Digora® fmx

Service Manual

CE
0537

Medical Device Directive

93/42/EEC

04 / 2003

Digora® fmx - Service Manual
Document code 8200823

Original approved English language version

Manufactured by SOREDEX
P.O. BOX 250
00031 HELSINKI, FINLAND
Tel. +358 010 394 820
Fax +358 9 701 5261

Soredex endeavours to produce product documentation that is accurate and up to date. However, our policy of continual product development may result in changes to products that are not reflected in the product documentation. Therefore, this document should not be regarded as an infallible guide to current product specifications. Soredex maintains the right to make changes and alterations without prior notice.

Contents

1. ABOUT THIS MANUAL

This manual describes how to service and maintain the Digora fmx intraoral imaging plate scanner.

Please read the warnings and precautions before starting to service or maintain the scanner.

Main Mechanical Assemblies

These assemblies are described in detail later in this manual.

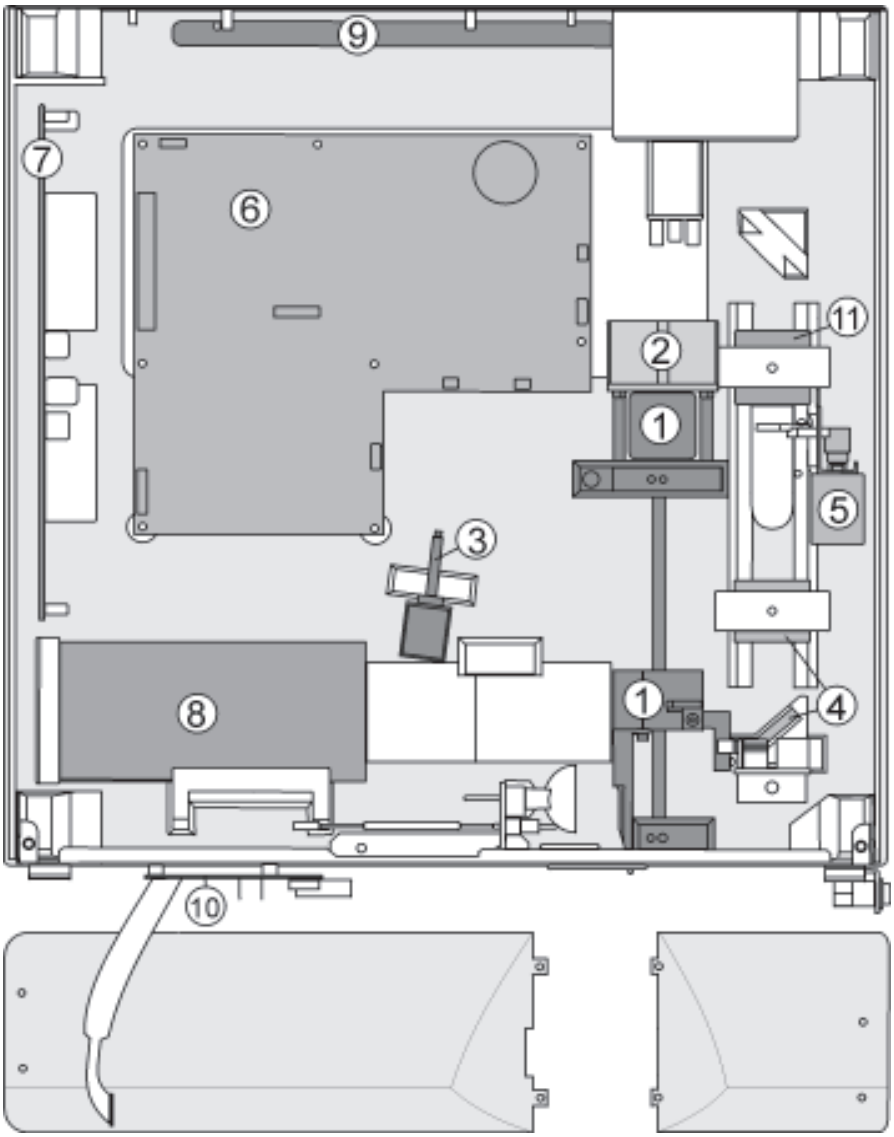


FIGURE 1-1

1 Transport Unit
2 Transport Motor
3 Galvanometer
4 Optical Component
5 Preread Lens Motor
6 Processor Board P4000
7 Stepper Drive and High Voltage Supply T4101
8 Photo Multiplier T4300
9 Main Power Supply T4400
10 Keys and Display Board T4501
11 Laser Diode Assembly

2. WARNINGS AND SYMBOLS

The safety of all the parties involved has been a major consideration during the design and development of the Digora system. Proper care, use and observance of all precautions will insure safe and reliable operation. Misuse, however, can result in damage to the equipment or serious danger to the service personnel, operator or patient.

2.1 Dangerous voltages

- in the mains switch assembly (line voltage) (1).
- in the mains power supply board T4400 (line voltage and its rectified peak value) (2).
- in the high voltage power supply for the photomultiplier tube on the T4100 board. There is a led which is lit when the high voltage is on (up to 1000 volts) (3).
- in the photomultiplier tube itself and its bias board T4300 (up to 900 volts) (4).
- in the wires and connectors between these parts. The parts carrying the lethal voltages are protected from unintentional touching but the protection does not totally prevent touching the high voltage power supply for the photomultiplier tube on the T4100 board (4). The lightning symbols for lethal voltage appear in the tab preventing direct access to the high voltage supply for the photomultiplier tube on the T4100 board.

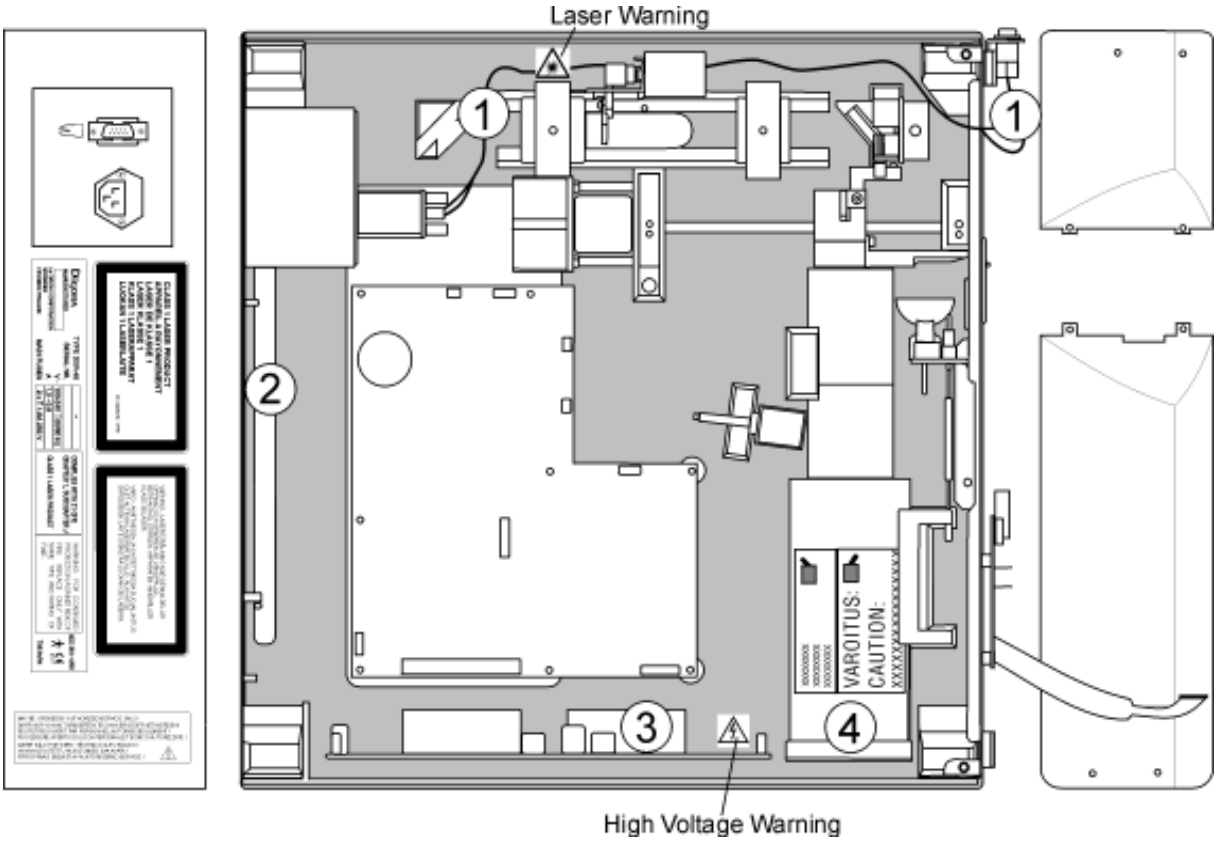


FIGURE 2 - 1

2.2 Laser radiation

WARNING!
Protective glasses must be used when servicing Digora!

WARNING!
Avoid exposure to beam!

The Digora scanner contains a laser. Externally the scanner meets the requirements for laser class 1, even if the scanner door is held open. When the scanner cover is removed, the scanner meet the requirements for laser class 3 B.

The laser tube has a nominal output power of 2 mW. The laser light wavelength is 635 nm.

2.3 Safety/service switch operation

Since a class 3B laser beam is harmful to eyes if viewed directly, the scanner has a combined safety/service switch. When the scanner cover is removed, the safety switch turns off the laser (and the photomultiplier tube high voltage supply) thus preventing unintentional exposure to laser radiation.

The switch is mechanically operated when the scanner cover is removed and replaced. For service purposes, the switch can be manually bypassed allowing the microprocessor to enable the laser and the photomultiplier tube high voltage supply. Manual bypass is mechanically overridden when the scanner cover is replaced.

Manual bypass is visually indicated by the switch position (lever down) and by the fact that the green LEDs on the processor board P4000 near the EPROM are all turned off.

When the safety/service switch is manually bypassed, the laser beam has access out of the scanner if it does not hit the imaging plate or imaging plate holder. The laser beam coming out of the scanner is harmful to eyes from distances of several meters.

If you have manually bypass the safety switch, make sure nobody is able to look at the beam.

If you have to look at the galvanometer to check if the laser beam is targeted to the centre of the mirror, use always proper protective blue glasses designed for the red laser light. Even with the protective glasses, do not look straight into the mirror. Look instead from the side to avoid getting the focused laser beam straight into your eyes.

2.4 Precautions with the imaging plates

This information is also found in the user manual.

For patient safety
The imaging plate must be sealed into a tight protective bag, because
- the plate requires protection against light and moisture
- the patient must be protected against contamination from other patients
- the active substance under the plastic coating of the plate is toxic.

Although an imaging plate is harder to swallow than intraoral dental film, never use imaging plates with patients that might swallow or chew the plate.

If the patient swallows the imaging plate, it must be immediately removed by a physician from the patients body. A swallowed plate will most likely be trapped in the esophagus.

If the patient bites or chews the plate so that the plate is damaged, the patient's mouth must be rinsed with a large volume of water and the plate must be discarded. If the patient manages to bite off some of the white substance and swallow it, a gastric lavage must be performed immediately.

Never place the imaging plate into the patient's mouth without enclosing it first into a tightly sealed protective bag. If you notice that the protective bag has leaked, discard the imaging plate.

Do not use cracked, chipped, bent, soaked or otherwise damaged imaging plates.

2.5 Weight of the scanner

The scanner weights 20 kilograms. Use caution when moving it to avoid hurting yourself.

2.6 Fragile components

Although the whole scanner is a precision optical measuring device, there are some components that are especially vulnerable:

- galvanometer tail: hits
- galvanometer mirror assembly: damage when moving the light guiding tube
- laser position, laser end mirrors: shocks, hits
- Photomultiplier tube: sensitive to bright ambient light if out of its metal tube or if high voltage is applied while the scanner cover has been removed
- Photomultiplier tube: fixing screws of the steel tube must be short enough to prevent damaging the PMT
- transport mechanism, optics: dust and dirt
- bending aluminium: screws fixing the galvanometer, the rotatable right angle mirror, the lift mechanism, the lens holders and the steel tube containing the photomultiplier tube

2.7 Responsibility

It is the responsibility of the owner to ensure that the system is operated only by properly trained, qualified personnel who have obtained credentials from local, state, and federal authorities where required.

If the system does not operate properly or fails to respond to the controls as described in the User's Manual, the owner should call the nearest manufacturer representative to troubleshoot and repair the system.

The owner must make certain that only properly trained, qualified service personnel undertake the installation, maintenance, calibration, and repair of the system.

Address questions and comments regarding safety to the appropriate Soredex Service Organization.

2.8 Unauthorized modifications

Unauthorized changes or modifications to any part of the system could have harazdous consequences. Changes or modifications must not be made unless specifically authorized by Soredex.

2.9 Symbols

ON (Power: Connection to the mains)

OFF (Power: Disconnection from the mains)

Alternating current

Protective earth (Ground)

Earth (Ground: functional)

DANGEROUS VOLTAGE

This is a classification symbol, for a type B applied part equipment, IEC-601-1

Interface Cable Connector

CE (0537) Symbol MDD 93/42/EEC

Action Button

Action Indicator

Power ON indicator "ON" only for a part of equipment

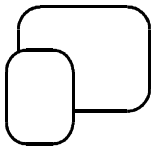
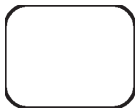


Image Size Selector



Normal Size Indicator

Small Size Indicator

LASER RADIATION

Attention, consult accompanying documents

UL Classification Symbol

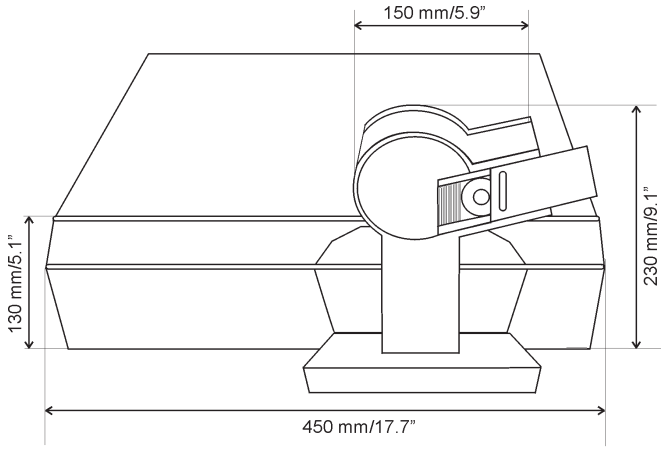
2.10 WARNINGS

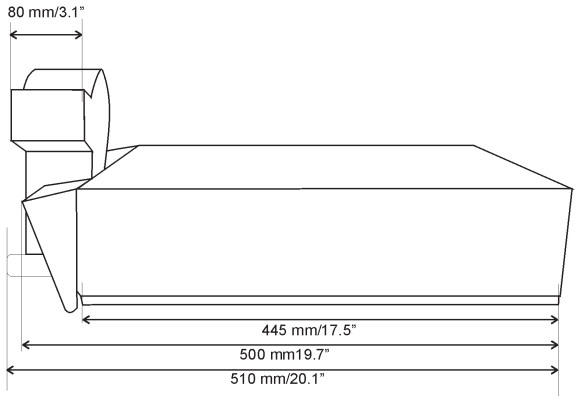
CLASS 1 LASER EQUIPMENT

DANGER: Any failure to follow the recommendations and instructions given in this manual may expose the user to laser radiation exceeding the class 1 specifications.

- This scanner must only be used to read image plates, supplied by the manufacturer and must not be used for any other purpose.
- This unit or its accessories must not be modified, altered or remanufactured in any way.
- Annual maintenance and repair can be performed by the manufactured authorized service personnel only.
- Only imaging plates and protective bags supplied by the manufacturer shall be used with the system.
- This device can interfere other devices due to its EMC.
- This device can be interfered by other devices due to the EMC.

2.11 DIMENSIONS (with optional Autoloader)





3. COVERS AND TYPE LABEL

3.1 Opening the covers

When removing the covers of the Digora scanner, first remove the cover in the middle that is held in place with magnets.

If the unit has a Autoloader, it must be removed prior to removing the top cover. To do that follow the instructions below.

1. Remove the Autoloader rear cover by removing M4 screw (1) at the rear.

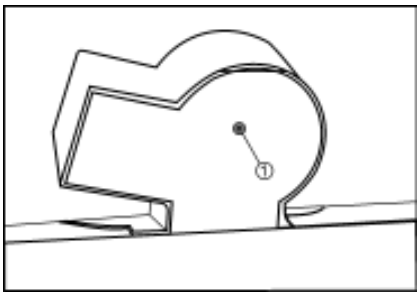


FIGURE 3 - 1: Removing rear covers

2. Remove the Autoloader front cover by removing the three M3 screws (1) (Figure 3-2) and one M4 screw (1) (Figure 3-3)

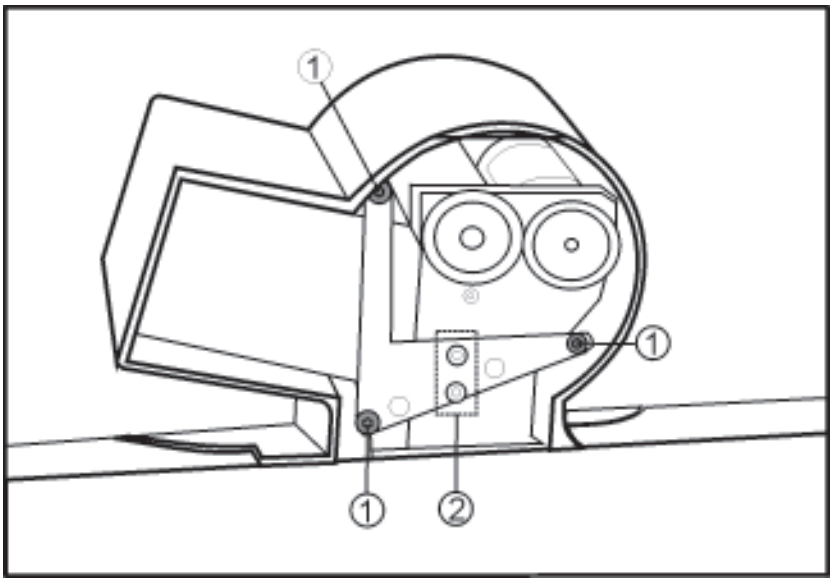


FIGURE 3 - 2: Removing front cover

1 Open the four M4 Allen screws (2) (Figure 3-3 and 3-4) of the scanner front panel.

2 Grip the front panel from the left hand side of it and push it to the left to release the two hidden supports holding the front panel in place. Repeat this to the other side of front panel.

3 Open the two M3 allen screws in the left hand side of the revealed scanner front panel and one in the right top corner.

4 Disconnect the Autoloader motor and microswitch from the T4501 pcb. Remove the autoloader by removing the two M4 screws (5) (Figure 3-3).

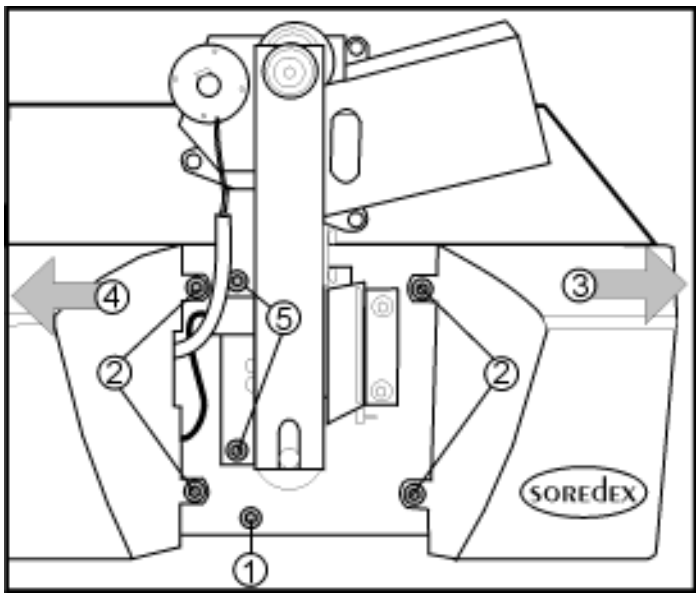


FIGURE 3 - 3: Opening front panels

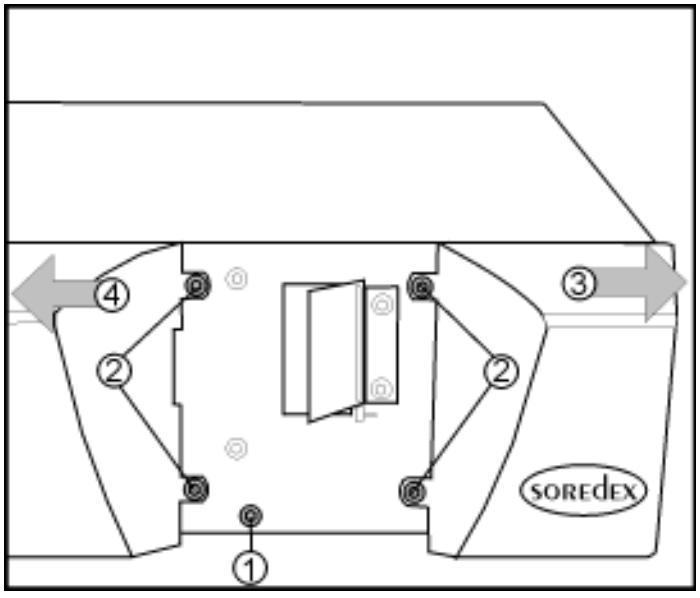


FIGURE 3 - 4: Opening front panels

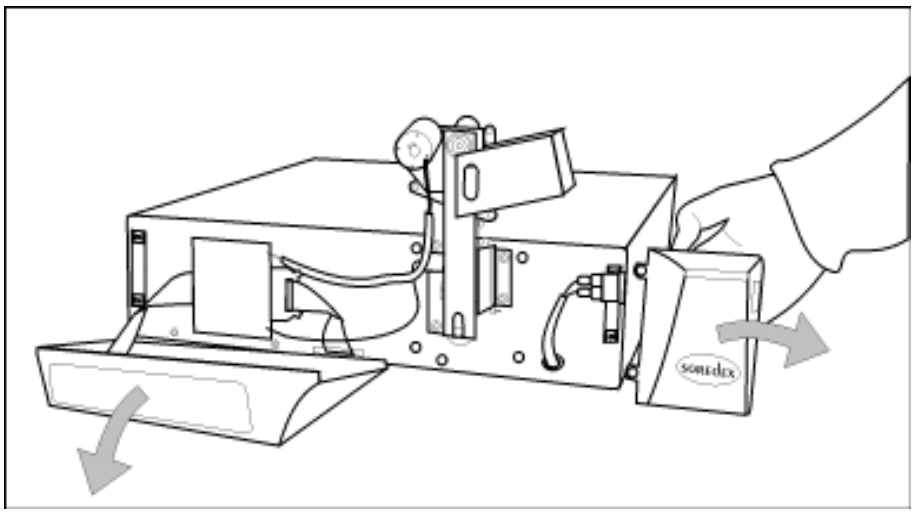


FIGURE 3 - 5: Opening front panels

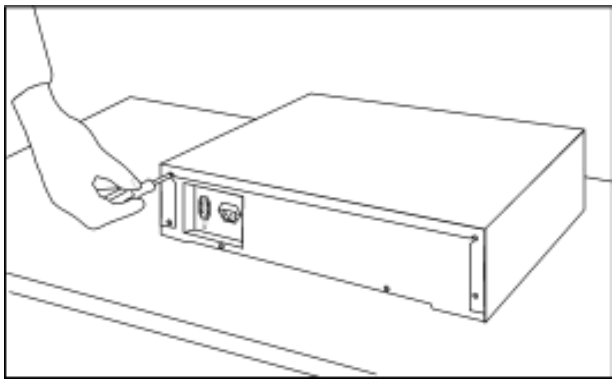


FIGURE 3 - 6: Opening scanner cover

5. Then open the two (2) M4 allen screws at rear, holding the top cover in place.

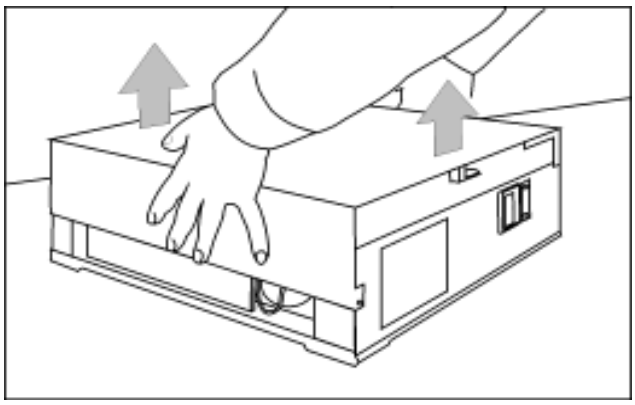


FIGURE 3 - 7: Removing scanner cover

6 Now you can lift off the scanner cover by first pushing it slightly inwards from the sides.

7 Since the cover is fitting tightly in the longitual grooves at the sides of the scanner base plate, it may be somewhat tight. Don't let the cover tilt when lifting it up avoid it getting stuck in vertical direction. When you lift the cover off, a flap inside the cover toggles the safety/service switch that disables the laser tube and the power supply of the photomultiplier tube.

3.2 Closing the covers

When you close the covers, make sure they don't disengage the cables from their connectors or make any of the cables to get trapped.

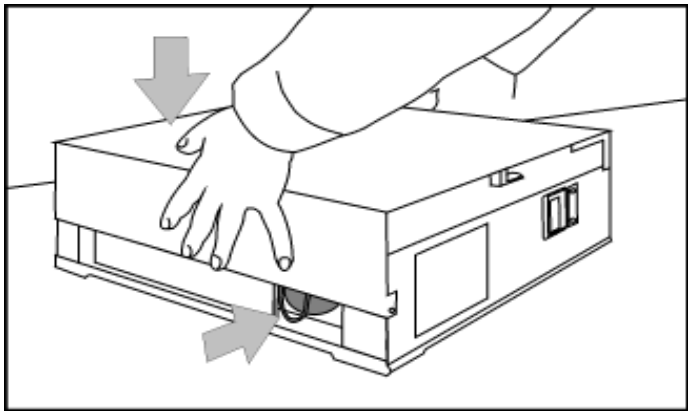


FIGURE 3 - 8: Assembling top cover

3.3 Type Label

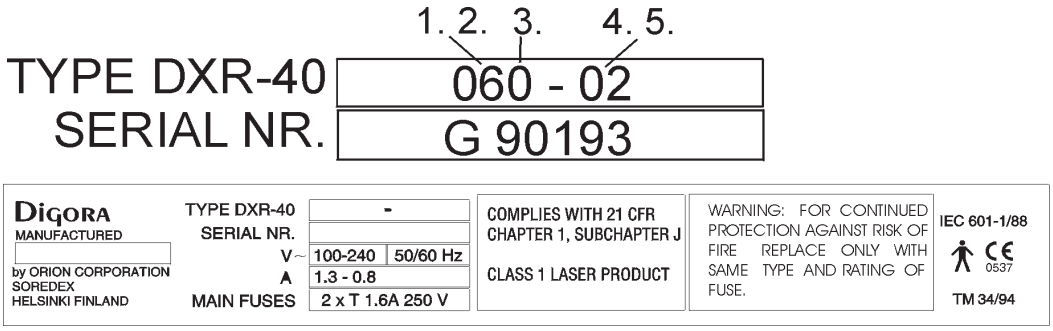


FIGURE 3 - 9: Type Label

Digora scanner´s type label is fitted into the back panel. Digora´s type number is DXR40.

1. and 2. These digits are for identification of the country or language:

0	General (English)
1	UK only
2	German
3	USA
4	Australia
5	France
6	Finland and Sweden
7	Russian
8	Italy
9	Spain
10	Portugal
11	Japan
2x-9x	OEM products

3. This digit is for identification different hardware components inside the scanner:

0	Aerotech laser tube
1	Melles Griot laser tube
2	Laser diode

4. and 5. These digits are for hardware version identification numbers:

0	Pilot production version	
1	1st production version	
2	2nd production version	
3	3rd production version	(Digora fmx)

4. FUNCTIONAL DESCRIPTION

4.1 Functional Description

Digora imaging system replaces dental intraoral x-ray films with imaging plates. Film development and chemicals are replaced by reading the plates in the Digora scanner. Film archive is replaced by storing the images in the computer. There is no x-ray source included in Digora imaging system.

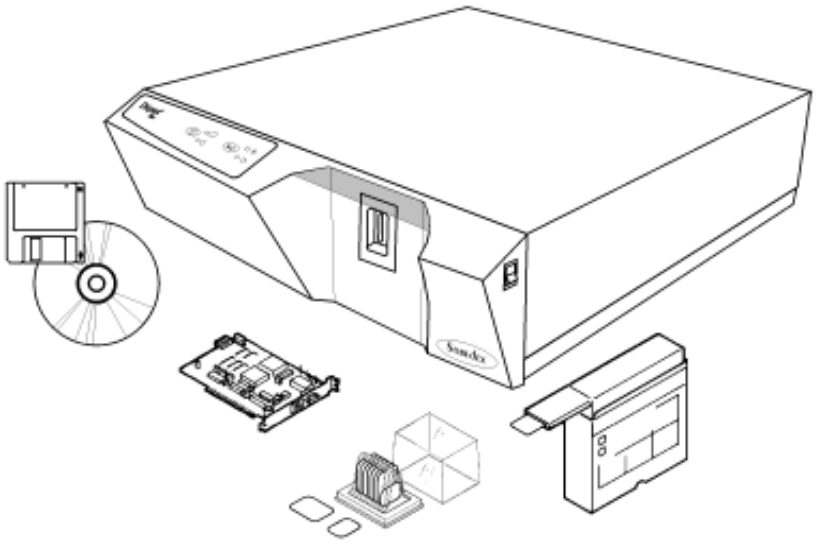


FIGURE 4 - 1: Fmx unit with the interface board, imaging plates, imaging plate box and software diskettes/CD´s.

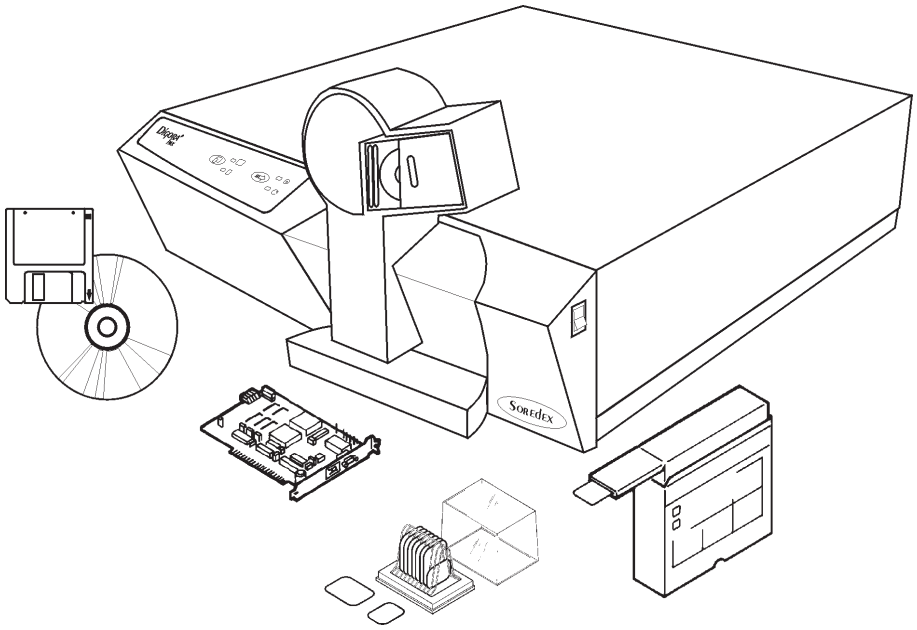


FIGURE 4 - 2: Fmx unit with the Autoloader, interface board, imaging plates, imaging plate box and software diskettes/CD´s.

Digora imaging system consists of imaging plates, protective bags for imaging plates, the Digora scanner, an interface board and a Windows based software, Digora for windows. Optional Autoloader is also available for scanning imaging plates in series.

4.2 Imaging plate principle

Digital imaging plates produce X-ray images of high quality and low noise, and they require only 20 to 50 percent of the dose required for highspeed film imaging. It is, however, possible to use the same dose as used for x-ray film without any risk of overexposure. If you want, you can reduce the X-ray dose even lower, to just 10 percent of the dose required when film is used. At this very low exposure level there is an increased level of noise in the images, but this may be an acceptable trade-off for decreasing exposure levels.

4.3 X-ray film and intensifying screen

Before explaining the details of the digital imaging plate, here is a short review of the operating principles of the two imaging methods.

Radiographic dental imaging film is sensitive to light but relatively insensitive to X-rays. When the film is used outside the patient's mouth, an intensifying screen is used to enhance the X-ray sensitivity of the film. The fluorescent substance of the intensifying screen is excited by the X-ray falling onto the plate. These excited states of the atoms revert to normal almost immediately and, in so doing, generate visible light that exposes the x-ray film.

4.4 The Imaging plate

The fluorescent substance of an imaging plate has been modified to inhibit the immediate revision of the excited states. This inhibition is usually successful up to a 50-percent level, which means that the imaging plate also acts as an intensifying screen. The remaining excited states, on the other hand, are almost permanent. An exposed imaging plate stored in a dark environment and enclosed in a protective bag has more than half of the excited states left after one day. An imaging plate exposed to ambient light loses the excited states in less than a minute. An exposure of a few seconds to normal, indirect light will usually not affect the quality of the latent image on the imaging plate.

4.5 The scanner

The remaining excited states can be reverted by applying a red laser beam to the surface of the imaging plate. The laser beam is focused into a spot whose diameter is 64 micrometres (0,07 mm) and directed on the surface of the plate. The laser beam reverts the excited states almost completely. As this happens, the imaging plate emits blue light of very low intensity (by a factor of about 10^{-8} compared to the laser beam intensity). The scanner detects and amplifies the image produced by the blue light. After the readout, any remaining excited states are erased with a bright halogen light.

The amount of energy stored in the imaging plate is linearly proportional to the x-ray exposure. The linearity is maintained throughout the entire dose range, which means that the imaging plate cannot be over- or underexposed. In this sense, the imaging plate differs from both films and semiconductor sensors which are much more vulnerable to changes in the exposure dose.

To take full advantage of this valuable benefit of the imaging plate, the scanner prereads the imaging plate. Preread involves measuring the X-ray dose used for exposure before the actual readout. The preread is done with a lower laser beam intensity so as not to revert too high a proportion of the excited states before the actual readout. Because of the preread, the resulting image is almost identical irrespective of the dose used for exposure.

4.6 Noise

The dose has an effect on the quality of the image: the lower the x-ray exposure dose, the noisier (more granular) the resulting latent image. The noise in the latent image will be reproduced in the digital computer image and cannot be eliminated without compromising the resolution.

This phenomenon cannot be seen in traditional X-ray film which is rather insensitive to X-rays. Consequently, a relatively high dose must be used in exposure. Such a high dose generates an image with a low noise level. An image plate can always be exposed using a high dose; in such a case, the resulting noise level is as low as with film.

Other digital intraoral imaging approaches are based on semiconductor sensors. There are two types of such sensors: ones that use an intensifying screen, and ones that so not use it. When an intensifying screen is used, the noise level is comparable to that of an imaging plate using the same dose. However, sensors without an intensifying screen produce very noisy images when compared to those produced by imaging plates with the same dose. The fact that semiconductor sensors require a relative accurate exposure to produce acceptable image makes it difficult to evaluate the effect of the x-ray dose on the noise level.

4.7 Preread

The scanner prereads the imaging plate before the actual redout. Preread is based on detecting the darkest area of the image. The success of preread depends on the contents of the image and, in particular, the level of diagnostic interest of the various dark or bright areas of the image. The scanner deliberately reads the image with low contrast and thus includes shades of less diagnostic interest. After the readout, the automatic grayscale adjustment function tries to "guess" how the dentist wants to see the image.

If the image read is so dark or bright that it cannot be fixed with grayscale controls, a new image has to be exposed. In such a case, the settings of the X-ray source should not be modified. After all, this would not help, because it is the image contents (pattern) that matters, not the exposure dose. Instead, you should enter a correction factor using the Readout Setup command of the Options menu to account for required correction in grayscales.

If the result of the readout is fine, but the automatic grayscale adjustment produces too dark or bright images, you should change the settings of the automatic grayscale adjustment, using the Automatic Grayscale Adjustment command in the Options menu.

4.8 Main functions

The scanner reads the imaging plates using a scanning laser beam and a linear transport motion.

When the scanner start to read an imaging plate, it first prereads the plate measuring the x-ray dose used in the exposure. It sets the internal amplified according to the measured signal level and starts the actual readout of the plate. In the readout, scanner's A/D converter reads pixel density values from the plate and sends them instantly to the PC interface board. Data from the board is stored into PC memory and displayed the line on PC monitor.

After the readout the scanner erases the imaging plate using a bright halogen lamp. The scanner returns the erased imaging plate to the scanner opening. During the erasure, Digora for Windows automatically saves the image on the PC hard disk. Digora for Windows then processes the image according to user selectable options and displays the processed image both in an image window and in the patient card.

5. TRANSPORT UNIT

The transport unit features a screw shaft and a plastic tongue (2) that converts the rotation of the shaft to the linear motion of the imaging plate holder (1). The holder has an adjustment screw (4) that works together as a spring with the magnet (3) of the plastic tongue. Screw (5) prevents the tongue from coming too much out of the imaging plate holder.

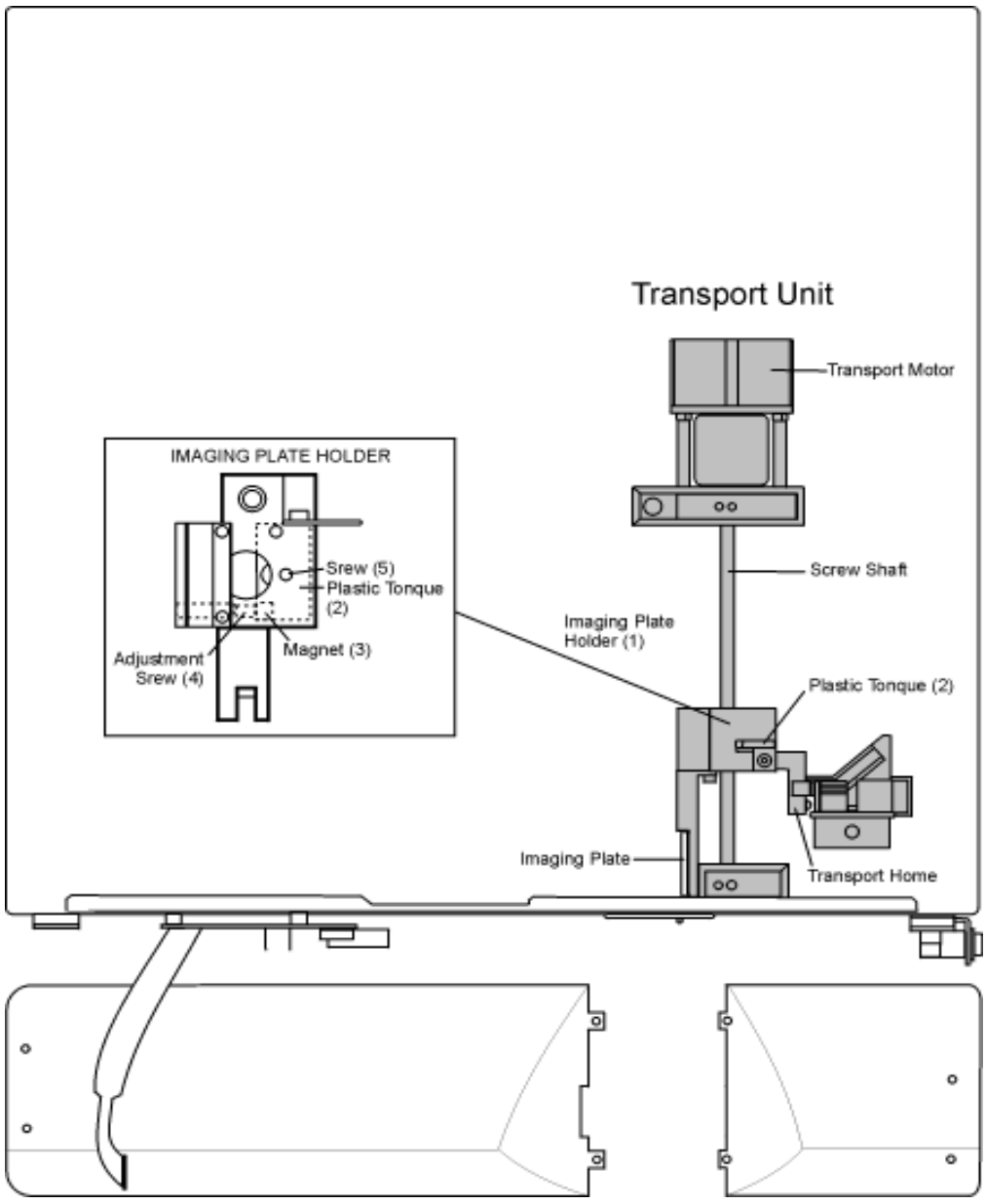


FIGURE 5 - 1: Transport Unit

5.1 Possible problems

5.1.1 Cleaning the screw shaft

The screw, upper and lower quiding rods and the plastic tongue may gather dust that enters into the scanner. Excessive amounts of dust may impair the image quality. If necessary, clean the screw by wiping (use lint free cotton) it during rotation. Clean also the rods and plastic tongue. To get access to the tongue, open the screw (5) and turn the tongue horizontally.

If wiping doesn't clean the screw, dismantle the transport mechanism, wash the screw thoroughly, oil it with thin oil and reassemble the transport mechanism. Use thin oil also on upper and lower guiding rods. Dismantle the transport mechanism the following way:

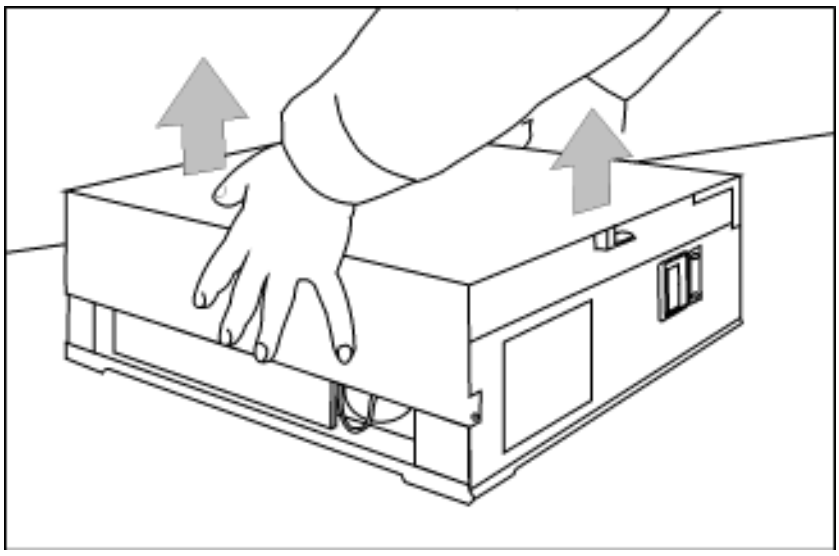


FIGURE 5 - 2

1 Remove the scanner front panels and the scanner cover.

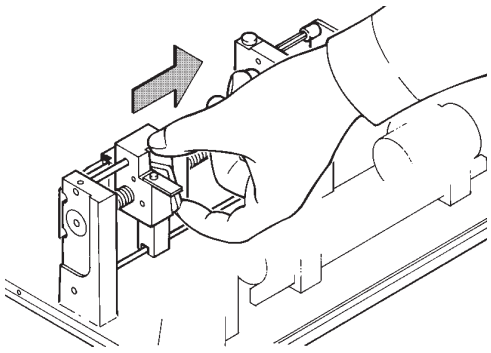


FIGURE 5 - 3

2 Move the imaging plate holder to the inner end of the screw shaft (close to the stepper motor). You can move the imaging plate holder quickly if you pull the plastic tongue out with your nail.

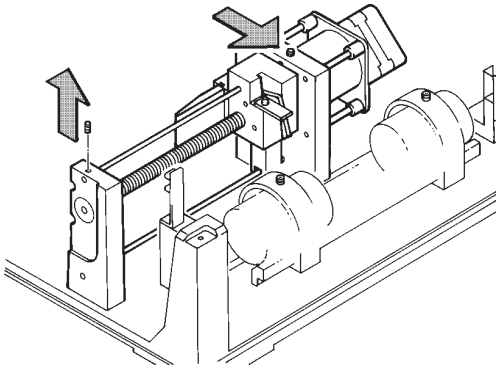


FIGURE 5 - 4

3 Remove the M5 set screw fixing the outer end of the upper guiding rod and open the M4 set screw fixing the inner end of the upper guiding rod.

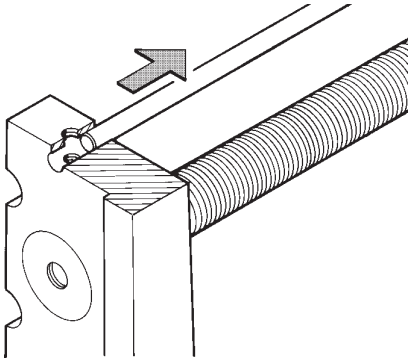


FIGURE 5 - 5

4 Push the upper guiding rod towards the stepper motor to clear the hole from which you removed the M5 set screw.

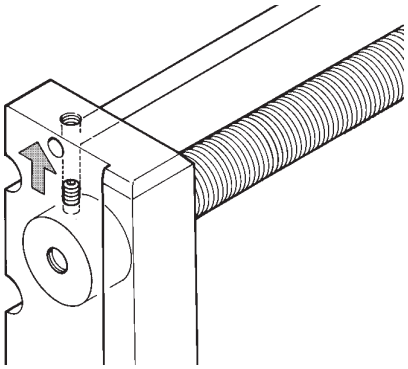


FIGURE 5 - 6

5 Open the M4 set screw located deeper in the hole.

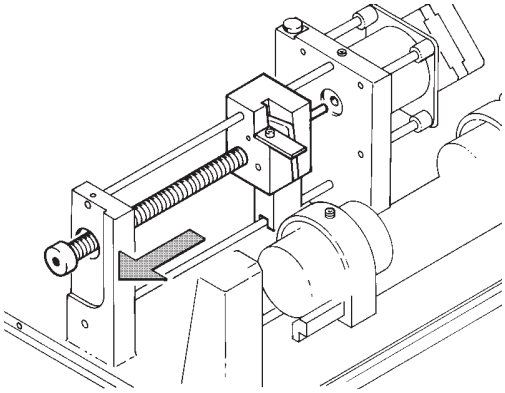


FIGURE 5 - 7

6 Pull out he screw shaft.

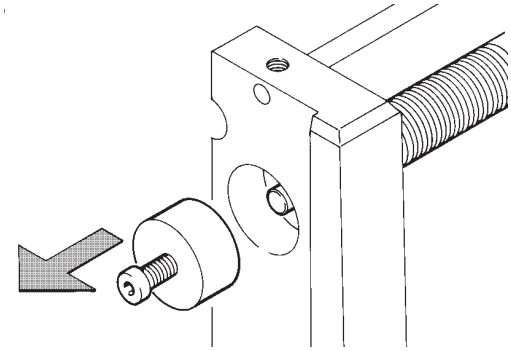


FIGURE 5 - 8

7 If the shaft doesn't move, turn a M4x20 screw to the hole in the bearing holder at the outer end of the screw shaft. The M4x20 screw pulls the bearing holder out and frees the outer end of the screw shaft.

NOTE! In the units manufactured from year 2000 on the bearing holder has a mark on it to identify the correct alignment of it. When reassembling it, make sure to keep the same alignment.

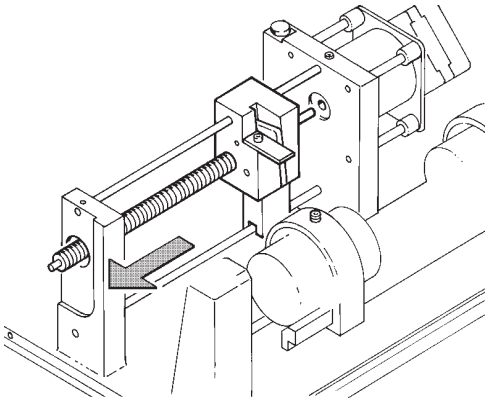


FIGURE 5 - 9

8 Pull out the screw shaft but don't damage the thread by hitting it to the scanner frame. If you feel a strong rubbery resistance and can't pull the shaft out, remove the stepper motor and the flywheel to free the inner end of the shaft.

5.2 The flywheel

To remove the flywheel, open the four M5 nuts fixing the stepper motor assembly to the elastic absorbers. Put a screwdriver between the flywheel and the aluminium plate of the stepper motor and force the stepper motor shaft out of the flywheel. Make sure you have the laser tube cover secured on its place to avoid hitting the laser tube with the stepper motor. Pull out the flywheel from the inner end of the screw shaft.

The flywheel is not secured to the shafts of the stepper motor and the transport mechanism. The rotating motion is coupled through O-rings located in the internal grooves of the flywheel. If the O-rings are oily or hardened, they may not function properly. Replace the whole flywheel with a spare part with ready-assembled O-rings of right size and properties.

When you reassemble the transport mechanism, put a screwdriver between the flywheel and the aluminium plate of the stepper motor to prevent the flywheel from sliding too close to the stepper motor and its fixing screws.

If you find it hard to push the shafts into the flywheel, moisten the O-rings with spirits to lubricate them temporarily. Do NOT use oil or water since oil decreases friction permanently and water rusts the ends of the shafts which makes further removal of the flywheel very difficult.

Do not overtighten the M5 nuts fixing the stepper motor assembly to the elastic absorbers since this makes the M5 bolts to rotate inside the rubber the next time anyone tries to open the nuts. If you find the bolt is rotating inside the rubber, use plyers to keep the bolt steady while opening the nut.

5.2.1 Adjusting the plastic tongue

The screw shaft is not perfect and this causes two kinds of problems:

1 The Screw is not perfectly straight. This results in wide darker and lighter vertical zones in uniform grey areas of the x-ray image. There are thirteen pairs of such areas during the whole length of the imaging plate.

2 The surface of the screw may initially have scratches, or dust and dirt may accumulate on the screw. This results in more or less local, very narrow vertical stripes of the x-ray image.

The plastic tongue of the imaging plate holder is adjustable to minimize the above-mentioned problems. The basic adjustment is to turn the screw (4) until it pushes the plastic tongue noticeably and then take back something between half a turn and a full turn. The idea is to get the screw close to the magnet (3) of the tongue but to keep it so far away that it never touches the magnet when the screw shaft rotates.

After the basic adjustment, test the scanner by reading a few all-grey x-ray images to check for striping. If disturbing striping is visible, the basic adjustment should be fine-turned to either direction to minimize the striping.

NOTE that this disturbing striping can be caused also because of other reasons too (dust in upper or lower rods, etc.)

5.2.2 Aligning the shaft

In units manufactured from year 2000 on, the alignment of the shaft can be adjusted by turning the bearing holder (see fig 5-8). An adjustable construction is recognized from the bearing holder which will have two holes to allow turning it.

Correct orientation of the bearing holder is found in the following way:

- Adjust the plastic tonque (imaging plate holder in the rearmost position) so that the imaging plate holder can just be moved without the plastic tonque hitting the shaft
- Move the imaging plate holder from the front end to the rear end
- The plastic tonque should not touch the shaft
- Repeat this when the plastic tongue is adjusted in the outmost position
- Adjust the orientation of the of the bearing holder by turning it so that the criteria above will apply.

After alignment of the bearing holder the plastic tonque must be adjusted according to 5.2.1.

5.3 Light collecting tube adjustment

Although light collecting tube is not part of the transport unit it has some influence on the performance of the transport mechanics. The light collecting tube is the tube between the Photo Multiplier Tube and the Imaging Plate holder (refer figure 1-1 in this manual).

Adjustment of the light collecting tube means the adjusting the gap between the Light Collecting Tube and the Imaging Plate Holder. The gap is factory adjusted and should not need any adjustment. Incorrect adjustment may allow Imaging Plates to drop inside the unit if they are inserted into the scanner incorrectly or carelessly.

The correct gap between the light collecting tube and the imaging plate holder is 0.6mm (+/- 0.2mm). If the tube needs to be adjusted:
-move the imaging plate holder manually in front of the light collecting tube
-loosen the nut that holds the steel belt around the light collecting tube
-move the light collecting tube towards imaging plate holder so that the adjustment criteria is met. Make sure not to turn the tube so that it would touch the galvanometer and prevent its movement
- tighten the nut to tighten the light collecting tube in plate
-loosen the two screws that are provided to tighten the PMT in place. Move the PMT towards the light collecting tube until they are attached. Tighten the screws.

6. Laser DIODE ASSEMBLY

6.1 Laser alignment

Either when aligning the laser beam or/and when replacing the laser follow the precautions described in the chapter 2: Warnings and Symbols in this manual. Always use the protective blue glasses.

The laser diode inside the laser diode assembly is fixed and it´s position can not be adjusted.

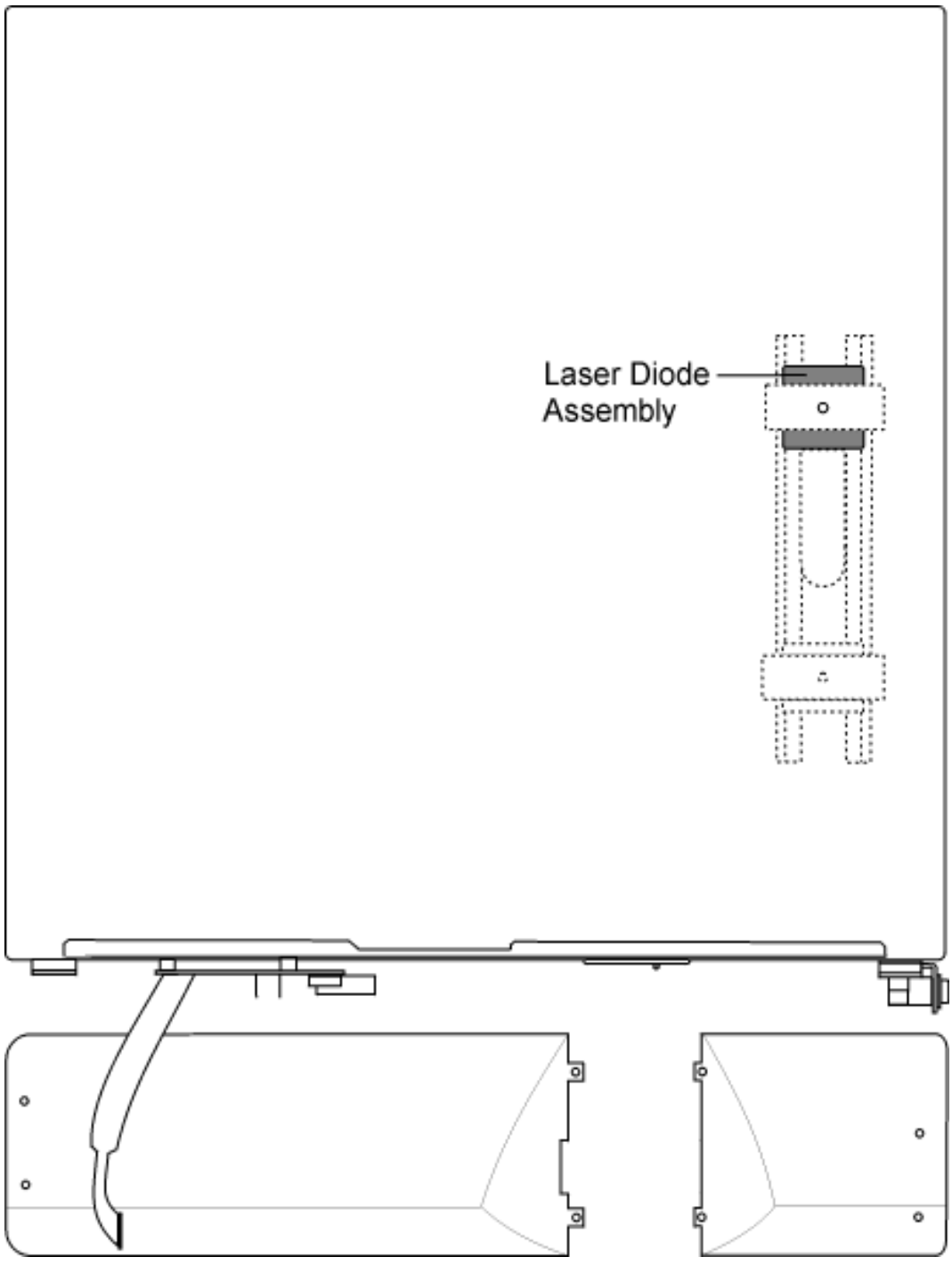


FIGURE 6 - 1: Laser Diode Assembly

6.2 Laser diode assembly replacement

Laser may need replacement if it isn´t turned on although everything else is working properly (i.e. +12V voltage supply and signal Laseren are existing)

Before removing the laser diode assembly, be sure to turn off the scanner and mark the longitual position of the assembly.

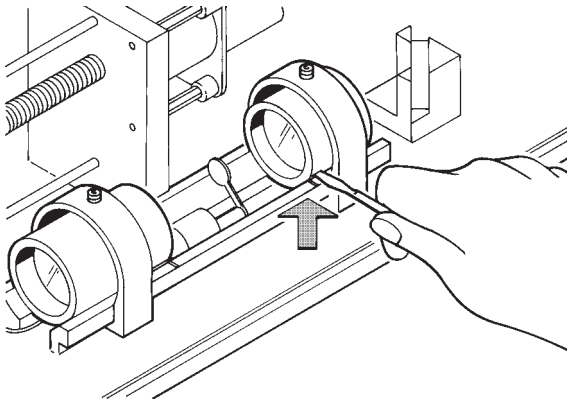


FIGURE 6 - 2: Marking the longitual position of the assembly

Assemble the new laser diode assy in the same longitual position as the old one.

Switch on the scanner and disactivate the safety switch. Switch on the laser (use DSA command LASER ON). Monitor the shape of laser beam on the galvanometer mirror. Rotate the laser diode assy to get the laser spot into the middle of galvanometer mirror at 45 degrees. See the figure 6-3. Tighten the laser diode assembly screw after assebly (torque 40 Nm).

Adjust by turning the round mirror assembly if necessary.

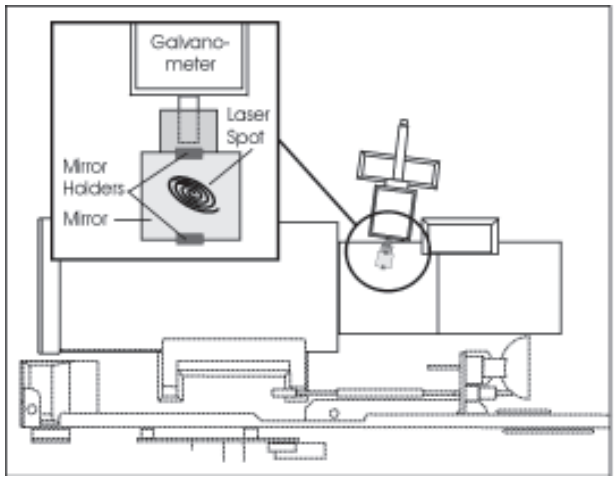


FIGURE 6 - 3: Laser spot on galvanometer mirror.

The factory alignment of the laser diode is done with a filtered video camera that shows the actual shape of the laser spot at surface of the imaging plate.

7. GALVANOMETER

The galvanometer turns a little mirror that scans the laser spot in vertical direction over the imaging plate.

The horizontal position of the galvanometer is correct when the laser spot hits the center of the galvanometer mirror.

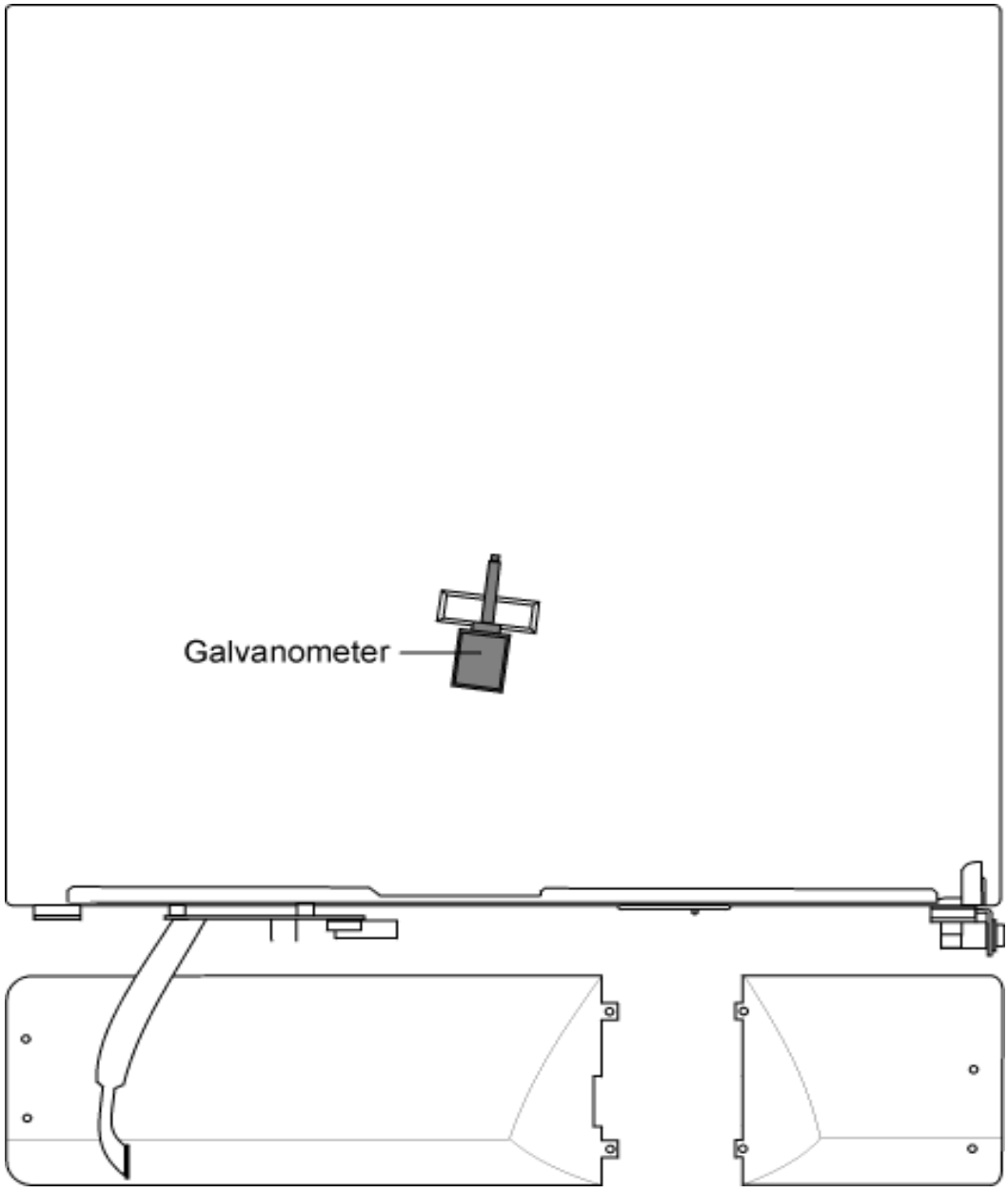


FIGURE 7 - 1: Galvanometer

The angular position of the galvanometer sets the vertical position of the image on the screen. The angular position is correct when the laser spot reflected from the galvanometer mirror hits the center of the screw shaft while the galvanometer cable is disconnected from the driving electronics. The fine-tuning of the vertical position of the image on the screen is done with the Calibration procedure activated from the Options menu.

The remove the galvanometer, loosen first the M5 screws fixing the steel tube of the photomultiplier tube and slide the steel tube to the left. Open then the M5 nut fixing the clamp for the light guiding tube. While opening the nut, hold the light guiding tube steady to avoid it from hitting the galvanometer mirror. Keep the clamp off the way and remove carefully the light guiding tube. The screw fixing the galvanometer may be tight because it is clamping the cast aluminium structure of the scanner frame. Use caution not to hit or bend the galvanometer tail.

The galvanometer mirror is glued into its holder. The mirror holder assembly is available as a spare part.

Remove the mirror holder assembly by pulling it straight out. Be careful not to bend the shaft of the galvanometer. Push the new mirror holder assembly straight onto the galvanometer shaft keeping both parts in your hands. Do NOT push them against the tabletop as this easily results in bending the galvanometer shaft. When pushing the parts together, increase the pushing force gradually until the holder slides onto the shaft. When sliding stops, the holder sits firmly on the shaft. Do NOT try to push it any further . Failure to follow this mirror holder assembly replacement procedure may cause the galvanometer to work very unlinearily.

Do NOT ever try to rotate the mirror holder in respect to the galvanometer body. Always adjust the angular position of the galvanometer by rotating the whole galvanometer body in respect to the scanner frame.

8. OPTICAL COMPONENTS

The laser beam is guided inside the scanner and focused by a right angle mirror, a lens assemby and the galvanometer. Other optical components in the system are the slotted optical switch and the reflective sensor.

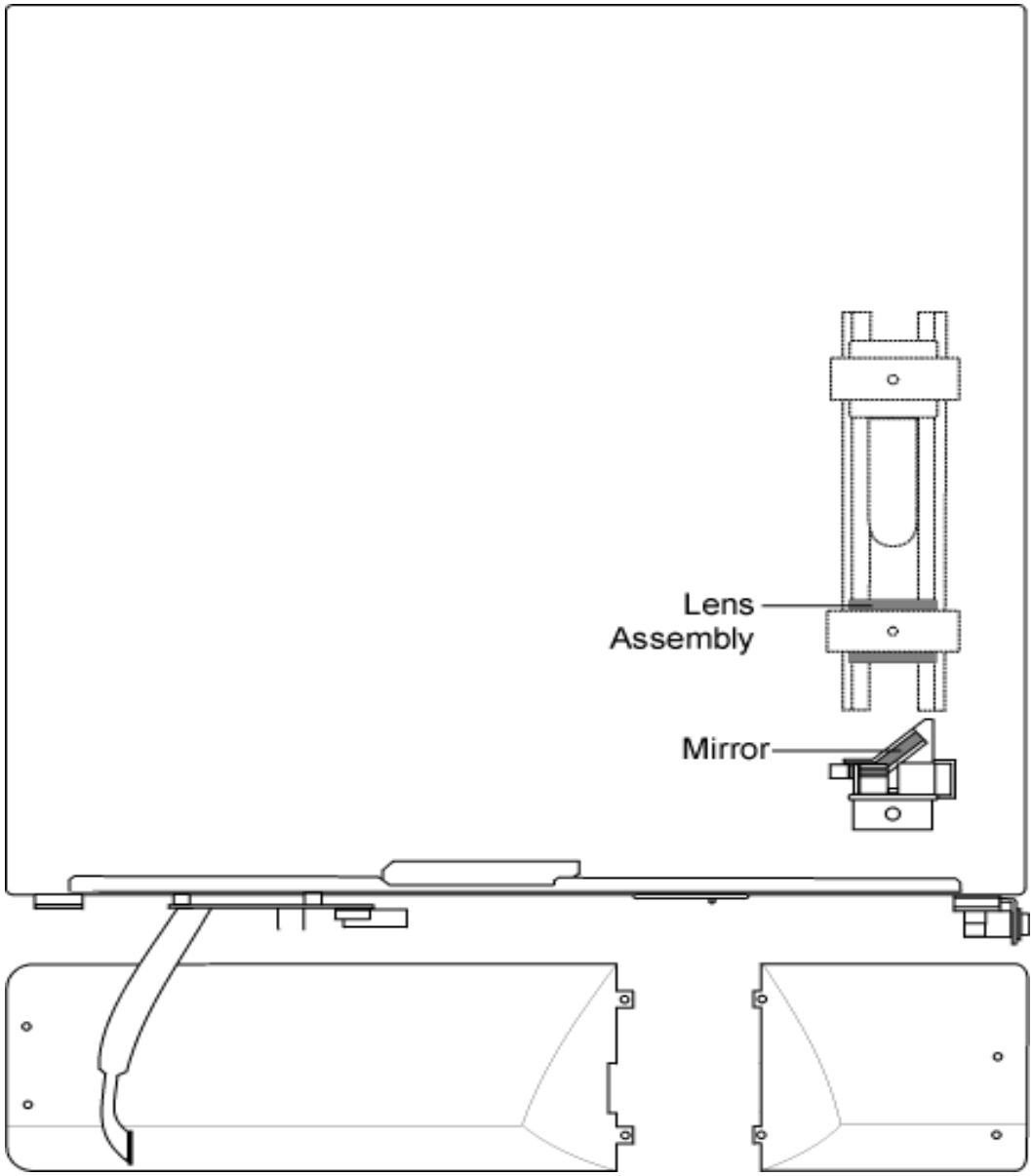


FIGURE 8 - 1: Optical Components; Lens Assembly and Mirror

8.1 Mirrors and lens assemblies

The right angle mirror is designed to reflect the red laser light. Reflection takes place on the outer surface. The outer surface is kept in contact with the precision machined aluminium surface of the scanner frame with a leaf spring. The outer surface of the mirror and lenses must be reasonably free of dust and absolutely free of fingerprints.

Use oilless compressed air to blow off the dust from the mirror and lenses. If you use compressed air from a spray can, keep the can in vertical position when spraying the air.

To remove particles that can't be blown off from the mirror on lenses, wipe them with a tissue moistened with clean spirits that doesn't leave any residual film on the surfaces. If you wipe them as dry, use a soft cloth.

8.2 Slotted optical switch

The position of the slotted optical switch sets the horizontal position of the image on the screen. If you need to open the screws of the slotted optical switch or the metal piece travelling through the slot, remember to recalibrate the scanner using the Calibration mode selectable from the Options menu.

8.3 Reflective sensor

The reflective sensor detects the white side of the imaging plate. The proper sensor position is slightly tilted towards the inside of the scanner pointing to the casted body of the unit. The guide plate of the imaging plate holder is painted mat black to make it non-reflective. The sensor uses infrared light which means it may interprete a black surface as white if the surface reflects the infrared light well enough.

Information from the reflective sensor is needed when the scanner is pushing the imaging plate out (1) and when the user has pressed the Action button of keybord (2).

1 If the detector interpretes there is no imaging plate in the scanner, the scanner doesn't push the imaging plate holder fully out. If the imaging plate inside the scanner is of small size, the scanner pushes the imaging plate holder so much out that the reflective sensor can see the imaging plate.

2 When the user has pressed the Action button the scanner sends an image redout request to the computer if the reflective sensor has detected an imaging plate in the scanner.

8.4 Adjustment of reflective sensor

The software measures a reference value of the reflective sensor signal after each power-on and interprets this to represent the absence of the imaging plate. When the reflective sensor then sees something that reflects significantly better, it interprets that to be the white side of the imaging plate. If that happens to be the dark side of the imaging plate, the scanner tries to read it. It recovers the misinterpretation after having seen the real white side of the imaging at least once after power-on.

Reflective sensor functionality can be tested with DSA comman "Test reflective sensor", see Chapter "DSA, Digora Service Assistant". It is recommended to use it to verify the functionality of reflective sensor.

9. PREREAD LENS MOTOR

The preread lens decreases the intensity of the laser beam and defocuses it to prevent the preread from leaving visible traces to the information gathered from the imaging plate during actual readout. The preread lens is turned on at the beginning of preread sequence and off at the end of preread sequence.

The preread motor has a small diameter coupling and a friction plate. The lens position during preread is controlled by the motor's angular position, which is limited by mechanical means.

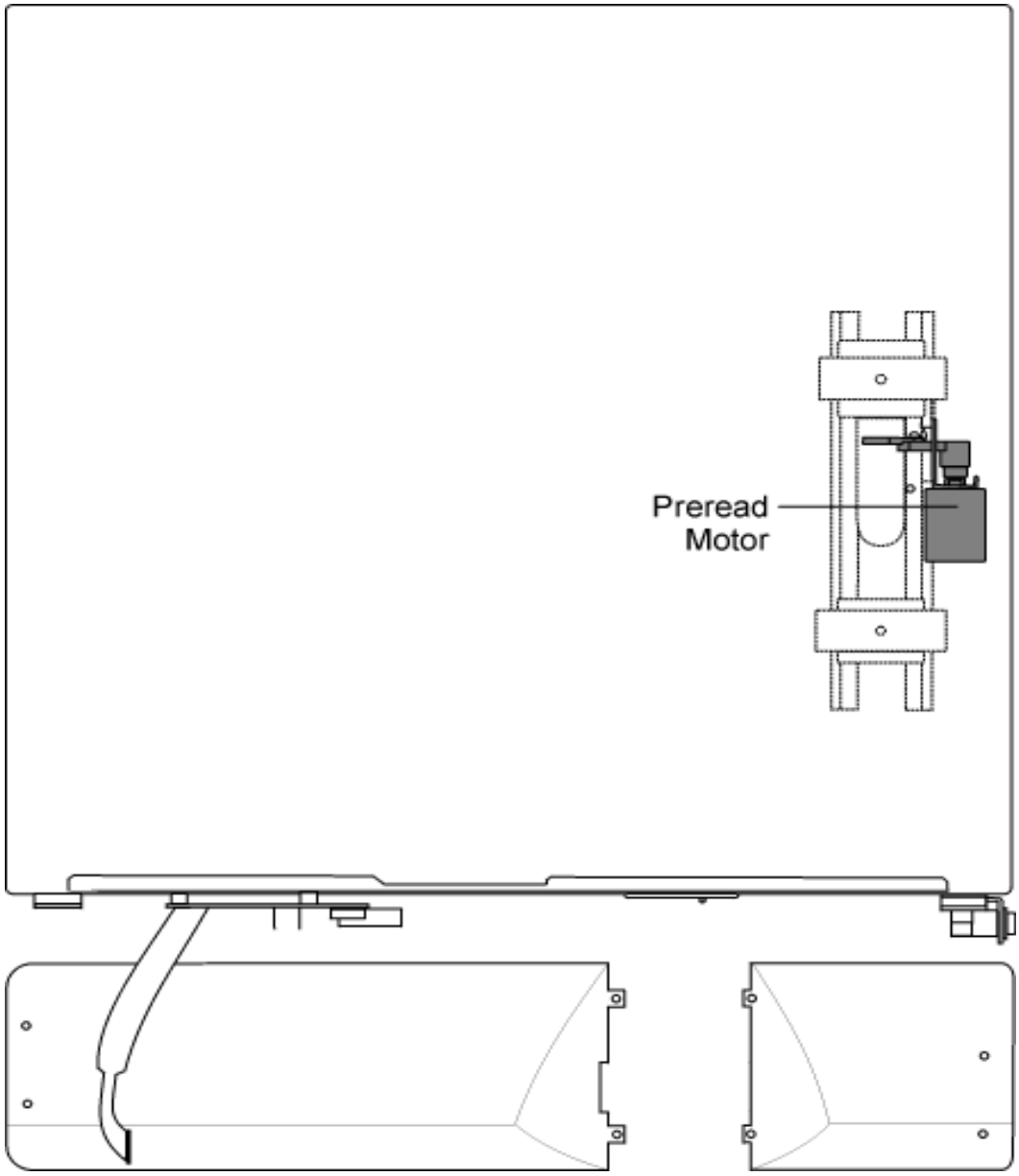


FIGURE 9 - 1: Preread Lens Motor

10. ELECTRICAL DESCRIPTION DXR-40 XXX-02

Mains cord is connected to the power inlet of Digora. Power inlet includes the mains filter and two line fuses. Mains voltage is connected to T4400 Power Supply which generates supply voltages +5 VDC, -12 VDC and +12 VDC. The supply voltages are lead through T4101 Stepper Drive and HV supply pcb to P4000-2 Microprocessor board and T4501 Key and Display pcb.

10.1 Functions connected to T4101 stepper drive and HV supply PCB

T4100 has electronics to generate high voltage to Photo Multiplier Tube. The signal coming from PMT is readby the P4000 pcb.

The laser diode assembly gets its +12 VDC supply voltage from T4101 as well as control signal LASEREN for laser. When signal LASEREN goes low, the laser connected to the voltage supply will be turned on.

Transport stepper motor is driven by this board to move the imaging plate horizontally.

Galvanometer is provided to sweep the beam vertically over the image plate. Sweep signal is controlled by microprocessor according to the results of calibration.

10.2 Functions connected to P4000-2 microprocessor PCB

Ground of all pcb's is connected to chassis.

Microprocessor of P4000 reads the signal level from preamplifier of T4300 PMT pcb.

Transport home optical switch is used to stop the transport mechanism always at the same place.

Reflective sensor detects the presence of the imaging plate. Scan starts automatically when the imaging plate is inserted into the unit and the action key pressed.

Preread DC motor is provided to turn the preread lens into the laser beam at preread sequence of the scan. To turn the preread lens the motor is run for a couple of seconds clockwise and after preread sequence another couple of seconds counter-clock-wise to move the lens off the beam. Mechanical means are provided to limit the turn of preread lens.

12 V halogen lamp is provided for erasing the image plate after read out.

Safety switch is provided to block out laser and high voltage when equipment cover is removed.

A PC Interface adapter pcb is connected with interface cable to P4000 pcb by using RS485 interface protocol.

10.3 Functions connected to T4501 key and display PCB

Keyboard/display as well as the optional Autoloader motor and position detector (microswitch) are connected into this pcb.

10.4 The PC boards

The names and functions of all Digora PC boards are as follows:

P4000-1 Processor board
This is the main PCB that contains the micro controller (Intel 80C198) that controls the scanner, amplifier for the analog signal from the photomultiplier tube, galvanometer control front end circuit, erasing lamp control, optoisolated RS485 serial port and driver for the pre-read DC-motor.

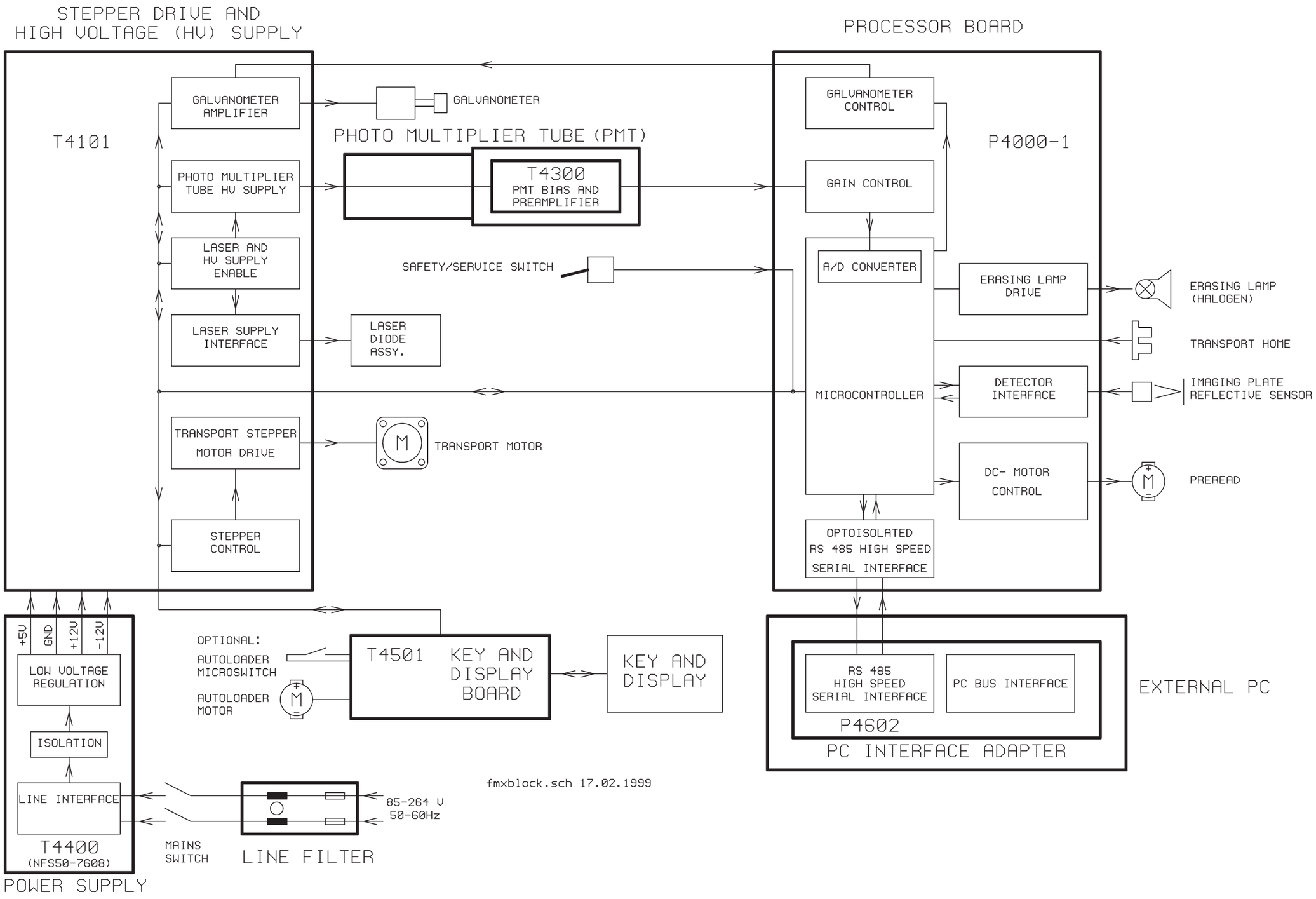
T4101 Stepper drive and HV supply
This PCB contains a high voltage power supply for the photo multiplier tube, laser power supply control, galvanometer power amplifier and a controller and a driver for the transport stepper motor.

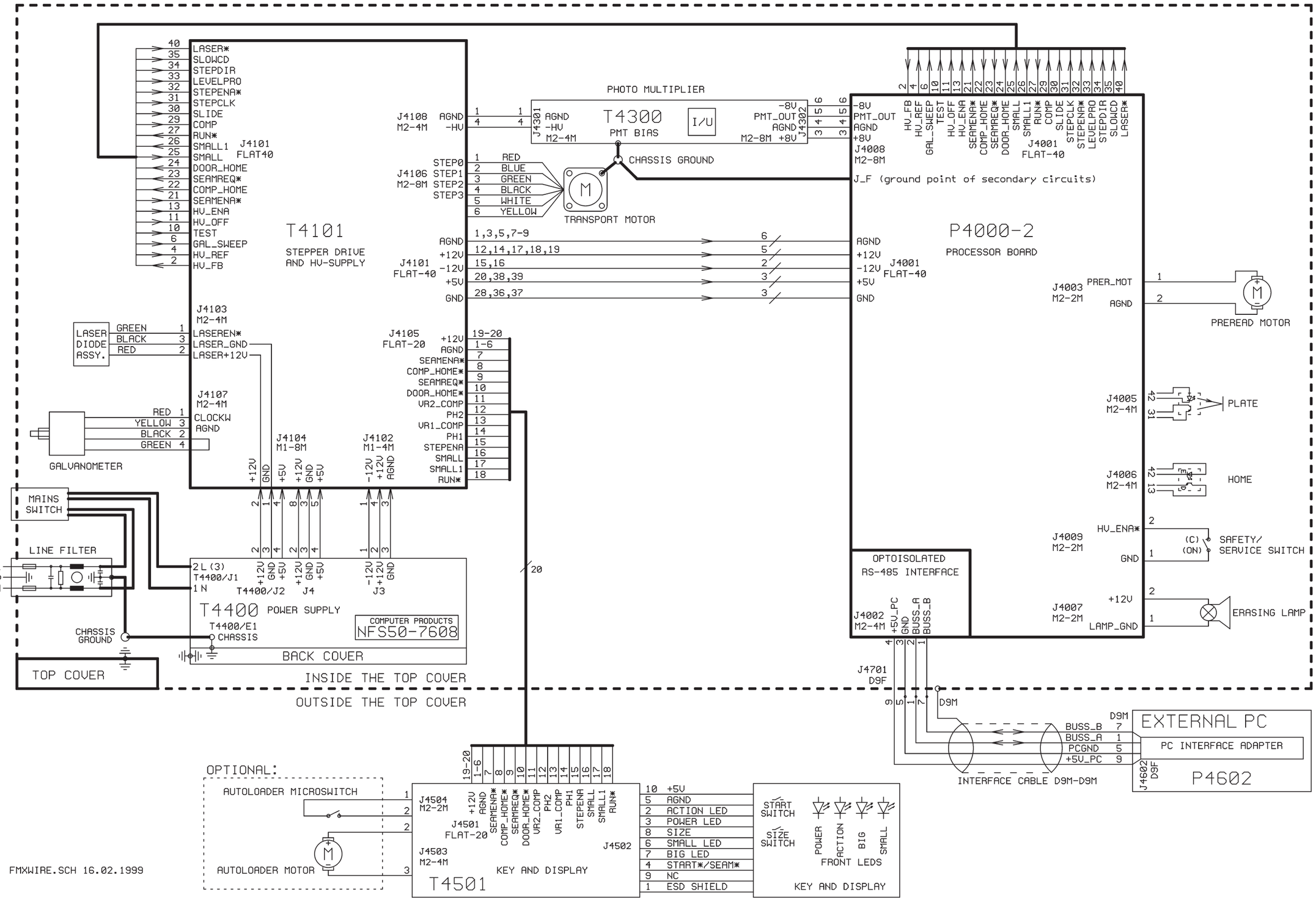
T4300 PMT bias
This PCB contains a resistive voltage divider for the photo multiplier tube (PMT) biasing voltages and a preamplifier for the PMT signal. This PCB is part of the PMT assembly.

T4400 Mains power supply
This is a universal input switching mode power supply.

T4501 Key and display
This PCP contains control for the keys and LEDs, a test jumper, connector for the autoloader motor and connector for the autoloader micro switch. This PCB is mounted behind the plastic front panel.

P4601 & P4602 Interface adapters
These are the interface adapter board between Digora and the PC computer.


STEPPER DRIVE AND
HIGH VOLTAGE (HV) SUPPLY
T4101
GALVANOMETER AMPLIFIER
GALVANOMETER
PHOTO MULTIPLIER TUBE (PMT)
PHOTO MULTIPLIER TUBE HV SUPPLY
T4300
PMT BIAS AND PREAMPLIFIER
LASER AND HV SUPPLY ENABLE
SAFETY/SERVICE SWITCH
LASER SUPPLY INTERFACE
LASER DIODE ASSY.
TRANSPORT STEPPER MOTOR DRIVE
TRANSPORT MOTOR
STEPPER CONTROL
PROCESSOR BOARD
P4000-1
GALVANOMETER CONTROL
GAIN CONTROL
A/D CONVERTER
ERASING LAMP DRIVE
ERASING LAMP (HALOGEN)
TRANSPORT HOME
MICROCONTROLLER
DETECTOR INTERFACE
IMAGING PLATE REFLECTIVE SENSOR
DC- MOTOR CONTROL
PREREAD
OPTOISOLATED RS 485 HIGH SPEED SERIAL INTERFACE
+5V
GND
+12V
-12V
LOW VOLTAGE REGULATION
ISOLATION
LINE INTERFACE
T4400
(NFS50-7608)
POWER SUPPLY
OPTIONAL:
AUTOLOADER MICROSWITCH
AUTOLOADER MOTOR
T4501 KEY AND DISPLAY BOARD
KEY AND DISPLAY
MAINS SWITCH
LINE FILTER
85-264 V
50-60Hz
RS 485 HIGH SPEED SERIAL INTERFACE
PC BUS INTERFACE
P4602
PC INTERFACE ADAPTER
EXTERNAL PC
fmxblock.sch 17.02.1999


T4101
STEPPER DRIVE
AND HV-SUPPLY
J4101 FLAT40
LASER*
SLOWCD
STEPDIR
LEVELPRO
STEPENA*
STEPCLK
SLIDE
COMP
RUN*
SMALL1
SMALL
DOOR_HOME
SEAMREQ*
COMP_HOME
SEAMENA*
HV_ENA
HV_OFF
TEST
GAL_SWEEP
HV_REF
HV_FB
PHOTO MULTIPLIER
T4300
PMT BIAS
I/U
J4301
J4108 M2-4M
AGND
-HV
M2-4M
-8V
PMT_OUT
AGND
+8V
M2-8M
J4302
CHASSIS GROUND
J4106 M2-8M
STEP0
STEP1
STEP2
STEP3
RED
BLUE
GREEN
BLACK
WHITE
YELLOW
TRANSPORT MOTOR
J4101 FLAT-40
AGND
+12V
-12V
+5V
GND
1,3,5,7-9
12,14,17,18,19
15,16
20,38,39
28,36,37
P4000-2
PROCESSOR BOARD
J4001 FLAT-40
J4008 M2-8M
J_F (ground point of secondary circuits)
J4003 M2-2M
PRER_MOT
PREREAD MOTOR
J4005 M2-4M
PLATE
J4006 M2-4M
HOME
J4009 M2-2M
HV_ENA*
(C)
(ON)
SAFETY/
SERVICE SWITCH
J4007 M2-2M
+12V
LAMP_GND
ERASING LAMP
OPTOISOLATED
RS-485 INTERFACE
J4002 M2-4M
+5V_PC
BUSS_A
BUSS_B
J4701 D9F
D9M
BUSS_B 7
BUSS_A 1
PCGND 5
+5V_PC 9
INTERFACE CABLE D9M-D9M
EXTERNAL PC
PC INTERFACE ADAPTER
J4602 D9F
P4602
J4103 M2-4M
LASEREN*
LASER_GND
LASER+12V
LASER DIODE ASSY.
GREEN
BLACK
RED
J4107 M2-4M
CLOCKW
AGND
GALVANOMETER
J4104 M1-8M
J4102 M1-4M
J4105 FLAT-20
+12V
AGND
SEAMENA*
COMP_HOME*
SEAMREQ*
DOOR_HOME*
VR2_COMP
PH2
VR1_COMP
PH1
STEPENA
SMALL
SMALL1
RUN*
19-20
1-6
7
8
9
10
11
12
13
14
15
16
17
18
20
MAINS SWITCH
LINE FILTER
L
GND
N
2L(3)
T4400/J1
1 N
T4400/J2
J4
J3
T4400 POWER SUPPLY
COMPUTER PRODUCTS
NFS50-7608
T4400/E1
CHASSIS
CHASSIS GROUND
BACK COVER
TOP COVER
INSIDE THE TOP COVER
OUTSIDE THE TOP COVER
OPTIONAL:
AUTOLOADER MICROSWITCH
AUTOLOADER MOTOR
J4504 M2-2M
J4501 FLAT-20
J4503 M2-4M
J4502
KEY AND DISPLAY
T4501
+5V
AGND
ACTION LED
POWER LED
SIZE
SMALL LED
BIG LED
START*/SEAM*
NC
ESD SHIELD
START SWITCH
SIZE SWITCH
POWER
ACTION
BIG
SMALL
FRONT LEDS
KEY AND DISPLAY
FMXWIRE.SCH 16.02.1999

11. PROCESSOR BOARDS P4001 AND P4000-2

Processor board P4001 is the same as its predecessor (P-4000-2) except that it has a different processor (Intel 80C196KC) and I/O addressing. In addition, some of the IC-circuits have been replaced with surface mounted devices.
Because the I/O addressing was changed, new software for the P4001 was required. The software on P4001 is NOT interchangeable with the software on P4000-2, and vice versa. For more information on the P4001 software, refer to the section "Scanner Software".

The P4000-2 board is installed in units up to serial number G16234

The P4001 board is installed in units from G16235

This is the main PCB that comprises the micro processor that controls the scanner, amplifier for the analog signal from the photomultiplier tube, galvanometer control front end circuit, erasing lamp control, RS485 serial port and the driver for the pre-read DC-motors.

11.1 Functional description; Main Features:

- Intel 80C196KC (P4001)/80C198 CPU (P4000-2), 32 kB external code ROM, no external RAM
- internal 10-bit 4-channel A/D converter
- 750 kBd optoisolated serial RS485 interface to PC or compatible computer
- motor drive circuits for DC motors (preread motor)
- photo multiplier signal amplifier with CPU controlled 2-stage gain control and offset adjustment
- photo multiplier high voltage power supply control DAC
- galvanometer drive circuit (front end) with hardware protection mechanism
- imaging plate reflective sensor interface
- transport home slotted optical switch interface
- input connectors for several switches
- separate +/-5 V and +/-8 V regulation for analog circuits
- Internal watchdog circuit in CPU
- 12V halogen lamp drive for erasing the imaging after readout

11.3 CPU interface

CPU operating frequency is 12Mhz, which is further divided by 16 (IC2) to create a 750 kHz clock for internal timing purposes. This clock is connected to timer 2 input of CPU.

Both 32 kB (27256) and 64 kB (27512) EPROMs can be used. EPROM is mapped to the lower half of CPU address space.

All 1/0 is mapped to the upper half of CPU address space (addresses 8000...FFFF).

11.3 Photo multiplier amplifier

PMT amplified has a total maximum gain of 212. It has been built from three separate amplifier stages, which have gains of 1,53 and 4. Gain is controlled by a dual digital potentiometer between the stages. The first half of the digital potentiometer can attenuate the signal down to 1/256, while the other half is used by the CPU to fine-tune the adjustment and can only attenuate the signal down to 128/256. Thus the minimum gain of the overall amplifier is about 0,41 (212/256 by 128/256). There is also a CPU controlled offset adjustment to eliminate PMT dark current.

The first amplifier stage (1C14/a) is a differential amplifier, which is connected as a normal non inverting amplifier by shorting JP1. The maximum input allowed from PMT is around 4 volts. A typical maximum input from PMT is around 2 volts when an x-ray dose equal to calibration dose is used. The first amplifier stage has a manual offset adjustment.

The second amplifier stage (IC14/b) has a gain of 53. It has two offset adjustments. The manual adjustment range is +/-0,5 V and the CPU adjustment range (digital potentiometer) is 0 ... -1 V measured at TP4.
Attenuator between the first and second stage can attenuate the signal down to 1/256.
Third amplifier has a gain of 4 and the attenuation can go down to 128/256.

The positive power supply of the amplifiers is also the reference voltage of the A/D converter. This guarantees that the voltage at the A/D converter input will never be greater than Vref. The negative power supply of the last op-amp is at ground to prevent negative voltages in A/D converter input.

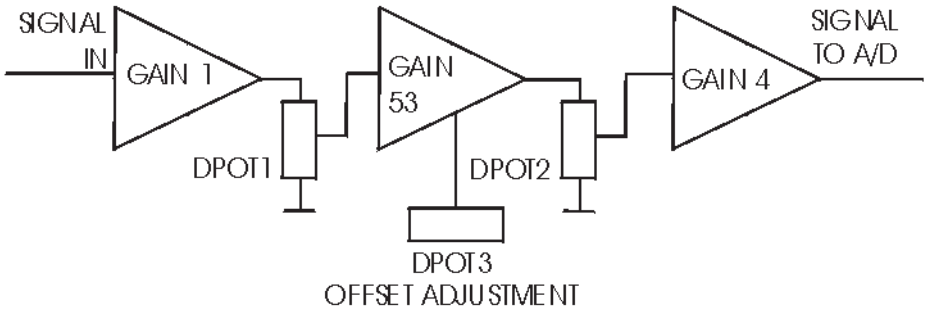


FIGURE 11 - 1: Photo multiplier amplifier block diagram - manual offset adjustment not shown

11.4 Adjustment of manual potentiometers

Potentiometer R40 is for compensating the offset voltage from the PMT tube preamplifier and the first premaplifier of IC14. Potentiometer R35 is for compensating the offset voltages from the second and third amplifier sages os IC14 an IC23.

The manual potentiometers are adjusted at factory. To check the adjustment or re-adjust it, do as follows:

- Switch the power off, wait for a few seconds and switch it on again to reset the digital potentiometers to their default values.
- Make sure that the PMT unit is connected to connector J4008. Connect the negative terminal of a DVM to analog ground at TP3 or TP12. Wait for 2 minutes to allow the amplifier offsets to settle after power-on.
- Adjust R40 to get a 0 m V reading from TP10.
- Adjust R35 to get a 50 mV reading from TP13.
  Since the first stage offset adjustment is also used to compensate offset errors of the amplifier on PMT assembly, the adjustment is only valid when a tube assembly is present during adjustments. If the tube assembly is to changed, adjustments must be done again.

11.5 Galvanometer driver

The galvanometer drive signal is a triangle wave, whose amplitude, DC offset and frequency are adjustable. In practice only the amplitude (sweep length) and DC offset (sweep position) are adjusted while the frequency (vertical line frequency) is kept constant.

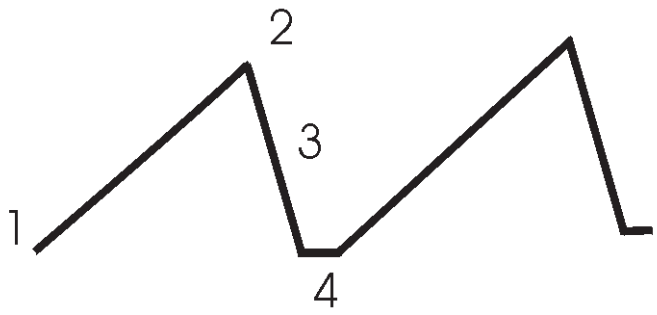


FIGURE 11 - 2: Triangle wave form for sweeping the galvanometer

The galvanometer signal is generates with an integrator (1C26/a). three different voltage levels are switched to integrator input with analog switches (!C20, 25) and the integrator capacitor is disharged with switch IC25/c.

CPU generates all signal transitions by controlling the integrator switches continuously during plate readout:

1 Vertical sweep: negative voltage is integrated about 20 ms (INT_POS active)
2 Sweep return: positive voltage is integrated about 4 ms (INT_NEG active)
3 Integrator is cleared momentarily (INT_CLEAR active) when about half of the sweep return has taken place. DC offset is adjusted by controlling the precise timing of clearing in respect to the sweep return.
4 Galvanometer stabilisation time: zero volt signal is integrated about 6 ms (INT_0 active)

The CPU controls the signal amplitude by writing the digital potentiometer (IC21), which sets integrator input voltages. Changing integrator input voltages affects the output amplitude when frequency is kept constant. Both the positive and negative slope of the triangle wave are controlled by the same digital potentiometer output. The resulting adjustment range for pin 7 of IC26 is -0,5 ... -1 V (INT_POS) an for pin 7 of IC8 it is 2.5 ... 5 V (INT_NEG).

The signal for INT_NEG (2.5 ... 5 V) is also accessible to the A/D converter as GAL_TEST. At present the A/D converted only measures it as the input signal for the Scanner Test Image (available when Digora Service Assistant is used).

The integrator signal amplitude and DC offset are changed according to the

results of the calibration procedure activated by the user.

Wen the galvanometer is not used, CPU keeps the integrator continuously cleared and disables all other control signals. This keeps the integrator output at zero volts. If the integrator clearing signal is not active for any reason, the integrator begins to integrate its own offset voltage and output is driven towards either of the supply voltages, which causes excessive heating of the galvanometer and its power driver. This is prevented with a protection circuit, which monitors the integrator output. If the output signal is continuously greater than +/- 4 V, it opens an analog switch (IC20c or d) that connects the integrator output to the power driver.

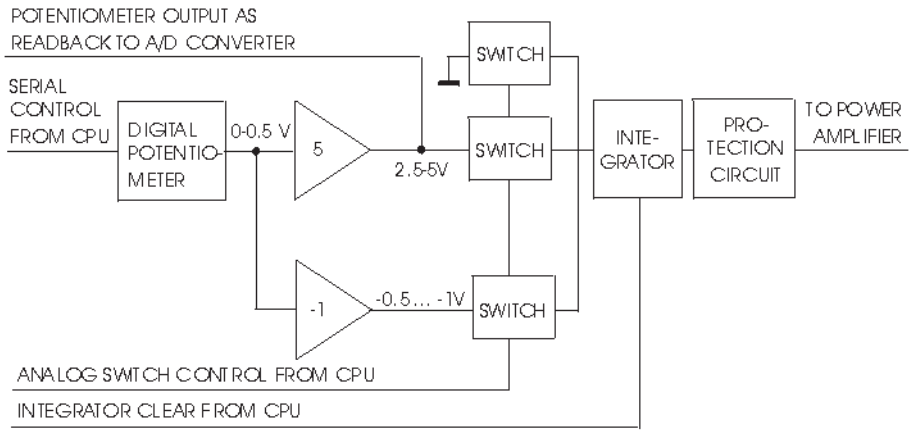


FIGURE 11 - 3: Galvanometer control circuitry, simplified block diagram

11.6 Plate detector

The plate detector is used to sense if an imaging plate is inserted properly or not. The plate detector is an optical reflective IR sensor, which gives a high signal if the white side of a plate is towards it. If a plate is inserted the wrong way or is not present, the signal is smaller. Due to the mechanical assembly, reflector sensitivity variations, sensor aging and temperature drift the scanner adjusts the sensitivity of the plate detector in run time.

The detector consists of a transmitter and a receiver. The transmitter LED current is adjusted by a voltage controlled current generator (IC27/c, R62 and TR3). The LED current is set by IC21. the maximum current is 3mA. The current generator is enabled with the PLATEDET* signal, otherwise the current is zero to prevent the LED light from erasing the image from the imaging plate before readout. The LED current is at maximum by default, but if this gives too high a receiver signal, the current is decreased. The PLATEDET* signal activity is connected to safety/service switch position. When the switch indicates that the scanner cover is open (laser and high voltage supply can't be activated), the PLATEDET* signal is on constantly to make it easier to measure the plate detector signals. When the switch is turned to the other position, the PLATEDET* signal is on only in short pulses (about 20 ms each) and only when absolutely needed to protect the image in the imaging plate.

The receiver is a photo transistor, whose output signal is buffered and limited with IC27/a and can be read with the A/D converter.

11.7 Test points

TP1	Digital +5V supply
TP2	Digital ground
TP3	Analog ground
TP4	PMT signal after second amplifier (gain 53) and first attenuator (1 ... 255 /245)
TP5	Analog -8V
TP6	Analog +8V
TP7	Analog -5V
TP8	Analog +5V (A/D ref)
TP9	Galvanometer integrator output
TP10	PMT signal after first amplifier stage (gain 1)
TP11	INT_CLEAR, galvanometer integrator clear signal
TP12	Analog ground
TP13	FINALPMT, amplified PMT signal to A/D converter
TP14	HV_REF, analog high voltage control signal
TP16	Plate detector LED current,
TP18	TcD/RxD* RS485 transceiver direction control from CPU
TP19	RxD from RS485 transceiver
TP20	TxD from CPU
TP21	TEST, pixel clock for A/D conversions
TP23	Digital ground
TP24	Digital ground

11.8 Led indicators

Power supply indicators (always active)

D1	Analog -8V
D2	Analog +8V
D3	Analog -5V
D4	Analog +5V (Vref)
D12	High voltage on (see notes)

The rest of LED indicators are active only when the safety/service switch is in upper position

D11	Service (safety/service switch active)
D13	Laser active
D10	TxD, flickering indicates RS485 activity
D9	RxD, flickering indicates RS485 activity

NOTES:
High voltage power supply and laser are always disabled when the scanner cover is removed. If these circuits need to be activated for test purposes, the safety/service switch should be set to down position. The high voltage LED indicates that CPU is trying to activate the circuit, but if the service switch is in the upper position, it cannot be done.

On the high voltage supply board T4101 there is another LED, which gives real indication whether the high voltage is active or not.

11.9 P4000-2 connector pinouts

J4001

1, 3, 5, 7, 8, 9	AGND	-	-
12, 14, 17,18, 19	+12V	in	-
15,16	-12V	in	-
20, 38, 39	+5V	in	-
28, 36, 37	GND	-	-
2	HV_FB	in	analog feedback signal from hv power supply
4	HV_REF	out	analog high voltage control signal, 5V=850V
6	GAL_sweep	out	galvanometer drive signal to power amplifier
10	TEST	out	pixel clock for A/D conversions
11	HV_OFF	out	hv power supply on/off control from CPU
13	HV_ENA	out	high voltage enable (from safety/service switch)
21	SEAMENA*	out	seamer drive enable fro CPU
22	COMP_HOME*	in	seamer compression motor is at start position
23	SEAMREQ*	in	front panel seamer push button
24	DOOR_HOME*	in	door micro switch to indicate of door is open
25	SMALL	out	LED output for small plate indocator LED
26	SMALL	in	small push button in front panel
27	RUN*	in	front panel test push button
29	COMP	out	connect stepper driver to seamer motor, active when seamer motor is running
30	SLIDE	out	connect stepper driver to plate movement motor, active when plate movement motor is running
31	STEPCLK	out	clock for plate movement motor and seamer stepper
32	STEPENA*	out	stepper driver enable
33	LEVELPRO	out	stepper motor operation mode
34	STEPENA*	out	stepper rotation direction control
35	SLOWCD	out	control signal for slow current decay mode of stepper motor
40	LASER*	out	enables laser

J4002

1	BUSS_B	i/o	RS485 signal line
2	BUSS_A	i/o	RS485 signal line
3	PCGND	-	PC ground for isolated RS485
4	+5C_PC	in	RS485 power supply from PC

J4003

1	PRER_	out	preread lens motor drive signal
2	AGND	-	

J4004

1	LIFT_MOT	out	plate lift motor drive signal
2	AGND	-	-

J4005

1	PLATE	in	signal to indicate reflectiveness of material in front of reflective sensor
2	-	out	low when reflective sensor is activated, this signal is high when presense of imaging plate is detected
3	GND	-	-
4	-	out	supply voltage for LED

J4006

1	HOME	in	signal to indicate when the imaging plate transport motor is at start position
2	GND	-	-
3	GND	-	-
4	-	out	supply voltage for LED

J4007

1	LAMP_GND	out	open collector output for plate erase lamp
2	+12v	-	-

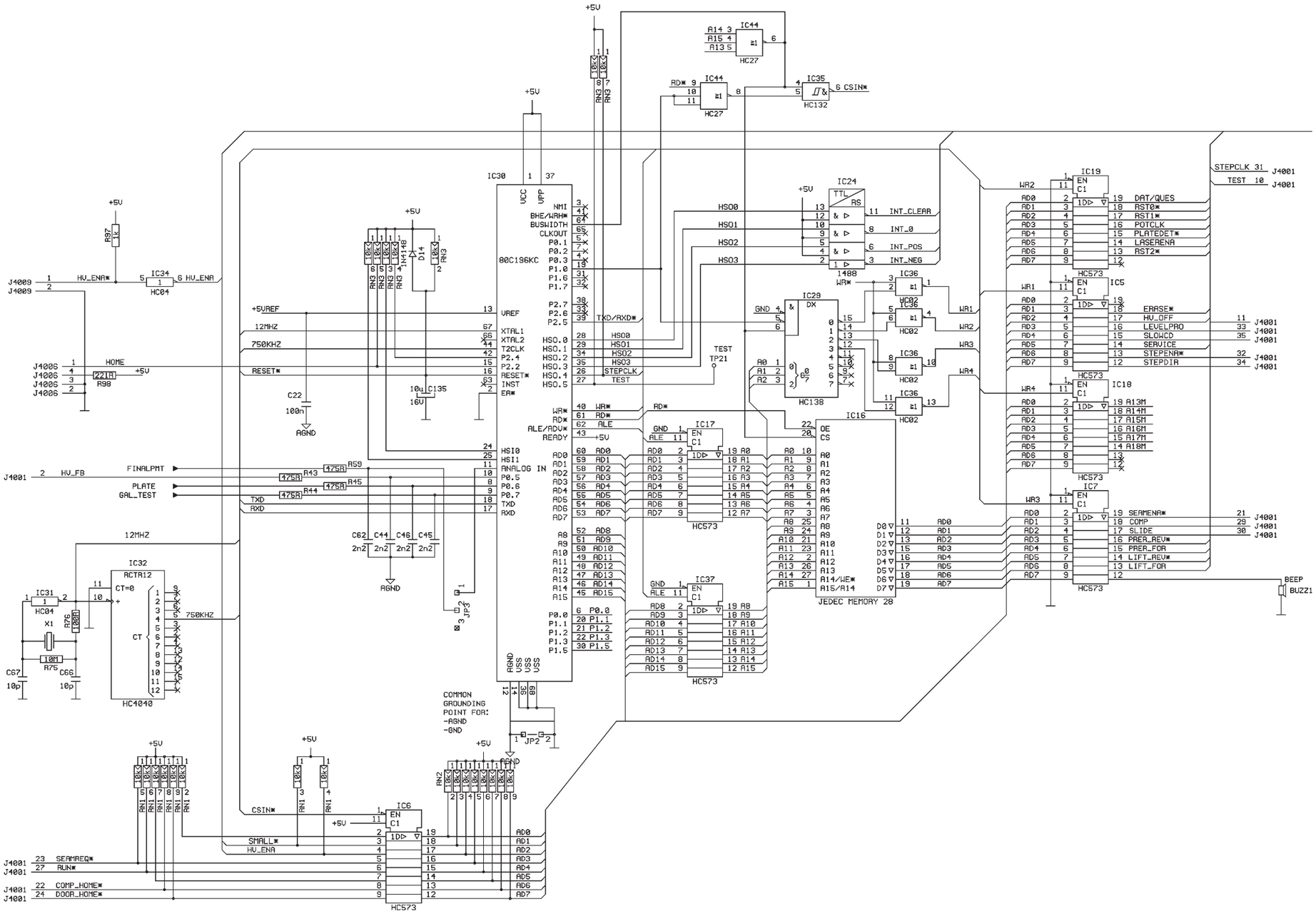
J4008

1,2,7,8	nc.	-	
3	+8V	-	+8V supply voltage
4	AGND	-	-
5	PMT_OUT	in	analog signal from photo multiplier tube
6	-8V	-	-8V supply voltage

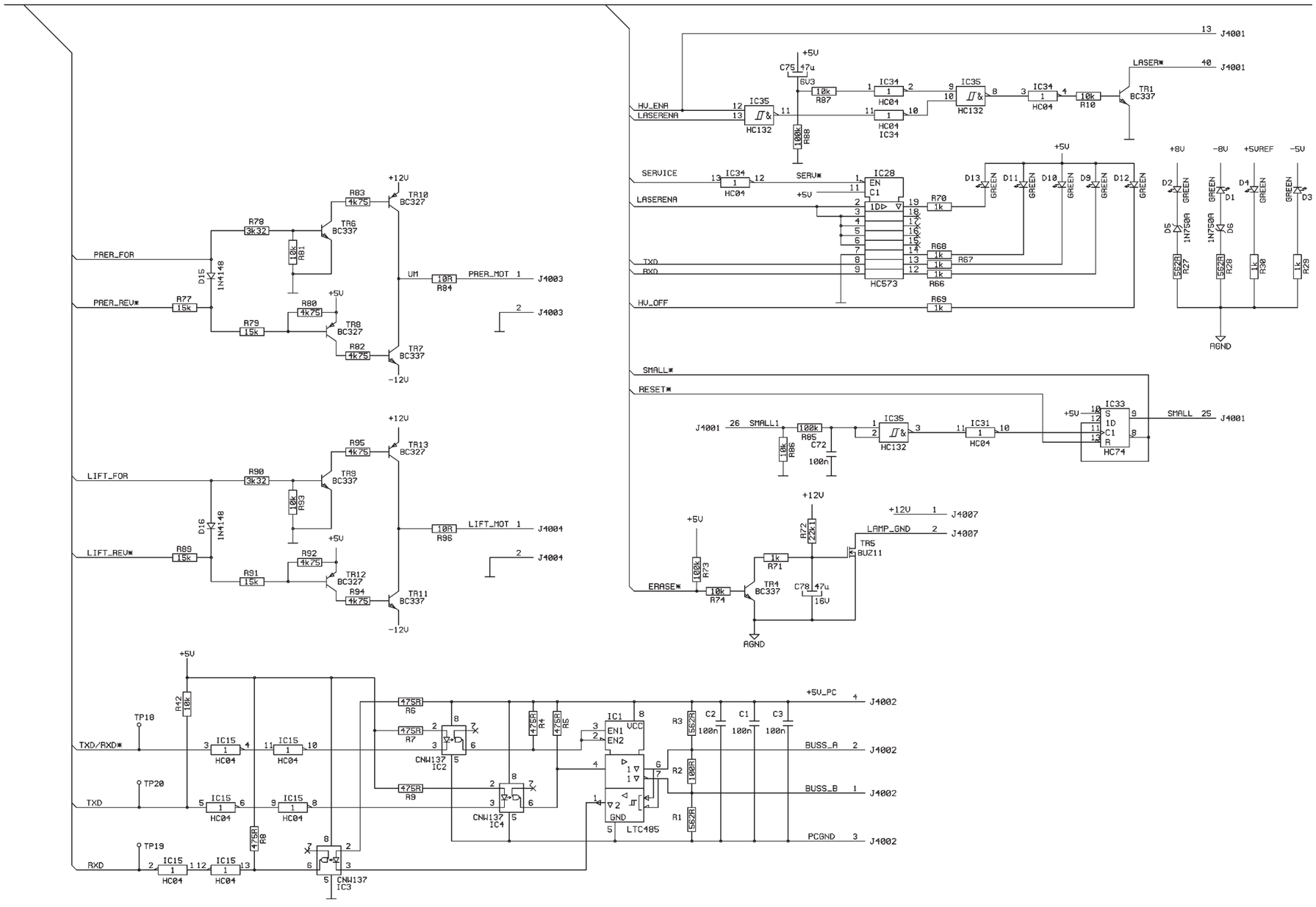
J4009

1	GND	-	-
2	HV_ENA*	in	safety/service switch to disable hv and laser when cover is open
JF		-	ground point of secondary circuit

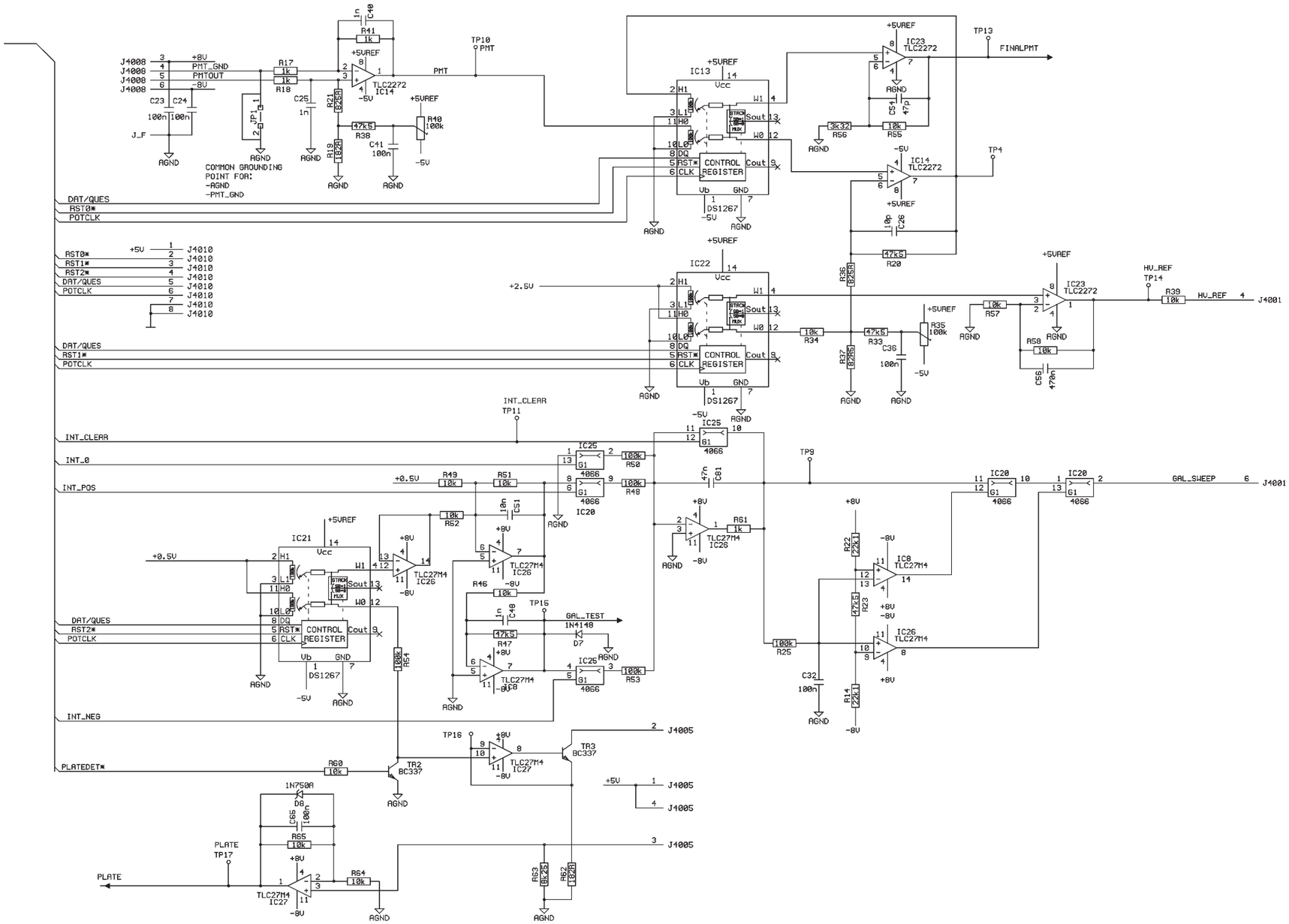
*) = indicates that signal is active LOW, all other signals are active HIGH



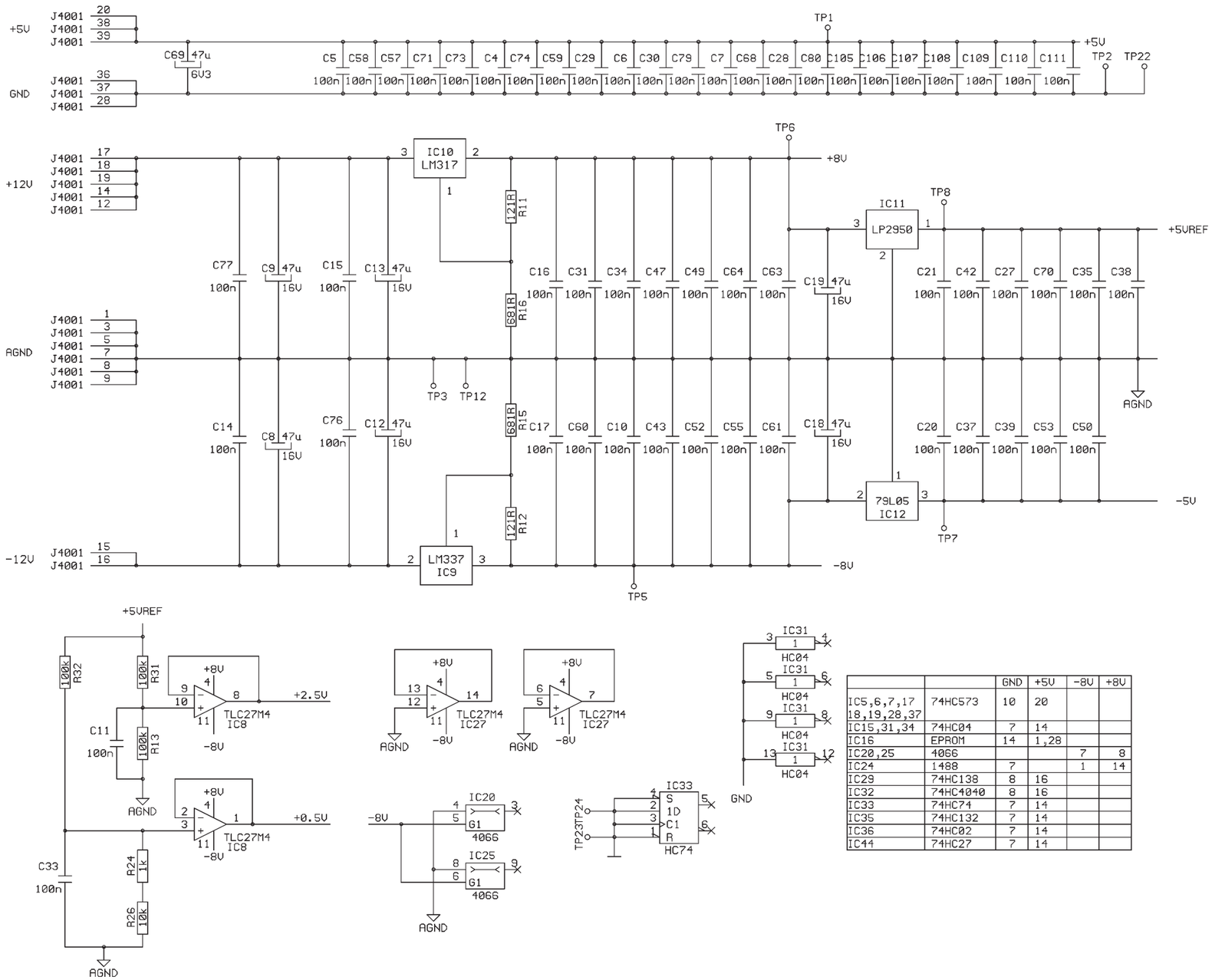
P4001 Processor board, circuit diagram (Sheet 1/4)



P4001 Processor board, circuit diagram. (Sheet 2/4)

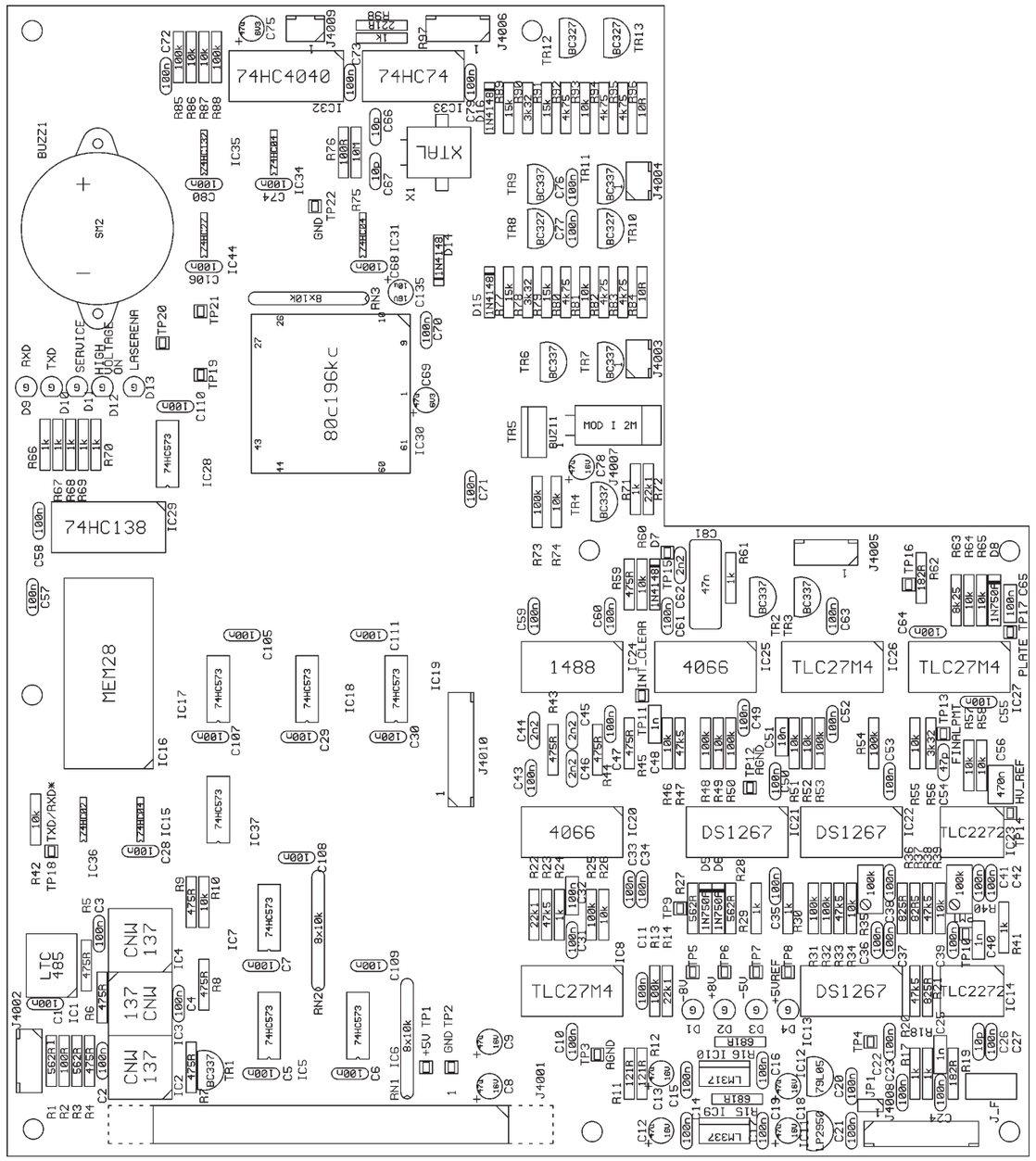


P4001 Processor board, circuit diagram. (Sheet 3/4)

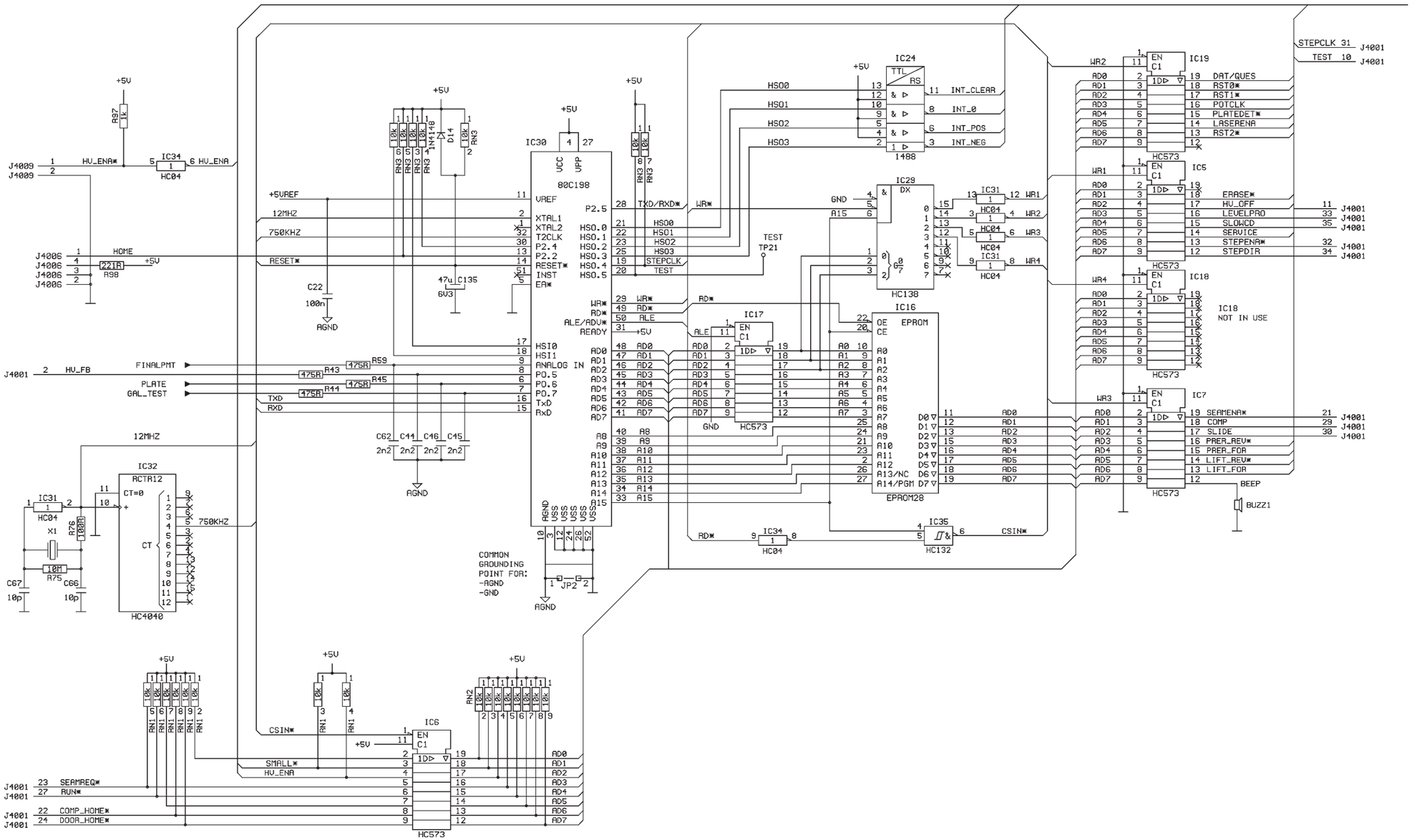


		GND	+5V	-8V	+8V
IC5,6,7,17 18,19,28,37	74HC573	10	20		
IC15,31,34	74HC04	7	14		
IC16	EPROM	14	1,28		
IC20,25	4066			7	8
IC24	1488	7		1	14
IC29	74HC138	8	16		
IC32	74HC4040	8	16		
IC33	74HC74	7	14		
IC35	74HC132	7	14		
IC36	74HC02	7	14		
IC44	74HC27	7	14		

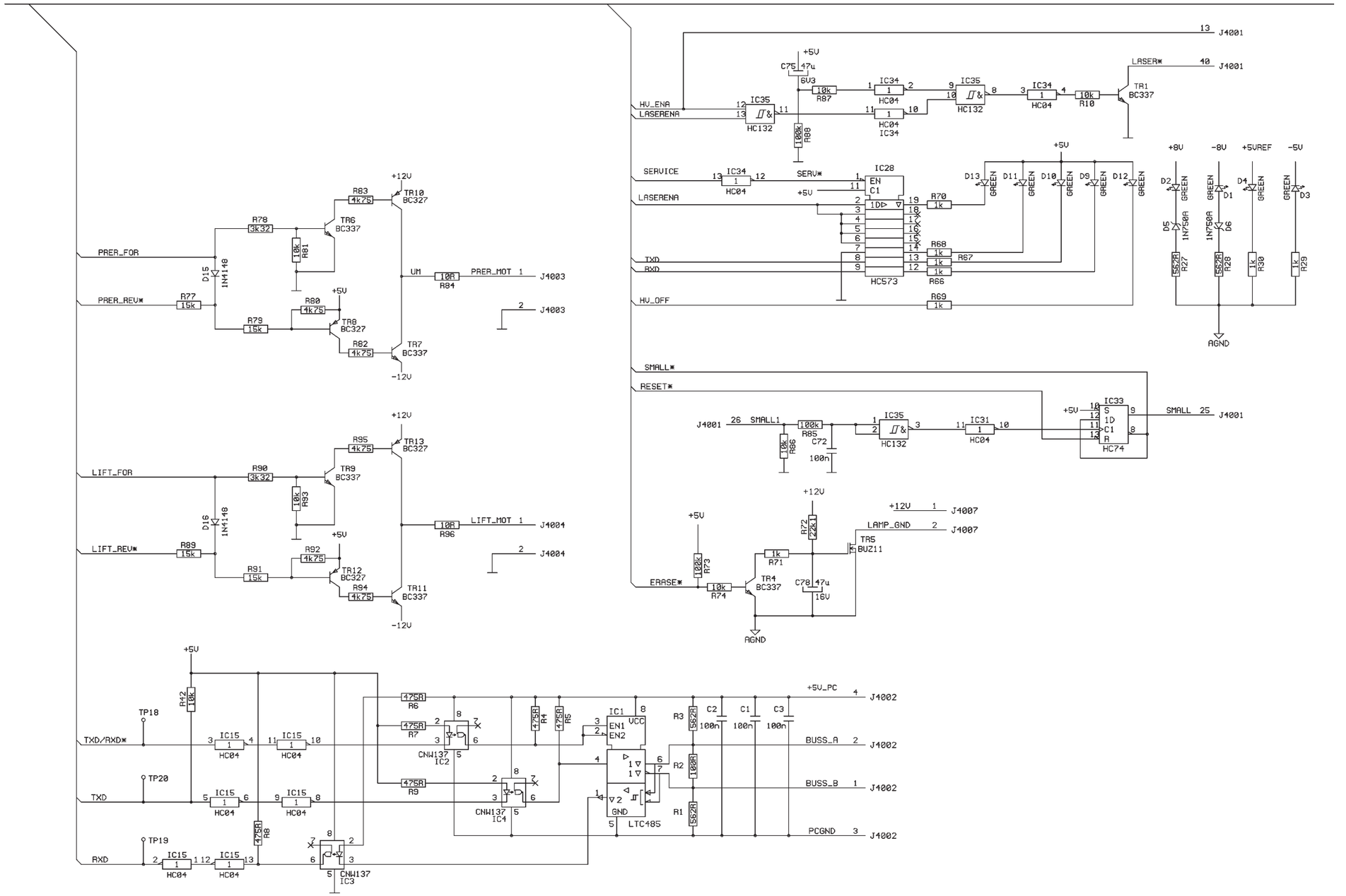
P4001 Processor board, circuit diagram. (Sheet 4/4)



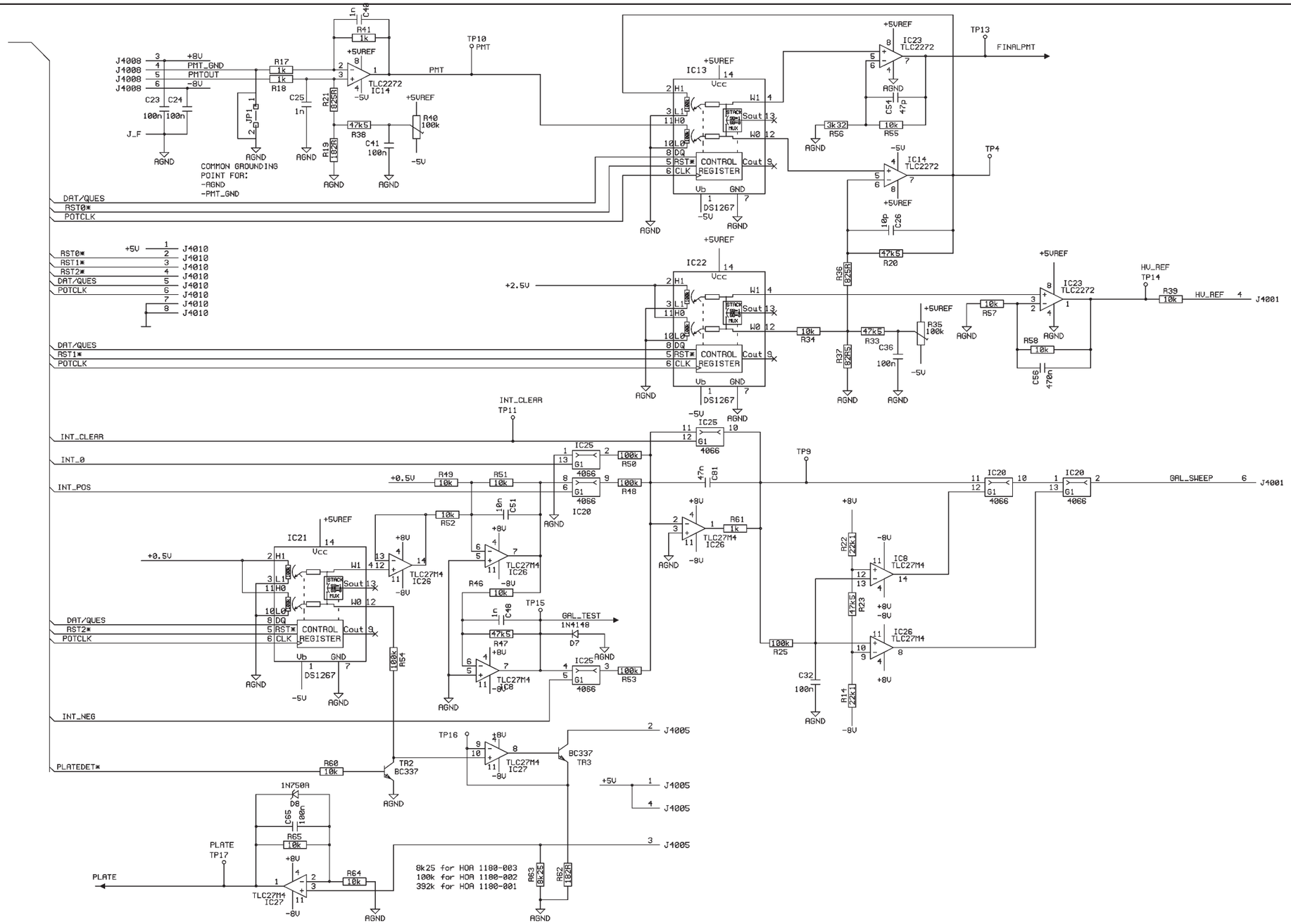
P4001 Processor board. (Component layout)



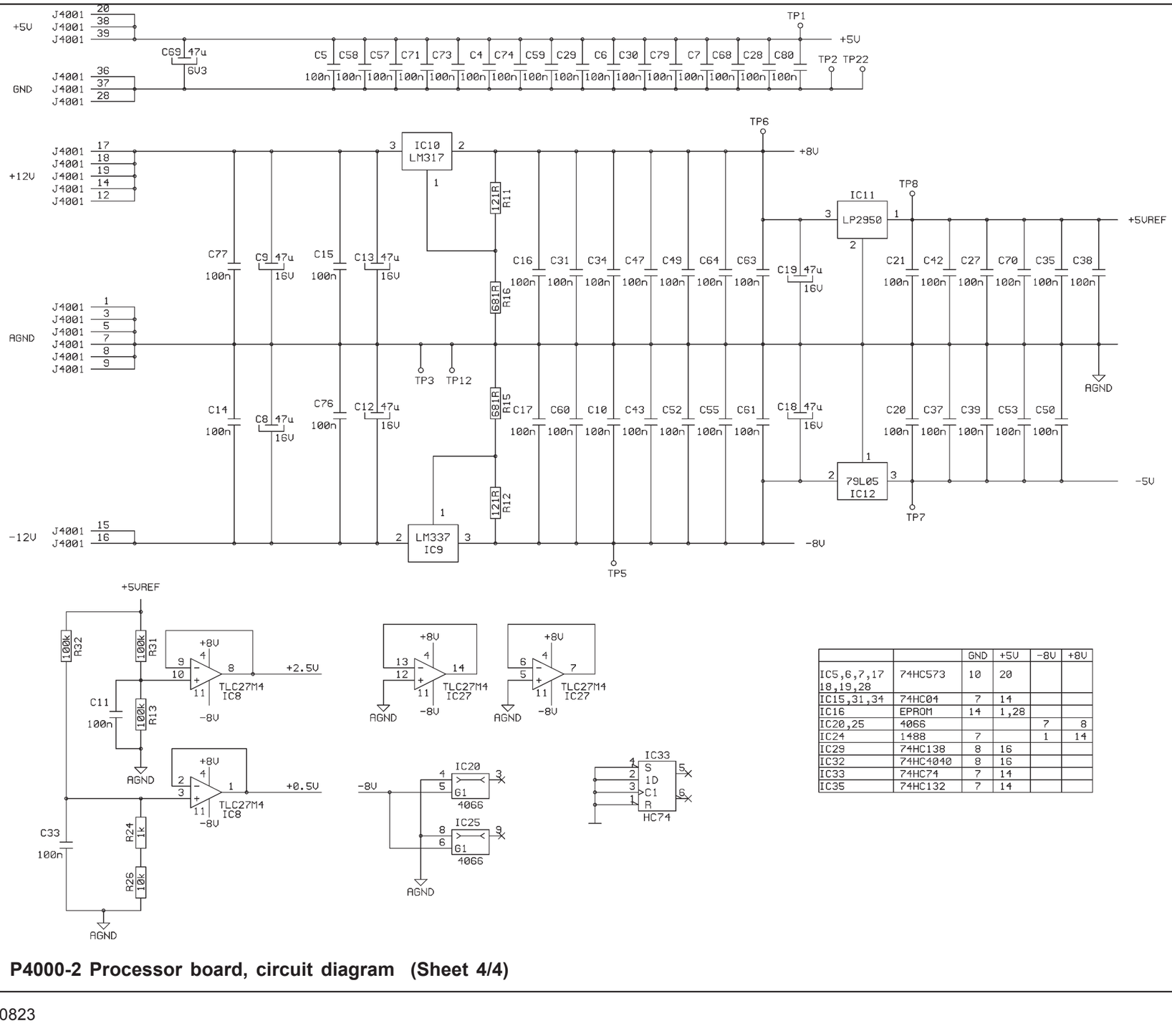
P4000-2 Processor board, circuit diagram (Sheet 1/4)



P4000-2 Processor board,circuit diagram (Sheet 2/4)

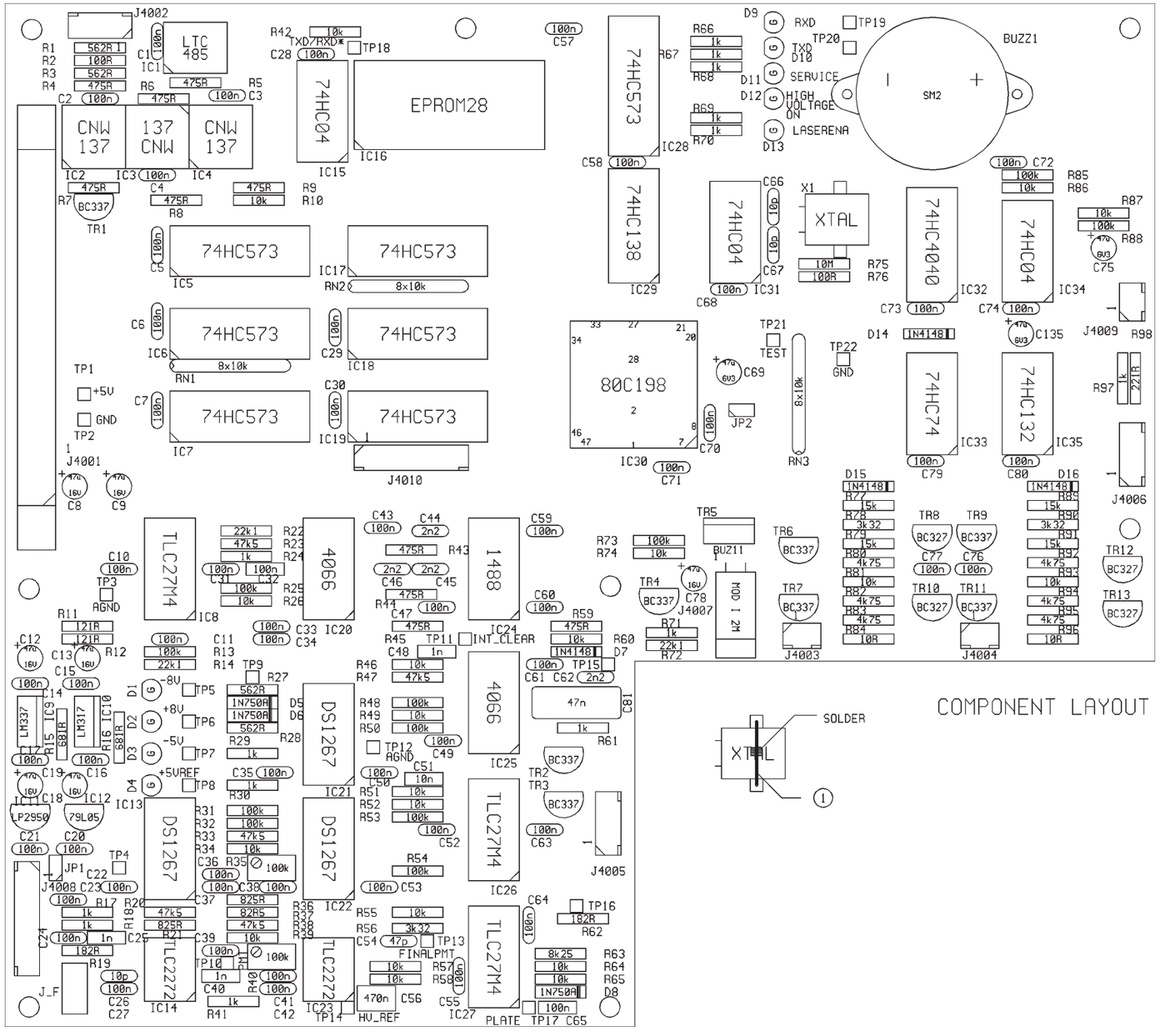


P4000-2 Processor board, circuit diagram (Sheet 3/4)



		GND	+5V	-8V	+8V
IC5,6,7,17 18,19,28	74HC573	10	20		
IC15,31,34	74HC04	7	14		
IC16	EPROM	14	1,28		
IC20,25	4066			7	8
IC24	1488	7		1	14
IC29	74HC138	8	16		
IC32	74HC4040	8	16		
IC33	74HC74	7	14		
IC35	74HC132	7	14		

P4000-2 Processor board, circuit diagram (Sheet 4/4)



P4000-2 Processor board (Component layout)

Processor board P4000-2 is identical to P4000-1 except that connector J4007 has been changed to AMP MOD 1 type.
For this reason P4000-1 and 4000-2 are not interchangeable without changing the erasing lamp connector. Also additional jumper wires have been implementented in the PCB design.

12. STEPPER DRIVE AND HIGH VOLTAGE SUPPLY T4101

This PCB contains a high voltage power supply for the photo multiplier tube, a single stepper controller, laser tube power supply control, galvanometer power amplifier and a driver for the transport stepper motor.

12.1 Functional description

Main features

- CPU controlled high voltage supply for photo multiplier tube
- galvanometer power amplifier
- micro stepper contoller interface and power amplifier for imaging plate movement motor
- laser On/Off control

12.2 High voltage power supply

Specifications:

Voltage range	-350 ... -880 VDC
Output current	max. 1 mA
Ripple	50 mVpp (When noise at HV_REF<100 uV)
Line regulation	0.05 %

Output voltage of high voltage supply is set by CPU DAC with HV_REF signal. Supply is stable with a 1Mohm load in the voltage range of -350 ... -880V. Voltage range is set with resistor R1+R2+R3/R6+R7, and a control signal of 5 volts is equal to -880V output voltage. If output is set to a voltage less than -350 volts, ripple is not within specified limits. The output is current limited and short circuit protected.

UC3846 PWM controller has two totem pole outputs, one them drives a fet controlling the transformer and other is connected to a led, which indicates if the high voltage supply is active.

Input power of the high voltage supply is stabilised to 9.8 volts with IC3 to improve line regulation.

12.3 Control signals

HV_REF analog input, sets output voltage

HV_FB analog output, read back of output voltage for 5V = -880V

HV_OFF input on/off control signal from CPU

HV_ENA input, on/off from safety/service switch

Truth table of HV_ENS and HV_OFF:

HV_ENA	HV_OFF	hv output
0	0	disabled
0	1	disabled
1	0	enabled
1	1	disabled

12.4 Micro stepper interface

Micro stepper controller drives stepper motors by controlling motor winding currents resulting in one motor step being divided into 32 parts. This means that with a 200 step motor, one revolution is equal to 6400 microsteps. Micro stepper circuit is driven by CPU with following control lines:

STEPENA* Controls stepper current on/off

STEPDIR Sets rotation direction

STEPCLK Step pulse input: each rising edge moves motor with on microstep

LEVELPRO Selects power amplifier operating mode, fast or slow. Fast mode allows fast current transitions in stepper windings. It may be used when very fast speed is required. Fast mode is currently not used

SLOWCMD Forces power amplifier to slow mode overriding the LEVELPRO setting

TEST Synchronises power amplifier chop per frequency with A/D conversion frequency

COMP/SLIDE These signals can be used to select between two stepper motors. When imaging plate movement motor is used, SLIDE signal is active.

Controller is built from a 8bit up/down counter (IC9,11), which keeps track of

a current step position and provides address inputs for an EPROM, where motor current tables are stored. EPROM data outputs drive a dual D/A converter (IC/10) which sets power amplifier (IC/7) output currents for both motor windings. Maximum output current is set with current measurement resistors R34 ... R37 and is 650 mA.

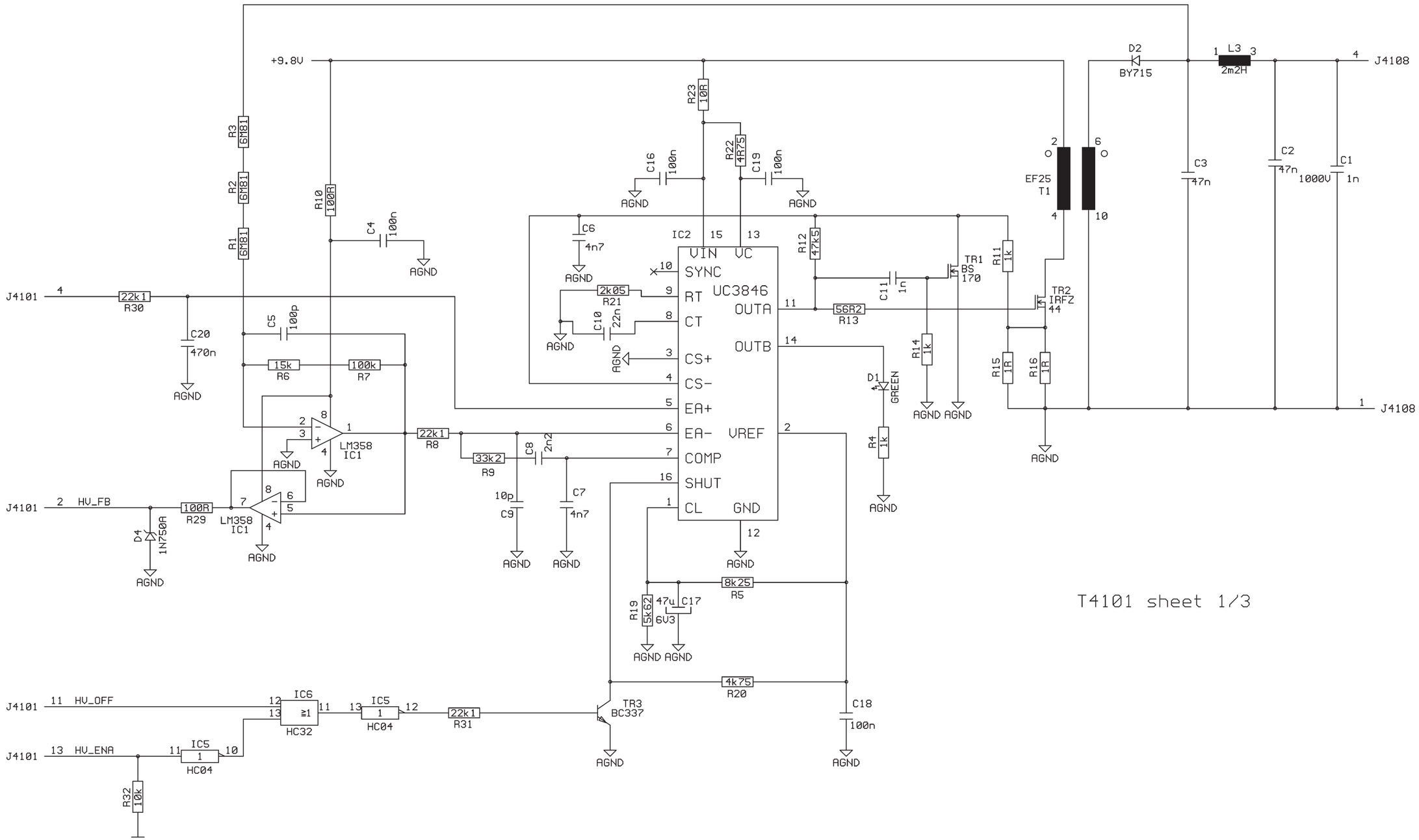
12.5 Test points

TP1	analog ground
TP2	-9.8V for hv supply
TP3	CLOCKW, galvanometer output
TP4	+12V (for analog circuits)
TP5	analog ground
TP6	-12V
TP7	DIGITAL GROUND
TP8	stepper power stage mode control input, phase 1
TP9	stepper current sense, phase 1
TP10	+12V for stepper
TP11	stepper current polarity input, phase 2
TP12	stepper power stage mode control input, phase 2
TP13	analog input, phase 2 stepper current
TP14	stepper current sense, phase 2
TP15	stepper chopper oscillator
TP16	stepper current polarity input, phase 1
TP17	DIGITAL GROUND
TP18	analog input, phase 1 stepper current
TP19	+5v

12.6 Laser and photomultiplier high voltage control

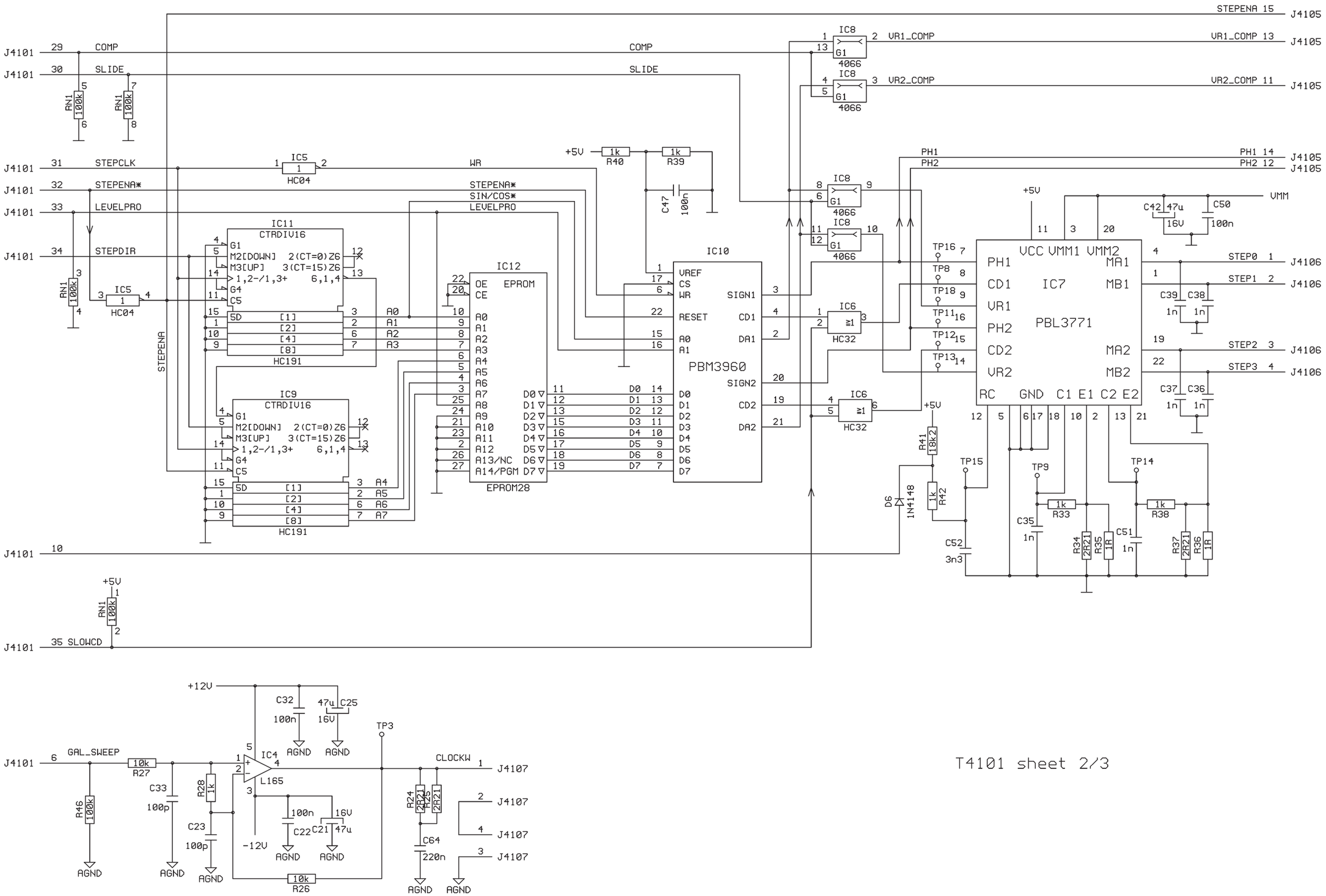
In normal operating state the HV_ENA signal from the safety/service switch is high, the PMT high voltage power supply follows the HV_REF voltage and laser power supply con be enabled or disabled by the LASERENA signal.

Input voltages for the LASER power supply (LASER +12v and LASER_GND) are connected directly to the scanner power supply by dedicated wires and the LASEREN* signal is optoisolated.

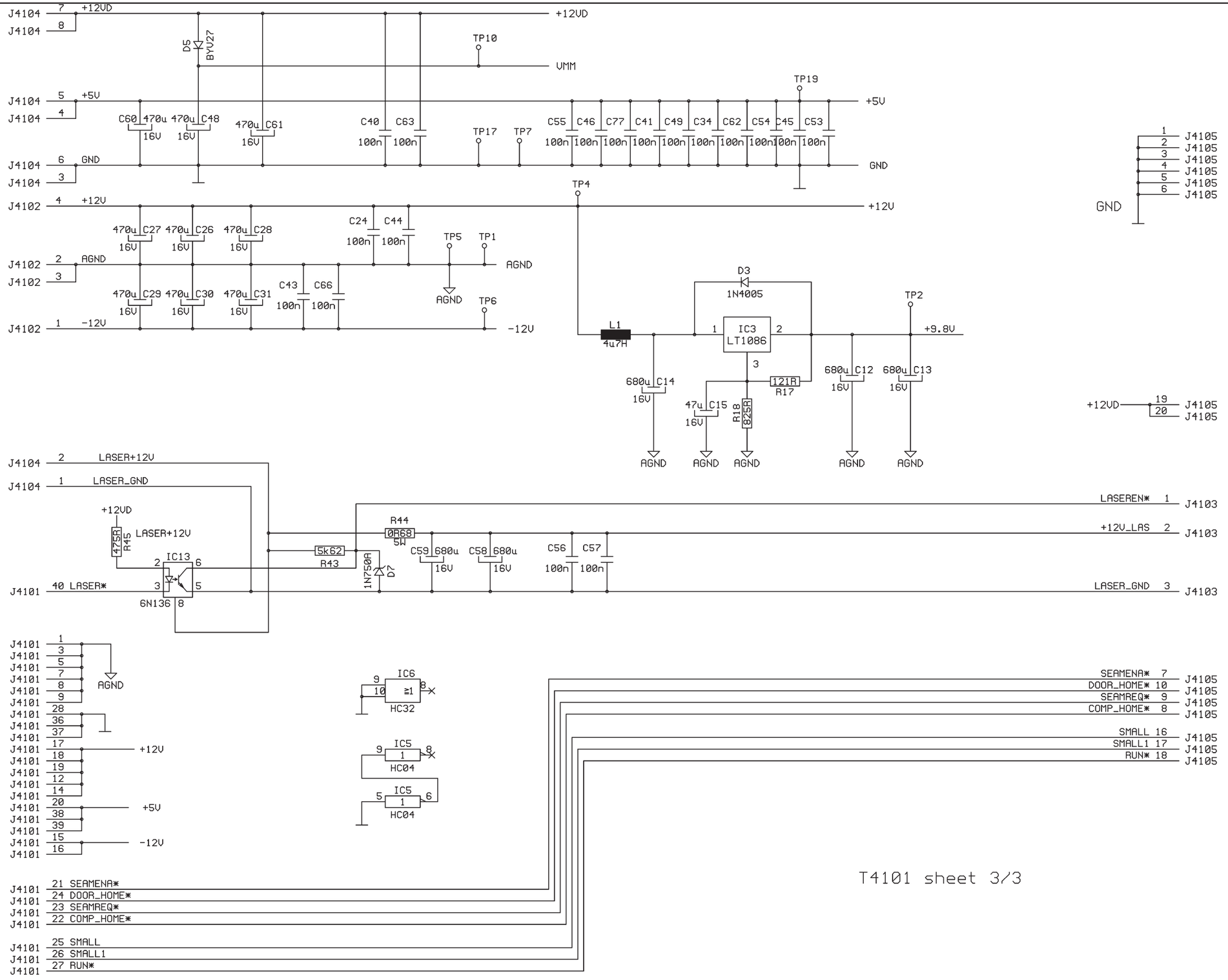


T4101 sheet 1/3

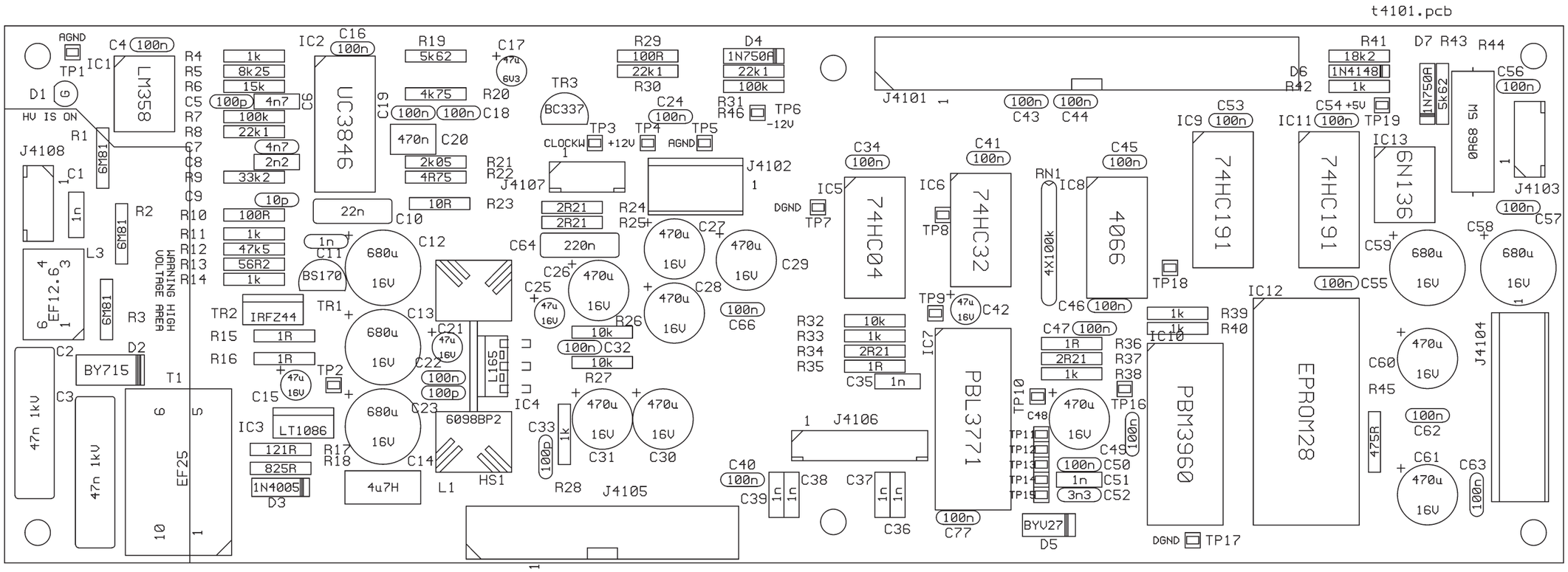
Circuit Diagram for T4101 Stepper drive and high voltage supply (Sheet 1/3)



Circuit Diagram for Stepper drive and high voltage supply T4101 (Sheet 2/3)



Circuit Diagram for Stepper Drive and high voltage supply T4101 (Sheet 3/3)



Component layout for T4101 Stepper drive and high voltage supply (Component layout)

13. PMT BIAS T4300

This PCB contains a resistive voltage divider for the photo multiplier tube (PMT) biasing voltages and a preamplifier for the PMT signal. This PCB is mounted inside the PMT assembly and is a part of the actual PMT. The principal of this PCB is described in the following description.

13.1 Photomultiplier tube biasing

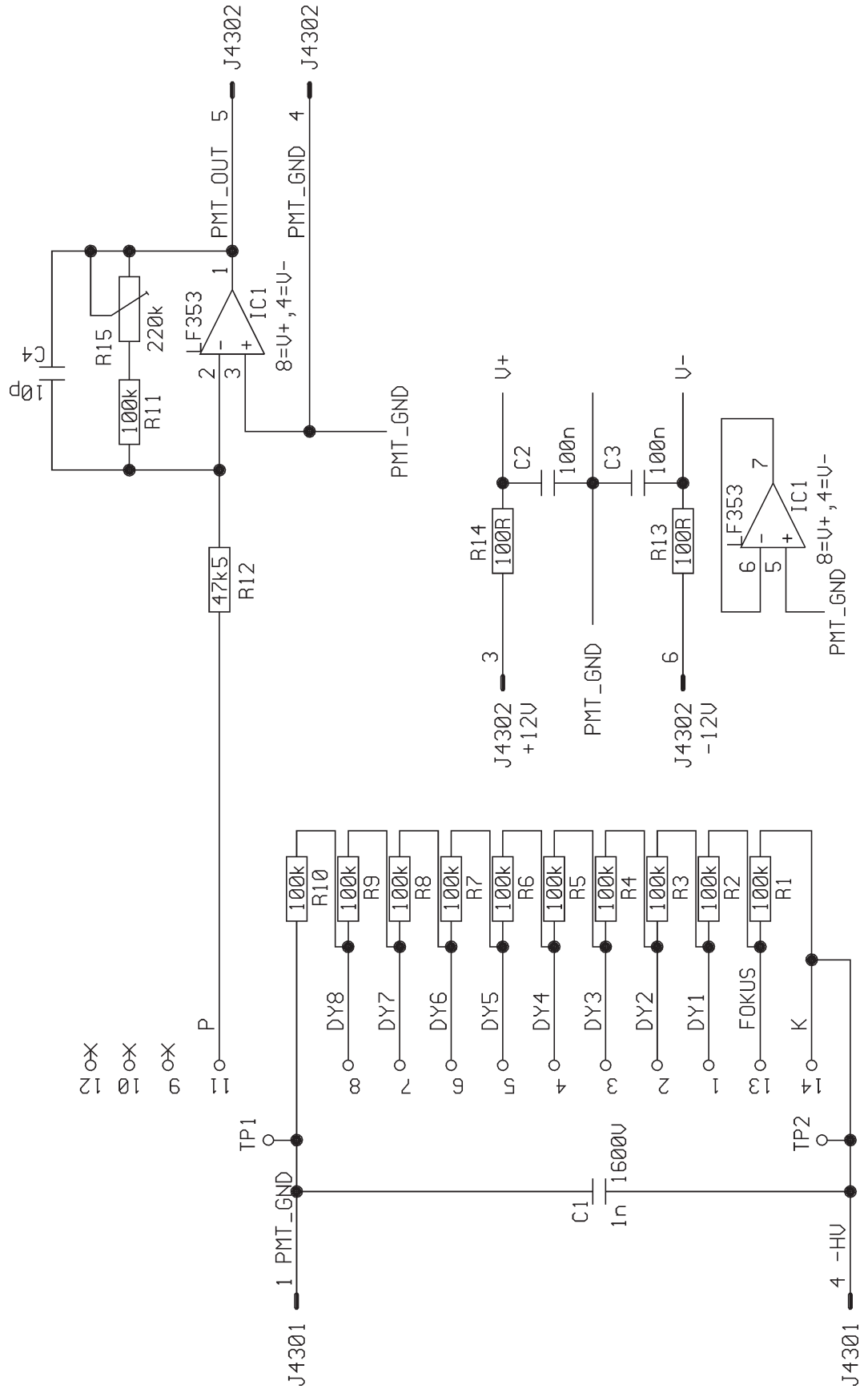
PMT operating voltage (-HV) is adjusted by the micro controller between approximately -400 to -800V depending on the x-ray dose of the calibration image. This voltage is divided evenly between PMT dynodes by resistors R1 ... R10.

13.2 PMT signal preamplifier

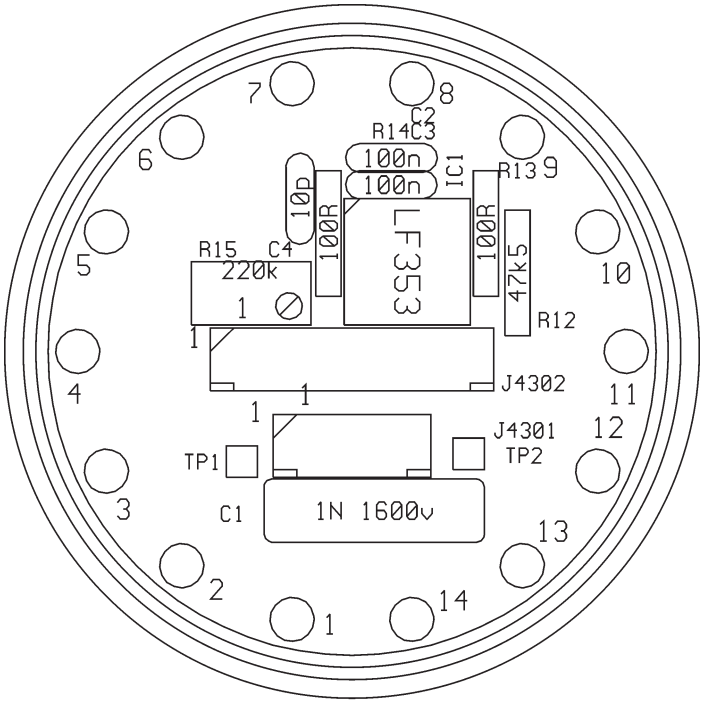
Current from the PMT anode is converted to voltage (PMT_OUT by opamp IC1. Its gain can be adjusted by trimmer R15 to compensate for varying sensitivities between PMTs.

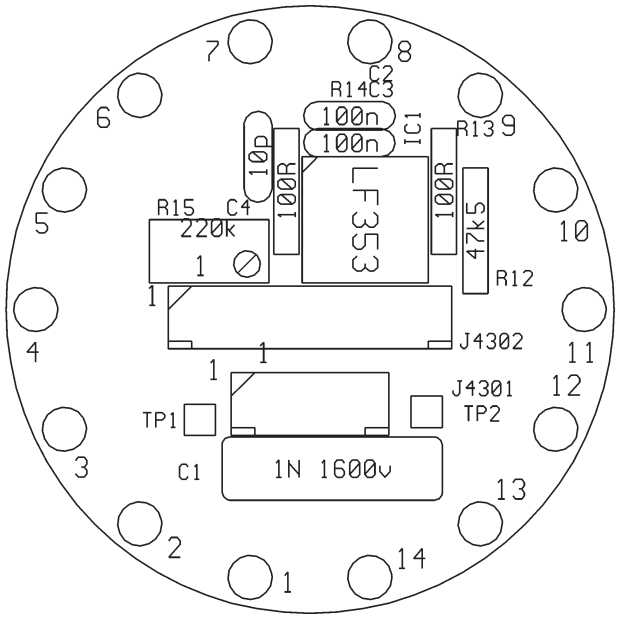
PMTs are supplied as complete units including the tube and a factory adjusted preamplifier.

13.3 T4300 Circuit Diagram for photomultiplier



13.4 T4300 Component layout for photomultiplier





14. MAINS POWER SUPPLY T4400

T4400 is a standard power supply NFS50 type 3223 or equivalent. T4400 can be connected to any mains supply voltage from 100 VAC to 240 VAC.

Connector pinouts (NFSSO type 3223):

T4400/J2

(nc.)	-12 V	-12 Supply Voltage
2	+12 V	+12 V Supply Voltage for laser
3	GND	Ground Potential for laser
4	+5 V	+5 V Supply Voltage

T4400/J3

1	-12 V	-12 V Supply Voltage for galvanometer power amplifier
2	+12 V	+12 V Supply Voltage for galvanometer power amplifier
3	GND	Ground Potential for galvanometer
(nc.)	+5 V	+5 V Supply Voltage

T4400/J4

(nc.)	-12 V	-12 V Supply Voltage
2	+12 V	+12 V Supply Voltage
3	GND	Ground Potential
4	+5 V	+5 V Supply Voltage

Connector Pinouts (PM65-31A):

1	+5 V	+5 V Supply Voltage
2	+5 V	+5 V Supply Voltage
3	GND	Ground Potential
4	GND	Ground Potential
5	+12 V	+12 V Supply Voltage
6	+12 V	+12 V Supply Voltage
7	-12 V	+12 V Supply Voltage
8	NC	

15. Key and display T4501

This pcb contains all the electronics necessary for the membrane keyboard/ LED display connected to J4502. It also contains the circuitry to move and control the autoloader motor.

Run (Action) Led is blinking when signal STEPENA is high. The circuitry controlling the blinking frequency is made by IC2 (two gates), resistors and capacitor C1. The other half of IC1 is used to allow the CPU to read either jumper J2 (mode) or autoloader microswitch signal through one single signal (COMP_HOME). When STEPENA is in L state, CPU can read the state of MODE jumper (no jumper means normal unit, with jumper means that unit has an Autoloader option) and when STEPENA is H, CPU can read the autoloader microswitch signal.

Jumper J1 (Run) is provided for testing purposes. When jumper is inserted, the scanner performs continously the scanning sequence using the internal readout values (not the values of calibration) and also therefore the connection to the PC is not necessary. Autoloader is not functionable when jumper is inserted in J1.

Connector Pinouts

J4501

1-6	AGND		GND to the circuitry
7	MOTENA*	IN	when L, activates the autoloader motor
8	COMP_HOME*	OUT	L active signal, presence of mode jumper or autoloader microswitch connecting
9	SEAMREQ*	OUT	goes L when Action button is pressed
10	DOOR_HOME	OUT	
11-14			no connection
15	STEPENA	IN	controls the Action led blinking and select switch to be monitored
16	SMALL	IN	controls which of image size LEDs is ON
17	SMALL1	OUT	goes H when image size button is pressed
18	RUN*	OUT	goes L whem jumper is inserted in J1
19-20	+12V		+12Vdc supply voltage to the circuitry

J4502

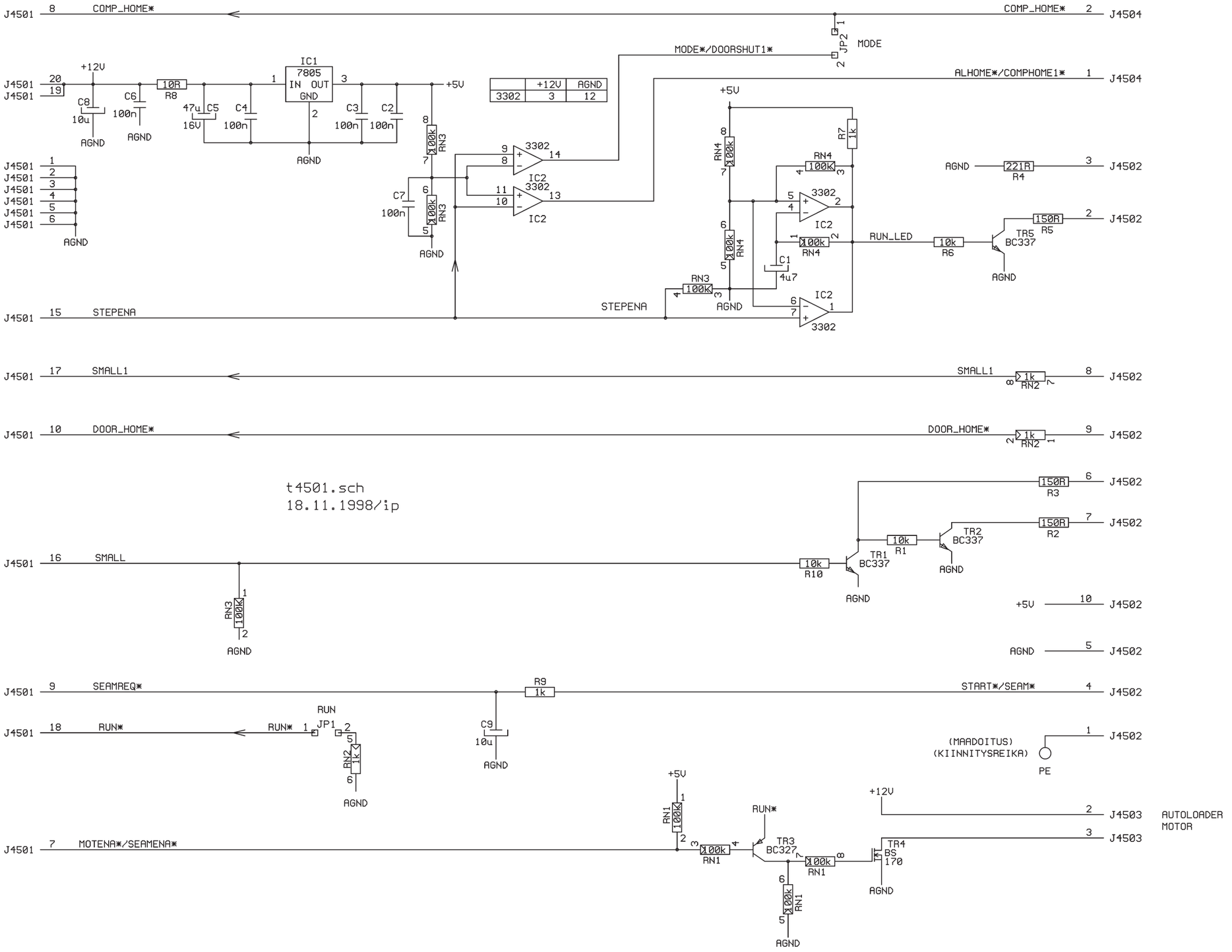
pin	signal	dir	Description
1	PE		shield of keyboard
2	RUN_LED	OUT	controls the ACTION led on the membrane keyboard
3	AGND		GND to the POWER ON LED on membrane keyboard
4	START*	IN	goes L when Action button is pressed
5	AGND		GND to membrane keyboard
6		OUT	when L switches on the smalll size LED
7		OUT	when L switches on the normal size LED
8	SMALL1	IN	goes H when image sixe button is pressed
9	DOOR_HOME		no connection
10	+5Vdc		

J4503

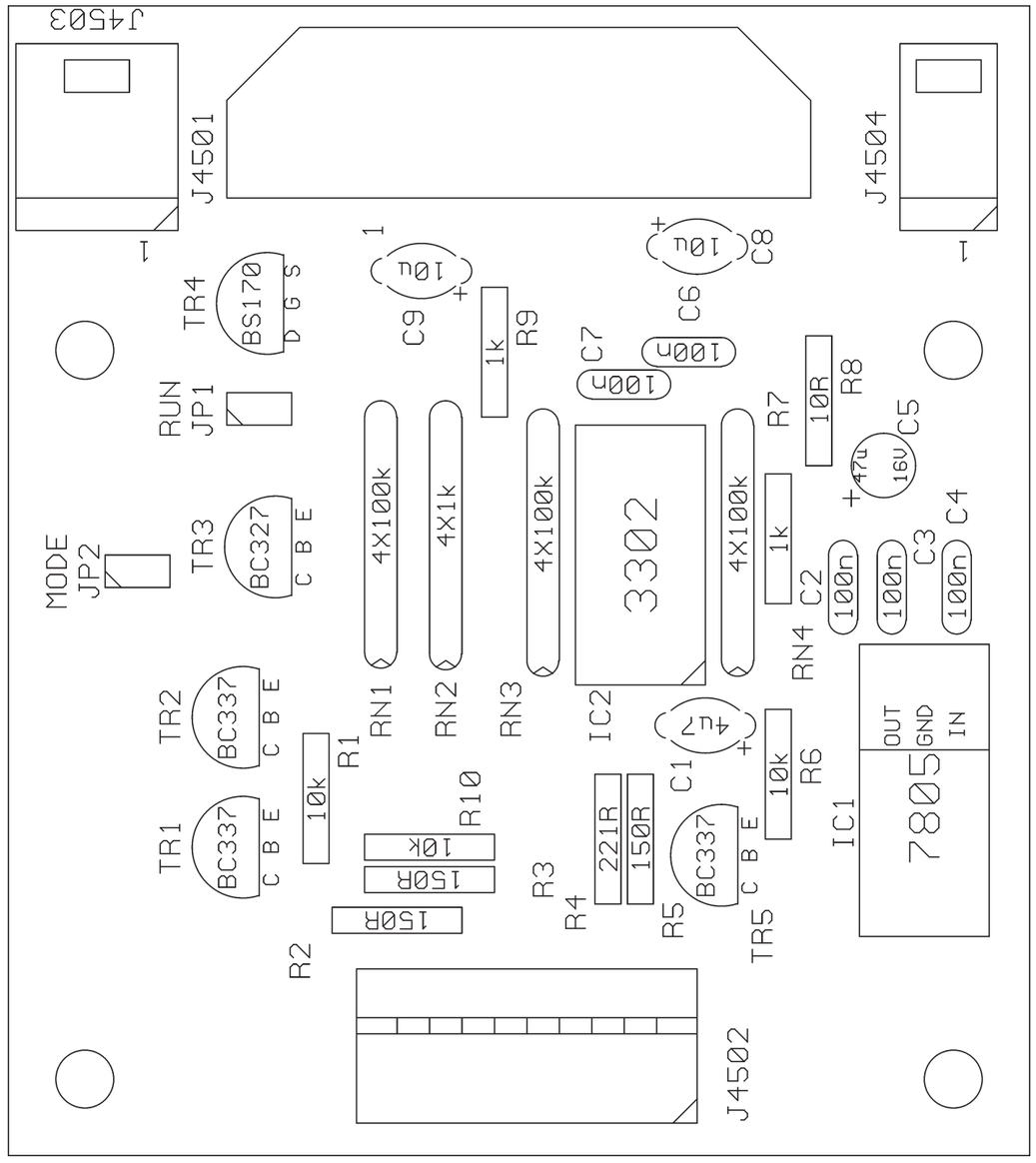
1		OUT	autoloader dc motor connection
2		OUT	autoloader dc motor connection

J4504

1	ALHOME*	OUT	when L enables autoloader microswitch to be monitored
2	COMP_HOME	IN	goes L, when autoloader microswitch is enabled and activated



Circuit Diagram for Key and Display T4501



Component layout for Key and Display T4501

16. PC interface adapters

16.1 P4602

PC Interface Adapter P4602 is a interface board between the scanner and computer and it is installed in the PCI bus of the computer. It consist of configurable FPGA circuit which reads its configuration, the program, from a serial EPROM. The FPGA circuit takes care of the interfacing to the PCI bus and all the UART (asyncronous receiving and transceiving) functions required. RS485 circuit and filtering are provided for proper interfacing to the Digora scanner. This board requires DfW 2.0 (revision 2 or later) to be installed in the PC.

16.2 P4601

This is the interface adapter board between the scanner and the computer and it is installed in the ISA bus. This pcb is basically a semi-intelligent bi-directional serial transfer buffer with 2 kilobytes of dual port RAM.

16.2.1 Micro controller and dual port ram

The micro controller 1C7 (Intel 80C198) controls data transfer between scanner and PC/AT using a 2kx8 dual port RAM IC8. This dual port RAM has two separate address, data and control busses, which enables asynchronous access to any memory location via both busses. If both busses refer to same memory location, the control logic sets the BUSY* signal for the delayed bus.

One side of the dual port RAM is connected to PC/AT bus and the other side via the processor's serial port to the scanner. This RAM functions as a double line buffer between scanner and PC/AT.

The Interface Adapter board's base 1/0 address can be selected between 100h ... 3F8h with increments of eight consecutive 1/0 memory locations.

16.2.2 Interface board connection for opto couplers

The opto couplers are included in the P4000-2 processor board to provide ground isolation between the scanner and the PC. This ground isolation decreases the chances of electrical interference to the scanner from the PC. Ground isolation is also required for the Digora scanner to be compatible with the requirements of IEC601-1.

16.2.3 Control Signals

TP3	STATUS	Informs PC/AT of valid data in dual port RAM.
TP8	TOGGLE	Memory page toggle at PC/AT side of dual port RAM.
TP7	PENDING	Informs the micro controller of data being written to dual port RAM by PC/AT.
TP5	READY	Informs the micro controller of valid data in dual port RAM

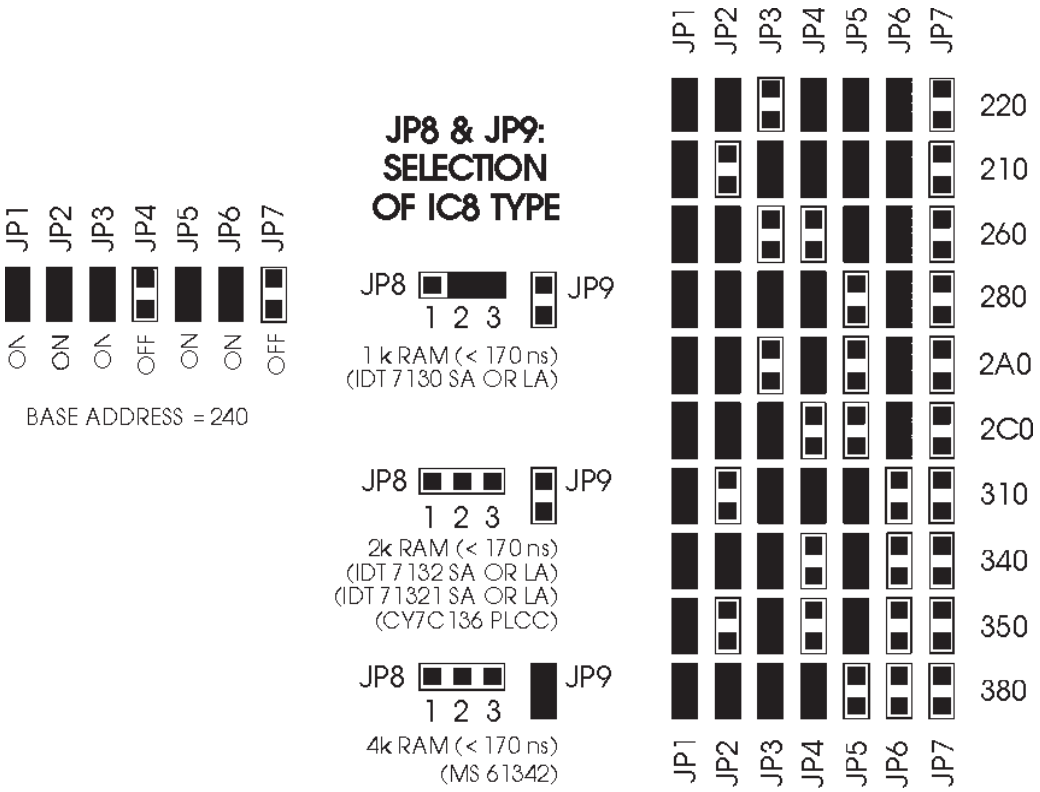


FIGURE 16 - 1: Control Signals

16.2.4 Test points

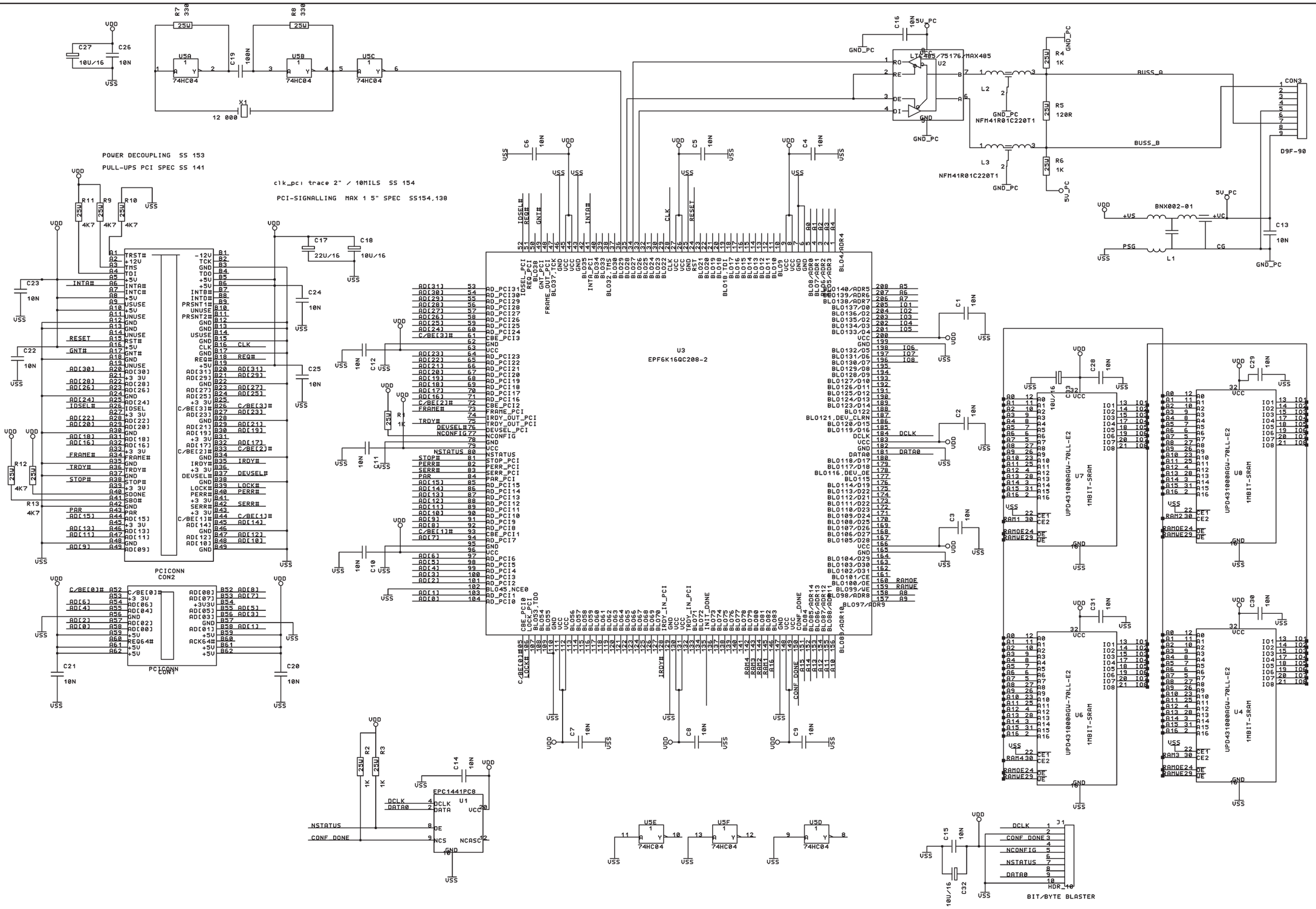
TP1	ADRMATCH*	Address set for this board matches the address on the PV address bus (signal is shorter than 1 us).
TP2	10_ACCESS	Read of Write access in 1/0 address space on the bus. (This interface board is accessed only when both ADRMEATCH* and 10_ACCESS are active.)
TP3	STATUS	Valid data for PC in dual Port RAM.
TP4	CE_L	Chip Enable for Dual Port RAM from PC bus.
TP5	READY	Valid data for local CPU in Dual Port RAM.
TP6	CE_R	Chip Enable for Dual Port RAM from local CPU.
TP7	PENDING	Data is being written to Dual Port RAM by PC.
TP8	TOGGLE	Selection between page 0 and page 1 of Dual RAM by PC.
TP9	COM_ERR*	Communication error detected by PC (not in use).
TP10	BUSYL*	Wait state request to PC bus.
TP11	BUSYR*	Wait state request to local CPU
TP12	TXD/RXD*	Direction of RS485 bus.
TP13	TXD	TxD of local CPU.
TP14	RXD	RxD of local CPU
TP15	+5V	Positive supply from PC bus
TP16	GND	

16.2.5 CONNECTOR PINOUTS J4601 (to PC bus)

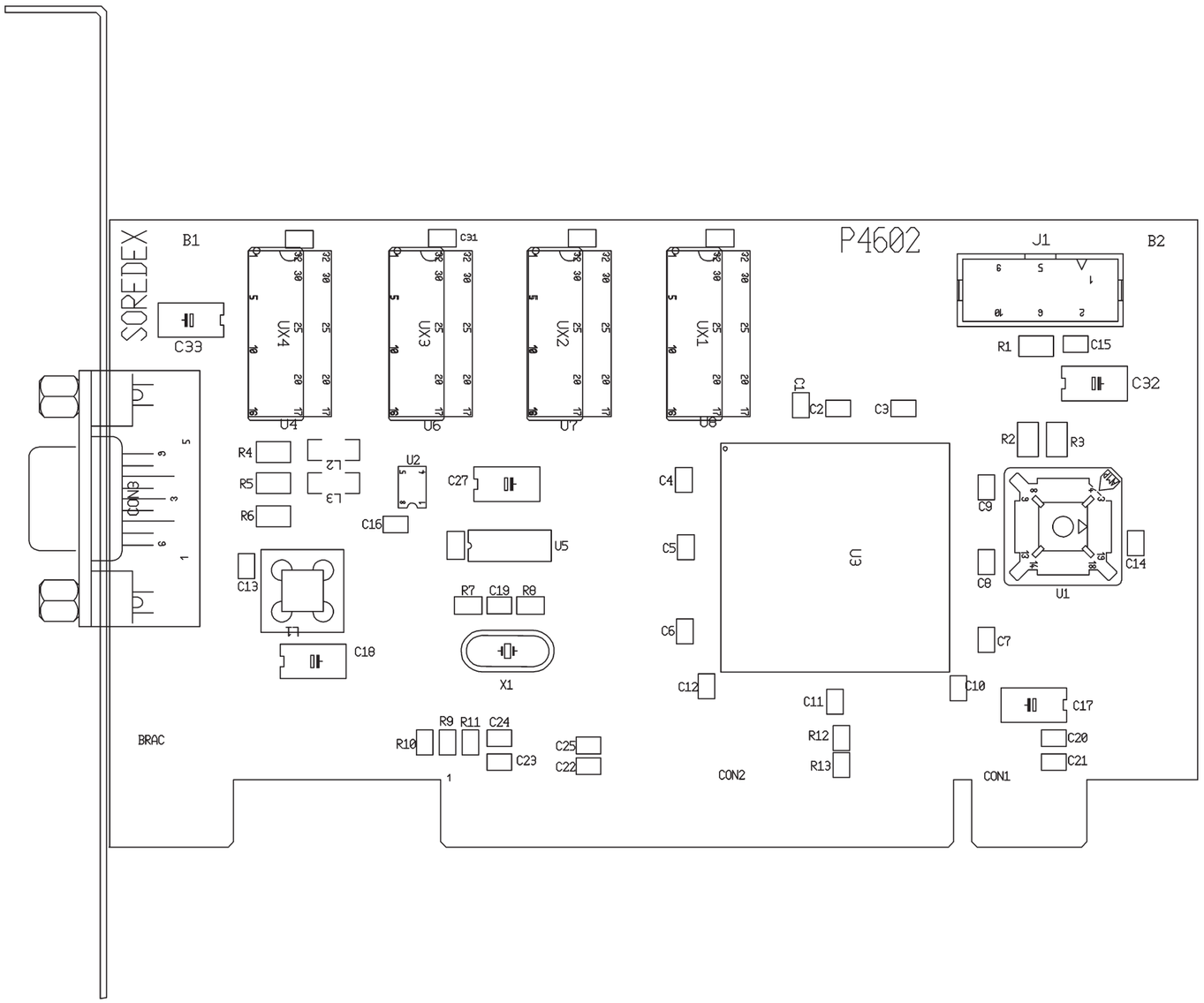
PIN	SIGNAL	DESCRIPTION
1	nc	
2-9	AT - D7-D0	Low byte of AT data bus
10	IOCHRDY	I/O channel ready to AT bus
11	AT-AEN	Address enable from AT bus
12-21	nc	
22-31	AT - AD9-AD0	10 lowest bits of AT ADDRESS BUS
32	GND	-
33	RST	Reset from AT bus
34	+5 V	Supply voltage from AT bus
35-40	nc	
41	GND	-
42, 43	nc	
44	IOW*	I/O write cycle from AT bus
45	IOR*	I/O read cycle from AT bus
46-61	nc	
62	GND	-

16.2.6 CONNECTOR PINOUTS J4602 (to Digora rear panel)

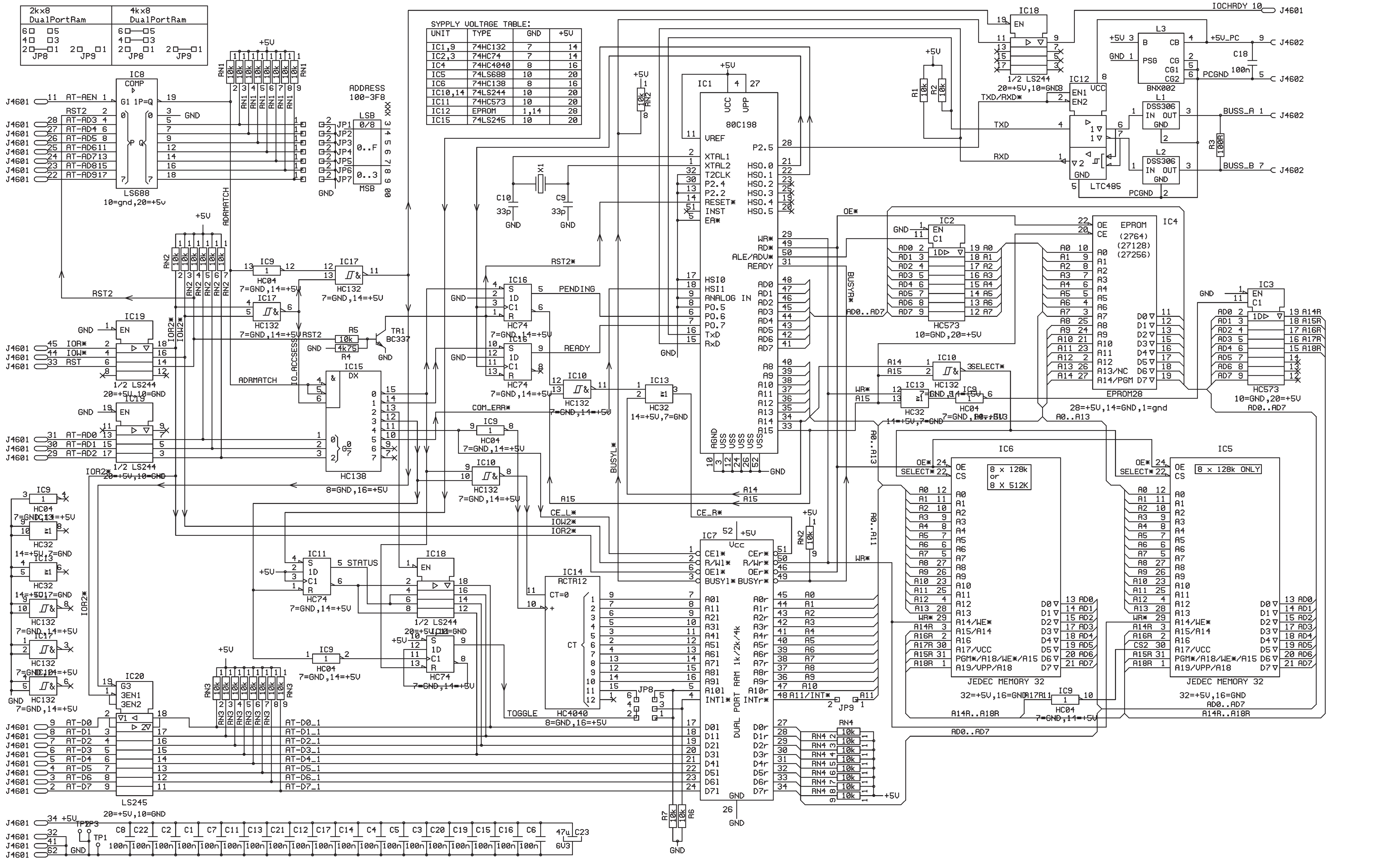
PIN	SIGNAL	DESCRIPTION
1	BUSS_A	One signal line of RS485 bus
2-4	nc	
5	GND	
6	nc	
7	BUSS_B	Other signal line of RS485
8	nc	
9	+5 V	Supply voltage to opto isolated parts of Digora



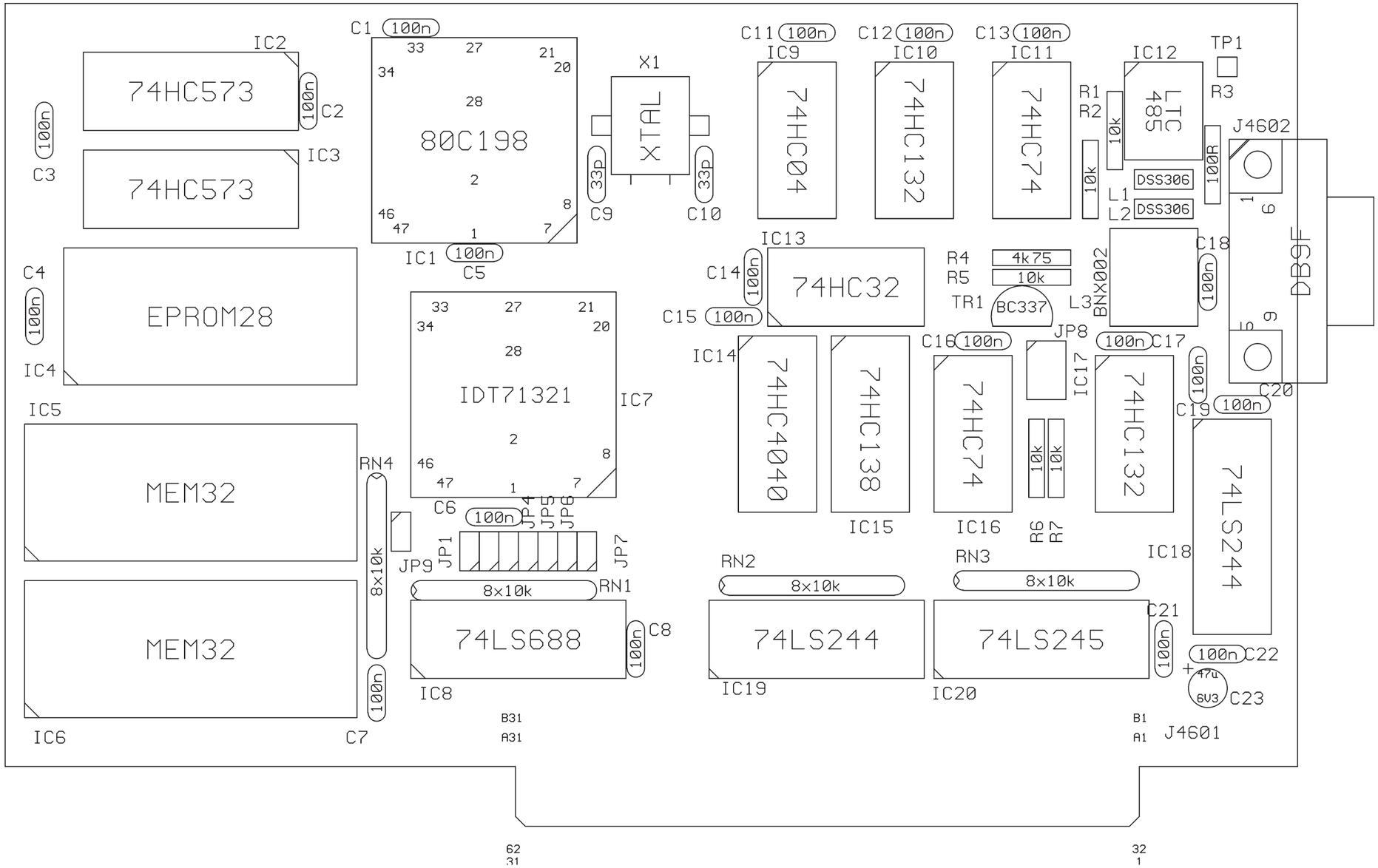
P4602-1 Circuit Diagram for Interface Adapter



P4602-1 Component layout for Interface Adapter



P4601 Circuit Diagram for Interface Adapter



P4601 Component layout for Interface Adapter

17. SCANNER SOFTWARE

The microcontroller on the P4001/P4000-2 board controls all the functions of the scanner. It communicates with the PC interface board which links the communication to the Digora for Windows software running in PC.

The microcontroller software resides in an EPROM circuit labelled P4001/P4000. Software versions 4.0x/3.0x are used with P4601 (ISA) surface boards and versions 4.1x/3.1x with P4602 (PCI) interface boards.

Since the scanner has no image buffers, it must immediately send all image data to the interface board. In normal operation, the scanner reads imaging plates only if Digora for windows allows it (that is , when the transport unit has stopped), the scanner software checks the states of the scanner switches (action button, image size selector button, test switch, safety/service switch) and responds to their changes.

The scanner software responds to the connection tests of Digora for Windows also while it moves the transport mechanism as soon as the actual readout has ended. The scanner software responds to the functions of Digora Service Assistant only when the scanner is idle.

17.1 Timing of the main functions

17.1.1 Power-on sequence consists of:

- initializing the preread lens position (0.1 s)
- driving the imaging plate holder inwards pass the slotted optical switch (5s)
- initializing the reflective sensor sensitivity data (0.1 s)
- returning the imaging plate holder completely out (7 s)
- imaging plate holder remains in this position if imaging plate is present in the holder.
- driving the imaging plate holder inwards as long as the door closes (2 s)

17.1.2 Image readout sequence consists of:

- premove of the imaging plate holder (1 s)
- preread of the imaging plate (4 s)
- actual image readout (16 s)
- move to the erasing area (2 s)
- erasure of the residual image (4 to 44 s depending on the High voltage setting and the signal read from imaging plate)
- return to the slotted optical switch (2 s)
- pushing the imaging plate holder to its outmost position if the scanner door is open and if there is an imaging plate in the holder (2 s).

17.1.3 Calibration sequence consists of:

- premove of the imaging plate holder (17 s)
- preread of the imaging plate (18 s)
- actual image readout (16 s)
- move to the erasing area (2 s)
- erasure of the residual image (4 to 44 s depending on the High Voltage setting and the signal read from imaging plate)
- return to the slotted optical switch (2 s)
- pushing the imaging plate holder to its outmost position if there is an imaging plate in the holder (2 s)

17.2 Software versions

Versions 3.00 and 3.10

Original software versions of Digora fmx. 3.0x version is for scanners which are connected with ISA interface board (P4601) to the PC and 3.1x version is for scanners which are connected with PCI interface board (P4602) to the PC.

Versions 3.01 and 3.11

These software replaces the original versions. The changes are:

- The acceptable values of calibration parameter Horizontal Length is limited to start from 4000. Originally the minimum value for this parameter was 3000. Refer to chapter Calibration and Adjustment.

- The software has been made mode error tolerant when receiving messages from the PC. It is strongly recommended that all units having the Autoloader option have this (or newer) software installed.

Versions 4.01 and 4.11

These software versions are used with processor board P4001 (versions 3.01 and 3.11 are used only with processor board P4000-2).
Software version 4.01 and 4.11 function in exactly the same way as versions 3.01 and 3.11, but they are NOT interchangeable, for example versions 4.01 and 4.11 CANNOT be used with the P4000-2 processor board, and versions 3.01 and 3.11 CANNOT be used with the P4001 processor board.

18. DIGORA SERVICE ASSISTANT (DSA)

18.1 Installation

Digora Service Assistant (DSA) is meant to be used by digora service personnel only. It was installed automatically when DfW 2.0 was installed. It is also useful for research purposes since it provides data needed to calculate imaging plate signal levels. For either purpose, its use requires caution because DSA does not prevent you from destroying the valid settings of the parameters in DIGORA.INI file.

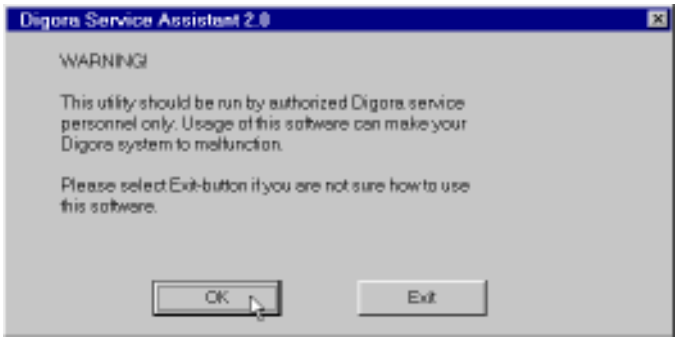


FIGURE 18 - 1: Opening Window of DSA

Digora Service Assistant should be run simultaneously with Digora for Windows. It lets you manipulate the DIGORA.INI file and send the manipulated data to the Digora scanner. This allows you to:

- manipulate the parameters set beforehand in the calibration mode
- change the operation mode of the scanner
- separately activate most of the functions of the scanner
- obtain information of the internal registers of the scanner micro controller

DSA can be activated by pressing simultaneously ALT+CTRL+SHIFT+D keys.

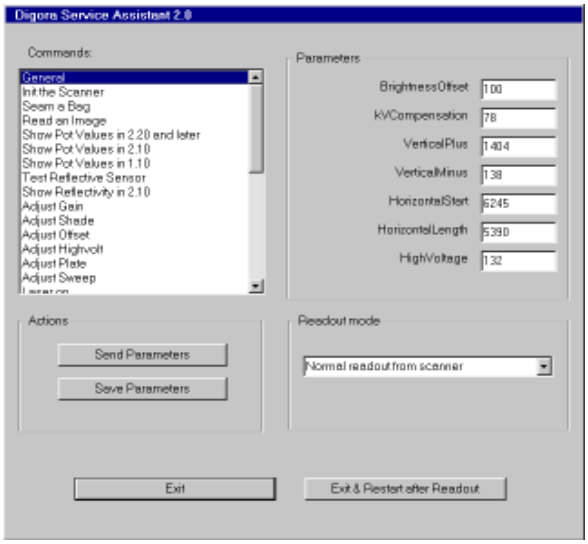


FIGURE 18 - 2: Main window of DSA

Press EXIT if you want ot close the DSA or Exit & RESTART if you want DSA to open automatically after the next image readout.

18.2 Commands, Parameters and Actions

18.2.1 General command

The first command in the *Commands* list box is *General*. It allows you to manipulate all the scanner parameters included in the DIGORA.INI file. You can individually edit each parameter shown in the *Parameters* table. Usually this is done to correct the slight errors in image size and position caused by the calibration routine. There is nothing to protect the system from the errors you might make when editing these parameters. In case you lose track of the proper parameters, you can get (almost) the original parameters back if you re-calibrate the scanner.

The Actions buttons allow you to either send the parameters directly to the scanner (*Send Parameters*) or save them permanently into the file (*Save parameters*). The difference between these two buttons comes from the fact that Digora for Windows always fetches the parameters from DIGORA.INI file before it sends them to the scanner to start image readout. Usually you want to affect the scanner behaviour permanently meaning you must be use the *Save parameters* button. If you only use the *Send Parameters* button, the changes you made are only used until the next image readout is started.

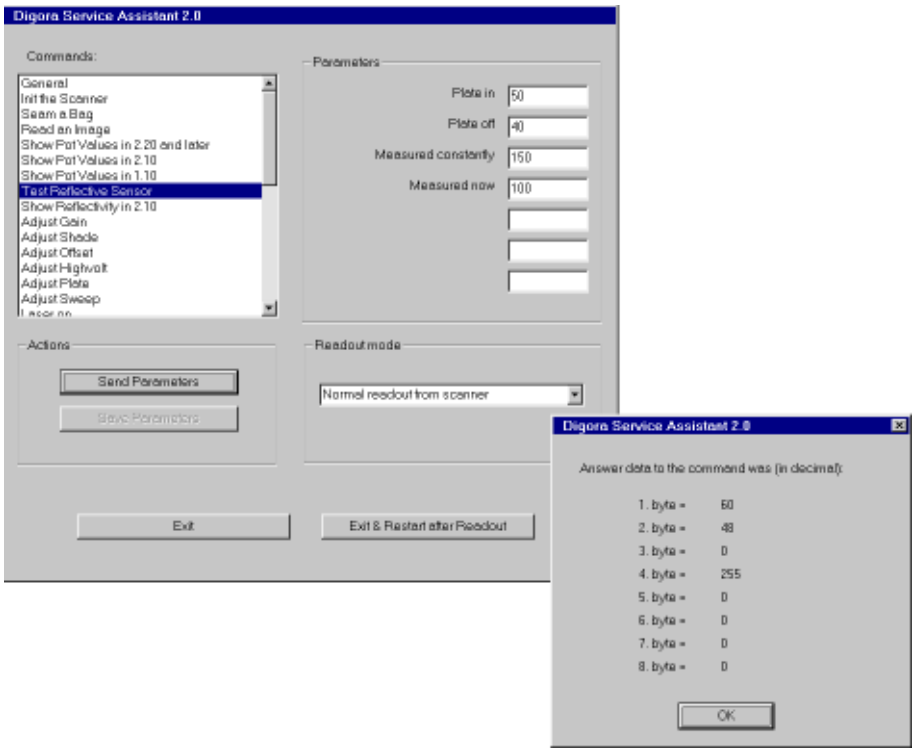


FIGURE 18 - 3: Explanation of the bytes in parameters table and the answer data window

18.2.2 Function commands

All other commands in the *Commands* list box are DSA functions. They allow you to separately activate most of the functions of the scanner and to obtain information of the internal registers of the scanner micro controller. The scanner only responds to the functions when it is not busy. All the functions are described later in this chapter. When you select any of these functions, the *Save parameters* button turns gray since you can only send these function commands to the scanner with the *Send Parameters* button.

The parameters relevant to each of these functions are shown in the *Parameters* table. You can edit each of them but the system is not protected from out-of-range values of these parameters. Any editing you make to these parameters is lost when you exist DSA. Editing is NOT lost as long as you witch between Digora for Windows and DSA without exiting DSA.

In case the function gives answer data from the scanner, there are always 8 bytes of data in the answer. If the scanner is busy when you send the parameters to it, no answer data is displayed. Only a few first ones of the answer data bytes are meaningful. The contents of those bytes are explained in the function descriptions later in this chapter. The answer byte contents and their typical values are also shown as parameters in the *Parameters table* of those functions.

You can edit the DSA.DAT file with Notepad or other ASCII editor to make permanent changes to the DSA functions or to change the order they appear in the *Commands* list box. The changes take place when you re-open Digora Service Assistant after editing and saving the DSA.DAT file. Again, there is nothing to protect the system from the error you make while editing.

18.3 Readout modes

By pressing the *Readout modes* button you can open a dialog box that allows you to set the type of readout the system does after the readout command is given.

Normally the readout command is given by pressing the Action key. For maintenance purposes it is also possible to give the readout command from the keyboard. This can be done (when the scanners idle) by pressing simultaneously four keys: Control, Alt, Shift and R (R for Read). Image plate should be in place and image plate holder in image plate insertion position. The combination is difficult to make because the user should not start the image readout this way.

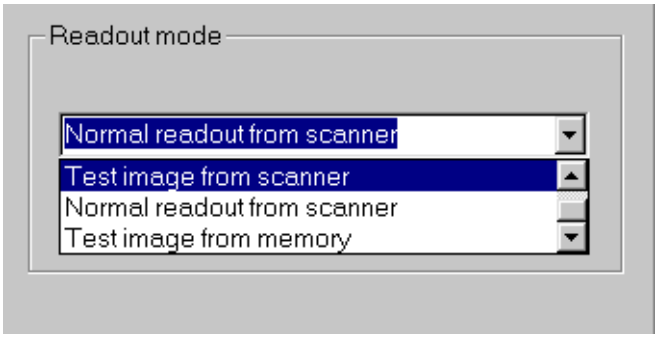


FIGURE 18 - 4: The readout modes window

For normal use, only the mode *Normal readout from scanner* is needed. Take caution to remember to set the mode back to Normal readout after you have used other modes:

- If any other mode is set while calibration is activated, the calibration procedure will fail.

- If any of the test image modes is set and the scanner is activated after a new imaging plate has been inserted into the scanner, the system will enter a closed loop: Digora for Windows reads continuously new images as soon as it can since the scanner keeps on asking for an image readout. You can interrupt this loop by switching the scanner off. This cancels the image readout request from the scanner.
  You can use the test image modes to test the communication between Digora for Windows, the super VGA display driver software, the interface board and the scanner:

- *Test image from memory* displays horizontally divided pieces of gray scales. This might be useful for checking the basic functionality of the Super VGA driver.

- *Test image from scanner* displays an even gray image. The shade of the gray depends on the parameter Horizontal Minus. The image is built with the same speed as during normal image readout. This image is built with the same speed as during normal image readout. This mode is useful for checking the communication from the scanner Digora for Windows without using imaging plates.

- *Normal readout from scanner* is used for normal operation.

18.4 Function descriptions

The basic use of the functions is described earlier in this chapter under the heading Function commands of Commands, Actions and Parameters.

The (bracketed numbers) after function parameters are default values. If you edit the parameters, use the allowed values only. Don't use negative parameter values. The allowed values are believed to be functional but they are not thoroughly tested.

The (bracketed numbers) after reply values are typical replies.

Init the Scanner:
- Parameters: none
- Reset the scanner to its initial status exactly the same way as after power on.

Seam a Bag:
- Parameters: none
- In older Digora models this executes the full seaming procedure exactly the same way as ifthe seaming button had been pressed.
- In Digora fmx model this moves the Autoloader motor one step forward.

Read an Image:
- Parameters: none
- Activates the scanner for normal readout exactly the same way as if the Test button (on the P4500 board) had been pressed. The readout mode setting of DSA has no effect with this function. Since Digora for Windows doesn´t know about this image readout, it gives an error message when the scanner starts to send the image.

Show Pot values in 2.20 and later:
- Parameters: none
- Replies: Gain (4), Shade (128), Offset (0), Highvolt (180), Plate (225), Sweep (128)
- Displays the settings of digital potentiometer.

Show Pot Values in 2.10:
- Parameters: Base Address (172)
- Replies: Gain (4), Shade (128), Highvolt (180), Plate (225), Sweep (128)
- Displays the settings of digital potentiometers. The first byte of the answer data represents the gain value. **DO NOT USE!**

Show Pot Values in 1.10:
- Parameters: Base Address (176)
- Replies: Shade (140), Gain (4), Offset (0), Highvolt (130)
- Displays the settings of digital potentiometers. The first byte of the answer data represents the shade value. **DO NOT USE!**

Test reflective sensor:
- Parameters: none
- Replies: Plate in (150), Plate of (40), Measured constantly (150), Measured now (100)

- Displays reflectivity reference values for the reflective sensor. Parameters plate in and plate off are initialized after scanner power-on: At the moment the scanner has moved the imaging plate holder to the inmost position during the initialization, the scanner measures the reflectivity of the black frame of the scanner facing the reflective sensor.

  The measurement data multiplied by 2.5 is set as a reference called plate in while the same measurement data multiplied by 2 is called plate off. Thereafter the plate is considered to be absent if reflectivity signal is smaller than plate off.

- The parameter measured constantly is reset after scanner power-on. When reflectivity signal is both larger than plate in and larger than (measured constantly/2), it is used to update data for measured constantlyand the plate is considered to be present.

  If reflectivity signal after scanner power-on has never been larger than plate in, the parameter measured constantly equals to zero.

- The reflectivity signal at the moment when this command was activated is shown as the fourth item.

- Generally when testing the reflective sensor, the value Measured now should be +10% higher than value Plate in only when imaging plate is in front of the detector and in all other cases (no image plate, image plate back pointing to the sensor) the value should be lower than value Plate off.

Adjust Gain:
- Parameters: Gain value (4)
- Allowed range: 1 - 255
- Effect: Attenuation 1/256 - 255/256
- Sets the first digital potentiometer (IC13) of the photomultiplier signal amplifiers to the given value. The setting made with this function is NOT used during image readout.

Adjust Shade:
- Parameters: Shade Value (128)
- Allowed range: 128 - 255
- Effect: 128/256 - 255/256
- Sets the second digital potentiometer (1C13) of the photomultiplier signal amplifiers to the given value. The setting made with this function is NOT used during image readout. This potentiometer is used to fine-tune the gain set by the Gain potentiometer.

Adjust Offset:
- Parameter: Offset Value (0)
- Allowed range: 0 - 255
- Effect: Offset (0 - 255)/307 V at TP4
- Sets the photomultiplier signal offset level digital potentiometer (IC22) to the given value. The setting made with this function is NOT used during image readout.

Adjust Highvolt:
- Parameters: High Volt Value (180)
- Allowed range: 100 - 255
- Effect: DC voltage 1.05 - 2.5 V at TP 14
- Sets photomultiplier high voltage digital potentiometer (IC22) to the given value. The resulting high voltage is approximately -2.5 x (100 - 255)V. The setting made with this function in NOT used during image readout.

Adjust Plate:
- Parameters: Plate Value (255)
- Allowed range: 0 - 255
- Effect: DC voltage 0 - 500 mV at TP16
- Sets the reflective sensor current digital potentiometer (IC21) to the given value. The resulting current is approximately 0 -3 mA. The setting made with this function is NOT used during image readout.

Adjust Sweep:
- Parameters: Sweep Value (128)
- Allowed range: 0 - 255
- Effect: DC voltage 2.4 - 4.8 V at TP15
- Sets the sweep digital potentiometer (IC21) to the given value to adjust the amplitude of galvanometer sweep. The resulting sweep peak-to-peak amplitude (TP9) is approximately 2.0 - 4.0 V. The setting made with this function is NOT used during image readout.

Laser On:
- Parameters: none
- Turn the laser on without resetting the microcontroller. This function is able to turn the laser on only if the safety/service switch allows it.

Laser Off:
- Parameters: none
- Turns the laser off.

Test Lamp:
- Parameters: Duration (2000)
- Allowed range: 0 - 9999
- Switches the erasure lamp on for the given number of milliseconds.

Actual time may vary a bit due to the component tolerances of the turn-on circuitry.

Test Lift Motor:
- Parameters: none
- Raises the lift arm (in the older models) to the top position, pauses for the visual pause time (0,5 s) and lowers the lift arm to the down position.

Test Lens Motor:
Parameters: none
Turns the preread lens to the active position, pauses for the visual pause time (0,5s) and turns the lens to the rest position.

Test Seamer/Autoloader Motor:
Parameters: none
Closes the seamer jaws in the older models having a seamer unit. Pauses for the visual pause time (0,5 s) and opens the seamer. The times used for closing and opening the seamer jaws are the default times, not the ones measured after power-on in P4000 version 2.10 and later. None of the other functions related with seaming (such as heating) are executed.
In Digora fmx unit which has an Autoloader this command runs the autoloader motor until the microswitch activates or the time limit is reached (defective microswitch).

High Voltage On:
Parameters: High Voltage (180)
Allowed range: 100 - 255
Effect: -3.5 x (100-255) V
Switches photo multiplier high voltage on permanently. Execution is sustained for 0.5 seconds to let the voltage settle. This function is able to switch the high voltage on only if the safety/service switch allows it.

The effect of this function is canceled by the functions High Voltage off, Measure High Voltage and Sweep High Voltage, as well as by the image readout command in modes Normal Readout and Continuous Readout.

High Voltage Off:
Parameters: none
Switches photomultiplier voltage off. Use this function to cancel the effect of High Voltage On.

Measure High Voltage:
- Replies: High voltage A/D measurement result (180)
- Measures the photomultiplier high voltage once. Before activating this function, use the function High Voltage on to activate the high voltage. The voltage is switched off by this function after the measurement. The reply value multiplied by -3.5 times gives the actual high voltage value. This function is able to switch the high voltage on only if the safety/ service switch allows it.

Measure Final PMT signal:
- Replies: Final photomultiplier signal measurement result (0)
- Measures the final photomultiplier signal at TP14 once. usually there is zero volt signal in TP14 when the scanner is idle. A value of 0 is equal to a zero volt and a value of 255 is equal to a 5 volt signal. (A zero volt signal represent white in an x-ray image because the data in the Density measurement window of digora for Windows is inverted according to VGA signal levels, the white signal is there equal to 255).

Sweep Galvanometer:
- Parameters: Amplitude (128), Sweep Cycles (100)
- Allowed range: 0 - 255
- Effedt: Sweep amplitude 2.0 - 4.0 Vpp
- Allowed range: 1 - 9999
- Sweeps the galvanometer control voltage using the given amplitude and the given number of times. The laser beam in not activated.

Sweep Galvanometer with laser:
- Parameters: Amplitude (128), Sweep Cycles (100)
- Allowed range: 0 - 255
- Effect: Sweep amplitude 2.0 - 4.0 Vpp
- Allowed range: 1 - 9999
- Sweeps the galvanometer control voltage using the given amplitude and the given nubmer of times. The laser beam is activated.

Sweep High voltage
(works also with P4000 version 2.10 and 1.10):
Parameters:
- Lowest Voltage (100)
  Allowed range: 100 - 255
- Highest Voltage (250)
  Allowed range: 100 - 255
- Volt Increment/100 ms (10)
  Allowed range: 1 - 155
- Volt Decrement/100ms (10)
  Allowed range: 1 - 155
- Sweep Cycles (1)
  Allowed range: 1 - 9999

- Sweeps the photomultiplier voltage up and down the given number of times by altering the setting of the high voltage potentiometer. Voltage limits yield the actual voltages when ultiplied by -3.5. Ascent and descent speeds (and thereby the sweep frequency) are determined by the size of the Volt Increment and Volt Descrement (that is, by the time it takes to make as many voltage changes as the difference between highest and lowest voltage requires). This function is able to switch the high voltage on only if the safety/service switch allows it.

Sweep Reflector current:
- Parameters: Lowest Current (0), Highest Current (250),
  Sweep Cycles (1)
- Not used (0)
- Allowed range: 0 - 255
- Effect: 3 mA x setting/256
- Allowed range: 0 - 255
- Effect: 3 mA x setting/256
- Allowed range: 1 - 9999
- Sweeps the reflector current up and down the given number of times by altering the setting of the plate potentiometer.

Run Stepper Inwards:
- Parameters: Speed Divider (12), Duration (2000)
- Allowed range: 1 - 9999
- Allowed range: 1 - 9999
- Moves the imaging plate holder inwards into the scanner for the given number of milliseconds. The stepper speed os determined by the speed divider, which is varied between 12 (fastest) and 72 (slowest) in normal readout.

Run Stepper Outwards:
- Parameters: Speed Divider (12), Duration (2000)
- Allowed range: 1 - 9999
- Allowed range: 1 - 9999
- Moves the imaging plate holder outwards into the scanner for the given number of milliseconds. The stepper speed is determined by the speed divider, which is varied between 12 (fastest) and 72 (slowest) in normal readout.

Run Stepper Forth and Back:
- Parameters: Speed Divider (12), Run Cycles (1)
- Allowed range: 1 - 9999
- Allowed range: 1 - 9999
- Executes the given number of forth-and back cycles of the imaging plate holder. The stepper speed is determined by the speed divider, which is varied between 12 (fastest) and 72 (slowest) in normal readout. If the applied speed setting would result in a one-way movement lasting longer than the maximum wait time (65 seconds), the time of the movement is limited to the maximum time. Before the actual movement cycles are run, the location of the imaging plate holder is determined by running a shorter forth-and-back cycle to find the optp switch. This function occasionally causes Digora for windows to output the error message 1080.

Show Safety Switch Status:
- Replies: Switch state
- Returns the state of the service safety switch. Value 255 of the first reply parameter implies that the laser can be activated, and value 0 that it cannot.

19. CALIBRATION AND ADJUSTMENT

The purpose of calibration is to adapt the scanner to the X-ray source and to fine-tune the mechanism of the scanner.

19.1 Setting the high voltage

If you X-ray source has adjustable high voltage, select high voltage (kV), you are going to use in the future. If you change the voltage setting afterwards, you must calibrate the scanner again.

If you have several X-ray sources with the same high voltage setting, the same calibration status applies for all of them. If you have several X-ray sources with different high voltage settings, you will usually have to recalibrate the scanner separately for images exposed with different X-ray sources. However, if the voltage difference between various X-ray sources is not higher than 10 kilovolts, the same scanner recalibration may be applicable. The necessity for recalibration will depend on your judgement: How large a variation in image darkness is acceptable to you? You can modify the darkness of the on-screen image using the Automatic grayscale adjustment settings. As far as calibration is concerned it does not matter whether the X-ray source uses a DC or AC power source.

19.2 Setting the x-ray dose

The Scanner can read images exposed with a very high or very low X-ray dose. To take full advantage of this capability, the scanner must know the largest dose that is going to occur in the exposed imaging plates. This information is given to the scanner during the same calibration run that is used for passing on information on the high voltage setting. Consequently, you should expose the calibration image using the largest X-ray dose that you are ever going to use in the future.

To use the largest applicable dose, place the imaging plate close to the x-ray source and select the longest exposure time (or the largest patient or tooth size setting) that you are going to use in the future. By using the maximum dose in calibration you will ensure that the scanner is set up in a manner that will eliminate any future overexposures. Since the scanner performs preread before each readout, the calibration is applicable even if you are actually using a dose which is only 10 percent of the maximum calibration dose.

If your X-ray source has a very wide range of dose adjustment, and you are convinced that you are not going to use that largest doses, perform the calibration with a dose that, according your judgment, is the largest that you are going to use. This will ensure that the calibration also applies for the very small doses which you might be using in the future.

19.3 Fine-tuning the mechanism

The scanner adjusts the mechanism during the calibration to ensure correct positioning of the image. This fine tuning can fail if the X-ray beam does not cover the entire imaging plate area. You can evaluate the coverage of the beam by looking at the calibration image displayed on the screen during calibration. The precision of the measurements performed with the images depends partly on the success of the mechanical fine tuning.

19.4 Calibration parameters

Calibration activity of Digora for windows is not especially precise. This means that horizontal and vertical size and place may be somewhat incorrect after the calibration process. Each calibration is made independent of the previous ones. Thus repeating the calibration doesn't increase the precision any more than what the calibration results vary in general. The calibration results are stored in a register file and they can be edited with Digora Service Assistant if desired.

The operators manual suggests that the scanner should be recalibrated in case the high voltage of the x-ray source is changed. This is probably necessary only in very few cases.

In there is ambient light leaking into the scanner during the calibration, the calibration result will cause the images to be too low and possibly too narrow.

After the calibration process has terminated normally, Digora for Windows automatically deactivates the calibration mode. If the calibration process doesn't terminate normally, the calibration mode stays active.

The following table lists all the parameters and their nominal values. All parameters from kV Compensation to High Voltage are updated in each Full Calibration. (Dose only calibration calibrates only values kV compensation and High Voltage). If any of these six parameters is manually set outside its allowed range, the software uses the upper or lower limit of the range instead.

PARAMETER **NAME**	DEFAULT **VALUE**	ALLOWED **VALUE**	EFFECT OF **INCREASE TO IMAGE**
BrightnessOffset	100	-	-
kV Compensation	50	0-230	Darker
Vertical Plus	1200	800-1600	Moves down
Vertical Minus	128	0-255	Becomes lower
Horizontal Start	5500	3000-8000	Moves left
Horizontal Lenght	4000	3000-8000	Becomes Narrower
High Voltage	180	105-255	Signal saturates
Reserved 1 to 9	100	-	-

19.5 Usable calibration ranges

The calibration range is from 0.01 to 1.0 seconds with most intraoral x-ray sources. This means that x-ray doses from 0.01 to 1.0 seconds give valid calibration result with all the calibration parameters.

The usable x-ray dose range after calibration is from 10 % to 100 % compared to the calibration dose. If too low dose (less than 10 %) is used, the image may be too light (nothing in the image is really black). If too high dose (above 100 %) is used, the darkest areas of the image may saturate (there are no details left in them although they may be not quite black).

19.6 How the calibration range is achieved

Imaging plates have very wide dynamic range, as well as some x-ray generators. The calibration is used to adapt the ten-fold range (10 to 100 %) of the scanner to the range of the imaging plates and x-ray generators.

The calibration routine of the scanner controls the sensitivity of the photo detector (photomultiplier tube) by adjusting its high voltage bias supply (High Voltage). It is also controls the gain of the photomultiplier signal amplifier which adjusts the signal to fit into the dynamic range of the 8-bit A/D converter. The value of parameter kV Compensation is used as the reference value for the A/D conversion result.

The calibration routine replaces the normal preread routine carried out before the actual image readout. At the beginning of calibration the stepper starts to advance the imaging plate, the high voltage is set to a middle values (180 as the parameter), kV Compensation is set to nominal value (50 as the parameter) and the gain is set to maximum (255 as the parameter). The scanner starts to read the imaging plate and decreases the gain if the A/D conversion result exceeds the reference value. If the gain becomes very small, the high voltage is decreased, the gain is set to maximum and the imaging plate is read again. This is repeated until the gain stays large enough. If the gain becomes too large, the high voltage is increased, the gain is set to maximum and the imaging plate is read again.

After both the high voltage and gain have settled, the actual image readout is done. During the readout, the scanner searches for the largest signal (darkest pixel of the image). After the readout, the scanner calculates the difference of the largest signal from a pre-set reference value and adjusts the kVCompensation parameter accordingly. The High Voltage and kVCompensation parameters are the updated with the new values.

After calibration, the High Voltage and kVCompensation parameters are used as fixed values in normal preread routine before actual image readout. The High Voltage sets the sensitivity of the photomultiplier (and thus the overall dynamic range) and kVConpensation is again used as a reference (setting the density of the image). Gain is initially set to maximum and decreased during the preread if the A/D conversion result exceeds the reference value. After the preread, the image readout is done with the gain fixed during preread.

19.7 Control of the gray scale output of the scanner

The calibration dose sets the allowed x-ray dose range, as described earlier. The parameter kVCompensation sets the density of the images. Its setting after the calibration is completed depends.

1 slightly of the high voltage of the x-ray generator used for the calibration dose
2 of the properties of the preread lens inside the scanner and
3 of the parameter Brightness Offset during calibration

You can control how the calibration sets the kVCompensation parameter by using the Brightness Offset of next Readout setting just before you start the calibration. Alternatively, you can edit the kVCompensation parameter directly with Digora Service Assistant.

To temporarily change the gray scale output of the scanner, use the Brightness Offset of Next Readout before reading any normal image. It affects the image data of a single image the scanner reads after you have set a non-zero percentage there. You can use either positive or negative percentage. The non-zero percentage is automatically reset after the next readout.

19.8 Control of the gray scale display of Digora for Windows

After the scanner has produced images, you can control the way Digora for Windows displays the gray scale. These controls don't affect the original image data but the way it is displayed.

The basic setting is straight-forward: if you remove the cross from the box Perform Automatic Grayscale Adjustment (After Readout) in the submenu General Setup under the Options menu, Digora for Windows will show all new images without trying to optimize the grayscale display. This often gives an impression that the images have poor contrast.

If you do the opposite selection and put a cross to the box, the Automatic Grayscale Adjustment suggests an optimized grayscale that it calculates from the histogram of the image. The idea of Digora for windows is to initially read the images with the scanner having a bit too wide grayscale (to be sure that the desired grayscale information is also included) and then use the Automatic Grayscale Adjustment to display the desired information. The Automatic grayscale Adjustment obviously makes a lot of compromises and presumptions which can't suit all images. If the result of the Automatic Grayscale Adjustment tends to be usually too dark or too bright, use the Brightness Correction of the Automatic Grayscale Adjustment of the Automatic Grayscale Adjustment Setup submenu of the Options menu to control Adjustment. You can use either a positive or negative percentage.

The same setup percentage works both for the Automatic Grayscale Adjustment you can activate from the Readout Setup and for the Automatic Grayscale Adjustment you activate from the button in the Tools window.

20. Troubleshooting

PROBLEM #1.
THE POWER INDICATOR IS NOT ON CAUSE:
1. The power lead is loose.
2. There is no mains power supply.
3. The fuse is blown.
4. There is a hardware failure.

CORRECTIVE ACTION:
1. Connect the power cord correctly.
2. Connect the mains plug to a live power supply.
3. Replace the fuse at the rear of the unit.
4. Remove the covers, check the internal cables.
   Note that some pcb:s have LED`s for supply voltage indication.

PROBLEM #2.
THE MAGNET DOES NOT ENGAGE THE IMAGING PLATE

CAUSE:
1. The previous imaging plate is still in the scanner.
2. The wrong image size was selected.
3. The end of the bag is folded or incompletely cut.

CORRECTIVE ACTION:
1. Remove the previous plate.
2. Select the correct image size.
3. Push the imaging plate gently out of the bag.

PROBLEM #3.
THE READOUT PROCESS DOES NOT START

CAUSE:
1. Digora has not been switched on.
2. The interface cable between the scanner and the computer is loose.
3. The scanner mechanism has not warmed up yet.
4. The previous imaging plate is still in the scanner.
5. The imaging plate has been placed in the scanner the wrong way round.
6. There is a hardware problem with Digora.

CORRECTIVE ACTION:
1. Switch on Digora, if the power indicator light is off.
2. Connect the cable correctly.
3. Wait until the scanner mechanism has warmed up.
4. Remove the previous imaging plate.
5. Reposition the imaging plate quickly and press the Action buttons to close the scanner door.
6. Check the reflective sensor, refer Chapter 8.

P**ROBLEM #4.**
THE DENTAL IMAGE DISPLAYED ON
THE SCREEN IS COMPLETELY WHITE

CAUSE:
1. The imaging plate has not been exposed or it was incorrectly positioned in the patient´s mouth.
2. The X-ray device is faulty or the Digora scanner is faulty.

CORRECTIVE ACTION:
1. Exposure a new image.
2. Check the operation of the scanner as follows:

2.1 Start image scanning normally
2.2 Open the scanner door in the middle of the scanning sequence.
2.3 Look inside the door. If you see scattered red light, the laser inside the scanner is working.
2.4 When you open the scanner door in the middle of scanning sequence, the image displayed on the screen should change from white to gray or black. The image may also have slanted stripes.
2.5 If you saw a red light and if the white image became darker, the scanner is working and the X-ray device is faulty.

PROBLEM #5.
IF THE DENTAL IMAGE DISPLAYED ON THE SCREEN...

1. has black stripes on it or is completely black.
2. contains a ghost image.
3. contains traces of bubbles or stains.
4. contains a white frame.

CAUSE:

1.1 The scanner door was not closed properly.
2.1 The imaging plate has been stored too long in a protective bag.
2.2 The erasing lamp inside the scanner is defective.
2.3 The imaging plate is dirty.
2.4 The imaging plate is scratched.
3.1 The protective bag has leaked.
3.2 The imaging plate has been damaged by improper cleaning solvent.
4. The calibration of the scanner has failed or the image position settings of the scanner have changed or the image plate has been inserted incorretly.

CORRECTIVE ACTION:

1.1 Check whether the door will close properly. If not, contact the service representative.
2.1 Expose a new image.

NOTE: Imaging plates sealed in protective bags should not be stored for more than three days.

2.2 Contact the service representative.
2.3 Wipe the imaging plate gently with a swab moistened with alcohol.
2.4 Discard the imaging plate.
3.1 Discard the imaging plate.

NOTE: Always seal protective bags carefully.

3.2 Discard the imaging plate.
4. Re-calibrate Digora, if reoccurs.

PROBLEM #6.
THE IMAGE APPEARS TO SHOW THE OPPOSITE JAW; I.E. THE IMAGE IS MIRRORED.

CAUSE:
The imaging plate has accidentally been inserted back to front in the patients mouth, thereby creating a mirror image. The imaging, plate in the protective bag, may also have been placed back to front. This mistake could have led you to insert the imaging plate the wrong way around in the scanner.

CORRECTIVE ACTION:
Select the Mirror command in the Image menu and reply Yes in the confirmation question. As the image was taken on the wrong side of the imaging plate, the image is noisier than normally.

THE FOLLOWING WITH THE AUTOLOADER:

PROBLEM #1.
THE IMAGING PLATE READ OUT DOES NOT START WHEN ACTION BUTTON IS PRESSED.

1. The unit only gives beeper sound.
2. Imaging plates are moved from the magazine and they drop to the imaging plate tray and a beeping sound is heard. No scanned images appear.
3. Autoloader moves imaging plate from the cassette but does not start to read it.

CAUSE:
1.1 Autoloader motor is disconnected or broken.
1.2 Image plate is jammed in the track.
2.0 Autoloader position detector is disconnected or needs adjustment.
3.0 One of the imaging plates was inserted back side pointing to the plate feeding mechanism.

CORRECTIVE ACTION:
1.1 Reconnect or replace the motor.
1.2 Remove the jammed imaging plate. Find out the reason for the jam and inform the operators for correct usage of the unit.

NOTE:
The imaging plate frames must be properly fitted on the plate in order not to make autoloader get jammed.

2.0 Verify the correct operation of Autoloader microswitch.
3.0 Press the Action button to bring the image plate out. Remove it quickly from the imaging plate tray, put the tray in place and insert the imaging plate back to the cassette in the correct way and close the door.

PROBLEM # 2.
DEFECTIVE AUTOLOADER

At power on beeper sound is generated.

CAUSE:
Autoloader motor is not running or position detector is not working.

CORRECTIVE ACTION:
Reconnect or replace the motor or microswitch.

PROBLEM # 3.
AUTOLOADER PROBLEM

CAUSE:

The imaging Plate readout starts when action button is pressed with and without imaging plate.

CORRECTIVE ACTION:
Check the reflective sensor. Refer Chapter 8.

21. LIST OF ACCESSORIES/RECOMMENDED SPARE PARTS

This chapter lists the accessories and technical literature that can be used with Digora fmx

21.1 Accessories:

CODE	DESCRIPTION
3900130	Main cord, European style
3900215	Main cord, USA style
4801045	Interface cable 1,5 m
4801046	Interface cable 10 m
4801262	Foot Pedal (DfW 2.0 Video Capture)
4801099	P4601 - Interface adapter board, ISA bus
4801273	P4602 - Interface adapter board, PCI bus
1200180	SVRAM - 4 Mb
8200707	User Manual / English
8200708	User Manual / Finnish
8200709	User Manual / French
8200805	User Manual / German
8200806	User Manual / Italian
8200807	User Manual / Spanish
8200823	Service Manual /English
8200846	Spare Part Cataloque / English
8200847	Accessory Catalogue / English
9801307	HR Imaging plates (8pcs standard, 2 pcs small) in storage box
9801308	HR Imaging plates (10pcs standard) in storage box
9801309	HR Imaging plates (10 pcs small) in storage box
9801385	SR Imaging plates (8pcs standard, 2 pcs small) in storage box
9801386	SR Imaging plates (10pcs standard) in storage box

9801387	SR Imaging plates (10 pcs small) in storage box
9801765	HR Imaging plates (8pcs standard, 2 pcs small) - Japan
9801887	HR Imaging plates (10pcs standard) in storage box - Japan
9801888	HR Imaging plates (10 pcs small) in storage box - Japan
9801954	SR Imaging plates (8pcs standard, 2 pcs small) - Japan
9801955	SR Imaging plates (10pcs standard) in storage box - Japan
9801956	SR Imaging plates (10 pcs small) in storage box - Japan
9801871	Disposable plastic bags for standard Imaging plates (500 pcs roll)
9801872	Disposable plastic bags for small Imaging plates (500 pcs roll)
9801926	Disposable plastic bags for standard Imaging plates (20 x 500 pcs roll)
9801927	Disposable plastic bags for small Imaging plates (20 x 500 pcs roll)
9890123	Imaging Plate Holder - Super-Bite
9890124	Imaging Plate Holder - Kwick-Bite/Bite Wing
9891865	Autoloader for FMX systems

21.2 Recommended spare parts for Digora fmx:

CODE	DESCRIPTION
1250034	P4100 Eprom
1250087	P4000-2 Software 3.00 for ISA bus
1250099	P4000-2 Software 3.10 for PCI bus
2800054	T4400 Power Supply
4801094	P4000-2 Processor Board
3600035	Mains fuses 1,6 AT (10 pcs)
3600056	Mains fuses 1.6 AT (10 pcs) 5 x 20
3200151	Erasing Lamp
3200150	Mains Switch
3900215	Power Cord
4801042	T4100-1 Protect / Service Switch
4801270	T4501 Key and Display
4801271	T4101 Stepper Drive and Hv-Supply
4801099	Interface Board, ISA bus
4801306	Interface Board, PCI bus
4801037	P4000-1 Transp.Opto
4801038	Reflective Sensor
4801040	Microswitch assy, autoloader
4801045	Interface cable 1,5 m
4801046	Interface cable 10 m
4801234	Pre-read lens motor
4801246	Autoloader motor
6101190	Screw Shaft
6102530	Upper Guide Bar
6309260	Lower Guide Bar
6803100	Slide (for transport trolley)
6902730	Laser Diode Module
9801312	Cover Assembly
9801421	Galvanometer
9801897	Front panel assy, autoloader
9801898	Front panel assy, middle
9801899	Front panel assy, right
9801900	Front panel assy, left
9891421	Galvanometer mirror assembly
9891785	Pre read assembly
9891281	Plastic Tonque + with magnet

22. LIST OF TOOLS REQUIRED

All tools are metric.

22.1 Allen keys:

- 4 mm
- 3 mm
- 2.5 mm
- 2 mm

22.2 Closed loop wrenches:

- 8 mm
- 7 mm
- 5.5 mm

22.3 Screwdrivers:

- Pozidriv 1
- Slotted screw (in screw terminals)

22.4 Torque spanners for torques of

- 0,4 Nm with allen key 4 (Clamp for Lens and laser Assemblies).
- 0,7 Nm with hex socket 8 (Clamp for Light Guiding Tube).
- 3 Nm with Allen key 4 (Steel Tube containing Photomultiplier Tube).

22.5 Miscellaneous

- Screw M4x20
  (To pull out the bearing holder when dismantling the screw shaft.)
- Protective glasses (for laser light).

23. MAINTENANCE SCHEDULE

Following maintenance program should be carried out annually / biannually, depending on the usage of the scanner.

1. Remove scanner top cover

2. Clean and lubricate transport unit drive shaft and guiding rods.
   - refer to chapter 5 in service manual

3. Clean optical system (lenses and mirrors) from dust, using compressed air.
   - refer to chapter 8 in service manual

4. Proper operation of safety/service switch.
   - refer to chapter 2 in service manual, for precautions, when performing this test
   - make sure that switch is in up position
   - start read out by inserting an imaging plate and pressing the action button
   - scanning sequence should be completed without activation of the laser beam and photomultiplier high voltage
   - verify proper operation of the erasing lamp at end of the sequence

5. Replace all covers.

6. Resolution and linearity test.
   - take a test image from resolution phantom
   - place phantom so that lines are parallel to long side of the plate and numbers indicating resolution are visible on right side of the image
   - use density measurement tool of Digora for Windows to evaluate resolution
   - image should produce 8 LP/mm
   - verify that numbers, indicating resolution, are equal in height

7. Image quality test
   - expose imaging plate (without object) and scan it
   - verify that there are no stripes, caused by transport unit or ambient light leaking in the scanner
   - for corrective action, refer to chapter 5 in service manual

8. Condition of the imaging plates
   - imaging plates with scratches or having frames which are not fitting properly are recommended not to be used

24. AUTOLOADER

24.1 Autoloader

The Digora fmx can be equipped with a optional Autoloader for reading several imaging plates from the magazine one after each other. Maximum capacity of the magazine is 20 imaging plates.

Autoloader comprises:
a) a magazine
b) a pair of timing belts
c) a DC motor
d) a microswitch.

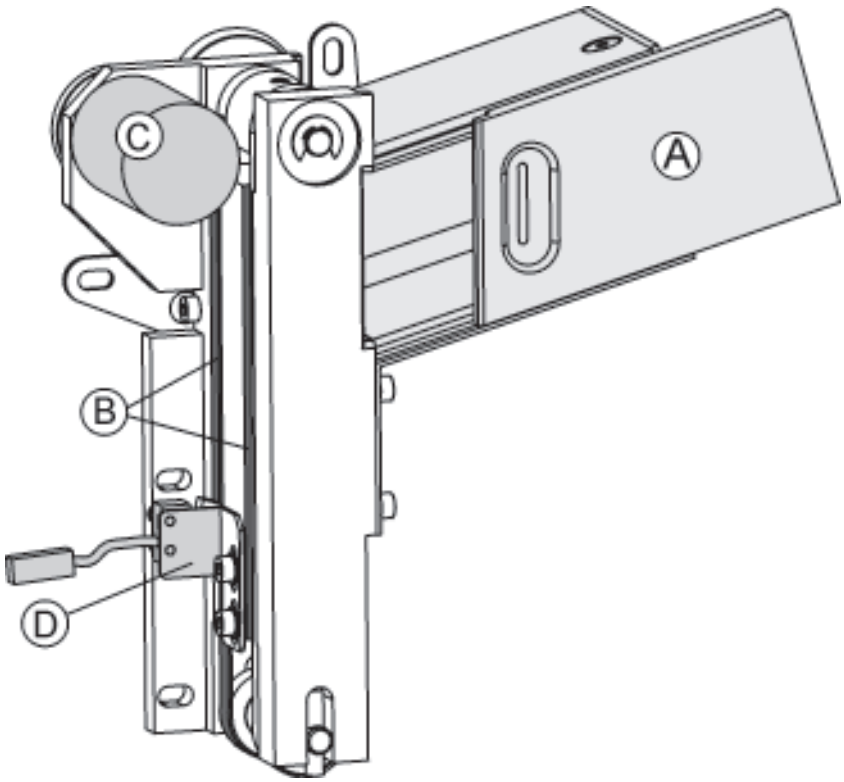


FIGURE 24 - 1: Autoloader comprises

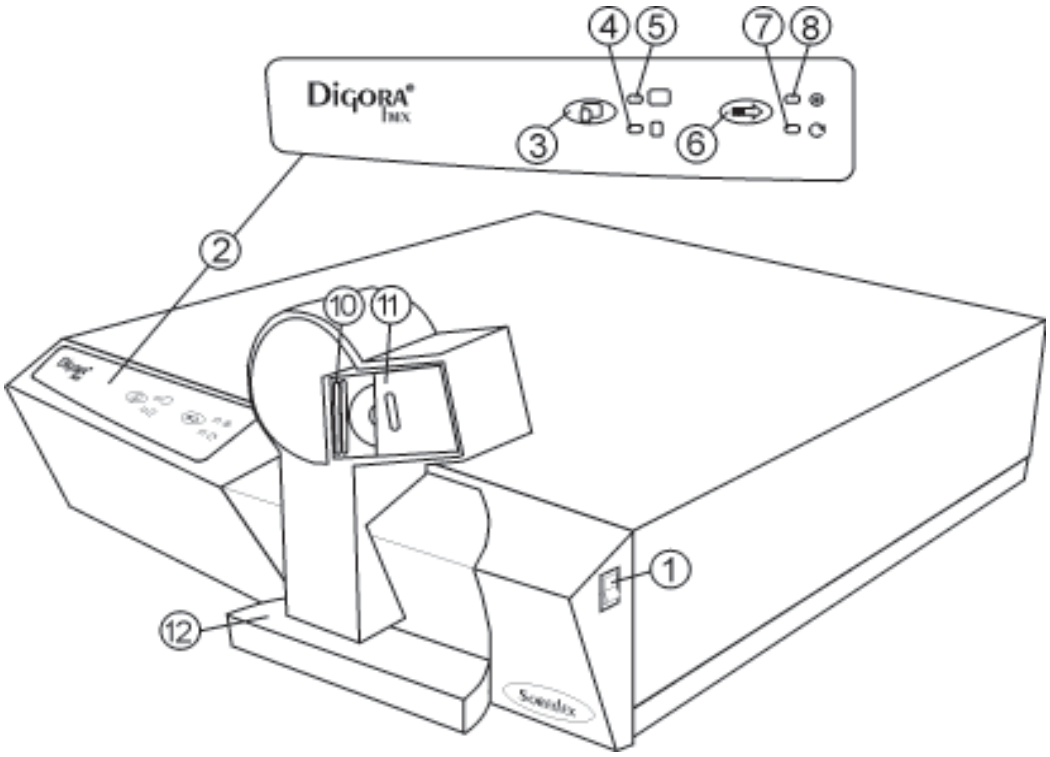


FIGURE 24 - 2: Parts of the Autoloader unit

1) Main switch
2) Control Panel
3) Image size selector
4) Small size Indicator light
5) Normal size Indicator light
6) Scan button
7) Scan Indicator light
8) Power ON Indicator light
9) (not in autoloader unit)
10) Imaging plates in the Imaging Plate magazine
11) Autoloader door
12) Autoloader Imaging Plate Tray

The imaging plates are loaded in the magazine between the moving cylinder and the timing belt or the last loaded imaging plate. The cylinder pushes the imaging plates towards the timing belt and keeps the imaging plates straight. There are also magnets in the autoloader frame that pull the imaging plates towards the timing belt.
The timing belt back has also teeth. The distance between two consecutive teeth allows the imaging plate to fit between them. The timing belt moves the imaging plates vertically. The first position of imaging plate is the magazine, the second position is 4.1 cm lower than the first inside the track cover and third is another 4.1 cm lower where the image plate holder will engage the imaging plate.

The DC-motor drives the timing belt and when the microswitch switches the microprocessor stops the motor. These steps are equivalent to a 4.1 cm movement of the timing belt which represents a movement of one imaging plate from one position to the next.

24.2 Installation of the Autoloader

1. Remove the middle cover from DIGORA fmx unit. It is held in place by magnets.

2. Remove the door by removing the two M4 screws. Keep the screws because they will be needed when the similar Autoloader door is installed.

3. Remove the two screws at the left side of door assembly. Keep the screws because they will be needed when the Autoloader is installed.

4. **Remove the two screws holding the left front cover (with the keyboard) and grip the front cover from the left hand side of it and push it to the left to release the two hidden supports holding the front panel in place.**

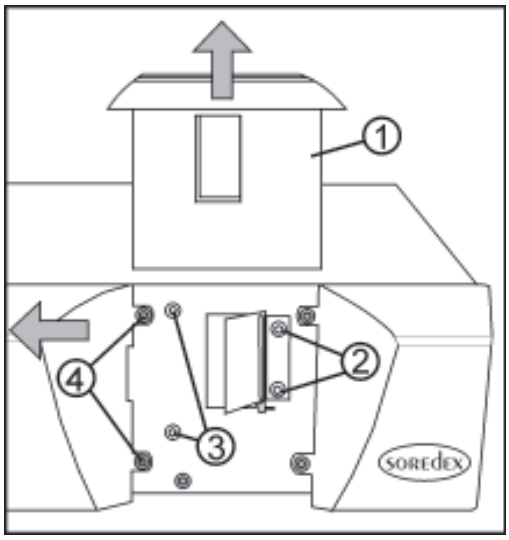


FIGURE 24 - 3

5. Remove the Autoloader rear cover by removing M4 allen screw.

6. Remove the Autoloader front cover by removing the three Allen screws

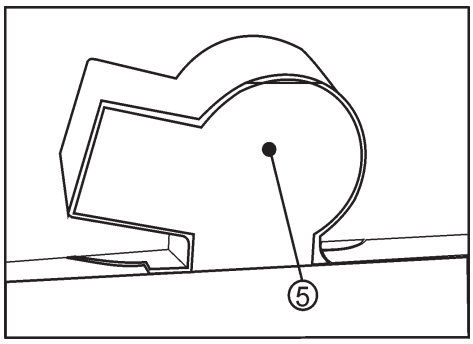


FIGURE: 24 - 4

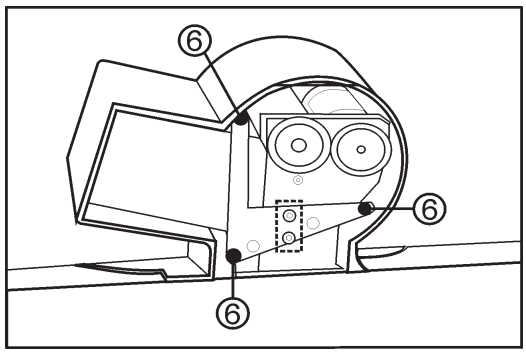


FIGURE 24 - 5

7. Place the Autoloader to the front plate and install it using the screws (3).
8. Connect the Autoloader microswitch 2 pin connector (J4504) and the motor 4 pin connector (J4503) to the T4501 (Key&Display board). Place a jumper on the 2-pin connector JP2 (Mode) of the T4501 board. This tells the microprocessor that the Autoloader is in use.

9. Replace the left front cover and tighten the screws. Make sure that while pushing the cover in place the Autoloader connectors do not become loose from T4501.

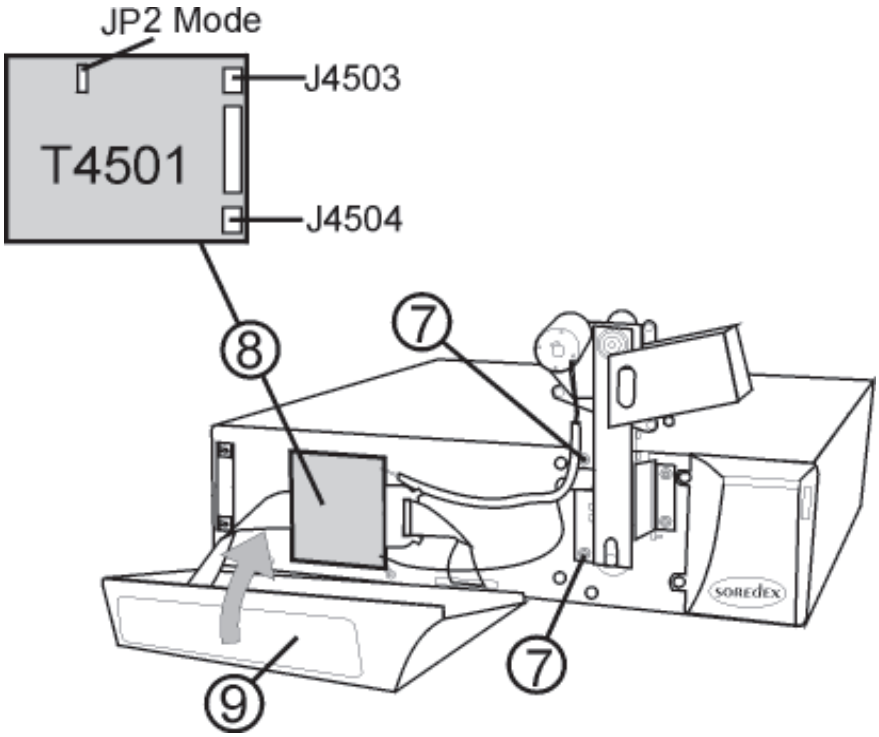


FIGURE 24 - 6

10. Switch ON the Digora and switch it OFF when the imaging plate holder has come completely out. Put the adjusting plate between imaging plate holder and the autoloader frame (Note that there shall be no timing belt tooth prohibiting to do this). Adjust the Autoloader position by loosening its fixing screws, moving it to be in touch with the imaging plate holder adjustment plate being in place. Tighten the fixing screws. Remove the adjustment plate.

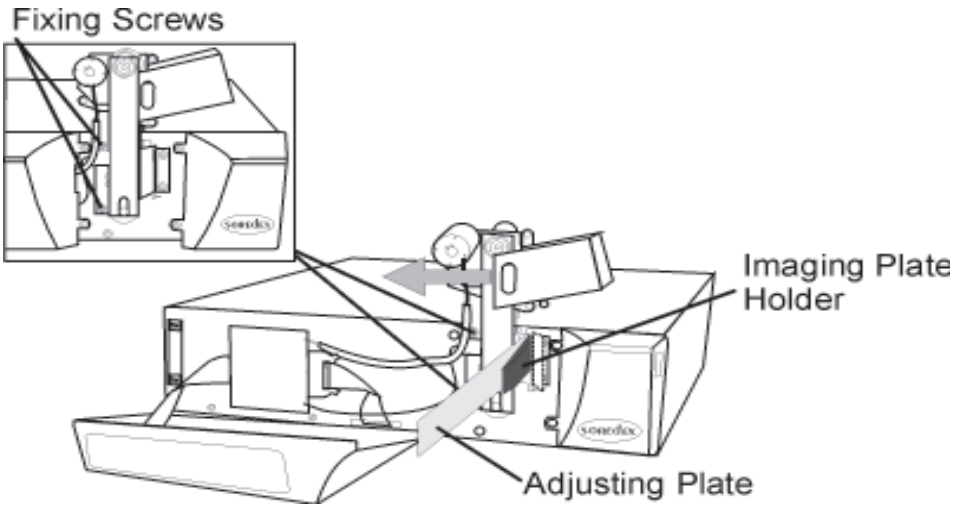


FIGURE 24 - 7

11. Assemble the new door assembly so that when the door closes it will stop on the autoloader frame, not on the front plate. Note also that the left side of it verticallly lines up with the autoloader frame thus preventing ambient light to get in the unit. This can be best seen when erasing lamp is on (by scanning an imaging plate or by using DSA).

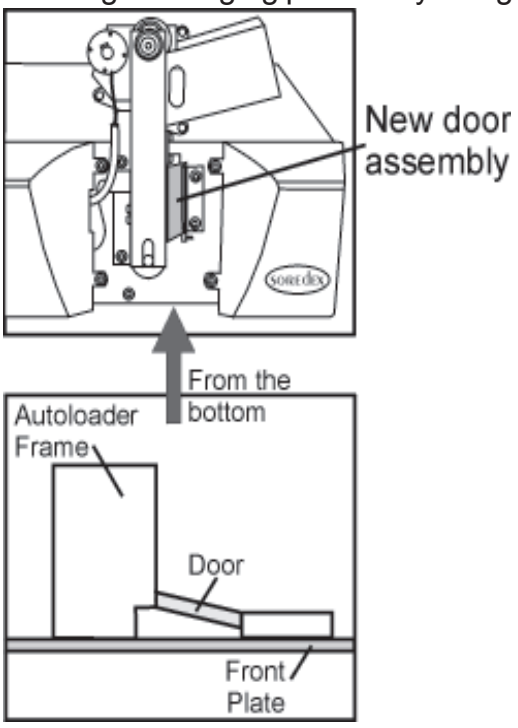


FIGURE 24 - 8

12. Switch ON the unit , put some imaging plates in the magazine. Check that the cylinder pushes the imaging plates towards the timing belt and keeps the imaging plates straight. If you can see the teeth of timing belt withinthe magazine, it means that the start position must be adjusted. See instructions ”Adjustment of the micro switch”. Press the Action button and verify the correct operation of the Autoloader. Verify that the door opens and closes properly without getting stuck. Readjust if necessary.

13. Replace the Autoloader (front) cover by frist removing the scanners front plate fixing screw which is visible at the lower edge. Put the cover in place and insert and tighten the removed screw through the cover mounting plate. Use the three M3 screws to fix the Autoloader cover to the frame from the rear. Note that the mounting plate (L-shape) at the rear is not tightened yet to the frame at this point to allow the cover to be assembled in place properly. While tightening the three M3 screws (which act like cover adjustment screws) make sure that the magazine door can be opened easily without getting stuck to the Autoloader cover. When cover is fitted in place properly tighten the screws of the mounting plate.

14. Replace the Autoloader rear cover in place and secure it in place with one M4x12 screw. Do not tighten too much, excessive tightening may make the magazine door to get jammed.

15. Insert the Imaging plate tray beneath the Autoloader. If there is no table space for it, an external support must be assembled to the scanner base plate. To do it look at the bottom of scanner, two M4 screws will be visible in the front. Remove these, assemble the support with these screws . Adjust the position of the support so that it holds the imaging plate tray in place properly and still allows the tray to be removed for imaging plate removal. Tighten the screws when proper position has been found.

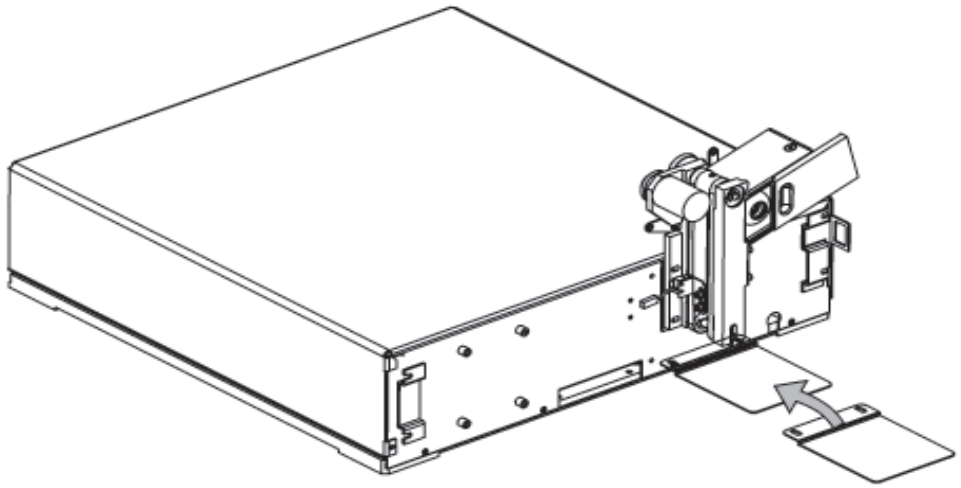


FIGURE 24 - 9

24.3 Adjustment of the Microswitch

1. Adjust the microswitch position by loosening the two M3 screws of its adjustment plate and moving the adjustment plate vertically.

2. Correct position of microswitch is so that the tooth which move the imaging plates stops at a position inside the magazine so that it is just below the bottom surface of the magazine. So when inserting the imaging plates inside the magazine they do not hit any of the teeth.

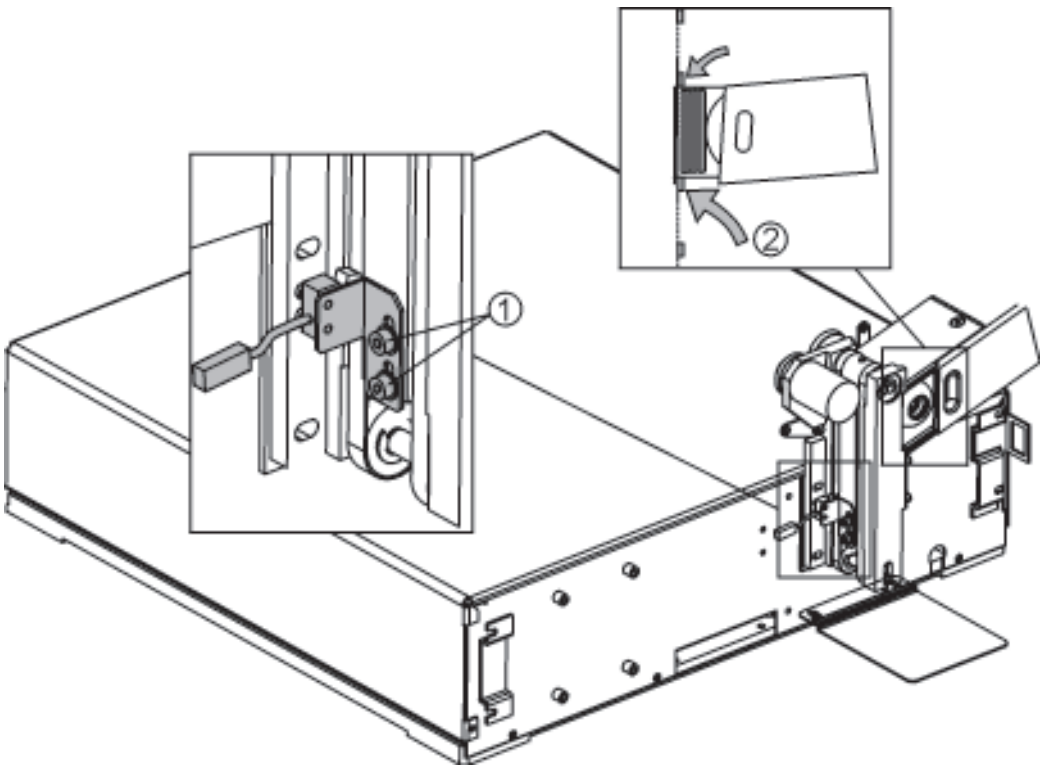


FIGURE 24 - 10

24.3.1 PART NUMBERS

9891865	Autoloader upgrade kit for DIGORA fmx
9891864	Upgrade kit for converting a Digora to a Digora fmx.

25. SPECIFICATIONS AND SYSTEM REQUIREMENTS

Imaging plates

Imaging Plates:	Normal Size (2)	Small Size (0)
Dimensions:	35 x 45 x 1,6 mm	26 x 35 x 1,6 mm
Image Area:	30 x 40 mm	21 x 30 mm
Image Size:	466 x 628 pixels	326 x 466 pixels
Pixel Size:	- 64 x 64 micrometers	
Resolution:	- More than 8 line pairs per millimeter.	
Image File:	- 286 KB or 75 KB (lossy compression). Recommended	
dose:	- 20 ... 50 % of a typical X-ray film exposure dose.	
Storage:	- Imaging plates must be stored in their box below 33ºC. - The box must be closed to remain dust free.	
Cleaning:	- Use lint free cotton or lens cleaner to wipe imaging plates. - Use ethanol anhydride dampened cleaning cloths to clean stains that do not come off easily. - Never use any other cleaning solvents.	
Disposal:	- Imaging plates are problem waste. They must be returned to the manufacturer for disposal. - Never use damaged imaging plates.	
Material	- Europium activated Barium fluorohalide.	

Unit

DXR 40 Classification IEC601-1
- Class I equipment.
- Type B equipment.
- Continuous operation.
- IPX0 (enclosed equipment without protection against ingress of liquids).

Operating voltage: - 100 - 240 V, 50 - 60 Hz.

Current: - Less than 1,3 A.

Operating environment:
- +10 -+ 40ºC, 30 - 75 RH%, 800 - 1080 mbar
- Dental office or other dry and dustless space.
- When not in use keep the scanner door closed.

Operation postition:
- Horizontal, can be placed under the PC and display.

Storage/Transportation:
- +0 - +50ºC, 0 - 85 RH%, 500 - 1080 mbar.

Cleaning: - Equipment can be cleaned with water or ethanol or a mixture of both.

Maintenance: - Maintenance must be performed annually by a service representative authorized by the manu facturer.

SCANNER DIMENSIONS: Width: 450mm/17.7"
Depth: 445mm/17.5"
Height: 130mm/5.1"
Weight: 20kg/44lbs

Interface cables:
- 1,5m/59" (code:4801045) and 10m/394" (code: 4801046)

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 includes 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
- z-carriage counter weight (Pb)
- cassettes (Pb), intensifying screens and imaging plates

Hardware requirements

* Operating System: WIN 95/98 or Windows NT

* PC:	Pentium Processor or better, 3.5" 1.44Mb Disk drive, CD-ROM, CD-R drive recommended
RAM-Memory	64 Mb or more
Hard Disk	More than 2 Gb
Monitor	Min. 15" SGVA, (17" recommended), 1024 x 768 pixels True Colour over 70 Hz
Display Adapter	64-bit accelerated with 8 Mb or better
Back-up	(SCSI) Tape drive or other back-up device supported by Windows

Connection to the PC must meet IEC 601-1 requirements.

* 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 and/or IEC 601-1-1 harmonized national standard
- only RS 232C interface cable, provided by the manufacturer, shall be used.

PROTECTIVE BAGS:

* Disposable protective bags for both imaging plate sizes in rolls enclosed in box.

Material:	- Polyethene
Disposal:	- Follow the national requirements. Can be burned if allowed.

26. CONVERTING A DIGORA TO A DIGORA FMX

These instructions describe how to upgrade a DIGORA (type number DXR XXX-02, X=any number) to a DIGORA fmx unit. The upgraded unit will only be equivalent to DIGORA fmx with the latest version of Interface board P4601- 1 and Digora for Windows 2.0 software installed.

Upgrade kit includes the following parts;

- front panel assembly (including new erasing lamp, Key & Display T4501 board)
- three plastic front covers
- mains switch
- adapter flat cable 40/20 pin
- tape seal protective bags (2x500 pcs)
- type SR imaging plates (8+2 IP's)
- 8lp/mm EPROM 3.0 software for the P4000 processor board
- DIGORA fmx Scanner driver version 2.20. This software is needed ONLY if the latest Digora for Windows 2.0 is already installed
- DIGORA fmx user's and Installation manual
- Upgrade instructions

NOTE!!!!
The latest version of Digora for Windows 2.0 software and P4601-1 Interface board upgrade are not included in the above fmx update kit. These items has to be ordered separately.

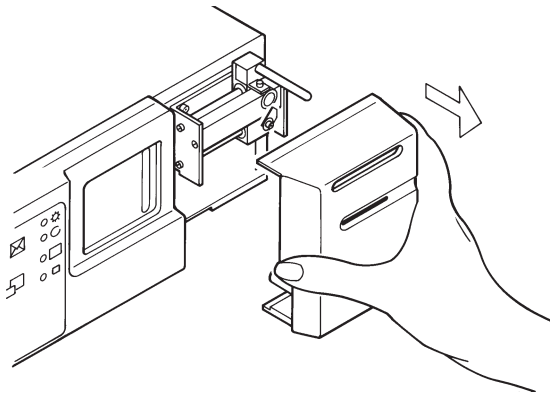
Note also that the PC hardware requirements are different compared to the older versions of Digora for Windows.

INSTRUCTIONS

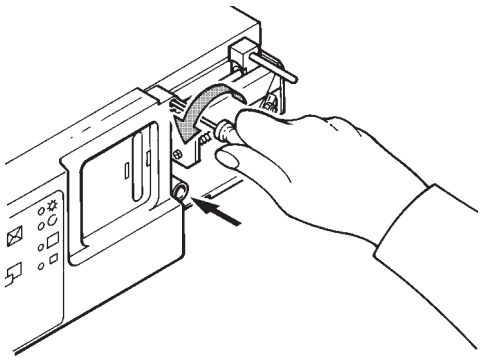
Disconnect the unit from mains before performing the update to the unit

1. Remove the front panels, the top cover, the front cover (including the seaming and cutting unit).

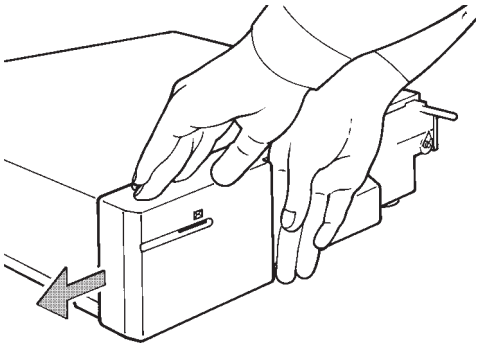
   When removing the covers from the Digora scanner, first remove the cover of the cutting unit that is held in place with magnets. Remove the cover by pulling it way from the scanner.



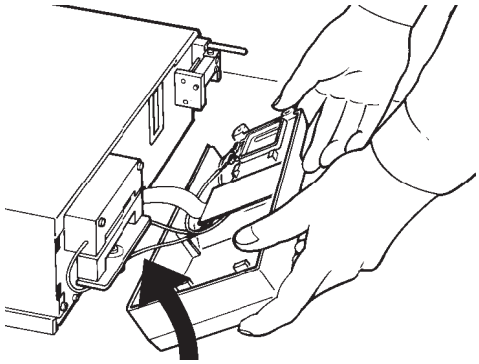
1) Open the two M3 Allen screws now revealed in the right hand side of the scanner front panel.



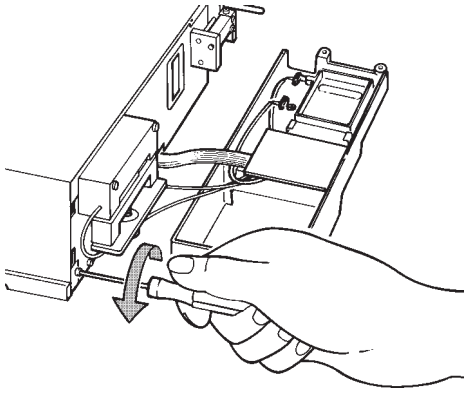
2) Grip the front panel from the left hand side of it and push it to the left to release the two hidden supports holding the front panel in place.

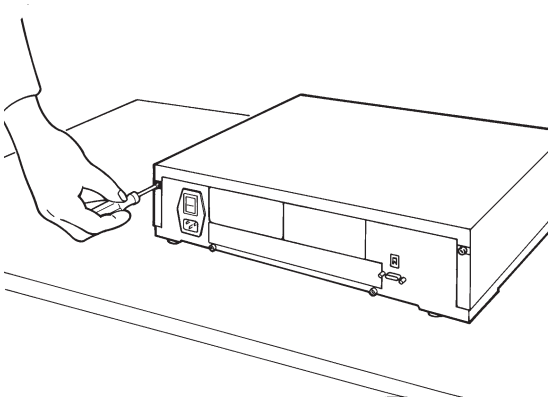


3) Lay the front panel flat in front of the scanner.

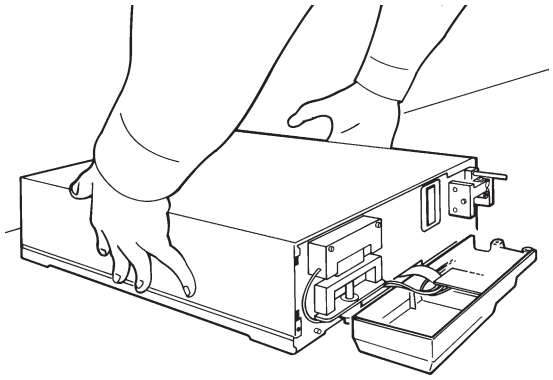


4) Open the M3 allen screw in the left hand side of the revealed scanner front panel. Disconnect hot seaming unit cables and flat cable from T4500 board (Key&Display).

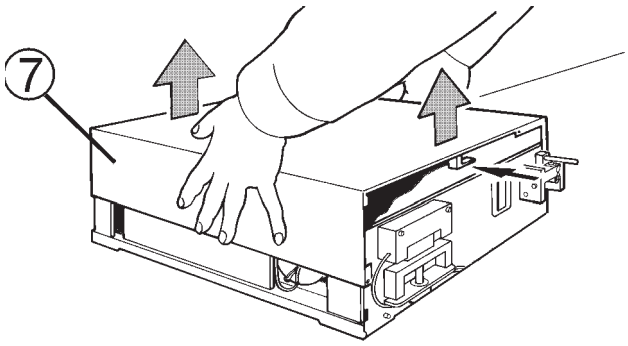




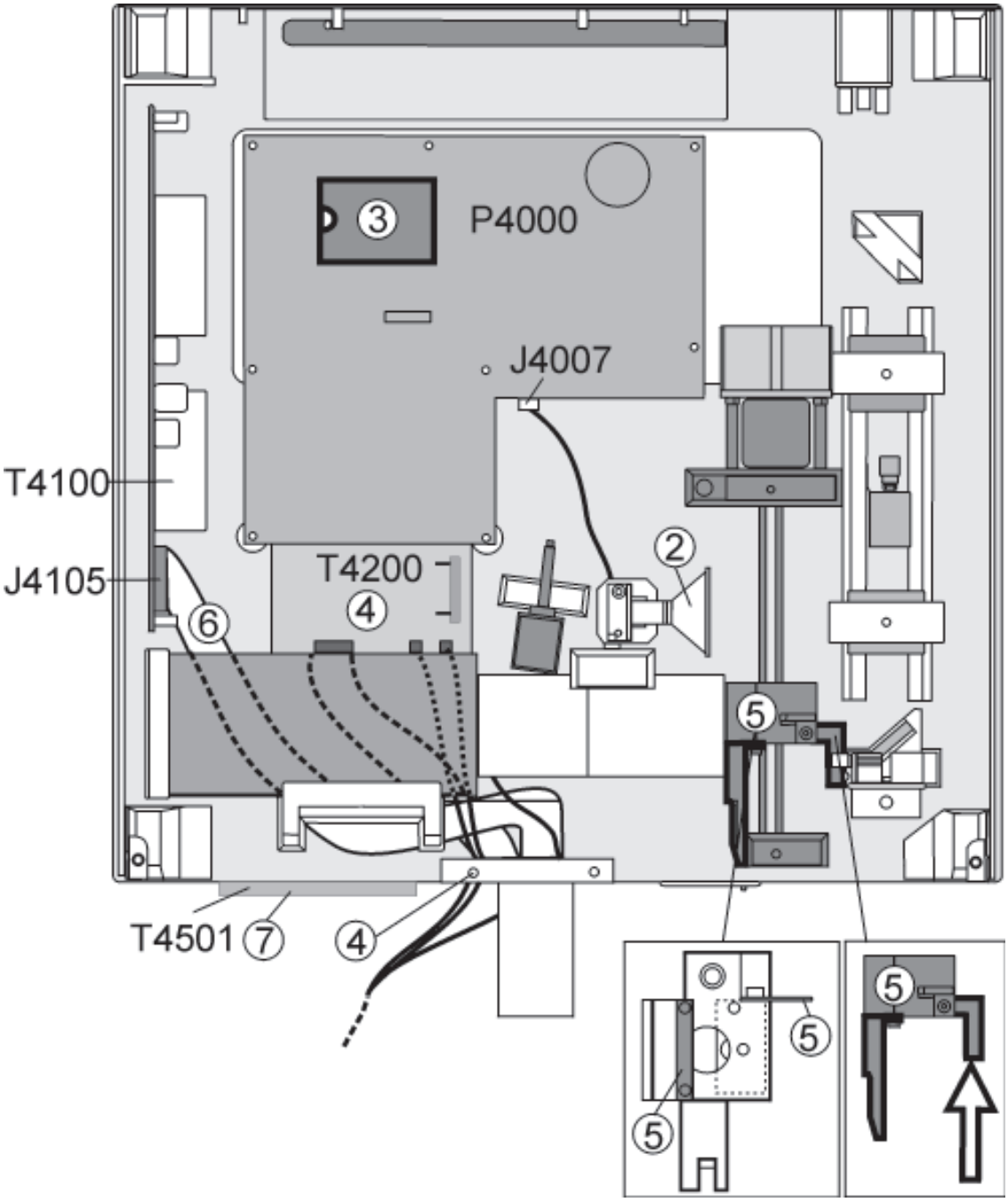
5) Then open the two M4 allen screws at rear, holding the cover in place.



6) Now you can lift off the scanner cover by pushing it slightly inwards from the sides.



7) Since the cover is fitting tightly in the longitual grooves at the sides of the scanner base plate, it may be somewhat tight. Don't let the cover tilt when lifting it up avoid it getting stuck in vertical direction. When you lift the cover off, a flap inside the cover toggles the safety/service switch that disables the laser tube and the power supply of the photomultiplier tube.



1. Disconnect connector J4007 from the P4000 board (processor) and remove the erasing lamp assembly.

2. Remove the Eprom 2.xx version from the P4000 processor board and replace it with EPROM 3.00. NOTE!!! Make sure that you insert the chip the correct way round. The small notch in the chip must be the same end as the corner mark on the IC socket.

3. Remove the all cables from T4200 (Seamer drive board). To remove the seamer cables and keyboard flat cable, the cable holder at the front of the unit must be removed. Seamer board T4200 does not have to be removed.

4. Remove the interrupter plate (interrupts the opto switch) and the imaging plate holder from the transport mechanism. Install the new imaging plate holder and the new interrupter plate using the original screws.

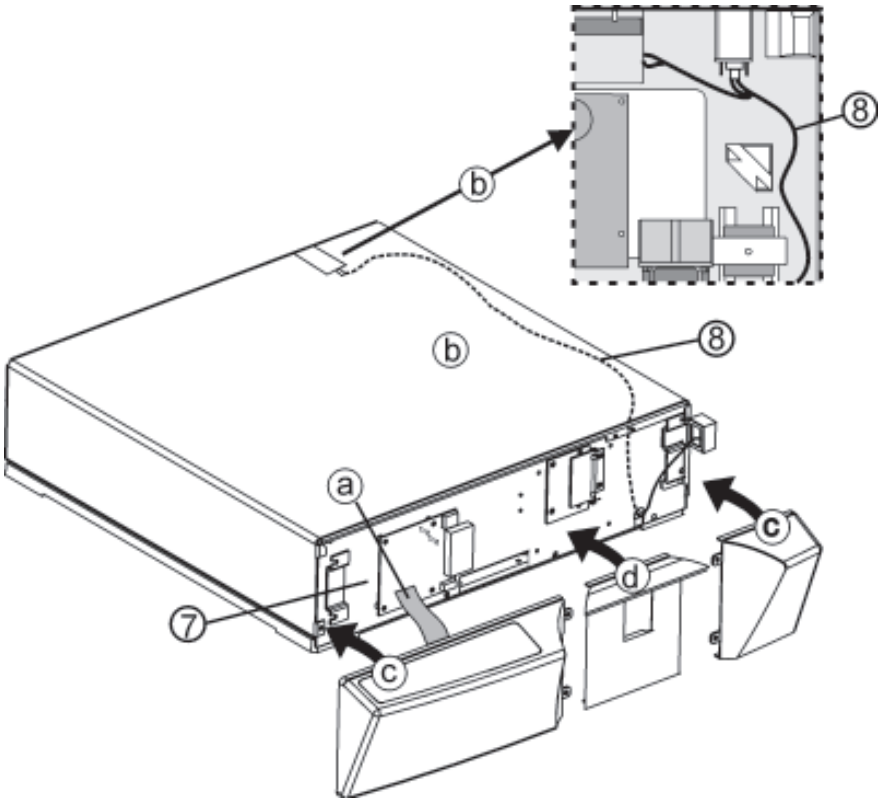
NOTE: Digora units with serial number smaller than G61308 have a lift motor to lift the imaging plate to a certain height. The motor is attached to a aluminium ring outside the light guiding tube. This ring (and the lift motor) must be removed . Remove the ring completely by first moving the transport mechanics fully in so that it will be out of way and then loosening the allen set screws of the ring and pulling it out.

5. Take the new adapter flat cable 40/20 pin and connect the 40 pin connector at one end of the flat cable to the connector J4105 on the T4100 board. The flat cable must be routed under the photo multiplier tube and the cable holder. Tighten the cable holder in place.

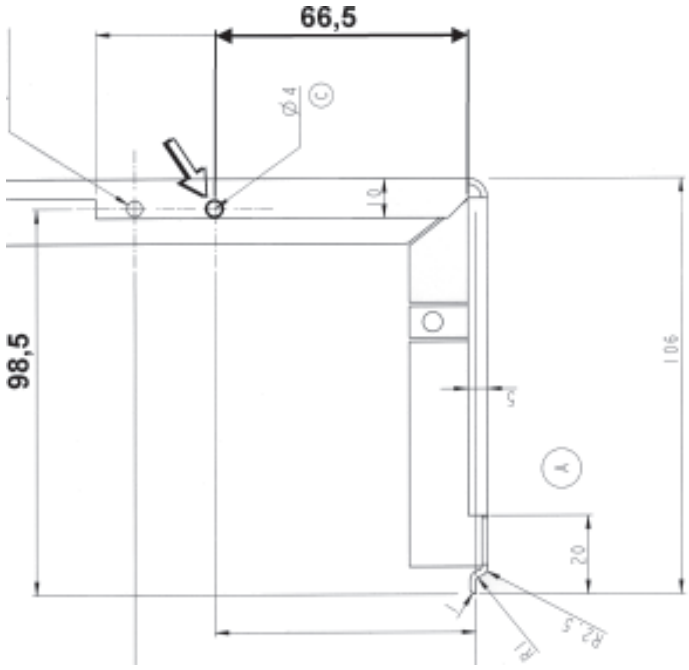
6. Install new front panel assembly using the original screws. Connect the flat cable connector 20pin to the T4501 board.

7. Connect the new main switch(ON/OFF) cable in place so that first remove the two flat connectors from the mains filter (not the yellow/ green lead). Connect the two female flat connectors of the mains switch cable to the mains filter (polarization does not matter).

   Connect then the male flat connectors of the cable to the female connectors that were removed from the mains filter. Pull the tubing on this connection and by using heat make the tubing to shrink (to keep in place). NOTE!! The old main switch must be ON all the time otherwise the new main switch does not work.



8. Drill a new hole (diameter 4mm) in the edge of the top cover according to the drilling drawing. A drilling guide is supplied with the kit to assist to drill the new hole.



9. Replace the top cover. When you close the covers, make sure they don't disengage the cables of the photomultiplier tube.

10. Connect the keyboard flat cable connector, attached to the left hand cover, to the T4501 key & display board.

NOTE!!! The correct orientation of the cable connected to the board is such that the black edge of it is pointing down.

11. Install the both plastic covers (left and right hand side) using M4 allen screws.

12. Install the middle plastic cover. It is held in place with magnets.

INTERFACE BOARD

The interface board in the computer must be version P4601-1 which includes the 4Mb SRAM memory chip for the image memory.

NOTE!!!
Before upgrading check the serial number of the Scanner to see what version of Interface board has been installed in the PC and check from the table below what changes might have to be made to the interface board.

Old board P4600 must be replaced with new board P4601-1 on which is installed the new 4Mb SRAM.

Board P4601 need not be replaced BUT the new 4Mb SRAM memory chip MUST be installed in socket IC6. If there are any 1Mb SRAMs in the slots IC5 and IC6 they MUST be removed.

Scanner serial numbers and interface board versions

Scanner	PC interface	SRAMs board
Digora before G50730	P4600	No SRAM sockets
Digora from G50730	P4601	Empty socket
Digora from G62068	P4601	2 x 1Mb SRAM (IC5, IC6)
Digora fmx from G94473	P4601-1	1 x 4Mb SRAM (IC6)

Upgrading Interface board version P4600 to version P4601

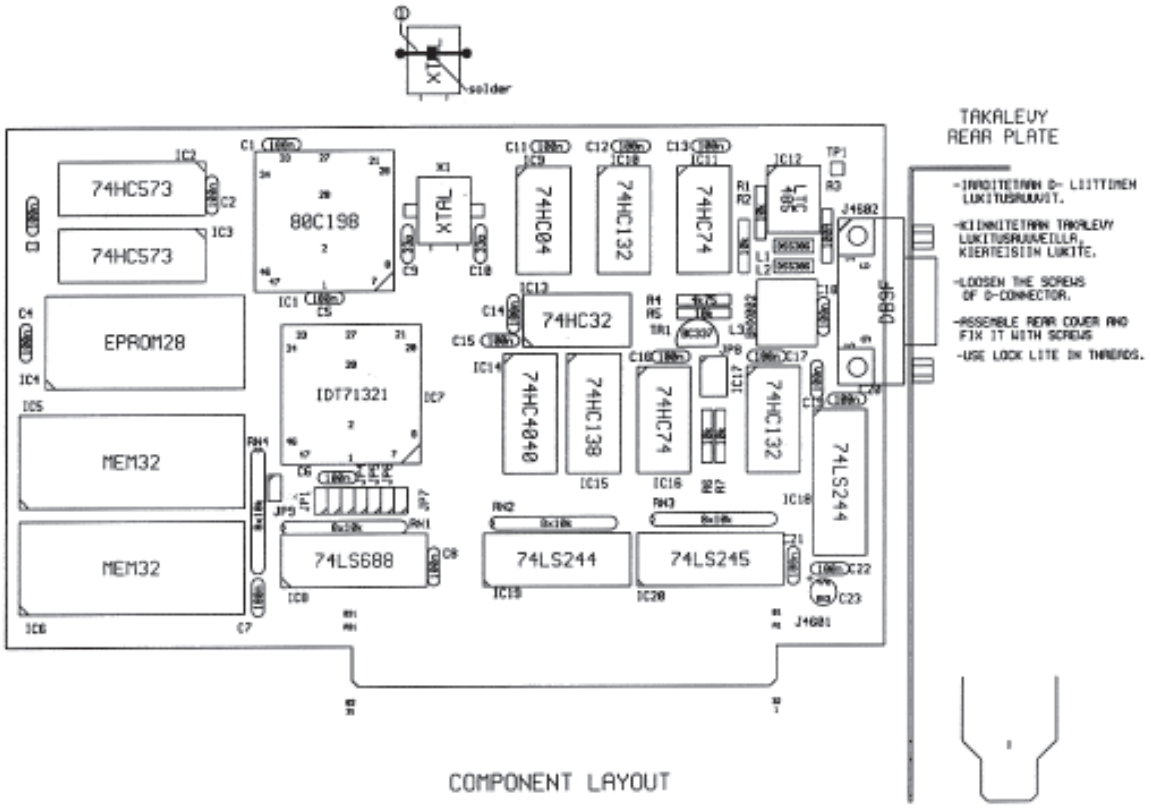
1. Remove the cover from the PC
2. Remove the old P4600 Interface board.
3. Check that the base address of the new Interface board is the same as the old one (location of the address jumpers).
4. Install the new P4601 Interface board and secure in to place with screw.
5. Replace the PC cover.

Upgrading Interface board version P4601

1. Remove the cover from the PC
2. Remove the P4601 interface board
3. If IC sockets IC5 and IC6 are empty install SRAM circuit to the socket IC6, see the drawing below.

NOTE!!! Make sure that you insert the chip the correct way round. The small notch in the chip must be the same end as the corner mark on the IC socket.

4. If there are already SRAM circuits installed, remove both and install the single latest version. The old type of SRAM does not have enough memory (old type 1Mb each, new type 4Mb).
5. Check that the base address of the new interface board is the same as the old one (location of the address jumpers).
6. Reinstall the upgraded interface board and secure in to place with screw. Reinstall the PC cover and secure in with screws.



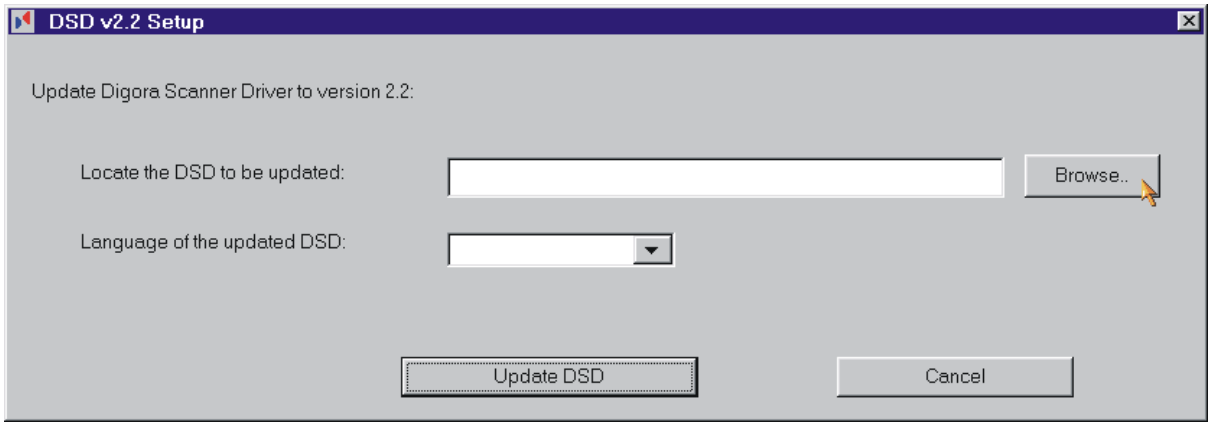
SCANNER DRIVER 2.20

DIGORA fmx units

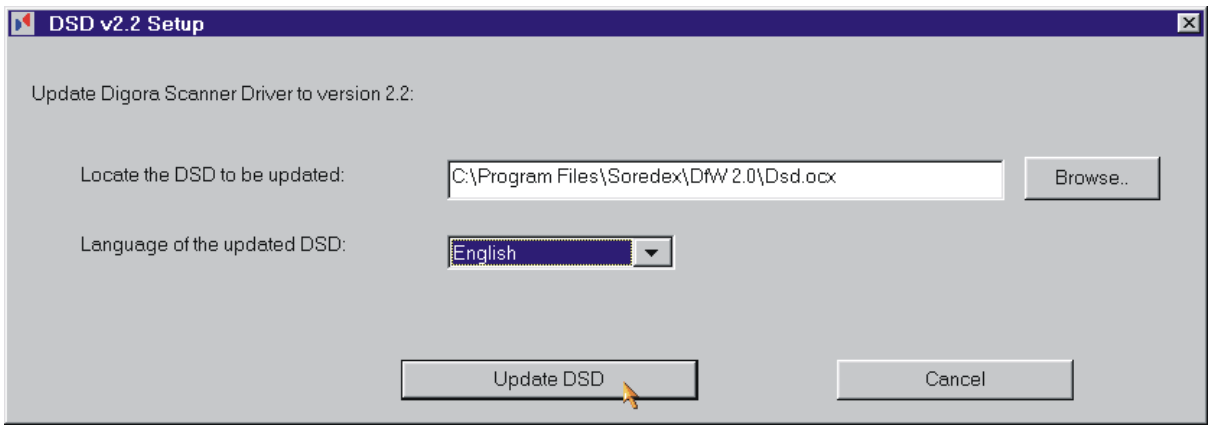
The Scanner driver upgrade is needed ONLY if the latest Digora for Windows 2.0 is already installed.
Before beginning please make sure that DfW 2.0 is installed in the computer. The application, however, must not be running during this procedure.

1) Use the Explorer to study the disk labeled 'fmx scanner driver'.

2) Locate and launch 'fmxsetup.exe'. The following dialog will be displayed:



3) Use the Explorer to locate ('Browse') the current DSD.OCX in the system to be updated. Following that, choose the desired user interface language and start the actual update by clicking the 'Update DSD' button.



CALIBRATING THE SCANNER

The scanner must be calibrated after the upgrading. To calibrate the scanner, follow the instructions in the DIGORA fmx user's and installation manual chapter 6.5.

PART NUMBERS

9891864 Upgrade kit for converting a DIGORA to a DIGORA fmx

4801099 P4601-1 Interface board

1200180 4 Mb SRAM memory chip