

DSA328 Quench Protection Heater Test Results_II

This is a follow up note on DSA328 heater tests. There are eight heaters in DSA328, two in each quadrant for quench protection.

The purpose of heater tests during the second cooldown was to measure the minimum energy required to produce a heater induced quench. Heater test results from the first thermal cycle of DSA328 are given in detail in TS-SSC92-025, which shows the effect of insulation thickness between the coil and the heater and its effect on the energy requirement to produce a heater induced quench.

The heaters were fired, in different combinations, at two different magnet currents i.e. 2000 A and 5000 A. The test were conducted under the same conditions as before.

The minimum energy required to quench the magnet, at 2 kA, with the heater combination of data set 1 and 3 is about 19.7 and 26.8 joules with 90 and 105 Vhfu respectively. I have added these results in the table from previous test results.

There is an estimated 10 msec uncertainty in finding quench start (T_q) and a ± 5 percent variation in heater voltages which translates to roughly 10 percent variation in energy deposition, which is well within the range of errors for this test. The differences in heater response time T_{fn} are consistent with measurement uncertainties.

DATA SET 1:

DSA328 Heaters 1B and 3B in series, were fired together, with one 5-mil kapton between the heater and the coil

=====
R_{tot} =5.1 ohm; C =35 mF; Rh =.71 ohm;

Tfn (msec)	Imag (A)	VHFU (v)	Edep (joule)
110	2003.	175.	74.4
160	2003.	150.	54.6
210	2003.	135.	44.2
215	2003.	115.	32.1
220	2003.	125.	37.9
380	2003.	100.	24.2
390	2003.	90.	19.7 minimum energy required to quench the magnet

NOTE: Imag=5000 A, heater did not fire below 85 Vhfu

87	5003.	160.	62.1
115	5005.	130.	41.0
130	5006.	115.	32.1
170	5002.	107.	27.8
232	5004.	100.	24.3
342	5002.	85.	17.5 minimum energy required to quench the magnet

DATA SET 2:

DSA328 Heaters 2A and 4A in series, were fired together, with two 5-mil kapton between the heater and the coil

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R_{tot} =5.1 ohm; C =35 mF; Rh =.71 ohm;

Tfn (msec)	Imag (A)	VHFU (v)	Edep (joule)
255	2002.	150.	54.6
195	2002.	205.	102.0

145	2002.	250.	151.7
140	2002.	280.	190.3
120	2002.	300.	218.5
560	2003	105	26.8 minimum energy required to quench the magnet

(Imag=5000 A

125	5004.	220.	117.5
165	5000.	180.	78.6
202	5004.	140.	47.6
366	5003.	105	26.8
310	5003.	82.5	16.5 minimum energy required to quench the magnet

DATA SET 3:

DSA328 Heaters 2B and 4B in series, with two 5-mil kapton between the heater and the coil

=====
R_tot =5.1 ohm; C =35 mF; Rh =.71 ohm;

Tfn (msec)	Imag (A)	VHFU (v)	Edep (joule)	
120	2003.	300.	218.5	
155	2003.	240.	139.8	
175	2002.	200.	97.1	
205	2003.	175.	74.3	
275	2003.	141.	48.3	
450	2002.	110.	29.4	
560	2004	105	26.8	minimum energy required to quench the magnet

NOTE: Imag=5000 A, heater did not fire below 95 Vhfu

(Imag=5000 A

90	5004.	260.	164
107	5004.	220.	117
125	5000.	180.	78.6
135	5004.	160.	62.1
180	5000.	140.	47.6
373	5000.	105.	29.4
530	5005.	95.	21.9 minimum energy required to quench the magnet

DATA SET 4:

Individual heater test results

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R_tot =4.5 ohm; C =35 mF; Rh =.71 ohm; Edep=110 joules

(Tfn (msec)	Imag (A)	VHFU (v)	T_hfu (joule)	Tq	Heater
150	2002	200	230	80	;2B
150	2002	200	240	90	;4B
145	2002	200	265	120	;2A
150	2002	200	270	120	;4A
90	2002	200	165	75	;1B
90	2002	200	175	85	;3B
90	2002	200	200	110	;1A

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