SIEMENS

POLYMOBIL III/Plus

SP

Troubleshooting Guide

System

Serial numbers 20,000 and higher

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Document revision level

The document corresponds to the version/revision level effective at the time of system delivery. Revisions to hardcopy documentation are not automatically distributed.

Please contact your local Siemens office to order current revision levels.

Disclaimer

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Safety Notes, Notes and Symbols

⚠ DANGER	**DANGER indicates an immediate danger that if disregarded will cause death or serious physical injury.** ➪
⚠WARNING	**WARNING indicates a possible danger that if disregarded can cause death or serious physical injury.** ➪
⚠CAUTION	**CAUTION used with the safety alert icon indicates a possible danger that if disregarded will or can lead to minor or moderate physical injury and/or damage to property.** ➪
NOTICE	**NOTICE used without the safety alert icon indicates a possible danger that if disregarded can or will lead to an undesirable outcome or state other than death, physical injury or property damage.** ➪
NOTE	**NOTE is used to indicate information that explains the proper way to use devices or to carry out a process, i.e., provides pointers and tips.**

Warning about ionizing radiation or radioactive substances. Tests and adjustments that must be performed with the radiation switched on are indicated by this radiation warning icon.

Dangerous electrical voltage > 25 VAC or > 60 VDC.

Caution! General hazard warning.

ESD: Warning about electrostatically sensitive components.

Report icon. Used to indicate entries in certificates.

Safety information and protective measures

⚠WARNING

Risk of death, injury or material damage.

Strictly follow

- the product-specific safety information, the general safety information in the document TD00-000.860.01... and the safety information according to ARTD Part 2.

- ➪ **Non-compliance can lead to death, injuries, or material damage.**

⚠WARNING

X-ray radiation!

When working on the system where radiation has to be released, comply with all radiation protection directives and the rules for radiation protection according to ARTD-002.731.02.

- ➪ **Non-compliance can lead to illnesses, irreversible damage to body cells and to genetic make-up, severe injuries, or death.**
- ➪ **Use available radiation protection devices.**
- ➪ **Wear radiation protection clothing (lead apron).**
- ➪ **Maintain the greatest possible distance from the radiation source.**
- ➪ **Release radiation only if necessary.**
- ➪ **Set radiation activity as low as possible (low KV and mAs values).**

⚠WARNING

POLYMOBIL Plus! (with X3 connected!)

To avoid electrical shock from components under voltage, also be aware that:

The capacitor bank might still carry a charge. Do not attempt to work on the system while this condition exists.

After switching off the system, approximately 450 VDC may still be present in the system even after disconnecting the line voltage plug. Within 10 minutes, this voltage will drop to approximately 10 V.

- **Inspect LEDs V40 and V41 on D927, which is discharged with the bank.**
- **Measure the voltage between the chassis and the right side of F5 (D927) --> X3 connected!**
- **Before beginning any service work, wait until the voltage drops to approx. 10V within approx. 10 minutes; the LEDs V1 to V10 on D 971 are then off (each of them represents the voltage in one condenser).**
- **If one or more fuses on the D 971 have responded, high voltage may still be present at the affected capacitor even after a prolonged period of time.**
- **If connector X3 or X9 on D 927 or D 952 are not inserted or there is a defect in the circuit, the capacitor bank will not discharge. This can cause life-threatening voltage to be present in the system even after a prolonged period of time.**
- **Refer to the POLYMOBIL III/ Plus "Replacement of parts, SPR8-125.841.10... ".**

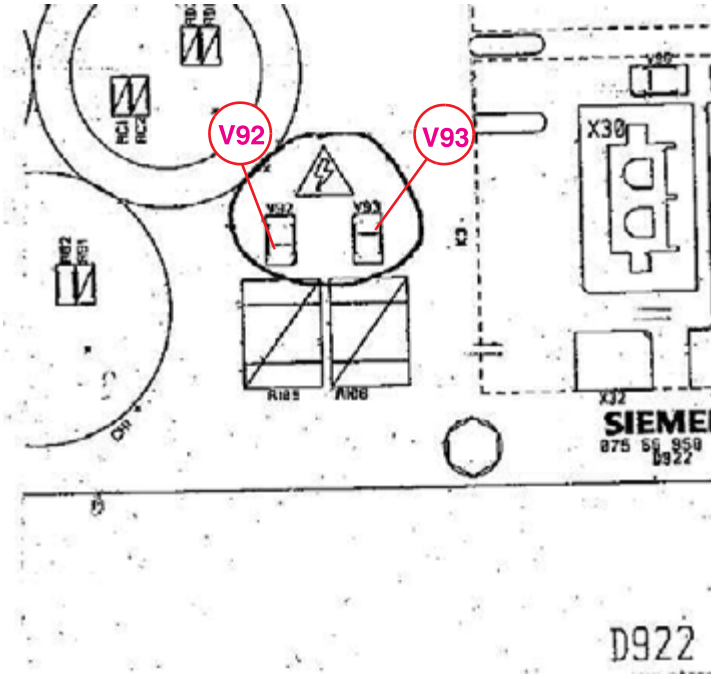

Fig. 1: D922_V92_V93

⚠WARNING

POLYMOBIL III! To avoid electrical shock from components under voltage, also be aware that:

After the system is switched off, around 300 V direct voltage are present in the control console for the main inverter.

➪ **Before beginning any service work, wait until the voltage drops to approx. 12V within approx. 1.5 minutes; the LED‘s V92 and V93 on D922 are then off. V92: - 330 V, V93: + 330 V, see (Fig. 1 / p. 9).**

- Connect the POLYMOBIL Plus / III only to a line voltage supply (receptacle) that complies with the requirements of VDE 0107 or corresponds to the local national standards.
- In general, switch off the system and disconnect the power cable from the mains prior to any service work.
- Remove or insert boards with the generator switched OFF only; observe ESD guidelines when handling boards.

Tools, measurement and auxiliary devices

NOTE

All tools, measurement and auxiliary devices with the exception of those marked " * " are listed along with their specifications in the STC (Service Tools Catalog).

Standard service kit*	n/a
Digital multimeter	n/a
2-channel memory oscilloscope	n/a
mAs meter	n/a
Protective conductor meter	n/a
Equivalent leakage current meter	n/a
Current transformer (50 A : 50 mA)* In addition, a metal film resistor with 10 Ohms; 0.5 W; 1% is required* Refer also to Speed Info 06/91	Part no. 31 51 289

⚠WARNING

Dangerous electrical voltage present during service work!

Risk of death or serious physical injury.

- ➪ **The oscilloscope must be connected to ground before measurements are performed. A TEK video isolator and the trigger set must be used whenever there is a risk of ground loops distorting the measurement results (see ARTD-002.731.22...).**

Cleaning

- The unit must always be switched off and disconnected from the mains before cleaning. Use only water to clean the unit or a lukewarm solution consisting of water and a household cleaning agent.
- Do not use abrasive cleaning agents or organic solvents such as benzene, alcohol, or spot remover.
- Do not spray water on the unit.
- For additional information, refer to the Operating Instructions.

NOTICE

To check the assemblies, remove the upper covers, the handles, and the lower front cover of the switchbox.

➪ **Follow the Replacement Instructions, SPR8-125.841.10...**

POLYMOBIL III

D916

D916 CPU, control and measurement value acquisition

Overview D916:

Name	Function / Information	Value
V24	This blinks when the software is working	n/a
P1	This adjusts the mAs counter	Adjusted service program 14: 320 kHz (test point F1 adjusted in the factory)
P2	Not used	n/a
P3	Adjustment of the maximum frequency of the heating converter	Service Program 9: 80 kHz ± 1 kHz (Test point "FC1")
P4	Adjustment of the maximum frequency of the main inverter	Service Program 7: 24.5 kHz ± 0.5 kHz (test point "FC2")
P5	Adjustment of heating current	Test point "I" Resonance, pre-adjustment: test point "IH" fine tuning
SW2B	Operating modes: Normal / service	Normal: Position 1 Service: Position 2
SW1	For factory use only	Do not use
SW3	Button Operating modes: Activation/reset	SW2B in position 2: Press = Service Mode SW2B in position 1: Press = Normal Mode

Power connector D916.X15:

D916.X15 Pin	Color	
1	black	Ground (+ 5 V)
3	black	Ground (+ 5 V)
4	red	+ 5 V ± 5 %
5	brown	+15 V ± 10%
6	blue	Ground (+/- 15 V)
7	yellow	-15 V ± 10%

LED D916:

V24	ON	Blinking during exposure

Potentiometers D916:

P1	OFFSET of mAs converter. Set at the factory - Do **not** change!
P3	Filament inverter frequency
P4	Main inverter frequency
P5	Adjustment/setting of filament heating circuit

Reset - switch

Test points D916 CPU

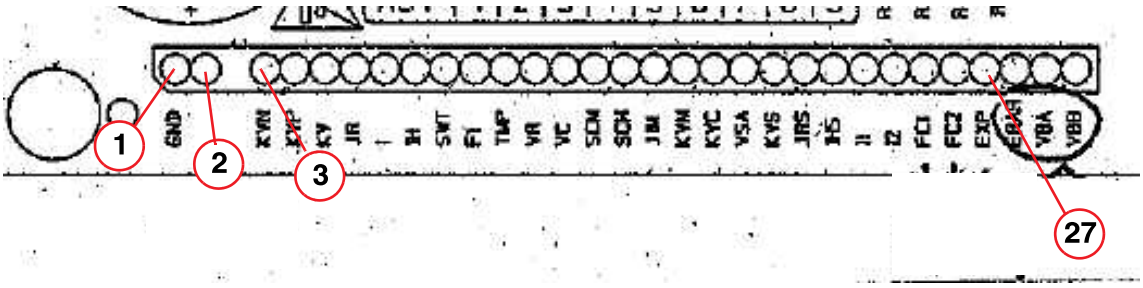

Fig. 2: D916_test points

Left to right Range	**TP**	**Function/information**	**Measurement**
1	GND	Mass measurement	n/a
2	GND	Mass measurement	n/a
3	KVN	Negative branch	1 V ≙ 10 k V

4	KVP	Positive branch	1 V ≙ 10 k V
5	KV	“Kv Ist” in tube	1 V ≙ 30 k V
6	JR	Tube current	1 V ≙10 mA
7	I	Heating resonant current	1 V ≙ 1 A (primary)
8	IH	Heating current	1 V ≙ 1.2 A (secondary)
9	SWT	Switching to regulate tube current	High = kV > 70% “KV soll”
10	F1	mAs integration frequency	max. 5V/ 320 kHz
11	TMP	Single tank temperature	
12	VR	Reference voltage 5 V - dc	± 0.01
13	VC	Capacitor bank voltage	1 V ≙100 V
14	SCM	Main inverter short circuit	Error 35 and 4
15	SCH	Heating inverter short circuit	Error 22, 36, 15 and 12
16	JIM	Tube overcurrent (heating or rays)	Error 23 or Error 34
17	KVM	KV overvoltage (positive or negative branch)	Error 31
18	KVC	Main inverter resonance current	1 V ≙50 A
19	VSA	Not used	n/a
20	KVS	"KV soll" (kv selected)	1 V ≙30 kV
21	JRS	"Soll tube current" (mA required)	1 V ≙10 mA
22	IHS	"Soll heating current" (ih required)	1 V ≙ 1.2 As
25	FC1	Current inverter frequency	
26	FC2	Main inverter frequency	
27	EXP	High = no exposure (kV regulator disabled)	Low = Exposure

D922, filament inverter, ON/OFF switching circuit

LED:

V86	+15 V for inverter frequency OK and 24 V presence
V85	24 V presence
V15	Auxiliary voltage OK
V3	Collimator On
V93, V92	DC voltage BUS

Fuses:

F1	15 AT	Phase line fuse
F2	15 AT	Neutral line fuse
F3	1 AT	+24 voltage fuse

Measurement points:

VP	0V
0V24	Ground 24V
P24V	+24V
HIP5	+5V
GNDA	Ground 5V
HIER	Error drivers heating current (ground for tester GNDA)
HID1	control TRANSISTOR High (ground for tester GNDA)
HID2	control TRANSISTOR Low (ground for tester GNDA)
FAUX	Hz generation auxiliary supplies
HVD1	Control transistors High and Low of the other branch (Main Inverter) (ground for tester GNDC)
HVD2	Control transistors Low and High of the other branch (Main Inverter) (ground for tester GNDC)
HVRS	Reset of the drivers of Main Inverter
HVER	Error in the drivers of Main Inverter

U1 power supply unit 5 V ± 5% / 15 V ± 10%

Fuse: 2 A T

U2 power supply unit 12.5 V ± 10%

Fuse: 5 A T

D98 Display board

The display board shows the selected mAs and KV values. By pressing the membrane keyboard button, you can change the ON/OFF, KV, and mAs values.

D1/ Measurement circuit

The D1 measurement board of the high voltage main circuit represent KV and mA values to the CPU.

C1/ Inverter capacitor

The C1 capacitor is the capacitive portion of the main inverter. The C1 single tank belongs to the high voltage circuit.

Pre-load and discharge resistors

The pre-load and discharge resistors are responsible for the switch-on current and the discharge of the capacitor within 10 minutes after the system has been switched off, from approximately 400VDC to a level below 10VDC.

Status of the LEDs (optimum condition)

a) POLYMOBIL III OFF, line voltage plug connected:

D922:	LED	V85	24V presence

b) POLYMOBIL III ON, standby

D922:	LED	V86	ON	15V and 24V presence
	LED	V85	ON	24V presence
	LED	V15	ON	Auxiliary voltage OK
	LED	V93	ON	DC bus voltage

	LED	V92	ON	DC bus voltage
	LED	V3	OFF	ON, if collimator button is pushed

POLYMOBIL Plus

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P5	Adjustment of heating current	Test point "I" Resonance, pre-adjustment: test point "IH" fine tuning
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12	VR	Reference voltage 5 V - dc	± 0.01
13	VC	Capacitor bank voltage	1 V ≙100 V
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15	SCH	Heating inverter short circuit	Error 22, 36, 15, and 12
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17	KVM	KV overvoltage (positive or negative branch)	Error 31
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19	VSA	Not used	n/a
20	KVS	"KV soll" (kv selected)	1 V ≙30 kV
21	JRS	"Soll tube current" (mA required)	1 V ≙100 mA
22	IHS	"Soll heating current" (ih required)	1 V ≙ 1.2 As
23	I1	"Motor current" (stator 1 rewinding)	1 V ≙4 A
24	I2	"Motor current" (stator 2 rewinding)	1 V ≙4 A
25	FC1	Current inverter frequency	
26	FC2	Main inverter frequency	
27	EXP	High = no exposure (kV regulator disabled)	Low = Exposure
28	ERAR	Starter signal	Error 28

D927

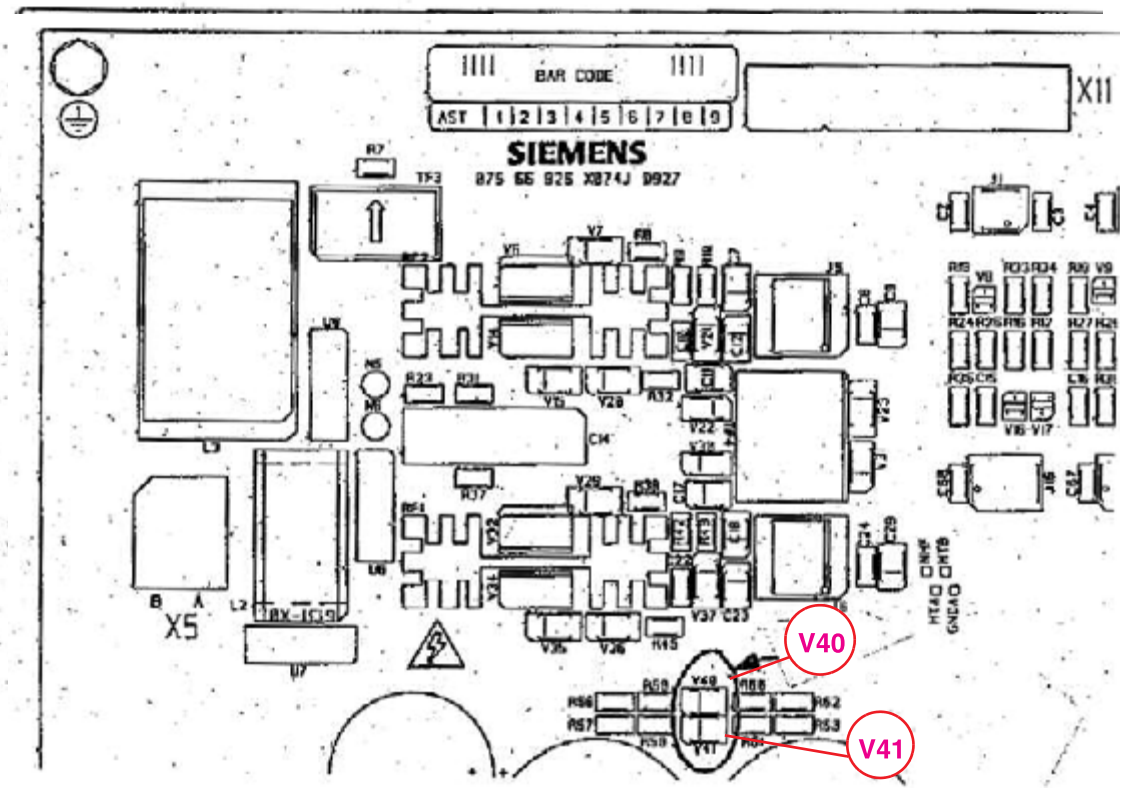

Fig. 3: D927_V40_V41

Name	Function / Information	Value
P1	Collimator voltage adjustment	Adjusted to obtain > 180 lux in light field (Approx. 25 V in connector X7).
V12	Presence of + 24 V DC	n/a
V5	Enables + 15 V DC	n/a
V40	Capacitor bank Voltage indication	n/a
V41	Capacitor bank Voltage indication	n/a
V46	Internal power supplies are working	n/a
V59	Collimator on	n/a

Fuse	value	referring to
F3	1 AT (250 V ~ / slow)	n/a

F5	6 AF (500 V DC / fast)	n/a
F6	20 AF (500 V DC / fast)	n/a
F7	15 AF (250 V ~ / slow)	Line voltage
F8	15 AF (250 V ~ / slow)	Line voltage

U1 power supply unit 5 V ± 5% / 15 V ± 10%

Fuse: 2 A T

U2 power supply unit 12.5 V ± 10%

Fuse: 5 A T

D952 capacitor charging circuit

LED:

Vin (V8)	ON	Line voltage OK
VDC (V1)	ON	Capacitor voltage present (the voltage can also be considerably lower than 450 V)
V31		Charging cycle (OFF --> not charging) / (ON --> charging)
V30		Error indication (OFF --> OK) / (ON --> with errors)
V32		Enable charger (ON --> enable charging) / (OFF --> disable)

Fuse:

F1	15 AT (250 V ~ / delayed)	Charging circuit

Test points:

ERR	Error output charging error
VC	Capacitor voltage 1 V : 100 V
IC	Capacitor charging current
FR1	Charging circuit frequency (dependent on the line voltage and VC)
GND	Ground
CAR	Signal to enable the charger
NCBC	CAR enable and charging
OK	Signal to indicate the full charge

D971 (capacitor bank)

LED:

Name	Function / Information	Value
V1 - 10	C1 - C10 (10mF) charged > 40V	Yellow LEDs ON

Fuse	value	referring to
F1-F10	20 A (500 V DC / fast)	C1 - C10 individual capacitor
F12	20 A (500 V DC / fast)	Capacitor bank input
F11	100 A (500 V DC / high speed)	Capacitor bank output

D98 Display board

The display board shows the selected mAs and KV values. By pressing the membrane keyboard button, you can change the ON/OFF, KV, and mAs values.

C1 main inverter capacitor

6.8 µV ±10 %

C2

C2 is the capacitor used to accelerate the rotor (phase shift); it is connected to the XCAP connector.

K22 switch-on relay

Connects and disconnects the discharge resistors.

Discharge resistors

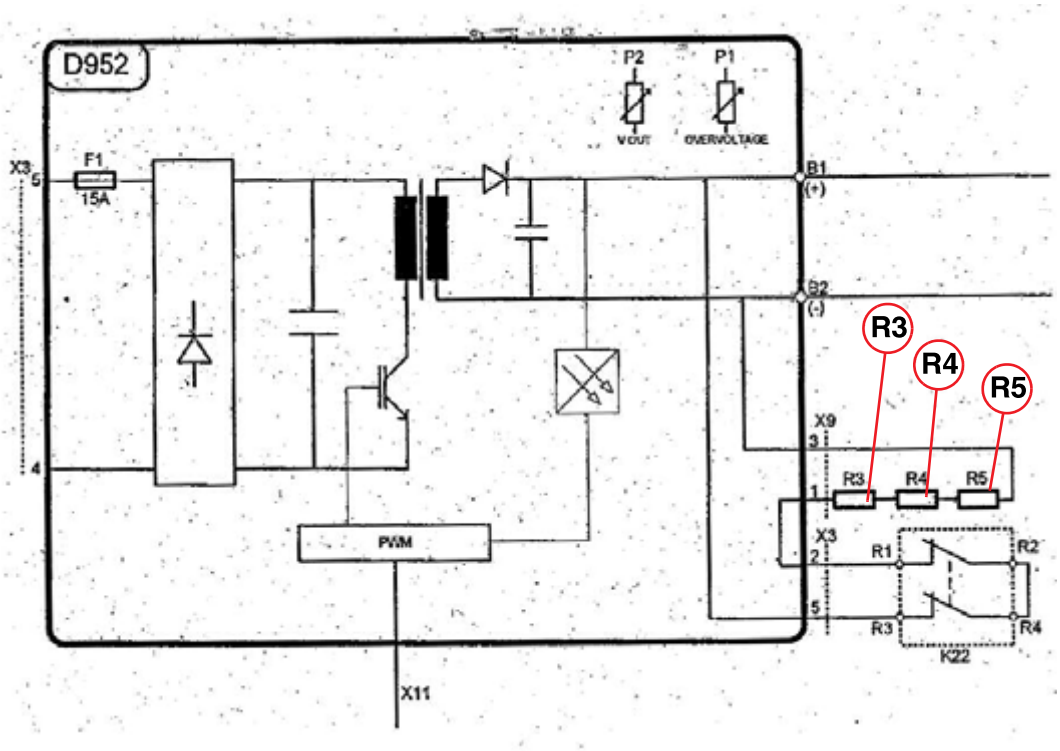

Fig. 4: R3_R4_R5

R3, R4 and R5 --> 510 Ohm ± 5%.

They have to be screwed down tight to prevent their being damaged.

Status of the LEDs (optimum condition)

a) POLYMOBIL Plus OFF, line voltage plug connected:

D952:	LED	450 VDC (V1)	glows for 10 minutes following shutdown
D971:	all LEDs		glows for 10 minutes following shutdown

b) POLYMOBIL Plus ON, standby

D952:	**LED**	Vin (V8)	ON
	LED	450 VDC (V1)	ON
D971:	all LEDs		ON

POLYMOBIL III

Error 1 - Loss of the + 15 V dc

Error 1	**+ 15 V missing**
System status: Standby	Explanation: Action: • Check X15 (D916): - Pin 1, 3: 0V - Pin 4 : 5V - Pin 5: +15V - Pin 6: 0V - Pin 7: -15V • Check the U1 power supply and the cable connection at the U1.

Error 3 - Oil pressure rise or overheating of the tube

Error 3	**Oil pressure rise or overheating of the tube**
System status: Standby	Explanation: Action: • Check the oil switch. (Normal tube condition = switch closed) ➪ Warning: let the tube cool off before testing! • Check the connections and the cable between the switch and the D916 X8-9 and X8-8.

Error 4 - Static short circuit of the main inverter

Error 4	Static short circuit of the main inverter
System status: Standby	Explanation: Action: • Check the power supplies U1 / U2 and the connections to the main inverter. ➪ Some other possible causes are: capacitor C1 or D922 may be defective. • Disconnect capacitor C1. - **Warning:** Turn off the equipment. **Wait 10 minutes** for it to **discharge**. Turn it back on. - If the error disappears, then it might be the tube, C1, the cables and/or the connections to the tube.

Error 6 - IH heating measured < IH of preheating

Error 6	IH heating measured < IH of preheating
System status: Standby	Explanation: Action: • Compare IH and IHS in D916 to make sure they are not the same. • Check the frequency of the heating inverter in the D916 TP - FC1. • Check the form of the resonance current at the TP-I D916 (use Service Program 9). ➪ Possible causes are a bad cable connection from D916 to D1(X8) (high resistance) to the single tank, a defective heating inverter on board D922, a defective heating transformer (single tank), the filament in the single tank is defective, the D916 and/or the D922 are defective, or the tube is defective.

Error 7 - IH heating measured > IH allowed by software

Error 7	IH heating measured > IH allowed by software.
System status: Standby	Explanation: Action: • Before inhibition, IHM exceeds 3.75V; i.e. 4.25A max. allowed. • Check the form of the resonance current in the TP-I D916. ➪ Some possible causes are bad cable connections from D916 to D1 (X8), or D916 and/or D922 are defective, or the tube is defective (filament).

Error 8 - kV measured < > 0 in idle

Error 8	kV measured < > 0 in idle
System status: Standby	Explanation: Action: • Check the cable connections D916 to D1 (X8). ➪ Some other possible causes may be: the CPU D916 and/or the D922 and/or the tube are defective.

Error 9 - mA measured < > 0 in idle

Error 9	mA measured < > 0 in idle
System status: Standby	Explanation: Action: • Check the cable connections, especially the ones between the tube and the CPU D916 (X8). ➪ Some other possible causes may be: the CPU D916 or the tube is defective.

Error 11 - Voltage too high in the capacitor bank

Error 11	Voltage too high in the capacitor bank.
System status: Standby	Explanation: D916 (CPU) detects overvoltage (> 440 V) in the capacitor bank. After the system is switched on, the capacitor bank voltage is about 440 V (VC). This voltage is reduced to 1% of its former level and the reduced voltage can be measured on board D916, TP VC. Action: • Check the VC test point of the D916 and check the voltage directly in the capacitor bank VC (possible point: HVVC in D922).

Error 12 - Noise in the static short circuit signal in the heating inverter

Error 12	Noise in the static short circuit signal in heating
System status: Standby	Explanation: Action: • Check the SCH test point on the D916 (a high level means a short circuit). • Check the cable connection between the D916 CPU and the power board D922. • Switch off the system and disconnect X5 on the power board D922. Switch on the system. . ➪ If Error 6 appears, the CPU D916 should be OK. Check D922, cable connection to the single tank. ➪ If Err 12 is still displayed, replace D916 CPU. • If the Err 12 disappears, the D916 CPU is OK. • Then look over the possible problems on the power board D922, the tube and the wiring.

Error 13 - Voltage in the capacitor bank is low during charge process

Error 13	Voltage in the capacitor bank is low during charge process
System status: Standby	Explanation: The voltage in the capacitor bank is lower than the voltage expected from the CPU. The capacitor bank voltage after the system is switched on is about 400V (VC) and divided on board 100:1 to be monitored from the CPU (Vc). Action: • Check the cable connection between the CPU and the D922 (X20). • Check the VC test point of the D916, and check the voltage directly in the capacitor bank VC (possible point: HVVC on D922).

Error 15 - Static short circuit, heating inverter

Error 15	Static short circuit, heating inverter
System status: Standby	Explanation: Action: • Check the SCH test point of the D916 (a high level means a short circuit of the heating inverter). • Switch off the system and disconnect X5 on the power board D922. Switch on the system. . ➪ If Error 6 appears, the CPU D916 should be OK. Check D922, cable connection to the single tank. ➪ If Err 15 is still displayed, replace D916 CPU. ➪ If Err 15 disappears, then the D922 is OK. • Use Service Program 9 and check the maximum frequency of the heating inverter (refer to document "Replacement of parts" SPR8-125.841.10..).

Error 22 - short circuit, heating inverter

Error 22	Short circuit, heating inverter
System status: Preparation	Explanation: Action: • Check the SCH test point of the D916 (a high level means a short circuit of the heating inverter). • Check cable connection to the tube. • Switch off the system and disconnect X5 on the power board D922. Switch on the system. ➪ If Error 6 appears, the CPU D916 should be OK. Check D922, the cable connection to the single tank, and the single tank. ➪ If Err 22 is still displayed, replace D916 CPU. ➪ If Err. 22 disappears, then the D922 is OK. • Short circuit outside the tube, look over the connections and wiring that go to the tube. • Use Service Program 9 and check the maximum frequency of the heating inverter.

Error 23 - Tube current limitation

Error 23	Tube current limitation
System status: Preparation	Explanation: Action: • Check the JIM test point of the D916 (a high level means a tube current error). • Use Service Program 9 and check the filament current of the tube (refer to document "Replacement of parts" SPR8-125.841.10...). ➪ It is possible that the filament inside the tube is defective. ➪ It is possible that the filament current in preparation is bad. Adjust with the potentiometer P5 on the D916.

Error 25 - Preparation timeout

Error 25	Preparation timeout
System status: Preparation	Explanation: This error occurs when preparation time (hand switch, first step) exceeds 15 seconds without an exposure being taken. Action: • If this error occurs without the hand switch being activated for more than 15 seconds, then check the connection between the hand switch and the CPU. It may be bad or the CPU may be defective.

Error 31 - kV limit

Error 31	kV limit
System status: Exposure	Explanation: Action: • Check the KVM test point of the D916 (a high level means an error). • Check the signal cable connection between the tube and the D916. • Check the maximum frequency of the main inverter (Service Program 7, refer also to document "Replacement of parts" SPR8-125.841.10...). • Check the filament current (Service Program 9), refer also to document "Replacement of parts" SPR8-125.841.10...). ➪ Possible defects: the D916 or the D1 may be defective.

Error 34 - Tube current limit

Error 34	Tube current limit
System status: Exposure	Explanation: Action: • Check the JIM test point of the D916 (A high level means a tube current error). • Use Service Program 9 and check the filament current and the maximum frequency of the heating inverter (refer to document "Replacement of parts" SPR8-125.841.10...). ➪ It is possible that the filament inside the tube is defective. ➪ It is possible that the filament current in preparation is bad. Adjust with the potentiometer P5 on the D916. • Analyze to see if other error messages appear, especially with high or low KV's. ➪ A short-circuit problem may exist in the tube.

Error 35 - Short circuit in the main inverter

Error 35	Short circuit in the main inverter
System status: Exposure	Explanation: Action: • Check the SCM test point in D916 (a high level means a short circuit error); it is possible the tube is defective. • Check the cable connections between the D916 and the D922 (X20). • Check the cable connections between the D922 and the tube XoutA XoutB. • Check C1.

Error 36 - Short circuit in the heating inverter

Error 36	Short circuit in the heating inverter
System status: Exposure	Explanation: Action: • Check SCH signal in the D916 (A high level means a short circuit). • Check the maximum filament frequency and the signal in test point I (Service Program 9), (refer to the document "Replacement of parts" SPR8-125.841.10...) • Check the cable connections between the D922 (X5) and the tube. ➪ Possible defect: D922

Error 37 - Regulation failure in the kV loop

Error 37	Regulation failure in the kV loop
System status: Exposure	• kV_actual (KV) is in a different range than kV_nominal (KVS). • Check the connections between the D916 (X8) and the tube. ➪ The D916 may be faulty. ➪ Check heating current adjustment, using P5 (very important if D916 will be replaced!) - see “Replacement of Parts”, SPR8-125.841.10...

Error 38 – Regulation failure in the mA loop

Error 38	Regulation failure in the mA loop
System status: Exposure	• i_actual (JR) is in a different range than kV_nominal (JRS). • Check the connections between the D916 (X8) and the tube. ➪ The D916 may be faulty.

Error 39 - Exposure timeout

Error 39	Exposure timeout
System status: Exposure	• Check the frequency of the heating inverter at the D916 test point FC1 (Service Program 9). ➪ The system interrupts the exposure. This may occur when the mAs integrator fails in the D916.

Error 41 - The exposure has not finished

Error 41	The exposure has not finished.
System status: Exposure	• The exposure switch is released during exposure. ➪ If the interruption was caused by another problem, it may be a kV and/or mA regulation failure. Also see errors Err 37 and Err 38.

Error 42 - Heating current limit

Error 42	Heating current limit
System status: Exposure	• Check the JIM test point on the D916. • Check heating current (Service program 9). It is possible that the potentiometer P5 is not properly adjusted (the preparation current is too low).

Error 92 - RAM failure

Error 92	RAM/D916 failure.
System status: Init	• Replace D916

Error 93 - Failure in the initial verification of the + 15 V DC

Error 93	Failure in the initial verification of the + 15 V DC
System status: Init	• Check the voltages of U1 and D916 X15. - + 15 V D916 X15 Pin 5 - 6 - - 15 V D916 X15 Pin 6 - 7 - + 5 V D916 X15 Pin 4 - 3

Error 94 - Difference between doubler signal and voltage level

Error 94	Difference between doubler signal and voltage level
System status: Init	• Check cable X10 • Check cable X in D922 that comes from filter • Check mains resistance

Error 95 - Precharge Error

Error 95	Precharge Error
System status: Init	Explanation: Voltage below 80V after 9 seconds • Check mains resistance. • Check cable X in D922 that comes from filter.

Error 96 - Failure of Channel D (KV_NOM) in A/D converter

Error 96	Failure of Channel D (KV_NOM) in A/D converter
System status: Init	• Failure of CPU Channel D (KV_NOM) in A/D converter. ➪ The CPU D916 is faulty.

Error 97 - Failure of Channel B (JR_NOM) in A/D converter

Error 97	Failure of Channel B (JR_NOM) in A/D converter
System status: Init	• Failure of CPU Channel B (JR_NOM) in A/D converter. ➪ The CPU D916 is faulty.

Error 98 - Failure of Channel C (Ih_NOM) in A/D converter

Error 98	Failure of Channel C (Ih_NOM) in A/D converter
System status: Init	• Failure of CPU Channel C (Ih_NOM) in A/D converter. ➪ The CPU D916 is faulty.

POLYMOBIL Plus

"Pause" error

Pause	Message: "Pause"
System status: Standby	Explanation: This message appears when the temperature of the capacitor charging circuit board has exceeded a defined value (caused by a number of exposures being taken within a short time). Action: • Wait until the temperature has dropped. • Error: If this message ("Pause") does not go away or if it appears immediately after the unit is switched on, the D952 board may need to be replaced.

Error 1 - Loss of the + 15 V dc

Error 1	+ 15 V missing
System status: Standby	• Check X15 (D916): - Pin 1, 3: 0V - Pin 4: 5V - Pin 6: 0V - Pin 7: -15V • Check the U1 power supply and the cable connection at the U1.

Error 3 - Oil pressure rise or overheating of the tube

Error 3	Oil pressure rise or overheating of the tube
System status: Standby	• Check the oil switch. (Normal tube condition = switch closed) ➪ Warning: let the tube cool off before testing! • Check the connections and the cable between the switch and the D916 X8-9 and X8-8.

Error 4 - Static short circuit of the main inverter

Error 4	Static short circuit of the main inverter
System status: Stand-by	• Check the power supplies U1 / U2 and the connections to the main inverter. ➪ Some other possible causes are: capacitor C1 or D927 may be defective. • Disconnect capacitor C1. - **Warning:** Turn off the equipment. **Wait 10 minutes** for it to **discharge**. Turn it back on. - If the error appears again, it may be that the D961 is faulty. - If the error disappears, then it might be the tube, the C1, the cables, and/or the connections to the tube.

Error 6 - IH heating measured < IH of preheating

Error 6	IH heating measured < IH of preheating
System status: Standby	• Compare: IH and IHS are not the same. • Check the frequency of the heating inverter in the D916 TP - FC1. • Check the form of the resonance current at the TP-I D916 (use service program 9). ➪ Some possible causes are a bad connection (high resistance), faulty heating transformer, bad filament, faulty D916 and/or D927 and/or the tube.

Error 7 - IH heating measured > IH allowed by software

Error 7	IH heating measured > IH allowed by software
System status: Standby	• Before inhibition, IHM exceeds 4.26V, i.e. 5.12A • Check the form of the resonance current in the TP-I D916. ➪ Some possible causes are bad cable (resistance), faulty D916 and/or D927 and/or the tube

Error 8 - kV measured < > 0 in idle

Error 8	kV measured < > 0 in idle
System status: Standby	• Check the cables, especially the ones between the tube and the CPU (connector X8). ➪ Some other possible causes may be: the CPU D916 and/or the D927 and/or the tube are defective.

Error 9 - mA measured < > 0 in idle

Error 9	mA measured < > 0 in idle
System status: Standby	• Check the cables, especially the ones between the tube and the CPU (connector X8). ➪ Some other possible causes may be: the CPU D916 is faulty or the tube is faulty.

Error 11 - Voltage too high in the capacitor bank

Error 11	Voltage too high in the capacitor bank or capacitor loader D952 is faulty.
System status: Standby	Explanation: D916 (CPU) detects overvoltage (> 440 V) in the capacitor bank. After the system is switched on, the capacitor bank voltage is about 440 V (VC). This voltage is reduced to 1% of its former level and the reduced voltage can be measured on board D916, TP VC. Action: • Check the VC test point of the D916 and check the voltage directly in the capacitor bank VC (possible points: between the earth and fuse F5 located on D927).

Error 12 - Noise in the static short circuit signal in the heating inverter

Error 12	Noise in the static short circuit signal in heating
System status: Standby	• Check the SCH test point on the D916 (a high level means a short circuit). • Check the cable connection between the D916 CPU and the power board D927. • Switch off the system and disconnect X5 on the power board D927. Switch on the system. ➪ If the Err 12 disappears, the D916 CPU is OK. Then look over the possible problems on the power board D927, the tube and wiring.

Error 13 - Voltage in the capacitor bank is low during charge process

Error 13	Voltage in the capacitor bank is low during charge
System status: Standby	Explanation: The voltage in the capacitor bank is lower than the voltage expected from the CPU. The capacitor bank voltage after the system is switched on is about 440V (VC) and divided on board 100:1 to be monitored from the CPU (Vc). Action: • Check the connection between the CPU and the D952 (X20) and the connection between the D927 and the D952 (X3). • Check the Vc test point of the D916 and the voltage directly in the capacitor bank (possible points: between the earth and fuse F5 located on D927). ➪ If VC and Vc are close to 440 V and 4.4 V, then D916 may be faulty. ➪ If VC is close to 440 V but Vc is not at 4.4 V, then either the D952 or the D916 may be bad. ➪ If they are not close, then the D952 may be faulty.

Error 15 - Static short circuit, heating inverter

Error 15	Static short circuit, heating inverter
System status: Standby	• Check the SCH test point of the D916 (a high level means a short circuit of the heating inverter). • Switch off the system and disconnect X5 on the power board D927. Switch on the system. ➪ If Error 6 appears, the CPU D916 should be OK. Check D927, cable connection to the single tank. ➪ If Err 15 is still displayed, replace D916 CPU. ➪ If Err15 disappears, then the D927 is OK. • Use Service Program 9 and check the maximum frequency of the heating inverter (refer to document "Replacement of parts" SPR8-125.841.10...).

Error 22 - Short circuit, heating inverter

Error 22	Short circuit, heating inverter
System status: Preparation	• Check the SCH test point of the D916 (a high level means a short circuit). • Check cable connection to the tube. • Switch off the system and disconnect X5 on the power board D922. Switch on the system. ➪ If Error 6 appears, the CPU D916 should be OK. Check D927, the cable connection to the single tank, and the single tank. ➪ If Err 22 is still displayed, replace D916 CPU. ➪ If Err. 22 disappears, then the D927 is OK. • Short circuit outside the tube, look over connections and wiring that go to the tube. • Use Service Program 9 and check the maximum frequency of the heating inverter.

Error 23 - Tube current limitation

Error 23	Tube current limitation
System status: Preparation	• Check the JIM test point of the D916 (A high level causes the error). • Use Service Program 9 and check the filament current of the tube (refer to document "Replacement of parts" SPR8-125.841.10...). ➪ It is possible that the filament inside the tube is bad. ➪ It is possible that the filament current in preparation is bad (very high or very low). Adjust the potentiometer P5 of the D916.

Error 24 - The anode does not get up to its startup speed

Error 24	The anode does not reach its startup speed
System status: Preparation	• Check the I1 and I2 test points of D916. • Check the connection to C2, the phase shift capacitor, the XCap, and the X6 connector. • Check the connection between the power board D927 X11 and CPU D916 X11. • Check F5 6AT on the power board D927. • Check F6 20AT on the power board D927.

Error 25 - Preparation timeout

Error 25	Preparation timeout
System status: Preparation	• This error occurs when preparation time (hand switch, first step) exceeds 15 seconds without an exposure being taken. ➪ If this error occurs without the hand switch being activated for more than 15 seconds, then check the connection between the hand switch and the CPU. It may be bad or the CPU may be defective.

Error 28 - Starter short circuit

Error 28	Starter short circuit
System status: Preparation	• Check the phase displacement capacitor (C2). • Check the winding resistances of the stator (X6 - 3 - X6 - 1 should be close to 83 Ohms, X6 - 3 and C2 should be close to 174 Ohms). ➪ Possible defects: the D927, C2 and check the cable connection to the starter within the tube.

Error 31 - kV limit

Error 31	kV limit
System status: Exposure	• Check the KVM test point of the D916 (a high level means an error). • Check test point KVC of the D916. • Check the signal cable connection between the tube and the D916. • Check the maximum frequency of the main inverter (Service Program 7), refer also to document "Replacement of parts" SPR8-125.841.10...). • Check the filament current (Service Program 9), refer also to document "Replacement of parts" SPR8-125.841.10...). ➪ Possible defects: the D916 or the D900 may be defective.

Error 34 - Tube current limit

Error 34	Tube current limit
System status: Exposure	• Check the JIM test point on the D916. ➪ It is possible that the potentiometer P5 is not properly adjusted, thus causing the heating current in preparation to be very high. • If an error exists in the entire range of kV during the exposure, especially at low kVs, a problem must exist inside the tube. • Use Service Program 9 and check the filament current and the maximum frequency of the heating inverter (refer to document "Replacement of parts" SPR8-125.841.10...). ➪ It is possible that the filament inside the tube is defective. ➪ It is possible that the filament current in preparation is bad. Adjust with the potentiometer P5 on the D916. • Analyze to see if other error messages appear, especially high voltage ones. ➪ A short-circuit problem may exist in the tube.

Error 35 - Short circuit in the main inverter

Error 35	Short circuit in the main inverter
System status: Exposure	• Check the SCM test point in D916. ➪ If a persistent error appears in the entire kV range during the exposure, especially at low kVs, the tube may be faulty. • Check the connections between the D916 and the D961 (X20). • Check the connections between the D961 and the tube (U - V)/X4. • Check C1.

Error 36 - Short circuit in the heating inverter

Error 36	Short circuit in the heating inverter
System status: Exposure	• Check SCH signal in the D916 (A high level means a short circuit). • Check the maximum filament frequency and the signal in test point I (Service Program 9), (refer to the document "Replacement of parts" SPR8-125.841.10...) • Check the connections between the D927 (X5) and the tube. ➪ The D927 may be faulty.

Error 37 - Regulation failure in the kV loop

Error 37	Regulation failure in the kV loop
System status: Exposure	• kV_actual (KV) is in a different range than kV_nominal (KVS). • Check the connections between the D916 (X8) and the tube. ➪ The D916 may be faulty. ➪ Check heating current adjustment, using P5 (very important if D916 will be replaced!) - see “Replacement of Parts”, SPR8-125.841.10...

Error 38 – Regulation failure in the mA loop

Error 38	Regulation failure in the mA loop
System status: Exposure	• i_actual (JR) is in a different range than kV_nominal (JRS). • Check the connections between the D916 (X8) and the tube. ➪ The D916 may be faulty.

Error 39 - Exposure timeout

Error 39	Exposure timeout
System status: Exposure	• Check the frequency of the heating inverter at the D916 test point FC1 (Service Program 9). ➪ The system interrupts the exposure. This may occur when the mAs integrator fails in the D916.

Error 41 - The exposure has not finished

Error 41	The exposure has not finished.
System status: Exposure	• The exposure switch is released during exposure. ➪ If the interruption was caused by another problem, it may be a kV and/or mA regulation failure. Also see errors Err 37 and Err 38.

Error 42 - Heating current limit

Error 42	Heating current limit
System status: Exposure	• Check the JIM test point on the D916. • Check heating current (Service program 9). It is possible that the potentiometer P5 is not properly adjusted (the preparation current is too low).

Error 92 - RAM failure

Error 92	RAM failure.
System status: Init	• Replace D916

Error 93 - Failure in the initial verification of the + 15 V DC

Error 93	Failure in the initial verification of the + 15 V DC
System status: Init	• Check the voltages of U1 and D916 X15. - + 15 V D916 X15 Pin 5 - 6 - - 15 V D916 X15 Pin 6 - 7 - + 5 V D916 X15 Pin 4 - 3

Error 96 - Failure of Channel D (KV_NOM) in A/D converter

Error 96	Failure of Channel D (KV_NOM) in A/D converter
System status: Init	• Failure of CPU Channel D (KV_NOM) in A/D converter. ➪ The CPU D916 is faulty.

Error 97 - Failure of Channel B (JR_NOM) in A/D converter

Error 97	Failure of Channel B (JR_NOM) in A/D converter
System status: Init	• Failure of CPU Channel B (JR_NOM) in A/D converter. ➪ The CPU D916 is faulty.

Error 98 - Failure of Channel C (Ih_NOM) in A/D converter

Error 98	Failure of Channel C (Ih_NOM) in A/D converter
System status: Init	• Failure of CPU Channel C (Ih_NOM) in A/D converter. ➪ The CPU D916 is faulty.

General

Activation of the service programs

- Turn off the unit.
- Take off the cover.
- Move the SW2B service switch to position 2 on the D916.
- Turn on the unit.
- "Pr 1" will appear on the display.
- For the selection of the required program, use mAs+ / mAs-
- To enter, press the collimator light button. To exit, press it again.

While we are in service programming, the X-rays are disabled.

To quit the service mode, move SW2B to position 1 and press the Reset button SW3, or turn the POLYMOBIL OFF and then ON again.

POLYMOBIL III

Service programs

Program 2 - exposure counter

Program 2
• Press the collimator light button to enter. • Read the exposure counter on the display. • Press the collimator light button to exit. **NOTE:** A reset is not possible. In the event that the tube is changed, make a note of the start triggers.

Program 3 - error buffer

Program 3
• Press the collimator light button to enter. • Show the last 20 errors on the display. • On the left, the position it occupies is shown. • On the right, the error code is indicated. • The most recent errors are shown at the top of the list. • To go backwards, use the "mAs-" key. • Press the collimator light button to exit.

Program 4 - deletion of error buffer

Program 4
• Press the collimator light button to enter. • To delete, press the "kV+" button for approximately 4 seconds. • Press the collimator light button to exit.

Program 5 - Change of initial values (kV and mAs) or last value

Program 5
• Press the collimator light button to enter. • Press kV+, kV- and/or mAs+/mAs- to select the values. • To save the values, press the collimator light button.

Program 6 - maximum values of kV and mAs

Program 6
• Press the collimator light button to enter. • To limit the maximum values, select with kV+, kV- and/or mAs+/mAs-. • To save the values, press the collimator light button.

Program 7 - maximum main inverter frequency

Program 7
• Press the collimator light button to enter. • On the display, "ADJF" will appear. • The maximum frequency can be measured at TP FC2 on the D916 CPU. • Press the exposure switch to obtain the maximum frequency. • To adjust, use the P4 potentiometer of the D916. • The adjustment will be carried out until the following value is reached on the D916 - P4 TP FC2: 24.5 kHz ± 0.5 kHz. • Press the collimator light button to exit.

Program 8 - Collimator ON/OFF with exposure switch

Program 8
• Press the collimator light button to enter. • Collimator OFF/ON will appear on the display. • To start: press the exposure switch. To brake: release the exposure switch. • Press the collimator light button to exit.

Program 9 - heating current testing

Program 9
• Press the collimator light button to enter. • "FIL 3" will appear on the display. There should be 3 A of current. • Press the exposure switch. The filament current will increase to 3.7 A and "FIL 3.7" will appear on the display. • Press the collimator light button to exit.

Program 10 - AutoOff ON/OFF (available but not used)

Program 10
• Press the collimator light button to enter. • Can be used, and changed: - “OFF” no autooff - “ON” autooff is running

Program 11 - exposure points or half points

Program 11
• Press the collimator light button to enter. • "ON" or "OFF" will appear on the display. • ON = 47 steps (manufacturer's default); OFF = 24 steps • To change it, press the mAs+ or mAs- keys. • To save what you have selected, press the collimator light button ON.

Program 12 - firmware version

Program 12
• Press the collimator light button to enter. • "POL 101" will appear on the display. • To exit, press the collimator light button.

Program 13 - eliminate the buzzers

Program 13
• Press the collimator light button to enter. • "BEP x" will appear on the display. • To change it, press the mAs+ or mAs- keys. ➪ 3 different buzzer volumes are available. • To save what you have selected, press the collimator light button.

Program 14 - adjustment of mAs V/F converter

Program 14
• Press the collimator light button to enter. • "F1 On" will appear on the display. • The maximum frequency can be measured at TP F1 on the D916 CPU. • To adjust, use the P1 potentiometer of the D916. Adjust to 320 kHz. ➪ Take care with that adjustment, the frequency must be VERY CLOSE to 320 kHz! • To exit, press the collimator light button.

Program 15 - one resonance pulse

Program 15
• Press the collimator light button to enter. • "P OFF" will appear on the display. • Put the oscilloscope tester KVC on the D916 CPU. • Press the exposure switch; one resonance pulse is obtained, see (Fig. 5 / p. 53). • To exit, press the collimator light button.

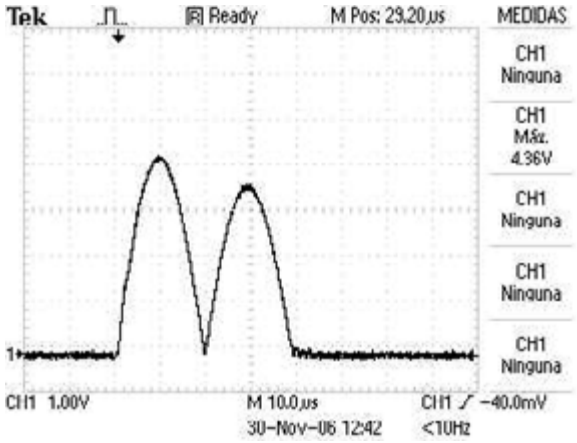

Fig. 5: Program 15

POLYMOBIL Plus

Service programs

Program 1 - formatting the capacitor bank

Program 1
• Press the collimator light button to enter. • After starting up this service program, the message "CAP 150" appears on the display. • The voltage increases from 150 V to 440 V DC. The program remains in each stage for approximately 6 minutes. The system stays at 440 V DC (last stage) for approximately 1 hour, showing "CAP END". • Press the light to exit. **NOTE:** If the voltage is over 150 V, the program begins first by discharging and then starts the charging process.

Program 2 - exposure counter

Program 2
• Press the collimator light button to enter. • Read the exposure counter on the display. • Press the collimator light button to exit. **NOTE:** A reset is not possible. In the event that the tube is changed, make a note of the start triggers.

Program 3 - error buffer

Program 3
• Press the collimator light button to enter. • Show the last 20 errors on the display. • On the left, the position it occupies is shown. • On the right, the error code is indicated. • The latest errors are shown at the top of the list. • To go backwards, use the "mAs-" key. • Press the collimator light button to exit.

Program 4 - deletion of error buffer

Program 4
• Press the collimator light button to enter. • To delete, press the "kV+" button for approximately 4 seconds. • Press the collimator light button to exit.

Program 5 - change of initial values (kV and mAs) or last value

Program 5
• Press the collimator light button to enter. • Press kV+, kV- and/or mAs+/mAs- to select the values. • To save the values, press the collimator light button.

Program 6 - maximum values of kV and mAs

Program 6
• Press the collimator light button to enter. • To limit the maximum values, select with kV+, kV- and/or mAs+/mAs-. • To save the values, press the collimator light button.

Program 7 - Maximum main inverter frequency

Program 7
• Press the collimator light button to enter. • On the display, "ADJF" will appear. • The maximum frequency can be measured at TP FC2 on the D916 CPU. • Press the exposure switch to obtain the maximum frequency. • To adjust, use the P4 potentiometer of the D916. • The adjustment will be carried out until the following value is reached on the D916 - P4 TP FC2: 18 kHz ± 0.5 kHz. • Press the collimator light button to exit.

Program 8 - checking the anode rotation starter

Program 8
• Press the collimator light button to enter. • ROT 220 will appear on the display. • To start: press the exposure switch. To brake: release the exposure switch. • Press the collimator light button to exit.

Program 9 - heating current testing

Program 9
• Press the collimator light button to enter. • "FIL 3" will appear on the display. There should be 3 A of current, see (Fig. 29 / p. 82). • Press the exposure switch. The filament current will increase to 5 A (see (Fig. 30 / p. 83) and "FIL 5" will appear on the display. • Press the collimator light button to exit.

Program 10 - AutoOff ON/OFF

Program 10
• Press the collimator light button to enter. • Can be used, and changed: - “OFF” no autooff - “ON” autooff is running

Program 11 - exposure points or half points

Program 11
• Press the collimator light button to enter. • "ON" or "OFF" will appear on the display. • ON = 47 steps (manufacturer's default); OFF = 24 steps • To change it, press the mAs+ or mAs- keys. • To save what you have selected, press the collimator light button.

Program 12 - firmware version

Program 12
• Press the collimator light button to enter. • "POL 101" will appear on the display. • To exit, press the collimator light button.

Program 13 - eliminate the buzzers

Program 13
• Press the collimator light button to enter. • "BEP x" will appear on the display. • To change it, press the mAs+ or mAs- keys. ➪ 3 different buzzer volumes are available. • To save what you have selected, press the collimator light button.

Program 14 - adjustment of mAs V/F converter

Program 14
• Press the collimator light button to enter. • "F1 On" will appear on the display. • The maximum frequency can be measured at TP F1 on the D916 CPU. • To adjust, use the P1 potentiometer of the D916. Adjust to 320 kHz. ➪ Take care with that adjustment, the frequency must be VERY CLOSE to 320 kHz! • To exit, press the collimator light button.

Program 15 - low consumption (reduced switch-on current), only if necessary

Program 15
• Press the collimator light button to enter. • "Pot OFF" will appear on the display • Press mAs+ button to change "Pot On", put jumper on the D952 board • To exit, press the collimator light button.

Program 16 - one resonance pulse

Program 16
• Press the collimator light button to enter. • "P OFF" will appear on the display. • Put the oscilloscope tester KVC on the D916 CPU. • Press the exposure switch; one resonance pulse is obtained, see (Fig. 6 / p. 58). • To exit, press the collimator light button.

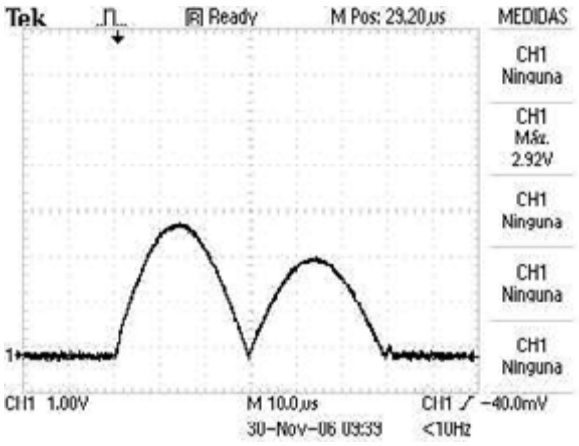

Fig. 6: Program 16

POLYMOBIL Plus

High-voltage circuit

The purpose of the high voltage circuit is to reach the high voltage required in the shortest possible period of time, and to keep it constant during the exposure. This voltage is used to accelerate the electrons emitted by the filament. Impelled by that energy, these electrons strike the anode, producing heat and x-rays in the resulting sudden deceleration.

The high-voltage circuit is controlled by a controller located on the D916 and it is directed toward the D961 by means of a driver. The HV inverter consists of IGBTs (Isolated Gate Bipolar Transistor). An H-Bridge diagonal inverter triggers the IGBTs, and the current passes through the C1 capacitor and the high-voltage transformer located within the single tank. The capacitor within stores energy that comes to it in pulses.

The high voltage is controlled by means of a microcontroller J36 (u167), when an exposure is requested. The required value is converted by means of a D/A converter to an analog value that can be measured at TP KVS. This analog value controls a PI (proportional - integral) regulator. The output of this amplifier is introduced into a VCO (Voltage Controlled Oscillator) to generate a voltage depending upon the frequency. The maximum frequency is 18 KHz. This signal is separated into opposite lines in order to handle the complete bridge of the D961. For safety reasons, these signals are signals that can be interrupted.

The transformed voltage of the high transformer is connected by means of some current limiters to the X-ray tube. In standby mode, there is no high voltage present - the inverter is not active. During the exposure, the high voltage is present; it is monitored by the D916 CPU. The signals measured can be observed at TP KVN and KVP, corresponding to the positive pulses and to the negative pulses. The sum of both is measured at TP KV (1V ≙ 30 KV). The KV signal is compared to the required KVS. The error of both is adjusted with the PI.

- Possible error messages from the main inverter

ERR 4	Static short circuit of the main inverter
ERR 8	kV < > 0 in standby
ERR 31	kV limit
ERR 34	Current limit of X-rays
ERR 35	Short circuit of the main inverter
ERR 37	kV regulation failure

A risk of death by electric shock exists when repairs, troubleshooting, or maintenance is performed while the side panels of the equipment are off.

There are some areas that have dangerous voltages.

If you are working for some time with the side panels removed, please follow the advice given in chapter 1 of these instructions.

- To check control functions, use the following measurement points and representations. Test point on the D916 ((Fig. 7 / p. 60)).

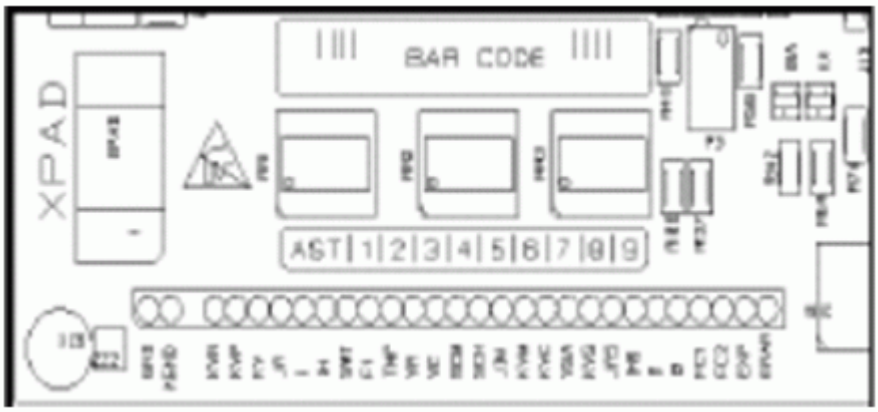

Fig. 7: D916_TP

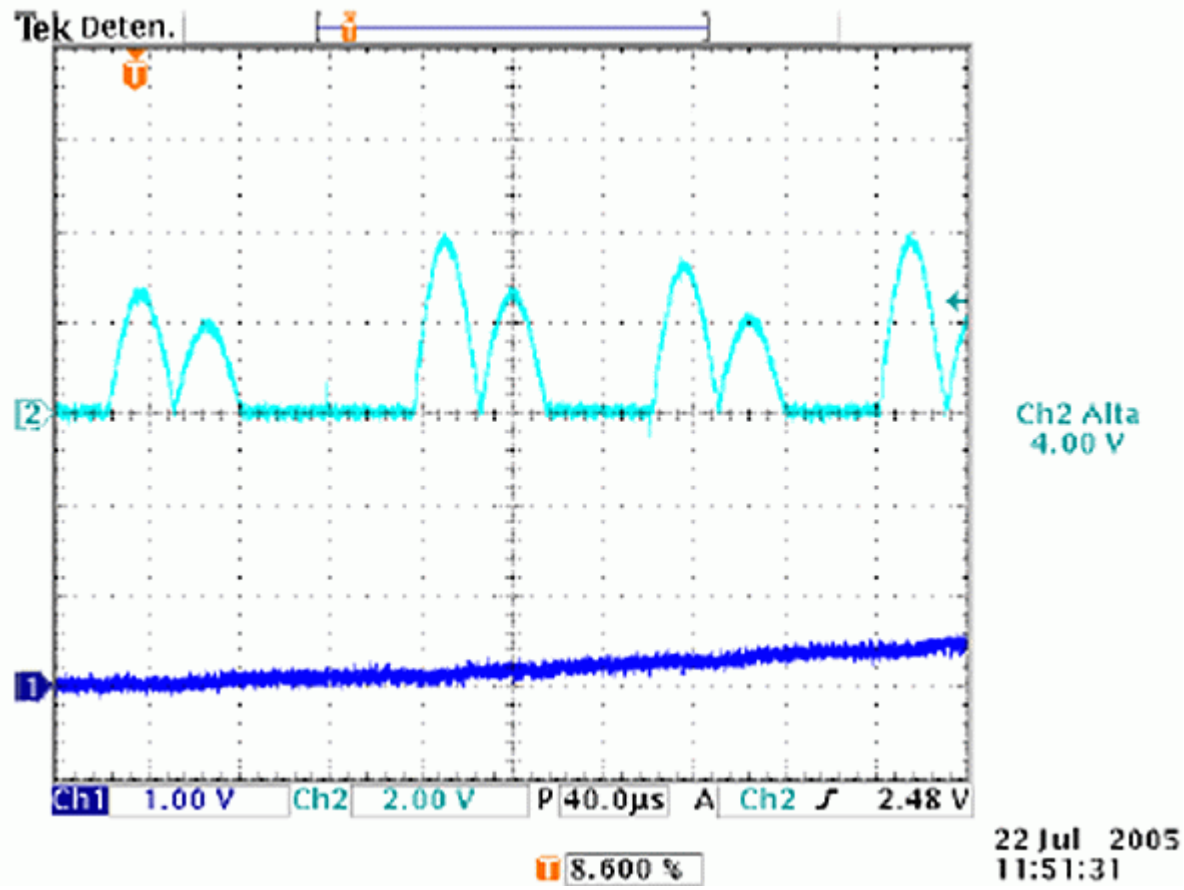

Fig. 8: Exposure_kV_kVC_(1)

- On the POLYMOBIL Plus, select 81 kV, 5 mAs.

Figure (Fig. 8 / p. 60) shows two channels of an oscilloscope at the KVC test point (resonance current of the main inverter) and at the kV test point (total kilovolts).

Channel 1 = TP “KV” 1V/div, Channel 2 TP “KVC” 2V/div, Trigger = Channel 2, level 2.48 V Time scale 40 µs/div

The TP KVC signal may vary due to different load conditions. The main inverter uses the frequency changes to obtain the energy output. The system works as a serial resonant circuit. The closer the frequency of the converter to the resonance frequency, the greater the transfer of energy will be.

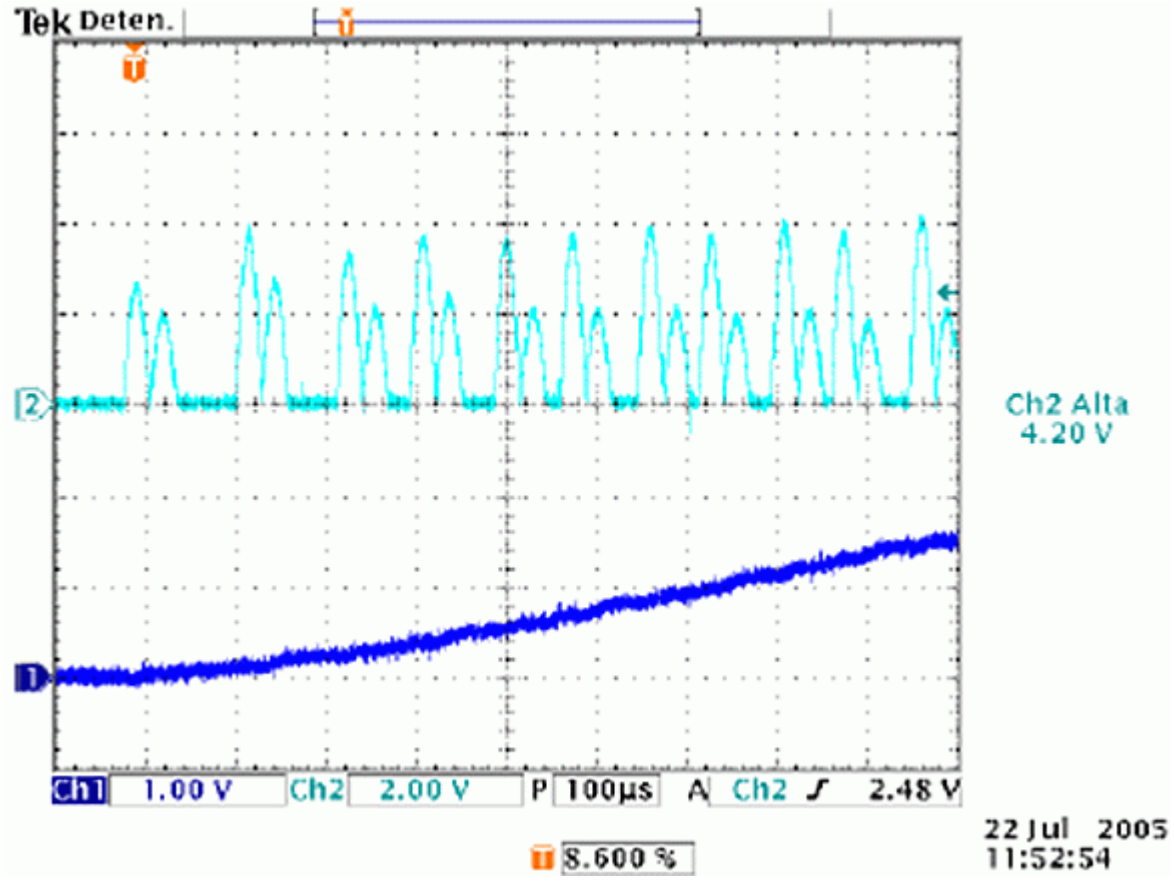

Fig. 9: Exposure_kV_kVC_(2)

- On the POLYMOBIL Plus, select 81 kV, 5 mAs.

  Figure (Fig. 9 / p. 61) shows two channels of an oscilloscope at the KVC test point (resonance current of the main inverter) and at the kV test point (total kilovolts).

  Channel 1 = TP “KV” 1V/div, Channel 2 TP “KVC” 2V/div, Trigger = Channel 2, level 2.48 V Time scale 100 µs/div

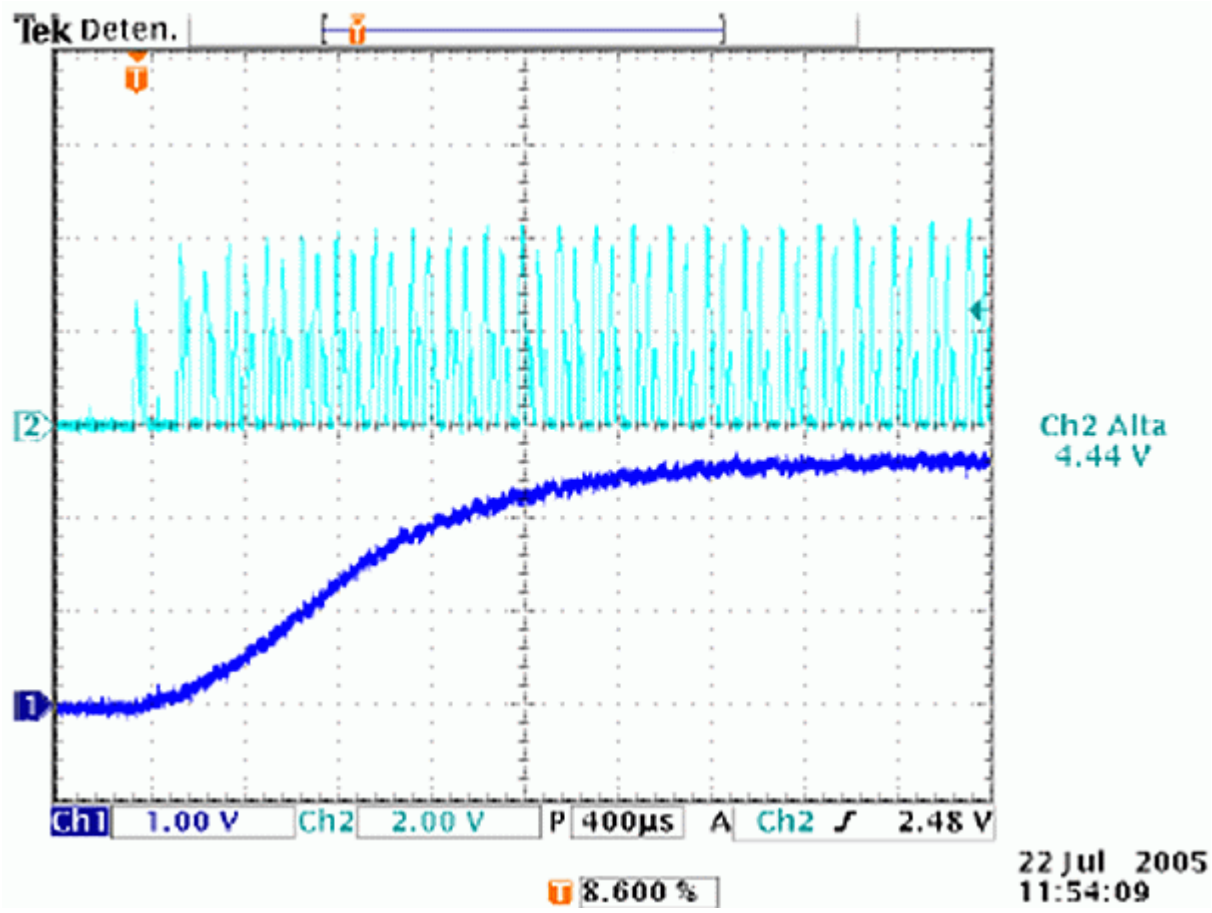

Fig. 10: Exposure_kV_kVC_(3)

- On the POLYMOBIL Plus, select 81 kV, 5 mAs.

  Figure (Fig. 10 / p. 62) shows two channels of an oscilloscope at the KVC test point (resonance current of the main inverter) and at the kV test point (total kilovolts).

  Channel 1 = TP “KV” 1V/div, Channel 2 TP “KVC” 2V/div, Trigger = Channel 2, level 2.48 V Time scale 400 µs/div

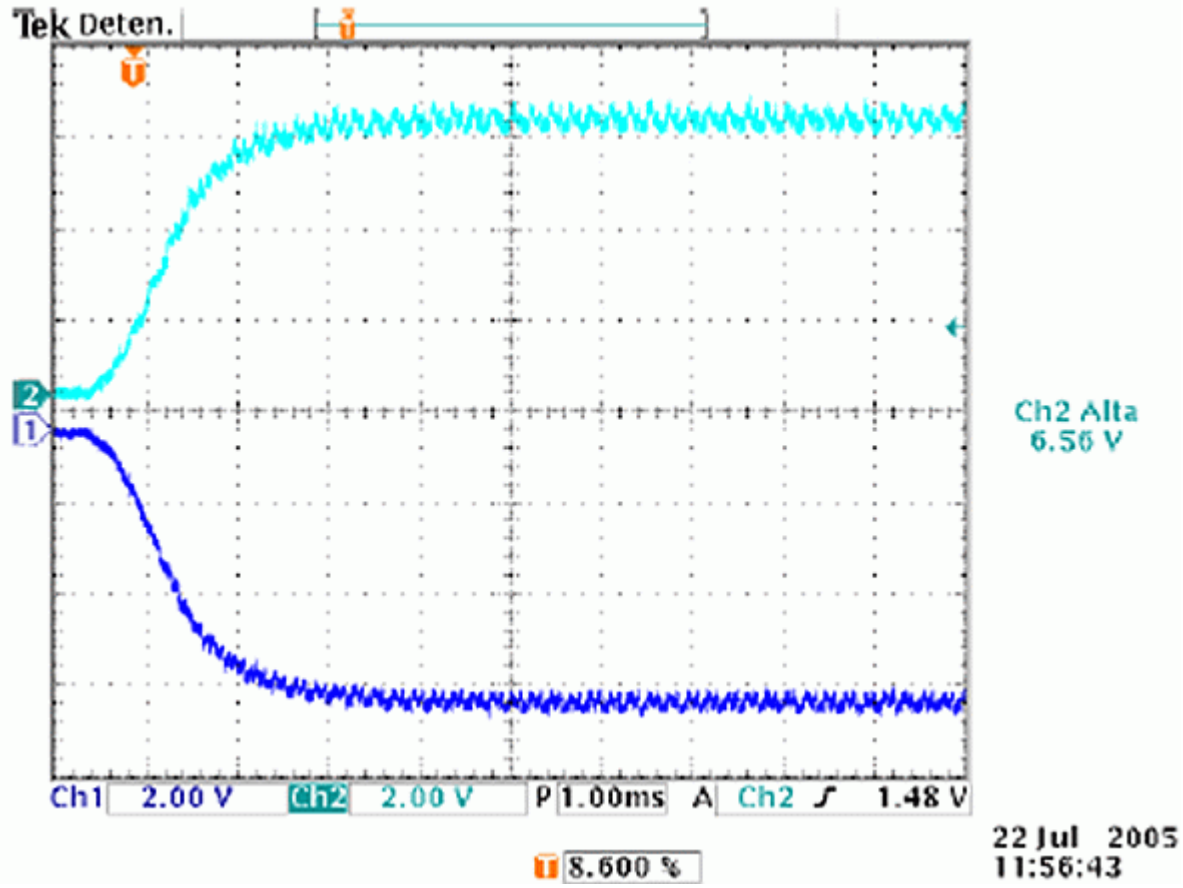

Fig. 11: Exposure kVp_kVn_(1)

- On the POLYMOBIL Plus, select 121 kV, 5 mAs.

Figure (Fig. 11 / p. 63) shows two channels of an oscilloscope at the KVP test point (positive branch of kV) on the D916 and at test point KVN (negative branch of kilovolts).

Channel 1 = TP “KVN” 2V/div, Channel 2 TP “KVP” 2V/div, Trigger = Channel 2, level 1.48 V Time scale 1 ms/div

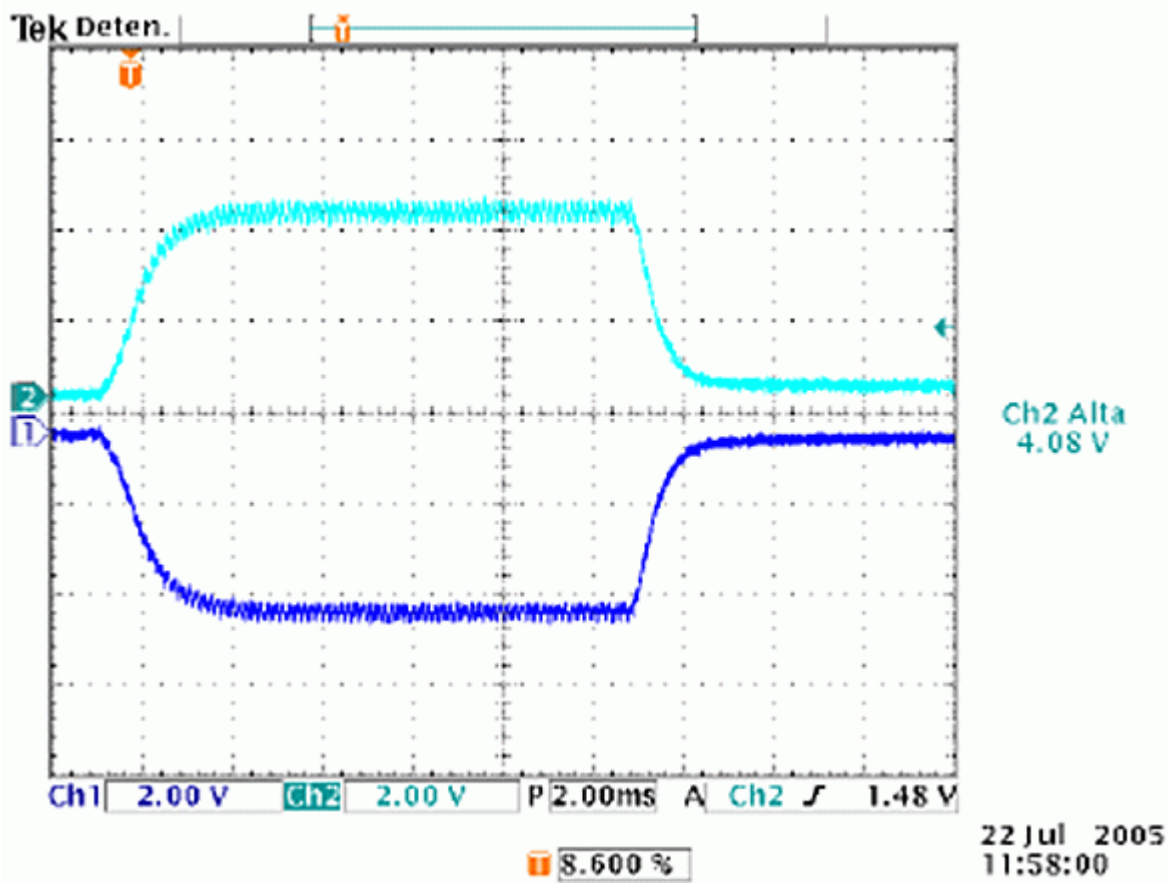

Fig. 12: Exposure kVn_kVp_(1)

- On the POLYMOBIL Plus, select 81 kV, 5 mAs.

Figure (Fig. 12 / p. 64) shows two channels of an oscilloscope at the KVP test point (positive branch of kV) on the D916 and at test point KVN (negative branch of kilovolts).

Channel 1 = TP “KVN” 2V/div, Channel 2 TP “KVP” 2V/div, Trigger = Channel 2, level 1.48 V Time scale 2 ms/div

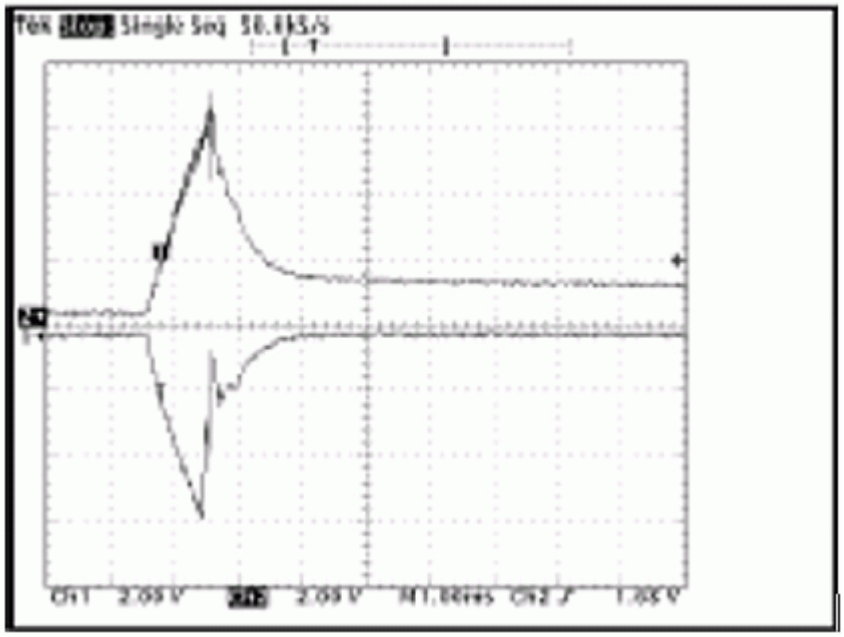

Fig. 13: Exposure kVp_kVn_(2)

Example of ERROR 34 (X-ray current limit in exposure)

- On the POLYMOBIL Plus, select 125 kV, 2 mAs (when the tube is really cold).

Figure (Fig. 13 / p. 65) shows two channels of an oscilloscope at the KVP test point (positive branch of kV) on the D916 and at test point KVN (negative branch of kilovolts).

Channel 1 = TP “KVN” 2V/div, Channel 2 TP “KVP” 2V/div, Trigger = Channel 2, level 1.5 V Time scale 1 ms/div

If you do not obtain information from the above graphs:

- Switch to the service mode.
- Select program 7: Adjustment of maximum frequency of main inverter
- Measure 18 kHz ± 0.5 kHz at TP FC2 of the D916.

- If this is not the case, adjust P4 to 18 kHz ± 0.5 kHz.

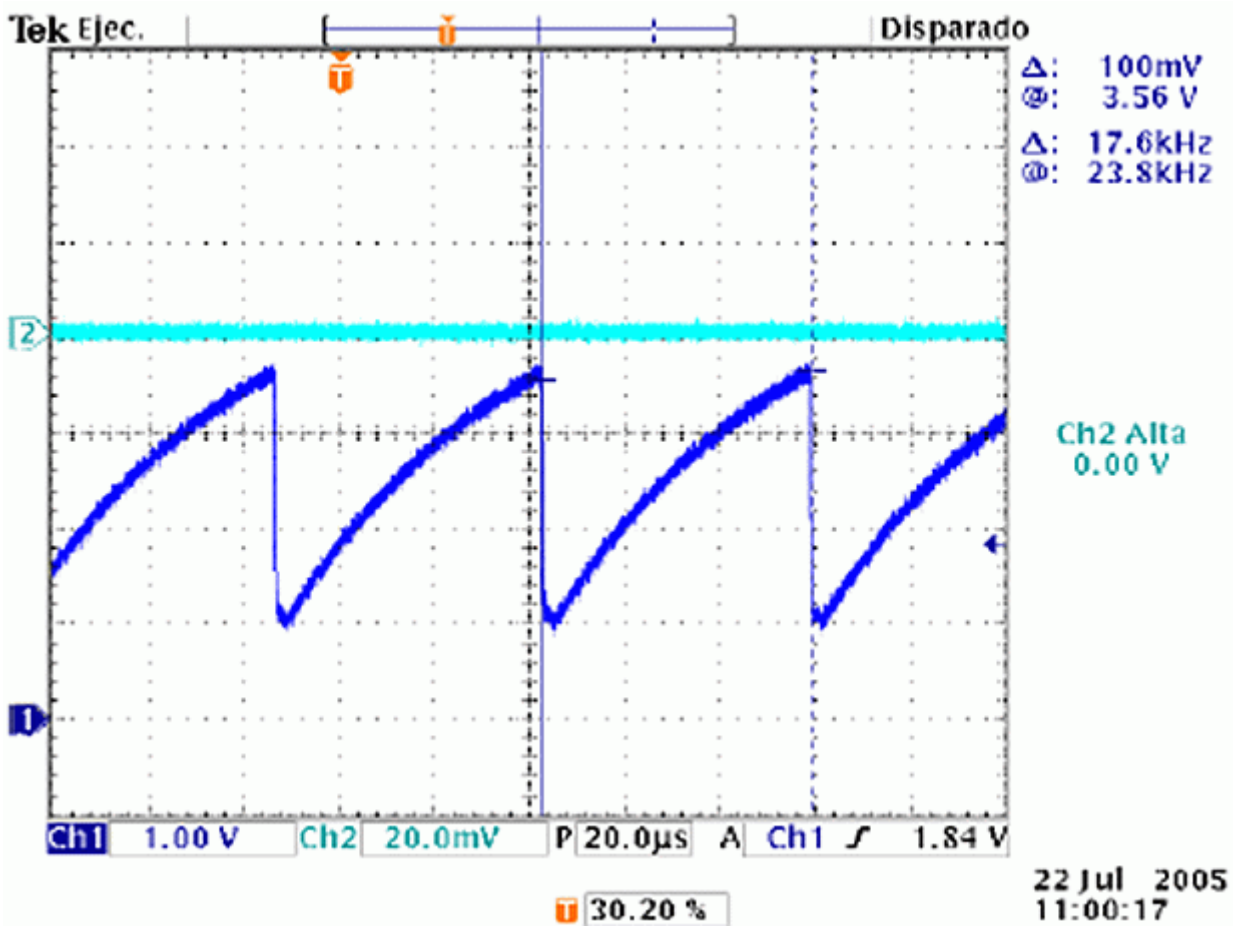

Fig. 14: FC2_18 kHz_(1)

Filament heating circuit

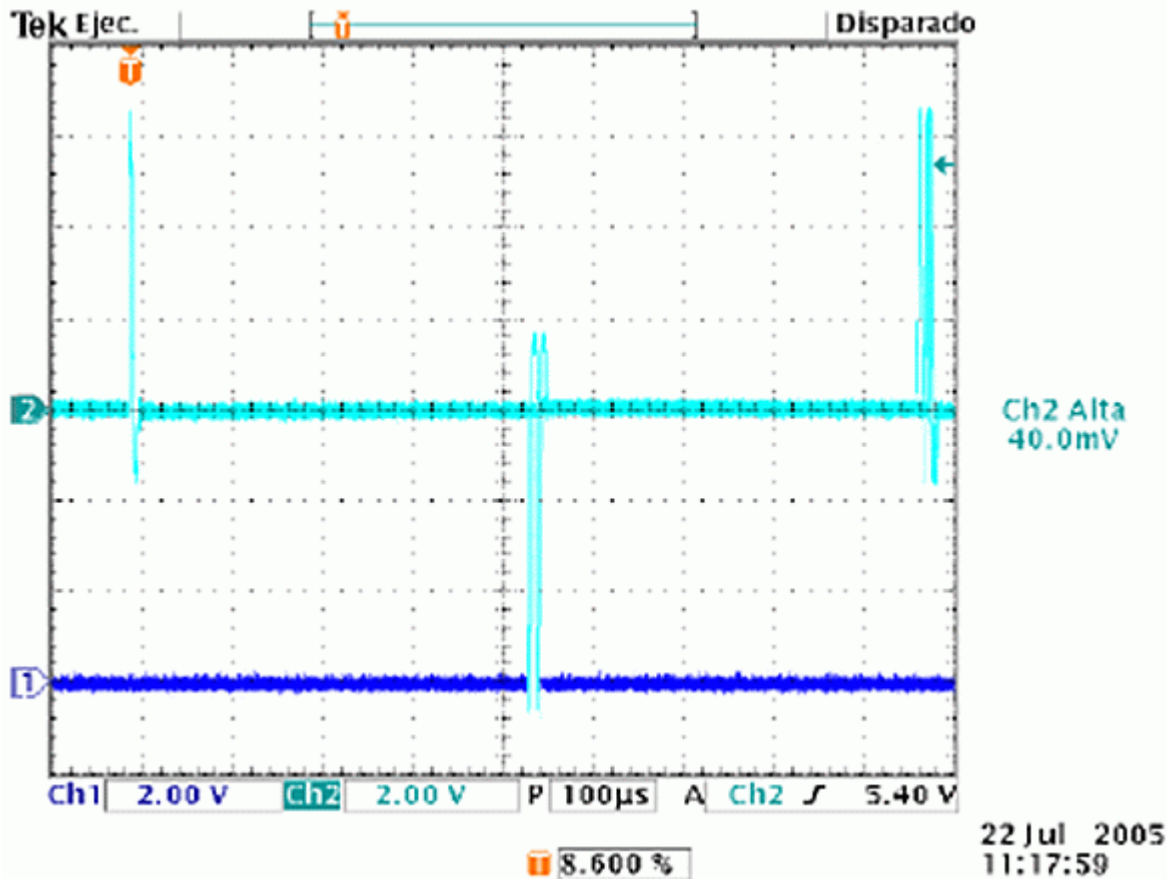

Fig. 15: Stand-by_ih_jr_(1)

Figure (Fig. 15 / p. 67) shows two channels of an oscilloscope at the TP I test point (Resonance current) on the D916 and at the JR test point (X-ray current). We see that in standby, there is no X-ray current present.

Channel 1 = TP “JR” 2V/div, Channel 2 TP “I” 2V/div, Trigger = Channel 2, level 5.4 V Time scale 100 µs/div

Maximum frequency of the current inverter

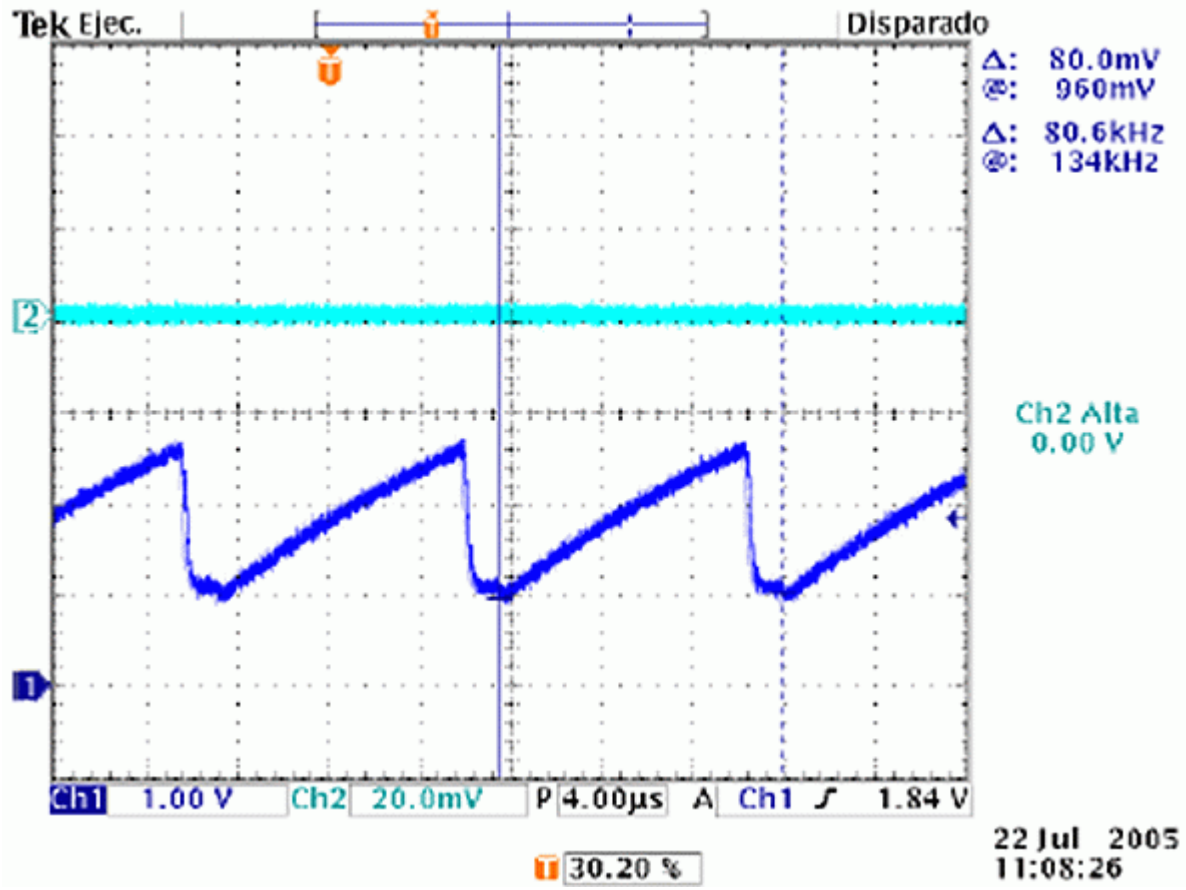

Fig. 16: FC1_frequency_80kHz_(1)

- Disconnect X5 on the D927, output of heating current to the tube.

Figure (Fig. 16 / p. 68) shows two channels of an oscilloscope at the TP FC1 test point (heating inverter frequency) on the D916 and at the JR test point (X-ray current). We see that in standby, there is no X-ray current present.

Channel 1 = TP “FC1” 1V/div, Channel 2 TP “JR” 2V/div, Trigger = Channel 2, level 1.84 V Time scale 4 µs/div

The frequency should be 80 kHz ± 1 kHz

During preparation, no X-ray current should be present either. The heating current through the primary is sensed and measured at the TP I (1V = 5 A). To handle this frequency, an RMS converter is used. After the conversion and adaptation, this value can be measured at TP IH. In order to regulate the heating current, this value is compared to a preset filament value IHS. The deviations among these values can be adjusted.

During preparation

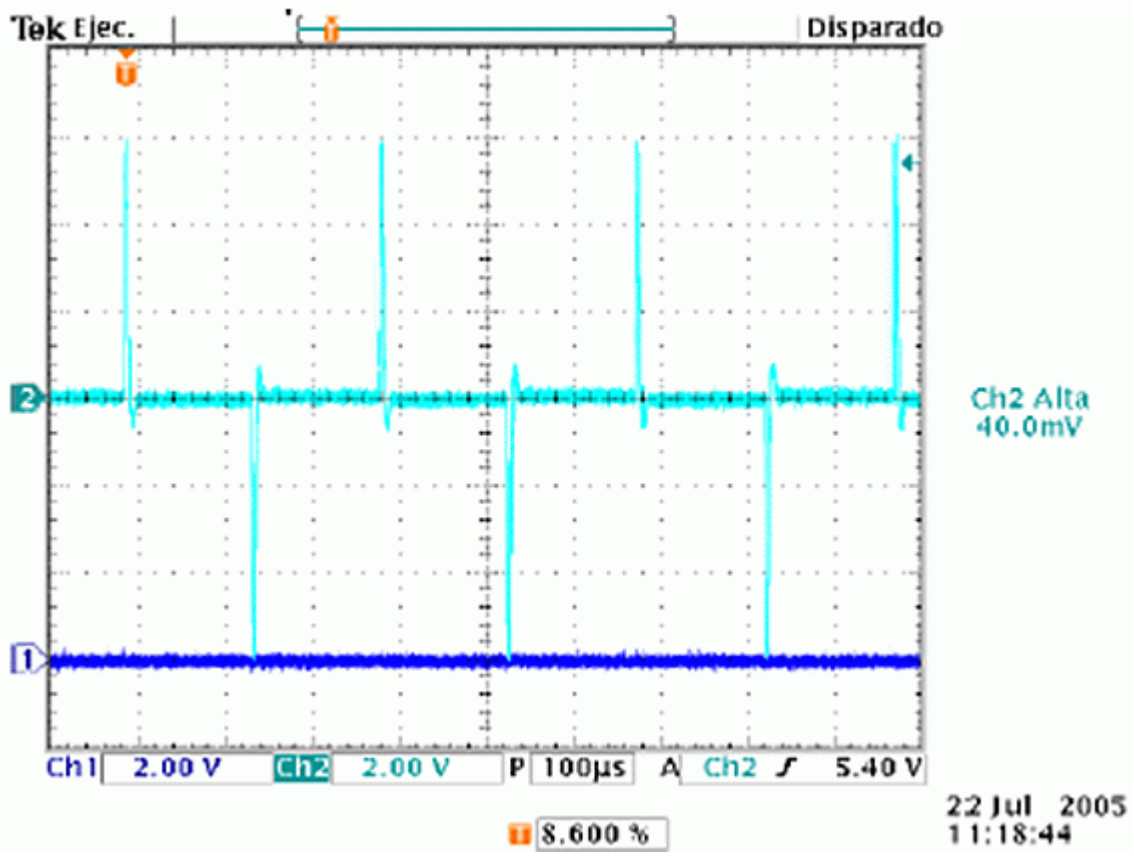

Fig. 17: Preparation_i_jr_(1)

Figure (Fig. 17 / p. 69) shows two channels of an oscilloscope at the TP 1 test point (resonance current) on the D916 and at the JR test point (X-ray current).

We see that in standby, there is no X-ray current present.

Channel 1 = TP “JR” 2V/div, Channel 2 TP “I” 2V/div, Trigger = Channel 2, level 5.4 V
Time scale 100 µs/div

During exposure, a real X-ray current is measured due to the existence of high voltage between the anode and the cathode. This current is measured by means of a virtual ground in the D900 and sent to the D916 CPU card. The corresponding signal can be monitored at TP JR. The microcontroller switches between the heating regulation and the tube current regulation.

During exposure

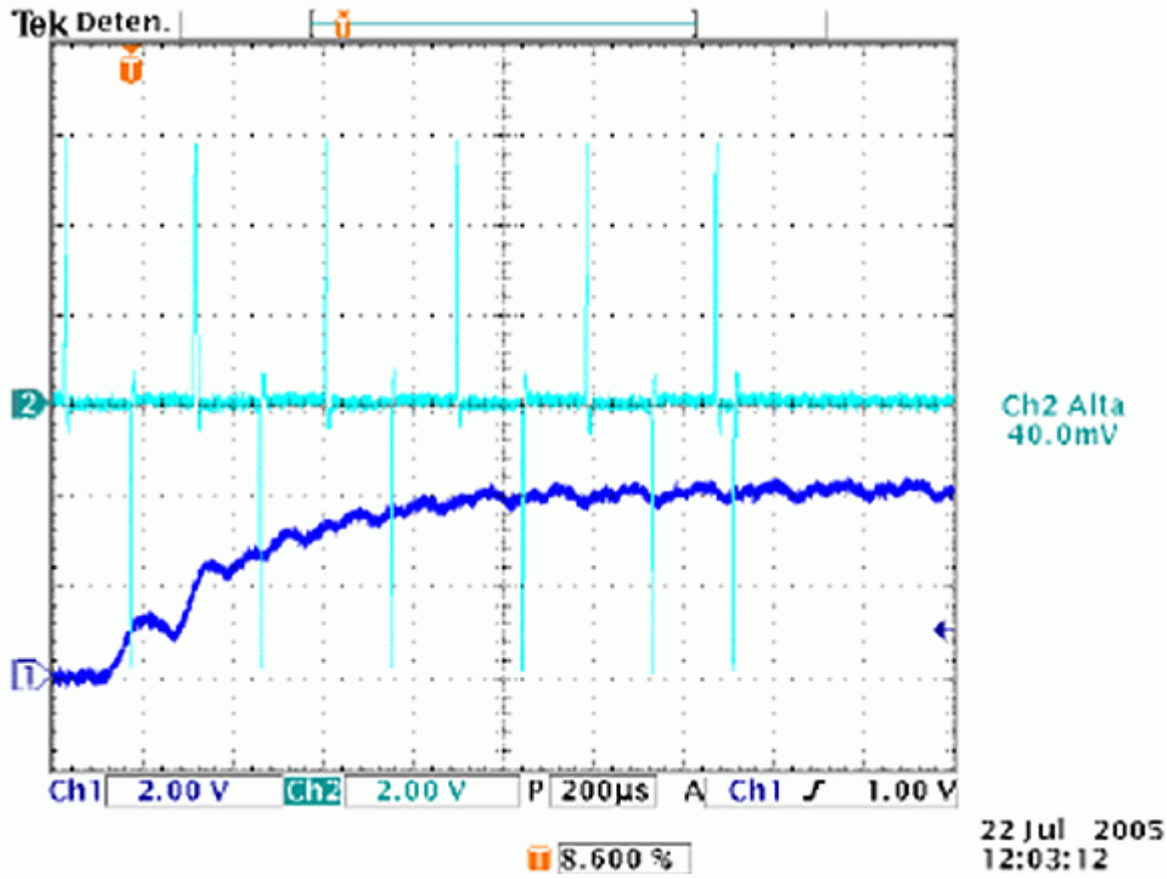

Fig. 18: Exposure_i_jr_(1)

Figure (Fig. 18 / p. 70) shows two channels of an oscilloscope at the TP 1 test point (resonance current) on the D916 and at the JR test point (X-ray current). We see that in standby, there is no X-ray current present.

Channel 1 = TP “JR” 2V/div, Channel 2 TP “I” 2V/div, Trigger = Channel 2, level 1
VTime scale 200 µs/div

At the end of the exposure, it returns to standby heating.

Due to the capacity limit of the capacitor bank, the system uses a decreasing load operational mode, by which the POLYMOBIL Plus takes advantage of the tube's curve.

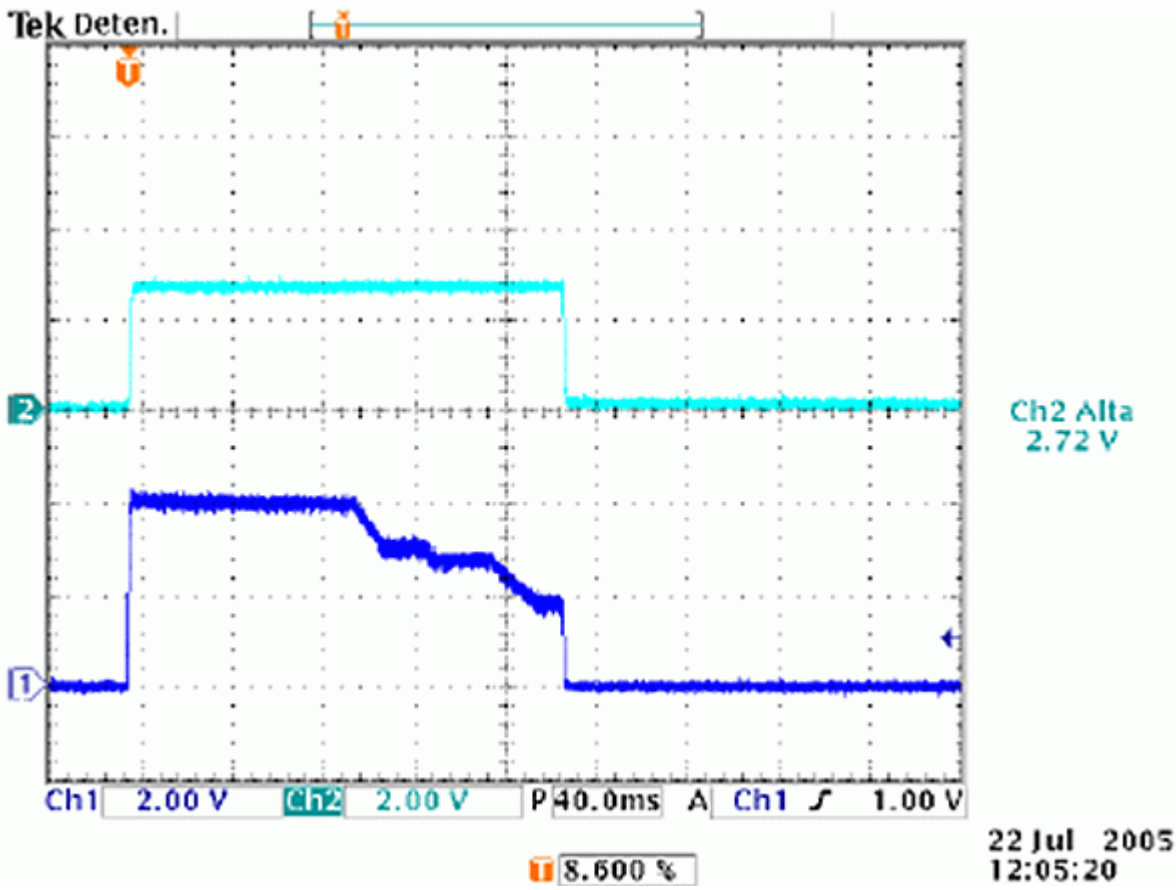

Fig. 19: Exposure_kV_jr_(1)

- On the POLYMOBIL Plus, select 81 kV, 40 mAs.

  Figure (Fig. 19 / p. 71) shows two channels of an oscilloscope at the JR test point (X-ray current) and at the kV test point (total kilovolts).

  Channel 2 = TP “KV” 2V/div, Channel 1 TP “JR” 2V/div, Trigger = Channel 1, level 1 V
  Time scale 40 ms/div

  During exposure

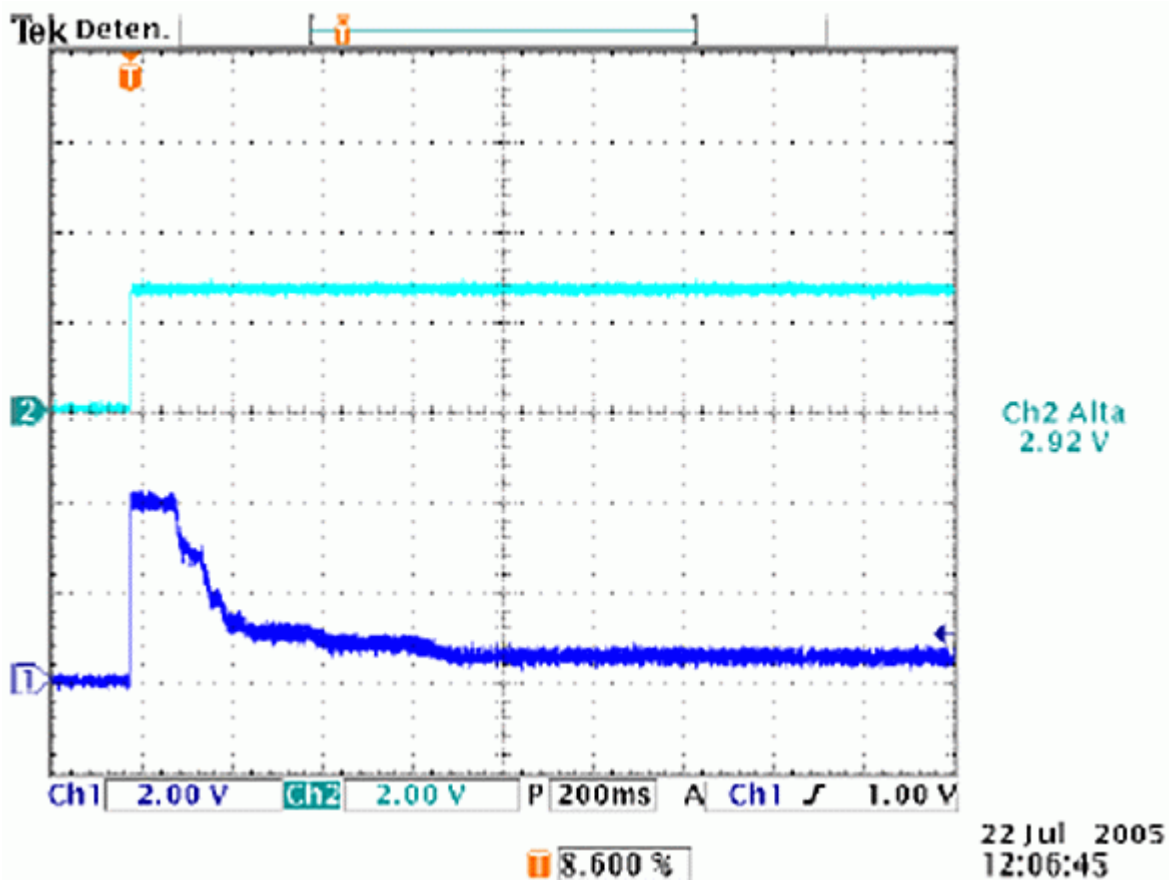

Fig. 20: Exposure_kV_jr_(2)

- On the POLYMOBIL Plus, select 81 kV, 90 mAs.

Figure (Fig. 20 / p. 72) shows two channels of an oscilloscope at the JR test point (X-rays current) and at the kV test point (total kilovolts).

Channel 2 = TP “KV” 2V/div, Channel 1 TP “JR” 1V/div, Trigger = Channel 1, level 1 VTime scale 100 ms/div

mAs counter

Please use the wiring diagram as you read the following information.

The tube current, measured on the D900 card, enters the frequency voltage converter J1 located on the D916 card. This converter generates a frequency that is proportional to the voltage value, it being 1 V 64 kHz. The output pulses can be measured with an oscilloscope at the TP F1 of the D916 card. These pulses are digitally integrated in a counter until the mAs's required are obtained. This count ends when a preselected value is reached.

The end of the exposure is controlled by a counter and a prescaler. When the exposure ends, the system goes into standby. The only time that an exposure is interrupted ahead of time is in the event that the system is operating incorrectly. Interruptions that last a long time are automatically interrupted and an Err 39 error message appears.

Line voltage

The line voltage must be set to 110 V (+ 10%) or 230 V (+ 10%). The line voltage is adjusted automatically.

Measuring KV and JR

- Connect the oscilloscope to TP "JR" (i.e. Itube), "KV" (i.e. KVist) and "GND" on D916

CH1	TP "JR"	1.0 V/Div
CH2	TP "KV"	1.0 V/Div
		Ground at "GND"
		10 ms /Div
		Trigger at CH1

- Set 90 kV and 10 mAs at the POLYMOBIL Plus and release an exposure. The oscillogram should correspond to what is shown here: (Fig. 21 / p. 74).

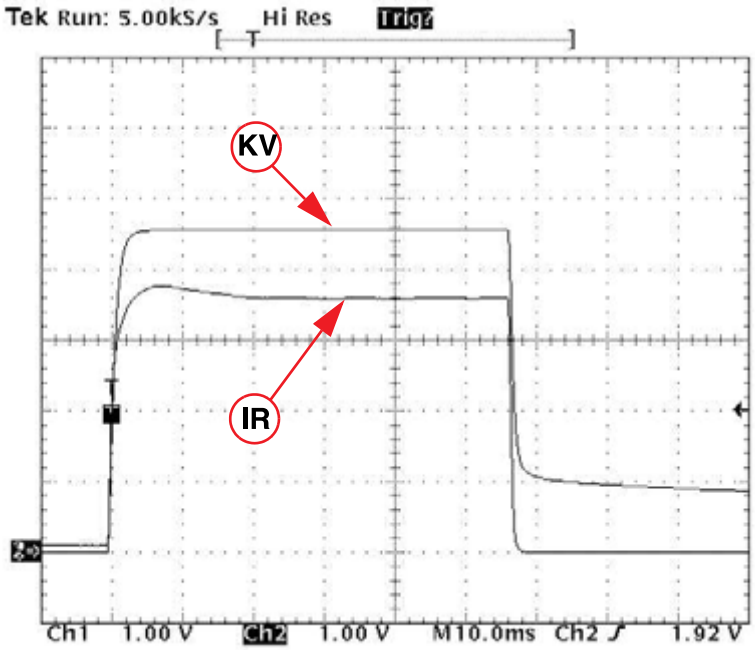

Fig. 21: kV_Itube

Capacitor charging circuit

NOTE	**Signals are only present during charging of the capacitors.**

Charging frequency (TP “FR1”) and capacitor charging current (TP “IC”)

- Connect the oscilloscope to D 952 at TP "FR1", TP “IC” and "GND"

CH1	TP "FR1"	5.0 V/Div
CH2	TP "IC"	1 V/Div
		Ground at "GND"
		10 µs/Div

- After switch-on, the following oscillogram can be measured:

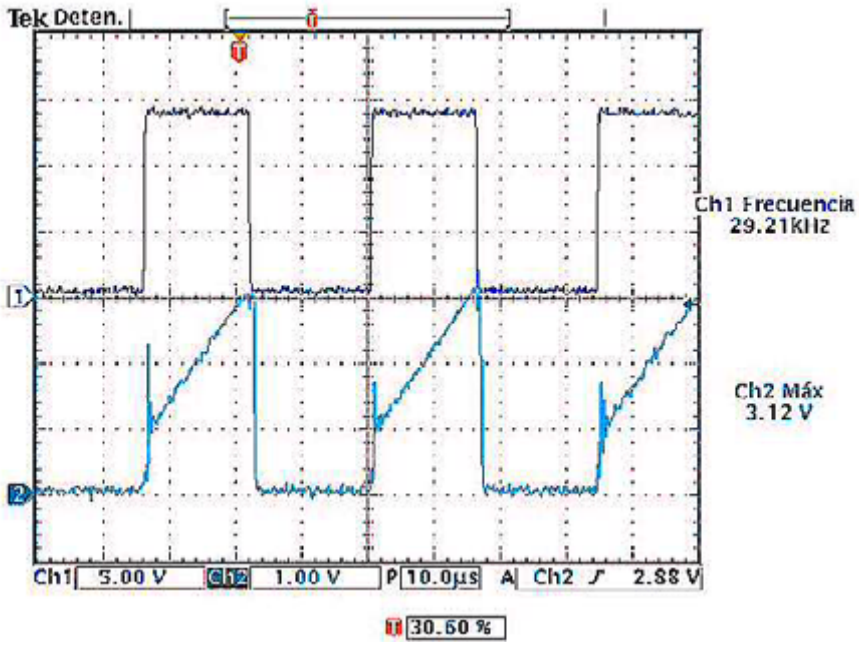

Fig. 22: D952_FR1_IC_approx 27 kHz

The capacitor charging frequency is approx. 27 kHz and cannot be adjusted.

The charging current depends on the line voltage present and on the charge status (capacitor voltage Uc) of the capacitor bank. (Fig. 22 / p. 75) shows the charging current in standby, i.e. when the C-bank is charged.

Capacitor voltage (Uc) and charging time

In exposure-ready status, the capacitor voltage is approximately 440 V and can be measured on D 952 TP "VC". If the device is switched off because of overvoltage, the signal "ERR" is output on D952

⚠WARNING

A danger of electric shock exists when work is performed on a system with open cover panels!

Risk of death or serious physical injury.

➪ **You can measure the capacitor voltage at TP "VC" only if POLYMOBIL Plus is switched on.**

The charging time depends upon the residual charge of the capacitor bank and on the available line voltage, e.g. with 230 V the maximum charging time is about 15 s. In the worst case, (line voltage < 100 V and residual charge = 0 V), the charging time can be 40 seconds.

For the following measurement, the line voltage was 230 V and the residual charge 30 V

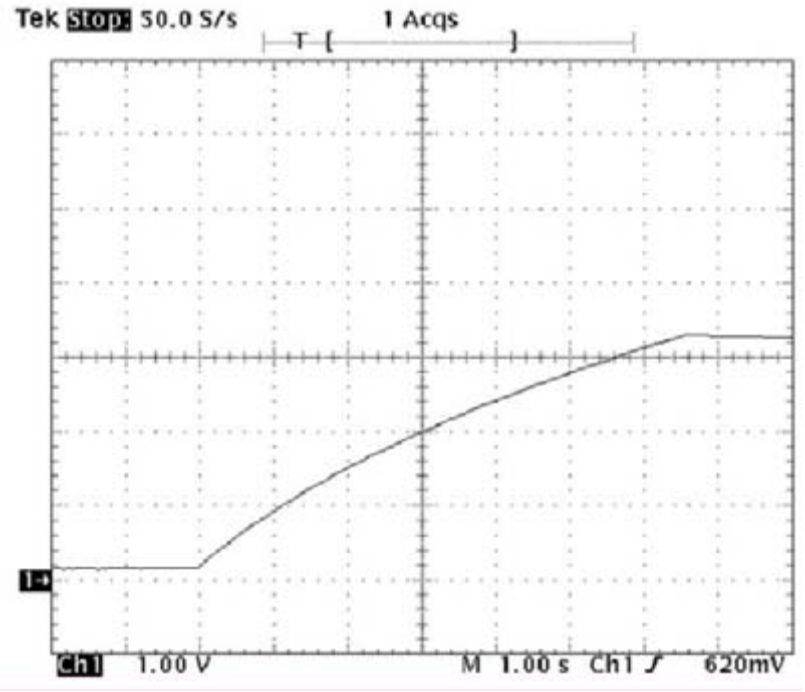

*Fig. 23: Uc_time_*

D916 test point “VC” (1V ≙ 100 V)

Rotating anode starter

Acceleration

(Fig. 24 / p. 77) shows the stator currents during rotating anode acceleration (230 V)

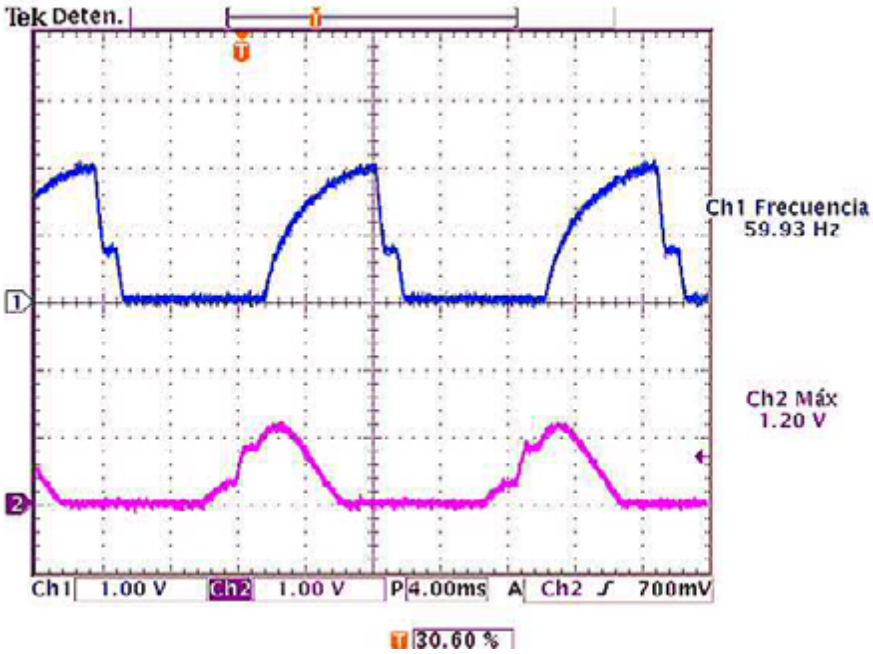

Fig. 24: PLUS_I1_I2_STARTER_CURRENT

CH2 D916 test point “I1” (I1max ≙ 2.4V)

CH1 D916 test point “I2” (I2max ≙ 1.5 V)

4 ms /Div

NOTE	**The currents are correspondingly lower at 100 V line voltage.**

kV Control

Checking the maximum main inverter frequency

NOTE	**It is generally not necessary to set the main inverter frequency in the field. When ordered as a replacement, D916 is preset at the factory.**

- Connect the oscilloscope to D916 at TP "FC2" and "GND".

  1V/Div

  40 µs/Div

  F_{MAX} = 18 KHz

- Measure FMAX in the service program Pr. 7 (See "Service program", section on "Service programs available")

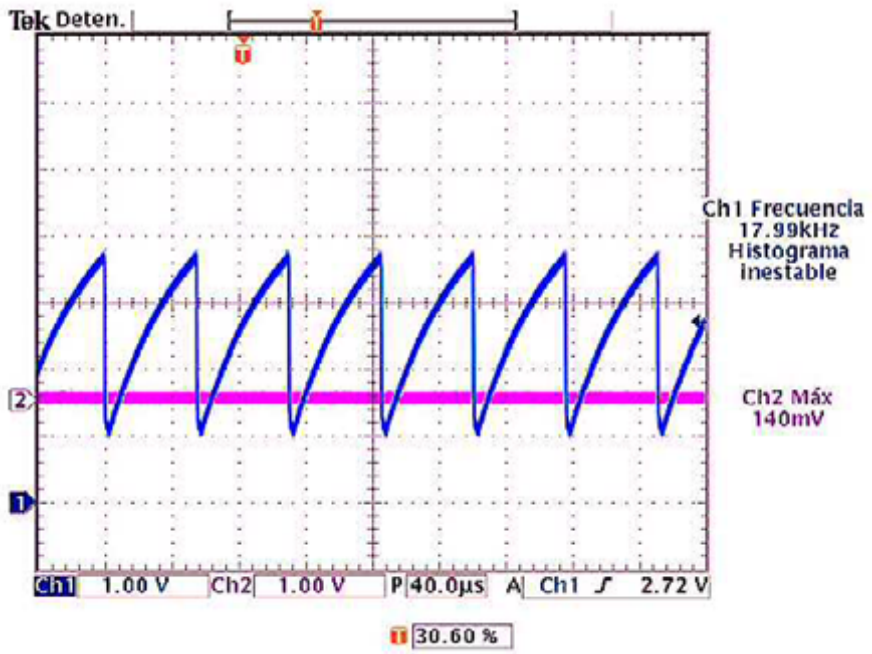

Fig. 25: FC2_for adjustment

- Setting the maximum main inverter frequency with potentiometer P4 on D 916.

Measuring the oscillating current

⚠WARNING

A danger of electric shock exists when work is performed on a system with open cover panels!

Risk of death or serious physical injury.

➪ **Prior to beginning work steps described in the following instructions, you must discharge the capacitor bank because life-threatening DC voltage is present. Check the actual charge with the DVM.**

- Switch OFF POLYMOBIL Plus and wait until the capacitor voltage has dropped to a value < 10 V.
- Disconnect the cable from the inverter to capacitor C1. Push the cable through the current transformer 50 A: 50 mA (with a parallel resistor of 10 ohms) and reconnect the cable.
- Connect the oscilloscope to the current transformer.
- Switch ON POLYMOBIL Plus.
- Set 60 KV, 10 mAs on POLYMOBIL Plus and release exposure.

  The diagram must correspond to (Fig. 26 / p. 79).

NOTICE

Maximum main inverter frequency

➪ **The maximum main inverter frequency can only be measured in the ascending part of the high voltage, i.e. in the first microseconds, because afterwards the frequency is lower.**

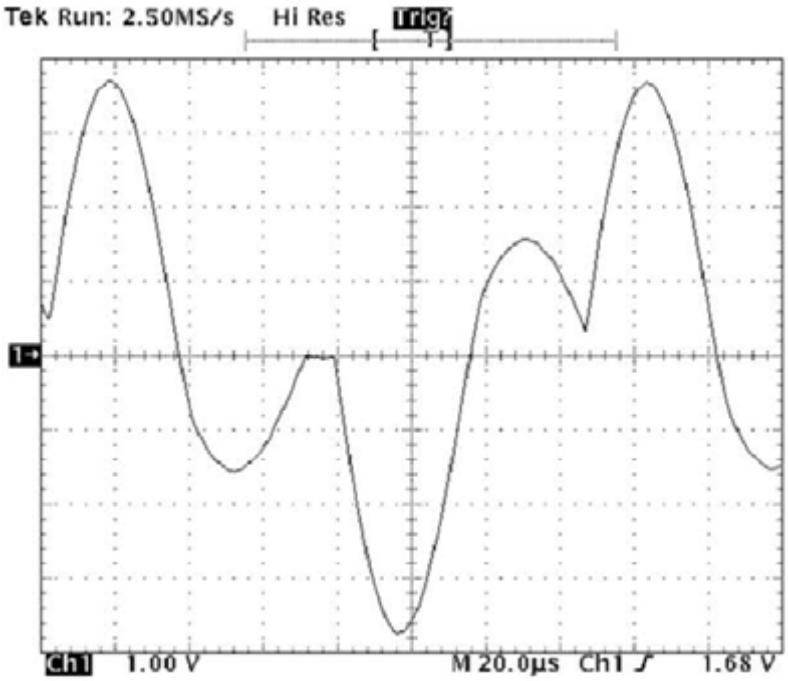

*Fig. 26: current_measurement_*
CH1: 1 V/Div,
20 µs /Div

NOTE

To obtain one image similar to this one above, you have to use a current transformer in one of the output cables of the main inverter.

Measuring the kVact and kVnom

- Connect the oscilloscope to D916 at TP "KV", "KVS" and "GND".
- Set 60 KV, 10 mAs on POLYMOBIL Plus and release exposure.
- The oscillogram must appear as shown in (Fig. 27 / p. 80).
- The KVnom value can be set with P7 on D916.

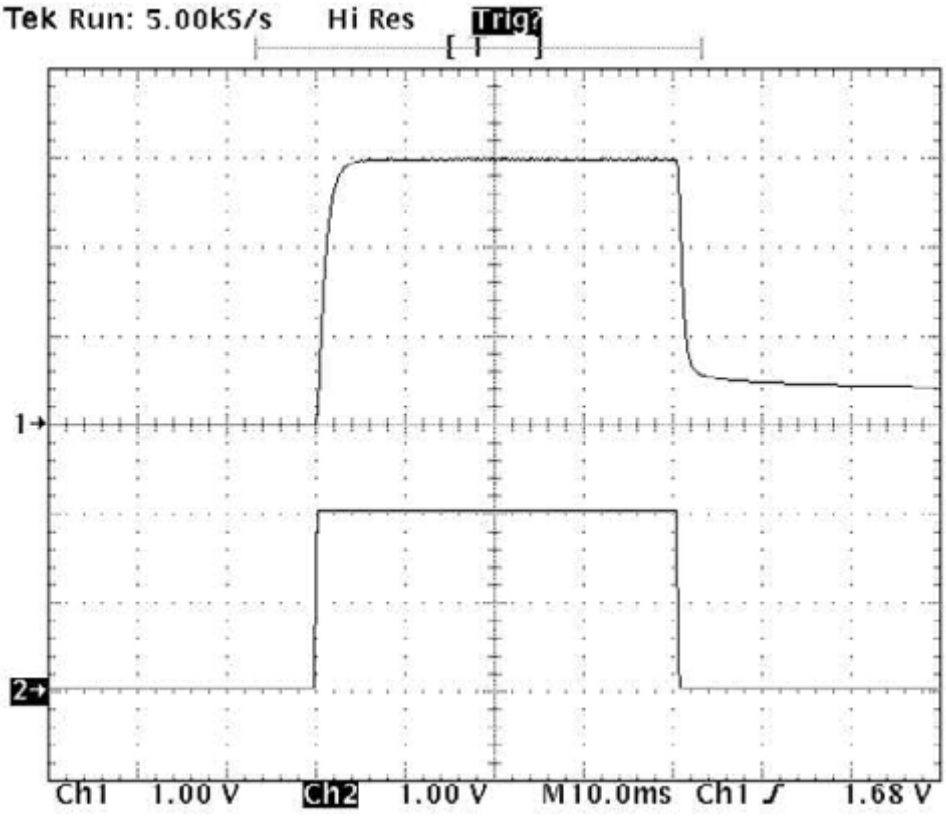

Fig. 27: kVact_kVnom

kVact:	CH1 D916 test point "KV"	1 V ≙20 KV
	CH2 D916 test point "KVS"	1 V ≙30 KV
	20 ms /Div	

Error in the kVact acquisition

(Fig. 28 / p. 81) shows that one kVact cable from the single tank generator to the D916 is damaged or disconnected. The monitor (KVM) responds (curve 3) because KVN and KVP have different amplitudes; the exposure is terminated with ERR 12. Refer to function description "KV monitoring".

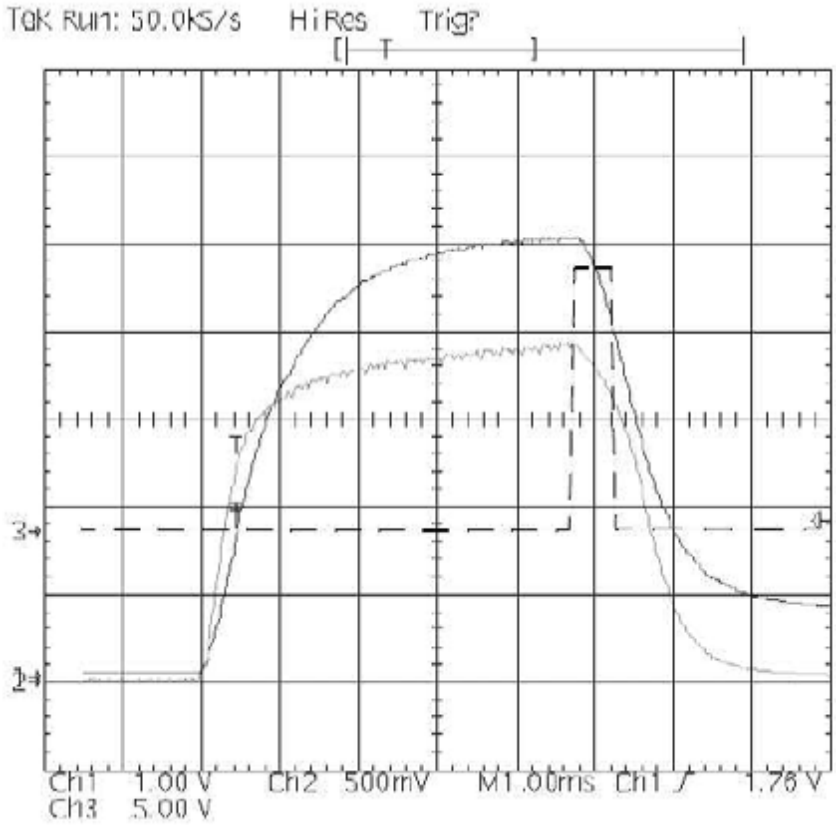

Fig. 28: Error in kVact

Exposure data: 102 KV 10 mAs

KVact:	CH1:	D916 test point "KV"
Itube:	CH2:	D916 test point "JR"
	CH3:	D916 test point "KVM"
		1 ms /Div

Testing the filament circuit

Filament circuit in standby

- Connect the oscilloscope to D916 at TP "IH", "I" and "GND".

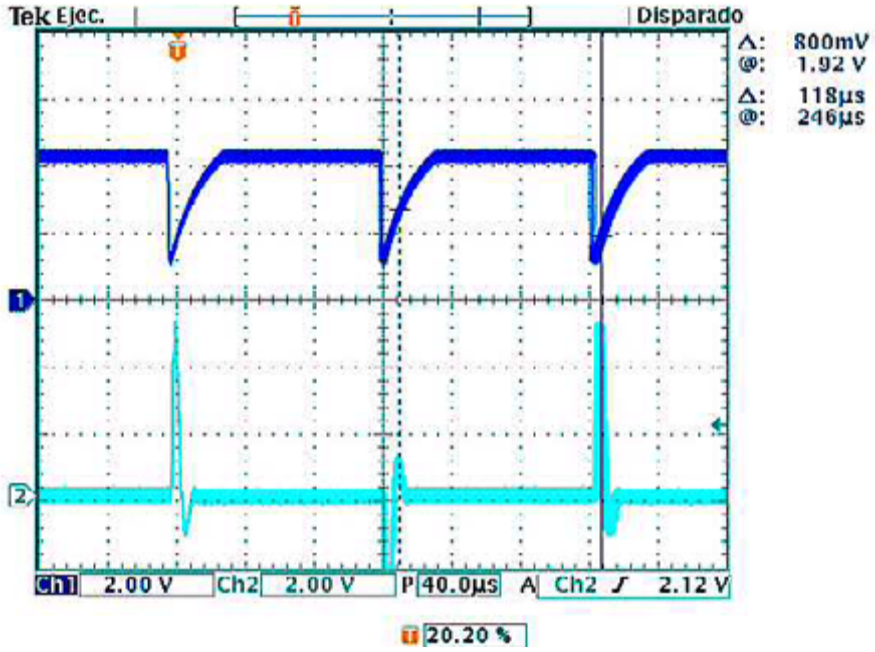

Fig. 29: PLUS_FC1_I_3A

Filament inverter frequency	CH1: D916 test point "IH"
Filament current	CH2: D916 test point "I"

Setting the maximum filament inverter frequency

The maximum filament inverter frequency is approx. 80 kHz and can be set with P3 on D916.

Proceed as follows:

- Switch POLYMOBIL Plus OFF.
- Remove fuse F6 on D927.
- Connect the oscilloscope to D916 at TP "IH" and "GND".
- Switch POLYMOBIL Plus ON (Err 03 is blinking).

The oscillogram must appear as shown in (Fig. 30 / p. 83).

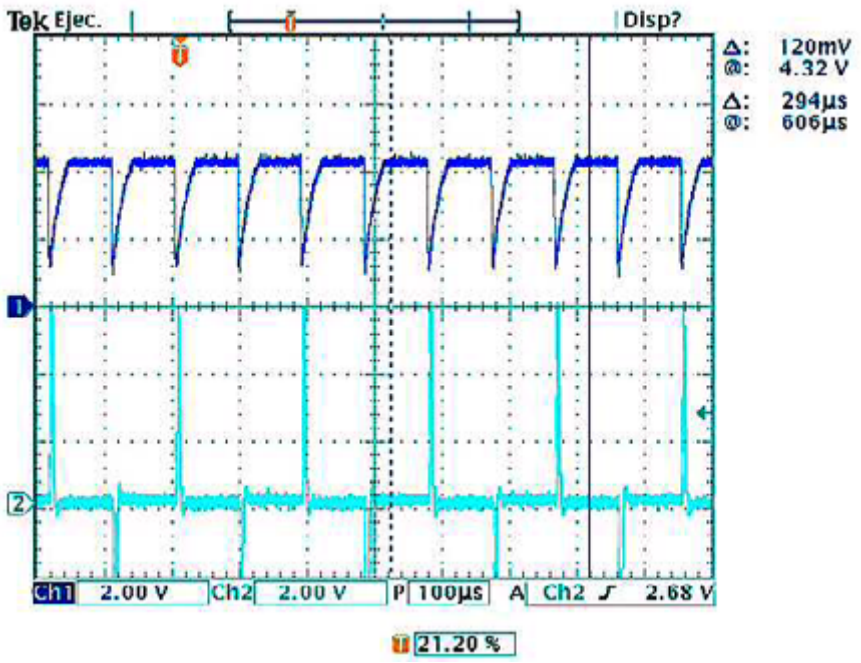

Fig. 30: PLUS_FC1_I_5A

100 µs/Div

- Setting the maximum filament inverter frequency with potentiometer P3 on D916.

Measuring the filament nominal value

The filament nominal value is set at the factory and should not be changed.

The filament nominal value can be measured on D916 at TP "JRS" and "GND" with the DVM and is 1.5 V ± 4% in standby.

NOTE	**If this value is changed, the nominal values for preparation and exposure are also affected.**

Setting the tube current for the exposure

The tube current must be reset for each tube.

Proceed as follows:

- Connect the oscilloscope to D916 at TP "JR", "IH" and "GND".
- Set 60 kV, 10 mAs on POLYMOBIL Plus and release an exposure.

The oscillogram must appear as shown in (Fig. 31 / p. 84).

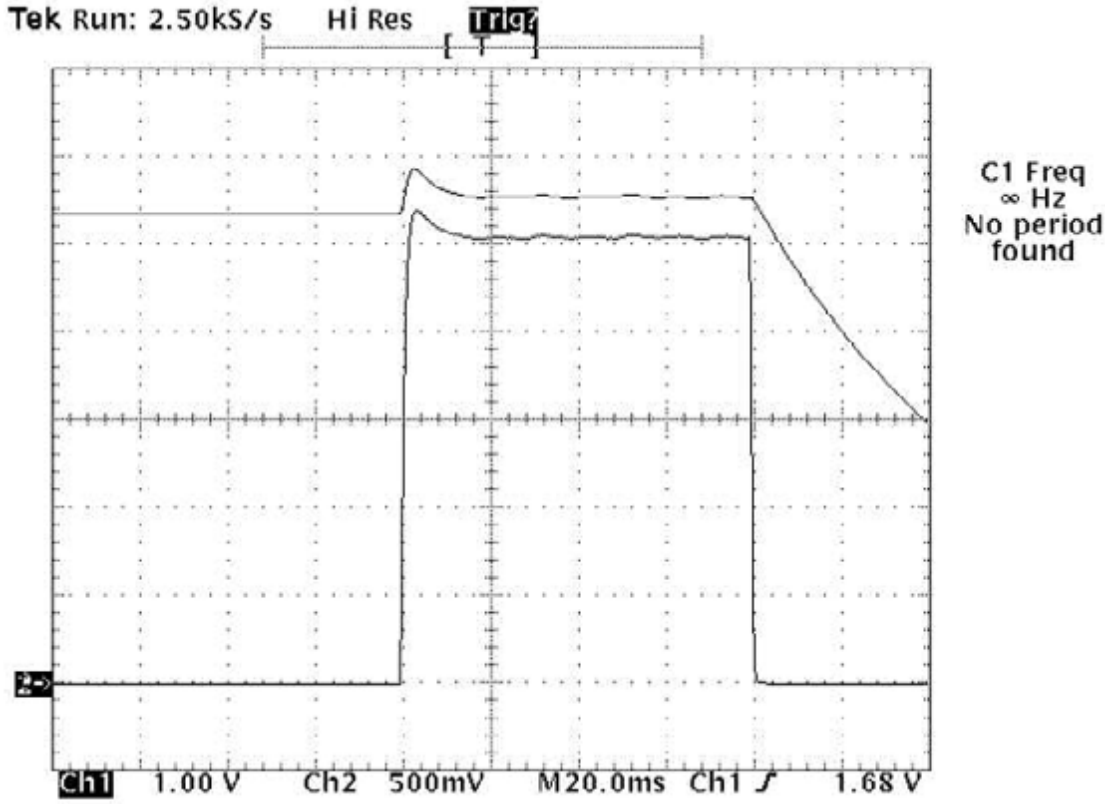

Fig. 31: IH_IR

Actual tube current value	CH1: D916 test point "JR"
Actual fil. current value	CH3: D916 test point "IH"

If this is not the case, adjust P5 on D916 until there is minimal current overshoot at the beginning of the exposure.

The standby heating of the exposure is set via P5 (P5 clockwise: IH decreases / P5 counterclockwise: IH increases).

(Fig. 31 / p. 84) shows the correct setting.

In figure (Fig. 32 / p. 85) the standby heating is set too high.

In figure (Fig. 33 / p. 86) the standby heating is set too low.

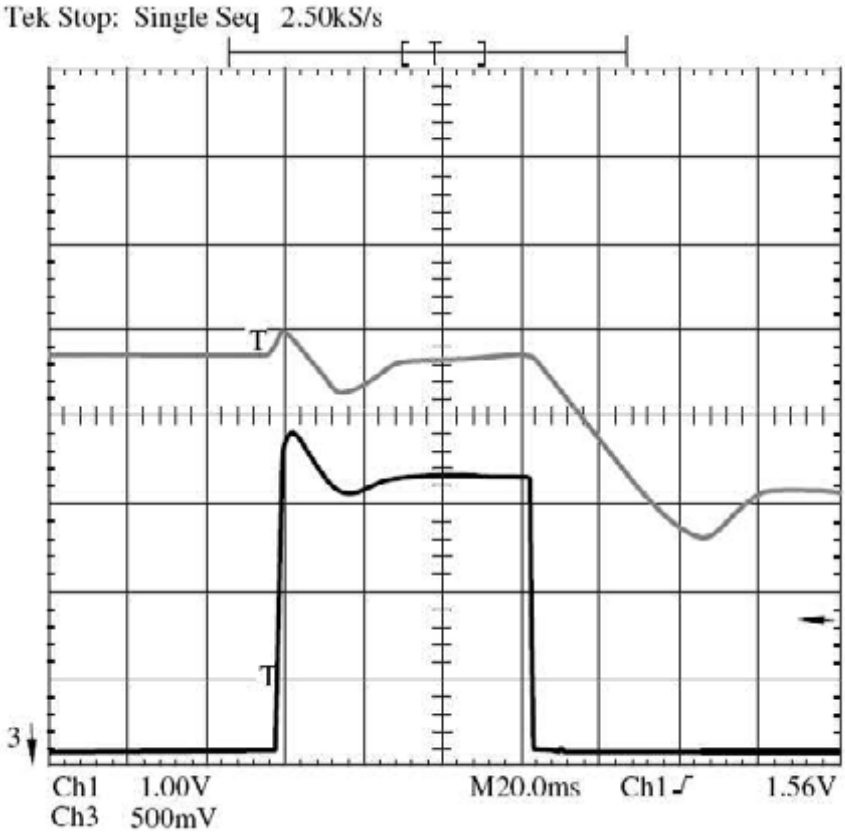

Fig. 32: Standby heating too high

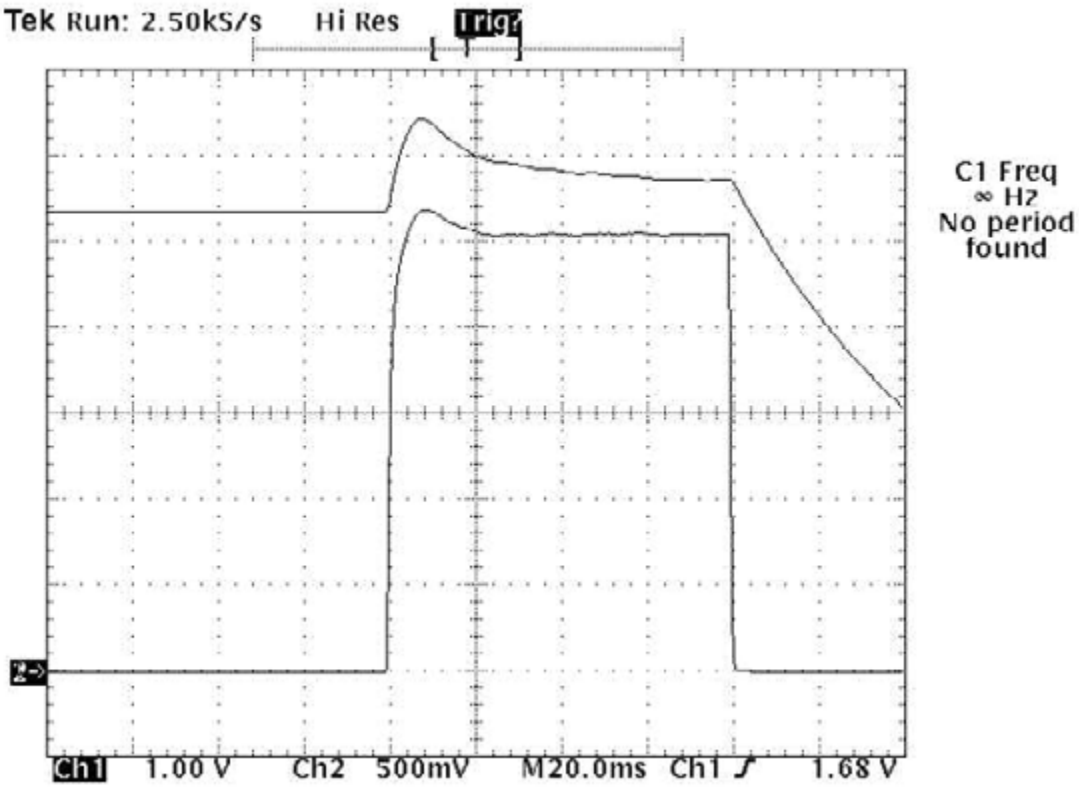

Fig. 33: Standby heating too low

Testing and setting the mAs counter

- Unscrew the lid of the single tank cover.
- Pull out the mAs jumper on D900 and connect the mAs meter.
- Set 70 kV, 80 mAs on POLYMOBIL Plus and release exposure.

If the value displayed on the mAs meter does not coincide with the value set on POLYMOBIL Plus, adjust the mAs counter with P1 on D916.

Release another exposure and compare the display.

⚠CAUTION

Overheating of the tube during radiation.

The tube can be damaged.

➪ **Observe the cooling intervals for the tube.**

Coincidence of light and radiation fields

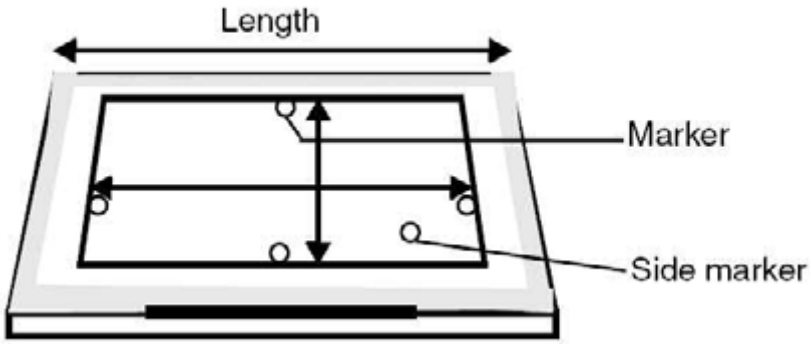

Fig. 34: Coincidence_light and radiation

NOTE

If the POLYMOBIL is equipped with a DAP measuring system, remove the DAP ionization chamber first.

Procedure:

- Insert film into the 24 cm x 30 cm or 10” x 12” cassette and place it on a table or similar surface.
- Adjust the vertical SID of 100 cm or 40” to the top edge of the cassette using a measuring tape.
- Use the knobs to set a format of 18 cm x 24 cm or 8” x 10”.
- Switch on the light localizer and align the cassette.
- Apply radiopaque markers (e.g. washers, coins) as shown in (Fig. 34 / p. 87). Use one washer as a side marker.

- Release an exposure (60 kV, 10 mAs) and develop the film.
- Log the following data on the developed film using a water-resistant felt-tip pen
  - SID setting
  - Film size
  - Radiation field size

Evaluation:

- Measure the deviations (X1, X2, Y1, Y2) between the edges of the light field and the radiation field on all four sides, corresponding to (Fig. 35 / p. 88).

- Calculate the total deviations in the X and Y directions (disregarding the algebraic sign).

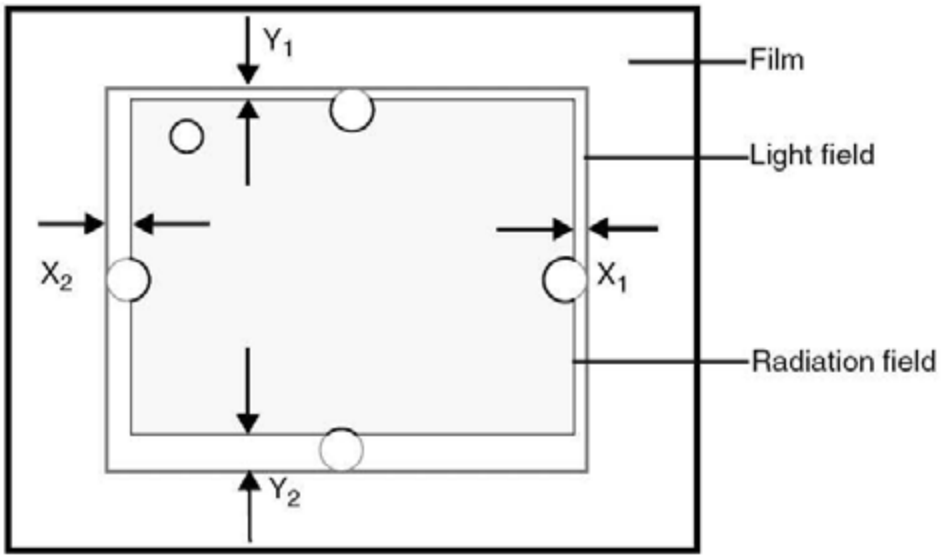

Fig. 35: Deviations

- The deviations in length (total Y) as well as the deviations in width (total X) must be smaller than 1.6 cm respectively.

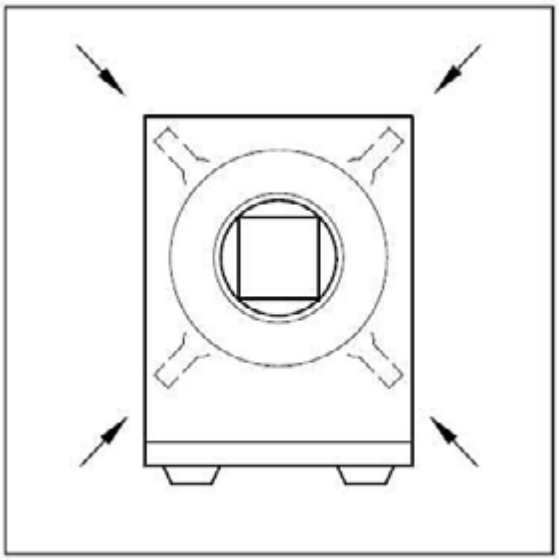

Fig. 36: collimator_movement_1

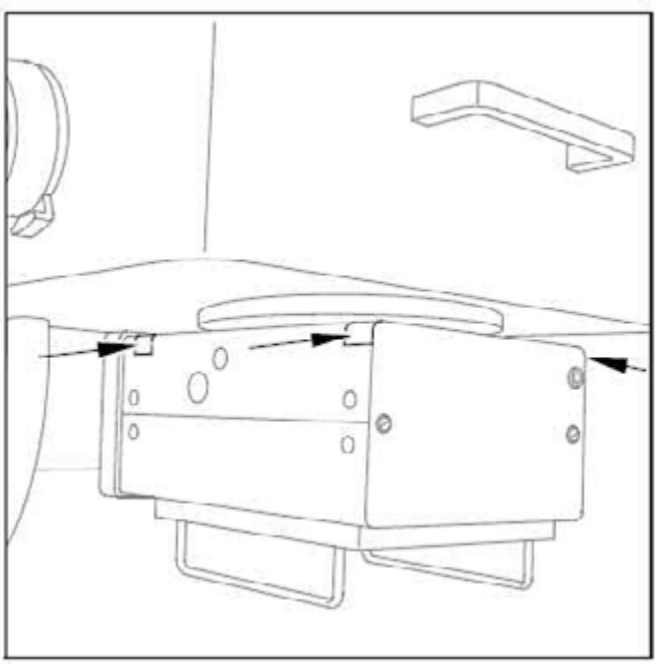

Fig. 37: collimator_movement_2

- If the deviation is higher, loosen the 4 Allen screws slightly (arrows/Fig. 36 / p. 88) and (arrows/Fig. 37 / p. 89) and move the collimator accordingly.

  Then, tighten the screws on the collimator (arrows/Fig. 36 / p. 88) (torque Nom: **0.75 Nm**, tolerance: ±10%) and (arrows/Fig. 37 / p. 89) again.
- Repeat the check and, if necessary, adjust the collimator again until the deviation between the light field and the radiation field is within the admissible tolerance (< 1.6 cm).

POLYMOBIL III

Checking the maximum main inverter frequency

- POLYMOBIL III OFF
- Open bridge "S1" on D922 (solder).
- Connect oscilloscope on D916 to MP "REG" and "GND".
- POLYMOBIL III ON
- Release exposure.

NOTICE

➪ **- Err 15 is displayed.**

➪ **- No radiation.**

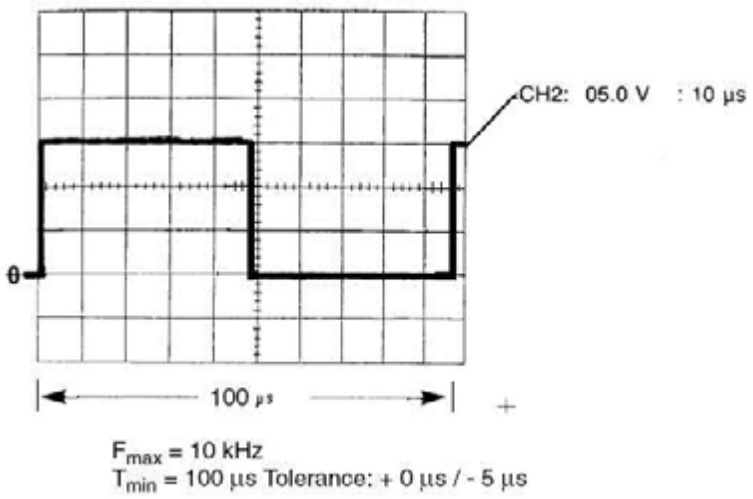

Fig. 38: max_main_inv_frequency_III

- Adjust the maximum main inverter frequency with potentiometer P2 to D916.
- POLYMOBIL III OFF
- Connect jumper "S1" on D920 (solder).

Oscillating current measurement

- POLYMOBIL III **OFF**
- Connect oscilloscope on D922 to MP "Is" and "GND".

NOTICE

➪ **Integrated current transformer.**

➪ **1V ≙50 A**

- POLYMOBIL III **ON**
- Trigger exposure with default values 60 kV, 10 mAs.

Main inverter OK

- During the kV rise

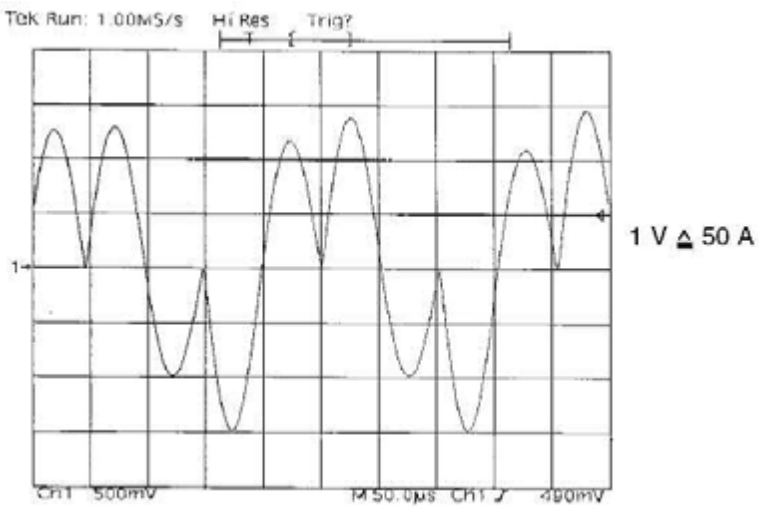

Fig. 39: main_inv_ok_1

- After the kV rise

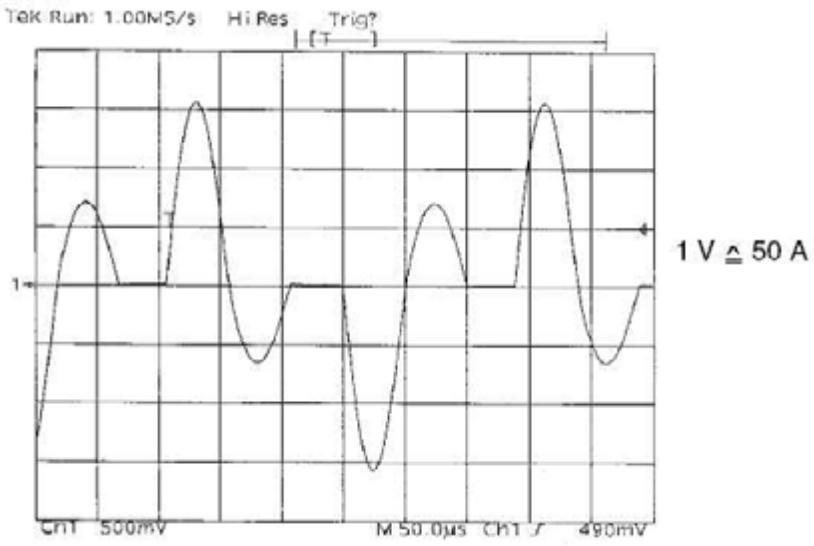

Fig. 40: main_inv_ok_2

Error case

Only one diagonal is fired.

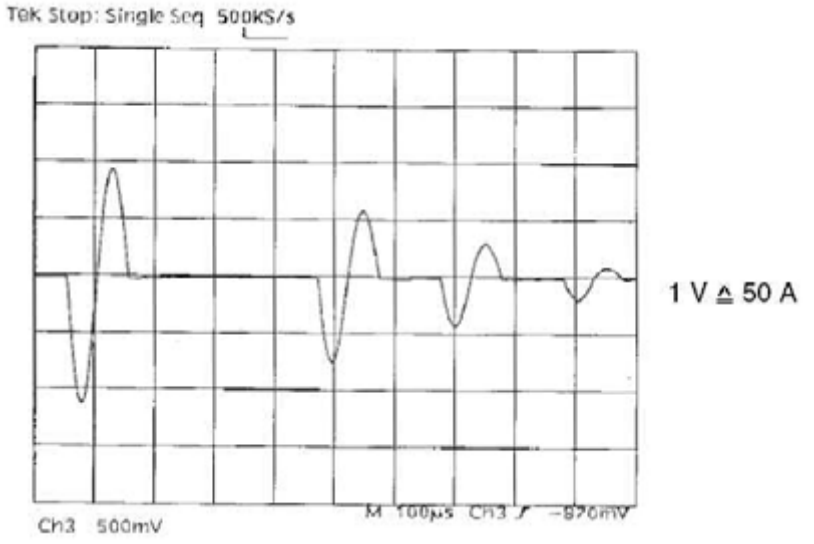

Fig. 41: main_inv_err_3

Checking the high-voltage kV_{NOM} and kV_{ACT}

- Connect oscilloscope on D910 to MP "kVS" (1 V ≙ 20 kV nominal value) and "kV" (1 V ≙ 10 kV actual value) and "GND".
- POLYMOBIL III **ON**
- Trigger an exposure with the default values 60 kV; 10 mAs.

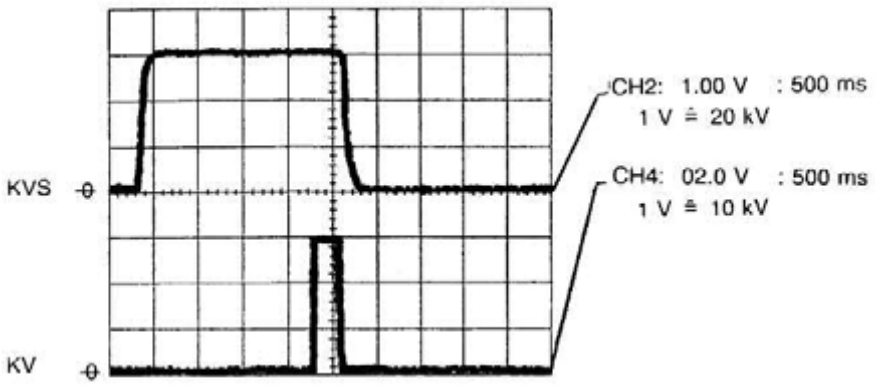

Fig. 42: kVnom_kVact

Checking the filament and tube current

Filament current

- Connect oscilloscope on D916 to MP "IHS" (NOMINAL), "IH" (ACTUAL) , "I" (ACTUAL) And "GND".
- POLYMOBIL III **ON**

  After approx. 7 seconds the standby filament current comes on.

- Release an exposure with the default values 60 kV, 10 mAs.

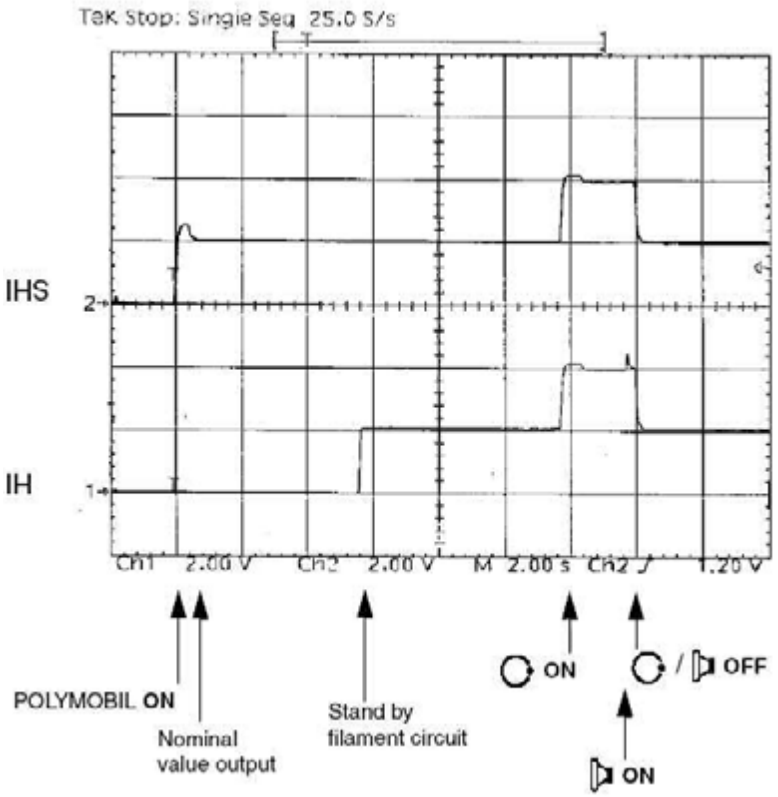

Fig. 43: fil_tube curr_1.

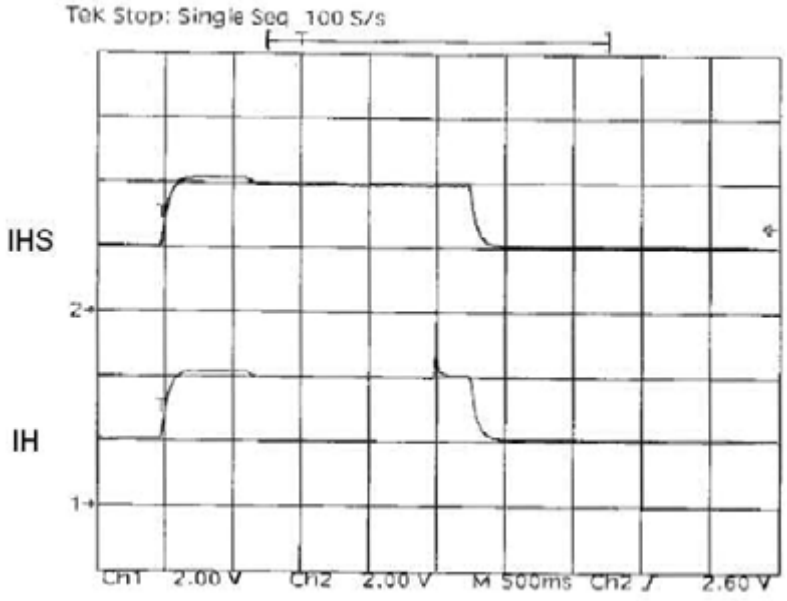

Fig. 44: fil_tube curr_2

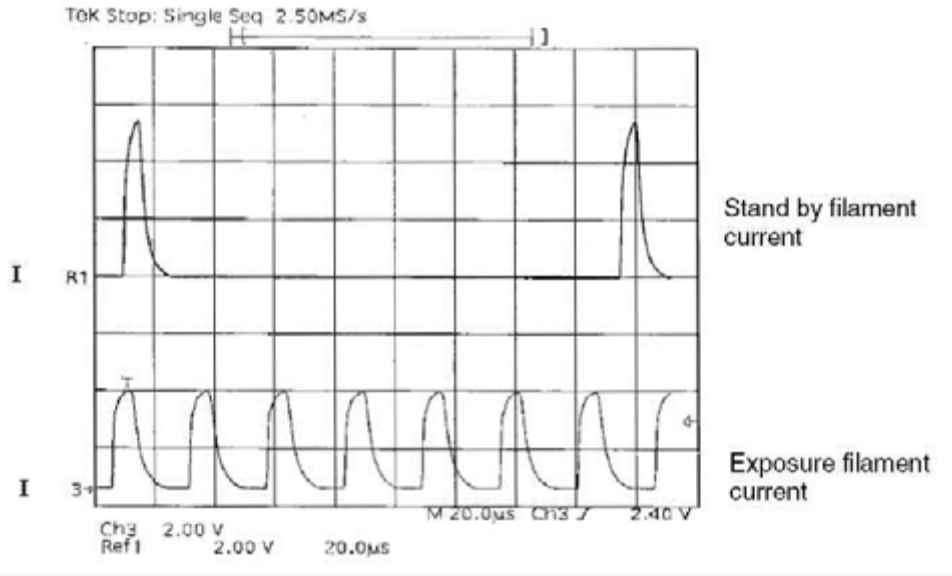

Fig. 45: fil_tube curr_3

Setting the maximum filament frequency

- POLYMOBIL III **OFF**
- Remove fuse F5 on D922.
- Connect oscilloscope on D916 to MP "CAL" and "GND".
- POLYMOBIL III **ON**

NOTICE

➪ **Err 3 is displayed.**

- Using P3, set the maximum filament frequency to D916 (100 kHz ≙ 10 µs)

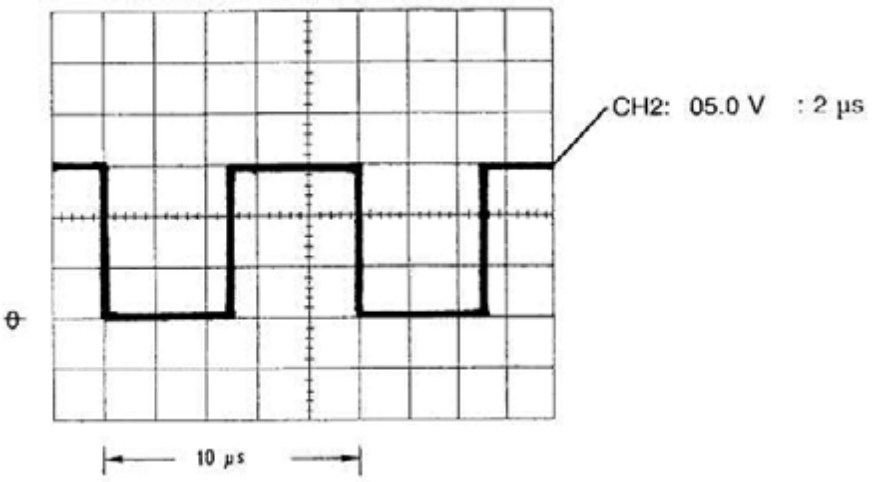

Fig. 46: max_fil_frequency_III

Checking the tube current

- Connect oscilloscope on D916 to MP "IRS" (NOMINAL), "IR" (ACTUAL) and "GND".
- POLYMOBIL III **ON**
- Trigger an exposure with the default values 60 kV, 10 mAs.

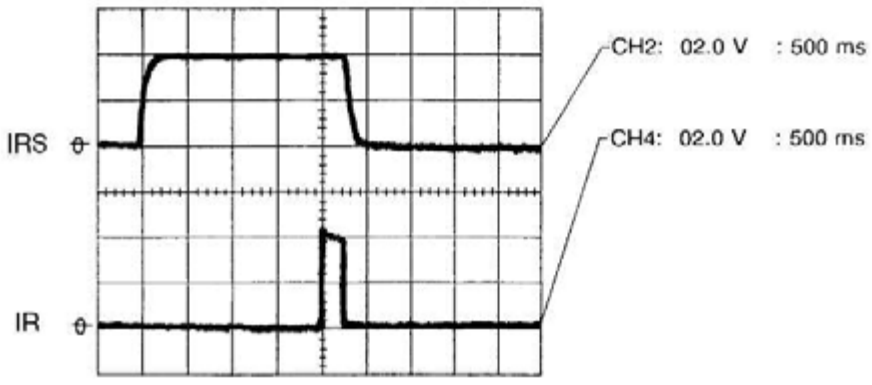

Fig. 47: tube_curr_III

Checking the kV and tube current (IR)

- Connect oscilloscope on D916 to MP "kV", "IR" and "GND".

- POLYMOBIL III **ON**
- Release exposure with the default values 60 kV, 10 mAs.

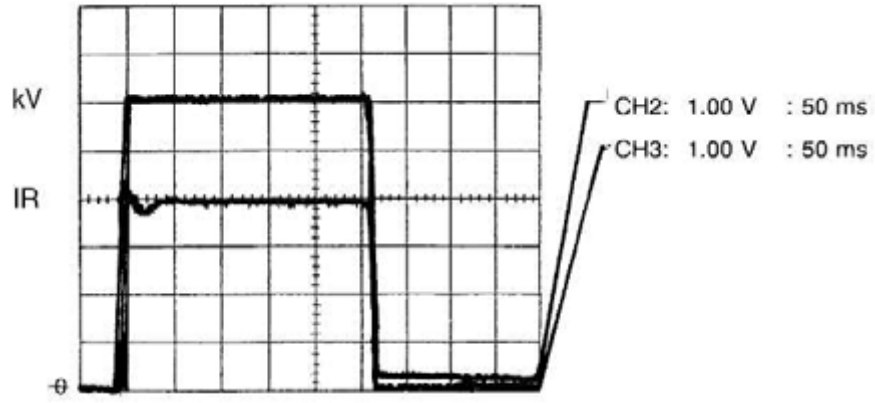

Fig. 48: kV and tube current_1

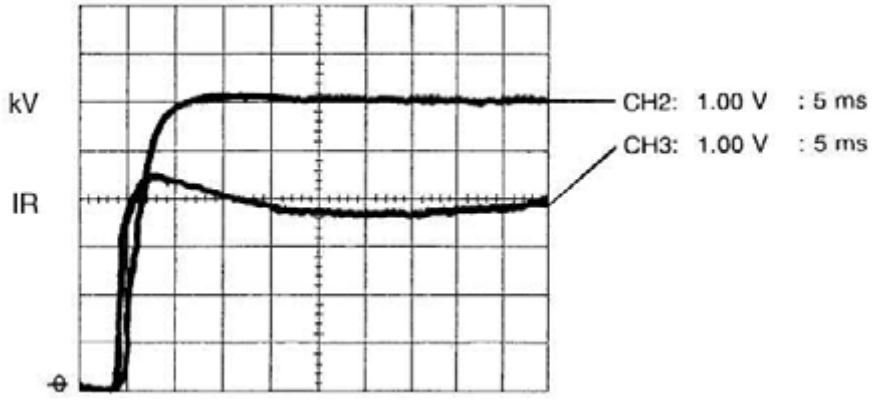

Fig. 49: kV and tube current_2

NOTICE

➪ **The transient response of the tube current can be set with P1 on D916.**

Checking the mAs values

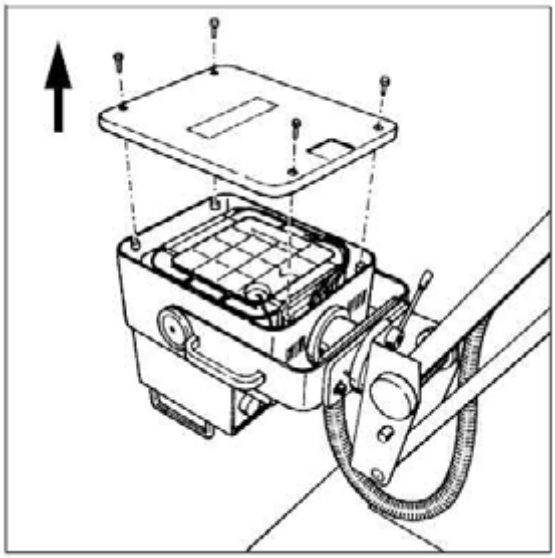

Fig. 50: single_tank_III

- Remove the 4 Allen screws (3 mm key size) from the lid of the single tank and take off the lid ((Fig. 50 / p. 98)).
- Remove jumper ”mA+ / mA - ” in the single tank.
- Connect the mAs meter to the ”mA + / mA - ” sockets.
- Release the following exposures:

Setting at control panel	valid mAs values
40 kV, 200 mAs	195 ... 205 mAs
66 kV, 100 mAs	97 ... 103 mAs
90 kV, 1 mAs	1,0 ... 1.3 mAs

- Remove the mAs meter and reinsert the jumper in the single tank at ”mA+ / mA - ” .
- Reinstall the lid of the single tank.

Adjusting the mAs

- Unplug plug X2 on D916.
- Establish connection (jumper) from plug contact X2.5 (side of the board) toMP "P5 VR" on D916.
- Establish connection (jumper) from plug contact X2.6 (side of the board) to MP "GND" on D916.
- Connect oscilloscope on D916 to MP "F1" and "GND" (1 V 3.2 kHz).
- POLYMOBIL **ON**

NOTICE

➪ **Err 6 is displayed.**

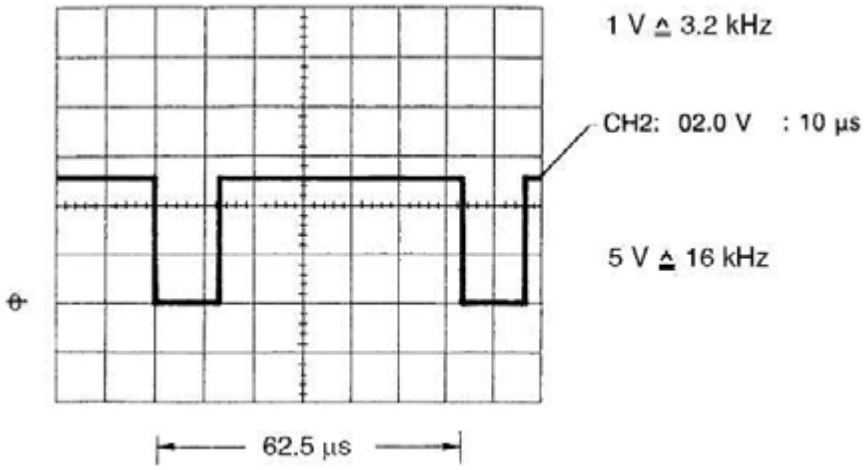

Fig. 51: adjusting_mAs_III

- Adjustment with potentiometer P7 on D916 (adjust to 16 kHz)

Coincidence of light and radiation fields

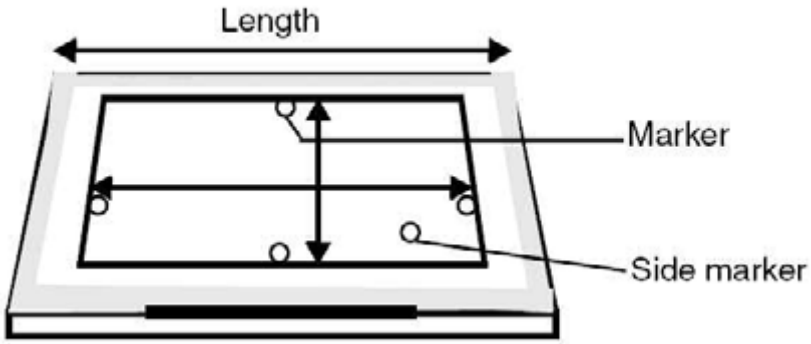

Fig. 52: Coincidence_light and radiation

NOTE

If the POLYMOBIL is equipped with a DAP measuring system, remove the DAP ionization chamber first.

Procedure:

- Insert film into the 24 cm x 30 cm or 10” x 12” cassette and place it on a table or similar surface.
- Adjust the vertical SID of 100 cm or 40” to the top edge of the cassette using a measuring tape.
- Use the knobs to set a format of 18 cm x 24 cm or 8” x 10”.
- Switch on the light localizer and align the cassette.
- Apply radiopaque markers (e.g. washers, coins) as shown in (Fig. 52 / p. 99). Use one washer as a side marker.

- Release an exposure (60 kV, 10 mAs) and develop the film.
- Log the following data on the developed film using a water-resistant felt-tip pen
  - SID setting
  - Film size
  - Radiation field size

Evaluation:

- Measure the deviations (X1, X2, Y1, Y2) between the edges of the light field and the radiation field on all four sides, corresponding to (Fig. 53 / p. 100).
- Calculate the total deviations in the X and Y directions (disregarding the algebraic sign).

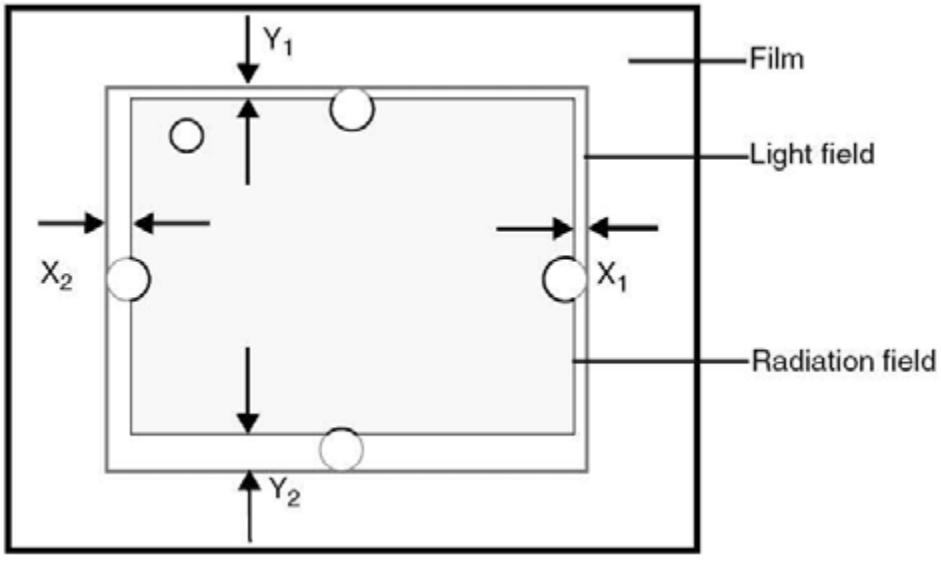

Fig. 53: Deviations

- The deviations in length (total Y) as well as the deviations in width (total X) must be smaller than 1.6 cm respectively.

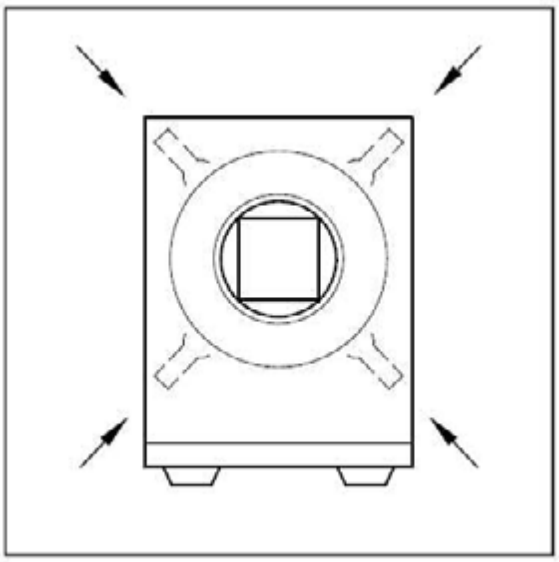

Fig. 54: collimator_movement_1

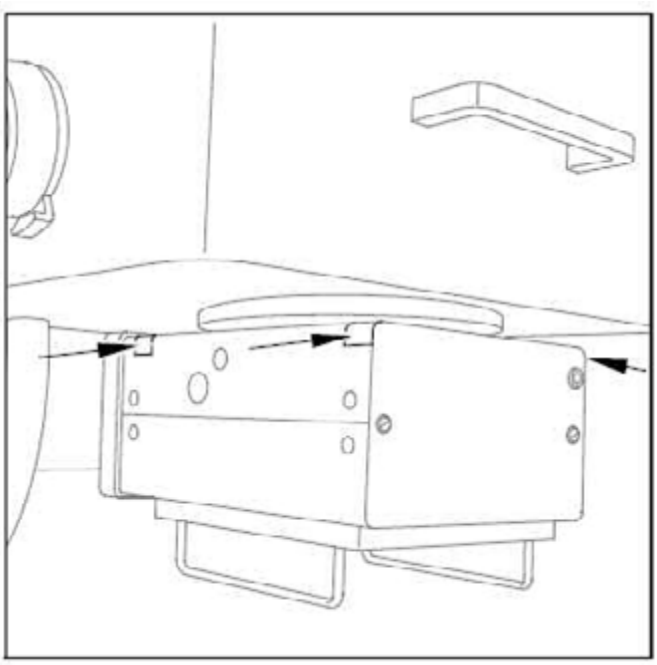

Fig. 55: collimator_movement_2

- If the deviation is higher, loosen the 4 Allen screws slightly (arrows/Fig. 54 / p. 101) and (arrows/Fig. 55 / p. 101) and move the collimator accordingly.

  Then, tighten the screws on the collimator (torque Nom: **0.75 Nm**, tolerance: ±10%) (arrows/Fig. 54 / p. 101) and (arrows/Fig. 55 / p. 101) again.

- Repeat the check and, if necessary, adjust the collimator again until the deviation between the light field and the radiation field is within the admissible tolerance (< 1.6 cm).

Chapter	Changes
3	"Pause" error for Polymobil PLUS added