

Switching Effects of OCEM Power Supplies II

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1. Introduction

This memo continues the investigation of switching effects in the O.C.E.M. power supply which first was described in a memo of March 29, 2006(at <http://www-group.slac.stanford.edu/met/MagMeas/MAGDATA/ILC/OCEM-PS/2006-03/ocem-ps.pdf> or .odt or .doc or .html).

In the past measurements, the controller frequency (set by a RC circuit) had been about 6 Hz; this time we report measurements with this frequency changed to 10 Hz and 25 Hz. Also, the maximal current, which had been 120 A, is now 150A, and we report on switching at currents of 150 A, 75 A, and 25A, which corresponds to magnetic fields in the magnet of ~ 3.1 kGauss, 1.5 kGauss and 0.43 kGauss, respectively.

2. Setup and Method

As described in the previous memo, the effects of switching were observed and recorded with a Tektronix TDS 3014B 'eScope'. A typical trace is shown in Fig.1.

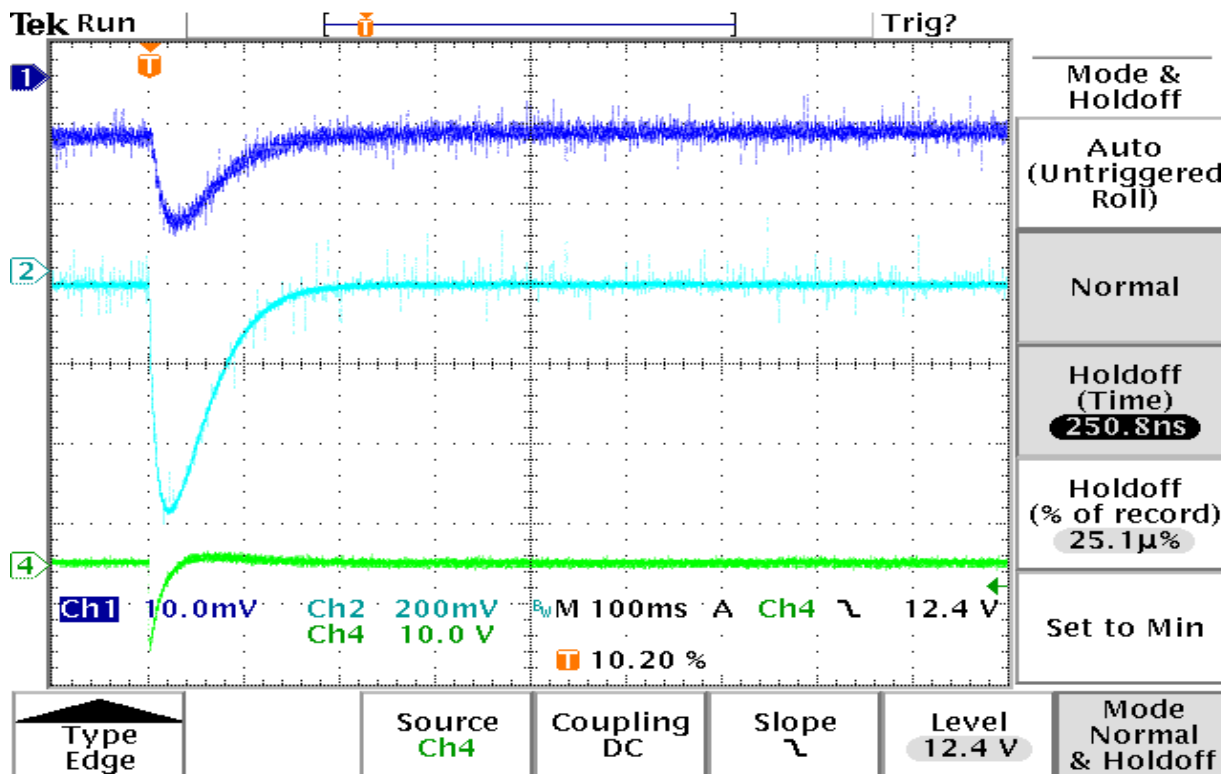


Figure 1. Oscilloscope trace of Hall Voltage (top, blue trace), current (middle, light blue trace) and voltage (bottom, green trace) . Time scale is 100 ms/division. (150A nominal current) .

The Hall Voltage, proportional to the magnetic field, the current, and the voltage were measured, typically in a 400 ms time window (with ~40 ms before, and ~360 ms after the trigger for the switching; or 1000 ms, with ~100ms before, and ~900ms after).. The oscilloscope records 10,000 data points in this (400ms or 1000ms) time window.

As most data were overlaid with some high-frequency noise, the following procedure was adopted for the analysis and presentation of data: The data before the trigger were averaged to constitute the nominal value of field, current, and voltage. The data after the trigger, starting from the minimum point, and up to the last recorded point, was divided in several segments, and an average taken over each segment. For a time window of 400ms, one has thus nominal values from an average over slightly less than 40 ms before the switching trigger, and, for e.g. 9 segments, nine averages over a bit less than $360\text{ms}/9 = 40\text{ms}$ each after the maximal drop.

Dividing these averages by the nominal value, multiplying by 100 and subtracting 100, one obtains then a percent deviation from the nominal value, which is shown in the tables below.

For an error estimate on this percent deviation, I take the standard deviation for each segment average, and scale it by $100/(\text{nominal value})$.

Appendix A shows tables for these averages and percent average deviations from the nominal values, for 9 segments

The curve to the right of the minimum should possibly have the form $(1-\exp(t/\tau))$. To investigate the time constant τ , I also fitted (with MatLab) the negative logarithm of the averages to a linear function, whose inverse slope it then τ . However, most of the time the fit was rather bad, and dominated by noise at the late times, and leading to complex values for τ .

A total of 13 data sets were taken, at 150 A, 75 A, and 25A. The data files are marked by the nominal current (50 A, 75 A, and 25A) and the board version (10Hz, 25 Hz).All data are shown in Appendix A.

3. Results

From looking at the figures and tables in Appendix A one can conclude the following:

- By looking at the figures, in all cases current and magnetic field have recovered their pre-trigger value in about 200 ms(for the 10Hz board) or about 150 ms for the 25 Hz board. This is definitely faster than the 400ms recovery time reported for the 6Hz board in our previous note. So the increase in controller frequency seems to hasten recovery.
- The voltage recovers faster, but overshoots by 2-4 percent, and then returns from above the nominal.
- For every segment average, also a standard deviation is calculated, typically ~0.009 kGauss for the field, 0.2 to 0.3 A for the current, 0.13 – 0.3 V for the voltage (shown as the number after +/- in the upper tables, 'Data as measured').

When the standard deviations are rescaled by dividing by the pre-trigger value/100 they give a scale at which a percentage deviation from the nominal value cannot be distinguished from the nominal value.

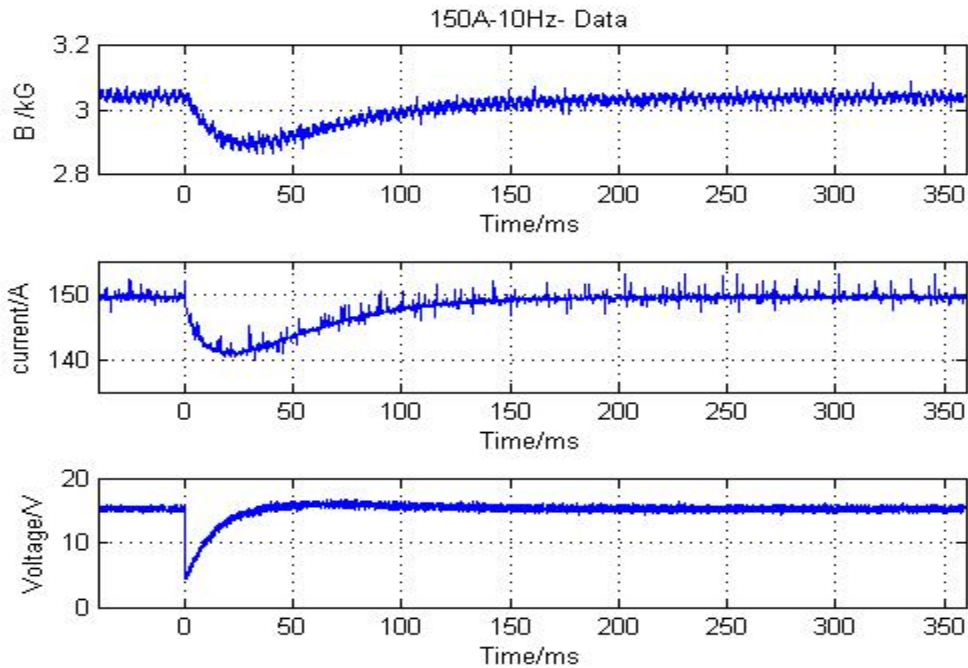
The percentage deviation from the nominal is less than this error for all fields and currents in the time segments with times greater than 200ms, and in several cases lower than that.

Hence we conclude that the field, current, and voltage indeed return to their pre-switching value, without the need for an additional standardization of the magnet.

Appendix A

Here for every data file, a figure of B-field (top), current (middle), voltage (bottom) is shown, followed by a table of the average values and deviations from nominal of each segment (of ~40 ms or ~100ms).

Data File 1: 150A-10Hz



```

----- Data as measured : -----
|Time interval [ms]|      ch1 [kG]      |      ch2 [A]      |      ch4 [V]      |
| -40.80 -  -0.08 | 3.043 +/- 0.009 | 149.495 +/- 0.253 | 15.280 +/- 0.225 |
|   0.04 - 39.88 | 2.932 +/- 0.045 | 142.236 +/- 1.689 | 12.192 +/- 3.113 |
| 39.92 - 79.76 | 2.938 +/- 0.022 | 144.538 +/- 1.231 | 15.885 +/- 0.313 |
| 79.80 - 119.64 | 2.993 +/- 0.014 | 147.601 +/- 0.649 | 15.732 +/- 0.298 |
| 119.68 - 159.52 | 3.019 +/- 0.011 | 148.878 +/- 0.325 | 15.464 +/- 0.292 |
| 159.56 - 199.40 | 3.031 +/- 0.009 | 149.307 +/- 0.238 | 15.322 +/- 0.294 |
| 199.44 - 239.28 | 3.036 +/- 0.009 | 149.443 +/- 0.289 | 15.288 +/- 0.299 |
| 239.32 - 279.16 | 3.038 +/- 0.009 | 149.481 +/- 0.286 | 15.254 +/- 0.287 |
| 279.20 - 319.04 | 3.040 +/- 0.009 | 149.494 +/- 0.254 | 15.261 +/- 0.286 |
| 319.08 - 358.92 | 3.041 +/- 0.009 | 149.484 +/- 0.249 | 15.249 +/- 0.289 |

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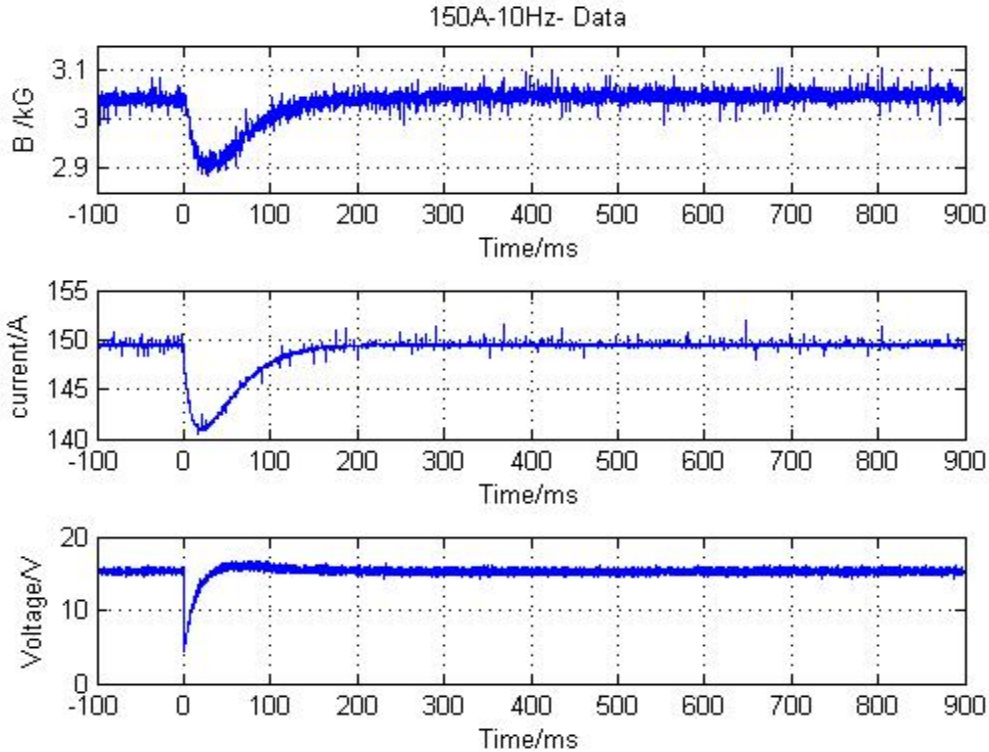
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-----Percent difference from 100:
-----((chxave(i)/chxave(first seg)*100 -100) with scaled errors): -----
|Time interval [ms]|      ch1      |      ch2      |      ch4      |
| -40.80 -  -0.08 | 0.000 +/- 0.296 | 0.000 +/- 0.169 | 0.000 +/- 1.474 |
|   0.04 - 39.88 | -3.660 +/- 1.478 | -4.856 +/- 1.130 | -20.208 +/- 20.373 |
| 39.92 - 79.76 | -3.451 +/- 0.711 | -3.316 +/- 0.823 | 3.955 +/- 2.046 |
| 79.80 - 119.64 | -1.663 +/- 0.471 | -1.267 +/- 0.434 | 2.955 +/- 1.950 |
| 119.68 - 159.52 | -0.782 +/- 0.358 | -0.413 +/- 0.217 | 1.202 +/- 1.908 |
| 159.56 - 199.40 | -0.399 +/- 0.294 | -0.126 +/- 0.159 | 0.272 +/- 1.925 |
| 199.44 - 239.28 | -0.237 +/- 0.293 | -0.035 +/- 0.193 | 0.052 +/- 1.955 |
| 239.32 - 279.16 | -0.175 +/- 0.280 | -0.010 +/- 0.191 | -0.171 +/- 1.878 |
| 279.20 - 319.04 | -0.105 +/- 0.301 | -0.001 +/- 0.170 | -0.126 +/- 1.870 |
| 319.08 - 358.92 | -0.062 +/- 0.284 | -0.007 +/- 0.166 | -0.205 +/- 1.894 |

```

-----Done with file no. 1 -----

Data File 2:150A-10Hz-Timesegment 100ms



Notice: Time window segment here is about 100ms (all other files have ~40 ms).
 The oscilloscope trace for this dataset is shown in Fig.1

---- Data as measured : -----

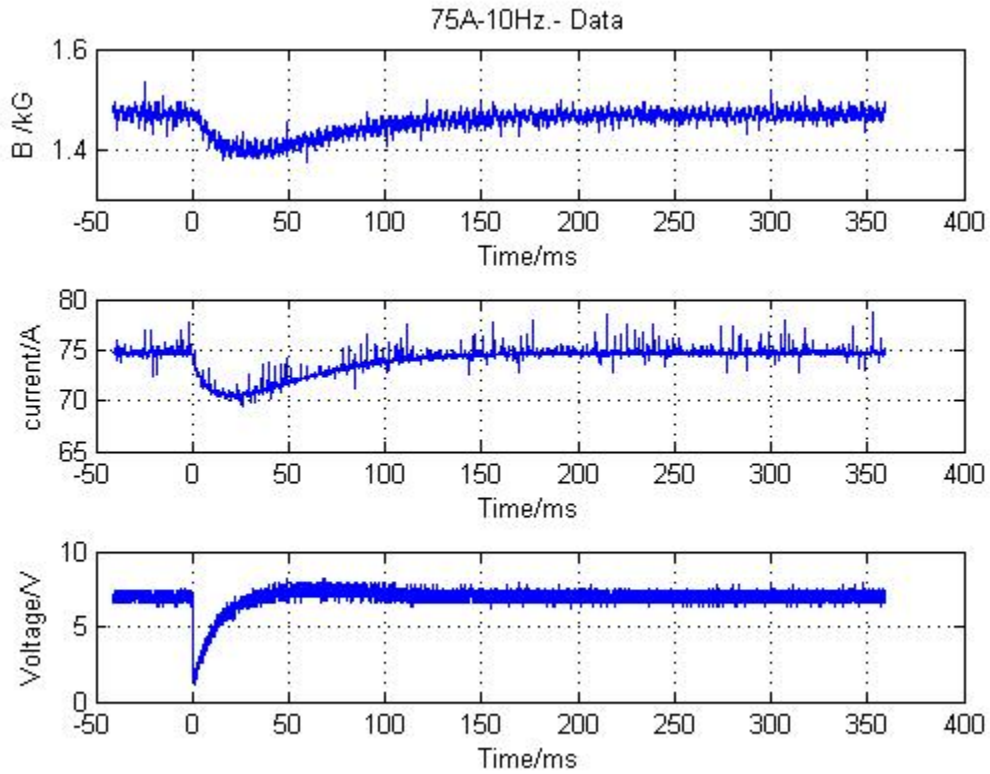
Time interval [ms]	ch1 [kG]	ch2 [A]	ch4 [V]
-102.00 - -0.20	3.040 +/- 0.009	149.480 +/- 0.156	15.352 +/- 0.218
0.10 - 99.70	2.952 +/- 0.037	144.120 +/- 2.222	14.497 +/- 2.634
99.80 - 199.40	3.028 +/- 0.014	148.895 +/- 0.501	15.548 +/- 0.295
199.50 - 299.10	3.042 +/- 0.009	149.460 +/- 0.137	15.327 +/- 0.284
299.20 - 398.80	3.046 +/- 0.009	149.491 +/- 0.131	15.311 +/- 0.292
398.90 - 498.50	3.046 +/- 0.009	149.485 +/- 0.121	15.279 +/- 0.279
498.60 - 598.20	3.047 +/- 0.009	149.499 +/- 0.113	15.280 +/- 0.280
598.30 - 697.90	3.047 +/- 0.009	149.488 +/- 0.140	15.323 +/- 0.298
698.00 - 797.60	3.048 +/- 0.008	149.493 +/- 0.124	15.328 +/- 0.303
797.70 - 897.30	3.048 +/- 0.009	149.489 +/- 0.117	15.342 +/- 0.278

----Percent difference from 100:
 ----((chxave(i)/chxave(first seg)*100 -100) with scaled errors): -----

Time interval [ms]	ch1	ch2	ch4
-102.00 - -0.20	0.000 +/- 0.280	0.000 +/- 0.104	0.000 +/- 1.423
0.10 - 99.70	-2.892 +/- 1.207	-3.586 +/- 1.487	-5.570 +/- 17.161
99.80 - 199.40	-0.388 +/- 0.449	-0.392 +/- 0.335	1.276 +/- 1.920
199.50 - 299.10	0.072 +/- 0.285	-0.013 +/- 0.091	-0.162 +/- 1.851
299.20 - 398.80	0.188 +/- 0.286	0.007 +/- 0.088	-0.263 +/- 1.900
398.90 - 498.50	0.207 +/- 0.291	0.003 +/- 0.081	-0.472 +/- 1.820
498.60 - 598.20	0.220 +/- 0.283	0.012 +/- 0.076	-0.470 +/- 1.823
598.30 - 697.90	0.235 +/- 0.287	0.005 +/- 0.094	-0.185 +/- 1.944
698.00 - 797.60	0.250 +/- 0.267	0.008 +/- 0.083	-0.157 +/- 1.976
797.70 - 897.30	0.250 +/- 0.293	0.006 +/- 0.079	-0.061 +/- 1.811

----Done with file no. 2 -----

Data File 3: 75A-10Hz



---- Data as measured : ----

Time interval [ms]	ch1 [kG]	ch2 [A]	ch4 [V]
-40.80 - -0.08	1.471 +/- 0.009	74.765 +/- 0.236	7.022 +/- 0.223
0.04 - 39.88	1.416 +/- 0.024	71.145 +/- 0.841	5.499 +/- 1.617
39.92 - 79.76	1.418 +/- 0.013	72.327 +/- 0.606	7.361 +/- 0.266
79.80 - 119.64	1.446 +/- 0.010	73.840 +/- 0.393	7.280 +/- 0.270
119.68 - 159.52	1.460 +/- 0.009	74.471 +/- 0.223	7.109 +/- 0.256
159.56 - 199.40	1.466 +/- 0.008	74.677 +/- 0.200	7.052 +/- 0.272
199.44 - 239.28	1.468 +/- 0.008	74.745 +/- 0.268	7.029 +/- 0.265
239.32 - 279.16	1.469 +/- 0.007	74.755 +/- 0.186	6.983 +/- 0.269
279.20 - 319.04	1.470 +/- 0.008	74.765 +/- 0.256	7.007 +/- 0.272
319.08 - 358.92	1.470 +/- 0.008	74.759 +/- 0.208	7.067 +/- 0.262

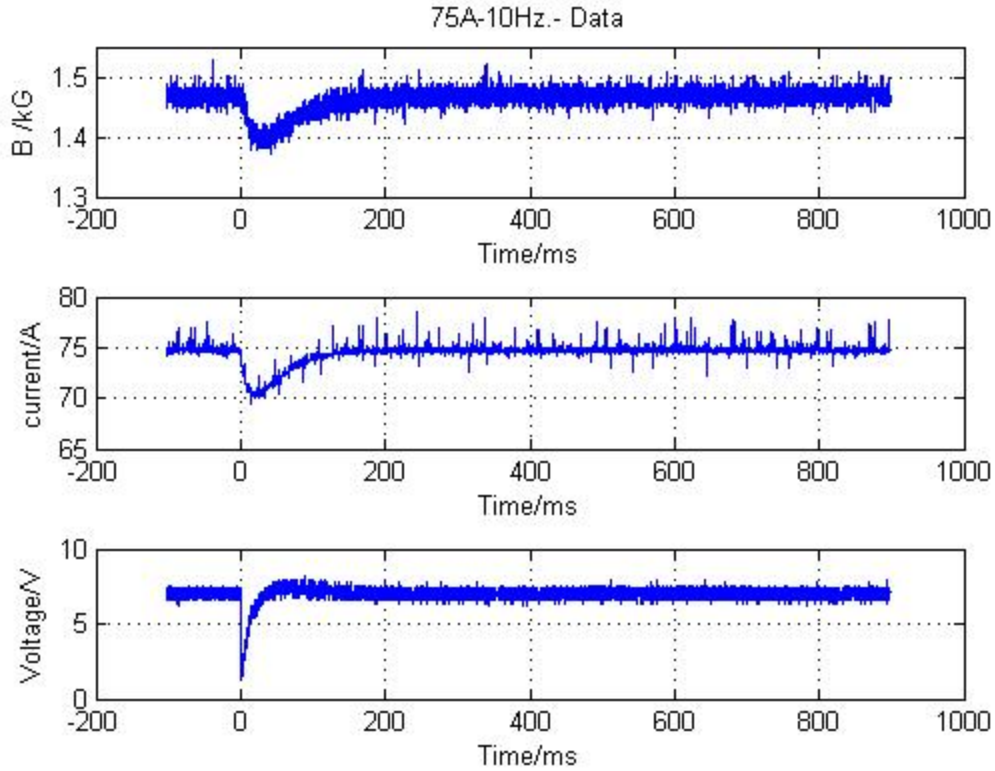
----Percent difference from 100:

----((chxave(i)/chxave(first seg)*100 -100) with scaled errors): ----

Time interval [ms]	ch1	ch2	ch4
-40.80 - -0.08	0.000 +/- 0.581	0.000 +/- 0.316	0.000 +/- 3.169
0.04 - 39.88	-3.757 +/- 1.603	-4.842 +/- 1.124	-21.692 +/- 23.032
39.92 - 79.76	-3.591 +/- 0.883	-3.261 +/- 0.810	4.826 +/- 3.786
79.80 - 119.64	-1.724 +/- 0.705	-1.238 +/- 0.526	3.666 +/- 3.847
119.68 - 159.52	-0.710 +/- 0.585	-0.393 +/- 0.298	1.238 +/- 3.652
159.56 - 199.40	-0.355 +/- 0.521	-0.119 +/- 0.267	0.424 +/- 3.871
199.44 - 239.28	-0.200 +/- 0.522	-0.027 +/- 0.358	0.096 +/- 3.774
239.32 - 279.16	-0.139 +/- 0.504	-0.015 +/- 0.248	-0.559 +/- 3.824
279.20 - 319.04	-0.089 +/- 0.546	-0.001 +/- 0.342	-0.210 +/- 3.879
319.08 - 358.92	-0.043 +/- 0.533	-0.009 +/- 0.278	0.644 +/- 3.731

----Done with file no. 3 ----

Data File 4: 75A-10Hz- Timesegment 100ms



---- Data as measured : -----

Time interval [ms]	ch1 [kG]	ch2 [A]	ch4 [V]
-102.00 - -0.20	1.468 +/- 0.011	74.781 +/- 0.224	7.085 +/- 0.217
0.10 - 99.70	1.420 +/- 0.020	72.114 +/- 1.129	6.603 +/- 1.373
99.80 - 199.40	1.458 +/- 0.012	74.483 +/- 0.333	7.178 +/- 0.266
199.50 - 299.10	1.467 +/- 0.010	74.760 +/- 0.228	7.029 +/- 0.271
299.20 - 398.80	1.469 +/- 0.011	74.769 +/- 0.224	7.004 +/- 0.263
398.90 - 498.50	1.470 +/- 0.010	74.767 +/- 0.196	7.041 +/- 0.272
498.60 - 598.20	1.470 +/- 0.010	74.766 +/- 0.226	7.092 +/- 0.269
598.30 - 697.90	1.470 +/- 0.010	74.774 +/- 0.278	7.067 +/- 0.279
698.00 - 797.60	1.470 +/- 0.010	74.772 +/- 0.230	7.058 +/- 0.264
797.70 - 897.30	1.470 +/- 0.010	74.766 +/- 0.239	7.038 +/- 0.270

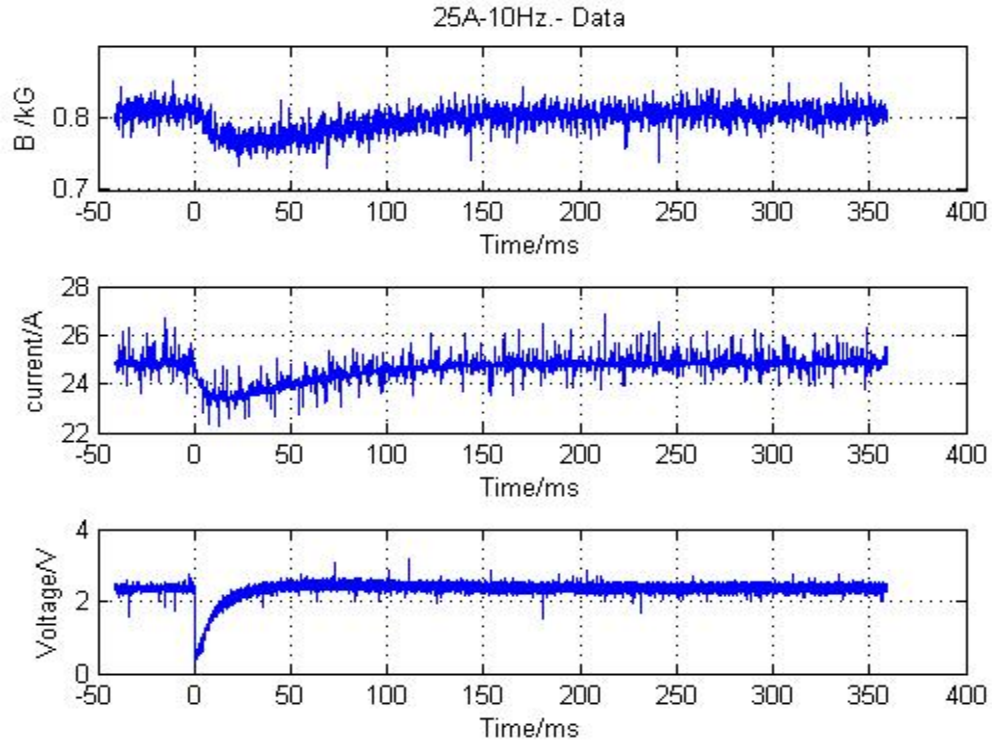
----Percent difference from 100:

----((chxave(i)/chxave(first seg)*100 -100) with scaled errors): -----

Time interval [ms]	ch1	ch2	ch4
-102.00 - -0.20	0.000 +/- 0.725	0.000 +/- 0.300	0.000 +/- 3.066
0.10 - 99.70	-3.258 +/- 1.391	-3.567 +/- 1.509	-6.806 +/- 19.383
99.80 - 199.40	-0.666 +/- 0.803	-0.399 +/- 0.445	1.315 +/- 3.757
199.50 - 299.10	-0.085 +/- 0.707	-0.028 +/- 0.305	-0.786 +/- 3.824
299.20 - 398.80	0.069 +/- 0.716	-0.017 +/- 0.299	-1.143 +/- 3.717
398.90 - 498.50	0.097 +/- 0.711	-0.019 +/- 0.262	-0.616 +/- 3.840
498.60 - 598.20	0.092 +/- 0.694	-0.020 +/- 0.302	0.100 +/- 3.790
598.30 - 697.90	0.121 +/- 0.689	-0.010 +/- 0.372	-0.251 +/- 3.932
698.00 - 797.60	0.116 +/- 0.671	-0.013 +/- 0.308	-0.376 +/- 3.722
797.70 - 897.30	0.152 +/- 0.672	-0.021 +/- 0.319	-0.656 +/- 3.806

----Done with file no. 4 -----

Data File 5: 25A-10Hz



Notice: An amplification of Hall voltage of 200 (instead of 100) was used here, hence B-field shown is a factor 2x high. (Should be 0.405 kG...)

---- Data as measured : -----

Time interval [ms]	ch1 [0.5 kG]	ch2 [A]	ch4 [V]
-40.80 - -0.08	0.810 +/- 0.009	24.859 +/- 0.187	2.362 +/- 0.068
0.04 - 39.88	0.776 +/- 0.015	23.623 +/- 0.281	1.876 +/- 0.547
39.92 - 79.76	0.777 +/- 0.011	24.093 +/- 0.238	2.434 +/- 0.088
79.80 - 119.64	0.792 +/- 0.010	24.545 +/- 0.161	2.426 +/- 0.090
119.68 - 159.52	0.801 +/- 0.009	24.744 +/- 0.145	2.397 +/- 0.088
159.56 - 199.40	0.804 +/- 0.009	24.814 +/- 0.164	2.377 +/- 0.088
199.44 - 239.28	0.806 +/- 0.009	24.840 +/- 0.160	2.366 +/- 0.091
239.32 - 279.16	0.807 +/- 0.009	24.862 +/- 0.153	2.362 +/- 0.087
279.20 - 319.04	0.807 +/- 0.009	24.856 +/- 0.153	2.364 +/- 0.086
319.08 - 358.92	0.807 +/- 0.009	24.868 +/- 0.149	2.364 +/- 0.085

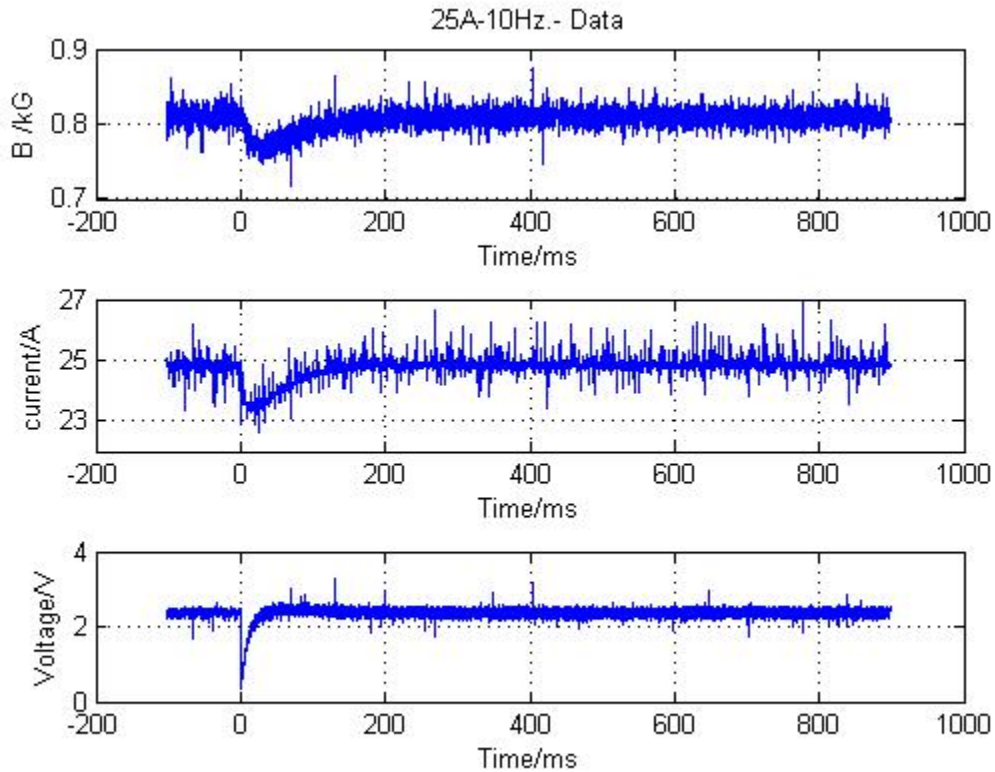
----Percent difference from 100:

----((chxave(i)/chxave(first seg)*100 -100) with scaled errors): -----

Time interval [ms]	ch1	ch2	ch4
-40.80 - -0.08	0.000 +/- 1.104	0.000 +/- 0.752	0.000 +/- 2.895
0.04 - 39.88	-4.250 +/- 1.905	-4.972 +/- 1.131	-20.578 +/- 23.147
39.92 - 79.76	-4.101 +/- 1.321	-3.081 +/- 0.959	3.048 +/- 3.729
79.80 - 119.64	-2.287 +/- 1.181	-1.262 +/- 0.647	2.697 +/- 3.790
119.68 - 159.52	-1.214 +/- 1.126	-0.461 +/- 0.583	1.479 +/- 3.744
159.56 - 199.40	-0.849 +/- 1.105	-0.180 +/- 0.661	0.619 +/- 3.731
199.44 - 239.28	-0.542 +/- 1.113	-0.077 +/- 0.644	0.155 +/- 3.838
239.32 - 279.16	-0.467 +/- 1.137	0.014 +/- 0.615	-0.012 +/- 3.671
279.20 - 319.04	-0.442 +/- 1.063	-0.011 +/- 0.614	0.077 +/- 3.651
319.08 - 358.92	-0.385 +/- 1.068	0.037 +/- 0.601	0.083 +/- 3.615

----Done with file no. 5 -----

Data File 6: 25A-10Hz-Timesegment100ms



Notice: An amplification of Hall voltage of 200 (instead of 100) was used here, hence B field listed (ch1) is a factor 2 too high.

---- Data as measured: ----

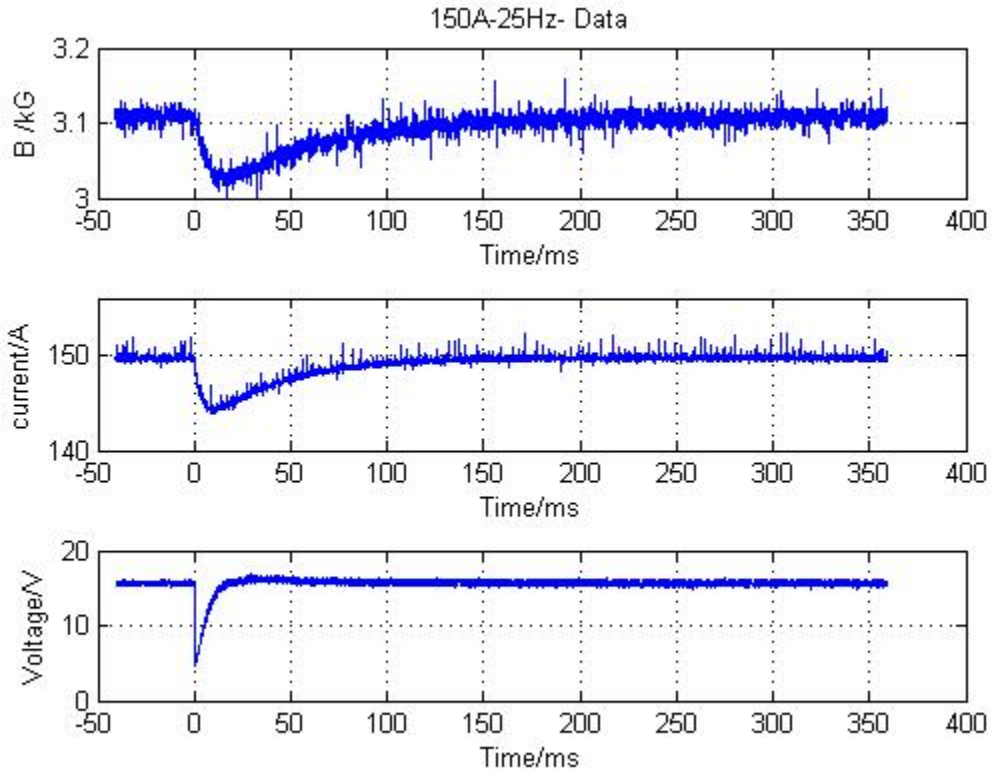
Time interval [ms]	ch1 [0.5 kG]	ch2 [A]	ch4 [V]
-102.00 - -0.20	0.812 +/- 0.010	24.827 +/- 0.158	2.369 +/- 0.063
0.10 - 99.70	0.781 +/- 0.014	23.971 +/- 0.396	2.224 +/- 0.440
99.80 - 199.40	0.803 +/- 0.010	24.742 +/- 0.159	2.401 +/- 0.092
199.50 - 299.10	0.808 +/- 0.009	24.845 +/- 0.135	2.375 +/- 0.088
299.20 - 398.80	0.810 +/- 0.009	24.851 +/- 0.144	2.374 +/- 0.085
398.90 - 498.50	0.810 +/- 0.009	24.847 +/- 0.148	2.370 +/- 0.089
498.60 - 598.20	0.810 +/- 0.009	24.848 +/- 0.143	2.366 +/- 0.082
598.30 - 697.90	0.810 +/- 0.009	24.851 +/- 0.143	2.374 +/- 0.086
698.00 - 797.60	0.810 +/- 0.009	24.843 +/- 0.154	2.369 +/- 0.089
797.70 - 897.30	0.810 +/- 0.009	24.848 +/- 0.147	2.369 +/- 0.086

----Percent difference from 100:
 ----((chxave(i)/chxave(first seg)*100 -100) with scaled errors): ----

Time interval [ms]	ch1	ch2	ch4
-102.00 - -0.20	0.000 +/- 1.273	0.000 +/- 0.637	0.000 +/- 2.652
0.10 - 99.70	-3.876 +/- 1.684	-3.445 +/- 1.597	-6.140 +/- 18.559
99.80 - 199.40	-1.179 +/- 1.211	-0.340 +/- 0.642	1.321 +/- 3.870
199.50 - 299.10	-0.448 +/- 1.132	0.073 +/- 0.545	0.252 +/- 3.728
299.20 - 398.80	-0.295 +/- 1.158	0.096 +/- 0.581	0.193 +/- 3.592
398.90 - 498.50	-0.258 +/- 1.141	0.081 +/- 0.596	0.038 +/- 3.762
498.60 - 598.20	-0.282 +/- 1.114	0.085 +/- 0.576	-0.140 +/- 3.479
598.30 - 697.90	-0.288 +/- 1.075	0.096 +/- 0.576	0.218 +/- 3.614
698.00 - 797.60	-0.266 +/- 1.078	0.064 +/- 0.620	-0.027 +/- 3.773
797.70 - 897.30	-0.226 +/- 1.091	0.084 +/- 0.594	-0.009 +/- 3.623

----Done with file no. 6 ----

Data File 7: 150A-25Hz



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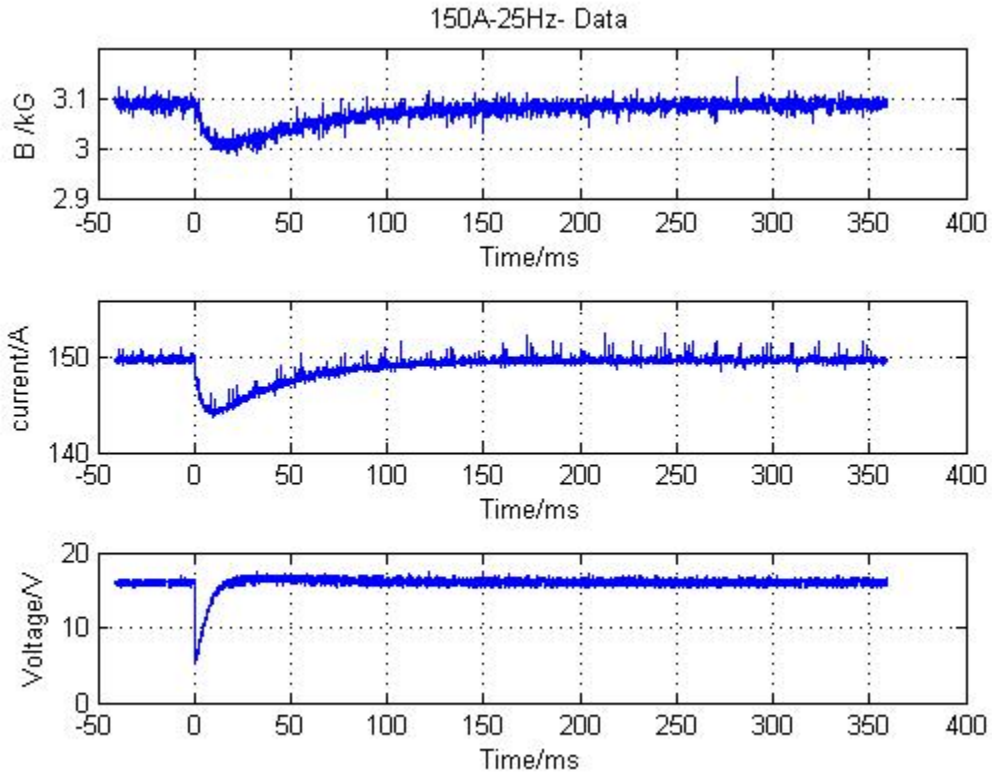
---- Data as measured : -----
|Time interval [ms]|      ch1 [kG]      |      ch2 [A]      |      ch4 [V]      |
| -40.80 -  -0.08 |  3.108 +/- 0.006 | 149.713 +/- 0.223 | 15.646 +/- 0.137 |
|   0.04 - 39.88 |  3.043 +/- 0.019 | 145.556 +/- 1.000 | 14.210 +/- 3.051 |
| 39.92 - 79.76 |  3.068 +/- 0.011 | 147.969 +/- 0.572 | 15.992 +/- 0.236 |
| 79.80 - 119.64 |  3.089 +/- 0.008 | 149.129 +/- 0.271 | 15.804 +/- 0.240 |
| 119.68 - 159.52 |  3.099 +/- 0.007 | 149.554 +/- 0.216 | 15.711 +/- 0.231 |
| 159.56 - 199.40 |  3.103 +/- 0.006 | 149.691 +/- 0.198 | 15.681 +/- 0.230 |
| 199.44 - 239.28 |  3.105 +/- 0.007 | 149.751 +/- 0.202 | 15.660 +/- 0.228 |
| 239.32 - 279.16 |  3.106 +/- 0.006 | 149.756 +/- 0.214 | 15.653 +/- 0.229 |
| 279.20 - 319.04 |  3.107 +/- 0.006 | 149.753 +/- 0.228 | 15.657 +/- 0.229 |
| 319.08 - 358.92 |  3.108 +/- 0.006 | 149.729 +/- 0.187 | 15.648 +/- 0.230 |

----Percent difference from 100:
----((chxave(i)/chxave(first seg)*100 -100) with scaled errors): -----
|Time interval [ms]|      ch1      |      ch2      |      ch4      |
| -40.80 -  -0.08 |  0.000 +/- 0.201 |  0.000 +/- 0.149 |  0.000 +/- 0.878 |
|   0.04 - 39.88 | -2.111 +/- 0.626 | -2.777 +/- 0.668 | -9.176 +/- 19.499 |
| 39.92 - 79.76 | -1.307 +/- 0.342 | -1.165 +/- 0.382 |  2.210 +/-  1.510 |
| 79.80 - 119.64 | -0.619 +/- 0.246 | -0.391 +/- 0.181 |  1.013 +/-  1.534 |
| 119.68 - 159.52 | -0.291 +/- 0.221 | -0.107 +/- 0.144 |  0.415 +/-  1.477 |
| 159.56 - 199.40 | -0.165 +/- 0.208 | -0.015 +/- 0.132 |  0.226 +/-  1.469 |
| 199.44 - 239.28 | -0.096 +/- 0.209 |  0.025 +/- 0.135 |  0.092 +/-  1.459 |
| 239.32 - 279.16 | -0.078 +/- 0.195 |  0.028 +/- 0.143 |  0.047 +/-  1.464 |
| 279.20 - 319.04 | -0.039 +/- 0.201 |  0.027 +/- 0.152 |  0.070 +/-  1.464 |
| 319.08 - 358.92 | -0.004 +/- 0.200 |  0.010 +/- 0.125 |  0.015 +/-  1.471 |

----Done with file no. 7 -----

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Data File 8: 150A-25Hz



---- Data as measured : -----

Time interval [ms]	ch1 [kG]		ch2 [A]		ch4 [V]	
-40.80 - -0.08	3.093 +/-	0.006	149.712 +/-	0.176	16.080 +/-	0.222
0.04 - 39.88	3.025 +/-	0.019	145.553 +/-	0.983	14.616 +/-	2.988
39.92 - 79.76	3.051 +/-	0.011	147.955 +/-	0.574	16.410 +/-	0.288
79.80 - 119.64	3.072 +/-	0.008	149.109 +/-	0.276	16.252 +/-	0.275
119.68 - 159.52	3.081 +/-	0.007	149.513 +/-	0.189	16.156 +/-	0.290
159.56 - 199.40	3.085 +/-	0.007	149.655 +/-	0.221	16.113 +/-	0.288
199.44 - 239.28	3.088 +/-	0.007	149.692 +/-	0.215	16.143 +/-	0.294
239.32 - 279.16	3.090 +/-	0.006	149.716 +/-	0.234	16.105 +/-	0.289
279.20 - 319.04	3.091 +/-	0.007	149.715 +/-	0.206	16.099 +/-	0.288
319.08 - 358.92	3.091 +/-	0.006	149.724 +/-	0.203	16.102 +/-	0.291

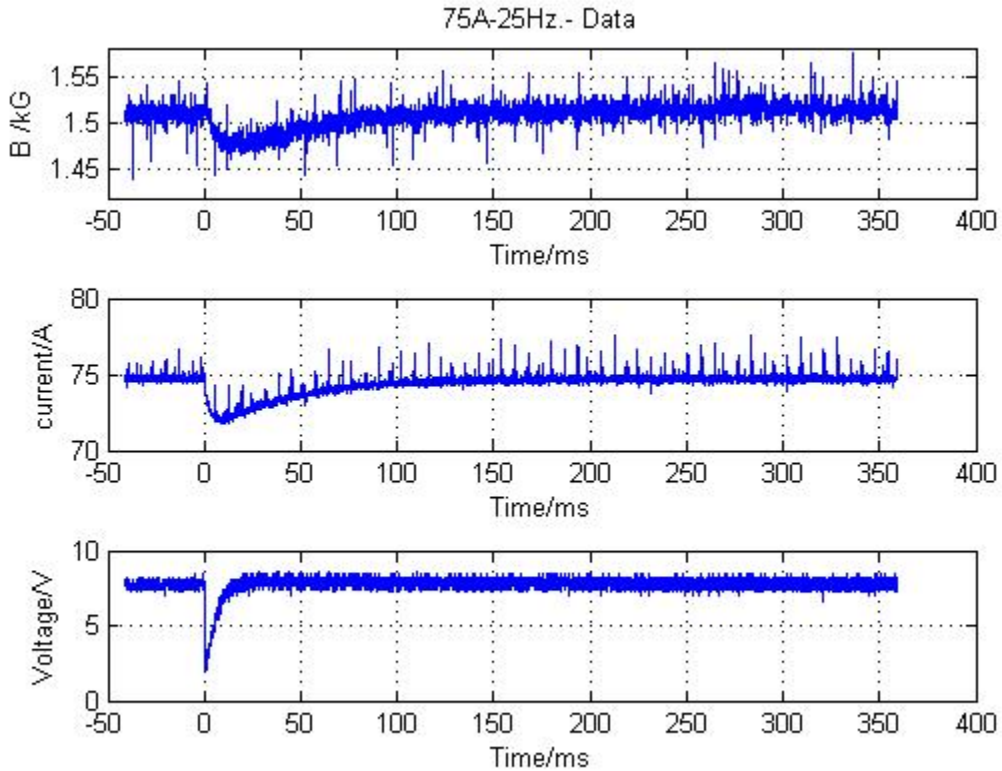
----Percent difference from 100:

---- ((chxave(i)/chxave(first seg)*100 -100) with scaled errors): -----

Time interval [ms]	ch1		ch2		ch4	
-40.80 - -0.08	0.000 +/-	0.209	0.000 +/-	0.118	0.000 +/-	1.382
0.04 - 39.88	-2.186 +/-	0.607	-2.778 +/-	0.656	-9.104 +/-	18.582
39.92 - 79.76	-1.371 +/-	0.351	-1.174 +/-	0.383	2.056 +/-	1.791
79.80 - 119.64	-0.695 +/-	0.243	-0.403 +/-	0.184	1.069 +/-	1.710
119.68 - 159.52	-0.374 +/-	0.236	-0.133 +/-	0.126	0.473 +/-	1.801
159.56 - 199.40	-0.244 +/-	0.224	-0.038 +/-	0.148	0.205 +/-	1.791
199.44 - 239.28	-0.171 +/-	0.228	-0.014 +/-	0.144	0.392 +/-	1.831
239.32 - 279.16	-0.098 +/-	0.210	0.003 +/-	0.157	0.155 +/-	1.798
279.20 - 319.04	-0.079 +/-	0.215	0.002 +/-	0.137	0.116 +/-	1.789
319.08 - 358.92	-0.050 +/-	0.208	0.008 +/-	0.135	0.136 +/-	1.812

----Done with file no. 8 -----

Data File 9: 75A-25Hz



---- Data as measured : -----

Time interval [ms]	ch1 [kG]	ch2 [A]	ch4 [V]
-40.80 - -0.08	1.510 +/- 0.007	74.732 +/- 0.177	7.765 +/- 0.192
0.04 - 39.88	1.485 +/- 0.011	72.694 +/- 0.489	7.060 +/- 1.503
39.92 - 79.76	1.497 +/- 0.008	73.866 +/- 0.322	7.953 +/- 0.247
79.80 - 119.64	1.507 +/- 0.006	74.438 +/- 0.214	7.893 +/- 0.246
119.68 - 159.52	1.511 +/- 0.007	74.634 +/- 0.193	7.860 +/- 0.245
159.56 - 199.40	1.513 +/- 0.006	74.703 +/- 0.223	7.858 +/- 0.243
199.44 - 239.28	1.514 +/- 0.006	74.715 +/- 0.206	7.824 +/- 0.252
239.32 - 279.16	1.515 +/- 0.007	74.730 +/- 0.203	7.814 +/- 0.244
279.20 - 319.04	1.516 +/- 0.006	74.731 +/- 0.201	7.820 +/- 0.249
319.08 - 358.92	1.515 +/- 0.006	74.729 +/- 0.205	7.797 +/- 0.250

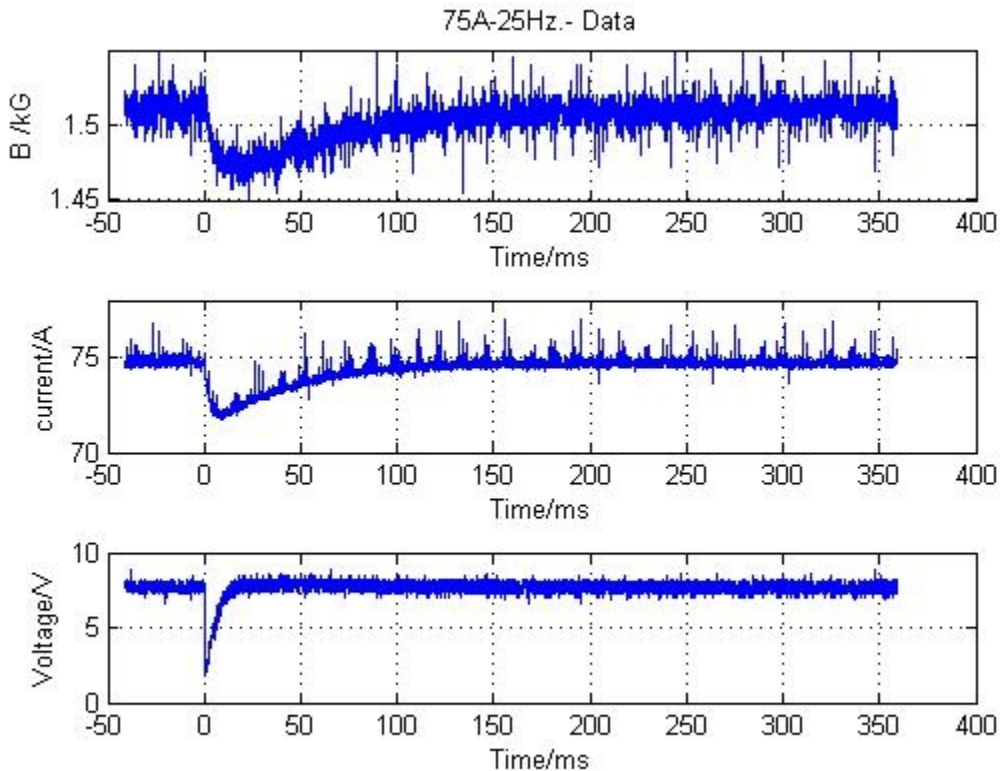
----Percent difference from 100:

----((chxave(i)/chxave(first seg)*100 -100) with scaled errors): -----

Time interval [ms]	ch1	ch2	ch4
-40.80 - -0.08	0.000 +/- 0.463	0.000 +/- 0.236	0.000 +/- 2.467
0.04 - 39.88	-1.693 +/- 0.741	-2.726 +/- 0.655	-9.084 +/- 19.353
39.92 - 79.76	-0.907 +/- 0.540	-1.159 +/- 0.431	2.417 +/- 3.178
79.80 - 119.64	-0.212 +/- 0.422	-0.393 +/- 0.286	1.647 +/- 3.167
119.68 - 159.52	0.043 +/- 0.439	-0.131 +/- 0.258	1.221 +/- 3.151
159.56 - 199.40	0.168 +/- 0.428	-0.039 +/- 0.298	1.190 +/- 3.130
199.44 - 239.28	0.237 +/- 0.409	-0.022 +/- 0.276	0.758 +/- 3.250
239.32 - 279.16	0.295 +/- 0.467	-0.003 +/- 0.272	0.622 +/- 3.147
279.20 - 319.04	0.380 +/- 0.419	-0.001 +/- 0.269	0.704 +/- 3.208
319.08 - 358.92	0.294 +/- 0.423	-0.004 +/- 0.274	0.402 +/- 3.215

----Done with file no. 9 -----

Data File 10: 75A-25Hz



---- Data as measured : ----

Time interval [ms]	ch1 [kG]	ch2 [A]	ch4 [V]
-40.80 - -0.08	1.510 +/- 0.007	74.736 +/- 0.170	7.735 +/- 0.198
0.04 - 39.88	1.479 +/- 0.011	72.685 +/- 0.505	6.999 +/- 1.538
39.92 - 79.76	1.490 +/- 0.007	73.862 +/- 0.326	7.898 +/- 0.243
79.80 - 119.64	1.501 +/- 0.007	74.439 +/- 0.199	7.772 +/- 0.246
119.68 - 159.52	1.506 +/- 0.006	74.648 +/- 0.201	7.735 +/- 0.252
159.56 - 199.40	1.508 +/- 0.006	74.705 +/- 0.171	7.697 +/- 0.249
199.44 - 239.28	1.508 +/- 0.006	74.725 +/- 0.163	7.692 +/- 0.240
239.32 - 279.16	1.509 +/- 0.007	74.729 +/- 0.186	7.694 +/- 0.249
279.20 - 319.04	1.510 +/- 0.006	74.730 +/- 0.166	7.680 +/- 0.254
319.08 - 358.92	1.510 +/- 0.006	74.737 +/- 0.181	7.667 +/- 0.249

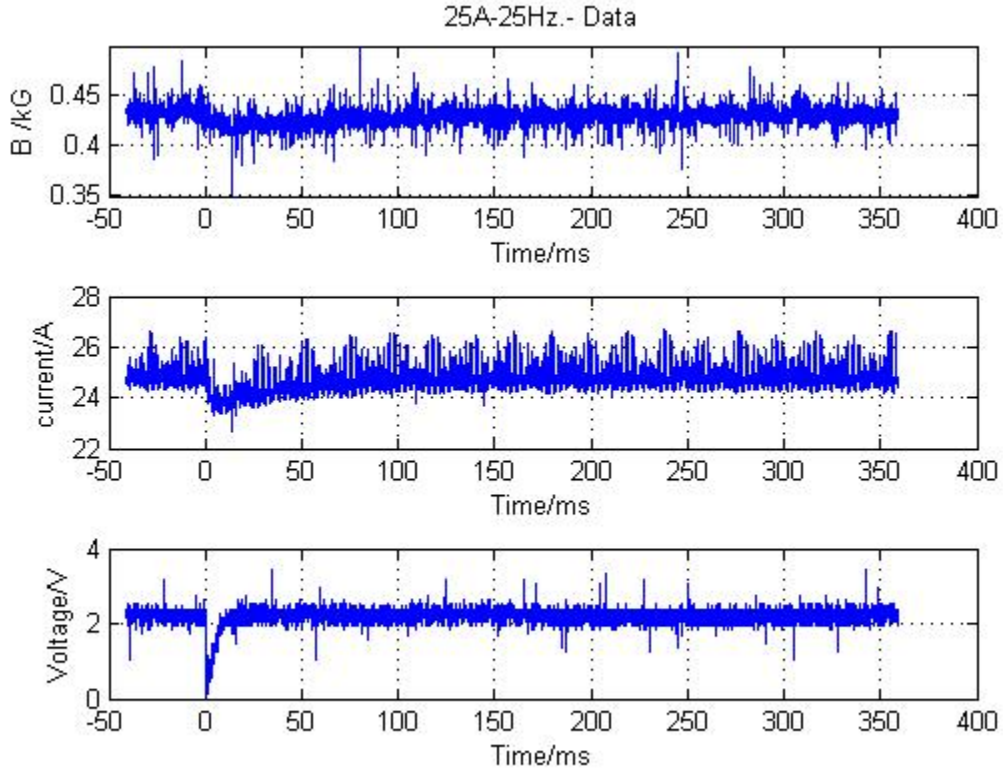
----Percent difference from 100:

---- ((chxave(i)/chxave(first seg)*100 -100) with scaled errors): ----

Time interval [ms]	ch1	ch2	ch4
-40.80 - -0.08	0.000 +/- 0.432	0.000 +/- 0.227	0.000 +/- 2.556
0.04 - 39.88	-2.086 +/- 0.697	-2.745 +/- 0.676	-9.517 +/- 19.880
39.92 - 79.76	-1.336 +/- 0.481	-1.170 +/- 0.436	2.104 +/- 3.142
79.80 - 119.64	-0.596 +/- 0.434	-0.398 +/- 0.266	0.480 +/- 3.181
119.68 - 159.52	-0.289 +/- 0.413	-0.119 +/- 0.269	-0.004 +/- 3.262
159.56 - 199.40	-0.126 +/- 0.405	-0.043 +/- 0.229	-0.500 +/- 3.220
199.44 - 239.28	-0.126 +/- 0.412	-0.016 +/- 0.218	-0.559 +/- 3.106
239.32 - 279.16	-0.073 +/- 0.438	-0.010 +/- 0.249	-0.539 +/- 3.216
279.20 - 319.04	-0.015 +/- 0.405	-0.008 +/- 0.222	-0.710 +/- 3.284
319.08 - 358.92	0.008 +/- 0.427	0.001 +/- 0.243	-0.878 +/- 3.224

----Done with file no. 10 ----

Data File 11: 25A-25Hz



---- Data as measured : -----

Time interval [ms]	ch1 [kG]	ch2 [A]	ch4 [V]
-40.80 - -0.08	0.435 +/- 0.007	24.814 +/- 0.231	2.242 +/- 0.126
0.04 - 39.88	0.422 +/- 0.007	24.127 +/- 0.287	1.998 +/- 0.522
39.92 - 79.76	0.425 +/- 0.007	24.534 +/- 0.259	2.259 +/- 0.132
79.80 - 119.64	0.429 +/- 0.007	24.718 +/- 0.246	2.250 +/- 0.129
119.68 - 159.52	0.430 +/- 0.006	24.781 +/- 0.240	2.259 +/- 0.126
159.56 - 199.40	0.430 +/- 0.006	24.802 +/- 0.248	2.216 +/- 0.141
199.44 - 239.28	0.431 +/- 0.006	24.805 +/- 0.240	2.193 +/- 0.143
239.32 - 279.16	0.431 +/- 0.006	24.807 +/- 0.232	2.194 +/- 0.135
279.20 - 319.04	0.431 +/- 0.006	24.808 +/- 0.243	2.219 +/- 0.139
319.08 - 358.92	0.431 +/- 0.006	24.810 +/- 0.238	2.252 +/- 0.138

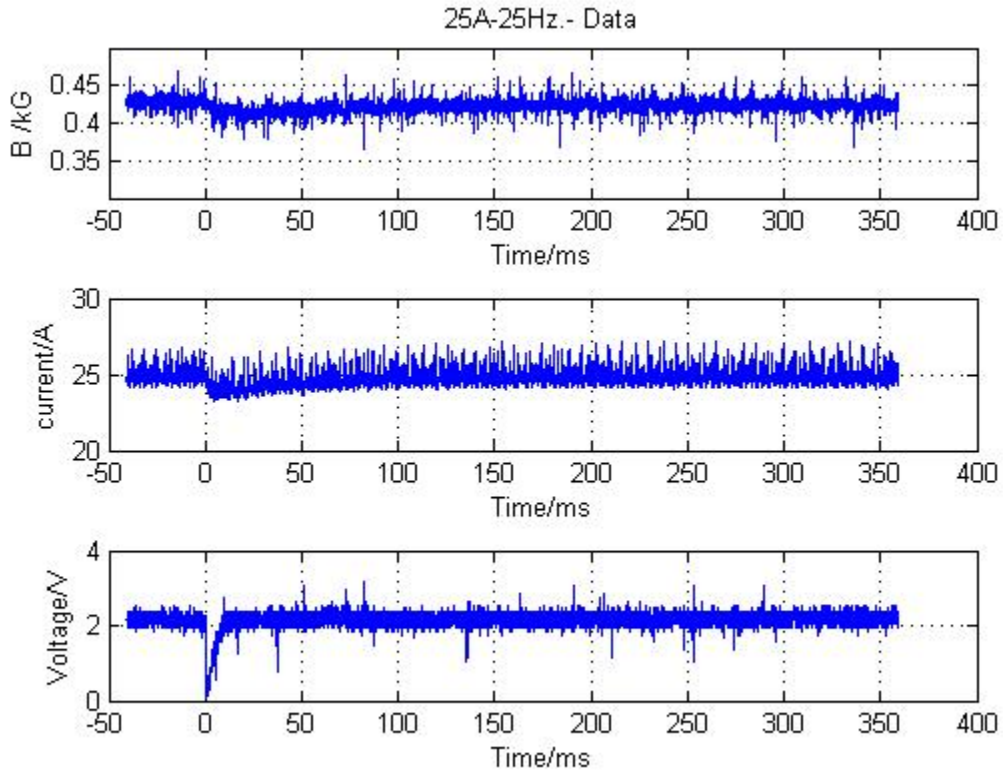
----Percent difference from 100:

----((chxave(i)/chxave(first seg)*100 -100) with scaled errors): -----

Time interval [ms]	ch1	ch2	ch4
-40.80 - -0.08	0.000 +/- 1.561	0.000 +/- 0.930	0.000 +/- 5.599
0.04 - 39.88	-2.822 +/- 1.724	-2.769 +/- 1.156	-10.890 +/- 23.303
39.92 - 79.76	-2.153 +/- 1.553	-1.130 +/- 1.042	0.783 +/- 5.877
79.80 - 119.64	-1.362 +/- 1.596	-0.386 +/- 0.993	0.349 +/- 5.744
119.68 - 159.52	-1.009 +/- 1.456	-0.135 +/- 0.965	0.792 +/- 5.634
159.56 - 199.40	-0.959 +/- 1.449	-0.048 +/- 0.999	-1.145 +/- 6.292
199.44 - 239.28	-0.856 +/- 1.489	-0.038 +/- 0.969	-2.166 +/- 6.370
239.32 - 279.16	-0.809 +/- 1.446	-0.027 +/- 0.934	-2.134 +/- 6.019
279.20 - 319.04	-0.711 +/- 1.441	-0.025 +/- 0.979	-1.034 +/- 6.206
319.08 - 358.92	-0.723 +/- 1.392	-0.016 +/- 0.958	0.479 +/- 6.137

----Done with file no. 11-----

Data File 12: 25A-25Hz



---- Data as measured : -----

Time interval [ms]	ch1 [kG]	ch2 [A]	ch4 [V]
-40.80 - -0.08	0.429 +/- 0.006	24.811 +/- 0.300	2.184 +/- 0.122
0.04 - 39.88	0.415 +/- 0.007	24.139 +/- 0.332	1.931 +/- 0.526
39.92 - 79.76	0.418 +/- 0.006	24.536 +/- 0.311	2.219 +/- 0.135
79.80 - 119.64	0.422 +/- 0.006	24.731 +/- 0.303	2.179 +/- 0.140
119.68 - 159.52	0.423 +/- 0.006	24.798 +/- 0.305	2.182 +/- 0.139
159.56 - 199.40	0.424 +/- 0.007	24.813 +/- 0.294	2.176 +/- 0.135
199.44 - 239.28	0.424 +/- 0.006	24.820 +/- 0.304	2.189 +/- 0.141
239.32 - 279.16	0.424 +/- 0.006	24.829 +/- 0.301	2.196 +/- 0.142
279.20 - 319.04	0.424 +/- 0.006	24.831 +/- 0.300	2.211 +/- 0.131
319.08 - 358.92	0.424 +/- 0.006	24.822 +/- 0.308	2.223 +/- 0.129

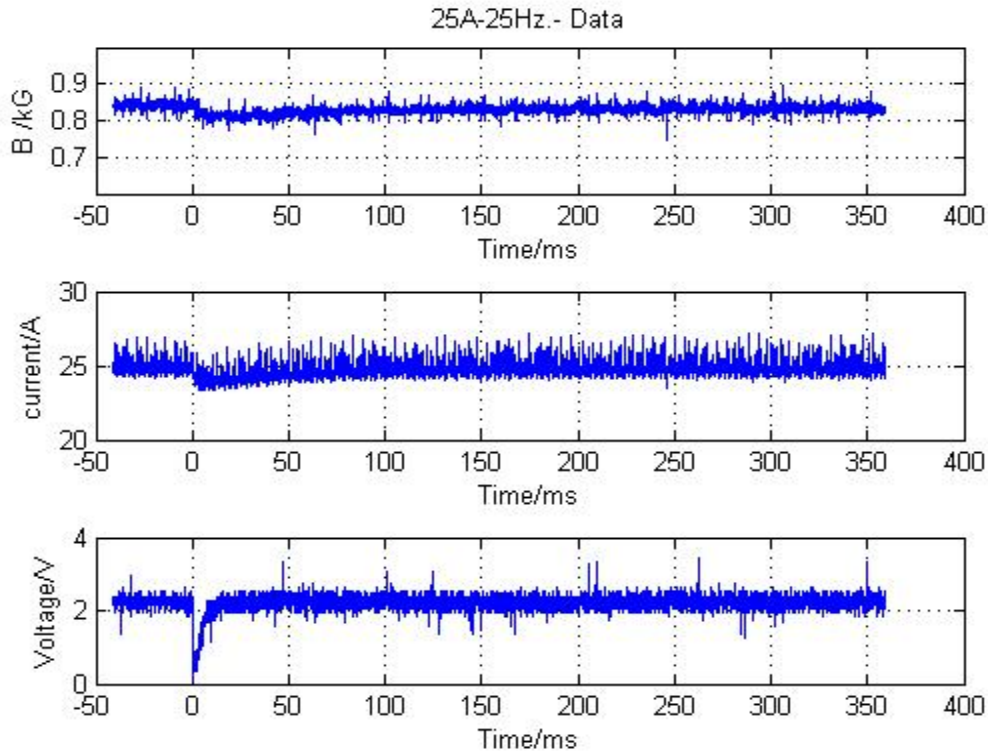
----Percent difference from 100:

---- ((chxave(i)/chxave(first seg)*100 -100) with scaled errors): -----

Time interval [ms]	ch1	ch2	ch4
-40.80 - -0.08	0.000 +/- 1.435	0.000 +/- 1.209	0.000 +/- 5.601
0.04 - 39.88	-3.175 +/- 1.571	-2.710 +/- 1.339	-11.606 +/- 24.059
39.92 - 79.76	-2.394 +/- 1.464	-1.109 +/- 1.254	1.567 +/- 6.181
79.80 - 119.64	-1.542 +/- 1.477	-0.325 +/- 1.223	-0.255 +/- 6.429
119.68 - 159.52	-1.269 +/- 1.383	-0.055 +/- 1.228	-0.131 +/- 6.380
159.56 - 199.40	-1.038 +/- 1.557	0.007 +/- 1.186	-0.398 +/- 6.202
199.44 - 239.28	-1.082 +/- 1.489	0.033 +/- 1.223	0.222 +/- 6.462
239.32 - 279.16	-0.989 +/- 1.438	0.070 +/- 1.214	0.539 +/- 6.517
279.20 - 319.04	-0.966 +/- 1.470	0.077 +/- 1.208	1.232 +/- 5.993
319.08 - 358.92	-1.068 +/- 1.474	0.043 +/- 1.240	1.756 +/- 5.922

----Done with file no. 12-----

Data File 13: 25A-25Hz



Notice: An amplification of Hall voltage of 200 (instead of 100) was used here, hence the ch1 B-field values are a factor 2 too high.

---- Data as measured : -----

Time interval [ms]	ch1 [0.5kG]	ch2 [A]	ch4 [V]
-40.80 - -0.08	0.842 +/- 0.009	24.820 +/- 0.302	2.239 +/- 0.119
0.04 - 39.88	0.816 +/- 0.010	24.145 +/- 0.339	2.001 +/- 0.513
39.92 - 79.76	0.821 +/- 0.009	24.539 +/- 0.312	2.272 +/- 0.140
79.80 - 119.64	0.829 +/- 0.008	24.723 +/- 0.292	2.260 +/- 0.127
119.68 - 159.52	0.831 +/- 0.009	24.784 +/- 0.292	2.234 +/- 0.147
159.56 - 199.40	0.832 +/- 0.009	24.822 +/- 0.309	2.226 +/- 0.135
199.44 - 239.28	0.833 +/- 0.009	24.818 +/- 0.298	2.246 +/- 0.140
239.32 - 279.16	0.833 +/- 0.009	24.815 +/- 0.293	2.269 +/- 0.132
279.20 - 319.04	0.833 +/- 0.009	24.827 +/- 0.305	2.261 +/- 0.133
319.08 - 358.92	0.833 +/- 0.008	24.827 +/- 0.300	2.261 +/- 0.132

----Percent difference from 100:
 ----((chxave(i)/chxave(first seg)*100 -100) with scaled errors): -----

Time interval [ms]	ch1	ch2	ch4
-40.80 - -0.08	0.000 +/- 1.075	0.000 +/- 1.217	0.000 +/- 5.331
0.04 - 39.88	-3.120 +/- 1.188	-2.720 +/- 1.366	-10.662 +/- 22.927
39.92 - 79.76	-2.465 +/- 1.076	-1.134 +/- 1.256	1.453 +/- 6.250
79.80 - 119.64	-1.582 +/- 0.989	-0.392 +/- 1.175	0.916 +/- 5.690
119.68 - 159.52	-1.311 +/- 1.033	-0.143 +/- 1.175	-0.240 +/- 6.582
159.56 - 199.40	-1.139 +/- 1.011	0.007 +/- 1.247	-0.616 +/- 6.021
199.44 - 239.28	-1.061 +/- 1.058	-0.008 +/- 1.202	0.280 +/- 6.249
239.32 - 279.16	-1.065 +/- 1.108	-0.018 +/- 1.182	1.305 +/- 5.910
279.20 - 319.04	-0.998 +/- 1.104	0.028 +/- 1.231	0.978 +/- 5.951
319.08 - 358.92	-1.082 +/- 1.005	0.029 +/- 1.209	0.970 +/- 5.883

----Done with file no. 13-----