KENTECH INSTRUMENTS, LTD

OPERATIONS MANUAL

for

COMPACT OPTICAL STREAK CAMERA

OSC12/25XX

Covering versions with the following options:

• Sweep and shutter modes
• External reducing intensifier
• Switchable sweep and shutter speeds

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Kentech Instruments Ltd., Unit 7, Hall Farm Workshops, South Moreton, Oxon, OX11 9AG, UK

Phone 0235 510748 FAX 0491 25067

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(i) FIGURE CAPTIONS

(ii) 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. accepts 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.

Under no circumstances should the camera be powered up with any cover removed.

IMPORTANT

Blanking is achieved via the micro-channel plate therefore the cathode is active all the time the camera is powered up. Protect the cathode from excessive continuous illumination WHENEVER power is applied to the camera.

1 INTRODUCTION

The OSC12/L is a micro channel plate intensified optical streak camera with a short trigger delay. It has an active cathode >25mm in diameter which is fibre optic coupled. The electro-optical magnification is x1.3 and the camera is very compact, being only 15cm along its optical axis. It is pictured in figure 1.

The camera has three modes of operation:

i) static image with MCP DC on (shutter mode, DC button pressed, no trigger input)
ii) static image with gated MCP (shutter mode, with trigger input)
iii) swept image with MCP gated (sweep mode with trigger input)

and may thus be used as a streak camera or as a fast gated image intensifier. Figure 2 is a block diagram of the camera. The turn off of the MCP is determined by the sweep trigger; the turn off occurring just as the image leaves the screen. The start position of the image can be set at screen centre (position control set to shutter/focus mode) or at the screen edge (position control set to sweep mode) to allow optimum use of the low trigger delay. The electrostatically focused internally intensified tube design gives a large number of pixels across the >25mm diameter cathode. The dynamic spatial resolution is typically >10 1pmm^{-1}.

The camera is of compact mechanical design and the fibre optic input/output format allows great versatility and facilitates simple coupling to a CCD readout.

The cathode responds to 850nm light which allows easy setup with a laser diode (not supplied).

The input window is electrically insulated from the (live) cathode and may thus be contacted to earth potential.

1(a) SPECIFICATIONS

Tube type:	Electrostatically focused, micro channel plate intensified streak tube. MCP gated. S25 or S20 input, P20 output, fibre optic input and output coupling. Internal off phosphor baffling.
Camera:	Polaroid® flat pack (suits 667 and 612 film).
Streak time window:	Twelve speeds in a 1-3-10 sequence from 10ns to 3ms
Trigger delay:	<20ns to first image motion
Sweep hold-off time:	<3ms
Ultimate time resolution:	Better than100ps
MCP gain rise/fall time:	10ns
MCP on/off gate triggers:	Internally derived from sweep trigger
MCP gate off contrast:	>10^6 at high gain
Power requirements:	120/240 V AC <100watts.
Optical length:	15cm +/- 0.5cm
PRF:	1 Hz.
Jitter:	<50p.secs.
Trigger requirements:	10V into 50Ω <5n.secs rise.

2 GETTING TO KNOW THE INSTRUMENT

2(a) PRINCIPLES OF OPERATION

The camera consists of an internally intensified streak tube compactly packaged with a high voltage supply and a pair of VMOS sweep boards. Figure 2 shows the main functional blocks in the camera. A polaroid camera is supplied.

Camera blanking is achieved by gating the internal micro-channel plate (MCP). The trigger signal is split to drive the sweep circuit and the MCP turn on circuit. There is an internal delay generator which is controlled by the sweep/shutter speed switch. The turn off is timed to coincide with the swept image leaving the phosphor. The shutter time is thus the same as the sweep duration.

In order to make best use of the rapid triggering of the sweep and gate circuits the sweep should starts close to the edge of the phosphor.

Figure 3 shows the connections to the camera.

The camera has an AC supply and can operate from 120V AC or 240V AC.

Figure 4 shows the mechanical layout of the camera and figure 5 shows the layout of the streak tube. Figure 6 shows the mounting plate footprint.

2(b) THE HIGH VOLTAGE SUPPLY

The phosphor of the streak tube is grounded potential and all the other static voltages are derived from a high voltage bleeder chain. The MCP output is approximately 3.5kV -ve with respect to the phosphor and this potential is fixed by a zener diode chain. The MCP gain is set by a string of switched zener diodes. In DC mode this zener string is biased continuously and in gated mode the voltage is pulsed. The MCP input is at the anode potential and the sweep plates are each biased symmetrically about this potential. The cathode is at approximately -10kV relative to the phosphor. The focus electrode is set approximately 150V +ve with respect to the cathode and this voltage is trimmed by the focus potentiometer in the high voltage divider box. The high voltage is obtained from a regulated DC/DC inverter. Figures 7 and 8 show the low voltage supply and high voltage divider network respectively.

Be sure not to press the DC button when there is a substantial signal on the photocathode. Moreover in this gated MCP design the cathode is active all the time the camera is powered up so take precautions to protect the cathode from excessive illumination before applying AC power.

2(c) THE SWEEP ELECTRONICS

The rapid trigger sweep circuit is a VMOS Miller integrator. The sweep speed is set by the charging current and the feedback capacitor. The sweep gate signal is generated by a high frequency trigger regenerator. There are two sweep boards; one each negative and positive. They are each powered from 3kV adjustable high voltage DC/DC inverters and are triggered from an input trigger regenerator. The regenerator is required to ensure that the sweep boards are triggered synchronously when there is a slow rising trigger pulse and it adds a delay of approximately 5ns. The trigger regenerator consists of a back to back pair of HF bipolar transistors. This regenerator also feeds the gate-off circuit. The sweep plate bias voltages are obtained from the high voltage bleeder chain and are coupled into the sweep ramps via decoupling components on the sweep boards. Figures 9, 10 and 11 show the positive and negative sweep circuits and trigger regenerator respectively.

2(d) THE MCP GATING ELECTRONICS

The MCP gate circuit consists of two fast switching circuits, one each for turn on and turn off. The circuits are each a pair of high voltage VMOS power transistors driven by an avalanche transistor. Each driver switches 1300V and has a delay of approximately 15ns. The voltage risetime into the MCP capacitive load is approximately 10ns. The turn off circuit is triggered from the sweep trigger regenerator via a switched delay generator. The switching is linked to the sweep speed switching. The turn on is triggered from the regenerator circuit. Figure 12 shows the MCP gating circuitry.

The gain is controlled by a parallel switched string of zener diodes which clamp the MCP voltage.

3 USE

3(a) CONNECTIONS AND MECHANICS

The input to the cathode may be fibre optic coupled. If this is the case then care must be taken to avoid excessive force on the input window. Should a slit be required it is directly contacted onto the fibre optic window. A slit and lens holder are provided which include a standard lens mount (Olympus bayonet). A standard lens is also supplied. If the user plans to couple the image to the cathode with fibre optics the slit mechanism can be abandoned and the slit defined by the positioning of the fibre on the input fibre optic plate. The area of the cathode outside the slit or fibre optic assembly should be screened completely from stray light, as the cathode is sensitive over a complete disc of >25mm diameter.

The camera has four mounting holes on its base but can be operated in any orientation if it is adequately supported. Figure 6 shows the mounting plate footprint.

The Polaroid® camera fitting may be removed allowing access to mounting holes which can be used to mount a CCD readout or reducing intensifier.

The required electrical connections are:

1 AC power supply
2 Sweep trigger signal (10V positive, 50Ω, approximately 5ns before first light reaches cathode)

3(b) CAMERA TRIGGERING

The MCP gate circuit and sweep circuit are triggered from a common input. The minimum pretrigger delay is ~20ns. The camera may be operated in DC mode by holding the DC button in. Be sure that the image on the phosphor is not excessively bright as this could damage the streak tube.

MCP gating is automatic and is triggered from the sweep trigger regenerator. There is a switchable delay generator which allows the MCP turn off to be set close to the end of sweep. This is desirable as a bright image at the end of the sweep could produce a background and degrade the data.

The sweep starts quickly after the receipt of a sweep trigger signal. The start position of the image determines the effective trigger delay as the image has to move onto the active area of the recording device before data can be taken. To minimise the trigger delay the image should be positioned close to or even on the active area of the detector. When the camera is set to sweep mode the start position of the image is just on the edge of the phosphor screen. When the position control is set to shutter mode there is no start position bias and the image starts at the cenre of the phosphor. Figure 13 is a timing diagram for signals within the camera.

3(c) TIMING SET-UP AND TESTS.

Camera timing tests are most conveniently accomplished using a laser diode light pulser and a variable delay generator such as a switchable cable delay box. The diode image can first be viewed in DC mode (with care having been taken to exclude all but the diode light from the cathode). The camera should then be set to shutter mode and the diode pulse located with a long shutter time. The shutter time can then be narrowed progressively while adjusting the delay to bring the diode pulse within the shutter window. The camera can then be set to streak mode and a streaked image of the diode pulse will appear. Changing the delay will move the image across the phosphor, indeed this is a convenient way to calibrate the sweep speeds. Be sure not to exceed a repetition rate of 1Hz or the gating circuits will not have time to recharge and spurious triggering will be observed.

Blanking is achieved via the MCP therefore the cathode is active all the time the camera is powered up. Protect the cathode WHENEVER power is applied to the camera.

Focusing tests.

The camera, with the recording device removed, should be set up with a resolution grid in intimate contact with the input fibre optic. A resolution grid on film can be conveniently and temporarily stuck to the input with a small drop of fine and clean oil. Ensure that the emulsion is towards the cathode. The MCP and sweep triggers need not be connected for this test.
A controlled and uniform light source should be used to illuminate the cathode.This may be a variable output microscope lamp with a diffuser and ND filters over the front. Typically ND1 and a diffuser should be used. This lamp should be placed approximately 1 metre from the imager and all other light sources should be excluded from the input by using a black tube.
A microscope should be set up to view the output. This can be an objective lens mounted close to the output. Take care not to scratch the fibre optic window.
In a dimly lit room (ie just enough light to manoeuvre) turn on the camera in the DC mode with the gain set to minimum. Depress the DC button and gradually turn up the lamp until a dim image is seen. Then turn up the gain by three stops and a relatively bright image of the resolution mask should be present on the output.
Ensure that the camera is able to resolve at least 15 lpmm^{-1}. The camera may be focused by the potentiometer which sticks out of the high voltage divider box. The side panel must be removed for access. If this is to be adjusted take great care as high voltages are present in the camera body. **Do not attempt to make this adjustment with power connected to the camera. Disconnect the power cord before removing the covers, make a small adjustment and then replace the covers before observing the change.** This process should be iterated until best focus is achieved.

The adjustment should only be made with the camera turned off and the power disconnected. Also the camera should be left for two minutes after turning it off to allow high voltage capacitors to discharge.

Having set up this test an image may be recorded on film. Turn the camera off and remove the microscope. Replace the film back and arrange that a single trigger pulse can be applied to the MCP trigger input. In this mode the imager is gated on for several msecs after the receipt of a trigger signal.

To test the cathode spectral response a calibrated light source and a picoammeter are required. For this test the focus should be connected to the cathode and all other electrodes connected together. Consult one of our technical staff regarding making connections to the streak tube.

Dynamic test.

For this test a short pulse light source is required. A laser diode is most convenient although a single pulse mode locked glass laser can be used. The source should have a wavelength between 850nm and 380nm and should produce >10^8 photons per pulse. A >100mWatt peak power laser diode with a 100psec pulse duration is suitable. In both cases a pretrigger signal is required with a lead time >20nsecs which will allow the camera to be triggered from the same source. The sweep trigger should satisfy the trigger requirements in the specification. A variable delay (eg a switched cable delay generator) will be required.

Be sure to use the appropriate laser safety goggles.

Connect up the pulser, trigger source and delay such that the camera is triggered before the laser pulse strikes the cathode where the delay is set by the delay generator and is adjustable from approximately 15ns to (15ns plus the maximum sweep duration to be measured). The film back should be removed from the camera. The light source ideally will run at a repetition rate of 1Hz. Set up the source to run at 1Hz with the power level on the cathode at a minimum.

Take care that the power level is not so great as to burn the cathode. This is not a danger when using a laser diode. All other light sources should be excluded from the input.

Set the position control to shutter and the sweep/shutter control to sweep mode. Disconnect the trigger lead.

In a dimly lit room turn on the camera with the gain at minimum and the trigger disconnected. Depress the focus button and turn up the source brightness until a dim image is seen. Turn the gain up three stops and a relatively bright image of the slit should be present on the output. This establishes a reasonable exposure level for the test.

Now refer to figure 13 for the timing required for the dynamic test. Initially the centre bias position should be used (position switch set to shutter mode). In this mode the coarse timing will be easy to find. Reconnect the trigger cable. In a dimly lit room turn on the camera and with the source intensity and gain setting as in the previous section scan the delay until an image is seen to move across the screen with changing delay. Set the position control to sweep mode and find the time delay for the image to just start moving.

The sweep speed may now be measured by recording a series of images on one piece of film with the delay increased by a known and fixed amount between each exposure. The recorded image will be a series of images of the slit separated by the chosen delay. A similar measurement may be made by using a mode locked pulse train with a fixed time delay between each pulse.

The trigger delay can be measured by comparison of the arrival of the trigger pulse at the camera with the arrival of light at the cathode, conveniently measured with a photo-diode. The gate off can be observed by setting the controls to shutter mode and increasing the delay until the image disappears due to the MCP turning off.

4 SPECIFICATION SHEETS

4(a) Data sheet

This apparatus is set for 120 / 240 V a.c. operation. (Delete as applicable)

Camera type	………………………………………
Camera number	………………………………………
Customer	………………………………………
Date tested	………………………………………
Cathode type	………………………………………
Sweep lengths	…………………………………………
Shutter durations	…………………………………………
Extra equipment	…………………………………………

5 REDUCING INTENSIFIER

This camera is supplied with a reducing intensifier. This provides gain and low distortion reduction for coupling to electronic readouts. The reduction ratio is 0.32. The photon gain in the tube is ~X4 and the area demagnification is 10:1 which gives a radiant gain of ~X20. This is ~100 times better than an f/1 lens. The intensifier and power supply package are illustrated in figure 14.

The input aperture is 50mm and the output is 16mm in diameter. The windows are both fibre optic faceplates.

The intensifier contains a high voltage power supply and is powered from ~24V which is available from the auxiliary power output on the side of the OSC12 camera. This connector is a threaded coaxial type (TNC).

There are a power switch, a power indicator, a TTL active low enable input and a power input on the intensifier power supply box. The enable input is normally grounded (active) with a terminator which is supplied with the intensifier. This can be removed for remote switching of the intensifier. The rise/fall time of the supply is ~5second and it is not intended for gating purposes. Figure 15 shows the controls.

The inensifier is mounted on the phosphor output of the OSC12 camera via the same mounting holes as the Polaroid camera holder. The mounted intensifier is shown in figure 16.

To remove the Polaroid mechanics first remove the Polaroid camera. Unscrew and remove the horizontal bar which restrains the film jacking lever. Unscrew the to long slide screws along with the carrier slides. There are springs on these screws which press the film onto the phosphor. Remove and store the Polaroid camera holder, jacking rings, screws and springs.

The intensifier can now be offered up to the phosphor. Take great care to mount the intensifier centrally to avoid scratching any of the fibre optic faceplates. There is a locating ring (~10cm diameter) on the mounting flange of the intensifier. This should locate in the recess surrounding the phosphor in the face of the OSC12. Insert and tighten the two cross head mounting screws provided. Connect the threaded connector to the auxiliary power outlet. Gently slide the intensifier tube around to make sure that it is flat against the phosphor output. It is lightly sprung against the phosphor.

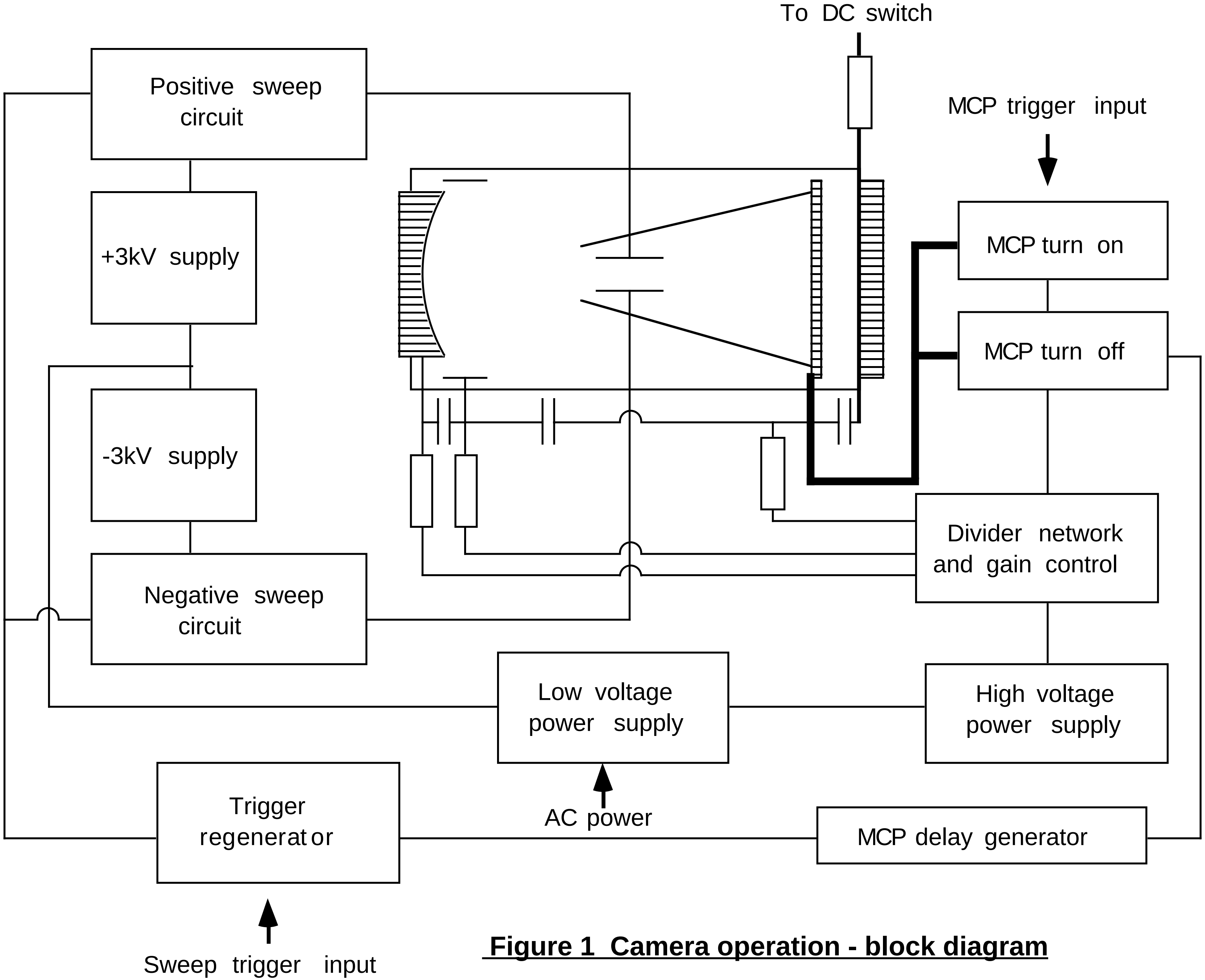

Figure 1 Camera operation - block diagram

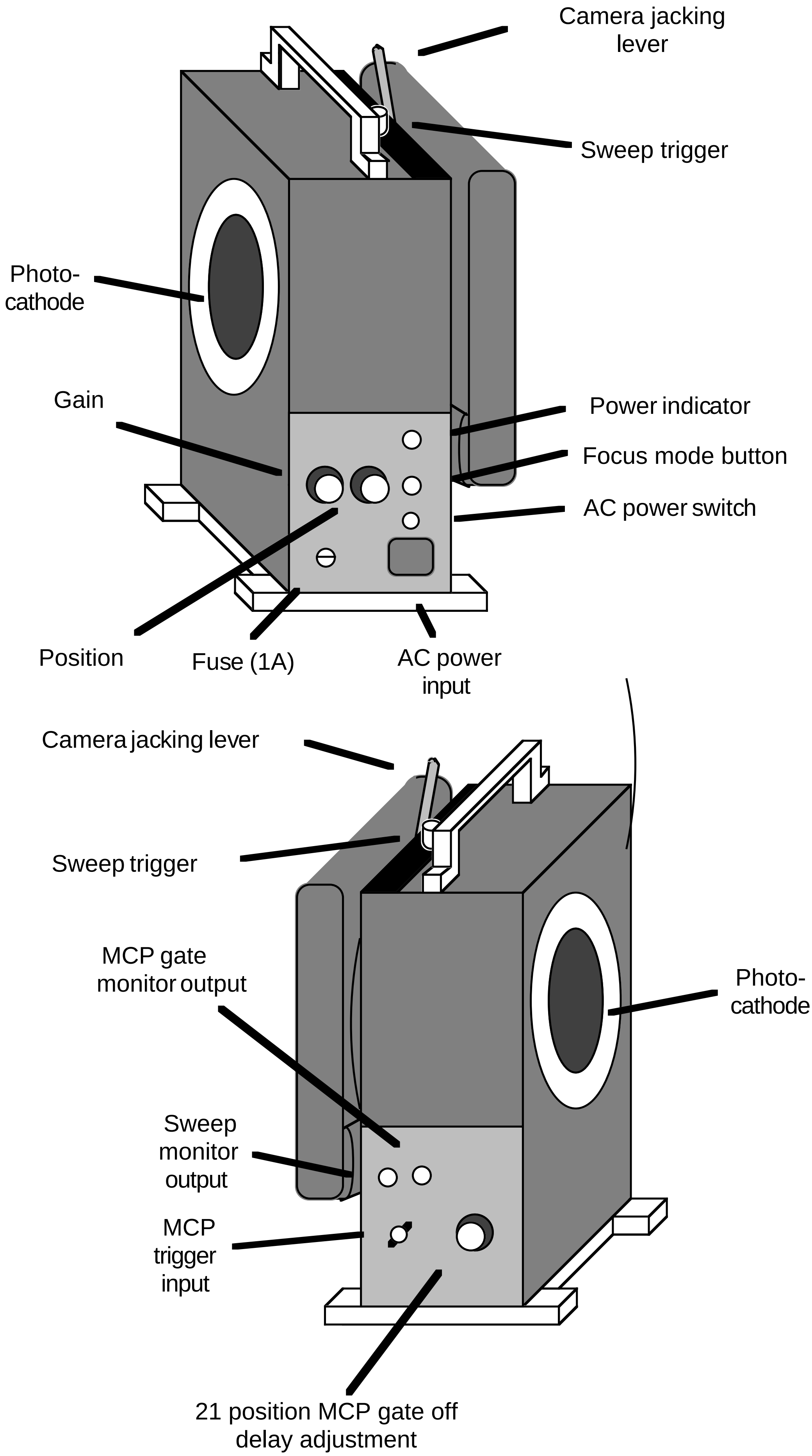

Figure 2 Connections to the camera

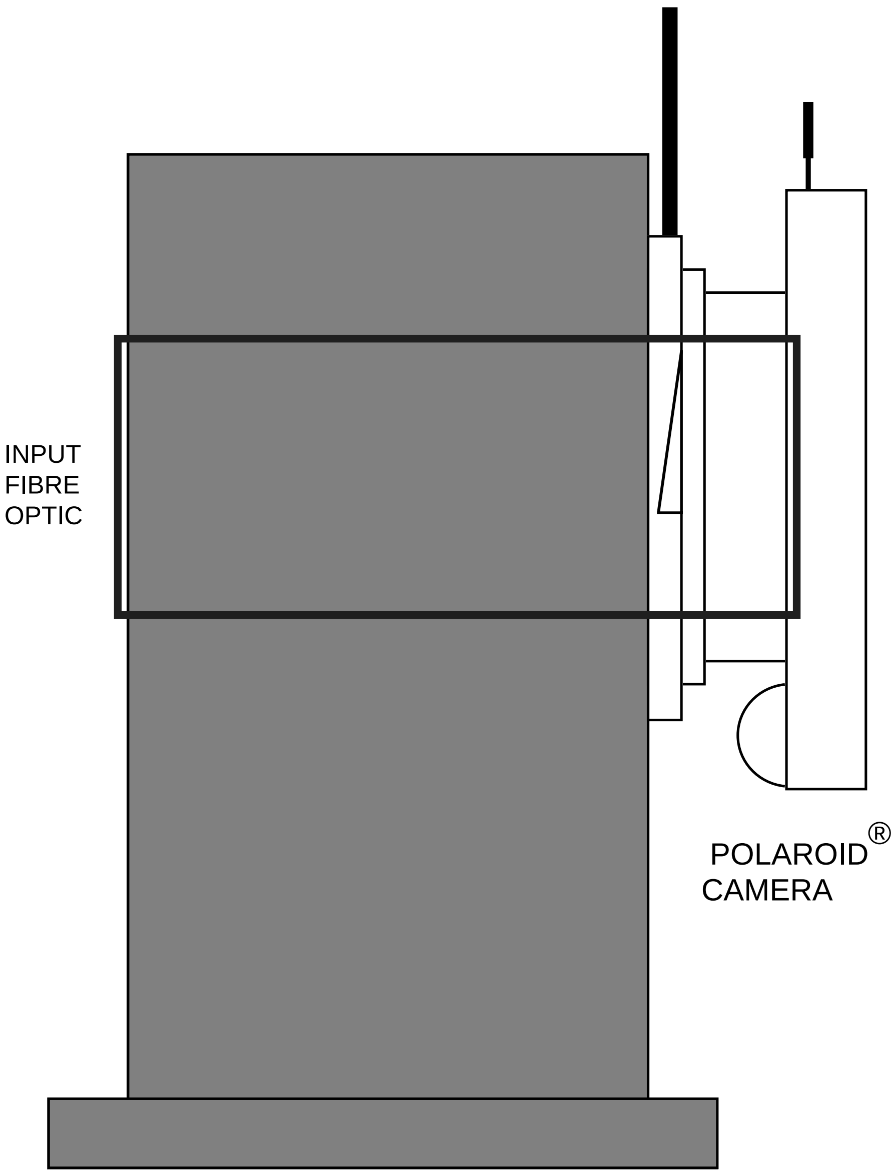

Figure 3 Mechanical arrangement

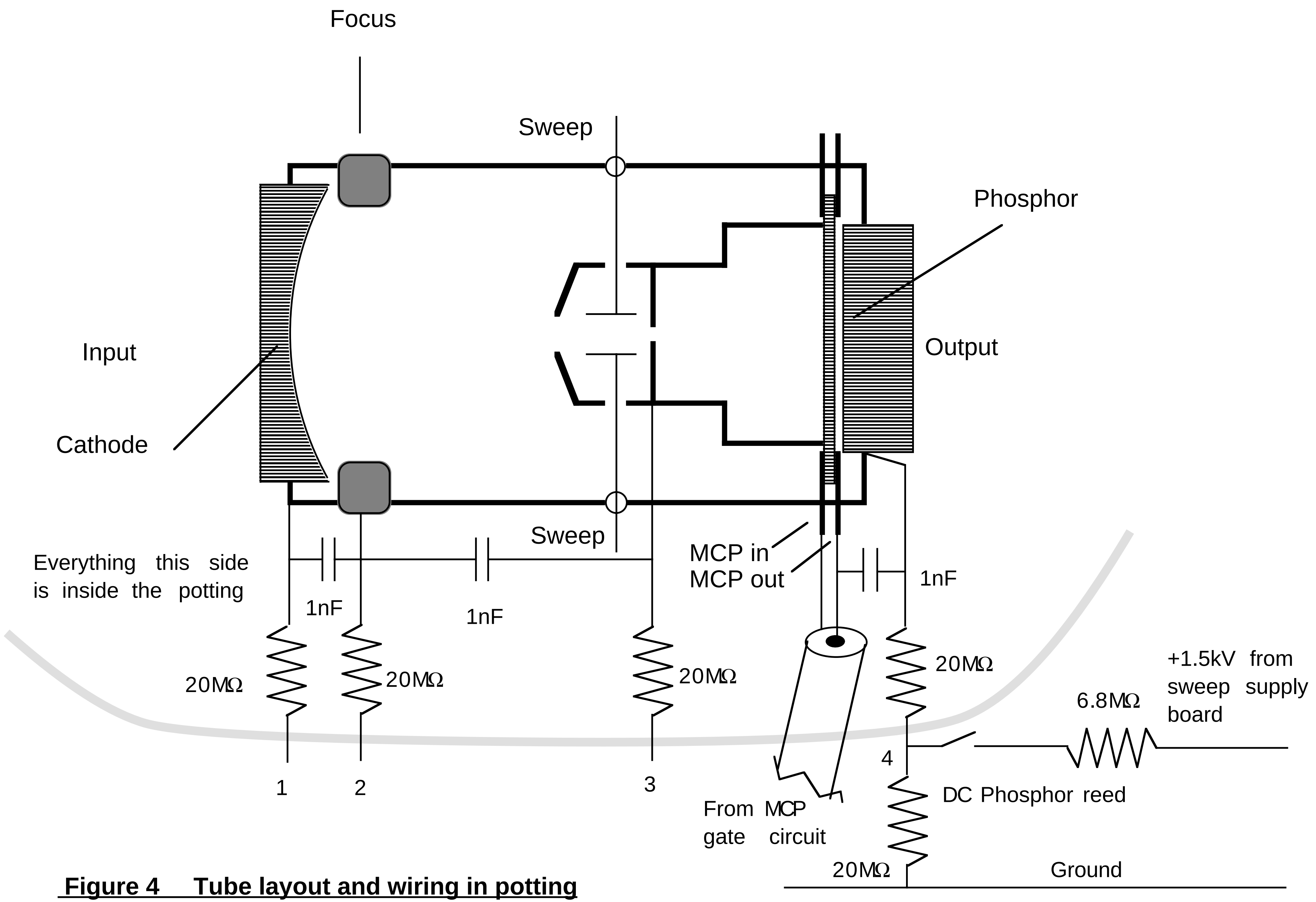

Figure 4 Tube layout and wiring in potting

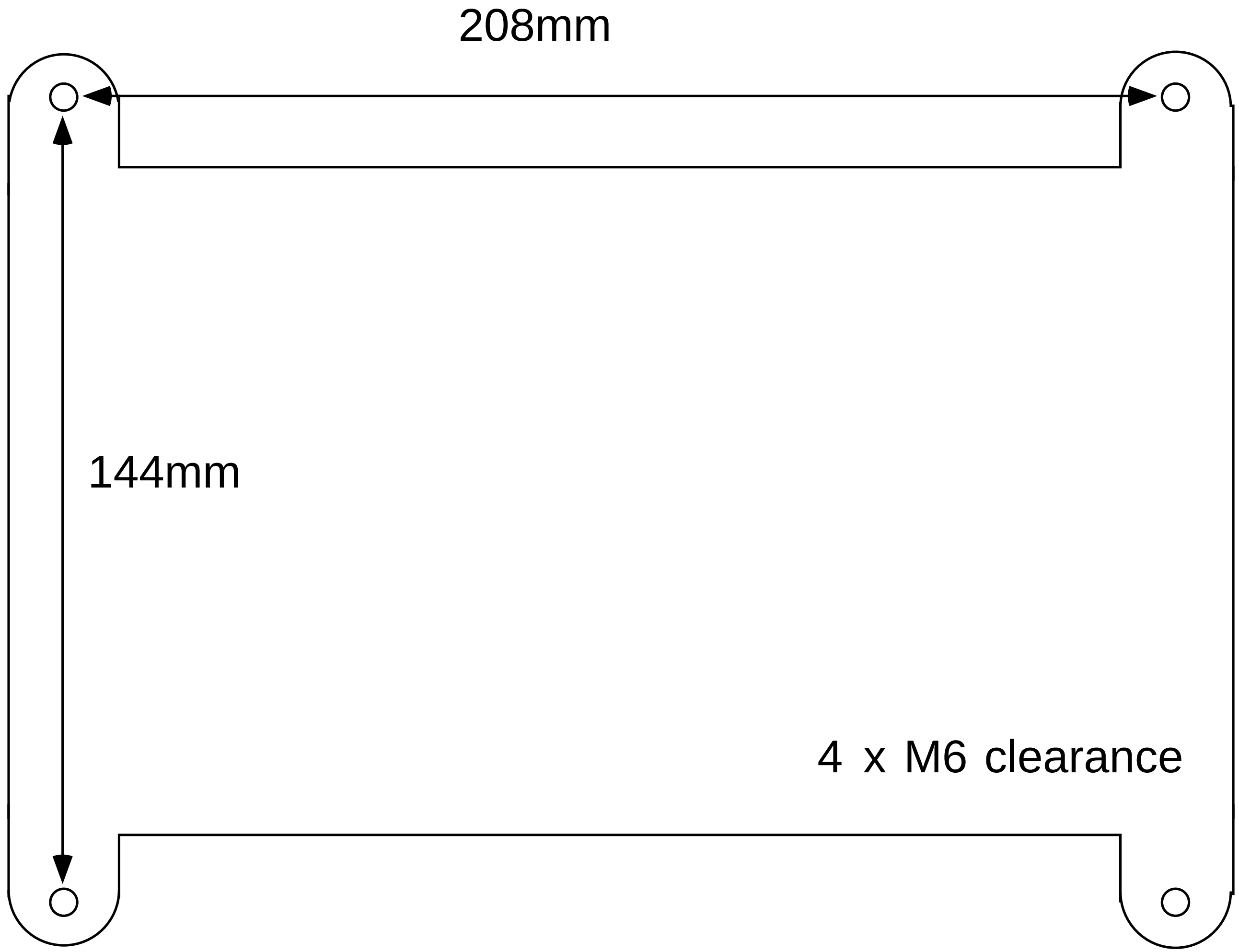

Figure 5 Mounting plate footprint

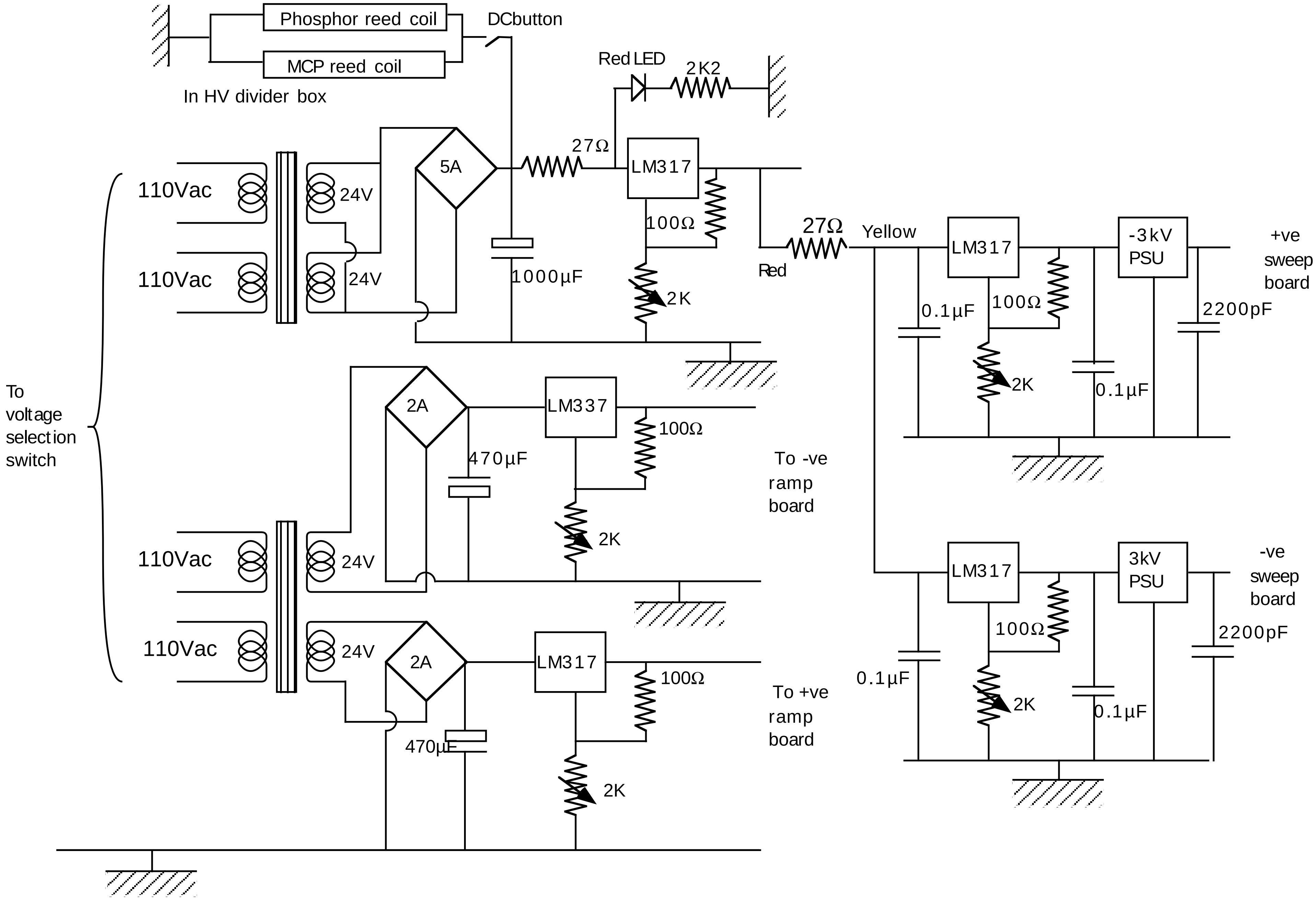

Figure 6 Power supply : low voltage circuit

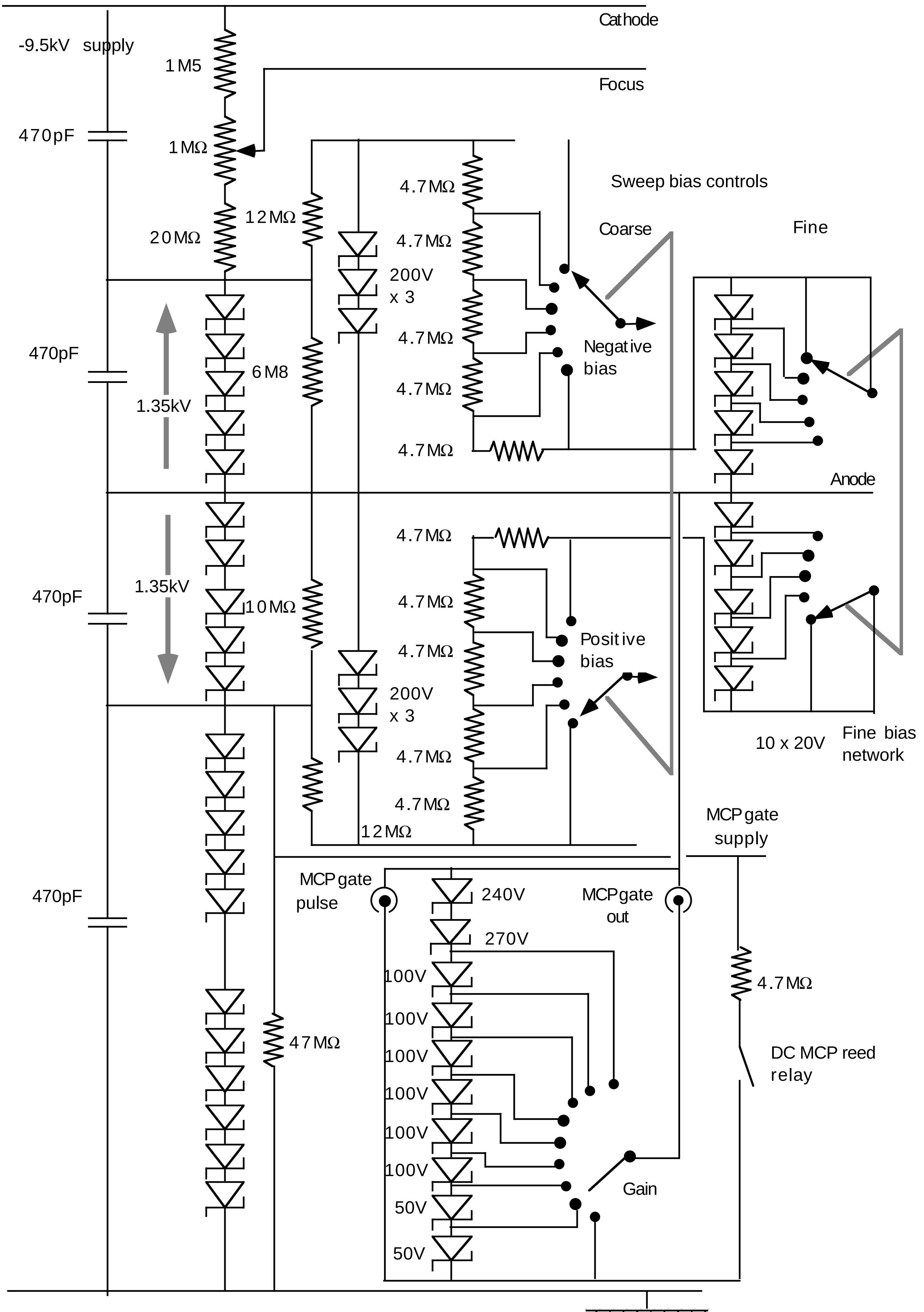

Figure 7 HV supply: divider network

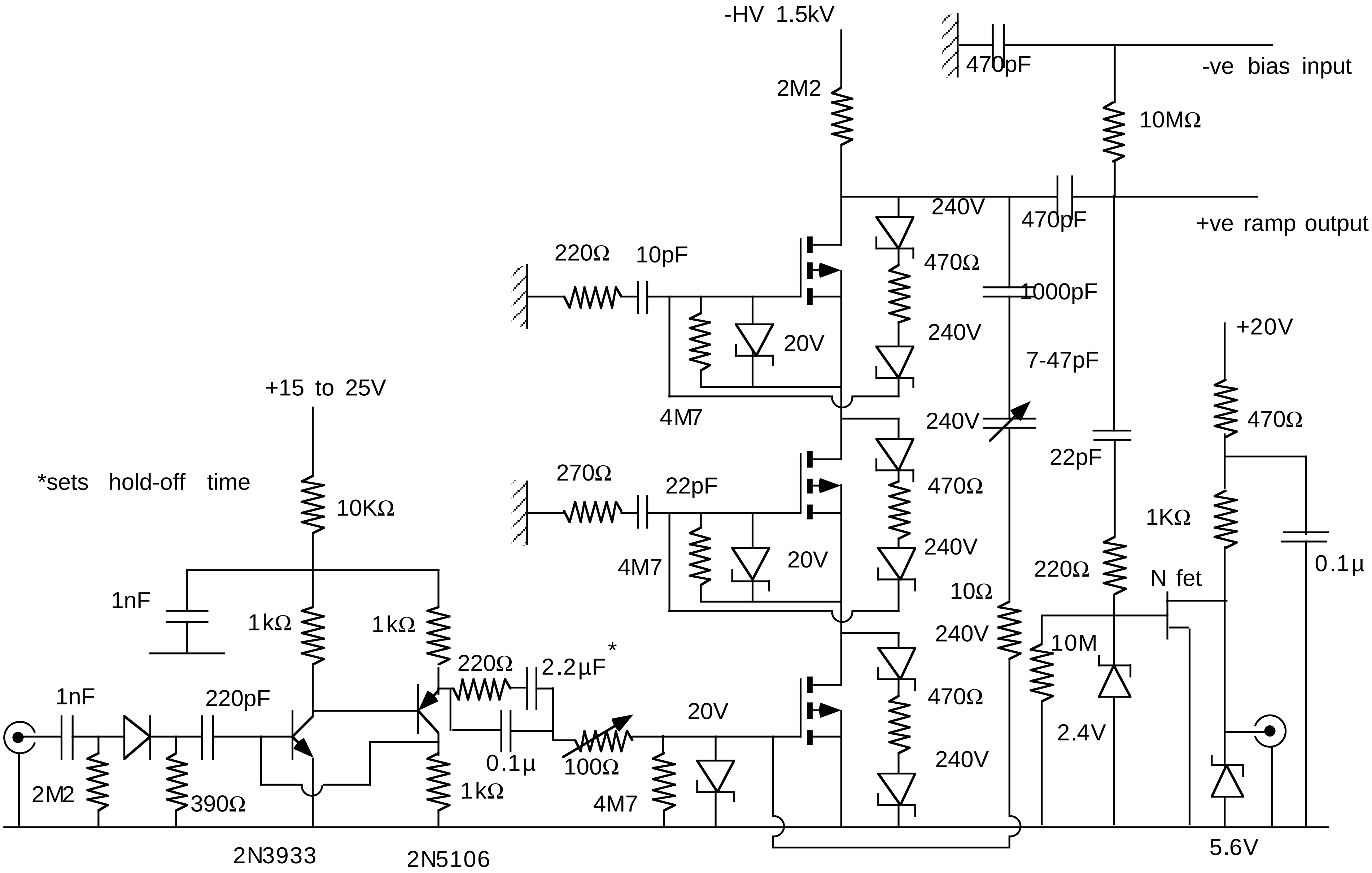

Figure 8 Positive sweep circuit

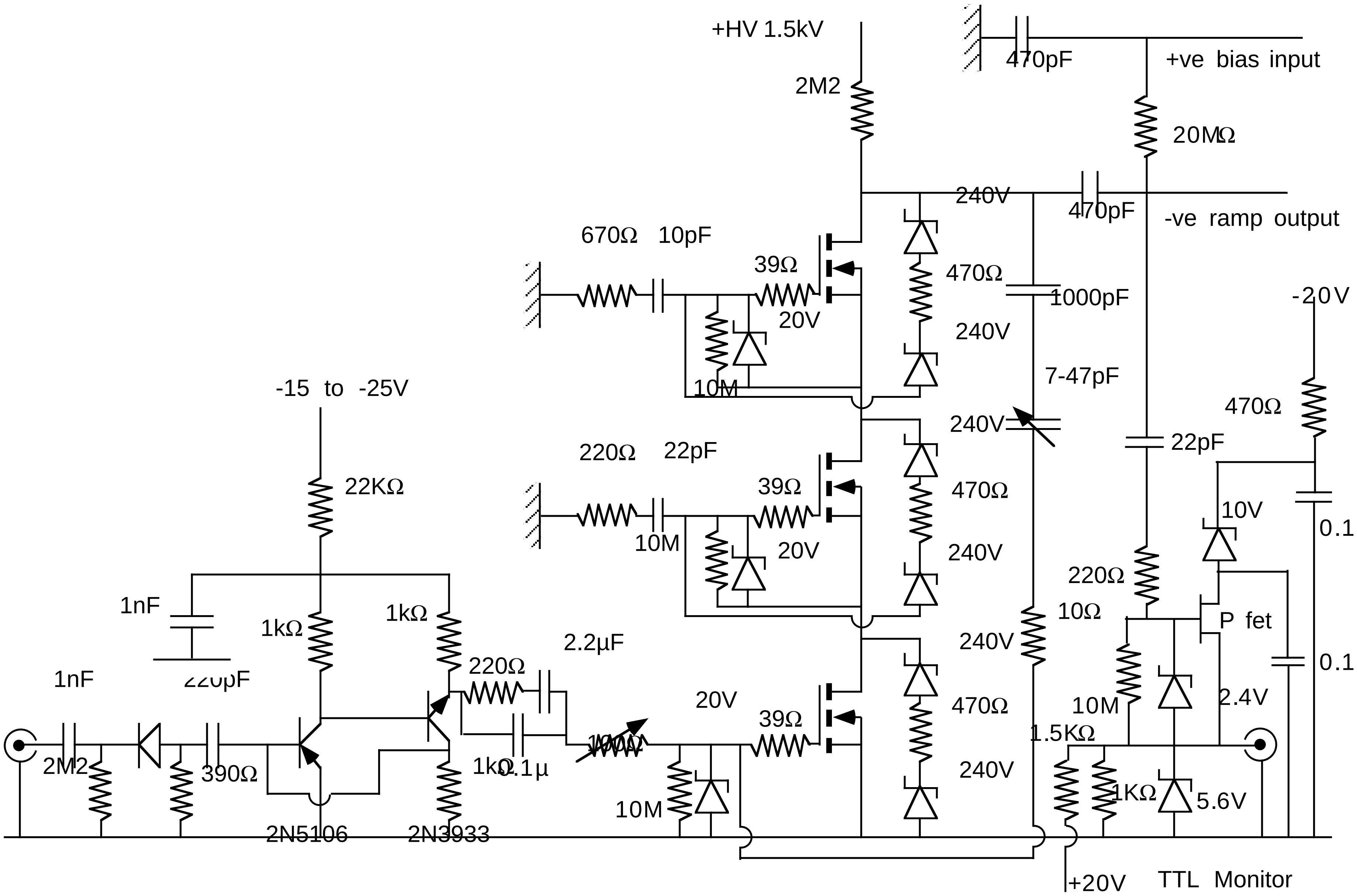

Figure 9 Negative sweep circuit

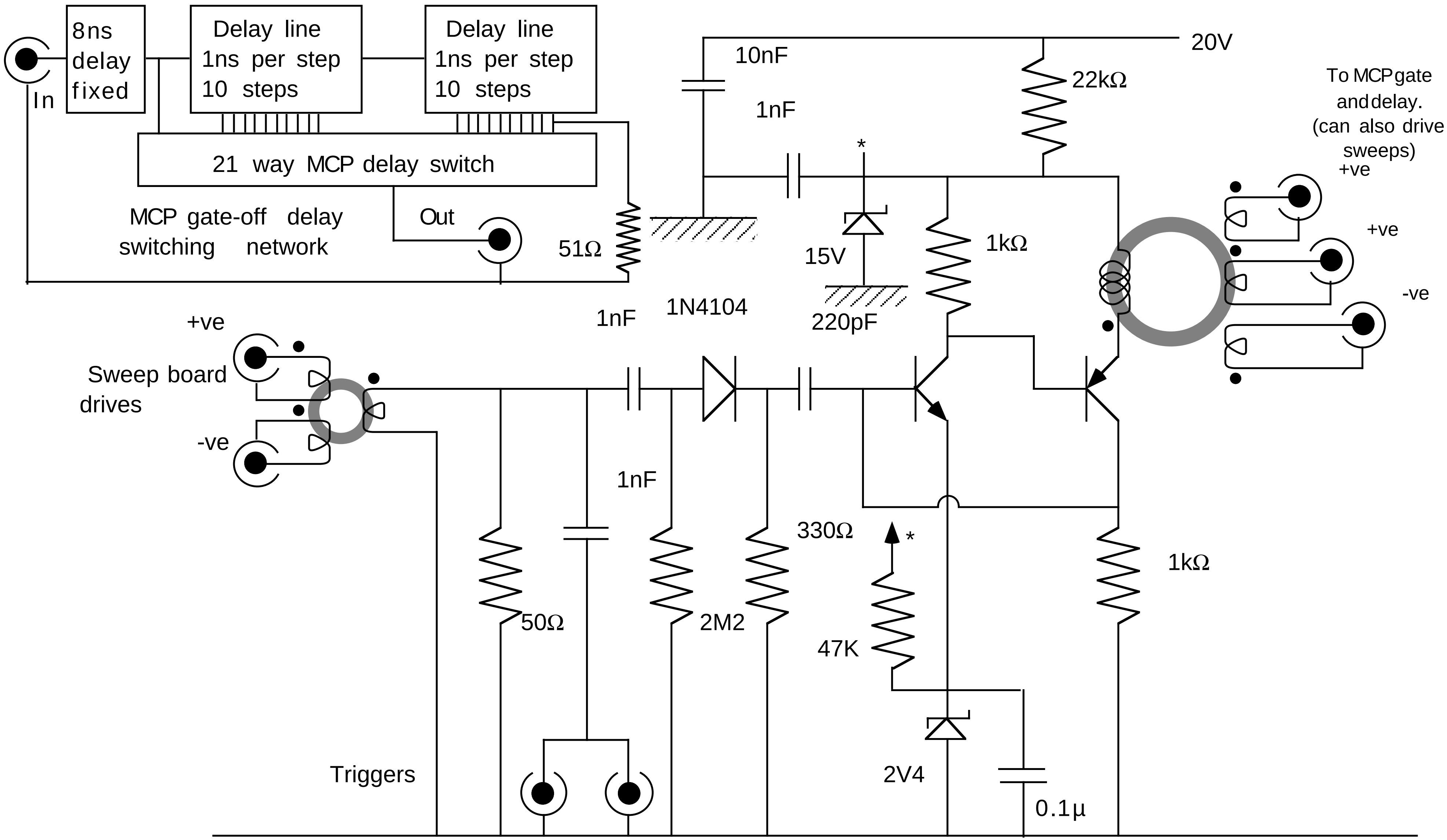

Figure 10 Trigger regenerator circuit

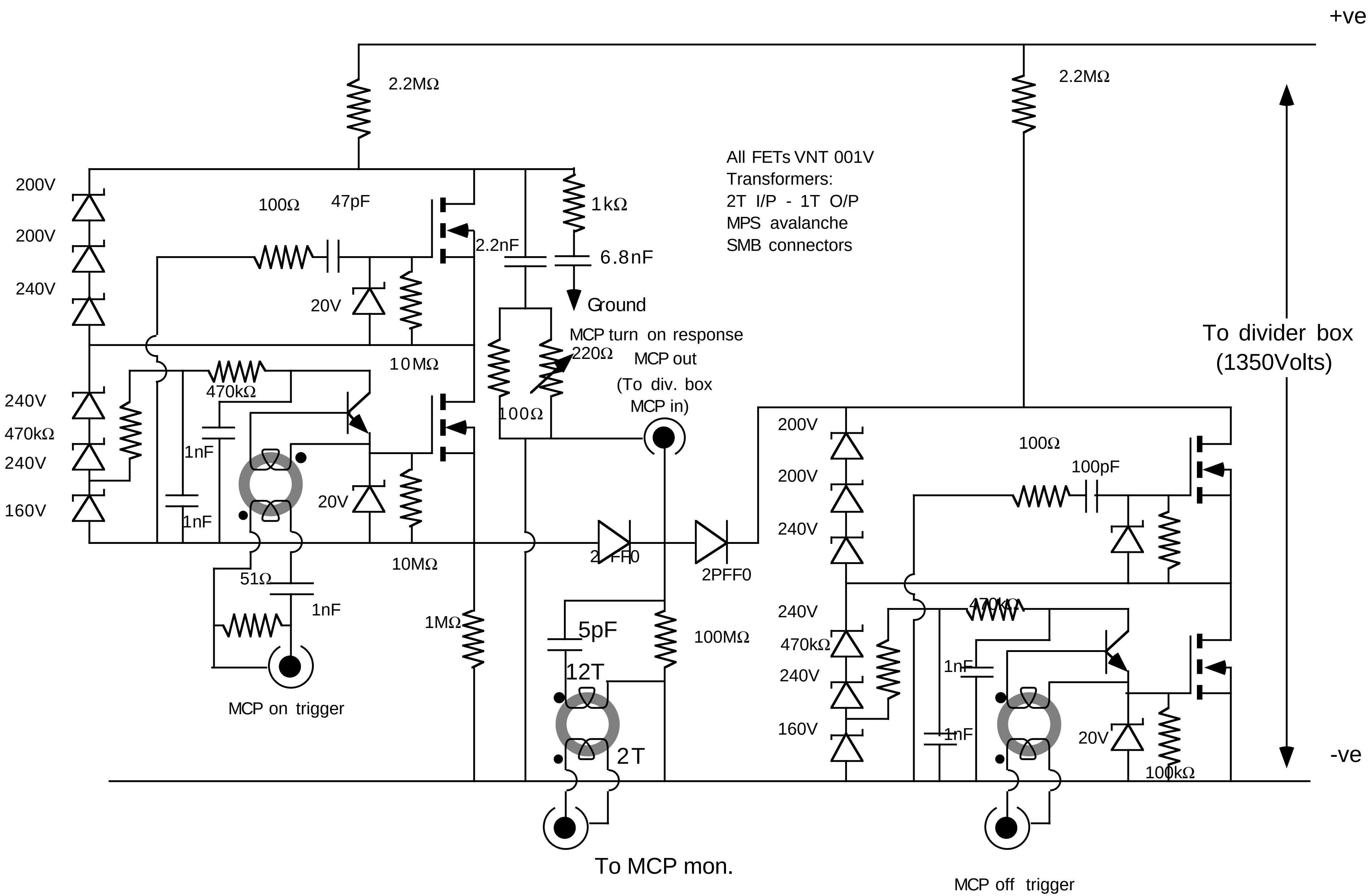

Figure 11 MCP gating circuit

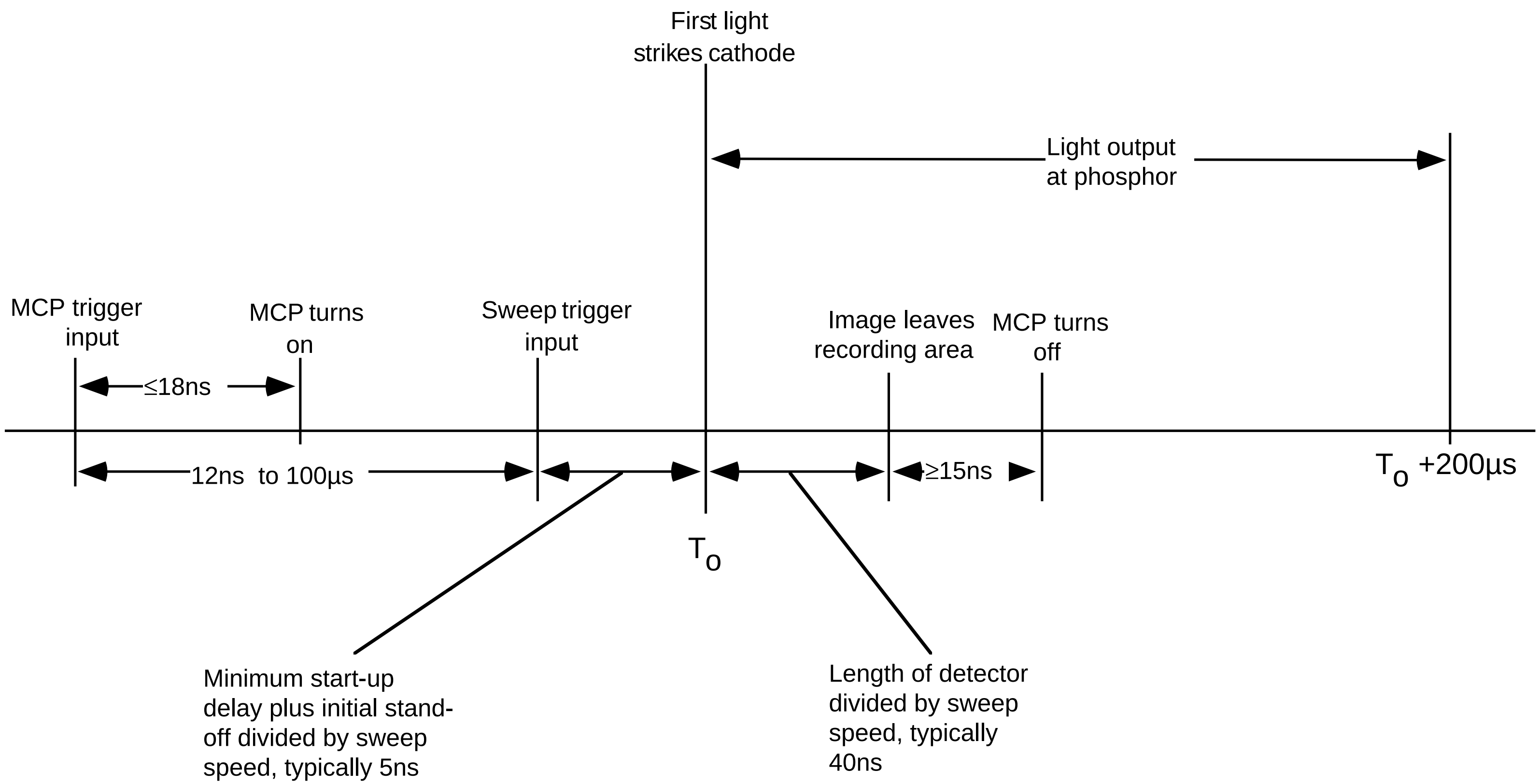

Figure 12 Timing diagram

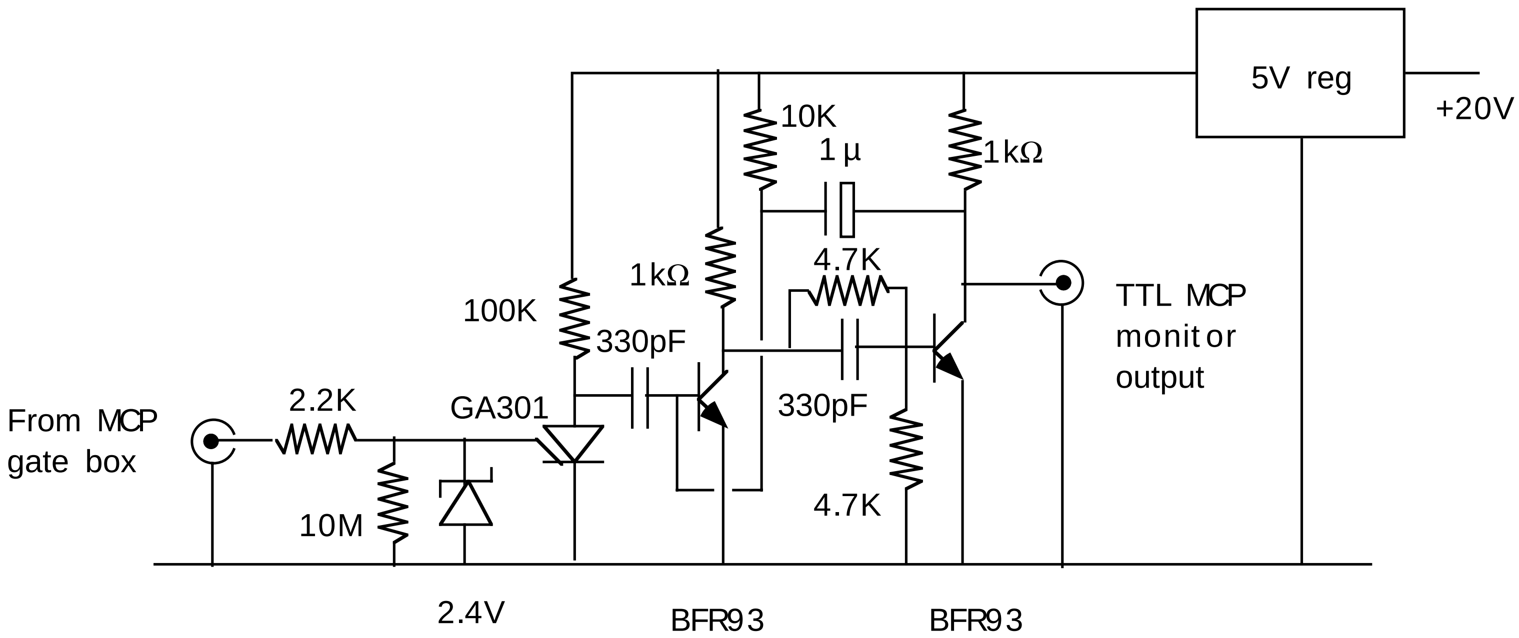

Figure 13 TTL MCP monitor network and buffer