UNITED STATES DEPARTMENT OF COMMERCE
National Institute of Standards and Technology
Gaithersburg, Maryland 20899-

REPORT OF SPECIAL TEST

of

AC VOLTAGE STANDARD

Transmille, Model 3000AC
Serial Number 111211G14

Submitted by:

Transmille
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This AC Voltage Standard (ACVS) was tested from March 21, 2016 through May 3, 2016, under the service listed as NIST SP250 Test Number 55200S. The ACVS was tested at its nominal 7.07 V_{rms} (10 V_{pk}) AC voltage at its four output frequencies. The test used a digital multimeter (DMM) calibrated using NIST DC voltage standards and an AC meter calibrated with NIST AC voltage standards. The DC voltage was also tested using a calibrated DMM.

The results as reported in Table 1-4 are corrections to the Vrms value as calculated from DCV step measurements. The data in Table 5 are corrections to a nominal DC voltage of 10 V. In general, a correction is applied to the calculated V_{rms} or 10 V_{dc} by the relationship represented by the following equation:

$$A = R(1 + C/10^6),$$

where

A is the actual output value
R is the calculated V_{rms} or nominal 10 V_{dc}
C is the correction in proportional parts of the reading (i.e., μV/V).

The test conditions are summarized in Table 6 and additional information is given on the fact sheet.

Measurements performed by:

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NIST

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Table 1. Test results for 15 Hz range, correction to nominal 7.07 V.

Date	Measured Correction (μV/V)	Calculated Correction (μV/V)	Meas – Calc Correction (μV/V)
4/19/2016	-883.9	-876.5	-7.4
4/20/2016	-883.7	-876.2	-7.5
4/21/2016	-884.8	-874.4	-10.4
4/25/2016	-883.1	-875.8	-7.3
4/26/2016	-881.5	-875.8	-5.7
4/27/2016	-879.2	-874.7	-4.5
4/28/2016	-882.2	-874.7	-7.5
4/29/2016	-876.5	-866.0	-10.5
5/2/2016	-878.9	-864.9	-14.0
5/3/2016	-873.4	-863.3	-10.1
Exp. *U* (k=2) (μV/V) =	**26**	**Average Correction (μV/V) =**	**-8**

Table 2. Test results for 60 Hz range, correction to nominal 7.07 V.

Date	Measured Correction (μV/V)	Calculated Correction (μV/V)	Meas – Calc Correction (μV/V)
4/19/2016	-875.4	-873.7	-1.7
4/20/2016	-874.7	-874.0	-0.7
4/21/2016	-875.1	-873.4	-1.7
4/25/2016	-872.8	-872.4	-0.4
4/26/2016	-869.8	-872.4	2.6
4/27/2016	-870.3	-872.1	1.9
4/28/2016	-870.7	-872.4	1.7
4/29/2016	-866.7	-866.6	-0.1
5/2/2016	-866.1	-865.2	-0.9
5/3/2016	-863.8	-863.6	-0.2
Exp. *U* (k=2) (μV/V) =	**21**	**Average Correction (μV/V) =**	**0**

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Table 3. Test results for 200 Hz range, correction to nominal 7.07 V.

Date	Measured Correction (μV/V)	Calculated Correction (μV/V)	Meas – Calc Correction (μV/V)
4/19/2016	-876.6	-875.5	-1.1
4/20/2016	-877.5	-875.9	-1.6
4/21/2016	-877.3	-875.9	-1.4
4/25/2016	-875.2	-875.9	0.7
4/26/2016	-870.6	-869.8	-0.8
4/27/2016	-871.5	-869.8	-1.6
4/28/2016	-873.2	-869.4	-3.8
4/29/2016	-868.5	-866.3	-2.3
5/2/2016	-866.8	-865.1	-1. 7
5/3/2016	-866.0	-864.1	-1.8
Exp. *U* (k=2) (μV/V) =	**11**	**Average Correction (μV/V) =**	**-2**

Table 4. Test results for 1000 Hz range, correction to nominal 7.07 V.

Date	Measured Correction (μV/V)	Calculated Correction (μV/V)	Meas – Calc Correction (μV/V)
4/19/2016	-880.0	-875.1	-4.9
4/20/2016	-880.0	-875.1	-4.9
4/21/2016	-879.0	-874.2	-4.8
4/25/2016	-877.1	-874.2	-2.9
4/26/2016	-874.2	-871.6	-2.5
4/27/2016	-873.4	-869.3	-4.1
4/28/2016	-874.2	-869.3	-4.9
4/29/2016	-870.5	-867.0	-3.5
5/2/2016	-869.7	-865.7	-4.0
5/3/2016	-867.4	-864.3	-3.0
Exp. *U* (k=2) (μV/V) =	**11**	**Average Correction (μV/V) =**	**-4**

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Table 5. Test results for the DC Voltage output, correction to nominal 10 V.

Function	Date	Correction (μV/V)	Exp. *U* (k=2) (μV/V)
DCV	3/21/2016	-1927.5	0.5
DCV	3/30/2016	-1927.7	0.5
DCV	3/31/2016	-1927.7	0.5
DCV	4/4/2016	-1927.7	0.5
DCV	4/14/2016	-1928.1	0.5
DCV	4/14/2016	-1928.2	0.5
DCV	4/14/2016	-1928.1	0.5
DCV	4/19/2016	-1928.1	0.5
DCV	4/21/2016	-1928.3	0.5
DCV	5/3/2016	-1928.6	0.5

Table 6. Additional Test Data

Date the ACVS arrived at NIST	March 20, 2016
Condition of the ACVS upon arrival	No visible damage
NIST SP250 Test Number	53200S
Room temperature range during the test	22.5 – 23.0 °C
Warm-up period before testing	≥ 2 hours

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FACT SHEET for the Transmille 3000AC Test

This instrument uses a simulated sine wave as generated by 256 voltage steps. The ACVS self-verification mode is a procedure as defined in the Transmille manual. The instrument was stepped through all 256 steps and each dc voltage step measured with a digital voltmeter, calibrated with NIST DC voltage standards. The calculated rms AC voltage output is

$$V_{rms} = \sqrt{\frac{1}{n}\sum_{i=1}^{n} V_i^2} = \sqrt{\frac{V_1^2 + V_2^2 + \cdots + V_n^2}{n}}$$

The ACVS actual AC voltage output at each frequency is measured with an AC voltmeter, calibrated with NIST AC voltage standards. The correction from a nominal 7.07 V_{rms} to the measured AC voltage output is reported in Table 1-4, calculated as in the following equation

$$Correction\ (\mu V/V) = (V_{meas} - V_{nom})/(V_{nom}) \times 10^6.$$

Similarly, Table 5 reports the test data for the 10 V nominal DC output.

Special notes: The AC voltage output on the 200 Hz range contained a glitch in the AC generated step pattern that occurred approximately every 0.62 s, which added noise to the measured AC voltage measurements. It was found that the DC voltage varied with the AC output setting, so it was measured with the AC mode set to Step 0 (entered from 1 kHz). The instrument demonstrated severe drift for the first several weeks, so data for this time is not reported.

The uncertainty associated with each reported value is consistent with the practice recommended by the International Bureau of Weights and Measures (BIPM). It is the expanded uncertainty, $U = ku_c$, where u_c is the relative combined standard uncertainty for all known sources of error and k is a coverage factor. Consistent with international practice, NIST uses a coverage factor of $k = 2$. The expanded uncertainty is thus given by

$$U = 2u_c = 2\left(\sum u_i^2\right)^{0.5}$$

where u_i is the estimated relative standard uncertainty associated with the i^{th} source of error and expressed as an equivalent standard deviation. One component is an estimated Type A standard uncertainty based on the standard deviation of the mean of four or more individual measurements. The uncertainty contains no allowance for long-term drift or for the possible effects of transporting the instrument between laboratories. Details of the NIST method of expressing uncertainties can be found in reference [1].

[1] B.N. Taylor and C.E. Kuyatt, "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results," NIST Technical Note 1297, 1994 Edition.

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