Kentech Instruments Ltd.

Photocathode Pulser

Serial Number J98*****

20th. November 1998

PLEASE READ THIS MANUAL CAREFULLY BEFORE

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

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.

Warning

This unit is heavy. It weighs 20kg and the weight is distributed towards the rear of the unit.

Contents

Figure Captions

1 Introduction

This manual describes the operation and use of the general purpose photocathode pulser.

1.1 Specifications

Voltage range	-0.2kV to -15kV as a negative pulse device.
Maximum repetition rate	Depends upon the voltage. 40Hz at 15kV into an open circuit.
Trigger input	3 volts 10ns f.w.h.m. into 50Ω.
Jitter	Approximately 100ps or less (hard to measure)
Synchronisation Output	TTL approximately 50ns after trigger.
Main output	Reverse terminated 75Ω. Output will > 20kV into an open circuit with the HT set to maximum.
Remote HT enable	This 12 volt input needs to be shorted to activate the HT.
Status	TTL (high on ready) on the front panel for remote interrogation of the status. The status is high when the voltage on the switch equals that preset on the front panel, and when the HT is on.
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 25 watts.
Connectors	
Power	IEC
Trigger input	BNC
Sychronisation output	BNC
Status Output	Lemo 00 (Part number FFA.00S.250.CTA C27)
Main output	Fischer DK105A005/7.2 Note that the output has a female centre pin.

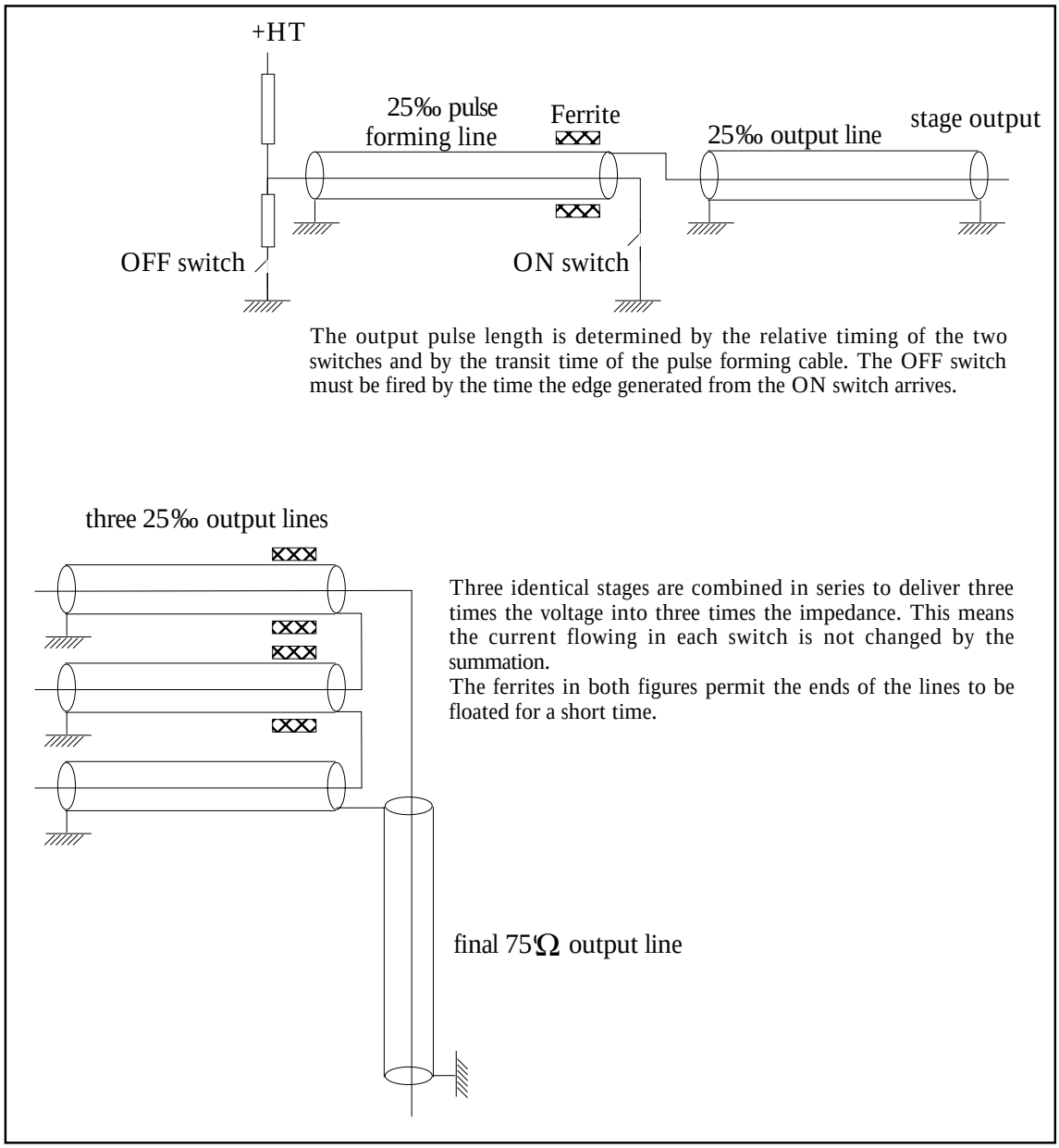
Note The Fischer connectors should not be used unmated at high voltages.

2 Principal of operation

The pulser uses an active self terminated line configuration, the layout is shown in figure The switches are series and parallel arrays of FETs in stacks each of 108 FETs. This arrangement allows the load to be anything resistive from short circuit to open circuit and small capacitors up to around 1nF. In addition the switch is only on for around 100ns most of the current flow must stop before this time. The current flow time is determined by the length of the cabling to the load and the load, if capacitive. For a short cable the load capacitance should be less than 1nF For pure open circuits the lead length should be less than 40ns transit time, i.e. around 8 meters. For loads and cable lengths other than these it is the presence of current at times after 80ns that can cause problems.

The self terminated line is a well known configuration that normally uses a single switch to produce a pulse into a resistive load. In the normal configuration the pulse length is determined by the round trip time of a pulse forming cable. In this unit the pulse edges are generated separately and the switch generating the falling edge also terminates the line for the pulses reflected from the load.

At the high voltage used in this unit the internal terminating resistors are not very linear and some changes in the termination arises at differing voltages.



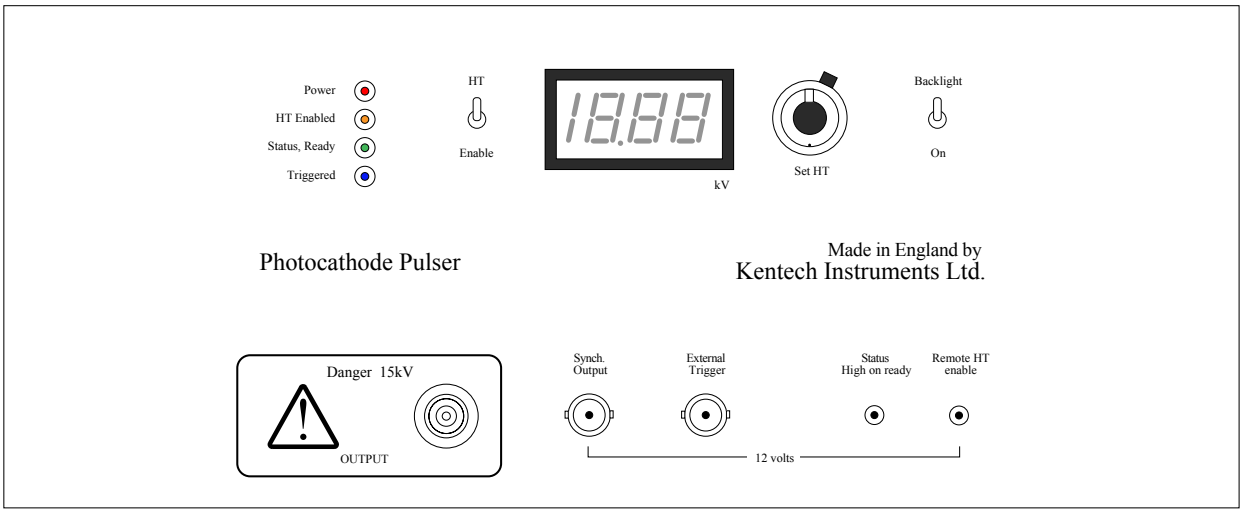


Figure 2 The front Panel

In order to achieve a high voltage output without using very high voltage internally the pulser is made in three sections which are summed at the output transformer. In this way the typical internal voltages are kept to around 9kV, whilst the output can be turned up to around 23kV (In practice the maximum output is set lower than this)

3 Getting to know the instrument

The pulser consists of a trigger circuit, HT stabalisation circuitry, some logic and an array of high voltage switches. The trigger circuit processes the incoming trigger signal, prevents multiple triggers and amplifies and fans out to 12 outputs which go in pairs to the six high voltage switches.

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

3.1 Front panel controls, connections and indicators.

The front panel is shown in figure 2.

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

The HT can be enabled either with the front panel momentary action switch or by shorting out the HT enable socket. If a logic drive for this is required a simple Open Collector arrangement can be used. 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

The HT can be disabled from the front panel with the HT switch providing the remote enable is not active. The unit will always power up with the HT off unless HT remote enable is active. The triggering circuit will operate even when the HT is off. The panel meter will only indicate the charge voltage when the HT is on.

There are four LEDs which indicate the Power On, the HT enabled, the status 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.

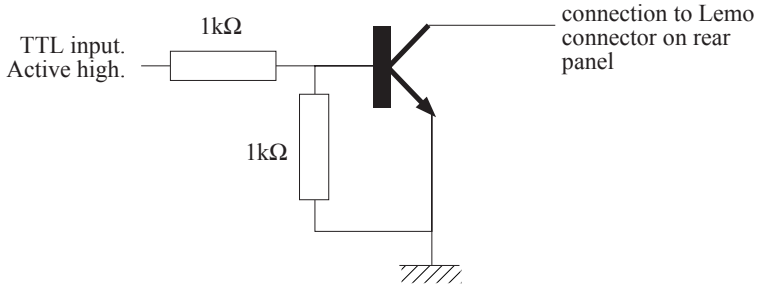


Figure 3 Conversion of TTL signal to Open collector drive for the HT

The displayed HT is that requested of the power supply, only when the status light is illuminated does the HT actually equal the set voltage. If the unit is not being triggered this should always be the case unless the HT is set very high. When the unit is triggered the HT falls and the status light will

go out until the HT has recovered. This will not normally be visible, but if the repetition rate is too high the unit never recovers and the status light will remain out.

The unit uses a feedback control loop around a proportional HT supply. Consequently the full power of the unit is generally available and consequently the repetition rate can be higher at lower voltages.

There are five front panel connectors. The trigger input, the synchronisation output, the main output, the Status output and the HT enable input.

Note that the main output connector will break down at around 12kV unmated and should not normally be operated unmated at all.

3.2 Rear panel connections

There is only one rear panel connections the power inlet switch. The power inlet is filtered and will accept IEC leads. It uses a universal supply that will run from a variety of AC voltages, see specifications.

The power switch is also located on the rear panel.

4 Use

The pulser may be used in a variety of ways depending upon the application. The unit is basically a high voltage reverse terminated pulse source driving into a 75Ω cable.

The unit may be used to drive small capacitances and charge them to a high voltage (up to >15kV) for around 20ns or may be used to deliver high currents (> 200 amps) for 20ns.

The maximum output power will be achieved at a load impedance of 75Ω, >3Mwatts

4.1 Connections

The output connector of this unit is only rated for mated use. Running the unit unmated at high voltages will lead to break down of the output connector an eventually to damage to it.

Fast high voltage connectors are always a problem as there is a conflict between the demands of small size and uniformity for high speed and those of large distances for high voltage hold off.

The Fischer output connectors supplied have been found to adequate at the voltage and risetime of this unit. They are also available in hermetically sealed varieties permitting the transportation of the pulse into a vacuum system.

5 Circuit descriptions

The switch is described in section 2.

The trigger circuit delivers around 700 volts into twelve 50Ω outputs and is also a FET pulser. Two outputs go to each of the six switches.

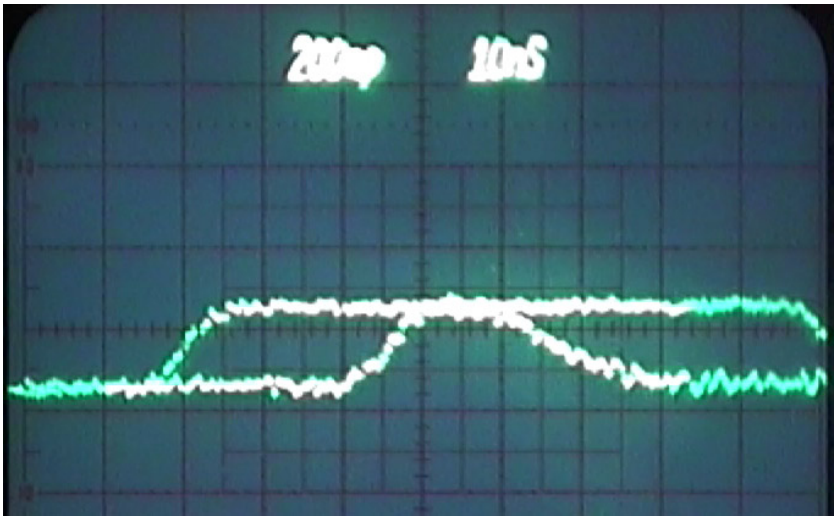
The trigger circuit uses a simple flip flop to prevent the circuit being triggered too rapidly. The output of the flip flop is fed via buffer ICs into low voltage FETs and then into increasingly high voltage fets to deliver the final stack trigger voltage. The buffer IC also drives the front panel LED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

The HT is supplied by a small proportionally driven encapsulated supply . The drive to this contains a feedback loop that maintains the HT stable. A precision reference voltage IC is used for comparison of the HT. The reference is divided down with the front panel potentiometer to set the desired HT. The enable/disable signal controls the input to this circuit.

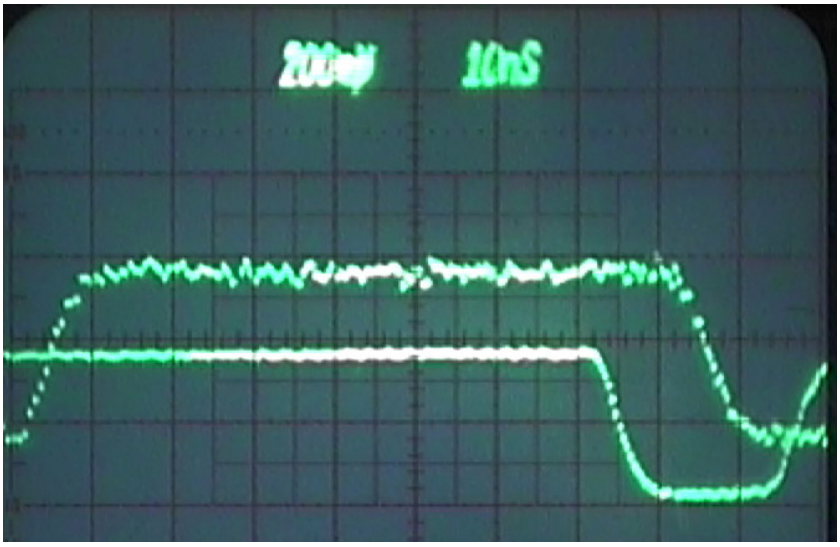
The LCD display actually displays a voltage proportional to the reference voltage used for comparison to the HT. The constant of proportionality is adjusted so that the display indicates approximately the pulser output voltage into an open circuit load.The output pulse voltage will be half of this into 75Ω.

The LCD display calibration adjustment is accessible on the right hand side of the unit if the side panel is removed (four small screws).

Also here is an adjustment that sets the maximum HT setting, i.e. it affects the scale on the multiturn potentiometer. This is currently set so that the maximum pulse voltage into an open circuit is 20kV, (the display only goes up to 19.99kV). Some headroom is available on this control should even higher voltages be required.



Trigger input followed by the synch. output, both measured at the front panel. Synch is approximately 27ns later.



Trigger input followed by the main output at the end of 3.3meters of cable. The output is approximately 65ns after the trigger input.

Figure 4 Timing traces

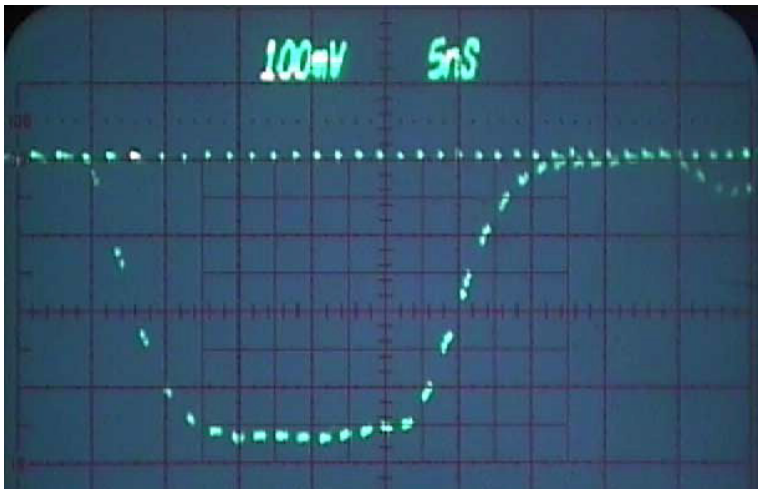


Figure 5 Output waveform into 25Ω with the unit set to 15kV. 1kV per division and 5ns per division. The output into an open circuit is 4 times this.

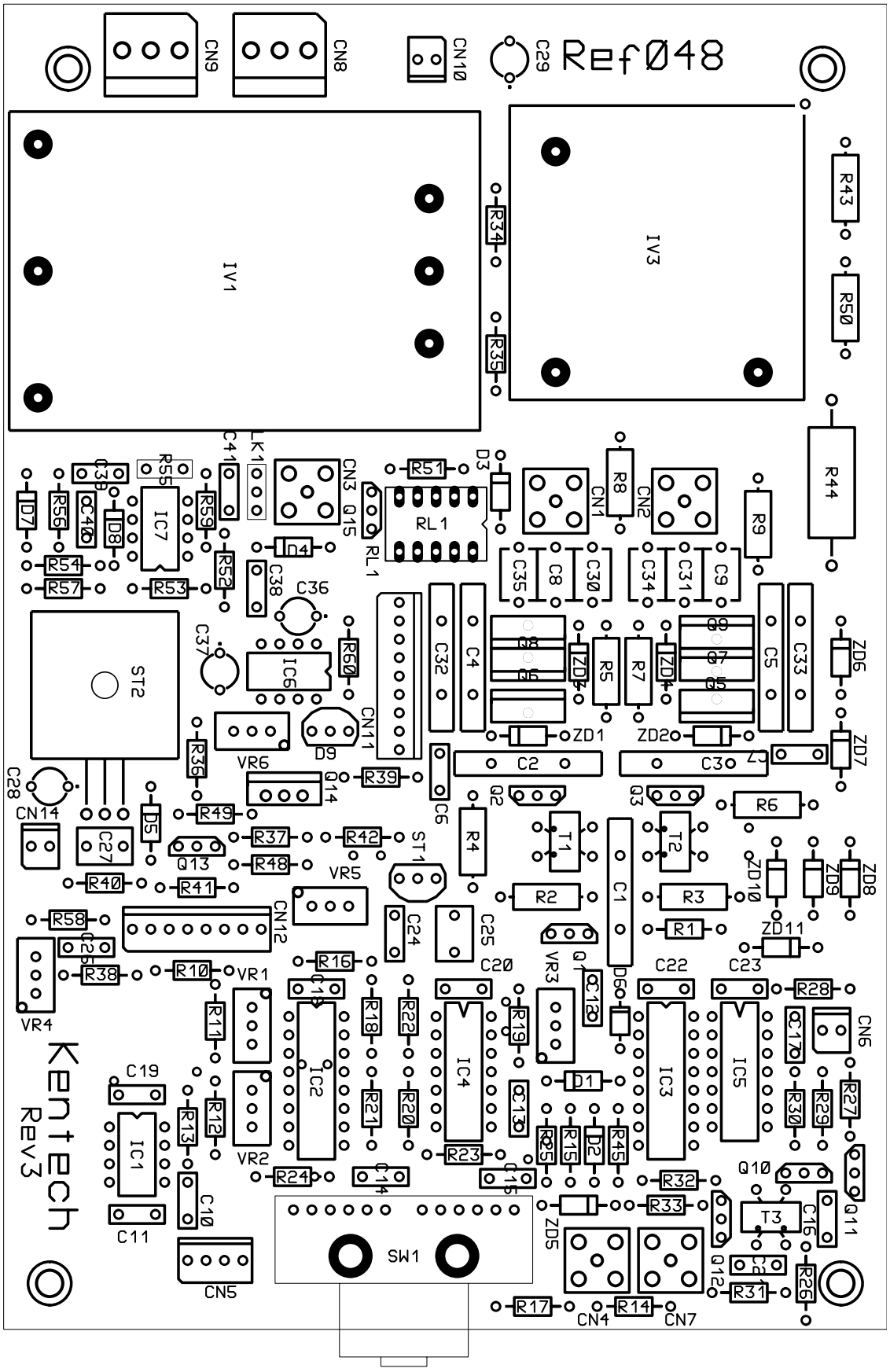


Figure 6 The trigger card. The rate generator, peak hold meter circuit and output trigger stage are absent as they are not needed in this unit.

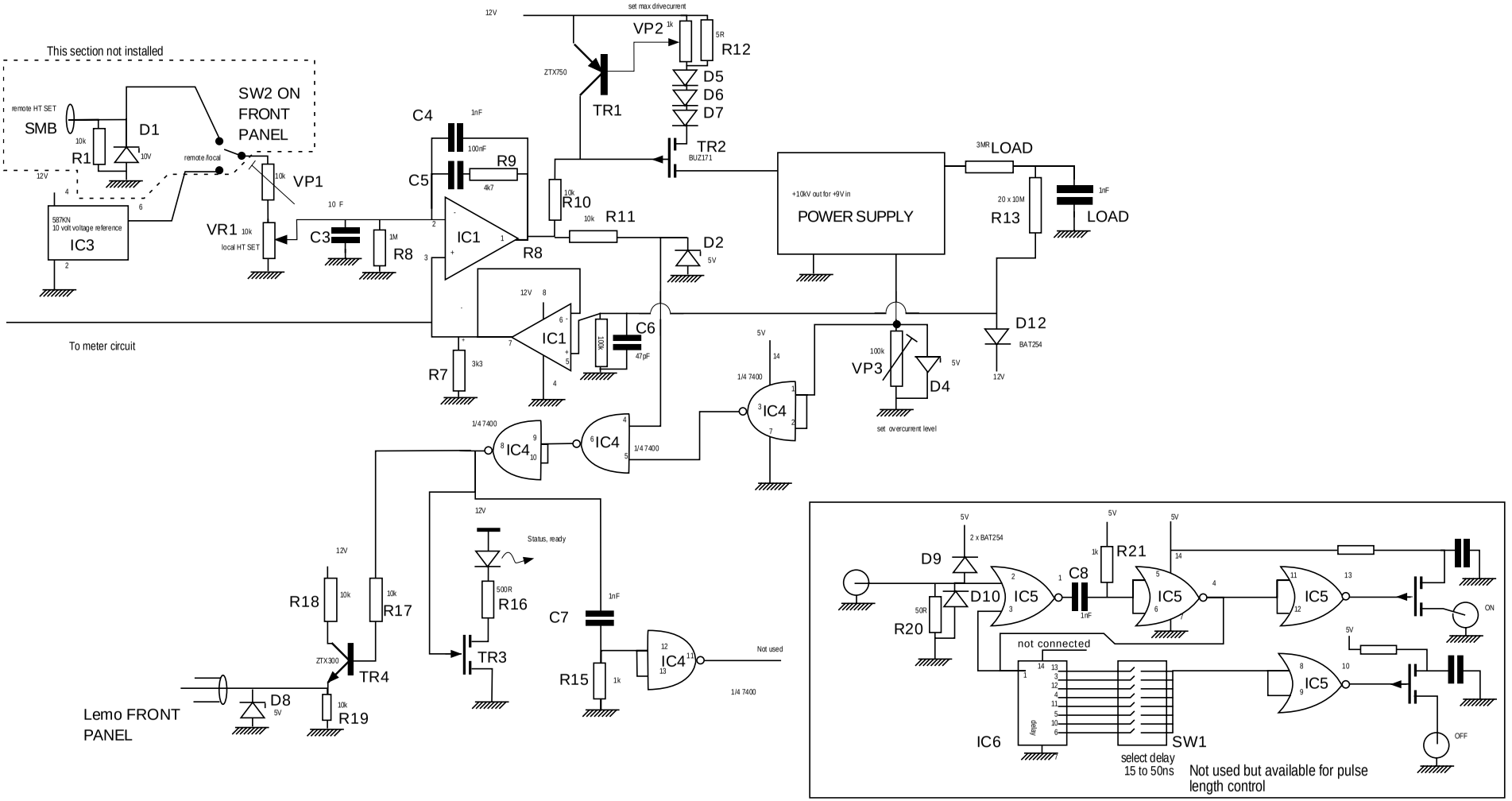


Figure 7 HT drive circuit

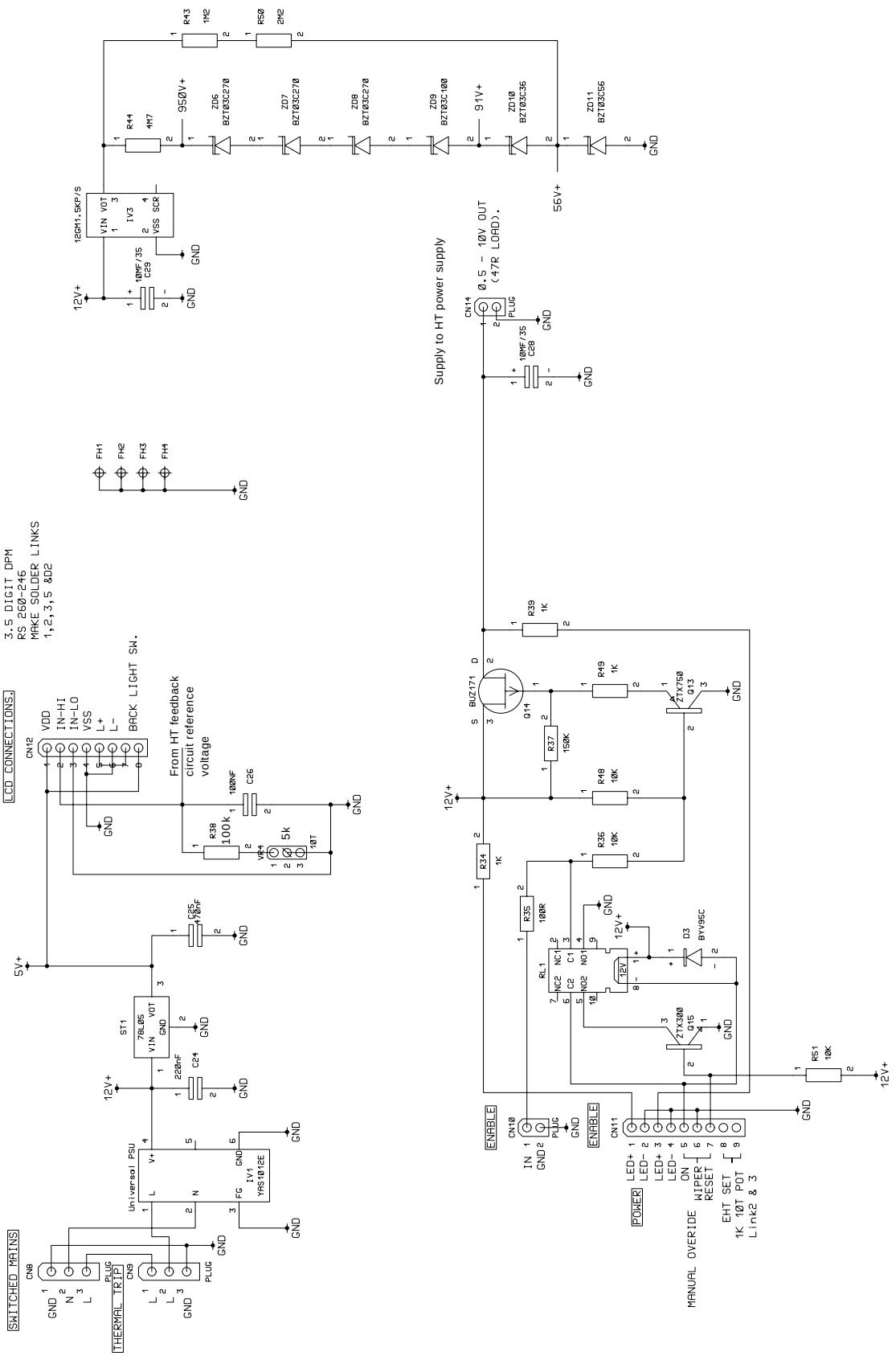


Figure 8 Power supplies and meter circuit

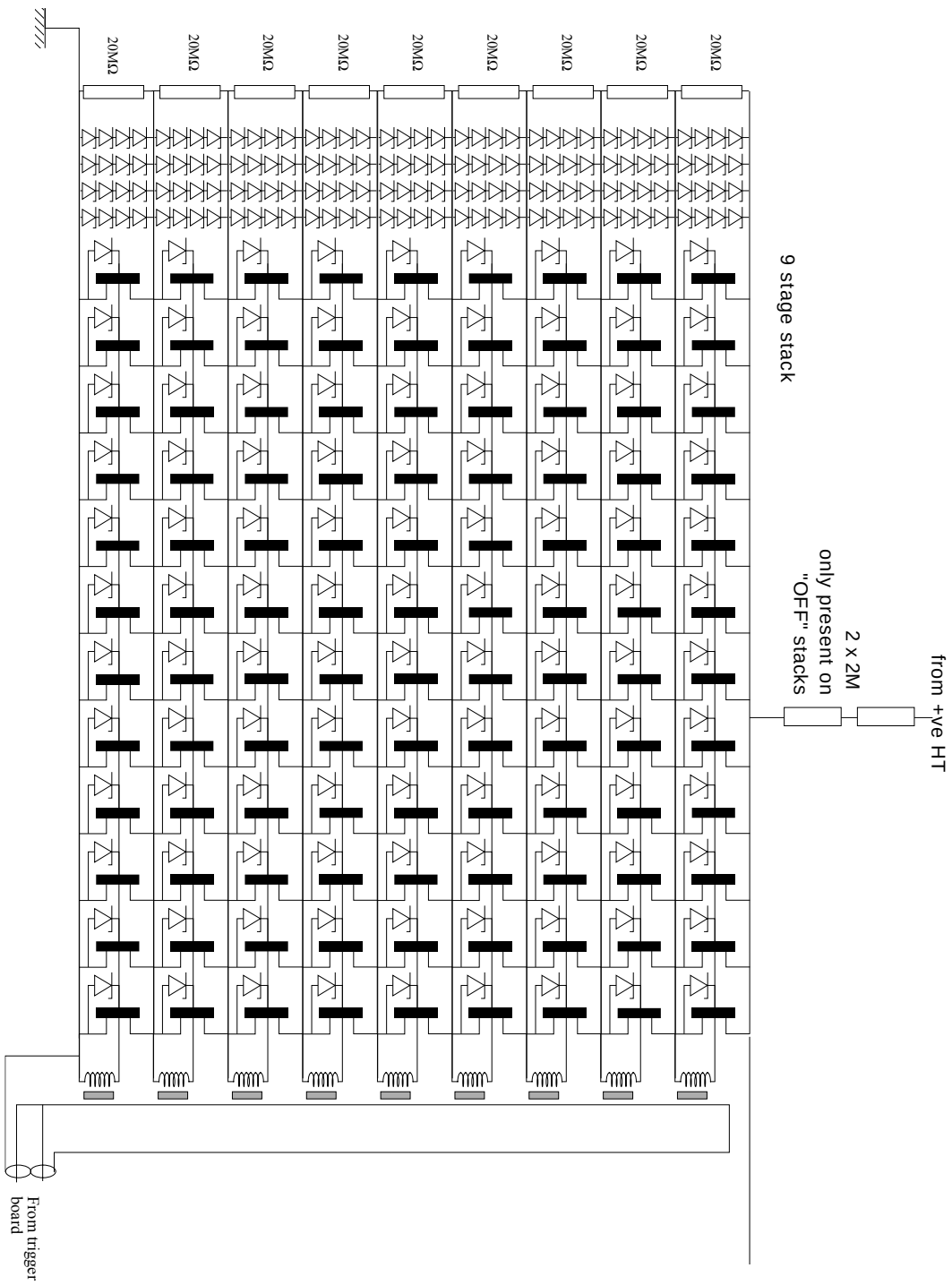


Figure 9 The stack

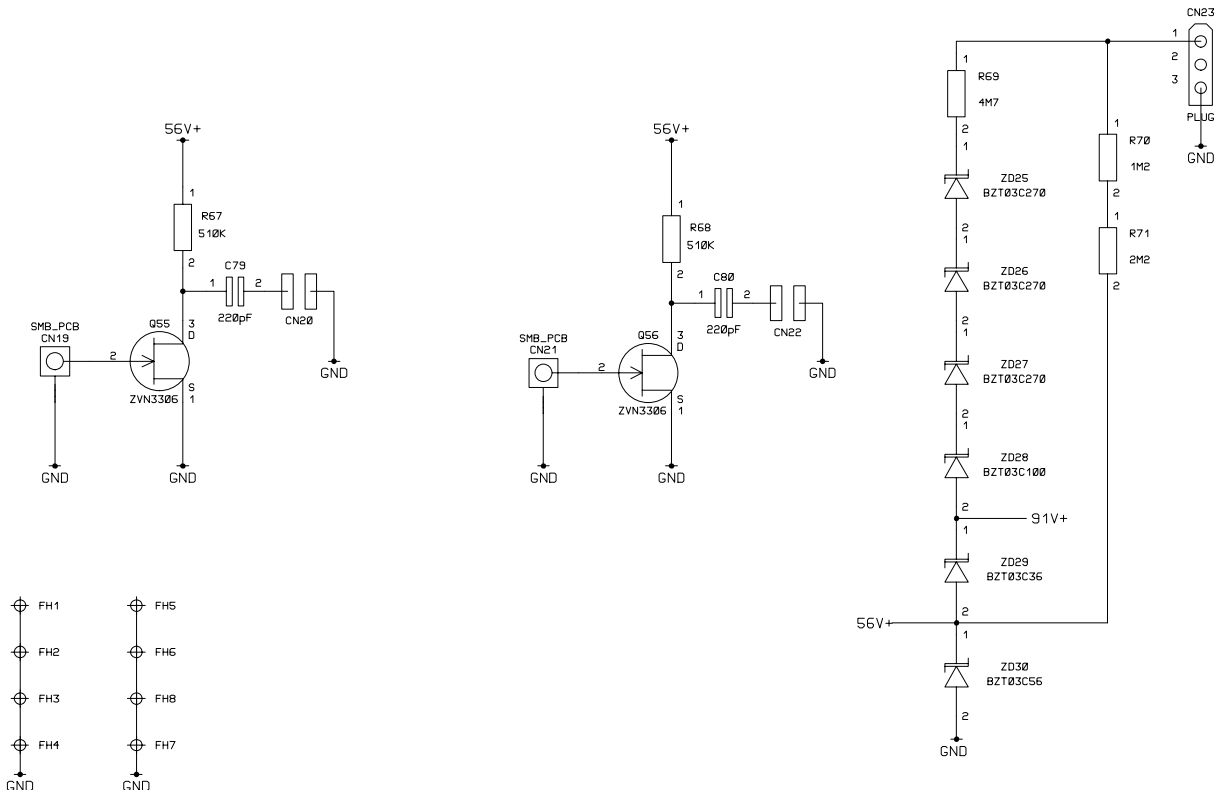


Figure 10 The six output stages are drive from a pair of trigger circuits via cable transformers.

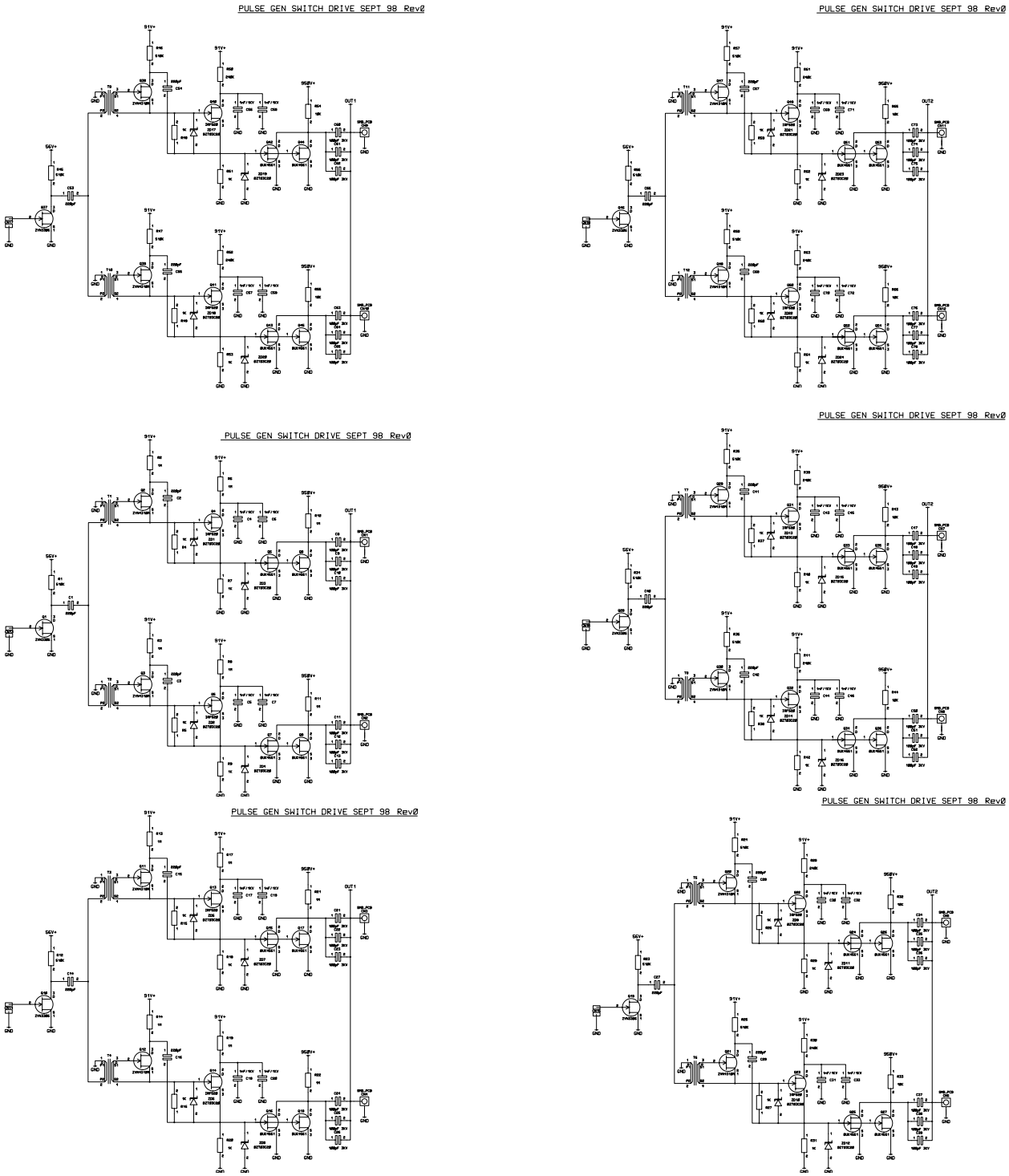


Figure 11 The six output stages, each drives one outpuit stack

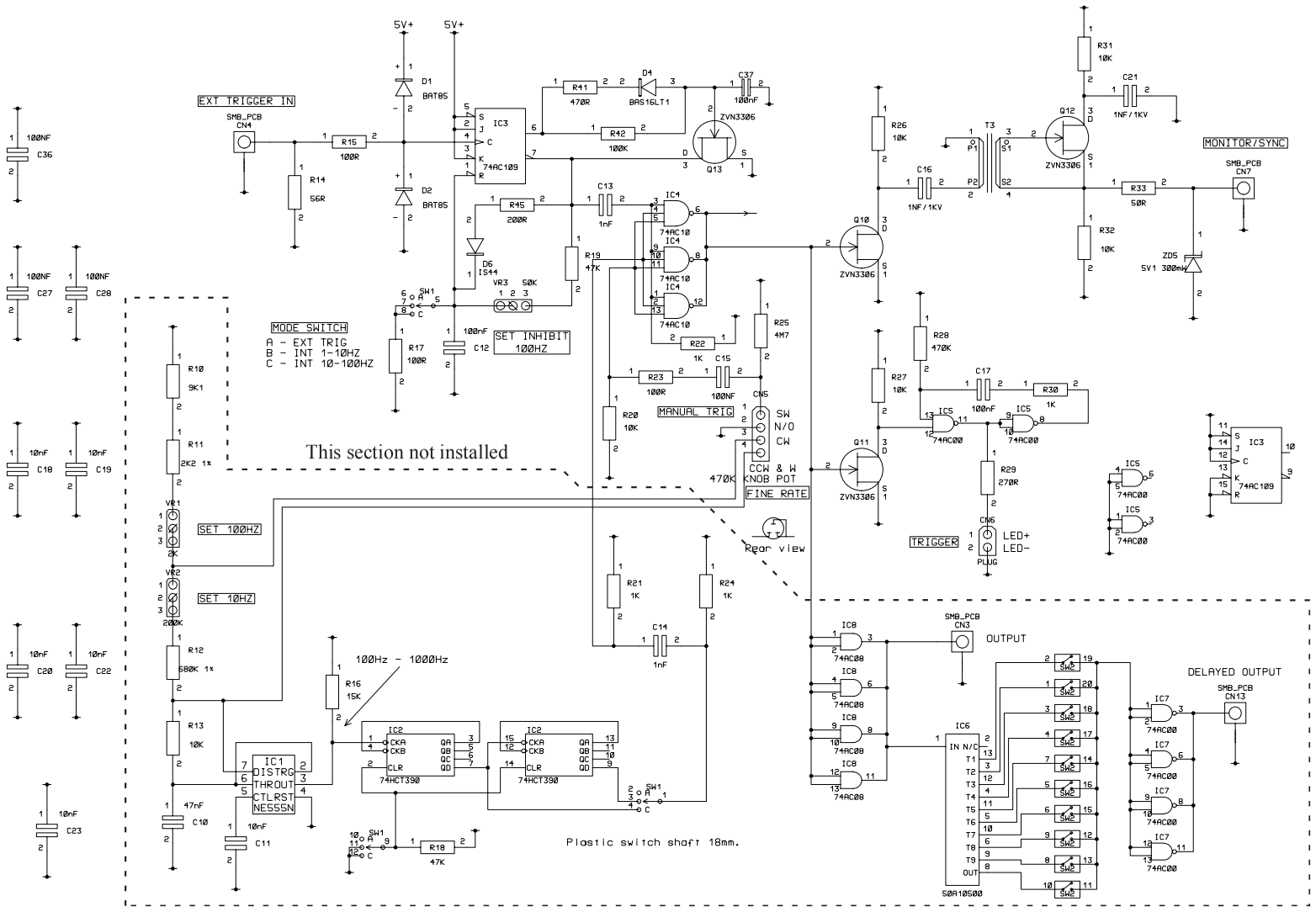


Figure 12 The trigger card. This unit does not have the rate generator. Also the output stage has been modified to supply two outputs, one for the "ON" stacks and one for the "OFF" stacks. The length of the cables from this card to the driver board determines the pulse length.