Kentech Instruments Ltd.

LOW MAGNIFICATION
X–RAY
STREAK CAMERA
with Intensifier [Photek 40mm single MCP]
and CCD camera [Dynavision from LaVision]

19th. February 2003

Serial NumberJ02*****

PLEASE READ THIS MANUAL CAREFULLY BEFORE USING THE CAMERA.

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DISCLAIMER

This equipment contains high voltage power supplies. Although the current supply capacity is small, careless use could result in electric shock. It is assumed that this highly specialised equipment will only be used by qualified personnel.

Kentech Instruments Ltd. accept no responsibility for any electric shock or injury arising from use or misuse of this equipment. It is the responsibility of the user to exercise care and common sense with this highly versatile equipment.

SERIAL NUMBERS

Focus supply	J02*****F
regular Sweep unit	J02*****/FS
Slow sweep unit	J02*****/SS
Intensifier Tube and power supply	Photek E02030
CCD camera	LA Vision KA 02 131
CCD Chip	CCD - 3425
Computer	
TTL card	
ADC card	
TTL fan out card	
Streak tube	J02*****/T
Cathodes/meshes	9002907000
Dongles	

Figure Captions

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1 INTRODUCTION

This manual describes the operation and use of the Kentech Low Magnification X–ray streak camera. This camera is optimised for the ultra sensitive recording of X–ray images and spectra from laser produced plasmas. The (approximately X1.2) magnification allows a 25mm length cathode to be used within a 40mm diameter intensifier window. The manual gives the mechanical and electrical specifications and describes the setting up procedure to obtain optimum time resolved data.

This manual describes the components made by Kentech in some detail and gives enough information of the parts of the system supplied by others to Kentech to allow the user to obtain data. For more information on the intensifier, the CCD camera and the software the user should consult the relevant manuals included with the system. Please contact Kentech regarding any problems or uncertainties. A more prompt response to software issues will probably be available through LaVision directly but Kentech will endeavour to sort any such issues should they be presented to us.

1.1 SPECIFICATIONS OF THE STREAK CAMERA

Trigger delay standard sweep unit	~30ns on the fastest setting, see timing data
Electro-optical magnification	X 1.2 (nominal)
Number of sweep speeds	six on the standard unit + six on the slow unit
Phosphor	P20
Cathode length	>25mm
Supply	Universal
Sweep Trigger input	Normally 10 volts, rising in < 1ns for minimum delay
Trigger input to the intensifier may be triggered from either sweep unit.	
Spatial resolution	Better than 100 μm at the cathode
Sweep hold off time	Standard sweep unit approximately 30μs Slow Sweep unit 15μs

2 GETTING TO KNOW THE INSTRUMENT

The camera system comprises the camera tube and three boxes of electronics. In addition there is an intensifier with a fourth box of electronics and a readout system. The readout system comprises, the camera head with lens coupling to a back thinned CCD, mounted onto the intensifier, a power supply for the CCD camera comes from the computer, a pair of PCI boards and a fan out connector unit for a computer and software on both CD ROM and Floppy disk (for customer settings).

The streak camera electronics are remote from the electron optics, which are of a design unique to Kentech, allowing compact mechanics. The electron optics have been designed to use only three focusing potentials. The outer diameter of the re-entrant housing is only 145mm. The re-entrant design allows the photocathode to be very close to the plasma.

2.1 LAYOUT AND PRINCIPLES OF OPERATION

The tube fits into the re-entrant vessel the outside diameter of which is 145mm. The vacuum seal is made to the outside wall of the vacuum interaction chamber. Figures 1 and 2 show the internal parts and connections to the camera. Note that the camera can only be used under a reasonable vacuum.

The X–rays, which are incident on the photocathode, produce photoelectrons. The photoelectrons are imaged by the focusing electrodes, passing through the hole in the anode and form an image on the phosphor at the end of the streak tube. With a slit in front of the photocathode an image of the slit is formed on the phosphor. This image is swept across the phosphor by a ramp potential applied

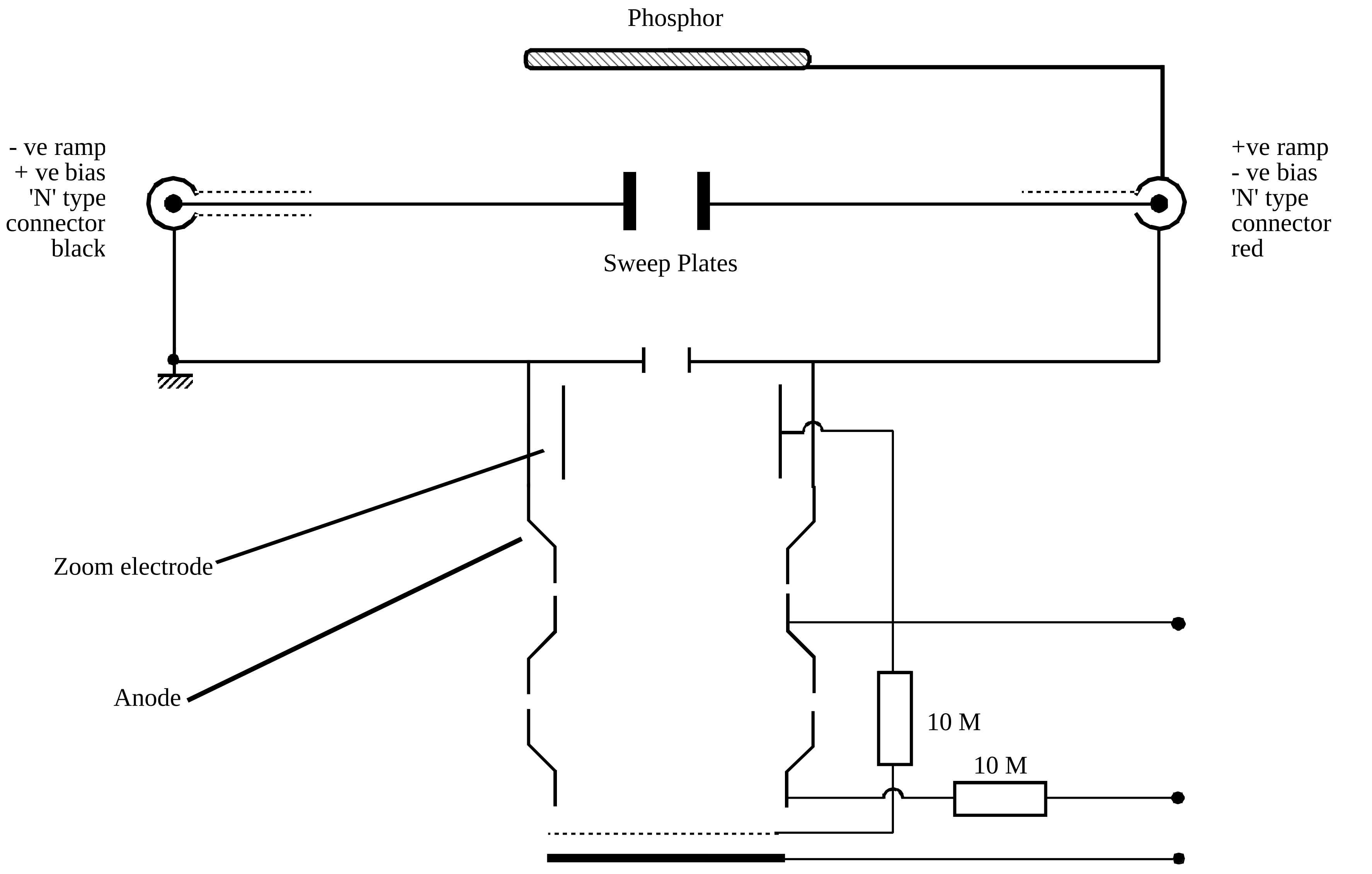

Figure 1 Connections, internal

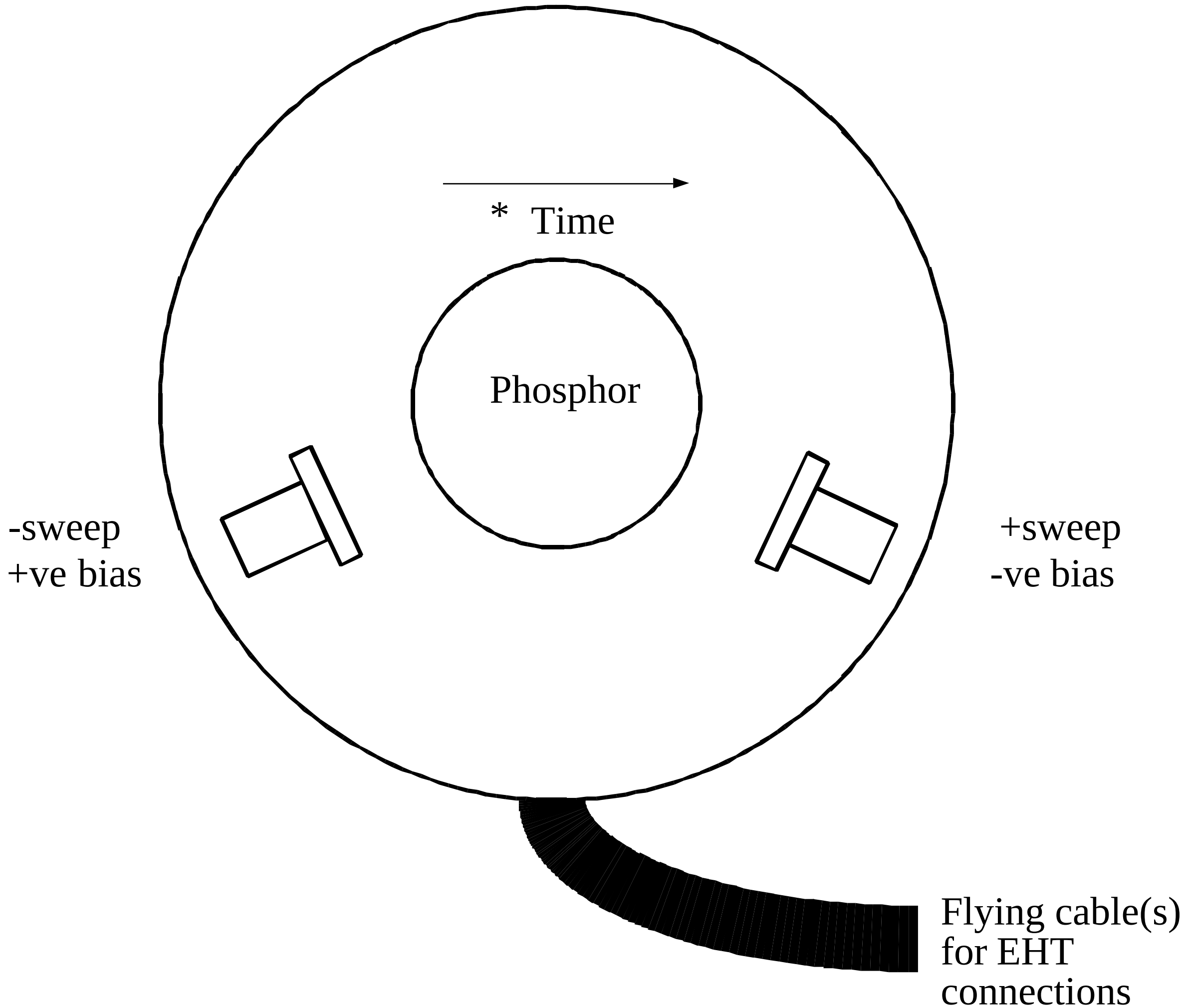

Figure 2   Connections, external

to deflection plates situated just beyond the anode hole. Position along the photocathode is magnified nominally by a factor of 1.2 onto the phosphor. The direction normal to this corresponds to time. There is an inversion in the electron optics.

2.2 THE ELECTRON OPTIC FOCUSING

Before the high voltage focusing supply is switched on the vacuum chamber must be at a suitably low pressure. For low time resolution work the extraction field between the cathode and extraction grid can be $15kVcm^{-1}$ and in this case the pressure should be below 10^{-4} torr in the region of the cathode. In order to obtain higher time resolution it will become necessary to increase the extraction field to $>30kVcm^{-1}$ and under these conditions we recommend that the pressure be below 10^{-5} torr, see section 3.3. At higher pressures electrical breakdown may occur which can damage the cathode, mesh and even the intensifier.

A block diagram of the focusing supply is shown in figure 36. The voltages applied to the focusing electrodes are given in the data section 8. The cathode is at -15kV and users should be aware not to place metallic objects near to the front end of the camera.

The focusing power supply is set to produce these voltages during the factory test of the camera, (see data section 8).

The voltages are produced by a resistive divider as illustrated in figure 37. This unit is potted. The two adjustable potentials can be set through holes in the top of the potted box, accessible by removing the top of the unit.

GREAT CARE MUST BE USED WHEN FOCUSING. USE AN INSULATED SCREWDRIVER.

Figure 1 diagrammatically shows the cathode assembly. Note the high value resistor situated close to the mesh. This limits the current flow in the event of breakdown and can save the mesh/cathode from destruction. The capacitance of the cathode to mesh is sufficient to supply the charge required to form an image. In any case the inductance of the leads effectively isolates the electrodes from the supply.

The Focus unit has an ON/OFF switch for mains power and an ENABLE switch to turn on the Focus potentials. The unit should be ON but does not need to be enabled in order that the CCD camera software can interrogate the electronics.

2.3 SWEEP UNITS

2.3.1 THE STANDARD SWEEP UNIT

The streak voltage is supplied by an external ramp generator. Figure 39 shows a block diagram of the unit.

The standard ramp generator consists of an avalanche unit. It delivers ramp voltages of about 1500 volts rising in 1ns on the fastest range. By having a large voltage the nonlinearity of the ramp is stretched by over scanning the phosphor. In addition there is a “SYNCH/OPERATE” switch. This sets the start position to either at screen edge to off screen. The positions may be adjusted with four potentiometers accessible by removing the top of the unit and a white internal cover, see figure 7. Use a high voltage 1 GΩ probe and digital voltmeter on the ramp outputs whilst adjusting these voltages. Note that the ramp speeds will depend upon the settings of these potentiometers as they determine which part of the ramp is used.

2.3.2 THE SLOW SWEEP UNIT

The slow sweep unit uses a Miller integrator and is inherently much more linear than the regular unit. The bias voltages that set the start position are adjusted in a similar manner to the regular unit but there is currently no adjustment for the Synch. position that will be at screen centre; i.e. there is no bias voltage in the Synch. position on the slow unit, only on the regular unit.

2.4 MAGNETIC FIELDS

The electron optics are prone to image displacement under the influence of stray magnetic fields. To remove this effect a mumetal screen, which fits around the re-entrant housing, is supplied. It is not essential to use this screen, however, it is recommended if any magnets are around the chamber (such as ion pumps or gauges).

NOTE

The use of screws of magnetic materials in or near the photocathode assembly can give rise to image displacement. If it is necessary to replace screws ensure that they are of unplated brass or nonmagnetic stainless steel. The use of nickel (magnetic) plated brass screws has not been found to cause problems but we would advise against it. Similarly the residual magnetic field from stainless steel screws generated in the screw manufacturing process has not been found to be a problem.

The screws clamping the cathode snout should be of nylon.

2.5 MECHANICS

Note that the nine screws clamping the inner housing cover with the three crescent shaped clamps are drilled to permit evacuation of the blind holes. Do not mix these screws with others of similar size used elsewhere on the instrument. (A few spares are provided.)

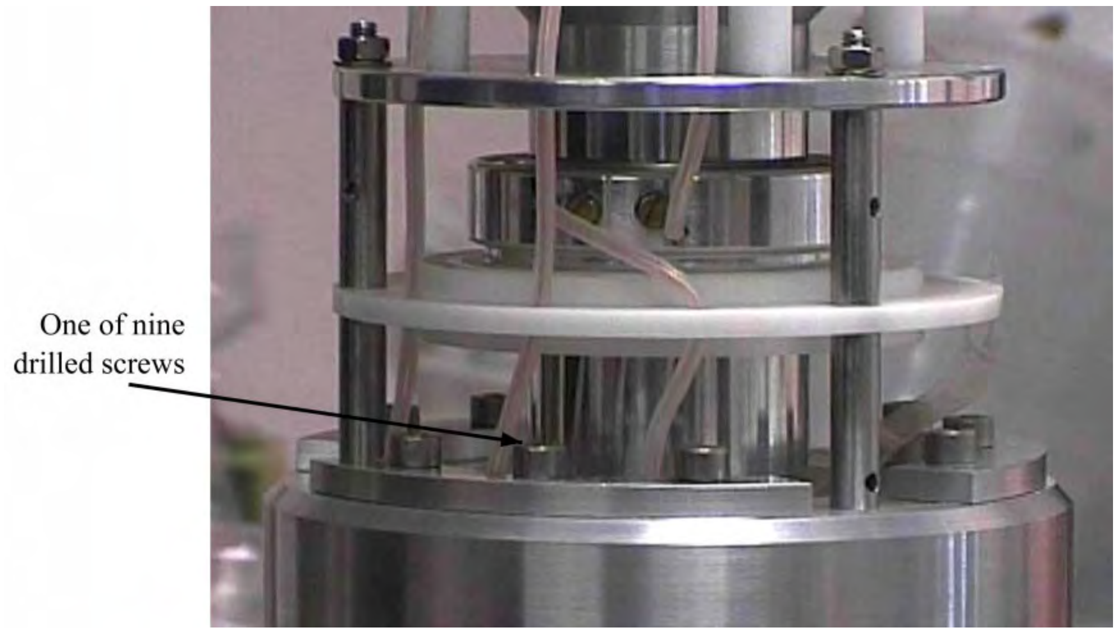

Figure 3 The zoom electrode and the position of the drilled screws

3 USE

3.1 CONNECTIONS AND MECHANICS

The high voltage focusing potentials are taken to the camera via 3 coaxial colour coded cables.

Red	:	cathode
Orange	:	mesh
White	:	focusing cone

Either sweep unit is connected via two 50Ω leads. These leads have “N” type connectors that fit the sweep unit and "N" connectors to fit the camera. The camera is labelled with the appropriate ramp connections, as is the sweep unit. These ‘N’ type connectors may break down if used unmated. Avoid unmated use and always keep them clean and free from metal particulates. If necessary regrease the threads to reduce thread wear which leads to brass particles in the connectors.

Remember that metal particulates can cause a break down in the connectors and an also get embedded in the soft fibre optics used on the camera.

Figure 1 shows the internal connections and figure 2 shows the sense of the connectors on the camera face. The direction of increasing time is also shown in this figure, time goes from the negative ramp side towards the positive. This direction with respect to the camera housing may be reversed by swapping the polarity of the sweep leads. Do not forget that there is a further inversion in a lens coupled readout system but that this is normally accounted for in the readout head. The flat field intensifier does not invert the image.

The CCD camera supplied may invert the image depending upon how it is configured. The unit supplied with system corrects the inversion in software as it is set up.

The re-entrant design allows complete access to the internal components of the camera without disturbing the re-entrant vessel. Since this vessel is the usual mounting point for any diagnostic attachment, removal of the camera streak tube will not disturb the alignment. To remove the streak tube the intensifier if fitted should be removed. The chamber should be vented at the last moment as this will improve the pump down time. There are eight holes in the camera on the intensifier mounting flange. An Allen key (supplied) can be passed through these holes to remove the eight screws which hold the streak tube to the re-entrant housing. The streak tube must be withdrawn

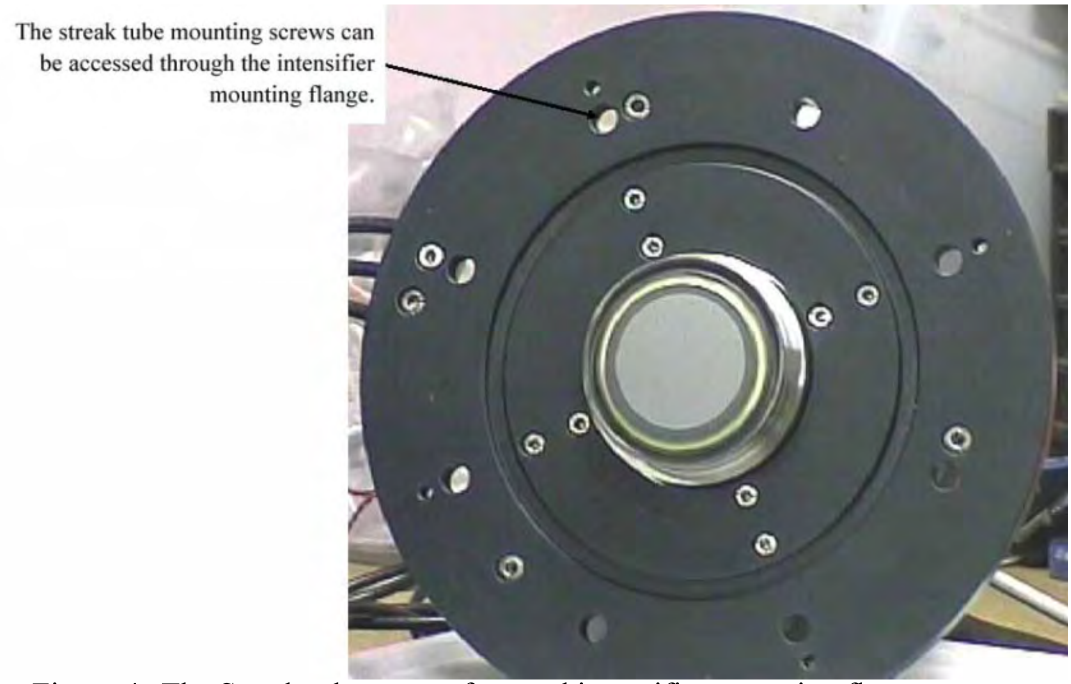

Figure 4 The Streak tube output face and intensifier mounting flange

carefully so that the cathode assembly does not strike the re-entrant housing. This is particularly important for salt cathodes that may fall apart if subjected to large acceleration.

The time for which the camera is exposed to the atmosphere should be minimised as;

(i) the cathode may degrade under the influence of atmospheric moisture and (ii) the pump down time is shorter for a short exposure to air.

N.B. The mechanical versatility allows the camera to be oriented in many ways. Be sure that the slit axis is correctly aligned with respect to any diagnostic attachments.

3.2 CATHODE AND MESH ASSEMBLY

For transit the cathodes and meshes are stored in a protective container. They should be transferred to a more suitable container on receipt, for example an evacuated desiccator. A suitable cathode and mesh need to be inserted before the camera can be used.

The instructions that follow refer to components shown in figure 5. In order to access the photocathode assembly four nylon screws around the periphery of the holder should be removed. The clamp may then be removed. Always take extreme care at this stage. The photocathodes are delicate, subject to contamination and very expensive. The meshes (underneath) are also very fragile and expensive. With the mesh and photocathode removed there is a direct line to the output phosphor (although there is only a small aperture in the lens assembly). Hence particular care must be taken not to drop small screws or other items into the camera.

The items to be placed into the snout of the camera are as follows and must be in the sequence and orientation specified. It is assumed that the camera is orientated with the snout looking upwards.

1. Mesh contact ring (not actually removable without unsoldering from lead) solder contact side downwards. The contact ring must seat evenly with solder of the connection being in the rebate of the housing.
2. Mesh with mesh side upwards, [also called grid or accelerator grid]
3. Spacer. There are two standard spacers. Normally the 3mm one should be used. The 1.5mm one is used to obtain greater time resolution but a better vacuum may be required to prevent breakdown. If the vacuum and cathode quality permit, a 1.5mm spacer may be used. The voltage across this gap is about 4.5kV giving extraction fields from 15 to 30 $kVcm^{-1}$.

   The spacer may be reduced even further. We have worked with and 1mm spacers (not supplied here) on low magnification cameras but only after gaining confidence at larger spacings and establishing a good vacuum. Make sure that when using very high extraction fields that the condition of both the mesh and cathode is good and that there are no spikes protruding. **In addition the spacers and snout must be very clean and free from contamination or burn marks.** If burn marks occur they must be removed completely. This usually involves machining the damage away or replacement. Solvent cleaning does not work well enough.
4. Photocathode with photocathode side downwards i.e. nearest the mesh.
5. Slit, providing that the cathode is not made on a slit substrate.
6. Photocathode contact ring with solder connection upwards away from the photocathode.
7. Remaining spacer(s). Must be placed in so that the rebate covers the solder

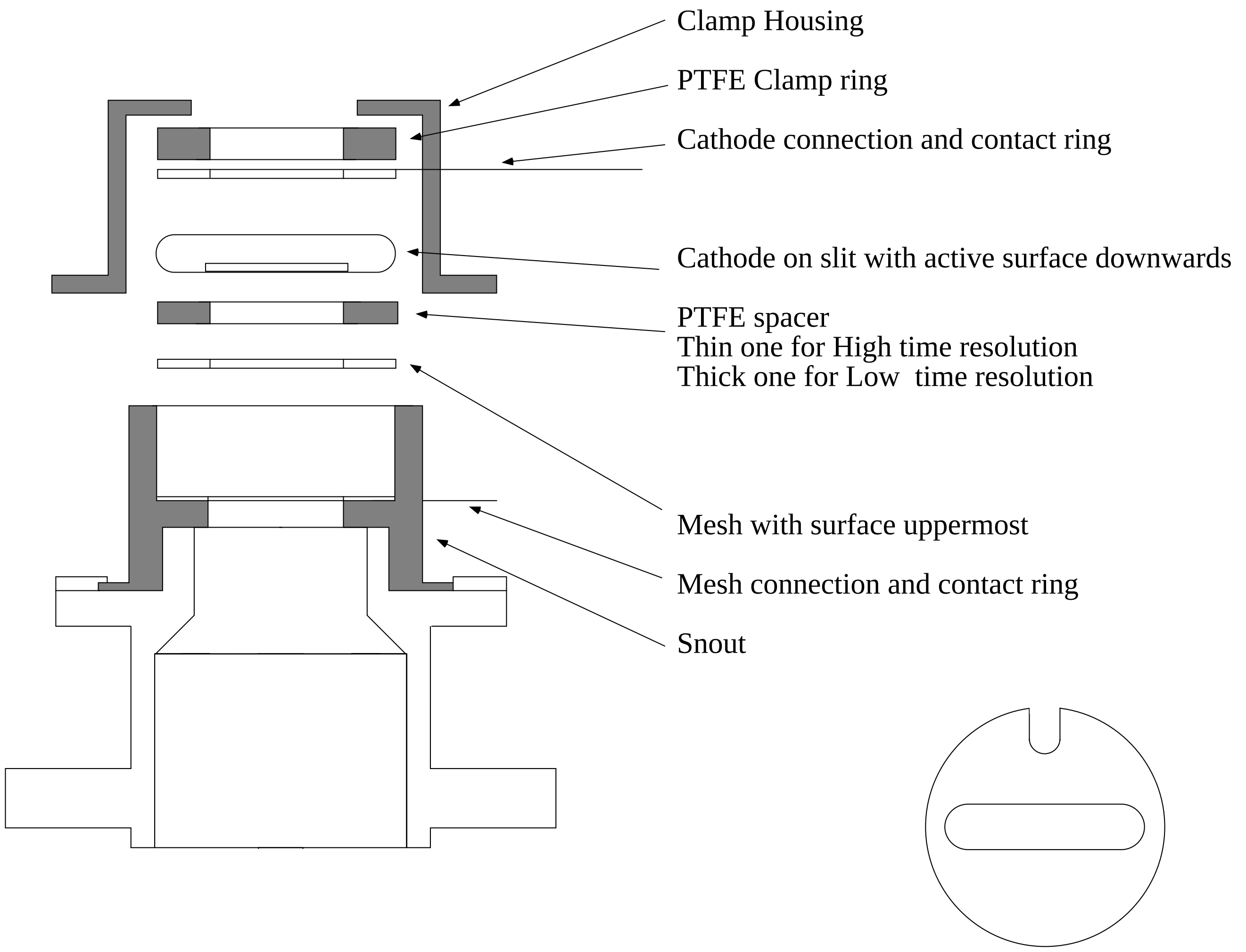

Figure 5 Cathode/mesh assembly

connection to the photocathode contact ring. If reduced thickness spacers have been used between the mesh and cathode more spacers may be necessary here to give enough height to the stack of components so that they are compressed by the outer clamping piece.

If using a low angle of incidence option it will be necessary to use a top spacer with a cut out. This is a non standard option.

Note 1:- Cathodes come in two main formats, normally for slow sweep speeds the cathode and slit are separate items. In this case the slit should go in after the cathode. For faster work we have made the cathode on the slit assembly. This eliminates two main problems, firstly if a laser beam is focused onto the slit the beam may well have expanded again by the time it reaches the cathode. Secondly, multiple reflections between the cathode and slit may give rise to spurious results. By using a single slit/cathode unit these are overcome, however, at the expense of losing independent control of the slit and cathode.

3.3 INITIAL POWER-UP

It is necessary for the vacuum interlock to be set before the HT can be turned on. This requires that the vacuum interlock connector at the rear of the unit be shorted out. It is intended that this be connected to relay contacts on a vacuum gauge. The focusing supply must not be turned on if the pressure is higher than 10^{-4} torr. At extraction fields greater than ~15kVcm^{-1} (3 mm spacer) it may be necessary to obtain a better pressure. We recommend that the camera first be timed and set up with a low extraction field (3mm spacer between the cathode and mesh). Once the system is operating satisfactorily at this field the spacer can be reduced and the vacuum improved. Note that the pressure in the cathode to mesh gap is what is important, not that at some distance from the cathode.

When the power is first applied a small breakdown will usually occur as a result of absorbed gas released under the influence of high electric fields. The normal procedure, after the vacuum chamber has been evacuated, is to turn the camera on **with the intensifier removed** while watching the phosphor in semidarkness. At the first application of power there will probably be a slight flash of light. The focusing supply should be switched on and off a few times, such that no light is visible on the phosphor and the fault does light not flash. It may be necessary to wait for the pressure to improve before this test is passed. Only after this test is passed satisfactorily should the intensifier be mated and powered up. This test is only required once after venting the vacuum chamber. Note that the focus unit is set up to come on slowly. This has been found to help with breakdown problems.

It is not a good idea to leave the camera powered up for long periods while waiting for shots as an unexpected rise in the chamber pressure due to accidental venting or possibly pump failure could result in destruction of the cathode and/or the mesh.

It is also undesirable to leave recording film, if used, exposed to the intensifier for any longer than is necessary as it may pick up noise and degrade the data.

For use with the CCD readout system supplied please see section 6

3.4 PROCEDURE FOR TIMING THE STREAK CAMERA

In general the trigger signal should be timed so that it coincides with the X–ray signal on the photocathode, with allowance made for:

(i) the flight time of electrons from the cathode to the sweep plates (approximately 1.7ns)

(ii) the time delay from triggering the sweep unit to the image reaching the middle of the screen. This time depends very much on the sweep speed in use.

(iii) the flight time of photons from the plasma to the cathode

(iv) the relative timing of the electrical trigger and the start of the event at the target.

Alternatively timing can be performed in the usual manner, i.e. time up in a "SYNCH" mode and then switch to the “OPERATE” mode.

In "SYNCH" mode the image starts at on screen at the edge (or centre in the case of the slow sweep unit). If the image does not sweep, i.e. it remains in the static untriggered position, then the trigger arrived after the event and the trigger delay must be reduced. Alternatively, if no image is seen on the screen then the trigger arrived too early and the image was swept off screen before the event. In this case the trigger delay should be increased. With this procedure a binary search for the event can be made, but beware of bad shots or other mishaps that can lead one down a false trail in the binary search. Go back and check old positions occasionally as not seeing the image can be caused by a lack of intensifier trigger or no focus voltage, also a stationary image can be caused by a loss of sweep signal.

Once a moved image is recorded the timing should be adjusted so that the image is just on the far side of the phosphor (away from the start point) and then the unit can be switched to “OPERATE”. The swept beam spends a significant amount of time off screen before arriving at the screen (especially with the regular sweep unit) it may be necessary to trigger a little earlier to see the image on screen in “OPERATE” mode. See the timing data in section 8.2.

3.5 TESTS

The electron optics may be tested with either a DC X–ray source or a DC UV source, such as a mercury vapour lamp with quartz envelope. However, for optimum focus, the wavelength should match that to be used in the experiment. A suitable test pattern may be needed. We can supply cathodes made onto resolution charts to do this. [Dynamic focusing effects may occur at very high sweep speeds. In this case it will be necessary to refocus the camera slightly at the sweep speed in use.]

The camera must be operated in a vacuum so the user must provide a suitable pumping system. The vacuum requirement is a pressure of not more than 10^{-4} torr. A suitable window and cathode must be provided for UV use. (Kentech can advise on the supply of such a cathode, being either 10nm gold or 100nm aluminium on a quartz substrate) and a UV mercury vapour lamp, which will operate in the vacuum chamber. Alternatively a more powerful lamp may be imaged through a quartz window onto the cathode.

A typical mercury vapour lamp operating 20cm from the cathode will give a bright image on an intensifier in contact with the phosphor. With suitable cathodes and reduced lamp to cathode spacing, it is possible to obtain moderately bright images without an intensifier. Remember that the cathode is at 15kV and that the lamp is probably grounded. In normal (swept or short exposure) operation an intensifier should always be used in order to maintain a low electron current in the tube and still obtain a recordable image. It is possible to melt the cathode with some types of UV lamp. Also the UV output from UV lamps usually increases significantly as they warm up. Note that at the time of writing UV light emitting diodes are not of short enough wavelength to activate a gold cathode.

The focus controls may be accessed after removing thew top cover of the focusing supply. Great care must be exercised when this is done as high voltages are present. The focusing potentiometers may be adjusted by turning the potentiometers in the potted EHT divider network. The screwdriver used MUST be insulated.

It is possible for the sweep plates, if left unconnected, to become charged causing image displacement and also for them to pick up electrical noise. Consequently we recommend that they be grounded during static focusing work.

With the DC source, the focusing supply and the intensifier, switched on, the focus should be set for optimum image quality. The two potentials are interdependent and the optimum image quality is obtained by iterating between the two settings. The cathode voltage should first be checked to be –15kV. Then a best image should be found by adjusting the mesh potential and then the focus voltage should be changed slightly. The mesh voltage should be again set for a best image and the image compared with that obtained with the previous focus setting. The greatest effect of the focus voltage will be on those parts of the image furthest from the axis. The focus should be chosen to give the best edge image quality while always maintaining the mesh potential at a best image position. The position of the crossover should also be close to the hole in the anode. If it is not vignetting will occur. This is obvious when focusing the camera. Note that vignetting can occur if the crossover is either too far or too near the cathode. A suitable mid position must be found and this will be with the cross over roughly at the anode. This will ensure that the cross over is near the sweep plate assembly.

If DC tests are performed with a CCD readout system it is important that the exposure is maintained at a constant time for image comparison. It may be advisable to trigger the intensifier also or it can be used DC. The intensifier power supply has several gating modes. For DC focusing the DC and the external gate will be the most suitable. The internal and fixed gates are very short and really only suitable for normal use. In external gate mode the intensifier will gate for the length of the trigger pulse applied to the gate. It is possible to configure the CCD camera software to produce a suitable trigger pulse of specified length and timed to correspond to the CCD integration time.

Stray magnetic fields may displace the image slightly. The mumetal screen may be adequate to remove this if necessary. Otherwise the magnetic field will have to be eliminated.

3.6 POSSIBLE FAULTS

1 No DC image

Focusing unit not on or vacuum interlock not set.
Insensitive cathode.
Bad connections to cathode/mesh assembly.
Short circuit between mesh and cathode.
Breakdown of EHT feed (indicated by fault light on focusing supply).

2 Bad focus.

Poor connections to cathode/mesh.
Old/damaged cathode.
Poorly mated EHT connector.
Fault in bias/sweep supply. (Confirm by switching off sweep circuit supply, which should restore focus).
Focus voltages have drifted (unlikely).
Photocathode and mesh not normal to camera axis.
Image is due to x-rays going straight through the tube and exciting the phosphor. Check that no image is present with the focusing unit switched off. If necessary block the direct x-ray path.

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3 No streaked image.

Intensifier triggering at wrong time, possibly from noise.
CCD camera triggering at the wrong time.
Sweep unit triggering at wrong time from noise.
Sweep feeds incorrectly connected.
Inadequate trigger signal causing jitter.

4 Spurious blobs of light.

Breakdown in chamber.
Pressure too high. Check vacuum and perform initial power up test.
Breakdown on shot. Plasma or target debris getting into electron optics. Is front of re-entrant vessel adequately screened? It is wise to restrict the front aperture as much as possible and cover the X–ray line of sight with as thick a filter as will transmit the desired X–rays.

5 Reduced sweep speed combined with possible loss of focus

Bad connection of one sweep lead. This reduces applied voltage ramp but also fails to a maintain zero potential in drift tube, hence affecting the focus.

6 Jitter present in image.

Inadequate or irreproducible trigger signal. The electronics has a jitter of about 20ps rms. It is necessary to provide a good and stable trigger source for the electronics. This may well not be easy but is left to the user. Kentech can advise about solution to trigger problems but the subject is too wide for a discussion here.

N.B. Poor connections to the mesh or cathode will often result in an apparent drift in the focusing as the electrodes charge up.

4 CIRCUIT DESCRIPTIONS

4.1 SWEEP CIRCUITS

The regular sweep unit is based upon two high voltage avalanche step generators unique to Kentech. These two generators provide balanced steps of amplitude > +/- 1.5kV into 50Ω loads, with a rise time of <1ns. These generators are fed into the sweep leads via 50Ω reverse terminating resistors, which reduces the amplitude to 0.75kV. When this edge reaches the open circuit end at the sweep plates it doubles up to 1.5kV. The reverse pulse is absorbed by the reverse terminating resistors. A block diagram of the unit is shown in figure 39.

Different sweep rates are obtained by the switchable pulse forming LCR network and selected by the sweep rate switch (see figure 41). *The sweep leads form part of this network and their length must therefore not be changed.*

A further function of the sweep units is to provide the required bias voltages to define the start of the sweep. For historical reasons the two units behave slightly differently.

4.1.1 STANDARD SWEEP UNIT OPERATE, SYNCH AND FOCUS

On the each sweep unit there are two positions ,"SYNCH" and "OPERATE".

For the regular sweep unit, in Synch. mode the sweep starts on just on screen. So one can see the sweep beginning. In operate mode the sweep starts well before the screen so that the voltage ramp is in its most linear part when it gets to the screen centre.

For the slow sweep unit the Synch. starts at screen centre. The operate starts just off screen. This unit is more linear and overscan is less necessary so the start point can be closer to the screen edge.

4.1.2 SLOW SWEEP UNIT OPERATE, SYNCH AND FOCUS

The slow sweep unit uses a FET based Miller integrator circuit to obtain the ramps. This is inherently much more linear than an avalanche circuit and consequently less overscanning is required. Also the sweep rate is set by an RC time constant around the output FET. This is easily adjusted. As the output sweep range has to cover a considerable range the resistor is switched for each sweep speed with relays and the feed back capacitor is also switched for some range positions. The circuit uses six resistors and two capacitors to obtain six speeds. If speeds outside of the existing range are required the resistors may be changed and or the capacitors. In addition the relay that switches in more capacitance for some sweep speeds can be made active or not on a given position. All these modifications will require some soldering etc. Small adjustments to the sweep speeds can be effected by adjusting the variable resistors for each sweep position. Make sure that the slowest (position 1) is set first and then the others as the slowest speed uses a resistor that is always in the circuit. See figure 6 for details.

The bias voltages that set the start position are adjusted in a similar manner to the regular unit but there is currently no adjustment for the Synch. position that will be at screen centre; i.e. there is no bias voltage in the Synch. position on the slow unit, only on the regular unit.

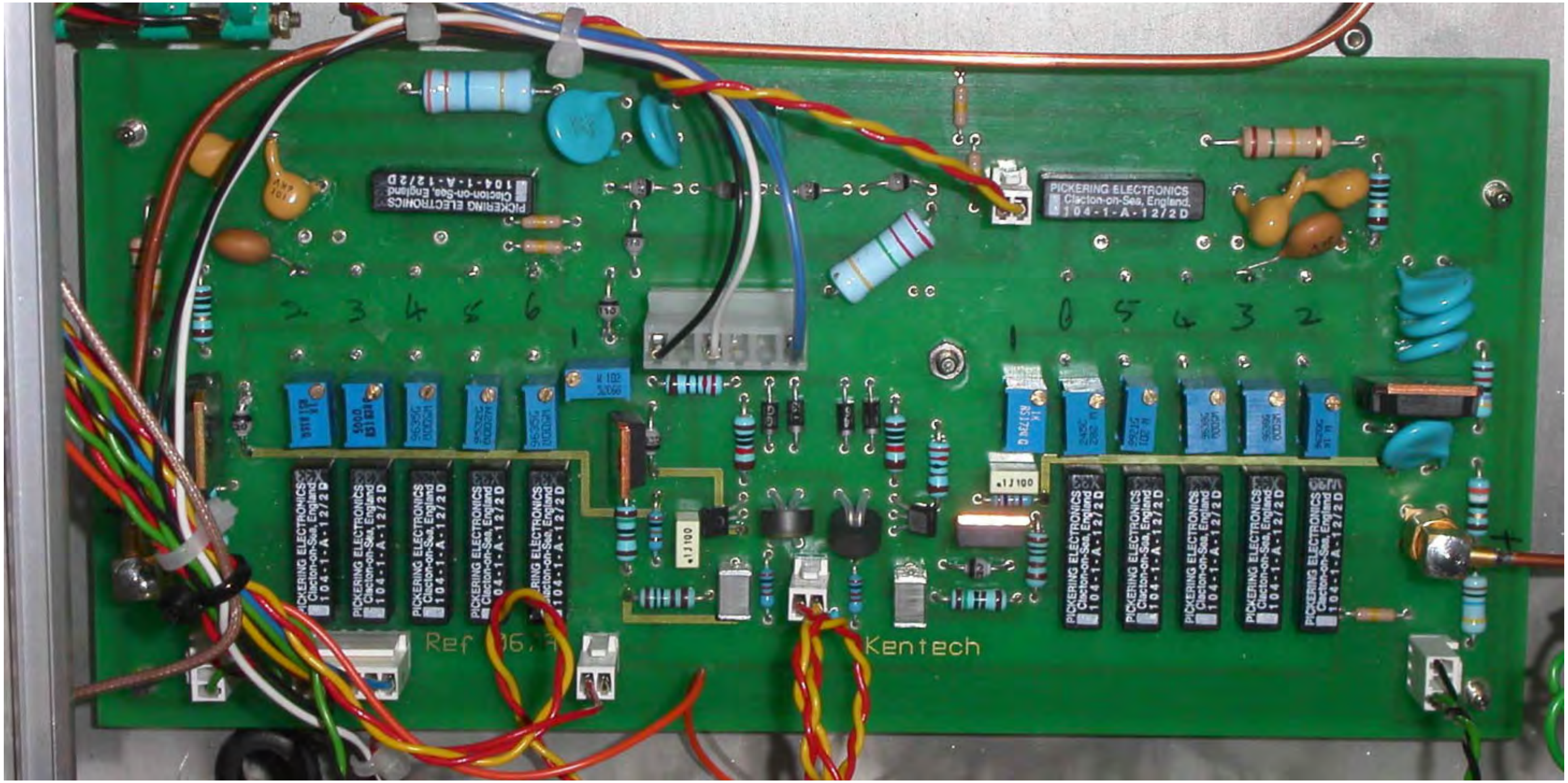


Figure 6 The slow sweep board, showing adjustment pots

4.2 THE FOCUSING SUPPLY

Figure 36 is a block diagram of the focusing supply with circuit details in figure 46. The focusing potentials are derived from a resistive divider chain, passing a nominal current of 100 μamps. The operation of this network requires no explanation except to say that the high voltage zener diodes are to limit the voltages appearing across resistors in the network in the event of a breakdown, thus stopping damage by excessive dissipation. (The network is shown in Figure 37). The -15kV potential is obtained from a regulated solid state encapsulated supply. This supply is in turn supplied from a regulated low voltage DC source.

The focus and mesh potentials can be varied by means of the potentiometer spindles to be found inside the focusing supply. If they are to be adjusted then an insulated screwdriver must be used, taking great care to keep fingers away from the potted box and the high voltage connectors.

The potentials may be measured with a high impedance probe. A 1GΩ probe will cause a significant voltage drop on the mesh and focus outputs and a correction must be made if the true voltages are required. The specification at the end of this manual quotes the indicated voltages measured sequentially with such a probe. It does not give the true voltages which may be obtained with bridge measurements.

The fault indicator light is activated if the camera draws any appreciable current from the supply. The -15kV is obtained from a Start Spellman encapsulated DC/DC converter. A signal is taken from this supply which is a measure of the power output. A trimmer on the low voltage board sets the threshold at which the indicator lights in response to this signal. A breakdown is usually accompanied by intermittent changes in the brightness of the fault lamp.

At the rear of the unit is a connection for an interlock. The centre pin needs to be grounded to the outer connection to enable the high voltage supplies. This is intended for use with vacuum gauges having pressure level switches. This feature should on no account be used to turn the unit on and off as it is likely that the pressure will damage the camera before the switch in the gauge acts. It is intended purely to prevent accidental *powering up* with the pressure too high. An interlock plug with a leads is provided.

The HTs are set to come on slowly (around 10 seconds) to help reduce breakdown problems.

5 CATHODES

The cathode materials normally recommended for X–ray use are cæsium iodide and gold but for high time resolution the energy spread from these is too great. We recommend the use of potassium bromide or potassium iodide. It has also been noted that low density cæsium iodide cathodes exhibit a tail in the emission after illumination with a very short pulse. Consequently we recommend solid density cathodes for high time resolution. As these have a very limited lifetime the user will have to be able to recoat the cathodes supplied regularly or be extremely careful about their exposure to anything but a clean vacuum.

TRANSFER THE CATHODES SUPPLIED TO AN EVACUATED DESICCATOR AS SOON AS POSSIBLE AFTER RECEIPT OF THE CAMERA

5.1 CATHODE MANUFACTURE

The most sensitive cathodes we have used are low density cæsium iodide. This material is made by thermal evaporation in a background atmosphere of argon. The cathode is in the form of a foam, with a structure scale length of a few microns. The voids in the material allow electrons to escape from a greater depth. Furthermore the presence of a large electric field in the material causes a cascading effect resulting in a small amount of gain. Ironically the low density material, with a very

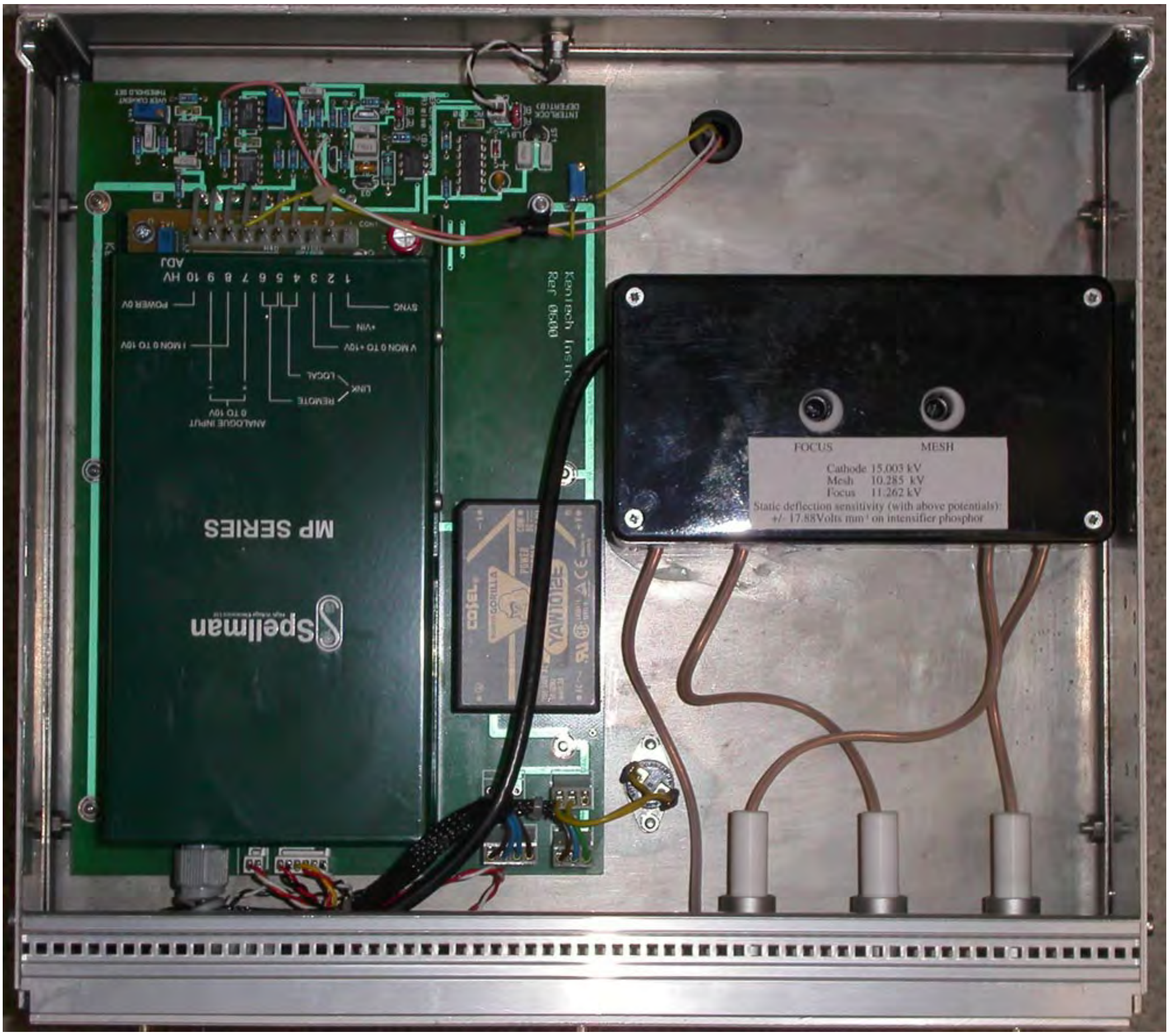


Figure 7 The focus supply, showing focusing pots

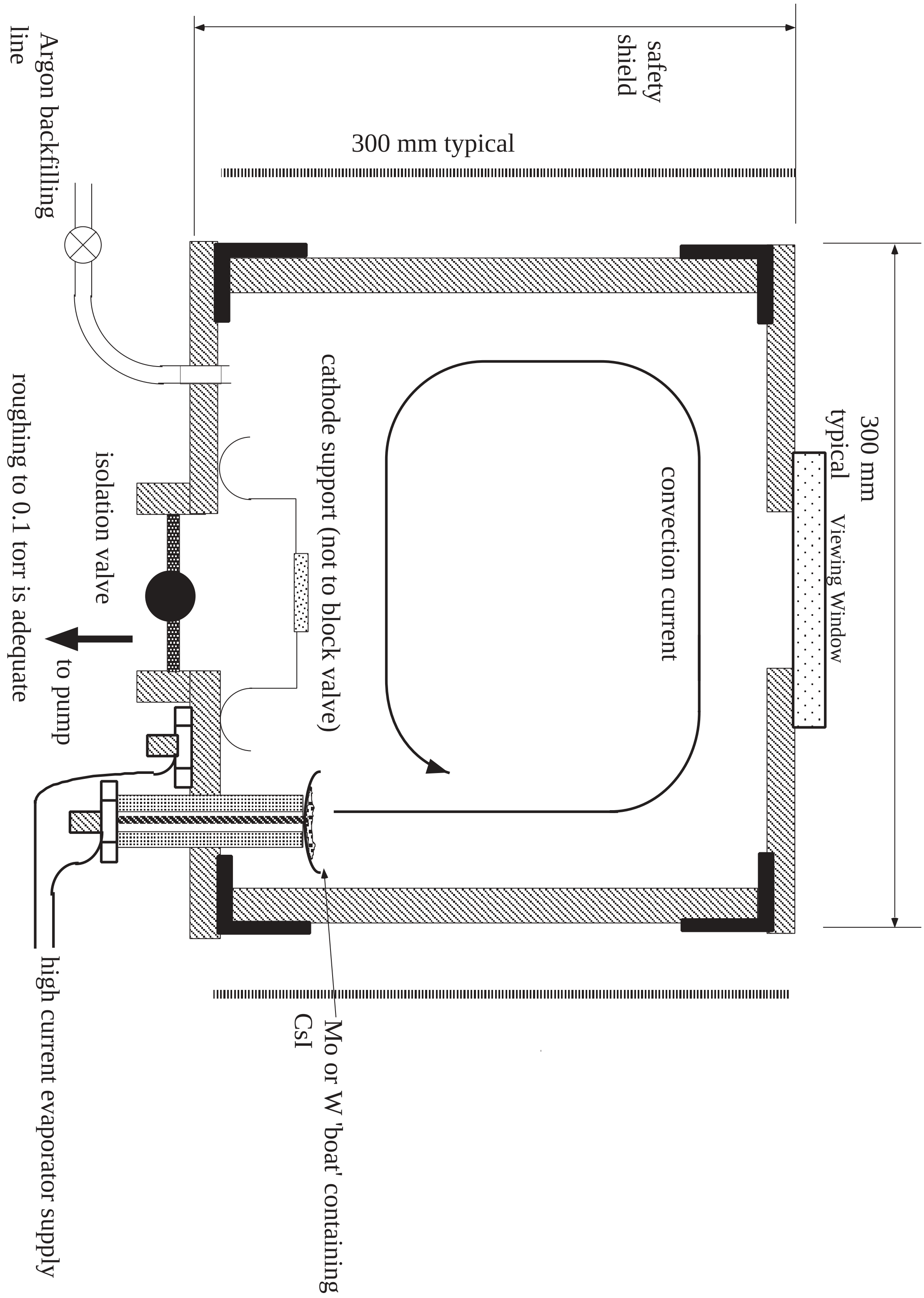


Figure 8 Low Density cathode manufacture

large effective surface area, is most tolerant of atmospheric water vapour. We believe this is because the absorbed water is quickly lost under vacuum, as a result of the large surface area. Low density cathodes are, however, not very mechanically robust.

A suitable "recipe" for the production of such cathodes is to evaporate approximately 1-2ccs of powdered cæsium iodide in a background of 5 millibars of argon. The layout of the deposition chamber should be roughly as shown in figure 8. The cæsium iodide is carried in the form of a smoke by convection currents in the background gas. A very uniform cathode can be made by rotating the substrate during the deposition, see figure 8.

6 PHOTEK IMAGE INTENSIFIER AND LAVISION CCD CAMERA

The Photek 40mm flat field image intensifier is supplied with the original equipment manufacturer's manual and reference should be made to that in conjunction with these notes. Similarly the manuals for the LaVision CCD camera should be referred to also.

The CCD camera is supplied ready fitted to a demagnifying lens assembly and to the intensifier. Unless the user wishes to switch to film as a recording medium this assembly need not be dismantled at all.

6.1 INTERFACING THE INTENSIFIER TO THE STREAK CAMERA

Figure 9 Intensifier mount flange with knurled nuts and the lens assembly removed

Figure 10 The CCD camera vents

Prior to mounting the intensifier to the streak camera, perform the initial power up test on the streak camera, see section 3.3.

The intensifier is supplied mounted in a housing with the readout fitted.

Remove any protective covers from both the intensifier input and streak tube output faces if these are present. This is best done using a piece of adhesive tape rather than trying to use a sharp object under the edge of the cover. Keep all hard or sharp objects away from the intensifier.

Make sure that the fibre optic surfaces to be mated (the streak camera output and the intensifier input windows) are scrupulously clean. If necessary clean with a "use once" lens tissue with some suitable solvent cleaner, e.g. low residue alcohol or acetone. Use a single wipe across the face with a folded tissue and then discard the tissue. If necessary repeat the process. Remember that the fibre optic faces are image planes and any residue, dirt or damage will appear on the final image data.

Present the intensifier/CCD assembly to the streak tube and slide over the four studs protruding from the streak tube. Carefully bring the two units together. The last few mm are spring loaded as the intensifier can move back in the housing slightly. It will fit in any of four orientations. The user should decide which way round is best suited to a particular application and mount the intensifier accordingly. However, all the data shown here in the calibration section assumes that the CCD camera is mounted with its top upper most and that the focus leads to the streak tube are lower most. This will produce a left to right sweep.

With the head held on the four protruding studs, carefully fit and tighten the four large brass knurled nuts until the head is firmly held against the streak tube flange. Note that as the intensifier is spring loaded the pressure between the intensifier and the streak tube optics is not related to the tightening of these large brass nuts.

Make sure there can be unsrestricted airflow around the air inlet and outlet grilles on the sides of the CCD head, see figure 10.

Note that although the CCD camera is fitted with water cooling facilities, these are not needed in this application as the integration time will be short. No cooling beyond the built in air cooled thermoelectric cooler is supplied. The camera normally operates at 0°C

6.2 INTENSIFIER POWER SUPPLY AND TRIGGERING

The intensifier is connected to its power supply via a cable and a high voltage Fischer plug. **Make sure that the power supply is turned off before fitting or removing the plug.**

The intensifier has five modes, OFF, External, Variable, Fixed and ON. In normal use we recommend the fixed position. This will give around a 300µs gate when triggered. This matches the phosphor decay time of the streak tube and is suitable for recording a single event. During calibrations and focusing a longer integration time may be more suitable. The internal Variable position does not offer gate lengths any longer than 1ms and so the External mode will be suitable for focusing work. In this mode the gate length will equal the input trigger pulse length, often called "slave" mode. If problems with timing are experienced the ON mode may be suitable on shots but for focusing work this will result in smeared images if the input signal is continuous.

The intensifier may be triggered from the sweep generators using the monitor/synch. outputs. Make sure that the intensifier power supply is set to +ve edge triggering. If an alternative trigger source is used then it should be TTL level and the pulse duration must be less than 300µs. Trigger signals greater than 300µs may extend the gate time accordingly. Although the manual states that the trigger pulse should be longer than 100ns we have found that the shorter signals from the sweep units will trigger the intensifier.

The intensifier gain will rise about 30ns after the trigger is supplied. The phosphor of the streak tube decays over several hundred microseconds. Triggering the intensifier at the same time as the standard sweep unit will therefore result in a very small loss of signal.

Figure 11 The Intensifier power supply panels

Before turning off the power to the intensifier supply it is advisable to remove all light sources from the device, switch the photocathode gating control to "OFF" and the gain to minimum. In normal use with the intensifier bolted to the streak camera there will be no light into the intensifier anyway. However, during D.C. focusing there may be light falling on the intensifier input. This should be removed before switching off.

When the power is removed from the intensifier the voltage on the cathode may not hold the tube off while the other power rails collapse and a large exposure could result if there is light falling on the cathode.

Figure 12 The Intensifier cable gland can be rotated

The intensifier power supply employs a current limit so that if the tube is over exposed the current drawn will be limited to protect the tube. **On no account should this limit be used generally. It is for protection in the case of an accident and cannot be relied upon to protect the tube fully.**

The cable gland where the Intensifier cable enters the intensifier housing can be rotated. If necessary slacken the screws on the input face of the housing, rotate the gland to the required position and re-tighten the screws. Do not attempt to over rotate the gland.

6.3 CCD READOUT SYSTEM

The readout system consists of the head, supplied attached to the intensifier, two PCI cards, a TTL fan out card and several leads and software.

6.3.1 A SUITABLE COMPUTER

A suitable computer will need at least the following specification:-

Ability to run Microsoft™ Windows 98

Three spare PCI slots

Floppy drive

CD ROM drive

Free Serial Port COM 1 (the software can be configured for Com 1 through Com 6)

Free parallel port (or USB if you ask LaVision for a USB dongle)

A lot of memory; with more memory, more images can be stored and manipulated. We have found that 128 Mbytes gives adequate resources.

A reasonable size hard disc, as the images are more than 4Mbytes each.

We have found that 37 Gbytes is adequate (probably a lot less would be OK also)

We have found that an 800MHz machine works adequately but a slower one would probably be adequate.

It is a good idea to have method for backing up the data. e.g. a writable CD system.

6.3.2 SETTING UP THE COMPUTER

It is assumed that the user is able to set up a computer to run a Windows operating system.

With the computer shut down and the power lead removed off, insert the two PCI cards into the PCI bus. The TTL/I/O card has a piggy back board that uses a third output slot but does not connect to the PCI interface directly.

There is a trigger lead from the TTL I/O card to the A to D convertor card outside the computer, make sure that this is fitted, see figures 13 and 14.

With the computer power off connect up the CCD camera. There is one lead from the camera to the computer. This carries power and all the control signals.

Screw down the leads that have screws requiring screwing down. All the leads are colour coded.

Attach the dongle supplied to the parallel port.

The software is configured to enable reading of the settings on the Focus unit, the Intensifier power supply and either of the Sweep Units. To enable this the Focus unit should be connected to the COM1 port of the computer with the supplied 25 way to 9 way serial lead. The focus unit should then be connected to the sweep unit in use and that to the intensifier. These connections are by way of 5 pin round Fischer connectors.

The rear of the computer should look like figure 14.

Note that the unit to unit communication is by I^2C bus. The focus unit has a RS232 to I^2C bus adapter inside. This needs to be powered. So the focus unit needs to be switched on to enable the reading of the units by the software. The focus unit should not be enabled until it is necessary to use the streak tube. With the focus unit on but not enabled, the settings of the various boxes can be read by the software, however, the software will also detect whether the units are switched on or not. So for example to do a focus shot with the regular sweep unit connected, it can be turned off. The software will then interpret this as being present but not ON and suggest that this is a focus shot, unless the intensifier is not on, in which case it is a dark current shot.

The software can distinguish between not connected and turned off, except in the case of the main power to the focus unit.

6.3.3 SOFTWARE INSTALLATION

The system will come preinstalled if the user also purchases a computer with the read out system. In this case this section can be skipped

Insert the CD ROM and the floppy disc. If installation does not start automatically open the CD ROM directory and launch the SETUP.EXE application. Follow on screen instructions.

Make a back up copy of the floppy disc. This contains customer settings files which the software can modify but it is always a goods idea to keep a copy of the original set.

In addition copy the folder cl-Xray into the same folder as the DaVis folder. Do not put it inside the DaVis folder. cl-Xray contains the Macros that have been written for use with the X-ray streak camera and customise the DaVis software.

The installation process will require re-booting the computer.

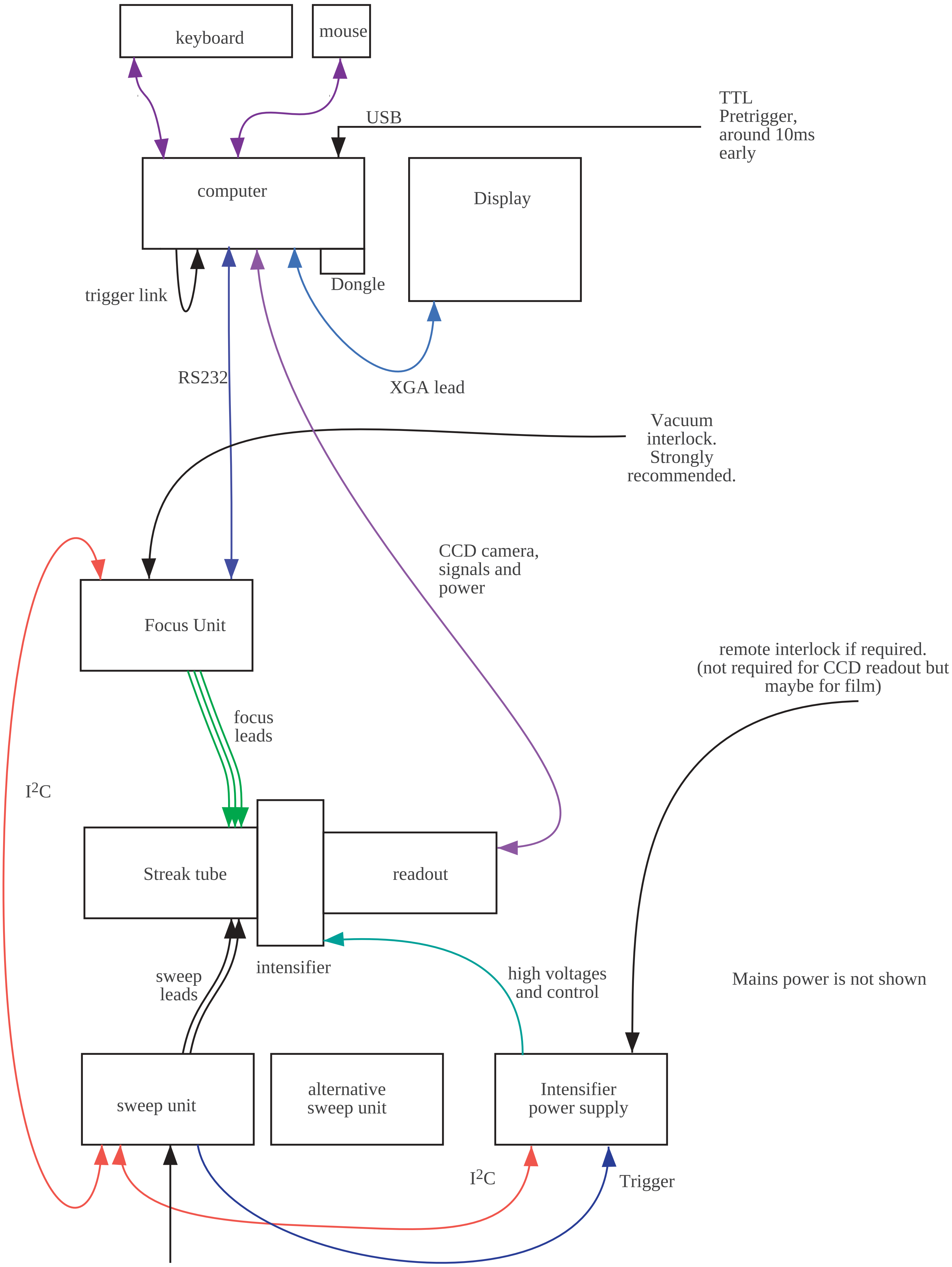


Figure 13 Connecting up the whole system

6.3.4 FIRST RUN OF THE SOFTWARE

The user should read the manuals that come with the software.

The program is launched by double clicking the DaVis icon on the desktop or single clicking the icon in the task bar. The software should find the dongle and the two PCI cards. Should there be any problems at this stage check for poor connections to these items and restart the machine from scratch.

Note that in this software the difference between the OK and Apply buttons is that OK closes the window also. It is necessary to hit one of these buttons to make the software react to changes.

Once the software is running there should be a window entitled “X-Ray Streak camera”. This enables the user to take images and read the settings on the various boxes of electronics. The macros that generate this window are in the cl-Xray folder, this has been customised to interface with the streak camera.

If the serial communication to the other boxes is all connected and the focus unit is ON but not enabled, then one can proceed. If it has been decided to proceed without the serial communication the communication port may be set to “SIM” see figure 19. This will load a communications simulator that can be made to give suitable responses. Note that if you shut down DaVis it will remember all the current settings, including whether you have selected a COM port or the simulator.

6.3.5 THE X-RAY STREAK CAMERA WINDOW

Look at figure 20 very carefully. This window has two modes. It can either show the status of the Streak Camera Electronics the last time it was interrogated or it can show the status of the electronics when an image was acquired. After an image is acquired the software interrogates the electronics and stores the settings wit the image. If DaVis is used to display the image at a later date then clicking on the “Show Image Status” button will display the settings of the electronics at the time the selected image was taken. The selected image will be the one in the active window or selected image buffer. By clicking on “Read Streak Camera Status” the mode will flip back to looking at the current set up of the electronics.

If the focus unit fault indicator comes on the Streak Camera Window will also detect this and issue flashing and audible alerts. TURN OFF THE FOCUS UNIT IMMEDIATELY.

6.4 CCD TIMING AND TRIGGERING

There is an ambiguity in the software as to the exact nature of an “external trigger”. The camera can operate with either an internal trigger or external. This is set in the Camera Parameter window, accessible from the tool bar (camera). This external trigger should always be checked as it synchronises the operation of the camera to the timing acquisition sequence, see Acquisition Timing dialog in figure 21

There is a second level of internal/external trigger that allows one to synchronise the camera to an external event. In internal mode the software determines the timing and the outputs on the TTL I/O card can be used to synchronise external events to the software. In external mode the reverse is the case. The external event will control the software. This is the most likely configuration for normal shots. However for focusing and dark current shots the internal may be more appropriate.

In either case the External trigger in the Camera Parameter window must be checked to allow any synchronisation at all. The external trigger in the X-Ray Streak Camera window is the only one that should be manipulated.

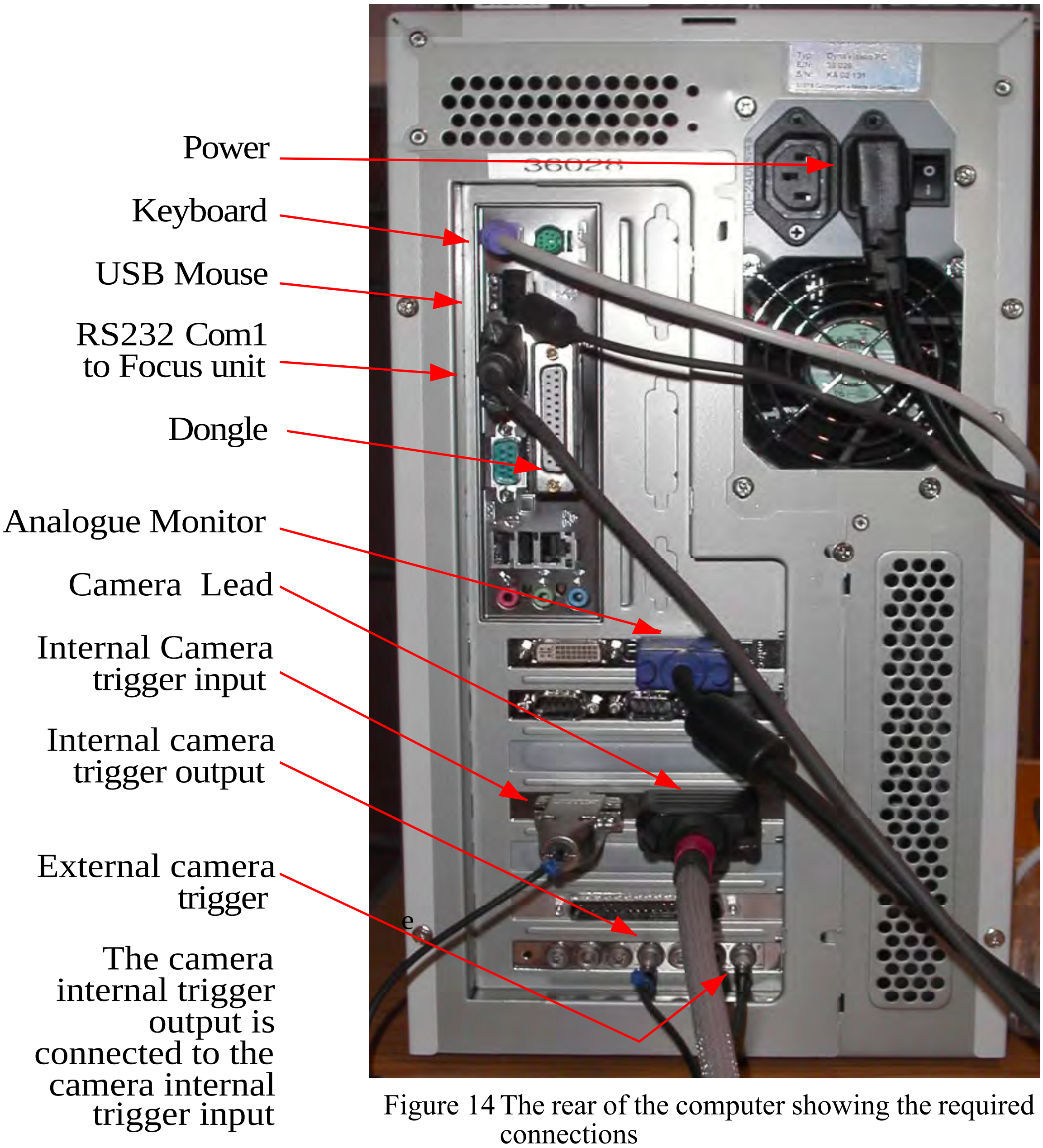


Figure 14 The rear of the computer showing the required connections

Figure 15 The Camera Parameter window.

Note.

1. The external trigger must be checked.
2. The integration time is set here.
3. The horizontal mirror is set here to compensate for the image flipping.
4. Hardware binning can be set to increase frame rates when continuously grabbing.
5. "Settings" is where the temperature is set.

Click here to read the status of the various boxes of electronics.

Flip display mode to show setting when an image was captured.

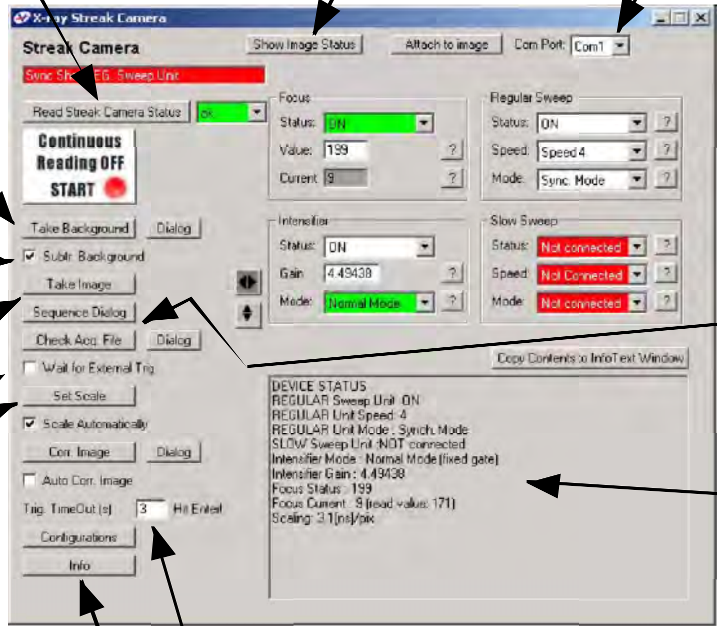
Is the focus unit connected to COM1?

To take a background shot make sure the intensifier is off.

This will get checked after a background shot has been captured. It can only be toggled once there is a background image to subtract.

Images can be taken with take image but the sequence dialog will also enable the image to be saved immediately. This is a safer way to take real shots

This uses the Sweep unit settings to scale the data in the time axis.



The timing acquisition file should not normally be changed. The "wait for external trigger" check box will modify it internally.
It could be modified to provide a trigger pulse of specified length to the intensifier.

This information will be stored with the image data.

Help and other information

It is VERY important to set these two correctly. For testing it may be more suitable to have external triggering disabled but it must be on to synchronise to an external event.
If it is switched on then the Time out wait should be set appropriately; i.e. perhaps 1200 seconds on a real shot, or 3 seconds for testing.

Once the take image button is hit all interrupts to the software are disabled until a trigger is received or the time out is reached. This can be a long wait if it has been inappropriately set. Similarly on a real shot the time out time must exceed the wait time to a trigger signal

Figure 16 The X-ray Streak Camera Window

Figure 17 Sequence/Summing Window
Use this window if you wish to take an image and save it automatically. You may also set the buffer to which the image is saved. Normally the Stop after N images would be set to one.

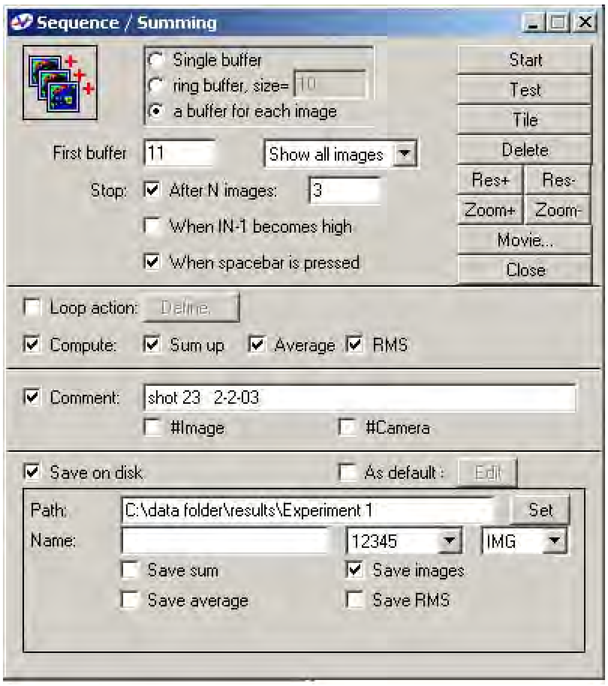
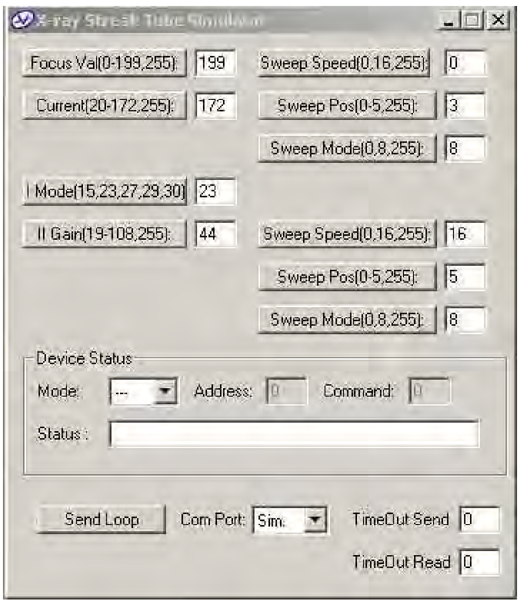
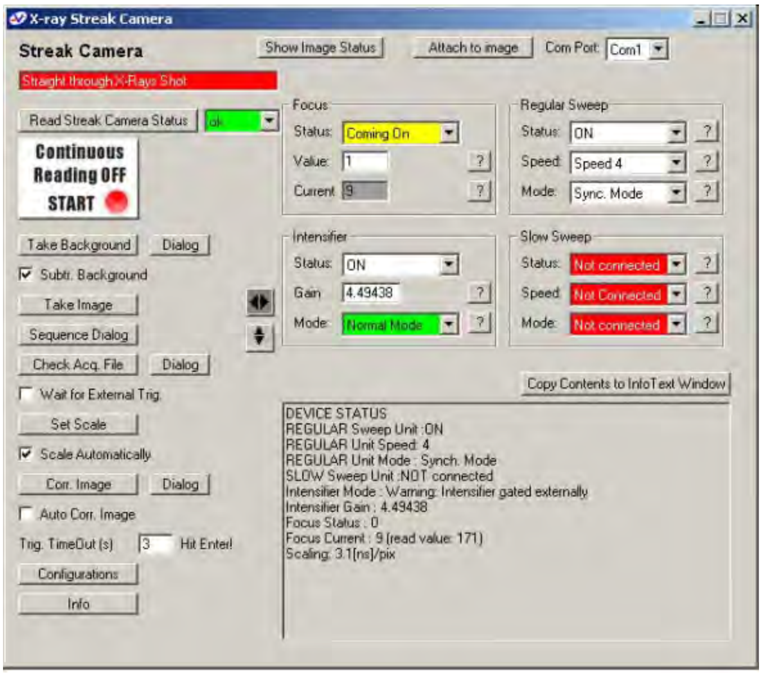


Figure 18 Background Window
Use this window to change the default background buffer or to view the background. Leave other settings unchanged.

Figure 19 X-ray Simulator Window
This can be used to check operation of the communications system or to set up artificial information about a shot.
For each parameter only the values in brackets have meaning, a “-” indicates a range.
The lower section “device status” is for checking real RS232 communication with two computers and need not concern the user.





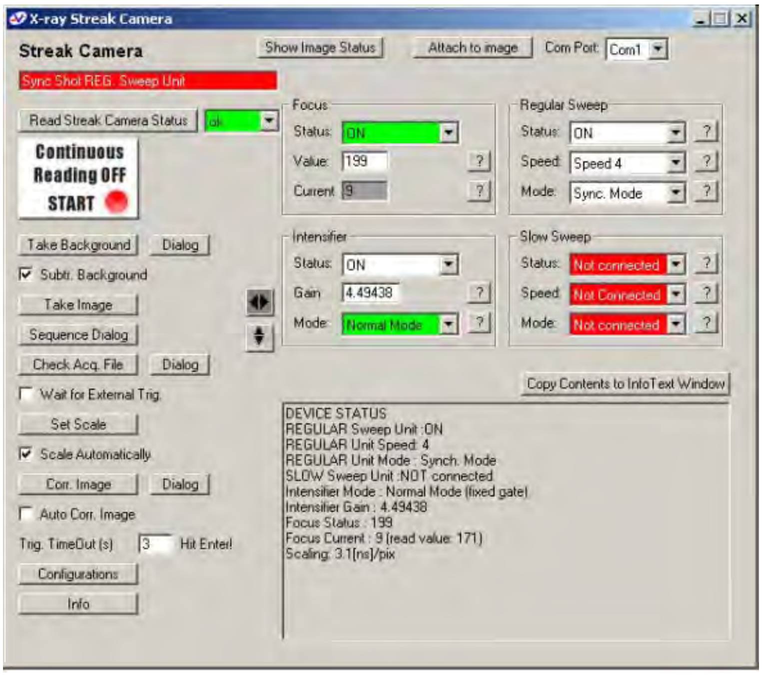


Figure 20 The Streak Camera Window

This can display the status of the streak camera. It can be read once on command or continuously at about 0.2Hz.

With the three units (focus supply, intensifier and sweep unit) in different modes the program will try to determine what type of shot is being made, background, focus, straight through X rays, synch. or normal.)

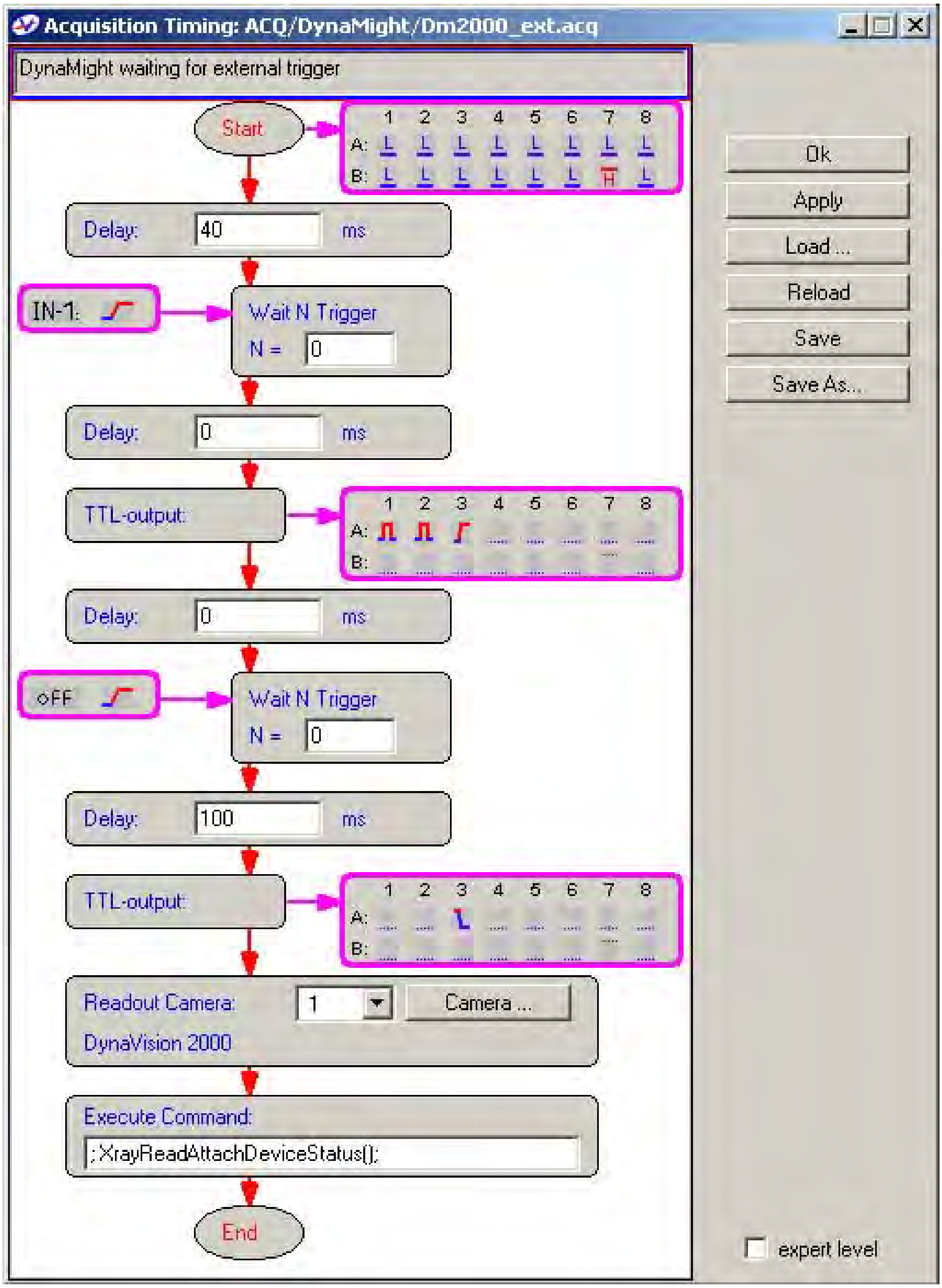


Figure 21 The Acquisition Timing Window

This is shown set up for internal trigger, i.e. the software determines the timing. The IN-1 input is the external trigger input and the "wait N trigger" should be set to 1 for external triggering. This is done by the External trigger in the check box in the X-ray Streak Camera window but can be done here. If the window save button is hit the new state will become the default. However, the X-ray Streak Camera window does not read this file and will assume the default is 0 triggers, i.e. internal trigger.

This input should not be confused with the "external trigger" check box in the Camera parameter window. That external trigger just synchronises the camera to this timing diagram.

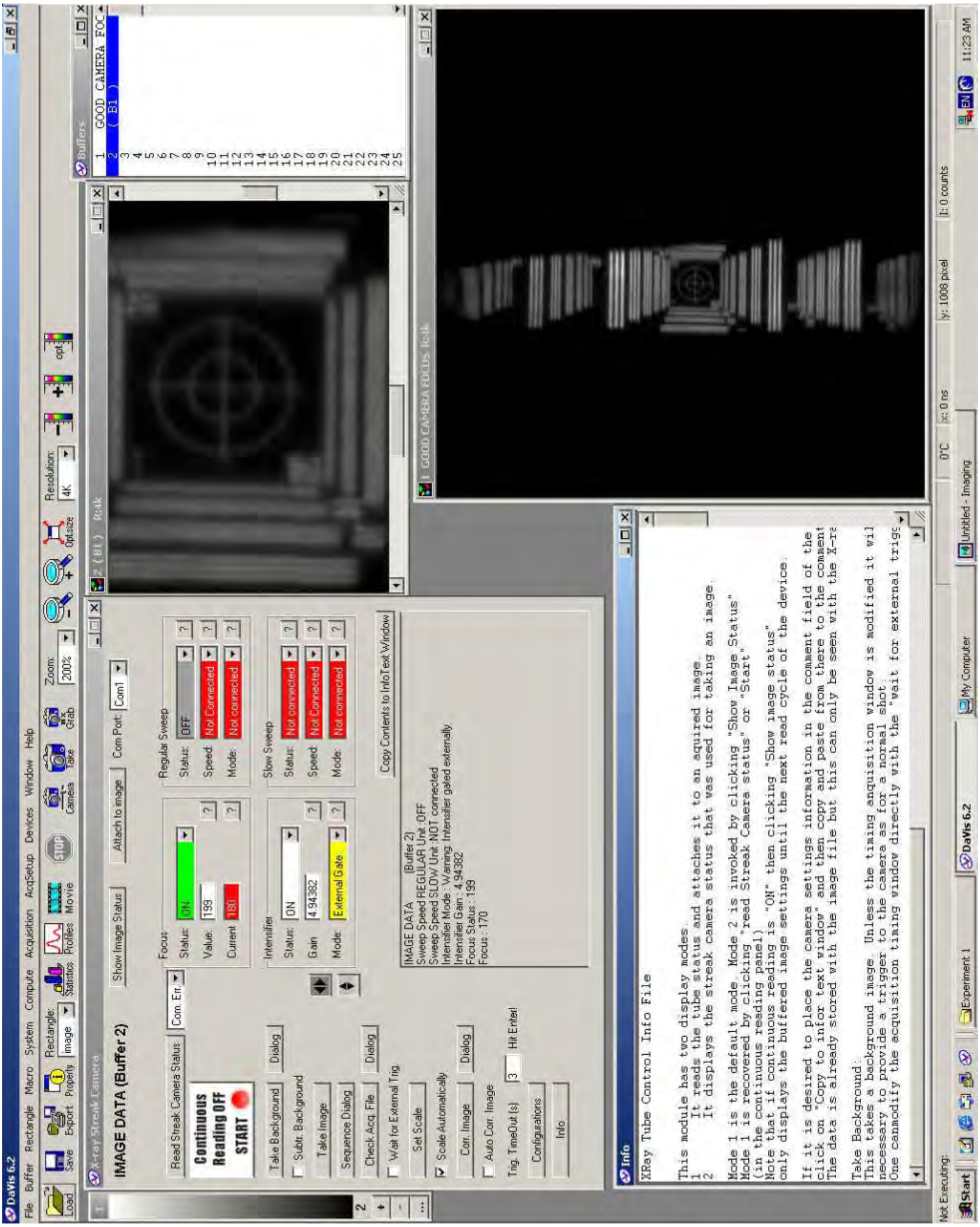


Figure 22 The screen during a typical session.

For normal operation the system needs an external trigger into the top socket on the TTL I/O card, (positive going TTL level of around 50ms). Attach a suitable trigger signal and attempt to take an image. The CCD camera needs such a trigger unless it is triggered with software.

The CCD chip needs a trigger to start the image integration and a trigger to stop it. These are provided by the TTL I/O board supplied through the edge on A3, see figure 21.

In normal use requiring synchronisation to an external event of known duration the best mode to use is to trigger the camera at the beginning of the integration and let the software turn it off and then readout the data. It is, however, possible to use hardware to do both.

The input at the top of the TTL I/O board is connected in hardware to the logical input IN1 on the timing acquisition diagram, see figure 21.

The pulse applied to this input should be positive going and at least 3ms before the event to be recorded. The integration actually starts on the rising edge of A3, but a further 3 ms should be allowed after this time to allow the electronics to settle.

The integration time is set in the camera parameter window. For focusing it may be appropriate to increase this beyond the 100ms normally set. Do not forget to reset it.

So the sequence of events to take a normal image is:-

From the keyboard/mouse issue a take image command. The software will then clear out the charge in the CCD chip, disable the computer interrupts and then wait for the trigger signal into the top port on the TTL I/O board. If this is not forthcoming before the timeout value the image acquisition will abort and issue an error message. The interrupts will be re-enabled.

After the trigger command is detected, the system waits 100ms (as set in the camera parameter window) before telling the camera to readout, this takes around 1 second.

By changing the parameters in the timing acquisition window one can make the camera wait for and end of event command or issue trigger pulses etc. However, note that the dark current signal will depend upon the integration time so if one uses a configuration that waits for the end of the event the dark signal could vary from shot to shot.

One may save many Acquisition timing configurations and then load them back another time. It is a good idea not to overwrite those on the floppy provided with the system.

6.5 BACKGROUND SHOTS

The software permits the taking of a background signal and automatically subtracting this from each image. Note, however, that this background image should be taken under the same conditions as the main data, i.e. the same integration time, same intensifier gate width and gain as well as the same Area of Interest (AOI), should this be reset in the software. The background image may be averaged over several shots. We recommend that the streak tube focus be turned off but that other settings allowed to remain the same. It may be found that just the CCD dark current should be subtracted not the image intensifier dark current as well. In this case the intensifier should be off for the background shot.

Note that there is fluctuation in the dark current of around the square root of the count in each pixel. This occurs on the shot as well as on the background. By averaging many background shots half this noise can be removed. One is still left with the dark current noise on the shot itself. Note that the dark current will appear to have a gradient across the CCD chip. This is because the readout time dominates the integration time. Areas of the chip readout later have a longer integration time and so accumulate more dark current.

The background data is by default put into buffer 300, this can be changed or viewed through the background dialog window. This window can also permit many background shots to be averaged.

6.6 TAKING SHOTS

Once one is happy that the camera is taking suitable images prior to a real data short then take the relevant background image. The typical pixel count in a background image is around 500 counts.

Before a real shot it is important to set the timeout of a realistic value. This could be many minutes. This is set in the “X-ray Streak Camera ” window.

Images should be saved to disc as soon as possible. This can be done by right clicking the buffer item in the buffer list. Make sure the file format used is suitable. A 16 bit format will be required to preserve all the data but most PC image manipulation programs will require an 8 bit image.

By using the Sequence summing options (hit Sequence Dialog in the Run Experiment window) one can set up the system to take one frame, subtract the background and save to disc with a sequential file name.

Note that hitting the Escape key can close windows. The “X-ray Streak Camera” window may be opened from the Macro menu. Navigate to the cl-Xray folder and open the file Xray.cl . This will relaunch the “X-ray Streak Camera” window.

When examining images note that profiles can be accessed under both buffer 0 and under each individual buffer with a right click on the buffer item in the buffer list. Buffers may contain several images and profiles.

Buffer names and scales are overwritten when an image is grabbed into it. Many of these features are customerisable by way of the command language (CL).

6.7 CONTINUOUS ILLUMINATION

The camera is not designed for continuous illumination. If there is continuous illumination smeared images will result. The read out takes 1 second, during this time the camera is still sensitive.

6.8 TEMPERATURE CONTROL

The recommended operating temperature is 0°C. When first switched on the CCD camera head may need to get down to the operating temperature. This is shown in the task bar at the bottom of the screen. The temperature is set from the camera parameter window by clicking settings. The camera parameter window is opened by clicking “Camera” in the tool bar.

6.9 FOCUSING THE CCD CAMERA

This is a little involved. It is best to focus the CCD camera on the output of the intensifier with the intensifier removed from the streak camera. Then one can use full field illumination and have a grid on the input face of the intensifier; a grid printed onto an overhead transparency is very adequate although we use grids made on film. The problem is that the depth of field of the lens system is very small and the position of the intensifier is changed when it is mounted on the Streak tube.

Note that the focusing ring on the lens closer to the intensifier (normally the longer focal length one) does not affect the focus as this lens is mounted from what is normally its input. This focusing ring just moves the back end of the tube to which the lens is mounted and can help with manipulating the bellows around the intensifier.

7 Arrange for suitable triggering of the intensifier, adjust the intensifier gain, the ambient lighting, the intensifier gate length, the camera integration time until a suitable light level can be recorded on the readout; perhaps 10,000 count in the white parts.

8 Reduce the aperture of the lens assembly, see figure 23 to a minimum.

9 Take an image

10 If the camera focus is not approximately right now then move the focusing ring or the CCD head to find the best possible focus at a desired magnification.

11 Once the approximate focus is achieved the lens aperture can be increased (lower f/numbers). With a larger aperture the focus will have to be adjusted more accurately to achieve focus. Once at full aperture with a moderately well focused system the line-out facilities in DaVis can be used to tweak the focus to the best possible position.

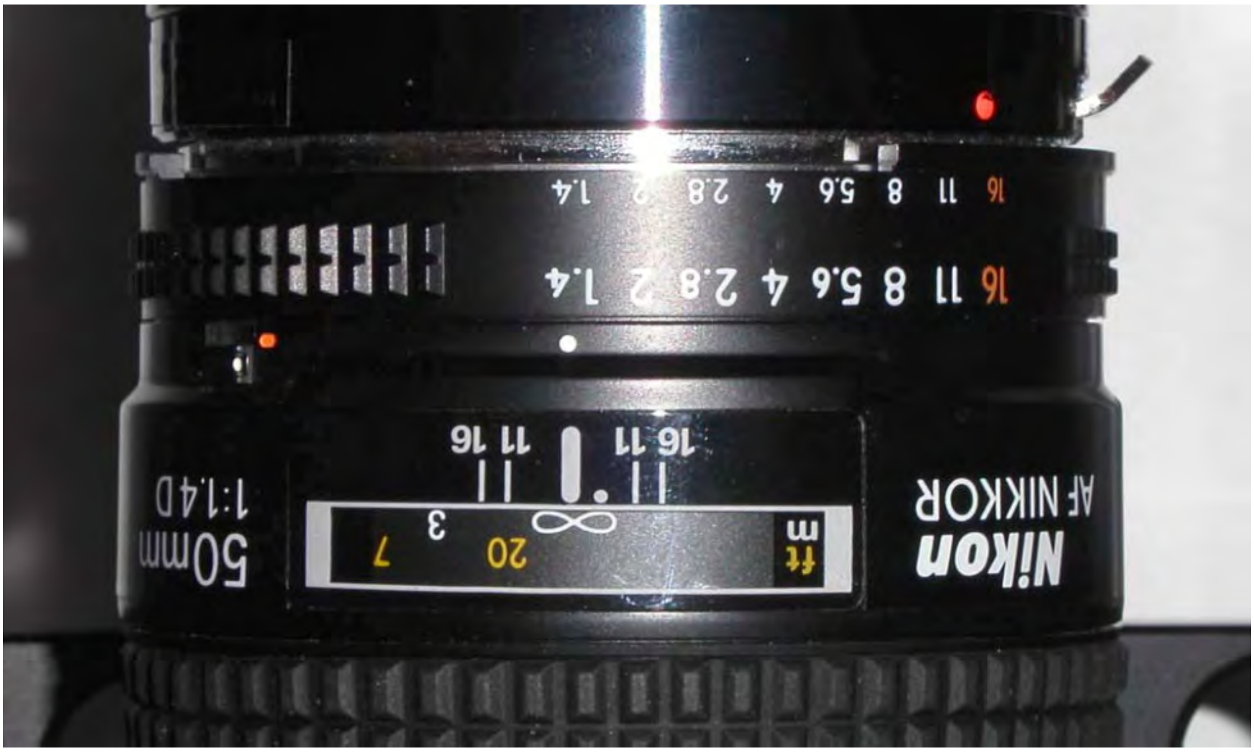


Figure 23 The second lens showing the focusing ring and the aperure control
Note there is also an aperture control on the first lens. The focusing rinf on the first lens has no effect on the focus.

The readout system can be set up for a range of magnifications. It will be necessary to move the CCD head back on its rails to obtain more demagnification.

With more demagnification there will be more vignetting. The vignetting can be over come by stopping down the lenses. This is not unreasonable as less sensitivity is likely to be needed at higher demagnifications. Alternatively the vignetting could be reduced by mounting the lenses differently and getting the abutting faces closer together. This is left to the user to consider.

Here is a suggested sequence of events to get the correct focus.

1 Mount the readout onto the streak camera.

2 Make sure that the intensifier is sprung onto the streak camera and not being held off by the jacking screws.

3 Do up the jacking screws to remove the spring pressure from the intensifier onto the streak tube, but not so tight as to start jacking the intensifier off the streak tube.

4 remove the readout from the streak tube.

5 place a transparency grid on the input face of the intensifier, see above.

6 Place the readout assembly down onto the polythene protective cover that is supplied with the camera or some other diffuser.

Figure 24 The Intensifier mount showing the spring pillars and jacking screws.

6.10 PRESHOT CHECK LIST

1 Streak tube and readout are focused

2 Readout lens is at a suitable aperture (there are two stop rings)

3 Readout bellows is in place

4 Focus supply is ON

5 Intensifier is ON and in “Normal Mode”

6 The gain is set suitably

7 One sweep unit is ON, set to “Operate”

8 The desired sweep speed is selected

9 The timing for a particular sweep speed is set (user to arrange).

10 A background shot has been acquired and
subtract background is set

11 The CCD camera, sweep and intensifier triggers are working and timed

12 The trigger timeout is set to greater than the expected wait
for a trigger, allow for shot hold up problems.

12 The acquisition file has been set to “wait for external trigger”

13 Communications with the Streak camera has been established

14 The camera integration time is set suitably, ~100ms

15 The destination file location and name have been set
Use the sequence dialog

17 The destination buffer is set,
either by selecting it or in the sequence dialog.

18 The capture sequence is started from inside the sequence dialog
This ensures the file will get saved.

This check list assumes that the various camera parameters are not changed from the default. The times in the acquisition window should be correct and the integration time in the camera window. Also no other set up parameters are changed.

6.11 CHANGING THE SWEEP CALIBRATIONS WITHIN THE SOFTWARE

If it is necessary to change the sweep calibrations that the software uses to label the data with, these are changed in the Xray.cl file located in the Folder cl-Xray which is at the same level as the DaVis folder (not inside it).

The file can be edited with the Context application which has a short cut available on the desktop.

Backup the current file.

At the top of the file are indicated the line numbers where the new data has to be inserted as well as the format for the data.

Once the file is edited and saved, it can be relaoded within DaVis without restarting the program. When ever DaVis detects that it has to run part of the file as a Macro it will note that it has been changed as ask to reload it.

For the dedicated programmer the Xray.cl file can be modified in many ways to change the customerisation of the program. Most of the information required is in the DaVis manuals.

6.12 DATA PROCESSING AND IMAGE MANIPULATION

DaVis is a very powerful data manipulation program. However, it is likely that the processing will be done away from the data capture machine. Davis may be installed from the enclosed CDs on a second machine, the installation will ask for the customer settings disc. There is a second Dongle to allow it to run on such a machine. If the X-ray Streak camera Window and associated behaviour is required on the second machine then the cl-Xray folder should be installed on the second machine also, this folder is also on the customer settings disc.

7 SWITCHING BETWEEN FILM BACK AND CCD READOUT HEAD

The readout assembly is simply removed but unscrewing the 6 M4 screws holding it to the intensifier flange. On refitting the readout it may need refocussing , section 6.9.

With the readout removed the film back is simple attached using the three radial knurled screws.

With the readout off the intensifier may be protected with the transit cover.

7.1 USING THE INTENSIFIER WITH FILM

Wafer tubes, as supplied here, use cathode gating to turn them on and off. Consequently the phosphor is exposed to dark current from the microchannel plate if the tube is left on but ungated. Although the tube is supplied so that film can be left in contact with the output window without exposure this will only be good for a limited time, several minutes. The intensifier may be turned off completely but there is always a risk of flashes when the tube is turned on again prior to exposure.

7.1.1 INTENSIFIER INTERLOCK

The current Photek power supply incorporates an interlock facility for turning the unit on and off remotely. Note that this is a true ON/OFF command unlike the front panel one that only controls the cathode bias voltage. The interlock will remove all power from the tube. The interlock is enabled with a small switch on the rear panel. The interlock connections are on the D type connector on the real panel, see figure 11 The user is left to establish a good procedure in order to achieve unfogged film for their particular application. After exposure, the film back holder should be unclamped and the holder withdrawn partially from the intensifier. Do not undo the clamp screws fully or the holder will come right off and lead to ruining of the film. With the holder away from the intensifier the film may be drawn through and processed, or the dark slide may be inserted.

7.1.2 USE WITH NEGATIVE FILM

Although the system is not designed to cope with standard negative film, many users do use it with such. It is possible to mount a piece of film in front of a polaroid film so that both instant and higher quality output are available on one shot. The increase in light level required for standard film (it does depend upon the film) roughly compensates for the attenuation of the light going through the standard film so that the Polaroid™ is exposed satisfactorily.

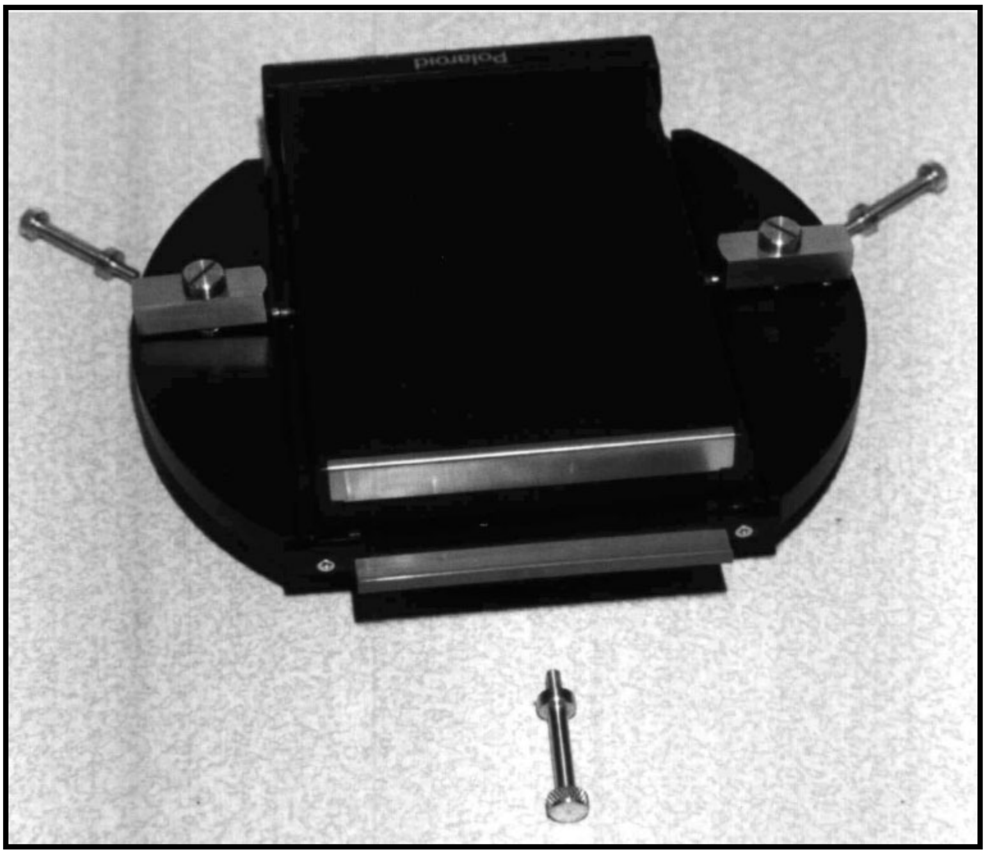


Figure 25 The Polaroid film back can be fitted to the intensifier.
The back takes film types 667 or 612. The CCD camera and fibre optic taper must be removed from the rear of the intensifier. The three radial knurled screws are used to clamp the film back in position. In normal use these are not removed, just slackened so that the film back can be slid away from the intensifier to allow the film to be pulled through. DO NOT ATTEMPT TO PULL THE FILM THROUGH WHEN THE FILM IS IN CONTACT WITH THE INTENSIFIER.

Figure 26 Photek Intensifier

8 DATA SHEETS

8.1 STATIC FOCUSING

Camera type	LMXRSC
Camera number	J02*****
Customer	USA
Date tested	19th. February 2003
Phosphor type (P11 or P20)	P20

Focus potentials as measured with 1000MΩ probe.

Cathode	15.003 kV
Mesh	10.285 kV
Focus	11.262 kV

Static deflection sensitivity (with above potentials):

+/- 17.88Volts mm^{-1} on intensifier phosphor

8.2 SWEEP SPEEDS AND TRIGGER DELAYS

The sweep speeds are measured electrically and are therefore only nominal. The faster speeds in particular are less likely to be accurate due to transit time effects and the difficulty of making precise electrical measurements.

The calibrations of the output onto the CCD are based upon the CCD camera being used with the sweep horizontal and the magnification as supplied.

The trigger delay for the monitor output is ~20ns

Slow Sweep Unit

Knob position	Voltage ramp	Tube sweep speed	CCD sweep speed	CCD sweep rate	Delay to screen centre	Screen range
	V/ns	ns/mm	ns/pixel	pixels/ns	ns	ns
1	1.212	14.759	0.485144	2.061	454	354
2	1.723	10.380	0.341220	2.931	326	249
3	2.976	6.008	0.197497	5.063	202	144
4	4.394	4.069	0.133753	7.476	141	98
5	7.149	2.501	0.082213	12.163	96	60
6	12.418	1.440	0.047331	21.128	75	34.6

Regular Sweep unit

Knob position	Voltage ramp	Tube sweep speed	CCD sweep speed	CCD sweep rate	Delay to screen centre	Screen range
0	V/ns	ns/mm	ns/pixel	pixels/ns	ns	ns
1	17.2	1.03953	0.034172	29.264	76	24.9
2	79	0.22633	0.007440	134.410	456	5.4
3	259	0.06903	0.002269	440.662	35.6	1.7
4	467.7	0.03823	0.001257	795.744	31.6	0.92
5	836	0.02139	0.000703	1422.369	29.6	0.51
6	1648	0.01085	0.000357	2803.904	27.6	0.26

Streak Camera sensitivity	17.88 V/mm
CCD camera scaling	30.421 pixels/mm horizontal

Note the CCD camera magnification can be changed, this is the magnification as supplied.

Figure 27 Sweep details

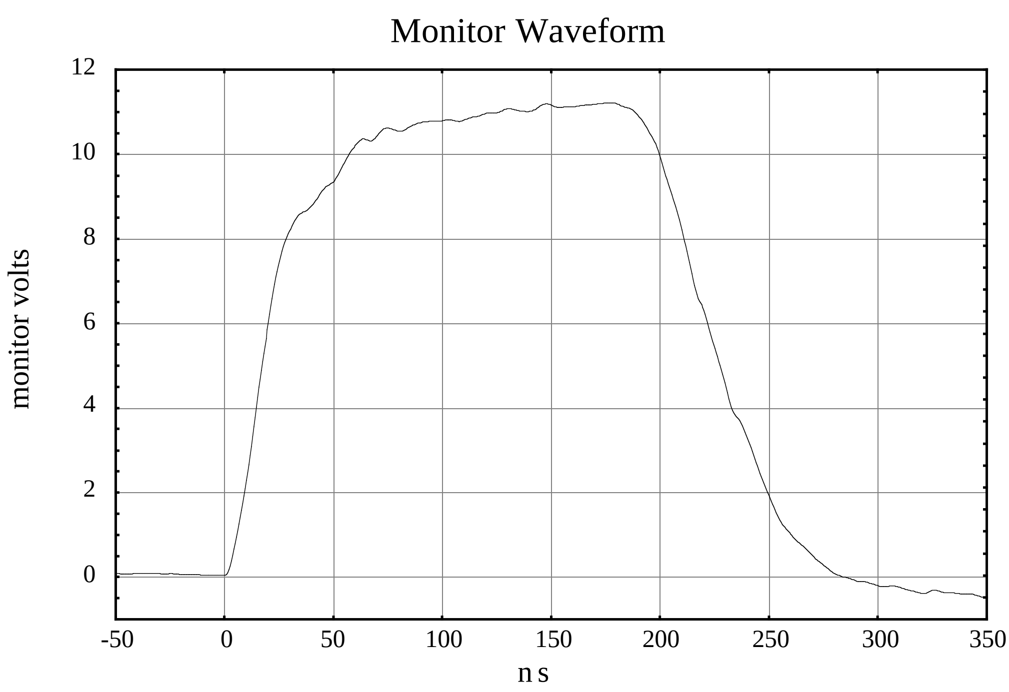


Figure 28 The monitor output into 50Ω

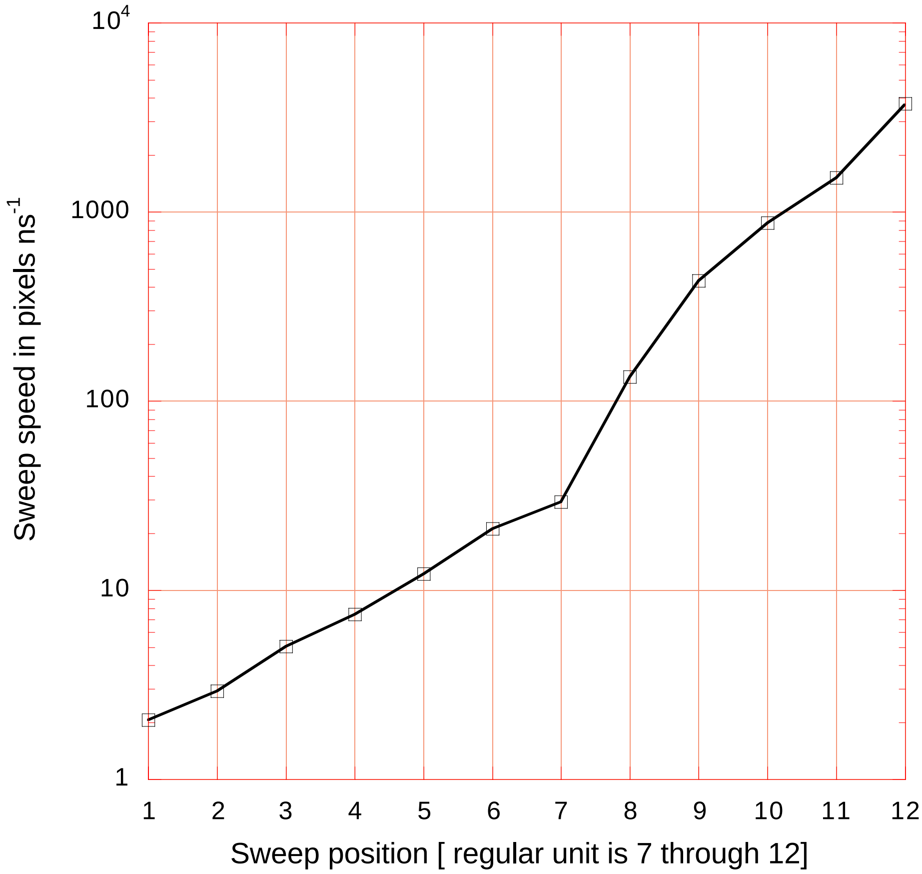


Figure 29 Available Sweep Speeds

8.3 BIAS VOLTAGES

Regular Sweep Unit
Bias SYNCH ±179 volts
Bias OPERATE sweeps 1 through 6 ±720 volts

Slow Sweep Unit
Bias SYNCH 0 volts
Bias OPERATE sweeps 1 through 6 ±442 volts

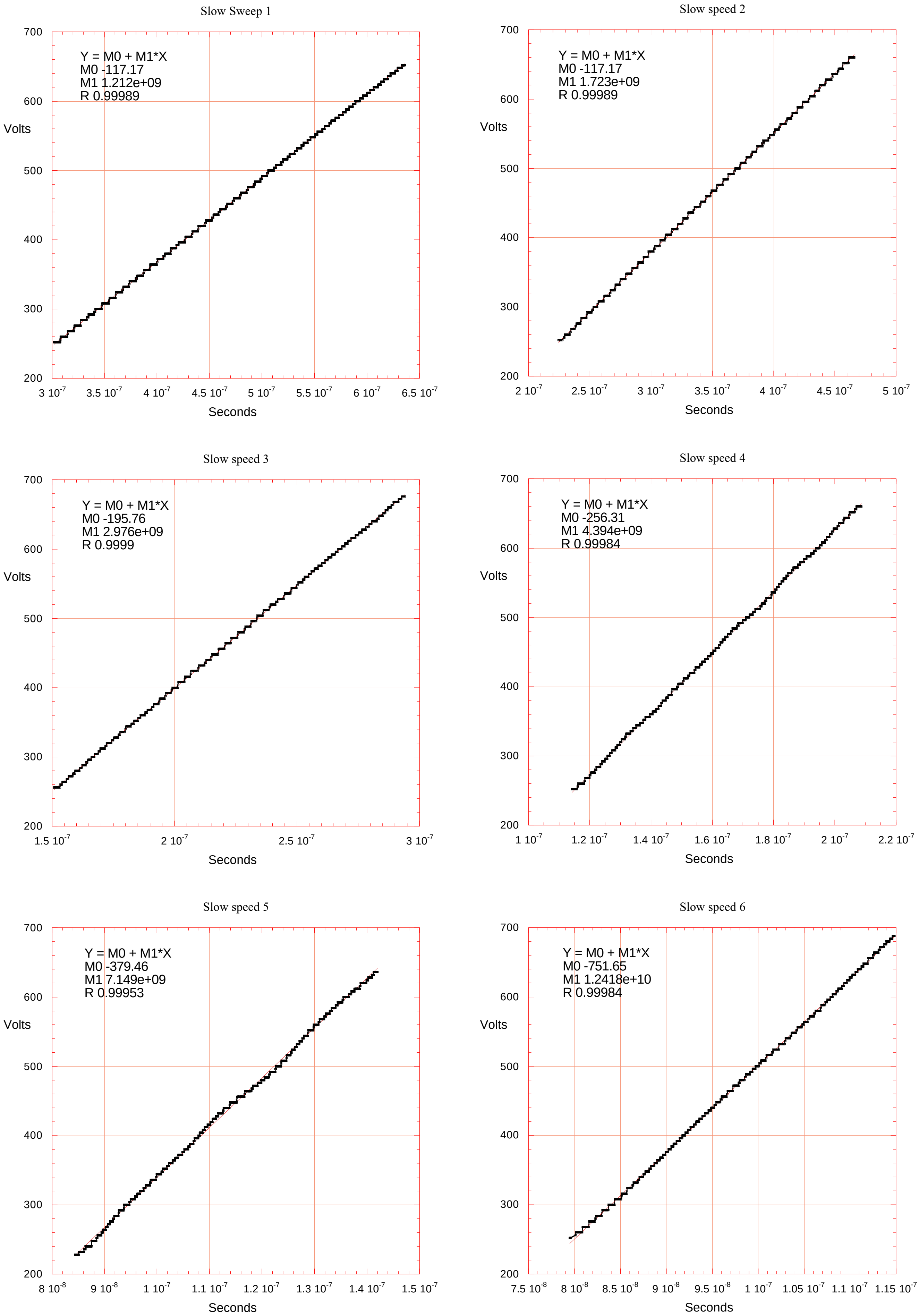


Figure 30 Slow ramps

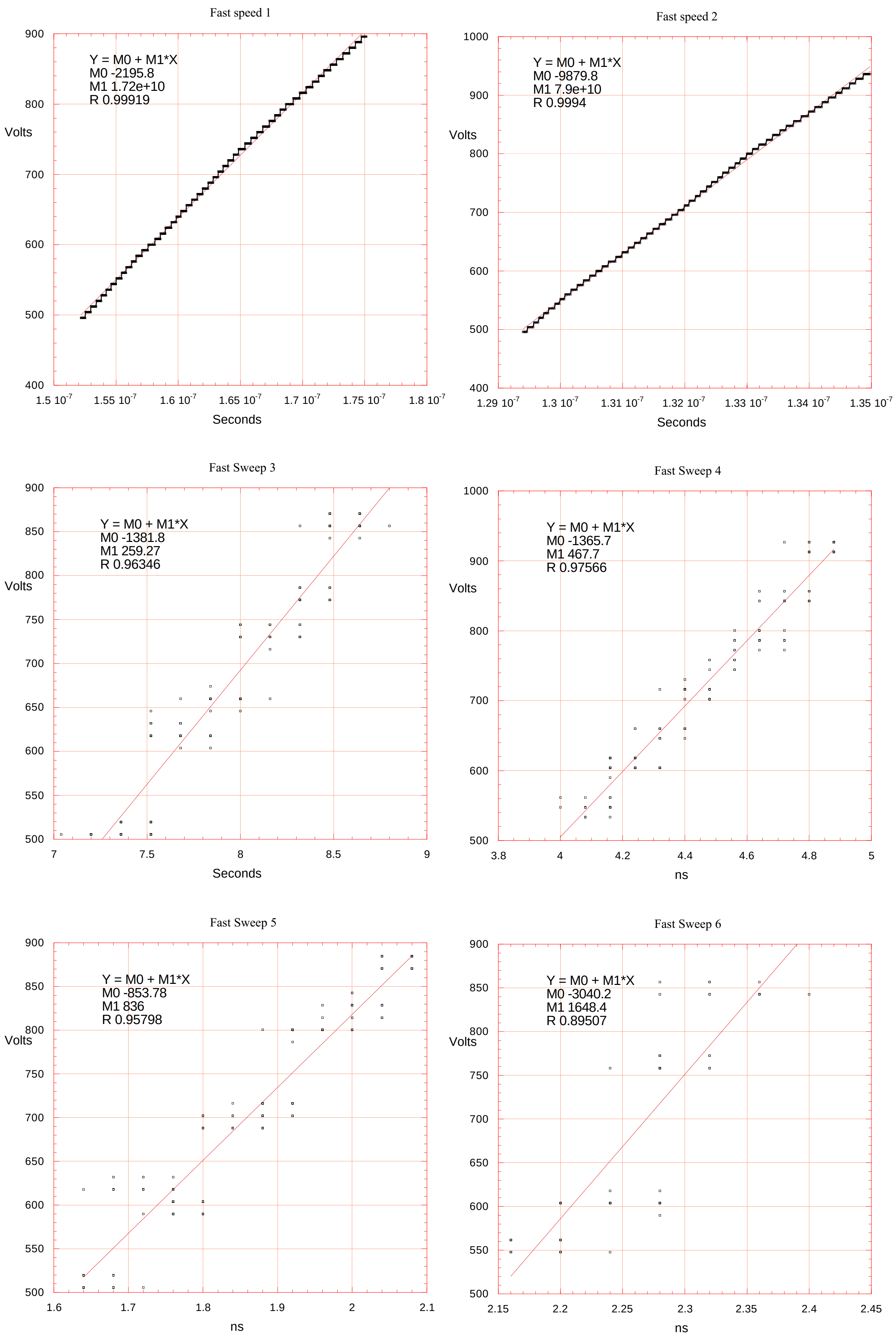


Figure 31 Fast ramps

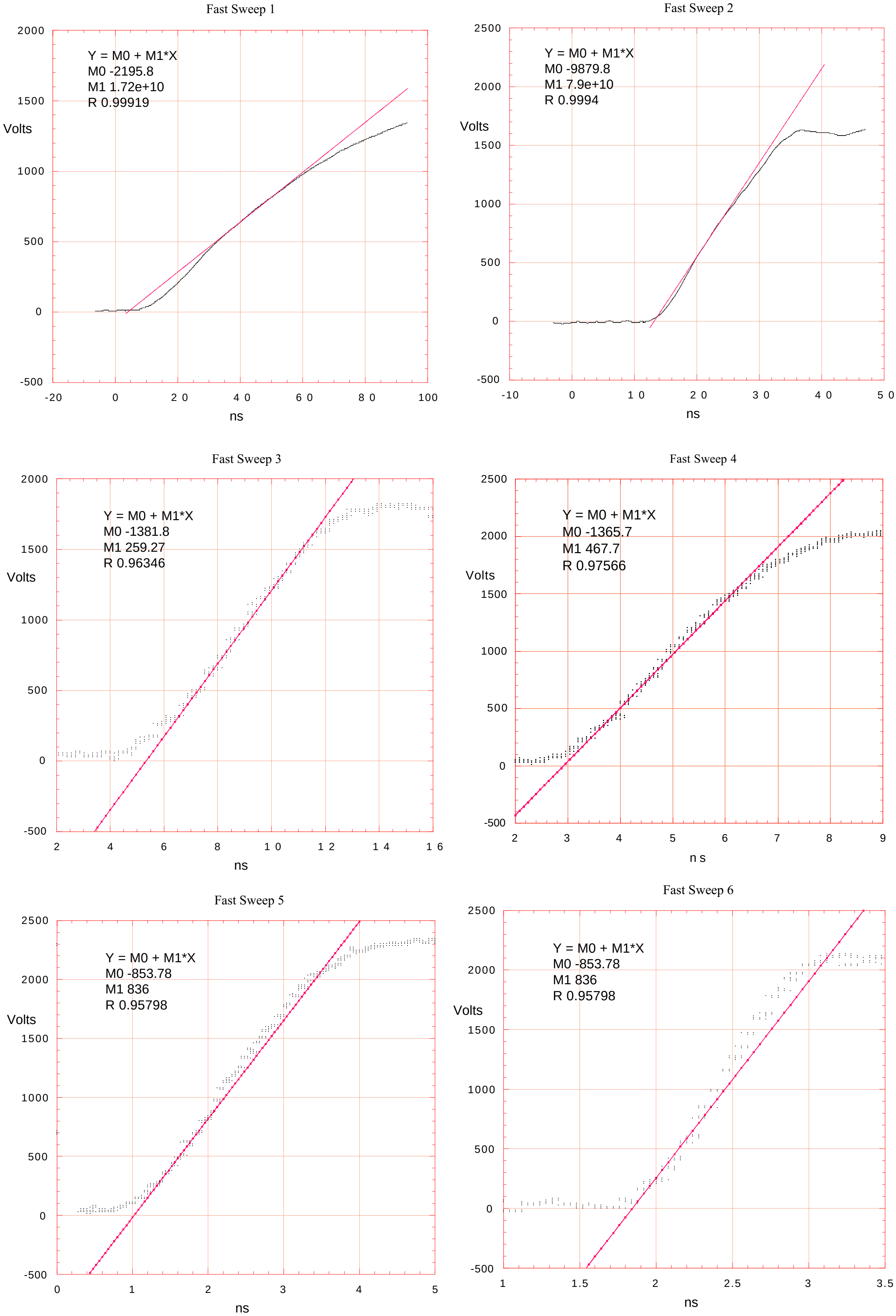


Figure 32 Fast ramps whole waveform

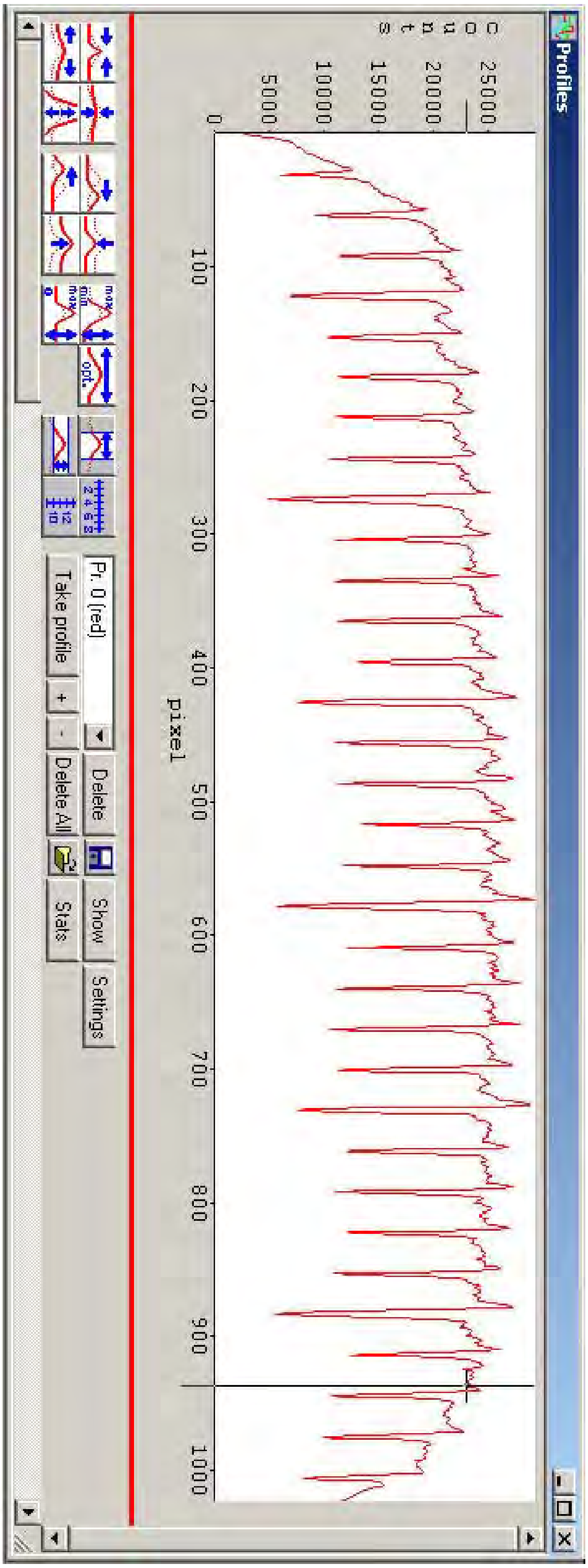
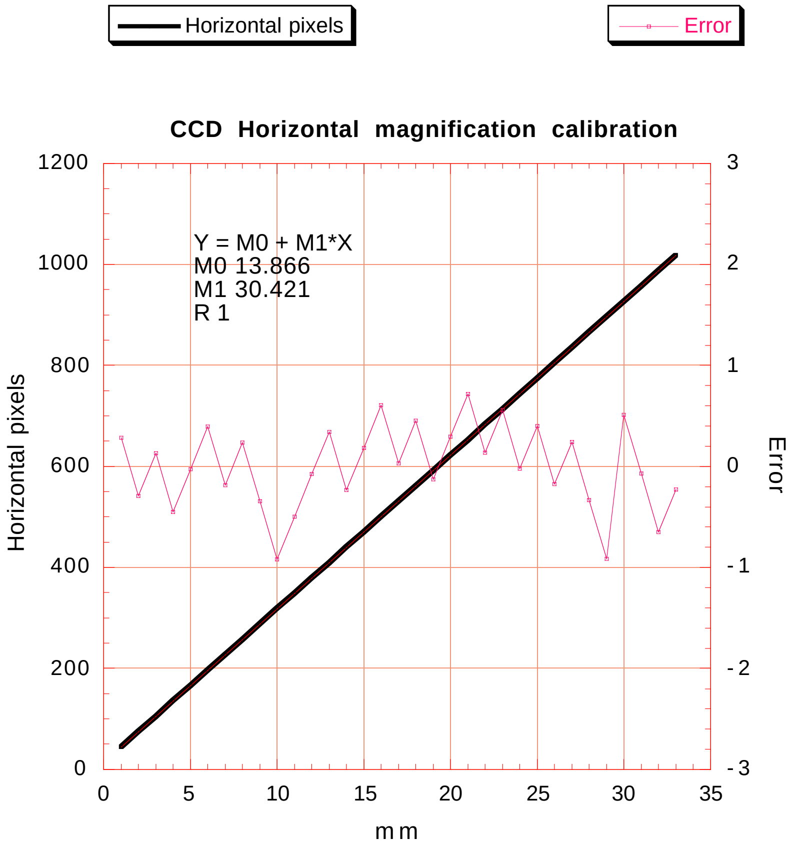


Figure 33 Magnification measurement



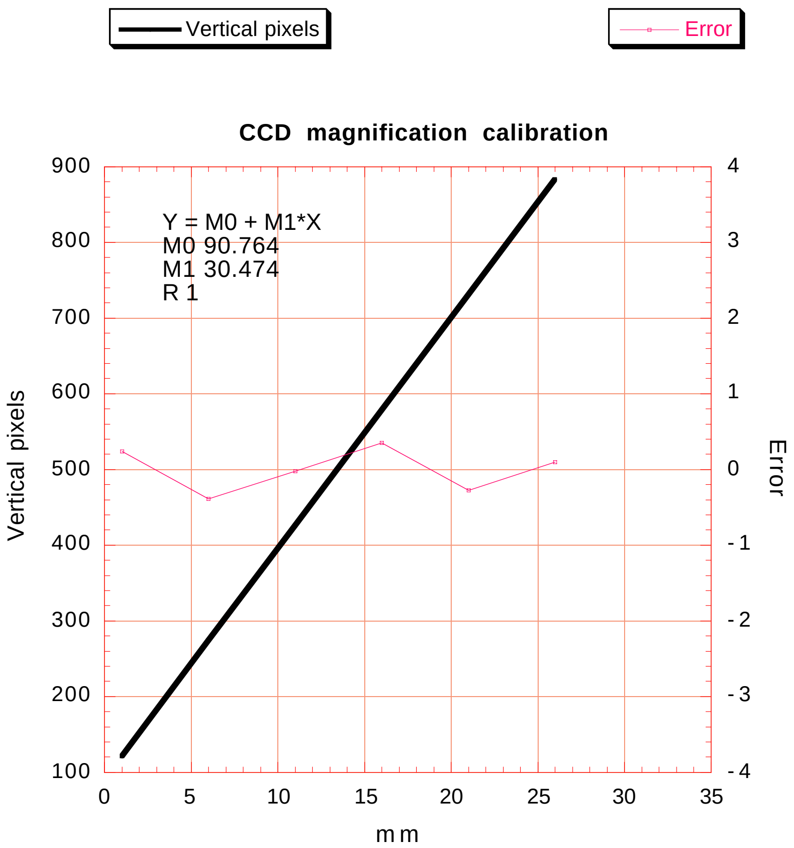


Figure 34 Distortion measurements

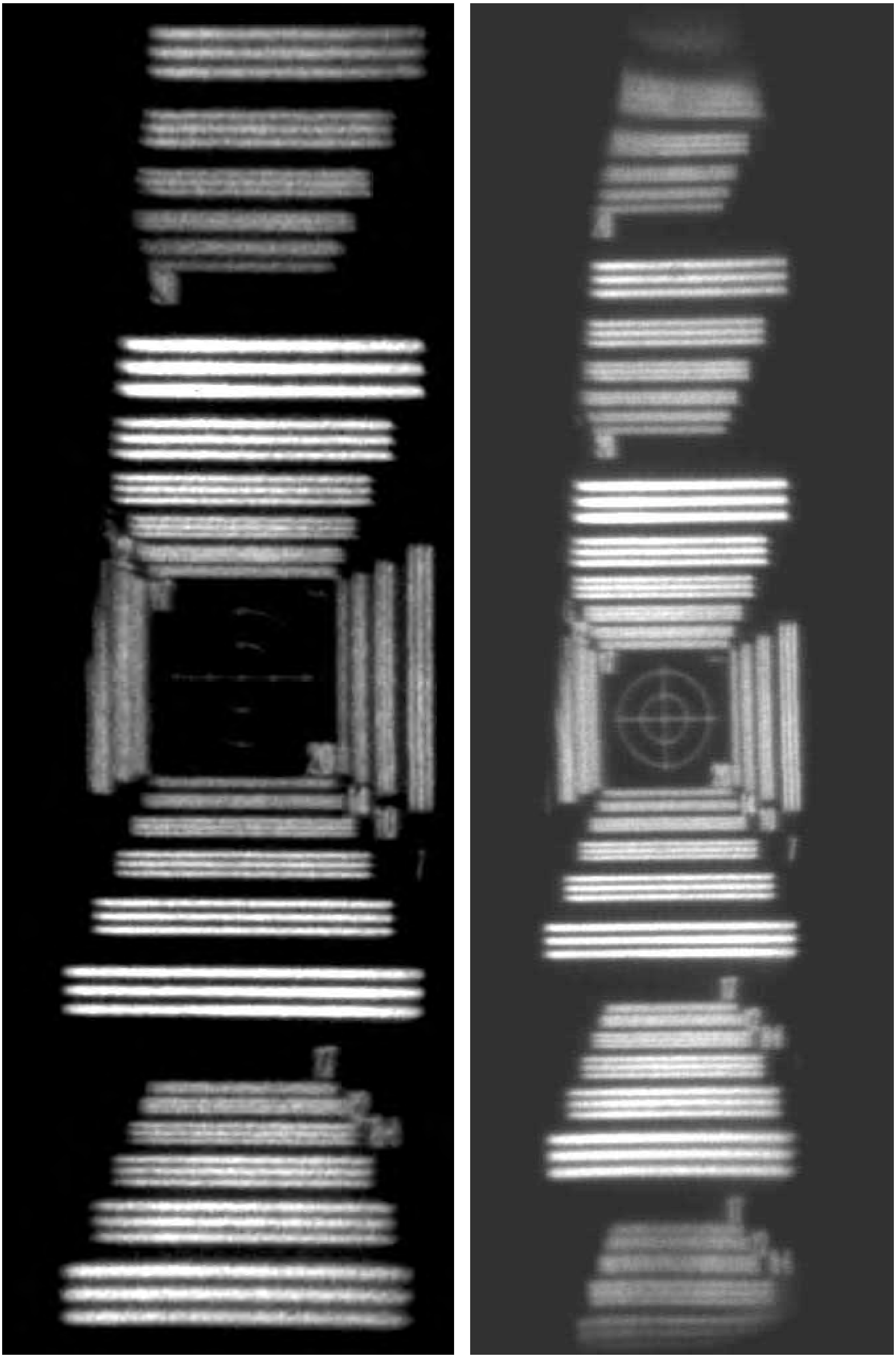


Figure 35 Resolution cathode pictures

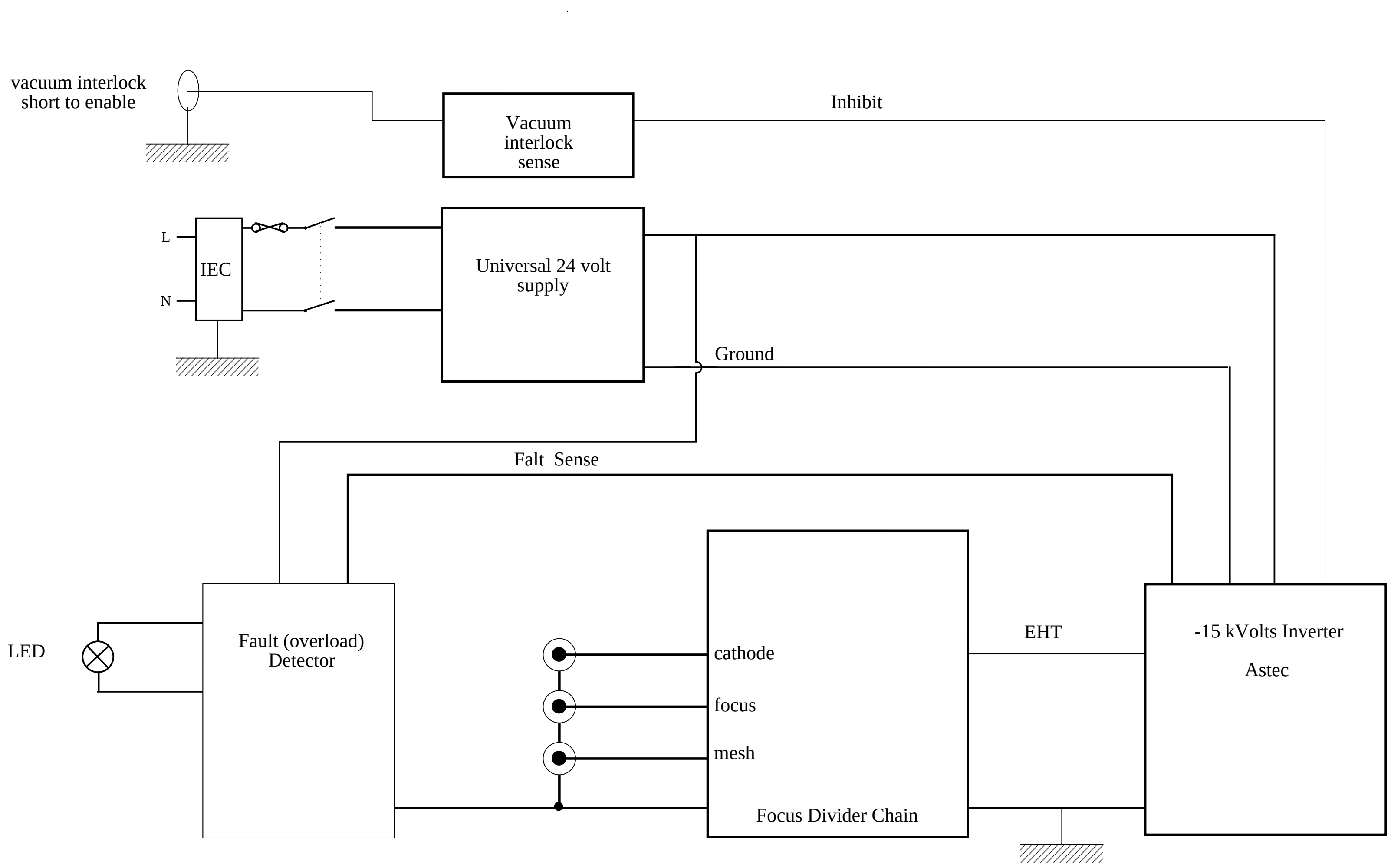


Figure 36 Focusing supply, block diagram

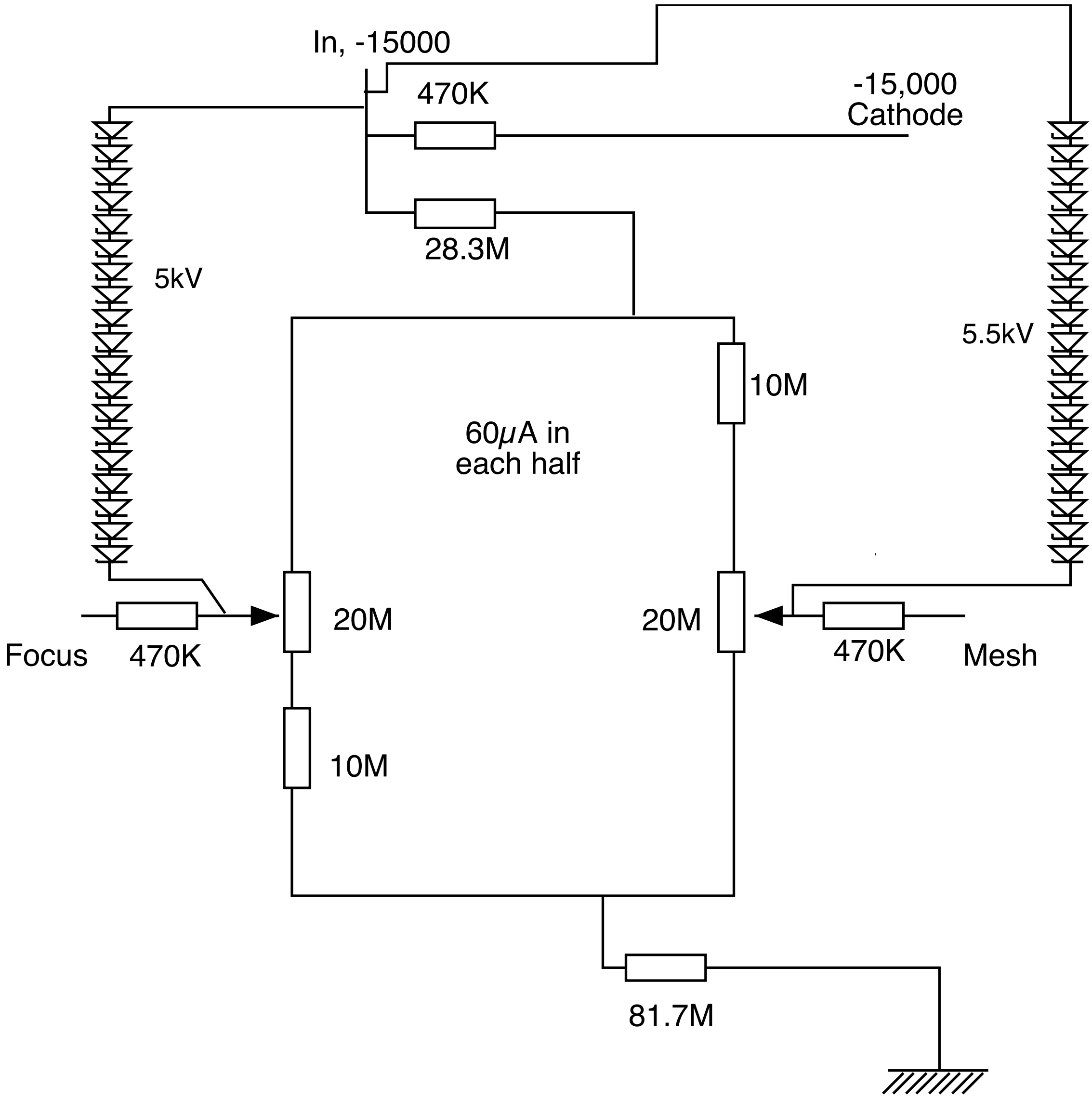


Figure 37 Focus potential divider network

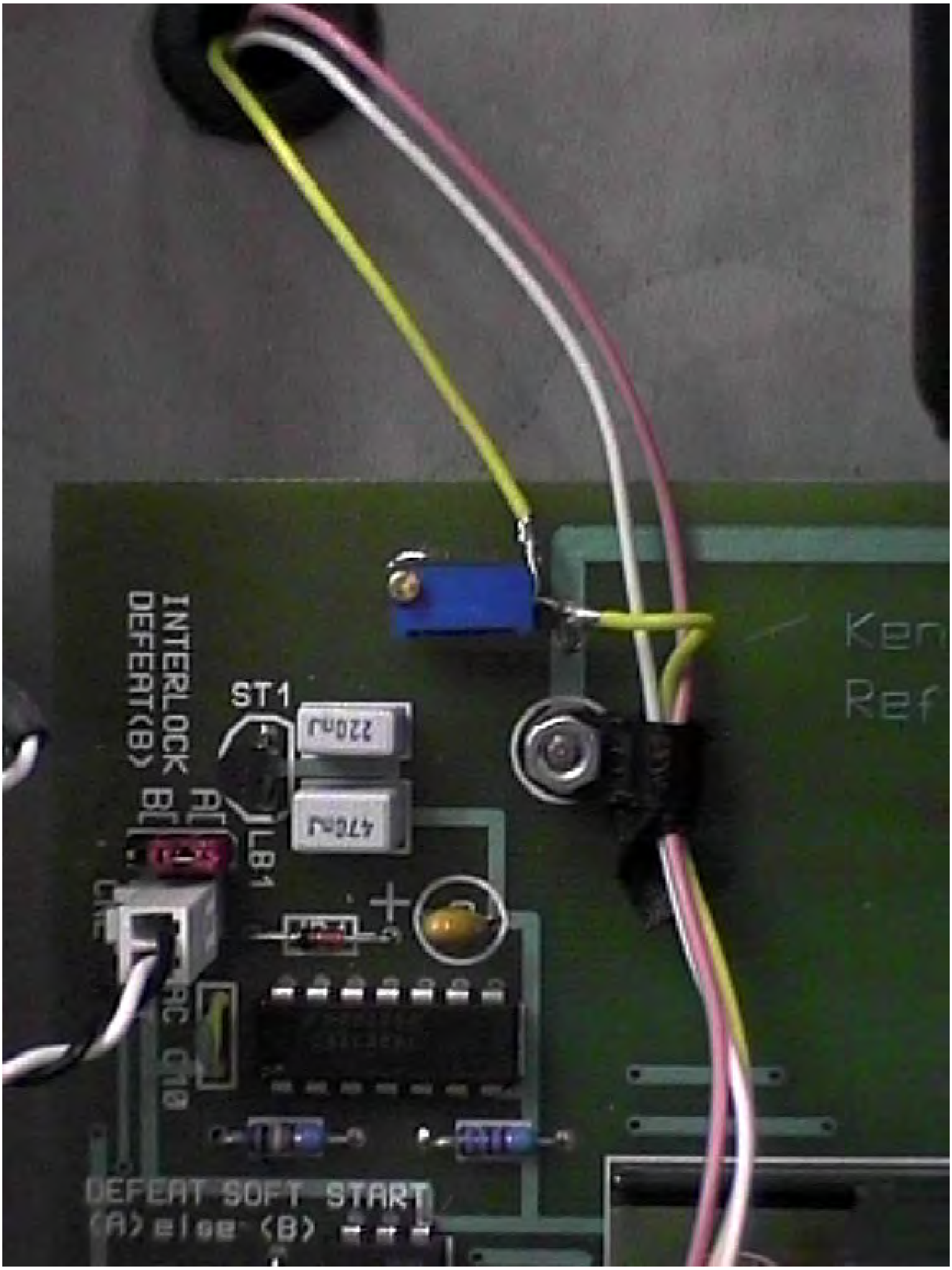


Figure 38 Adjustment for Focus on signal level to I^2C bus

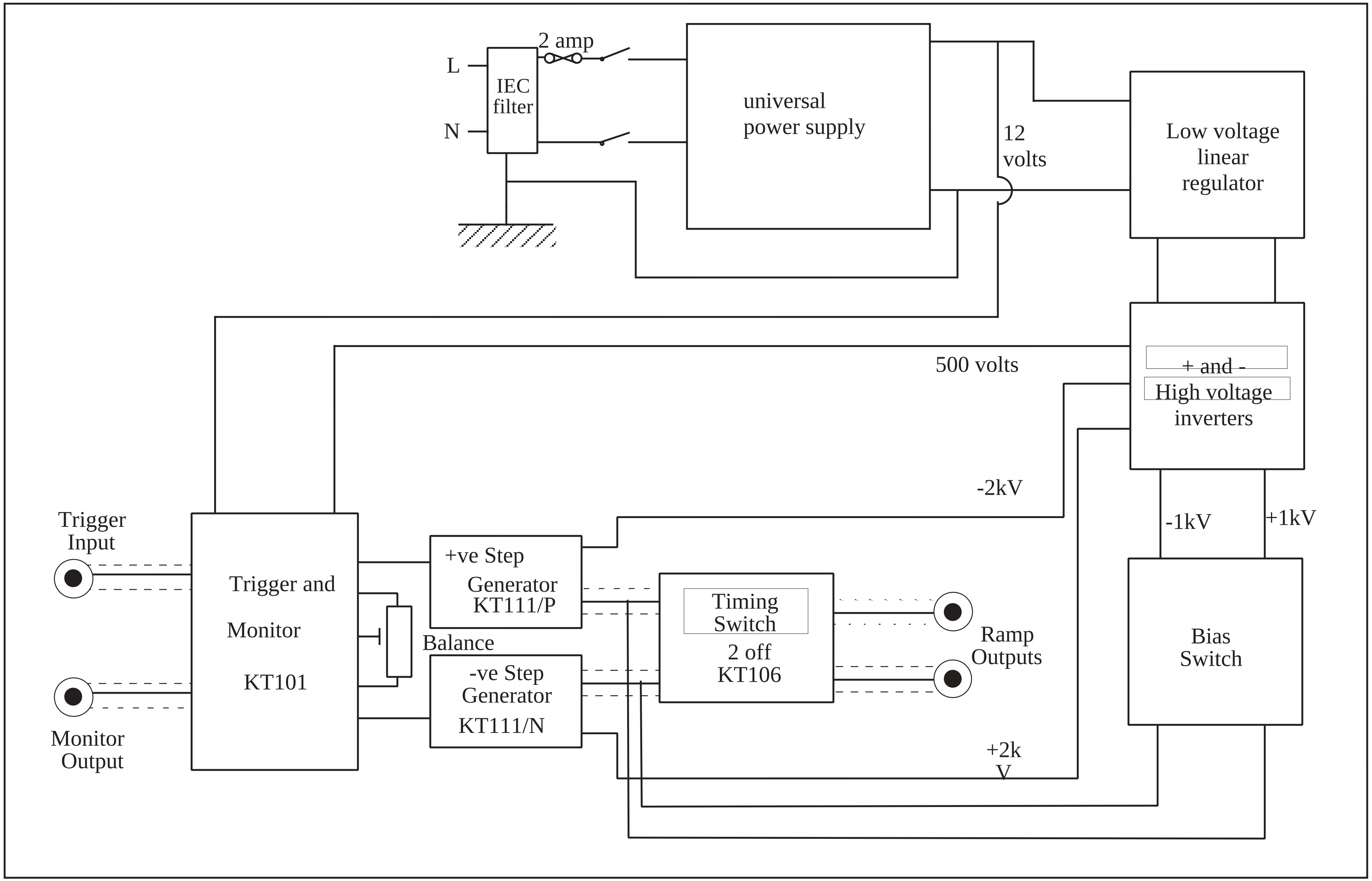


Figure 39 Regular Sweep unit, block diagram

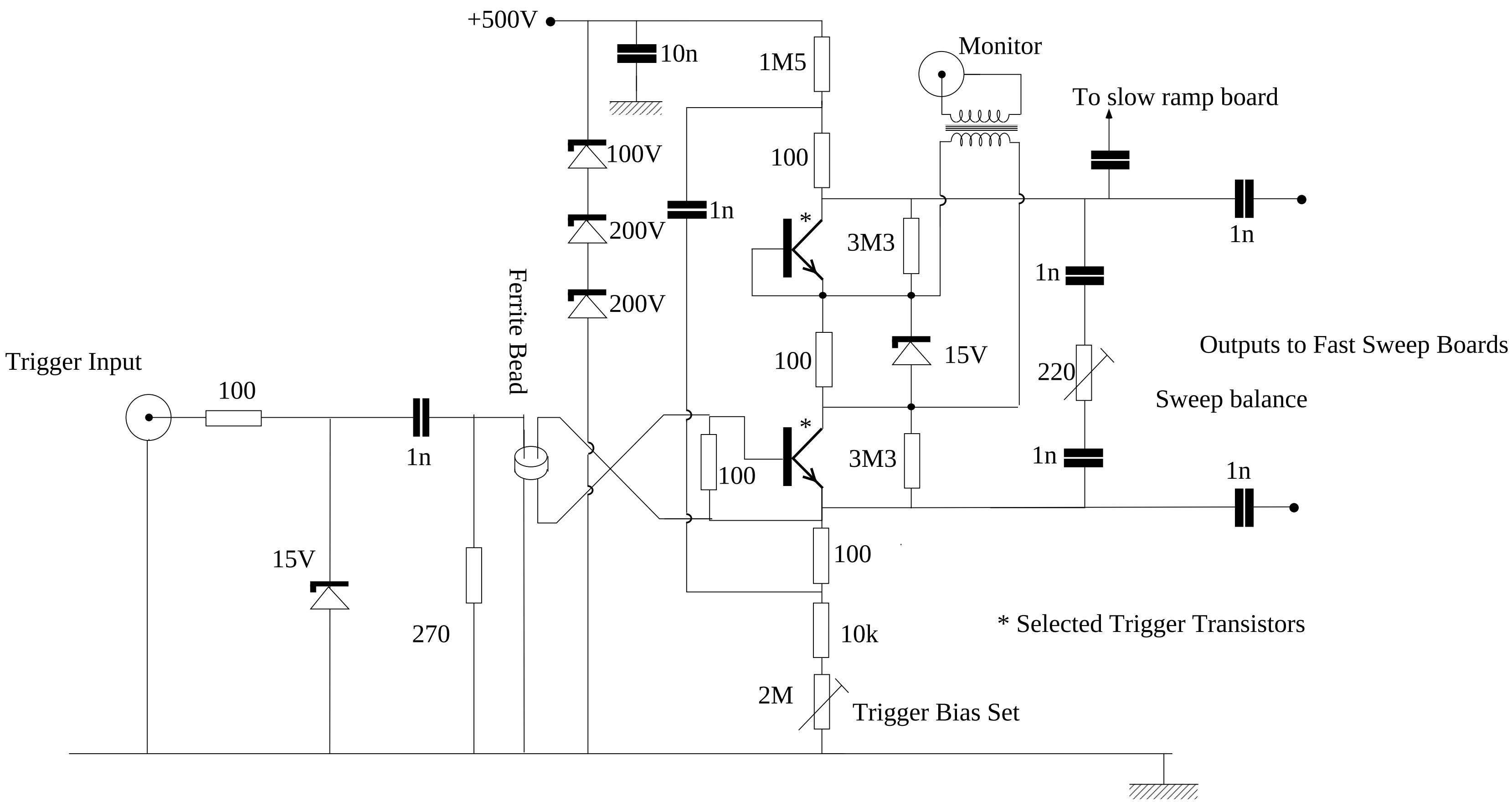
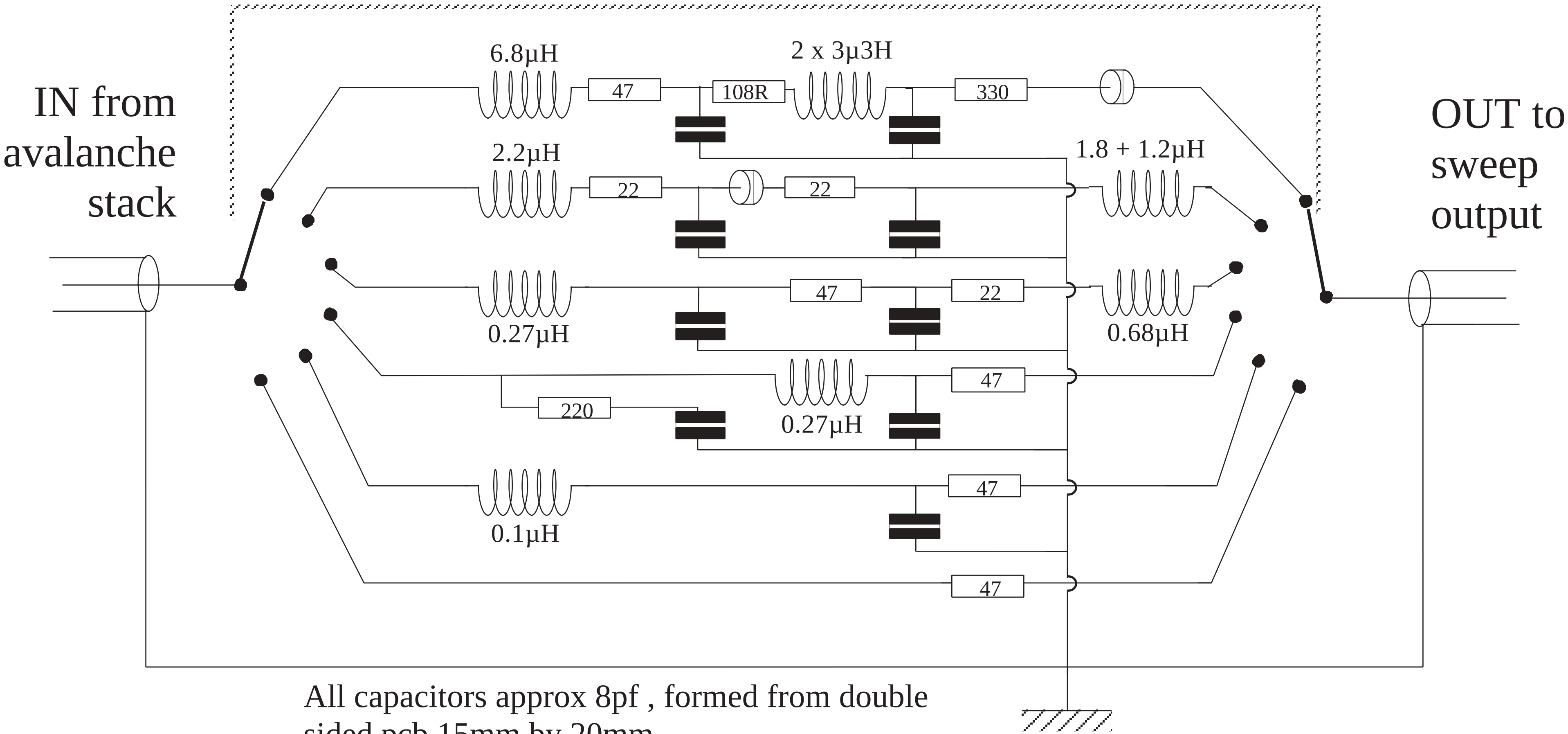


Figure 40 Sweep unit Trigger board



All capacitors approx 8pf , formed from double sided pcb 15mm by 20mm

Figure 41 Sweep unit timing switch

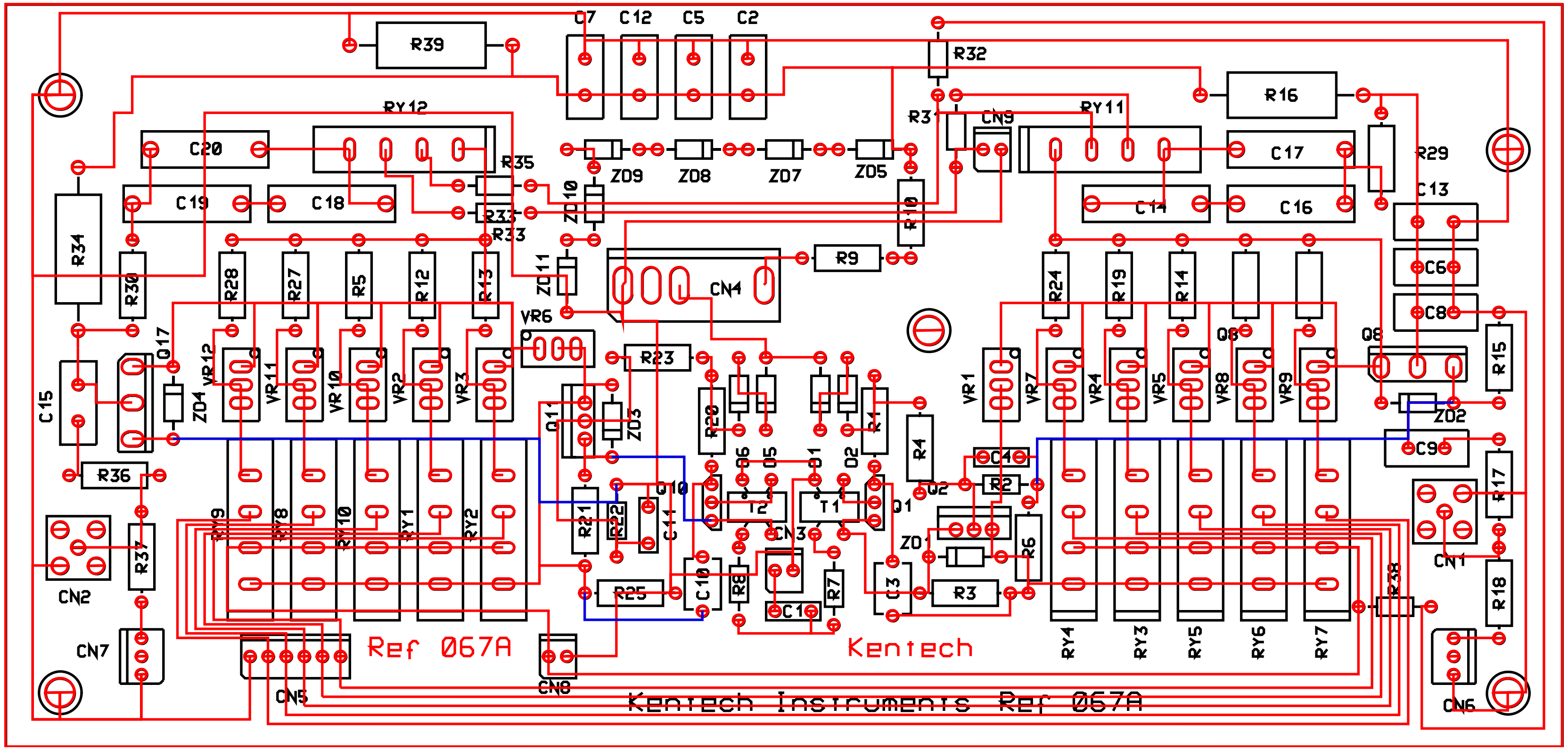


Figure 42 Slow Sweep unit ramp card

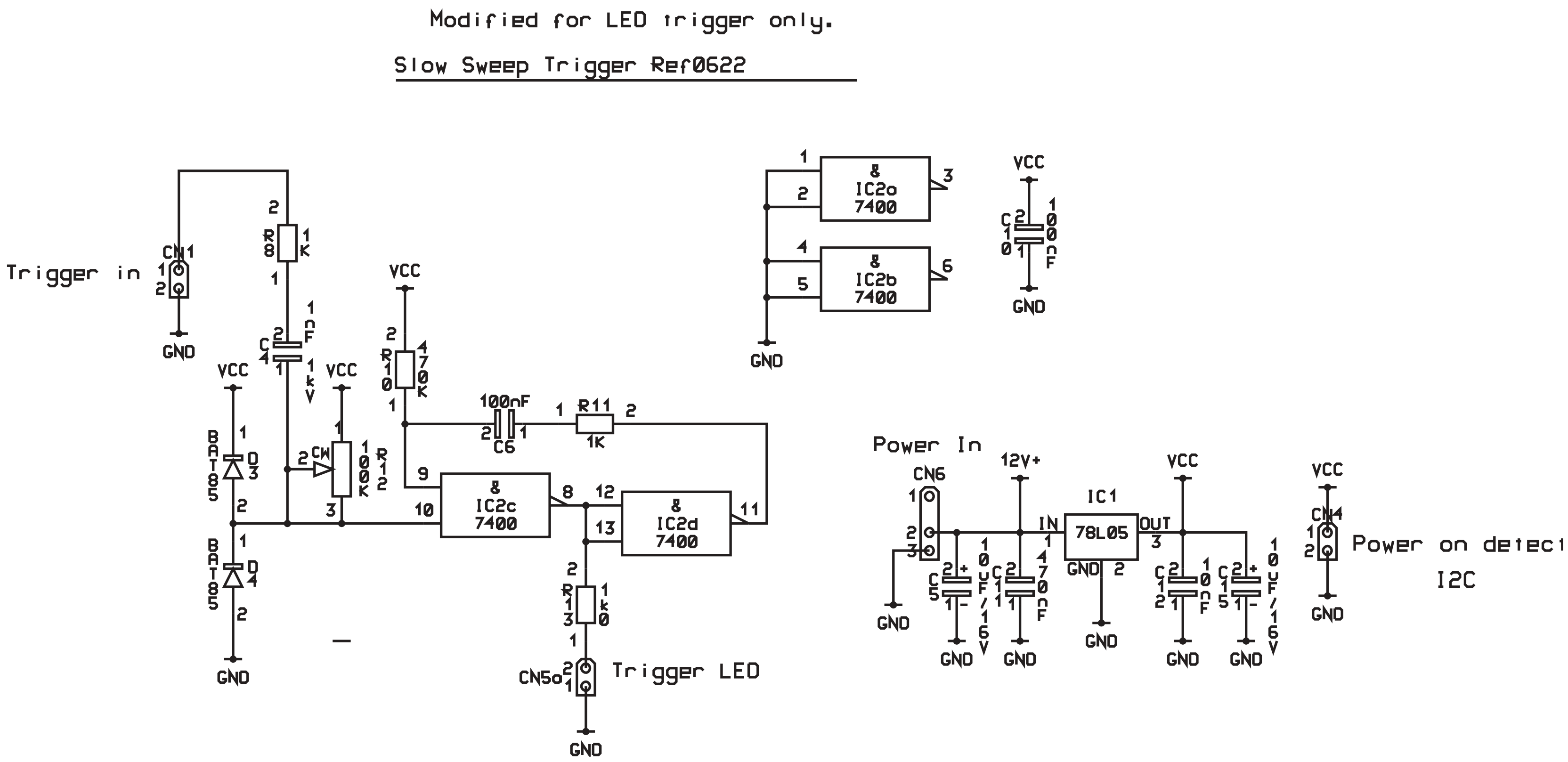


Figure 43 Sweep unit trigger light drive

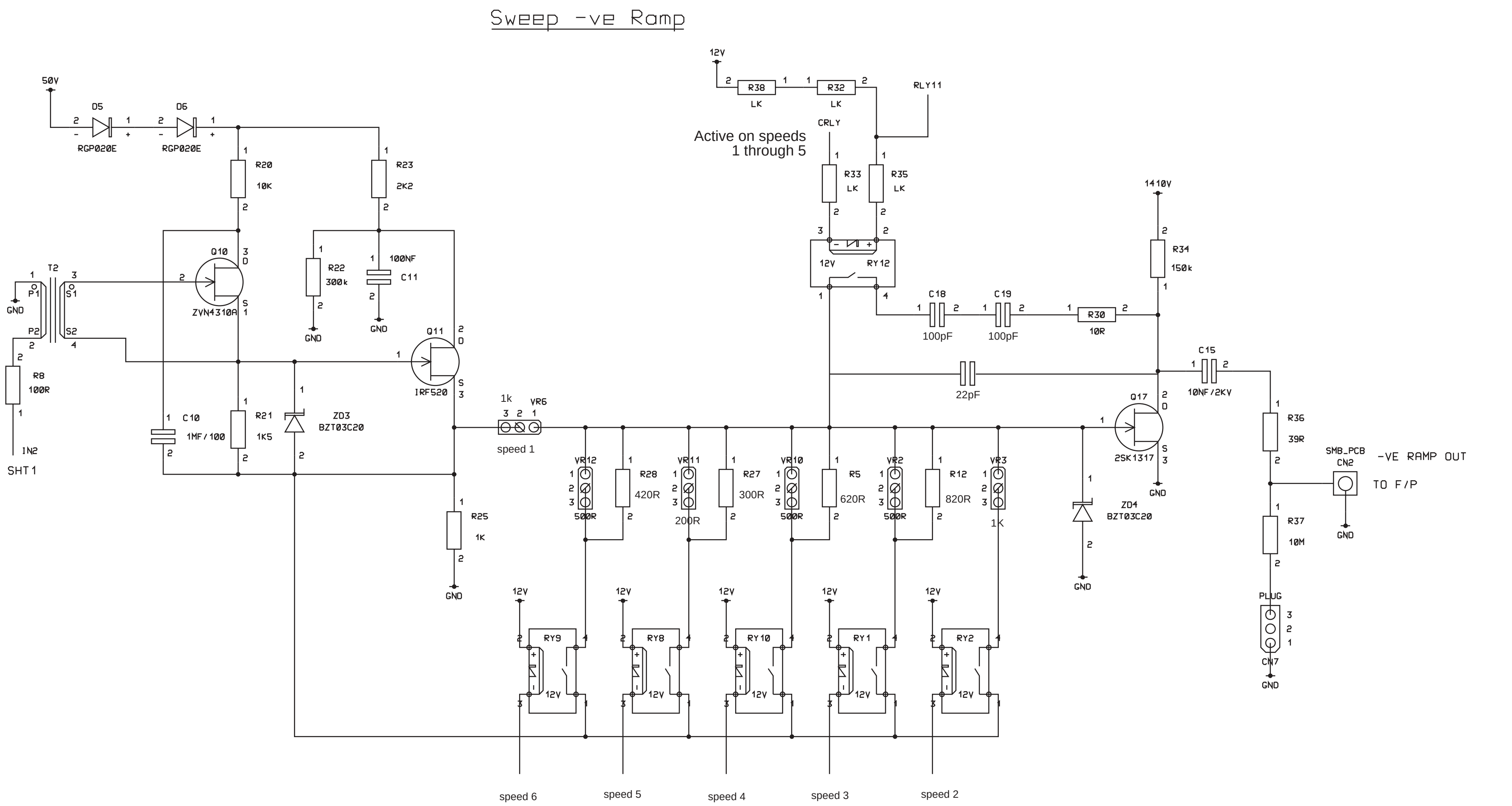


Figure 44 Negative Slow Sweep ramp circuit

SHEET2

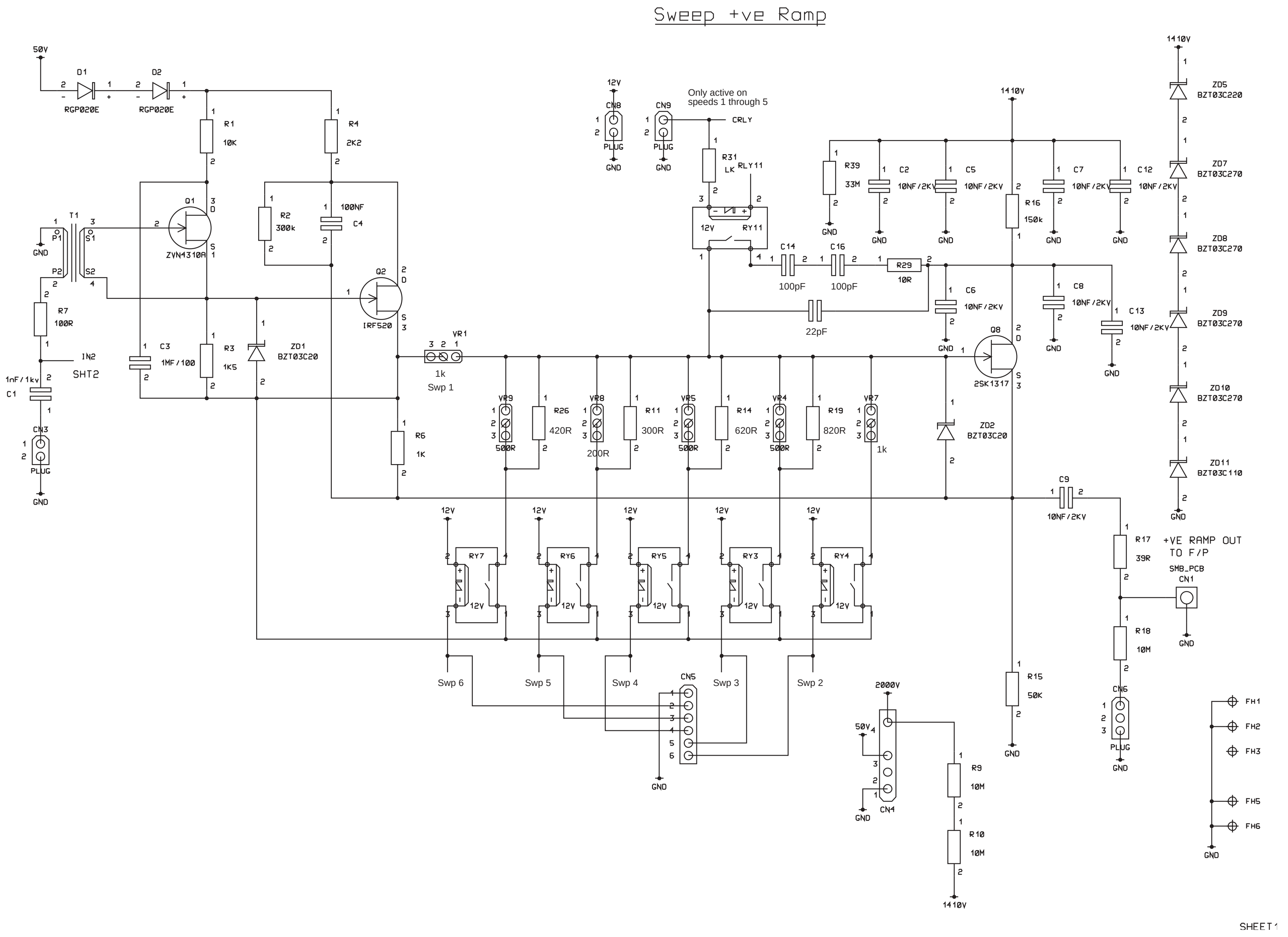


Figure 45 Positive Slow Sweep ramp circuit

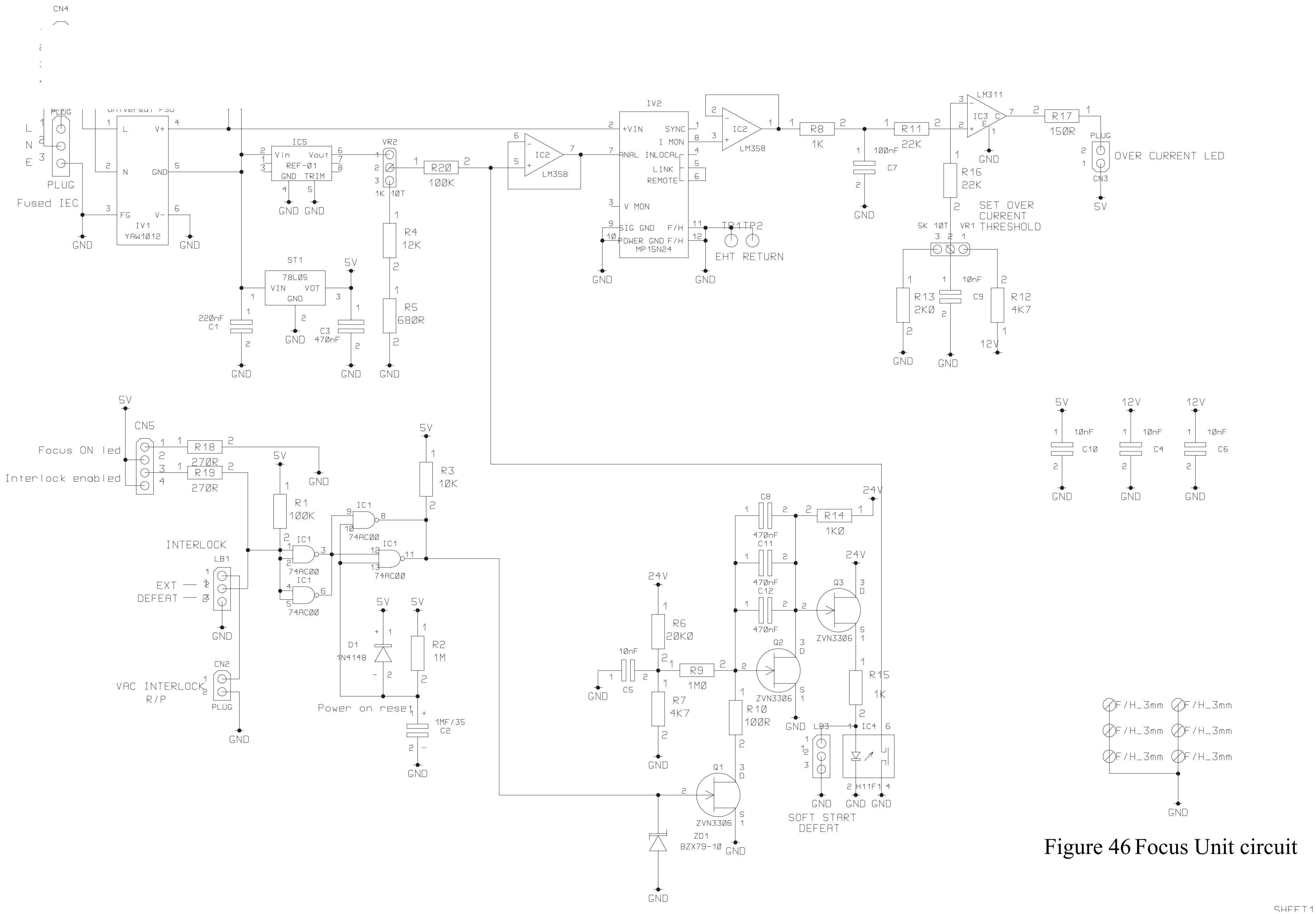


Figure 46 Focus Unit circuit

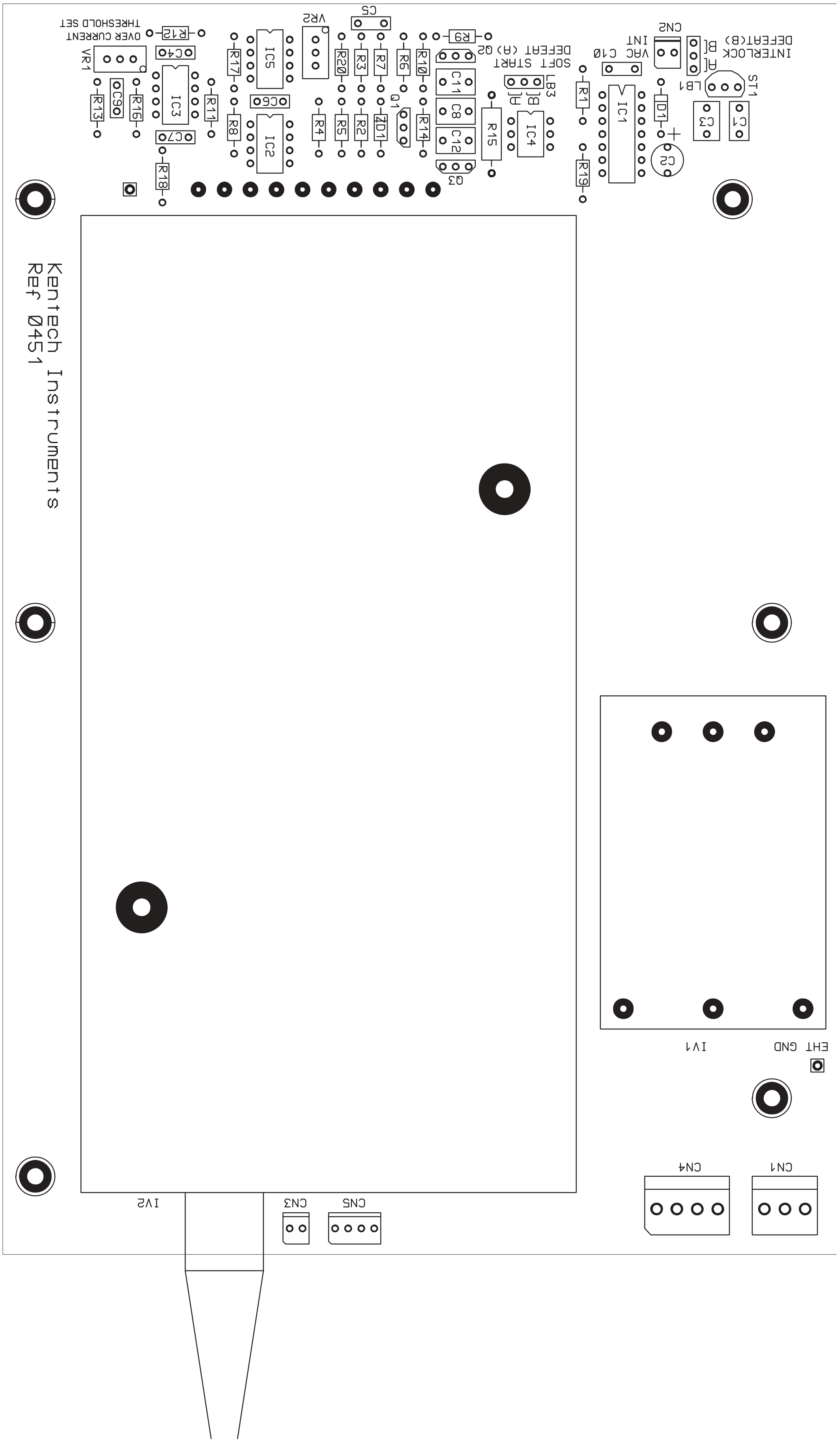


Figure 47 EHT control board components

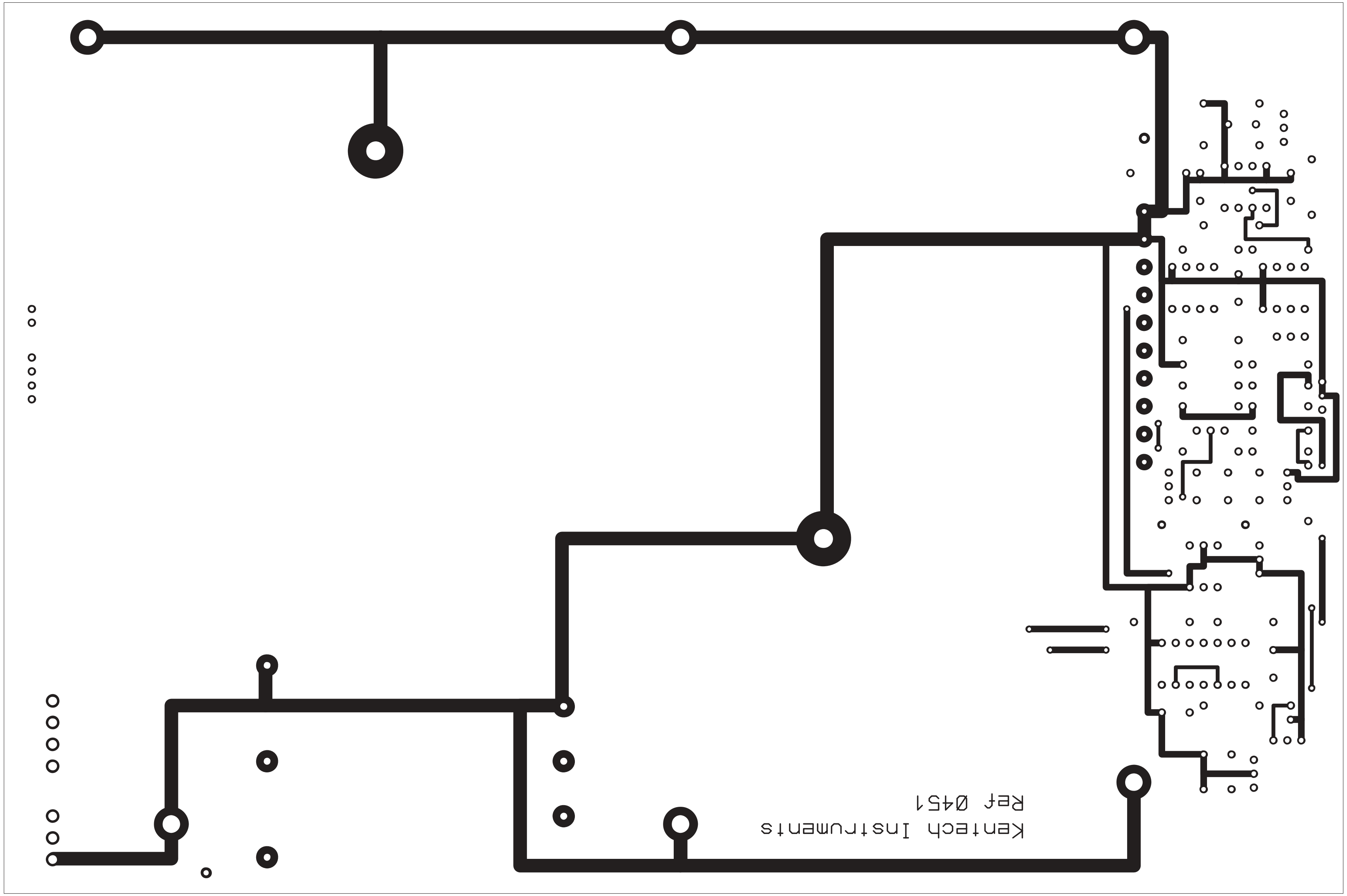


Figure 48 EHT board EHT tracks top

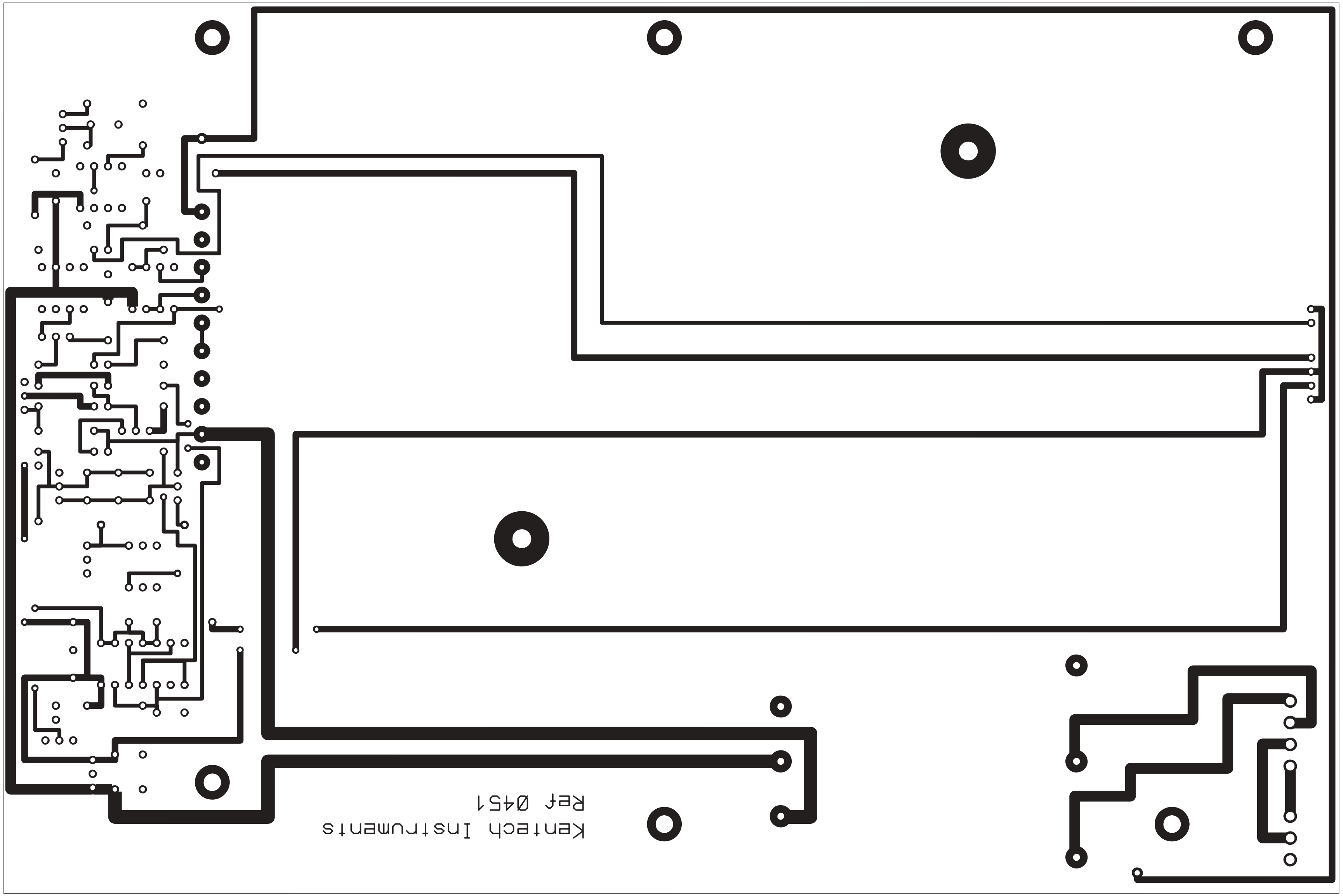


Figure 49 EHT board EHT tracks bottom

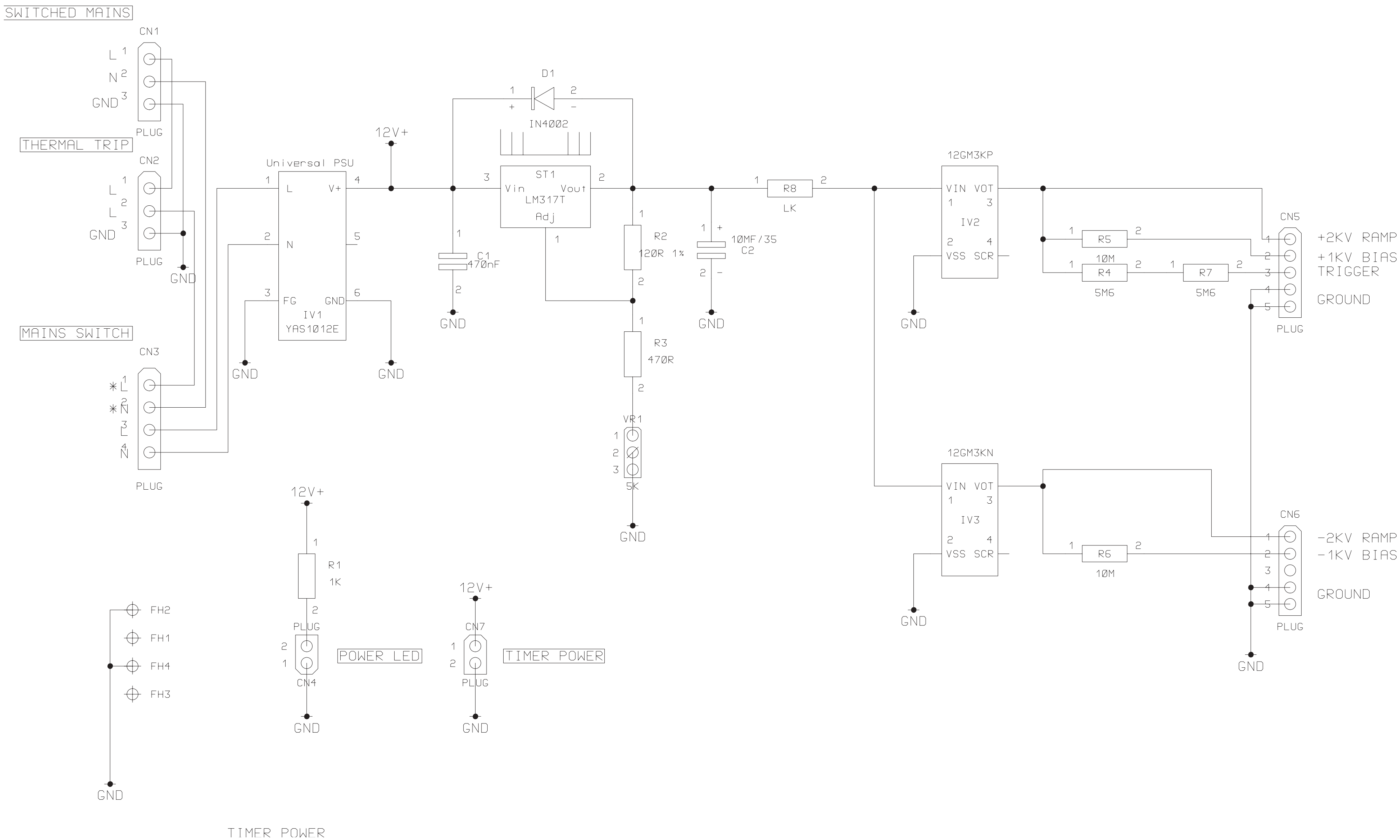


Figure 50 Sweep power supply circuit

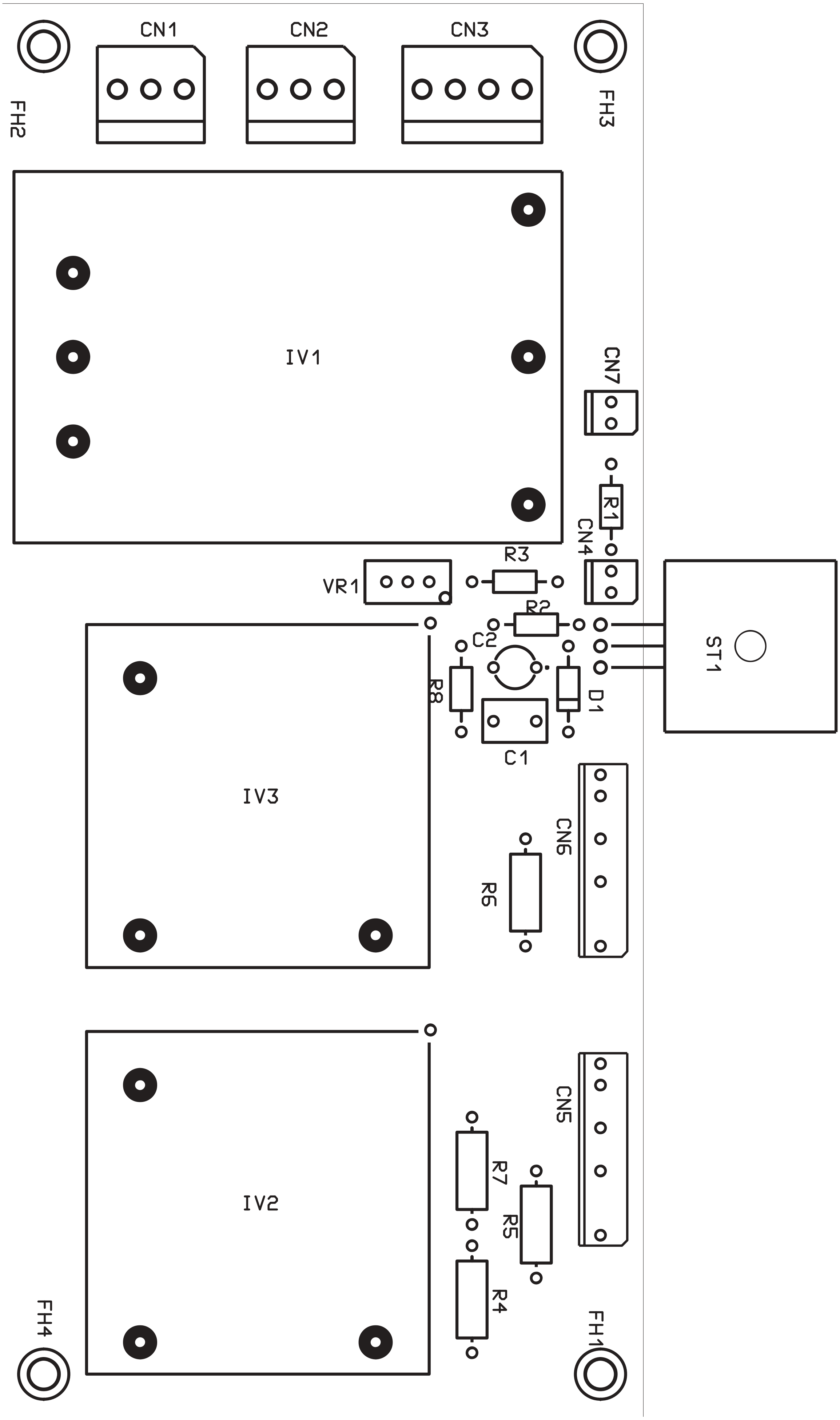


Figure 51 Sweep power supply components

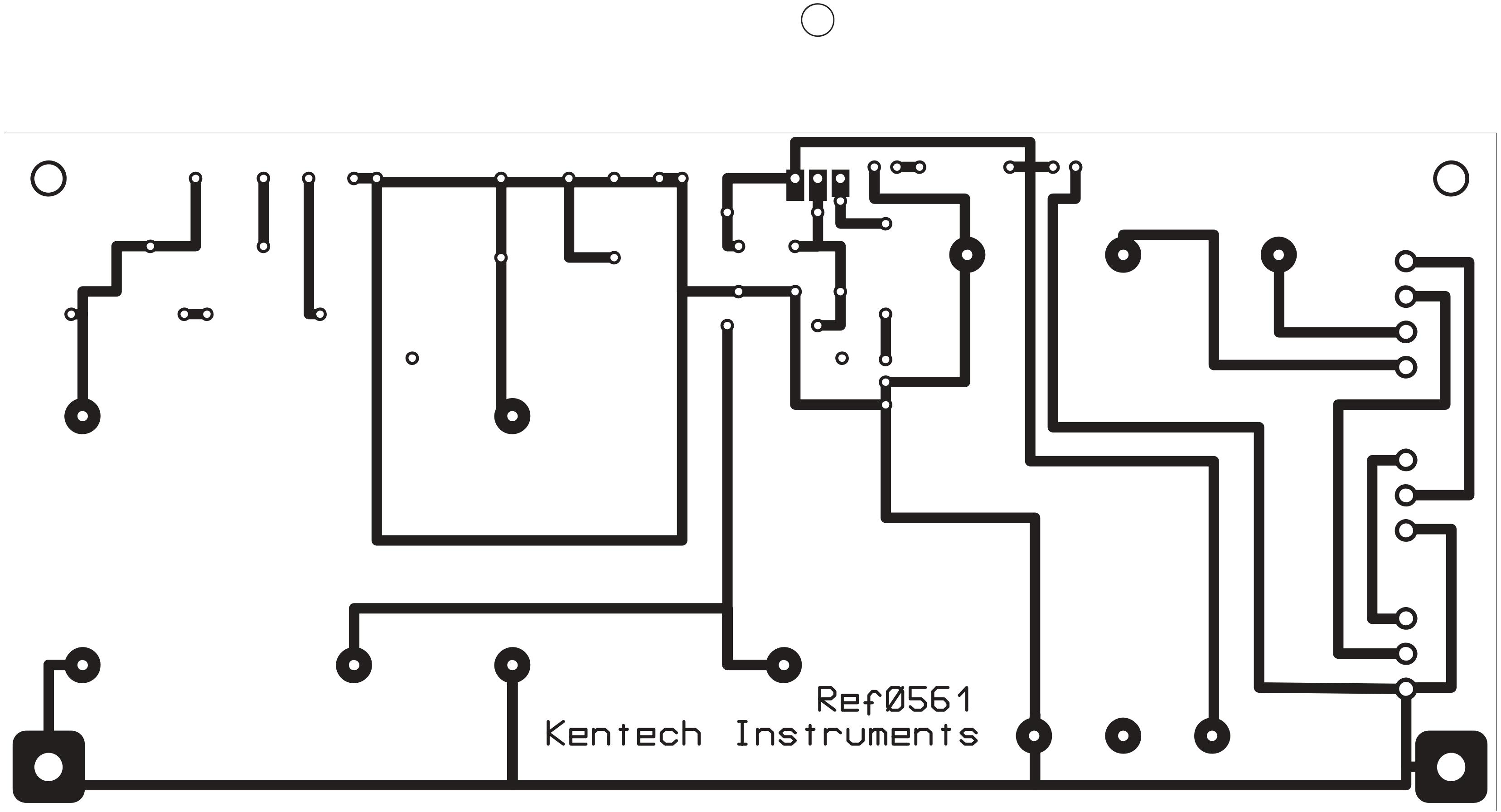


Figure 52 Sweep power supply tracks

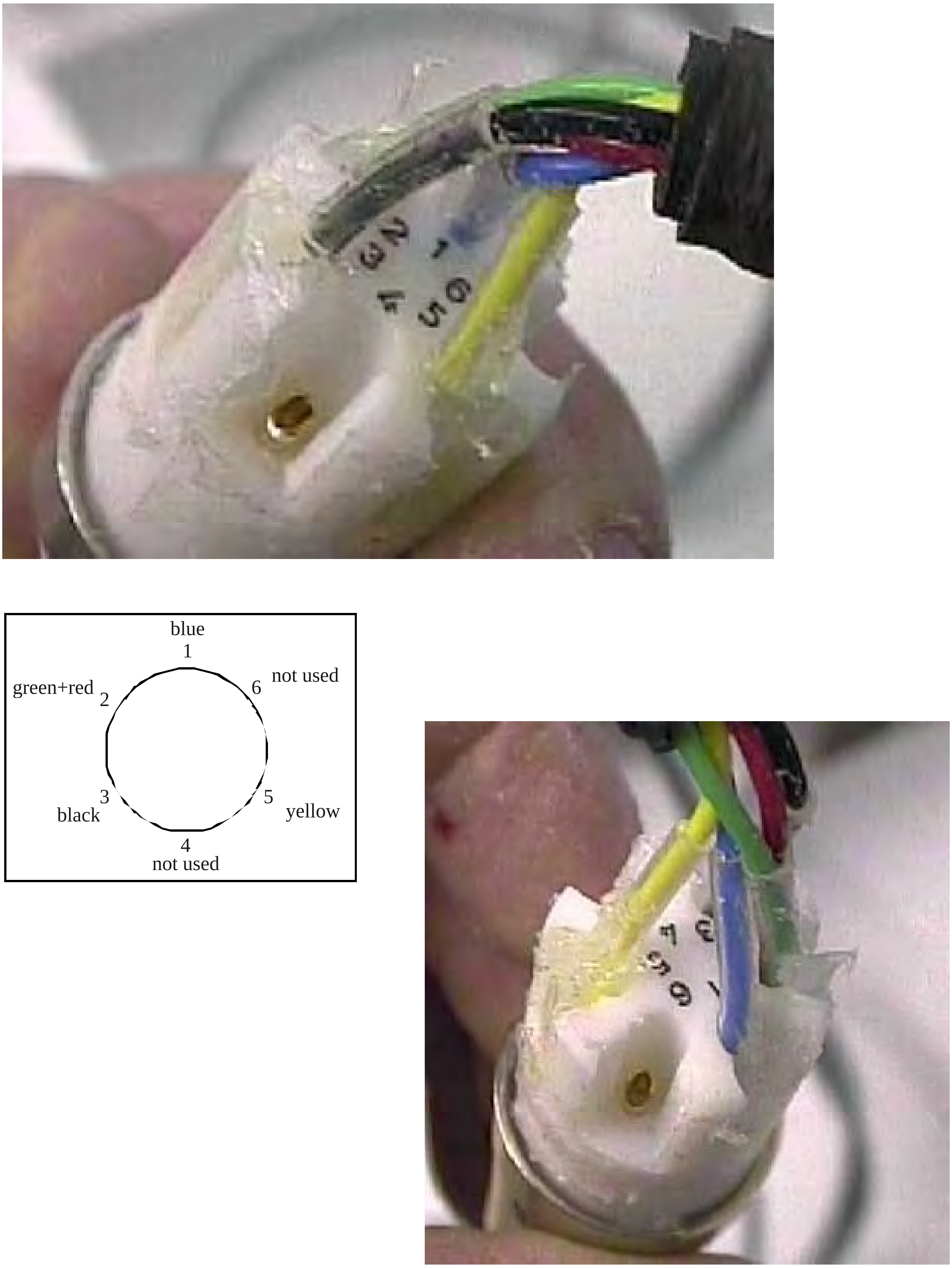


Figure 53 Intensifier lead pin out

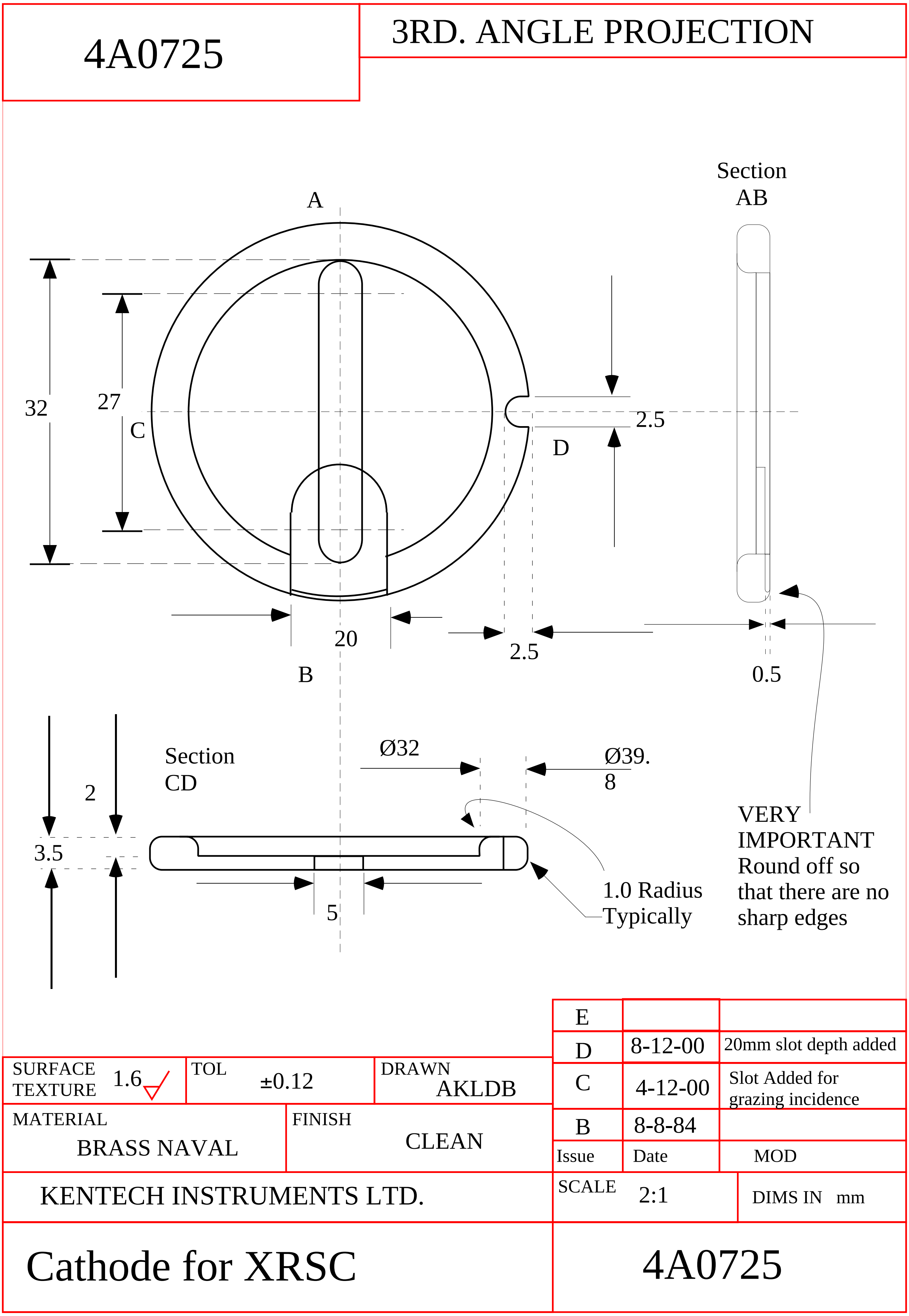
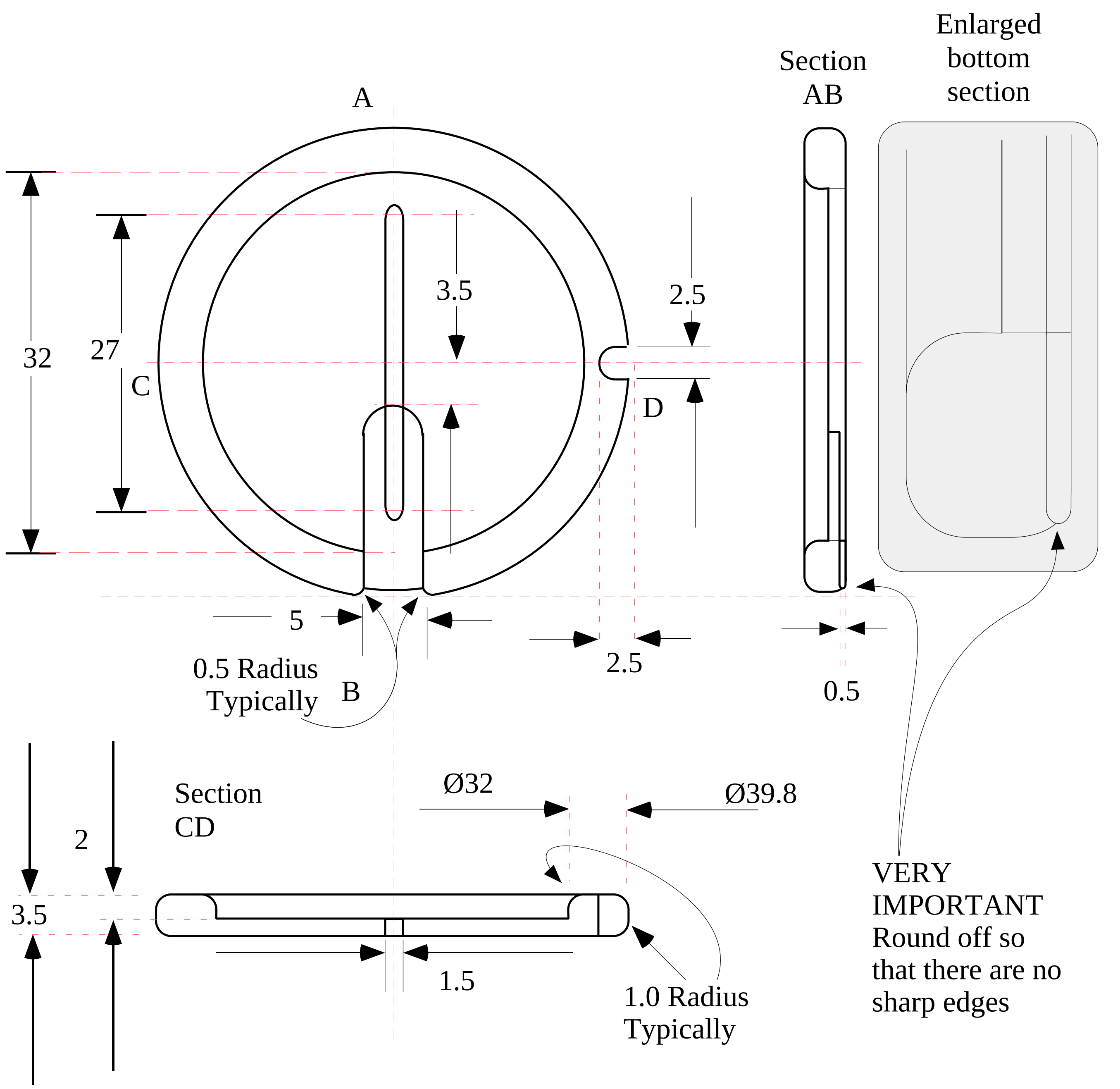


Figure 54 Engineering drawing normal slit and low angle of incidence option

4A0102121

3RD. ANGLE PROJECTION



SURFACE TEXTURE 1.6

TOL ±0.12

DRAWN AKLDB

MATERIAL BRASS NAVAL

FINISH CLEAN

Issue	Date	MOD
A	12-2-2001	

SCALE 2:1

DIMS IN mm

KENTECH INSTRUMENTS LTD.

Narrow, Low angle Cathode for XRSC

4A0102121

Figure 55 Engineering drawing narrow slit and low angle of incidence option

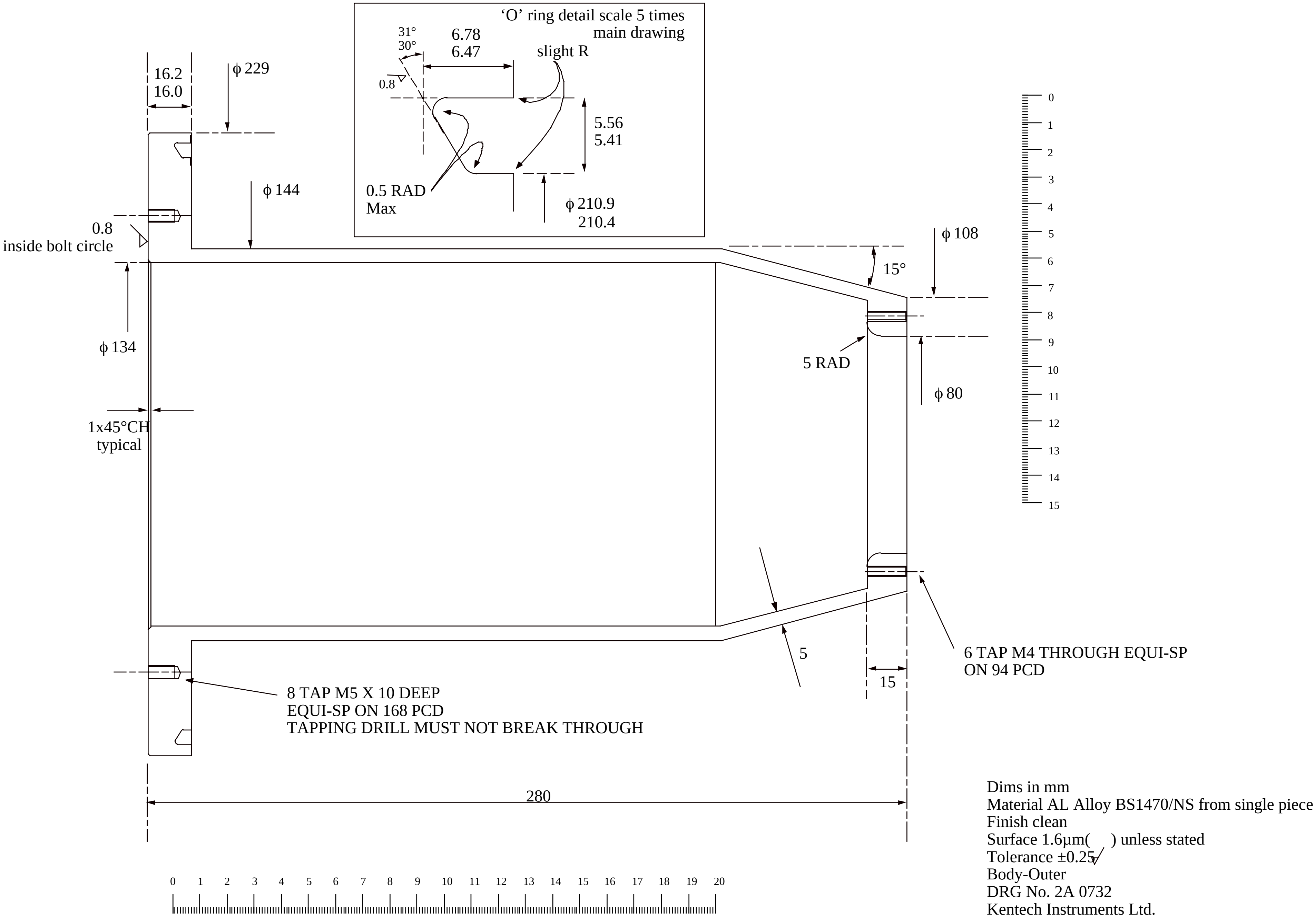


Figure 56 Engineering drawing of re-entrant housing

9 SYSTEM EQUIPMENT LIST

Item	Qty.	Description
1	1	Streak tube assembly comprising
a	1	Tube in re-entrant housing with flying focusing leads, main ‘O ring fitted.
b	1	Magnetic screen (normally fits round Streak tube assembly).
c	1	Nylon transit end cover
2	1	Clamp ring
3	3	Meshes
4	3	Slit plates
5	3	Cathodes
6	2	PTFE spacer rings
7	1	Focusing supply
8	2	Sweep/bias feed leads, N type to N type
9	1	Vacuum Interlock flying lead to lead Lemo 00
10	1	Regular Sweep unit
11	1	Slow Sweep unit
12	4	Large knurled nuts.
13	1	Film attachment comprising
a	1	Polaroid film holder
b	1	Film back for intensifier
c	3	Knurled screws to clamp film back
d	1	Intensifier protective transit cover
14	1	Tool kit with trimmer tool
15	1	Spare screws
16	6	IEC to IEC power leads
17	1	Six way IEC power adapter
18	1	IEC, US power lead
19	1	Computer comprising
a	1	PCI A to D convertor card
b	1	PCI TTL I/O card
c	1	TTL lemo output connector card
d	1	Computer
e	1	keyboard
f	1	mouse
g	1	Screen
h	1	Screen power supply
20	2	BNC to Lemo lead 3m long
21	1	Camera lead assembly
22	1	Camera Head with intensifier and cover plate.
23	1	CD ROM of software
24	1	Floppy Disc with customer settings.
25	1	CR ROM of web site and manual
26	1	Streak Camera manual
27	1	Software manual
28	1	Dynavision manual
29	1	Command Language manual
30	1	Photek Intensifier Power supply.
31	1	Photek Intensifier manual
32	1	Intensifier trigger lead BNC to BNC
33	2	Parallel port Dongle