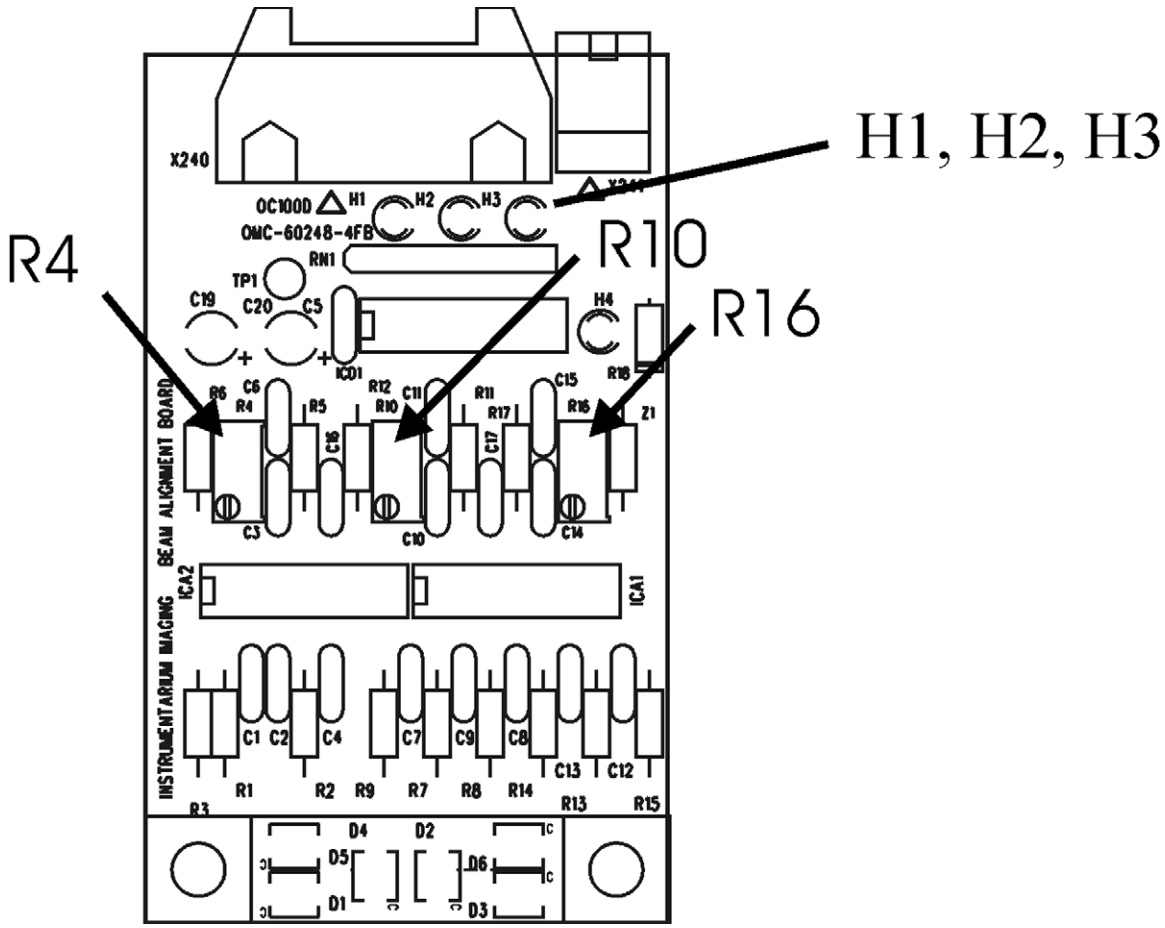
Orthopantomograph® OP100 & OP100 D
Orthoceph® OC100 & OC100 D

Electrical Operation & Wiring Manual



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INSTRUMENTARIUM

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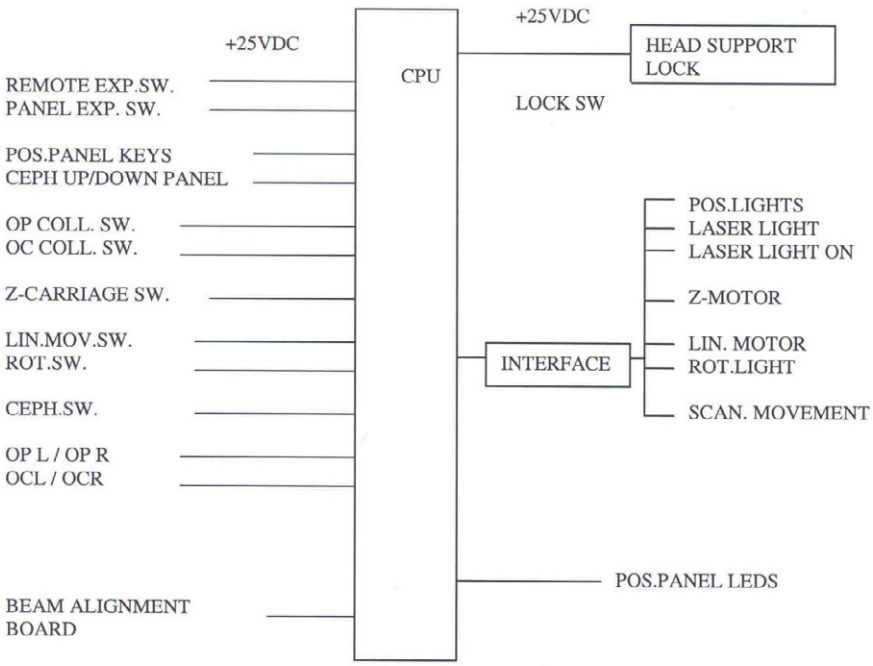
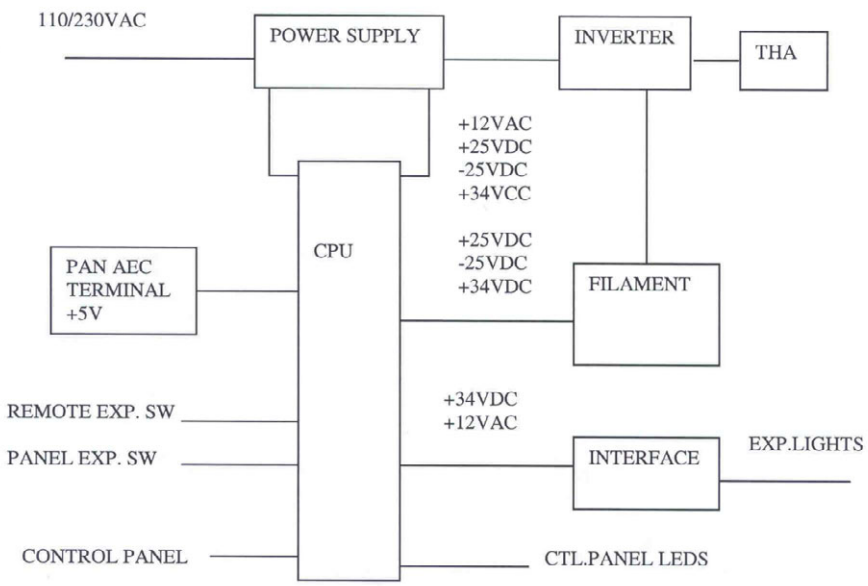
1 Electrical operation, schematics and layouts

1.1 ELECTRICAL BLOCK DIAGRAMS

BLOCK DIAGRAM – POSITIONINGS & MOVEMENTS



BLOCK DIAGRAM – EXPOSURE



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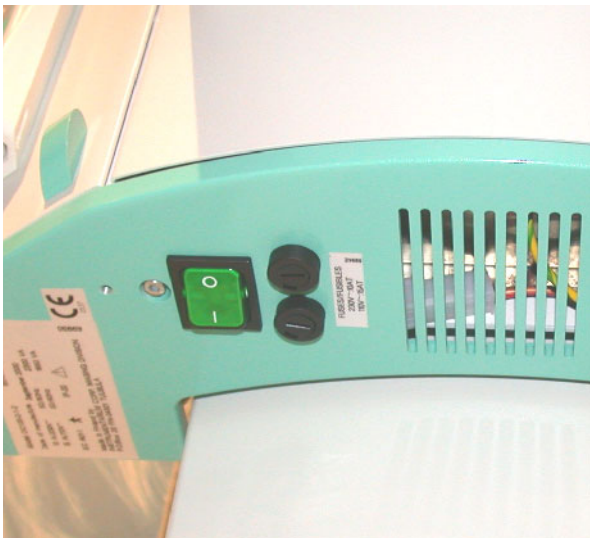
1.2 WIRING DIAGRAM

Copies of OP100 Wiring diagrams, see section “List of Documents”.

1.3 PRIMARY ELECTRONICS

1-phase electric power is fed through a 3-pole cable to the column where the cable goes inside the right side groove to the vertical carriage (connectors X101 and X122). Line filter is located under the lower shelf. Line filter ground is connected to the incoming 3-pole cable ground. Flat connectors or fixed screws are used. The line filter type with CE-marking: type S-124-10 or NM-240-10 (code 69025).



WARNING!

Always make sure OP100 D has a good protective ground.

Main switch with power on indicator light is located under the vertical carriage. Main fuses are located below the vertical carriage. Both F1 and F2 are slow blow type for incoming main voltage 230 VAC:

NOTE!

In USA/Canada 15AT fuses are used also with 230 VAC rating.

1.4 POWER SUPPLY BOARD (CODE 60113)

Power Supply Board rectifies AC voltages and filters the unregulated DC voltages. Power Supply Board consists of two main parts: low voltage and high voltage parts.

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WARNING!

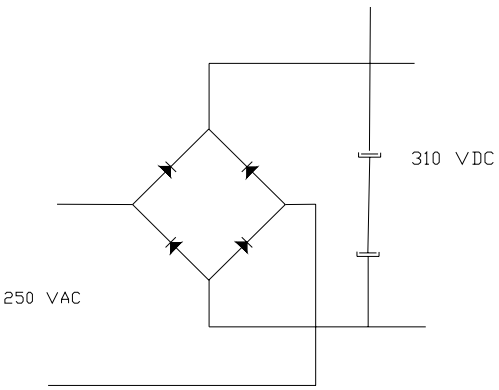
Voltages in high voltage part of the power supply board can be deadly. The peak-to-peak voltage level normally exceeds 600 V.

1.4.1 Line voltage jumper

Jumper S2 is for setting the unit to local line voltage:

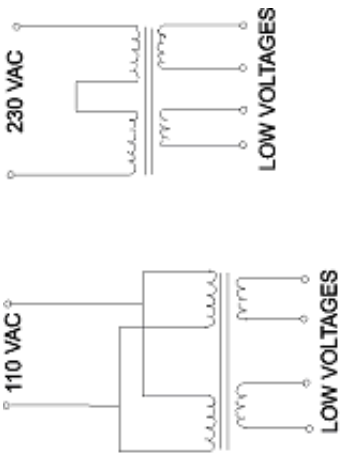
S1 switches the rectifier V4 to the 1500uF capacitors C1 and C2, located above the Power Supply Board, to be full-wave rectified (230 VAC).

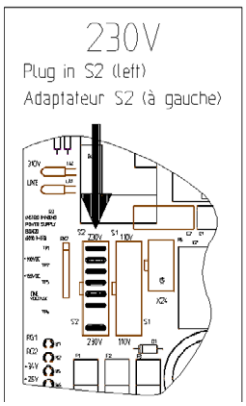
It also connects the primary coils of the line transformer TF1 & TF2 parallel (230 VAC).



WARNING!

The line voltage selection jumper must always be at the correct position; left for 230 VAC.





1.4.2 High voltage section

In high voltage section (upper half of the PC board) there is a rectifier D 4 for line voltage and loading circuitry K1-K2-R6 for two capacitors C1 and C2, which are connected to the PC board through connector X22.

1.4.3 Low voltage section

In low voltage section (= lower half of the PC board) there are fuses, rectifiers and filter capacitors for low operating voltages:

- 24 VAC (from transformer TF1) is fused by F2, rectified by D5 (to +34 V) and filtered by C3-C4-C5.
- 18 VAC (from transformer TF2) is fused by F3, rectified by D6 (to +25 V) and by D7 (to -25 V) and filtered by C7-C8.
- 12 VAC (from transformer TF2) is fused by F1.

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POWER SUPPLY BOARD FUSES			
FUSE	RATING	FUNCTION	SIZE
F1	6.3 AT or 10 AT	+12 VAC	6.3 x 32 mm
F2	6.3 AT	+34 VAC	6.3 x 32 mm
F3	2 AT	+25 V, -25 V	6.3 x 32 mm

NOTE!

F1 with 10 AT rating is needed, if the OP100 has with 5 projectors for double side patient positioning.

List of indicators and test points, see *Service Manual: Trouble Shooting*.

1.5 C167 CORE MODULE (CODE 60244)

OP100/OP100 D is a microprocessor controlled equipment. Core Module monitors control it's all movements and other operations, except the head support lock operation and ceph soft tissue display (in OP100). All key inputs, microswitches and optocouplers are read by the Core Module. Accordingly the Core Module controls all operations by supplying control signals through it's input/output. Core Module is connected to other boards through Digital I/O Board (60229). X902 connects module to Digital I/O Board.

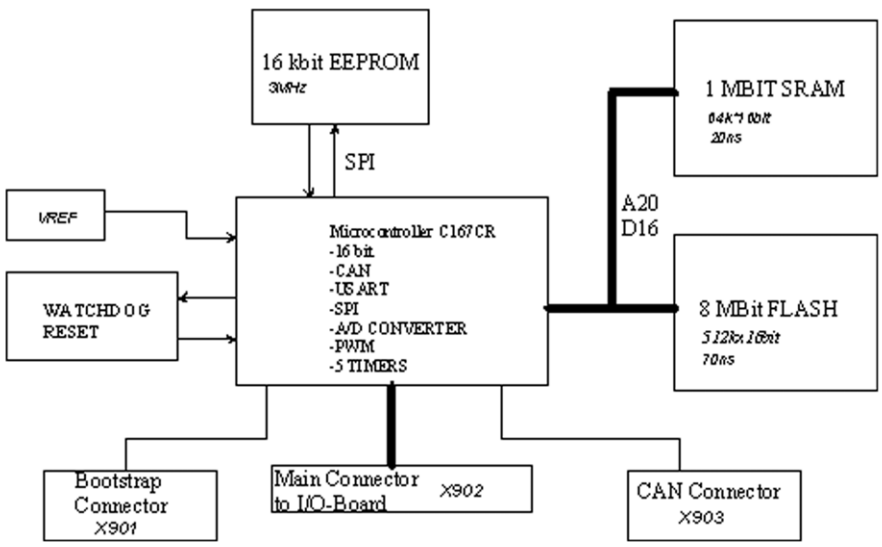

Fig 1.1. C167 Core Module Block Diagram.

SAB-C167CR-LM (ICD6) is 16-bit microcontroller. Program is stored in 8 Mbit flash ICD1. 5 MHz clock frequency is multiplied internally by four to get operating frequency 20 MHz.

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Core Module has different digital and analog ground. They are connected to each other by R30.

During voltage startup or at reset configuration is loaded to ICD6. ICD7-8, RN1, RN6, R23, R1, R5, R6, R9 and S2-E are used for configuring. When /RST from ICD3 goes low it enables ICD7 and 8 which load configuration to bus. ICD6 reads the configuration values at the end of the internal reset sequence. The rising edge of /ALE sets ICD7 and 8 to high impedance state after configuration. Default values are: clock multiply by four, 16 bit demultiplexed data bus, no bootstrap, /WR and /BHE control, two chip select lines (/CS0 and /CS1), 1 Mbyte directly accessible address space.

For details of configuration see C167CR Derivatives User's manual.

X901 can be used to load program to Core Module. X903 is a CAN connector. Core Module includes CAN driver.

DIL switch S2 settings are the same in all OP units.

1-4 must be ON and 5-8 OFF. Their functions are presented in schematics.

Push button switch S1 can be used to RESET the microcontroller.

RESET CIRCUIT

ICD3 (MAX823) is a watchdog RESET generator. During startup ICD resets the microcontroller. ICD3 has also a "watchdog" feature. If the software does not frequently generate pulses in /WD signal, ICD3 activates the RESET signal. Switch S1 can also be used to generate RESET.

RS232

Driver that converts C167 serial data to RS232 voltage levels is located in Digital I/O Board.

+5V VOLTAGE REGULATOR

6V is fed from Digital I/O Board. Linear regulator ICA1 regulates it to 5V.

Reference Voltage

Reference voltage is made by ICA2. It is 4.096V.

LEDS

H2 Green lit when supply voltage 5V is on.
H1 Red lit when ICD6 is in reset.

1.6 DIGITAL I/O BOARD (60229)

Digital I/O Board forms interface between Core Module and other boards.

Supply Voltages

Switcher ICA1 (L4971) is used to convert 25V input to 5V required by the board and 6V to Core Module.

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Grounding

There are three separate ground levels in the I/O Board. The actual I/O board ground level (GND for +5V). The generator ground-level from Filament Control Board and Inverter Board (from connector X 4, pins 22, 23, 25 and 26). Connected to several optoisolators. Signals from Control Panel are filtered to the ground level which is connected to chassis at the left hand lower corner of the IO-board to reduce common mode interference at control panel cable.

Signals with different GND levels are isolated by optoisolators to eliminate noise and RF interference problems, but connected inside the Tube Head Assembly and in the Power Supply Board.

PARALLEL INPUTS/OUTPUTS

I/O from I/O drivers to connectors is buffered and protected according to use:

- Relay drives and control panel signals are buffered by ICD34 (2803, Darlington driver).
- Signals to x-ray generator (Filament Drive Board, Inverter Board and Tube Head Assembly) and signal AECFRQ are optoisolated by quad-optoisolators.
- Rest of the output signals are driven by line driver HCT245 and protected by serial resistors.

SWITCHES:

SERVICE JUMPER X90 pins 3 and 4

Service switch is connected to pins 3 and 4 at connector X90. If pushed and keep pressed during reset or voltage startup it brings service programs available.

OPTION JUMPER X11

Jumper X11 is an option switch, normally in "off" position. When switched "on", the OP100 can be demonstrated normally, but the exposure is prevented. This feature can be used eg. in exhibitions.

Figure: X11 in ON position, XRAYS prevented.

X14

Program options in Core Module.

X15

L position, cephalo on left side.

R position, cephalo on right side.

JP1-3

These are used to select RS232 routing. In OP100/OP100 D they must be in A position.

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Signals at A position

	INPUT	OUTPUT	
TXD0	X10-52	X12-5, X3-4	Select=1
TXD0	X10-52	X3-1	Select=0
RXD2	X12-6	X10-53	Select=1
rXD1	X3-2	X10-53	Select=0
rXD2	X3-5	X10-53	Select=1

In B position RXD and TXD from X12 and X10 go to X3.

SPI

SPI interface is used between Core Module and Digital I/O board to reduce the number of connections. Serial data from Core Module is loaded to ICD28 and outputs are then buffered by HCT245 line drivers. Respectively a part of signals (for example microswitch states) are fed as serial data to Core Module.

SPI_SELECT is used to select data source. When 0 data to Core is from ICD17 and from Core to ICD28. When 1 data is read and written to control panel.

S1 settings

Fig 1.2. Service switch

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Switch	Function	Setting
1 (A)	Film/Digital OP selection	OFF=FILM, ON=DIGITAL
2 (B)	COL3SW	OFF, not used with 69088 cable
3 (C)	COL2SW	OFF, not used with 69088 cable
4 (D)	COL1SW	OFF, not used with 69088 cable
5 (E)	NOT CONNECTED	
6 (F)	NOT CONNECTED	
7 (G)	NOT CONNECTED	
8 (H)	CAEFRQ	ON in digital OP, off in film OP

1.7 INTERFACE BOARD (CODE 60166)

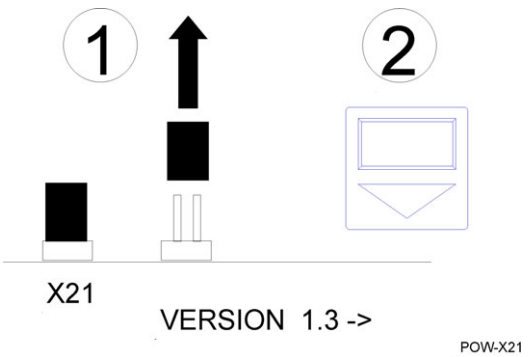
Interface Board contains driver circuits for stepper motors, DC motors, driver projector and warning lights, under the control of C167 core module.

STEPPER MOTOR DRIVERS

Stepper motor drivers ICA's 2, 7 & 11 (PMB 3690) convert incoming frequencies to stepper motor control sequences, and the half-bridge drivers ICA's 1, 3 & 5 (L298) drive the stepper motor windings.

FILM UNIT CASSETTE RACK

It is possible to increase power to the cassette holder down drive. This is done by removing X 21 jumper. Full power is available for down movement. This can be used if the cassette holder movement is jammed.



DC MOTOR DRIVERS

The Vertical carriage motor (Z-motor) and the Cassette lift motor (rack motor) are driven accordingly by circuits around pulse width modulators ICA9 and ICA10 (TL494).

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PROJECTORS, WARNING LIGHTS

Positioning projectors are controlled by relay K1. The x-ray warning lights LA1 and LA2 are controlled by relay K4.

Interface board OT: Laser lights are used in Ortho Trans units. Lasers are controlled by transistor T7.

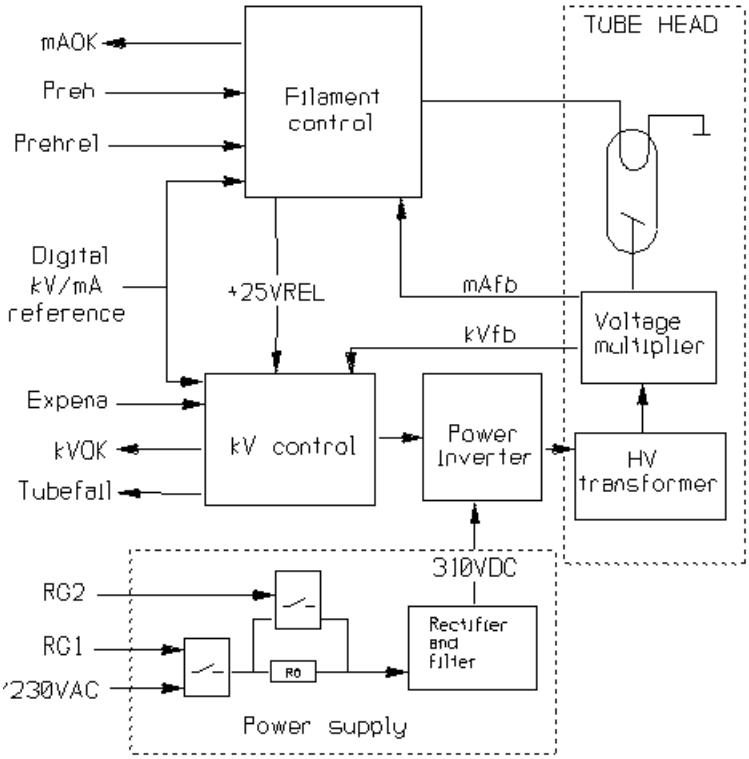
+15V VOLTAGE REGULATOR

+15V operating voltages for PWM circuits ICA9 and ICA10 are regulated from unregulated +25V by ICA1 (LM317).

List of indicators and test points, see *Troubleshooting Manual*.

1.8 X-RAY GENERATOR

The X-ray generator consist of Tube Head assembly, Filament control Board and Inverter Board.



Generator exposure sequence

Time 0: Exposure button pressed, exposure sequence starts

- **RG1 on:**
  - Connects high voltage (+310V) to the Inverter Board (via soft start resistor R6 on Power supply Board).
  - Red LED H1 (RG1) on Power supply Board is lit.
  - Green led H1 (+310V) on inverter Board is lit.
- **PREH on:**
  - Sets the Filament control Board into preheat mode.
  - Red LED H7 (PREH) on Filament control Board is lit.
- **PREHREL on:**
  - Enables filament power circuit.

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- Red LED H6 (PREHREL) on the Filament control Board is lit.
- Red LEDs H8, H10 and H11 on the Filament control Board are glowing.
- Connects +25V to the Inverter Board.
- Green LED H7 (+25) on the Inverter Board is li

TIME 800mS

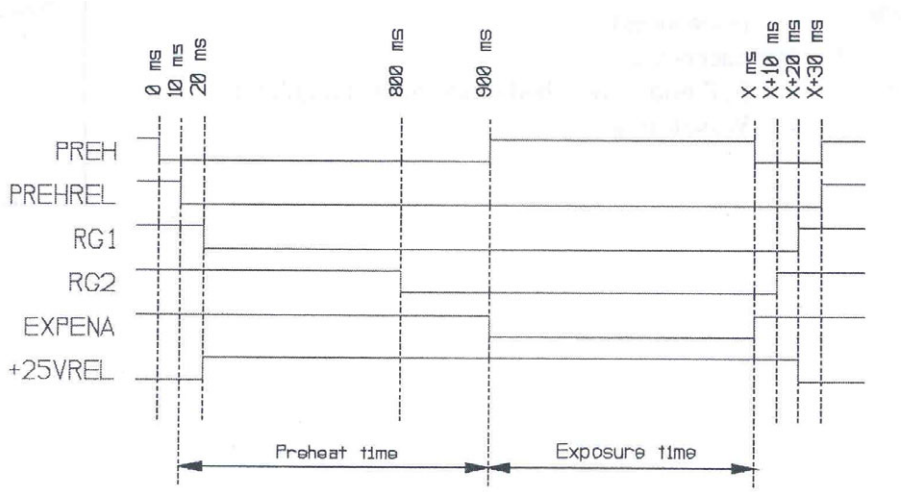
- **RG2 on:**
  - Soft start resistor R6 on the Power supply Board is bypassed.
  - Full power is connected to Inverter Board.
  - Red LED H2 on Power supply Board is lit.

TIME 900mS:

- **EXPENA on:**
  - Enables the generator high voltage (kV) circuit.
  - Red LED H6 on Inverter Board is lit.
  - Red LEDs H2, H3, H8, H9, H10 and H11 on Inverter Board are glowing.
  - High voltage is generated.
- **PREH off:**
  - Sets Filament control Board into tube current regulating mode.
  - Red LED H7 on Filament control Board goes off.

TIME 910mS:

- Generator is generating X-rays:
  - kVOK red LED H4 on Inverter Board is on.
  - mAOK red LED H5 on Filament control Board is on.



1.9 FILAMENT CONTROL BOARD (CODE 60114)

Filament Control Board regulates filament heating level prior to the exposure (preheat control) and during the exposure (mA control), according to the digital references controlled by C167 Core Module.

MA-REFERENCE

Digital mA/preheat reference (signals KVMA0 - KVMA7) is latched to D/A converter ICA2 (7524) at 20 ms intervals by the negative edge of signal KVMACLK, while signal KVMASEL is being low at the same time.

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The +5V input reference from D 17 (LM336-5.0) is fed to the D/A converter via a buffer amplifier ICA1 (TL074). The output reference (MAREF) is also buffered by ICA1.

MA-REGULATOR

PWM (pulse width modulator) ICA3 (TL494) regulates the filament heating level by adjusting the duty cycle of the driver transistors so that the feedback voltage at pin 1 is the same as the reference voltage at pin 2.

PWM FEEDBACK MULTIPLEXER

The feedback voltage to the pin 1 of the PWM circuit ICA3 (TL494) comes through the multiplexer ICD2 (4052). The feedback source (from ICD2) depends on the control signals PREH and PREHREL:

STATUS	PREH (TP5)	PREHEL (TP6)	FEEDBACK-SOURCE
preheat sequence normal exposure (mA-reference check) (stand by)	active (0) active (0) passive (15V) passive (15V)	active (0) passive (15V) active (0) passive (15V)	PREHFB MAFB (MAFB) (MAFB)

FILAMENT TRANSFORMER DRIVE

Pulse Width Modulator ICA3 (TL494) drives the FET switches T1 and T2, which drive the filament transformer primary. Filament voltage is rectified and monitored as signal PREHFB.

MA-FEEDBACK MONITORING

C167 Core Module is able to check some voltage levels in the Filament Control Board by reading the frequency MAFRQ in different situations; The voltage to the U/F converter ICA4 (AD654) comes through the multiplexer ICD2 (4052). The voltage source (from ICD2) depends on the control signals PREH and PREHREL:

STATUS	PREH (TP5)	PREHREL (TP6)	VOLTAGE-SOURCE
preheat sequence	active (0)	active (0)	MAFB +5V
normal exposure	active (0)	passive (15V)	MAREF LINEFB
(mA-reference check)	passive (15V)	active (0)	
(stand by)	passive (15V)	passive (15V)	

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mA References and Feedbacks			
mA	**Nominal reference [V]**	**Reference tolerances [V]**	**Feedback tolerances [V]**
2.0	0.49	0.48 - 0.50	0.46 - 0.52
2.5	0.61	0.60 - 0.62	0.57 - 0.65
3.2	0.76	0.75 - 0.78	0.71 - 0.82
4.0	0.96	0.94 - 0.98	0.89 - 1.03
5.0	1.22	1.19 - 1.24	1.13 - 1.30
6.4	1.53	1.50 - 1.56	1.42 - 1.64
8.0	1.92	1.88 - 1.96	1.79 - 2.06
10	2.43	2.38 - 2.48	2.26 - 2.60
13	3.06	3.00 - 3.12	2.84 - 3.27
16	3.84	3.77 - 3.92	3.57 - 4.11

The frequency MAFRQ is monitored by the C167 Core Module.

- During preheat sequence C167 Core Module is able to measure the mA value (tube current), which enables the automatic preheat adjustment.
- During normal exposure the C167 Core Module is able to calibrate reading of the U/F converter ICA4 (AD654), since the U/F converter converts +5V reference into frequency.
- During mA-reference check sequence C167 Core Module is able to check the reference that has been written to the D/A converter ICA2 (7524).
- During stand-by the C167 Core Module monitors the LINEFB, which indicates the line voltage level.

If MAFB does not rise, signal MAOK does not go active during the exposure.

Measure test points on the board:

TP1= GND
TP2 = mAFB
TP4 = mAREF

+/- 15V VOLTAGE REGULATOR

Supply voltages are regulated from unregulated +/- 25V by switching regulator ICA6 (L4962) for +15V and linear regulator ICA7 (LM337) for -15V.

List of indicators and test points, see *Troubleshooting Manual*.

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NOTE!

Rule of thumb: 1V is approx. 4 mA.

1.10 INVERTER BOARD (CODE 60115)

Inverter Board regulates kV during the exposure, according to the digital reference controlled by C167 Core Module. Inverter Board consists of two main parts: High voltage section containing the FET bridge, and low voltage section containing the regulating, reference and pulsing circuits.

WARNING!

Voltages in high voltage part of the inverter board can be deadly.
The peak-to-peak voltage level normally exceeds 600 V.

FET BRIDGE (HIGH VOLTAGE)

The FET-transistors in the H-bridge switch power to the high voltage transformer in the tubehead assembly. The higher the frequency in the FET bridge is, the lower the power level (kV*mA) in the tubehead assembly. In general, FET's T1, 2, 7 and 8 conduct at the same time, and FET's 3, 4, 5 and 6 accordingly, at the opposite phase.

KV REFERENCE

Digital kV reference (signals KVMA0 - KVMA7) is latched to D/A converter ICA3 (7524) at 20 ms intervals by the negative edge of signal KVMACLK, when signal KVMASEL is high at the same time.

The +5V input reference D21 (LM336-5.0) of the D/A converter is buffered by ICA1 (LM324). The output reference (KVREF) is also buffered by ICA1.

KV REGULATOR

kV regulator consists of KVFB buffer & error amplifier ICA1 (LM324), frequency modulator & comparator ICA2 (LM339) and pulse shaping circuit & flip flop ICD2 (4013). kV regulator regulates kV by adjusting the operating frequency of the high voltage FET bridge.

PULSE TRANSFORMER DRIVE

Drivers ICA4 and ICA5 (SG3635) drive the pulse transformers TF3 and TF4, which in turn drive the FET-switches of the H-bridge.

KV-FEEDBACK MONITORING

If kVfb does not rise, signal KVOK does not go active during the exposure.

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kV references and feedbacks			
kV	**Nominal reference [V]**	**Reference tolerances [V]**	**Feedback tolerances [V]**
57	2.84	2.78 - 2.90	2.64 - 3.04
60	3.00	2.94 - 3.06	2.79 - 3.21
63	3.16	3.10 - 3.22	2.94 - 3.38
66	3.31	3.24 - 3.38	3.08- 3.54
70	3.49	3.42 - 3.56	3.25 - 3.73
73	3.67	3.60 - 3.74	3.41 - 3.93
77	3.84	3.76 - 3.92	3.57 - 4.11
81	4.06	3.98 - 4.14	3.78 - 4.34
85	4.25	4.17 - 4.34	3.95 - 4.55

Measure test points on the board:

TP17 = GND
TP18 = KVFB
TP19 = KVREF

BACK-UP TIMER

Back-up timer ICA2 (LM339) disables the pulses, if the EXPENA signal is active for too long period (approximately 22 s).

TEST SWITCH

When testing the unit without x-rays, or without kV, TEST switch S, from board version 1.3 jumper X35, allows the activation of the exposure sequence and imaging movements regardless of the KVOK feedback.

+15V/+25V SUPPLY VOLTAGES

Supply voltages to Inverter Board are connected via the Filament Control Board. +25V is only present during exposure (when PREHREL signal is active in Filament Control Board).

FUSE

High voltage fuse in the Inverter Board, to protect the printed circuit board in case of short circuits. Fuse rating is 16 AFF, or 10 AT (from August 1994).

INVERTER BOARD FUSE			
FUSE	RATING	FUNCTION	SIZE
F1	10 AT or 16 AFF	INCOMING 310 VDC	6.3 x 32 mm

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List of indicators and test points, see *Troubleshooting Manual*.

NOTE!

Rule of thumb: 1V is approx. 20 kV.

1.11 TUBE HEAD ASSEMBLY (CODE 66360)

WARNING!

Voltages inside the tube head assembly are deadly. Maintenance of the tube head assembly can only be accomplished at the factory. There are no field serviceable parts inside the tube head assembly, and opening of the tube head assembly causes non-repairable damage and oil leakage.

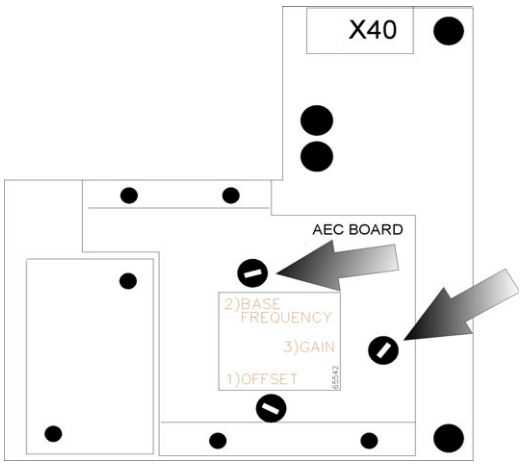
Tube head assembly consists of high voltage transformer TF1, voltage multiplier circuit D1-16 and C1-8, feedback resistors and the tube insert.

1.12 AUTOMATIC EXPOSURE CONTROL (AEC) BOARD (CODE 60122)

NOTE!

AEC board is for film units only.

AEC Board detects the radiation intensity through the cassette, converts the current mode signal from the detectors to voltage mode signal, and converts the voltage to frequency. The frequency (AECFRQ) is monitored by C167 Core Module. AEC-board has three adjustment points and all adjustments must be done after OP100 electronics have reached their operational temperatures.



AMPLIFIERS

Incoming current mode signal from the x-ray detectors D50 - D51 is converted to voltage mode signal and amplified by ICA1 (AD546) and ICA3 (AD706).

OFFSET R3 is used to adjust the offset for operational amplifiers. It has been adjusted at the factory for 0 VDC measured from TP1.

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U/F CONVERTER

The amplified voltage is converted to frequency signal by the voltage-to-frequency converter ICA4 (AD654), and the frequency (AECFRQ) is wired to the C167 Core Module.

BASE FREQUENCY

R27 is used for base frequency adjustment of 5 kHz ± 0.25 kHz at 0 kV / 0 mA. The value is measured from TP2 or by using the "Sr 90 PIn" service program test mode and reading the frequency from the display.

GAIN

R6 is the gain adjustment. It is adjusted by exposing through a special service tool (code 60441). Gain will be adjusted using Sr 90 PIn program AEC mode to read as follows:

230 VAC: 73 kV / 13 mA 144 kHz ± 3 kHz

List of indicators and test points, see *Troubleshooting Manual*.

1.13 PAN AEC TERMINAL BOARD (CODE 60247)

NOTE!

Pan AEC Terminal Board is for digital units only.

Terminal Board and fibre cable

- A bridge between the optical (towards the PC) and electrical (OP) communication
- Sends control messages from the PCI Board to the C167 Core Module and Camera according to the address.
- Combines control data (from the OP C167 Core Module and Camera) to the image data from the Camera and sends that to the PC via PCI Board.

Other features:

- FPGA based logic "router".
- RS422 and RS232 voltage level shifts
- LOOP_SENSE: Hot swap feature for camera.
- PPOWER, PIMAGE, PDETCLK (from the OP C167 Core Module) control the image acquisition.
- Connections to the OP C167 Core Module and PCI Board are optoisolated.
- 16MHz oscillator and internal 10-multiplier for the Link clock (160MHz)
- See adjustments for PAN AEC gain adjustment

NOTE!

Jumper J1 must be open when you use removable cameras. Jumper is only closed in old units with fixed camera.

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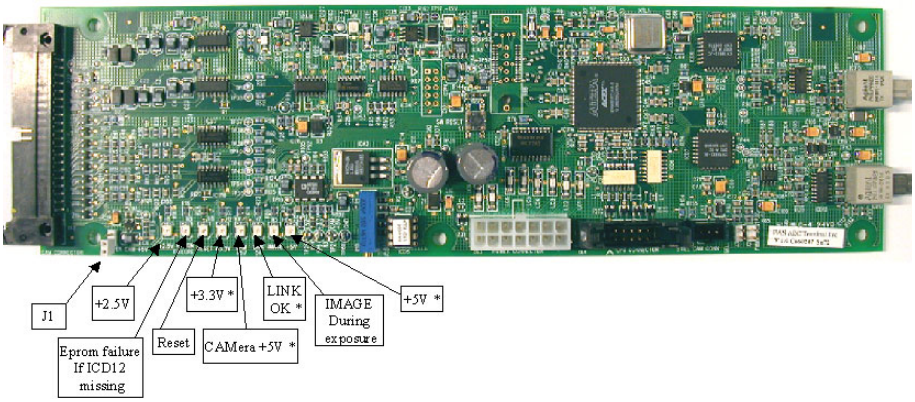
LED	H1:	+2.5V
	H2:	+3.3V
	H3:	EPROM failure (red)
	H4:	CAM +5V
	H5	CIMAGE
	H6:	+5V
	H7	LINK_OK
	H8:	RESET (red)
	H9:	AEC +15V
	H10:	AEC-15V

PAN AEC Terminal Board



1.13.1 PAN Automatic Exposure Control (AEC)

PAN AEC Board detects the radiation intensity through the sensor, converts the current mode signal from the detectors to voltage mode signal, and converts the voltage to frequency. The frequency (PAECFRQ) is monitored by C167 Core Module. This board has one adjustment point (R10) and all adjustments must be done after OP100 D electronics have reached their operational temperatures.

AMPLIFIERS

The incoming voltage mode signal from the sensor is amplified by ICA6.

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U/F CONVERTER

The amplified voltage is converted to frequency signal by the voltage-to-frequency converter ICA5 and the frequency (PAECFRQ) is wired to the C167 Core Module.

BASE FREQUENCY

Digital unit does not use base frequency. Only during exposure you can see values of the frequency.

PAN AEC sensitivity adjustment

1 Switch POWER ON and wait 10 minutes for system to warm up.

2 Install to the front cover of the tube head the 20 mmAl phantom

3 Select service program Sr 90 PIn, AEC mode and exposure values 73 kV/13 mA/2 seconds.

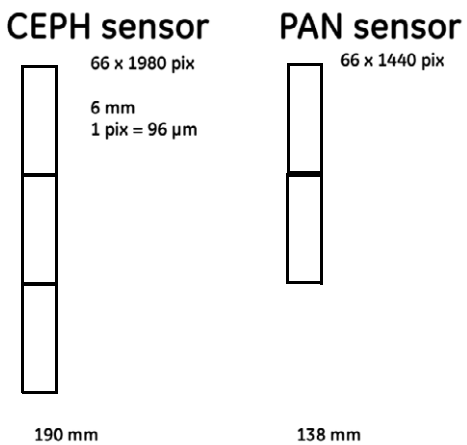
4 Make exposures and adjust with the Gain trimmer (R10) on the PAN AEC Terminal Board so that the time display shows 144kHz +/-3kHz

NOTE!

Before adjusting remember to enable image capturing from CliniView of similar before each AEC frequency test shot.

1.14 PANORAMA & CEPHALOMETRIC CAMERA (DIGI ONLY)

- 2 models: PAN (DCP138 - 7) and CEPH (DCC184 - 8) removable cameras
- Contains CCD Board which includes:
  - CCDs (2 chips on PAN and 3 on CEPH) with A/D and clocking electronics
  - straight fibre optics
  - scintillator
  - lead shielding
- Connects to the system via a Terminal Board



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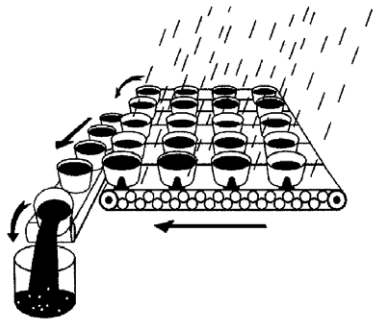

Fig 1.3. Functional description of the CCD

PAN / CEPH CAMERA

- CCD terminology (Charged Couple Devices for Quantitative Electronic Imaging):
- Parallel and seriel shifts, Binning, TDI mode (Time Delay Integration)
- Correlated Double Sample (CDS), A to D conversion (A/D)
- 12-bit image information
- Scintillator and fibre optics
- Serial communication bus, RS232, 9.6kb/s: Imaging mode selection and communication.
- 6-bit wide image data bus (Hi/Lo bytes, RS422)
- Control signal (RS422) to the Camera: TDI clock, line clock controls A/D conversion according TDI speed.
- Control signal (RS232) to the Camera: IMAGE enable
- 3 Control signals from the Camera for image data sync
- RS-422 signals for byte high/low (H/L) indication, DS for sampling image data
- RS-232 signal (VV) for individual image line.

1.15 CAMERA POWER SUPPLY BOARD (CODE 60197) (DIGI ONLY)

SUPPLIES POWER FOR THE PAN CAMERA

- Generates voltages to the Terminal Board and to the Camera.
- +34V, +5V and +3.3V are permanent voltages; the rest are controlled with POWER signal by the OP C167 Core Module.

LED:	H1:	+5V
	H2:	-5V
	H3:	+5V
	H4:	-18V
	H5:	+18V
	H6:	+26V
	H7:	+3.3V (permanent)
	H8:	+5V (permanent)
	H9:	+34V (permanent)

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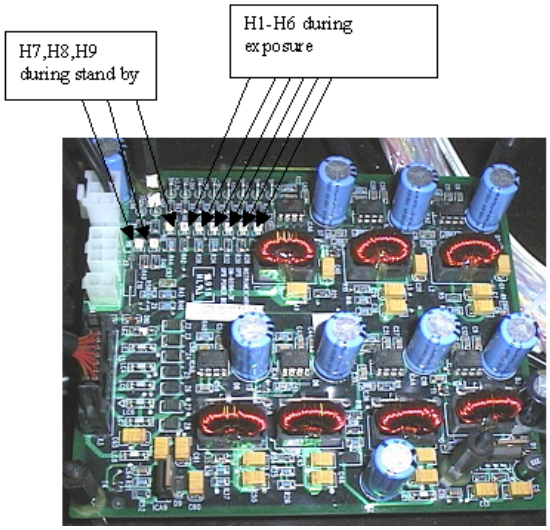

1.16 CEPH TERMINAL BOARD (CODE 60191) (DIGI ONLY)

- See PAN AEC terminal Board about the image capturing control signals.
- In addition to the image capturing part (excluding AEC) the board measures the nasio support position.
- The measurement result is transmitted to the OP C167 Core Module which ramps down the exposure values accordingly providing soft tissue filtering.
- Nasio frequency adjustment

LED	H1:	+2.5V
	H2:	+3.3V
	H3:	EPROM FAILURE (red)
	H4:	CAM+5V
	H5:	CIMAGE
	H6:	+5V
	H7:	LINK_OK
	H8:	RESET (red)
	H9:	+2V

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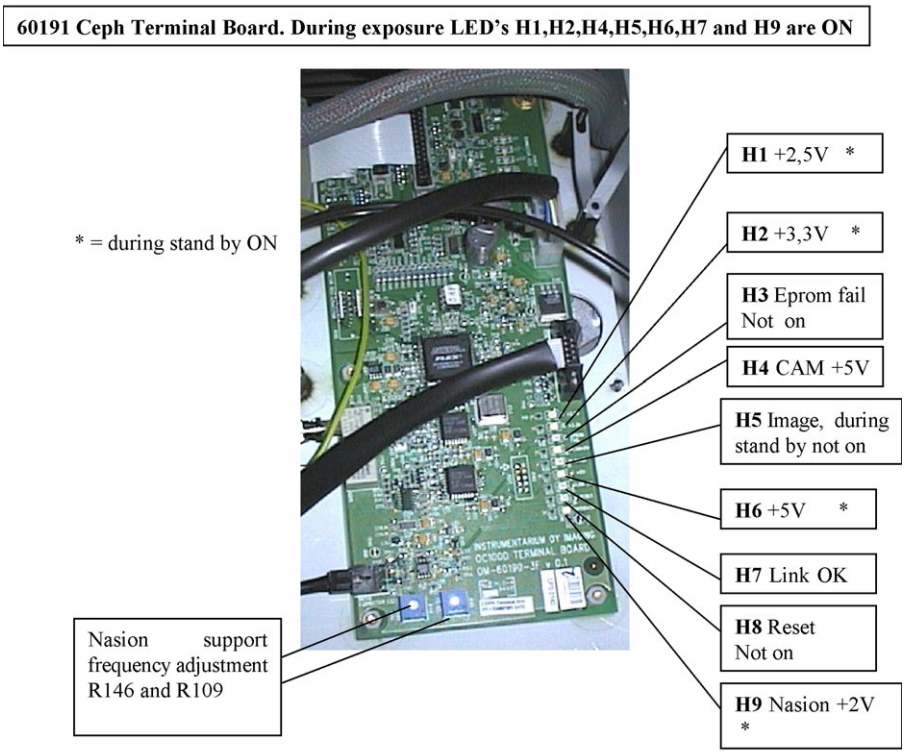
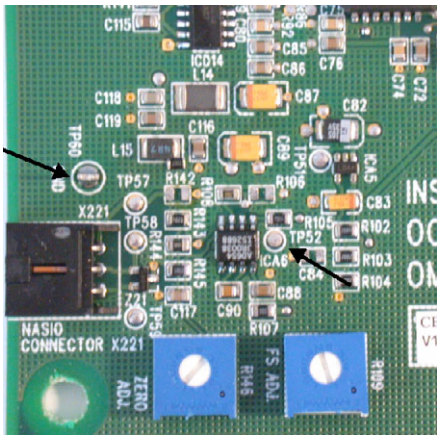
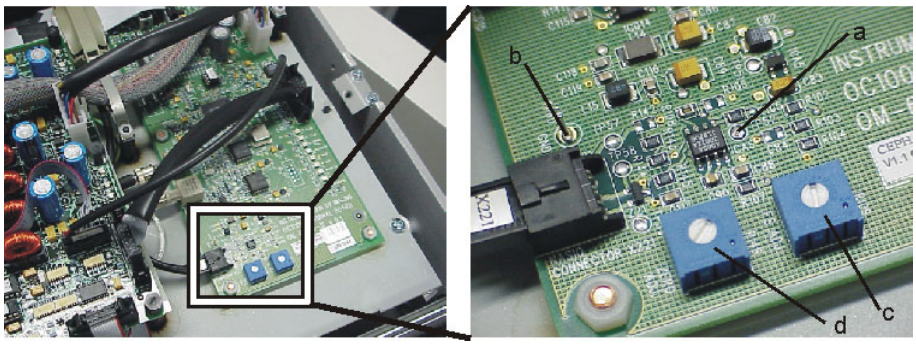


1.16.1 Nasio -frequency adjustment



Connect the frequency meter to the Ceph terminal Board test points TP52 (NASIO FRQ) **(a)** and TP60 (GND) **(b)**. Slide the nasion support to the furthest position from the ear rods. Adjust with the trimmer R109 **(c)** the reading of the frequency meter to 4000 Hz ((25 Hz). Slide the nasion support to the closest position to the ear rods. Adjust with the trimmer R146 **(d)** the reading of the frequency meter to 2000 Hz (25 Hz). Check the readings again and repeat the adjusting if needed.



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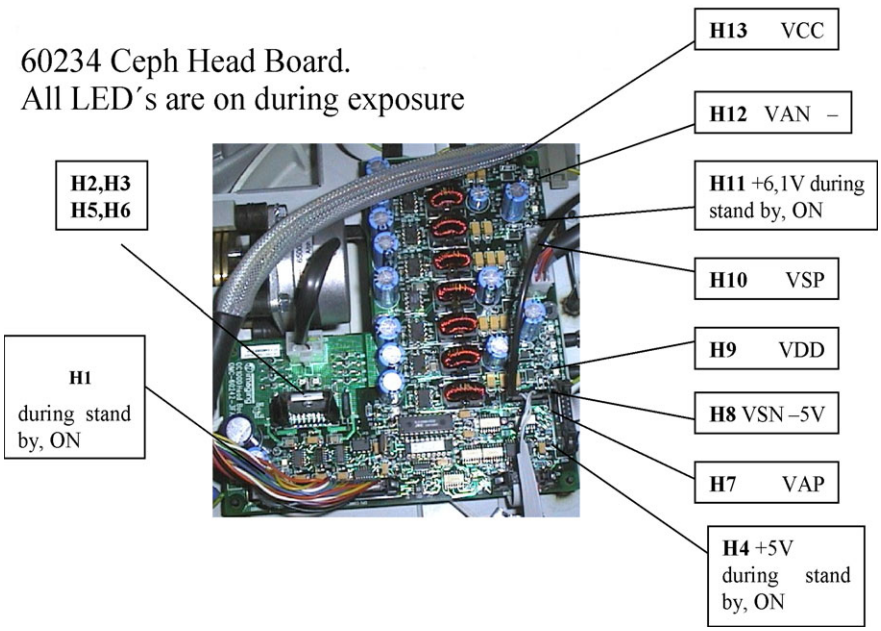
1.17 CEPH HEAD BOARD (CODE 60243) (DIGI ONLY)

- CEPH imaging movements
- Power supplies for the CEPH camera
- Drives movements, laser positioning light and all supply voltages to the CEPH Camera and electronics on the CEPH head assembly.
- Jumper J1: OFF normal use, ON enables exposure without Beam alignment Board (Don't care CEPHC-signal)

LED:	H1:	+34V(permanent)
	H2:	SCAN1
	H3:	SCAN2
	H4:	+5V (permanent)
	H5:	SCAN3
	H6:	SCAN4
	H7:	+18V (VAP)
	H8:	-5V (VSN)
	H9:	+26V (VDD)
	H10:	+5 (VPS)
	H11:	+6.1V (permanent)
	H12:	-18V (VAN)
	H13:	+5V (VCC)



1.18 BEAM ALIGNMENT BOARD (CODE 60249) (DIGI ONLY)

- The CEPH beam alignment is supervised by the OP C167 Core Module throughout the exposure.
- The X-ray beam position related to the secondary collimator is detected by the Beam alignment Board.with three detection channels (CEPHL, CEPHR& CEPHC)

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- If the CEPHL or CEPHR -signals become active the OP C167 Core Module accelerates or decelerates the rotation and linear (=X-ray beam movement).
- If CEPHC -signal becomes passive the exposure is terminated (Sy32 PoA, Alignment error).
- See channel sensitivity adjustment

LED	H1:	CEPHL
	H2:	CEPHC
	H3:	CEPHR
	H4:	+5V

- Beam alignment detection sensitivity adjustment

1 Check beam alignment (see figure functional description)

2 Align the movements with Sr 91 Cin - T-mode and press exposure button.

3 Make (EPS) exposures with Sr 91 Cin M-mode/2 mA and adjust center channel (CEPHC) sensitivity (R10) so that it reliably detects (LED H2 is lit) radiation. Sensitive increases when R10 is turned clockwise and decreases when R10 is turned counter-clockwise.

In case of Prüfkörper checks (German units) place 0.8 Cu plate in front of tube and made exposures with 85 kV/8 mA.

4 Move the Ceph movement by hand so that the secondary collimator moves to the left 10mm and adjust the right channel (CEPHR) sensitivity with R16 and H3. Use 60kV and 2.5mA.

5 Repeat step 4 to the left channel (R4, H1).

NOTE!

The function of the LED´s H1, H2 and H3 you can also detect on the control panel density scale.

Density Scale

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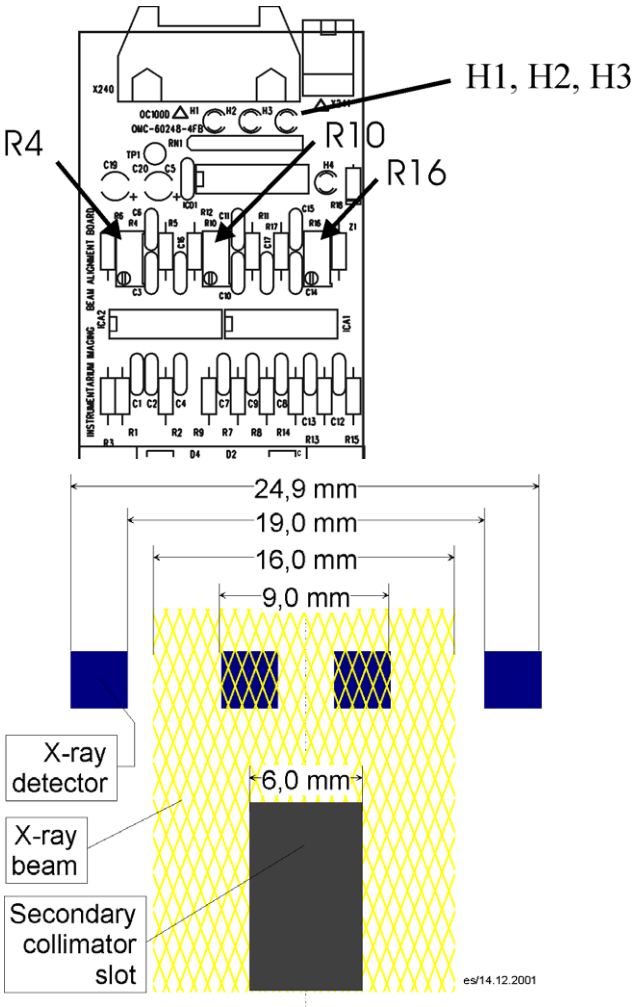

Fig 1.4. Functional description

NOTE!

Before adjusting channel sensitivities make sure that x-ray beam is in the middle of beam alignment board.

1.19 PCI BOARD (CODE 60187) AND FIBRE CABLE (CODE 69061) (DIGI ONLY)

The standard optical fibre cable length between the PC and OP-unit is 10m long, and the data transmission speed is 160Mbps.

Features:

- A bridge between the optical / serial (from OP) and electrical / parallel PCI bus.
- Sorts incoming image and control data according to the address attached to the data.
- FPGA based logic “series to parallel converter”
- 16MHz oscillator and internal 10-multiplier for the Link clock (160MHz)

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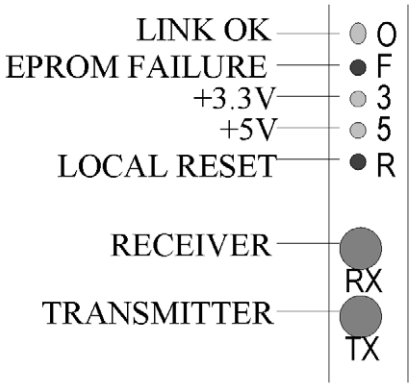
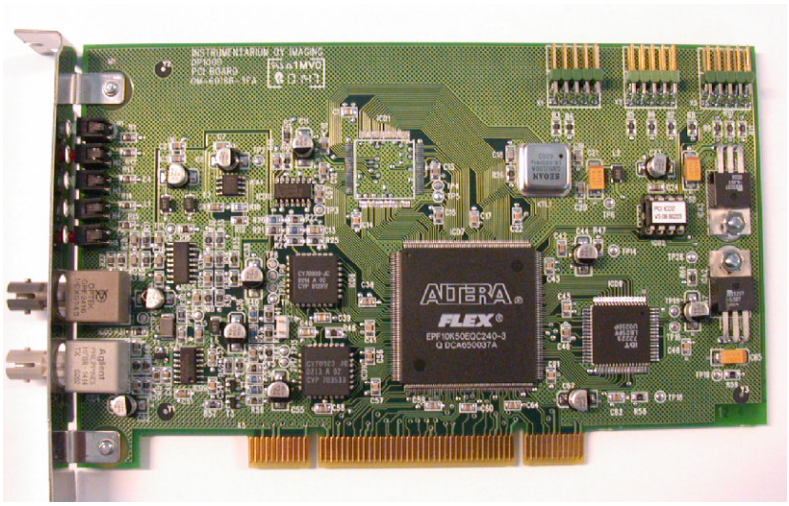
LED	H1:	LINK_OK
	H2:	EPROM FAILURE (red)
	H3:	+3.3V
	H4:	+5V
	H5:	LOCAL RESET (red)





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2 Other components

2.1 CONTROL PANELS (CODE 64105 FOR FILM AND 64104 FOR DIGITAL)

Control panel allows the operator to control OP100, and displays the status of the equipment to the operator. Control panel is monitored and controlled from C167 Core Module by a serial link.

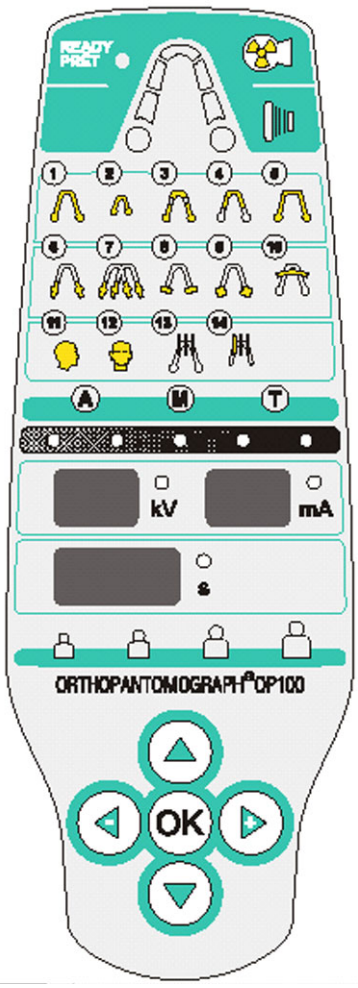

Fig 2.1. Film unit control panel

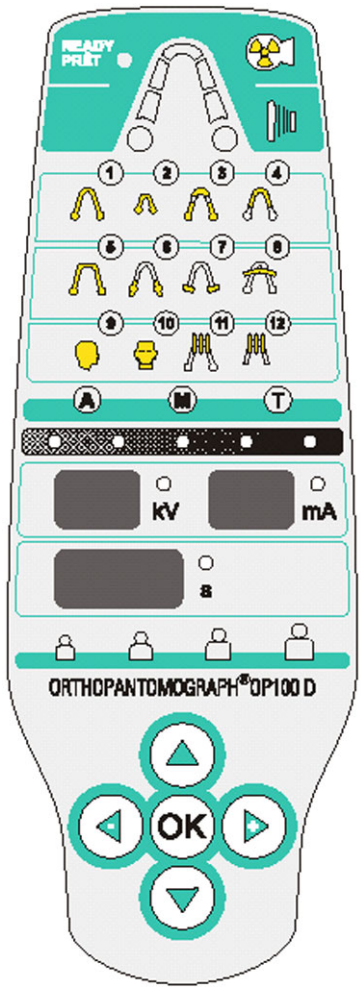

Fig 2.2. Digital unit control panel

DISPLAY DATA IN

Serial mode input signals from the C167 Core Module are buffered by ICD7 (40106), and wired to decoder circuit ICD4 (74HC138).

Incoming data is decoded to drive the LED indicators L1-L25 through ICD3 (M5450V).

The 7-segment display drive is in a separate piggy-back pcb. The incoming data is decoded to drive the 7-segment displays through ICD1 and ICD2 (MC14489).

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KEY SWITCH DATA OUT

Key switches S1, S2, S3, S4 and S6 (up-left-down-right-OK) are buffered by ICD6 (40106), decoded and multiplexed by circuits ICD2 (74HC165) and ICD4 (74HC138), and driven to the C167 Core Module through the serial link.

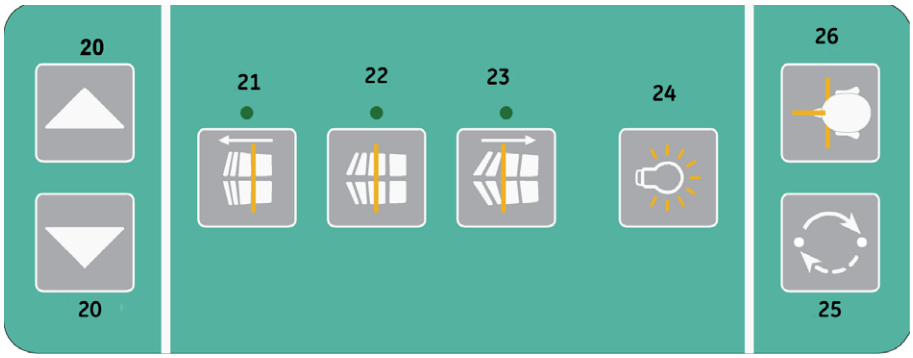
Exposure switch S5 is wired directly to the C167 Core Module. It is possible to disable S5 function with Automatic and Manual mode operation. In this case the exposure with radiation is acticaed via remote control only. See Sr 89 rEo or Sr 89 COP options for details.

VOLTAGE REGULATOR

Supply voltage +5V is regulated by ICA5 (L4963).

2.2 PATIENT POSITIONING PANEL (CODE 60218)

Patient Positioning Panel includes all the key switches required when positioning the patient in OP100. The occlusal corrections according to the biting of the patient are indicated by three LED indicators.



The three LED indicators for SW H22 - H24 are driven from the C167 Core Module, and key switches S20 - S27 are wired to the C167 Core Module. Pressing any key will ground the C167 Core Module input line. Pressing any key (except "OK") at power up causes Er 45 InP message.

The Patient Positioning Panel is usually installed to the left hand operation. For the right hand operation, connect the panel to the right side of the lower shelf and use the connectors on the right side. Cable C 10 has double connectors (X 47/L, X 47/R and X 48/L, X 48/R) specially coded to inform C167 Core Module about the panel location.

C167 Core Module detects whether the Patient Positioning Panel button is pressed from left or right side. Thus the patient positioning is possible on left or right sides, the positioning should naturally be performed on side, where the positioning lights are projected. The imaging sequence operation with digital units is only from one side with clockwise rotation, but with film units the imaging sequence can be bi-directional.

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NOTE!

Technically it is possible to have two Patient positioning panels installed on both sides at the same time. In this case, the operation direction depends on which side the cassette happens to be when starting the image capture. User program Pr 57 Hon affects to the fact on which side the film cassette is automatically raised up.

2.3 HEAD SUPPORT LOCK

Head Support Lock consists of the magnet lock and the lock switches and the movement is horizontal. The head support assembly is fixed in vertical movement.

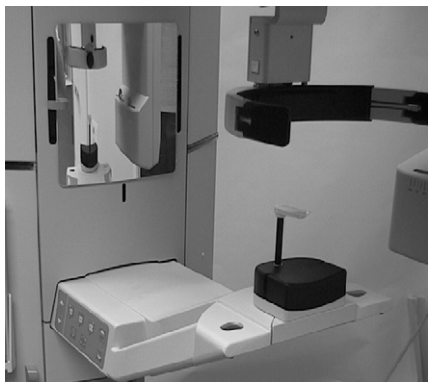
+ 25 VDC

Power is received from Power Supply Board. When the OP100 power is on, current is drawn through magnet L2 and the head lock is on. Circuit is opened by pressing one of the switches S2 or S3 located at the sides of the head support assembly.

NOTE!

C167 Core Module does not control the head support lock operation.

2.4 HALOGEN POSITIONING LIGHTS



For panoramic and TMJ positioning there are three halogen lights. Lights are controlled through Interface Board. They do not operate in QA nor CEPH operating modes.

For digital unit cephalostat patient positioning there is a laser FH-light.

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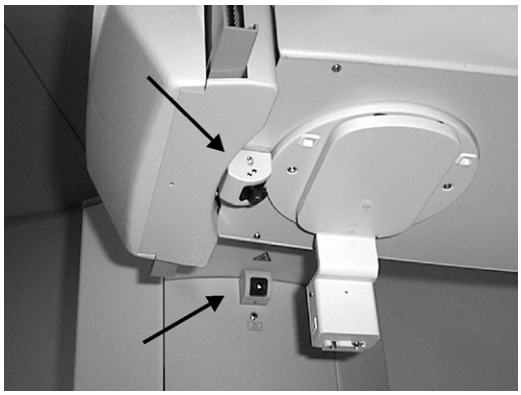
2.5 ORTHO TRANS POSITIONING LIGHTS



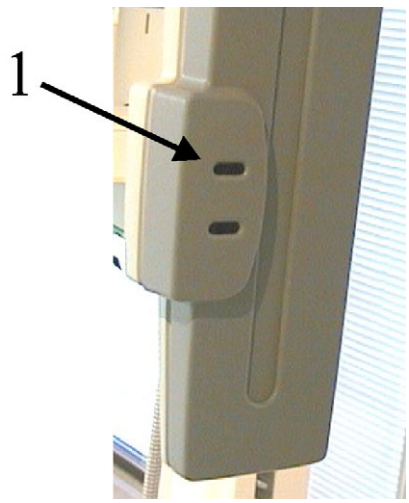
Ortho Trans models have two laser lights, one above the mirror and the other under the rotating cover. Laser lights are controlled by Interface board OT. There are not adjustable parts inside the laser light assembly. Lasers are lit when

- Ortho Trans opton is active (Sr 89 COP / 7 P11 "on") and
- the TOMO collimator is selected and lights on or occlusal correction keys are pressed on positioning panel.

2.6 FH LASER LIGHT (DIGI ONLY)

The laser lightprojector in OC100D is located in the secondary collimator

- If the standard earholders are used the light comes out of the upper hole (1).
- If there are used the extended earholders the light can be moved to the lower hole.



NOTE!

Observe pre-drilled marking holes for laser vertical position!

2.7 REMOTE EXPOSURE CONTROL

A remote control exposure switch with cable (code 69961) can be connected to a junction box located at the rear of the column. This switch is normally open and it is directly wired to the C167 Core Module. Signals are logical level voltages.

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REMOTE EXPOSURE ONLY

With **Sr 89 COP** one can configure OP100 so that exposure (Automatic and Manual Exposure control) can only be initiated from the remote exposure button. However, Test mode can always be demonstrated from Control Panel while **Sr 89 COP / 1 rE** is set **on**.

2.8 CEPH SOFT TISSUE DISPLAY (FILM ONLY)

The movement of the nose support changes the trimmer R 30 resistance. This board will show the nose support travel on two 7 segment displays with values "0 - 60", where value represents the distance from the center of the ear holders to nose support. The actual distance is "value" + "60 mm".

+25 VDC

Power is received from Power Supply board.

ADJUSTMENTS

There are trimmers R6 and R7 to adjust offset for "0" and gain for "60".

NOTE!
This board has no feedback to CPU board

2.9 CEPH SOFT TISSUE AUTOMATIC ADJUSTMENT (DIGI ONLY)

The digital unit automatically adjust the kV/mA values on the soft tissue areas. The reference for the adjustment is coming to the C167 Core Module through the Nasion support horizontal movement value according to the patients size.

The Nasio frequency can be adjusted from the ceph terminal board (chapter 1.17 in this manual)

2.10 CEPH NOSE SUPPORT

Horizontal and vertical movements. Part of the nose support assembly is a trimmer R221, whose resistance value changes when the nose support is moved. This value is used as an input to Ceph Soft Tissue automatic adjustment in digital units and as an input for ceph soft tissue display in film units.

2.11 UP/DOWN PANEL (CODE 60193) + UP/DOWN SWITCH (CODE 60143) (DIGI ONLY)

On the digital cephalostat cover there are a up/down switches for the vertical carriage movement and FH positioning laser light. In film unit instead of panel there are only up/down switches, signals of both these

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are wired to C167 core module. These keys together with Patient Positioning Panel keys have the same function, but they are wired to different I/O ports.

2.12 CEPHALOSTAT L/R CODING

The coding for the cephalostat and x-ray tube orientation is controlled with the jumper X 15 on the Digital I/O board. CEPH arm side LEFT or RIGHT.

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3 Overview of Digital Image Capture

3.1 Operation Overview

- During image acquisition state (when the “TAKE PAN IMAGE” -button on the CliniView is clicked) the OP C167 Core Module is a master and the imaging chain a slave:
- OP C167 Core Module starts and ends the exposures if the PC (and the imaging chain) is ready.
- The PC with the chain acts as a digital cassette, which receives the image and processes it.
- The PC knows whether any cameras (one or many) are connected to the system and sends that information to the OP via optical link. Without this information OP will not be READY for exposure.
- The following modalities can be connected to the same optical link (=PCI-board):

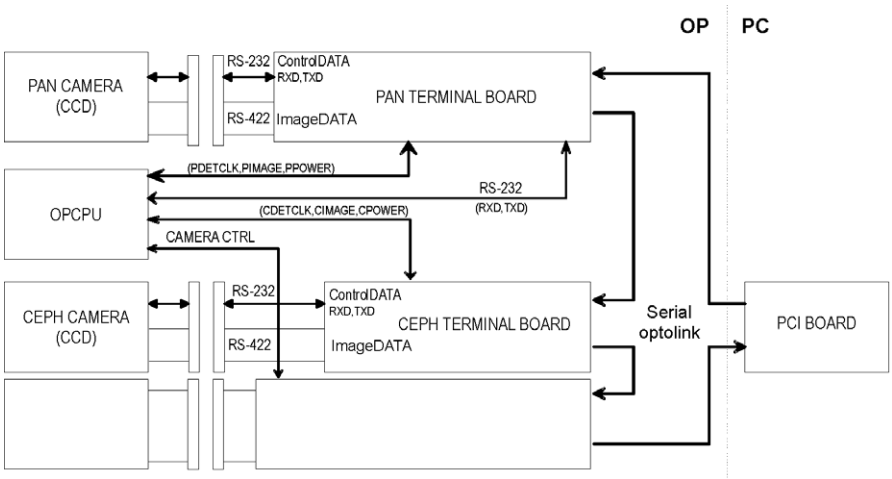
  1 Panoramic imaging

  2 Cephalometric imaging

  3 Future option

v.1.0/es /6.11.2

OCD IMAGING CHAIN ARCHITECTURE



- To one PCI-board can be connected up to 4 Terminal Boards, each of which provide 4 subaddresses to communicate with. For example on the block diagram, the upmost Terminal Board sees 3 devices (=subaddresses: OP C167 Core Module, PANCamera Image bus and PANCamera command bus), to/from which it conveys data.
- Each Terminal Board passes on data coming from the optical link if the address on the data is not its own.
- After power up the number of Terminal Boards on the system is configured automatically.
- The main task of each Terminal Board is to establish a logical connection between a camera and the optical link while the Adapter Board (which is combined to the Terminal in this case) adapts the electrical signal levels.

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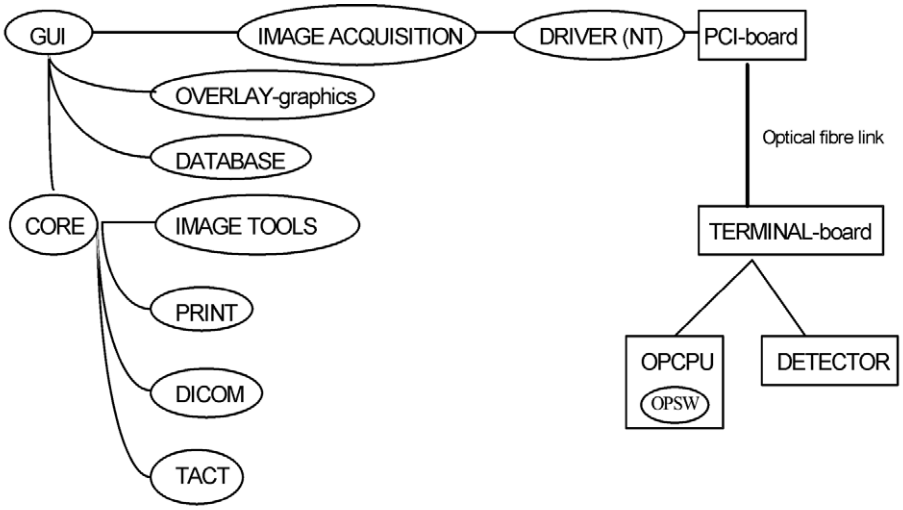
COMMUNICATION EXAMPLE: PAN IMAGE

SOFTWARE ARCHITECTURE OVERVIEW

Part name	Functional description
GUI	Graphical User Interface, uses directly overlay graphic functions and the database. Other image related functions are executed using services provided by the Core.
Image Acquisition (DICC)	Controls the imaging chain HW. Reads the image and control data from the Driver. Executes image preprocessing (=removes HW artifacts from the image) and gives the image to the GUI.
Driver (W2000)	SW interface to the PCI-board. Trough it the DICC is connected up to 4 Terminal-boards which is the start of the communication link on the application. The Terminal Board handles the communication with the application (such as OP100D) and the image detector related.
Overlaygraphics	Draws figures and text over the image and provides measurement functions.
Database	Database for the images and patients
Core	Structure which provides image manipulation tools, printing and future TACT and DICOM extensions.
OPSW	Application software controls all the other functions of the unit (exept the image chain) ie. X-rays, movements, etc.



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Preconditions	1	PC &OP:Power ON (Auto configuration of the imaging chain)
	2	CliniViewGUI and the PCI driver are running
	3	Patient has been selected from database.
	4	A PAN imaging program has been selected from the OP by the user
	5	Manual exposure mode has been selected on the OP
	6	At least a PAN camera has been mounted by the user
	7	Patient positioning has been made by the user
	8	OP/OC100 D is otherwise ready for exposure.

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9	**Description**	1 User @ CliniViewGUI: Take_OP_X-ray 2 DICC cheks installed Cameras [PC<-> PanCAM, CephCAM, ProfCAM*, TactCAM*] (*=future options) 3 DICC informs OP about installed Cameras (CASn) [PC->OP C167 Core Module] 4 OP goes READY if selected imaging program (=P1, Standard PAN) matches one of the installed cameras. 5 Exposure sequence starts (user presses exposure button) 6 Exposure parameter label from OP to DICC [OP C167 Core Module->PC] 7 OP positions itself to the start of a PAN image scan 8 Nasio position is measured and the result is sent to OP (AECfreq) [PAN Terminal -> OP C167 Core Module] 9 Exposure start parameters are displayed at the caption of the image capturing window [DICC] 10 ExposureStart message from OP to DICC [OP C167 Core Module ->PC] 11 DICC arms Camera for image acquisition [PC->PAnCAM] 12 The exposure scan starts: 1st dark current data to DICC [PanCAM->PC] and base frequency for AEC (AEC freq) [PanTeminal->OP C167 Core Module] 13 Image data to DICC [PanCAM->PC] 14 Dose data for AEC(AEC freq) [PanTerminal->OP C167 Core Module] 15 Exposure ends, 2nd dark current data to DICC[PanCAM->PC] 16 ExposureEnd message to DICC [OP C167 Core Module->PC] 17 Exposure parameter label (end values) from OP to DICC [OP C167 Core Module->PC] 18 End values are stored to the CVGUI database and shown at the display 19 Image is preprocessed by DICC and forwarded to CVGUI which displays the image 20 User approves the image and stores the image to the database @ CliniViewGUI 21 The user dismisses the patient from the OP and prepares the unit for new exposure
Postconditions		The system is ready to start a new image capture sequence or to display the taken images

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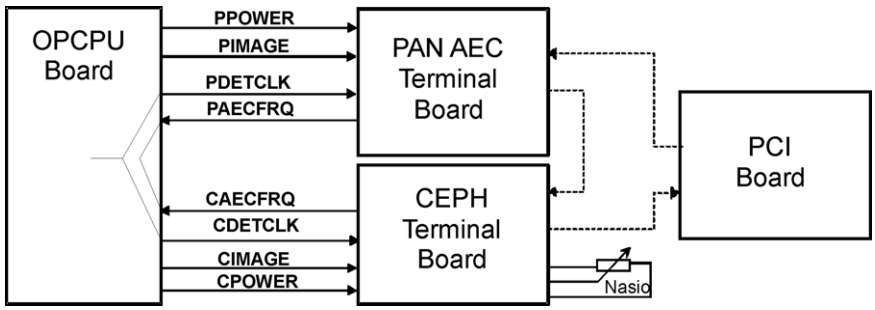
TIMING DIAGRAM SIGNALS

- EXPSW: Exposure switch
- RS:OP<=>PC: RS232 communication between OP C167 Core Module and PC.
- PC ==> Driver: PC resets the driver.
- Imaging movements: The start of the imaging layer
- EXPENA: Exposure (X-ray generator) enable

- PPOWER / CPOWER: Enables PAN / CEPH camera supply voltages
- AECFREQ: Frequency generated by the Terminal Board (=LINK_OK during exposure)
- PIMAGE / CIMAGE: PAN / CEPH image acquisition enable
- PDETCLK / CDETCLK: PAN / CEPH detector clock; “scanning speed of the cassette”



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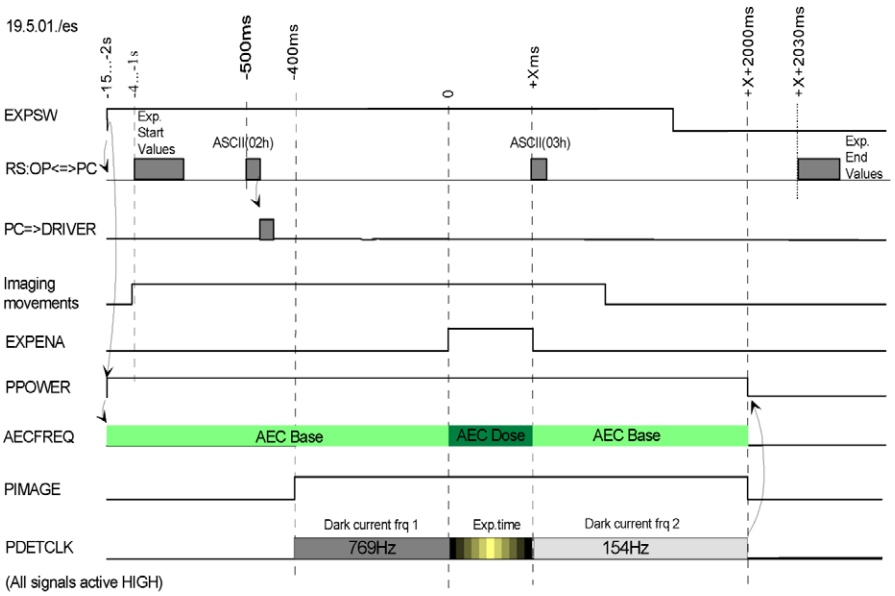
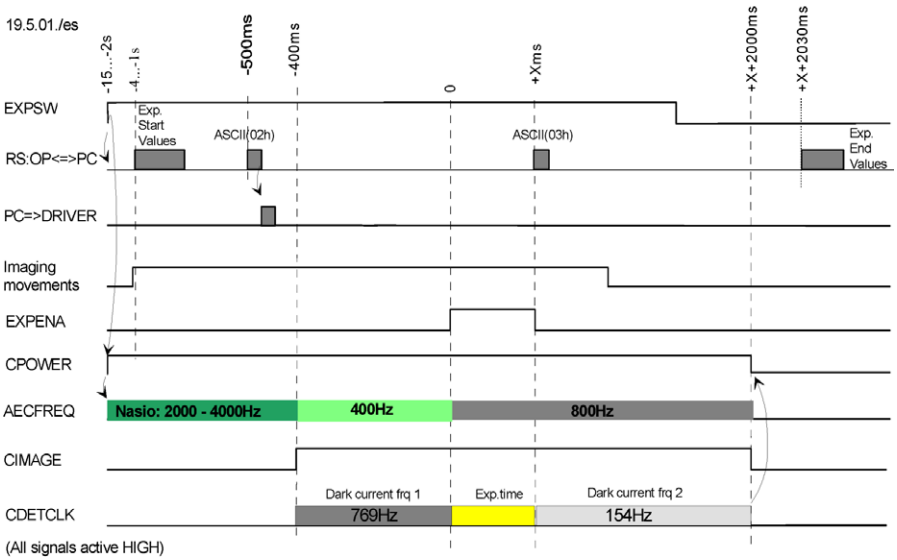
TIMING DIAGRAM: PAN EXPOSURE



TIMING DIAGRAM: CEPH EXPOSURE



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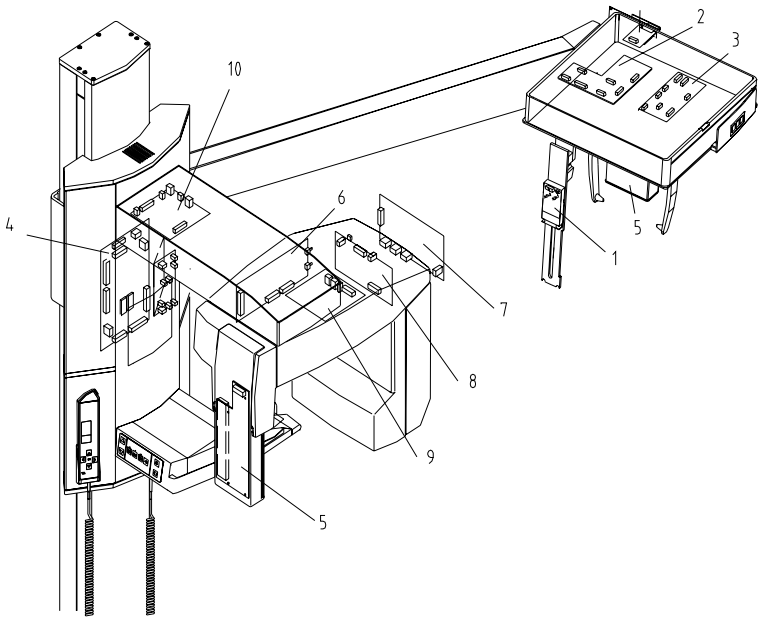
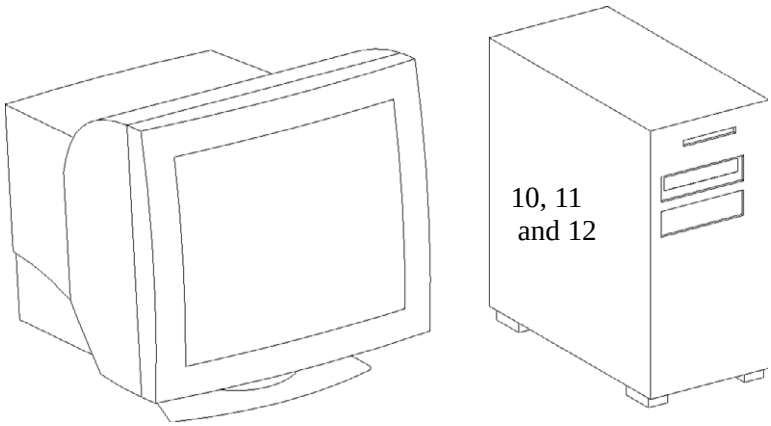
3.2 DIGITAL PARTS OVERVIEW





1 Beam Alignment board
2 Ceph head Board
3 Ceph terminal Board
4 OP C167 Core Module + Digital I/O board
5 PAN & CEPH camera Assembly
6 PAN AEC terminal Board
7 Inverter Board
8 Filament control Board
9 Camera supply Board
10 Interface Board
11 PC work station
12 PCI Board
13 CliniView PC SW

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4 List of documents

4.1 COMMON FILM AND DIGITAL UNIT DOCUMENTS

The following OP100 and OP100 D documents should be part of this section:

Code	Document
69137	Main wiring diagram
60229	Digital I/O board
60113	Power Supply Board
60114	Filament control Board
60115	Inverter Board
60134	Head support lock
60166	Interface Board
60218	Patient positioning panel
66370	Tube head assembly
69088	Cabel C67 (main cable)
69091	Ceph straight connector board

In the case of missing or out-of-date documents please contact your authorized distributor or Instrumentarium Dental Technical Service.

4.2 FILM UNIT DOCUMENTS

The following OP100 documents should be part of this section:

Code	Document
60110	Ceph Soft Tissue Display
60122	AEC Board
60143	Ceph Up/Down Switch
60147	Cassette Opto Sensors
64105	Control Panel and Display
69136	Ceph cable

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4.3 DIGITAL UNIT DOCUMENTS

The following OP100 D/OC100 D documents should be part of this section:

Code	Document
60187	PCI Board 32 bit
60191	Ceph terminal Board
60193	OCD up/down panel
60197	OPD camera supply Board
60241	Movement detection Board
60243	Ceph head Board

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Code	Document
60247	Pan AEC terminal Board
60249	Beam alignment Board
69068	Cabel C50 (main cable to ceph)
69091	Ceph straight connector board

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Orthoceph® OC100 & OC100 D
Electrical Operation & Wiring Manual, English

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