

# Technician's instructions

## KaVo In eXam 3510



Always be on the safe side.



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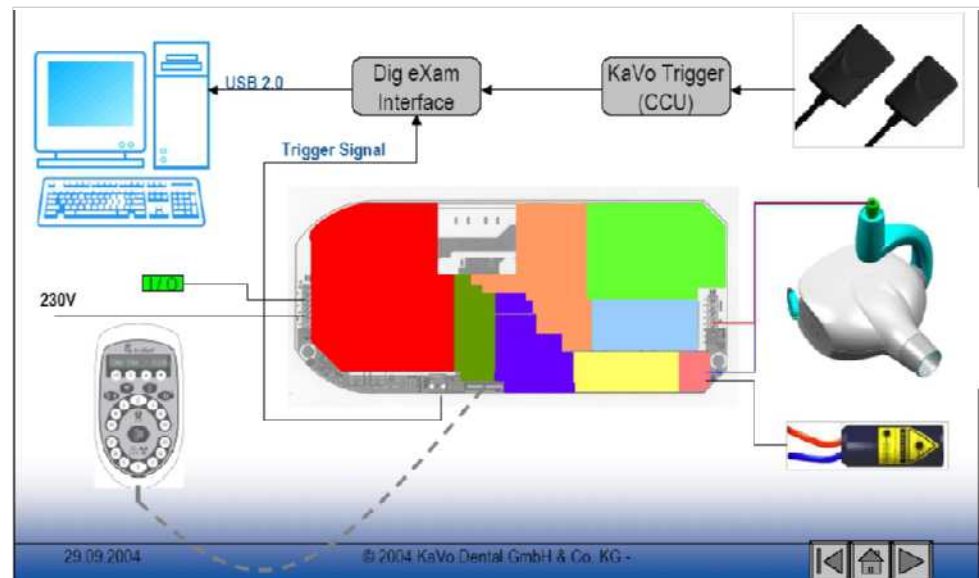
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## 1 Product description

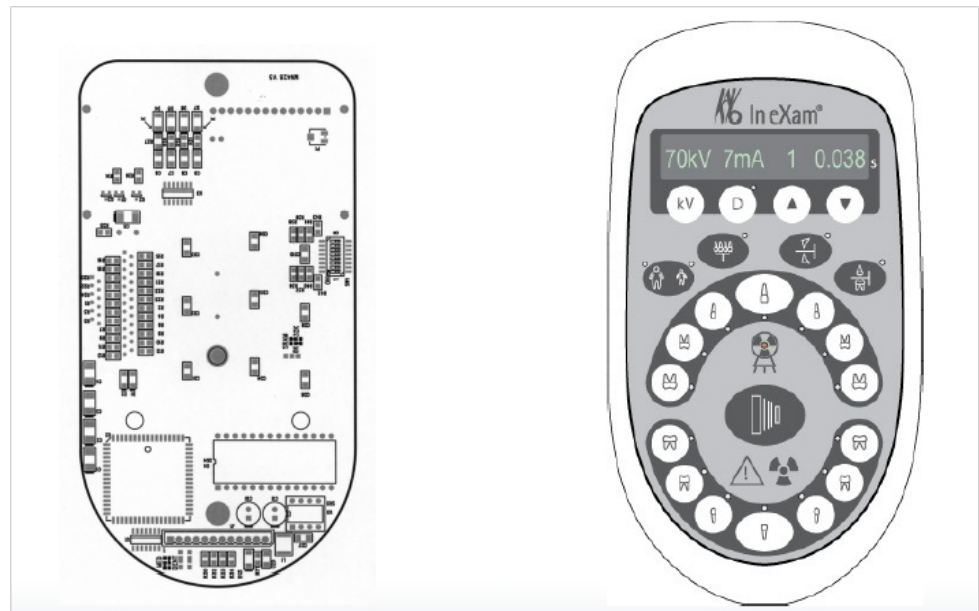
### 1.1 Description of electronics

#### 1.1.1 System overview

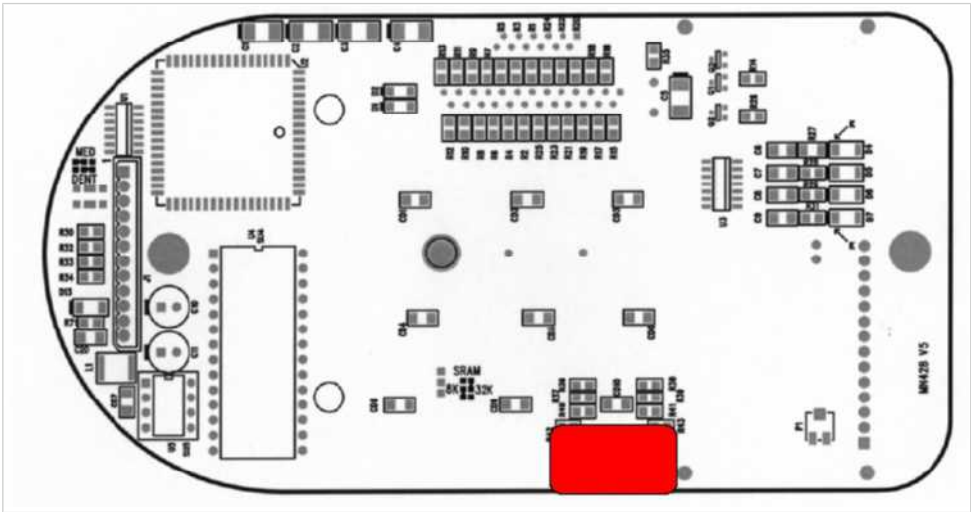


#### 1.1.2 Control unit

##### Layout



DIP switch



Default

on

1	2	3	4	5	6	7	8

Only the In eXam control unit is connected and active.

Dig eXam-Mode blocked

on

1	2	3	4	5	6	7	8

The tube current cannot be switched to 4 mA.  
7 mA is permanently selected.

Special settings for Australia

on

1	2	3	4	5	6	7	8

In Australia, the setting is specified for film correction during the acceptance test and cannot be changed by the user.

on

1	2	3	4	5	6	7	8

Only film types 0-5 can be selected when the required combination of keys is pressed.

On							
Off							
	1	2	3	4	5	6	7
	8						

Only film types 0-7 can be selected when the required combination of keys is pressed.

on

1	2	3	4	5	6	7	8

Only film types 0-8 can be selected when the required combination of keys is pressed.

### External exposure switch or control unit

on

1	2	3	4	5	6	7	8

When there is an external exposure switch, the exposure can be independently triggered by the In eXam control unit or the external switch.

### External exposure switch and control unit

on

1	2	3	4	5	6	7	8

Exposure is only triggered when the external exposure switch and the control unit's exposure switch are simultaneously activated (such as the door safety switch).

### External exposure switch

on

1	2	3	4	5	6	7	8

The exposure can only be triggered with the external exposure switch; the control unit is only used to select the exposure data.

### Self test

- ▶ Turn off the In eXam.
- ▶ Hold down the D(igital) key, and turn on the In eXam.
- ▶ Release the D(igital) key when there is nothing on the display.

The following tests are independently run by the system:

- The firmware version is displayed
- LED Test
- Acoustic alarm; four different beeps
- Keyboard test
- The setting of the DIP switches (SW 1...8) is displayed
- The exposure counter is displayed
- The exposure counter total is displayed

After a test is successful, the unit switches to user mode.

All LEDs are on, a beep sounds.

The EEPROM has a bad contact in the socket.

Open the control unit, and check the EEPROM for a proper seat.

### EEPROM test

- ▶ Turn off the In eXam
- ▶ Hold down the film type selection key ▼, and turn on the In eXam

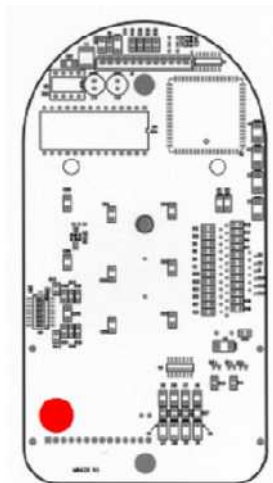
- ▶ Once the display no longer shows anything, release the key.
- ▶ «EEPROM test» appears on the display.
- ▶ After the test is successful, «EEPROM passed» appears.
- ▶ The exposure counter is reset

### Initialisation

- ▶ Turn off the In eXam.
- ▶ Hold down the kV key and D(igital) key, and turn on the In eXam.
- ▶ Release the key when there is nothing on the display.
- ▶ The message «Init:Context» appears on the display.
- ▶ The exposure counter is reset.

### Adjust the display brightness

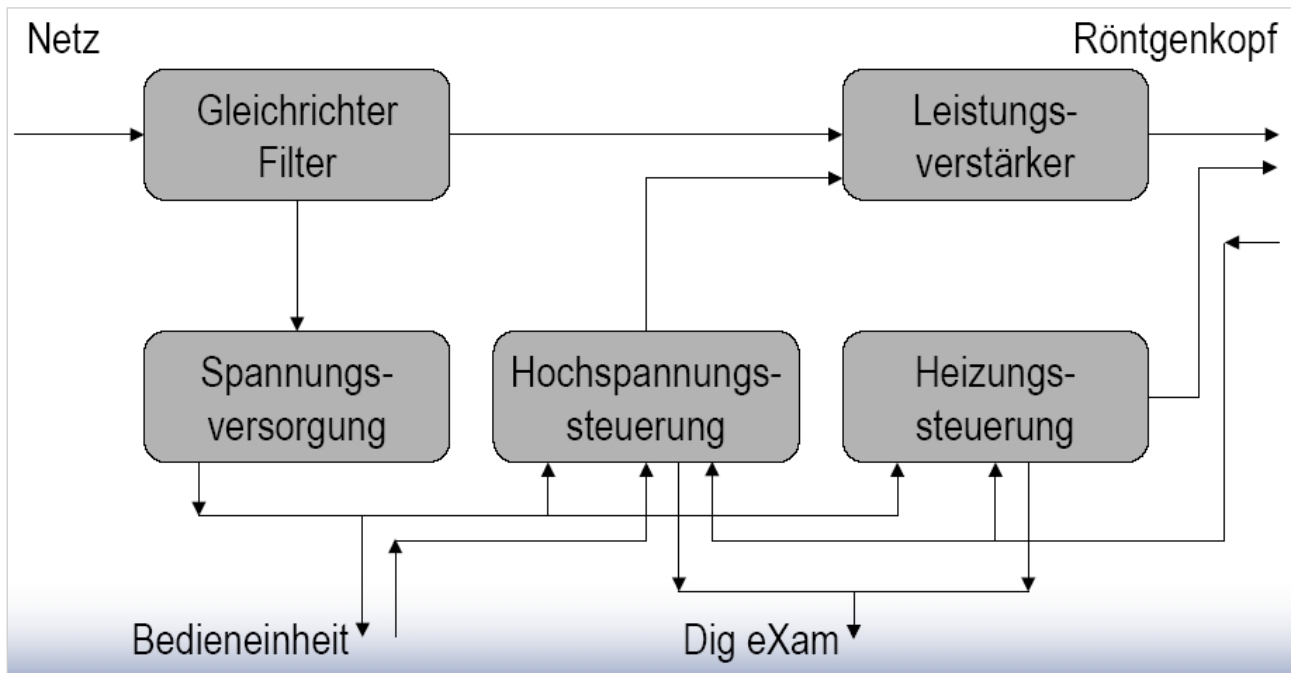
When all functions are okay and there is nothing on the display or the display is dim:  
Adjust the display brightness.



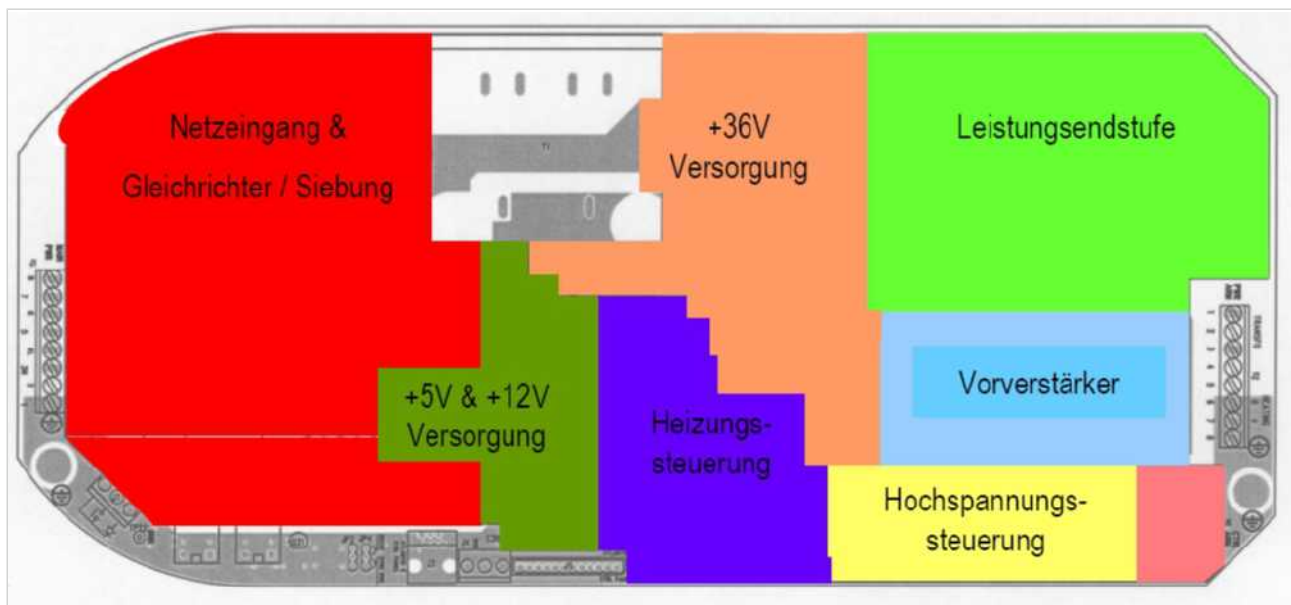
- ▶ Open the In eXam control unit, and adjust with potentiometer P1.

### 1.1.3 HF Mainboard

#### Block diagram of mainboard



#### In eXam HF mainboard



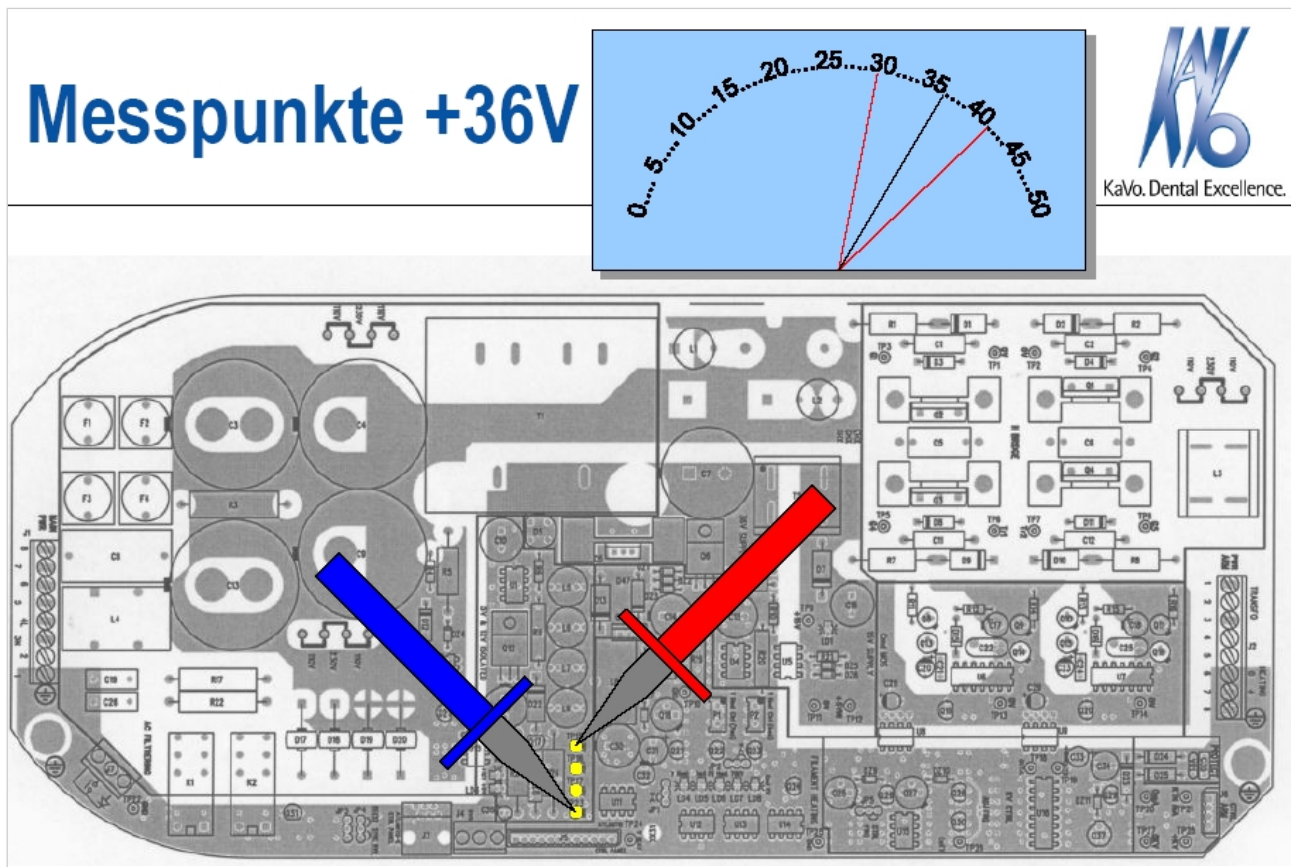
#### Measure mains voltage

- ▶ Set the voltmeter to the 300VAC measuring range
- ▶ Set the voltmeter to the 300VAC measuring range
- ▶ Connect the measuring tips to L +N
- ▶ Connect the measuring tips to L +N



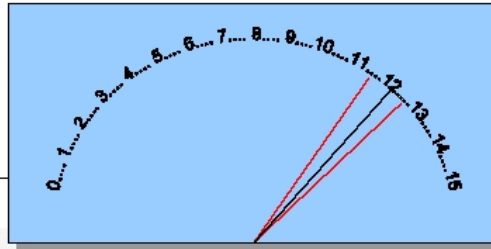
- ▶ Turn on the In eXam
- ▶ Turn on the In eXam
- ▶ Note the no-load voltage:  $U_o = 230 \text{ V}$  (+6%/-10%)
- ▶ Note the no-load voltage:  $U_o = 230 \text{ V}$  (+6%/-10%)
- ▶ Set parameters: Film type 9, 60kV, 7mA, occlusal mode
- ▶ Observe radiation protection measures
- ▶ Trigger the exposure
- ▶ Note the load voltage ( $U_{load}$ ) during exposure
- ▶ Calculate the voltage fluctuation ( $U_o - U_{load} < 9 \text{ V}$  [-4%])
- ▶ When the voltage fluctuation  $> 9 \text{ V}$ : Check the power cable

+ 36 V

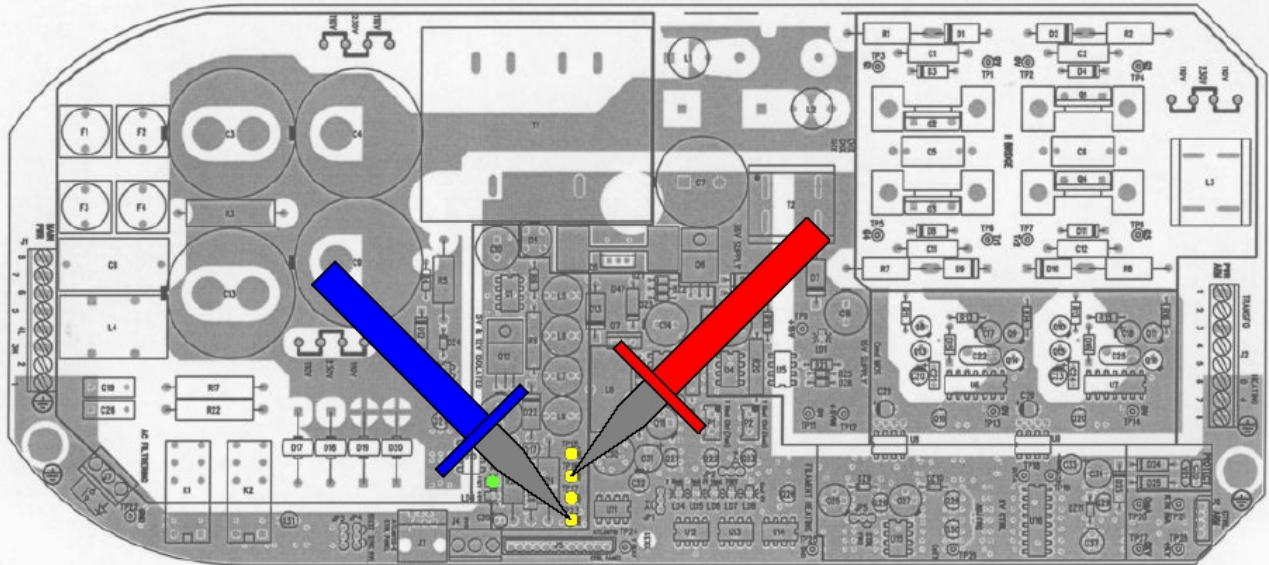


+ 12 V, isolated

## Messpunkte +12V

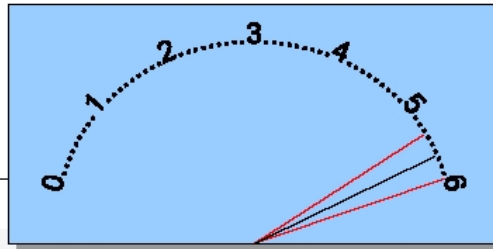


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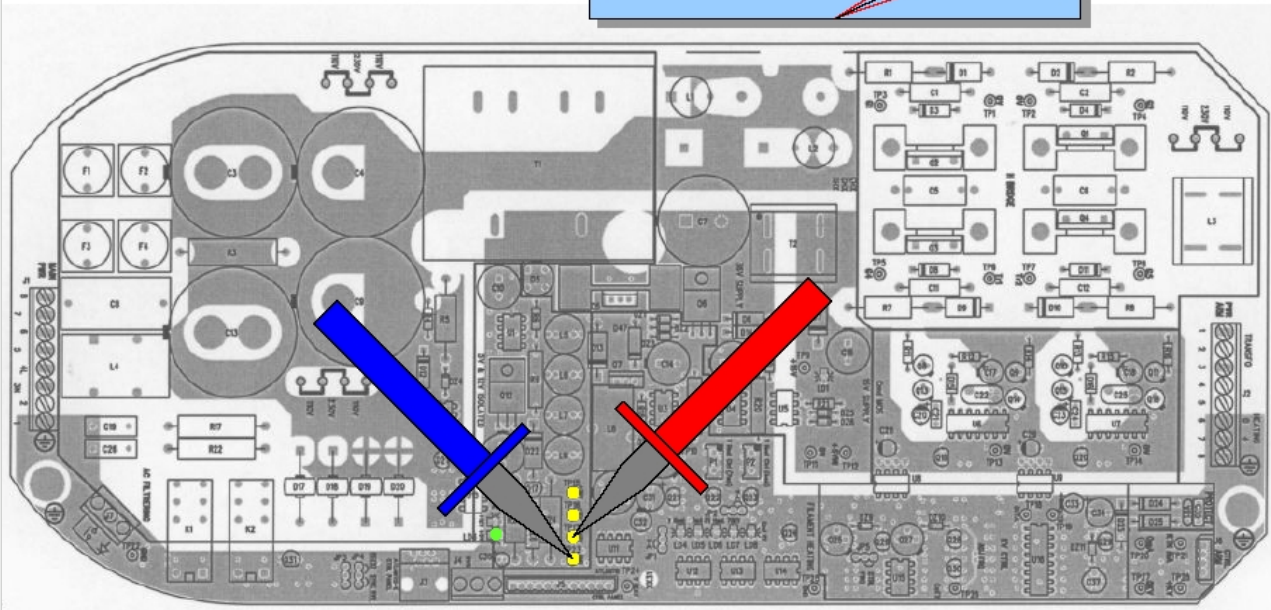


+ 5 V, isolated

## Messpunkte +5V

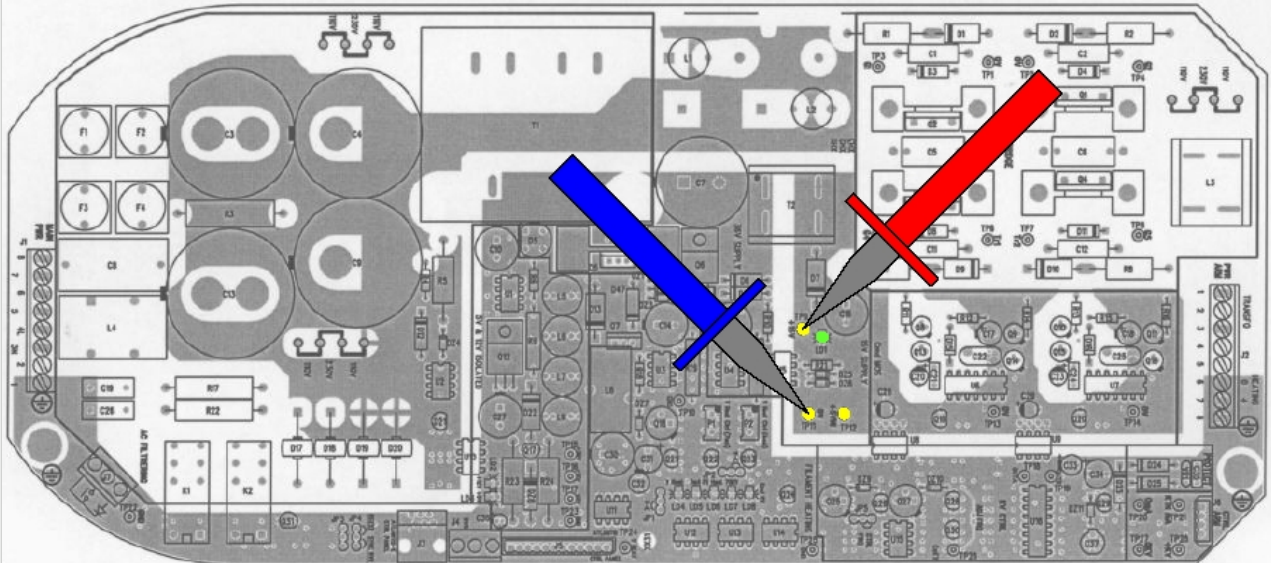
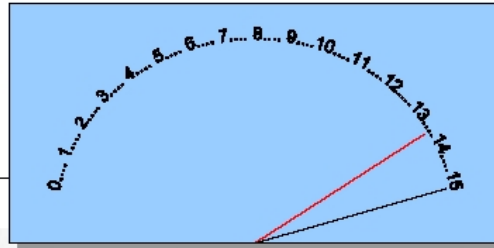


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+ 15 V

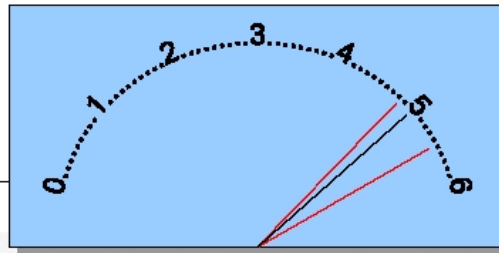
## Messpunkte +15V



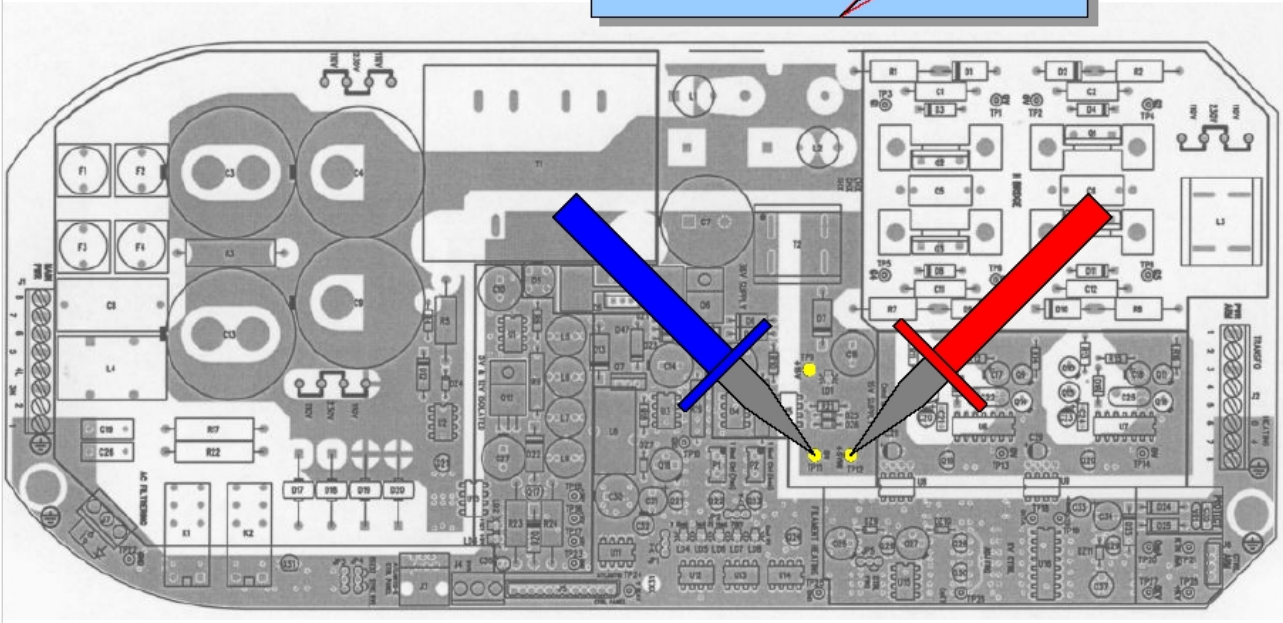


+ 5 V

## Messpunkte +5V

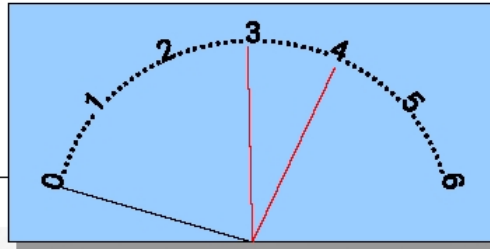


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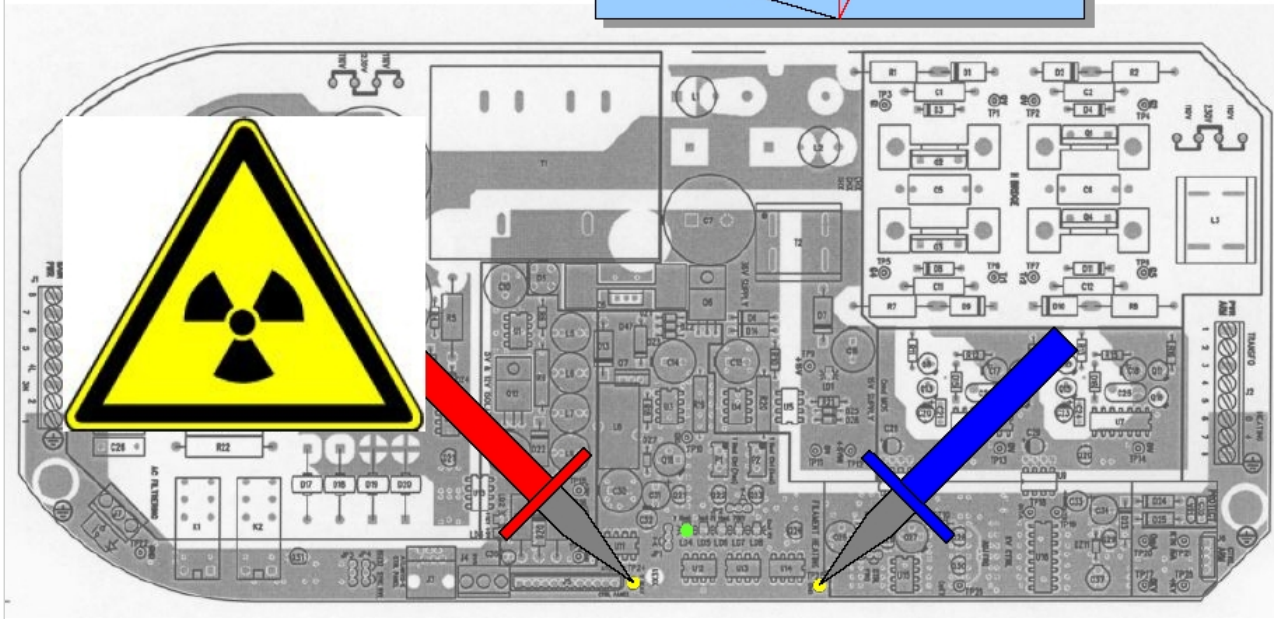


## Heating voltage

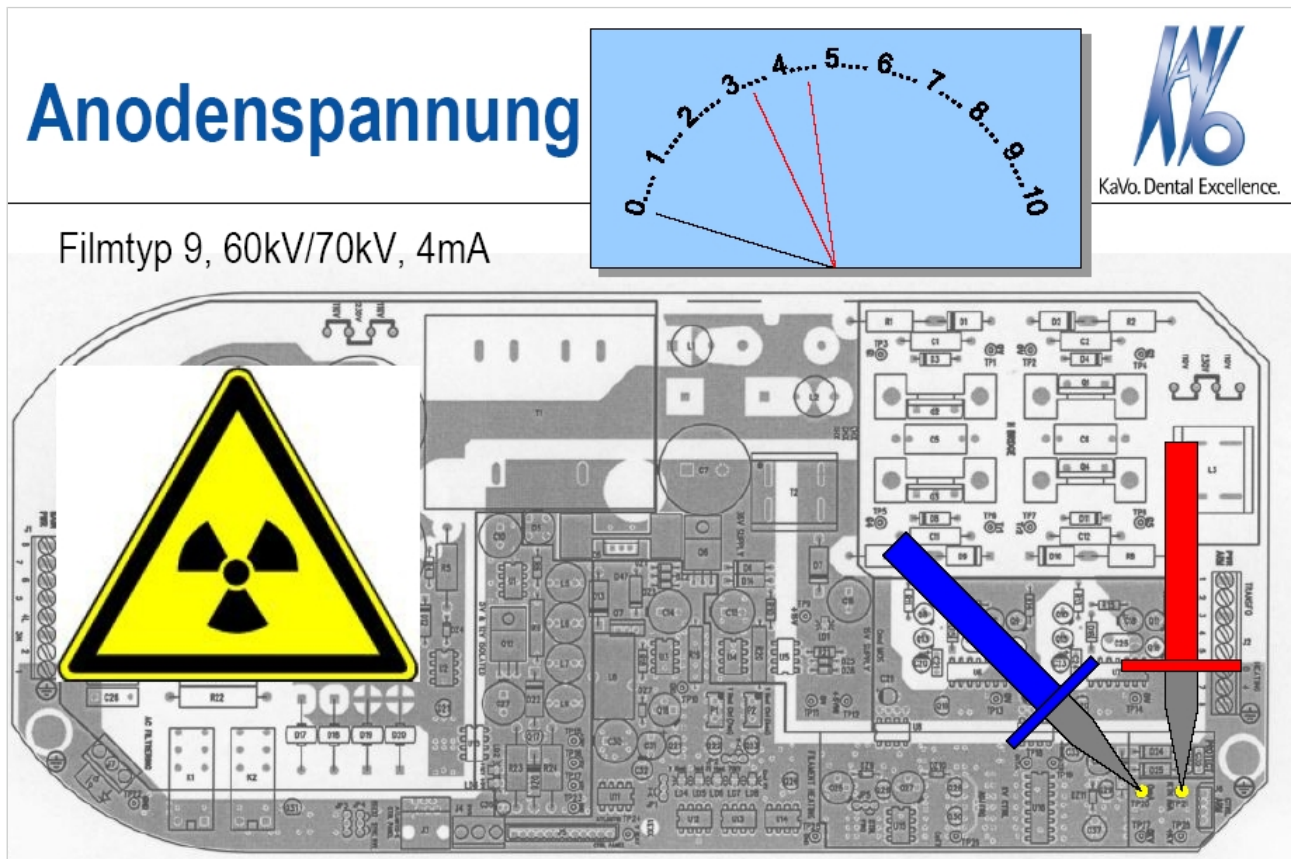
# Heizspannung

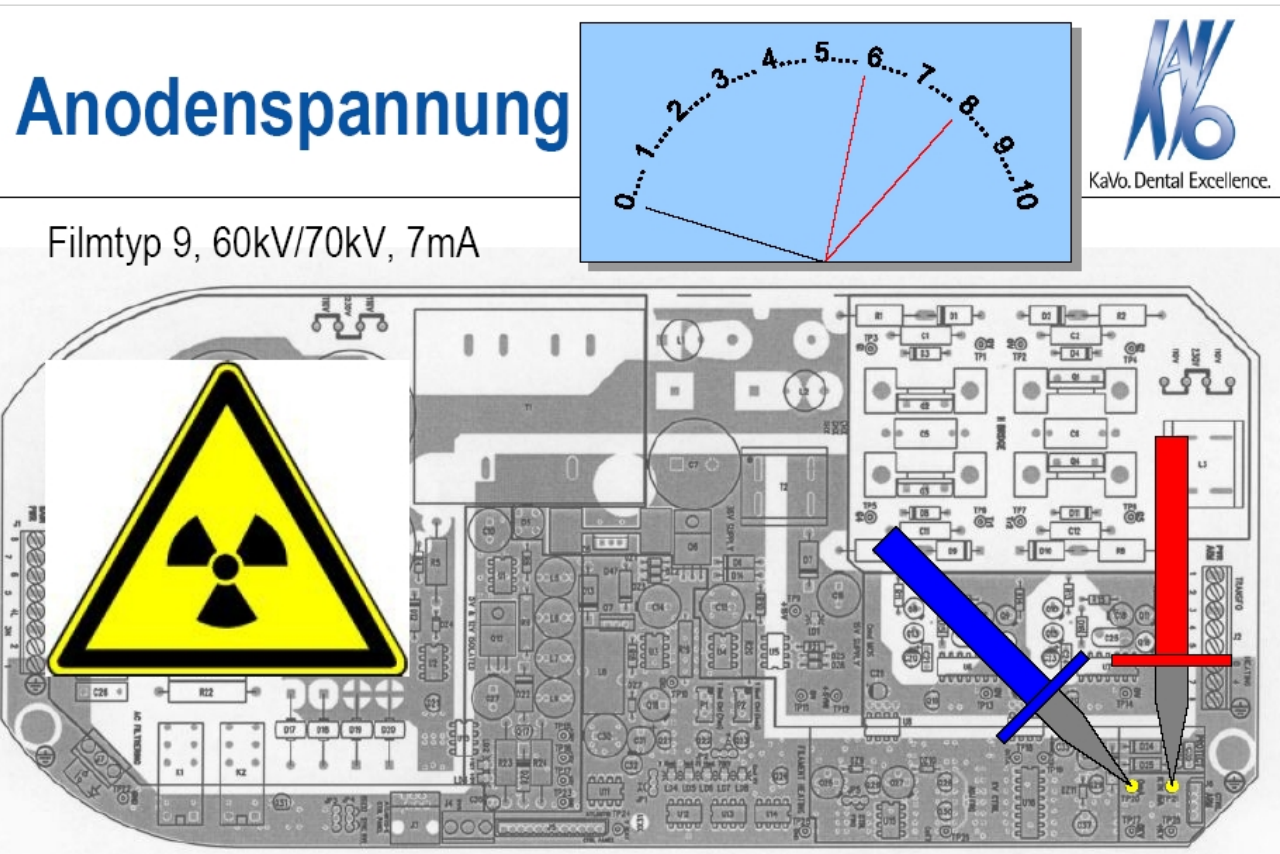


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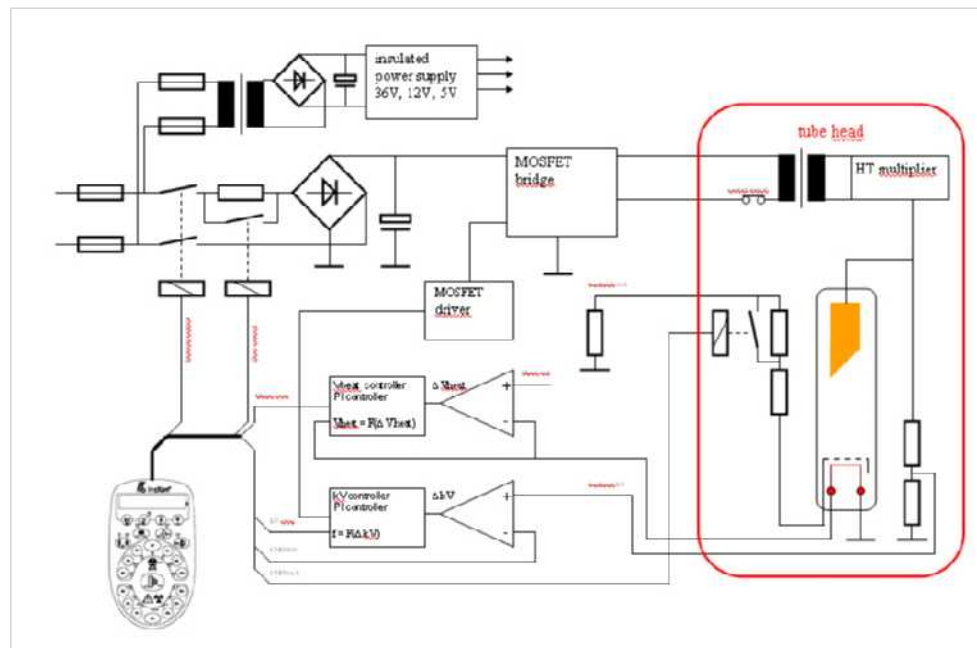
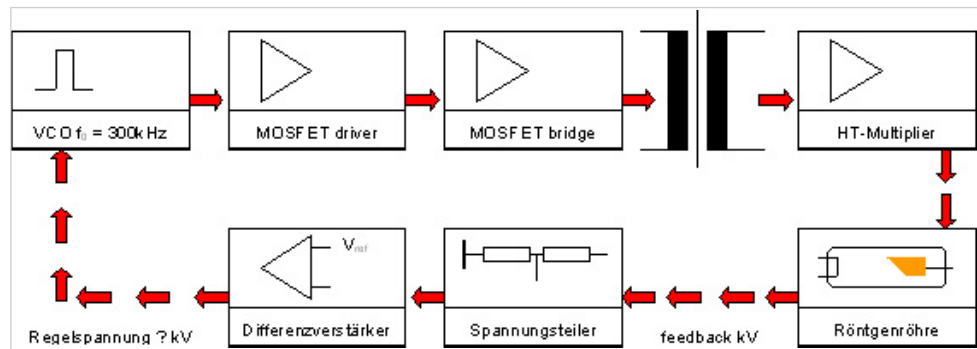
## Anode current







## 1.2 Functioning of In eXam electronics



### 1.2.1 Basic mode (idling)

- Turn on the mains voltage
- The mains voltage is applied via F2 (main fuse) and F4 (control circuit fuse) to the transformer T1, is transformed to 36 VDC, rectified and filtered.
- From the 36 VDC, +12 VDC and +5 VDC voltage are generated that are isolated from the high voltage side. LD 2 and LD 3 shine for the control.
- The control unit is supplied with voltage
- The control unit runs a self test (buzzer, LEDs and LCD display)
- Depending on the setting of the control unit, the HF main board shows the following:
  - at 7mA default > LD 5 shines
  - at 70kV default > LD 7 shines

### 1.2.2 Switch between 4/7mA

- Select via the control unit, e.g. 7mA
- The relay in the x-ray head is de-energised and thereby bridges one of the resistors that are series-connected to the cathode  $\gg R > I$ .

- Switching to 4 mA causes the relay to be energised, and the resistor is again series-connected >>  $R > I$ . LD 5 shines.

### 1.2.3 Exposure

- The trigger in the control unit is activated
- In the 1st stage,
  - The "Heating Control" signal is emitted by the control unit, and the corresponding relay is energised. Subsequently, the charging capacitors for current limiter are connected to the mains voltage via a series resistor and the rectifier, and charged. The voltage supply is therefore available for the power output stage.
  - At the same time, the unisolated voltages +5VDC and +15VDC are applied at the preamplifier, and LD 1 shines.
  - Cathode heating is activated, LD 4 (Vheat) and LD 6 (Fil heat) shine
- In the delayed second stage,
  - the signal "X ray control" is output by the control unit. Subsequently, the corresponding relay is operated, whereby the charging resistor of the capacitor bank is bridged, and the capacitors are directly supplied from the mains.
  - The kV control (described below) is activated, and high voltage is subsequently applied to the tube.
  - LD 8 "Cmd KV" shines during the display

### 1.2.4 Vheat control

The tube current is indirectly regulated by means of the heat voltage.

- The reference voltage  $V_{\text{heatref}}$  is applied to the comparator. This depends on the different components such as tube voltage (60/70 kV) and tube current (4/7 mA).
- Depending on this reference voltage, the heating voltage  $V_{\text{heat}}$  is applied to the filament of the tube.
- The heating voltage is simultaneously applied as a feedback signal to the comparator, and compared to the reference voltage  $V_{\text{heatref}}$ . If  $V_{\text{heat}}$  deviates, the voltage is adjusted and thereby kept constant.
- If the heating voltage cannot be adjusted corresponding to the instructions, exposure is terminated, and in the error message "power error" is output by the control unit.

### 1.2.5 kV selection and kV control

- The kV is selected with the control unit. By means of the signal CMD kV, a reference voltage at the comparator is applied to this setting.
- The kV controller generates a square wave signal with an  $f_0$  that depends on the preselected kV.
- The square wave signal is amplified by the preamplifier and power output stage.
- By means of the arm cable, this voltage is transferred to the transformer in the x-ray head and transformed upward. The higher or lower  $f_0$  that is output corresponding to the preselected kV has an effect here. The higher the frequency of the voltage at the primary winding, the lower the induced voltage at the secondary winding, i.e., the frequency  $f_0$  has higher with the selected 60kV than with the preselected 70kV.
- Subsequently, this voltage is quadrupled via an 8-level cascade, and then it is applied to the anode. Given the relatively higher frequency ( $\sim 300\text{kHz}$ ), the low capacitance of the high-voltage cascade is sufficient to smooth the alternating

voltage so that a high voltage is applied to the anode of the x-ray that has almost no residual ripple (DC).

- Parallel to the tube is voltage divider by means of which the anode voltage is returned directly as a feedback signal to the comparator. The reference signal "CMD kV" and the feedback signal "feedback kV" are compared with each other, and the frequency  $f_0$  is adjusted if there is a difference. This ensures constant voltage during the entire exposure.
- If the anode voltage cannot be controlled within a specific tolerance range, the high-voltage is interrupted, and the message "kV Error" is output on the control unit.

## 2 Complete exchange of the x-ray head

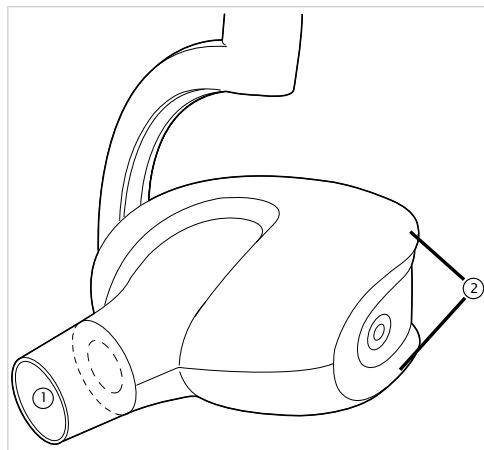
### 2.1 Remove the x-ray head



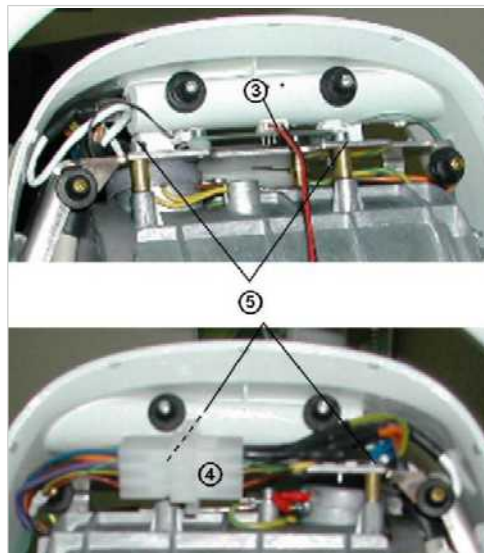
#### Note

Disconnect the In eXam from the mains, and make sure that it cannot be turned on.

- ▶ Remove the tube ①.
- ▶ Remove the lock screws in the x-ray head cover, and remove the cover ②



- ▶ Unplug the laser diode ③



- ▶ Unplug the x-ray head from the arm cable ④
- ▶ Place the scissor arm in a vertical position, and secure it with belts.



**Injury from unsecured scissor arm.**

2 Complete exchange of the x-ray head | 2.1 Remove the x-ray head

**CAUTION**

If the scissor arm is not secured, the arm may shoot up once the x-ray head is removed. Risk of injury

- ▶ Before disassembly, attach the safety strap or an equivalent type of retention before the arm system is lifted out of the bearing.
- ▶ Loosen the four hexagon socket screws ⑤ at the fastening points



**Note**

Unscrew the ball-head bolts that prevent disassembly

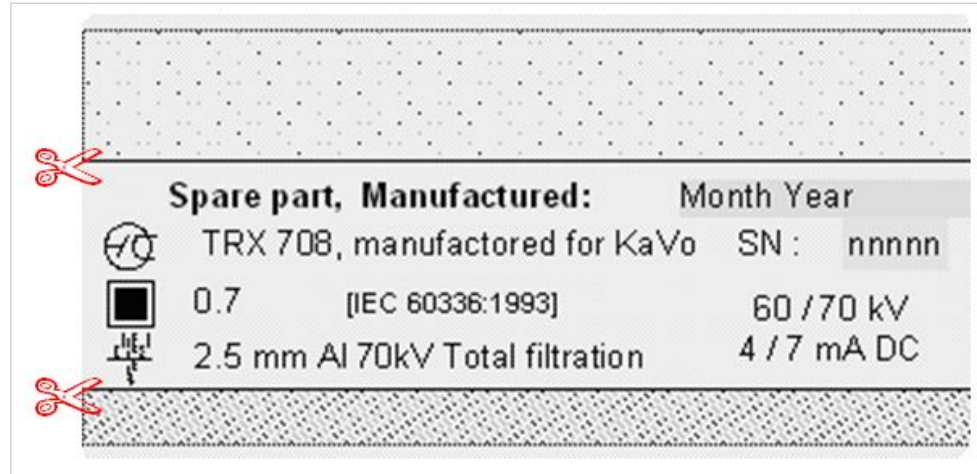
- ▶ Hold the x-ray head and remove the loosened hex socket screws.
- ▶ Remove the x-ray head.

## 2.2 Install the x-ray head

- ▶ Position the x-ray head on the mounting points
- ▶ Screw back in the 4 hex socket screws ⑤
- ▶ Connect the x-ray head to the arm cable ④
- ▶ Plug in the laser diode ③
- ▶ Screw in the ball-head bolts if applicable
- ▶ Lock the x-ray head covers in place, and screw them together ②
- ▶ Remount the tube ①

## 2.3 Final tasks

- ▶ Cut the provided rating plate to size, and affix it on the original rating plate on the x-ray head.



- ▶ Check the voltages and functions as described in the section 9 of the installation instructions, starting the In eXam
- ▶ Depending on national regulations, run a safety check according to VDE 0751-1 (Installation Instructions, section 10.4)
- ▶ Depending on national regulations, perform a part acceptance test
- ▶ Update the x-ray system log

### 3 Exchanging the scissor arm

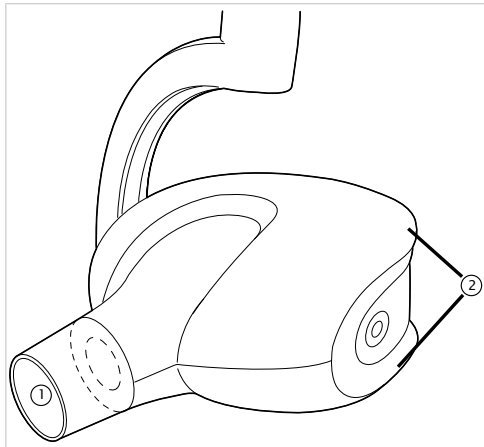
#### 3.1 Remove the x-ray head



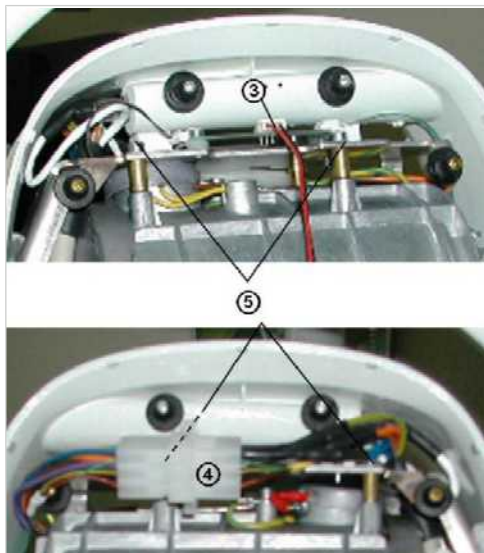
**Note**

Disconnect the In eXam from the mains, and make sure that it cannot be turned on.

- ▶ Remove the tube ①.
- ▶ Remove the lock screws in the x-ray head cover, and remove the cover ②



- ▶ Unplug the laser diode ③



- ▶ Unplug the x-ray head from the arm cable ④
- ▶ Place the scissor arm in a vertical position, and secure it with belts.



**Injury from unsecured scissor arm.**



3 Exchanging the scissor arm | 3.1 Remove the x-ray head

**CAUTION**

If the scissor arm is not secured, the arm may shoot up once the x-ray head is removed. Risk of injury

- ▶ Before disassembly, attach the safety strap or an equivalent type of retention before the arm system is lifted out of the bearing.
- ▶ Loosen the four hexagon socket screws ⑤ at the fastening points



**Note**

Unscrew the ball-head bolts that prevent disassembly

- ▶ Hold the x-ray head and remove the loosened hex socket screws.
- ▶ Remove the x-ray head.

## 3.2 Disassembling the scissor arm



### Note

The puller will help later to pull the new arm line into the support arm. When the old arm line is pulled out, the puller is pulled into the support arm and left there. Make sure that there is enough length to stick out at both sides so that the arm line can be pulled in.

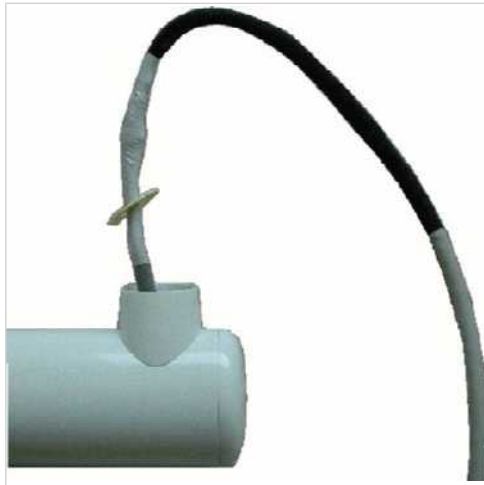
- ▶ Open the wall box cover.
- ▶ Disconnect the arm line (terminal block J2, 4-pin plug J6, 2-pin plug or USB plug).
- ▶ Remove the brake from the bearing block.
- ▶ The safety strip (or any other fastener) affixed at the bearing block while assembling the device must be fastened to the arm system.

### 3.3 Assembling the scissor arm

- Disassemble it as described in Installation Instructions, sections 6.4 & 6.5.
- Connect the arm cable as described in Installation Instructions, section 7.1.2

#### 3.3.1 Prepare the arm system

- ▶ Place the nylon ring on the arm line and then connect the arm line to the line puller.
- ▶ Pull mains tubing of the arm line over the exposed cable ends.



- ▶ Fit approximately 10 cm of the mains cable of the support arm (pull-in aid) and the mains cable of the arm line together and fix with insulating tape to ensure they do not separate.



#### Note

Make sure that all litz wires and plugs are properly insulated since projecting litz wires can become damaged when they are pulled through the support arm, or projecting plugs can be torn off.



**CAUTION**

#### Undesired unfolding of the scissor arm system during assembly

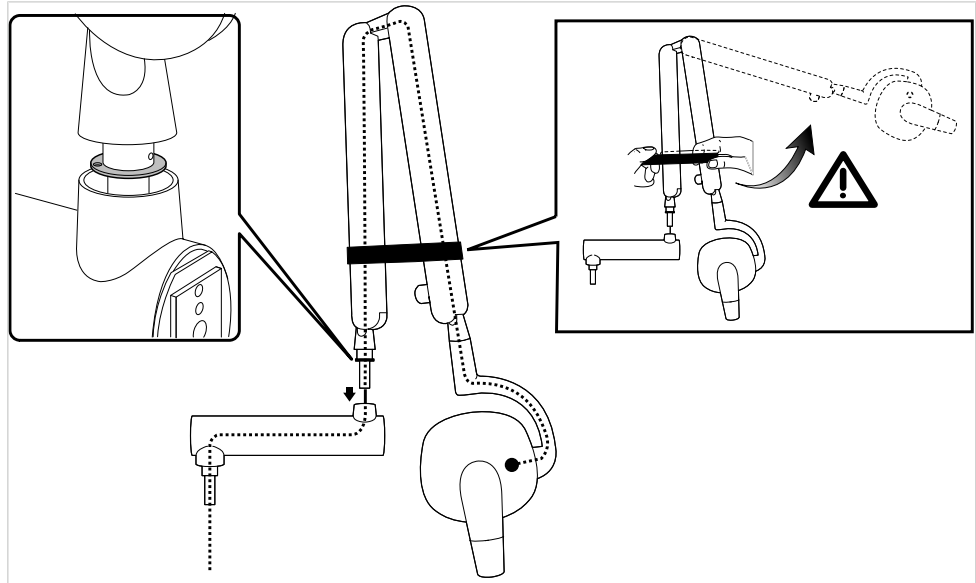
Injury hazard

Damage to the arm system

- ▶ Before assembly, check if the available distance to the ceiling is sufficient.
- ▶ Before assembly, check if the safety strap is correctly attached.
- ▶ Do not remove safety strap while preparing the arm system. Remove the safety strap during assembly.

3 Exchanging the scissor arm | 3.3 Assembling the scissor arm

- Carefully feed the cable into the extension arm.



- Completely attach the extension arm with the bearing bushing onto the scissor arm pivot pin, making sure that the nylon ring is in the correct position.

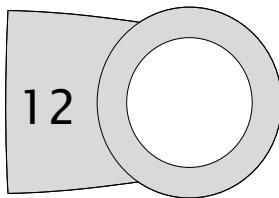
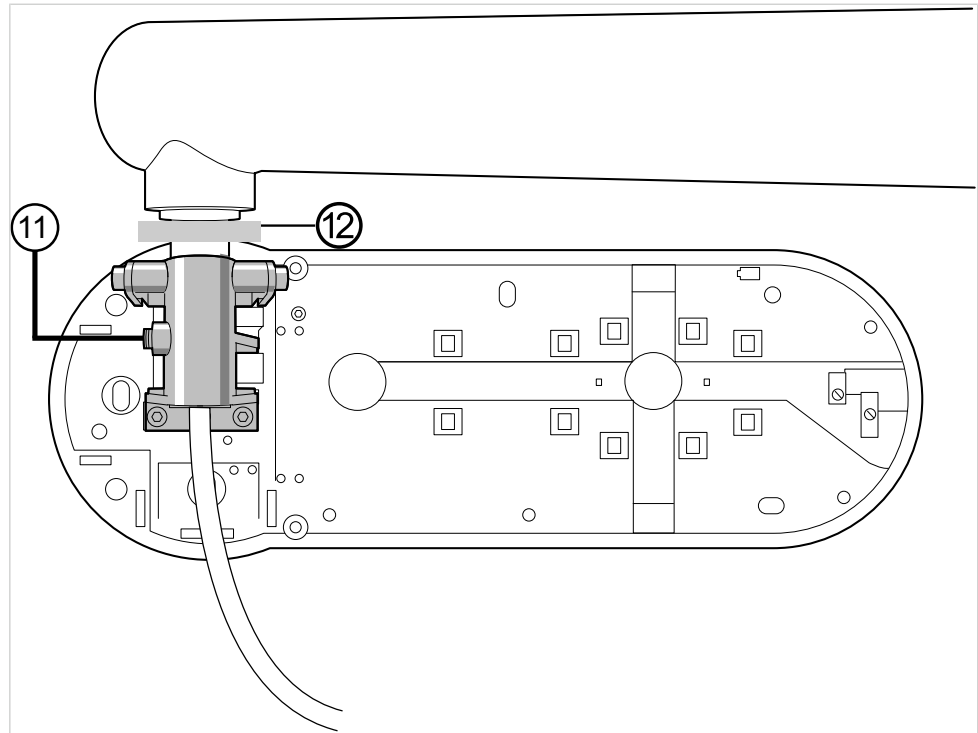


**Note**

Leave the pull-in aid on the arm cable; you will need it later.

### 3.3.2 Mount the arm system

- ▶ Check that brake ⑪ at the bearing block has been released.



- ▶ Attach extension arm cover ⑫ of the wall box onto the bearing stud

- ▶ Position the completely pre-assembled arm system close to the bearing block.
- ▶ With the aid of the used pull rope pull the arm cable through the bearing block from the top.

**See also:**

- ▶ Use the bearing stud to insert the extension arm into the bearing block from above. Make sure that the bearing stud is fully held in the bearing bushing. As it has been designed to be quite a tight fit, you may need to raise the arm system up slightly to prevent the bearing stud from canting in the bearing bushing.
- ▶ Remove the pull-in aid and insulating tape from the arm cable
- ▶ Remove the safety strap from the arm system and fasten it at the bearing block to the arm line so that it can be reattached if the arm system is disassembled.

### 3.3.3 Wiring








**Note**

Run the individual connectors so that they do run over the stop bolt for the cover.

### 3.4 Final tasks

- ▶ Check the adjustment of the arm system and adjust it if necessary according to installation instructions
- ▶ Check the voltages and functions (as described in the section, "Starting the In eXam" of the installation instructions).
- ▶ Depending on national regulations, run a safety check according to VDE 0751-1 (Installation Instructions, section 10.4)
- ▶ Close the wall box cover
- ▶ Create an exposure for consistency and check it
- ▶ Fill in the provided rating plate (both values can be taken from the original rating plate):  
 Check the voltage version  
 Enter the serial number of the source head

Kaltenbach & Voigt GmbH			
Tube / HV Housing Assembly [Spare part]			
TYPE:	3510 [ ] 110V	SN:	??????
	 230V	Manufactured:	Month Year
	TRX 708, manufactured for KaVo	SN:	 2
	0.7 [IEC 60335:1993]	60 / 70 kV	
	2.5 mm Al 70kV Total filtration	4 / 7 mA DC	
This product complies with FDA regulation 21 CFR Subchapter J at the date of manufacture			

- ▶ Update the x-ray system log

## 4 Troubleshooting for service

### 4.1 Error messages on the display

Error message	Reason	Display	Solution
Error: Cooling	The x-ray head is too hot The message also appears when the In eXam was only turned on for the exposure. The measurement is not an actual measurement but only a calculated value.	The display appears upon touching the exposure key.	Turn on the In eXam and leave it connected to the mains until the message disappears.
OP.Error	The exposure key was released before exposure was over.	An error message appears in the display, and the remaining time is shown. An acoustic alarm sounds.	Press any key on the control unit.
kV Error	The maximum voltage in the tube deviates $\geq 10\%$ from the anticipated value.	The error message is shown on the display by pressing the exposure key.	See the following section
Power Error	The mains voltage is too low, or the fluctuations are too high. No heating voltage at the x-ray tube.	The error message is shown on the display by pressing the exposure key.	LED $V_{\text{heat}}$ must appear. The voltage between GND and $V_{\text{heat}}$ must be 3-4 VCD See the following section

## 4.2 Measurements

### 4.2.1 Voltage measurement on the mainboard

Test point [name]	Test point [name]	Range
23 [GND]	15 [+ 36 V]	30 VDC < ... < 41 VDC
23 [GND]	16 [+ 12 V (LD 2)]	11.4 VDC < ... < 12.6 VDC
23 [GND]	17 [+ 5 V (LD 3)]	5.3 VDC < ... < 5.9 VDC
11 [0 V]	9 [+ 15 V (LD 1)]	13.5 VDC < ... < 15 VDC (only measurable during the exposure)
11 [0 V]	12 [+ 5 VIN]	4.8 VDC < ... < 5.4 VDC (only measurable during the exposure)
25 [GND]	24 [V <sub>heat</sub> ]	3 VDC < ... < 4 VDC (only measurable during the exposure)
20 [0 mA]	21 [RTN mA] Setting: 4mA	3.4 VDC < ... < 4.6 VDC (only measurable during the exposure)
20 [0 mA]	21 [RTN mA] Setting: 7mA	6 VDC < ... < 8 VDC (only measurable during the exposure)


**Note**

If at least one value lies outside of the tolerance range, the supply electronics must be exchanged.



### 4.2.2 Measure resistance on the main board

Test point [name]	Test point [name]	Range
27 [0 kV]	28 [+ kV]	$10.6 < \dots < 12.6 \Omega$
20 [0 mA]	21 [RTN mA]	1 k $\Omega$
20 [0 mA]	J2 - 8 [PWR ARM]	$\sim 0 \Omega$
20 [0 mA]	J2 - 7 [PWR ARM]	$\sim 0 \Omega$
20 [0 mA]	J2 - 6 [PWR ARM]	$\sim 0 \Omega$
20 [0 mA]	J2 - 3 [PWR ARM]	$\infty$
20 [0 mA]	J6 - 1 [CTRL ARM]	$\sim 3 \text{ k}\Omega$
J2 - 1 [PWR ARM]	J2 - 3 [PWR ARM]	$\sim 0 \Omega$


**Note**

If at least one value is incorrect, the supply electronics or the arm cable can be detected.

### Disconnect the arm cable

Test point [name]	Test point [name]	Range
27 [0 kV]	28 [+ kV]	$86.5 < \dots < 95.5 \Omega$
20 [0 mA]	21 [RTN mA]	1 k $\Omega$
20 [0 mA]	J2 - 8 [PWR ARM]	$\sim 0 \Omega$
20 [0 mA]	J2 - 6 [PWR ARM]	$\sim 0 \Omega$
20 [0 mA]	J2 - 3 [PWR ARM]	$\infty$
20 [0 mA]	J6 - 1 [PWR ARM]	$\infty$
1 [0 V]	3 [G 1]	10 k $\Omega$
2 [0 V]	4 [G 2]	10 k $\Omega$
6 [Tr 1]	5 [G 4]	10 k $\Omega$
7 [Tr 2]	8 [G 5]	10 k $\Omega$


**Note**

If at least one value lies outside of the tolerance range, the supply electronics must be exchanged.

### Cable disconnected

Colour / Test Point	Colour / Test Point	Value Tolerance
blue / J2-6	red / J6-2	$\infty$
blue / J2-6	yellow / J6-4	$12 < \dots < 14.6 \text{ k}\Omega$
blue / J2-6	green / J6-1	3 k $\Omega$
blue / J2-6	purple / J2-7	$\sim 0 \Omega$
blue / J2-6	brown / J2-1	$\infty$
blue / J2-6	gn/yl/ / J2-8	$\sim 0 \Omega$
gn/yl/ J2-8	brown / J2-1	$\infty$
gn/yl/ J2-8	shielding / J6-3	$\sim 0 \Omega$
brown / J2-3	orange / J2-3	$\sim 0 \Omega$


**Note**

If at least one value lies outside of the tolerance range, exchange the arm cable or x-ray head.

### 4.3 Identifying errors

Malfunction	Cause	Remedy
Nothing works.	The device is not directly connected.	► Check the connections.
	The fuse on the main board is defective.	► Exchange the fuse.
	The building fuse has tripped.	► Turn on the fuse.
No display on the control unit.	The In eXam control unit is not connected.	► Correctly connect the In eXam timer.
	The control unit line is defective.	► Replace the cable.
	The fuse is defective.	► Exchange the fuse.
	In eXam control unit defective	► Exchange the In eXam timer.
No x-rays.	The x-ray tube is too hot.	► Wait until the "COOLING" message disappears.
	The release switch is defective.	► Run a self test of the In eXam control unit and exchange it if necessary.
	The dip switch is not adjusted corresponding to the installation.	► Check the settings of the dip switches and external safety switch.
Image too bright or dark	Wrong type of film selected.	► Use correct setting.
	Tube is in the wrong position.	► Correct the position.
	Exposure time is too long/short.	► Correct the exposure time.
X-rays are okay, but picture is too bright/dark. Film development	Developing time too short/long.	► Note the description of the developing machine.
	The developer is too cold/warm.	► Check and adjust the temperature.
	The chemicals are too old.	► Replace the chemicals.
X-rays are okay, but picture is too bright/dark. Other reasons.	mA setting is wrong.	► Film setting: Select 7 mA. Sensor setting: Select 4mA.
	The film was inserted backwards.	► When inserting, note the marking on the film.
	The In eXam was not properly installed.	► Inform a qualified technician.





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