Proposed High-Voltage High-Current Solid State Tesla Coil Spark Gap Design

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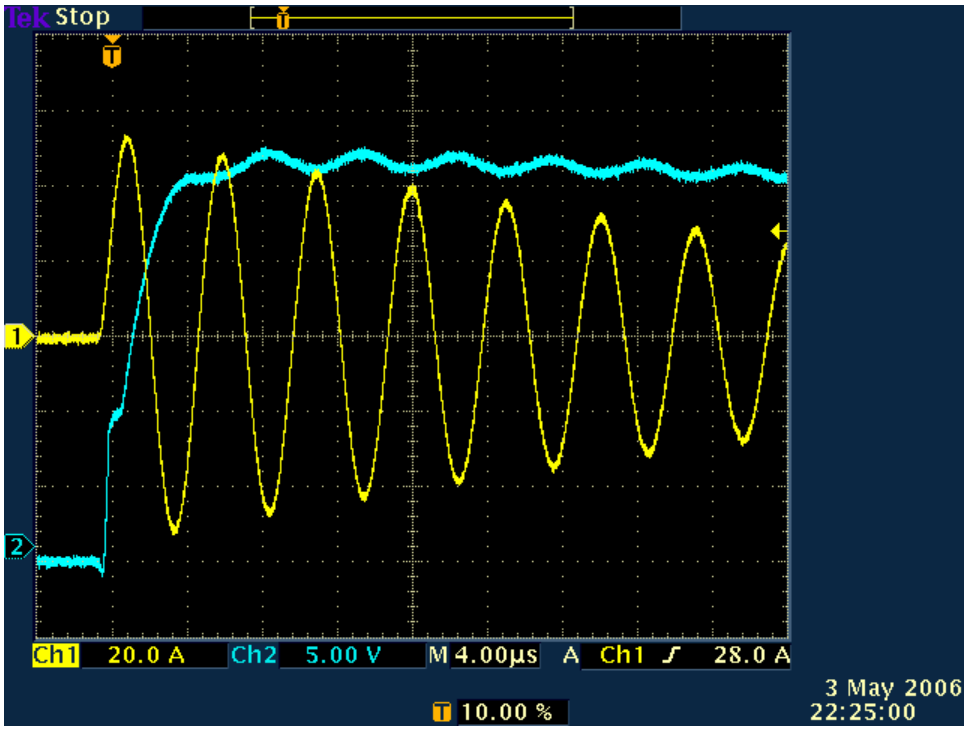
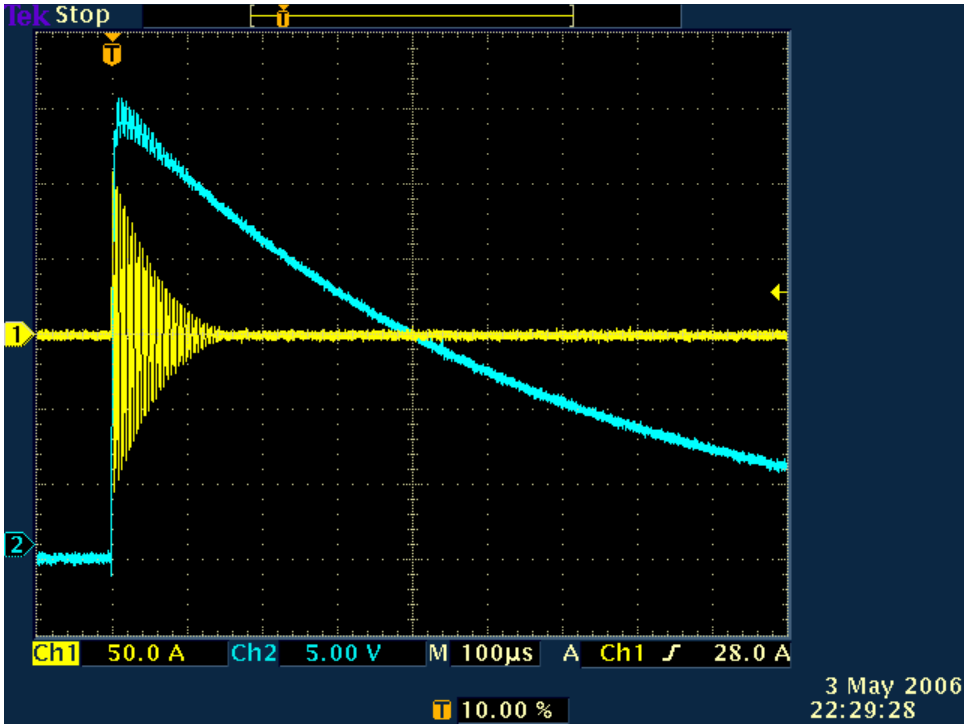
Modified Circuit

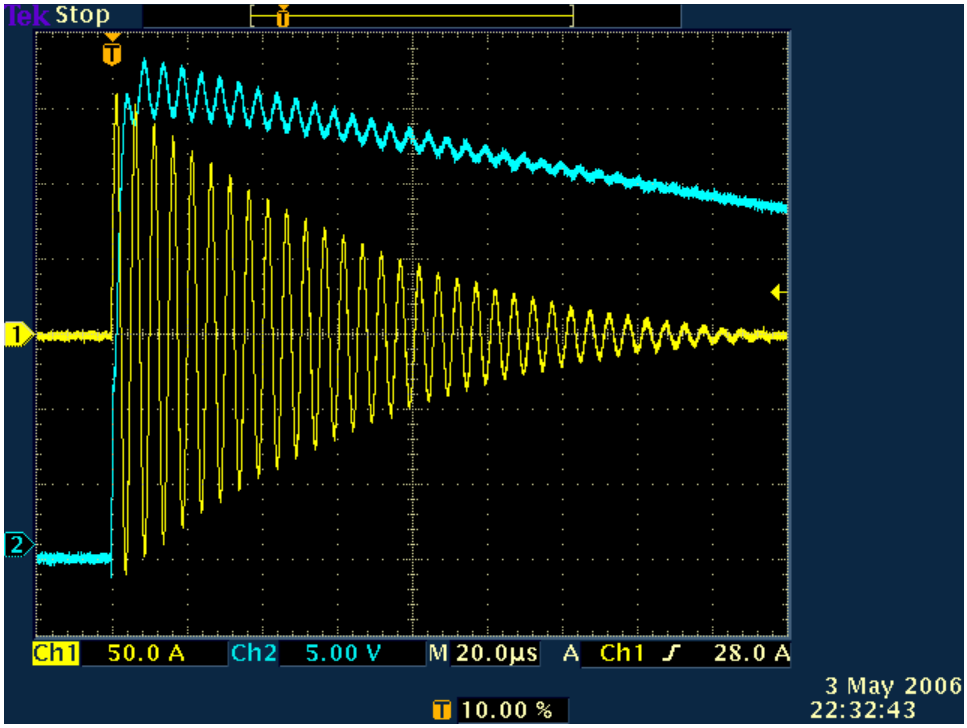
After looking at the scope pictures, it appears that the SIDACs are staying on very long (many microseconds) even with a current reversal. They stay shorted just like a "real" spark gap... That shorts out the capacitor and takes all the power out of the gate drive circuit. The circuit keeps turning off every cycle and is burning up all the energy thus the poor efficiency. The simple fix is to add a 1N5918 diode between the transorb and the capacitor to trap the voltage in the gate drive circuit regardless of what the SIDACs are doing. Once the diode was added the circuit began to perform properly.



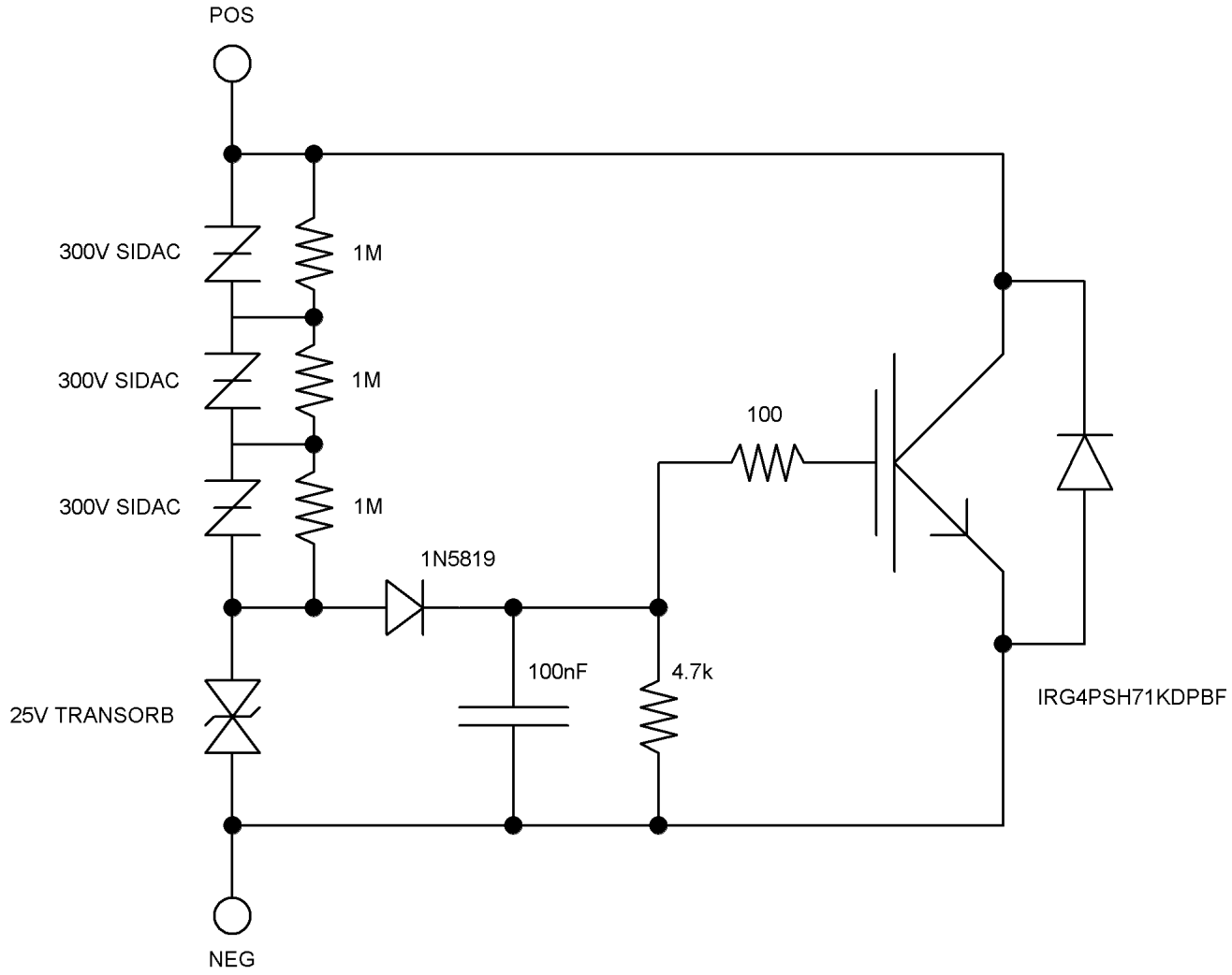
Primary Current (yellow) IGBT Base Voltage (blue)



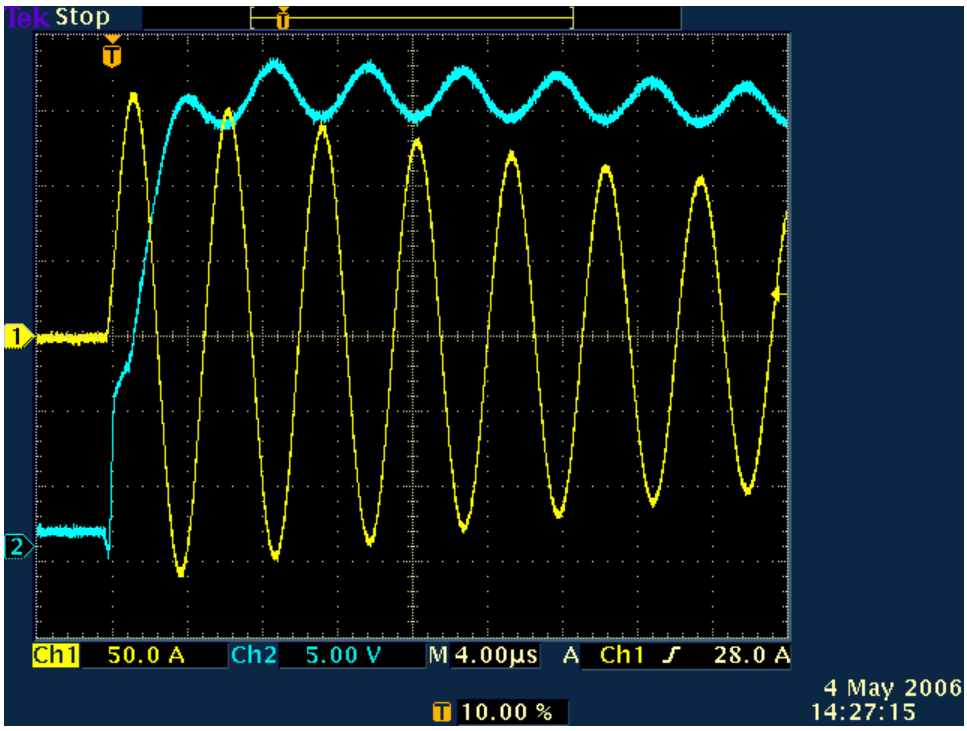
The jumper was removed so the circuit could run at the full 900V.



There are now three 1M ohm resistors across the SIDACs as well to insure even voltage distribution across the array. These along with the 4.7k resistor impart about 1.56 volts across the gate just before the circuit fires. This helps speed somewhat. The circuit now looks like this:

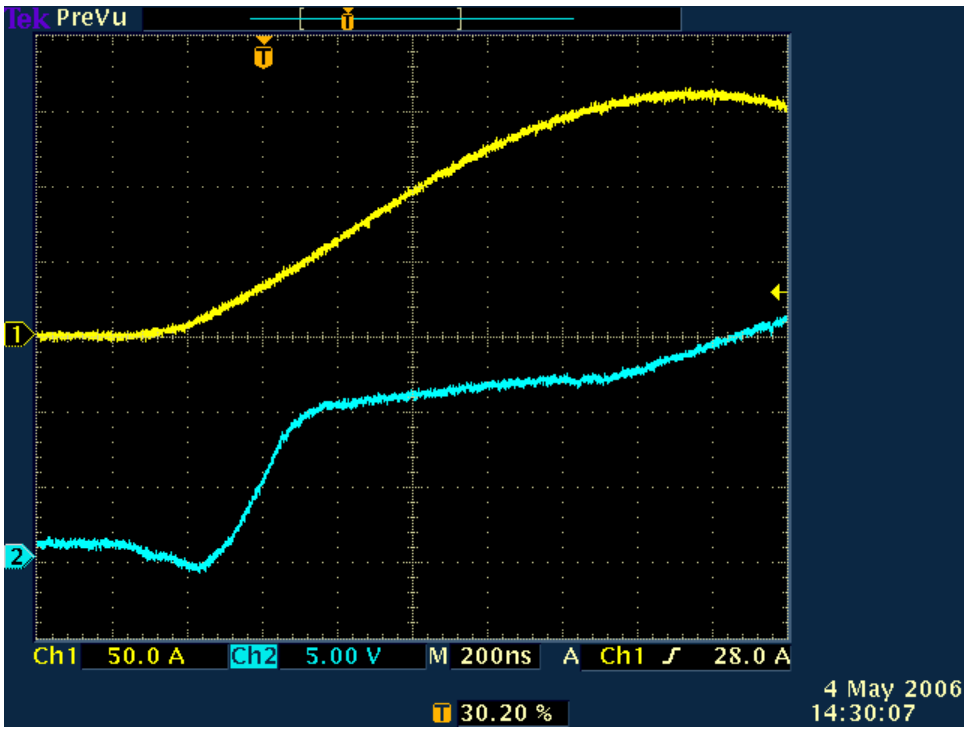


QTY	DigiKey#	Description	Cost (10)	Total
3	K3000F1-ND	300V TO-202 SIDAC	0.86	2.58
1	1.5KE24CADICT-ND	24V 1500W Bi-Transorb	0.60	0.60
1	1N5819DICT-ND	1N5819 Diode	0.30	0.30
1	P100W-2BK	100 Ohm 2W Resistor	0.21	0.21
1	PF2104-ND	100nF 250V Poly Capacitor	0.42	0.42
1	IRG4PSH71KDPBF	1200V IGBT with Diode	12.10	12.10
3	1.0MQBK-ND	1M Ohm 1/4W Resistor	0.02	0.06
1	4.7KQBK-ND	4.7K Ohm 1/4W Resistor	0.02	0.02
				16.29

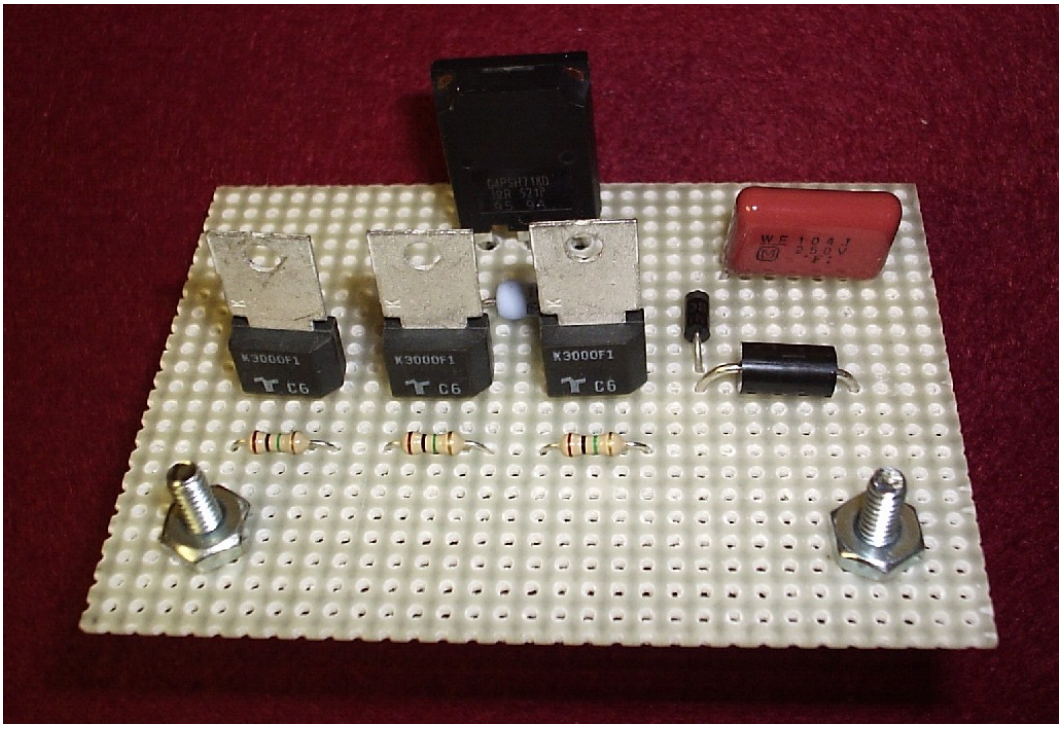


Primary Current (yellow) Gate Voltage (blue)

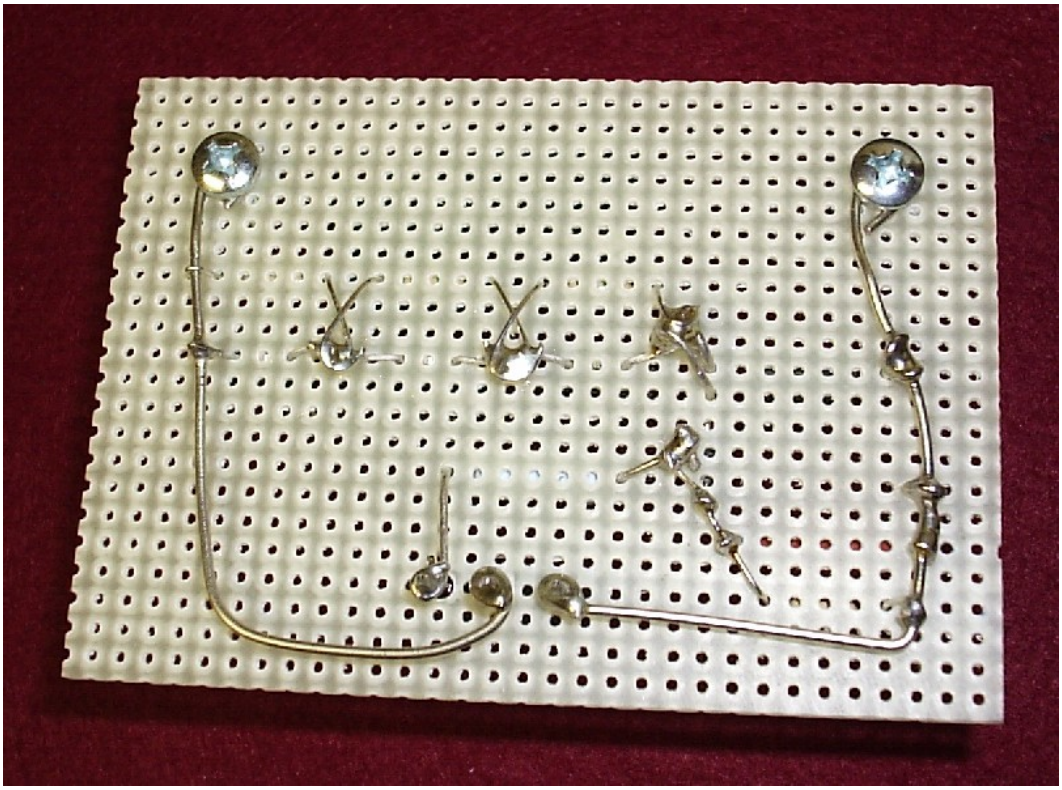
The IGBT gate starts to turn on at about 200nS which is excellent.



Primary Current (yellow) Gate Voltage (blue)



Latest board top view.



Latest board bottom view.