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CA-1108R8

Calibration

HF Series Generators

REVISION HISTORY

REVISION	DATE	REASON FOR CHANGE
0	APR 15, 2014	First Edition.
1	DEC 04, 2014	Fluoro parameters accuracy and general updates.
2	DEC 15, 2015	kVp oscillator adjustment and Gains adjustment updated.
3	DEC 23, 2015	New Fluoro and AEC calibration features.
4	APR 29, 2016	New Tech Service Console version.
5	DEC 20, 2016	New Tech Service Console version and kVp oscillator adjustment for 40 and 50 kW Single Phase Generators.
6	JAN 23, 2017	New Tech Service Console version and kVp oscillator adjustment for 32 kW Single Phase Generators.
7	JUN 22, 2018	New Tech Service Console version and kVp oscillator adjustment for 50 kW Single Phase Generators at 230 VAC.
8	FEB 24, 2020	New Three Phase Generators at 208 VAC and mA Gains Adjustment updated.

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

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

ADVISORY SYMBOLS

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

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

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

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

Note ☞

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

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SECTION 1 INTRODUCTION

This Calibration document provides information and procedures to perform all the adjustments required to establish an optimal performance of this Generator.

CAUTION

Calibrate the Generator immediately after Configuration is completed.

WARNING

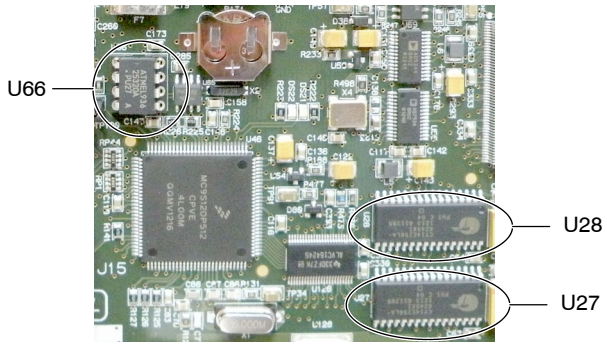
DO NOT SUPPLY THE MAIN POWER UNTIL SPECIFICALLY INSTRUCTED TO DO SO IN THIS DOCUMENT.

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

Calibration data is entered in digital form and stored in a non-volatile memory chip (U66-EEPROM) located on the Control board, thus no battery back-up is required. The U66 memory is fitted in a socket and it can be easily removed for data transfer from one Generator to another, in case the calibration and configuration backup files cannot be restored from the computer.

U27 and U28 are the non-volatile RAM, where the Error log, Generator and Tubes Counters, daylight saving time, Generator power limited by user, initial parameters values (as set before the last shut down), downloaded tube's data and oscilloscope data are saved.

Illustration 1-1
EEPROM and RAM location



Note ☞ *Calibration procedures must be performed in the order listed in this document. Perform only the sections required to calibrate this unit.*

1.1 GENERATOR SPECIFICATIONS

1.1.1 MINIMUM CURRENT TIME PRODUCT (mAs)

- Minimum Current Time Product obtained at 0.1 s is 1 mAs.
- Minimum Current Time Product within the specified ranges of compliance for linearity and constancy is 0.1 mAs.

1.1.2 ACCURACY OF RADIOGRAPHIC PARAMETERS

Note ☞ *Specified accuracy does not include test equipment accuracy.*

PARAMETERS		ACCURACY (with 12 BITS HT)
RAD	kV	± (3% + 1 kV)
	mA	± (4% + 1 mA)
	Exposure Time	± (2% + 0.1 ms)
	mAs	± (10% + 0.2 mAs)
FLUORO	kV	± (3% + 1 kV)
	mA	± 10%
	Exposure Time	± (1% + 20 ms)

1.1.3 HV FREQUENCY

The operating HV Frequency of this Generator is 25 kHz.

1.1.4 DUTY CYCLE

The Generator duty cycle is continuous, but limits should be set during installation depending on the capacity of the X-ray tube.

SECTION 2 CALIBRATION PROCEDURES

Note ☞ *Enter in the SC Program for Calibration procedures as described in the "Configuration" document.*

Enter and store calibration data in the Calibration screens as described in Sections 2.3, 2.4, 2.11.1, 2.6, 2.7 and 2.8.

Before calibration, bear in mind that:

- For calibration and kVp measurement it is recommended a Non-Invasive kVp Meter placed and centered on the X-ray Tube output at the required SID *(refer to the Non-Invasive kVp Meter documentation).*

  A HV Bleeder can also be used when a Non-Invasive kVp Meter is not available.

- For calibration and mAs measurement it is needed a mAs Meter plugged to TP85 and TP86 on the Control board *(refer to Section 2.1).*

- It is needed a jumper on pins 7 and 8 on J18 Connector to allow the kV oscillator operation.

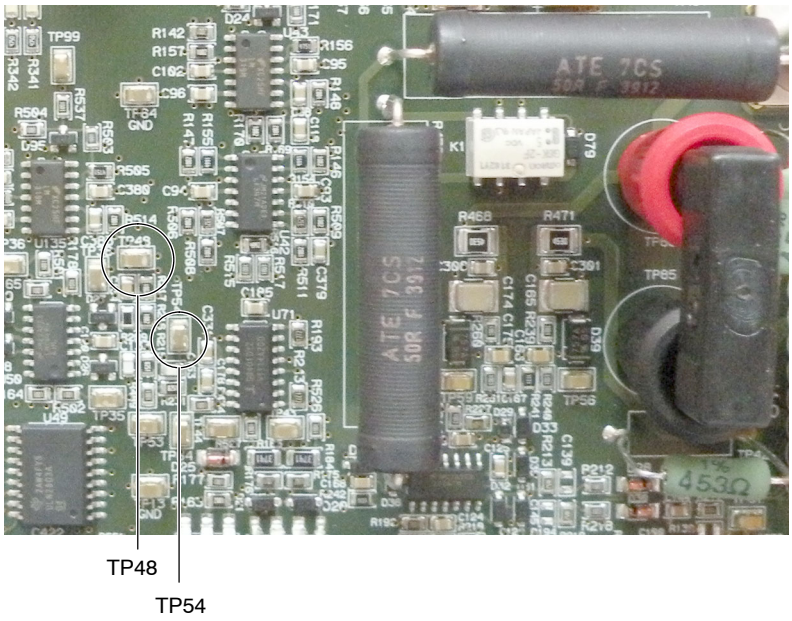
Note ☞ *Test points on the Control board can also be used to monitor the kV and mA readings but* ***<u>should not be used</u>*** *to calibrate the unit. These test points must be checked with scope:*

— mA test point is TP48 and the scale factor is:

— up to 10 mA, 1 volt = 1 mA.
— from 10 to 80 mA, 1 volt = 10 mA.
— from 100 mA, 1 volt = 100 mA.

— kV test point is TP54 and the scale factor is 1 volt = 33.3 kVp (0.3 volt = 10 kVp).

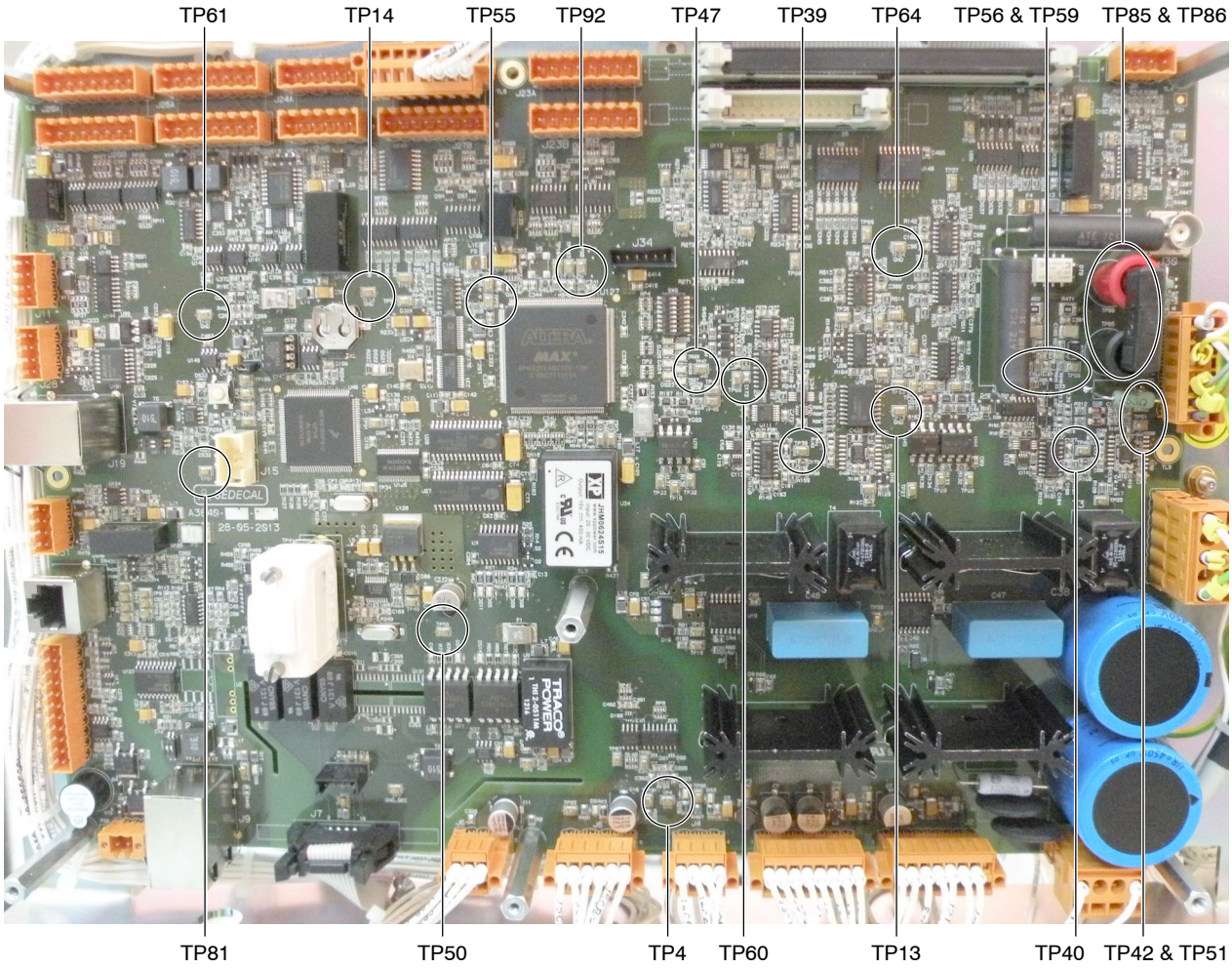
Illustration 2-1
TP48 and TP54 location



- Verify position of dip switches on the Control board during every calibration procedure:

DIP SWITCH	OPEN (OFF)	CLOSED (ON)
3640SW6-4	Position during operation — Enables Filament	Disables Filament so no radiation will be produced during the exposure.

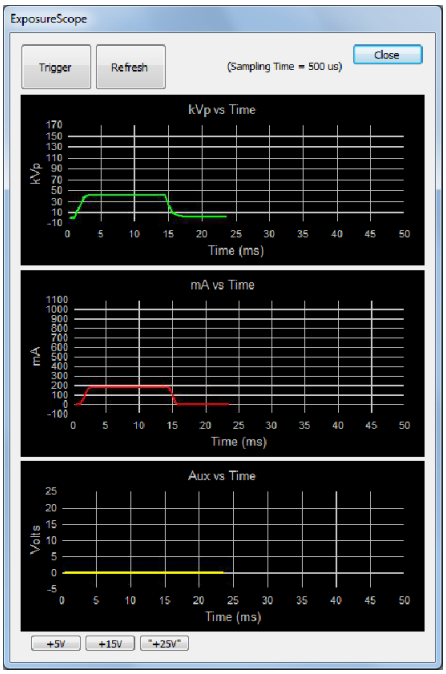
2.1 TP LOCATION



2.2 EXPOSURE SCOPE

Open the Exposure Scope by pressing the “Exposure Scope” button on the SC menu.

Illustration 2-2
Exposure Scope



The Exposure Scope can be used as an internal oscilloscope, it shows the measurement made by the microprocessor located on the Control board. Nevertheless, it is recommended to connect an external oscilloscope to the Generator to accurately perform the measurements indicated in this document. The measures obtained using the internal oscilloscope are not precise, they can only be used as a visual reference, not as trusted measurements.

The Exposure Scope screen is divided in three different fields, the first two are related to kVp and mA. Measurement scale is automatically adjusted according to the performed measurements once the exposure has been made.

If the Exposure Scope is open during Autocalibration *(refer to Section 2.4),* kV and mA are shown in their corresponding fields with every exposure, but it makes the Autocalibration process a little slower.

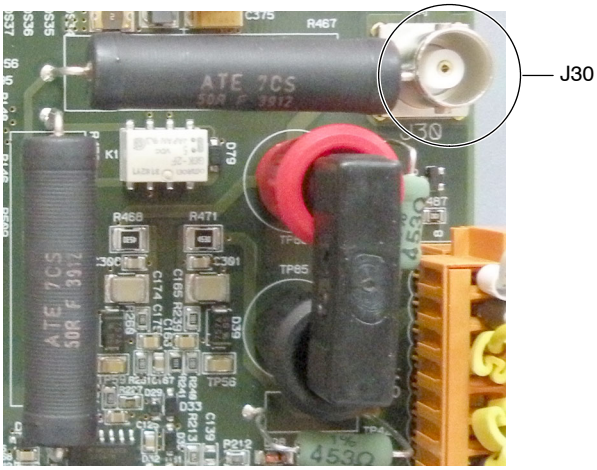
During DSI no signal is shown until the exam is finished. Then, only the last exposure kV and mA can be seen.

The third field can be used to measure any other signal on the Control board connecting a 1x scope probe (the usage of a 10x scope probe will result in obtaining an attenuated signal) to J30 of the Control board instead of connecting it to an oscilloscope. 5V, 15V and 25V scales can be selected, depending on the value to be measured. Only positive signals up to 25V can be measured.

WARNING

USE A SCOPE PROBE CONNECTED TO J30 TO MEASURE ONLY SIGNALS REFERENCED TO THE A3640-XX CONTROL BOARD GROUND (GND).

Illustration 2-3
J30 on Control board



2.3 PARAMETERS CALIBRATION WINDOW

Press the “Parameters Calibration” button to launch the Parameters Calibration window. This window has several tabs to access the different calibration screens (Parameters Calibration Main Page, General Parameters, Fluoro Calibration and AEC Calibration).

When all the calibration parameters are set on each screen, press the “Store Data (In SHFR)” button to save the changes. If any value is later modified, press the “Store Data (In SHFR)” button to save the changes.

If an error is detected when trying to save the entered data in any of the Parameters Calibration screens, a pop-up message is shown containing information about the field of the screen where the error is detected. Modify the incorrect value and press the “Store Data (In SHFR)” button again to save the changes.

Illustration 2-4
Configuration error

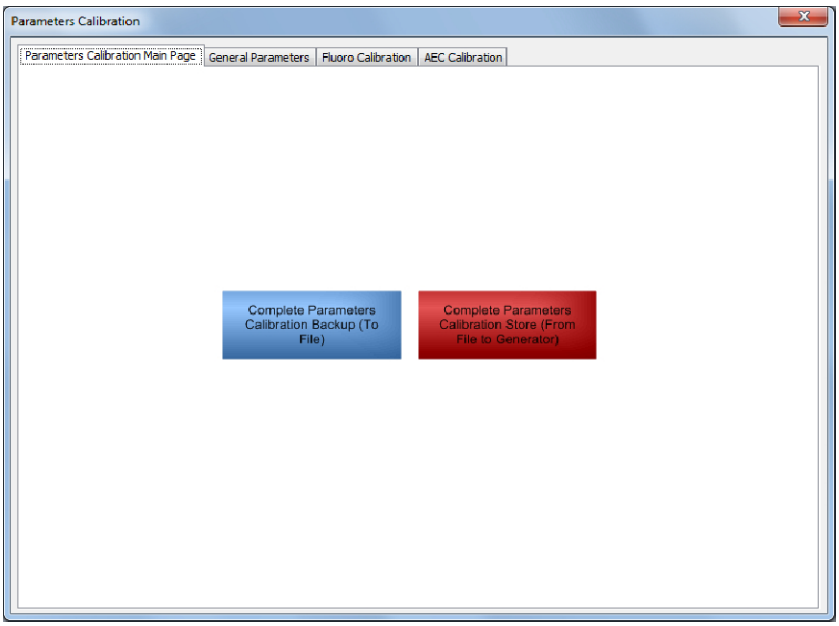
To check if a value has been properly saved, click on the “Refresh (From SHFR)” button. Values can be recovered from the Generator using the “Refresh (From SHFR)” button.

2.3.1 PARAMETERS CALIBRATION MAIN PAGE

The Parameters Calibration window initially displays the Parameters Calibration main page, with two options:

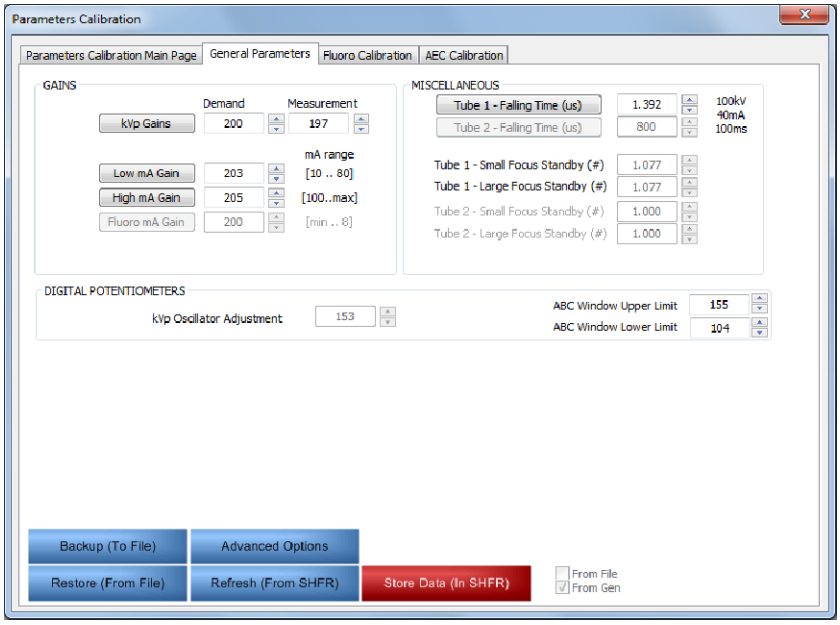
- **Complete Parameters Calibration Store (From File To Generator):** Click to restore the calibration data previously saved in a computer.
- **Complete Parameters Calibration Backup (To File):** Use this option once the Calibration process is completed *(refer to Section 2.9)*.

Illustration 2-5
Parameters Calibration main page



2.3.2 GENERAL PARAMETERS

Illustration 2-6
General Parameters screen



2.3.2.1 kVp OSCILLATOR ADJUSTMENT

Note ☞ *kVp oscillator is factory adjusted. There is no need to adjust it again unless the EEPROM is initialized without keeping the potentiometers adjustment or if the A3640-XX Control board is replaced.*

Press the “Advanced Options” button in the General Parameters screen and enter the **password 5365** to activate the kVp Oscillator Adjustment option.

SINGLE PHASE GENERATORS AND 208 V~ THREE PHASE GENERATORS

Two adjustments are needed for all the Single Phase Generator models and for 32 kW Three Phase Generators connected to 208 V~, kVp oscillator and auxiliary kVp oscillator, both meassured in TP60. To switch between one and the other, press the “Aux. kVp/Aux. Selected” button of the Sevice Console.

The type of adjustment needed (A, B or C) according to the Generator maximum power is displayed next to the Auxiliary kVp Oscillator Adjustment field *(Refer to Table 2-1 and to Illustration 2-7).*

Table 2-1
Adjustment of 32 kW Three Phase Generators at 208 V~ and Single Phase Generators

GENERATOR	ADJUSTMENT	KVP OSCILLATOR	AUX. KVP OSCILLATOR
50 kW	A	45 μ	51 μ
40 kW	B	41 μ	50 μ
32 kW	C	41 μ	50 μ

To adjust the kVp oscillator, proceed as follows:

1. With the “Aux. kVp” button grey shaded, measure the kVp inverter frequency in TP60 with an oscilloscope, it must be adjusted to 41 μs for 32 kW and 40 kW Generators and to 45 μs for 50 kW Generators. If the measured value is higher, increase the value in the kVp Oscillator Adjustment field. If the measured value is lower, decrease the value in the kVp Oscillator Adjustment field.

2. Press the “Aux. kVp” button. It gets lighted and changes to “Aux. Selected”. Now, the auxiliary kVp oscillator is measured in the same TP.

3. The Auxiliary kVp inverter frequency measured in TP60 with the oscilloscope must be adjusted to 50 μs for 32 kW and 40 kW Generators and to 51 μs for 50 kW Generators. If the measured value is higher, increase the value in the Auxiliary kVp Oscillator Adjustment field. If the measured value is lower, decrease the value in the Auxiliary kVp Oscillator Adjustment field.

The new value is automatically stored in both cases, it is not necessary to press the “Store Data” button. Just close the Parameters Calibration window to exit once the kVp oscillator and the auxiliary kVp oscillator are adjusted.

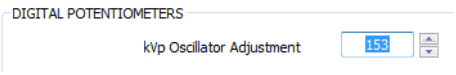
Illustration 2-7
kVp Oscillator and Auxiliary kVp Oscillator Adjustments

THREE PHASE GENERATORS FROM 230 TO 480 V~

Measure the kVp inverter frequency in TP60 with an oscilloscope, it must be adjusted to 36 μs, except for Generators operating at 230 V~, which must be adjusted to 40 μs. If the measured value is higher, increase the value in the kVp Oscillator Adjustment field. If the measured value is lower, decrease the value in the kVp Oscillator Adjustment field.

The new value is automatically stored, it is not necessary to press the “Store Data” button. Just close the Parameters Calibration window to exit once the kVp oscillator is adjusted.

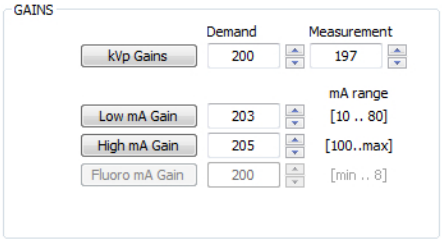
Illustration 2-8
kVp Oscillator Adjustment



2.3.2.2 GAINS ADJUSTMENT

Note ☞ *Gains are factory adjusted. There is no need to calibrate them again unless the A3640-XX Control board or the HV Transformer have to be replaced (just the kV gain) or if the EEPROM is initialized. In this case, kV and mA gains have to be adjusted unless the EEPROM has been initialized keeping the mA gain values, so only the kV gains have to be calibrated.*

Illustration 2-9
Gains calibration



Gains values have a 15% tolerance. Starting value is 200, so the final value will be within 170 and 230.

The following gains are adjustable (only the needed gains have to be adjusted):

- kVp gain.
- Low mA gain: from 10 to 80 mA.
- High mA gain: from 100 mA.
- Fluoro mA gain: below 10 mA (if available).

Note ☞ *Use a non-invasive meter or a HV Bleeder to measure kVp and a mA/mAs meter connected to TP85 and TP86 of the Control board for mA measurement* (refer to Section 2.1).

Before the Gains calibration it is necessary to calibrate manually one or several mA stations (only the needed mA stations have to be calibrated):

1. Go to Manual Calibration by pressing the “Manual Calibration” button on the SC menu and calibrate:

   a. 10 mA for **Low mA gain** adjustment, 100 mA for **High mA gain** adjustment and 8 mA (if available) for **Fluoro mA gain** adjustment, all of them for 80 kVp and Large Focal Spot, if possible *(refer to Section 2.11.1).* Otherwise, calibrate for Small Focal Spot those mA stations which are not available for Large Focal Spot.

   b. The lowest mA station with 80 kVp for **kVp gain** adjustment, if it has not been calibrated in the previous step. Calibrate it for Large Focal Spot if the lowest mA station of the Generator is available for Large Focal Spot. Otherwise, calibrate it for Small Focal Spot *(refer to Section 2.11.1).*

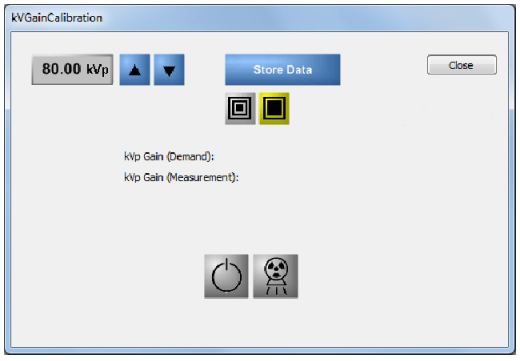
2. Write down the FIlament Data of the calibrated mA stations.

PERMANENT DAMAGE CAN BE CAUSED TO THE TUBE IF THE REQUIRED MA STATIONS ARE NOT ACCURATELY CALIBRATED BEFORE PERFORMING THE GAINS ADJUSTMENT.

kVp GAIN ADJUSTMENT

1. Press the “kVp gains” button in the General Parameters screen. A pop-up screen will be displayed.

Illustration 2-10
kVp Gain calibration screen



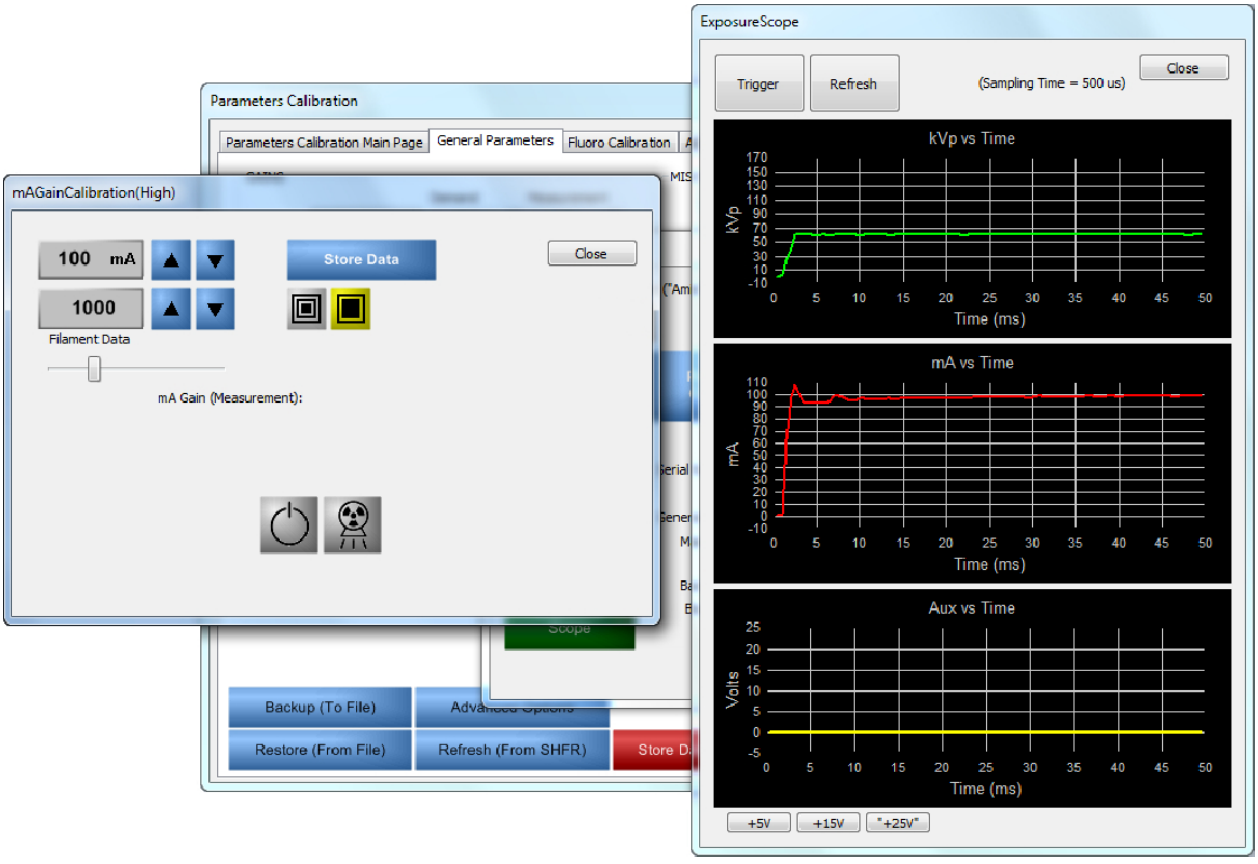
2. Make an exposure and measure kVp with a non-invasive meter or with a HV Bleeder.

3. Select on the “kV Gain Calibration” screen the measured value and press “Store Data”.

4. Press “Close” to exit. kVp is then adjusted and the “Demand” and “Measurement” values are automatically modified.

mA GAIN ADJUSTMENT

Illustration 2-11
High mA Gain calibration screen



1. Open the Exposure Scope *(refer to Section 2.2)*.

2. Press the “Parameters Calibration” button and go to the General Parameters screen.

3. Press the “Low mA Gain” button. A pop-up screen will be displayed *(refer to Illustration 2-11).*

4. Enter the Filament Data obtained for the 10 mA station previously calibrated.

5. Make an exposure and measure mA with the mA/mAs meter.

6. Select on the “mA Gain Calibration (Low)” screen the measured value of mA and press “Store Data”.

7. Press “Close” to exit. Low mA Gain is then adjusted and its value is automatically modified in the Parameters Calibration menu.

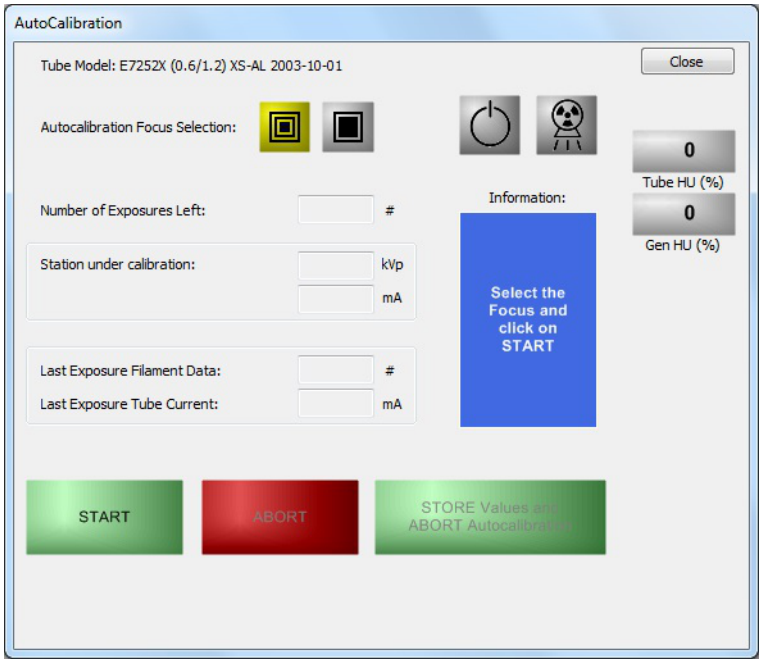
8. Repeat the same procedure for High gain, entering the Filament Data obtained for the 100 mA station previously calibrated.

9. Finally, repeat the procedure for Fluoro gain (if available).

Note ☞ *If the Automatic adjustment of the kVp and/or mA gains cannot be performed, proceed with the Manual adjustment* (refer to Section 2.11.2).

2.4 AUTOCALIBRATION

Illustration 2-12
Autocalibration screen



Autocalibration of the Filament Current data is divided in two separated procedures related to the mA stations configured for the Small or Large Focal Spots.

It is recommended to start with the Small Focal Spot and continue with the Large Focal Spot.

Autocalibration process can be carried out with any workstation selection.

If Filament Data Graph *(refer to Illustration 2-15)* is open during Autocalibration, a red curve representing the Filament Current is drawn during the process. This can be used to check if any error occurs while autocalibrating (insufficient mA, space charge, etc.). Keep in mind that keeping the Filament Data Graph open during Autocalibration makes the process slightly slower.

Exposure Scope *(refer to Section 2.2)* can be open during Autocalibration as well. kV and mA are shown in their corresponding fields every time a exposure is made but, as with the Filament Data Graph, keeping the Exposure Scope open during Autocalibration makes the process a little slower.

1. Enter in Autocalibration mode by pressing the “Autocalibration” button on the SC menu.

2. Check that the Heat Units used by the X-ray Tube are 0% or nearly so.

3. Select the **Small Focal Spot** and press the “Start” button.

4. Keep the Handswitch button fully pressed to perform continuous exposures. The “Ready” icon is lighted in green and the “Exposure” icon is lighted in yellow every time a exposure is made.

Note ☞ *In Autocalibration mode, all technique parameters are factory pre-programmed and they can not be changed.*

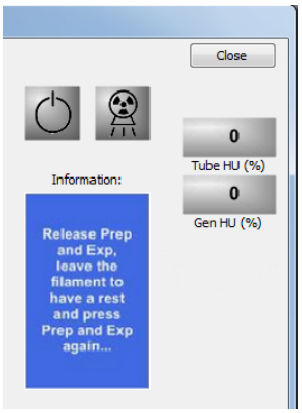
Autocalibration starts with a series of exposures, increasing the Filament data in 100 steps until reaching half of the mA of the first station to be calibrated.

Then, Autocalibration of the first kVp/mA station begins with the minimum available mA station for the selected Focal Spot at the minimum kVp and follows with all the other combinations of mA stations for the selected Focal Spot at Low, Medium and High kVp.

5. Autocalibration process is paused after every kVp station calibration, then it is mandatory to release the Handswitch, a message is shown in the screen asking to do so. Wait a few seconds and then press and hold the Handswitch again in order to continue with the calibration process.

Note ☞ *It is strongly recommended to release the handswitch and keep it released for quite a while to let the Tube to cool down (check the HU indicator) to prevent filament overheat when many stations are to be calibrated.*

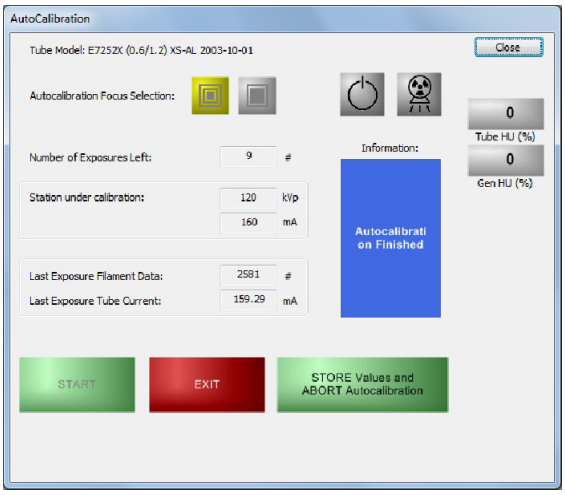
Illustration 2-13
Release the Handswitch when instructed to do so



Note ☞ *To exit Autocalibration without calibrating every station, press the "Store Values and Abort Autocalibration" button after completing the last needed station. Previously stored values will be deleted and replaced by the values calibrated so far. Non-calibrated values have to be calibrated manually* (refer to Section 2.11.1).

6. When Autocalibration ends, the message "Autocalibration Finished" is shown in the Information screen. Press the "Exit" button, all calibrated parameters will be automatically saved.

Illustration 2-14
Autocalibration completed successfully



Note ☞ *Autocalibration can be paused momentarily releasing the Handswitch button, whenever there is not an exposure in process. Press the Handswitch again to resume the Autocalibration process.*

Note ☞ *Press the "Abort" button before starting the calibration procedure to leave without losing any data previously stored. This can be made even if the "Start" button has been pressed, whenever the Handswitch has not been pressed yet.*

CAUTION ***Autocalibration can be cancelled by releasing the Handswitch and pressing the "Abort" button. All data will be lost.***

Note ☞ *If the Tube Heat Units are too high, calibration procedure will be momentarily stopped. No message will be shown on screen, just release the handswitch and wait for the Tube to cool down before pressing the handswitch again to continue with the autocalibration.*

Generator tries to calibrate each kV/mA combination in ten (10) attempts (maximum). If it is not possible to calibrate the current mA station in ten attempts, error “E60” is shown on the screen. Reset the error condition and continue with the Autocalibration procedure.

When Autocalibration is successfully performed, message “Autocalibration Finished” is shown on the screen. Press the “Exit” button and close the Autocalibration screen to go back to the SC menu or select the Large Focal Spot and press the “Start” button to continue with the other Focal Spot calibration procedure.

7. Repeat the same procedure for the **Large Focal Spot.**

Note ☞ *If any error occurs during the Autocalibration process or the Autocalibration process ends before the whole procedure is completed, refer to Section 2.11.1 for manual calibration of the remaining kV/mA combinations.*

8. After performing both procedures (for Small and Large Focal Spots), enter in “Manual Calibration” mode by pressing the “Manual Calibration” button on the SC menu, and select each combination of the available mA stations for each Focal Spot at the kV break points (Low, Medium and High kVp). Read on the “Filament Data” field the new value of the Filament Current data stored for each combination and write down the new values in the Data Book.

9. Exit from “Manual calibration” mode.

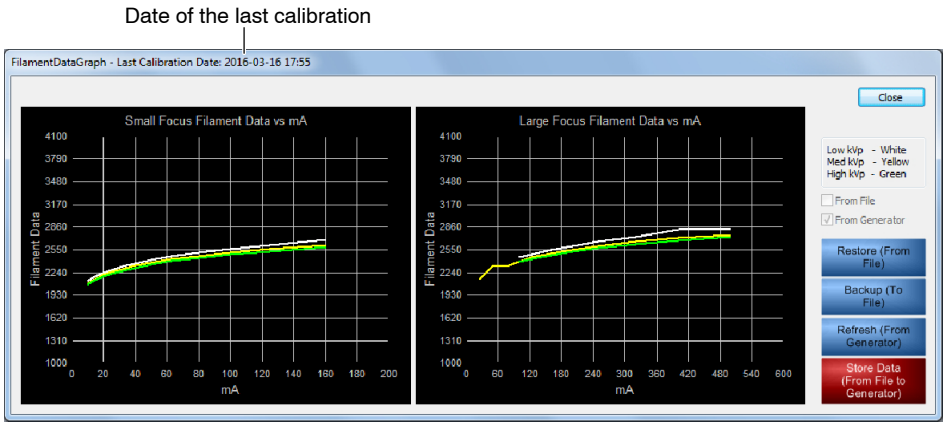
Note ☞ *The Filament Stand-by value is adjusted by the Generator during the Autocalibration process and is automatically stored. Filament Stand-by values are not field changeable.*

2.5 FILAMENT DATA CALIBRATION CHECKS AND BACKUP

1. Press the “Filament Data Graph” button to see the Filament curves of the calibrated Tube. The left graphic shows the Small Focus Filament data and the right one shows the Large Focus Filament data, with the Low kVp curve drawn in white, the Medium kVp in yellow and the High kVp in green.

2. Check that there are neither sawtooth waves nor step waves in the curves graphs. That would indicate an unreliable calibration.

Illustration 2-15
Filament Data Graph



The following operations can be performed in the Filament Data Graph screen:

- **Restore (from File):** Press to view the Filament Current data stored in a file previously saved in a computer. Data is shown on screen but not transferred to the Generator. Use this option before storing the Filament Current data in the Generator to check that the mA stations contained in the file are allowed by the licence (check “Licence info” in the SC menu) and by the Configuration of the Generator (”Min kV” and “Max mA” fields).

- **Backup (to File):** Press to make a backup copy of the Filament Current data in the computer. A file containing the calibration data will be created in the designated directory of the computer.

- **Refresh (from Generator):** Press to view the Filament Current data of the calibrated mA stations as stored in the Generator.

- **Store Data (from File to Generator):** Press to replace the Filament Current data of the Generator with the data stored in a file previously saved in a computer.

Note ☞ *The data storage process will not be completed if the file to be restored contains mA stations not allowed by the licence plugged to J17 of the A3640-XX Control board or by the Configuration of the Generator (”Min kV” and “Max mA” fields).*

2.6 FALL TIME ADJUSTMENT

Once the Autocalibration process is completed, go back to the General Parameters screen *(refer to Section 2.3.2)* to perform the Fall Time adjustment.

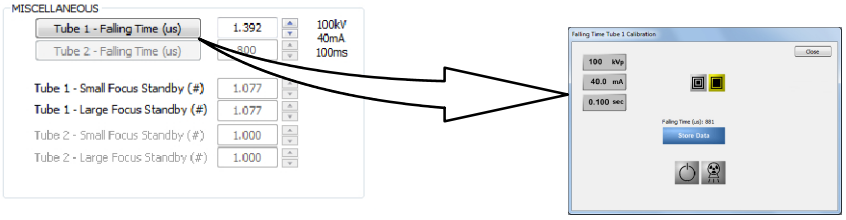
Note ☞

kVp gain and Low mA gain must be adjusted before proceeding with the Fall Time adjustment. Otherwise, the microcontroller is not able to precisely measure the cables capacity (refer to Section 2.3.2.2).

CAUTION

It is mandatory to perform the Fall Time adjustment every time the A3640-XX Control board, Tube, HV cables or HV Tank are replaced.

Illustration 2-16
Fall Time data



1. Press the “Tube 1 - Falling Time (μs)” button. A pop-up window will be displayed showing the parameters of the exposure to be made.
2. Make an exposure.
3. Press the “Store Data” button. The Fall Time value is automatically adjusted.
4. Close the pop-up window and press the “Store Data (in SHFR)” button to save the changes.

Note ☞

If the Automatic adjustment cannot be performed, proceed with the Manual adjustment (refer to Section 2.11.3).

2.7 FLUORO

This generator uses Continuous Fluoro and Pulsed Fluoro (a series of short exposures at the selected PPS).

Fluoro exposures are controlled by kV with a constant filament current. The kV values are manually (Manual mode) or automatically (ABC mode) adjusted to obtain the desired brightness (entrance dose rate) on the TV Monitor.

The Fluoro calibration consists of three different adjustments for Pulsed Fluoro and exactly the same adjustments for Continuous Fluoro (manual, automatic and boost):

- Manual at **5 R/min** (43.5 mGy/min) (maximum level of regulation limit) with a maximum Fluoro kV at **125 kV.**
- Automatic at **10 R/min** (87 mGy/min) (maximum level of regulation limit) with a maximum Fluoro kV at **125 kV.**
- Boost at **20 R/min** (174 mGy/min) (maximum level of regulation limit) with a maximum Fluoro kV at **125 kV.**

Note that, in practice, the rejection limits for entrance exposure rate must be somewhat less than the maximum specified due to Radiation Meter calibration accuracy *(refer to Table 2-2).*

Table 2-2
Rejection Limits Based on Meter Calibration Accuracy (1 Rad = 8.7 mGy)

METER CALIBRATION ACCURACY	REJECTIONS LIMITS		
	FOR 5 R/min (43.5 mGy/min) MAXIMUM	FOR 10 R/min (87 mGy/min) MAXIMUM	FOR 20 R/min (174 mGy/min) MAXIMUM
±5%	4.75 R/min (41.3 mGy/min)	9.5 R/min (82.7 mGy/min)	19 R/min (165.4 mGy/min)
±10%	4.50 R/min (39.2 mGy/min)	9.0 R/min (78.3 mGy/min)	18 R/min (156.6 mGy/min)
±15%	4.25 R/min (37.0 mGy/min)	8.5 R/min (74.0 mGy/min)	17 R/min (148.0 mGy/min)

2.7.1 PREVIOUS ADJUSTMENTS

Make sure that the X-ray tube is properly warmed-up.

1. Connect the Fluoro Pedal to the Interface board (where available) or to J23B of the A3640-XX Control board *(refer to the schematics document).*

2. Set up a Radiation Meter to measure the Maximum Skin Dose Radiation. Position the Probe at the center of the primary beam with the entire active volume within the primary beam. Place the Probe according to the Tube's position:

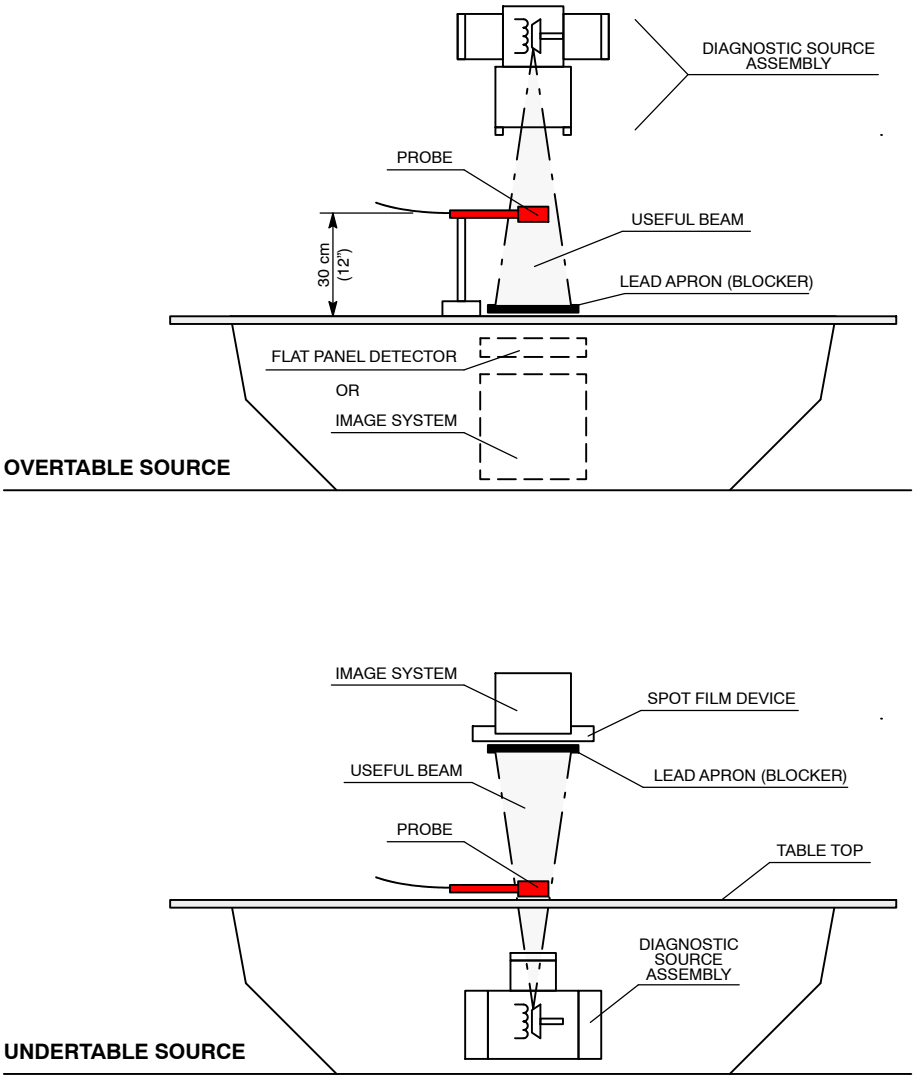
   - Overtable source systems: Position the Probe at 30 cm from the top of the Tabletop. *(refer to Illustration 2-17).*
   - Undertable source systems: Position the Probe on the Tabletop. *(refer to Illustration 2-17).*

Make sure the Probe's Sensor is positioned 30 cm from the top of the Tabletop for Overtable source systems. Some probes have sensors inside their housing that are not located at the edge of the probe. To ensure the sensor component of the probe is located 30 cm above the Tabletop refer to the measurement device's instructions on sensor placement.

3. Place the Tube-Collimator Assembly at 1 meter SID, fully open the Collimator Blades and align the Image Intensifier with the light beam. Block radiation input to Image Intensifier with a Lead Apron. *(refer to Illustration 2-17).*

If the Tabletop is not on the Table when measurements are taken, inaccurate readings will occur. If inaccurate readings are used during the calibration process, exposure levels in excess of what is considered acceptable by the local regulation could occur.

Illustration 2-17
Fluoro Entrance Exposure Rate Test Set-up



4. Make sure the configuration options are selected as follows *(refer to the Configuration document):*

   - "ABC Input Selection: None".
   - "Synchronism Source: Int"

Note ☞ *ABC Input Selection and Synchronism Source options must be configured according to the customer's equipment once the fluoro calibration procedure is finished.*

5. Before starting the Fluoro calibration procedure, it is necessary to select the minimum and maximum PPS and the maximum pulse width at maximum PPS. For that purpose, press the “Parameters Calibration” button on the SC menu and go to the Fluoro Calibration screen.

6. Select the minimum PPS to be used for Pulsed Fluoro. If Continuous Fluoro is to be used, this field selection has to be set to 0, no matter the minimum PPS for Pulsed Fluoro. If a value different from 0 is selected, the “Continuous Fluoro” fields are automatically disabled.

7. Select the maximum PPS to be used for Pulsed Fluoro. If minimum and maximum PPS are both set to 0, the “Pulsed Fluoro” fields are automatically disabled.

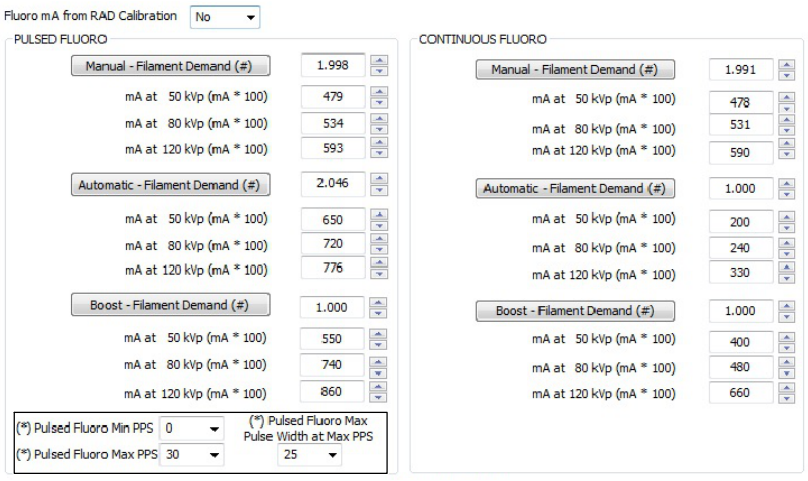
8. Select the maximum pulse width for maximum PPS.

9. Finally, select the desired option in the “Fluoro mA from RAD Calibration” field:

   a. Select “No” for only fluoro Generators or in case the RAD calibration has not been performed yet.

   b. Select “Yes” if the RAD calibration has been already performed. Thus, only the Filament demand has to be adjusted and the mA values are automatically calculated by the Generator using the previously calibrated mA RAD stations.

Illustration 2-18
Fluoro calibration fields



10. Press the “Store Data (In SHFR)” button to save the changes.

11. Close the Parameters calibration window and press the “Reboot Generator” button to apply the new settings.

12. Once the Generator is rebooted, start with the calibration procedure.

2.7.2 FLUORO CALIBRATION

Note ☞ *If the Fluoro calibration cannot be performed, proceed with the Manual adjustment* (refer to Section 2.11.4).

Note ☞ *There is no need to configure a workstation with fluoro to perform this calibration procedure.*

2.7.2.1 PULSED FLUORO

MANUAL PULSED FLUORO

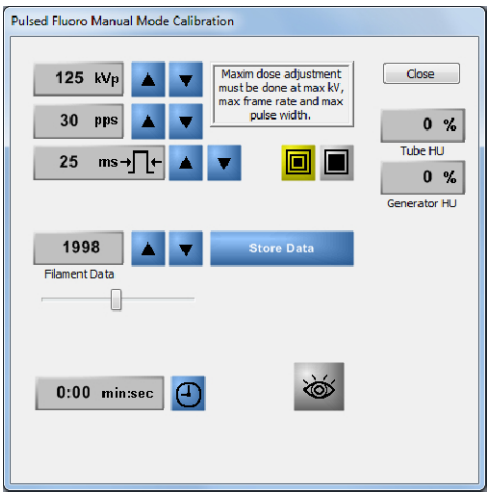
1. Press the “Parameters Calibration” button on the SC menu and go to the Fluoro Calibration screen.

Manual - Filament Demand (#)

2. Press the “Manual - Filament Demand” button on the Pulsed Fluoro area. A pop-up window will be displayed.

3. Select **maximum kVp, maximum PPS and maximum pulse width.**

Illustration 2-19
Fluoro calibration screen



4. Press the Fluoro pedal and measure the exposure rate. It should not be over the Rejection Limits for **5 R/min** *(refer to Table 2-2).* Modify the “Filament Data” value taking into account that radiation increases when the value is increased and decreases when it is decreased.

5. Measure the exposure rate again and modify the value as many times as needed to accurately calibrate the exposure rate.

6. Press “Store Data” once the exposure rate is calibrated.

Note ☞ *Make exposures of, at least, 3 seconds to make sure that the mA are stable.*

7. Go to step 15. and close the pop-up window if “Yes” was selected in the “Fluoro mA from RAD Calibration” field or continue with step 8. if “No” was selected in that same field.

8. Connect a mA/mAs meter to TP85 and TP86 of the Control board for mA measurement.

9. Select **50 kVp**.

10. Press the Fluoro pedal and write down the mA as measured in the mA/mAs meter.

11. Repeat the previous step for **80 and 120 kVp.**

12. Close the pop-up window.

13. Enter the previously measured mA multiplied by 100 in their respective fields for 50, 80 and 120 kVp of the Manual Pulsed Fluoro area on the Fluoro Calibration screen.

14. Once the automatic adjustment for Manual Pulsed Fluoro is completed, proceed to perform the automatic adjustment for Automatic Pulsed Fluoro.

AUTOMATIC PULSED FLUORO

15. Press the “Automatic - Filament Demand” button on the Pulsed Fluoro area. A pop-up window will be displayed.

16. Select **maximum kVp, maximum PPS and maximum pulse width.**

17. Press the Fluoro pedal and measure the exposure rate. It should not be over the Rejection Limits for **10 R/min** *(refer to Table 2-2).* Modify the “Filament Data” value taking into account that radiation increases when the value is increased and decreases when it is decreased.

18. Measure the exposure rate again and modify the value as many times as needed to accurately calibrate the exposure rate.

19. Press “Store Data” once the exposure rate is calibrated.

20. Go to step 27. and close the pop-up window if “Yes” was selected in the “Fluoro mA from RAD Calibration” field or continue with step 21. if “No” was selected in that same field.

21. Select **50 kVp**.

22. Press the Fluoro pedal and write down the mA as measured in the mA/mAs meter.

23. Repeat the previous step for **80 and 120 kVp.**

24. Close the window.

25. Enter the previously measured mA multiplied by 100 in their respective fields for 50, 80 and 120 kVp of the Automatic Pulsed Fluoro area on the Fluoro Calibration screen.

26. Once the automatic adjustment for Automatic Pulsed Fluoro is completed, proceed to perform the automatic adjustment for Boost Pulsed Fluoro.

BOOST PULSED FLUORO

27. Press the “Boost - Filament Demand” button on the Pulsed Fluoro area. A pop-up window will be displayed.

28. Select **maximum kVp, maximum PPS and maximum pulse width.**

29. Press the Fluoro pedal and measure the exposure rate. It should not be over the Rejection Limits for **20 R**/**min** *(refer to Table 2-2).* Modify the “Filament Data” value taking into account that radiation increases when the value is increased and decreases when it is decreased.

30. Measure the exposure rate again and modify the value as many times as needed to accurately calibrate the exposure rate.

31. Press “Store Data” once the exposure rate is calibrated.

32. Go to step 38. and close the pop-up window if “Yes” was selected in the “Fluoro mA from RAD Calibration” field or continue with step 33. if “No” was selected in that same field.

33. Select **50 kVp**.

34. Press the Fluoro pedal and write down the mA as measured in the mA/mAs meter.

35. Repeat the previous step for **80 and 120 kVp.**

36. Close the window.

37. Enter the previously measured mA multiplied by 100 in their respective fields for 50, 80 and 120 kVp of the Boost Pulsed Fluoro area on the Fluoro Calibration screen.

38. Once the automatic adjustment for Boost Pulsed Fluoro is completed, proceed to perform the automatic adjustment for Continuous Fluoro in case it is going to be used. Otherwise, fluoro calibration is finished and ABC Input Selection and Synchronism Source options must be configured according to the customer's equipment *(refer to the Configuration document).*

2.7.2.2 CONTINUOUS FLUORO

Continuous Fluoro calibration is carried out as for Pulsed fluoro. Just take into account that the parameters selection varies according to the Fluoro operation mode. Therefore, only kVp selection is available in the pop-up window and PPS is set, by default, to 0.

39. Calibrate manual, automatic and boost adjustments for Continuous Fluoro as explained in *Section 2.7.2.1* for Pulsed Fluoro, steps 1. to 37.

40. Remove the Radiation Meter. Connect the Detector power supply or unblock radiation input to Detector.

2.8 AEC

This section describes the adjustments needed to calibrate the AEC according to the customer input. Therefore, AEC exposures will be made during the calibration process in order to insure AEC functionality.

The Optical Density/Dose Level is controlled by the values stored in the generator memory. These values are influenced by film speed, screen speed, dark room procedures and customer requirements.

Use a homogeneous Phantom with enough density to produce an exposure of 100 ms. The AEC will be calibrated to produce a density of 1.0 (or the customer preference Optical Density/Dose Level):

- Filtration based on the RQA5 standard (21 mm Al) for the Collimator Filter Holder (recommended for AEC/ABC calibration).
- Copper Plates can be used Instead of Aluminum:
  2 units of 1 mm thickness,
  1 unit of 0.5 mm thickness,
  2 units of 0.2 mm thickness,
  1 unit of 0.1 mm thickness.
- Acrylic Plastic Plates can be used Instead of Copper Plates:
  6 units of 5 cm. thickness,
  5 units of 1cm. thickness.

Note ☞ *For AEC calibration with Film, use the same Film and Cassettes used by the customer. AEC calibration must be performed using all the Film/Screen speed combinations that are going to be used by the customer. The Medium Film/Screen speed has to be double of the Slow and half of the Fast (a.e. 200-Slow, 400-Medium, 800-Fast).*

Note ☞ *When using CR (Computed Radiography) or DR (Digital Radiography) calibrate the sensitivities used by the customer and instead of measuring Optical Density:*

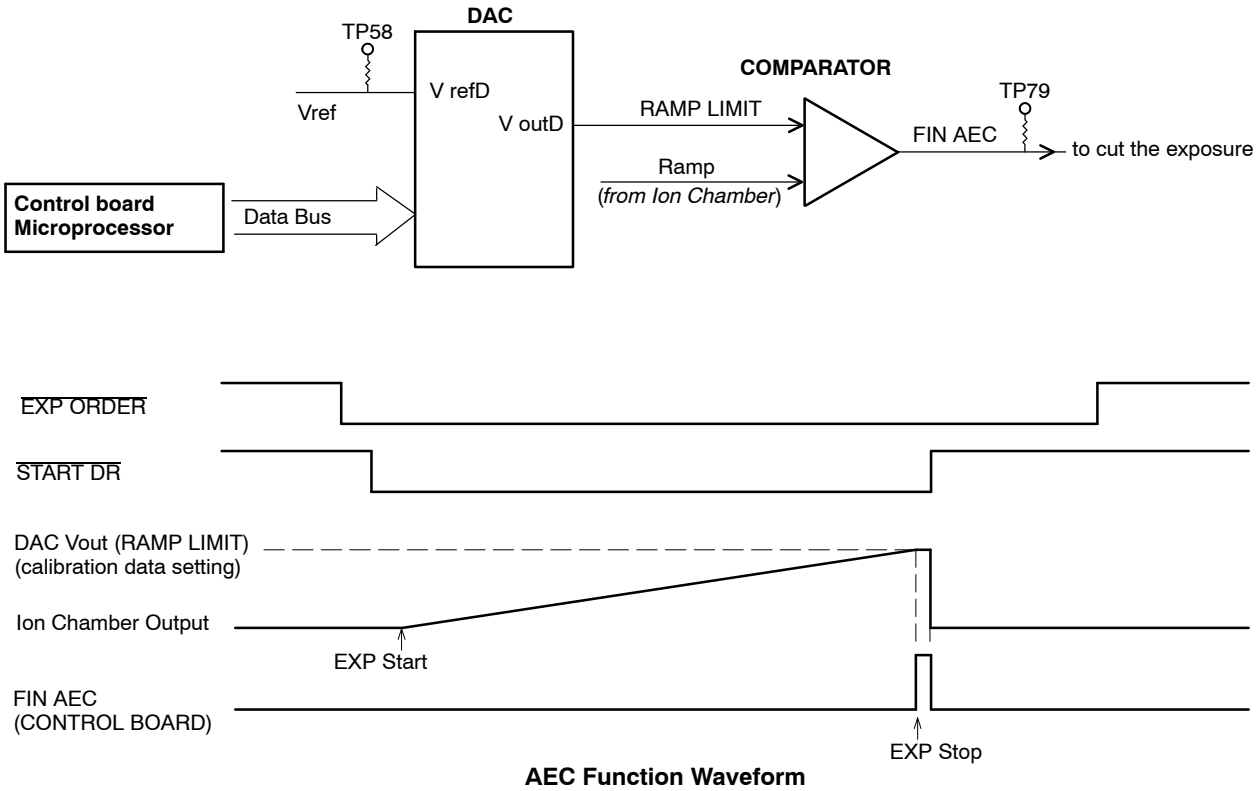
- measure the Image Gray level by using the needed software tools inside each application (refer to CR or DR documentation).

- or measure the Dose level:

- For CR, placing the Dosimeter as close as possible to the Cassette and centered with the Central Area of the Ion Chamber.

- For DR, placing the Dosimeter as close as possible to the Panel, centered with the Central Area of the Ion Chamber and with the Grid removed.

Illustration 2-20
Automatic Exposure Control



AEC Function Waveform

2.8.1 PREVIOUS CHECKS

CAUTION

Before starting with the AEC Calibration, it is necessary that the Alignment of X-Ray Beam and the Alignment of Light Field with X-Ray Field should be performed.

Make sure the automatic processor works correctly, and the concentration and temperature of the solutions comply with manufacturer specifications.

Obtain a sensitometric curve to determine gamma (γ) of the film and the solution quality. The procedure normally requires a sensitometer, but if it is not available proceed as follows:

1. Make two exposures using the same kV and Film/Screen combination (medium is recommended) but with different mAs settings, mAs(f1) and mAs(f2).

2. Develop and measure the Density (d) of each, d(f1) and d(f2).

3. Determine gamma (γ) by the formula:

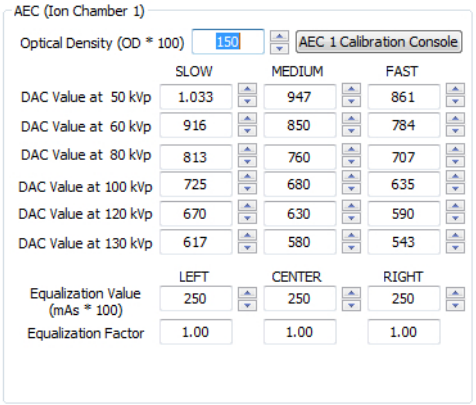
$$\gamma = \frac{d(f2) - d(f1)}{log_{10} \frac{mAs(f2)}{mAs(f1)}}$$

Gamma (γ) must be between 2 and 3, if not change or renew solutions.

2.8.2 AEC CALIBRATION

1. Press the “Parameters Calibration” button on the SC menu and go to the AEC Calibration screen.

Illustration 2-21
AEC calibration screen



2. If the Ion Chamber has the following switches or potentiometers, set them to mid range (Refer to the Ion Chamber documentation):

   - Master Gain switch or potentiometer
   - Balance potentiometers for the Three Field Detectors (cells)

Note ☞ *This section describes the AEC calibration using the Service Console. AEC can be calibrated using the Ion Chamber potentiometers as well* (refer to the Ion Chamber documentation).

3. Set the SID at any Focal Distance from 1 to 2 meters (39 to 78 inches).

4. Collimate the X-ray beam so that it completely covers all three fields.

5. Add a filtration based on the RQA5 standard (21 mm Al) in the Collimator Filter Holder.

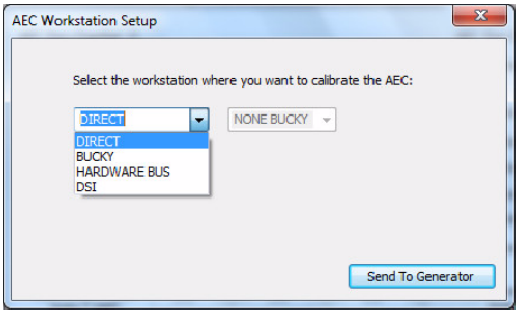
Note ☞ *Make sure that the X-ray beam does not extend beyond the limits of the phantom if it is placed on the tabletop of the Table or on the Wall Stand front panel instead of being placed in the Collimator Filter Holder.*

6. Set the Optical Density/Dose Level to the desired value in the “Optical Density (OD * 100)” field. A value of 100 is equal to an Optical Density/Dose Level of 1. Value can be set from 100 to 500.

Illustration 2-22
Optical Density

7. Click on the “AEC 1 Calibration Console” button. A pop-up window with the available Workstations for the AEC calibration will be displayed.

Illustration 2-23
AEC Workstation Setup

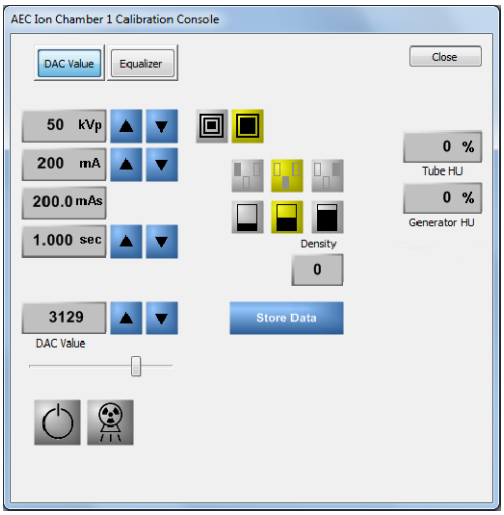


8. Select the Workstation where the AEC is going to be calibrated and click on “Send To Generator”.

9. The Calibration Console is now displayed. Select:

   - RAD: 50 kV, 200 mA, Large Focal spot and 1 second back-up time.
   - AEC: Select the Film/Screen combination to be calibrated. “Central Area” and “Density 0” are selected by default.

Illustration 2-24
AEC calibration menu



10. **For analog buckys:**

    a. Make an exposure with film in the cassette (exposure time varies if film is removed) and make sure the exposure time is within 40 and 100 ms. Modify the mA selection as needed in case the time is out of this boundaries. Time will be increased when decreasing the mA selection and vice versa. Make as many exposures as needed using the same film to get the desired exposure time.

    b. Insert into the Bucky tray a cassette with the Film-Screen combination used by the customer. Make an exposure, develop the film and check the density, it should be approximately 0.8 to 1.2 (or the customer's density preference).

    c. Increase the value in the "DAC Value" field in case it is needed to increase the density or decrease the value if the measured density is too high. When modifying this value, exposure time could change. Modify the mA selection as needed and make a new exposure using the same film to check that the exposure time is within 40 and 100 ms.

d. Make an exposure with new film in the cassette to check the density again.

e. Repeat steps b. and c. as many times as needed until getting the desired density and click on the “Store data” button.

f. Go to step 12.

11. **For Digital Detectors:**

a. Make an exposure with the previously selected values, as explained in step 7., and measure the Dose level.

b. Increase the value in the “DAC Value” field in case it is needed to increase the density or decrease the value if the measured density is too high. Time must be always within 40 and 100 ms, modify the mA selection as needed in case the time is out of this boundaries. Time will be increased when decreasing the mA selection and vice versa.

c. Repeat steps a. and b. as many times as needed to accurately calibrate the “DAC value” and click on the “Store data” button.

d. Go to step 12.

12. Repeat the previous procedure for 60, 80, 100, 120 and 130 kVp.

Note ☞ *If the Generator maximum kV are lower than 130, use the same DAC value obtained for 120 kVp to calibrate the 130 kVp station.*

Note ☞ *Adjust the potentiometers of the Ion Chamber if unable to get an exposure time within 40 and 100 ms for every kVp station.*

13. Repeat the whole procedure for the remaining film/screen speed combinations.

2.8.3 EQUALIZATION

Note ☞ *Make sure to keep the same SID during the whole process and that the Exposure field covered by the X-ray beam remains constant.*

Once the Central Area is calibrated, it is needed to calibrate the Left and Right Ion Chamber fields by adjusting the Equalization value. The equalization Factor remains constant for the Central Area and is automatically adjusted for the Left and Right Areas when modifying their respective Equalization value.

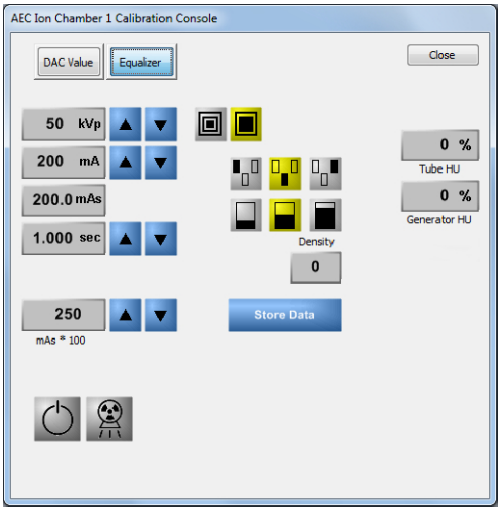
CAUTION

The equalization Factor for the Left, Center and Right areas must be set to 1.00 before starting this process.

Illustration 2-25
Equalization Factor before starting the Equalization procedure

For the Left and Right Ion Chamber fields calibration, perform the following procedure:

1. Click on the “Equalizer” button in the “AEC 1 Calibration Console” screen.



2. Select 80 kVp and Central Area and make an exposure to get a mAs value close to 2.5.

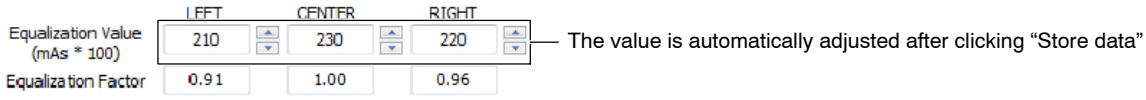
Note ☞ *It is recommended to make three exposures with the same parameters and calculate the average mAs value for a more accurate calibration.*

3. Enter the obtained mAs multiplied by 100 in the “mAs * 100” field (must be close to 2.5) and click on the “Store data” button.

4. Make the same exposure/s with the Left Area and, finally, with the Right Area selected, storing their respective mAs values after the exposures. The equalization factor is then automatically adjusted so the same mAs is obtained with every exposure, no matter which field or combination of fields is selected.

5. Click “Close” to exit the “AEC 1 Calibration Console”.

Illustration 2-26
Equalization Value



6. Repeat the whole calibration and equalization procedures for AEC 2 if a second Ion Chamber is to be used, clicking on the “AEC 2 Calibration Console”.

2.9 BACKUP AND RESTORE DATA

Once the Calibration process has finished, it is recommended to make a backup copy of the Calibration data. It is possible to save a backup of all the Calibration data or just a part of it.

COMPLETE CALIBRATION BACKUP AND RESTORATION

To save all the calibration data in the computer, go to the Parameters Calibration Main Page and press the “Complete Parameters Calibration Backup (To File)” button. A file containing the calibration data will be created in the designated directory of the computer.

To restore a complete calibration:

1. Go to the Parameters Calibration Main Page and press the “Complete Parameters Calibration Store (From File to Generator)” button.
2. Select the folder that contains the file with the data and open it.
3. Wait until the confirmation message is displayed on screen.

This is especially useful to restore an old calibration or to copy the calibration data to the U66-EEPROM of a new Generator instead of removing the EEPROM from the socket of the old Generator to fit it in the new one.

PARTIAL CALIBRATION BACKUP AND RESTORATION

To save just part of the calibration data, go to one of the Parameters Calibration screens and press the “Backup (To File)” button to save in the computer the calibration data contained in that screen. A file containing the calibration data will be created in the designated directory of the computer.

Note ☞ *It is recommended to press the “Refresh (From SHFR)” button before pressing the “Backup (To File)” button to ensure that the created backup file matches exactly the calibration of the generator.*

To recover the data saved on the file:

1. Press the “Restore (From File)” button.
2. Select the folder that contains the file with the data and open it.
3. Check that the restored file contains the desired data and press the “Store Data (in SHFR)” button to apply the changes.

This is especially useful to restore part of the calibration data when some other values have to be recalibrated, e.g. to restore just the AEC data when the A3640-XX Control board has to be replaced.

2.10 FINAL CHECKS

1. Verify that all configuration and calibration data have been properly stored:

- Go to the Configuration window and press the “Refresh (from SHFR)” button on every screen to check that all the configuration parameters stored in the Generator are correct.
- Go to the Parameters Calibration window and press the “Refresh (from SHFR)” button on every screen to check that all the calibration parameters stored in the Generator are correct.
- Go the the Filament Data Graph screen and press the “Refresh (from Generator)” button to check that calibration of the Filament Current data is correct for both focal spots.

2. Turn off the Generator and check that Dip switches are set as indicated in Section 1.1 of the Configuration document:

- A3640-XX Control board:
  - **3640SW2:** All its switches in **On** position.
  - **3640SW6:** All its switches in **Off** position once the calibration and configuration procedures are finished.
  - **3640SW7:** All its switches in **On** position.
- S0008009 Dual Speed Starter:
  - **S0008009S1:** All its switches but S0008009S1-2 in **Off** position. Dip switch S0008009S1-2 in **On** position.

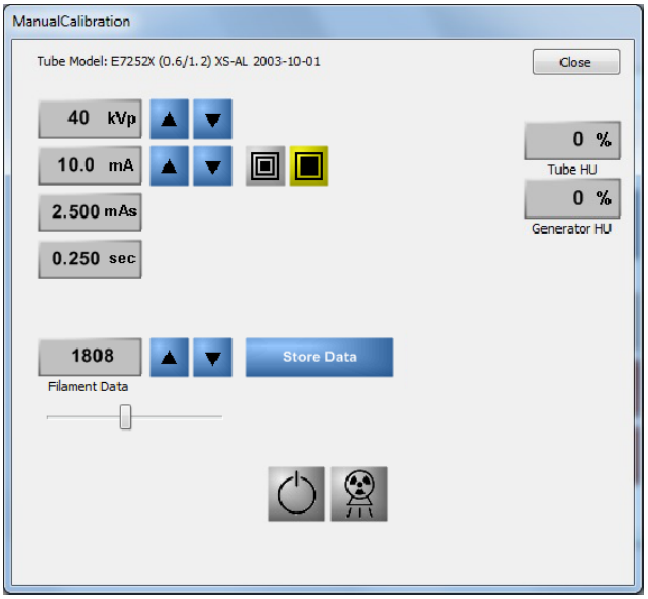
3. Once the calibration and configuration procedures are completed, it is strongly recommended to save a general backup in the computer in case it is needed to be restored in the future *(refer to Section 2.2 on the Configuration document).* Write down in the Data Book the name and location of the folder containing the backup files.

2.11 MANUAL CALIBRATION PROCEDURES

Note ☞ *Perform the procedures explained in this section only if the Automatic procedures cannot be done or if specifically indicated in the previous sections of this document.*

2.11.1 MANUAL CALIBRATION

Illustration 2-27
Manual calibration screen



This procedure describes the Manual calibration of all the Filament Current data. To enter in Manual mode press the “Manual Calibration” button on the SC menu.

Note ☞ *Manual Calibration has to be performed before the Gains calibration (in case it is needed and just for the needed mA stations) and to calibrate the kV/mA combinations not performed during Autocalibration procedure if it has not been completed. These combinations have the Filament Current data set to “1000”, so only these combinations have to be manually calibrated as described in this procedure.*

If Autocalibration for one of the Focal Spots has been successful, it is only required to perform the manual calibration of the mA stations that have not been calibrated for the other Focal Spot.

Manual Calibration is initiated at the Low kVp break point by entering the appropriate Filament Current data for the proper tube current at each selectable mA. Calibration at the other kV break points (Low, Medium and High kVp) are obtained by adding or subtracting values as indicated in Table 2-3.

Although the suggested values *(refer to Table 2-3)* could change depending on the X-ray tube used, entering those values will approximate accurate calibration without making excessive exposures.

Table 2-3
mA Calibration Data Change

mA STATION	FILAMENT CURRENT DATA AT kV BREAK POINT		
	Low kVp	Medium kVp	High kVp
10	A_1	A_1-30	A_1-45
12.5	A_2	A_2-30	A_2-45
16	A_3	A_3-30	A_3-45
20	A_4	A_4-30	A_4-45
25	A_5	A_5-30	A_5-45
32	A_6	A_6-30	A_6-45
40	A_7	A_7-30	A_7-45
50	A_8	A_8-30	A_8-45
63/64/65*	A_9	A_9-30	A_9-45
80	A_{10}	A_{10}-30	A_{10}-45
100	A_{11}	A_{11}-50	A_{11}-70
125	A_{12}	A_{12}-50	A_{12}-70
160	A_{13}	A_{13}-50	A_{13}-70
200	A_{14}	A_{14}-50	A_{14}-70
250	A_{15}	A_{15}-50	A_{15}-70
320	A_{16}	A_{16}-70	A_{16}-100
400	A_{17}	A_{17}-70	A_{17}-100
500	A_{18}	A_{18}-70	A_{18}-100
630/640/650*	A_{19}	A_{19}-70	A_{19}-100
800	A_{20}	A_{20}-70	A_{20}-100
1000	A_{21}	A_{21}-70	A_{21}-100

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

** Configurable under requirement*

In “Manual Calibration” mode, the Filament Current data is shown on the “Filament Data” box after selecting the respective kV/mA combination. The value can be changed by pressing the “Increase” or “Decrease” buttons and stored by pressing the “Store Data” button.

Note that in Manual calibration mode, only the mA stations and kV (at the break points) can be selected.

1. With the Generator power OFF, remove the link between TP85 and TP86 on the Control board and connect the mA/mAs meter to TP85 and TP86 to measure mAs.

2. Turn the Generator ON and enter in Manual calibration mode by pressing the “Manual Calibration” button on the SC menu.

3. Check that the Heat Units used by the X-ray Tube are 0% or nearly so.

4. According to X-ray tube ratings or maximum Generator power, check which kV/mA combinations in Table 2-3 are allowed.

   If an intermittent beep sounds after selecting a kV/mA combination, it means this particular combination is not allowed for the selected X-ray Tube or the Generator power is exceeded by this combination.

   Note which combinations in Table 2-3 can not be calibrated by making exposures (combinations not allowed due to Tube rating, maximum Generator power, space charge, etc.).

5. Select the lowest kV/mA combination available that was not automatically calibrated (Filament Data set to “1000”). Enter the Filament Current data of the previous mA station for the same kV **increased in 40.**

Note ☞

If Autocalibration has not been performed before initiating the Manual calibration or no kV/mA combination has been calibrated for any reason, it is recommended to start the Manual calibration by selecting 40 kV and the lowest mA station available. Start increasing the Filament Data in 100 steps, making exposures and calculating the mA based on the measured mAs. Then, increase the Filament data in 10 points for every mA that is needed to be increased (only when calibrating mA stations lower than 25 mA) and make another exposure. Adjust the Filament data to obtain the desired mAs and proceed to calibrate the rest of the desired kV/mA stations using the Filament data of the calibrated station as a reference and Table 2-3 as a guide, as explained in this section.

6. Make an exposure. The mAs read on the mA/mAs meter must be the same mAs displayed on the calibration screen with a tolerance of ± 0.1 mAs (tolerance of the parameter and mA/mAs meter).

7. If the mAs is low, increase the filament data. If the mAs is high, decrease the filament data. Repeat until the mA station is calibrated. Press the "Store Data" button once the kV/mA station is calibrated.

Note ☞ *Press the "Store Data" button to store the new data (Filament Current) before selecting the next kV or mA stations.*

CAUTION

Filament data (currently in memory) may or may not be close to your requirements. If it is not close, the potential exists to damage the X-ray tube (i.e. too much mA). Thus, as the mA calibration procedure starts, note how close or how far from the mA break points you are. If a large adjustment (more than 40 points) is required at the low mA stations, make estimated adjustments to the high mA stations before those exposures are made.

8. Select the next mA station at Low kVp, increase in 40 the Filament Current data calibrated for the previous mA station and repeat steps 6. and 7.

Note ☞ *To make calibration easier, Filament Data is kept the same when moving up or down one mA or kVp station after storing a new Filament value.*

To check the real value of a kVp/mA combination consecutive to the combination that has been just stored, select the kVp/mA combination to be checked, then, select the next or the previous kVp or mA station and return to the kVp/mA combination to be checked.

9. Complete the calibration process for all mA stations at Low kVp as described before.

   The new values stored for the calibrated mA stations appear in the "Filament Data" field when selecting the desired station. Write down the new values stored for each mA station at Low kVp in the Data Book.

10. Select the kV/mA combinations not allowed for Low kVp and store as their Filament data the value of the previous mA station increased in 40.

11. Complete the calibration process for the remaining kV/mA combinations at Medium and High kVp **using Table 2-3 as a guide.** It is not necessary to make exposures to do so. Compute the value for all the kV break points of each available mA station, even for those combinations that are not reachable due to the Generator power limit. Select the corresponding kV/mA combination and enter the computed value.

12. Check calibration at all break points (making exposures) and correct any Filament data as needed.

Note ☞ *If "Tube Overload" error is shown directly after the selection of an allowed combination (refer to step-4.), wait until the X-ray tube anode cools down to permit the calibration of the mA station.*

13. Recalculate the values of the non-allowed combinations in accordance to the new values obtained by exposures. (*Refer to Table 2-3*).

14. Exit from Manual Calibration and enter in user mode by pressing the "User Console" button on the SC menu. Select the nearest allowed kVp value to each kV/mA combination not allowed (keeping the same mA). Check calibration at these kV/mA combinations by making exposures. If needed, enter in Manual Calibration mode and correct the Filament Current data of the respective non-allowed kV/mA combination.

15. Exit from the "User Console" screen and enter in Manual Calibration mode, select each combination of the available mA stations at the kV break points (Low, Medium and High kVp). Read on the "Filament Data" box the final value of the Filament Current data stored for each combination. Write down the final values in the Data Book.

16. Exit Manual Calibration mode.

17. Make a backup copy of the Filament Current data *(refer to Section 2.5).*

18. After calibration of Filament Current data:

    - Switch the Generator power OFF.
    - Disconnect the mAs Meter from TP85 and TP86 on the Control board.
    - Re-install the link between TP85 and TP86.

2.11.2 GAINS MANUAL ADJUSTMENT

Note ☞ *Perform the Manual adjustment only if the Automatic adjustment cannot be done.*

kVp GAIN ADJUSTMENT

1. Go to the User Console by pressing the “User Console” button on the SC menu, select 80 kVp and the lowest mA station of the Generator (previously calibrated), make an exposure and read the kVp measured with the non-invasive kVp meter or with a HV Bleeder.
2. Exit the “User Console” screen and enter in the General Parameters screen of the Parameters Calibration window.
3. **Increase** the kVp gain in the Demand field if the value measured is **lower** than the one selected or **decrease** the gain if the value measured is **higher.**
4. Press the “Store Data (in SHFR)” button to save the changes and check again.
5. Repeat the process as many times as necessary to accurately calibrate the kVp gain. kVp and mA selection remains the same, there is no need to go to the User Console again.

mA GAIN ADJUSTMENT

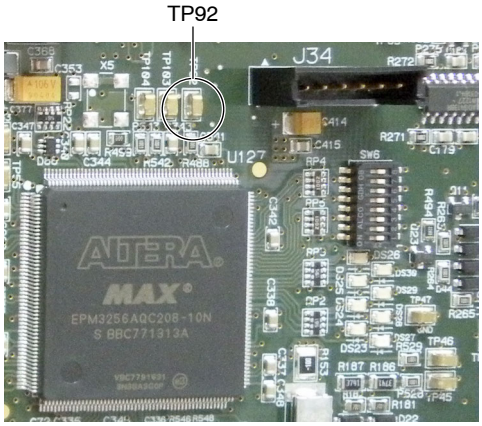
1. Go to the “User Console“ screen, make an exposure with 10 mA (previously calibrated) and long exposure time (at least 2 seconds), and measure the value with the mA meter.
2. Exit the “User Console” screen and enter in the General Parameters screen of the Parameters Calibration window.
3. **Increase** the Low mA gain if the value measured is **higher** than the one selected or **decrease** the gain if the value measured is **lower.**
4. Press the “Store Data (in SHFR)” button to save the changes and check again.
5. Repeat the process as many times as necessary to accurately calibrate the Low mA gain.
6. Repeat the process for High mA gain calibration with the 100 mA station previously calibrated selected and, finally, with the 8 mA station (if available) for Fluoro mA gain calibration.

2.11.3 FALL TIME MANUAL ADJUSTMENT

Note ☞ *Perform the Manual adjustment only if the Automatic adjustment cannot be done.*

1. Use an oscilloscope to check the XOn signal (TP92) and kVp (TP54).

Illustration 2-28
TP92 in Control board



2. Enter in User mode and select 100 kVp, 40 mA and 40 ms (less time selection could result in a non-precise mA measurement).

3. Check the elapsed time since the kV start falling from 100% until they reach 75% using the XOn signal measured in TP92 as a reference.

4. Write down the time in μs and insert the data in the “Fall Time” field in the General Parameters screen of the Parameters Calibration window *(refer to Illustration 2-29).*

5. Make a short exposure (e. g. 20 mA and 5 ms) and check that the exposure time is correct.

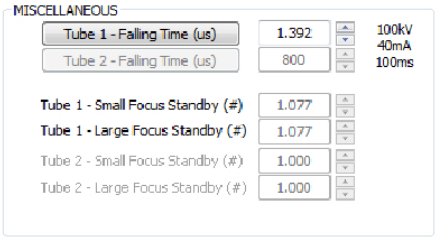
6. **Increase** the Fall Time data if the exposure time measured is **higher** than the one selected or **decrease** the data if the time measured is **lower.**

7. Make different exposures increasing and decreasing the mA and check that the cut-off point at 75% is always the same.

8. Adjust the Fall Time value if needed until the cut-off point at 75% is the same for any parameters selection.

9. Press the “Store Data (in SHFR)” button to save the changes.

Illustration 2-29
Fall Time data



2.11.4 FLUORO MANUAL CALIBRATION

Note ☞ *Perform the Manual calibration only if the Automatic adjustment cannot be done.*

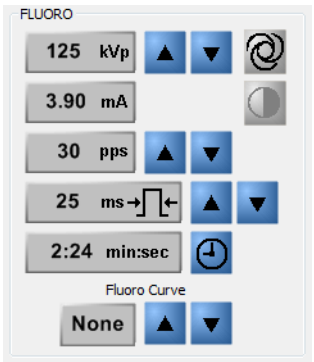
Note ☞ *Make sure to have a workstation configured for fluoro (STD R&F) to perform this calibration procedure.*

2.11.4.1 PULSED FLUORO

1. Go the the User Console screen to start the Pulsed Fluoro calibration procedure.

2. Select the Workstation configured for Fluoro operation and select **maximum kVp, maximum PPS and maximum pulse width** in the Fluoro fields of the User Console screen.

Illustration 2-30
Fluoro parameters



MANUAL PULSED FLUORO

3. Press the Fluoro pedal and measure the exposure rate. It should not be over the Rejection Limits for **5 R/min** *(refer to Table 2-2).* Modify the "Manual - Filament Demand" value of the Pulsed Fluoro area in the Fluoro Calibration screen of the Parameters Calibration window, taking into account that radiation increases when the value is increased and decreases when it is decreased.

4. Measure the exposure rate again and modify the value as many times as needed to accurately calibrate the exposure rate.

Note ☞ *Make exposures of, at least, 3 seconds to make sure that the mA are stable.*

5. Go to step 12. and close the pop-up window if "Yes" was selected in the "Fluoro mA from RAD Calibration" field or continue with step 6. if "No" was selected in that same field.

6. Connect a mA/mAs meter to TP85 and TP86 of the Control board for mA measurement.

7. Select **50 kVp** in the respective Fluoro field of the User Console.

8. Press the Fluoro pedal and check the mA as measured in the mA/mAs meter.

9. Enter the measured mA multiplied by 100 in the "mA at 50 kVp (mA * 100)" field of the Manual Pulsed Fluoro area in the Fluoro Calibration screen of the Parameters Calibration window.

10. Repeat steps 8. and 9. for **80 and 120 kVp.**

11. Once the adjustment for Manual Pulsed Fluoro is completed, proceed to perform the adjustment for Automatic Pulsed Fluoro.

AUTOMATIC PULSED FLUORO

12. Press the “Automatic Fluoro” icon on the “User Console” to select Automatic Fluoro.

13. Press the Fluoro pedal and measure the exposure rate. It should not be over the Rejection Limits for **10 R/min** *(refer to Table 2-2).* Modify the “Automatic - Filament Demand” value of the Pulsed Fluoro area in the Fluoro Calibration screen of the Parameters Calibration window, taking into account that radiation increases when the value is increased and decreases when it is decreased.

14. Measure the exposure rate again and modify the value as many times as needed to accurately calibrate the exposure rate.

15. Go to step 21. and close the pop-up window if “Yes” was selected in the “Fluoro mA from RAD Calibration” field or continue with step 16. if “No” was selected in that same field.

16. Select **50 kVp** in the respective Fluoro field of the User Console.

17. Press the Fluoro pedal and check the mA as measured in the mA/mAs meter.

18. Enter the measured mA multiplied by 100 in the “mA at 50 kVp (mA * 100)” field of the Automatic Pulsed Fluoro area in the Fluoro Calibration screen of the Parameters Calibration window.

19. Repeat steps 17. and 18. for **80 and 120 kVp.**

20. Once the adjustment for Automatic Pulsed Fluoro is completed, proceed to perform the adjustment for Boost Pulsed Fluoro.

BOOST PULSED FLUORO

21. Press the “Boost Fluoro” icon on the “User Console” to select Automatic Fluoro.

22. Press the Fluoro pedal and measure the exposure rate. It should not be over the Rejection Limits for **20 R/min** *(refer to Table 2-2).* Modify the “Boost - Filament Demand” value of the Pulsed Fluoro area in the Fluoro Calibration screen of the Parameters Calibration window, taking into account that radiation increases when the value is increased and decreases when it is decreased.

23. Measure the exposure rate again and modify the value as many times as needed to accurately calibrate the exposure rate.

24. Go to step 29. and close the pop-up window if “Yes” was selected in the “Fluoro mA from RAD Calibration” field or continue with step 25. if “No” was selected in that same field.

25. Select **50 kVp** in the respective Fluoro field of the User Console.

26. Press the Fluoro pedal and check the mA as measured in the mA/mAs meter.

27. Enter the measured mA multiplied by 100 in the “mA at 50 kVp (mA * 100)” field of the Boost Pulsed Fluoro area in the Fluoro Calibration screen of the Parameters Calibration window.

28. Repeat steps 26. and 27. for **80 and 120 kVp.**

29. Once the adjustment for Boost Pulsed Fluoro is completed, proceed to perform the adjustment for Continuous Fluoro in case it is going to be used. Otherwise, fluoro calibration is finished and ABC Input Selection and Synchronism Source options must be configured according to the customer’s equipment *(refer to the Configuration document).*

2.11.4.2 CONTINUOUS FLUORO

Continuous Fluoro calibration is carried out as for Pulsed fluoro. Just take into account that the parameters selection varies according to the Fluoro operation mode.

1. Go to the User Console screen to start the Continuous Fluoro calibration procedure.

2. Select the Workstation configured for Fluoro operation and select **maximum kVp and 0 PPS** in the Fluoro fields of the User Console screen.

3. Calibrate manual, automatic and boost adjustments for Continuous Fluoro as explained in *Section 2.11.4.1* for Pulsed Fluoro, steps 3. to 28.

4. Remove the Radiation Meter. Connect the Detector power supply or unblock radiation input to Detector.