Kentech Instruments Ltd.

LOW MAGNIFICATION
LOW DELAY X–RAY
STREAK CAMERA
with Intensifier [Photek 40mm single MCP]

8th. March 2004

Serial Number J03*****&J03*****

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	J03*****/2
Sweep Control unit	J03*****/1
Intensifier Tube and power supply	Photek 73030624
	Kentech J03*****/1 (supply)
	J03*****/2 (tube and housing)
Streak tube	J03*****/1

Figure Captions

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INTRODUCTION

This manual describes the operation and use of the Kentech Low Magnification Low Delay X-ray streak camera. 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 user should consult the relevant manuals included with the system. Please contact Kentech regarding any problems or uncertainties.

1.1 SPECIFICATIONS OF THE STREAK CAMERA

Trigger delay standard sweep unit	~6ns on the fastest setting, see timing data
Electro-optical magnification	X 1.2 (nominal)
Number of sweep speeds	six
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

2 GETTING TO KNOW THE INSTRUMENT

The camera system comprises the camera tube and two boxes of electronics. In addition there is an intensifier with a third box of electronics.

The streak camera electronics are close the electron optics, allowing rapid triggering. 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 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.

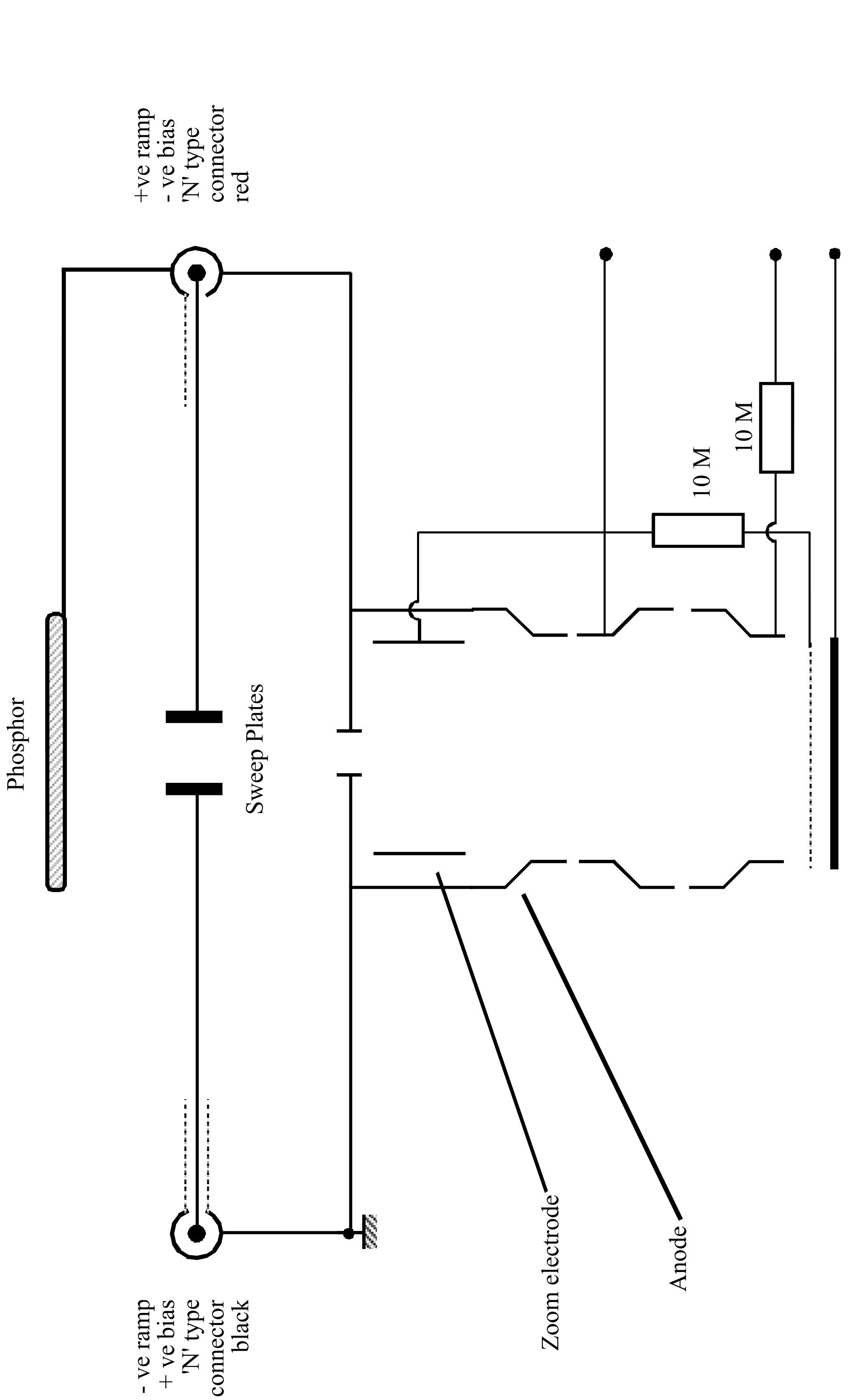


Figure 1 Connections, internal

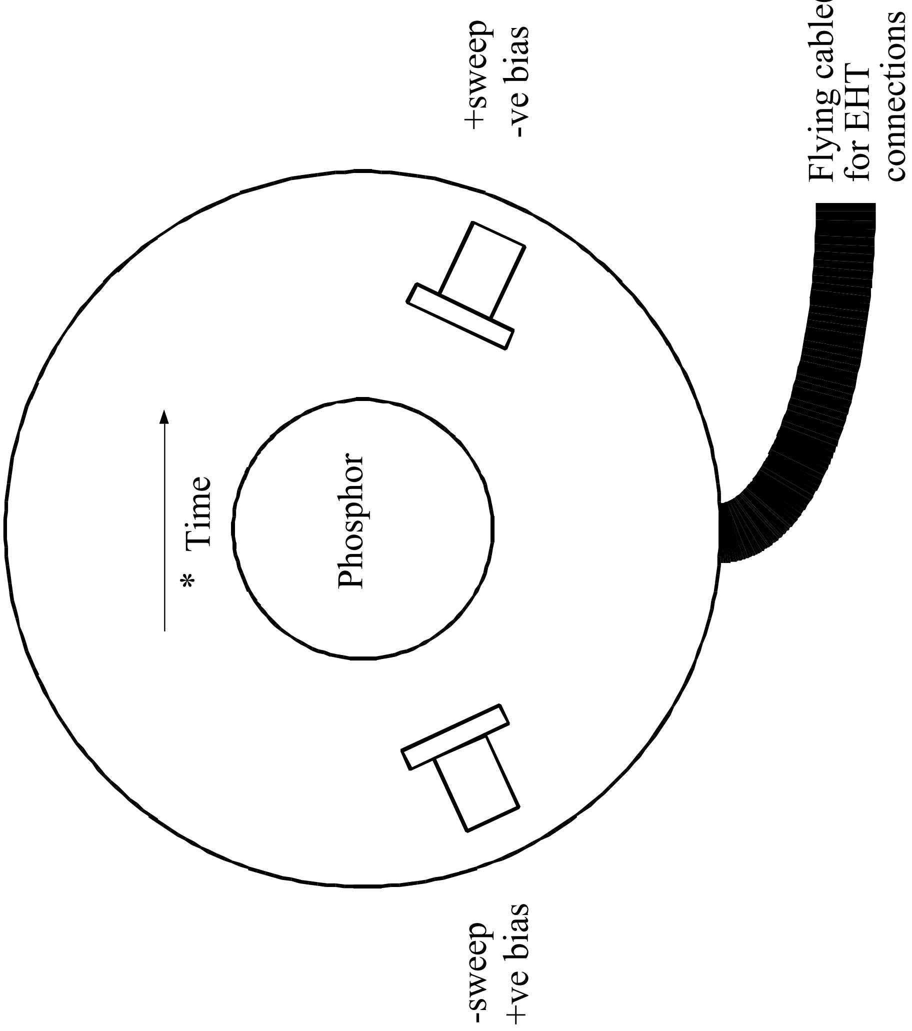


Figure 2 Connections, external

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 15. The voltages applied to the focusing electrodes are given in the data section 7. The cathode can be as high as -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 7.1).

The voltages are produced by a resistive divider as illustrated in figure 16. 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. The overall high voltage is adjustable over the range ~-10 to -15kV. At lower voltages the deflection sensitivity is increased, the internal electron transit time is increased but eh detection sensitivity decreased.

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. There is also an interlock that should be connected to the vacuum system to prevent accidental switching on of the tube when the vacuum is too high. Note that this interlock will not act fast enough to protect the tube against accidental loss of vacuum.

2.3 SWEEP UNIT

The streak voltage is supplied by a ramp generator.

The standard ramp generator consists of a pair of FETs driven by a pair of avalanche transistors. For slow sweep the unit work as a miller integrator. For the fastest sweep the FET is driven as fast as possible and the sweep is determined by the FET characteristics. This is done to achieve the minimum trigger delay.

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, may be obtained. 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.

3 USE

3.1 CONNECTIONS AND MECHANICS

3.1.1 THE FOCUSING UNIT

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

Red	:	cathode
Orange	:	mesh
White	:	focusing cone

The sweep control unit is connected via three leads. All three are different to avoid cross connecting.

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. Do not forget that there is a further inversion in a lens coupled readout system if fitted but that this may be accounted for in the readout head/software. The flat field intensifier does not invert the image.

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 anode mounting flange but only 6 are available for use due to modifications to fit the low delay sweep electronics. The streak tube must be withdrawn 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.

3.1.2 THE SWEEP CONTROL UNIT

The sweep control unit delivers the high voltages for the sweep and bias to the sweep unit attached to the side of the camera tube. It also sets the relays in the sweep unit to select the sweep speed.

All the sweep positions are the same, however, they can be configured differently. Each sweep position on the control unit can be set to have its own bias setting to define the start position of the sweep and to set any of the five relays in the sweep unit to open or closed.

As shipped the sweeps are from 1, slow to 6, fast and all the biases are set to 160 volts which will place the sweep start off screen when the unit is used at the maximum overall voltage.

3.2 INTENSIFIER TRIGGERING

The user will have to arrange for a second trigger signal to trigger the intensifier. Ideally this should arrive around 200ns or so before the sweep trigger. See page 19 of the Intensifier manual.

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 4. 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.

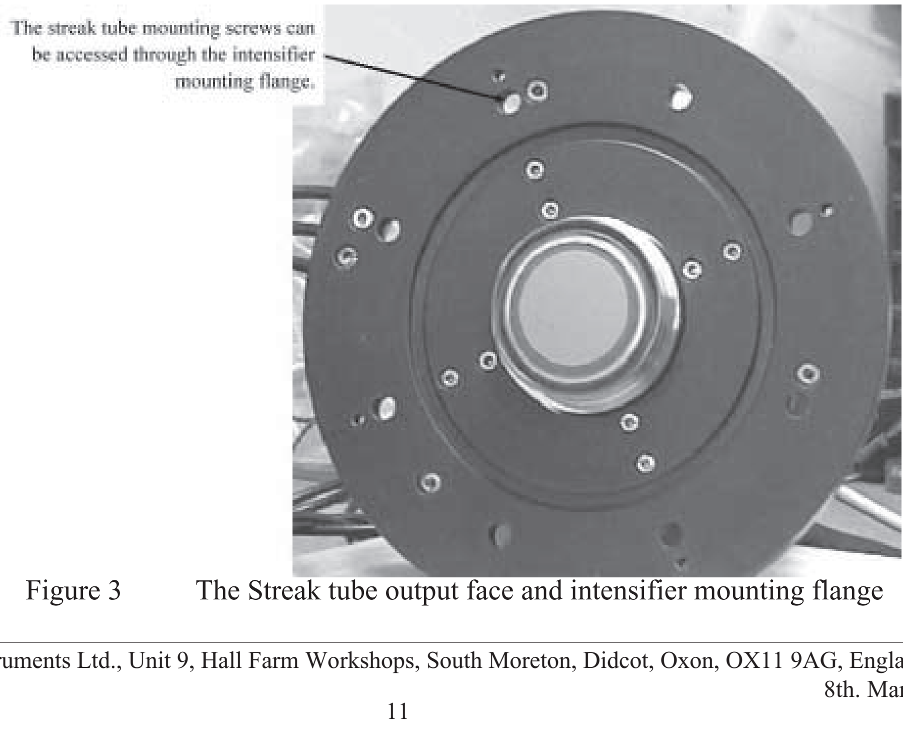


Figure 3 The Streak tube output face and intensifier mounting flange

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 $kVcm^{-1}$ (a maximum cathode voltage).

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.

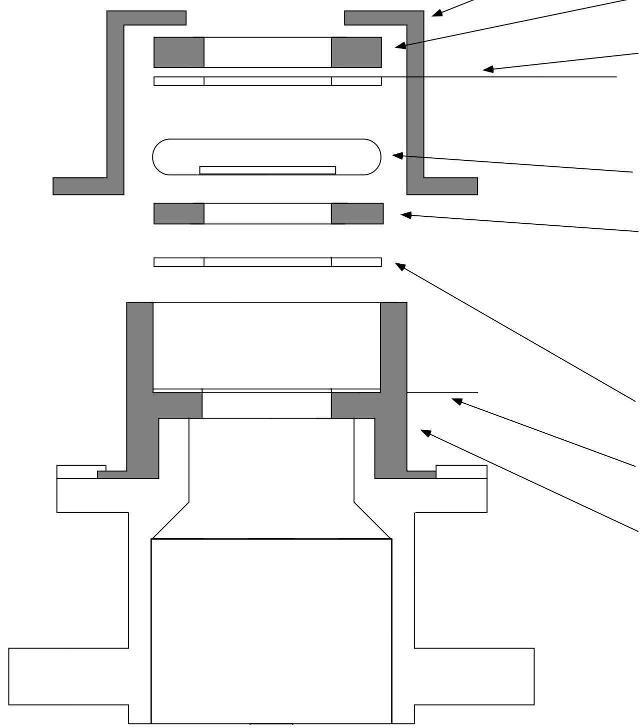
7 Remaining spacer(s). Must be placed in so that the rebate covers the solder connection to the photocathode contact ring. If reduced thickness spacers have been used between the mesh and cathode more spacers may be necessary here to give enough height to the stack of components so that they are compressed by the outer clamping piece.

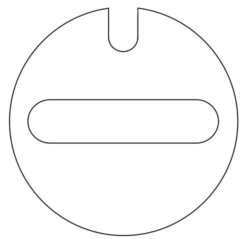
If using a low angle of incidence option it will be necessary to use a top spacer with a cut out. This is a non standard option.

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 ~15$kVcm^{-1}$ (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.





cathode and mesh outline

Figure 4 Cathode/mesh assembly

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.

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 @15kV increasing to 2ns at 10kV)

(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 normally starts at on screen at the edge. 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.

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 efects 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.

Stray magnetic fields may displace the image slightly. A 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 CIRCUIT

The low delay sweep unit uses a FET based Miller integrator circuit to obtain the ramps. 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 three resistors and one capacitor 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. Small adjustments to the sweep speeds can be effected by adjusting the variable resistors. This works for speeds 3,4 and 5. Speed 6 is flat out, speeds 1 and 2 have to be like two of 3,4 or 5, a sum of any othe these and possibly with the capacitor switched in. The configuration is set up in the control unit. Any relay can be made active at any sweep position. So one can assign any of the available speeds to any of the front switch positions. See figure 5 for details.

The bias voltages that set the start positions are just off screen. There is a bias setting for each sweep position and another for the synch mode. In synch mode the individual bias settings do not function and the start position is set purely by the synch control.

4.2 THE FOCUSING SUPPLY

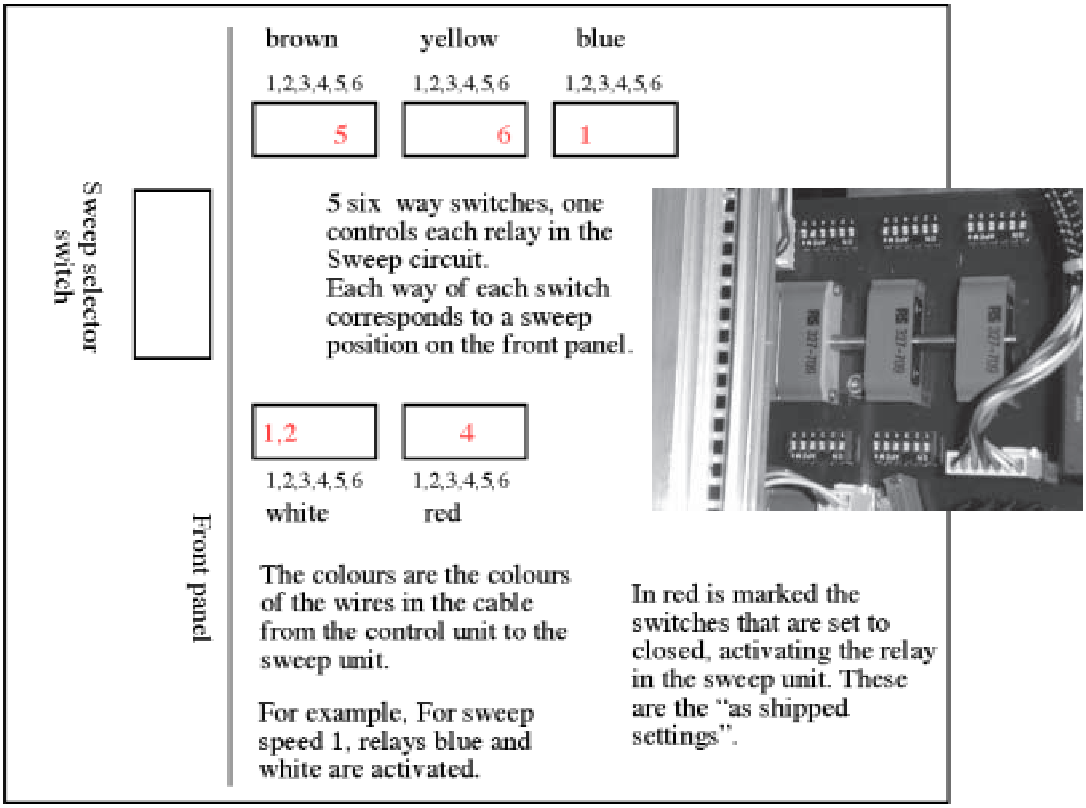
Figure 15 is a block diagram of the focusing supply. The focusing potentials are derived from a resistive divider chain, passing a nominal current of ~100μamps. The operation of this network requires no explanation except to say that the high voltage zener diodes are to limit the voltages appearing across resistors in the network in the event of a breakdown, thus stopping damage by excessive dissipation. (The network is shown in figure 16). 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. So that the electron transit time may be increased and the ramp sensitivity increased this unit has an adjustable cathode potential. This adjusts the voltage to the top of the divider. The focus is retained while the overall HT is changed. The user will notice some loss of detections sensitivity but a significant increase in deflection sensitivity and some increase in the electron transit time. These latter two effects improve the chance of seeing an event with a late trigger.

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



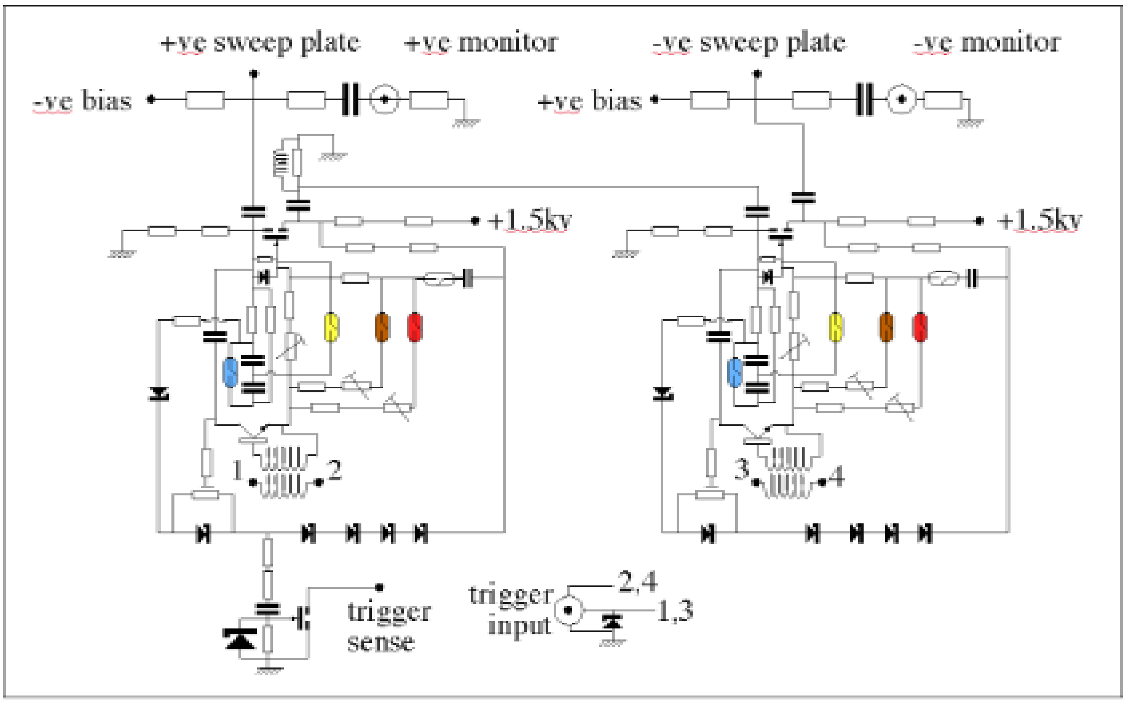


Figure 5 The sweep circuit and the control logic.
Note the potentiometers which set the sweep speeds.

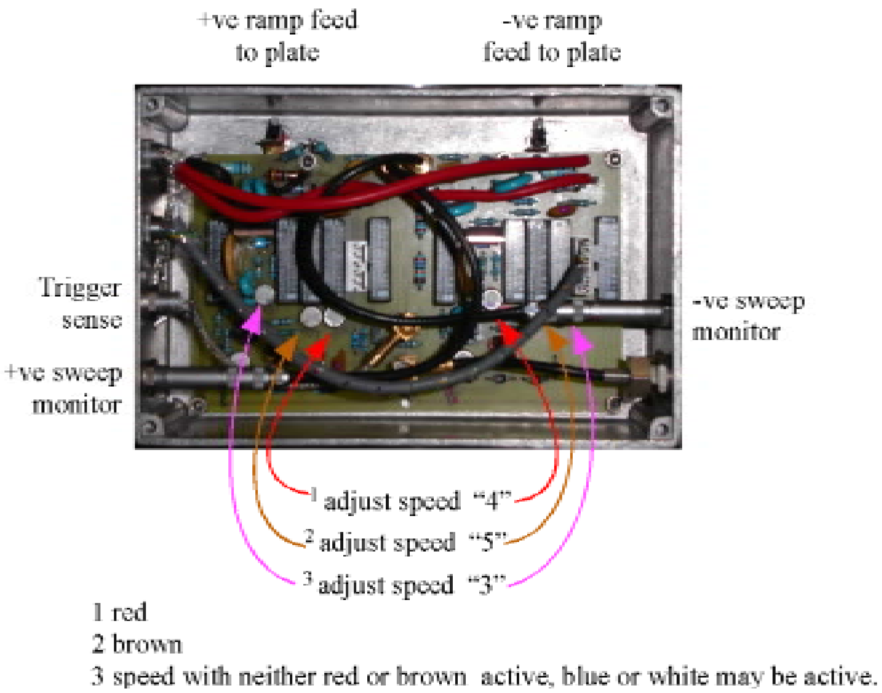


Figure 6 Where to adjust sweep speeds.
Note that the speed positions correspond to the factory set ones. Really they correspond to the relevant relay settings.

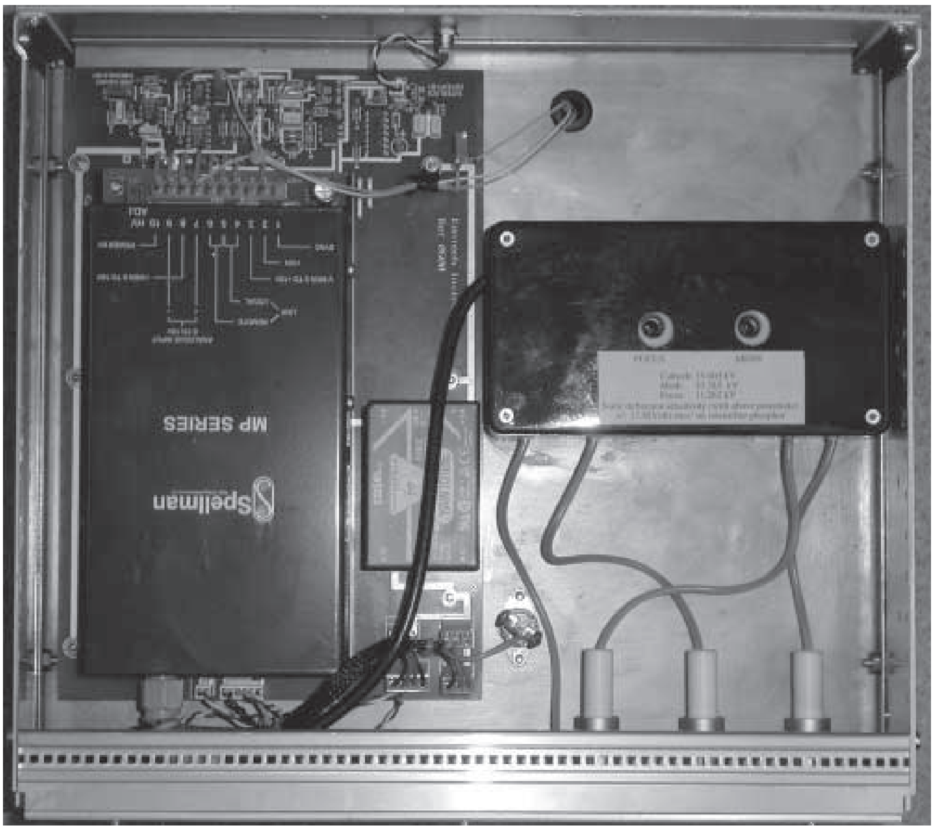


Figure 7 A typical focus supply showing the position of the focusing controls.

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 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 10. 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 10.

6 PHOTEK IMAGE INTENSIFIER

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.

6.1 INTERFACING THE INTENSIFIER TO THE STREAK CAMERA

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.

Before fitting the intensifier make sure that the intensifier tube is well jacked up by tightening the three knurled jacking screws around the intensifier tube. Fit the intensifier housing with four M5 screws. 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 the mounting screwsThe gradually loosen in turn each of the three knurled screws until all three are loose. If you think the tube has jammed, possibly due to loosening one screw too much before the others, then retighten all three and start again. Do not allow the tube to spring down onto the streak tube window. This could be very expensive.

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 will require a separate trigger sourceThis should ideally be around µs to 200ns or more before the shot. Make sure that the intensifier power supply is set to the correct edge triggering for whatever trigger you supplyThe trigger source is used then it should beTTL level and the pulse duration must be less than 300µs. Trigger signals greater than 300µs may extend the gate time accordingly.

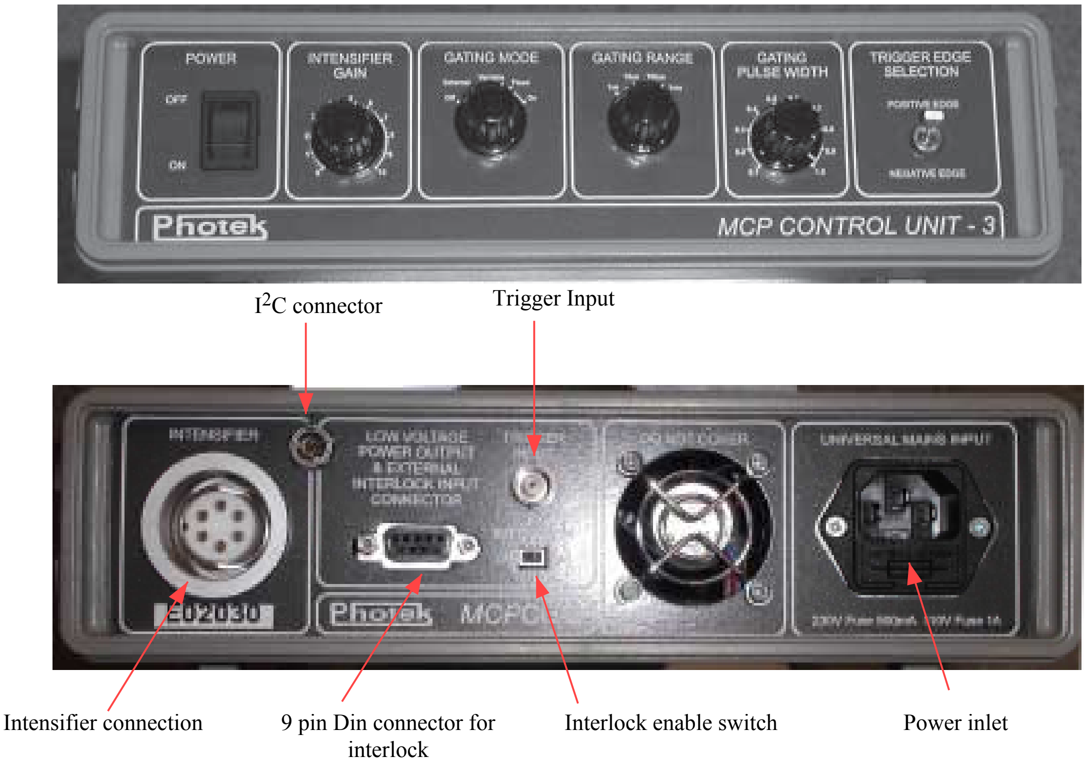


Figure 8 The Intensifier power supply panels

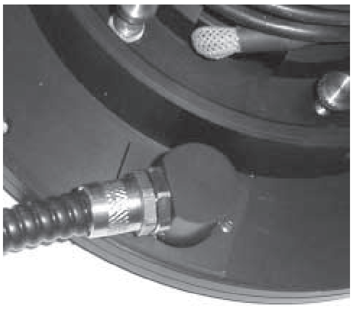


Figure 9 The Intensifier cable gland can be rotated

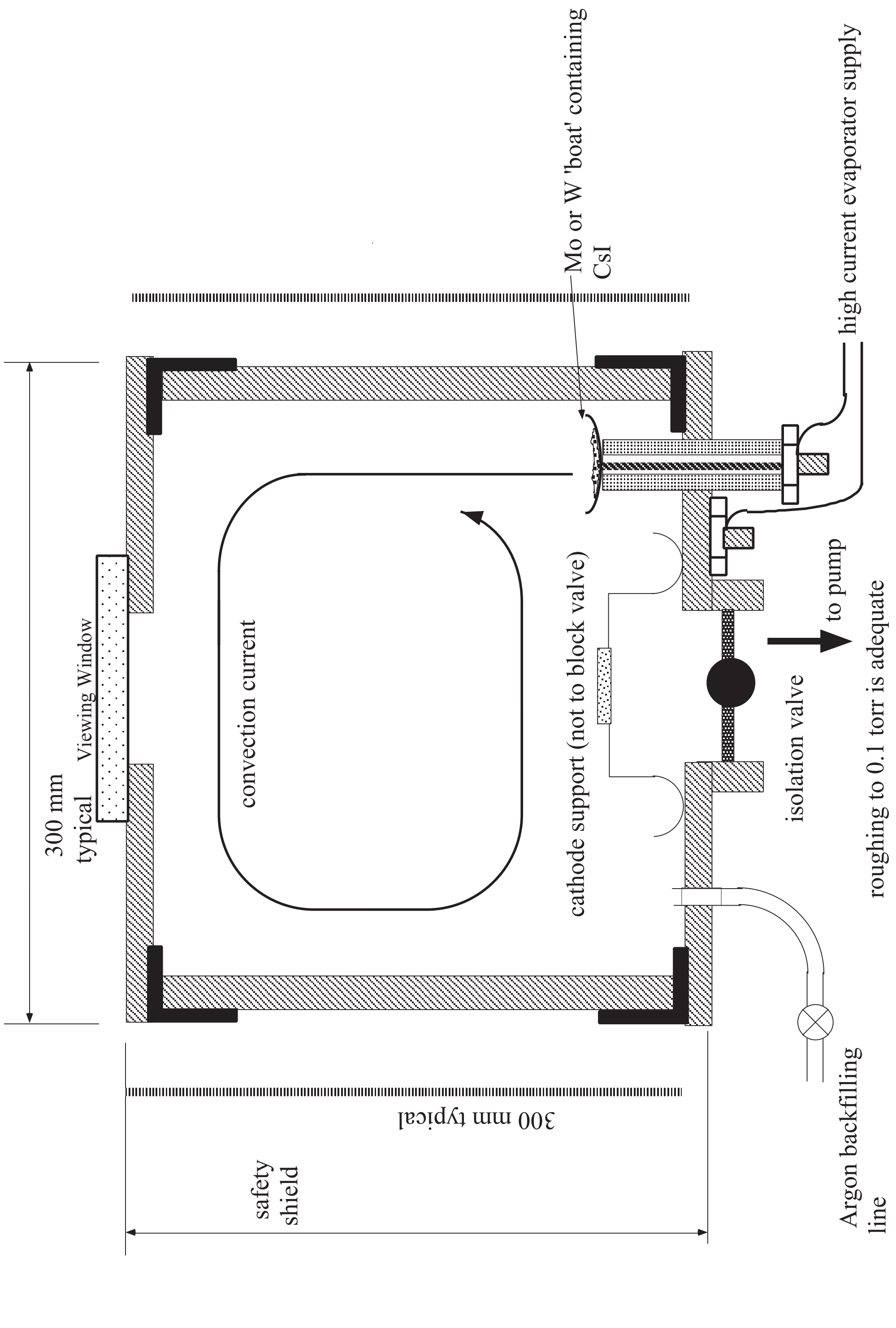


Figure10 Low Density cathode manufacture

The intensifier gain will rise about 200ns 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.

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 its 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.

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 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.

7 DATA SHEETS

7.1 STATIC FOCUSING

Camera type	LDXRSC
Camera number	J03*****
Customer	Cornell University
Date tested	1st. March 2004
Phosphor type (P11 or P20)	P20

Focus potentials as measured with 1000MΩ probe.

Cathode	14.817 kV
Mesh	10.248 kV
Focus	10.982 kV

Static deflection sensitivity (with above potentials):
+/- 12.3Volts mm^{-1} on intensifier phosphor

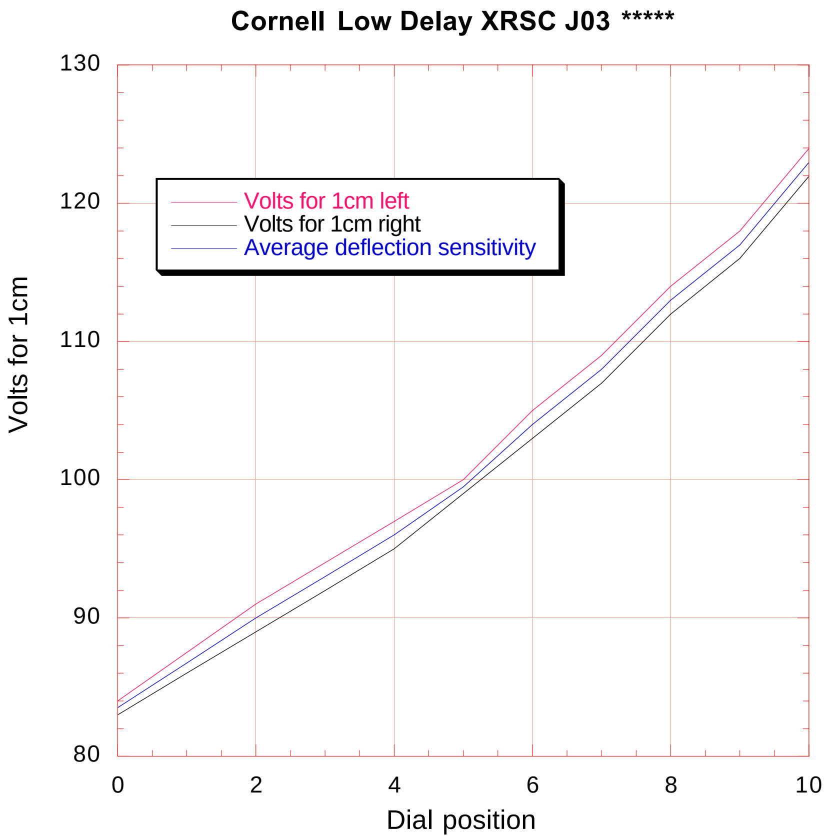
7.2 SWEEP SPEEDS AND TRIGGER DELAYS

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 ef fects and the difficulty of making precise electrical measurements.

8.3 BIAS VOLTAGES

Bias SYNCH	±160 volts
Bias OPERATE sweeps 1 through 6	±160 volts

This may not be the optimum setting but is a good place to start.



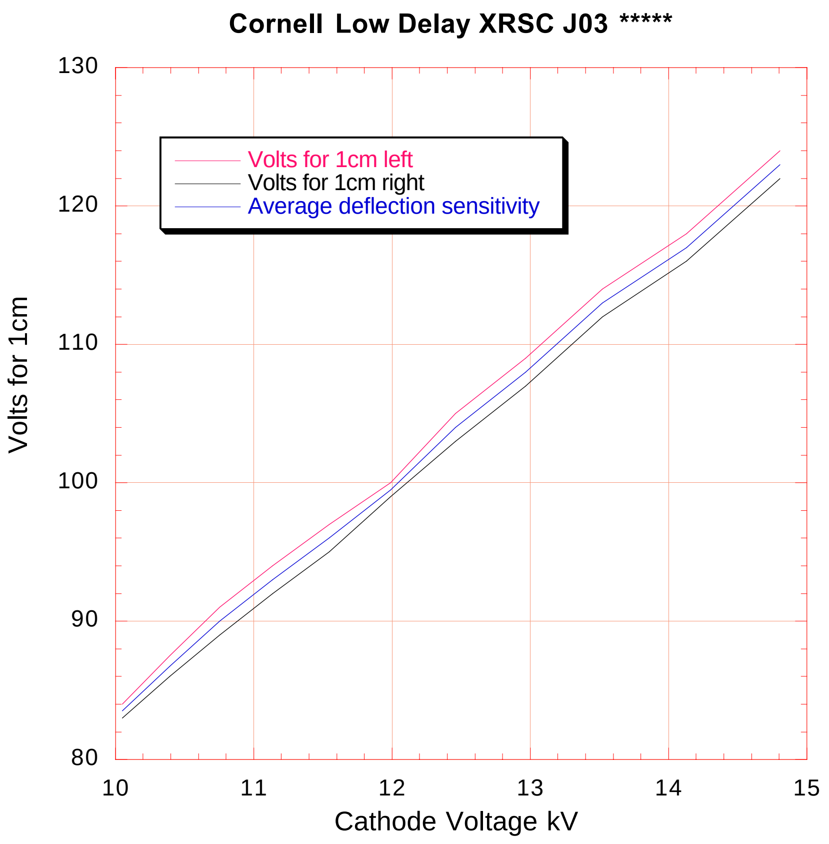
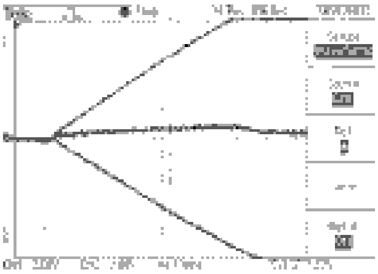
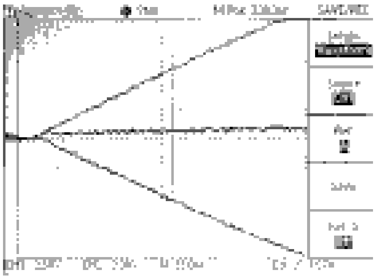


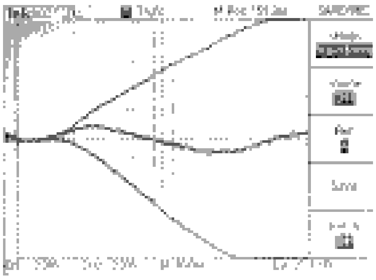
Figure 11 Sweep sensitivity as a function of overal tube voltage



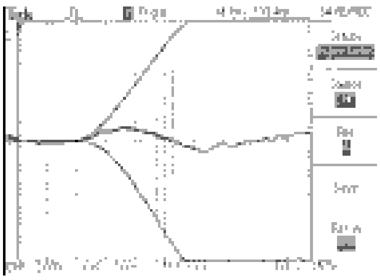
Sweep 1
1.3V/ns
ps/mm = 6423 ps/mm @ dial setting 0, 9462 ps/mm @dial setting 10



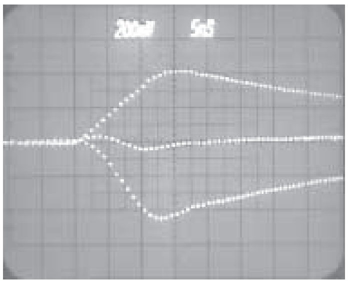
Sweep 2 3.6V/ns
ps/mm = 2319 ps/mm @ dial setting 0, 3417 ps/mm @dial setting 10



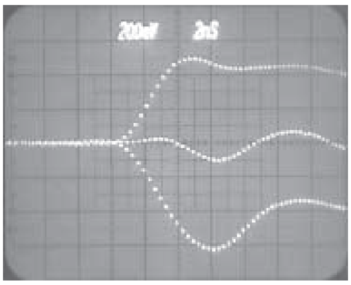
Sweep 3 10.6V/ns
ps/mm = 788 ps/mm @ dial setting 0, 1160 ps/mm @dial setting 10



Sweep 4 53.3V/ns
ps/mm = 157 ps/mm @ dial setting 0, 231 ps/mm @dial setting 10



Sweep 5 60V/ns
ps/mm = 139 ps/mm @ dial setting 0, 205 ps/mm @dial setting 10



Sweep 6 420V/ns
ps/mm = 19.9 ps/mm @ dial setting 0, 29.3 ps/mm @dial setting 10

Figure 12 Sweep speeds.

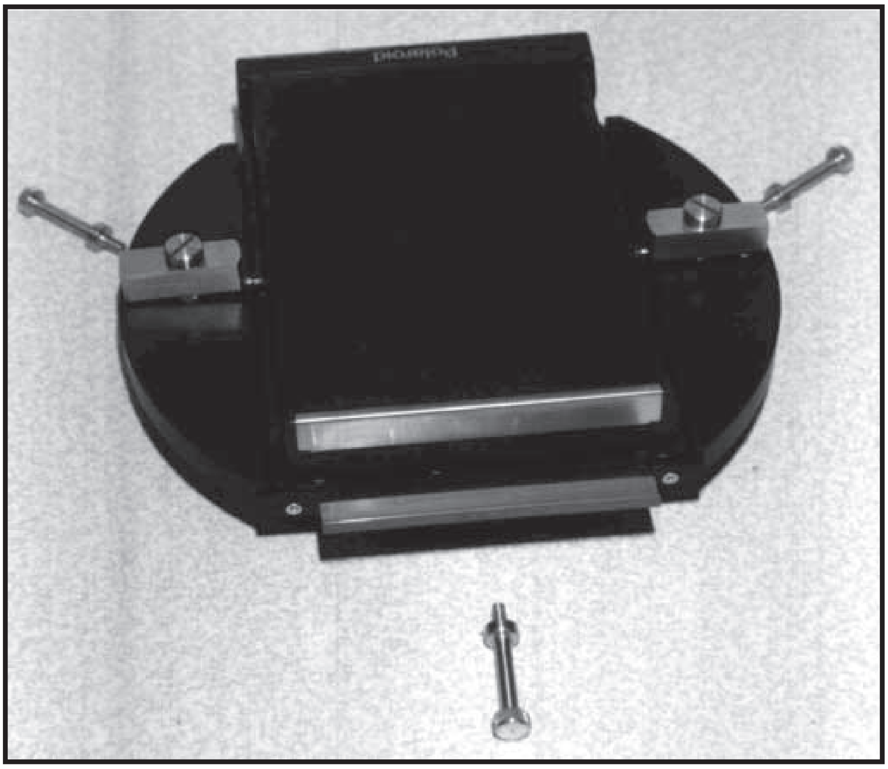


Figure 13 The Polaroid film back can be fitted to the intensifier.
The back takes film types 667 or 612. The CCD camera and fibre optic taper must be removed from the rear of the intensifier. The three radial knurled screws are used to clamp the film back in position. In normal use these are not removed, 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 14 Photek Intensifier

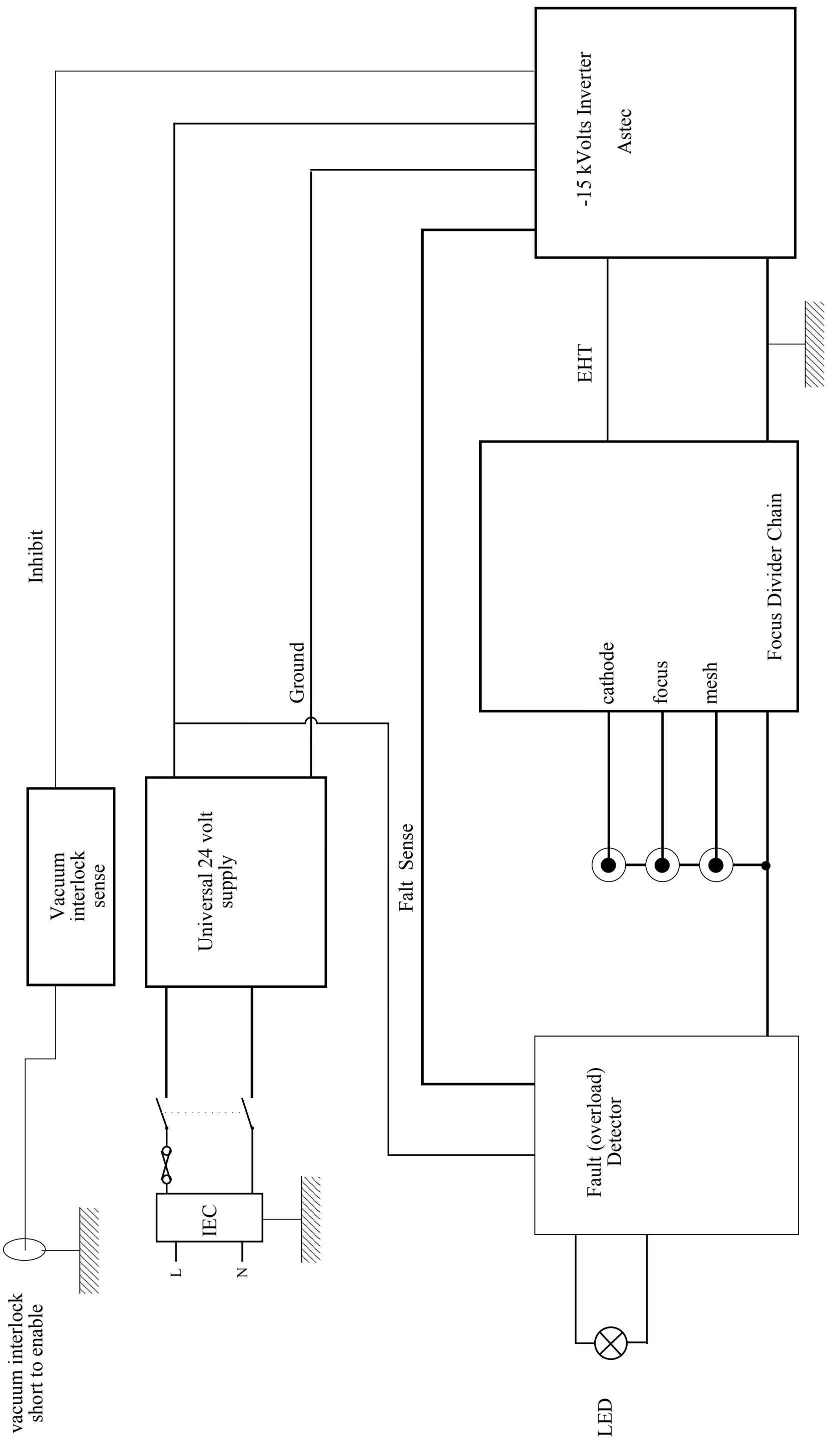


Figure 15 Focusing supply, block diagram

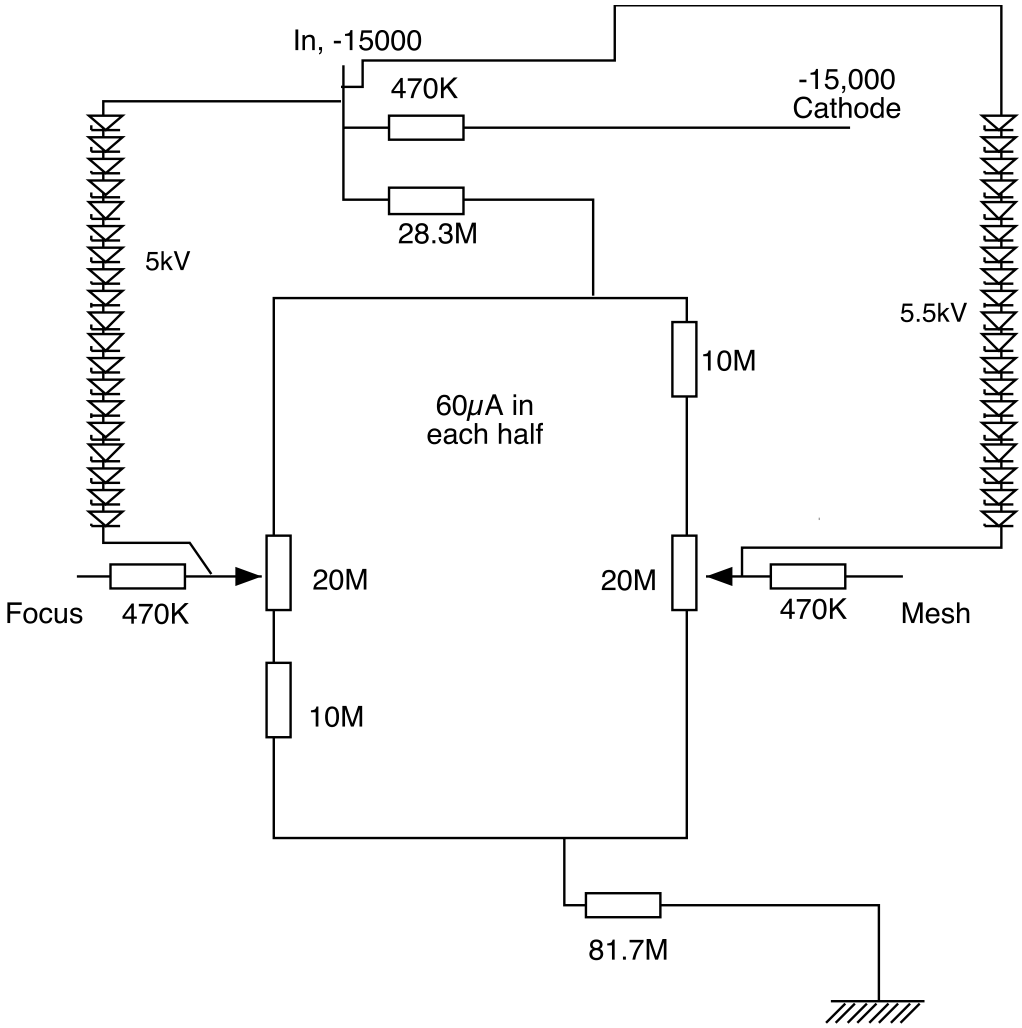


Figure 16 Focus potential divider network

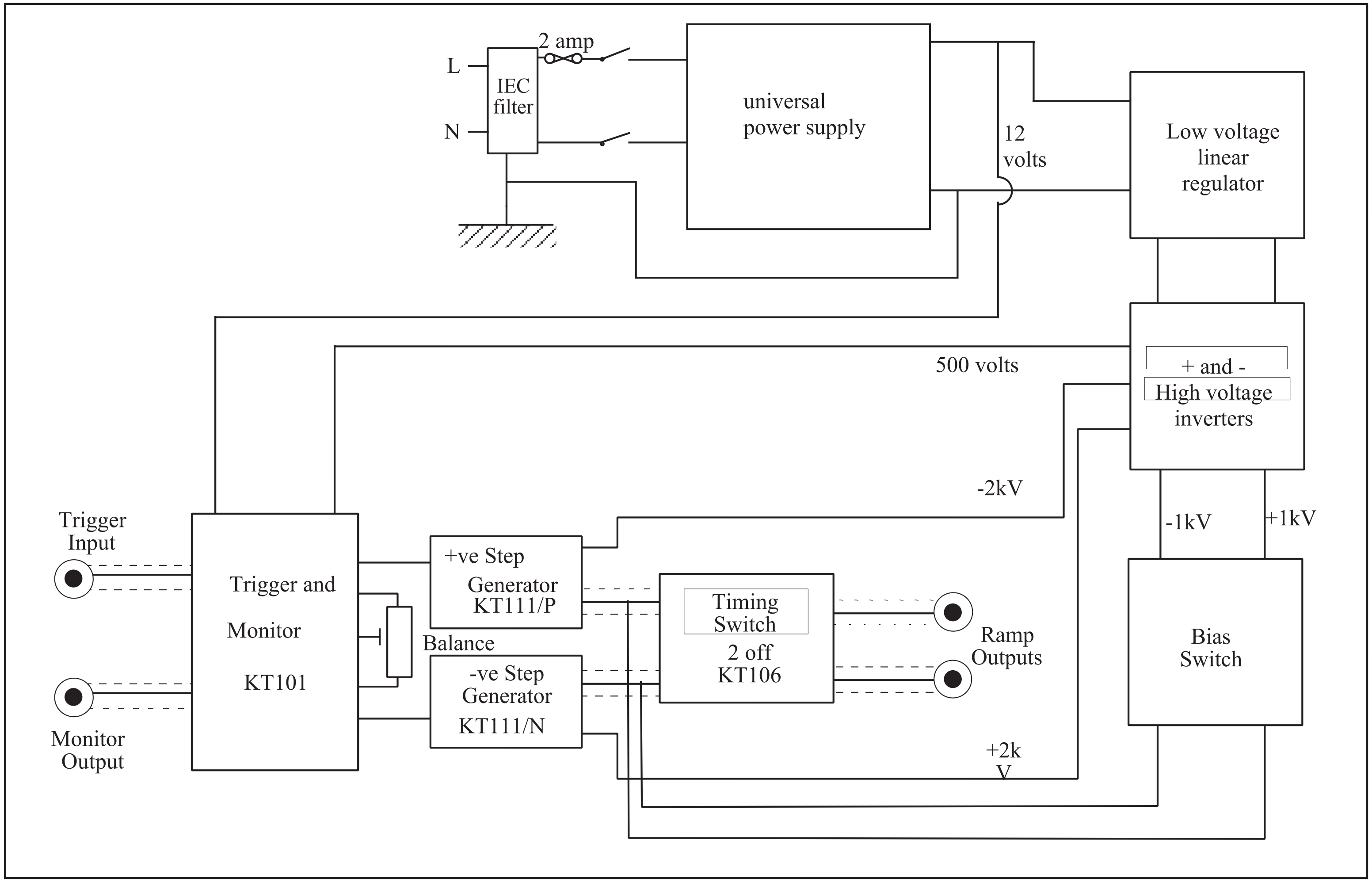


Figure 17 Regular Sweep unit, block diagram

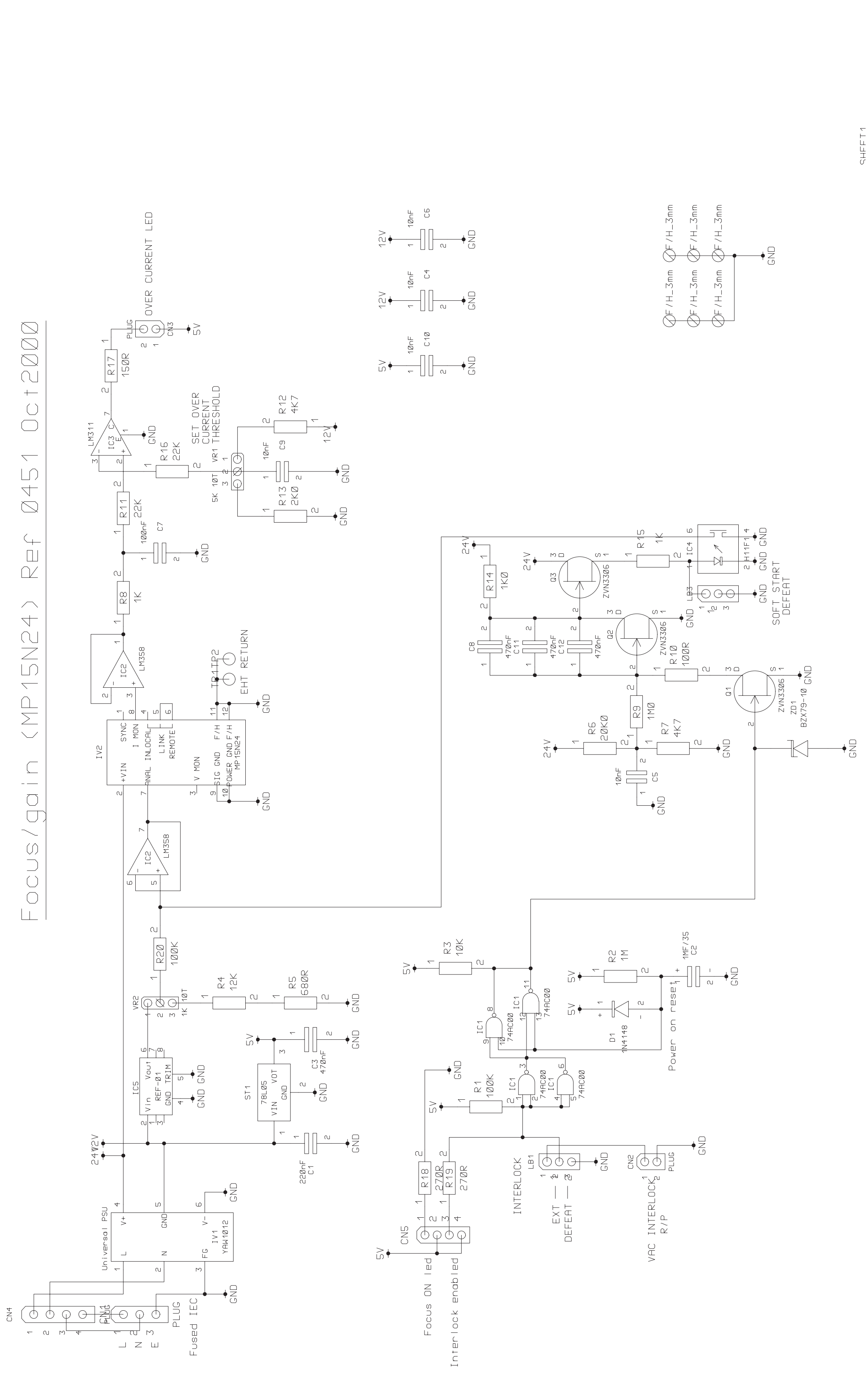


Figure 18 Focus Unit circuit

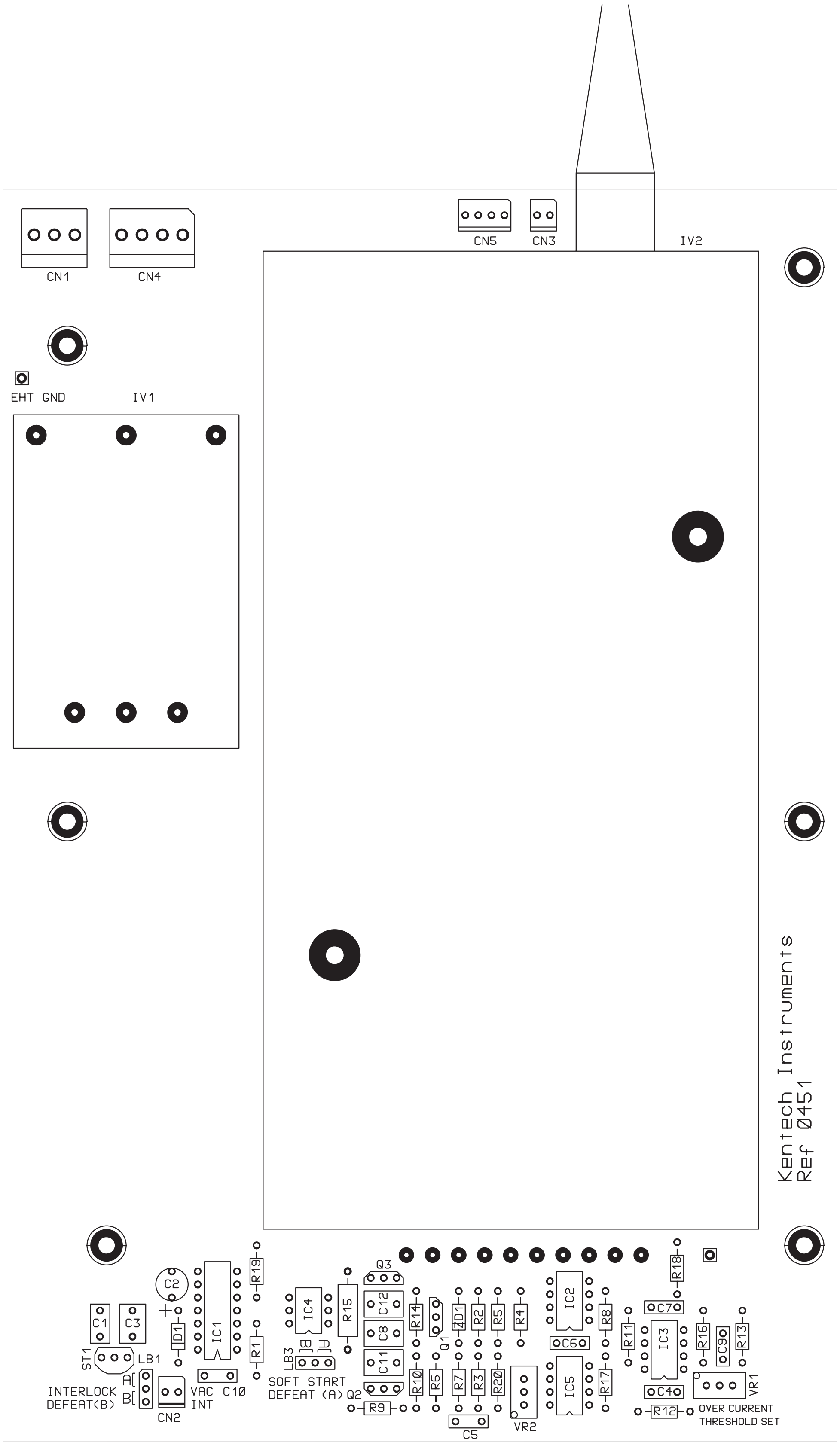


Figure 19 EHT control board components

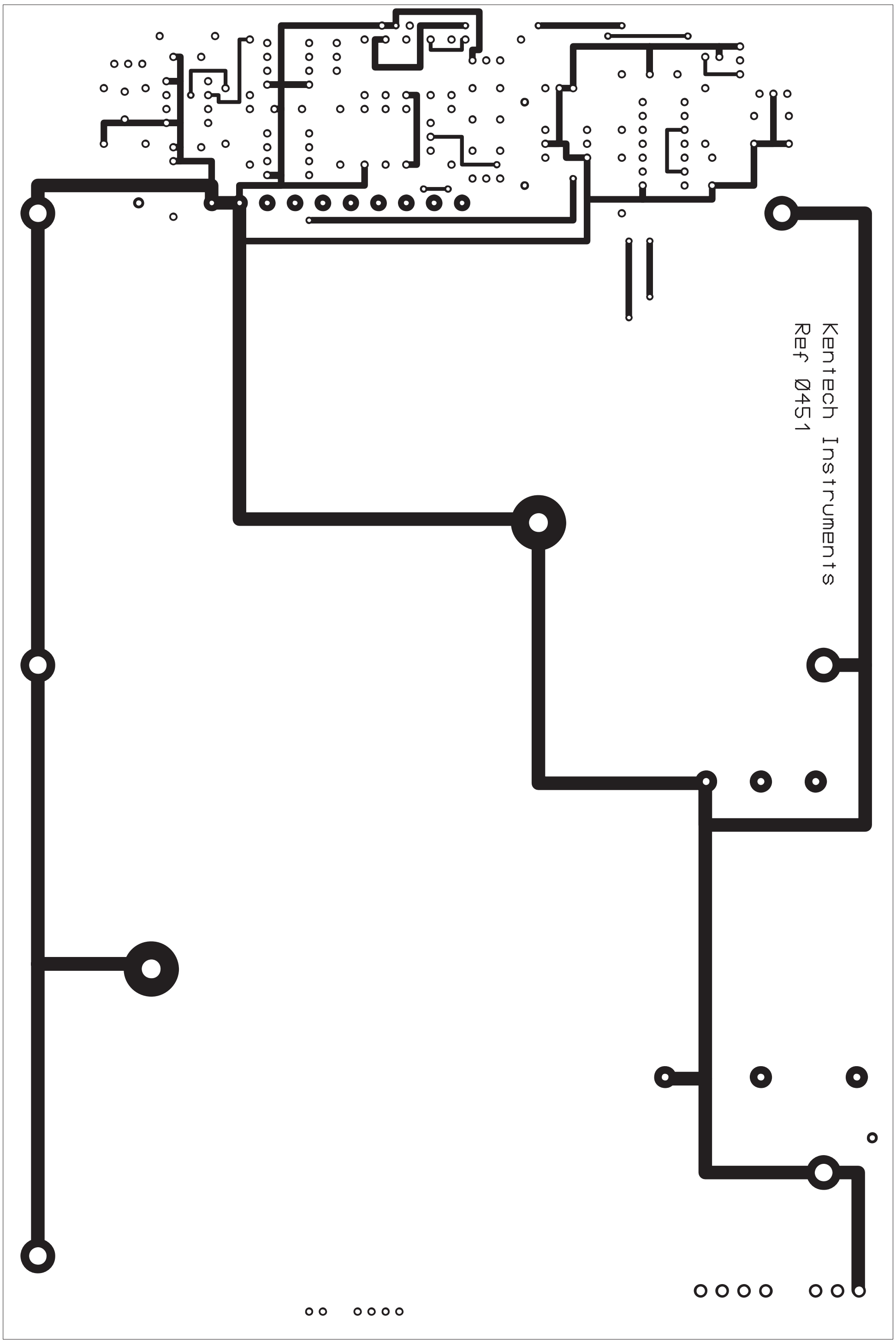


Figure 20 EHT board EHT tracks top

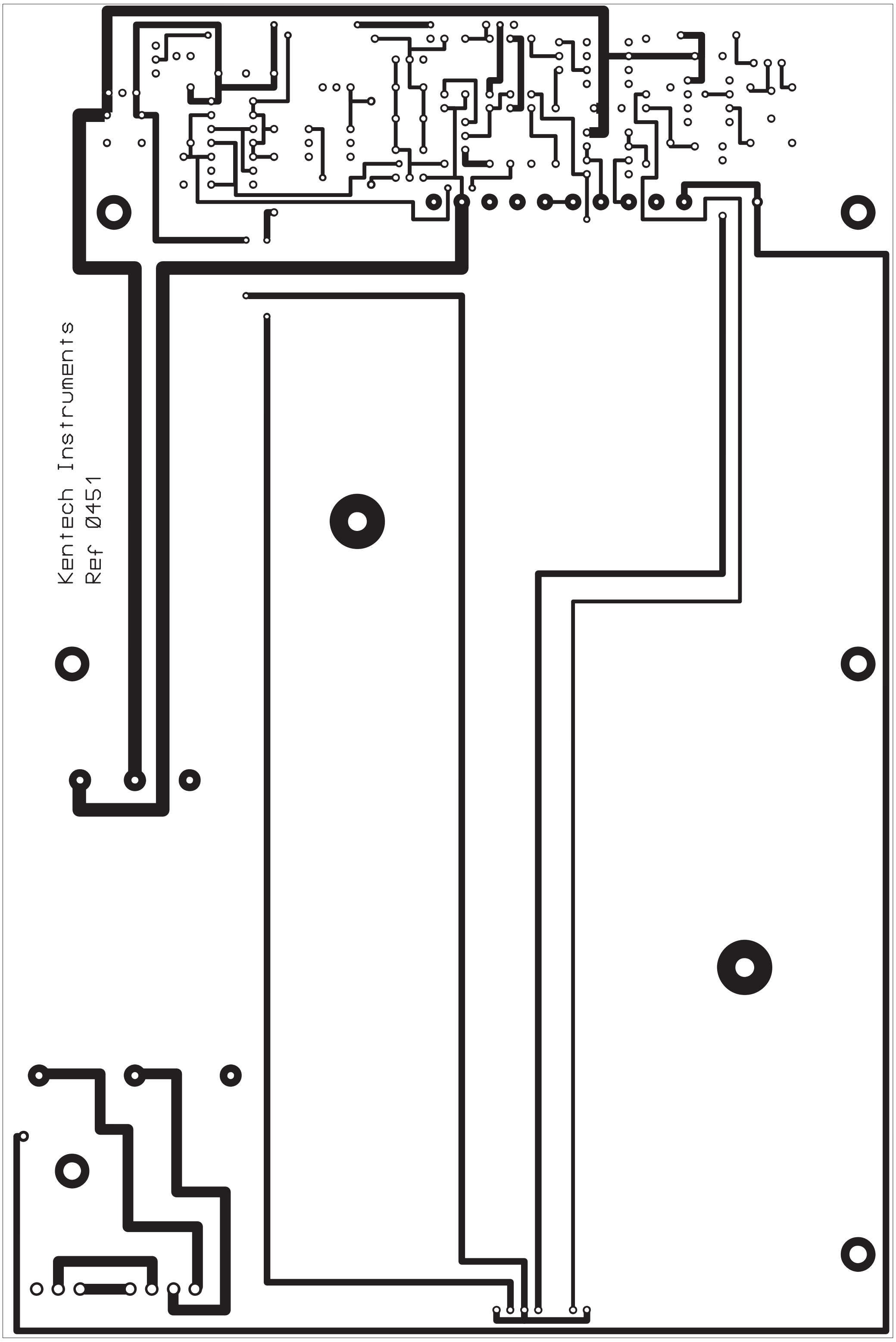


Figure 21 EHT board EHT tracks bottom

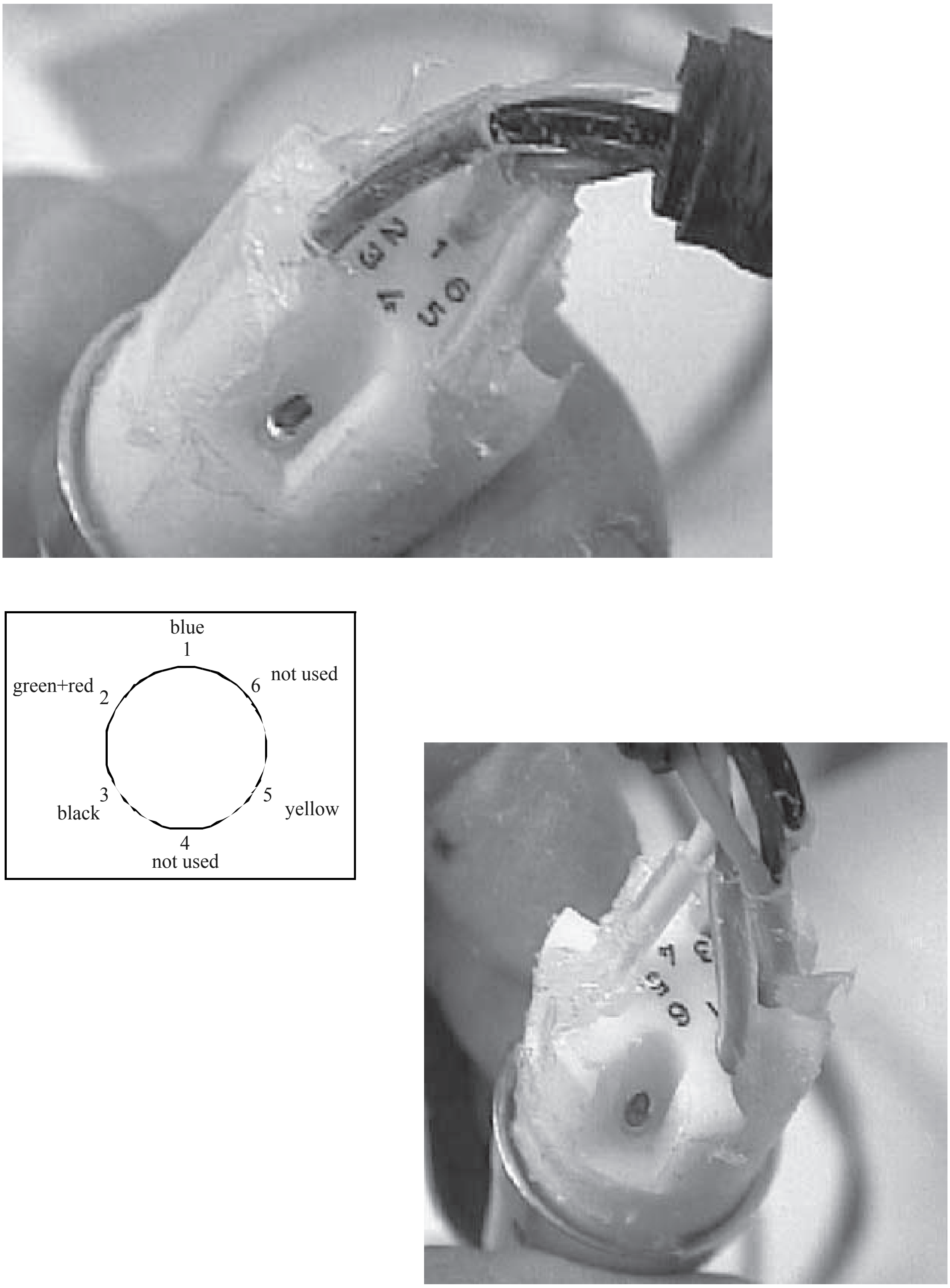
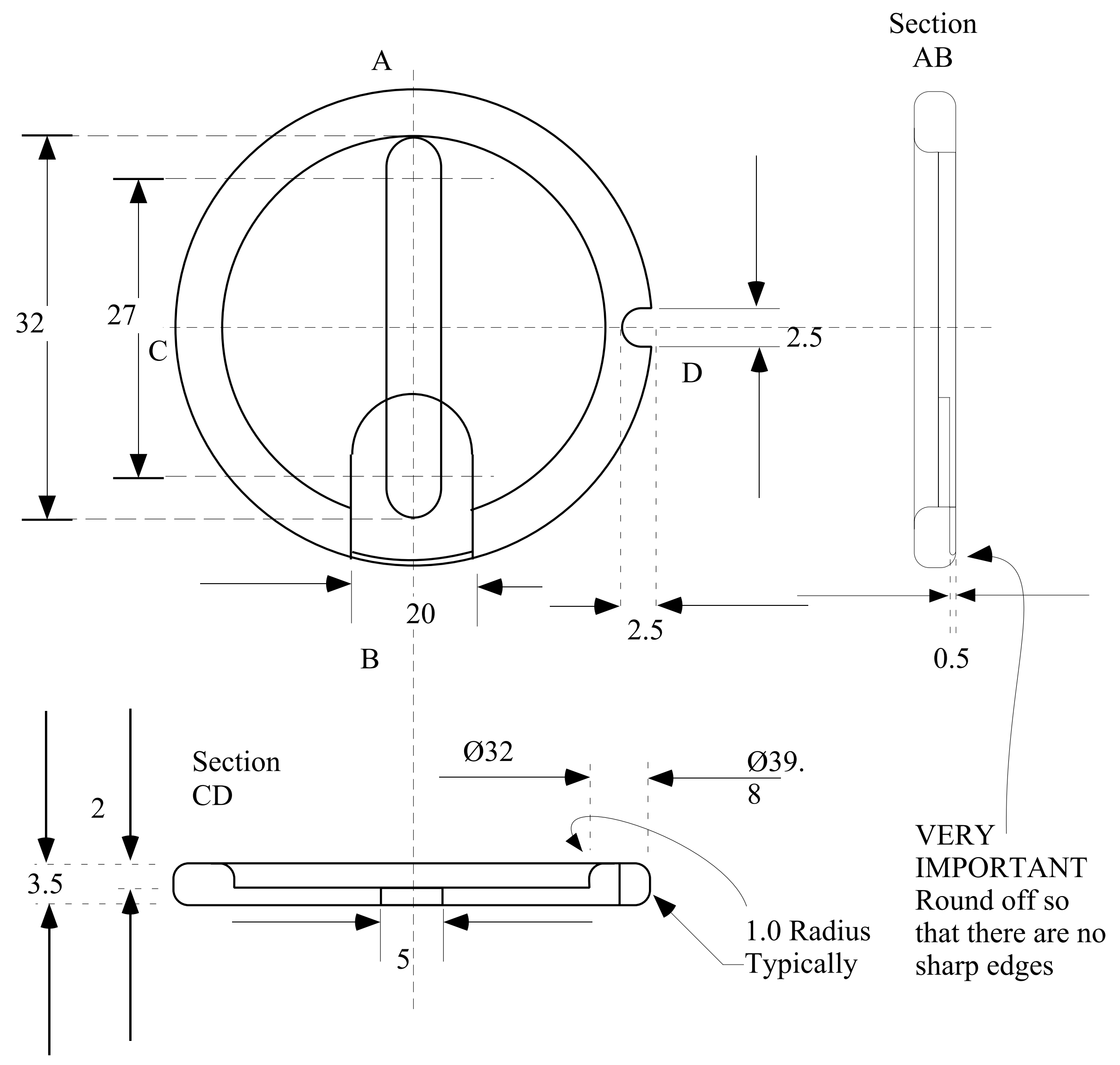


Figure 22 Intensifier lead pin out

4A0725	3RD. ANGLE PROJECTION



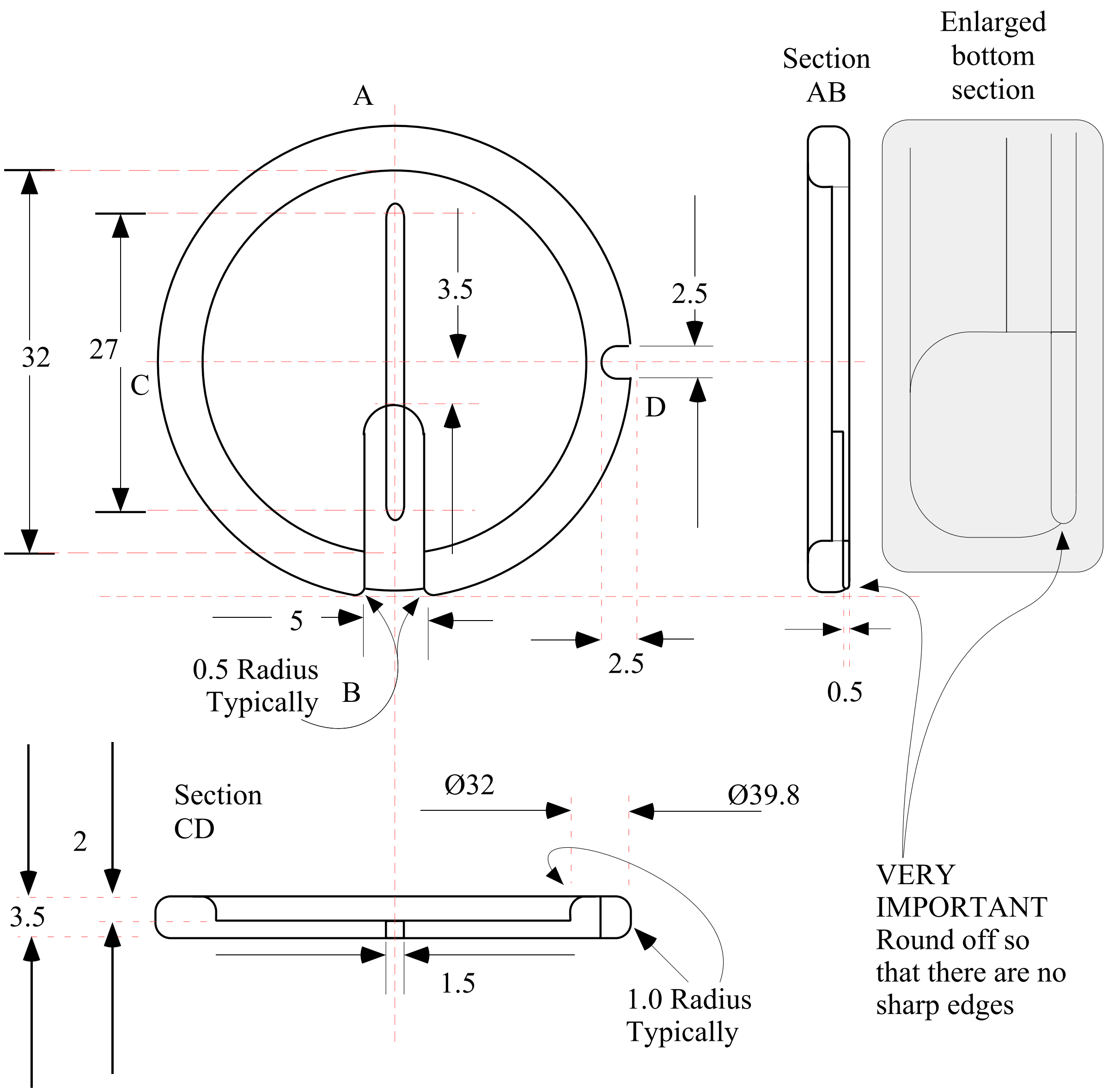
Issue	Date	MOD
E		
D	8-12-00	20mm slot depth added
C	4-12-00	Slot Added for grazing incidence
B	8-8-84	

SURFACE TEXTURE 1.6	TOL ±0.12	DRAWN AKLDB
MATERIAL BRASS NAVAL	FINISH CLEAN	
KENTECH INSTRUMENTS LTD.	SCALE 2:1	DIMS IN mm
Cathode for XRSC	4A0725	

Figure 23 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		A	12-2-2001
			Issue	Date	MOD
KENTECH INSTRUMENTS LTD.			SCALE 2:1	DIMS IN mm
Narrow, Low angle Cathode for XRSC			4A0102121	

Figure 24 Engineering drawing narrow slit and low angle of incidence option

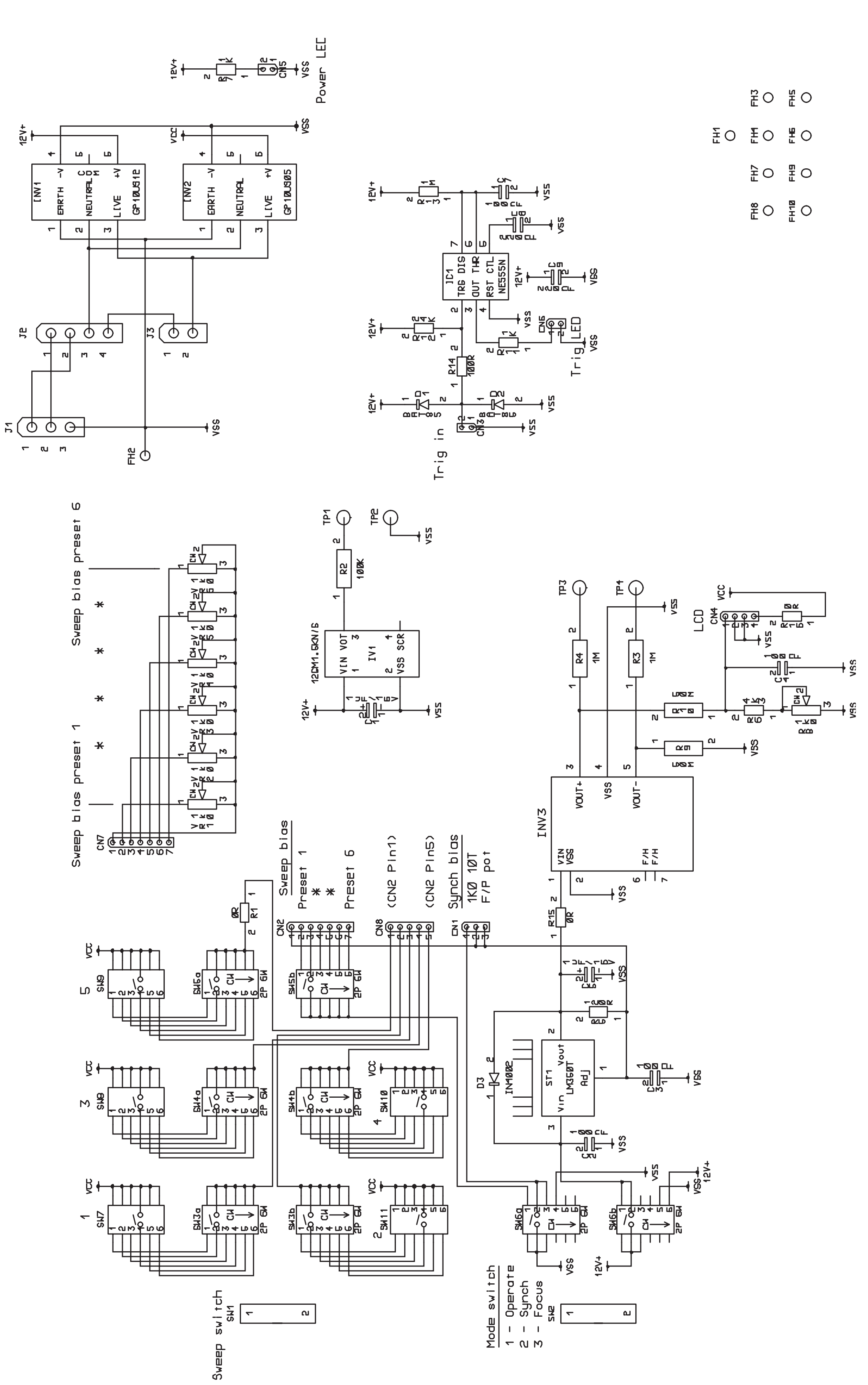
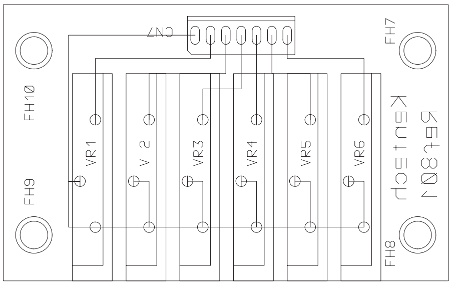


Figure 25 Sweep control unit circuit



Modifications to do the following:

1 Focus mode has no high voltage on sweep card. This inhibits bias and trigger.

2 Run 5 volt relays from 12 volt rail with series resistors near the relay coils. This reduces the effect of stray capacitance between the coils and contact on the positive ramp relays.

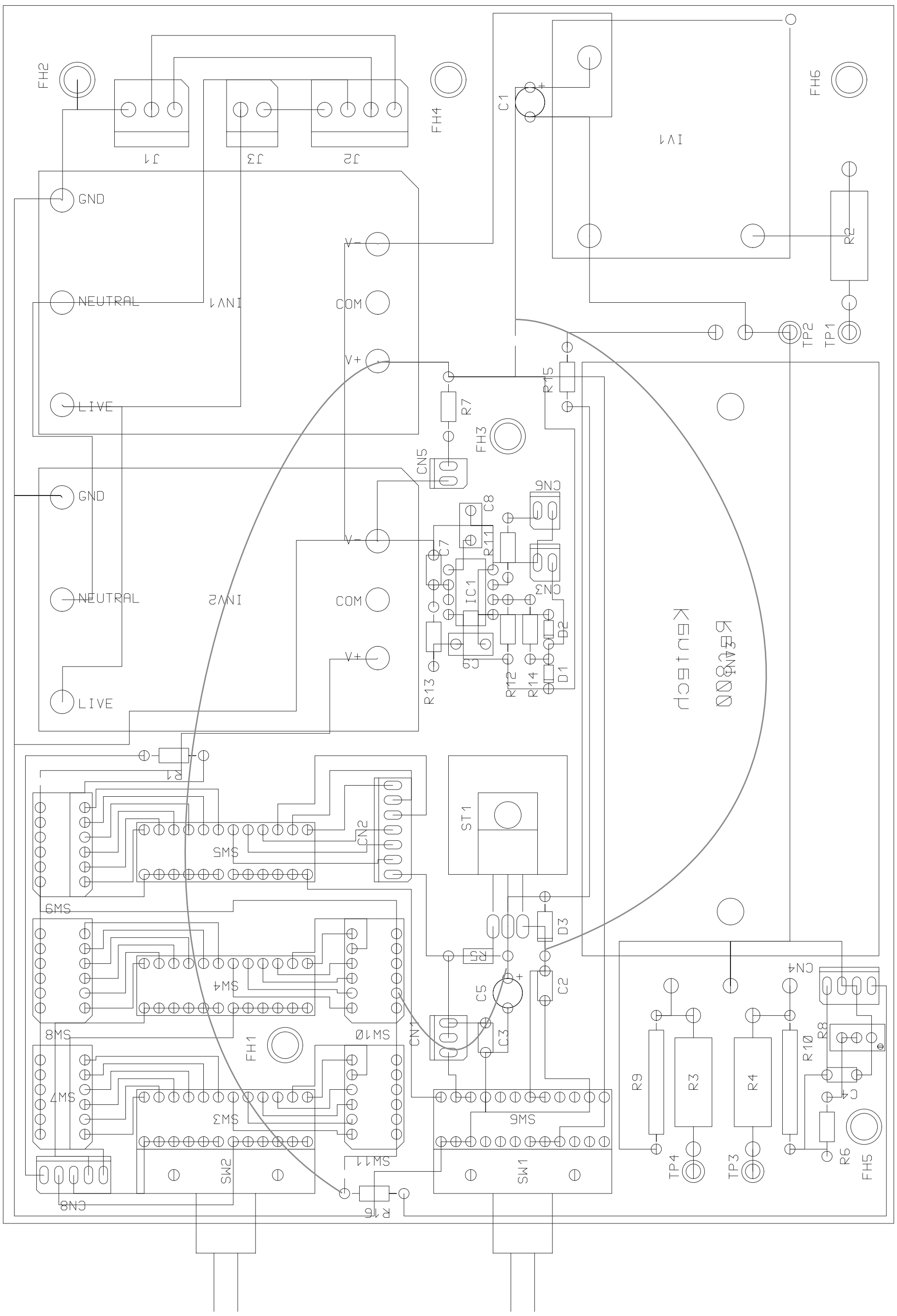


Figure 26 Sweep control unit layout and mods

8 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.
c	1	Nylon transit end cover
2	1	Clamp ring
3	3	Meshes
4	3	Slit plates
5	2	PTFE spacer rings
6	1	Focusing supply
7	1	Vacuum Interlock flying lead to lead Lemo 00
8	1	Film attachment comprising
a	1	Polaroid film holder
b	1	Film back for intensifier
9	1	Spare screws
10	3	IEC, US power lead
11	1	BNC to Lemo 00 Lead
12	1	Streak Camera manual
13	1	Image Intensifier assembly
14	1	Photek Intensifier Power supply.
15	1	Photek Intensifier manual
16	1	Sweep control unit

Items checked