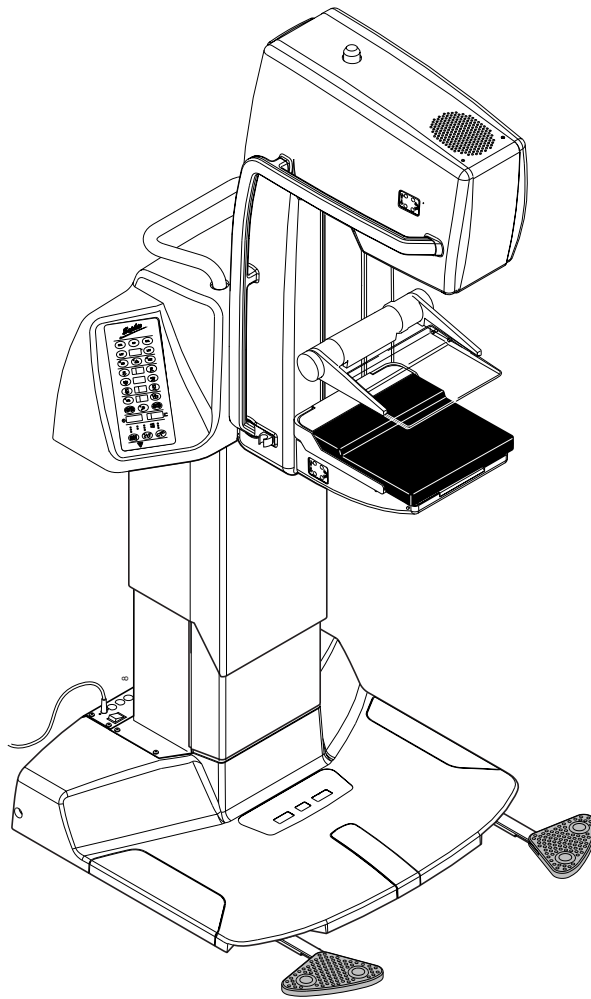


# PLANMED SOPHIE

## MAMMOGRAPHY X-RAY UNIT



## TECHNICAL MANUAL

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**Chapter A GENERAL & TECHNICAL DATA**

<b>1 WARNINGS</b> .....	<b>A-1</b>
<b>2 MANUAL VERSIONS</b> .....	<b>A-2</b>
<b>3 UNIT MODELS</b> .....	<b>A-2</b>
<b>4 SOFTWARE REVISIONS &amp; COMPATIBILITY</b> .....	<b>A-3</b>
<b>5 HOW TO FIND INFORMATION IN THIS MANUAL</b> .....	<b>A-4</b>
<b>6 TECHNICAL SPECIFICATIONS (TOSHIBA E7272 X-RAY TUBE)</b> ....	<b>A-5</b>
<b>7 USER'S STATEMENT FOR PLANMED SOPHIE (TOSHIBA E7272 X-RAY TUBE)</b> .....	<b>A-7</b>
7.1 Definition of measurement criteria .....	A-7
7.2 Toshiba E7272 x-ray tube ratings .....	A-9
7.3 Cooling curves for x-ray tube .....	A-10
<b>8 TECHNICAL SPECIFICATIONS (TOSHIBA E7290 X-RAY TUBE)</b> ...	<b>A-11</b>
<b>9 USER'S STATEMENT FOR PLANMED SOPHIE (TOSHIBA E7290 X-RAY TUBE)</b> .....	<b>A-13</b>
9.1 Toshiba E7290 x-ray tube ratings .....	A-15
9.2 Cooling curves for x-ray tube .....	A-16

**Chapter B UNPACKING & INSTALLATION**

<b>1 PRE-INSTALLATION REQUIREMENTS</b> .....	<b>B-1</b>
1.1 Tools required .....	B-1
1.2 Environmental requirements .....	B-1
1.3 Space requirement .....	B-1
1.4 Radiation protection .....	B-2
1.5 Power requirement .....	B-2
<b>2 UNPACKING THE UNIT</b> .....	<b>B-3</b>
2.1 General about unpacking .....	B-3
2.2 Step-by-step unpacking instructions .....	B-3
2.3 Driving the unit out of the transportation position .....	B-5
2.4 Attaching the unit to the floor .....	B-6
2.5 Unpacking the accessories .....	B-7
<b>3 ATTACHMENT OF ACCESSORIES</b> .....	<b>B-8</b>
3.1 Compression paddles .....	B-8
3.2 Remote control attachment (optional for the mobile unit) .....	B-8
3.3 Mobile Sophie special accessories attachment .....	B-8
3.4 Exposure warning light (option) .....	B-8
3.5 Printer (option) .....	B-8
3.6 ADMARK darkroom film-marking system .....	B-8
<b>4 SETUPS AND CHECKS PRIOR TO USE</b> .....	<b>B-9</b>
<b>5 RE-PACKING &amp; TRANSPORTATION OF THE SOPHIE UNIT</b> .....	<b>B-10</b>
5.1 Driving the unit into the transportation position .....	B-10
5.2 Transporting the unit on its own wheels (non-mobile unit) .....	B-10
<b>6 MOBILE SOPHIE HANDLING &amp; TRANSPORTATION</b> .....	<b>B-11</b>
6.1 Preparing the mobile unit for use after transportation .....	B-11
6.2 Preparing the mobile unit for transportation .....	B-12

**Chapter C KEYBOARD FUNCTIONS & MODES**

<b>1 KEYBOARD OVERVIEW</b> .....	<b>C-1</b>
<b>2 USER MODE FUNCTIONS SHORT-FORM</b> .....	<b>C-2</b>
2.1 Normal user functions .....	C-2
2.2 Special user settings .....	C-2
<b>3 SERVICE MODE FUNCTIONS SHORT-FORM</b> .....	<b>C-4</b>
3.1 How to enter / exit the service mode .....	C-4

3.2	Meaning of displays in the service mode	C-4
3.3	Service mode settings & special displays	C-5
<b>4</b>	<b>SERVICE MODE FUNCTION DETAILS</b>	<b>C-7</b>
4.1	Transport position	C-7
4.2	Display of internal temperatures	C-7
4.3	Displaying the real density value	C-8
4.4	Displaying the exposure counter	C-8
4.5	Displaying the recent 49 error messages	C-8
4.6	Print a list of the recent 49 errors	C-9
4.7	Ignore errors temporarily	C-9
4.8	Diagnostic display of internal signals	C-10

---

**Chapter D HELP AND ERROR MESSAGES**

<b>1</b>	<b>GENERAL ABOUT ERROR DISPLAYS</b>	<b>D-1</b>
1.1	Stop-message	D-1
1.2	Help messages	D-1
1.3	Error messages	D-1
<b>2</b>	<b>HELP MESSAGES SHORTFORM TABLE</b>	<b>D-2</b>
<b>3</b>	<b>ERROR MESSAGES SHORTFORM TABLE</b>	<b>D-4</b>
<b>4</b>	<b>DETAILED ERROR MESSAGE EXPLANATIONS</b>	<b>D-8</b>
4.1	ERRORS 00-09 (User related, not stored in internal error list)	D-8
4.2	ERRORS 10-16 (X-ray safety and AEC-sensor related)	D-9
4.3	ERRORS 20-29 (motion and compression related)	D-10
4.4	ERRORS 30-38 (tube head and power supply related)	D-12
4.5	ERRORS 40-49 (sensor & switch related)	D-13
4.6	ERRORS 50-59 (temperature & special sensor related)	D-15
4.7	ERRORS 60-68 (serial communication & CPU voltage related)	D-16
4.8	ERRORS 71-78 (CPU software related)	D-16
4.9	ERRORS 80-87 (CPU hardware related)	D-17
4.10	ERRORS 90-97 (Erroneous sensor signals)	D-18

---

**Chapter E PREVENTIVE MAINTENANCE**

<b>1</b>	<b>SYSTEM MAINTENANCE</b>	<b>E-1</b>
1.1	Cleaning	E-1
1.2	Operator's maintenance schedule	E-1
<b>2</b>	<b>PREVENTIVE MAINTENANCE CHECKS</b>	<b>E-2</b>
2.1	Preventive maintenance schedule	E-2
2.2	Calibration and verification of the instruments	E-2
2.3	Determining half value layer (HVL / beam quality)	E-3
2.4	Checking X-ray tube efficiency (radiation output)	E-4
2.5	Focal spot size measurement	E-4
2.6	Image quality evaluation	E-5
2.7	Verifying AEC-system control limits	E-5
<b>3</b>	<b>OTHER PREVENTIVE CHECKS</b>	<b>E-6</b>
3.1	Verifying compression force measurement	E-6
3.2	Verifying filament pre-heating voltages	E-6
3.3	Verifying the anode voltage (kV)	E-6
3.4	Verifying the tube current (mA) and the exposure time (Toshiba E7272 x-ray tube)	E-8
3.5	Verifying the tube current (mA) and the exposure time (Toshiba E7290 x-ray tube)	E-9
3.6	Verifying x-ray beam alignment	E-10
3.7	Verifying light-field beam illumination	E-10
3.8	Verifying visually defined x-ray fields	E-11
3.9	Verifying electrical safety	E-11

---

**Chapter F ADJUSTMENT & CALIBRATION**

<b>1</b>	<b>SPECIAL REGIONAL &amp; INITIAL SETUPS</b>	<b>F-1</b>
1.1	Regional setups before using the unit	F-1
1.2	Other setups before using the unit	F-1

<b>2</b>	<b>KEYBOARD-CONTROLLED (in normal mode)</b>	<b>F-3</b>
2.1	Automatic kV mode	F-3
2.2	Automatic rhodium/molybdenum filter selection mode	F-3
2.3	Default magnification factor	F-4
2.4	Automatic release of compression after exposure	F-4
2.5	Initial descent speed	F-4
2.6	Compression speed decrease rate	F-5
2.7	Intermediate compression stopping force	F-5
2.8	Twincomp compression on/off	F-5
2.9	Lift motor crawling speed	F-5
2.10	Setting correct time and date	F-6
2.11	Density offset adjustment	F-6
2.12	AAEC contrast adjustment	F-6
2.13	Automatic film labeling (on/off)	F-6
2.14	Disabling bucky grid movement	F-7
2.15	Alarm sound frequency (loudness)	F-7
2.16	Dimming the displays	F-7
2.17	mA limit (on/off)	F-7
<b>3</b>	<b>KEYBOARD-CONTROLLED (in service mode)</b>	<b>F-8</b>
3.1	How to enter the service mode	F-8
3.2	Factory preset (recalling settings for all parameters)	F-9
3.3	C-arm upright position calibration	F-12
3.4	Breast thickness measurement calibration	F-12
3.5	Compression force measurement calibration	F-13
3.6	X-ray tube filament preheating voltage calibration	F-14
3.7	AEC-sensor calibration	F-15
3.8	kV-value fine-adjustment	F-16
3.9	Special system parameters setup	F-17
<b>4</b>	<b>FINE TUNING SOPHIE AEC FOR NONSTANDARD FILM/SCREEN COMBINATIONS</b>	<b>F-24</b>
4.1	Background	F-24
4.2	Testing the AEC for proper tracking	F-24
4.3	Adjusting the thickness, tube potential and time compensations	F-24
4.4	Adjusting the filter and imaging mode adjustments	F-26
<b>5</b>	<b>MECHANICAL ADJUSTMENTS</b>	<b>F-28</b>
5.1	MAG/LOAD mechanism positional calibration	F-28
5.2	UP/DOWN mechanism positional calibration	F-28
5.3	X-ray beam adjustment (Toshiba E7272 X-ray tube)	F-29
5.4	X-ray beam adjustment (Toshiba E7290 X-ray tube)	F-35
5.5	Light field beam adjustment	F-42
5.6	Filter position adjustment	F-43
5.7	Twincomp paddle damper adjustment	F-43
5.8	Gas spring tension adjustment	F-43
<b>6</b>	<b>ADJUSTING SENSORS &amp; SWITCHES</b>	<b>F-44</b>
6.1	Collimator mechanism limit sensors	F-44
6.2	Compression mechanism limit sensors	F-49
6.3	MAG/LOAD mechanism limit sensors	F-52
6.4	Labeling head disk position sensor	F-54
6.5	C-arm rotation sensor	F-54
6.6	UP/DOWN mechanism sensors	F-58
6.7	Cassette table size identification switches	F-61
6.8	Lower paddle identification switches	F-64

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## Chapter G TROUBLESHOOTING & FAULTFINDING

<b>1</b>	<b>DISPLAYING INTERNAL SENSOR SIGNALS</b>	<b>G-1</b>
<b>2</b>	<b>ELECTRICAL PROBLEMS</b>	<b>G-1</b>
2.1	Unit completely dead	G-1
<b>3</b>	<b>MOTOR &amp; MOTION RELATED PROBLEMS</b>	<b>G-2</b>
3.1	DC motors	G-2
3.2	Stepper motors	G-3

<b>4 MECHANICAL PROBLEMS</b> .....	<b>G-6</b>
4.1 Paddle holder related .....	G-6
<b>5 BEFORE CALLING FOR ASSISTANCE</b> .....	<b>G-8</b>
5.1 General required information .....	G-8
5.2 How to report image quality problems .....	G-8
5.3 How to contact Planned head office .....	G-8

---

## Chapter H PARTS REPLACEMENT & REPAIR

<b>1 REMOVING &amp; REPLACING COVERS</b> .....	<b>H-1</b>
1.1 Base covers .....	H-2
1.2 Telescopic column covers .....	H-2
1.3 Stationary column covers .....	H-3
1.4 C-arm covers .....	H-4
1.5 Hood .....	H-6
1.6 Cassette table cover .....	H-7
1.7 Collimator cover .....	H-7
<b>2 SOFTWARE VERSION UPDATING</b> .....	<b>H-8</b>
2.1 Replacing software chips .....	H-8
<b>3 REPLACING FUSES</b> .....	<b>H-10</b>
3.1 Mains fuses .....	H-10
3.2 Power supply fuses .....	H-10
<b>4 LIGHTFIELD BULB REPLACEMENT</b> .....	<b>H-12</b>
<b>5 REPLACING THE X-RAY TUBEHEAD</b> .....	<b>H-13</b>
5.1 Preparations before changing the tubehead .....	H-14
5.2 Removal of the tubehead .....	H-17
<b>6 REPLACING THE POWER SUPPLY</b> .....	<b>H-18</b>
<b>7 REPLACING CIRCUIT BOARDS</b> .....	<b>H-19</b>
7.1 Location of PC-boards .....	H-19
7.2 Boards in the base & column .....	H-20
7.3 C-arm pc-boards .....	H-20
7.4 Tubehead assembly boards .....	H-22
7.5 Keyboards & displays .....	H-22
<b>8 REPLACING SENSORS &amp; SWITCHES</b> .....	<b>H-23</b>
8.1 Placement of sensors & switches .....	H-23
8.2 Limit sensors .....	H-24
8.3 Lift motor rotation sensor replacement .....	H-24
8.4 C-arm motor rotation sensor replacement .....	H-25
8.5 MAG-motor rotation sensor replacement .....	H-25
<b>9 MOTOR REPLACEMENT</b> .....	<b>H-26</b>
9.1 Lift motor replacement .....	H-26
9.2 C-arm rotation motor replacement .....	H-28
9.3 Compression motor replacement .....	H-34
9.4 Magnification motor replacement .....	H-35
<b>10 REPLACING THE LABELING HEAD</b> .....	<b>H-37</b>
<b>11 GAS SPRING REPLACEMENT</b> .....	<b>H-38</b>
11.1 C-arm is functional .....	H-38
11.2 C-arm is not rotating .....	H-38
11.3 Replacing the gas-spring .....	H-38
<b>12 REPLACING PARTS IN COMPRESSION MECHANISM</b> .....	<b>H-39</b>
12.1 Replacing the twin-comp damper .....	H-39

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## Chapter I SCHEMATICS & DIAGRAMS

# GENERAL & TECHNICAL DATA

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## 1 WARNINGS

**WARNING**

**THE FOLLOWING WARNINGS, CAUTIONS AND NOTES MUST ALWAYS BE CONSIDERED WHILE SERVICING, 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 rules for radiation safety.*

*Never touch or scratch the surface of the x-ray tube radiation window. The window is made of beryllium that can be harmful if inhaled or swallowed.*

*Never attempt to open the TUBE-HEAD. It does not contain any serviceable parts and this would make it inoperable and void the warranty.*

*Never make any exposures without the Mo/Al filter in the beam, or without the beam limiting device (collimator) in place. Otherwise the radiation safety cannot be guaranteed.*

**CAUTION****ELECTRICAL SAFETY RULES**

*The unit contains hazardous voltages. While servicing internal parts, always disconnect the unit from the mains (if possible) by removing the plug from the wall outlet, 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 requires careful handling and storage.*

**CAUTION****GENERAL SAFETY RULES**

*The unit must be serviced only by qualified personnel, trained by PLANMED 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 jeopardize the function of the unit, if not followed as stated.*

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## 2 MANUAL VERSIONS

PLANMED pursues a policy of continuous product development. Although every effort is made to produce up-to-date product documentation this manual should not be regarded as an infallible guide to current production specifications. Planmed reserves the right to make changes to specifications without prior notice. **This manual is valid for all versions of the Sophie Mammography X-ray units with SID 650mm. In case you have the unit with SID 600mm, you need a technical manual revision 9.**

**NOTE**

**THIS TECHNICAL MANUAL IS VALID FOR SOFTWARE REVISIONS: TUBE CPU 2.41 (OR LATER) AND REAR CPU 4.41 (OR LATER).**

***If you find that your SOPHIE doesn't have some keyboard functions, or its keyboard functions differs from procedures described in this manual, then either the software must be replaced with at least the above mentioned revision, or you have to relate to an older version of this manual. The former procedure is recommended.***

---

## 3 UNIT MODELS

All Sophie Mammography X-ray unit models are electrically and mechanically identical, except for some minor details. This manual is valid for all versions since the differences are small.

The darkroom versus daylight differs only in the size and dimensions of the cassette table and film marking device.

The mobile versus the stationary units differs only in the base wheel system and the X-ray tube locking system (for transportation).

Daylight units can be converted to darkroom units (and vice versa), please contact PLANMED for details.



## 4 SOFTWARE REVISIONS & COMPATIBILITY

### Background

Since this unit is fully microprocessor controlled, its operation is controlled by the currently installed software. PLANMED reserves the right to improve functionality or to add new features to the product by modifying the software and/or hardware. Manuals are updated accordingly and technical bulletins published in order to inform about these changes or additions.

### Hardware compatibility

As a general rule; new software releases are compatible with all existing hardware. New software releases (or possible upgrading kits containing new software) are normally directly compatible with existing hardware, but not necessarily without some re-calibration procedures.

### Software numbering & compatibility

Since the unit contains two communicating microprocessors, these must be able to “understand” each other.

Incompatible software versions should never be used together, the unit would either be totally non-functional, produce continuous error codes, or some important features or functions could be missing. However, no damage or safety hazard would result if two non-compatible software chips are accidentally used together.

The following table contains information about compatible software versions. Use versions together only as listed in this table.

**Table 1: SOFTWARE COMPATIBILITY LIST**

REAR CPU	TUBE CPU	REAR CPU	TUBE CPU
1.20 - 1.28	1.20 - 1.28	1.80	1.80, 2.00
1.59	1.59	1.81	1.81, 2.01
1.60	1.60	4.00	2.01
1.63	1.63	4.01/2.01	2.04
1.64	1.64	4.02/2.02	2.04
1.65	1.64	4.06/2.06	2.04
1.66	1.64	4.20	2.20
1.67	1.64	4.21	2.22
1.68	1.64	4.22	2.23
1.69	1.69	4.23	2.25
1.70	1.69	4.30	2.31
1.71	1.69	4.40	2.40
1.72	1.69	4.41	2.41
1.73	1.69		
1.74	1.69		
1.75	1.69, 1.70		
1.76	1.75, 1.76		
1.77	1.77, 1.78, 1.79		

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## 5 HOW TO FIND INFORMATION IN THIS MANUAL

For normal operating instructions, please refer to the "SOPHIE USER'S MANUAL". However, this manual contains also full explanations of all user accessible adjustments that can be done with the keyboards.

For navigation, please refer to the **table of contents** in the beginning of this manual. The following is a brief description of the chapters in this manual.

### **"GENERAL & TECHNICAL DATA" on page A-1 (this chapter)**

This chapter contains general information as well detailed technical specifications of the unit. Here you can find answers to all questions related to the unit specifications. Full technical specification details can be found here.

### **"UNPACKING & INSTALLATION" on page B-1**

This chapter contains complete instructions how to unpack and install the unit, with information about installation requirements. Also information about transportation and handling is included.

### **"KEYBOARD FUNCTIONS & MODES" on page C-1**

This chapter contains a complete short-form presentation of all available special keyboard functions. For explanation of normal user operation. Please refer to the "SOPHIE USER'S MANUAL". The special display modes are also described here.

The detailed descriptions of all adjustments performed with the help of the keyboards can be found in the chapter "ADJUSTMENT & CALIBRATION" on page F-1.

### **"HELP AND ERROR MESSAGES" on page D-1**

This chapter contains general information as well as a complete short-form presentation of all available special messages (STOP, HELP, ERROR) that can appear on the displays. A detailed description of the error messages and their reasons is also included.

### **"PREVENTIVE MAINTENANCE" on page E-1**

This chapter describes the operators maintenance. Complete step-by-step instructions how to check the performance of the unit are also included. Some of these checks must be performed annually and before using the unit.

### **"ADJUSTMENT & CALIBRATION" on page F-1**

This chapter contains detailed instructions of how to perform keyboard-controlled adjustments and calibrations, mechanical adjustments and sensor & switch adjustments.

### **"GENERAL & TECHNICAL DATA" on page A-1**

For help and guidance with general troubleshooting and faultfinding, please refer to this chapter. It contains information of how to proceed in possible problematic situations.

### **"PARTS REPLACEMENT & REPAIR" on page H-1**

This chapter contains detailed instructions how to replace both mechanical and electrical parts. It also reminds of what possible calibrations or adjustments must be performed after replacing particular parts.

### **"SCHEMATICS & DIAGRAMS" on page I-1**

This chapter contains electrical wiring diagrams and schematics.

## 6 TECHNICAL SPECIFICATIONS (TOSHIBA E7272 X-RAY TUBE)

### ORIGINAL MANUFACTURER

PLANMED Oy, Asentajankatu 6, 00810 Helsinki, FINLAND  
phone: +358-9-7590 5300, fax: +358-9-7590 5555

### MODEL AND APPROVALS

MODELS: PLANMED SOPHIE, PLANMED SOPHIE MOBILE  
APPROVALS: IEC safety class: I, IEC degree of protection: B, IEC enclosure class: IP20  
Complies with IEC 601-1 safety and IEC 601-2-7 radiation regulations

### X-RAY TUBE ASSEMBLY

X-ray tube	Toshiba E7272
Anode type	rotating anode (3000 rpm at 50 Hz)
Anode braking	Automatic, electrical
Anode thermal capacity	300 000 HU
Anode target material	Molybdenum
Anode target angle	16 degrees
Tube port material	Beryllium
Focal spot sizes	0.3mm / 0.1 x 0.07 mm
Filtration	30µm Mo and 0.5mm Al or 30µm Mo and 25µm Rh

### GENERATOR ASSEMBLY (for both tube types if not otherwise specified)

Generator	constant potential, high frequency
Anode voltage range	20 - 35kV ± 2kV, virtually DC
Anode current range/0.3mm focus	70 - 110mA (70 - 120 mA @ 60Hz) ± 5mA
Anode current range/0.1mm focus	10 - 22mA (12 - 22 mA @ 60Hz) ± 1mA
mAs range/0.3mm focus	10 - 500mAs (optional 600mAs in GB) ± 4mAs or ±10% (whichever is larger)
mAs range/ 0.1mm focus	10 - 200 mAs
Exposure time /0.3mm focus	0.1 - 5 seconds (optional 6 seconds) ±5%
Exposure time / 0.1mm focus	0.1 - 9.9 seconds ±5%
Cooling	automatically controlled (internal fan)
Line voltage	208 - 240V~, 50 or 60Hz - single phase
Line voltage compensation	automatic ±10%
Line voltage regulation	±10% (absolute minimum/maximum 187V~/265V~)
Fuses	2 x 15AT / 250V
Total power consumption	max. 100VA idle, 4000VA max. for 5 seconds
Power factor	> 0.95
Mode of operation	intermittent
Maximum mains resistance	Ω 1 ¾
Maximum continuous heat dissipation	< 250W

### BUCKY GRID SPECIFICATION

Grid manufacturer	Gilardoni
Grid type	GRIDGIL HT; Fiber interspaced vertical
Grid movement	Variable amplitude oscillation
Grid ratio	r5
Grid lines per cm	N36
Focusing distance	f <sub>0</sub> 65
Application limits	<b>18x24:</b> f <sub>1</sub> 50 f <sub>2</sub> 91 <b>24x30:</b> f <sub>1</sub> 53 f <sub>2</sub> 82
Material of absorbing strips	Pb
Contrast improvement ratio	K1.47
Selectivity	Σ6.04
Grid exposure factor	B1.69
Transmission of primary radiation	T <sub>p</sub> 0.75
Max. deviation between the central line indication and the true central line	Δ2

**AUTOMATIC EXPOSURE CONTROL (AEC)**

Sensors	three selectable large area solid-state sensors
Density adjustment	15 density steps (13% change in OD per step) plus fine adjustment $\pm 5$ steps (0,05 OD per step)
Function modes	Normal AEC, Advanced AEC (AAEC)

**C-ARM**

Rotation	motorized, range $-135^{\circ}$ to $+180^{\circ}$
Vertical movement	motorized, range 795mm to 1350mm (31.3in to 53.1in)
SID	650mm
Compression	fully motorized, variable speed, variable angle (twincomp)
Cassette sizes	18 x 24cm and 24 x 30cm
Magnification	motorized, variable range from 1.3 to 1.8

**MECHANICAL DATA**

Dimensions	(H x D x W) 1000 x 900 x 755 (mm) minimum (36.6 x 35.0 x 29.7 inch minimum)
Weight	160kg (352lbs), unpacked
Color	RAL 9016

## 7 USER'S STATEMENT FOR PLANMED SOPHIE (TOSHIBA E7272 X-RAY TUBE)

### Radiation leakage technique factors

The maximum-rated peak tube potential is **35 kVp** and the maximum rated continuous tube current is **3.5mA** for the maximum-rated peak tube voltage.

### Minimum filtration

The Beam-limiting device contains three different filtrations **30µm molybdenum**, **25µm rhodium** and **0.50mm aluminum**. The measured half-value layers are **0.343mmAl**, **0.373mmAl** and **0.377mmAl** at 30kVp. These measured values correspond to aluminum equivalents of **0.55 - 0.65mmAl**.

### Rate line voltage

**208 - 240V~ ±10%**. Line voltage regulation 10%.

### Maximum line current

Maximum **22 Amperes** at absolute minimum stated mains voltage (187V~)

### Technique factors that constitute the maximum line current condition

27kV / 110mA

### Generator rating and duty cycle

**3kW**. The duty cycle and wait period can be calculated using the following formulas:

- Wait period =  $T_w = kV * mA * exp. Time / 500W$
- Duty Cycle =  $1 / (1 + kV * mA / 500W)$

### Maximum deviation of peak tube potential from indicated value

±2kV

### Maximum deviation of tube current from indicated value

±5mA large focal spot, ±1mA small focal spot

### Maximum deviation of exposure time tube current product from indicated value

±4mAs or ±10%, whichever is larger

### Maximum deviation of exposure time from indicated value

±5%

## 7.1 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 measured high voltage mean value measured with a calibrated non-invasive kVp meter.

### Tube current

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

### mAs product

Is defined as the product of the exposure time and the tube current measurements.

### The nominal x-ray voltage together with the highest x-ray tube current obtainable from the high-voltage generator when operated at its nominal x-ray tube voltage

35kV 80mA / 60Hz - large focal spot, 35kV 70mA / 50Hz - large focal spot  
35kV 16mA / 60Hz - small focal spot, 35kV 14mA / 50Hz - small focal spot

**The highest x-ray tube current together with the highest x-ray tube voltage obtainable from the high-voltage generator when operated at its highest x-ray tube current**

120mA 24kV / 60Hz - large focal spot, 110mA 24kV / 50Hz - large focal spot  
22mA 26kV / 60Hz - small focal spot, 22mA 24kV / 50Hz - small focal spot

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

27kV 110mA / 60Hz - large focal spot, 34kV 80mA / 50Hz - large focal spot  
26kV 22mA / 60Hz - small focal spot, 24kV 22mA / 50Hz - small focal spot

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

35kV 80mA / 60Hz - 2800W large focal spot, 35kV 70mA / 50Hz - 2450W large focal spot  
35kV 16mA / 60Hz - 560W small focal spot, 35kV 14mA / 50Hz - 490W small focal spot

**Reference current time product**

large focal spot: for all kV values	40mA / 0.1s / 4mAs
small focal spot: for all kV values	10mA / 0.1s / 1mAs

**The lowest current time product within the specified range of compliance**

large focal spot:	30mA / 0.1s / 3mAs
small focal spot:	10mA / 0.1s / 1mAs

**The nominal shortest irradiation time in the AEC-mode**

20ms

## 7.2 Toshiba E7272 x-ray tube ratings

### Manual exposures

With manual exposures the tube kV, mAs and focal spot can be selected by the user. The mA value is automatically determined by the selected kV value, and the exposure time is determined by the selected mAs value. The mA value used is always the highest possible value, that depends on the kV value, focal spot, exposure time and line frequency (see following table on the next page). The maximum exposure time is 6.0 sec. for the large focal spot, and 9.9 sec. for the small focal spot. The minimum mAs value is 10 mAs and it can be increased in approx. 20% steps to the maximum (see values below). The maximum mAs value for the large focal spot is either 300, 500, 550 or 600 mAs, depending on the value of the service mode parameter 6. The maximum mAs value for the small focal spot is 200 mAs.

The possible mAs values are: 10, 12, 14, 16, 18, 20, 25, 30, 35, 40, 50, 60, 70, 85, 100, 120, 140, 160, 180, 200, 225, 260, 300, 350, 400, 450, 500, 550, 600.

### Automatic exposures

Automatic exposures are terminated when the radiation detector indicates that the required dose has been reached. In this mode the kV is selected by the operator and mA is chosen to be the maximum allowed mA for the selected kV and Hz (line frequency).

If the exposure time is longer than 1 sec (5 sec for the small focal spot) then a falling load technique is used. The exposure is started at the mA as specified in the following tables. The accumulated dose is checked at 0.45 sec (2.45 sec for the small focal spot) and if it has reached more than half of the required dose, the exposure can be continued at the same mA level, and will be terminated within 1 second (5 seconds for the small focal spot) - well before the tube is overloaded.

If the accumulated dose is detected to be less than half of the required, a longer exposure time than the one specified for the tube current can be expected. Therefore the tube current is reduced at this time (after 0.45 or 2.45 sec exposure) to a lower mA that, when added to the already produced tube loading, will not exceed the maximum tube rating. The falling load current levels are listed in the two following tables.

### Thermal ratings

Two separate methods are used to protect the tube from overload. One is measuring the tube head enclosure temperature and if it exceeds 60 °C no further exposures are allowed until it falls below 60 °C.

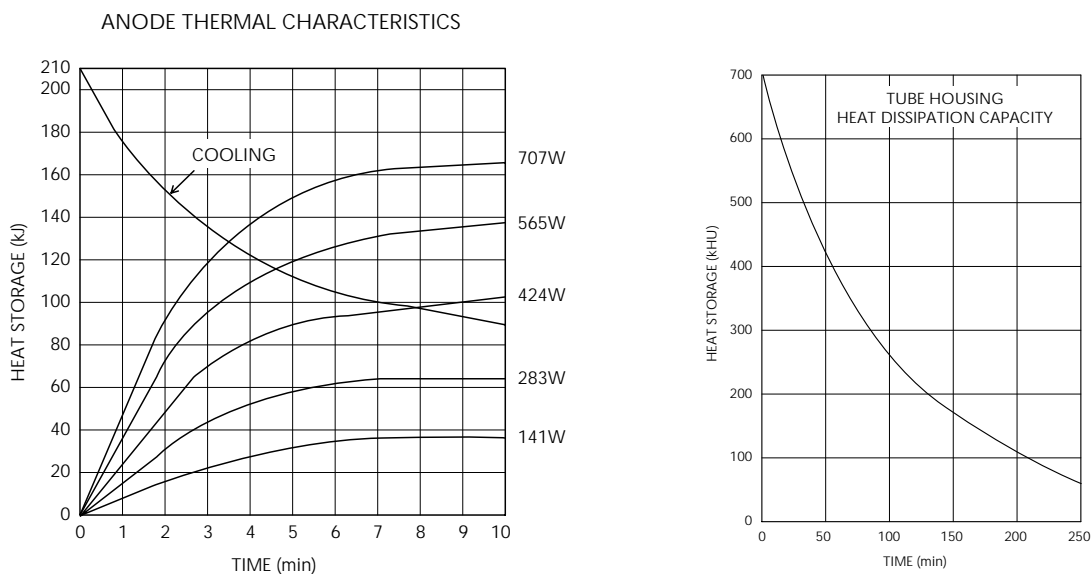
The other method keeps the average input power into the tube below or equal to 500W. The exposure parameters are limited as indicated by the following tables, but this feature forces a waiting time between the exposures to ensure that the average power into the tube never can exceed this limit. For example if an exposure of 24 kV, 100 mA, 1 sec is performed a wait period of 5 seconds is calculated and no further exposures are allowed until this time has elapsed.

There is no way to bypass these safety feature under any circumstances, and it is thus virtually impossible to overload the X-ray tube.

Table 2: Maximum mA for Tube E7272 vs. different modes and line frequencies

kV	MANUAL EXPOSURE MODE										AUTOMATIC (AEC) EXPOSURE MODE										
	Large focal spot (0.3 mm)						Small focal spot (0.1 mm)				Large focal spot (0.3 mm)					Small focal spot (0.1 mm)					
	0 - 1 sec		1 - 5 sec		1 - 6 sec		0 - 5 sec		> 5 sec		0 - 1 sec		0.45 - 5 sec		0.45 - 6 sec		0 - 5 sec		2.45 - 10 sec		
	50 Hz	60 Hz	50 Hz	60 Hz	50 Hz	60 Hz	50 Hz	60 Hz	50 Hz	60 Hz	50 Hz	60 Hz	50 Hz	60 Hz	50 Hz	60 Hz	50 Hz	60 Hz	50 Hz	60 Hz	
20	70	70	70	70	80	80	20	20	20	20	70	70	70	70	80	85	20	20	18	20	
21	80	80	80	80	90	90	20	20	18	20	80	80	80	80	90	95	20	20	18	18	
22	90	90	90	90	100	100	22	22	18	18	90	90	90	90	100	105	22	22	16	18	
23	100	100	100	100	100	100	22	22	18	18	100	100	98	100	98	108	22	22	16	18	
24	110	110	100	100	90	90	22	22	16	18	110	110	98	108	93	103	22	22	16	17	
25	100	110	90	100	90	90	20	22	16	16	100	110	95	97	90	92	20	22	14	15	
26	100	110	90	90	90	90	20	22	16	16	100	110	91	98	89	96	20	22	14	15	
27	100	110	80	90	80	80	18	20	14	16	100	110	87	87	83	83	18	20	14	14	
28	90	100	80	90	80	80	18	20	14	14	90	100	85	88	79	82	18	20	12	14	
29	90	100	80	80	80	80	18	20	14	14	90	100	82	88	78	84	18	20	12	13	
30	90	90	80	80	70	70	16	18	12	14	90	90	80	77	79	72	16	18	13	13	
31	80	90	70	80	70	70	16	18	12	14	80	90	77	78	73	72	16	18	10	12	
32	80	90	70	80	70	70	16	18	12	12	80	90	75	78	69	72	16	18	10	11	
33	80	90	70	70	60	60	16	16	12	12	80	90	72	78	67	73	16	16	10	11	
34	80	80	70	70	60	60	14	16	12	12	80	80	70	68	65	65	14	16	11	10	
35	70	80	60	70	60	60	14	16	10	12	70	80	67	68	64	65	14	16	11	10	

### 7.3 Cooling curves for x-ray tube





## 8 TECHNICAL SPECIFICATIONS (TOSHIBA E7290 X-RAY TUBE)

### ORIGINAL MANUFACTURER

PLANMED Oy, Asentajankatu 6, 00810 Helsinki, FINLAND  
phone: +358-9-7590 5300, fax: +358-9-7590 5555

### MODEL AND APPROVALS

MODELS: PLANMED SOPHIE, PLANMED SOPHIE MOBILE  
APPROVALS: IEC safety class: I, IEC degree of protection: B, IEC enclosure class: IP20  
Complies with IEC 601-1 safety and IEC 601-2-7 radiation regulations

### X-RAY TUBE ASSEMBLY

X-ray tube	Toshiba E7290
Anode type	rotating anode (9700 rpm at 180 Hz)
Anode braking	Automatic, electrical
Anode thermal capacity	300 000 HU
Anode target material	Molybdenum
Anode target angle	16 degrees (large focal spot) / 10 degrees (small focal spot)
Tube port material	Beryllium
Focal spot sizes	0.3mm / 0.1 mm
Filtration	30µm Mo and 0.5mm Al or 30µm Mo and 25µm Rh

### GENERATOR ASSEMBLY

Generator	constant potential, high frequency
Anode voltage range	20 - 35kV $\pm$ 2kV, virtually DC
Anode current range/0.3mm focus	80 - 110mA $\pm$ 5mA
Anode current range/0.1mm focus	21 - 35mA $\pm$ 1mA
mAs range/0.3mm focus	10 - 500mAs (optional 600mAs in GB) $\pm$ 4mAs or $\pm$ 10% (whichever is larger)
mAs range/ 0.1mm focus	10 - 310 mAs
Exposure time /0.3mm focus	0.1 - 5 seconds (optional 6 seconds) $\pm$ 5%
Exposure time / 0.1mm focus	0.1 - 9.9 seconds $\pm$ 5%
Cooling	automatically controlled (internal fan)
Line voltage	208 - 240V~, 50 or 60Hz - single phase
Line voltage compensation	automatic $\pm$ 10%
Line voltage regulation	$\pm$ 10% (absolute minimum/maximum 187V~/265V~)
Fuses	2 x 15AT / 250V
Total power consumption	max. 100VA idle, 4000VA max. for 5 seconds
Power factor	> 0.95
Mode of operation	intermittent
Maximum mains resistance	$\leq$ 1 $\Omega$
Maximum continuous heat dissipation	< 250W

### BUCKY GRID SPECIFICATION

Grid manufacturer	Gilardoni
Grid type	GRIDGIL HT; Fiber interspaced vertical
Grid movement	Variable amplitude oscillation
Grid ratio	r5
Grid lines per cm	N36
Focusing distance	f <sub>0</sub> 65
Application limits	<b>18x24:</b> f <sub>1</sub> 50 f <sub>2</sub> 91 <b>24x30:</b> f <sub>1</sub> 53 f <sub>2</sub> 82
Material of absorbing strips	Pb
Contrast improvement ratio	K1.47
Selectivity	$\Sigma$ 6.04
Grid exposure factor	B1.69
Transmission of primary radiation	T <sub>p</sub> 0.75
Max. deviation between the central line indication and the true central line	$\Delta$ 2

**AUTOMATIC EXPOSURE CONTROL (AEC)**

Sensors	three selectable large area solid-state sensors
Density adjustment	15 density steps (13% change in OD per step) plus fine adjustment $\pm 5$ steps (0,05 OD per step)
Function modes	Normal AEC, Advanced AEC (AAEC)

**C-ARM**

Rotation	motorized, range $-135^{\circ}$ to $+180^{\circ}$
Vertical movement	motorized, range 795mm to 1350mm (31.3in to 53.1in)
SID	650mm
Compression	fully motorized, variable speed, variable angle (twincomp)
Cassette sizes	18 x 24cm and 24 x 30cm
Magnification	motorized, variable range from 1.3 to 1.8

**MECHANICAL DATA**

Dimensions	(H x D x W) 1000 x 900 x 755 (mm) minimum (36.6 x 35.0 x 29.7 inch minimum)
Weight	160kg (352lbs), unpacked
Color	RAL 9016

## 9 USER'S STATEMENT FOR PLANMED SOPHIE (TOSHIBA E7290 X-RAY TUBE)

### Radiation leakage technique factors

The maximum-rated peak tube potential is **35 kVp** and the maximum rated continuous tube current is **3.5mA** for the maximum-rated peak tube voltage.

### Minimum filtration

The Beam-limiting device contains three different filtrations **30µm molybdenum**, **25µm rhodium** and **0.50mm aluminum**. The measured half-value layers are **0.343mmAl**, **0.373mmAl** and **0.377mmAl** at 30kVp. These measured values correspond to aluminum equivalents of **0.55 - 0.65mmAl**.

### Rate line voltage

**208 - 240V** ~ ±10%. Line voltage regulation 10%.

### Maximum line current

Maximum **22 Amperes** at absolute minimum stated mains voltage (187V~)

### Technique factors that constitute the maximum line current condition

**33kV / 97mA**

### Generator rating and duty cycle

**3.2kW**. The duty cycle and wait period can be calculated using the following formulas:

- Wait period =  $T_w = kV * mA * \exp. \text{Time} / 500W$
- Duty Cycle =  $1 / (1 + kV * mA / 500W)$

### Maximum deviation of peak tube potential from indicated value

±2kV

### Maximum deviation of tube current from indicated value

±5mA large focal spot, ±1mA small focal spot

### Maximum deviation of exposure time tube current product from indicated value

±4mAs or ±10%, whichever is larger

### Maximum deviation of exposure time from indicated value

±5%

### 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 measured high voltage mean value measured with a calibrated non-invasive kVp meter.

#### Tube current

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

#### mAs product

Is defined as the product of the exposure time and the tube current measurements.

**The nominal x-ray voltage together with the highest x-ray tube current obtainable from the high-voltage generator when operated at its nominal x-ray tube voltage**

35kV 91mA - large focal spot  
35kV 28mA - small focal spot

**The highest x-ray tube current together with the highest x-ray tube voltage obtainable from the high-voltage generator when operated at its highest x-ray tube current**

110mA 29kV - large focal spot  
35mA 28kV - small focal spot

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

33kV 97mA - large focal spot  
31kV 32mA - small focal spot

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

35kV 91mA - 3185W large focal spot  
35kV 28mA 980W small focal spot

**Reference current time product**

large focal spot: for all kV values	40mA / 0.1s / 4mAs
small focal spot: for all kV values	10mA / 0.1s / 1mAs

**The lowest current time product within the specified range of compliance**

large focal spot:	30mA / 0.1s / 3mAs
small focal spot:	10mA / 0.1s / 1mAs

**The nominal shortest irradiation time in the AEC-mode**

20ms

## 9.1 Toshiba E7290 x-ray tube ratings

### Manual exposures

With manual exposures the tube kV and mAs can be selected by the user. In order to keep the exposure times at minimum the required mAs is always achieved at highest possible tube current for the kV selected. The parameters are listed in the following table.

### Automatic exposures

Automatic exposures are terminated when the radiation detector indicates that the required dose has been reached. In this mode the kV is selected by the operator and mA is chosen to be the maximum allowed mA for the selected kV.

If the exposure time is longer than 1 sec (5 sec for the small focal spot) then a falling load technique is used. The exposure is started at the mA as specified in the following table. The accumulated dose is checked at 0.45 sec (2.45 sec for the small focal spot) and if it has reached more than half of the required dose, the exposure can be continued at the same mA level, and will be terminated within 1 second (5 seconds for the small focal spot) - well before the tube is overloaded.

If the accumulated dose is detected to be less than half of the required, a longer exposure time than the one specified for the tube current can be expected. Therefore the tube current is reduced at this time (after 0.45 or 2.45 sec exposure) to a lower mA that, when added to the already produced tube loading, will not exceed the maximum tube rating. The falling load current levels are listed in the following table.

### Thermal ratings

Two separate methods are used to protect the tube from overload. One is measuring the tube head enclosure temperature and if it exceeds 60 °C no further exposures are allowed until it falls below 60 °C.

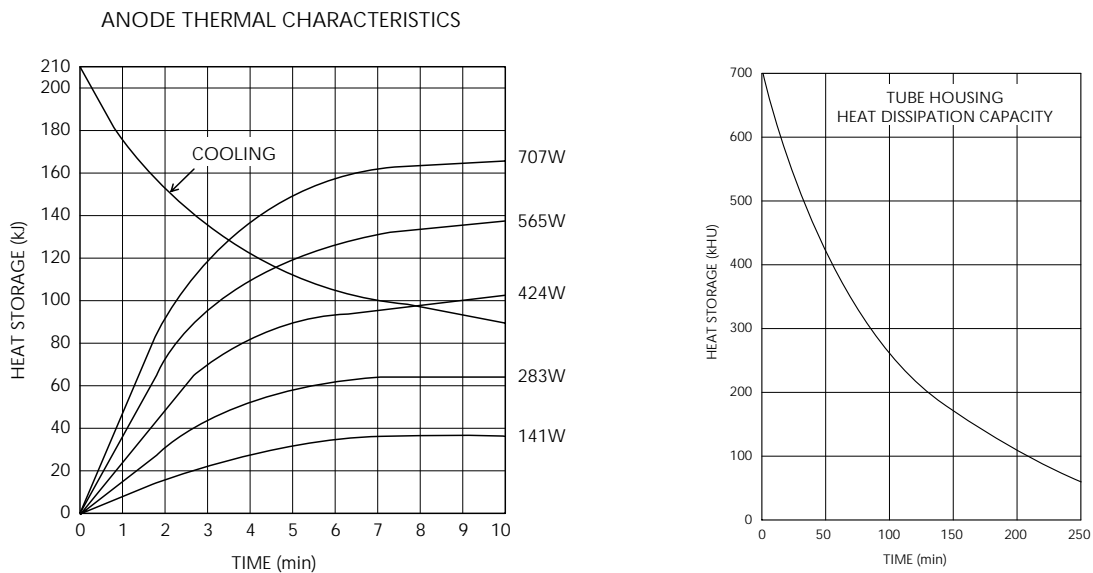
The other method keeps the average input power into the tube below or equal to 500W. The exposure parameters are limited as indicated by the following table, but this feature forces a waiting time between the exposures to ensure that the average power into the tube never can exceed this limit. For example if an exposure of 24 kV, 100 mAs is performed a wait period of 5 seconds is calculated and no further exposures are allowed until this time has elapsed.

There is no way to bypass these safety feature under any circumstances, and it is thus virtually impossible to overload the X-ray tube.

Table 3: Maximum mA for Tube E7290 vs. different modes

kV	MANUAL EXPOSURE MODE					AUTOMATIC (AEC) EXPOSURE MODE				
	Large focal spot (0.3 mm)			Small focal spot (0.1 mm)		Large focal spot (0.3 mm)			Small focal spot (0.1 mm)	
	0 - 1 sec.	1 - 5 sec.	1 - 6 sec.	0 - 5 sec.	> 5 sec.	0 - 1 sec.	0.45 - 5 sec.	0.45 - 6 sec.	0 - 5 sec.	2.45 - 10 sec.
20	80	80	80	20	20	80	80	80	20	20
21	84	84	84	21	21	84	84	84	21	21
22	88	88	88	23	23	88	88	88	23	23
23	92	92	92	25	25	92	92	92	25	25
24	96	96	96	27	27	96	96	96	27	27
25	100	100	100	29	29	100	100	100	29	29
26	104	104	104	31	31	104	104	104	31	31
27	108	108	108	33	31	108	108	108	33	30
28	110	110	110	35	30	110	110	110	35	28
29	110	107	104	34	29	110	106	103	34	27
30	110	104	100	33	28	110	103	99	33	26
31	107	101	97	32	27	107	100	96	32	25
32	103	98	93	31	26	103	97	92	31	24
33	100	95	90	30	25	100	94	89	30	23
34	97	92	87	29	24	97	91	86	29	22
35	94	88	84	28	24	94	87	83	28	22

9.2 Cooling curves for x-ray tube



# UNPACKING & INSTALLATION

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## 1 PRE-INSTALLATION REQUIREMENTS

Since the SOPHIE is a very small and light-weight unit, the installation can be performed by one person only. The unit is shipped complete so there is no need to perform special assembly or calibrations on the field. The unit is normally used free-standing, and the mobile version standing on its own locked wheels, so there's not normally any need to drill holes during the installation.

---

### 1.1 Tools required

#### Tools for the mechanical installation

A standard set of screwdrivers (a motorized one is recommended for opening the packaging crate) and millimeter based Allen-keys is about what you need.

#### Other tools

Please refer to chapter "PREVENTIVE MAINTENANCE CHECKS" on page E-2 for details of test instruments needed for the installation check-up.

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### 1.2 Environmental requirements

#### Strength requirement for the floor

The weight of the unit (approx. 160kg) is moderate and does not cause any special requirements for the strength of the floor.

However, the floor must be straight within 0,5%. The stationary unit has four small feet in the base that can be adjusted to level the unit if the floor is uneven.

The unit should never be placed on thick carpets for stability and reliability reasons. Antistatic floor materials should be preferred.

#### Temperature & Humidity

The operating temperature range is from **+15°C to +35°C**, non condensing. The acceptable humidity range is from **25% to 75%**. The storage temperature range is from **0°C to +45°C**.

**NOTE** *If the unit has been stored at temperatures under +10°C for more than a few hours, time must be allowed for the unit to reach room temperature before turning it on.*

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### 1.3 Space requirement

#### Width of door openings

The unit can be transported on its wheels through door openings that are **76 cm** wide.

#### Minimum and recommended Height & Width

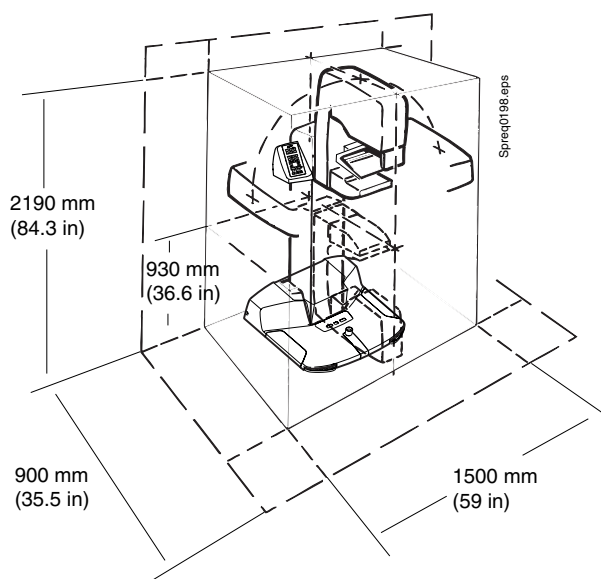
The following illustration shows the absolute minimum space requirement of the Sophie unit. The texts in the following picture indicates the minimum recommended space needed.

Recommended minimum clearance above the C-ARM is 200 mm (8 inch) when the arm is in the highest possible position.

This equals a ceiling height of 2190 mm (84.3 in.)

Recommended minimum clearance around the unit (left - front - right) is >900 mm (>35.5 in.).

This equals an operating depth (from the wall) of 1500 mm (59 in.), and an operating width (side to side) of 2980 mm (117 in.)



## 1.4 Radiation protection

The radiation safety regulations of individual countries must be complied with. Radiation protection devices should be used, as movable or stationary radiation shields. The mobile version of the Sophie has an integral radiation shield that must be attached to the unit.

### Safe distances without specific shielding

A few exposures (without additional radiation shielding) can be made without exceeding the mR/hour per month limit, if the operator distance is far enough from the unit. Please refer to local regulations. However, protective operator shielding is always recommended, and should always be used.

### Wall LEAD-equivalence

The lead-equivalence of the walls in the room depends on the material used, please refer to local radiation protection regulations. A recommended safe value of the **wall lead equivalence is  $\geq 1$  mm** and should cover even the most strict requirements.

### Movable shields

Radiation shields are also available. Please refer to the "SPARE PARTS MANUAL".

## 1.5 Power requirement

### Mains voltage & frequency

Nominal operating voltage can be from **208-240 V~**, **single phase**, either between the phases or between one phase and neutral. The built in line voltage compensation ensures proper operation within  $\pm 10\%$  fluctuation (**187-265 V~**). The mains frequency can be either **50** or **60 Hz  $\pm 10\%$** .

### Fuse ratings

The minimum recommended external fuse rating is **15 AT** (time-lag). Electromagnetic circuit breakers can be used, since the unit's power factor is **>0.95**. The unit is also protected internally with 15 AT fuses.

### Mains impedance & earthing

To ensure proper operation over the recommended mains voltage range, the resistance of the mains should not exceed **1  $\Omega$** . The unit must be connected to an **earthed outlet**.

### Typical power consumption

The idle power consumption is less than **100VA**. The maximum power consumption is worst case **4000VA** for a maximum of 5 seconds (Toshiba E7272 tube: at 27kV / 110mA exposure settings, Toshiba E7290 tube: 33kV / 97mA exposure settings).



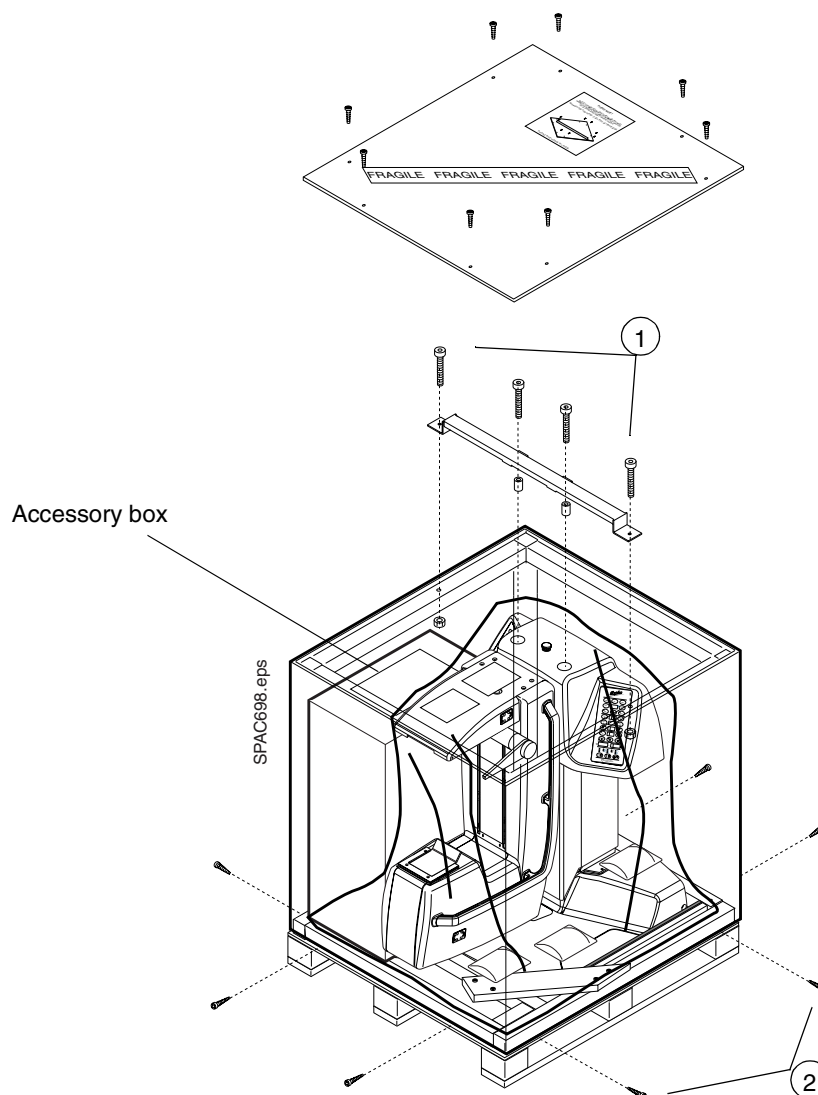
## 2 UNPACKING THE UNIT

### 2.1 General about unpacking

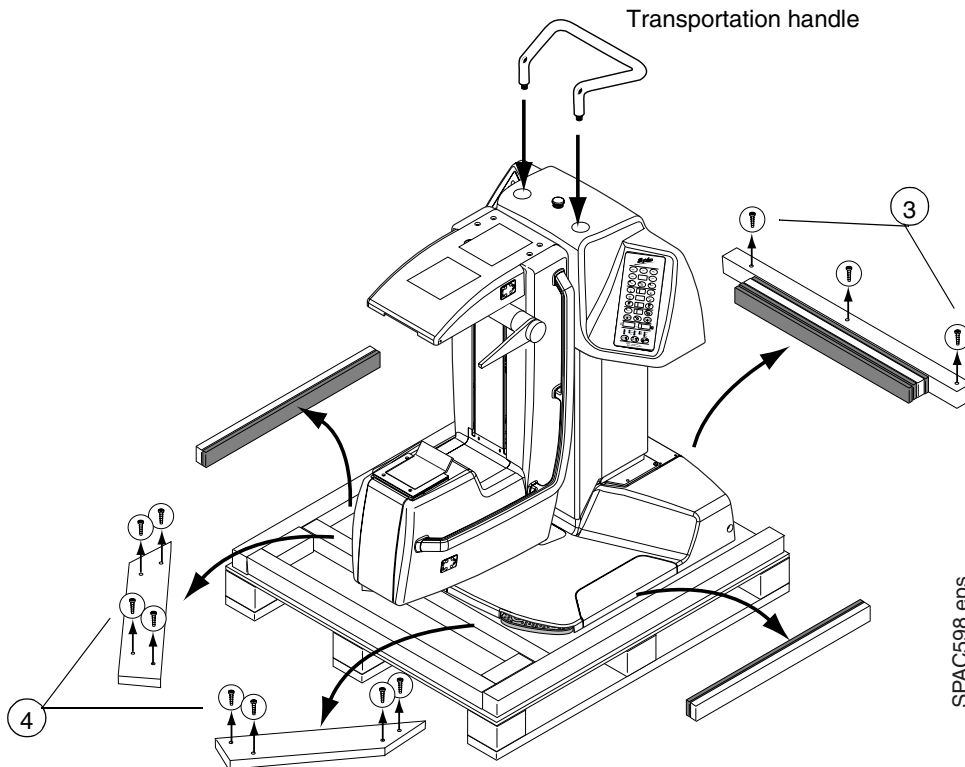
Unpack the unit indoors in a convenient place, preferably as close as possible to the final installation location. The unit can be transported to the final location on its own wheels. The only limiting factors can be narrow doors or lifts and the fact that you need a mains outlet (208-240VAC) within 3 meters from the unpacking location. Unpacking the mobile version is similar to what is described below.

### 2.2 Step-by-step unpacking instructions

- a) Open and remove the 8 screws on the top of the crate cover. Lift and remove the top cover. Remove the four large Allen head bolts (item 1). Remove the accessory box from the crate.
- b) Remove the 8 screws (item 2) around the base of the crate and lift the rectangular crate carefully up and away.



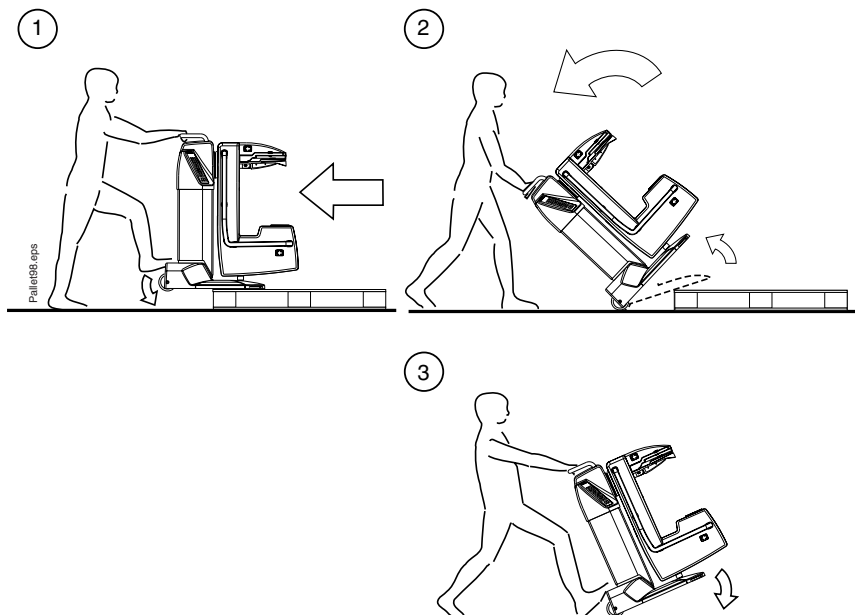
- c) Unpack the transportation handle from the accessories box and install it at the top of the unit, as illustrated. The screws are already in the handle.
- d) Remove the 3 screws that hold the wooden rear support bar in place (item 3). Remove the eight screws that hold the wooden front support bars in place (item 4). Remove the support bars and the rear foam cushion.



- e) Slide the unit carefully to the rear (by pulling from the handle) until you reach the point of balance.
- f) Carefully let the unit wheels touch the floor and wheel the unit close to the place where it's going to be installed or used.

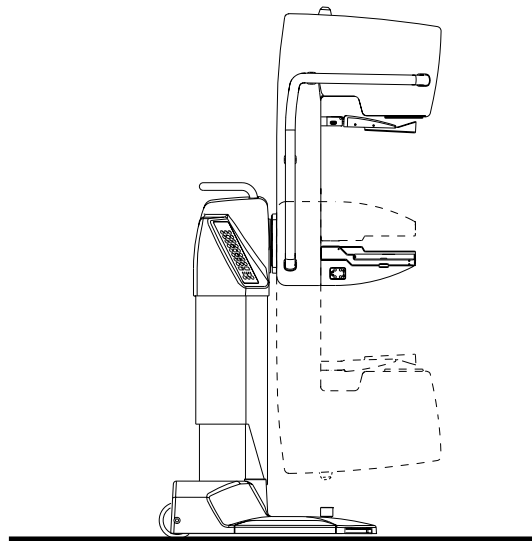
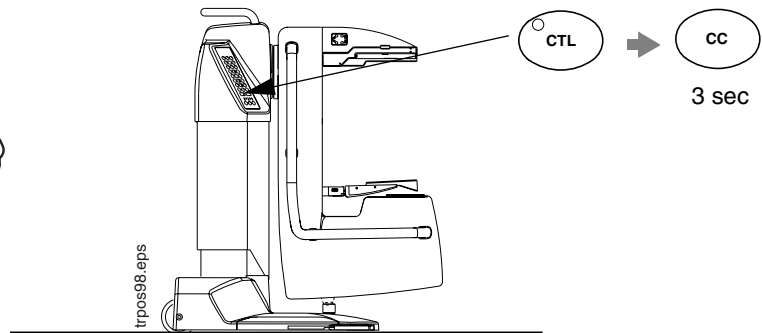
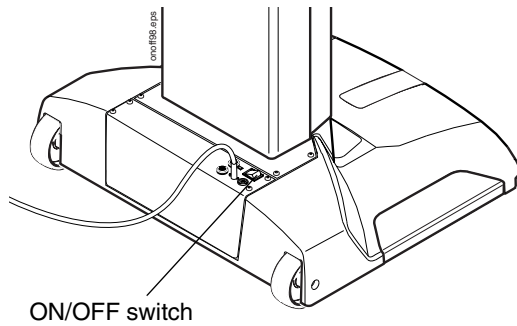
**CAUTION** *Be careful not to drop the unit when levelling it down to the floor. It's quite heavy and must be handled by a strong person(s). It's always a good idea to use a helping hand or two.*

**CAUTION** *NEVER lift it from the FOOT-PEDALS, C-ARM or HOOD. When handling the unit, lift the unit from the metal base and/or the transportation handle.*



### 2.3 Driving the unit out of the transportation position

- Move the unit to the location where it's going to be used.
- Make sure that there is enough room around the unit so that the C-arm can rotate without hitting any obstacles. Plug the unit to a mains (208-240V~) outlet and switch it on.
- Wait for the unit to perform its self-tests (about 10 seconds). Drive the unit to the normal operating position by pressing the CTL-key and then pressing and holding the CC-key for three seconds, or drive the C-arm 300mm upwards with the C-arm/cassette table up switch.
- Remove the C-arm locking knob by turning it clockwise. Insert the cover plug to the hole.
- The transportation handle can now be removed, and the supplied plastic plugs inserted to cover the holes in the hood.



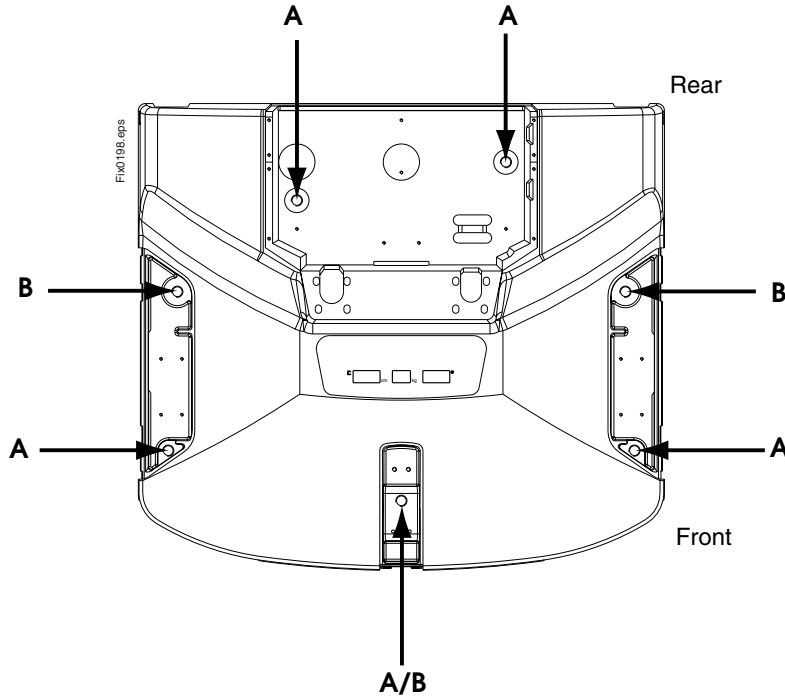
**CAUTION** Do not rotate C-arm in its lowest position when the C-arm locking knob is in its place.

**CAUTION** Never transport the unit without first driving it down to the transport position.

2.4 Attaching the unit to the floor

It is recommended to bolt the unit to the floor. The stability of the unit must be checked after installation.

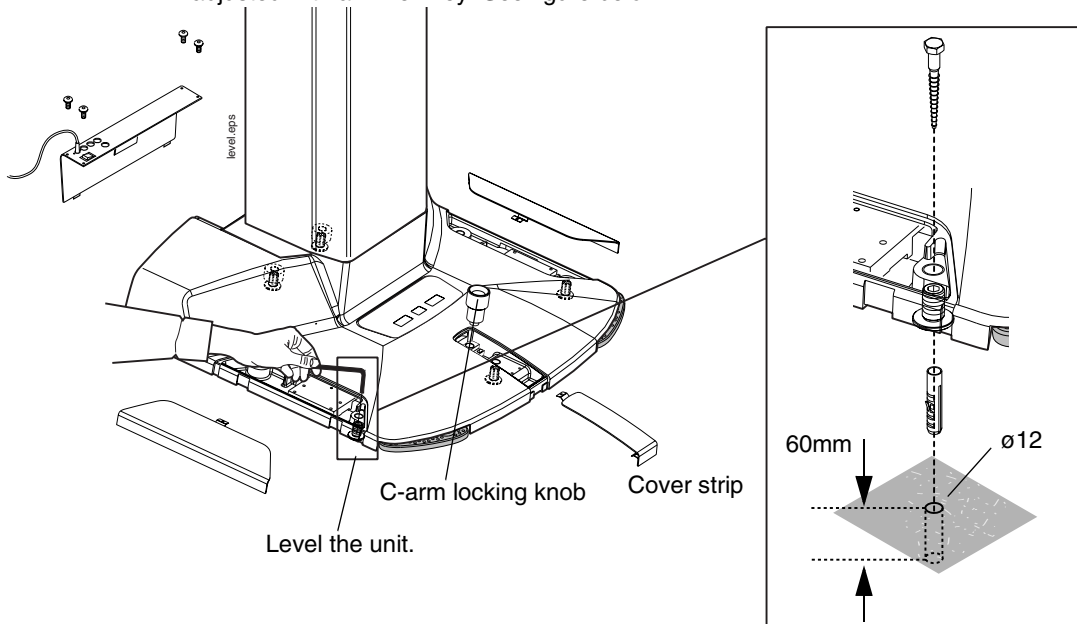
- a) Turn off the unit and unplug it from the mains.
- b) Remove the base covers, see section “Base covers” on page H-2.
- c) The unit can be bolted either with five (A) or with three screws (B) according to the figure below. It is recommended to use five screws. Note, that if you are going to use three fastening screws, move the levelling feet from the front side holes to the rear ones.



Use either holes labeled A or holes labeled B.

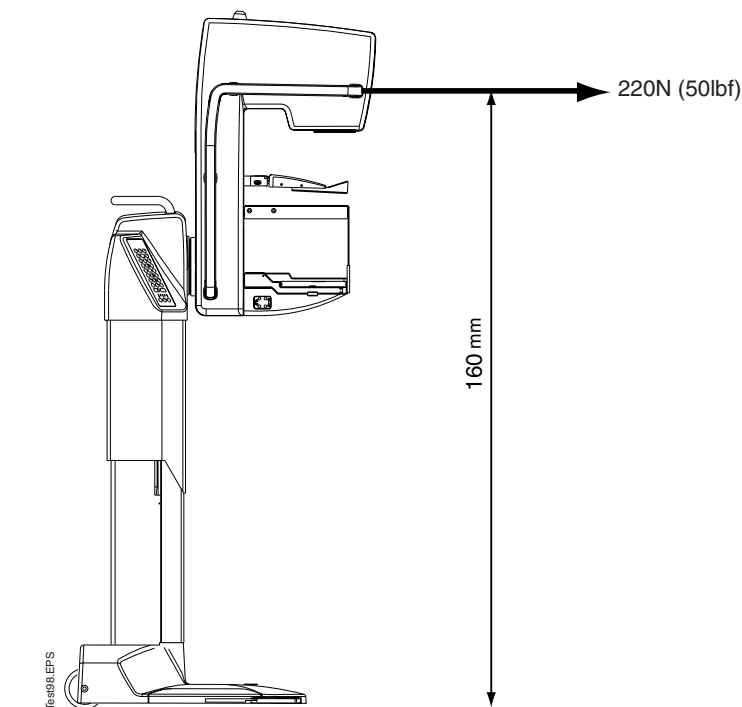
In case you use the holes labeled B, move the levelling feet from side holes labelled A to side holes labelled B.

- d) Level the unit if the floor is uneven. The unit has small feet in the fastening holes that can be adjusted with an Allen key. See figure below.



- e) Use the base as a template and mark the positions of the five/three fastening screw holes to the floor. Drill the holes (12mm in diameter and 60mm deep) and insert the 12x60 expansion anchors into the holes.
- f) Fasten the unit to its place with three 8x70 DIN 571 screws. Replace the removed covers.
- g) Remove the C-arm locking knob and attach the cover strip to its position.

- h) Check the attachment of the unit. The unit must stay in its position when it is pulled forward as described below.
- Drive the C-arm to the uppermost and upright position.
  - Pull the unit forward at the side handles with a force of at least 220 N (22 kg, 50 lbf).



## 2.5 Unpacking the accessories

The following minimum set of accessories should be found inside the crate, in every shipped unit:

- Upper compression paddles (4 pcs): TWINCOMP, Normal, Spot, Biopsy
- Lower compression paddle 18x24cm
- Remote control box and 10m cable (delivered, but optional for the mobile unit)
- Transportation handle
- Chin guard
- Radiation shield (only with the mobile unit model)
- Rear control panel (only with the mobile unit model)

Unpack carefully the accessories from the boxes found inside the crate. Note that the unit is normally delivered without cassettes.

**NOTE** *The small accessories bag is located under the right cover strip of the unit base.*

---

## 3 ATTACHMENT OF ACCESSORIES

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### 3.1 Compression paddles

Please refer to the User's manual for instructions how to insert the upper compression paddle, the lower compression paddle or the Bucky device.

---

### 3.2 Remote control attachment (optional for the mobile unit)

**NOTE** *There are two types of the remote control box, the traditional and the extended (that has an additional READY-light). They unit must be programmed accordingly, depending of which box is in use. See paragraph "12. Setting type of remote control box" on page F-18 for details.*

Attach the remote control box to the rear of the radiation shield to be used, or to any other convenient location that is shielded from radiation. According to local radiation safety regulations, there must often be a visual contact between the patient and the operator. Please take this into account when finding a proper location for the remote box.

Connect the remote box to the unit with the supplied cable. It's NOT recommended to cut the excess length. The cable should be attached to the walls or put in a cable viaduct, never let the cable lie on the floor where it can be damaged. Please notice that the remote cable has one male and one female connector. The male connector is the one that is connected to the unit.

---

### 3.3 Mobile Sophie special accessories attachment

The rear control panel and the folding radiation shield must be attached to the unit. Connect the rear control panel cable to the free connector coming out through the hood and push the excess of the cable (and the connectors through the hole).

---

### 3.4 Exposure warning light (option)

An optional exposure warning light can be connected to the remote box. The light must be powered from an external power source, since the box contains only a circuit breaker relay. See the schematics for details.

---

### 3.5 Printer (option)

To be able to attach a label-printer to the unit, you need an PLANMED manufactured adapter (please refer to the Spare Parts Manual) to connect to the remote control cable. This adapter is then connected to the printer with a straight 25-pin RS-232 cable.

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### 3.6 ADMARK darkroom film-marking system

Please refer to the ADMARK manual how to install and use it with the SOPHIE mammographic unit.

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## 4 SETUPS AND CHECKS PRIOR TO USE

Before using the unit for patient work, some initial setups and checks **must be performed**. Continue with the setups described in “SPECIAL REGIONAL & INITIAL SETUPS” on page F-1.

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## 5 RE-PACKING & TRANSPORTATION OF THE SOPHIE UNIT

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### 5.1 Driving the unit into the transportation position

- a) Make sure that there is enough room around the unit so that the C-arm can rotate without hitting any obstacles.
- b) Drive the unit to the transport position by pressing the CTL-key and then pressing and holding the CC-key for four seconds.



- c) If you are going to re-pack the unit, the C-arm locking knob must be inserted to the unit's base before driving the unit to the transport position.
- d) After driving the unit to the transport position, drive the C-arm to its lowest position with the C-arm/cassette table down -switch.

**CAUTION** *Do not rotate C-arm in its lowest position after the C-arm locking knob has been inserted to its place.*

---

### 5.2 Transporting the unit on its own wheels (non-mobile unit)

- a) Make sure that the unit is in the transport position.
- b) The transportation handle must be attached, if not, please see paragraph "Step-by-step unpacking instructions" on page B-3 for details how to attach the handle.
- c) Turn off the unit and unplug it from the mains. Tilt the unit carefully to the rear (by pulling from the handle) while supporting the base from moving by your foot until you reach the point of balance.
- d) Carefully wheel the unit to the place where it's going to be re-packed.

**NOTE** *Always avoid rough handling, such as running the unit over thresholds at high speed, and avoid to transport the unit on rough or uneven floors that could cause excessive vibrations in the unit.*

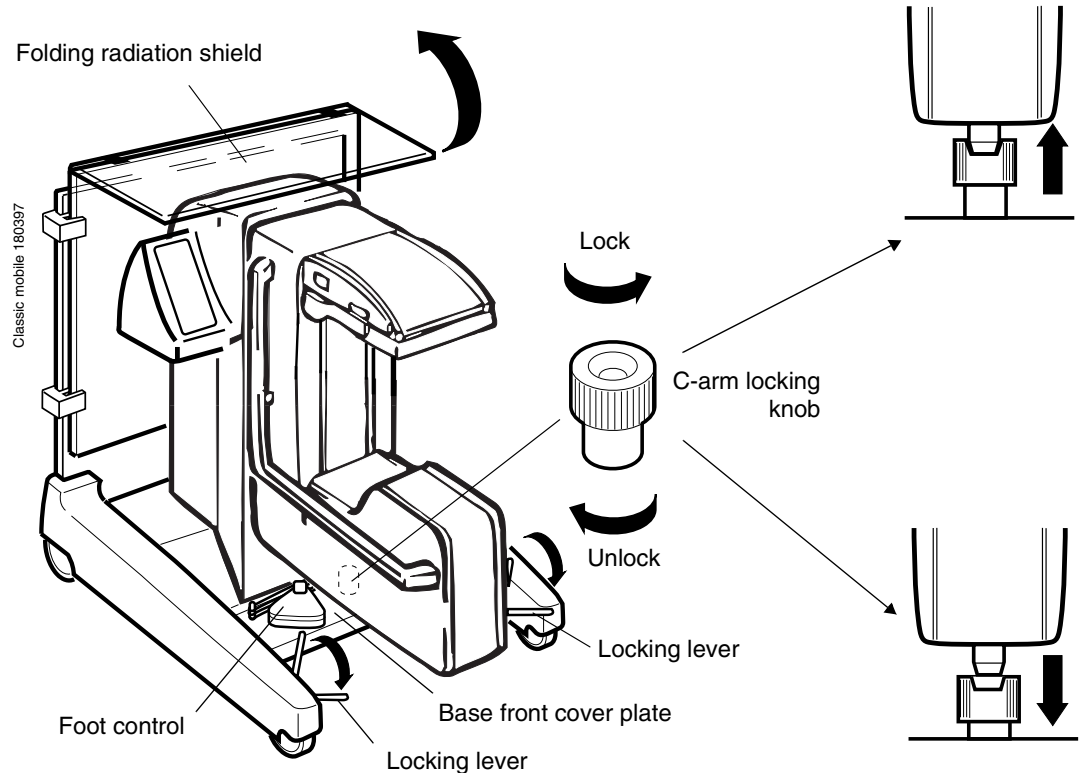


## 6 MOBILE SOPHIE HANDLING & TRANSPORTATION

The mobile version of the SOPHIE mammographic unit is intended to be easily transported. However, certain precautions must be followed to guarantee that no harm comes to the unit when turning the unit into and from the transport position.

**CAUTION** *Never transport the Sophie Mobile unit without first driving it to the transport position. Never lift it from the C-ARM or the HOOD. When handling the unit, lift the unit only from the metal base and/or the transportation handle*

**NOTE** *Make sure that there is enough space around the unit so that the C-arm can freely rotate. Use the red STOP buttons in case of an emergency.*



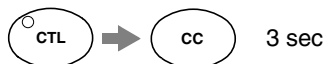
### 6.1 Preparing the mobile unit for use after transportation

- a) Lock the transportation wheels by pushing the locking levers down, please see figure above.
- b) Lift the folding top part of the radiation shield into position.
- c) Plug the unit into an appropriate outlet and switch the unit on. A STOP-message should appear on the time/cm displays.
- d) Turn the C-arm locking knob (located underneath the C-arm) clockwise as far as it goes until it stops rotating. The STOP-message on the display will disappear.
- e) Lift the foot controls down on the floor, and drive the unit out of the transport position by pressing the CTL-key and then holding the CC-key for 3 seconds. The unit is now ready for use



## 6.2 Preparing the mobile unit for transportation

- a) Make sure that the C-arm locking knob is in its lowest position. Also make sure that the foot controls are on the floor and not on the base front cover plate.
- b) Drive the unit into the transport position by pressing the CTL-key and then holding the CC-key for 3 seconds.



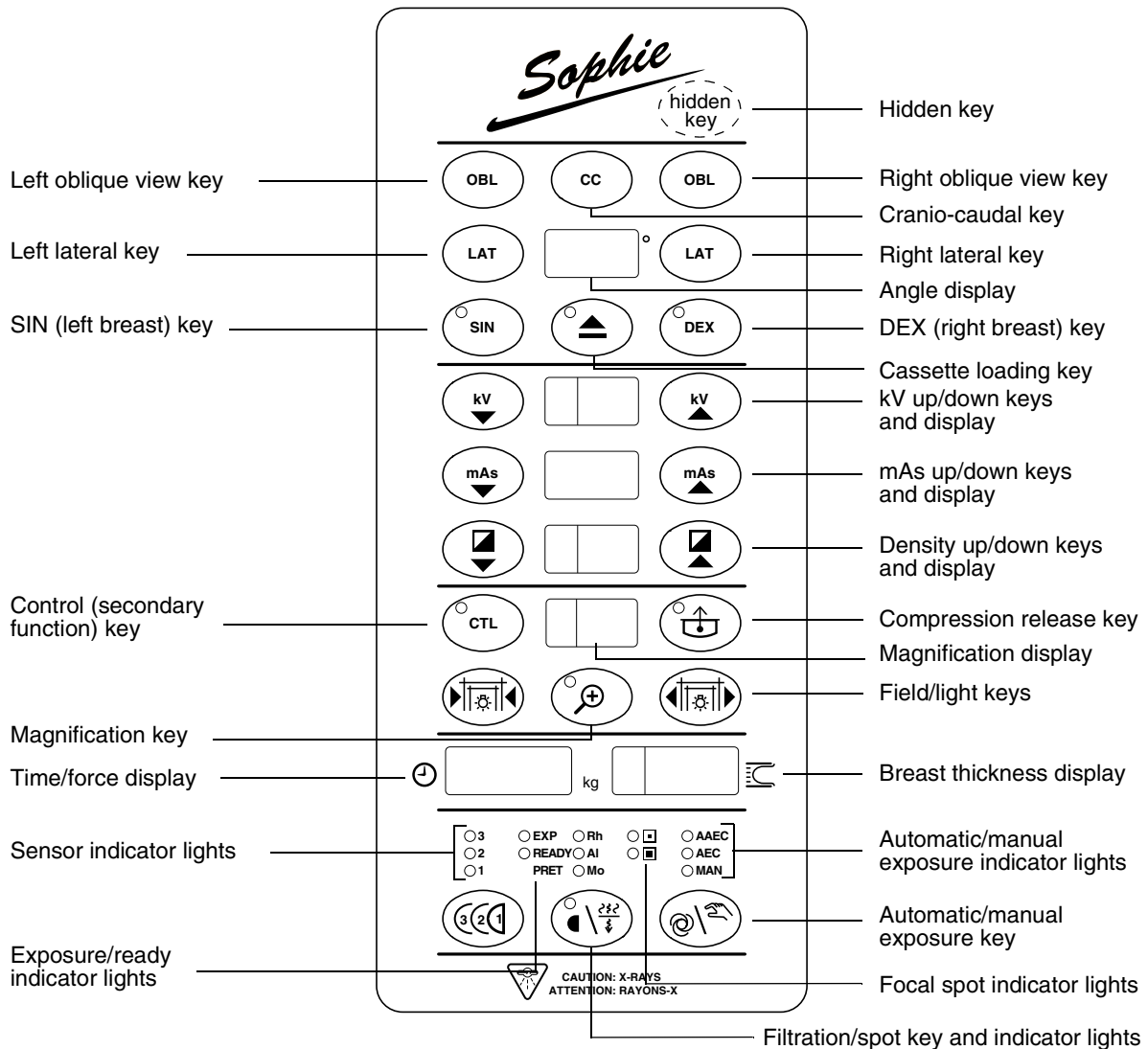
- c) Wait until the C-arm movement has stopped and drive the C-arm to its lowest position by pressing and holding the DOWN-switch.
- d) Turn the C-arm locking knob counterclockwise until it just touches the locking stud. Do not over tighten the knob since it could bend the C-arm. The STOP-message will now appear on the displays.
- e) Turn off the power and disconnect the unit from the mains outlet. Place the mains cable on top of the base so that it cannot fall on the floor during transportation.
- f) Fold down the top part of the radiation shield. Place the foot controls on the base front cover plate on either side of the C-arm
- g) Pull the locking levers up to release the transportation wheel brakes and the unit is ready for transportation.

# KEYBOARD FUNCTIONS & MODES

## 1 KEYBOARD OVERVIEW

This chapter describes all keyboard functions in a short-form format, and special display modes in details. For detailed descriptions about adjustments and settings performed with the help of the keyboards, please refer to chapter “ADJUSTMENT & CALIBRATION” on page F-1.

The unit’s keyboards works in parallel and are identical (see picture below). However, if one of the keyboards would fail, it is still possible to operate the unit using the other one, since the keyboards operate electronically independently.



## 2 USER MODE FUNCTIONS SHORT-FORM

### 2.1 Normal user functions

The keyboards are always in the normal operating mode when the unit is turned on. Please refer to the SOPHIE USER'S MANUAL for descriptions for the normal keyboard operation and instructions for normal everyday use of the unit.

### 2.2 Special user settings

There are some adjustments that the user/operator can perform to set the unit to fulfil individual needs. The following table is a short-form of these functions. Please refer to the User Manual for more detailed descriptions.

#### How to access these special user settings

Press the CTL-key (its LED turns on) and then press the corresponding button. Some of the settings (especially infrequently used ones) require that the corresponding button is held down for three (3) seconds, preventing inadvertent entry into these modes. Exit from these special user functions is either automatic or done by pressing again the CTL-key, see details in table below.

Table 10: Special user settings

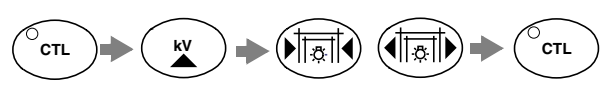
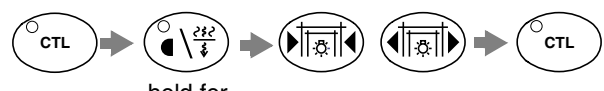
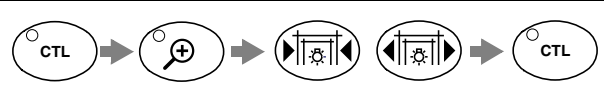
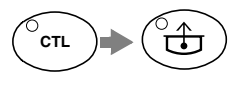
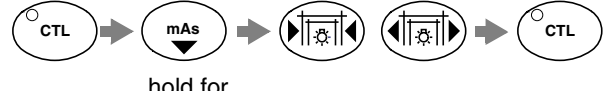
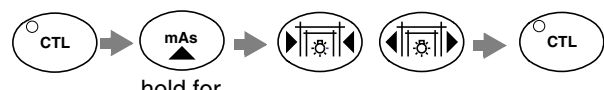


















































USER MODE FUNCTION	KEY SEQUENCE	FOR DETAILS, PLEASE REFER TO
AUTOMATIC kV MODE		"Automatic kV mode" on page F-3
AUTOMATIC RHODIUM/MOLYBDENUM FILTER SELECTION MODE	 hold for 2 seconds	"Automatic rhodium/molybdenum filter selection mode" on page F-3
DEFAULT MAGNIFICATION FACTOR		"Default magnification factor" on page F-4
AUTOMATIC RELEASE OF COMPRESSION		"Automatic release of compression after exposure" on page F-4
INITIAL COMPRESSION SPEED	 hold for 3 seconds	"Initial descent speed" on page F-4
COMPRESSION SPEED DECREASE RATE	 hold for 3 seconds	"Compression speed decrease rate" on page F-5
STOP LIMIT OF THE COMPRESSION FORCE	 hold for 3 seconds left LAT key	"Intermediate compression stopping force" on page F-5

Table 10: Special user settings (Continued)

USER MODE FUNCTION	KEY SEQUENCE	FOR DETAILS, PLEASE REFER TO
TWINCOMP COMPRESSION ON/OFF	 →  →  →  →  hold for 3 seconds	"Twincomp compression on/off" on page F-5
LIFT MOTOR CRAWLING SPEED	 →  →  →  →  hold for 3 seconds	"Lift motor crawling speed" on page F-5
TIME & DATE ADJUSTMENT	 →  →  →  → 	"Setting correct time and date" on page F-6
TRANSPORT POSITION (TO/FROM)	 →  hold for 3 seconds	"Transport position" on page C-7
DENSITY COMPENSATION ADJUSTMENT	 →  →  →  →  hold for 3 seconds	"Density offset adjustment" on page F-6
AAEC CONTRAST ADJUSTMENT	 →  →  →  →  hold for 3 seconds	"AAEC contrast adjustment" on page F-6
AUTOMATIC FILM LABELING (ON/OFF)	 →  →  →  →  hold for 3 seconds right LAT key	"Automatic film labeling (on/off)" on page F-6
DISABLE BUCKY GRID MOVEMENT	 →  →  →  →  hold for 3 seconds	"Disabling bucky grid movement" on page F-7
ALARM SOUND FREQUENCY (loudness)	 →  →  →  →  hold for 3 seconds	"Alarm sound frequency (loudness)" on page F-7
IGNORE ERRORS TEMPORARILY	 hold for 3 seconds	"Ignore errors temporarily" on page C-9
DIMMING THE DISPLAYS	 →  hold for 3 seconds	"Dimming the displays" on page F-7
mA LIMIT	 →  hold for 3 seconds	"mA limit (on/off)" on page F-7
SERVICE MODE ENTRY	 →  hold for 4 seconds	"How to enter the service mode" on page F-8

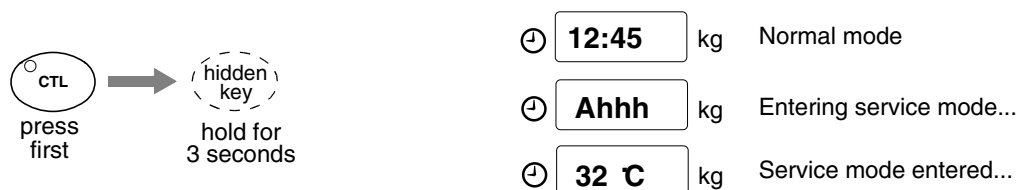
### 3 SERVICE MODE FUNCTIONS SHORT-FORM

**CAUTION** Some of the functions in the service mode may be jeopardize the proper operation of the unit. Never use special service mode functions if you are not familiar with how they operate. The service mode is only intended for the trained technician.

The service mode provides easy diagnostics and special setup and calibration functions. Additionally there are also some special control and display modes that are not normally available.

The normal time-of-day display is replaced in the service mode with a temperature display. The unit operates normally and exposures can be made in the service mode, but with few exceptions. The unit also ignores user related errors (missing cassettes etc.) and can make exposures as long as no safety hazards are violated (open feedbacks etc.)

#### 3.1 How to enter / exit the service mode



- Press the **CTL**-key so that its LED turns on.
- Press and hold the **HIDDEN**-key for **3 seconds** (Above the right oblique view key). The time/force -display shows briefly the message “**Ahhh**” and then turns to display the temperature of the tube head. This is an indication of a successful entry into the service mode.

#### To exit from the service mode

Press the **HIDDEN**-key briefly, or turn off the unit temporarily.

#### 3.2 Meaning of displays in the service mode

Some of the normal displays have additional meanings in the service mode. Please see the following table.

**Table 11: Meaning of displays in the service mode**

DISPLAYS	DURING STANDBY	DURING EXPOSURE
12:45 kg	Tube head or power supply temperature (°C), waiting time (blinking), breast thickness, help & error messages	Briefly after the exposure; time difference (in milliseconds) between the anode motor windings. Used only for factory diagnostic purposes.
0.6	Breast thickness	<u>Actual</u> measured X-ray tube cathode filament voltage (V)
28	Selected kV	<u>Actual</u> measured X-ray tube anode voltage (kV)
110	Selected mAs	<u>Actual</u> measured X-ray tube anode current (mA)

3.3 Service mode settings & special displays

**NOTE** *Make sure that the unit is in the service mode before performing the functions described in the following table. Some key sequences might have another meaning if not in the service mode.*

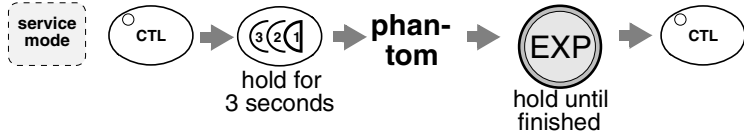
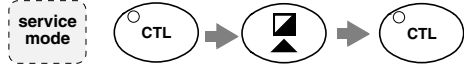
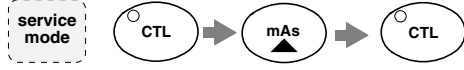
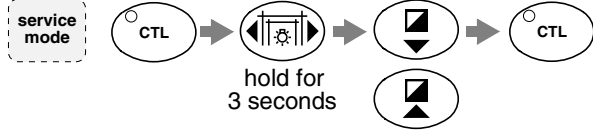
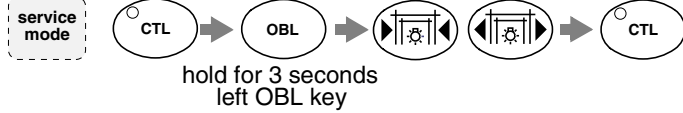
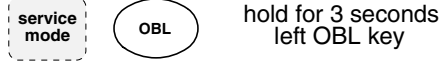
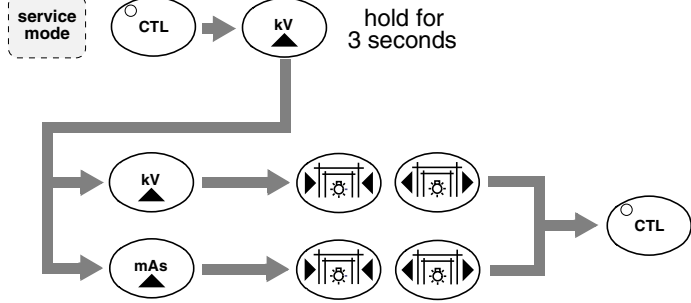
Generally special service modes are entered by pressing the CTL-key (so that it's led turns on) and the respective key either briefly or by holding it for three (3) seconds, please refer to the shortform tables. Many of the special service modes require that you exit by pressing the CTL-key. In those modes the CTL-key LED is kept blinking as a reminder to press the CTL-key again to exit.

The following table is a short-form of all available special service mode keyboard functions. Enter the service mode first before performing any of the mentioned functions (see page C-4).

Table 12: Service mode keyboard function short-form

SERVICE MODE FUNCTION	KEY SEQUENCE IN SERVICE MODE	FOR DETAILS, PLEASE REFER TO
DISPLAYING INTERNAL TEMPERATURES	<p>service mode CTL → CTL</p>	"Display of internal temperatures" on page C-7
C-ARM UPRIGHT POSITION CALIBRATION	<p>service mode CTL → CC → [C-arm icon] → [C-arm icon] → CTL hold for 3 seconds</p>	"C-arm upright position calibration" on page F-12
BREAST THICKNESS MEASUREMENT CALIBRATION	<p>service mode CTL → [Breast icon] → CTL hold for 3 seconds</p>	"Breast thickness measurement calibration" on page F-12
COMPRESSION FORCE MEASUREMENT CALIBRATION	<p>service mode CTL → LAT → [15kg icon] → CTL hold for 3 seconds left LAT key</p>	"Compression force measurement calibration" on page F-13
SPECIAL SYSTEM PARAMETERS	<p>service mode CTL → mAs → [System icon] → [System icon] → CTL hold for 3 seconds</p>	"Special system parameters setup" on page F-17
X-RAY TUBE FILAMENT VOLTAGE CALIBRATION	<p>service mode CTL → [Tube icon] → [System icon] → [System icon] → CTL hold for 3 seconds</p> <p>tube type C A</p> <p>large focus bias setting: mAs → [System icon] → [System icon] → [System icon]</p> <p>small focus bias setting: kV → [System icon] → [System icon] → [System icon]</p> <p>EXP hold until finished</p> <p>exit without programming CTL</p>	"X-ray tube filament preheating voltage calibration" on page F-14

Table 12: Service mode keyboard function short-form (Continued)

SERVICE MODE FUNCTION	KEY SEQUENCE IN SERVICE MODE	FOR DETAILS, PLEASE REFER TO
AEC-SENSOR CALIBRATION		"AEC-sensor calibration" on page F-15
DISPLAY OF REAL DENSITY VALUE		"Displaying the real density value" on page C-8
EXPOSURE COUNTER DISPLAY		"Displaying the exposure counter" on page C-8
DIAGNOSTIC DISPLAY OF INTERNAL SIGNALS		"Diagnostic display of internal signals" on page C-10
DISPLAY RECENT 49 ERROR MESSAGES		"Displaying the recent 49 error messages" on page C-8
PRINT RECENT 49 ERROR MESSAGES		"Print a list of the recent 49 errors" on page C-9
KV-VALUE FINE-ADJUSTMENT		"kV-value fine-adjustment" on page F-16



## 4 SERVICE MODE FUNCTION DETAILS

The following pages in this chapter contains detailed descriptions of all service mode keyboard functions, **except for all adjustment and setup functions**. Please refer to “KEYBOARD-CONTROLLED (in service mode)” on page F-8 for details how to perform setups and calibrations controlled in the service mode.

A shortform of all service mode functions can be found in the paragraph “SERVICE MODE FUNCTIONS SHORT-FORM” on page C-4.

### 4.1 Transport position



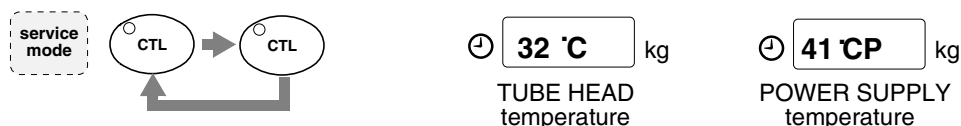
**CAUTION** *Ensure that there is free space around the unit so that the C-arm doesn't hit any obstacles during the movement. To stop the C-arm in an emergency situation, press either any of the STOP-buttons or the foot controls.*

Press the **CTL**-key and press and hold the **CC**-key for **3 seconds**.

This key sequence drives the unit either to the transport position or back to normal upright position. After driving the unit to the transport position, drive the C-arm to its lowest position by pressing the C-arm height adjusting down -switch.

The unit should never be transported when not in the transport position. In the transport position the unit runs the C-arm as low as possible and turns the tube-head against the floor. This ensures that the center point of gravity is as low as possible.

### 4.2 Display of internal temperatures



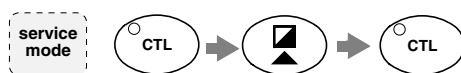
Press the **CTL**-key when in the service mode to toggle between the two different internal temperature displays. The temperature of the TUBE HEAD housing is shown in the time/force display when the CTL-key led is off (the display shows the temperature in degrees Celsius). The temperature of the POWER SUPPLY heatsink is shown when the CTL-key led is on (the display shows the temperature in degrees Celsius and the “P”-letter as an indication of “P”ower supply temperature).

**NOTE** *This temperature display has the lowest priority. It could be sometimes replaced by other more important displays in the service mode, such as magnification ratio, waiting time etc.*

The TUBE HEAD temperature slowly increases about 10°C to 15°C above the ambient temperature, even if the unit stands idle. This is fully normal since the POWER SUPPLY is using the housing of the TUBE HEAD as it's heatsink.

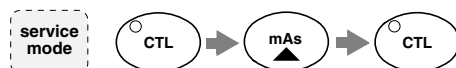
The POWER SUPPLY heatsink temperature slowly increases about 10°C to 15°C above the TUBE HEAD temperature even if the unit stands idle. This is fully normal since the thermal contact from the power supply to the TUBEHEAD is not ideal, but fully sufficient for effective cooling of the power supply. If the temperature of the POWER SUPPLY heatsink increases more than mentioned, it could indicate that the power supply is not properly tightened into its place.

#### 4.3 Displaying the real density value



In service mode, press the **CTL**-key, the **density up** -key and then the **CTL**-key to display the *real density setting*, without the zero compensation (can be set in the user mode).

#### 4.4 Displaying the exposure counter



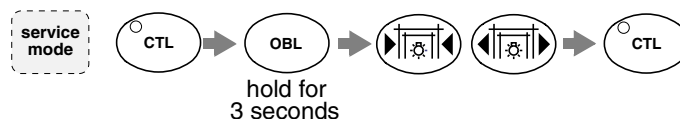
⌚ 1437 kg

Number of exposures / 10

In the service mode, press the **CTL**-key and then press the **mAs up** -key. The time/force -displays shows the number of exposures divided by ten (10). Press the **CTL**-key to exit from this mode. In the example above the actual number of exposures is c. 14.370.

The capacity of the counter is **50.000** exposures, after which it is cleared and starts again from zero. Remember that the exposure counter memory is on the REAR CPU, replacing it also means that you loose the current exposure counter data. The exposure counter can be cleared (together with the error message list), but only by PLANMED. Spare REAR CPU boards have the exposure counter cleared at the factory.

#### 4.5 Displaying the recent 49 error messages

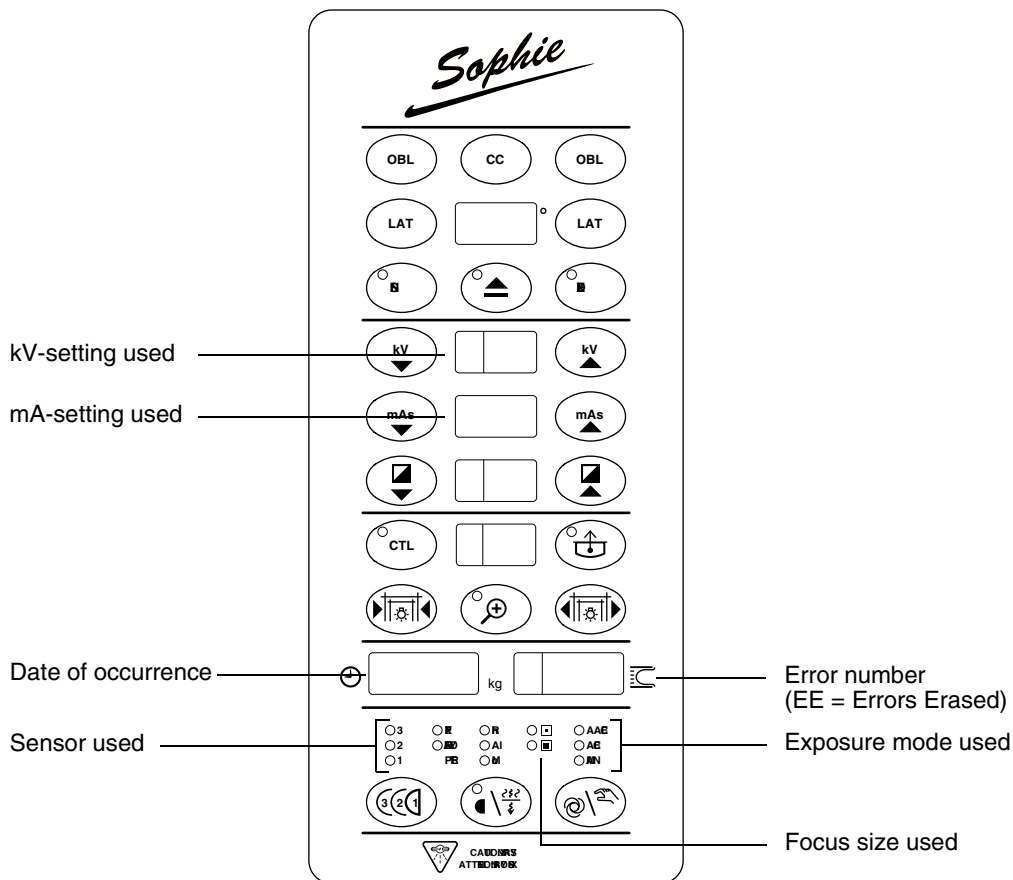


In service mode, press the **CTL**-key and then press and hold the **left OBL key** for **3 seconds**. Use the **field/light** -keys to scroll through the list. The **left field/light** -key steps backwards in the list (and time), the **right field/light** -key steps forward in the list. Press the **CTL**-key to exit this mode.

The list is always shown in chronological order (by date/time). The maximum length of the list is 49 error messages. The oldest ones are dropped off the list if the list is full and there are new errors that needs to be stored. The list is shorter if there are less than 49 error messages store. It also wraps around from the newest to the oldest error message if you continue pressing the **field/light** -keys.

The error list can be cleared (together with the exposure counter) but only by PLANMED. The error message list is stored on the REAR CPU, replacing this also means that you loose the error history data. Spare REAR CPU boards have the error list cleared at the factory.

The message “EE” instead of an error number does not indicate an error. It indicates the date and time when the error list was erased (EE = errors erased). See the picture below for more details of the error message displays.

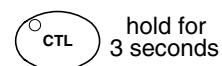


#### 4.6 Print a list of the recent 49 errors



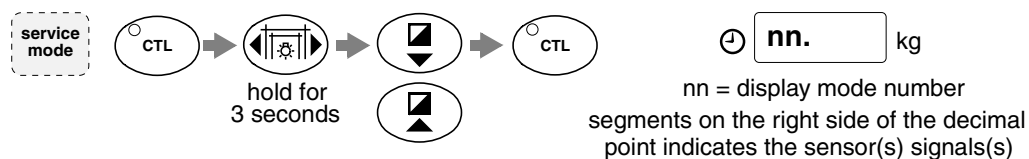
In the service mode, press and hold the **left OBL** -key for **3 seconds** to print the complete error list on an optional printer. The printing cannot be aborted. Briefly turn off the printer to stop printing.

#### 4.7 Ignore errors temporarily



Pressing and holding the **CTL**-key for **3 seconds** ignores temporarily error codes that are related to motorized movements. This function is useful in situations when the unit needs to be driven to a certain position, but because of an possible error this would not be possible Error that are related with the safety of the unit cannot be ignored this way (such as X-ray tube related problems).

## 4.8 Diagnostic display of internal signals



In the service mode, press the **CTL**-key and then press and hold the **field/light up** -key for **3 seconds**. Use the **density**-keys to step to the desired mode, please refer to the details below. Press the **CTL**-key to exit from this special display mode.

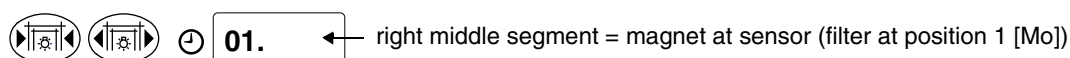
In this display mode it is possible to monitor the signals from virtually all sensors and switches, reaching both the REAR and TUBE CPUs. Additionally, if the sensor(s) selected are related with a motorized function, it is possible to control the related motor with the help of the **field/light** keys.

**CAUTION** *During this mode the sensors that normally operate as limit sensors are displayed but otherwise fully ignored. It is thus possible to drive the respective mechanism past the normal operating range to the mechanical end. Use this feature with care and avoid overloading the mechanisms.*

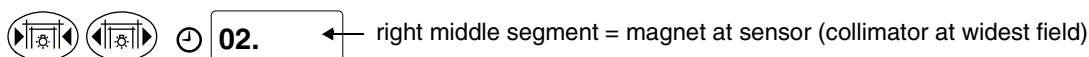
## 00. Mirror mechanism Hall-sensor signal &amp; motor drive



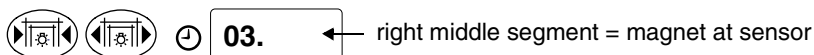
## 01. Filter mechanism Hall-sensor signal &amp; motor drive



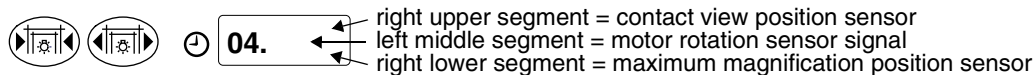
## 02. Collimator mechanism Hall-sensor signal &amp; motor drive



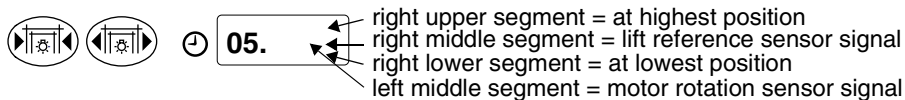
## 03. Labeling disc Hall-sensor signal &amp; motor drive

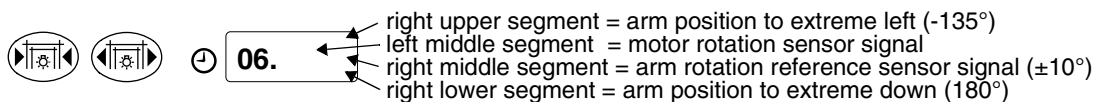
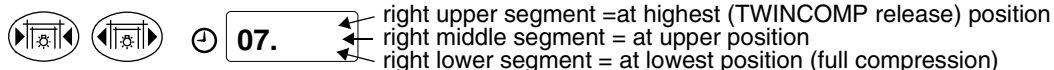
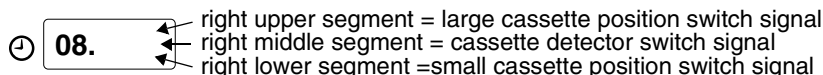
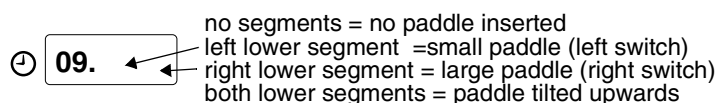
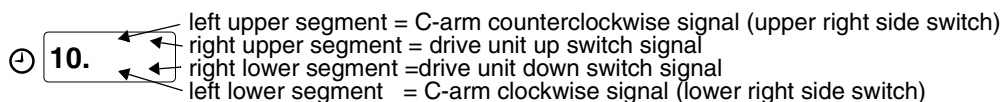


## 04. MAG/LOAD mechanism Hall-sensor signals &amp; motor drive

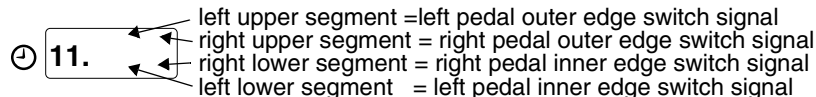
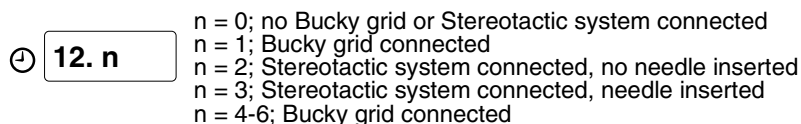
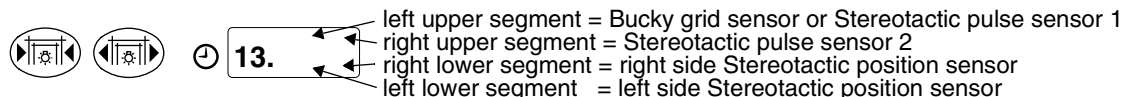
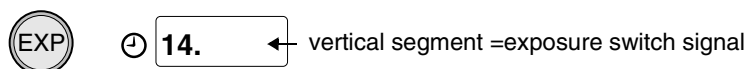
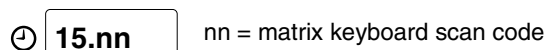


## 05. UP/DOWN mechanism Hall-sensor signals &amp; motor drive



**06. C-arm mechanism and rotation reference sensor signals & motor drive****07. Compression mechanism sensors Hall-sensor signals & motor drive****08. Cassette table size and cassette in place sensor switch signals****09. Lower compression paddle size sensor switch signals****10. Cassette table control switch signals**

Note, that the operation of the left side C-arm rotation switches is opposite of the operation of the right side switches.

**11. Foot pedal switch signals****12. Bucky & Stereotactic identification signal****13. Bucky & Stereotactic internal sensor signals****14. Exposure switch signal****15. Keyboard & Lamp test**

All LEDs should be lit on panels when you press the automatic/manual exposure key.

### 16. Compression force sensor output

⌚ **16.nn** nn = hexadecimal value of the compression force sensor signal

This display shows (as a hexadecimal number) the compression force sensor output (used for internal factory tests only).

### 17. Tube temperature sensor output

⌚ **17.nn** nn = hexadecimal value of the tubehead temperature sensor signal

This display shows (as a hexadecimal number) the tube temperature sensor output (used for internal factory tests only).

### 18. Power supply temperature sensor output

⌚ **18.nn** nn = hexadecimal value of the power supply temperature sensor signal

This display shows (as a hexadecimal number) the power supply temperature sensor output (used for internal factory tests only).

# HELP AND ERROR MESSAGES

## 1 GENERAL ABOUT ERROR DISPLAYS

The microprocessor system in the SOPHIE is capable of reporting about various abnormal conditions. There are three different message types that can appear on the clock displays; STOP, HELP and ERROR.

The STOP and HELP displays are mainly intended to guide the user in everyday use of the unit. The ERROR system is intended as an aid for the service technician in case of faults or abnormal conditions. The last 49 ERROR events are stored in internal memory and can be retrieved and viewed on demand (or printed if a suitable printer is connected), see paragraph "Printer (option)" on page B-8 for details.

### 1.1 Stop-message



The STOP message indicates that one or several of the red emergency STOP-buttons are activated. No motorized movements or exposures are possible during this condition. Release (pull upwards) both STOP-buttons in the foot controls to clear this situation. If the STOP cannot be cleared from the displays, turn the unit off momentarily, and if the STOP-message still appears, please check the condition of the STOP button switches

### 1.2 Help messages



The HELP message (**nn**= any two digit number) is shown on the clock display as long a key that has no function is pressed, or if the function is not allowed. The help display disappears automatically when the key that caused it is released. Please refer to paragraph "HELP MESSAGES SHORTFORM TABLE" on page D-2 for details about help codes. HELP messages 0 to 9 have the same meaning as the respective ERROR codes. For flexibility, many of the HELP-messages are NOT shown when the unit is in the SERVICE-mode. If the unit is reporting help messages not found in this manual, please contact your Planned dealer for a newer revision of the Technical Manual.

### 1.3 Error messages



The ERROR message (**nn**= any two digit number) appears on the clock display if a fault or abnormal condition is detected. The error must be cleared from the display with the CTL-key, before you can continue to use the unit. The last 49 occurrences are stored in internal memory, from where it's possible to check the unit's error history. The date, time and also exposure parameters are stored together with the error codes to improve the diagnostic value of the error memory. Some of the ERROR messages (0 to 9) as well as STOP and HELP messages are not stored in the list, since they are not categorized as a device malfunction. Please see the detailed error description list for details. If the unit is reporting error messages not found in this manual, please contact your Planned dealer for a newer revision of the Technical Manual.

## 2 HELP MESSAGES SHORTFORM TABLE

The following is a list of all currently available HELP messages. These messages appear on the TIME/FORCE-display if a key without any function is pressed, or if the function is not allowed for some reason. The HELP message disappears automatically when the key is released. Help messages in the range from 1 to 9 have the same meaning than the respective error codes.

**Table 13: Help messages shortform table**

HE	REASON	ACTION
HE 1	Magnification is not allowed with a Bucky grid	Remove the Bucky grid first
HE 2	Bucky is not correctly positioned or properly inserted into the unit	Check that the guide pins are firmly inserted
HE 4	The cassette is not properly positioned into the holder	Push the cassette against the labeling head
HE 5	The cassette has not been removed since the previous exposure	Remove and reload with a fresh film (double exposure prevention warning)
HE 6	The cassette table is in an undefined position	Fully push or pull the labeling head to either end
HE 7	A large cassette with a small lower paddle is not allowed because the lower compression paddle would collide with the cassette	Either change to a small cassette or a large lower compression paddle
HE 8	A small cassette with a large lower paddle is not allowed because the film labeling head would collide with the compression paddle	Either change to a large cassette or a small lower compression paddle
HE 9	No projection angle is selected	Use the LM, MLO or CC-key for projection selection
HE10	The lower compression paddle has risen too far upwards	Remove any obstructing objects and check that the cassette and lower paddle are firmly inserted
HE11	The Up/Down movement of the unit is not allowed during the compression of the breast	Release the paddle before driving the unit, or turn off this safety feature in the service mode
HE13	The Aluminum filter (filter no 2) is not allowed with kV-settings lower than 30 kV	Increase the kV-setting if you wish to use the Aluminum filter
HE14	The kV-setting cannot be changed before you either reduce the mAs-setting	Reduce the mAs setting first
HE18	A higher mAs-value is not allowed with the current kV-setting	Decrease the kV-setting first
HE20	This key functions only during AEC-mode	Select the AEC-mode first with the AEC-key
HE21	This key functions only in the manual exposure mode	Select manual mode first with the AEC-key
HE23	This key has no function in together with the CTL-key	Press the CTL-key to turn its indicator off
HE24	The C-arm cannot be rotated with the C-arm rotation switches, either the exposure view is not selected or the compressive force is more than 5 kg.	Select the exposure view or decrease the compression force.
HE25	The error must be cleared first from the display	Press the CTL-key
HE26	This key has no function in the STEREOTACTIC-mode (ex. SIN, ML, LOAD etc.)	Remove the STEREOTACTIC system first
HE27	The exposure switch is still activated	Release the exposure switch in the remote control
HE28	The C-arm is not allowed to continue to rotate without pressing any of the foot controls	Press and hold any of the foot controls to continue the movement of the C-arm



Table 13: Help messages shortform table (Continued)

HE	REASON	ACTION
<b>HE29</b>	You cannot proceed because the cassette table is in the LOAD- position	Press the LOAD-key
<b>HE30</b>	The UP/Down movement or change of projection is not allowed in the STEREO-mode with the needle inserted	Remove needle before repositioning the unit
<b>HE31</b>	Use the REL-key to drive the STEREO- device	
<b>HE33</b>	LOAD and MAG positions are not allowed when using the STEREOTACTIC-system	Press either MAG- or LOAD-key to drive back to contact view position
<b>HE34</b>	The C-arm is not allowed to continue to rotate without pressing any of the foot controls in the STEREOTACTIC mode	Press and hold down any of the foot-controls, otherwise the C-ARM will not rotate. The patient may remain in position
<b>HE35</b>	You can not select the Automatic paddle release	
<b>HE36</b>	You have to release the upper compression paddle before selecting the exposure view	Press and hold down the REL-key until the upper compression paddle has reached its highest position
<b>HE37</b>	The bucky grid is not connected.	Connect the bucky grid.
<b>HE39</b>	The AAEC mode is not allowed with current kV-setting. OR A lower kV-setting is not allowed with the AAEC.	Increase the kV-setting first if you wish to use AAEC.
<b>HE40</b>	The advanced AEC mode can not be used with the aluminium filter.	Select the molybdenum filter.

### 3 ERROR MESSAGES SHORTFORM TABLE

The following is a list of all currently available error messages. For a detailed discussion about fault finding, please refer to paragraph "TROUBLESHOOTING & FAULTFINDING" on page G-1.

**NOTE** *Error messages marked with an asterisk (\*) are not stored in the internal error list. These error share the same meaning as the respective HELP messages*

Table 14: Error Codes Short Form Table

Er	ERROR MESSAGE EXPLANATIONS
Er00*	Exposure switch was released too early during the exposure
Er01*	Magnification exposures cannot be taken with the Bucky connected. Remove the Bucky grid.
Er02*	Bucky is not correctly positioned or the paddle size sensing microswitch signal is wrong
Er03*	There signal from the selected AEC-sensor is too low or missing completely, or the radiation reaching the sensor is extremely low or missing completely, or the small focus is accidentally selected (instead of normal)
Er04*	The cassette is not properly positioned on the cassette table, or a problem with the cassette sensing switch
Er05*	The cassette was not removed from the unit after the last exposure (double exposure prevention)
Er06*	The cassette guides are not positioned firmly against the sides of the cassette, or a problem with the cassette size sensing switches
Er07*	A large cassette with a small lower paddle is not allowed, or a problem with the size sensing switches
Er08*	A small cassette with a large lower paddle is not allowed, or a problem with the size sensing switches
Er09*	Exposure is not allowed before you select a projection, or the cassette table is in the LOAD-position
Er10	X-ray tube Anode voltage (kV) overshoot
Er11	X-ray tube Anode voltage (kV) dropped suddenly
Er12	X-ray tube cathode filament pre-heating voltages are not calibrated
Er13	X-ray tube Anode current (mA) sudden peak (possible X-ray tube arching)
Er14	AEC-sensor(s) are not calibrated
Er15	Failure in the currently selected AEC-sensor (occurs mainly during calibration of the AEC-sensor)
Er16	AEC-sensor feedback signal open circuit failure
Er17	Bias values for normal and small focus are not selected
Er18	kV fine-adjustment parameter values in TUBE CPU differ from the values in REAR CPU
Er20	Mirror motor time-out. The mirror mechanism doesn't reach the limit sensor within a specified time
Er21	Filter motor time-out. The filter mechanism doesn't reach the limit sensor within a specified time
Er22	Collimator motor time-out. The collimator mechanism doesn't reach the limit sensor within a specified time. OR Cutter motor time-out. The cutter mechanism doesn't reach the sensor within a specified time.
Er23	Labeling motor time-out. Labeling disc magnet does not pass the reference sensor within specified time
Er24	Bucky grid motor time-out. The grid does not move or there is no signal from sensor within a specified time
Er25	MAG/LOAD motor error. No pulses from motor even if the motor is driven.
Er26	X-ray tube anode doesn't rotate properly, or a problem in the anode motor rotation sensing

Table 14: Error Codes Short Form Table (Continued)

Er	ERROR MESSAGE EXPLANATIONS
<b>Er27</b>	Compression motor time-out. The mechanism doesn't reach the limit sensor within a specified time
<b>Er28</b>	Compression force measurement calibration failure, force signal out of range
<b>Er29</b>	Membrane keyboard key short-circuited/pressed or faulty display board during the self test
<b>Er30</b>	X-ray tube Anode voltage (kV) missing, dropping during exposure or lower than the setting
<b>Er31</b>	X-ray tube Anode current (mA) missing, dropping during exposure or lower than the setting
<b>Er32</b>	X-ray tube Anode current (mA) higher than the setting
<b>Er33</b>	X-ray tube Filament voltage (V) missing, or outside the required (too low or too high)
<b>Er34</b>	X-ray tube Bias voltage (V) power supply circuitry failure
<b>Er35</b>	The Mains-sync signal from the SYNC PCB is not reaching the TUBE-CPU
<b>Er36</b>	The REAR CPU detected a too long exposure (>10sec) and terminated it
<b>Er37</b>	kV feedback signal open circuit
<b>Er38</b>	mA feedback signal open circuit
<b>Er39</b>	Cassette table key failure or pressed during self test
<b>Er40</b>	Lower compression paddle not firmly inserted or lifted up by something obstructing it, or problem with the lower compression paddle size identification switches
<b>Er41</b>	C-arm angle-, Lift mechanism height-, or Compression paddle positional information was wrong
<b>Er42</b>	Spurious pulses from C-arm motor rotation sensor, or the motor rotates even if not commanded
<b>Er43</b>	No pulses from C-arm rotation motor rotation sensor, or motor does not rotate even if commanded
<b>Er44</b>	MAG-motor is rotating even if not commanded, or spurious pulses from MAG-motor rotation sensor
<b>Er45</b>	Lift- motor is rotating even if not commanded, or spurious pulses from Lift-motor rotation sensor
<b>Er46</b>	No pulses from Lift-motor rotation detector, or motor does not rotate even if commanded
<b>Er47</b>	Mains frequency out of range (45...65 Hz) or failure in frequency measurement circuitry
<b>Er48</b>	Failure in the STEREOTACTIC-device stepper motor or its control circuitry or in the rotation sensors
<b>Er49</b>	The STEREOTACTIC-device shelf is not at the end position sensor, or a failure in the sensor
<b>Er50</b>	Tube head assembly temperature sensor short circuit
<b>Er51</b>	Tube head assembly temperature sensor open circuit
<b>Er52</b>	Filament voltage feedback open circuit
<b>Er53</b>	Power supply heatsink temperature sensor short circuit
<b>Er54</b>	Power supply heatsink temperature sensor open circuit
<b>Er55</b>	C-arm rotation reference sensor failure
<b>Er56</b>	Compression mechanism release limit sensor failure during calibration
<b>Er57</b>	Exposure switch failure (short circuit) or pressed during self test
<b>Er58</b>	Foot control switch failure (short circuit) or pressed during self test
<b>Er59</b>	Failure in internal emergency STOP-system

Table 14: Error Codes Short Form Table (Continued)

Er	ERROR MESSAGE EXPLANATIONS
<b>Er60</b>	TUBE CPU internal $\pm$ 15VDC voltage is out of limits
<b>Er61</b>	Failure or sporadic disturbance in serial communication between TUBE- and REAR-CPU or non compatible software versions
<b>Er62</b>	Failure or sporadic disturbance in serial communication between REAR CPU and external test device
<b>Er63</b>	Error in STOP communication line between TUBE- and REAR-CPU
<b>Er64</b>	Error in exposure communication line between TUBE- and REAR-CPU
<b>Er68</b>	Both switches (paddle down and paddle up) of one foot control are pressed down.
<b>Er71</b>	Software chip (EPROM) failure on TUBE CPU
<b>Er72</b>	Software chip (EPROM) failure on REAR CPU
<b>Er73</b>	REAR CPU attempted to execute an illegal program instruction
<b>Er74</b>	REAR CPU watchdog reset occurred (please contact Planned)
<b>Er75</b>	REAR CPU illegal interrupt detected (please contact Planned)
<b>Er76</b>	REAR CPU timer interrupt error (please contact Planned)
<b>Er77</b>	REAR CPU stack overflow (please contact Planned)
<b>Er78</b>	Time-of-day clock oscillator (32768 Hz) not oscillating or out of tolerance
<b>Er79</b>	TUBE-CPU stack overflow (please contact Planned)
<b>Er80</b>	REAR CPU parameter memory (EEPROM) failure
<b>Er81</b>	TUBE CPU parameter memory (EEPROM) failure
<b>Er82</b>	REAR CPU CONFIG-register contains wrong data
<b>Er83</b>	TUBE CPU CONFIG-register contains wrong data
<b>Er84</b>	REAR CPU parameter memory (EEPROM) is empty or erased
<b>Er85</b>	Flat battery on REAR CPU (RAM stand-by NiCad battery is drained or has failed)
<b>Er86</b>	Short mains voltage abruption or drop was detected, or error in detection circuitry
<b>Er87</b>	Illegal country code or country code not set
<b>Er 88</b>	Battery back-up memory (RAM) is erased
<b>Er 89</b>	Wrong type C-ram rotation motor sensor in the EEPROM memory
<b>Er90</b>	Wrong type of rotation motor rotation sensor (must be a HEDS-type sensor if Stereotactic system is used)
<b>Er91</b>	Error in the STEREOTACTIC-sensor system (both end limit sensors are on simultaneously)
<b>Er92</b>	Error in the MAG/LOAD movement sensor system (simultaneous signals from both end limit sensors)
<b>Er93</b>	Error in the compression system end limit sensors (simultaneous signals from both end limit sensors)
<b>Er94</b>	Error in the C-arm rotation sensor system (simultaneous signals from the reference and/or limit sensors)
<b>Er95</b>	Error in the lift mechanism sensor system (simultaneous signals from both end limit sensors)
<b>Er96</b>	Error in the Bucky mechanism or in the sensor or in the movement of the mechanism. (This error is NOT displayed, but is stored in the error list)

Table 14: Error Codes Short Form Table (Continued)

Er	ERROR MESSAGE EXPLANATIONS
<b>Er97</b>	No pulses from the MAG/LOAD motor rotation sensor, or the motor does not rotate even if commanded

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## 4 DETAILED ERROR MESSAGE EXPLANATIONS

The purpose of the error messages is to make faultfinding easier. The internal list of the last 49 error occurrences is of a great help since it contains additional information, such as time, date and other exposure parameters and settings when the error occurred. Please refer to paragraph "SERVICE MODE FUNCTIONS SHORT-FORM" on page C-4 how to display (or print) the error list. This chapter discusses in greater detail the errors and gives background information about reasons for the errors. If you need further assistance with faultfinding, please refer to paragraph "TROUBLESHOOTING & FAULTFINDING" on page G-1.

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### 4.1 ERRORS 00-09 (User related, not stored in internal error list)

These errors usually indicate that some external circumstance causes a situation where the unit refuses to continue with the exposure. These errors can easily be corrected by the user. However, some of these errors could be caused by a malfunctioning sensor, cable or switch and the following explanations should help in detecting the problem.

#### **ER00 - Exposure switch was released too early during exposure**

The most probable cause (if the switch really was pressed firmly during the whole exposure) is a bad exposure switch or faulty spiral cable, or interconnection cable. The signal from the switch can be viewed in the service mode for easier faultfinding. The signal goes from the switch to the remote control box, and from here to the BASE PCB and REAR CPU.

#### **ER01 - Magnification is not possible with Bucky installed**

Remove the Bucky cable plug from the connector under the cassette table. If this error appears even with no Bucky connected, there is a problem in indentifying if the Bucky is connected or not. The identifying signal can be monitored in the service mode for easier faultfinding. The Bucky signals goes to the TUBE CPU. Check the wiring and as a last remedy, change the TUBE CPU.

#### **ER02 - Bucky is not inserted but cable is connected**

If the Bucky grid is inserted with the attaching pins all the way down into the holes, and the error still occurs, then there is a problem in identifying the compression paddle through the rear fingers. There are two microswitches (one inside each pin hole) identifying the paddle size and existence. Check the operation of these switches, their signals can be viewed in the service mode for easier faultfinding. There could be a bad microswitch or a faulty cable or connector. The signals from these switches goes through the FRONT COLLECTOR PCB and REAR COLLECTOR PCB boards to the REAR CPU.

#### **ER03 - No or too low signal from the AEC-sensor**

The TUBE CPU doesn't get any signal from the AEC SENSOR PCB during the exposure or very little radiation is reaching the selected sensor. Check first if there are any foreign objects obstructing the beam. Check that the small focus has not been accidentally selected instead of the normal size one. Check if the other two sensors give the same error. If not, then the AEC sensor assembly must be replaced. If the tube is really producing a beam that reaches the sensor (check with a fluorescent screen) and this error still occurs it is an indication that the AEC sensor signal is not reaching the TUBE CPU. Probably the AEC-sensor PCB produces a signal but there is a break or bad contact somewhere. Check the wiring from the sensor to the TUBE CPU. Change the AEC-sensor assembly. The last one to change is the TUBE CPU or POWER SUPPLY.

#### **ER04 - The cassette is not properly positioned**

The cassette rear edge is not touching the labeling head assembly front edge where the sensing button is located. If the button is pressed and the error still repeats, then there is a problem with the sensing microswitch or its cabling. Check that the microswitch is not mechanically damaged or obstructed. The switch signal can be monitored in the service mode for easier faultfinding. Check the wiring starting from inside the labeling device. The signal goes from the switch through the LABELING PCB and SHELF COLLECTOR PCB to the TUBE CPU. Change the TUBE CPU as last remedy.

**ER05 - Cassette was not removed since the previous exposure**

If the cassette was removed but this error still appears, perform the same checks as in ER04.

**ER06 - The cassette table edges are not firmly against the cassette side**

There are two microswitches under the cassette table indicating that the table is in either extreme position. Check that nothing is obstructing the table movement. If however this error appears even if the cassette table is fully in either extreme position then there is a problem with the switch(es) or in the cabling. The switch signals can be monitored in the service mode for easier faultfinding. Check the condition of the microswitches and that all cables and connectors are firmly connected. The signals go from these switches through the SHELF COLLECTOR PCB to the TUBE CPU.

**ER07 - Cassette size identification problem**

A large cassette is not allowed with a small lower compression paddle. The side edges of the narrow compression paddle would interfere with the cassette table. If you use an allowed combination (or no lower compression paddle at all) and this error still occurs, then there is a problem in either the paddle size recognition or the table position recognition. Make the same tests as in errors ER02 and/or ER06

**ER08 - Cassette size identification problem**

A small cassette is not allowed with a large lower compression paddle. The film labeling device is so much forward that it would collide with the lower compression paddle. If you use an allowed combination (or no lower compression paddle at all) and this error still occurs, then there is a problem in either the paddle size recognition or the table position recognition. Make the same tests as in errors ER02 and/or ER06.

**ER09 - No projection angle is selected**

Exposure is not allowed if the cassette table is in the load position or if no projection is selected.

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**4.2 ERRORS 10-16 (X-ray safety and AEC-sensor related)**

These errors are related to built-in safety circuitry, monitoring the performance of the x-ray tube during the exposures. All these errors stop the radiation immediately even in the middle of an exposure. The partially exposed film should be developed to see if a retake is necessary

**ER10 - X-ray tube anode (kV) voltage overshoot**

This condition is monitored (by the TUBE CPU hardware) during the whole exposure and if the anode voltage rises above 40 kV the exposure is immediately aborted and this error indicated. Possible reasons are: Partial x-ray tube arcing (current spikes can cause the voltage regulating electronic servo to overshoot). This kind of sparking 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 tubehead. If this error occurs constantly it is probably caused by a faulty POWER SUPPLY or TUBE CPU or TUBE HEAD (replace in this order). A bad galvanic contact between the power supply heatsink surface (the small rectangular surfaces under the power supply bottom) and the mating tubehead cast surfaces, could cause this error, so these surfaces must be totally clean and grease-free, and the power supply firmly tightened to the tube-head (not too tight).

**ER11 - X-ray tube anode (kV) voltage dropped suddenly**

This condition is monitored (by the TUBE CPU hardware) during the whole exposure and if the voltage suddenly drops more than 6 kV below the actual setting, the exposure is aborted and this error indicated. Possible reasons are: X-ray tube housing arcing (a knocking sound can be heard) either spuriously (should be considered quite normal if it doesn't occur frequently). Make the same tests as in ER10.

**ER12 - X-ray tube filament pre-heating voltages are not calibrated**

See paragraph "X-ray tube filament preheating voltage calibration" on page F-14 for details how to perform the calibration. The TUBE CPU has EEPROM nonvolatile memory that contains parameters such as the preheat voltages for the x-ray tube filaments, and AEC-sensor calibration values. These parameters must be re-calibrated whenever the TUBE CPU is replaced (alone, or together with the POWER SUPPLY).

**ER13 - X-ray tube anode current (mA) was too high**

This condition is monitored (by the TUBE CPU hardware) during the whole exposure and if the current suddenly jumps above 180 mA, the exposure is immediately aborted and this error indicated. Possible reasons are: Spurious X-ray tube arcing, that should be considered quite normal if it doesn't occur frequently. If this error occurs frequently or all the time, change the POWER SUPPLY, TUBE CPU, TUBE HEAD (in this order).

**ER14 - AEC-sensors are not calibrated**

See paragraph "AEC-sensor calibration" on page F-15 for details how to perform the calibration. The TUBE CPU has internal memory that contains parameters such as AEC-sensor calibration values and the pre-heat voltages for the x-ray tube filaments. These parameters must be re-calibrated whenever the TUBE CPU is replaced (alone, or together with the POWER SUPPLY).

**ER15 - AEC-sensor calibration failure**

This error occurs only during the calibration procedure. The TUBE CPU is not capable to adjust the AEC-sensor gain in such a way, that the parameters would fall within an allowed range. Check that you have nothing else in the beam (such as a cassette, compression paddle or other obstacles) except for the AEC-calibrating phantom, and that the phantom is covering the whole sensor surface (the black area at the front of the cassette table). If the error still occurs, check the sensor cables and connectors. If no problem with these can be found, replace the AEC-sensor assembly, and as the last remedy the TUBE CPU.

During calibration= calibration failure, during exposure = sensor not calibrated or there is no signal (or weak) from the sensor after 400 ms.

**ER16 - AEC sensor feedback cable open circuit**

There is an open circuit between the AEC sensor board in the cassette table and the TUBE CPU. Check for any pinched or broken wires, especially if you have been working inside the cassette table where the AEC board is located.

**ER17 - Bias values for normal and small focus are not selected**

This error can occur after replacing the TUBE CPU board, or if the filament preheating voltage initialization procedure was not finished properly. Please refer to "X-ray tube filament preheating voltage calibration" on page F-14 for details how to perform the calibration.

**ER18 - kV fine-adjustment parameters in TUBE CPU differ from the parameters in REAR CPU**

Both the REAR CPU and the TUBE CPU contain the kV fine-adjustment parameters. If parameters in one CPU differ from parameters in the other, this error message occurs when the unit is switched on.

Entering the kV fine-adjustment mode sets the parameters the same in both CPU's. See paragraph "kV-value fine-adjustment" on page F-16 for detailed instructions. You do not have to change the parameter values, but it is recommended to confirm that the values correspond to the current circumstances.

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**4.3 ERRORS 20-29 (motion and compression related)**

These errors are related to monitoring the movement of all motorized mechanisms. The time-out means that a motor driven mechanism doesn't reach a position hall-sensor within a specified time. This time-out function ensures that the motor is turned off in case of a mechanical, electrical or sensor failure. See paragraph "MOTOR & MOTION RELATED PROBLEMS" on page G-2 for detailed descriptions for faultfinding. See paragraph "ADJUSTING SENSORS & SWITCHES" on page F-44 for detailed instructions how to adjust the hall sensors.

**ER20 - Mirror stepper motor time-out**

The mirror driving mechanism inside the collimator assembly doesn't reach its limit sensor or the sensor signal is missing. The sensor is located on the COLLIMATOR PCB that also have an indicator-LED that should be lit when the magnet is at the sensor. The signal reaching the TUBE CPU can be monitored in the service mode for easier faultfinding. Check the position of the magnet and sensor if the mechanism seems to work properly.



There could be a fault on the TUBE CPU PCB stepper motor driver electronics if this error always occurs after turning on the unit and there is no sound from any of the stepper motors inside the beam limiting device, especially if the mirror mechanism and sensors seems to be OK. The unit performs a test sequence at power-up, starting with the mirror motor. If the stepper motor control electronics on the TUBE CPU is faulty then no other stepper motors (filter, collimator, labeling disk, bucky, stereotactic) could either be driven. Since the test fails at the first motor (mirror motor) then the ER20 is reported.

Make sure that there are no short circuited wires at the tubehead or at the COLLIMATOR BOARD, and that all screws in the collimator are tight (no screws touching the collimator board). Replace the TUBE CPU board when you have ensured that there are no short circuits.

**ER21 - Filter stepper motor time-out**

The filter driving mechanism inside the collimator assembly doesn't reach its limit sensor or the sensor signal is missing. The sensor is located on the COLLIMATOR PCB that also have an indicator-LED that should be lit when the magnet is at the sensor. The signal reaching the TUBE CPU can be monitored in the service mode for easier faultfinding. Check the position of the magnet and sensor if the mechanism seems to work properly.

**ER22 - Collimator stepper motor time-out OR Cutter motor time-out**

The collimator driving mechanism inside the collimator assembly doesn't reach its limit sensor or the sensor signal is missing. The sensor is located on the COLLIMATOR PCB that also have an indicator-LED that should be lit when the magnet is at the sensor. The signal reaching the TUBE CPU can be monitored in the service mode for easier faultfinding. Check the magnet holder so that is not loose.

The cutter driving mechanism does not reach the reference optical-slot sensor within a predetermined time. The sensor is located on the CUTTER PCB. The mirror indicator-LED located on the COLLIMATOR PCB should be lit when the mechanism is at the sensor. Check if the mechanism is working properly, i.e. the motor is running and the sensor signal is not missing.

**ER23 - Labeling stepper motor time-out**

The rotating labeling disk inside the cassette rear guide (the labeling device) doesn't pass its reference sensor or the sensor signal is missing. The sensor is located under the rotating disk. The signal reaching the TUBE CPU can be monitored in the service mode for easier faultfinding. Check that the disk can rotate freely and that the sensor is not too far from the magnet. Indicator on shelf-PCB.

**ER24 - Bucky stepper motor time-out**

The Bucky grid mechanism inside the Bucky assembly doesn't pass the reference optical-slot sensor within a predetermined time. Check that the Bucky cable connector is firmly inserted. Check with another Bucky if the problem is in the unit or Bucky. The sensor signal reaching the TUBE CPU can be monitored in the service mode for easier faultfinding. Indicator on shelf-PCB

**ER25 - Magnification DC-motor time-out**

The MAG/LOAD mechanism motor is not rotating or the rotation sensor signal is missing. The motor and sensor are located at the rear of the tube-head assembly. There is no indicator-LED for this signal but the signal can be monitored in the service mode for easier faultfinding. Check that the sensor is not too far from the rotating magnet on the motor shaft.

**ER26 - X-ray tube anode AC-motor rotation problem**

The anode is not rotating or is rotating at wrong speed, or a problem in the rotation sensing system. The TUBE CPU is monitoring the voltage waveforms at the motor windings just before the exposure starts. If an abnormal condition is detected the exposure is inhibited to protect the tube anode from possible damage due to local overheating.

If this error occurs only occasionally it is recommended to perform the tube filament definition procedure, see paragraph "X- ray tube filament preheating voltage calibration" on page F-14 how to do this. This procedure corrects also for small tolerance changes in the anode motor control circuitry by storing new reference values in TUBE CPU memory.

A faulty or disconnected anode motor capacitor (the 2 capacitors located on the rear side of the tube head) also can cause this error. Check the capacitor cables and connectors for good contact.

A fault in the tube head internal stator winding or its wiring could also be the case. Check the winding resistances through the 32-way connector, after you have removed the power supply.

Check also the condition of the tubehead connector and its mating connector in the power supply.

If the anode motor is not rotating at all (no hissing sound can be heard from inside the tubehead) it is possible that the anode stator protection FUSE is blown inside the POWER SUPPLY. See paragraph "Power supply fuses" on page H-10 for instructions how to replace it. If the anode motor starts immediately after turning on the unit then the POWER SUPPLY is faulty and needs to be replaced.

If the motor seems to accelerate and brake normally to about full stop and the filament definition procedure doesn't help, the problem is in the POWER SUPPLY or TUBE CPU.

The measured phase difference (in milliseconds) between the two motor windings should be between 4 to 7 milliseconds. For additional diagnostic use this measured time difference is displayed on the clock display (but only in service mode) after an exposure.

#### **ER27 - Compression stepper motor time-out**

The upper compression paddle driving mechanism doesn't reach its limit sensor or the sensor signal is missing. There are 3 hall-sensors (one lower and two upper ones) that also have respective indicator-LEDs (on the FRONT COLLECTOR PCB) that should be lit when the magnet is at the sensor. The signals reaching the REAR CPU can be monitored in the service mode for easier faultfinding. 1 minute time-out.

#### **ER28 - Compression force measurement error**

The REAR CPU is not capable of measuring/adjusting the compression force. The FORCE SENSOR PCB and the STRAIN GAUGE sensor are located under the upper compression mechanism. Check the cables and connectors. Make a visual check that the strain gauge is properly glued to the surface of the aluminium strain-block. If no problem with these can be found, replace the FORCE-sensor assembly together with the STRAIN GAUGE. As the last remedy replace the REAR CPU. The unit can be temporarily operated even if the force sensor is faulty.

#### **ER29 - Keyboard key short-circuit**

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 keyboard keys are arranged in a matrix, one key's short could cause the whole keyboard to act erroneously, therefore this check is important. Normally the unit can be operated even if one keyboard is faulty, since they operate independently. You still have to determine which keyboard is the faulty one.

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### **4.4 ERRORS 30-38 (tube head and power supply related)**

These errors are related to software diagnostics, monitoring the performance of the x-ray tube and power supply before and during exposures. All these errors stop the radiation immediately even in the middle of an exposure. The partially exposed film should be developed to see if a retake is necessary.

#### **ER30 - X-ray tube Anode voltage (kV) missing or too low**

The tube voltage is sampled periodically (by the TUBE CPU) and if the actual measured kV-value is below the setting this error is displayed. Check that the incoming mains voltage doesn't drop below 187 Vrms during the exposure. A partial failure of the voltage multiplier inside the tube-head could cause this error to occur, especially at higher mA-settings. Try to perform the filament definition procedure. If this doesn't help and the error occurs constantly replace the POWER SUPPLY, TUBE CPU and/or TUBE-HEAD (replace in this order).

#### **ER31 - X-ray tube Anode current (mA) missing or too low**

The tube current is sampled periodically (by the TUBE CPU) and if the actual mA-value is lower than the setting then this error is displayed. Proceed with the filament definition, see paragraph "X-ray tube filament preheating voltage calibration" on page F-14 for details. An open circuit inside the tubehead in the filament circuit could also produce this error. Check the filament resistances (<0.5 ohm) through the 32-way tubehead connector, please refer to the schematics. Check also the mA-feedback resistance through this same connector. If the error occurs constantly replace the POWER SUPPLY, TUBE CPU, TUBE-HEAD (replace in this order).

**ER32 - X-ray tube Anode current (mA) too high**

The tube current is sampled periodically (by the TUBE CPU) and if the actual measured mA-value is above the setting the error occurs. If the filament preheating voltage is incorrect it could cause this error to be displayed. Proceed with the filament definition, see paragraph "X-ray tube filament preheating voltage calibration" on page F-14 for details. Check the filament resistances (<0.5 ohm) through the 32-way tubehead connector (please refer to the schematics) and replace the TUBE-HEAD if necessary. If the error occurs constantly replace the POWER SUPPLY, TUBE CPU, TUBE-HEAD (replace in this order)

**ER33 - X-ray tube Filament voltage (V) missing or outside specification**

The tube filament voltage is sampled periodically (by the TUBE CPU) and if the actual measured filament voltage differs from the required then this error is displayed. Performing the filament definition to recalibrate the filament voltages could help, see "X-ray tube filament preheating voltage calibration" on page F-14 for details.

The filament power supply (inside the POWER SUPPLY) could be faulty, or that there could be a problem in the filament feedback signals. Replace the POWER SUPPLY, TUBE CPU, TUBE-HEAD (replace in this order). The filament voltage is displayed in the service mode during exposures in the SEC-display.

**ER34 - X-ray tube Bias voltage (V) error**

The bias voltage control circuitry is not able to control the X-ray tube grid bias voltage. The problem is either in the POWER SUPPLY or the TUBE-HEAD. If this error occurs repeatedly, change the POWER SUPPLY and/or the TUBE-HEAD (replace in this order).

**ER35 - Mains Sync-pulses don't reach the TUBE-CPU**

Check the wires and cables between the two processors, please refer to the schematics.

**ER36 - Too long exposure (>10 sec) was terminated by the REAR CPU**

The exposure is normally always timed and terminated by the TUBE CPU, or whenever the user releases the exposure switch. If, however, the TUBE CPU would fail and continue the exposure more than 10 seconds, then the REAR CPU would terminate the exposure. This is a safety procedure, that guarantees that the exposure is terminated under all conditions. Replace the TUBE CPU if this error occurs repeatedly.

**ER37 - kV feedback signal open-circuit**

There is an open circuit in the kV-feedback signal from the TUBE HEAD to the TUBE CPU. When the feedback signal is open circuited, the TUBE CPU prevents all exposures (normal and service mode) to ensure TUBEHEAD safety. Check the condition of the 32-way TUBEHEAD connector and the mating one in the POWER SUPPLY. Remove the POWER SUPPLY and measure the kV- feedback resistance at the 32-way tubehead connector, please refer to the schematics. Replace the TUBE CPU, POWER SUPPLY or TUBE HEAD (in this order) if you cannot find the problem.

**ER38 - mA feedback open circuit**

There is an open circuit in the mA-feedback signal from the TUBE HEAD to the TUBE CPU. When the feedback signal is open circuited, the TUBE CPU prevents all exposures (normal and service mode) to ensure TUBEHEAD safety. Check the condition of the 32-way TUBEHEAD connector and the mating one in the POWER SUPPLY. Remove the POWER SUPPLY and measure the mA- feedback resistance at the 32-way tubehead connector, please refer to the schematics. Replace the TUBE CPU, POWER SUPPLY or TUBE HEAD (in this order) if you cannot find the problem.

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**4.5 ERRORS 40-49 (sensor & switch related)****ER40 - Lower compression paddle is tilted upwards**

If this error occurs the MAG/LOAD mechanism movement towards the contact view position is inhibited. Make sure that the lower paddle doesn't collide with the cassette or any other objects. Check also the operation and correct adjustment of the paddle size identification switches. The signals reaching the REAR CPU can be monitored in the service mode for easier faultfinding. There are also LEDs on the front-collimator PCB displaying the signals from these two microswitches.

**ER41 - C-ARM, LIFT- or Compression position information was lost or erroneous**

The position information is stored on the REAR CPU in battery backup RAM. If the unit has been stored for several months some positional information might be lost. Running the respective mechanisms from end to end will restore the position information.

**ER42 - C-ARM is rotating even if not commanded, or spurious pulses from sensor**

If the C-ARM really rotates after turning on the power; check that the connectors at the REAR COLLECTOR PCB are not cross connected (some of them have the same pin count). This could be the case especially after servicing the unit when the REAR COLLECTOR PCB has been removed.

If the arm still rotates without the user intervention, replace the SYNC PCB. If there is not rotation but this error still occurs, check the motor rotation sensor signal that there are no spurious pulses. Replace the SYNC or REAR CPU.

**ER43 - C-ARM motor rotation sensor pulses don't reach the REAR-CPU**

- a) If the motor doesn't rotate: please check for mechanical obstruction, check motor condition and cables going to the SYNC-PCB, check motor capacitor condition and connections. Check cables from SYNC PCB to REAR COLLECTOR PCB. Replace the SYNC PCB if necessary.
- b) If the motor rotates: Check the rotation sensor wire from the motor to the REAR COLLECTOR-PCB. The motor rotation sensor could be faulty. The signal can be monitored on the REAR COLLECTOR-PCB, as well as in the service mode.

**NOTE** *The motor contains a self-resetting circuit breaker that operates if the motor becomes too hot. Allow the motor to cool down before continuing the faultfinding.*

**ER44 - MAG-motor is rotating even if not commanded or spurious pulses from sensor**

If the motor really is running by itself it might be because of a failure on the MAG-PCB (in close proximity with the motor). Check the pulse sensor cable connections.

**ER45 - LIFT-motor is rotating even if not commanded spurious pulses from sensor**

If the motor is running by itself, change the check or change the BASE-PCB. If the motor is not running by itself, please check the rotation sensor and its connections and the spiral wire connections going from the BASE-PCB to the REAR COLLECTOR PCB.

**ER46 - No pulses from the LIFT-motor rotation sensor or the motor is not rotating**

Check spiral cable condition and connections between the BASE-PCB to the REAR COLLECTOR PCB.

- a) If the motor doesn't rotate: please check for mechanical obstruction, check motor condition and cables going to the BASE-PCB, check motor capacitors condition and connections.
- b) If the motor rotates: Check the rotation sensor wires from the motor to the REAR COLLECTOR-PCB. The motor rotation sensor could be faulty. The signal can be monitored on the BASE-PCB, as well as in the service mode.

**NOTE** *The motor contains a self-resetting circuit breaker that operates if the motor becomes too hot. Allow the motor to cool down before continuing the faultfinding.*

**ER47 - Mains frequency out of range**

The unit is designed to operate on a mains frequency range of 47 to 63 Hz. If the mains is OK but this error still occurs repeatedly, please check the condition of the mains wire connections, check or replace the SYNC-PCB.

**ER48 - Failure in STEREOTACTIC stepper motor control circuitry or sensors**

There is no indication that the STEREOTACTIC mechanism stepper motor is rotating. The motor rotation is always monitored for safety reasons. Either the mechanism is obstructed or overloaded, the motor is not getting proper power, or there is a problem in the rotation sensors or in the electronics.

Check the distance from the infrared reflecting sensors to the rotating reflector disc. If this error occurs close to the mid-position when moving from side to side, it could be an indication that the sensors are too far from the reflector disc. At the stereotactics center position the disk is at maximum distance from the sensors. Carefully bend the sensors closer to the disc, ensuring that the sensors does not touch the reflecting disc when it is at its closest position.

**ER49 - The STEREOTACTIC shelf is not at the end position**

The end positions (left/right) are monitored by sensors for safety and precision. This error is displayed if the mechanism doesn't reach the sensor after a certain number of stepping pulses to the motor. The sensor could be faulty or not adjusted properly, or there could be a break in the sensor signal wires.

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**4.6 ERRORS 50-59 (temperature & special sensor related)****ER50 - Tube-head temperature sensor open circuit**

See ER51. If the problem doesn't disappear by disconnecting the sensor wire from the MAG PCB, check the cables or change the TUBE-CPU PCB.

**ER51 - Tube head temperature sensor short-circuit**

All exposures are inhibited by the TUBE CPU during this condition. The tube-head temperature is measured by the TUBE CPU using a sensor at the rear of the tube head. The sensor is a NTC resistor and has a nominal resistance of 1k $\Omega$  at 25 °C. Check the cable and connector from the sensor to the MAG PCB, and/or the connector and cables from the MAG-PCB to the POWER SUPPLY. The sensor can be verified with an ohm-meter. The other wire of the sensor is connected to the chassis ground (at the rear of the tubehead cast), check that this wire is not loose or open.

**ER52 - Filament voltage feedback open circuit**

There is an open circuit in the filament voltage feedback from the TUBE HEAD to the TUBE CPU. When the feedback signal is open circuited, the TUBE CPU prevents all exposures (normal and service mode) to ensure TUBEHEAD safety. Check the condition of the 32-way TUBEHEAD connector and the mating one in the POWER SUPPLY. Remove the POWER SUPPLY and measure the filament feedback resistance at the 32-way tubehead connector, please refer to the schematics. Replace the TUBE CPU, POWER SUPPLY or TUBE HEAD (in this order) if you cannot find the problem.

**ER53 - Power Supply Heatsink temperature sensor short circuit**

All exposures are inhibited by the TUBE CPU during this condition. The temperature of the heat-sink inside the POWER SUPPLY is measured by the TUBE CPU with a similar sensor as the tubehead temperature (see ER50). This sensor is located inside the POWER SUPPLY and cannot be replaced. Replace the TUBE-CPU or the POWER SUPPLY (in this order).

**ER54 - Power Supply Heatsink temperature sensor open circuit**

Please see ER53.

**ER55 - C-ARM upright position sensor failure**

The ROTATION REFERENCE PCB in the rear of the moving column is not functional or there is a problem in the wiring. Check the cable from the REAR COLLECTOR PCB to the ROTATION REFERENCE PCB. This PCB has two LED indicators; one for power, the other for the signal. Please note that this sensor gets power only during the operation or the rotation motor (during service mode the sensor is powered constantly).

**ER56 - Compression mechanism RELEASE sensor failure**

Occurs only during calibration. There is no signal from the release sensor.

**ER57 - Exposure switch failure (short circuit) during self test**

Check the external exposure switch and remote control box cables for damage or short circuit. Disconnect the remote cable from the unit. If the error still occurs, the problem is internal. Check the wiring from the remote connector in the base to the BASE PCB, and the wires from here to the REAR COLLECTOR PCB. Replace the REAR CPU as the last remedy. The switch signal can be displayed also in the service mode.

**ER58 - Foot control switch failure (short circuit) during self test**

Any of the foot-control switches was activated during the self test. Check for mechanical damage on the switches. There are status indicator LEDs on the BASE PCB that can be used for fault-finding. The foot-control switch signals can be also displayed in the service mode.

**ER59 - Failure in internal emergency STOP system**

The REAR CPU is not able to pull low the internal emergency STOP-signal. If the STOP signal wiring is OK (this signal can be found on almost all boards) then replace the REAR CPU.

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**4.7 ERRORS 60-68 (serial communication & CPU voltage related)****ER60 - TUBE CPU internal  $\pm 15$  VDC is out of limits**

The analog circuitry in the TUBE CPU board needs proper  $\pm 15$ V voltages to operate. Turn off the unit for at least 30 seconds and turn it back on. If the problem still occurs, replace the TUBE CPU. If this doesn't help, then replace the POWER SUPPLY.

**ER61 - Failure in communication between TUBE-CPU and REAR-CPU**

Possible open circuit or bad connection in the serial communication wire between the two processors. Trace the SCL named line from the REAR CPU to the TUBE CPU. If this error occurs after replacing the software chips (EPROMs) in the unit, please check that the program chip(s) are properly inserted in the socket(s) and the software installed on both processor boards are compatible and can be used together. If everything seems to be OK (check also for possible short circuits), then replace the TUBE CPU or the REAR CPU (in this order).

**NOTE** *Please note that some earlier TUBE CPU boards had a jumper to determine the capacity of the software (EPROM) chip used. After replacing the software on such a board, the ER61 could be an indication that the jumper is in the wrong position.*

**ER62 - Failure in communication between REAR-CPU and external device**

If this error occurs after replacing a software chip, please check that the chip is correctly inserted in the socket and the new software is compatible. If this error occurs intermittently check the external wiring.

Possible open circuit or bad connection in the serial communication wire between the REAR CPU and an external device. Trace the SLL named line from the REAR CPU to the remote device. If everything seems to be OK (check also for possible short circuits), then replace the REAR CPU.

**ER63 - Error in STOP communication line between TUBE- and REAR-CPU**

Possible open circuit or bad connection in the serial communication wire between the two processors. Trace the STOP named line from the REAR CPU to the TUBE CPU. If everything seems to be OK (check also for possible short circuits), then replace the TUBE CPU or the REAR CPU (in this order).

**ER64 - Error in Exposure communication line between TUBE- and REAR-CPU**

Possible open circuit or bad connection in the serial communication wire between the two processors. Trace the Exp named line from the REAR CPU to the TUBE CPU. If everything seems to be OK (check also for possible short circuits), then replace the TUBE CPU or the REAR CPU (in this order).

**Er68 - Both switches (paddle down and paddle up) of one foot control are pressed down**

If the foot control is below the unit's base, check that the base does not press the switches down. If not, the most probable cause is a faulty foot control cable.

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**4.8 ERRORS 71-78 (CPU software related)**

The errors 71...77 usually indicate an error, that is either processor circuitry related, or an internal software error. In this case, please contact Planmed and, if possible, report the exact circumstances when this error occurred as well as the software version and unit serial number.

**ER71 - Software chip (EPROM) failure on the TUBE-CPU**

Check that the EPROM is properly inserted in its socket on the TUBE CPU (all pins make a good contact). If so, it could be that the contents of the EPROM is not valid. Replace it with a new software chip before continuing to use the unit. When replacing software, please use only compatible versions.

**ER72 - Software chip (EPROM) failure on the REAR-CPU**

Check that the EPROM is properly inserted in its socket on the REAR CPU (all pins make a good contact). If so, it could be that the content of the EPROM is not valid. Replace it with a new software chip before continuing to use the unit. When replacing software, please use only compatible versions.

**ER73 - REAR-CPU illegal program instruction**

If this occurs repeatedly try first to replace the software chip (EPROM) with a new one or replace the software chips in the unit to the most recent revision number. If this doesn't help, then replace the REAR-CPU board.

**ER74, ER75, ER76, ER77 REAR CPU program errors**

Replace the software in the unit (both REAR CPU and TUBE CPU) to the latest compatible revisions. If this doesn't help, please contact your PLANMED dealer.

**ER78 - REAR-CPU low frequency clock oscillator problem**

The 32768 Hz oscillator is not oscillating at all or is out of tolerance. In this case also the time-of-day clock would not advance or run at wrong speed. Replace the REAR-CPU.

**ER79 - TUBE-CPU stack overflow**

Please contact Planmed.

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**4.9 ERRORS 80-87 (CPU hardware related)**

Many of these error relate to wrong information in the EEPROM memory inside the CPU chips on respective board. Since the CPU chip is soldered directly to the board and is factory initialized, it is not possible to replace only the chip on the field. Please replace the whole board for repair at the PLANMED factory. Please remember that the possibility for these errors is very low. They are added to the error list just because of maximal system and patient safety.

**ER80 - REAR CPU parameter EEPROM-memory failure**

The CPU chip on the REAR CPU board is faulty and cannot be programmed. Replace the REAR CPU board.

**ER81 - TUBE CPU parameter EEPROM-memory failure**

The CPU chip on the TUBE CPU board is faulty and cannot be programmed. Replace the TUBE CPU board.

**ER82 - REAR CPU CONFIG register contains wrong data**

The CPU chip on the REAR CPU board contains wrong data in one of its configuration registers (this error occurs also if the chip is replaced with a wrong type, or if the chip initialization data is wrong or corrupted). Replace the REAR CPU board.

**ER83 - TUBE CPU CONFIG register contains wrong data**

The CPU chip on the TUBE CPU board contains wrong data in one of its configuration registers (this error occurs also if the chip is replaced with a wrong type, or if the chip initialization data is wrong or corrupted). Replace the TUBE CPU board.

**ER84 - REAR-CPU parameter EEPROM-memory is empty or erased**

The CPU chip on the REAR CPU board contains a list of some system parameters that is missing. Replace the REAR CPU board.

**ER85 - Flat NiCad battery for the battery back-up memory (RAM)**

This error message could occur if the unit has been switched off for a prolonged period (1 to 3 months or longer), or if the unit is not used more than a few minutes per day. In this case this error doesn't mean necessarily that there is something wrong with the unit. The time-of-day clock as well as many user selected parameters are stored in a memory on the REAR CPU board that relies on constant voltage backup. This voltage is supplied by a rechargeable NiCad battery when the unit is switched off, and the battery is charged whenever the unit is on.

If the unit is used on a regular basis but this error still appears repeatedly, the battery is faulty or the electronics on the REAR CPU board is excessively loading the battery. In this case replace the complete REAR CPU.

**ER86 - Short main voltage abrupton was detected**

This error can occur because a bad connection in the internal mains cabling, or if the impedance of the incoming mains is too high (if more than 1¼ and at extremely low mains voltage). If the mains is OK, there could be a problem with the detection circuitry.

**ER87 - Country code not set**

Before the unit can be operated and fulfils regional requirements, the country code must be set (please see "Regional setups before using the unit" on page F-1 for instructions). This country code is normally cleared in new units at the PLANMED factory, especially if the end customer is not known. Spare REAR CPU:s (that contain this data) are also cleared at the PLANMED factory to guarantee that this code is set initially by the service technician, before operating the unit with patients.

**ER88- Battery back-up memory (RAM) contents not valid**

A parameter in the memory has a wrong value. Check the parameters according to the tables given in paragraph "Factory preset (recalling settings for all parameters)" on page F-9.

If appears more than once, replace the REAR CPU board.

**ER89 - Wrong type of C-arm rotation motor sensor in the EEPROM memory**

There are two different types of C-arm rotation sensors. The HEDS-type rotation sensor is nowadays standard in all units. If the EEPROM memory contains a wrong sensor type, the C-arm upright position must be calibrated. See section "C-arm upright position calibration" on page F-12 for details how to calibrate the position.

---

**4.10 ERRORS 90-97 (Erroneous sensor signals)****ER90 - Wrong type of rotation sensor in C-arm rotation motor (during STEREOTACTIC)**

The STEREOTACTIC system requires that the C-arm rotation motor is equipped with a HEDS-type rotation sensor (the small black bow at one end of the motor). This sensor is nowadays standard in all units, with or without STEREOTACTIC added. However, the traditional motor rotation sensor (the internal non-visible HALL sensor) cannot be used in units with the STEREOTACTIC system installed. See "Lift motor replacement" on page H-26 for details how to replace the motor.

**ER91 - Error in STEREOTACTIC system sensor signals**

The two end limit sensor signals cannot be active simultaneously (mechanically impossible). If this would still happen, then this error is generated. Check the sensors and the wiring. The sensor signals are visible on LEDs on the SHELF COLLECTOR PCB and can also be displayed in the service mode.

**ER92 - Error in MAG/LOAD mechanism sensor signals**

The two end limit sensor signals cannot be active simultaneously (mechanically impossible). If this would still happen, then this error is generated. Check the sensors and the wiring. The signals are visible on LEDs on the SHELF COLLECTOR PCB and can also be displayed in the service mode.

**ER93 - Error in the compression mechanism sensor signals**

The two end limit sensor signals cannot be active simultaneously (mechanically impossible). If this would still happen, then this error is generated. Check the sensors and the wiring. The signals are visible on LEDs on the FRONT COLLECTOR PCB and can also be displayed in the service mode.

**ER94 - Error in C-arm mechanism sensor signals**

The two end limit sensor signals, or the ROTATION REFERENCE sensor signal cannot be active simultaneously (mechanically impossible). If this would still happen, then this error is generated. Check the sensors and the wiring. The signals are visible on LEDs on the REAR COLLECTOR PCB and can also be displayed in the service mode.



**ER95 - Error in lift mechanism sensor signals**

The two end limit sensor signals cannot be active simultaneously (mechanically impossible). If this would still happen, then this error is generated. Check the sensors and the wiring. The signals are visible on LEDs on the REAR COLLECTOR PCB and can also be displayed in the service mode.

**ER96 - Error in Bucky mechanism or sensor signal**

This error indicates missing steps in the stepper motor that controls the Bucky grid movement. If the grid is totally jammed or the sensors is faulty, then ER24 is generated. If there are visible (grid) lines on the film, please check the error list for ER96 occurrences. Check the proper operation of the grid movement with the help of the service mode. The grid plate should not hit either side of the support mechanism during the reciprocating movement.

**NOTE**      *The error ER96 is NOT displayed, it is only stored in the internal error list. If the exposed films have signs of grid lines (especially with exposure times longer than 0,4 sec), check the error list for ER96 occurrences.*

**ER97 - No pulses from the MAG/LOAD motor rotation sensor**

- a) If the motor doesn't rotate: please check for mechanical obstruction, check motor condition and cables going to the MAG PCB, and from here to the POWER SUPPLY and TUBE CPU.
- b) If the motor rotates: Check the rotation sensor wires to the MAG PCB. The motor rotation sensor could be faulty, the magnet is with the wrong pole against the sensor (after replacing parts), or the magnet too far from the sensor. The signal can be monitored in the service mode.
- c) If this error occurs after the initial self test: the STOP signal does not reach the TUBE CPU board. Follow this signal all the way from the REAR CPU board to the TUBE CPU, there is a break somewhere. If no error is found and the STOP circuitry is otherwise operational, then replace the TUBE CPU board.



# PREVENTIVE MAINTENANCE

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## 1 SYSTEM MAINTENANCE

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### 1.1 Cleaning

**CAUTION** *When disinfecting the unit surfaces, always disconnect the unit from the mains supply. The unit must not be exposed to gaseous disinfectants or explosive anesthetics.*

*Never spill any liquids into the unit. Compression paddles should not be cleaned using alcohol based solutions.*

The transparent compression paddles, as well as the lower compression paddles and BUCKY-devices, can be cleaned with NON-ALCOHOLIC disinfection solutions.

Never use alcohol based solutions for cleaning the paddles, the paddles can become brittle after prolonged cleaning with alcohol-based solutions.

#### Other unit surfaces

With a soft cloth damped in a cleaning solution.

---

### 1.2 Operator's maintenance schedule

The following inspections must be performed on a monthly basis by the responsible operator of the unit.

- a) **Exposure indicators**  
Confirm that both exposure indicators lights turns on in the control panels and the remote control for the length of the exposure. Check also the optional external indicator, if such is attached.
- b) **Audible exposure indicator**  
Confirm that the buzzer comes on for the length of the exposure. The lower pitch signal should sound during the 2 second start-up (anode acceleration and preheating of the filament), and the higher pitch signal during the radiation generation.
- c) **Exposure switch**  
Confirm that the exposure switch requires continuous activation to maintain the exposure. Releasing the exposure switch during the radiation should produce the ER00 message on the displays (clear it by pressing the CTL-key once). Make a visual check that the exposure switch spiral cable is not damaged.
- d) **Labels**  
Check that no labels (compression paddles, shields or unit) are detached or worn and that they are all legible.
- e) **AEC performance**  
Take an exposure of your test phantom and compare the developed film with older exposures. Adjust the internal density correction, if needed. See the Operators Manual for details.
- f) **Compression force display**  
Remove the cassette and replace it with a small scale. Put a soft spacer between the paddle. Compress with the front edge of the paddle a small scale and compare the value with the compression display in the unit. The deviation should be less than  $\pm 15\%$ .

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## 2 PREVENTIVE MAINTENANCE CHECKS

**NOTE**      *These checks must be performed by a qualified service technician during the installation of the unit and thereafter on an annual basis. Failure to do so could affect image quality or patient safety.*

---

### 2.1 Preventive maintenance schedule

The preventive maintenance inspection must be scheduled by the user of the equipment to be performed by an authorized service representative. Checks described in this chapter ("PREVENTIVE MAINTENANCE CHECKS" on page E-2) must be performed **once a year**.

---

### 2.2 Calibration and verification of the instruments

The used measurement and test instruments must be calibrated once a year by authorized calibration officials, to ensure long-term accuracy.

### 2.3 Determining half value layer (HVL / beam quality)

#### Applicable measurement instruments and tools

• MDH, Model 1515	Radiation monitor
MDH, Model 1050U	Converter
MDH, Model 10x5-6M	Ion chamber
Aluminum blocks	0,3 x 100 x 100 mm (type 1100 alloy)
Field defining Pb-diaphragm	3 x 200 x 200 mm, with a 45 mm hole in center

#### Preparations for measurements

Remove the compression paddle from the x-ray beam.

Connect the low sensitivity ion chamber (10x5-6M) to the converter. Place the chamber on the image receptor support so that the chamber is in the centre of the front edge.

Collimate the x-ray beam to restrict the beam to an area slightly larger than the ion chamber. Turn on the radiation monitor by rotating the "FUNCTION SELECTOR" -knob to the "MEASURE" position. Select the "PULSE EXPOSURE" mode from the "MODE SELECTOR".

#### Measurement procedure

- a) Select **30 kV, 50 mAs** manual exposure and **filter 1** (30 $\mu$ m Mo) from the SOPHIE control panel.
- b) Take an exposure and record the mR-reading (R normal)
- c) Place the 0.3 mm aluminum block to the beam, just outside the collimator
- d) Take an exposure and record the mR-reading {R with extra Al}
- e) Calculate the ratio  $r1 = \{R \text{ with extra Al}\} / \{R_{\text{normal}}\}$
- f) Select 30 kV, 50 mAs, filter 2 (0.5 mm Al) from the control panel of SOPHIE.
- g) Take an exposure and record the mR-reading {Rwith extra Al}
- h) Remove the aluminum block (0.3 mm) from the beam
- i) Take an exposure and record the mR-reading {Rnormal}
- j) Calculate the ratio  $r2 = \{R_{\text{with extra Al}}\} / \{R_{\text{normal}}\}$ .

#### Rejection Limit

Both ratios r1 and r2 must be at least 0.51.

## 2.4 Checking X-ray tube efficiency (radiation output)

### Applicable measurement instruments and tools

MDH, Model 1515	Radiation monitor
MDH, Model 1050U	Converter
MDH, Model 10x5-6M	Ion chamber

### Preparation for measurement

Remove the compression paddle from the X-Ray beam and drive Sophie to CC projection.

Connect the ion chamber to the converter and monitor. Place the ion chamber on the image receptor support so that the chamber is exactly in the center of the AEC sensor cover. Turn the monitor on by turning the 'FUNCTION SELECTOR' knob to the 'MEASURE' position and the 'MODE SELECTOR' knob to the 'EXPOSURE' position. Allow it to stabilize for some minutes.

Select filter 1 (30  $\mu$ m Mo), large focus, manual exposure mode 27 kV, 50 mAs and perform 10 exposures to warm up the X-Ray tube.

### Measurement Procedure

- Turn the 'FUNCTION SELECTOR' knob to 'HOLD' and back to 'MEASURE' to clear the display
- Take an exposure and record the mR-reading
- Select small focal spot, 27 kV, 10 mAs
- Turn the 'FUNCTION SELECTOR' knob to 'HOLD' and back to 'MEASURE' to clear the display
- Take an exposure and record the mR-reading

### Rejection Limit

Compare both large and small focal spot radiation readings to the readings that were measured when the equipment was first taken into use. If the current values are less than 70% of the initial values the tube radiation output has lowered so much that a tube replacement is recommended. If no earlier readings are available the radiation readings should exceed 500 mR for large and 100 mR for small focal spot.

## 2.5 Focal spot size measurement

### Applicable measurement instruments and tools

Victoreen, Model 07-542    Star X-Ray Test Pattern, 1 °

### Preparation for measurement

Drive Sophie to CC projection and place a loaded film cassette in place. Select proper exposure factors to achieve right film density, for example AEC mode on and select for 22 kV.

### Measurement Procedure

Please follow the operating instructions of the Star Pattern. Repeat the procedure for both focal spots. Because the focal spot size variations that depend on the used kV and mA are compensated for in Sophie, it is not necessary to perform the focal spot size measurements at different technique factors.

### Rejection Limit

If the focal spot dimension tolerances exceed the tolerances defined in IEC336 standard the tube head must be replaced. The nominal sizes are 0.3 x 0.3 mm for large and 0.1 x 0.07 mm, E7272 tube (0.1 x 0.1 mm, E7290 tube) for small focal spot.

## 2.6 Image quality evaluation

### Applicable measurement instruments and tools

RMI, Model 156      Mammographic Accreditation Phantom

### Preparation for measurement

Drive Sophie to CC projection and place a loaded film cassette in place. Select proper exposure factors to achieve right film density, for example Advanced AEC mode on and select for 27 kV. Select for AEC sensor 2. For better contrast adjust the dose/contrast of the Advanced AEC mode to the maximum contrast setting.

### Measurement Procedure

Please follow the operation instructions given in the Phantom User Manual. Verify that the Phantom is placed to cover the sensor 2 completely. Repeat the procedure for both focal spots.

### Rejection Limit

The score is calculated as instructed in the Phantom's User Manual. A minimum score of 10 for fibrils, 8 for simulated micro-calcifications and 3 for masses should be achieved to meet ACR criteria.

## 2.7 Verifying AEC-system control limits

### Applicable measurement instruments and tools

• MDH, Model 1515	Radiation monitor
MDH, Model 1050U	Converter
MDH, Model 10x5-6M	Ion chamber
FLUKE, Model 8060A	Digital multimeter
Lead Block	1 x 100 x 100 mm

### Preparation for measurement

Connect the low-sensitivity ion chamber (10x5-6M) to the converter. Place the chamber on the image receptor support so that the chamber is in the center of the front edge.

If the value of the feedback resistance is unknown, turn power off from SOPHIE and measure the resistance of the feedback resistor from the connector on the generator module and record it. Leave the measuring pins across the feedback resistor, but select voltage range.

Turn the power on to the Radiation monitor by rotating the 'FUNCTION SELECTOR' knob to the 'MEASURE' position. Select the 'PULSE DURATION' mode from the 'Mode selector' of MDH. Set the 'PULSE FRACTION THRESHOLD' to 70% using the thumbwheel on the MDH.

Place the lead block (1 mm) on the image receptor support so that it covers the AEC-detectors.

### Measurement Procedure (Toshiba E7272 x-ray tube)

- Select 24 kV, AEC-mode, filter 1 (30  $\mu$ m Mo), sensor 1 from the SOPHIE CLASSIC panel
- Take an exposure.
- Read the exposure time on the display of MDH and calculate the corresponding mAs-value according to the formula:  $110\text{mA} \times 450\text{ms} + (\text{exp. time} - 450\text{ms}) \times 100\text{mA}$ .
- Repeat the above procedure using the same settings, but with sensors 2 and 3.

### Measurement Procedure (Toshiba E7290 x-ray tube)

- Select 28 kV, AEC-mode, filter 1 (30  $\mu$ m Mo), sensor 1 from the SOPHIE CLASSIC panel
- Take an exposure.
- Read the exposure time on the display of MDH and calculate the corresponding mAs-value according to the formula:  $\text{exp. time} \times 110\text{mA}$
- Repeat the above procedure using the same settings, but with sensors 2 and 3.

### Rejection limit

All measured mAs-values must be less than 700 mAs.

### 3 OTHER PREVENTIVE CHECKS

#### 3.1 Verifying compression force measurement

- a) Place the scale on the cassette table and a soft pad (thickness 5-10 cm) between the upper compression paddle front edge and the scale.
- b) Run the upper paddle down until the scale shows 15 kg. Check that the unit shows the same value within  $\pm 1,5$  kg (13,5...16,5 kg). If not, please see paragraph "Compression force measurement calibration" on page F-13 how to calibrate.

#### 3.2 Verifying filament pre-heating voltages

It is recommended that the filament preheating voltages are calibrated (they cannot be measured) once a year to compensate for any changes in the X-ray tube parameters. See paragraph "X-ray tube filament preheating voltage calibration" on page F-14 how to perform this.

#### 3.3 Verifying the anode voltage (kV)

There are two different measurement procedures that can be used: Measurement with Mammographic kVp meter and Invasive measurement with Digital multimeter.

##### Applicable measurement instruments and tools

- |                          |                        |
|--------------------------|------------------------|
| • Victoreen, Model 4000M | Mammographic kVp meter |
| FLUKE, Model 8060A       | Digital multimeter     |
| Feedback measuring cable | Order No. 7827773      |

##### Measurement procedure using Mammographic kVp meter

- a) Select Mo/Mo using the filter wheel, accessible from the rear panel of Victoreen. Select High Sensitivity, Mo/Mo anode/filter and Radio Mode from the front panel of Victoreen. Place the kVp-meter on the image receptor support so that the chamber is in the center of the front edge.
- b) Select 27 kV, 50 mAs, filter 1 (30  $\mu$ m Mo), large focus from the SOPHIE panel. Make sure that the Automatic kV selection and the AEC modes are **not** selected.
- c) Take an exposure and read the kVp average - value from the display of the Victoreen.
- d) Use the calibration curves to determine the actual kVp and record it.
- e) Repeat the procedure using 31 kV and 35 kV.
- f) Select 35 kV, 14 mAs, filter 1 (30  $\mu$ m Mo), small focus from the SOPHIE panel.
- g) Take an exposure and read the kVp average - value from the display of Victoreen.
- h) Use the calibration curves to determine the actual kVp and record it.

##### Measurement procedure using Digital multimeter

- a) Turn off the power from SOPHIE.
- b) Remove the following C-arm covers: top cover, lower cover and vertical cover (refer to section "C-arm covers" on page H-4). Remove the power supply cover (refer to section "Replacing the Tube CPU software" on page H-9).
- c) Connect the Feedback measuring kV cable to the connector P3 on the 109-10-15 PCB. The board is located in the rear end of the Power supply, see Fig. E.1.



- d) Connect the cable to the multimeter: first red to V $\Omega$  and black to COM, and after that connect the black connector to kV connector.

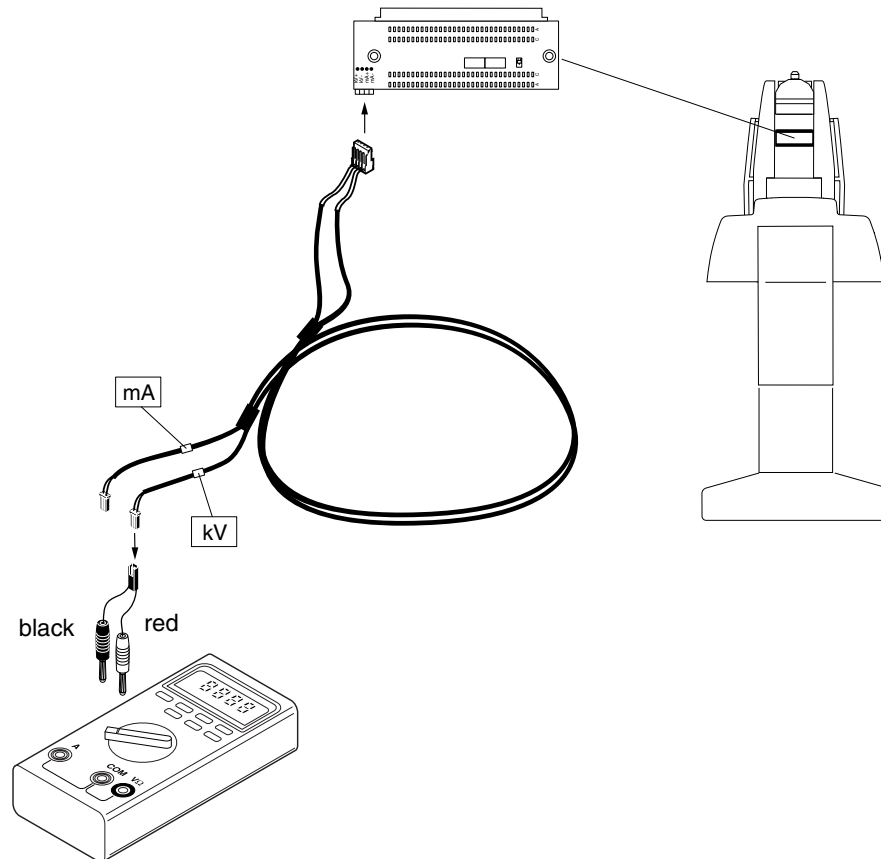


Figure E.1

- e) Switch the multimeter to the voltage range. Turn the SOPHIE on.

**CAUTION** *The X-ray unit may be damaged if the power is turned on when the multimeter is on the resistance range.*

- f) E7272 tube: Select 20kV, 50mAs and small focus from the control panel of SOPHIE.  
E7290 tube: Select 20kV, 100mAs and small focus from the control panel of SOPHIE.  
Make sure that the Automatic kV selection and the AEC modes are **not** selected.
- g) Take an exposure and record the multimeter value during exposure. The right kV value is calculated from the measured voltage value by multiplying it by 8950, e.g.
- $2.289V \times 8950 = 20.5kV$
- h) Perform exposures with the following values:
- |        |        |                     |                                   |
|--------|--------|---------------------|-----------------------------------|
| • 20kV | 50mAs  | small focus         |                                   |
| 28kV   | 50mAs  | small focus         |                                   |
| 35kV   | 50mAs  | small focus         |                                   |
| 20kV   | 140mAs | large focus         |                                   |
| 28kV   | 140mAs | large focus         |                                   |
| 35kV   | 140mAs | large focus         |                                   |
| 24kV   | 500mAs | large focus (E7272) | (28kV 500mAs large focus (E7290)) |
- Rejection limits  
All measured kV-values must be within  $\pm 1.5$  kV of the pre-selected kV-values.

### 3.4 Verifying the tube current (mA) and the exposure time (Toshiba E7272 x-ray tube)

#### Applicable measurement instruments and tools

- |                          |                    |
|--------------------------|--------------------|
| • MDH, Model 1515        | Radiation monitor  |
| MDH, Model 1050U         | Converter          |
| MDH, Model 10x5-6M       | Ion chamber        |
| FLUKE, Model 8060A       | Digital multimeter |
| Feedback measuring cable | Order No. 7827773  |

#### Measurement procedure

- a) Connect the low-sensitivity ion chamber (10x5-6M) to the converter. Place the chamber to the image receptor support so that the chamber is in the center of the front edge.
- b) Turn off the power from SOPHIE.
- c) Remove the following C-arm covers: top cover, lower cover and vertical cover (refer to section "C-arm covers" on page H-4). Remove the power supply cover (refer to section "Replacing the Tube CPU software" on page H-9).
- d) Connect the Feedback measuring cable to the connector P3 on the 109-10-15 PCB. The board is located in the rear end of the Power supply, see Fig. E.1.
- e) Connect the cable to the multimeter: first red to  $V\Omega$  and black to COM, and after that connect the black connector to mA connector.
- f) Switch the multimeter to the resistance range and record the mA feedback line resistance value (R) (nominal  $34\Omega$ ).
- g) Switch the multimeter to the voltage range.
- h) Turn on the power to the Radiation monitor by rotating the 'FUNCTION SELECTOR' knob to the 'MEASURE' position.
- i) Select the 'PULSE DURATION' mode from the 'MODE SELECTOR' of MDH. Set the 'PULSE DURATION THRESHOLD' to 70% using the thumbwheel on the MDH.
- j) Turn on the SOPHIE.

**CAUTION** *The X-ray unit may be damaged if the power is turned on when the multimeter is on the resistance range.*

- k) Select 20kV, 50mAs and small focus from the control panel of SOPHIE. Make sure that the Automatic kV selection and the AEC modes are **not** selected.
- l) Take an exposure and record the multimeter voltage value (U) during exposure. Record also the time reading on the display of MDH.
- m) The right current (I) value is calculated from the measured voltage value by dividing it by the measured resistance value, e.g.
  - $R = 34.2\Omega$
  - $U = 341\text{mV}$
  - $I = U/R = 341\text{mV}/34.2\Omega = 9.98\text{mA}$
- n) The corresponding mAs value is calculated by multiplying the mA value by the exposure time-value.
- o) Perform exposures with the following values:
 

• 20kV	50mAs	20mA	2.5 sec.	small focus
35kV	14mAs	14mA	1 sec.	small focus
20kV	350mAs	70mA	5 sec.	large focus
35kV	300mAs	60mA	5 sec.	large focus

#### Rejection limits

- All measured mA-values must be within  $\pm 4\text{mA}$  of the pre-selected mA-values when the large focus is used and within  $\pm 1\text{mA}$  when the small focus is used.
- All measured times must be within  $\pm 4\%$  of the pre-selected times.
- For mAs-values that are less than 40mAs the measured mAs-values must be within  $\pm 3\text{mAs}$  of the pre-selected mAs values.
- For mAs-values that are more than 40mAs the measured mAs-values must be within  $\pm 8\%$  of the pre-selected mAs values.

### 3.5 Verifying the tube current (mA) and the exposure time (Toshiba E7290 x-ray tube)

#### Applicable measurement instruments and tools

- |                          |                    |
|--------------------------|--------------------|
| • MDH, Model 1515        | Radiation monitor  |
| MDH, Model 1050U         | Converter          |
| MDH, Model 10x5-6M       | Ion chamber        |
| FLUKE, Model 8060A       | Digital multimeter |
| Feedback measuring cable | Order No. 7827773  |

#### Measurement procedure

- Connect the low-sensitivity ion chamber (10x5-6M) to the converter. Place the chamber to the image receptor support so that the chamber is in the center of the front edge.
- Turn off the power from SOPHIE.
- Remove the following C-arm covers: top cover, lower cover and vertical cover (refer to section "C-arm covers" on page H-4). Remove the power supply cover (refer to section "Replacing the Tube CPU software" on page H-9).
- Connect the Feedback measuring cable to the connector P3 on the 109-10-15 PCB. The board is located in the rear end of the Power supply, see Fig. E.1.
- Connect the cable to the multimeter: first red to V $\Omega$  and black to COM, and after that connect the black connector to mA connector.
- Switch the multimeter to the resistance range and record the mA feedback line resistance value (R) (nominal 34 $\Omega$ ).
- Switch the multimeter to the voltage range.
- Turn on the power to the Radiation monitor by rotating the 'FUNCTION SELECTOR' knob to the 'MEASURE' position.
- Select the 'PULSE DURATION' mode from the 'MODE SELECTOR' of MDH. Set the 'PULSE DURATION THRESHOLD' to 70% using the thumbwheel on the MDH.
- Turn on the SOPHIE.

**CAUTION** *The X-ray unit may be damaged if the power is turned on when the multimeter is on the resistance range.*

- Select 20kV, 50mAs and small focus from the control panel of SOPHIE. Make sure that the Automatic kV selection and the AEC modes are **not** selected.
- Take an exposure and record the multimeter voltage value (U) during exposure. Record also the time reading on the display of MDH.
- The right current (I) value is calculated from the measured voltage value by dividing it by the measured resistance value, e.g.
  - $R = 34.2\Omega$
  - $U = 341\text{mV}$
  - $I = U/R = 341\text{mV}/34.2\Omega = 9.98\text{mA}$
- The corresponding mAs value is calculated by multiplying the mA value by the exposure time-value.
- Perform exposures with the following values:
 

• 20kV	50mAs	21mA	2.38 sec.	small focus
35kV	28mAs	28mA	1 sec.	small focus
20kV	400mAs	80mA	1 sec.	large focus
35kV	300mAs	88mA	3.41 sec.	large focus

#### Rejection limits

- All measured mA-values must be within  $\pm 4\text{mA}$  of the pre-selected mA-values when the large focus is used and within  $\pm 1\text{mA}$  when the small focus is used.
- All measured times must be within  $\pm 4\%$  of the pre-selected times.
- For mAs-values that are less than 40mAs the measured mAs-values must be within  $\pm 3\text{mAs}$  of the pre-selected mAs values.
- For mAs-values that are more than 40mAs the measured mAs-values must be within  $\pm 8\%$  of the pre-selected mAs values.

### 3.6 Verifying x-ray beam alignment

#### Applicable measurement instruments and tools

- |                            |                         |
|----------------------------|-------------------------|
| • 18 x 24 cm, Kodak Min.-R | Film cassette           |
| 24 x 30 cm, Kodak Min.-R   | Film cassette           |
| 18 x 24 cm                 | Mammographic x-ray film |
| 24 x 30 cm                 | Mammographic x-ray film |
| 30 cm                      | Ruler                   |
| Fluorescent screen         | Planmed special screen  |

#### Preparation for measurement

Place the fluorescent tool on the image receptor support as you would place a normal large cassette.

#### Measurement procedure using the fluorescent screen

- a) E7272 tube: Select 20 kV, 50 mAs.  
E7290 tube: Select 20 kV, 100 mAs.  
Adjust the field size to its maximum using the size adjust buttons on the control panel of SOPHIE.  
Turn off the lights in the room.
- b) Take an exposure and check that the yellow area that can be seen on the fluorescent screen is symmetrical, and stays within tolerances.
- c) Remove the tool and adjust the support for a small cassette. Place the fluorescent tool back on the image receptor support as you would place a normal small cassette.
- d) Take an exposure and check that the yellow area that can be seen on the fluorescent screen is symmetrical, and stays within tolerances.
- e) Check the field sizes using film (procedure 3.2).

#### Measurement procedure using x-ray film

- a) Place a loaded large cassette on the image receptor support so that it overhangs 10 mm on the chest wall edge of the support.
- b) Place a ruler 20 mm back from the chest wall edge of the cassette (10 mm back from the actual chest wall edge of the film).
- c) Select 25 kV, 20 mAs and take an exposure and develop the film.
- d) Measure the unexposed areas on both sides of the film (R and L)
- e) Measure the exposed area between the ruler and the chest wall edge of the film and subtract 10 mm from it (F). This number (F) is zero if the x-ray field is flush with the film and 3mm if it extends 3 mm beyond the film.
- f) Repeat the above procedure using the small cassette.

#### Rejection limits

For the chest wall edge the x-ray field must cover the whole film, but must not extend beyond the chest wall edge more than 3 mm. For all other edges the unexposed area must be between 1 mm - 4 mm.

### 3.7 Verifying light-field beam illumination

#### Applicable Measurement Instruments and Tools

- |                           |           |
|---------------------------|-----------|
| • Delta Ohm, Model HD8366 | Lux-meter |
|---------------------------|-----------|

#### Measurement procedure

- a) Remove the additional light limiter in the measuring device so that full field size of the equipment is used.
- b) Divide the image receptor support into four equal quadrants.

- c) Measure the illuminance of the light localizer from the center of each quadrant. Record these readings.

#### Rejection limits

All measured illumination figures must be more than 200 lux.

### 3.8 Verifying visually defined x-ray fields

#### Applicable measurement instruments and tools

- |                           |                          |
|---------------------------|--------------------------|
| • Delta Ohm, Model HD8366 | Lux-meter                |
| 18 x 24 cm, Kodak Min-R   | Film cassette            |
| 24 x 30 cm, Kodak Min-R   | Film cassette            |
| 18 x 24 cm                | Mammographic x-ray film  |
| 24 x 30 cm                | Mammographic x- ray film |
| 30 cm                     | Ruler                    |

#### Preparation for measurement

The x-ray field alignment must be checked and approved before performing this test. Insert the additional light limiter in the measuring device so that it uses 1 mm slot for measurements to allow exact contrast measurements.

#### Measuring alignment of visually defined X-ray fields

- Place a loaded small cassette (18x24) on the image receptor support. Switch the light field on. Place coins to the corners of the light field.
- Take an exposure (25 kV, 20mAs) and develop the film.
- Measure the misalignment between the light field marked with coins and the x-ray field on the film. Record the results.
- Repeat the above procedure using the large cassette (24x30).

#### Measuring contrast of light defined X-ray fields

- Switch the light field on.
- Starting with the chest wall, measure the illumination 3 millimeters from the edge of the field toward the center of the field, and the illumination 3 millimeters from the edge of the light field away from the center of the field.
- Record these results.
- Divide these results and record the contrast ratio on the same sheet.
- Repeat the above procedure for all other edges.

#### Rejection limits

The maximum allowed misalignment of the edges of the visually defined light field with the respective edges of the x-ray field is 4 mm. The minimum contrast ratio of the edge of the light field is 4.

### 3.9 Verifying electrical safety

#### Protective earth

Measure with an ohm meter from the mains plug ground terminal against any bare metal part in the unit, the display must be under 0.2 ohms.

#### Spiral cables

Check visually for wear out or extensive slack when unit is driven to its lowest position. Rear covers of the column must be removed.

#### External cable conditions

Check visually the remote control cable, and the spiral cable to the exposure switch



# ADJUSTMENT & CALIBRATION

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## 1 SPECIAL REGIONAL & INITIAL SETUPS

---

### 1.1 Regional setups before using the unit

The unit is tested and adjusted at the factory, to comply with various regional safety requirements. The software controlled parameters (stored in internal non-volatile memory) should however be verified prior to normal operation, since they could vary from region to region. Also after replacing either the TUBE CPU or the REAR CPU board these setups must be verified and some keyboard controlled calibrations performed.

The list below (a to e) are adjustments that **must always be performed** before using the unit for the first time. There is also a number of other adjustments that affect the behavior of the unit. These are preset at the factory to convenient values, so no readjustment is normally needed. However, chapters “KEYBOARD-CONTROLLED (in normal mode)” on page F-3 and “KEYBOARD-CONTROLLED (in service mode)” on page F-8 contain full details of all available keyboard controlled adjustments.

- a) **Maximum allowed mAs**  
The maximum allowed mAs (milliampereseconds) can either be 300 mAs, 500 mAs or 600 mAs. See paragraph “06. Maximum regional mAs limit” on page F-17 for details.
- b) **Maximum allowed breast compression force**  
The unit is capable of compressing the breast up to 25kg (20kg is the factory default). If this limit needs to be changed, please see paragraph “01. Maximum compression force” on page F-17 for details.
- c) **Enable/disable height-control during compression**  
The unit is delivered so that the height control is inoperative if the breast is compressed. See paragraph “04. Mode of UP/DOWN movement” on page F-17 for instructions how to change this behavior.
- d) **Enable/disable C-arm rotation without foot control activation**  
Some countries require that the C-arm motorized movement is not allowed without a continuous activation of a (foot) control switch. See paragraph “02. Mode of C-arm rotation” on page F-17 for instructions how to change this behavior.
- e) **Correct time and date**  
See paragraph “Setting correct time and date” on page F-6 for how to set the internal clock and calendar. However, this is not essential for the normal operation of the unit.

---

### 1.2 Other setups before using the unit

- a) **Film/screen combination**  
To ensure correct optical density, please set this parameter according to the type of film and intensifying screens used. Please refer to the “Sophie User’s Manual”. If you want to use film/screen combination which is not listed in the user’s manual, adjust the AEC for the selected combination as follows:
  - Select the film/screen combination number 0.

- Set all the density parameters to value 0:
    - Density offset, see section “Density offset adjustment” on page F-6
    - Special system parameter 13: Density fine-adjustment, see section “13. Density fine-adjustment (sensor 1)” on page F-18.
  - Select desired AEC optical density, i.e. 1.2 or 1.6, see section “30. AEC optical density selection” on page F-20.
  - Select the AEC mode (not advanced AEC).
  - Take a test exposure with a 40 mm thick plexiglass phantom. If the film density level is too high adjust the special system parameter 9 value downwards, see section “09. Film/screen combination 0 (zero) gain” on page F-17. If the film density level is too low adjust the special system parameter 9 value upwards. Repeat this until you have reach the desired density. Note that if the density is too large with one parameter value and too small with the next one, it can not be corrected at this point.
  - Adjust the film/screen combination steepness: take one test exposure with a 40 mm thick plexiglass phantom using the density value 0, and a second exposure using density value 1. If the density change between these two films is smaller than 13%, adjust the special system parameter 10 upwards, see section “10. Film/screen combination 0 (zero) steepness” on page F-18. If the density change between these two films is larger than 13%, adjust the special system parameter 10 downwards. Repeat this until you have reach the desired density step.
  - Fine-tune the film density with the special system parameter 13, see section “13. Density fine-adjustment (sensor 1)” on page F-18.
- b) **Printer/Label type (option)**  
Ignore this setup if you do not use a printing device attached directly to the Sophie unit. One of three different printer systems can be used. For printer type selection see “11. Setting type of printer and/or height of labels used” on page F-18 for details.



## 2 KEYBOARD-CONTROLLED (in normal mode)

Some special adjustments can be performed (with the help of the keyboard) by the end-user. The following pages lists all these special adjustments that can be performed in the normal (user) keyboard mode. These are also explained in the “Sophie User’s Manual”.

Space is reserved under each heading for writing down the current setting for this particular unit. It is a good idea to write down the preferred settings, in the case there is a need to do such service to the unit, where this information is lost (replacing CPU boards).

A complete table with all parameters and their respective factory defaults, with space also reserved for personal preferences, can be found in “Factory preset (recalling settings for all parameters)” on page F-9.

### 2.1 Automatic kV mode

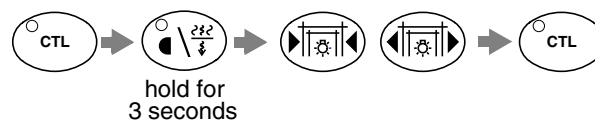


Setting in this unit:

Press the **CTL**-key and the **kV up** key to enter the Automatic kV mode setting. The time/force display show the current setting. Use the **field/light** -keys to change mode, and press the **CTL**-key to exit.

- a)  kg Automatic pre-selection of kV is off. The user selection of the kV is used unaltered during the exposures. **The factory default is off.**
- b)  kg Automatic pre-selection of kV is on. The kV is set automatically according to the compression thickness to a pre-selected value. The user can alter the kV setting as normally if the suggested kV value is considered not to be optimum for the compressed breast.

### 2.2 Automatic rhodium/molybdenum filter selection mode



Setting in this unit:

Press the **CTL**-key and then press and hold the **filtration** key for **3 seconds**. Use the **field/light** keys to change the setting. The range is from 6.6cm to 9.9cm. Press the **CTL**-key to exit. **The factory default is 7.5cm.**

- a)  kg Automatic rhodium/molybdenum filter selection is on. The breast thickness can be changed with the **field/light** -keys. The user can alter the filter as normally after the breast is compressed. The automatic rhodium/molybdenum filter selection is switched off by pressing the **right field/light** -key after the maximum breast thickness has been reached.
- b)  kg Automatic rhodium/molybdenum filter selection is off. The filter is selected manually. The automatic rhodium/molybdenum filter selection is switched on by pressing the **left field/light**-key.

### 2.3 Default magnification factor



Setting in  
this unit:

Press the **CTL**-key and the **magnification** key to set the default magnification factor. The time/force display shows the magnification symbol "o" and the current magnification factor. Use the **field/light** -keys to change the setting (from 1.30 to 1.80 in steps of 0.1), press the **CTL**-key to exit. **The factory default value is 1.80.**



The magnification factor is displayed in the time/force display during the MAG-mode and can be manually set to any value from the 1.30 minimum to the current maximum, simply by pressing the MAG-key repeatedly.

### 2.4 Automatic release of compression after exposure



Setting in  
this unit:

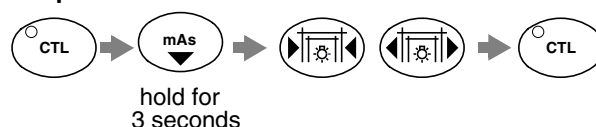
Press the **CTL**-key and the **release** key to toggle the automatic compression release feature on or off.

- a)  LED OFF = No automatic release. The breast must be released manually by pressing this key after each exposure, or by driving the compression paddle upwards from the controls.
- b)  LED ON = Automatic release of compression selected. The compression paddle is automatically driven after the exposure to the highest position. **The factory default is on.**

The unit can also be set to run the cassette table automatically into the LOAD position at the same time as the automatic release is selected, see "05. AUTO-LOAD on/off" on page F-17.

**CAUTION** *During normal use of the unit it should be noted that the automatic compression release function should always be turned off to prevent inadvertent movement of the compression paddle during biopsy procedures. When the automatic release is switched off, also the (optional) Auto-load movement is inhibited.*

### 2.5 Initial descent speed



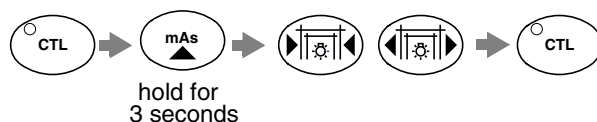
Setting in  
this unit:

Press the **CTL**-key and then press and hold the **left mAs** -key for **3 seconds**. Use the **field/light** -keys to change the setting. The range is from 1 (slowest) to 6 (fastest). Press the **CTL**-key to exit.

This key sequence sets the maximum speed of the compression paddle during compression (down) movement. The time/force -display shows the current setting. The factory default is 5. Using the fastest speed when familiar with the unit is recommended.

**NOTE** *The setting 0 (zero) should and can be used only if the compression force measurement is inoperative. In this mode the force measurement is totally ignored. Compression starts at a moderate speed and continues only at crawling speed, after the compression movement is shortly interrupted by releasing the control switch.*

## 2.6 Compression speed decrease rate

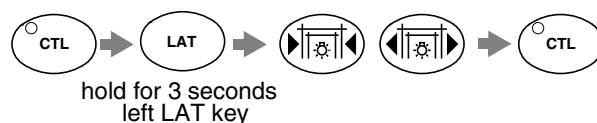


Setting in this unit:

Press the **CTL**-key and the press and hold the **right mAs** -key for **3 seconds**. Use the **field/light** -keys to change the setting. The range is from 1 (small ratio; speed decreases only a little) to 6 (large ration; speed decreases a lot). Press the **CTL**-key to exit.

This key sequence set the ratio of the compression speed reduction related to the compression force. The time/force display shows the current setting. The factory default is 4.

## 2.7 Intermediate compression stopping force



Setting in this unit:

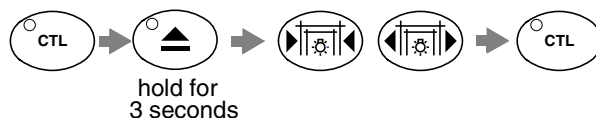
Press the **CTL**-key and the press and hold the **left LAT** -key for **3 seconds**. Use the **field/light** -keys to change the setting. The range is from 1 to 25 kg. Press the **CTL**-key to exit.

This key sequence sets the compression force where the compression temporarily stops and changes over to crawling speed. The time/force display shows the current setting. **The factory default is 10 kg.**

The intermediate compression stopping force of the twincomp compression can be 1-5 kg greater than this compression force used in normal compression, see "33. Intermediate compression stopping force offset with the twincomp compression" on page F-20.

The maximum compression force can be set in the service mode, see "01. Maximum compression force" on page F-17.

## 2.8 Twincomp compression on/off

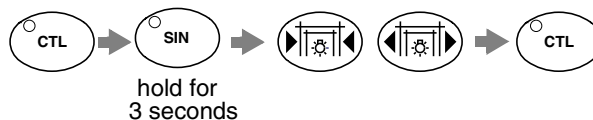


Setting in this unit:

Press the **CTL**-key and the press and hold the **load**-key for **3 seconds**. Use the **field/light** -keys to change the setting. Press the **CTL**-key to exit.

This key sequence sets the compression method to either traditional (OFF = parallel paddles) or TWINCOMP (ON = tilting upper paddle). The time/force -display shows the setting. **The factory default is ON** (TWINCOMP selected).

## 2.9 Lift motor crawling speed

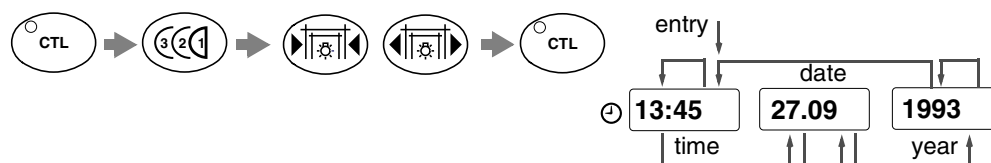


Setting in this unit:

Press the **CTL**-key and the press and hold the **SIN**-key for **3 seconds**. Use the **field/light** -keys to change the setting. The range is from 1 (very slow) to 6 (speedy). Press the **CTL**-key to exit.

This key sequence set the lowest crawling speed for the lift motor (UP/DOWN movement of the unit) used for fine-adjusting the height. The TIME/CM-display shows the current setting. **The factory default is 4.** The maximum lift motor speed can be set in the service mode, see "03. Maximum speed of UP/DOWN movement" on page F-17

## 2.10 Setting correct time and date

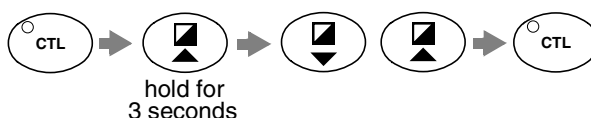


Press the **CTL**-key and then press the **sensor** key once (or repeatedly) to step to the parameter(s) to be adjusted, the sequence is as illustrated above;

- minutes - hours - day - month - years - century - minutes -

The parameter to be altered with the **field/light** -key is blinking. Press the **CTL**-key to exit at any time. Upon exit the (non visible) seconds counter is zeroed. The clock is set at the factory to local time and should be set to show correct time/date before using the unit.

## 2.11 Density offset adjustment



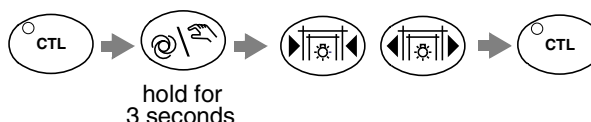
Setting in this unit:

Press the **CTL**-key and the press and hold the **density** -key for **3 seconds**. Use the **field/light** keys to set the display to the same value you had to use in the normal user density compensation to achieve YOUR own ZERO density. Press the **CTL**-key to exit.

This key sequence restores the user density display back to zero. In many cases there is a slight deviation from the factory preset density compared with the required density. This adjustment makes possible to show the user a ZERO density, even if the actual density differs from the factory default. Factory default is 0 (zero).

**NOTE** To perform this adjustment the AEC-mode must first be selected!

## 2.12 AAEC contrast adjustment



Setting in this unit:

Press the **CTL**-key and then press and hold the **automatic/manual exposure** -key for **3 seconds**. Use the **field/light** -keys to alter the setting. The range is from -3 (higher kV and less contrast but short exposure times) to +3 (lower kV and more contrast but longer exposure times). Press the **CTL**-key to exit.

This key sequence fine-adjusts the contrast/versus exposure time when using the AAEC mode. The factory default is 0 (zero).

## 2.13 Automatic film labeling (on/off)

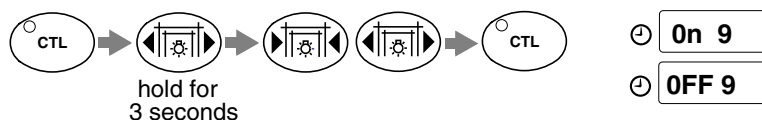


Setting in this unit:  
 On L  
 OFF L

Press the **CTL**-key and then press and hold the **right LAT** -key for **3 seconds**. Use the **field/light** -keys to change the setting. The time/force display the current setting (ON L=Labeling on, OFF L=Labeling off). Press the **CTL**-key to exit.

This key sequence sets the automatic film labeling either on or off. It is useful to disable the film marking, if another film marking system is used, or if the marking system is causing some errors (these would be then ignored). **The factory default is ON.**

### 2.14 Disabling bucky grid movement

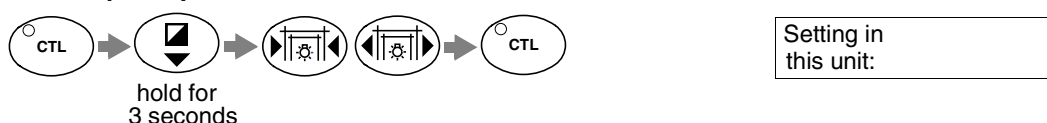


Press the **CTL**-key and then press and hold the **right FIELD/LIGHT** -key for **3 seconds**. Use the **field/light** -keys to change the setting. The time/force display the current setting (ON 9=Grid moves, OFF 9=Grid doesn't move). Press the **CTL**-key to exit.

This key sequence sets turns the BUCKY grid movement either on or off. This feature is normally only used for diagnostic purposes. **The factory default is ON.**

**NOTE** Note that the grid movement is always forced ON every time the unit is turned on.

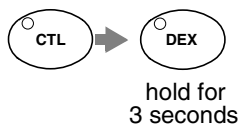
### 2.15 Alarm sound frequency (loudness)



Press the **CTL**-key and then press and hold the **left field/light** key for **3 seconds**. Use the **field/light** keys to change the frequency. Press the **CTL**-key to exit.

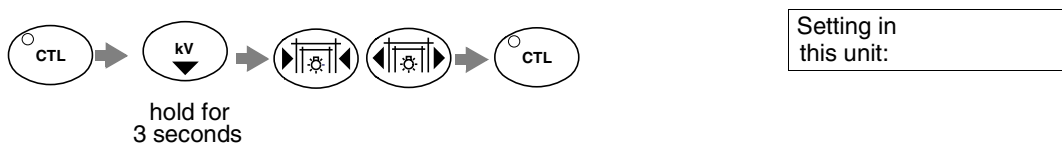
This key sequence sets the alarm sound frequency. This frequency is sounded shortly when a key is pressed and also during the exposures. By changing the frequency the loudness can also be somewhat affected.

### 2.16 Dimming the displays



Press the **CTL**-key and the **DEX** key to toggle the display dimming feature on or off.

### 2.17 mA limit (on/off)



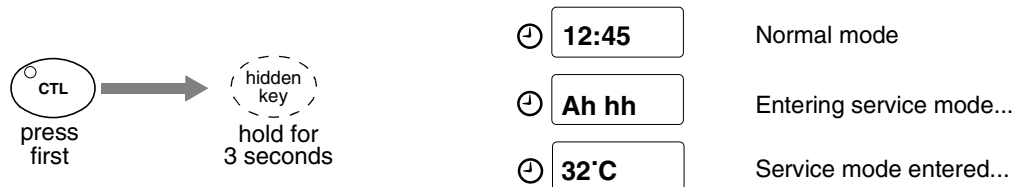
Press the **CTL**-key and then press and hold the **kV down** key for **3 seconds**. Use the **field/light** -keys to change the setting. The time/force display the current setting (ON c=limit on, OFF c=limit off). Press the **CTL**-key to exit.

- OFF c** kg mA limit is off. The mA value is chosen to be the maximum allowed mA for the selected kV according to the table shown in section "Toshiba E7290 x-ray tube ratings" on page A-15. **The factory default is off.**
- On c** kg mA limit is on. The maximum mA value that is used is 80 mA.

### 3 KEYBOARD-CONTROLLED (in service mode)

Some more advanced (and also critical) adjustments and functions can be performed in the special service mode. To be able to perform any of the below mentioned calibrations you must first enter the service mode. Additionally, all available special service mode functions are listed in a short-form mode in the chapter "KEYBOARD FUNCTIONS & MODES" on page C-1.

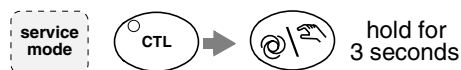
#### 3.1 How to enter the service mode



Press the **CTL**-key and press and hold the **HIDDEN**-key for **3 seconds**. This key sequence enters the special service mode. The normal time-of-day display is briefly replaced by the text "AHHH" and then replaced by the temperature display of the tube head assembly.

**CAUTION** *This special service mode is intend only for the experienced service technician, and should not be entered (under normal circumstances) by the user.*

### 3.2 Factory preset (recalling settings for all parameters)



**CAUTION** *Performing this function results in loss of all individual setups of all operating parameters. However, these are replaced with factory predetermined settings, leaving the unit fully functional.*

#### Why and when to make a factory preset

This function is used (as the name indicates) at the factory, to program shipped units to a pre-defined state. Spare-part CPU boards (that contain the actual parameter memories) are also treated this way. This mode is useful also if the unit has been in use before the installation.

#### How to perform the factory preset

Being in the service mode, pressing the **CTL-key** and then press and hold the **automatic/manual exposure -key** for **3 seconds**.

**Table 4: Normal mode parameters affected by the factory default**

Parameter	factory default	for details	setting in this unit
Automatic kV-selection	On	page F-3	
Automatic Rh/Mo filter selection	On, 7.5cm	page F-3	
Default MAG-factor	1.80	page F-4	
Automatic release after exposure	On	page F-4	
Maximum compression speed	5 (moderate)	page F-4	
Compression retardation ratio	1 (small)	page F-5	
Intermediate compression force	10 kg	page F-5	
Twincomp compression	Yes	page F-5	
Lift motor crawling speed	4 (moderate)	page F-5	
Density offset adjustment	0 (no offset)	page F-6	
AAEC contrast adjustment	0 (normal contrast)	page F-6	
Automatic film labeling	On	page F-6	
BUCKY grid movement	On	page F-7	
Alarm sound frequency (loudness)	5 (moderate)	page F-7	

Table 5: Service mode parameters affected by the factory default

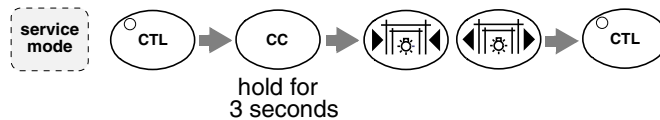
Special system parameters	factory default	for details	setting in this unit
01. Maximum compression force	20 kg	page F-17	
02. Mode of C-arm rotation	0 (direct movement)	page F-17	
03. Maximum up/down speed	4 (moderate)	page F-17	
04. Mode of up/down movement	0 (not during comp)	page F-17	
05. Auto-load function	1 (on)	page F-17	
06. Maximum regional mAs limit	1	page F-17	
07. Mode of foot-control operation	1 (outer edge comp)	page F-17	
08. BUCKY grid type	2 (Gilardoni)	page F-17	
09. Film/screen comb. 0 gain	10 (normal)	page F-17	
10. Film/screen comb. 0 steepness	10 (normal)	page F-18	
11. Type of label printer	0 (Admark or none)	page F-18	
12. Type of remote control box	2 (advanced)	page F-18	
13. Density fine-adjustment (sensor 1)	0 (no adjustment)	page F-18	
14. Mode of LAT key operation	0 (LM selected first)	page F-18	
15. Auto-kV offset	0 (no offset)	page F-19	
16. cm-display offset adjustment	0 mm (no offset)	page F-19	
17. Height of spot-paddle	40 mm (normal)	page F-19	
18. Duration of the filter selection time-out	5 seconds	page F-19	
19. Number of spacing rows in the serial printer	2	page F-19	
20. Mode of MAG/LOAD and release operations	0	page F-19	
21. Speed of the rotation motor	4	page F-19	
22. HE37 disabled/enabled	1	page F-19	
26. Speed of LOAD-movement	15	page F-20	
27. Minimum kV value in AAEC mode	20 kV	page F-20	
28. Mode of spot collimator/small focus operation	1	page F-20	
29. Mode of magnification/spot collimator operation	0	page F-20	
30. AEC optical density selection	0 (1.2)	page F-20	
31. Sophie/Sophie CLASSIC selection	0 (Sophie)	page F-20	
32. Filter selection in the spot mode	0 (spot collimator)	page F-20	
33. Intermediate compression stopping force offset with the twincomp compression	0	page F-20	



Table 5: Service mode parameters affected by the factory default

Special system parameters	factory default	for details	setting in this unit
34-42. Exposure mode and filter dependent density adjustment parameters	0 (for each parameter)	page F-21	34: 35: 36: 37: 38: 39: 40: 41: 42:
43. Density fine-adjustment (sensor 2)	0	page F-21	
44. Density fine-adjustment (sensor 3)	0	page F-21	
45. Mode of the OBL key operation	0	page F-21	
46. Maximum kV value in AAEC mode	35	page F-21	
47. Mode of LOAD/ready	0	page F-22	
48-77. Parameters transformed from the Mammotool software		page F-22	48: 49: 50: 51: 52: 53: 54: 55: 56: 57: 58: 59: 60: 61: 62: 63: 64: 65: 66: 67: 68: 69: 70: 71: 72: 73: 74: 75: 76: 77:
78. mA limit	0 (limit off)	page F-23	
79. Mode of Mammotool parameters usage	3	page F-23	

### 3.3 C-arm upright position calibration



#### Why and when to calibrate

Perform this adjustment whenever the REAR CPU is replaced with another one, or if the C-arm is not straight upwards when in the 0° CC-projection position. The correct upright position information is stored in the REAR CPU, thus this calibration can be done from the keyboards.

#### Instruments and tools required

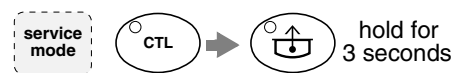
A water scale makes the adjustment easier, but it is not necessary.

#### Performing the calibration

- Being in the service mode, pressing the **CTL**-key and then press and hold the **CC**-key for **3 seconds**.
- The C-arm starts first an initial test run where it rotates down to find the position of the hall-sensor and then back up to the normal CC-position. Wait until the movement stops.
- Adjust the upright position with the **field/light** keys. Placing a water scale on the cassette table makes the adjustment easier.
- Press the **CTL**-key when ready. Note that the C-ARM now makes an additional movement to both sides (approximately  $\pm 15$  degrees) to finalize the calibration. To exit without erasing the old calibrated value, press either foot-control.

**CAUTION** *In this mode the C-ARM is rotating by itself, make sure there's enough space around the unit. Use the STOP-buttons for an emergency stop.*

### 3.4 Breast thickness measurement calibration



#### Why and when to calibrate

Perform this calibration whenever the REAR CPU is replaced with another one, or if you have been servicing the compression mechanism or its sensors. This calibration runs the mechanism from end to end, checking simultaneously the distance between the end sensors.

The flexing of the compression paddle (during the compression) always causes a small error in the actual cm-display. This is, however, compensated for by the software. 1 cm is automatically added to the cm-display for every 10kg of compression force (in MAG-mode 2 cm is added for each 10kg of force).

#### Instruments and tools required

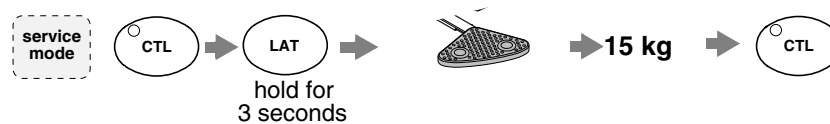
None, but remove all obstacles so that the compression paddle can move freely from end to end.

#### Performing the calibration

In the service mode, press the **CTL**-key and then press and hold the **release**-key for 3 seconds. Wait for the movement sequence to end.

**NOTE** *For a more precise breast thickness display, the residual gap between the upper and lower compression paddles can be compensated for. Please see page F-19 (special system parameters) how to correct or zero the display reading.*

### 3.5 Compression force measurement calibration



#### Why and when to calibrate

This calibration must be performed whenever the REAR CPU and /or the COMPRESSION FORCE sensor is replaced with another one, or whenever there is doubts about the measurement accuracy. The calibration is performed by the REAR-CPU, which stores the parameters on-board nonvolatile (EEPROM) memory.

#### Instruments and tools required

You need a small accurate scale of the bathroom type or equivalent, or preferably a compression calibration gauge (accessory part number 7003030).

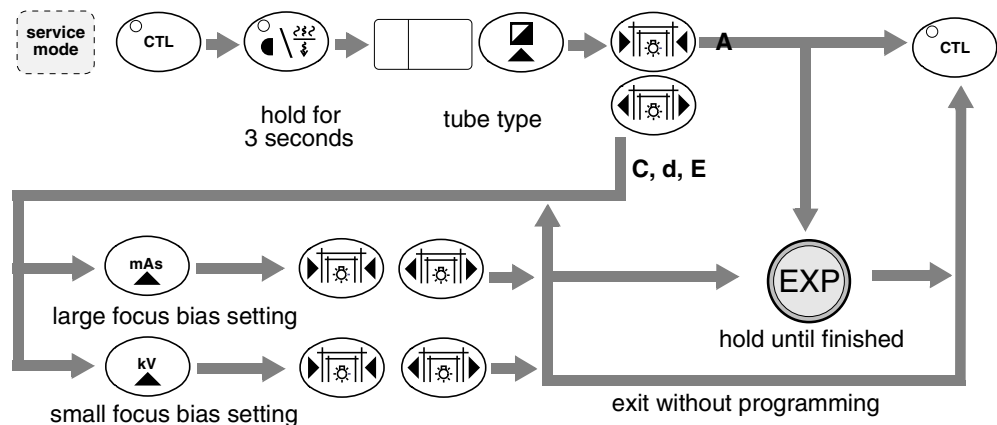
#### Performing the compression force measurement calibration

- a) Remove the lower compression paddle (BUCKY) and cassette, but not the upper compression paddle.
- b) Place the gauge (or scale) in line with the front edge of the cassette table. If you use a scale, place on the top of the scale a soft pad (about 5-10 cm thick), could be a piece of soft foam-plastic or a 1/2 liter soft bottle of infusion fluid (or equivalent).
- c) In the SERVICE mode, press the **CTL-key** and then press and hold the **left LAT** -key for **3 seconds**. The C-arm will now run to the CC-position (upright) if not already in this position.
- d) The upper compression paddle will now drive automatically to its highest position where a zero force calibration takes place (lasts for about a second). During this time you should not touch or load the compression paddle.
- e) Drive the paddle normally downwards (with the help of either the foot-controls or the switches on the sides of the cassette table) so that the center of the soft pad is at the center of the AEC-sensor markings on the upper compression paddle.
- f) Increase the compression until the scale shows 15 kg. Tap gently the scale to get a truthful reading.
- g) Press the **CTL**-key to exits and store the new parameters into memory.

**CAUTION** *The C-arm will automatically move to the CC-position (upright) if not already in this position. Make sure there is room around the unit for this movement.*

**NOTE** *For convenience, the old calibration values are not overwritten if the signal from the force sensor is totally out of range.*

### 3.6 X- ray tube filament preheating voltage calibration



**CAUTION** *Some X-ray radiation is emitted during this function (duration from 60 to 120 seconds) even if the light field beam mirror is not driven out of the X-ray beam. Always shield yourself against the radiation. Be sure to set the right tube type (A, C, d or E) before performing the calibration. Additionally, if the type is C, d or E, set also the bias values properly. Failing to do this could damage the anode of the x-ray tube. If the type is A or C, select the generator type. The type is indicated with generator colour: the new one is blue and the old one is black. With the tube types d and E the new generator is always used.*

#### Why and when to calibrate

This calibration must be performed whenever the TUBEHEAD and/or the TUBE CPU (alone or together with the POWER SUPPLY) is replaced. No special tools or instruments are needed for the calibration. It is also recommended that this calibration is performed during the annual maintenance of the unit to compensate for any possible changes in the tube parameters.

Currently there are two tube types in production, the tube type in use (and bias voltage parameters for type C, d and E) must be set before continuing with this filament calibration. The tube type data (and bias parameters) can be found on the labels on the tube assembly and also on the original C-arm top cover.

These bias parameters for tube type C determines (one for each focus size) the correct voltage to the internal bias-grid, to guarantee the optimum and safe size of the focal spot.

#### Entering the filament voltage calibration mode (all tube types)

- In the SERVICE mode, press the **CTL-key** and then press and hold the **filtration/spot** key for **3 seconds**.
- The currently selected tube type is displayed in the **density** display. If tube type is wrong, select the tube type with the **field/light** keys from these two possibilities;
  - **A** = TOSHIBA E7236 tube
  - **C** = TOSHIBA E7272 tube
  - **d** = TOSHIBA E7290 tube
  - **E** = TOSHIBA E7290 tube

#### Generator type selection (tube type A or C)

- When the filament voltage calibration mode is entered the text **GE.-** is shown on the time/force display.
- Press the **density down** -key to select the generator type. The text in the time/force display starts to flash.
- Use the **field/light** -keys to select the right generator:
  - **GE.1** = new generator (blue)
  - **GE.0** = old generator (black)

### Presets that must be set for tubes type C, d and E

- The currently set bias value for the normal size focus is displayed on the mA-display. If the value is wrong, press the **mAs UP**-key and then use the **field/light** keys to set it right. Check the correct value from the tube label.
- The currently set bias value for the small focus is displayed on the kV-display. If the value is wrong, press the **kV UP** key and then use the **field/light** keys to set it right. Check the correct value from the tube label.

### Performing the calibration procedure

- Go to the exposure switch and stand behind a radiation shield.
- Press and hold the **EXPOSURE** switch and wait until the series of exposures ceases. Press the **CTL**-key to exit. Releasing the switch during the calibration cycle is allowed, the calibration continues when the switch is again activated. The cycle must be successfully completed, otherwise the system could produce ERROR messages **ER12**, **ER30** or **Er33**. If **Er17** is appearing to the display, then the bias parameters for the tube type C are not properly set.

### 3.7 AEC-sensor calibration



**NOTE**      *The AEC mode must be activated when entering the service mode.*

#### Why and when to calibrate

This calibration must be performed whenever the AEC-sensor, TUBEHEAD or the TUBE CPU (alone or together with the POWER SUPPLY) is replaced with an other one, or during the annual service to ensure the AEC-performance.

#### Instruments and tools required

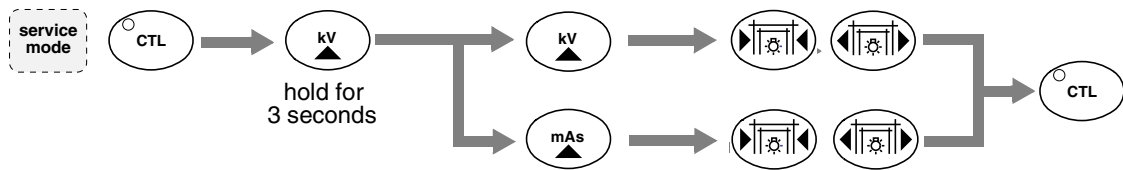
You need a special manufactured test phantom (spare part number **7003002**) to be able to perform this calibration properly. Please note that entering this calibration mode and pressing the EXPOSURE-switch, erases the previous calibration results. This makes the AEC-system inoperable, until the calibration is performed to the end.

#### Performing the AEC calibration

- Remove all obstacles between the AEC-sensor surface and the tube head, including ALL compression paddles, cassette and any other objects that would obstruct the beam.
- Place the test phantom directly on the AEC-sensor surface (on the black area at the front of the cassette table). Select **filter 1** (30µm Mo).
- Being in SERVICE MODE, press the **CTL-key** and then press and hold the **sensor-key** for **3 seconds**. Go to the exposure switch and stand behind the radiation shield.
- Press and hold the EXPOSURE switch until the series of exposures ceases. Press the **CTL**-key to exit. Releasing the switch during the calibration cycle is allowed as the calibration continues when the switch is again activated. The cycle must be completed, otherwise the AEC-system could later produce ERROR messages **ER14** or **ER15**
- If one of the (3) sensors is faulty the unit would produce an error. The calibration can however be continued by clearing the error (using the CTL-key) and continuing the cycle. Only those sensors that are calibrated properly can be used during AEC exposures.

**CAUTION**      *Radiation is emitted during the whole calibration cycle (duration  $\delta$  30 sec). Always shield yourself again unnecessary radiation.*

### 3.8 kV-value fine-adjustment



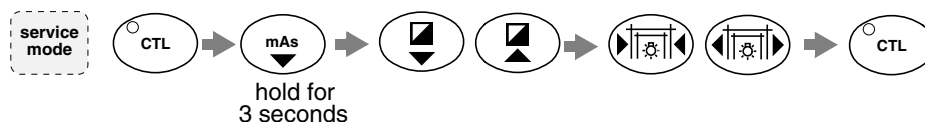
**CAUTION** *The kV calibration is performed at the factory and these parameters are set to zero. These parameters should be changed only when it is necessary to satisfy the local needs. Use this feature with care.*

The kV value can be adjusted with two parameters: offset and gain. The offset parameter is used to shift kV values up or down. The range is from -0.8 kV to +0.8 kV, one step equals 0.2 kV. The gain parameter is used to change the kV ramp steepness: the 35 kV value remains unchanged while the 20 kV value will be shifted up by the parameter value selected. The range is from 0 kV to 2.0 kV, one step equals to 0.2 kV.

**NOTE** *The kV-value adjustment can be performed only in manual exposure mode.*

- In the service mode press the **CTL**-key and then press and hold down the **kV UP** -key for 3 seconds. The kV-display shows the message CAL, the kV-display shows the kV gain value and the mAs-display shows the kV offset value.
- Press the **mAs UP** key to change the kV offset value. The value in the mAs-display starts to flash.
- Use the **field/light** keys to change the value.
- Press the **kV UP**-key to change the kV gain value. The value in the kV-display starts to flash.
- Use the **field/light** keys to change the value.
- Press the **CTL**-key to exit and store the new parameter values into memory.

## 3.9 Special system parameters setup



In the service mode, press the **CTL**-key then press and hold the **mAs down** -key for **3 seconds**. Use the **density up/down** -keys to move to the desired mode. Change the parameter value with the **field/light** -keys. Exit by pressing the **CTL**-key. This key sequence enters the special system parameter setup mode.

Currently there are 41 different parameters available. If the actual number of parameters documented differs from the actual unit, please make sure that you are using a manual that is compatible with the software installed in the unit.

## 01. Maximum compression force

⊖  kg      n = maximum compression force (kg).  
The range is from 5 to 25 kg.  
Factory preset is 20 kg.     

## 02. Mode of C-arm rotation

⊖  kg      n = 0; C-arm moves directly but Stereotactic  
movement needs footpedal        
n = 1; All C-arm movements need foot

## 03. Maximum speed of UP/DOWN movement

⊖  kg      n = speed of UP/DOWN movement.  
speed range: from 1 (slowest) to 6 (fastest),  
factory preset is 4     

## 04. Mode of UP/DOWN movement

⊖  kg      n = 0; Cannot run during compression  
n = 1...25 kg; maximum compression force  
below which the up/down movement can be run     

## 05. AUTO-LOAD on/off

⊖  kg      n = 0; load movement always manual only  
n = 1; load movement is also automatic if  
user selects AUTO-release     

## 06. Maximum regional mAs limit

⊖  kg      n = 1; 500mAs/50Hz, 550mAs/60Hz (FIN)  
n = 2; 600mAs/50Hz, 600mAs/60Hz (ENG)  
n = 3; 300mAs/50Hz, 300mAs/60Hz (NY)     

## 07. Mode of FOOT CONTROL operation

⊖  kg      n = 0; outer edge releases, inner compresses  
n = 1; inner edge releases, outer compresses     

## 08. Type of BUCKY grid

⊖  kg      n = 1; Smith roentgen bucky  
n = 2; Gilardoni bucky (factory default)     

## 09. Film/screen combination 0 (zero) gain

⊖  kg      n = film/screen combination 0 gain value  
range: from 2 (darkest) to 99 (lightest),  
factory default is 10

**10. Film/screen combination 0 (zero) steepness**⌚  kgn = film/screen combination 0 steepness value  
range: 0 (low contrast) to 20 (high contrast),  
factory default is 10Setting in  
this unit:**11. Setting type of printer and/or height of labels used**⌚  kgn = 0; no marking system  
n = 1; STAR thermal label printer  
n = 2; standard serial label printer  
n = 3; Livingston film ID system  
n = 4; Agfa film printer  
n = 5; enable communication between Sophie and PC  
n = 6; Kodak film printerSetting in  
this unit:

- With selection **code 0** the PLANMECA **ADMARK** darkroom film marking system can be used, that prints all office, patient and technic setting information directly onto an unprocessed film in the darkroom. The patient and office information is entered by the keyboard provided.
- With selection **code 1** the **COSTAR ASCII Label Writer II** label printer can be used, that prints all technic setting information on a thermal label. The patient and office information is manually written to the label, before exposing the information on the label to the film.
- With selection **code 2** a standard **RS-232 serial printer** can be used, that prints all technic setting information on form-feed labels. The printer should be set to 9600 baud. The number of spacing rows between the labels is determined with parameter 19. The patient and office information is manually written to the label, before exposing the information onto the film.
- With selection **code 3** the **LIVINGSTON** Film ID System can be used, that exposes all office, patient and technic setting information directly onto a film after an exposure. The patient information and the date is entered by the system's keyboard.
- With selection **code 4** the **Agfa** Film Printer can be used.
- With selection **code 5** the communication between the Sophie and PC is enabled. This is needed when the AEC is fine-tuned by using the MAMMOTOOL software, refer to section "FINE TUNING SOPHIE AEC FOR NONSTANDARD FILM/SCREEN COMBINATIONS" on page F-24.
- With selection **code 6** the **Kodak** Film Printer can be used.

**NOTE**

*Please note that **only one** of the above mentioned systems can be simultaneously used. A serial printer cannot be used without a special Sophie compatible adapter.*

**12. Setting type of remote control box**⌚  kgn = 1; Traditional remote with 1 indicator  
n = 2; Advanced remote with 2 indicatorsSetting in  
this unit:

The factory default is n = 2 (Advanced remote control). If you use the old box and have the unit set for the new one, then the EXP-led would be on all the time in the remote box. If you use the new control box and the unit is set for the old one, then the remote box READY-led would not function (EXP works as before).

**13. Density fine-adjustment (sensor 1)**⌚  kgn = density fine adjustment value  
range: from -5 (lighter film) to 5 (darker film),  
one step equals 2.6% of OD (or 1/5 of the  
coarse density control setting)Setting in  
this unit:

The factory default is n = 0 (no adjustment). Use this fine adjustment to fine-tune the film density for sensor number 1 if one normal density step is too coarse.

**14. Mode of LAT key operation**⌚  kgn = 0; LM view is selected when  
the LAT key is pressed  
n = 1; ML view is selected when  
the LAT key is pressedSetting in  
this unit:

The factory default is n = 0.



**15. Auto-kV offset**

⊖  kg      n = Auto-kV system kV-offset value  
range: from -3 to +3kV, one step equals one kV     

The factory default is n = 0 (uses factory default Auto-kV values). Use this adjustment to change (fine-tune) the suggested Auto-kV setting, if the suggested kV value differs from the desired.

**16. cm-display offset adjustment**

⊖  kg      n = cm-display offset  
range: -9...+25 mm, one step equals one mm     

The factory default is n = 0. Use this feature to cancel the error between the actual cm-display and the minimum distance between the compression paddles.

**17. Height of SPOT-paddle**

⊖  kg      n = height of SPOT paddle (millimeters)  
range: 30...90 mm, one step equals one mm     

The factory default is n = 40. Use this feature to compensate for the different thicknesses in different type of SPOT-paddles. After programming the correct height of the SPOT-paddle in use, the compression thickness display will show correct values with all paddles, including the SPOT.

**18. Duration of the filter selection time-out**

⊖  kg      n = filter selection time-out  
range: 1-10 sec., one step equals one sec.     

The factory default is 5 seconds. This feature changes the duration of the filter selection time-out in the AEC mode. The rhodium filter is automatically changed to the molybdenum filter if the kV-value goes below 27 kV. The filter is changed after this preset time or when the exposure switch is pressed.

**19. Number of spacing rows in the serial printer**

⊖  kg      n = number of spacing rows between labels  
range: 0-20, one step equals one row     

This feature changes the number of spacing rows between the labels printed with the serial printer.

**20. Mode of MAG/ LOAD and release operations**

⊖  kg      n = 0; normal operation  
n = 1; manual MAG/LOAD operation  
n = 2; manual MAG/LOAD and release operations     

- n=0; normal MAG/LOAD and release operations. The factory default is n=0.
- n=1; manual MAG/LOAD operation. The MAG- or LOAD-key must be pressed and held down to move the C-arm.  
The AUTO-LOAD can not be selected. The REL-key operates normally.
- n=2; manual MAG/LOAD and release operations. The MAG- or LOAD-key must be pressed and held down to move the C-arm. The REL-key must be pressed and held down to drive the compression paddle open.  
The AUTO-release can not be selected.

**21. Speed of rotation motor**

⊖  kg      n = speed of rotation movement.  
speed range: from 1 (slowest) to 6 (fastest),  
factory preset is 4     

**22. HE 37 disabled/enabled**

⊖  kg      n = 0; HE37 disabled  
n = 1; HE37 enabled     

- n=0; HE37: The bucky grid is not connected is disabled. The factory default is 0.
- n=1; HE37 is enabled.

**26. Speed of the LOAD-movement**⌚  kgn = speed of LOAD-movement.  
speed range: from 1 (slowest) to 15 (fastest),  
factory preset is 15Setting in  
this unit:

This feature controls the speed of the cassette table when driving it to the loading position. Note, that the C-arm is driven to the magnification position always with the maximum (15) speed.

**27. Minimum kV value in AAEC mode**⌚  kgn = minimum kV value.  
The range is from 20 to 27 kV.  
Factory preset is 20 kV.Setting in  
this unit:**28. Mode of spot collimator/small focus operation**⌚  kgn = 0; The small focus is not selected  
automatically when the spot collimator is  
chosen (factory preset).  
n = 1; The small focus is automatically selected  
when the spot collimator is chosen.Setting in  
this unit:

Note, that the small focus is always chosen when the magnification mode is selected regardless of this parameter value.

**29. Mode of magnification/spot collimator operation**⌚  kgn = 0; The spot collimator is not selected  
automatically when the magnification mode is  
selected (factory preset).  
n = 1; The spot collimator is automatically selected  
when the magnification mode is selectedSetting in  
this unit:**30. AEC optical density selection**⌚  kgn = 0; optical density is 1.2 (factory preset)  
n = 1; optical density is 1.6Setting in  
this unit:**31. Sophie/Sophie CLASSIC selection**⌚  kgn = 0; SOPHIE software (factory preset)  
n = 1; SOPHIE CLASSIC softwareSetting in  
this unit:

The text SOP (Sophie) or CLA (Sophie Classic) is shown briefly on the breast thickness display when switching on the unit.

**32. Filter selection in the spot mode**⌚  kgn = 0; The spot collimator is selected  
when the spot mode is chosen  
(factory preset).  
n = 1; The molybdenum filter is selected  
when the spot mode is chosen. The breast thickness  
read-out is adjusted for the spot paddle.Setting in  
this unit:**33. Intermediate compression stopping force offset with the twincomp compression**⌚  kgn = Intermediate compression stopping force  
offset with the twincomp compression  
range: 0...5 kgSetting in  
this unit:

The factory default is n = 0. The intermediate compression stopping force when the twincomp compression is used is the compression force with the normal compression plus this offset value. Setting the compression force with the normal compression is described in section "Intermediate compression stopping force" on page F-5.

**34-42. Exposure mode and filter dependent density adjustment parameters**

The density value can be adjusted to be different for each filter and exposure mode (see table below). This parameter will be added to the density value set in the normal user mode with the density adjustment keys. The adjustment range of the parameters is from -3 (lighter exposures) to +3 (darker exposures). **Note, that the total density value range is still from -7 to +7.**

The factory default is n=0 for all the parameters.

Parameter number	Filter/exposure mode	Setting in this unit:
34	Molybdenum/Contact view exposure	
35	Aluminum/Contact view exposure	
36	Rhodium/Contact view exposure	
37	Molybdenum/Bucky exposure	
38	Aluminum/Bucky exposure	
39	Rhodium/Bucky exposure	
40	Molybdenum/MAG exposure	
41	Aluminum/MAG exposure	
42	Rhodium/MAG exposure	

**43. Density fine-adjustment (sensor 2)**

⊕  kg

n = density fine adjustment value  
range: from -5 (lighter film) to 5 (darker film),  
one step equals 2.6% of OD (or 1/5 of the  
coarse density control setting)

Setting in  
this unit:

The factory default is n = 0 (no adjustment). Use this fine adjustment to fine-tune the film density for sensor number 2 if one normal density step is too coarse.

**44. Density fine-adjustment (sensor 3)**

⊕  kg

n = density fine adjustment value  
range: from -5 (lighter film) to 5 (darker film),  
one step equals 2.6% of OD (or 1/5 of the  
coarse density control setting)

Setting in  
this unit:

The factory default is n = 0 (no adjustment). Use this fine adjustment to fine-tune the film density for sensor number 3 if one normal density step is too coarse.

**45. Mode of the OBL key operation**

⊕  kg

n = 0; DEX MLO view is selected when  
the left OBL key is pressed and SIN MLO  
view is selected when the right OBL key  
is pressed  
n = 1; SIN MLO view is selected when  
the left OBL key is pressed and DEX MLO  
view is selected when the right OBL key  
is pressed

Setting in  
this unit:

The factory default is n = 0.

**46. Maximum kV value in AAEC mode**

⊕  kg

n = maximum kV value.  
The range is from 30 kV to 35 kV.  
Factory preset is 35 kV.

Setting in  
this unit:

#### 47. Mode of LOAD/ready movement

⊖ 62.n kg

n = 0: Driving the cassette table by using the foot control is prohibited

n = 1; Driving the cassette table by using the foot control is allowed

Setting in this unit:

If a cassette is loaded and the film has been changed after the previous exposure (= cassette has been removed between the exposures), a short push of the outer corner of the foot control drives the cassette table from the LOAD position to the READY position. The factory default is 0.

#### 48-77. Parameters transformed from the Mammotool software

Sometimes, especially with film/screen combinations that are nonstandard for Sophie, it is necessary to do some additional adjustments to get the AEC system track properly. The density correction parameters (correction curves) for voltages (kV) (parameters 48-63), breast thickness (parameters numbers 64-72) and exposure time (parameters numbers 73-77) are separately adjusted by several adjustable parameters per curve (voltages with 15, breast thickness with 9 and exposure time curve with 5). The adjustment is done according to the test images with a computer program (MammoTool) and transformed into the Sophie's memory. These transformed parameters can be seen in the service mode parameters 48...77, where they have values between 1...99 (value 43 corresponds to the 0% adjustment level, which is also the factory default for each parameter). In order to establish the connection between Sophie and computer, the value 5 must be set in the service mode parameter 11. Please refer to section "FINE TUNING SOPHIE AEC FOR NONSTANDARD FILM/SCREEN COMBINATIONS" on page F-24 for detailed instructions on how to fine tune AEC.

The factory default is n=43 for all the parameters.

Parameter number	Setting in this unit:	Parameter number	Setting in this unit:
<b>48 (voltage)</b>		<b>49 (voltage)</b>	
<b>50 (voltage)</b>		<b>51 (voltage)</b>	
<b>52 (voltage)</b>		<b>53 (voltage)</b>	
<b>54 (voltage)</b>		<b>55 (voltage)</b>	
<b>56 (voltage)</b>		<b>57 (voltage)</b>	
<b>58 (voltage)</b>		<b>59 (voltage)</b>	
<b>60 (voltage)</b>		<b>61 (voltage)</b>	
<b>62 (voltage)</b>		<b>63 (voltage)</b>	
<b>64 (breast thickness)</b>		<b>65 (breast thickness)</b>	
<b>66 (breast thickness)</b>		<b>67 (breast thickness)</b>	
<b>68 (breast thickness)</b>		<b>69 (breast thickness)</b>	
<b>70 (breast thickness)</b>		<b>71 (breast thickness)</b>	
<b>72 (breast thickness)</b>		<b>73 (breast thickness)</b>	
<b>74 (exposure time)</b>		<b>75 (exposure time)</b>	
<b>76 (exposure time)</b>		<b>77 (exposure time)</b>	

**78. mA limit**⊖ **78.n** kg

n = 0: mA limit is off.

n = 1; mA limit is on.

Setting in  
this unit:

When the mA limit is off the mA value is chosen to be the maximum allowed mA for the selected kV according to the tables shown in sections "Toshiba E7272 x-ray tube ratings" on page A-9 and "Toshiba E7290 x-ray tube ratings" on page A-15. When the mA limit is on the maximum mA value that can be used is 80 mA. **The factory default is n=0.**

**79. Mode of Mammotool parameters usage**⊖ **79.n** kg

n = 1; adjustment is used for large focus

n = 2; adjustment is used for small focus

n = 3; adjustment is used for both focus sizes

Setting in  
this unit:

This feature defines if the correction parameters from the Mammotool software are used for the large focus (n=1), the small focus (n=2) or both (n=3). **The factory default is n=3.**

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## 4 FINE TUNING SOPHIE AEC FOR NONSTANDARD FILM/SCREEN COMBINATIONS

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### 4.1 Background

Normally the Sophie AEC system functions with good results without any other adjustments than the selection of the appropriate film/screen combination and density.

However, sometimes, especially with film/screen combinations that are nonstandard for Sophie, it is necessary to do some additional adjustments to get it track properly. These adjustments depend on the nature of the tracking problem.

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### 4.2 Testing the AEC for proper tracking

If a problem is suspected, it is necessary to first make a series of test exposures (see example test exposure protocol on page F-27). From these test exposures the service technician must then decide what kind of adjustments should be tried. As there are so many variables in the whole imaging chain, it is impossible to give firm instructions, instead guidelines are provided here. If required, it is also acceptable to use a test protocol as specified by a customer, e.g. a protocol defined by the local authorities.

From the test exposures the service technician must determine if the tracking problem is related to specific filter (Mo, Al or Rh) or imaging mode (contact, bucky or magnification). In that case the service modes 34-44 should be used, see section "Adjusting the filter and imaging mode adjustments" on page F-26.

If it is judged that the problem is related to the tissue thickness, tube potential or time, the special adjustment software that runs in a PC laptop computer must be used, see section "Adjusting the thickness, tube potential and time compensations" on page F-24.

**NOTE** *The tissue thickness compensation is based on the compressed tissue thickness, so it is necessary to apply compression when taking the test exposures. All the test exposures should be done in normal mode, i.e. not in service mode.*

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### 4.3 Adjusting the thickness, tube potential and time compensations

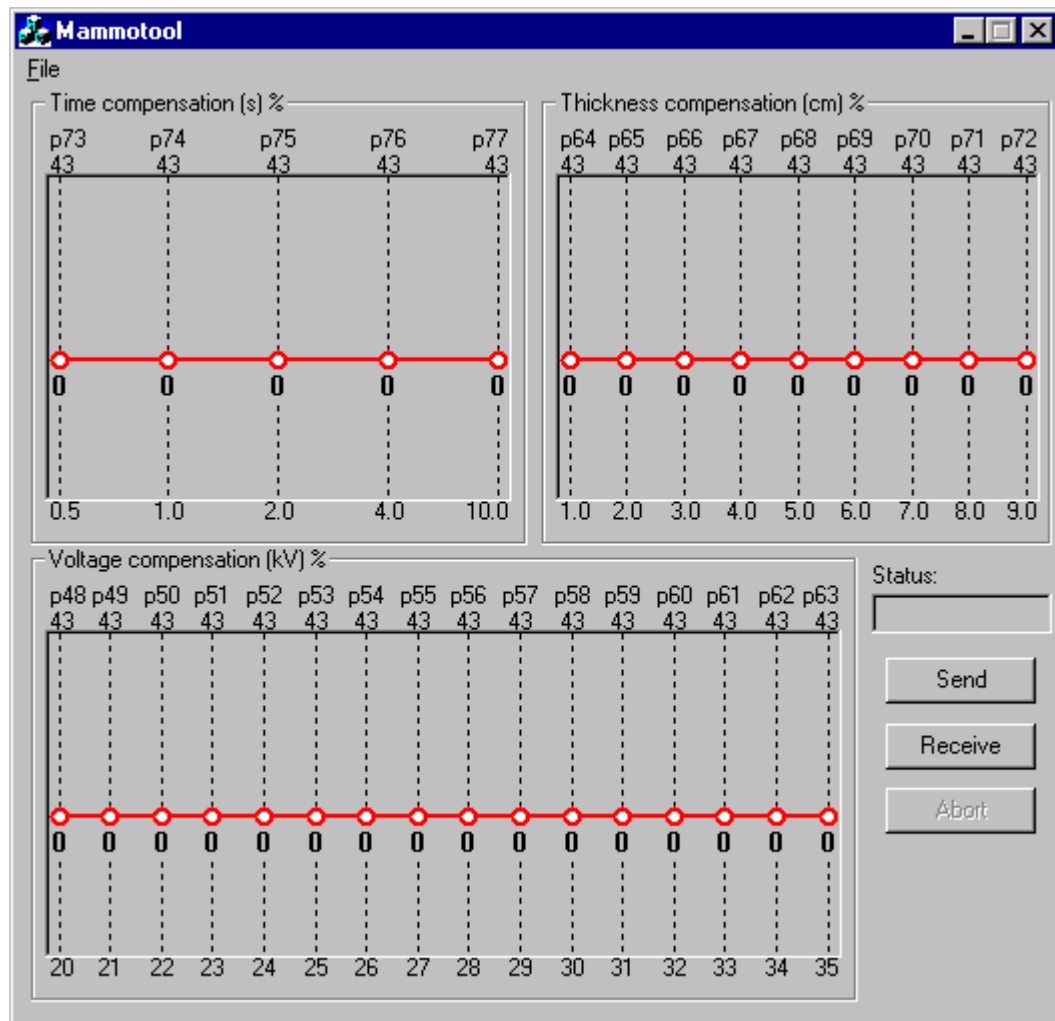
These adjustments are available starting from software version REAR 4.10 and TUBE 2.10. To do these adjustments a PC computer is required on the site. The PC serial port 'COM1' (or 'COM2', the file/option menu can be used to change the port) is connected to the Sophie connector using a cable (order code 7827752) and a special connection box (order code 10000140). The MAMMOTOOL (version 1.0) software (order code 10000139) must be installed on the PC.

First set the service mode parameter 11 to value 5. This enables the communication between Sophie and PC.

Next start the MAMMOTOOL software on the PC.

**NOTE** *Starting from Sophie software version REAR 4.41 and TUBE 2.41 you can define whether the adjustments are used only or the large focus, only for the small focus or both, see section "79. Mode of Mammotool parameters usage" on page F-23.*

The software should appear as illustrated below.



The MAMMOTOOL software has three main functions: receive, modify and send back the current AEC compensation values to and from the Sophie. In addition to that the current values can be saved/loaded to/from the PC hard disk, which makes it possible for the service technician to collect settings on his/her PC hard disk. This is handy, if for example the CPU board must be changed, in which case all the AEC adjustments will be lost.

The basic procedure for adjusting the AEC is the following:

1. Make test exposures.
2. Load the current setting from Sophie to PC.
3. Decide (based on point 1.) what kind of adjustments are required.
4. Make the adjustments on the PC. Adjustment can be done by dragging the dots with left mouse button, or by "drawing" the curve with right mouse button.
5. Send the new adjustment values to Sophie from the PC.
6. Redo the test exposures.
7. Decide if further adjustments are necessary, if so go to point 3.

Note, that because all the adjustments are interrelated (adjusting e.g. kV compensation may affect thickness compensation), it necessary to make full test exposure series after any adjustments. In practice it is probably best to do this so that e.g. first the thickness compensation is adjusted until the tracking with respect to thickness is acceptable. Then the tube potential test exposure series is made and the tube potential compensation is adjusted until the tracking is acceptable in that respect. Finally the full test protocol is performed.

To test that the connection between Sophie and the PC is functioning, click the 'Receive' button. The status control should briefly display the text "Waiting" and then text 'Ready'.

When PC is sending values to Sophie, Sophie will confirm the transfer with a 'beep'.

---

#### 4.4 Adjusting the filter and imaging mode adjustments

The service mode parameters 34-44 can be used to change the density setting of the AEC according to the operation mode and filter used. A positive value will make images darker and a negative will make images lighter.



## Test Exposure protocol

AEC:					AAEC:				
cm	kV	mAs	sec	OD	cm	kV	mAs	sec	OD
1	20	_____	_____	_____	1	_____	_____	_____	_____
2	22	_____	_____	_____	2	_____	_____	_____	_____
3	24	_____	_____	_____	3	_____	_____	_____	_____
4	26	_____	_____	_____	4	_____	_____	_____	_____
5	27	_____	_____	_____	5	_____	_____	_____	_____
6	29	_____	_____	_____	6	_____	_____	_____	_____
7	31	_____	_____	_____	7	_____	_____	_____	_____
8	33	_____	_____	_____	8	_____	_____	_____	_____

AEC:					AAEC:				
cm	kV	mAs	sec	OD	cm	kV	mAs	sec	OD
1	20	_____	_____	_____	1	_____	_____	_____	_____
2	22	_____	_____	_____	2	_____	_____	_____	_____
3	24	_____	_____	_____	3	_____	_____	_____	_____
4	26	_____	_____	_____	4	_____	_____	_____	_____
5	27	_____	_____	_____	5	_____	_____	_____	_____
6	29	_____	_____	_____	6	_____	_____	_____	_____
7	31	_____	_____	_____	7	_____	_____	_____	_____
8	33	_____	_____	_____	8	_____	_____	_____	_____

---

## 5 MECHANICAL ADJUSTMENTS

---

### 5.1 MAG/LOAD mechanism positional calibration

There is no actual need to calibrate this parameter. Driving the mechanism once from side to side (from limit sensor to limit sensor) would restore the positional information if it was wrong. Please perform this movement if you have replaced the TUBE CPU board (with or without the POWER SUPPLY).

---

### 5.2 UP/DOWN mechanism positional calibration

There is no actual need to calibrate this parameter. Driving the mechanism once from the lowest position to the upmost position (from limit sensor to limit sensor) C-arm in upright position would restore the positional information if it was wrong. Please perform this movement if you have replaced the REAR CPU board (with or without the POWER SUPPLY).

### 5.3 X-ray beam adjustment (Toshiba E7272 X-ray tube)

#### Preparations

- Drive the C-arm to the upright position, turn off the power.
- Remove the necessary covers, see chapter H, section 1. Remove the collimator cover, see chapter H, section 1.7.
- Check that the cassette is firmly in position. Perform the cassette table adjustment if needed, see "Cassette table size identification switches" on page F-61.

#### X-ray beam adjustment

- Loosen the collimator screws (Fig. F.2, 1) and pull the collimator assembly to the front at the TUBEHEAD (Fig. F.2, 2), to make sure that the X-ray beam reaches over the cassette table front edge (Fig. F.2, 3).
- The final adjustment of the X-ray beam front edge is performed with the stationary collimator primary front edge (Fig. F.2, 4).

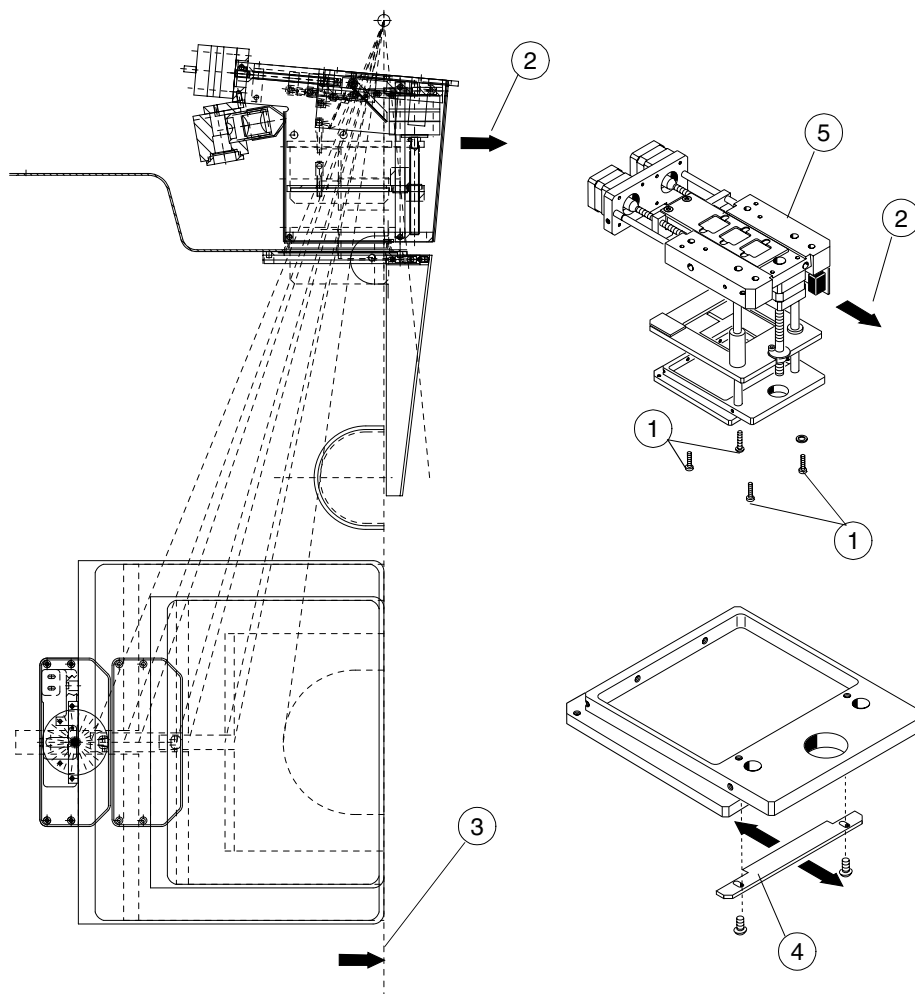


Figure F.2

## Adjustment procedure using the fluorescent screen

**CAUTION** Protect yourself from radiation when taking an exposure.

- a) Turn on the power.
- b) Adjust the cassette table for a large cassette.
- c) Place the fluorescent screen on the cassette table (Fig. F.3, 1). Enter the service mode (see "How to enter / exit the service mode" on page C-4.).
- d) Select filter 1, 25 kV, small focal spot.
- e) Take an exposure.
- f) Check that the yellow area is straight and symmetrically according to Fig. F.3, 1 and 2 (rectangle marked off in grey).
- g) The side direction adjustment is performed by moving the collimator magnet holder (Fig. F.3, 3).
- h) The front edge adjustment is performed by moving the stationary collimator primary front edge (Fig. F.3, 4).

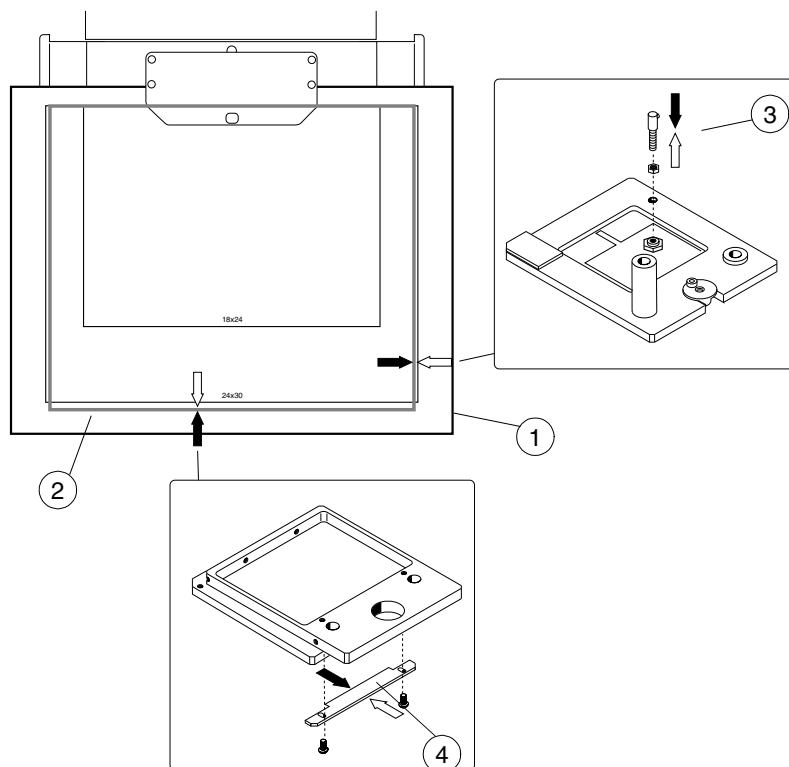


Figure F.3

**Adjustment procedure using x-ray film**

**CAUTION** *Protect yourself from radiation when taking an exposure.*

- a) Place a loaded large cassette on a cassette table (Fig. F.4, 1).
- b) Select 25 kV, AEC, small focal spot, filter 1, take an exposure and develop the film (film A).
- c) Measure the unexposed areas on both sides of the film. The unexposed area must be between 0 mm - 3 mm (Fig. F.4, 2)

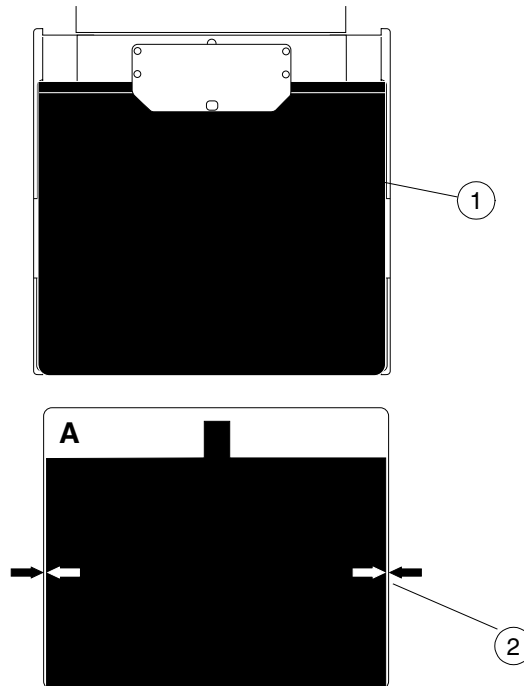


Figure F.4

- d) Check that the exposed area is straight on the film. Adjust the collimator magnet holder when needed (Fig. F.3, 3), and if that does not correct the situation, turn the collimator assembly slightly (Fig. F.2, 5).

- e) Place a loaded large cassette crosswise on the cassette table (Fig. F.5, 1).
- f) Select 25 kV, AEC, small focal spot, filter 1, take an exposure and develop the film (film B).

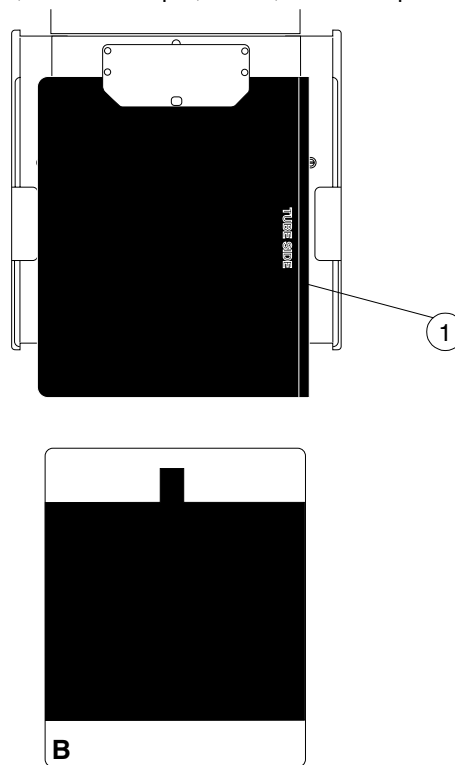


Figure F.5

- g) Place the film A on the top of the film B. Measure the area that has exposed over the cassette table front edge (1). The exposed area must be between 2 mm - 4 mm.

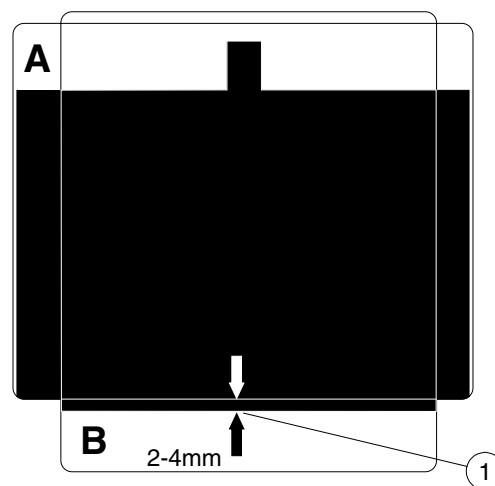


Figure F.6

- h) If needed, the front edge adjustment is performed by moving the stationary collimator primary front edge (Fig. F.3, 4).

### Spot collimator adjustment

- a) Place a loaded large cassette on a cassette table (Fig. F.7, 1).
- b) Select 25 kV, AEC, spot collimator, small focal spot, take an exposure and develop the film.
- c) Check that the exposed area corresponds to the area in Fig. F.7.
- d) Loosen the spot collimator assembly screws and perform the side direction adjustment (Fig. F.7, 2).
- e) The back/front adjustment is performed by moving the COLLIMATOR PCB (Fig. F.7, 3). After adjustment make sure that the collimator worm-screw nut does not hit the collimator lower frame or stick to the beginning of the worm-screw. If needed, adjust the collimator limit sensors, see "Collimator mechanism limit sensors" on page F-44.

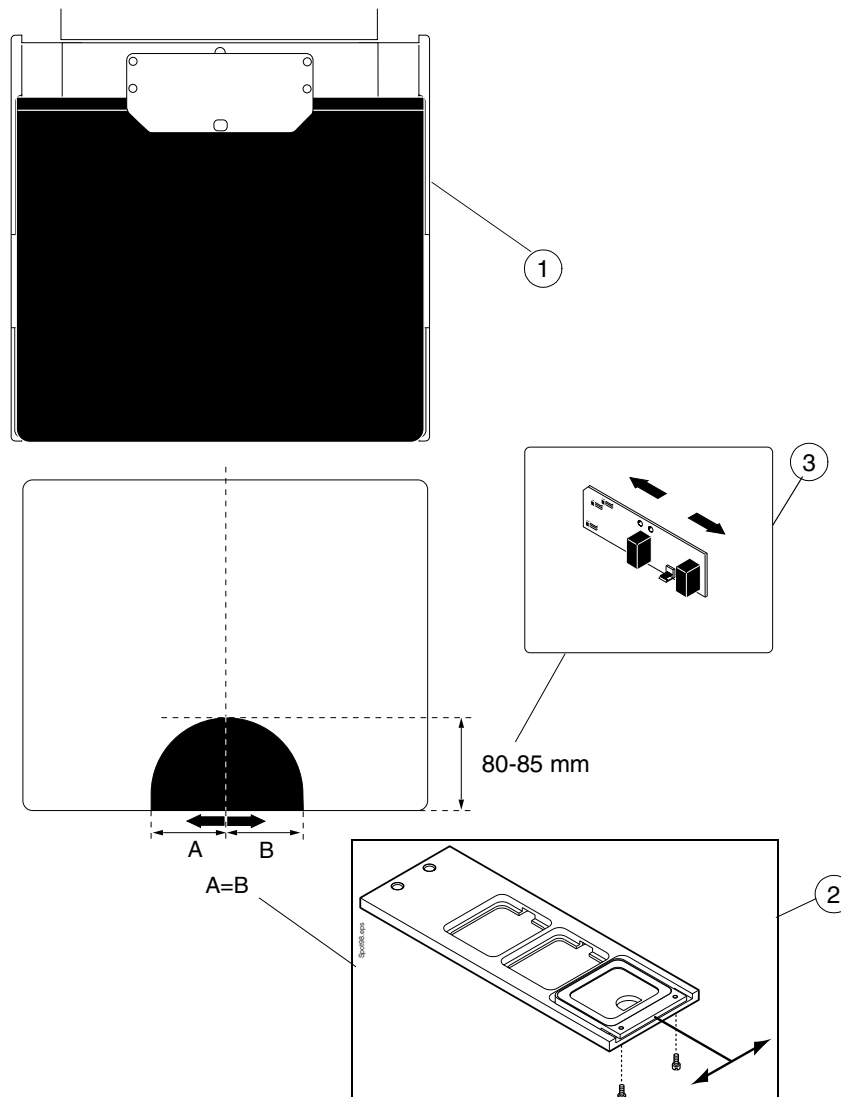


Figure F.7

### Checking the cleanness of the filters

- a) Filter 1:
  - Place a loaded large cassette on a cassette table.
  - Select 25 kV, AEC, filter 1, small focal spot. Take an exposure and develop the film.
  - Check the exposed area. Clean the filter if needed, use soft cloth moistened with alcohol-containing preparation (e.g. Solventol).
  - If the cleaning does not improve the image quality, change the filter ladder assembly.

- b) Filter 2:
  - Place a loaded large cassette on a cassette table.
  - Select 30 kV, AEC, filter 2, small focal spot. Take an exposure and develop the film.
  - Check the exposed area. Clean the filter if needed, use soft cloth moistened with alcohol-containing preparation (e.g. Solventol).
  - If the cleaning does not improve the image quality, change the filter ladder assembly.
- c) Spot collimator
  - Place a loaded large cassette on a cassette table.
  - Select 25 kV, AEC, spot collimator, small focal spot. Take an exposure and develop the film.
  - Check the exposed area. Clean the filter if needed, use soft cloth moistened with alcohol-containing preparation (e.g. Solventol).
  - If the cleaning does not improve the image quality, change the filter ladder assembly.



## 5.4 X-ray beam adjustment (Toshiba E7290 X-ray tube)

### Preparations

**CAUTION** *Protect yourself from radiation when taking an exposure.*

- Drive the C-arm to the upright position, turn off the power.
- Remove the necessary covers, see chapter H, section 1. Remove the collimator cover, see chapter H, section 1.7.
- Check that the cassette is firmly in position. Perform the cassette table adjustment if needed, see "Cassette table size identification switches" on page F-61.
- Loosen the collimator screws (Fig. F.8, 1) and pull the collimator assembly to the front at the TUBEHEAD (Fig. F.8, 2), to make sure that the X-ray beam reaches over the cassette table front edge (Fig. F.8, 3).

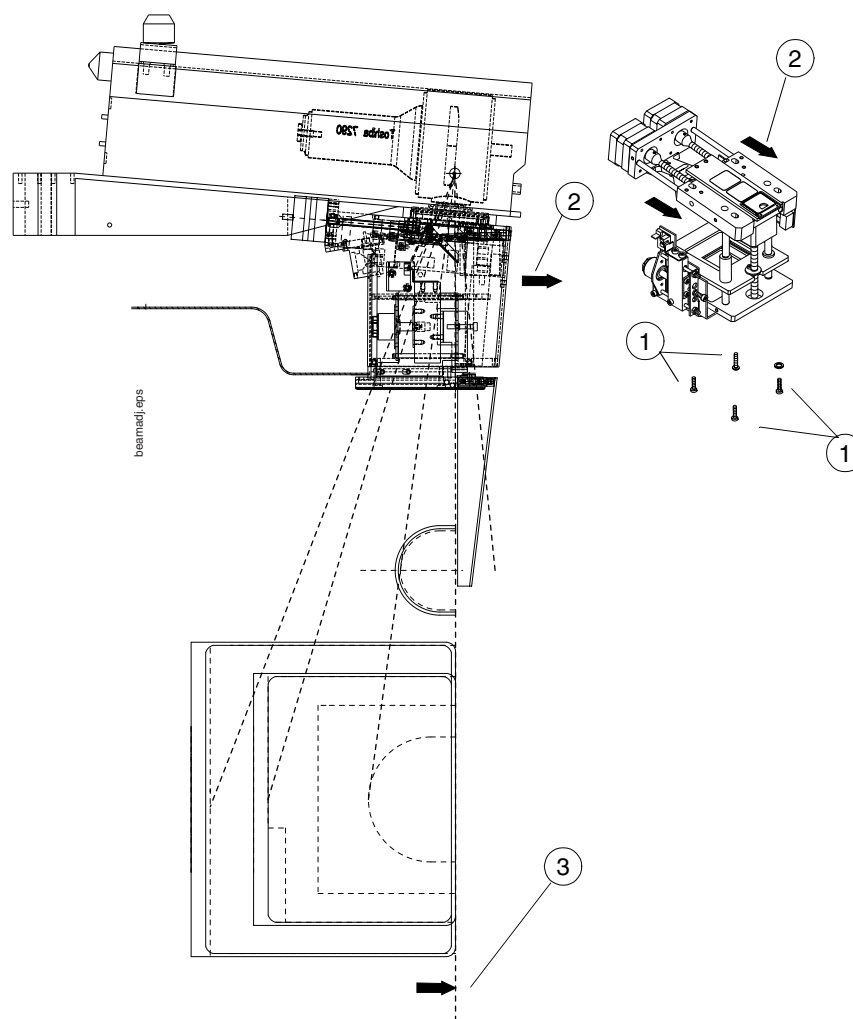


Figure F.8

- e) The adjustment of the X-ray beam front edge is performed by adjusting the cutter assembly. Loosen the cutter assembly screws (Fig. F.9, 1) and move the assembly forward as far as it goes (Fig. F.9, 2) to make sure that the cutter does not limit the beam front edge (Fig. F.9, 3).

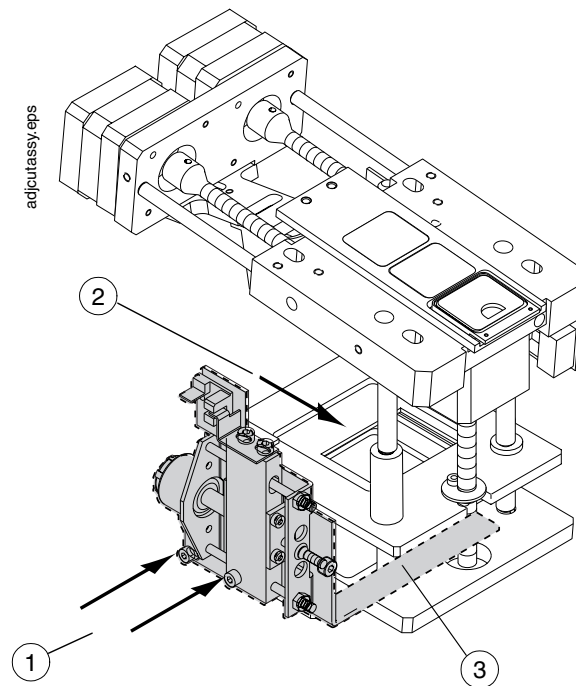


Figure F.9

## Spot collimator adjustment

- Place a loaded small cassette on a cassette table (Fig. F.10, 1).
- Select 25 kV, AEC, spot collimator, small focal spot, take an exposure and develop the film.
- Check that the exposed area corresponds to the area in Fig. F.10.
- Loosen the spot collimator assembly screws and perform the side direction adjustment (Fig. F.10, 2).
- The back/front adjustment is performed by moving the COLLIMATOR PCB (Fig. F.10, 3), or the collimator assembly (Fig. F.10, 4). After adjustment make sure that the collimator worm-screw nut does not hit the collimator lower frame or stick to the beginning of the worm-screw. If needed, adjust the collimator limit sensors, see "Collimator mechanism limit sensors" on page F-44.

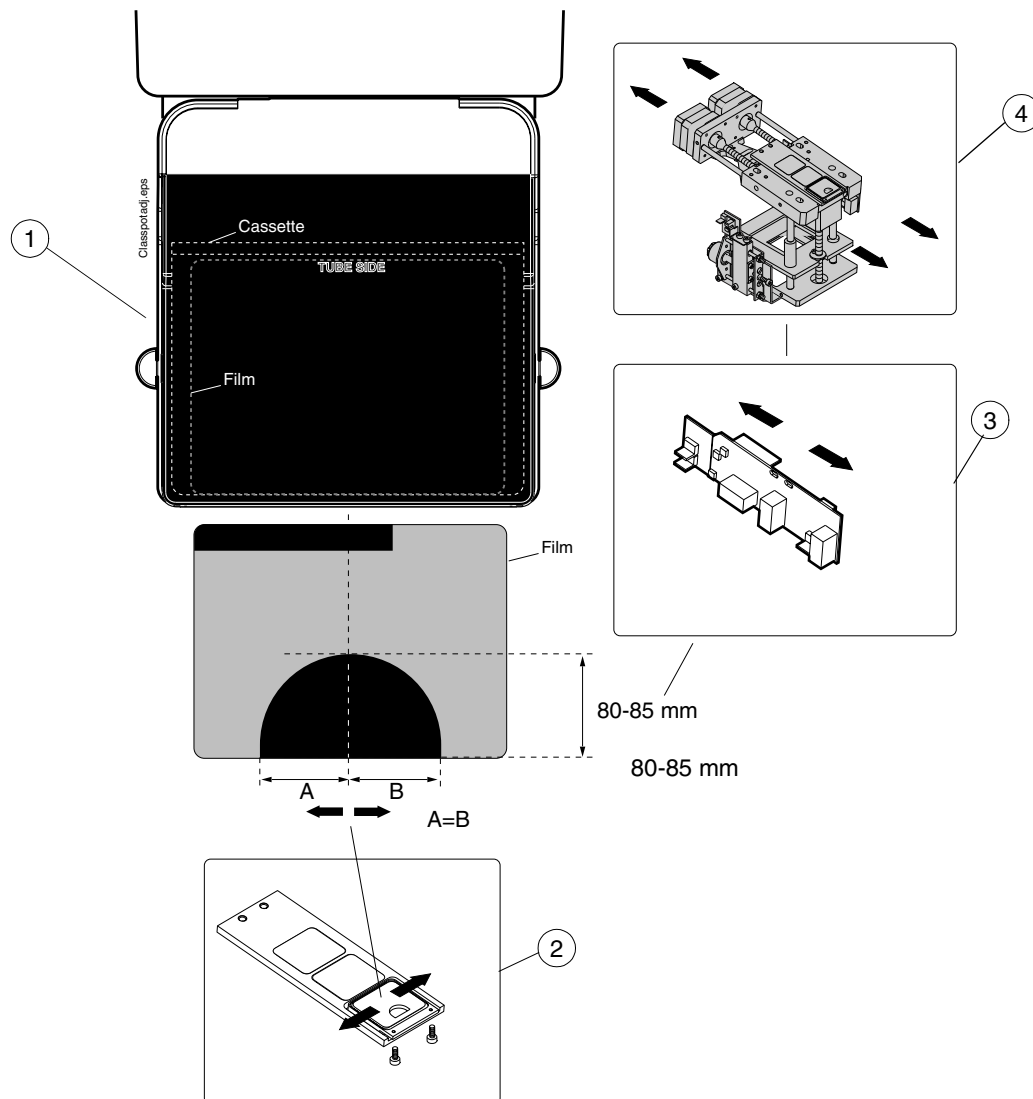


Figure F.10

**X-ray beam adjustment/large focal spot**

- a) Place a loaded small cassette on a cassette table (Fig. F.4, 1).
- b) Select 25 kV, AEC, large focal spot, filter 1, take an exposure and develop the film (film A).

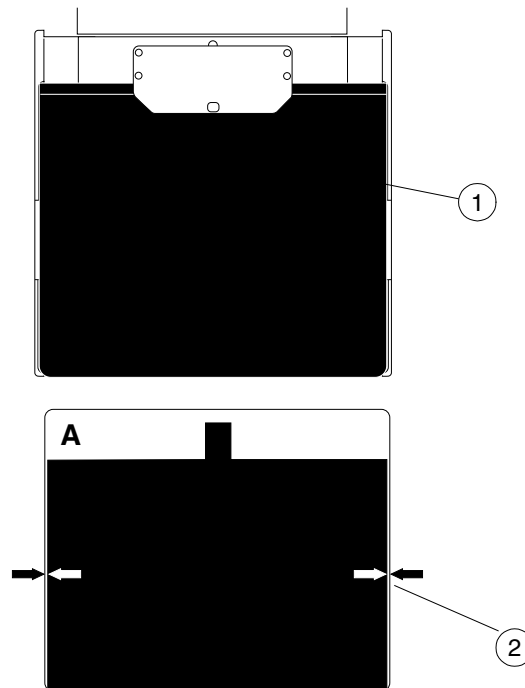


Figure F.11

- c) Measure the unexposed areas on both sides of the film. The unexposed area must be between 0 mm - 3 mm (Fig. F.4, 2). Adjust the area by lifting and lowering the collimator magnet holder (Fig. F.12, 1).

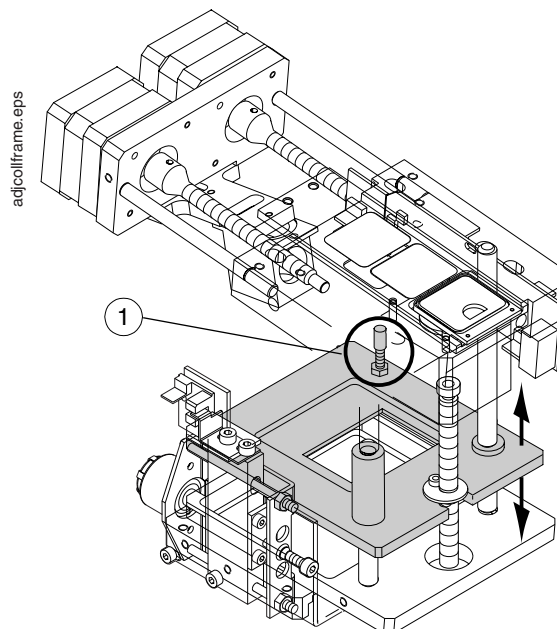


Figure F.12

- d) Check that the exposed area is straight on the film. Adjust the collimator magnet holder when needed (Fig. F.12, 1), and if that does not correct the situation, turn the collimator assembly slightly.

- e) Place a loaded small cassette crosswise on the cassette table (Fig. F.5, 1).
- f) Select 25 kV, AEC, small focal spot, filter 1, take an exposure and develop the film (film B).

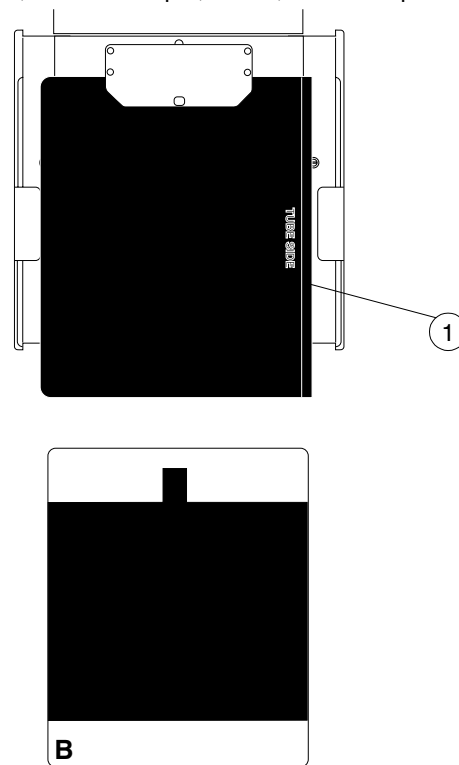


Figure F.13

- g) Place the film A on the top of the film B. Measure the area that has exposed over the cassette table front edge (1). The exposed area must be between 2 mm - 4 mm.

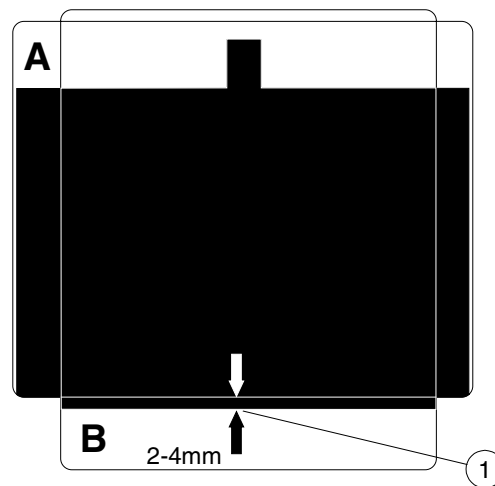


Figure F.14

- h) If needed, the front edge adjustment for **large** focal spot is performed by adjusting the cutter assembly position (Fig. F.15, 1). Loosen the cutter assembly screws and adjust the assembly position so that the area that has exposed over the cassette table front edge is between 2 mm - 4 mm (see Fig. F.14 on previous page).

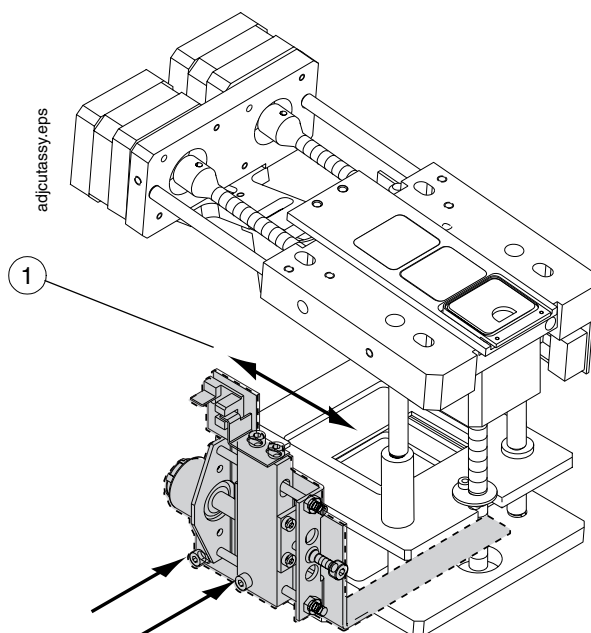


Figure F.15

### X-ray beam adjustment/small focal spot

- a) Perform the same adjustment as with large focal spot (a - g) with small focal spot.
- b) If needed, the front edge adjustment for **small** focal spot is performed with the stop screw on the cutter assembly (Fig. F.16, 1). Adjust the cutter position so that the area that has exposed over the cassette table front edge is between 2 mm - 4 mm (see Fig. F.14 on previous page).

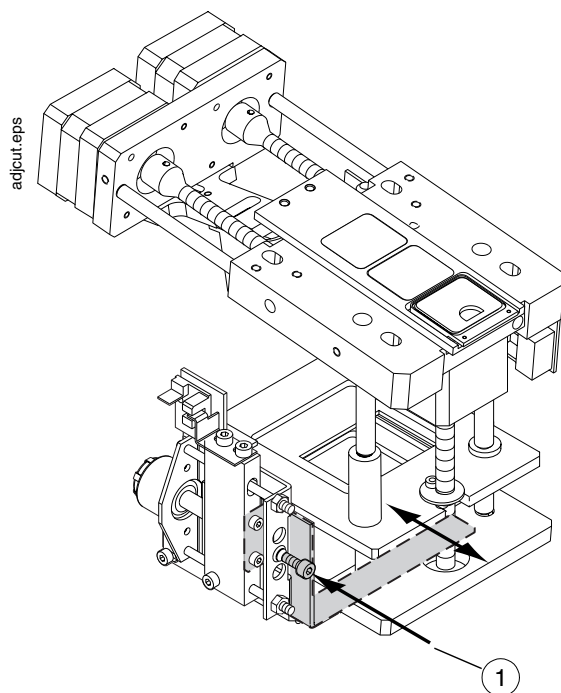


Figure F.16

### Checking the cleanness of the filters

- a) Filter 1:
  - Place a loaded large cassette on a cassette table.
  - Select 25 kV, AEC, filter 1, small focal spot. Take an exposure and develop the film.
  - Check the exposed area. Clean the filter if needed, use soft cloth moistened with alcohol-containing preparation (e.g. Solventol).
  - If the cleaning does not improve the image quality, change the filter ladder assembly.
- b) Filter 2:
  - Place a loaded large cassette on a cassette table.
  - Select 30 kV, AEC, filter 2, small focal spot. Take an exposure and develop the film.
  - Check the exposed area. Clean the filter if needed, use soft cloth moistened with alcohol-containing preparation (e.g. Solventol).
  - If the cleaning does not improve the image quality, change the filter ladder assembly.
- c) Spot collimator
  - Place a loaded large cassette on a cassette table.
  - Select 25 kV, AEC, spot collimator, small focal spot. Take an exposure and develop the film.
  - Check the exposed area. Clean the filter if needed, use soft cloth moistened with alcohol-containing preparation (e.g. Solventol).
  - If the cleaning does not improve the image quality, change the filter ladder assembly.

### 5.5 Light field beam adjustment

- a) Place a loaded large cassette on a cassette table so that it overhangs on the cassette table front edge (Fig. F.17, 1).
- b) Drive the moving collimator to the lower position (small cassette position):
  - Enter the service mode (see “How to enter / exit the service mode” on page C-4.).
  - Select the display of internal signals mode 02 (see “Diagnostic display of internal signals” on page C-10.).
  - Press the field/light keys to drive the moving collimator to the lower position.
- c) Switch on the light field.
- d) Place small metal objects (e.g. coins) to the corners of the light field (Fig. F.17, 2).
- e) Select 25 kV, AEC, small focal spot, filter 1. Take an exposure and develop the film.
- f) Check the misalignment between the light field marked with coins and the X-ray field on the film.
- g) The maximum allowed misalignment of the fields is  $\pm 4$  mm (Fig. F.17, 3).
- h) If needed, adjust the bulb housing in the collimator frame (Fig. F.17, 4):
  - Turn off the power.
  - Remove the power supply (see chapter H, section “Replacing the power supply”).
  - Loosen the bulb housing fixing screws (Fig. F.17, 5) and turn the lamp assembly (Fig. F.17, 6). Tighten the screws, replace the power supply and take a new exposure.
  - Repeat the above procedure if needed.
- i) If the misalignment in the back/front direction is more than  $\pm 4$  mm (Fig. F.17, 7), adjust the light field with the mirror angle adjusting screw (Fig. F.17, 8).

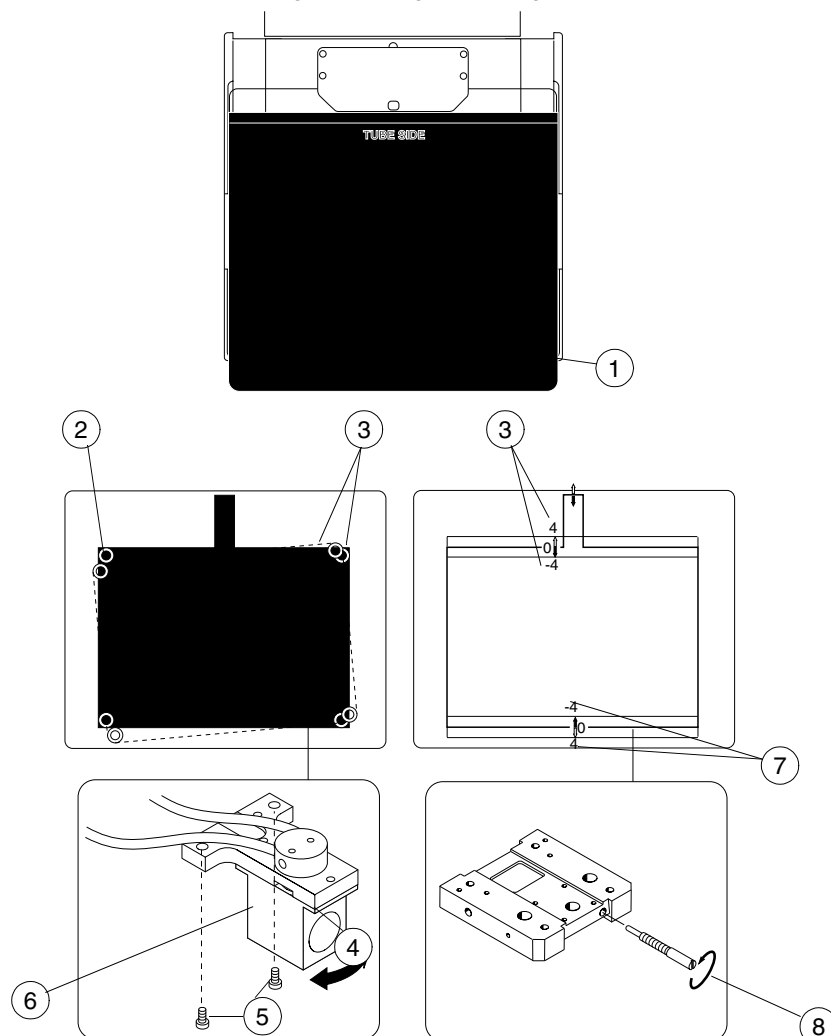


Figure F.17

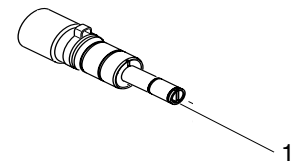


### 5.6 Filter position adjustment

The position hall-sensor is situated on the COLLIMATOR PCB. The final position of the filter ladder is adjusted by moving the sensor by adjusting the horizontal placement of this PCB (fixing hole are oval ones). The position of the other two (mirror and collimator) sensors will change as well, but the position of these is not very critical.

### 5.7 Twincomp paddle damper adjustment

- Turn the absorber adjusting screw (1) fully clockwise. You may have to hold the axle to prevent it from rotating.
- Lift up the paddle to the horizontal position and wait for about 10 seconds to allow the absorber to reset (internal oil pressure equalized).
- Release the paddle manually by pushing it slightly downwards. Note the release speed.
- If the release speed is too slow (or fast), turn the adjustment screw counter clockwise a quarter degree at a time and repeat from point b. Remember to wait between the tests.



### 5.8 Gas spring tension adjustment

- Drive the C-arm fully upright (CC-proj). Switch the unit off and remove the stationary column and telescopic column rear panels.
- Loosen the upper and lower locking nuts (M17) by rotating them counterclockwise.
  - If the adjustment is correct the gas spring tension should keep constant when rotating the tension adjuster about two turns counterclockwise. Rotate it clockwise until the gas spring feels loose, and leave it loose.
  - In the case of a wrong adjustment (the spring is pulling, not pushing), the gas spring would become loose when the tension adjuster is turned counterclockwise. Leave it loose.
- Check and tighten the gas spring's lower pivot axle if it feels loose. It could be loose if the spring was originally incorrectly adjusted.
- With the gas spring loose turn the tension adjuster counterclockwise as tight you can get, using your fingers only. Using a M17 wrench, turn the tension adjuster counterclockwise one extra turn.
- Using the wrench, tighten the upper and lower locking nuts by rotating them clockwise.

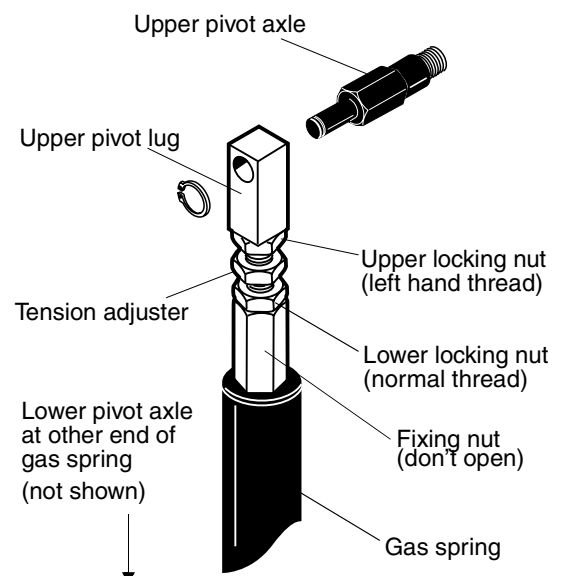
**NOTE** *Rotational directions referred to are when looking at the mechanism from above*

*The upper thread of the tension adjuster is left handed, as the upper locking nut.*

*The tension adjuster must always be used to remove the tension before the gas spring is (or can be) removed.*

*Never extend the tension adjuster more than described, otherwise it could come loose and the gas spring could extend rapidly, causing injury or damage.*

*Adjust the tension adjuster only when the arm is upright (in CC-proj). The gas spring must be pushing, not pulling.*



## 6 ADJUSTING SENSORS & SWITCHES

The adjustment of sensors and switches and checking their operation is fairly simple, especially when using the displays provided by the special service mode (Fig. F.18), see “Diagnostic display of internal signals” on page C-10. how to enter these. Most of the signals have also respective diagnostic LED-indicators on the so called “collector” PC-boards.

### Display signals

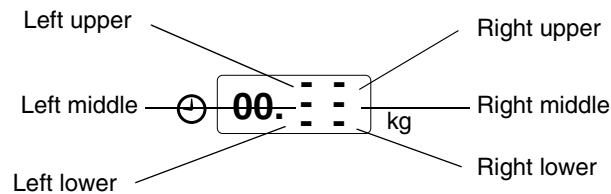


Figure F.18

### 6.1 Collimator mechanism limit sensors

The instructions for initial adjustments of mirror, filter and collimator are given in this section. The final adjustment is performed according to the instructions given in chapter F, sections 4.3 and 4.4.

#### Preparations

- a) Drive the C-arm to the upright position, turn off the power.
- b) Remove the C-arm covers, see chapter H, section 1.4.
- c) Remove the collimator cover, see chapter H, section 1.7.
- d) Turn the power on.

## FILTER

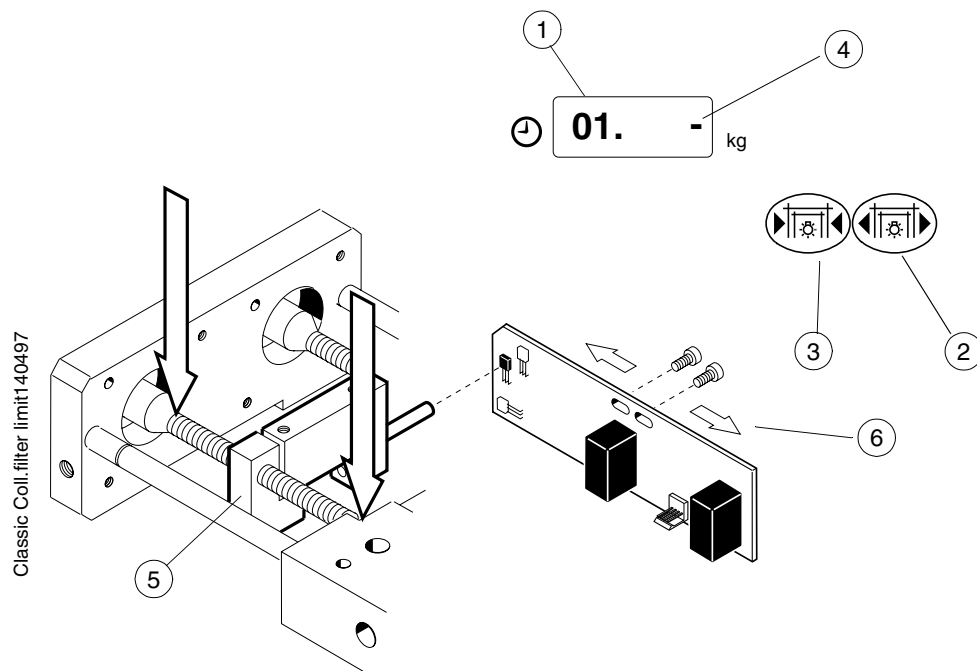


Figure F.19

**Checking the limit sensor adjustment**

- a) Enter the service mode and select the display of internal signals mode 01 (Fig. F.19, 1).
- b) Pressing the field/light keys (Fig. F.19, 2,3) drive the filter worm-screw nut (Fig. F.19, 5) to hall-sensor and check that the indicator LED on the COLLIMATOR PCB lights as well as the right middle signal (Fig. F.19, 4) on the display.

**Mechanical checking and adjustment**

The filter worm-screw nut may not hit the collimator frame or stick to the beginning of the worm-screw (arrows on Fig. F.19). To prevent this adjust the position of the COLLIMATOR PCB (Fig. F.19, 6). The final adjustment of the filter position is performed according to instructions described in chapter F, section 4.3. Especially the spot collimator adjustment must be checked.

## MIRROR

### Checking the limit sensor adjustment

- Enter the service mode and select the display of internal signals mode 00 (Fig. F.20, 1).
- Press the right field/light key (Fig. F.20, 2). The mirror rotates away from the radiation window and stops automatically to its limit. The indicator LED on the COLLIMATOR PCB lights as well as the right middle signal on the display (Fig. F.20, 4) if the mirror magnet reaches the hall-sensor.
- Press and hold down the left field/light key (Fig. F.20, 3). The mirror rotates to its initial position. Release the key when the position is reached.

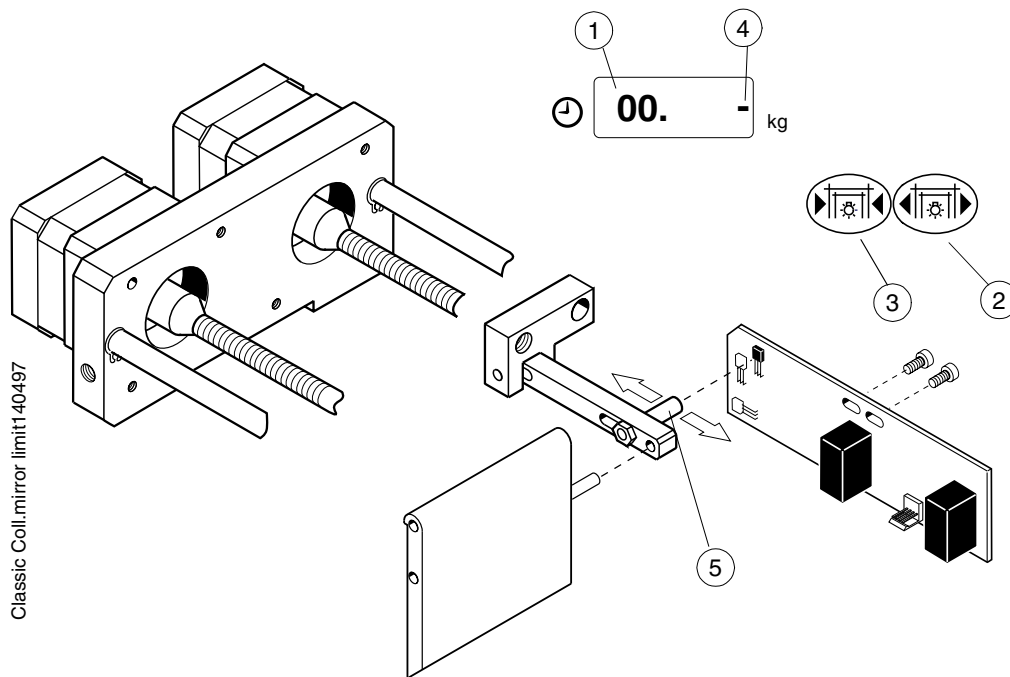


Figure F.20

### Mechanical checking and adjustment

The mirror may not hit the collimator frame, adjust the mirror magnet holder (Fig. F.20, 5) if needed. The final adjustment of the mirror position is performed according to instructions described in chapter F, section 4.4.

## COLLIMATOR

### Checking the limit sensor adjustment

- a) Enter the service mode and select the display of internal signals mode 02 (Fig. F.21, 1).
- b) Pressing the filed/light keys (Fig. F.21, 2,3) drive the moving collimator to the hall-sensor and check that the indicator LED on the COLLIMATOR PCB lights as well as the right middle signal (Fig. F.21, 4) on the display.

### Mechanical checking and adjustment

The collimator worm-screw nut may not hit the collimator lower frame or stick to the beginning of the worm-screw (arrows). To prevent this adjust the collimator magnet holder (Fig. F.21, 5) in up/down direction. The final adjustment of the collimator positions is performed according to instructions described in chapter F, section 4.3.

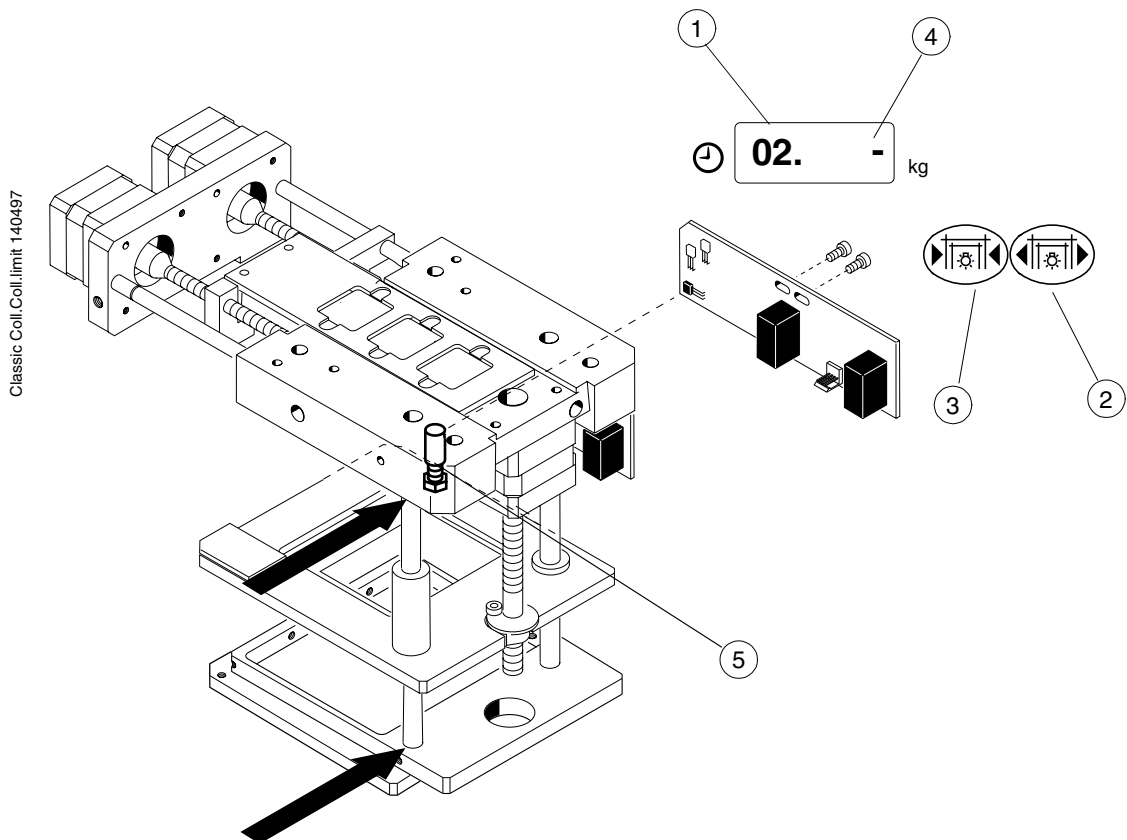


Figure F.21

## COLLIMATOR MECHANISM MECHANICAL AND VISUAL CHECKING

- a) Check that all the worm-screws rotate easily (Fig. F.22, 1). If there is stiffness, try to reduce it with following procedure:
  - Loosen the fixing screws (arrows) of the stepper motor.
  - Drive the worm-screw nut from side to side and leave it to the position nearest the stepper motor. Fasten the stepper motor screws.
  - Check the rotation of the worm-screw. Repeat the adjustment if needed.
- b) Check that the worm-screws has a thin layer of vaseline. The vaseline may not contain silicon and it must be heat-proof and colorless. Factory recommendation: KLÜBER paralia GA 351.
- c) Check that the filter ladder outer edges have a thin layer of vaseline (Fig. F.22, 2).
- d) Check that the mirror moves easily and that it is clean.
- e) Check and fasten, if necessary, all the screws and nuts.
- f) If the collimator assembly has been removed from or sifted in the tubehead, the adjustment according to chapter F, sections 4.3 and 4.4 is required.
- g) If the places of magnet holders or COLLIMATOR PCB have been changed, the adjustment according to chapter F, sections 4.3 and 4.4 is recommended.

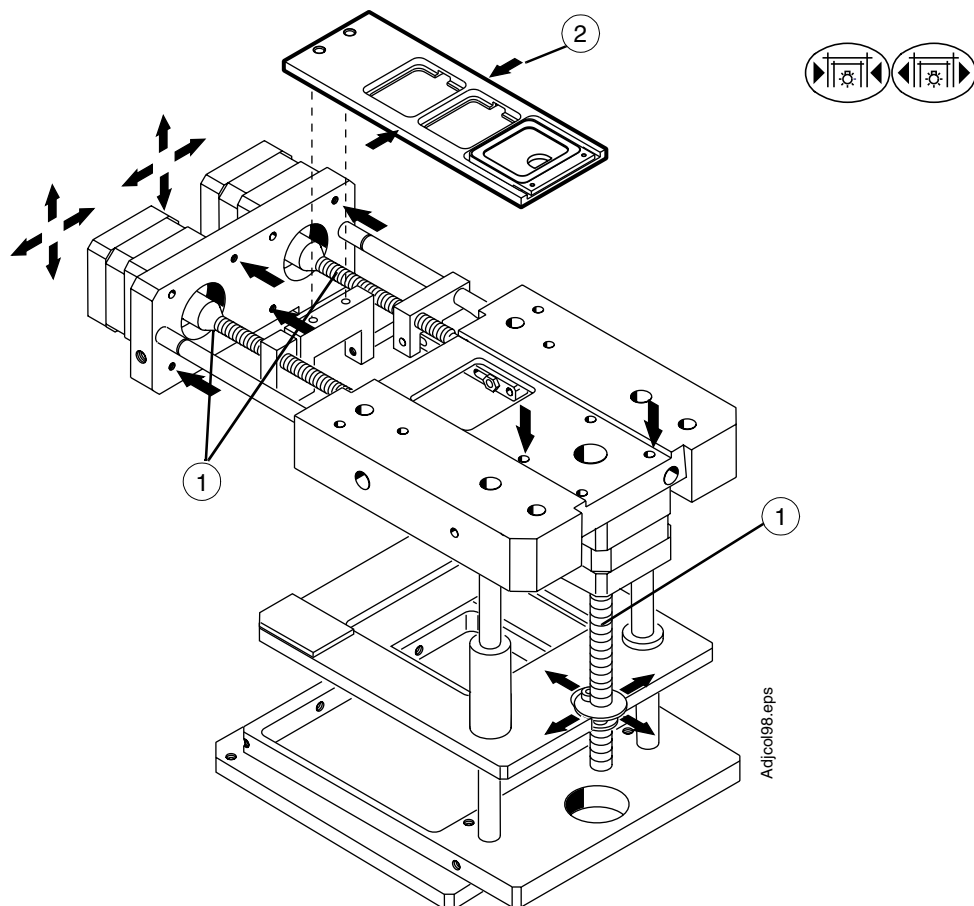


Figure F.22

- h) If the signal(s) on the display does not light when the magnet is at the sensor, or there are electrical problems, "COLLIMATOR" on page G-4.

## 6.2 Compression mechanism limit sensors

- a) Enter the service mode and select the display of internal signals mode 07 (Fig. F.23, 1).
- b) Drive the upper compression paddle mechanism with the field/light keys (Fig. F.23, 5) from top to bottom (from limit sensor to limit sensor):
  - Upper limit: the upper compression paddle should stop and the right middle signal (Fig. F.23, 2) on the display should light. Paddle or any part of it may not hit to any other parts.
  - Release (highest) limit: drive the upper compression paddle to the release limit. The right upper signal (Fig. F.23, 3) should light and the paddle should tilt.
  - Lower limit: place the Bucky grid to the lower paddle holders and drive the upper compression paddle to its lower limit. The right lower signal (Fig. F.23, 4) on the display should light. Check that there is 1-2 mm space between the paddle and the Bucky.
- c) If the compression mechanism display signal(s) does not light, or there is an electrical problem, "Compression" on page G-3.

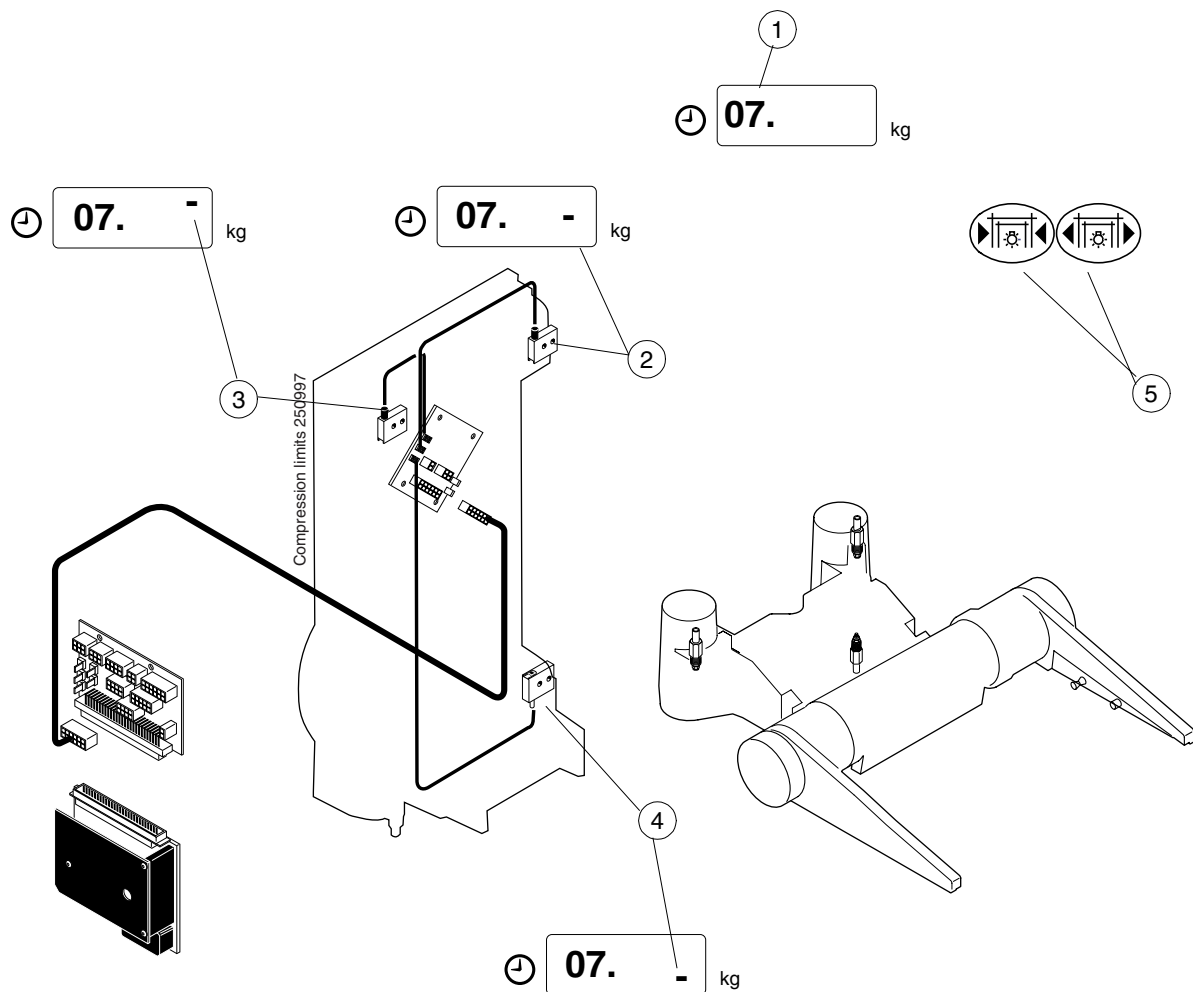


Figure F.23

### Mechanical adjustments

- Enter the service mode and select the display of internal signals mode 07 (Fig. F.24, 1).
- Drive the upper compression paddle mechanism with the field/light keys (Fig. F.24, 2) so that only the right middle signal is lit (Fig. F.24, 3).
- Adjust the paddle tilting sensitivity with the holding screw (Fig. F.24, 4). The paddle should be released by pushing it lightly.
- Adjust the height of the spring holder screw to 9mm (Fig. F.24, 5).
- Adjust the distance between the spring holder screw and the releasing plate to 2-3mm (Fig. F.24, 6).
- Drive the upper compression paddle mechanism upwards so that both the right upper and the right middle signals are lit (Fig. F.24, 7). The distance between the upper compression paddle mechanism and the upper mechanical limit must be 3-5mm (Fig. F.24, 8).
- Move the upper compression paddle mechanism to the mechanical limit by rotating the bearing screw (Fig. F.24, 10). The trigger (Fig. F.24, 11) must still be movable.

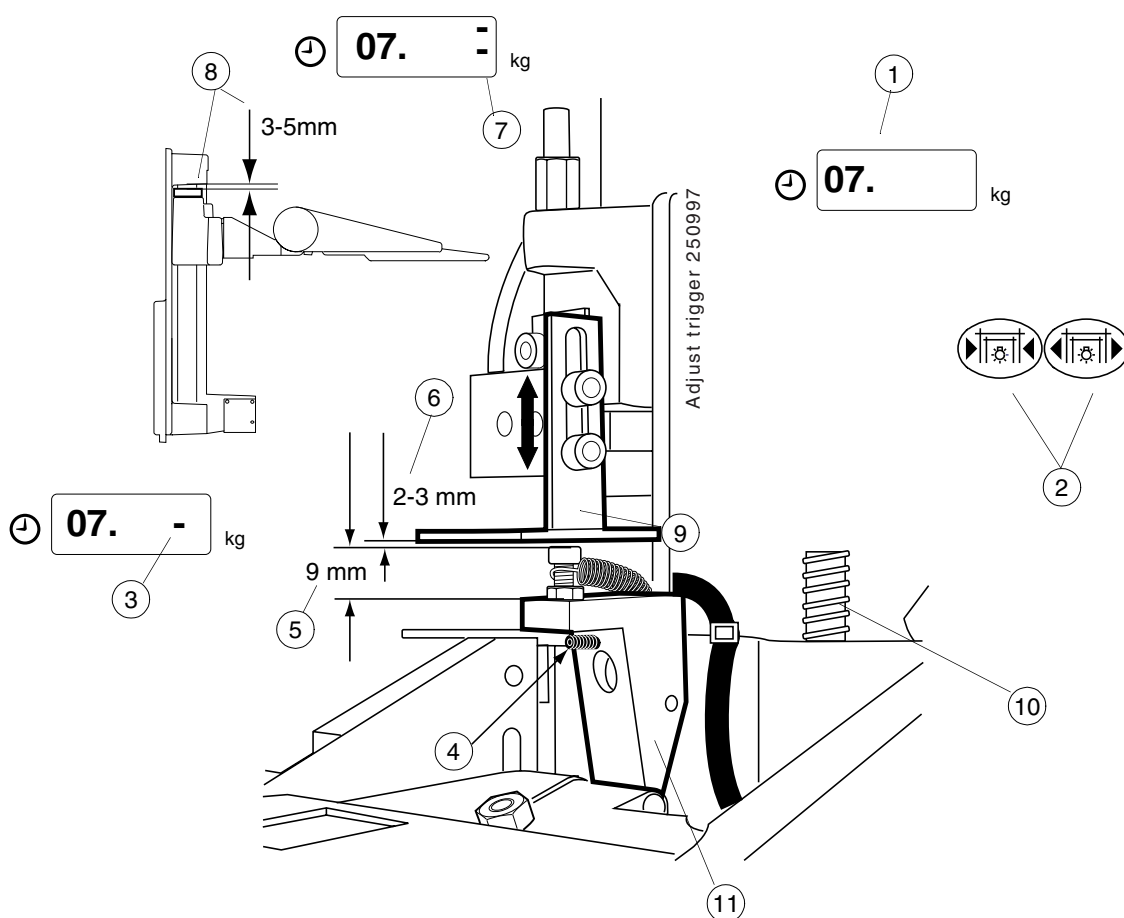


Figure F.24

**NOTE** *Wrong adjustment of the spring holder screw (Fig. F.24, 5) may cause the twincomp latch assembly to hit and damage the bracket's edge (Fig. F.24, 9).*



- h) The backlash in the paddle holders' (Fig. F.25, 1) normal position is removed by adjusting the screws (Fig. F.25, 2) in the tilting lever assembly (Fig. F.25, 4) so that their ends pass through the assembly about the length of the gap. When the adjustment is done in the both sides, secure the screws (Fig. F.25, 2) with the nuts (Fig. F.25, 3).
- i) Check the tightness of other nuts in the assembly.

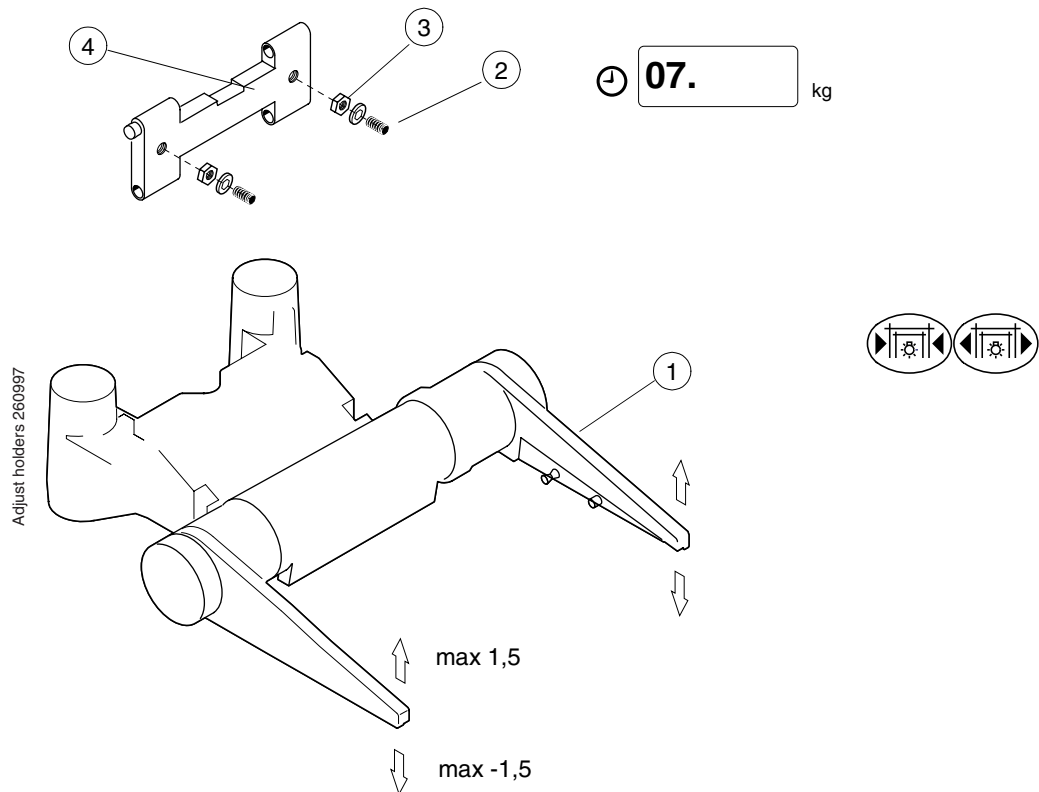


Figure F.25

### 6.3 MAG/LOAD mechanism limit sensors

**NOTE** *The adjustments described in this section must be performed with extreme caution. The wrong adjustment of the limit sensors may cause collision, which can cause injury or damage. Before adjustment and especially after replacing the limit sensor, check the condition of the limit sensors with a separate magnet.*

#### Preparations

- Drive the C-arm to the upright (CC-) position.
- Enter the service mode and select the display of internal signals mode 04, see "SERVICE MODE FUNCTIONS SHORT-FORM" on page C-4. (Fig. F.26, 1).

#### Checking the limit sensors

- Drive the cassette table to the upper position (Mag-up) with field/light keys (Fig. F.26, 2) and check that the right upper signal (Fig. F.26, 3) on the display lights. When driving the cassette table the left middle signal (Fig. F.26, 7) on the display should blink.
- Drive the cassette table to the lower position (Mag-down) and check that the right lower signal (Fig. F.26, 4) on the display lights.

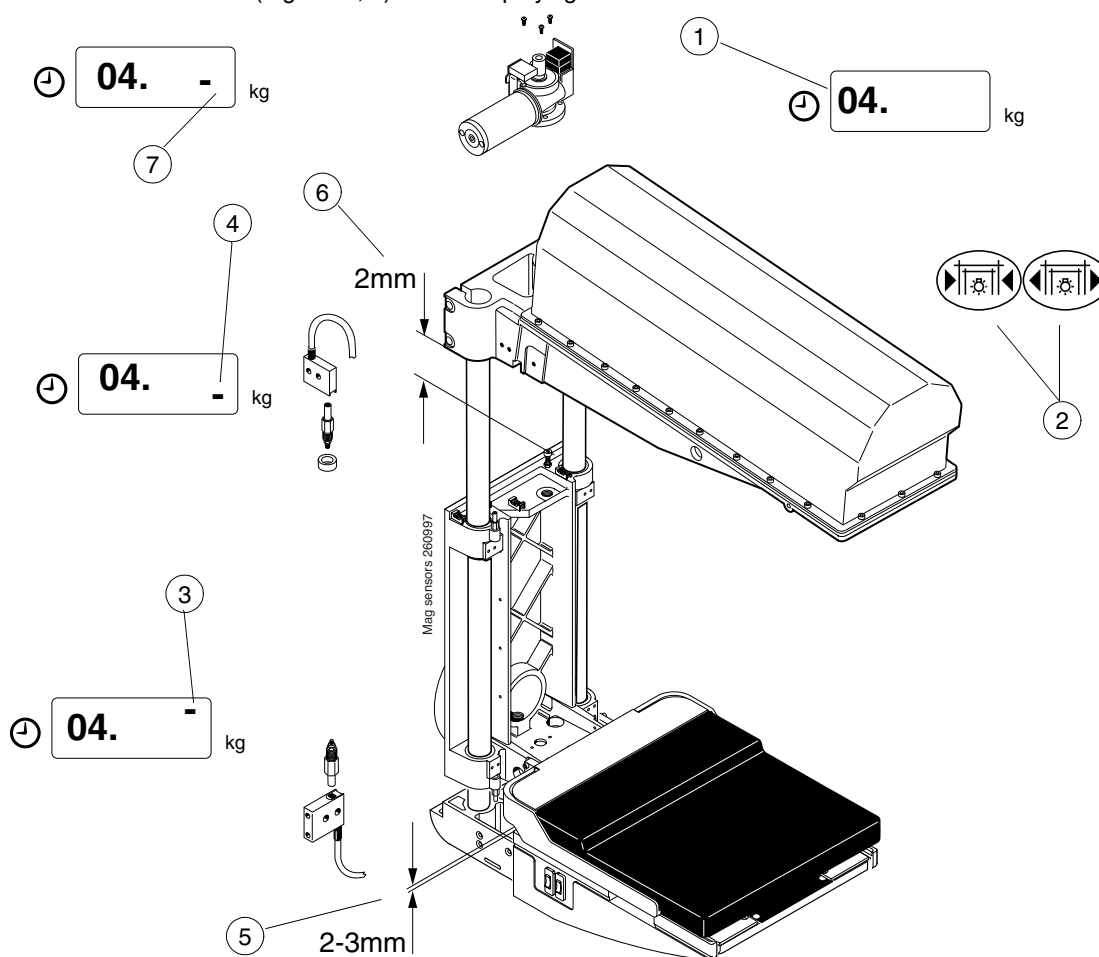


Figure F.26

#### Mechanical checking and adjustment

- Mag-up (normal mode) position's limit sensor:
  - Place the lower paddle to the lower paddle holders.
  - Drive the cassette table to Mag-up position, the space between frame side and table guide should be 2-3 mm (Fig. F.26, 5).
  - Adjust the magnet holder until the space is correct.

- b) Mag-down (magnification mode) position's limit sensor:
- Check that the mechanical limit is correctly positioned.
  - Make sure that the compression mechanism limit sensors have been adjusted (chapter F, section 5.2).
  - The adjustment is performed with right C-arm side panel fastened to make sure that the upper compression paddle assembly does not hit the side panel at the lower limit (this is possible failure when the C-arm is in MAG-position, compression paddle non-tilted and in its highest position (tilt release position) (Fig. F.27).
  - If needed, adjust the magnet holder so that the conditions above are fulfilled.
  - Make sure that the hall-sensor hits the magnet holder accurately.
  - Check that the space between the mechanical limit and the tubehead is at least 2 mm when the cassette table is in the Mag-down position (Fig. F.26, 6).

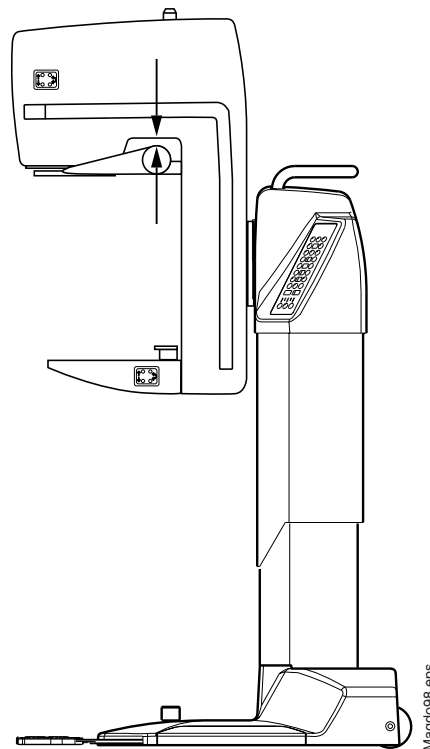


Figure F.27

- c) If the signal(s) on the display does not light when the magnet is at the sensor, or there are electrical problems, see "MAG/LOAD mechanism" on page G-2.

#### 6.4 Labeling head disk position sensor

- a) Drive the C-arm to the upright (CC-) position.
- b) Enter the service mode and select the display of internal signals mode 03, see "SERVICE MODE FUNCTIONS SHORT-FORM" on page C-4..
- c) When the labeling head disk magnet points to the hall-sensor on the LABELING PCB, the LED D12 (CRL) on the SHELF CIRCUIT BOARD lights as well as right middle signal on the display. If the LED D12 does not light, see "LABELING" on page G-4..

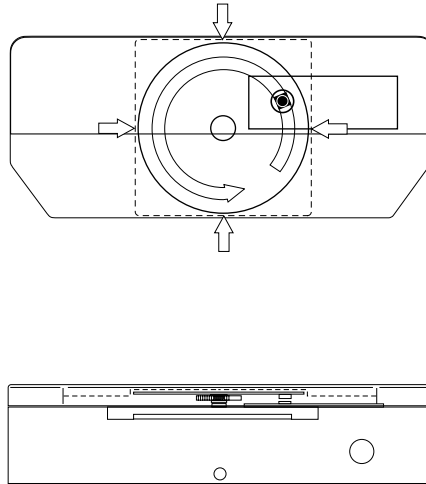


Figure F.28

- d) Check that the labeling head disk is rotating freely and does not hit the cover, the frame or cables

#### 6.5 C-arm rotation sensor

**NOTE** *The adjustments described in this section must be performed with extreme caution. The wrong adjustment of the limit sensors may cause collision, which can cause injury or damage. Before adjustment and especially after replacing the limit sensor, check its condition with a separate magnet.*

- a) Remove the necessary covers, see instructions described in chapter H, sections 1.1, 1.2, 1.3, and 1.5. Note that the hood should be removed if the place of the Rotation lower limit sensor is adjusted.

- b) Check that the Rotation mechanical limits (Fig. F.29, 1,2) are in their positions.

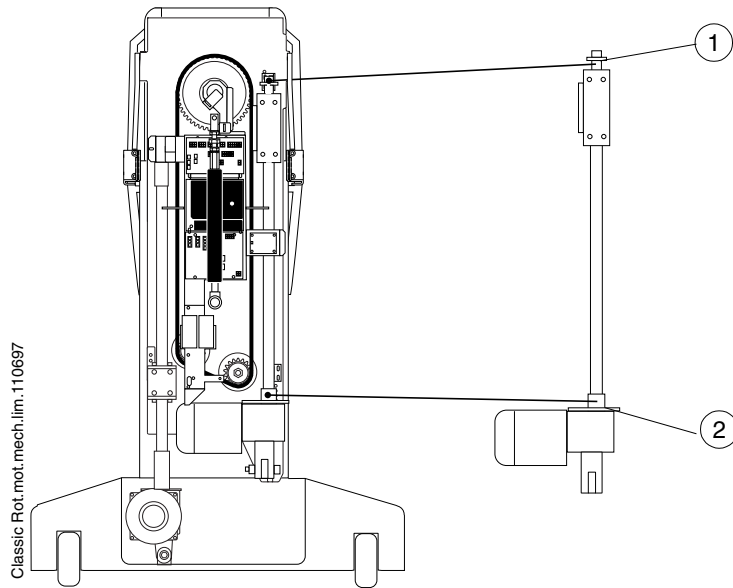


Figure F.29

- c) Enter the service mode and select the display of internal signals mode 06, see “SERVICE MODE FUNCTIONS SHORT-FORM” on page C-4. (Fig. F.30, 1).

**Tubehead against floor (≈ 180°), (= transportation position)**

- a) Drive the C-arm to the transportation position with field/light keys (Fig. F.30, 2). Check that the right lower signal on the display (Fig. F.30, 3) lights when the C-arm reaches the vertical position.
- b) The C-arm is must be slightly over 180° position before the right lower signal lights, adjust the position of the Rotation lower limit sensor (Fig. F.30, 4) if needed. Check the C-arm rotation and readjust, if needed.

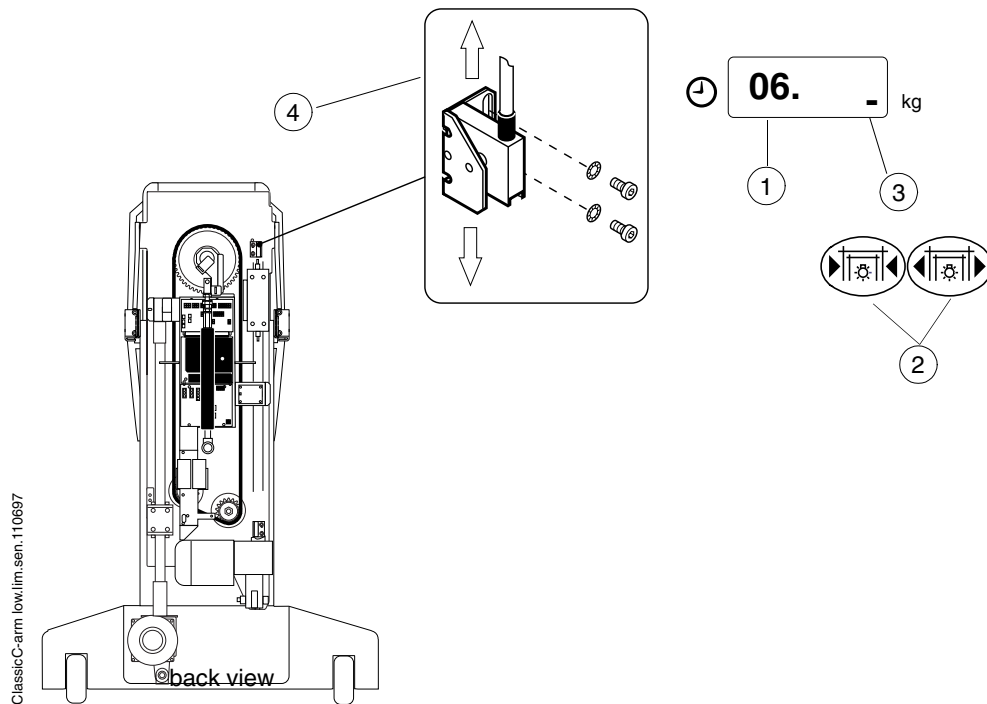


Figure F.30

**Rotation to extreme left ( $\approx -135^\circ$ )**

- a) Drive the C-arm to the  $-135^\circ$  position with field/light keys. (Fig. F.31, 1) Check that the right upper signal on the display (Fig. F.31, 2) lights when the C-arm is in the position slightly over  $-135^\circ$  but the worm screw nut does not hit the spacer.
- b) If this does not happen, adjust the position of the Rotation upper limit sensor (Fig. F.31, 3). Check the rotation and readjust, if needed.

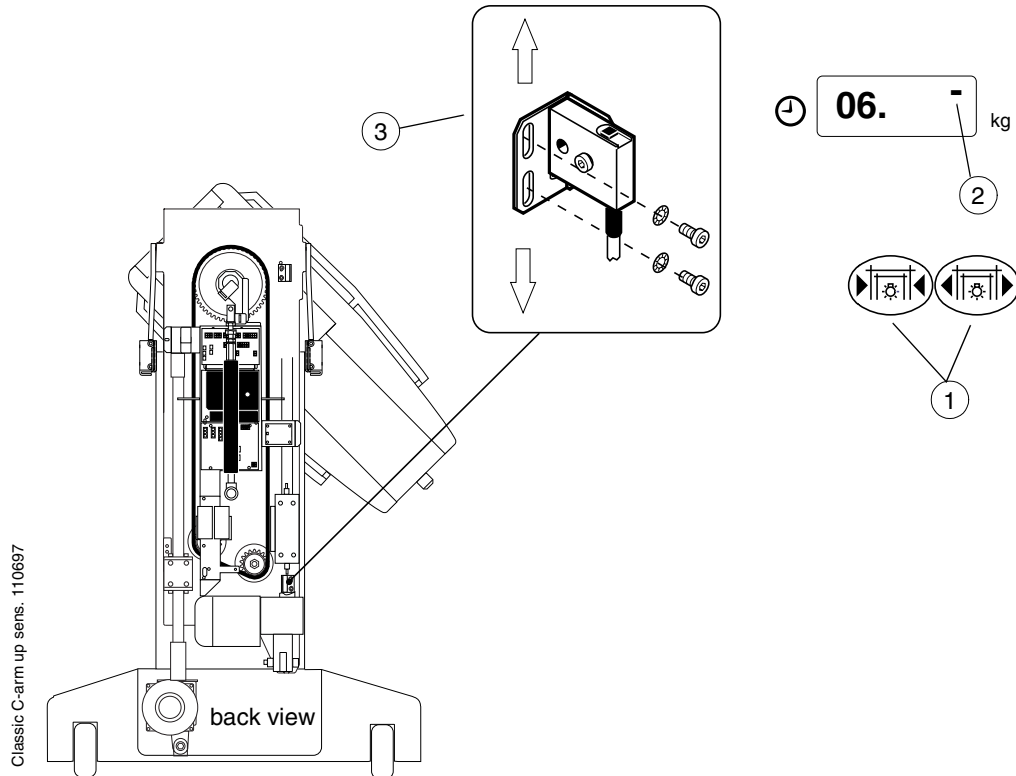


Figure F.31

**C-arm at upright**

- a) See instructions described in chapter F, section 3.3.
- b) Check that the right middle signal (Fig. F.32, 1) on the display light when the C-arm is in the upright position ( $\pm 10^\circ$ ).

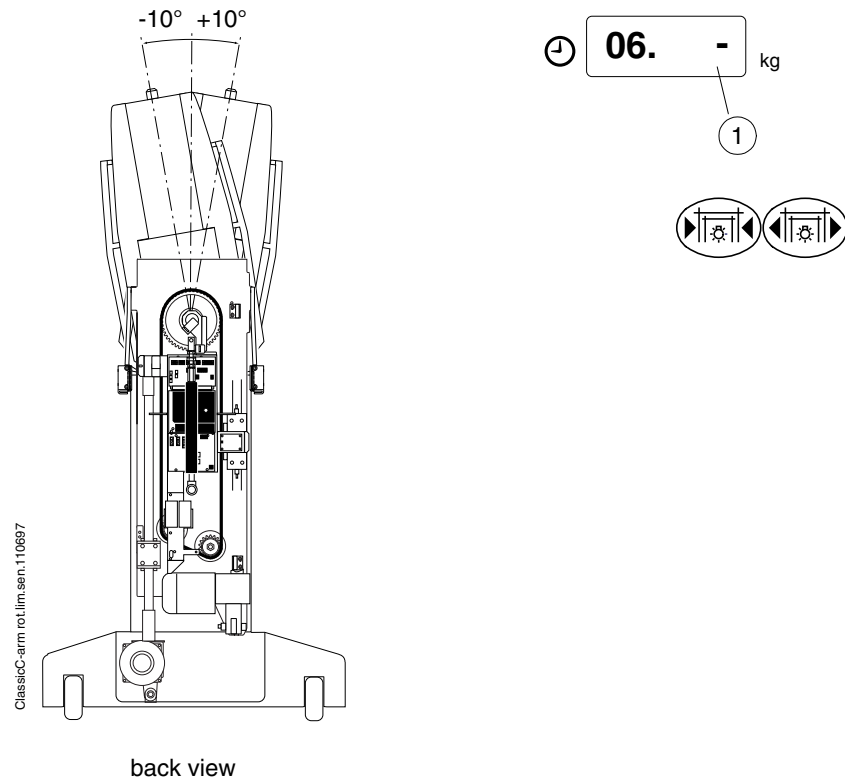


Figure F.32

Check after adjustments that the worm screw nut has a free movement with respect to Telescopic column installation plate, Rotation reference circuit board and the cables.

Check that the Rotation upper hall-sensor does not hit the spacer.

## 6.6 UP/DOWN mechanism sensors

### Preparations

- Remove the necessary covers, see instructions described in chapter H, sections 1.1, 1.2 and 1.3.
- Check that the mechanical limits of the lift motor (Fig. F.33, 1) and (Fig. F.35, 2) are in their positions.

### Checking the Lift down limit sensor:

- Enter the service mode and select the display of internal signals mode 05 (Fig. F.33, 3).
- Drive the moving column to the lower limit with the C-arm up/down switches (Fig. F.33, 4).
- Check that the right lower signal on the display (5) lights when the worm-screw nut (Fig. F.33, 6) is at  $4.5 \pm 0.5$  mm space from the spacer (Fig. F.33, 1).

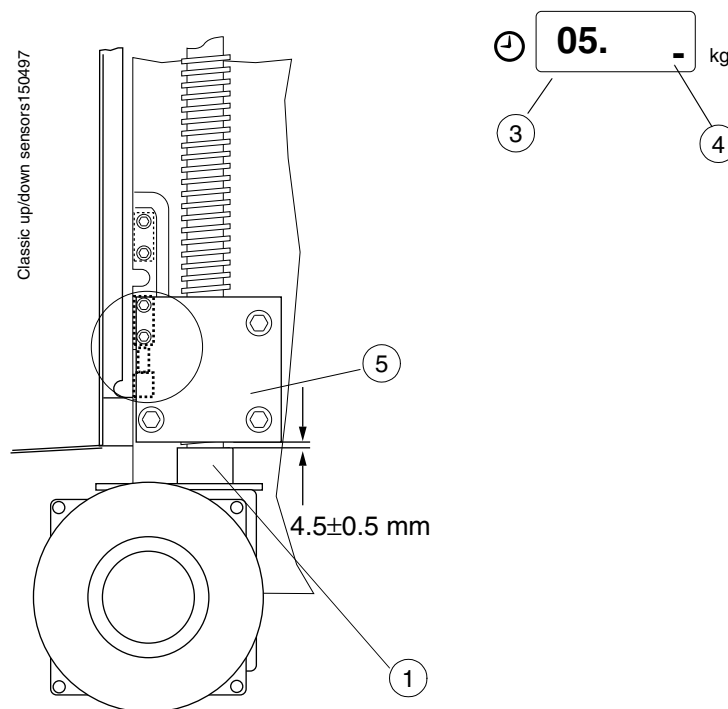


Figure F.33



- d) If the space differs from  $4.5 \pm 0.5$  mm, adjust the magnet holder's nut (Fig. F.34, 1) so that the right space is reached:
- Press the spindle down and take a hold of the spindle arm with the clamp and screw the nut to the right position on the spindle thread.
  - Check that the spindle moves freely in the casing and returns to its upper position with its spring.

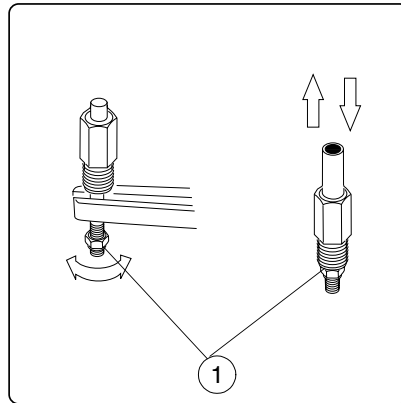


Figure F.34

**NOTE** *The sticking of the magnet holder to the lower position may cause injury or damage.*

- e) Place the magnet holder to its position and check that the 4.5 mm space is left between the spacer and the worm-screw nut. If not, readjust the magnet holder.

#### Checking the Lift up limit sensor:

- a) Check the Lift up limit sensor in the same way as the Lift down limit sensor.
- b) Check that the right upper signal on the display (Fig. F.35, 1) lights when the worm-screw nut (Fig. F.35, 2) is at  $4.5 \text{ mm} \pm 0.5$  space from the worm-screw cap (Fig. F.35, 3).

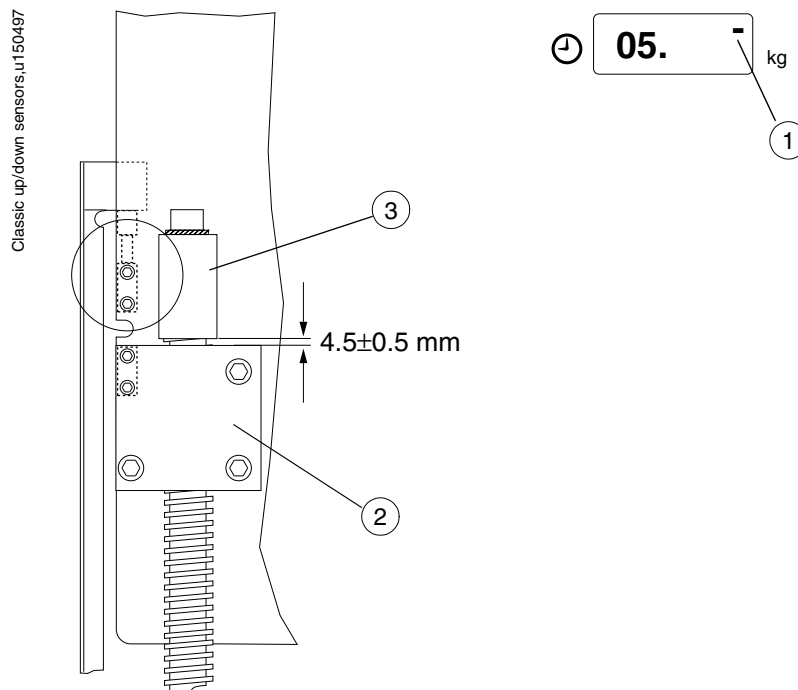


Figure F.35

### Checking the lift reference sensor

- a) Drive the C-arm to the PA-position.
- b) Enter the service mode and select the display of internal signals mode 05 (Fig. F.33, 3).
- c) When the detector plate (Fig. F.36, 1) hits the opto-sensor on the lift reference PCB (Fig. F.36, 2), the right middle segment lights.
- d) Adjust the position of the detector plate as follows (standard Sophie unit):
  - Insert the C-arm locking knob to the unit's base.
  - Drive the C-arm downwards carefully so that the locking stud just touches the locking knob.
  - Adjust the detector plate's position so that when the locking stud touches the locking knob, the distance between opto-sensor middle line and the upper edge of the detector plate is 26mm (Fig. F.36, 3).
- e) Adjust the position of the detector plate as follows (mobile Sophie unit):
  - Drive the C-arm downwards carefully so that the distance between the locking stud and the locking knob is 3-4mm.
  - Adjust the detector plate's position so that the distance between opto-sensor middle line and the upper edge of the detector plate is 26mm (Fig. F.36, 4).

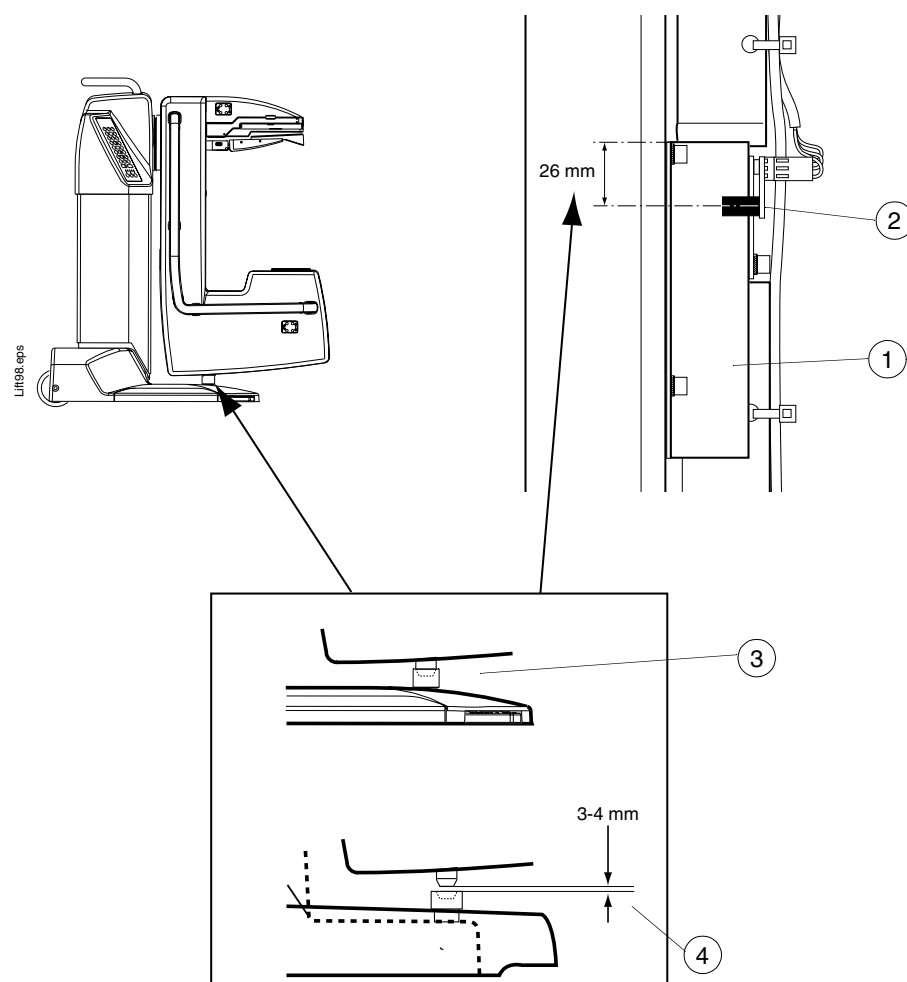


Figure F.36

## 6.7 Cassette table size identification switches

### Preparations

- a) Drive the C-arm to the upright (CC-) position.
- b) Enter the service mode and select the display of internal signals mode 08, see "SERVICE MODE FUNCTIONS SHORT-FORM" on page C-4. (Fig. F.38, 1).

### Cassette table mechanical adjustment

- a) Adjustment is performed with both small and large cassette.
- b) Remove the cassette table top cover.
- c) Adjustment of the side guides:
  - Check that the side guides move freely and straight.
  - Loosen the lever holder (Fig. F.37, 3) screws.
  - Place the small cassette (Fig. F.37, 1) on the cassette table, press the side guides firmly to the cassette sides (Fig. F.37, 2).
  - Adjust the movement of the lever assembly stop to this position with the lever holders.
  - Tighten the lever holder screws. Check the adjustment and repeat, if needed.
  - Perform the same adjustment with the large cassette.

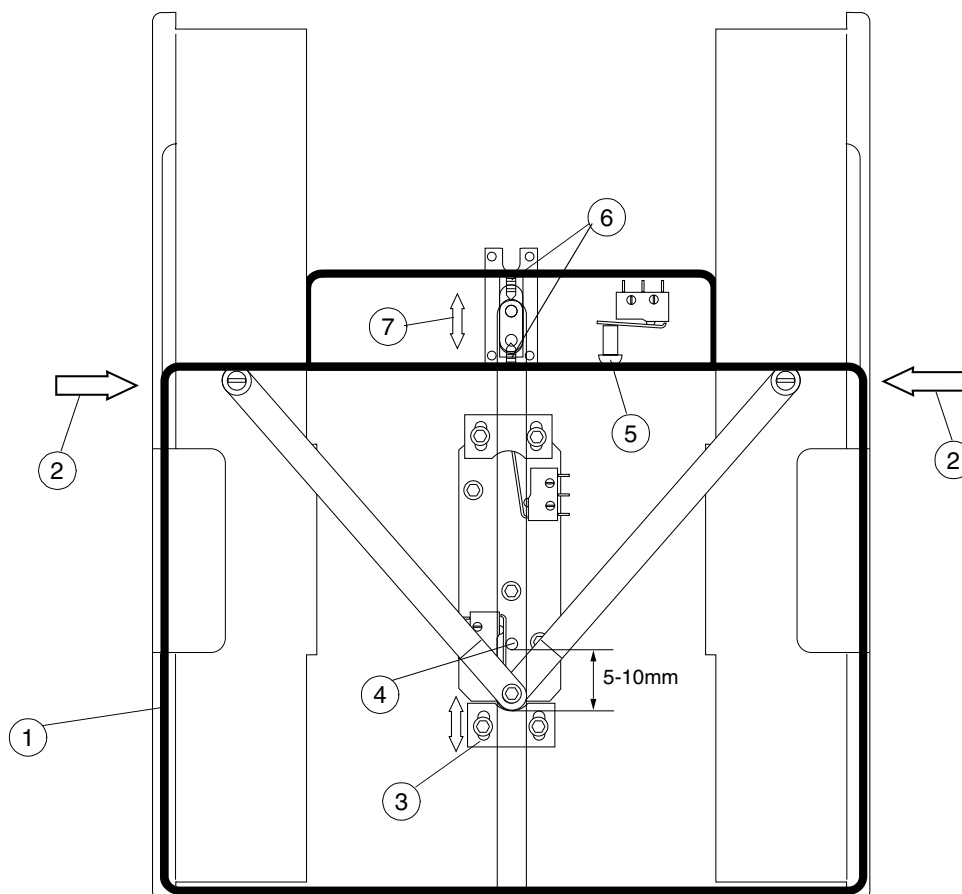


Figure F.37

### Adjusting the cassette microswitches

- a) Adjust the microswitches to connect 5 - 10 mm before lever assembly mechanical limit.
- b) Check that the lever assembly knob (Fig. F.37, 4) hits only to the microswitch actuating lever.

### Adjusting and checking the labeling head

- a) Check that the sensing button (Fig. F.37, 5) connects the microswitch at least in the middle of buttons movement. Check that the button moves freely to the frame level.
- b) If the labeling head has been removed from the table top cover, check before fixing that the slide pieces are in position and in the same level.
- c) Fasten the labeling head tentatively to the top cover with fixing screws.
- d) Check that the labeling head moves without clearance and with as small friction as possible.
- e) Fasten the table top cover with the labeling head to the cassette shelf.
  - Check the movement of labeling head.
  - The centre of top cover may not bend upwards after installation of the labeling head.
  - Check that the top cover fastening screws are at the same level as the cover surface.
- f) Adjust with the holding screws (Fig. F.37, 6) the labeling head in front/back direction (Fig. F.37, 7) so that the cassette is firmly against the labeling head frame.
- g) Check that the cassette is firmly against the cassette table.

### Checking the microswitches

- a) Small cassette microswitch:
  - Pull the labeling head to the front position (small cassette).
  - The right lower signal (Fig. F.38, 2) on the display should light when the labeling head is 5 - 10 mm from the extreme position.

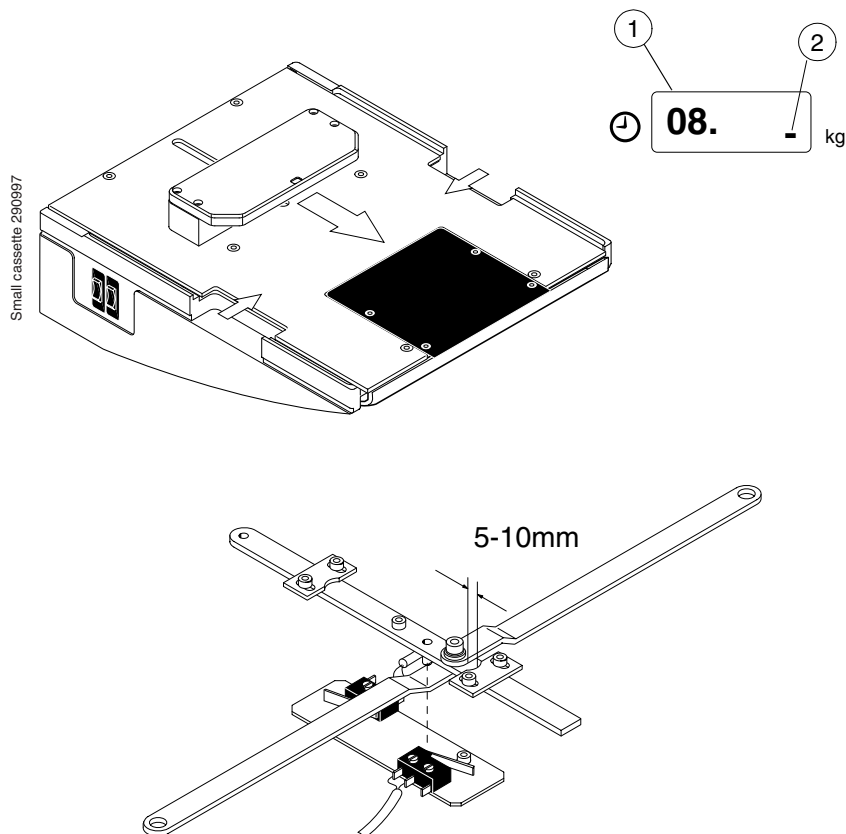


Figure F.38

- b) Large cassette microswitch:
- Push the labeling head to the back position (large cassette).
  - The right upper signal (Fig. F.39, 2) on the display should light when the labeling head is 5 - 10 mm from the extreme position.

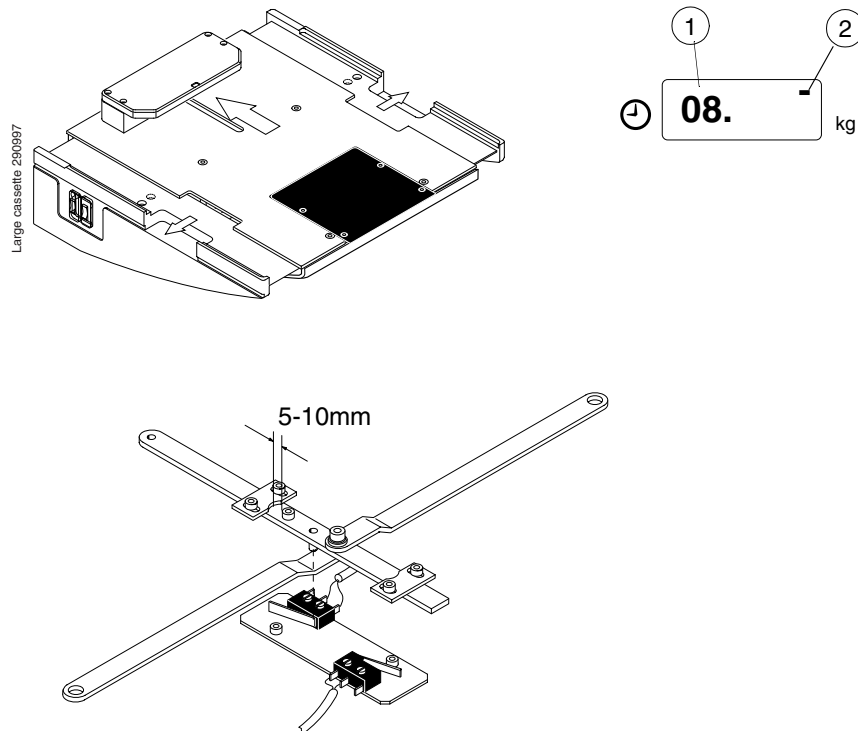


Figure F.39

- c) Cassette in position (Labeling head) microswitch:
- Press the sensing button (Fig. F.40, 1) and check that the right middle signal (Fig. F.40, 2) on the display lights.

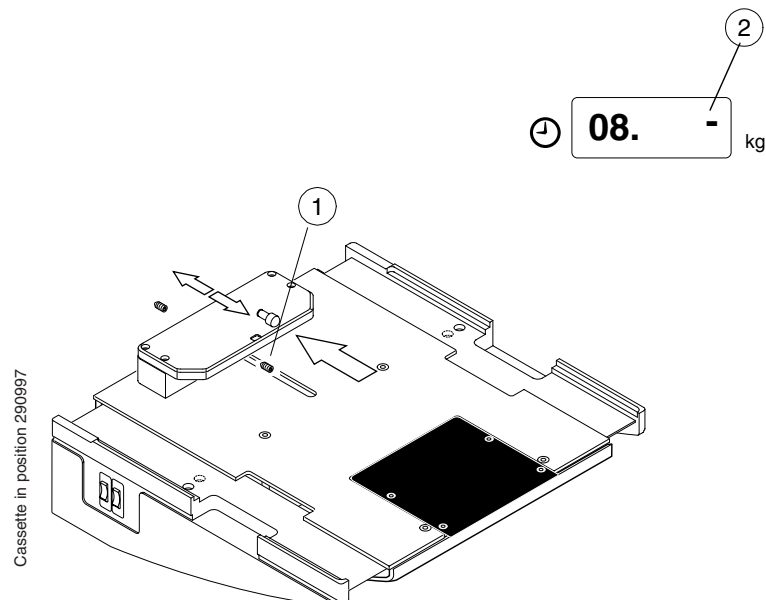


Figure F.40

- d) If some of the signals on the display does not light, see "Paddle holder related" on page G-6.

## 6.8 Lower paddle identification switches

### Preparations

- Drive the C-arm to the upright (CC-) position. Drive the cassette table to the LOAD-position.
- Enter the service mode and select the display of internal signals mode 09, see "SERVICE MODE FUNCTIONS SHORT-FORM" on page C-4. (Fig. F.41, 1).
- Check the functioning of the lower paddle holders with small and large lower compression paddles and small and large bucky grids.

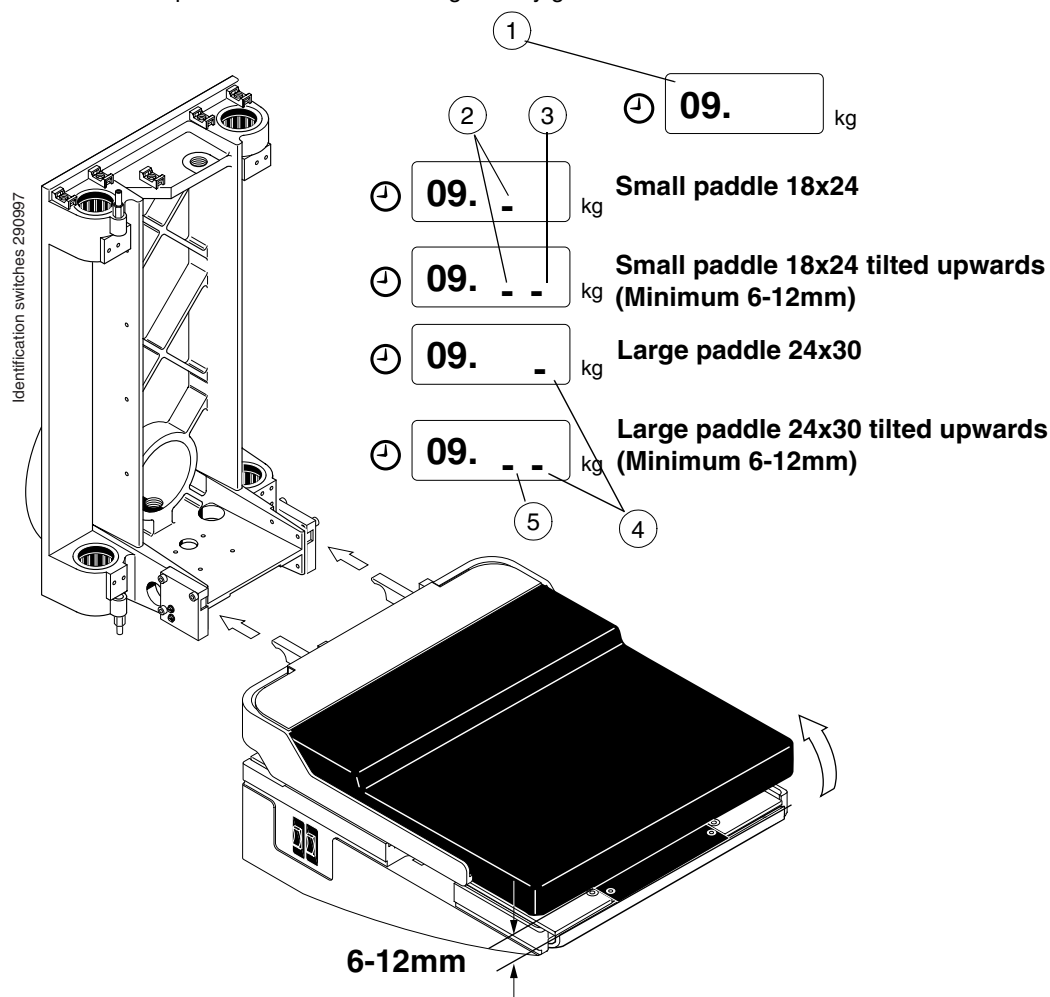


Figure F.41

### Checking the microswitches

- Push the small lower compression paddle to the paddle holders and check that the left lower signal on the display lights (Fig. F.41, 2).
- Tilt the lower compression paddle upwards and check that the right lower signal (Fig. F.41, 3) lights when the lower edge of the compression paddle is 6-12 mm from the cassette table top cover.
- Perform the same checking with the large lower compression paddle (Fig. F.41, 4 and 5) and the small and large bucky grids. Note, that when there is no paddle inserted, no display light is on.

### Mechanical checking and adjustment

- a) If the right lower signal does not light when the paddle is tilted 6 - 12 mm, adjust the place of paddle holders' microswitches (Fig. F.42, 4).
- b) Remove the C-arm covers, see instructions in chapter H, section 1.4.
- c) If the paddle is not straight, adjust the height of the holders (Fig. F.42, 5)
- d) If the prongs stick into the lower paddle holders, remove the holders from the C-arm center frame and check (Fig. F.42):
  - Do the parts (1) have vaseline.
  - Are the parts (1) clean of burrs.
  - Is the spring (2) whole and straight.
  - Adjust the screw (3).

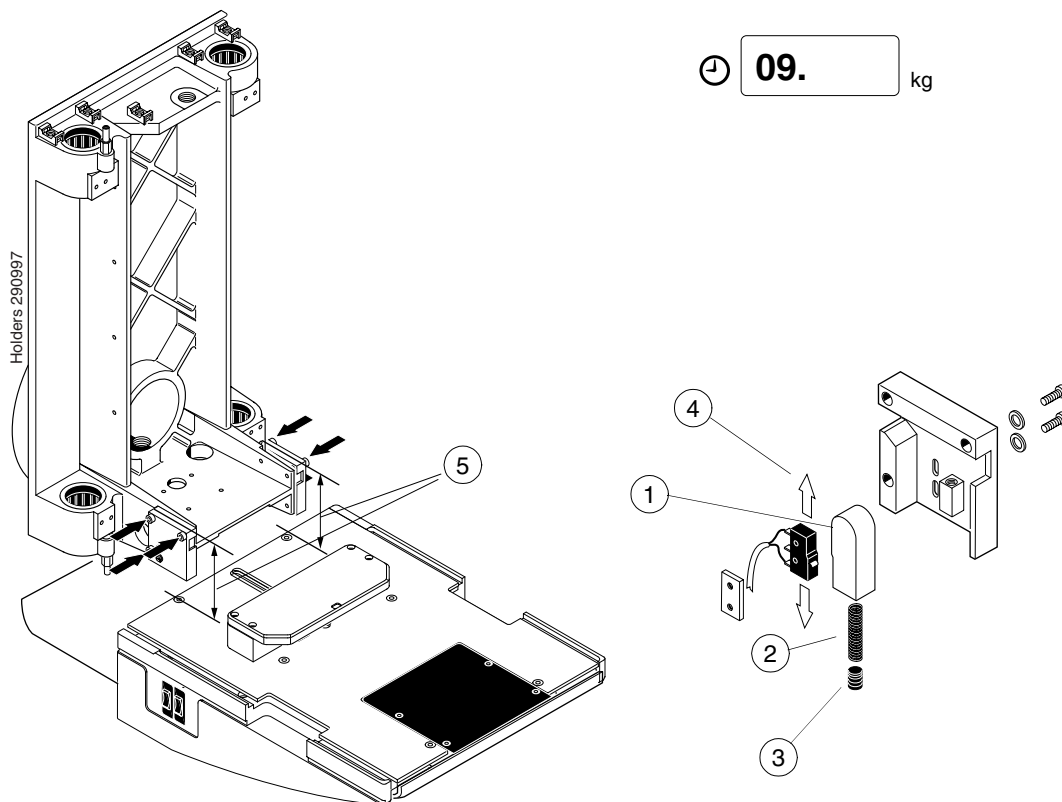


Figure F.42

If the signal(s) on the display does not light or there is a mechanical problem, see "Paddle holder related" on page G-6.





# TROUBLESHOOTING & FAULTFINDING

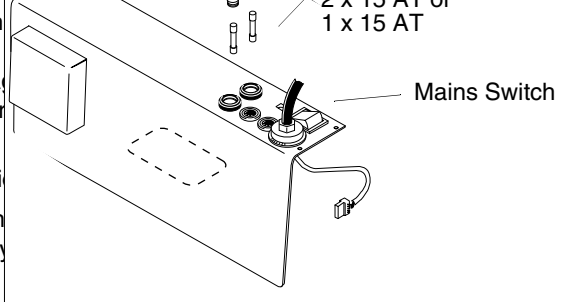
## 1 DISPLAYING INTERNAL SENSOR SIGNALS

Please refer to “Diagnostic display of internal signals” on page C-10 for details. This mode provides helpful information when tracing sensor and switch signals, since all signals can be viewed here.

## 2 ELECTRICAL PROBLEMS

### 2.1 Unit completely dead

#### Checking fuses and mains voltage

- a) Unplug the unit from the outlet and test with another electrical appliance that there is a mains voltage present. Check that the voltage is within 208-240VAC with an AC-voltmeter.
  - b) Check that the unit is turned on (the rocker switch in the rear base panel is in ON-position).
  - c) Check main fuses at the rear base panel on the unit (make a conductivity check to really make sure that the fuses are OK).
- 
- d) Open the covers so you get access to the POWER SUPPLY and check it's 1,6 AT starter fuse.
  - e) Remove the base rear cover to get access to the mains inlet. Trace forwards for a break in the mains voltage; Mains screw terminals, Fuse holders, Mains switch (set switch to ON), Mains filter, BASE PCB, SYNC PCB.
  - f) Remove covers so you get access to the POWER SUPPLY power connector (at the right side of the black power supply box. Check for mains voltage at the connector.
  - g) Check that the POWER SUPPLY is firmly inserted into its connectors.
  - h) Measure if you can find any voltage on the collector boards, or if any led-indicators are on.
  - i) Before replacing the POWER SUPPLY; Remove some boards to find a possible short circuit that heavily loads the power supply outputs. Disconnect the loads, one by one to find the problem.

#### NOTE

**The POWER SUPPLY as well as many of the other circuit boards contains self-resetting overcurrent circuit breakers. These would be triggered because of short-circuits or overloads on the voltage supply lines. To reset them, simply turn off the power for at least 30 seconds.**

### 3 MOTOR & MOTION RELATED PROBLEMS

#### 3.1 DC motors

##### MAG/LOAD mechanism

##### a) ELECTRICAL PROBLEMS:

Enter the service mode and select the display internal signals mode 04.

If the signal on the display does not light when the magnet is at the limit sensor:

- Measure the operating voltages of PCB(15 V, 33 V).
- Check the condition of the hall-sensor.
- In the Mag-up position, check if the indicator LED D2 on the SHELF COLLECTOR PCB (1) lights.
- In the Mag-down position check if the indicator LED D1 on the SHELF COLLECTOR PCB lights.

If the LEDs on the SHELF COLLECTOR PCB has lit but the display signals do not light, the failure is between the SHELF COLLECTOR PCB and the TUBE CPU or in them. Turn off the unit and measure the resistances of wires given in table below. If needed, check all the wiring from the SHELF COLLECTOR PCB (1) to TUBE CPU (2). If the signals are OK, but the signals on the display do not lit, change the TUBE CPU.

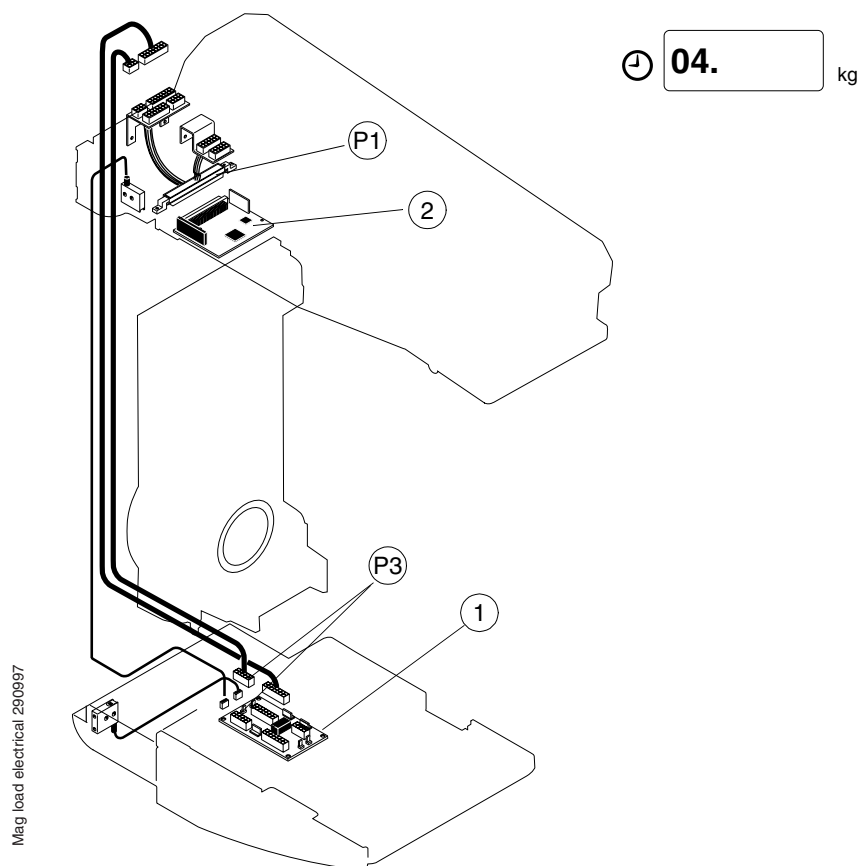


Figure G.1

FROM		TO	
Shelf collector PCB		Tube interface cable	
Connector	Pin	Connector	Pin
P3	3 (MDL)	P1	C 22
P3	8 (MVL)	P1	A 22

### 3.2 Stepper motors

#### Compression

a) ELECTRICAL PROBLEMS:

Enter the service mode (see “How to enter / exit the service mode” on page C-4.) and select the internal signals mode 07 (see “Diagnostic display of internal signals” on page C-10).

If the signal on the display does not light when the magnet is at the limit sensor:

- Check if the indicator LED related to the sensor on the FRONT COLLECTOR PCB has lit.

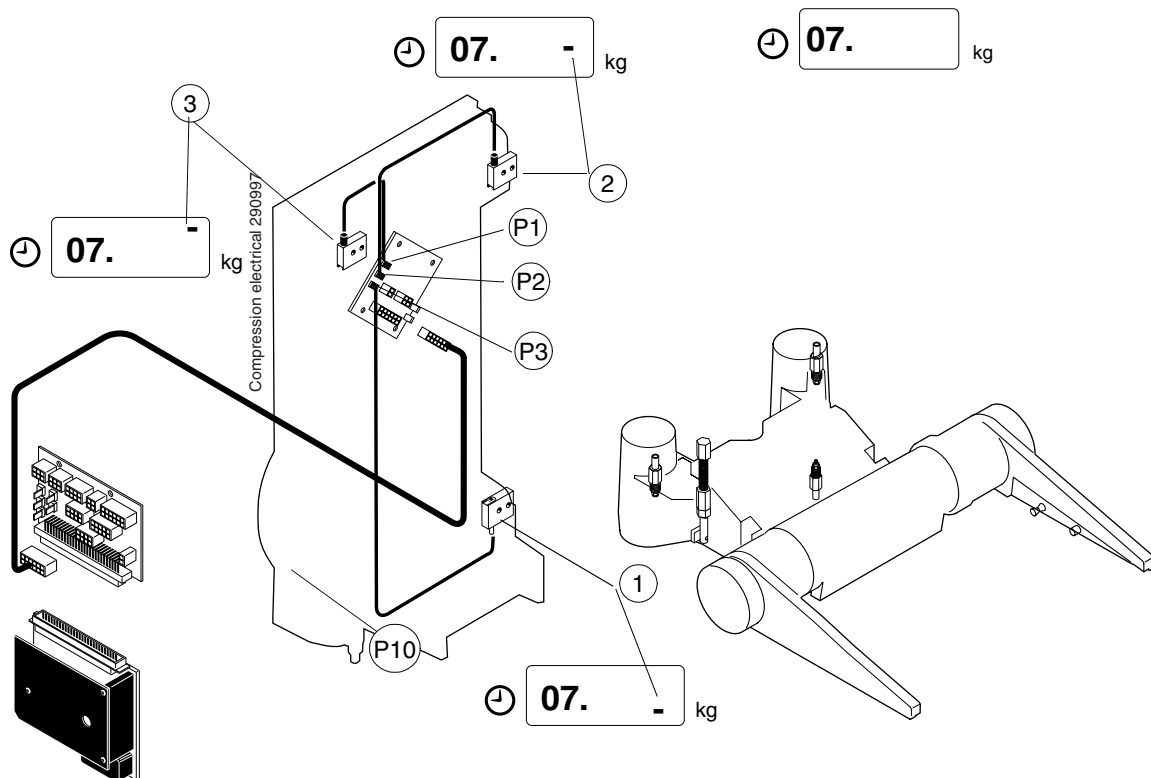


Figure G.2

- Measure the operating voltages of the PCB (15 V, 33 V).

If the LEDs on the FRONT COLLECTOR PCB has lit but the display signals do not light, the failure is between the FRONT COLLECTOR PCB and the REAR COLLECTOR PCB or in them.

Turn off the power and measure the resistances of wires given in table below. If the wires are OK, but the signals on the display do not light, change the REAR CPU.

FROM		TO	
Front Collector PCB		Rear Collector PCB	
Connector	Pin	Connector	Pin
P1	1 (GND)	P10	A 26
P1	2 (PRL)	P10	C 5
P1	3	P10	
P2	1 (GND)	P10	A26
P2	2 (PUL)	P10	C4
P2	3	P10	
P3	1 (GND)	P10	A26
P3	2 (PLL)	P10	A5
P3	3	P10	

### LABELING

- a) When the labeling head disk magnet points to the hall-sensor on the LABELING PCB, the LED D12 (CRL) on the SHELF CIRCUIT BOARD lights as well as right middle signal on the display.
- b) If the LED D12 (CRL) does not light, check if:
  - The labeling head disk magnet moves too far from the hall-sensor.
  - There is a loose connection between the LABELING PCB and SHELF COLLECTOR PCB.

### COLLIMATOR

- a) ELECTRICAL PROBLEMS:

Enter the service mode (see (see "How to enter / exit the service mode" on page C-4.) and select the internal signals mode 07 (see "Diagnostic display of internal signals" on page C-10.)

If the signal on the display does not light when the magnet is at the limit sensor:

If the indicator LED(s) on the COLLIMATOR PCB does not light, measure the operating voltages of the PCB (15 V, 33 V).

If some of the collimator assembly display signal(s) does not light, turn off the power and measure the resistances of following signal lines. If needed, measure the resistances of all Generator to Collimator cable wires.

FROM		TO	
Generator to collimator cable		Tube interface cable	
Connector	Pin	Connector	Pin
P1	1 (CRL)	P1	A 3
P1	2 (FRL)	P1	C 3
P1	3 (MRL)	P1	C 4

If all signal lines are OK, but the display signal(s) still does not light, change the TUBE CPU (1) or COLLIMATOR PCB (2).

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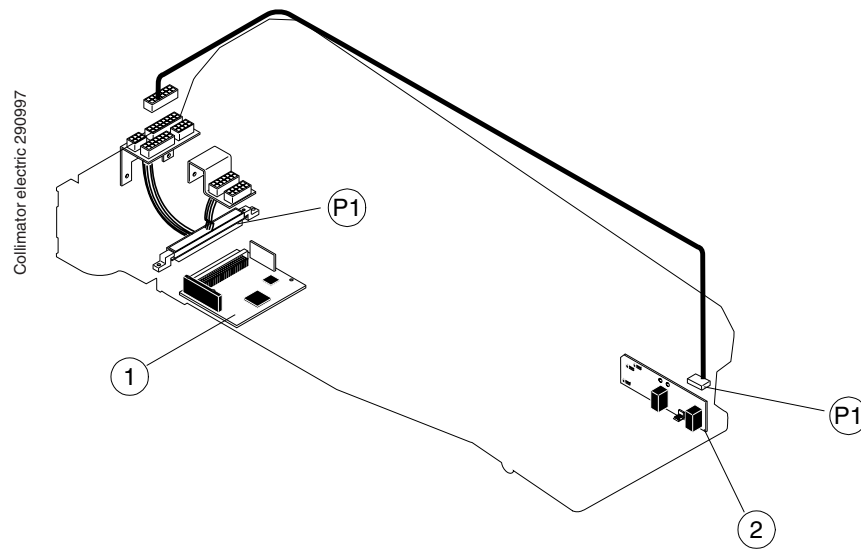


Figure G.3

**FILTER**

**MIRROR**

## 4 MECHANICAL PROBLEMS

### 4.1 Paddle holder related

- a) CASSETTE TABLE SIZE IDENTIFICATION  
 Enter the service mode (see “How to enter / exit the service mode” on page C-4.) and select the internal signals mode 08 (see “Diagnostic display of internal signals” on page C-10.).
- If some of the signals on the display does not light, check the condition of the corresponding microswitch.
  - Check the microswitch indicator-LEDs on the SHELF COLLECTOR PCB (B = large cassette, S = small cassette).

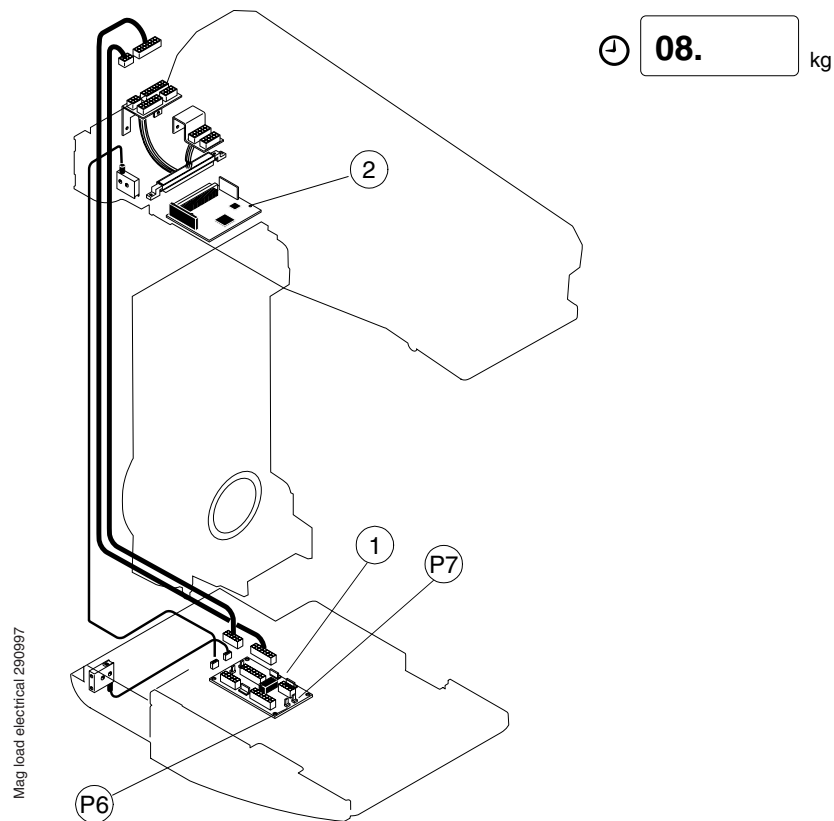


Figure G.4

- If the LEDs on the SHELF COLLECTOR PCB have lit but the display signals do not light, the failure is between the SHELF COLLECTOR PCB (1) and the TUBE CPU (2) or in them. Turn off the unit and measure the resistances of wires given in table below. If needed, check all the lines between the SHELF COLLECTOR PCB and TUBE CPU. If the signals are OK, but the signals on the display do not lit, change the TUBE CPU.

FROM		TO	
Shelf Collector PCB		Tubehead interface cable	
Connector	Pin	Connector	Pin
P6	1 (GND)	P1	A 13
P6	2 (CDBL)	P1	A12
P7	1 (GND)	P1	A 13
P7	2 (CDSL)	P1	C 12

b) LOWER PADDLE IDENTIFICATION

Enter the service mode (see “How to enter / exit the service mode” on page C-4.) and select the internal signals mode 09 (see “Diagnostic display of internal signals” on page C-10.)

- If some of the signals on the display does not light, check the condition of the corresponding microswitch.

⌚ 09. kg

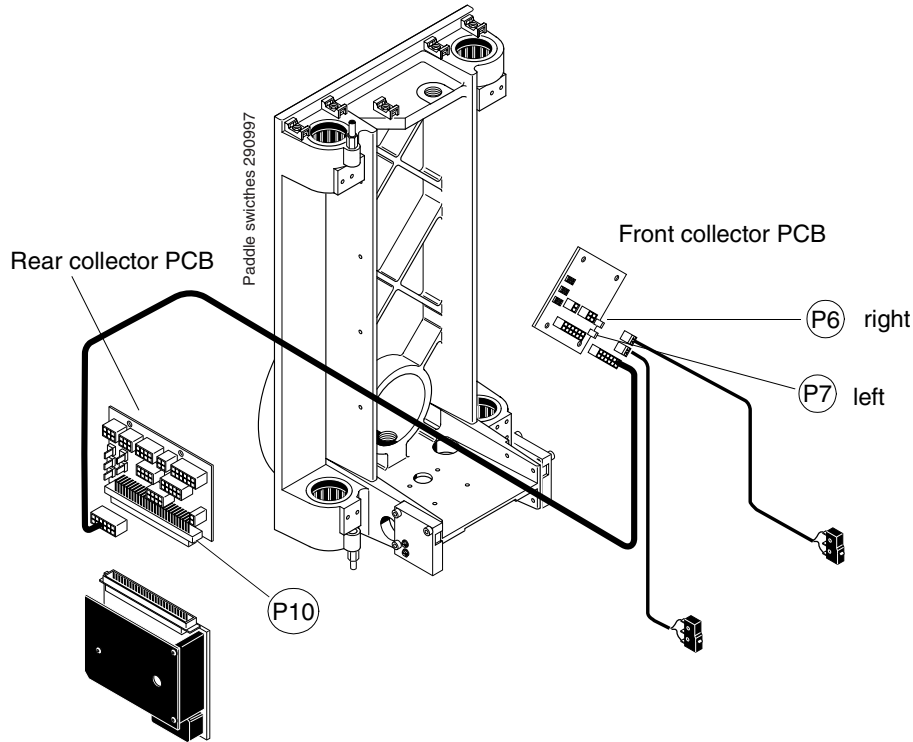


Figure G.5

- Check the microswitch indicator-LEDs on the FRONT COLLECTOR PCB.
- If the LEDs on the FRONT COLLECTOR PCB are lit but the display signals do not turn on, the failure is between the FRONT COLLECTOR PCB and the REAR COLLECTOR PCB or in them. Turn off the unit and measure the resistances of wires given in table below. If needed, check all the wiring from the FRONT COLLECTOR PCB. If the signals are OK, but the signals on the display do not lit, change the REAR CPU.

FROM		TO	
Front Collector PCB		Rear Collector PCB	
Connector	Pin	Connector	Pin
P6	1 (GND)	P10	A 26
P6	2 (CDRL)	P10	A 4
P7	1 (GND)	P10	A 26
P7	2 (CDLL)	P10	C 3

---

## 5 BEFORE CALLING FOR ASSISTANCE

---

### 5.1 General required information

Check the unit serial number and also the tube-head serial number.

---

### 5.2 How to report image quality problems

Please record the circumstances where or when the problem occurred, used cassette type, used film type, film processor type, type of developer liquids used, and any other relevant data.

---

### 5.3 How to contact Planned head office

- Phone intl +358 - 9 - 7590 5500
- Fax intl +358 - 9 - 7590 5555
- Address Asentajankatu 6, 00810 HELSINKI, FINLAND



# PARTS REPLACEMENT & REPAIR

## 1 REMOVING & REPLACING COVERS

**CAUTION** *The unit contains hazardous voltages. Always disconnect the unit from the mains by removing the plug from the wall outlet, and wait for 2 minutes before starting to remove covers.*

To be able to access inner parts some covers must be removed in a particular order. All the covers are shown in Fig. H.1 and these are referred to by these names in the texts and descriptions in this manual.

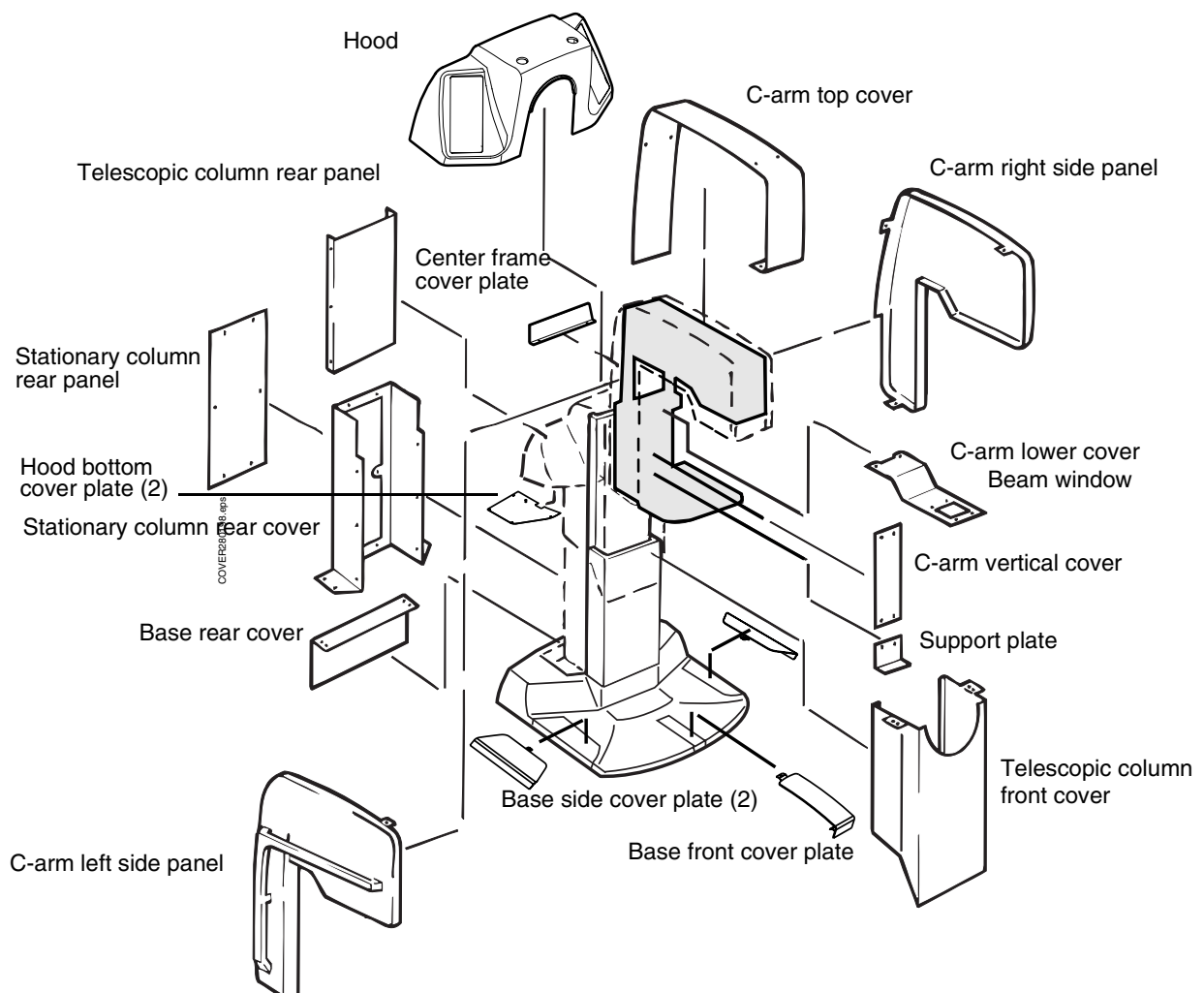


Figure H.1

## 1.1 Base covers

- a) Base rear cover:
- Unscrew the rear cover assembly screws (4 pcs) (Fig. H.2, 1).
  - Disconnect the rear cover assembly ground cable (Fig. H.2, 2) from the base.
  - Disconnect the remote control cable (Fig. H.2, 3) and the main filter output cable (Fig. H.2, 4) from the Base PCB (Fig. H.2, 5).

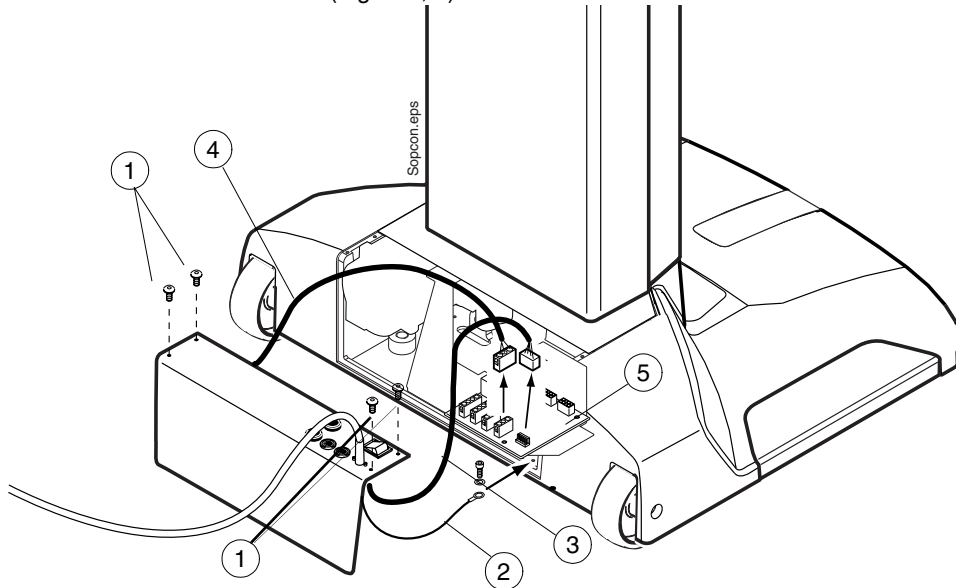


Figure H.2

- b) Base front cover plate and side cover plates:  
Remove the front cover plate by pulling it outwards e.g. with a screwdriver (Fig. H.3, 1). Remove the side cover plates by lifting them carefully upwards (Fig. H.3, 2).

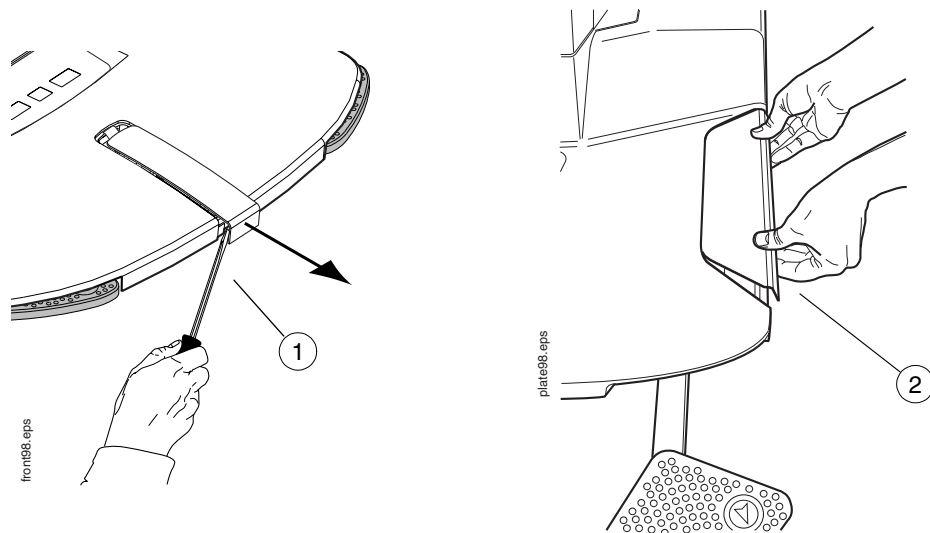


Figure H.3

## 1.2 Telescopic column covers

### Hood bottom cover plates (2 pcs) (Fig. H.4, 1)

- Remove the plate screws (4 pcs).
- Disconnect the bottom plate ground cable from the hood support arm.
- The plate can now be removed.

**Telescopic column rear panel (Fig. H.4, 2)**

- a) Remove the cover screws (8 pcs).
- b) The cover can be removed.

**Telescopic column front cover (Fig. H.4, 3)**

- a) The hood bottom cover plates and stationary column rear panel must first be removed.
- b) Remove the four screws that hold the front cover to the hood support arms and the two screws on each side of the unit.
- c) Lower the cover slightly and remove it.

**1.3 Stationary column covers****Stationary column rear panel (Fig. H.4, 4)**

- a) Remove the cover screws (6 pcs).
- b) Cover can now be removed from the stationary column rear cover.

**Stationary column rear cover (Fig. H.4, 5)**

- a) The stationary column rear panel must be removed.
- b) Remove the screws (6 pcs) that hold the column cover to the column and base and lift the cover off.

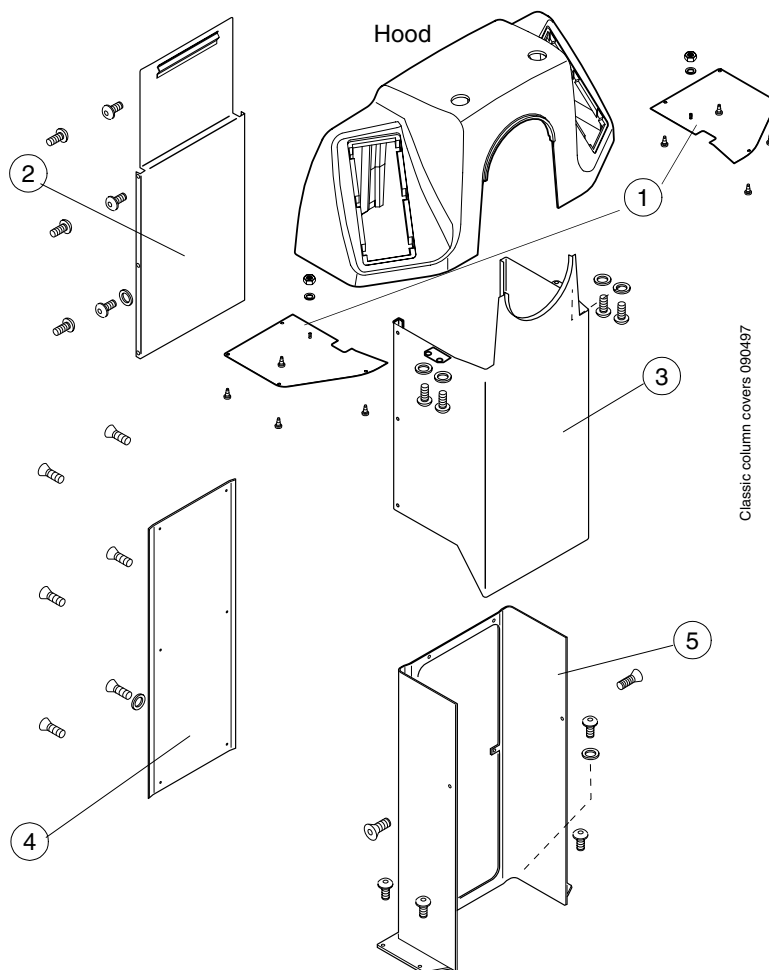


Figure H.4

## 1.4 C-arm covers

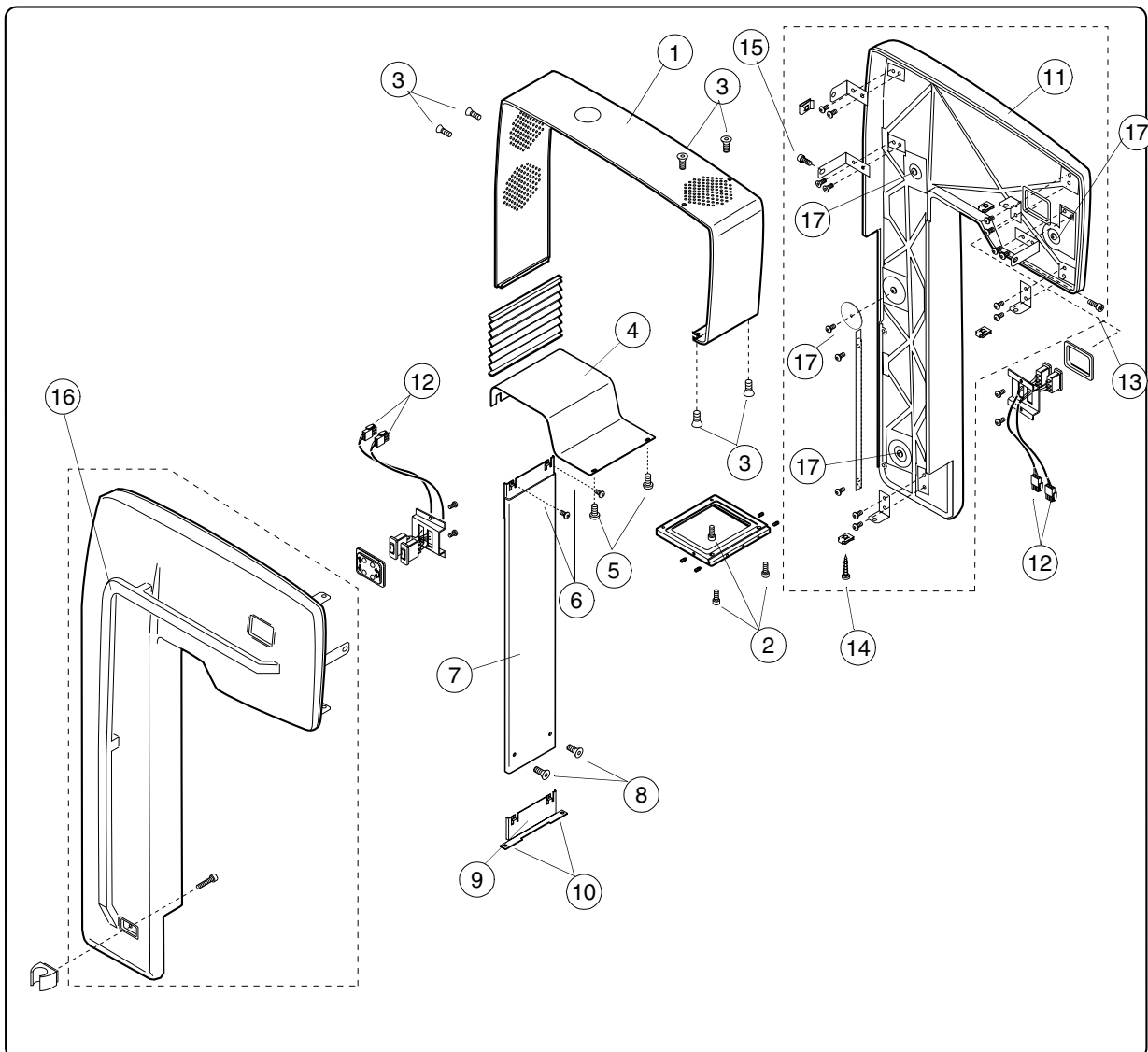


Figure H.5

Drive the C-arm to upright position. Drive the cassette table to MAG 1.8 position and the compression paddle to the release (highest) position. Turn off the power and unplug the unit. Wait for 2 minutes before proceeding.

**NOTE** The C-arm covers must be removed in the following order.

**C-ARM top cover (Fig. H.5, 1)**

- a) Remove the beam window (Fig. H.5, 2) from the underside of the tubehead assembly by unscrewing its three screws. The screws secure also the top cover and side panels in position.
- b) Loosen the top cover screws (Fig. H.5, 3) and lift the top cover off.

**C-arm lower cover (Fig. H.5, 4)**

- a) Remove the two screws at the C-arm lower cover (Fig. H.5, 5) and the two screws at the upper part of the C-arm vertical cover (Fig. H.5, 6) and slide the lower cover off.

**C-arm vertical cover (Fig. H.5, 7)**

- a) Remove the two screws that hold the vertical cover to the support plate (Fig. H.5, 8).
- b) Remove the vertical cover.

**Vertical cover support plate (Fig. H.5, 9)**

- a) Remove the support plate fixing screws (2 pcs) (Fig. H.5, 10).
- b) Remove the support plate.

**C-arm side panels (Fig. H.5, 11)**

- a) Disconnect the connectors of the C-arm switches from the PCB (Fig. H.5, 12).
- b) Remove the side panel locking screws located at the front on the side panel (Fig. H.5, 13).
- c) Remove the screws on the underside of the cassette table (Fig. H.5, 14).
- d) Support the side panel with your hand and remove the screw located at the back of the unit (Fig. H.5, 15).
- e) Remove the side panel.

**Side handles (Fig. H.5, 16)**

- a) Remove the four screws (Fig. H.5, 17) from the side panel.
- b) Remove the side handle.

### 1.5 Hood

- a) Remove the transport handle or the handle hole cover plugs (Fig. H.6, 1) from the hood. Remove the hood bottom cover plates (Fig. H.6, 2).
- b) Remove the screws that hold hood to the support plates (Fig. H.6,3). There are two screws on each side of the unit.
- c) Lift the hood up slightly and disconnect the right and left keyboard cables from respective Display PCB.
- d) The hood can be removed.

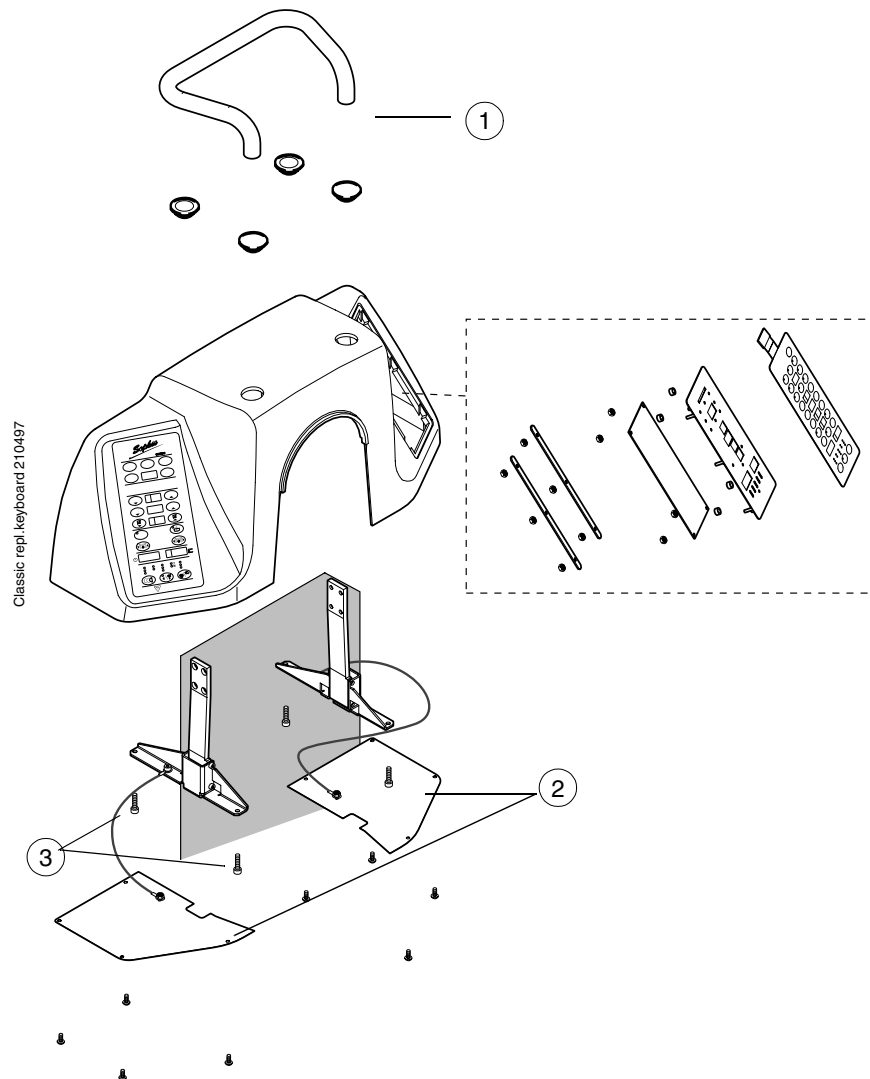


Figure H.6

### 1.6 Cassette table cover

- a) Unscrew the AEC sensor assembly screws (4 pcs) (Fig. H.7, 1).
- b) Unscrew the table cover screws (6 pcs) (Fig. H.7, 2).
- c) Disconnect the labeling head cable from SHELF COLLECTOR PCB.
- d) Lift up the table cover slightly and pull it from the table casting (Fig. H.7, 3).

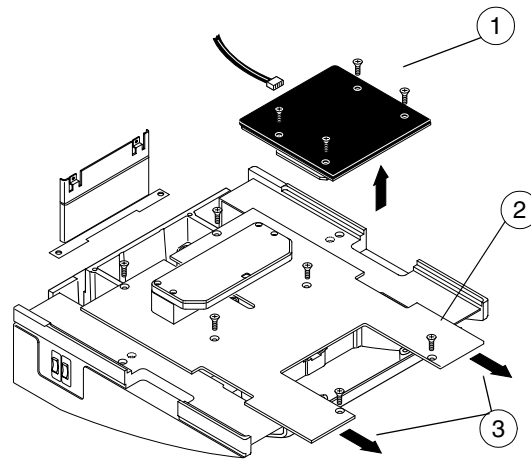


Figure H.7

### 1.7 Collimator cover

- a) Remove the collimator cover screws.
- b) Remove the cover.

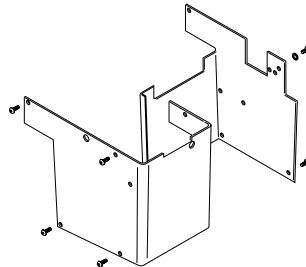


Figure H.8

## 2 SOFTWARE VERSION UPDATING

**CAUTION** *The software chips are sensitive to static electricity. Follow normal handling precautions for static sensitive circuits. The chips should shipped, stored and handled only in anti-static packaging materials.*

*Make sure that the chip is put into the socket in right orientation, otherwise immediate chip damage will occur when turning on the power.*

*Never power on the unit with a software chip removed from the socket(s)*

**NOTE** *The softwares used in the Rear CPU and Tube CPU must be compatible, (softwares with the same version number are always). See the published technical bulletins for complete software compatibility lists.*

*Never put the chip intended for the Tube CPU to the Rear CPU (or vice versa). There is no risk for damage, but neither will there be any operation.*

### 2.1 Replacing software chips

#### Replacing the Rear-CPU software

- a) Remove the telescopic column rear panel, see “Telescopic column covers” on page H-2.
- b) Drive the telescopic column to the position where you can reach the Rear processor PCB.

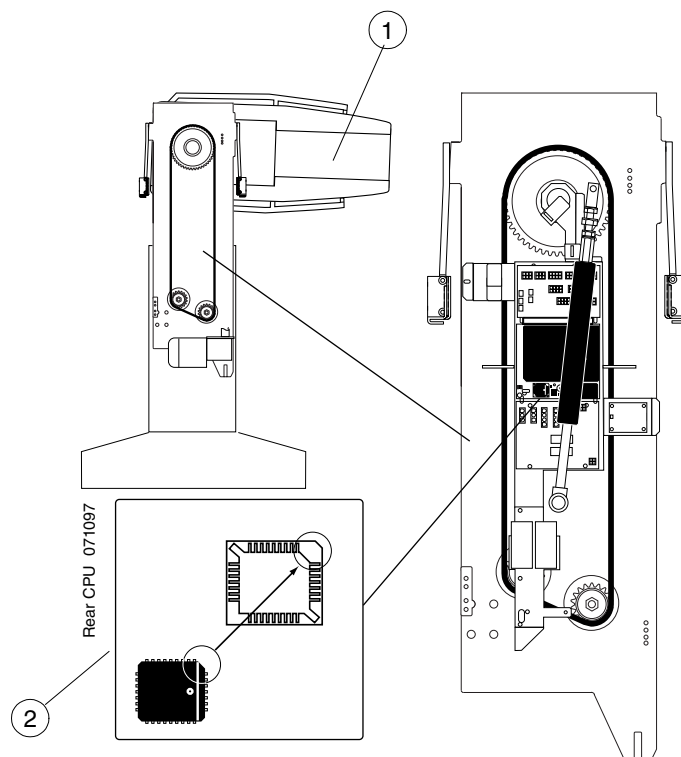


Figure H.9

- c) Drive the C-arm to -90° (Fig. H.9, 1) for easier access.
- d) Turn off the power.
- e) Replace the rear cpu chip (Fig. H.9, 2).
- f) Replace the removed parts, turn on the power and check that the unit is functioning



### Replacing the Tube CPU software

- a) Drive the C-arm to upright position. Turn off the power and unplug the unit. Wait for 2 minutes before proceeding.
- b) Remove following covers: C-arm top cover, C-arm lower cover and C-arm vertical cover, see instructions described in section "C-arm covers" on page H-4.

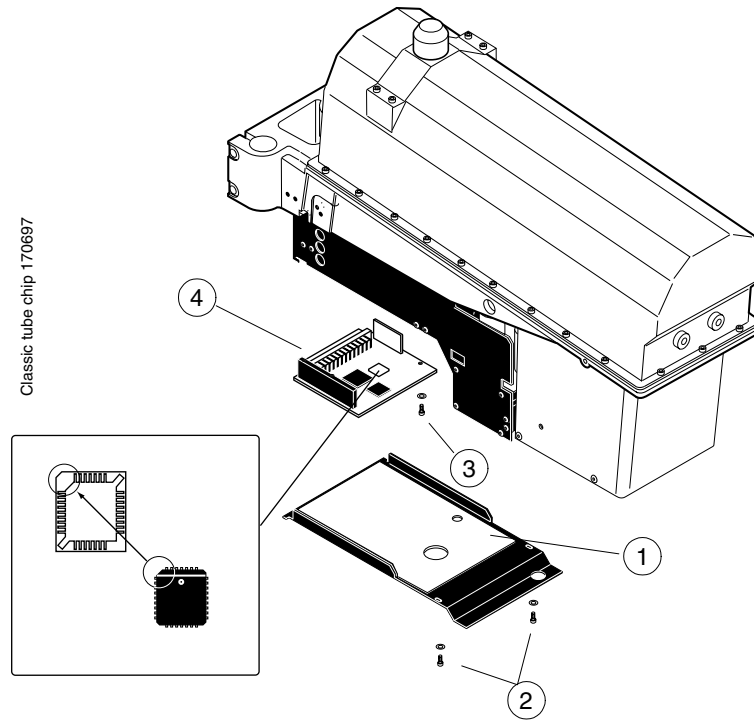


Figure H.10

- c) Remove the two screws and washers (Fig. H.10, 2) of the power supply cover (Fig. H.10, 1). Remove the cover.
- d) Remove the single screw (Fig. H.10, 3) holding the Tube CPU board (Fig. H.10, 4) in place and carefully remove the board by first pulling it from the edge connector until it opens.
- e) Replace the software chip.
- f) Replace the board and make a brief check with the power connected to see that the unit passes the self-test. Replace the covers in reverse order.

### 3 REPLACING FUSES



#### **WARNING**

*Always replace the fuse with the same type and rating. Failure to do so may risk patient and operator safety.*

There are only 4 replaceable fuses in the whole unit. Two of these are in the incoming mains lines and two are inside the Power supply for internal protection. When checking the condition of a fuse, always use an ohmmeter or equivalent to check the conductivity. Never trust your bare eyes, a fuse might be blown even if it looks to be OK.

#### 3.1 Mains fuses

##### **Rating**

15 AT/250V (slow blow) glass body 6 x 30 mm, 2 pieces (or only 1 fuse in some models)

##### **Location**

The mains fuses are accessible from the outside and they are placed at the rear of the unit, close to the mains switch.

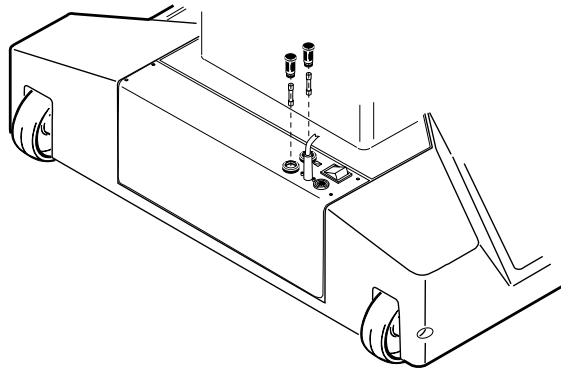


Figure H.11

##### **Purpose**

The purpose of the mains fuses is to protect the unit in case of an internal short circuit or electrical failure. These fuses guarantee efficient protection even if the fuses in the external fuse box are rated too high.

#### 3.2 Power supply fuses

##### **Ratings**

- 1,6 AT/250V (slow blow) glass body 5 x 20 mm, 1 piece
- 5 AT/250V (slow blow) glass body 5 x 20 mm, 1 piece

##### **Location**

These fuses are located inside the power supply. To gain access to these fuses the power supply cover must be opened.

The 1,6 AT fuse is situated inside a black upright fuse socket close to the internal fan.

The 5 AT fuse is situated inside a black horizontal fuse holder that is mounted on a small vertical PCB. The fuse socket must be slightly and carefully pulled upwards to replace the fuse.

**Purpose**

The 1,6 AT fuse protects the internal soft-start resistor that limits the initial surge current when turning on the unit. This fuse blows only in case of component failure in the power supply. If this fuse blows repeatedly the power supply must be replaced.

The 5 AT fuse protects the X-ray tube anode motor stator windings, in the case of a component failure inside the power supply. If this fuse is blown the anode motor will not rotate, and if it blows repeatedly then the power supply must be replaced.

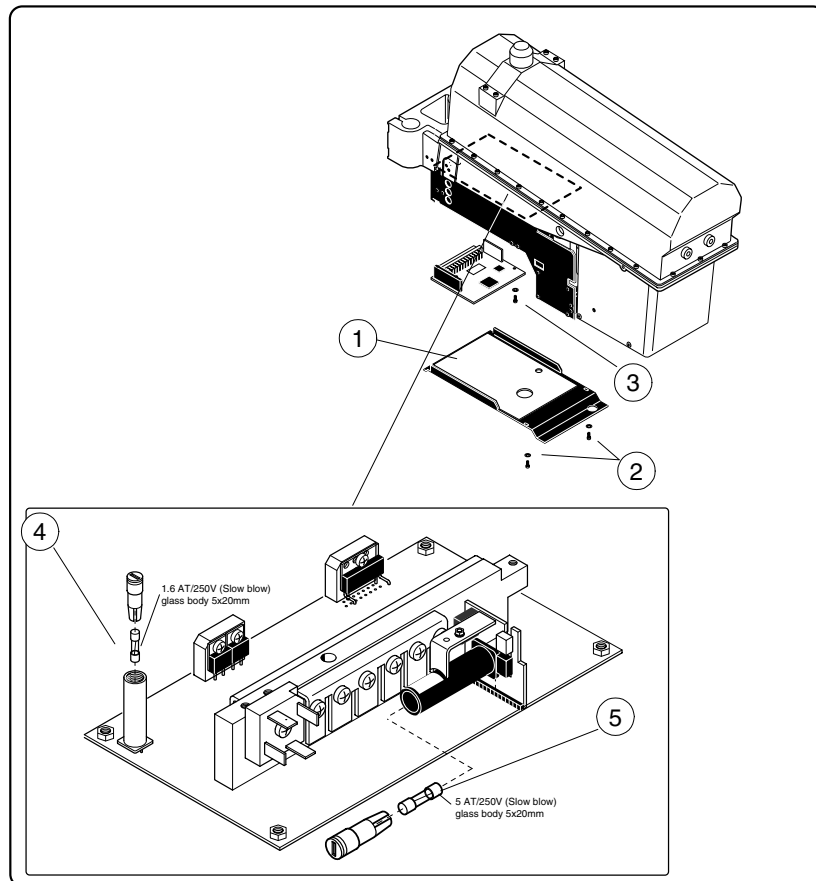


Figure H.12

**Replacing the fuses**

- Drive the C-arm to upright position. Turn off the power and unplug the unit. Wait for 2 minutes before proceeding.
- Remove the following covers: C-arm top cover, C-arm lower cover and C-arm vertical cover. See "C-arm covers" on page H-4.
- Remove the two screws and washers (Fig. H.12, 2) of the power supply cover (Fig. H.12, 1). Remove the cover.
- Remove the single screw (Fig. H.12, 3) holding the Tube CPU in place and carefully remove the board by first pulling it from the edge connector until it opens.
- Replace the required fuse (Fig. H.12, 4 or 5).

## 4 LIGHTFIELD BULB REPLACEMENT

**CAUTION** After a prolonged use of the unit the temperature of the bulb assembly can be reasonably high. Allow the assembly to cool down before touching it.

**NOTE** Never touch the replacement bulb glass surface with you bare fingers. Any grease or dirt on its surface will decrease its lifetime.

**NOTE** Use only the type of bulb recommended

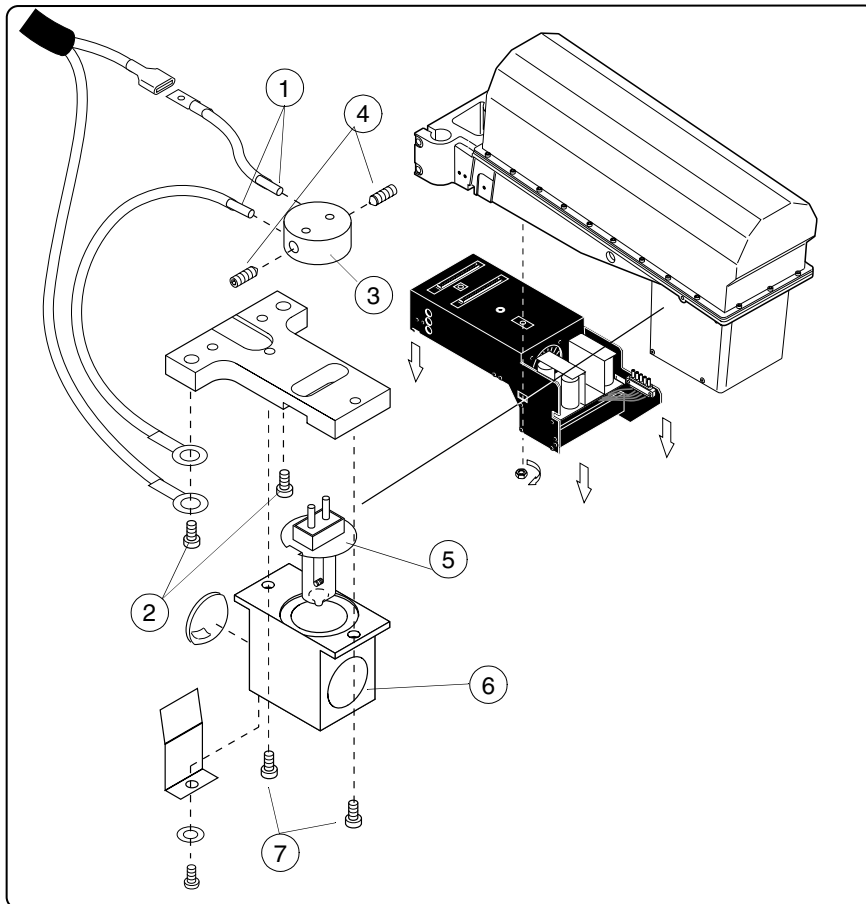


Figure H.13

- a) Drive the C-arm to upright position. Remove the C-arm covers, see section "C-arm covers" on page H-4.
- b) Remove the power supply, see section "REPLACING THE POWER SUPPLY" on page H-18.
- c) Disconnect the bulb wires (Fig. H.13, 1).
- d) Remove the lamp housing assembly from the installation plate by removing the two screws (Fig. H.13, 2)
- e) Remove the lamp holder (Fig. H.13, 3) by loosening the two screws (Fig. H.13, 4).
- f) Remove the lamp housing (Fig. H.13, 6) by removing the two screws (Fig. H.13, 7).
- g) Pull the bulb (Fig. H.13, 5) out of the housing and replace with a similar one (12V/30W).
- h) Replace the removed parts in reverse order.
- i) Turn on the power and check that the bulb adjustment (see section "Light field beam adjustment" on page F-42), before replacing the covers.

## 5 REPLACING THE X-RAY TUBEHEAD

The spare tubehead is shipped without the collimator or power supply from the factory. If you need to replace also these, please order them separately.

The replacement of the tubehead can be performed easier if you have a special locking device. With this device the replacement can be made in this same upright position, otherwise the C-arm must be tilted to slightly more than 90 ° to prevent the cassette table mechanism from falling out.

**NOTE** *There are no field serviceable parts inside the tube-head. NEVER open the tubehead cover or its fixing screws, it would void the warranty and cause the oil to leak out. If there is a problem with the x-ray tube, the whole tubehead must be changed.*

**CAUTION** *Removing the Magnification motor during this procedure loosens the cassette table mechanism. The whole mechanism can fall out. Extreme caution is needed to prevent injuries or harm to the equipment.*

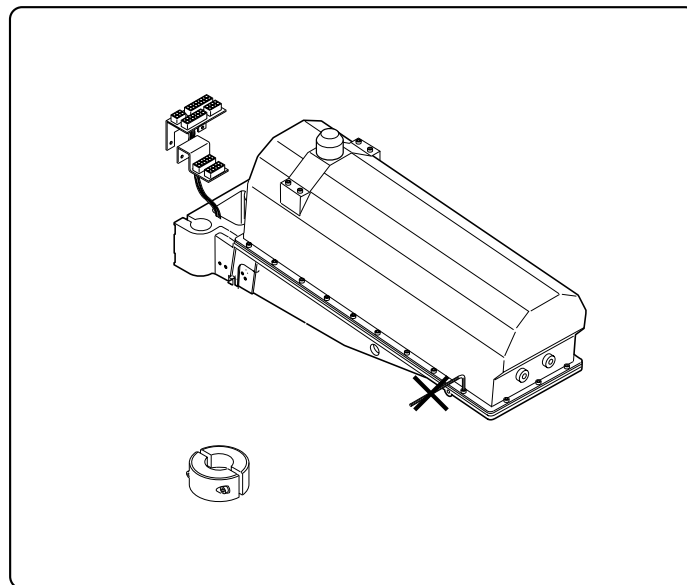


Figure H.14

### 5.1 Preparations before changing the tubehead

- a) Drive the C-arm to the upright (CC-) position. Adjust the height of the unit so that the top of the C-arm is at a convenient working level. Turn the unit off and unplug it from the mains.
- b) Remove the C-arm covers, see section "C-arm covers" on page H-4.
- c) There are two possible C-arm positions: the upright position and slightly past horizontal position.
  - When the C-arm is at the upright position, you need always a locking device. Attach the locking device to the bearing shaft (Fig. H.15, 1). It prevents the tubehead to fall down when opening the MAG-mechanism thread. (Fig. H.15, a)

**NOTE** *Failing to obey this rule can cause injury when opening the MAG-mechanism thread.*

- If you don't have the locking device, turn on the power for a while and drive the C-arm little more than 90 degrees (slightly past horizontal) so that the cassette table is slightly higher than the tubehead. Drive the cassette table to MAG 1.06 position. Turn off the power and unplug the unit. (Fig. H.15, b)

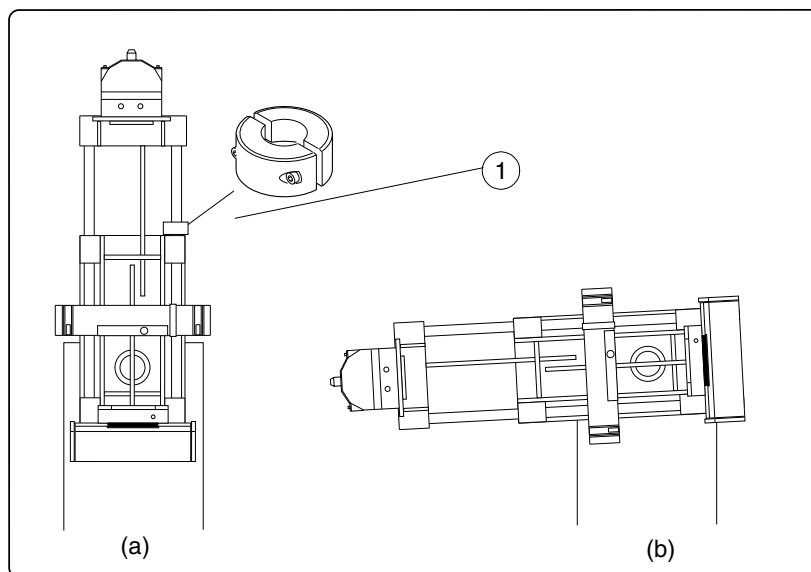


Figure H.15

- d) Remove the power supply, see section “REPLACING THE POWER SUPPLY” on page H-18.

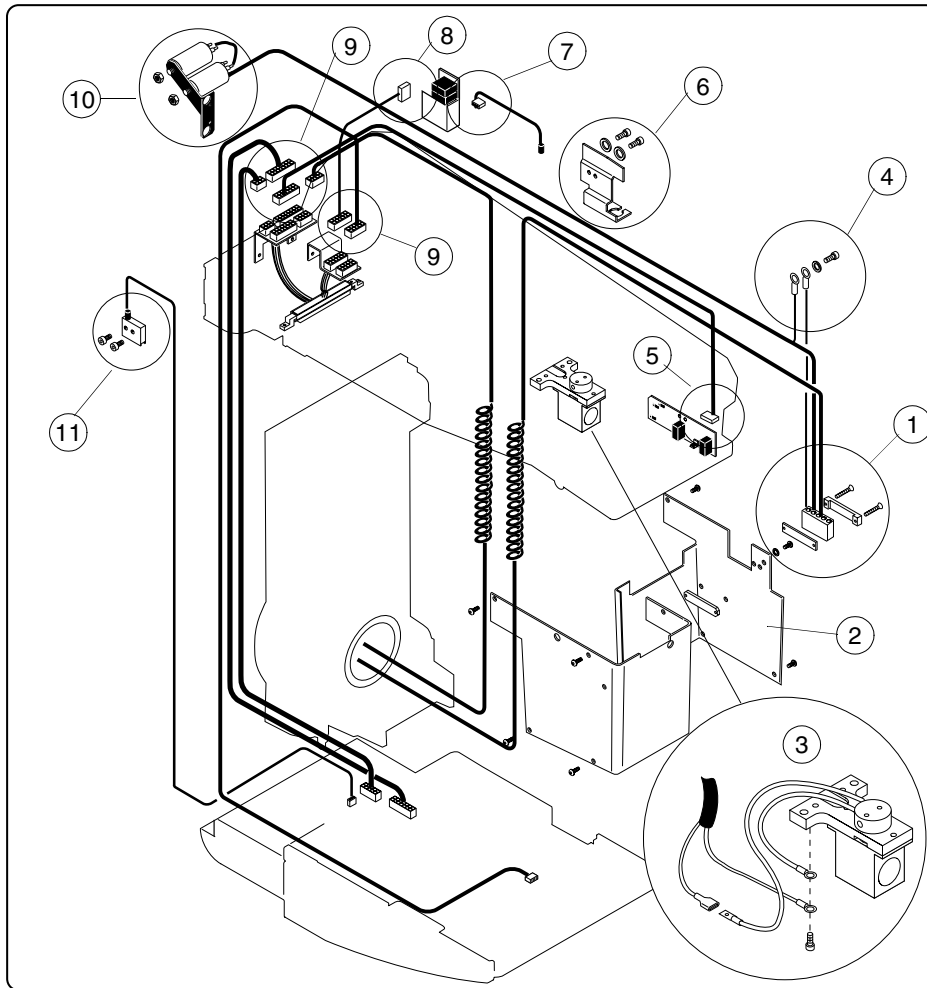


Figure H.16

- e) Unscrew the power connector bracket and remove the mains connector (Fig. H.16, 1) that connects to the power supply at the right side of the collimator shield (also called beam limiting device).
- f) Remove the collimator shield (Fig. H.16, 2). Disconnect the lightfield bulb wires (Fig. H.16, 3).
- g) Remove the ground connectors of the generator power spiral cable (Fig. H.16, 4) from the tubehead.
- h) Disconnect the generator to collimator cable from the COLLIMATOR PCB (Fig. H.16, 5).
- i) Remove the cable holding bracket (Fig. H.16, 6).
- j) Disconnect the tubehead temperature sensor cable from the MAG PCB (Fig. H.16, 7).
- k) Disconnect the generator to mag control cable from the MAG PCB (Fig. H.16, 8).
- l) Disconnect all the connectors from tubehead interface cable (Fig. H.16, 9).
- m) Remove the capacitors (Fig. H.16, 10).  
Remove the mag down hall cable from the tubehead (Fig. H.16, 11)

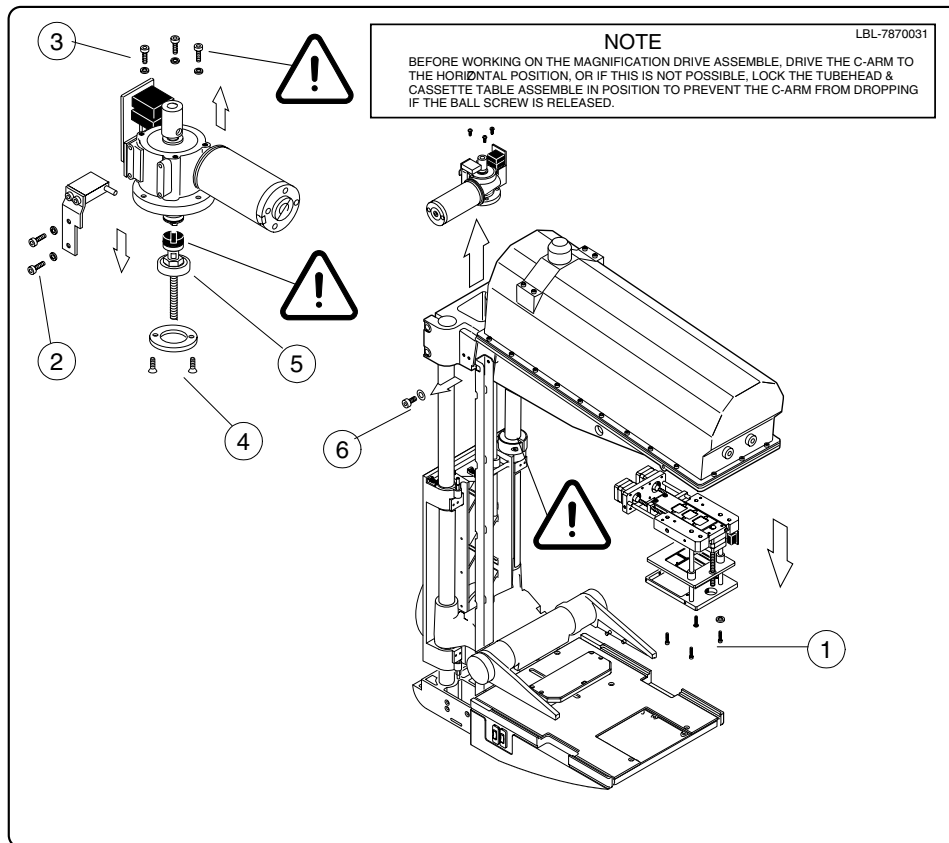


Figure H.17

- n) Remove the collimator from the tubehead by opening the fixing screws (4 pcs) (Fig. H.17, 1). Do not touch the radiation window.
- o) Disconnect the mag pulse hall cable from the MAG/LOAD motor (Fig. H.17, 2). If you are using the locking device, make sure that it is correctly positioned. Remove the MAG/LOAD motor (Fig. H.17, 3). When unscrewing the bearing holding bracket screws (Fig. H.17, 4), make sure that the Allen key used is in good condition since the screws are locked with Loctite 222 glue. If needed, the screws can be warmed up with the hot-air blower.
- p) Pull the ball screw assembly (Fig. H.17, 5) from the tubehead.
- q) Remove the cable guide screw (Fig. H.17, 6).



## 5.2 Removal of the tubehead

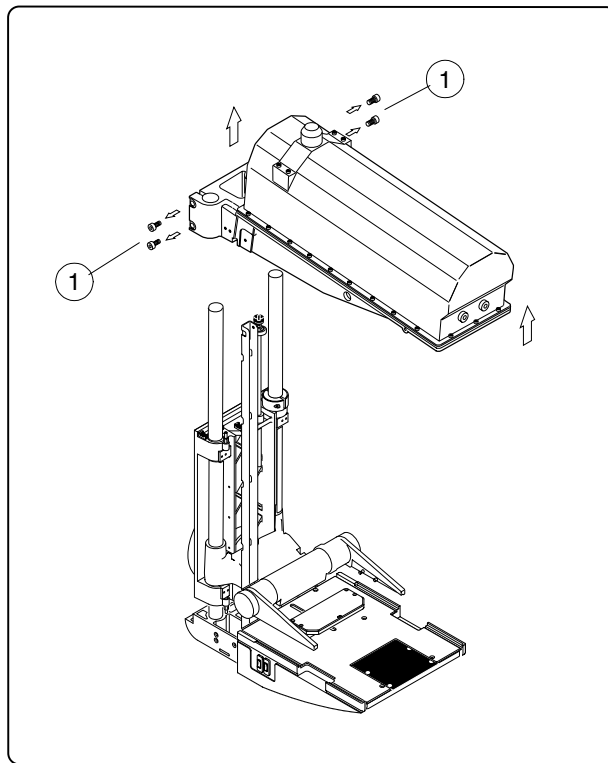


Figure H.18

- a) Make sure that the tubehead is freed from any attached parts.
- b) Loosen the four screws that fix the tubehead cast to the two shafts (Fig. H.18, 1).
- c) Carefully pull the tubehead out from the shafts.
- d) Place the new tubehead to its position.
- e) Tighten the four tubehead screws (Fig. H.18, 1).
- f) Replace the removed parts in reverse order. Secure the bearing holding bracket screws with the Loctite 222 glue.
- g) Turn on the power.
- h) Perform the checks described in chapter E, sections 3.1 - 3.7.

## 6 REPLACING THE POWER SUPPLY

- a) Drive the C-arm to upright position. Remove the C-arm covers, see section “C-arm covers” on page H-4.
- b) Turn off the power. Wait for two minutes before proceeding.

**NOTE** *The connectors in the power supply and tubehead can be damaged, the removal and replacement of the power supply must be performed with extra care. Make sure that the fixing screw of the power supply does not bend. Do not tighten the nut too tight to avoid the fixing screw to rotate or break in the tubehead.*

- c) Support the power supply (Fig. H.19, 1) with the other hand while removing the nut (Fig. H.19, 2).
- d) Pull the power supply straight out.

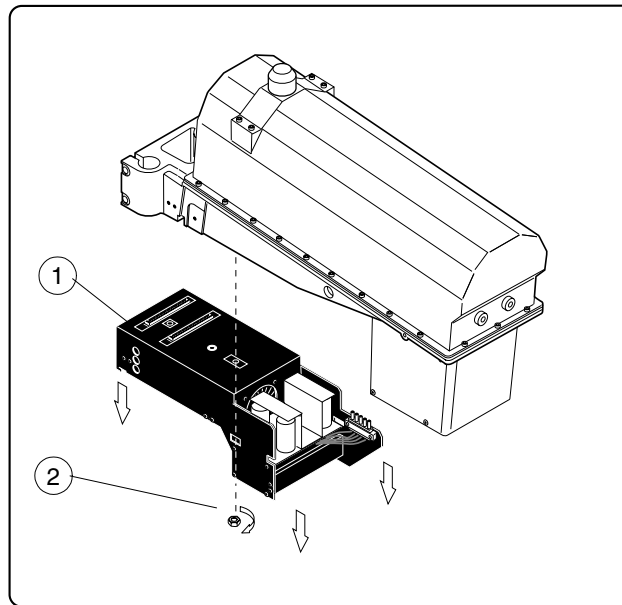


Figure H.19

- e) Replace the new power supply in reverse order.

## 7 REPLACING CIRCUIT BOARDS

**NOTE** *The circuit board holder breaks easily. The replacement of the circuit board must be performed with extra care.*

**CAUTION** *After replacing the board make sure that the cables are connected to the right connectors. Wrong connections may risk patient and operator safety and damage the unit.*

When removing the circuit board press the PCB holder tongue (Fig. H.10, 1) carefully and lift the board from its place (Fig. H.10, 2).

Make sure that the tongues lock the board to the board supports when replacing the board.

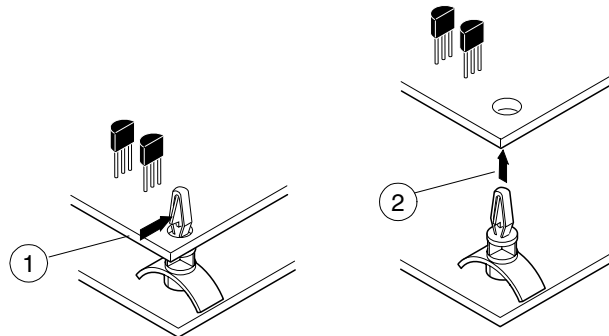


Figure H.20

### 7.1 Location of PC-boards

1. Base PCB
2. Remote control PCB
3. Rotation reference PCB
4. Sync PCB
5. Rear processor PCB
6. Rear collector PCB
7. Display PCB
8. Shelf collector PCB
9. AEC sensor PCB
10. Labeling PCB
11. Force sensor PCB
12. Front collector PCB
13. Tube processor PCB
14. Mag control PCB
15. Collimator PCB
16. Bucky grid reference PCB
17. Stereotactic control PCB
18. Lift reference PCB

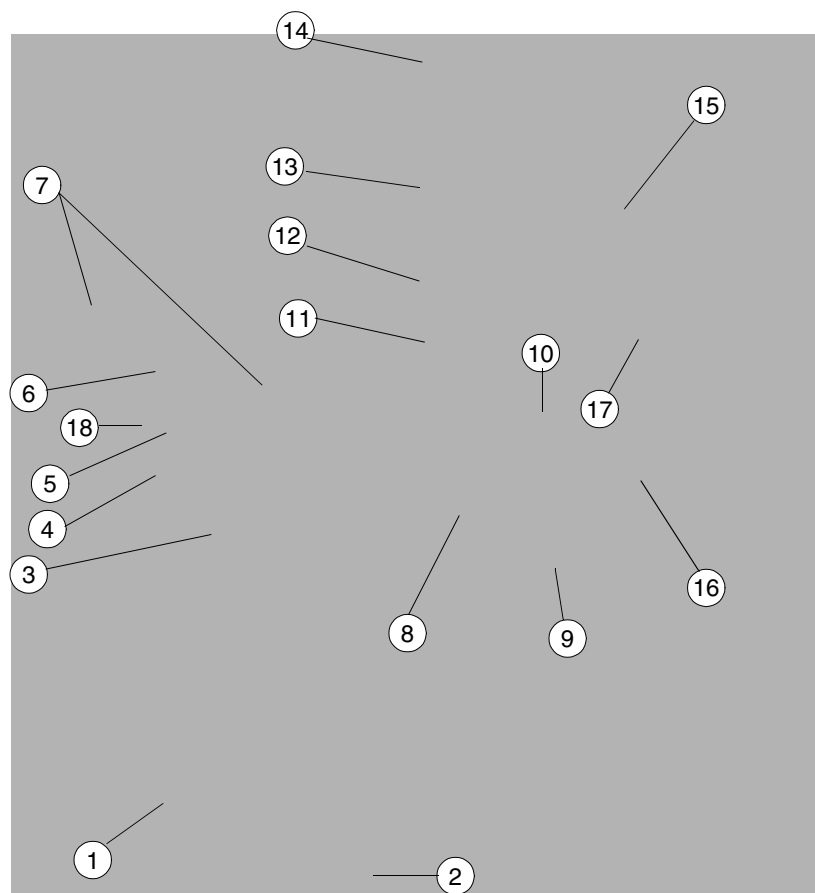


Figure H.21

## 7.2 Boards in the base & column

### Base PCB

- a) Remove the Base rear cover, see section “Base covers” on page H-2.
- b) Disconnect all the connectors from Base PCB.
- c) Detach the PCB from its holders (see Fig. H.22).

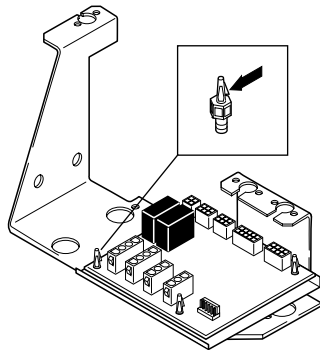


Figure H.22

- d) Insert the new PCB. Connect the wires.
- e) Replace the Base rear cover.

### Sync PCB, Rear collector PCB, Rear processor PCB

- a) Drive the C-arm to straight upright (CC-) position and turn off the power.
- b) Remove the Stationary column rear cover, Telescopic column rear cover and Stationary column rear cover, see sections “Telescopic column covers” on page H-2 and “Stationary column covers” on page H-3.
- c) Remove the Gas spring, see section “GAS SPRING REPLACEMENT” on page H-38.
- d) Disconnect all connectors from the Sync PCB.
- e) Detach the PCB from its holders, see instructions given in section “REPLACING CIRCUIT BOARDS” on page H-19.
- f) Insert the new PCB. Connect all wires to the PCB.
- g) Replace all the covers.

**CAUTION** *When replacing the Rear collector PCB make sure that the connectors of the limit sensors are connected correctly. Wrong connections may cause injury or a damage.*

## 7.3 C-arm pc-boards

### Shelf collector PCB

- a) Drive the C-arm to straight upright (CC-) position and turn off the power.
- b) Remove the Cassette table cover, see section “Cassette table cover” on page H-7.
- c) Disconnect all connectors from the PCB.
- d) Detach the PCB from its holders, see instructions given in section “REPLACING CIRCUIT BOARDS” on page H-19.
- e) Insert the new PCB. Connect all wires to the PCB.
- f) Replace the Cassette table cover.

**Force sensor PCB**

- a) Drive the C-arm to straight upright (CC-) position and turn off the power.
- b) Remove the required C-arm covers, see section "C-arm covers" on page H-4.
- c) Disconnect the connector from the PCB.
- d) Loosen the Force sensor circlips (Fig. H.23, 1). Unscrew the two screws of the Force sensor PCB (Fig. H.23, 2) and remove the PCB (Fig. H.23, 3).
- e) Replace the new PCB in reverse order.

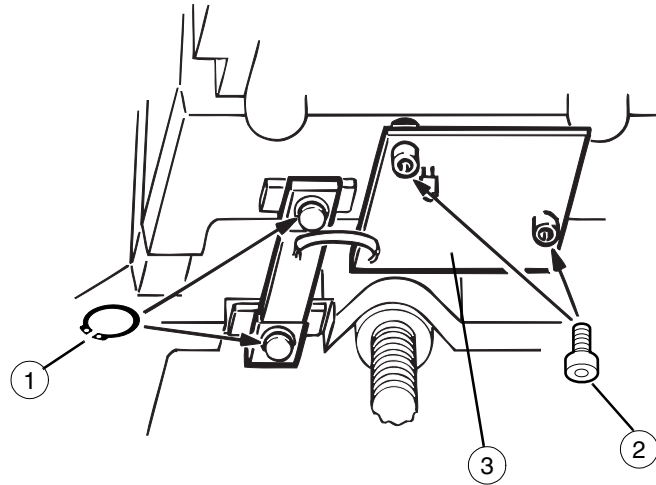


Figure H.23

**AEC-sensor PCB**

- a) Drive the C-arm to straight upright (CC-) position and turn off the power.
- b) Unscrew the four screws of the AEC sensor cover (Fig. H.24, 1).
- c) Lift the AEC sensor assembly carefully from the cassette table (Fig. H.24, 2). Disconnect the AEC cable connector from the assembly (Fig. H.24, 3).

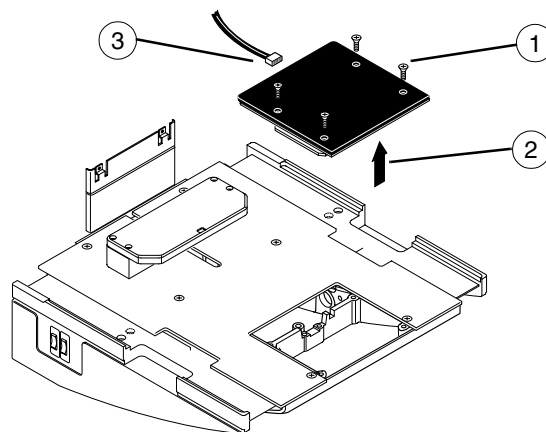


Figure H.24

**NOTE** *Do not touch the sensors under the black AEC sensor cover.*

*The AEC sensor and the cover can not be separated from each other. Always change the whole AEC sensor assembly.*

- d) Insert the new sensor assembly to its position. The sensor cover must be at the same level as the cassette table cover.

## 7.4 Tubehead assembly boards

### Mag control board

- a) Drive the C-arm to straight upright (CC-) position and turn off the power.
- b) Remove the C-arm top cover, Beam window, C-arm lower cover and the Right C-arm side panel, see section "C-arm covers" on page H-4.
- c) Disconnect all the connectors from the PCB.
- d) Unscrew the two screws of the MAG motor assembly and remove the MAG motor assembly from the Tubehead.
- e) Insert the new MAG motor assembly and connect the connectors to the PCB.
- f) Replace the covers.

### Tube processor board

Follow the instructions given in section "Replacing the Tube CPU software" on page H-9.

## 7.5 Keyboards & displays

- a) Turn off the power.
- b) Remove the Hood and the Hood bottom cover plate, see section "Telescopic column covers" on page H-2 and "Hood" on page H-6.
- c) Unscrew the six nuts of the Display PCB assembly (Fig. H.25 , 1) and remove the assembly from the hood (Fig. H.25, 2).
- d) Install the new assembly.
- e) When the membrane is changed, clean the surface carefully before sticking the new membrane.

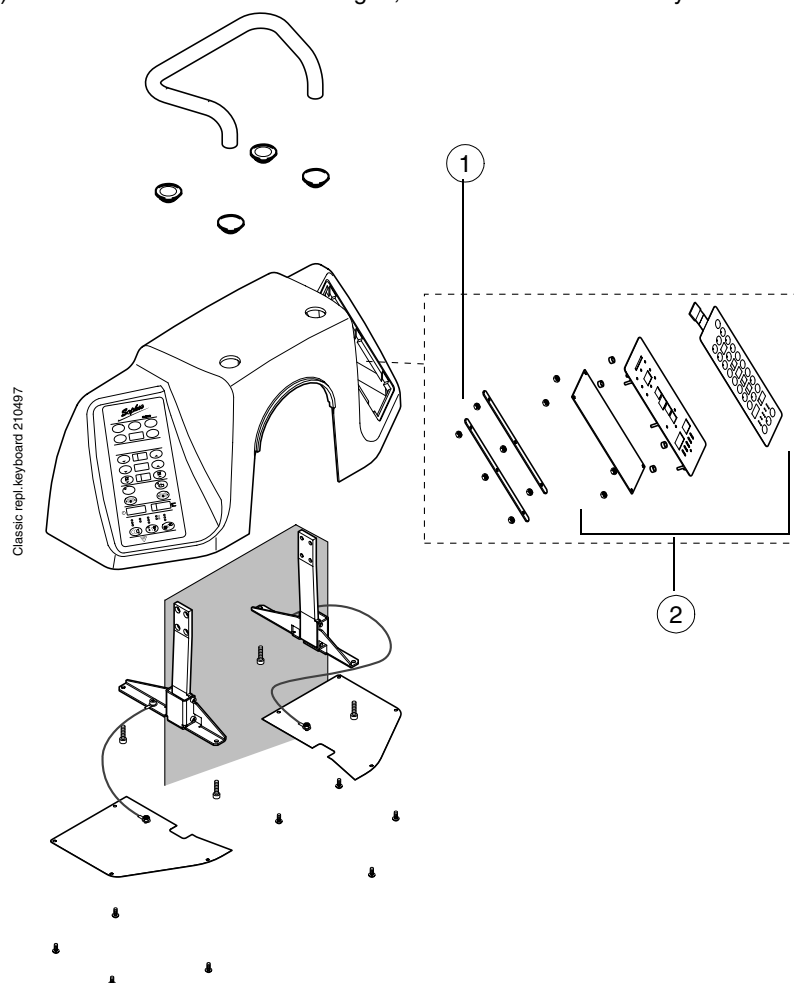


Figure H.25

## 8 REPLACING SENSORS & SWITCHES

### 8.1 Placement of sensors & switches

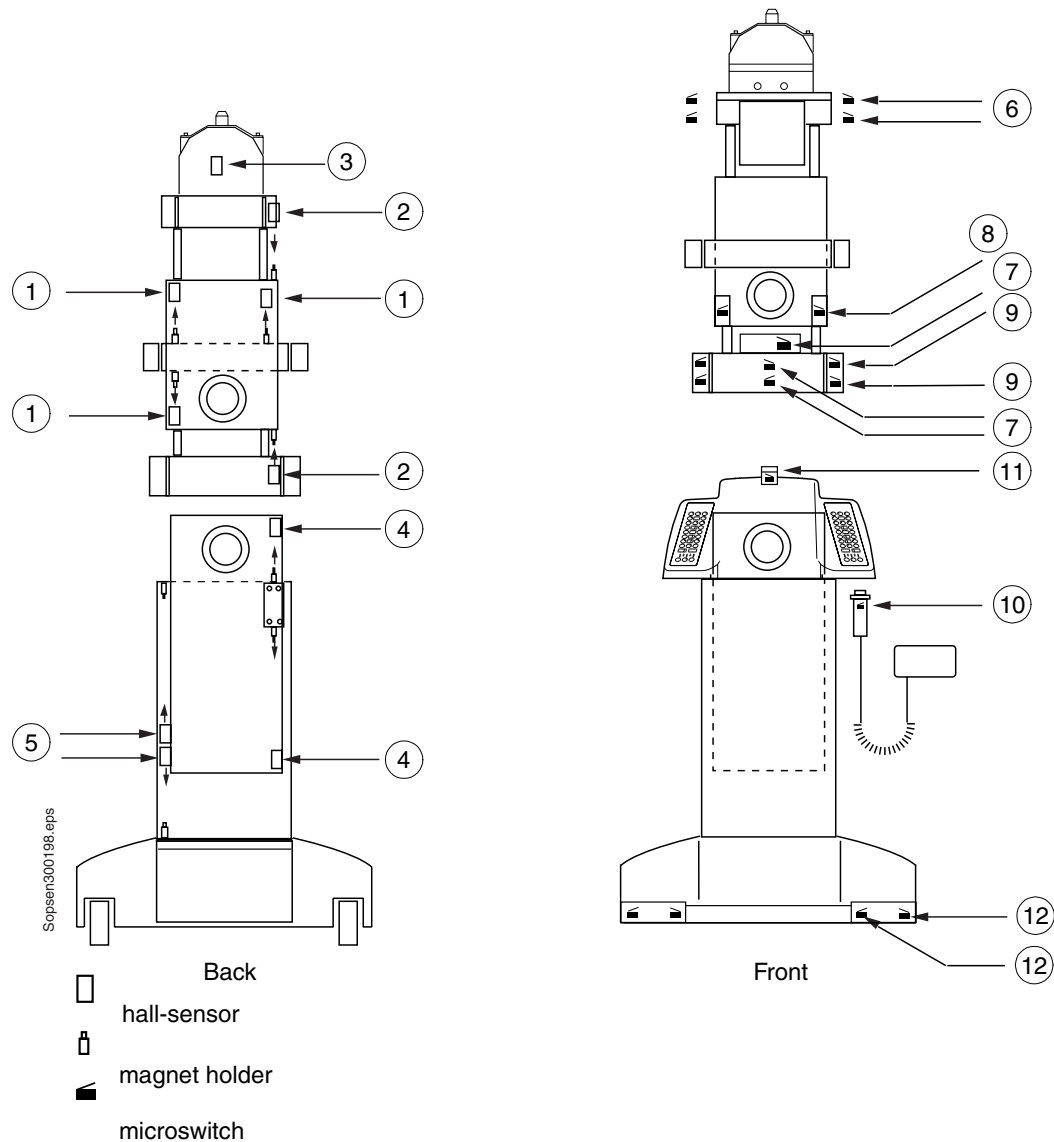


Figure H.26

- |   |  |
|---|--|
| <ol style="list-style-type: none"> <li>1. Compression mechanism limit sensors</li> <li>2. MAG/LOAD mechanism limit sensors</li> <li>3. Motor rotation sensor</li> <li>4. C-arm rotation sensor</li> <li>5. UP/DOWN mechanism sensors</li> <li>6. C-arm control microswitches</li> </ol> | <ol style="list-style-type: none"> <li>7. Cassette table size identification microswitches</li> <li>8. Lower paddle identification microswitches</li> <li>9. Cassette table control microswitches</li> <li>10. Exposure control microswitch</li> <li>11. Emergency stop microswitch</li> <li>12. Foot pedal microswitches</li> </ol> |
|---|--|