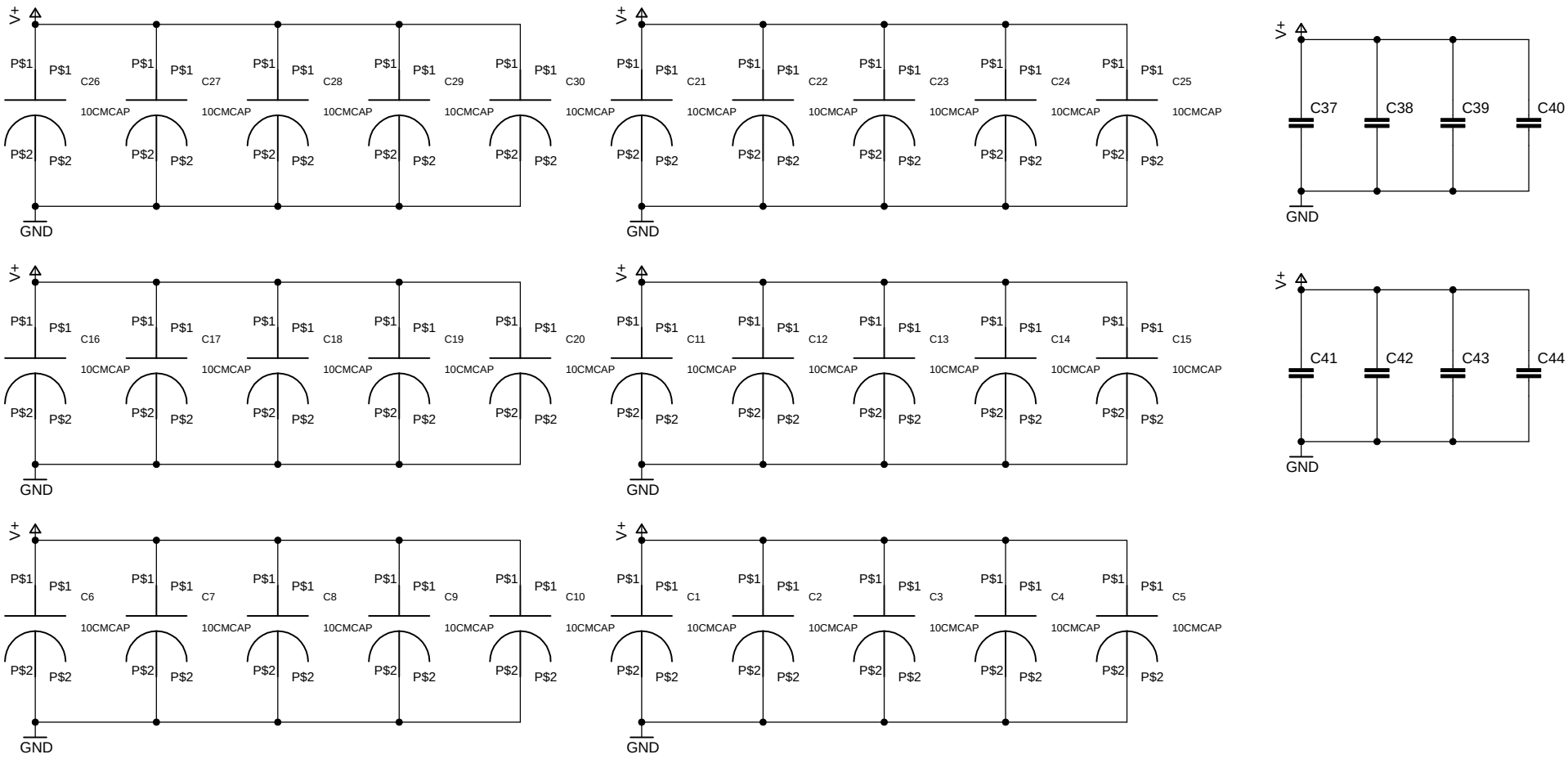
180 J Capacitive Discharge Spot Welder

Eratta: There is an excessive ammount of isolation of the bottom PCB layer which adds around 60uOhm of resistance.
The Gate driver needs to be replaced for Rev 2.
There are better MOSFETs available.
The lead ring terminal contacts are made with an extra large via in the PCB view and are not shown in the schematics.
A large aluminum cap should be added to VIN
A new gate driver should be used.

Capacitors

Quality spot welds require high sustained current. The internal resistance of the capacitors (ESMH160VSN473MR50T) is 14mOhm. With 30 in parallel, the resistance is 0.46mOhm.
These Electrolytic Capacitors are currently the best value for Farads / $ for a 16V rated part.
The ceramic capacitors provide a low inductance path for current to flow into for inductive return current spikes when the MOSFETS are turned off.



Open Drain

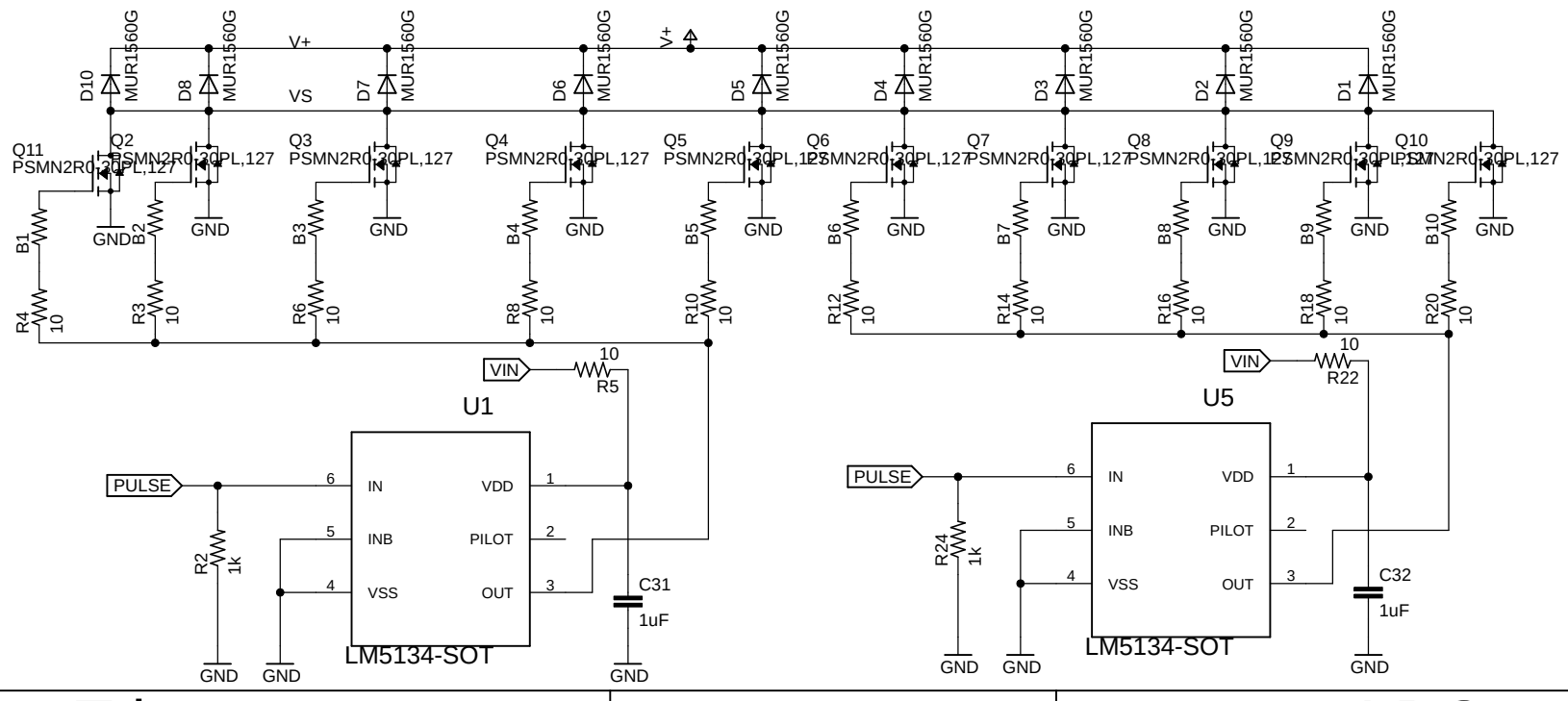
Current through the leads is controlled by a bank of paralled MOSFETS. Effectively, these MOSFETS act as a very high current open drain output.
The positive lead is always connected to the positive terminal of the capacitors, but the 'negative' lead is allowed to float. The MOSFETs connect the negative lead to ground during discharge periods.
The on resistance of this FET (PSMN2R0-30PL,127) is 2.1 mOhm which with ten in parallel is 0.21 mOhm. The maximum current through the FET for a period of 1ms is 500A. All ten in parallel provide a maximum current of 5000A.

A better MOSFET would be (PSMN1R1-30PL,127) which has an on resistance of 1.3mOhm and which supports a maximum current for 1ms of 1000A. Using this FET would increase the maximum current capability to 10 kA.
The resistance of the PCB copper traces can be approximated to 0.2 mOhm. The resistance of the leads can be approximated to 1.5mOhm. Adding 0.21 mOhm for the FETs and 0.46mOhm for the caps, the total dead short resistance is 2.37mOhm.
At 16V, the maximum current would be 6700A. The weld itself and the contact between the probes whould they be unintentionall shorted adds some resistance, so the maximum FETs will not be dammaged in normal opeation.

The diodes carry the flyback curent from the inductance of the probes and lead wires. Having 10 flyback diodes is overkill; half could be safely eliminated.

The ZXGD3003E6TA is NOT a good gate driver to use. It was selected for low cost, but it is more suited to drive IGBTs than MOSFETS. It acts as a current buffer and will not allow the output current to rise above the voltage of teh input which is limited to 5.5V.

The B* parts are ferrite beads to reduce ringing.

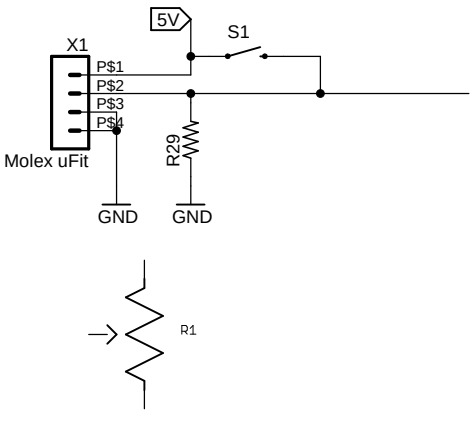


Trigger

The LTC6993CS6-1 is a pulse generator IC which outputs a varible pulse widdth based on the input voltage of its SET pin which is controlled by a potentiometer. The general range fo the pulse width is set by the DIV voltage divider.

This circuit does not have any debounce and it only provides single pulses, not double pulses. A bettery circuit should be used here for a second revision.

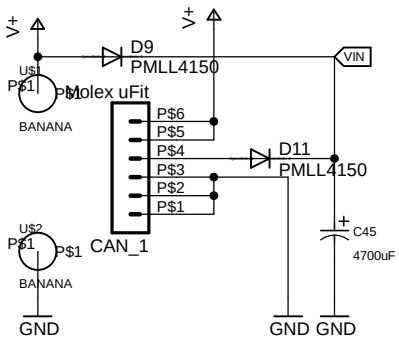
X1 connects to an external foot switch and S1 is a test fire momentary switch.



Inputs

The capacitors can be charged through either through the banana plug inputs or through a Molex Microfit.

The logic circuitry is powered through diodes so that is the capacitors rapidly discharge to zero the gate drivers will remain powered.



LDO

LDO for logic portion. The LT3080 allows the voltage to be adjusted by changing R80, but a cheaper LDO could certainly be used.