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INTRODUCTION

X-RAY GENERATOR TO COUPLE VIDEO CHAIN WITH BRILLIANCY INTENSIFIER PROPERLY DEVELOPPED FOR X-RAY SYSTEM ORIENTATION IN LITHOTRIPSY.

X-RAY EQUIPMENTS CAN BE DANGEROUS FOR PATIENT AND OPERATOR HEALTH IN THE ABSENCE OF RIGOROUS PROTECTION'S MEASURES.

Although this equipment is planned and assembled following safety regulations, X-ray sources ever can be dangerous for the operator and the patient. X-ray excessive exposure cause damages for one's health.
All people using these devices must protect them with appropriate X-ray shielding.
Consequently must be taken all necessary cautions in order to void the use of this equipment to not authorized or not qualified people as to represent a danger for himself and for other peoples.
Authorized and qualified people to use this equipment, before to perform any action, must be informed of protection's measures as in compliance with X-ray protection rules of International Commission and nationals rules on the matter.
Electromagnetic interference in conformity to 89-336 rule "don't use in presence of mobile phones or other equipments that can cause electromagnetic interferences", such to endanger the equipment's functioning.

Properly use of this equipment require previous and accurate operator's consultation of this user's manual.

CLASSIFICATION

GENERATOR CLASSIFICATION

- 93/42 EEC, Class II b, Annex IX, rule 10
- Class I Equipment (IEC 60601-1)
- Applied rule Type B (IEC 60601-1)
- Protection Degree IP X0
- Use Requirements “Equipment planned for continuous working with discontinuous charge”
- Safety Degree “Equipment not suitable for use in presence of antiseptic mixture with air, oxygen or with nitrous oxide”

GENERAL DESCRIPTION

X-RAY GENERATOR MAIN FEATURES

- Frequency 40 kHz.
- X-Ray dose checking during X-ray emission.
- A web interface with res 800x600 simplifies user's work.
- User friendly system configuration.
- Continuous Fluoroscopy, pulsed Fluoroscopy and Snap-Shot modes.
- Integrated self-diagnosis with automatical alert messages.
- Image intensifier parameter and digital camera control.
- Tube's thermal units checking.
- Exposure data self-calibration system.

ENVIRONMENTAL SPECIFICATIONS

IN USE

- Ambient temperature range: 10 – 40 C°.
- Relative humidity: 20 – 80%, not condensing
- Positioning from sea to 2440 meter above sea level (from 700 to 1100 hPa).

TRANSPORT AND STORAGE

- Ambient temperature range: -25 – 70 C°.
- Relative humidity: 5 – 95%, not condensing.
- Atmospheric pressure range: 500 – 1060 hPa (375 – 795 mm Hg).

The information container herein is presented only as a guide for the use condition in respect of operator and x-ray generator safety.
X-ray generator must be used only in respect of safety notice in this section and possible additional manufacturer's information and/or safety relevant authorities.

X-RAY GENERATOR ACCESSORIES
(Not supplied by P.S.M.)

- Video system with Image intensifier and camera with digital memory Flxis 9" & 12".

- R605 Automatic collimator with CAN interface.

X-RAY GENERATOR PARAMETERS 15kW

Max power supplied:	15 kW	
Max Voltage at the Tube:	120 kV	
KV range:	from 40 kV to 120 kV	KV accuracy ±(5% + 1) kV
Fluoroscopy mA range:	from 0.2 to 5.0 mA Low / from 0.4 to 10.0 mA High	
Pulsed mA value:	10-15-30-60-120 mA.	mA accuracy ±(10% + 1) mA

Factor charge in order to produce minimum current - time:	4.8 kW	40 kV, 120mA, 20ms
Max X-ray tube power and max X-ray tube voltage at this current-time:	14.4 kW	120 kV, 120 mA
Combination of X-ray tube voltage and X-ray tube current at max power supply:	14.4 kW	120 kV, 120 mA
Max continuous supply at 100 kV, in continuous:	370 w	100kV, 3.7mA

OPERATING MODE 15 kW

Continuous fluoroscopy

- automatic or manual kV selection;
- automatic calculation of associated mA value in function of the set curve
- possibility of mA doubling in high dose;
- possibility of mA halving in low dose.

Pulse fluoroscopy

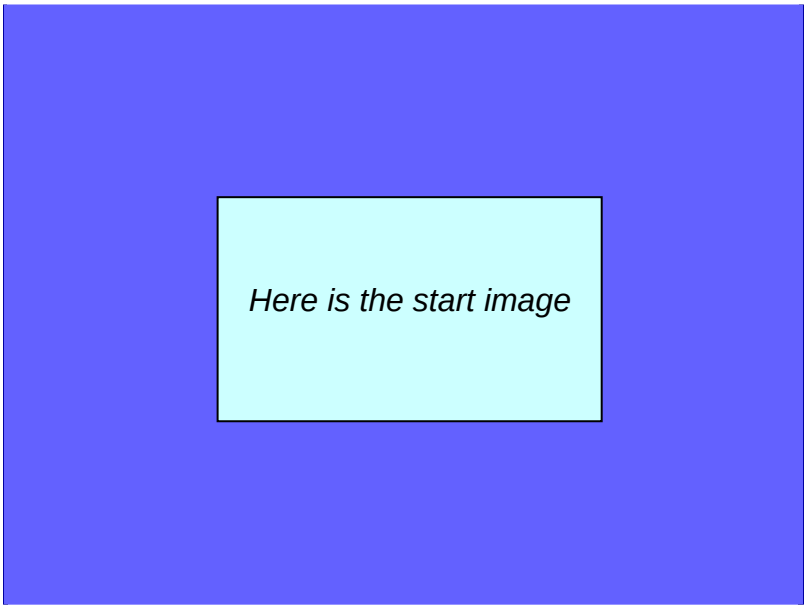
- automatic or manual kV selection;
- mA value 10/15/30/60 for small focus and 30/60/120 for large focus;
- possibility of selection among 6, 9 or 12 fps frame rate;
- exposure time checked by digital memory.

Snap shot

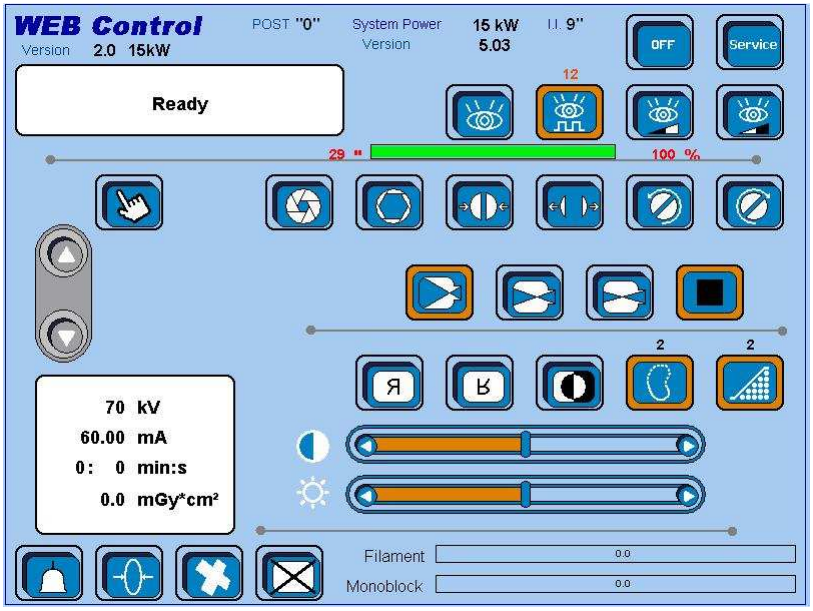
- automatic or manual kV selection;
- mA value 60 for small focus and 120 for large focus;
- Burst time 180 ms;
- 5 pulses;
- X-Ray time per pulse of 20 ms;
- exposure time checked by digital memory.

WORK PAGE

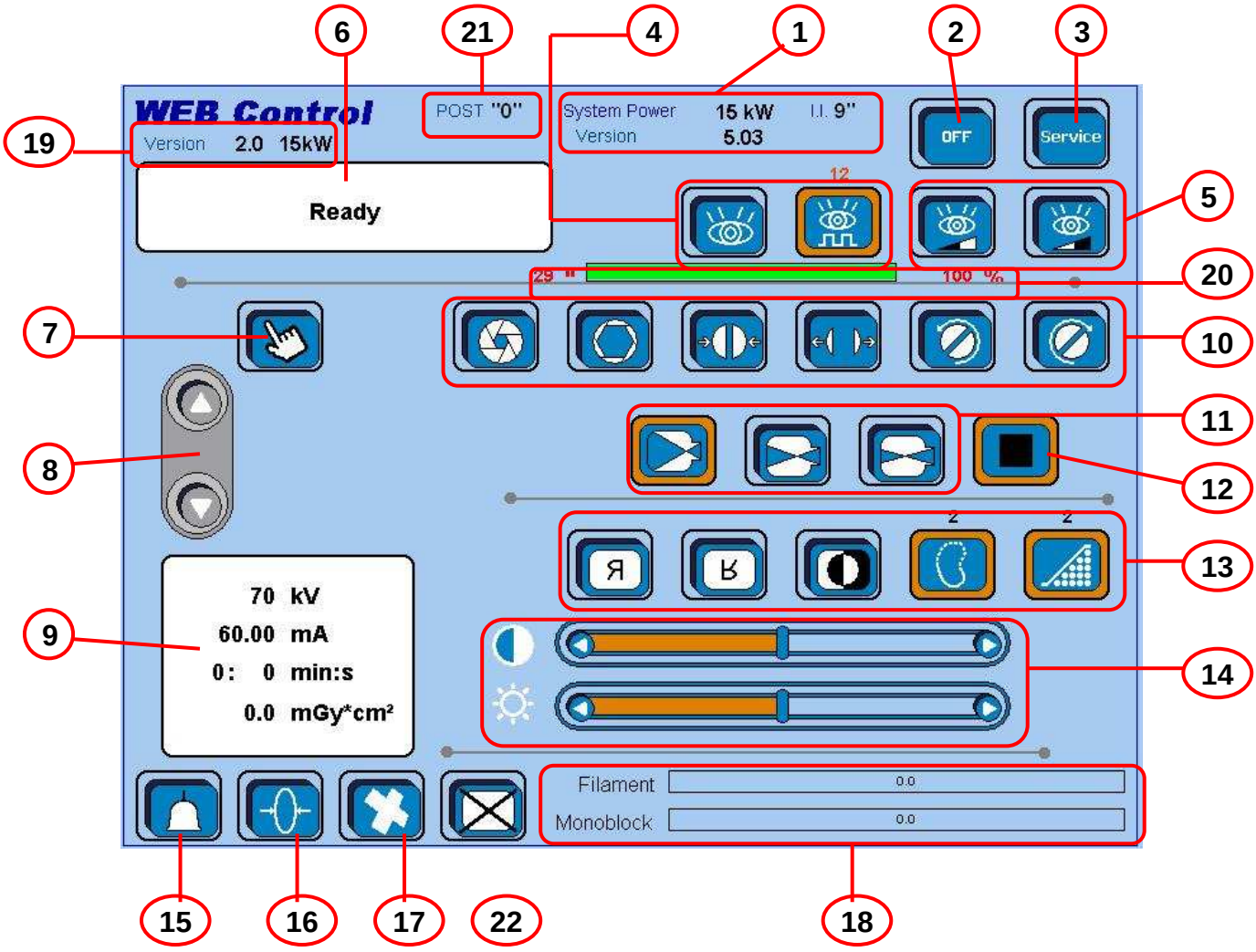
Click on the image area to switch on the unit and access the Work page.



The Work page appears.



WORK PAGE FEATURES



1 Indication of power, software version and I.I. model.
2 Power OFF button.
3 Access to Service page button.
4 Fluoro/Rad selection switches.
5 Low/High dose selection switches.
6 Status message area.
7 Auto/Manual mode selection switch.
8 kV selection buttons.
9 RX data display.
10 Collimator control buttons.
11 I.I. zoom selection switches.
12 Small/Large focus selection switch.
13 FLXIS functions buttons.
14 Image contrast and brightness change buttons.
15 Alarm time reset button.
16 RX time and dose reset button.
17 Message reset button.
18 Filament and monoblock heat units gauge bars.
19 Web pages version.
20 Anode heat units.
21 I.I. Check
22 Clear screen

Web pages version

At the top left of the screen you can read the web pages version; this is different from the software version.

Anode heat units

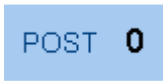
This gauge bar and the percentage number on the right show how many anode heat units are still available for X-raying. On the left you can read how many seconds are still usable for X-raying.

While X-raying, you will see these values decrease.

When you reach the ‘0%’ value it means that the anode is overheated and you won’t be able to shoot anymore in pulse mode, while you still can go with the continuous mode.

In order to be able to use the pulse mode again, you must wait till the 15% of the anode heat units are restored.

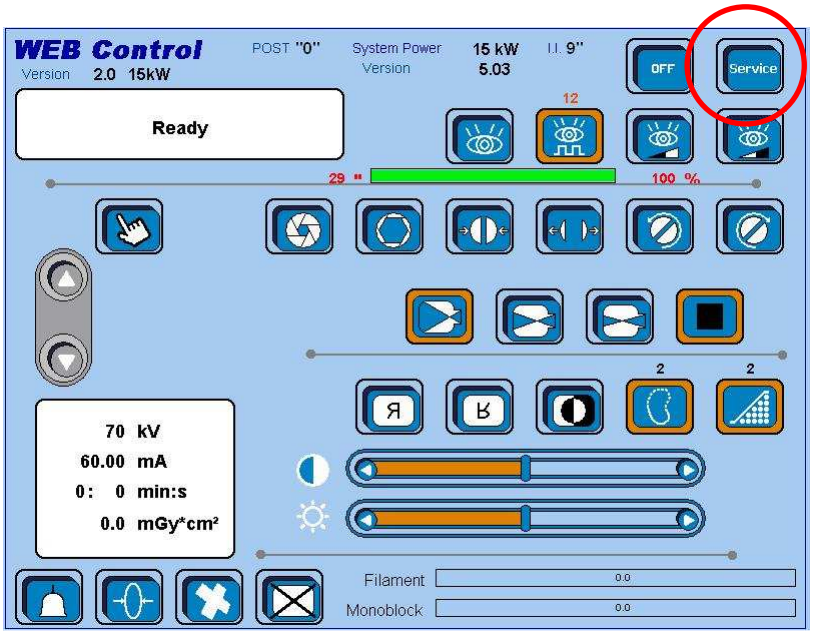
I.I. Check



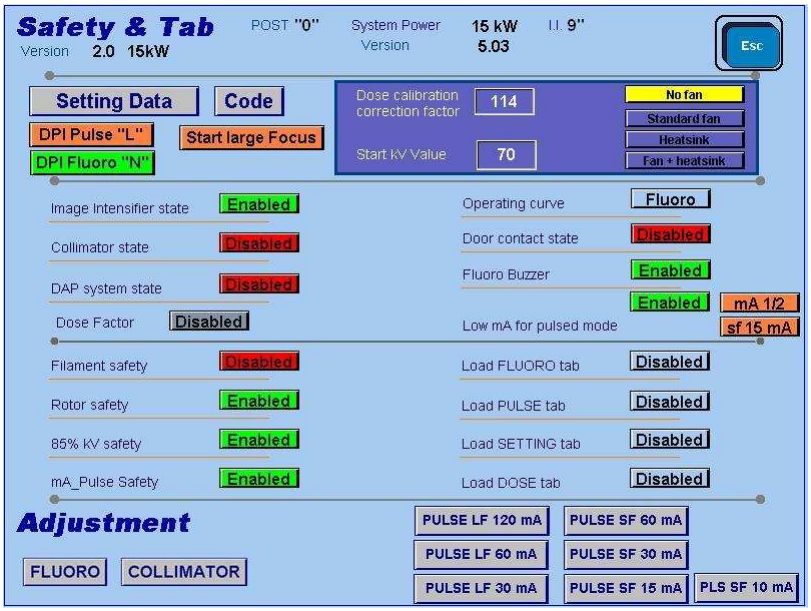
At the top of the screen you can see the word <POST> followed by a number. If you read ‘0’ then the I.I. communication is OK; if you read any other number, then please refer to the FLXIS documentation.

SERVICE PAGE

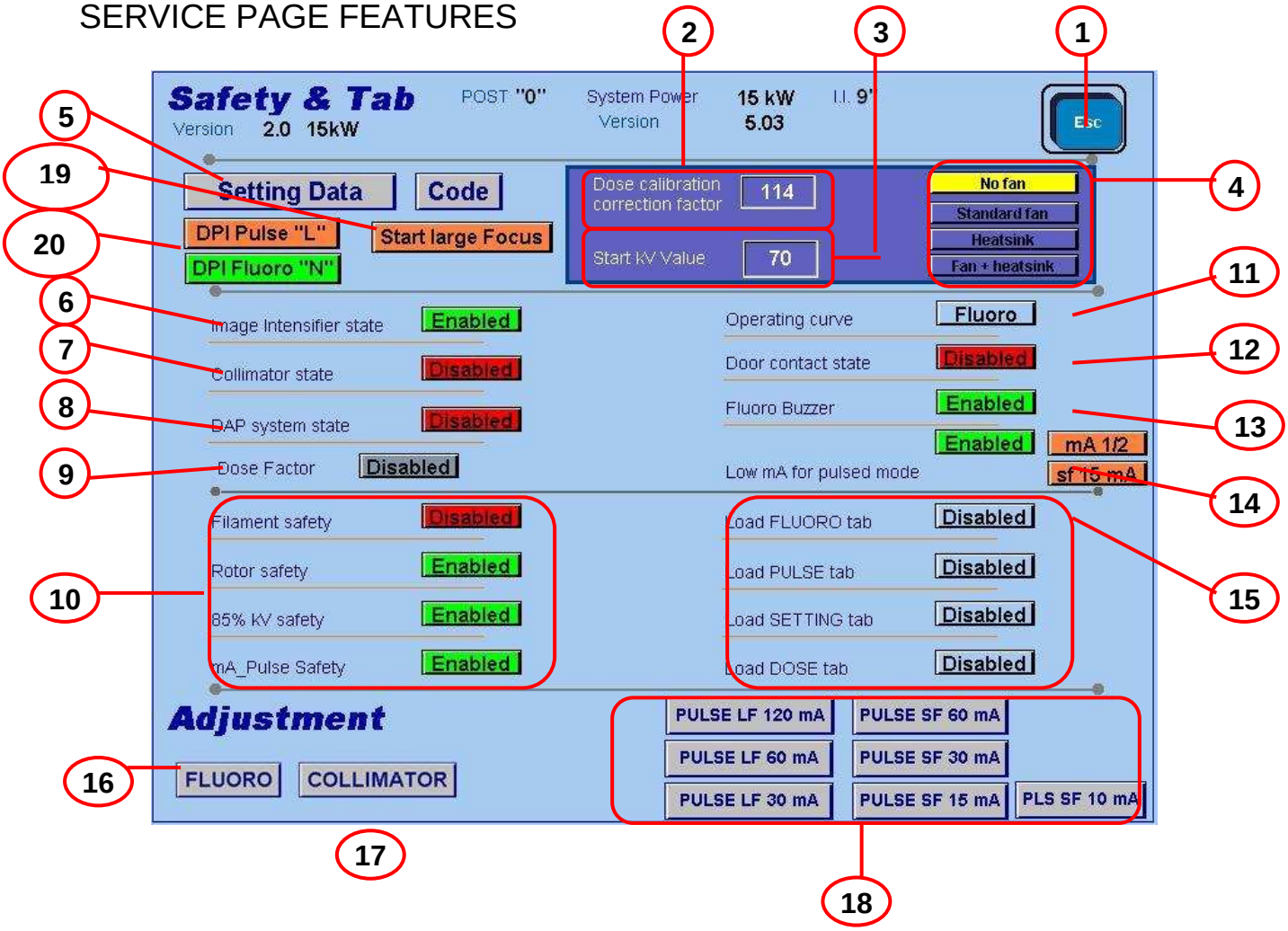
Press the <SERVICE> button to access the Service page.



The Service page appears.



SERVICE PAGE FEATURES



1 Return to Work page button.
2 Dose calibration correction factor.
3 Start kV value.
4 Dissipation system selection switches.
5 Access to Setting Data page button.
6 I.I. enable/disable switch.
7 Collimator enable/disable switch.
8 DAP system enable/disable switch.
9 Dose factor enable/disable switch.
10 Safeties enable/disable switches.
11 Fluoro/Isowatt curve selection switch.
12 Door contact state enable/disable switch.
13 Buzzer enable/disable switch.
14 Half / quarters or more mA for pulse enable/disable switch.
15 Default data loading switches.
16 Access to Fluoro calibration page.
17 Access to Collimator calibration page.
18 Access to Pulse calibration pages buttons.
19 Selection focus at switch on
20 Selection Low or High DosePerImage for Pulse and Fluoro

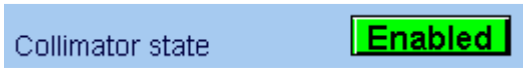
Dose calibration correction factor

You can change this correction factor, which alter the dose calculus

Code

This button allows to access a new page where you can set some system parameters. **This page is currently under construction.**

Collimator state



This switch allows you to activate/disactivate the use of collimator.

When the switch is set to <DISABLED>, the machine detects no collimator, regardless whether the collimator is actually installed or not.
When the switch is set to <ENABLED>, at the start-up the system performs a test in order to check the serial communication with the collimator. If the test is passed, the collimator will work correctly. Instead, if the collimator is absent or broken, or if it is not connected correctly to the generator, then the communication will fail, and the following error message will appear on the work page.

DAP system

This switch allows you to activate/disactivate the DAP system.

You can install on the machine one of the following types of DAP:

- VacuDAP-C
- VacuDAP-C duo

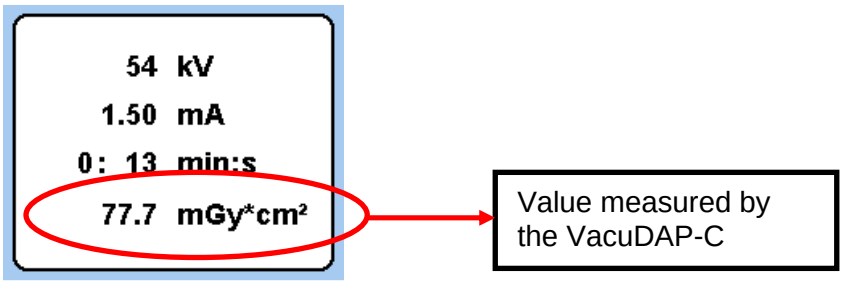
When you set the switch to ENABLED, the generator automatically recognizes which type of DAP system is installed. Four different situations can verify.

VacuDAP-C is installed and the DAP state is ENABLED

Next to the button you can read the following code:**7_1.46**

- 7 is the number which identifies the first type of DAP (VacuDAP-C);
- 1.46 is the firmware version.

If you look at the display in the WORK page, you will see the following dose data among the X-ray values:



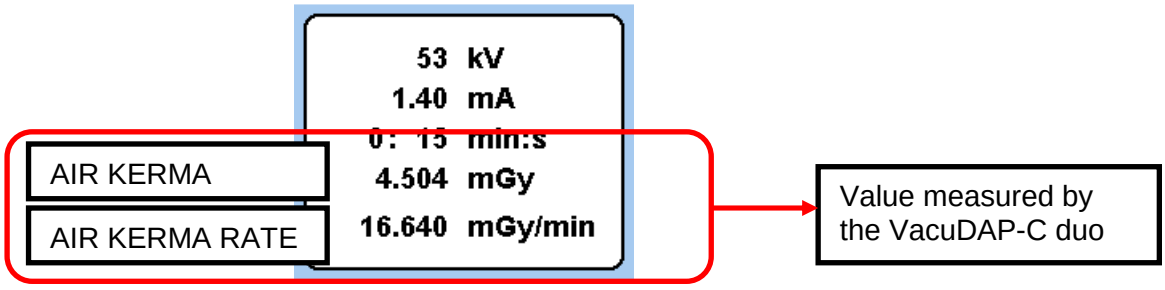
In the SETTING DATA page you can read the following cumulation dose data.

VacuDAP-C duo is installed and the DAP state is ENABLED

Next to the button you can read the following code:**8_1.46**

- 8 is the number which identifies the second type of DAP (VacuDAP-C duo);
- 1.46 is the firmware version.

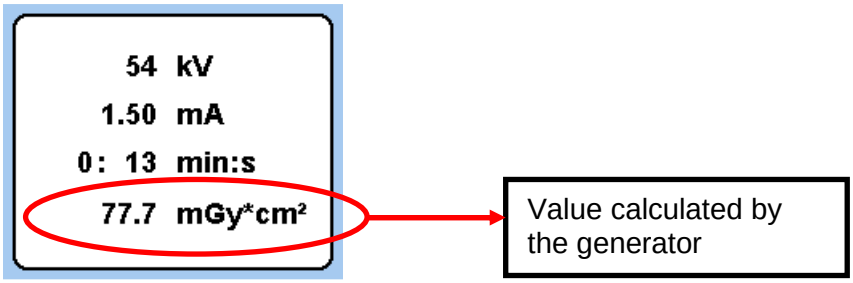
If you look at the display in the WORK page, you will see the following dose data among the X-ray values:



In the SETTING DATA page you can read the following cumulation dose data.

No DAP system is installed and the DAP state is ENABLED

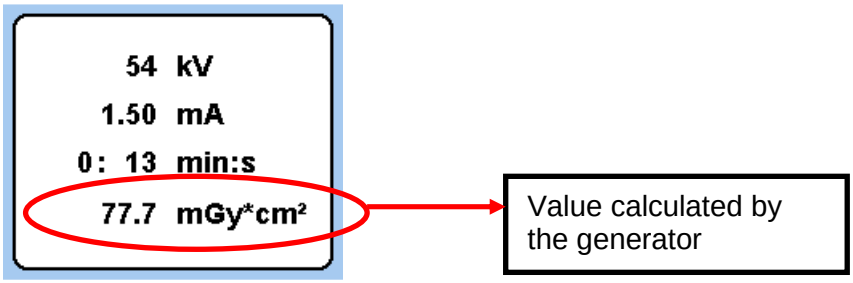
Next to the button you will read no code. This happens if the DAP is not installed correctly, or it is out of order. So no communication between the DAP and the generator can start.
The dose value that appears on the display in the WORK page is the value calculated by the generator.

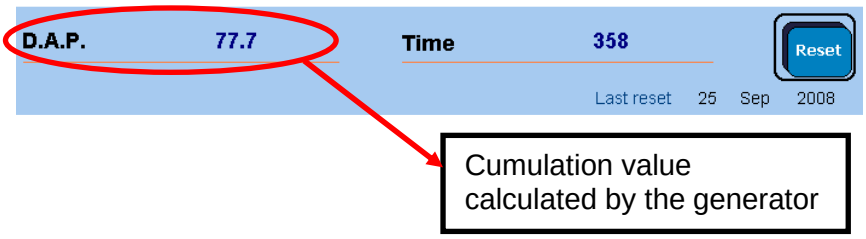


Also, in the SETTING DATA page you can read the calculated cumulation dose data.

DAP state is DISABLED

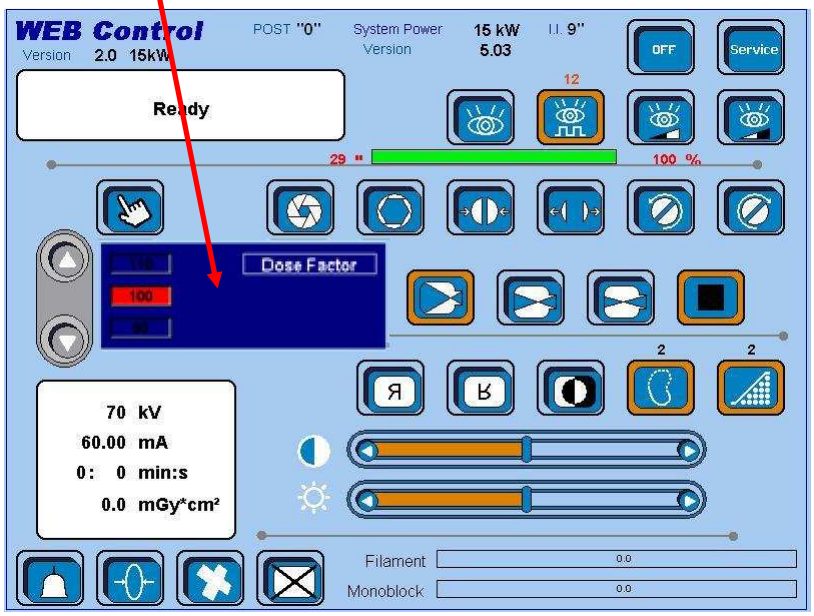
I doesn't make difference whether the DAP system is installed or not. No code appears, and the only dose values available are the ones calculated by the generator.





Dose factor

When this switch is set to <Enabled>, a new area appears when you go back to the Work page.



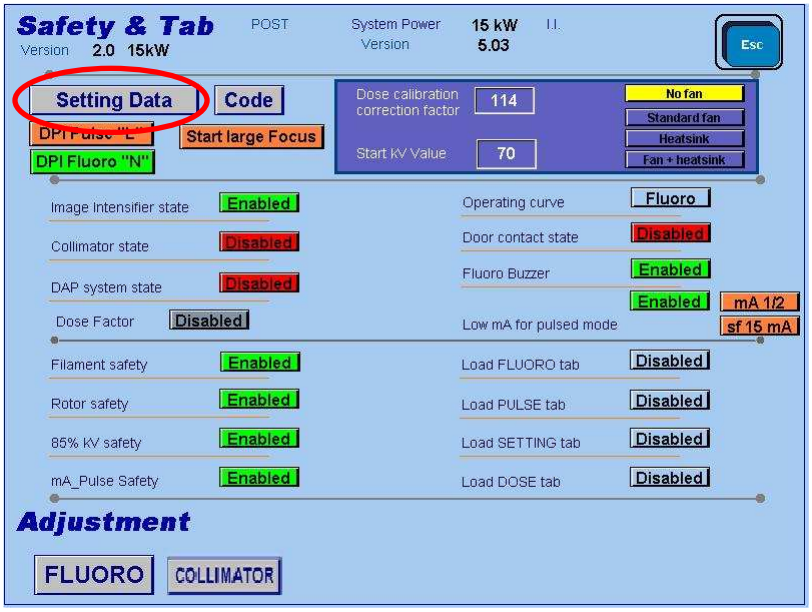
Here you can change three factors which affect the dose calculus, each related to a fixed range of collimator opening areas.

Reduction mA for pulse mode

			mA Large focus	mA small focus
Low mA for pulsed mode	Disabled	mA 1/2 sf 15 mA	120	60
Low mA for pulsed mode	Enabled	mA 1/2 sf 15 mA	60	30
Low mA for pulsed mode	Enabled	mA 1/4 sf 15 mA	30	15
Low mA for pulsed mode	Enabled	mA 1/4 sf 10 mA	30	10

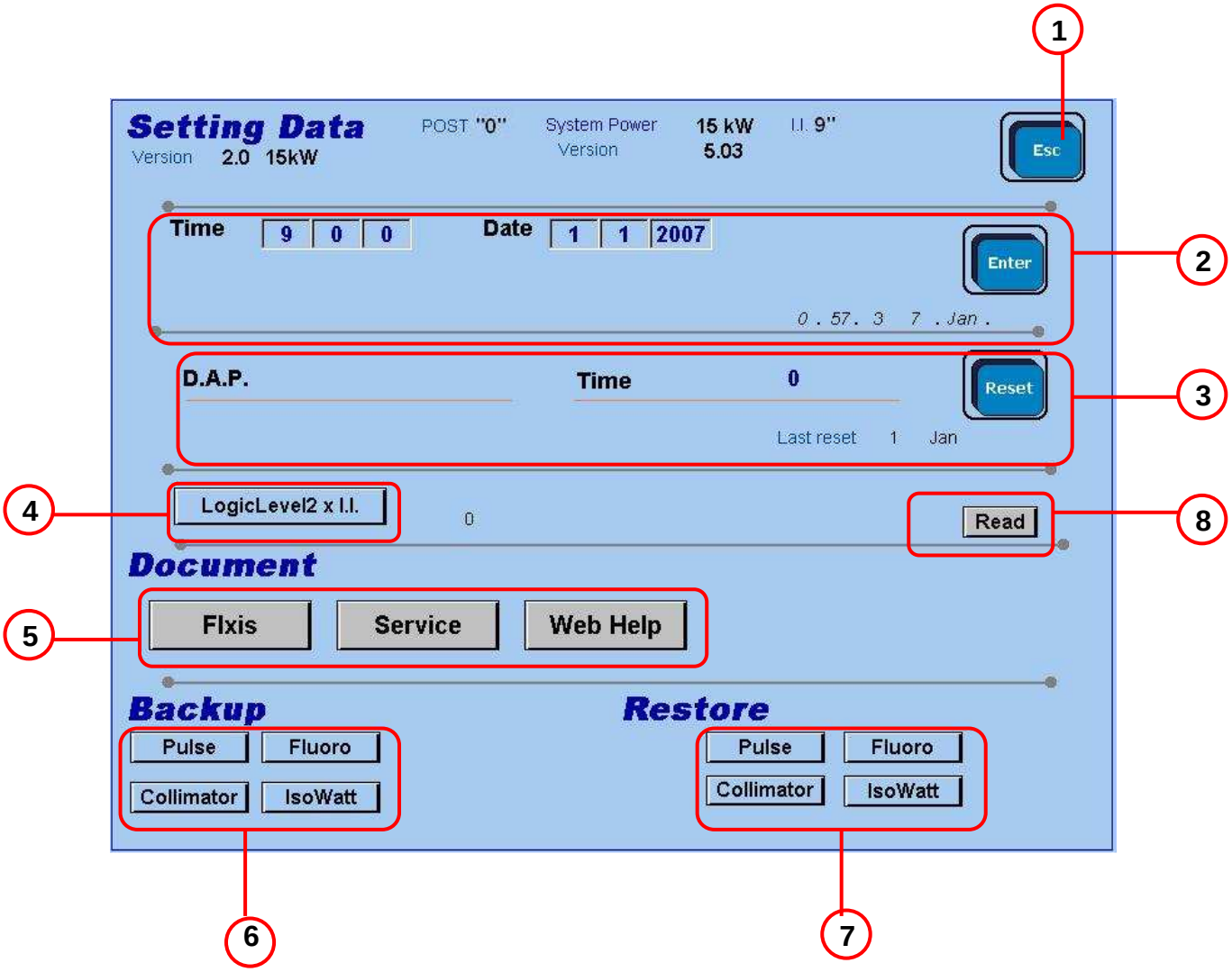
SETTING DATA PAGE

Press the <SETTING DATA> button to access the Setting Data page.



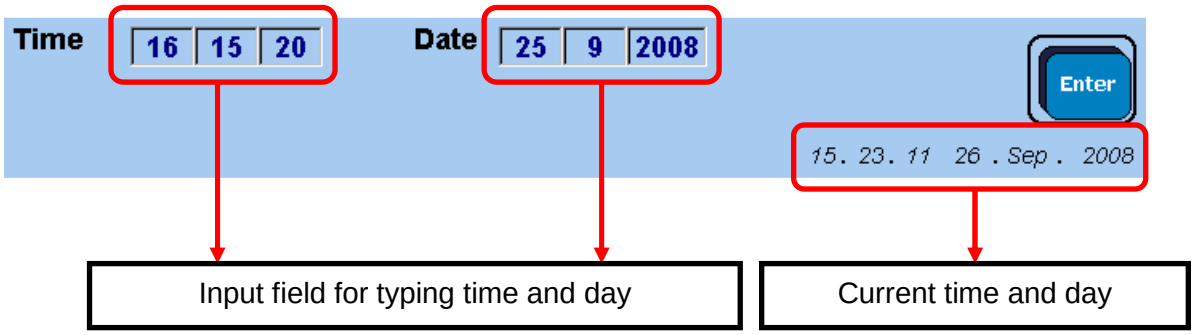
The Service page appears.

SETTING DATA FEATURES



1 Return to Service page button.
2 Time and data setting area.
3 RX dose and time resetting area.
4 I.I. Logic Level selection switch.
5 Links to documentation.
6 Data backup buttons.
7 Data restore buttons.
8 Indication of anode overheatings.

Time and data setting area



Links to documentation

This buttons open three different .pdf files including documentation for Flxis, Service and Web Help. The last button actually links to this document.

Indication of anode overheatings

If you press the ‘Read’ button, a number appears on the left of the button, showing how many times you had the anode overheating before.

SELECTION AT THE START OF THE FOCUS

when start the generator the large focus is selected

when start the generator the small focus is selected

SELECTION D.P.I.

DosePerImage in Pulse is 5,0 nGy/image

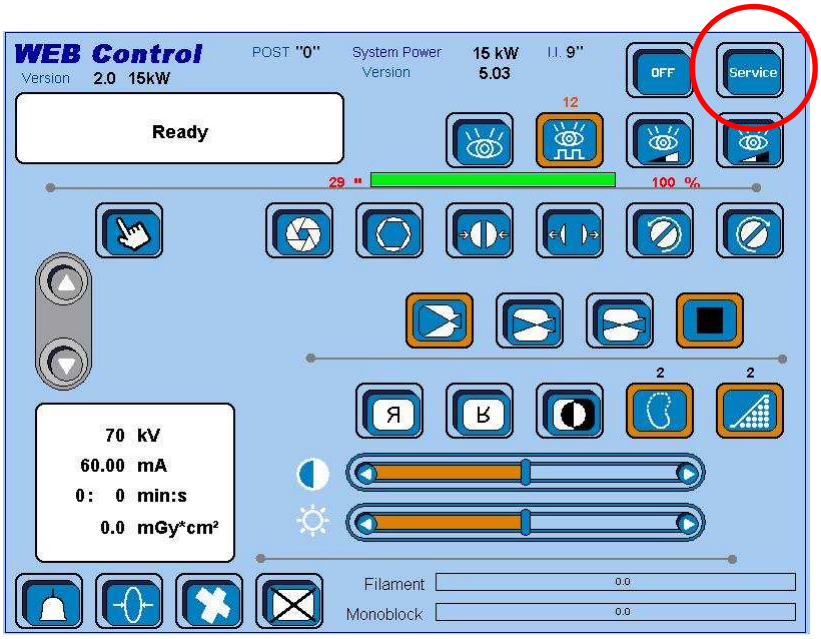
DosePerImage in Pulse is 6,4 nGy/image

DosePerImage in Fluoro is 6,4 nGy/image

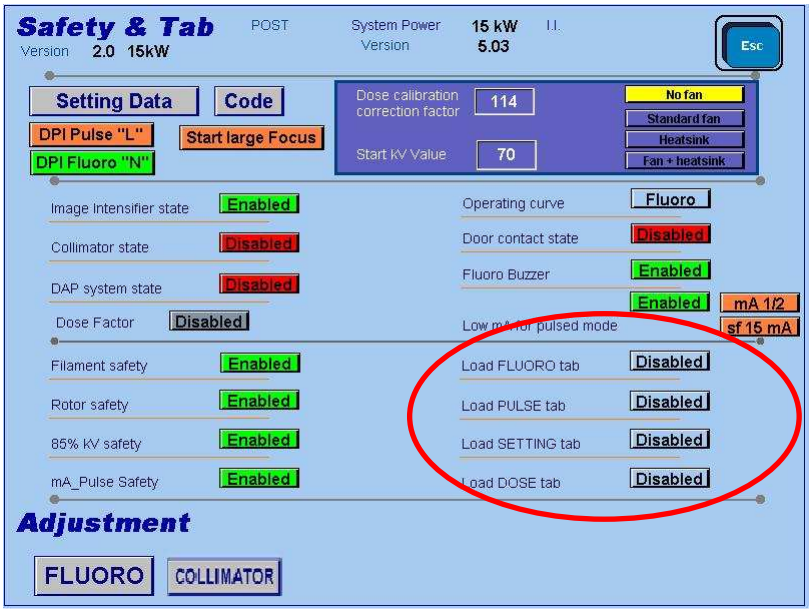
DosePerImage in Fluoro is 10,2 nGy/image

LOADING THE DEFAULT DATA

Step 1 - Press the <Service> switch.

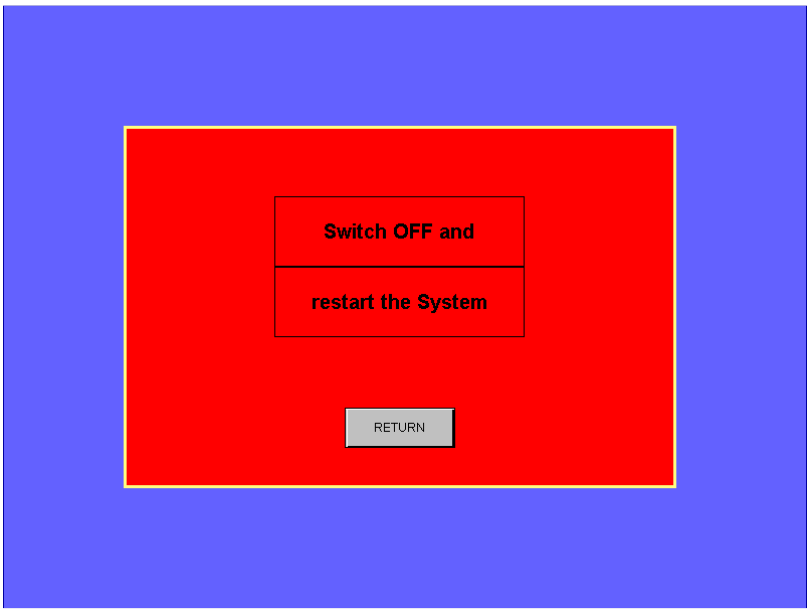


Step 2 - In the Service page you can see four switches on the right; they are set on <DISABLED>.



Step 3 - Press all of them to turn them to <ENABLED>.

Step 4 - After this, restart the system.
NB: each time you switch to <ENABLED>, the system asks to be restarted; you can skip this, set all the four switches to <ENABLED>, then restart the system just once.



Now the default data are loaded on the system, which means you have to do a full calibration and configure all the system settings again.

RX TUBE ADJUSTMENT

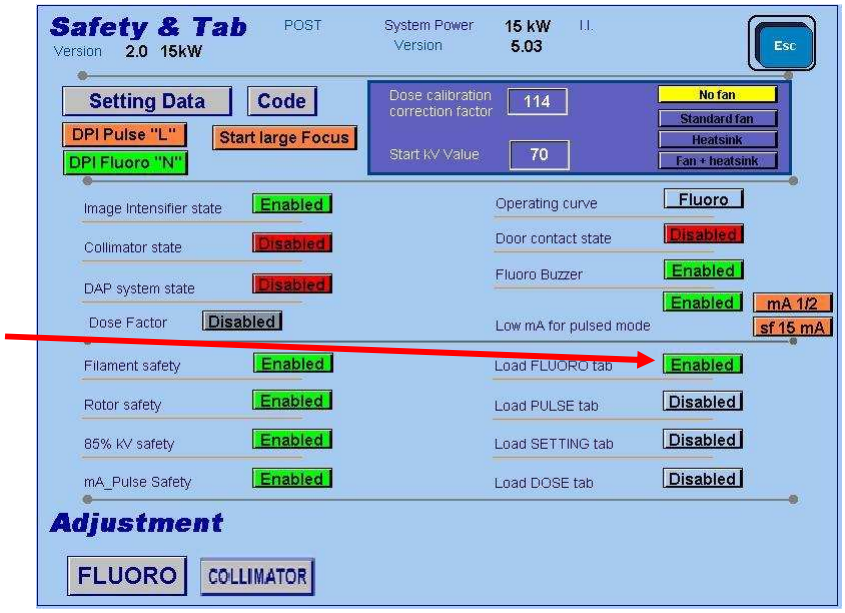
The RX tube adjustment involves a fluoro adjustment and a pulse adjustment.

IMPORTANT: after any calibration it is wise to save the data by using the BACKUP functions. Refer to the 'Backup' chapter of this manual.

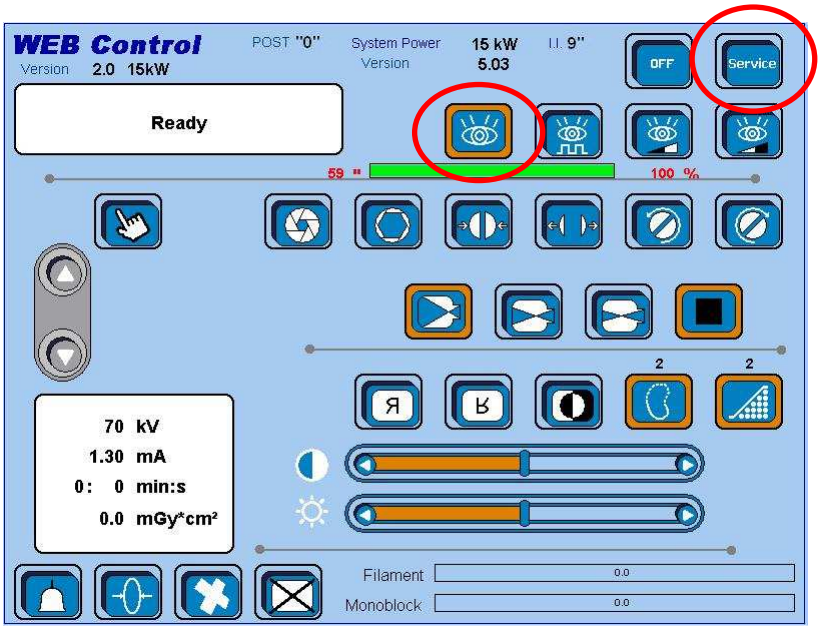
Fluoro adjustment

IMPORTANT: before doing any fluoro calibration you need to load the FLUORO default data. This is to be done either if you want to adjust both the curves or if you only need to adjust one of them. In this last case the curve that is not adjusted is set to default.

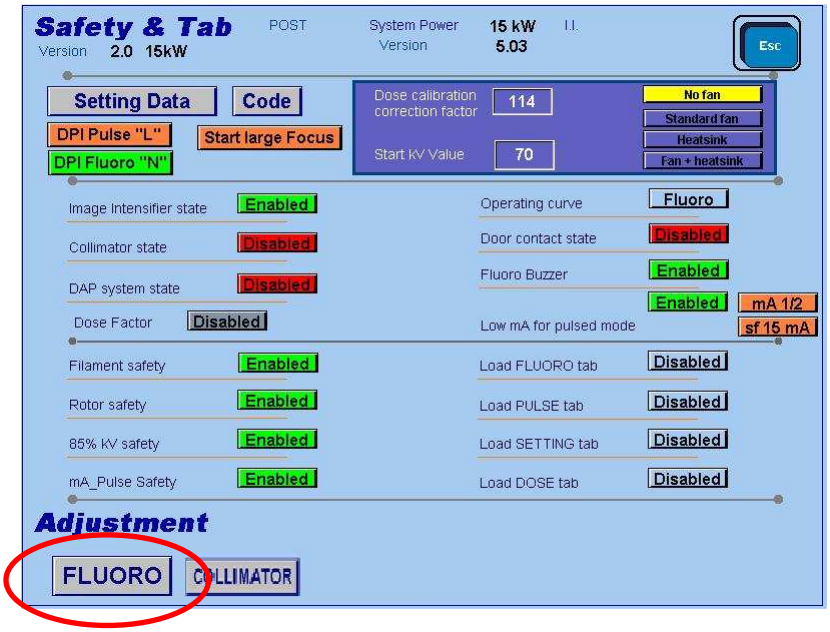
Step 1 - In the Service page set the <Load FLUORO tab> switch to ENABLED. Then restart the system.



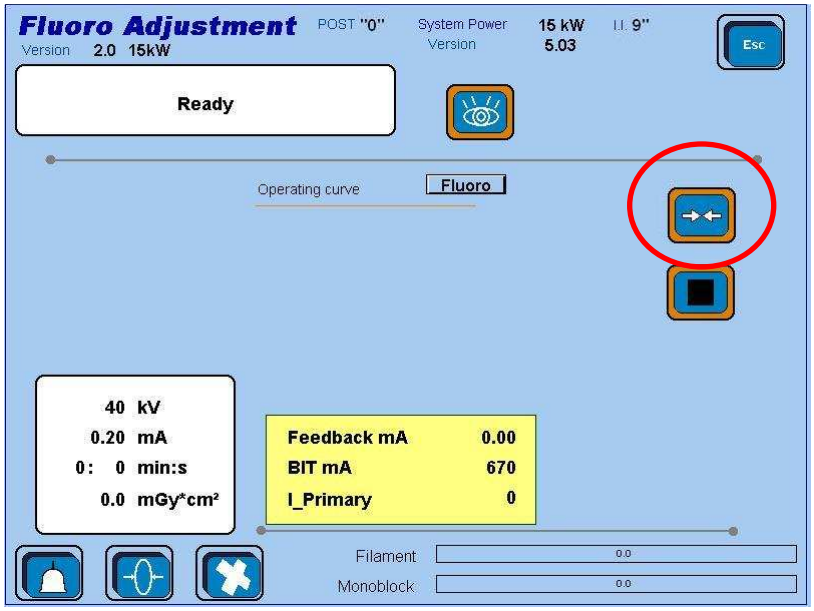
Step 2 - In the start page be sure that continuous RX mode is selected. Then press <Service>.



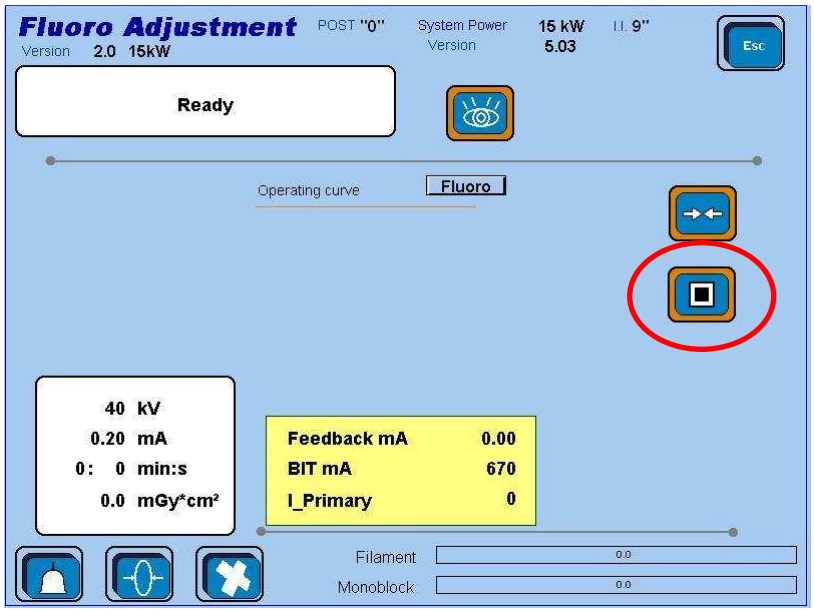
Step 3 - In the <Serivice> page press <Fluoro> to access the Fluoro calibration page.



Step 4 - This is the Fluoro calibration page.
You need to calibrate the Fluoro and Isowatt curves, and large and small focus for both the curves; so you have to do four calibrations.
In the figure you have Fluoro curve and small focus; to do calibration press the switch circled below, then press the RX button to X-ray, and keep it pressed until the calibration is over.

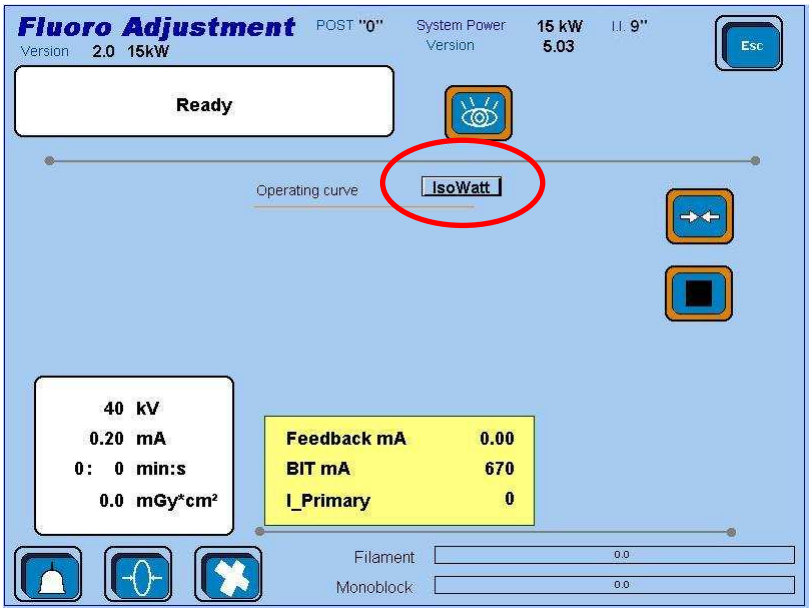


Step 5 - Now switch to large focus by pressing the proper button, press the button with the two matching arrows and do the second calibration.

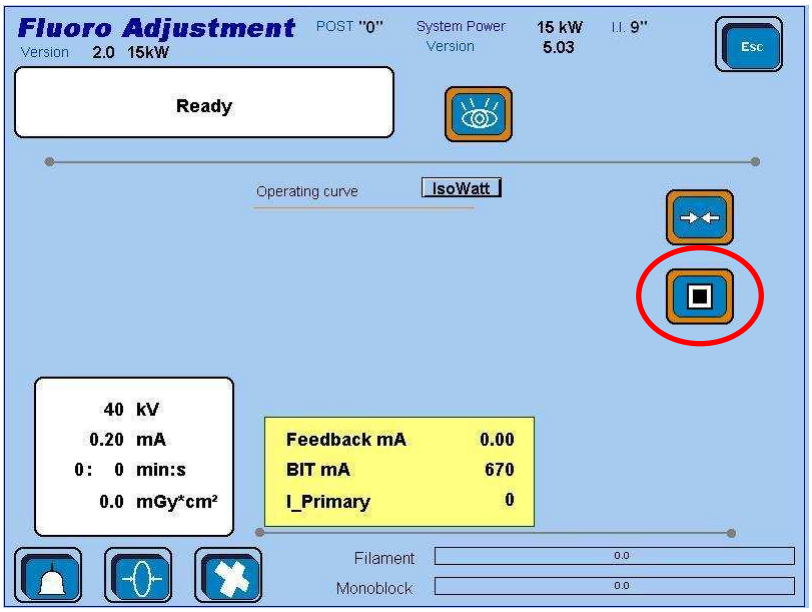


Step 6 - You still miss the two calibration for the Isowatt curve; so restart the system, press the button for the selection of the Isowatt curve in the Service page, then restart the system again.

Step 7 - Repeat Step 2 and Step 3 then press the two matching arrows button and do the third calibration.

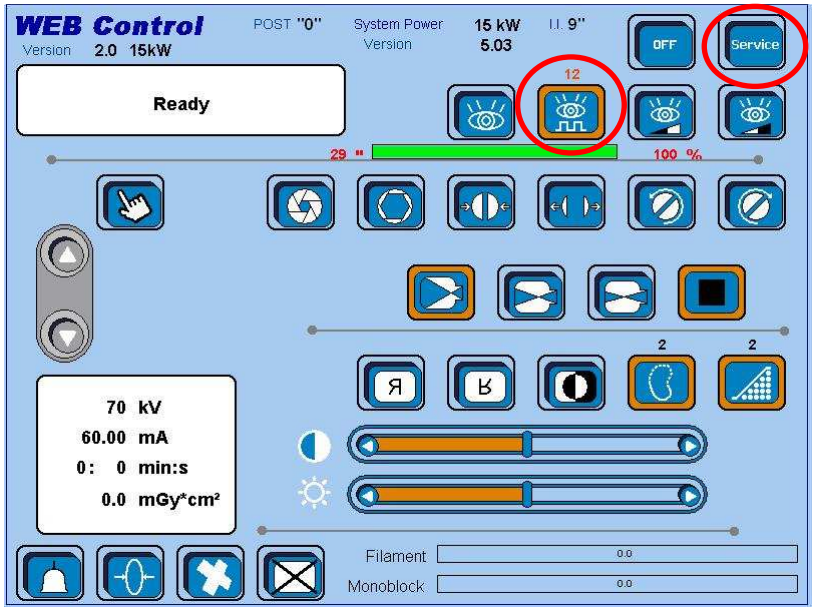


Step 8 - At last, select the small focus again, press the two matching arrows button and do the fourth calibration. Restart the system.



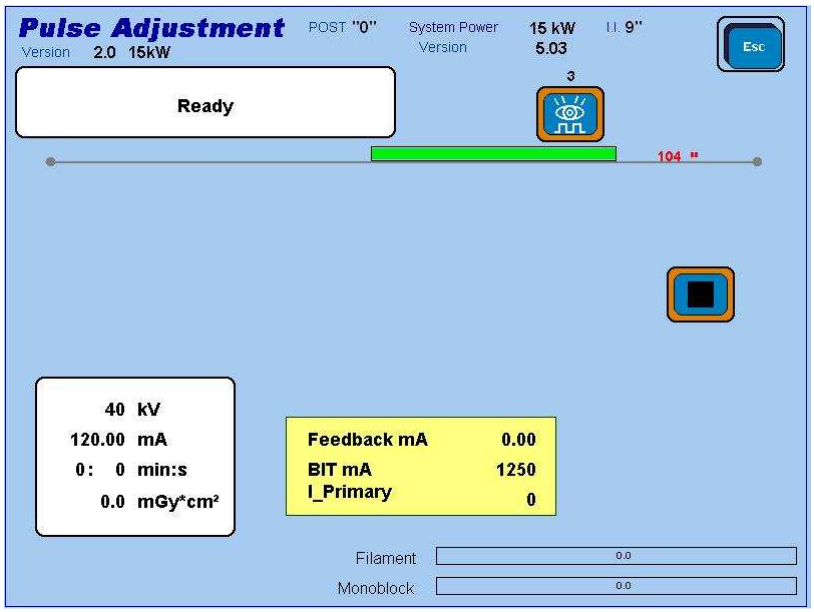
Pulse adjustment

Step 1 - In the start page, be sure that pulse mode is selected. Then press <Service>.

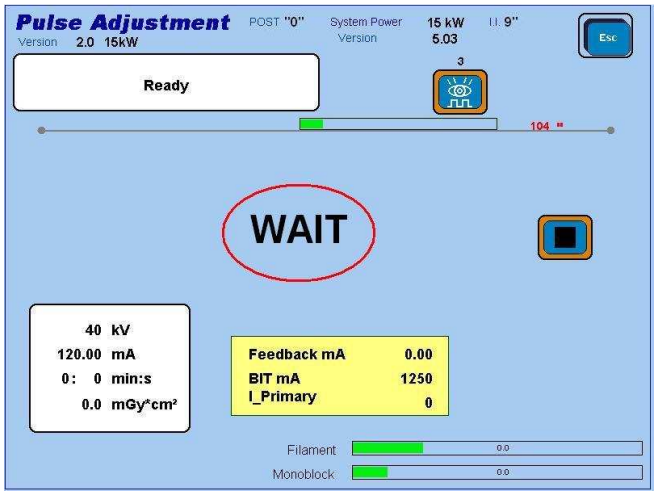


Step 2 - You have to do seven calibrations for the pulse mode: three for the large focus and tour for the small focus. Select one of the four buttons at the bottom of the screen; here we choose the large focus at 120 mA, but only as an example.

Step 3 - Now you are in the Large Focus – 120 mA Pulse calibration page. Just press the RX button and keep it pressed to do the calibration.

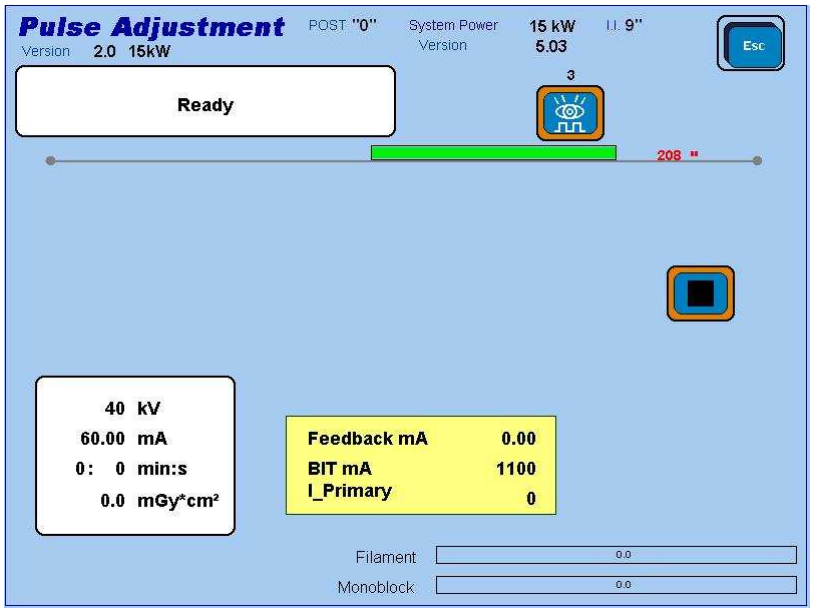


NOTE
As the calibration ends, a <WAIT> message appears in the middle of the screen. You must wait for 90 seconds before performing the other adjustments. This wait time is meant to prevent you from doing a full cycle of calibrations and thus overstressing the tube. It appears after each pulse calibration.



Step 4 - To perform the other calibrations you need to return to the <Service> page and select them from there (you can do this even before the wait time ends, but you still cannot x-ray).

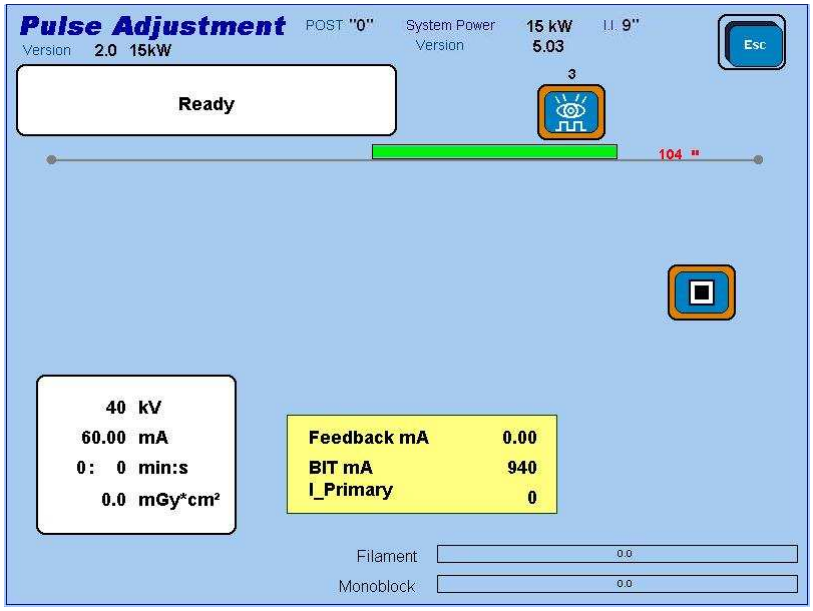
Step 5 - Now you are in the Large Focus – 60 mA Pulse calibration page. If the wait time has ended, press the RX button and keep it pressed to do the calibration.



As the calibration ends, wait for 90 seconds before performing the other adjustments (see NOTE in step 3).

Step 6 - To perform the other calibrations you need to return to the <Service> page and select them from there.

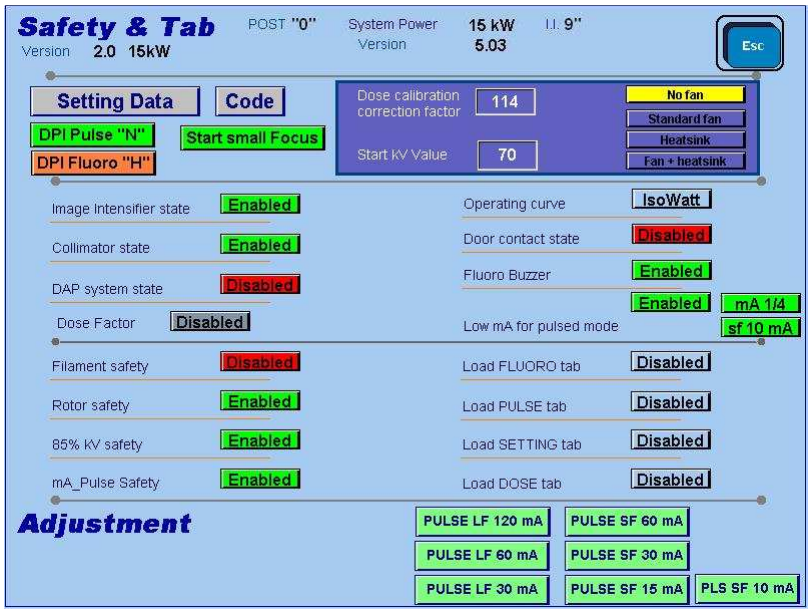
Step 7 - Now you are in the Small Focus – 60 mA Pulse calibration page. If the wait time has ended, press the RX button and keep it pressed to do the third calibration.



As the calibration ends, wait for 90 seconds before performing the other adjustments (see NOTE in step 3).

Step 8 - To perform the next calibration left click on the switch and access the proper page.

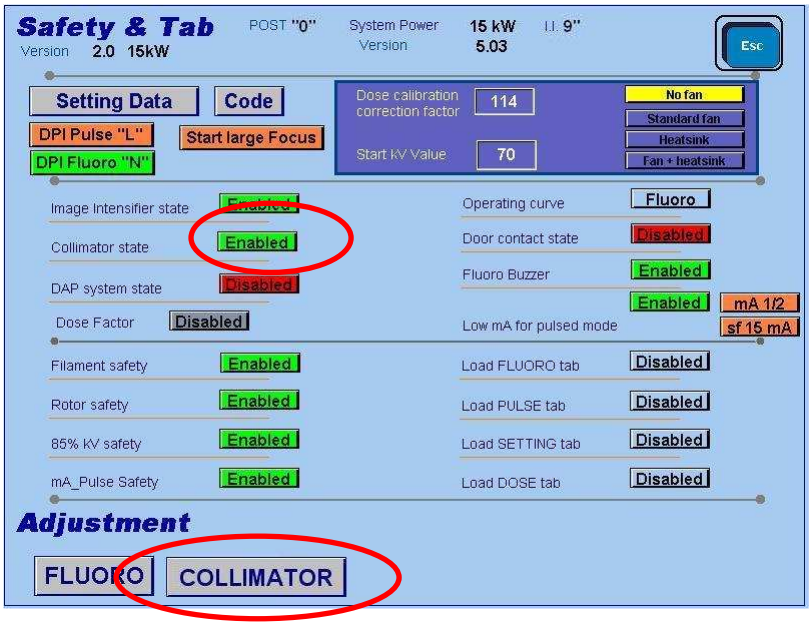
Step 9 - Proceed in this way with all the values to be calibrated.



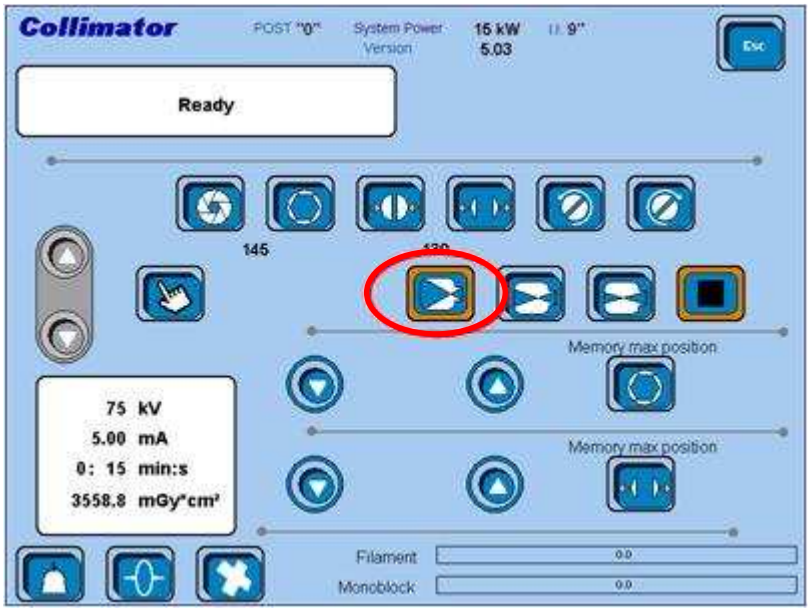
Pulsed mode calibration procedure is finished, turn off the generator.

COLLIMATOR ADJUSTMENT

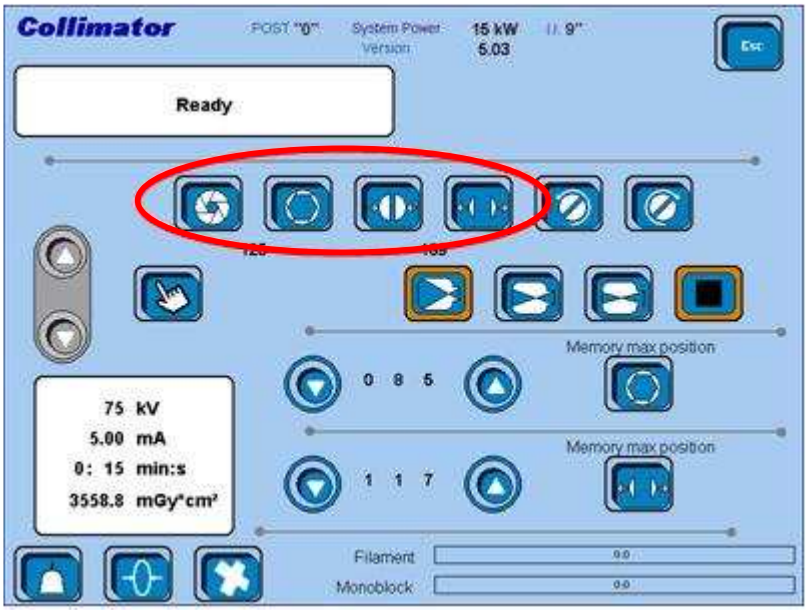
Step 1 - Access the <Service> page. Here be sure that the collimator is enabled; if so, you will see a big grey button named <Collimator> at the bottom of the page. Press it to access the collimator calibration page.



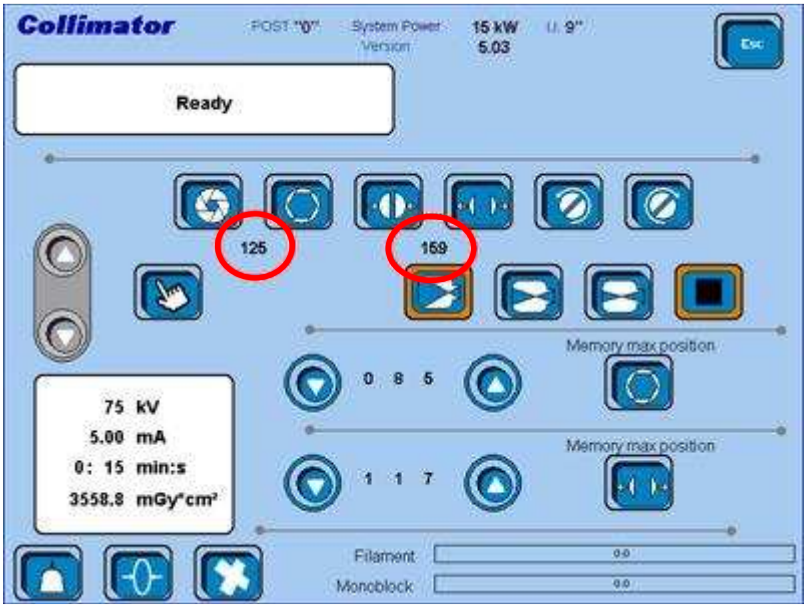
Step 2 - This is the collimator adjustment page.
First select the I.I. total field.



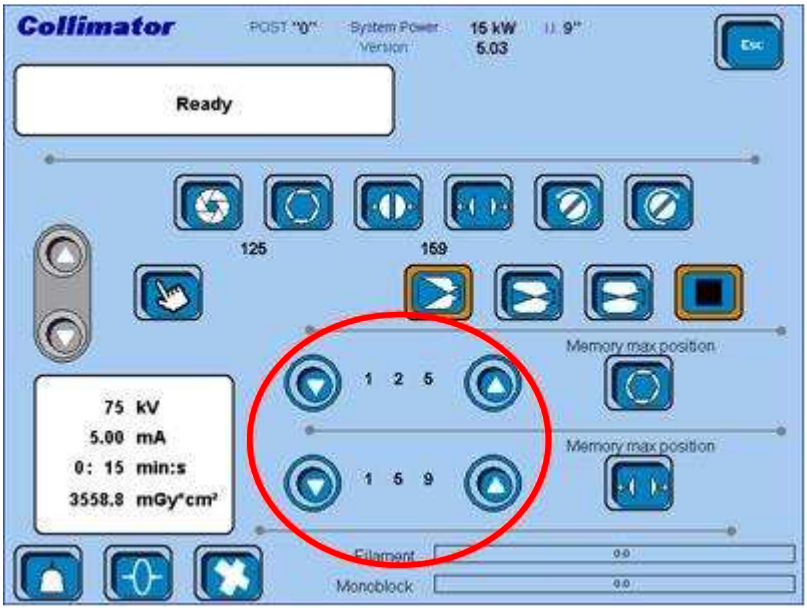
Step 3 - Then press the RX switch to make an RX exposition. While the RX button is pressed, use the switches circled in the figure below to set the diaphragms opening.



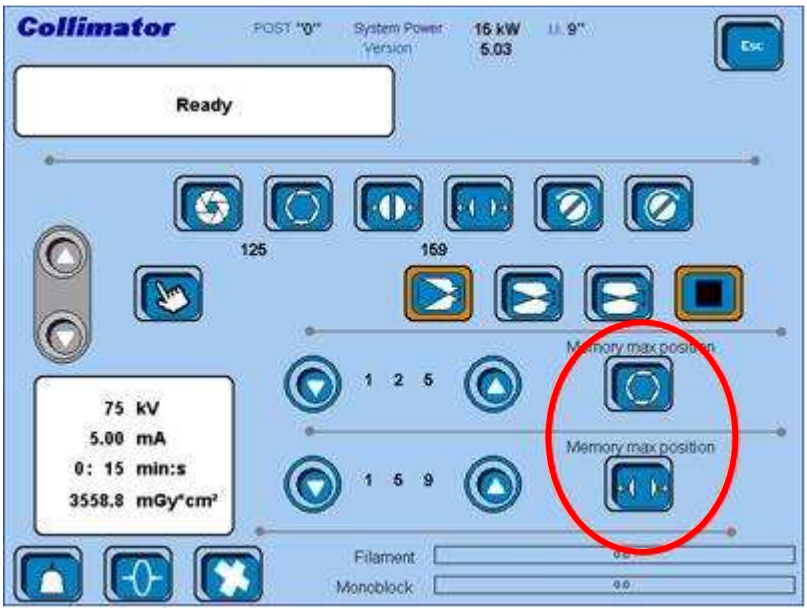
Step 4 - Now release the RX switch and read the two values circled below.



Step 5 - Adjust the values circled in the figure below by using the arrow keys.

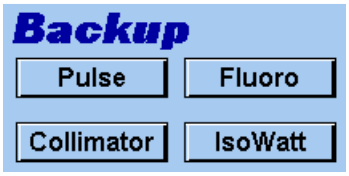


Step 6 - Now press the two buttons aside to save the set values.



Step 7 - To end the collimator calibration you need to repeat this whole procedure for the I.I. zoom 1 and zoom 2.

BACKUP



It is recommended to use the Backup function after any calibration. Pressing the buttons on the left allows to save, through four separate files, the data of Pulse, Fluoro curve, Isowatt curve, and Collimator adjustments.

IMPORTANT: you must use these four buttons one by one, turning off and restarting the system, and then performing the next adjustment, after each single press.

EXAMPLE
As an example, we suppose that you're doing a full calibration.
A correct sequence of actions is as follows.

Step 1 - Turn on the system, select the pulse mode in the Work page; then enter the Service page and perform the all pulse calibrations (both focuses). Enter the Setting Data page and press the <Pulse> button (BACKUP). Then turn off the system.

Step 2 - Turn on the system again, enter the Service page and press the <Load FLUORO tab> button. Turn off the system.

Step 3 - Turn on the system, select the fluoro mode from the Work page; then enter the Service page and perform the fluoro calibration (both focuses).
Now let's suppose that you've just adjusted the Fluoro curve. Enter the Setting Data page and press the <Fluoro> button (BACKUP). Then turn off the system.

Step 4 - You now need to choose the Isowatt curve: turn on the system again, enter the Service page and select the Isowatt curve from there. Turn off the system.

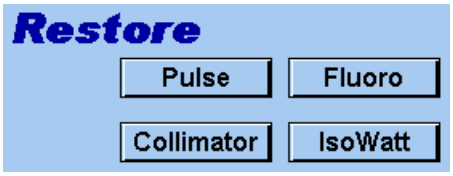
Step 5 - Turn on the system again, select the fluoro mode from the Work page; then enter the Service page and perform the fluoro calibration (both focuses). This time you have adjusted the Isowatt curve, so enter the Setting Data page and press the <Isowatt> button (BACKUP). Turn off the system.

Step 6 - Turn on the system again, be sure that the collimator is enabled (check it in the Service page), then perform the collimator adjustment. Enter the Setting Data page and press the last <Collimator> button (BACKUP). Turn off the system one last time.

Step 7 - Restart the system, which is now ready for use.

IMPORTANT: it does not matter the order you choose to use the four buttons. Just remember to restart the system anytime you press one of them. Pay attention when you change the fluoro curve (FLUORO/ISOWATT), because you need to restart the system once more to load the new curve (this is what happens in STEP 3 of the example above).

RESTORE



The Restore buttons allow to load the data that had been previously saved.
This is especially useful after updating the system software, since it prevents you from doing any calibration.

NOTE: unlike the BACKUP buttons, you can press all of them and then restart the system.

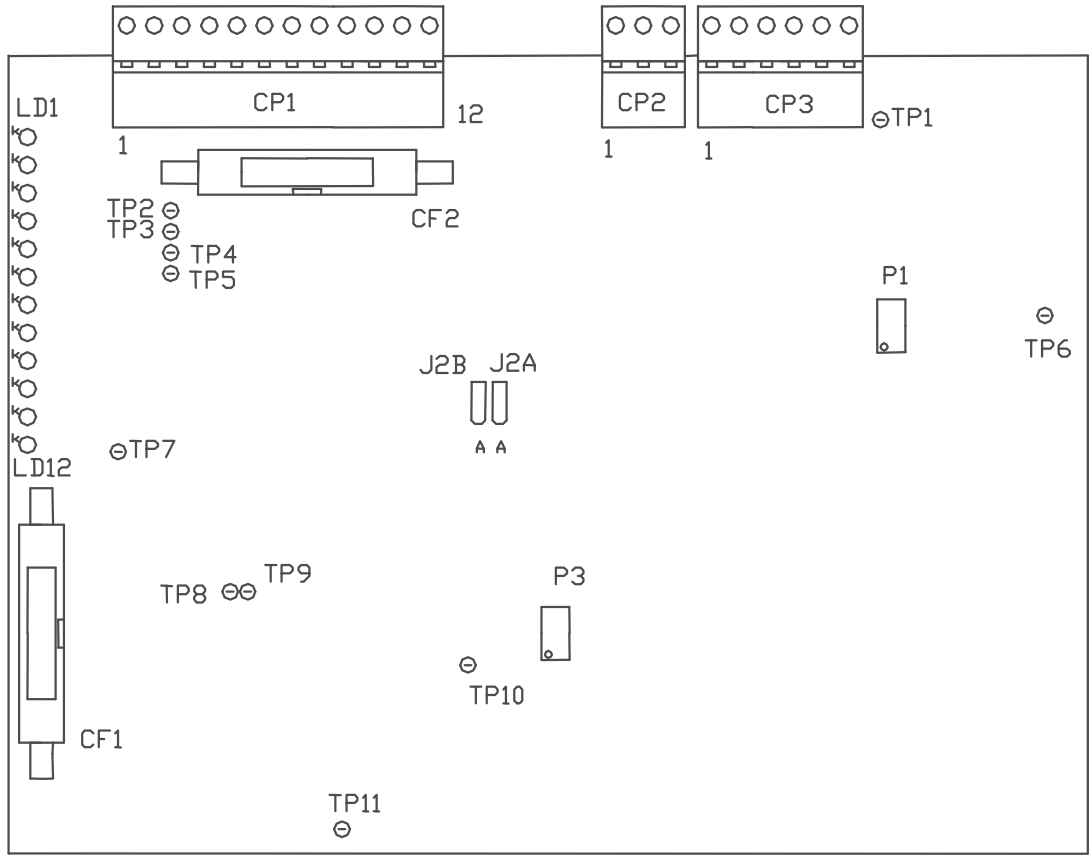
COMPONENTS

The X-ray generator electronic control is mainly composed by the following electronic boards:

- Inverter logical board PSM05
- Monobloc connection board PSM26/R
- Inverter driver board PSM15
- Rotating board PSM20
- 20 kHz filament board PSM46
- Interface board PSM17
- RS232 / CAN Collimator board PSM30

The microprocessor is composed by a mother board, on which is installed the processor of Motorola 68340 family, the operative system firmware and the Flash-EPROM with user's program.
This mother board is integrated with a 16 digital input module with filter of 0.2 msec., a 16 digital output module, with 8 analogue inputs with 10 bit resolution, a 4 analogue output module with 12 bit resolution, a module for the conduction of serial port communication with PC external control, and a module with 2 serial port for communication whit Flxis and D.A.P. System.

INVERTER LOGICAL BOARD PSM05



Ld1r = Driver Fault
Ld2r = Delta kV Max
Ld3r = kV > 110%
Ld4r = kV minimum
Ld5r = I primary maximum
Ld6y = Control driver channel 1
Ld7y = Control driver channel 2
Ld8y = Radiographic preparation
Ld9y = Radiographic input
Ld10y = Pulse selection
Ld11g = + 15 Vdc Supply ± 0.2V
Ld12g = - 15 Vdc Supply ± 0.2V

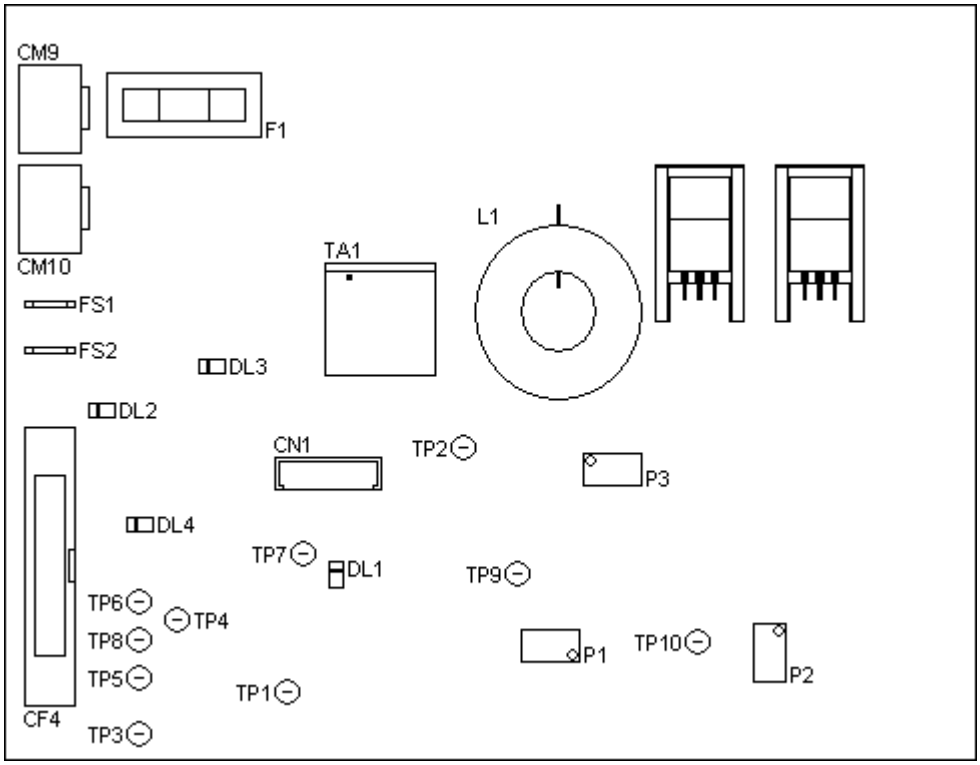
CP1 = External signal interface
CP2 = mAs Meter
CP3 = kV / mA Feedback
CF1 = External signal interface
CF2 = Driver interface

r = red y = yellow g = green

TP1 = Kv + (+1v = +10 kV)
TP2 = mA Fluoro (1V = 1 mA)
TP3 = kV tube (1V = 20 kV)
TP4 = mA Pulse (1V = 20 mA)
TP5 = GND
TP6 = Kv - (-1v = -10 kV)
TP7 = I primary
TP8 = Driver channel 1
TP9 = Driver channel 2
TP10 = Control PWM
TP11 = Inverter frequency

P1 = primary Max I
P3 = Inverter frequency
N.B. SET IN FACTORY
DO NOT MODIFY

FILAMENT SUPPLY BOARD PSM46

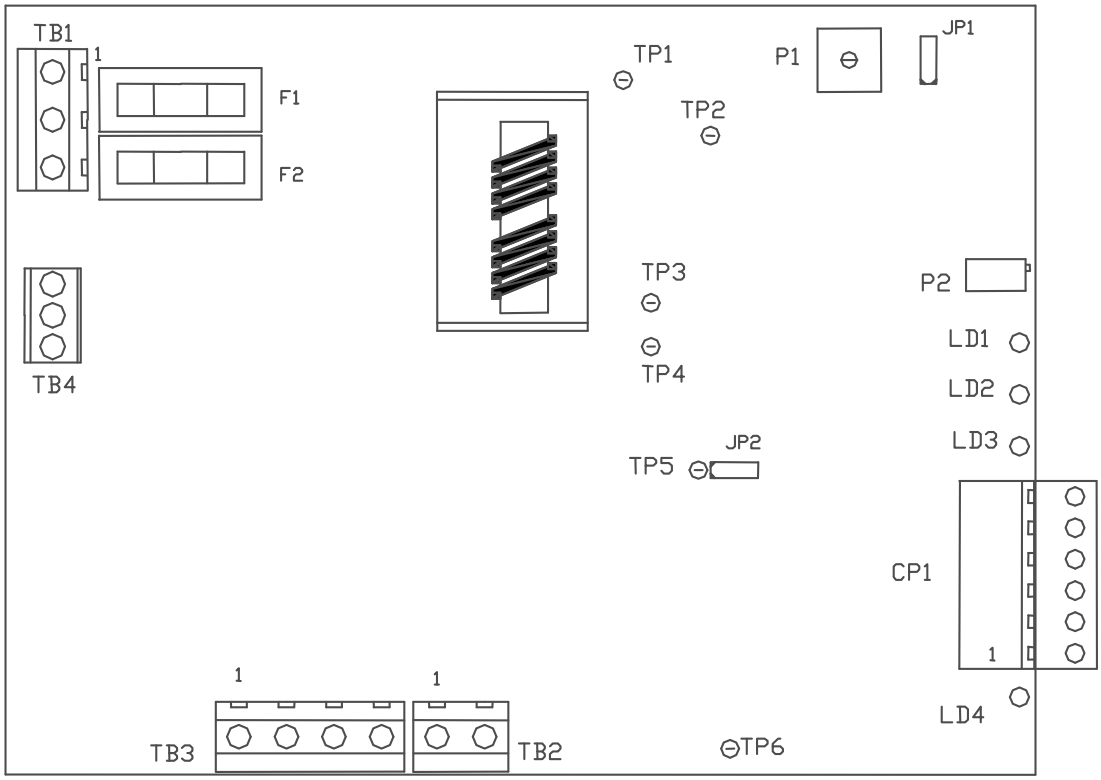


DL1	=	mA stabilization	CM9	=	320 Vcc power supply
DL2 ON	=	Filament over-current	CM10	=	filament output
DL2 BLINKING	=	Filament under-current	CF4	=	Interface check
DL3	=	Small filament	FS1-2	=	GND
DL4	=	Filament ready	CN1	=	n.u.

TP1	= feedback mA set	(1V = 1mA)	mA Setting ± 3%
TP3	= I filament set	Stand-By = 1,2V ± 0.2V	X-Ray 3,0V ± 0.5V
TP4	= - 15Vdc Supply	15V± 0.2V	
TP5	= + 15Vdc Supply	15V± 0.2V	
TP6	= mA anodic feedback from the inverter		(1V = 1mA)
TP8	= I filament feedback	Stand-By = 4,4V ± 0.2V	X-Ray 8,0V ± 1.0V
TP9	= GND		
TP10	= GND		

P1 – P2 – P3 – P4 **N.B. SET IN FACTORY**
DON'T MODIFY

3000 rpm ROTATION CHECK BOARD PSM20

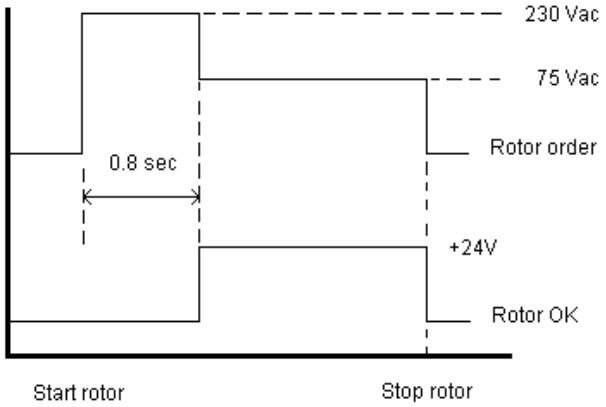


Ld1y = Fluoro Command
Ld2y = Maintenance voltage
Ld3g = Rotation OK
Ld4y = Pulse Command

y = yellow g = green

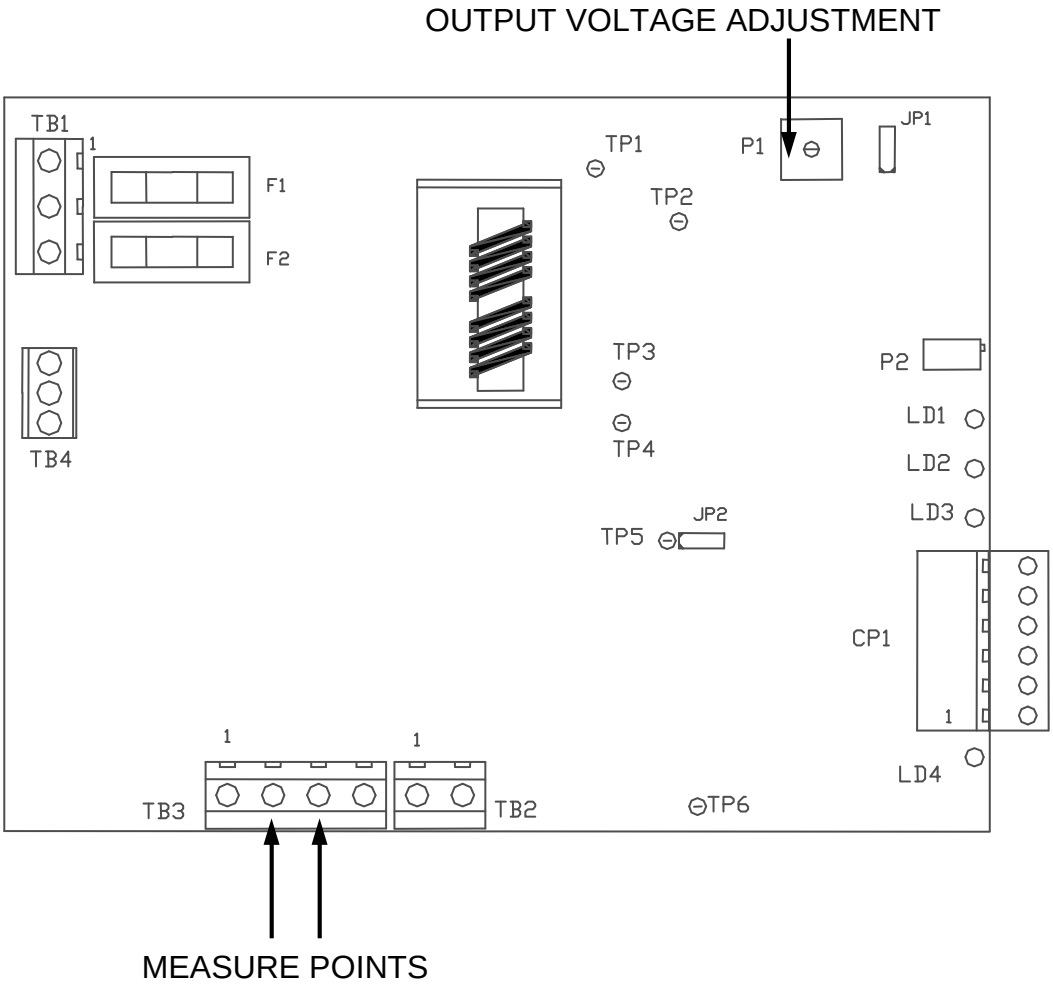
P1 = Output voltage
P2 = Anode rotation time

TB1 = 230V~ power supply
TB2 = phase shift
TB3 = anode rotation output
TB4 = n.u.
CP1 = control signal

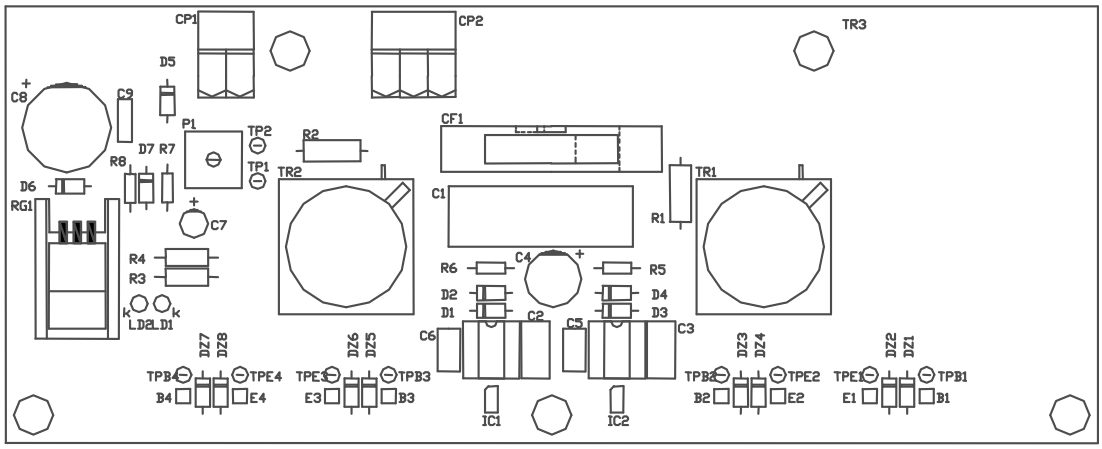


PSM 20 ROTATING ANODE OUTPUT VOLTAGE ADJUSTMENT

Connect a voltmeter in Vac “true RMS”, between **TB3-2** terminal and **TB3-3** terminal of PSM20 stator rotating.
Operate, with Fluoroscopy foot-lever, and verify within 10 s that the instrument visualizes the output voltage between 70 and 80 Vac.
If necessary adjust this voltage with the potentiometer **P1** of the rotating anode board.



DRIVER BOARD **PSM15**



TPB1 = Base IGBT 1
TPE1 = Emitter IGBT 1
TPB2 = Base IGBT 2
TPE2 = Emitter IGBT 2
TPB3 = Base IGBT 3
TPE3 = Emitter IGBT 3
TPB4 = Base IGBT 4
TPE4 = Emitter IGBT 4

P1 = +15Vdc Adj

TP1 = + 15Vdc ±0.2V
TP2 = GND

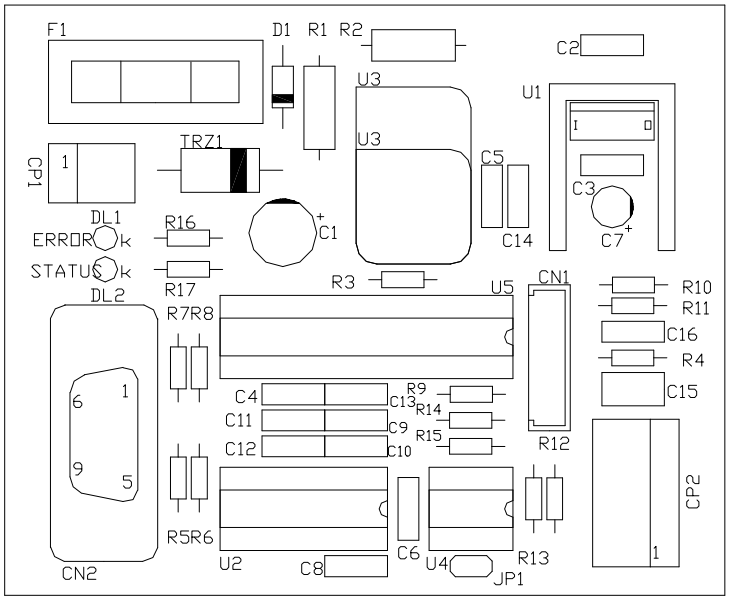
CP1 = Power supply 24Vdc
CP2 = Current transformer
CF1 = Interface signal with PSM05
Ld1g = + 15Vdc
Ld2y = Driver command

y = yellow g = green

N.B. SET IN FACTORY
DO NOT MODIFY

!! ATTENTION !! LINE TENSION CONNECTED BOARD
USE NOT GROUND CONNECTED INSTUMENT

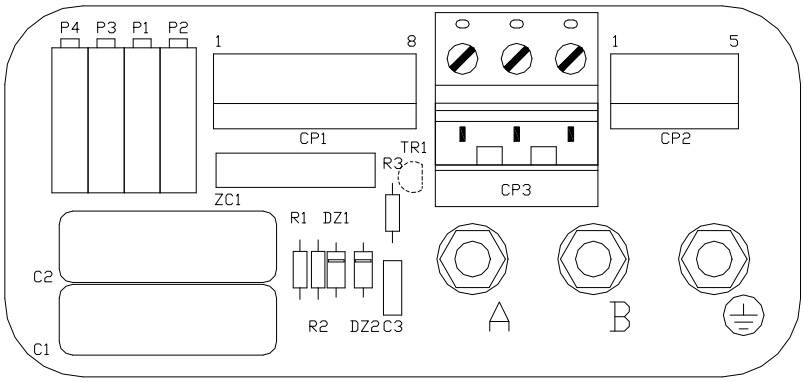
RS232 / CAN COLLIMATOR BOARD PSM30



CP1 = Power Supply +24Vdc ±0.2V
CP2 = Collimator Plug
CN2 = PLC Serial Port-2

Ld1r = Error
Ld2g = Status
r = Red g = Green

CONNECTION BOARD PSM26 R

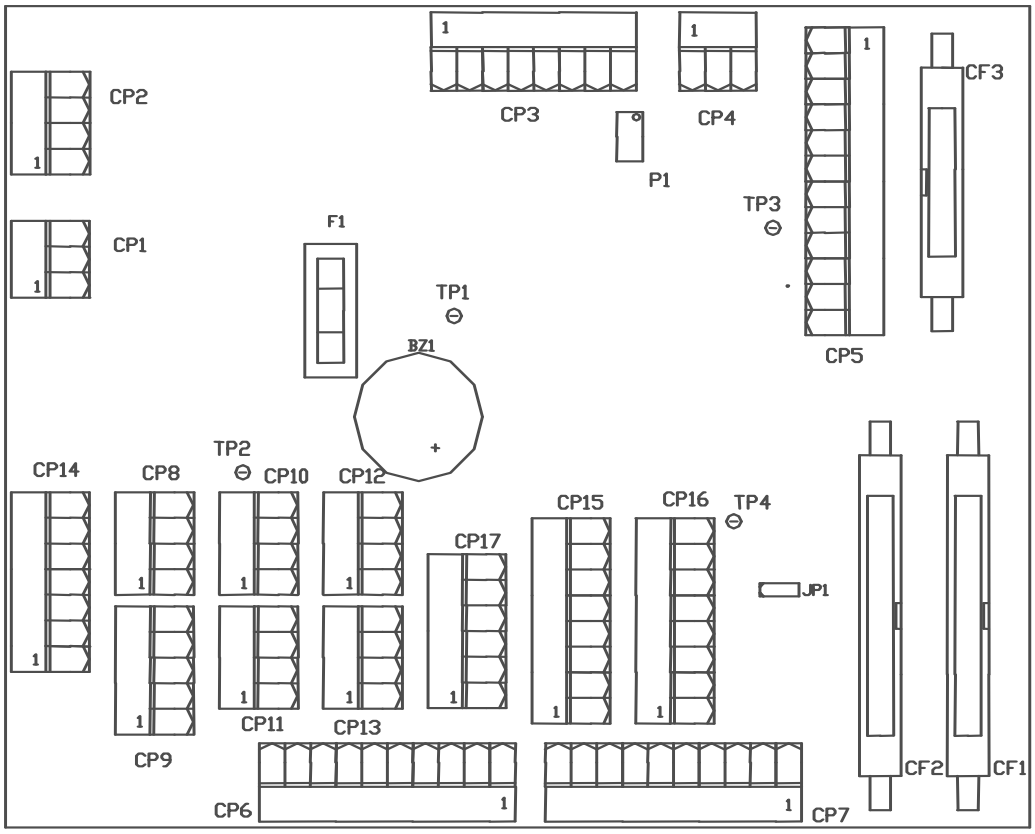


CP1 = Feedback/Thermal Contact
CP2 = Focal Plug
CP3 = Anode rotation Plug

A = Primary Power Supply Connector
B = Primary Power Supply Connector
GND = GND Power Connector

P1 – P2 – P3 – P4 **N.B. SET IN FACTORY DO NOT MODIFY**

INTERFACE BOARD **PSM17**



CP1 = 230Vac > PSM46 input
CP2 = +350Vcc > PSM46 output
CP3 = + 24Vcc
CP4 = GND
CP5 = signals > PSM05
CP6 = OUT Analog. < Microprocessor
CP7 = IN Analog. > Microprocessor
CP8 = X-ray remote foot-lever
CP9 = signals for insertion
CP10 = thermal safety signals
CP11 = Signals > PSM20
CP12 = Collimator power supply
CP13 = N.U.
CP14 = X-Ray room interface
CP15 = N.U.
CP16 = Signals > Flxis
CP17 = N.U.
CF1 = IN Digitals > Microprocessor
CF2 = OUT Digitals < Microprocessor
CF3 = Signals > PSM46

P1 = maximum radiographic time

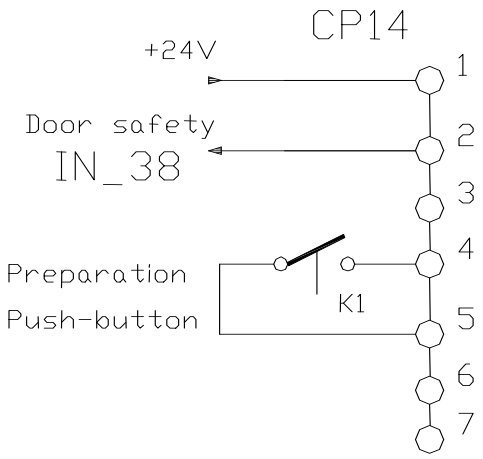
N.B. SET IN FACTORY
DO NOT MODIFY

EXTERNAL INTERFACE

EXTERNAL SIGNALS RADIOLOGICAL ROOM

CP14 connector of PSM17 interface board puts at disposal, on pin 1 and 2, the possibility to connect a micro switch as to signal the condition of the door accessing to radiological room. Opened contact is shown on the display with the message “DOOR SAFETY” and the X-ray generator is disabled to X-ray emissions.

PSM 17



On CP14 connector, pin 4 and 5, there is at disposal a “clean” contact of K1 relay.
This contact is closed by radiographic preparation command executed by the remote foot-switch.

SAFETIES

The **MX-350/S15** has been planned in respect of all possible risks coming from malfunctioning.
The safeties that have been used can be shared in two principal groups:
“hardware” safeties and “software” safeties.

HARDWARE SAFETIES

Total safety

On the machine is installed a red colour safety button.
The pressure of this button causes the fall of power supply on the auxiliary relay **K_STOP,** that in consequence causes the interruption of power supply to the filament board, rotation anode board and the coil of the insertion relay **K_INS**.

Door safety

On pin 1 and 2 of the terminal board CP14 of PSM17 board must be linked a micro switch that signals the door opening in the radiological room.
The opening of the contact disables any X-ray emissions; this condition is signalled by a warning message on the screen.

X-ray tube thermal safety

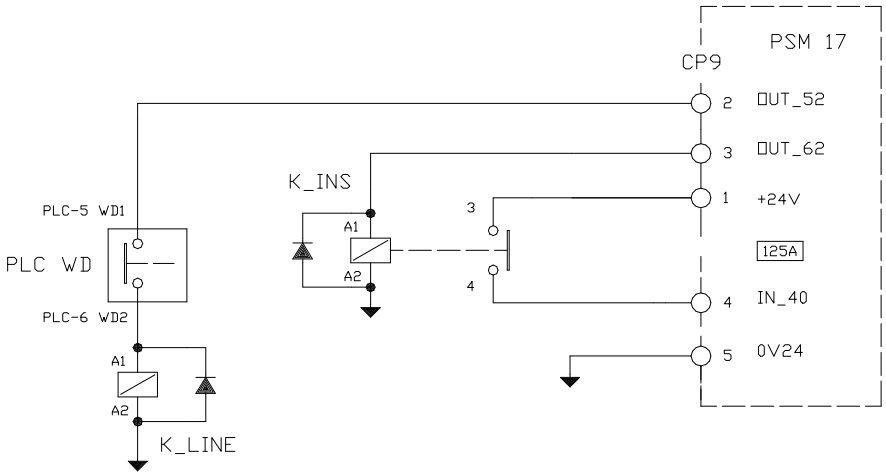
On pin 1 and 3 of terminal board CP10 of PSM17 board must be linked the terminal of the X-ray tube housing thermal safety.
The opening of this contact disables any X-ray emissions; this condition is signalled by a warning message on the screen.

Watch-dog contact of the PLC

In series with the coil of the relay K_LINE, that causes the insertion of generator power group, is located the contact relay of the PLC watch-dog.

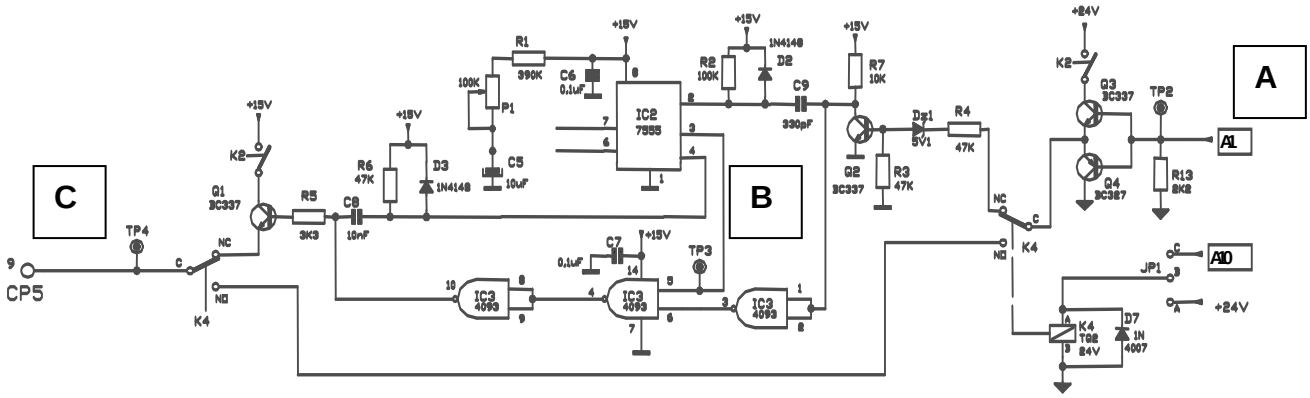
The command to this relay is directly sent by the PLC software and must be refreshed with a minimum cadence of 5 Hz equal to once each 200 milliseconds.

The blockage, for any reason, of the microprocessor watch-dog causes the interruption of the power supply (OUT_52) to insertion primary relay K_LINE.

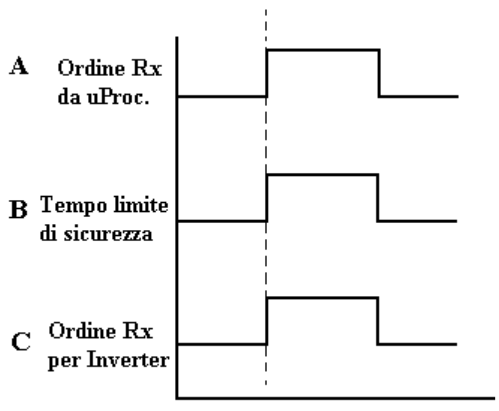


Maximum radiographic time safety

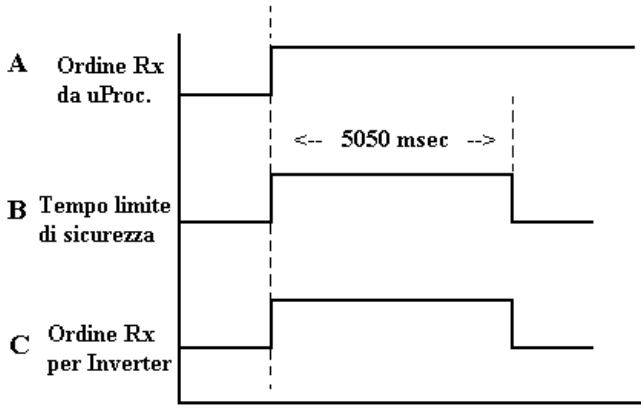
On the interface board PSM17, the circuit shown below causes the interruption of X-ray exposure command to the inverter after a maximum time fixed in advance, regardless of the signal presence coming from the microprocessor.



The signal “A” is the X-ray order coming from the microprocessor and defines the X-ray emission time.
The signal “C” is the X-ray emission command for the logic board of the inverter.
These two signals, normally at low logic level (0 Volt), go at high logic level during the emission time.
The X-ray maximum time that can be set on the generator web interface is of 5 seconds.
If, for a system failure, the signal “A” is not interrupted after the time set by the microprocessor, the signal “B”, set by hardware circuit to stay at high logic level for 5050 milliseconds, cuts the command toward the inverter logic board.



Normal functioning



Safety intervention

SOFTWARE SAFETIES

The software safeties have been introduced as to assure “step by step” the check of X-ray parameters.
First of all we point out the fact that, after executing the X-ray preparation command, the X-ray generator controls the parameters sent to the X-ray tube and the reading of the feedback inputs coming from the high voltage generator “only”.
This assures a time of engine cycle < than 1 millisecond.
By this time they are checked all the signals from and to the inverter, the analogical values of filament current and, after X-ray command, of mA and of actual kV.
Besides they are always inspected all the alert signals that can cause the exposure blockage, like door safety, thermal safety, accessories installed, generator power supply.
The feedback values are compared with set data and if they both fall within a tolerance field, the exposure can finish normally.

Filament safety

From stand-by condition to X-ray preparation, the filament current is continuously checked.
The filament check board PSM46 sends to the microprocessor the signal “ready” only if the filament power supply is included between a minimum value and a maximum value, both fixed in the project phase.
If the values exceed this range and the signal “ready” is missing, on the screen appears a warning message and the X-ray unit does not execute any command towards the power part.

mA maximum safety

The actual mA value is compared with the mA maximum value supported by the X-ray tube for the fixed data.
If the actual values exceed the accepted data for a consecutive reading number set by the program, the exposure is interrupted and it appears an alert message on the screen.
This solution has been adopted as to avoid that a single peak signal could cause the exposure interruption.

mA minimum safety

If the actual values are lower than the accepted data for a consecutive reading number setted by the X-ray generator, the exposure is interrupted and it appears an alert message on the screen.

ERROR LIST

E.01	Rotor Starter Not OK	X-ray tube rotating anode signal NOT present after the command of radiographic exposure in pulse or One shoot mode.

Check the following conditions:

PSM20	TB1-1 with TB1-3	230 Vac ± 10%
		Check the electrical power board connection PSM20 Check the contact of the remote-control switch K_STOP

PSM20	F1 – F2	10 A – T
		Replace the fuses F1-F2

PSM20	Ld4 yellow	ON Preparation order (OUT 60) executed.
		Check the connection with PSM17 CP16-3

PSM20	Ld3 green	ON Rotor consent (IN 35) present.
		Check the connection with PSM17 CP11-3 Check the maintenance tension value

E.02	Collimator not ready	At the start-up, the system cannot detect the collimator, and collimator state is set to ENABLED in the service page.

Check the following conditions:

		Check the connection between PSM30 board and the PLC Check the connection between PSM30 board and the collimator Check +24Vdc on CP1, pin1 and 2 of PSM30 board

E.03	Kv>85% Not OK	85% kV feedback of the X-ray tube signal NOT present during the exposure.

Check the following conditions:

		Check the connection between PSM17 CP5-4 and PSM05 CP1-4

E.04	mA limit	During calibration, the mA value exceeded the maximum mA value that the generator can bear.

Check the following conditions:

		Call the servicing

E.05	Thermal HU limit	Exposure blockage when the monobloc thermal limit is reached (software calculated).

N.B.
Wait for the monobloc cooling in functioning limits.

To avoid the continuous intervention of the thermal limit, it is recommended to take again the use of the generator after the thermal bar gets < 85%.

E.06	Inverter Fault	Inverter blockage signal present during X-ray emission.

Check the following conditions:

PSM05	Ld2 red	OFF
		ON = Difference between kV+ and kV- higher to allowed limit. DISTURBANCE ON H.T. CIRCUIT

PSM05	Ld3 red	OFF
		ON = kV Feedback upper to 110% of kV max. DISTURBANCE ON H.T. CIRCUIT

PSM05	Ld4 red	OFF
		ON = kV Feedback not present DISTURBANCE ON H.T. CIRCUIT

PSM05	Ld5 red	OFF
		ON = Inverter primary current upper to allowed limit OVERLOAD ON H.T. CIRCUIT

E.06	Inverter Fault	Inverter blockage signal present at the switch on of the unit.

Check the following conditions:

PSM05	Ld4 red	OFF
		ON = check electrical connection of the of the feedback signal between the monobloc and the PSM05-CP3 board

E.07	Filament Fault	Filament board consent signal NOT present during the exposure

Check the following conditions:

PSM 17	CP1-1 con CP1-3	230 Vac +/- 10%
		Check electrical connection of the filament board. Check the contact of the remote-control switch K_STOP

PSM 17	F1	2A T
		Replace the fuses F1

PSM46	F1	1A T
		Replace the fuses F1

PSM46	Ld2 green	ON = filament board ready signal (IN 34)
		OFF = check electrical connection between filament board and monobloc Check monobloc functionality

E.08	Monobloc Thermal Safety	Inner monobloc thermal safety NOT present (IN 39)

Check the following conditions:

PSM06	IN 39	ON
		OFF = Check the electrical connection between monobloc PSM06 CP2– terminal board interface M2 – board PSM17 CP10

		If it has been selected the cooling with the fan, check the presence of the fan. Check the fan functioning

E.09	Door Safety	X-ray room door micro switch opens during X-ray emission (IN 39)

Check the following condition:

	⚠	Reset the condition of normal use

If the system is in stand-by condition, and then there isn't x-ray emission, the x-ray room door opening is signaled on the screen with the write "DOOR SAFETY", without the indication of the error number.
The door micro switch closing deletes automatically the message and returns to "READY". condition.

E.10	Max Fluoroscopy Time	Exposure blockage after 10 minutes of fluoroscopy accumulation without reset command

⚠ Loosen the X-ray foot-switch, reset the error message and, if necessary, repeat the test.

N.B.
30 seconds before the safety intervention, the system sends out a continuous acoustic signal to alert the operator that it's reaching the maximum limit of accumulation in fluoroscopy, to continue the test, without interruption, press the button in the picture below.

E.13	Failed Communication I.I.	The system is not able to communicate with the I.I. flxis

	⚠	Check the connection between the I.I. system and the M4 connection board Check the connection between the M4 connection board and the PLC

E.14	Max I Filament	Filament current upper to the max limit for the selected focus.

Check the following condition:

		To check the setting value To check the filament current value, to connect a measuring instrument (multimeter), with sequence in Vcc, PSM46 board between Tp10 (gnd) and Tp8 (signal). the measured value, on Volt, multiplied for the constant, 50, furnishes the mA value that circulate in the primary of the Coolidge. This value, multiplied for the factor 11, furnishes, indirectly, the value of the current that circulate in the X-ray tube filament. Ex. measured value with multimeter 4.35 Volt 4.35 x 50 = 217,5 mA primary Coolidge 217,5 x 11 = 2.39 filament ampere

ADDITIONAL INFORMATION

No X-ray emission after the command of the foot-switch

- The generator isn't in work mode.
- Error message on the screen.
- X-ray room door open.
- Connection interrupted or absence of the foot-switch.

No external lighting indication during X-ray emission.

- External bulb broken or burnt out.
- Connection interrupted or absence of the bulb.

No motion of the collimator.

- Collimator not enabled from the Set-up
- Connection interrupted or absent between the collimator and PSM30 – CP2

Monitor off

- Generator in stand-by condition
- Power monitor fuse F3 broken.

MAINTENANCE

Installer and/or operator of the unit described in this document has to know all the safety rules and regulations.
All the X-ray generator parts must be controlled and inspected at least once a year, to ensure unit correct functioning and operator and patient safety.
Every 12 (twelve) months an engineer must inspect and, if necessary, replace those parts that will be representing danger for wear and tear effect.
Verify the screens and all the visual and sound signals, pay particular attention to X-ray emission indicator that must be visible during the effective X-ray emission only, otherwise immediately interrupt the maintenance and contact the service department.

N.B. During the X-ray emission functioning tests put the protective wearing (lead-covered), keep properly distance and carry an exposure control film – badge or personal pen dosimeter.

CLEANING

Switch off and disconnect the system from power supply before cleaning.

- Clean plastic areas with water and mild soap.
- Other substance can damage plastic parts.
- **Do not utilize cleaning agents or corrosive creams, solvents or abrasives.**
- Be sure that water or other liquid substance don't penetrate the unit.
- That caution prevent short-circuits and components corrosion.
- It isn't recommended the spray disinfection, as the disinfectant can penetrate the X-ray unit.

WASTE

Unit out of use must be wasted following the current regulation of special waste.

SYMBOLS

- Annex “D” (IEC 60601-1)
- Filtration 
- Small Focus 
- Large focus 
- Warning 
- Radiation 
- EC marking 

- Earthing