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PLANMECA Intra

technical manual

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The manufacturer, assembler, and importer are responsible for the safety, reliability and performance of the unit only if:

- installation, calibration, modification and repairs are carried out by qualified authorized personnel
- electrical installations are carried out according to the appropriate requirements such as IEC364
- equipment is used according to the operating instructions

Planmeca pursues a policy of continual product development. Although every effort is made to produce up-to-date product documentation this publication should not be regarded as an infallible guide to current specifications. We reserve the right to make changes without prior notice.

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1 GENERAL & TECHNICAL DATA

1.1 Warnings and cautions



WARNING

THE FOLLOWING WARNINGS, CAUTIONS AND NOTES MUST ALWAYS BE CONSIDERED WHILE SERVICING THE UNIT, IN ORDER TO AVOID EITHER PERSONAL INJURY OR DAMAGE TO THE UNIT.

CAUTION RADIATION SAFETY RULES

Some procedures described in this manual produces X-ray radiation. Always follow the rules for radiation protection. Never attempt to open the tube head. It does not contain any serviceable parts, and radiation safety could not be guaranteed any more.

CAUTION ELECTRICAL SAFETY RULES

The unit contains hazardous voltages. While servicing internal parts, always turn off externally the power to the unit, and wait for 2 minutes before touching any electrical parts. Always replace the fuses with ones of the same type and rating. Otherwise patient, operator or equipment safety cannot be guaranteed. The circuit boards can be damaged due to static discharges and require careful handling.

CAUTION GENERAL SAFETY RULES

The unit must be serviced only by qualified personnel, trained by PLANMECA. Repairs and parts replaced by unqualified personnel carry no warranty. Periodical maintenance as described in this manual must be performed on a regular basis, to ensure the safety and image quality of the unit. Some procedures described in the unit could be dangerous, if not followed as stated.


CAUTION *Check that the X-ray unit is installed properly and no mechanical play caused by wear, corrosion, metal fatigue or ageing can be found between the wall bracket and horizontal arm.*

1.2 Manual versions

Planmeca pursues a policy of continual product development. Although every effort is made to produce up-to-date product documentation this publication should not be regarded as an infallible guide to current specifications. We reserve the right to make changes without prior notice.

NOTE This manual is only valid for the software version 3.08 and later.

1.3 Technical specifications

Generator	Constant potential, microprocessor controlled, operating frequency 66 kHz
X-ray tube	Toshiba D-0711SB
Focal spot size	 0.7 mm according to IEC 60336
Cone diameter	60 mm (2.36 in.) Rectangular 33 x 43 mm (1.30 x 1.69 in.)
Max. symmetrical radiation field	ø 60 mm at SSD 200 mm ø 60 mm at SSD 300 mm according to IEC 806
Total filtration	min. 2 mm Al equivalent at 70 kV according to IEC 60522
Inherent filtration	1 mm Al equivalent at 70 kV according to IEC 60522
Anode voltage	50, 52, 55, 57, 60, 63, 66, 70 kV, ± 2 kV
Anode current	8, 7, 6, 5, 4, 3, 2 mA $\pm(5\% + 0.2 \text{ mA})$
Target material	Tungsten
Target angle	16°
Exposure times	0.01-3.2 sec. $\pm(5\% + 0.001 \text{ sec.})$, 26 steps
Reference current time product	8 mAs at 70 kV, 8 mA, 1 sec.
Lowest current time product	0.02 mAs at 2 mA, 0.01 sec.
Max. nominal anode voltage	70 kV
Power input	1000 VA
Max. electrical output	560 W at 70 kV, 8 mA
Electrical output at 0.1 sec.	560 W at 70 kV, 8 mA
Max. loading energy	1800 mAs/h at 70 kV
SID (SID = source - image receptor distance)	min. 200 mm (8 in.)
SSD (Source-Skin Distance)	
Standard/Long	200 mm (8 in.)/300 mm (12 in.)
Long with rectangular collimator	306 mm (12.04 in.)
Mains voltage	100 V~/110-115 V~/220-240 V~
Apparent resistance	0.3 ohms 100-115 V~ / 0.8 ohms 220-240 V~
Mains frequency	50/60 Hz
Fusing	units with 100V~ or 110-115V~ voltage setting: 15AT, 250V, slow blow (6.3x32mm) (special fuse, manufacturer Bussmann, type MDA) units with 220-240V~ voltage setting: 8AT, 250V, slow blow (6.3x32mm) (special fuse, manufacturer Bussmann, type MDA)
Duty cycle	1:15, automatic control

Electrical classification	Class I Type B
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Mechanical data

Weight	total 23 kg (51 lbs) tube head 4.2 kg (9.3 lbs) with standard cone 4.5 kg (10 lbs) with long cone
Color	RAL 9016

Environmental requirements

Ambient temperature	operating +5°C - +40°C storage -10°C - +50°C transport -10°C - +50°C
Humidity	25% - 75%
Atmospheric pressure range	700 hPa - 1060 hPa

External mains fuse recommendation

The recommendation for the external mains fuses are:

- units with 100V~ or 115V~ voltage setting: 16A, time lag
- units with 220-240V~ voltage setting: 10A, time lag

No other equipment should be connected to the same fused mains line as the x-ray unit. In some countries an additional external fault current guard is also required.

Original manufacturer

PLANMECA Oy, Asentajankatu 6, FIN-00880, Helsinki, FINLAND
phone: +358-20-7795 500

1.4 User's statement for Planmeca Intra

Radiation leakage technique factors

The maximum rated peak tube potential is 70 kV and the maximum rated continuous tube current is 0.53 mA for the maximum rated peak tube potential.

Minimum filtration

The radiation port contains an added 1.0 mm aluminium filtration. The measured half-value is 0.50 - 0.55 at 70 kV. The measured value corresponds to an aluminium equivalent of 2.0 mm.

Rated line voltage

100, 110-117, 220-240 V~ $\pm 10\%$. Line voltage regulation 10%.

Maximum line current

6.1 A at 230 V~, 12.2 A at 115 V~

Technique factors that constitute the maximum line current condition

70 kV, 8 mA

Generator rating and duty cycle

1.4 kW, duty cycle 1:15. The wait period is controlled automatically by calculating it according to the formula $t_w = 15 \times t_{exp}$.

Maximum deviation of peak tube potential from indicated value

± 2.0 kV

Maximum deviation of tube current from indicated value

$\pm 10\%$

Maximum deviation of exposure time from indicated value

$\pm 10\%$

DEFINITION OF MEASUREMENT CRITERIA

Exposure time

The beginning and end points of the exposure time are defined at 70% of the peak radiation waveform measured with a calibrated x-ray monitor.

Peak tube potential

Is defined as the high voltage mean value measured with a calibrated non-invasive kVp meter.

Tube current

Is defined using the voltage over the feedback resistor measured with a calibrated multimeter. The mA value is calculated by dividing the voltage by the resistance value.

The nominal x-ray voltage together with the highest x-ray tube current obtainable from the high-voltage generator when operated at it's highest x-ray tube voltage

70 kV, 8 mA

The nominal x-ray tube current when operated at the highest x-ray tube voltage

8 mA, 70 kV

The x-ray tube voltage and tube current which result in the highest electric output power

70 kV, 8 mA

The nominal electric power for a load time of 0.1 sec and at the nominal x-ray tube voltage

1.4 kW at 70 kV, 8 mA

Anode heating/cooling curve of the X-ray tube

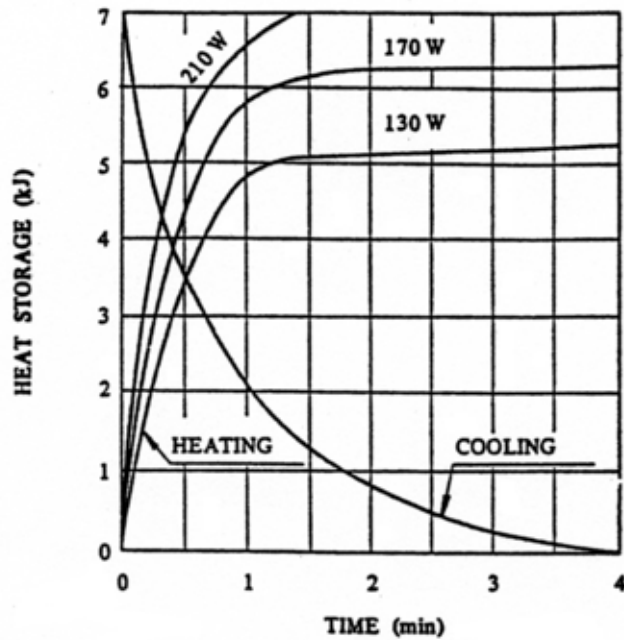


Figure 1

X-ray tube assembly heating/cooling curve

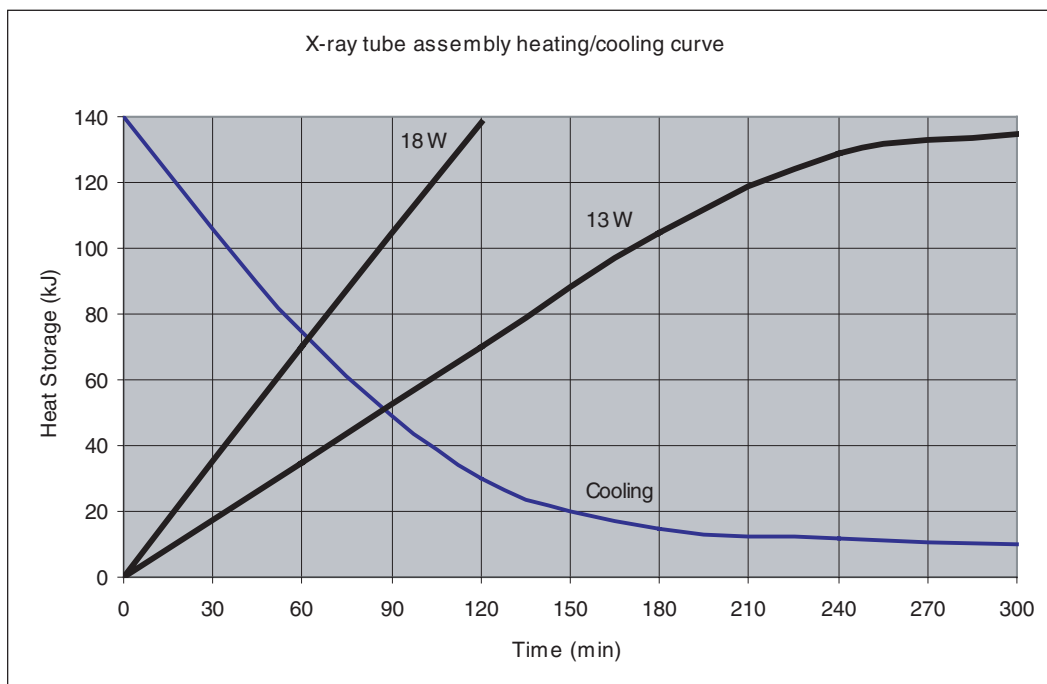


Figure 2

Reference axis to which the target angle and the focal spot characteristics of the tube head assembly refer

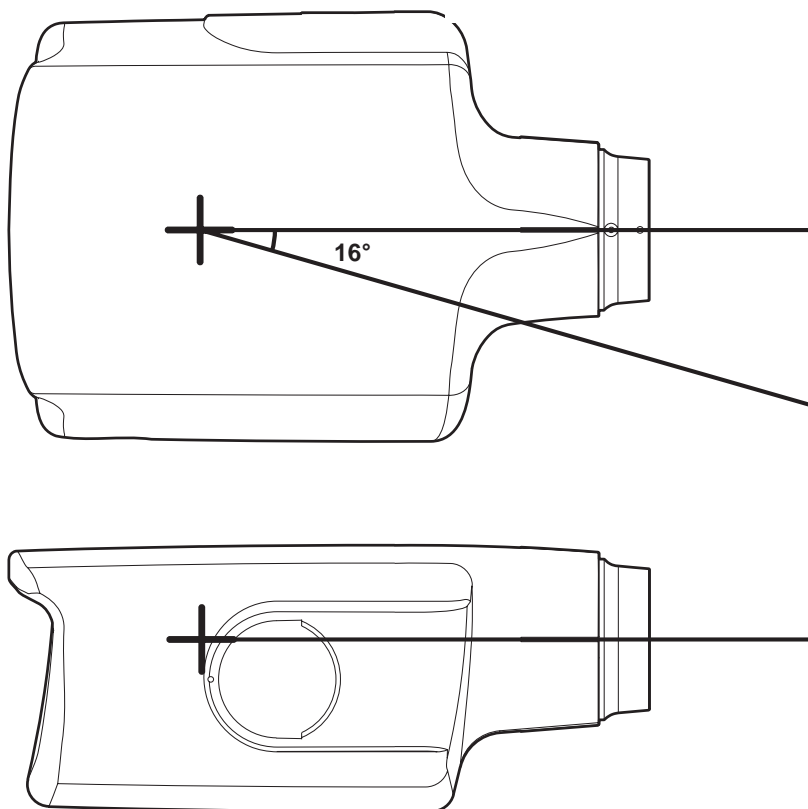


Figure 3

Target angle with respect to the reference axis

16°

Dimensions of the tube head assembly

(WxHxD) 175mm x 105mm x 165mm

Weight of the tube head assembly

3.1 kg

Values of loading factors concerning leakage radiation

70 kV, 8 mA

Tolerances of the focal spot on the reference axis

X= ±0.5 mm (sideways)

Y= ±0.5 mm (in depth)

Z= ±0.5 mm (in height)

1.5 Stray radiation measurements for Planmeca Intra X-ray unit

The measurements are given for loading factors which result in the maximum local dose per current time product. The loading factors include the highest selectable X-ray tube voltage.

PMMA phantom with a diameter of 160 mm and a height of 160 mm has been used for the measurements. The phantom is compatible with the specification in international standard IEC 60601-1-3.

The values were measured in the horizontal plane which was at the height of the centre of the phantom and the X-ray source. The unit of measurement was air kerma per mAs applied to the X-ray tube during normal use.

Exposure values:

70 kV / 8 mA / 0.5 s

Dose values are presented in nGy/mAs.

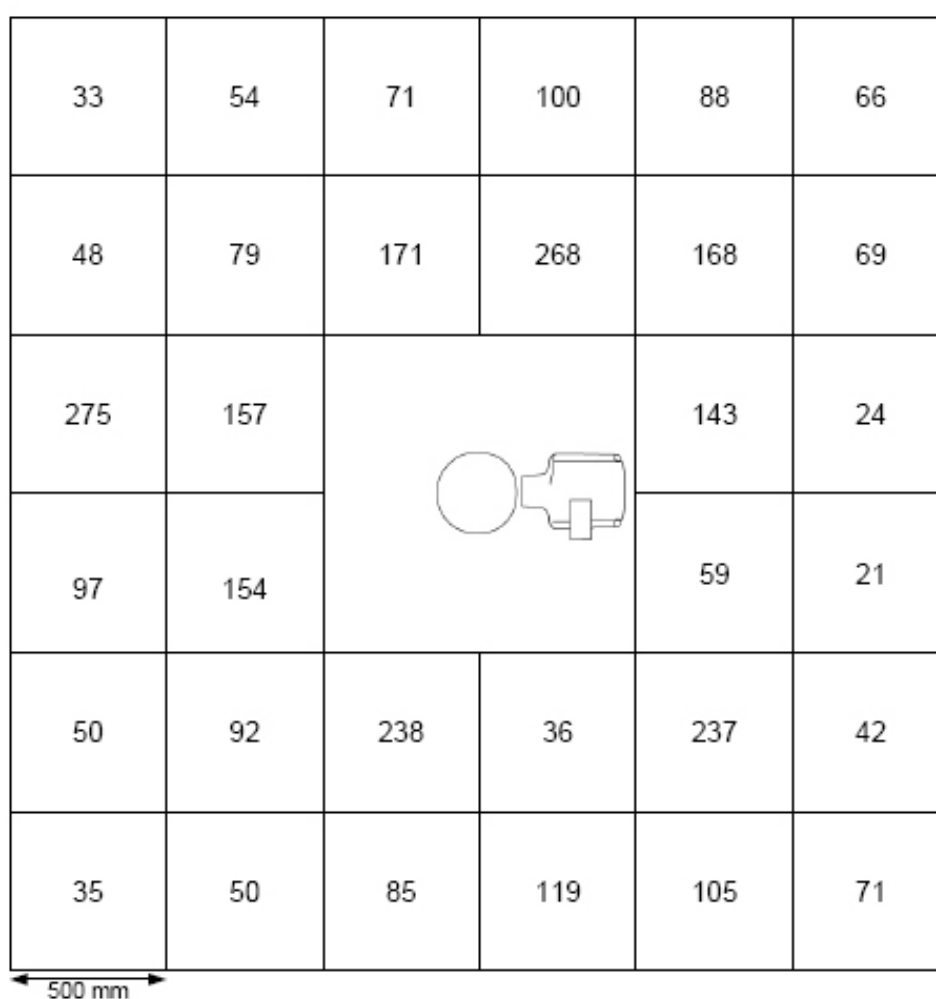


Figure 4

1.6 EMC information

**WARNING**


Use of any accessories and cables other than those specified in Planmeca Intra X-ray unit's documentation, with exception of cables sold by Planmeca as replacement parts for internal components, may result in increased emission or decreased immunity of the X-ray unit.

**WARNING**

Planmeca Intra X-ray unit should not be used adjacent to or stacked with other equipment. If adjacent or stacked use is necessary, the Planmeca Intra X-ray unit should be observed to verify normal operation in configuration which it will be used.

Guidance and manufacturer's declaration - electromagnetic emissions		
Planmeca Intra X-ray unit is intended for use in the electromagnetic environment specified below. The customer or the user of the Planmeca Intra X-ray unit should assure that it is used in such an environment.		
Emissions test	Compliance	Electromagnetic environment – guidance
RF emissions CISPR 11	Group 1	Planmeca Intra X-ray unit uses RF energy only for its internal function. Therefore, its RF emissions are very low and are not likely to cause any interference in nearby electronic equipment.
RF emissions CISPR 11	Class B	Planmeca Intra X-ray unit is suitable for use in all establishments, including domestic establishments and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.
Harmonic emissions IEC 61000-3-2	Class A	
Voltage fluctuations/ flicker emissions IEC 61000-3-3	Complies	

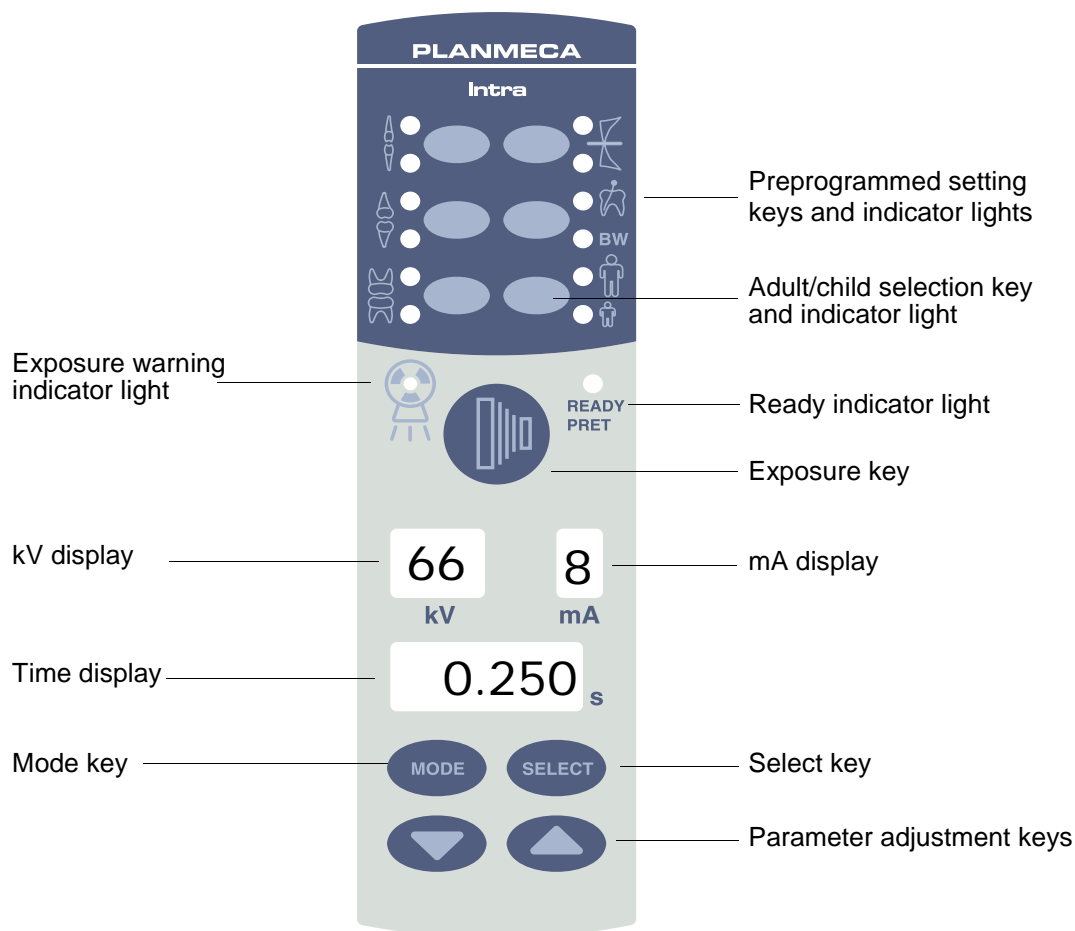
Guidance and manufacturer's declaration - electromagnetic immunity			
Planmeca Intra X-ray unit is intended for use in the electromagnetic environment specified below. The customer or the user of Planmeca Intra X-ray unit should assure that it is used in such an environment.			
Immunity test	IEC 60601 test level	Compliance level	Electromagnetic environment-guidance
Electrostatic discharge (ESD) IEC 61000-4-2	±6 kV contact ±8 kV air	±6 kV contact ±8 kV air	Floors should be wood, concrete or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30%.
Electrical fast transient/burst IEC 61000-4-4	±2 kV for power supply lines ±1 kV for input/output lines	±2 kV for power supply lines ±1 kV for input/output lines	Mains power quality should be that of a typical commercial or hospital environment
Surge IEC 61000-4-5	±1 kV line to line ±2 kV line to earth	±1 kV line to line ±2 kV line to earth	Mains power quality should be that of a typical commercial or hospital environment.
Voltage dips, short interruptions and voltage variations on power supply input lines IEC 61000-4-11	<5 % U_T (>95 % dip in U_T) for 0,5 cycle 40 % U_T (60 % dip in U_T) for 5 cycles 70 % U_T (30 % dip in U_T) for 25 cycles <5 % U_T (>95 % dip in U_T) for 5 s	<5 % U_T (>95 % dip in U_T) for 0,5 cycle 40 % U_T (60 % dip in U_T) for 5 cycles 70 % U_T (30 % dip in U_T) for 25 cycles <5 % U_T (>95 % dip in U_T) for 5 s	Mains power quality should be that of a typical commercial or hospital environment. If the user of Planmeca Intra X-ray unit requires continued operation during power mains interruptions, it is recommended that Planmeca Intra X-ray unit be powered from an uninterruptible power supply.
Power frequency(50/60 Hz) magnetic field IEC 61000-4-8	3 A/m	3 A/m	Power frequency magnetic fields should be at levels characteristic of a typical location in a typical commercial or hospital environment. The power frequency magnetic field should be measured in the intended installation location to assure that it is sufficiently low.
NOTE U_T is the a.c. mains voltage prior to application of the test level.			

Guidance and manufacturer's declaration - electromagnetic immunity			
Planmeca Intra X-ray unit is intended for use in the electromagnetic environment specified below. The customer or the user of Planmeca Intra X-ray unit should assure that it is used in such an environment.			
Immunity test	IEC 60601 test level	Compliance level	Electromagnetic environment-guidance
Conducted RF IEC 61000-4-6	3 Vrms 150 kHz to 80 MHz	3 Vrms	<p>Portable and mobile RF communications equipment should be used no closer to any part of the Planmeca Intra X-ray unit, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter.</p> <p>Recommended separation distance</p> $d = 1,2\sqrt{P}$ $d = 1,2\sqrt{P} \quad 80 \text{ MHz to } 800 \text{ MHz}$ $d = 2,3\sqrt{P} \quad 800 \text{ MHz to } 2.5 \text{ GHz}$ <p>where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer and d is the recommended separation distance in metres (m).</p> <p>Field strengths from fixed RF transmitters, as determined by an electromagnetic site survey,^a should be less than the compliance level in each frequency range.^b</p> <p>Interference may occur in the vicinity of equipment marked with the following symbol:</p> 
NOTE 1: At 80 MHz and 800 MHz, the higher frequency range applies.			
NOTE 2: These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.			
<p>^a Field strengths from fixed transmitters, such as base stations for radio (cellular/cordless) telephones and land mobile radios, amateur radio, AM and FM radio broadcast and TV broadcast cannot be predicted theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured field strength in the location in which Planmeca Intra X-ray unit is used exceeds the applicable RF compliance level above, Planmeca Intra X-ray unit should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as re-orienting or relocating Planmeca Intra X-ray unit.</p> <p>^b Over the frequency range 150 kHz to 80 MHz, field strengths should be less than 3 V/m.</p>			

Recommended separation distances between portable and mobile RF communications equipment and Planmeca Intra X-ray unit			
Planmeca Intra X-ray unit is intended for use in an electromagnetic environment in which radiated RF disturbances are controlled. The customer or the user of Planmeca Intra X-ray unit can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and the Planmeca Intra X-ray unit as recommended below, according to the maximum output power of the communications equipment.			
Rated maximum output power of transmitter W	Separation distance according to frequency of transmitter m		
	150 kHz to 80 MHz $d = 1,2\sqrt{P}$	80 MHz to 800 MHz $d = 1,2\sqrt{P}$	800 MHz to 2.5 GHz $d = 2,3\sqrt{P}$
0.01	0.2	0.2	0.3
0.1	0.4	0.4	0.7
1	1.2	1.2	2.4
10	4.0	4.0	8.0
100	12.0	12.0	24.0

2 SERVICE MODE

2.1 Control panel



2.2 How to enter/exit the service mode

SELECT

Press and hold down the select key for 4 seconds.

MODE

Press and hold down the Mode key for more than 2 seconds, until the four uppermost preprogrammed setting indicator lights come on.

To exit from the service mode

MODE

Press the Mode key briefly.

2.3 X-ray tube filament preheating voltage calibration



Enter the service mode according to the instruction given in section 2.2 “How to enter/exit the service mode” on page 12.

Press and hold down the adult/child mode selection key for 2 seconds or until the indicator light starts to blink. The indicator lights will start to blink indicating that you are in the preheating voltage calibration mode.

Move as far away from the x-ray tube as the length of the cable from the control panel permits.



Press and hold the exposure key on the control panel until 16 exposures are performed (approx. 30 seconds).



Press the Mode key briefly to exit the service mode.

2.4 kV range selection

Enter the service mode according to the instruction given in section 2.2 “How to enter/exit the service mode” on page 12.

Press the parameter adjustment up key until the parameter number 14 appears on the kV display.



Parameter adjustment up -key



The code of the kV range (0 - 9) is shown on the time display. The kV ranges are: 0 = 50-70, 1 = 55-70, 2 = 60-70, 3 = 66-70, 4 = 70, 5 = 50-68, 6 = 55-68, 7 = 60-68, 8 = 66-68 and 9 = 68 kV.

Press the Select key until the kV range code starts to blink, and the range can now be changed with the parameter adjustment keys.



Select key



Parameter adjustment keys



Accept the new kV range by pressing the Select key.

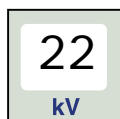


Press the Mode key briefly to exit the service mode.

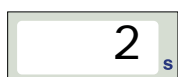
2.5 mA minimum value selection

Enter the service mode according to the instruction given in section 2.2 “How to enter/exit the service mode” on page 12.

Press the parameter adjustment up key until the parameter number 22 appears on the kV display



Parameter adjustment up -key



The minimum mA value (2 - 8) is shown on the time display.

Press the Select key until the mA minimum value starts to blink. The minimum value can now be changed with the parameter adjustment keys.



Select key



Parameter adjustment keys



Accept the new mA minimum value by pressing the Select key.

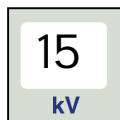


Press the Mode key briefly to exit the service mode.

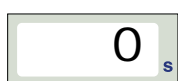
2.6 Operation of the preprogrammed settings keys (kV hold)

Enter the service mode according to the instruction given in section 2.2 “How to enter/exit the service mode” on page 12.

Press the parameter adjustment up key until the parameter number 15 appears on the kV display.



Parameter adjustment up -key



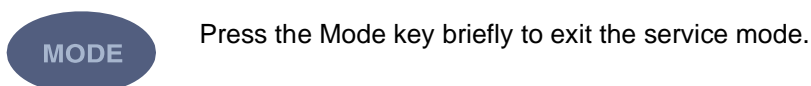
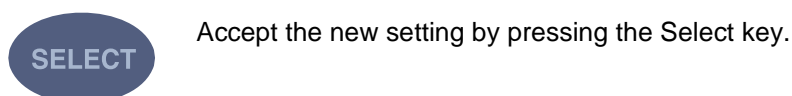
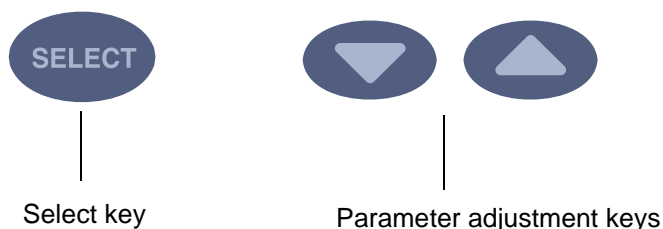
The number indicating the operation of preprogrammed settings keys (0 or 1) is shown on the time display.

0: Normal operation (factory setting). The preprogrammed settings keys operate as described in the Planmeca Intra user's manual.

1: kV hold. The selection of a preprogrammed setting does not affect the prior manually inserted kV value, but the exposure time is recalculated to achieve constant optical density on the film. In the case the kV value is now manually altered, the exposure time will also

be changed automatically. If the exposure time is manually altered, the unit will return into manual mode. At any time, the preprogrammed setting for the kV value, mA value and exposure time for any tooth position is called by selecting the preprogrammed setting and pressing the child mode selection key twice.

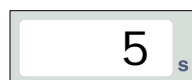
Press and hold down the Select key until the number starts to blink, and the number can now be changed with the parameter adjustment keys.



2.7 Dimming the displays

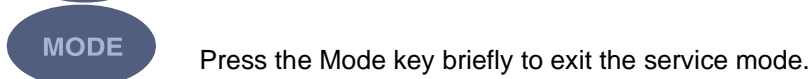
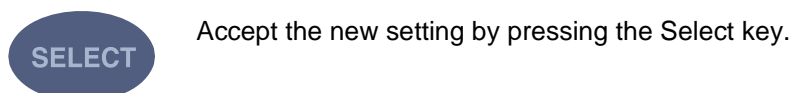
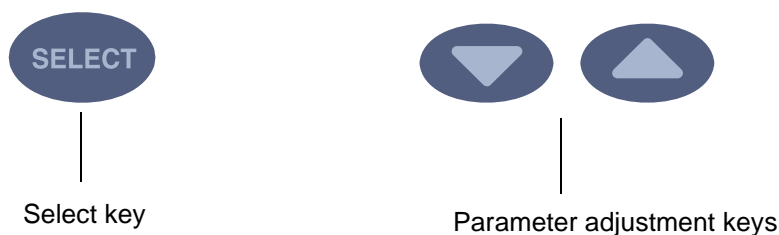
Enter the service mode according to the instruction given in section 2.2 “How to enter/exit the service mode” on page 12.

Press the parameter adjustment up key until the parameter number 16 appears on the kV display.



The number indicating the brightness of the displays (from 1 to 5, factory default is 5) is shown on the time display.

Press the Select key until the number starts to blink, and the value can now be changed with the parameter adjustment keys.



2.8 Duration of the displays dimming time-out

Enter the service mode according to the instruction given in section 2.2 “How to enter/exit the service mode” on page 12.

Press the parameter adjustment up key until the parameter number 17 appears on the kV display.



Parameter adjustment up -key



The number indicating the time-out value (0, 1, 2, 3, 4, 5) is shown on the time display. The time-out values are: 0 = no dimming, 1 = 1 min., 2 = 2 min., 3 = 5 min., 4 = 20 min. and 5 = 60 min. Factory default is 1.

Press the Select key until the number starts to blink, and the value can now be changed with the parameter adjustment keys.



Select key



Parameter adjustment keys



Accept the new setting by pressing the Select key.

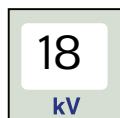


Press the Mode key briefly to exit the service mode.

2.9 Disabling the exposure key

Enter the service mode according to the instruction given in section 2.2 “How to enter/exit the service mode” on page 12.

Press the parameter adjustment up key until the parameter number 18 appears on the kV display.



Parameter adjustment up -key



The number indicating the mode of exposure key operation is shown on the time display. 0 = exposure key normal operation, 1 = exposure key operation disabled. The factory default is 0.

Press the Select key until the number starts to blink, and the value can now be changed with the parameter adjustment keys.



Select key



Parameter adjustment keys



Accept the new setting by pressing the Select key.

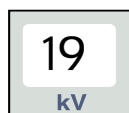


Press the Mode key briefly to exit the service mode.

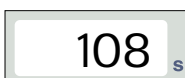
2.10 Automatic identification of the cascade card

Enter the service mode according to the instruction given in section 2.2 “How to enter/exit the service mode” on page 12.

Press the parameter adjustment up key until the parameter number 19 appears on the kV display.



Parameter adjustment up -key



The value indicating the type of the cascade card is shown on the time display. Value < 108 equals an old card and value ≥ 108 equals a new card. The type of the cascade card affects the adjustment functionality of the preheat and mA.

2.11 Specifying the PCB versions

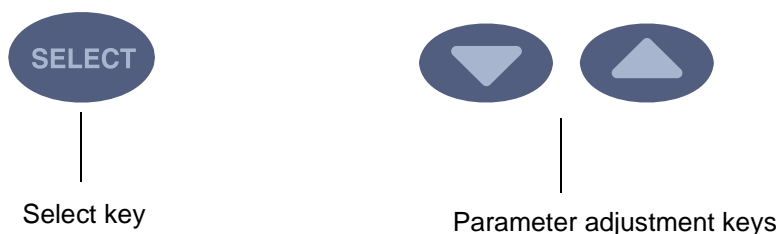
Enter the service mode according to the instruction given in section 2.2 “How to enter/exit the service mode” on page 12.

Press the parameter adjustment up key until the parameter number 20 appears on the kV display.



The value indicating the type of the PCB versions is shown on the time display. 1 = CPU PCB version C3 (or older) with older cascade PCB, 2 = CPU PCB version C5 with newer cascade PCB and 3 = CPU PCB version E1, works with both old and new cascade PCB. The factory default is 3.

Press the Select key until the number starts to blink, and the value can now be changed with the parameter adjustment keys.



Accept the new setting by pressing the Select key.



Press the Mode key briefly to exit the service mode.

2.12 Ready-state setting

The Planmeca Intra X-ray unit can be set so that the Ready indicator light will only come on when the Dimaxis program is ready for the exposure, i.e. the *Waiting for exposure* message is on the computer screen.

Enter the service mode according to the instruction given in section 2.2 “How to enter/exit the service mode” on page 12.

Press the parameter adjustment up key until the parameter number 21 appears on the kV display.

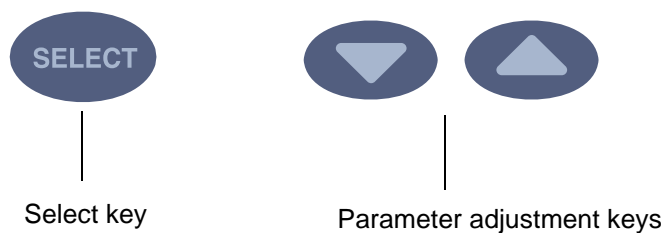


The number indicating the ready-state setting (0 or 1) is shown on the time display.

0: Normal operation (factory setting). The Planmeca Intra X-ray unit will go into Ready-state regardless of PC operation.

1: The Ready indicator light will only come on when the Dimaxis program is ready for the exposure

Press and hold down the Select key until the number starts to blink, and the number can now be changed with the parameter adjustment keys.



Accept the new setting by pressing the Select key.

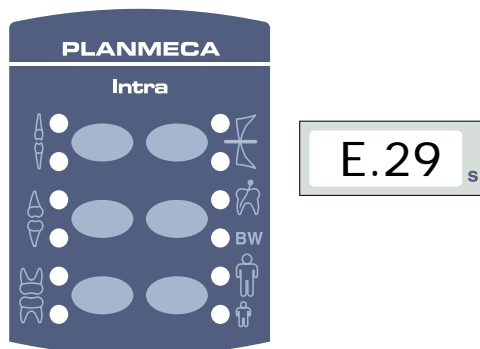


Press the Mode key briefly to exit the service mode.

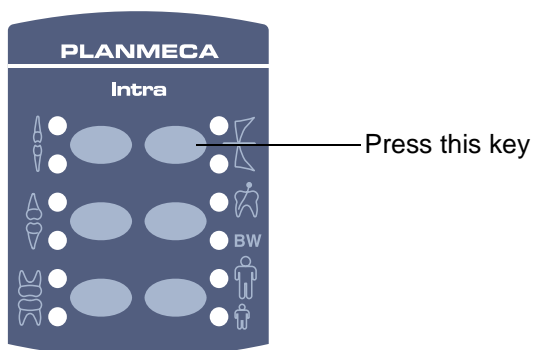
3 RECALLING THE FACTORY PREPROGRAMMED EXPOSURE VALUES

The factory preprogrammed exposure values are in the Planmeca Intra user's manual, section 9 "EXPOSURE VALUES".

Press and hold down any of the preprogrammed setting keys when switching the unit on. The error code E.29 will appear on the time display.



Do not clear the error code by pressing the select key, but press the Occlusal exposure key for 6 seconds. The factory preprogrammed values and density value 0 will be stored into memory.



4 PREVENTIVE MAINTENANCE

4.1 Cleaning

Surfaces

NOTE When cleaning the unit surfaces, always disconnect the unit from mains.

The unit surfaces can be cleaned with a soft cloth dampened in a mild cleaning solution. Stronger agents can be used for disinfecting the surfaces. We recommend Dürr System-hygiene FD 322 or respective disinfecting solution.

Film holder

The film holder can be autoclaved up to 145°C or cleaned with alcohol-based solutions.

4.2 Operation checks

Indicator light for ready status

Confirm that the green ready status indicator light comes on when the unit is ready to take an exposure.

Exposure warning indicator light and signal

Confirm that the yellow exposure warning light will come on when you take an exposure. Confirm also that the audible warning sound is heard during the exposure.

Exposure key

Confirm that the exposure key requires continuous activation to maintain the exposure.

Labels

Check that no labels are detached or worn and that they are all legible.

4.3 Preventive maintenance adjustments

- Arm balance. Adjust, if needed. Refer to section 7.1 “Adjusting the balance of the arm” on page 31.
- Bracket arm angles. Adjust, if needed. Refer to section 7.2 “Adjusting the bracket arm angles” on page 32.
- Stiffness of tube head’s horizontal axle. Adjust, if needed. Refer to section 7.3 “Adjusting the stiffness of the tube head’s horizontal axle” on page 33.
- Tube head vertical stiffness. Adjust, if needed. Refer to section 7.4 “Vertical tube head stiffness adjustment screw” on page 34.

4.4 Measuring KV / MA signals (invasive testing)

NOTE The manufacturer does not require the invasive testing. The invasive test must only be performed if the local authorities require it.

An invasive method should be used for checking the tube current (mA), and can be used for checking the kV. This method requires that the covers around the tube head assembly are removed. The analog feedback voltage signals can be measured with a calibrated multimeter.

1. Unscrew the two M4x20 DIN 7984 fastening screws of the cone.
2. Remove the tube head front cover and the cone.
3. Unscrew the six fastening screws of the tube head cover and remove the cover.
4. Attach sprung hook test leads from multimeter to P1-connector pins 1 (negative kV) and 2 (positive kV) in the tube head PCB. See figure 5.

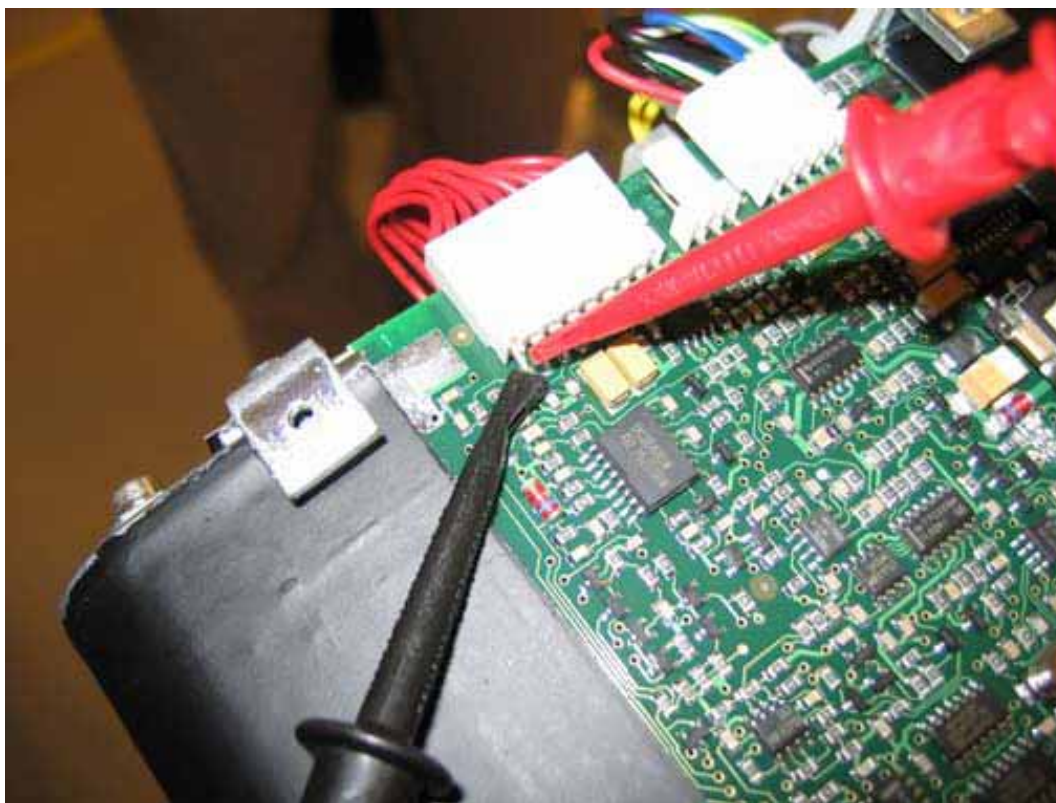


Figure 5

5. Set multimeter to DC voltage mode with a measurement range of 1 to 5V signal level. Take 2 seconds exposure with desired kV setting. Selected mA value has no effect, however lowest possible mA should be used to minimise the amount of unnecessary radiation. When the voltage reading has been stabilized, record it.

Actual tube voltage (in volts) = 21 672 * measured feedback voltage (in volts)

The resulting tube voltage should be within $\pm 5\%$ of the voltage indicated in the user interface.

6. Move test leads to P1-connector pins 3 (negative mA) and 4 (positive mA).



Figure 6

7. Set multimeter to DC voltage mode with a measurement range of 100mV to 5V signal levels. Take 2 seconds exposure with desired mA setting. Selected kV value has no effect, however lowest possible kV should be used to minimise the amount of unnecessary radiation. When the voltage reading has been stabilized, record it.

Actual tube current (in mA) = 2.5 * measured feedback voltage (in volts)

The resulting tube current should be within $\pm 10\%$ of the current indicated in the user interface.

5 TROUBLESHOOTING

The control panel displays do not come on and the indicator light of generator box is not on

Problems in mains voltage, or a fuse is blown.

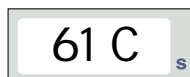
Check the mains voltage. Check the mains cable. Check and replace, if necessary, the fuses located on the lower left side of the generator box. Open the generator box and check and replace, if necessary, the generator fuse F2. Replace the generator. (Perform the checks and parts replacements in this order).

The control panel displays do not come on and the indicator light of generator box is on

Control panel power failure, or the control panel is defective. The control panel operates with 12 V produced on the generator low voltage supply.

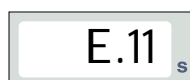
Check the control panel cable and the telephone cable. Replace the control panel. (Perform the checks and parts replacements in this order).

Temperature of the tube head too high



If the temperature of the tube head exceeds 60 °C, the temperature will appear on the time display. The control panel does not operate. Wait until the temperature drops.

6 ERROR MESSAGES



The error code is displayed on the time display.



Press the select key to clear the error from the display.

6.1 Error message shortform table

ERROR CODE	ERROR MESSAGE EXPLANATION
E.00	Exposure key was released too early during the exposure.
E.10	X-ray tube Anode voltage (kV) overshoot.
E.11	X-ray tube Anode voltage (kV) dropped suddenly.
E.12	X-ray tube cathode filament preheating voltages are not calibrated.
E.13	Filament preheating voltage calibration failed.
E.29	Membrane keyboard key short-circuited/pressed during the self test or faulty display board.
E.30	kV value does not reach or it exceeds the given value (difference more than 5%).
E.31	X-ray tube Anode current (mA) missing, or not in specified limits.
E.33	X-ray tube Filament voltage (V) missing, or outside the range (too low or too high).
E.34	X-ray tube Anode voltage (kV) missing, or below the specified limit.
E.36	Too long exposure.
E.37	kV feedback signal open circuit or short circuit.
E.38	mA feedback signal open circuit or short circuit.
E.50	Tube head temperature sensor short circuit.
E.51	Tube head temperature sensor open circuit.
E.52	Filament voltage feedback not in specified limits
E.57	Exposure key pressed during self test.
E.60	$\pm 15\text{VDC}$ voltage is out of limits
E.61	Communication error between control panel and tube head CPU.

ERROR CODE	ERROR MESSAGE EXPLANATION
E.71	FLASH memory check-sum error (tube head CPU).
E.81	EEPROM memory defective (tube head CPU).
E.83	Config register error (tube head CPU).

6.2 Detailed error message explanations

E.00 Exposure key was released too early during exposure

The most probable cause (if the key really was pressed firmly during the whole exposure) is faulty control panel or faulty separate exposure switch.

Replace the control panel or the separate exposure switch. Check the control panel cable, telephone cable and the arm cable.

E.10 X-ray tube anode voltage (kV) overshoot

This condition is monitored by the watch-dog circuit on the tube head PCB during the whole exposure and if the anode voltage rises above 95 kV the exposure is immediately aborted and this error indicated. A knocking sound may be heard from the tube head at the same time. This kind of arcing can occur now and then without any special reason, and should be considered a normal phenomenon. If however the occurrence frequency becomes too high, it could be an indication of a degrading tube head.

If this error occurs constantly it is probably caused by a faulty tube head or tube head PCB or generator PCB (replace in this order). The possible reason is also faulty feedback cable (9 pole) in the tube head.

E.11 X-ray tube anode voltage (kV) dropped suddenly

The x-ray tube voltage suddenly drops, and a knocking sound is heard from the tube head at the same time. The exposure is aborted and this error indicated. This phenomenon should be considered quite normal if it doesn't occur frequently. If the generator is damaged during the exposure, or the arm/extension cable is broken, this error is indicated and during next exposure the error E.30 occurs.

If this error occurs constantly it is probably caused by a faulty tube head or tube head PCB or generator PCB (replace in this order). The possible reason is also faulty feedback cable in the tube head.

E.12 X-ray tube cathode filament preheating voltages are not calibrated

The tube head PCB has been replaced, but the X-ray tube cathode filament preheating voltages are not calibrated.

See paragraph 2.3 "X-ray tube filament preheating voltage calibration" on page 13 for details how to perform the calibration.

E.13 Filament preheating voltage calibration failed

During preheat calibration the filament voltage is measured to be in specified limits. The filament circuit in the tube head or in the tube head PCB is faulty or the tube head is faulty.

Perform the calibration procedure again. If it fails, replace the tube head or tube head PCB (in this order). The possible reason is also faulty feedback cable in the tube head.

E.29 Control panel key short-circuited/pressed during the self test

This error can occur only during the self-test. During the self test the unit checks that all keys are open (normal state if not pressed). If a key is found to be in short circuit, this error is displayed. Because the control panel keys are arranged in a matrix, one key's short could cause the whole keyboard to operate erroneously, therefore this check is important.

Replace the control panel.

The factory predetermined settings are recalled and the density value is set to zero by pressing any of the keys during the self test. The error code E.29 appears on the time display, after which the right-hand preprogrammed setting key must be pressed and held down for 6 seconds. See section 3 "RECALLING THE FACTORY PREPROGRAMMED EXPOSURE VALUES" on page 20.

E.30 kV value does not reach or it exceeds the given value (difference more than 5%)

The tube voltage is sampled periodically (by the tube head CPU) and if the actual measured kV-value differs more than ± 3 kV from the specified value this error is displayed. The tube head, tube head PCB, generator PCB or arm/extension cable signals HV1, HV2 or KVC (see wiring diagram) can be faulty. See also error E.11 and E.34.

Check the incoming mains voltage during the exposure. Check the arm/extension cable and the tube head feedback cable. Replace the generator PCB, tube head PCB or tube head (replace in this order).

E.31 X-ray tube anode current (mA) missing, or not in specified limits

The tube current is sampled periodically (by the tube head CPU) and if the actual measured mA-value differs more than ± 2 mA from the specified value this error is displayed. The tube head, tube head PCB or tube head feedback cable can be faulty.

Proceed with the filament definition, see paragraph 2.3 "X-ray tube filament preheating voltage calibration" on page 13 for details. If this does not help and the error occurs constantly check the tube head feedback cable, replace the tube head PCB, or tube head (in this order).

E.33 X-ray tube filament voltage (V) missing, or outside the range (too low or too high)

The tube filament voltage is sampled periodically (by the tube head CPU) and if the actual measured filament voltage is not in the specified limits (1.0 - 4.5 V) then this error is displayed. The filament circuit in the tube head or on the tube head PCB can be faulty.

Check the tube head feedback cable. Replace the tube head PCB or the tube head (in this order).

E.34 X-ray tube anode voltage (kV) missing, or below the specified limit

This error occurs in the beginning of the exposure, when the tube anode voltage does not rise. The tube head, tube head PCB, generator PCB or arm/extension cable signals HV1, HV2 or KVC (see wiring diagram) can be faulty. See also error E.11 and E.30.

Check the incoming mains voltage during the exposure. Check the arm/extension cable and the tube head feedback cable. Replace the generator PCB, tube head PCB or tube head (replace in this order).

E.36 Too long exposure

The control panel CPU monitors the exposure time by measuring the state of the exp-signal. If, however, the tube head CPU continues the exposure more than the maximum exposure time, then the control panel CPU terminates the exposure and this error occurs. This is a safety procedure, that guarantees that the exposure is terminated under all conditions.

Replace the tube head PCB if this error occurs repeatedly.

E.37 kV feedback signal open circuit or short circuit

The kV feedback signal is monitored by the tube head CPU. The internal connection of the tube head or tube head feedback cable is faulty.

Check the condition of the feedback cable, replace the tube head PCB or the tube head (in this order).

E.38 mA feedback signal open circuit or short circuit

The mA feedback signal is monitored by the tube head CPU. The internal connection of the tube head or tube head feedback cable is faulty.

Check the condition of the feedback cable, replace the tube head PCB or the tube head (in this order).

E.50 Tube head temperature sensor short circuit

The tube head temperature sensor signal is measured by the tube head CPU. The sensor is short-circuited, the tube head PCB or the tube head feedback cable is faulty.

Check the feedback cable. Replace the temperature sensor (beside the signal connectors of the tube head), or the tube head PCB (in this order).

E.51 Tube head temperature sensor open circuit

The tube head temperature sensor signal is measured by the tube head CPU. The temperature sensor is damaged, the tube head PCB or the tube head feedback cable is faulty.

Check the feedback cable. Replace the tube head PCB.

E.52 Filament voltage feedback not in specified limits

The filament voltage is monitored by the tube head CPU. The amplifier is faulty.
Replace the tube head PCB.

E.57 Exposure key pressed/failure during self test

The tube head CPU checks the state of the exp-signal when the unit is switched on. The exposure key or the separate exposure switch can be short-circuited. The arm, extension, control panel or telephone cable can be faulty. The tube head PCB or the generator PCB can be faulty.

Check the cables and the separate exposure switch. Replace the control panel, tube head PCB or the generator PCB (in this order).

E.60 $\pm 15\text{VDC}$ voltage is out of limits

The tube head CPU measures the internal voltages generated by tube head PCB power supply from the 12V operating voltage. If this error occurs before exposure, the tube head PCB is faulty. If the error occurs after the exposure, the generator 12V power supply is faulty, or the mains filtering capacitors charging circuit is faulty. The extension cable can be too long and/or the wire cross sections too small.

If the error occurs immediately after switching the unit on, replace the tube head PCB. If the error occurs only after starting the exposure, measure the 12 V voltage at the generator PCB P13 connector. If the voltage drops at the beginning of the exposure (generator's green indicator light dims), replace the generator PCB. Check the connectors of the arm cable and the length of the extension cable, as well as the wire cross sections. The properties of extension cable are given in the figure 7 below.

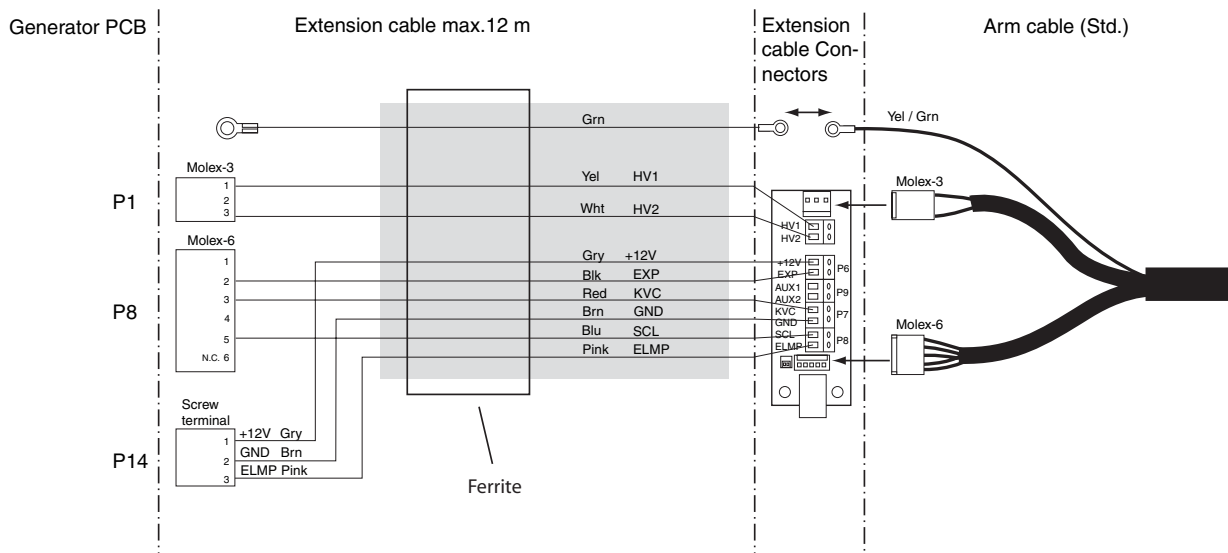


Figure 7

E.61 Communication error between control panel and tube head CPU

The tube head PCB's 12V voltage feed or the communication between the control panel and tube head CPU is failed. The arm/extension cable or control panel/telephone cable is faulty.

Check the cables. Measure the 12V voltage at the tube head PCB P2 connectors pins 1 and 4. Check if the red LED D7 on the tube head PCB is on. Replace the tube head PCB, control panel or the generator PCB (in this order).

E.71 FLASH memory check-sum error (tube head CPU)

Tube head CPU internal error.

Replace the tube head PCB.

E.81 EEPROM memory defective (tube head CPU)

Tube head CPU internal error.

Replace the tube head PCB.

E.83 Config register error (tube head CPU)

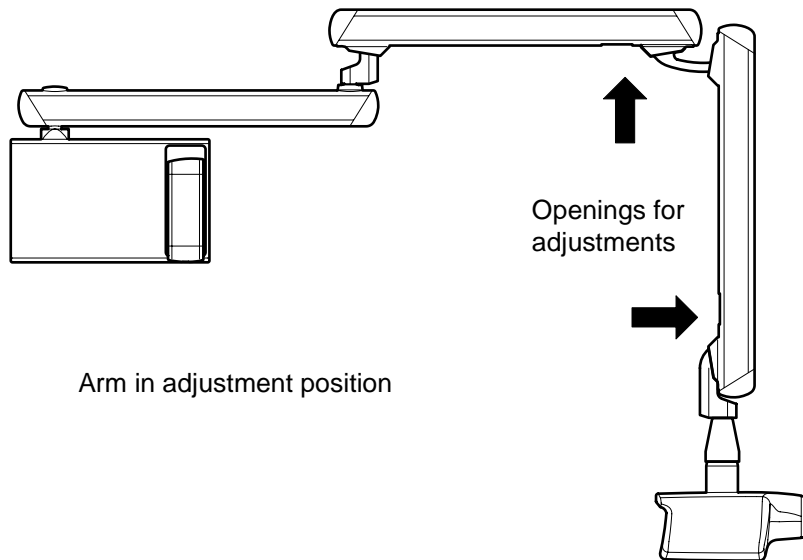
Tube head CPU internal error.

Replace the tube head PCB.

7 MECHANICAL ADJUSTMENTS

7.1 Adjusting the balance of the arm

Adjust the balance of the arm by turning the adjustment nuts with a screwdriver. The adjustment nuts are located inside the bracket arm and can be reached through the openings at the under-side of the bracket arm.



NOTE Adjust the arm from the lower part of the adjustment nut.

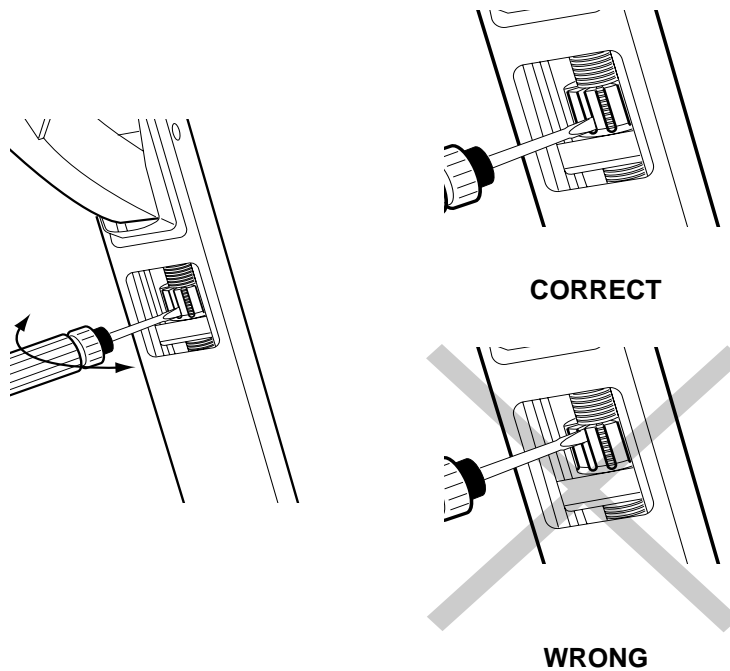


Figure 8

7.2 Adjusting the bracket arm angles

In case the bracket arm angles need to be adjusted it can be done with the limiting plates. Remove the cover plug from the end of the bracket arm. Attach the limiting plate to the arm with two M3 Allen screws. Adjust the angle with the limiting plate adjustment screws.

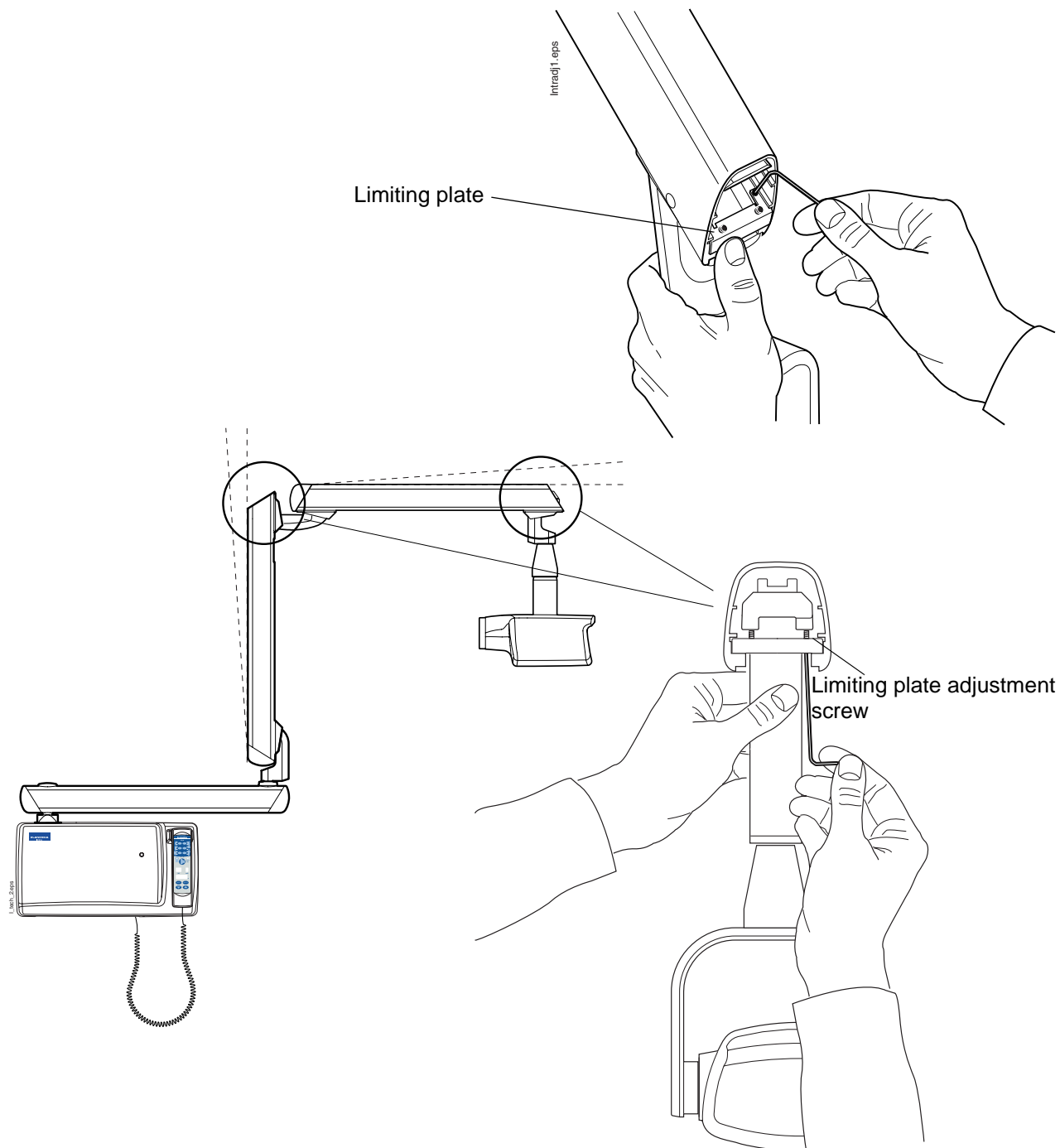


Figure 9

7.3 Adjusting the stiffness of the tube head's horizontal axle

Remove the plug from the tube head's axle and adjust the tightness of the two adjusting screws evenly (arrows on the figure below).

WARNING!

Do not touch the painted screws
or the earth spring attachment screw.

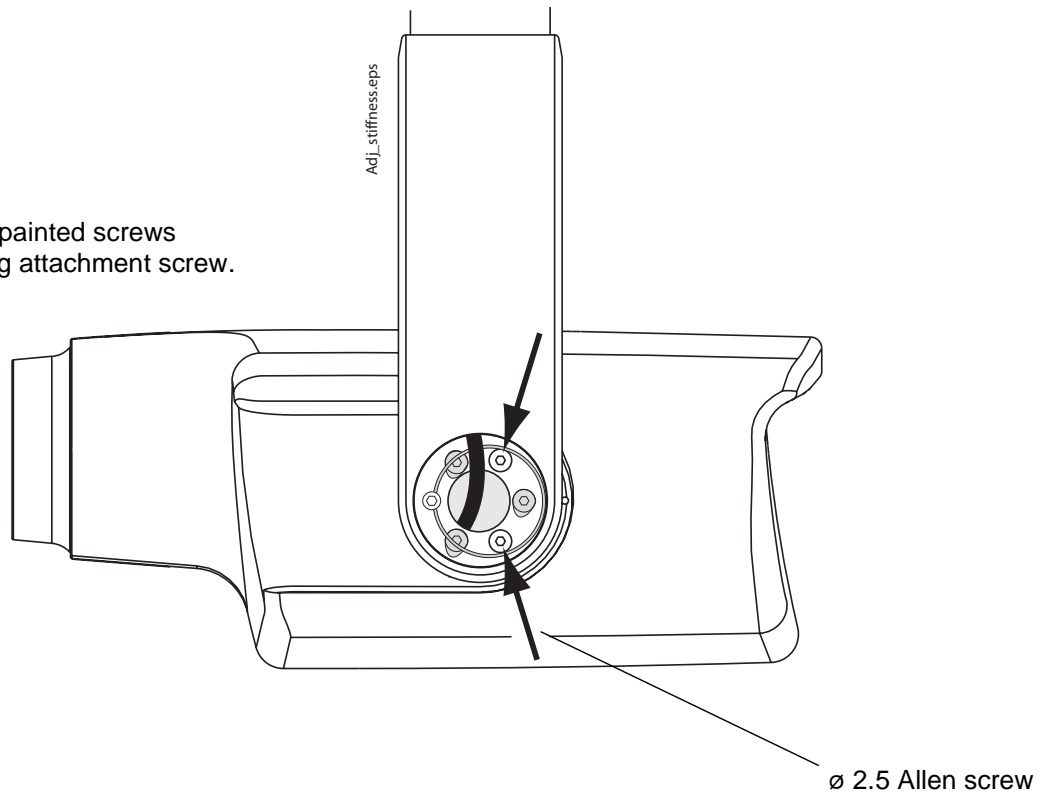


Figure 10

7.4 Vertical tube head stiffness adjustment screw

Adjust the stiffness of the vertical tube head by turning the adjustment screw on the support axle manually or with a wrench tool.

The stiffness of the vertical tube head has been preadjusted at the factory, and can be changed, if necessary.

Turn the adjustment screw 0,5 - 1 rounds clockwise if you want to tighten the tube head and 0,5 - 1 rounds counterclockwise to loosen it.

NOTE Do not turn the adjustment screw too much counterclockwise to avoid the screw to come loose.

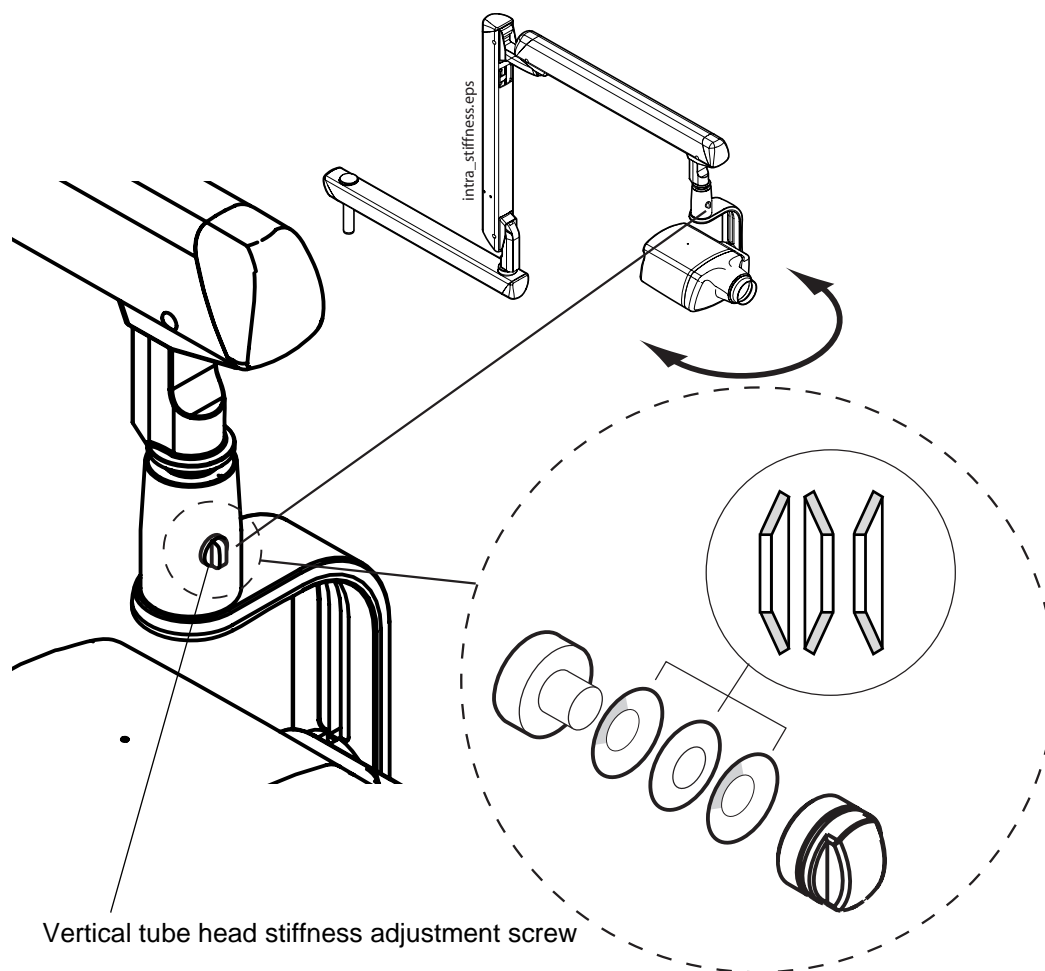


Figure 11

8 PARTS REPLACEMENT & REPAIR



WARNING

Make sure that the power supply is switched off before starting parts replacement.

8.1 Replacing the Generator PCB

1. Unscrew the three M4x6 ULS screws and remove the generator cover.

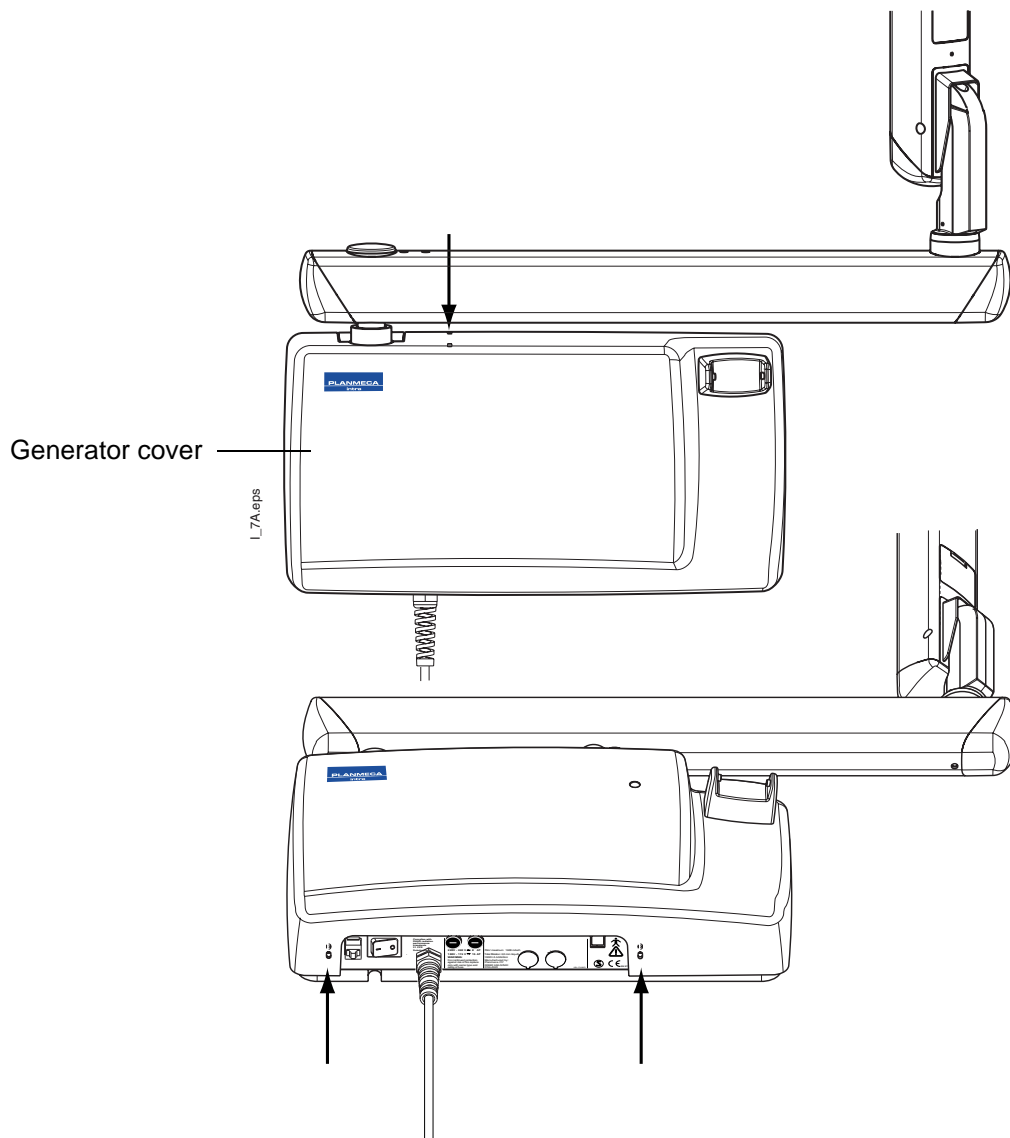


Figure 12

2. Measure that the mains voltage is not present at the mains input terminals (P5) marked N and L (see figure below).
3. Disconnect the connectors from terminals P1, P3, P5, P6 P7, P8 and P9.

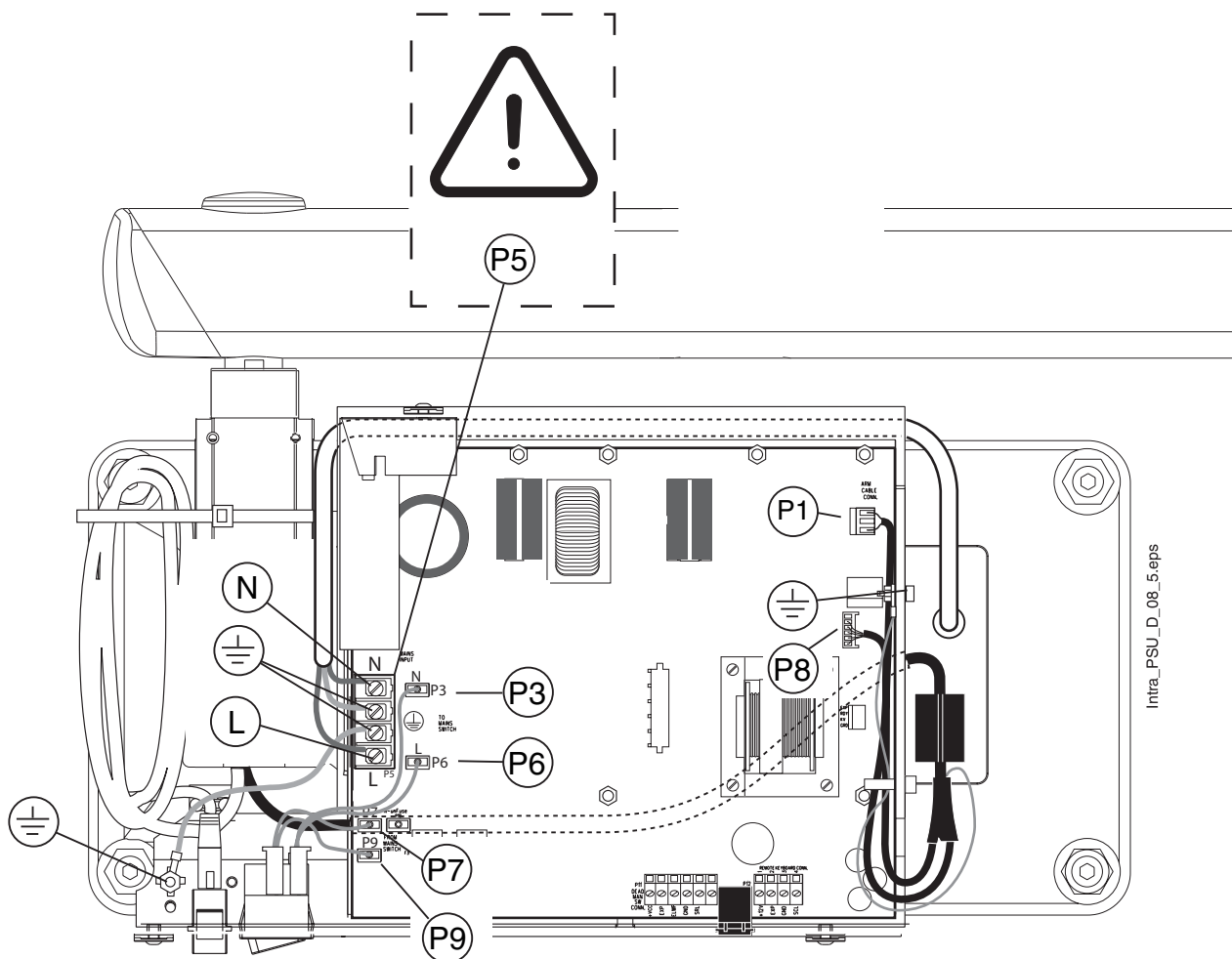


Figure 13

4. Loosen the four M4x8 ISO 7380 screws of the generator assembly frame (figure 14, 1). Lift the generator assembly upwards (figure 14, 2). The generator assembly can now be lifted away from the wall adapter (figure 14, 3).

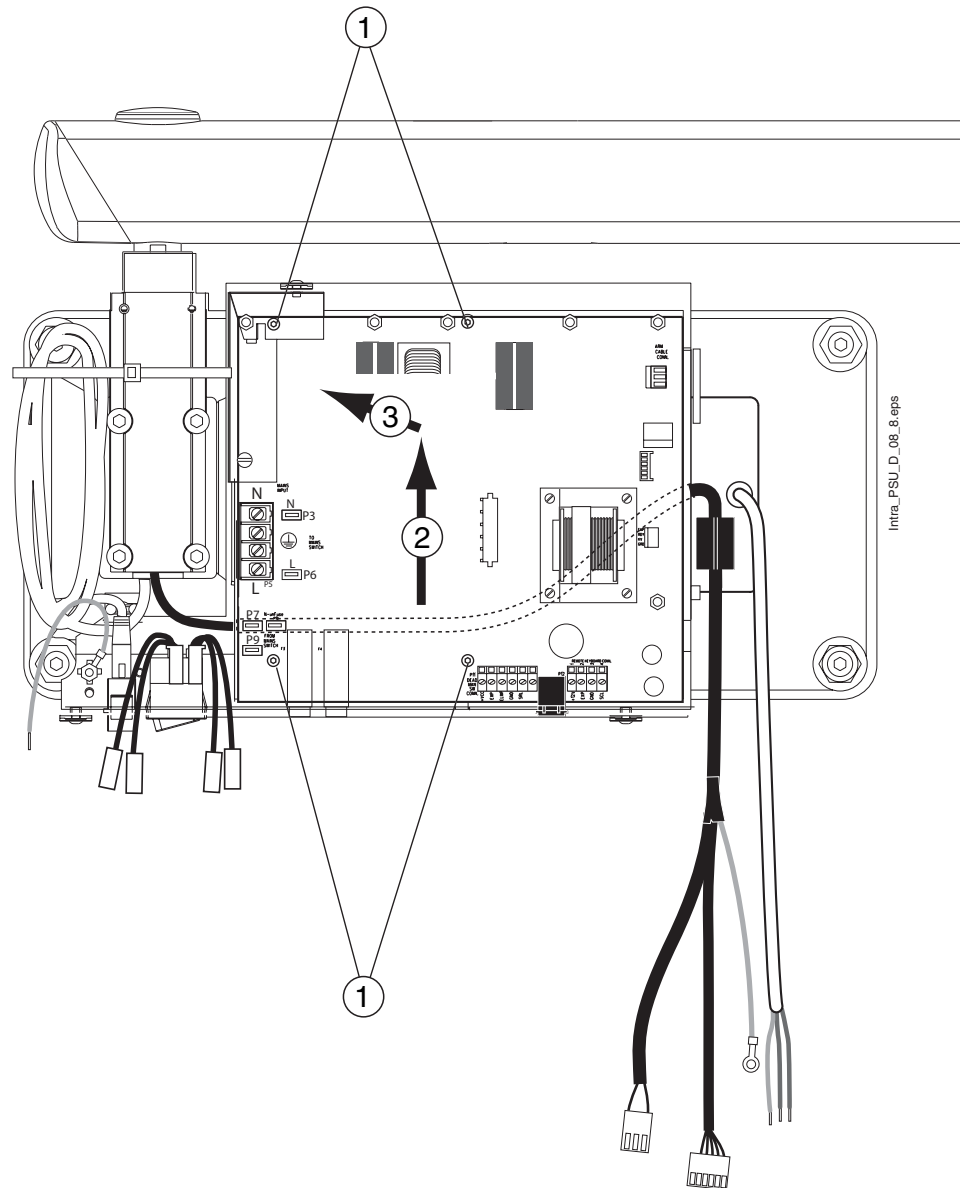


Figure 14

5. Remove the eight M4 DIN 934 attachment nuts and $\varnothing 4.3$ DIN 6798 washers from the Generator PCB (figure 15, 1). Unscrew the two M4x8 DIN 84 screws (figure 15, 2). Lift the generator assembly away from the wall adapter and open the two M3x6 DIN 912 screws located behind the generator assembly frame (figure 15, 3).
6. Remove the Generator PCB.

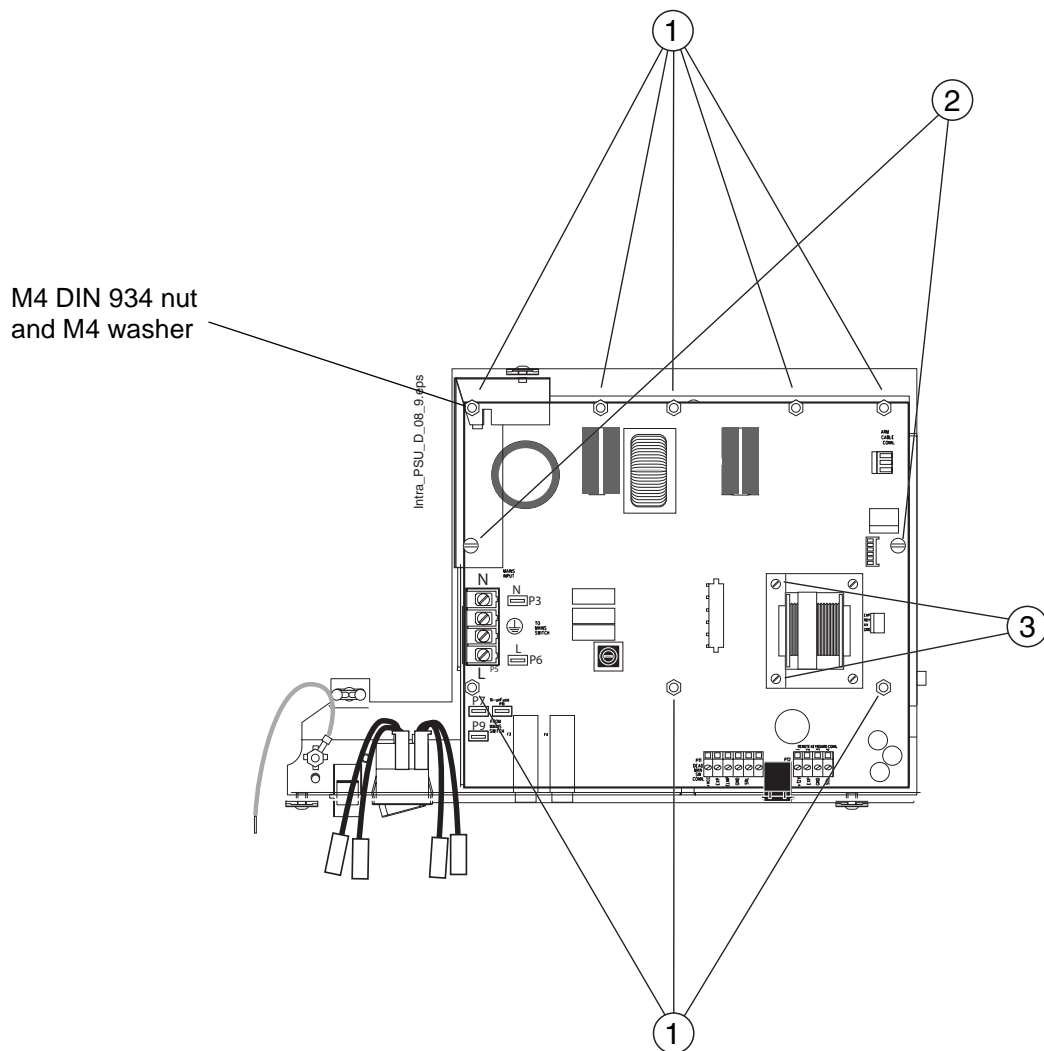


Figure 15

7. Install the new Generator PCB in reverse order. Note, that the new Generator PCB is not attached to the frame with the two M3x6 DIN 912 screws located behind the generator assembly frame.

8.2 Replacing the tube head PCB

1. Unscrew the two M4x20 DIN 7984 fastening screws (figure 16, 1) of the cone (figure 16, 2) (inside the cone).
2. Remove the tube head front cover (figure 16, 3) and the cone.
3. Disconnect the two connectors from the tube head PCB (figure 16, 4).
4. Pull the tube head PCB (figure 16, 5) from the tube head.
5. Install the new PCB in reverse order.
6. Perform the x-ray tube filament preheating voltage calibration, see section 2.3 "X-ray tube filament preheating voltage calibration" on page 13.

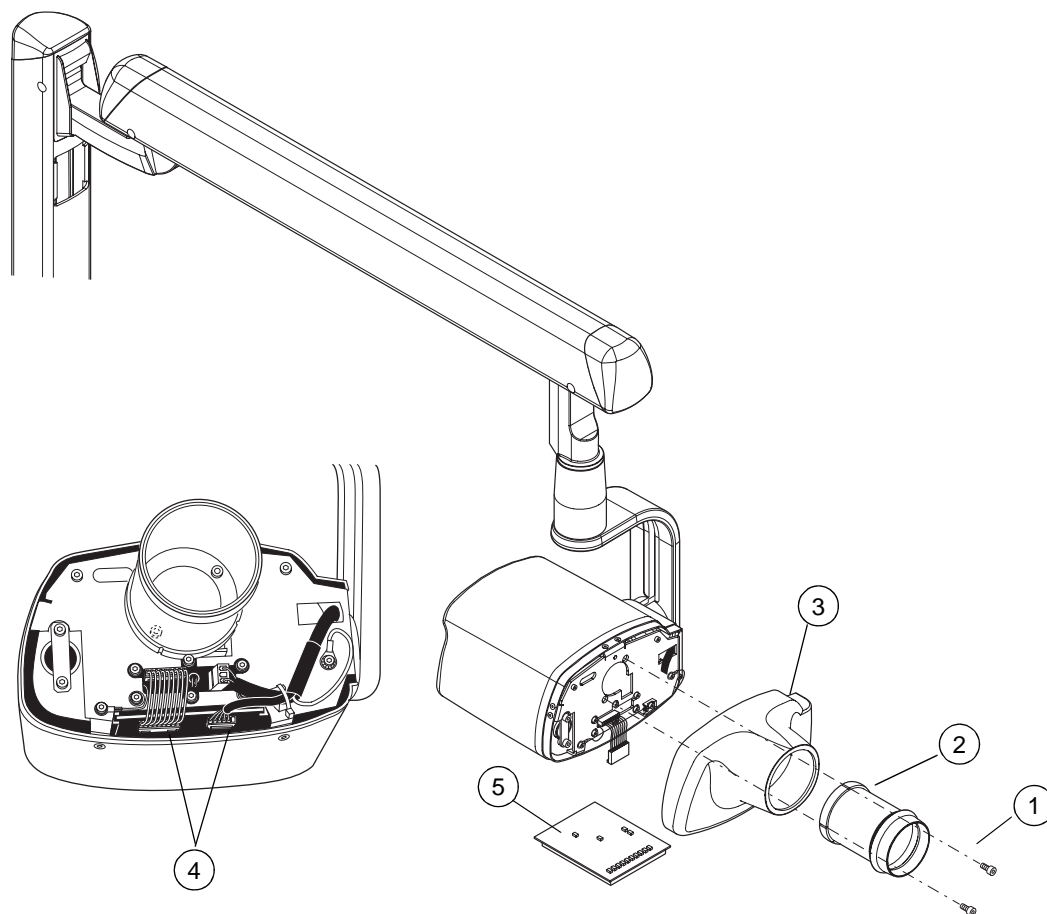


Figure 16

8.3 Replacing the tube head

1. Remove the tube head PCB as described in section 8.2 “Replacing the tube head PCB” on page 39.
2. Unscrew the six fastening screws of the tube head cover (figure 17, 1) and remove the cover (figure 17, 2).
3. Unscrew the five screws from the support frame (figure 17, 3) and remove the tube head (figure 17, 4). Note, that there is a grounding plate under the lower left attachment screw.
4. Install the new tube head in reverse order. Make sure that the grounding plate touches the tube head PCB.

NOTE Do not overtighten the tube head cover fastening screws to avoid damaging the cover.

5. Perform the x-ray tube filament preheating voltage calibration, see section 2.3 “X-ray tube filament preheating voltage calibration” on page 13.

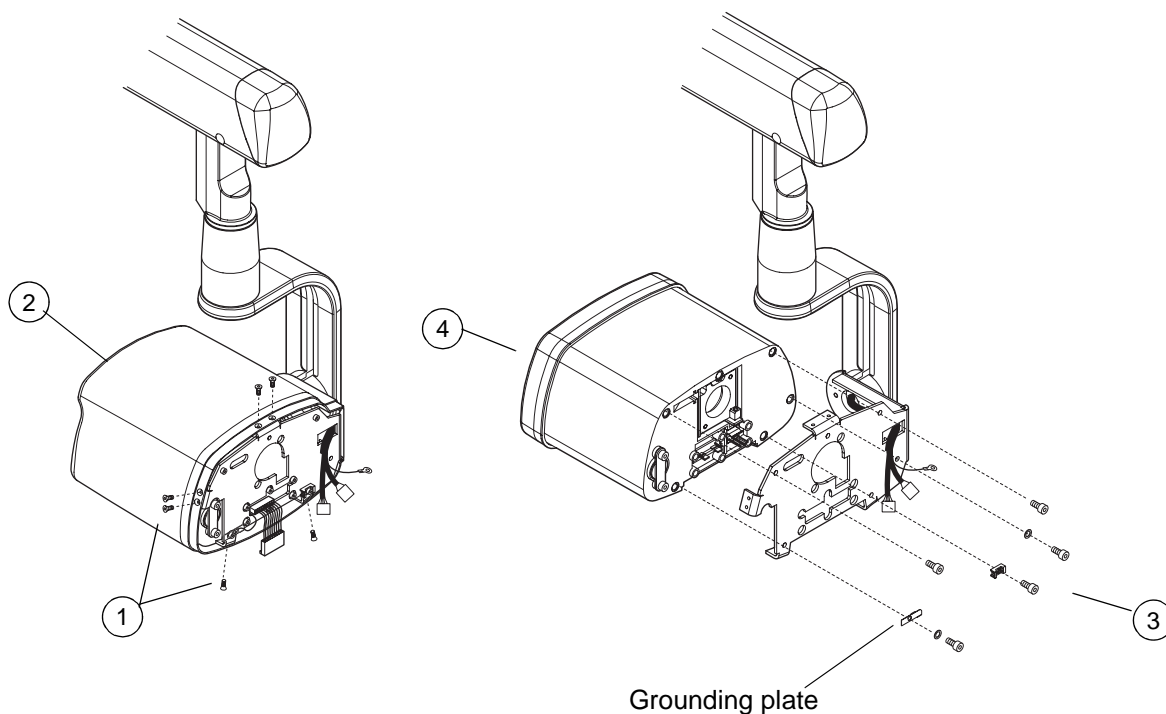


Figure 17

8.4 Replacing the arm cables

NOTE The Dixi interconnection cable is attached to the arm cable and you have to replace both cables. The Dixi interconnection cable is attached to the new arm cable at the factory.

NOTE The x-ray units with serial number IXRF41386 or smaller need old 7mm (0.28 in.) thick arm cable, part number 06320002. Do not use the new, 9mm (0.35 in.) thick arm cable (part number 10006682) in these x-ray units.

1. Remove the tube head as described in section 8.3 "Replacing the tube head" on page 40.
2. Unscrew the three M4x6 ULS screws and remove the generator cover.
3. Disconnect the arm cable connectors from the Generator PCB (terminals P1 and P8). Detach the grounding lead of the arm cable. (figure 18, 1).
4. Remove the extension arm cover plugs (figure 18, 2).
5. Pull the arm cable and the Dixi interconnection cable through the extension arm.
6. Detach the plug of the tube head support (figure 18, 3).
7. Remove the cover plug from the bracket arm opening. Detach the Dixi interconnection cable from the Dixi control box OR pull the cable out from the bracket arm (figure 18, 4).
8. Unscrew the M3x6 ISO 7380 screw of the tube head support (figure 18, 5) and remove the cover plate of the tube head support (figure 18, 6). The plate is attached with double-sided adhesive tape.
9. Cut off the connectors from the tube head end of the arm cable push the cable through the support frame (figure 18, 7).

10. Cut off the connectors from the generator end of the arm cable and Dixi interconnection cable. The grounding lead should be left longer than the other leads (figure 18, 8).

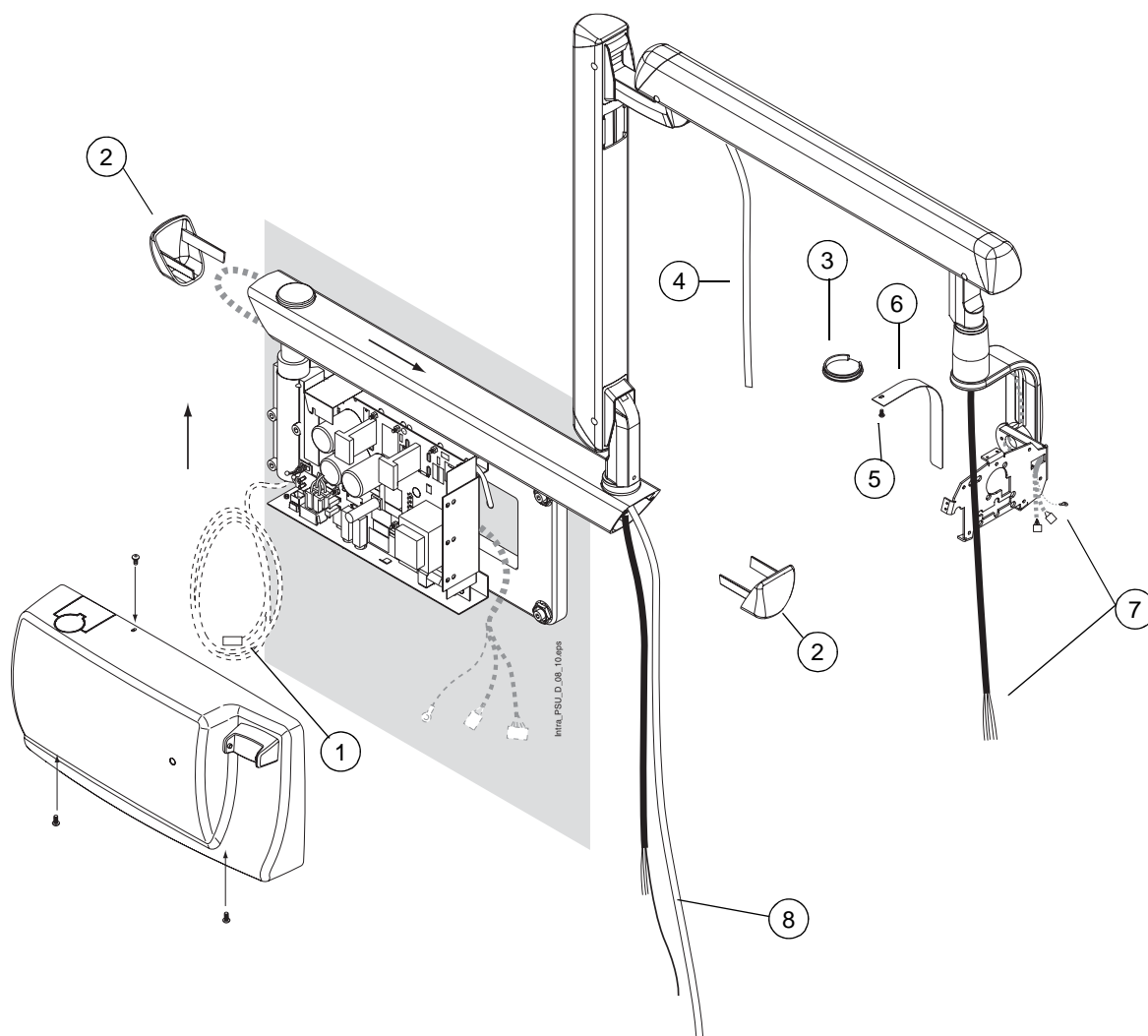


Figure 18

11. Join the old and new cables together as shown in figure 19 below. Tape the joining point firmly. Do not tape the old Dixi interconnection cable, it is pulled out from the opening on the bracket arm (see figure 20)

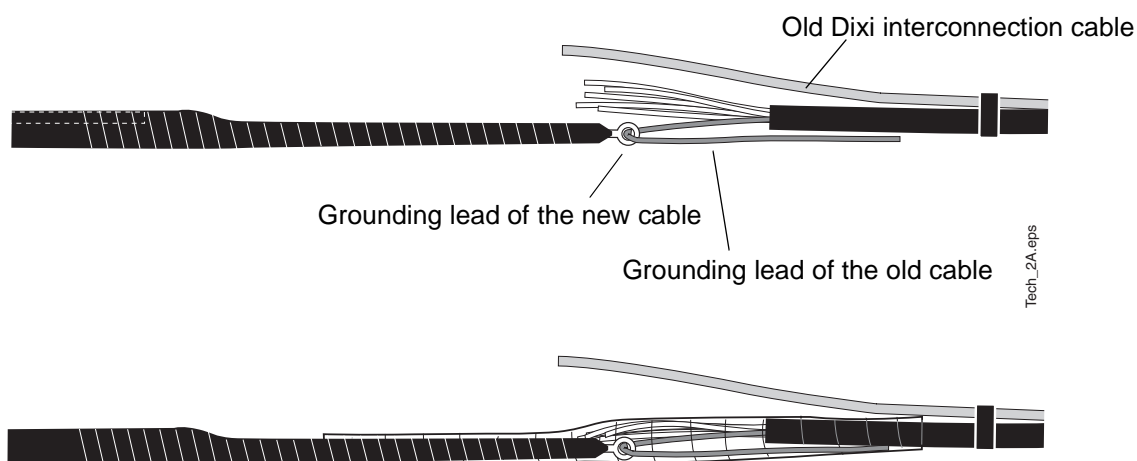


Figure 19

12. Coat the new arm cable with silicone, grease or similar. Pull from the tube head end of the arm cable and simultaneously move the arm up and down.

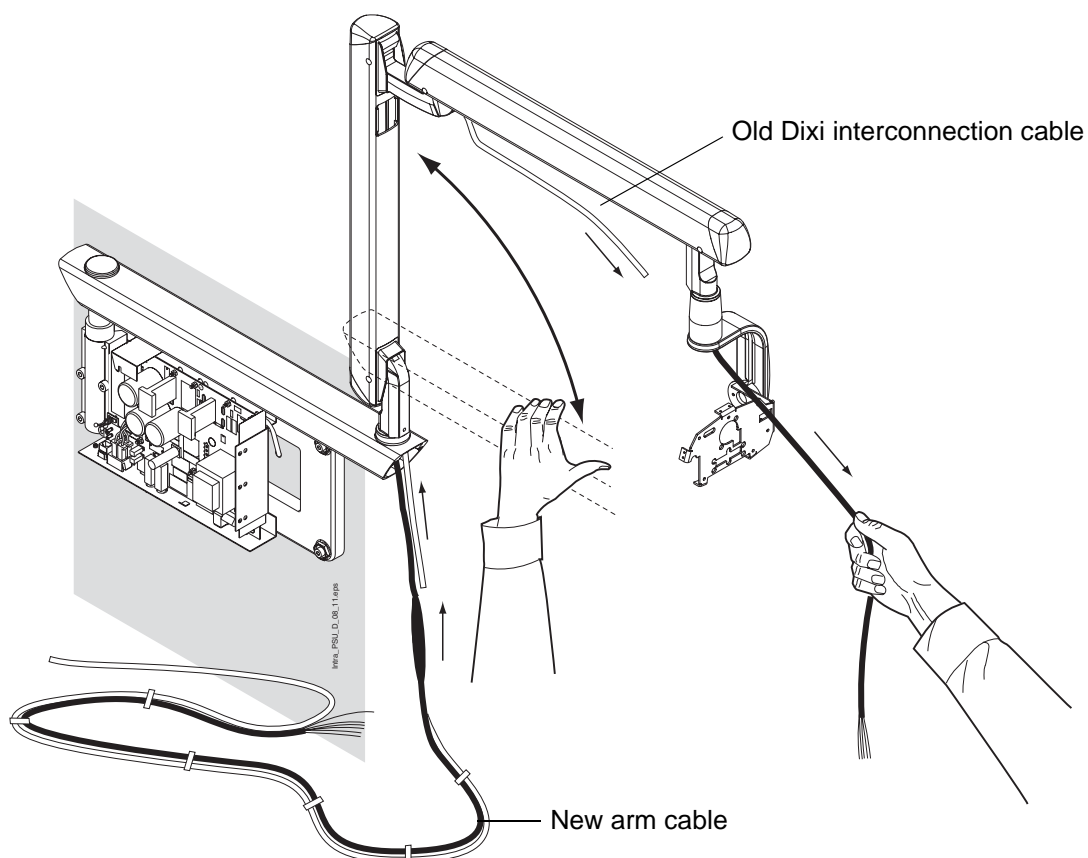


Figure 20

NOTE Make sure that the arm cable and the Dixi interconnection cable are not twisted when you are pulling them into the arm.

13. Stop pulling when the new cable is 390-400 mm out from the opening of the tube head support (figure 21, 1). Route the cable through the opening on the support frame (figure 21, 2).

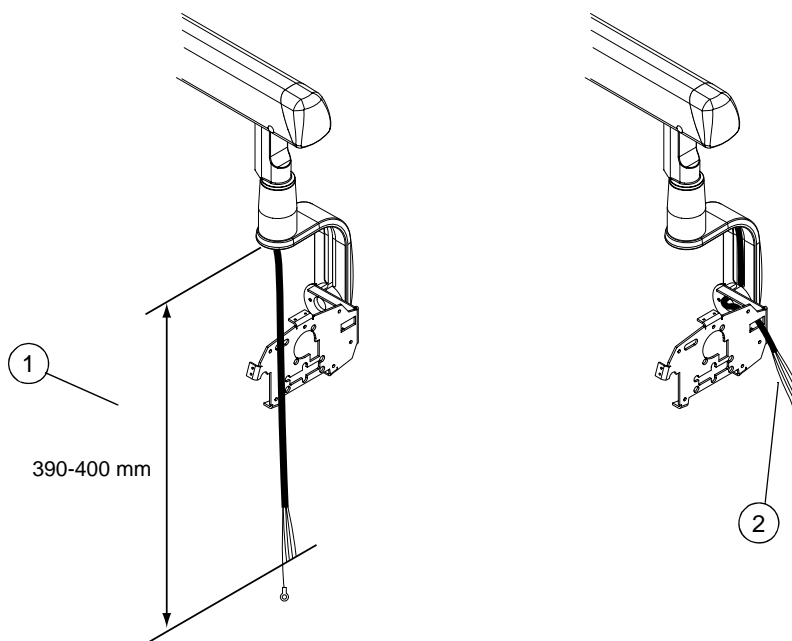
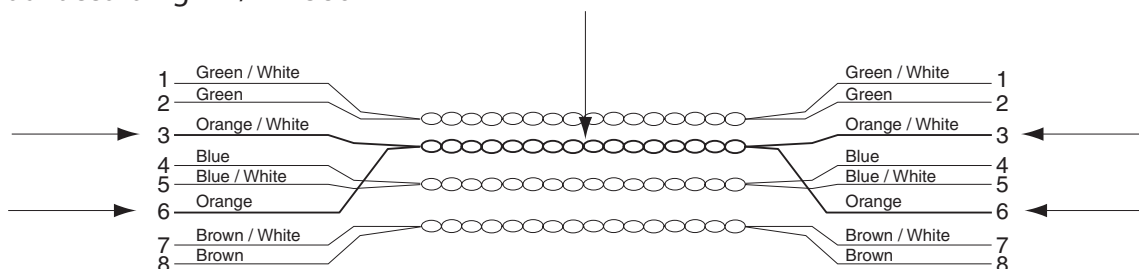


Figure 21

- Strip approx. 11 mm of the outer jacket of the cable. Slide the shield onto the interconnection cable. Align the leads and insert them into the RJ45 connector in the order shown on the figure 22 below.

Colour according EIA/TIA-586A



NOTE!

The colours marked to the figure are only examples. The lead colours of the cable you are using can differ from the colours marked to the figure.

Figure 22

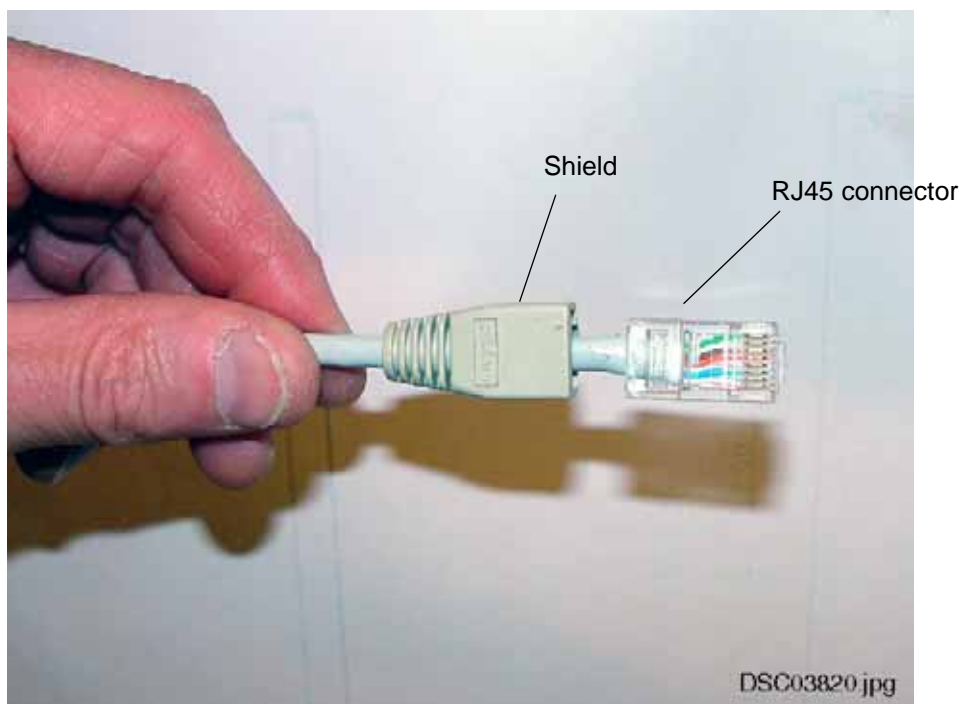


Figure 23

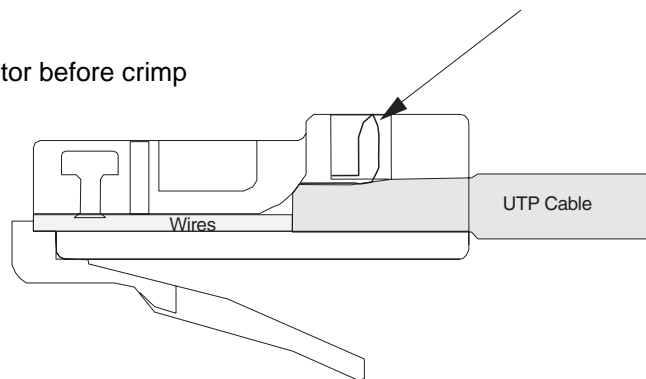
15. Insert the RJ45 connector into the cable crimp tool. Press the handles of the crimp tool as far as they will go. Check with the cable tester that the cable is functioning.



Figure 24

16. Check the RJ45 connector to make sure that the cable is properly attached to the connector.

RJ45 connector before crimp



RJ45 connector after crimp

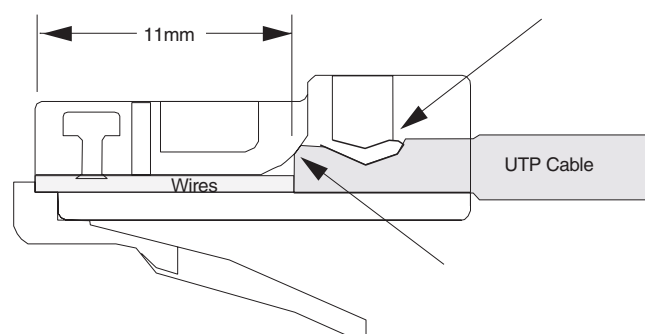


Figure 25

17. Pull the Dixi interconnection cable out from the bracket arm opening. Connect the Dixi interconnection cable to the Dixi control box or push the cable into the bracket arm. Attach the cover plug to the bracket arm opening.

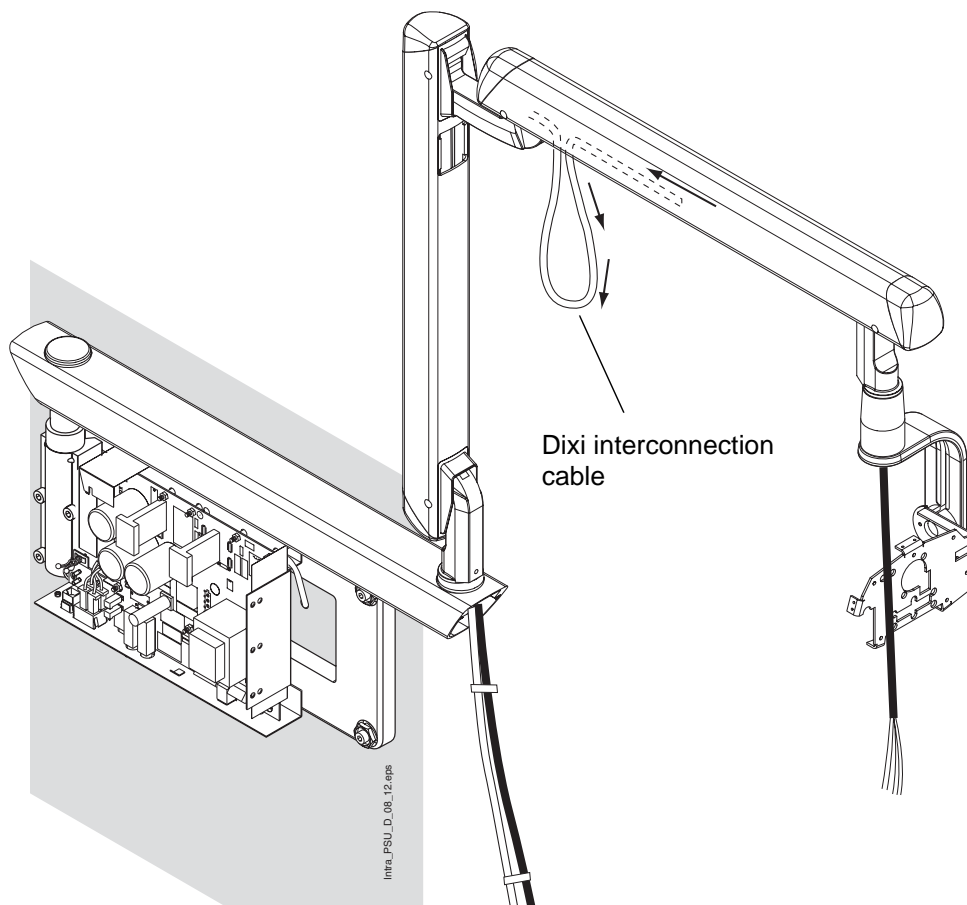


Figure 26

18. Attach the tube head to the support frame with the five M4x8 DIN 7984 screws.
19. Slide the tube head PCB into its position and connect the feedback cable to the tube head PCB terminal P1.
20. Connect the arm cable leads to the connectors as described in figure 27 below.

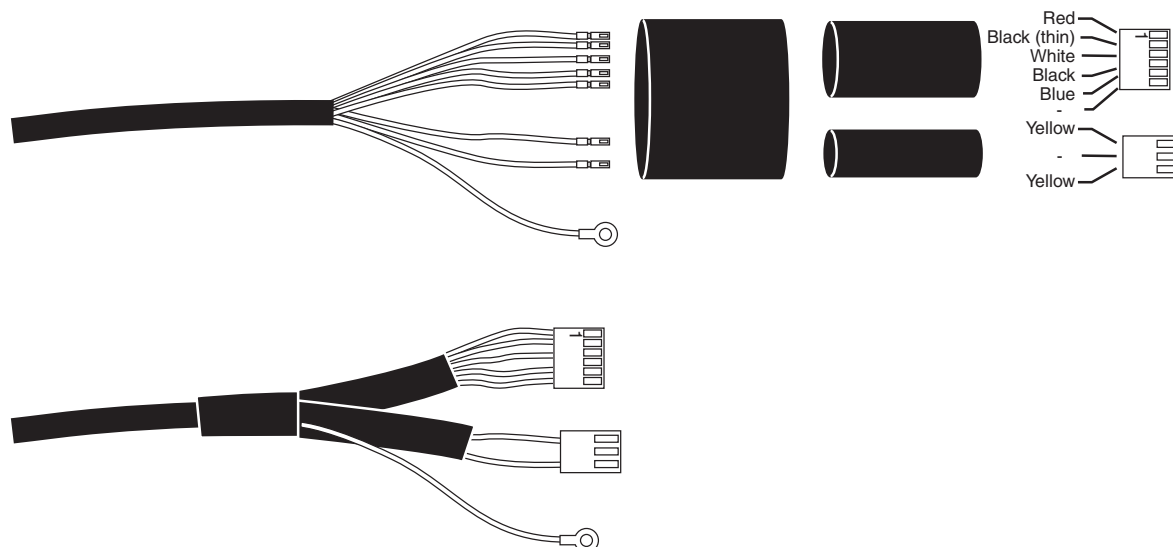


Figure 27

21. Connect the arm cable to the tube head PCB and connect the grounding lead to the grounding point near the support frame opening.

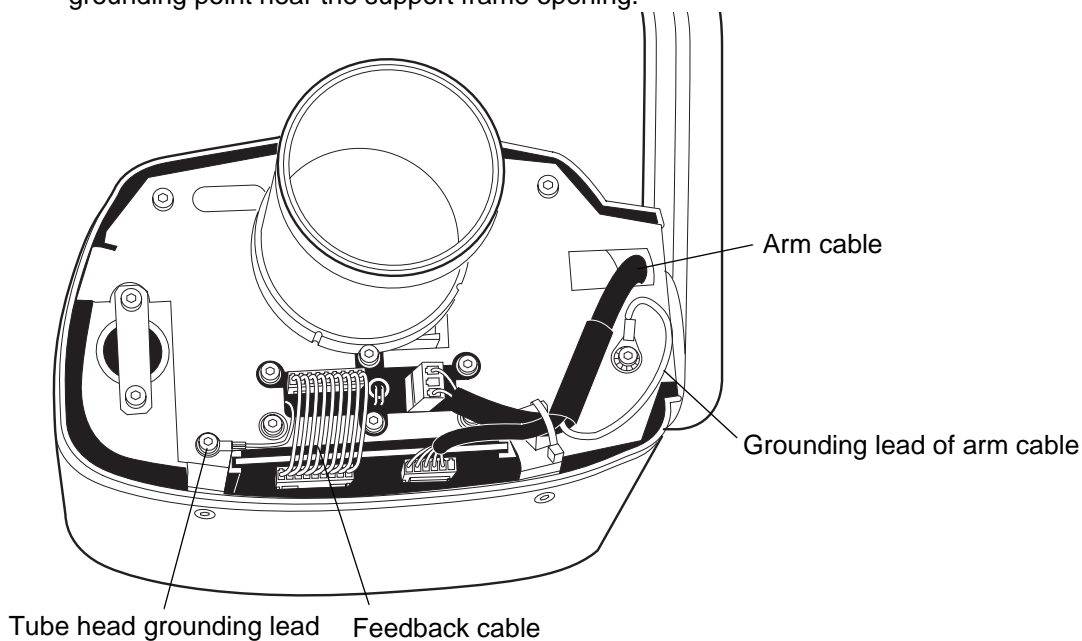


Figure 28

22. Check that the arm cable remains in the groove of the tube head support when moving the arm from one extreme position to another. Secure the arm cable to the support frame with a cable tie.
23. Pull the cables through the extension arm and connect the cables to the generator assembly connectors.
24. Replace the removed covers and plugs.

8.5 Replacing the control panel cable

1. Press the clip of the connector (figure 29, 1) and pull the socket from the terminal of the generator box (figure 29, 2).
2. Detach the connector from the control panel in the same way as from the generator box.
3. Connect the new cable to the generator box and to the control panel.

CAUTION *Do not connect any other equipment to the terminal of the generator box.*

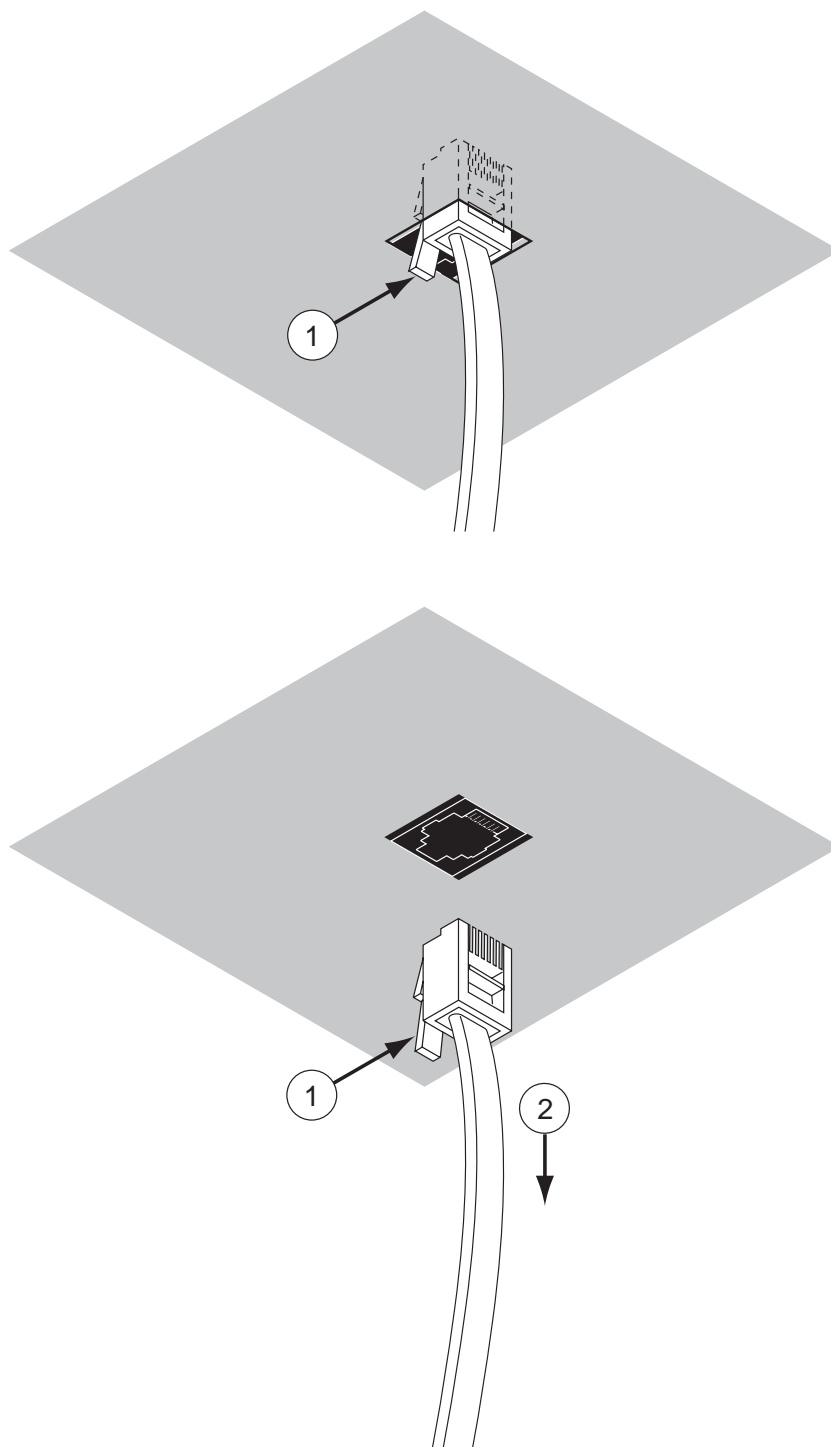
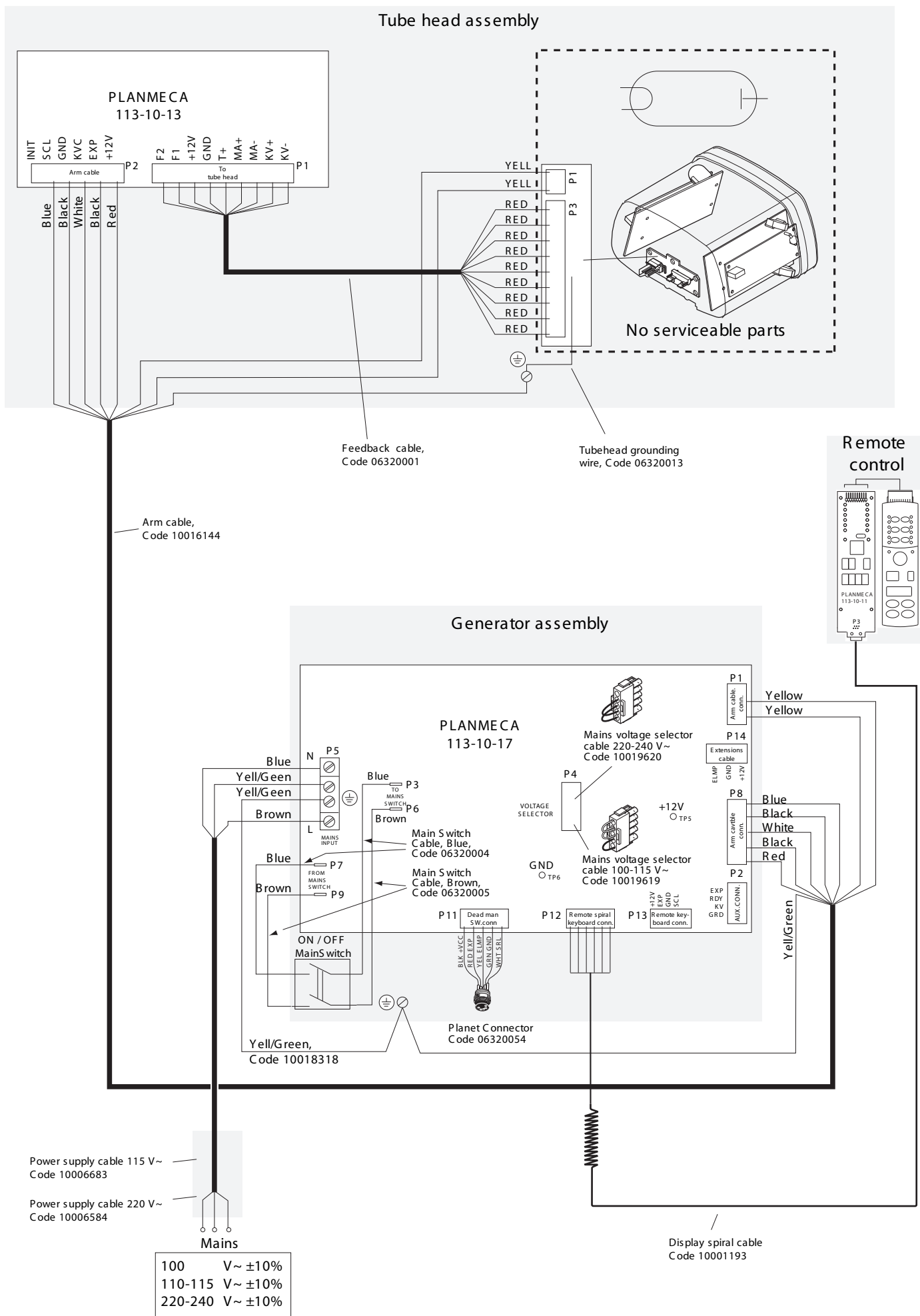


Figure 29

9 DIAGRAMS



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