Kentech Instruments Ltd.

Pockels Cell Driver

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Kentech Instruments Ltd., Unit 9, Hall Farm Workshops, South Moreton, Didcot, Oxon, OX11 9AG, U.K.

Figure Captions

PLEASE READ THIS MANUAL CAREFULLY BEFORE USING THE PULSER

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.

The manufacturers and suppliers 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.

Contents

1 INTRODUCTION

This manual describes the operation and use of the general purpose pockels cell driver.

1.1 SPECIFICATIONS

Voltage range	-2.5 to -8kV as a switch to ground device.
Maximum repetition rate	Depends upon the load. For around 120pF it is 100Hz. For larger capacitors is set by the RC charging time of the load, R~10MΩ.
Trigger input	3 volts 10ns f.w.h.m. into 50Ω.
Internal rate generator	Approx. 1Hz to 100Hz in two ranges.
Synchronisation Output	TTL approximately 30ns after trigger.
Main output	Switch to ground approximately 33ns after trigger.
Return output	This is connected to the high voltage supply via a 10MΩ resistor. It is also connected to ground via a 1nF capacitor and 50Ω. This will be at the same voltage as the main switched output before the switch is triggered.
Remote HT enable	This input needs to be shorted to activate the HT. An open collector device rated at more than 12 volts will work. The turn on delay is about 100ms. The turn off delay is about 500ms for a 200pF load. The HT may also be enabled via a front panel switch.
Power input	Universal 85 to 264 volts A.C. at 47 to 440Hz. 2 amp fuse, type T (anti-surge) This unit contains an auto-resetting thermal trip rated at 70°C Maximum average power consumption 25watts.
Connectors	
Power	IEC
Trigger input	BNC
Sychronisation output	BNC
Main output	SHV
Return output	SHV

Note The SHV connectors should not be used unmated, particularly at higher voltages.

Limitations of use	This unit uses a proportionally controlled High voltage supply. At higher repetition rates it will be necessary to increase the set voltage.

2 GETTING TO KNOW THE INSTRUMENT

The pulser consists of a trigger circuit, some logic and a high voltage switch. The trigger circuit processes the incoming trigger signal, prevents multiple triggers and amplifies the signal to trigger the main switch stack.

The trigger circuit also permits the use of an internal rate generator and a manual trigger, both intended for setting up use.

The logic controls the voltage on the main switch, drives the panel indicators and controls the high voltage enable signal.

2.1 FRONT PANEL CONTROLS, CONNECTIONS AND INDICATORS.

The front panel is shown in figure 1.

The internal rate generator is enabled by switching the mode switch to one of the two internal rate positions. The adjacent Rate control sets the rate within each range.

The manual trigger is only active when the mode switch is set to external.

The backlight control turns on the backlight to the panel meter which indicates the voltage at the top of the switch.

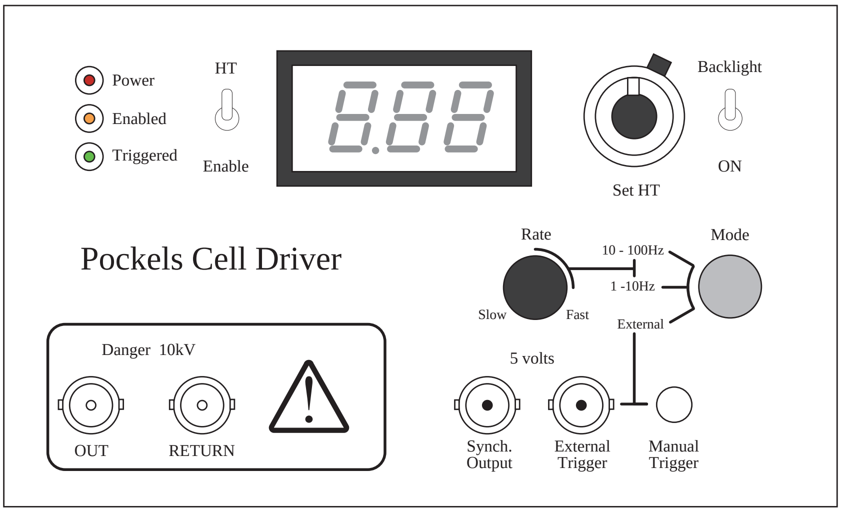

Figure 1 The front panel

Note also that the maximum repetition rate of 100Hz is only available for capacitive loads of around 120pF or less. More capacitive loads will take longer to charge and hence limit the repetition rate. In practice the unit may be triggered at up to 100Hz, independent of the load but the load capacitor may not have had time to recharge and so will not be at the voltage indicated by the panel meter when the triggering is removed. No damage will be done to the unit by switching larger capacitors, however, the stack is only turned on for about 80ns, so the load capacitor must be significantly smaller than 1.6nF for the voltage to be pulled down.

The HT enable switch turns on the voltage to the high voltage switch. The triggering circuit will operate even when this is off. The panel meter will only indicate the charge voltage when the HT is on. Note that this switch operates in parallel with the rear panel connector which can be used to control the HT ON/OFF state remotely.

There are three LEDs which indicate the Power On, the HT On and the trigger. Note that the unit can be triggered with the HT off. This is useful in setting up systems.

The HT voltage is set with a multiturn potentiometer. Its position may be locked. Allow the unit to warm up for several minutes before setting a voltage.

There are four front panel connectors. The trigger input, the synchronisation output, the main output and the return output. It is the main output that is switched to ground on receipt of a trigger signal. The return output remains at the pre-switched voltage. This is useful for biasing the other side of a capacitive load so that there is no net voltage across the device prior to triggering. Note that this requires that both sides of the capacitive load are able to float above ground to the required voltage.

With these connectors and the possible connection of an external capacitor the unit may be used in a variety of configurations.

2.2 REAR PANEL CONNECTIONS

The rear panel is shown in figure 2.

There are only two rear panel connections the power inlet switch and the remote HT enable. The power inlet is filtered and will accept IEC leads. It uses a universal supply that will run from a variety of voltages, both AC and DC, see specification.

The Lemo (size 00) socket requires to be short circuited to enable the HT supply. An open collector device with voltage rating in excess of 12 volts and minimal current capability can be used. If a pulse response is required it will be necessary fit a single transistor stage in open collector configuration across this input, see figure 3

3 USE

The pulser may be used in a variety of ways depending upon the application. The unit is basically a high voltage switch to ground through a 50Ω load resistor, and a high voltage power supply. The following indicate some possible configurations. It is assumed that the user is familiar with simple pulse forming techniques using transmission lines and passive components. We recommend that the total RC time of the discharge should be less than 80ns. If a significant current is flowing at 80ns after the trigger then as the switch tries to turn off the current will get diverted to the protective zenner chain and could damage it. In practice this means that the load capacitor should not be greater than around 1nF.

3.1 CONNECTIONS AND APPLICATIONS

Figure 4 indicates a variety of configurations. The pulser has two outputs the main switch to ground through a 50Ω load and a second labelled “Return” that is a connected to ground via 50Ω and a 1nF capacitor and to the HT via a 10MΩ resistor. Some of the configurations will require other types of termination of the cabling. It is important to note however, that in order to produce a pulse only half the charge voltage is available. i.e. up to 4kV.

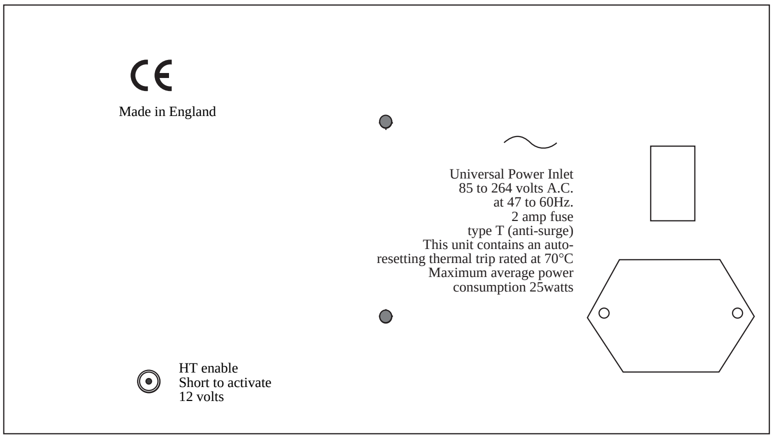

Figure 2 The rear panel

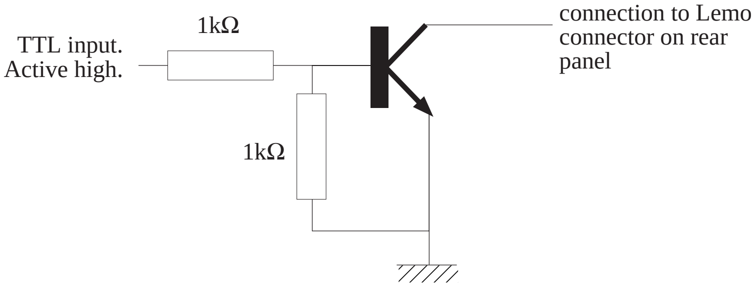

Figure 3 Conversion of TTL signal to Open collector drive for the HT

3.2 HIGHER REPETITION RATES WITH AN EXTERNAL POWER SUPPLY

The high voltage switch removes all the charge from the load capacitor at each shot (subject to this being possible in 80ns with the resistors used). After this time the load is recharged. The time constant for this is of the order of a few milliseconds but the peak charging current is such that the high voltage supply does not perform well, and recharging can take up to 50 ms giving a repetition rate of 20Hz. However, before the load is fully charged the switch may be fired again. The switch repetition rate is limited to ~100Hz in the trigger circuitry. Thus if high repetition rates are used it may become necessary to increase the HT to achieve the same effective switched HT. The user is also reminded that the total load capacitance may determine the maximum repetition rate and that 100Hz is only achievable for loads (including cabling) of around 120pF. The trigger circuit will work at up to 100Hz for any size capacitive load. With larger capacitors it is the RC time constant of the charging that limits the repetition rate, not a limitation of the switch, only of the built-in power supply. If the user is able to use an external power supply then the internal one can be inhibited and the external one used. Such a configuration is shown in figure 5. In this configuration the display will still indicate the applied voltage and the circuit will function as normal but with the extra repetition rate available from faster charging. The RC time of the external charging circuit should be made so that it is several time less than the desired interpulse period and certainly there is no need for it to be less than a few milliseconds. It should also be noted that the switch is only on for about 80ns. After this time it will switch off. Consequently the discharge time $50C_L$ must be less than 80 ns. C_L is the total load capacitance including the cabling from the main output to the load capacitor and also account may need to be taken of the reverse connection if made. It is important that the applied voltage does not exceed 9kV. The switch has zenner diodes across it to protect it but if enough current is forced through them they will fail and lead to failure of the whole switch.

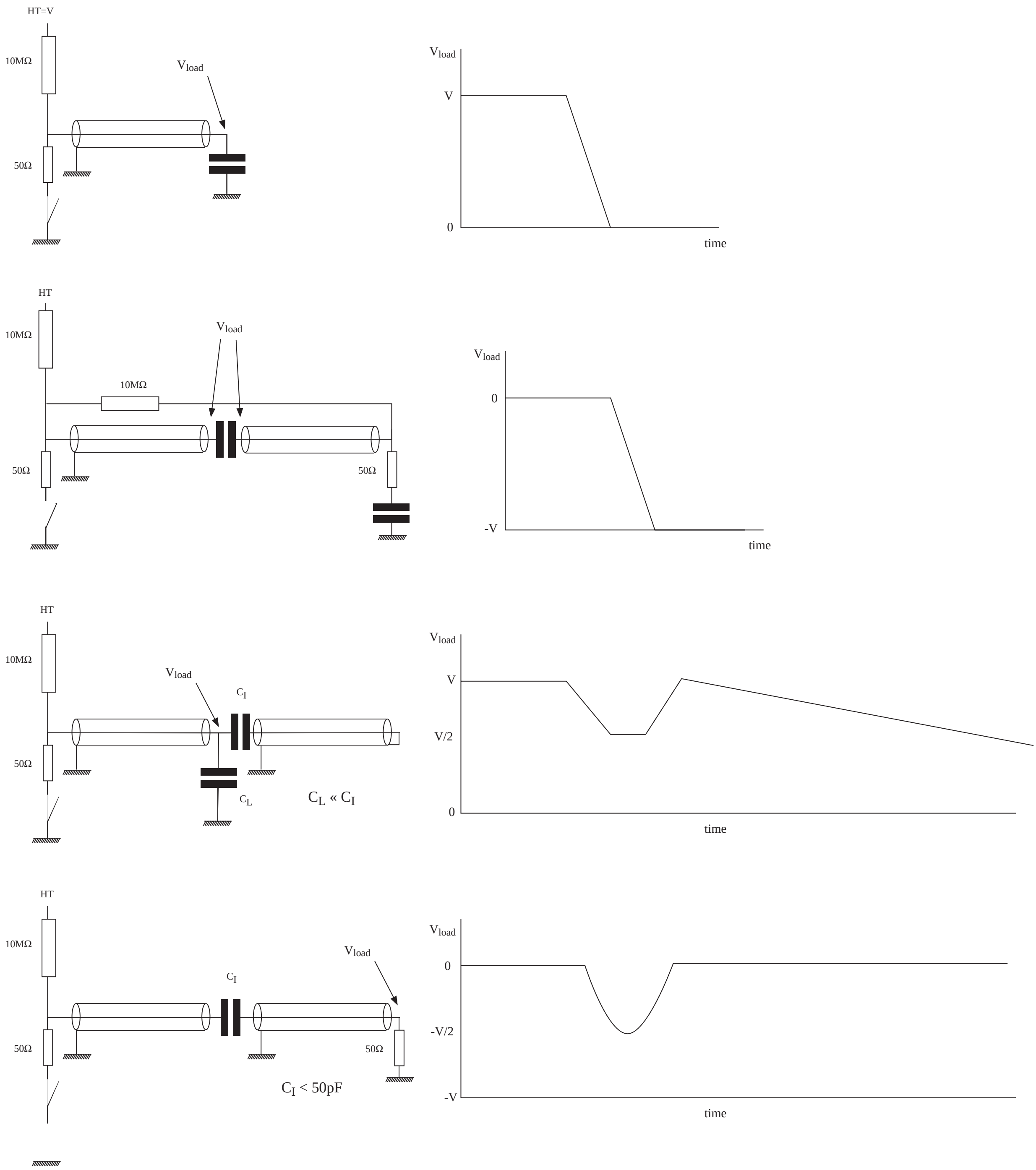

Figure 4 Some possible configurations of the pulser.

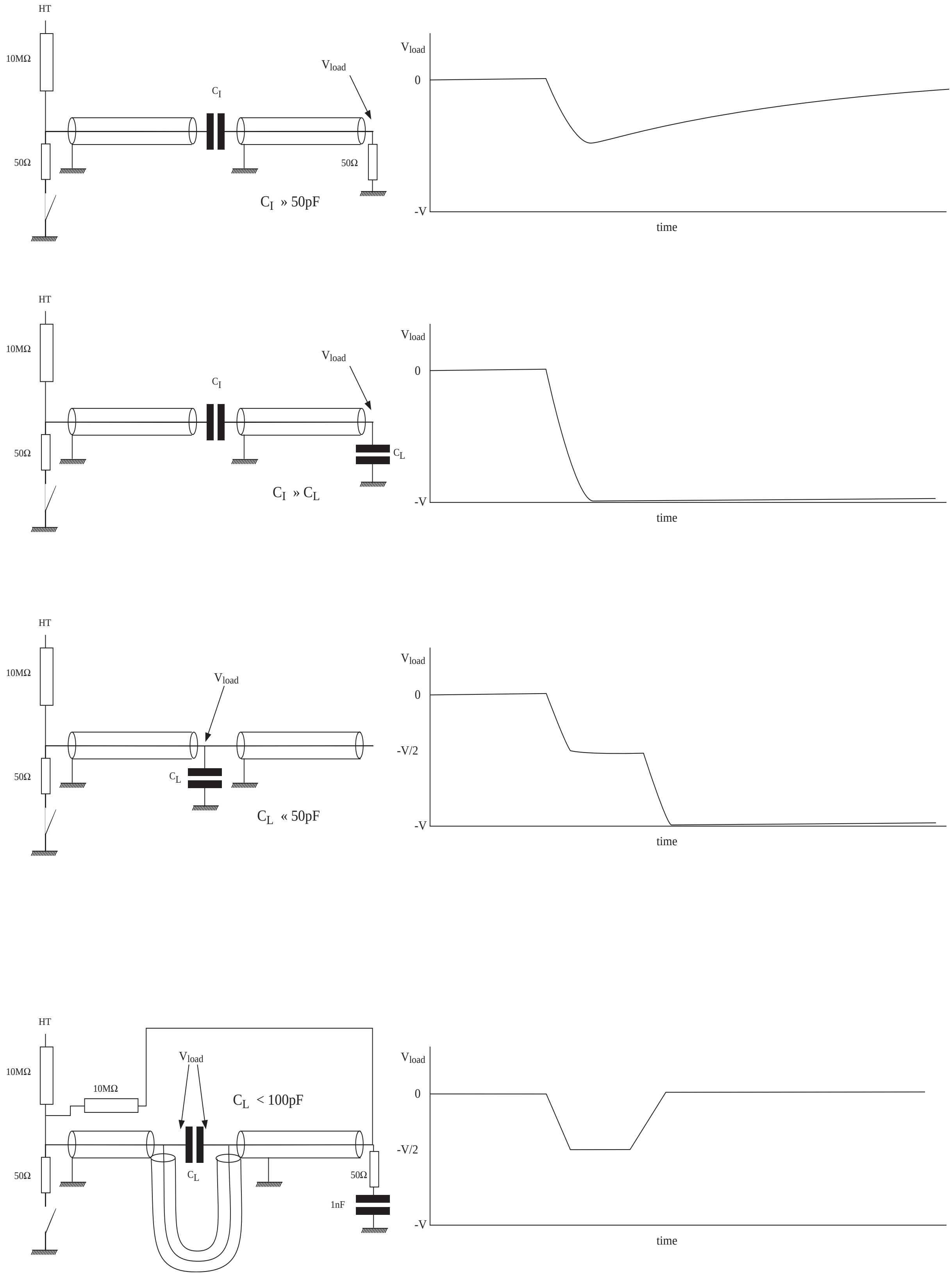

Figure 4 Some possible configurations of the pulser.

3.3 FULL WAVE OPERATION

If a pockels cell is operated at full wave then transmission through crossed polarisers will only occur during the transition period. By this means shorter optical chopping may be obtained than with other techniques, the apparent increase in system bandwidth comes from the increased use of the non-linearity of the pockels cell. There are several considerations however; firstly, after the voltage step has arrived at the pockels cell there will be a slow recovery of the voltage and consequently the system will go through a second transmission phase at late times. This will be a slow transition and will not normally be suitable when chopping continuous optical waveforms. The second consideration is that, unless actively avoided, the arrangement will require a DC voltage on the pockles cell which for some materials will degrade the crystal. It is anticipated from simple calculations that this technique could provide sub ns chopping.

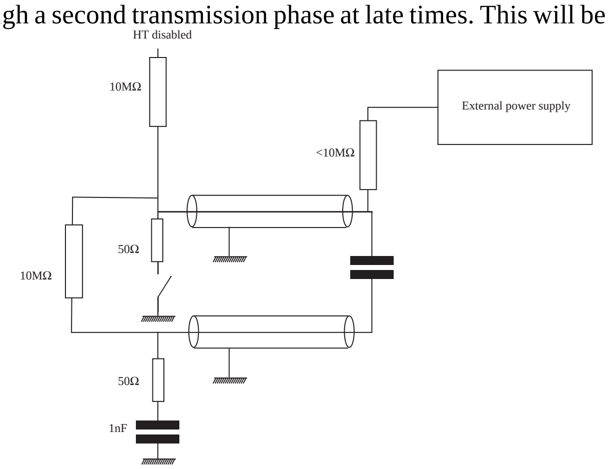

Figure 5 Connection of an external power supply for higher

4 CIRCUIT DESCRIPTIONS

The circuit consists of a high voltage series parallel array of 1kV FETs 132 arranged 12 wide and eleven high. This is driven by a single trigger pulse that is transformer coupled to all the fets. The switch switches to ground but there is a 40Ω resistor connected between the high voltage side of the Stack and the output. The output is also connected to the HT supply via a 3MΩ resistor.

The stack is protected against breakdown and over volting with zener diode chains. A resistive chain down the stack also allows the unit to run at lower voltages whilst maintaining the equal distribution of voltage across each stage. This resistor chain is also used to monitor the stack voltage. The chain current is measured and fed to a DMM on the front panel.

The trigger circuit delivers around 650 volts into 25Ω and is also a FET pulser with four similar FETs to those used in the stack.

The trigger circuit uses a simple flip flop to prevent the circuit being triggered too rapidly. The output of the flip flop is fed via buffer ICs into low voltage FETs and then into increasingly high voltage fets to deliver the final stack trigger voltage. The buffer IC also drives the front panel LED and synchronisation output.

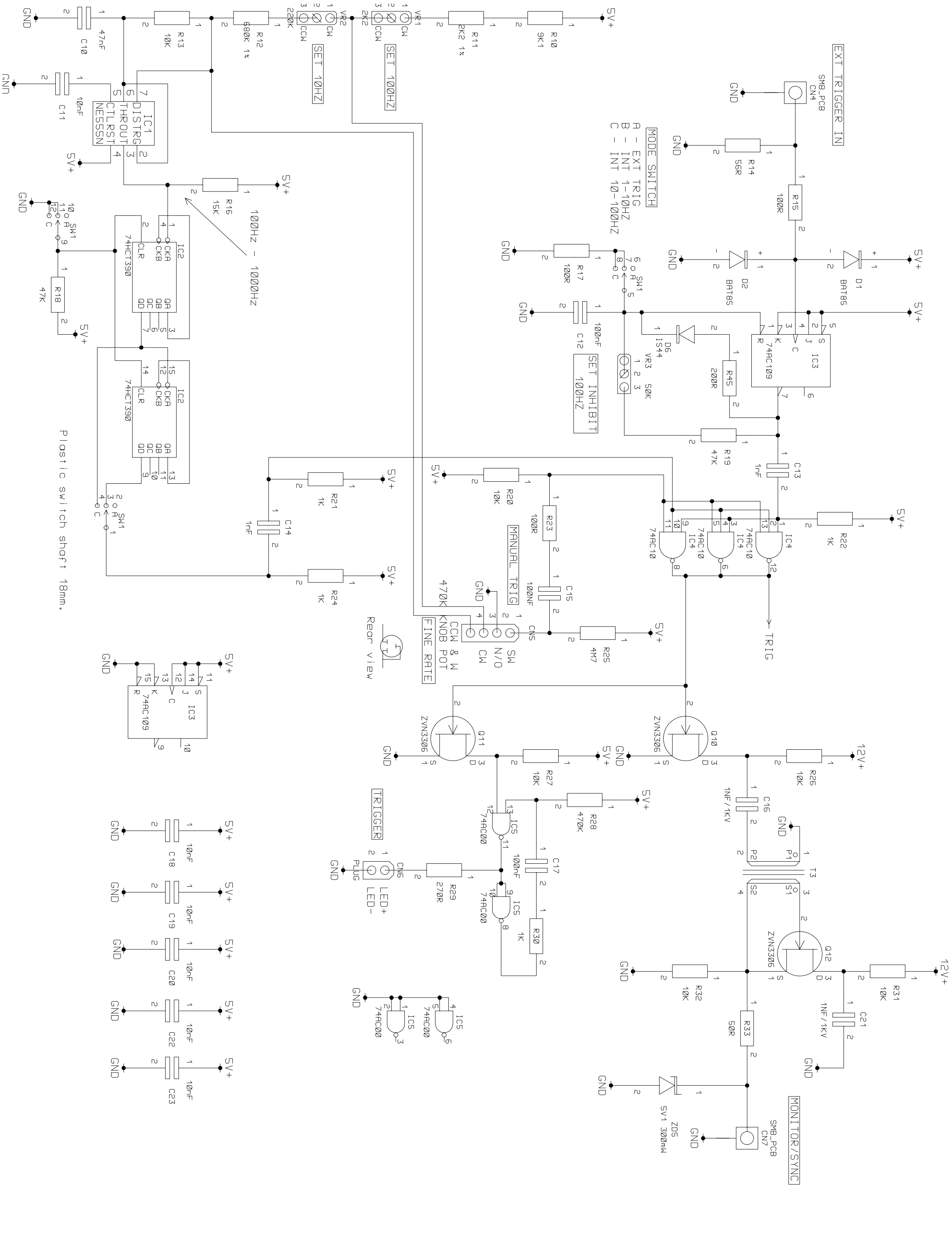

Figure 6 The trigger circuit

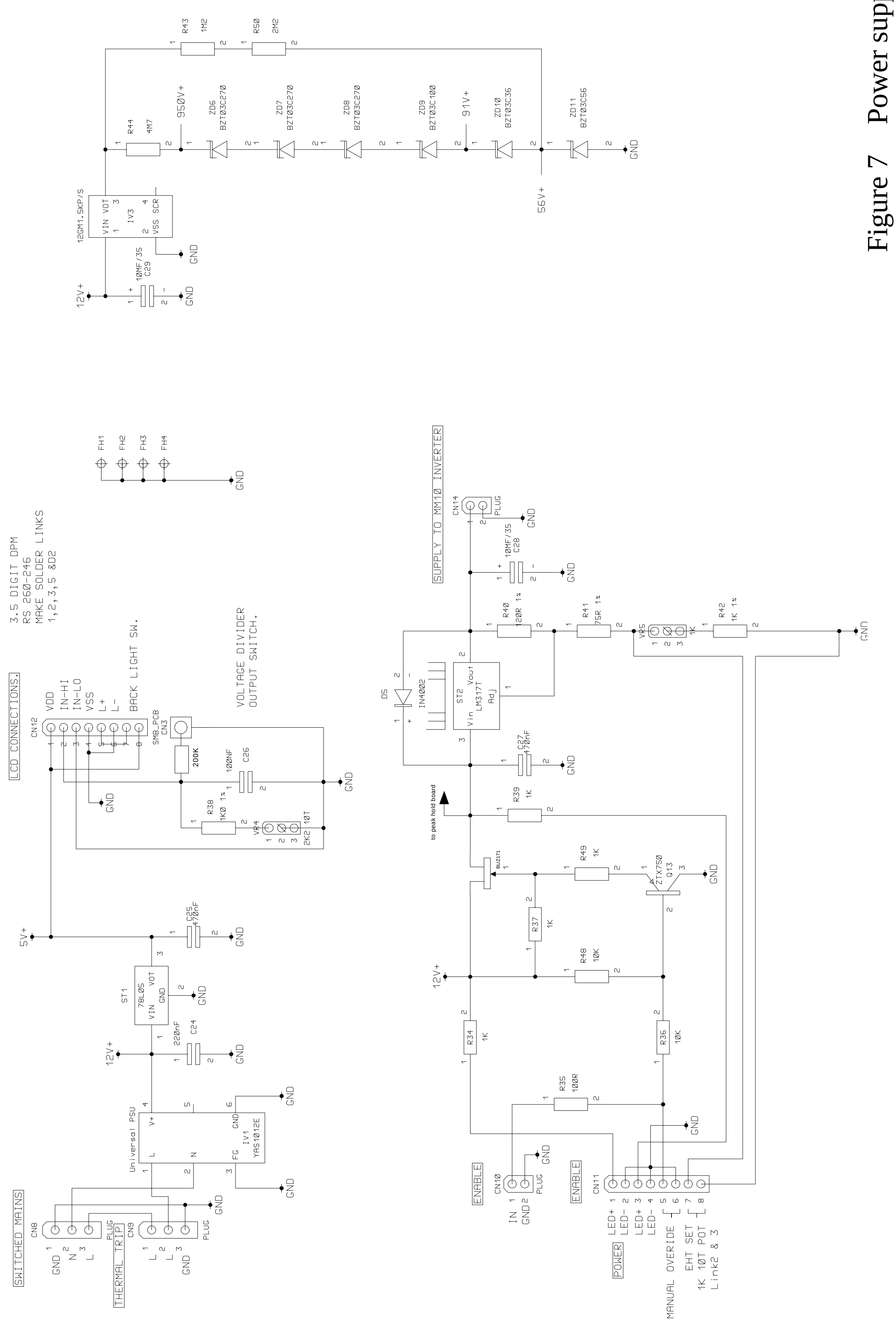

Figure 7   Power supplies

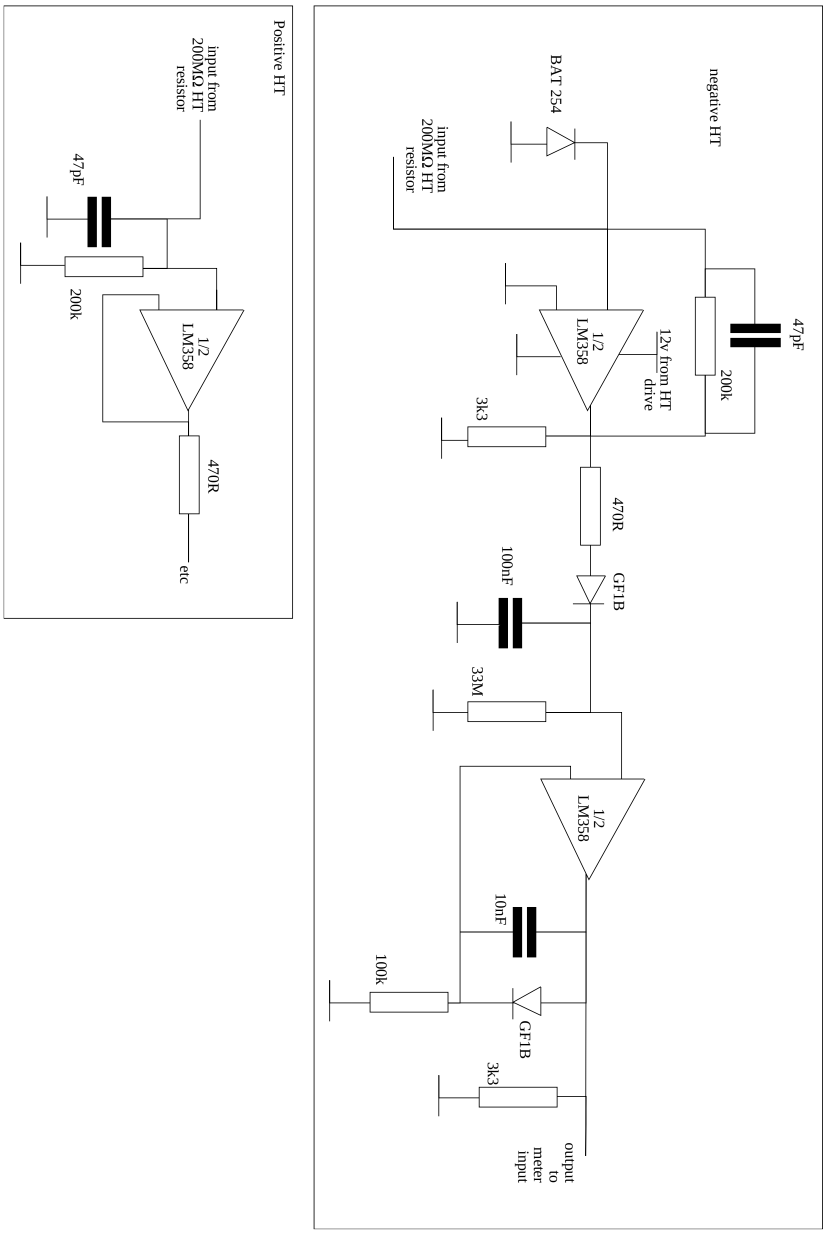

Figure 7 Peak hold circuit

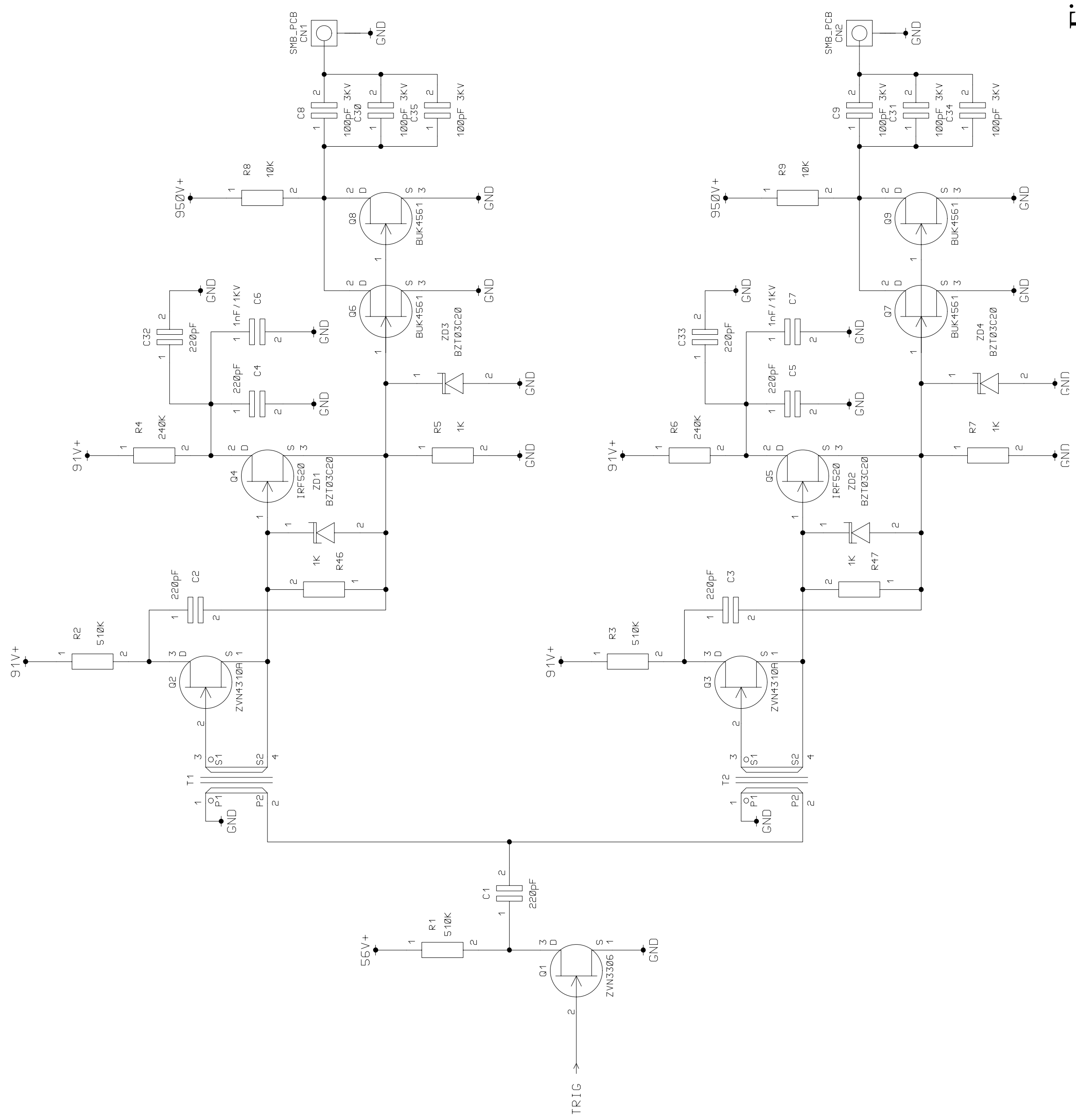

Figure 9 Trigger output stage

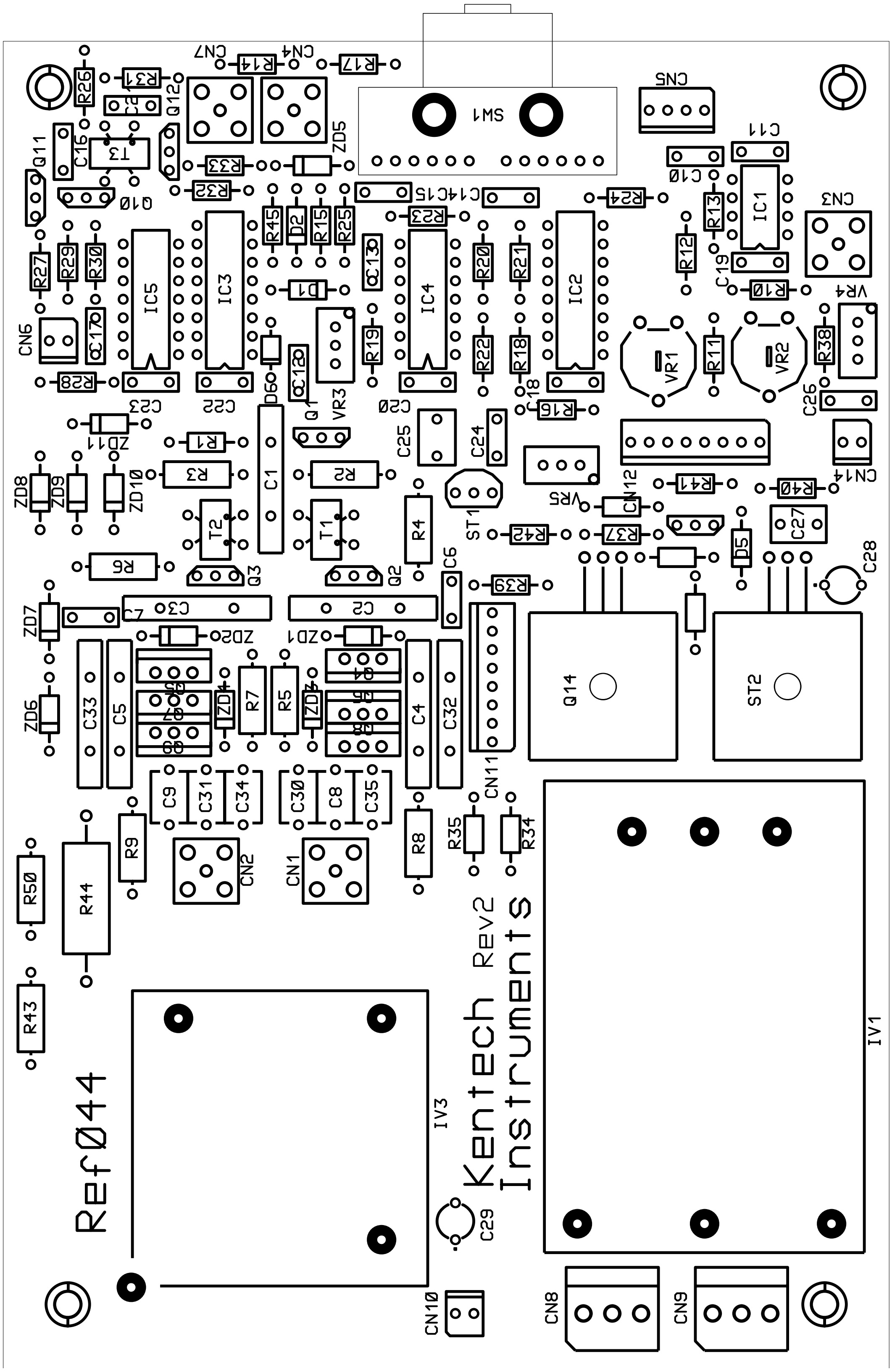

Figure 9 Trigger board layout

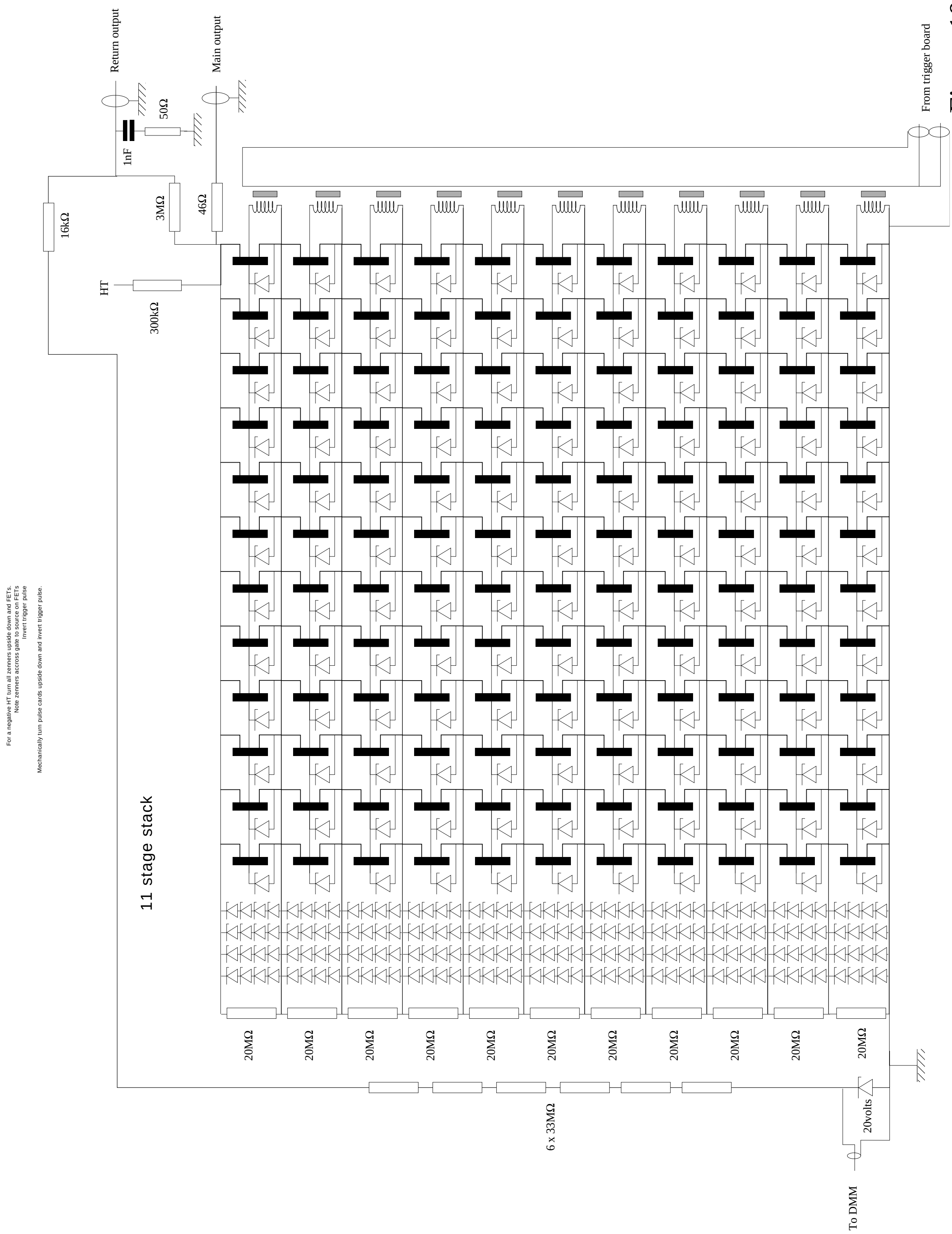

Figure 10 The stack