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Institut des étalons
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1200 Montreal Road, M-36
Ottawa, Canada
K1A 0R6

1200, chemin Montréal, M-36
Ottawa, Canada
K1A 0R6



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Calibration Report

Calibration of Danfysik DC Current Transformer System
STH600 DCCT S/N 10053160, STH2000 DCCT S/N 10057791, with
Ultrastab Saturn Subsystem, S/N 10057681

For

GMW Associates
955 Industrial Rd.
San Carlos, California
USA, 94070

Attn.: Mr. Daniel Walker

Client order number: **CONTRACT**

NRC order number: **462452**

Signed by:

Authorised by:

D. Bennett, Metrologist
(613) 990-6347
david.bennett@nrc-cnrc.gc.ca

A. Bulinski, Group Leader
(613) 990-4022
alexander.bulinski@nrc-cnrc.gc.ca

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1. Description

The system under test is a Danfysik Ultrastab Saturn Precision Current Transformer System for 500 A DC and 2000 A DC operation. The components of this system, the configurations used when performing current measurements, and the maximum currents applied during calibration are shown in Table 1.

Table 1. Summary of Components of Danfysik Ultrastab Saturn Precision Current Transformer System, when calibrated at 500A DC and 2000A DC

Danfysik Ultrastab Saturn Precision Current Transformer System Components			
Maximum Test Current	DC Current Transformer	Adapter Plug	Danfysik Ultrastab Saturn Electronic Subsystem
500 A DC	STH600 S/N 10053160	Part No. 81089282 (500:1 A/A)	S/N 10057681
2000 A DC	STH2000 S/N 10057791	Part No. 81089288 (2000:1 A/A)	

2. Preliminary Inspection

These devices were received at the NRC High-Voltage Laboratory in May 2008. Upon receiving them, it was noted that the upper part of the chassis of the Ultrastab Saturn electronic enclosure (S/N 10057681) was deformed from previous shipping, as indicated by a note that was attached to the chassis. A preliminary check of the measuring system without primary current applied to the system indicated that these devices were acceptable for calibration.

3. Calibration

The calibration was performed according to INMS Quality Procedure No. EPM-201 [1].

The Danfysik Ultrastab Saturn Precision Current Transformer System was calibrated between 2008-06-19 and 2008-06-23, at an ambient temperature of $(22 \pm 2)^\circ\text{C}$ and relative humidity of $(35 \pm 20)\%$ in the high-voltage laboratory of NRC, using a Current-Comparator-Based DC Current Ratio Bridge.

The error of the system under test is defined by the following formula:

$$\text{Error} = (I_S - (I_P / n)) / (I_P / n) \times 10^{-6}$$

Where: I_P and I_S are the primary and secondary currents respectively, and n is the nominal current ratio of the device.

During calibration, a burden of 0.1Ω was applied to the secondary circuit of the System Under Test. Primary currents were applied to a single turn primary conductor which was inserted into the feed-through hole of the STH600 or the ST2000 and measurements were performed at those test currents shown in Tables 2, 3, 4, and 5.

Following calibration, the primary System components were marked with a calibration sticker numbered EPM-2008-0009, dated 02-Jul-2008.

The calibration results are traceable to SI Units through measurement standards, in particular DC current-comparator-based ratio standards, maintained within the Electrical Power Measurements Group at the Institute for National Measurement Standards, NRC.

The total estimated uncertainties (coverage factor $k = 2$) shown in Tables 2, 3, 4 and 5 encompass the Type A uncertainty (2 sigma of the average of three sets of measurements over 3 days) and the Type B uncertainty of the NRC calibration system, which is 4×10^{-6} for DC Current Ratio. The confidence level that the reported Ratio Errors are within the quoted uncertainties is estimated at 95%.

It should be noted that these uncertainties are not an indication of the long-term stability of the System Under Test and they do not include the uncertainties due to its repeatability characteristics, handling, aging, current history, proximity of conductors or any other influences of the environment in which the System Under Test is used in, which are different from the conditions of this calibration.

[1] EPM-201: Calibration of DC Current Ratio Devices, Version 3.1, Issued: 15 May 2006, <http://www.deis.nrc.ca/epmg/QS/QM/EPM-201-a.doc>

Table 2
Danfysik STH600 DCCT S/N 10053160 with Danfysik
Ultrastab Saturn S/N 10057681, Positive Current, 0.1Ω Burden

Primary Current (A)	Measured Offset Current (μA)
0	$< 1 \pm 3$

Primary Current (A)	Error (μA/A)
50	1 ± 45
100	0 ± 18
150	2 ± 14
200	1 ± 13
250	1 ± 11
300	1 ± 10
350	1 ± 10
400	1 ± 8
450	1 ± 7
500	1 ± 7

Table 3
Danfysik STH600 DCCT S/N 10053160 with Danfysik
Ultrastab Saturn S/N 10057681, Negative Current, 0.1Ω Burden

Primary Current (A)	Measured Offset Current (μA)
0	$< 1 \pm 3$

Primary Current (A)	Error (μA/A)
-50	-7 ± 7
-100	-3 ± 5
-150	-1 ± 5
-200	-1 ± 5
-250	-1 ± 5
-300	-1 ± 5
-350	-1 ± 5
-400	-1 ± 5
-450	-1 ± 5
-500	-1 ± 5

Table 4
Danfysik STH2000 DCCT S/N 10057791 with Danfysik
Ultrastab Saturn S/N 10057681, Positive Current, 0.1Ω Burden

Primary Current (A)	Measured Offset Current (μA)
0	< 1 ± 3

Primary Current (A)	Error (μA/A)
200	14 ± 25
400	8 ± 10
600	4 ± 5
800	3 ± 5
1000	2 ± 5
1200	1 ± 6
1400	1 ± 5
1600	1 ± 5
1800	1 ± 5
2000	1 ± 5

Table 5
Danfysik STH2000 DCCT S/N 10057791 with Danfysik
Ultrastab Saturn S/N 10057681, Negative Current, 0.1 Ω Burden

Primary Current (A)	Measured Offset Current (μA)
0	$< 1 \pm 3$

Primary Current (A)	Error (μA/A)
-200	4 ± 22
-400	4 ± 10
-600	2 ± 8
-800	3 ± 6
-1000	2 ± 5
-1200	2 ± 5
-1400	2 ± 5
-1600	2 ± 5
-1800	2 ± 5
-2000	1 ± 5