Date: Fri, 23 Sep 2005 23:10:32 -0600
To: tesla@pupman.com
From: Terry Fritz <vardin@twfpowerelectronics.com>
Subject: Off Line - DRSSTC (OL-DRSSTC) Concept....
Cc:
Bcc:
X-Attachments:
In-Reply-To:
References:
Message-Id: <6.2.3.4.2.20050923220914.01ed6088@twfpowerelectronics.com>
X-Persona: <vardin>

Hi All,

The OLTC is very simple and tough, the DRSSTC is fairly complex and not quite as tough... I think there is a system (concept only!) that might marry the two in a very simple, cheap, and hardy configuration that any coiler should be able to put together...

I direct you attention to this schematic:

http://hot-streamer.com/temp/OL-DRSSTC.gif

Allow me to explain...

From the top right, the AC line voltage (probably from a variac) is rectified and charges a capacitor (Cresonant) through a blocking inductor to say 300VDC. This capacitor is similar to the ~3000uF buss caps we use in the DRSSTC. However, this capacitor is significantly smaller in value since it is limiting system power in this "fixed" 120 BPS coil. For a 1000W 120 BPS coil:

1000W = 120BPS x Ecap Ecap = 8.33Joules 8.33 = 1/2 x C x 300^2 C = 185uF

Note that with the proper selection of blocking inductor, the capacitor voltage can be "resonantly doubled" off the 60Hz AC line. I think "my" OLTC is the only one that ever used that proven concept...

Note that if the IGBTs obnoxiously decide to cross conduct, the 8.33 joules could be absorbed directly by the thermal mass of the IGBTs and the blocking inductor would provide time for them to correct. - It should never blow up...

So every 120th of a second, the system is provided with a say 185uF cap charged to 300VDC to "run the thing"... The duration of the cycle will be determined by how long it takes to use up the 185uF cap's energy.

Lprimary and Cprimary are typical per DRSSTC standards as is the secondary coil and all...

The H-bridge has four typical IGBTs with anti-parallel diodes.

The gate drive to the IGBTS is derived directly from the primary current now! There are four current transformers that provide isolated gate drive directly to each of the IGBTS from the primary current loop. Back to back Zener and Schottky diodes provide voltage control and very fast switching control of the current from the CTs to control the IGBTs. Of course, the "phasing" needs to be correct...

So the 185uF cap will discharge thought the IGBT H-Bridge and drive the coil. The direct connected, but voltage limited, CTs will feedback the primary current to the IGBTs providing synchronized timing control.

The firing MOVs "start" the cycle. Once the voltage reaches their level, they will conduct and "turn on" the system so the CT and IGBT system will start running.

As the 185uF cap drains, the system will fall out of conduction. When the primary current and drive signals collapse, the system's power will be almost all drained, so no harm should come...

This is all purely untested "pie in the sky stuff"... But if the concept is valid, it would bring together the best of the OLTC and DRSSTC together in a very simple, cheap, and robust system.

You can hold the AC line - to primary tank drive system in the palm of your hand!!!

If the concept holds, everything just changed... Again ;-)))

Cheers,

Terry

Date: Sun, 25 Sep 2005 04:40:48 -0600
To: tesla@pupman.com
From: Terry Fritz <vardin@twfpowerelectronics.com>
Subject: Off Line - DRSSTC (OL-DRSSTC) Concept - 2.0
Cc:
Bcc:
X-Attachments:
In-Reply-To:
References:
Message-Id: <6.2.3.4.2.20050925042336.01e84b10@twfpowerelectronics.com>
X-Persona: <vardin>

Hi All,

I played with computer models today and had a few changes to the concept.

http://hot-streamer.com/temp/OL-DRSSTC-02.gif

1. I think bi-directional transorbes can replace the Zener/Schottky pairs so only one device is needed instead of four on the IGBT gates.

2. The old trigger circuit did not work well, so I added a whole new trigger circuit. It is a MOV in series with a SIDAC and a current limiting resistor. The SIDAC could fire at say 20V and make a nice sharp current pulse to start the system.
The separate trigger current loop wire is simply strung though the CTs along with the primary wire.

I think to begin, one should just charge Cdrive (name changed from Cresonant since that caused confusion with Cprimary) with a DC power supply. The resonant charging thing is sort of trick and the other issues need to be worked out first. The trigger circuit could also be easily fiddled with for testing.

One problem modeling suggested is that it does not like to turn "off". Once the oscillation is started, it tended to start pulling current directly off the AC line. I think fiddling more with Lblock can solve that.

Modeling did show that it "loves" to run and found no basic problems with the topology.

I should not that this is all theory and has never been tested in hardware...

Cheers,

Terry

Date: Tue, 27 Sep 2005 18:32:45 -0600
To: tesla@pupman.com
From: Terry Fritz <vardin@twfpowerelectronics.com>
Subject: Off Line - DRSSTC (OL-DRSSTC) - 3
Cc:
Bcc:
X-Attachments:
In-Reply-To: <20050924174921.20544.qmail@web32609.mail.mud.yahoo.com>
References: <6.2.3.4.2.20050923220914.01ed6088@twfpowerelectronics.com>
<20050924174921.20544.qmail@web32609.mail.mud.yahoo.com>
Message-Id: <6.2.3.4.2.20050927180913.01e80370@twfpowerelectronics.com>
X-Persona: <vardin>

Hi All,

I have been running a lot of models and now have this for the OL -DRSSTC concept schematic:

http://hot-streamer.com/temp/OL-DRSSTC-03.gif

I had to go to 60BPS instead of 120 BPS. I use the dead 1/2 cycle to fire the coil so there is no incoming current to quickly recharge the buss cap. Otherwise, once the coil is started, in never turns off!! The waveforms look like this:

http://hot-streamer.com/temp/OL-DRSSTC-03a.gif

It should put out nice 60BPS bursts with 200kV peaks. Very long 2mS duration. Power to the streamer is roughly 1080 watts. The resonant charger gets the cap up to about 520VDC firing voltage with the line and resistive losses (note that the inductor is 19mH now for 60Hz). It is a stunning 25 joules per bang!!!

The primary current is only 200 amps and everything else seems generally easy without massive over loads. The 50 ohm resistors across the gates reduce the gate voltage and act a bit like a dead zone for the IGBT crossover.

The trigger circuit is pretty much out of the SIDAC data sheet...

The only concern is the 185uF buss cap. It will see about 22A RMS! That would kill most single electrolytics so I will have to look into that more.

By changing the SIDAC value, it should work off 120VAC or a variac at lower test voltages too. Everything can be "fiddled with" as needed to make adjustments or to get it to work.

So it is looking pretty good on paper and by computer. I think I will order some parts...

Cheers,

Terry

Date: Thu, 29 Sep 2005 01:50:14 -0600
To: tesla@pupman.com
From: Terry Fritz <vardin@twfpowerelectronics.com>
Subject: Re: Off Line - DRSSTC (OL-DRSSTC) - 4
Cc:
Bcc:
X-Attachments:
In-Reply-To:
References:
Message-Id: <6.2.3.4.2.20050929014429.01e9bd68@twfpowerelectronics.com>
X-Persona: <vardin>

Hi All,

I think I have done about all the computer modeling I can. Here is the schematic that is

getting pretty firmed up now.

http://hot-streamer.com/temp/OL-DRSSTC-04.gif

I will order parts tomorrow.

Cheers,

Terry

Date: Thu, 29 Sep 2005 20:31:02 -0600
To: tesla@pupman.com
From: Terry Fritz <vardin@twfpowerelectronics.com>
Subject: Off Line - DRSSTC (OL-DRSSTC) - 4 = 5
Cc:
Bcc:
X-Attachments:
In-Reply-To: <20b.a6c69f0.306d7cb4@aol.com>
References: <20b.a6c69f0.306d7cb4@aol.com>
Message-Id: <6.2.3.4.2.20050929202035.01fc0e60@twfpowerelectronics.com>
X-Persona: <vardin>

Hi All,

Here is the present parts list for the OL-DRSSTC thing:

http://hot-streamer.com/temp/OL-DRSSTC-05-MasterPartsList.pdf

Version 5 is just a typo cleanup of V4 with no significant changes...

Again, this is all completely untested unproven stuff. Don't go building it right away if you will blame me for it not working ;-)) But I know a number of folks are interested in these details...

I ordered the parts today...

Cheers,

Terry

Date: Tue, 04 Oct 2005 23:58:03 -0600
To: tesla@pupman.com
From: Terry Fritz <vardin@twfpowerelectronics.com>
Subject: OL-DRSSTC About "5" now...
Cc:
Bcc:
X-Attachments:

In-Reply-To:
References:
Message-Id: <6.2.3.4.2.20051004233051.01ea5210@twfpowerelectronics.com>
X-Persona: <vardin>

Hi All,

I got my "care package" from DigiKey today :-)

I got the H-Bridge and CTs built up:

http://hot-streamer.com/temp/OL-DRSSTC_H-Bridge_CTs.jpg

It is just like my other DRSSTC H-bridge but with 24V transorbs and no gate resistors. The "board" is real nice here too!! :-)) I don't have any extras so don't ask :o))

The newest "hopeful" schematic is here:

http://hot-streamer.com/temp/OL-DRSSTC-05.gif

I dropped the SIDAC voltage to 140V since the 150 volt ones fired too high. I also added a 1M 1/2 resistor across the 1uF trigger circuit cap since it stays charged "forever" without it. The 1.5K resistor in the trigger circuit gets to about 80-90C. But I have the 2W version installed. Might want to go to 5W if you don't like to burn you pinkies ;-) The super duty resistors, I use "don't care"... >:D

Here is the present, but ever changing, parts list:

http://hot-streamer.com/temp/MasterPartsList-OL-DRSSTC.pdf

I did test out the trigger circuit and it works perfectly like the computer and Teccor's data sheets said it would :-)))) I just put that into a PDF since it might have many DRSSTC uses ;-)

http://hot-streamer.com/temp/OL-DRSSTC-Trigger.pdf

Cheers,

Terry

Date: Wed, 05 Oct 2005 22:03:57 -0600
To: tesla@pupman.com
From: Terry Fritz <vardin@twfpowerelectronics.com>
Subject: OL-DRSSTC 6

Cc:
Bcc:
X-Attachments:
In-Reply-To:
References:
Message-Id: <6.2.3.4.2.20051005215652.01db75d0@twfpowerelectronics.com>
X-Persona: <vardin>

Hi,

I got a lot of the OL-DRSSTC wired up now. Looks like this.

http://hot-streamer.com/temp/OL-DRSSTC-001.jpg

For those tired of lugging those heavy DRSSTCs around, the circuits weigh in at just under 1.5 pounds ;-)

Cheers,

Terry

Date: Sun, 09 Oct 2005 14:34:39 -0600
To: tesla@pupman.com
From: Terry Fritz <vardin@twfpowerelectronics.com>
Subject: OL-DRSSTC 7 - It's Alive!
Cc:
Bcc:
X-Attachments:
In-Reply-To:
References:
Message-Id: <6.2.3.4.2.20051009141341.01f1ebb8@twfpowerelectronics.com>
X-Persona: <vardin>

Hi All,

I was not able to work on the OL-DRSSTC concept thing for the last few days, but today I am back at it.

It seems to work fine!!!!!

I am just running in a "single shot" mode right now and there is a 1 ohm damping resistor in the primary loop just to keep things pleasantly under control for testing.

Here is the first time the primary only system fired where the CT feedback fully "takes over" the IGBT gate drive. The primary was a 56uH coil, 37.5uF cap and the 1 ohm "load" resistor. The 440uF storage cap was charged to 200VDC:

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-09-01-First-Fire!.gif

Primary loop current is in yellow and gate drive voltage is in blue.

At about 40 amps of primary current, the gate drive voltage locked in solid and was nicely clipped at 25 volts by the gate transorbs.

Here is the entire burst:

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-09-02.gif

Here is the tail:

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-09-03.gif

Here is the start:

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-09-04.gif

Here is primary current (yellow) and buss cap voltage (blue).

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-09-05.gif

Here is the first time I fired the full coil with the secondary in place. This is a very significant firing in that it simply "did not blow up "

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-09-06.gif

The coil was pretty out of tune so I took a turn of the primary:

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-09-07.gif

I took another turn of the primary and hooked the plane wave antenna to the blue channel. Top voltage is about 80kV:

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-09-08.gif

Here is the first time it arced to a grounded object. Just a grounded rod a foot away. Nothing blew up :-)))

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-09-09.gif

Since I am firing single shoot I could not get an arc "picture", but trust me :o))

Here is the bench setup"

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-09-10.jpg

The OL-DRSSTC "guts":

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-09-11.jpg

The coil side:

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-09-12.jpg

Here is the latest schematic. Not much changed other than the trigger circuit is using a 0.47uF cap and I changed back to the old primary cap and inductance since it was easier to fiddle with right now.

http://hot-streamer.com/temp/OL-DRSSTC-06.gif

The trigger circuit still needs work. The "cheap" caps get hot so it needs nice foil poly caps too!! I think you need to "tune" it so that the trigger pulse is also a resonant circuit near the coil's frequency. It takes a good powerful pulse to start the thing. It "could" be more sensitive, but I am afraid it might not turn off well if it were too easy to trigger. Modeling suggests that "turning off" could be a significant problem...

The trigger loop through the CTs acts like and inductor. The trigger circuit cap and SIDAC are just like a coil's primary circuit. The 2.7 ohm resistor could be lowered too give more "bang' too... The tiny SIDAC seems to run stone cold and loves this service!

It does take a primary voltage over about 200V to get the coil to trigger. It would be nice if that were lower so it could run under power control with a variac... I was also using a 100 ohm resistor "tapped" across the bridge output to give extra kick for manual firing. Interesting since that opens up some possibilities for 120BPS and other very simple BPS controls.

BTW - I know many are interested in the Gate drive and I forgot to get a scope picture of it, so I went and did it now:

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-09-GateDrive.gif

Yellow is primary current and blue is a gate voltage. Between 15 and 16uS you can see the dead time glitches.

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-09-GateDrive1.gif

timing seems pretty late, but the peak current is low so the gate drive is low and slow too:

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-09-GateDrive2.gif

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-09-GateDrive3.gif

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-09-GateDrive4.gif

In general, it seems to work fine! Some technology certainly need to be worked out, but there is no fundamental problem at all... And, it makes foot+ sparks "easily" even the "first time" ;-))

Cheers,

Terry

Date: Tue, 11 Oct 2005 19:22:13 -0600
To: tesla@pupman.com
From: Terry Fritz <vardin@twfpowerelectronics.com>
Subject: OL-DRSSTC 9 - Better trigger!!
Cc:
Bcc:
X-Attachments:
In-Reply-To:
References:
Message-Id: <6.2.3.4.2.20051011184703.01f15748@twfpowerelectronics.com>
X-Persona: <vardin>

Hi All,

The OL-DRSSTC coil now triggers at any input voltage so the power can be "fully" controlled by a variac! I went to a "fully resonant tuned" trigger pulse and it will now fire "anything"!!

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-11-001.gif

The trigger pulse is a big 35 amp 96kHz decrement sinewave now that lasts for about 8 cycles! It will start up any lazy ol-DRSSTC :o)) It could probably even power a little Tesla coil all by itself, but it is only 5.3mJ/bang or 0.32 watts. Almost 1 inch by the Freau equation... Might be useful for "enyweeny" coils:

http://www.roffesoft.co.uk/tesla/enyweeny/enyweeny.htm

The drive circuit is here in the upper right:

http://hot-streamer.com/temp/OL-DRSSTC-08.gif

I took out the 2.7ohm resistor and added a reverse diode across the SIDAC. I added a loop of "primary" wire to the trigger loop so I could tune it right to the Fo frequency of the primary coil. So it runs much like the original OLTC did. There is not much to it (it really only needs "one" cap...):

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-11-005.jpg

One could probably fiddle with the part values as you please. The SIDAC "could" probably push 80 amps!! Peak current is controlled by the firing voltage and primary loop impedance. The voltage ringup is able to keep the circuit in conduction until the cap energy is used up. Really cool!! ;-))

With a test load, the circuit fires right up! Yellow is primary current and blue is the trigger circuit loop current.

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-11-002.gif

At 60BPS, this heated the IGBTs to about 40C with the fan in place (could use a "better" instead of the "cheapest" fan...).

I hooked it to the full coil and tuned it for some nasty primary currents and it started and ran fine:

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-11-003.gif

The firing pulse train looks like this:

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-11-004.gif

So that is where I am... Things to do...

A simple inrush current limiter could replace the big blocking inductor for less power but a far smaller size...
The fan needs to be "better"... Maybe a big CPU fan, but I don't have the low voltage to run it...
I need to put back in the 150nF primary cap and 16uH primary to optimize it all much better.
I need to get a few more parts from DigiKey....

BTW - I think DK# P12241-ND 2.4uF 400V poly caps could directly replace the 2.5uF

caps from Richardson...

Cheers,

Terry

Date: Wed, 12 Oct 2005 19:56:00 -0600
To: tesla@pupman.com
From: Terry Fritz <vardin@twfpowerelectronics.com>
Subject: OL-DRSSTC 10
Cc:
Bcc:
X-Attachments:
In-Reply-To:
References:
Message-Id: <6.2.3.4.2.20051012193456.01ed1588@twfpowerelectronics.com>
X-Persona: <vardin>

Hi All,

I mostly did paperwork today updating the parts list and ordering parts.

http://hot-streamer.com/temp/OL-DRSSTC-MasterPartsList.pdf

I also got the 150nF primary cap installed and retuned the primary coil. I need to change the bias resistors from 47K to 4.7K for the big primary cap, but the super trigger still seems to fire up the coil fine. The latest schematic is here:

http://hot-streamer.com/temp/OL-DRSSTC-09.gif

With the new primary cap and coil values, the bang cycle time is way down:

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-12-001.gif

The IGBTs run far cooler now with the shorter cycle time!! I also raised the fan further above the IGBTs so the airflow and cooling are much better. It will run 100 amps at about +5C now which is very good. Higher currents also have far less transition time as show in this captures:

2.5uS at 50 amps

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-12-002.gif

1.56uS at 100 amps
http://hot-streamer.com/temp/OL-DRSSTC-2005-10-12-003.gif

The CT's feedback voltage is at 1V/amp right now. I could raise that to say 5V/amp if more speed is needed. It seems to take about 8 volts to turn on the IGBTs...

I also thought about laying it all out on a single 6 x 6 PC board...

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-12-004.gif

Didn't get much else done today.

Cheers,

Terry

Date: Thu, 13 Oct 2005 15:39:07 -0600
To: tesla@pupman.com
From: Terry Fritz <vardin@twfpowerelectronics.com>
Subject: OL-DRSSTC 11
Cc:
Bcc:
X-Attachments:
In-Reply-To:
References:
Message-Id: <6.2.3.4.2.20051013145436.01f270f0@twfpowerelectronics.com>
X-Persona: <vardin>

Hi All,

I took some fascinating waveforms!!! Pretty technical stuff though %:-)

Here is the drive voltage from the H-Bridge (blue) and the primary loop current (yellow):

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-13-001.gif

If your really interested, here is the raw data file that can be opened in a spreadsheet or MathCad (text too):

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-13-002.CSV

Here is a close-up at the highest current peak:

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-13-003.gif

The DRSSTC designers will note that this wave form is pretty odd!! The voltage on the buss caps is dropping linearly as expected in this system during the firing cycle. Since it is run off a variac, the buss voltage is 52V volts at start in this case.

First you will notice the rather extreme dip in the drive voltage in the center of what should be a squarewave. The dV/dT and current matches about 5uF which is what the big poly buffer caps are. This suggests that the electrolytic array is pretty soft into 100 amps. It looks like they can hold their own again at about 60 amps. This might be a real problem at higher currents. Here is a detailed picture:

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-13-003a.gif

The droop seems less on the negative side, so perhaps the electrolytics can supply more negative current than positive current... But it looks like I might need better electrolytics or more poly buffer caps at higher current.

Next we look at the IGBT switching cycle:

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-13-004.gif

It looks like the IGBTs are shutting off about 50nS after the zero current crossing!! That is very good since it means the bridge is not "fighting" the primary loop oscillation. Note how the bridge actually switches almost 1uS after the current crossing!!

For the next ~700nS, the voltage has just jumped to the rail voltage limited by the reverse diode. This is very interesting because the circuit is free of drive at this point. All the IGBTs are independently controlled by independent CTs. It looks like the buss caps are being recharged a bit here since the voltage rises some in this zone.

This is a close up of the IGBTs switching from on open circuit limited by the reverse diodes to full IGBT "on" in 370nS:

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-13-005.gif

I suppose one could figure switching energy (or push a bunch of buttons on the scope to calculate it directly), but I have not yet. The actual switching time is about ~370nS so it is very fast, just pretty late. Note that the primary current (amplified here) shows no switching glitches at all!

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-13-007.gif
Here is the gate drive signal in relation to the primary loop current:

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-13-006.gif

For a current transformer driven gate with a resistor across it, the switching time is given fairly closely by this equation I derived. I wrote the derivation down in my notes here next to Fermat's theorem :o)

T = SQRT ((V x C) / (K x D x I x F x pi))

T = switching time
V = Voltage from initial state to IGBT turn on (25 + 10 = 35) C = Gate capacitance (3.3nF)
K = CT ratio (1/100)
F = Frequency (96000)
R = Gate parallel resistance (100)
I = Peak current
D = Division ratio (0.195)

D = R / SQRT(R^2 + (1 / 2 x pi x F x C)^2) = 0.195

T = SQRT ((35 x 3.3e-9) / (0.01x 0.195 x 100 x 96000 x pi)) = 1.40uS

So one can play with these variable to try and reduce the late switching time. If there were no parallel resistance at all, it would be 619nS. Lowering the gate rail voltage to 20 volts would reduce it about 100nS but that is probably a bad idea for such a small gain. Lower frequency helps, but the coil is as it stands. Probably do not want to double wrap the CTs since they are already taking a LOT of current already ;-)) Custom CTs might do better here, but I like the COTS ones ;-) IGBTs with lower gate capacitance helps, but the IGBTS are as they are here.

The time definitely goes down with higher primary current. At 500 amps it is 626nS. With 500 amps and no parallel resistor, it is 276nS. So the time will pick up naturally with higher current but I need to look at a higher parallel resistance for sure!

The current at switching is:

Is = I x 2 x pi x F x t

So at 500 amps and 276 nS:

Is = 500 x 2 x pi x 96000 x 276e-9 = 83 amps

With a 100 ohm resistor that is 188 amps!!

So the gate drive resistor needs to go higher which is the next order of business....

We can also estimate IGBT heating:

P = BPS x t x Is x Vbuss / SQRT(2) x cycles

P = 60 x 276e-9 x 83 x 250 / 1.414 x ~100 = 24 watts

Happily, that is easily within the range of the H-bridge.

If we leave in the gate resistance (as it is right now):

P = 60 x 619e-9 x 188 x 250 / 1.414 x ~100 = 123 watts!

So the OL-DRSSTC really is simple, when it is all done ;-))

Cheers,

Terry

Date: Fri, 14 Oct 2005 20:14:02 -0600
To: tesla@pupman.com
From: Terry Fritz <vardin@twfpowerelectronics.com>
Subject: OL-DRSSTC - 12
Cc:
Bcc:
X-Attachments:
In-Reply-To:
References:
Message-Id: <6.2.3.4.2.20051014195220.01da8d70@twfpowerelectronics.com>
X-Persona: <vardin>

Hi All,

Today I tracked down the voltage droop problem.

I looked much into buss resonances and all that and there are some issues there. You want to keep the leads and all real short and all that.

But the main issue turned out to be the high internal resistance of the electrolytic cap array. I disconnected the poly buffer caps so the thing was running off the electrolytics only:

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-14-002.gif

When the IGBTs turn on, the voltage across the caps drops to the 10 volt IGBT rail. The electrolytics contribute NO real current to the oscillation!!! They are only good for

charging the buffer caps. The two 2.5uF buffers are supporting the entire primary loop current!

Here is the rail with the original 2.5uF 942 buffers:

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-14-001.gif

I then replaced the caps with two 5 uF 940 series caps:

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-14-003.gif

The old caps are shadowed in white and the blue area is the droop with the caps of twice the value. The droop is reduced dramatically!! Probably a little more than expected sue to some resonant effects.

The drive signal now looks very good so the new caps were just enough to do the trick:

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-14-004.gif

The voltage right across the electrolytics is also fairly smooth now:

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-14-005.gif

So it looks like everything is all worked out now :-))

Cheers,

Terry

Date: Sat, 15 Oct 2005 16:27:59 -0600
To: tesla@pupman.com
From: Terry Fritz <vardin@twfpowerelectronics.com>
Subject: OL-DRSSTC - 13
Cc:
Bcc:
X-Attachments:
In-Reply-To:
References:
Message-Id: <6.2.3.4.2.20051015155107.034f5790@twfpowerelectronics.com>
X-Persona: <vardin>

Hi All,

Today I did some single shot testing at ~170v buss:

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-15-001.gif

Primary current yellow, buss voltage is blue.

As expected, the burst shortens up so most of the real power is in the first 400uS. This is an interesting tuning spot since you can see the modes switching between poles as the streamer forms.

The droop is not bad at all anymore but the turn-on timing is still about 950nS out:

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-15-002.gif

It tries to turn on at ~600nS but it seems to have to build up steam to drive the current out. It stutters for about 200nS while the gate voltage builds up. The turn on transition is about 350nS against about 220amps. Not sure how bad that is. I will find out when running it full blast ;-) The total power is not bad, but the peak power is high there... I may get away with it...

I moved to the big variac now. The little OL-DRSSTC get lost between the variac and scope ;-)

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-15-003.jpg

Note the "blast shield" between the OL-DRSSTC and the scope now :o)))

Here are some little sparks at only 35V buss for DC Cox :o))

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-15-004.jpg

I am a little worried about loop current. With a primary inductor, the buss voltage can hit 240VDC where the computer says:

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-15-005.gif

It can hit 600 amps!! That is sort of "high"...

I can reduce system power buy lowering the buss capacitance, reducing buss voltage, and decreasing the primary capacitance. But I think I will leave as is since I really don't want to use the buss inductor at all. That would put the nominal firing voltage at 170VDC which might be just right....

Computer says...
435 amps peak
36 Arms primary current
18A peak AC line current

7.9 Arms AC line current
390 W buss power
225 W streamer power
150kV peak output voltage

Seems just fine ;-)) I should note that streamer models are weak and the above numbers do depend a lot on that (especially streamer power). But history says that those are good numbers in any case. Steamer power could probably be better estimated as "BussPower - SystemLoss" in the DRSSTC case...

Cheers,

Terry

Date: Sun, 16 Oct 2005 15:22:35 -0600
To: tesla@pupman.com
From: Terry Fritz <vardin@twfpowerelectronics.com>
Subject: OL-DRSSTC - 14 - Movie
Cc:
Bcc:
X-Attachments:
In-Reply-To:
References:
Message-Id: <6.2.3.4.2.20051016151221.01e138c0@twfpowerelectronics.com>
X-Persona: <vardin>

Hi All,

I did higher power testing (80%) today and everything seems to stay fairly cool for few second runs. Here is the system as it now stands:

http://hot-streamer.com/temp/OL-DRSSTC-2005-10-16-001.jpg

I think it is pretty much good to go now. At full power it should easily hit 30 inches. I did not play much with ground strikes since there is too much electronics around. Here is a movie in Video CD format that should play on any viewer.

http://hot-streamer.com/temp/OL-DRSSTC-01.mpg

Everything seems to hold together nicely with no problems :-))

Cheers,

Terry