P3-APMP.EM-S5

APMP Bilateral Supplementary Comparison of Ac-dc Transfer Standards Between NMIA (Australia) and NIMT (Thailand)

FINAL REPORT

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1. Introduction

This comparison was conducted under the project "PTB/NML/NIMT Collaboration in Electrical and Temperature Metrology – 2003", based on the MoU between PTB and NMIA[1]. The comparison is intended to demonstrate through the comparison NIMT's ability to establish and maintain its ac-dc transfer standards.

NMIA was the pilot laboratory for this NMIA-NIMT bilateral comparison, and has already participated in the CCEM-K6.a, CCEM-K6.c, and CCEM-K9 key comparisons for ac-dc transfer standards. NMIA was the coordinator of APMP.EM-K6.a. This comparison includes all the measurement points of CCEM-K6.a and APMP.EM-K6.a, all the points except those above 1 MHz of CCEM-K6.c, and all the points except 10 kHz of CCEM-K9. In addition, this comparison includes the 0.5 V, 1 V, 10 V, 60 V, 100 V and 200 V ranges.

This comparison was conducted on the basis of the CIPM guidelines that are appropriate for bilateral comparisons.

The measurements for this comparison were conducted between December 2003 and August 2004.

2. Definition of the Measurand

Ac-dc transfer difference is defined as:

$$\delta = \frac{U_{ac} - U_{dc}}{U_{dc}}$$

where:

U_{ac} is the rms value of the alternating voltage applied to the input, and
U_{dc} is the magnitude of the applied direct voltage which, when reversed, produces the same mean output response as the alternating voltage.

Ac-dc transfer differences are expressed in microvolts per volt (μV/V), and a positive sign signifies that a greater alternating voltage than direct voltage was required to produce the same output response.

These voltages are defined at the mid-point of the Tee adaptor used to connect the reference and unknown units in parallel.

[1] The former National Measurement Laboratory CSIRO is now part of the National Measurement Institute of Australia (NMIA) declared on 1st July 2004.

3. The Travelling Standard

The Travelling Standard was supplied by NMIA and was a set of Holt Model 11 Thermoelements and Range Resistors, with the following nominal parameters, comprising :

Thermoelement : P/N 90081A, 2.5 mA, 1 V, S/N 159,
Thermoelement : P/N 90081B, 5.0 mA, 2 V, S/N 159,
Thermoelement : P/N 90081C, 10 mA, 4 V, S/N 151,

Adaptor Plate : P/N 84980,

Range Resistor (3.6 kΩ): P/N 90080B, 10/20/40 V, S/N 171,
Range Resistor (11.6 kΩ): P/N 90080C, 30/60/120 V, S/N 171,
Range Resistor (39.6 kΩ): P/N 90080D, 100/200/400 V, S/N 221,
Range Resistor (120 kΩ): P/N 90080E, 300/600/1200 V, S/N 221.

The Thermoelements each have a nominal input resistance of 400 Ω and a nominal output voltage of 7 mV. The Range Resistors and Adaptor Plate each have a type GR874 connector on the input side.

4. Test Points

The ac-dc transfer difference of the Travelling Standard was measured at the following frequencies (in kHz) for the voltages shown:

0.5 V :	0.01,	0.04,	1,	20,	50,	100,	500,	1000.
1 V :	0.01,	0.04,	1,	20,	50,	100,	500,	1000.
3 V :	0.01,	0.04,	1[1],	20[1],	50,	100[1],	500[2],	1000[1,2].
10 V :	0.01,	0.04,	1,	20,	50,	100,	500,	1000.
60 V :	0.01,	0.04,	1,	20,	50,	100.		
100 V :	0.01,	0.04,	1,	20,	50,	100.		
200 V :	0.01,	0.04,	1[3],	20[3],	50[3],	100[3].		
500 V :	0.01,	0.04,	1[3],	20[3],	50[3],	100[3].		
1000 V :	0.01,	0.04,	1[3],	20[3],	50[3],	100[3].		

Note :- Points in CCEM-K6.a are marked [1].
Points in CCEM-K6.c are marked [2].
Points in CCEM-K9 are marked [3].

5. Transportation

The travelling standards were transported in a specially made aluminium transit case with a hinged lid, latches (without locks) and anti-static foam lining. The individual items were each wrapped in protective bubble-wrap and all resistors were disconnected from the thermoelements. The case with standards was transported by air-freight between the two laboratories. There were no unusual delays in

transportation or Customs handling and the standards returned to the pilot laboratory (NMIA) with no apparent physical damage.

6. Reported Results

(a) General

The first round of measurements at NMIA was made from 09/12/2003 to 23/01/2004.
The measurements at NIMT were made from 18/03/2004 to 22/04/2004.
The second round of measurements at NMIA was made from 14/05/2004 to 16/08/2004. This extended period of the second round was due to the need to perform additional measurements in investigating the apparent drift of several range resistors of the travelling standards (see results following).

The temperature and relative humidity during the NMIA measurements (round 1 and round 2) were 23 ± 0.5 °C and 50 ± 5 %, and for the NIMT measurements were 23 ± 2 °C and 50 ± 15 % respectively.

(b) Equipment and Methods used

At NMIA all measurements were performed with a GR874 Tee adaptor, with no other adaptors needing to be used as all of the references used had GR874 input connectors. The references used at 1 V and 3 V were the NMIA primary standards, and at the other levels were intermediate or working standards.

At NIMT all measurements below 10 V were made with a GR874 Tee adaptor, with no other adaptors used, as the references used were Holt Model 11 type. For the levels of 10 V and greater a homemade Type N to GR874 Tee adaptor was used as the reference used was a Fluke Ac-Dc Transfer Standard Model 792A (with range resistor Fluke Model 792A-7002 for 500 V and 1000 V) which have a Type N input connector. Likewise, no other adaptors were used at these levels to connect the above units and the travelling standards to the Tee.

In all measurements by each laboratory the case and input low, and the output low, of all units were connected to ground, and the guard of the 792A was also connected to ground, but with earth-loops being avoided.

(c) Traceability

The NIMT measurements are traceable to PTB, Germany, through the Calibration marks 3882 PTB 00 and 2491 PTB 03 covering the Fluke 792A Ac-Dc Transfer Standard and 792A-7002 range resistor, and to NMIA, Australia, through Measurement Report No. RN46820 covering the Holt Model 11 Thermal Voltage Converters at 1 V and 3 V. The NIMT measurements given in this report are taken from NIMT Certificate of Calibration No. EL-04/034.

The measurements made at NMIA are traceable to the NMIA Primary Standards of Ac-Dc Transfer Difference through Measurement Reports RN40246, RN40247, RN40778 and RN40779.

(d) Measurement Results

The following pages show the detailed results of measurements of each laboratory at each voltage from 0.5 V to 1000 V. The values given are the means of all measurements made (for the particular voltage and frequency) on that occasion. The second table and graph on each page show all measured values adjusted relative to the first (round 1) measurement at NMIA. All uncertainties and error bars on graphs are at the 95% level of confidence.

Measured AC-DC Difference of Thermal Voltage Converter HOLT 11, 90081A, S/N 159

at 0.5 V

(parts per million)

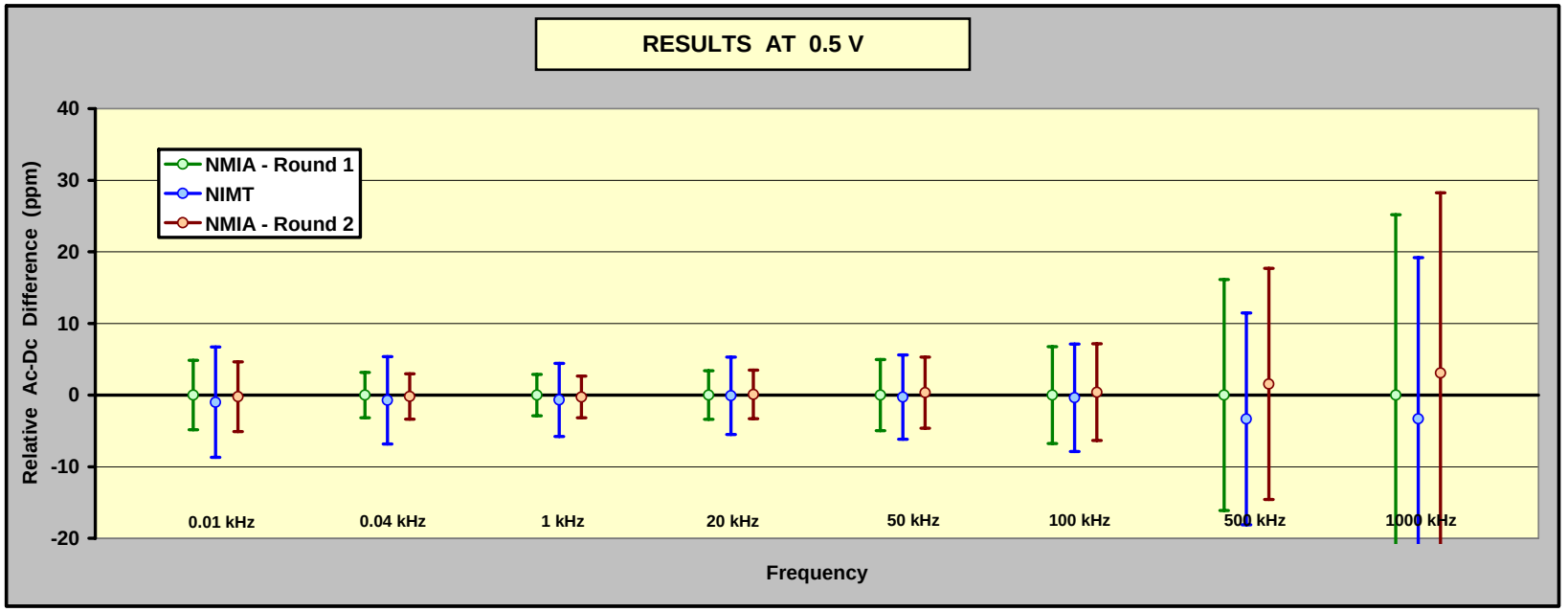
NMI	Date	Frequency (kHz)															
		0.01		0.04		1		20		50		100		500		1000	
		Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc
NMIA	Jan-04	-0.7	4.9	-1.1	3.2	-0.6	2.9	4.9	3.4	10.9	5.0	18.0	6.7	51.8	16.1	75.1	25.2
NIMT	Apr-04	-1.7	7.7	-1.8	6.1	-1.3	5.1	4.8	5.4	10.6	5.9	17.6	7.5	48.5	14.8	71.8	22.5
NMIA	May-04	-0.9	4.9	-1.3	3.2	-0.9	2.9	5.0	3.4	11.2	5.0	18.4	6.7	53.4	16.1	78.2	25.2

Relative AC-DC Difference of Thermal Voltage Converter HOLT 11, 90081A, S/N 159

at 0.5 V

(parts per million)

NMI	Date	Frequency (kHz)															
		0.01		0.04		1		20		50		100		500		1000	
		Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc
NMIA	Jan-04	0.0	4.9	0.0	3.2	0.0	2.9	0.0	3.4	0.0	5.0	0.0	6.7	0.0	16.1	0.0	25.2
NIMT	Apr-04	-1.0	7.7	-0.7	6.1	-0.7	5.1	-0.1	5.4	-0.3	5.9	-0.4	7.5	-3.3	14.8	-3.3	22.5
NMIA	May-04	-0.2	4.9	-0.2	3.2	-0.3	2.9	0.1	3.4	0.3	5.0	0.4	6.7	1.6	16.1	3.1	25.2



Measured AC-DC Difference of Thermal Voltage Converter HOLT 11, 90081A, S/N 159

at 1 V

(parts per million)

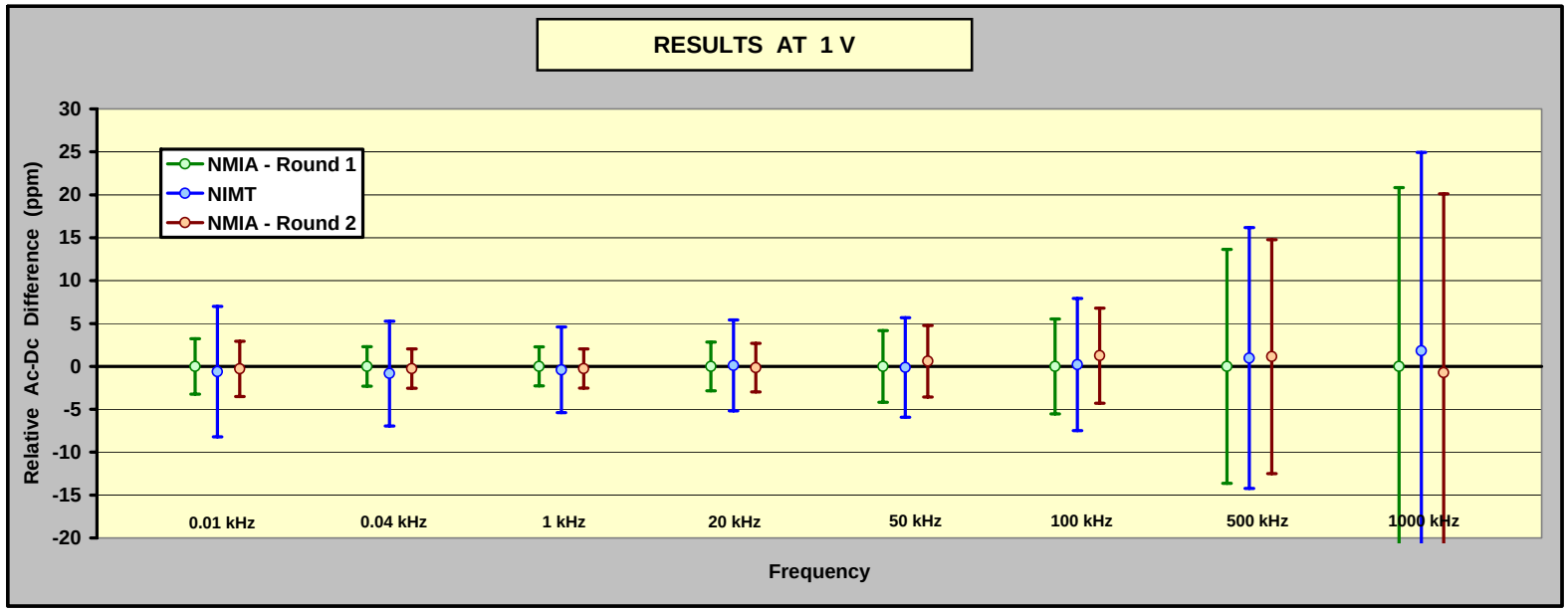
NMI	Date	Frequency (kHz)															
		0.01		0.04		1		20		50		100		500		1000	
		Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc
NMIA	Jan-04	-1.3	3.2	-1.2	2.3	-0.8	2.3	4.6	2.8	10.5	4.2	17.4	5.5	49.3	13.6	71.4	20.8
NIMT	Apr-04	-1.9	7.6	-2.0	6.1	-1.2	5.0	4.7	5.3	10.4	5.8	17.6	7.7	50.3	15.2	73.2	23.1
NMIA	May-04	-1.6	3.2	-1.4	2.3	-1.0	2.3	4.4	2.8	11.1	4.2	18.6	5.5	50.5	13.6	70.6	20.8

Relative AC-DC Difference of Thermal Voltage Converter HOLT 11, 90081A, S/N 159

at 1 V

(parts per million)

NMI	Date	Frequency (kHz)															
		0.01		0.04		1		20		50		100		500		1000	
		Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc
NMIA	Jan-04	0.0	3.2	0.0	2.3	0.0	2.3	0.0	2.8	0.0	4.2	0.0	5.5	0.0	13.6	0.0	20.8
NIMT	Apr-04	-0.6	7.6	-0.8	6.1	-0.4	5.0	0.1	5.3	-0.1	5.8	0.2	7.7	1.0	15.2	1.8	23.1
NMIA	May-04	-0.3	3.2	-0.3	2.3	-0.3	2.3	-0.2	2.8	0.6	4.2	1.3	5.5	1.1	13.6	-0.7	20.8



Measured AC-DC Difference of Thermal Voltage Converter HOLT 11, 90081C, S/N 151

at 3 V

(parts per million)

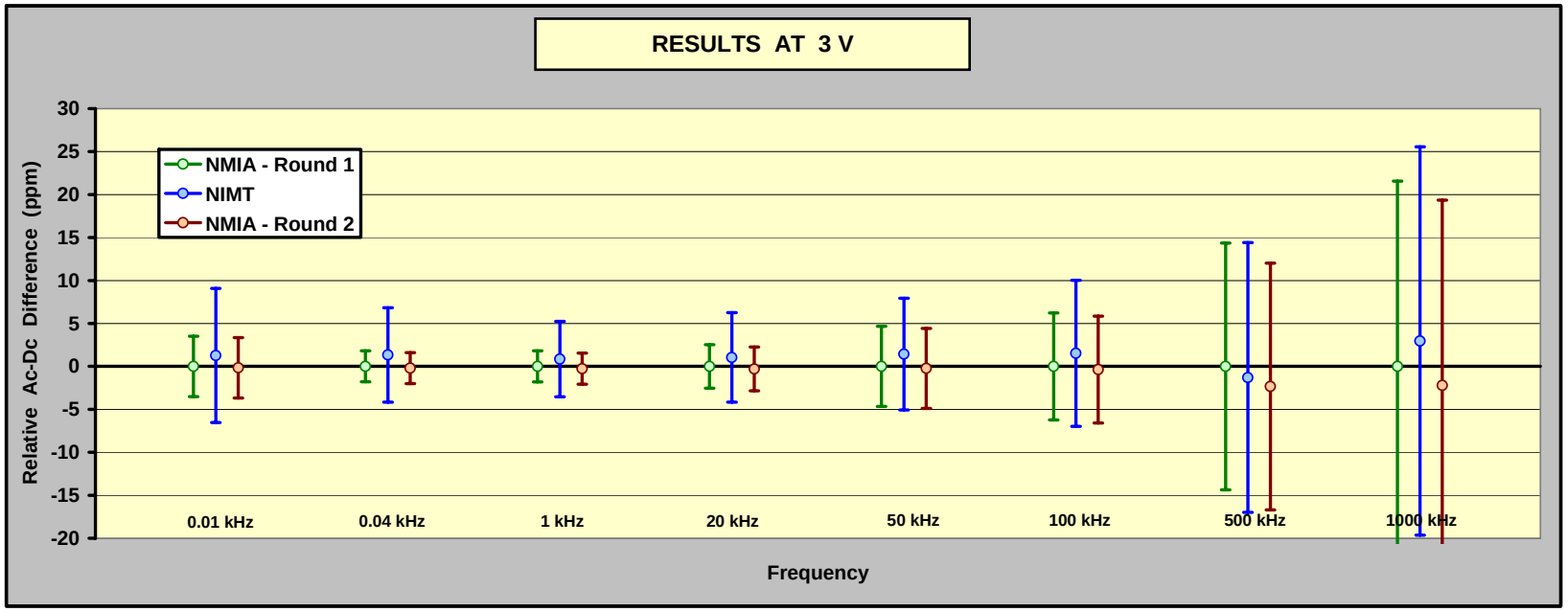
NMI	Date	Frequency (kHz)															
		0.01		0.04		1		20		50		100		500		1000	
		Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc
NMIA	Jan-04	-11.2	3.5	-9.0	1.8	-7.6	1.8	-2.7	2.5	2.4	4.7	7.9	6.2	33.3	14.4	43.4	21.6
NIMT	Apr-04	-9.9	7.8	-7.7	5.5	-6.7	4.4	-1.7	5.2	3.8	6.5	9.4	8.5	32.0	15.7	46.3	22.6
NMIA	May-04	-11.3	3.5	-9.3	1.8	-7.8	1.8	-3.0	2.5	2.1	4.7	7.5	6.2	31.0	14.4	41.1	21.6

Relative AC-DC Difference of Thermal Voltage Converter HOLT 11, 90081C, S/N 151

at 3 V

(parts per million)

NMI	Date	Frequency (kHz)															
		0.01		0.04		1		20		50		100		500		1000	
		Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc
NMIA	Jan-04	0.0	3.5	0.0	1.8	0.0	1.8	0.0	2.5	0.0	4.7	0.0	6.2	0.0	14.4	0.0	21.6
NIMT	Apr-04	1.3	7.8	1.3	5.5	0.9	4.4	1.0	5.2	1.4	6.5	1.5	8.5	-1.3	15.7	3.0	22.6
NMIA	May-04	-0.2	3.5	-0.2	1.8	-0.3	1.8	-0.3	2.5	-0.2	4.7	-0.4	6.2	-2.3	14.4	-2.2	21.6



Measured AC-DC Difference of Thermal Voltage Converter HOLT 11, 90081A, S/N 159 and 90080B, S/N 171

at 10 V

(parts per million)

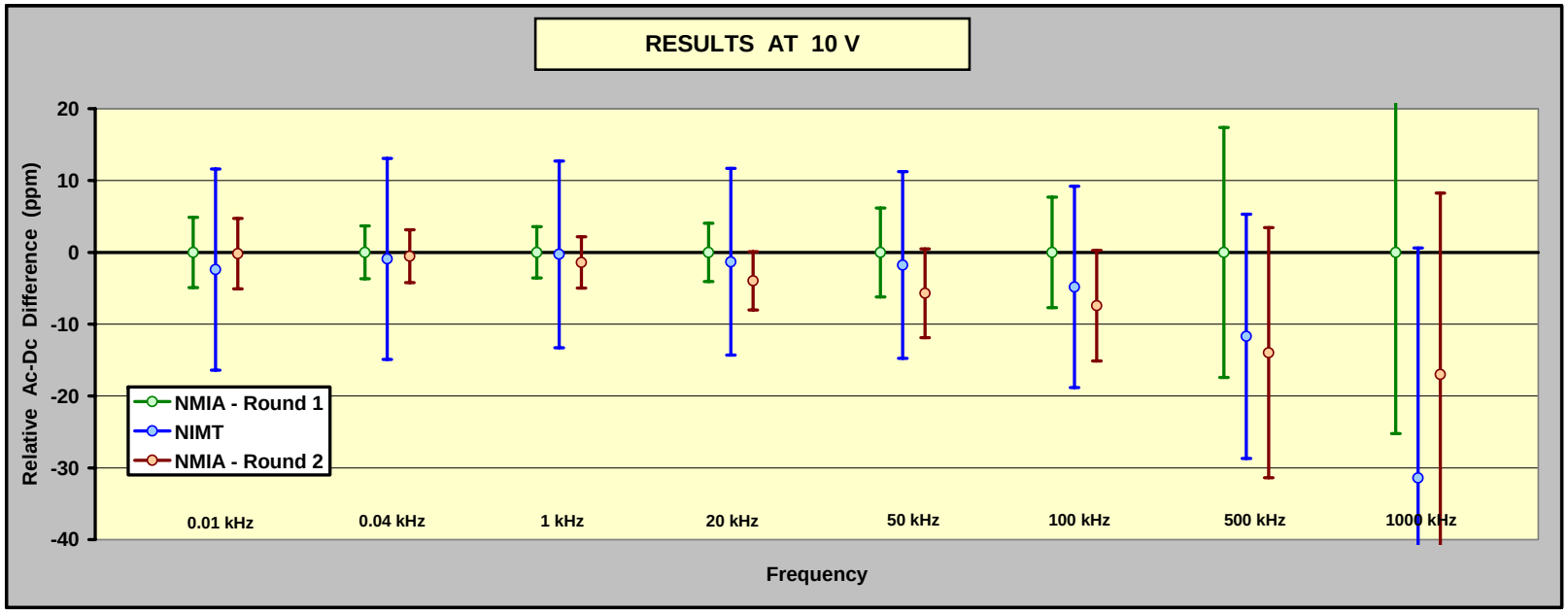
NMI	Date	Frequency (kHz)															
		0.01		0.04		1		20		50		100		500		1000	
		Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc
NMIA	Jan-04	-1.6	4.9	-1.1	3.7	-0.7	3.6	-2.7	4.1	-6.2	6.2	-15.2	7.7	-112.3	17.4	-266.6	25.2
NIMT	Apr-04	-4.0	14.0	-2.0	14.0	-1.0	13.0	-4.0	13.0	-8.0	13.0	-20.0	14.0	-124.0	17.0	-298.0	32.0
NMIA	May-04	-1.8	4.9	-1.6	3.7	-2.1	3.6	-6.6	4.1	-11.9	6.2	-22.6	7.7	-126.3	17.4	-283.6	25.2

Relative AC-DC Difference of Thermal Voltage Converter HOLT 11, 90081A, S/N 159 and 90080B, S/N 171

at 10 V

(parts per million)

NMI	Date	Frequency (kHz)															
		0.01		0.04		1		20		50		100		500		1000	
		Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc
NMIA	Jan-04	0.0	4.9	0.0	3.7	0.0	3.6	0.0	4.1	0.0	6.2	0.0	7.7	0.0	17.4	0.0	25.2
NIMT	Apr-04	-2.4	14.0	-0.9	14.0	-0.3	13.0	-1.3	13.0	-1.8	13.0	-4.8	14.0	-11.7	17.0	-31.4	32.0
NMIA	May-04	-0.2	4.9	-0.5	3.7	-1.4	3.6	-4.0	4.1	-5.7	6.2	-7.4	7.7	-14.0	17.4	-17.0	25.2



Measured AC-DC Difference of Thermal Voltage Converter HOLT 11, 90081B, S/N 159 and 90080C, S/N 171

at 60 V

(parts per million)

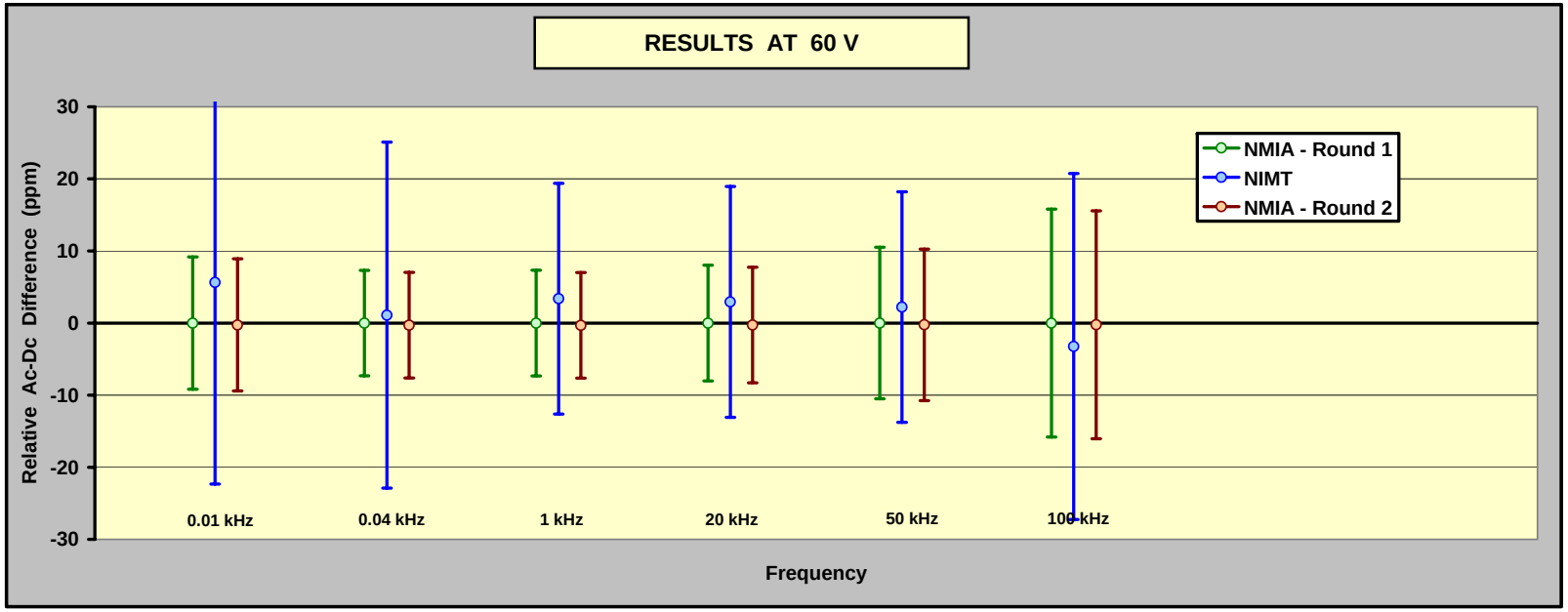
NMI	Date	Frequency (kHz)															
		0.01		0.04		1		20		50		100		500		1000	
		Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc
NMIA	Jan-04	12.4	9.2	-3.1	7.3	-2.4	7.3	2.1	8.0	6.8	10.5	18.2	15.8	--	--	--	--
NIMT	Apr-04	18.0	28.0	-2.0	24.0	1.0	16.0	5.0	16.0	9.0	16.0	15.0	24.0	--	--	--	--
NMIA	May-04	12.1	9.2	-3.4	7.3	-2.7	7.3	1.8	8.0	6.5	10.5	18.0	15.8	--	--	--	--

Relative AC-DC Difference of Thermal Voltage Converter HOLT 11, 90081B, S/N 159 and 90080C, S/N 171

at 60 V

(parts per million)

NMI	Date	Frequency (kHz)															
		0.01		0.04		1		20		50		100		500		1000	
		Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc
NMIA	Jan-04	0.0	9.2	0.0	7.3	0.0	7.3	0.0	8.0	0.0	10.5	0.0	15.8	--	--	--	--
NIMT	Apr-04	5.6	28.0	1.1	24.0	3.4	16.0	2.9	16.0	2.2	16.0	-3.2	24.0	--	--	--	--
NMIA	May-04	-0.3	9.2	-0.3	7.3	-0.3	7.3	-0.3	8.0	-0.2	10.5	-0.2	15.8	--	--	--	--



Measured AC-DC Difference of Thermal Voltage Converter HOLT 11, 90081A, S/N 159 and 90080D, S/N 221

at 100 V

(parts per million)

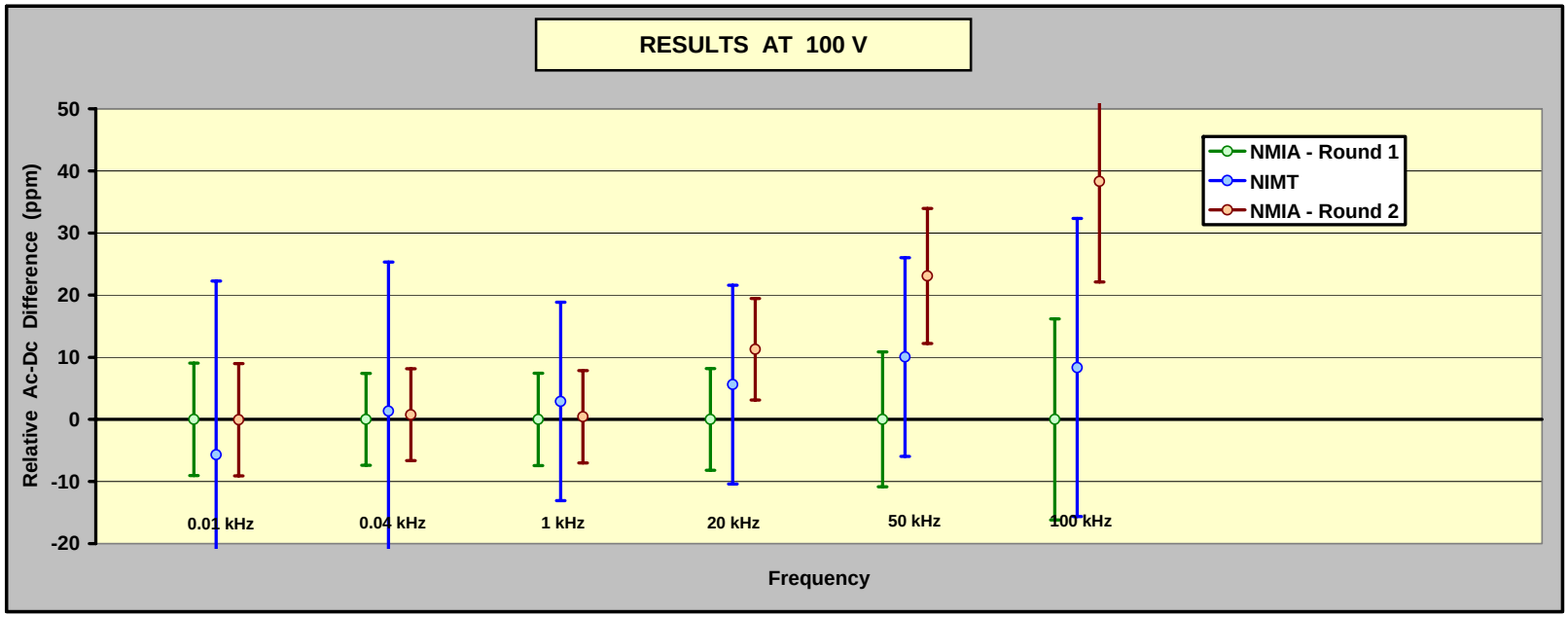
NMI	Date	Frequency (kHz)															
		0.01		0.04		1		20		50		100		500		1000	
		Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc
NMIA	Jan-04	-2.3	9.0	-3.3	7.4	2.1	7.4	38.4	8.2	80.0	10.9	141.7	16.2	--	--	--	--
NIMT	Apr-04	-8.0	28.0	-2.0	24.0	5.0	16.0	44.0	16.0	90.0	16.0	150.0	24.0	--	--	--	--
NMIA	May-04	-2.3	9.0	-2.6	7.4	2.5	7.4	49.7	8.2	103.0	10.9	180.0	16.2	--	--	--	--

Relative AC-DC Difference of Thermal Voltage Converter HOLT 11, 90081A, S/N 159 and 90080D, S/N 221

at 100 V

(parts per million)

NMI	Date	Frequency (kHz)															
		0.01		0.04		1		20		50		100		500		1000	
		Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc
NMIA	Jan-04	0.0	9.0	0.0	7.4	0.0	7.4	0.0	8.2	0.0	10.9	0.0	16.2	--	--	--	--
NIMT	Apr-04	-5.7	28.0	1.3	24.0	2.9	16.0	5.6	16.0	10.1	16.0	8.3	24.0	--	--	--	--
NMIA	May-04	0.0	9.0	0.7	7.4	0.4	7.4	11.3	8.2	23.1	10.9	38.3	16.2	--	--	--	--



Measured AC-DC Difference of Thermal Voltage Converter HOLT 11, 90081B, S/N 159 and 90080D, S/N 221

at 200 V

(parts per million)

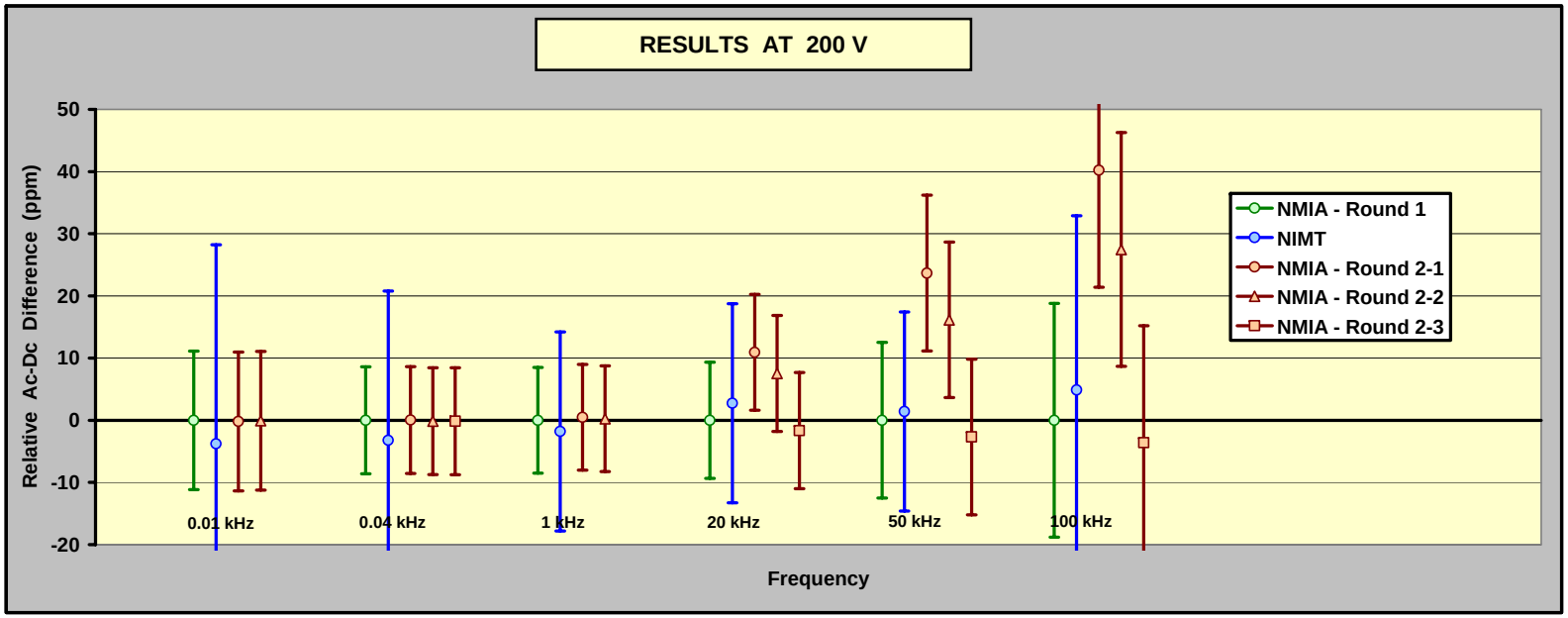
NMI	Date	Frequency (kHz)															
		0.01		0.04		1		20		50		100		500		1000	
		Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc
NMIA	Jan-04	14.8	11.1	1.2	8.6	1.8	8.5	42.3	9.3	90.6	12.5	158.1	18.8	--	--	--	--
NIMT	Apr-04	11.0	32.0	-2.0	24.0	0.0	16.0	45.0	16.0	92.0	16.0	163.0	28.0	--	--	--	--
NMIA	19-May-04	14.6	11.1	1.3	8.6	2.3	8.5	53.2	9.3	114.3	12.5	198.3	18.8	--	--	--	--
NMIA	31-May-04	14.7	11.1	1.1	8.6	2.0	8.5	49.8	9.3	106.7	12.5	185.6	18.8	--	--	--	--
NMIA	13-Aug-04	--	11.1	1.1	8.6	--	8.5	40.6	9.3	87.9	12.5	154.5	18.8	--	--	--	--

Relative AC-DC Difference of Thermal Voltage Converter HOLT 11, 90081B, S/N 159 and 90080D, S/N 221

at 200 V

(parts per million)

NMI	Date	Frequency (kHz)															
		0.01		0.04		1		20		50		100		500		1000	
		Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc
NMIA	Jan-04	0.0	11.1	0.0	8.6	0.0	8.5	0.0	9.3	0.0	12.5	0.0	18.8	--	--	--	--
NIMT	Apr-04	-3.8	32.0	-3.2	24.0	-1.8	16.0	2.7	16.0	1.4	16.0	4.9	28.0	--	--	--	--
NMIA	19-May-04	-0.2	11.1	0.0	8.6	0.5	8.5	10.9	9.3	23.7	12.5	40.2	18.8	--	--	--	--
NMIA	31-May-04	-0.1	11.1	-0.1	8.6	0.3	8.5	7.5	9.3	16.2	12.5	27.5	18.8	--	--	--	--
NMIA	13-Aug-04	#N/A	11.1	-0.2	8.6	#N/A	8.5	-1.7	9.3	-2.7	12.5	-3.6	18.8	--	--	--	--



Measured AC-DC Difference of Thermal Voltage Converter HOLT 11, 90081B, S/N 159 and 90080E, S/N 221

at 500 V

(parts per million)

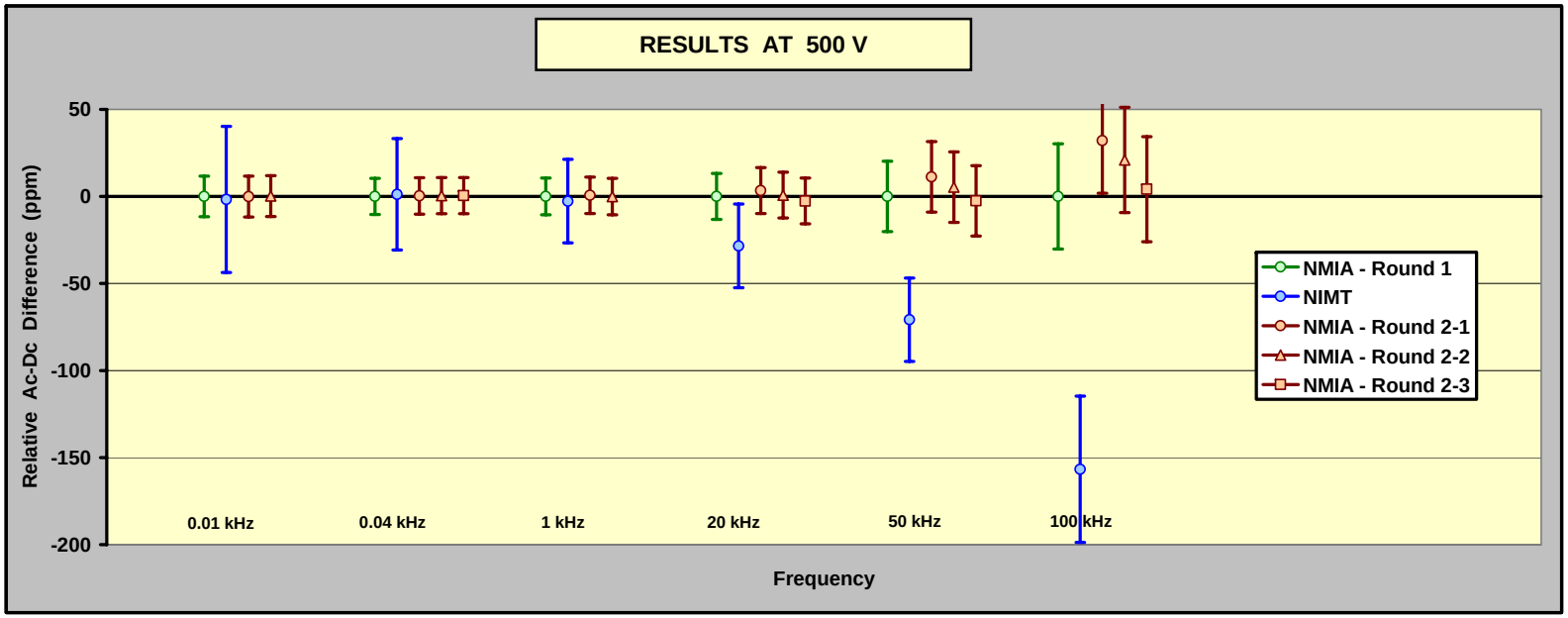
NMI	Date	Frequency (kHz)															
		0.01		0.04		1		20		50		100		500		1000	
		Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc
NMIA	Jan-04	4.8	11.7	-2.2	10.4	0.7	10.5	19.4	13.2	13.8	20.3	-57.3	30.2	--	--	--	--
NIMT	Apr-04	3.0	42.0	-1.0	32.0	-2.0	24.0	-9.0	24.0	-57.0	24.0	-214.0	42.0	--	--	--	--
NMIA	20-May-04	4.7	11.7	-1.9	10.4	1.4	10.5	22.7	13.2	25.0	20.3	-25.1	30.2	--	--	--	--
NMIA	01-Jun-04	5.0	11.7	-1.8	10.4	0.7	10.5	20.1	13.2	19.1	20.3	-36.3	30.2	--	--	--	--
NMIA	16-Aug-04	--	11.7	-1.7	10.4	--	10.5	16.8	13.2	11.2	20.3	-53.0	30.2	--	--	--	--

Relative AC-DC Difference of Thermal Voltage Converter HOLT 11, 90081B, S/N 159 and 90080E, S/N 221

at 500 V

(parts per million)

NMI	Date	Frequency (kHz)															
		0.01		0.04		1		20		50		100		500		1000	
		Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc
NMIA	Jan-04	0.0	11.7	0.0	10.4	0.0	10.5	0.0	13.2	0.0	20.3	0.0	30.2	--	--	--	--
NIMT	Apr-04	-1.8	42.0	1.2	32.0	-2.7	24.0	-28.4	24.0	-70.8	24.0	-156.7	42.0	--	--	--	--
NMIA	20-May-04	0.0	11.7	0.3	10.4	0.7	10.5	3.4	13.2	11.3	20.3	32.1	30.2	--	--	--	--
NMIA	01-Jun-04	0.2	11.7	0.5	10.4	0.0	10.5	0.8	13.2	5.3	20.3	20.9	30.2	--	--	--	--
NMIA	16-Aug-04	#N/A	11.7	0.5	10.4	#N/A	10.5	-2.6	13.2	-2.6	20.3	4.2	30.2	--	--	--	--



Measured AC-DC Difference of Thermal Voltage Converter HOLT 11, 90081C, S/N 151 and 90080E, S/N 221

at 1000 V

(parts per million)

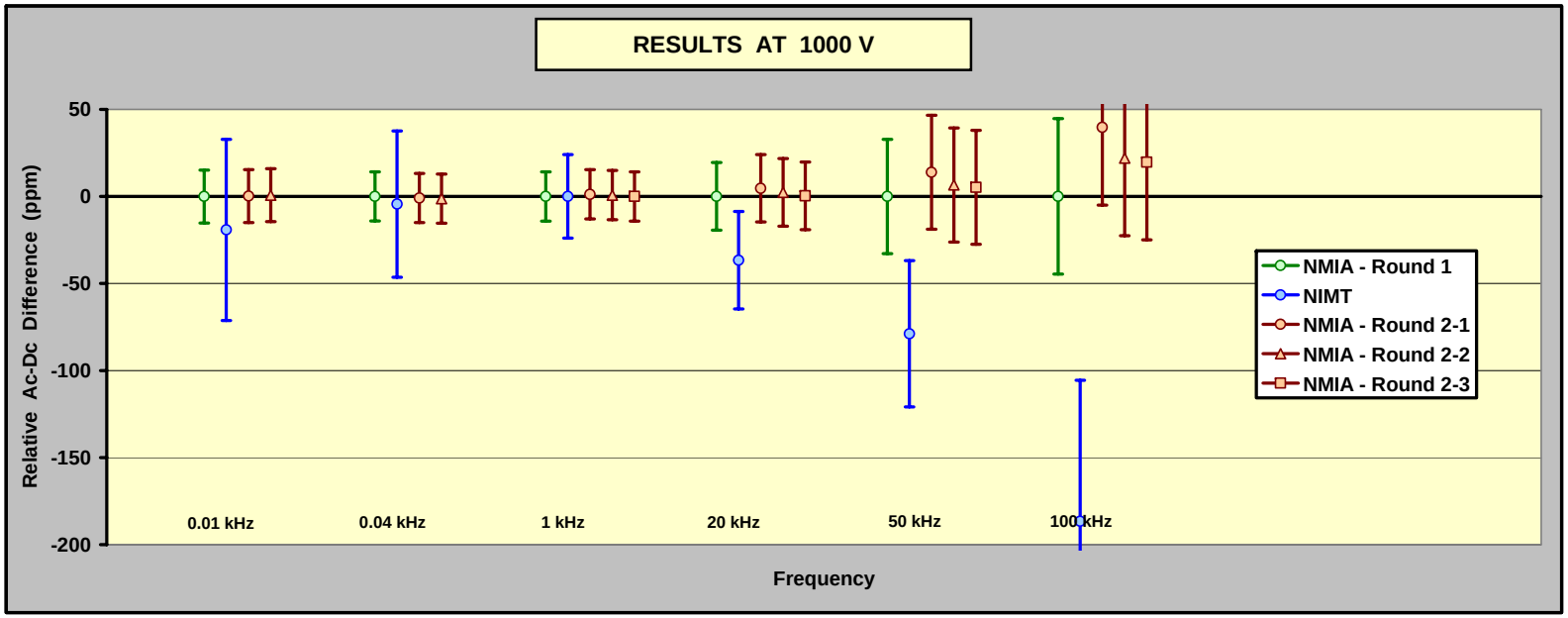
NMI	Date	Frequency (kHz)															
		0.01		0.04		1		20		50		100		500		1000	
		Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc
NMIA	Jan-04	-9.8	15.2	-7.7	14.1	-6.0	14.2	35.7	19.4	70.9	32.8	65.6	44.6	--	--	--	--
NIMT	Apr-04	-29.0	52.0	-12.0	42.0	-6.0	24.0	-1.0	28.0	-8.0	42.0	-121.0	81.0	--	--	--	--
NMIA	21-May-04	-9.6	15.2	-8.5	14.1	-4.8	14.2	40.4	19.4	84.8	32.8	105.3	44.6	--	--	--	--
NMIA	03-Jun-04	-9.1	15.2	-8.9	14.1	-5.3	14.2	38.0	19.4	77.5	32.8	87.7	44.6	--	--	--	--
NMIA	13-Aug-04	--	15.2	--	14.1	-6.1	14.2	36.0	19.4	76.2	32.8	85.3	44.6	--	--	--	--

Relative AC-DC Difference of Thermal Voltage Converter HOLT 11, 90081C, S/N 151 and 90080E, S/N 221

at 1000 V

(parts per million)

NMI	Date	Frequency (kHz)															
		0.01		0.04		1		20		50		100		500		1000	
		Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc	Res	Unc
NMIA	Jan-04	0.0	15.2	0.0	14.1	0.0	14.2	0.0	19.4	0.0	32.8	0.0	44.6	--	--	--	--
NIMT	Apr-04	-19.2	52.0	-4.3	42.0	0.0	24.0	-36.7	28.0	-78.9	42.0	-186.6	81.0	--	--	--	--
NMIA	21-May-04	0.2	15.2	-0.9	14.1	1.2	14.2	4.7	19.4	13.9	32.8	39.7	44.6	--	--	--	--
NMIA	03-Jun-04	0.7	15.2	-1.2	14.1	0.8	14.2	2.3	19.4	6.6	32.8	22.1	44.6	--	--	--	--
NMIA	13-Aug-04	#N/A	15.2	#N/A	14.1	0.0	14.2	0.3	19.4	5.2	32.8	19.7	44.6	--	--	--	--



7. Discussion of Results

The requirements prescribed in the comparison protocol were followed.

At the levels of 0.5 V, 1 V, 3 V and 60 V, at all frequencies from 10 Hz to 1 MHz, the measurements of Ac-Dc Transfer Difference made at NIMT and NMIA agree very well within the stated uncertainties. This demonstrates NIMT's ability to establish, maintain and disseminate standards of Ac-Dc Transfer Difference at these levels.

At the levels of 10 V, 100 V, 200 V, 500 V and 1000 V the measurements made at NIMT and NMIA also agree very well within the stated uncertainties at frequencies from 10 Hz to 1 kHz. At higher frequencies of 20 kHz and above, the measurements have been affected, to various degrees, by the drift in the travelling standard discussed below. Nevertheless, it can be seen that at 10 V, 100 V and 200 V the uncertainties of the results of the two laboratories overlap, which indicates that the measurements at NMIT are also within the claimed uncertainties. However, at 500 V and 1000 V the results at 20 kHz and above differ significantly. This difference cannot be explained by the drift in the travelling standard and, therefore, indicates a possible problem with NIMT measurements.

8. Performance of the Travelling Standard

The travelling standard has shown excellent stability at frequencies from 10 Hz to 1 kHz at all levels, and above 1 kHz at the levels of 0.5 V, 1 V, 3 V and 60 V.

At the levels of 10 V, 100 V, 200 V, 500 V and 1000 V it is clear that the high frequency response (generally ≥ 20 kHz) of the travelling standards drifted during the comparison. This can be attributed to the drift of the range resistors P/N 90080B (used for 10 V), P/N 90080D (used for 100 V and 200 V) and P/N 90080E (used for 500 V and 1000 V), as each of the thermoelements used in combination with these resistors to produce the required voltage levels did not show any drift. The thermoelement P/N 90081A, 2.5 mA, was used for the 0.5 V and 1 V levels, the thermoelement P/N 90081B, 5 mA, was used for 60 V, and the thermoelement P/N 90081C, 10 mA, was used for 3 V. As can be seen from the repeated later round 2 measurements at NMIA at the 200 V, 500 V and 1000 V levels, the resistors are returning or have returned to their initial values. It is possible that the resistors were exposed to moisture and/or high RH during transit [2, 3], which could explain the return to their original values.

9. References

[1] I. Budovsky and B. D. Inglis, "High-Frequency AC-DC Differences of NMIA Single-Junction Thermal Voltage Converters," *IEEE Trans. on Instrum. Meas.*, vol. 50, pp. 101-105, Feb. 2001.

[2] I. Budovsky, "Algorithm and uncertainties of ac-dc transfer measurements, " in Proc. Metrology Society of Australia Biennial Conf., Gold Coast, Oct 2001, pp 82-88.

[3] Liu, L.X.; Chua, S.W.; Ang, C.K., "Behaviour and frequency dependence of AC-DC high voltage transfer standard under humidity step changes," CPEM 2002 Conference Digest, 16-21 June 2002, pp. 368 - 369

10. Appendix 1. NIMT Uncertainty Budgets

Uncertainty Budget for Ac-dc Voltage Transfer at 0.5 V

	Repeatability of meas		Calibration of std TVC		Drift of Standard		Calibrat of Sens		Drift in Temp & Hum		Drift in Different St.		Linearity of Ac-dc		Error of Connector		Dist and Noise		EMI and RFI		Drift in Freq setting		Votage Independence		Resol of Mon DMM		Stabilty of UUC					
Unit	1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6					
Dist.	Normal		Normal		Rect		Normal		Rect		Rect		Rect		Normal		Rect		Rect		Normal		Normal		Rect		Rect					
Divisor	1		2		sqrt 3		1		sqrt 3		sqrt 3		sqrt 3		sqrt 3		sqrt 3		sqrt 3		sqrt 3		sqrt 3		sqrt 3		sqrt 3					
Ci	1		1		1		1		1		1		1		1		1		1		1		1		1		1					
Vi	11		∞		∞		∞		∞		∞		∞		∞		∞		∞		∞		∞		∞		∞					
Freq																																Ue
(Hz)	Value	ur	Value	us	Value	ud	Value	usen	Value	ut	Value	uds	Value	ulin	Valu	ucon	Value	udis	Value	uem	Value	ufr	Value	ufr	Value	ures	Value	ust	Uc	neff	k	1*10^-6
10	1.02	1.02	2.8	1.4	0.50	0.3	1	1	1	0.58	1	0.58	1	0.58	1	0.58	1	0.58	1	0.58	5	2.89	1	0.58	0.5	0.29	1	0.58	*3.9*	2236.1	2.001	***7.7***
40	1.22	1.22	2.2	1.1	0.60	0.3	1	1	1	0.58	1	0.58	1	0.58	1	0.58	1	0.58	1	0.58	3	1.73	1	0.58	0.5	0.29	1	0.58	*3.0*	423.48	2.006	***6.1***
1 k	0.97	0.97	2.6	1.3	0.20	0.1	1	1	1	0.58	1	0.58	1	0.58	1	0.58	1	0.58	1	0.58	1	0.58	1	0.58	0.5	0.29	1	0.58	*2.5*	508.02	2.005	***5.1***
20 k	1.07	1.07	3.1	1.6	0.10	0.1	1	1	1	0.58	1	0.58	1	0.58	1	0.58	1	0.58	1	0.58	1	0.58	1	0.58	0.5	0.29	1	0.58	*2.7*	447.29	2.006	***5.4***
50 k	0.81	0.81	4.1	2.1	0.70	0.4	1	1	1	0.58	1	0.58	1	0.58	1	0.58	1	0.58	1	0.58	1	0.58	1	0.58	0.5	0.29	1	0.58	*3.0*	1966.3	2.000	***5.9***
100 k	1.11	1.11	5.3	2.7	0.50	0.3	1	1	1	0.58	1	0.58	1	0.58	2	1.15	1	0.58	1	0.58	1	0.58	2	1.15	0.5	0.29	1	0.58	*3.8*	1438.1	2.002	***7.5***
500 k	0.99	0.99	13	6.5	2.00	1.2	1	1	1	0.58	1	0.58	1	0.58	3	1.73	1	0.58	1	0.58	2	1.15	3	1.73	0.5	0.29	1	0.58	*7.4*	34196	2.000	***14.8***
1 M	1.07	1.07	20	10	3.00	1.7	1	1	1	0.58	1	0.58	1	0.58	5	2.89	1	0.58	1	0.58	3	1.73	5	2.89	0.5	0.29	1	0.58	*11.2*	134419	2.000	***22.5***

0.5 V

Uncertainty Budget for Ac-dc Voltage Transfer at 1 V

	Repeatability of meas		Calibration of std TVC		Drift of Standard		Calibrat of Sens		Drift in Temp & Hum		Drift in Different St.		Linearity of Ac-dc		Error of Connector		Dist and Noise		EMI and RFI		Drift in Freq setting		Resol of Mon DMM		Stabilty of UUC					
Unit	1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6					
Dist.	Normal		Normal		Rect		Normal		Rect		Rect		Rect		Normal		Rect		Rect		Normal		Rect		Rect					
Divisor	1		2		sqrt 3		1		sqrt 3		sqrt 3		sqrt 3		1		sqrt 3		sqrt 3		1		3		3					
Ci	1		1		1		1		1		1		1		1		1		1		1		1		1					
Vi	11		∞		∞		∞		∞		∞		∞		∞		∞		∞		∞		∞		∞					
Freq																														Ue
(Hz)	Value	ur	Value	us	Value	ud	Value	usen	Value	ut	Value	uds	Value	ulin	Value	ucon	Value	udis	Value	uem	Value	ufr	Value	ures	Value	ust	Uc	neff	k	1*10^-6
10	1	1.02	2.8	1.4	0.50	0.3	0.1	0.1	1	0.58	1	0.58	1	0.58	3	3	1	0.6	1.0	0.6	1.0	1.0	0.5	0.29	0.2	0.12	*3.8*	2143.6	2.001	***7.6***
40	1.2	1.22	2.2	1.1	0.60	0.3	0.1	0.1	1	0.58	1	0.58	1	0.58	2	2	1	0.6	1.0	0.6	1.0	1.0	0.5	0.29	0.2	0.12	*3.0*	425.62	2.006	***6.1***
1 k	1	0.97	2.6	1.3	0.20	0.1	0.1	0.1	1	0.58	1	0.58	1	0.58	1	1	1	0.6	1.0	0.6	1.0	1.0	0.5	0.29	0.4	0.23	*2.5*	466.02	2.005	***5.0***
20 k	1.1	1.07	3.1	1.6	0.10	0.1	0.1	0.1	1	0.58	1	0.58	1	0.58	1	1	1	0.6	1.0	0.6	1.0	1.0	0.5	0.29	0.2	0.12	*2.6*	410.11	2.006	***5.3***
50 k	0.8	0.81	4.1	2.1	0.70	0.4	0.1	0.1	1	0.58	1	0.58	1	0.58	1	1	1	0.6	1.0	0.6	1.0	1.0	0.5	0.29	0.3	0.17	*2.9*	1837	2.000	***5.8***
100 k	1.1	1.11	5.3	2.7	0.50	0.3	0.1	0.1	1	0.58	1	0.58	1	0.58	2	2	1	0.6	1.0	0.6	1.0	1.0	0.5	0.29	0.2	0.12	*3.8*	1582.4	2.002	***7.7***
500 k	1.0	0.99	13	6.5	2.00	1.2	0.1	0.1	1	0.58	1	0.58	1	0.58	3	3	1	0.6	1.0	0.6	1.0	1.0	0.5	0.29	2.4	1.39	*7.6*	38403	2.000	***15.2***
1 M	1.1	1.07	20	10	3.00	1.7	0.1	0.1	1	0.58	1	0.58	1	0.58	5	5	1	0.6	1.0	0.6	1.0	1.0	0.5	0.29	2.0	1.15	*11.5*	148231	2.000	***23.1***

1 V

Uncertainty Budget for Ac-dc Voltage Transfer at 3 V

	Repeatability of meas		Calibration of std TVC		Drift of Standard		Calibrat of Sens		Drift in Temp & Hum		Drift in Different St.		Linearity of Ac-dc		Error of Connector		Dist and Noise		EMI and RFI		Drift in Freq setting		Resol of Mon DMM		Stabilty of UUC					
Unit	1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6					
Dist.	Normal		Normal		Rect		Normal		Rect		Rect		Rect		Normal		Rect		Rect		Normal		Rect		Rect					
Divisor	1		2		sqrt 3		1		sqrt 3		sqrt 3		sqrt 3		1		sqrt 3		sqrt 3		1		3		3					
Ci	1		1		1		1		1		1		1		1		1		1		1		1		1					
Vi	11		∞		∞		∞		∞		∞		∞		∞		∞		∞		∞		∞		∞					
Freq																														Ue
(Hz)	Value	ur	Value	us	Value	ud	Value	usen	Value	ut	Value	uds	Value	ulin	Value	ucon	Value	udis	Value	uem	Value	ufr	Value	ures	Value	ust	Uc	neff	k	1*10^-6
10	1.1	1.13	3.1	1.6	0.20	0.1	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	3.0	3.0	1.0	0.6	1.0	0.6	1.0	1.0	0.5	0.29	0.4	0.23	*3.9*	1553.1	2.002	***7.8***
40	0.6	0.59	1.7	0.9	0.30	0.2	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	2.0	2.0	1.0	0.6	1.0	0.6	1.0	1.0	0.5	0.29	0.0	0.00	*2.7*	5143.5	2.000	***5.5***
1 k	0.8	0.77	1.7	0.9	0.40	0.2	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	1.0	1.0	0.6	1.0	0.6	1.0	1.0	0.5	0.29	0.2	0.12	*2.2*	723.59	2.003	***4.4***
20 k	0.6	0.57	2.5	1.3	1.50	0.9	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	1.0	1.0	0.6	1.0	0.6	1.0	1.0	0.5	0.29	1.5	0.87	*2.6*	4838.4	2.001	***5.2***
50 k	0.6	0.62	4.6	2.3	1.70	1.0	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	1.0	1.0	0.6	1.0	0.6	1.0	1.0	0.5	0.29	1.1	0.64	*3.2*	8157	2.000	***6.5***
100 k	0.7	0.69	6.1	3.1	2.00	1.2	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	2.0	2.0	1.0	0.6	1.0	0.6	1.0	1.0	0.5	0.29	1.1	0.64	*4.2*	15622	2.000	***8.5***
500 k	0.5	0.45	14	7	1.00	0.6	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	3.0	3.0	1.0	0.6	1.0	0.6	1.0	1.0	0.5	0.29	0.9	0.52	*7.8*	1E+06	2.000	***15.7***
1 M	0.4	0.43	20	10	0.00	0.0	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	5.0	5.0	1.0	0.6	1.0	0.6	1.0	1.0	0.5	0.29	0.7	0.40	*11.3*	5E+06	2.000	***22.6***

3 V

Uncertainty Budget for TVC 10 V 792A PTB as STD

	Repeat of meas		Calibrat of 792A		Drift of Standard		Calibration of n factor		Drift in Temp drift		Drift in Hum drift		Linearity of Ac-dc		Error of Connector		Distort and Noise		EMI and RFI		Different Calibrator		Drift in Freq setting		Resolution of DMM		Stabilty of TVC					
Unit	1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6					
Dist.	Normal		Normal		Rect		Normal		Rect		Rect		Rect		Normal		Rect		Rect		Rect		Normal		Rect		Rect					
Divisor	1		2		sqrt3		1		sqrt3		sqrt3		sqrt3		sqrt3		sqrt3		sqrt3		sqrt3		sqrt3		sqrt3		sqrt3					
Ci	1		1		1		1		1		1		1		1		1		1		1		1		1		1					
Vi	11		∞		∞		∞		∞		∞		∞		∞		∞		∞		∞		∞		∞		∞					
Freq																																Ue
(Hz)	Value	ur	Value	us	Value	ud	Value	usen	Value	ut	Value	uh	Value	ulin	Value	ucon	Value	udis	Value	uemi	Value	ucal	Value	ufr	Value	ures	Value	Ustb	Uc	neff	k	1*10^-6
10	1.7	1.65	6	3	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	0.8	0.5	1.0	0.6	0.5	0.29	1.0	0.58	*6.9*	3376.1	2.001	***13.8***
40	1	0.95	6	3	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	1.2	0.7	1.0	0.6	0.5	0.29	1.0	0.58	*6.8*	28754	2.000	***13.6***
1 k	1.3	1.28	4	2	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	0.3	0.2	1.0	0.6	0.5	0.29	1.0	0.58	*6.4*	7033.1	2.000	***12.9***
20k	0.8	0.82	4	2	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	0.3	0.2	1.0	0.6	0.5	0.29	1.0	0.58	*6.4*	39833	2.000	***12.7***
50k	0.59	0.59	4	2	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	0.1	0.1	1.0	0.6	0.5	0.29	1.0	0.58	*6.3*	146057	2.000	***12.7***
100k	0.7	0.74	6	3	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	0.2	0.1	1.0	0.6	0.5	0.29	1.0	0.58	*6.7*	75347	2.000	***13.5***
500k	0.85	0.85	12	6	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	0.8	0.5	1.0	0.6	0.5	0.29	1.0	0.58	*8.5*	111362	2.000	***17.1***
1M	0.92	0.92	30	15	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	3.7	2.1	1.0	0.6	0.5	0.29	1.0	0.58	*16.3*	1E+06	2.000	***32.6***

10 V

Uncertainty Budget for TVC 60 V 792A PTB as STD

	Repeat of meas		Calibrat of 792A		Drift of Standard		Calibration of n factor		Drift in Temp drift		Drift in Hum drift		Linearity of Ac-dc		Error of Connector		Distort and Noise		EMI and RFI		Different Calibrator		Drift in Freq setting		Resolution of DMM		Stabilty of TVC					
Unit	1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6					
Dist.	Normal		Normal		Rect		Normal		Rect		Rect		Rect		Normal		Rect		Rect		Rect		Normal		Rect		Rect					
Divisor	1		2		sqrt3		1		sqrt3		sqrt3		sqrt3		sqrt3		sqrt3		sqrt3		sqrt3		sqrt3		sqrt3		sqrt3					
Ci	1		1		1		1		1		1		1		1		1		1		1		1		1		1					
Vi	11		∞		∞		∞		∞		∞		∞		∞		∞		∞		∞		∞		∞		∞					
Freq																																Ue
(Hz)	Value	ur	Value	us	Value	ud	Value	usen	Value	ut	Value	uh	Value	ulin	Value	ucon	Value	udis	Value	uemi	Value	ucal	Value	ufr	Value	ures	Value	Ustb	Uc	neff	k	1*10^-6
10	1	1.03	25	13	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	0.4	0.2	1.0	0.6	0.5	0.29	1.0	0.58	*13.9*	364517	2.000	***27.8***
40	0.7	0.73	20	10	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	0.4	0.2	1.0	0.6	0.5	0.29	1.0	0.58	*11.7*	720091	2.000	***23.4***
1 k	0.8	0.81	10	5	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	0.1	0.1	1.0	0.6	0.5	0.29	1.0	0.58	*7.8*	96397	2.000	***15.7***
20k	0.7	0.65	10	5	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	1.9	1.1	1.0	0.6	0.5	0.29	1.0	0.58	*7.9*	239834	2.000	***15.8***
50k	0.8	0.77	10	5	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	0.1	0.1	1.0	0.6	0.5	0.29	1.0	0.58	*7.8*	117801	2.000	***15.7***
100k	0.8	0.79	20	10	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	0.6	0.3	1.0	0.6	0.5	0.29	1.0	0.58	*11.7*	526230	2.000	***23.4***

60 V

Uncertainty Budget for TVC 100 V 792A PTB as STD

	Repeat of meas		Calibrat of 792A		Drift of Standard		Calibration of n factor		Drift in Temp drift		Drift in Hum drift		Linearity of Ac-dc		Error of Connector		Distort and Noise		EMI and RFI		Different Calibrator		Drift in Freq setting		Resolution of DMM		Stabilty of TVC					
Unit	1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6					
Dist.	Normal		Normal		Rect		Normal		Rect		Rect		Rect		Normal		Rect		Rect		Rect		Normal		Rect		Rect					
Divisor	1		2		sqrt3		1		sqrt3		sqrt3		sqrt3		sqrt3		sqrt3		sqrt3		sqrt3		sqrt3		sqrt3		sqrt3					
Ci	1		1		1		1		1		1		1		1		1		1		1		1		1		1					
Vi	11		∞		∞		∞		∞		∞		∞		∞		∞		∞		∞		∞		∞		∞					
Freq																																Ue
(Hz)	Value	ur	Value	us	Value	ud	Value	usen	Value	ut	Value	uh	Value	ulin	Value	ucon	Value	udis	Value	uemi	Value	ucal	Value	ufr	Value	ures	Value	Ustb	Uc	neff	k	1*10^-6
10	2.50	2.50	25	13	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	2.1	1.2	1.0	0.6	0.5	0.29	1.0	0.58	*14.1*	11234	2.000	***28.3***
40	0.40	0.40	20	10	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	0.3	0.2	1.0	0.6	0.5	0.29	1.0	0.58	*11.7*	8E+06	2.000	***23.3***
1 k	0.81	0.81	10	5	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	0.2	0.1	1.0	0.6	0.5	0.29	1.0	0.58	*7.8*	96429	2.000	***15.7***
20k	0.35	0.35	10	5	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	1.2	0.7	1.0	0.6	0.5	0.29	1.0	0.58	*7.8*	3E+06	2.000	***15.7***
50k	0.59	0.59	10	5	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	1.5	0.9	1.0	0.6	0.5	0.29	1.0	0.58	*7.9*	347358	2.000	***15.7***
100k	0.55	0.55	20	10	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	3.3	1.9	1.0	0.6	0.5	0.29	1.0	0.58	*11.8*	2E+06	2.000	***23.6***

100 V

Uncertainty Budget for TVC 200 V 792A PTB as STD

	Repeat of meas		Calibrat of 792A		Drift of Standard		Calibration of n factor		Drift in Temp drift		Drift in Hum drift		Linearity of Ac-dc		Error of Connector		Distort and Noise		EMI and RFI		Different Calibrator		Drift in Freq setting		Resolution of DMM		Stabilty of TVC					
Unit	1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6					
Dist.	Normal		Normal		Rect		Normal		Rect		Rect		Rect		Normal		Rect		Rect		Rect		Normal		Rect		Rect					
Divisor	1		2		sqrt3		1		sqrt3		sqrt3		sqrt3		sqrt3		sqrt3		sqrt3		sqrt3		sqrt3		sqrt3		sqrt3					
Ci	1		1		1		1		1		1		1		1		1		1		1		1		1		1					
Vi	11		∞		∞		∞		∞		∞		∞		∞		∞		∞		∞		∞		∞		∞					
Freq																																Ue
(Hz)	Value	ur	Value	us	Value	ud	Value	usen	Value	ut	Value	uh	Value	ulin	Value	ucon	Value	udis	Value	uemi	Value	ucal	Value	ufr	Value	ures	Value	Ustb	Uc	neff	k	1*10^-6
10	1.2	1.24	30	15	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	1.2	0.7	1.0	0.6	0.5	0.29	1.0	0.58	*16.2*	321279	2.000	***32.4***
40	1.1	1.10	20	10	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	0.6	0.3	1.0	0.6	0.5	0.29	1.0	0.58	*11.7*	141200	2.000	***23.4***
1 k	1	1.04	10	5	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	0.8	0.5	1.0	0.6	0.5	0.29	1.0	0.58	*7.9*	36209	2.000	***15.8***
20k	0.7	0.70	10	5	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	1.4	0.8	1.0	0.6	0.5	0.29	1.0	0.58	*7.9*	175561	2.000	***15.7***
50k	0.9	0.92	10	5	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	3.1	1.8	1.0	0.6	0.5	0.29	1.0	0.58	*8.1*	64494	2.000	***16.1***
100k	0.5	0.48	25	13	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	1.7	1.0	1.0	0.6	0.5	0.29	1.0	0.58	*13.9*	8E+06	2.000	***27.8***

200 V

Uncertainty Budget for TVC 500 V ***792A PTB as STD***

	Repeat of meas		Calibrat of 792A		Drift of Standard		Calibration of n factor		Drift in Temp drift		Drift in Hum drift		Linearity of Ac-dc		Error of Connector		Distort and Noise		EMI and RFI		Different Calibrator		Drift in Freq setting		Resolution of DMM		Stabilty of TVC					
Unit	1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6					
Dist.	Normal		Normal		Rect		Normal		Rect		Rect		Rect		Normal		Rect		Rect		Rect		Normal		Rect		Rect					
Divisor	1		2		sqrt3		1		sqrt3		sqrt3		sqrt3		sqrt3		sqrt3		sqrt3		sqrt3		sqrt3		sqrt3		sqrt3					
Ci	1		1		1		1		1		1		1		1		1		1		1		1		1		1					
Vi	11		∞		∞		∞		∞		∞		∞		∞		∞		∞		∞		∞		∞		∞					
Freq																																Ue
(Hz)	Value	ur	Value	us	Value	ud	Value	usen	Value	ut	Value	uh	Value	ulin	Value	ucon	Value	udis	Value	uemi	Value	ucal	Value	ufr	Value	ures	Value	Ustb	Uc	neff	k	1*10^-6
10	2.9	2.87	40	20	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	0.4	0.2	1.0	0.6	0.5	0.29	1.0	0.58	*21.1*	31969	2.000	***42.1***
40	1.2	1.24	30	15	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	0.3	0.2	1.0	0.6	0.5	0.29	1.0	0.58	*16.2*	320180	2.000	***32.4***
1 k	1.3	1.31	20	10	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	1.2	0.7	1.0	0.6	0.5	0.29	1.0	0.58	*11.7*	71087	2.000	***23.5***
20k	1.1	1.05	20	10	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	3.8	2.2	1.0	0.6	0.5	0.29	1.0	0.58	*11.9*	181647	2.000	***23.8***
50k	1.2	1.17	20	10	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	0.5	0.3	1.0	0.6	0.5	0.29	1.0	0.58	*11.7*	110518	2.000	***23.4***
100k	1.2	1.23	40	20	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	1.9	1.1	1.0	0.6	0.5	0.29	1.0	0.58	*20.9*	923984	2.000	***41.9***

500 V

Uncertainty Budget for TVC 1000 V ***792A PTB as STD***

	Repeat of meas		Calibrat of 792A		Drift of Standard		Calibration of n factor		Drift in Temp drift		Drift in Hum drift		Linearity of Ac-dc		Error of Connector		Distort and Noise		EMI and RFI		Different Calibrator		Drift in Freq setting		Resolution of DMM		Stabilty of UUC					
Unit	1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6					
Dist.	Normal		Normal		Rect		Normal		Rect		Rect		Rect		Normal		Rect		Rect		Rect		Normal		Rect		Rect					
Divisor	1		2		sqrt3		1		sqrt3		sqrt3		sqrt3		sqrt3		sqrt3		sqrt3		sqrt3		sqrt3		sqrt3		sqrt3					
Ci	1		1		1		1		1		1		1		1		1		1		1		1		1		1					
Vi	11		∞		∞		∞		∞		∞		∞		∞		∞		∞		∞		∞		∞		∞					
Freq																																Ue
(Hz)	Value	ur	Value	us	Value	ud	Value	usen	Value	ut	Value	uh	Value	ulin	Value	ucon	Value	udis	Value	uemi	Value	ucal	Value	ufr	Value	ures	Value	Ustb	Uc	neff	k	1*10^-6
10	2.3	2.26	50	25	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	0.5	0.3	1.0	0.6	0.5	0.29	1.0	0.58	*25.8*	186992	2.000	***51.6***
40	1.5	1.49	40	20	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	0.5	0.3	1.0	0.6	0.5	0.29	1.0	0.58	*20.9*	428294	2.000	***41.9***
1 k	1.6	1.62	20	10	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	0.2	0.1	1.0	0.6	0.5	0.29	1.0	0.58	*11.8*	30592	2.000	***23.5***
20k	0.8	0.81	25	13	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	3.7	2.1	1.0	0.6	0.5	0.29	1.0	0.58	*14.0*	993526	2.000	***28.1***
50k	0.88	0.88	40	20	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	6.7	3.9	1.0	0.6	0.5	0.29	1.0	0.58	*21.2*	4E+06	2.000	***42.5***
100k	2	1.95	80	40	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	0.4	0.2	1.0	0.6	0.5	0.29	1.0	0.58	*40.5*	2E+06	2.000	***81.0***

1000 V

Uncertainty Budget for TVC 1000 V ***792A PTB as STD***

	Repeat of meas		Calibrat of 792A		Drift of Standard		Calibration of n factor		Drift in Temp drift		Drift in Hum drift		Linearity of Ac-dc		Error of Connector		Distort and Noise		EMI and RFI		Different Calibrator		Drift in Freq setting		Resolution of DMM		Stabilty of UUC					
Unit	1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6		1*10^-6					
Dist.	Normal		Normal		Rect		Normal		Rect		Rect		Rect		Normal		Rect		Rect		Rect		Normal		Rect		Rect					
Divisor	1		2		sqrt3		1		sqrt3		sqrt3		sqrt3		sqrt3		sqrt3		sqrt3		sqrt3		sqrt3		sqrt3		sqrt3					
Ci	1		1		1		1		1		1		1		1		1		1		1		1		1		1					
Vi	11		∞		∞		∞		∞		∞		∞		∞		∞		∞		∞		∞		∞		∞					
Freq																																Ue
(Hz)	Value	ur	Value	us	Value	ud	Value	usen	Value	ut	Value	uh	Value	ulin	Value	ucon	Value	udis	Value	uemi	Value	ucal	Value	ufr	Value	ures	Value	Ustb	Uc	neff	k	1*10^-6
10	2.3	2.26	50	25	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	0.5	0.3	1.0	0.6	0.5	0.29	1.0	0.58	*25.8*	186992	2.000	***51.6***
40	1.5	1.49	40	20	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	0.5	0.3	1.0	0.6	0.5	0.29	1.0	0.58	*20.9*	428294	2.000	***41.9***
1 k	1.6	1.62	20	10	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	0.2	0.1	1.0	0.6	0.5	0.29	1.0	0.58	*11.8*	30592	2.000	***23.5***
20k	0.8	0.81	25	13	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	3.7	2.1	1.0	0.6	0.5	0.29	1.0	0.58	*14.0*	993526	2.000	***28.1***
50k	0.88	0.88	40	20	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	6.7	3.9	1.0	0.6	0.5	0.29	1.0	0.58	*21.2*	4E+06	2.000	***42.5***
100k	2	1.95	80	40	10	5.8	0.1	0.1	1.0	0.58	1.0	0.58	1.0	0.58	1.0	0.6	1.0	0.6	1.0	0.6	0.4	0.2	1.0	0.6	0.5	0.29	1.0	0.58	*40.5*	2E+06	2.000	***81.0***

11. Appendix 2. NMIA Uncertainty Budgets

P3-APMP.EM-S5 - 0.5 V UNCERTAINTY CALCULATION - 1-s Components

	Reference		Type	R (%)	υ	Frequency kHz																	
						0.01	0.02	0.03	0.04	0.057	0.1	0.4	1	5	10	20	30	50	100	200	300	500	800	1000
NMIA Standard - X1(3)	this work		B		50	1.74	1.85	1.39	1.31	1.31	1.32	1.32	1.14	1.21	1.30	1.42	1.72	2.10	2.78	3.46	5.32	6.81	8.45	10.42
Drift in NMIA Standard	Typical (except 10Hz)		B		1000	1.00	1.30	0.60	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.50	0.80	1.20	1.50	2.00	3.00	4.00
Connectors	For NIMT		B	10	50	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.24	0.31	0.46	0.88	1.25	1.44	1.63	2.38	2.75	3.50
System (C213)	this work		B		2	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
Max Transfer ESDM	this work		A		20	0.05	#N/A	#N/A	0.04	#N/A	#N/A	#N/A	0.04	#N/A	#N/A	0.04	#N/A	0.05	0.04	#N/A	#N/A	0.04	#N/A	0.04
Temperature/ Humidity	Typical		B	15	22	0.70	0.50	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.35	0.62	0.76	1.08	2.00	1.54	2.00
Sensitivity - IUT	--		B		10	0.01	0.01	0.01	0.01	0.01	#N/A	0.01	0.01	0.05	0.01	0.05	0.08	0.12	0.19	0.55	0.19	0.55	0.68	0.80
Sensitivity - REF	--		B		10	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.03	0.05	0.09	0.17	0.28	0.36	0.50	0.67	0.77
Freq Setting	--		B	10	50	0.00	0.00	0.00	0.00	#N/A	0.00	#N/A	0.00	0.00	0.00	0.02	0.00	0.00	0.02	0.33	0.33	0.23	0.03	0.03
IUT Stability	Typical (except 10Hz)		B	10	50	1.00	1.30	0.60	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.50	0.80	1.20	1.50	2.00	3.00	4.00
Rounding off values	this work		B		1000	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.29	0.29	0.29	0.29
IUT Values	this work					-0.8	-1.2	-0.8	-1.2	-0.8	#N/A	-1.2	-0.8	4.9	-0.8	4.9	8.0	11.0	18.2	52.6	18.2	52.6	64.6	76.7
REF Values - X1(3)	RN 44211					-1.1	-1.2	-1.3	-1.4	-1.3	-1.3	-1.4	-1.4	-0.9	0.2	2.5	4.7	8.5	15.8	26.5	34.4	47.9	63.6	73.6
IUT N-Factor	this work	1.9087			3																			
REF N-Factor	this work	1.9101			3																			
IUT N-Factor - 1s	Typical	0.01	B																					
REF N-Factor - 1s	Typical	0.01	B																					
Freq error kHz - 1s	RN 43015		A			9.51E-06	2.66E-05	3.75E-05	7.14E-05	8.55E-05	1.66E-04	2.32E-04	6.94E-04	5.45E-03	1.22E-02	8.38E-02	9.69E-02	9.69E-02	1.52E-01	3.55E+00	4.64E+00	6.51E+00	8.02E+00	3.24E+00
TOTAL UNCERT						4.857	#N/A	#N/A	3.171	#N/A	#N/A	#N/A	2.895	#N/A	#N/A	3.388	#N/A	4.974	6.747	#N/A	#N/A	16.139	#N/A	25.176
neff						128.3	#N/A	#N/A	54.4	#N/A	#N/A	#N/A	48.4	#N/A	#N/A	59.4	#N/A	82.8	98.0	#N/A	#N/A	94.5	#N/A	102.5
k						1.98	#N/A	#N/A	2.00	#N/A	#N/A	#N/A	2.01	#N/A	#N/A	2.00	#N/A	1.99	1.98	#N/A	#N/A	1.99	#N/A	1.98

P3-APMP.EM-S5 - 1 V UNCERTAINTY CALCULATION - 1-s Components

	Reference		Type	R (%)	υ	Frequency kHz																	
						0.01	0.02	0.03	0.04	0.057	0.1	0.4	1	5	10	20	30	50	100	200	300	500	800	1000
NMIA Standard - Y4	RN 44211		B		50	0.79	0.78	0.77	0.80	0.77	0.75	0.75	0.78	0.87	0.98	1.10	1.40	1.58	2.05	2.58	4.54	5.54	7.03	8.52
Drift in NMIA Standard	RN 43015		B		1000	0.34	0.34	0.23	0.23	0.23	0.23	0.23	0.24	0.23	0.23	0.33	0.43	0.57	0.67	0.78	0.90	1.01	1.23	1.29
Connectors	For NIMT		B	10	50	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.24	0.31	0.46	0.88	1.25	1.44	1.63	2.38	2.75	3.50
System (C213)	this work		B		2	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
Max Transfer ESDM	this work		A		12	0.08	#N/A	#N/A	0.08	#N/A	#N/A	#N/A	0.09	#N/A	#N/A	0.08	#N/A	0.06	0.09	#N/A	#N/A	0.07	#N/A	0.09
Temperature/ Humidity	Typical		B	15	22	0.70	0.50	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.35	0.62	0.76	1.08	2.00	1.54	2.00
Sensitivity - IUT	--		B		10	0.02	0.02	0.02	0.02	0.01	#N/A	0.02	0.01	0.05	0.01	0.05	0.09	0.13	0.21	0.59	0.21	0.59	0.72	0.84
Sensitivity - REF	--		B		10	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.05	0.10	0.19	0.31	0.41	0.58	0.77	0.89
Freq Setting	--		B	10	50	0.00	0.00	0.00	0.00	#N/A	0.00	#N/A	0.00	0.00	0.00	0.01	0.00	0.00	0.02	0.38	0.39	0.11	0.14	0.01
IUT Stability	Typical (except 10Hz)		B	10	50	1.00	#N/A	#N/A	0.40	#N/A	#N/A	#N/A	0.40	#N/A	#N/A	0.40	#N/A	0.50	0.80	#N/A	#N/A	2.00	#N/A	4.00
Rounding off values	this work		B		1000	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.29	0.29	0.29	0.29
IUT Values	this work					-1.4	-1.3	-1.4	-1.3	-0.9	#N/A	-1.3	-0.9	4.5	-0.9	4.5	7.7	10.8	18.0	49.9	18.0	49.9	60.5	71.0
REF Values - Y4	RN 44211					-1.4	-2.3	-2.3	-2.2	-2.1	-2.2	-2.2	-2.1	-1.7	-0.5	2.2	5.0	9.6	17.7	29.6	38.9	54.8	73.1	84.4
IUT N-Factor	this work	1.6883			3																			
REF N-Factor	this work	1.8879			3																			
IUT N-Factor - 1s	Typical	0.01	B																					
REF N-Factor - 1s	Typical	0.01	B																					
Freq error kHz - 1s	RN 43015		A			9.51E-06	2.66E-05	3.75E-05	7.14E-05	8.55E-05	1.66E-04	2.32E-04	6.94E-04	5.45E-03	1.22E-02	8.38E-02	9.69E-02	9.69E-02	1.52E-01	3.55E+00	4.64E+00	6.51E+00	8.02E+00	3.24E+00
TOTAL UNCERT						3.229	#N/A	#N/A	2.295	#N/A	#N/A	#N/A	2.277	#N/A	#N/A	2.837	#N/A	4.166	5.539	#N/A	#N/A	13.631	#N/A	20.833
neff						72.2	#N/A	#N/A	26.9	#N/A	#N/A	#N/A	26.3	#N/A	#N/A	47.1	#N/A	96.4	124.3	#N/A	#N/A	105.0	#N/A	102.7
k						1.99	#N/A	#N/A	2.06	#N/A	#N/A	#N/A	2.06	#N/A	#N/A	2.01	#N/A	1.98	1.98	#N/A	#N/A	1.98	#N/A	1.98

P3-APMP.EM-S5 - 3 V UNCERTAINTY CALCULATION - 1-s Components

	Reference		Type	R (%)	υ	Frequency kHz																	
						0.01	0.02	0.03	0.04	0.057	0.1	0.4	1	5	10	20	30	50	100	200	300	500	800	1000
NMIA Standard - Z4	RN 40247		B		50	1.05	0.50	0.35	0.35	0.30	0.30	0.30	0.35	0.60	0.75	0.90	1.40	1.90	2.50	3.50	4.50	6.00	8.00	9.00
Drift in NMIA Standard	RN 43015		B		1000	0.34	0.34	0.23	0.23	0.23	0.23	0.23	0.24	0.23	0.23	0.33	0.43	0.57	0.67	0.78	0.90	1.01	1.23	1.29
Connectors	For NIMT		B	10	50	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.24	0.31	0.46	0.88	1.25	1.44	1.63	2.38	2.75	3.50
System (C213)	this work		B		2	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
Max Transfer ESDM	this work		A		12	0.05	#N/A	#N/A	0.06	#N/A	#N/A	#N/A	0.05	#N/A	#N/A	0.13	#N/A	0.06	0.09	#N/A	#N/A	0.05	#N/A	0.07
Temperature/ Humidity	Typical		B	15	22	0.70	0.50	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.35	0.62	0.76	1.08	2.00	1.54	2.00
Sensitivity - IUT	--		B		10	0.12	0.10	0.12	0.10	0.08	#N/A	0.10	0.08	0.03	0.08	0.03	0.00	0.02	0.08	0.34	0.08	0.34	0.39	0.44
Sensitivity - REF	--		B		10	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.00	0.02	0.05	0.10	0.18	0.31	0.41	0.58	0.77	0.87
Freq Setting	--		B	10	50	0.00	0.00	0.00	0.01	#N/A	0.00	#N/A	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.39	0.40	0.06	0.28	0.07
IUT Stability	Typical (except 10Hz)		B	10	50	1.00	#N/A	#N/A	0.40	#N/A	#N/A	#N/A	0.40	#N/A	#N/A	0.40	#N/A	0.50	0.80	#N/A	#N/A	2.00	#N/A	4.00
Rounding off values	this work		B		1000	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.29	0.29	0.29	0.29
IUT Values	this work					-11.25	-9.15	-11.25	-9.15	-7.69	#N/A	-9.15	-7.69	-2.89	-7.69	-2.89	-0.32	2.24	7.69	32.13	7.69	32.13	37.18	42.24
REF Values	RN 40247					-2.00	-2.30	-2.30	-2.30	-2.30	-2.30	-2.30	-1.90	-1.30	-0.20	2.30	4.80	9.50	17.60	30.00	39.80	55.90	74.10	83.70
IUT N-Factor	this work	1.9068			3																			
REF N-Factor	this work	1.9349			3																			
IUT N-Factor - 1s	Typical	0.01	B																					
REF N-Factor - 1s	Typical	0.01	B																					
Freq error kHz - 1s	RN 43015		A			9.51E-06	2.66E-05	3.75E-05	7.14E-05	8.55E-05	1.66E-04	2.32E-04	6.94E-04	5.45E-03	1.22E-02	8.38E-02	9.69E-02	9.69E-02	1.52E-01	3.55E+00	4.64E+00	6.51E+00	8.02E+00	3.24E+00
TOTAL UNCERT						3.521	#N/A	#N/A	1.801	#N/A	#N/A	#N/A	1.806	#N/A	#N/A	2.545	#N/A	4.659	6.220	#N/A	#N/A	14.360	#N/A	21.567
n_{eff}						86.7	#N/A	#N/A	11.6	#N/A	#N/A	#N/A	11.7	#N/A	#N/A	37.6	#N/A	89.2	103.9	#N/A	#N/A	96.0	#N/A	96.5
k						1.99	#N/A	#N/A	2.20	#N/A	#N/A	#N/A	2.20	#N/A	#N/A	2.03	#N/A	1.99	1.98	#N/A	#N/A	1.98	#N/A	1.98

P3-APMP.EM-S5 - 10 V UNCERTAINTY CALCULATION - 1-s Components

	Reference		Type	R (%)	υ	Frequency kHz																	
						0.01	0.02	0.03	0.04	0.057	0.1	0.4	1	5	10	20	30	50	100	200	300	500	800	1000
NMIA Standard - X3+B	RN 46906		B		50								0.60	0.80	0.90	1.10	1.50	2.00	2.40	3.40	4.50	6.00	8.10	9.00
- Ref Low Freq Profile					20	0.06	0.05	0.05	0.04	0.05	0.04	0.05												
- Reference for Low Freq is 1kHz value					20	0.60	0.60	0.60	0.60	0.60	0.60	0.60												
- Flatness of XLV+B1				50	2	0.29	0.29	0.29	0.29	0.29	0.29	0.29												
- Connectors for Low Freq					50	0.20	0.20	0.20	0.20	0.20	0.20	0.20												
- Variation of Sys Offset	this work		B		20	0.20	0.20	0.20	0.20	0.20	0.20	0.20												
- Temperature/ Humidity	Typical		B	15	22	0.70	0.50	0.30	0.30	0.30	0.30	0.30												
Drift in NMIA Standard	RN 43015		B		1000	0.34	0.34	0.23	0.23	0.23	0.23	0.23	0.24	0.23	0.23	0.33	0.43	0.57	0.67	0.78	0.90	1.01	1.23	1.29
Connectors	For NIMT		B	10	50	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.24	0.31	0.46	0.88	1.25	1.44	1.63	2.38	2.75	3.50
System (C213)	this work		B		2	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
Max Transfer ESDM	this work		A		16								0.25	#N/A	#N/A	0.18	#N/A	0.07	0.07	#N/A	#N/A	0.06	#N/A	0.09
Temperature/ Humidity	Typical		B	15	22	0.70	0.50	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.35	0.62	0.76	1.08	2.00	1.54	2.00
Sensitivity - IUT	--		B		10	0.02	0.01	0.02	0.01	0.02	#N/A	0.01	0.02	0.05	0.02	0.05	0.07	0.10	0.20	1.25	0.20	1.25	2.07	2.89
Sensitivity - REF	--		B		10	0.01	0.01	0.01	0.01	0.00	#N/A	0.01	0.00	0.01	0.01	0.03	0.04	0.06	0.16	0.40	0.70	1.42	2.80	3.89
Freq Setting	--		B	10	50	0.00	0.00	0.00	0.00	#N/A	0.00	#N/A	0.00	0.00	0.00	0.01	0.00	0.00	0.08	0.92	1.53	0.32	1.34	0.46
IUT Stability	Typical		B	10	50	2.00	#N/A	#N/A	1.50	#N/A	#N/A	#N/A	1.50	#N/A	#N/A	1.50	#N/A	2.00	2.50	#N/A	#N/A	5.00	#N/A	6.00
Rounding off values	this work		B		1000	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.29	0.29	0.29	0.29
IUT Values	this work					-1.68	-1.36	-1.68	-1.36	-1.44	#N/A	-1.36	-1.44	-4.66	-1.44	-4.66	-6.87	-9.08	-18.90	-119.29	-18.90	-119.29	-197.19	-275.10
REF Values	RN 46906					-1.45	-0.76	-1.45	-0.76	-0.33	#N/A	-0.76	-0.33	-0.91	-1.31	-2.44	-3.55	-6.10	-15.45	-38.77	-67.45	-137.41	-270.63	-376.81
IUT N-Factor	this work	1.6945			3																			
REF N-Factor	this work	1.7351			3																			
IUT N-Factor - 1s	Typical	0.01	B																					
REF N-Factor - 1s	Typical	0.01	B																					
Freq error kHz - 1s	RN 43015		A			9.51E-06	2.66E-05	3.75E-05	7.14E-05	8.55E-05	1.66E-04	2.32E-04	6.94E-04	5.45E-03	1.22E-02	8.38E-02	9.69E-02	9.69E-02	1.52E-01	3.55E+00	4.64E+00	6.51E+00	8.02E+00	3.24E+00
TOTAL UNCERT						4.898	#N/A	#N/A	3.677	#N/A	#N/A	#N/A	3.575	#N/A	#N/A	4.061	#N/A	6.187	7.700	#N/A	#N/A	17.411	#N/A	25.223
n_{eff}						88.3	#N/A	#N/A	68.2	#N/A	#N/A	#N/A	63.8	#N/A	#N/A	91.1	#N/A	129.3	141.2	#N/A	#N/A	141.9	#N/A	132.5
k						1.99	#N/A	#N/A	2.00	#N/A	#N/A	#N/A	2.00	#N/A	#N/A	1.99	#N/A	1.98	1.98	#N/A	#N/A	1.98	#N/A	1.98

P3-APMP.EM-S5 - 60 V UNCERTAINTY CALCULATION - 1-s Components

	Reference		Type	R (%)	υ	Frequency kHz																	
						0.01	0.02	0.03	0.04	0.057	0.1	0.4	1	5	10	20	30	50	100	200	300	500	800	1000
NMIA Std - Y1(2)+C1	RN 40778		B		50	3.85	3.40	3.35	3.15	3.15	#N/A	3.10	3.15	#N/A	3.30	3.40	3.65	4.40	7.00	--	--	--	--	--
Drift in NMIA Standard	Typical		B		1000	1.16	#N/A	#N/A	0.87	#N/A	#N/A	#N/A	0.87	#N/A	#N/A	0.87	#N/A	0.87	1.45	#N/A	#N/A	#N/A	#N/A	#N/A
Connectors	For NIMT		B	10	50	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.24	0.31	0.46	0.88	1.25	1.44	1.63	2.38	2.75	3.50
System (C213)	this work		B		2	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
Max Transfer ESDM	this work		A		12	0.09	#N/A	#N/A	0.06	#N/A	#N/A	#N/A	0.11	#N/A	#N/A	0.06	#N/A	0.05	0.06	#N/A	#N/A	#N/A	#N/A	#N/A
Temperature/ Humidity	Typical		B	15	22	0.70	0.50	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.35	0.62	0.76	1.08	2.00	1.54	2.00
Sensitivity - IUT	--		B		10	0.13	0.03	0.13	0.03	0.03	#N/A	0.03	0.03	0.02	0.03	0.02	0.04	0.07	0.19	0.43	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Sensitivity - REF	--		B		10	0.15	0.03	0.00	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.03	0.13	0.34	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Freq Setting	--		B	10	50	0.00	0.02	0.01	0.04	#N/A	0.00	#N/A	0.00	0.00	0.00	0.03	0.01	0.00	0.00	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
IUT Stability	Typical		B	10	50	2.00	#N/A	#N/A	1.50	#N/A	#N/A	#N/A	1.50	#N/A	#N/A	1.80	#N/A	2.50	3.00	#N/A	#N/A	#N/A	#N/A	#N/A
Rounding off values	this work		B		1000	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.29	0.29	0.29	0.29
IUT Values	this work					12.23	-3.24	12.23	-3.24	-2.55	#N/A	-3.24	-2.55	1.92	-2.55	1.92	4.29	6.66	18.11	41.02	--	--	--	--
REF Values	RN 40778					14.60	2.50	-0.10	-1.40	-1.00	-0.33	-0.60	-1.20	-0.91	0.50	0.40	0.40	2.60	12.60	32.60	--	--	--	--
IUT N-Factor	this work	1.6914			3																			
REF N-Factor	this work	1.6195			3																			
IUT N-Factor - 1s	Typical	0.01	B																					
REF N-Factor - 1s	Typical	0.01	B																					
Freq error kHz - 1s	RN 43015		A			9.51E-06	2.66E-05	3.75E-05	7.14E-05	8.55E-05	1.66E-04	2.32E-04	6.94E-04	5.45E-03	1.22E-02	8.38E-02	9.69E-02	9.69E-02	1.52E-01	3.55E+00	4.64E+00	6.51E+00	8.02E+00	3.24E+00
TOTAL UNCERT						9.183	#N/A	#N/A	7.321	#N/A	#N/A	#N/A	7.323	#N/A	#N/A	8.021	#N/A	10.508	15.804	#N/A	#N/A	#N/A	#N/A	#N/A
n_{eff}						92.9	#N/A	#N/A	84.4	#N/A	#N/A	#N/A	84.5	#N/A	#N/A	88.0	#N/A	91.3	78.4	#N/A	#N/A	#N/A	#N/A	#N/A
k						1.99	#N/A	#N/A	1.99	#N/A	#N/A	#N/A	1.99	#N/A	#N/A	1.99	#N/A	1.99	1.99	#N/A	#N/A	#N/A	#N/A	#N/A

P3-APMP.EM-S5 - 100 V UNCERTAINTY CALCULATION - 1-s Components

	Reference		Type	R (%)	υ	Frequency kHz																
						0.01	0.02	0.03	0.04	0.057	0.1	0.4	1	5	10	20	30	50	100	200	300	500	800	1000
NMIA Std - X1(3)+D2	RN 40778		B		50	3.75	3.40	3.35	3.15	3.20	3.20	3.15	3.20	3.30	3.35	3.45	3.70	4.50	7.00	--	--	--	--	--
Drift in NMIA Standard	Typical		B		1000	1.16	#N/A	#N/A	0.87	#N/A	#N/A	#N/A	0.87	#N/A	#N/A	0.87	#N/A	0.87	1.45	#N/A	#N/A	#N/A	#N/A	#N/A
Connectors	For NIMT		B	10	50	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.24	0.31	0.46	0.88	1.25	1.44	1.63	2.38	2.75	3.50
System (C213)	this work		B		2	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
Max Transfer ESDM	this work		A		12	0.40	#N/A	#N/A	0.51	#N/A	#N/A	#N/A	0.34	#N/A	#N/A	0.19	#N/A	0.11	0.16	#N/A	#N/A	#N/A	#N/A	#N/A
Temperature/ Humidity	Typical		B	15	22	0.70	0.50	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.35	0.62	0.76	1.08	2.00	1.54	2.00
Sensitivity - IUT	--		B		10	0.02	0.03	0.02	0.03	0.02	#N/A	0.03	0.02	0.46	0.02	0.46	0.71	0.96	1.69	3.14	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Sensitivity - REF	--		B		10	0.02	0.02	0.02	0.03	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.11	0.58	1.51	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Freq Setting	--		B	10	50	0.00	0.00	0.00	0.01	#N/A	0.00	#N/A	0.01	0.00	0.00	0.27	0.12	0.05	0.07	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
IUT Stability	Typical		B	10	50	2.00	#N/A	#N/A	1.50	#N/A	#N/A	#N/A	1.50	#N/A	#N/A	1.80	#N/A	2.50	3.00	#N/A	#N/A	#N/A	#N/A	#N/A
Rounding off values	this work		B		1000	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.29	0.29	0.29	0.29
IUT Values	this work					-2.32	-2.95	-2.32	-2.95	2.32	#N/A	-2.95	2.32	44.04	2.32	44.04	67.77	91.50	160.82	299.46	--	--	--	--
REF Values	RN 40778					-1.90	-2.30	-2.00	-2.50	-1.80	-0.80	-0.90	-1.00	-0.60	0.90	1.10	2.30	10.60	55.70	145.90	--	--	--	--
IUT N-Factor	this work	1.6971			3																			
REF N-Factor	this work	1.7076			3																			
IUT N-Factor - 1s	Typical	0.01	B																					
REF N-Factor - 1s	Typical	0.01	B																					
Freq error kHz - 1s	RN 43015		A			9.51E-06	2.66E-05	3.75E-05	7.14E-05	8.55E-05	1.66E-04	2.32E-04	6.94E-04	5.45E-03	1.22E-02	8.38E-02	9.69E-02	9.69E-02	1.52E-01	3.55E+00	4.64E+00	6.51E+00	8.02E+00	3.24E+00
TOTAL UNCERT						9.041	#N/A	#N/A	7.391	#N/A	#N/A	#N/A	7.437	#N/A	#N/A	8.183	#N/A	10.851	16.198	#N/A	#N/A	#N/A	#N/A	#N/A
n_{eff}						96.1	#N/A	#N/A	87.5	#N/A	#N/A	#N/A	84.7	#N/A	#N/A	90.3	#N/A	94.8	85.1	#N/A	#N/A	#N/A	#N/A	#N/A
k						1.98	#N/A	#N/A	1.99	#N/A	#N/A	#N/A	1.99	#N/A	#N/A	1.99	#N/A	1.99	1.99	#N/A	#N/A	#N/A	#N/A	#N/A

P3-APMP.EM-S5 - 200 V UNCERTAINTY CALCULATION - 1-s Components

	Reference		Type	R (%)	υ	Frequency kHz																
						0.01	0.02	0.03	0.04	0.057	0.1	0.4	1	5	10	20	30	50	100	200	300	500	800	1000
NMIA Std - Y1(2)+D2	RN 40778		B		50	5.00	4.50	4.10	3.90	4.00	#N/A	3.80	3.85	#N/A	4.00	4.15	4.50	5.50	8.50	--	--	--	--	--
Drift in NMIA Standard	Typical		B		1000	1.16	#N/A	#N/A	0.87	#N/A	#N/A	#N/A	0.87	#N/A	#N/A	0.87	#N/A	0.87	1.45	#N/A	#N/A	#N/A	#N/A	#N/A
Connectors	For NIMT		B	10	50	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.24	0.31	0.46	0.88	1.25	1.44	1.63	2.38	2.75	3.50
System (C217)	this work		B		2	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29
Max Transfer ESDM	this work		A		10	0.18	#N/A	#N/A	0.11	#N/A	#N/A	#N/A	0.12	#N/A	#N/A	0.14	#N/A	0.14	0.12	#N/A	#N/A	#N/A	#N/A	#N/A
Temperature/ Humidity	Typical		B	15	22	0.70	0.50	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.35	0.62	0.76	1.08	2.00	1.54	2.00
Sensitivity - IUT	--		B		10	0.15	0.01	0.15	0.01	0.02	#N/A	0.01	0.02	0.44	0.02	0.44	0.70	0.95	1.66	3.08	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Sensitivity - REF	--		B		10	0.19	0.06	0.05	0.04	0.01	#N/A	0.01	0.01	0.01	0.01	0.01	0.04	0.11	0.57	1.47	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Freq Setting	--		B	10	50	0.00	0.02	0.00	0.03	#N/A	0.00	#N/A	0.01	0.00	0.00	0.26	0.12	0.06	0.07	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
IUT Stability	Typical		B	10	50	2.00	#N/A	#N/A	1.50	#N/A	#N/A	#N/A	1.50	#N/A	#N/A	1.80	#N/A	2.50	3.00	#N/A	#N/A	#N/A	#N/A	#N/A
Rounding off values	this work		B		1000	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.29	0.29	0.29	0.29
IUT Values	this work					14.77	1.23	14.77	1.23	1.79	#N/A	1.23	1.79	42.26	1.79	42.26	66.42	90.58	158.12	293.19	--	--	--	--
REF Values	RN 40778					18.40	5.50	4.40	3.60	1.20	#N/A	0.90	0.60	1.00	1.40	1.10	3.50	11.10	54.70	141.90	--	--	--	--
IUT N-Factor	this work	1.6899			3																			
REF N-Factor	this work	1.6122			3																			
IUT N-Factor - 1s	Typical	0.01	B																					
REF N-Factor - 1s	Typical	0.01	B																					
Freq error kHz - 1s	RN 43015		A			9.51E-06	2.66E-05	3.75E-05	7.14E-05	8.55E-05	1.66E-04	2.32E-04	6.94E-04	5.45E-03	1.22E-02	8.38E-02	9.69E-02	9.69E-02	1.52E-01	3.55E+00	4.64E+00	6.51E+00	8.02E+00	3.24E+00
TOTAL UNCERT						11.145	#N/A	#N/A	8.589	#N/A	#N/A	#N/A	8.499	#N/A	#N/A	9.332	#N/A	12.518	18.812	#N/A	#N/A	#N/A	#N/A	#N/A
n_{eff}						75.1	#N/A	#N/A	71.9	#N/A	#N/A	#N/A	72.5	#N/A	#N/A	77.1	#N/A	80.0	73.3	#N/A	#N/A	#N/A	#N/A	#N/A
k						1.99	#N/A	#N/A	1.99	#N/A	#N/A	#N/A	1.99	#N/A	#N/A	1.99	#N/A	1.99	1.99	#N/A	#N/A	#N/A	#N/A	#N/A

P3-APMP.EM-S5 - 500 V UNCERTAINTY CALCULATION - 1-s Components

	Reference		Type	R (%)	υ	Frequency kHz																	
						0.01	0.02	0.03	0.04	0.057	0.1	0.4	1	5	10	20	30	50	100	200	300	500	800	1000
NMIA Std - YLV+F792A	RN 40779		B		50	4.65	4.65	4.65	4.65	4.70	4.65	4.65	4.70	4.95	5.25	6.00	7.00	9.00	13.50	--	--	--	--	--
Drift in NMIA Standard	Typical		B		1000	1.74	#N/A	#N/A	1.16	#N/A	#N/A	#N/A	1.16	#N/A	#N/A	1.74	#N/A	3.48	5.22	#N/A	#N/A	#N/A	#N/A	#N/A
Connectors	Typical		B	10	50	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	#N/A	#N/A	#N/A	#N/A	#N/A
System (C217)	this work		B		2	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29
Max Transfer ESDM	this work		A		10	0.31	#N/A	#N/A	0.27	#N/A	#N/A	#N/A	0.29	#N/A	#N/A	0.25	#N/A	0.25	0.25	#N/A	#N/A	#N/A	#N/A	#N/A
Temperature/ Humidity	Typical		B	15	22	0.70	0.50	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.35	0.62	0.76	1.08	2.00	1.54	2.00
Sensitivity - IUT	--		B		10	0.05	0.02	0.05	0.02	0.01	#N/A	0.02	0.01	0.20	0.01	0.20	0.17	0.14	0.60	2.09	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Sensitivity - REF	--		B		10	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.00	0.02	0.03	0.10	0.19	0.45	1.31	3.03	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Freq Setting	--		B	10	50	0.01	0.00	0.00	0.01	#N/A	0.00	#N/A	0.00	0.00	0.01	0.13	0.09	0.05	0.04	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
IUT Stability	Typical		B	10	50	3.00	#N/A	#N/A	2.00	#N/A	#N/A	#N/A	2.00	#N/A	#N/A	2.00	#N/A	3.00	4.00	#N/A	#N/A	#N/A	#N/A	#N/A
Rounding off values	this work		B		1000	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.29	0.29	0.29	0.29
IUT Values	this work					4.76	-2.24	4.76	-2.24	0.74	#N/A	-2.24	0.74	19.38	0.74	19.38	16.58	13.78	-57.26	-199.33	--	--	--	--
REF Values	RN 40779					-0.60	-0.60	-0.60	-0.60	-1.60	0.50	1.00	0.10	-1.50	-3.20	-10.10	-18.10	-43.10	-126.30	-292.70	--	--	--	--
IUT N-Factor	this work	1.7850			3																			
REF N-Factor	this work	1.9151			3																			
IUT N-Factor - 1s	Typical	0.01	B																					
REF N-Factor - 1s	Typical	0.01	B																					
Freq error kHz - 1s	RN 43015		A			9.51E-06	2.66E-05	3.75E-05	7.14E-05	8.55E-05	1.66E-04	2.32E-04	6.94E-04	5.45E-03	1.22E-02	8.38E-02	9.69E-02	9.69E-02	1.52E-01	3.55E+00	4.64E+00	6.51E+00	8.02E+00	3.24E+00
TOTAL UNCERT						11.719	#N/A	#N/A	10.436	#N/A	#N/A	#N/A	10.527	#N/A	#N/A	13.167	#N/A	20.259	30.206	#N/A	#N/A	#N/A	#N/A	#N/A
n_{eff}						107.2	#N/A	#N/A	76.6	#N/A	#N/A	#N/A	76.1	#N/A	#N/A	71.6	#N/A	79.2	77.6	#N/A	#N/A	#N/A	#N/A	#N/A
k						1.98	#N/A	#N/A	1.99	#N/A	#N/A	#N/A	1.99	#N/A	#N/A	1.99	#N/A	1.99	1.99	#N/A	#N/A	#N/A	#N/A	#N/A

P3-APMP.EM-S5 - 1000 V UNCERTAINTY CALCULATION - 1-s Components

	Reference		Type	R (%)	υ	Frequency kHz																	
						0.01	0.02	0.03	0.04	0.057	0.1	0.4	1	5	10	20	30	50	100	200	300	500	800	1000
NMIA Std - Z1+E4	RN 40778		B		50	6.00	5.50	5.50	5.50	5.50	5.50	5.50	5.50	6.50	7.00	8.50	10.50	15.00	20.00	--	--	--	--	--
Drift in NMIA Standard	Typical		B		1000	2.03	#N/A	#N/A	1.74	#N/A	#N/A	#N/A	1.74	#N/A	#N/A	2.32	#N/A	4.06	5.80	#N/A	#N/A	#N/A	#N/A	#N/A
Connectors	Typical		B	10	50	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	#N/A	#N/A	#N/A	#N/A	#N/A
System (C217)	this work		B		2	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29
Max Transfer ESDM	this work		A		10	1.02	#N/A	#N/A	0.58	#N/A	#N/A	#N/A	0.85	#N/A	#N/A	0.51	#N/A	0.64	0.69	#N/A	#N/A	#N/A	#N/A	#N/A
Temperature/ Humidity	Typical		B	15	22	0.70	0.50	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.35	0.62	0.76	1.08	2.00	1.54	2.00
Sensitivity - IUT	--		B		10	0.10	0.08	0.10	0.08	0.06	#N/A	0.08	0.06	0.37	0.06	0.37	0.56	0.74	0.69	0.58	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Sensitivity - REF	--		B		10	0.00	0.02	0.03	0.03	0.02	0.02	0.03	0.05	0.12	0.16	0.17	0.03	0.67	5.04	13.77	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Freq Setting	--		B	10	50	0.00	0.00	0.00	0.01	#N/A	0.00	#N/A	0.01	0.01	0.00	0.19	0.15	0.66	1.30	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
IUT Stability	Typical		B	10	50	4.00	#N/A	#N/A	4.00	#N/A	#N/A	#N/A	4.00	#N/A	#N/A	4.00	#N/A	5.00	6.00	#N/A	#N/A	#N/A	#N/A	#N/A
Rounding off values	this work		B		1000	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.29	0.29	0.29	0.29
IUT Values	this work					-9.79	-7.67	-9.79	-7.67	-6.03	#N/A	-7.67	-6.03	35.69	-6.03	35.69	53.30	70.91	65.62	55.03	--	--	--	--
REF Values	RN 40778					0.20	-2.20	-2.50	-2.50	-2.40	-2.40	-2.60	-5.00	-11.90	-15.60	-16.40	-2.50	65.30	487.50	1331.90	--	--	--	--
IUT N-Factor	this work	1.8850			3																			
REF N-Factor	this work	1.9105			3																			
IUT N-Factor - 1s	Typical	0.01	B																					
REF N-Factor - 1s	Typical	0.01	B																					
Freq error kHz - 1s	RN 43015		A			9.51E-06	2.66E-05	3.75E-05	7.14E-05	8.55E-05	1.66E-04	2.32E-04	6.94E-04	5.45E-03	1.22E-02	8.38E-02	9.69E-02	9.69E-02	1.52E-01	3.55E+00	4.64E+00	6.51E+00	8.02E+00	3.24E+00
TOTAL UNCERT						15.201	#N/A	#N/A	14.114	#N/A	#N/A	#N/A	14.169	#N/A	#N/A	19.420	#N/A	32.776	44.639	#N/A	#N/A	#N/A	#N/A	#N/A
n_{eff}						107.0	#N/A	#N/A	105.8	#N/A	#N/A	#N/A	107.2	#N/A	#N/A	81.1	#N/A	70.3	75.4	#N/A	#N/A	#N/A	#N/A	#N/A
k						1.98	#N/A	#N/A	1.98	#N/A	#N/A	#N/A	1.98	#N/A	#N/A	1.99	#N/A	1.99	1.99	#N/A	#N/A	#N/A	#N/A	#N/A