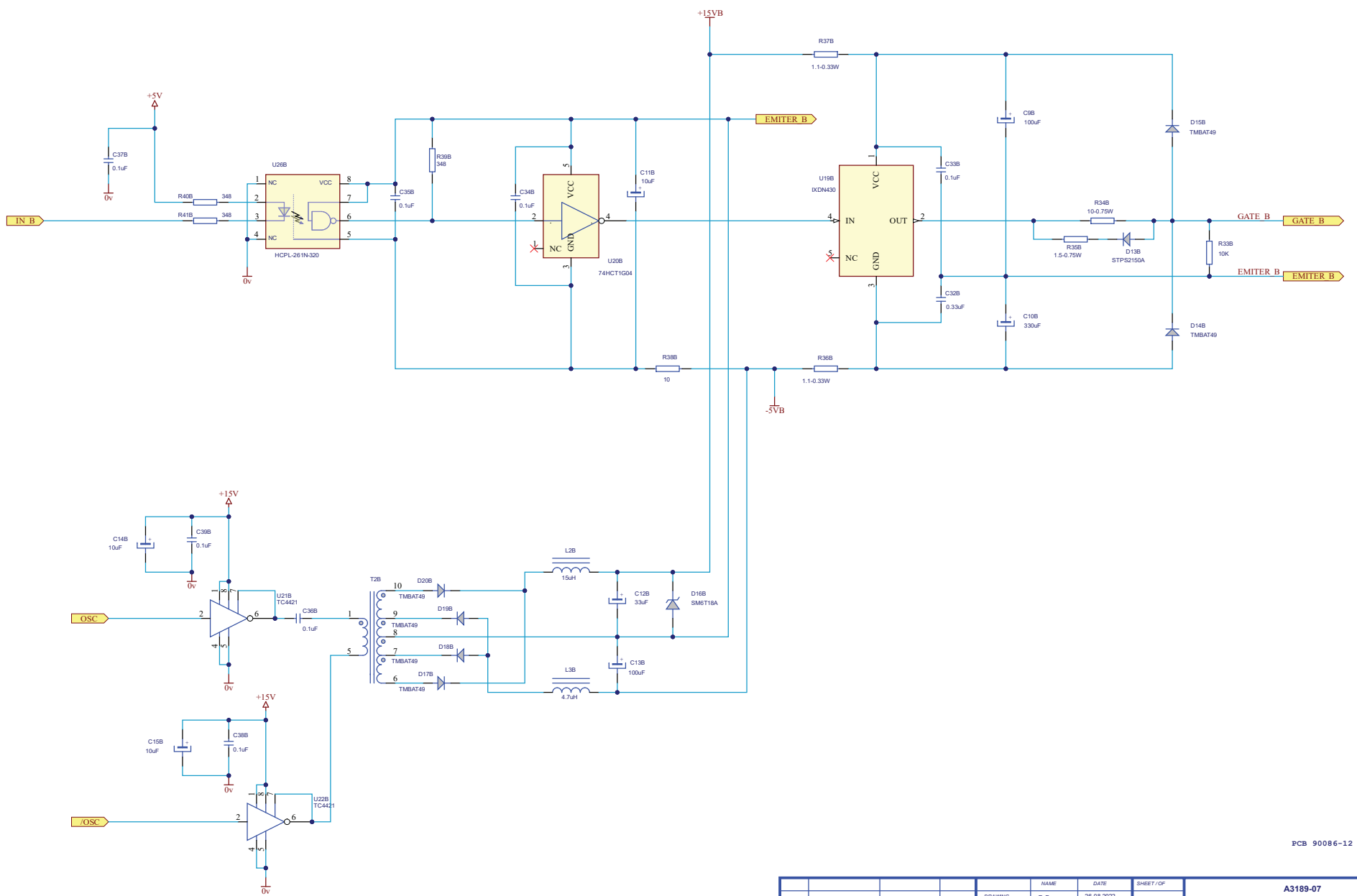
PCB 90086-12

DRAWING		NAME	DATE	SHEET/OF	A3189-07	
REVISED		R. Franco	26-08-2022	5/7		
REV		J.L. Molina	26-08-2022		A ← REV	
A	New version	R. Franco	26-08-2022			
REV	DESCRIPTION	ISSUED BY	DATE			



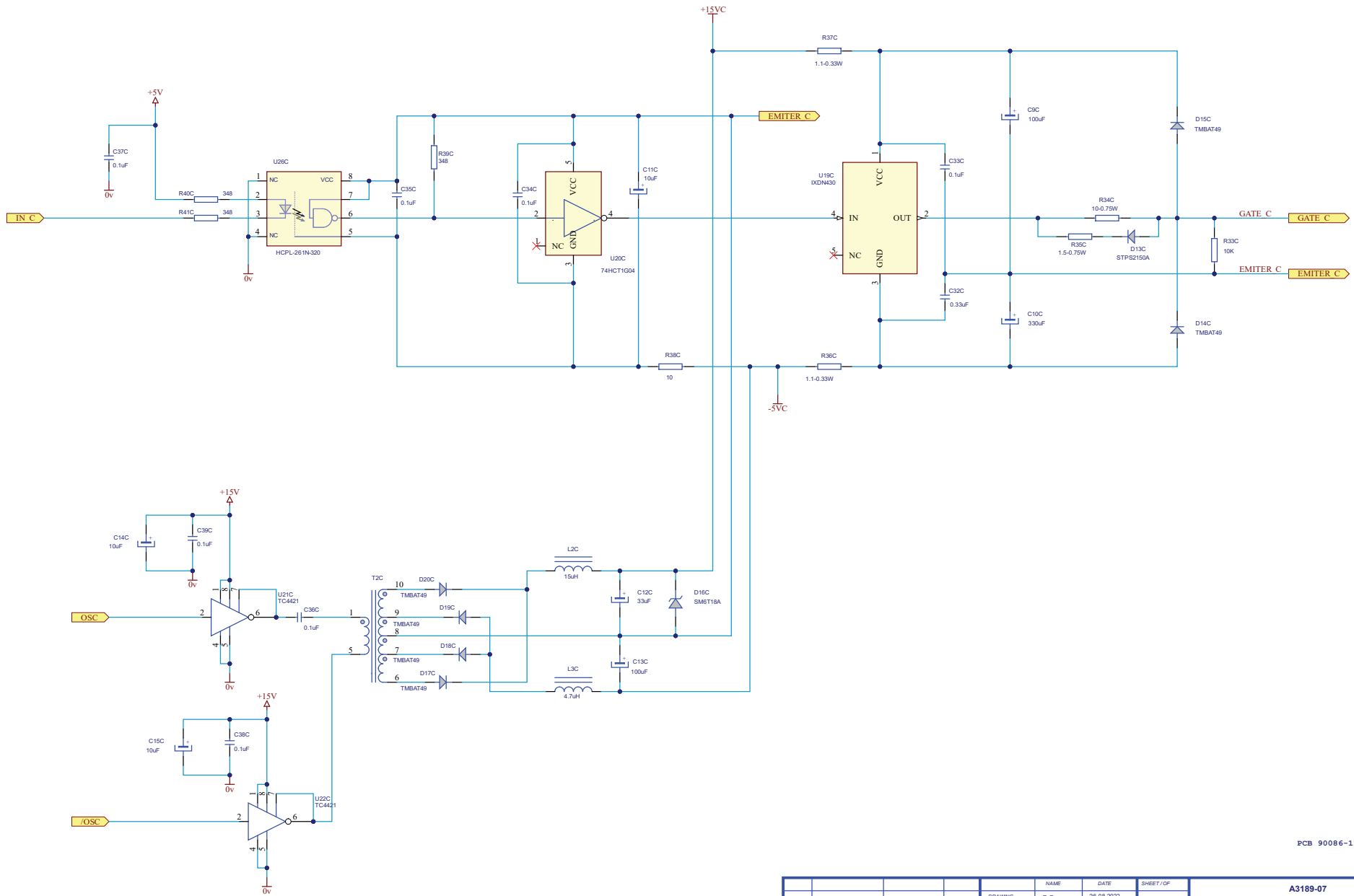
PCB 90086-12

DRAWING		NAME	DATE	SHEET / OF	A3189-07	
REVISED		R. Franco	26-08-2022	6A/7		
		J.L. Molina	26-08-2022			
A	New version	R. Franco	26-08-2022	 CONTROL-DRIVER		
REV	DESCRIPTION	ISSUED BY	DATE			



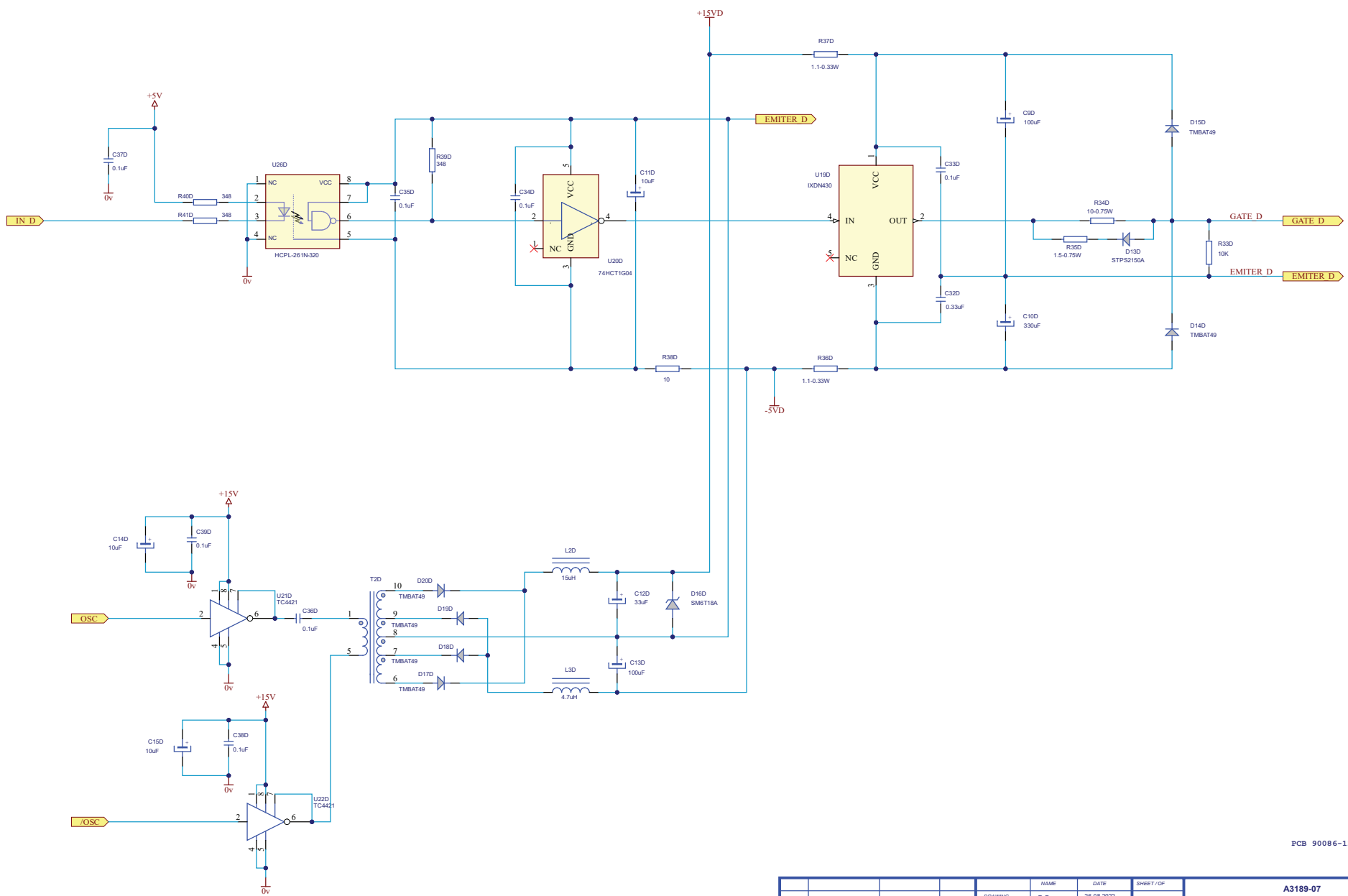
PCB 90086-12

			NAME	DATE	SHEET/OF	A3189-07		
			R. Franco	26-08-2022	6B/7			
			REVISED	J.L.Molina	26-08-2022			
						CONTROL-DRIVER		
A	New version	R. Franco	26-08-2022					
REV	DESCRIPTION	ISSUED BY	DATE					




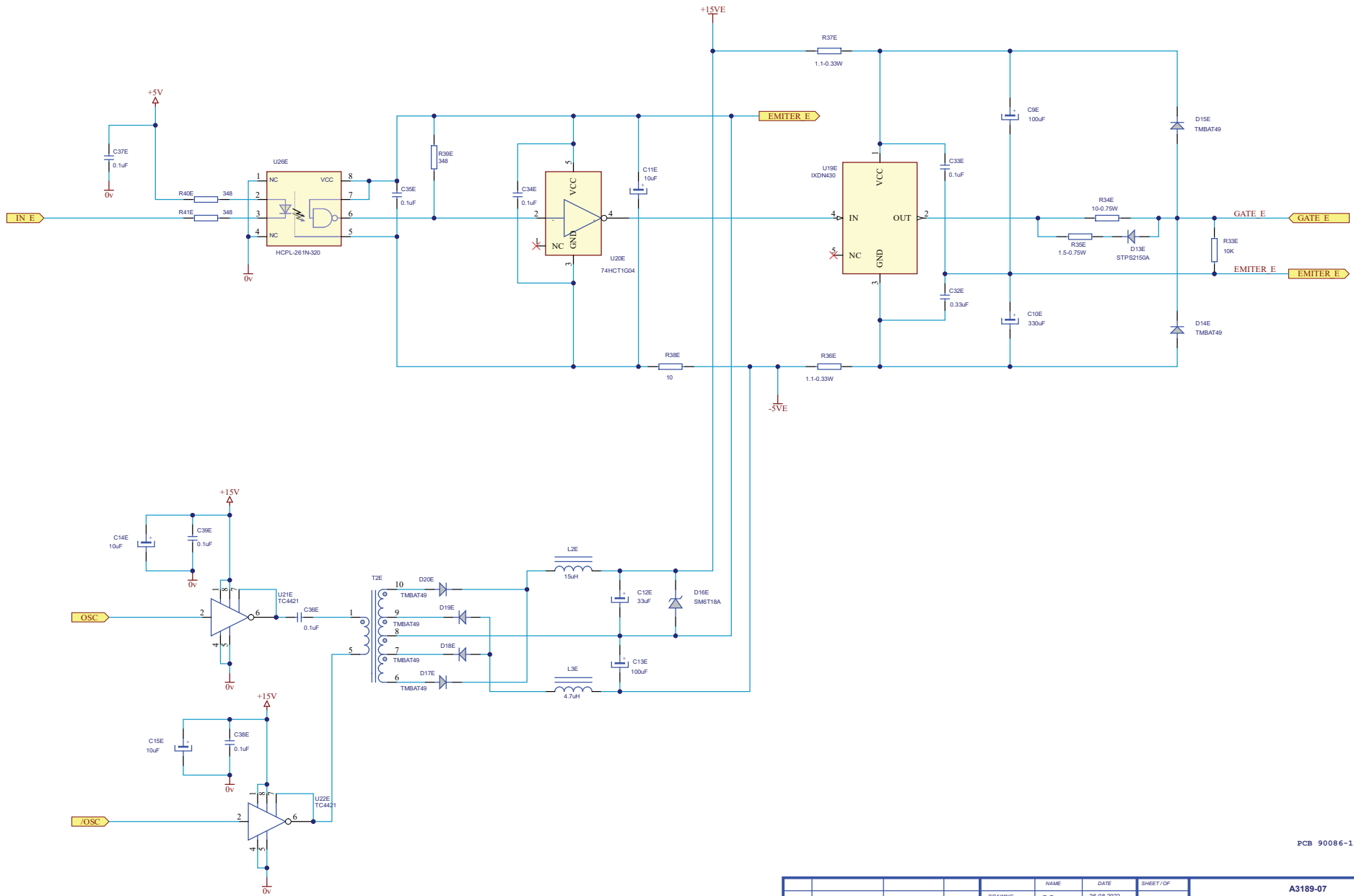
PCB 90086-12

DRAWING		NAME	DATE	SHEET/OF	A3189-07	
REVISED		R. Franco	26-08-2022	6C/7		
		J.L. Molina	26-08-2022		A ← REV	
A		New version	R. Franco	26-08-2022	 CONTROL-DRIVER	
REV	DESCRIPTION	ISSUED BY	DATE			



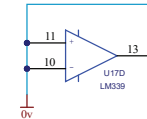
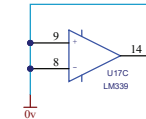
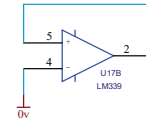
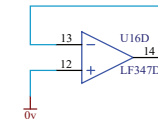
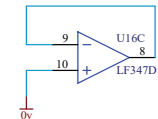
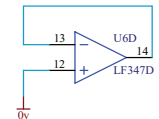
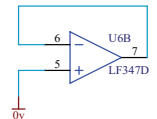
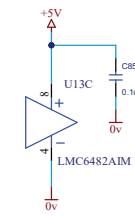
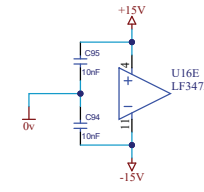
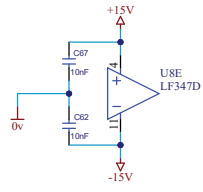
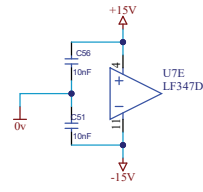
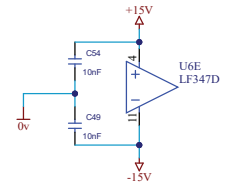
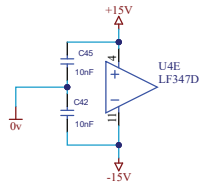
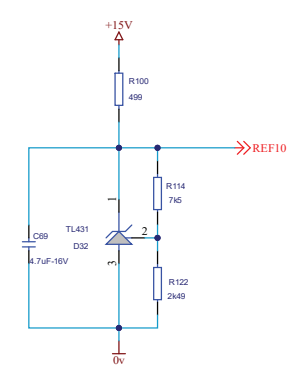
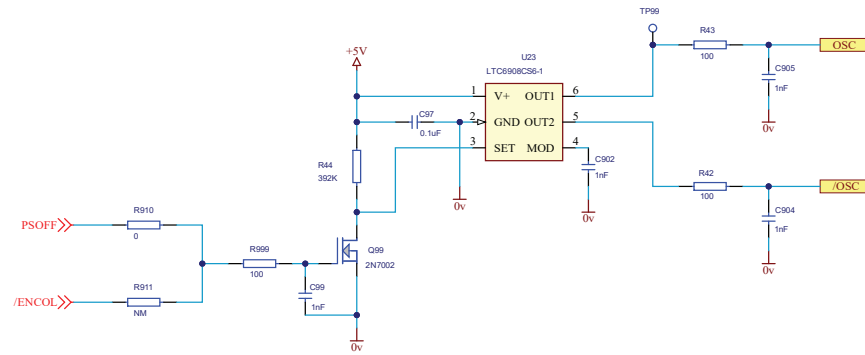
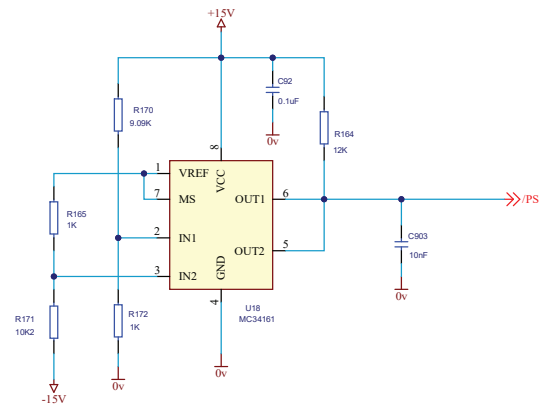
PCB 90086-12

DRAWING		NAME	DATE	SHEET/OF	A3189-07	
REVISED		R. Franco	26-08-2022	6D/7		
		J.L. Molins	26-08-2022		A ← REV	
A		New version	R. Franco	26-08-2022	 CONTROL-DRIVER	
REV	DESCRIPTION	ISSUED BY	DATE			



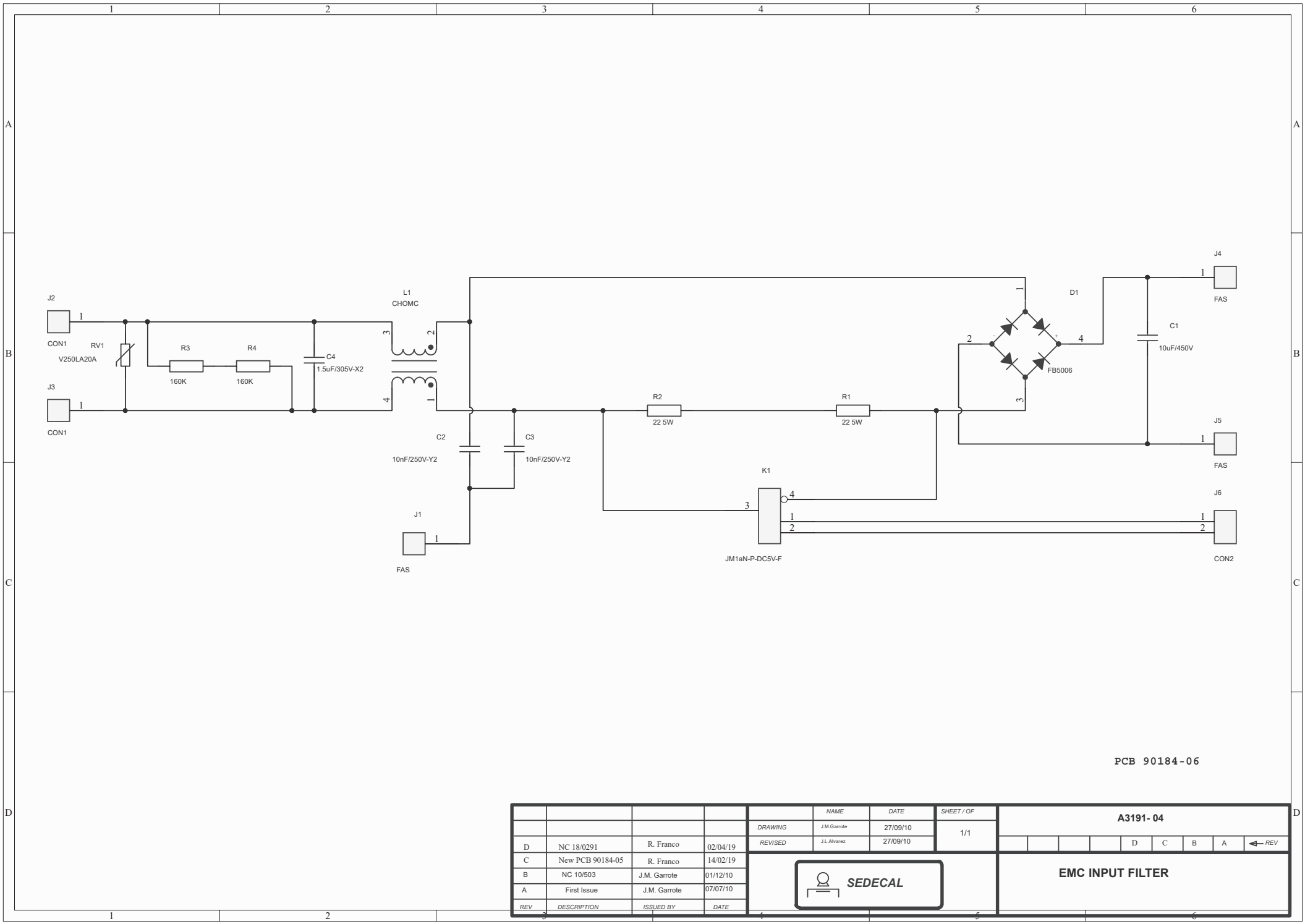
PCB 90086-12

			NAME	DATE	SHEET/OF	A3189-07	
			R. Franco	26-08-2022	6E/7		
			REVISED	J.L.Molina	26-08-2022	A ← REV	
					CONTROL-DRIVER		
A	New version	R. Franco	26-08-2022				
REV	DESCRIPTION	ISSUED BY	DATE				




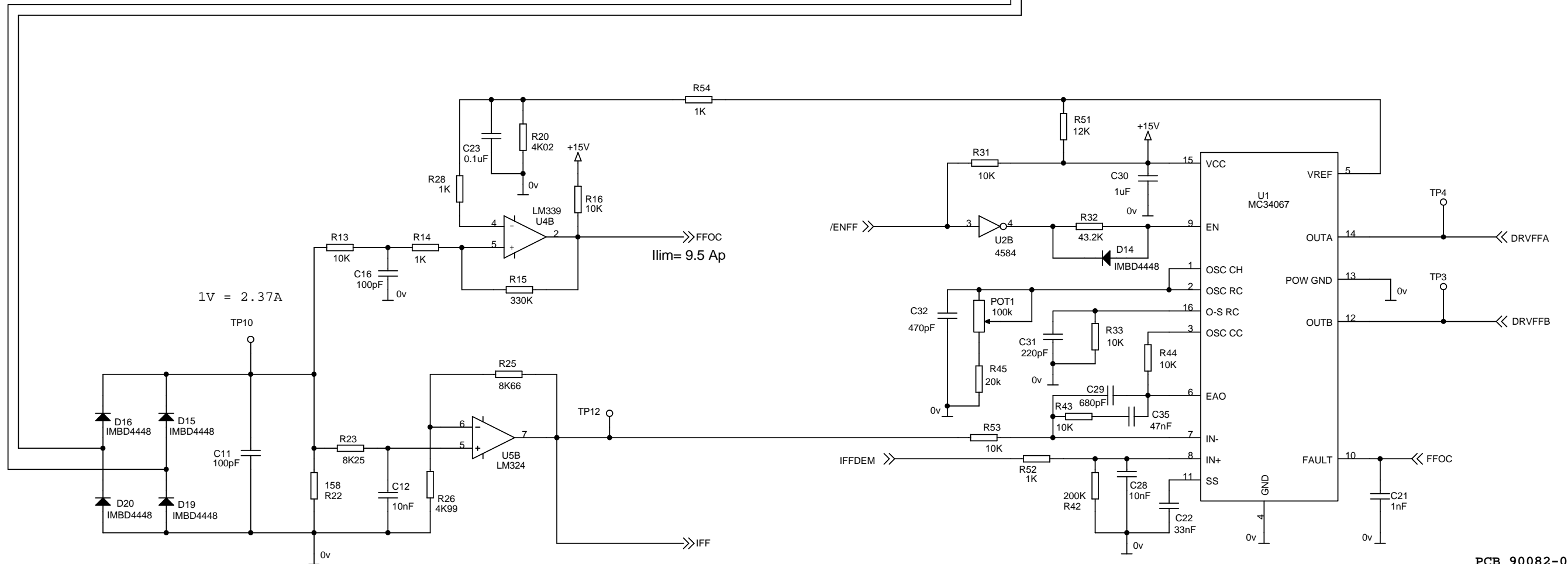
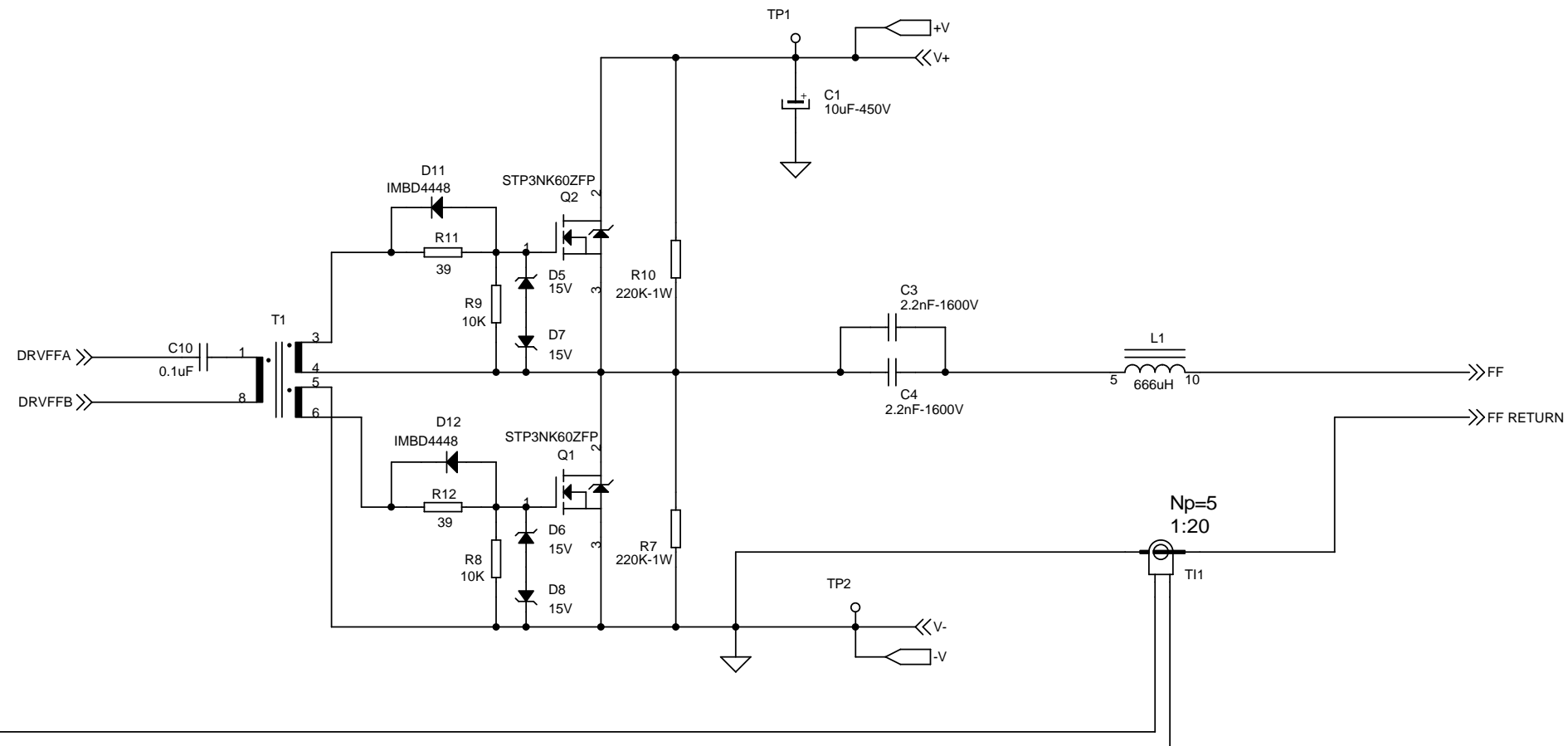
PCB 90086-12

				NAME	DATE	SHEET / OF	A3189-07	
				DRAWING	R. Franco	26-08-2022	7 / 7	
				REVISED	J.L. Molina	26-08-2022		
						CONTROL-DRIVER		
A	New version	R. Franco	26-08-2022					
REV	DESCRIPTION	ISSUED BY	DATE					



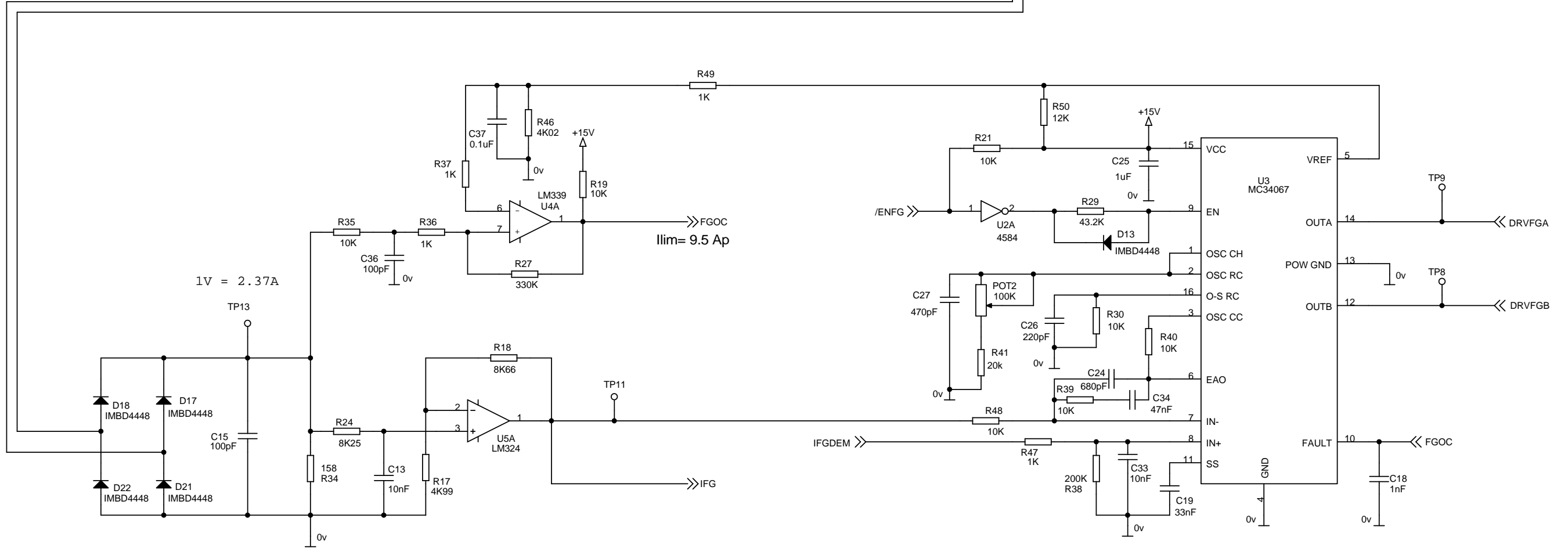
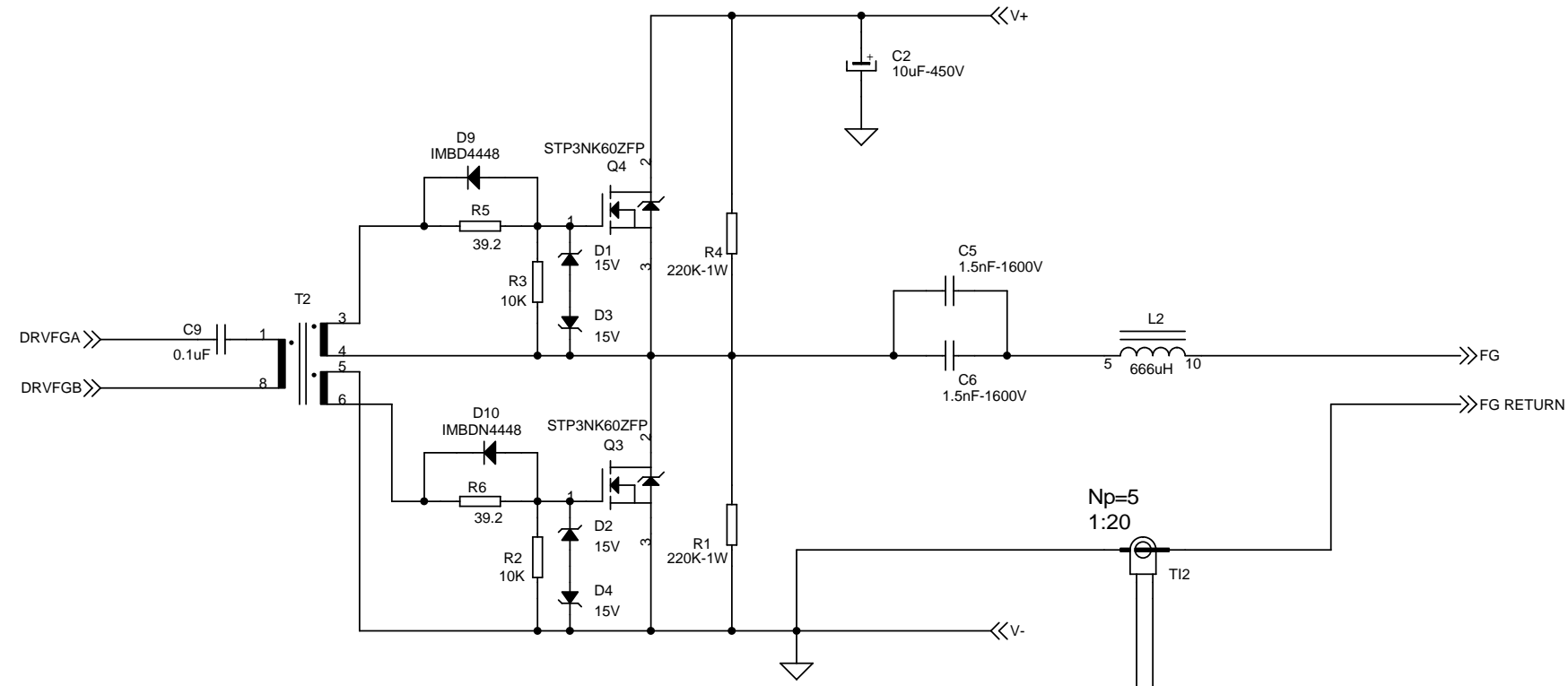
PCB 90184-06

				NAME		DATE		SHEET / OF		A3191-04					
				DRAWING		27/09/10		1/1							
				REVISED		27/09/10				D C B A ← REV					
D	NC 18/0291	R. Franco	02/04/19								EMC INPUT FILTER				
C	New PCB 90184-05	R. Franco	14/02/19												
B	NC 10/503	J.M. Garrote	01/12/10												
A	First Issue	J.M. Garrote	07/07/10												
REV	DESCRIPTION	ISSUED BY	DATE												

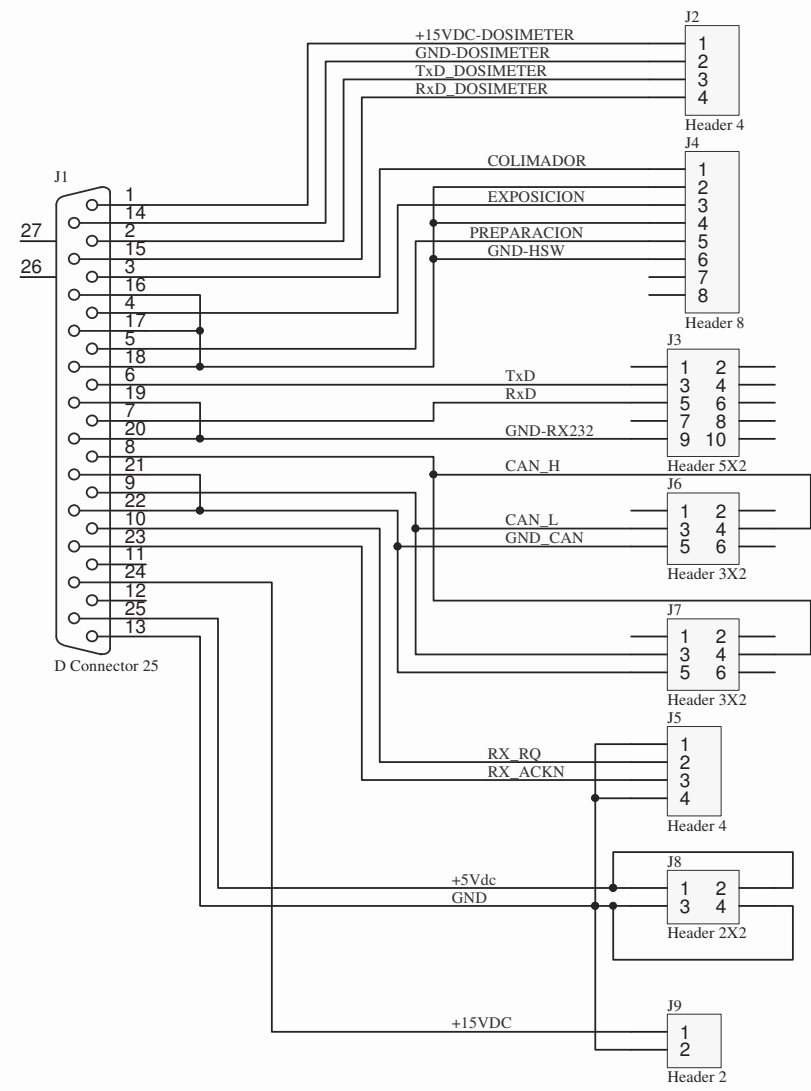


PCB 90082-04

REV	DESCRIPTION	ISSUED BY	DATE	NAME	DATE	SHEET / OF	A9500-01				
				DRAWING	JALVAREZ	23-04-09	1/3				
				REVISED	ADIAZ	23-04-09					
B	NC 09/308 R40/44	JLALVAREZ	06-11-09	SEDECAL				FILAMENTS HF			
A		JLALVAREZ	23-04-09								
REV	DESCRIPTION	ISSUED BY	DATE					B A ← REV			



REV	DESCRIPTION	ISSUED BY	DATE	NAME	DATE	SHEET / OF	A9500-01				
				DRAWING	JALVAREZ	23-04-09					
				REVISED	ADIAZ	23-04-09	2/3				
B	NC 09/308 R40/44	JLALVAREZ	06-11-09	SEDECAL				FILAMENTS HF			
A		JLALVAREZ	23-04-09								
REV	DESCRIPTION	ISSUED BY	DATE								

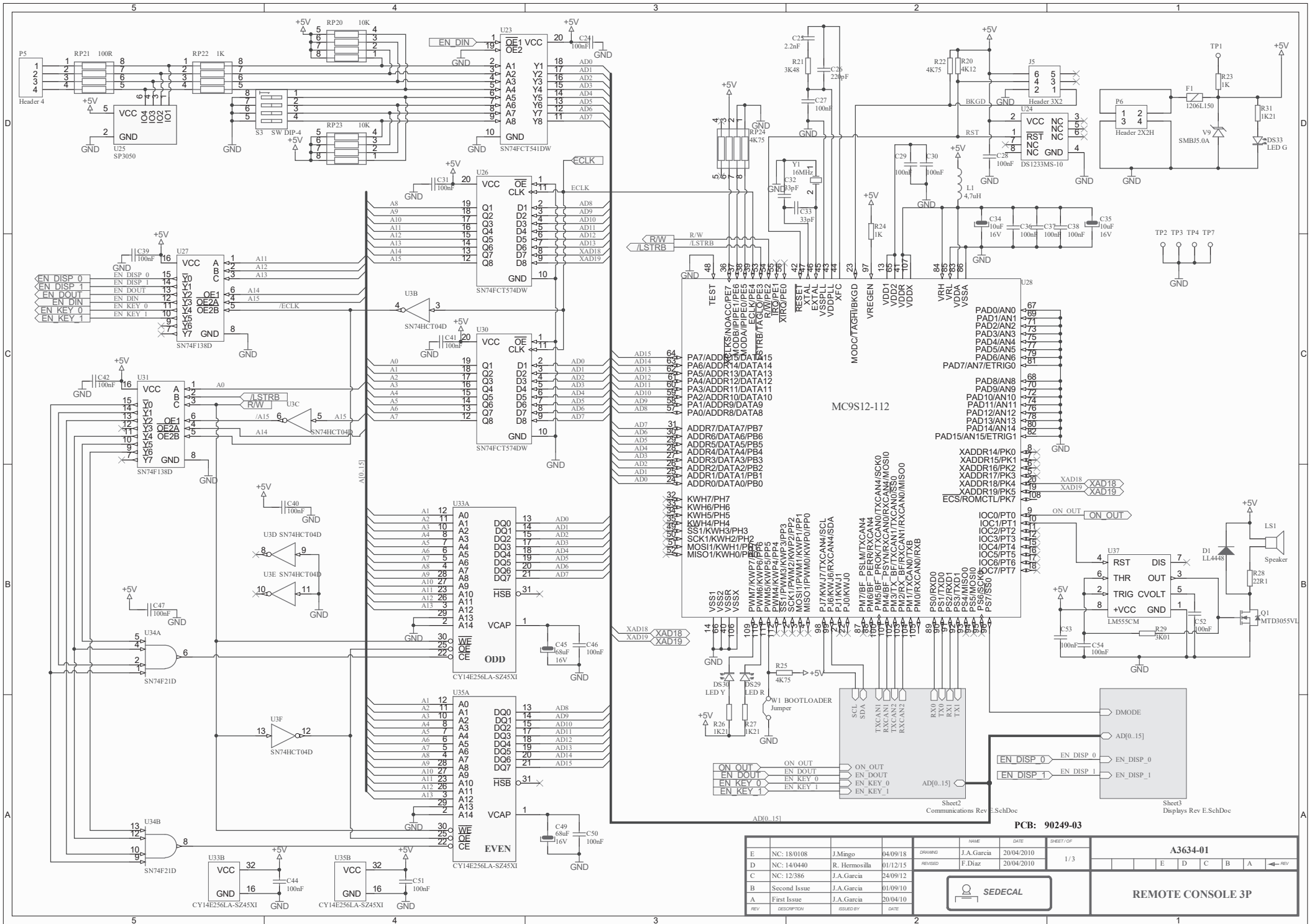


CONNECTOR DESCRIPTION

- J2 POWER AND COMMUNICATION FOR DOSEMETER
- J4 HANDSWITCH
- J3 SERIAL COMMUNICATIONS
- J6 CAN-BUS COMMUNICATIONS
- J7 CAN-BUS COMMUNICATIONS
- J5 DIGITAL PANEL INTERFACE
- J8 POWER SUPPLY FROM X-RAY GENERATOR.
- J9 +15VDC-GND

PCB: 90240-03

				NAME	DATE	SHEET / OF	A3632-02				
				DRAWING	J.A.Garcia	18/10/2010					1 / 1
				REVISED	F.Díaz	18/10/2010			B	A	← REV
B	NC 14/164	S.Pérez	24/03/201			CONECTORES CAJA DRAGON					
A	First Issue	J.A.Garcia	18/10/201								
REV	DESCRIPTION	ISSUED BY	DATE								

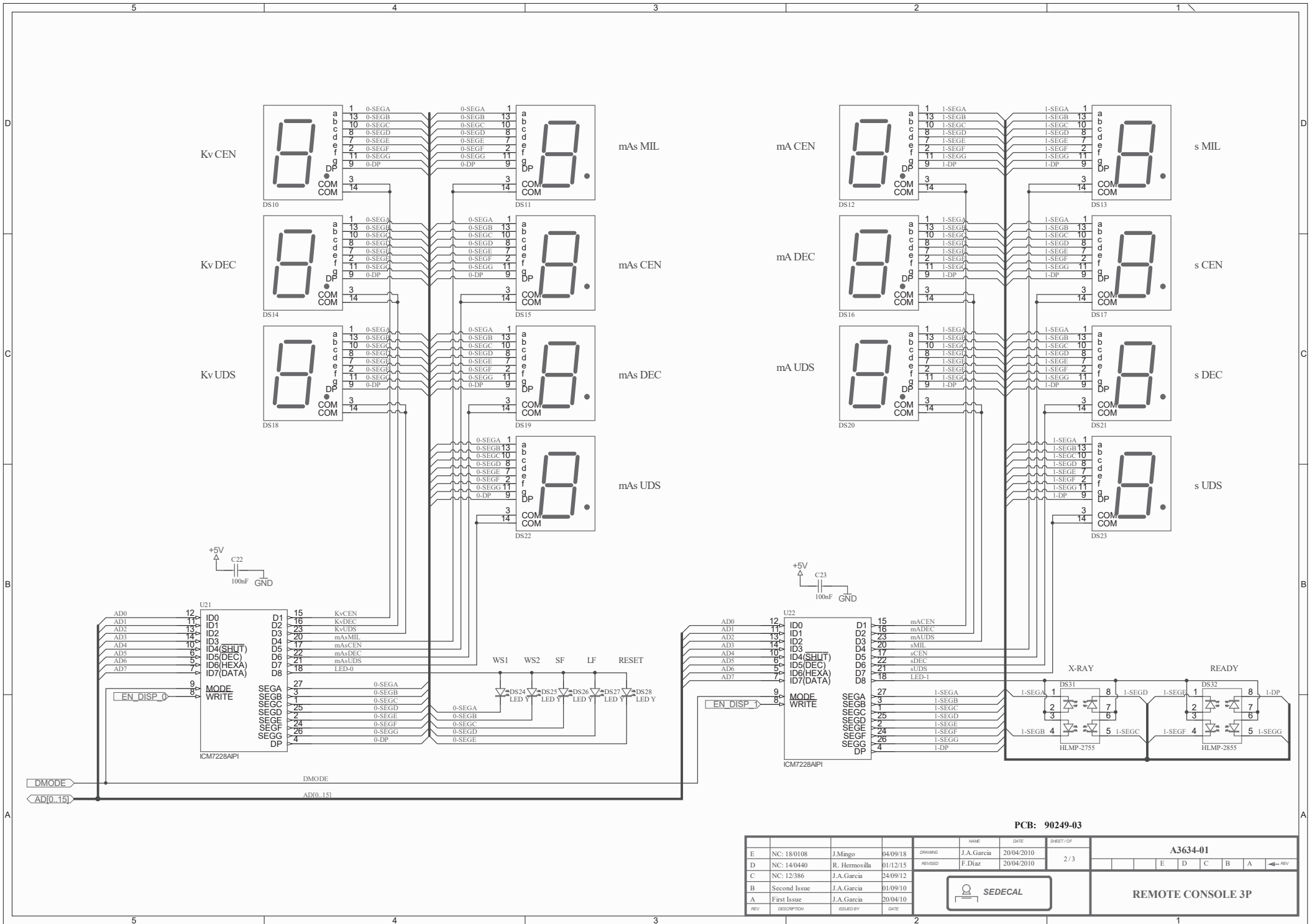


PCB: 90249-03

REV	DESCRIPTION	ISSUED BY	DATE	DRAWING	NAME	DATE	SHEET/OP	A3634-01				
E	NC: 18/0108	J.Mingo	04/09/18	DRAWING	J.A.Garcia	20/04/2010	1/3	E	D	C	B	A
D	NC: 14/0440	R. Hermosilla	01/12/15	REVISED	F.Diaz	20/04/2010						
C	NC: 12/386	J.A.Garcia	24/09/12									
B	Second Issue	J.A.Garcia	01/09/10									
A	First Issue	J.A.Garcia	20/04/10									



REMOTE CONSOLE 3P

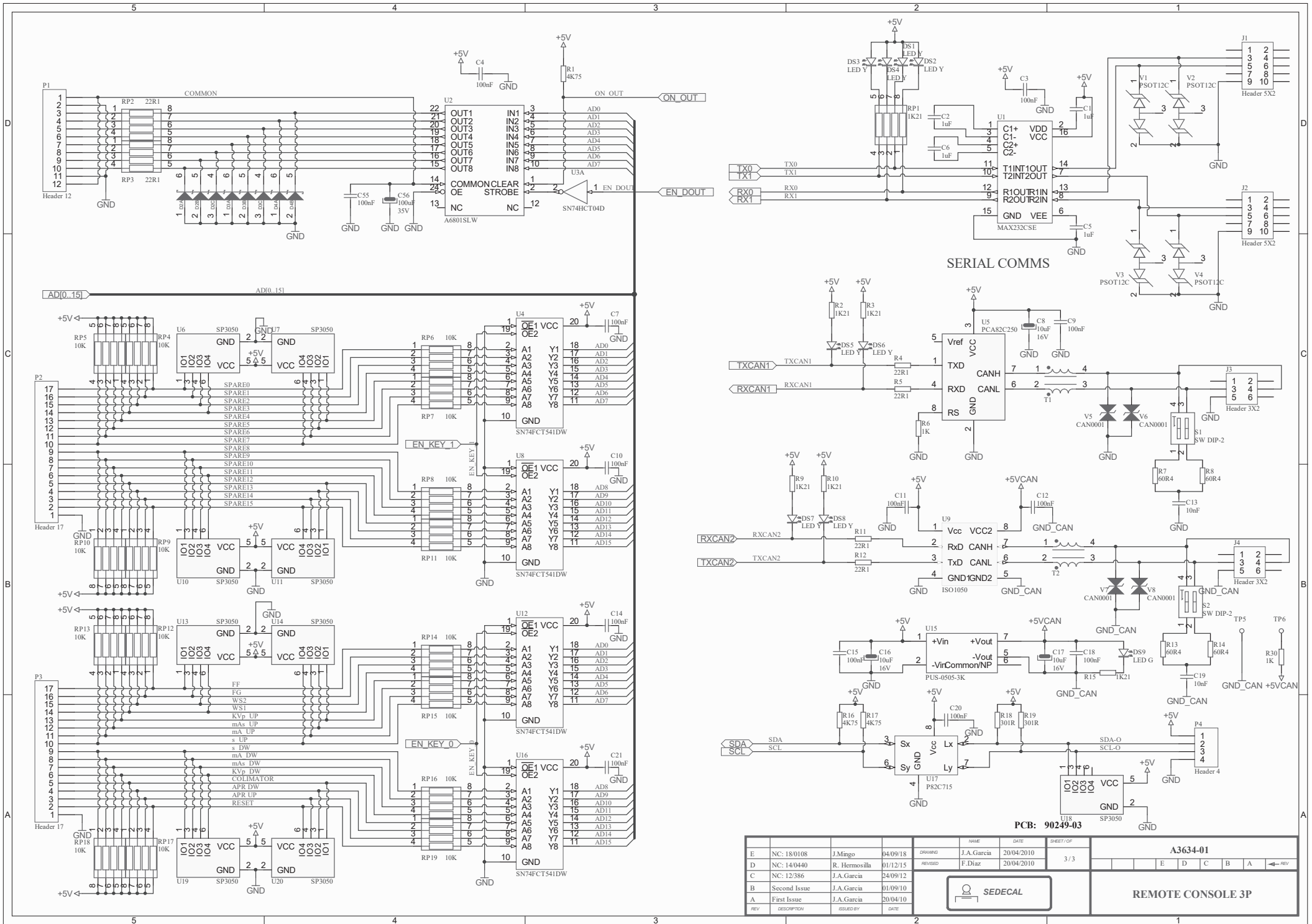


PCB: 90249-03

REV	DESCRIPTION	ISSUED BY	DATE	DRAWING	NAME	DATE	SHEET / OF	A3634-01				
E	NC: 18/0108	J.Mingo	04/09/18	DRAWING	J.A.García	20/04/2010	2 / 3	E	D	C	B	A
D	NC: 14/0440	R. Hermosilla	01/12/15	REVISED	F.Díaz	20/04/2010						
C	NC: 12/386	J.A.García	24/09/12									
B	Second Issue	J.A.García	01/09/10									
A	First Issue	J.A.García	20/04/10									



REMOTE CONSOLE 3P



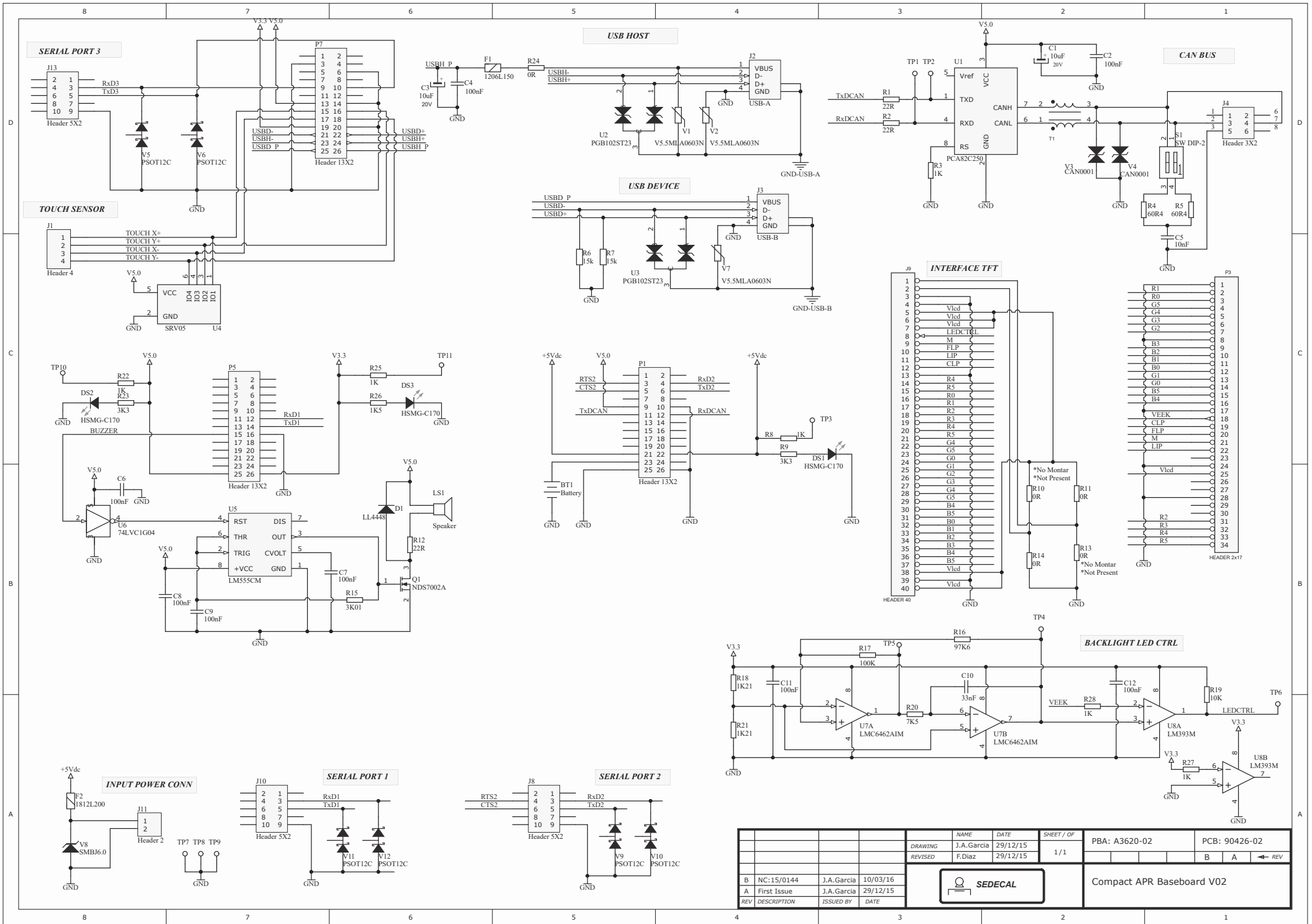
SERIAL COMMS

PCB: 90249-03

REV	DESCRIPTION	ISSUED BY	DATE	DRAWING	NAME	DATE	ISSUED / OF	A3634-01				
E	NC: 18/0108	J.Mingo	04/09/18		J.A.García	20/04/2010	3 / 3	E	D	C	B	A
D	NC: 14/0440	R. Hermosilla	01/12/15		F.Díaz	20/04/2010						
C	NC: 12/386	J.A.García	24/09/12									
B	Second Issue	J.A.García	01/09/10									
A	First Issue	J.A.García	20/04/10									



REMOTE CONSOLE 3P



DRAWING		NAME	DATE	SHEET / OF	PBA: A3620-02	PCB: 90426-02
REVISED		J.A.Garcia	29/12/15	1 / 1	B	A
REV		F.Diaz	29/12/15			← REV
B	NC:15/0144	J.A.Garcia	10/03/16			
A	First Issue	J.A.Garcia	29/12/15			
				Compact APR Baseboard V02		