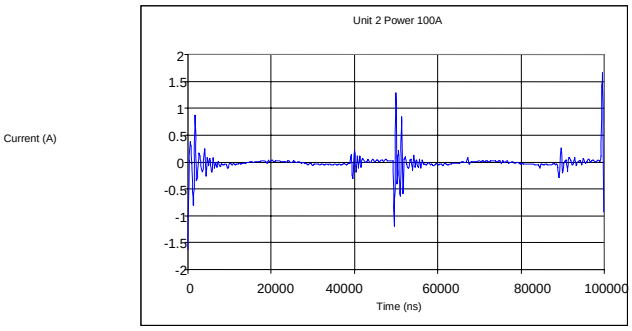
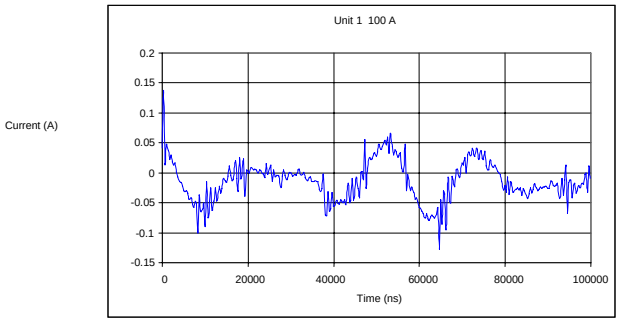
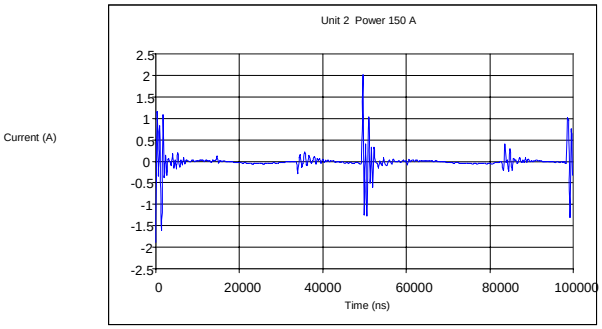
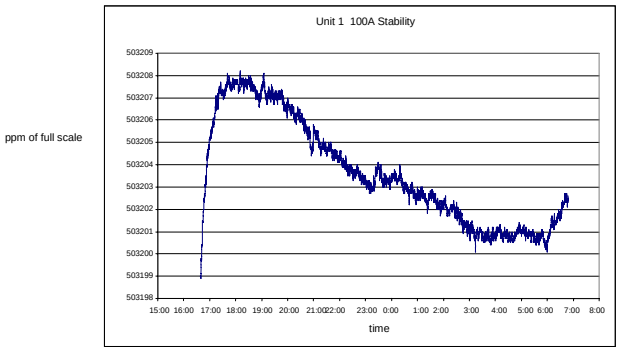




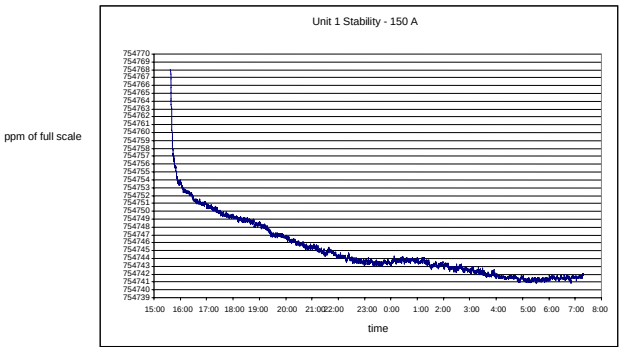


.8 hour Stability

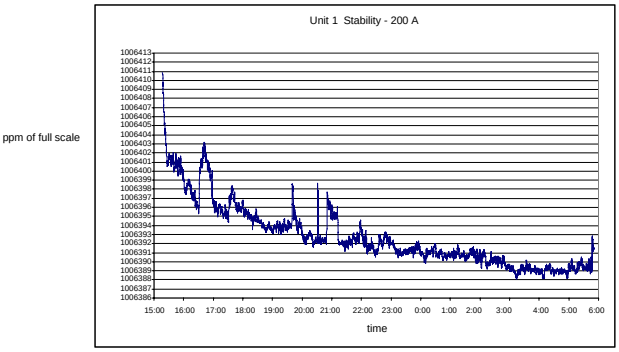
The stability over a minimum of 8 hours has been measured at three output levels for each of the converters. The power supplies are run with a constant setpoint and the output current is continually logged. The maximum variation over a 30 minute period (excluding the first 100 seconds) and the the maximum variation over a 8 hour period (excluding the first 60 minutes) have been recorded and compared with the specification requirement. The results of the two units are presented graphically in the following tables. The x – axis denotes the time, and y – axis denotes the recorded current.



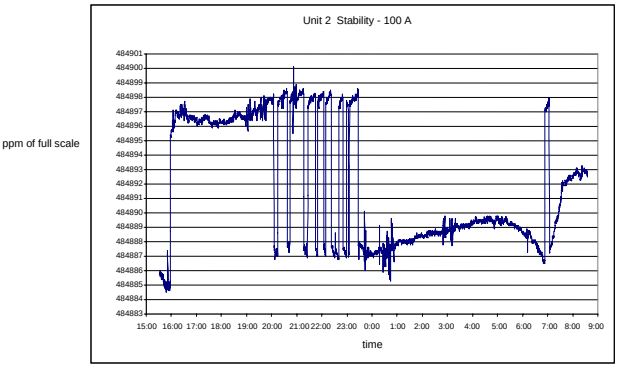
Stability of Unit 1 at 100 A



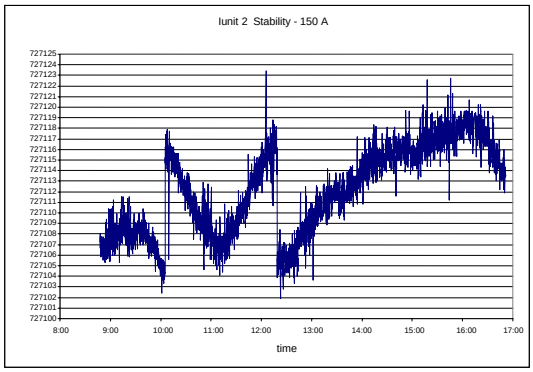
Stability of Unit 1 at 150 A



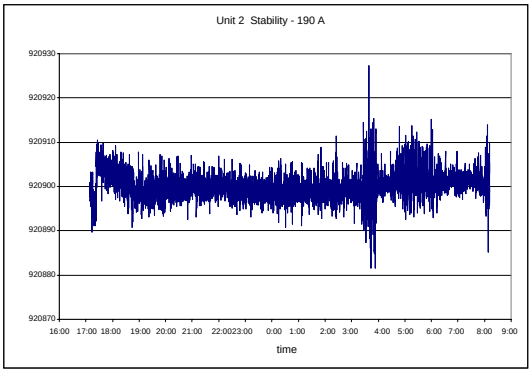
Stability of Unit 1 at 200 A



Stability of Unit 2 at 100 A



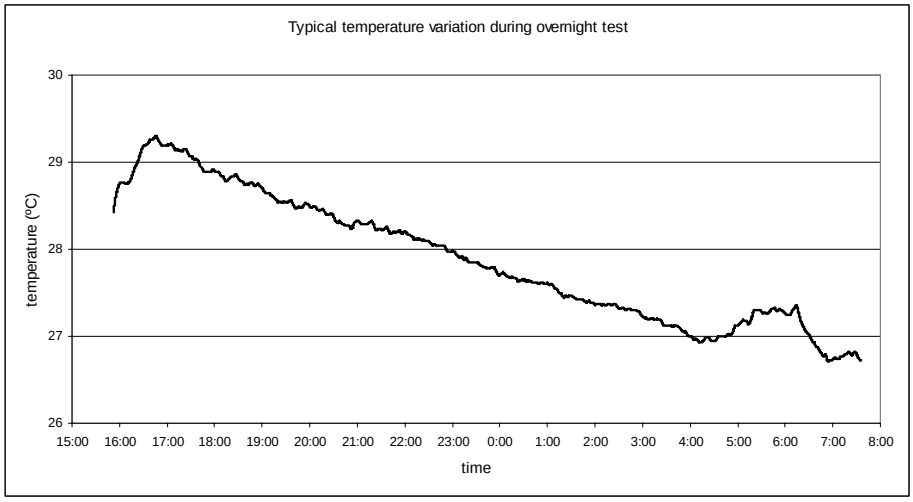
Stability of Unit 2 at 150 A



Stability of Unit 2 at 190 A

The Unit 1 performs well within the 10 ppm requirement once the first half hour of operation is passed. Unit 2 by contrast, performs within the specification for some period of time but suffers a sudden change in output current. A possible cause may be some temperature instability in the current feedback circuitry.

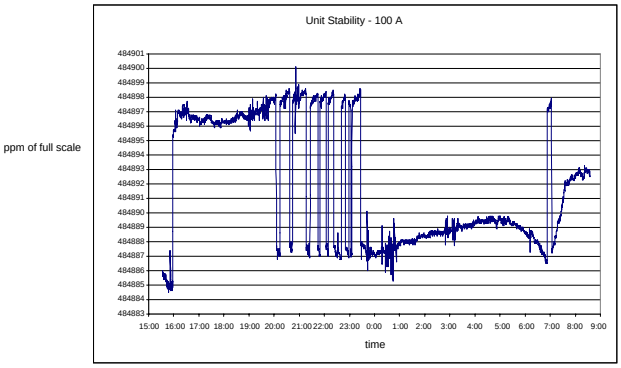
The stability of the units under test needs to be shown in comparison with the ambient temperature drift during the period of the test. The following graph shows the temperature recorded by a PRT thermometer during the course of a stability run.



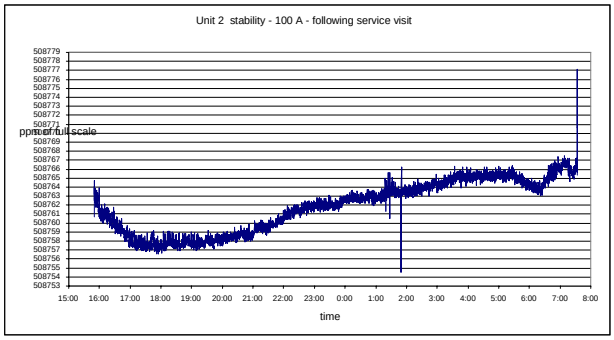
Temperature variation during stability measurement

As can be seen in the graph, the temperature varied by 2.5ºC during this period. The DCCT used for the external current measurement is specified with a temperature stability of 1 ppm per ºC. It is clear that the variation in ambient temperature variation accounts for some but not all of the output current variation.

The behaviour of Unit 2 was investigated by the manufacturer during a site visit. It was suspected that the cause of the instability was a faulty temperature controller for the feedback burden resistor and ADC. The temperature control box was removed, and the unit subsequently performed as shown in the right hand diagram. The performance with the temperature box in situ is shown on the left for comparison.

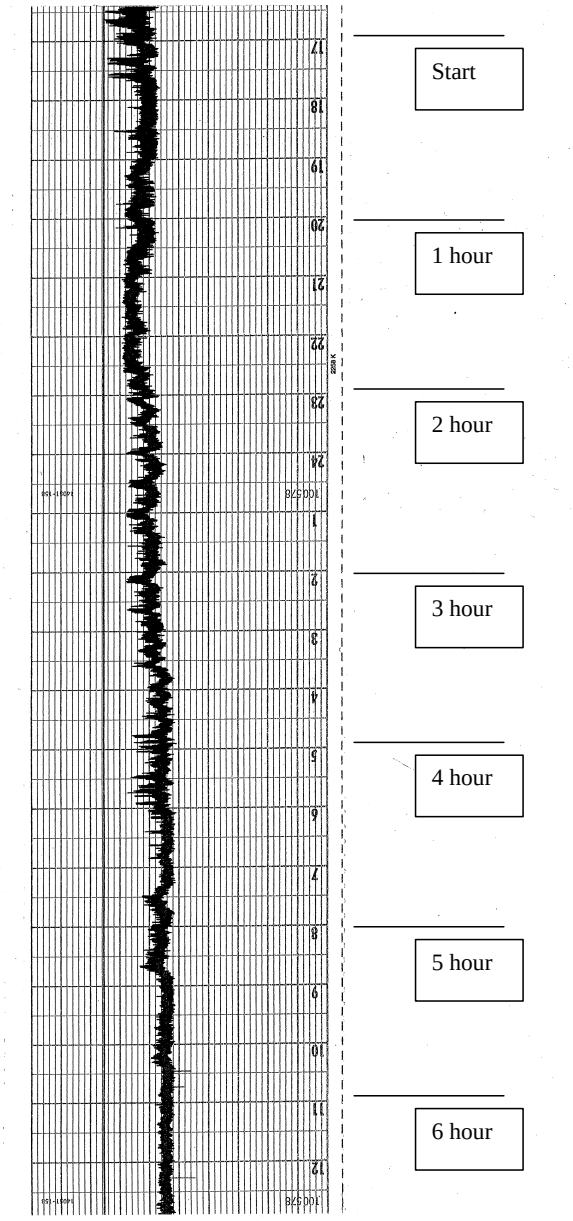


Unit 2 at 100 A before visit by representative.



Stability of Unit 2 at 100 A following visit by representative.

Stability data have been provided for Unit 3 and are presented in the figure below. In this test the output current was 150A. The full scale represents 200 ppm, and each division 20 ppm, and each subdivision 4 ppm.



These results show that Unit 3 is stable to within 50 ppm over the 6 hour period.

It is recommended that definition of stability should include a warm up period of 2 hours. During this period, the power supply may drift outside of the 10 ppm range.

Form E: Resolution Report Form

DCCT	Internal	External
Full scale I		200
Full scale V		10
DCCT multiplier		20

Initial Set Point	50%		
Increment	Set Point	DCCT	Recorded Current
0	100.00000	5.032140	100.6428
1	100.00076	5.032133	100.6427
2	100.00152	5.032127	100.6425
3	100.00228	5.032123	100.6425
4	100.00304	5.032198	100.6440
5	100.00380	5.032271	100.6454
6	100.00456	5.032266	100.6453
7	100.00532	5.032271	100.6454
8	100.00608	5.032349	100.6470
9	100.00684	5.032505	100.6501
10	100.00760	5.032504	100.6501
11	100.00836	5.032503	100.6501
12	100.00912	5.032503	100.6501
13	100.00988	5.032734	100.6547
14	100.01064	5.032658	100.6532
15	100.01140	5.032656	100.6531
16	100.01216	5.032658	100.6532

Initial Set Point	75%		
Increment	Set Point	DCCT	Recorded Current
0	150.00000	7.547525	150.9505
1	150.00076	7.547675	150.9535
2	150.00152	7.547678	150.9536
3	150.00228	7.547681	150.9536
4	150.00304	7.547683	150.9537
5	150.00380	7.547762	150.9552
6	150.00456	7.547841	150.9568
7	150.00532	7.547843	150.9569
8	150.00608	7.547849	150.9570
9	150.00684	7.548003	150.9601
10	150.00760	7.548001	150.9600
11	150.00836	7.548003	150.9601
12	150.00912	7.548000	150.9600
13	150.00988	7.548077	150.9615
14	150.01064	7.548077	150.9615
15	150.01140	7.548072	150.9614
16	150.01216	7.548147	150.9629

Initial Set Point	95%		
Increment	Set Point	DCCT	Recorded Current
0	190.00000	9.559970	191.1994

1	190.00076	9.560015	191.2003
2	190.00152	9.559941	191.1988
3	190.00228	9.560167	191.2033
4	190.00304	9.560090	191.2018
5	190.00380	9.560088	191.2018
6	190.00456	9.560087	191.2017
7	190.00532	9.560082	191.2016
8	190.00608	9.560230	191.2046
9	190.00684	9.560310	191.2062
10	190.00760	9.560305	191.2061
11	190.00836	9.560304	191.2061
12	190.00912	9.560450	191.2090
13	190.00988	9.560453	191.2091
14	190.01064	9.560449	191.2090
15	190.01140	9.560445	191.2089
16	190.01216	9.560595	191.2119

NPLC: 200 Cycles – 2 s The test was performed using the PC control interface control allowing the setpoint to be incremented in 0.00076 A steps.

Form F: Accuracy Report Form

DCCT	Internal	External
Full scale I		200
Full scale V		10
DCCT multiplier		20

Set Point								
% of rated	Value	Internal DCCT DVM Reading	Internal DCCT reading	External DCCT DVM Reading	External DCCT reading	Internal loop Error (A)	External loop Error (A)
0%	0A			0.00010565	0.002113	0	-0.00211
5%	10A			0.5035847	10.07169	10	-0.07169
10%	20A			1.006769	20.13538	20	-0.13538
15%	30A			1.509910	30.1982	30	-0.1982
20%	40A			2.013117	40.26234	40	-0.26234
25%	50A			2.516251	50.32502	50	-0.32502
30%	60A			3.019426	60.38852	60	-0.38852
35%	70A			3.522453	70.44906	70	-0.44906
40%	80A			4.025694	80.51388	80	-0.51388
45%	90A			4.528804	90.57608	90	-0.57608
50%	100A			5.031694	100.6339	100	-0.63388
55%	110A			5.535145	110.7029	110	-0.7029
60%	120A			6.038205	120.7641	120	-0.7641
65%	130A			6.541382	130.8276	130	-0.82764
70%	140A			7.044431	140.8886	140	-0.88862
75%	150A			7.547556	150.9511	150	-0.95112
80%	160A			8.050679	161.0136	160	-1.01358
85%	170A			8.553711	171.0742	170	-1.07422
90%	180A			9.056880	181.1376	180	-1.1376
95%	190A			9.559994	191.1999	190	-1.19988
100%	200A			10.063230	201.2646	200	-1.2646
		Maximum Error					
		Permitted Error	10mA (50 ppm @ 200A)				
		Pass ❑	Fail ❑				

NPLC: 500 cycles – 10 s

Form G: Reproducibility report form

DCCT	Internal	External
Full scale I		
Full scale V		
DCCT multiplier		

Set Point	Test	Output Current after 100s (A) (External DCCT)	Stable output current (B)	2nd run A – 1st run B	2nd run B – 1st run B	Filename
50%	1					
	2					
75%	1					
	2					
95%	1					
	2					

Maximum variation	
Permitted variation	4mA (20 ppm @ 200A)
Pass ❑	Fail ❑

Form H: Ripple voltage/current measurement report form

DCCT	Internal	External
Full scale I		200 A
Full scale V		10 V
DCCT multiplier		20

Set Point		< 300 Hz		> 1 kHz	
% of rated	Value	pk – pk ripple (A)	pk – pk ripple (ppm)	pk – pk ripple (A)	pk – pk ripple (ppm)
50%	100A			0.26 A	1300 ppm
75%	150A	0.015 A	75 ppm	0.45 A	2250 ppm
100%	200A	0.1 A	500 ppm		
		Maximum Ripple	500 ppm	Maximum Ripple	2250 ppm
		Permitted Ripple	2 ppm		
		Pass		Fail ✓	

Form I: 8 hour stability run report form

DCCT	Internal	External
Full scale I		200 A
Full scale V		10 V
DCCT multiplier		20

Internal DCCT

Set Point							
% of max	Value	Max I DCCT reading	Min I DCCT reading	Average I DCCT reading	Worst case deviation over 30 minute period after initial 30 minutes	Worst case deviation over 8 hour period after initial 100 seconds
50%	100A					
75%	150A					
100%	200A					
		Maximum Range				
		Permitted Range				
		Pass ❑		Fail ❑		

External DCCT

Set Point						
% of max	Value	Max I DCCT reading	Min I DCCT reading	Average I DCCT reading	Worst case deviation over 30 minute period after initial 30 minutes	Worst case deviation ove
50%	100A	100.6416	100.6398	100.6407	0.00046	0.00168
75%	150A	150.9536	150.9482	150.9491	0.00042	0.00384
100%	200A	201.2822	201.2776	201.2787	0.00236	0.0036
		Maximum Range			0.00236 = 11.8 ppm	0.0036 = 18 ppm
		Permitted Range			0.002 = 10 ppm	0.002 = 10 ppm
		Pass		Fail ✓		

Power supply Testing: Assignment

STUDENT ASSIGNMENT : CONTROL SYSTEMS

This covers part of outcomes 1 and 3 of the control and automation unit (plus parts of other units as well – see Foundation Degree units).

TASK ONE

(a)	Produce a block diagram of a suitable control system for a D.C. magnet power supply. Explain briefly the working of this control system.
(b)	What is meant by the following terms applied to the output of a control system?
	i) Resolution ii) Accuracy and linearity iii) Ripple iv) Stability
TASK TWO	
Using the specification and data provided, compare the output parameters above in the performance of UNIT one and UNIT two.	
TASK THREE	
Draw a diagram of the equipment used to measure the stability of a power supply. Present your results and analyse them.	