# Service Manual
for the
# Cranex Dental Panoramic X-ray Series

(Excel, Excel Ceph, Excel D,
BaseX and BaseX D)

(This manual can also be used to service the
Cranex 3+ Ceph, 3+, 2.5+ and C)

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# Contents

# 1 Introduction

## 1.1 Scope of this manual

This manual describes how to service the Cranex Excel range of dental panoramic x-ray units. The range includes four cassette versions and two digital versions.
The cassette versions are the:
- **Excel**
- **Excel Ceph**
- **BaseX**
- **Cranex C** (cephalometric unit only)

These use conventional film and/or Soredex imaging plates.

The digital versions are the:
- **Excel D**
- **BaseX D**

The digital versions use CCD sensors. Two versions of the sensor are available, DM and DS versions.

Functional and operational differences between the different versions are given where appropriate.

**IMPORTANT NOTE**
The information in this manual also applies to earlier cassette versions of the Cranex, the **Cranex 3+ Ceph, 3+, 2.5+** and **Cranex C**. Differences between these earlier versions and the latest **Excel** and **BaseX** versions will be described where appropriate.

## 1.2 Associated documentation

Cranex Excel/BaseX user’s manuals.
These describe how to operate the different versions of the unit.

Cranex Excel/BaseX installation manual and separate appendices.
These describe how to install and set up the different versions of the unit.

## 1.3 Servicing warnings and precautions

### General precautions

The Cranex Excel range of dental x-ray units must only be serviced and repaired by service personnel who have been trained and approved by Soredex.
This manual is an aid to servicing the units and is NOT a substitute for approved Soredex service training.

Before attempting to service a unit make sure that you know how to operate it. Read the appropriate Cranex Excel user's manual.
Only use original Soredex spare parts when repairing the unit or replacing parts.

### Radiation Safety

Before servicing the unit familiarise yourself with local and national radiation safety standards and requirements relating to dental x-ray equipment.
If you need to take test exposures you MUST take adequate steps to protect yourself from radiation.
Use a lead apron or stand behind a suitable radiation shield.
In addition, when taking exposures stand at least two metres (six feet) from the unit.

## Mechanical safety

Switch the power off before repairing or replacing mechanical parts.
Be careful when operating the unit not to get body parts or clothing trapped between moving parts.
The aperture plate in the collimator is made of lead (Pb) which is a toxic material. Do not touch it with your bare hands.

## Electrical Safety

Switch the power off before repairing or replacing electrical parts.
Live electrical terminals are potentially dangerous. Make sure that main power supply is OFF before removing covers or circuit boards.
This equipment should be used only in areas that are provided with a protective earth connection to ensure an equipotential ground connection.
Before cleaning or disinfecting the unit switch the main power supply off.

## Electrostatic discharge

Electrostatic Discharge (ESD) can damage or destroy electronic components.
A static electricity charge builds up in everyone. The build up is due to movement, humidity, the person's clothing and the conductivity of the floor. If anyone charged with static electricity touches a electronic component the static electricity will discharge through the component and can damage or destroy it. Note that components damaged by electrostatic discharge can fail at a later date.

When servicing the unit take proper 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 guide lines below.

Before handling any electrical parts or components make sure that any static electricity charge that has built up in you body is discharged.
When handling electrical parts or components use an elasticated 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.

If an antistatic mat is used, connect the wrist wrap to the carpet and the carpet to the ground potential. Wash the wrist wrap and check that it is good condition frequently.

## 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.

## Operating warnings and precautions

The x-ray unit must only be used to take dental, TMJ and cephalometric (optional) x-ray exposures. It must not be used for any other purpose.

The unit or its accessories must not be modified, altered or remanufactured in any way. Repairing shall be performed by Soredex authorized service only.

As radiation safety and protection requirements vary from country to country and state to state it is the responsibility of the operator to ensure that all local and national radiation safety and protection requirements are met.

Never leave film cassettes open in daylight. Daylight can damage intensifying screens.

The use of ACCESSORY equipment not complying with the equivalent safety requirements of this equipment may lead to a reduced level of safety of the resulting system. Consideration relating to the choice shall include:

– use of the accessory in the PATIENT VICINITY
– evidence that the safety certification of the ACCESSORY has been performed in accordance to the appropriate IEC 601-1 or IEC 950 and/or IEC 601-1-1 harmonized national standard.

## 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 Soredex.

When properly assembled with a compatible beam-limiting device, 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 device or tube housing assembly.
Never remove or remanufacture any part of the tube head assembly or beam-limiting device unless under the direction of Soredex or their authorized distributor.

Never adjust any part of the beam-limiting device unless under the direction of Soredex or their authorized distributor.

## Disposal

At the end of the useful working life of the equipment and/or its accessories make sure that you follow national and local regulations regarding the disposal of the equipment, its accessories, parts and materials.
The equipment may include some or all of the following parts that are made of or include materials that are non-environmentally friendly or hazardous:
- batteries
- x-ray tube head (Pb, Be and mineral oil)
- all electronic circuit boards
- column counter weight (Pb)
- cassettes (Pb), intensifying screens and imaging plates

## Disclaimer

Soredex 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 Soredex with respect to its products.

# 2 Unit description

## 2.1 Versions

**Excel Ceph**
The Excel Ceph is a dental panoramic x-ray unit that uses film or Soredex imaging plates as the imaging media. It can take panoramic, reduced width panoramic, sinus and TMJ exposures. In addition, Symmetric Vertical (SV), Asymmetric Vertical (AV) and Horizontal (H) exposures to be taken with the cephalometric unit. The Excel Ceph has three patient positioning lights, midsagittal, frankfort, focal trough, a focal trough position indicator and motorized height adjustment.

**Excel**
Similar to the Excel Ceph but does not have the cephalometric unit.

**BaseX**
Similar to the Excel, but can only take panoramic, reduced width panoramic and sinus exposures. In addition, it only has two positioning lights, frankfort and focal trough, does not have a focal trough position indicator and the height adjustment is manual.

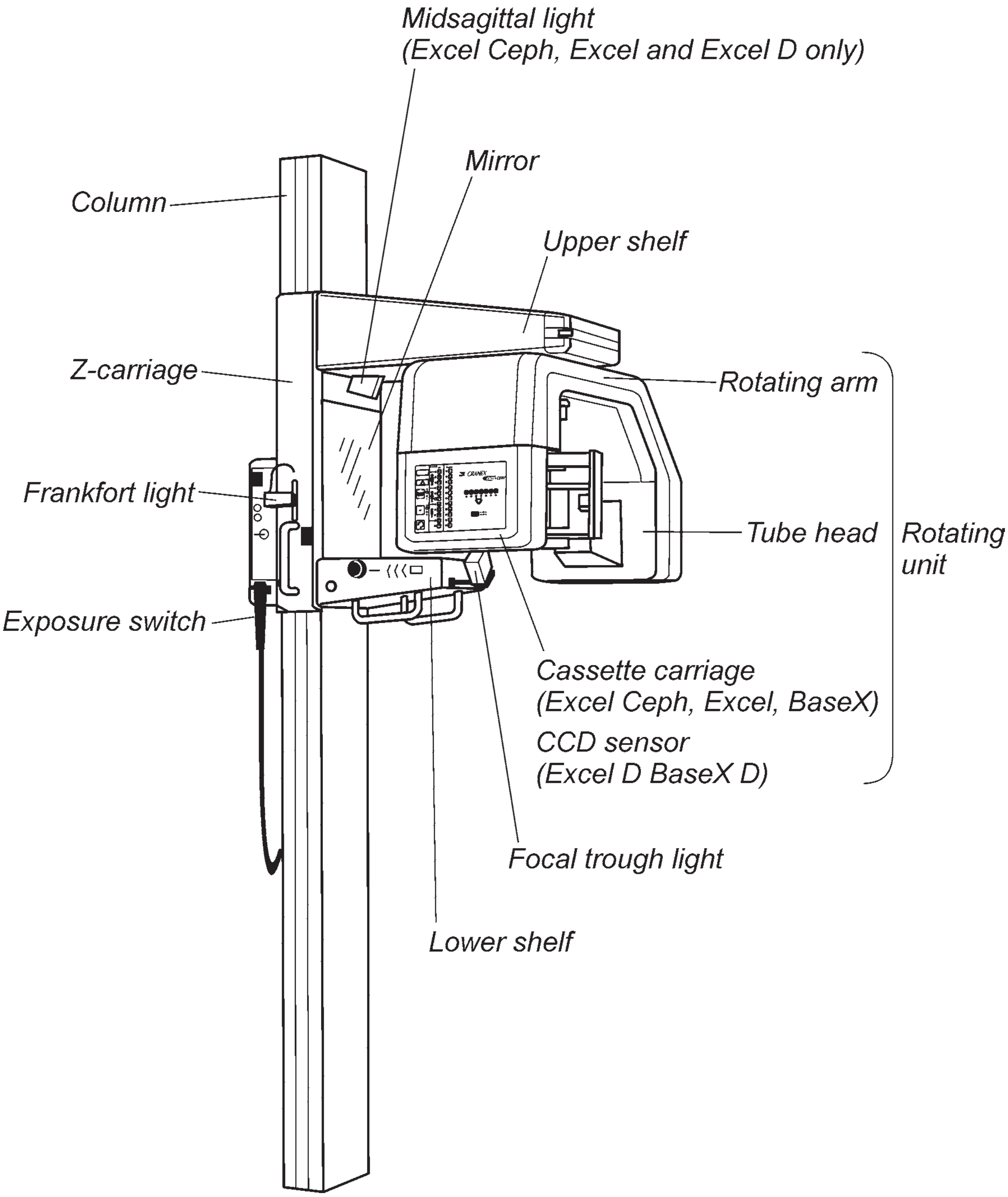
**Excel D**
Similar to the Excel but uses a CCD sensor as the imaging media.

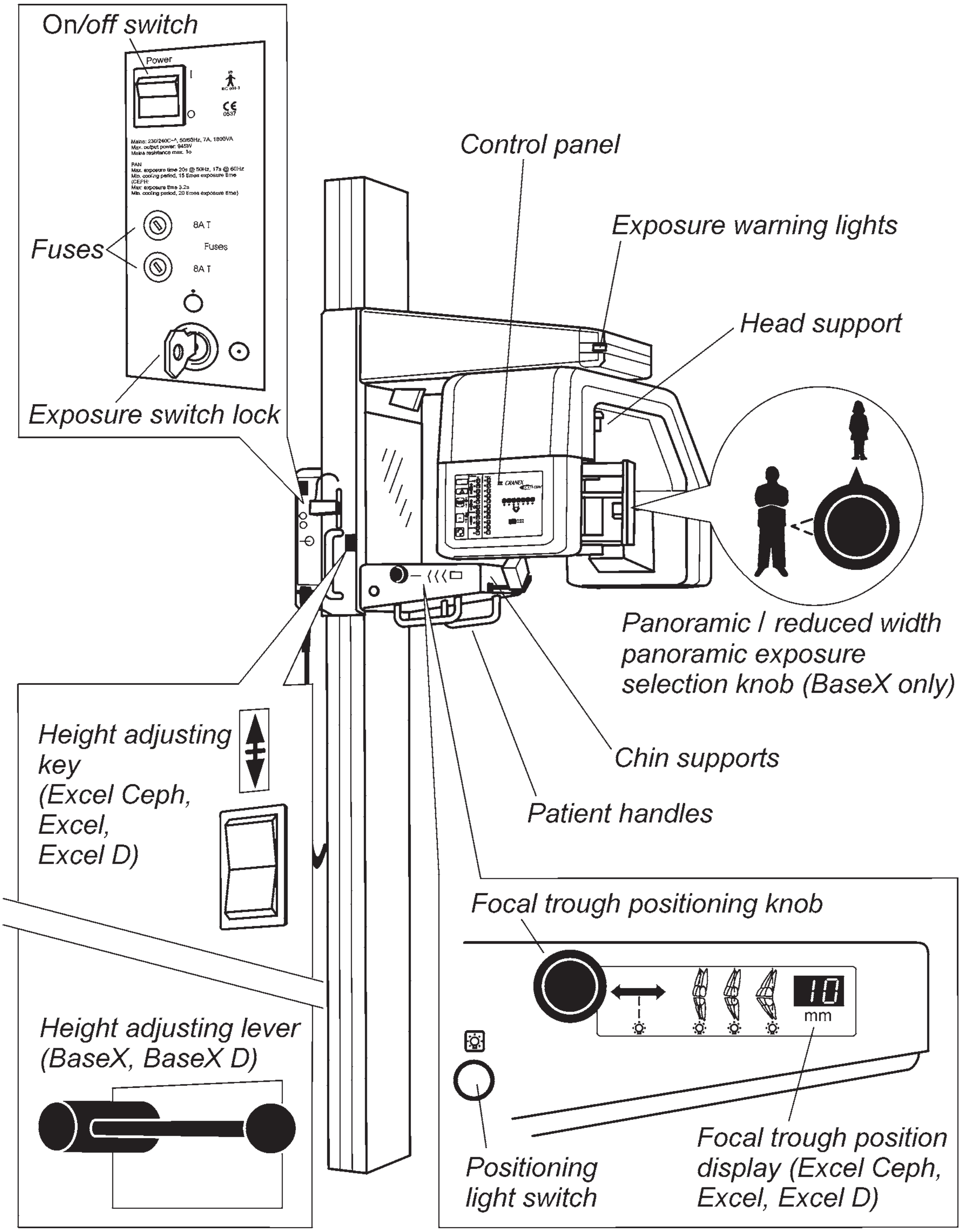
**BaseX D**
Similar to the BaseX but uses a CCD sensor as the imaging media.

**Cranex C**
This is a cephalometric only unit and takes Symmetric Vertical (SV), Asymmetric Vertical (AV) and Horizontal (H) exposures.

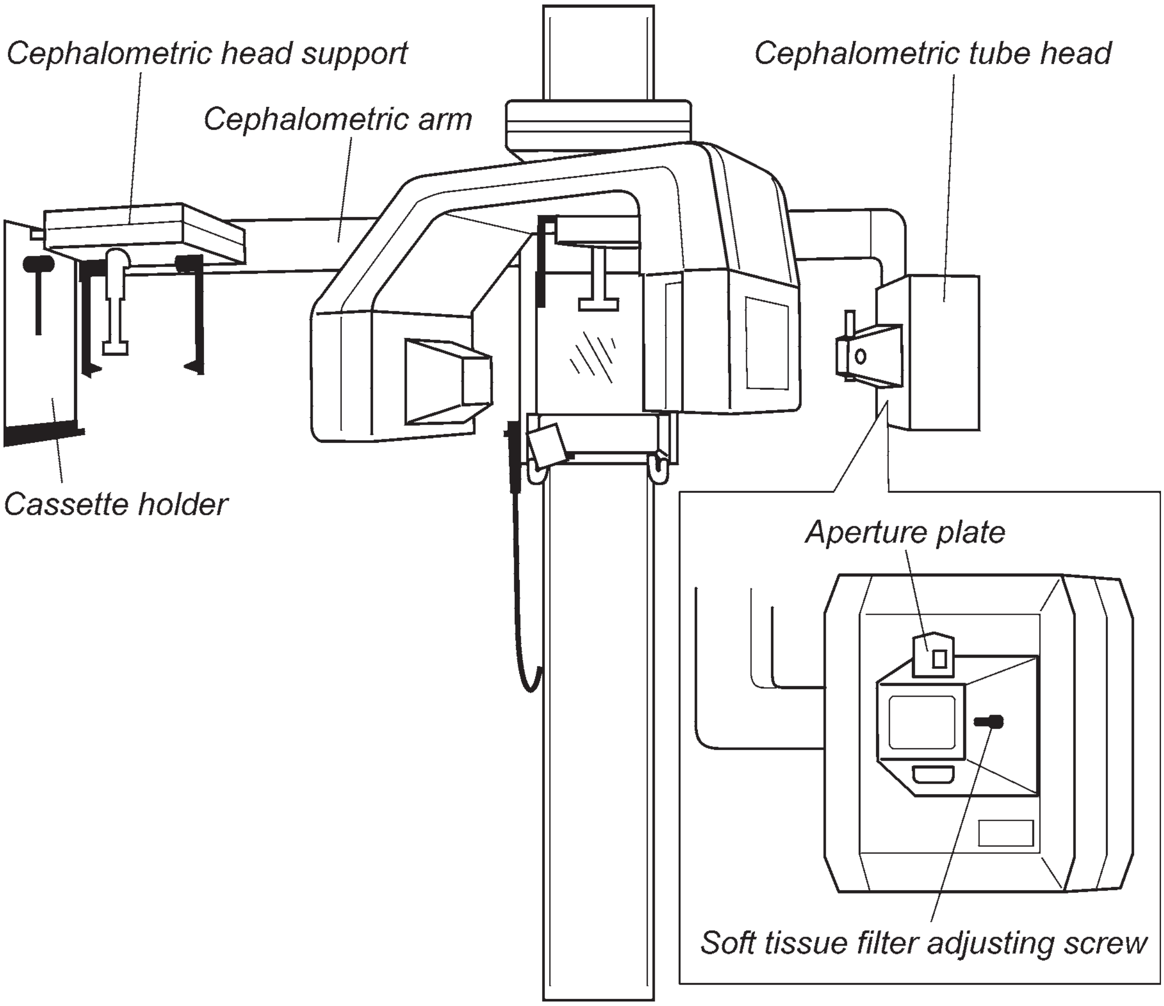
The **Cranex 3+ Ceph, 3+** and **2.5+** are earlier versions of the Excel Ceph, Excel and BaseX, repectively, but they do not include the Auto kV feature.

## 2.2 Main parts - Excel, Excel D, BaseX and BaseX D




On/off switch
Power
Fuses
8A T
Fuses
8A T
Exposure switch lock
Control panel
Exposure warning lights
Head support
Panoramic / reduced width panoramic exposure selection knob (BaseX only)
Chin supports
Patient handles
Height adjusting key (Excel Ceph, Excel, Excel D)
Height adjusting lever (BaseX, BaseX D)
Focal trough positioning knob
10
mm
Positioning light switch
Focal trough position display (Excel Ceph, Excel, Excel D)

## 2.3 Main parts - Excel Ceph



## 2.4 Mechanical description and operation

The units consist of a column, a Z-carriage, that can slide up and down the column, and a rotating unit (not Cranex C) that is attached to the Z-carriage.

### Column

The top of the column is attached to the wall with a wall bracket and the bottom of the column is free-standing on a rubber foot pad. The Z-carriage moves vertically up and down the column and is connected, by means of steel wires, to a counter-weight inside the column.
With Excel versions an electric motor at the rear of the Z-carriage drives the Z-carriage up and down. The motor control is on the left-hand side of the Z-carriage.
With BaseX versions the Z-carriage is moved up and down manually. A lever on the side of the Z-carriage allows the Z-carriage to be locked when it is in the required position.

### Z-carriage

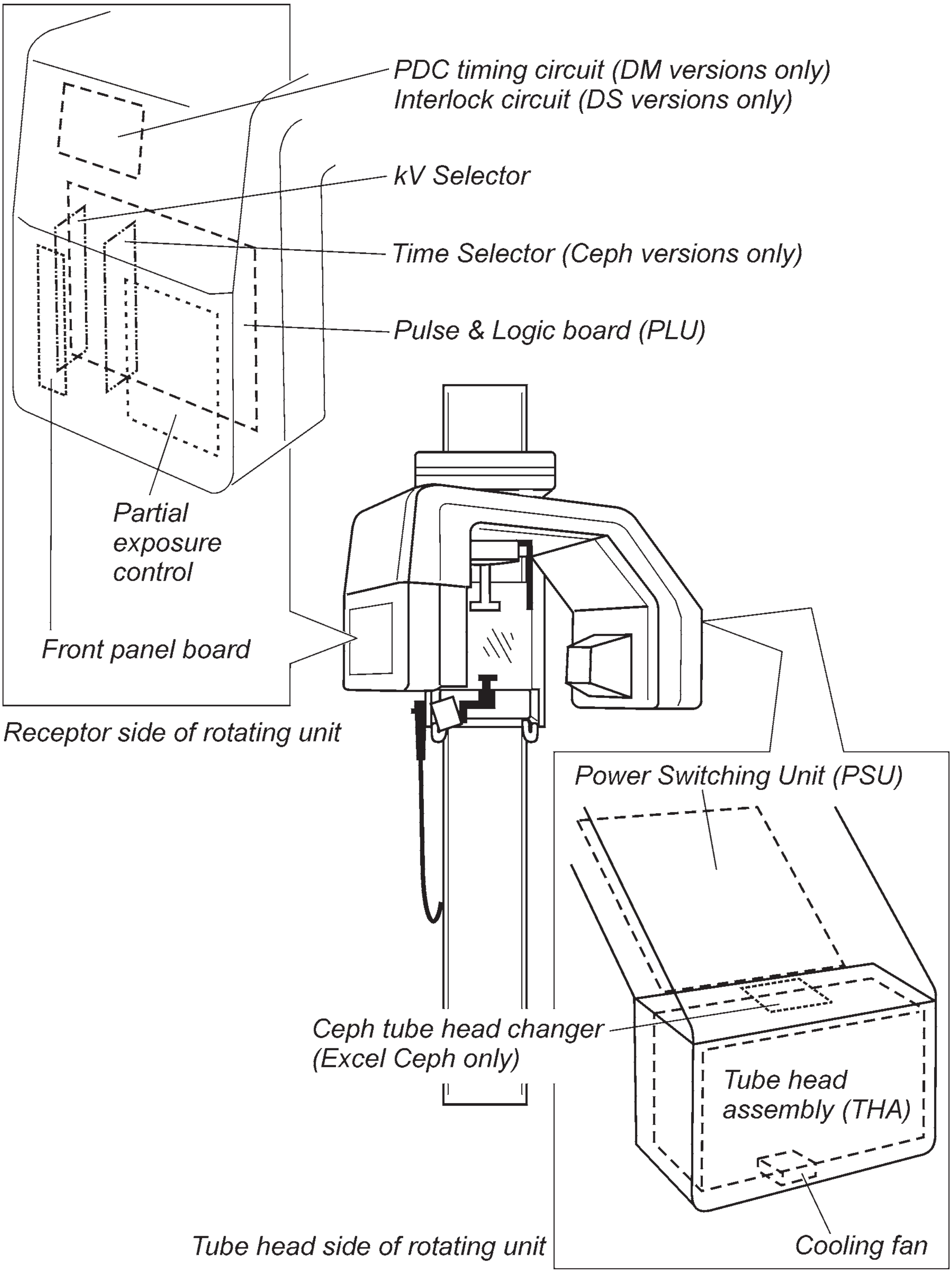
The Z-carriage comprises upper and lower shelves. The upper shelf holds the rotating unit and the lower shelf the patient chin rest, patient positioning knob and focal trough light. When the knob is turned to position the focal trough correctly, the rotating unit moves simultaneously with the light. The frankfort plane positioning light is attached to the left-hand side of the Z-carriage and the midsagittal positioning light (Excel units only) is under the upper shelf. At the back of the Z-carriage there is the mains input, with fuses and the main power switch. The exposure switch is connected to the rear of the Z-carriage.
The upper shelf houses the mains power unit that supplies power to the X-ray generator.

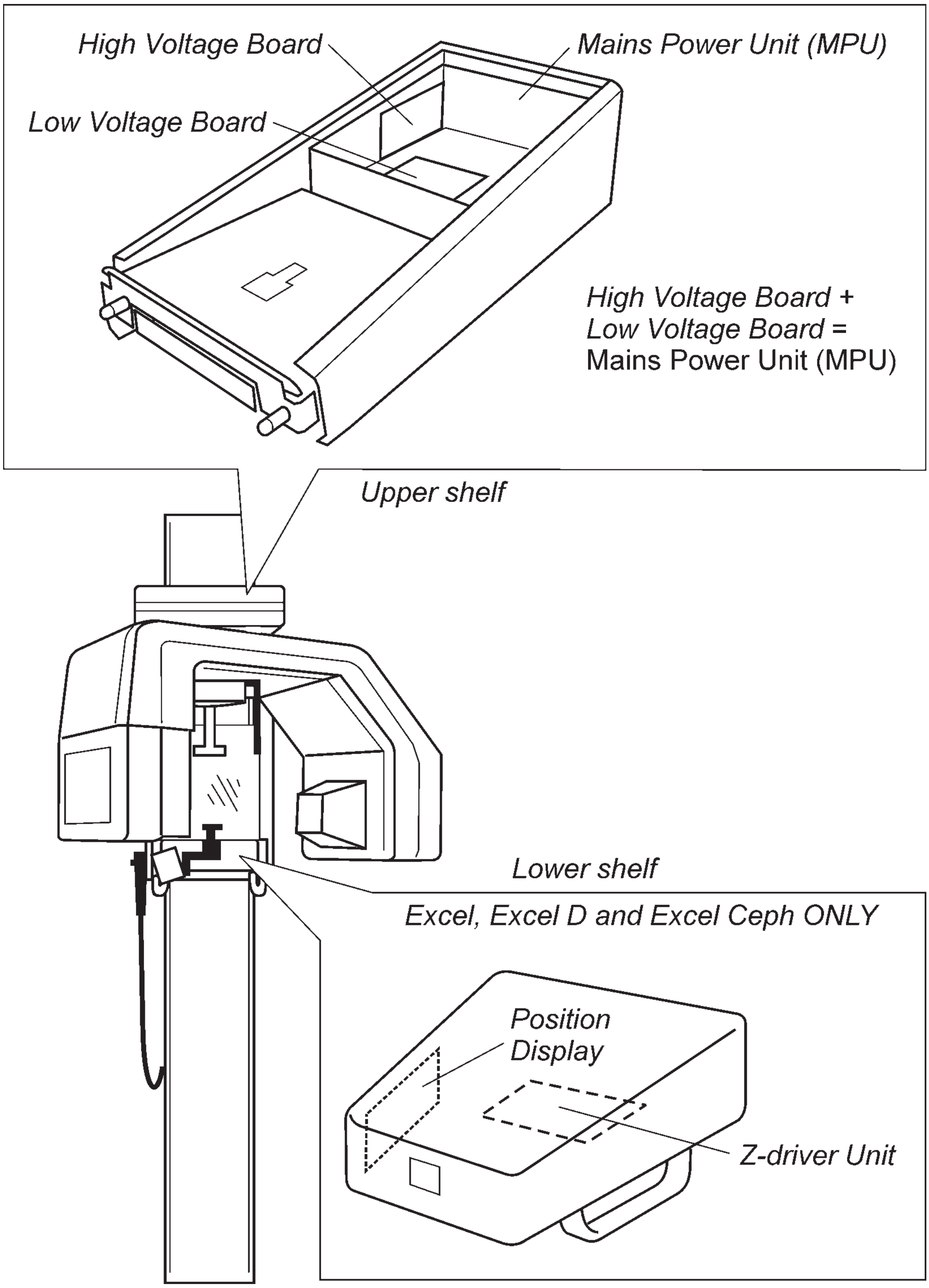
## Rotating unit (not Cranex C)

The rotating unit is attached to the underside of the upper shelf. It comprises a tube head and a cassette carriage (with digital units a CCD sensor). During an exposure the rotating unit rotates around the patient's head in the horizontal plane. The tube head generates the x-ray beam which is collimated by the primary slit. The radiation passes through the patient to the secondary slot. Behind the secondary slot the x-ray beam strikes the film/imaging plate cassette which is synchronized to move linearly as the rotating unit rotates (with digital units a CCD sensor is used). A cam mechanism also slides the rotating unit backwards and forwards along the x-axis as the rotating unit rotates. This x-axis movement allows the x-ray beam to follow the shape of the jaw more accurately and avoids x-ray concentration at the stationary rotation center.

During rotation, the speed of the cassette carriage varies in relation to other movements (with digital units the speed profile, TDI-file, of the CCD sensor determines the virtual movement). This movement determines the imaging layer (focal trough). Basic synchronization of the drive motor and the cassette drive motor is done electrically. The two AC motors run at the same speed. The speed of the cassette carriage is adjusted by changing the angle at which the drive wheel touches the cassette carriage roller. This is accomplished with a cam and follower mechanism.

## 2.5 Circuit board location




High Voltage Board
Mains Power Unit (MPU)
Low Voltage Board
High Voltage Board +
Low Voltage Board =
Mains Power Unit (MPU)
Upper shelf
Lower shelf
Excel, Excel D and Excel Ceph ONLY
Position
Display
Z-driver Unit

## 2.6 Which circuit board which version

| Circuit Board | Excel Ceph (Cranrx 3+ Ceph) | Excel Ceph (Cranex 3+) | BaseX (Cranex 2.5+) | Excel D | BaseX D | Cranex C |
|---|---|---|---|---|---|---|
| Mains Power Unit (MPU) | Yes | Yes | Yes | Yes | Yes | Yes |
| High-Voltage Board | Yes | Yes | Yes | Yes | Yes | Yes |
| Low-Voltage Board | Yes | Yes | Yes | Yes | Yes | Yes |
| Power Switching Unit (PSU) | Yes | Yes | Yes | Yes | Yes | Yes |
| Tubehead Exchanger | Yes | - | - | - | - | - |
| Z-Drive Unit | Yes | Yes | - | Yes | - | Yes |
| Position Display | Yes | Yes | - | Yes | - | - |
| Pulse Logic Board (PLU) | Yes | Yes | Yes | Yes | Yes | Yes |
| kV Selector Assembly | Yes | Yes | Yes | Yes | Yes | Yes |
| Time Selector Assembly | Yes | - | - | - | - | Yes |
| Partial Exposure Controller (PEC) | Yes | Yes | - | Yes | Yes | - |
| Front Panel Board | Yes | Yes | Yes | Yes | Yes | Yes |
| PDC Timing Circuit (DM vers. only)<br>**OR**<br>Interlock Circuit Board (DS vers. only) | -<br><br>- | -<br><br>- | -<br><br>- | Yes<br><br>Yes | Yes<br><br>Yes | -<br><br>- |

## 2.7 Electrical operation

### General description

The unit has a high frequency switching mode X-ray generator consisting of five units: The mains power unit (MPU) located in the upper shelf of the Z-carriage, the power switching unit (PSU), the pulse and logic unit (PLU), the partial exposure controller (PEC), and the tube head (THA) located in the rotating unit.

### The Operating Principle of the Generator

The generator is fed by a single phase 220 VAC line. Auxiliary voltages are produced by a 50/60 Hz transformer, rectifying and filtering networks. All auxiliary voltages are grounded.

### High Voltage Section

The mains input is rectified and filtered and then fed to the high frequency generator. This supply is connected to the power switching regulator. The regulator works at 23.5 kHz (old 20 kHz) and consists of transistor switches, a LC network, and a flywheel diode. The voltage across the LC network capacitor is dependent on the duty cycle (on time, a pulse width of 23.5 kHz waveform) of the transistor switches.

The output voltage of the power switching regulator (= capacitor voltage of the LC network) is fed to the power inverter. The power inverter consists of two transistor switches, working at 23.5 kHz (old 20 kHz). The transistor switches work in a push-pull mode, creating an AC waveform in the output of the H.T. transformer. The output of the H.T. transformer is connected to voltage multipliers that multiply, rectify and filter high voltage for the X-ray tube.
The level of high voltage is dependent on the input voltage of the power inverter. As a result, the high voltage is dependent on the pulse width of the power switching regulator. There is feedback from the high voltage which is compared with a preset value, and if it is found to be different, the error is corrected by varying the pulse width of the power switching regulator. This feedback works in real time and is fast enough to compensate, for example, a 60 Hz ripple.

## X-ray Tube Current

Filament heating, that controls the X-ray tube current, is produced by using a high frequency 23.5 kHz inverter. The pulse width of the inverter is variable to allow filament heating to be adjusted. The actual X-ray tube current is compared to a preset value and if it is found to be incorrect the inverter pulse width is changed to compensate the error.

## Automatic kV selection

The head support has a built-in potentiometer that measures the patient's head when the temple supports are closed. A signal from the potentiometer goes to the kV selector, which then selects a suitable kV value.

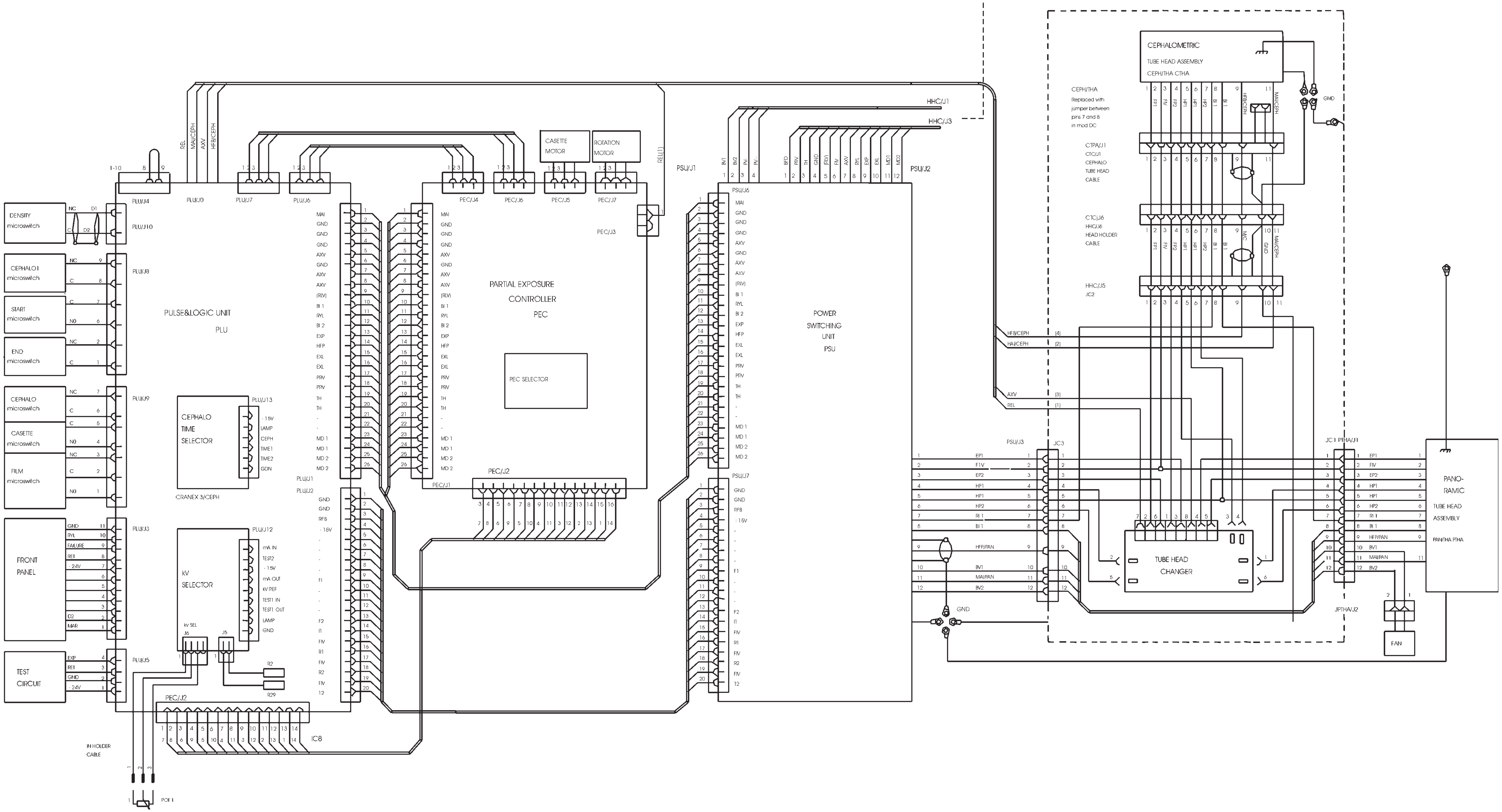
## Exposure times

| | 50 Hz | 60 Hz | Tolerance |
|---|---|---|---|
| **Normal** | 19 s | 16 s | +/- 15% |
| **Child/Sinus** | 17 s | 14 s | +/- 15% |
| **Sides** | 11 s | 9 s | +/- 15% |
| **Middle** | 10 s | 8 s | +/- 15% |
| **TMJ** | 3.3 + 3.3 s | 3.3 + 3.3 s | +/- 15% |

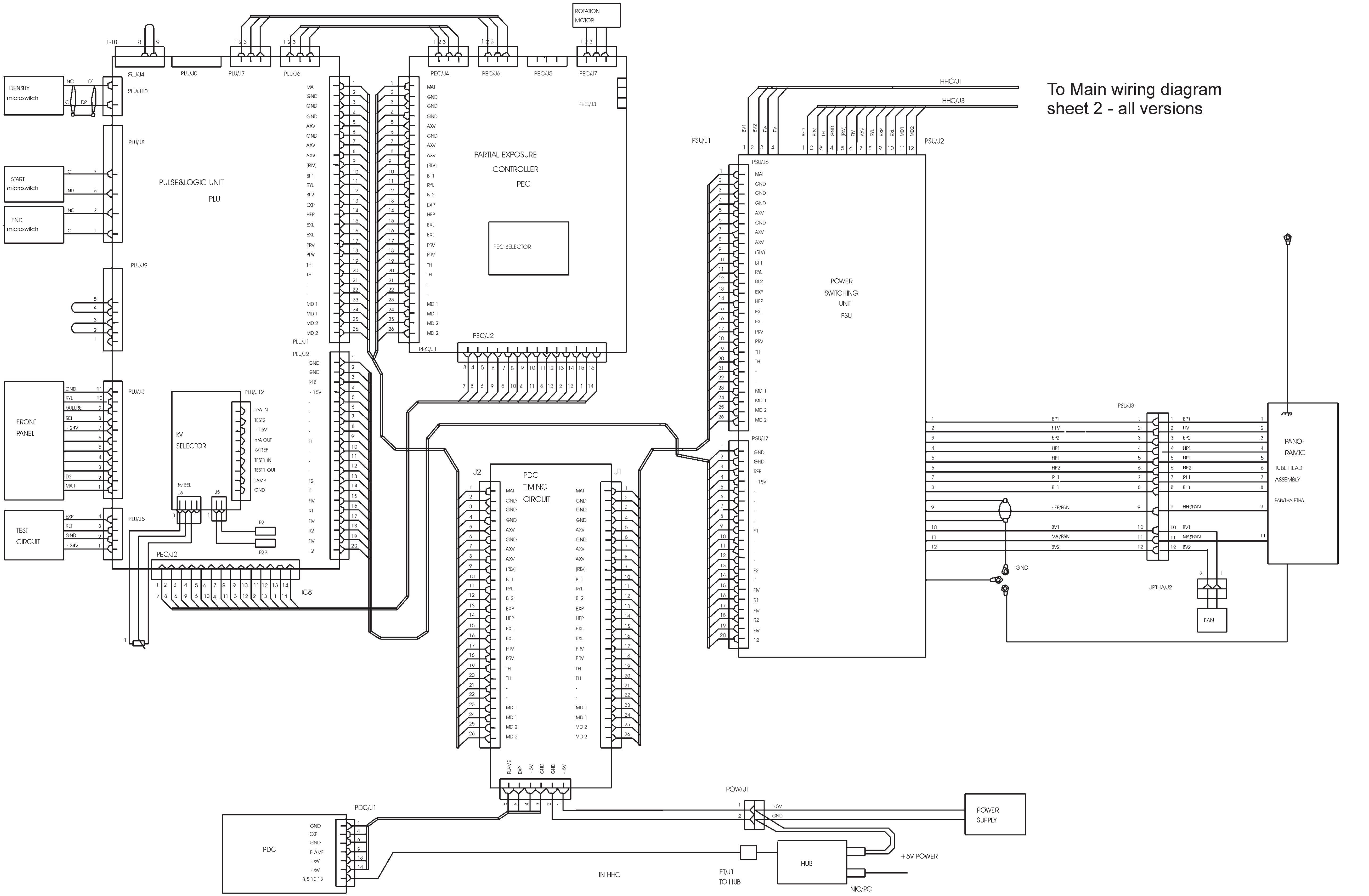
# 3 Main wiring diagrams

## 3.1 Sheet 1 - cassette version

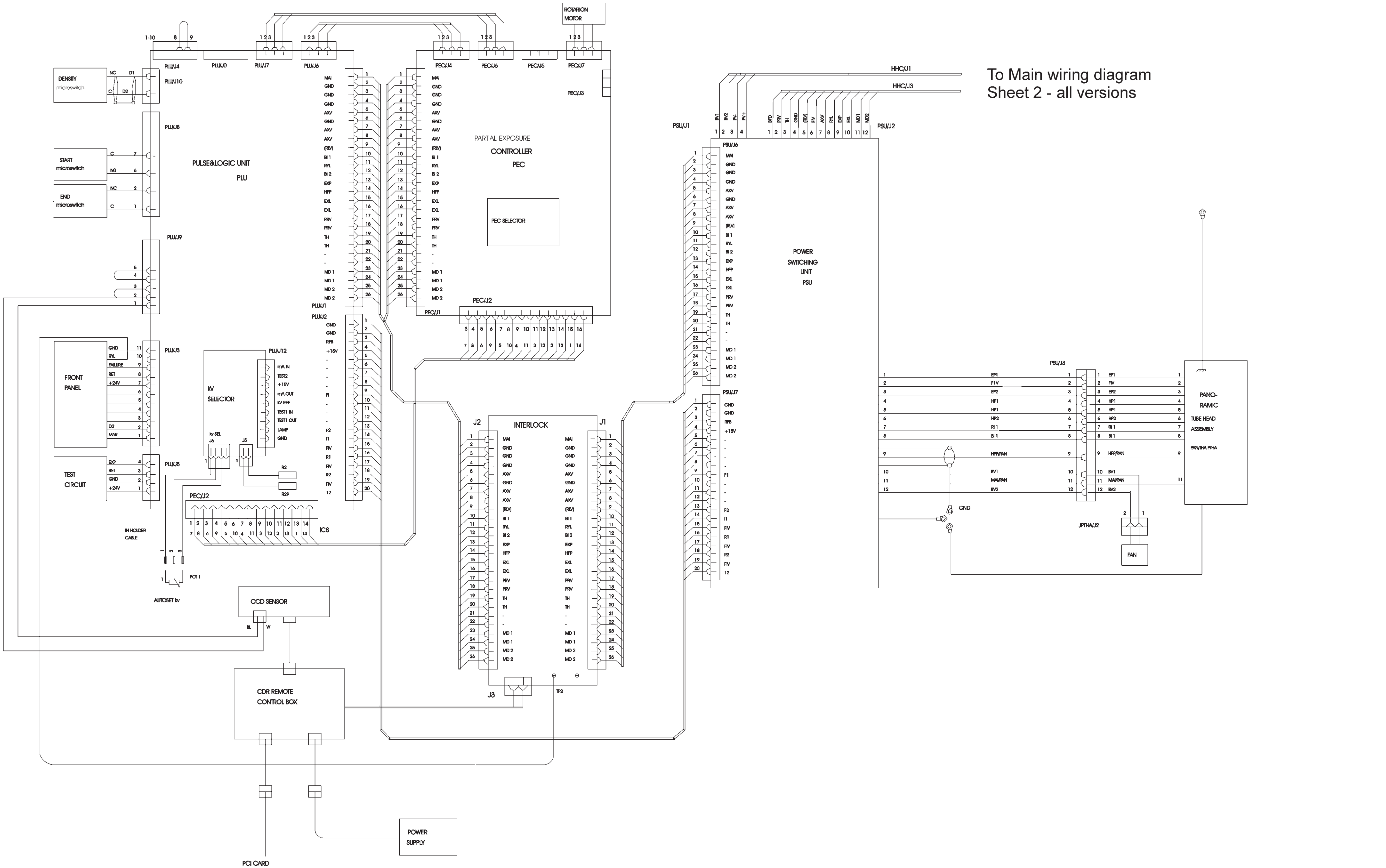
To Main wiring diagram sheet 2 - all versions



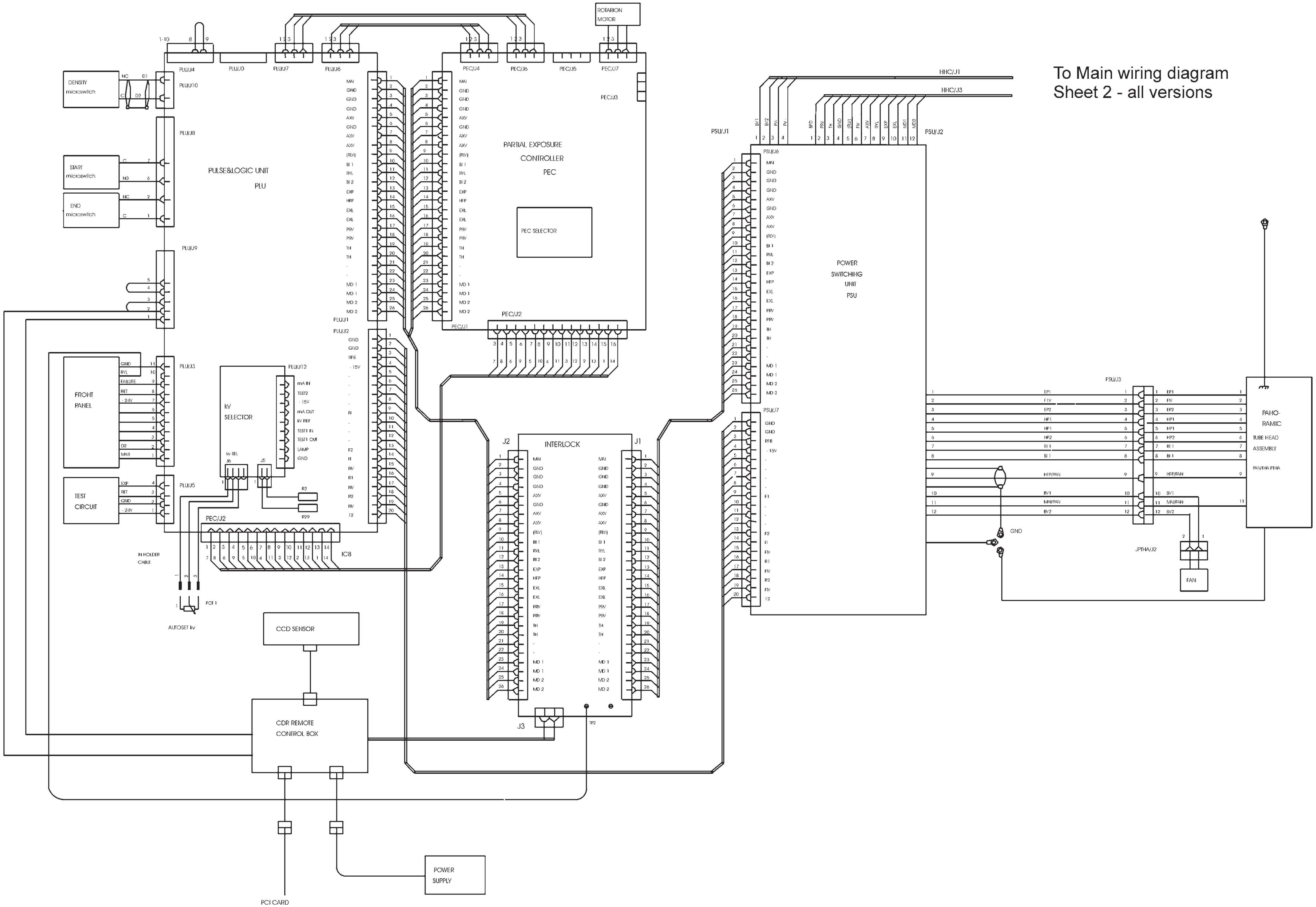
## 3.2 Sheet 1 - DM version



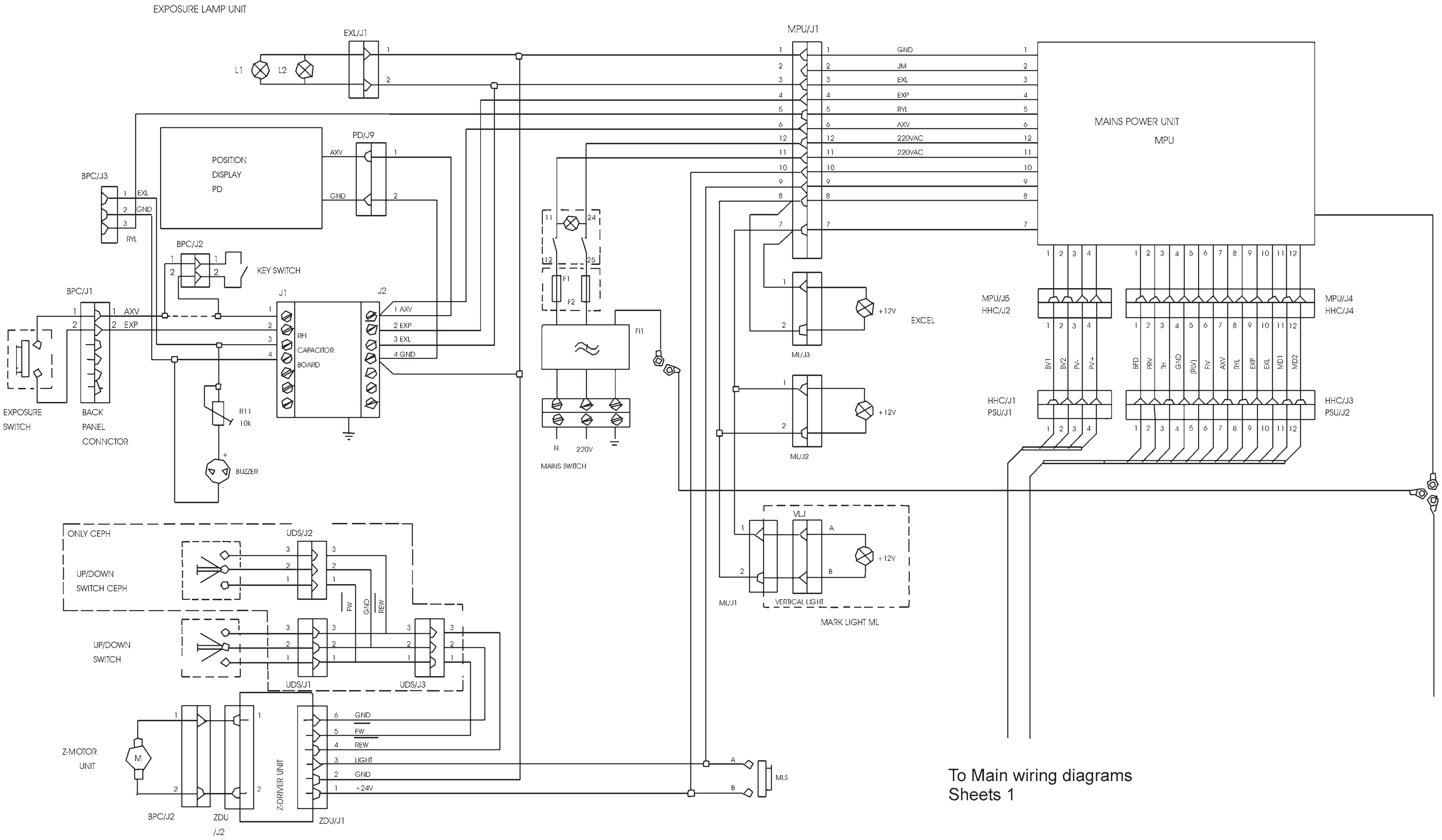
## 3.3 Sheet 1 - DS fixed version



## 3.4 Sheet 1 - DS cassette version

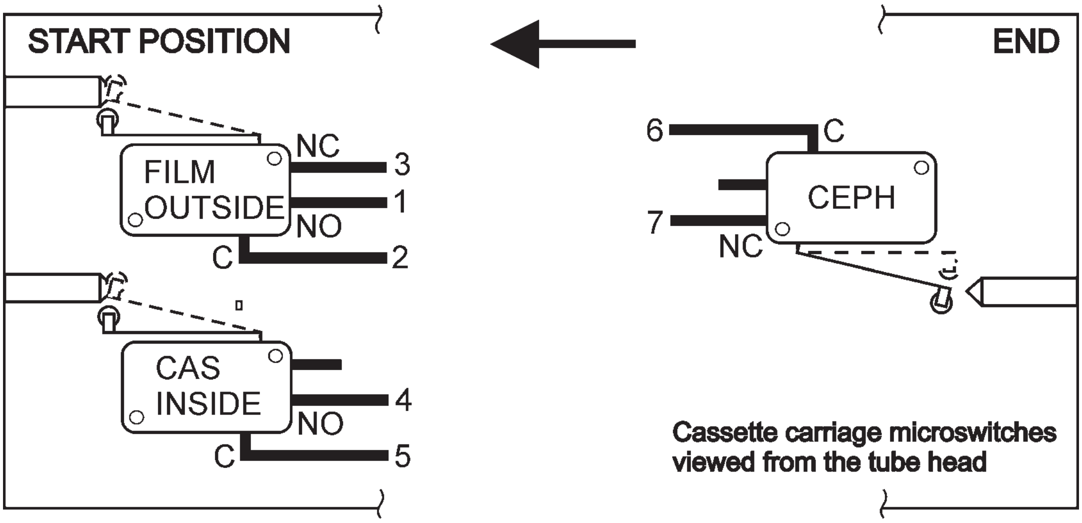


## 3.5 Sheet 2 - all versions



# 4 Microswitches

## 4.1 Cassette carriage (cassette carriage versions only)




**Cassette (CAS) microswitch, connects to PLU/J9**

| Pin | Signal | Description |
|---|---|---|
| 4 | NO | Closed when cassette is in start position. Enables ready condition. |
| 5 | C | |

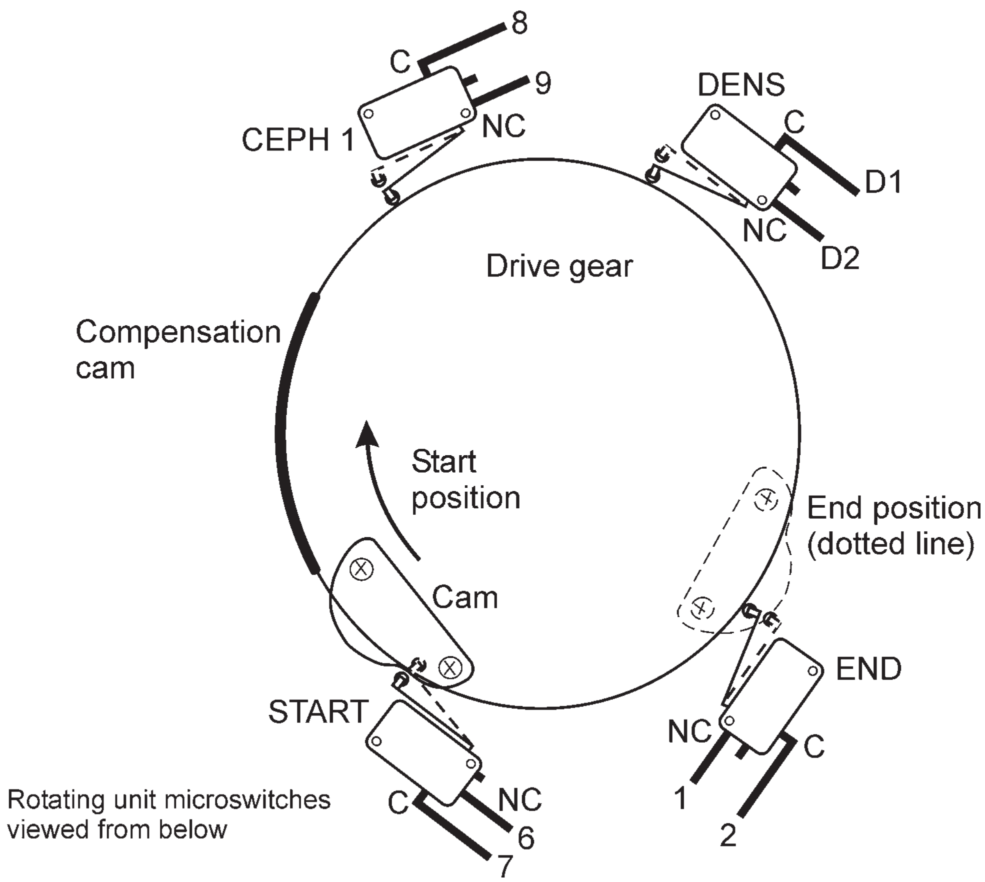
**Film (FILM) microswitch, connects to PLU/J9**

| Pin | Signal | Description |
|---|---|---|
| 1 | NO | Closed when cassette carriage is in start and stop positions (film beginning and end). Controls radiation on and off. Stops exposure normally. |
| 2 | C | |
| 3 | NC | |

**Cephalo (CEPH) microswitch, connected to PLU/J9**

| Pin | Signal | Description |
|---|---|---|
| 6 | C | Open when cassette carriage is in CEPH position. Stops cassette carriage movement when unit is moving to CEPH position. |
| 7 | NC | |

## 4.2 Rotating unit microswitches




**Start (START) microswitch, connects to PLU/J8**

| Pin | Signal | Description |
|---|---|---|
| 6 | NC | Closed when rotating unit is in start position. Enables ready condition. Stops return movement. |
| 7 | C | |

**Cephalo 1 (CEPH 1) microswitch, connects to PLU/J8**

| Pin | Signal | Description |
|---|---|---|
| 8 | C | Open when rotating unit is in the CEPH position (parallel to wall). Stops rotation when it reaches the CEPH position in the CEPH mode. |
| 9 | NC | |

### End (END) microswitch, connects to PLU/J8

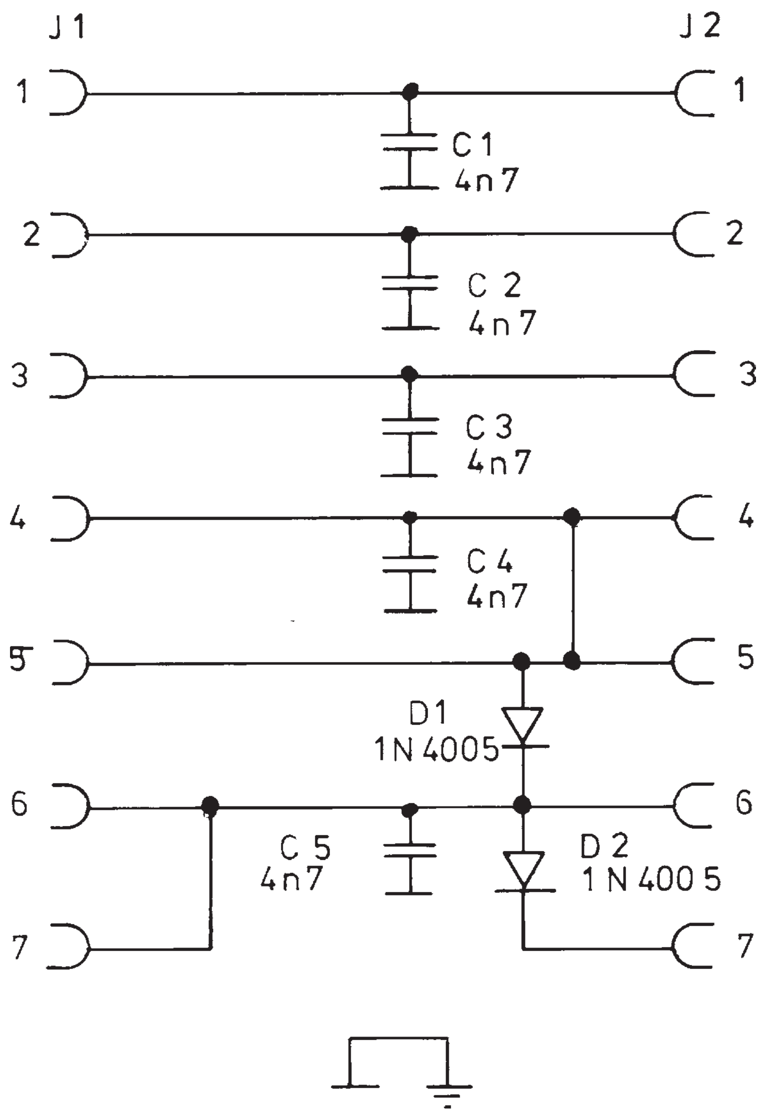
| Pin | Signal | Description |
|---|---|---|
| 1 | NC | Opens when the rotating unit reaches the end position. This is a safety function to stop an exposure.<br>In normal operation the microswitch is closed until the rotating unit reaches the end position, the film microswitch stops the exposure when the cassette comes to the end position. |
| 2 | C | |

### Density (DENS) microswitch, connects to PLU/J10

| Pin | Signal | Description |
|---|---|---|
| D1 | C | Opens in middle of exposure if compensation is selected, DENS increases the mA in middle of an exposure. |
| D2 | NC | |

# 5 Capacitor Board

| | |
|---|---|
| Key Switch | Cuts off AXV from Exposure Switch line. |
| F1, F2 | 8 A slow main fuses. |
| FI1 | RFI filter on back bracket. |
| Capacitor Board | Filter signals going to remote control and exposure switch. |
| MLS | Patient positioning light trigger switch. |



# 6 Mains Power Unit (MPU)

## 6.1 General description

The Mains Power Unit (MPU) consists of a High Voltage Board and a Low Voltage Board. Mains power is supplied to the MPU through 2 x 8 A slow-blow fuses and a two-pole main switch. Transformer T1 produces all the auxiliary voltages for the unit.

## 6.2 High Voltage Board

The mains power is fed to the High Voltage Board, which supplies power to the power switching unit. At the start of an exposure, a PRV signal turns high, and closes relays P1, P2 and P3. When P1 and P2 close, they connect the mains power to filter network C1 - CH1 - C2, and through resistor R1 to rectifier D1. R1 limits the surge current when capacitor C4 is initially charged. After the preheating time has elapsed, the TH signal turns low, closes relay R, and allows C4 to be charged directly from the mains. Capacitor C4 has a DC voltage of 230 - 300 VDC, which is supplied to the PSU through fuses F3 and F4, in the form of PV+ and PV- signals.

## 6.3 Low Voltage Board

Transformer T1 supplies power to the Low Voltage Board which then produces auxillary voltages from this power. T1 secondary-coils are connected through fuses F5 and F6 to rectifiers D4 and D6, and filtered with capacitors C5, C6 and C7.

Relay P3 connects the supply-voltage to a regulator network which then produces a filament inverter supply voltage (FIV). When FIV is used the positioning lights are turned off.

IC1 is a voltage regulator that produces a 20 V output. TR1 and TR4 are used to increase the output current capability of the regulator.

Supply voltage for the two drive motors (MD1, MD2) is derived from a 24 V transformer secondary-coil. Voltage from capacitor C7 (AXV) is supply to exposure switch (J1/6), digital display (J1/6), and pulse logic board (J4/7).

Power to the positioning light control relay V is supplied through the normally closed P3 contact, ensuring that the patient position lights turn off when P3 is opened. When the positioning light switch is pressed it allows capacitor C11 to be charged through resistor R12. Transistor TR3 receives base current through R13. The base current generates an emitter current which then causes the V relay to close.

When the V relay closes, a half-wave rectified (D17) voltage of 12 VRMS is supplied to the patient positioning lights.

The patient positioning light bulbs are 12 V. Relay V will open when capacitor C11 is discharged through R13, or when relay P3 closed.

At the beginning of an exposure the PRV signal goes high and triggers relays P1 and 2 and close the contacts that they control. The PRV signal also triggers relay P3 which opens two and closes one of the contacts it controls. The R9 - C9 - D11 - D12 network produces a pull-out delay for relays, ensuring that no power is going through P1 and 2 contacts when disconnected.

## 6.4 Connection box at rear of Z-Carriage

The mains power is connected through the mains input terminal, radio interference filter and 2 x 8 A slow main fuses to a double-pole mains switch.

The connection box also includes a RFI capacitor board that filters AXV-, EXP-, EXL-, GND- signals using 4.7 nF capacitors.

## 6.5 Power Line Connection

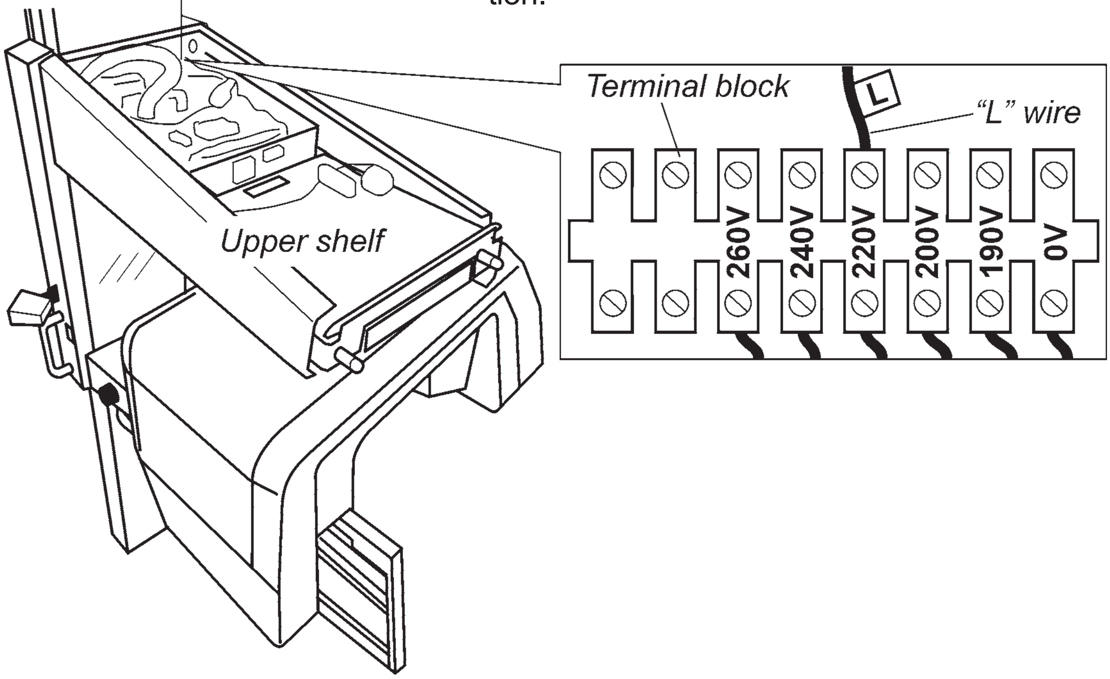
The unit can be used with line voltages ranging from 175 to 250 volts. The factory setting is 220 volts (between 205 - 225 V).

1. With a digital volt meter (DVM) check the line voltage to which the unit is to be connected. Also check the earth connection and the circuit breaker.
   If the line voltage is not the same as the factory setting, the voltage of the unit must be changed.

2. To change the voltage of the unit move the wire marked “L”, on the transformer terminal block, to the terminal with the line voltages to be used. The line voltage ranges for the terminals are as follows:

| **LINE VOLTAGES** | | **TERMINAL** |
|---|---|---|
| - 175 - 190 V, | use the | 190 V terminal |
| - 190 - 205 V, | use the | 200 V terminal |
| - 205 - 225 V, | use the | 220 V terminal |
| - 225 - 250 V, | use the | 240 V terminal |

**IMPORTANT NOTE**
If the mains resistance is significant, the input voltage will drop below the required level when an exposure is taken. In this case, select a terminal one step lower to ensure proper operation.



## 6.6 Mains Power Unit Connectors

**MPU/J1:At back of MPU.**

| Pin | Signal | Description |
|---|---|---|
| 1 | GND | Ground |
| (2) | JM | Not used.<br>(Unregulated supply 30 VDC for Z-magnetic brake in older Cranex models). |
| 3 | EXL | Exposure light. High (24 V) when kV over 50. |
| 4 | EXP | Exposure command. High (28-35 VDC) when exposure switch pressed. |
| (5) | RYL | Not used. (Ready light. High (24VDC) when unit is ready). |
| 6 | AXV | Unregulated supply 28 - 35 VDC. |
| 7, 8 | - | Positioning light supply. High 12 VDC across when positioning lights triggered on. |
| 9 | - | Positioning light trigger. High (28 -35 VDC) when light trigger switch. |
| 10 | - | Unregulated supply for positioning light trigger. Low during exposure. |
| 11, 12, | - | 220 VAC input mains voltage. Present when the unit is switched on. |

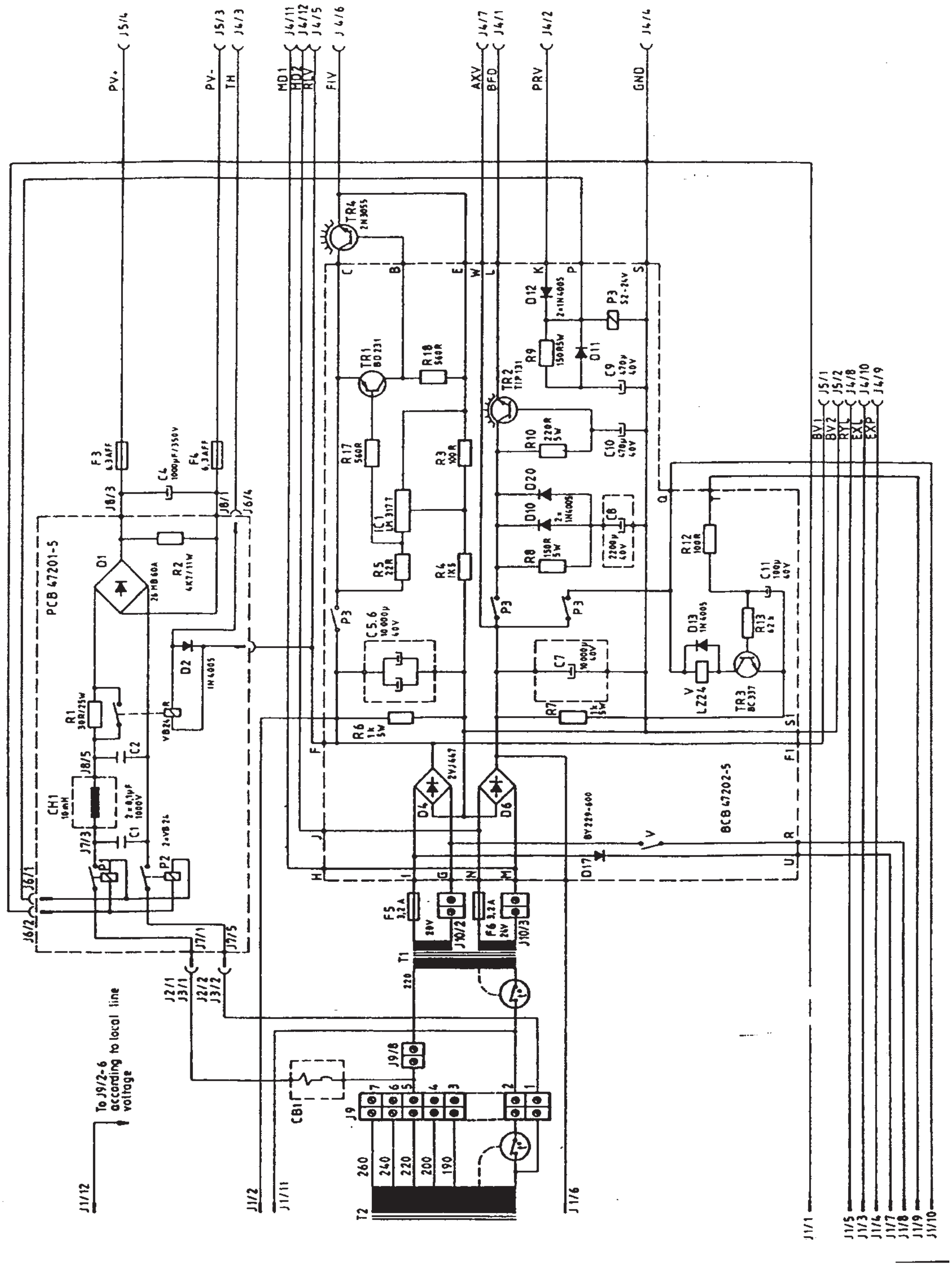
**MPU/J4: In front of MPU.**

| Pin | Signal | Description |
|---|---|---|
| 1 | BFD | Not used (Unregulated supply for PSU). High (20-30 VDC) during exposure. |
| 2 | PRV | P-relay control. High (28-35 VDC) during exposure. |
| 3 | TH | R-relay control. Low after preheat. |
| 4 | GND | Signal ground. |
| (5) | RVL | Not used. (Relay Voltage. Full wave rectified 20 VAC). |
| 6 | FIV | Filament inverter supply. Regulated. High (20VDC) during exposure. |
| 7 | AXV | Unregulated supply 28-35 VDC. |
| (8) | RYL | Not used. (Ready light drive. High (24 VDC) when unit is ready for exposure). |
| 9 | EXP | Exposure command. High (28-35 VDC) when exposure switch pressed. |
| 10 | EXL | Exposure light drive. High (24 VDC) when kV over 50. |
| 11, 12 | MD1, MD2 | Supply for drive motors, PSU and low voltage supply. 24 VAC across. |

**MPU/J5: In front of MPU**

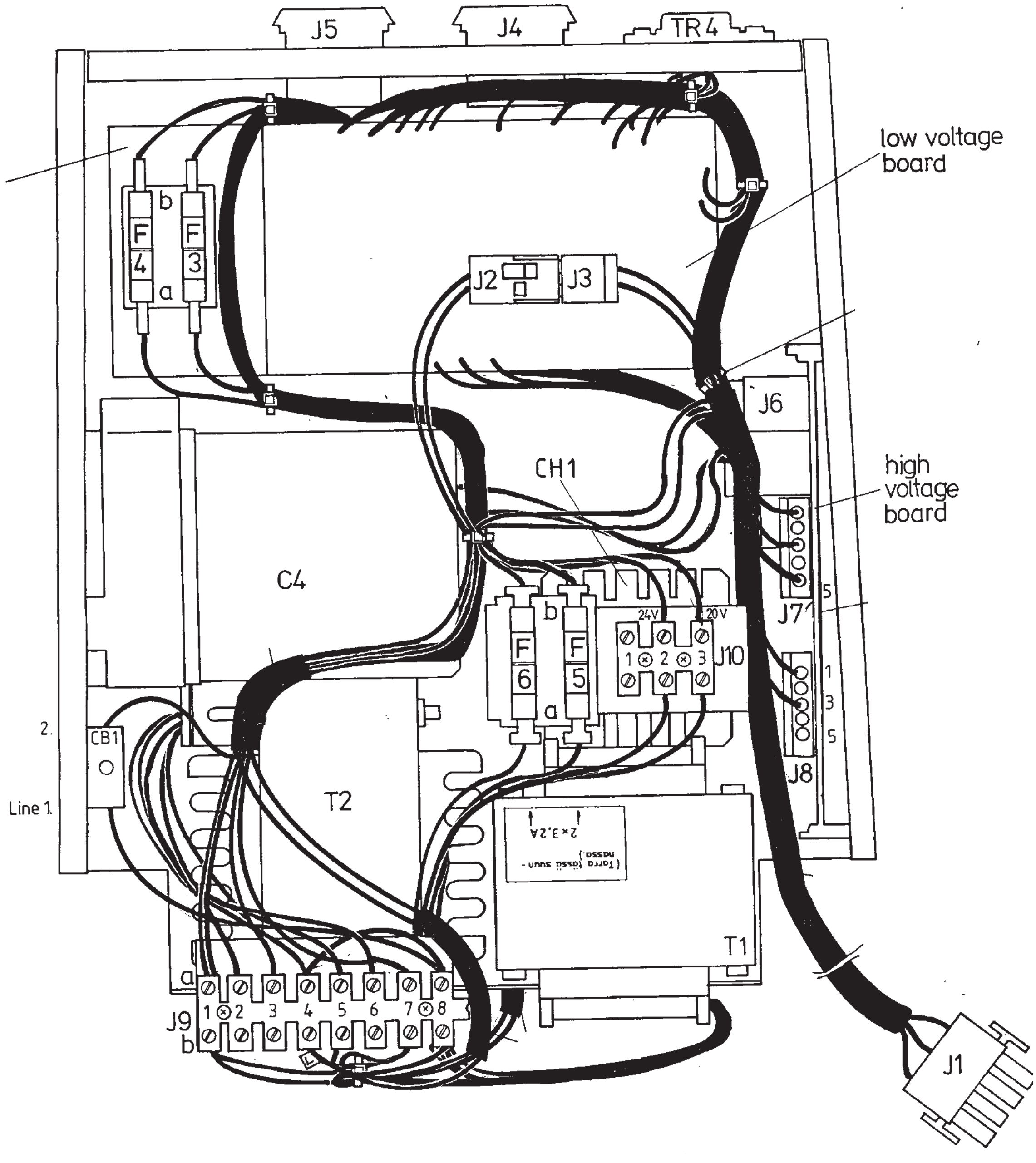
| Pin | Signal | Description |
|---|---|---|
| 1, 2 | BV1, BV2 | Supply for tube head cooling fan. 24 VDC . |
| 3, 4 | PV+, PV- | Supply for power switching unit. High (230-300 VDC across) during exposure. |

## 6.7 MPU schematic diagram

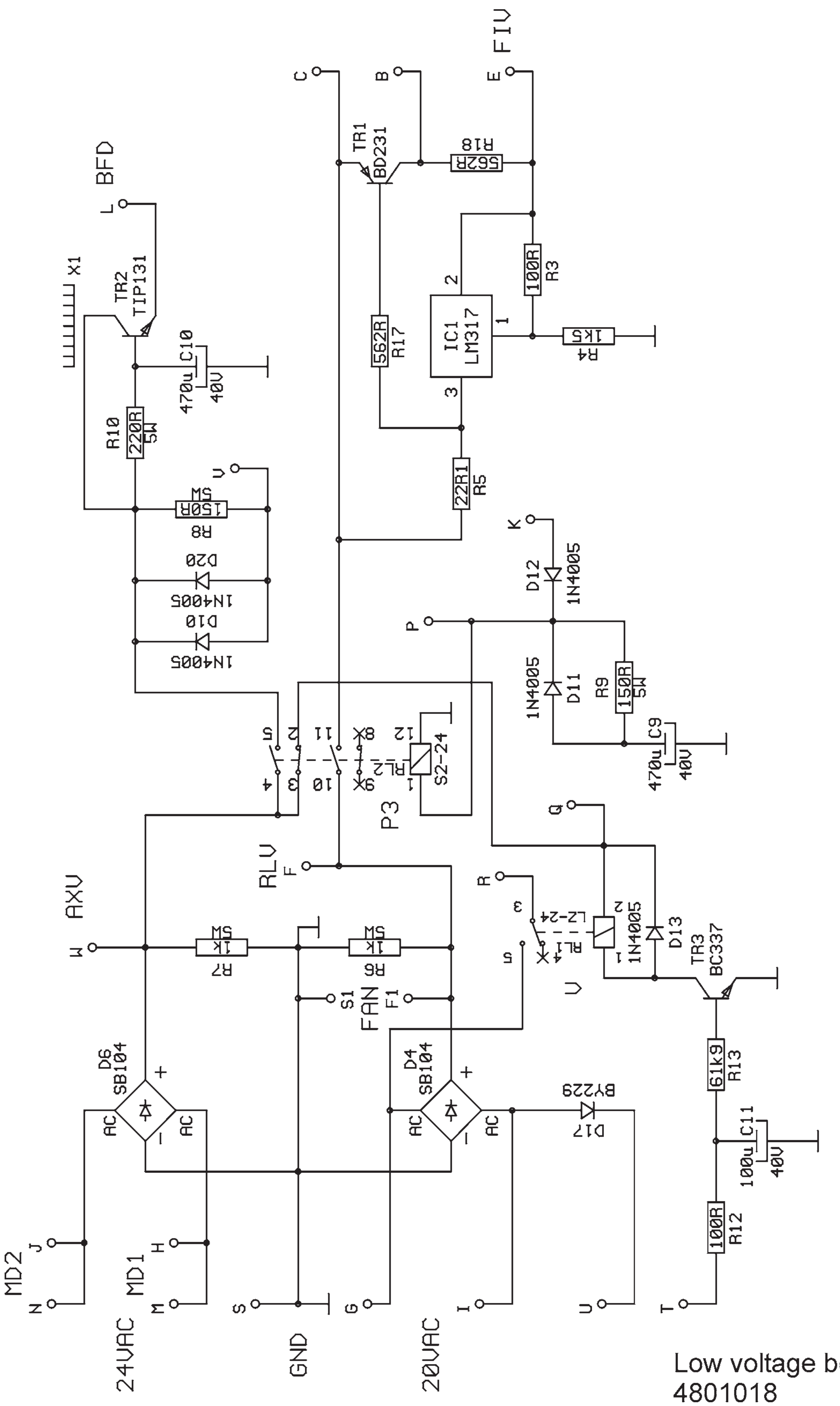



Mains Power Unit (MPU)

## 6.8 MPU Component Layout

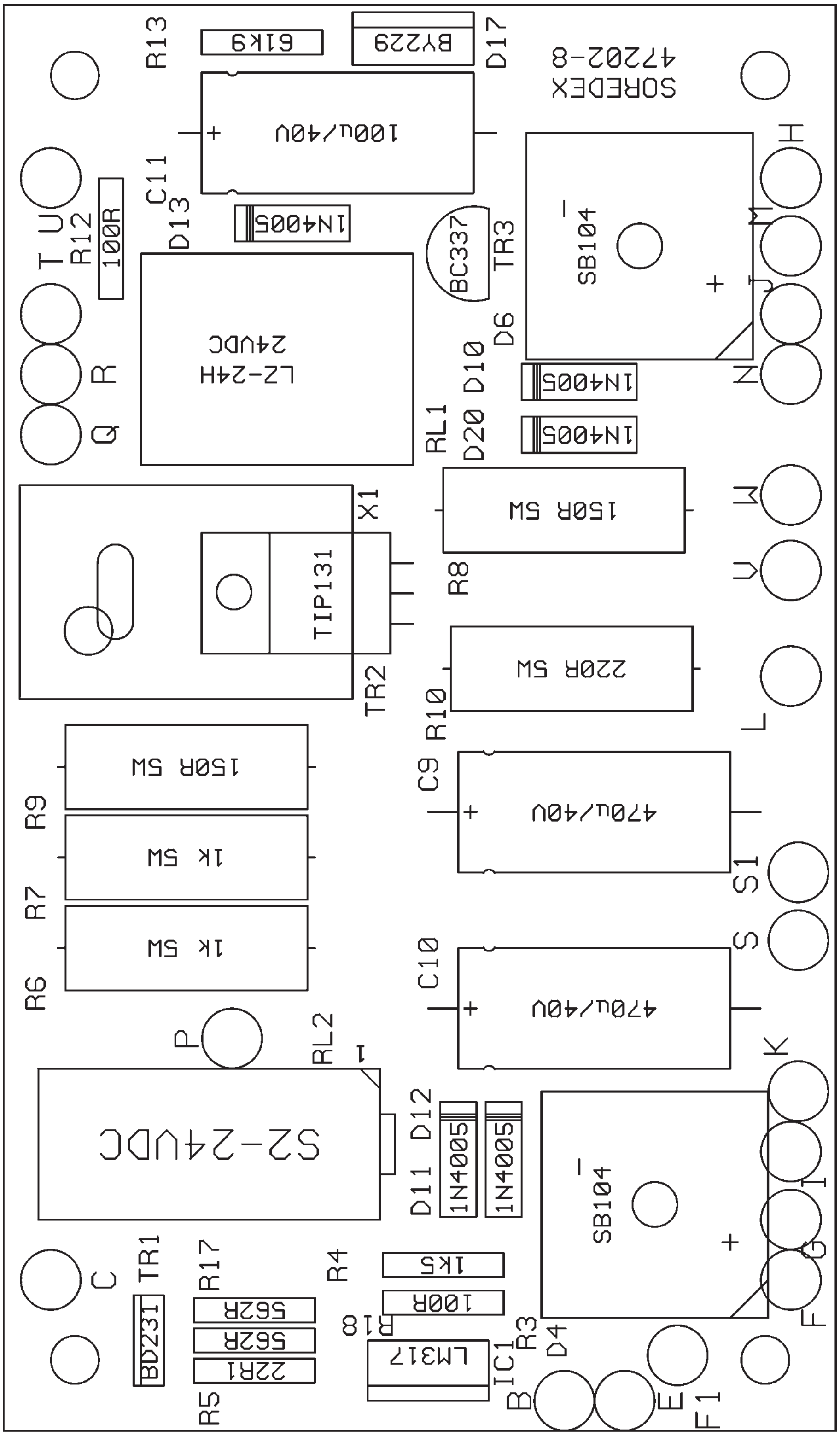


## 6.9 Low voltage board - schematic diagram



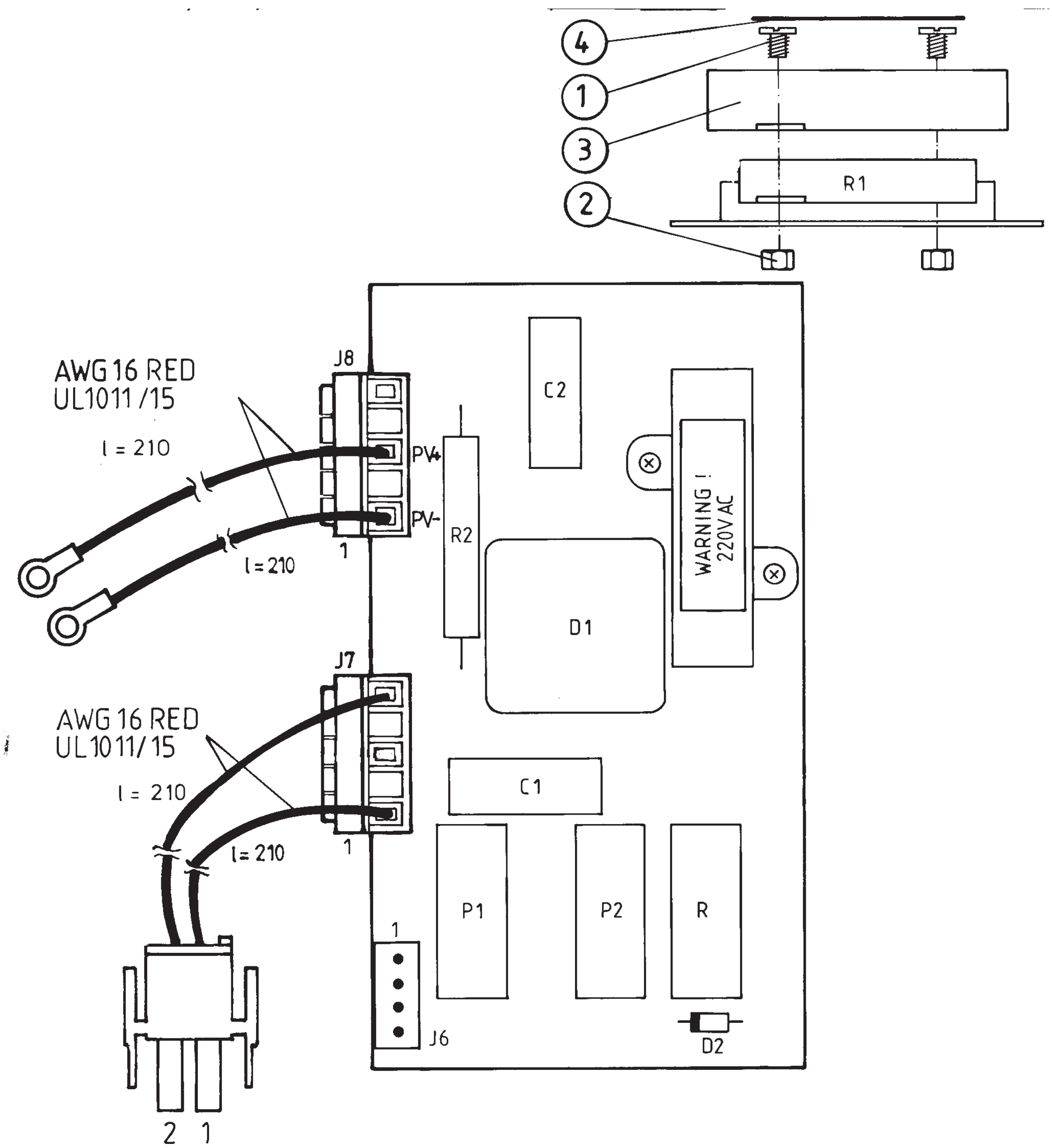

Low voltage board
4801018

## 6.10 Low voltage board - component layout




Low voltage board 4801018

## 6.11 High voltage board - component layout



# 7 Pulse Logic Unit (PLU)

The Pulse Logic Unit is located beneath the control panel. It includes all the X-ray generator controls, protection circuits and exposure logic. Voltage is supplied to the PLU board by the AXV. IC16 produces a 24 volt supply for technique selector boards, indicator lights and microswitches. IC15 produces a +15 volt supply for the logic and generator control ICs. The R37 - C12 network supplies a reduced input voltage for IC15.
IC8 is located on the Partial Exposure Controller board (PEC). (Note that not all units have the PEC board)

## 7.1 Exposure Logic

In normal operation the TA switch is in the DOWN position. If the TA switch is in the UP (TEST) position radiation is generated when the exposure button is pressed, but the rotating unit and cassette carriage do not move and all the microswitches, except for the thermal switch in the tube head, are bypassed. The unit is ready to take an exposure when a high voltage (+15 VDC) is supplied to IC9, pin 6. This happens when:

1. The start microswitch is closed, indicating that the rotating unit is in the start position.

2. The CAS microswitch is closed, indicating that the cassette carriage is in start position.

3. The temperature sensor(s) is closed, indicating that the temperature in normal in the tube head(s).

4. Protection circuitry not activated.

If the TA switch is UP, only the temperature sensor and protection circuitry are checked to see that they are in the ready condition.

When a high voltage is supplied to pin 6 on IC9 the ready-light (RYL signal) will come on. The protection circuitry trigger will prevent an exposure when a low voltage is supplied to pin 6 on IC7. The protection light will then come on.

When the EXPOSURE switch is pressed, a high voltage is produced on pin 13 on J1. Because the END microswitch is closed in the ready state, a high voltage is also produced on pin 5, IC7. This produces a low voltage on pin 4, IC9. Pin 6, IC9, has a high voltage because of the ready condition. This produces a low voltage on pin 13, IC8.

Before exposure starts a high voltage is produced on pin 10, IC9, and a low voltage on pin 8, IC9. This produces a high voltage on pin 12, IC9, which in turn produces a low voltage on pin 12, IC8. Thus a high voltage is produced on pin 11, IC8 (PRE signal). When the PRE signal voltage goes high preheating begins.

If a kV value has been selected (the unit is not in the TEST mode) pin 14, IC4, produces a low voltage. If a kV value is selected instead of TEST TR1 will come on and produce a high voltage PRV signal that activates the P-relays on the MPU. If the show switch connection to the MPU is cut (the show switch is down for the show mode) the PRV signal is not transmitted to the MPU and the P-relays are disabled.

Capacitor C4 begins to charge through R9 and when pin 12, IC2, reaches the voltage level of pin 13, IC2 (approximately 9 volts), the voltage of pin 14, IC2, goes up. Now the voltage of pin 16, IC3, goes low which closes the M-relay and the drive motors are energized (with digital units software handles the movement). When leading edge of the film reaches the secondary slot, the F-microswitch connects pin 14, IC2, to pin 10, IC2, (over 9 volts) and the voltage of pin 8, IC2, goes up.

The voltage of pin 11, IC5, goes up because pin 13, IC5, was at a high voltage level. The voltage of pin 13, IC5, stays at a high voltage level as long as the voltage of capacitor C6 is less than the voltage of the V-TIMER. C6 is charged through R12 and gives BACK - UP -TIME of about 23.5 sec.

The high voltage of pin 11, IC5, causes the voltage of pin 12, IC9, to go down, but because the voltage of pin 5, IC8, is high, the voltage of pin 4, IC8, remains low.

A high voltage on pin 11, IC5, normally produces a low voltage on pin 11, IC7 (EXT-NOT-signal). When the EXT-NOT-signal is low the X-rays will be generated.

When the trailing edge of the film passes the secondary slot, the F-microswitch grounds pin 10, IC2, which causes the voltage at pin 8, IC2, to go down and the voltage (EXT-NOT-signal) at pin 11, IC7, goes up, causing the generation of X-ray stop.

When the voltage on pin 11, IC5, goes down, the voltage on pin 4, IC8, goes up and a low voltage is produced on pin 11, IC8, which deactivates the P-relay. If the exposure switch is released during exposure or the END microswitch opens at end of rotation, the voltage of pin 4, IC7, will go up, producing high voltage on pin 13, IC8, and a low voltage pin 12, IC8. This causes the voltage (PRE-signal) on pin 11, IC8, to go down turning off X-ray generation. Further exposure is possible only after the unit is returned to the ready position again and the voltage on pin 6, IC7, goes up.

## 7.2 Return Function

When the RETURN switch is pressed, the voltage on pin 9, IC5, goes up, and if the voltage on pin 8, IC5, is high, a high voltage is produced on pin 10, IC5, which, with the help of D4, holds itself at the high level. When the voltage at pin 10, IC5, is at a high level, it drives the D- and M-relays. The D-relays change rotating direction of motors to return. The voltage at pin 8, IC5, goes down when the EXP switch is pressed (pin 8, IC8, goes high) or when the rotating unit reaches start position and START microswitch closes (pin 9, IC8, goes high).

## 7.3 Technique Selection

Technique selection is done with the kV selector row. The kV selector generates a selected reference voltage to kV REF output. When TEST mode is selected, TEST 1 contact is low, inhibiting P-relay pull-in and TEST 2 contact is high, connecting high to IC8, pin 1, that prevents the EXT-NOT signal from going low.

## 7.4 Filament Control Circuitry

IC14 produces pulse-width controlled 23.5 kHz drive signals to the filament inverter transistors on the PSU through FIL1 and FIL2. IC14 has two separate controls for pulse width: preheating and tube current feedback.

Regulated supply voltage for filament inverter, FIV, is connected to R83 - R82 - C34 network and produces reference to IC14, pin 4 through R40 - R41 - R43 - C16. In the beginning of the preheat period IC10b turns on and connects reference to IC14, pin 4 since IC10d is on (EXT-NOT-signal high). The voltage of IC14, pin 4 rises. This voltage controls the duty cycle during preheat time. After the preheat time, the EXT- NOT signal goes low, turns IC10d off and IC14, pin 4 drops low. Pulse width is now controlled by tube current feedback.

The tube current feedback signal, MAI, is connected through R75 to R38. The voltage across R38 is fed into -input of error amplifier, IC14, pin 2. The +input IC14, pin 1 is connected to reference voltage on capacitor C19. Reference voltage is derived from 5 volts source of IC13 through R48 - R51 - R50 network.

If 6 mA selection is made, resistor R84 connects in parallel with R50. In compensation mode, R85 connects in parallel with R50, except in the middle part of exposure to produce a lower (7.5 or 4.5 mA) current on sides and full (10 mA or 6 mA) current in the middle.

The R86 - C19 network filters the reference voltage to give a smooth change for tube current in compensation mode. Error amplifier adjusts pulse width, so that feedback signal across R38 is the same as reference across C19. If this does not hold true, the pulse width will change in order to compensate for the error.

R69 and R70 supply base current through IC14 to filament inverter transistors.

R44 - R45 and C17 determine the clock frequency of X-ray generator. It is adjusted with R45 to be 47 kHz. The output of IC12, 13, 14 has 23.5 kHZ waveform because of an internal divider of IC’s. IC14 acts as master oscillator. It gives frequency to IC12 and IC13 through pin 5’s which are connected together.

## 7.5 Power Inverter Control

IC13 operates as a controller for the power inverter transistors. It works at a constant pulse width, duty cycle being 90%. In case of an mA overrun, pin 4 goes high and shuts down the power inverter.

## 7.6 High Voltage Control Circuitry

IC12 operates as a power regulator drive circuit. It produces variable pulse width according to feedback signals from the power regulator output voltage (RFB) and high voltage (HFB).

After preheat time, the EXT-NOT signal turns low, turning off IC10c. IC12, pin 4 drops low and output pulse width is controlled by error amplifier of IC12. EXT-NOT going low turns off, also IC10a and kV-REF signal on IC11, pin 5 begins to rise in compliance with the R61 -C22 network towards value selected in kV-selector. IC11, pin 7 begins to rise because of +input going higher than -input. IC12, pin 2 goes higher than IC2, pin 1 and pulse width on output pins 8,11 begins to increase. Thus, the power regulator output voltage rises and also the RFB-signal on IC12, pin 1 rises following IC12, pin 2. High voltage on tube rises also according to the power regulator output voltage and the HFB signal begins to rise. IC11, pin 3 and 1 rises and follows the voltage on IC11, pin 5. Stable condition in feedback system is achieved when IC11, pin 1 has the same voltage as IC11, pin 5 and IC12, pin 2 same as IC12, pin 1. Now, the feedback system works to maintain this condition.

If, for some reason, the HFB-signal is missing and IC11, pin 7 stays high, RFB signal level will match the level on IC12, pin 2 and the power regulator output voltage is limited to yield approximately 85 kV on tube.

## 7.7 PSU Protection Circuit

Normally the PSU protection circuit is activated when the regulator voltage or inverter current are too high. When the PSU protection circuit is active it will trigger the PLU protection circuit through the HFB line. The X-ray generator has circuitry that inhibits or interrupt exposure if an unsafe condition exists. IC6, pin 10 is normally low, and when high, it interrupts exposure by producing low on IC7, pin 6, and by raising EXT-NOT high by low on IC8, pin 3 and indicates the condition through low on IC4, pin 15, which drives the protection indicator lamp. IC6, pin *(4) 11 high indicates the protection condition. When IC5, pin 5 goes high after preheating, output IC5, pin 4 is dependent on output IC6, pin *(4) 11. If the condition still exists, IC6, pin 8 goes high and latches IC6, pin 10 high. Connection of IC6, pin 10 to pin 9 makes the high stay until power is switched off.

IC2, pin 6 is connected through divider R15 - R16 - R17 - C7 to unregulated supply voltage, AXV. If AXV is too low, indicating a low mains voltage, IC2, pin 6 goes lower than 9 volts reference (V9) on IC2 pin 5, and output IC2 pin 7 and also IC6 pin *(4) 11 will go high. IC1, pin 10 is connected to HFB signal through R18 - C8. If it goes higher than 9 volts (V9) indicating a high voltage on X-ray tube (90 kV), output IC1, pin 8 and also IC6, pin 4 will go high. IC1, pin 5 is also connected to HFB-signal. Output IC1, pin 7 is controls the EXL signal through IC3, pin 10 and TR2. EXL signal is high if the tube has more than 50 kV.

The tube current is sensed on R75 - R38 by IC17, pin 6. If the current becomes too high, indicating tube arc, output IC17, pin 1 goes high and latches high on IC6, pin 10 and about IC13, pin 4 that inhibits power inverter drive pulses. IC17, pin 1 is brought low by a pulse on IC17, pin 4 through C28 - R72 at power up.

## 7.8 Motor Drive

J1/23, 24 (MD1) and J1/25, 26 (MD2) use 24 AC supply derived from the MPU. MD2 is brought through a TA switch contact that disables motors when in the up position.

M-relay controls supply to motors through contacts in both MD1 and MD2 line. D-relay controls direction of motor run by connecting MD1 signal either to J6/1 and J7/3 or J6/3 and J7/1. (J4/8 and J4/9 are shorted together with a jumper on connector.)

## 7.9 Pulse Logic Unit connectors

**PLU/J1: 26-pin ribbon cable**

| Pin | Signal | Description |
|---|---|---|
| 1 | MAI | Tube current feedback from panoramic tube head. |
| 2, 3, 4, 6 | GND | Signal ground. |
| 5, 7, 8 | AXV | Unregulated supply 28-35 VDC. |
| (9) | RVL | Not in use. Full wave rectified 20 VAC. |
| 10 | BI1 (RI1) | Tube head temperature signal. High (24 VDC) when unit in start position, kV selected and tube head temperature sensor closed or TA switch on PLU board up and tube head temperature sensor closed. |
| 11 | RYL | Ready light drive. High (24 VDC) when unit ready for exposure. |
| 12 | BI2 | Tube head temperature sensor supply. High when unit in start position and kV selected, or TA-switch on PLU board up. |
| 13 | EXP | Exposure command. High (28-35 VDC) when exposure switch pressed. |
| 14 | HFB | High voltage feedback from pan tube head. |
| 15, 16 | EXL | Exposure light drive. High (24 VDC) when kV over 50. |
| 17, 18 | PRV | P-relay control. High (28-35 VDC) during exposure. |
| 19, 20 | TH | R-relay control. Low after preheat. |
| 23-26 | MD1, MD2 | Supply for drive motors. 24 VAC across. |

**PLU/J2: 20-pin ribbon cable**

| Pin | Signal | Description |
|---|---|---|
| 1, 2 | | Signal ground. |
| 3 | RFB | Regulator voltage feedback. |
| 4 | +15 | Regulated supply +15V |
| 9, 13 | F1, F2 | Filament inverter control. High (1.2 VDC, 0.2 VAC) during exposure. |
| 15,17,19 | FIV | Filament inverter supply. High (20 VDC) during exposure. |
| 16, 18 | R1, R2 | Power regulator control. High (2.2 DC) during preheat, low (1.5 DC) after preheat. |
| 14, 20 | I1, I2 | Power inverter control. 1.5 DC, 0.3 VAC during exposure. |

**PLU/J3: Front panel connector**

| Pin | Signal | Description |
|---|---|---|
| 11 | GND | Signal ground. |
| 10 | RYL | Ready light drive. High (24 VDC) when unit ready for exposure. |
| 9 | FAILURE | Protection indicator drive. Low when protection condition occurs. |
| 8 | RET | Return command. High (24 VDC) when return switch is pressed. |
| 7 | +24V | Regulated supply. +24 VDC. |
| 2 | D2 | Compensation selection. Shorted to ground when compensation selected. |
| 1 | MAR | 6/10 mA selection. Shorted to ground when 6 mA selected. |

**(PLU/J4) Cassette motor versions only.**

Special note, pins 8 and 9 must be shorted

**(PLU/J5:) Not in use. Test circuit connector.**

| Pin | Signal | Description |
|---|---|---|
| 4 | - | Exposure command. High (28-35 VDC) when exposure switch pressed. |
| 3 | RET | Return command. High (24 VDC) when return switch pressed. |
| 2 | GND | Signal ground. Ground point for DMM. |
| 1 | +24V | Regulated supply. 24 VDC. |

**PLU/J6: Cassette motor (where applicable)**

| Pin | Signal | Description |
|---|---|---|
| 1 | - | Cassette motor supply. High (24 VAC to 2) during return movement, when TA switch is down. |
| 2 | - | Cassette motor supply. |
| 3 | - | Cassette motor supply. High (24VAC to 2) after preheat, when TA switch is down. |

### PLU/J7: Rotation motor

| Pin | Signal | Description |
|---|---|---|
| 1 | - | Rotation motor supply. High (24 VAC to 2) after preheat, when TA switch is down. |
| 2 | - | Rotation motor supply. |
| 3 | - | Rotation motor supply. High (24 VAC to /2) during return movement, when TA switch is down. |

### PLU/J8: Rotation microswitches

| Pin | Signal | Description |
|---|---|---|
| 1 | - | Exposure command. High (28-35 VDC) when exposure switch pressed. |
| 2 | - | Exposure command. High (28-35 VDC) when exposure switch pressed and rotation unit “not in end” position. |
| 3, 4, 5 | - | Not in use. |
| 6 | | Rotation start position. High (24 VDC) when rotation unit in start position. |
| 7 | - | Regulated supply. +24 VDC. |
| 8, 9 | - | Rotation unit position in Ceph mode. Open across when rotation unit in Ceph position. |

### PLU/J9: Cassette carriage microswitches (cassette versions)

| Pin | Signal | Description |
|---|---|---|
| 1 | - | Signal ground. |
| 2 | - | Radiation enable signal. High (15 VDC) after preheat when film comes behind secondary slot. |
| 3 | - | Motors start signal. High (15 VDC) after preheat. |
| 4 | - | Cassette start supply. High (24 VDC) when rotation unit is in start position. |
| 5 | - | Cassette start signal. High (24 VDC) when rotation unit and cassette carriage are in start position. |
| 6, 7 | - | Cassette carriage position in Ceph mode. Open across when cassette carriage in Ceph position. |

### PLU/J9: Cassette carriage microswitches (DM versions)

| Pin | Signal | Description |
|---|---|---|
| 1 | - | Not in use. |
| 2 / 3 | - | Shorted. |
| 4 / 5 | - | Shorted. |

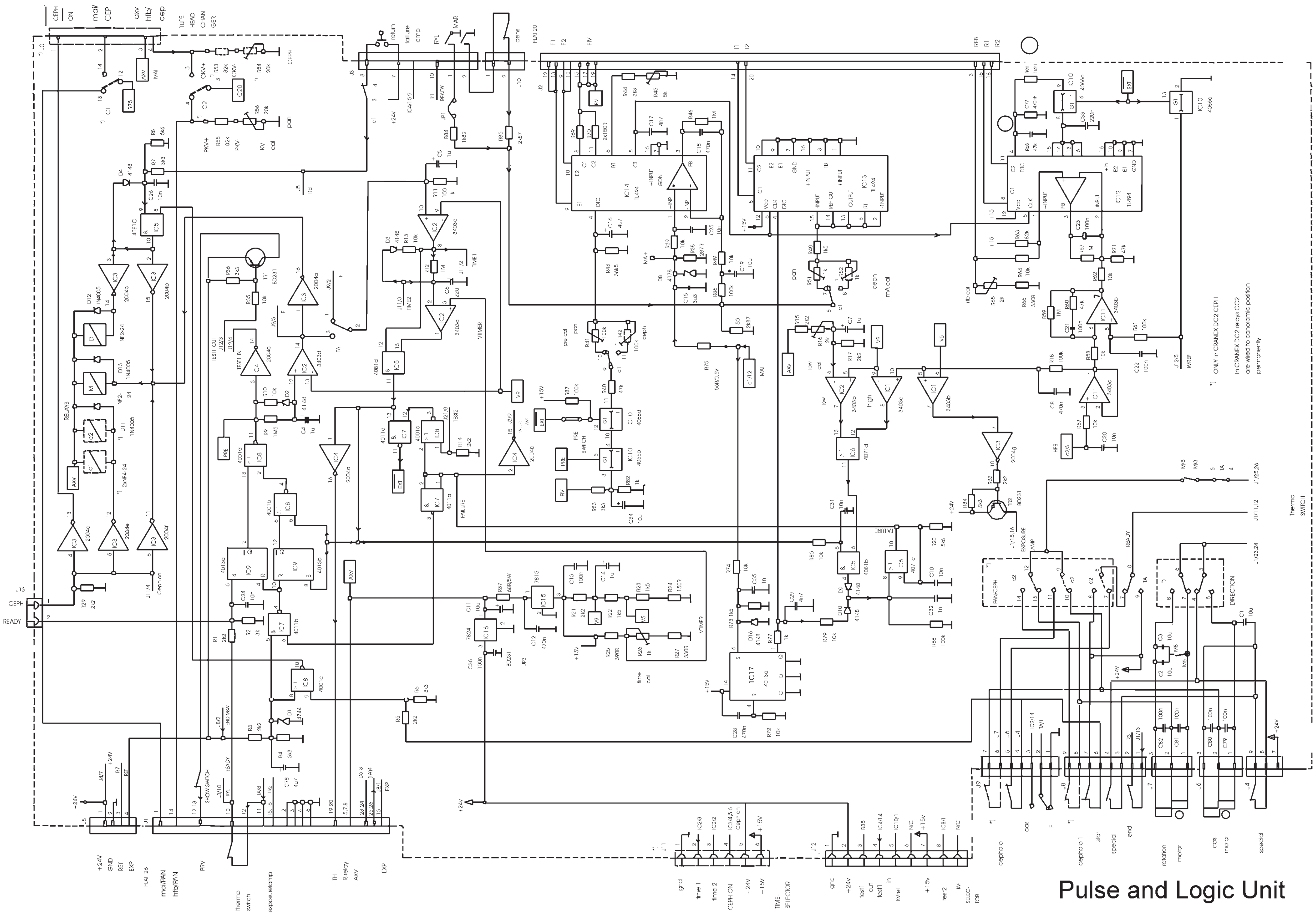
### PLU/J9: Cassette carriage microswitches (DS versions)

| Pin | Signal | Description |
|---|---|---|
| 1 | - | CDR remote control box. |
| 2 | - | CDR remote control box. |
| 2 / 3 | - | Shorted. |
| 4 / 5 | - | Shorted. |

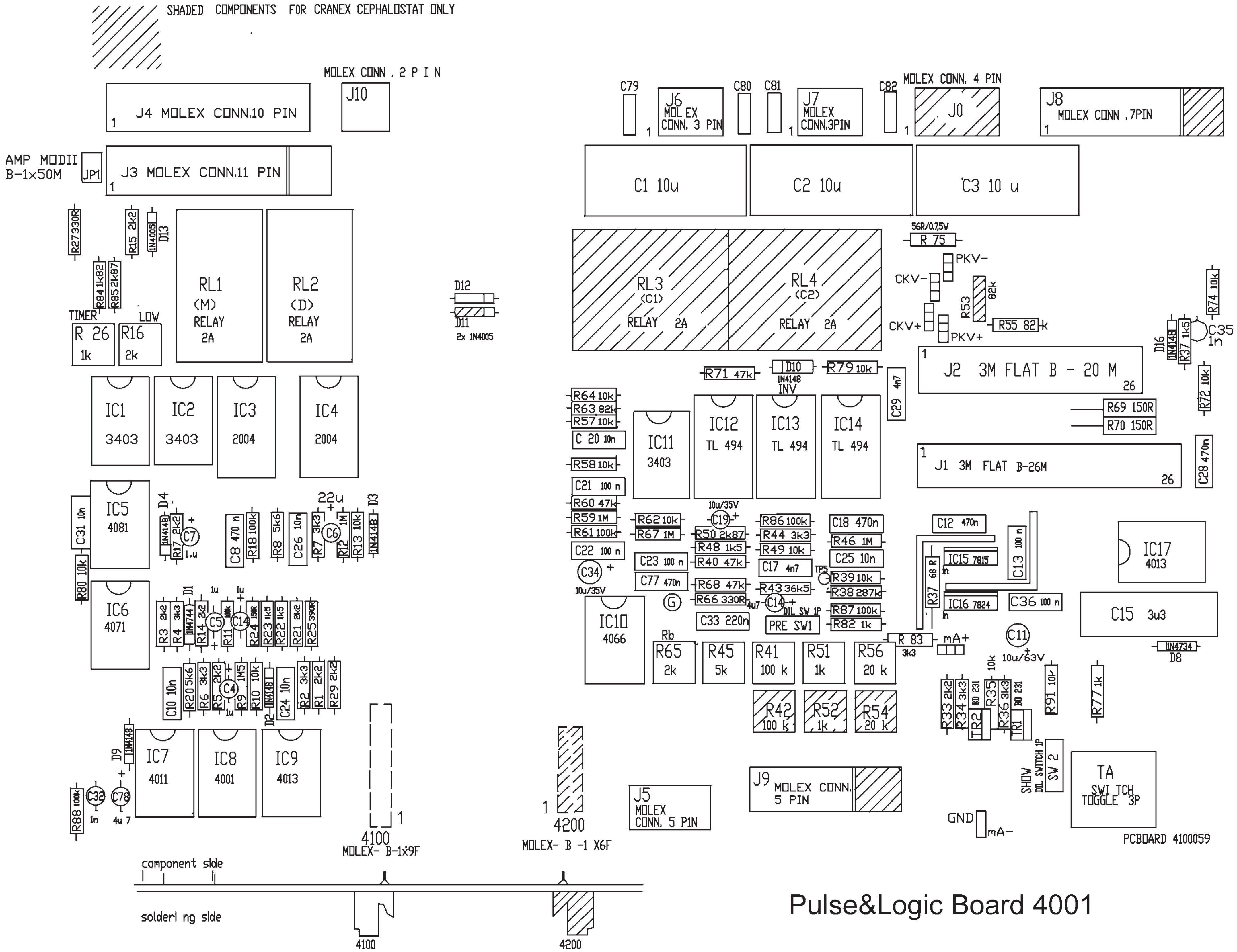
### PLU/J10: Compensation microswitch

| Pin | Signal | Description |
|---|---|---|
| 2 | D1 | Compensation control signal. Shorted to ground in compensation mode except in the middle part of the revolution. |
| 1 | D2 | Compensation selection. Shorted to ground when compensation selected. |

## 7.10 PLU Schematic diagram



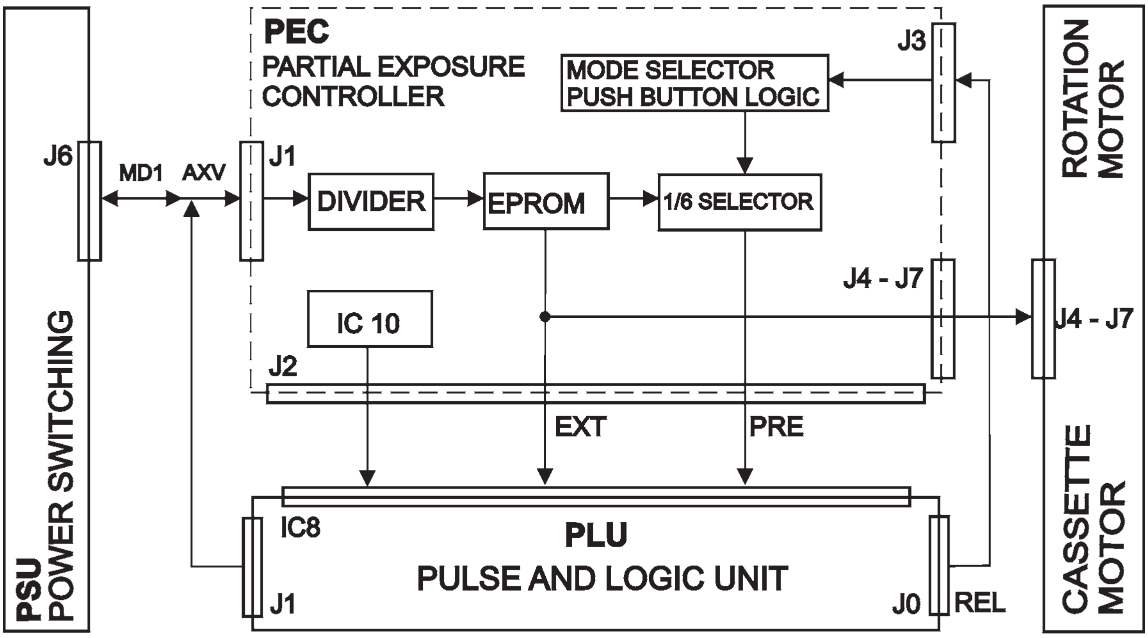
## 7.11 PLU Component Layout




Pulse&Logic Board 4001

# 8 Partial Exposure Controller (PEC)

## 8.1 Block diagram




Block diagram of the PEC

## 8.2 Operation

The main parts of the partial exposure controller are a 12-bit divider 4040 (IC1), EPROM 27128 (IC2) and push buttons which are selecting the exposure method. The timing pulse is produced from AC voltage MD1 (J1, pin 23,24), which is in line frequency (50/60 Hz). Divider makes an 11-bit address for EPROM (IC2). All the 6 partial exposure methods are stored in EPROM (IC2). When the partial program is selected, the PEC board drives signals PRE (PLU/IC8 pin 11) and EXT (PLU/IC7 pin 13) in the PLU board through IC 8 socket and also drives motors with relays RL1 and RL2 in the PEC. PRE and -EXT signals control irradiation in the pulse and logic unit. During normal exposure, PEC has no effect on the actions of the PLU and motors when normal PAN is selected. Both 15+ and 5+ DC voltages are used, because of the EPROM. They are produced from AXV connection (J1 6,7,8) by regulators IC11 +15V and IC12 +5V.

## 8.3 Eprom 27128 (IC2) and Divider 4040 (IC1)

When a partial program is selected, one of the data bits of the EPROM (IC2) 0, 1, 2, 4, or 5 is connected to drive PRE signal. Bit no. 3 drives -EXT signal of the PLU board and preheating of filament. When the EXPOSURE button is pressed, the state of PEC J2 14 changes “0" (= PLU IC 9 pin 2), with the result that IC 1 pin 11 (Reset) and IC 2 pin 22 change to "0"-state and divider 4040 and EPROM are activated. The connection of the F-microswitch in the cassette carriage changes the state of Flip Flop (FF) IC 9 pin 3 (clk input) to “1" through PLU J2 7 with the result that pin 2 (-Q) changes to ”0". Then the IC 4040 counter receives the clock signal (IC1 pin 10) and starts the stepping and EPROM the program. Memory starts the operation from address 000 except when the TMJ 2 program is selected, when the start address is Hex. 800. The address increases by increasing one step every line cycle (50/60 Hz). The state “1" of the selected driving bit (IC 2 output) causes the PRE signal (IC7 pin 3, J2 10) to rise to +15 V. The rising edge of PRE signal (IC 9 pin 11) sets the output Q of IC 9 to “1” if bit 3 is “1” in EPROM. The state of FF (IC9) keeps the preheating on by keeping the -EXT signal (PEC J2 pin 11) in +15 V until bit 3 changes to ”0" state with the result that FF is reset, -EXT drops to “0" and radiation starts. When -EXT changes back to +15V, the radiation stops.

## 8.4 Mode selector

The push buttons located on PEC controlling board are comprised of switches SW1 - SW7. Selecting logic includes the ten counter IC3 4017, the Darlington transistor circuit IC6 2003 and NAND IC7. When the button is pushed, IC7 pin 13 is connected to +15V. This causes the oscillator circuit which is comprised of NAND IC7 to start, and IC3 receives the clock signal (pin 14). The counter IC3 starts to step if reset pin 15 is “0". The outputs of IC3 Q0-Q1 are rise to state ”1" one by one. IC6 converts all the inputs to state “0". Stepping continues as long as the corresponding output is activated. In consequence, when pin 13 of IC7 changes to ”0" state, the oscillator and counter stop. The corresponding output of pushed button remains in the “1" state and lights up the LED by IC6. The selected output (IC3 Q0..Q6) also activates the corresponding selecting switch from IC4 or IC5 which causes selection of the desired program output of IC2 (D0, D1...).

## 8.5 Motor Driving

Bits 6 and 7 of IC2 drive the cassette and rotating motors. When bit 7 is in “1" state relay RL1 is closed, and when bit 6 is in ”1", relay RL2 is closed.

## 8.6 PEC J3 1

Signal connection ensures that the partial exposure logic can not operate when cephalometric operation is selected.

## 8.7 IC 10

The PEC is connected to the PLU trough IC8 socket in the PLU and IC8 is transferred to the PEC (IC10).

## 8.8 PEC control panel

Switches SW1 - SW7 and LEDs D1 - D7 are located in control panel, which is mounted at the top of PEC board. Locations of previous versions buttons and LEDs are also present in PEC board of maintenance purpose.

## 8.9 Lengths of exposured areas using the PEC

| | | |
|---|---|---|
| 1. | Normal width panoramic X-ray | 265 mm +/- 5 |
| 2. | Reduced width X-ray for children | 235 mm +/- 5 |
| 3. | Temporomandibular joints, first exposures | 2 x 70 mm +/- 5 |
| 4. | Temporomandibular joints, second exposure | 2 x 70 mm +/- 5 |
| 5. | Left side of the panoramic X-ray | 150 mm +/- 5 |
| 6. | Right side of the panoramic X-ray | 150 mm +/- 5 |
| 7. | Middle part of the panoramic X-ray | 100 mm +/- 5 |

## 8.10 Partial Exposure Controller (PEC) Connectors

### PEC/J1: Connected parallel to 26-pin

| Pin | Signal | Description |
|---|---|---|
| 2, 3, 4, 6 | GND | Signal ground. |
| 5, 7, 8 | AXV | Unregulated supply 28-35 VDC. |
| 23, 24 | MD1 | Supply for drive motors 20 VAC. |
| 25, 26 | MD2 | Clock signal for IC1. |

### PEC/J2: Connects PEC IC10 to PLU IC8

| Pin | Signal | Description |
|---|---|---|
| 3 | GND | Signal ground. |
| 4, 5, 6, 8, 9, 12, 13, 15, 16 | - | No special action in PEC circuit. Connections only replace IC8 functions in PLU. |
| 7 | - | Start signal for PEC. Rising up when F-micro switch in cassette carriage changes the state at the beginning of movement. |
| 10 | PRE | Driving the PRE signal (pre heating of tube filament) in PLU. Rising up (15VDC) 1 sec. before radiation. |
| 11 | EXT | Driving the -EXT signal in PLU. Up (15VDC) during radiation. |
| 14 | - | Reset signal for PEC. Low when exposure button pressed. |

### PEC/J3:

| Pin | Signal | Description |
|---|---|---|

Securing that PLU logic can not start when cephalometric operation is selected. Low when cephalostat is selected.

### PEC/J4: Cassette motor supply from PLU (where appropriate)

| Pin | Signal | Description |
|---|---|---|
| 1 | - | Cassette motor supply. High (20 VAC MD1 to /2) during return movement, when TA switch is down. |
| 2 | - | Cassette motor supply (MD2). |
| 3 | - | Cassette motor supply. High (20 VAC MD1 to /2) after preheating, when TA switch is down. |

**PEC/J5: Cassette motor (where appropriate)**

| Pin | Signal | Description |
|---|---|---|
| 1 | - | Cassette motor drive. High (20 VAC to /2) during return movement, when TA switch is down. |
| 2 | - | Cassette motor drive. |
| 3 | - | Cassette motor drive. High (20 VAC to /2) when RL1 is “0" and RL2 ”1" or RL1 and RL2 are “1". |

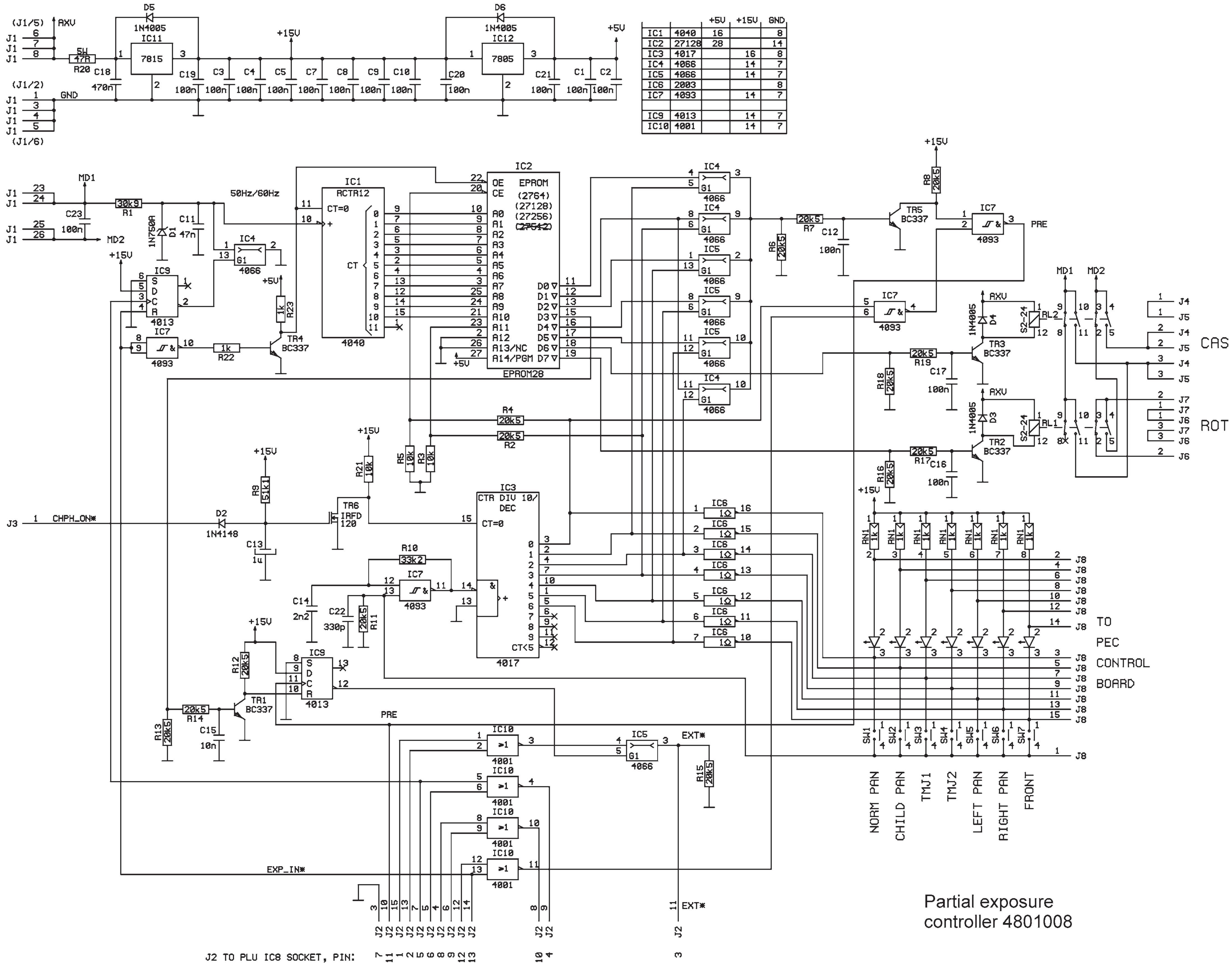
**PEC/J6: Rotation motor supply from PLU**

| Pin | Signal | Description |
|---|---|---|
| 1 | - | Rotation motor supply. High (20 VAC MD1 to /2) after preheating, when TA switch is down. |
| 2 | - | Rotation motor supply (MD2). |
| 3 | - | Rotation motor supply. High (20 VAC MD1 to /2) during return movement, when TA switch is down. |

**PEC/J7: Rotation motor**

| Pin | Signal | Description |
|---|---|---|
| 1 | - | Rotation motor supply. High (20 VAC to /2) when RL1 “0" and RL2 ”1" or RL1 “1" and RL2 ”0". |
| 2 | - | Rotation motor supply. |
| 3 | - | Rotation motor supply. High (20 VAC to /2) during return movement, when TA switch is down. |

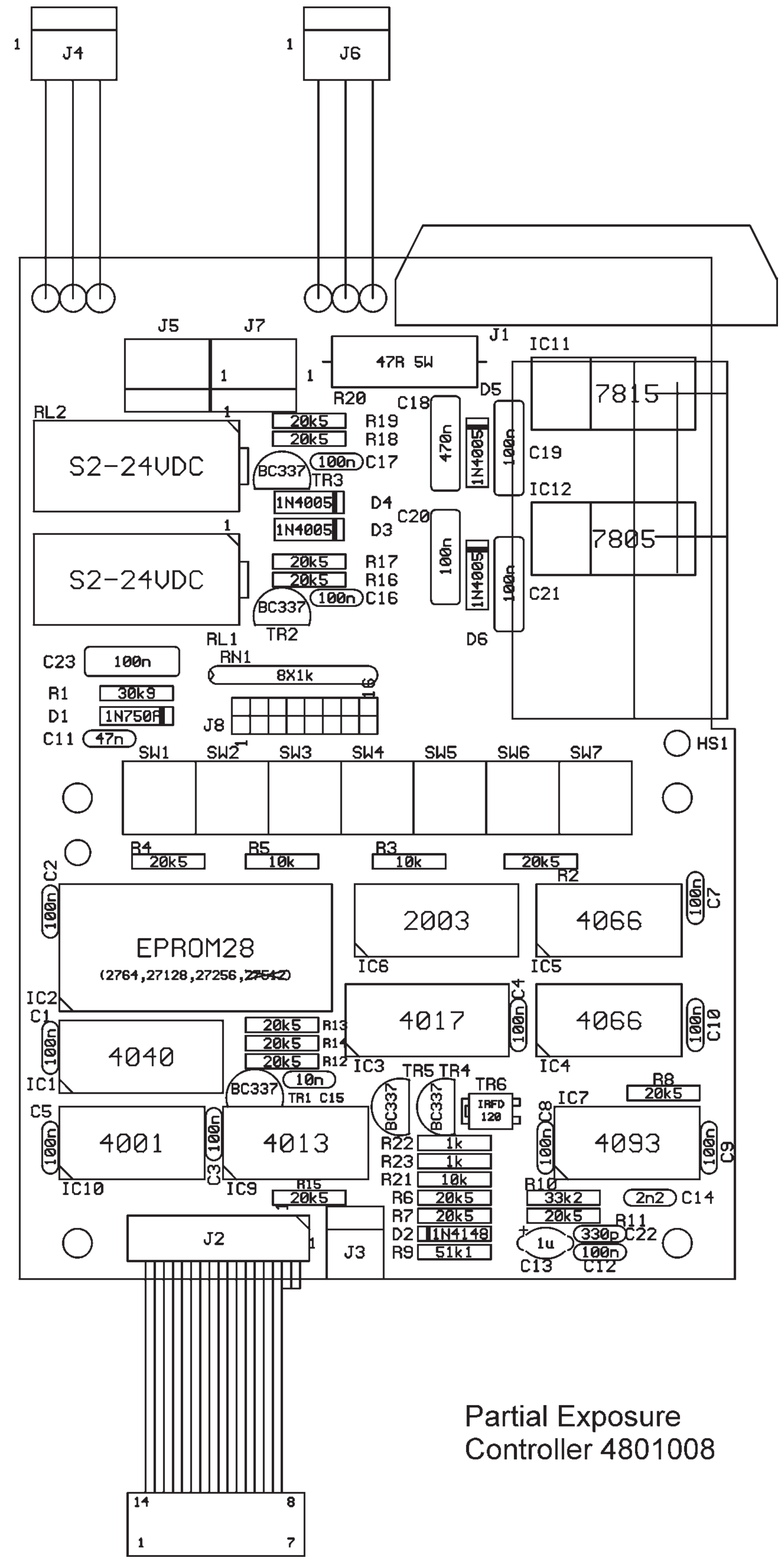
## 8.11 Partial Exposure Controller (PEC) schematic diagram




| | | +5V | +15V | GND |
|---|---|---|---|---|
| IC1 | 4040 | 16 | | 8 |
| IC2 | 27128 | 28 | | 14 |
| IC3 | 4017 | | 16 | 8 |
| IC4 | 4066 | | 14 | 7 |
| IC5 | 4066 | | 14 | 7 |
| IC6 | 2003 | | | 8 |
| IC7 | 4093 | | 14 | 7 |
| | | | | |
| IC9 | 4013 | | 14 | 7 |
| IC10 | 4001 | | 14 | 7 |

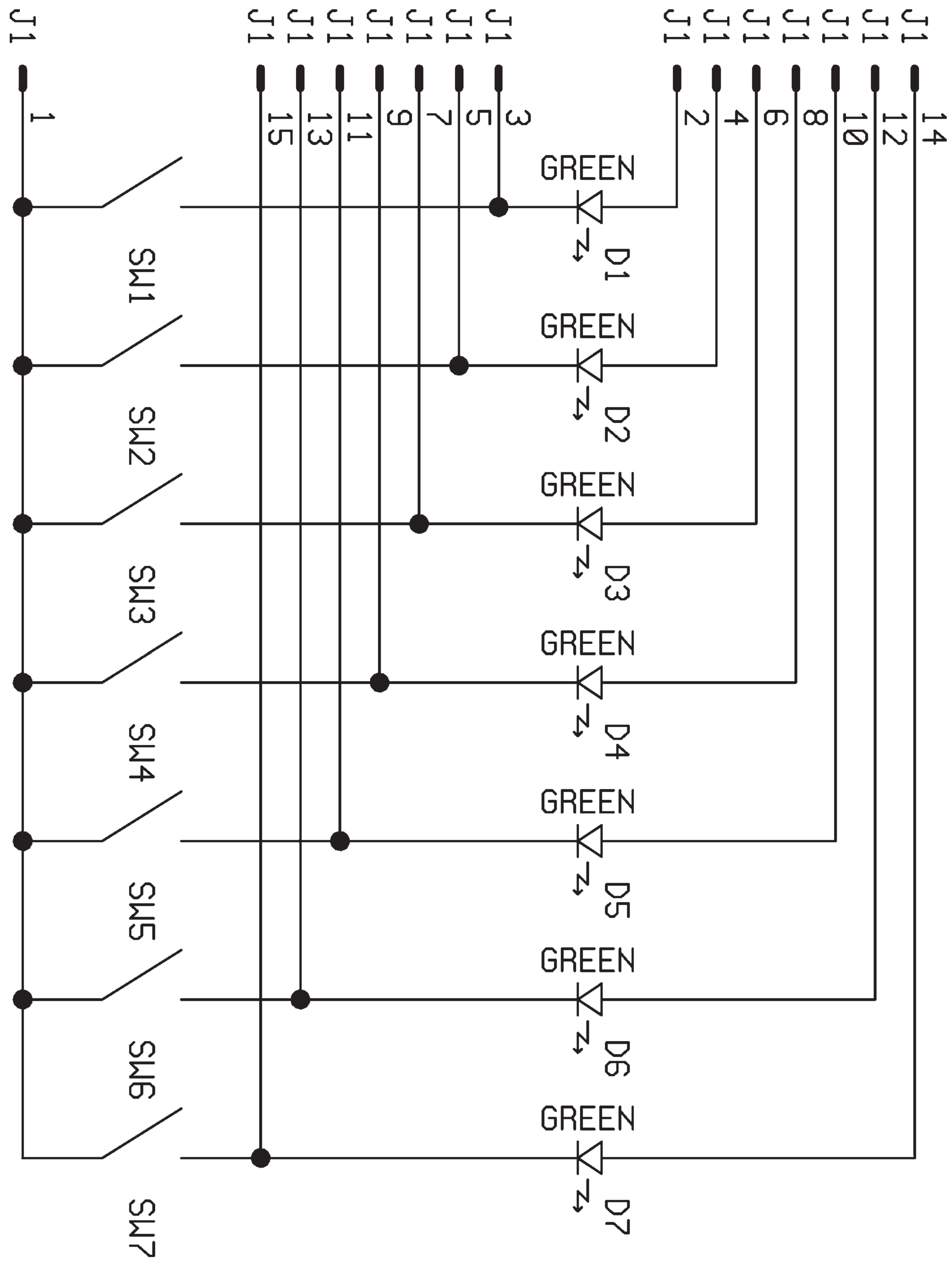
Partial exposure controller 4801008

## 8.12 Partial Exposure Controller (PEC) component layout

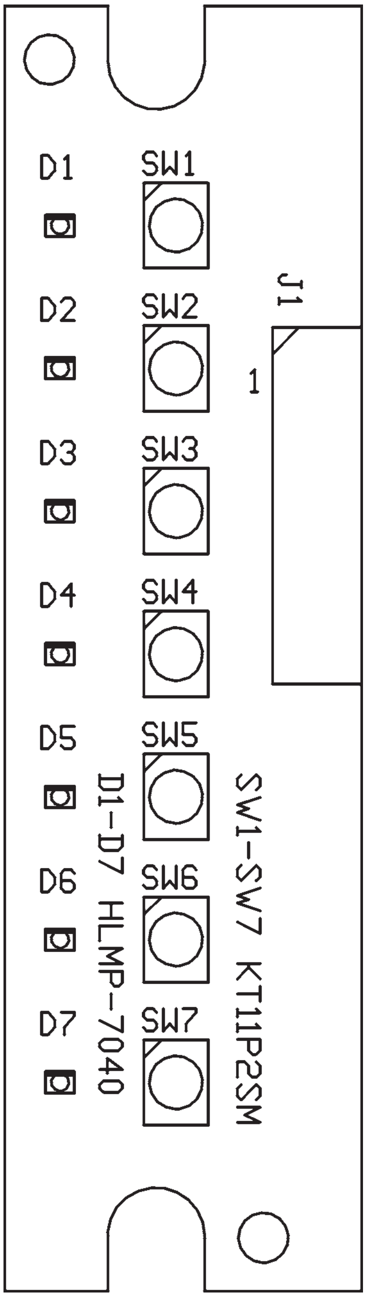



Partial Exposure
Controller 4801008

## 8.13 PEC Switches - schematic diagram



## 8.14 PEC Switches - component layout



# 9 Front Panel board 4050-1

## 9.1 Functional Description

The main function of front panel board is to support toggle type switches: compensation off/on and mA = 10 or 6. There are also located return switch and unit state indicating LEDs: ready and protection. When power is switched on the RC-network (C7 and R6) resets IC1, so outputs (Q) in pin 1 and pin 13 are low. This puts the system into the default state (the default can be set by repositioning jumper JP1): LEDs D6 and D8 on, indicating that compensation is off and selected tube current is 10 mA (TR1 and TR2 are off). When the user pushes SW1 the IC1 is clocked (pin 3 goes high) and changes its state to 1, so Q (pin 1) goes high (led D6 off, TR1 on) and -Q (pin 2) goes low, which switches LED D7 on (compensation on). When user push SW1 again the state returns back to default (D6 on, TR1 off, D7 off). SW2 controls mA level same way. IC2 is used to sharpen the clock signal. R2, R3, C5 and R4, R5, C6 are needed to get switch open level signal, level shift and filtration. IC3 regulates +15V power needed by CMOS logic (IC1 and IC2). SW3 is return switch and it is connected to PLU logic. D1-D4 are indicating that unit is ready for exposure, controlled by RYL signal from PLU. D5 is protection circuit activation indicator, controlled by FAIL_L* signal from PLU.

## 9.2 Connector Signals

The front panel connects directly to PLU J3. The pin numbers for that connector are given below.

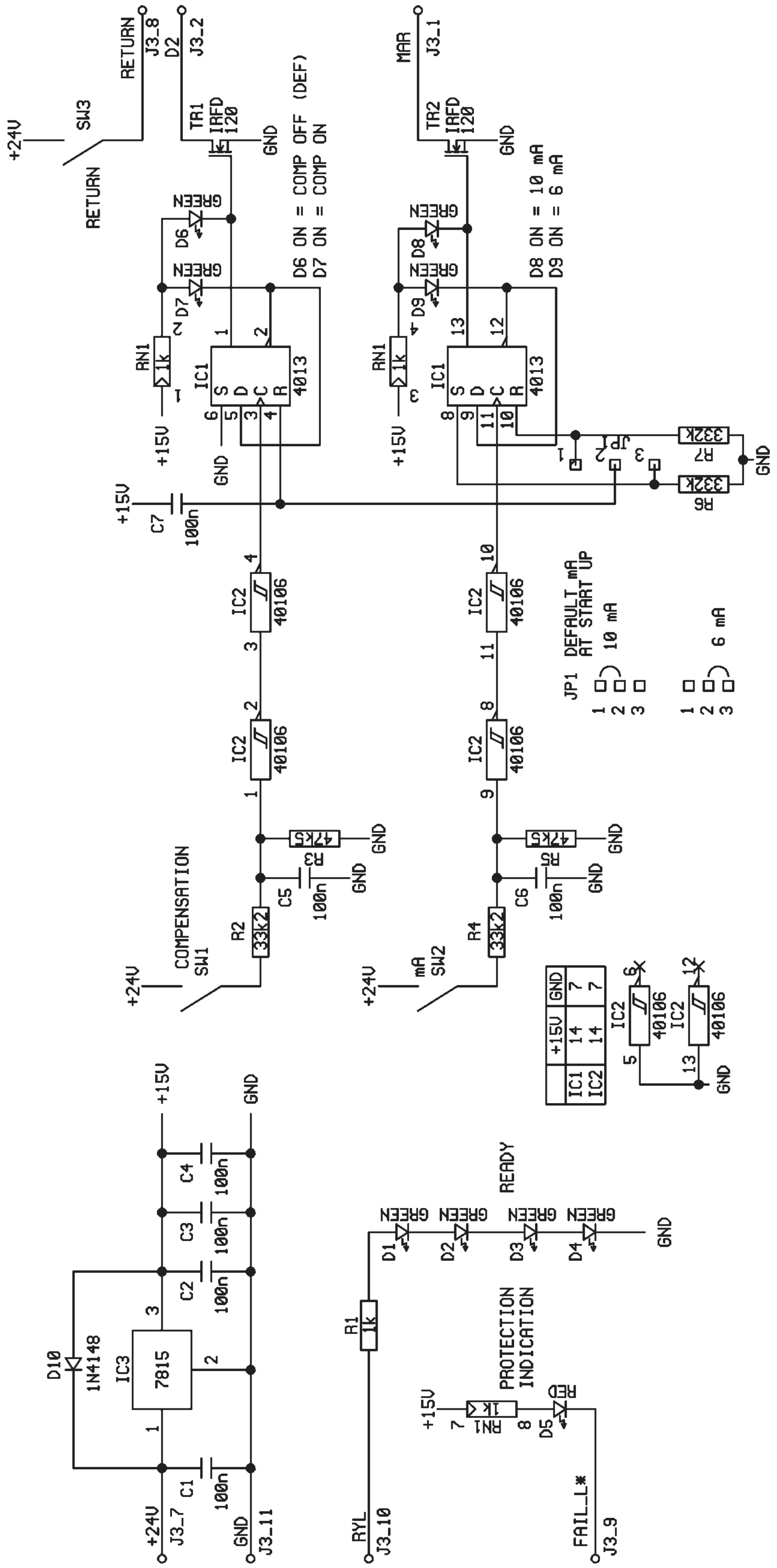
**Front panel board connects to PLU/J3**

| Pin | Signal | Description |
|---|---|---|
| 1 | MAR | 6/10 mA selection. Low when 6 mA is selected, high impedance when 10 mA is selected (default). |
| 2 | D2 | Compensation selection. Low when comp. selected, high impedance when not (default). |
| 7 | +24V | Regulated +24V supply. |
| 8 | RETURN | Return command. High when return switch is pressed. |
| 9 | FAIL _L* | Protection indicator drive. High (+24) when unit is ready for exposure. |
| 10 | RYL | Ready LEDs drive. High (+24V) when unit is ready for exposure. |
| 11 | GND | Signal ground. |

**Jumper JP1 allows the default mA at start up to be set**

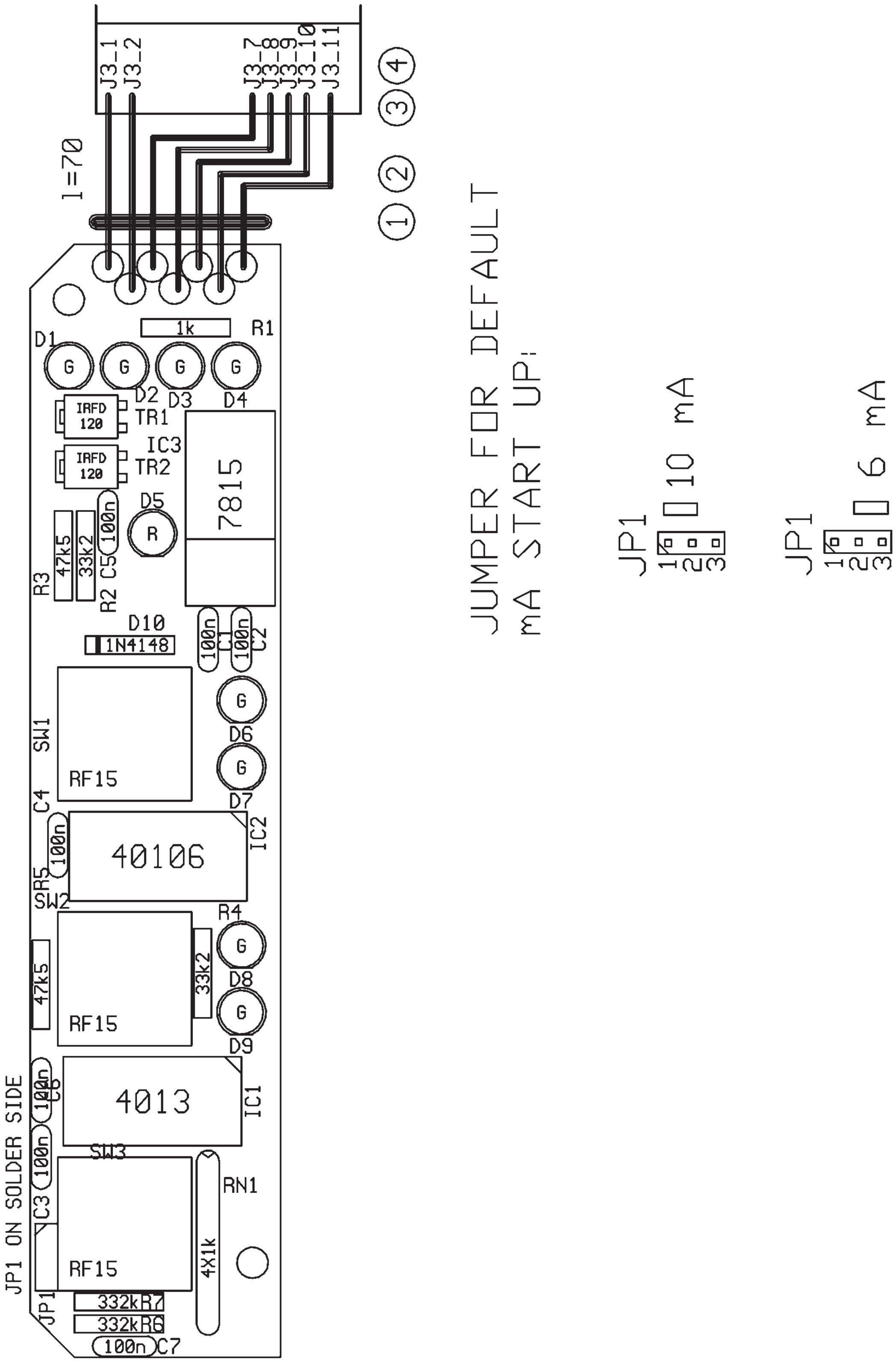
Connect pins 1 - 2 for 10 mA default
Connect pins 2 - 3 for 6 mA default

## 9.3 Front panel board- schematic diagram




Front Panel
4801092

## 9.4 Front panel board - component layout




Front Panel 4801092

# 10 kV selector

## 10.1 kV-Selector 4120-1 - functional description

The main function of the kV-selector is to give a reference voltage to the X-ray generator. This reference voltage depends on which kV-value is selected by the user. So, when the user presses one of the selector buttons on the kV-selector card, this one-of-eleven data is transferred to a 4-bit binary word by two 8-bit priority encoders (IC3 & IC4). This 4-bit word is latched (IC5) and this latched data is then driving two 1-of-16 analog multiplexers / demultiplexers (IC1 & IC2). First of them (IC1) selects the LEDs on the selector buttons so that only one LED is burning at a time showing the selected kV-value. At the same time the other demultiplexer (IC2) gives to the kVref-output (J1/5) the right reference voltage value (for the selected kV-value) from the voltage divider circuit (resistors R10-R20). When the user selects TEST-mode from the kV-selector two things happens. Firstly the kVref is switched to the 0-potential (IC2) and secondly transistor TR2 is turned off and transistor TR3 is turned on. When TR2 is off no X-rays are produced during exposure (on TEST-mode). As TR3 is turned on, the TEST2-line (J1/8) will rise near 15 volts. During exposure the TEST1IN-line is near zero volts preventing the change of kV-value by dragging the EI-line down (IC4,pin 5). After power has been turned on the R2, C2-circuit will RESET the circuit and selecting the 71kV-value automatically. The other RC-circuit (R1 & C1) gives a necessary delay to the CLK-signal (IC5, pin 9) of the data latches.
Physically the circuit is divided in two circuit boards, one containing the switches (with in-build LEDs) and the other with the rest of the circuit.

## 10.2 kV-Selector 4120-1 - Automatic kV select

**Note**
The automatic kV select is only used with the Excel, Excel Ceph, Excel D, BaseX and BaseX D. It is not used with the Cranex 3+, 3+ Ceph, 2.5+ or C.

### Measuring the patient's head

The head support has a built-in potentiometer that measures the patient's head when the temple supports are closed. A signal from the potentiometer goes to the kV selector, which then selects the kV.

### Automatic selection of the kV to be used

Measurement of the size of the patients head is given to the kV-selector. This voltage is connected to A/D converter (IC 7), pin 11. This circuit has adjustments for zero, relative 0 and gain. The result of this measurement is given in a four bit digital BCD word from A/D converter. Word "0" corresponds to 63kV and word "9" 81kV.

### Adjustment of this circuit is as follows

Zero: short connect analog inputs of A/D converter and adjust output to "0000" (R 43).
Relative zero: the head support closed should now be adjusted to give BCD word 0000 if you want the minimum kV value to be 63 kV (R45).

**Note** that the value of kV selector can only be changed when the "Ready"- light comes on!
Gain: Is used to get BCD word "9" when the head support is wide open (R44).
With these two adjustments you can also determine the limits for min. and max. kV to be used by the automatic select.

## Autoset kV

The most significant digit from A/D converter is read to multiplexer circuit (IC10) through latch circuit (IC9). Ten outputs of this multiplexer are controlled by BCD word. “0”=0000, “9”=1001. If the measured value from head support is “0”, the minimum, small patient, the multiplexer (IC10) selects its output “0” (pin 9) to be activated. This means that there is a connection between pin 9 and pin 1 (common). Outputs of the multiplexer are connected to Cranex kV-selector: “0”-63kV…”9”-81kV. The selected kV-value is transferred to kV-selector the moment the unit is in the “Ready” position and ready to take an exposure.
If unit is set to the “Test” or “Ceph” mode, no automatic kV- select is possible.

## Changing kV after automatic select of kV

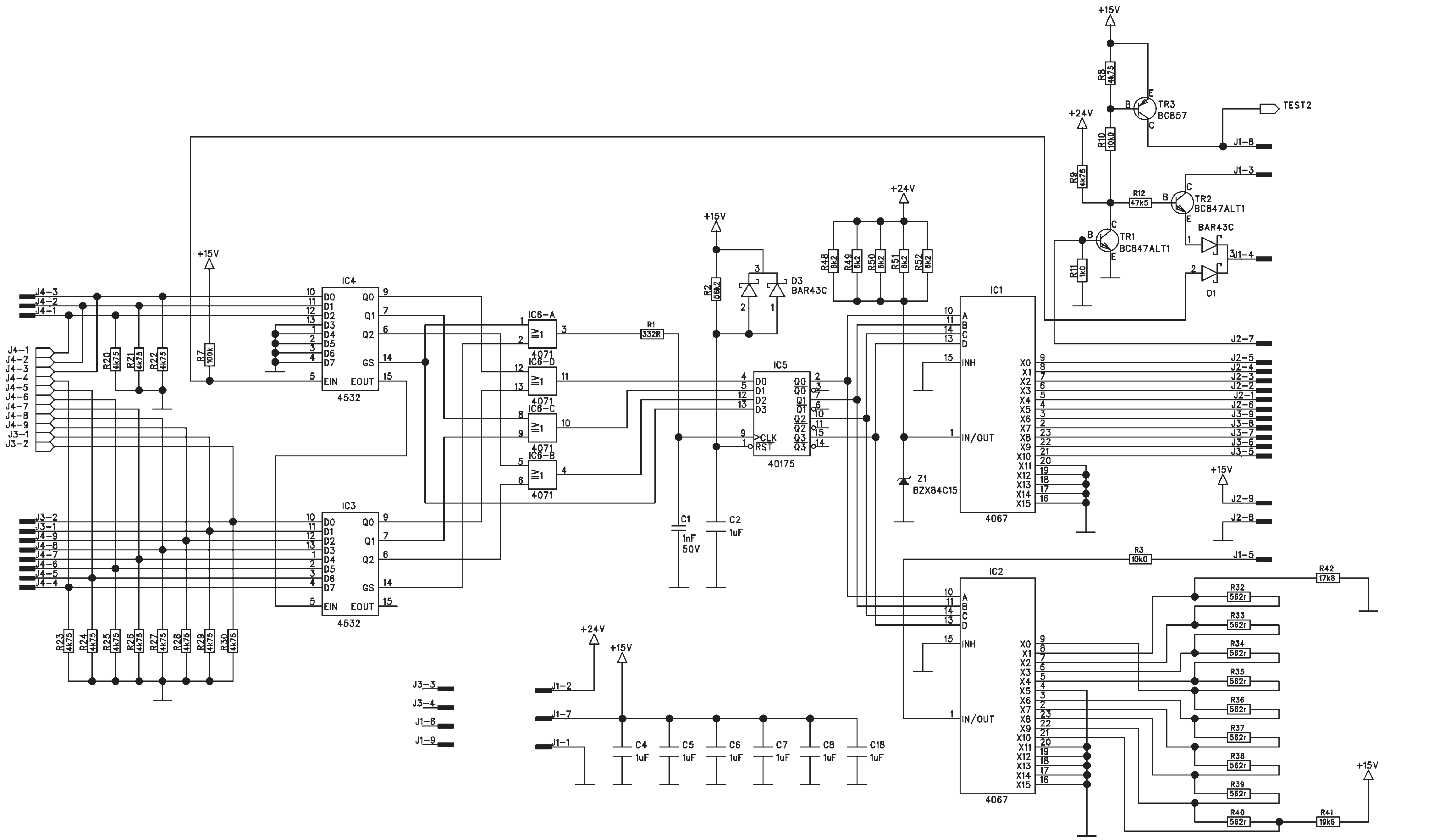
The automatic kV value can always be changed manually if required (select a new kV value during the “Ready” mode before exposure.)
After the exposure the automatic kV select is ready again.

## 10.3 kV selector - Connectors

### kV selector/J1 (goes to PLU/J12)

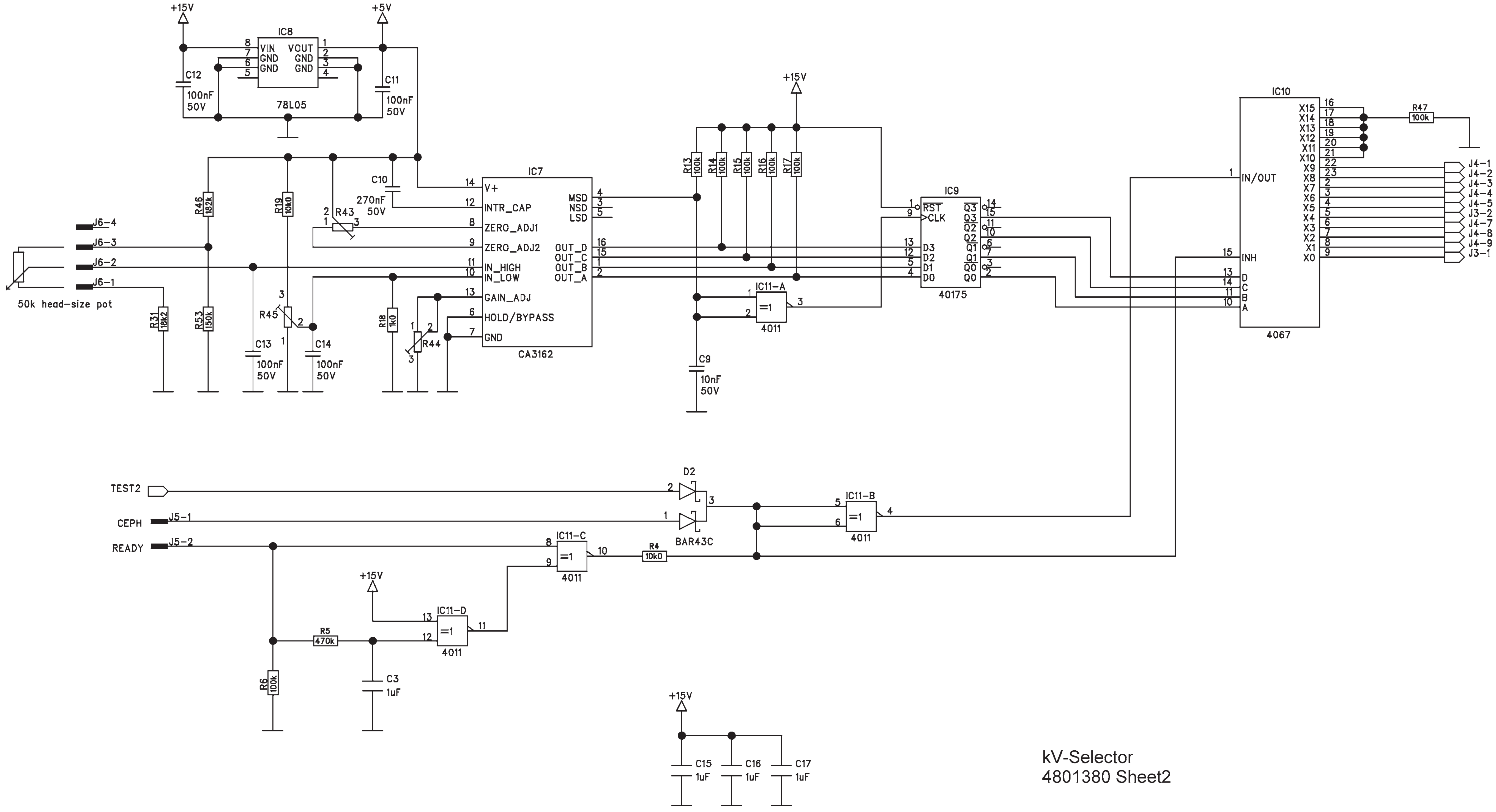
| Pin | Signal | Description |
|---|---|---|
| 1 | GND | |
| 2 | +24 V | |
| 3 | test 1 out | |
| 4 | test 1 in | |
| 5 | kV ref | |
| 6 | N/C | |
| 7 | +15 V | |
| 8 | test 2 | |
| 9 | N/C | |

## 10.4 kV selector - schematic diagram 1



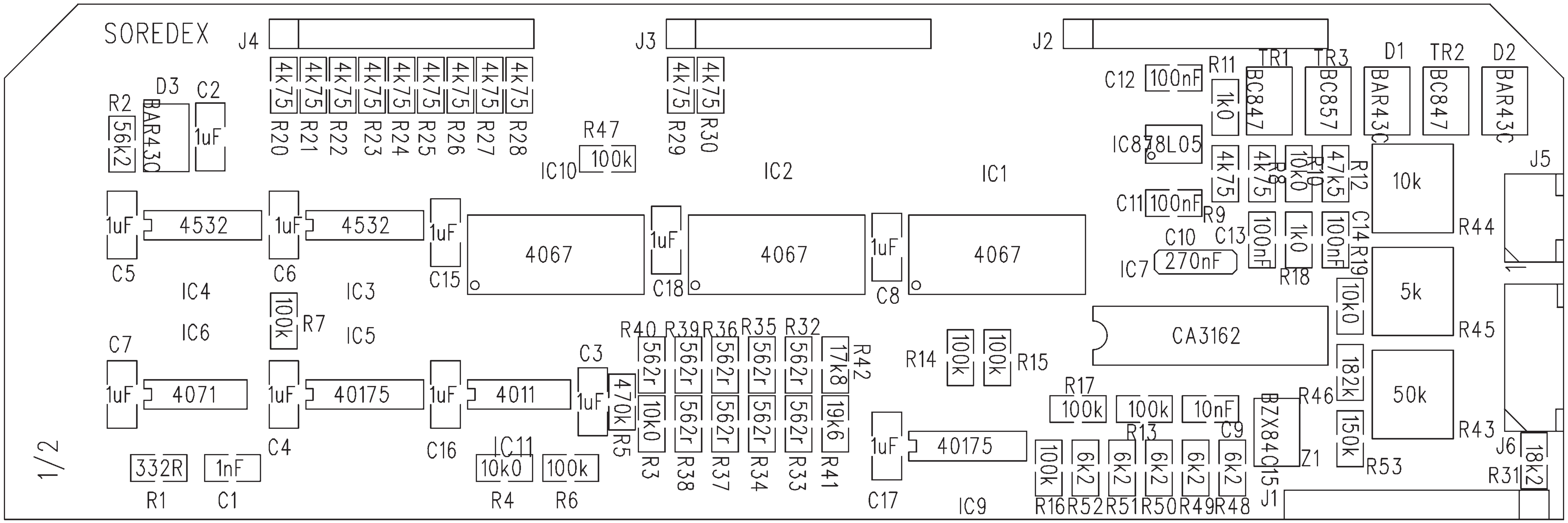

kV-Selector
4801380 sheet1

## 10.5 kV selector - schematic diagram 2



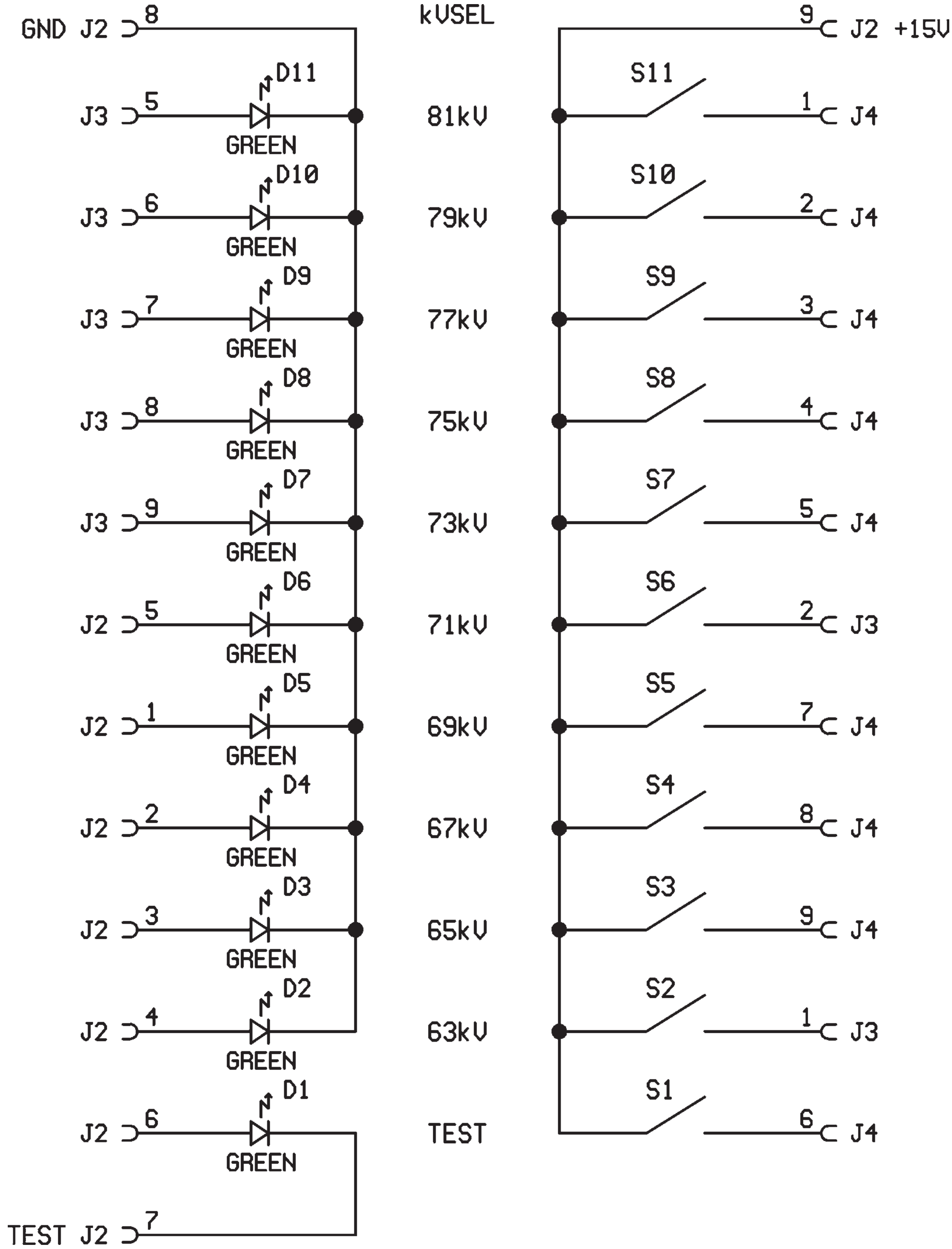

kV-Selector
4801380 Sheet2

## 10.6 kV selector - component layout

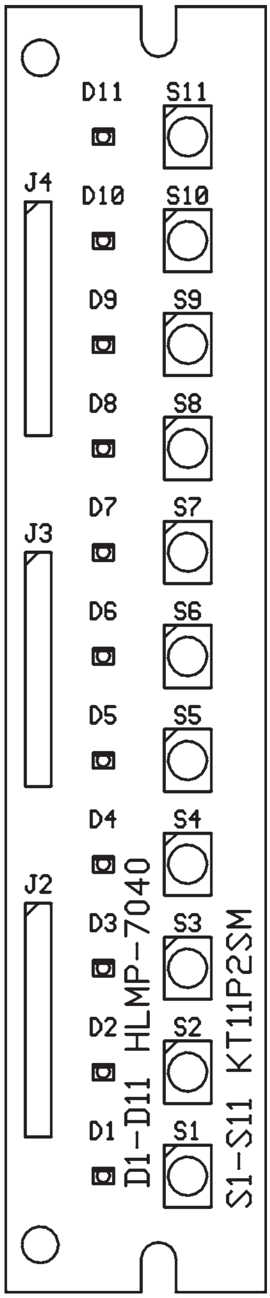



4120-2 kV selector
48013801

## 10.7 kV selector switches - schematic diagram



## 10.8 kV selector switches - component layout



# 11 Time Selector 4230-1

## 11.1 Introduction

Time selector (TSEL) controls cephalo exposure times. In panorama mode (power up) it is used as backup timer (time out after 25 seconds in panorama mode). It is connected to pulse and logic board via six pin connector J1. Three pins of J1 is used by digital signals TIME1, TIME2 and CEPH_ON and other three are power lines. All three signals are active high and logic level is +15V. Three power lines are +24V, +15V and ground. Time selector uses +24V from which it regulates +5V with regulator IC4. The +15V is used only for digital signals CEPH_ON and TIME2 so the supply current depends on the loads on pulse and logic board. Jumper JP1 is added on TSEL-board to tell timing controller (IC1) in which unit it is operating (Excel, Excel Ceph and Cranex C). When it is shorted (IC1 pin 25 connected to ground) then Cranex C is selected and Excel Ceph when left open. Exposure is always disabled in panorama mode in Cranex C by setting TIME2 high irrespective of whether exposure key is pressed or not.

## 11.2 Time Selector 4230-1 - functional description

Time selector is based on timing controller unit (IC1). It only needs external oscillator which is generated from 4MHz crystal X1 (all exposure times are based on this frequency).
Timing controller scans 11 key keyboard which is organized as matrix having three rows. First and second rows have both four keys and third has three. Timing controller’s scanning TTL logic level signals KEY_SCN0, KEY_SCN1 and KEY_SCN2 are made open collector with transistors TR1, TR2 and TR3. Keyboard columns are pulled up and connected directly to Timing controller’s pins 15 -19. A pressed key grounds one key column signal. When a valid key (only one key is active at a time) is found then internal status is changed, new exposure time is written to internal timer and a LED is switched on the

operating panel. If the key pressed was a cephalo exposure time signal is active then signal CEPH_ON is activated (logic high). LEDs are connected to +24V with series current limiting resistors (R3 and R4) and are driven with darlington transistors (IC2 and IC3). Only one LED is on at a time. Transistors TR4 to TR7 converts logic levels. TR4 and TR5 from +15V to +5V and transistors TR6 and TR7 from +5V to +15V. Test point TP5 is ‘connected’ to Timing controller’s internal timer and toggles between 0V and +5V after every 10ms only during exposure (TIME1 high and TIME2 low).
A logic high level on signal TIME1 starts the timing sequence. The internal timer is started and 100Hz square wave signal appears to TP5. When selected time is reached TIME_OUT signal goes high enabling logic high level on signal TIME2 which terminates the exposure by triggering the backup timer on pulse and logic board. LM393 generates RESET to timing controller whenever +5V drops under 4V. Timing controller can operate from 3.3V to 5V.

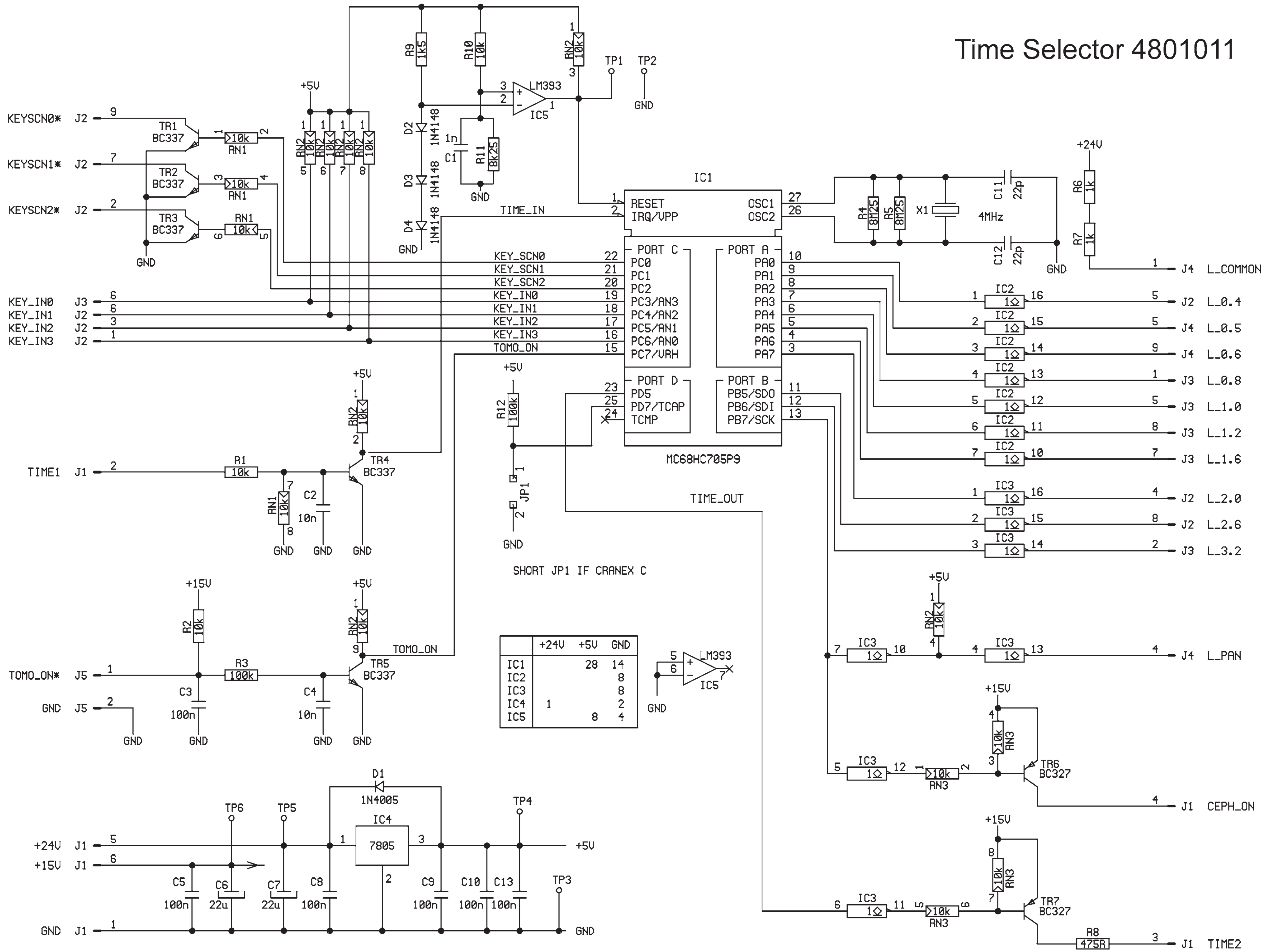
The panoramic exposure mode is always disabled in the Cranex C by setting TIME2 high irrespective of whether the exposure key is pressed or not.

| **JMP1** | **UNIT** |
|---|---|
| Shorted | Cranex C |
| Open | Excel or BaseX |

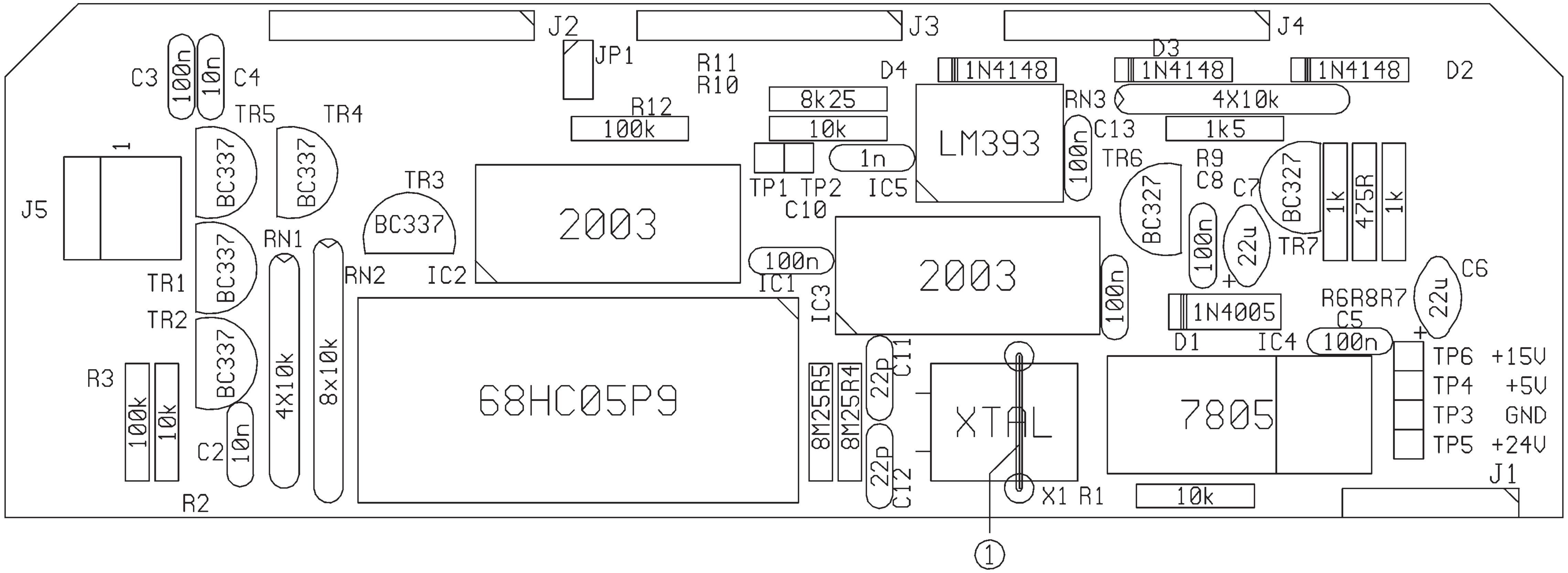
### Time selector/J1 (goes to PLU/J13)

| Pin | Signal | Description |
|---|---|---|
| 1 | GND | Signal and power ground |
| 2 | TIME1 | |
| 3 | TIME2 | |
| 4 | CEPH_ON | |
| 5 | +24V DC | |
| 6 | +15V DC | |

## 11.3 Time selector - schematic diagram

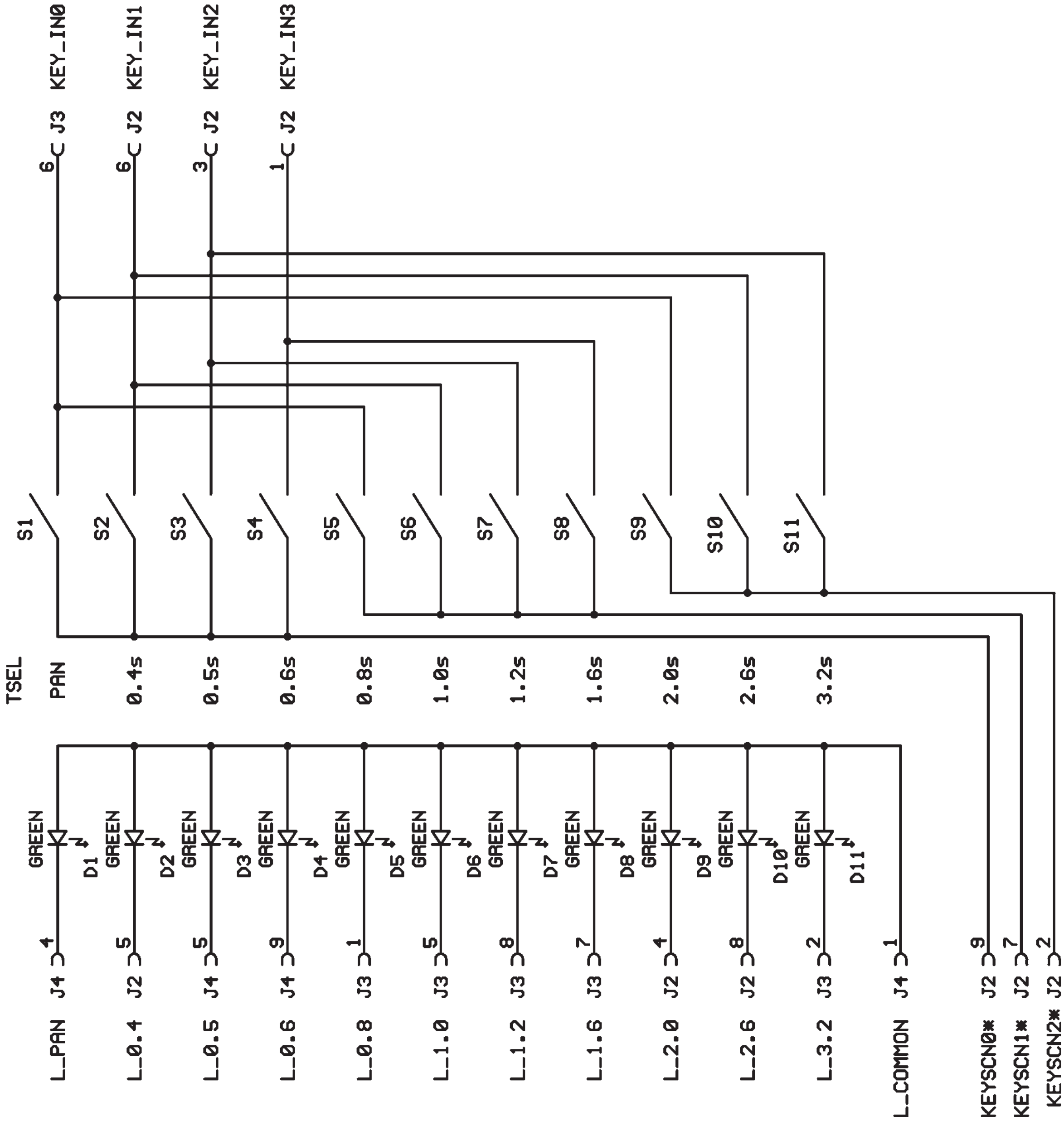


## 11.4 Time selector - component layout

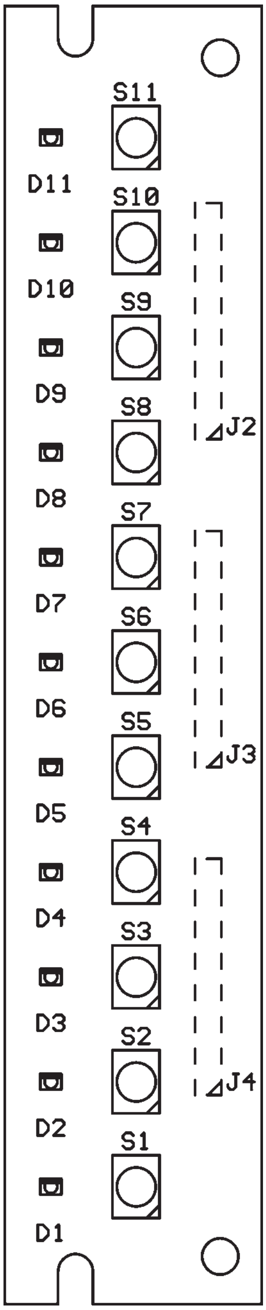



Time selector
4801011

## 11.5 Time selector switches - schematic diagram



## 11.6 Time selector switches - component layout



# 12 Power Switching Units

## 12.1 PSU 47602

The PSU 47602 includes high frequency power circuits and their drive circuits, as well as a filament inverter.

## 12.2 Filament Drive Circuit - 47602

Filament inverter transistors (Fet) TR6, TR7 drive the filament transformer at a frequency of 23.5 kHz. Drive signal pulse width for TR6 and TR7 is controlled by the PLU board.

## 12.3 Regulator TR4, TR5 - 47602

The regulator controls the voltage across C13. The voltage is then fed to the tube head by the power inverter. The MPU supplies rectified and filtered line voltage PV+, PV-. PV+ is fed through TR4 and TR5 to C13. Regulator transistors TR4 and TR5 control, through CH2, the voltage across C13.
The regulator is controlled by the PLU using pulse width modulation.
The drive pulse is formed by connecting drive signals R1 and R2 in parallel on PSU board. This pulse is fed to IC9, then to TR8 and then to opto driver IC4. The opto driver IC4 controls TR4 and TR5. The opto driver IC4 also provides galvanic isolation between the low and high voltage circuits.

## 12.4 Inverter TR2, TR3 - 47602

The inverter works in a push pull mode using a 90% duty cycle, and transfers the regulator voltage to the tube head. The PLU controls the inverter using drive signals I1, I2, which are fed to opto isolators IC1 and IC2, which are drive inverter transistors TR2, TR3. TR2 and TR3 which control the high voltage transformer in the push pull mode.

## 12.5 Protection Circuit - 47602

The protection circuit monitors the inverter over current and regulator over voltage. The comparator IC7 monitors current through inverter transistors and also the voltage across C13. Protection logic is performed by IC9 and the surrounding components. In the event of over current (tube arching) or over voltage (over 90kV) occuring, IC7 output will trigger opto isolator IC8 which in turn will trigger IC9. IC9 will shut down the regulator pulses through TR8 and inverter pulses through TR1. It will raise the HFB signal to a value that will trigger the PLU protection circuit and then switch the protection light on.
D15 is the protection indicator for PSU protection. To reset the protection circuit the unit must be switched off briefly.

## 12.6 Transformer T1 - 47602

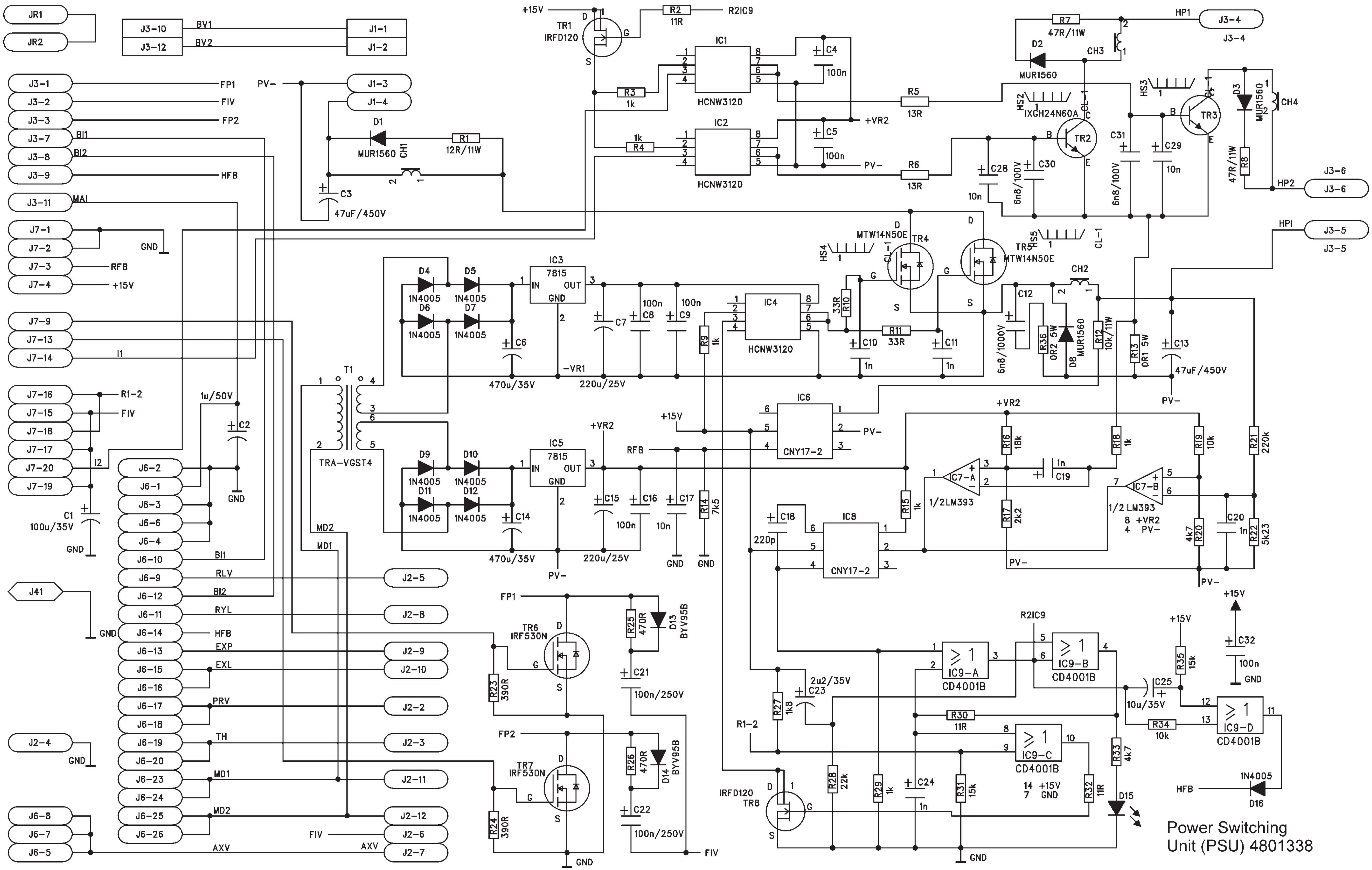
T1 is used to supply operating voltages to opto isolators and IC7.

## 12.7 Power Switching Unit (PSU) Connector Signals - 47602

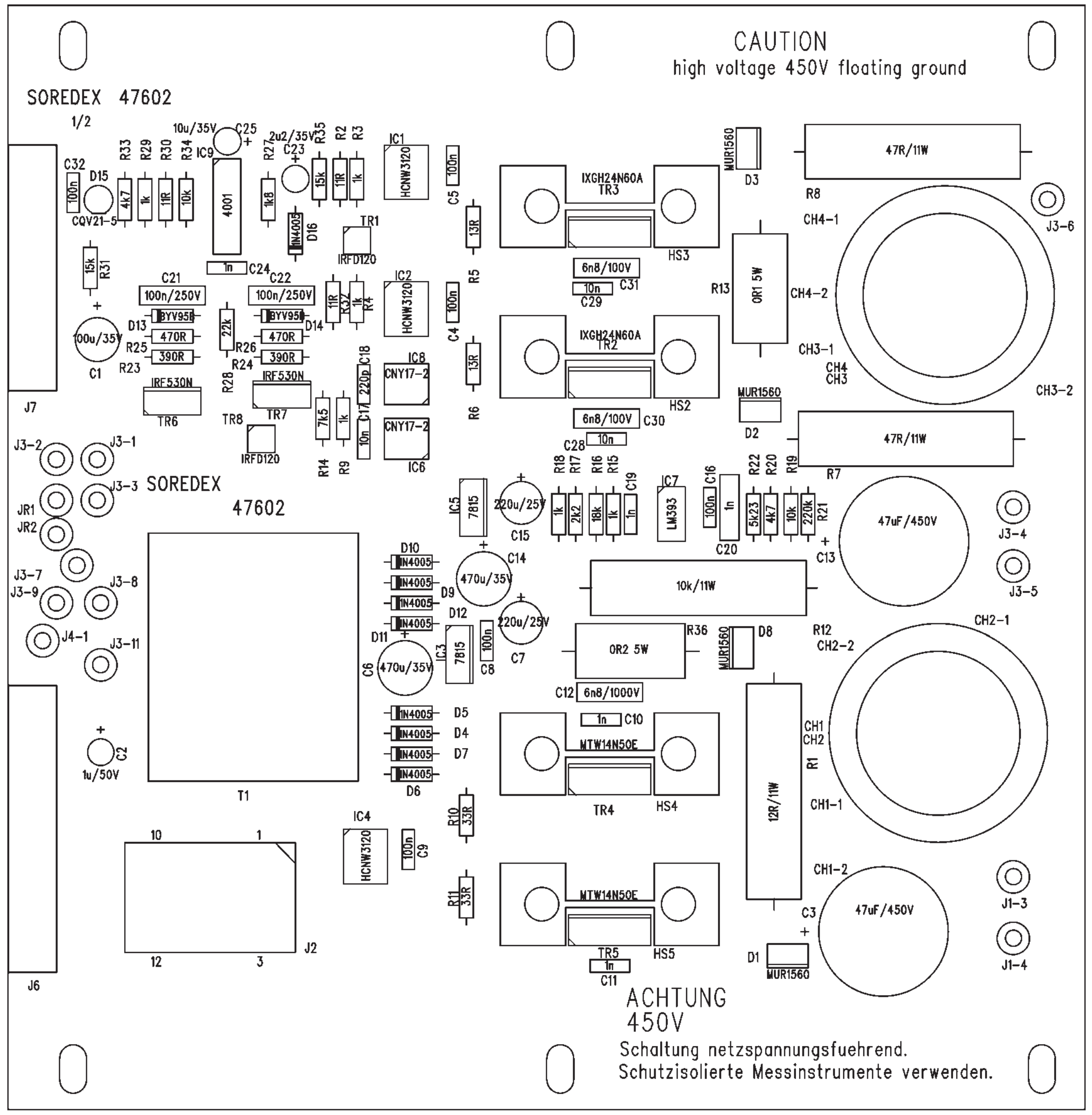
**PSU/J3: Above panoramic tube head**

| Pin | Signal | Description |
|---|---|---|
| 1, 3 | FP1, FP2 | Filament transformer drive. High (20 VDC, 32 VAC) during exposure. |
| 2 | FIV | Filament inverter supply. High (20VDC) during exposure. |
| 4, 6 | HP1, HP2 | High voltage transformer drive. High (100VAC across) after preheat. |
| 5 | HPI | High voltage inverter supply. High (120 –190 VDC to – PV) after preheat. |
| 7, 8 | BI1, BI2 | Tube head temperature signal. High (24VDC) when unit is in start position and the tube head temperature sensor is closed or when the TA-switch on the PLU board up. |
| 9 | HFB/PAN | High voltage feedback from panoramic tube head. |
| 10, 12 | BV1, BV2 | Tube head cooling FAN supply (24 VAC across). |
| 11 | MAI/PAN | Tube current feedback from panoramic tube head. |

## 12.8 Power Switching Unit - 47602 schematic diagram



## 12.9 Power Switching Unit - 47602 component layout




Power Switching Unit
(PSU) 4801338

## 12.10 OLD Power Switching unit (PSU) - 47601

The PSU includes high frequency power circuits and their drive circuits, as well as a filament inverter.

The power transistor base drive circuits and filament inverter are located on the kV/mA drive board attached to the PSU. BFD voltage gives supply for drive signals. Drive transistor T1 is controlled by I1 signal derived from the PLU D1 -D2 - D43 network prevent TR1 saturation making its transitions faster. Transistor TR1 drives pulse transformer T1. Resistor R4 and capacitor C1 form current limiting and pulse shaping network. Pulse transformer T1 isolates and makes the drive pulse bipolar. D44 -C16 -R14 - D51 - D52 networks protect transistor against voltage spikes. Power transistor on the secondary side of T1 is turned on when TR1 is turned off by low in T1. The other three drive circuits (TR2, 3, 4) are identical to this.

Filament inverter power transistors TR6 and TR7 drive filament transformer in 20 kHz frequency through FP1 and FP2. FIV is constant voltage supply. TR6 and TR7 are controlled through F1 and F2 derived from the PLU. Networks D11 - D 53 -D54 and D12 - D40 - D50 prevent transistor saturation making switching faster.

Networks D13 - C6 - R22 and P14 - C7 - R23 protect transistors in turn-off state and diodes D56 and D57 make opposite path for inverter current.

The power section of the unit has two sections, the power regulator section and power inverter section. C10 is the output capacitor of the power regulator and feeds the power inverter.

The power regulator is supplied with rectified and filtered mains through PV+ and PV-. Capacitor C20 filters the supply input. CH1 - R46 -D19 network forms turn-on protection for switching transistors.

TR8 and TR7 work in parallel and are driven by pulse transformer T2 through antisaturation network D15 - D17 - D18. Diode D16 improves transistors turn-off. Resistors R26 and R27 balance current through the transistors.

The other pair of transistors TR10 and TR11 are identical, and the two pairs are driven at 20 kHz in push-pull mode to increase the power handling capability of the section. C9 -D24 - R30 network protects transistor pairs in turn-off.

CH2 and C10 form an LC network that filters switched square-wave voltage across flywheel diode D25. When transistor pairs are driven on, current flows along the path (PV+) - (CH1) -(TR8-9) - (CH2) - (C10) - (PV-) or (PV+) - (CH1) - (TR10-11) - (CH2) -(CH10) - (PV-); and when driven off the current will continue, because of inductance, along path (CH2) - (CH10) - (D25). The duty cycle of transistors determines voltage across C10. C14 - R41 protect D25 against voltage spikes. Opto-isolator IC1 LED is fed through R31 R45 -C19 to give feedback signal (RFB) which depends on C10 voltage. RFB signal goes to the PLU. C10 voltage is fed to power inverter section through fuse F1. Power inverter transistors TR13 and TR14 work in push-pull mode at 20 kHz frequency and constant 90% duty cycle. They are driven through T1 and T4. The power inverter drives a high tension transformer in tube head trough HP1 and HP2. Transformers T5 and T6 with D41 and D42 balance loading. C13 is an intermediate filter capacitor.

D26 - D27 - D29 network prevents TR13 saturation, and D28 improves turn-off. D32 - C11-R35 protects TR13 against voltage spikes in turn-off and D31 forms an opposite current path. Identical networks can be found at TR14. When operating, power inverter current flows along the path (C10+) - (F1) - (HPI) - (H.T.) - (HP1) - (D30) - (TR13) - (C10) or (C10+) - (F1)-(HPI)-(HP2)-(D35)-(TR14) - (C10).

NOTE: The power section of unit is galvanically connected to mains, whereas all other parts of electronics, including kV/mA drive board, are grounded. Never measure the power section with a grounded oscilloscope.

| **Test point** | **Steady state** | | **Pre-heat** | | **Exposure** | |
|---|---|---|---|---|---|---|
| | ACV | DCV | ACV | DCV | ACV | DCV |
| TP2, TP3 (Inv. dr) | 0 | 0.5 | 11-14 | 15-19 | 11-14 | 19-22 |
| TP7, TP8 (Reg. dr.9) | 0 | 0.5 | 0 | 1.6 | 10-13 | 14-19 |
| TP5, TP6 (Fil. dr.9) | 0 | 0.5 | 8-10 | 19-21 | 8-11 | 19-20 |

## 12.11 Power transistor verification - 47601

This procedure will reveal faulty power transistors in the PSU. Use DMM in diode range to get correct readings.

Look at the transistor so that the pins are pointing towards you and are closer to the top hole. Base (B) is left pin, Emitter (E) is the right pin, and Collector (C) is the case.

If one test fails, the transistors must be replaced.

**BUY 69 A** or equipvalent in Power Regulator:

| Red Led | Black lead | Reading if OK |
|---|---|---|
| B (left) | E(right) | 0.4 - 0.8 |
| B (left) | C(case) | 0.4 - 0.8 |
| C (case) | E (right) | Open |

**BUT15, MJ10009, MJ10014, ST10014** or equivalent Darlingten transistor:

| Red Led | Black Led | Reading if OK |
|---|---|---|
| B (left) | E (right) | Not short |
| B (left) | C (case) | 0.4 - 0.8 |
| C (case) | E (right) | Open |
| E (right) | C (case) | 0.4 - 0.8 |

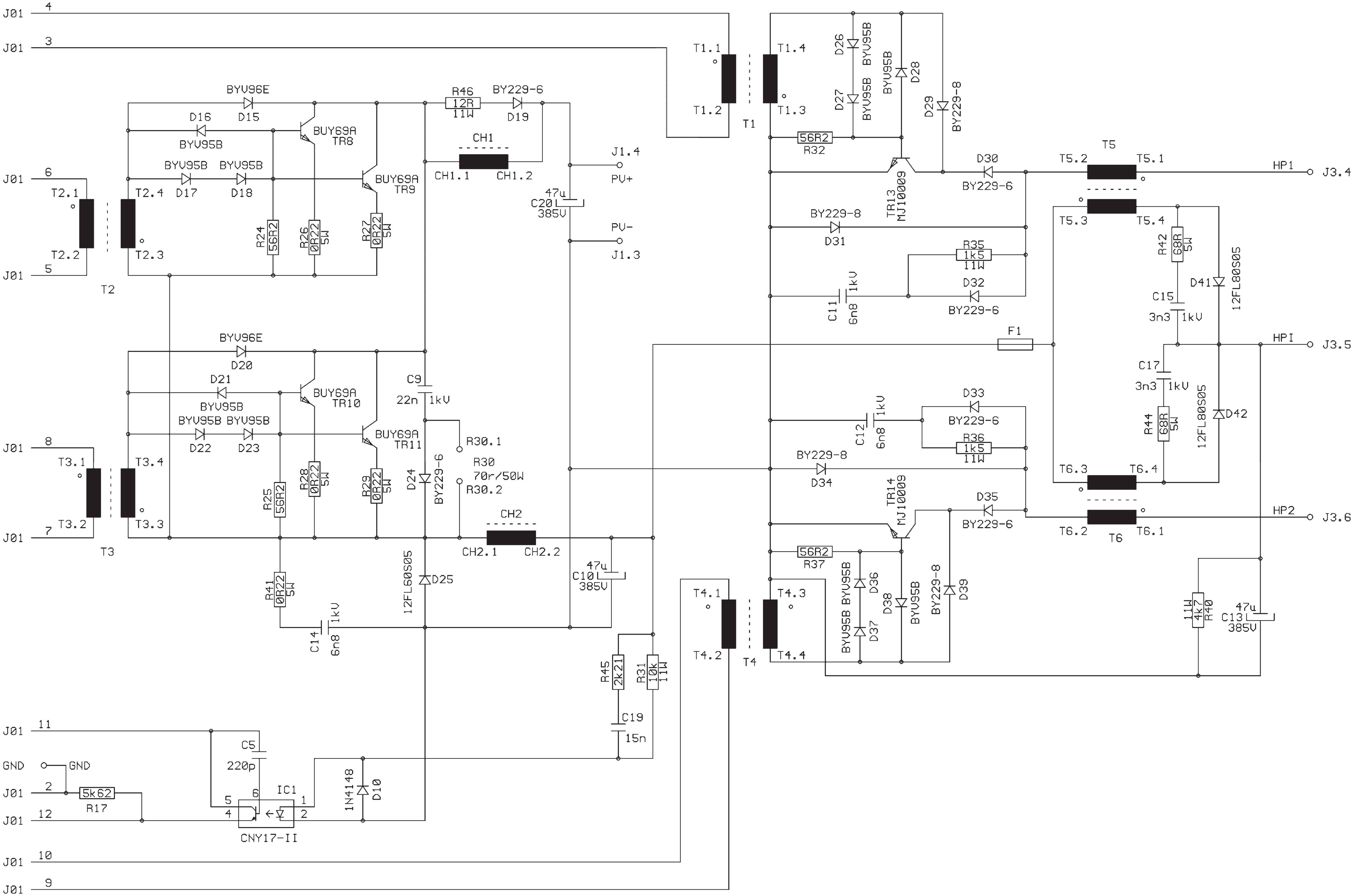
If your DMM does not have a diode range, resistor range 200 kOhm will give 20 - 50 kOhm reading, rather than 0.4 - 0.8.

## 12.12 Power switching unit connector signals - 47601

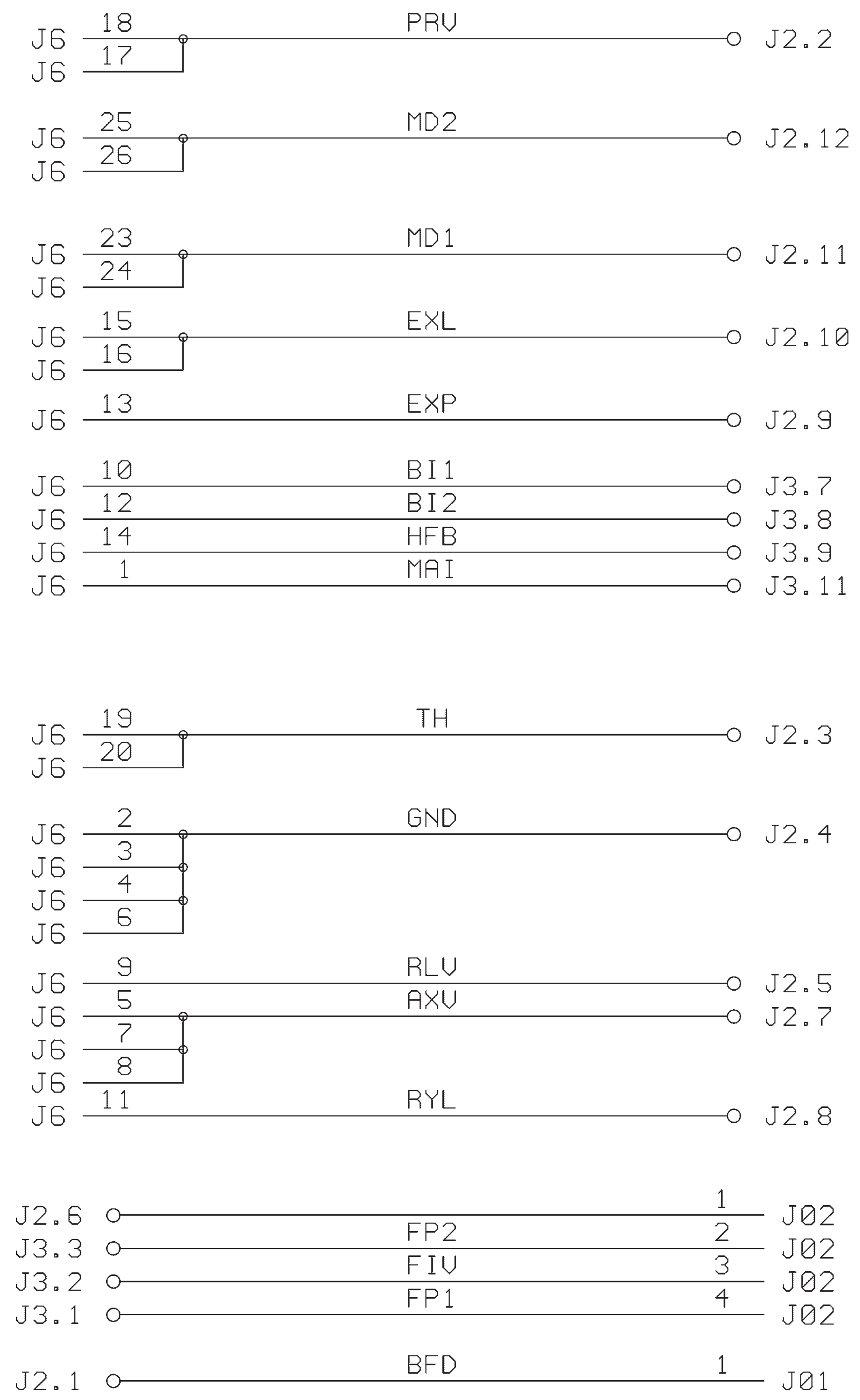
**PSU/J3: Above panoramic tube head**

| Pin | Signal | Description |
|---|---|---|
| 1, 3 | FP1, | Filament transformer drive. High (20 FP2 VDC, 32 VAC) during exposure. |
| 2, | FIV | Filament inverter supply. High (20 VDC) during exposure. |
| 4, 6 | HP1, | High voltage transformer drive. High HP2 (100 VAC across) after preheat. Floating. |
| 5 | HPI | High voltage inverter supply. High (120-190 VDC to - PV) after preheat. Floating. |
| 7 | RI1 (BI1) | Tube head temperature signal. High (24 VDC) when unit in start position, kV selected and tube head temperature sensor closed or TA-switch on PLU board up and tube head temperature sensor closed. |
| 8 | BI2 | Tube head temperature sensor supply. High (24 VDC) when unit in start position, kV selected or TA switch on PLU board up. |
| 9 | HFB/ | High voltage feedback from PAN panoramic tube head. |
| 10, 12 | | Tube head cooling fan supply (110 BV1,BV2 VAC across). Floating potential. |
| 11 | MAI/ | Tube current feedback from PAN panoramic tube head. |

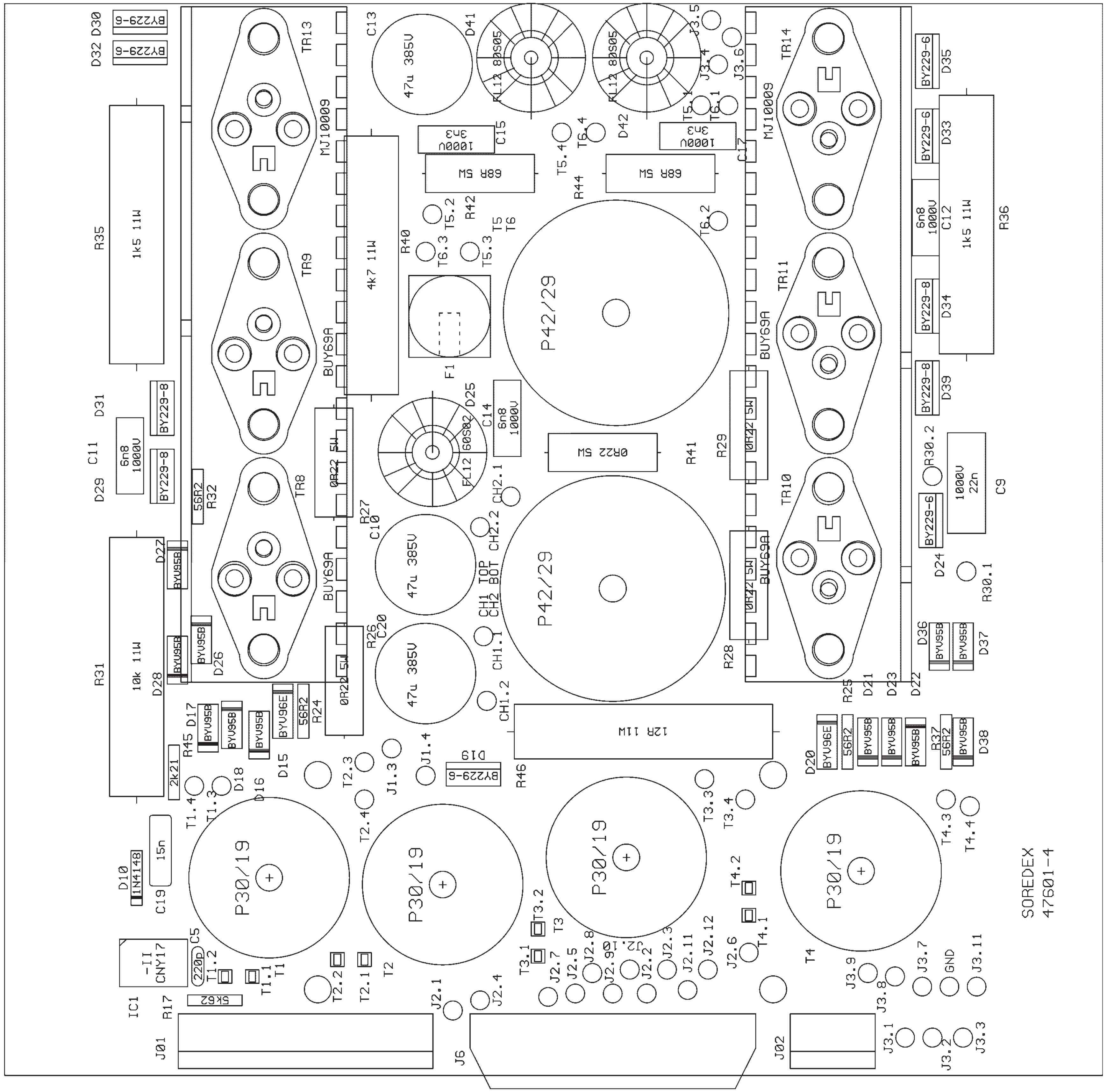
## 12.13 OLD PSU - 47601 schematic diagram sheet 1



## 12.14 OLD PSU - 47601 schematic diagram sheet 2



## 12.15 OLD PSU - 47601 component layout

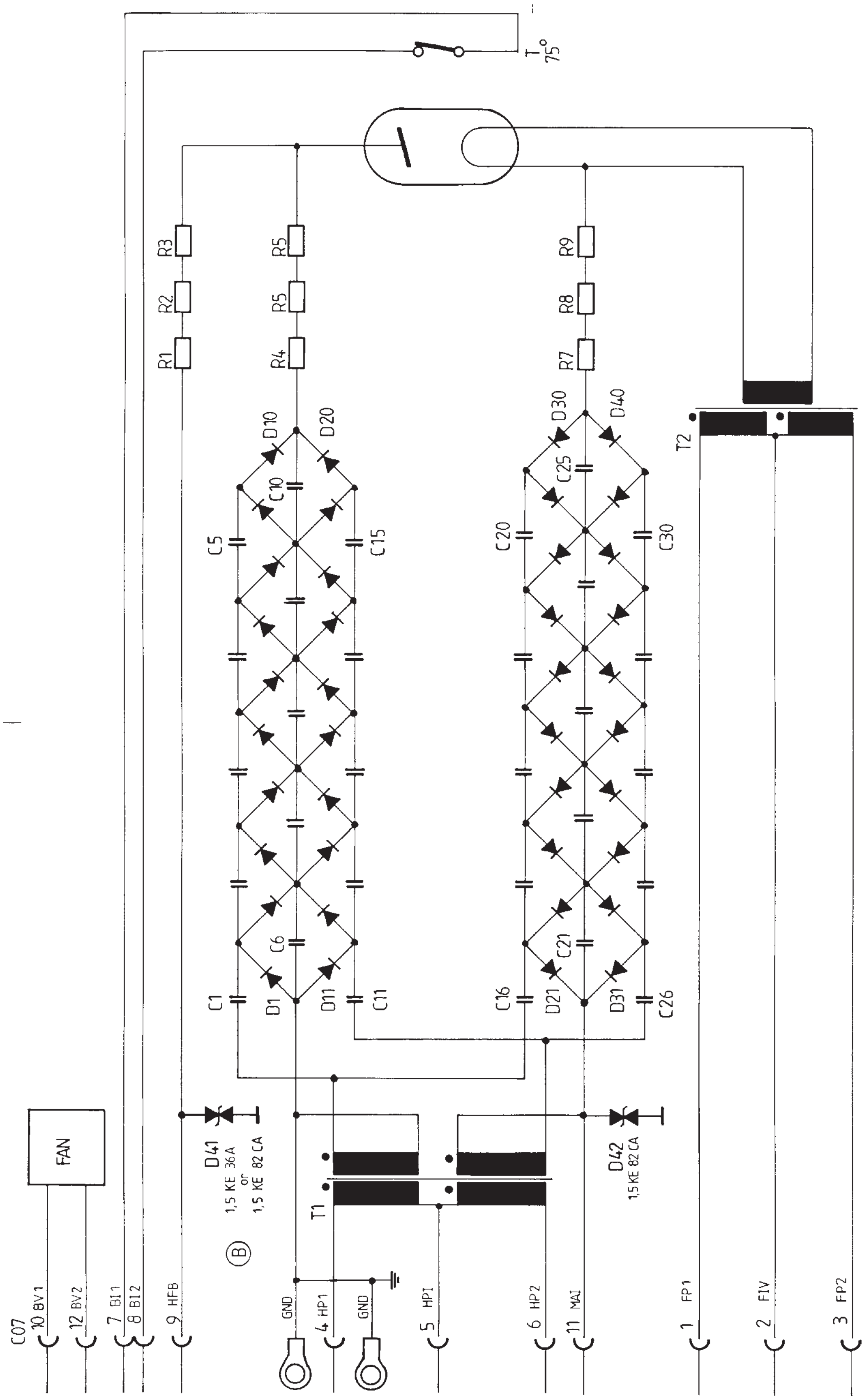


# 13 Tube Head Assembly (THA)

## 13.1 Description

THERE ARE NO SERVICEABLE PARTS INSIDE THE TUBE HOUSING ASSEMBLY.
THE OPENING OR REASSEMBLY OF THE TUBE HOUSING ASSEMBLY BY OTHER THAN SOREDEX IS PROHIBITED AND VOIDS THE WARRANTY CERTIFICATION.
The panoramic and cephalometric tube heads are identical. The tube head contains the high voltage section of the generator. High frequency power signals HP1, HPI and HP2 are connected to high tension transformer T1, which supplies the two cascade multipliers C1 - 15 and C16 - 30. Cascade multipliers C1 - 15 multiply, rectify and filter the transformer output to a maximum +41 kV, and cascade multipliers C16 - 30 to a maximum of -41 kV. The tube voltage is derived from this bipolar supply through surge resistors R4 - 9. The positive half of the tube voltage is connected to 3 x 150 Mohm resistors that a form high voltage feedback signal (HFB). High frequency filament heating signals FP1, FIV, FP2 are connected to the filament transformer T2 which supplies the X-ray tube filament.
The other return line of the high tension transformer is grounded, and the other forms the MAI signal to the PLU for tube current adjustment. The current in the MAI line is equal to the tube current. The tube head contains temperature sensor that opens if the oil temperature reaches 75 C = 167 F. The ready signal is disabled in this case and next exposure is possible only after cooling. The panoramic tube head has a fan to improve cooling.

## 13.2 Circuit diagram



# 14 Position Display Board

## 14.1 The Position Display

The position display board is located inside the lower shelf. It includes a slide potentiometer, A/D converter, display driver and two seven segment displays. The potentiometer is connected to the focal trough light support bracket. The potentiometer supplies input voltage to the A/D converter. IC2, pin 11 is dependent on focal trough light adjustment. A/D converters voltage difference in pins 10 and 11 to 3 digit BCD output, digit selection being on pins 3, 4 and 5 and BCD code on 1, 2, 15 and 16. When IC2 outputs a digit to display, it also outputs the corresponding BCD code. BCD code is connected to IC3 to be converted to a seven segment display drive signal.

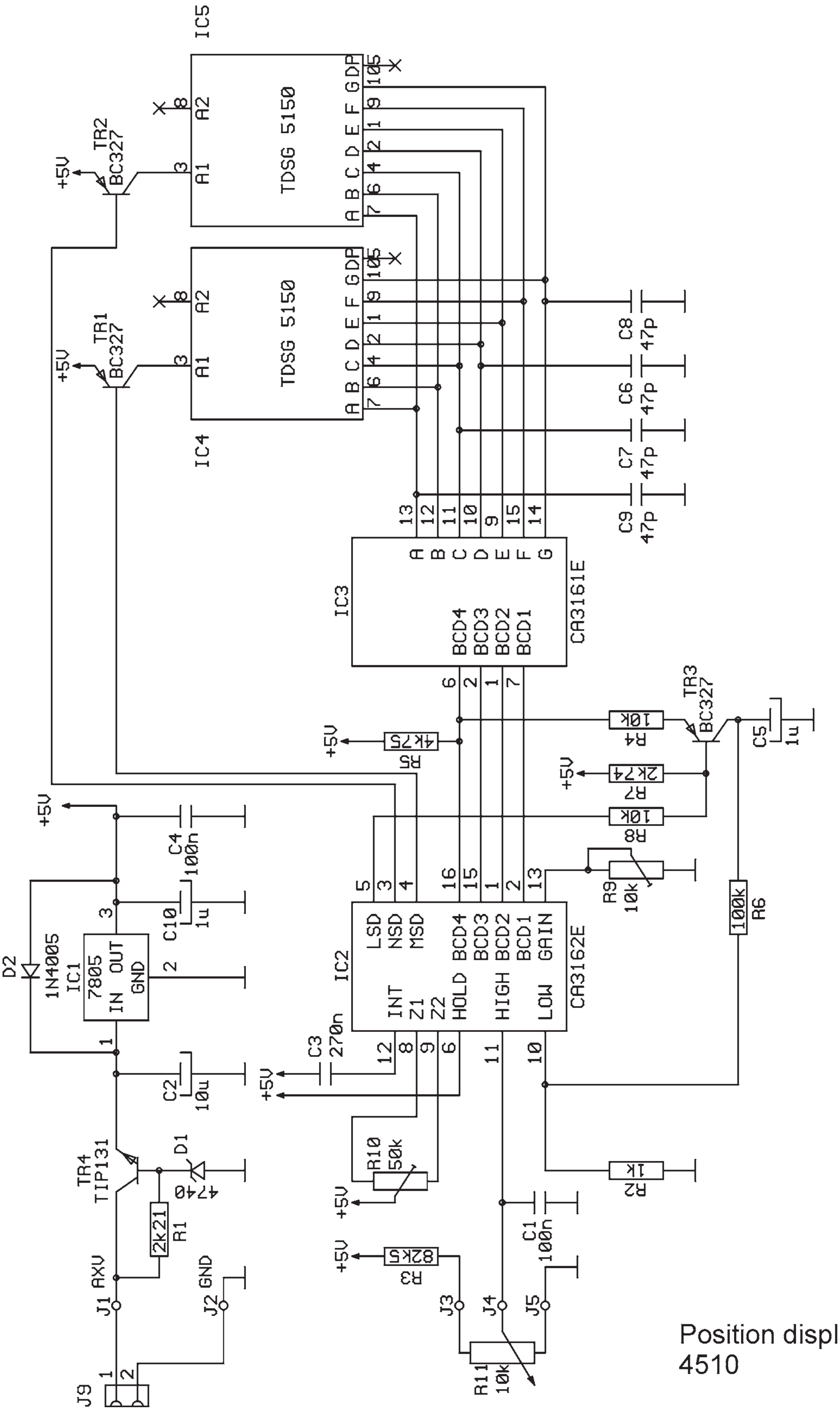
A zero reading is adjusted with R9. Gain of conversion is adjusted with R10. Supply voltage for the board is derived from AXV. R1 - D1 - TR1 regulate the supply to 10 volts which is connected to a 5-volts regulator, IC1. Capacitors C6, 7, 8, 9 reduce noise produced by IC3.

## 14.2 Position Display Connector Signals

**PD/J9: At lower shelf.**

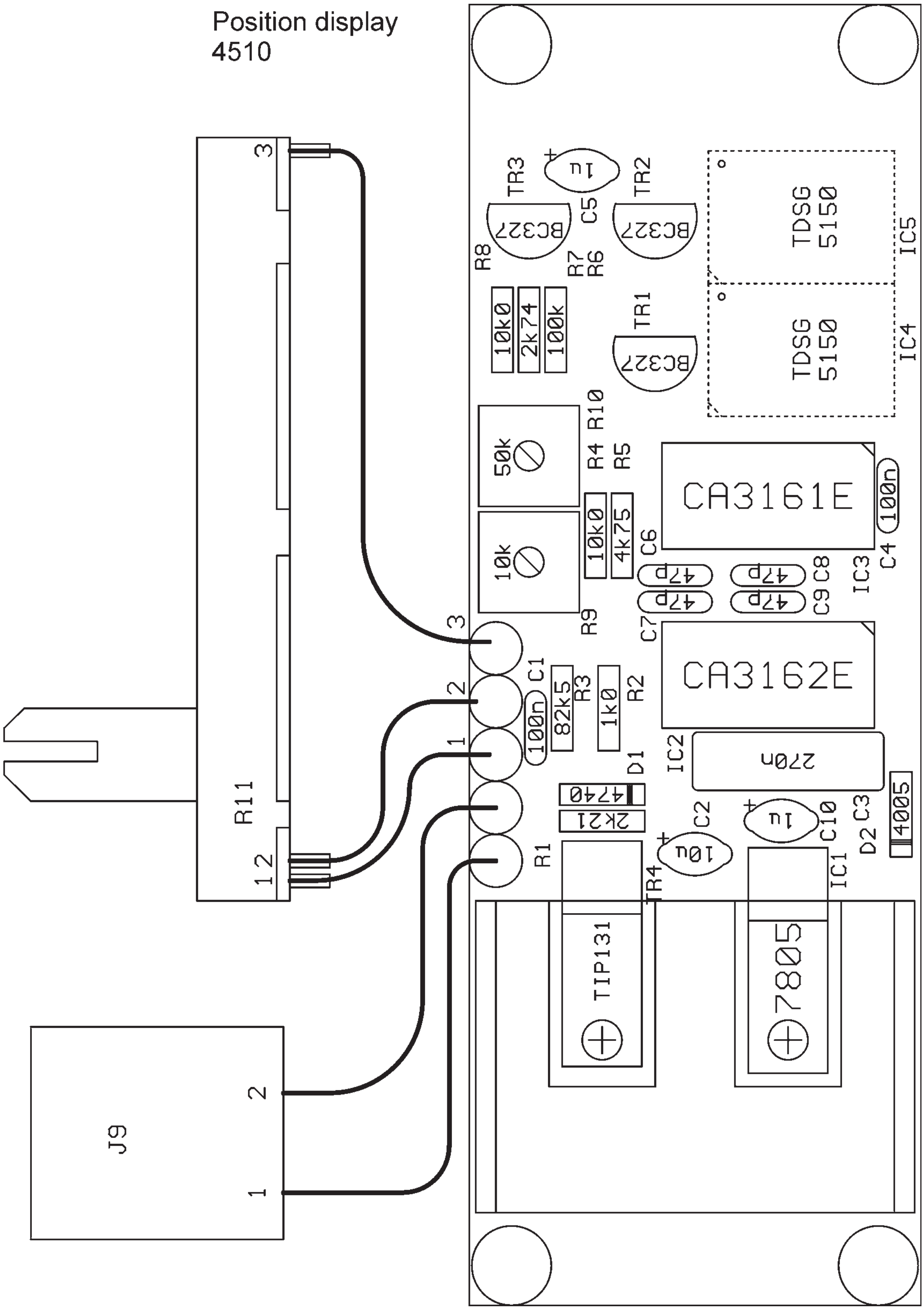
| Pin | Signal | Description |
|---|---|---|
| 1 | AXV | Unregulated supply 28-35 VDC. |
| 2 | GND | Signal ground. |

## 14.3 Position display schematic diagram




Position display
4510

## 14.4 Position display component layout



# 15 Z-Driver Unit

## 15.1 Speed Reference Circuit

The speed reference circuit (IC1, NAND) controls the motor drive circuit (IC2, pulse width modulator) with two signals: SHUT-signal (IC2, pin 4) enables the motor drive when low. Vref signal (IC2, pin 1) determines duty cycle of IC2; the lower voltage Vref, the higher the duty cycle of IC2 is and the faster the motor runs. When the UP/DOWN-switch is pushed, either the REV or the FW signal is grounded (low) and the START-signal become high. Therefore the SHUT signal becomes low, which activates the motor drive (IC2). At the same time, IC1 pin 8 gets high, but pin 9 remains low due to

The SLOW signal is now high and the FAST signal low. Voltage Vref is now formed by R8, R9 and R10. After the voltage across capacitor C3 rises, IC1 pin 9 becomes high, the SLOW signal gets low and the FAST signal high, and voltage Vref is formed by R11, R12 and R13. When the UP/DOWN-switch is pushed, voltage Vref is grounded through capacitor C4. This supplies full power to the motor for about 50 ms to get the motor running.

## 15.2 Moset - Output Stage

The output stage is controlled by the REV signal and buffers IC3 and IC4, and by pulse width modulator IC2. When the motor runs forwards (REV signal high) transistors T3 and T4 are off, T2 is on, and transistor T5 is switching with the same duty cycle as pulse width modulator IC2.

When the motor runs backwards (REV signal low) transistors T2 and T5 are off, T3 is on, and transistor T4 is switching.

## 15.3 6V Step-up Circuit

Transistors T2 and T3 use 36V gate voltage. The voltage is produced by diodes D4, D5 and capacitors C9, C10. When the motor is running, IC2, pin 10 switches between 0V and 12V. The voltage across capacitor C9 is 24V. The voltage at the anode of diode D5 varies between 24V and 36V, and the voltage capacitor C10 is 36V.

## 15.4 Current Limit

Current through the output stage is measured with resistor R7. Voltage across R7 should be less than the current reference, voltage at IC2, pin 15. When the current increases, voltage at IC2, pin 16 increases. If voltage at IC2, pin 16 reaches the voltage at IC2, pin 15, motor control circuit IC2 limits the duty cycle, and the current, to that value.

## 15.5 Patient positioning lights

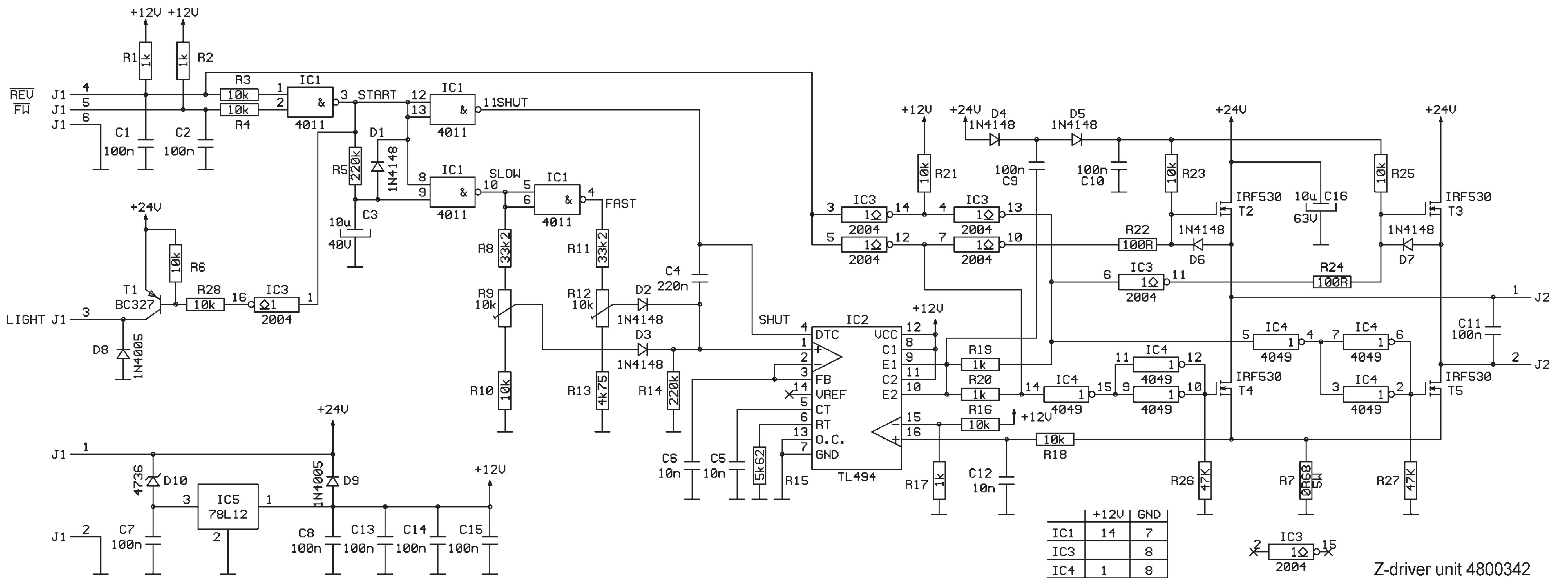
When the UP/DOWN-switch is pushed, transistor T1 (controlled by the START signal) turns on. This triggers the positioning light timer in the mains power unit and patient positioning lights are automatically switched on.

## 15.6 Z-Driver Unit Connector Signals

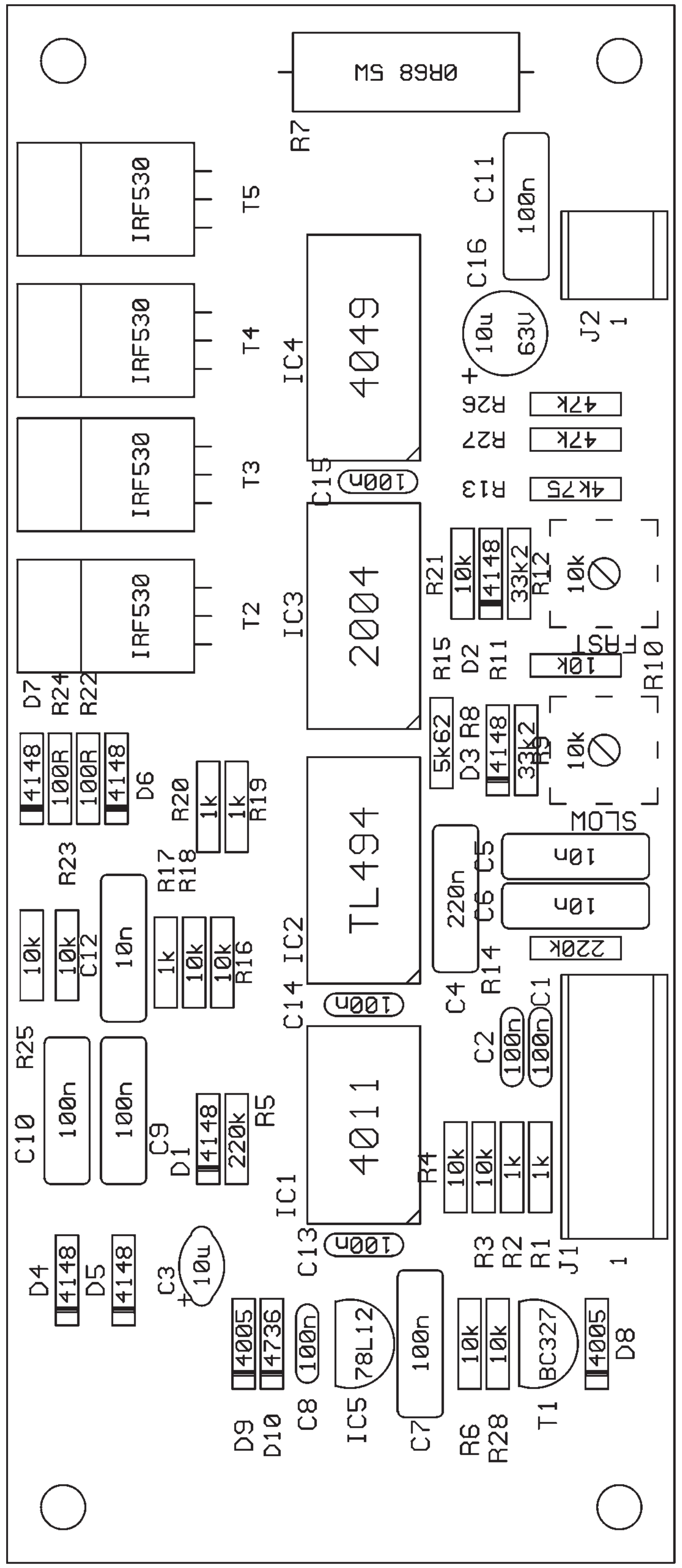
**ZDU/J1: At lower shelf**

| Pin | Signal | Description |
|---|---|---|
| 1 | +24V | Unregulated supply 28-35 VDC. |
| 2 | GND | Signal ground. |
| 3 | LIGHT | Patient positioning lights trigger.<br>High when (28-30 VDC) Up/Down switch is pressed. |
| 4 | -REW | Z-carriage moves down when grounded low. |
| 5 | -FW | Z-carriage moves up when grounded low. |
| 6 | GND | Signal ground. |

## 15.7 Z-driver schematic diagram



## 15.8 Z-driver component lay out



Z-driver unit 4800342

# 16 PDC timing circuit - for DM versions

The purpose of the PDC Timing circuit is to galvanically isolate the PDC cassette from the Cranex unit and to act as a timer for the PDC supply voltage.

## 16.1 Operation

PDC timing circuit is connected in series with the exposure signal. Pressing the exposure button will activate relay K1 which will supply the operating voltage to PDC. R6 and C4 initiate a two second delay of the exposure signal, which gives the PDC electronics time to stabilize.
At same time counter IC3 starts to time the operating power to the sensor, which must stay on for about 2 minutes. The purpose of R5, R16 and C4 is to cause a time delay that is the same as the Cranex pre-heat time. When IC1 pin 8 goes high, J3 pin 5 is pulled down, the speed profile (TDI-file) starts to be read, which times the speed profile so that it is equal to the rotating speed of the Cranex unit.

Switch S1 (when in on position) allows the beam alignment to be checked.

## 16.2 PDC timing circuit connector signals

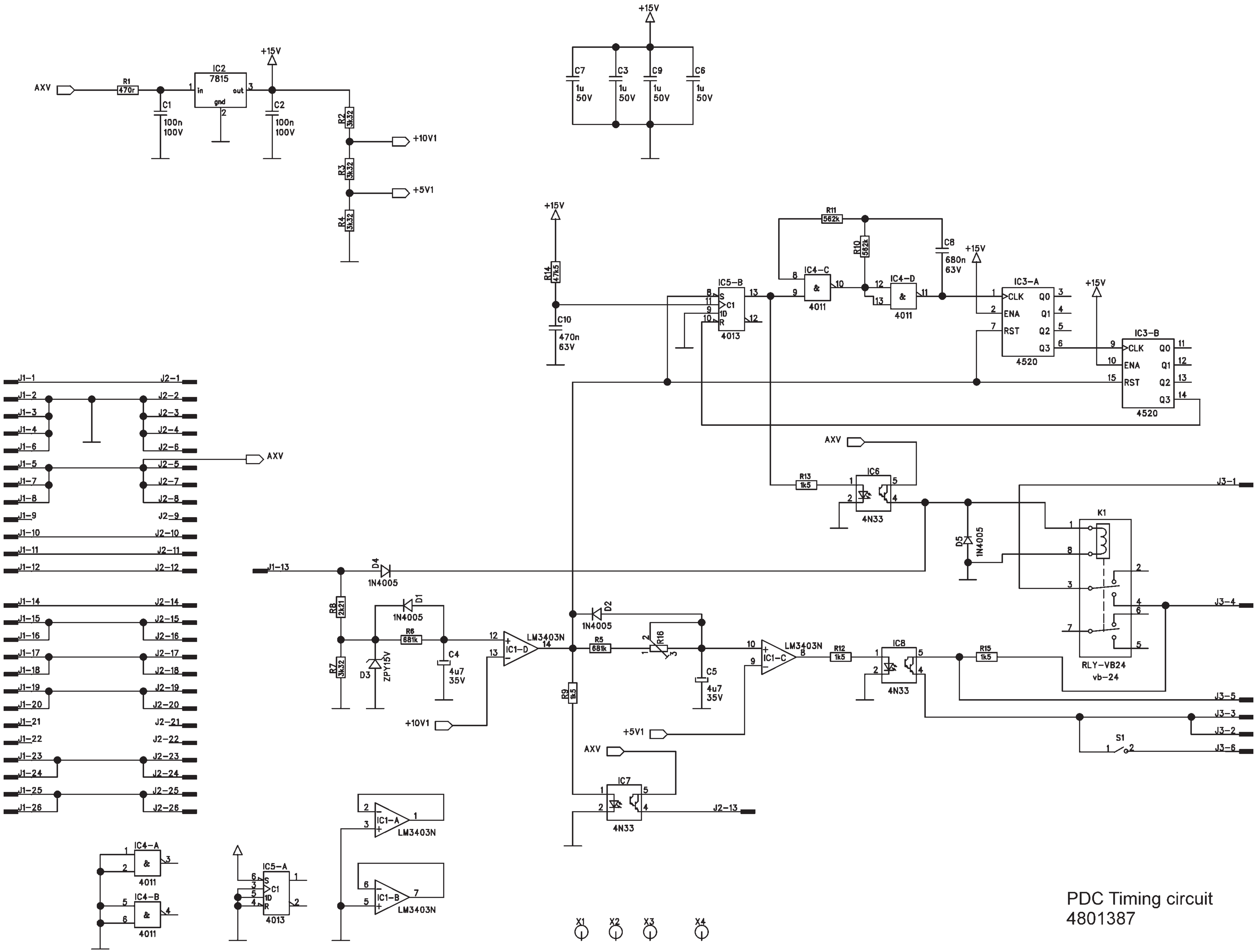
**PDC/J1: 26-pin ribbon cable**

| Pin | Signal | Description |
|---|---|---|
| 1 | MAI | Tube current feedback from panoramic tube head. |
| 2, 3, 4, 6 | GND | Signal ground. |
| 5, 7, 8 | AXV | Unregulated supply 28-35 VDC. |
| (9) | RVL | Not in use. Full wave rectified 20 VAC. |
| 10 | BI1 (RI1) | Tube head temperature signal. High (24 VDC) when unit in start position, kV selected and tube head temperature sensor closed or TA switch on PLU board up and tube head temperature sensor closed. |
| 11 | RYL | Ready light drive. High (24 VDC) when unit ready for exposure. |
| 12 | BI2 | Tube head temperature sensor supply. High when unit in start position and kV selected, or TA-switch on PLU board up. |
| 13 | EXP | Exposure command. High (28-35 VDC) when exposure switch pressed. |
| 14 | HFB | High voltage feedback from pan tube head. |
| 15, 16 | EXL | Exposure light drive. High (24 VDC) when kV over 50. |
| 17, 18 | PRV | P-relay control. High (28-35 VDC) during exposure. |
| 19, 20 | TH | R-relay control. Low after preheat. |
| 23-26 | MD1, MD2 | Supply for drive motors. 24 VAC across. |

**PDC/J3**

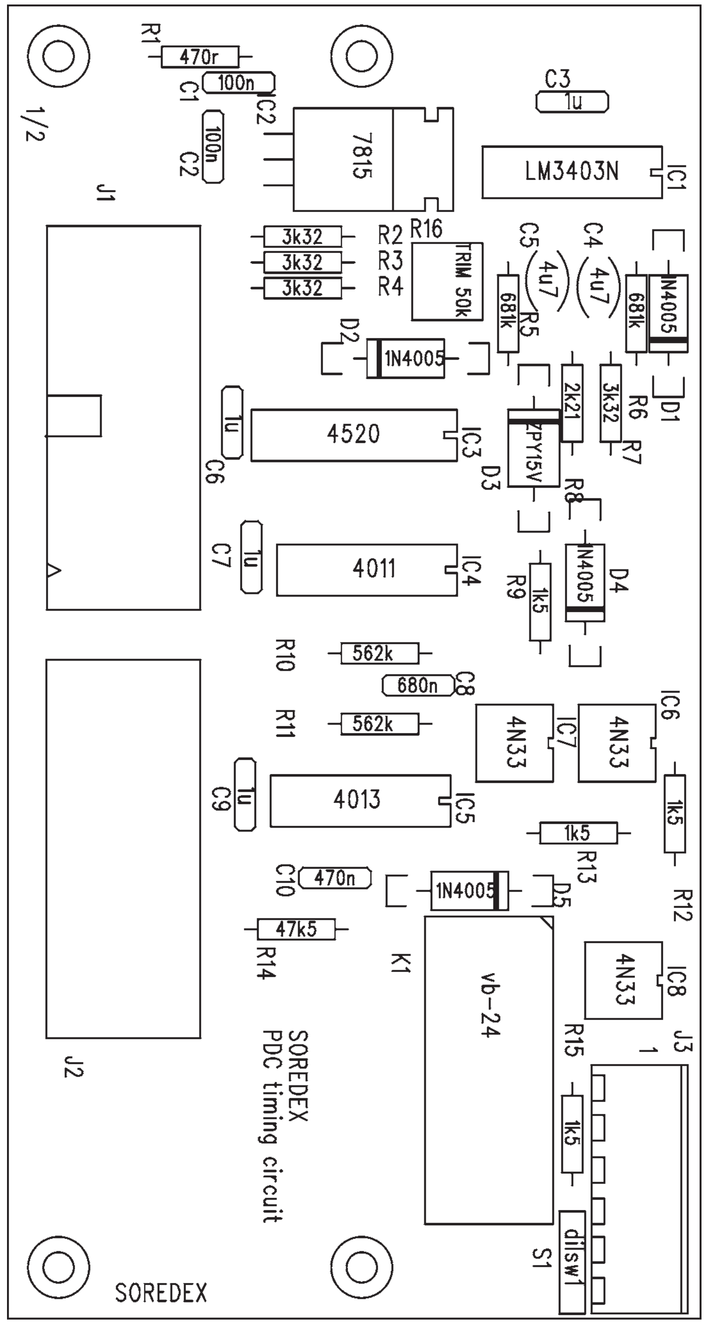
| Pin | Signal | Description |
|---|---|---|
| 1, 4 | +5v | 5 VDC input to the PDC timing circuit |
| 2, 3 | GND | Ground input to the PDC circuit |
| 5 | EXP | Goes up to +5v when radiation starts and starts to read the TDI profile from the PDC |
| 6 | Flame | Goes up to +5v when radiation starts and switch S1 is in the ON position |

## 16.3 PDC timing circuit (DM) schematic diagram




PDC Timing circuit
4801387

## 16.4 PDC timing circuit (DM version) component layout




PDC Timing Circuit
4801387

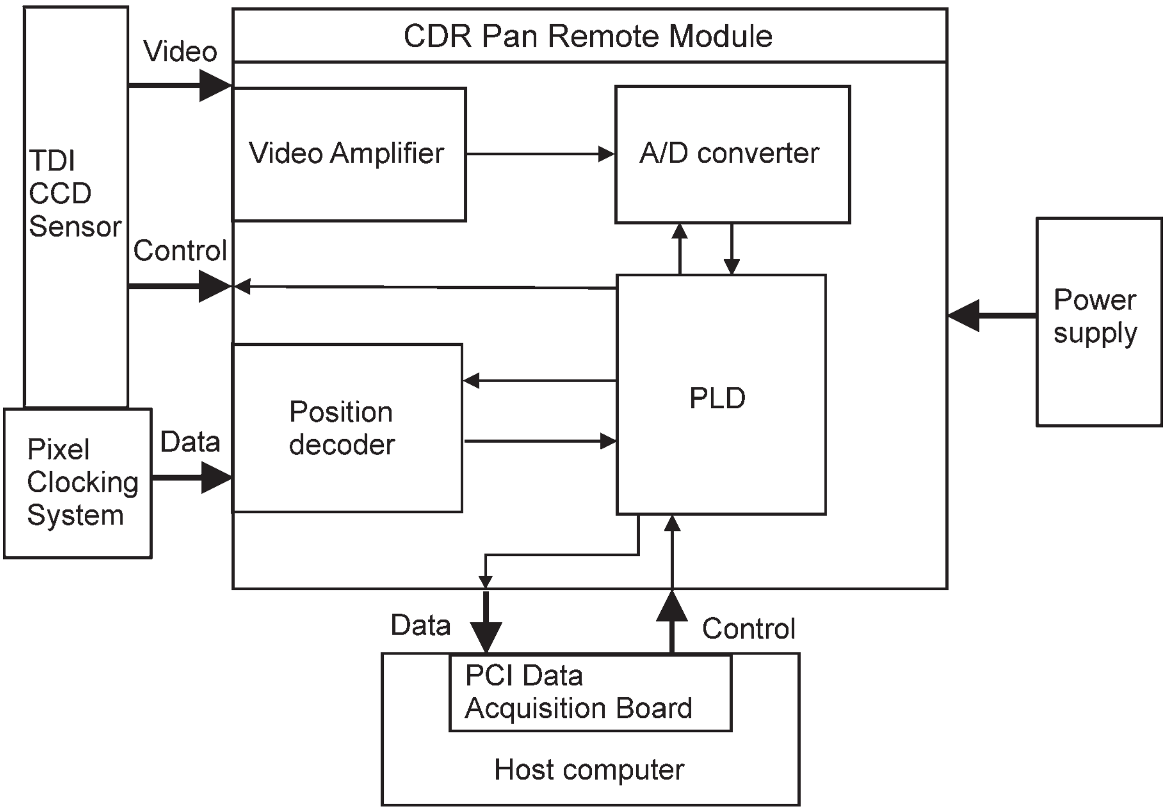
# 17 Interlock circuit board - for DS versions

The purpose of the interlock circuit is to galvanically isolate the CCD-sensor from the Cranex unit and to allow an exposure to be taken after the DS program activates the exposure sequence. The ready light will start to blink when an exposure can be taken.

## 17.1 Operation

Interlock circuit is connected in series with the ready signal. When a program is selected the Remote Module sends a signal to J3, which will then activate opto isolator IC3. When IC3 pin 4 goes high, the ready state is transferred to PLU through pin J2 pin 10. The purpose of IC1 is to activate (flash) the ready light, which is connected to TP2 with C4's charge and discharge cycle.
Switch S1 bypasses IC3, so that the generator can be calibrated without the DS program.

CDR Pan - Block Diagram



## 17.2 Interlock circuit board connector signals

### Interlock/J1: 26-pin ribbon cable

| Pin | Signal | Description |
|---|---|---|
| 1 | MAI | Tube current feedback from panoramic tube head. |
| 2, 3, 4, 6 | GND | Signal ground. |
| 5, 7, 8 | AXV | Unregulated supply 28-35 VDC. |
| (9) | RVL | Not in use. Full wave rectified 20 VAC. |
| 10 | BI1 (RI1) | Tube head temperature signal. High (24 VDC) when unit in start position, kV selected and tube head temperature sensor closed or TA switch on PLU board up and tube head temperature sensor closed. |
| 11 | RYL | Ready light drive. High (24 VDC) when unit ready for exposure. |
| 12 | BI2 | Tube head temperature sensor supply. High when unit in start position and kV selected, or TA-switch on PLU board up. |
| 13 | EXP | Exposure command. High (28-35 VDC) when exposure switch pressed. |
| 14 | HFB | High voltage feedback from pan tube head. |
| 15, 16 | EXL | Exposure light drive. High (24 VDC) when kV over 50. |
| 17, 18 | PRV | P-relay control. High (28-35 VDC) during exposure. |
| 19, 20 | TH | R-relay control. Low after preheat. |
| 23-26 | MD1, MD2 | Supply for drive motors. 24 VAC across. |

### Interlock/J2: 20-pin ribbon cable

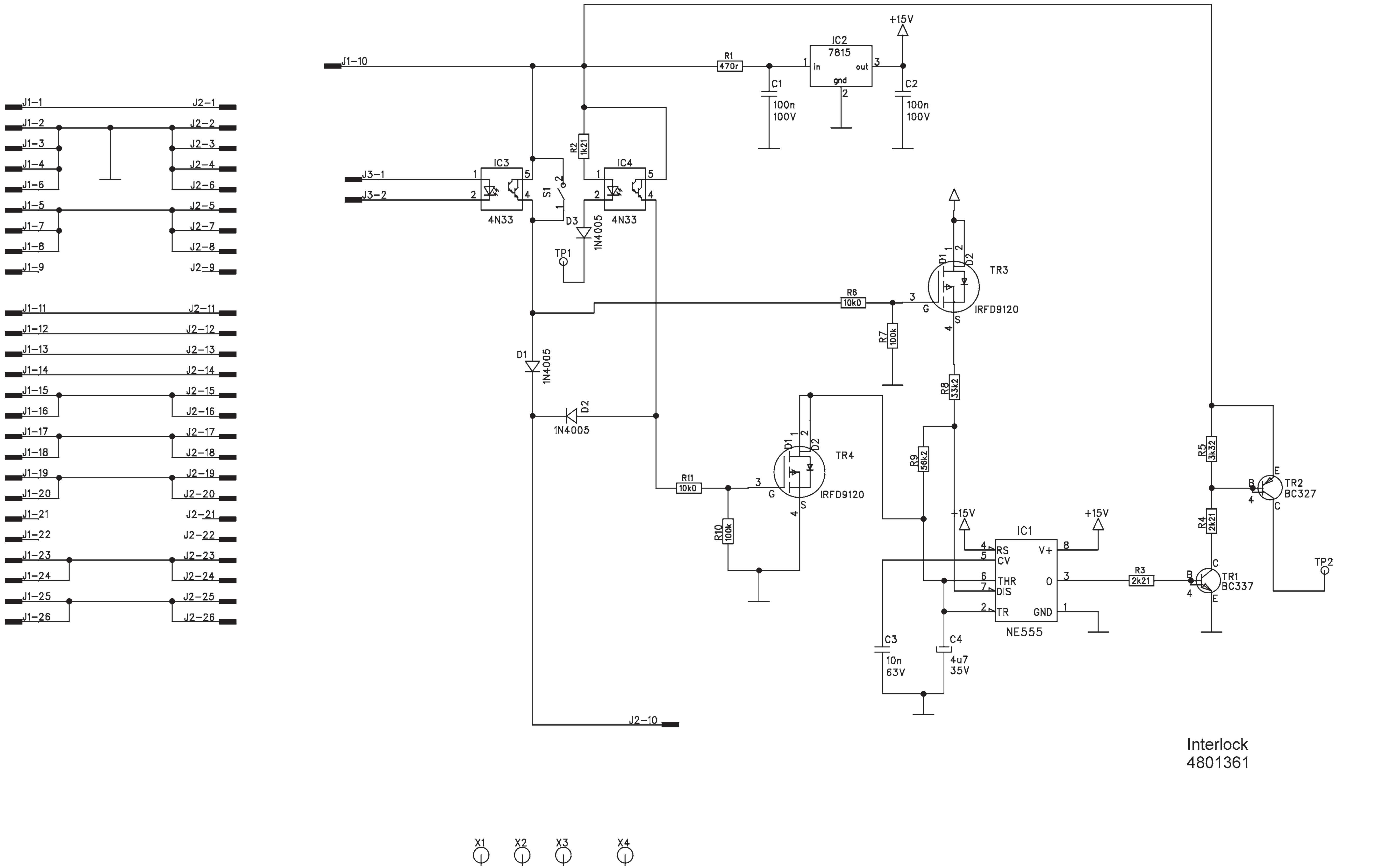
| Pin | Signal | Description |
|---|---|---|
| 1, 2 | | Signal ground. |
| 3 | RFB | Regulator voltage feedback. |
| 4 | +15 | Regulated supply +15V |
| 9, 13 | F1, F2 | Filament inverter control.<br>High (1.2 VDC, 0.2 VAC) during exposure. |
| 15,17,19 | FIV | Filament inverter supply. High (20 VDC) during exposure. |
| 16, 18 | R1, R2 | Power regulator control. High (2.2 DC) during preheat, low (1.5 DC) after preheat. |
| 14, 20 | I1, I2 | Power inverter control. 1.5 DC, 0.3 VAC during exposure. |

| Pin | Signal | Description |
|---|---|---|
| 1 | TP2 | Ready signal |

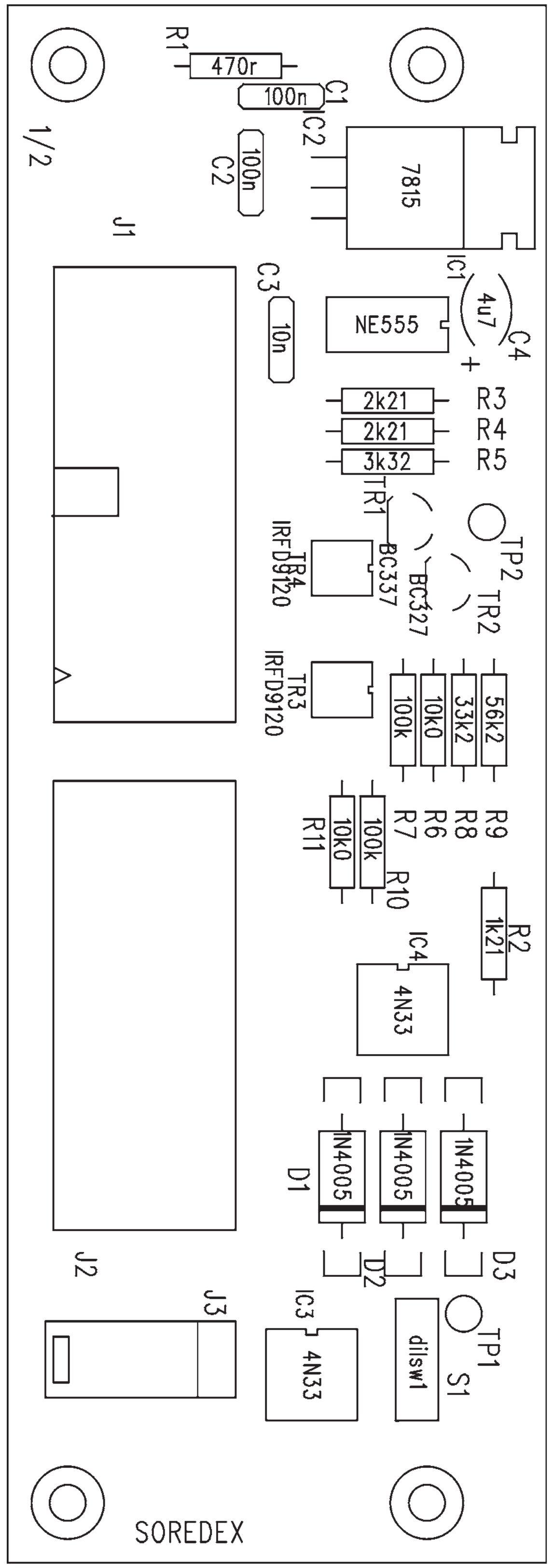
**Interlock/J3**

| Pin | Signal | Description |
|---|---|---|
| 1 | | Trigger signal |
| 2 | | Ground |

## 17.3 Interlock circuit board (DS) - schematic diagram



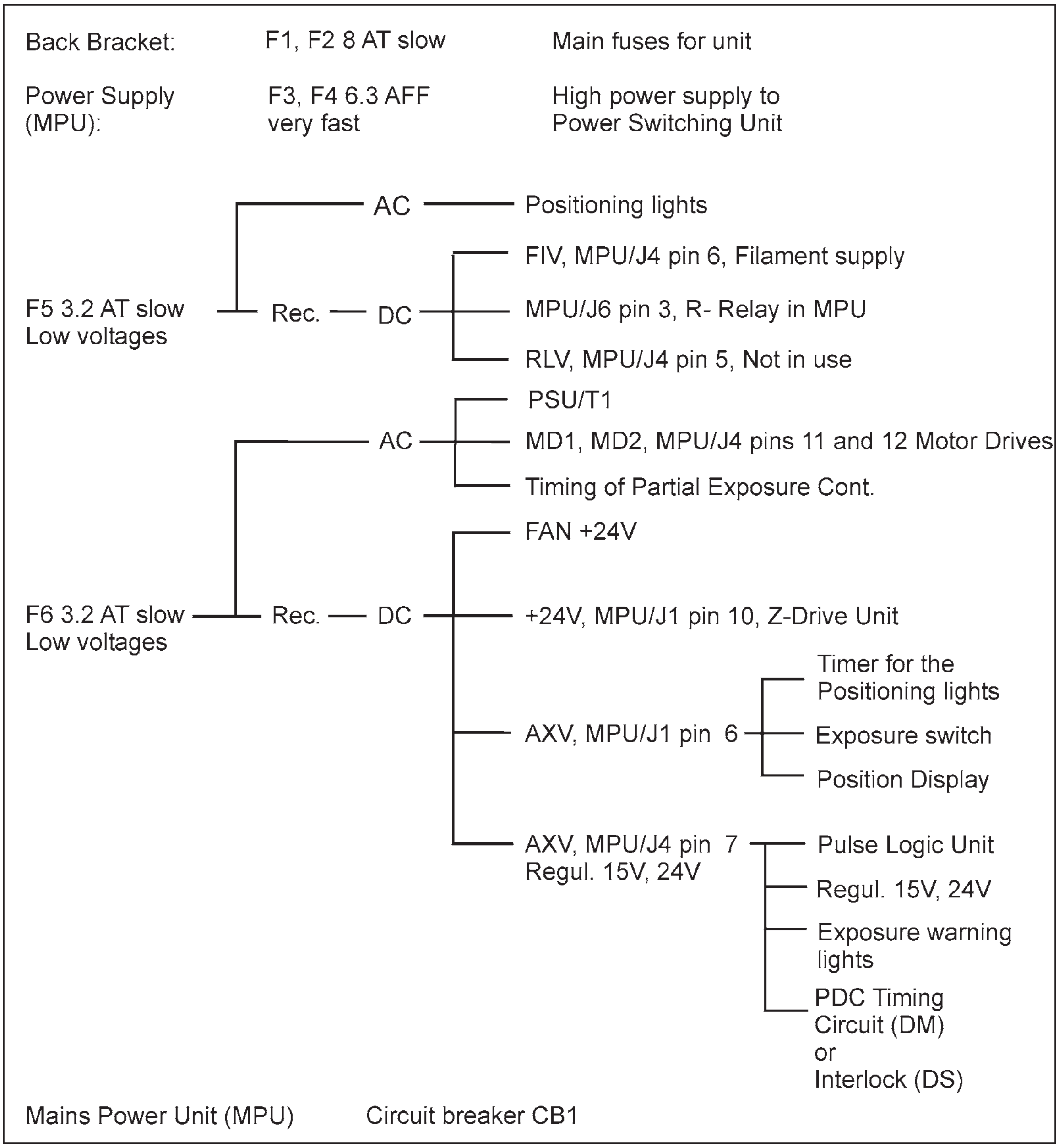
## 17.4 Interlock circuit board (DS) - component layout




Interlock 4801361

# 18 Troubleshooting

## 18.1 Fuse Chart



## 18.2 Problems, causes (c) and *solutions (s)*

### Operating problems - panoramic units

**No power when the unit is switched on (switch light not on)**

1c There is no line voltage.
*1s Check and correct reason for line voltage failure.*

2c Fuses F1 and F2 have blown.
*2s Replace F1 and F2 with an 8 A fuse.*

*Turn the power on. If the display lights come on, the low voltage side of the power supply is operating.*

*Press the exposure button. If fuse F1 or F2 blows again, the high voltage card is shorted.*

*Check diode bridge D1 on MPU High Voltage Board. If D1 is faulty, replace.*

**Exposure warning lights and buzzer come on when unit switched on**

1c TR2 is shorted on the PLU board and the exposure warning lights sockets have been damaged by overtightening the bulbs
*1s Replace the lamp sockets, transistor TR3 or the PLU board.*

**The READY light does not come on**

1c The unit is not in the ready position.
*1s Press the RETURN key to drive the unit to the ready position. Then slide the cassette carriage (where applicable) to the left as far as it will go.*

2c Unit in the ready position but no READY light. The cassette carriage or start microswitch is defective, or the unit is in the protection mode or the thermal switch inside the tube head is open.
*1s Turn the TA switch on the PLU board to the up position. If the READY light comes on the cassette carriage or start microswitch is defective. If it does not the unit is in the protection mode or the thermal switch inside the tube head is open.*

**Protection light comes on**

1c Line voltage not compatible with the terminal setting on the MPU.

*1s Check line voltage or voltage and then check the terminal setting on the MPU. If the setting is not compatible with the line voltage change the terminal setting. The line voltage and terminal settings are as follows:*

| ***Line voltages*** | | ***Terminal*** |
|---|---|---|
| *175 - 190 V,* | *use the* | *190 V terminal* |
| *190 - 205 V,* | *use the* | *200 V terminal* |
| *205 - 225 V,* | *use the* | *220 V terminal* |
| *225 - 250 V,* | *use the* | *240 V terminal* |

2c The kV / mA levels are too high.

*2s Check and if necessary adjust the kV / mA levels of the PLU board.*

3c A head holder cable or connector is loose or damaged.

*3s Check all cables, connectors and ground wires. Replace if necessary.*

4c kV too high.

*4s The PSU protection circuit monitors the regulator voltage. If the regulator voltage is 200 V or above, the PSU protection circuit will be activated which will terminate the regulator- and inverter pulses, raise the HFB signal to a value that will trigger the PLU protection circuit, and switch the protection light on.*
*Check and if necessary calibrate the generator.*

5c Inverter current too high.

*5s Check and if necessary calibrate the generator.*

6c Shorted D8 on PLU

*6s If the tube head arcs the mA will increase which can then destroy D8 on the PLU. Replace D8 or the PLU.*

7c Tube head defective.

*7s Replace tube head.*

8c Poor or no grounding between PLU, PSU, MPU and tube head.

*8s Check groundings*

**None of the patient positioning lights come on**

1c The light button is defective.
*1s Check operation of the button. Replace if defective.*

2c Fuse F5 on the MPU has blown.
*2s Replace fuse F5.*

3c D17 on the MPU low voltage board is defective.
*3s Replace D17 or Low Voltage Board.*

4c The positioning light timer or V-relay not working.
*4s Replace Low Voltage Board.*

**One of the positioning lights does not come on**

1c Bulb blown.
*1s Replace bulb.*

**Bulbs in the patient positioning lights keep blowing**

1c D17 on MPU low voltage board may be short-circuited.
*3s Replace D17 or Low Voltage Board.*

**The patient positioning lights do not switch off after the preset time**

1c Timer circuit on the MPU Low Voltage Board does not work.
*1s Replace Low Voltage Board.*

**Height adjustment movement (pan or pan/ceph) does not work**

1c The switch is faulty.
*1s Replace switch.*

2c Check the reference voltage from the Z-drive board. If no voltage, the board is faulty.
*2s Replace the Z-drive board.*

*3c The Z-drive motor is faulty.*

*3s Replace the motor.*

*4c The drive belt is slipping or broken.*

*4s Replace the drive belt. See section "20 Testing, Calibrating and Adjusting - Adjusting the Z-motor belt":*

**No radiation when exposure taken (movement but no lights)**

1c Fuses F3 and F4 on MPU have blown.

*1s Replace fuses. Make sure that they are the correct rating, 6.3 AFF very fast. Also check the regulator and inverter transistors on the PSU.*

2c Tube head malfunctioning.

*2s Replace the tube head.*

3c Circuit breaker on MPU has tripped.

*3s Reset the circuit breaker CB1. If it trips repeatedly, R1 on MPU High Voltage Board has blown. Replace R1 or the High Voltage Board.*

5c Connector pins are damaged or have been pushed out of the connector.

*5s Check all cables and connectors. Replace if they cannot be repaired.*

**None of the lights come on**

1c Fuse F6 has blown.

*1s Replace fuse.*

2c AXV 28 VDC shorted to ground.

*2s Check wiring for shorts to ground.*

3c Exposure switch shorted to ground.

*3s Replace exposure switch*

4c Voltage regulators or other circuits on the PLU, Partial Exposure Controller (PEC), Position Display, Z-Driver Unit or PDC Timing Circuit (DM version only) arr short circuiting.

*4s Replace defective board.*

**Rotating unit and/or cassette carriage do not move during exposure**

1c Fuse F6 blown.

*1s Replace fuse.*

2c Motor(s) malfunctioning.

*2s Replace motor(s).*

**Exposure apparently normal, but no image produced**

1c No mA.

*1s Check the FIV line, fuse F5 and the transistors on the PSU. Replace any that are faulty. Check the operation of the PSU after replacing any of the transistors*

## Image quality problems - panoramic units

The easiest way to determine if there is an operating or alignment problem is to take a ball/pin exposure. From the size and shape of the ball/pin image, operating malfunctions and alignment errors can be identified and then corrected.
For information on how to take a ball/pin exposure see section “21 Aligning procedures - Taking a ball/pin exposure”.

**End of the image is missing (partial exposure)**

1c. Exposure button released too early.
*1s. Operator error. Retake the exposure if required.*

2c Film microswitch activated too early.
*2s Adjust position of the microswitch.*

3c Back-up timer not set correctly (time too short).
*3s Carry out a back-up timer test and then set the back-up timer.*

**Part of the image is in focus and part out of focus**

1c. Unit not correctly aligned.
*1s. Take a ball pin exposure to determine the alignment error. Realign the unit accordingly.*

2c Focal trough adjustment (y-movement) wire is broken.
*2s Replace the wire.*

**Image too light, too dark or not enough contrast - cassette versions only**

1c. Film/screen incompatibility.
*1s. Check the film and intensifying screens being used are compatible. Replace or change if necessary.*

2c. Faulty film processing.
*2s. Make sure that the film processing system is working correctly and that the processing chemicals are correct, fresh and at the right temperatures.*

3c. Incorrect kV.

*3s. Check the generator calibration*

4c. Darkroom is not light-tight or the wrong lamp is being used with the safelight.

*4s. Check that there are no light leaks in the darkroom. Do this by placing a coin on a piece of unexposed film placed on a flat surface in the darkroom. After five minutes process the film. If an image of the coin appears on the film, it indicates that the darkroom is not light-tight. If there is no image on the film, the lamp is correct for the safelight.*

**The image is not symmetrical**

1c The column is not vertical which is causing the rotating unit to change speed during exposures

*1s Reposition the column to get the unit in to the vertical position.*

**There are dark vertical lines (over exposure) on the film**

1c The cassette carriage bearing block is dirty or loose.

*1c Clean or adjust the bearing block.*

2c The cassette carriage roller is dirty.

*2c Clean cassette carriage roller with alcohol.*

3c The cassette carriage roller is worn.

*3c Replace cassette carriage roller.*

4c The cassette motor drive wheel does not touch the cassette roller.

*4c Adjust the cassette motor drive wheel so that it touches the cassette roller.*

5c The rotation drive gear wheel or gear track is dirty or damaged (broken tooth).

*5s Clean if dirty, replace relevant parts if broken.*

6c The cam pin on top trim cover of rotation unit is not in the slot.

*6c Reposition the pin so that it is in the slot.*

**The length of the image (exposed area) in not correct**

1c The cassette carriage is not moving at the correct speed.
*1s Check and if necessary adjust the speed of the cassette carriage.*

2c The cassette carriage drive wheel is not in proper contact with the roller.
*2s Check that cassette drive wheel makes proper contact with roller.*

3c The FILM microswitch and / or the END microswitch are out of adjust.
*3s Readjust the positions of the microswitches.*

**The middle balls on the ball/pin image are oval and not round**

1c The focal trough is not correctly aligned in relation to the rotating unit.
*1s Check and if required realign the focal trough.*

2c The profile follower is broken or is not in proper contact with the lower profile
*2s Replace the profile arm assembly if the follower is broken and reposition the follower if not in proper contact with the lower profile.*

**DM and DS digital versions:**

1c. The CCD sensor has not been calibrated correctly.
*1s. Refer to the separate calibrating instructions supplied with the DM and DS versions of the unit.*

## Image quality problems - Ceph units

**The margins are not all the same width**

1c The beam is out of alignment.

*1s Check and if necessary adjust the beam alignment. Refer to the installation manual.*

2c The ear rings are not concentric.

*2s Adjust the position of the ear posts to get the ear rings concentric.*

3c The soft tissue filter does not move.

*3s Replace the soft tissue adjustment screw.*

# 19 Removing covers

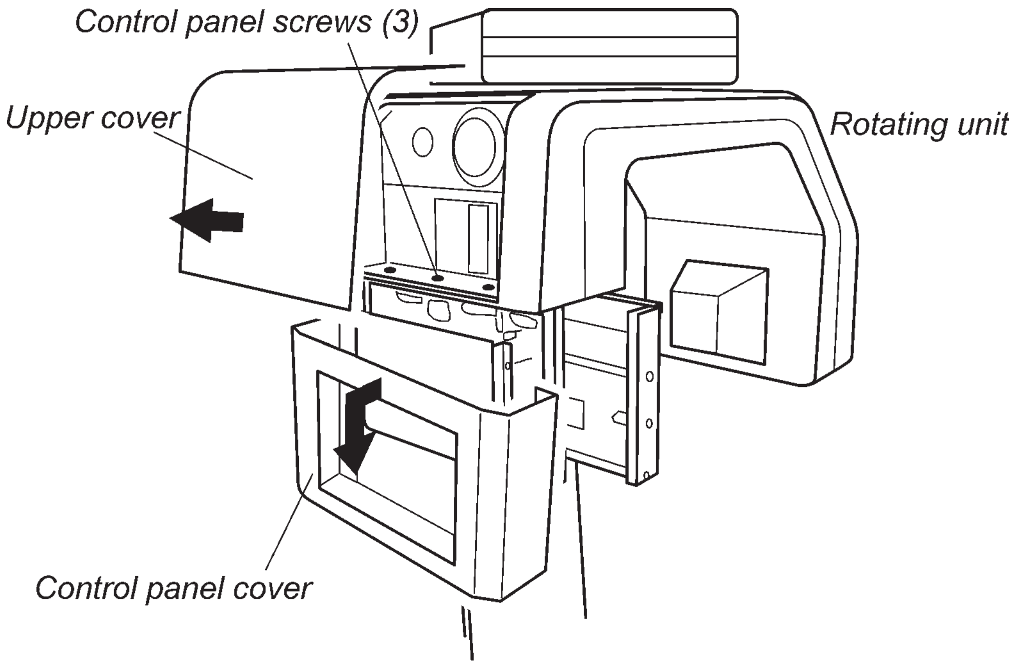
Most of the unit covers are held in place with Torx screws. A Torx screwdriver is supplied with every unit. Be careful when removing covers as many have ground wire connected to them.

**NOTE**
When replacing covers ALWAYS reconnect the ground wires.

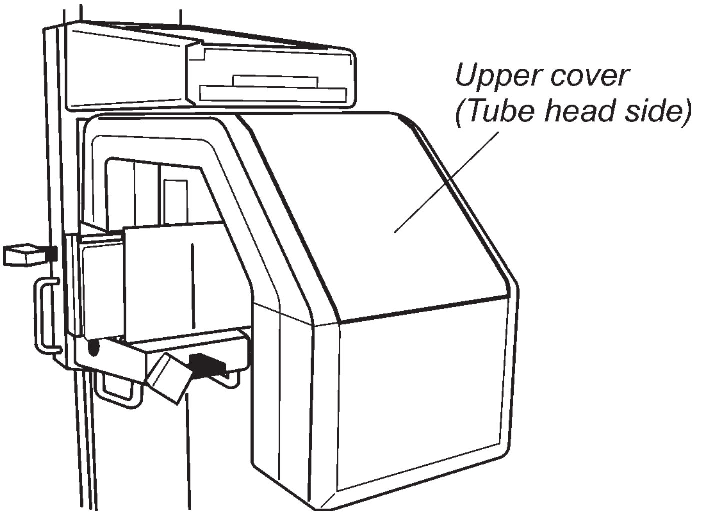
**NOTE**
When replacing covers ALWAYS replace grounding washers in their original positions.

## 19.1 Rotating unit

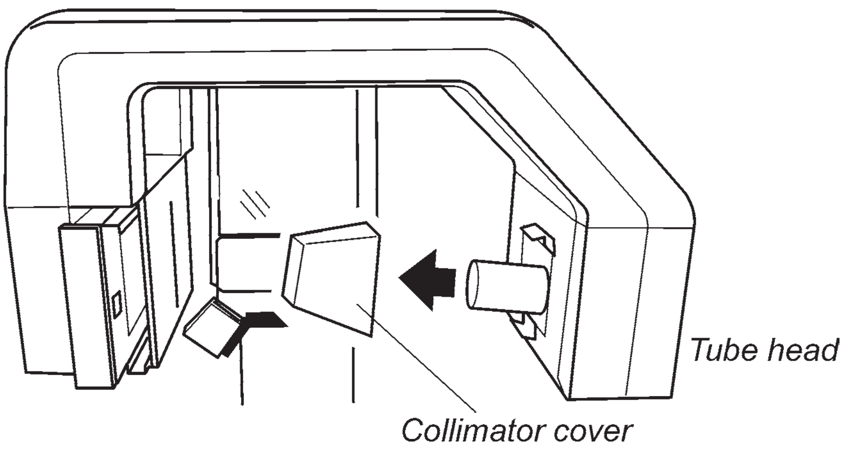
1. The upper cover on the control panel side of the rotating unit is held in place with four (4) screws, two on the top and two on the side. Note that you may have to turn the rotating unit to access the top two screws.
   The control panel is held in place with three (3) screws. These cannot be accessed until the upper cover has been removed.



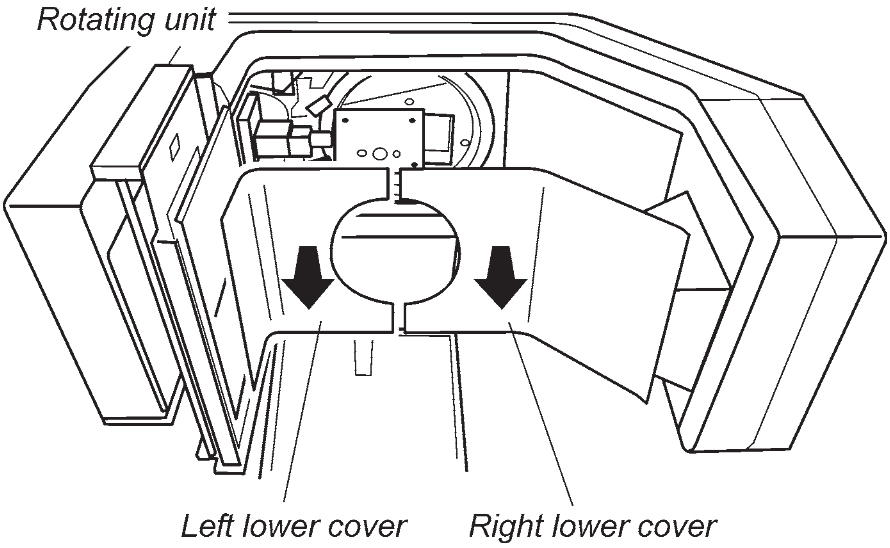
2. The upper cover on the tube head side of the rotating unit is held in place with four (4) screws. Note that you may have to turn the rotating unit to access the top two screws.




3. The collimator cover is held in place with two screws.

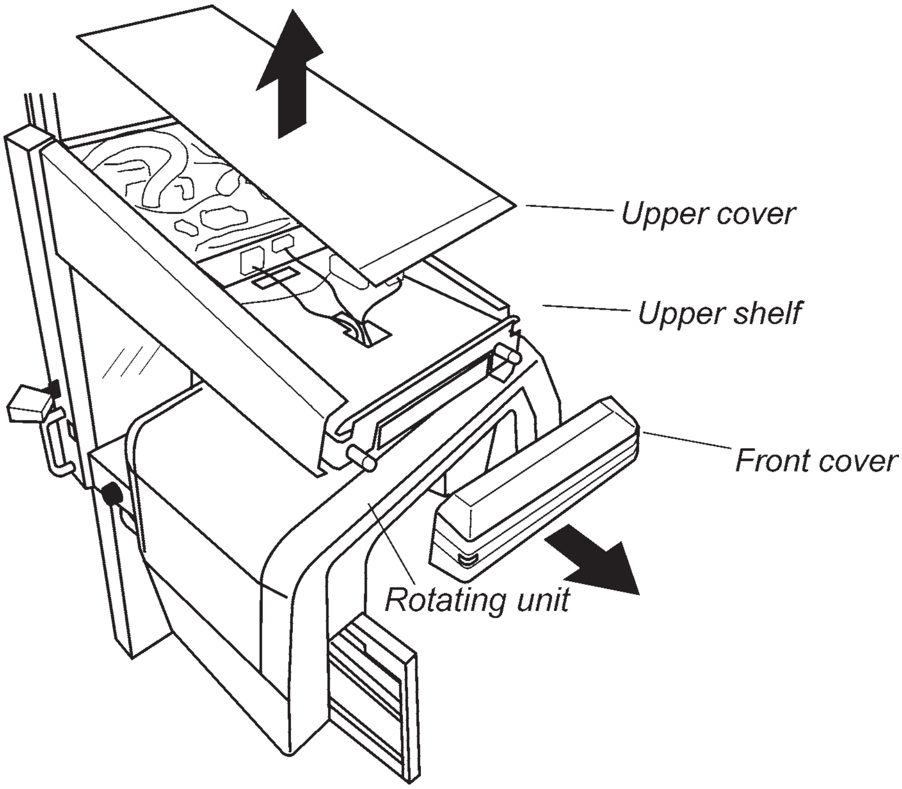


4. The left lower cover is held in place with 4 screws. The right lower cover is held in place with 4 screws.



## 19.2 Upper shelf cover

1. Remove the front cover first (2 screws) and then the upper cover from the shelf (4 screws).



# 20 Testing, Calibrating and Adjusting

## 20.1 kV/mA Calibration procedure

A digital multimeter (DMM) with a frequency counter of known accuracy is required to complete this procedure. PLU boards from type 4001-8 are fitted with test points (TP) PKV+, PKV- CKV+, CKV-, mA+, mA-.

1. Remove the control panel covers and the control panel. Place lead shield over the primary slit.
2. Turn TA switch to the up “TEST” position and check that the PRE switch is to the right, in the normal (ON) position. Both switches are on the PLU board.
3. Switch the unit on.
4. Select the frequency counter mode, and then connect the DMM to TP mA- and pin 5 on IC14.
5. Adjust R45 to get a frequency of:
   - 47 kHz, for tube heads with serial numbers beginning with 13xxxxx and 23xxxxx
   - 40 kHz old tube heads with serial numbers beginning with 12xxxxx and 22xxxxx
6. Turn trimpots:
   - R41(PRE) to the middle position,
   - R51(mA) counter clockwise to a minimum,
   - R56(kV) clockwise to a maximum,
   - R65(RFB) counter clockwise to a minimum.
7. Connect the DMM to TPs PKV+ and PKV- on the PLU.
8. Select exposure values of 81kV, 10mA and no compensation.

9. Press and hold down the exposure switch and adjust R65(RFB) until the DMM reading is 8.15V (= 90kV).
   Then adjust R56 (kV) until the DMM reading is 7.34V (= 81kV).

10. Connect the DMM to TPs mA+ and mA- on the PLU board.

11. Push the PRE switch to the left, the OFF position. Select exposure values of 63kV, 10mA and no compensation.

12. Press and hold down the exposure switch and adjust R41(PRE) until the DMM reading is:
    - 1.5V - 1.6V (40 kHz) old tube heads with serial numbers beginning with 12xxxxx and 22xxxxx

    - 1.2 - 1.3V (47kHz) old tube heads with serial numbers beginning with 12xxxxx and 22xxxxx,

    - 2.55 - 2.65V (47kHz) new tube heads with serial numbers beginning with 13xxxxx and 23xxxxx

13. Push the PRE switch to the right, to the ON (normal) position. Select exposure values of 63kV, 10mA and no compensation.

14. Press and hold down the exposure switch and adjust R51(mA) until the DMM reading is 2.8V (= 10mA)

15. Select exposure values of 63kV, 6mA and no compensation. Press and hold down the exposure switch and check the DMM reading, it should be 1.6V - 1.8V.

16. Connect the DMM across Test Point PKV+, PKV- on PLU

17. Check the voltage levels for the different kV selections according to following table:

| | |
|---|---|
| 63kV = 5.72V | 73kV = 6.62V |
| 65kV = 5.90V | 75kV = 6.80V |
| 67kV = 6.08V | 77kV = 6.98V |
| 69kV = 6.26V | 79kV = 7.16V |
| 71kV = 6.44V | 81kV = 7.34V |

**Following steps apply to ceph units only**

1. Turn trimpots:
   - R42(PRE) to the middle position,
   - R52(mA) counter clockwise to a minimum,
   - R54(kV) clockwise to a maximum.

2. Connect the DMM to TPs CKV+ and CKV- on the PLU.

3. Select exposure values of 81kV, 10mA , no compensation, 3.2 seconds. Place the lead shield in front of the cephalostat beam

4. Press and hold down the exposure switch and adjust R54(kV) until the DMM reading is 7.34V (= 81kV).

5. Connect DMM across Test Points mA+, mA- on the PLU.

6. Push the PRE switch to the left the OFF position. Select exposure values of 63kV, 10 mA and no compensation.

7. Press and hold down the exposure switch and adjust R41(PRE) until the DMM reading is:
   - 1.5V - 1.6V (40 kHz) old tube heads with serial numbers beginning with 12xxxxx and 22xxxxx
   - 1.2 - 1.3V (47kHz) old tube heads with serial numbers beginning with 12xxxxx and 22xxxxx,
   - 2.55 - 2.65V (47kHz) new tube heads with serial numbers beginning with 13xxxxx and 23xxxxx.

8. Push the PRE switch to the right, to the ON (normal) position.

9. Press and hold down the exposure switch and adjust R52(mA) until the DMM reading is 2.8V (=10mA).

10. Connect the DMM across TPs CKV+ and CKV- on the PLU.

11. Check the voltage levels for the different kV selections according to following table:

| | |
|---|---|
| 63kV = 5.72V | 73kV = 6.62V |
| 65kV = 5.90V | 75kV = 6.80V |
| 67kV = 6.08V | 77kV = 6.98V |
| 69kV = 6.26V | 79kV = 7.16V |
| 71kV = 6.44V | 81kV = 7.34V |

## 20.2 Adjusting the low line triggering

1. Rotate trimpot R16, on the PLU, clockwise as far as it will go.

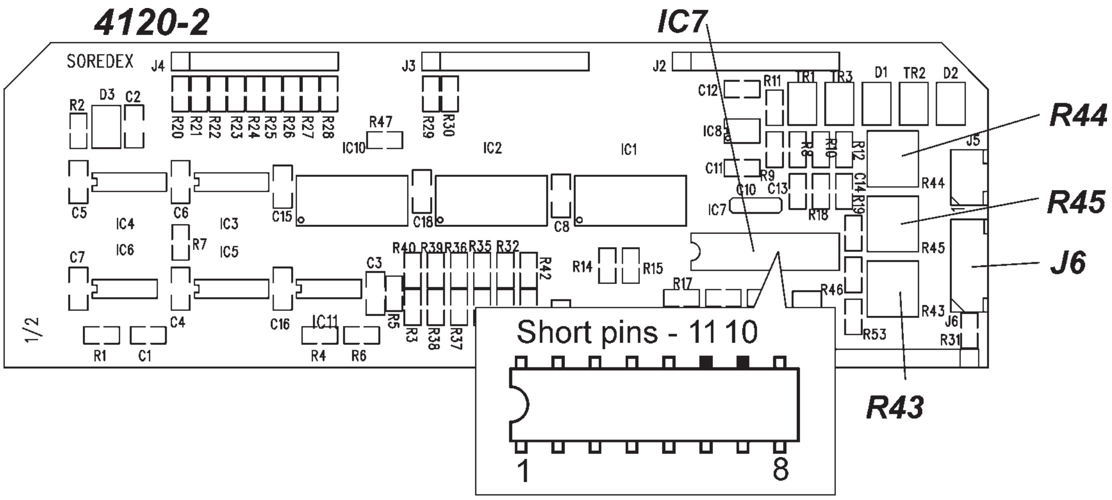
## 20.3 Backup timer test

The units are equipped with a backup exposure timer to prevent excessive exposure periods. The backup timer test circuit can be tested as follows:

1. Remove the cover from the PLU board.
2. Push the TA switch to the UP (TEST) position.
3. Turn the power on.
4. Select exposure values of 63 kV, 6 mA and no compensation.
5. Place the radiation shield over the collimator.
6. Press and hold down the exposure switch and time the audible signal using a stopwatch.
7. Proper exposure or audible signal should be 23 seconds +/- 1.5 seconds.
8. If the backup time is not correct it can be adjusted with potentiometer R26 on the PLU.

## 20.4 Calibrating the Autoset kV (cassette units only)

1. Disconnect the cable that goes to the head support from J6 on the kV selector board (4120-2).




2. On the kV selector board, short pins 10 and 11 on IC 7.

3. Make sure that the x-ray unit is NOT in the READY position.

4. Push the TA switch on the PLU board to the DOWN position and then adjust trimmer R43 on 4120-2 to set the kV value to 63 kV. Note that the kV value will NOT change when you adjust the trimmer. To check that the 63 kV has been selected push the TA switch to the UP position and check that the 63 kV light comes on. If it does not push the TA switch to the DOWN position again, and readjust the trimmer.

5. Remove the short from pins 10 and 11 and re-connect the head support cable to J6.

6. Close the temple supports as far as they will go.

7. Repeat the operation described in 4 above, only this time adjust trimmer R45 to set the kV value to 67 kV.

8. Open the temple supports as far as they will go.

9. Repeat the operation described in 4 above, only this time adjust trimmer R44 to set the kV value to 79 kV.
   The head support calibration is now complete.

   NOTE
   The kV range from 67 – 79 is based on:

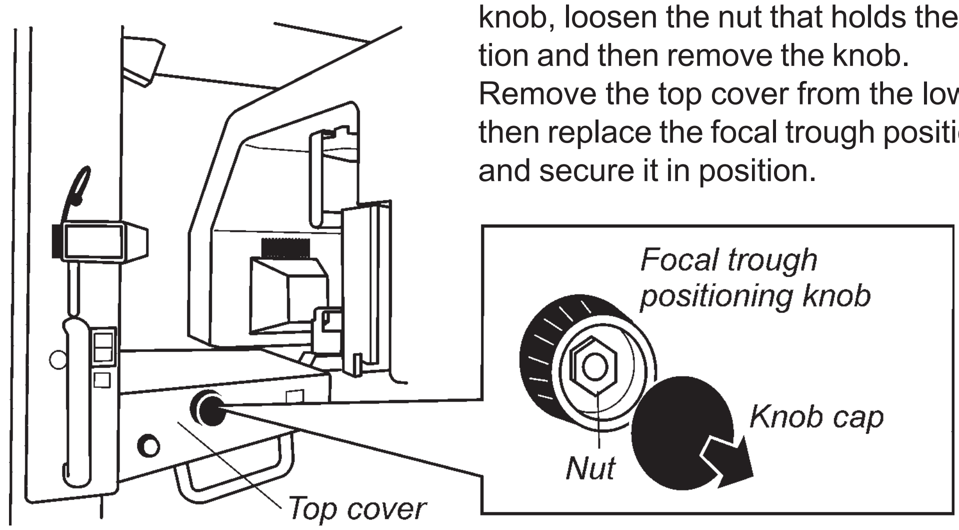
   - a Kodak T-MAT G / Lanex Medium film/screen combination (240 speed) at 10 mA with spinal compensation ON

   - or a Kodak T-MAT G / Lanex Regular film/screen combination (400 speed) at 6 mA with spinal compensation ON

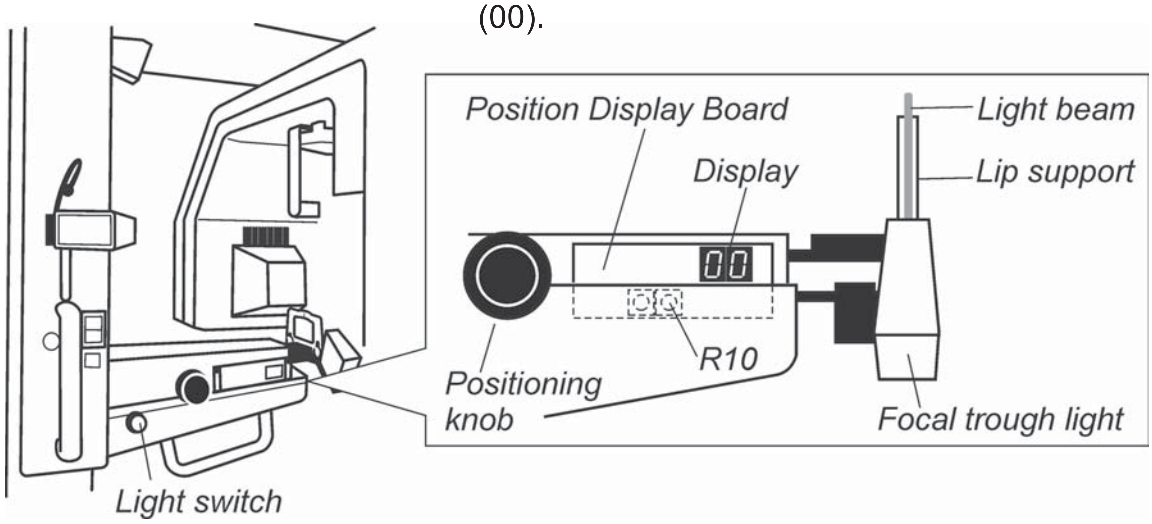
## 20.5 Calibrating the positioning display

After the positioning display board or focal trough wire has been, the position display must be calibrated. This is done as follows:

1. Remove the cap from the focal trough positioning knob, loosen the nut that holds the knob in position and then remove the knob.
   Remove the top cover from the lower shelf and then replace the focal trough positioning knob and secure it in position.

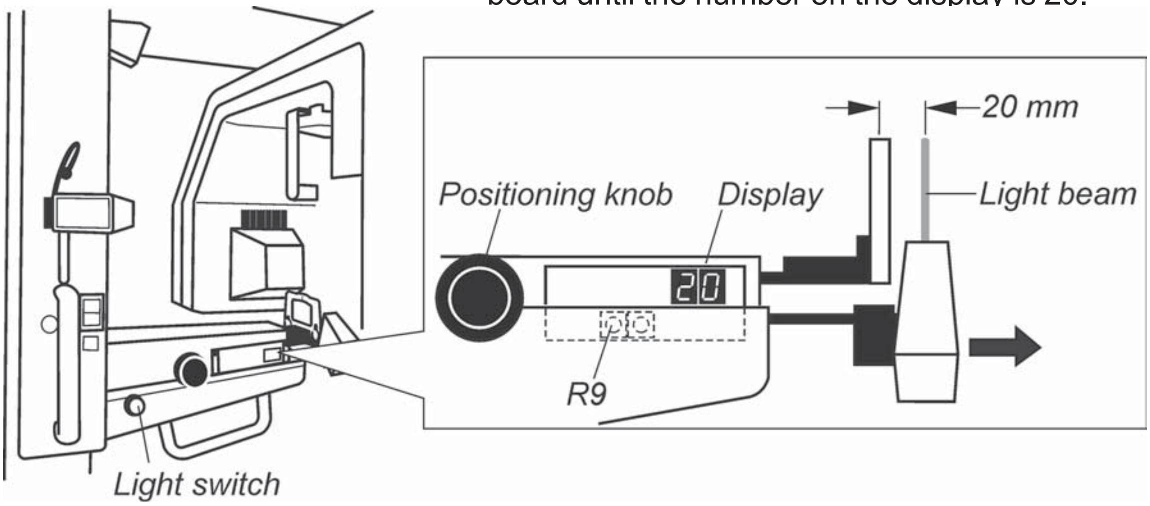



2. Insert the chin rest into the lower shelf.
3. Switch the unit on and then switch the patient positioning lights on.
4. Rotate the focal trough positioning light knob until the focal trough light strikes the side of the chin rest.
5. Adjust trimmer R10 on the positioning display board until the number on the display is zero (00).



6. Rotate the focal trough positioning knob clockwise to move the light beam 20 mm backwards (away from the column). Use a ruler to position it correctly.

7. Adjust trimmer R9 on the positioning display board until the number on the display is 20.



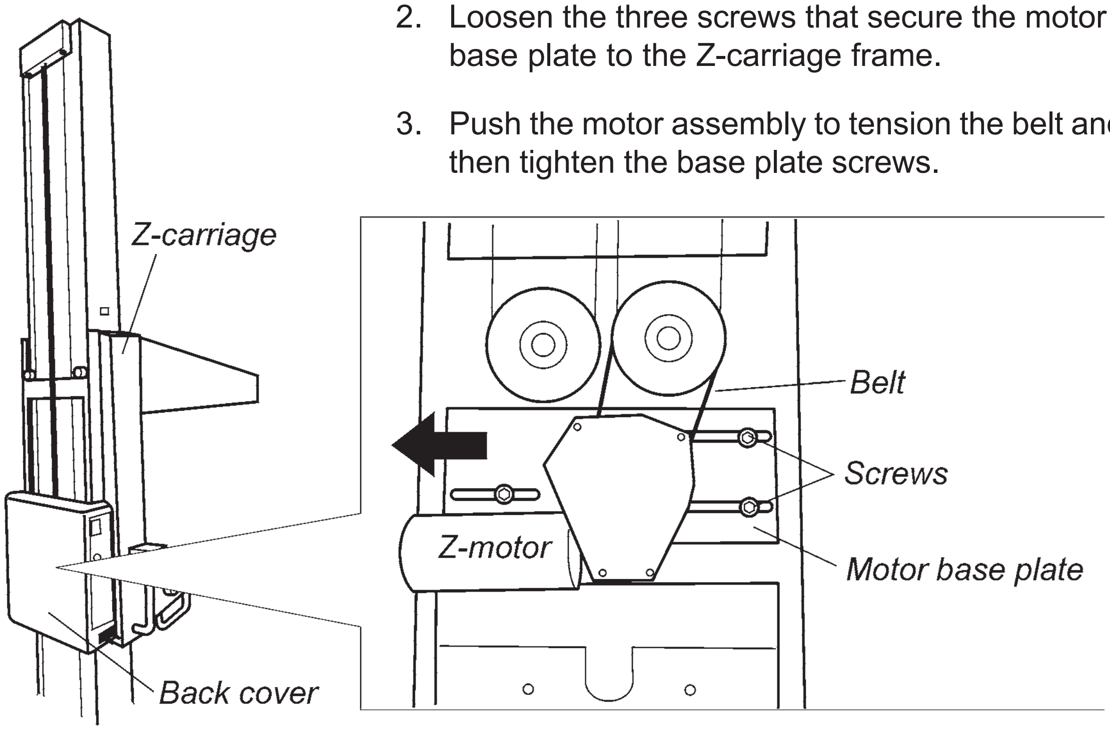

8. Rotate the focal trough position knob back to its original position (striking the side of the chin rest) and check that the number on the display is still zero (00). If not, adjust trimmer R10 again.

9. Replace the top cover.

## 20.6 Adjusting the Z-motor belt

If the Z-motor is running but the Z-carriage does not move, the tension of the Z-motor belt needs to be adjusted. To do this:

1. Remove the back cover.
2. Loosen the three screws that secure the motor base plate to the Z-carriage frame.
3. Push the motor assembly to tension the belt and then tighten the base plate screws.

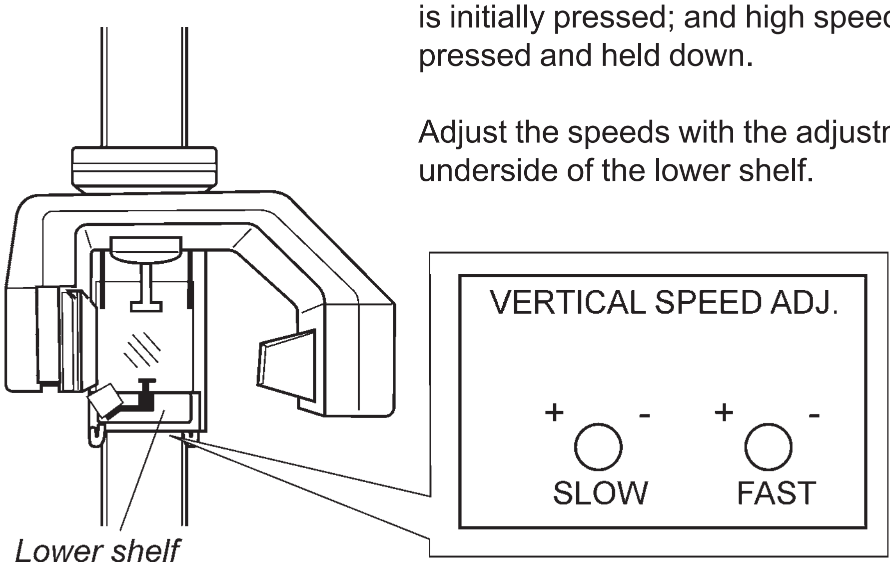



4. Press the up/down switch to check that the Z-carriage moves up and down.
   Replace the cover.

## 20.7 Adjusting the up/down speed (z-driver) (Excel and Excel Ceph units only)

The speed at which the Z-carriage moves up and down can be adjusted. There are two speed adjustments. Slow speed - when the height adjusting key is initially pressed; and high speed if the key is pressed and held down.

Adjust the speeds with the adjustment screws on the underside of the lower shelf.




## 20.8 Adjusting the volume of the exposure warning tone

The volume of the buzzer can be adjusted with the trimmer T11 inside the rear bracket cover.

## 20.9 Calibrating CCD sensors - DM versions

1. Remove the cover from the PLU board and push the TA switch to the UP (TEST) position.
2. Remove the cover from the +5 V power supply unit that is connected to the CCD sensor.
3. Remove the covers from the CCD sensor
4. Connect a voltmeter across pin 13 and the metal body of the D-connector.
5. Place the radiation shield over the collimator.
6. Take an exposure and adjust the trimmer in the power supply unit to get a voltage of 5 VDC ±0.05 VDC.
7. Replace all the covers.

## 20.10 Calibrating CCD sensors - DS versions

For information on calibrating DS versions of the CCD sensor, refer to the documentation supplied with the sensor.

## 20.11 Checking the operation of PSU 47602-1

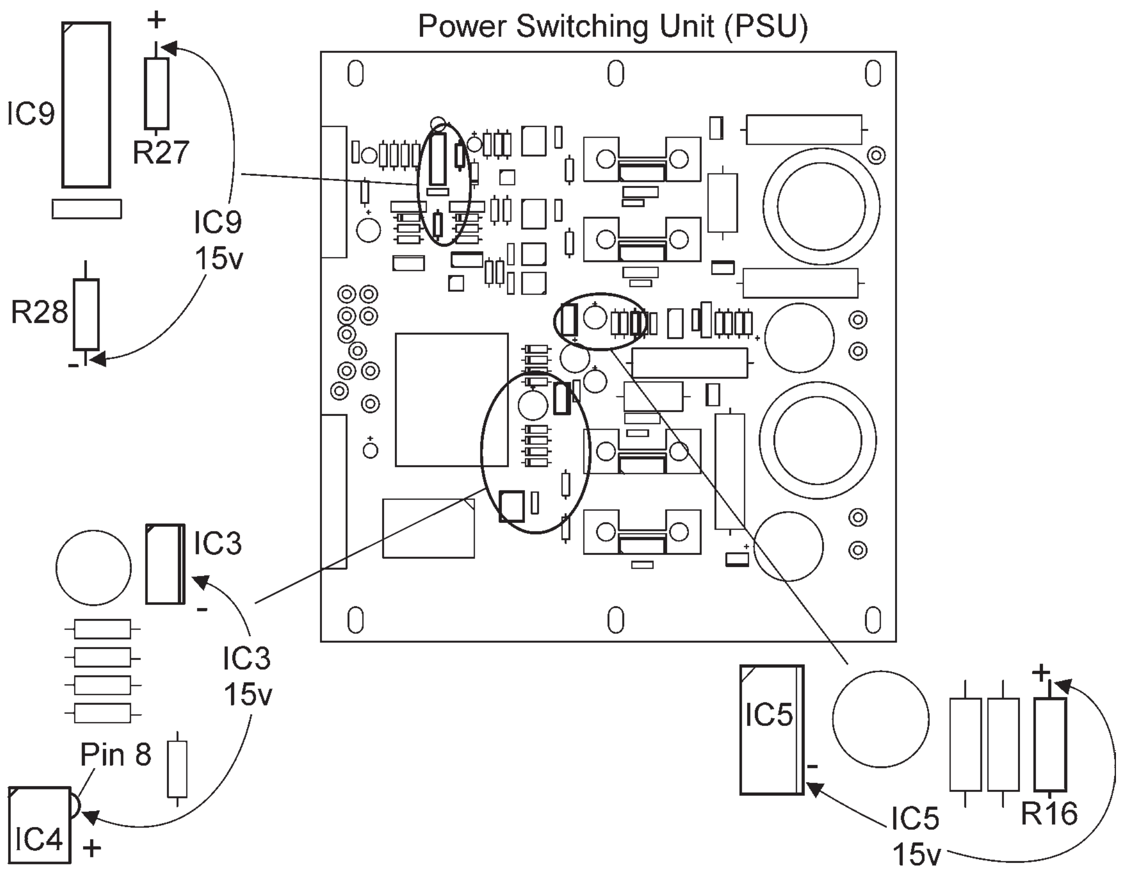
### Checking the reference voltages

Turn the power on and check the reference voltages.

1. Switch the power on and check the following reference voltages with a DMM:
   - the 15V output voltage of IC 3.
   Use case of IC3 as GND and pin 8 on IC4 as output.

   - the 15V output voltage of IC 5.
   Use case of IC5 as GND and the top end of R16 as output.

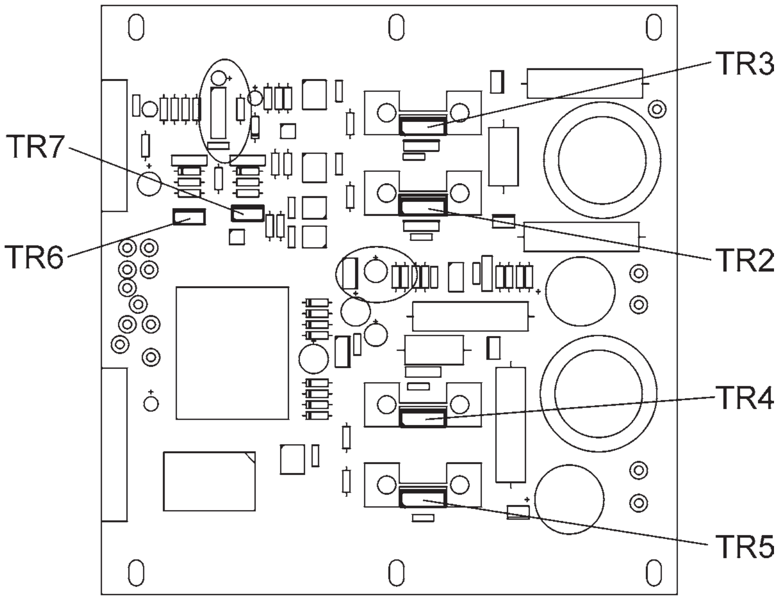
   - the 15V between IC9 pin 14 and 1
   Use top end of R27 as GND and the bottom end of R28 as output.



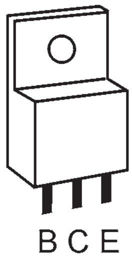
## Power transistor verification

This procedure will reveal faulty power transistors on the PSU. Use a DMM in the diode range to get the correct readings

Power Switching Unit (PSU)



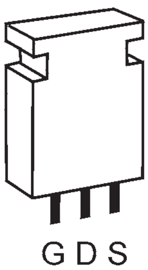

TR2, 3




TR 2, 3

| | | | | |
|---|---|---|---|---|
| Black | B | B | C | E |
| Red | E | C | B | C |
| | 0.56 | ~2 | ~2 | ~1.7 |

TR 4, 5, 6,7




TR 4, 5

| | | | |
|---|---|---|---|
| Black | G | D | S |
| Red | S | G | G |
| | ~0.56 | 2.5 - 3 | 2.5 - 3 |

TR 6, 7

| | | | |
|---|---|---|---|
| Black | G | S | G |
| Red | S | G | D |
| | ~0.2 | ~0.2 | 0.75 |

## Checking the wave forms

1. Switch the power on.

2. Disconnect J2/J3 on MPU

a. Take an exposure and verify the filament inverter pulse wave form from TR6 and TR7 drain against GND

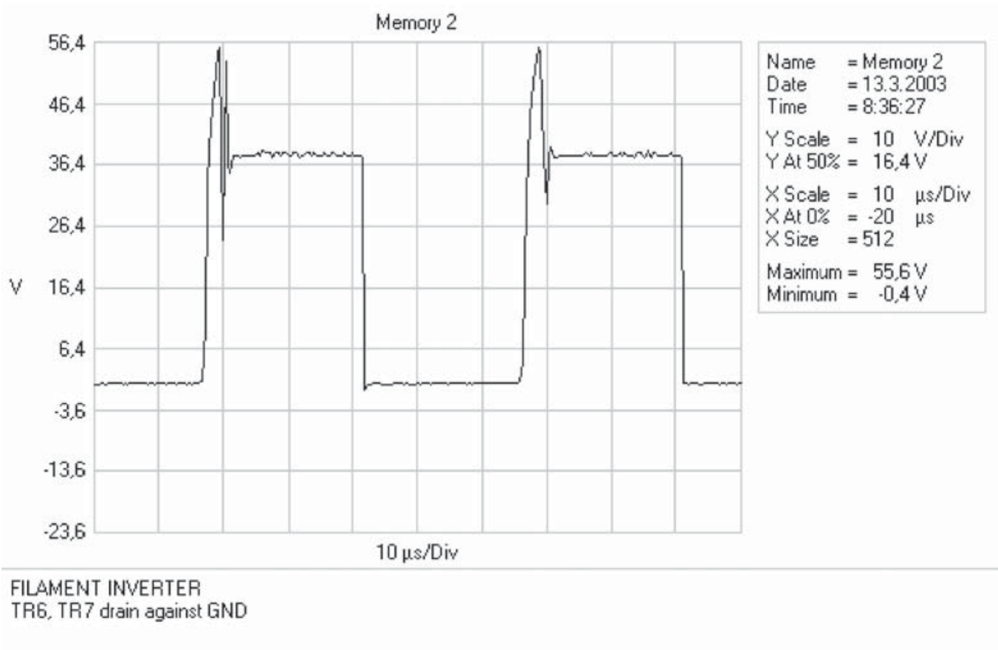



fig 1

b. Check inverter control pulses IC1/pin3 and IC2/ pin3

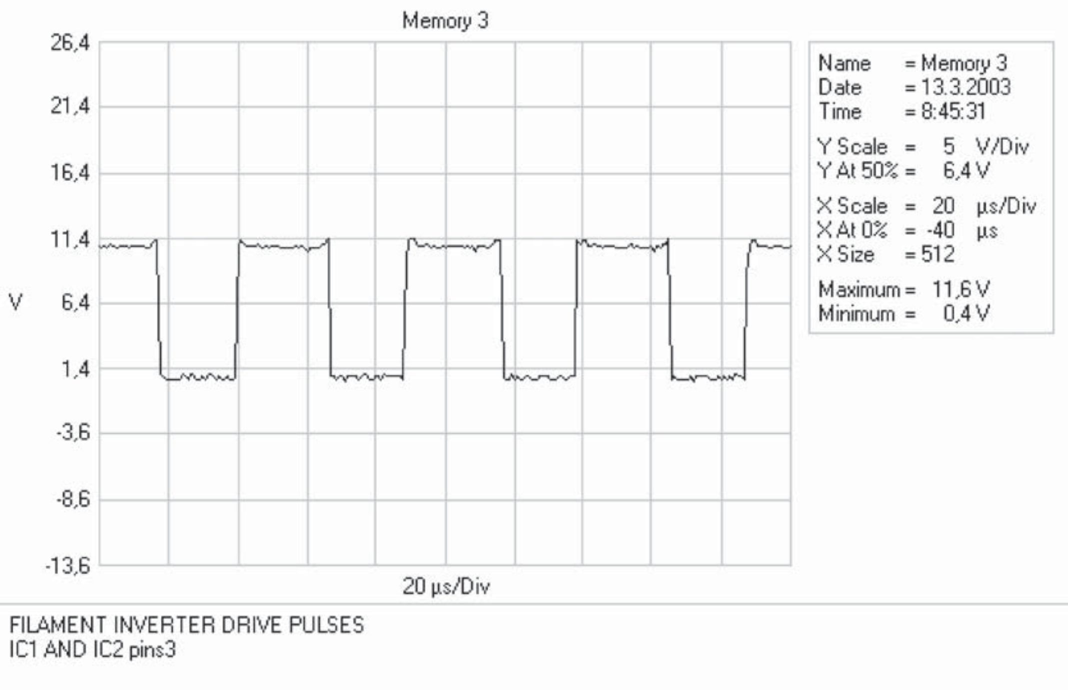



fig 2

c. Check inverter pulses at gates of TR2 and TR3, against PV- (PV- is floating GND)

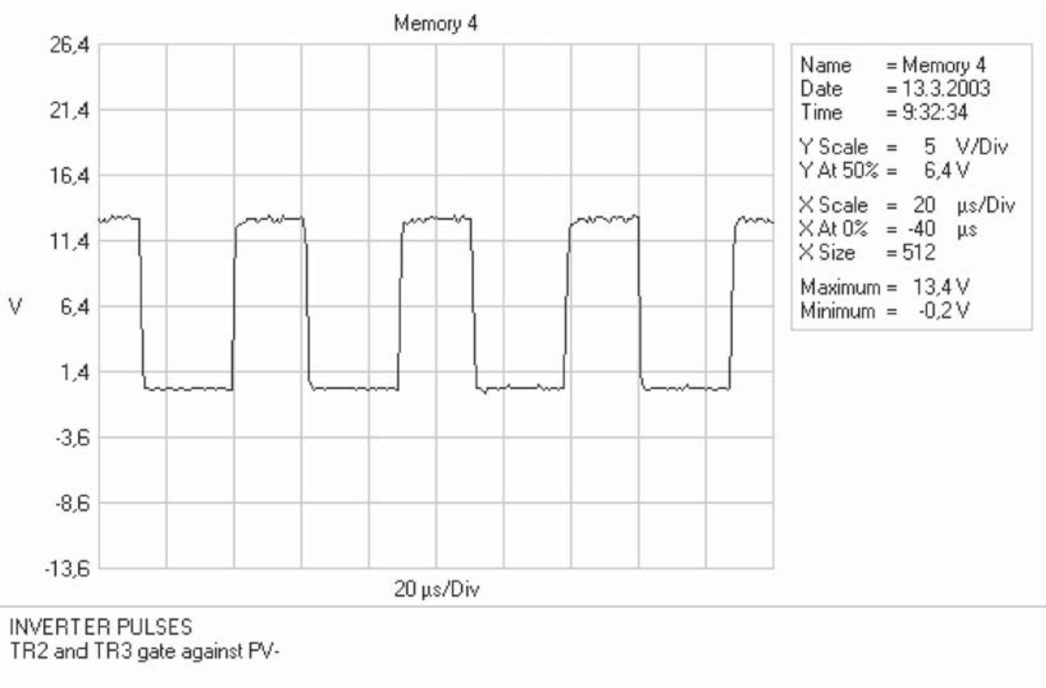



fig 3

d. Check regulator pulses IC4/pin3 against GND

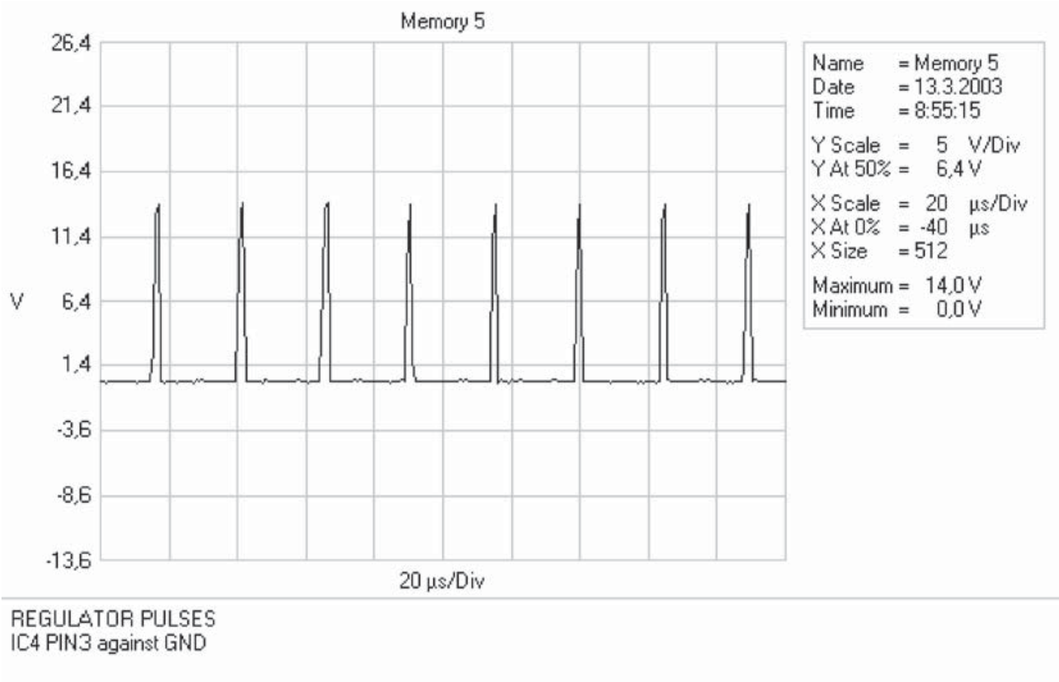



fig 4

e. Check regulator pulses at gates of TR4 and TR5 (against source)

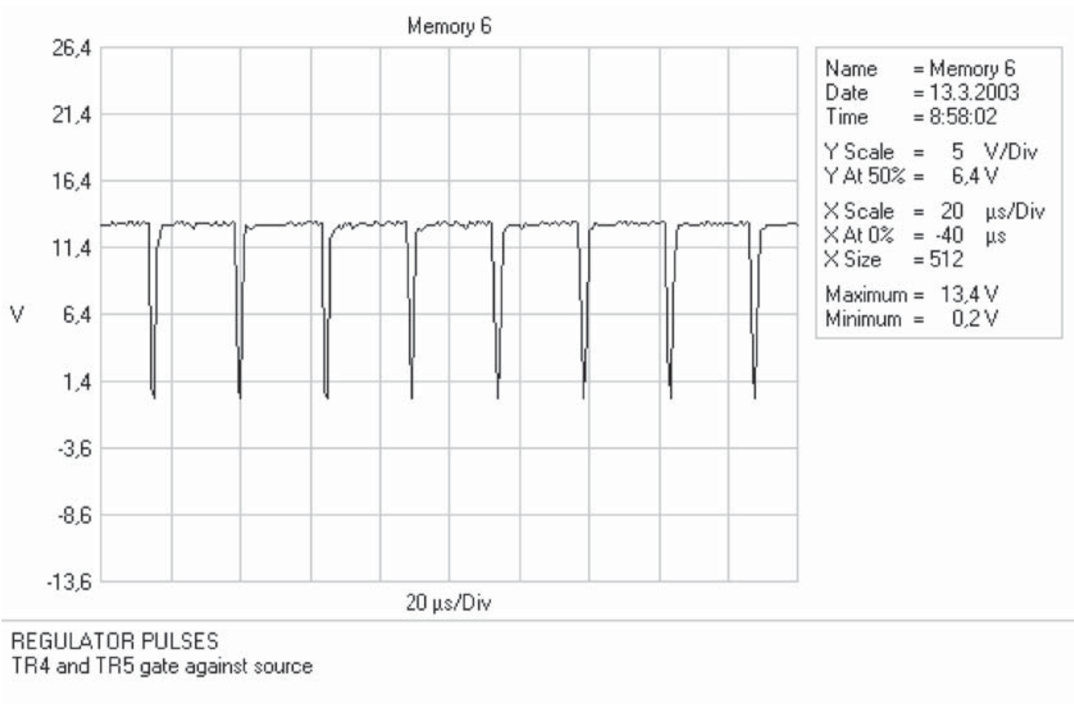



fig 5

3. Check protection circuit operation

   Press the exposure button and short IC8 pins 4 and 5. LED15 must light up and exposure must terminate. Switch power off for 20 seconds and switch it back on.

   Check IC7 reference voltages pin3 = 1.6V and pin 5 = 5V

4. Connect J2/J3 on MPU

   Select 63kV/10mA, take an exposure and check the current wave form for tube head from J3/5 (HPI) with a current probe.

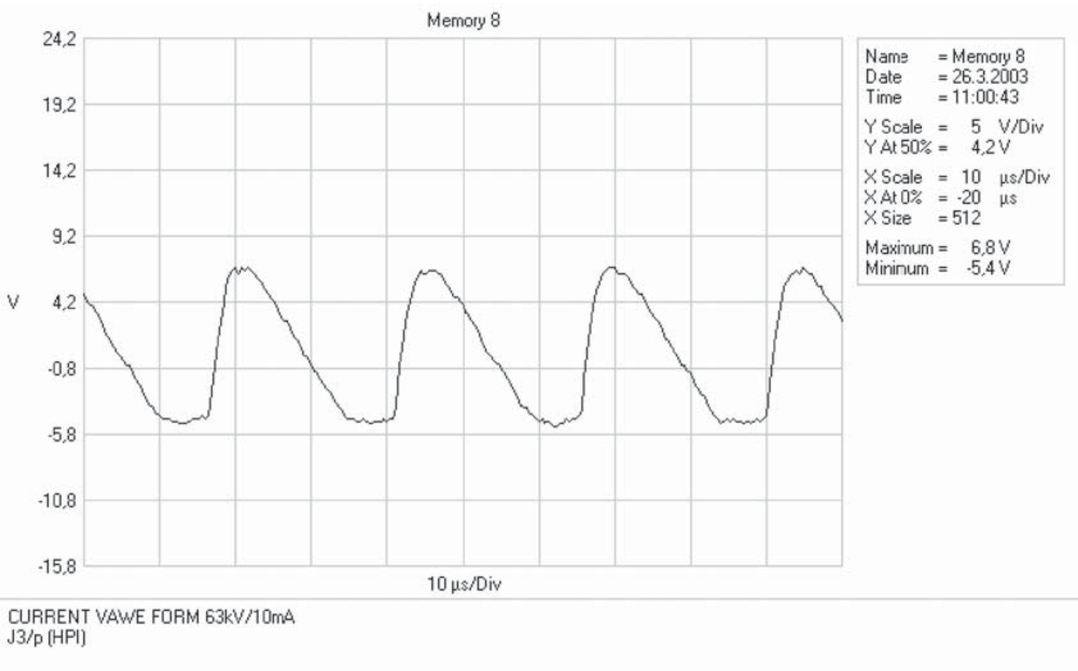



fig 6

Current Wave form with 81kV/10mA

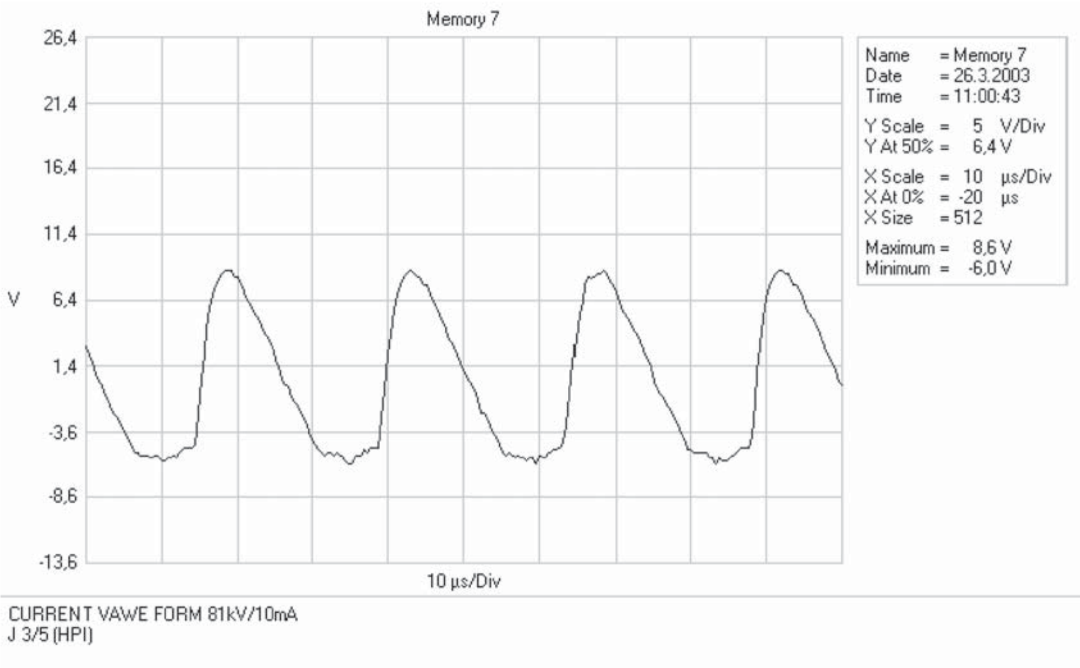



fig 7

5. Make an exposure and check the voltage across regulator transistors

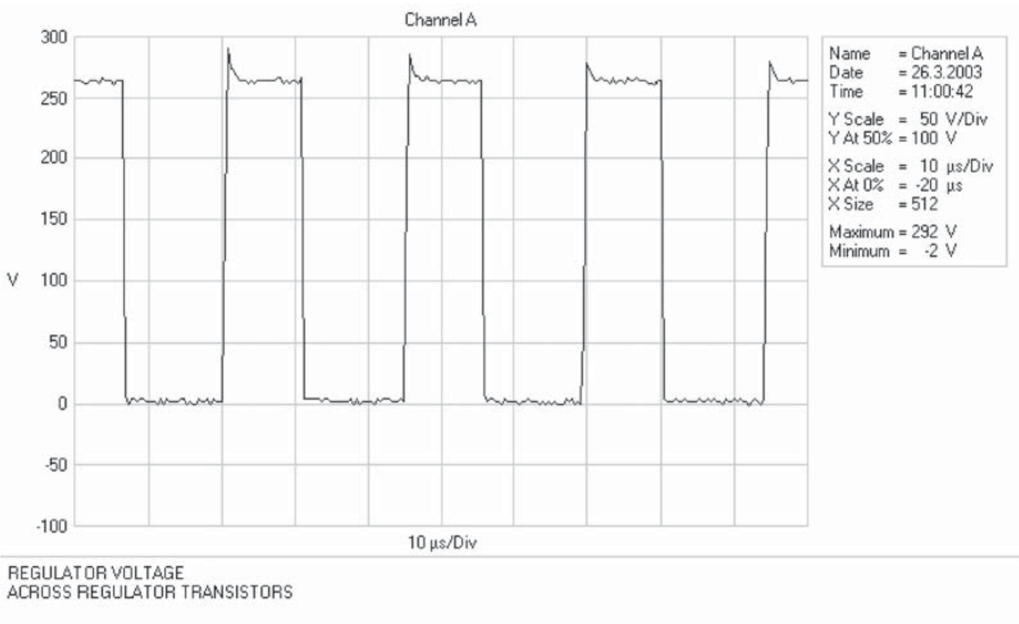



fig 8

6. Make an exposure and check the voltage across inverter transistors

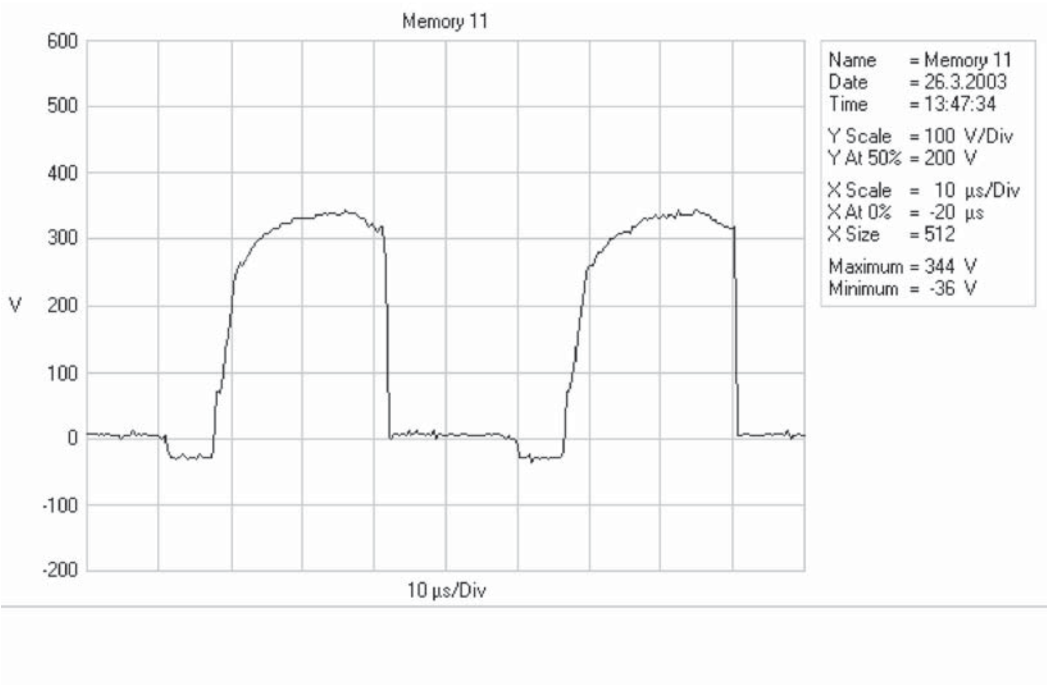



fig 9

7. Make an exposure and measure regulator voltage (across C13)

   63kV/10mA = approximately 145V

   81kV/10mA = approximately 180V

# 21 Aligning procedures

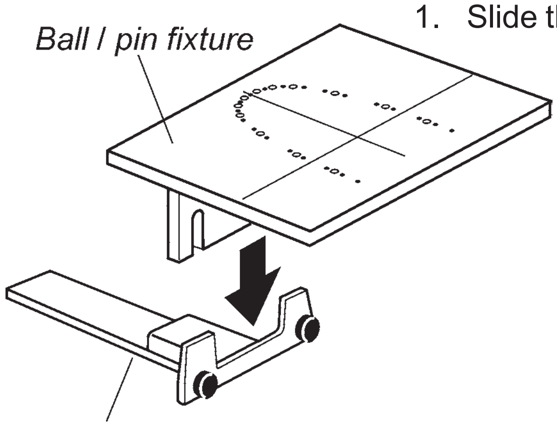
The procedures in this section describe how to identify and correct operating and image quality problems.

## 21.1 Taking a ball/pin exposure

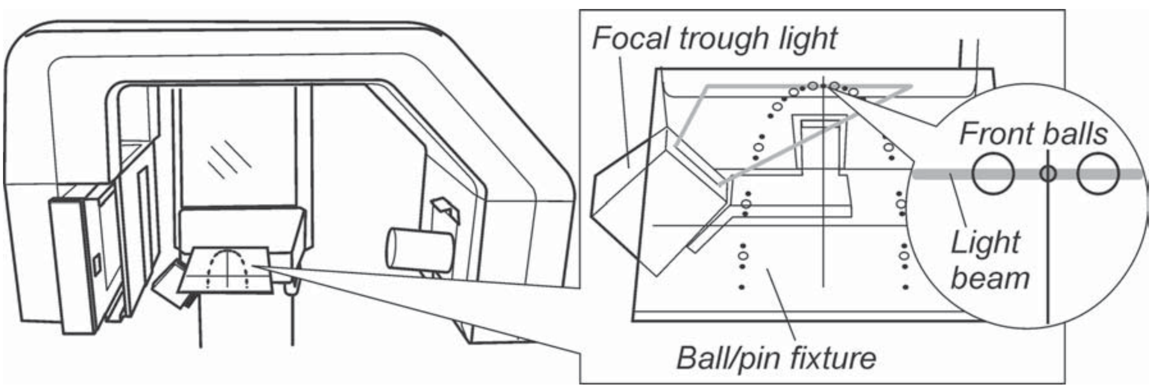
The first step towards correcting image quality and/ or operating problems is to take a ball/pin exposure. From the size and shape of the balls and pins on the image, alignment and operating problems can be identified and then corrected.

**Taking a ball/pin exposure**

1. Slide the ball/pin fixture in the lower shelf.



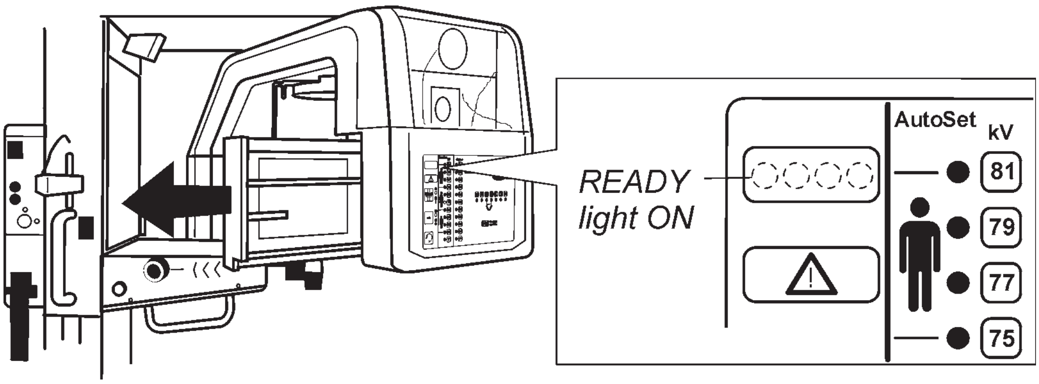

2. Switch the positioning lights on and position the focal trough light beam so that it is on the middle of the two front balls.



**Cassette versions:**

3. Insert into the cassette carriage a cassette loaded with film and its sheet of backing paper (the film must be placed on the side of the cassette with the L/R marks), or a cassette with an imaging plate.

4. Press the return key to drive the unit to the ready position. Select exposure values of 63 kV, 6 mA with spinal compensation off. Slide the cassette carriage to the left until the READY light comes on.




**DM digital versions:**

> **! Refer to the documentation supplied with DfW software**

3 Open DfW and open a new patient card.

4. Press the RETURN key to drive the rotating unit to the start position.
The READY light and 65 kV light will come on.

**DS digital versions:**

> **! Refer to the documentation supplied with the imaging software**

3. Open the CDR program. When the program is running open a “New Exam”. This will activate the CCD sensor in the unit so that an exposure can be taken.
Refer to the “User’s Guide” supplied with the CDRPan software for information on how to do this.

4. Press the return key to drive the unit to the ready position. Select exposure values of 75 kV, 6 mA with spinal compensation off.
   Slide the cassette carriage to the left until the ready light on the unit control panel starts to flash. This indicates that an exposure can be taken.

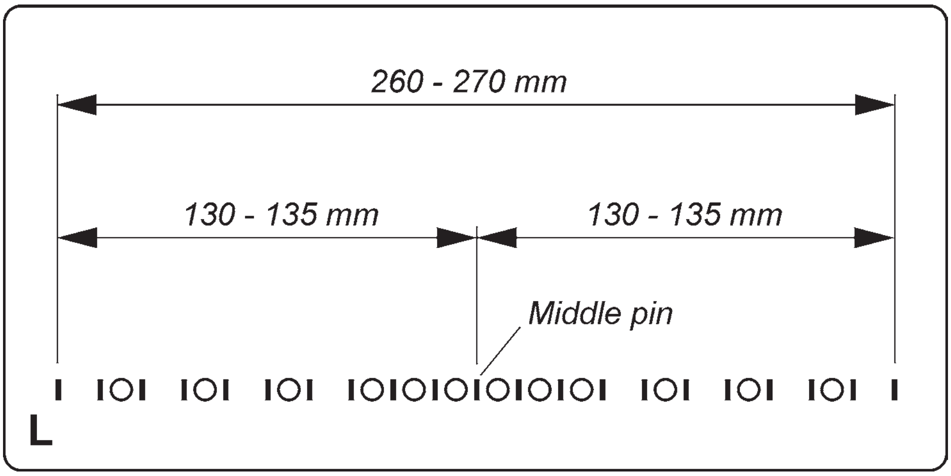

5. Protect yourself from radiation and take an exposure.

6. Process the film and examine the image.
   With imaging plates scan the image and then open the image and examine it using the dental imaging software that is being used.
   With digital versions of the unit, use the dental imaging software being used to examine the image.

## 21.2 Analysing the ball/pin image

### The correct shape image

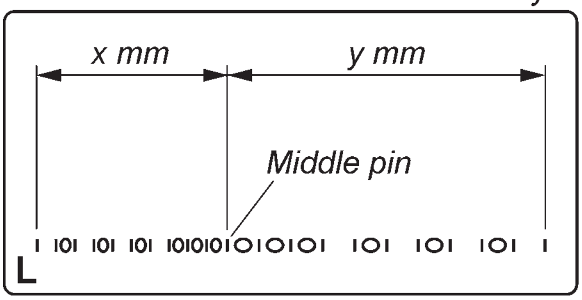
If the unit is set-up, aligned and operating correctly, the distance between the two outermost pins of the ball and pin image will be between 260 - 270 mm. In addition, the distances from the middle pin to the left and right outermost pins will be equal (withinn 3mm) and between 130 - 135 mm. The balls will also be round and not oval.

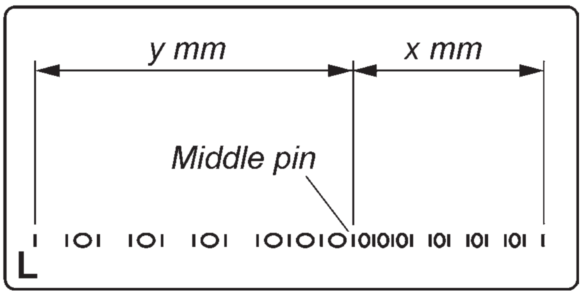



### Image length correct, but image not symmetrical

If the length of the image is correct but the two sides of the image are not the same length (the image is not symmetrical) it indicates that the unit is not vertical.

*Not symmetrical*



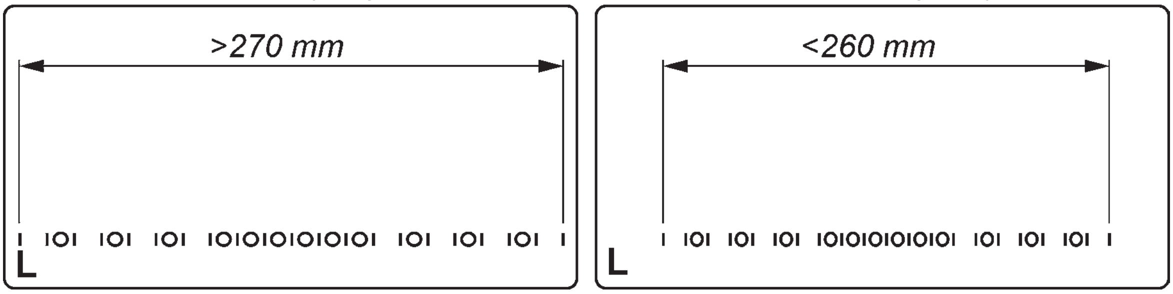




To adjust the unit so that it is vertical see “Adjusting the symmetry of the image” in the Installation Manual.

## Image too long or too short (Cassette versions only)

If the image is too long (above 270 mm) or too short (below 260 mm), it indicates that the cassette carriage is moving either too fast or too slow.

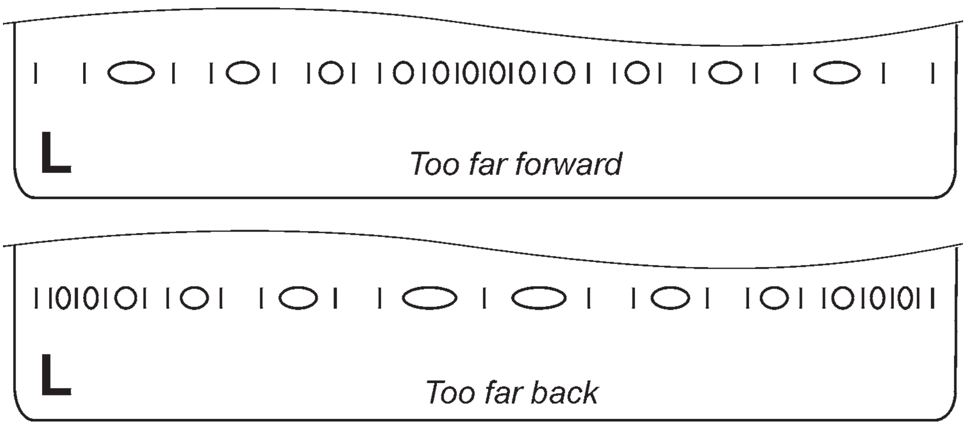
*Too wide (fast)* *Too narrow (slow)*




To adjust the speed of the cassette carriage see “Adjusting the length of the image” in the installation manual.

## The middle balls are not the same shape as the side balls

If the images of the balls in the middle of the exposure are a different oval shape to the balls at the sides, this indicates that the focal trough is not correctly positioned.




To adjust the position of the focal trough see “Checking the position of the focal trough” in the Installation Manual.

## The shape of the balls are not the same on both sides

If the images of the balls on one side of the exposure are a different oval shape to the balls on the side, it indicates that the centre of rotation is not correctly positioned.



To adjust the centre of rotation see “Checking and adjusting the centre of rotation” in the Installation manual.

# 22 Replacing parts

**CAUTION**
Switch the unit off before repairing or replacing any parts or circuit boards. All recognised safety procedures should be followed, including power off.

## 22.1 Replacing the Mains Power Unit (MPU)

The MPU is removed by removing the screws (one in each corner). The connectors should be removed by pressing the release buttons and pulling apart. The ground wires should also be removed. Reinstallation is performed by reversing this procedure.
After the MPU has been installed the following procedure MUST be carried out:

a. Check the power line connection

b. kV-mA calibration procedure.

## 22.2 Replacing the Pulse Logic Unit (PLU).

The connectors should be removed from the circuit board after removal of the four nut pins that hold it in place. Caution is advised in the replacement of covers to prevent jamming of selector switches and pinching of wires.
After the PLU has been installed the following procedure MUST be carried out:

a kV-mA calibration procedure.

b Backup timer confirmation.

## 22.3 Replacing the Partial Exposure Controller (PEC)

The exposure controller can be removed by detached the control panel, opening the connectors and finger nuts. If the controller is broken it could be temporarily taken off when IC10 in the PEC is transferred to the IC8 socket in the PLU and the motor connectors are connected to the PLU. The functions of the PEC procedure must be checked after replacement.

## 22.4 Replacing the Front panel board

Make sure that the default mA is set (Jumper).

## 22.5 Replacing the kV and Time Selector

Check the reference voltages. Refer to kV/mA calibration.
Calibrate the autoset kV.

## 22.6 Replacing the Power Switching Unit (PSU)

The power switching unit should be removed by unfastening the screws from the metal chassis. Care should be taken to observe the polarity of the ribbon connectors. All AMP connectors should be inspected after replacement to prevent pushed out pins from causing accidental failure. Ground wires must also be removed and replaced. Failure to replace ground wires here, or on the tube head, may cause external arcing.
After the PSU has been installed the following procedure MUST be carried out:

a kV-mA calibration procedure.

## 22.7 Replacing the Tube Head Assembly

The following special tools are required for electrical and mechanical checks when the tube head is changed:

- DVM
- Alignment spike
- Panoramic fluorescent screen
- Ball and pin phantom

**CAUTION**
Protect your self from radiation when taking test exposures.

1. Turn the power off. Install the transportation pin into the counterweight. Disconnect the connector and the ground wires from the tube head.
2. Remove the tube head covers. Mark the position of the THA and then remove the tube head by unscrewing two 13 mm nuts that hold the tube head to the rotating unit.
3. Remove the beam collimator from the old tube head and attach it to the replacement tube head.
4. Install the new tube head and covers on the rotational drive unit casting. Finger tighten the M13 mounting nuts.
5. Reconnect the connectors and ground wires. Check for pushed out pins.
6. Calibrate the tube head, see “kV/mA calibration procedure” for information on how to do this.
7. Turn the rotating unit parallel to the wall. Install the fluorescent screen and an empty cassette.
8. Remove the head holder and screw the alignment spike into the center hole.

9. Select 71 kV, 10 mA, compensation OFF and turn the TA switch on the PLU to the up position.

10. Remove the primary slit from the beam collimator.

11. Take an expose and adjust the focal trough adjustment so that the image of the alignment spike is in the center of the fluorescent screen.

13. Turn the rotating unit 180 degrees. Make sure that the Y-movement stays the same. Take a second exposure. The image of the alignment spike shadow may be offset on the fluorescent screen.

14. Adjust for half of the offset by moving the tube head towards the error. Adjust the other half by adjusting the focal trough.

15. Turn the rotating unit 180 degrees and verify the adjustment. Repeat if necessary. The focal spot rotation centre and secondary slot are now on the same center line.

16. Tighten the tube head securing screws and replace the primary slit to the beam collimator.

17. Remove the alignment spike.

18. Replace the primary slit. Adjust the beam collimator. See “Checking the position of the panoramic beam” in the Installation Manual.

19. Remove fluorescent screen and push the TA switch to the down position.

20. Carry out a ball and pin test to check the alignment. See section 7 “Aligning Procedures” in this manual.

21. Replace covers.

## 22.8 Replacing the Cephalometric Tube Head

When replacing the cephalometric tube head follow the same procedure as used when changing the panorama tube head.

After the cephalometric tube head has been replaced the following procedure MUST be carried out:

a kV-mA calibration procedure.

b Cephalometric beam alignment test. See section “Aligning the cephalostat” in the Cranex Installation Manual.

## 22.9 Replacing the Position Display Assembly

The display board can be replaced by removing the top cover from the lower shelf.
After the board has been replaced, the position display must be reset.
See section 20: Testing, Calibrating and Adjusting - Calibrating the positioning display, in this manual.

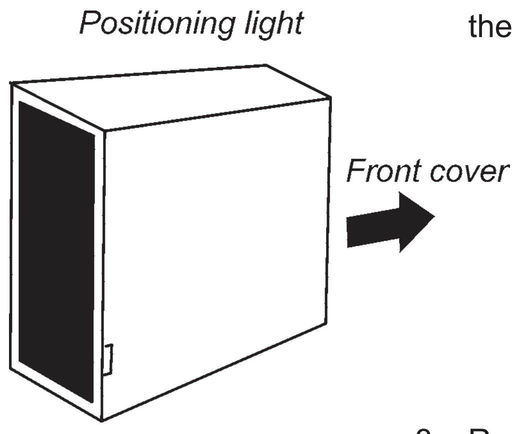
## 22.10 Replacing Z-Driver Unit Board (Excel units only)

The driver board can be detached by removing the bottom cover from the lower shelf of the z-carriage and removing the connectors. The vertical movement speed adjustment procedure must be completed after replacement. See section 20: Testing, Calibrating and Adjusting - Adjusting the up/down speed (z-driver).

## 22.11 Replacing positioning light bulbs

1. Switch the power off

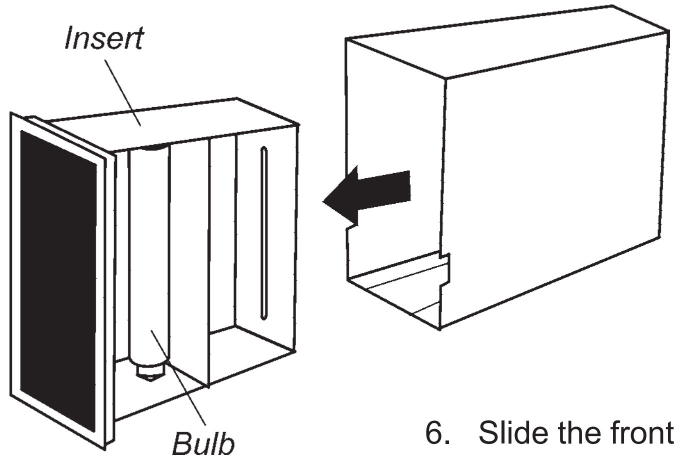
2. Pry the front cover off of the light with a small screwdriver.
   NOTE. Handle the light insert carefully, so that the position of apertures do not move.




3. Remove the blown light bulb and insert the the new bulb into the bulb holder.

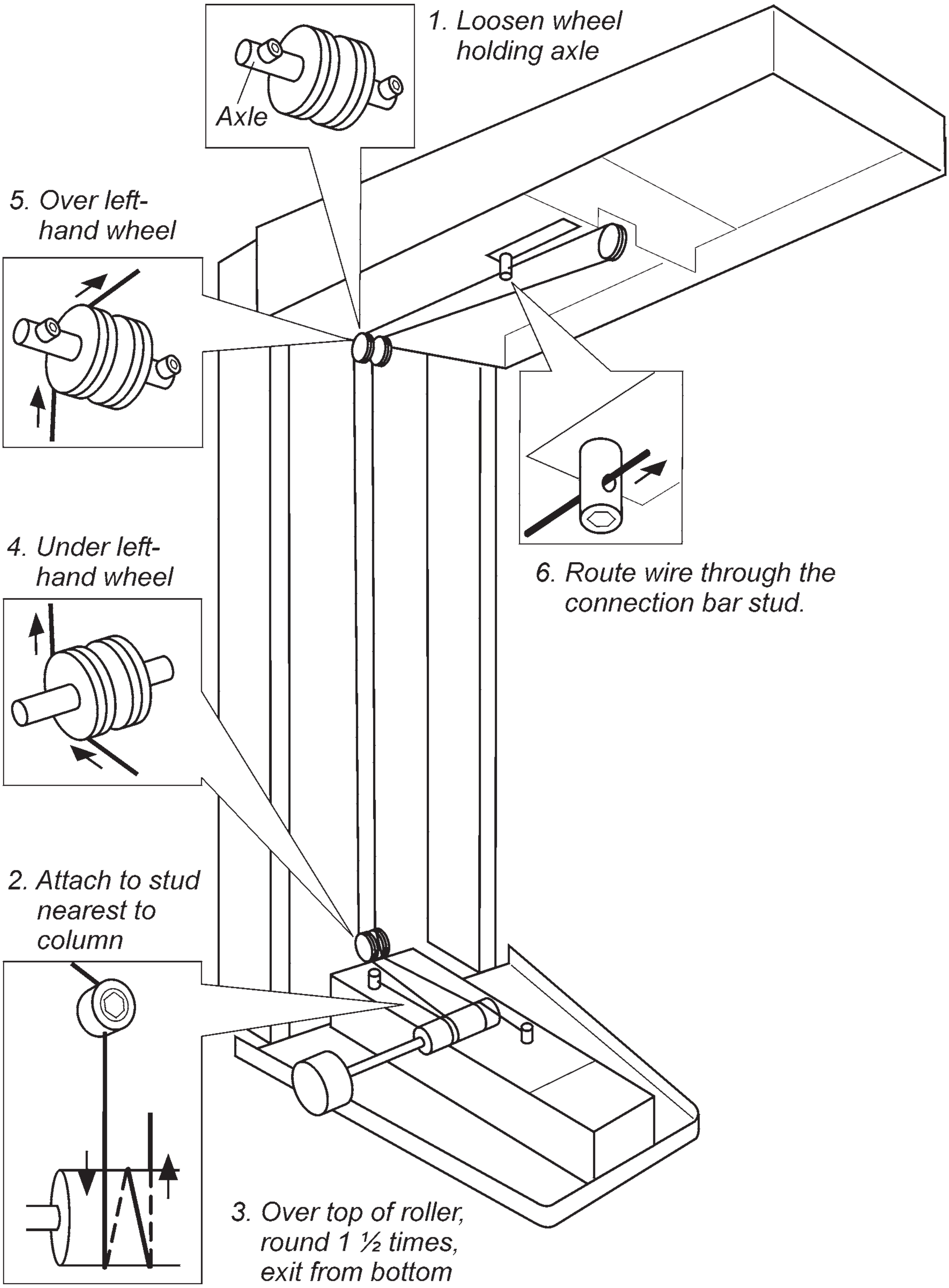
4. Switch the power on. Make sure that light insert is not grounded by the metal covers. Switch on the positioning lights.

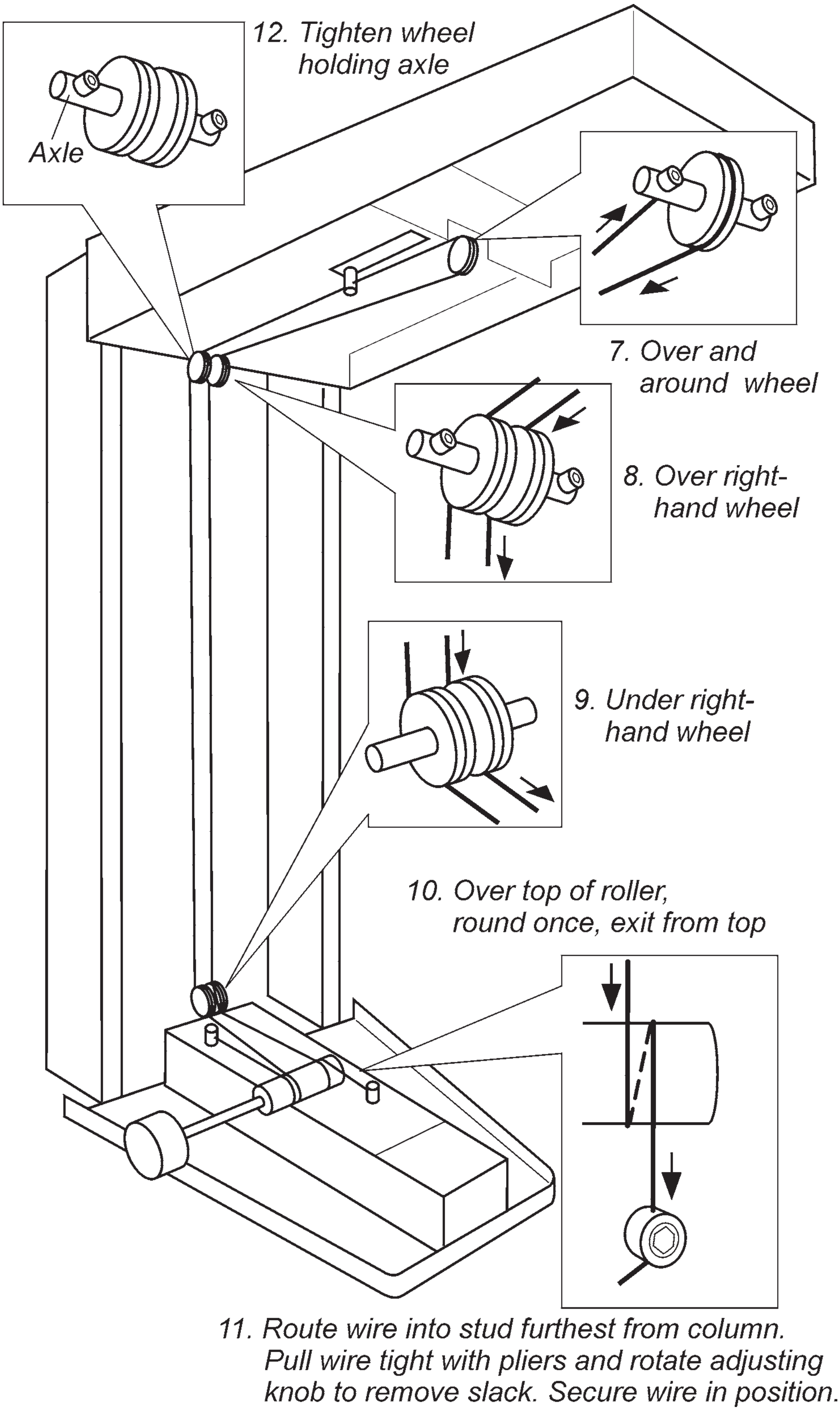
5. Rotate the bulb in its holder until the light is the brightest and sharpest.




6. Slide the front cover back onto the light..

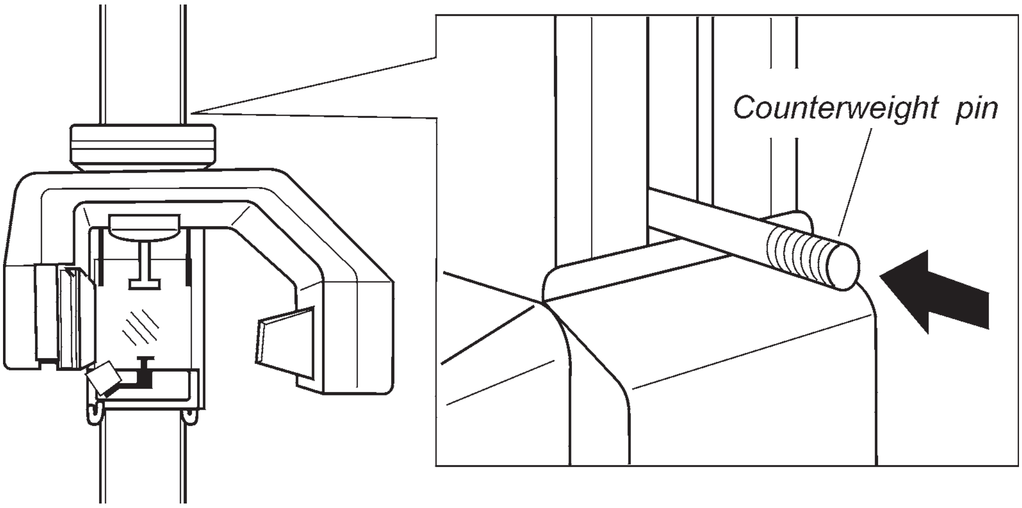
## 22.12 Replacing the Focal Trough Cable



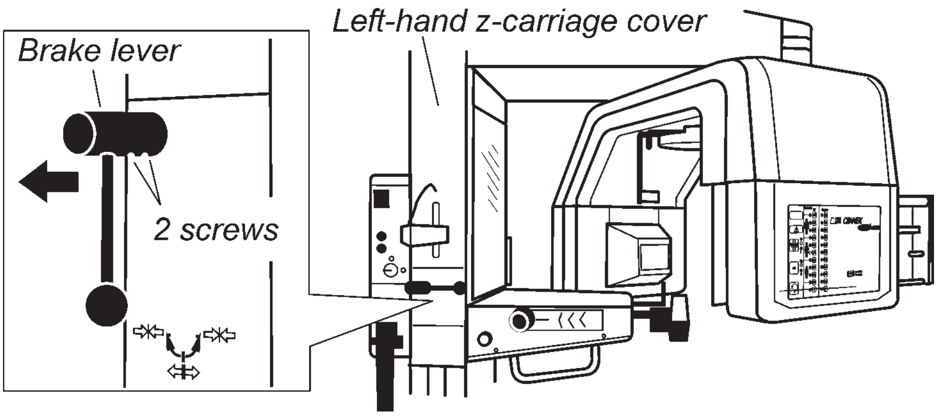

12. Tighten wheel holding axle
Axle
7. Over and around wheel
8. Over right-hand wheel
9. Under right-hand wheel
10. Over top of roller, round once, exit from top
11. Route wire into stud furthest from column. Pull wire tight with pliers and rotate adjusting knob to remove slack. Secure wire in position.

## 22.13 Replacing z-carriage brake pads (BaseX Only)

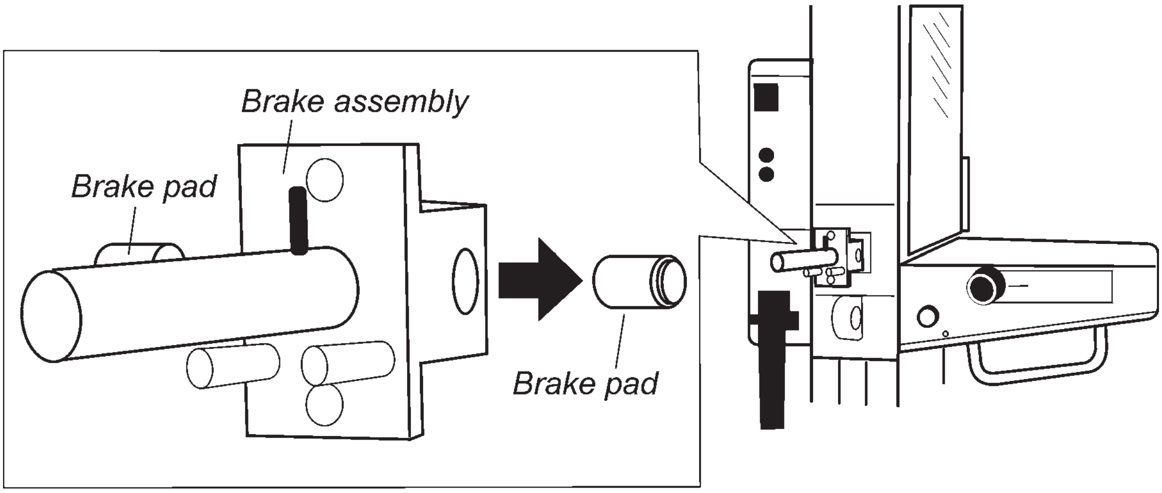
1. Lock the counter weight in place with counter-weight pin.




2. Turn the brake Iver to the downwards position to release the brake. Remove the brake lever and then the cover from the left-hand side of the z-carriage.



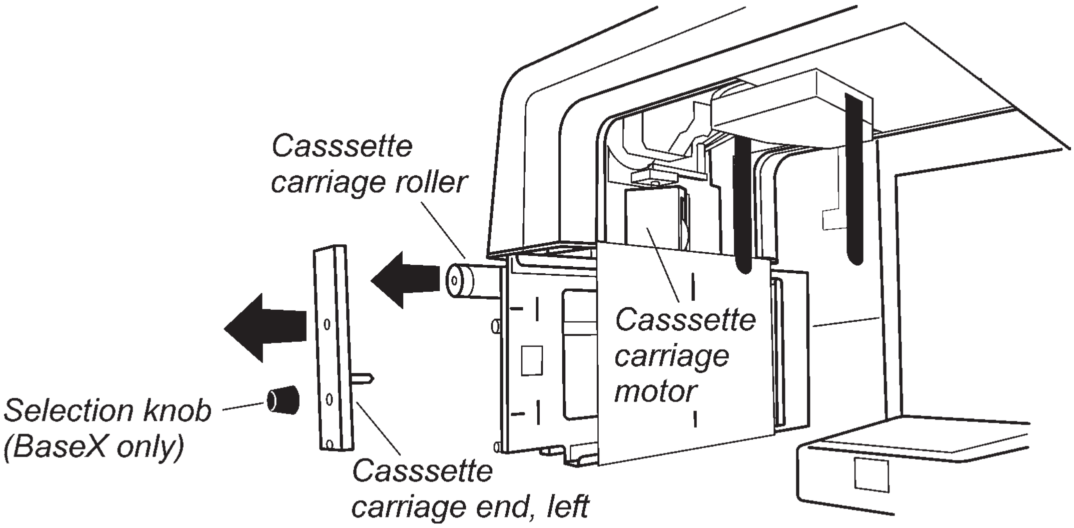
3. Remove the brake assembly and slide out the brake pads and replace them with new ones




4. Reassemble in reverse order

## 22.14 Replacing the cassette carriage roller.

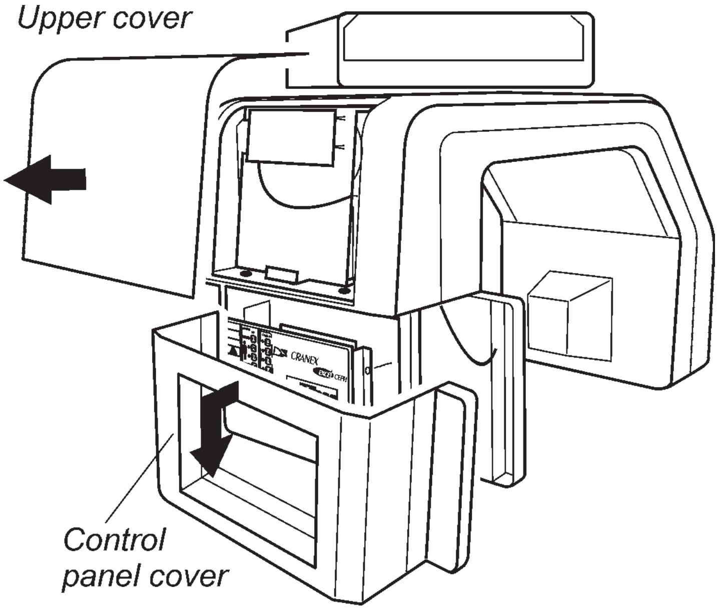
1. Remove the left-hand cassette carriage end. (If it is a BaseX unit remove the adult/child selection knob first)
2. Lift the cassette carriage motor up slightly, and then side out the cassette carriage roller.
3. Pull out the cassette drive shaft.



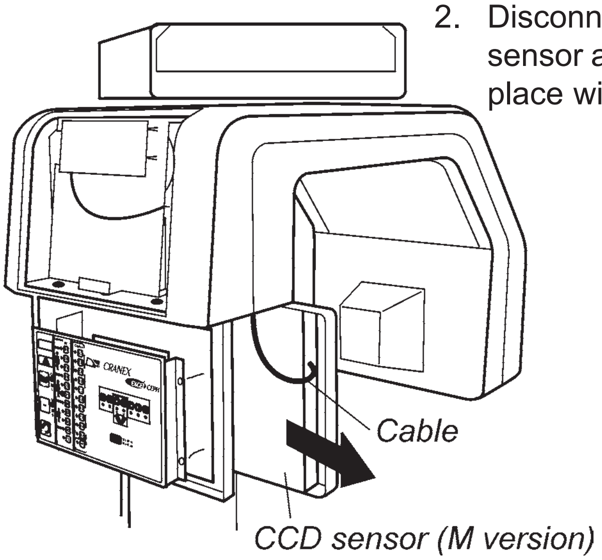

4. Insert the new cassette carriage roller.
5. Replace the cassette carriage end. (If the unit is a BaseX also replace the selection knob.

## 22.15 Replacing the CCD sensor - DM version

1. Remove the upper cover and the control panel cover from the rotating unit.




2. Disconnect the cable from the side of the CCD sensor and then remove the sensor. It is held in place with four (4) screws.

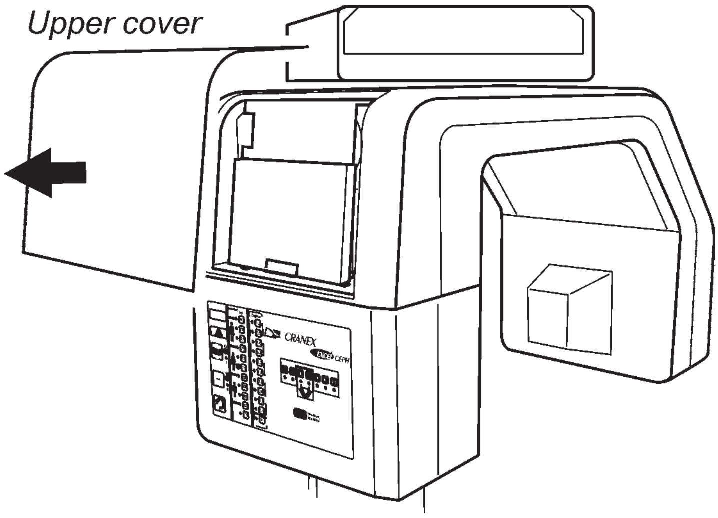



3. Install the new CCD sensor, reconnect the cable and then replace the covers.

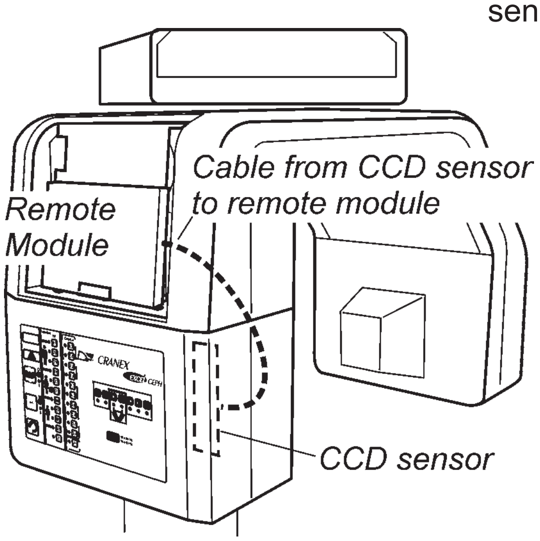
4. Calibrate the new CCD sensor and then check the beam alignment. Refer to the DM installation appendix

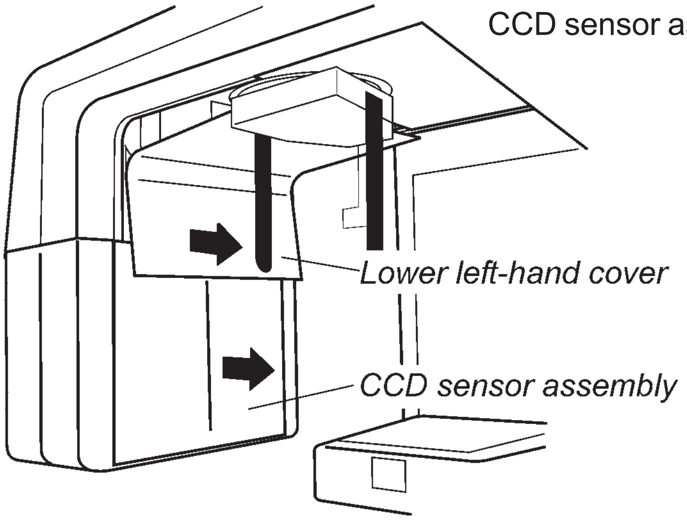
## 22.16 Replacing the CCD sensor - DS version

1. Remove the upper cover from the rotating unit.

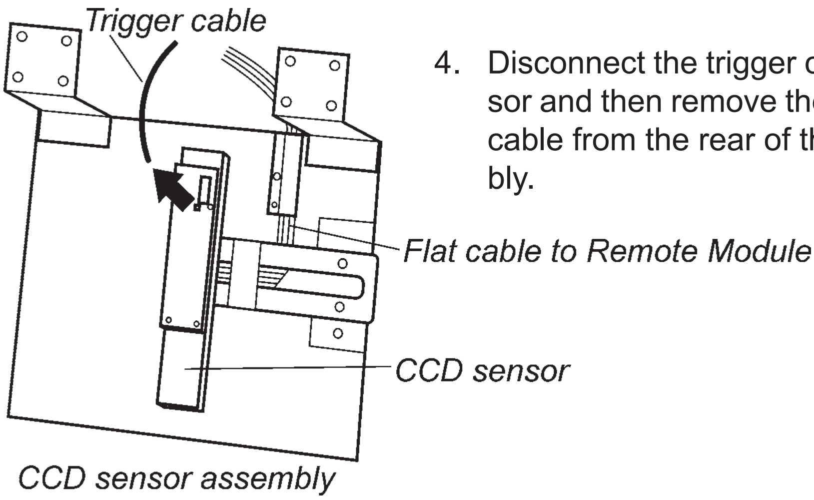



2. Disconnect the cable, that goes to the CCD sensor, from the remote module.






3. Remove the lower left-hand cover and then the CCD sensor assembly.




4. Disconnect the trigger cable from the CCD sensor and then remove the CCD sensor and flat cable from the rear of the CCD sensor assembly.

5. Attach a new CCD sensor to the rear of the CCD sensor assembly. Route the flat cable through the unit and connect it to the remote module. Reconnect the trigger cable to the CCD sensor.

6. Reattach the CCD assembly to the unit. Calibrate the new CCD sensor and then check the beam alignment. Refer to the DS installation appendix. Replace all the covers.

# 23 Yearly check

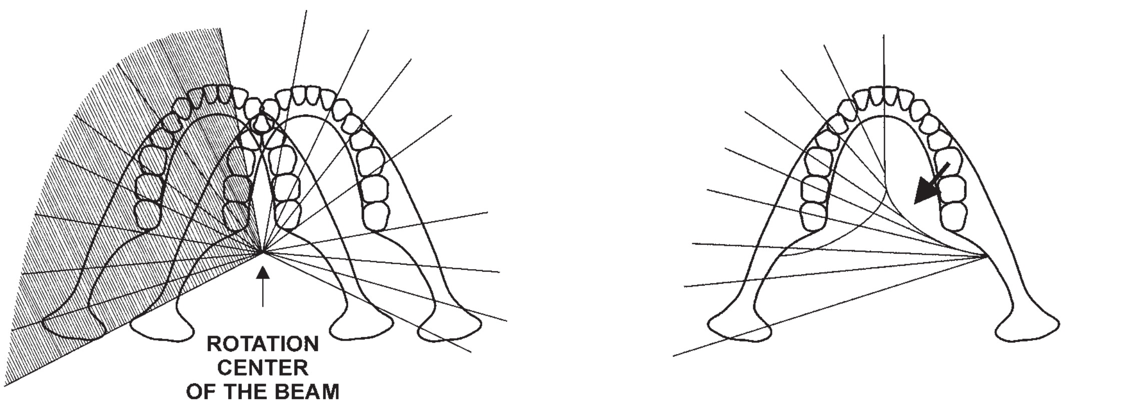
Once a year an authorized service technician must carry out a full inspection of the unit.
During the inspection the following test and checks MUST be carried out:

- a kV/mA test
- a ceph exposure time test (ceph units only)
- a beam alignment test
- a ball/pin test
- a check to see that the safety ground is connected
- a check to see that the positioning lights operate
- a check to see that the tube head is not leaking
- a check to see that the cassette carriage roller is not worn or damaged (cassette versions only)
- a check to see that all covers and mechanical parts are correctly secured and have not come loose.

# 24 Theory of operation

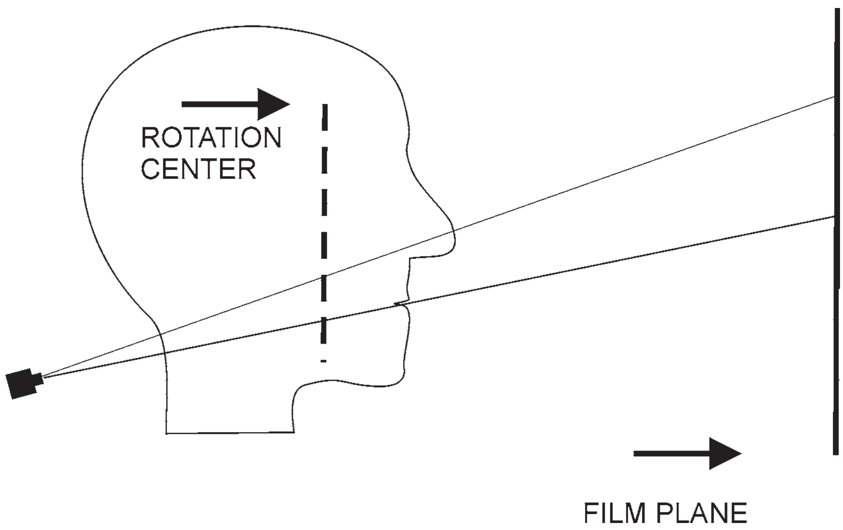
## 24.1 Working principles of narrow beam rotational radiology

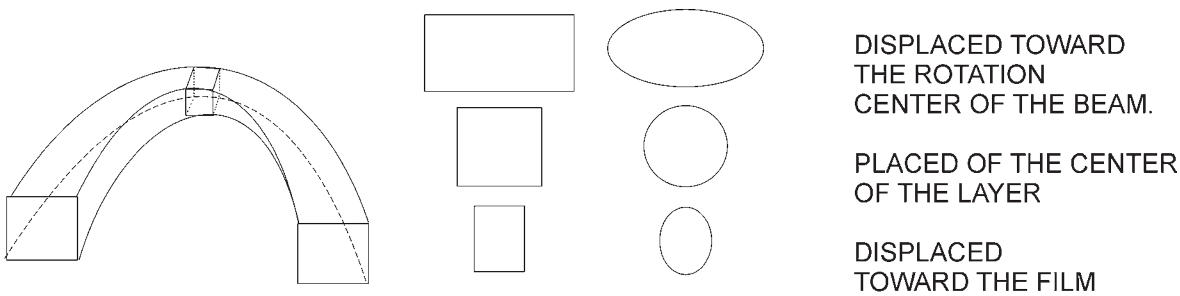
Rotational panoramic radiography is a specific radiographic projection technique which utilizes a narrow beam of X-rays to image a curved layer. The simplest projection technique applied in practice utilizes one stationary rotation center placed at one side of the jaws projecting the other side onto the film. One side of the jaws is exposed at a time, and the position of the rotation center (the functional focus of the projection) is shifted symmetrically between exposures by moving the patient. This projection technique creates what is called a SPLIT IMAGE. In Cranex systems, to create continuous images, several different movement patterns of the beam are utilized to achieve the desired projection of the jaws. The objective is to project each part of the jaws as close to perpendicular as possible. The beam may be given a sliding movement throughout the total excursion so that the effective projection center (the functional focus) is continuously shifted along a defined path. The central ray of the beam is always tangential to this path at some point. The form of the path defines the direction of the beam and hence the projection of each successive part of the jaws.




FIRST POSITION SECOND POSITION PATH OF THE SLIDING ROTATION CENTER

The position and form of the layer is independent of the movement patterns of the beam discussed previously. These movement patterns serve only to define the projection of the object, the jaws. Starting from any of possible beam movement patterns, the image layer may be given any desired form and position by matching the film speed at each moment during the exposure to the speed of the moving shadows of object points in the center of the desired layer. In the horizontal plane, the plane of rotation, the rotation center serves as the functional focus of the projection. The image is registered successively on the moving film as the beam scans the object. In the vertical dimension, the tube target serves as the focus of the projection. The fact that the projections in the horizontal and vertical directions have different foci causes distortion effects that are characteristic of rotational panoramic radiography.



At the center of the layer, the magnification factors in the horizontal and vertical directions are equal. This implies that a small flat object positioned at the center of the layer will be portrayed in proper proportion. Outside the center of the layer, the magnification factors in these two dimensions will be unequal. This results in distortion effects. If three planes are cut out from the layer at different object depths, the images of objects in these planes will exhibit different proportions. The plane at the center of the layer is correctly depicted. The plane positioned toward the rotation center of the beam will be magnified more in the horizontal than in the vertical dimension, and will appear too wide. The plane positioned toward the film will be diminished more in the horizontal than in the vertical dimension and will appear too narrow. The preceding considerations imply that teeth positioned between the center of the layer and the film appear narrow. This indicates that the patient has been positioned too far forward during the exposure. Similarly, teeth positioned between the center of the layer and the rotation center of the beam appear wide. This indicates that the patient has been positioned too far back during the exposure.

UNSHARPNESS

The film is given a speed which matches the projected speed of points lying in a selected curved plane. As a result, these points will be sharply depicted on the film. The projection of object points outside the sharply depicted plane, either toward the rotation center of the beam or toward the film, will have a different projected speed at the film plane than the film itself. As a result, the projection of these points will move in relation to the film and will appear blurred. Since the difference between the speed of the film and the speed of the of the points in the object will increase with the distance from the sharply

depicted object plane, the unsharpness increases in both directions from this plane. At some distance the unsharpness will reach a level where an object point is no longer perceptible in the image. In this way a zone in the object may be defined which contains those object points which are depicted with sufficient resolution that they may be distinguished. This zone is referred to as the image layer. Preferably, the layer thickness in rotational panoramic radiography should be great enough that the whole depth of the jaws, which in themselves constitute a layer, would be sharply depicted in the image. In practice this condition is never realized. Especially in the anterior region of continuous images the layer is so narrow that the positioning of the patient is critical.
Unsharpness in this region, lowering the diagnostic information, is a frequent experience in clinical work with rotational panoramic radiography. Thus, while the
unsharpness may be disturbing, it is usually not great enough to conceal large object details.
However, it may happen that a malpositioned tooth may be difficult or impossible to detect in the image if it is positioned toward the rotation center of the beam and at a great distance from the center of the layer. Unsharpness alone does not cause this effect in the image. The extreme magnification of objects displaced toward the rotation center is also a contributing factor. The tooth in this case is so greatly magnified in the horizontal dimension that the resulting image has a lower contrast relative to the surrounding structures than it would have had without the magnification. The tooth will be concealed due to the combined effects of distortion and unsharpness. The unsharpness and distortion effects are important criteria when evaluating panoramic radiographs. The fact that the teeth in a certain region appear too broad as compared to their length indicates, together with unsharpness, that this region has been malpositioned toward the rotation center of the beam during the

exposure. A narrowing of the teeth, on the other hand, together with the accompanying unsharpness, indicates that the region in question has been malpositioned toward the film during the exposure. This information is easily used to correct the patient's positioning when a retake is made. Generally, if there is no significant unsharpness and no significant distortion in a region of a panoramic radiograph, or in the whole radiograph, this indicates that the image is essentially reliable when evaluating the morphology of normal or pathological changed structures. Those measurements which may be relied upon, for instance angular measurements, may be performed on such a panoramic radiograph.

## 24.2 Quality Cephalometric Radiographs

Cephalometric analysis is the term used for evaluating growth or morphology on the basis of cephalometric tracing. The accuracy of the tracing depends on the quality of the film and the ability of the operator to locate the landmarks. For instance, if the patient's head is not exactly centered in the cephalostat, certain structures will appear on the cephalogram as double images. Accuracy and consistency of technique are essential, and are developed only through practice. To make a cephalometric tracing, a sheet of acetate paper is placed over the cephalometric film and is attached to the film along one edge with masking tape. Using a sharp pencil, the landmarks, soft tissue profile, planes, and angles are traced. The cephalogram should be traced on a view box in a room with reduced illumination to allow better visualization of indistinct landmarks. The organization of a cephalometric analysis requires that first the cephalometric landmarks be located and then that certain landmarks be joined into cephalometric planes. Once the planes are established, angles can be measured and compared with established norms.

## 24.3 X-ray principles

### Beam Quality

- Higher kV = harder beam.
- Higher kV = lower contrast , lower patient dose.
- 10 kV increase doubles radiation output.
- Changing mA does not change beam quality.
- Doubling mA doubles radiation output.
- More AL-filtration = harder beam.
- More AL-filtration = less radiation output.
- DC beam is harder than AC with the same filtration.
- Optimum contrast in panoramic use is acquired with 69-77 kV.

### Focal Spot

- A smaller focal spot produces sharper images.
- Size limited by thermal loading (kV, mA, Time).
- Actual focal spot up to 1.5 x nominal.
- Nominal focal spot measured in max. kV and half of mA.
- Instantaneous loading limits AC use.
- More mA =larger focal spot.
- Gauss distribution of intensity most favourable.

## Magnification

- Reduces scatter radiation.
- More magnification requires smaller focal spot.
- More magnification requires less resolution on screens.
- Constant magnification enables measurements (not in PAN).
- In panoramic radiograph TMJ’s must fit on a 30 cm film, which limits magnification.

# 25 Technical specifications

## Classification

Complies with IEC class I type B, IPX0
Complies with IEC 601-1, IEC 601-2-7 and EN 55011 standards
Group 1, class B
Complies with DHHS Radiation Performance Standard, 21CFR Subchapter J.

The unit must be installed in a protected clinical environment.

## Description

Dental panoramic and panoramic/cephalometric x-ray units with a high frequency switching mode x-ray generators. The panoramic version takes panoramic exposures. The panoramic/cephalometric version takes panoramic and cephalometric exposures and uses a dedicated x-ray source to take cephalometric exposures.

## Generator

TUBE
- OPX/105, DE 100/15 or equivalent

FOCAL SPOT
- 0.5 mm IEC 336

TARGET ANGLE
- 5º

TARGET MATERIAL
- Tungsten

OPERATING TUBE POTENTIAL
- Panoramic 63 - 81 kV (±5 kV) at preselected settings

OPERATING TUBE CURRENT
- 6 mA and 10 mA (±1 mA) at preselector,
  4.5 mA and 6 mA or 7.5 mA and 10 mA in compensation mode

MAXIMUM TUBE CURRENT
- 11 mA

MAXIMUM OUTPUT POWER
- 945 W nominal

FILTRATION
- minimum filtration 2.5 mm Al

BEAM QUALITY
- HVL over 2.5 mm Al at 81 kV

OUTER SHELL TEMPERATURE
- +50ºC (122ºF) maximum

DUTY CYCLE
- Panoramic: 1:15, 81 kV/10mA
- Cephalometric: 1:20, 81 kV/10mA

## Power requirements

INPUT VOLTAGE
- 175-250 VAC (±10%), 50/60 Hz, adjustable, single phase, grounded socket

MAXIMUM LINE CURRENT
- 7 A at 81 kV/10mA

MAXIMUM LINE RESISTANCE
- 1 ohm

MAXIMUM LINE FUSING
- 10 A slow (main fuse 8A slow in device)

LINE SAFETY SWITCH (when required)
- Approved type, min. 10 A 250 VAC

EARTH LEAKAGE CIRCUIT BREAKER (when required)
- Approved type, min. 16 A 250 VAC, breaker activation leakage current in accordance with local regulations.

## Mechanical parameters

PANORAMIC
- SID 520 mm (±10 mm)
- Magnification factor 1.3

CEPHALOMETRIC
- SID 1635 - 1700 mm ±20 mm
- SID, USA only, fixed 1700 mm ±20 mm
- SOD (Source object distance) 1500
- Magnification factor 1.09 - 1.13 (Non US unit, set during installation)
- Magnification factor, USA only, fixed 1.13

WEIGHT
- Panoramic unit 150 kg (330 lb.)
- Pan Ceph unit 195 kg (430 lb.)

DIMENSIONS
- Panoramic unit (HxWxD) 2240 x 1200 x 970 mm (88" x 47" x 38")
- Pan Ceph unit (HxWxD) 2240 x 1200 x 1850 mm (88" x 47" x 74")

VERTICAL HEIGHT OF CHIN REST
- 850-1700 mm (33"-67")

## Cassettes

PANORAMIC
- 15 x 30 cm (6" x 12") Optional 24 x 30 cm (10” x 12”) available

CEPHALOMETRIC
- 18 x 24 cm (8" x 10")
- optionally 24 x 30 cm

## Timer

PANORAMIC EXPOSURE TIMES:

| | 50 Hz | 60 Hz |
|---|---|---|
| Normal | 19 s (±15%) | 16 s (±15%) |
| Child | 17 s (±15%) | 14 s (±15%) |
| Sides | 11 s (±15%) | 9 s (±15%) |
| Middle | 10 s (±15%) | 8 s (±15%) |
| TMJ | 3.3 + 3.3 s (±15%) | 2.8 + 2.8 s (±15%) |
| | Max 240 mAs | Max 202 mAs |

CEPHALOMETRIC EXPOSURE TIMES:

- 0.4 - 3.2 s (±15%), ten steps in accordance with R’ 10, series (ISO)
- 4 mAs - 32 mAs nominal, maximum 40.4 mAs

BACK-UP TIME

- 23.5 s (±1.5s)

## Leakage technique factors

PANORAMIC

- 81 kV, 2400 mAs/h (81 kV, 10 mA, duty cycle 1:15)
  (One normal exposure per 4 minutes cool-down period)

CEPHALOMETRIC

- 81 kV, 1800 mAs/h (81 kV, 10 mA, duty cycle 1:20)
  (One 3.2 s exposure per 1 minute cool-down period)

## Measurement bases

- The kV is measured by monitoring the current flowing through a 450 Mohm, 1% feedback resistor connected between the tube anode and ground.

- The mA is measured by monitoring current in the HT return line, which equals the tube current.

- Both parameters are measured using a Soredex kV/mA meter (pt. no. 4800177) or with a digital multimeter (DMM) according to a specified procedure. The exposure time is measured using a radiation probe positioned in the primary beam.

## Cephalometric collimator

18 x 24 A or 24 x 18 A for lateral projection,
18 x 24 S for P.A. and A.P. projections
24 x 30 aperture optional

8" x 10" A or 10" x 8" A for lateral projections
8" x 10" S for A.P. and P.A. projections

Adjustable soft tissue filter for lateral projection

## Operating Room Temperature

- 15ºC (59ºF) to 32ºC (90ºF)

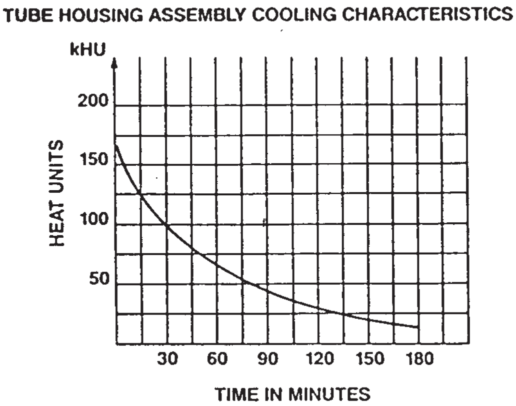
## Operating Relative Humidity Maximum

- 95%

## Storage/transportation

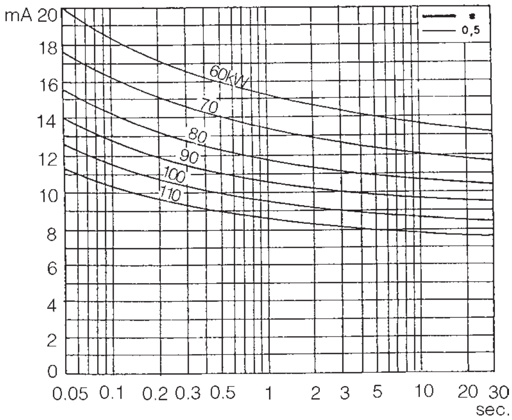
- +0 - +50ºC, 0 - 85 RH%, 500 - 1080 mbar

# Tube housing assembly cooling characteristics

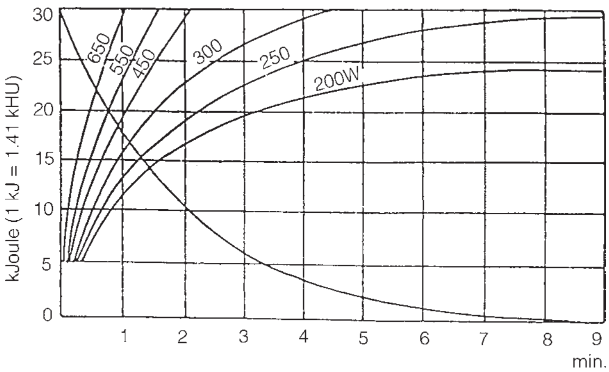


## Tube rating chart

## OPX/105

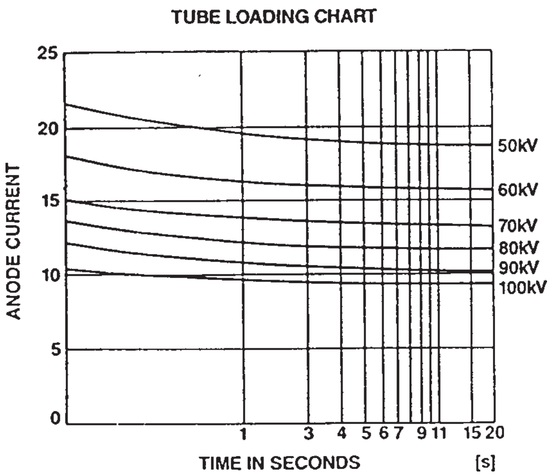



## Anode thermal characteristics

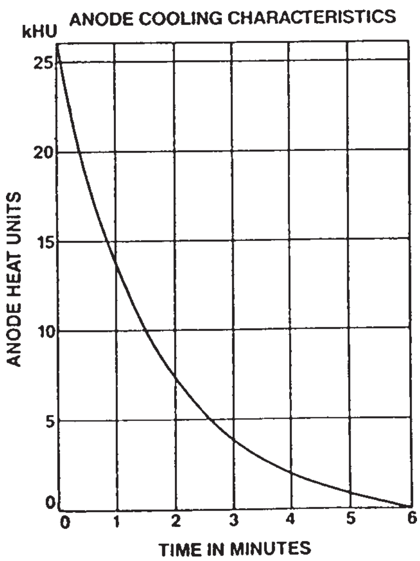



## Tube rating chart

## DE 100/15 ö




## Anode thermal characteristics



## Unit dimensions