Service Manual

for the

CRANEX® Novus e
Dental X-ray Unit

208710 rev. 1 (2013-01)

Service Manual for the CRANEX® Novus e Dental X-ray Unit

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1. General Information

1.1 Introduction

This manual describes how to service the CRANEX® Novus e Digital Panoramic X-ray Unit (hereinafter referred to as the unit).

1.2 Associated documentation

The unit user's manual.
The unit installation manual.
The unit spare-parts manual.

1.3 Service precautions and warnings

Servicing precautions

Only service personnel trained and approved by the manufacturer of the unit are allowed to service the unit.

Before attempting to service the unit make sure that you know how to operate it. Read the unit user's manual.

Read and familiarize yourself with the warnings and precautions listed in the unit user's manual.

Only use original SOREDEX® spare parts when repairing the unit or replacing parts.

The unit can operate using voltages:
100 to 120 VAC or **220 to 240 VAC**.
The only difference between the two versions is the supplied power cable.

Warning - Radiation Safety

Before servicing the unit familiarize yourself with local and national radiation safety standards and requirements relating to dental x-ray equipment.

When taking test exposures take adequate precautions to protect yourself from radiation. Stand behind a suitable radiation shield positioned at least two metres (six feet) from the unit.

Warning - Mechanical safety

Disconnect the unit from the main power supply before removing any covers.

Disconnect the unit from the main power supply before repairing or replacing mechanical parts or installing accessories.

Be careful when operating the unit not to get body parts or clothing trapped between moving parts.

During operation some surfaces and components may become hot. Take precautions to avoid burning yourself.

The aperture plate in the collimator is made of lead (Pb) which is toxic. Do not touch it with your bare hands.

Do not open the tubehead. There are no serviceable parts, mechanical or electrical, inside the tubehead.

Warning - Electrical Safety

Disconnect the unit from the main power supply before replacing circuit boards or other electrical components.

If there are capacitors on a circuit board or electrical component wait ten (10) minutes, after disconnecting the unit from the power supply, before handling the board or component.

If you have to leave the unit unattended during servicing or maintenance, disconnect the unit from main power supply to protect people, who may touch the unit, from electric shock.

This unit should be used only in areas that are provided with a protective earth connection to ensure an equipotential ground connection.

Caution - electrostatic discharge

Electrostatic Discharge (ESD) can damage or destroy electronic components.

When servicing the unit take precautions to avoid electrostatic build up and discharge (ESD). Follow the recommendations for the prevention of ESD that are used in the country in which you are working. If no recommendations are available, follow the guidelines below:

- Leave all new or replacement circuit boards and electrical parts in their protective packaging until the boards are needed.
- Before handling circuit boards and electrical parts make sure that any static electricity charge that has built up in you body is discharged.
- When examining and checking circuit boards use an antistatic wrist wrap which is connected to a ground point through a 1 Mohm current limiting cable. For a ground point use water pipes, radiators or other objects that are known to be connected to the ground. Also use a cable to connect the unit to the same ground potential as the wrist wrap.
- When handling circuit boards hold them by their edges and do not touch any components or connectors.
- If an antistatic mat is used, connect the wrist wrap to the mat and the mat to the ground potential.
- Wash the wrist wrap and check that it is in good condition frequently.

Warning - Explosion hazard

Certain disinfectants and cleaning agents may vaporize to form an explosive vapour. If such chemicals are used the vapour should be allowed to disperse before switching the unit on.

Warning - Cleaning the unit

Switch the unit off and disconnect it from the main power supply before cleaning or disinfecting the unit.

1.4 Unauthorized Modifications

Unauthorized changes or modifications to any part of the unit or its equipment can have hazardous consequences. Changes or modifications must not be made unless specifically authorized by the manufacturer of the unit.
When properly assembled with a compatible beam-limiting unit, the diagnostic source assembly will fully meet the United States of America Federal Performance Standards for Diagnostic X-Ray Systems and Their Components (21 CFR 1020. 30-32) provided no components or parts are removed from the unit and no unauthorized adjustments are made to the beam-limiting unit or tube housing assembly.
Never remove or remanufacture any part of the tube housing assembly or beam-limiting unit.
Never adjust any part of the beam-limiting unit unless under the direction of the manufacturer of the unit or their authorized distributor(s).

1.5 Disclaimer

The manufacturer of the unit shall have no liability for consequential damages, personal injury, loss, damage or expense directly or indirectly arising from the use of its products. No agent, distributor or other party is authorized to make any warranty or other liability on behalf of the manufacturer of the unit with respect to its products.

1.6 Yearly maintenance

The following tests and inspections must be carried out annualy by an authorized service person to verify that the unit meets the specifications and performance criteria essential for correct and safe operation.
When taking measurements that require a multimeter, always use a digital multimeter (DMM).

mA test

WARNING: X-rays are generated when this test is carried out. PROTECT YOURSELF FROM RADIATION.

1. Connect the +probe of a DMM to test pin TP18 (mAfb) and the -probe to TP17(GND) on the L1800 Generator board.

2. Select service command **exp** and an exposure time of 2000 ms (refer to section 4 Service assistant and service functions, in this manual).

3. Protect yourself from radiation and take an exposure. Check the feedback values from the DMM. The feedback values must be within the tolerance.

Selected mA	mAfb (V)	Tolerance (V)
8	1.58	±0.15 (1.43 - 1.73)
10	2.0	±0.15 (1.85 - 2.15)

If the value is not within the tolerance, recalibrate the Generator board, see section 5.2 Service Commands (the **calib** command).

kV test

WARNING: X-rays are generated when this test is carried out. PROTECT YOURSELF FROM RADIATION.

1. Connect the +probe of a DMM to test pin TP14 (kVfb) and the -probe to TP17(GND) on the Generator board.

2. Select service command **exp** and an exposure time of 2000 ms (refer to section 4 Service assistant and service functions, in this manual).

3. Protect yourself from radiation and take an exposure. Check the feedback values from the DMM. The feedback values must be within the tolerances.

Selected kV	kVfb	Tolerance (V)
63	2.86	±0.1 (2.76 - 2.96)
66	3.00	±0.1 (2.90 - 3.10)
70	3.18	±0.1 (3.08 - 3.28)
73	3.32	±0.1 (3.22 - 3.42)
77	3.50	±0.1 (3.40 - 3.60)

If the values are not within the tolerances, recalibrate the Generator board, see section 5.2 Service Commands (the **calib** command).

Beam alignment test

Check the beam alignment. Refer to the Installation and set-up manual for information on how to do this.

Ground test

Disconnect the unit from the main power supply before carrying out this test.
For ME EQUIPMENT with an APPLIANCE INLET the impedance between the earth pin in the APPLIANCE INLET and any part that is PROTECTIVELY EARTHED shall not exceed 0.1 ohm. The grounding resistance is measured between APPLIANCE INLET ground pin and any metal part of the unit.
The resistance MUST be <0.1 ohm.

Motor movements

Switch the unit off and then manually rotate the rotating unit to check that the stepper motor moves freely and without any looseness.

Switch the T-mode "test" and then take an exposure to check that the motors operate smoothly and without any noise.

Press the up/down keys to check the Z-motor (vertical carriage movement). The motor must operate smoothly and without any noise.

Position detectors

Press the up key and drive the unit up. Make sure that the unit stops moving at its uppermost position.
Press the down key and drive the unit down. Make sure that the unit stops moving at its lowermost position.

Manually rotate the rotating unit to one of its end positions and then press the return button and make sure that the rotating unit returns to the ready position. Repeat the test for the other end position.

Use service command **optotest**, see section 5.2 Service Commands, to check the rotating unit optosensors. Manually turn the rotating unit in one direction and then press return. Repeat for the other direction.

Patient Positioning Lasers

Check that the patient positioning lasers work and are positioned correctly. Refer to the Installation and set-up manual for information on how to do this.

Mains power supply cable

Check the condition of main power supply cable and replace it if damaged.

Tubehead

Make sure that oil is not leaking from the tubehead. If the tubehead shows signs of oil leakage, replace it.

Covers and Labels

Check that all covers are correctly installed and in good condition. Also check that all the labels are attached to the unit and that they are all legible.

Fire risk

WARNING: Disconnect the unit from the main power supply before carrying out the next task.
Use a vacuum cleaner to remove all dust that has accumulated inside the unit and cover air vents to eliminate the risk of fire. Remove all dust from the circuit boards, and pay special attention to the Generator board L1800 and PFC P1910.

1.7 Disposal

At the end of useful working life of the unit, its spare and replacement parts and accessories make sure that you follow all local, national and international regulations regarding the correct and safe disposal and/or recycling of the unit, its spare and replacement parts and accessories.

The unit and its spare parts and accessories may include parts that are made of or include materials that are non-environmentally friendly or hazardous. These parts must be disposed of in accordance with all local, national and international regulations regarding the disposal of non-environmentally friendly or hazardous materials.

The following hazardous materials and substances can be found in the unit, its spare and replacement parts and assemblies:

- Lead (Pb):
  circuit boards, tubehead, collimator, CCD sensor assembly
- Cadmium (Cd):
  none
- Mercury (Mg):
  none
- PBB Polybrominated biphenyls:
  none
- PBDE polybrominated diphenyl ethers:
  none

Other materials and substances in the unit, its spare parts and assemblies that could be hazardous and are non-environmentally friendly are:

- Mineral oil:
  tubehead

2. Unit description

2.1 The CRANEX® Novus e

The CRANEX® Novus e extraoral x-ray unit is designed to take exposures of the dento-maxillofacial region. The unit cannot be used to take x-ray exposures of any other part of the human anatomy.

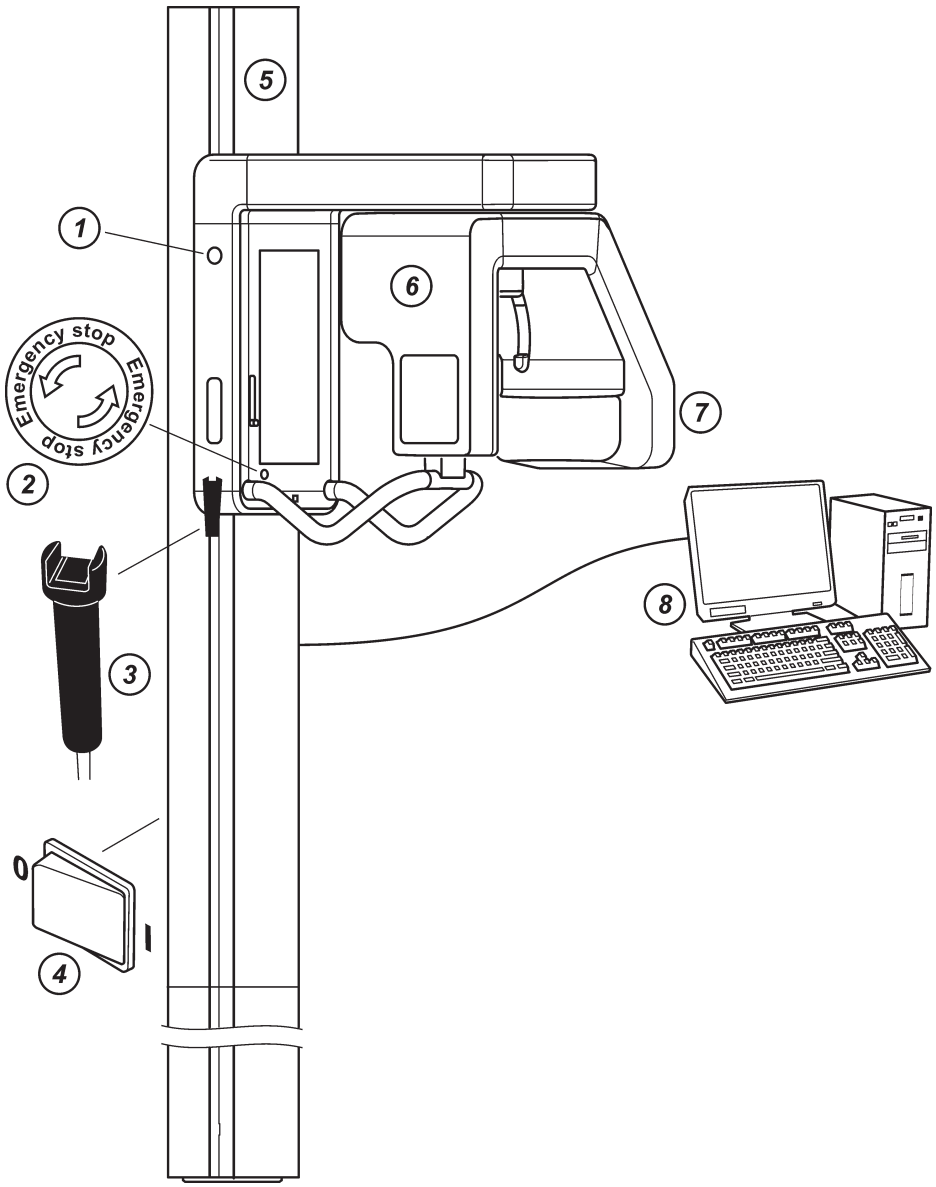
The unit can be used to take adult panoramic (full width), child panoramic (reduced width), TMJ and bitewing images.

The unit can operate using voltages:
from **100 to 120 VAC** or **220 to 240 VAC**

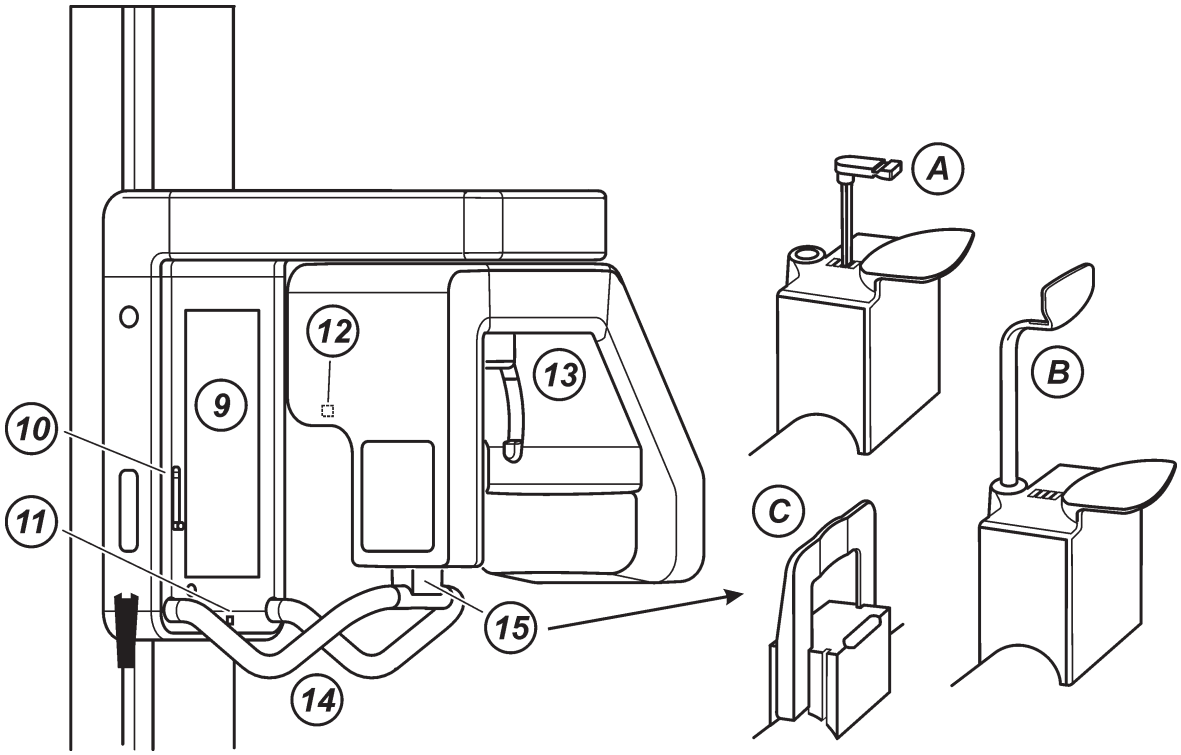
The unit is used with a PC in which **Scanora®** or **Digora® for Windows** or some other MDD approved dental imaging software are installed.

For information on how to use the unit refer to the User Manual.

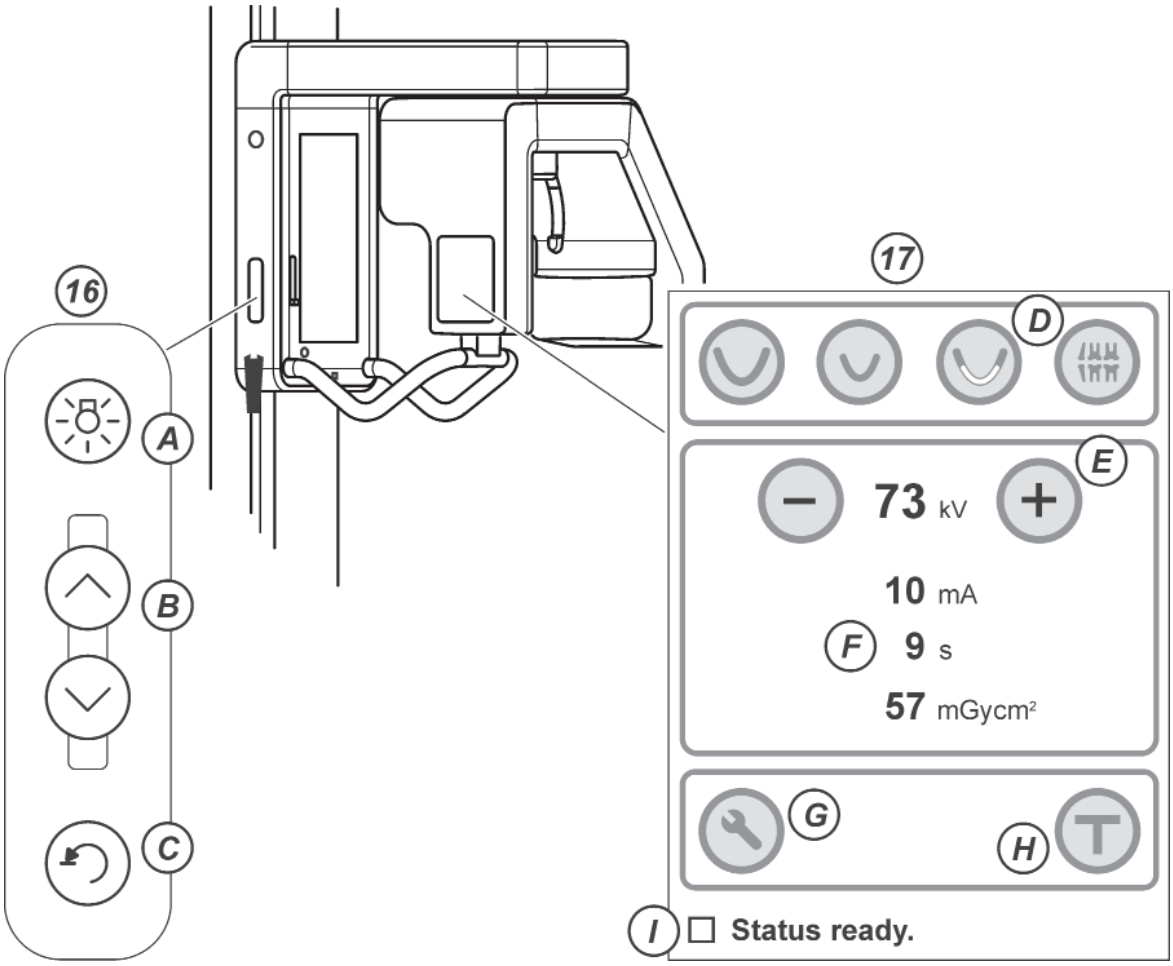
2.2 The main parts and assemblies



1 Motorized carriage
2 Emergency stop button - Press to stop, rotate to release
3 Exposure switch
4 On / Off switch (rear of the column)
5 Column
6 CCD sensor
7 Tubehead
Tubehead (7) + CCD sensor (6) = **Rotating unit**
8 PC with MDD approved dental imaging software



9 Patient positioning mirror
10 Frankfort light
11 Midsaggital light
12 Focal through light
13 Head support
14 Patient handles
15 Chin support
A. Chin rest and bite block
B. Chin rest and lip holder
C. Lip support



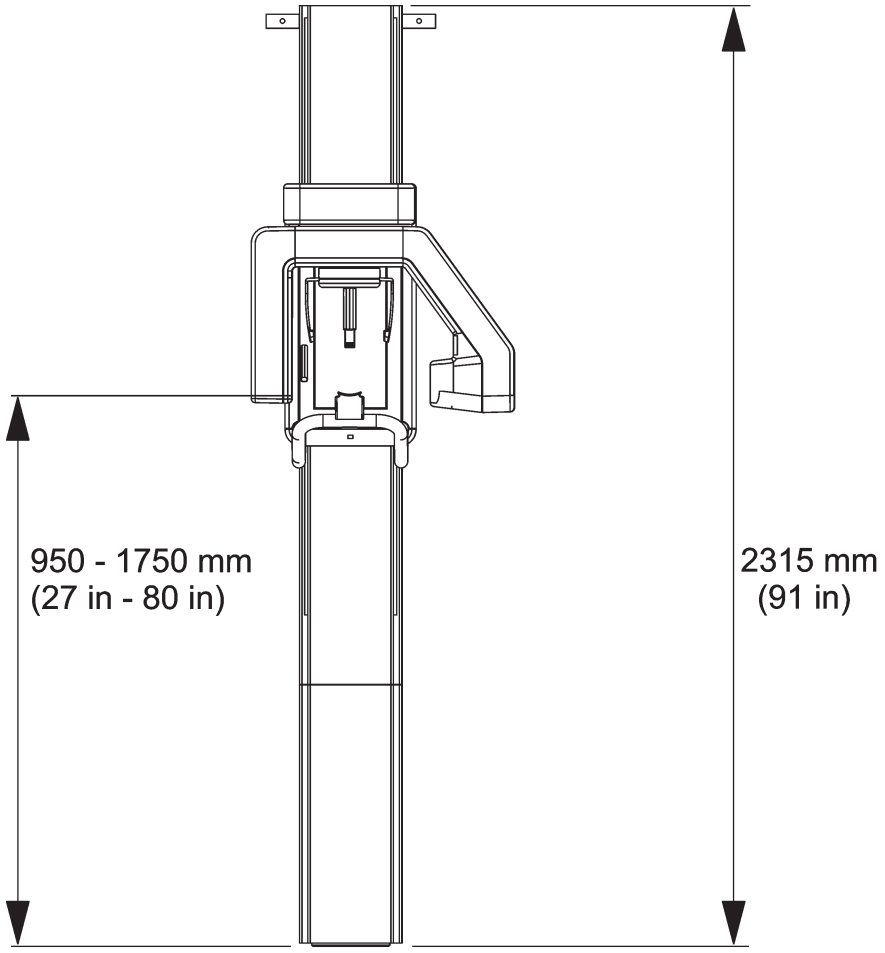
16 Side control panel

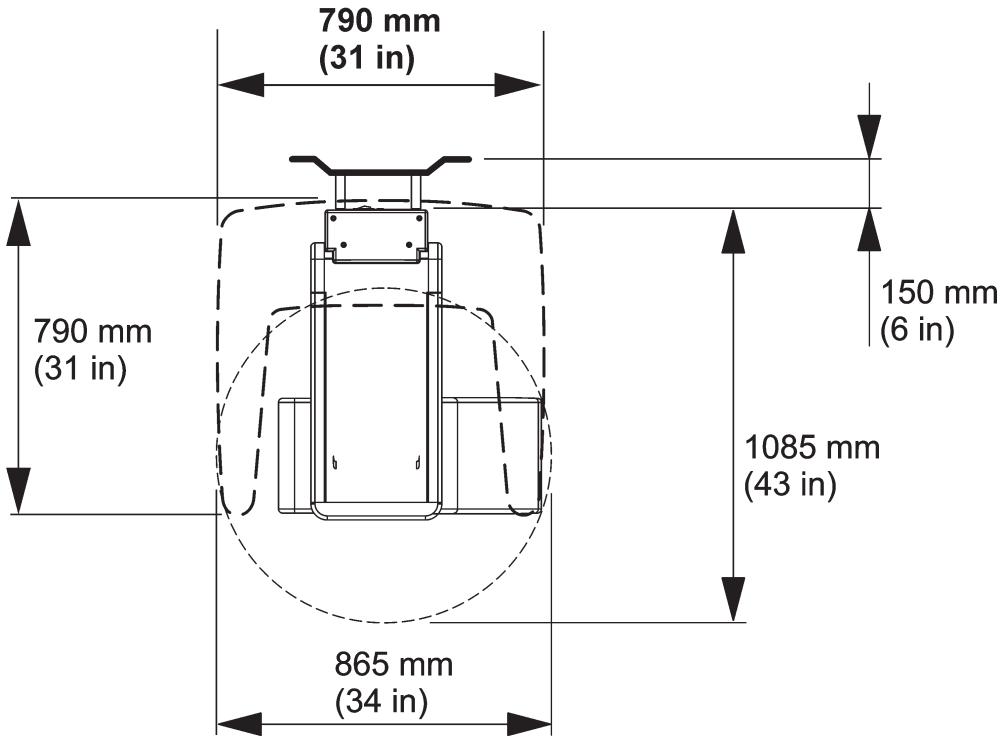
- A Lights key - switches the patient positioning lights on and off
- B Up / down keys
- C Return key, drives rotating unit to the patient in/out position (PIO)

17 Main control panel

- D Program keys - adult pan, child pan, TMJ, bitewing (optional)
- E kV selection keys
- F Exposure values
- G Service key
- H Test exposure key
- I Unit status indicator

2.3 Unit dimensions





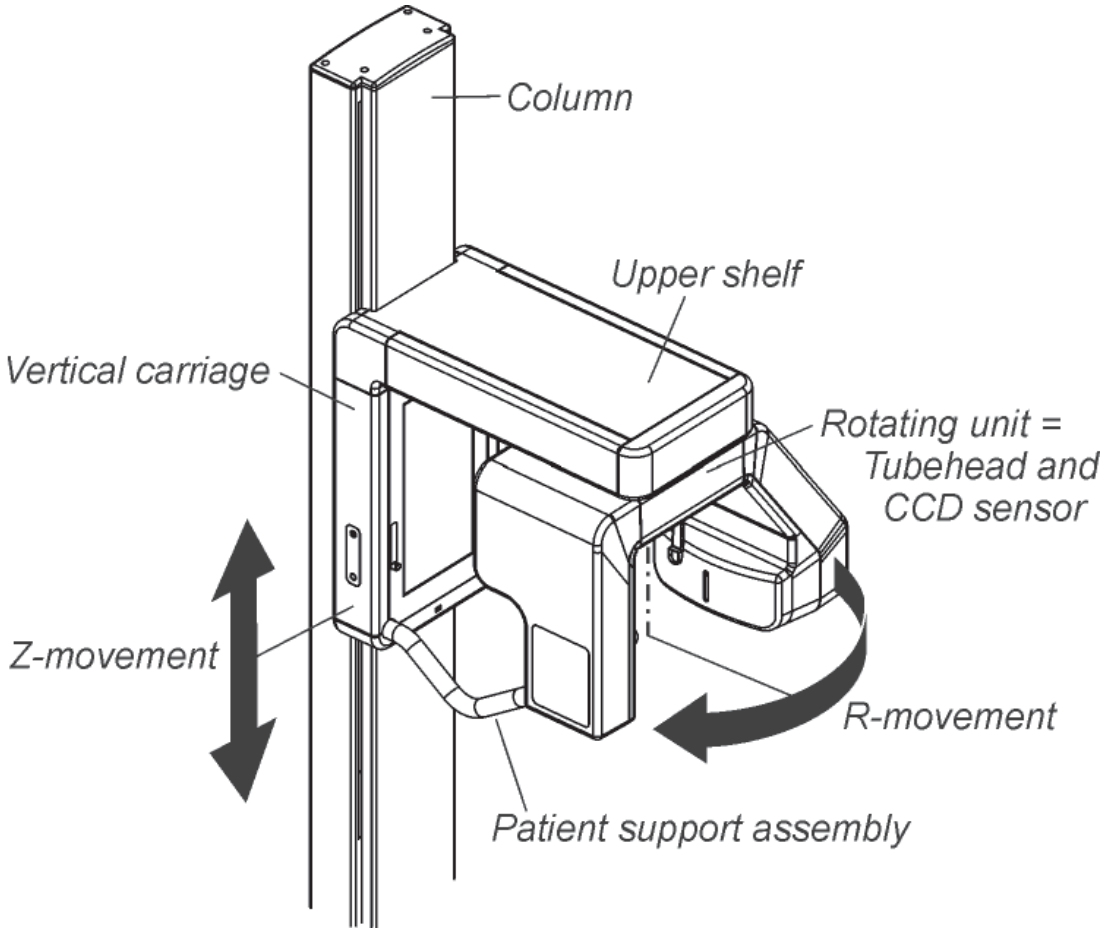
2.4 Mechanical description

The unit comprises a **column**, a **motorized carriage**, an **upper shelf**, a **rotating unit** and a **patient support assembly**.

The **column** is permanently fixed to the wall, using wall bracket and, if required or necessary to the floor.
The unit can also be used free standing but it must be attached to the show stand (part no. 9802666).

The **motorized carriage** is attached to the **column** and can slide up and down the **column** (Z-movement, for adjusting the height of the unit). The **upper shelf** is attached to the top of the **motorized carriage**.

The **rotating unit**, which comprises the **tubehead** and collimator and the **CCD sensor**, is attached to the underside of the upper shelf. The **rotating unit** rotates to take panoramic exposures (R-movement).

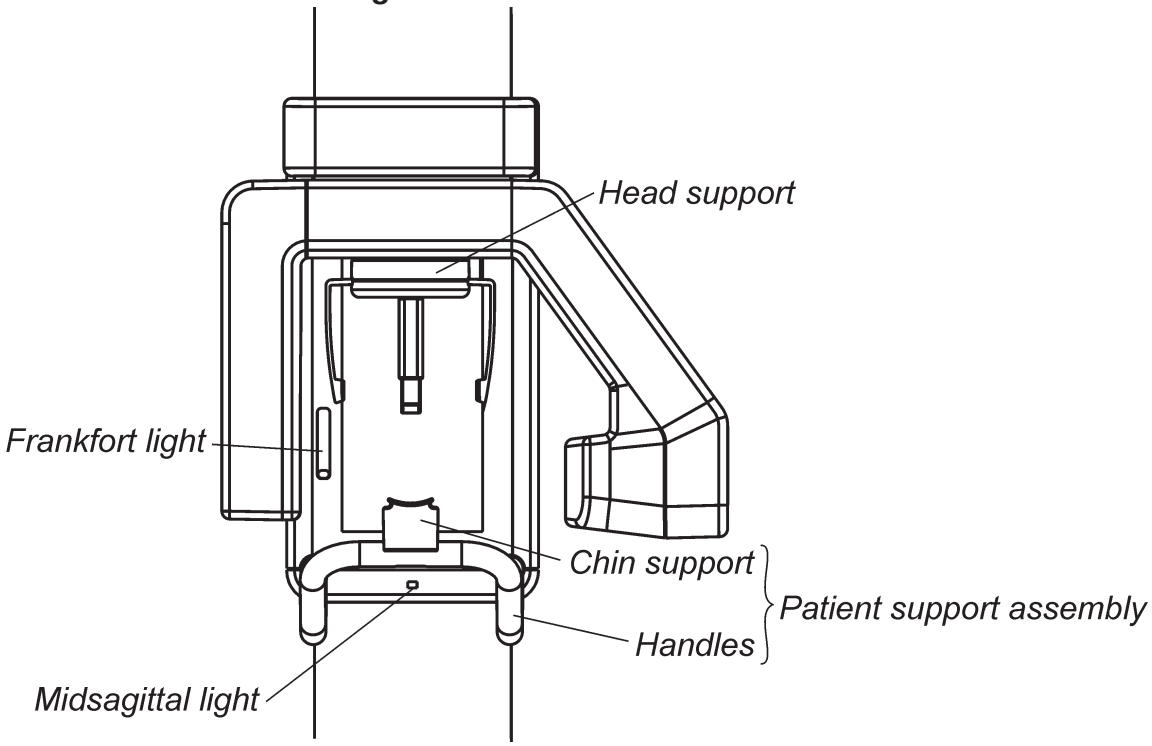


Inside the **tubehead** there is the x-ray tube. It is a fixed tungsten anode type.

The **patient support assembly** is attached to the bottom of the vertical carriage. It comprises **handgrips** for the patient to hold and the **patient support**.

The **chin rest** supports the patients lower jaw and the two temple supports on the **head support** hold the upper part of the patient's skull.

There are three patient positioning lasers, **midsagittal light**, **Frankfort (horizontal) light** and **Focal through light**.



2.5 Electrical description

Circuit boards

Circuit boards are described in detail in section **3. Circuit Boards**.

Power supply

Mains voltage is supplied to P1910 PFC Power Supply Board via L1600 Z-Motor Driver. P1910 supplies power to L1800 Generator Board and L1500 Power Supply board which supplies low voltages to all the other circuit boards.

The power for the AC-motor (Z-Motor) comes from an autotransformer that is automatically set to the correct voltage. The Z-Motor input voltage is always 230 VAC. The autotransformer is connected to L1600.

Main fuses

Two T-10A-H-250V.
Dimensions 6.3 x 32 mm / 1/4 x 1-1/4", UL approved.

They are located below the main power supply cable at the rear of the column.

Unit control

The unit is controlled by a microprocessor on L1200 (CPU board). It continually monitors and controls the operation of the unit. A serial peripheral interface communication protocol (SPI - RS485) and direct digital I/O are used to monitor most of the unit functions.
The microprocessor:

- monitors the optosensors

- monitors control (touch) panel keys

- controls unit movements during exposures

- starts, controls and stops x-ray generation

- controls the digital imaging chain

- controls unit / PC communications

The necessary unit settings and parameters for all the imaging programs are stored in the memory which is also on L1200.

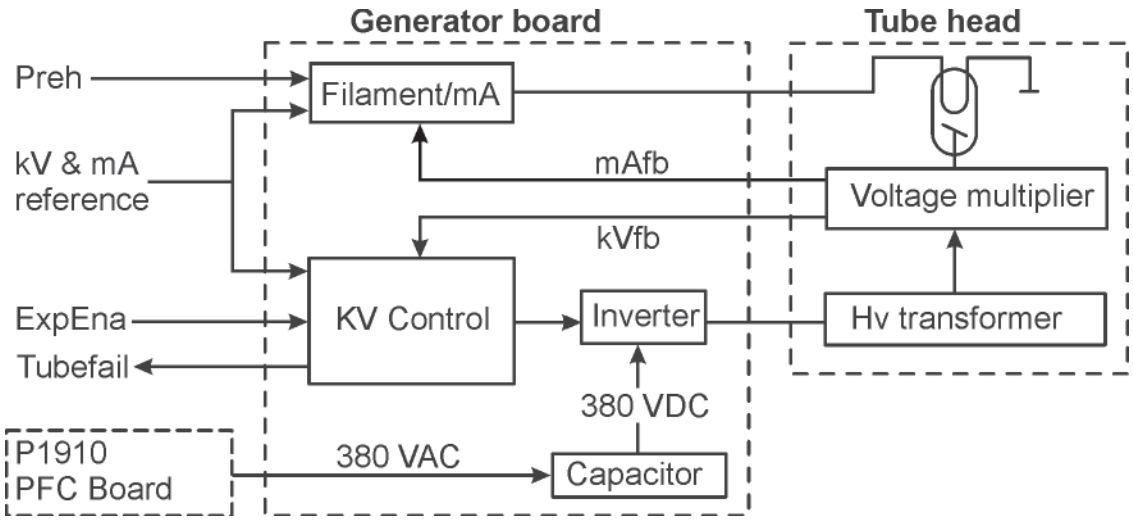
Motors and motor control

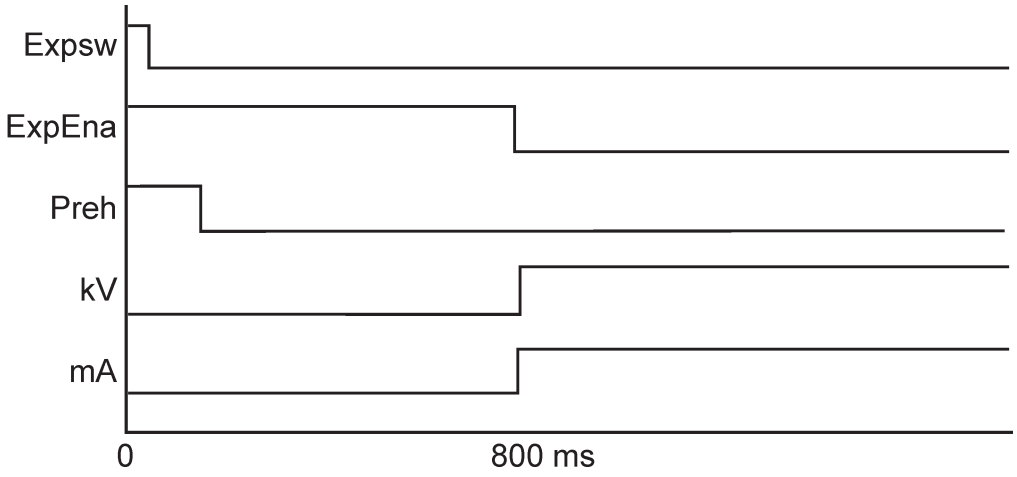
There is one stepper motor and one AC-motor in the unit.
The stepper motor drives the rotating unit (R-movement). The stepper motor is driven and controlled by R5100 (3-Phase Microstepper Driver).

The AC-motor (Z-motor) adjusts the height of the unit (Z-movement), and the motor is activated by L1600. To activate the Z-motor L1600 must receive a control signal from L1200 and a separate control (enable) signal from the Z-movement (up/down) keys.
An emergency switch on the front of unit disables the Z-motor (Z-movement) and stepper motor (R-movement) when pressed.

Exposure logic

An exposure can only be taken when the unit is in the ready state (the exposure ready light on the control panel is on) and the exposure button is pressed and held down.
The Generator board receives the correct kV and mA references from the CPU. A few milliseconds after the exposure button is pressed (Expsw) preheat is enabled (Preh). After 800ms the exposure will start (ExpEna). The tubehead will receive power from the Generator board and the Generator board will also start to regulate the mA and kV according to mA- and kV- feedback.





Position control

The position of the rotating unit (R-movement) is monitored by optosensors on L2100 (Rotation Position Sensor Circuit). The optosensors indicate in which sector the rotating unit is. The optosensors ensure that the rotating unit is in the correct position, start or PIO (Patient In/Out), for an exposure.
The statuses of the optosensors are monitored continually by the unit software.

The upper and lower limits of the vertical carriage (Z-movement) are monitored by microswitches.

A overview of the Imaging Chain

This description assumes that the unit is ready to take an exposure.

Image acquisition is controlled by the **DSD** software component which is installed in the PC connected to the unit.

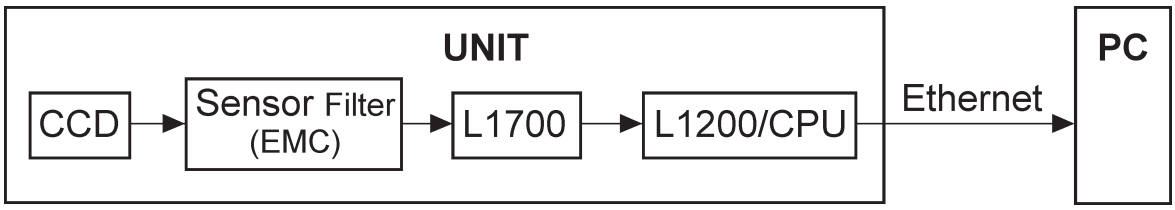
When an exposure is taken L1200 (the CPU) then sends a PPOWER and CCDENA signal. CCDENA signal activates voltages for the CCD sensor.

The CPU's control software continuously monitors the status of the connection with the DSD driver. After image exposure but before image transfer the CPU sends a label that includes the imaging and dose parameters (—kV/—mA/ —s) and an imaging program identifier.

The CPU enables the IMAGE signal to activate pixel clocking. The CPU then produces the TDI clock signal, which clocks the pixels from the CCD sensor. Derivation of several CCD clock signals from the TDI clock is done by the CCD sensor board.

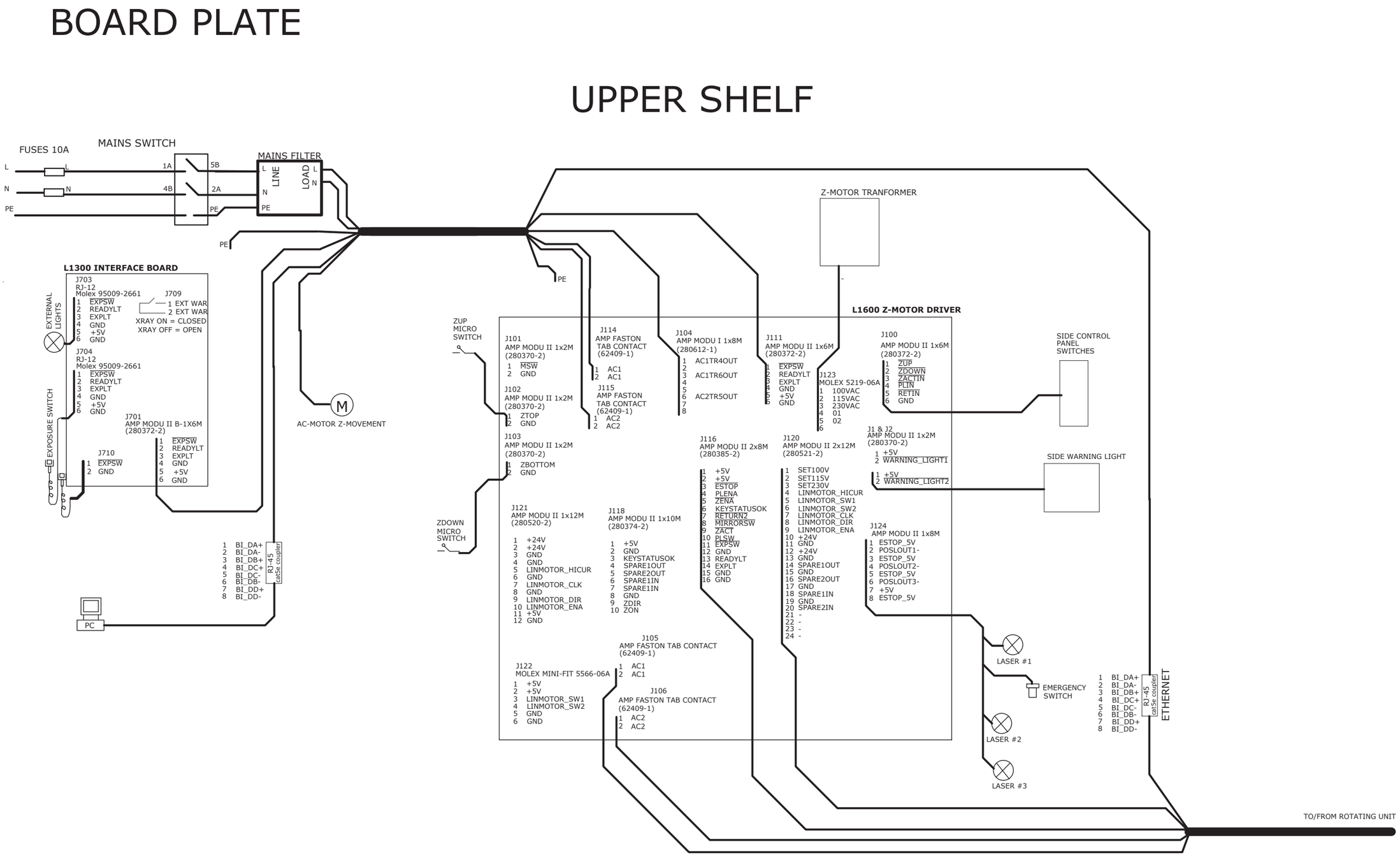
Radiation striking the CCD sensor is converted to visible light which is detected by the CCD cell. A binning procedure is carried out on individual pixels, i.e. two adjacent pixels in a row and column (2 x 2 binning) forms one large pixel (96µm x 96µm). The output voltage of the CCD is fed to a 14-bit A/D converter.

The CCD sensor board sends the image data (now 12 bits) to the CPU board where they are saved on the SDRAM. The image information is transferred to the PC via the Ethernet cable.

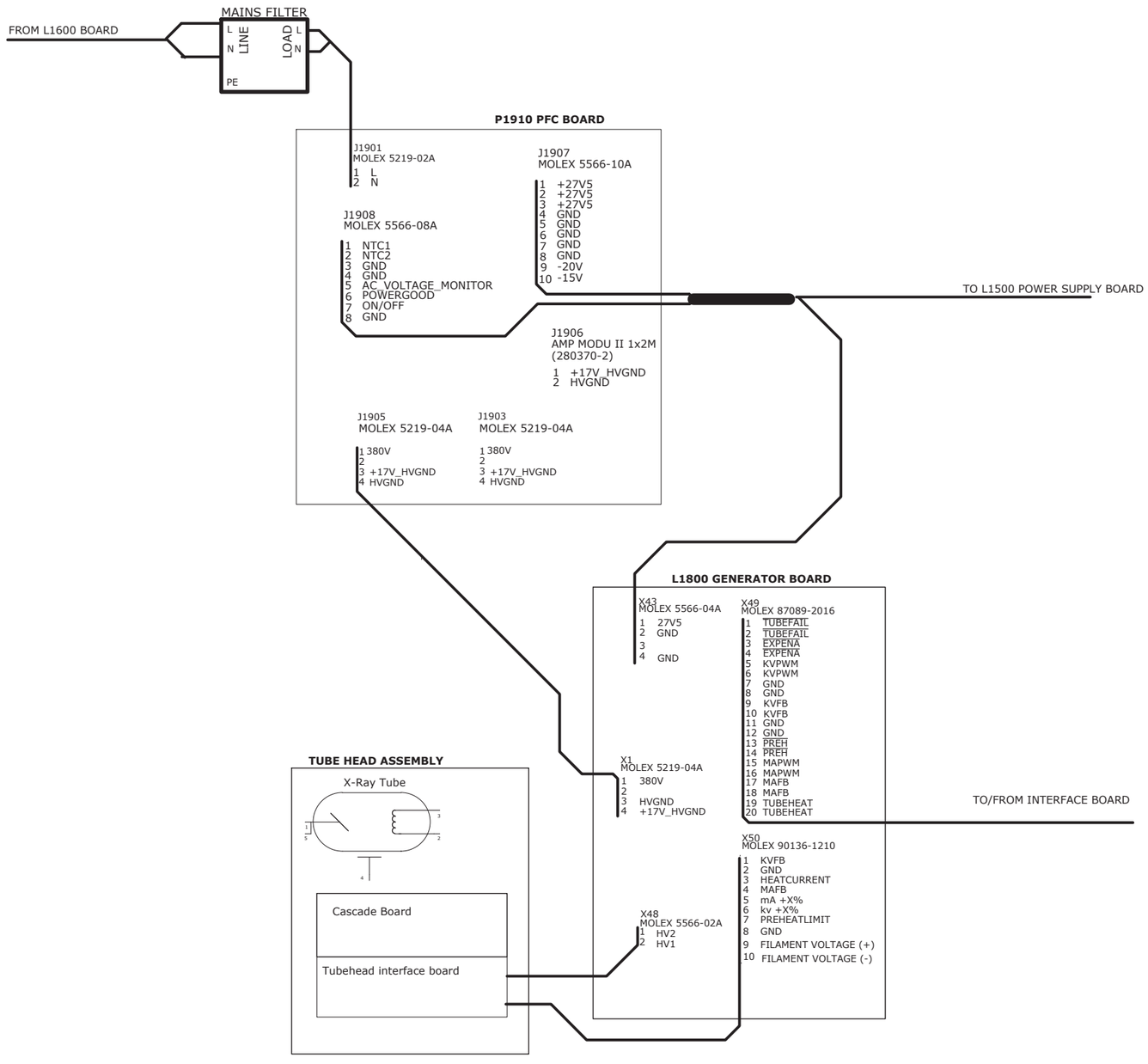


In the PC there is a Network Interface Card (NIC). After image data transfer the DSD preprocesses the raw image, for example it interpolates gaps between CCD chips, and carries out dark current correction and gain correction (the pixels do not have equal characteristics).

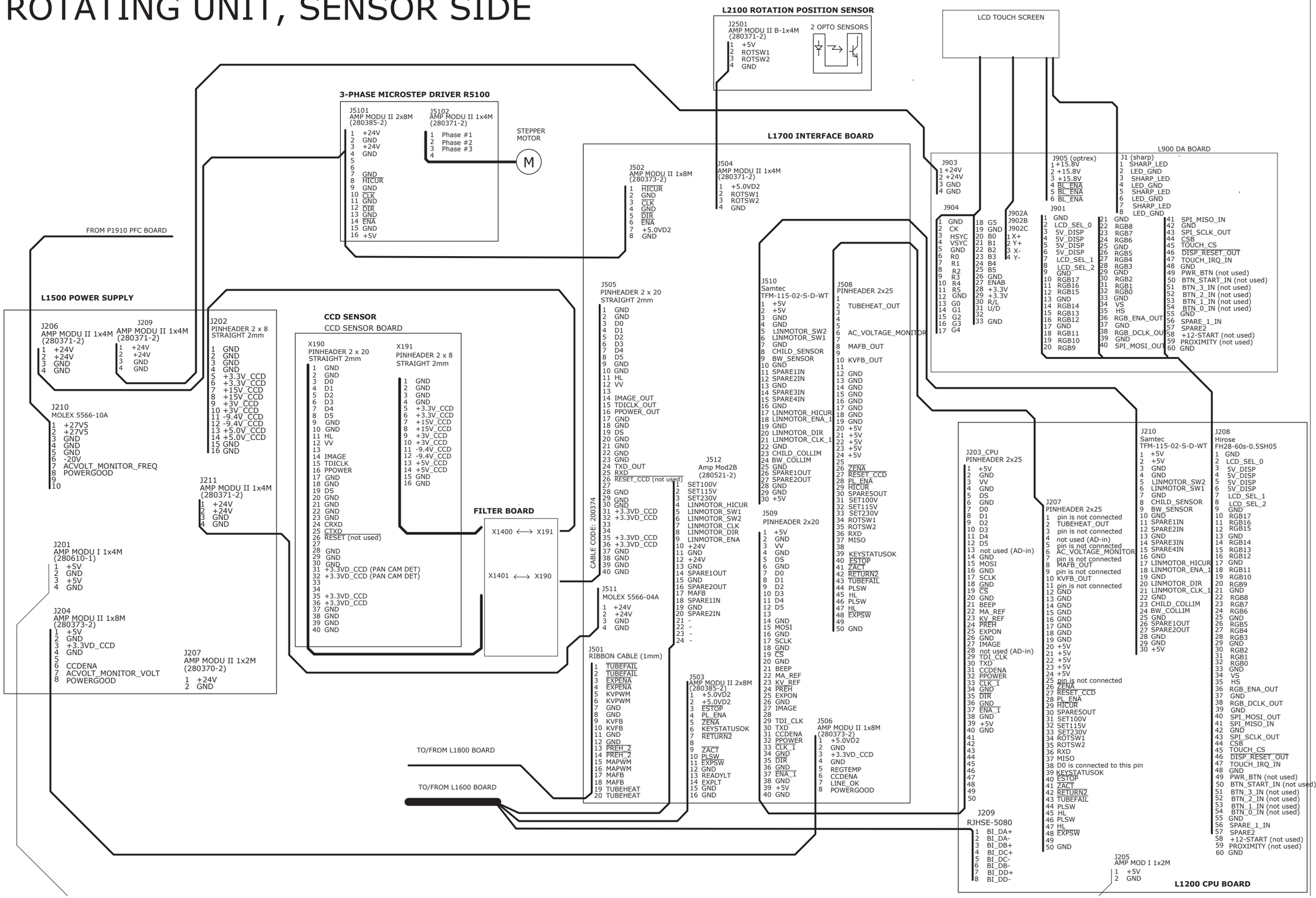
2.6 Wiring diagrams - overview



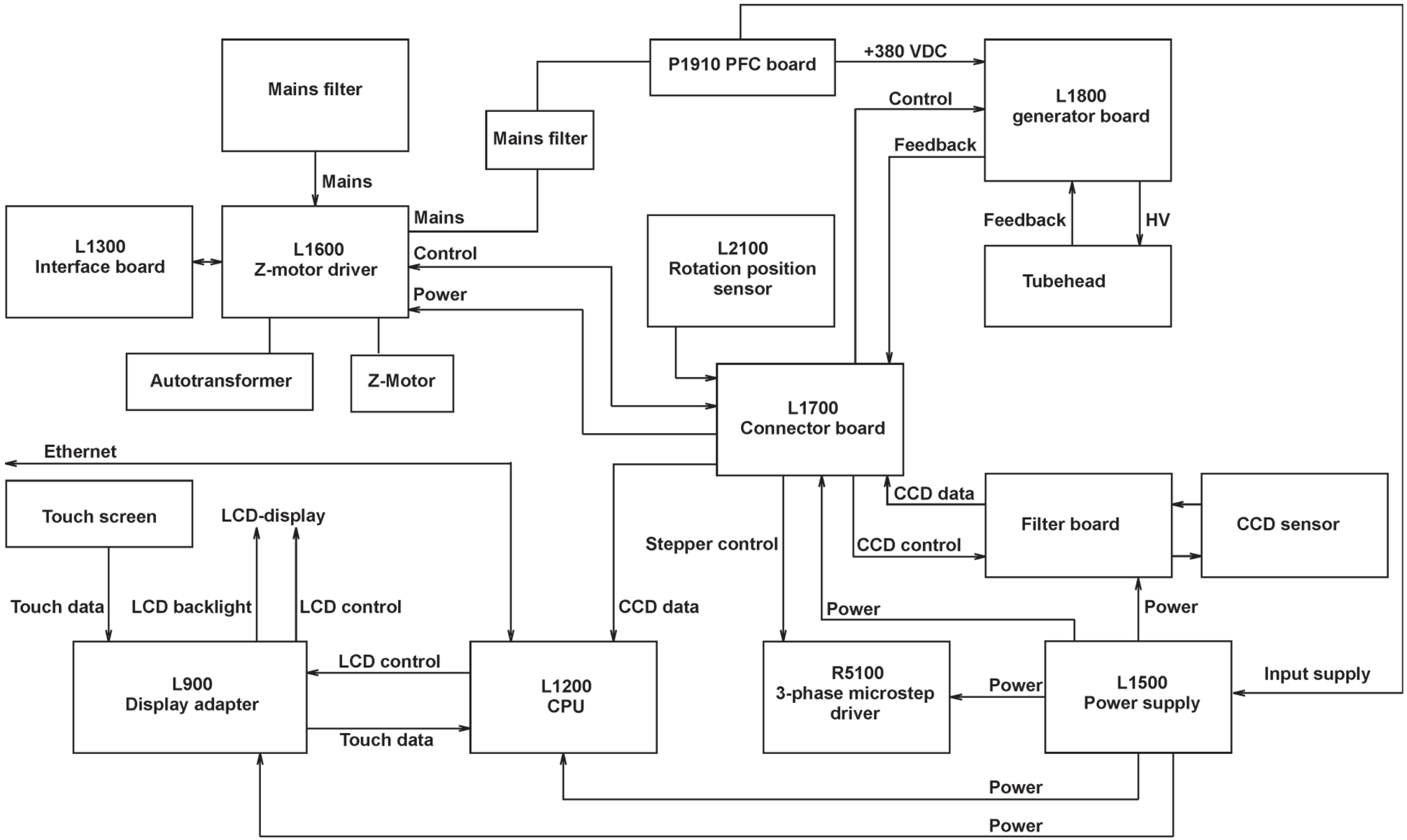
ROTATING UNIT TUBEHEAD SIDE



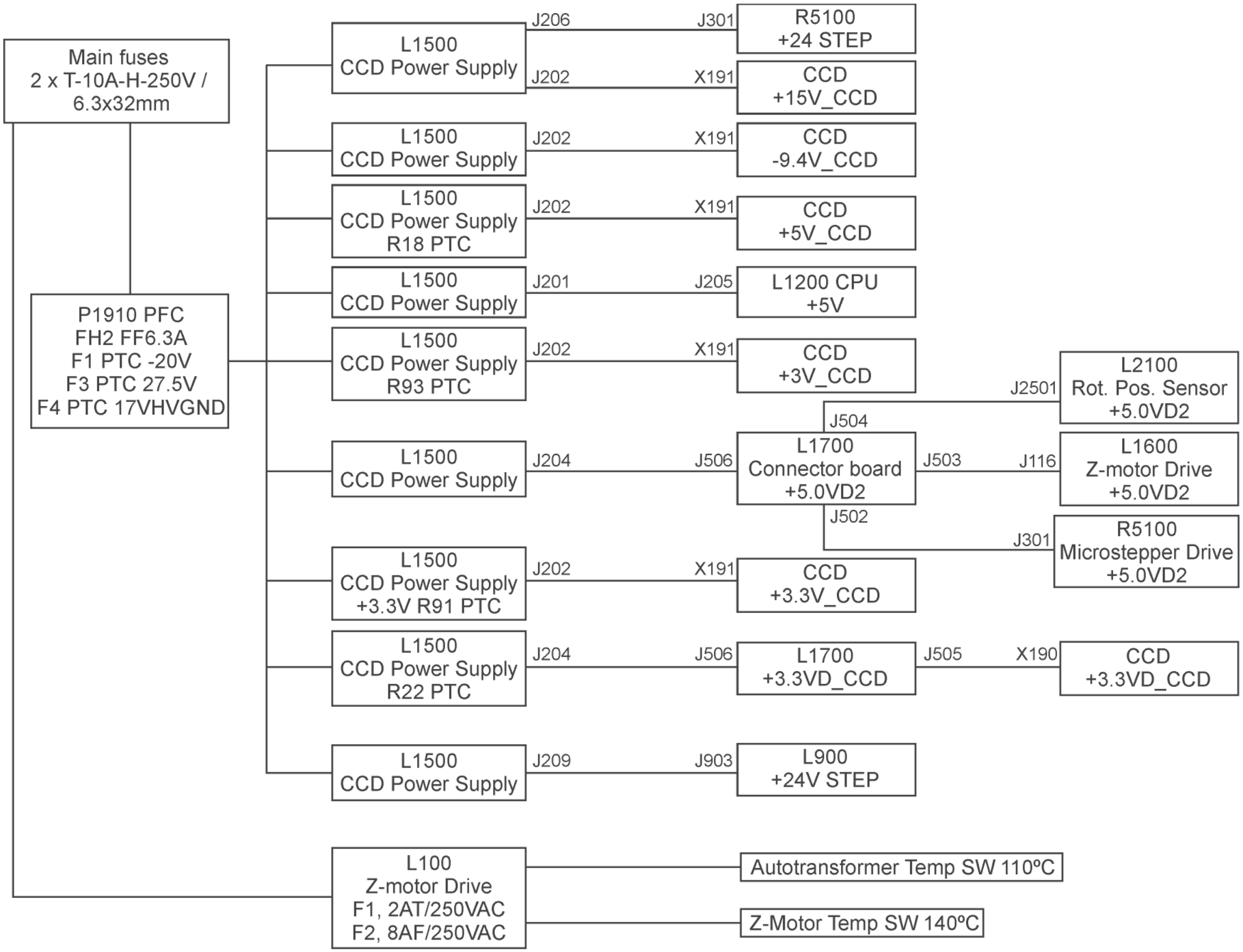
ROTATING UNIT, SENSOR SIDE



2.7 Block diagram



2.8 Fuse diagram



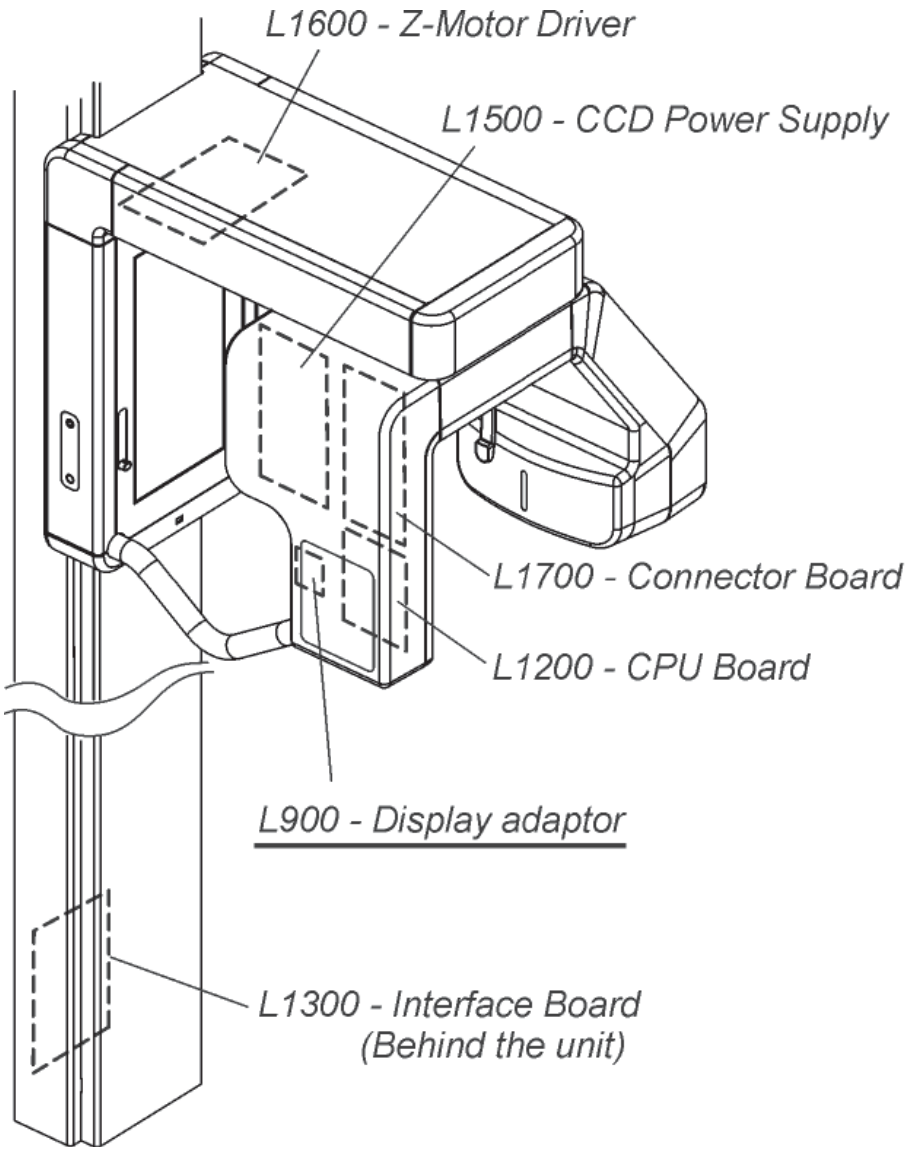
3. Circuit Boards

NOTE: An asterisk (*) after a signal name indicates an active low-level signal.

3.1 L900, Display adapter

L900 - Location

In the rotating unit on the CCD sensor side.
To access remove sensor external cover.



L900 - Field replaceable parts

None

L900 - Description

L900 is a display adapter/interface board that controls the display (touch screen interface). L900 reads touch screen data and sends it to L1200 CPU board via the SPI interface. L1200 CPU board drives the display data throught the L900 board.
L900 board produces supply voltages +3.3V for the display and +15.8V for the display backlight.

L900 - Indicator LEDs

LED	Colour	Indicates
H1	green	3.3V OK
H2	green	+15.8V OK
H3	green	+5V OK

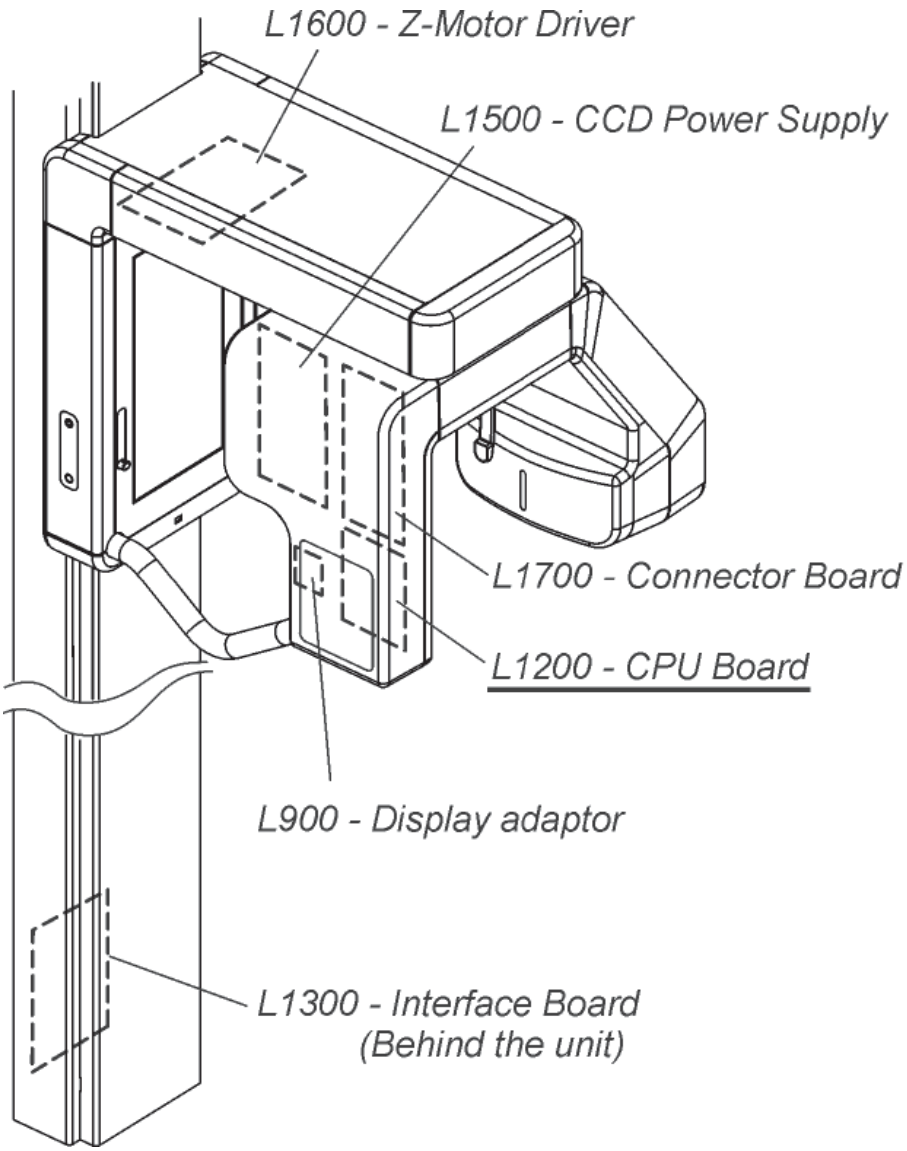
L900 - Test Points

None

3.2 L1200 CPU Board

L1200 - Location

In rotating unit on the CCD sensor side. To access remove the sensor external cover (see section 7.1).



L1200 - Field replaceable parts

None.

L1200 - Description

The CPU board controls the unit. It controls the rotation and Z movements, the operation of the X-ray tube and reads the signals from the touch panel. It uses an embedded microcontroller on an Altera Cyclone FPGA circuit. The board also has an Ethernet transceiver (for PC connection), I/O buffers, and a 14-bit A/D converter. The image data are saved in an SDRAM.

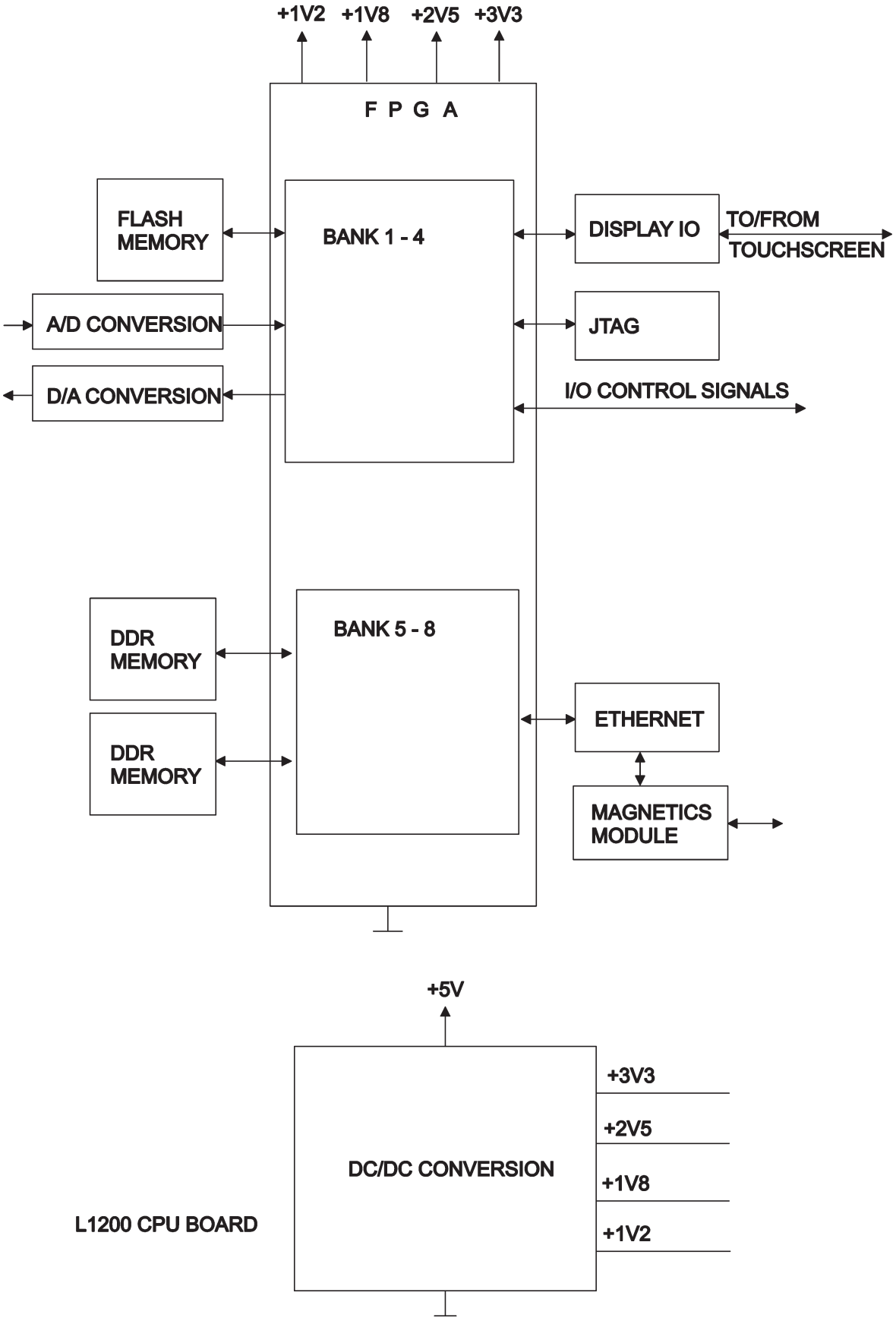
L1200 - Indicator LEDs

LED	Colour	Indicates
D6	green	+5V on
D8	green	Ethernet signal activity
D9	green	10-Base-T (10Mbit/s) in use
D10	green	100-Base-T (100MBit/s) in use
D11	green	1000-Base-T (1000MBit/s) not supported
D12	green	Full Duplex mode in use
D13	green	+1.2V
D14	green	+1.8V
D20	green	+5V
D23	green	+3.3V
TEST1	green	Flashing = Core functioning
TEST2	green	Flashing = Firmware functioning
TEST3	green	Flashing = Not currently used

L1200 - Test Points

None

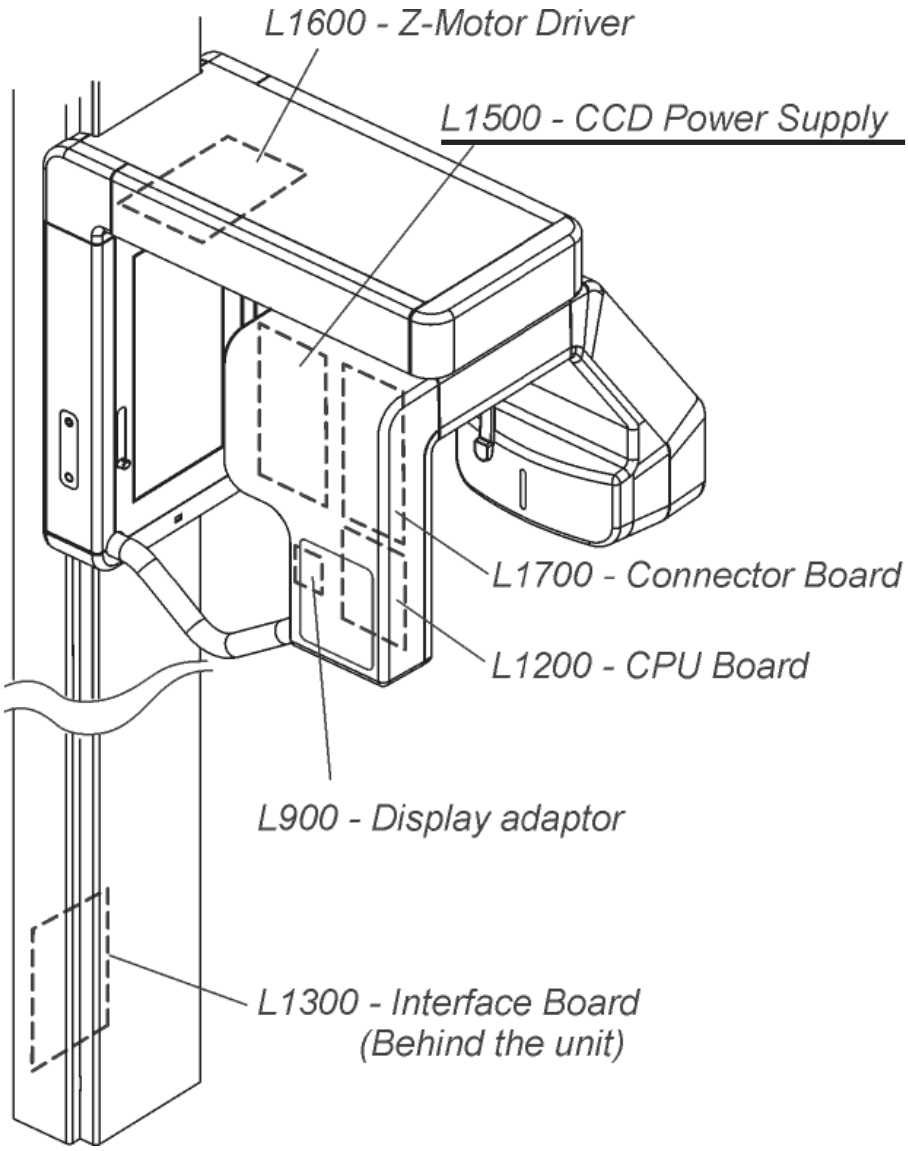
L1200 - Block Diagram



3.3 L1500, CCD Power Supply

L1500 - Location

In the rotating unit on the the CCD sensor side.
To access remove sensor external cover.



L1500 - Field replaceable parts

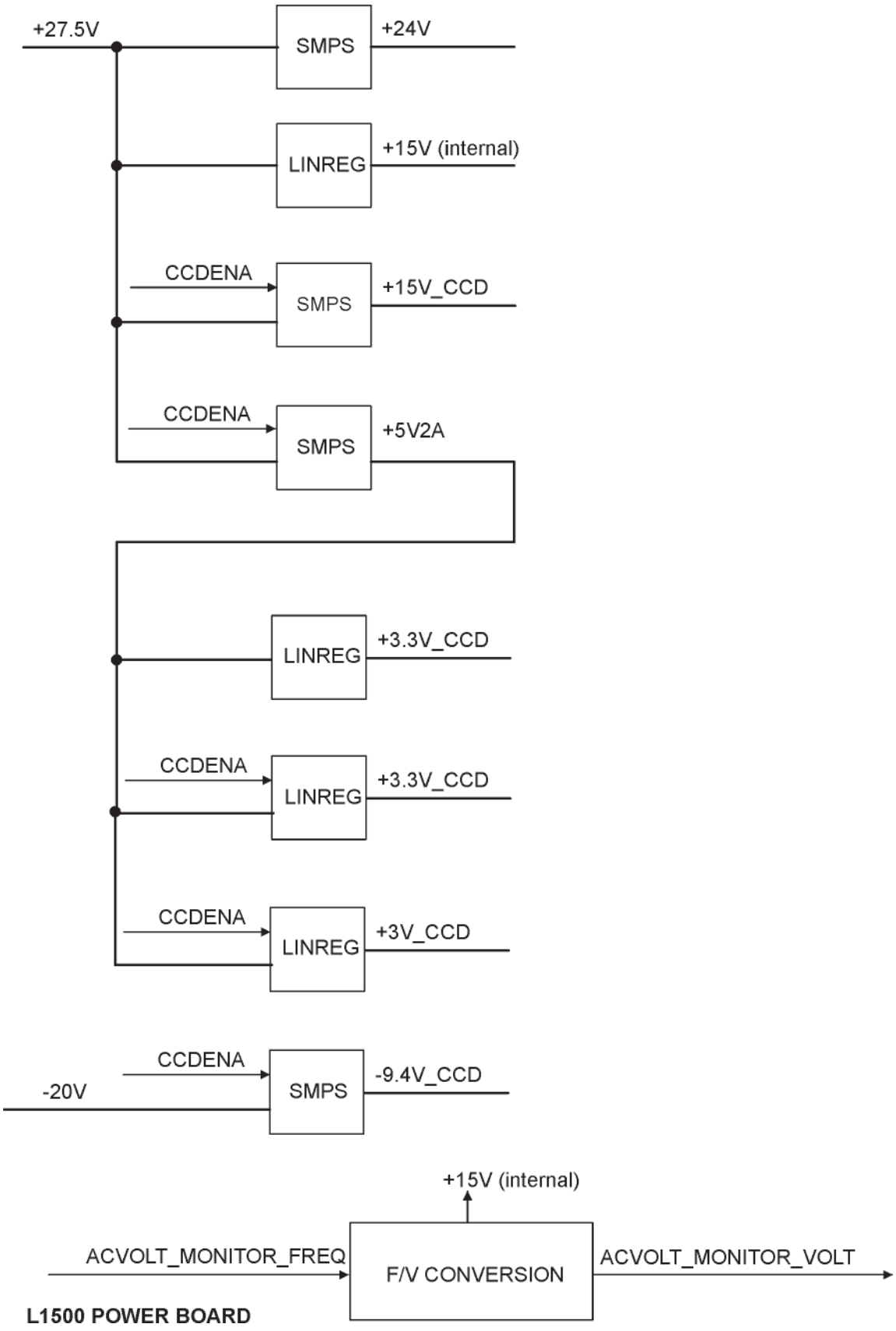
None.

L1500 - Description

L1500 supplies different voltages to most of the circuit boards in the unit. L1500 receives +27V5 and -20V from P1910 PFC and regulates these voltages to produce the other voltages that the unit requires.
The CCD sensor require +3.3V, +3.3V, +3V, +15V, -9.4V, +5V.
L900 and the 3-phase stepper motor require 24V.
L1200 and peripheral electronics require a regulated 5VDC power supply.

P1910 measures mains voltage. This value is converted to frequency signal and is then transferred to L1500 board. On L1500 board the signal is converted to DC voltage. This DC voltage is measured by AD-converters on L1200 CPU board.

L1500 - Block diagram



L1500 POWER BOARD

L1500 - Indicator LEDs

LED	Colour	Indicates
D8	green	+15V_CCD on
D9	green	+3.0V_CCD on
D10	green	+3.3V_CCD on
D12	green	+5V on
D13	green	+5.0V_CCD on
D14	green	-9.4V_CCD on
D16	green	+24V on
D17	green	+3.3V on

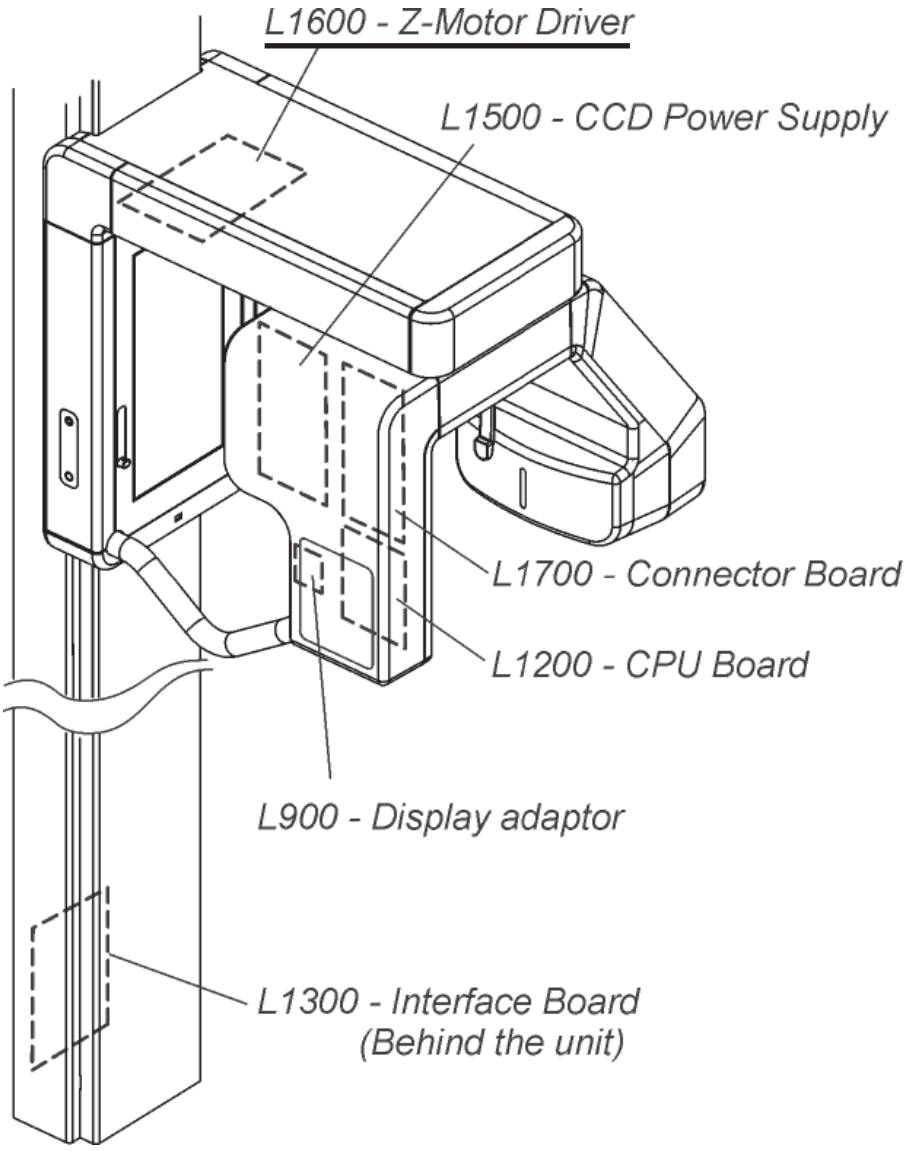
L1500 - Test Points

Number	Description	Value
TP1	+24V	+24V
TP5	CCDENA	5V on, 0V off
TP7	+5.0V	
TP8	+5.0V_CCD	
TP10	+3.3V	
TP11	+3.0V_CCD	
TP12	+15V	
TP15	U_IN	Between 1.3V and 3.5V
TP18	-9.4V_CCD	
TP25	GND (logic)	0V
TP40	+3.3V_CCD	
TP65	GND (logic)	0V
TP65	GND (logic)	0V

3.4 L1600, Z-Motor Driver

L1600 - Location

On the upper shelf.
To access remove shelf upper cover (see section 7.1).



L1600 - Field replaceable parts

NOTE:
The fuses used MUST be the approved type, UL listed and CSA certified.

Approved fuses:

Fuse F1
2AT/250VAC Cooper Bussmann MDL-2
2AT/250VAC Littelfuse 0313002 HXP

Fuse F2
8AF/250V Littelfuse 0312008 312 series
8AF/250V Cooper Bussman AGE

Dimensions 6.3 mm x 32 mm.

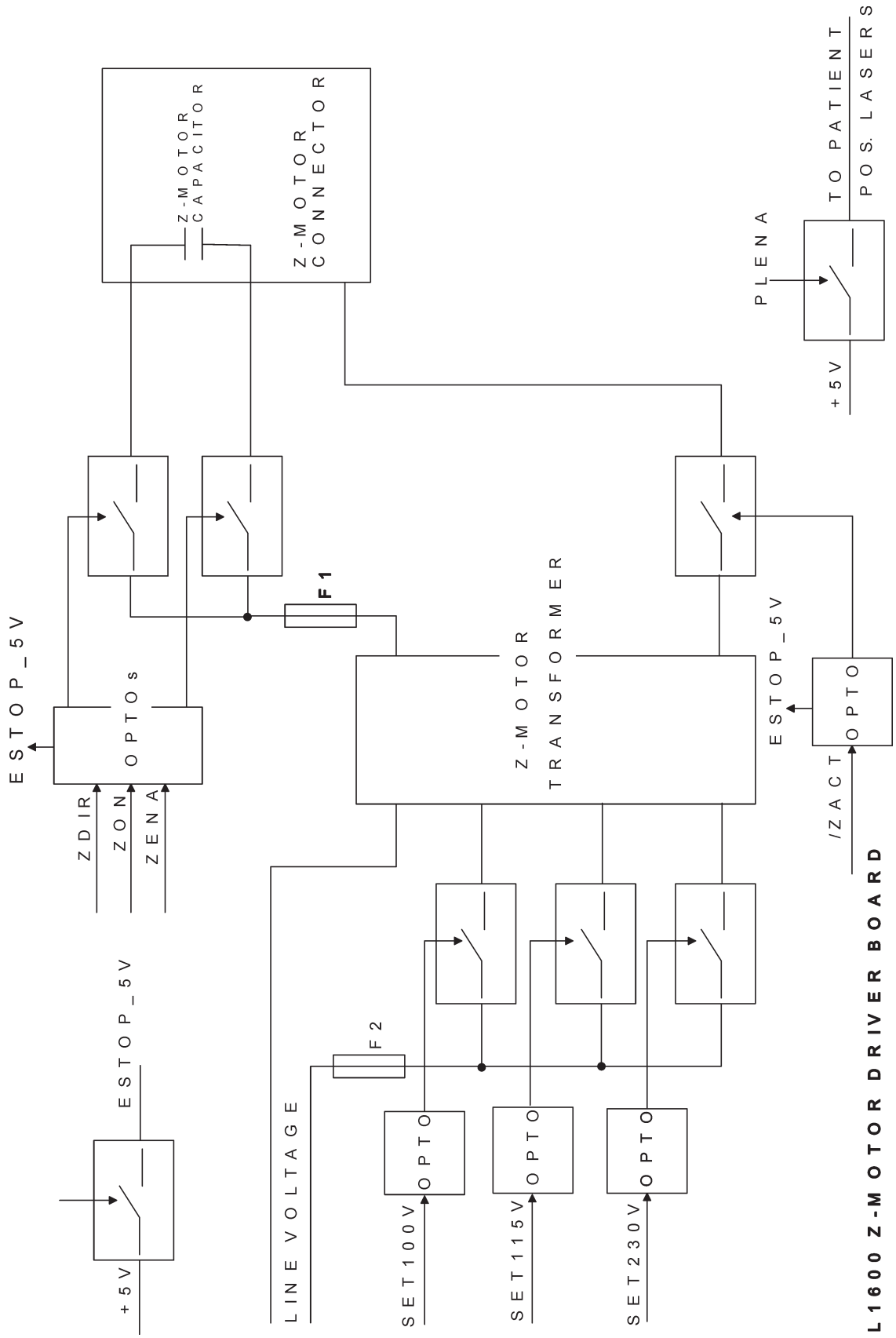
L1600 - Description

L1600 (Z-Motor Driver) controls the AC-motor that drives the unit up and down. Membrane switches on the side of the vertical carriage are used to activate the AC-motor.

Micro switches at the top and bottom of the column monitor the upper and lower positions of the Z-movement. Based on the logic on the circuit board, the movement of the AC motor is enabled or prohibited. Three triacs control the Z-motor currents. Outputs are opto-coupled from the user inputs with TLP3063 circuits. The board also includes light controls for the laser positioning lights.

L1600 also sets the autotransformer input winding. There are three SET signals, SET 100V, SET 115V and SET 230V that control what mains voltage goes to what input winding of the autotransformer.
The auto transformer output voltage is always 230 VAC

L1600 - Block diagram



L1600 - Indicator lamp

Lamp	Function	Indicates
LA1 GLIM	AC indicator lamp	L1600 receiving line voltage.

L1600 - Indicator LEDs

LED	Colour	Indicates
D1	green	+5V on
D2	green	ZACT-movement key pressed
D3	green	ZON on
D4	red	ESTOP on. Emergency stop button is on.
D5	green	SET 100V: autotransformer tapping enabled
D6	green	SET 115V: autotransformer tapping enabled
D7	green	SET 230V: autotransformer tapping enabled

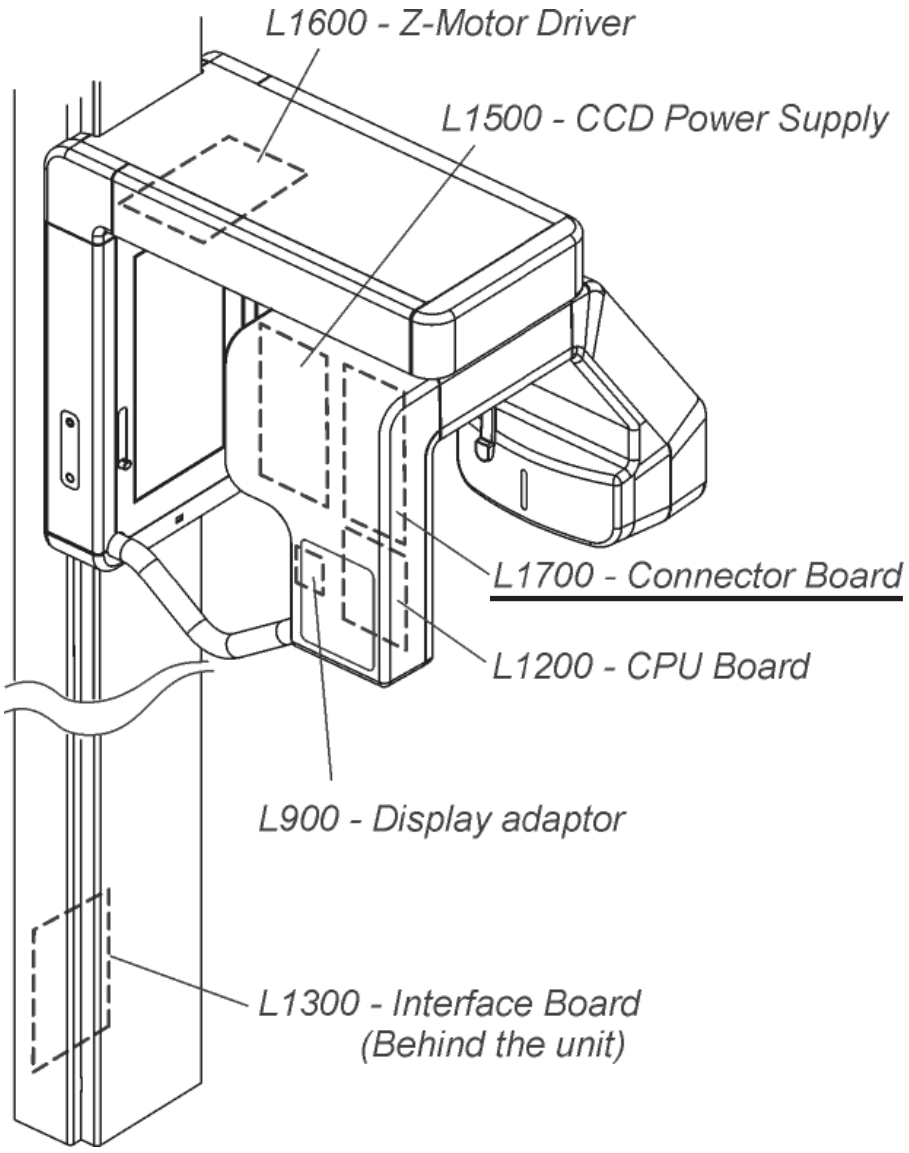
L1600 - Test Points

Number	Signal	Value
TP1	ESTOP_5V	+5V normally, 0 ... +0.5V when emergency button pressed down
TP2	ZDIR	0V driving up, +4.8V...+5V driving down
TP3	ZON	+3V when up/down key pressed, 0V when not.
TP4	+5V	+5V
TP5	GND	0V
TP6	ZACT*	0 ... +0.5 when up/down key pressed, otherwise close to +5V.

3.5 L1700 Connector Board

L1700 - Location

In the rotating unit on the the CCD sensor side.
To access remove sensor external cover.



L1700 - Field replaceable parts

None.

L1700 - Description

L1700 routes most of the signals to the other boards. L1700 receives signals from the tubehead (kVfb, mafb, and tubeheat) and scales the voltage swing (0…+5V) linearly to (1.25V…3.75 V) which is the input for the A/D converter on the CPU board. L1700 also includes external warning and ready light circuitry. The ESTOP signal enables stepper motor rotation and the exposure sequence.

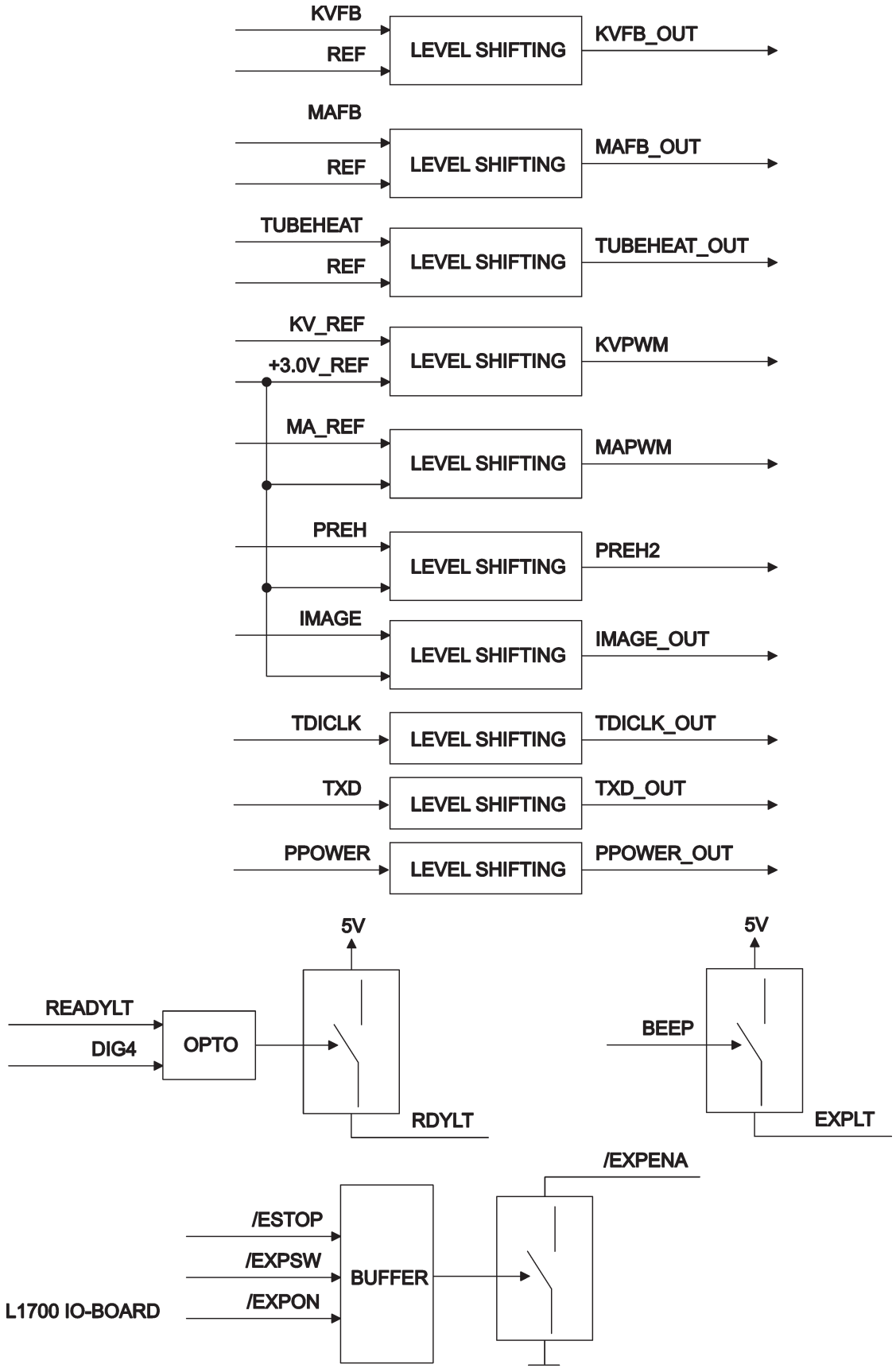
L1700 - Indicator LEDs

None.

L1700 - Test Points

Number	Description	Value
TP1	GND	0V
TP2	GND	0V

L1700 - Block Diagram



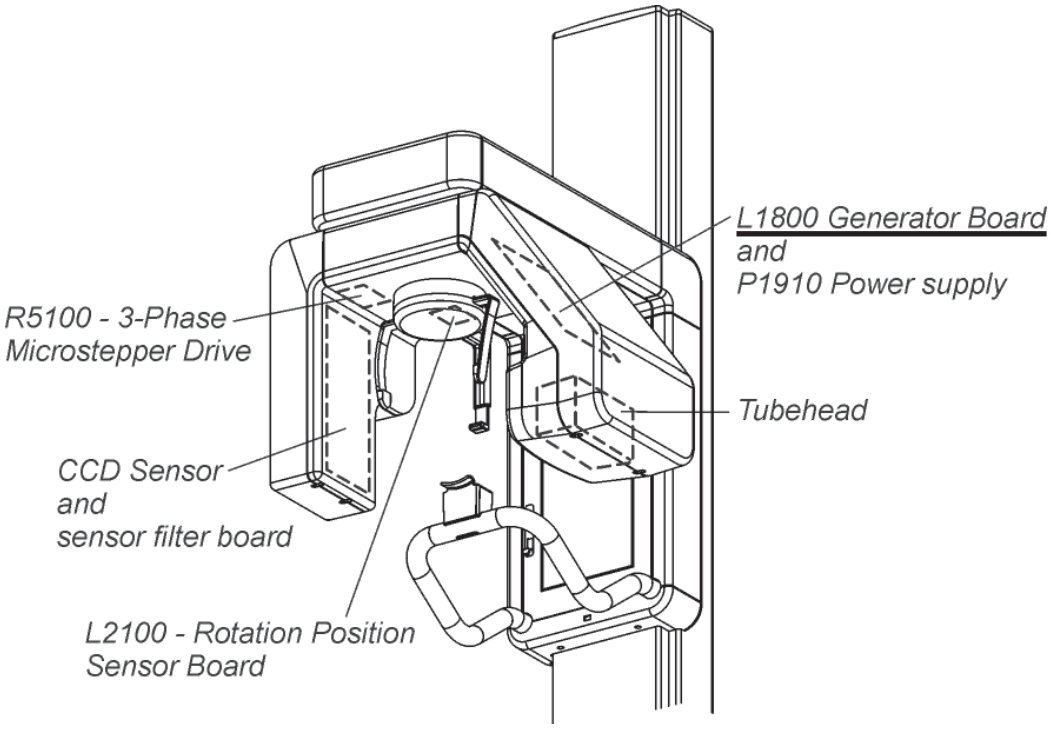
3.6 L1800, Generator Board

DANGER: HIGH VOLTAGE

WARNING:
Do not touch the Generator Board until the capacitors have discharged. After switching the unit off wait 10 minutes for the capacitors to discharge. When LED H1 goes out the capacitors are discharged.

L1800 - Location

In rotating unit on the tubehead side. To access remove the tubehead external cover (see section 7.1).



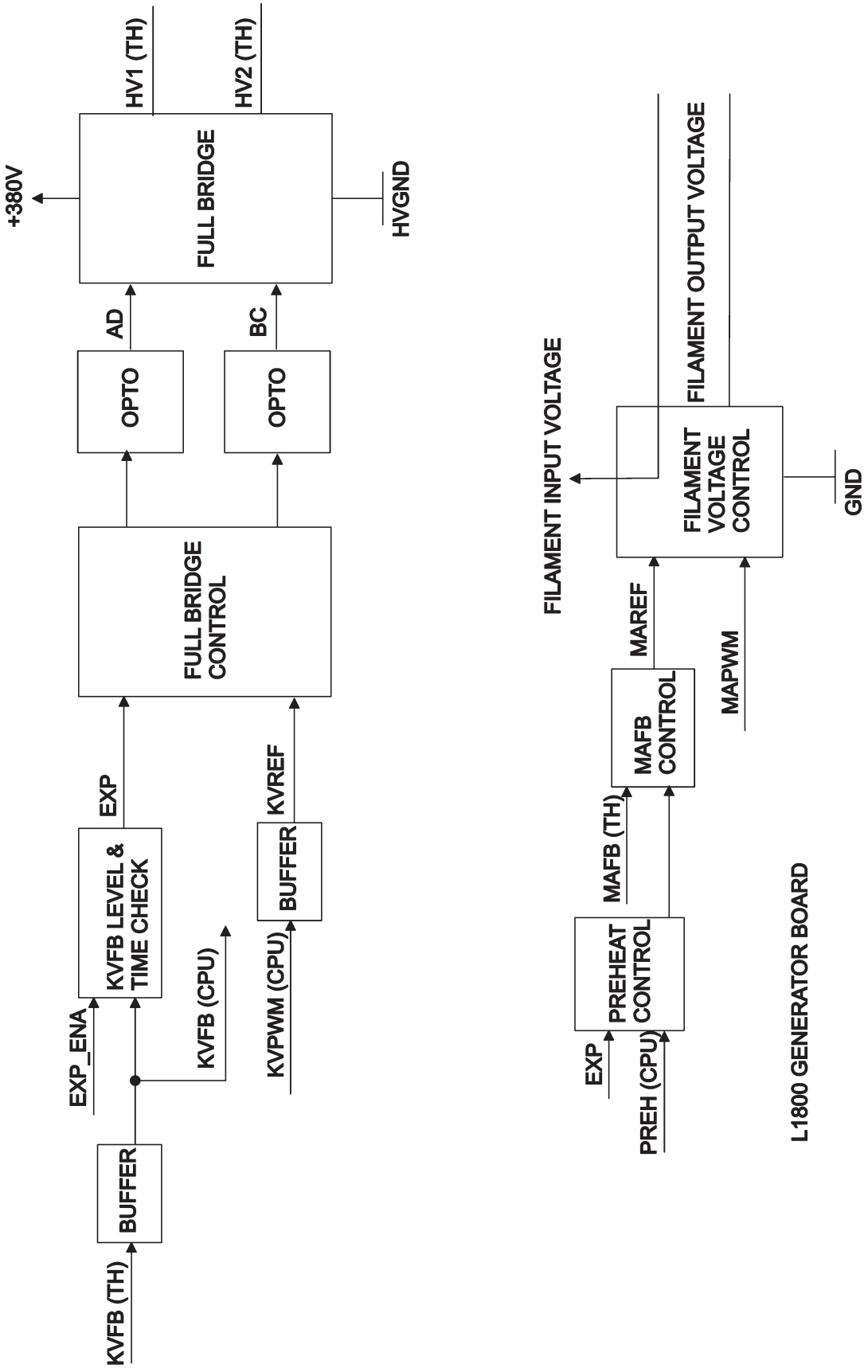
L1800 - Field replaceable parts

None

L1800 - Description

The Generator board receives kV and mA reference signals from L1200 as PWM modulated signal. Based on the kV-reference value, the Generator board generates the corresponding high voltage between the cathode and anode of the x-ray tube. Based on milliampere reference value, the generator board generates preheat current (to warm up the filament before x-rays are switched on) and filament current (during exposure). The Generator board receives kV and mA feedback signals from the tubehead that are used to monitor and adjust the generated values. The Generator board produces its own supply voltages.

L1800 - Block diagram



L1800 - Indicator lights

LED	Colour	Indicates
H1	green	+380V (capacitors charged)
H2	green	+15V
H3	yellow	Exposure
H4	red	Tube fail
H5	yellow	Preheat
H6	green	+15V_HVGND

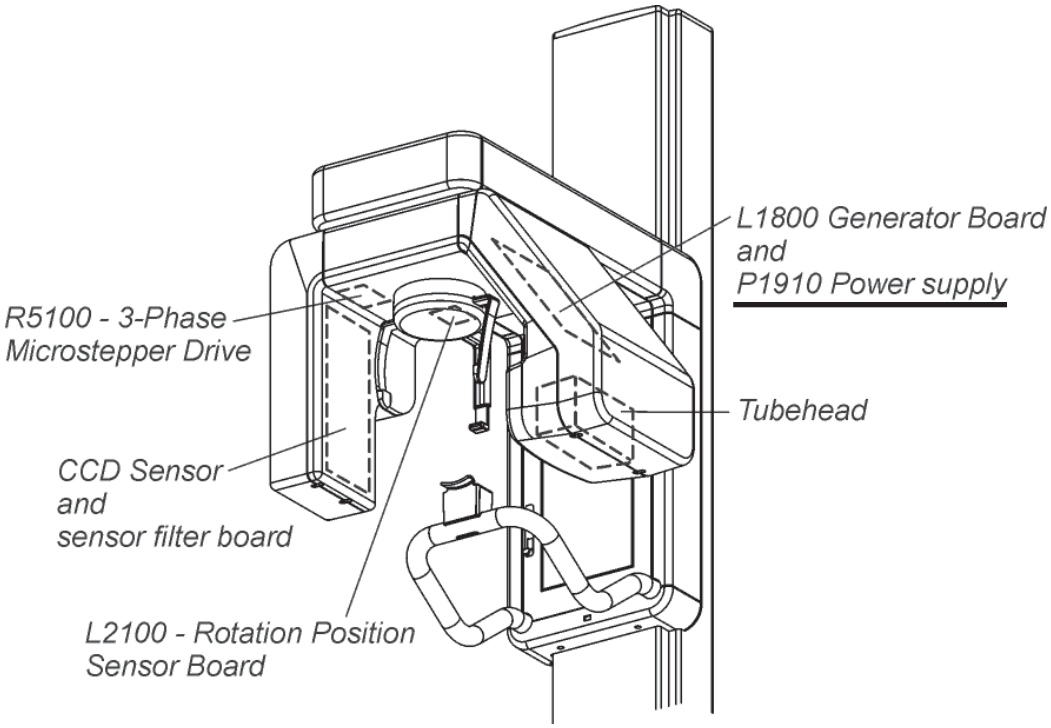
L1800 - Test Points

Number	Signal	Value
TP1		+27V5
TP2		+5V FILTERED MAPWM
TP3	GND	0V
TP4		+15V
TP5	-	NOT USED
TP6	-	NOT USED
TP7	HVGND	0V
TP8		+17V
TP9	VDD	+15V_HVGND
TP10	-	FILTERED KVPWM
TP11	mAref	Calibrated by the CPU
TP12	kVref	Counted from values: 1V=22kV
TP13	-	NOT USED
TP14	kVfb	Counted from values: 1V=22kV
TP15	EXPENA	on to enable off to disable
TP16	MAFB_INT	0.2V = 1mA
TP17	GND	0V
TP18	mAfb	0.2V = 1mA
TP19	Tubeheat	
TP20	-	J2 closed=25V (default); J2 open=20.7V
TP21	-	NOT USED
TP22	HVGND	Mains voltage side, ground
TP23	HV310	+380V (HVGND)

3.7 P1910, PFC Board

P1910 - Location

DANGER: High voltage on this board.
Do not touch this board when the unit is switched on.
There is high voltage on the large heat sink on this board when the unit is switched on.
Do not touch this board until the capacitors have discharged. After switching the unit off wait 10 minutes for the capacitors to discharge.



P1910 - Field replaceable parts

Fuse FH2: SIBA FF6.3A 70 125 40. 6.3A

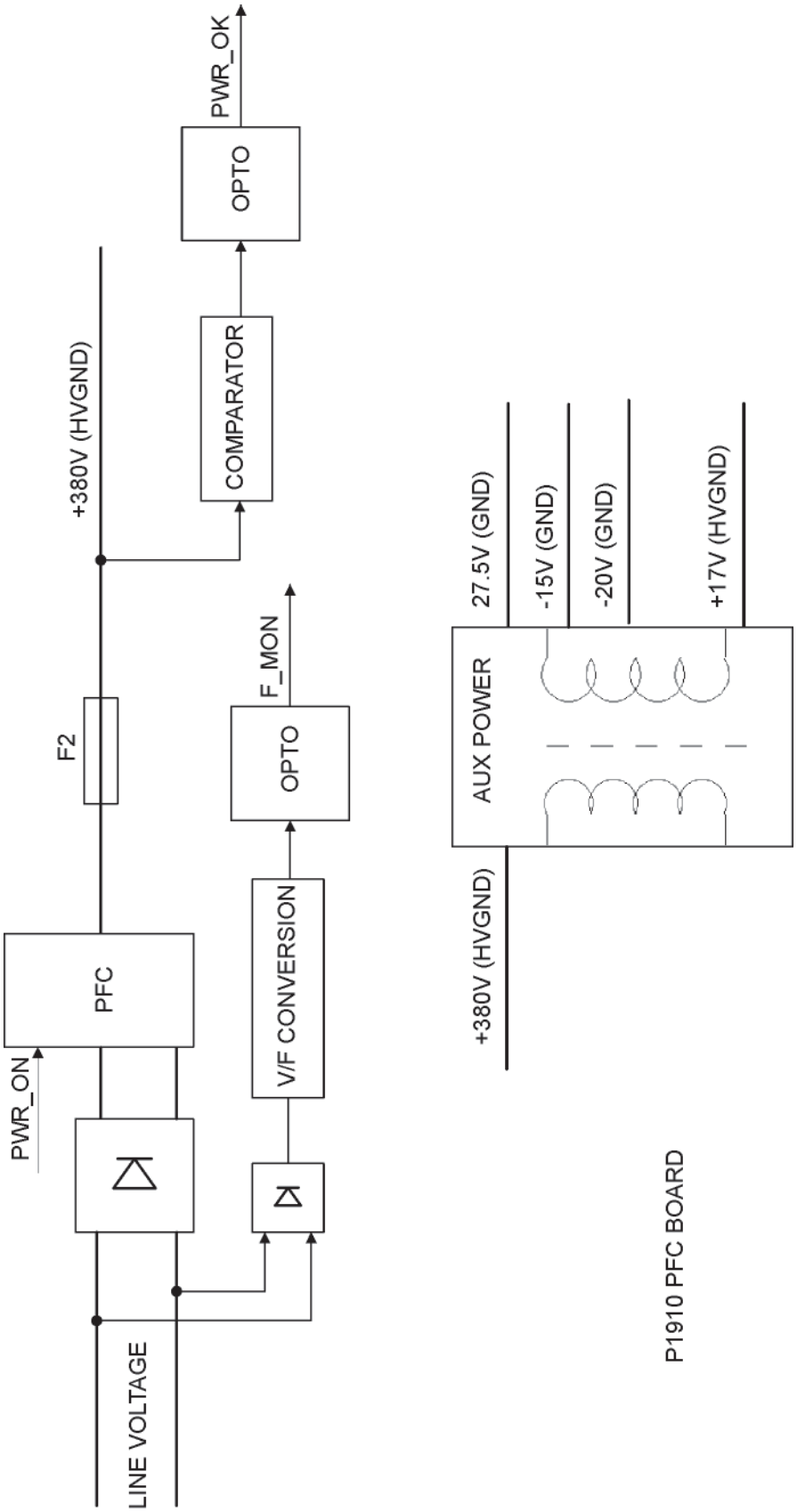
P1910 - Description

The P1910 PFC (Power Factor Correction) power supply board generates the supply voltages for the unit. This board works with mains voltages between 100VAC to 240VAC, 50/60Hz.
The board produces the +380Vdc for the generator board. The board also has auxiliary flyback converter that produces the lower raw voltages for the L1500 power supply board.

The major features of the board:

- the supply voltages do not depend on the line voltage (PFC)
- it supplies voltages +380VDC and +17VDC (against HVGND)
- it supplies voltages +27.5VDC, -15VDC and -20VDC (against GND)
- it monitors the line voltage (FMON) and PFC middle circuit voltage (PWR_OK)

P1910 - Block diagram



P1910 - Indicator LEDs

LED	Colour	Indicates
A5	green	+380V
A8	green	+27V5
A9	green	+20V
A10	green	17V_HVGND
A15	green	-15V

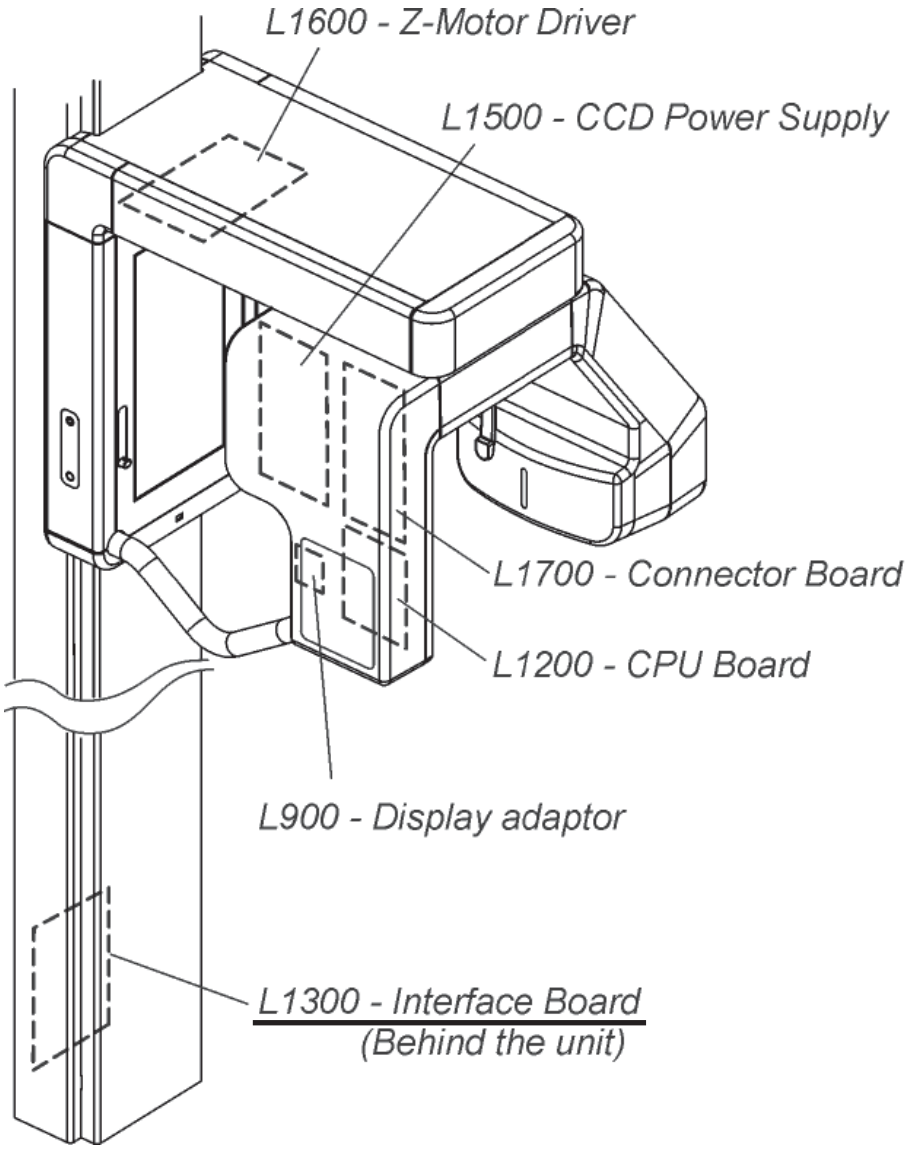
P1910 - Test Points

None

3.8 L1300 Interface Board

L1300 - Location

At the rear of the column near the base.



L1300 - Field replaceable parts

None.

L1300 - Description

L1300 serves as an external interface to the outside environment. The exposure button and the remote exposure button are connected to this board.

L1300 - Indicator LEDs

None.

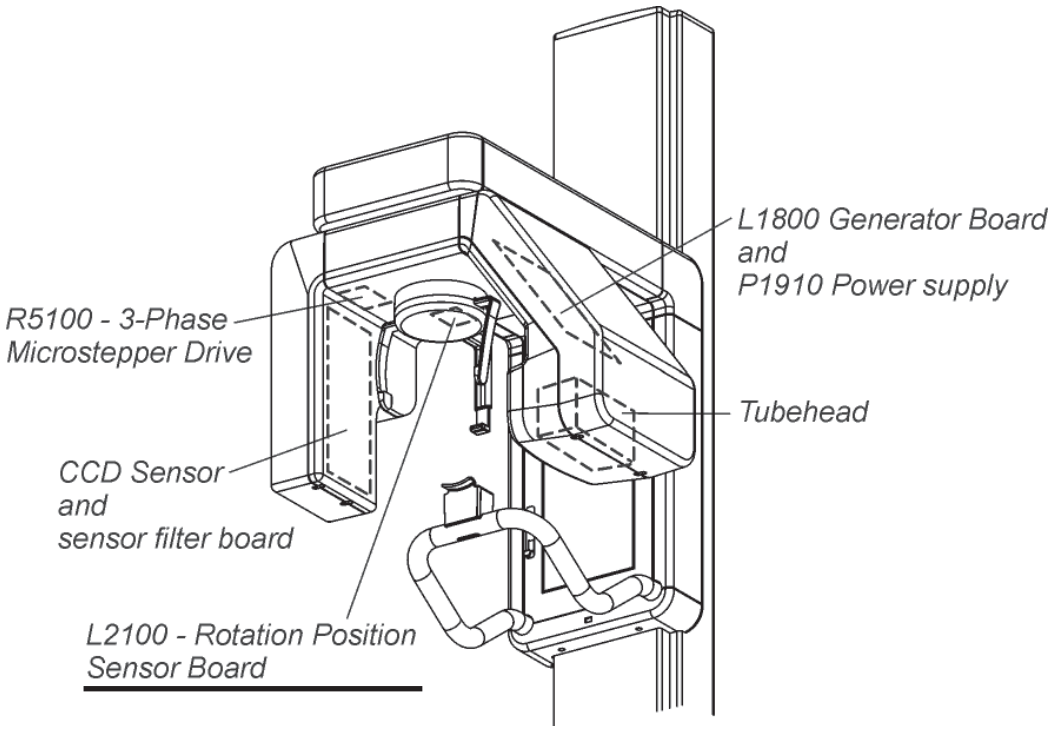
L1300 - Test Points

None.

3.9 L2100 Rotation Position Sensor Board

L2100 - Location

Inside the rotating unit under the head support. To access, remove the head support and then the lower protective cover (see section 7.1).



L2100 - Field replaceable parts

None.

L2100 - Description

L2100 is used to detect the position of the rotating unit. L2100 has two optical switches that generate sensor signals ROTSW1 and ROTSW2 according to which position is activated.
L2100 includes a transmitter LED, and a receiver, or base. The sensor signals remain on as long as the base receives light from the LED. When the light to the base is cut off by the positioning rail, the sensor signal is switched off.

L2100 - Indicator LEDs

None.

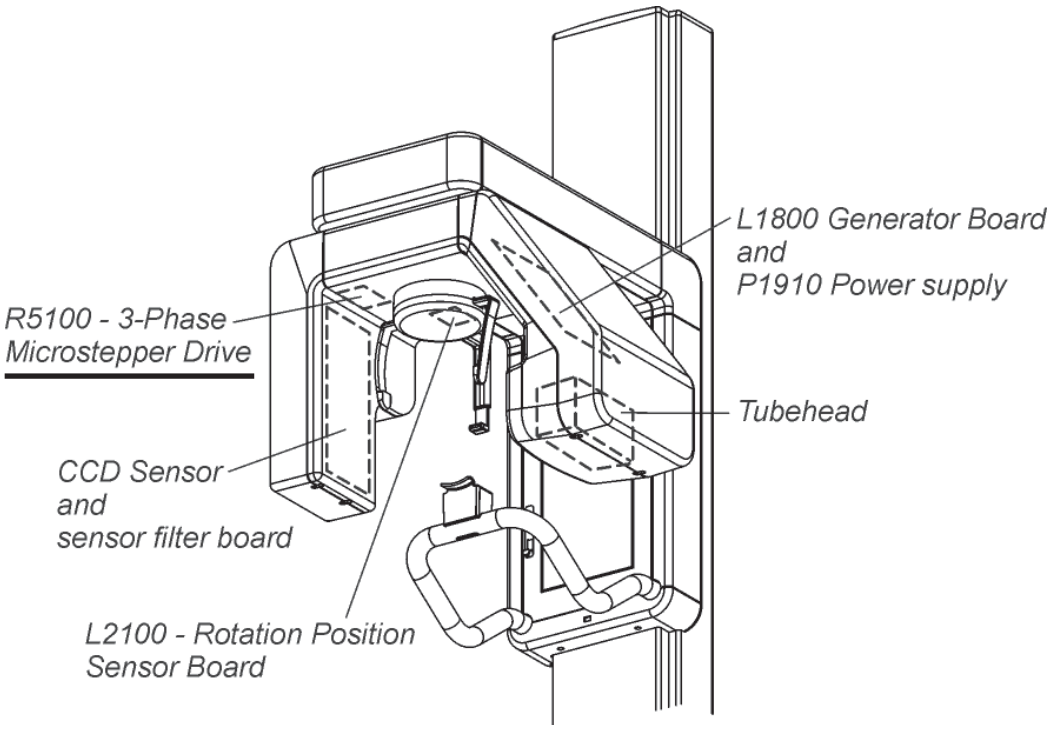
L2100 - Test Points

None.

3.10 R5100, 3-Phase Microstepper Driver

R5100 - Location

Inside the rotating unit, above the head support. To access, remove the head support, lower protective cover (see section 7.1).



R5100 - Field replaceable parts

None.

R5100 - Description

R5100 controls the 3-phase stepper motor that drives the Rotating Unit. The board receives in three control signals: clk, dir, and ena. It produces phase voltages for the stepper motor windings.

R5100 - Indicator LEDs

LED	Colour	Indicates
D1	green	+5V on
D2	green	+24V on

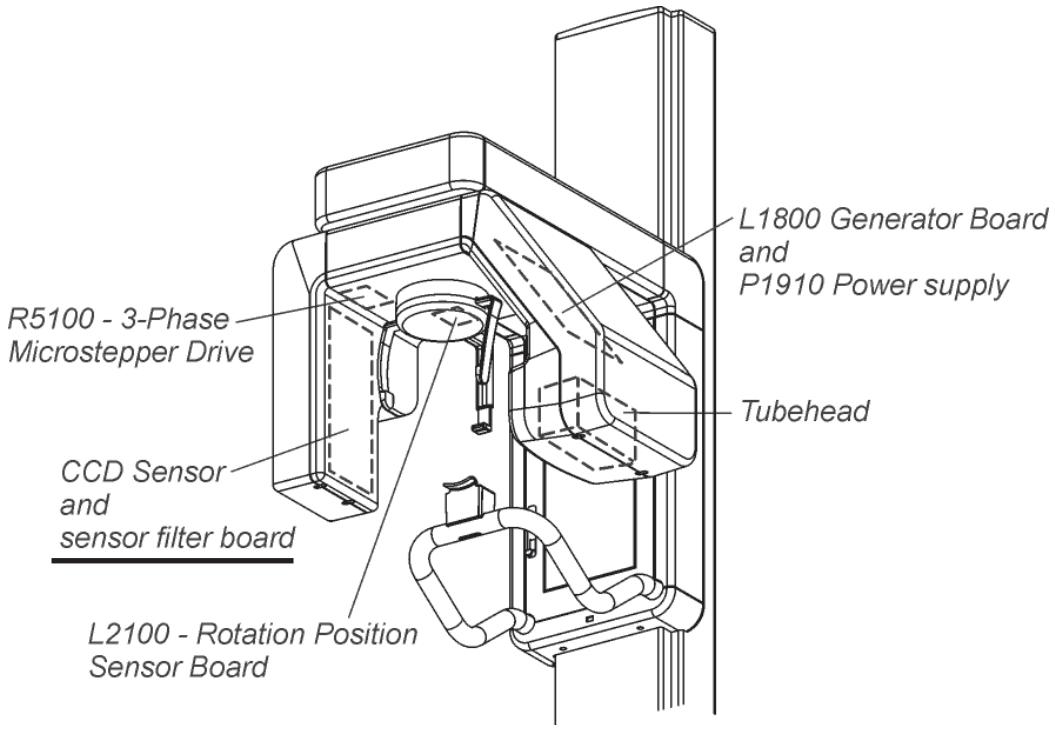
R5100 - Test Points

Number	Description	Value
TP1	GND	0V
TP2	VREF	0.97V ±0.1V; when HICUR* = '1' 1.95V ±0.1V; when HICUR* = '0' (default value)
TP3	CLK	+5V freq <15kHz
TP4	ENA	+5V active, 0V idle
TP5	DIR	+5V when idle or when moving to the PIO position. 0V when driving to end position.
TP6	PGND	0V

3.11 CCD Sensor / Filter board

CCD / Filter - Location

In rotating unit. To access, remove the sensor inner cover (see section 7.1).



CCD - Field replaceable parts

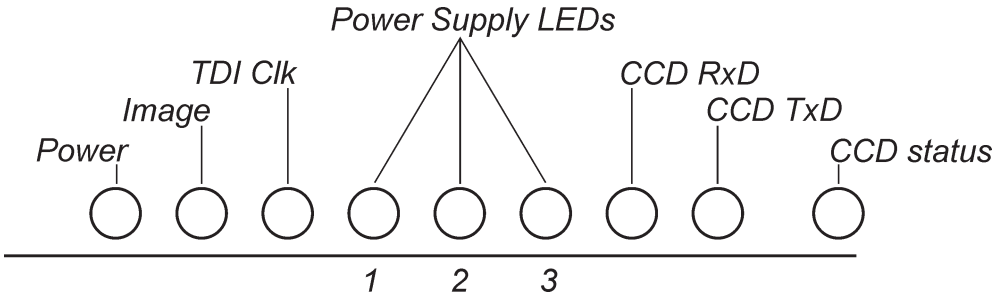
None. Inside the CCD Sensor there is the CCD Sensor board. The board cannot be accessed.

CCD - Description

CCD sensor converts X-ray radiation to visible light and and then the CCD semiconductor chips measure the intensity of the visible light. The analog signal is A/D-converted and sent in parallel data lines to the CPU board.

CCD - Indicator lights

Remove the covers from the CCD side of the rotating unit On the rear of the CCD sensor there are a number of LEDs that indicate the status of the CCD sensor.



LED	Colour	Indicates
Power	Yellow	Indicates that the power signal is active.
Image	Yellow	Indicates image signal activity. It tells the CCD sensor A/D-converter to sample image data according to the TDI frequency.
TDI Clk	Yellow	Indicates that the clocking frequency of the CCD is available.
	Off	TDI frequency is between 0...50Hz.
	On	TDI frequency is between 100 Hz...1kHz.
	Flashing	TDI frequency is between 50...100Hz or above 1kHz.
Power Supply		Indicate the different voltages required by the CCD sensor. The microcontroller in the CCD sensor monitors the voltages and activates the LEDs accordingly. There are software set limits for the various supply voltages. The LEDs come on during image capture.
1	Yellow	+3.3V and +1.8V LEDs Supply voltages for the CCD clock controlling FPGA. The +3.3V is generated by L1500. The +1.8V step down is generated in CCD sensor board from +3.3V. LIMITS: +3.3V between +3.0 and +3.6V. +1.8V between +1.71V and +1.89V.
2	Yellow	Analog +5V LED. Supply voltage for AD-converters. LIMITS: between +4.5V and +5.5V

3	Yellow	+15V, +3V and –9.4V LED CCD gate voltages LIMITS: +15V between +13.5V to +16.5V +3V between +2.4V and +3.6V -9V between -9.92V and -9.17V Another required voltage is µC +3.3V. It is used to power the microcontroller, +3.3VD_CCD.
CCD TxD and CCD RxD		
	Yellow	Serial communication. In normal operation they flash intermittently. They indicate communication activity. If CCD RxD is off (passive CCD sensor), CCD TxD will also be off. **NOTE:** If CCD TxD is off, CCD RxD is on and the CCD status LED flashes during and after image capture it indicates that the CCD sensor tried to receive the image, but the transmit communication routine failed.
CCD Status	3-color	It indicates that the CCD is connected, all the software has been downloaded and it is ready to take an image.
	Green	Stand-by mode.
	Yellow	Image capture mode (power on).
	Red	In position but not yet ready, SW is being loaded.
	Red flashing	Fatal SW error / communication routine failure after an image has been taken. If this happens, switch the unit off for 10 seconds and then switch the unit on again.

Filter - Field replaceable parts

None.

Filter - Description

Sensor filter board is a low pass type RF-filter board which filters electromagnetic interference (EMI) from all CCD-signal and and power supply lines.

Filter - Test Points

None.

4. Troubleshooting

4.1 Initial checks

Restarting the unit

If the unit fails to operate, does not operate correctly or if an error code appears, switch the unit off, wait for a few seconds and then switch the unit on again. If the unit still does not operate correctly or the error message reappears, follow the troubleshooting procedures described here to correct the problem.

If there is a problem with image transfer, close and reopen the dental imaging software and/or restart the PC.

Error Codes

If the unit malfunctions or if it is used incorrectly an error code will appear on the main control panel.
There are two categories of error code:

- **H**, user errors, and
- **E**, system errors.

When an error code appears on the display the unit will stop working. The unit cannot be operated while the error code is on the display.
To clear an error code from the display, correct the error and then press any key on the main control panel (NOT the side control panel).
NOTE:
Error E18, display failure can only be seen on the service assistant.

Checking circuit boards

Circuit boards cannot be repaired in the field. On some boards some fuses can be replaced. But, if a board is faulty, replace it.

On most of the circuit boards there are indicator LEDs, that allow the operation of the board to be monitored, and test pins (TP), that allow the operation of the board to be checked. LED and test pin descriptions for each circuit board are in the section 3 Circuit Boards.
Use a digital multimeter (DMM) when checking boards.

Checking cables and connectors

Visually check cables for mechanical damage, cuts, damaged insulation and twists. If a cable is damaged in any way replace it.

If there is no obvious mechanical damage to a cable but you think that it may be faulty, use a digital multimeter (DMM) to check the resistance of the different wires within the cable. An undamaged wire will have close to no resistance (>0 ohm), a damaged wire will have a high resistance value.

Make sure that all cables are correctly and securely attached to their respective connectors. Connectors must not be loose or misaligned. If the connector has a locking mechanism make sure that it is locked.

If you find a loose or misaligned connector, disconnect it and check for bent, broken or missing pins. If there is damage that can be easily repaired, for example straightening a bent pin, repair the damage and reconnect the connector. If the damage cannot be repaired replace the cable.
Note that if the connector on the board is also damaged, the board may also have to be replaced.

Power supply problems

Power supply problems are described in section - **4.2 Problems during start up**.

4.2 Problems during start up

Nothing happens when the unit is switched on

The on/off switch light does not come on.

CAUSE A
Power cut.
SOLUTION A
Check to see if the power has been cut off.

CAUSE B
Unit not connected to the main power supply
SOLUTION B
Make sure that the unit is connected to the main power supply. Check the condition of the power supply cable. If it is damaged, replace it.

CAUSE C
The main fuses (2) have blown.
SOLUTION C
Disconnect the main power supply cable from the unit and then replace the main fuses (2). They are located below the main power supply cable at the rear of the column.
The fuse ratings are stated in chapter **2.5 Electrical description - Main fuses**

The on/off switch light comes on but the display does not come on.

CAUSE A
L900 (Control panel) is not receiving power or is faulty.
SOLUTION A
Check the supply of power to L900. Power is routed to L900 as follows:

1. Mains power is supplied to **L1600 (Z-Motor Driver**.
   If L1600 is receiving power lamp LA1 (on L1600) will be on.
   If it is not, check the cables and connectors between the on/off switch and L1600 (J105 and J106) and replace the cables if they are faulty.
   If the cables are okay, replace L1600.

2. L1600 (Z-motor driver) supplies mains voltage to the P1910 (FPC board) via a filter.
   Check that LEDs
   A5 = +380V,
   A8 = 27V5,
   A9 = -20V,
   A10 = +17V
   and A15 = -15V on P1910 are on.
   If they are not on check fuse FH2, and replace if blown.
   If the fuse is not blown check and if necessary replace the cables between L1600 and the filter and between the filter and P1910.
   If the LEDs on P1910 still remain off, replace P1910.

   If the P1910 LEDs are on but the display is not working, check the LEDs on L1500 (Power Supply Board). LED:
   D8 = +15V on when CCDENA is active
   D9 = +3V on when CCDENA is active
   D10 = +3.3VD on when CCDENA is active
   D12 = +5V, must be on
   D13 = +5V on when CCDENA is active
   D14 = -9.9V on when CCDENA is active
   D16 = +24V, must be on
   D17 = +3.3V, must be on

   Test jumper J23 can be used to set on CCDENA; Open=default, closed=CCDENA enabled

   If the LEDs do do not function as described above, check the cable between P1910 and L1500. Replace if faulty.

3. L1500 supplies 24V to L900. At normal state, the leds burn when 24V voltage is connected to L900. H1 is +3.3V indicator led, touch controller ic powered with +3.3V. H2 is +15.8V indicator led for LCD backlight voltage(OPTREX T-55265GD057J-LW-CAN not default).
   Check that LED H1 is on (green). Check that LED H2 is on (green). If LEDs H1 and H2 are not on replace L900.
   H3 is on (green) as the +5V comes from L1200 (CPU board).

4. Check the cables between L900 and the LCD-display. If the cables are okay, replace LCD-display. Check the cable between L900 and L1200, replace if faulty.

CAUSE B
The display backlight power level has been set to OFF.
SOLUTION B
Use the service terminal to change the display backlight power level.

Error E3 (CFG Data lost)

CAUSE
L1200, CPU board, has lost the calibration data and settings.
SOLUTION
Recalibrate L1200, see **5. Service Assistant and Service Functions**.
The required calibrations are:
- IP address will default, must be reset if another address is required (see installation manual)
- tubehead calibration: service command "calib"
- line voltage calibration
- set the serial number

If the error message reappears after recalibration, L1200 is faulty. Replace, see **7.5 Replacing circuit boards**.

Error E5 (Line voltage out of limits)

CAUSE A
Line voltage to high or low.
SOLUTION A
The error code will clear automatically when the voltage returns to its normal level.
If the voltage is not stable where the unit is being used, you may have to instal a voltage stabilizer.

CAUSE B
Line voltage has not been calibrated.
SOLUTION B
Calibrate the line voltage.

CAUSE C
Faulty cable(s).
SOLUTION C
Check cables and connections between
P1910 and L1500
L1500 and L1700
L1700 and L1200.
Replace any faulty cables or boards with faulty connectors.

Error E8 (File system failure)

CAUSE
GUI graphics are corrupted.
SOLUTION
Update the GUI graphics.

Error E16 (Z lift not allowed due to duty cycle)

CAUSE
Z-motor over heated.
SOLUTION
Allow motor to cool down.

Error E18 (Display not connected)

Check Service Assistant for information about this error code

CAUSE A
Cable from L1500 to L900 faulty.
SOLUTION A
Replace cable.

CAUSE B
L1500 faulty.
SOLUTION B
Replace L1500.

CAUSE C
Cable between L1200 and L900 faulty.
SOLUTION C
Replace cable.

CAUSE D
Cable between L900 and LCD display faulty.
SOLUTION D
Replace cable.

CAUSE E
L900 faulty.
SOLUTION E
Replace L900.

CAUSE F
LCD display is faulty.
SOLUTION E
Replace LCD display.

Error E19 (Exposure switch stuck down)

CAUSE
Exposure switch stuck down during unit start up.
SOLUTION
Switch the unit off and check that the exposure switch is not stuck in the exposure position. Switch the unit on again. If the message reappears, the switch is faulty, replace.

Error E20 (PCF: POWERGOOD signal is down)

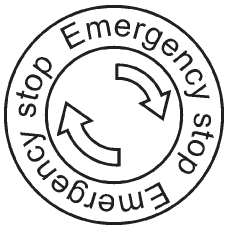
CAUSE
No power signal.
SOLUTION
Check to see if the signal is present on L1500.
If the signal is not present, replace P1910.
If signal is present, the fault could be in the signal routing. Check signal on L1500, L1700 and L1200 and in the relevant cables. Replace any faulty boards or cables.

Error E22 (Button stuck)

Appears only on start-up
CAUSE
The membrane switches on the column are stuck.
SOLUTION
Reboot, if probles persists, replace the membrane buttons.

4.3 Problems while preparing the unit for an exposure

Image of emergency button appears on main display



CAUSE
The emergency switch has been pressed down.
NOTE: LED D4 (ESTOP on) on L1600 will come on when the emergency switch is pressed down.
SOLUTION
Turn the emergency switch clockwise to release it.

The side control panel Return key does not work

CAUSE
The Membrane key panel is faulty.
SOLUTION
Press some of the other keys to see if they work correctly. If they do it indicates that the return membrane key is faulty and the membrane key panel must be replaced.

Error E7 (Opto or r-motor failed during r-movement)

CAUSE
L2100 or R5100 or rotating unit stepper motor is faulty.
The rotating unit cannot position itself correctly and keeps on rotating, until the timeout (E 9) stops movement, because L2100 is faulty.
The rotating unit does not move when the R key is pressed.
SOLUTION
L2100 can be checked by using the service command "optotest", see section **Service Assistant and Service Functions**.
The **optotest** command displays values that indicate the position of L2100. When you manually rotate the rotating unit the values should change, sector 0, sector 1, sector 2 and sector 3, which indicates that the optosensors on the board are working and that L2100 is functioning correctly.
If the values do not change, L2100 or the cable from L1700 to L2100 is defective.
If L2100 is functioning correctly it indicates that there is a problem with the stepper motor.
Check if R5100, the stepper motor or cable from R5100 to the stepper motor are faulty. Replace any that are.

Rotating unit stop rotating, no error code

CAUSE A
Faulty R5100 or stepper motor.
SOLUTION A
Check the cables connected to R5100. If ok, replace R5100.
If the unit still does not work, replace the stepper motor.

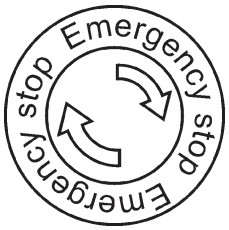
Patient positioning light(s) do not come on

The patient positioning lights (lasers) come on when:
- the light key is pressed
- or the up or down key is pressed

One of lights does not come on.

CAUSE A
The light is faulty.
SOLUTION A
Check the cable and connector from the L1600 (Z-motor driver) to the light and replace the cable and light if faulty.
Realign the light, refer to the installation manual.
If the cable is okay replace the L1600 (Z-motor driver).

None of the lights come on.



CAUSE A
The emergency stop button has been pressed down.
The emergency stop icon appears on main display.
NOTE: LED D4 (ESTOP on) on L1600 will come on when the emergency switch is pressed down.
SOLUTION A
Turn the emergency switch clockwise to release it.

CAUSE B
The emergency stop icon appears on the main display but does not clear when the emergency stop button is released. The patient positioning lasers do not come on.
SOLUTION B
Check connector JP129 on L1600 (Z-motor driver).
Check cable between L1600 and the emergency stop button.
NOTE:
When LED D1, on L1600 (Z-motor driver), is on it indicates that the board is receiving 5VDC from L1500 (CCD power supply). If the LED D1 is not on there is a power supply problem.

CAUSE C (Unlikely)
All the lights are faulty.
SOLUTION C
Replace all the lights, they are connected to L1600 (Z-motor driver) and then realign them. Refer to the installation manual.

Up/down (Z-motor) keys do not work

CAUSE A
The emergency switch has been pressed down.
Image of emergency button appears on main display.
NOTE: LED D4 (ESTOP on) on L1600 will come on when the emergency switch is pressed down.
SOLUTION A
Turn the emergency switch clockwise to release it.

CAUSE B
Z-motor not receiving power.
SOLUTION B
Check to see if lamp LA1 and LED D1 on L1600 are on. If they are not then check fuses F1 and F2. Replace if blown.
If after replacing fuse F2 lamp LA1 comes on but LED D1 still does not come on,check cables between L1600 and L1700. If the cables are OK, check if D12 is on on L1500. If it's not, replace L1500.

If LA1 and D1 are on check the cable from L1600 (J104) to the Z-motor. Replace if faulty.
If the cable is not faulty measure the AC voltage from the Z-motor connector, on L1600, to the Z-motor. Press the UP/DOWN key and check that there is an AC-voltage.
Note that you need to connect the DMM differently when running the unit in the Up direction and in the Down direction.
If no voltage can be measured, replace L1600.
If there is voltage but the Z-motor does not operate, replace the Z-motor.

Check the autotransformer connection.
Make sure that only one of the primary windings is connected.
D5 = SET 100V
D6 = SET 115V
D7 = SET 230V

CAUSE C
The side control panel (up/down keys) has failed
SOLUTION C
If D2 and D3 on L1600 do not come on when the up/down keys are pressed it indictes that the side control panel or the cable from the control panel are faulty and must be replaced.

CAUSE D (Unlikely)
The Z-movement end microswitch (top or bottom has failed) and the mechanical Z-movement end stops have stopped the Z-carriage.
SOLUTION D
Check to see if D3 on L1600 is on. If on it indicates that the top or bottom Z-movement end microswitch has not been activated.

CAUSE E
The autotransformer internal thermal switch has opened. The thermal switch will open if the winding temperature goes over 110°C.
SOLUTION E
There is a probably a short circuit inside the transformer winding that has caused it to overheat.
Replace the transformer.

CAUSE F
The Z-motor internal thermal switch has opened. If the unit is driven up and down for a long period time the Z-motor can overheat and cause the thermal switch to open.
SOLUTION F
Wait for the Z-motor to cool down and the thermal switch to close.

4.4 Problems during exposure

Nothing happens when the exposure button is pressed

CAUSE A
Exposure switch failed.
SOLUTION A
Replace the exposure switch.

CAUSE B
Unit not in ready mode,no PC-connection or no active client reserving the unit.
SOLUTION B
Check PC connection and SW status.

CAUSE C
Faulty cable(s) between L1300 (Interface board) and L1600 (Z-motor driver), or between L1600 and L1700 (Connector board), or between L1700 and L1200 (CPU board), or between L1700 and L1800 (Generator board).
SOLUTION C
Replace faulty cable(s).

Error code H1 (Exposure interupted)

CAUSE A
OPERATOR ERROR. The exposure button was released during an exposure.
SOLUTION A
Advise the operator to hold down the exposure button for the duration of the exposure.

CAUSE B
The exposure button failed while it was being pressed during an exposure.
SOLUTION B
Take a test exposure to see if the same error code appears again. If it does, replace the exposure button.

Error codes E0, E1 and E2

NOTE:
Error codes E0, E1, E2 all indicate that the tubehead and/or Generator board are not functioning correctly.

E0 (Tube arcing)
CAUSE
Tube arcing.
NOTE:
Check the tube fail LED (red) in the upper right corner of the Generator board. If it is on it indicates that the tube is arcing.
E1 (tubehead voltage)
CAUSE
Tubehead high voltage (kV) out of limits.
E2 (tubehead current)
CAUSE
Tubehead current (mA) out of limits.
SOLUTION
Use the S2terminalt to check the mA and kV feedback signals from the tubehead to see if the tube voltage and current are correct (Software Check).
See **S2terminal and service functions**.

If the feedback values are not correct use the **exp** service function to measure and compare the values (Refer to Service Assistant and Service functions in section 5).

Select an exposure time of 2000 ms (2 seconds) or greater so that the mAfb and kVfb ADC values can be measured.

CAUTION:
Protect yourself from radiation when carrying out this procedure.

Press and hold down the exposure button. The "actual" mAfb and kVfb ADC values will appear on the display next to "target" values.
If the "actual" values differ by less that ±2kV from the target values, the tubehead is working correctly.

If the "actual" values differ by more than ±2kV from the target values, it indicates that there is a problem and the tubehead must be recalibrated.

From the Service Assistant select **calib** and calibrate the tubehead.
NOTE:
Keep exposure switch pressed for the duration of the calibration program.
After recalibrating the tubehead check if the calibration was successful.

If the calibration is successful select the **exp** function again and confirm that the mA and kV feedback signals are correct.

If the calibration was unsuccessful and the unit still does not work correctly, check the hardware.

Hardware check
Remove the cables from the tubehead side of the rotating unit. Check the cables between the Tubehead and the L1800 Generator board. Replace them if they are faulty and then recalibrate (**calib**) the tubehead.

If recalibration is not sucessful, measure the feedback signals from the Generator board. From the Service Assistant select **exp**.

Connect a DMM to the TP14 (kVfb) and TP17 (GND) on the Generator board and take an expose.

Then connect the DMM to TP18 (mAfb) and TP17 (GND) and take another exposure.
The values for feedback signals can be counted as described in chapter **3.6 L1800, Generator Board - Test points**

If values for the feedback signals are not within the limits, and recalibration does not help, measure the reference signals from L1800 Generator board.

Connect a DMM to TP12 (kVref) and TP17 (GND) on L1800 and take an exposure.

Then connect the DMM to TP11 (mAref) and TP17 (GND) and take another exposure.
The values for the reference signals can be counted as described in chapter **3.6 L1800, Generator Board - Test points**

If the reference values are correct, but feed back values are not, the Tubehead and/or the L1800 Generator board may be faulty and must be replaced.
If there are no reference signals check the cabling between the L1800 Generator board and L1700. Replace if faulty.

Error E10 (CCD initialization/configuration failure)

CAUSE
There is no serial bus connection or the CCD sensor could not configure itself.
SOLUTION
Check the condition of all the cables and connectors to/from the CCD sensor as well as the cables from CPU to L1700 and cables between L1700 and L1500. Check that none of the fuses on L1500 have blown.
Check that CCD filter board is mounted correctly and cables are properly connected. If the problem still exists, replace sensor.

Error E11 (CCD power failure)

CAUSE
Supply voltages to the CCD sensor were not within tolerances during imaging.
SOLUTION
Check the condition of all the cables and connectors to/from the CCD sensor.
Check the voltages on L1500 by checking the reference LEDs. Always measure the voltages from the test points. Note that the voltages are only enabled during an exposure. To enable the CCD voltages without taking an exposure, connect a jumper to J23. Remove the the jumper after taking measurements.

Error E12 (CCD line failure)

CAUSE
The image data flow from the CCD sensor to L1200 was interrupted during the exposure.
SOLUTION
Refer to the trouble shooting information given in error code E11.

Error E13 (CCD configuration checksum failure)

CAUSE
L1200 CPU failed to read CCD configuration parameters.
SOLUTION
Reboot the unit. If the problem persists, change the CCD sensor.

4.5 Problems after exposure

Error E4 (Tubehead too hot)

CAUSE A
The tube head has overheated (> 55°).
SOLUTION A
Wait for the tubehead to cool down.
When the tubehead reaches the right temperature the error message will automatically disappear. Note that this could take over 45 minutes.
Note that you will not be able to clear the error message until the tube head has cooled to the correct temperature. If the error message appears even if the unit has not been used a lot, switch the unit off and then on again.

CAUSE B
The tube heat signal is missing.
SOLUTION B
If the error message never clears check the path of the tube heat signal. The tubehead and/or the generator board may be faulty and must be replaced.

Vertical white stripes on the image

Probably due to tube arcing.
Refer to the trouble shooting information given in error code E0.

Horizontal white stripes on the image

Recalibrate the CCD.
Refer to the section **Calibrating the CCD sensor** in the installation manual.

4.6 Bad quality images

Bad quality images can be due to one or more of the following:

- incorrect patient positioning
- a badly aligned unit
- the CCD sensor is not calibrated

Incorrect patient positioning

If the unit is producing bad quality images, first make sure that the user is positioning the patients correctly. For information on how to position the patient refer to the User's Manual.

A badly aligned unit

If patient positioning is correct, check the alignment of the unit.
For information on how to align the unit refer to the Installation and set-up manual.

The CCD sensor is not calibrated

Calibrate the CCD.
Refer to the section **Calibrating the CCD sensor** in the installation manual.

5. S2terminal and service commands

5.1 Using the S2terminal

The S2terminal utility includes a number of commands that allow the unit to be tested and configured during installation, set up and service.

To open the S2terminal:

1. Make sure that the dental imaging program being used is closed.
2. The PC's IP address must be in same subnet. If not, modify it according to installation manual
3. Create a new folder in the PC connected to the unit and copy the s2terminal files into the new folder.
4. Open the **Command Prompt**. (**Start\Programs\Accessories**).
5. In the Command prompt key in **cd**, space and then the path where the s2terminal files are installed (e.g. **c:\s2terminal**).

```
cd c:\s2terminal
```

Press **ENTER**.

6. Key in **s2terminal**, space and then the **IP address** of the unit. The IP address can be displayed by touching the settings button on the GUI.

```
s2terminal 194.9.227.251
```

Press **ENTER** to open the s2terminal and make a connection to the unit.

7. To enter the **SERVICE** state key in "**s**" and press **ENTER**.

```
s
```

---

8. Key in "**help**" and press **ENTER**.

---

help

A list of commands will appear.

NOTE:
The list may vary according to unit version

CMD	DESCRIPTION (* available also in normal mode)
calib	calibrates generator references and preheat
conf	display summary of configuration data
confccd	display summary of CCD configuration data
dap	dose area product calibration value [<value>]
dc	takes dark current image
demo	enter demo mode
display	display power level (<value>)
endu	endurance test, drives rotating unit 75 rounds
exitdemo	exit demo mode
exp	exposure (<time>) in milliseconds, default is 1000
expcnt	exposure counter, use [<clear>] option to clear it
help	display info on command (‘help [cmd]’ or ‘h [cmd]’)
imagecalib	takes a calibration image for calibrating the DSD
ip	configure ip address
kVcheck	test kV/mA combinations
log	service log [<all> <clear> <newest> <statistics>]
logsign	make a service signature for current events
mac	print mac address
maincalib	calibrates main voltage high and low limits parameters: <current voltage>
mainsprint	print current mains voltage value
motortest	run exposure ramp
optotest	prints optosensor values until user types 'q' on keyboard
patt	generates test pattern from CCD module
printgen	prints the generator settings
quit	quit service terminal
reset	reboot the unit
restore	restore factory configuration
serno	print unit serial number
setserno	configure serial number (and MAC accordingly)
stillmode	still image exposure mode
warmup	tubehead warmup before first use

>

---

9. To select a function key in the function name, for example **exp**, into the field at the bottom of the **service terminal**.

   >exp

   Information about the selected function will appear at the bottom of the list of functions.

10. To display information about an individual command key in **help cmd**, where cmd is the command name in question.

    >help cmd

    ---

11. To exit the **service terminal**, key in **quit**.

    >quit

    Then press **Enter**.

5.2 The Service commands

COMMAND	DESCRIPTION
calib	**calibrates generator references and preheat** Calibrates the voltage (kV), current (mA) and preheat (mApreh) reference values for the tubehead and generator board. This calibration procedure must be carried out when the - tubehead - generator - or CPU are replaced. **CAUTION:** **Protect yourself from radiation when carrying out this procedure.** Press and hold down the exposure button for the duration of the procedure, which will last up to three minutes. During the calibration procedure you will hear the exposure warning signal and calibration values, current at the start and calibrated at the end, will appear on the display. When the calibration procedure is successful completed the message, **CALIBRATION WAS SUCCESSFUL** will appear. Exit (quit) the service assistant. **NOTE:** If the calibration procedure is not successful the message, **!!!!! Calibration was NOT successful !!!!!** will appear. If this happens repeat the calibration **(calib)** procedure. If the calibration procedure is still not successful after repeating the procedure two or three times there is a hardware problem. See error codes E0, E1 and E2.

conf **display summary of configuration data**

Displays all the current configuration parameters of the unit. The figures in brackets (1) are factory settings.
If you wish to restore the factory settings use the **restore** command.

NOTE:
default program 1 = adult pan, 2 = child pan, 3 = TMJ and 5 = Test.

confccd **display summary of CCD configuration data**

Displays the factory and current configuration parameters of the CCD sensor. These values are for information only.

dap **dose area product calibration value [<value>]**

Displays the dose area product (DAP) calibration value
Use values 8mA, 70kV and 1sec.
FACTORY USE ONLY!

dc **takes dark current image (dc = dark current)**

Is used to check if the CCD sensor is working.
Press the "Return" key to start the check.
During the check a series of values will appear in the service assistant window.
When the check is complete the image will be transferred.
When the sensor is working correctly the vertical centre of the image will be slightly gray because of noise.

NOTE:
If an image does not appear, then the CCD sensor is faulty.

demo **enter demo mode**

Enters the unit demonstration mode.
X-rays shall be disabled and unit shall be in ready state even without computer.
This is for exhibition use.

display **display power level (<value>)**

Sets the power level of the display. Upper or lower case text can be used.
OFF
LOW
NORMAL
HIGH

endu **endurance test, drives rotating unit 75 rounds**

Automatically drives the rotating unit through 75 rotation cycles. No radiation in generated during rotation.
This command is used during factory testing.

exitdemo **exit demo mode**

Exits the unit demonstration mode.

exp **exposure (<time>) in milliseconds, default is 1000**

Generates x-rays. The CCD sensor is not activated and the rotating unit does not move.
It is used to check the beam alignment during unit installation (refer to the Installation manual for more information), and to trouble shoot the tubehead and generator board.

CAUTION:
Protect yourself from radiation when using this function.
The default exposure time is 1000 ms (when "exp" is keyed in). If you wish to have a longer exposure time key in "exp" and them enter a value, for example:

>exp 3000

---

will result an exposure time of 3000 ms. The minimum value you can key in is 100 ms and the maximum is 20000.

Press and hold down the exposure button to activate x-rays.

If exposure times of 1000 ms or longer are used, the mAfb and kVfb ADC values will appear.

To exit the command key in **q** and then press **Enter** or press the **RETURN** key on the unit control panel.

NOTE:
The kV value used for the exposure will be the one selected before entering the service mode. The kV value cannot be changed while the unit is in the service mode. If you wish to change the kV, you must exit the service mode.

NOTE:
The "**still**" command, described later, generates x-rays and activates the CCD sensor but the rotating unit does not move.

expcnt **exposure counter, use [<clear>] option to clear it**

Displays the total number of exposures taken with the tubehead.

To zero the exposure counter enter clear,

>expcnt clear

---

and then press **Enter**.

NOTE:
Always zero the exposure counter when the tubehead is replaced.

help **display info on command ('help [cmd]' or 'h [cmd]')**

Displays the service command list and information about the commands.

imagecalib **takes a calibration image for calibrating the DSD**

Creates a technical image which is then used by the image capturing driver for image correction.

This function can also be carried out using the unit GUI. See the section "Calibrating the CCD sensor" in the installation manual.

ip **configure ip address**

Displays the current IP address of the unit.

To change the IP address enter the new one,

> ip *aaa.bbb.ccc.ddd (the new IP address)*

---

and then press **Enter**.

After changing the IP address of the unit, communication between the unit and the PC will be lost and the link to the PC will have to be reconfigured. Refer to section, **3.5 Configuring the communication link to the PC**, in the installation manual.

NOTE:
The IP address can also be reset using the driver tools

kVcheck **test kV/mA combinations**

Displays feedback values of all kV/mA combinations.

log **service log [<all> <clear> <newest> <statistics>]**

Displays exposure logs.
There are several log options:
<all> = (default) display the complete log
<clear> erase all log entries
<newest> display the latest log entry
<statistics> display the log statistics.

To select one of the log options enter the required command,

> log clear

---

and then press **Enter**.

logsign **make a service signature for current events**

Allows a short note to be added to a log entry.

Add the note,

> logsign *Note .....*

---

and then press **Enter**. The note will appear in the log.

mac **print mac address**

Displays the current MAC address of the unit.

mainscalib **calibrates mains voltage**
parameters: <current voltage>

Recalibrates the mains voltage if L1200 CPU board is replaced.

Use a RMS multimeter to measure the actual supply voltage (from the mains plug, L1910 or L1500) and then enter this value.

>mainscalib xxx
(xxx is the value read from multimeter)

---

and then press **Enter**.

mainsprint **print current mains voltage value**

Displays the current line voltage value as measured by the unit.

Useful for debugging when the unit displays error E5.

motortest **run exposure ramp**

A test drive for the rotation motor. The test checks that motor is driven to the correct angle and that it works as specified.

optotest **prints optosensor values for 30 seconds**

Allows L2100 to be checked. Optosensors on L2100 monitor the position of the rotating unit.

The "optotest" command displays, for 30 seconds, values that indicate the position of the L2100 board. When you manually rotate the rotating unit the values should change,

---

sector 0
sector 1
sector 2
sector 3

---

which indicates that the optosensors on the L2100 board are working and that the board is functioning correctly.
If the values do not change, the L2100 board or the cabling is faulty.

patt **generates test pattern from CCD module**

Produces a test pattern image from the CCD.

The pattern shows a number of two-tone gray vertical lines. These indicate that the data lines to the CCD sensor are working correctly.

printgen **prints the generator settings**

Displays the settings that are stored in the configuration memory.

quit **quit service terminal**

Exits and closes the service terminal.

reset **reboot the unit**

Reboots the unit.

restore **restore factory configuration**

Restores the configuration settings to the default factory settings. You must key in **restore configuration**.

> restore configuration

---

and then press **Enter**.

setserno **configure serial number (and MAC accordingly)**

To display the CURRENT setting key in

> serno => *the current serial number appears*

---

and then press **Enter**.

To change the serial number, e.g. if you change the CPU board key in

---

> setserno SOXXXXXXX (*new serial number*)

---

and then press **Enter**.

stillmode **still image exposure**

Generates x-rays and activates the CCD sensor but the rotating unit does not move.
It is used to check the beam alignment during unit installation (refer to the Installation manual for more information).

CAUTION:
Protect yourself from radiation when carrying out this procedure.

Press and hold the exposure switch to take a still image exposure.

NOTE:
The "**exp**" command, described earlier, generates x-rays but does not activate the sensor or move the rotating unit.

warmup **tubehead warmup before first use**

Initializes the tubehead. Must be used when the unit is installed or if the unit has not been used for a long time.

CAUTION:
Protect yourself from radiation when carrying out this procedure.

Press and hold the exposure switch until the procedure is complete. The procedure may take some minutes.

6. Updating unit firmware, core and display graphics

6.1 Firmware zip file

SOREDEX will supply a zip file containing all the necessary files for the upgrade.

The zip file will include the following:

- s2terminal for the update
- Firmware file (ELEOfw_r1.00.srec)
- Core file (ELEOcore_r36.rbf)
- Graphics file (ImagesPO_r1.bin)
- Upgrade manifest file (ELEO-r1.txt)

6.2 Upgrading the unit firmware

1. Extract the zip files into a suitable path on your PC.

2. Open the terminal connection.

3. Key in command **xu X** and press ENTER

   NOTE
   Version number X is the version of the manifest file.

   A message will appear asking if you wish to update the firmware. Click **Yes**. The files are automatically uploaded to the unit in correct order.

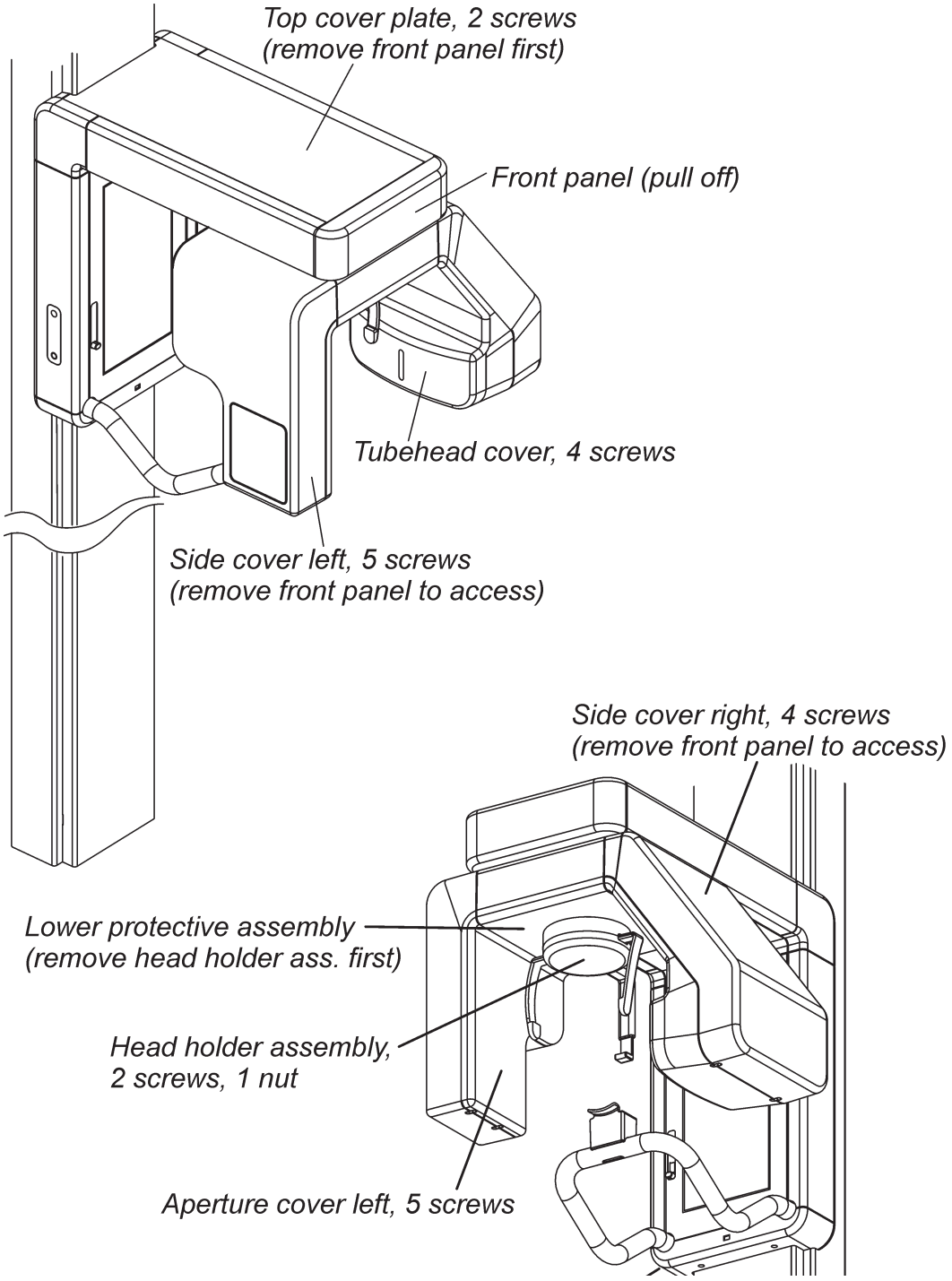
4. When files are updated, follow the instructions on the terminal.

5. Restart the unit when requested.

7. Replacing parts.

7.1 Removing covers

Instruction on how to remove the ss cover are in section 7.6 Replacing the z-carriage motor.



7.2 Replacing the tubehead

Tools required

The normal installation and alignment tools.

Replacement parts

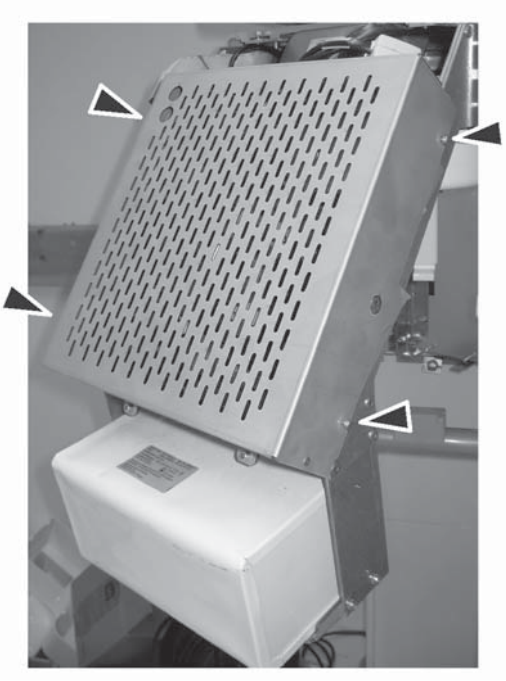
- New tubehead
- Tubehead label

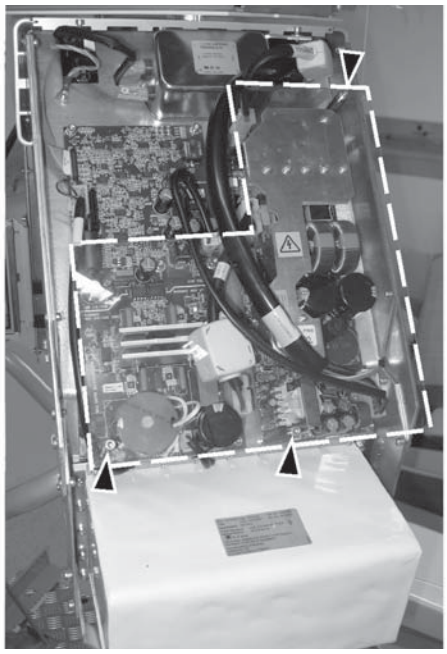
Replacing the tubehead

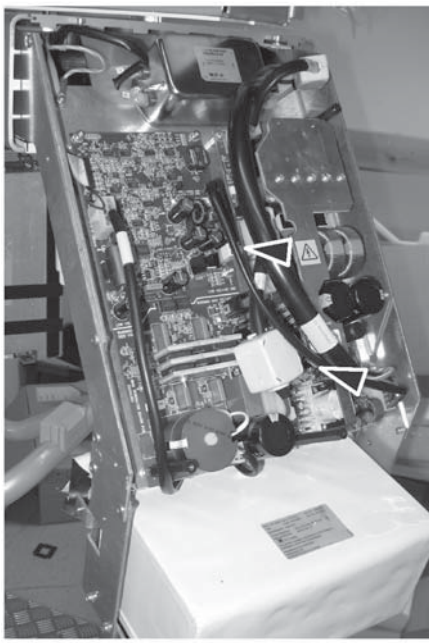
1. Switch the unit off and disconnect it from the main power supply.

2. Remove the ***tubehead inner cover*** and the ***tubehead outer cover*** from the tubehead side of the rotating unit.

3. Remove the **EMC cover** (4 screws), and then the clear plastic **PFC and generator protection insulator** (3 screws)

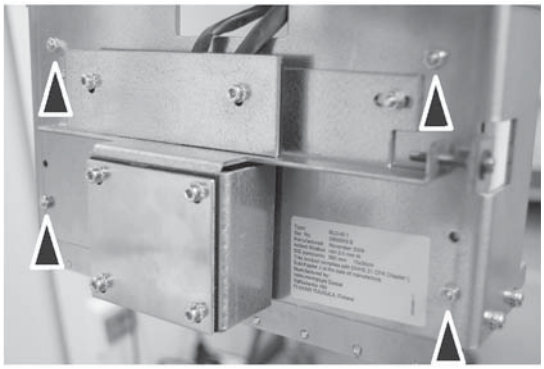






4. Disconnect all cables and the ground cable from the **tubehead**.

5. Remove the four (4) nuts that hold the **tube-head** to the **rotating unit frame** and remove the tubehead.



6. Attach the **new tubehead** to the rotating unit frame with the four (4) nuts.

6. Reconnect all the cables.

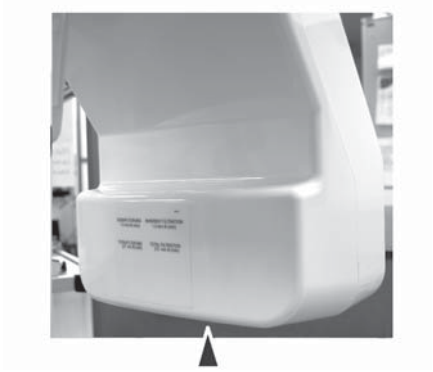
Calibrating the tube head and checking the alignment

1. Reconnect the unit to the power supply and then switch the unit on.

2. Open the service assistant.
   Carry out the **calib** procedure.
   Also set the exposure counter to zero (**expcnt clear**).

3. Realign the unit (refer to section **8. Aligning the unit**).

4. Carry out the image calibration. See the installation manual for details.



5. Replace the covers.

6. Attach the new tubehead label to the underside of the tubehead side of the rotating unit.

7.3 Replacing the CCD sensor

After replacing the CCD sensor, realign the unit (refer to section **8. Aligning the unit**).

7.4 Replacing the collimator

After replacing the collimator, realign the unit (refer to section **8. Aligning the unit**).

7.5 Replacing circuit boards

1. Switch the unit off and disconnect it from the power supply.

2. Remove the appropriate cover(s) so that you can access the circuit board you wish to replace.

3. Disconnect all the cables from the circuit board, remove the board and install the new one.

L900 Display adaptor - additional instructions

After replacing L900 and display assembly (rev 6 and later) check that the jumpers on the board are in the correct positions for the touch display installed in the unit.
For touch display:
- OPTREX T-55265GD057J-LW-ACN
SW1 = on, SW2 = on

For touch display:
- SHARP LQ057Q3DG01
SW1 = off, SW2 = on

NOTE:
When L900 and display assemblies are ordered as spareparts, they are always preset and tested at the factory.

The switch information is just for your information.

L1800 Generator board - additional instructions

After replacing the board use the Service Assistant to recalibrate the unit:
- calib
Refer to section **5. Service Assistant and Service Functions**.

L1700 Connector board - additional instructions

After replacing the board use the Service Assistant to recalibrate the unit:
- calib
Refer to section **5. Service Assistant and Service Functions**.

L1200 CPU board - additional instructions

After replacing the board use the Service Assistant to recalibrate the unit and the power supply limits and reset the serial number.
- calib
- mainscalib
- change the IP address, if required
- update the FW, if required
- serno
Refer to section **5. Service Assistant and Service Functions**.

L1500 Power Supply board - additional instructions

After replacing the board use the Service Assistant to recalibrate the unit.
- mainscalib
Refer to section **5. S2terminal and service commands**.

L1910 PFC board - additional instructions

After replacing the board use the Service Assistant to recalibrate the unit.
- mainscalib
Refer to section **5. Service Assistant and Service Functions**.

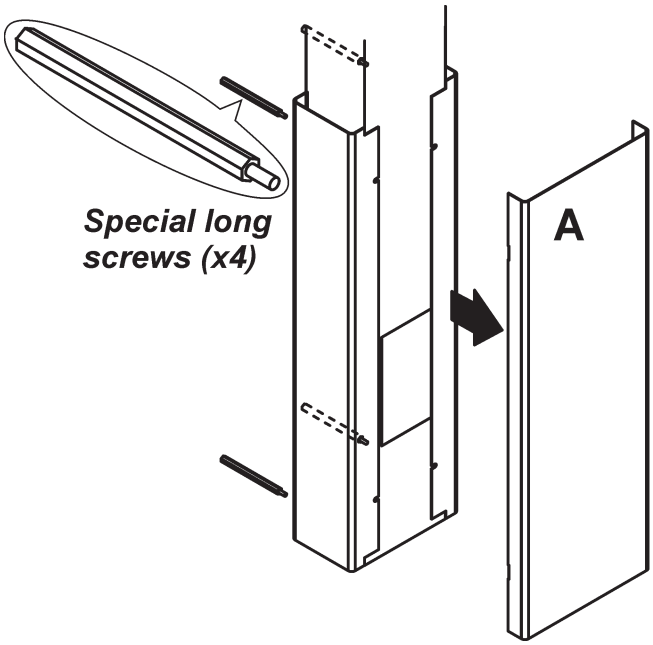
7.6 Replacing the z-motor

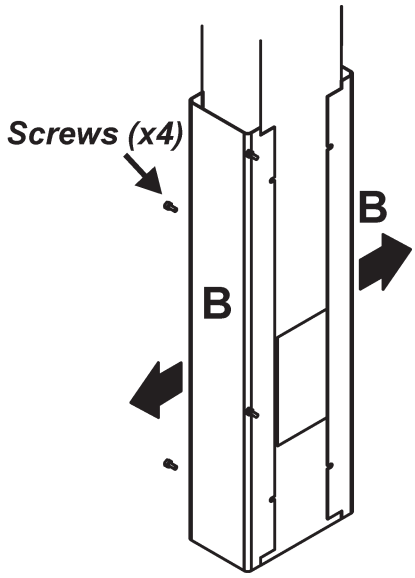
CAUTION:
DO NOT attempt to replace the z-motor while the unit is in the vertical position, either when attached to the wall or to an exhibition base.
The rotating unit must be removed from the z-carriage and then the unit removed from the wall and placed on the floor before the z-motor is replaced.

1. Switch the unit off and disconnect it from the power supply.

2. Remove the covers from the bottom of the column.

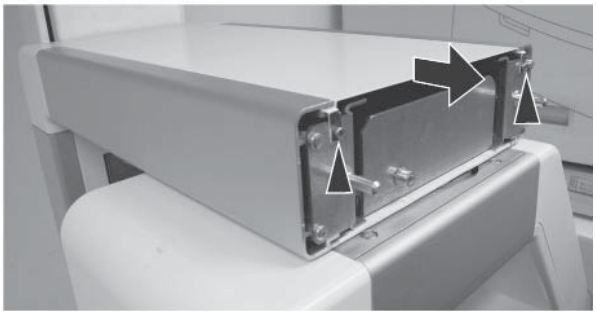
   Remove the long screws (4) that hold the Front Cover **A** to the bottom of the column, the screws can be accessed from the rear of the column, and remove the front cover.



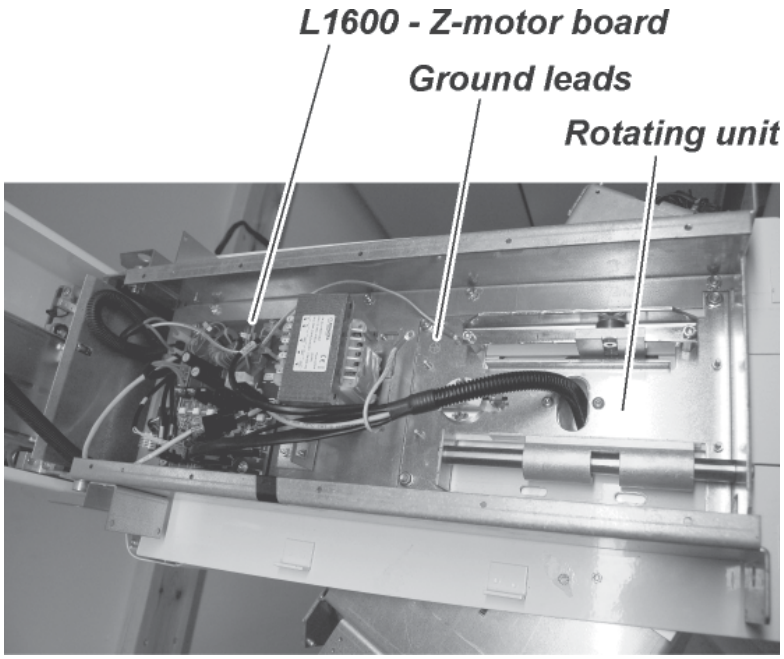


Remove the screws (2 x 2) that hold the two Side Covers, **B**, to the bottom of the column and remove the Side Covers.

3. Remove the upper shelf top cover (2 x M4 screws) from the upper shelf.

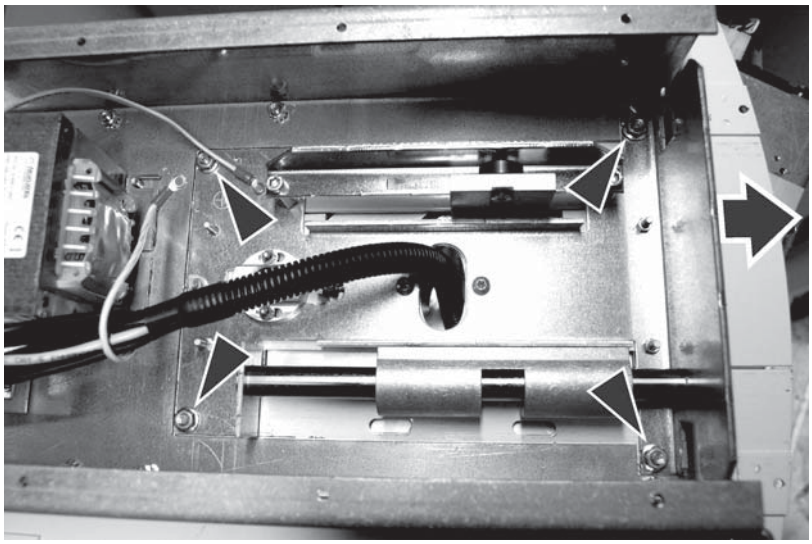


3. Disconnect all the cables that connect the rotating unit to the L1600 - Z-motor board. Also disconnect the Ethernet cable and the ground leads.



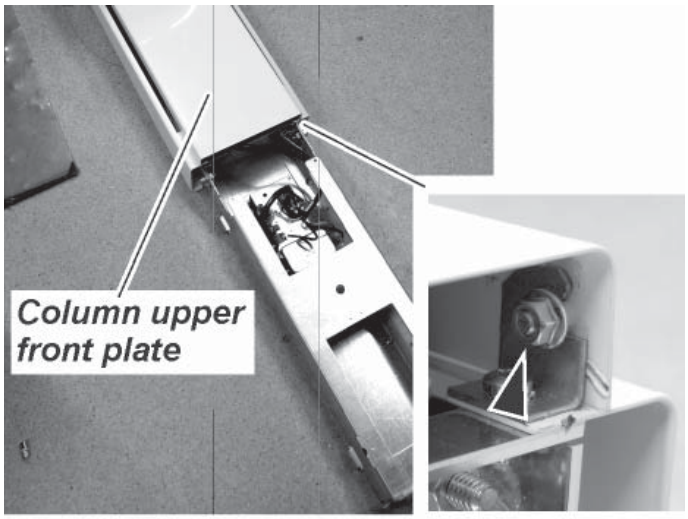
4. **CAUTION:** HEAVY OBJECT; THE FOLLOWING TASK REQUIRES TWO PEOPLE.
Place some soft material on the ground so that the rotating unit will not be damaged when it is removed from the upper shelf and placed on the ground.

Loosen the 4 nuts that hold the rotating unit to the upper shelf and then slide the rotating unit off of the upper shelf and place it on the ground.

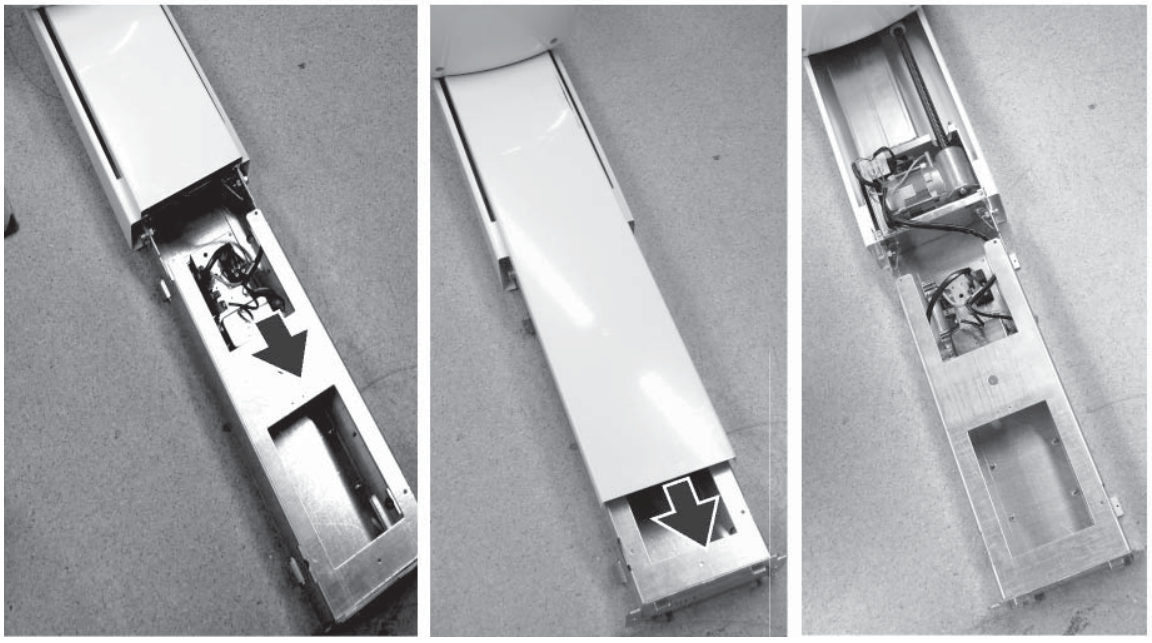


5. **CAUTION:** HEAVY OBJECT; THE FOLLOWING TASK REQUIRES TWO PEOPLE.
   Remove the unit from the wall or exhibition stand and lay it on the floor.
   For information on how to do this refer to the installation instructions and follow, in reverse order, the instructions on how to attach the unit to the wall or exhibition stand.

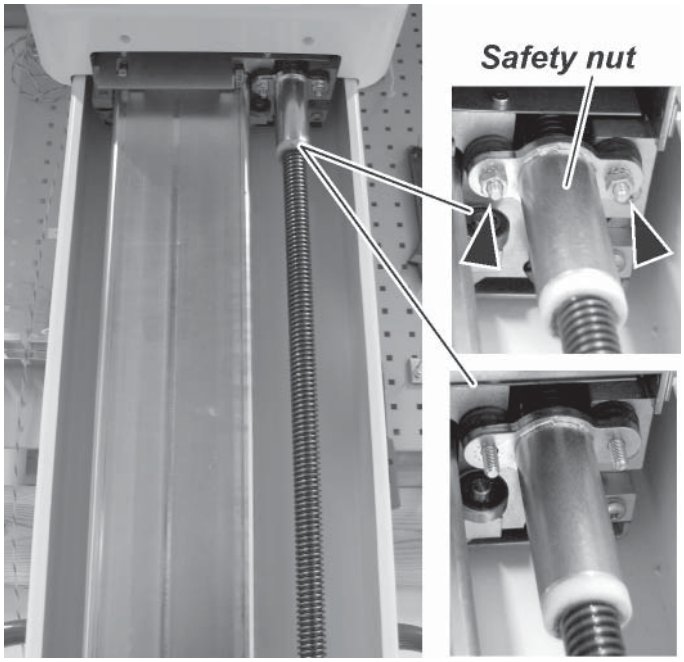
6. Loosen the nuts (4) that hold the column upper front plate in position. There are two at the top of the front plate and two at the bottom.



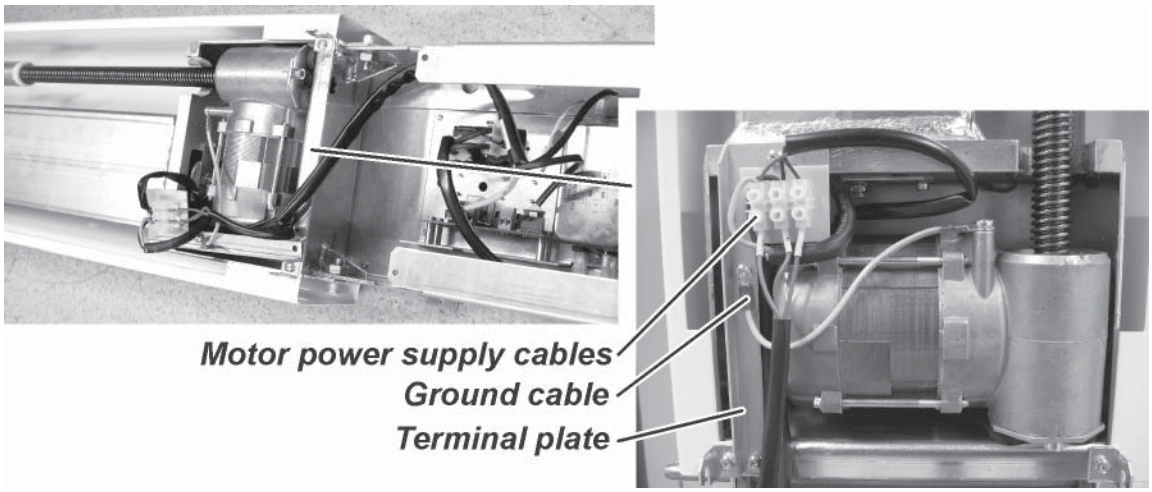
7. Carefully slide the column upper front plate off of the column.
   Be careful not to damage the surface finish.



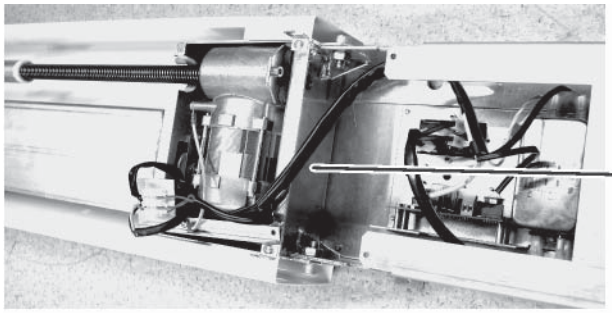
8. Remove the two nuts that hold the safety nut to the bottom of the z-carriage assembly and then slide the z-carriage upwards away from the safety nut.

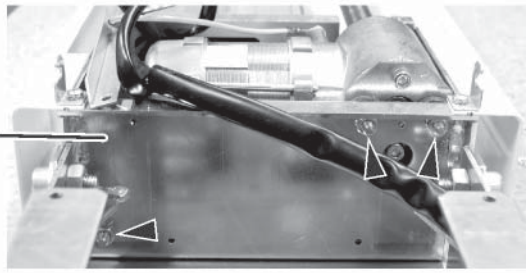


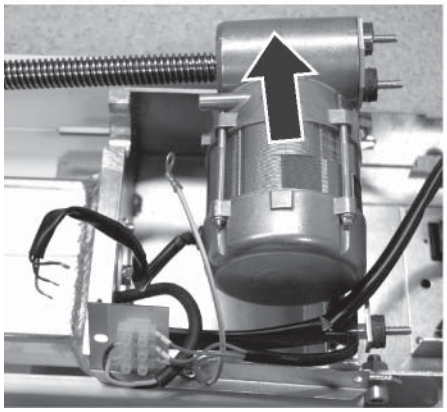
9. Remove the terminal plate from the column assemble (2 screws) and then disconnect the motor power supply cables from the terminal block and the ground cable from the motor.



10. Remove the three nuts that hold the z-motor to the bottom of the column assembly







and remove the motor.

11. Install a new z-motor, connect all the cables and then replace all part and covers.

12. Reattach the unit to the wall or exhibition stand and then reinstall the rotating unit.

13. Level the unit and check the alignment as described in the installation manual

8. Aligning the unit

After replacing one of more of the following: tubehead, collimator, CCD sensor, the alignment of the unit must be checked and if required adjusted.

8.1 Removing the covers

1. Remove the covers from the unit if they have not been removed already.

8.2 Checking and Aligning the CCD Sensor

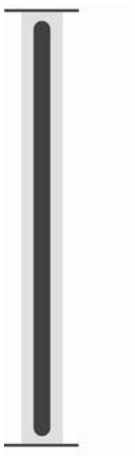
1. Switch the unit and PC on.

2. **PC:** Open the digital imaging software you are using and open a patient card where the alignment images can be stored.

3. **PC:** Enable image capture.

4. **PC:** Make sure that the **stillmode** in the **service assistant** is still selected.

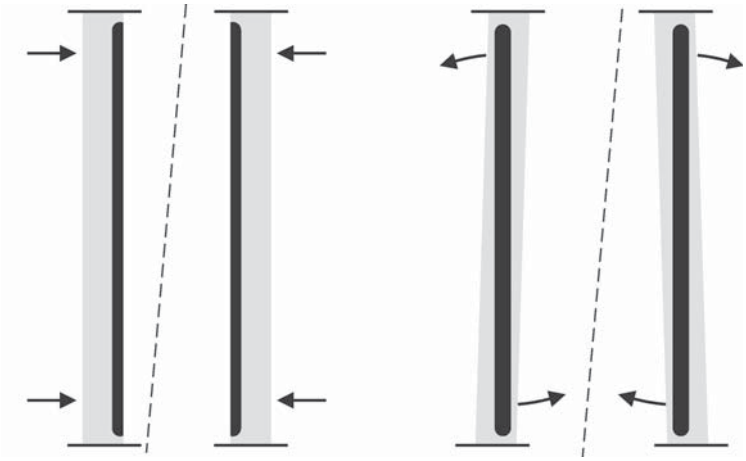
5. **Protect yourself from radiation**.
Press and hold down the exposure button to take an exposure.



6. The image should show a vertical black line (the beam) in the middle of a vertical light gray area (the CCD aperture). Both the beam (black line) and the CCD aperture (light gray area) must be vertical and the bottom edge of the beam (black line) must be between 0.1 and 2mm from the bottom edge of the image.

If the beam (black line) is not in the middle of the CCD aperture (the gray area), the position of the CCD Sensor must be adjusted to the right or left.

If the CCD aperture (gray area) is not vertical, the CCD sensor must be rotated slightly until it is vertical.



7. Loosen the nuts (4) that hold the CCD sensor in place and then adjust its position with the screws (2) on the left-hand side.

   Adjust and recheck the position of the CCD sensor until the beam is vertical and centered in the middle of the CCD aperture.

8.3 Checking and adjusting the position of the collimator

Checking and Adjusting the Center of Rotation

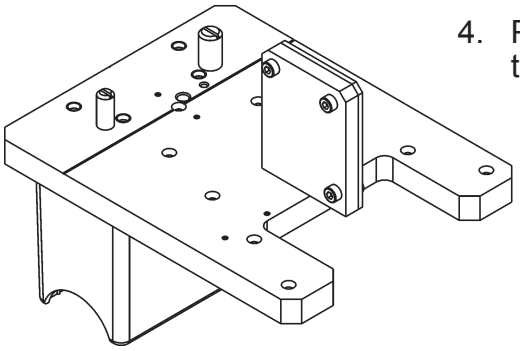
The centre of rotation is correct when the beam strikes the alignment plate at the same point (not necessarily the center) when the tubehead is positioned first on the left-hand side of the the beam alignment tool and then on the right.

Checking the position of the collimator

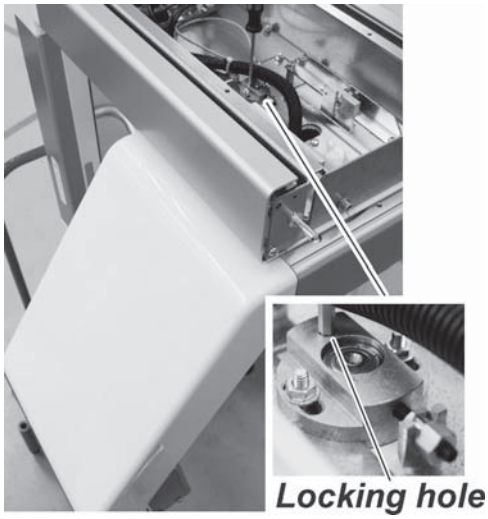
1. Pull the Front Panel from the Upper Shelf and then remove the screws (2) that hold the Top Cover Plate in position, and slide it off.

2. Drive the unit up until you are able to see the beam alignment tool from beneath the tubehead.

3. From the **CRANEX® Novus e service terminal** select the **exp** (exposure, no rotation, CCD sensor not active) function.

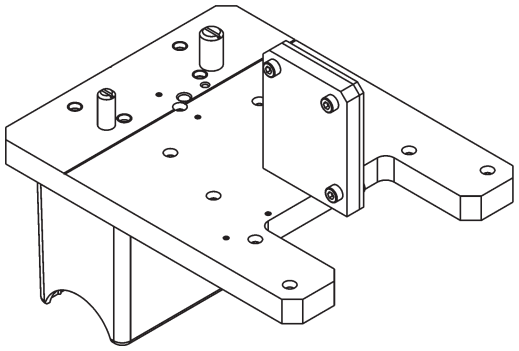


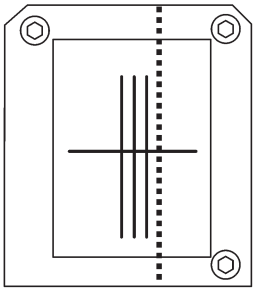
4. Place the alignment plate into the two holes at the back of the ball/pin phantom.

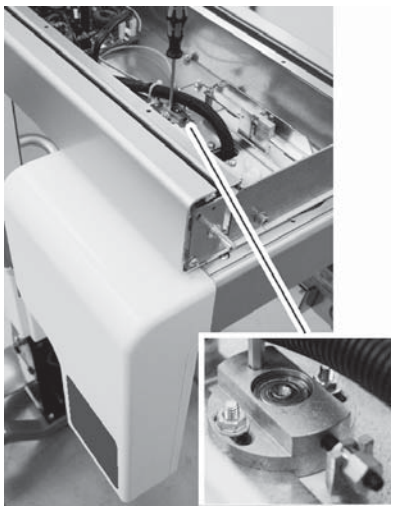


Manually rotate the Rotating Unit so that it is parallel to the **front** of the upper shelf and the tubehead is on the **left**. Insert a 4 mm hexagon socket wrench into the locking hole in the Rotation Bearing to hold the Rotating Unit in position.

6. **Protect yourself from radiation.**
Darken the room and then position yourself behind and below the tubehead.
Press and hold down the exposure switch.
Make a note of where the beam strikes the alignment plate.

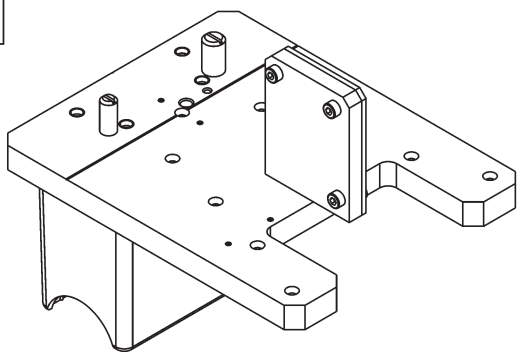


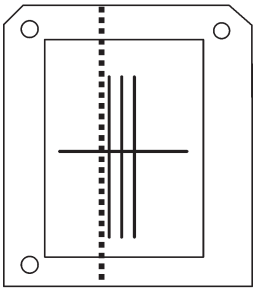




7. Remove the hexagon socket wrench from the locking hole and then manually rotate the Rotating Unit 180º so that it is parallel to the **front** of the upper shelf and the tubehead is on the **right**. Reinsert the hexagon socket wrench into the locking hole in the Rotation bearing to hold the rotating unit in position.

8. **Protect yourself from radiation.**
Press and hold down the exposure switch.
Make a note of where the beam strikes the alignment plate on this side.





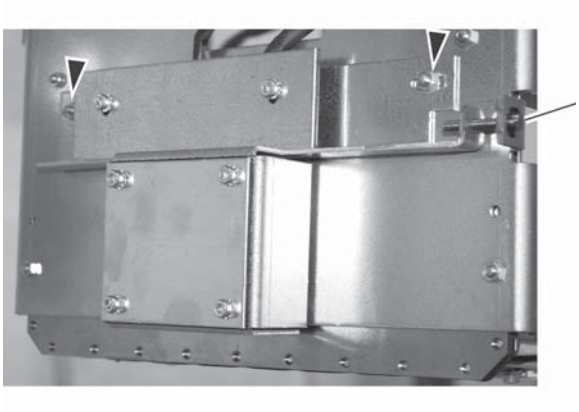
Compare the first beam position with the second beam position and determine how far and in which direction the Collimator must be adjusted.

9. Remove the screwdriver from the locking hole.

Adjusting the position of the collimator

1. Remove the Tubehead Cover (4 screws) from in front of the Collimator.

2. Loosen the nuts (2) that hold the Collimator Assembly in position and the adjust the left/ right position of the collimator with the screw (1) on the right-hand side.



3. Recheck the position of the beam (steps 4 - 7) and readjust the position of the Collimator until the beam strikes the same point on the plate when the tubehead is positioned on the left and then on the right.

NOTE:
The beam does **NOT** have to strike the center line on the Alignment Plate, it just has to strike the same point when the tubehead in on the left and then right.

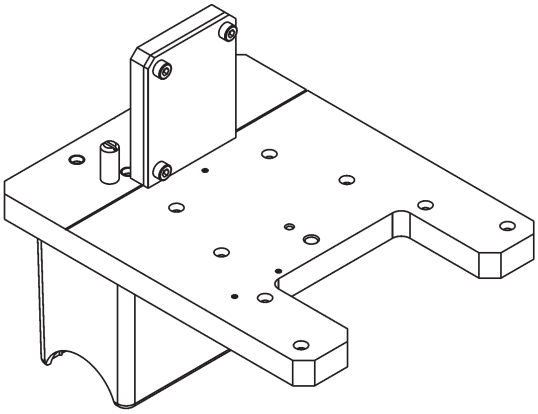
8.4 Checking and adjusting the Chin Support

The Chin Support is in the correct positioned when the beam strikes the middle line on the alignment plate when the rotating unit is parallel to the **side** of the upper shelf.

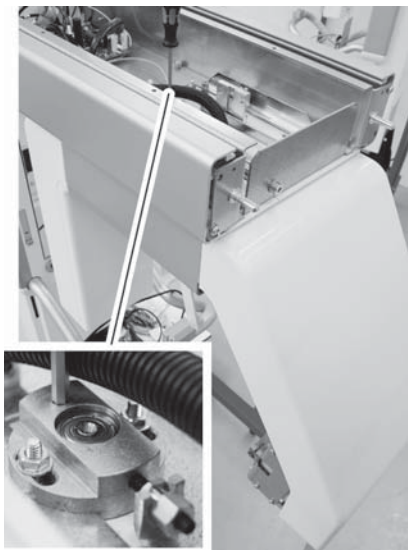
1. Make sure that the you are able able to see the beam alignment tool from beneath the tubehead.

2. Make sure that **exp** (exposure, no rotation, CCD sensor not active) function has been selected (**CRANEX® Novus e service terminal**).

3. Place the alignment plate into the two holes at the front of the ball pin phantom.

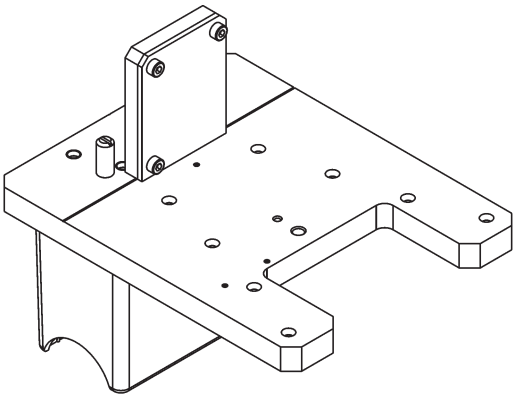


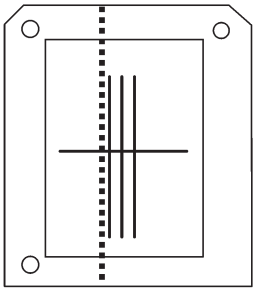
4. Manually rotate the Rotating Unit so that it is parallel to the **side** of the upper shelf and the tubehead is at the front. Insert a 4 mm hexagon socket wrench into the locking hole in the Rotation bearing to hold the rotating unit in position.



5. **Protect yourself from radiation.**
   Darken the room and then position yourself behind and below the tubehead.
   Press and hold down the exposure switch.

   Check how far the radiation beam is away from middle line of the alignment plate.

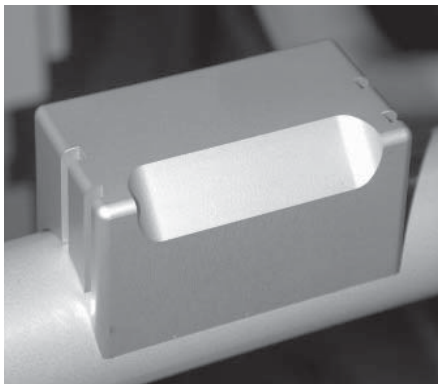




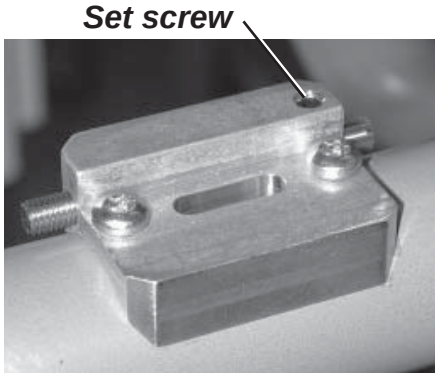
If the beam does not strikes the middle line of the alignment plate the position of the Chin Support must be adjusted.

Adjusting the position of the Chin Support

1. Remove the beam alignment tool.



2. Remove the Chin Support Holder (1 screw accessable from the underside of the patient support handle).



3. Loosen the set screw that holds the Lower Shelf Screw (the horizontal screw) in position and turn it to adjust the position of the Chin Support Holder.

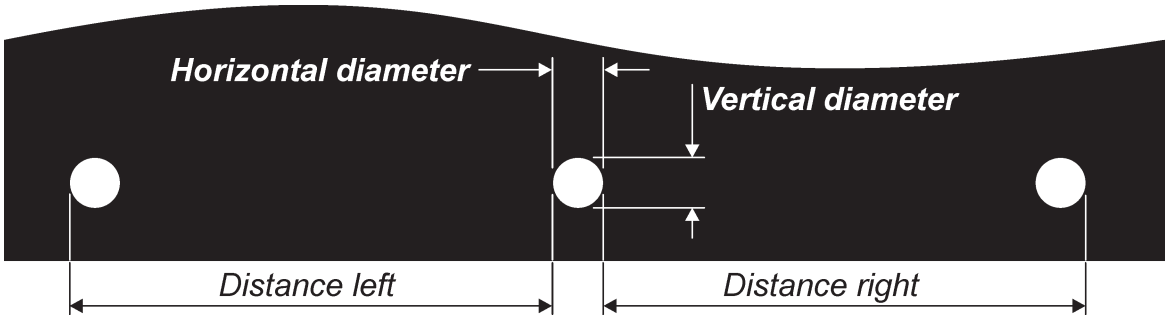
CAUTION:
DO NOT loosen the screws (2) that attach the Chin Rest Support to the Patient Handle.

4. Replace the previously removed parts and then repeat steps 3-5 to check the position of the Chin Support again.
Remove the parts and readjust if necessary.
Replace all the parts and tighen them when the adjustment is complete.

8.5 Checking and adjusting the focal trough

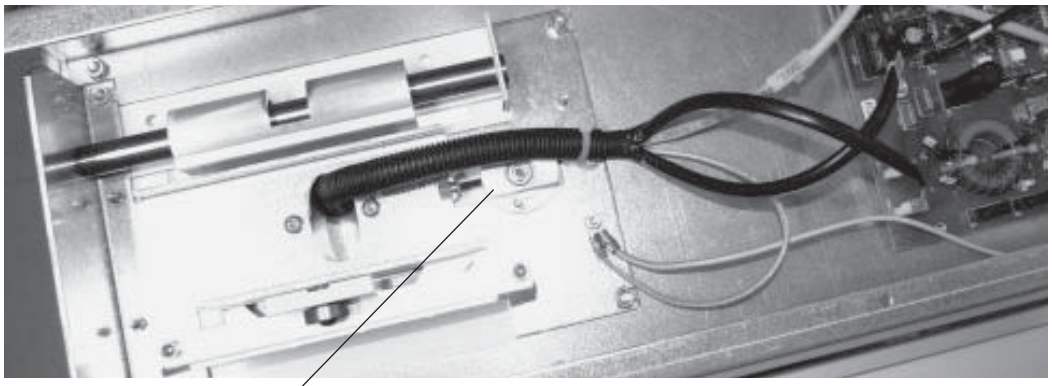
1. Press the RETURN button to drive the unit to the PIO position.

2. Take a panoramic exposure and examine the image.
If the center ball is not round, with no more than 0.2mm difference between the horizontal and vertical diameter, or the distance between the center ball and the left and right hand balls is same with no more than ±2.0 mm difference, the Rotating Unit must be positioned in the forward/backward position.



Adjusting the position of the focal trough

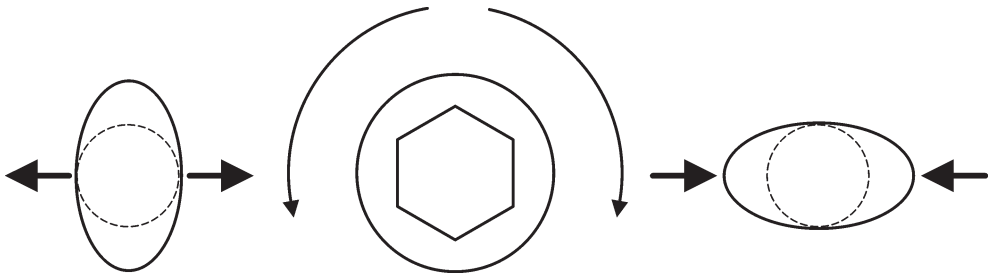
1. In the upper shelf loosen the two nuts that hold the Rotation Bearing in place. Turn the adjusting screw to adjust the position of the the Rotating Unit.
   Counter clockwise will move the Rotating Unit towards the column and clockwise away from it.



Rotation bearing

If the middle ball in the image is too wide turn the adjusting screw clockwise.

If the middle ball in the image is too narrow turn the adjusting screw counterclockwise.



Repeat this procedure until the middle ball is round according to the tolerance.

2. Replace the Top Cover Plate and the Front Panel.

8.6 Recheck the alignment

1. Take a ball-pin exposure to confirm that the unit is now correctly aligned. Refer to the **Installation Manual** section **5. Checking the alignment**.
   If the unit needs realigning, adjust accordingly.

8.7 Calibrating the CCD sensor

1. **PC:** Enable image capture.

2. **PC:** Select the **imagecalib**, refer to the installation manual for information on how to do this.

3. Protect yourself from radiation, and take an exposure.

4. Examine the image. It should be evenly grey all over with no granularity nor horizontal lines/ stripes. If the image is not evenly grey repeat the calibration until it is.