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

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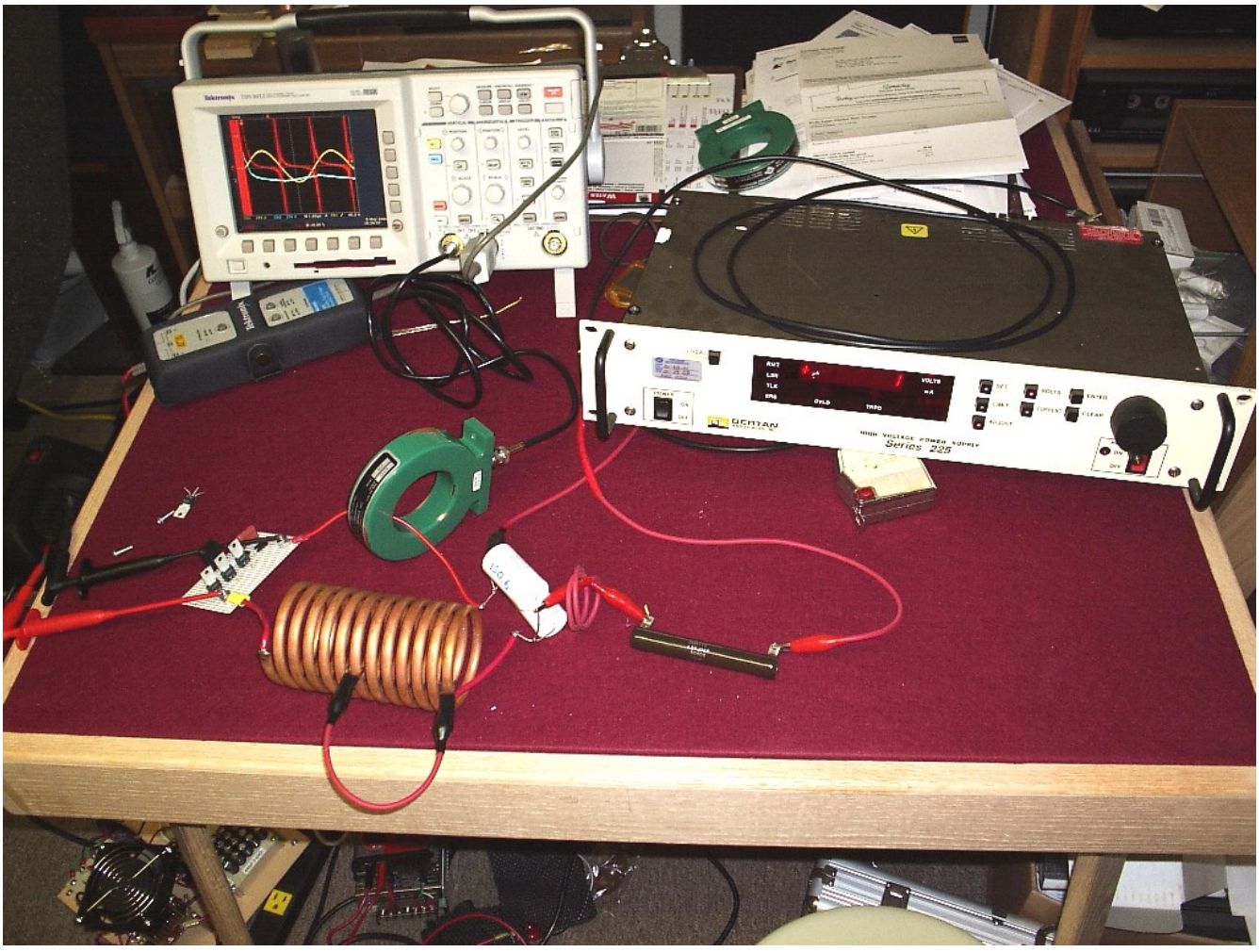
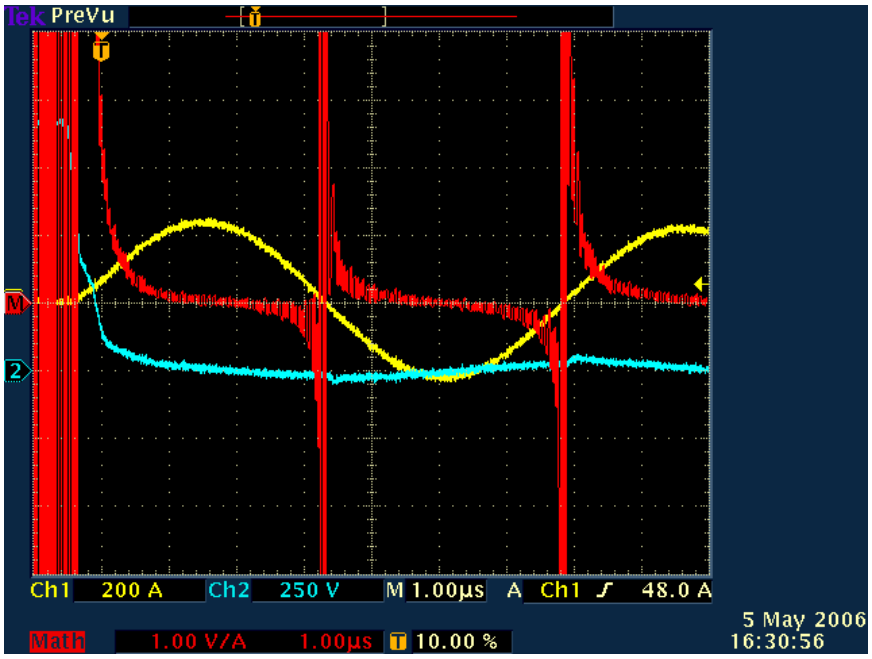
Hi Current Measurements -2

I ran the SIDAC / IGBT spark gap at higher and higher currents to see where the IGBT started to fall out of saturation. At some point, even with very high gate drive voltage, the IGBT will start to "open up". The structure inside the IGBT just can't keep the junction closed anymore.

In this case, I am using the IRG4PSH71KDBPF 1200V IGBT. There is 301.2 nF of primary capacitance and the firing voltage is 917 volts. By shorting across the primary inductor, I can increase the current gradually and monitor for the IGBT to become resistive during current peaks.

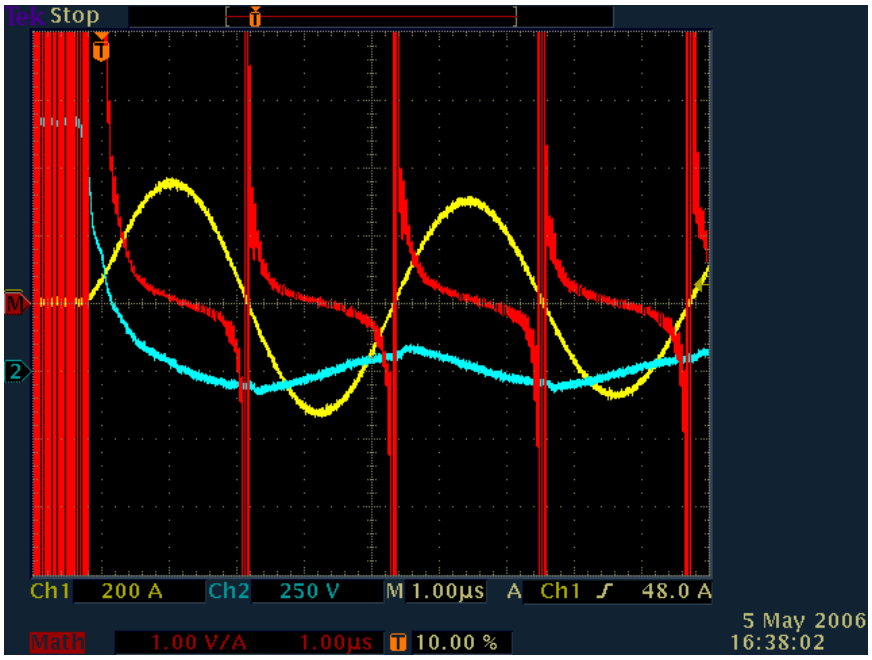


This is the normal 250 amp peak scope capture

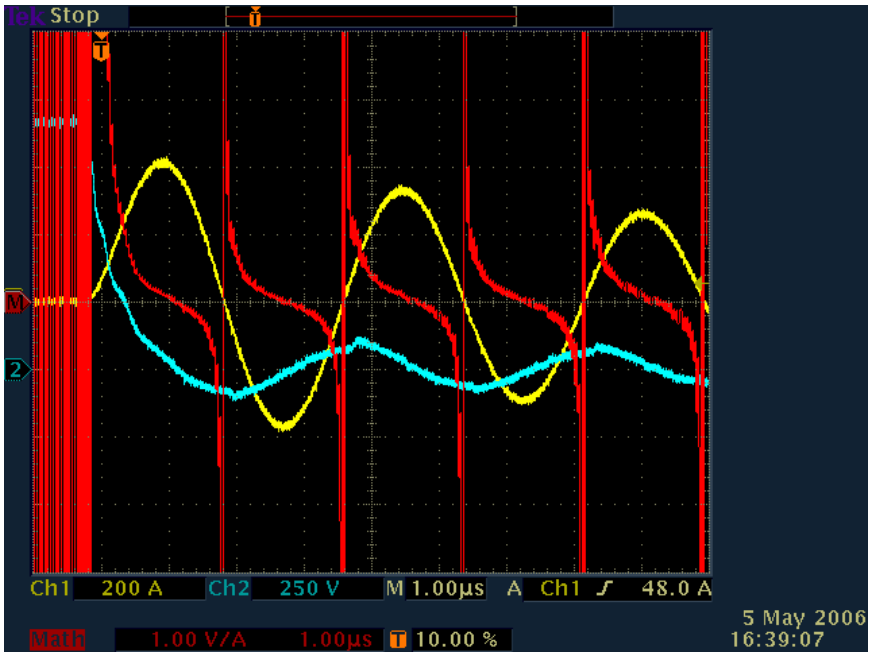


The current through the gap is in yellow at 200A/div. The blue is the voltage across the gap at 250V/div. The red is the resistance at 1 Ohm/div. The resistance stays flat and low during the current peaks.

At 360 amps peak, we start to see the first signs of desaturation where the resistance line starts to increase in angle and the voltage starts to rise.

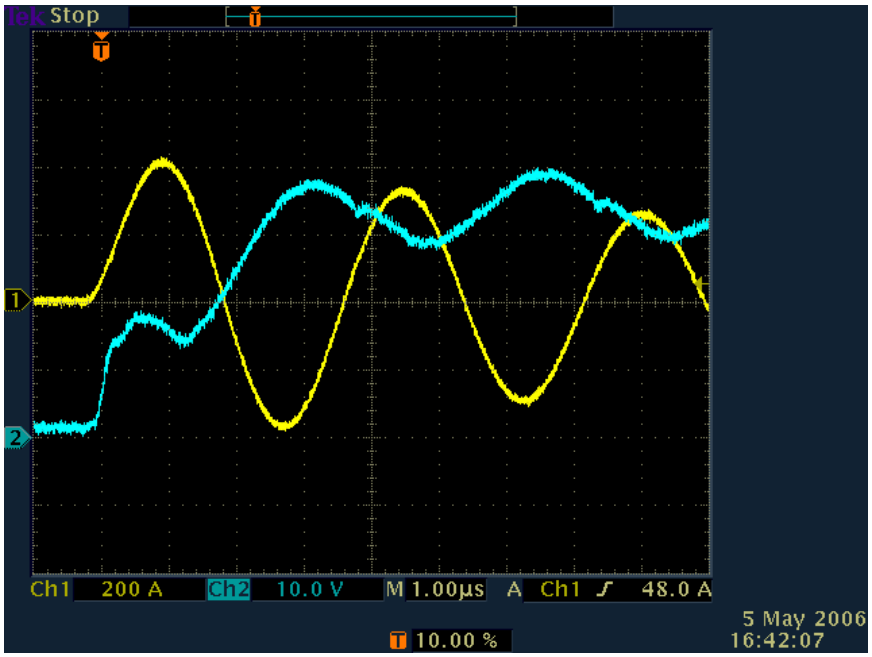


At 400 amps peak, the IGBT is no longer in control.



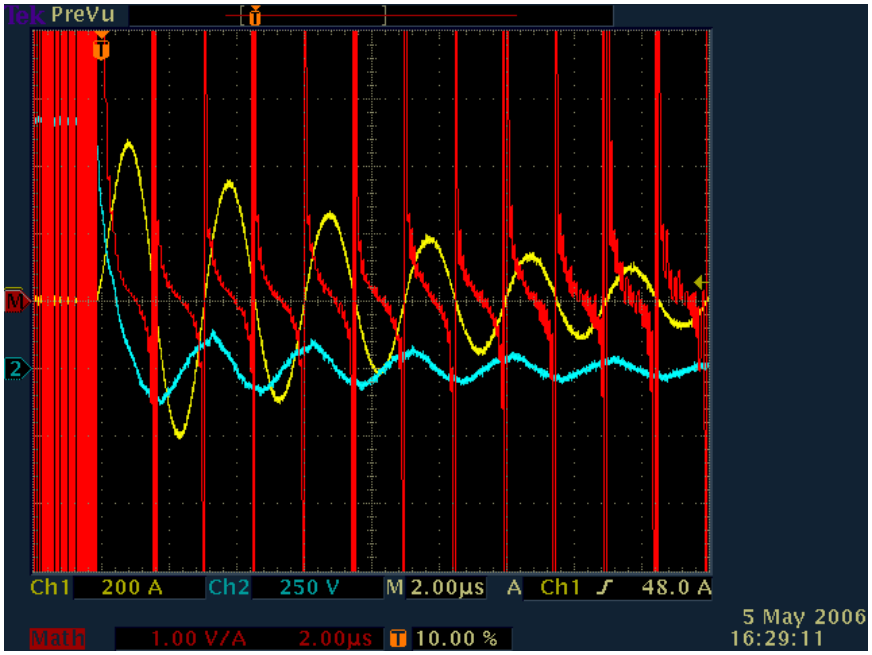
The resistance is high and there is significant voltage across the gap now. At this point, the IGBT will overheat if the gap is operating at say 120BPS.

We can look at the gate drive too.



There is "plenty" of gate drive :-) The emitter inductance is almost a problem now (~10nH) as noted by the heavy voltage swing in the gate voltage with the current. The device can "probably" take 50V on the gate before destruction.

We can run the gap in single pulsed mode at the maximum the circuit can deliver which is 540 amps peak.

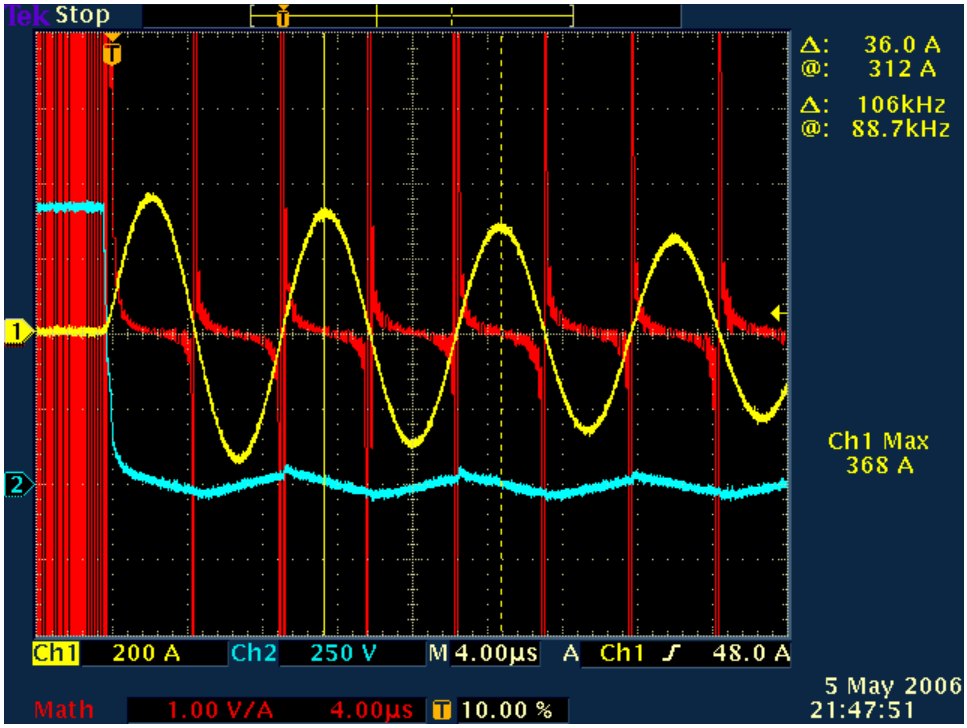


This does no damage to the gap but it would not run long like this in a Tesla coil. Note that the voltage across the gap is now completely out of control.

So it looks like 350 amps is a safe peak current level for the IRG4PSH71KDBPF IGBT. The circuit should be able to run any IGBT but this one was the cheapest ;-)

It should be noted that as the current was increased, the oscillation frequency also increased which may increase the stress on the IGBT. Lower frequencies "might" be able to take a little more current.

Follow up: I put in more primary capacitance to drop the frequency to 106kHz. the desaturation stayed the same as shown below.


Tek Stop
Δ: 36.0 A
@: 312 A
Δ: 106kHz
@: 88.7kHz
Ch1 Max
368 A
Ch1 200 A
Ch2 250 V
M 4.00µs
A Ch1 48.0 A
Math 1.00 V/A 4.00µs
10.00 %
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