

CCEM KEY COMPARISON CCEM.RF-K24.F

E-field measurements at frequencies of 1 GHz, 2.45 GHz, 10 GHz and 18 GHz and at indicated field levels of 10 V/m, 30 V/m and 100 V/m

Final Report of the Pilot Laboratory

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1 Introduction

In June 2008, a proposal to undertake an intercomparison of E-field measurements was submitted to GT-RF members. The proposal was formally accepted by the members in March 2010 and assigned the designation CCEM.RF-K24.F. NPL took on the role of pilot for this comparison.

Participation in this Key Comparison was open to all CCEM members and, additionally, Signatories of the Metre Convention. A list of participants is given at the start of this report.

At the outset, two sets of two travelling standards were used for the purpose of this comparison. One set was to be shipped amongst the participants located in Europe and the other was to be shipped amongst the participants located outside of Europe. Only NPL and PTB measured all four standards. Two probes were included in each set in case of a failure of one of the probes. Two sets were originally used in an attempt to speed up completion of the comparison. The intention was to link the results of the two loops through the measurements made at NPL and PTB.

However, one of the standards in the non-European shipping loop failed early on in the comparison. The standard was returned to the UK for repair but, upon inspection, appeared to have changed significantly at one of the required measurement frequencies. This, along with another minor fault, meant that it was simpler to use a single set of standards so, after completion of the European loop, the European standards were shipped to the rest of the participants following a ‘star’ pattern (i.e., each participant returned the standards to the pilot lab upon completion of their measurements). This approach also meant that it was no longer necessary to carry out the linking procedure between the two loops.

The participants reported the correction factor of each probe determined at four frequencies and three field strengths. All reported results are included in this report.

2 Travelling Standards

The travelling standards consisted of two field probes, an Amplifier Research FL7018 probe (3 MHz to 18 GHz, laser powered with a diode detector) and an Amplifier Research FP7050 (300 MHz to 50 GHz, battery powered with a thermal detector).

These standards were kindly provided by Amplifier Research for the purposes of this comparison.

The readout unit FM7004 is a 19-inch rack unit and a laser interface FL7000 was also supplied.

The full details of the standards measured by the participants are:

- Probe and data transmission unit FP7050 S/N: 0311660
- Probe FL7018 Star Probe 3 laser powered S/N: 0331688
- Readout unit FM7004 S/N: 0331664
- Laser Probe Interface FL7000 S/N: 0331780

Details of the items that failed (as mentioned in Section 1) are not included here as they serve no purpose and provide no further information in this comparison but they can be found in the comparison protocol [1].

3 Comparison Protocol and Schedule

The travelling standards were circulated to the participants, who were asked to provide the correction factor at the following frequencies:

- 1 GHz
- 2.45 GHz
- 10 GHz
- 18 GHz

at field strengths of 10 V/m (FP7018 only¹), 30 V/m and 100 V/m. It was recognised that not all participants would be able to perform these measurements and these participants were invited to perform as many measurements as possible, together with a reason for omitting the remainder [1].

If the maximum field strength could not be achieved, the participants were requested to perform the measurement at their maximum available field strength and report this result. These results are not used in the computation of any KCRV.

So that the measurements were consistent, participants were requested to make the measurements at one orientation only with the probe axis perpendicular to both the E-field and the direction of propagation.

The measurements were made between January 2010 and July 2012. Measurements were performed periodically by NPL throughout the comparison to monitor any drift that may have occurred over the course of the comparison. PTB also performed measurements for this purpose. Following NPL's measurement in October 2010, it was clear that the FP7050 probe was showing signs that it was drifting; therefore the standards were returned to and measured at NPL after each of the subsequent participants' measurements in a so-called "star" pattern² to monitor this drift over time.

At the request of LNE, the standards were shipped back to them for re-measurement at 1 GHz in October 2010 following their initial measurement in March 2010. This was permitted as no results had been distributed and did not affect the subsequent analysis.

Table 3.1 gives an indication of the dates when the measurements took place at each laboratory.

¹ At 10 V/m, the FP7050 is close to its noise floor. After initial measurements at NPL and PTB prior to commencing the comparison it was decided it would not be possible to obtain reliable results and for this reason it was decided not to request results from participants at this field strength.

² Although it seems counter-intuitive, a "star" shipping pattern appears to be a very efficient method both in terms of cost and time as it reduces the customs bureaucracy associated with the more traditional carnet shipping method.

4 Measurement Techniques

The measurement techniques used by each participant can be found in Appendix B.

Laboratory	Date of Measurement
NPL (UK)	January 2010
PTB (Germany)	February/March 2010
LNE (France)	March 2010
INRIM (Italy)	April 2010
NPL (UK)	May 2010
METAS (Switzerland)	June/July 2010
CMI (Czech Republic)	July/August 2010
VSL (Netherlands)	September 2010
PTB (Germany)	October 2010
LNE (France) re-measurement	October 2010
NPL (UK)	October 2010
NIM (China)	November/December 2010
NPL (UK)	January 2011
NIST (USA)	February 2011
NPL (UK)	March 2011
NMIA (Australia)	April 2011
NPL (UK)	May 2011
KRISS (Korea)	July 2011
NPL (UK)	August 2011
TUBITAK-UME (Turkey)	September/October 2011
NPL (UK)	October 2011
NMIJ (Japan)	November/December 2011
NPL (UK)	January 2012
VNIIFTRI (Russia)	May 2012
NPL (UK)	July 2012

Table 3.1 – Dates of measurements for this intercomparison

5 Results and Discussion

5.1 Discussion of results

The results were presented to the pilot laboratory in the format of the dimensionless correction factors of the two probes at the prescribed frequencies and field levels as outlined in Section 3.

Participants were also asked to provide estimates of the Type A and Type B uncertainties and the combined standard uncertainty (at one standard deviation) for the aforementioned measurands.

The measurement results and associated standard uncertainties together with the reference values and associated standard uncertainties can be found in Section 5.2.

Due to a re-measurement, LNE's results at 1 GHz are recorded as being performed in October 2010 whilst the rest of their results were performed in March 2010.

The most noticeable outcome of the comparison is that the FP7050 probe drifted between the start and finish of the exercise. It is possible to characterize the drift by fitting a straight line to the measurements – see Appendices D and E for further details. The drift is characterized using only the measurements from the pilot laboratory because only the device conditions drift between measurements.

So that a single fixed KCRV can be reported, all of the measurements are corrected to the start of the comparison in January 2010³.

The procedure used to determine the KCRV (including identification of outliers) can be found in Appendix A.

The results on the graphs are plotted as they were reported, i.e., they are not rounded in any way (some participants reported results to four decimal places), so there may be a slight difference between some of the graphs and the corresponding tables of results. Note also that the uncertainties plotted on the graphs are for $k = 1$.

The measurements of the FL7018 probe at 10 GHz show a large variation, similar at all three electric fields. This was noted in the periodic measurements made by the pilot, and also noted by some participants, that the spread of results was greater at this frequency. There may be two reasons for this: (i) the performance at this particular frequency may not be as good as at others; and (ii) the moveable manufacturer-supplied mount may have caused some interference in the measurement and, whilst it was requested early on in the comparison that this be removed before undertaking any measurement⁴, it can be seen attached in different positions in some of the reports supplied by the participants (see, for example, Figs B.9.3 and B.12.3 in Appendix B).

³ This is an arbitrary choice and it seemed reasonable to choose the start or the end of the comparison. It could easily have been any other point during the comparison.

⁴ The manufacturer-supplied mount was left attached during transit for logistical reasons. In hindsight, this problem could have been eliminated by permanently removing the mount.

At all other frequencies for this probe, whilst there is reasonably good agreement for most of the results, 23 out of the 138 degrees of equivalence have values greater than their expanded uncertainty ($k = 2$) suggesting that less than 85 % of the results are consistent with the reference value, which is lower than the expected 95 %.

These reasons combined make it difficult to reach a conclusion regarding the measurements of the FL7018 probe.

Conversely, for the FP7050 probe, 5 out of the 90 degrees of equivalence have values greater than their expanded uncertainty ($k = 2$), which is not unreasonable and one could conclude that the results are consistent when accounting for the drift.

5.2 Results as reported by each participant

The results of the measurements taken by the participants can be found in this section. The section is split further into two sub-sections to differentiate between the measurements of the different travelling standards. The uncertainty budgets provided by the participants can be found in Appendix C.

Measurements identified as outliers using the method in [2] are highlighted in the results tables in ***bold italic*** font. These entries are not used to calculate the KCRV. Measurement results not consistent with the KCRV (i.e., a measurement whose degree of equivalence is greater than its uncertainty) are highlighted in ***bold italic*** font in the tables listing degrees of equivalence.

All uncertainties have been reported as a standard combined uncertainty, i.e., coverage factor $k = 1$.

Both NPL and PTB made multiple measurements throughout the comparison period. The unweighted means of these results is used for the KCRV contributions.

5.2.1 FL7018 measurements and degrees of equivalence

The measurements as reported by each participant are tabulated in tables 5.1, 5.6 and 5.11 and shown graphically in figs 5.1 through 5.12. Note: the KCRV uncertainty intervals are displayed for $k = 1$.

Degrees of equivalence are listed in tables 5.2 through 5.5 for the 10 V/m reading, tables 5.7 through 5.10 for the 30 V/m reading and tables 5.12 through 5.15 for the 100 V/m reading. The original unrounded data was used to estimate the degrees of equivalence and the results rounded using spreadsheet software; therefore, rounding errors may be apparent in the tables. The uncertainties shown for degrees of equivalence are at 95 % confidence level ($k = 2$) to make it easier to identify inconsistent results.

5.2.2 FP7050 measurements and degrees of equivalence

The measurements as reported by each participant are tabulated in tables 5.16 and 5.22, with the results corrected for drift to the starting point of the comparison in January 2010 in tables

5.17 and 5.23, and the corrected results shown graphically in figs 5.13 through 5.20. Note: the KCRV uncertainty intervals are displayed for $k = 1$.

Degrees of equivalence corrected to January 2010 are listed in tables 5.18 through 5.21 for the 30 V/m reading and tables 5.24 through 5.27 for the 100 V/m reading. The original unrounded data was used to estimate the degrees of equivalence and the results rounded using spreadsheet software; therefore, rounding errors may be apparent in the tables. The uncertainties shown for degrees of equivalence are at 95 % confidence level ($k = 2$).

Table 5.1 – FL7018 Measurement and Combined Uncertainty ($k = 1$) in E-field 10 V/m

Participant	Date of measurement	1 GHz		2.45 GHz		10 GHz		18 GHz	
		Correction factor	Uncertainty (%)	Correction factor	Uncertainty (%)	Correction factor	Uncertainty (%)	Correction factor	Uncertainty (%)
NPL	Jan-10	1.12	1.93	1.08	1.87	0.95	1.89	1.50	1.89
PTB	Mar-10	1.07	6.00	1.08	8.50	0.80	8.50	1.48	8.50
LNE	Mar-10			1.07	3.10	0.93	3.10	1.36	3.10
INRIM	Apr-10	1.00	7.40	1.01	7.30	0.87	6.10	1.49	7.00
NPL	May-10	1.09	1.93	1.08	1.87	0.95	1.89	1.49	1.89
METAS	Jul-10	1.09	3.22	1.09	3.25	0.93	3.05	1.61	3.05
CMI	Aug-10	1.01	4.20	1.07	5.70	0.80	4.10	1.48	4.10
VSL	Sep-10	1.02	2.96	0.95	6.05				
PTB	Oct-10	1.05	6.00	1.11	8.50	0.78	8.50	1.48	8.50
LNE	Oct-10	1.18	3.10						
NPL	Oct-10	1.09	1.93	1.08	1.87	0.92	1.89	1.50	1.89
NIM	Dec-10			0.96	5.77	0.83	5.88		
NPL	Jan-11	1.09	1.93	1.06	1.87	0.95	1.89	1.46	1.89
NIST	Feb-11	0.96	7.40	1.08	7.20	0.93	9.90	1.75	15.60
NPL	Mar-11	1.09	1.93	1.07	1.87	0.91	1.89	1.49	1.89
NMIA	Apr-11	1.11	4.30	1.07	1.90			1.51	1.90
NPL	May-11	1.09	1.93	1.07	1.87	0.92	1.89	1.50	1.89
KRISS	Jul-11	1.05	5.00	1.05	5.00	0.85	5.00	1.51	5.00
NPL	Aug-11	1.10	1.93	1.08	1.87	0.92	1.89	1.50	1.89
TUBITAK	Oct-11	1.08	6.29	1.11	6.41	0.86	7.15	1.65	7.65
NPL	Oct-11	1.10	1.93	1.07	1.88	0.94	1.89	1.49	1.89
NMIJ	Dec-11	1.07	3.10	1.04	2.91				
NPL	Jan-12	1.09	1.93	1.07	1.87	0.94	1.89	1.48	1.89
VNIIFTRI	May-12	1.08	2.70	1.08	2.69	0.88	4.55	1.47	2.59
NPL	Jul-12	1.10	1.93	1.07	1.87	0.96	1.89	1.50	1.89
Multiple contributors contribution to KCRV									
NPL		1.10	1.93	1.07	1.87	0.94	1.89	1.49	1.89
PTB		1.06	6.00	1.10	8.50	0.79	8.50	1.48	8.50
KCRV		1.06	1.37	1.07	1.49	0.87	1.75	1.49	2.19

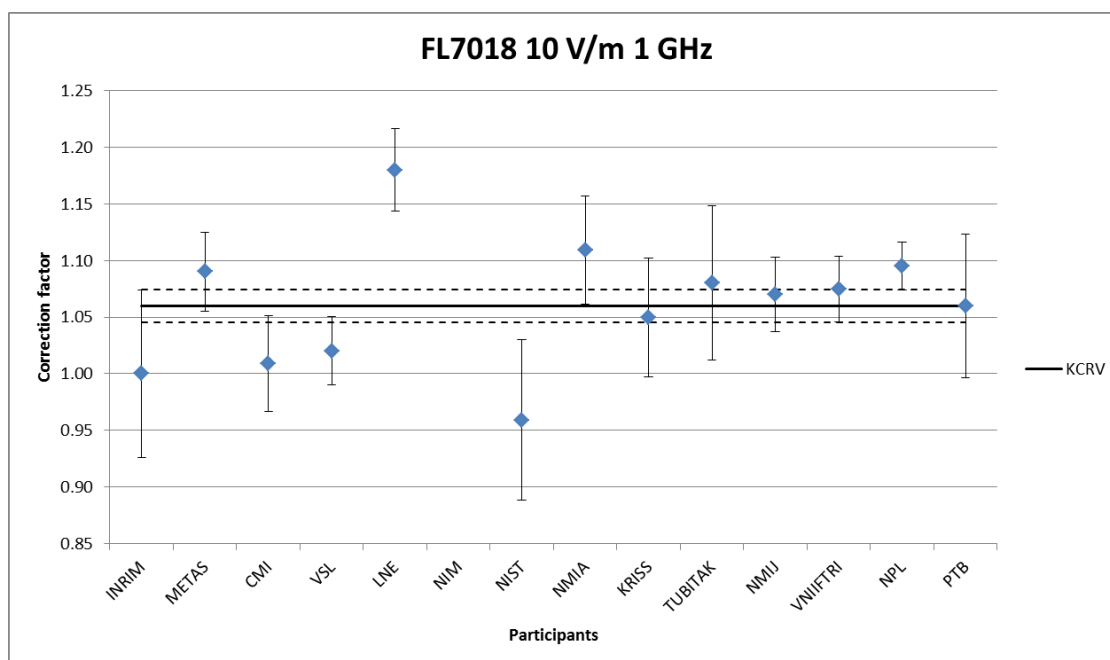


Fig 5.1 – FL7018 Measurement and Combined Uncertainty ($k = 1$) in E-field 10 V/m at 1 GHz

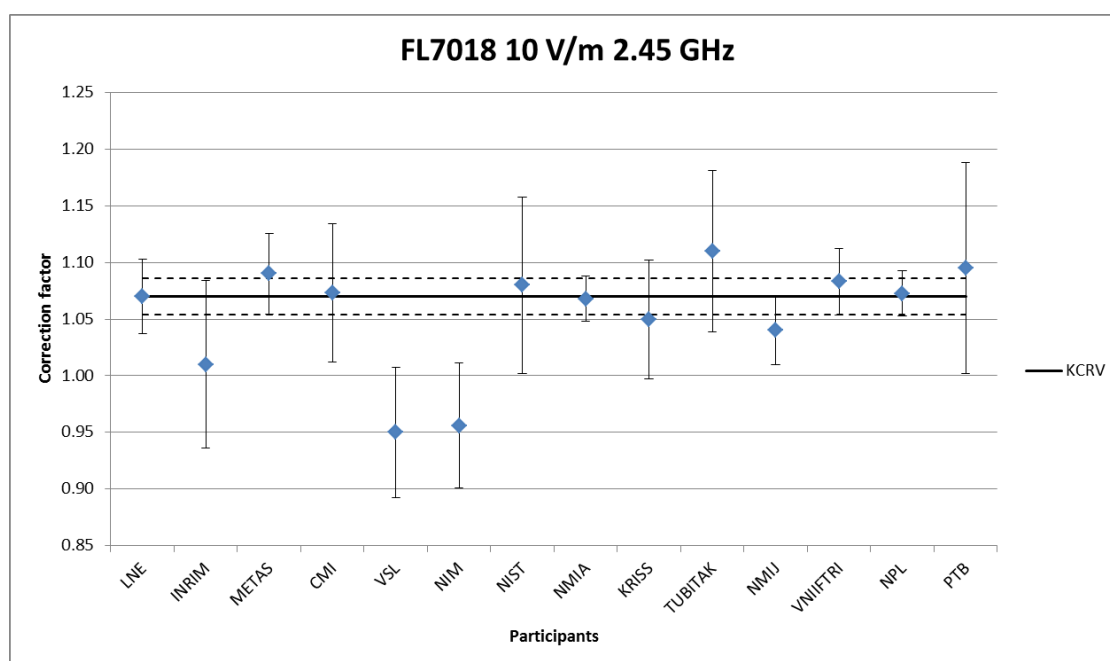


Fig 5.2 – FL7018 Measurement and Combined Uncertainty ($k = 1$) in E-field 10 V/m at 2.45 GHz

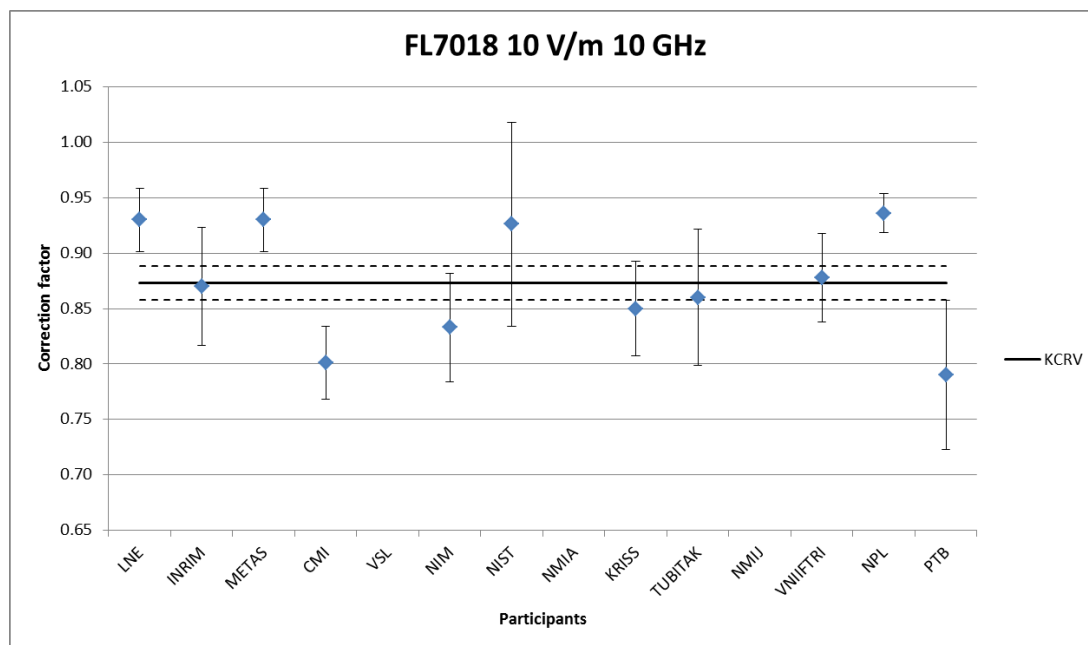


Fig 5.3 – FL7018 Measurement and Combined Uncertainty ($k = 1$) in E-field 10 V/m at 10 GHz

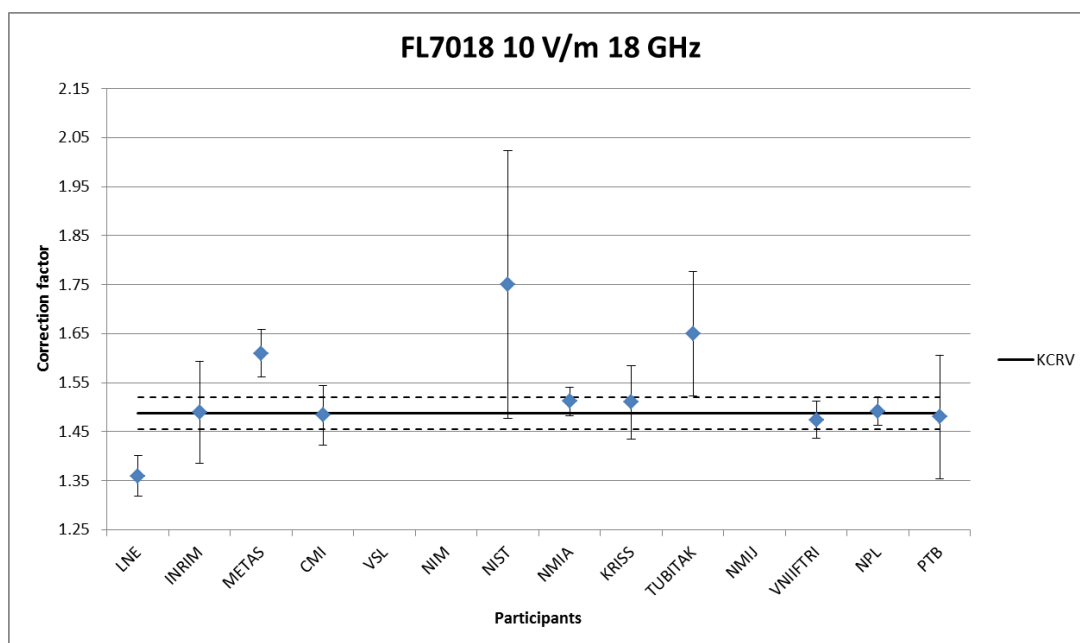


Fig 5.4 – FL7018 Measurement and Combined Uncertainty ($k = 1$) in E-field 10 V/m at 18 GHz

Table 5.2 – Degrees of equivalence and expanded uncertainty ($k = 2$) for FL7018 measurement in E-field 10 V/m at 1 GHz

Lab i	KCRV		INRIM		METAS		CMI		VSL		LNE	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
INRIM	-0.06	0.14			-0.09	0.16	-0.01	0.17	-0.02	0.16	-0.18	0.17
METAS	0.03	0.07	0.09	0.16			0.08	0.11	0.07	0.09	-0.09	0.10
CMI	-0.05	0.08	0.01	0.17	-0.08	0.11			-0.01	0.10	-0.17	0.11
VSL	-0.04	0.06	0.02	0.16	-0.07	0.09	0.01	0.10			-0.16	0.09
LNE	0.12	0.08	0.18	0.17	0.09	0.10	0.17	0.11	0.16	0.09		
NIM												
NIST	-0.10	0.14	-0.04	0.21	-0.13	0.16	-0.05	0.17	-0.06	0.15	-0.22	0.16
NMIA	0.05	0.09	0.11	0.18	0.02	0.12	0.10	0.13	0.09	0.11	-0.07	0.12
KRISS	-0.01	0.10	0.05	0.18	-0.04	0.13	0.04	0.13	0.03	0.12	-0.13	0.13
TUBITAK	0.02	0.13	0.08	0.20	-0.01	0.15	0.07	0.16	0.06	0.15	-0.10	0.15
NMIJ	0.01	0.07	0.07	0.16	-0.02	0.10	0.06	0.11	0.05	0.09	-0.11	0.10
VNIIFTRI	0.02	0.06	0.08	0.16	-0.02	0.09	0.07	0.10	0.05	0.08	-0.11	0.09
NPL	0.04	0.05	0.10	0.15	0.01	0.08	0.09	0.09	0.08	0.07	-0.08	0.08
PTB	0.00	0.12	0.06	0.20	-0.03	0.15	0.05	0.15	0.04	0.14	-0.12	0.15

Table 5.2 cont'd...

Lab i	KCRV		NIM		NIST		NMIA		KRISS		TUBITAK	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
INRIM	-0.06	0.14			0.04	0.21	-0.11	0.18	-0.05	0.18	-0.08	0.20
METAS	0.03	0.07			0.13	0.16	-0.02	0.12	0.04	0.13	0.01	0.15
CMI	-0.05	0.08			0.05	0.17	-0.10	0.13	-0.04	0.13	-0.07	0.16
VSL	-0.04	0.06			0.06	0.15	-0.09	0.11	-0.03	0.12	-0.06	0.15
LNE	0.12	0.08			0.22	0.16	0.07	0.12	0.13	0.13	0.10	0.15
NIM												
NIST	-0.10	0.14					-0.15	0.17	-0.09	0.18	-0.12	0.20
NMIA	0.05	0.09			0.15	0.17			0.06	0.14	0.03	0.17
KRISS	-0.01	0.10			0.09	0.18	-0.06	0.14			-0.03	0.17
TUBITAK	0.02	0.13			0.12	0.20	-0.03	0.17	0.03	0.17		
NMIJ	0.01	0.07			0.11	0.16	-0.04	0.12	0.02	0.12	-0.01	0.15
VNIIFTRI	0.02	0.06			0.12	0.15	-0.03	0.11	0.02	0.12	-0.01	0.15
NPL	0.04	0.05			0.14	0.15	-0.01	0.10	0.05	0.11	0.02	0.14
PTB	0.00	0.12			0.10	0.19	-0.05	0.16	0.01	0.16	-0.02	0.19

Table 5.2 cont'd...

Lab i	KCRV		NMIJ		VNIIFTRI		NPL		PTB	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
INRIM	-0.06	0.14	-0.07	0.16	-0.08	0.16	-0.10	0.15	-0.06	0.20
METAS	0.03	0.07	0.02	0.10	0.02	0.09	-0.01	0.08	0.03	0.15
CMI	-0.05	0.08	-0.06	0.11	-0.07	0.10	-0.09	0.09	-0.05	0.15
VSL	-0.04	0.06	-0.05	0.09	-0.05	0.08	-0.08	0.07	-0.04	0.14
LNE	0.12	0.08	0.11	0.10	0.11	0.09	0.08	0.08	0.12	0.15
NIM										
NIST	-0.10	0.14	-0.11	0.16	-0.12	0.15	-0.14	0.15	-0.10	0.19
NMIA	0.05	0.09	0.04	0.12	0.03	0.11	0.01	0.10	0.05	0.16
KRISS	-0.01	0.10	-0.02	0.12	-0.02	0.12	-0.05	0.11	-0.01	0.16
TUBITAK	0.02	0.13	0.01	0.15	0.01	0.15	-0.02	0.14	0.02	0.19
NMIJ	0.01	0.07			0.00	0.09	-0.03	0.08	0.01	0.14
VNIIFTRI	0.02	0.06	0.00	0.09			-0.02	0.07	0.01	0.14
NPL	0.04	0.05	0.03	0.08	0.02	0.07			0.04	0.13
PTB	0.00	0.12	-0.01	0.14	-0.01	0.14	-0.04	0.13		

Table 5.3 – Degrees of equivalence and expanded uncertainty ($k = 2$) for FL7018 measurement in E-field 10 V/m at 2.45 GHz

Lab i	KCRV		LNE		INRIM		METAS		CMI		VSL	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
LNE	0.00	0.07			0.06	0.16	-0.02	0.10	0.00	0.14	0.12	0.13
INRIM	-0.06	0.14	-0.06	0.16			-0.08	0.16	-0.06	0.19	0.06	0.19
METAS	0.02	0.07	0.02	0.10	0.08	0.16			0.02	0.14	0.14	0.14
CMI	0.00	0.12	0.00	0.14	0.06	0.19	-0.02	0.14			0.12	0.17
VSL	-0.12	0.12	-0.12	0.13	-0.06	0.19	-0.14	0.14	-0.12	0.17		
NIM	-0.11	0.11	-0.11	0.13	-0.05	0.18	-0.13	0.13	-0.12	0.16	0.01	0.16
NIST	0.01	0.15	0.01	0.17	0.07	0.21	-0.01	0.17	0.01	0.20	0.13	0.19
NMIA	0.00	0.05	0.00	0.08	0.06	0.15	-0.02	0.08	0.00	0.13	0.12	0.12
KRISS	-0.02	0.10	-0.02	0.12	0.04	0.18	-0.04	0.13	-0.02	0.16	0.10	0.16
TUBITAK	0.04	0.13	0.04	0.16	0.10	0.20	0.02	0.16	0.04	0.19	0.16	0.18
NMIJ	-0.03	0.06	-0.03	0.09	0.03	0.16	-0.05	0.09	-0.03	0.14	0.09	0.13
VNIIFTRI	0.01	0.06	0.01	0.09	0.07	0.16	-0.01	0.09	0.01	0.14	0.13	0.13
NPL	0.00	0.05	0.00	0.08	0.06	0.15	-0.02	0.08	0.00	0.13	0.12	0.12
PTB	0.02	0.17	0.03	0.20	0.09	0.24	0.01	0.20	0.02	0.22	0.15	0.22

Table 5.3 cont'd...

Lab i	KCRV		NIM		NIST		NMIA		KRISS		TUBITAK	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
LNE	0.00	0.07	0.11	0.13	-0.01	0.17	0.00	0.08	0.02	0.12	-0.04	0.16
INRIM	-0.06	0.14	0.05	0.18	-0.07	0.21	-0.06	0.15	-0.04	0.18	-0.10	0.20
METAS	0.02	0.07	0.13	0.13	0.01	0.17	0.02	0.08	0.04	0.13	-0.02	0.16
CMI	0.00	0.12	0.12	0.16	-0.01	0.20	0.00	0.13	0.02	0.16	-0.04	0.19
VSL	-0.12	0.12	-0.01	0.16	-0.13	0.19	-0.12	0.12	-0.10	0.16	-0.16	0.18
NIM	-0.11	0.11			-0.12	0.19	-0.11	0.12	-0.09	0.15	-0.15	0.18
NIST	0.01	0.15	0.12	0.19			0.01	0.16	0.03	0.19	-0.03	0.21
NMIA	0.00	0.05	0.11	0.12	-0.01	0.16			0.02	0.11	-0.04	0.15
KRISS	-0.02	0.10	0.09	0.15	-0.03	0.19	-0.02	0.11			-0.06	0.18
TUBITAK	0.04	0.13	0.15	0.18	0.03	0.21	0.04	0.15	0.06	0.18		
NMIJ	-0.03	0.06	0.08	0.13	-0.04	0.17	-0.03	0.07	-0.01	0.12	-0.07	0.15
VNIIFTRI	0.01	0.06	0.13	0.12	0.00	0.17	0.01	0.07	0.03	0.12	-0.03	0.15
NPL	0.00	0.05	0.12	0.12	-0.01	0.16	0.00	0.06	0.02	0.11	-0.04	0.15
PTB	0.02	0.17	0.14	0.22	0.02	0.24	0.03	0.19	0.05	0.21	-0.01	0.23

Table 5.3 cont'd...

Lab i	KCRV		NMIJ		VNIIFTRI		NPL		PTB	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
LNE	0.00	0.07	0.03	0.09	-0.01	0.09	0.00	0.08	-0.03	0.20
INRIM	-0.06	0.14	-0.03	0.16	-0.07	0.16	-0.06	0.15	-0.09	0.24
METAS	0.02	0.07	0.05	0.09	0.01	0.09	0.02	0.08	-0.01	0.20
CMI	0.00	0.12	0.03	0.14	-0.01	0.14	0.00	0.13	-0.02	0.22
VSL	-0.12	0.12	-0.09	0.13	-0.13	0.13	-0.12	0.12	-0.15	0.22
NIM	-0.11	0.11	-0.08	0.13	-0.13	0.12	-0.12	0.12	-0.14	0.22
NIST	0.01	0.15	0.04	0.17	0.00	0.17	0.01	0.16	-0.02	0.24
NMIA	0.00	0.05	0.03	0.07	-0.01	0.07	0.00	0.06	-0.03	0.19
KRISS	-0.02	0.10	0.01	0.12	-0.03	0.12	-0.02	0.11	-0.05	0.21
TUBITAK	0.04	0.13	0.07	0.15	0.03	0.15	0.04	0.15	0.01	0.23
NMIJ	-0.03	0.06			-0.04	0.08	-0.03	0.07	-0.06	0.20
VNIIFTRI	0.01	0.06	0.04	0.08			0.01	0.07	-0.01	0.20
NPL	0.00	0.05	0.03	0.07	-0.01	0.07			-0.02	0.19
PTB	0.02	0.17	0.06	0.20	0.01	0.20	0.02	0.19		

Table 5.4 – Degrees of equivalence and expanded uncertainty ($k = 2$) for FL7018 measurement in E-field 10 V/m at 10 GHz

Lab i	KCRV		LNE		INRIM		METAS		CMI		VSL	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
LNE	0.06	0.07			0.06	0.12	0.00	0.08	0.13	0.09		
INRIM	0.00	0.11	-0.06	0.12			-0.06	0.12	0.07	0.12		
METAS	0.06	0.06	0.00	0.08	0.06	0.12			0.13	0.09		
CMI	-0.07	0.07	-0.13	0.09	-0.07	0.12	-0.13	0.09				
VSL												
NIM	-0.04	0.10	-0.10	0.11	-0.04	0.14	-0.10	0.11	0.03	0.12		
NIST	0.05	0.19	0.00	0.19	0.06	0.21	0.00	0.19	0.13	0.19		
NMIA												
KRISS	-0.02	0.09	-0.08	0.10	-0.02	0.14	-0.08	0.10	0.05	0.11		
TUBITAK	-0.01	0.13	-0.07	0.14	-0.01	0.16	-0.07	0.14	0.06	0.14		
NMIJ												
VNIIFTRI	0.00	0.09	-0.05	0.10	0.01	0.13	-0.05	0.10	0.08	0.10		
NPL	0.06	0.04	0.01	0.07	0.07	0.11	0.01	0.07	0.14	0.07		
PTB	-0.08	0.13	-0.14	0.15	-0.08	0.17	-0.14	0.15	-0.01	0.15		

Table 5.4 cont'd...

Lab i	KCRV		NIM		NIST		NMIA		KRISS		TUBITAK	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
LNE	0.06	0.07	0.10	0.11	0.00	0.19			0.08	0.10	0.07	0.14
INRIM	0.00	0.11	0.04	0.14	-0.06	0.21			0.02	0.14	0.01	0.16
METAS	0.06	0.06	0.10	0.11	0.00	0.19			0.08	0.10	0.07	0.14
CMI	-0.07	0.07	-0.03	0.12	-0.13	0.19			-0.05	0.11	-0.06	0.14
VSL												
NIM	-0.04	0.10			-0.09	0.21			-0.02	0.13	-0.03	0.16
NIST	0.05	0.19	0.09	0.21					0.08	0.20	0.07	0.22
NMIA												
KRISS	-0.02	0.09	0.02	0.13	-0.08	0.20					-0.01	0.15
TUBITAK	-0.01	0.13	0.03	0.16	-0.07	0.22			0.01	0.15		
NMIJ												
VNIIFTRI	0.00	0.09	0.05	0.13	-0.05	0.20			0.03	0.12	0.02	0.15
NPL	0.06	0.04	0.10	0.10	0.01	0.19			0.09	0.09	0.08	0.13
PTB	-0.08	0.13	-0.04	0.17	-0.14	0.23			-0.06	0.16	-0.07	0.18

Table 5.4 cont'd...

Lab i	KCRV		NMIJ		VNIIFTRI		NPL		PTB	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
LNE	0.06	0.07			0.05	0.10	-0.01	0.07	0.14	0.15
INRIM	0.00	0.11			-0.01	0.13	-0.07	0.11	0.08	0.17
METAS	0.06	0.06			0.05	0.10	-0.01	0.07	0.14	0.15
CMI	-0.07	0.07			-0.08	0.10	-0.14	0.07	0.01	0.15
VSL										
NIM	-0.04	0.10			-0.05	0.13	-0.10	0.10	0.04	0.17
NIST	0.05	0.19			0.05	0.20	-0.01	0.19	0.14	0.23
NMIA										
KRISS	-0.02	0.09			-0.03	0.12	-0.09	0.09	0.06	0.16
TUBITAK	-0.01	0.13			-0.02	0.15	-0.08	0.13	0.07	0.18
NMIJ										
VNIIFTRI	0.00	0.09					-0.06	0.09	0.09	0.16
NPL	0.06	0.04			0.06	0.09			0.15	0.14
PTB	-0.08	0.13			-0.09	0.16	-0.15	0.14		

Table 5.5 – Degrees of equivalence and expanded uncertainty ($k = 2$) for FL7018 measurement in E-field 10 V/m at 18 GHz

Lab i	KCRV		LNE		INRIM		METAS		CMI		VSL	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
LNE	-0.13	0.11			-0.13	0.22	-0.25	0.13	-0.12	0.15		
INRIM	0.00	0.18	0.13	0.22			-0.12	0.23	0.01	0.24		
METAS	0.12	0.12	0.25	0.13	0.12	0.23			0.13	0.16		
CMI	0.00	0.12	0.12	0.15	-0.01	0.24	-0.13	0.16				
VSL												
NIM												
NIST	0.26	0.55	0.39	0.55	0.26	0.58	0.14	0.56	0.27	0.56		
NMIA	0.02	0.09	0.15	0.10	0.02	0.22	-0.10	0.11	0.03	0.13		
KRISS	0.02	0.14	0.15	0.17	0.02	0.26	-0.10	0.18	0.03	0.19		
TUBITAK	0.16	0.26	0.29	0.27	0.16	0.33	0.04	0.27	0.17	0.28		
NMIJ												
VNIIFTRI	-0.01	0.09	0.11	0.11	-0.02	0.22	-0.14	0.12	-0.01	0.14		
NPL	0.00	0.08	0.13	0.10	0.00	0.22	-0.12	0.11	0.01	0.13		
PTB	-0.01	0.22	0.12	0.27	-0.01	0.33	-0.13	0.27	0.00	0.28		

Table 5.5 cont'd...

Lab i	KCRV		NIM		NIST		NMIA		KRISS		TUBITAK	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
LNE	-0.13	0.11			-0.39	0.55			-0.15	0.17	-0.29	0.27
INRIM	0.00	0.18			-0.26	0.58			-0.02	0.26	-0.16	0.33
METAS	0.12	0.12			-0.14	0.56			0.10	0.18	-0.04	0.27
CMI	0.00	0.12			-0.27	0.56			-0.03	0.19	-0.17	0.28
VSL												
NIM												
NIST	0.26	0.55							0.24	0.57	0.10	0.60
NMIA	0.02	0.09			-0.24	0.55			0.00	0.16	-0.14	0.26
KRISS	0.02	0.14			-0.24	0.57					-0.14	0.29
TUBITAK	0.16	0.26			-0.10	0.60			0.14	0.29		
NMIJ												
VNIIFTRI	-0.01	0.09			-0.28	0.55			-0.04	0.17	-0.18	0.26
NPL	0.00	0.08			-0.26	0.55			-0.02	0.16	-0.16	0.26
PTB	-0.01	0.22			-0.27	0.60			-0.03	0.29	-0.17	0.36

Table 5.5 cont'd...

Lab i	KCRV		NMIJ		VNIIFTRI		NPL		PTB	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
LNE	-0.13	0.11			-0.11	0.11	-0.13	0.10	-0.12	0.27
INRIM	0.00	0.18			0.02	0.22	0.00	0.22	0.01	0.33
METAS	0.12	0.12			0.14	0.12	0.12	0.11	0.13	0.27
CMI	0.00	0.12			0.01	0.14	-0.01	0.13	0.00	0.28
VSL										
NIM										
NIST	0.26	0.55			0.28	0.55	0.26	0.55	0.27	0.60
NMIA	0.02	0.09			0.04	0.10	0.02	0.08	0.03	0.26
KRISS	0.02	0.14			0.04	0.17	0.02	0.16	0.03	0.29
TUBITAK	0.16	0.26			0.18	0.26	0.16	0.26	0.17	0.36
NMIJ										
VNIIFTRI	-0.01	0.09					-0.02	0.09	-0.01	0.26
NPL	0.00	0.08			0.02	0.09			0.01	0.26
PTB	-0.01	0.22			0.01	0.26	-0.01	0.26		

Table 5.6 – FL7018 Measurement and Combined Uncertainty ($k = 1$) in E-field 30 V/m

Participant	Date of measurement	1 GHz		2.45 GHz		10 GHz		18 GHz	
		Correction factor	Uncertainty (%)	Correction factor	Uncertainty (%)	Correction factor	Uncertainty (%)	Correction factor	Uncertainty (%)
NPL	Jan-10	1.13	1.93	1.10	1.87	0.93	1.89	1.51	1.89
PTB	Mar-10	1.09	6.00	1.12	8.50	0.82	8.50	1.53	8.50
LNE	Mar-10			1.14	3.10	0.97	3.10	1.45	3.10
INRIM	Apr-10	1.04	7.40	1.06	7.30	0.90	6.10	1.57	7.00
NPL	May-10	1.13	1.93	1.12	1.87	0.97	1.89	1.56	1.89
METAS	Jul-10	1.11	3.23	1.10	3.21	0.94	3.06	1.66	3.06
CMI	Aug-10	1.02	4.20	1.11	6.10	0.80	4.10	1.49	4.10
VSL	Sep-10	1.06	2.96	0.99	6.05				
PTB	Oct-10	1.06	6.00	1.13	8.50	0.79	8.50	1.53	8.50
LNE	Oct-10	1.21	3.10						
NPL	Oct-10	1.13	1.93	1.11	1.87	0.94	1.89	1.53	1.89
NIM	Dec-10			1.05	5.77	0.83	5.88		
NPL	Jan-11	1.12	1.93	1.10	1.87	0.95	1.89	1.54	1.89
NIST	Feb-11	0.95	8.30	1.08	7.40	0.88	7.10	1.80	12.50
NPL	Mar-11	1.13	1.93	1.10	1.87	0.91	1.89	1.49	1.89
NMIA	Apr-11	1.12	4.30	1.09	1.90				
NPL	May-11	1.14	1.93	1.12	1.87	0.93	1.89	1.53	1.89
KRISS	Jul-11	1.08	5.00	1.08	5.00	0.88	5.00	1.59	5.00
NPL	Aug-11	1.15	1.93	1.13	1.87	0.93	1.89	1.56	1.89
TUBITAK	Oct-11	1.11	6.29	1.12	6.41	0.88	7.15	1.67	7.65
NPL	Oct-11	1.15	1.93	1.12	1.88	0.95	1.89	1.52	1.89
NMIJ	Dec-11	1.11	3.02	1.08	2.95				
NPL	Jan-12	1.15	1.93	1.12	1.87	0.95	1.89	1.53	1.89
VNIIFTRI	May-12	1.15	2.64	1.12	2.41	0.89	4.62	1.47	2.51
NPL	Jul-12	1.14	1.93	1.10	1.87	0.96	1.89	1.56	1.89
Multiple contributors contribution to KCRV									
NPL		1.14	1.93	1.11	1.87	0.94	1.89	1.53	1.89
PTB		1.08	6.00	1.13	8.50	0.81	8.50	1.53	8.50
KCRV		1.10	1.27	1.10	1.45	0.88	1.62	1.58	2.13

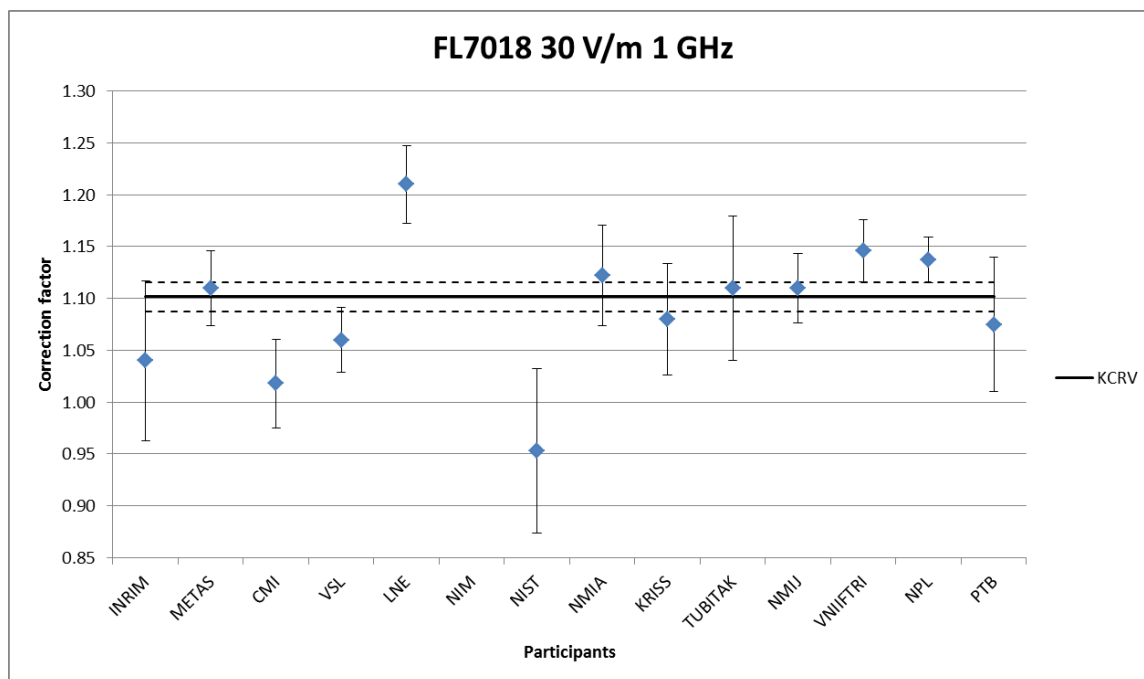


Fig 5.5 – FL7018 Measurement and Combined Uncertainty ($k = 1$) in E-field 30 V/m at 1 GHz

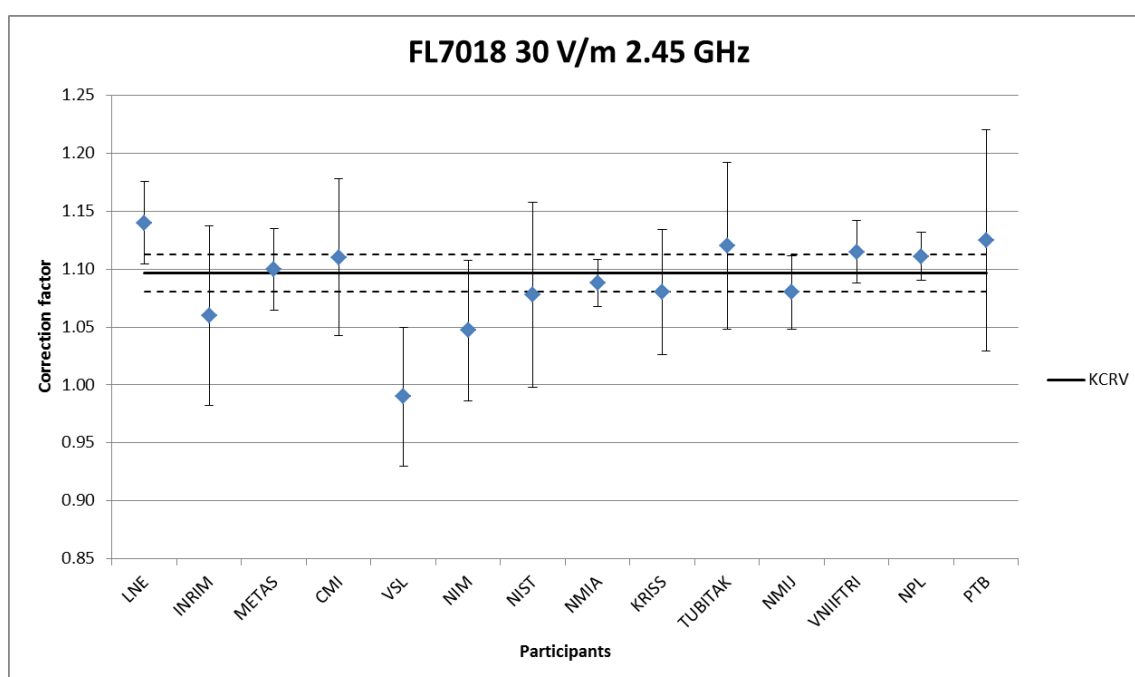


Fig 5.6 – FL7018 Measurement and Combined Uncertainty ($k = 1$) in E-field 30 V/m at 2.45 GHz

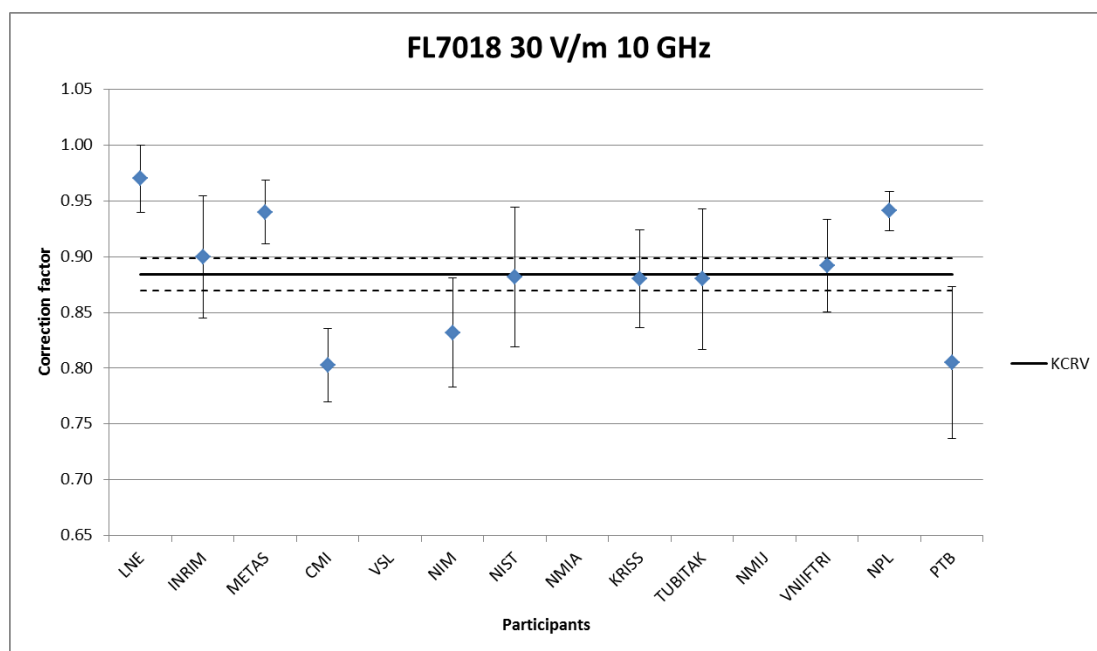


Fig 5.7 – FL7018 Measurement and Combined Uncertainty ($k = 1$) in E-field 30 V/m at 10 GHz

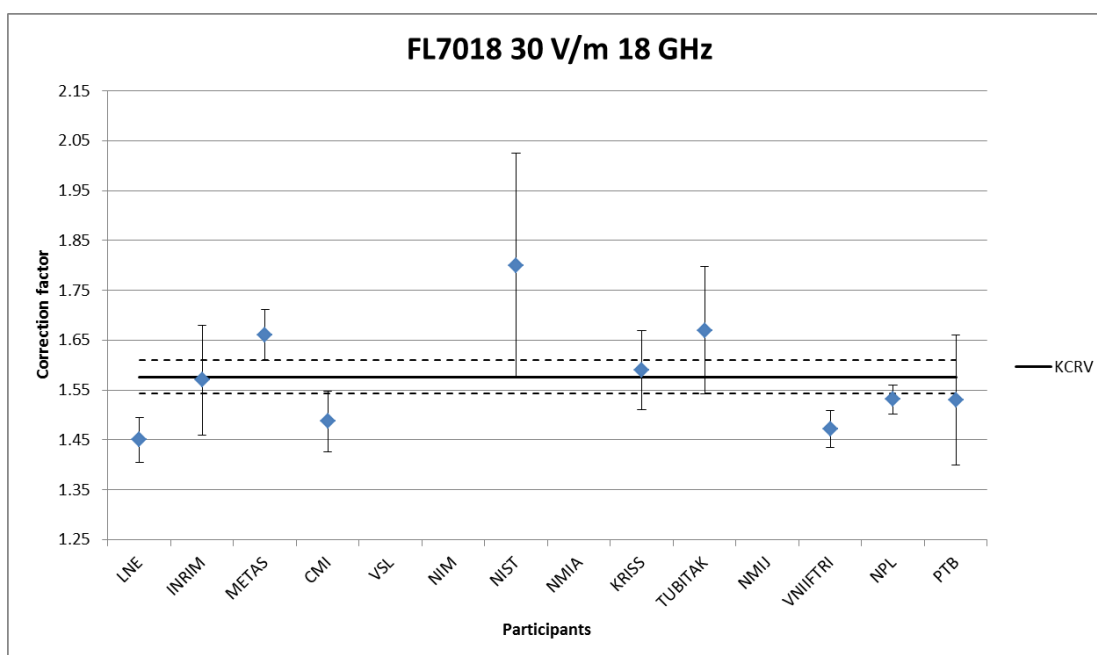


Fig 5.8 – FL7018 Measurement and Combined Uncertainty ($k = 1$) in E-field 30 V/m at 18 GHz

Table 5.7 – Degrees of equivalence and expanded uncertainty ($k = 2$) for FL7018 measurement in E-field 30 V/m at 1 GHz

Lab i	KCRV		INRIM		METAS		CMI		VSL		LNE	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
INRIM	-0.06	0.14			-0.07	0.17	0.02	0.18	-0.02	0.17	-0.17	0.17
METAS	0.01	0.07	0.07	0.17			0.09	0.11	0.05	0.10	-0.10	0.10
CMI	-0.08	0.08	-0.02	0.18	-0.09	0.11			-0.04	0.11	-0.19	0.11
VSL	-0.04	0.06	0.02	0.17	-0.05	0.10	0.04	0.11			-0.15	0.10
LNE	0.11	0.07	0.17	0.17	0.10	0.10	0.19	0.11	0.15	0.10		
NIM												
NIST	-0.15	0.16	-0.09	0.22	-0.16	0.17	-0.07	0.18	-0.11	0.17	-0.26	0.18
NMIA	0.02	0.09	0.08	0.18	0.01	0.12	0.10	0.13	0.06	0.12	-0.09	0.12
KRISS	-0.02	0.10	0.04	0.19	-0.03	0.13	0.06	0.14	0.02	0.12	-0.13	0.13
TUBITAK	0.01	0.13	0.07	0.21	0.00	0.16	0.09	0.16	0.05	0.15	-0.10	0.16
NMIJ	0.01	0.07	0.07	0.17	0.00	0.10	0.09	0.11	0.05	0.09	-0.10	0.10
VNIIFTRI	0.04	0.06	0.11	0.17	0.04	0.09	0.13	0.10	0.09	0.09	-0.06	0.10
NPL	0.04	0.05	0.10	0.16	0.03	0.08	0.12	0.10	0.08	0.08	-0.07	0.09
PTB	-0.03	0.12	0.04	0.20	-0.03	0.15	0.06	0.15	0.02	0.14	-0.14	0.15

Table 5.7 cont'd...

Lab i	KCRV		NIM		NIST		NMIA		KRISS		TUBITAK	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
INRIM	-0.06	0.14			0.09	0.22	-0.08	0.18	-0.04	0.19	-0.07	0.21
METAS	0.01	0.07			0.16	0.17	-0.01	0.12	0.03	0.13	0.00	0.16
CMI	-0.08	0.08			0.07	0.18	-0.10	0.13	-0.06	0.14	-0.09	0.16
VSL	-0.04	0.06			0.11	0.17	-0.06	0.12	-0.02	0.12	-0.05	0.15
LNE	0.11	0.07			0.26	0.18	0.09	0.12	0.13	0.13	0.10	0.16
NIM												
NIST	-0.15	0.16					-0.17	0.19	-0.13	0.19	-0.16	0.21
NMIA	0.02	0.09			0.17	0.19			0.04	0.14	0.01	0.17
KRISS	-0.02	0.10			0.13	0.19	-0.04	0.14			-0.03	0.18
TUBITAK	0.01	0.13			0.16	0.21	-0.01	0.17	0.03	0.18		
NMIJ	0.01	0.07			0.16	0.17	-0.01	0.12	0.03	0.13	0.00	0.15
VNIIFTRI	0.04	0.06			0.19	0.17	0.02	0.11	0.07	0.12	0.04	0.15
NPL	0.04	0.05			0.18	0.16	0.02	0.11	0.06	0.12	0.03	0.15
PTB	-0.03	0.12			0.12	0.20	-0.05	0.16	0.00	0.17	-0.03	0.19

Table 5.7 cont'd...

Lab i	KCRV		NMIJ		VNIIFTRI		NPL		PTB	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
INRIM	-0.06	0.14	-0.07	0.17	-0.11	0.17	-0.10	0.16	-0.04	0.20
METAS	0.01	0.07	0.00	0.10	-0.04	0.09	-0.03	0.08	0.03	0.15
CMI	-0.08	0.08	-0.09	0.11	-0.13	0.10	-0.12	0.10	-0.06	0.15
VSL	-0.04	0.06	-0.05	0.09	-0.09	0.09	-0.08	0.08	-0.02	0.14
LNE	0.11	0.07	0.10	0.10	0.06	0.10	0.07	0.09	0.14	0.15
NIM										
NIST	-0.15	0.16	-0.16	0.17	-0.19	0.17	-0.18	0.16	-0.12	0.20
NMIA	0.02	0.09	0.01	0.12	-0.02	0.11	-0.02	0.11	0.05	0.16
KRISS	-0.02	0.10	-0.03	0.13	-0.07	0.12	-0.06	0.12	0.00	0.17
TUBITAK	0.01	0.13	0.00	0.15	-0.04	0.15	-0.03	0.15	0.03	0.19
NMIJ	0.01	0.07			-0.04	0.09	-0.03	0.08	0.03	0.15
VNIIFTRI	0.04	0.06	0.04	0.09			0.01	0.07	0.07	0.14
NPL	0.04	0.05	0.03	0.08	-0.01	0.07			0.06	0.14
PTB	-0.03	0.12	-0.03	0.15	-0.07	0.14	-0.06	0.14		

Table 5.8 – Degrees of equivalence and expanded uncertainty ($k = 2$) for FL7018 measurement in E-field 30 V/m at 2.45 GHz

Lab i	KCRV		LNE		INRIM		METAS		CMI		VSL	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
LNE	0.04	0.07			0.08	0.17	0.04	0.10	0.03	0.15	0.15	0.14
INRIM	-0.04	0.15	-0.08	0.17			-0.04	0.17	-0.05	0.21	0.07	0.20
METAS	0.00	0.07	-0.04	0.10	0.04	0.17			-0.01	0.15	0.11	0.14
CMI	0.01	0.13	-0.03	0.15	0.05	0.21	0.01	0.15			0.12	0.18
VSL	-0.11	0.12	-0.15	0.14	-0.07	0.20	-0.11	0.14	-0.12	0.18		
NIM	-0.05	0.12	-0.09	0.14	-0.01	0.20	-0.05	0.14	-0.06	0.18	0.06	0.17
NIST	-0.02	0.15	-0.06	0.17	0.02	0.22	-0.02	0.17	-0.03	0.21	0.09	0.20
NMIA	-0.01	0.05	-0.05	0.08	0.03	0.16	-0.01	0.08	-0.02	0.14	0.10	0.13
KRISS	-0.02	0.10	-0.06	0.13	0.02	0.19	-0.02	0.13	-0.03	0.17	0.09	0.16
TUBITAK	0.02	0.14	-0.02	0.16	0.06	0.21	0.02	0.16	0.01	0.20	0.13	0.19
NMIJ	-0.02	0.07	-0.06	0.10	0.02	0.17	-0.02	0.10	-0.03	0.15	0.09	0.14
VNIIFTRI	0.02	0.06	-0.02	0.09	0.05	0.16	0.01	0.09	0.00	0.15	0.13	0.13
NPL	0.01	0.05	-0.03	0.08	0.05	0.16	0.01	0.08	0.00	0.14	0.12	0.13
PTB	0.03	0.18	-0.01	0.20	0.06	0.25	0.02	0.20	0.01	0.23	0.14	0.23

Table 5.8 cont'd...

Lab i	KCRV		NIM		NIST		NMIA		KRISS		TUBITAK	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
LNE	0.04	0.07	0.09	0.14	0.06	0.17	0.05	0.08	0.06	0.13	0.02	0.16
INRIM	-0.04	0.15	0.01	0.20	-0.02	0.22	-0.03	0.16	-0.02	0.19	-0.06	0.21
METAS	0.00	0.07	0.05	0.14	0.02	0.17	0.01	0.08	0.02	0.13	-0.02	0.16
CMI	0.01	0.13	0.06	0.18	0.03	0.21	0.02	0.14	0.03	0.17	-0.01	0.20
VSL	-0.11	0.12	-0.06	0.17	-0.09	0.20	-0.10	0.13	-0.09	0.16	-0.13	0.19
NIM	-0.05	0.12			-0.03	0.20	-0.04	0.13	-0.03	0.16	-0.07	0.19
NIST	-0.02	0.15	0.03	0.20			-0.01	0.16	0.00	0.19	-0.04	0.21
NMIA	-0.01	0.05	0.04	0.13	0.01	0.16			0.01	0.12	-0.03	0.15
KRISS	-0.02	0.10	0.03	0.16	0.00	0.19	-0.01	0.12			-0.04	0.18
TUBITAK	0.02	0.14	0.07	0.19	0.04	0.21	0.03	0.15	0.04	0.18		
NMIJ	-0.02	0.07	0.03	0.14	0.00	0.17	-0.01	0.08	0.00	0.13	-0.04	0.16
VNIIFTRI	0.02	0.06	0.07	0.13	0.04	0.17	0.03	0.07	0.03	0.12	-0.01	0.15
NPL	0.01	0.05	0.06	0.13	0.03	0.16	0.02	0.06	0.03	0.12	-0.01	0.15
PTB	0.03	0.18	0.08	0.23	0.05	0.25	0.04	0.20	0.04	0.22	0.00	0.24

Table 5.8 cont'd...

Lab i	KCRV		NMIJ		VNIIFTRI		NPL		PTB	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
LNE	0.04	0.07	0.06	0.10	0.02	0.09	0.03	0.08	0.01	0.20
INRIM	-0.04	0.15	-0.02	0.17	-0.05	0.16	-0.05	0.16	-0.06	0.25
METAS	0.00	0.07	0.02	0.10	-0.01	0.09	-0.01	0.08	-0.02	0.20
CMI	0.01	0.13	0.03	0.15	0.00	0.15	0.00	0.14	-0.01	0.23
VSL	-0.11	0.12	-0.09	0.14	-0.13	0.13	-0.12	0.13	-0.14	0.23
NIM	-0.05	0.12	-0.03	0.14	-0.07	0.13	-0.06	0.13	-0.08	0.23
NIST	-0.02	0.15	0.00	0.17	-0.04	0.17	-0.03	0.16	-0.05	0.25
NMIA	-0.01	0.05	0.01	0.08	-0.03	0.07	-0.02	0.06	-0.04	0.20
KRISS	-0.02	0.10	0.00	0.13	-0.03	0.12	-0.03	0.12	-0.04	0.22
TUBITAK	0.02	0.14	0.04	0.16	0.01	0.15	0.01	0.15	0.00	0.24
NMIJ	-0.02	0.07			-0.03	0.08	-0.03	0.08	-0.04	0.20
VNIIFTRI	0.02	0.06	0.03	0.08			0.00	0.07	-0.01	0.20
NPL	0.01	0.05	0.03	0.08	0.00	0.07			-0.01	0.20
PTB	0.03	0.18	0.04	0.20	0.01	0.20	0.01	0.20		

Table 5.9 – Degrees of equivalence and expanded uncertainty ($k = 2$) for FL7018 measurement in E-field 30 V/m at 10 GHz

Lab i	KCRV		LNE		INRIM		METAS		CMI		VSL	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
LNE	0.09	0.07			0.07	0.13	0.03	0.08	0.17	0.09		
INRIM	0.02	0.11	-0.07	0.13			-0.04	0.12	0.10	0.13		
METAS	0.06	0.06	-0.03	0.08	0.04	0.12			0.14	0.09		
CMI	-0.08	0.07	-0.17	0.09	-0.10	0.13	-0.14	0.09				
VSL												
NIM	-0.05	0.10	-0.14	0.11	-0.07	0.15	-0.11	0.11	0.03	0.12		
NIST	0.00	0.13	-0.09	0.14	-0.02	0.17	-0.06	0.14	0.08	0.14		
NMIA												
KRISS	0.00	0.09	-0.09	0.11	-0.02	0.14	-0.06	0.11	0.08	0.11		
TUBITAK	0.00	0.13	-0.09	0.14	-0.02	0.17	-0.06	0.14	0.08	0.14		
NMIJ												
VNIIFTRI	0.01	0.09	-0.08	0.10	-0.01	0.14	-0.05	0.10	0.09	0.11		
NPL	0.06	0.04	-0.03	0.07	0.04	0.12	0.00	0.07	0.14	0.07		
PTB	-0.08	0.13	-0.17	0.15	-0.10	0.18	-0.14	0.15	0.00	0.15		

Table 5.9 cont'd...

Lab i	KCRV		NIM		NIST		NMIA		KRISS		TUBITAK	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
LNE	0.09	0.07	0.14	0.11	0.09	0.14			0.09	0.11	0.09	0.14
INRIM	0.02	0.11	0.07	0.15	0.02	0.17			0.02	0.14	0.02	0.17
METAS	0.06	0.06	0.11	0.11	0.06	0.14			0.06	0.11	0.06	0.14
CMI	-0.08	0.07	-0.03	0.12	-0.08	0.14			-0.08	0.11	-0.08	0.14
VSL												
NIM	-0.05	0.10			-0.05	0.16			-0.05	0.13	-0.05	0.16
NIST	0.00	0.13	0.05	0.16					0.00	0.15	0.00	0.18
NMIA												
KRISS	0.00	0.09	0.05	0.13	0.00	0.15					0.00	0.15
TUBITAK	0.00	0.13	0.05	0.16	0.00	0.18			0.00	0.15		
NMIJ												
VNIIFTRI	0.01	0.09	0.06	0.13	0.01	0.15			0.01	0.12	0.01	0.15
NPL	0.06	0.04	0.11	0.10	0.06	0.13			0.06	0.09	0.06	0.13
PTB	-0.08	0.13	-0.03	0.17	-0.08	0.19			-0.08	0.16	-0.08	0.19

Table 5.9 cont'd...

Lab i	KCRV		NMIJ		VNIIFTRI		NPL		PTB	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
LNE	0.09	0.07			0.08	0.10	0.03	0.07	0.17	0.15
INRIM	0.02	0.11			0.01	0.14	-0.04	0.12	0.10	0.18
METAS	0.06	0.06			0.05	0.10	0.00	0.07	0.14	0.15
CMI	-0.08	0.07			-0.09	0.11	-0.14	0.07	0.00	0.15
VSL										
NIM	-0.05	0.10			-0.06	0.13	-0.11	0.10	0.03	0.17
NIST	0.00	0.13			-0.01	0.15	-0.06	0.13	0.08	0.19
NMIA										
KRISS	0.00	0.09			-0.01	0.12	-0.06	0.09	0.08	0.16
TUBITAK	0.00	0.13			-0.01	0.15	-0.06	0.13	0.08	0.19
NMIJ										
VNIIFTRI	0.01	0.09					-0.05	0.09	0.09	0.16
NPL	0.06	0.04			0.05	0.09			0.14	0.14
PTB	-0.08	0.13			-0.09	0.16	-0.14	0.14		

Table 5.10 – Degrees of equivalence and expanded uncertainty ($k = 2$) for FL7018 measurement in E-field 30 V/m at 18 GHz

Lab i	KCRV		LNE		INRIM		METAS		CMI		VSL	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
LNE	-0.13	0.10			-0.12	0.24	-0.21	0.14	-0.04	0.15		
INRIM	-0.01	0.21	0.12	0.24			-0.09	0.24	0.08	0.25		
METAS	0.08	0.11	0.21	0.14	0.09	0.24			0.17	0.16		
CMI	-0.09	0.13	0.04	0.15	-0.08	0.25	-0.17	0.16				
VSL												
NIM												
NIST	0.22	0.41	0.35	0.46	0.23	0.50	0.14	0.46	0.31	0.47		
NMIA												
KRISS	0.01	0.16	0.14	0.18	0.02	0.27	-0.07	0.19	0.10	0.20		
TUBITAK	0.09	0.24	0.22	0.27	0.10	0.34	0.01	0.27	0.18	0.28		
NMIJ												
VNIIFTRI	-0.10	0.09	0.02	0.12	-0.10	0.23	-0.19	0.13	-0.02	0.14		
NPL	-0.05	0.08	0.08	0.11	-0.04	0.23	-0.13	0.12	0.04	0.13		
PTB	-0.05	0.24	0.08	0.28	-0.04	0.34	-0.13	0.28	0.04	0.29		

Table 5.10 cont'd...

Lab i	KCRV		NIM		NIST		NMIA		KRISS		TUBITAK	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
LNE	-0.13	0.10			-0.35	0.46			-0.14	0.18	-0.22	0.27
INRIM	-0.01	0.21			-0.23	0.50			-0.02	0.27	-0.10	0.34
METAS	0.08	0.11			-0.14	0.46			0.07	0.19	-0.01	0.27
CMI	-0.09	0.13			-0.31	0.47			-0.10	0.20	-0.18	0.28
VSL												
NIM												
NIST	0.22	0.41							0.21	0.48	0.13	0.52
NMIA												
KRISS	0.01	0.16			-0.21	0.48					-0.08	0.30
TUBITAK	0.09	0.24			-0.13	0.52			0.08	0.30		
NMIJ												
VNIIFTRI	-0.10	0.09			-0.33	0.46			-0.12	0.18	-0.20	0.27
NPL	-0.05	0.08			-0.27	0.45			-0.06	0.17	-0.14	0.26
PTB	-0.05	0.24			-0.27	0.52			-0.06	0.30	-0.14	0.36

Table 5.10 cont'd...

Lab i	KCRV		NMIJ		VNIIFTRI		NPL		PTB	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
LNE	-0.13	0.10			-0.02	0.12	-0.08	0.11	-0.08	0.28
INRIM	-0.01	0.21			0.10	0.23	0.04	0.23	0.04	0.34
METAS	0.08	0.11			0.19	0.13	0.13	0.12	0.13	0.28
CMI	-0.09	0.13			0.02	0.14	-0.04	0.13	-0.04	0.29
VSL										
NIM										
NIST	0.22	0.41			0.33	0.46	0.27	0.45	0.27	0.52
NMIA										
KRISS	0.01	0.16			0.12	0.18	0.06	0.17	0.06	0.30
TUBITAK	0.09	0.24			0.20	0.27	0.14	0.26	0.14	0.36
NMIJ										
VNIIFTRI	-0.10	0.09					-0.06	0.09	-0.06	0.27
NPL	-0.05	0.08			0.06	0.09			0.00	0.27
PTB	-0.05	0.24			0.06	0.27	0.00	0.27		

Table 5.11 – FL7018 Measurement and Combined Uncertainty ($k = 1$) in E-field 100 V/m

Participant	Date of measurement	1 GHz		2.45 GHz		10 GHz		18 GHz	
		Correction factor	Uncertainty (%)	Correction factor	Uncertainty (%)	Correction factor	Uncertainty (%)	Correction factor	Uncertainty (%)
NPL	Jan-10	1.10	1.93	1.08	1.87	0.92	1.89	1.48	1.89
PTB	Mar-10			1.09	8.50	0.80	8.50	1.48	8.50
LNE	Mar-10			1.10	2.10	0.91	2.10	1.38	2.10
INRIM	Apr-10					0.91	6.10	1.53	7.00
NPL	May-10	1.11	1.93	1.09	1.87	0.95	1.89	1.51	1.89
METAS	Jul-10	1.10	4.17	1.09	4.17	0.92	5.23	1.66	4.30
CMI	Aug-10	1.01	4.30			0.80	4.10	1.46	4.10
VSL	Sep-10								
PTB	Oct-10			1.11	8.50	0.77	8.50	1.49	8.50
LNE	Oct-10	1.25	2.10						
NPL	Oct-10	1.10	1.93	1.09	1.87	0.92	1.89	1.49	1.89
NIM	Dec-10			1.03	5.77	0.82	5.88		
NPL	Jan-11	1.09	1.93	1.07	1.87	0.94	1.89	1.48	1.89
NIST	Feb-11	0.96	7.50	1.04	7.70	0.87	6.80	1.79	15.80
NPL	Mar-11	1.10	1.93	1.08	1.87	0.91	1.89	1.46	1.89
NMIA	Apr-11	1.11	4.50	1.07	1.90				
NPL	May-11	1.10	1.93	1.08	1.87	0.93	1.89	1.50	1.89
KRISS	Jul-11	1.06	5.00	1.07	5.00	0.88	5.00	1.57	5.00
NPL	Aug-11	1.12	1.93	1.10	1.87	0.93	1.89	1.52	1.89
TUBITAK	Oct-11	1.12	6.41	1.11	6.41	0.87	7.28	1.66	7.89
NPL	Oct-11	1.10	1.93	1.09	1.88	0.95	1.89	1.49	1.89
NMIJ	Dec-11	1.11	4.56						
NPL	Jan-12	1.10	1.93	1.09	1.87	0.94	1.89	1.49	1.89
VNIIFTRI	May-12	1.13	2.72	1.11	2.48	0.88	4.36	1.43	2.55
NPL	Jul-12	1.11	1.93	1.08	1.87	0.96	1.89	1.50	1.89
Multiple contributors contribution to KCRV									
NPL		1.10	1.93	1.08	1.87	0.93	1.89	1.49	1.89
PTB				1.10	8.50	0.79	8.50	1.49	8.50
KCRV		1.11	1.66	1.08	1.62	0.87	1.65	1.52	1.83

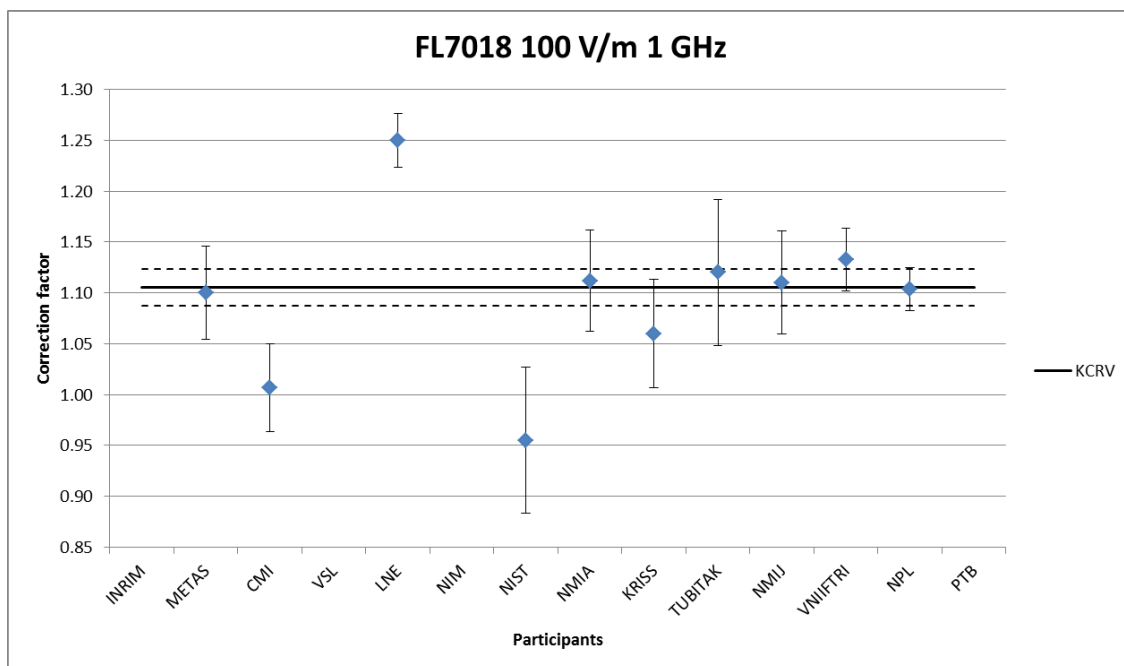


Fig 5.9 – FL7018 Measurement and Combined Uncertainty ($k = 1$) in E-field 100 V/m at 1 GHz

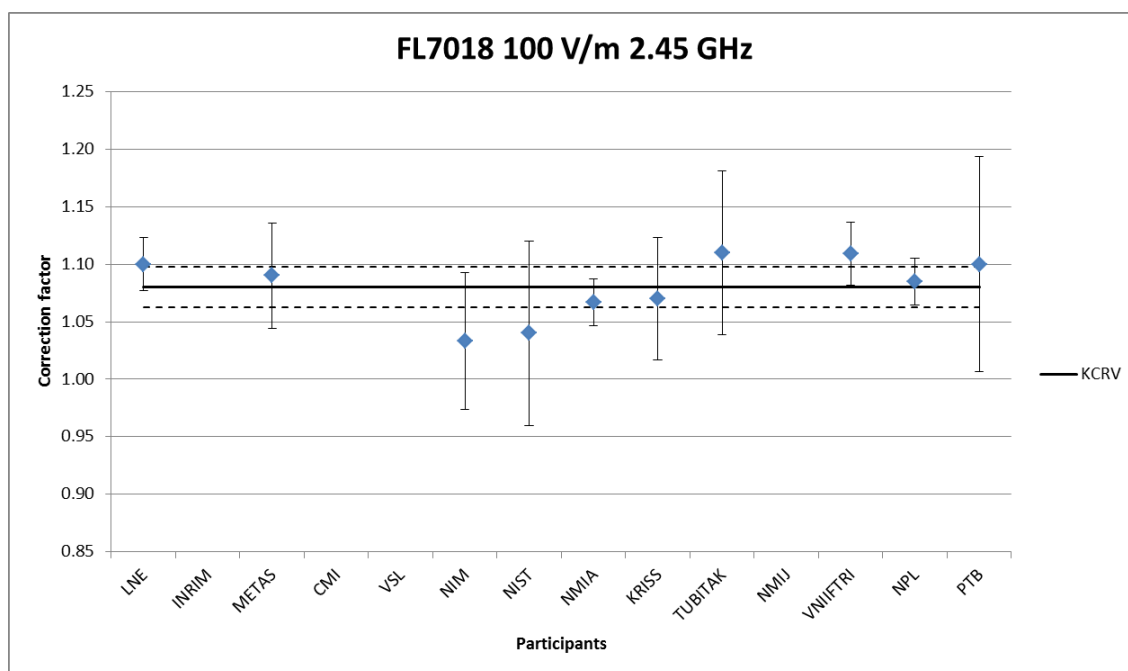


Fig 5.10 – FL7018 Measurement and Combined Uncertainty ($k = 1$) in E-field 100 V/m at 2.45 GHz

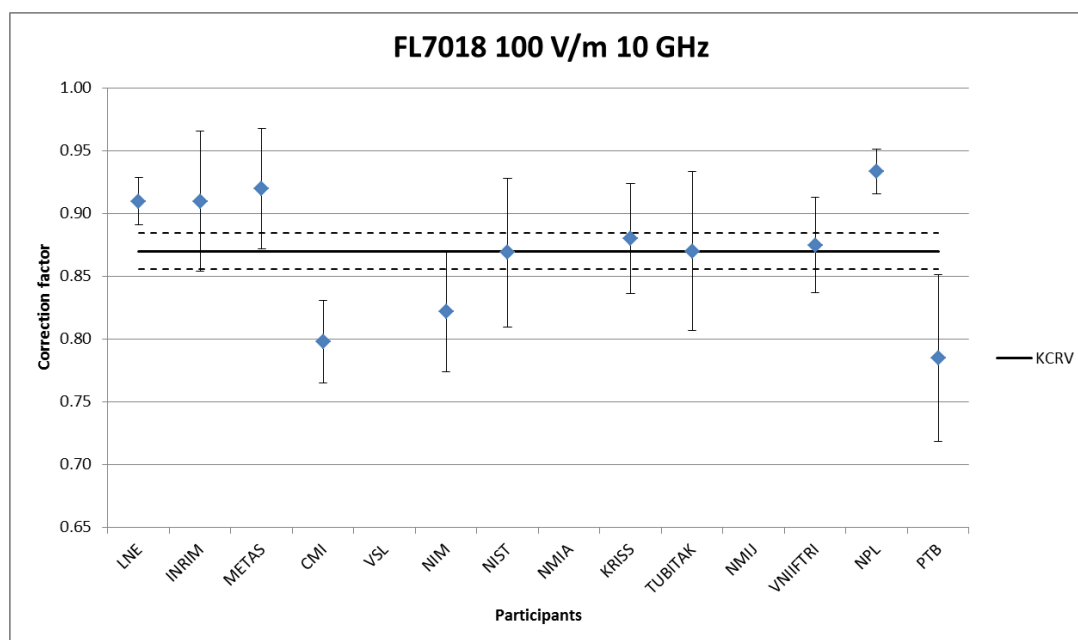


Fig 5.11 – FL7018 Measurement and Combined Uncertainty ($k = 1$) in E-field 100 V/m at 10 GHz

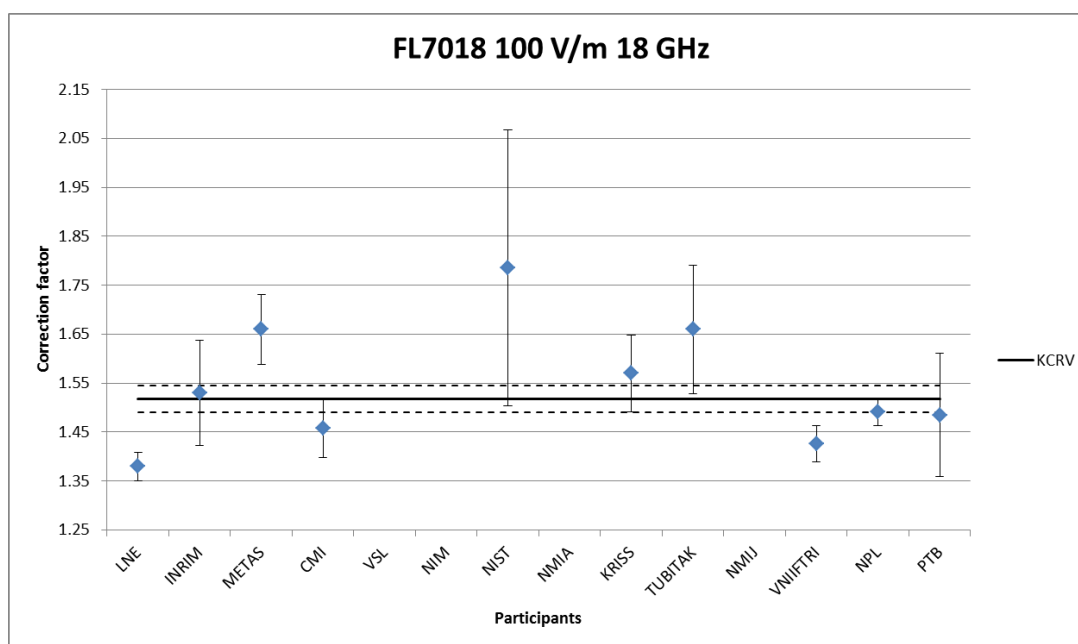


Fig 5.12 – FL7018 Measurement and Combined Uncertainty ($k = 1$) in E-field 100 V/m at 18 GHz

Table 5.12 – Degrees of equivalence and expanded uncertainty ($k = 2$) for FL7018 measurement in E-field 100 V/m at 1 GHz

Lab i	KCRV		INRIM		METAS		CMI		VSL		LNE	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
INRIM												
METAS	-0.01	0.09					0.09	0.13			-0.15	0.11
CMI	-0.10	0.09			-0.09	0.13					-0.24	0.10
VSL												
LNE	0.14	0.06			0.15	0.11	0.24	0.10				
NIM												
NIST	-0.15	0.15			-0.15	0.17	-0.05	0.17			-0.30	0.15
NMIA	0.01	0.09			0.01	0.14	0.11	0.13			-0.14	0.11
KRISS	-0.05	0.10			-0.04	0.14	0.05	0.14			-0.19	0.12
TUBITAK	0.01	0.13			0.02	0.17	0.11	0.17			-0.13	0.15
NMIJ	0.00	0.09			0.01	0.14	0.10	0.13			-0.14	0.11
VNIIFTRI	0.03	0.06			0.03	0.11	0.13	0.11			-0.12	0.08
NPL	0.00	0.05			0.00	0.10	0.10	0.10			-0.15	0.07
PTB												

Table 5.12 cont'd...

Lab i	KCRV		NIM		NIST		NMIA		KRISS		TUBITAK	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
INRIM												
METAS	-0.01	0.09			0.15	0.17	-0.01	0.14	0.04	0.14	-0.02	0.17
CMI	-0.10	0.09			0.05	0.17	-0.11	0.13	-0.05	0.14	-0.11	0.17
VSL												
LNE	0.14	0.06			0.30	0.15	0.14	0.11	0.19	0.12	0.13	0.15
NIM												
NIST	-0.15	0.15					-0.16	0.17	-0.11	0.18	-0.17	0.20
NMIA	0.01	0.09			0.16	0.17			0.05	0.15	-0.01	0.18
KRISS	-0.05	0.10			0.11	0.18	-0.05	0.15			-0.06	0.18
TUBITAK	0.01	0.13			0.17	0.20	0.01	0.18	0.06	0.18		
NMIJ	0.00	0.09			0.16	0.18	0.00	0.14	0.05	0.15	-0.01	0.18
VNIIFTRI	0.03	0.06			0.18	0.16	0.02	0.12	0.07	0.12	0.01	0.16
NPL	0.00	0.05			0.15	0.15	-0.01	0.11	0.04	0.11	-0.02	0.15
PTB												

Table 5.12 cont'd...

Lab i	KCRV		NMIJ		VNIIFTRI		NPL		PTB	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
INRIM										
METAS	-0.01	0.09	-0.01	0.14	-0.03	0.11	0.00	0.10		
CMI	-0.10	0.09	-0.10	0.13	-0.13	0.11	-0.10	0.10		
VSL										
LNE	0.14	0.06	0.14	0.11	0.12	0.08	0.15	0.07		
NIM										
NIST	-0.15	0.15	-0.16	0.18	-0.18	0.16	-0.15	0.15		
NMIA	0.01	0.09	0.00	0.14	-0.02	0.12	0.01	0.11		
KRISS	-0.05	0.10	-0.05	0.15	-0.07	0.12	-0.04	0.11		
TUBITAK	0.01	0.13	0.01	0.18	-0.01	0.16	0.02	0.15		
NMIJ	0.00	0.09			-0.02	0.12	0.01	0.11		
VNIIFTRI	0.03	0.06	0.02	0.12			0.03	0.07		
NPL	0.00	0.05	-0.01	0.11	-0.03	0.07				
PTB										

Table 5.13 – Degrees of equivalence and expanded uncertainty ($k = 2$) for FL7018 measurement in E-field 100 V/m at 2.45 GHz

Lab i	KCRV		LNE		INRIM		METAS		CMI		VSL	
	d_i	$u(d_i)$	d_{ij}	$u(d_{ij})$	d_{ij}	$u(d_{ij})$	d_{ij}	$u(d_{ij})$	d_{ij}	$u(d_{ij})$	d_{ij}	$u(d_{ij})$
LNE	0.02	0.05					0.01	0.10				
INRIM												
METAS	0.01	0.09	-0.01	0.10								
CMI												
VSL												
NIM	-0.05	0.11	-0.07	0.13			-0.06	0.15				
NIST	-0.04	0.15	-0.06	0.17			-0.05	0.18				
NMIA	-0.01	0.05	-0.03	0.06			-0.02	0.10				
KRISS	-0.01	0.10	-0.03	0.12			-0.02	0.14				
TUBITAK	0.03	0.13	0.01	0.15			0.02	0.17				
NMIJ												
VNIIFTRI	0.03	0.06	0.01	0.07			0.02	0.11				
NPL	0.00	0.05	-0.02	0.06			-0.01	0.10				
PTB	0.02	0.17	0.00	0.19			0.01	0.21				

Table 5.13 cont'd...

Lab i	KCRV		NIM		NIST		NMIA		KRISS		TUBITAK	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
LNE	0.02	0.05	0.07	0.13	0.06	0.17	0.03	0.06	0.03	0.12	-0.01	0.15
INRIM												
METAS	0.01	0.09	0.06	0.15	0.05	0.18	0.02	0.10	0.02	0.14	-0.02	0.17
CMI												
VSL												
NIM	-0.05	0.11			-0.01	0.20	-0.03	0.13	-0.04	0.16	-0.08	0.19
NIST	-0.04	0.15	0.01	0.20			-0.03	0.17	-0.03	0.19	-0.07	0.21
NMIA	-0.01	0.05	0.03	0.13	0.03	0.17			0.00	0.11	-0.04	0.15
KRISS	-0.01	0.10	0.04	0.16	0.03	0.19	0.00	0.11			-0.04	0.18
TUBITAK	0.03	0.13	0.08	0.19	0.07	0.21	0.04	0.15	0.04	0.18		
NMIJ												
VNIIFTRI	0.03	0.06	0.08	0.13	0.07	0.17	0.04	0.07	0.04	0.12	0.00	0.15
NPL	0.00	0.05	0.05	0.13	0.04	0.17	0.02	0.06	0.01	0.11	-0.03	0.15
PTB	0.02	0.17	0.07	0.22	0.06	0.25	0.03	0.19	0.03	0.22	-0.01	0.23

Table 5.13 cont'd...

Lab i	KCRV		NMIJ		VNIIFTRI		NPL		PTB	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
LNE	0.02	0.05			-0.01	0.07	0.02	0.06	0.00	0.19
INRIM										
METAS	0.01	0.09			-0.02	0.11	0.01	0.10	-0.01	0.21
CMI										
VSL										
NIM	-0.05	0.11			-0.08	0.13	-0.05	0.13	-0.07	0.22
NIST	-0.04	0.15			-0.07	0.17	-0.04	0.17	-0.06	0.25
NMIA	-0.01	0.05			-0.04	0.07	-0.02	0.06	-0.03	0.19
KRISS	-0.01	0.10			-0.04	0.12	-0.01	0.11	-0.03	0.22
TUBITAK	0.03	0.13			0.00	0.15	0.03	0.15	0.01	0.23
NMIJ										
VNIIFTRI	0.03	0.06					0.02	0.07	0.01	0.19
NPL	0.00	0.05			-0.02	0.07			-0.02	0.19
PTB	0.02	0.17			-0.01	0.19	0.02	0.19		

Table 5.14 – Degrees of equivalence and expanded uncertainty ($k = 2$) for FL7018 measurement in E-field 100 V/m at 10 GHz

Lab i	KCRV		LNE		INRIM		METAS		CMI		VSL	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
LNE	0.04	0.05			0.00	0.12	-0.01	0.10	0.11	0.08		
INRIM	0.04	0.11	0.00	0.12			-0.01	0.15	0.11	0.13		
METAS	0.05	0.10	0.01	0.10	0.01	0.15			0.12	0.12		
CMI	-0.07	0.07	-0.11	0.08	-0.11	0.13	-0.12	0.12				
VSL												
NIM	-0.05	0.10	-0.09	0.10	-0.09	0.15	-0.10	0.14	0.02	0.12		
NIST	0.00	0.12	-0.04	0.12	-0.04	0.16	-0.05	0.15	0.07	0.14		
NMIA												
KRISS	0.01	0.09	-0.03	0.10	-0.03	0.14	-0.04	0.13	0.08	0.11		
TUBITAK	0.00	0.13	-0.04	0.13	-0.04	0.17	-0.05	0.16	0.07	0.14		
NMIJ												
VNIIFTRI	0.00	0.08	-0.04	0.09	-0.04	0.13	-0.05	0.12	0.08	0.10		
NPL	0.06	0.05	0.02	0.05	0.02	0.12	0.01	0.10	0.14	0.07		
PTB	-0.09	0.14	-0.13	0.14	-0.13	0.17	-0.14	0.16	-0.01	0.15		

Table 5.14 cont'd...

Lab i	KCRV		NIM		NIST		NMIA		KRISS		TUBITAK	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
LNE	0.04	0.05	0.09	0.10	0.04	0.12			0.03	0.10	0.04	0.13
INRIM	0.04	0.11	0.09	0.15	0.04	0.16			0.03	0.14	0.04	0.17
METAS	0.05	0.10	0.10	0.14	0.05	0.15			0.04	0.13	0.05	0.16
CMI	-0.07	0.07	-0.02	0.12	-0.07	0.14			-0.08	0.11	-0.07	0.14
VSL												
NIM	-0.05	0.10			-0.05	0.15			-0.06	0.13	-0.05	0.16
NIST	0.00	0.12	0.05	0.15					-0.01	0.15	0.00	0.17
NMIA												
KRISS	0.01	0.09	0.06	0.13	0.01	0.15					0.01	0.15
TUBITAK	0.00	0.13	0.05	0.16	0.00	0.17			-0.01	0.15		
NMIJ												
VNIIFTRI	0.00	0.08	0.05	0.12	0.01	0.14			-0.01	0.12	0.01	0.15
NPL	0.06	0.05	0.11	0.10	0.06	0.12			0.05	0.09	0.06	0.13
PTB	-0.09	0.14	-0.04	0.16	-0.08	0.18			-0.10	0.16	-0.09	0.18

Table 5.14 cont'd...

Lab i	KCRV		NMIJ		VNIIFTRI		NPL		PTB	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
LNE	0.04	0.05			0.04	0.09	-0.02	0.05	0.13	0.14
INRIM	0.04	0.11			0.04	0.13	-0.02	0.12	0.13	0.17
METAS	0.05	0.10			0.05	0.12	-0.01	0.10	0.14	0.16
CMI	-0.07	0.07			-0.08	0.10	-0.14	0.07	0.01	0.15
VSL										
NIM	-0.05	0.10			-0.05	0.12	-0.11	0.10	0.04	0.16
NIST	0.00	0.12			-0.01	0.14	-0.06	0.12	0.08	0.18
NMIA										
KRISS	0.01	0.09			0.01	0.12	-0.05	0.09	0.10	0.16
TUBITAK	0.00	0.13			-0.01	0.15	-0.06	0.13	0.09	0.18
NMIJ										
VNIIFTRI	0.00	0.08					-0.06	0.08	0.09	0.15
NPL	0.06	0.05			0.06	0.08			0.15	0.14
PTB	-0.09	0.14			-0.09	0.15	-0.15	0.14		

Table 5.15 – Degrees of equivalence and expanded uncertainty ($k = 2$) for FL7018 measurement in E-field 100 V/m at 18 GHz

Lab i	KCRV		LNE		INRIM		METAS		CMI		VSL	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
LNE	-0.14	0.08			-0.15	0.22	-0.28	0.15	-0.08	0.13		
INRIM	0.01	0.20	0.15	0.22			-0.13	0.26	0.07	0.25		
METAS	0.14	0.14	0.28	0.15	0.13	0.26			0.20	0.19		
CMI	-0.06	0.12	0.08	0.13	-0.07	0.25	-0.20	0.19				
VSL												
NIM												
NIST	0.27	0.57	0.41	0.57	0.26	0.60	0.13	0.58	0.33	0.58		
NMIA												
KRISS	0.05	0.15	0.19	0.17	0.04	0.27	-0.09	0.21	0.11	0.20		
TUBITAK	0.14	0.24	0.28	0.27	0.13	0.34	0.00	0.30	0.20	0.29		
NMIJ												
VNIIFTRI	-0.09	0.08	0.05	0.09	-0.10	0.23	-0.23	0.16	-0.03	0.14		
NPL	-0.03	0.07	0.11	0.08	-0.04	0.22	-0.17	0.15	0.03	0.13		
PTB	-0.03	0.23	0.11	0.26	-0.05	0.33	-0.18	0.29	0.03	0.28		

Table 5.15 cont'd...

Lab i	KCRV		NIM		NIST		NMIA		KRISS		TUBITAK	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
LNE	-0.14	0.08			-0.41	0.57			-0.19	0.17	-0.28	0.27
INRIM	0.01	0.20			-0.26	0.60			-0.04	0.27	-0.13	0.34
METAS	0.14	0.14			-0.13	0.58			0.09	0.21	0.00	0.30
CMI	-0.06	0.12			-0.33	0.58			-0.11	0.20	-0.20	0.29
VSL												
NIM												
NIST	0.27	0.57							0.22	0.59	0.13	0.62
NMIA												
KRISS	0.05	0.15			-0.22	0.59					-0.09	0.31
TUBITAK	0.14	0.24			-0.13	0.62			0.09	0.31		
NMIJ												
VNIIFTRI	-0.09	0.08			-0.36	0.57			-0.14	0.17	-0.23	0.27
NPL	-0.03	0.07			-0.29	0.57			-0.08	0.17	-0.17	0.27
PTB	-0.03	0.23			-0.30	0.62			-0.09	0.30	-0.18	0.36

Table 5.15 cont'd...

Lab i	KCRV		NMIJ		VNIIFTRI		NPL		PTB	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
LNE	-0.14	0.08			-0.05	0.09	-0.11	0.08	-0.11	0.26
INRIM	0.01	0.20			0.10	0.23	0.04	0.22	0.05	0.33
METAS	0.14	0.14			0.23	0.16	0.17	0.15	0.18	0.29
CMI	-0.06	0.12			0.03	0.14	-0.03	0.13	-0.03	0.28
VSL										
NIM										
NIST	0.27	0.57			0.36	0.57	0.29	0.57	0.30	0.62
NMIA										
KRISS	0.05	0.15			0.14	0.17	0.08	0.17	0.09	0.30
TUBITAK	0.14	0.24			0.23	0.27	0.17	0.27	0.18	0.36
NMIJ										
VNIIFTRI	-0.09	0.08					-0.07	0.09	-0.06	0.26
NPL	-0.03	0.07			0.07	0.09			0.01	0.26
PTB	-0.03	0.23			0.06	0.26	-0.01	0.26		

Table 5.16 – FP7050 Measurement and Combined Uncertainty ($k = 1$) in E-field 30 V/m as reported by the participants

Participant	Date of measurement	1 GHz		2.45 GHz		10 GHz		18 GHz	
		Correction factor	Uncertainty (%)	Correction factor	Uncertainty (%)	Correction factor	Uncertainty (%)	Correction factor	Uncertainty (%)
NPL	Jan-10	1.09	1.83	1.10	1.87	1.10	1.90	1.10	1.90
PTB	Mar-10	1.07	6.01	1.02	8.50	0.97	8.50	1.02	3.54
LNE	Mar-10			1.06	3.10	1.03	3.10	1.01	3.10
INRIM	Apr-10	1.01	7.40	0.98	7.30	1.01	6.10	1.01	7.00
NPL	May-10	1.09	1.83	1.06	1.87	1.08	1.90	1.07	1.90
METAS	Jul-10	1.07	3.27	1.06	3.27	1.05	3.10	1.08	3.10
CMI	Aug-10	1.04	4.25	0.97	6.09	1.03	4.13	1.05	4.14
VSL	Sep-10	1.05	2.97	0.96	6.06				
PTB	Oct-10	1.04	6.01	1.03	8.50	0.97	8.50	1.04	3.50
LNE	Oct-10	1.15	3.10						
NPL	Oct-10	1.06	1.83	1.04	1.87	1.06	1.90	1.06	1.90
NIM	Dec-10			1.03	5.77	1.07	5.88	1.09	6.45
NPL	Jan-11	1.09	1.83	1.07	1.87	1.06	1.90	1.06	1.90
NIST	Feb-11	1.04	6.70	1.04	6.90	1.08	7.00	1.20	7.20
NPL	Mar-11	1.07	1.83	1.07	1.87	1.04	1.90	1.04	1.90
NMIA	Apr-11	1.06	4.50	1.00	2.60				
NPL	May-11	1.04	1.83	1.02	1.87	1.03	1.90	1.04	1.90
KRISS	Jul-11	1.01	5.00	1.04	5.00	1.02	5.00	0.97	5.00
NPL	Aug-11	1.04	1.83	1.00	1.87	1.02	1.90	1.02	1.90
TUBITAK	Oct-11	1.09	6.29	0.96	6.41	0.98	7.15	1.06	7.65
NPL	Oct-11	1.04	1.83	0.98	1.87	0.99	1.90	0.99	1.90
NMIJ	Dec-11	1.00	3.04	0.94	2.86				
NPL	Jan-12	1.01	1.83	0.96	1.87	0.97	1.90	0.96	1.90
VNIFTRI	May-12	0.96	2.67	0.96	2.56	0.91	2.35	0.95	2.39
NPL	Jul-12	0.96	1.83	0.90	1.87	0.94	1.90	0.96	1.90

Table 5.17 – FP7050 Measurement and Combined Uncertainty ($k = 1$) in E-field 30 V/m with applied correction for drift (w.r.t Jan 2010)

Participant	Date of measurement	1 GHz		2.45 GHz		10 GHz		18 GHz	
		Correction factor	Uncertainty (%)	Correction factor	Uncertainty (%)	Correction factor	Uncertainty (%)	Correction factor	Uncertainty (%)
NPL	Jan-10	1.09	1.83	1.10	1.87	1.10	1.90	1.10	1.90
PTB	Mar-10	1.08	5.96	1.03	8.40	0.98	8.40	1.03	3.51
LNE (1)	Mar-10			1.07	3.07	1.04	3.07	1.02	3.07
INRIM	Apr-10	1.02	7.31	1.00	7.17	1.03	6.00	1.03	6.90
NPL	May-10	1.11	1.82	1.08	1.86	1.11	1.87	1.09	1.87
METAS	Jul-10	1.09	3.22	1.10	3.20	1.08	3.01	1.11	3.03
CMI	Aug-10	1.07	4.16	1.01	5.86	1.07	3.99	1.09	4.02
VSL	Sep-10	1.08	2.92	1.01	5.81				
PTB	Oct-10	1.08	5.83	1.09	8.10	1.02	8.09	1.09	3.38
LNE (2)	Oct-10	1.19	3.04						
NPL	Oct-10	1.10	1.85	1.10	1.91	1.11	1.85	1.10	1.86
NIM	Dec-10			1.10	5.49	1.13	5.58	1.14	6.15
NPL	Jan-11	1.14	1.88	1.14	1.98	1.13	1.85	1.12	1.86
NIST	Feb-11	1.09	6.42	1.11	6.49	1.15	6.58	1.27	6.84
NPL	Mar-11	1.12	1.92	1.15	2.03	1.12	1.85	1.11	1.86
NMIA	Apr-11	1.12	4.34	1.09	2.67				
NPL	May-11	1.11	1.97	1.12	2.11	1.12	1.86	1.12	1.87
KRISS	Jul-11	1.08	4.78	1.15	4.72	1.12	4.61	1.06	4.64
NPL	Aug-11	1.12	2.04	1.11	2.24	1.13	1.88	1.11	1.89
TUBITAK	Oct-11	1.18	5.94	1.09	5.90	1.10	6.44	1.17	7.00
NPL	Oct-11	1.13	2.09	1.10	2.34	1.10	1.90	1.09	1.91
NMIJ	Dec-11	1.10	3.10	1.08	3.10				
NPL	Jan-12	1.10	2.20	1.10	2.49	1.10	1.93	1.09	1.95
VNIIFTRI	May-12	1.07	2.94	1.13	3.07	1.07	2.32	1.09	2.41
NPL	Jul-12	1.09	2.44	1.09	2.87	1.10	2.01	1.11	2.03
Multiple contributors contribution to KCRV									
NPL		1.11	2.03	1.11	2.20	1.11	1.98	1.11	0.04
PTB		1.08	5.89	1.06	8.24	1.00	8.24	1.06	0.72
KCRV with uncertainty calculated using LPU (accounting for participants' uncertainties)									
KCRV		1.09	1.55	1.08	1.75	1.08	1.60	1.09	1.72

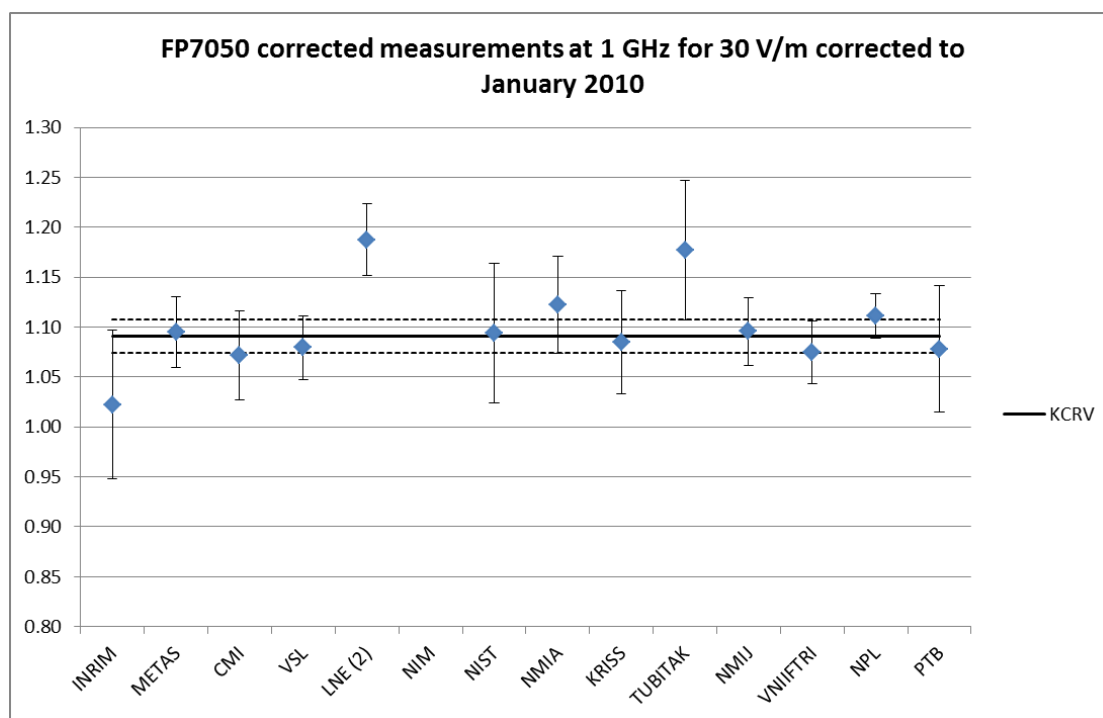


Fig 5.13 – FP7050 Measurement and Combined Uncertainty ($k = 1$) in E-field 30 V/m at 1 GHz with applied correction for drift (w.r.t. January 2010)

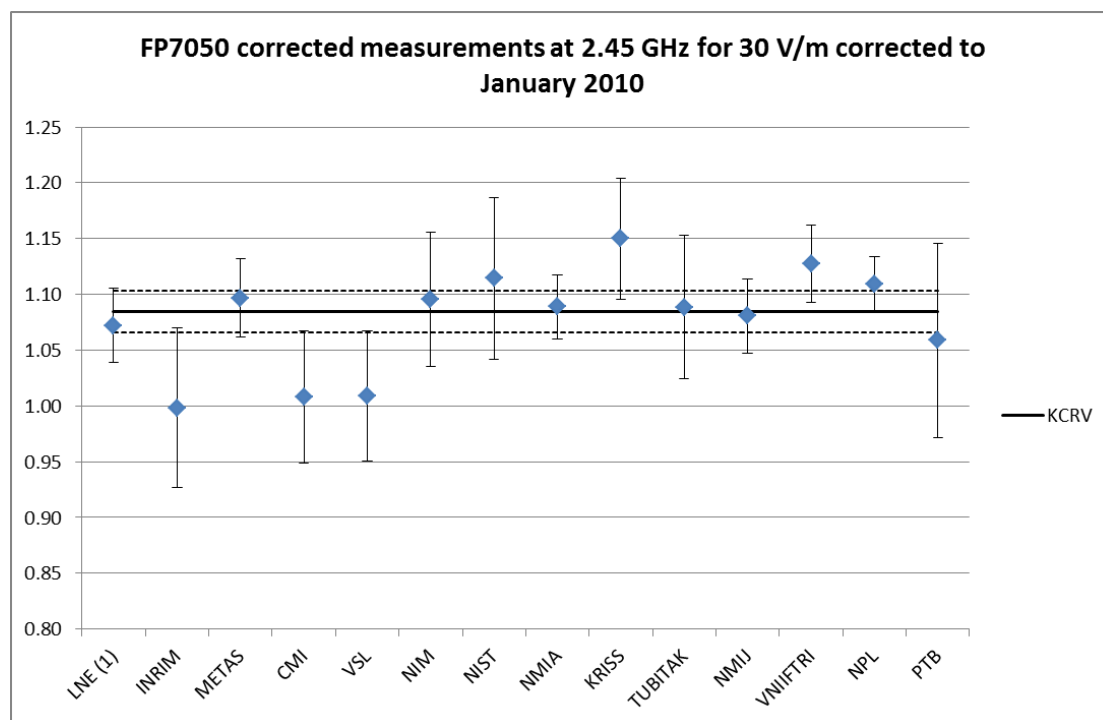


Fig 5.14 – FP7050 Measurement and Combined Uncertainty ($k = 1$) in E-field 30 V/m at 2.45 GHz with applied correction for drift (w.r.t. January 2010)

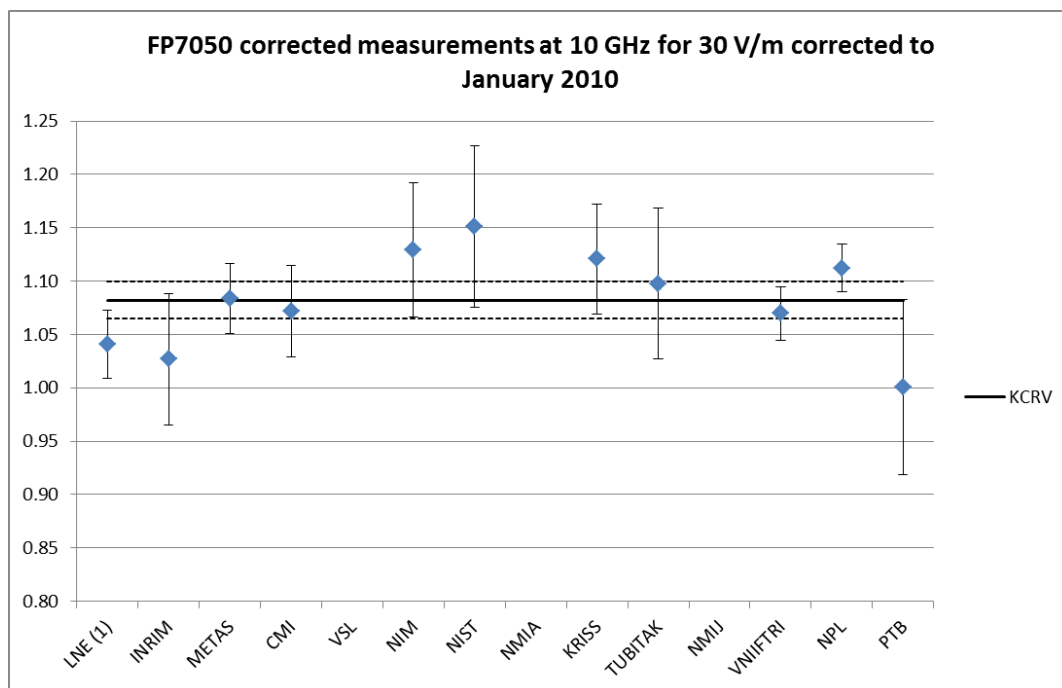


Fig 5.15 – FP7050 Measurement and Combined Uncertainty ($k = 1$) in E-field 30 V/m at 10 GHz with applied correction for drift (w.r.t. January 2010)

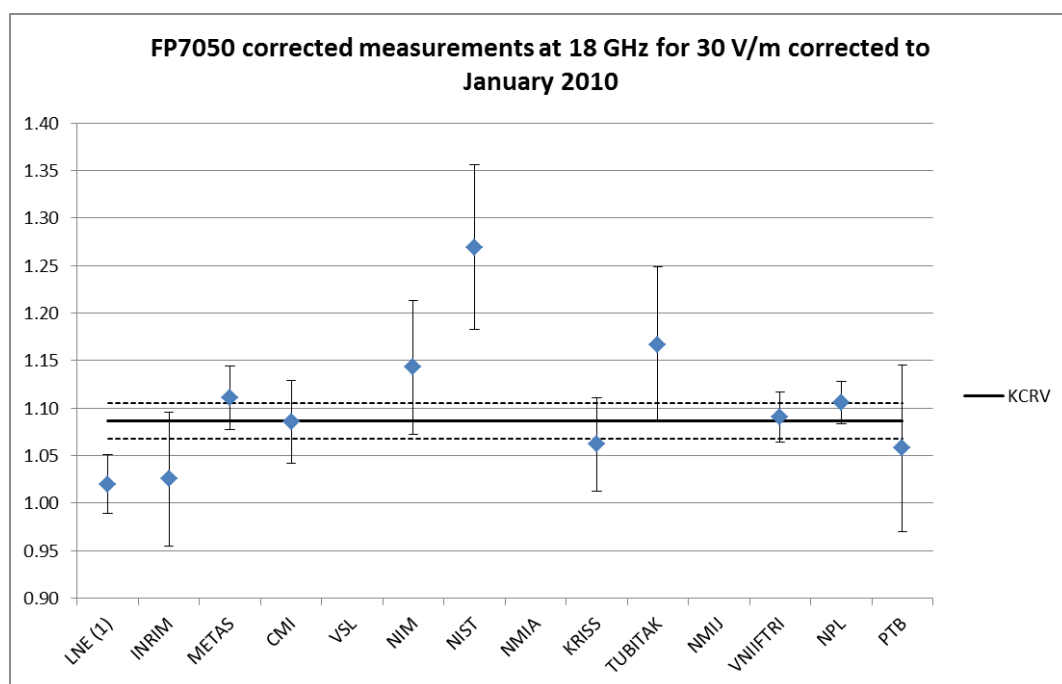


Fig 5.16 – FP7050 Measurement and Combined Uncertainty ($k = 1$) in E-field 30 V/m at 18 GHz with applied correction for drift (w.r.t. January 2010)

Table 5.18 – Degrees of equivalence and expanded uncertainty ($k = 2$) for FP7050 measurement in E-field 30 V/m at 1 GHz after applied correction (w.r.t. January 2010)

Lab i	KCRV		INRIM		METAS		CMI		VSL		LNE	
	di	U(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
INRIM	-0.07	0.15			-0.07	0.17	-0.05	0.17	-0.06	0.16	-0.16	0.17
METAS	0.00	0.07	0.07	0.17			0.02	0.11	0.02	0.09	-0.09	0.10
CMI	-0.02	0.08	0.05	0.17	-0.02	0.11			-0.01	0.11	-0.12	0.11
VSL	-0.01	0.06	0.06	0.16	-0.02	0.09	0.01	0.11			-0.11	0.09
LNE	0.10	0.08	0.16	0.17	0.09	0.10	0.12	0.11	0.11	0.09		
NIM												
NIST	0.00	0.13	0.07	0.20	0.00	0.16	0.02	0.17	0.01	0.15	-0.09	0.16
NMIA	0.03	0.09	0.10	0.18	0.03	0.12	0.05	0.13	0.04	0.11	-0.07	0.12
KRISS	-0.01	0.09	0.06	0.18	-0.01	0.12	0.01	0.14	0.01	0.12	-0.10	0.12
TUBITAK	0.09	0.14	0.15	0.20	0.08	0.16	0.11	0.16	0.10	0.15	-0.01	0.16
NMIJ	0.01	0.06	0.07	0.16	0.00	0.10	0.02	0.11	0.02	0.09	-0.09	0.10
VNIIFTRI	-0.02	0.06	0.05	0.16	-0.02	0.09	0.00	0.11	0.00	0.08	-0.11	0.09
NPL	0.02	0.04	0.09	0.16	0.02	0.08	0.04	0.10	0.03	0.07	-0.08	0.08
PTB	-0.01	0.12	0.06	0.14	-0.02	0.14	0.01	0.15	0.00	0.14	-0.11	0.15

Table 5.18 cont'd...

Lab i	KCRV		NIM		NIST		NMIA		KRISS		TUBITAK	
	di	U(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
INRIM	-0.07	0.15			-0.07	0.20	-0.10	0.18	-0.06	0.18	-0.15	0.20
METAS	0.00	0.07			0.00	0.16	-0.03	0.12	0.01	0.12	-0.08	0.16
CMI	-0.02	0.08			-0.02	0.17	-0.05	0.13	-0.01	0.14	-0.11	0.16
VSL	-0.01	0.06			-0.01	0.15	-0.04	0.11	-0.01	0.12	-0.10	0.15
LNE	0.10	0.08			0.09	0.16	0.07	0.12	0.10	0.12	0.01	0.16
NIM												
NIST	0.00	0.13					-0.03	0.17	0.01	0.17	-0.08	0.20
NMIA	0.03	0.09			0.03	0.17			0.04	0.14	-0.05	0.17
KRISS	-0.01	0.09			-0.01	0.17	-0.04	0.14			-0.09	0.17
TUBITAK	0.09	0.14			0.08	0.20	0.05	0.17	0.09	0.17		
NMIJ	0.01	0.06			0.00	0.15	-0.03	0.11	0.01	0.12	-0.08	0.15
VNIIFTRI	-0.02	0.06			-0.02	0.15	-0.05	0.11	-0.01	0.11	-0.10	0.15
NPL	0.02	0.04			0.02	0.14	-0.01	0.10	0.03	0.11	-0.07	0.14
PTB	-0.01	0.12			-0.02	0.19	-0.04	0.16	-0.01	0.16	-0.10	0.19

Table 5.18 cont'd...

Lab i	KCRV		NMIJ		VNIIFTRI		NPL		PTB	
	di	U(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
INRIM	-0.07	0.15	-0.07	0.16	-0.05	0.16	-0.09	0.16	-0.06	0.20
METAS	0.00	0.07	0.00	0.10	0.02	0.09	-0.02	0.08	0.02	0.14
CMI	-0.02	0.08	-0.02	0.11	0.00	0.11	-0.04	0.10	-0.01	0.15
VSL	-0.01	0.06	-0.02	0.09	0.00	0.08	-0.03	0.07	0.00	0.14
LNE	0.10	0.08	0.09	0.10	0.11	0.09	0.08	0.08	0.11	0.15
NIM										
NIST	0.00	0.13	0.00	0.15	0.02	0.15	-0.02	0.14	0.02	0.19
NMIA	0.03	0.09	0.03	0.11	0.05	0.11	0.01	0.10	0.04	0.16
KRISS	-0.01	0.09	-0.01	0.12	0.01	0.11	-0.03	0.11	0.01	0.16
TUBITAK	0.09	0.14	0.08	0.15	0.10	0.15	0.07	0.14	0.10	0.19
NMIJ	0.01	0.06			0.02	0.08	-0.02	0.07	0.02	0.14
VNIIFTRI	-0.02	0.06	-0.02	0.08			-0.04	0.07	0.00	0.14
NPL	0.02	0.04	0.02	0.07	0.04	0.07			0.03	0.13
PTB	-0.01	0.12	-0.02	0.14	0.00	0.14	-0.03	0.13		

Table 5.19 – Degrees of equivalence and expanded uncertainty ($k = 2$) for FP7050 measurement in E-field 30 V/m at 2.45 GHz after applied correction (w.r.t. January 2010)

Lab i	KCRV		LNE		INRIM		METAS		CMI		VSL	
	d_i	$u(d_i)$	d_{ij}	$u(d_{ij})$	d_{ij}	$u(d_{ij})$	d_{ij}	$u(d_{ij})$	d_{ij}	$u(d_{ij})$	d_{ij}	$u(d_{ij})$
LNE	-0.01	0.07			0.07	0.16	-0.02	0.10	0.06	0.13	0.06	0.13
INRIM	-0.09	0.15	-0.07	0.16			-0.10	0.16	-0.01	0.19	-0.01	0.18
METAS	0.01	0.07	0.02	0.10	0.10	0.16			0.09	0.14	0.09	0.14
CMI	-0.08	0.11	-0.06	0.13	0.01	0.19	-0.09	0.14			0.00	0.17
VSL	-0.08	0.11	-0.06	0.13	0.01	0.18	-0.09	0.14	0.00	0.17		
NIM	0.01	0.11	0.02	0.14	0.10	0.19	0.00	0.14	0.09	0.17	0.09	0.17
NIST	0.03	0.13	0.04	0.16	0.12	0.20	0.02	0.16	0.11	0.19	0.11	0.18
NMIA	0.00	0.06	0.02	0.09	0.09	0.15	-0.01	0.09	0.08	0.13	0.08	0.13
KRISS	0.07	0.10	0.08	0.13	0.15	0.18	0.05	0.13	0.14	0.16	0.14	0.16
TUBITAK	0.00	0.12	0.02	0.14	0.09	0.19	-0.01	0.14	0.08	0.17	0.08	0.17
NMIJ	0.00	0.06	0.01	0.09	0.08	0.16	-0.02	0.09	0.07	0.13	0.07	0.13
VNIIFTRI	0.04	0.06	0.05	0.09	0.13	0.16	0.03	0.09	0.12	0.13	0.12	0.13
NPL	0.02	0.05	0.04	0.08	0.11	0.15	0.01	0.08	0.10	0.12	0.10	0.12
PTB	-0.03	0.16	-0.01	0.19	0.06	0.23	-0.04	0.19	0.05	0.21	0.05	0.21

Table 5.19 cont'd...

Lab i	KCRV		NIM		NIST		NMIA		KRISS		TUBITAK	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
LNE	-0.01	0.07	-0.02	0.14	-0.04	0.16	-0.02	0.09	-0.08	0.13	-0.02	0.14
INRIM	-0.09	0.15	-0.10	0.19	-0.12	0.20	-0.09	0.15	-0.15	0.18	-0.09	0.19
METAS	0.01	0.07	0.00	0.14	-0.02	0.16	0.01	0.09	-0.05	0.13	0.01	0.14
CMI	-0.08	0.11	-0.09	0.17	-0.11	0.19	-0.08	0.13	-0.14	0.16	-0.08	0.17
VSL	-0.08	0.11	-0.09	0.17	-0.11	0.18	-0.08	0.13	-0.14	0.16	-0.08	0.17
NIM	0.01	0.11			-0.02	0.19	0.01	0.13	-0.05	0.16	0.01	0.17
NIST	0.03	0.13	0.02	0.19			0.03	0.15	-0.04	0.18	0.03	0.19
NMIA	0.00	0.06	-0.01	0.13	-0.03	0.15			-0.06	0.12	0.00	0.13
KRISS	0.07	0.10	0.05	0.16	0.04	0.18	0.06	0.12			0.06	0.16
TUBITAK	0.00	0.12	-0.01	0.17	-0.03	0.19	0.00	0.13	-0.06	0.16		
NMIJ	0.00	0.06	-0.01	0.13	-0.03	0.15	-0.01	0.08	-0.07	0.12	-0.01	0.13
VNIIFTRI	0.04	0.06	0.03	0.13	0.01	0.15	0.04	0.07	-0.02	0.12	0.04	0.13
NPL	0.02	0.05	0.01	0.13	-0.01	0.15	0.02	0.06	-0.04	0.11	0.02	0.13
PTB	-0.03	0.16	-0.04	0.21	-0.06	0.23	-0.03	0.18	-0.09	0.20	-0.03	0.21

Table 5.19 cont'd...

Lab i	KCRV		NMIJ		VNIIFTRI		NPL		PTB	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
LNE	-0.01	0.07	-0.01	0.09	-0.05	0.09	-0.04	0.08	0.01	0.19
INRIM	-0.09	0.15	-0.08	0.16	-0.13	0.16	-0.11	0.15	-0.06	0.23
METAS	0.01	0.07	0.02	0.09	-0.03	0.09	-0.01	0.08	0.04	0.19
CMI	-0.08	0.11	-0.07	0.13	-0.12	0.13	-0.10	0.12	-0.05	0.21
VSL	-0.08	0.11	-0.07	0.13	-0.12	0.13	-0.10	0.12	-0.05	0.21
NIM	0.01	0.11	0.01	0.13	-0.03	0.13	-0.01	0.13	0.04	0.21
NIST	0.03	0.13	0.03	0.15	-0.01	0.15	0.01	0.15	0.06	0.23
NMIA	0.00	0.06	0.01	0.08	-0.04	0.07	-0.02	0.06	0.03	0.18
KRISS	0.07	0.10	0.07	0.12	0.02	0.12	0.04	0.11	0.09	0.20
TUBITAK	0.00	0.12	0.01	0.13	-0.04	0.13	-0.02	0.13	0.03	0.21
NMIJ	0.00	0.06			-0.05	0.07	-0.03	0.07	0.02	0.18
VNIIFTRI	0.04	0.06	0.05	0.07			0.02	0.06	0.07	0.19
NPL	0.02	0.05	0.03	0.07	-0.02	0.06			0.05	0.18
PTB	-0.03	0.16	-0.02	0.18	-0.07	0.19	-0.05	0.18		

Table 5.20 – Degrees of equivalence and expanded uncertainty ($k = 2$) for FP7050 measurement in E-field 30 V/m at 10 GHz after applied correction (w.r.t. January 2010)

Lab i	KCRV		LNE		INRIM		METAS		CMI		VSL	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
LNE	-0.04	0.07			0.01	0.14	-0.04	0.09	-0.03	0.11		
INRIM	-0.06	0.12	-0.01	0.14			-0.06	0.14	-0.05	0.15		
METAS	0.00	0.07	0.04	0.09	0.06	0.14			0.01	0.11		
CMI	-0.01	0.08	0.03	0.11	0.05	0.15	-0.01	0.11				
VSL												
NIM	0.05	0.12	0.09	0.14	0.10	0.18	0.05	0.14	0.06	0.15		
NIST	0.07	0.14	0.11	0.16	0.12	0.20	0.07	0.16	0.08	0.17		
NMIA												
KRISS	0.04	0.10	0.08	0.12	0.09	0.16	0.04	0.12	0.05	0.13		
TUBITAK	0.02	0.13	0.06	0.15	0.07	0.19	0.01	0.16	0.03	0.16		
NMIJ												
VNIIFTRI	-0.01	0.05	0.03	0.08	0.04	0.13	-0.01	0.08	0.00	0.10		
NPL	0.03	0.05	0.07	0.08	0.09	0.13	0.03	0.08	0.04	0.09		
PTB	-0.08	0.15	-0.04	0.18	-0.03	0.21	-0.08	0.18	-0.07	0.19		

Table 5.20 cont'd...

Lab i	KCRV		NIM		NIST		NMIA		KRISS		TUBITAK	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
LNE	-0.04	0.07	-0.09	0.14	-0.11	0.16			-0.08	0.12	-0.06	0.15
INRIM	-0.06	0.12	-0.10	0.18	-0.12	0.20			-0.09	0.16	-0.07	0.19
METAS	0.00	0.07	-0.05	0.14	-0.07	0.16			-0.04	0.12	-0.01	0.16
CMI	-0.01	0.08	-0.06	0.15	-0.08	0.17			-0.05	0.13	-0.03	0.16
VSL												
NIM	0.05	0.12			-0.02	0.20			0.01	0.16	0.03	0.19
NIST	0.07	0.14	0.02	0.20					0.03	0.18	0.05	0.21
NMIA												
KRISS	0.04	0.10	-0.01	0.16	-0.03	0.18					0.02	0.17
TUBITAK	0.02	0.13	-0.03	0.19	-0.05	0.21			-0.02	0.17		
NMIJ												
VNIIFTRI	-0.01	0.05	-0.06	0.13	-0.08	0.16			-0.05	0.11	-0.03	0.15
NPL	0.03	0.05	-0.02	0.13	-0.04	0.16			-0.01	0.11	0.01	0.15
PTB	-0.08	0.15	-0.13	0.21	-0.15	0.22			-0.12	0.19	-0.10	0.22

Table 5.20 cont'd...

Lab i	KCRV		NMIJ		VNIIFTRI		NPL		PTB	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
LNE	-0.04	0.07			-0.03	0.08	-0.07	0.08	0.04	0.18
INRIM	-0.06	0.12			-0.04	0.13	-0.09	0.13	0.03	0.21
METAS	0.00	0.07			0.01	0.08	-0.03	0.08	0.08	0.18
CMI	-0.01	0.08			0.00	0.10	-0.04	0.09	0.07	0.19
VSL										
NIM	0.05	0.12			0.06	0.13	0.02	0.13	0.13	0.21
NIST	0.07	0.14			0.08	0.16	0.04	0.16	0.15	0.22
NMIA										
KRISS	0.04	0.10			0.05	0.11	0.01	0.11	0.12	0.19
TUBITAK	0.02	0.13			0.03	0.15	-0.01	0.15	0.10	0.22
NMIJ										
VNIIFTRI	-0.01	0.05					-0.04	0.06	0.07	0.17
NPL	0.03	0.05			0.04	0.06			0.11	0.17
PTB	-0.08	0.15			-0.07	0.17	-0.11	0.17		

Table 5.21 – Degrees of equivalence and expanded uncertainty ($k = 2$) for FP7050 measurement in E-field 30 V/m at 18 GHz after applied correction (w.r.t. January 2010)

Lab i	KCRV		LNE		INRIM		METAS		CMI		VSL	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
LNE	-0.07	0.07			-0.01	0.15	-0.09	0.09	-0.07	0.11		
INRIM	-0.06	0.13	0.01	0.15			-0.09	0.16	-0.06	0.17		
METAS	0.02	0.07	0.09	0.09	0.09	0.16			0.02	0.11		
CMI	0.00	0.09	0.07	0.11	0.06	0.17	-0.02	0.11				
VSL												
NIM	0.06	0.13	0.12	0.15	0.12	0.20	0.03	0.16	0.06	0.17		
NIST	0.18	0.18	0.25	0.18	0.24	0.22	0.16	0.19	0.18	0.19		
NMIA												
KRISS	-0.03	0.09	0.04	0.12	0.04	0.17	-0.05	0.12	-0.02	0.13		
TUBITAK	0.08	0.15	0.15	0.17	0.14	0.22	0.06	0.18	0.08	0.18		
NMIJ												
VNIIFTRI	0.00	0.06	0.07	0.08	0.07	0.15	-0.02	0.08	0.01	0.10		
NPL	0.02	0.05	0.09	0.08	0.08	0.15	-0.01	0.08	0.02	0.10		
PTB	-0.03	0.16	0.04	0.19	0.03	0.22	-0.05	0.19	-0.03	0.20		

Table 5.21 cont'd...

Lab i	KCRV		NIM		NIST		NMIA		KRISS		TUBITAK	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
LNE	-0.07	0.07	-0.12	0.15	-0.25	0.18			-0.04	0.12	-0.15	0.17
INRIM	-0.06	0.13	-0.12	0.20	-0.24	0.22			-0.04	0.17	-0.14	0.22
METAS	0.02	0.07	-0.03	0.16	-0.16	0.19			0.05	0.12	-0.06	0.18
CMI	0.00	0.09	-0.06	0.17	-0.18	0.19			0.02	0.13	-0.08	0.18
VSL												
NIM	0.06	0.13										
NIST	0.18	0.18	0.13	0.22					0.21	0.20	0.10	0.24
NMIA												
KRISS	-0.03	0.09	-0.08	0.17	-0.21	0.20					-0.11	0.19
TUBITAK	0.08	0.15	0.02	0.21	-0.10	0.24			0.11	0.19		
NMIJ												
VNIIFTRI	0.00	0.06	-0.05	0.15	-0.18	0.18			0.03	0.11	-0.08	0.17
NPL	0.02	0.05	-0.04	0.15	-0.16	0.18			0.04	0.10	-0.06	0.17
PTB	-0.03	0.16	-0.09	0.22	-0.21	0.25			0.00	0.20	-0.11	0.24

Table 5.21 cont'd...

Lab i	KCRV		NMIJ		VNIIFTRI		NPL		PTB	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
LNE	-0.07	0.07			-0.07	0.08	-0.09	0.08	-0.04	0.19
INRIM	-0.06	0.13			-0.07	0.15	-0.08	0.15	-0.03	0.22
METAS	0.02	0.07			0.02	0.08	0.01	0.08	0.05	0.19
CMI	0.00	0.09			-0.01	0.10	-0.02	0.10	0.03	0.20
VSL										
NIM	0.06	0.13								
NIST	0.18	0.18			0.18	0.18	0.16	0.18	0.21	0.25
NMIA										
KRISS	-0.03	0.09			-0.03	0.11	-0.04	0.10	0.00	0.20
TUBITAK	0.08	0.15			0.08	0.17	0.06	0.17	0.11	0.24
NMIJ										
VNIIFTRI	0.00	0.06					-0.01	0.06	0.03	0.18
NPL	0.02	0.05			0.01	0.06			0.05	0.18
PTB	-0.03	0.16			-0.03	0.18	-0.05	0.18		

Table 5.22 – FP7050 Measurement and Combined Uncertainty ($k = 1$) in E-field 100 V/m as reported by the participants

Participant	Date of measurement	1 GHz		2.45 GHz		10 GHz		18 GHz	
		Correction factor	Uncertainty (%)	Correction factor	Uncertainty (%)	Correction factor	Uncertainty (%)	Correction factor	Uncertainty (%)
NPL	Jan-10	1.11	1.83	1.09	1.87	1.10	1.90	1.07	1.90
PTB	Mar-10			1.02	8.50	0.99	8.50	1.02	8.50
LNE	Mar-10			1.07	2.10	1.03	2.10	1.02	2.10
INRIM	Apr-10					1.03	6.10	1.03	7.00
NPL	May-10	1.09	1.83	1.06	1.87	1.10	1.90	1.07	1.90
METAS	Jul-10	1.10	4.16	1.06	4.16	1.05	4.28	1.10	4.31
CMI	Aug-10	1.04	4.25			1.05	4.13	1.06	4.14
VSL	Sep-10								
PTB	Oct-10			1.04	8.50	0.98	8.50	1.05	8.50
LNE	Oct-10	1.14	2.10						
NPL	Oct-10	1.06	1.83	1.04	1.87	1.06	1.90	1.05	1.90
NIM	Dec-10			1.05	5.77	1.10	5.88	1.10	6.45
NPL	Jan-11	1.09	1.83	1.07	1.87	1.06	1.90	1.05	1.90
NIST	Feb-11	1.04	6.50	1.05	7.20	1.08	6.80	1.19	7.60
NPL	Mar-11	1.07	1.83	1.07	1.87	1.05	1.90	1.04	1.90
NMIA	Apr-11	1.08	4.80	1.00	2.50				
NPL	May-11	1.05	1.83	1.02	1.87	1.04	1.90	1.04	1.90
KRISS	Jul-11	1.01	5.00	1.06	5.00	1.04	5.00	0.98	5.00
NPL	Aug-11	1.03	1.83	1.00	1.87	1.03	1.90	1.02	1.90
TUBITAK	Oct-11	1.09	6.41	0.96	6.41	1.01	7.28	1.06	7.89
NPL	Oct-11	1.03	1.83	0.99	1.87	1.00	1.90	1.01	1.90
NMIJ	Dec-11								
NPL	Jan-12	1.00	1.83	0.96	1.87	0.99	1.90	0.98	1.90
VNIIFTRI	May-12	0.97	2.62	0.97	2.48	0.92	2.38	0.95	2.34
NPL	Jul-12	0.96	1.83	0.91	1.87	0.95	1.90	0.95	1.90

Table 5.23 – FP7050 Measurement and Combined Uncertainty ($k = 1$) in E-field 100 V/m with applied correction for drift (w.r.t Jan 2010)

Participant	Date of measurement	1 GHz		2.45 GHz		10 GHz		18 GHz	
		Correction factor	Uncertainty (%)	Correction factor	Uncertainty (%)	Correction factor	Uncertainty (%)	Correction factor	Uncertainty (%)
NPL	Jan-10	1.11	1.83	1.09	1.87	1.10	1.90	1.07	1.90
PTB	Mar-10			1.03	8.41	1.00	8.42	1.03	8.43
LNE (1)	Mar-10			1.08	2.08	1.04	2.08	1.03	2.09
INRIM	Apr-10					1.05	6.01	1.04	6.92
NPL	May-10	1.11	1.81	1.08	1.86	1.12	1.87	1.09	1.88
METAS	Jul-10	1.13	4.07	1.09	4.06	1.08	4.17	1.12	4.23
CMI	Aug-10	1.08	4.14			1.08	4.01	1.08	4.04
VSL	Sep-10								
PTB	Oct-10			1.09	8.13	1.03	8.14	1.09	8.22
LNE (2)	Oct-10	1.18	2.07						
NPL	Oct-10	1.11	1.82	1.09	1.93	1.11	1.86	1.09	1.87
NIM	Dec-10			1.11	5.51	1.16	5.62	1.15	6.22
NPL	Jan-11	1.15	1.84	1.14	2.00	1.12	1.86	1.10	1.88
NIST	Feb-11	1.10	6.18	1.13	6.80	1.14	6.43	1.24	7.30
NPL	Mar-11	1.14	1.86	1.15	2.06	1.12	1.87	1.10	1.89
NMIA	Apr-11	1.15	4.57	1.09	2.62				
NPL	May-11	1.12	1.88	1.11	2.16	1.12	1.88	1.11	1.90
KRISS	Jul-11	1.09	4.71	1.16	4.76	1.13	4.66	1.05	4.73
NPL	Aug-11	1.12	1.93	1.11	2.29	1.13	1.90	1.10	1.93
TUBITAK	Oct-11	1.19	5.97	1.08	5.96	1.12	6.65	1.15	7.36
NPL	Oct-11	1.12	1.97	1.11	2.40	1.11	1.92	1.09	1.95
NMIJ	Dec-11								
NPL	Jan-12	1.11	2.04	1.10	2.58	1.11	1.95	1.08	2.00
VNIIFTRI	May-12	1.10	2.71	1.13	3.09	1.06	2.38	1.06	2.48
NPL	Jul-12	1.10	2.20	1.08	2.98	1.10	2.05	1.08	2.10
Multiple contributors contribution to KCRV									
NPL		1.12	1.97	1.11	2.23	1.11	1.98	1.09	1.97
PTB				1.06	8.25	1.01	8.27	1.06	8.69
KCRV with uncertainty calculated using LPU (accounting for participants' uncertainties)									
KCRV		1.13	1.60	1.11	1.88	1.09	1.62	1.08	1.77

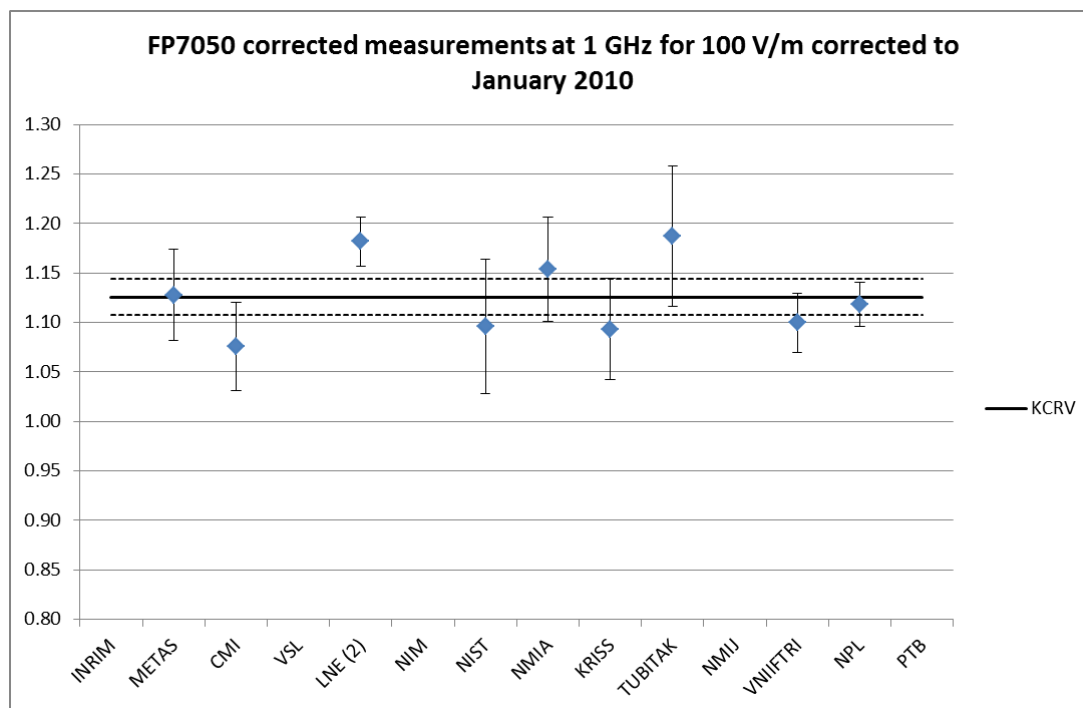


Fig 5.17 – FP7050 Measurement and Combined Uncertainty ($k = 1$) in E-field 100 V/m at 1 GHz with applied correction for drift (w.r.t. January 2010)

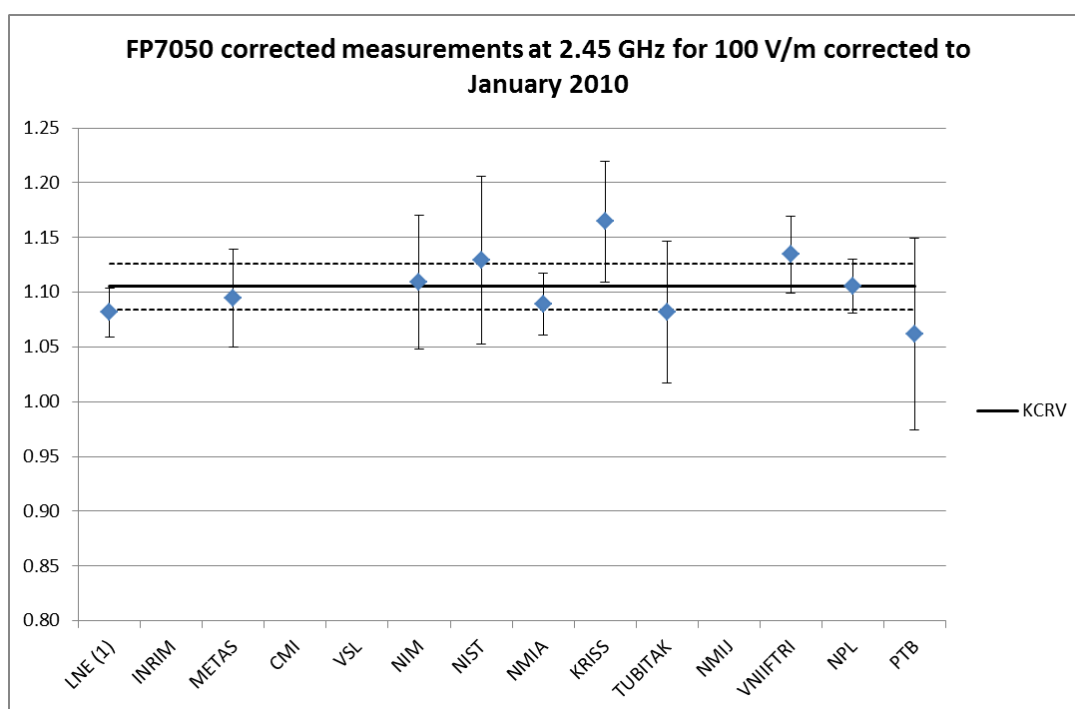


Fig 5.18 – FP7050 Measurement and Combined Uncertainty ($k = 1$) in E-field 100 V/m at 2.45 GHz with applied correction for drift (w.r.t. January 2010)

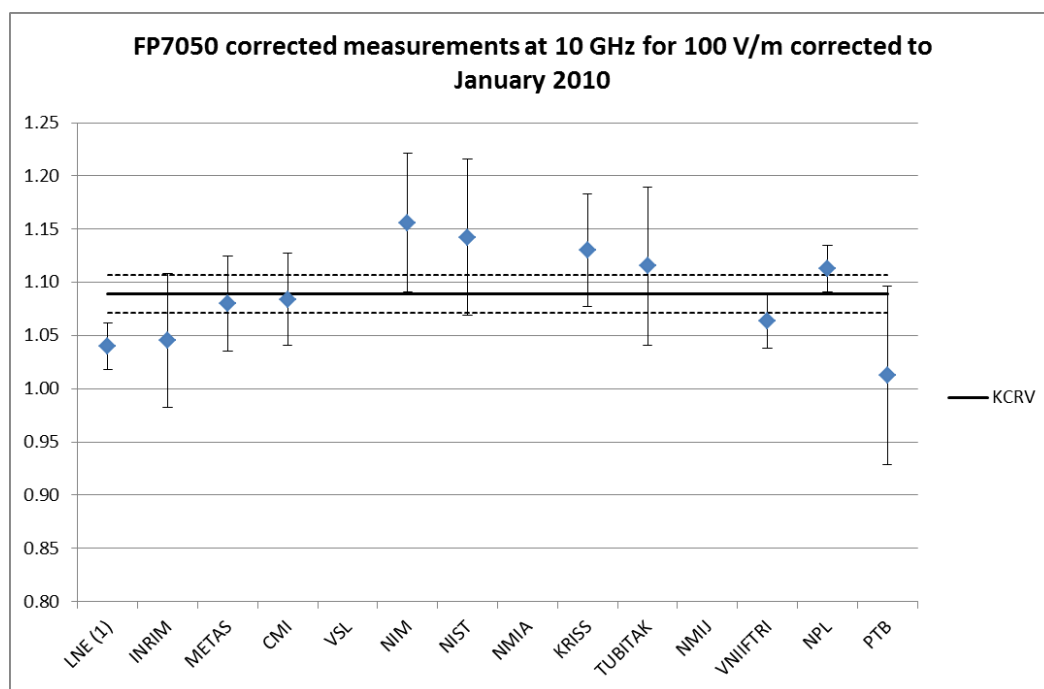


Fig 5.19 – FP7050 Measurement and Combined Uncertainty ($k = 1$) in E-field 100 V/m at 10 GHz with applied correction for drift (w.r.t. January 2010)

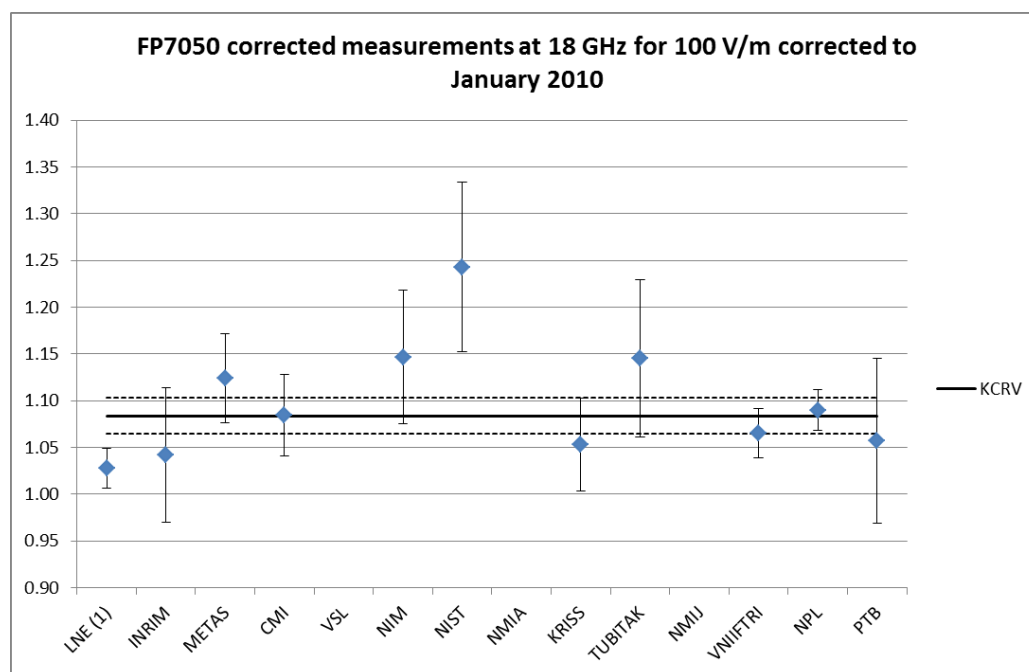


Fig 5.20 – FP7050 Measurement and Combined Uncertainty ($k = 1$) in E-field 100 V/m at 18 GHz with applied correction for drift (w.r.t. January 2010)

Table 5.24 – Degrees of equivalence and expanded uncertainty ($k = 2$) for FP7050 measurement in E-field 100 V/m at 1 GHz after applied correction (w.r.t. January 2010)

Lab i	KCRV		INRIM		METAS		CMI		VSL		LNE	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
INRIM												
METAS	0.00	0.09					0.05	0.13			-0.05	0.10
CMI	-0.05	0.08			-0.05	0.13					-0.11	0.10
VSL												
LNE	0.06	0.05			0.05	0.10	0.11	0.10				
NIM												
NIST	-0.03	0.12			-0.03	0.16	0.02	0.16			-0.09	0.14
NMIA	0.03	0.10			0.03	0.14	0.08	0.14			-0.03	0.11
KRISS	-0.03	0.09			-0.03	0.14	0.02	0.13			-0.09	0.11
TUBITAK	0.06	0.13			0.06	0.17	0.11	0.17			0.01	0.15
NMIJ												
VNIIFTRI	-0.03	0.06			-0.03	0.11	0.02	0.10			-0.08	0.07
NPL	-0.01	0.05			-0.01	0.10	0.04	0.10			-0.06	0.06
PTB												

Table 5.24 cont'd...

Lab i	KCRV		NIM		NIST		NMIA		KRISS		TUBITAK	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
INRIM												
METAS	0.00	0.09			0.03	0.16	-0.03	0.14	0.03	0.14	-0.06	0.17
CMI	-0.05	0.08			-0.02	0.16	-0.08	0.14	-0.02	0.13	-0.11	0.17
VSL												
LNE	0.06	0.05			0.09	0.14	0.03	0.11	0.09	0.11	-0.01	0.15
NIM												
NIST	-0.03	0.12					-0.06	0.17	0.00	0.17	-0.09	0.19
NMIA	0.03	0.10			0.06	0.17			0.06	0.15	-0.03	0.17
KRISS	-0.03	0.09			0.00	0.17	-0.06	0.15			-0.09	0.17
TUBITAK	0.06	0.13			0.09	0.19	0.03	0.17	0.09	0.17		
NMIJ												
VNIIFTRI	-0.03	0.06			0.00	0.14	-0.05	0.12	0.01	0.11	-0.09	0.15
NPL	-0.01	0.05			0.02	0.14	-0.04	0.11	0.02	0.11	-0.07	0.14
PTB												

Table 5.24 cont'd...

Lab i	KCRV		NMIJ		VNIIFTRI		NPL		PTB	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
INRIM										
METAS	0.00	0.09			0.03	0.11	0.01	0.10		
CMI	-0.05	0.08			-0.02	0.10	-0.04	0.10		
VSL										
LNE	0.06	0.05			0.08	0.07	0.06	0.06		
NIM										
NIST	-0.03	0.12			0.00	0.14	-0.02	0.14		
NMIA	0.03	0.10			0.05	0.12	0.04	0.11		
KRISS	-0.03	0.09			-0.01	0.11	-0.02	0.11		
TUBITAK	0.06	0.13			0.09	0.15	0.07	0.14		
NMIJ										
VNIIFTRI	-0.03	0.06					-0.02	0.06		
NPL	-0.01	0.05			0.02	0.06				
PTB										

Table 5.25 – Degrees of equivalence and expanded uncertainty ($k = 2$) for FP7050 measurement in E-field 100 V/m at 2.45 GHz after applied correction (w.r.t. January 2010)

Lab i	KCRV		LNE		INRIM		METAS		CMI		VSL	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
LNE	-0.02	0.06					-0.01	0.10				
INRIM												
METAS	-0.01	0.09	0.01	0.10								
CMI												
VSL												
NIM	0.00	0.11	0.03	0.13			0.01	0.15				
NIST	0.02	0.14	0.05	0.16			0.03	0.18				
NMIA	-0.02	0.06	0.01	0.07			-0.01	0.10				
KRISS	0.06	0.10	0.08	0.12			0.07	0.14				
TUBITAK	-0.02	0.12	0.00	0.14			-0.01	0.15				
NMIJ												
VNIIFTRI	0.03	0.06	0.05	0.08			0.04	0.11				
NPL	0.00	0.05	0.02	0.07			0.01	0.10				
PTB	-0.04	0.16	-0.02	0.18			-0.03	0.20				

Table 5.25 cont'd...

Lab i	KCRV		NIM		NIST		NMIA		KRISS		TUBITAK	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
LNE	-0.02	0.06	-0.03	0.13	-0.05	0.16	-0.01	0.07	-0.08	0.12	0.00	0.14
INRIM												
METAS	-0.01	0.09	-0.01	0.15	-0.03	0.18	0.01	0.10	-0.07	0.14	0.01	0.15
CMI												
VSL												
NIM	0.00	0.11			-0.02	0.19	0.02	0.13	-0.06	0.16	0.03	0.17
NIST	0.02	0.14	0.02	0.19			0.04	0.16	-0.04	0.19	0.05	0.20
NMIA	-0.02	0.06	-0.02	0.13	-0.04	0.16			-0.08	0.12	0.01	0.13
KRISS	0.06	0.10	0.06	0.16	0.04	0.19	0.08	0.12			0.08	0.16
TUBITAK	-0.02	0.12	-0.03	0.17	-0.05	0.20	-0.01	0.13	-0.08	0.16		
NMIJ												
VNIIFTRI	0.03	0.06	0.03	0.13	0.01	0.16	0.05	0.07	-0.03	0.12	0.05	0.13
NPL	0.00	0.05	0.00	0.13	-0.02	0.16	0.02	0.06	-0.06	0.11	0.02	0.13
PTB	-0.04	0.16	-0.05	0.21	-0.07	0.23	-0.03	0.18	-0.10	0.21	-0.02	0.22

Table 5.25 cont'd...

Lab i	KCRV		NMIJ		VNIIFTRI		NPL		PTB	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
LNE	-0.02	0.06			-0.05	0.08	-0.02	0.07	0.02	0.18
INRIM										
METAS	-0.01	0.09			-0.04	0.11	-0.01	0.10	0.03	0.20
CMI										
VSL										
NIM	0.00	0.11			-0.03	0.13	0.00	0.13	0.05	0.21
NIST	0.02	0.14			-0.01	0.16	0.02	0.16	0.07	0.23
NMIA	-0.02	0.06			-0.05	0.07	-0.02	0.06	0.03	0.18
KRISS	0.06	0.10			0.03	0.12	0.06	0.11	0.10	0.21
TUBITAK	-0.02	0.12			-0.05	0.13	-0.02	0.13	0.02	0.22
NMIJ										
VNIIFTRI	0.03	0.06					0.03	0.06	0.07	0.19
NPL	0.00	0.05			-0.03	0.06			0.04	0.18
PTB	-0.04	0.16			-0.07	0.19	-0.04	0.18		

Table 5.26 – Degrees of equivalence and expanded uncertainty ($k = 2$) for FP7050 measurement in E-field 100 V/m at 10 GHz after applied correction (w.r.t. January 2010)

Lab i	KCRV		LNE		INRIM		METAS		CMI		VSL	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
LNE	-0.05	0.05			-0.01	0.13	-0.04	0.10	-0.04	0.10		
INRIM	-0.04	0.12	0.01	0.13			-0.04	0.15	-0.04	0.15		
METAS	-0.01	0.09	0.04	0.10	0.04	0.15			0.00	0.12		
CMI	-0.01	0.09	0.04	0.10	0.04	0.15	0.00	0.12				
VSL												
NIM	0.07	0.12	0.12	0.14	0.11	0.18	0.08	0.16	0.07	0.16		
NIST	0.05	0.14	0.10	0.15	0.10	0.19	0.06	0.17	0.06	0.17		
NMIA												
KRISS	0.04	0.10	0.09	0.11	0.09	0.16	0.05	0.14	0.05	0.14		
TUBITAK	0.03	0.14	0.08	0.15	0.07	0.19	0.04	0.17	0.03	0.17		
NMIJ												
VNIIFTRI	-0.03	0.05	0.02	0.07	0.02	0.13	-0.02	0.10	-0.02	0.10		
NPL	0.02	0.05	0.07	0.06	0.07	0.13	0.03	0.10	0.03	0.10		
PTB	-0.08	0.16	-0.03	0.17	-0.03	0.21	-0.07	0.19	-0.07	0.19		

Table 5.26 cont'd...

Lab i	KCRV		NIM		NIST		NMIA		KRISS		TUBITAK	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
LNE	-0.05	0.05	-0.12	0.14	-0.10	0.15			-0.09	0.11	-0.08	0.15
INRIM	-0.04	0.12	-0.11	0.18	-0.10	0.19			-0.09	0.16	-0.07	0.19
METAS	-0.01	0.09	-0.08	0.16	-0.06	0.17			-0.05	0.14	-0.04	0.17
CMI	-0.01	0.09	-0.07	0.16	-0.06	0.17			-0.05	0.14	-0.03	0.17
VSL												
NIM	0.07	0.12			0.01	0.20			0.03	0.17	0.04	0.20
NIST	0.05	0.14	-0.01	0.20					0.01	0.18	0.03	0.21
NMIA												
KRISS	0.04	0.10	-0.03	0.17	-0.01	0.18					0.01	0.18
TUBITAK	0.03	0.14	-0.04	0.20	-0.03	0.21			-0.01	0.18		
NMIJ												
VNIIFTRI	-0.03	0.05	-0.09	0.14	-0.08	0.15			-0.07	0.11	-0.05	0.15
NPL	0.02	0.05	-0.04	0.14	-0.03	0.15			-0.02	0.11	0.00	0.15
PTB	-0.08	0.16	-0.14	0.21	-0.13	0.22			-0.12	0.20	-0.10	0.22

Table 5.26 cont'd...

Lab i	KCRV		NMIJ		VNIIFTRI		NPL		PTB	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
LNE	-0.05	0.05			-0.02	0.07	-0.07	0.06	0.03	0.17
INRIM	-0.04	0.12			-0.02	0.13	-0.07	0.13	0.03	0.21
METAS	-0.01	0.09			0.02	0.10	-0.03	0.10	0.07	0.19
CMI	-0.01	0.09			0.02	0.10	-0.03	0.10	0.07	0.19
VSL										
NIM	0.07	0.12			0.09	0.14	0.04	0.14	0.14	0.21
NIST	0.05	0.14			0.08	0.15	0.03	0.15	0.13	0.22
NMIA										
KRISS	0.04	0.10			0.07	0.11	0.02	0.11	0.12	0.20
TUBITAK	0.03	0.14			0.05	0.15	0.00	0.15	0.10	0.22
NMIJ										
VNIIFTRI	-0.03	0.05					-0.05	0.06	0.05	0.17
NPL	0.02	0.05			0.05	0.06			0.10	0.17
PTB	-0.08	0.16			-0.05	0.17	-0.10	0.17		

Table 5.27 – Degrees of equivalence and expanded uncertainty ($k = 2$) for FP7050 measurement in E-field 100 V/m at 18 GHz after applied correction (w.r.t. January 2010)

Lab i	KCRV		LNE		INRIM		METAS		CMI		VSL	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
LNE	-0.06	0.05			-0.01	0.15	-0.10	0.10	-0.06	0.10		
INRIM	-0.04	0.13	0.01	0.15			-0.08	0.17	-0.04	0.17		
METAS	0.04	0.09	0.10	0.10	0.08	0.17			0.04	0.13		
CMI	0.00	0.09	0.06	0.10	0.04	0.17	-0.04	0.13				
VSL												
NIM	0.06	0.13	0.12	0.15	0.10	0.20	0.02	0.17	0.06	0.17		
NIST	0.16	0.18	0.21	0.19	0.20	0.23	0.12	0.20	0.16	0.20		
NMIA												
KRISS	-0.03	0.10	0.03	0.11	0.01	0.18	-0.07	0.14	-0.03	0.13		
TUBITAK	0.06	0.15	0.12	0.17	0.10	0.22	0.02	0.19	0.06	0.19		
NMIJ												
VNIIFTRI	-0.02	0.06	0.04	0.07	0.02	0.15	-0.06	0.11	-0.02	0.10		
NPL	0.01	0.05	0.06	0.06	0.05	0.15	-0.03	0.10	0.01	0.10		
PTB	-0.03	0.16	0.03	0.18	0.02	0.23	-0.07	0.20	-0.03	0.20		

Table 5.27 cont'd...

Lab i	KCRV		NIM		NIST		NMIA		KRISS		TUBITAK	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
LNE	-0.06	0.05	-0.12	0.15	-0.21	0.19			-0.03	0.11	-0.12	0.17
INRIM	-0.04	0.13	-0.10	0.20	-0.20	0.23			-0.01	0.18	-0.10	0.22
METAS	0.04	0.09	-0.02	0.17	-0.12	0.20			0.07	0.14	-0.02	0.19
CMI	0.00	0.09	-0.06	0.17	-0.16	0.20			0.03	0.13	-0.06	0.19
VSL												
NIM	0.06	0.13										
NIST	0.16	0.18	0.10	0.23					0.19	0.21	0.10	0.25
NMIA												
KRISS	-0.03	0.10	-0.09	0.17	-0.19	0.21					-0.09	0.19
TUBITAK	0.06	0.15	0.00	0.22	-0.10	0.25			0.09	0.19		
NMIJ												
VNIIFTRI	-0.02	0.06	-0.08	0.15	-0.18	0.19			0.01	0.11	-0.08	0.17
NPL	0.01	0.05	-0.06	0.15	-0.15	0.19			0.04	0.11	-0.06	0.17
PTB	-0.03	0.16	-0.09	0.23	-0.19	0.25			0.00	0.20	-0.09	0.24

Table 5.27 cont'd...

Lab i	KCRV		NMIJ		VNIIFTRI		NPL		PTB	
	di	u(di)	dij	u(dij)	dij	u(dij)	dij	u(dij)	dij	u(dij)
LNE	-0.06	0.05			-0.04	0.07	-0.06	0.06	-0.03	0.18
INRIM	-0.04	0.13			-0.02	0.15	-0.05	0.15	-0.02	0.23
METAS	0.04	0.09			0.06	0.11	0.03	0.10	0.07	0.20
CMI	0.00	0.09			0.02	0.10	-0.01	0.10	0.03	0.20
VSL										
NIM	0.06	0.13								
NIST	0.16	0.18			0.18	0.19	0.15	0.19	0.19	0.25
NMIA										
KRISS	-0.03	0.10			-0.01	0.11	-0.04	0.11	0.00	0.20
TUBITAK	0.06	0.15			0.08	0.17	0.06	0.17	0.09	0.24
NMIJ										
VNIIFTRI	-0.02	0.06					-0.03	0.06	0.01	0.18
NPL	0.01	0.05			0.03	0.06			0.03	0.18
PTB	-0.03	0.16			-0.01	0.18	-0.03	0.18		

6 Acknowledgements

The authors would like to thank Amplifier Research for providing the travelling standards used in this comparison.

7 References

- [1] - , “Protocol for CCEM.RF-K24.F, E-field measurements at frequencies of 1 GHz, 2.45 GHz, 10 GHz and 18 GHz and at indicated field levels of 10 V/m, 30 V/m and 100 V/m,” version 1.7a, March 2010
- [2] J. RANDA, “Proposal for KCRV & Degree of Equivalence for GT-RF Key Comparisons”, *GT-RF/00-12*, August 2000

Appendix A – Outlier Identification and KCRV Derivation

Key comparison **CCEM.RF-K24.F**

MEASURAND: Correction factor, $CF_i(E, f)$, reported by participant i , where E is the field strength meter reading and f is the measurement frequency. Note: the reported uncertainties are given as a percentage of the correction factor. For the purposes of analysis, they must be converted to an absolute uncertainty and may be converted back to a percentage for representational purposes.

Variables followed by a prime (e.g., x') represent one which has been corrected for a drift over time.

Pilot Laboratory: NPL (UK)

A.1 Outlier Identification

Outlying results were excluded in obtaining the key comparison reference value (KCRV). Outliers were identified using the Median of Absolute Deviations [A.1], defined by

$$\sigma \approx S(MAD) \equiv k_1 \text{median}_j \left\{ |Y_j - Y_{med}| \right\}, \quad (\text{A.1})$$

where k_1 is a multiplier determined by simulation and Y_{med} is the median of the sample $\{Y_i\}$. A value of Y_j , which differs from the median by more than $2.5S(MAD)$, is considered an outlier, and this criterion may be used to test each point:

$$|Y_i - Y_{med}| > 2.5 \times S(MAD). \quad (\text{A.2})$$

Should the inequality (A.2) be true for any point Y_i , this point is identified as an outlier.

A.2 Formulae for deriving the KCRV and its uncertainty

The KCRVs, $CF_R(E, f)$, for this comparison are calculated using the unweighted mean [A.1, A.2, A.3] from the results of the participants as follows:

$$CF_R(E, f) = \frac{1}{N} \sum_{i=1}^N CF_i(E, f), \quad (\text{A.3})$$

where N is the number of participants after inconsistent data has been identified and discarded.

The combined uncertainties associated with the KCRV are obtained using [A.3]

$$u^2(CF_R(E, f)) = \frac{1}{N^2} \sum_i u^2(CF_i(E, f)). \quad (\text{A.4})$$

A.3 Deriving a linear time-varying KCRV and its uncertainty

The formulae in section A.2 assume that the travelling standard has remained stable over the life time of the comparison. However, some instruments may drift over time. This drift may take any form: linear, quadratic, sinusoidal, etc. or may even be random. This section proposes a KCRV for a device with a linear drift that can be model in the form $y = mx + c$.

Estimating the curve-fit parameters m and c , along with their associated uncertainties, is dealt with in Appendix E. The NPL data is used to derive these quantities. Because NPL's measurements were performed on the same measurement system following the same procedures each time, they are heavily correlated and the covariance associated with each pair of measurements (e.g., $\text{cov}(CF_{NPL_i}, CF_{NPL_j})$) is determined using the common Type B components of the uncertainty budget.

By characterising the drift in this form, the individual correction factors can be corrected to a single point at any time during the comparison using

$$CF_i(E, f)' = CF_i(E, f) - m(\Delta t_i), \quad (\text{A.5})$$

where Δt_i is the (positive or negative) number of months from the reference month. The uncertainty associated with this corrected result is given by

$$u^2(CF_i(E, f)') = u^2(CF_i(E, f)) + (-\Delta t_i)^2 u^2(m). \quad (\text{A.6})$$

There is no uncertainty associated with Δt_i as this is a fixed number. Equations (A.5) and (A.6) assume that the individual participant measures a single time during the comparison and that their result is not used to estimate m . Where this is the case, (A.5) and (A.6) become

$$CF_i(E, f)' = \frac{1}{M} \sum_j^M (CF_i(E, f))_j - \frac{m}{M} \sum_j^M (\Delta t_i)_j \quad (\text{A.7})$$

and

$$u^2(CF_i(E, f)') = \mathbf{J} \mathbf{V}_{CFi} \mathbf{J}^T, \quad (\text{A.8})$$

where M is the number of measurements submitted by participant i , $\mathbf{V}_{CFi}$ is the covariance matrix containing the covariance associated with the individual measurements $(CF_i(E, f))_j$ and m , and $\mathbf{J}$ is the associated Jacobian matrix. The superscript $\mathbf{T}$ denotes the matrix transpose.

The time-corrected KCRV, $CF_R(E, f)'$, can now be estimated (excluding outliers as described in section A.1) using

$$CF_R(E, f)' = \frac{1}{N} \sum_{i=1}^N CF_i(E, f)', \quad (\text{A.9})$$

where N is the number of participants used to determine the KCRV.

Note that correlation now exists between the individual data points used to estimate the time-corrected KCRV. Taking this into account, it can be shown that the uncertainty for the time-corrected KCRV is

$$u^2\left(CF_R(E, f)\right) = \frac{1}{N^2} \sum_{i=1}^N u^2\left(CF_i(E, f)\right) + \frac{2}{N^2} \sum_{i=1}^{N-1} \sum_{j=i+1}^N \text{cov}\left(CF_i(E, f), CF_j(E, f)\right). \quad (\text{A.10})$$

If neither $CF_i(E, f)$ nor $CF_j(E, f)$ were used to determine m , it is simple to show that

$$\text{cov}\left(CF_i(E, f), CF_j(E, f)\right) = (-\Delta t_i)(-\Delta t_j)u^2(m). \quad (\text{A.11})$$

However, if the result from participant i was used to determine m , the covariance is less straightforward and the covariance between the uncorrected $CF_i(E, f)$ and m must additionally be considered. Taking this into account, it can be shown that in such a case

$$\begin{aligned} \text{cov}\left(CF_i(E, f), CF_j(E, f)\right) &= (-\Delta t_i)(-\Delta t_j)u^2(m) \\ &+ \frac{(-\Delta t_j)}{M} \sum_{p=1}^M \sum_{q=1}^M \left(\frac{\partial(CF_i)_p}{\partial(CF_i)_q} \right) \left(\frac{\partial m}{\partial(CF_i)_q} \right) u^2((CF_i)_q). \end{aligned} \quad (\text{A.12})$$

Note that if either participant i or j submitted more than one measurement during the comparison, the time in months with respect to the chosen reference time point, Δt , is the mean number of months for all of their measurements.

A.4 Degrees of equivalence

The degree of equivalence represent how consistent a participant is with the KCRV and other participants (bilateral degrees of equivalence). The first sub-section outlines the common procedure for obtaining degrees of equivalence [A.4] and the second sub-section extends this procedure to a time-varying KCRV as characterised in section A.3.

A.4.1 Standard degrees of equivalence

The degree of equivalence, d_i , between an individual participant and the KCRV is given simply by

$$d_i = CF_i(E, f) - CF_R(E, f). \quad (\text{A.13})$$

The uncertainty depends on whether or not the participant's result was used in the determination of the KCRV [A.1]. If it was not used, the uncertainty is given by

$$u^2(d_i) = u^2(CF_i(E, f)) + u^2(CF_R(E, f)) \quad (\text{A.14})$$

but if it was used, then correlation will exist between the participant's result and the KCRV so this must be considered. It can be shown then that the uncertainty becomes

$$u^2(d_i) = \left(1 - \frac{2}{N}\right) u^2(CF_i(E, f)) + u^2(CF_R(E, f)). \quad (\text{A.15})$$

The bilateral degree of equivalence, d_{ij} , between two participants' results is given by

$$d_{ij} = CF_j(E, f) - CF_i(E, f) \quad (\text{A.16})$$

and the uncertainty is

$$u^2(d_{ij}) = u^2(CF_i(E, f)) + u^2(CF_j(E, f)). \quad (\text{A.17})$$

It is assumed that there is no correlation between the participants' measurements.

A.4.2 Time-varying degrees of equivalence

The method outlined in A.4.1 can be extended to allow for drift in the KCRV. The drift-corrected degree of equivalence is obtained simply by replacing the variables in (A.10) with their drift-corrected equivalents so

$$d'_i = CF'_i(E, f) - CF'_R(E, f). \quad (\text{A.18})$$

As in the previous sub-section, the uncertainty will depend on whether or not the participant's result was used in the determination of the KCRV. Regardless of whether a result was used or not, correlation exists between the drift-corrected result and the KCRV so (A.11) and (A.12) must be adjusted to take in this consideration.

Regardless of whether $CF'_i(E, f)$ was used to determine the KCRV or not, the uncertainty in the degree of equivalence is given by

$$u^2(d'_i) = u^2(CF'_i(E, f)) + u^2(CF'_R(E, f)) - 2 \text{cov}(CF'_i(E, f), CF'_R(E, f)) \quad (\text{A.19})$$

since correlation exists owing to the drift correction. How the covariance term in (A.19) is derived depends on whether or not the result from participant i was used to determine the KCRV and/or the drift correction gradient m .

If $CF'_i(E, f)$ was not used to determine the KCRV or the drift correction gradient, it can be shown that the covariance term is

$$\text{cov}(CF'_i(E, f), CF'_R(E, f)) = (-\Delta t_i) \left(-\overline{\Delta t_R} \right) u^2(m) \quad (\text{A.20})$$

$$+ \frac{(-\Delta t_i)}{MN} \sum_{p=1}^M \sum_{q=1}^M \left(\frac{\partial(CF_i)_p}{\partial(CF_i)_q} \right) \left(\frac{\partial m}{\partial(CF_i)_q} \right) u^2((CF_i)_q),$$

where $\overline{\Delta t_R}$ is the mean time in months since the reference point of all of the participants used to determine the KCRV.

If $CF_i(E, f)'$ was used to determine the KCRV but not the drift correction gradient, it can be shown that the covariance term is

$$\begin{aligned} \text{cov}\left(CF_i(E, f)', CF_R(E, f)'\right) &= (-\Delta t_i) \left(-\overline{\Delta t_R} \right) u^2(m) + \frac{1}{N} u^2(CF_i(E, f)) \\ &+ \frac{(-\Delta t_i)}{MN} \sum_{p=1}^M \sum_{q=1}^M \left(\frac{\partial(CF_m)_p}{\partial(CF_m)_q} \right) \left(\frac{\partial m}{\partial(CF_m)_q} \right) u^2((CF_m)_q), \end{aligned} \quad (\text{A.21})$$

where $CF_m \neq CF_i$ and refers to any uncorrected correction factor used to determine the drift correction gradient. If participant i measured the items on more than one occasion, the term $u^2(CF_i(E, f))$ refers to the uncertainty in the mean of the uncorrected measurements.

Finally, if $CF_i(E, f)'$ was used to determine both the KCRV and the drift correction gradient, it can be shown that the covariance term is

$$\begin{aligned} \text{cov}\left(CF_i(E, f)', CF_R(E, f)'\right) &= (-\Delta t_i) \left(-\overline{\Delta t_R} \right) u^2(m) + \frac{1}{N} u^2(CF_i(E, f)) \\ &+ \frac{1}{M} \left[\left(-\overline{\Delta t_R} \right) - \frac{\Delta t_i}{N} \right] \sum_{p=1}^M \sum_{q=1}^M \left(\frac{\partial(CF_m)_p}{\partial(CF_m)_q} \right) \left(\frac{\partial m}{\partial(CF_m)_q} \right) u^2((CF_m)_q). \end{aligned} \quad (\text{A.22})$$

The bilateral degrees of equivalence are obtained simply by substituting the drift-corrected values into (A.13) so

$$d_{ij}' = CF_j(E, f)' - CF_i(E, f)' \quad (\text{A.23})$$

As before, correcting for the drift causes $CF_i(E, f)'$ and $CF_j(E, f)'$ to be correlated. Taking this into consideration, the uncertainty in the drift-corrected bilateral degree of equivalence is

$$u^2(d_{ij}') = u^2(CF_i(E, f)') + u^2(CF_j(E, f)') - 2 \text{cov}\left(CF_i(E, f)', CF_j(E, f)'\right), \quad (\text{A.24})$$

where the covariance term is the same as that derived in section A.3.

For examining the consistency of the results, it is normal to use the expanded uncertainty with 95 % confidence level. A coverage factor $k = 2$ will be used with equations (A.19) and (A.24) to obtain the expanded uncertainty.

A.5 References

- [A.1] RANDA, J., “Proposal for KCRV & degree of equivalence for GTRF key comparisons,” *GT-RF/00-12*, BIPM, August 2000
- [A.2] - , “Protocol for CCEM.RF-K24.F, E-field measurements at frequencies of 1 GHz, 2.45 GHz, 10 GHz and 18 GHz and at indicated field levels of 10 V/m, 30 V/m and 100 V/m,” version 1.7a, March 2010
- [A.3] JCGM 100:2008, “Evaluation of measurement data – Guide to the expression of uncertainty in measurement,” BIPM, September 2008

Appendix B – Technical Reports from participating laboratories

The following reports on the measurement techniques were received from the participating laboratories.

B.1 NPL Measurements

MEASUREMENTS

The measurements for this comparison were undertaken in two separate anechoic chamber facilities, depending upon the frequency, as follows:

	Small PFD Chamber	Large PFD Chamber
Comparison frequencies	2.45, 10 & 18 GHz	1 GHz
Height (m)	3	4.5
Width (m)	3	4.5
Length width (m)	5	6
Absorber length (m)	0.6	0.9

At 1 GHz a coaxially fed double ridged guide horn antenna was used to set up the electric field in the anechoic chamber. For 2.45, 10 and 18 GHz waveguide fed standard gain horns were used, connected to high directivity waveguide couplers.

The general setup consists of a synthesised signal generator feeding a high power amplifier, which is connected via a low pass filter to the input of a directional coupler. A calibrated power meter on the side-arm of the coupler monitors the power, P incident on the antenna connected to the output of the coupler. Knowing the gain, G of the antenna at the distance, R , at which the calibration is performed, it is then possible to calculate the electric field strength, E .

$$E = \sqrt{\frac{PGZ_0}{4\pi R^2}} \quad [\text{V/m}]$$

The power, P , is determined from the power indicated by the power meter attached to the side-arm of the coupler. The precise relationship between the power accepted by the antenna and the power indicated on the power meter is given below for the two cases:

- a) Coaxial coupler system for the 1 GHz measurements
- b) Waveguide coupler systems for the measurements at 2.45, 10 and 18 GHz

a) Coaxial coupler system used at 1 GHz

The power sensors and couplers are calibrated separately. The method of the coupler calibration is set out in an internal NPL procedure (QPCETM-B-392) and this technique allows any combination of coaxial coupler, power sensor and coaxial antenna to be used.

The power available to a matched load on the side-arm of the coaxial coupler, P_{cs} is related to the power meter reading, P_r by

$$\frac{P_r}{PMF} = \frac{P_{cs}}{|1 - \Gamma_p \Gamma_{cs}|^2}$$

Where Γ_p and Γ_{cs} are the reflection coefficients of the power sensor and coupler side-arm respectively and the PMF is the Power Meter Calibration Factor given by:

$$PMF = \frac{\text{Power indicated on power meter}}{\text{Power incident on input port}}$$

The coupler ratio, CR , is measured using a calibrated Vector Network Analyser and gives the ratio of the powers available to a matched load at the *output* port to that of the side-arm port.

$$CR = \frac{\text{Power available to a matched load at output port}}{\text{Power available to a matched load on side-arm port}} = \frac{P_{cm}}{P_{cs}}$$

Note that CR is not the conventional coupling factor, which relates the side-arm power to the *input* power to the coupler.

The power available to a matched load at the output port of the main-arm of the coupler, P_{cm} , can therefore be expressed in terms of the reading on the power meter by:

$$P_{cm} = \frac{P_r CR |1 - \Gamma_p \Gamma_{cs}|^2}{PMF}$$

The power accepted by the antenna is given by:

$$P_t = \frac{P_{cm} (1 - |\Gamma_h|^2)}{|1 - \Gamma_h \Gamma_g|^2}$$

where

P_{cm} is the power available to a matched load at the output of the coupler.

Γ_h is the reflection coefficient of the horn antenna

Γ_g is the effective source reflection coefficient of the coupler main arm.

The power accepted by the antenna can now be re-written in terms of the above quantities

$$P_t = \frac{P_r CR |1 - \Gamma_p \Gamma_{cs}|^2 (1 - |\Gamma_h|^2)}{PMF |1 - \Gamma_h \Gamma_g|^2}$$

Hence, in terms of the power meter reading, P_r , the power flux density can be written as:

$$PFD = \frac{P_r CR |1 - \Gamma_p \Gamma_{cs}|^2}{PMF} \times \frac{G(1 - |\Gamma_h|^2)}{4\pi R^2 |1 - \Gamma_h \Gamma_g|^2} \quad [\text{W/m}^2]$$

b) Waveguide coupler systems 2.45, 10 & 18 GHz

Each of the couplers has been calibrated by connecting a calibrated coaxial power sensor to its output, using a calibrated waveguide to coaxial transformer, and noting the **indicated** side-arm reading and output powers at a number of frequencies across the operating band. This technique characterises the directional coupler and power sensor combination, along with any attenuators, which may be included in the circuit to optimise dynamic range, without having to calibrate each component independently. By this method, one obtains a series of calibration factors at spot frequencies across the band, which relates the output power to the indicated side-arm power. Linear interpolation is used to obtain data at frequencies between the calibrated points. The coupler ratio, CR , is the ratio of the power available to a matched load to the power indicated on the side-arm power meter:

$$CR = \frac{\text{Power available to a matched load at output port}}{\text{Power indicated on side arm meter}}$$

The coupler ratio can be written in terms of the above quantities as:

$$CR = \frac{P_{cm}}{P_r}$$

where P_r is the **indicated** coupler side-arm power meter reading and P_{cm} is the power available to a matched load at the output port of the coupler.

The power accepted by the antenna is given by:

$$P_{gh} = \frac{P_{cm} (1 - |\Gamma_h|^2)}{|1 - \Gamma_h \Gamma_g|^2}$$

where Γ_h and Γ_g are the reflection coefficients of the horn and effective source respectively.

Hence, in terms of the indicated side-arm power meter reading, the power flux density can be rewritten as:

$$PFD = P_r CR \times \frac{G (1 - |\Gamma_h|^2)}{4\pi R^2 |1 - \Gamma_h \Gamma_g|^2} \quad [\text{W/m}^2]$$

For both coupler systems, G is the true gain of the antenna and the product $G (1 - |\Gamma_h|^2)$ is the apparent, or realised gain. The remaining mismatch factor in the denominator is not evaluated, but treated as an uncertainty. The distance R is measured from the aperture of the horn antenna to the centre of the probe sensing element(s).

In each case the electric field strength, E , is calculated from the PFD using the following expression:

$$E = \sqrt{PFD Z_0} \quad [\text{V/m}]$$

The gains of the antennas have been measured by a modified version of the three antenna extrapolation technique to obtain the gain as a function of separation from the antenna aperture. For all measurements the separation between the antenna aperture and the centre of the probe was 1.5 m.

A low-pass filter was included on the output of the amplifier to ensure reduce harmonics to negligible levels.

B.2 PTB Measurements

B.2.1 Introduction

Measurements on the comparison artefacts have been performed in two different field generators which are a GTEM cell and standard gain horn antennas. The GTEM cell represents field strength between 1 MHz and 1 GHz and is routinely used for field strength meter sensor calibration in this frequency range. The standard gain horn antennas are routinely used for field sensor calibration above 1.1 GHz at PTB.

All measurements have been carried out in a temperature range between 21°C and 23 °C ten times. The field generators have been set to generate field strength values close to the desired readout for each instrument.

The uncertainty budget contains a contribution from the reference standards (type B) and a contribution from the experimental standard uncertainty (type A). Contributions from thermal effects are included in the experimental standard uncertainty (type A) for the measurement conditions specified in this report. Positional effects and effects of deviant thermal conditions are not within the scope of this comparison but are within the responsibility of the user of a calibrated field sensor.

B.2.2 Description of realization of electrical field

GTEM cell

The RMS value of the electric field strength E at the place of measurement is calculated from the power P_m measured at the “forward branch” output of the directional coupler (which is proportional to the incident power at the GTEM cell input) and a location- and frequency-dependent correction factor $k_{GTEM}(x,y,z,f)$ according to the following equation:

$$E = k_{GTEM} \sqrt{P_m}$$

The correction factor k_{GTEM} has been previously determined during a calibration measurement of the GTEM cell scanning the field distribution inside the test volume with a traceably calibrated reference sensor. For the field sensor calibration, it is read from a data file and then stored in computer memory. The correction factor contains the contributions of the directional coupler, power meter, and GTEM cell. With this procedure, the representation of the (empty) calibration field in the GTEM cell is realized with a relative expanded uncertainty of 12% ($k = 2$).

Horn antennas

The effective value of power flux density is calculated from the power measured at a directional coupler and antenna gain, according to the following equation:

$$S = \frac{P_m DG}{4\pi d^2}$$

where

S = power flux density,
 P_m = measured power,
 D = coupling attenuation factor of directional coupler,
 G = linear antenna gain
 d = distance antenna / EUT

The electric field strength is calculated from the power flux density according to the following equation:

$$E = \sqrt{SZ_0}$$

where S = power flux density
 Z_0 = free space impedance

The field probe calibration is realized with a relative expanded uncertainty of 17% ($k = 2$).

B.3 LNE Measurements

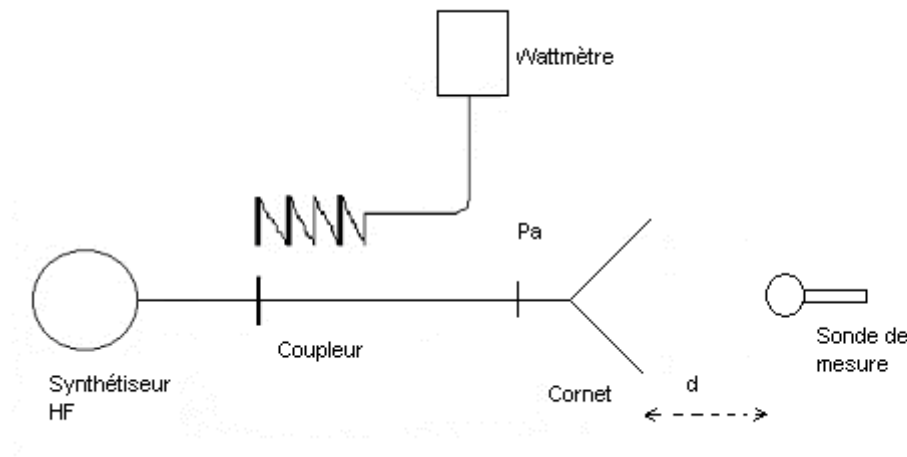
B.3.1 Measurand

The correction factor of each probe is determined at frequencies of 1 GHz, 2.45 GHz, 10 GHz and 18 GHz.

The travelling standards are :

- Probe and data transmission unit FP7050 S/N: 0311662
- Probe FL7018 Star Probe 3 laser powered S/N: 0331689
- Readout unit FM7004 S/N: 0331665,
- Laser Probe Interface FL7000 S/N: 0331781

B.3.2 Method



$$p = \frac{G_c}{4\pi d^2} \cdot P_l \cdot K \cdot \frac{(1 - \Gamma_c^2)}{|1 + D_d \rho_c|^2}$$

where :

- G_c : Calibrated horn antenna gain (dimensionless)
- ρ_c : Γ_c modulus, reflexion factor of calibrated horn antenna (dimensionless)
- d : distance between horn antenna and the system under test (with d_0 the distance of phase of the horn antenna calculated) $d = \text{distance} - d_0$ (in m)
- P_l : power measured on the lateral arm of coupler (W)
- D_d : directivity direct of coupler (dimensionless)
- p : Power density (W/m²)
- K : coupler gain (dimensionless)

Determination of d_0 at each frequency and with each horn antenna :

$$d_0 = -\frac{1 + \frac{d}{L}}{\frac{1}{L} + d\left(\frac{1}{L^2} + \frac{4\lambda^2}{\pi^2 h^4}\right)}$$

where :

d : distance between top of horn antenna and the probe

L : Horn length

h : Horn half-height

λ : ($\lambda=c/f$ with $c = 3.10^8$ m/s and f frequency in Hz), λ in m.

$$1 + E = \frac{1}{|1 + D_d \rho_c|^2}$$

So,

$$p = \frac{G_c}{4\pi d^2} \bullet P_l \bullet K \bullet (1 - \Gamma_c^2) \bullet (1 + E)$$

B.4 INRIM Measurements (M. Borsero, G. Vizio)

REALISATION OF THE ELECTRIC FIELD

The electric field was generated by using the method of the “reference field” within a fully anechoic room. A set of “standard” antennas were employed to generate the required field-strength value in the frequency range of interest at a suitable distance from the transmitting antenna, depending on the measuring frequency (see table below).

Frequency (GHz)	Antenna type	Distance (m)
1	Open-ended waveguide	1
2.45	Standard gain horn 1	2.5
10	Standard gain horn 2	1
18	Standard gain horn 3	1

MEASUREMENT EQUIPMENT

The following measuring equipment was employed:

- synthesized RF signal generator
- 25 W power amplifier (solid state) at frequencies of 1 GHz and 2.45 GHz
- 7 W power amplifier (solid state) at frequencies of 10 GHz and 18 GHz
- two dual directional couplers
- a dual channel power meter
- two power sensors (thermocouple for incident power and diode for reflected power)
- a set of four standard antennas

The dimensions of the fully anechoic room are 8 m x 4 m x 4 m (L x W x H, useful volume). All the walls of the room are tapered with pyramidal absorbing material (one meter height).

FIELD STRENGTH CALCULATION

The electric field-strength value is calculated by means of the well known formula

$$E = \frac{\sqrt{30PG}}{d}$$

where:

P is the net power delivered to the radiating antenna, evaluated as the difference between the incident and the reflected power at the antenna input

G is the numerical gain of the standard antenna, evaluated for the relevant distance

d is the separation distance between the antenna aperture and the field probe

Results are expressed in terms of the calculated correction factor defined as the ratio between the actual field (see equation above) and the field indicated by the probe.

B.5 METAS Measurements (F. Pythoud, B. Mühlemann)

B.5.1 Realization of the electrical field

The field has been created by a double ridged horn antenna in a configuration as shown in the following picture.

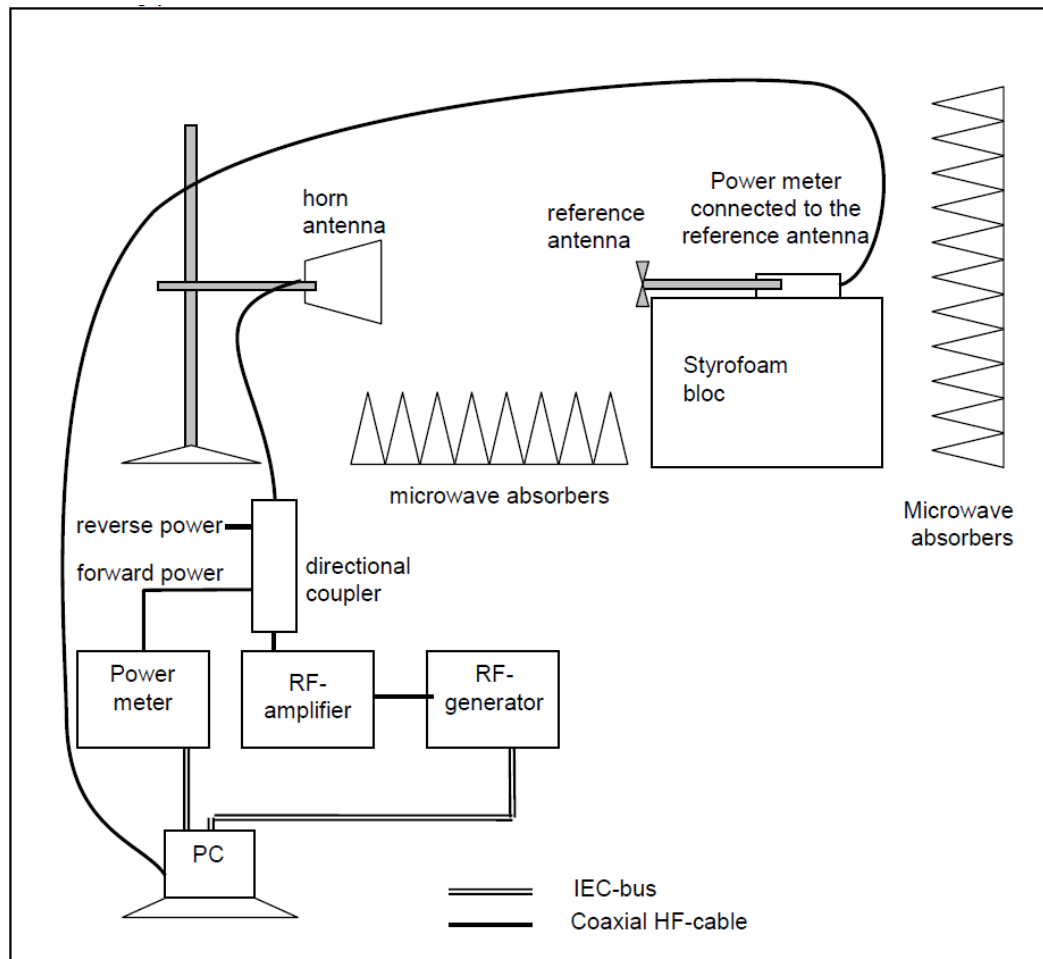


Figure 1: Schematic representation of the calibration setup

The electric field is defined in terms of an experimentally calibrated reference:

- Below 3 GHz: small biconical antenna placed in the reference volume connected to a power meter.
- Above 3 GHz: calibrated standard gain horn connected to a power meter.

The power meter connected to the forward power output of the directional coupler of the transmitting horn antenna is only used to reproduce stable field conditions. The distance from the horn antenna to the reference antenna is about 1.5 m for 10 V/m and 30 V/m, and about 0.8 m for 30 V/m (decrease of homogeneity). The height of the transmit axis is 0.9 m. Its polarisation is vertical. In order to reduce reflections, microwave absorbers are used below and behind the experimental setup. The computer controlled application allows controlling the stability of the whole system.

To increase the accuracy of the calibration, a set of two different reference antennas and two different power meters are used.

B.5.2 Measuring instruments

Device	Manufacturer	Type	Inventory
EMC Chamber	ETS	-	4665
Microwave absorbers (9 pieces for the wall)	TDK	IS 60	-
Microwave absorbers (6 pieces for the floor)	ETS	EMC CL24	-
Transmit antenna 1 GHz to 3 GHz	Schwarzbeck	BBHA 9120 E	5130
Transmit antenna 3 GHz to 18 GHz	ETS-Lindgren	3117	6826
RF Generator	Rohde & Schwarz	SMF 100A	6331
Directional coupler	Agilent	773D	6343
HF amplifier 800 MHz to 4 GHz	Amplifier Research	25S1G4	2650
HF amplifier 4 GHz to 18 GHz	Bonn Elektronik	BLMA 4018-20D	6311
Power meter	Rohde & Schwarz	NRVD	2001
Power meter head	Rohde & Schwarz	NRV-Z51	4157
Power meter head	Rohde & Schwarz	NRP-Z51	5874
Power meter head	Rohde & Schwarz	NRP-Z51	6056
Reference antenna 1 GHz to 3 GHz	Schwarzbeck	SBA 9113	4887 4889
Reference antenna 10 GHz	Flann	16240-20, WG16	6846 6847
Reference antenna 18 GHz	Flann	18240-20, WG18	6849 6850

B.5.3 Calculation method for electric field strength

The equation for electric field strength calculation is

$$E = AF \cdot \sqrt{P_{Antenna} Z_L}$$

where:

- $P_{Antenna}$ is the power at the receive antenna.
- Z_L is the reference impedance of 50 Ω (conventional value without uncertainty).
- AF is the antenna factor of the receive antenna.

The electric field strength is traceable to:

1. The antenna factor of the receive antenna.
2. The power measurements performed at the receive antenna.

Antenna Factor

We determine ourselves the antenna factor of our antenna using 3-antenna techniques. The antenna factor (in dB(1/m)) is traceable to

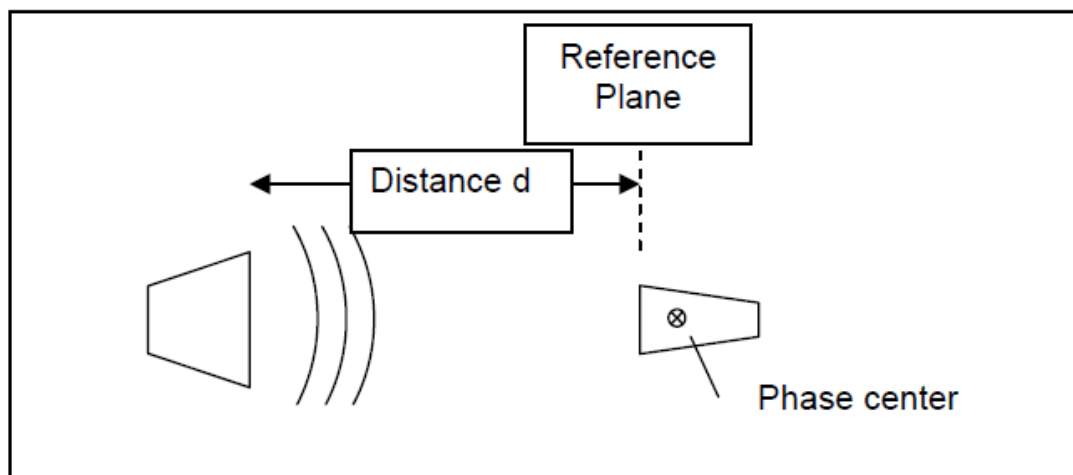
- Insertion loss measurements performed with our VNA whose linearity is checked in terms of calibrated attenuators. METAS owns a primary system for calibration of attenuators (WBCO: wave guide below cutoff).
- Distance measurement of the antennas under calibration, performed with a laser system calibrated at METAS who also owns a primary standard for length measurements.

Power measurement

The power measurements are traceable to other NMIs. However, since the uncertainty due to power measurement is small compared to other uncertainty sources, this traceability can be considered as independent.

B.5.4 Phase centre correction for standard gain horn

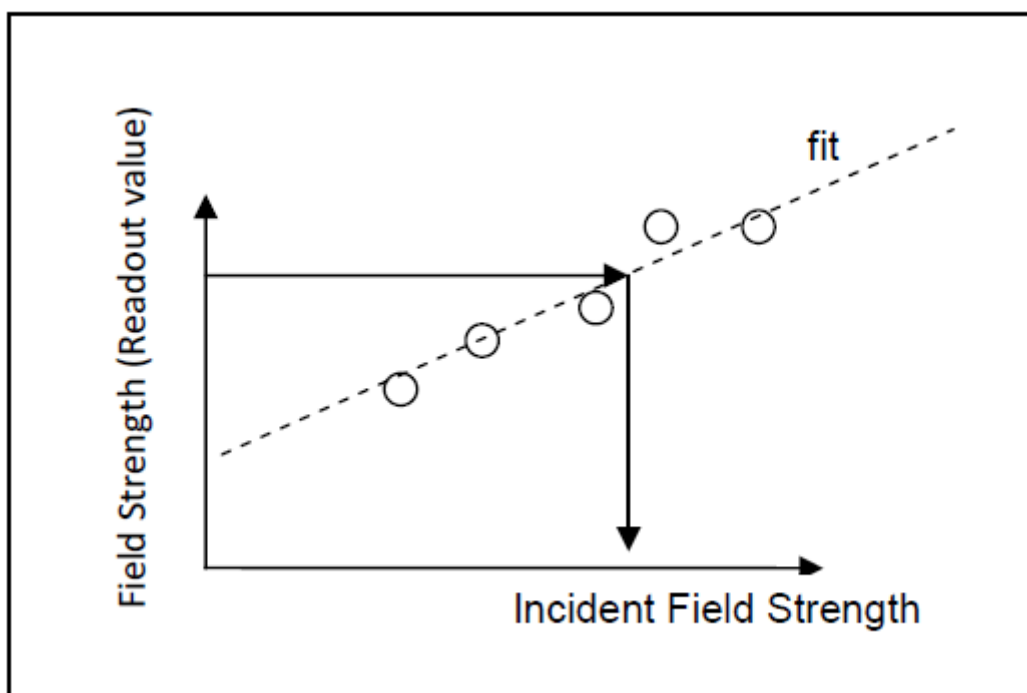
In order to determine the field precisely, the phase centre of the standard gain horns has been measured experimentally. Finally a fine correction has been applied to the electric field that was computed at the reference plane using the free field antenna factor.



B.5.5 Measuring process

Measurements have been performed at different values of the incident field strength around the nominal value (e.g. 10 V/m). The response of the field probe has then been modelled as a locally linear curve (linear fit), from which one can extract the electric field for a given reading.

This process has been repeated twice for each probe, frequency, and field strength.



B.6 CMI Measurements (K. Dražil)

B.6.1 Description of the realisation of the electric field

The measurements have been performed in a tapered TEM cell (1 GHz and 2.45 GHz) and in a fully anechoic chamber using standard horn antennas (10 GHz and 18 GHz).

At frequencies of 1 GHz and 2.45 GHz, the electric field strength E was calculated by means of the formula

$$E = \frac{\sqrt{PZ_0}}{h}$$

where:

P is the incident power delivered to the tapered TEM cell,
 Z_0 is the characteristic impedance of the tapered line,
 h is the septum distance at the location where the probe is inserted.

At frequencies of 10 GHz and 18 GHz, the electric field strength E was calculated by means of the well known formula

$$E = \frac{\sqrt{30PG}}{d}$$

where:

P is the incident power delivered to the antenna,
 G is the apparent gain of the antenna (evaluated for the relevant distance),
 d is the distance between the antenna aperture and the center of the field probe.

Measurements were performed at distance d of 1 m (10 GHz) and 0.7 m (18 GHz).

At indicated field levels of 100 V/m, measurements were performed at shorter distance of about 0.2 m because a sufficiently powerful amplifier was not available. At this shorter distance between the antenna and the probe, measurements at indicated field strength levels of 30 V/m and 100 V/m were carried out and actual electric field strength E_{100} at indicated level of 100 V/m was calculated according to formula

$$E_{100} = E_{30} \sqrt{\frac{P_{100,s}}{P_{30,s}}}$$

where:

E_{30} is the actual field strength determined at indicated field level of 30 V/m and distance d ,
 $P_{100,s}$ is the power delivered to the antenna for the field strength meter indicated level of 100 V/m and shorter measurement distance s ,

$P_{30,s}$ is the power delivered to the antenna for the field strength meter indicated level of 30 V/m and shorter measurement distance s .

B.6.2 List of equipment

Power sensor NRV-Z51, ROHDE & SCHWARZ, ser. no. 836942/010
Power meter NRVD, ROHDE & SCHWARZ, ser. no. 835843/022
Power sensor NRT-Z43, ROHDE & SCHWARZ, ser. no. 836493/028
Signal generator SME-03, ROHDE & SCHWARZ, ser. no. 100007/003
Signal generator E8257D, AGILENT, ser. no. US46461139
Tapered TEM cell, CMI, ser. no. 001
Horn antenna MCT90TA, Milan Chyba Engineering, ser. no. 001
Horn antenna MCT62TA, Milan Chyba Engineering, ser. no. 001
RF power amplifier BLWA 0210-25, BONN Elektronik, ser. no. 974436-02
RF power amplifier WJ-6633-511, Watkins-Johnson, ser. no. 336
RF power amplifier BLMA 8-018-2, BONN Elektronik, ser. no. 974434
Directional coupler X752C, Hewlett – Packard, ser. no. 21154
Directional coupler P752C, Hewlett – Packard, ser. no. 8423

B.7 VSL Measurements (D. Zhao)

B.7.1 Introduction

The purpose of the project is an international comparison of the generation of the electrical component of electromagnetic fields at the frequencies of 1 GHz, 2.45 GHz, 10 GHz and 18 GHz and at indicated field levels of 10 V/m, 30 V/m and 100 V/m. The measuring device was sent round by the coordinator in the manner described in the project protocol. The measurements have been performed in the period of 30 August 2010 until 17 September 2010 using the EM field facilities of the VSL, Dutch Metrology Institute in Delft, The Netherlands. The results are presented in this report.

B.7.2 Abstract

Presented is the result of the series of measurements performed, while exposing the travelling standard probe to an EM field within the VSL RF frequency EM-field facility called tapered cell. The field strength of the test volume inside the tapered cell is measured by a transfer standard probe, which is calibrated within another VSL RF frequency EM-field facility called micro TEM cell.

For the Euromet 520 intercomparison, measurements have been done on the micro TEM cell. The facility and uncertainty budget have already been evaluated. The results will be used directly in this report. In this report, emphasis is put on the measurement in the tapered cell.

A transfer standard probe is first calibrated in the micro TEM cell, and then it is used to calibrate the field strength in the tapered cell. The measurement uncertainties of the travelling standard probes have two main groups of sources. The first group of uncertainty sources comes from the uncertainty of the calibration of the transfer standard probe done in the micro TEM cell. The second group of uncertainty sources comes from the calibration of the travelling standard probe done in the tapered cell.

It is found that two measurements have a large difference in reading by rotating the probe 180 degrees even though for both measurements the mark on the probe is aligned with the electric field. The main reason is the capacitive coupling between the wall of the cells and the transmission or readout unit of the probe. Therefore, the depth of the probe penetrating into the tapered cell is adjusted to find minimized symmetric difference (0 degrees versus 180 degrees axial rotation) of the travelling standard. The measurements are done with those selected depths.

B.7.3 Description of the generating facilities

B.7.3.1 micro TEM cell

A micro TEM cell has been used for the generation of the required EM fields from 1 GHz up to 2.5 GHz. This cell was constructed by the VSL workshop using in company experiences in construction of look alike larger cells. The inner dimensions of the square mid section of the cell are 60 mm by 60 mm. The tapered ends and the middle section are constructed each out of one solid block of aluminium. The cell has a 1 mm thick brass septum connected with

special brass pencil shape rods to N-type connectors and is supported in the middle section by foam material.

B.7.3.2 Tapered cell

A tapered cell has been used for the generation of the required EM fields from 1 GHz up to 2.5 GHz. Also this cell was constructed by the VSL workshop. For all the heights of the cell, the cross-sections are square.

The top of the tapered cell is a coaxial connector. Between the connector and the septum is a connector pin. That is the main point where higher order TEM modes can occur. The connector pin is optimized, the reflection should be less than 10%.

The bottom of the tapered cell is covered by absorbers.

B.7.3.3 EM field generating circuitry for the micro TEM cell

For the generation of the field in the micro TEM cell in the frequency band from 1 GHz to 2.5 GHz, the following circuitry was used:

- an RF power generator was connected to a 10 dB power attenuator, which in its turn was connected to the TEM cell (port 1);
- an RF power measurement device was directly connected to the output of the TEM cell (port 2).

B.7.3.4 EM field generating circuitry for the tapered cell

For the generation of the field in the tapered cell in the frequency band from 1 GHz to 2.5 GHz the following circuitry was used:

- an RF power generator was connected to a power amplifier. The output of the power amplifier was connected to a 10 dB power attenuator, which in turn was connected to a bi-directional coupler (port 1);
- the output port of the bi-directional coupler (port 2) is connected to the input port of the tapered cell;
- two RF power measurement devices are connected to the bi-directional coupler (port 3 and port 4) to measure the incident and reflect power of the cell.

In Fig. B.7.1, the schematic diagram of the measurement setup of the tapered cell is shown.

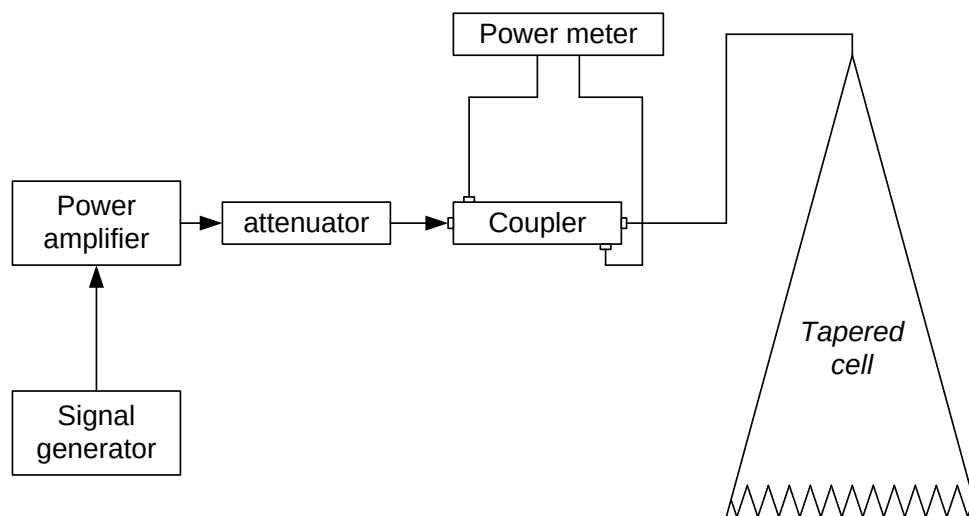


Fig. B.7.1. Schematic diagram of the measurement setup of the tapered cell

B.7.3.5 Geometrical positioning facilities

For the positioning purposes the probe was mounted on a 1 axis positioning lift. Two laser pointers were used to align the probe axis horizontally.

B.7.4 Description of the travelling standard probe

The travelling standard probes consist of two field probes, an Amplifier Research FL7018 probe (3 MHz to 18 GHz, laser powered with a diode detector) and an Amplifier Research FP7050 (300 MHz to 50 GHz, battery powered with a thermal detector).

The readout unit FM7004 and a laser interface FL7000 are also supplied. They are installed in two 19-inch rack units individually.

Here are the series numbers of all travelling standards:

- Probe and data transmission unit FP7050 S/N 0311660,
- Probe FL7018 Star Probe 3 laser powered S/N: 0331688
- Readout unit FM7004 S/N: 0331664,
- Laser Probe Interface FL7000 S/N: 0331780

The measurement values are collected using special software called “hi_ar.exe”, which is provided with the travelling standards. The PC communicates with the readout unit via serial link cable.

B.7.5 Measurement set up

Both probes were installed on a plastic bracket during measurements. The plastic bracket is electrically invisible. Two laser pointers are used to align the probe by checking the red light points fall exactly on the centre of the stem of the probes. The positions of the red light points are checked during movement of the bracket back and forth to ensure that the stem is horizontal and parallel to the septum of the tapered cell. The depth of the probe penetrating

into the tapered cell is measured by a ruler on the base of the bracket. The probes can be rotated by a dial with measurement so that the red dot or “x label” on the probe is aligned to the electric field. The way installing the travelling standard probe in the tapered cell is shown in Fig B.7.2.

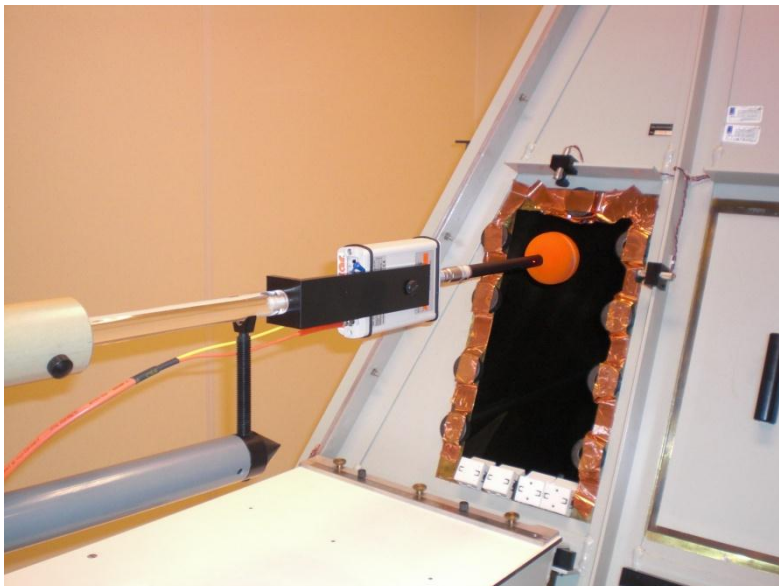


Fig. B.7.2. Travelling standard probe installed in the tapered cell

All readings were registered using the accompanying software installed on a PC.

B.7.6 Measurement conditions

During the measurements the ambient temperature has been continuously monitored. The TEM cell temperature has been registered at the start of each measurement cycle.

Measurements have been performed at an ambient temperature of $(23.0 \pm 0.4) ^\circ\text{C}$ and relative humidity of $(45 \pm 10) \%$. The cell temperature is $(23.4 \pm 0.1) ^\circ\text{C}$ up to $(23.8 \pm 0.1) ^\circ\text{C}$.

B.7.7 Actual measurements

At VSL, measurements have been performed only at 1 GHz and 2.45 GHz at a nominal indicated level on the travelling standard probes of 10 V/m and 30 V/m keeping the actual reading of the travelling standard probe within 29.8 and 30.2 V/m for FP7050, within 29.99 and 30.03 V/m for FP7018, and within 9.99 and 10.01 V/m for FP7018. VSL does not have facilities to generate fields at 10 GHz and 18 GHz, and the level is limited to 30 V/m. The performed measurements are included in this report.

B.7.7.1 Repeatability

Ten cycles of measurements were performed to measure the repeatability. Between cycles, the probe is extracted from the tapered cell and rotated 180 degree and inserted into the tapered cell again. Each cycle consisted of 10 measurements.

B.7.7.2 Reproducibility

The reproducibility was tested by removing and re-installing the probe and turning it around its (horizontal) axis between the measurement cycles and through exposing the probe in two different depths of the probe penetrating into the tapered cell. The measurements are done at all frequencies to the same field strength level.

Note: The results appeared to be completely in line with each other considering the uncertainty in the measurements.

B.7.7.3 Measurement programs used

The measurement values are collected using special software called “hi_ar.exe” provided with the travelling standards.

Separate software was used for setting the frequency and field strength level. This software contains an automated procedure, in which the field strength and the desired series of signal frequencies are pre-programmed. The actual field strength is automatically calculated by the program from the power meter reading, using various calibration constants and parameters taken from lookup tables. The measured values are stored after each run. The measured temperature of the TEM cells was recorded in each measurement cycle.

B.7.8 Traceability

The results of the measurements are based on the measurement of the RF power, the geometry of the main section of the cell, the alignment of the probe, the transmission line properties of the cell.

All geometric measurements are traceable to VSL standard for length. A vernier calliper, calibrated by the VSL mechanical standards department, has been used for the geometric measurements. Calibration of the electrical devices has been performed by the HF section of the electrical standards department using a Vector Network Analyser.

B.7.9 Measurement uncertainty for the micro TEM cell and derivation of the model equation

In Fig. B.7.3, the schematic diagram of the measurement setup of the micro TEM cell is shown.

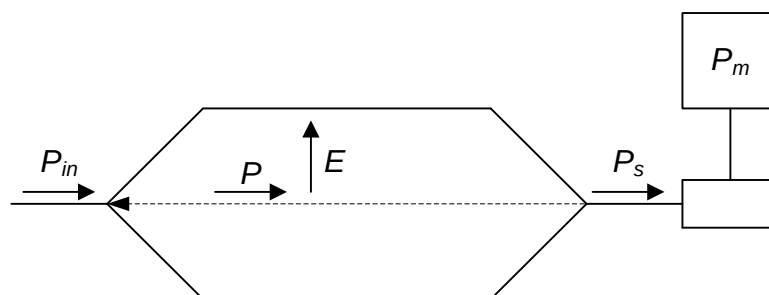


Fig. B.7.3 – Schematic diagram of the measurement setup of the micro TEM cell

B.7.9.1 Power measurement

In Fig. B.7.3, the following annotations are used.

P_{in}	=	Power entering into the TEM cell (not used for the calculations)
P	=	Power passing through the TEM cell at the position of the transfer standard probe
P_S	=	Power entering the power meter sensor
P_m	=	Measured RF power reading on the power meter

The power passing through the TEM cell at the position of the transfer standard probe is given by the following formula:

$$P = P_m k(A) k_1(f) k_2(f) M_{tot} D$$

$k(A)$	=	Correction factor for the power meter to account for non-linearity with respect to the power level
$k_1(f)$	=	Correction factor for the power meter to account for the frequency response
$k_2(f)$	=	Correction factor for the attenuation (S_{21}) of the TEM cell to account for the frequency response
M_{tot}	=	Mismatch factor = P/P_S
D	=	attenuation factor (here = 1, No attenuator is used at the output of the TEM cell.)

B.7.9.2 Mismatch losses

Mismatch causes a difference in power between a source S and a load L , which is expressed as a mismatch factor M_{tot} . The magnitude and phase of this factor vary with the frequency and the position in the transmission line, but the extremes are given by the following equation:

$$[M_{tot}]_{\min}^{\max} = 1 \pm 2 |\Gamma_S| |\Gamma_L|$$

where Γ_S and Γ_L are the reflection coefficients of the source (micro TEM cell) and the load (power sensor) respectively. The expectation value of the mismatch factor is 1, being the middle of the interval for M_{tot} .

Applying this to the output of the TEM cell, we can make the following observations: There is no information on the relative positions of the connectors and other places where mismatch occurs, except that we know that the distances are very small compared to the wavelength, so a net overall effect $|\Gamma|^2 = |\Gamma_S| |\Gamma_L|$ can be assumed between the TEM cell and the power sensor.

As a worst case estimate for the uncertainty we take the extreme values: $\pm 2|\Gamma|^2$, with a U-shaped probability, resulting in a standard uncertainty of $\sqrt{2}|\Gamma|^2$.

The reflection coefficients can be evaluated by scalar network analysis from the input port of the TEM cell. From the pattern obtained over the whole frequency spectrum of interest, a worst case estimate can be made for the combined mismatch $|\Gamma|^2$ at the output of the TEM cell.

Thus the expectation value of M_{tot} is 1 with a standard uncertainty equal to $\sqrt{2}|\Gamma|^2$.

B.7.9.3 Electric field strength calculation

The transverse electric field E is given by this following formula:

$$E = \frac{1000}{d} \sqrt{P Z_L} (1 + \delta_{SW}) f(x, y)$$

E	=	electric field strength at position (x,y), in V/m
d	=	inner distance between septum and upper wall of TEM cell, in mm
P	=	actual power in TEM cell, in watts
Z_L	=	characteristic impedance of the TEM cell (here 50 Ω)
δ_{SW}	=	correction term for standing waves in the TEM cell, scalar
$f(x, y)$	=	Form factor for the field strength as a function of the position in the TEM cell, scalar x is the horizontal position, y is the vertical position

B.7.9.4 Standing waves

Standing waves in the TEM cell are caused by various reflections, which are also the origins of the mismatch losses. Assuming that the reflection coefficients at the input and output of the TEM cell are small, only the first order reflection is considered (i.e. the reflected wave travelling to the left from the output terminal of the cell). Because the phase of the incoming and reflected waves is not known, the correction term has an expectation value 0. The probability distribution is U-shaped. The same evaluation of the combined mismatch $|\Gamma|^2$ is used to estimate the worst case effect of the standing waves:

$$u(\delta_{SW}) = \frac{1}{\sqrt{2}} \frac{VSWR-1}{VSWR+1} = \frac{|\Gamma|}{\sqrt{2}}$$

B.7.9.5 Form factor

The micro TEM cell used for these measurements has a w/b ratio of 0.83, where w is the width of the septum and b is the inner distance between the side walls of the cell. The form factor in the centre between the septum and the top wall has been derived from literature [B.7.1]. Also the gradients (in x- and y-directions) of the field strength have been evaluated on the hand of these tables. In the centre the gradient in the x-direction is actually 0, due to symmetry. The curvature ($\delta E / \delta x$) is so small, that an uncertainty of 3 mm in the measurement probe position in the x-direction leads to a negligible uncertainty contribution in the form factor. The gradient in the y-direction, however, can lead to a significant uncertainty contribution.

B.7.9.6 Temperature sensitivity

During the measurements the temperature of the TEM cell was measured within an accuracy smaller than 0.1 K, while the environmental temperature was also monitored and seen to be very close to the measured temperature of the TEM cell (within 0.3 K). The measured temperature of the TEM cell was entered into the field strength measurement program, so that corrections were automatically effected in the measuring program. Under the assumption that the transfer standard probe has the same temperature as the TEM cell (within 0.1 K), the uncertainty contribution due to the temperature sensitivity of the transfer standard probe can be neglected.

B.7.9.7 Overall model equation

The final measurement result is expressed as a normalised field strength: $E_{nor} = E_n E / E_m$. E_m is the field strength reading from the transfer standard probe. E_n is the nominal field strength. The term δE_{res} is the uncertainty due to the resolution of the field strength transfer system readout (The resolution is 0.01 V/m). The resulting model equation thus becomes:

$$E_{nor} = \frac{E_n}{E_m + \delta E_{res}} \frac{1000}{d} \sqrt{P_m k(A) k_1(f) k_2(f) M_{tot} D Z_L} (1 + \delta_{SW}) f(x, y)$$

B.7.10 Measurement uncertainty for the tapered cell

B.7.10.1 Power measurement

We use the following annotations:

P	=	Power passing through the tapered cell at the position of the travelling standard
P_{inc}	=	Power entering into the tapered cell
P_{ref}	=	Power reflected from the tapered cell
P_{m1}	=	Power reading on the power meter connecting to port 2
P_{m2}	=	Power reading on the power meter connecting to port 3

The following equation is used in to determine P :

$$P = P_{inc} - P_{ref} = P_{m1} |S_{21}/S_{31}| - P_{m2} / |S_{42}|$$

The power input into the tapered cell is derived from the readings from power meters and the measured couple ratios of the used coupler in two frequency points. The coupler ratios are measured by a vector network analyzer (VNA). The uncertainty of the attenuation can be calculated using $(0.005 + 0.002L)$ dB, here, L is in the range of 0 - 80 dB attenuation. For S_{31} and S_{42} , the L is around 20 dB. The uncertainties of S_{31} and S_{42} are 0.045 dB, which are equivalent to 1.04%. For S_{21} , the uncertainty is 0.12%. The uncertainty of the power measurement is calculated as 1.04%.

The term δP_{res} is the uncertainty due to the resolution of the power meter readout (The resolution of the digital display is 0.01 dB).

B.7.10.2 Probe positioning

The positioning error (tapered Cell) is evaluated by shifting the test position of the field probe ± 3 mm around the test point. The possible positioning error between the transfer standard probe and the travelling standard probe is estimated as ± 3 mm. The contribution of this uncertainty is 0.68%. The probability distribution is a rectangular distribution.

B.7.10.3 Field uniformity

The transfer field probe has a very small profile. The uncertainty contributed by field uniformity generated by the tapered Cell can be ignored for the transfer field probe. For the travelling field probe, the uncertainty due to field uniformity is estimated according to the volume of the travelling field probe. The contribution of this uncertainty is 1.06%.

B.7.10.4 Overall model equation

The resulting model equation thus becomes:

$$E = (E_m + \delta E_{res}) CF \frac{\sqrt{P + \delta P_{res}}}{d_2} \frac{1000}{f(x, y)}$$

E_m is the field strength reading from the travelling stand probe. A term δE_{res} is the uncertainty due to the resolution of the field strength meter readout (resolution is 0.01 V/m). CF is the correction factor of the field generator. δP_{res} is resolution of digital display of power meter. d_2 is the possible positioning error between the transfer standard probe and the travelling standard probe. P is the power passing through the tapered cell at the position of the travelling standard. $f(x, y)$ takes the uncertainty contributed by field uniformity into account.

B.7.11 Evaluation of parameter values and uncertainties

B.7.11.1 The uncertainty analysis for calibrating the transfer field probe in the micro TEM cell

Type-A evaluation

The measurements consist of pairs of readings (power meter, transfer standard). In each measurement run these pairs are recorded for a series of frequencies. In order to avoid the effects of possible covariance, the type-A evaluation is obtained from the spread in the E_m values, taken from a number of independent runs. The reproducibility is investigated by removing and reinserting the field strength probe between the runs. The symmetry is checked by rotating the probe around its axis by 180 degrees. Since a systematic difference in the measurements was detected depending on these 2 rotational positions their results have been presented separately. The type A evaluation on the readings therefore is based on each of these two positions separately. For the uncertainty evaluation only one overall budget is presented. The approach has been conservative by taking into account for each frequency only the highest of the two type A evaluated values.

E_m The spread in the readings is investigated by type-A evaluation as indicated above.

Type-B evaluation

δE_{res}	The expectation value for the resolution term is 0. The resolution of the readout of the transfer standard probe is 0.01 V/m, leading to a uniform distribution of half-width 0.005 V/m.
d	The distance was measured with a calibrated digital depth calliper, using a small hole in the top wall of the TEM cells. The value measured was 29.70 mm (micro cell), with an uncertainty of 0.1 mm (half-width of uniform distribution).
P_m	The power readings are automatically translated into field strength values E by the measurement program. The resolution has a negligible uncertainty contribution. The type-A contribution from the spread in readings is already taken care of (see above).
$k(A)$	The calibration constant for the power dependent non-linearity of the power sensor has been determined (at frequency of 50 MHz) very close to the levels used during the field strength measurements. The values found were 1.000 with an uncertainty ($k = 2$, normal distribution) of 0.002.
$k_1(f)$	The frequency response was taken from the calibration data of the sensor-meter combination. The minor corrections compared to the internal frequency correction of the power meter were taken into account Value: 1.0000 (1 GHz) up to 1.0013 (2.5 GHz) (due to the internal linearization of the power meter) Uncertainty, including drift and temperature sensitivity: 1.7 % ($k = 2$, normal distribution).
$k_2(f)$	The frequency dependent attenuation (S_{21}) which was taken from the calibration data of the cell. (Value: approx 1.008 at 1 GHz to approx 1.005 at 2.5 GHz). Uncertainty: 0.5 % ($k = 2$, normal distribution).
M_{tot}	Mismatch term: value = 1. Uncertainty, evaluated from Scalar Network Analysis: micro cell 0.02% (1 GHz) up to 0.32 % (2.5 GHz) (half-width of interval, U-shaped distribution).
Z_L	The nominal impedance is 50 Ω , which is taken as the actual value. The uncertainty has been estimated to be 0.2 Ω (half-width of uniform distribution).
δ_{SW}	Estimated value = 0. Uncertainty, from Vector Network Analysis: Micro cell 0.01 (1 GHz) to 0.04 (2.5 GHz).
$f(x, y)$	Calculated value 0.99. The y-gradient is calculated as (0.00958/ mm) and the uncertainty of y-position of the probe is estimated as 0.6mm. The uncertainty contributed by form factor is 0.00570 (half-width of uniform distribution).

The complete uncertainty budget is given in Appendix C.7.

B.7.11.2 The uncertainty analysis for calibrating the travelling field probe in the tapered cell

Type-A evaluation:

The measurements consist of pairs of readings (power meter, DUT). In each measurement, the readings are recorded for a series of frequencies. In order to avoid the effects of possible covariance, the type-A evaluation is obtained from the spread in the field strength reading, taken from a number of independent runs. The reproducibility is investigated by removing, rotating the probe around its axis by 180 degrees, and reinserting the field strength probe between the runs.

E_m The spread in the readings is investigated by type-A evaluation as indicated above.

Type-B evaluation:

CF	Correction factor of the field generator, calibrated by the transfer standard probe. The uncertainty is based on the uncertainty analysis of the micro TEM cell.
δE_{res}	The resolution of the readout of the travelling standard probe is 0.01 V/m, leading to an uniform distribution of half-width 0.005 V/m.
d_2	The possible positioning error between the transfer standard probe and the travelling standard probe is estimated as ± 3 mm. The contribution of this uncertainty is 0.68 %.
P	Power passing through the tapered cell at the position of the travelling standard. The uncertainty of power measurement is calculated as 1.04 %.
δP_{res}	Resolution of digital display is 0.01 dB, leading to a uniform distribution of half-width 0.12 %.
$f(x, y)$	The uncertainty due to field uniformity, estimated according to the volume of the travelling standard probe.
k_c	The uncertainty due to the coupling between the EUT and the test cell, estimated through two measurement results by rotating the EUT 180 degree.

The complete uncertainty budget is given in Appendix C.7.

B.7.12 Reference

- [B.7.1] M. L. Crawford, "Generation of standard EM fields using TEM transmission cells," *IEEE Trans. Electromag. Compat.*, vol. EMC-16, p.189, 1974.

B.8 NIM Measurements

B.8.1 INTRODUCTION

Field strength is one of the key parameters in wireless metrology, which can be expressed as power flux density at microwave frequencies. Field probes are the most common instruments for field strength measurements. In fact, in recent years, with a rapid development of advanced technology, more and more field probes have been utilized in lots of areas. Upper limit frequency of them reaches 40 GHz, even higher to 110 GHz. Therefore, to meet requirements of field strength calibration, the establishment of 1.4 GHz – 18 GHz power flux density standard was very important.

1.4GHz – 18GHz power flux density standard had been established in early 2008. The value of field strength at certain area before a standard gain antenna can be calculated analytically.

B.8.2 SYSTEM PRINCIPLE

In a fully anechoic chamber, a pyramidal horn antenna radiates P watts and has a gain G in a given direction. The power density in watt per square meter at a specific distance d from the radiating antenna will be $GP/(4\pi d^2)$. In terms of the field strength existing at the same field point, the power density is E^2/η . Therefore, the free-space field may be determined from the relationship in Equation (1).

$$S = \frac{GP}{4\pi d^2} (\text{W/m}^2), \quad E = \sqrt{\frac{\eta PG}{4\pi d^2}} (\text{V/m}) \quad (1)$$

where

E is the free-space electric field strength (V/m)

S is the free-space power density (W/m^2)

P is the net input power to the transmitting antenna (W)

G is the gain of the transmitting antenna in the direction toward the receiving point relative to an isotropic radiator (dimensionless)

d is the distance from the transmitting antenna to the receiving point (m)

η is the intrinsic impedance of the propagation medium (Ω)

The standard device is shown as Figure B.8.1.

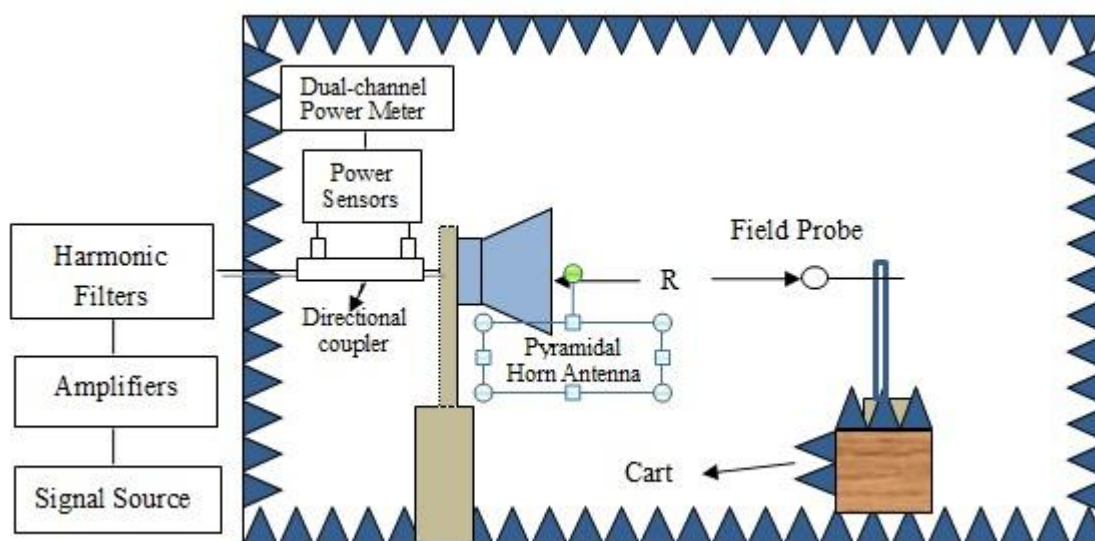


Figure B.8.1 General view of 1.4 GHz ~ 18 GHz power flux density standard

Standard gain pyramidal horn antennas are used as transmitting sources over the frequency range of 1.4 GHz to 18 GHz to generate known reference fields in the anechoic chamber. Here, the near-field gain of a transmitting standard gain pyramidal horn is accepted, because E-field measurements in an anechoic chamber are usually performed in near-field region ($d < 2D^2/\lambda$) from a transmitting antenna, where D is the largest dimension of the transmitting antenna and λ is the free-space wavelength. Thus, E-field calibration can be done at lower frequencies in the same size of the anechoic chamber. And, with the same net power, higher level of power flux density can be received in the near-field region of a transmitting standard antenna.

This power flux density standard was established in a fully anechoic chamber ($8\text{m} \times 4\text{m} \times 3.7\text{m}$), as shown in Figure B.8.2. The highest power density level can reach 10 mW/cm^2 , and the power density resolution response is 0.01 mW/cm^2 .

The 1.4 GHz – 18 GHz power flux density standard provides a service for calibration of field strength probes and radiation hazard monitors which are often used for Health and Safety reasons, providing field strength traceability to national standard, or EMC testing. With this standard, the Properties of frequency response, amplitude calibration level, and isotropy can be calibrated in the 1.4 GHz – 18 GHz range.



Figure 2 1.4 GHz – 18 GHz power flux density standard in the fully anechoic chamber

B.8.3 MEASUREMENT UNCERTAINTY

According to IEEE Std 1309-2005, the measurement uncertainties in 1.4 GHz – 18 GHz power flux density standard can be classified into several categories:

Measurement uncertainty influence quantities	Details
Calibration of the directional coupler	➤ directivity contribution ➤ transfer error ➤ mis-match errors ➤ calculation for coupling coefficients.
Calibration of the net input power	➤ Power meter and sensor uncertainties
Determining error for horn antenna gain	➤ alignment error ➤ error for near-field gain of horn antennas
Measurement environment	➤ field uniformity in the area where the probe is exposed ➤ multipath effect ➤ reflections in anechoic chamber ➤ Standing waves between probe and antenna
Spectrum purity from the source	➤ harmonics and spurious signals from an

	amplifier
Device configuration	➤ errors for cables and the cart for probe fixture
Probe-positioning	➤ distance measurement

The measurement uncertainties based on the testing data are shown in the table below.

Frequency GHz	Method	Power Density mW/cm ²	U_c dB
1.8	Near-field	0.10~10.00	0.96($k=2$)
2.45	Near-field	0.10~10.00	0.90($k=2$)
4.8	Near-field	0.10~2.00	0.82 ($k=2$)
10	Near-field	0.10~7.00	0.92($k=2$)
18	Near-field	0.10~10.00	0.92 ($k=2$)

Note: U_c in the table does not include the repeatability uncertainty.

B.8.4 CONCLUSIONS

This standard built in our lab fills domestic gap of field strength calibration from 1.4 GHz to 18 GHz. It meets the traceability requirements of instruments for electromagnetic environment monitoring and manufacturing measurement. Thus field strength calibration and measurement capability can reach the international level.

B.9 NIST Measurements (D. Camell)

B.9.1 Introduction

E-field measurements were performed at frequencies of 1 GHz, 2.45 GHz, 10 GHz and 18 GHz and at indicated field levels of 10 V/m, 30 V/m and 100 V/m. The traveling standards consist of two field probes for each loop: an Amplifier Research FL7018 probe (3 MHz to 18 GHz, laser powered with a diode detector) and an Amplifier Research FP7050 (300 MHz to 50 GHz, battery powered with a thermal detector).

B.9.2 Test Configuration

The probe was measured in one test facility to cover the requested frequency range. This facility was an anechoic chamber with dimensions 5 m x 5 m x 8 m.

In the anechoic chamber, the probe response was determined when it was oriented as described in the protocol document. In this case the E field was horizontally polarized and the probe was vertical and perpendicular to the boresite of the transmitting horn. The sphere of the probe was placed at the center of the boresite of the transmitting horn. Configuration of the NIST equipment for the anechoic chamber measurement is shown in figures B.9.1 and B.9.2. For the user's equipment, the two probes had similar setups.

For the FL7018 probe, the laser interface was in the chamber connected to the probe by a short 1.5 m (5 ft) fibre and then to the readout unit that was placed outside of the anechoic chamber by using the provided fibre extension cable. See Figure B.9.3 for a photo of the chamber setup.

For the FP7050 probe, the probe was connected to the readout unit that was outside of the anechoic chamber by using the provided fibre extension cable. See figure B.9.4 for a photo of the chamber setup.

The radiation source was a standard gain pyramidal horn for the appropriate frequency band. The electric field strength was set to the required probe indication and the power levels recorded. The probe used the provided program, 'RM Meter Reader v3', to display its indicated response on the computer.

The magnitude of the E-field was calculated in terms of the measured net power, the separation distance, and the calibrated gain of the transmitting antenna. The strength of the E-field used in the calibration is well approximated by [B.9.2]

$$E = \frac{\sqrt{30PG}}{d}, \quad (\text{B.9.1})$$

where:

E = the magnitude of the on-axis E-field, V/m,

P = the net power delivered to the transmitting antenna, W,

G = the calibrated gain of the transmitting antenna, including the appropriate near-zone correlation factors, and

d = the distance from the antenna aperture to the calibrating field point (on bore-sight to the probe element's centre), m.

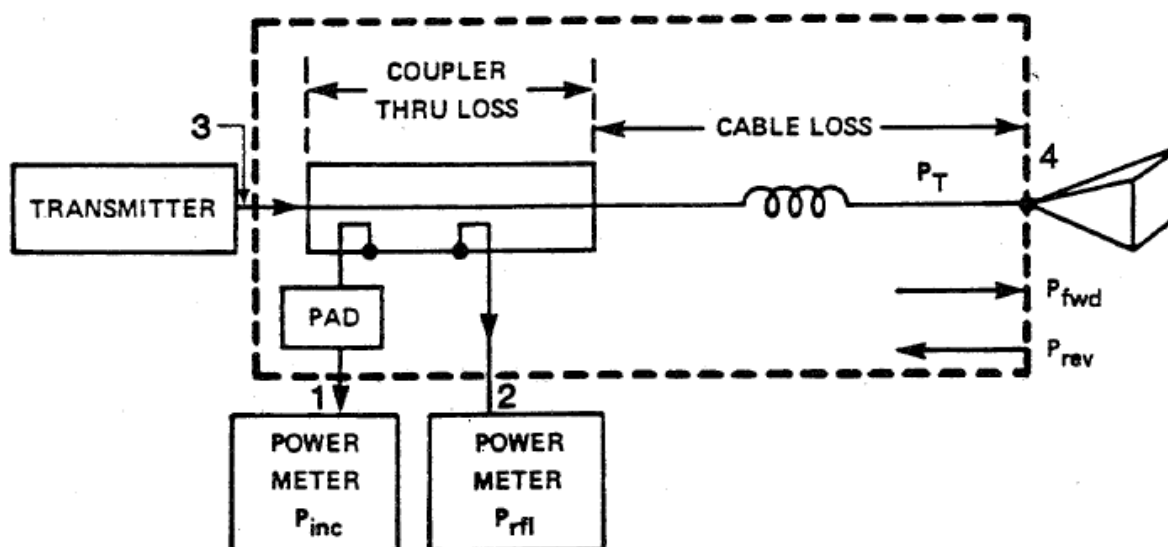


Fig B.9.1 – Diagram showing configuration of transmission equipment for the anechoic chamber measurements

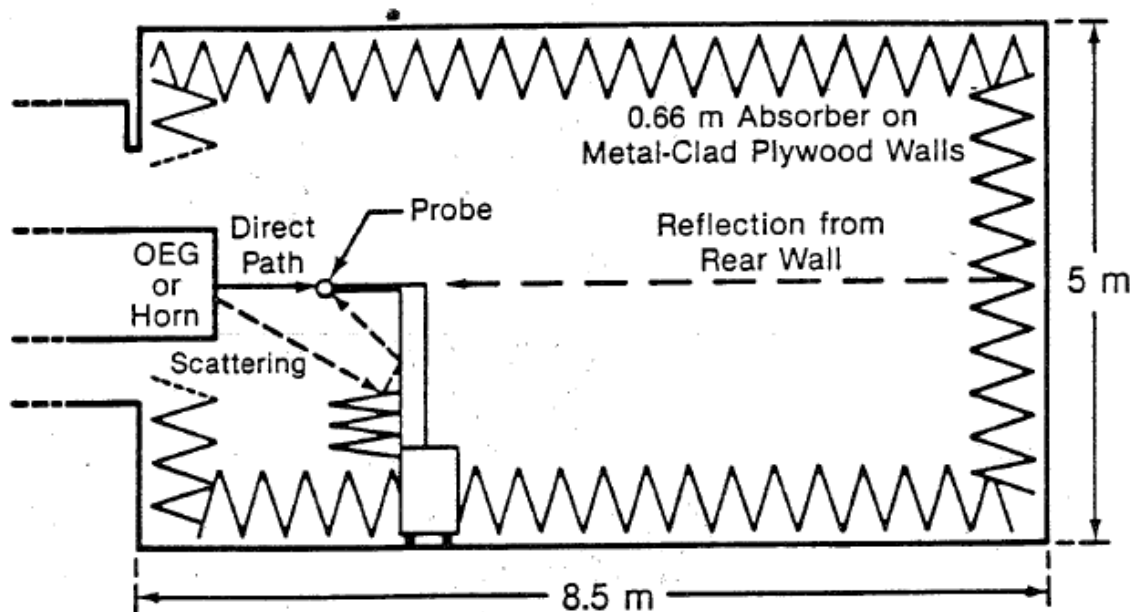


Fig B.9.2 – Diagram showing configuration of equipment inside the anechoic chamber

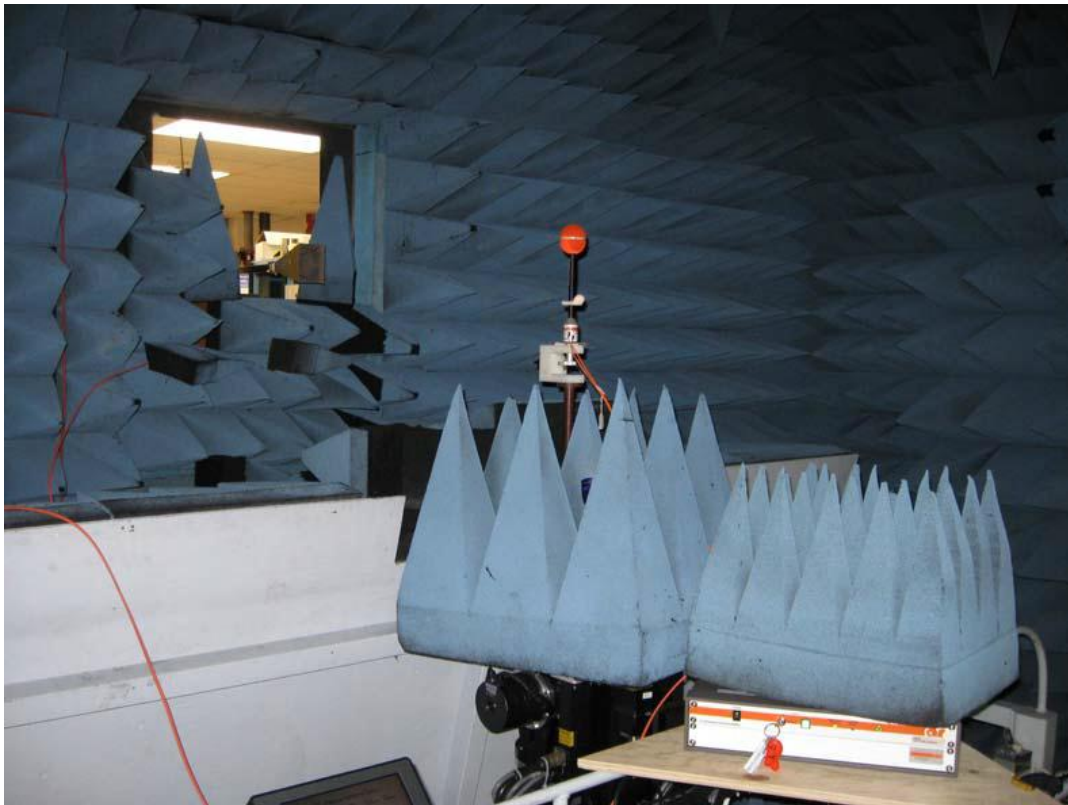


Fig B.9.3 – Photo showing configuration of probe FL7018 inside the anechoic chamber

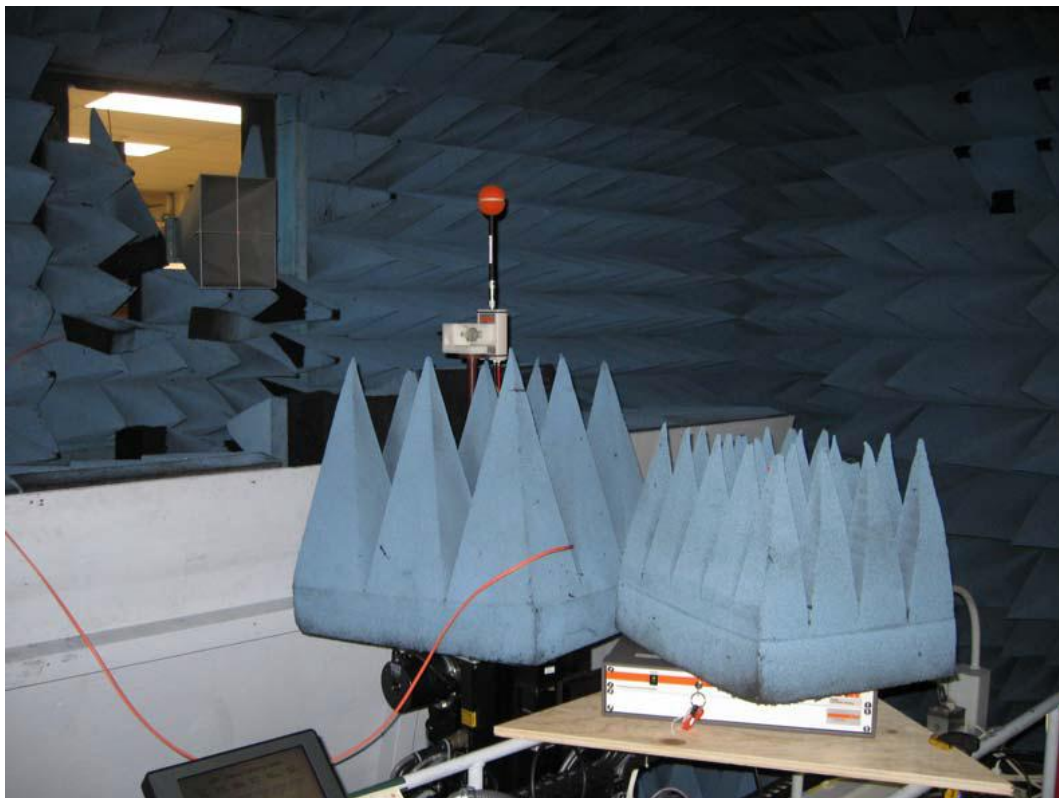


Fig B.9.4 – Photo showing configuration of probe FP7050 inside the anechoic chamber

B.9.3 Measurement Uncertainties

The result of a measurement is only an estimate of the value of a specific quantity. Thus, the measurand is complete only when a statement of uncertainty is given. A list of the individual uncertainties affecting measurements for the anechoic chamber measurements is given in Table 3. Tables 4 through 8 give the values of the individual uncertainties for at the given field levels as a function of frequency. These are determined using equation (B.9.2) and summarize in tables 1 and 2, above. Reference [B.9.2] defines in detail the guidelines used in this uncertainty analysis.

The equations used to determine the uncertainty, u , are

$$u = \sqrt{\sum \left(\frac{u_i}{K_i} \right)^2}, \quad (\text{B.9.2})$$

where:

u = combined standard uncertainty for anechoic chamber facility,

u_i = each individual uncertainty, and

K_i = probability distribution, (=1 for normal, $=\sqrt{3}$ for rectangular).

All of the instrumentation used in the calibration process are calibrated by the manufacturer or are traceable to NIST standards through an internal measurement process.

The uncertainty budgets can be found in Appendix C.9.

B.9.5 References

- [B.9.1] Hill, D., et al., “Generating Standard Reference Electromagnetic Fields in the NIST Anechoic Chamber, 0.2 to 40 GHz”, NIST Technical Note 1335, March 1990
- [B.9.2] Taylor, B.N. and Kuyatt, C.E., “Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurements Results”, NIST Technical Note 1297, 1994 Edition

B.10 NMIA Measurements (Y. Ji)

Different measurement techniques have been used for 1 GHz and above 1 GHz electric field probe calibrations. For all probe measurements, zero correction was not applied. The probe orientations and measurement channels were set as described in the protocol.

B.10.1 Measurements at 1 GHz

The standard electric field is generated in a microTEM (μ TEM) cell, and its strength is determined by a calibrated power passing through the cell, the input impedance of transmission line and the physical dimensions of the cell. This standard electric field within the μ TEM cell is then transferred to a miniaturized transfer probe which is placed within the GTEM cell to transfer the standard electric field to the GTEM at several distances and frequencies.

The travelling standards were placed midway between the septum and the floor of the cell in the GTEM cell.

The GTEM power was adjusted to provide a field strength of required level at each test position, and the output from the Standard was recorded using the software provided and NMIA's software. At 100 V/m, the measurements were based on the results at 30 V/m with a linear increase of the input power to the GTEM.

B.10.2 Measurements for above 1 GHz

The measurements were made in an anechoic chamber in which electric fields are generated by standard gain horn antennas. The calibration of the fields are performed using a calibrated receiver to obtain a 'system constant' that is used together with the transmitted power and separation distance to determine the true field strength.

With the device under test indicating the requested field strength, the probes were measured in 20 locations each a quarter wavelength apart. The effects of mutual reflections were eliminated by averaging. The near field compensation is performed before the averaging takes place so that the effect of the near field compensation does not bias the results of averaging.

Both probes were displaced by a quarter wavelength shifts from their original positions to reveal effects of the boom and trolley which were used to hold the probes. Measurements were made with absorber foam used to cover the metal box attached to the FP7050 probe, the foam was displaced by a quarter wavelength shifts from its original position to reveal the effect. These measurements were used to correct the results for each effect and estimate the uncertainty of these corrections.

Due to the limitation of available equipment and time, measurements at 30 V/m and 100 V/m for 18 GHz and all field levels for 10 GHz were not performed.

B.11 KRISS Measurements (N.-W. Kang)

The correction factor of the probe was determined at a fixed distance in a 13 m(L) x 9 m(W) x 8 m(H) anechoic chamber lined with 48 inch pyramidal absorbers. The chamber was shielded and its temperature was maintained at $(23 \pm 1)^\circ\text{C}$. A mast which was made of low permittivity foam was used to support the probe and it could translate along a 5.5 m linear rail slide. As a standard field generation device, horn antennas were used and the on axis gain of the antenna was measured using a three antenna technique based on extrapolation method. Alignment of the transmitting horn antenna and the probe was achieved by a laser aligner, and the polarization of the horn antenna was also aligned by a rotation positioner.

The input power of the antenna was monitored by a power sensor with a directional coupler. The undesirable harmonics due to a power amplifier were eliminated using appropriate filters.

B.12 TUBITAK-UME Measurements (M. Çetintaş)

The measurements were performed in accordance with the IEEE Std 1309:2005 Calibration Method B using calculated field strength in a full-anechoic chamber, whose net dimensions (from tip to tip of absorbers) are 2.6 m (w) x 5.6 m (l) x 2.3 m (h), by using a transmitting horn antenna. A transmitting horn antenna in free space that radiates P watts and has a gain g in a given direction will radiate $\frac{Pg}{4\pi}$ watts per steradian at a distance that is large compared to the antenna aperture. The power density in W/m^2 at a distance d from the antenna will be $\frac{Pg}{4\pi d^2}$. In terms of the field existing at the same distance, the power density is $\frac{E^2}{\eta}$. By equating these two expressions, the free space field is determined from the relationship:

$$E = \sqrt{\frac{\eta P_{net} g}{4\pi d^2}}, \quad (B.12.1)$$

where:

E is free space RMS electric field strength, V/m

P_{net} is net power to the transmitting antenna, W

g is the gain of the transmitting antenna in the direction toward the receiving point relative to an isotropic radiator (dimensionless)

d is the distance from the transmitting antenna to the sensor, m

η is intrinsic impedance of propagation medium, Ω (377 Ω)

In the measurements, the forward power (P_{fwd}) and reverse power (P_{rvs}) were measured directly at the input of the horn antenna by means of a dual directional coupler. Finally, the net power, P_{net} , was calculated by using

$$P_{net} = C_{fwd} P_{fwd} - C_{rvs} P_{rvs}, \quad (B.12.2)$$

where:

C_{fwd} is the forward coupling factor of the dual directional coupler

C_{rvs} is the reverse coupling factor of the dual directional coupler.

Four different horn antenna and directional coupler sets were used in the measurements according to the calibration frequency. No low pass filters at the output of the amplifiers were used in the measurements.

The general calibration setup was depicted in Fig B.12.1 and the photos taken during measurements are presented in Fig B.12.2 and Fig B.12.3.

CCEM.RF-K24.F – E-field measurements at frequencies of 1 GHz, 2.45 GHz, 10 GHz and 18 GHz and at indicated field levels of 10 V/m, 30 V/m and 100 V/m

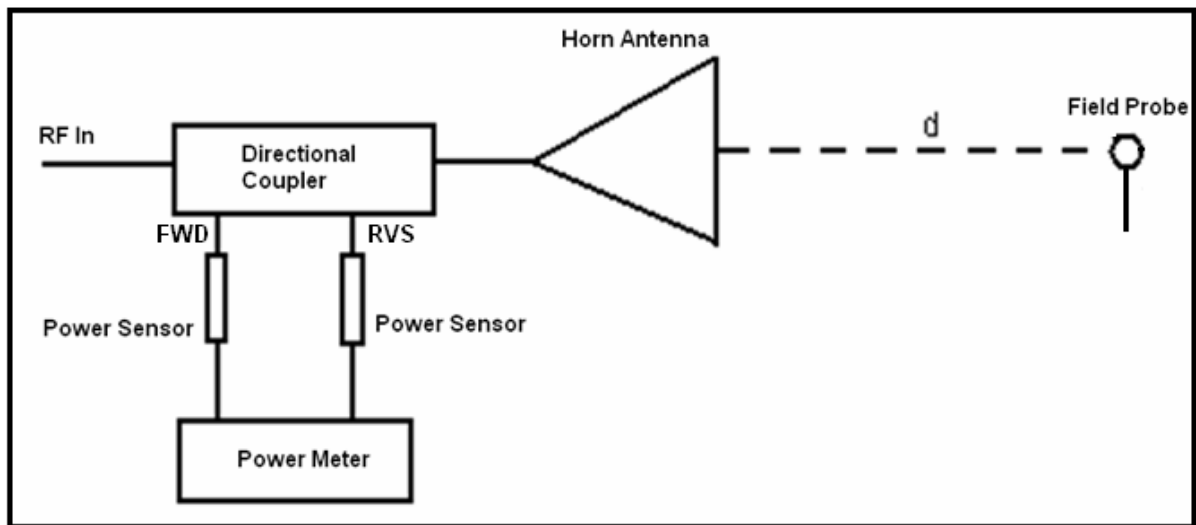


Fig B.12.1 – General calibration setup

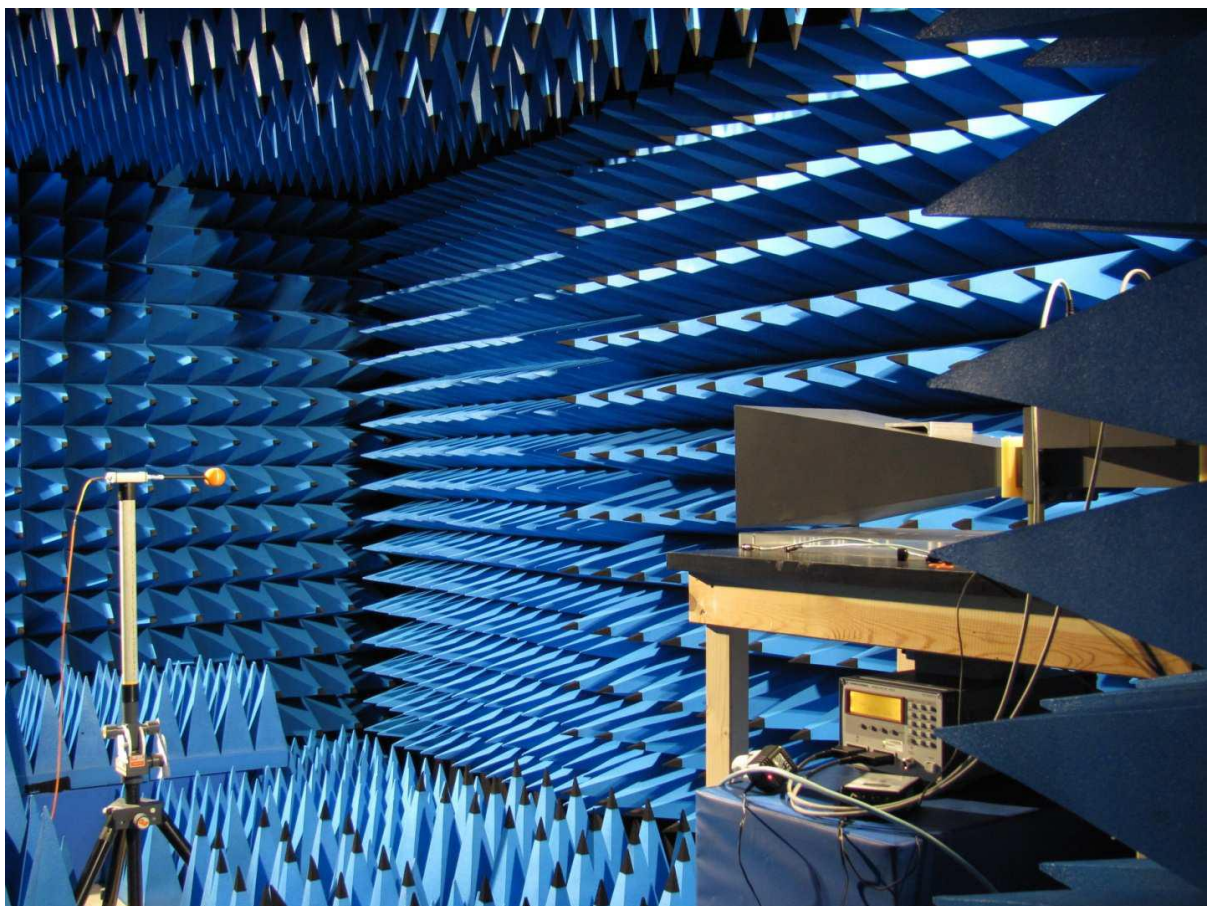


Fig B.12.2 – An example photograph taken during the calibration of FP7050

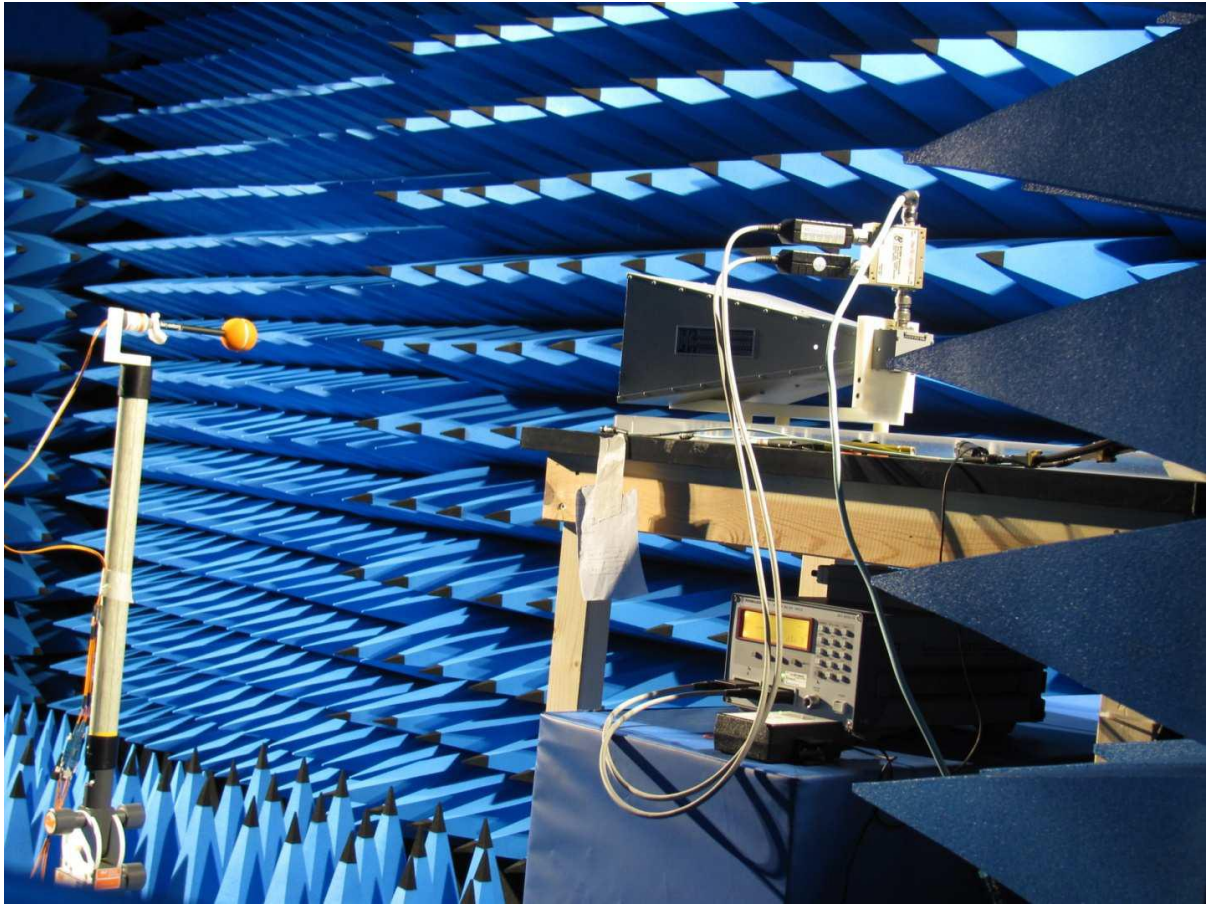


Fig B.12.3 – An example photograph taken during the calibration of FP7018

B.13 NMIJ Measurements (T. Morioka, M. Hirose)

The CCEM.RF-K24 focuses on the measurement capability of the correction factor of *E*-field probes. The correction factor of a probe *K* is defined as the ratio of the actual *E*-field strength applied to the probe $|E_{act}|$ to the indicated one readout from the probe $|E_{ind}|$ as given by

$$K = \frac{|E_{act}|}{|E_{ind}|}. \quad (\text{B.13.1})$$

The probes under test are an AR FL7018 (diode detector, 3 MHz – 18 GHz, 1 V/m – 1000 V/m, laser driven) and FP7050 (Thermal detector, 300 MHz - 50 GHz, 8 V/m – 614 V/m, battery driven). The target *E*-field levels are 10 V/m, 30 V/m and 100 V/m. Section B.13.2 includes the measured results and associated uncertainties at 1 GHz and Section B.13.3 at 2.45 GHz.

B.13.1 Summary

The device model and serial number:

- Probe and data transmission unit FP7050 S/N 0311660,
- Probe FL7018 Star Probe 3 laser powered S/N 0336188,
- Readout unit FM7004 S/N 0331664, and
- Laser Probe Interface FL7000 S/N 0331780

NMIJ received and checked the probes on 7th November 2011.

The 1 GHz measurements were performed from November 23th to November 24th 2011 and the 2.45 GHz measurements were performed from December 1st to December 7th 2011. The probes were despatched on December 7th 2011.

The measurement at 10 GHz nor 18 GHz were not made because NMIJ does not have this measurement capability. Results for 100 V/m at 2.45 GHz are not included because the power amplifier used at NMIJ cannot create the level.

For 2.45 GHz, the temperature in the anechoic chamber was between 24.2 °C and 24.8 °C.

A supplementary measurement at about 43 V/m was also performed, which was the maximum level realized by using our RF amplifier without distortion.

B.13.2 1 GHz Measurements

B.13.2.1 Method

The field probe calibration of the frequency range including 1 GHz is under investigation and the calibration service is scheduled to be available in 2014. The calibration of the field probes is implemented in a gigahertz transverse electromagnetic (G-TEM) cell. Since the *E*-field strength of the G-TEM cell is hard to be estimated with a sufficient accuracy, the two-step measurement is implemented. An *E*-field transfer probe is employed and calibrated against the standard field strength generated in an anechoic chamber [B.13.1]. The standard *E*-field strength is characterized using the calibrated dipole antenna factor (AF) [B.13.2]. By using

this method, the *E*-field strength in the G-TEM cell can be calibrated up to 2 GHz.

(A) Field transfer probe calibration

Fig. B.13.1 shows the schematic view of the probe calibration by using the dipole AF. The *E*-field is generated in free space using a dual ridged waveguide horn (DRGH) antenna (ETS3119). The DRGH is polarized for the vertical *E*-field generation. The cross-polarized field is much smaller than -30 dB compared with the dominant one at the measurement location.

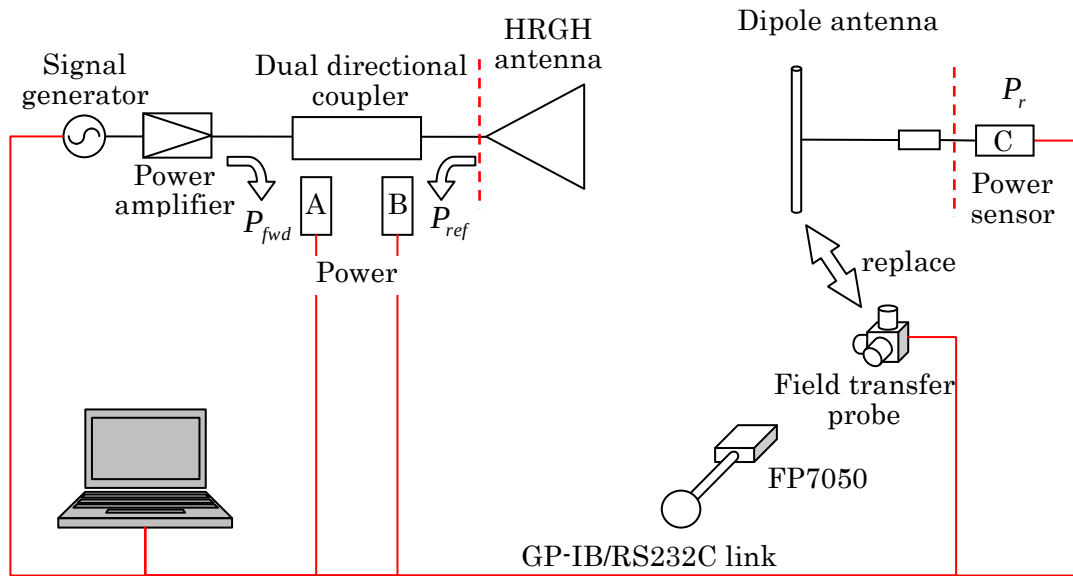


Fig B.13.1 – Schematic view of the *E*-field strength calibration

The target *E*-field strength $|E_{tgt}|$ at the measurement location is realized by measuring the received power at the dipole antenna port as shown in Fig. B.13.2. Once $|E_{tgt}|$ is generated, the coupled forward power P_{fwd} and reflected power P_{ref} at the dual directional coupler port are recorded. After the *E*-field strength is calibrated, the dipole antenna is removed and one axis of the field transfer probe (ETS HI6005) is located exactly at the location where the dipole element was. Then $|E_{tgt}|$ is regenerated by adjusting P_{fwd} within ± 0.02 dB from the recorded one.

Since the probe head of the FP7050 cannot be located at a proper location of the G-TEM cell, the correction factor of the FP7050 is calibrated by this method. Fig. B.13.3 (a) shows the measurement setup of the FP7050. $|E_{ind}|$ is averaged 10 times and the signal generator output is adjusted to make $|E_{ind}|$ become $|E_{tgt}|$. When $|E_{ind}|$ is sufficiently close to $|E_{tgt}|$, $|E_{ind}|$, P_{fwd} and P_{ref} are recorded. Then the probe is replaced by the dipole antenna as shown in Fig. B.13.3 (b) and the applied field level is regenerated by adjusting P_{fwd} to be ± 0.02 dB from the recorded one. Accordingly, $|E_{act}|$ at the dipole location is given by:

$$|E_{act}| = \sqrt{P_r Z_0} AF . \quad (B.13.2)$$

where P_r and AF are the received power at the port and the AF of the dipole, respectively. Z_0 is the terminal impedance representing the power sensor. Since the *E*-field strength of

100 V/m cannot be generated in free space due to the insufficient gain of the amplifier, the FP7050 is calibrated only at 30 V/m.

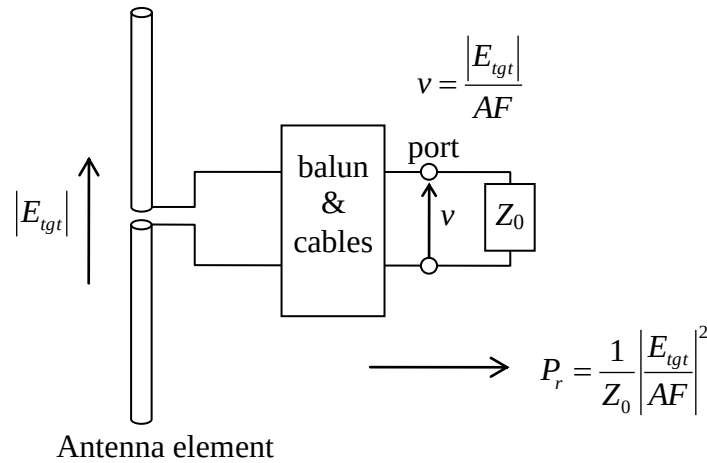
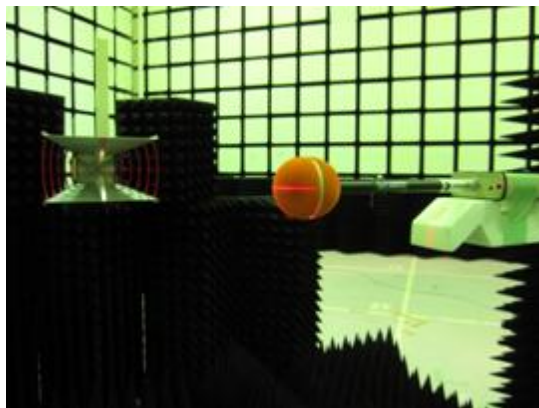
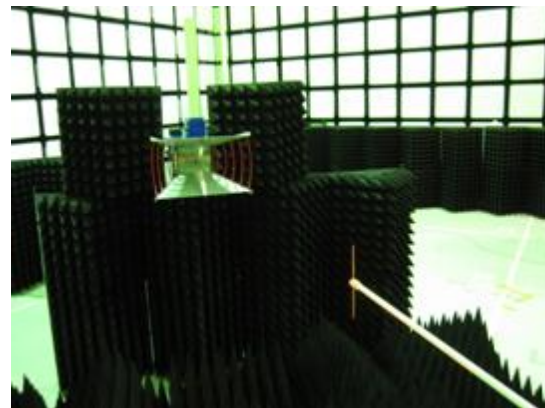


Fig B.13.2 – E-field strength calibration using the dipole antenna factor



(a) FP7050 in the measurement setup



(b) Calibrated dipole for the *E*-field characterization

Fig B.13.3 – Probe calibration by the standard *E*-field strength traceable to the dipole antenna factor

(B) Probe calibration in G-TEM cell

Since the *E*-field levels higher than 30 V/m cannot be generated in free space due to the insufficient gain of the amplifier, the probe calibration is usually implemented in the G-TEM cell. Figure B.13.4 shows the sketch of the probe calibration in the G-TEM cell. The FL7018 is located at a location in the cell and make the probe readout become close to $|E_{tgt}|$ by adjusting the signal generator output. When the probe readout is sufficiently close to $|E_{tgt}|$, $|E_{ind}|$, P_{fwd} and P_{ref} are recorded. Then the FL7018 is replaced with the field transfer probe and make P_{fwd} be same as the recorded one. Then the correction factor of the field transfer probe is applied to the readouts and $|E_{act}|$ is obtained. Figure B.13.5 shows the measurement setup of the FL7018 in the G-TEM cell.

Table B.13.1 shows the summary of the measurement conditions for this intercomparison.

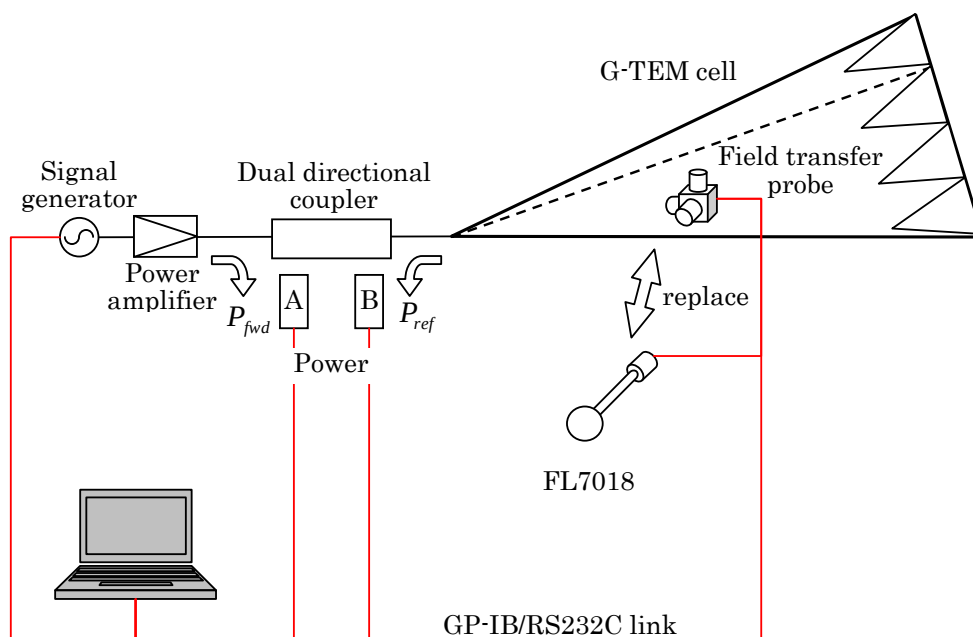


Fig B.13.4 – Schematic view of K measurement using a G-TEM cell

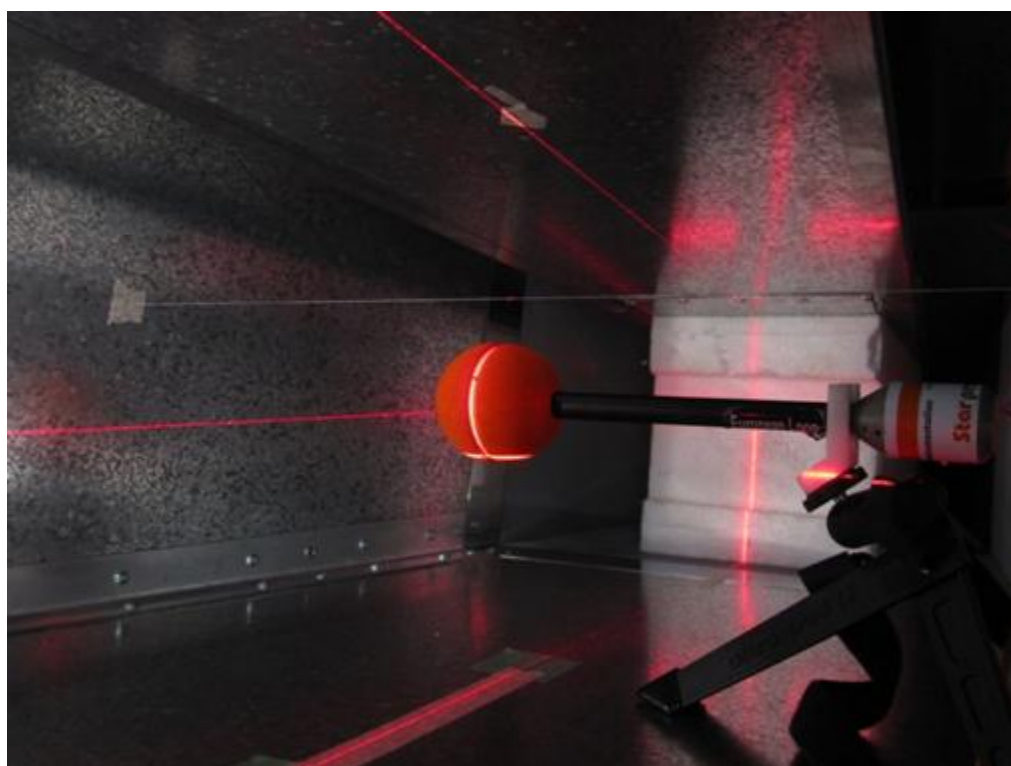


Fig B.13.5 – FL7018 located in the G-TEM cell

	FL7018	FP7050
--	--------	--------

	10 V/m	30 V/m	100 V/m	30 V/m	100 V/m
G-TEM cell	○	○	○	-	-
Free space	-	-	-	○	-

Table B.13.1 – Calibration environment of the probes

B.13.2.2 Conclusions and remarks

Correction factors of the *E*-field transfer probes were measured. The calibration of the field probe is implemented in a G-TEM cell due to the system compactness. The *E*-field strength of the cell is calibrated by using a field transfer probe. The field transfer probe is calibrated in an anechoic chamber applying the well-defined *E*-field strength using dipole AFs. The AR FL7018 was calibrated at field levels up to 100 V/m. Taking into account our system limitation, the correction factor of the FP7050 only at 30 V/m is measured in an anechoic chamber directly from the dipole AF.

B.13.3 2.45 GHz Measurements

B.13.3.1 Measurement theory

The electric field (*E*-field below) created by the antenna is calculated based on the assumptions below.

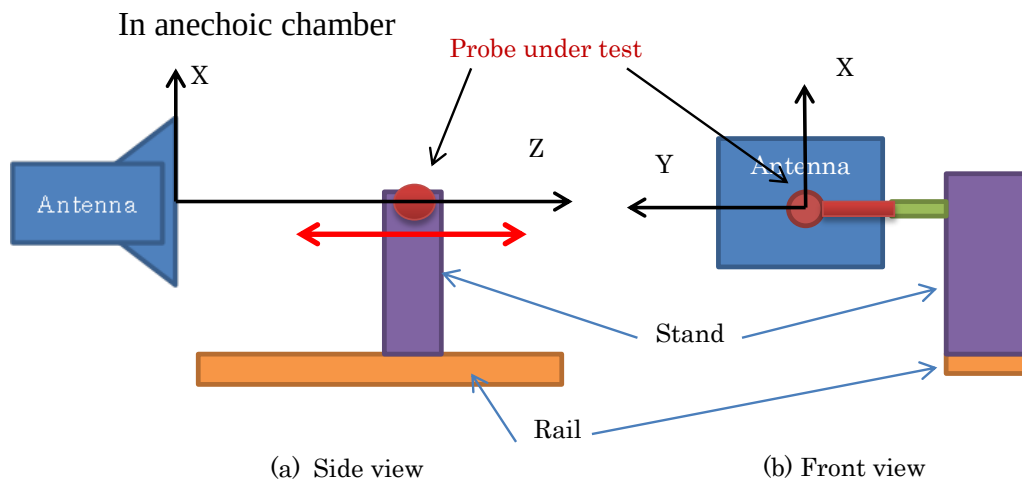


Fig. B.13.6 – Configuration and coordinate system of probe in anechoic chamber.

Figure B.13.6 shows the configuration for measurements for 2.45 GHz. We must determine the *E*-field at the position (0, 0, *z*) in the *xyz* coordinate system, created by the R-band horn antenna (MI Technologies 12-1.7). Since *z* is changing from 2 m to 2.25 m, the *x* component of the *E*-field (the direction of the polarization of the antenna) cannot be represented accurately by the far-fields as

$$E_A(z) = \sqrt{\frac{Z_0 G_A P_A}{4\pi z^2}}, \quad (\text{B.13.3})$$

where Z_0 , G_A , P_A are the free-space impedance, the antenna gain, the power radiated from the antenna respectively. Therefore, to obtain the E-field distribution along z , we use a commercially available electromagnetic simulator (FEKO [B.13.3]). That is, we assume that the E-field along z is the same form as the E-field calculated by FEKO as

$$E_A(z) = \text{const.} E_{FEKO}(z), \quad (\text{B.13.4})$$

where the constant is not dependent on z .

To determine the constant, we use the fact that (B.13.4) must be valid at the far-field condition. Using FEKO, the gain (G_{FEKO}), the radiated power (P_{FEKO}), and the x component of the electric field (E_{FEKO}) are related at the far-field condition as

$$E_{FEKO}(z) = \sqrt{\frac{Z_0 G_{FEKO} P_{FEKO}}{4\pi z^2}}. \quad (\text{B.13.5})$$

Inserting (B.13.3) and (B.13.5) into (B.13.4), we obtain the constant. Therefore

$$E_A(z) = E_{FEKO}(z) \sqrt{\frac{G_A P_A}{G_{FEKO} P_{FEKO}}}. \quad (\text{B.13.6})$$

In the following discussions, we use (B.13.6) as the actual E -field created by the antenna. Therefore, the relative uncertainty is expressed as

$$\left\{ \frac{u(E_A)}{E_A} \right\}^2 = \left\{ \frac{u(E_{FEKO} / \sqrt{G_{FEKO} P_{FEKO}})}{E_{FEKO} / \sqrt{G_{FEKO} P_{FEKO}}} \right\}^2 + \left\{ \frac{u(G_A)}{2G_A} \right\}^2 + \left\{ \frac{u(P_A)}{2P_A} \right\}^2. \quad (\text{B.13.7})$$

B13.3.2 Measurement Procedure

Before the probe measurements, a power meter of path-through type is calibrated by using a high-power attenuator (30 dB) and a calibrated power sensor shown along the green line in Fig. B.13.7. Then the E-field is created by the power flow along the red line in Fig. B.13.7. The input power to the antenna is monitored by the power meter while creating the electric field. The cable to connect the power meter and the attenuator or the adapter is the same for common use and its characteristic is included in the power meter in the following discussion.

B.13.3.2.1 Calibration of pass-through type power meter

The power meter is calibrated by using the attenuator and the power sensor. The attenuator characteristic is measured by a VNA using a impedance kits (calibrated by the impedance standard section in NMIJ) and also verified by comparing with the value calibrated by the attenuation standard section in NMIJ. The power sensor is calibrated by JQA (a test laboratory in Japan) and is traceable to the national standards of NMIJ.

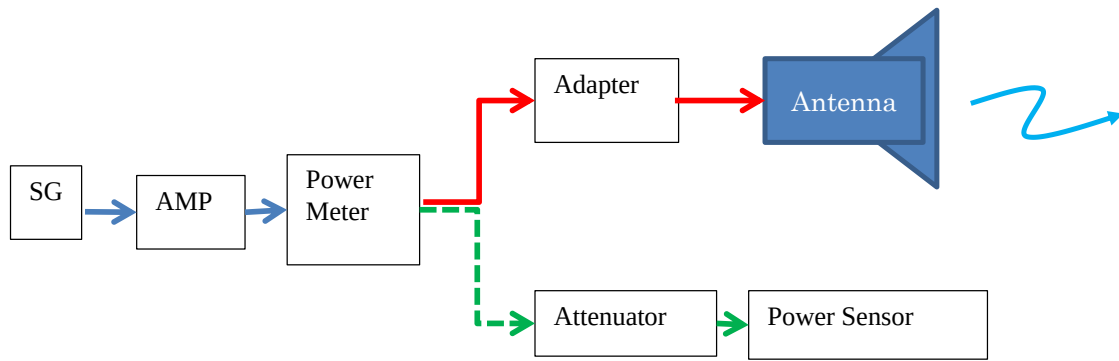


Fig. B.13.7 – Diagram of E-field creation and calibration of the power meter

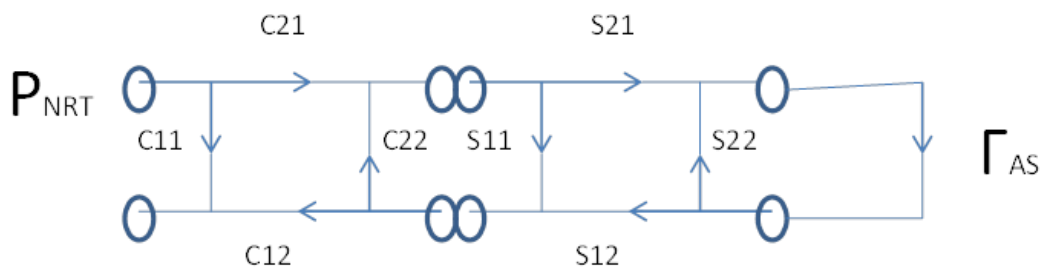


Fig. B.13.8 - Flow chart for the power meter (P_{NRT}) calibration using the power sensor (P_{AS})

Following the flow chart in Fig. B.13.8, the relation of the input power to the power sensor (P_{AS}) and the input power to the power meter (P_{NRT}) is given as

$$P_{AS} = \left| \frac{S_{21}}{1 - S_{22}\Gamma_{AS}} \right|^2 \left| \frac{C_{21}}{1 - C_{22}\Gamma_{AS}} \right|^2 P_{NRT}; \Gamma_{AAS} = S_{11} + \frac{S_{21}S_{12}\Gamma_{AS}}{1 - S_{22}\Gamma_{AS}}, \quad (\text{B.13.8})$$

where S_{ij} are the S-parameters of the attenuator, Γ_{AS} is the reflection coefficient of the power sensor, and C_{ij} is the power meter including the cable respectively. Because the contribution from the multiple reflection terms in the denominators in (B.13.8) are less than 0.1 %, we neglect the terms and finally we adopt

$$P_{AS} = |S_{21}|^2 |C_{21}|^2 P_{NRT} \quad (\text{B.13.9})$$

as the relationship between P_{AS} and P_{NRT} .

Usually the power meter calibration is to obtain the correction factor defined as

$$CF_{NRT} = \frac{P_{NRT}}{P_{NRT.Disp}}, \quad (\text{B.13.10})$$

where $P_{NRT.Disp}$ is the displayed values of the power meter. The meaning of the “displayed value” is the indicated value on the display of each apparatus. The word “displayed” is used for the meaning in the following. Inserting (B.13.10) and the correction factor CF_{AS}

(determined by JQA) of the power sensor into (B.13.9), the displayed value ($P_{NRT.Disp}$) of the power meter and the one ($P_{AS.Disp}$) of the power sensor are related as

$$CF_{AS} P_{AS.Disp} = |S_{21}|^2 |C_{21}|^2 CF_{NRT} P_{NRT.Disp} . \quad (B.13.11)$$

In our measurements as explained in the next section, we need the calibrated value of

$$|C_{21}|^2 CF_{NRT} = \frac{CF_{AS} P_{AS.Disp}}{|S_{21}|^2 P_{NRT.Disp}} . \quad (B.13.12)$$

Therefore the relative uncertainty of (B.13.12) is given as

$$\left\{ \frac{u(|C_{21}|^2 CF_{NRT})}{2|C_{21}|^2 CF_{NRT}} \right\}^2 = \left\{ \frac{u(CF_{AS})}{2CF_{AS}} \right\}^2 + \left\{ \frac{u(|S_{21}|)}{|S_{21}|} \right\}^2 + \left\{ \frac{u(P_{AS.Disp})}{2P_{AS.Disp}} \right\}^2 + \left\{ \frac{u(P_{NRT.Disp})}{2P_{NRT.Disp}} \right\}^2 . \quad (B.13.13)$$

B13.3.2.2 Determination of radiated power

To determine the actual E-field by (4), we must obtain the power (P_A) radiated from the antenna.

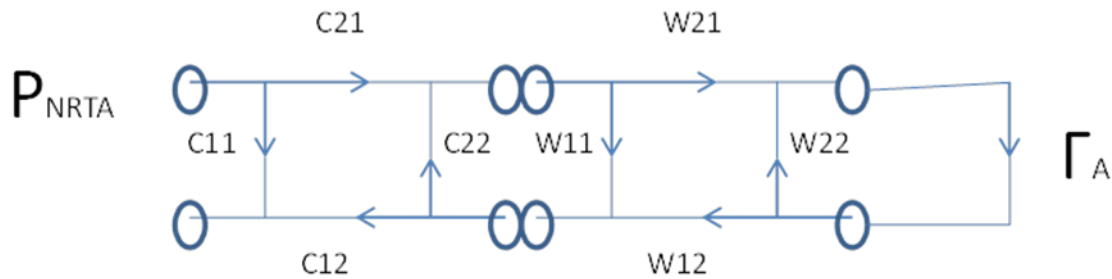


Fig. B.13.9 – Flow chart for the power (P_A) radiated from the antenna and the output of the power meter (P_{NRTA}). W_{ij} is the S-parameters of the coaxial-waveguide adapter.

To avoid the confusion, we use P_{NRTA} instead of P_{NRT} that is used in the process of the calibration of power meter. That is, P_{NRTA} is the measured value by the same power meter that is used in the calibration of power meter.

From Fig.B.13.9, the power (P_A) radiated from the antenna is given as

$$P_A = \left(1 - |\Gamma_A|^2\right) \left| \frac{W_{21}}{1 - W_{22}\Gamma_A} \right|^2 \left| \frac{C_{21}}{1 - C_{22}\Gamma_{AA}} \right|^2 P_{NRT} ; \Gamma_{AA} = W_{11} + \frac{W_{21}W_{12}\Gamma_{AS}}{1 - W_{22}\Gamma_{AS}} , \quad (B.13.14)$$

where W_{ij} is the S-parameters of the coaxial-waveguide adapter and Γ_A is the reflection coefficient of the antenna. As before, the contributions from the multiple reflection terms in the denominators are less than 0.1 %, we neglect those and finally we adopt

$$P_A = \left(1 - |\Gamma_A|^2\right) |W_{21}|^2 |C_{21}|^2 P_{NRTA} \quad (B.13.15)$$

In order to relate (B.13.15) to the displayed value $P_{NRTA.Disp}$ of the power meter, we insert (B.13.10) into (B.13.15) and obtain

$$P_A = (1 - |\Gamma_A|^2) |W_{21}|^2 (|C_{21}|^2 CF_{NRT}) P_{NRTA.Disp} \quad (B.13.16)$$

Finally, using (B.13.6) and (B.13.16), we can determine the actual E -field at z .

The relative uncertainty of P_A is given as

$$\left\{ \frac{u(P_A)}{2P_A} \right\}^2 = \left\{ \frac{|\Gamma_A| u(\text{Re}[\Gamma_A])}{1 - |\Gamma_A|^2} \right\}^2 + \left\{ \frac{u(|W_{21}|)}{|W_{21}|} \right\}^2 + \left\{ \frac{u(|C_{21}|^2 CF_{NRT})}{2|C_{21}|^2 CF_{NRT}} \right\}^2 + \left\{ \frac{u(P_{NRTA.Disp})}{2P_{NRTA.Disp}} \right\}^2. \quad (B.13.17)$$

B.13.3.2.3 Determination of calculated correction factor

The calculated correction factor (CCF) that should be reported is defined as

$$CCF \equiv \frac{\text{Actual} - \text{field}}{\text{Indicated} - \text{field}} = \frac{E_A}{E_D} \quad (B.13.18)$$

where E_D is the indicated field or displayed value of each probe.

In our measurements, the large multiple reflections can be seen from 2 m to 2.25 m in the distance between the horn antenna aperture and the center of the probe. We define the center of each probe as the physical center of the sensor head (ball) of each probe. Then we apply the moving average method to E_A and E_D to reduce the multiple reflections.

We assume the measured actual E-field (real quantity) is composed of the actual E-field (E_{AF} , complex number) calculated by (B.13.16) and the multiple reflections (E_{MR} , complex number) between the antenna and the probe, and the magnitude of the ratio of E_{MR}/E_{AF} is smaller than 1. Then

$$E_A = |E_{AF} + E_{MR}| = |E_{AF}| \left| 1 + \frac{E_{MR}}{E_{AF}} \right| \approx |E_{AF}| + \frac{\text{Re}(E_{MR} E_{AF}^*)}{|E_{AF}|}, \quad (B.13.19)$$

where $*$ represents complex conjugate. We do not know accurately the second term in (B.13.19). However, from the measurements, we found that the period of the second term in (B.13.19) is dominated by the main (1st) multiple reflections (we could not identify the second multiple reflections) and has about the half wavelength (61.22 mm at 2.45 GHz). Therefore taking the moving average of E_A , we can eliminate the second term in (B.13.19). We measured values at every 12.5 mm step and number 5 is the best for the moving average at this step. Whereas any integer multiplier of 12.5 mm is not the exact half wavelength (61.22 mm), adopting the integer 5 as the average number is proved to reduce the contribution from the second terms below 0.1 % by a numerical simulation that models (B.13.19).

Assuming the CCF is constant in the interval of $12.5 \text{ mm} \times 5 = 62.5 \text{ mm}$ or in the corresponding level of the E -field, we can determine CCF from

$$\text{Mov.Avg.}(E_D) = \text{Mov.Avg.}\left(\frac{E_{AF} + E_{Multi.ref}}{CCF}\right) = \frac{\text{Mov.Avg.}(E_{AF})}{CCF}, \quad (\text{B.13.20})$$

$$CCF = \frac{\text{Mov.Avg.}(E_{AF})}{\text{Mov.Avg.}(E_D)}. \quad (\text{B.13.21})$$

Therefore the relative uncertainty of the CCF is

$$\left\{\frac{u(CCF)}{CCF}\right\}^2 = \left\{\frac{u(\text{Avg.}(E_{AF}))}{\text{Avg.}(E_{AF})}\right\}^2 + \left\{\frac{u(\text{Avg.}(E_D))}{\text{Avg.}(E_D)}\right\}^2 = \left\{\frac{u(\text{Avg.}(E_{AF}))}{\text{Avg.}(E_{AF})}\right\}^2 + \left\{\frac{u(E_D)}{5E_D}\right\}^2 \quad (\text{B.13.22})$$

because the number of the moving average is 5.

B.13.3.3 Uncertainty

The uncertainty of the CCF is given as (B.13.22) and the final form is given below. From (B.13.7), the first term in (B.13.22) is expanded as

$$\left\{\frac{u(\text{Avg.}(E_{AF}))}{\text{Avg.}(E_{AF})}\right\}^2 = \left\{\frac{u(E_{FEKO} / \sqrt{G_{FEKO} P_{FEKO}})}{E_{FEKO} / \sqrt{G_{FEKO} P_{FEKO}}}\right\}^2 + \left\{\frac{u(G_A)}{2G_A}\right\}^2 + \left\{\frac{u(\text{Avg.}(P_A))}{2P_A}\right\}^2 \quad (\text{B.13.23})$$

From (B.13.17), the third term in (B.13.23) is given as

$$\begin{aligned} \left\{\frac{u(\text{Avg.}(P_A))}{2P_A}\right\}^2 &= \left\{\frac{|\Gamma_A| u(\text{Re}[\Gamma_A])}{1 - |\Gamma_A|^2}\right\}^2 + \left\{\frac{u(|W_{21}|)}{|W_{21}|}\right\}^2 + \left\{\frac{u(|C_{21}|^2 CF_{NRT})}{2|C_{21}|^2 CF_{NRT}}\right\}^2 \\ &+ \left\{\frac{u(\text{Avg.}(P_{NRTA.Disp}))}{2P_{NRTA.Disp}}\right\}^2. \end{aligned} \quad (\text{B.13.24})$$

and the fourth term in (B.13.24) is reduced to

$$\left\{\frac{u(\text{Avg.}(P_{NRTA.Disp}))}{2P_{NRTA.Disp}}\right\}^2 = \left\{\frac{u(P_{NRTA.Disp})}{10P_{NRTA.Disp}}\right\}^2 \quad (\text{B.13.25})$$

because the number of the average is 5. Therefore the final expression of the uncertainty of the CCF is

$$\left\{\frac{u(CCF)}{CCF}\right\}^2 = \left\{\frac{u(\text{Avg.}(E_{AF}))}{\text{Avg.}(E_{AF})}\right\}^2 + \left\{\frac{u(\text{Avg.}(E_D))}{\text{Avg.}(E_D)}\right\}^2 \quad (\text{B.13.26})$$

$$\begin{aligned}
 &= \left\{ \frac{u(E_{FEKO} / \sqrt{G_{FEKO} P_{FEKO}})}{E_{FEKO} / \sqrt{G_{FEKO} P_{FEKO}}} \right\}^2 + \left\{ \frac{u(G_A)}{2G_A} \right\}^2 \\
 &+ \left\{ \frac{|\Gamma_A| u(\text{Re}[\Gamma_A])}{1 - |\Gamma_A|^2} \right\}^2 + \left\{ \frac{u(|W_{21}|)}{|W_{21}|} \right\}^2 + \left\{ \frac{u(|C_{21}|^2 CF_{NRT})}{2|C_{21}|^2 CF_{NRT}} \right\}^2 \\
 &+ \left\{ \frac{u(P_{NRTA.Disp})}{10P_{NRTA.Disp}} \right\}^2 + \left\{ \frac{u(E_D)}{5E_D} \right\}^2.
 \end{aligned}$$

B.13.3.3.1 Quantities related to FEKO

The first term in (B.13.26) is calculated by the variations of E_{FEKO} , G_{FEKO} , and P_{FEKO} due to changing the meshing size (10 mm to 3.5 mm), the horn aperture size (± 1 mm), the length of the horn nose (± 1 mm). The relative variations are 0.19 %, 0.09 %, and 0.02 % respectively. We use only 0.19 % and assume the uniform distribution and the infinite degrees of freedom (DoF. 999 is used) as the uncertainty from FEKO.

B.13.3.3.2 G_A

The antenna gain of the standard horn antenna was determined by the transfer method [B.13.4] and the near-field gain correction [B.13.5] that assumes a simple electric field distribution of the aperture. The reference antenna was calibrated by NPL. The gain and its standard uncertainty are 17.17 dBi and 0.13 dB (2.9 %, $k=1$), respectively. Whereas the DoF is 21800, we treat it as 999 in the calculation of the DoF in the budget tables below without problems. By the way, the gain calculated by FEKO is 17.20 dBi.

B.13.3.3.3 Mismatch factor

The reflection coefficient of the antenna Γ_A was measured by using the VNA at the same time for the gain measurement. Since $|\Gamma_A| = 0.051$, $u(\text{Re}[\Gamma_A]) = 0.008$, and the DoF = 999, the sensitivity is $0.051 \cdot 100 = 5.1$ (in % scale). In this report, uncertainties of quantities measured by the VNA were calculated by using the uncertainty calculator released by Agilent technologies and the repeatability of connection between the adapter and the antenna. Since the uncertainty is 0.04 %, we neglect it.

B.13.3.3.4 W_{21}

S-parameters of the coaxial-to-waveguide adapter were measured by Short-Open-Load-Reciprocal method and TRL method using the VNA. The reference planes as the 2-port device are at the 3.5 mm coaxial female port and the flange of the waveguide port. W_{21} is -0.11 dB and its uncertainty and the DoF are 0.09 dB (1.0 %) and 999 respectively.

B.13.3.3.5 $|C_{21}|^2 CF_{NRT}$

The uncertainty of this term is composed of four terms due to (B.13.13). The relative uncertainty of CF_{AS} is given as 1.1 % by JQA. The S-parameters of the high power attenuator were measured by Short-Open-Load-Reciprocal method. The relative uncertainty and the

DoF of S_{21} are 0.13 dB (1.5 %) and 999, respectively. The relative uncertainty and the DoF of $P_{AS,Disp}$ (repeatability of displayed value of power sensor in the uncertainty sheet) are 2.5 % and 14 (connection repeatability of 15 times), respectively. The relative uncertainty and the DoF of $P_{NRT,Disp}$ (repeatability of displayed value of power meter in the uncertainty sheet) are 0.4 % and 14, respectively.

B.13.3.3.6 Reflections from walls

Because the probes are moving along the line in our measurement method, the reflections from walls of the anechoic chamber and the multiple reflection between the antenna and the probes are separated based on a simple simulation; each reflection has a different periodicity on the distance. Comparing the measurements and the simulation results, we concluded that the uncertainty is approximated as the maximum deviation of 0.25 % with the U-shape distribution.

B.13.3.3.7 $P_{NRTA,Disp}$

The uncertainty of $P_{NRTA,Disp}$ is calculated by the moving average (5 points) of the displayed values of the power meter at each measurement. Therefore the uncertainty is the standard deviation of the displayed value divided by the square root of 5. However, because this uncertainty was estimated below 0.1 %, we neglected it as explained in the section B.13.3.3.9.

B.13.3.3.8 E_D

The uncertainty of E_D is calculated by the moving average (5 points) of the saved values gathered by the program “hi-ar.exe”. Therefore the uncertainty is the standard deviation of the saved value divided by the square root of 5. Because this uncertainty was estimated below 0.1 %, we neglected it as explained in the section B.13.3.3.9.

B.13.3.3.9 Repeatability of probe connection

To obtain the uncertainty due to the repeatability of the probe connection, we repeated the power-switch on-off for FP7050 and the attaching and detaching of the laser cables for FL7018. The results for each time are tabulated in the data sheet of “raw data OO”. That is, the results in the numbered measurement in the sheet correspond to the ones for each probe connection.

The final result of the correction factor is obtained by averaging the one of each measurement. Then the uncertainty is calculated by the standard deviation of the final result divided by the square root of (Number of measurements - 1, that is, 4 for FL7018 or 5 for FP7050). Since total uncertainty is about a few %, we neglected the contributions from the displayed probe uncertainty and the displayed power meter uncertainty because they were estimated below 0.1 %.

B.13.3.3.10 Non-linearity of the probes

In the measurements for FL7018 at 10 V/m, the maximum values of the indicated E-field (around 9.2 V/m) were lower than 10 V/m. At the indicated E-field levels from 8.5 V/m to

9.5 V/m, the calculated correction factors after moving averaging were considered to be constant within 0.1 %.

In the measurements for FP7018 at 30 V/m, the values of the indicated E-field (around 27.5 V/m) were lower than 30 V/m. At the indicated E-field levels from 25 V/m to 28 V/m, the calculated correction factors after moving averaging were considered to be constant within 0.2 %. Therefore we neglect the uncertainty due to the non-linearity.

B.13.3.3.11 Misalignment of the probes

The alignment of the antenna and probes were adjusted by using the laser leveling tool. The alignment between the antenna axis and the center of the probe was within 0.6 degrees that is equal to the displacement of 20 mm at 2 m.

The uncertainty by the misalignment of the probes is calculated by the equation as

$$R_{ad} \equiv E_A(x, y, z) / E_A(0, 0, z) = 1 - c_1 x^2 - c_2 y^2 \quad (\text{B.13.27})$$

where c_1 and c_2 are constants determined by FEKO and the coordinates is the same as in Fig. B.13.6. Assuming the uniform distribution of the maximum deviation 20 mm, we obtain the uncertainty is 0.04 %. Therefore we neglect the uncertainty due to the misalignment.

B.13.3.4 List of equipment used

Equipment used in the measurements is listed below:

- Power meter: Rohde & Schwarz NRT-Z43
- Power sensor: Agilent 8482A
- Attenuator: Weinschel WA29-30-34 (attenuation 30 dB)
- SG : HP 83630A
- AMP: Ophir RF RF Power Amplifier Model 5162RE (0.8 – 4.2 GHz, 28 W.max)
- Adapter (coaxial to R-band waveguide): Maury WR430 Adapter (R200A1)
- Antenna: MI Technologies Standard Gain Horn Model 12-1.7
- Vector Network Analyzer: Agilent E8364A
- Calibration Kits: Agilent 85032F
- Stepped Attenuator: Agilent 84905M 60 dB Attenuator

B.13.4 Traceability

All equipment used in the measurements is traceable to the SI unit of NMIJ and NPL as shown in Fig. B.13.10.

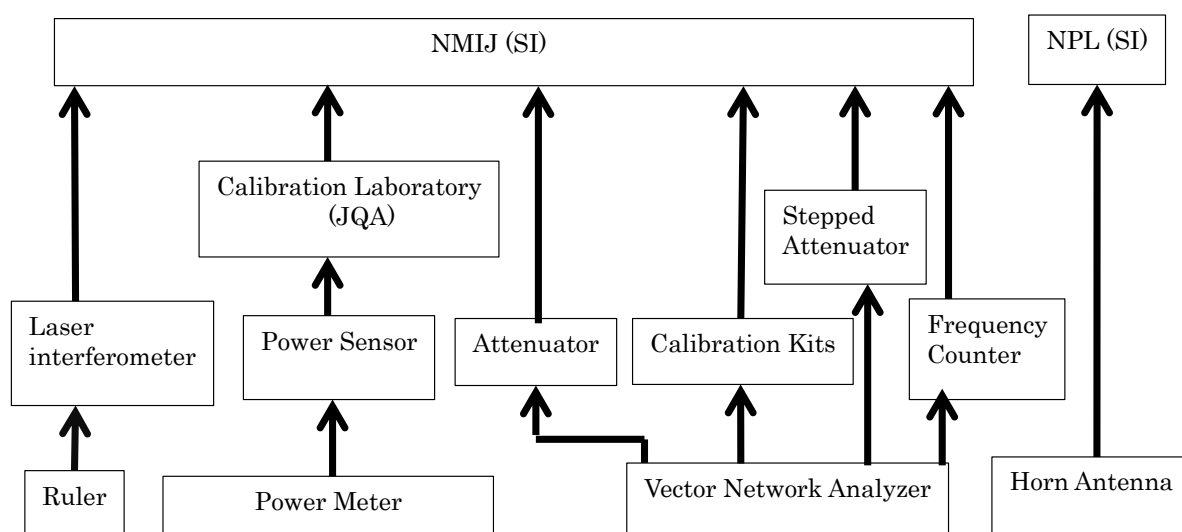


Fig. B.13.10 Traceability chart

B.13.4 References

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B.14 VNIIFTRI Measurements

Report not supplied.

Appendix C – Uncertainty budgets

C.1 – NPL uncertainty budgets

Table C.1.1 – Uncertainty budget for FL7018 measurement with 10 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Coupler power ratio	2.30	%	Normal	2.00	0.50	0.58	>10000
B	Power sensor accuracy	0.40	%	Normal	2.00	0.50	0.10	>10000
B	Power meter accuracy	0.50	%	Rectangular	1.73	0.50	0.14	>10000
B	Power meter reference	0.70	%	Rectangular	1.73	0.50	0.20	>10000
B	Power reference drift	0.10	%	Rectangular	1.73	0.50	0.03	>10000
B	Power meter zero setting	0.75	%	Rectangular	1.73	0.50	0.22	>10000
A	Connector repeatability	0.30	%	Normal	2.00	0.50	0.08	4
B	Power sensor linearity	1.20	%	Rectangular	1.73	0.50	0.35	>10000
B	Coupler/horn mismatch	1.30	%	U - shaped	1.41	0.50	0.46	>10000
B	Coupler/Power sensor Mismatch	0.70	%	U - shaped	1.41	0.50	0.25	>10000
B	Horn gain	3.70	%	Normal	2.00	0.50	0.93	>10000
B	Distance encoder	0.13	%	Rectangular	1.73	1.00	0.08	>10000
B	Horn/radome reference	0.14	%	Rectangular	1.73	1.00	0.08	>10000
B	Effective sensor position	0.33	%	Rectangular	1.73	1.00	0.19	>10000
B	Horn/probe alignment	0.37	%	Normal	2.00	0.50	0.09	>10000
B	Reflections in chamber	1.00	%	U - shaped	1.41	1.00	0.71	>10000
B	Reflections probe/holder	1.00	%	U - shaped	1.41	1.00	0.71	>10000
B	Reflections horn/probe	0.50	%	U - shaped	1.41	1.00	0.35	>10000
B	Scale reading	0.10	%	Rectangular	1.73	1.00	0.06	>10000
A	Repeatability	0.02	%	Normal	1.00	1.00	0.02	9
B	Reproducibility	1.00	%	Rectangular	1.73	1.00	0.58	>10000
B	Temperature effects	2.20	%	Rectangular	1.73	0.50	0.64	>10000
B	Horn gain drift	1.00	%	Rectangular	1.73	0.50	0.29	>10000
Uc(CF)	Combined uncertainty			normal			1.93	1737227
U	Expanded uncertainty			normal (k=2)			3.85	

Table C.1.2 – Uncertainty budget for FL7018 measurement with 10 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Coupler power ratio	4.10	%	Normal	2.00	0.50	1.03	>10000
B	Power meter accuracy	0.50	%	Rectangular	1.73	0.50	0.14	>10000
B	Power meter reference	0.70	%	Rectangular	1.73	0.50	0.20	>10000
B	Power reference drift	0.10	%	Rectangular	1.73	0.50	0.03	>10000
B	Power meter zero setting	0.75	%	Rectangular	1.73	0.50	0.22	>10000
A	Connector repeatability	0.30	%	Normal	2.00	0.50	0.08	4
B	Power sensor linearity	1.20	%	Rectangular	1.73	0.50	0.35	>10000
B	Coupler/horn mismatch	1.30	%	U - shaped	1.41	0.50	0.46	>10000
B	Horn gain	1.80	%	Normal	2.00	0.50	0.45	>10000
B	Distance encoder	0.13	%	Rectangular	1.73	1.00	0.08	>10000
B	Horn/radome reference	0.14	%	Rectangular	1.73	1.00	0.08	>10000
B	Effective sensor position	0.33	%	Rectangular	1.73	1.00	0.19	>10000
B	Horn/probe alignment	0.37	%	Normal	2.00	0.50	0.09	>10000
B	Reflections in chamber	0.75	%	U - shaped	1.41	1.00	0.53	>10000
B	Reflections probe/holder	1.00	%	U - shaped	1.41	1.00	0.71	>10000
B	Reflections horn/probe	0.50	%	U - shaped	1.41	1.00	0.35	>10000
B	Scale reading	0.10	%	Rectangular	1.73	1.00	0.06	>10000
A	Repeatability	0.12	%	Normal	1.00	1.00	0.12	9
B	Reproducibility	1.00	%	Rectangular	1.73	1.00	0.58	>10000
B	Temperature effects	2.20	%	Rectangular	1.73	0.50	0.64	>10000
B	Horn gain drift	1.00	%	Rectangular	1.73	0.50	0.29	>10000
Uc(CF)	Combined uncertainty			normal			1.87	424039
U	Expanded uncertainty			normal (k=2)			3.74	

Table C.1.3 – Uncertainty budget for FL7018 measurement with 10 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Coupler power ratio	4.10	%	Normal	2.00	0.50	1.03	>10000
B	Power meter accuracy	0.50	%	Rectangular	1.73	0.50	0.14	>10000
B	Power meter reference	0.70	%	Rectangular	1.73	0.50	0.20	>10000
B	Power reference drift	0.10	%	Rectangular	1.73	0.50	0.03	>10000
B	Power meter zero setting	0.75	%	Rectangular	1.73	0.50	0.22	>10000
A	Connector repeatability	0.30	%	Normal	2.00	0.50	0.08	4
B	Power sensor linearity	1.20	%	Rectangular	1.73	0.50	0.35	>10000
B	Coupler/horn mismatch	1.30	%	U - shaped	1.41	0.50	0.46	>10000
B	Horn gain	1.16	%	Normal	2.00	0.50	0.29	>10000
B	Distance encoder	0.13	%	Rectangular	1.73	1.00	0.08	>10000
B	Horn/radome reference	0.14	%	Rectangular	1.73	1.00	0.08	>10000
B	Effective sensor position	0.33	%	Rectangular	1.73	1.00	0.19	>10000
B	Horn/probe alignment	0.37	%	Normal	2.00	0.50	0.09	>10000
B	Reflections in chamber	1.00	%	U - shaped	1.41	1.00	0.71	>10000
B	Reflections probe/holder	1.00	%	U - shaped	1.41	1.00	0.71	>10000
B	Reflections horn/probe	0.50	%	U - shaped	1.41	1.00	0.35	>10000
B	Scale reading	0.10	%	Rectangular	1.73	1.00	0.06	>10000
A	Repeatability	0.06	%	Normal	1.00	1.00	0.06	9
B	Reproducibility	1.00	%	Rectangular	1.73	1.00	0.58	>10000
B	Temperature effects	2.20	%	Rectangular	1.73	0.50	0.64	>10000
B	Horn gain drift	1.00	%	Rectangular	1.73	0.50	0.29	>10000
Uc(CF)	Combined uncertainty			normal			1.90	1372422
U	Expanded uncertainty			normal (k=2)			3.79	

Table C.1.4 – Uncertainty budget for FL7018 measurement with 10 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Coupler power ratio	4.10	%	Normal	2.00	0.50	1.03	>10000
B	Power meter accuracy	0.50	%	Rectangular	1.73	0.50	0.14	>10000
B	Power meter reference	0.70	%	Rectangular	1.73	0.50	0.20	>10000
B	Power reference drift	0.10	%	Rectangular	1.73	0.50	0.03	>10000
B	Power meter zero setting	0.75	%	Rectangular	1.73	0.50	0.22	>10000
A	Connector repeatability	0.30	%	Normal	2.00	0.50	0.08	4
B	Power sensor linearity	1.20	%	Rectangular	1.73	0.50	0.35	>10000
B	Coupler/horn mismatch	1.30	%	U - shaped	1.41	0.50	0.46	>10000
B	Horn gain	1.16	%	Normal	2.00	0.50	0.29	>10000
B	Distance encoder	0.13	%	Rectangular	1.73	1.00	0.08	>10000
B	Horn/radome reference	0.14	%	Rectangular	1.73	1.00	0.08	>10000
B	Effective sensor position	0.33	%	Rectangular	1.73	1.00	0.19	>10000
B	Horn/probe alignment	0.37	%	Normal	2.00	0.50	0.09	>10000
B	Reflections in chamber	1.00	%	U - shaped	1.41	1.00	0.71	>10000
B	Reflections probe/holder	1.00	%	U - shaped	1.41	1.00	0.71	>10000
B	Reflections horn/probe	0.50	%	U - shaped	1.41	1.00	0.35	>10000
B	Scale reading	0.10	%	Rectangular	1.73	1.00	0.06	>10000
A	Repeatability	0.08	%	Normal	1.00	1.00	0.08	9
B	Reproducibility	1.00	%	Rectangular	1.73	1.00	0.58	>10000
B	Temperature effects	2.20	%	Rectangular	1.73	0.50	0.64	>10000
B	Horn gain drift	1.00	%	Rectangular	1.73	0.50	0.29	>10000
Uc(CF)	Combined uncertainty			normal			1.90	1073515
U	Expanded uncertainty			normal (k=2)			3.79	

Table C.1.5 – Uncertainty budget for FL7018 measurement with 30 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Coupler power ratio	2.30	%	Normal	2.00	0.50	0.58	>10000
B	Power sensor accuracy	0.40	%	Normal	2.00	0.50	0.10	>10000
B	Power meter accuracy	0.50	%	Rectangular	1.73	0.50	0.14	>10000
B	Power meter reference	0.70	%	Rectangular	1.73	0.50	0.20	>10000
B	Power reference drift	0.10	%	Rectangular	1.73	0.50	0.03	>10000
B	Power meter zero setting	0.75	%	Rectangular	1.73	0.50	0.22	>10000
A	Connector repeatability	0.30	%	Normal	2.00	0.50	0.08	4
B	Power sensor linearity	1.20	%	Rectangular	1.73	0.50	0.35	>10000
B	Coupler/horn mismatch	1.30	%	U - shaped	1.41	0.50	0.46	>10000
B	Coupler/Psensor Mismatch	0.70	%	U - shaped	1.41	0.50	0.25	>10000
B	Horn gain	3.70	%	Normal	2.00	0.50	0.93	>10000
B	Distance encoder	0.13	%	Rectangular	1.73	1.00	0.08	>10000
B	Horn/radome reference	0.14	%	Rectangular	1.73	1.00	0.08	>10000
B	Effective sensor position	0.33	%	Rectangular	1.73	1.00	0.19	>10000
B	Horn/probe alignment	0.37	%	Normal	2.00	0.50	0.09	>10000
B	Reflections in chamber	1.00	%	U - shaped	1.41	1.00	0.71	>10000
B	Reflections probe/holder	1.00	%	U - shaped	1.41	1.00	0.71	>10000
B	Reflections horn/probe	0.50	%	U - shaped	1.41	1.00	0.35	>10000
B	Scale reading	0.10	%	Rectangular	1.73	1.00	0.06	>10000
A	Repeatability	0.03	%	Normal	1.00	1.00	0.03	9
B	Reproducibility	1.00	%	Rectangular	1.73	1.00	0.58	>10000
B	Temperature effects	2.20	%	Rectangular	1.73	0.50	0.64	>10000
B	Horn gain drift	1.00	%	Rectangular	1.73	0.50	0.29	>10000
Uc(CF)	Combined uncertainty			normal			1.93	1724646
U	Expanded uncertainty			normal (k=2)			3.85	

Table C.1.6 – Uncertainty budget for FL7018 measurement with 30 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Coupler power ratio	4.10	%	Normal	2.00	0.50	1.03	>10000
B	Power meter accuracy	0.50	%	Rectangular	1.73	0.50	0.14	>10000
B	Power meter reference	0.70	%	Rectangular	1.73	0.50	0.20	>10000
B	Power reference drift	0.10	%	Rectangular	1.73	0.50	0.03	>10000
B	Power meter zero setting	0.75	%	Rectangular	1.73	0.50	0.22	>10000
A	Connector repeatability	0.30	%	Normal	2.00	0.50	0.08	4
B	Power sensor linearity	1.20	%	Rectangular	1.73	0.50	0.35	>10000
B	Coupler/horn mismatch	1.30	%	U - shaped	1.41	0.50	0.46	>10000
B	Horn gain	1.80	%	Normal	2.00	0.50	0.45	>10000
B	Distance encoder	0.13	%	Rectangular	1.73	1.00	0.08	>10000
B	Horn/radome reference	0.14	%	Rectangular	1.73	1.00	0.08	>10000
B	Effective sensor position	0.33	%	Rectangular	1.73	1.00	0.19	>10000
B	Horn/probe alignment	0.37	%	Normal	2.00	0.50	0.09	>10000
B	Reflections in chamber	0.75	%	U - shaped	1.41	1.00	0.53	>10000
B	Reflections probe/holder	1.00	%	U - shaped	1.41	1.00	0.71	>10000
B	Reflections horn/probe	0.50	%	U - shaped	1.41	1.00	0.35	>10000
B	Scale reading	0.10	%	Rectangular	1.73	1.00	0.06	>10000
A	Repeatability	0.08	%	Normal	1.00	1.00	0.08	9
B	Reproducibility	1.00	%	Rectangular	1.73	1.00	0.58	>10000
B	Temperature effects	2.20	%	Rectangular	1.73	0.50	0.64	>10000
B	Horn gain drift	1.00	%	Rectangular	1.73	0.50	0.29	>10000
Uc(CF)	Combined uncertainty			normal			1.87	1014672
U	Expanded uncertainty			normal (k=2)			3.74	

Table C.1.7 – Uncertainty budget for FL7018 measurement with 30 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Coupler power ratio	4.10	%	Normal	2.00	0.50	1.03	>10000
B	Power meter accuracy	0.50	%	Rectangular	1.73	0.50	0.14	>10000
B	Power meter reference	0.70	%	Rectangular	1.73	0.50	0.20	>10000
B	Power reference drift	0.10	%	Rectangular	1.73	0.50	0.03	>10000
B	Power meter zero setting	0.75	%	Rectangular	1.73	0.50	0.22	>10000
A	Connector repeatability	0.30	%	Normal	2.00	0.50	0.08	4
B	Power sensor linearity	1.20	%	Rectangular	1.73	0.50	0.35	>10000
B	Coupler/horn mismatch	1.30	%	U - shaped	1.41	0.50	0.46	>10000
B	Horn gain	1.16	%	Normal	2.00	0.50	0.29	>10000
B	Distance encoder	0.13	%	Rectangular	1.73	1.00	0.08	>10000
B	Horn/radome reference	0.14	%	Rectangular	1.73	1.00	0.08	>10000
B	Effective sensor position	0.33	%	Rectangular	1.73	1.00	0.19	>10000
B	Horn/probe alignment	0.37	%	Normal	2.00	0.50	0.09	>10000
B	Reflections in chamber	1.00	%	U - shaped	1.41	1.00	0.71	>10000
B	Reflections probe/holder	1.00	%	U - shaped	1.41	1.00	0.71	>10000
B	Reflections horn/probe	0.50	%	U - shaped	1.41	1.00	0.35	>10000
B	Scale reading	0.10	%	Rectangular	1.73	1.00	0.06	>10000
A	Repeatability	0.10	%	Normal	1.00	1.00	0.10	9
B	Reproducibility	1.00	%	Rectangular	1.73	1.00	0.58	>10000
B	Temperature effects	2.20	%	Rectangular	1.73	0.50	0.64	>10000
B	Horn gain drift	1.00	%	Rectangular	1.73	0.50	0.29	>10000
Uc(CF)	Combined uncertainty			normal			1.90	644126
U	Expanded uncertainty			normal (k=2)			3.79	

Table C.1.8 – Uncertainty budget for FL7018 measurement with 30 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Coupler power ratio	4.10	%	Normal	2.00	0.50	1.03	>10000
B	Power meter accuracy	0.50	%	Rectangular	1.73	0.50	0.14	>10000
B	Power meter reference	0.70	%	Rectangular	1.73	0.50	0.20	>10000
B	Power reference drift	0.10	%	Rectangular	1.73	0.50	0.03	>10000
B	Power meter zero setting	0.75	%	Rectangular	1.73	0.50	0.22	>10000
A	Connector repeatability	0.30	%	Normal	2.00	0.50	0.08	4
B	Power sensor linearity	1.20	%	Rectangular	1.73	0.50	0.35	>10000
B	Coupler/horn mismatch	1.30	%	U - shaped	1.41	0.50	0.46	>10000
B	Horn gain	1.16	%	Normal	2.00	0.50	0.29	>10000
B	Distance encoder	0.13	%	Rectangular	1.73	1.00	0.08	>10000
B	Horn/radome reference	0.14	%	Rectangular	1.73	1.00	0.08	>10000
B	Effective sensor position	0.33	%	Rectangular	1.73	1.00	0.19	>10000
B	Horn/probe alignment	0.37	%	Normal	2.00	0.50	0.09	>10000
B	Reflections in chamber	1.00	%	U - shaped	1.41	1.00	0.71	>10000
B	Reflections probe/holder	1.00	%	U - shaped	1.41	1.00	0.71	>10000
B	Reflections horn/probe	0.50	%	U - shaped	1.41	1.00	0.35	>10000
B	Scale reading	0.10	%	Rectangular	1.73	1.00	0.06	>10000
A	Repeatability	0.04	%	Normal	1.00	1.00	0.04	9
B	Reproducibility	1.00	%	Rectangular	1.73	1.00	0.58	>10000
B	Temperature effects	2.20	%	Rectangular	1.73	0.50	0.64	>10000
B	Horn gain drift	1.00	%	Rectangular	1.73	0.50	0.29	>10000
Uc(CF)	Combined uncertainty			normal			1.89	1589188
U	Expanded uncertainty			normal (k=2)			3.79	

Table C.1.9 – Uncertainty budget for FL7018 measurement with 100 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Coupler power ratio	2.30	%	Normal	2.00	0.50	0.58	>10000
B	Power sensor accuracy	0.40	%	Normal	2.00	0.50	0.10	>10000
B	Power meter accuracy	0.50	%	Rectangular	1.73	0.50	0.14	>10000
B	Power meter reference	0.70	%	Rectangular	1.73	0.50	0.20	>10000
B	Power reference drift	0.10	%	Rectangular	1.73	0.50	0.03	>10000
B	Power meter zero setting	0.75	%	Rectangular	1.73	0.50	0.22	>10000
A	Connector repeatability	0.30	%	Normal	2.00	0.50	0.08	4
B	Power sensor linearity	1.20	%	Rectangular	1.73	0.50	0.35	>10000
B	Coupler/horn mismatch	1.30	%	U - shaped	1.41	0.50	0.46	>10000
B	Coupler/Psensor Mismatch	0.70	%	U - shaped	1.41	0.50	0.25	>10000
B	Horn gain	3.70	%	Normal	2.00	0.50	0.93	>10000
B	Distance encoder	0.13	%	Rectangular	1.73	1.00	0.08	>10000
B	Horn/radome reference	0.14	%	Rectangular	1.73	1.00	0.08	>10000
B	Effective sensor position	0.33	%	Rectangular	1.73	1.00	0.19	>10000
B	Horn/probe alignment	0.37	%	Normal	2.00	0.50	0.09	>10000
B	Reflections in chamber	1.00	%	U - shaped	1.41	1.00	0.71	>10000
B	Reflections probe/holder	1.00	%	U - shaped	1.41	1.00	0.71	>10000
B	Reflections horn/probe	0.50	%	U - shaped	1.41	1.00	0.35	>10000
B	Scale reading	0.10	%	Rectangular	1.73	1.00	0.06	>10000
A	Repeatability	0.03	%	Normal	1.00	1.00	0.03	9
B	Reproducibility	1.00	%	Rectangular	1.73	1.00	0.58	>10000
B	Temperature effects	2.20	%	Rectangular	1.73	0.50	0.64	>10000
B	Horn gain drift	1.00	%	Rectangular	1.73	0.50	0.29	>10000
Uc(CF)	Combined uncertainty			normal			1.93	1725269
U	Expanded uncertainty			normal (k=2)			3.85	

Table C.1.10 – Uncertainty budget for FL7018 measurement with 100 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Coupler power ratio	4.10	%	Normal	2.00	0.50	1.03	>10000
B	Power meter accuracy	0.50	%	Rectangular	1.73	0.50	0.14	>10000
B	Power meter reference	0.70	%	Rectangular	1.73	0.50	0.20	>10000
B	Power reference drift	0.10	%	Rectangular	1.73	0.50	0.03	>10000
B	Power meter zero setting	0.75	%	Rectangular	1.73	0.50	0.22	>10000
A	Connector repeatability	0.30	%	Normal	2.00	0.50	0.08	4
B	Power sensor linearity	1.20	%	Rectangular	1.73	0.50	0.35	>10000
B	Coupler/horn mismatch	1.30	%	U - shaped	1.41	0.50	0.46	>10000
B	Horn gain	1.80	%	Normal	2.00	0.50	0.45	>10000
B	Distance encoder	0.13	%	Rectangular	1.73	1.00	0.08	>10000
B	Horn/radome reference	0.14	%	Rectangular	1.73	1.00	0.08	>10000
B	Effective sensor position	0.33	%	Rectangular	1.73	1.00	0.19	>10000
B	Horn/probe alignment	0.37	%	Normal	2.00	0.50	0.09	>10000
B	Reflections in chamber	0.75	%	U - shaped	1.41	1.00	0.53	>10000
B	Reflections probe/holder	1.00	%	U - shaped	1.41	1.00	0.71	>10000
B	Reflections horn/probe	0.50	%	U - shaped	1.41	1.00	0.35	>10000
B	Scale reading	0.10	%	Rectangular	1.73	1.00	0.06	>10000
A	Repeatability	0.05	%	Normal	1.00	1.00	0.05	9
B	Reproducibility	1.00	%	Rectangular	1.73	1.00	0.58	>10000
B	Temperature effects	2.20	%	Rectangular	1.73	0.50	0.64	>10000
B	Horn gain drift	1.00	%	Rectangular	1.73	0.50	0.29	>10000
Uc(CF)	Combined uncertainty			normal			1.87	1388095
U	Expanded uncertainty			normal (k=2)			3.74	

Table C.1.11 – Uncertainty budget for FL7018 measurement with 100 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Coupler power ratio	4.10	%	Normal	2.00	0.50	1.03	>10000
B	Power meter accuracy	0.50	%	Rectangular	1.73	0.50	0.14	>10000
B	Power meter reference	0.70	%	Rectangular	1.73	0.50	0.20	>10000
B	Power reference drift	0.10	%	Rectangular	1.73	0.50	0.03	>10000
B	Power meter zero setting	0.75	%	Rectangular	1.73	0.50	0.22	>10000
A	Connector repeatability	0.30	%	Normal	2.00	0.50	0.08	4
B	Power sensor linearity	1.20	%	Rectangular	1.73	0.50	0.35	>10000
B	Coupler/horn mismatch	1.30	%	U - shaped	1.41	0.50	0.46	>10000
B	Horn gain	1.16	%	Normal	2.00	0.50	0.29	>10000
B	Distance encoder	0.13	%	Rectangular	1.73	1.00	0.08	>10000
B	Horn/radome reference	0.14	%	Rectangular	1.73	1.00	0.08	>10000
B	Effective sensor position	0.33	%	Rectangular	1.73	1.00	0.19	>10000
B	Horn/probe alignment	0.37	%	Normal	2.00	0.50	0.09	>10000
B	Reflections in chamber	1.00	%	U - shaped	1.41	1.00	0.71	>10000
B	Reflections probe/holder	1.00	%	U - shaped	1.41	1.00	0.71	>10000
B	Reflections horn/probe	0.50	%	U - shaped	1.41	1.00	0.35	>10000
B	Scale reading	0.10	%	Rectangular	1.73	1.00	0.06	>10000
A	Repeatability	0.06	%	Normal	1.00	1.00	0.06	9
B	Reproducibility	1.00	%	Rectangular	1.73	1.00	0.58	>10000
B	Temperature effects	2.20	%	Rectangular	1.73	0.50	0.64	>10000
B	Horn gain drift	1.00	%	Rectangular	1.73	0.50	0.29	>10000
Uc(CF)	Combined uncertainty			normal			1.90	1317537
U	Expanded uncertainty			normal (k=2)			3.79	

Table C.1.12 – Uncertainty budget for FL7018 measurement with 100 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Coupler power ratio	4.10	%	Normal	2.00	0.50	1.03	>10000
B	Power meter accuracy	0.50	%	Rectangular	1.73	0.50	0.14	>10000
B	Power meter reference	0.70	%	Rectangular	1.73	0.50	0.20	>10000
B	Power reference drift	0.10	%	Rectangular	1.73	0.50	0.03	>10000
B	Power meter zero setting	0.75	%	Rectangular	1.73	0.50	0.22	>10000
A	Connector repeatability	0.30	%	Normal	2.00	0.50	0.08	4
B	Power sensor linearity	1.20	%	Rectangular	1.73	0.50	0.35	>10000
B	Coupler/horn mismatch	1.30	%	U - shaped	1.41	0.50	0.46	>10000
B	Horn gain	1.16	%	Normal	2.00	0.50	0.29	>10000
B	Distance encoder	0.13	%	Rectangular	1.73	1.00	0.08	>10000
B	Horn/radome reference	0.14	%	Rectangular	1.73	1.00	0.08	>10000
B	Effective sensor position	0.33	%	Rectangular	1.73	1.00	0.19	>10000
B	Horn/probe alignment	0.37	%	Normal	2.00	0.50	0.09	>10000
B	Reflections in chamber	1.00	%	U - shaped	1.41	1.00	0.71	>10000
B	Reflections probe/holder	1.00	%	U - shaped	1.41	1.00	0.71	>10000
B	Reflections horn/probe	0.50	%	U - shaped	1.41	1.00	0.35	>10000
B	Scale reading	0.10	%	Rectangular	1.73	1.00	0.06	>10000
A	Repeatability	0.03	%	Normal	1.00	1.00	0.03	9
B	Reproducibility	1.00	%	Rectangular	1.73	1.00	0.58	>10000
B	Temperature effects	2.20	%	Rectangular	1.73	0.50	0.64	>10000
B	Horn gain drift	1.00	%	Rectangular	1.73	0.50	0.29	>10000
Uc(CF)	Combined uncertainty			normal			1.89	1607013
U	Expanded uncertainty			normal (k=2)			3.79	

Table C.1.13 – Uncertainty budget for FP7050 measurement with 30 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Coupler power ratio	2.30	%	Normal	2.00	0.50	0.58	>10000
B	Power sensor accuracy	0.40	%	Normal	2.00	0.50	0.10	>10000
B	Power meter accuracy	0.50	%	Rectangular	1.73	0.50	0.14	>10000
B	Power meter reference	0.70	%	Rectangular	1.73	0.50	0.20	>10000
B	Power reference drift	0.10	%	Rectangular	1.73	0.50	0.03	>10000
B	Power meter zero setting	0.75	%	Rectangular	1.73	0.50	0.22	>10000
A	Connector repeatability	0.30	%	Normal	2.00	0.50	0.08	4
B	Power sensor linearity	1.20	%	Rectangular	1.73	0.50	0.35	>10000
B	Coupler/horn mismatch	1.30	%	U - shaped	1.41	0.50	0.46	>10000
B	Coupler/Psensor Mismatch	0.70	%	U - shaped	1.41	0.50	0.25	>10000
B	Horn gain	3.70	%	Normal	2.00	0.50	0.93	>10000
B	Distance encoder	0.13	%	Rectangular	1.73	1.00	0.08	>10000
B	Horn/radome reference	0.14	%	Rectangular	1.73	1.00	0.08	>10000
B	Effective sensor position	0.33	%	Rectangular	1.73	1.00	0.19	>10000
B	Horn/probe alignment	0.37	%	Normal	2.00	0.50	0.09	>10000
B	Reflections in chamber	0.50	%	U - shaped	1.41	1.00	0.35	>10000
B	Reflections probe/holder	1.00	%	U - shaped	1.41	1.00	0.71	>10000
B	Reflections horn/probe	0.50	%	U - shaped	1.41	1.00	0.35	>10000
B	Scale reading	0.10	%	Rectangular	1.73	1.00	0.06	>10000
A	Repeatability	0.10	%	Normal	1.00	1.00	0.10	9
B	Reproducibility	1.00	%	Rectangular	1.73	1.00	0.58	>10000
B	Temperature effects	2.20	%	Rectangular	1.73	0.50	0.64	>10000
B	Horn gain drift	1.00	%	Rectangular	1.73	0.50	0.29	>10000
Uc(CF)	Combined uncertainty			normal			1.83	651815
U	Expanded uncertainty			normal (k=2)			3.66	

Table C.1.14 – Uncertainty budget for FP7050 measurement with 30 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Coupler power ratio	4.10	%	Normal	2.00	0.50	1.03	>10000
B	Power meter accuracy	0.50	%	Rectangular	1.73	0.50	0.14	>10000
B	Power meter reference	0.70	%	Rectangular	1.73	0.50	0.20	>10000
B	Power reference drift	0.10	%	Rectangular	1.73	0.50	0.03	>10000
B	Power meter zero setting	0.75	%	Rectangular	1.73	0.50	0.22	>10000
A	Connector repeatability	0.30	%	Normal	2.00	0.50	0.08	4
B	Power sensor linearity	1.20	%	Rectangular	1.73	0.50	0.35	>10000
B	Coupler/horn mismatch	1.30	%	U - shaped	1.41	0.50	0.46	>10000
B	Horn gain	1.80	%	Normal	2.00	0.50	0.45	>10000
B	Distance encoder	0.13	%	Rectangular	1.73	1.00	0.08	>10000
B	Horn/radome reference	0.14	%	Rectangular	1.73	1.00	0.08	>10000
B	Effective sensor position	0.33	%	Rectangular	1.73	1.00	0.19	>10000
B	Horn/probe alignment	0.37	%	Normal	2.00	0.50	0.09	>10000
B	Reflections in chamber	0.75	%	U - shaped	1.41	1.00	0.53	>10000
B	Reflections probe/holder	1.00	%	U - shaped	1.41	1.00	0.71	>10000
B	Reflections horn/probe	0.50	%	U - shaped	1.41	1.00	0.35	>10000
B	Scale reading	0.10	%	Rectangular	1.73	1.00	0.06	>10000
A	Repeatability	0.13	%	Normal	1.00	1.00	0.13	9
B	Reproducibility	1.00	%	Rectangular	1.73	1.00	0.58	>10000
B	Temperature effects	2.20	%	Rectangular	1.73	0.50	0.64	>10000
B	Horn gain drift	1.00	%	Rectangular	1.73	0.50	0.29	>10000
Uc(CF)	Combined uncertainty			normal			1.87	288255
U	Expanded uncertainty			normal (k=2)			3.74	

Table C.1.15 – Uncertainty budget for FP7050 measurement with 30 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Coupler power ratio	4.10	%	Normal	2.00	0.50	1.03	>10000
B	Power meter accuracy	0.50	%	Rectangular	1.73	0.50	0.14	>10000
B	Power meter reference	0.70	%	Rectangular	1.73	0.50	0.20	>10000
B	Power reference drift	0.10	%	Rectangular	1.73	0.50	0.03	>10000
B	Power meter zero setting	0.75	%	Rectangular	1.73	0.50	0.22	>10000
A	Connector repeatability	0.30	%	Normal	2.00	0.50	0.08	4
B	Power sensor linearity	1.20	%	Rectangular	1.73	0.50	0.35	>10000
B	Coupler/horn mismatch	1.30	%	U - shaped	1.41	0.50	0.46	>10000
B	Horn gain	1.16	%	Normal	2.00	0.50	0.29	>10000
B	Distance encoder	0.13	%	Rectangular	1.73	1.00	0.08	>10000
B	Horn/radome reference	0.14	%	Rectangular	1.73	1.00	0.08	>10000
B	Effective sensor position	0.33	%	Rectangular	1.73	1.00	0.19	>10000
B	Horn/probe alignment	0.37	%	Normal	2.00	0.50	0.09	>10000
B	Reflections in chamber	1.00	%	U - shaped	1.41	1.00	0.71	>10000
B	Reflections probe/holder	1.00	%	U - shaped	1.41	1.00	0.71	>10000
B	Reflections horn/probe	0.50	%	U - shaped	1.41	1.00	0.35	>10000
B	Scale reading	0.10	%	Rectangular	1.73	1.00	0.06	>10000
A	Repeatability	0.09	%	Normal	1.00	1.00	0.09	9
B	Reproducibility	1.00	%	Rectangular	1.73	1.00	0.58	>10000
B	Temperature effects	2.20	%	Rectangular	1.73	0.50	0.64	>10000
B	Horn gain drift	1.00	%	Rectangular	1.73	0.50	0.29	>10000
Uc(CF)	Combined uncertainty			normal			1.90	935120
U	Expanded uncertainty			normal (k=2)			3.79	

Table C.1.16 – Uncertainty budget for FP7050 measurement with 30 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Coupler power ratio	4.10	%	Normal	2.00	0.50	1.03	>10000
B	Power meter accuracy	0.50	%	Rectangular	1.73	0.50	0.14	>10000
B	Power meter reference	0.70	%	Rectangular	1.73	0.50	0.20	>10000
B	Power reference drift	0.10	%	Rectangular	1.73	0.50	0.03	>10000
B	Power meter zero setting	0.75	%	Rectangular	1.73	0.50	0.22	>10000
A	Connector repeatability	0.30	%	Normal	2.00	0.50	0.08	4
B	Power sensor linearity	1.20	%	Rectangular	1.73	0.50	0.35	>10000
B	Coupler/horn mismatch	1.30	%	U - shaped	1.41	0.50	0.46	>10000
B	Horn gain	1.16	%	Normal	2.00	0.50	0.29	>10000
B	Distance encoder	0.13	%	Rectangular	1.73	1.00	0.08	>10000
B	Horn/radome reference	0.14	%	Rectangular	1.73	1.00	0.08	>10000
B	Effective sensor position	0.33	%	Rectangular	1.73	1.00	0.19	>10000
B	Horn/probe alignment	0.37	%	Normal	2.00	0.50	0.09	>10000
B	Reflections in chamber	1.00	%	U - shaped	1.41	1.00	0.71	>10000
B	Reflections probe/holder	1.00	%	U - shaped	1.41	1.00	0.71	>10000
B	Reflections horn/probe	0.50	%	U - shaped	1.41	1.00	0.35	>10000
B	Scale reading	0.10	%	Rectangular	1.73	1.00	0.06	>10000
A	Repeatability	0.14	%	Normal	1.00	1.00	0.14	9
B	Reproducibility	1.00	%	Rectangular	1.73	1.00	0.58	>10000
B	Temperature effects	2.20	%	Rectangular	1.73	0.50	0.64	>10000
B	Horn gain drift	1.00	%	Rectangular	1.73	0.50	0.29	>10000
Uc(CF)	Combined uncertainty			normal			1.90	252926
U	Expanded uncertainty			normal (k=2)			3.80	

Table C.1.17 – Uncertainty budget for FP7050 measurement with 100 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Coupler power ratio	2.30	%	Normal	2.00	0.50	0.58	>10000
B	Power sensor accuracy	0.40	%	Normal	2.00	0.50	0.10	>10000
B	Power meter accuracy	0.50	%	Rectangular	1.73	0.50	0.14	>10000
B	Power meter reference	0.70	%	Rectangular	1.73	0.50	0.20	>10000
B	Power reference drift	0.10	%	Rectangular	1.73	0.50	0.03	>10000
B	Power meter zero setting	0.75	%	Rectangular	1.73	0.50	0.22	>10000
A	Connector repeatability	0.30	%	Normal	2.00	0.50	0.08	4
B	Power sensor linearity	1.20	%	Rectangular	1.73	0.50	0.35	>10000
B	Coupler/horn mismatch	1.30	%	U - shaped	1.41	0.50	0.46	>10000
B	Coupler/Psensor Mismatch	0.70	%	U - shaped	1.41	0.50	0.25	>10000
B	Horn gain	3.70	%	Normal	2.00	0.50	0.93	>10000
B	Distance encoder	0.13	%	Rectangular	1.73	1.00	0.08	>10000
B	Horn/radome reference	0.14	%	Rectangular	1.73	1.00	0.08	>10000
B	Effective sensor position	0.33	%	Rectangular	1.73	1.00	0.19	>10000
B	Horn/probe alignment	0.37	%	Normal	2.00	0.50	0.09	>10000
B	Reflections in chamber	0.50	%	U - shaped	1.41	1.00	0.35	>10000
B	Reflections probe/holder	1.00	%	U - shaped	1.41	1.00	0.71	>10000
B	Reflections horn/probe	0.50	%	U - shaped	1.41	1.00	0.35	>10000
B	Scale reading	0.10	%	Rectangular	1.73	1.00	0.06	>10000
A	Repeatability	0.03	%	Normal	1.00	1.00	0.03	9
B	Reproducibility	1.00	%	Rectangular	1.73	1.00	0.58	>10000
B	Temperature effects	2.20	%	Rectangular	1.73	0.50	0.64	>10000
B	Horn gain drift	1.00	%	Rectangular	1.73	0.50	0.29	>10000
Uc(CF)	Combined uncertainty			normal			1.83	1398663
U	Expanded uncertainty			normal (k=2)			3.65	

Table C.1.18 – Uncertainty budget for FP7050 measurement with 100 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Coupler power ratio	4.10	%	Normal	2.00	0.50	1.03	>10000
B	Power meter accuracy	0.50	%	Rectangular	1.73	0.50	0.14	>10000
B	Power meter reference	0.70	%	Rectangular	1.73	0.50	0.20	>10000
B	Power reference drift	0.10	%	Rectangular	1.73	0.50	0.03	>10000
B	Power meter zero setting	0.75	%	Rectangular	1.73	0.50	0.22	>10000
A	Connector repeatability	0.30	%	Normal	2.00	0.50	0.08	4
B	Power sensor linearity	1.20	%	Rectangular	1.73	0.50	0.35	>10000
B	Coupler/horn mismatch	1.30	%	U - shaped	1.41	0.50	0.46	>10000
B	Horn gain	1.80	%	Normal	2.00	0.50	0.45	>10000
B	Distance encoder	0.13	%	Rectangular	1.73	1.00	0.08	>10000
B	Horn/radome reference	0.14	%	Rectangular	1.73	1.00	0.08	>10000
B	Effective sensor position	0.33	%	Rectangular	1.73	1.00	0.19	>10000
B	Horn/probe alignment	0.37	%	Normal	2.00	0.50	0.09	>10000
B	Reflections in chamber	0.75	%	U - shaped	1.41	1.00	0.53	>10000
B	Reflections probe/holder	1.00	%	U - shaped	1.41	1.00	0.71	>10000
B	Reflections horn/probe	0.50	%	U - shaped	1.41	1.00	0.35	>10000
B	Scale reading	0.10	%	Rectangular	1.73	1.00	0.06	>10000
A	Repeatability	0.03	%	Normal	1.00	1.00	0.03	9
B	Reproducibility	1.00	%	Rectangular	1.73	1.00	0.58	>10000
B	Temperature effects	2.20	%	Rectangular	1.73	0.50	0.64	>10000
B	Horn gain drift	1.00	%	Rectangular	1.73	0.50	0.29	>10000
Uc(CF)	Combined uncertainty			normal			1.87	1508774
U	Expanded uncertainty			normal (k=2)			3.74	

Table C.1.19 – Uncertainty budget for FP7050 measurement with 100 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Coupler power ratio	4.10	%	Normal	2.00	0.50	1.03	>10000
B	Power meter accuracy	0.50	%	Rectangular	1.73	0.50	0.14	>10000
B	Power meter reference	0.70	%	Rectangular	1.73	0.50	0.20	>10000
B	Power reference drift	0.10	%	Rectangular	1.73	0.50	0.03	>10000
B	Power meter zero setting	0.75	%	Rectangular	1.73	0.50	0.22	>10000
A	Connector repeatability	0.30	%	Normal	2.00	0.50	0.08	4
B	Power sensor linearity	1.20	%	Rectangular	1.73	0.50	0.35	>10000
B	Coupler/horn mismatch	1.30	%	U - shaped	1.41	0.50	0.46	>10000
B	Horn gain	1.16	%	Normal	2.00	0.50	0.29	>10000
B	Distance encoder	0.13	%	Rectangular	1.73	1.00	0.08	>10000
B	Horn/radome reference	0.14	%	Rectangular	1.73	1.00	0.08	>10000
B	Effective sensor position	0.33	%	Rectangular	1.73	1.00	0.19	>10000
B	Horn/probe alignment	0.37	%	Normal	2.00	0.50	0.09	>10000
B	Reflections in chamber	1.00	%	U - shaped	1.41	1.00	0.71	>10000
B	Reflections probe/holder	1.00	%	U - shaped	1.41	1.00	0.71	>10000
B	Reflections horn/probe	0.50	%	U - shaped	1.41	1.00	0.35	>10000
B	Scale reading	0.10	%	Rectangular	1.73	1.00	0.06	>10000
A	Repeatability	0.04	%	Normal	1.00	1.00	0.04	9
B	Reproducibility	1.00	%	Rectangular	1.73	1.00	0.58	>10000
B	Temperature effects	2.20	%	Rectangular	1.73	0.50	0.64	>10000
B	Horn gain drift	1.00	%	Rectangular	1.73	0.50	0.29	>10000
Uc(CF)	Combined uncertainty			normal			1.89	1585286
U	Expanded uncertainty			normal (k=2)			3.79	

Table C.1.20 – Uncertainty budget for FP7050 measurement with 100 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Coupler power ratio	4.10	%	Normal	2.00	0.50	1.03	>10000
B	Power meter accuracy	0.50	%	Rectangular	1.73	0.50	0.14	>10000
B	Power meter reference	0.70	%	Rectangular	1.73	0.50	0.20	>10000
B	Power reference drift	0.10	%	Rectangular	1.73	0.50	0.03	>10000
B	Power meter zero setting	0.75	%	Rectangular	1.73	0.50	0.22	>10000
A	Connector repeatability	0.30	%	Normal	2.00	0.50	0.08	4
B	Power sensor linearity	1.20	%	Rectangular	1.73	0.50	0.35	>10000
B	Coupler/horn mismatch	1.30	%	U - shaped	1.41	0.50	0.46	>10000
B	Horn gain	1.16	%	Normal	2.00	0.50	0.29	>10000
B	Distance encoder	0.13	%	Rectangular	1.73	1.00	0.08	>10000
B	Horn/radome reference	0.14	%	Rectangular	1.73	1.00	0.08	>10000
B	Effective sensor position	0.33	%	Rectangular	1.73	1.00	0.19	>10000
B	Horn/probe alignment	0.37	%	Normal	2.00	0.50	0.09	>10000
B	Reflections in chamber	1.00	%	U - shaped	1.41	1.00	0.71	>10000
B	Reflections probe/holder	1.00	%	U - shaped	1.41	1.00	0.71	>10000
B	Reflections horn/probe	0.50	%	U - shaped	1.41	1.00	0.35	>10000
B	Scale reading	0.10	%	Rectangular	1.73	1.00	0.06	>10000
A	Repeatability	0.07	%	Normal	1.00	1.00	0.07	9
B	Reproducibility	1.00	%	Rectangular	1.73	1.00	0.58	>10000
B	Temperature effects	2.20	%	Rectangular	1.73	0.50	0.64	>10000
B	Horn gain drift	1.00	%	Rectangular	1.73	0.50	0.29	>10000
Uc(CF)	Combined uncertainty			normal			1.90	1205764
U	Expanded uncertainty			normal (k=2)			3.79	

C.2 – PTB uncertainty budgets

The budgets in this appendix are taken from PTB's first measurement of the standards used during the European loop performed in March 2010.

The budgets for measurements of the standards used during the non-European loop are similar to these and will not be included here.

Table C.2.1 – Uncertainty budget for FL7018 measurement with 10 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Fluctuation from field probe	0.2750		Normal	1.00	1.00	0.28	11
B	Field representation (from cal. Certificate)	6.0000		Normal	1.00	1.00	6.00	∞
Uc(CF)	Combined uncertainty			normal			6.01	
U	Expanded uncertainty			normal (k=2)			12.01	

Table C.2.2 – Uncertainty budget for FL7018 measurement with 10 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Fluctuation from field probe	0.3975		Normal	1.00	1.00	0.40	11
B	Field representation (from cal. Certificate)	3.5000		Normal	1.00	1.00	3.50	∞
Uc(CF)	Combined uncertainty			normal			3.52	
U	Expanded uncertainty			normal (k=2)			7.05	

Table C.2.3 – Uncertainty budget for FL7018 measurement with 10 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Fluctuation from field probe	0.6933		Normal	1.00	1.00	0.69	11
B	Field representation (from cal. Certificate)	3.5000		Normal	1.00	1.00	3.50	∞
Uc(CF)	Combined uncertainty			normal			3.57	
U	Expanded uncertainty			normal (k=2)			7.14	

Table C.2.4 – Uncertainty budget for FL7018 measurement with 10 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Fluctuation from field probe	0.4451		Normal	1.00	1.00	0.45	11
B	Field representation (from cal. Certificate)	3.5000		Normal	1.00	1.00	3.50	∞
Uc(CF)	Combined uncertainty			normal			3.53	
U	Expanded uncertainty			normal (k=2)			7.06	

Table C.2.5 – Uncertainty budget for FL7018 measurement with 30 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Fluctuation from field probe	0.2510		Normal	1.00	1.00	0.25	11
B	Field representation (from cal. Certificate)	6.0000		Normal	1.00	1.00	6.00	∞
Uc(CF)	Combined uncertainty			normal			6.01	
U	Expanded uncertainty			normal (k=2)			12.01	

Table C.2.6 – Uncertainty budget for FL7018 measurement with 30 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Fluctuation from field probe	0.3913		Normal	1.00	1.00	0.39	11
B	Field representation (from cal. Certificate)	3.5000		Normal	1.00	1.00	3.50	∞
Uc(CF)	Combined uncertainty			normal			3.52	
U	Expanded uncertainty			normal (k=2)			7.04	

Table C.2.7 – Uncertainty budget for FL7018 measurement with 30 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Fluctuation from field probe	0.5911		Normal	1.00	1.00	0.59	11
B	Field representation (from cal. Certificate)	3.5000		Normal	1.00	1.00	3.50	∞
Uc(CF)	Combined uncertainty			normal			3.55	
U	Expanded uncertainty			normal (k=2)			7.10	

Table C.2.8 – Uncertainty budget for FL7018 measurement with 30 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Fluctuation from field probe	0.5394		Normal	1.00	1.00	0.54	11
B	Field representation (from cal. Certificate)	3.5000		Normal	1.00	1.00	3.50	∞
Uc(CF)	Combined uncertainty			normal			3.54	
U	Expanded uncertainty			normal (k=2)			7.08	

Table C.2.9 – Uncertainty budget for FL7018 measurement with 100 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Fluctuation from field probe	0.3374		Normal	1.00	1.00	0.34	11
B	Field representation (from cal. Certificate)	3.5000		Normal	1.00	1.00	3.50	∞
Uc(CF)	Combined uncertainty			normal			3.52	
U	Expanded uncertainty			normal (k=2)			7.03	

Table C.2.10 – Uncertainty budget for FL7018 measurement with 100 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Fluctuation from field probe	0.7412		Normal	1.00	1.00	0.74	11
B	Field representation (from cal. Certificate)	3.5000		Normal	1.00	1.00	3.50	∞
Uc(CF)	Combined uncertainty			normal			3.58	
U	Expanded uncertainty			normal (k=2)			7.16	

Table C.2.11 – Uncertainty budget for FL7018 measurement with 100 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Fluctuation from field probe	0.8301		Normal	1.00	1.00	0.83	11
B	Field representation (from cal. Certificate)	3.5000		Normal	1.00	1.00	3.50	∞
Uc(CF)	Combined uncertainty			normal			3.60	
U	Expanded uncertainty			normal (k=2)			7.19	

Table C.2.12 – Uncertainty budget for FP7050 measurement with 30 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Fluctuation from field probe	0.2320		Normal	1.00	1.00	0.23	11
B	Field representation (from cal. Certificate)	6.0000		Normal	1.00	1.00	6.00	∞
Uc(CF)	Combined uncertainty			normal			6.00	
U	Expanded uncertainty			normal (k=2)			12.01	

Table C.2.13 – Uncertainty budget for FP7050 measurement with 30 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Fluctuation from field probe	0.2994		Normal	1.00	1.00	0.30	11
B	Field representation (from cal. Certificate)	3.5000		Normal	1.00	1.00	3.50	∞
Uc(CF)	Combined uncertainty			normal			3.51	
U	Expanded uncertainty			normal (k=2)			7.03	

Table C.2.14 – Uncertainty budget for FP7050 measurement with 30 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Fluctuation from field probe	0.3653		Normal	1.00	1.00	0.37	11
B	Field representation (from cal. Certificate)	3.5000		Normal	1.00	1.00	3.50	∞
Uc(CF)	Combined uncertainty			normal			3.52	
U	Expanded uncertainty			normal (k=2)			7.04	

Table C.2.15 – Uncertainty budget for FP7050 measurement with 30 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Fluctuation from field probe	0.5595		Normal	1.00	1.00	0.56	11
B	Field representation (from cal. Certificate)	3.5000		Normal	1.00	1.00	3.50	∞
Uc(CF)	Combined uncertainty			normal			3.54	
U	Expanded uncertainty			normal (k=2)			7.09	

Table C.2.16 – Uncertainty budget for FP7050 measurement with 100 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Fluctuation from field probe	0.2715		Normal	1.00	1.00	0.27	11
B	Field representation (from cal. Certificate)	3.5000		Normal	1.00	1.00	3.50	∞
Uc(CF)	Combined uncertainty			normal			3.51	
U	Expanded uncertainty			normal (k=2)			7.02	

Table C.2.17 – Uncertainty budget for FP7050 measurement with 100 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Fluctuation from field probe	0.3148		Normal	1.00	1.00	0.31	11
B	Field representation (from cal. Certificate)	3.5000		Normal	1.00	1.00	3.50	∞
Uc(CF)	Combined uncertainty			normal			3.51	
U	Expanded uncertainty			normal (k=2)			7.03	

Table C.2.18 – Uncertainty budget for FP7050 measurement with 100 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Fluctuation from field probe	0.4082		Normal	1.00	1.00	0.41	11
B	Field representation (from cal. Certificate)	3.5000		Normal	1.00	1.00	3.50	∞
Uc(CF)	Combined uncertainty			normal			3.52	
U	Expanded uncertainty			normal (k=2)			7.05	

PTB did not reported results for the 100 V/m indication at 1 GHz on either probe.

C.3 – LNE uncertainty budgets

Table C.3.1 – Uncertainty budget for FL7018 measurement with 10 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Experimental standard uncertainty on mean of measurements (majorating)	0.0002		k=1	1.00	1.00	0.02%	9
B	Antenna calibration	0.0150		k=1	1.00	1.00	1.50%	
B	Coupler calibration	0.0220		k=1	1.00	1.00	2.20%	
B	SWR antenna	0.0035		k=1	1.00	1.00	0.35%	
B	wattmeter calibration	0.0100		k=1	1.00	1.00	1.00%	
B	ruler calibration	0.0010		k=1	1.00	2.00	0.20%	
B	drift ruler between 2 calibrations	0.0006		Rectangular	1.73	2.00	0.07%	
B	drift antenna between 2 calibrations	0.0013		Rectangular	1.73	1.00	0.07%	
B	drift coupler between 2 calibrations	0.0069		Rectangular	1.73	1.00	0.40%	
B	drift power meter between 2 calibrations	0.0035		Rectangular	1.73	1.00	0.20%	
B	mismatching	0.0004		k=1	1.00	1.00	0.04%	
B	imperfection anechoic chamber	0.0050		k=1	1.00	1.00	0.50%	
B	Modelisation	0.0055		k=1	1.00	1.00	0.55%	
B	Probe resolution	0.0005		Rectangular	1.73	1.00	0.03%	
B	Probe Stability	0.0021		Normal	3.00	1.00	0.07%	
Uc(CF)	Combined uncertainty			normal			3.00%	
U	Expanded uncertainty			normal (k=2)			6.01 %	

Table C.3.2 – Uncertainty budget for FL7018 measurement with 10 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Experimental standard uncertainty on mean of measurements (majorating)	0.0002		k=1	1.00	1.00	0.02%	9
B	Antenna calibration	0.0150		k=1	1.00	1.00	1.50%	
B	Coupler calibration	0.0220		k=1	1.00	1.00	2.20%	
B	SWR antenna	0.0035		k=1	1.00	1.00	0.35%	
B	wattmeter calibration	0.0100		k=1	1.00	1.00	1.00%	
B	ruler calibration	0.0010		k=1	1.00	2.00	0.20%	
B	drift ruler between 2 calibrations	0.0006		Rectangular	1.73	2.00	0.07%	
B	drift antenna between 2 calibrations	0.0013		Rectangular	1.73	1.00	0.07%	
B	drift coupler between 2 calibrations	0.0069		Rectangular	1.73	1.00	0.40%	
B	drift power meter between 2 calibrations	0.0035		Rectangular	1.73	1.00	0.20%	
B	mismatching	0.0004		k=1	1.00	1.00	0.04%	
B	imperfection anechoic chamber	0.0050		k=1	1.00	1.00	0.50%	
B	Modelisation	0.0055		k=1	1.00	1.00	0.55%	
B	Probe resolution	0.0005		Rectangular	1.73	1.00	0.03%	
B	Probe Stability	0.0021		Normal	3.00	1.00	0.07%	
Uc(CF)	Combined uncertainty			normal			3.00%	
U	Expanded uncertainty			normal (k=2)			6.01%	

Table C.3.3 – Uncertainty budget for FL7018 measurement with 10 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Experimental standard uncertainty on mean of measurements (majorating)	0.0001		k=1	1.00	1.00	0.01%	9
B	Antenna calibration	0.0150		k=1	1.00	1.00	1.50%	
B	Coupler calibration	0.0220		k=1	1.00	1.00	2.20%	
B	SWR antenna	0.0035		k=1	1.00	1.00	0.35%	
B	wattmeter calibration	0.0100		k=1	1.00	1.00	1.00%	
B	ruler calibration	0.0010		k=1	1.00	2.00	0.20%	
B	drift ruler between 2 calibrations	0.0006		Rectangular	1.73	2.00	0.07%	
B	drift antenna between 2 calibrations	0.0013		Rectangular	1.73	1.00	0.07%	
B	drift coupler between 2 calibrations	0.0069		Rectangular	1.73	1.00	0.40%	
B	drift power meter between 2 calibrations	0.0035		Rectangular	1.73	1.00	0.20%	
B	mismatching	0.0004		k=1	1.00	1.00	0.04%	
B	imperfection anechoic chamber	0.0050		k=1	1.00	1.00	0.50%	
B	Modelisation	0.0055		k=1	1.00	1.00	0.55%	
B	Probe resolution	0.0005		Rectangular	1.73	1.00	0.03%	
B	Probe Stability	0.0021		Normal	3.00	1.00	0.07%	
Uc(CF)	Combined uncertainty			normal			3.00%	
U	Expanded uncertainty			normal (k=2)			6.01%	

Table C.3.4 – Uncertainty budget for FL7018 measurement with 10 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Experimental standard uncertainty on mean of measurements (majorating)	0.0003		k=1	1.00	1.00	0.03%	9
B	Antenna calibration	0.0150		k=1	1.00	1.00	1.50%	
B	Coupler calibration	0.0220		k=1	1.00	1.00	2.20%	
B	SWR antenna	0.0035		k=1	1.00	1.00	0.35%	
B	wattmeter calibration	0.0100		k=1	1.00	1.00	1.00%	
B	ruler calibration	0.0010		k=1	1.00	2.00	0.20%	
B	drift ruler between 2 calibrations	0.0006		Rectangular	1.73	2.00	0.07%	
B	drift antenna between 2 calibrations	0.0013		Rectangular	1.73	1.00	0.07%	
B	drift coupler between 2 calibrations	0.0069		Rectangular	1.73	1.00	0.40%	
B	drift power meter between 2 calibrations	0.0035		Rectangular	1.73	1.00	0.20%	
B	mismatching	0.0004		k=1	1.00	1.00	0.04%	
B	imperfection anechoic chamber	0.0050		k=1	1.00	1.00	0.50%	
B	Modelisation	0.0055		k=1	1.00	1.00	0.55%	
B	Probe resolution	0.0005		Rectangular	1.73	1.00	0.03%	
B	Probe Stability	0.0021		Normal	3.00	1.00	0.07%	
Uc(CF)	Combined uncertainty			normal			3.00%	
U	Expanded uncertainty			normal (k=2)			6.01%	

Table C.3.5 – Uncertainty budget for FL7018 measurement with 30 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Experimental standard uncertainty on mean of measurements (majorating)	0.0004		k=1	1.00	1.00	0.04%	9
B	Antenna calibration	0.0150		k=1	1.00	1.00	1.50%	
B	Coupler calibration	0.0220		k=1	1.00	1.00	2.20%	
B	SWR antenna	0.0035		k=1	1.00	1.00	0.35%	
B	wattmeter calibration	0.0100		k=1	1.00	1.00	1.00%	
B	ruler calibration	0.0010		k=1	1.00	2.00	0.20%	
B	drift ruler between 2 calibrations	0.0006		Rectangular	1.73	2.00	0.07%	
B	drift antenna between 2 calibrations	0.0013		Rectangular	1.73	1.00	0.07%	
B	drift coupler between 2 calibrations	0.0069		Rectangular	1.73	1.00	0.40%	
B	drift power meter between 2 calibrations	0.0035		Rectangular	1.73	1.00	0.20%	
B	mismatching	0.0004		k=1	1.00	1.00	0.04%	
B	imperfection anechoic chamber	0.0050		k=1	1.00	1.00	0.50%	
B	Modelisation	0.0055		k=1	1.00	1.00	0.55%	
B	Probe resolution	0.0002		Rectangular	1.73	1.00	0.01%	
B	Probe Stability	0.0060		Normal	3.00	1.00	0.20%	
Uc(CF)	Combined uncertainty			normal			3.01%	
U	Expanded uncertainty			normal (k=2)			6.02 %	

Table C.3.6 – Uncertainty budget for FL7018 measurement with 30 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Experimental standard uncertainty on mean of measurements (majorating)	0.0005		k=1	1.00	1.00	0.05%	9
B	Antenna calibration	0.0150		k=1	1.00	1.00	1.50%	
B	Coupler calibration	0.0220		k=1	1.00	1.00	2.20%	
B	SWR antenna	0.0035		k=1	1.00	1.00	0.35%	
B	wattmeter calibration	0.0100		k=1	1.00	1.00	1.00%	
B	ruler calibration	0.0010		k=1	1.00	2.00	0.20%	
B	drift ruler between 2 calibrations	0.0006		Rectangular	1.73	2.00	0.07%	
B	drift antenna between 2 calibrations	0.0013		Rectangular	1.73	1.00	0.07%	
B	drift coupler between 2 calibrations	0.0069		Rectangular	1.73	1.00	0.40%	
B	drift power meter between 2 calibrations	0.0035		Rectangular	1.73	1.00	0.20%	
B	mismatching	0.0004		k=1	1.00	1.00	0.04%	
B	imperfection anechoic chamber	0.0050		k=1	1.00	1.00	0.50%	
B	Modelisation	0.0055		k=1	1.00	1.00	0.55%	
B	Probe resolution	0.0002		Rectangular	1.73	1.00	0.01%	
B	Probe Stability	0.0060		Normal	3.00	1.00	0.20%	
Uc(CF)	Combined uncertainty			normal			3.01%	
U	Expanded uncertainty			normal (k=2)			6.02 %	

Table C.3.7 – Uncertainty budget for FL7018 measurement with 30 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Experimental standard uncertainty on mean of measurements (majorating)	0.0007		k=1	1.00	1.00	0.07%	9
B	Antenna calibration	0.0150		k=1	1.00	1.00	1.50%	
B	Coupler calibration	0.0220		k=1	1.00	1.00	2.20%	
B	SWR antenna	0.0035		k=1	1.00	1.00	0.35%	
B	wattmeter calibration	0.0100		k=1	1.00	1.00	1.00%	
B	ruler calibration	0.0010		k=1	1.00	2.00	0.20%	
B	drift ruler between 2 calibrations	0.0006		Rectangular	1.73	2.00	0.07%	
B	drift antenna between 2 calibrations	0.0013		Rectangular	1.73	1.00	0.07%	
B	drift coupler between 2 calibrations	0.0069		Rectangular	1.73	1.00	0.40%	
B	drift power meter between 2 calibrations	0.0035		Rectangular	1.73	1.00	0.20%	
B	mismatching	0.0004		k=1	1.00	1.00	0.04%	
B	imperfection anechoic chamber	0.0050		k=1	1.00	1.00	0.50%	
B	Modelisation	0.0055		k=1	1.00	1.00	0.55%	
B	Probe resolution	0.0002		Rectangular	1.73	1.00	0.01%	
B	Probe Stability	0.0060		Normal	3.00	1.00	0.20%	
Uc(CF)	Combined uncertainty			normal			3.01%	
U	Expanded uncertainty			normal (k=2)			6.02 %	

Table C.3.8 – Uncertainty budget for FL7018 measurement with 30 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Experimental standard uncertainty on mean of measurements (majorating)	0.0005		k=1	1.00	1.00	0.05%	9
B	Antenna calibration	0.0150		k=1	1.00	1.00	1.50%	
B	Coupler calibration	0.0220		k=1	1.00	1.00	2.20%	
B	SWR antenna	0.0035		k=1	1.00	1.00	0.35%	
B	wattmeter calibration	0.0100		k=1	1.00	1.00	1.00%	
B	ruler calibration	0.0010		k=1	1.00	2.00	0.20%	
B	drift ruler between 2 calibrations	0.0006		Rectangular	1.73	2.00	0.07%	
B	drift antenna between 2 calibrations	0.0013		Rectangular	1.73	1.00	0.07%	
B	drift coupler between 2 calibrations	0.0069		Rectangular	1.73	1.00	0.40%	
B	drift power meter between 2 calibrations	0.0035		Rectangular	1.73	1.00	0.20%	
B	mismatching	0.0004		k=1	1.00	1.00	0.04%	
B	imperfection anechoic chamber	0.0050		k=1	1.00	1.00	0.50%	
B	Modelisation	0.0055		k=1	1.00	1.00	0.55%	
B	Probe resolution	0.0002		Rectangular	1.73	1.00	0.01%	
B	Probe Stability	0.0060		Normal	3.00	1.00	0.20%	
Uc(CF)	Combined uncertainty			normal			3.01%	
U	Expanded uncertainty			normal (k=2)			6.02 %	

Table C.3.9 – Uncertainty budget for FL7018 measurement with 100 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Experimental standard uncertainty on mean of measurements (majorating)	0.0003		k=1	1.00	1.00	0.03%	9
B	Antenna calibration	0.0150		k=1	1.00	1.00	1.50%	
B	Coupler calibration	0.0022		k=1	1.00	1.00	0.22%	
B	SWR antenna	0.0035		k=1	1.00	1.00	0.35%	
B	wattmeter calibration	0.0100		k=1	1.00	1.00	1.00%	
B	ruler calibration	0.0010		k=1	1.00	2.00	0.20%	
B	drift ruler between 2 calibrations	0.0006		Rectangular	1.73	2.00	0.07%	
B	drift antenna between 2 calibrations	0.0013		Rectangular	1.73	1.00	0.07%	
B	drift coupler between 2 calibrations	0.0007		Rectangular	1.73	1.00	0.04%	
B	drift power meter between 2 calibrations	0.0035		Rectangular	1.73	1.00	0.20%	
B	mismatching	0.0004		k=1	1.00	1.00	0.04%	
B	imperfection anechoic chamber	0.0050		k=1	1.00	1.00	0.50%	
B	Modelisation	0.0055		k=1	1.00	1.00	0.55%	
B	Probe resolution	0.0001		Rectangular	1.73	1.00	0.00%	
B	Probe Stability	0.0060		Normal	3.00	1.00	0.20%	
Uc(CF)	Combined uncertainty			normal			2.03%	
U	Expanded uncertainty			normal (k=2)			4.05 %	

Table C.3.10 – Uncertainty budget for FL7018 measurement with 100 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Experimental standard uncertainty on mean of measurements (majorating)	0.0002		k=1	1.00	1.00	0.02%	9
B	Antenna calibration	0.0150		k=1	1.00	1.00	1.50%	
B	Coupler calibration	0.0022		k=1	1.00	1.00	0.22%	
B	SWR antenna	0.0035		k=1	1.00	1.00	0.35%	
B	wattmeter calibration	0.0100		k=1	1.00	1.00	1.00%	
B	ruler calibration	0.0010		k=1	1.00	2.00	0.20%	
B	drift ruler between 2 calibrations	0.0006		Rectangular	1.73	2.00	0.07%	
B	drift antenna between 2 calibrations	0.0013		Rectangular	1.73	1.00	0.07%	
B	drift coupler between 2 calibrations	0.0007		Rectangular	1.73	1.00	0.04%	
B	drift power meter between 2 calibrations	0.0035		Rectangular	1.73	1.00	0.20%	
B	mismatching	0.0004		k=1	1.00	1.00	0.04%	
B	imperfection anechoic chamber	0.0050		k=1	1.00	1.00	0.50%	
B	Modelisation	0.0055		k=1	1.00	1.00	0.55%	
B	Probe resolution	0.0001		Rectangular	1.73	1.00	0.00%	
B	Probe Stability	0.0060		Normal	3.00	1.00	0.20%	
Uc(CF)	Combined uncertainty			normal			2.03%	
U	Expanded uncertainty			normal (k=2)			4.05 %	

Table C.3.11 – Uncertainty budget for FL7018 measurement with 100 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Experimental standard uncertainty on mean of measurements (majorating)	0.0004		k=1	1.00	1.00	0.04%	9
B	Antenna calibration	0.0150		k=1	1.00	1.00	1.50%	
B	Coupler calibration	0.0022		k=1	1.00	1.00	0.22%	
B	SWR antenna	0.0035		k=1	1.00	1.00	0.35%	
B	wattmeter calibration	0.0100		k=1	1.00	1.00	1.00%	
B	ruler calibration	0.0010		k=1	1.00	2.00	0.20%	
B	drift ruler between 2 calibrations	0.0006		Rectangular	1.73	2.00	0.07%	
B	drift antenna between 2 calibrations	0.0013		Rectangular	1.73	1.00	0.07%	
B	drift coupler between 2 calibrations	0.0007		Rectangular	1.73	1.00	0.04%	
B	drift power meter between 2 calibrations	0.0035		Rectangular	1.73	1.00	0.20%	
B	mismatching	0.0004		k=1	1.00	1.00	0.04%	
B	imperfection anechoic chamber	0.0050		k=1	1.00	1.00	0.50%	
B	Modelisation	0.0055		k=1	1.00	1.00	0.55%	
B	Probe resolution	0.0001		Rectangular	1.73	1.00	0.00%	
B	Probe Stability	0.0060		Normal	3.00	1.00	0.20%	
Uc(CF)	Combined uncertainty			normal			2.03%	
U	Expanded uncertainty			normal (k=2)			4.05 %	

Table C.3.12 – Uncertainty budget for FL7018 measurement with 100 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Experimental standard uncertainty on mean of measurements (majorating)	0.0009		k=1	1.00	1.00	0.09%	9
B	Antenna calibration	0.0150		k=1	1.00	1.00	1.50%	
B	Coupler calibration	0.0022		k=1	1.00	1.00	0.22%	
B	SWR antenna	0.0035		k=1	1.00	1.00	0.35%	
B	wattmeter calibration	0.0100		k=1	1.00	1.00	1.00%	
B	ruler calibration	0.0010		k=1	1.00	2.00	0.20%	
B	drift ruler between 2 calibrations	0.0006		Rectangular	1.73	2.00	0.07%	
B	drift antenna between 2 calibrations	0.0013		Rectangular	1.73	1.00	0.07%	
B	drift coupler between 2 calibrations	0.0007		Rectangular	1.73	1.00	0.04%	
B	drift power meter between 2 calibrations	0.0035		Rectangular	1.73	1.00	0.20%	
B	mismatching	0.0004		k=1	1.00	1.00	0.04%	
B	imperfection anechoic chamber	0.0050		k=1	1.00	1.00	0.50%	
B	Modelisation	0.0055		k=1	1.00	1.00	0.55%	
B	Probe resolution	0.0001		Rectangular	1.73	1.00	0.00%	
B	Probe Stability	0.0060		Normal	3.00	1.00	0.20%	
Uc(CF)	Combined uncertainty			normal			2.03%	
U	Expanded uncertainty			normal (k=2)			4.06 %	

Table C.3.13 – Uncertainty budget for FP7050 measurement with 30 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Experimental standard uncertainty on mean of measurements (majorating)	0.0009		k=1	1.00	1.00	0.09%	9
B	Antenna calibration	0.0150		k=1	1.00	1.00	1.50%	
B	Coupler calibration	0.0220		k=1	1.00	1.00	2.20%	
B	SWR antenna	0.0035		k=1	1.00	1.00	0.35%	
B	wattmeter calibration	0.0100		k=1	1.00	1.00	1.00%	
B	ruler calibration	0.0010		k=1	1.00	2.00	0.20%	
B	drift ruler between 2 calibrations	0.0006		Rectangular	1.73	2.00	0.07%	
B	drift antenna between 2 calibrations	0.0013		Rectangular	1.73	1.00	0.07%	
B	drift coupler between 2 calibrations	0.0069		Rectangular	1.73	1.00	0.40%	
B	drift power meter between 2 calibrations	0.0035		Rectangular	1.73	1.00	0.20%	
B	mismatching	0.0004		k=1	1.00	1.00	0.04%	
B	imperfection anechoic chamber	0.0050		k=1	1.00	1.00	0.50%	
B	Modelisation	0.0055		k=1	1.00	1.00	0.55%	
B	Probe resolution	0.0002		Rectangular	1.73	1.00	0.01%	
B	Probe Stability	0.0167		Normal	3.00	1.00	0.56%	
Uc(CF)	Combined uncertainty			normal			3.06%	
U	Expanded uncertainty			normal (k=2)			6.11 %	

Table C.3.14 – Uncertainty budget for FP7050 measurement with 30 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Experimental standard uncertainty on mean of measurements	0.0009		k=1	1.00	1.00	0.09%	9
B	Antenna calibration	0.0150		k=1	1.00	1.00	1.50%	
B	Coupler calibration	0.0220		k=1	1.00	1.00	2.20%	
B	SWR antenna	0.0035		k=1	1.00	1.00	0.35%	
B	wattmeter calibration	0.0100		k=1	1.00	1.00	1.00%	
B	ruler calibration	0.0010		k=1	1.00	2.00	0.20%	
B	drift ruler between 2 calibrations	0.0006		Rectangular	1.73	2.00	0.07%	
B	drift antenna between 2 calibrations	0.0013		Rectangular	1.73	1.00	0.07%	
B	drift coupler between 2 calibrations	0.0069		Rectangular	1.73	1.00	0.40%	
B	drift power meter between 2 calibrations	0.0035		Rectangular	1.73	1.00	0.20%	
B	mismatching	0.0004		k=1	1.00	1.00	0.04%	
B	imperfection anechoic chamber	0.0050		k=1	1.00	1.00	0.50%	
B	Modelisation	0.0055		k=1	1.00	1.00	0.55%	
B	Probe resolution	0.0002		Rectangular	1.73	1.00	0.01%	
B	Probe Stability	0.0167		Normal	3.00	1.00	0.56%	
Uc(CF)	Combined uncertainty			normal			3.06%	
U	Expanded uncertainty			normal (k=2)			6.11 %	

Table C.3.15 – Uncertainty budget for FP7050 measurement with 30 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Experimental standard uncertainty on mean of measurements	0.0013		k=1	1.00	1.00	0.13%	9
B	Antenna calibration	0.0150		k=1	1.00	1.00	1.50%	
B	Coupler calibration	0.0220		k=1	1.00	1.00	2.20%	
B	SWR antenna	0.0035		k=1	1.00	1.00	0.35%	
B	wattmeter calibration	0.0100		k=1	1.00	1.00	1.00%	
B	ruler calibration	0.0010		k=1	1.00	2.00	0.20%	
B	drift ruler between 2 calibrations	0.0006		Rectangular	1.73	2.00	0.07%	
B	drift antenna between 2 calibrations	0.0013		Rectangular	1.73	1.00	0.07%	
B	drift coupler between 2 calibrations	0.0069		Rectangular	1.73	1.00	0.40%	
B	drift power meter between 2 calibrations	0.0035		Rectangular	1.73	1.00	0.20%	
B	mismatching	0.0004		k=1	1.00	1.00	0.04%	
B	imperfection anechoic chamber	0.0050		k=1	1.00	1.00	0.50%	
B	Modelisation	0.0055		k=1	1.00	1.00	0.55%	
B	Probe resolution	0.0002		Rectangular	1.73	1.00	0.01%	
B	Probe Stability	0.0167		Normal	3.00	1.00	0.56%	
Uc(CF)	Combined uncertainty			normal			3.06%	
U	Expanded uncertainty			normal (k=2)			6.11 %	

Table C.3.16 – Uncertainty budget for FP7050 measurement with 30 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Experimental standard uncertainty on mean of measurements	0.0014		k=1	1.00	1.00	0.14%	9
B	Antenna calibration	0.0150		k=1	1.00	1.00	1.50%	
B	Coupler calibration	0.0220		k=1	1.00	1.00	2.20%	
B	SWR antenna	0.0035		k=1	1.00	1.00	0.35%	
B	wattmeter calibration	0.0100		k=1	1.00	1.00	1.00%	
B	ruler calibration	0.0010		k=1	1.00	2.00	0.20%	
B	drift ruler between 2 calibrations	0.0006		Rectangular	1.73	2.00	0.07%	
B	drift antenna between 2 calibrations	0.0013		Rectangular	1.73	1.00	0.07%	
B	drift coupler between 2 calibrations	0.0069		Rectangular	1.73	1.00	0.40%	
B	drift power meter between 2 calibrations	0.0035		Rectangular	1.73	1.00	0.20%	
B	mismatching	0.0004		k=1	1.00	1.00	0.04%	
B	imperfection anechoic chamber	0.0050		k=1	1.00	1.00	0.50%	
B	Modelisation	0.0055		k=1	1.00	1.00	0.55%	
B	Probe resolution	0.0002		Rectangular	1.73	1.00	0.01%	
B	Probe Stability	0.0167		Normal	3.00	1.00	0.56%	
Uc(CF)	Combined uncertainty			normal			3.06%	
U	Expanded uncertainty			normal (k=2)			6.11 %	

Table C.3.17 – Uncertainty budget for FP7050 measurement with 100 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Experimental standard uncertainty on mean of measurements	0.0008		k=1	1.00	1.00	0.08%	9
B	Antenna calibration	0.0150		k=1	1.00	1.00	1.50%	
B	Coupler calibration	0.0022		k=1	1.00	1.00	0.22%	
B	SWR antenna	0.0035		k=1	1.00	1.00	0.35%	
B	wattmeter calibration	0.0100		k=1	1.00	1.00	1.00%	
B	ruler calibration	0.0010		k=1	1.00	2.00	0.20%	
B	drift ruler between 2 calibrations	0.0006		Rectangular	1.73	2.00	0.07%	
B	drift antenna between 2 calibrations	0.0013		Rectangular	1.73	1.00	0.07%	
B	drift coupler between 2 calibrations	0.0007		Rectangular	1.73	1.00	0.04%	
B	drift power meter between 2 calibrations	0.0035		Rectangular	1.73	1.00	0.20%	
B	mismatching	0.0004		k=1	1.00	1.00	0.04%	
B	imperfection anechoic chamber	0.0050		k=1	1.00	1.00	0.50%	
B	Modelisation	0.0065		k=1	1.00	1.00	0.65%	
B	Probe resolution	0.0001		Rectangular	1.73	1.00	0.00%	
B	Probe Stability	0.0084		Normal	3.00	1.00	0.28%	
Uc(CF)	Combined uncertainty			normal			2.07%	
U	Expanded uncertainty			normal (k=2)			4.13 %	

Table C.3.18 – Uncertainty budget for FP7050 measurement with 100 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Experimental standard uncertainty on mean of measurements	0.0002		k=1	1.00	1.00	0.02%	9
B	Antenna calibration	0.0150		k=1	1.00	1.00	1.50%	
B	Coupler calibration	0.0022		k=1	1.00	1.00	0.22%	
B	SWR antenna	0.0035		k=1	1.00	1.00	0.35%	
B	wattmeter calibration	0.0100		k=1	1.00	1.00	1.00%	
B	ruler calibration	0.0010		k=1	1.00	2.00	0.20%	
B	drift ruler between 2 calibrations	0.0006		Rectangular	1.73	2.00	0.07%	
B	drift antenna between 2 calibrations	0.0013		Rectangular	1.73	1.00	0.07%	
B	drift coupler between 2 calibrations	0.0007		Rectangular	1.73	1.00	0.04%	
B	drift power meter between 2 calibrations	0.0035		Rectangular	1.73	1.00	0.20%	
B	mismatching	0.0004		k=1	1.00	1.00	0.04%	
B	imperfection anechoic chamber	0.0050		k=1	1.00	1.00	0.50%	
B	Modelisation	0.0065		k=1	1.00	1.00	0.65%	
B	Probe resolution	0.0001		Rectangular	1.73	1.00	0.00%	
B	Probe Stability	0.0084		Normal	3.00	1.00	0.28%	
Uc(CF)	Combined uncertainty			normal			2.07%	
U	Expanded uncertainty			normal (k=2)			4.13 %	

Table C.3.19 – Uncertainty budget for FP7050 measurement with 100 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Experimental standard uncertainty on mean of measurements	0.0003		k=1	1.00	1.00	0.03%	9
B	Antenna calibration	0.0150		k=1	1.00	1.00	1.50%	
B	Coupler calibration	0.0022		k=1	1.00	1.00	0.22%	
B	SWR antenna	0.0035		k=1	1.00	1.00	0.35%	
B	wattmeter calibration	0.0100		k=1	1.00	1.00	1.00%	
B	ruler calibration	0.0010		k=1	1.00	2.00	0.20%	
B	drift ruler between 2 calibrations	0.0006		Rectangular	1.73	2.00	0.07%	
B	drift antenna between 2 calibrations	0.0013		Rectangular	1.73	1.00	0.07%	
B	drift coupler between 2 calibrations	0.0007		Rectangular	1.73	1.00	0.04%	
B	drift power meter between 2 calibrations	0.0035		Rectangular	1.73	1.00	0.20%	
B	mismatching	0.0004		k=1	1.00	1.00	0.04%	
B	imperfection anechoic chamber	0.0050		k=1	1.00	1.00	0.50%	
B	Modelisation	0.0065		k=1	1.00	1.00	0.65%	
B	Probe resolution	0.0001		Rectangular	1.73	1.00	0.00%	
B	Probe Stability	0.0084		Normal	3.00	1.00	0.28%	
Uc(CF)	Combined uncertainty			normal			2.07%	
U	Expanded uncertainty			normal (k=2)			4.13 %	

Table C.3.20 – Uncertainty budget for FP7050 measurement with 100 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Experimental standard uncertainty on mean of measurements	0.0002		k=1	1.00	1.00	0.02%	9
B	Antenna calibration	0.0150		k=1	1.00	1.00	1.50%	
B	Coupler calibration	0.0022		k=1	1.00	1.00	0.22%	
B	SWR antenna	0.0035		k=1	1.00	1.00	0.35%	
B	wattmeter calibration	0.0100		k=1	1.00	1.00	1.00%	
B	ruler calibration	0.0010		k=1	1.00	2.00	0.20%	
B	drift ruler between 2 calibrations	0.0006		Rectangular	1.73	2.00	0.07%	
B	drift antenna between 2 calibrations	0.0013		Rectangular	1.73	1.00	0.07%	
B	drift coupler between 2 calibrations	0.0007		Rectangular	1.73	1.00	0.04%	
B	drift power meter between 2 calibrations	0.0035		Rectangular	1.73	1.00	0.20%	
B	mismatching	0.0004		k=1	1.00	1.00	0.04%	
B	imperfection anechoic chamber	0.0050		k=1	1.00	1.00	0.50%	
B	Modelisation	0.0065		k=1	1.00	1.00	0.65%	
B	Probe resolution	0.0001		Rectangular	1.73	1.00	0.00%	
B	Probe Stability	0.0084		Normal	3.00	1.00	0.28%	
Uc(CF)	Combined uncertainty			normal			2.07%	
U	Expanded uncertainty			normal (k=2)			4.13 %	

C.4 – INRIM Uncertainty Budgets

Table C.4.1 – Uncertainty budget for FL7018 measurement with 10 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Power delivered to the antenna	3.8436	(%)	Normal	1.00	0.50	1.92	∞
B	Antenna gain	25.8925	(%)	Normal	2.00	0.50	6.47	∞
B	Antenna / probe separation distance	1.0000	(%)	Rectangular	1.73	1.00	0.58	∞
B	E-field non-uniformity	5.0000	(%)	Rectangular	1.73	1.00	2.89	∞
B	Positional effects (repeatability)	0.0083	(%)	Normal	1.00	1.00	0.01	∞
A	Probe readings	0.0170	(%)	Normal	1.00	1.00	0.02	19
Uc(CF)	Combined uncertainty			normal			7.37	
U	Expanded uncertainty			normal (k=2)			14.73	

Table C.4.2 – Uncertainty budget for FL7018 measurement with 10 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Power delivered to the antenna	3.3484	(%)	Normal	1.00	0.50	1.67	∞
B	Antenna gain	25.8925	(%)	Normal	2.00	0.50	6.47	∞
B	Antenna / probe separation distance	1.0000	(%)	Rectangular	1.73	1.00	0.58	∞
B	E-field non-uniformity	5.0000	(%)	Rectangular	1.73	1.00	2.89	∞
B	Positional effects (repeatability)	0.0079	(%)	Normal	1.00	1.00	0.01	∞
A	Probe readings	0.0200	(%)	Normal	1.00	1.00	0.02	19
Uc(CF)	Combined uncertainty			normal			7.31	
U	Expanded uncertainty			normal (k=2)			14.61	

Table C.4.3 – Uncertainty budget for FL7018 measurement with 10 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Power delivered to the antenna	3.4053	(%)	Normal	1.00	0.50	1.70	∞
B	Antenna gain	20.2264	(%)	Normal	2.00	0.50	5.06	∞
B	Antenna / probe separation distance	1.0000	(%)	Rectangular	1.73	1.00	0.58	∞
B	E-field non-uniformity	5.0000	(%)	Rectangular	1.73	1.00	2.89	∞
B	Positional effects (repeatability)	0.0256	(%)	Normal	1.00	1.00	0.03	∞
A	Probe readings	0.0199	(%)	Normal	1.00	1.00	0.02	19
Uc(CF)	Combined uncertainty			normal			6.09	
U	Expanded uncertainty			normal (k=2)			12.19	

Table C.4.4 – Uncertainty budget for FL7018 measurement with 10 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Power delivered to the antenna	7.6792	(%)	Normal	1.00	0.50	3.84	∞
B	Antenna gain	20.2264	(%)	Normal	2.00	0.50	5.06	∞
B	Antenna / probe separation distance	1.0000	(%)	Rectangular	1.73	1.00	0.58	∞
B	E-field non-uniformity	5.0000	(%)	Rectangular	1.73	1.00	2.89	∞
B	Positional effects (repeatability)	0.0133	(%)	Normal	1.00	1.00	0.01	∞
A	Probe readings	0.0100	(%)	Normal	1.00	1.00	0.01	19
Uc(CF)	Combined uncertainty			normal			7.00	
U	Expanded uncertainty			normal (k=2)			14.00	

Table C.4.5 – Uncertainty budget for FL7018 measurement with 30 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Power delivered to the antenna	3.8336	(%)	Normal	1.00	0.50	1.92	∞
B	Antenna gain	25.8925	(%)	Normal	2.00	0.50	6.47	∞
B	Antenna / probe separation distance	1.0000	(%)	Rectangular	1.73	1.00	0.58	∞
B	E-field non-uniformity	5.0000	(%)	Rectangular	1.73	1.00	2.89	∞
B	Positional effects (repeatability)	0.0083	(%)	Normal	1.00	1.00	0.01	∞
A	Probe readings	0.0173	(%)	Normal	1.00	1.00	0.02	19
Uc(CF)	Combined uncertainty			normal			7.36	
U	Expanded uncertainty			normal (k=2)			14.73	

Table C.4.6 – Uncertainty budget for FL7018 measurement with 30 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Power delivered to the antenna	3.3486	(%)	Normal	1.00	0.50	1.67	∞
B	Antenna gain	25.8925	(%)	Normal	2.00	0.50	6.47	∞
B	Antenna / probe separation distance	1.0000	(%)	Rectangular	1.73	1.00	0.58	∞
B	E-field non-uniformity	5.0000	(%)	Rectangular	1.73	1.00	2.89	∞
B	Positional effects (repeatability)	0.0079	(%)	Normal	1.00	1.00	0.01	∞
A	Probe readings	0.0167	(%)	Normal	1.00	1.00	0.02	19
Uc(CF)	Combined uncertainty			normal			7.31	
U	Expanded uncertainty			normal (k=2)			14.61	

Table C.4.7 – Uncertainty budget for FL7018 measurement with 30 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Power delivered to the antenna	3.4074	(%)	Normal	1.00	0.50	1.70	∞
B	Antenna gain	20.2264	(%)	Normal	2.00	0.50	5.06	∞
B	Antenna / probe separation distance	1.0000	(%)	Rectangular	1.73	1.00	0.58	∞
B	E-field non-uniformity	5.0000	(%)	Rectangular	1.73	1.00	2.89	∞
B	Positional effects (repeatability)	0.0256	(%)	Normal	1.00	1.00	0.03	∞
A	Probe readings	0.0067	(%)	Normal	1.00	1.00	0.01	19
Uc(CF)	Combined uncertainty			normal			6.09	
U	Expanded uncertainty			normal (k=2)			12.19	

Table C.4.8 – Uncertainty budget for FL7018 measurement with 30 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Power delivered to the antenna	7.6846	(%)	Normal	1.00	0.50	3.84	∞
B	Antenna gain	20.2264	(%)	Normal	2.00	0.50	5.06	∞
B	Antenna / probe separation distance	1.0000	(%)	Rectangular	1.73	1.00	0.58	∞
B	E-field non-uniformity	5.0000	(%)	Rectangular	1.73	1.00	2.89	∞
B	Positional effects (repeatability)	0.0133	(%)	Normal	1.00	1.00	0.01	∞
A	Probe readings	0.0700	(%)	Normal	1.00	1.00	0.07	19
Uc(CF)	Combined uncertainty			normal			7.00	
U	Expanded uncertainty			normal (k=2)			14.00	

Table C.4.9 – Uncertainty budget for FL7018 measurement with 100 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Power delivered to the antenna	3.4339	(%)	Normal	1.00	0.50	1.72	∞
B	Antenna gain	20.2264	(%)	Normal	2.00	0.50	5.06	∞
B	Antenna / probe separation distance	1.0000	(%)	Rectangular	1.73	1.00	0.58	∞
B	E-field non-uniformity	5.0000	(%)	Rectangular	1.73	1.00	2.89	∞
B	Positional effects (repeatability)	0.0256	(%)	Normal	1.00	1.00	0.03	∞
A	Probe readings	0.0030	(%)	Normal	1.00	1.00	0.00	19
Uc(CF)	Combined uncertainty			normal			6.10	
U	Expanded uncertainty			normal (k=2)			12.20	

Table C.4.10 – Uncertainty budget for FL7018 measurement with 100 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Power delivered to the antenna	7.6843	(%)	Normal	1.00	0.50	3.84	∞
B	Antenna gain	20.2264	(%)	Normal	2.00	0.50	5.06	∞
B	Antenna / probe separation distance	1.0000	(%)	Rectangular	1.73	1.00	0.58	∞
B	E-field non-uniformity	5.0000	(%)	Rectangular	1.73	1.00	2.89	∞
B	Positional effects (repeatability)	0.0133	(%)	Normal	1.00	1.00	0.01	∞
A	Probe readings	0.0261	(%)	Normal	1.00	1.00	0.03	19
Uc(CF)	Combined uncertainty			normal			7.00	
U	Expanded uncertainty			normal (k=2)			14.00	

Table C.4.11 – Uncertainty budget for FP7050 measurement with 30 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Power delivered to the antenna	3.8313	(%)	Normal	1.00	0.50	1.92	∞
B	Antenna gain	25.8925	(%)	Normal	2.00	0.50	6.47	∞
B	Antenna / probe separation distance	1.0000	(%)	Rectangular	1.73	1.00	0.58	∞
B	E-field non-uniformity	5.0000	(%)	Rectangular	1.73	1.00	2.89	∞
B	Positional effects (repeatability)	0.0082	(%)	Normal	1.00	1.00	0.01	∞
A	Probe readings	0.3075	(%)	Normal	1.00	1.00	0.31	19
Uc(CF)	Combined uncertainty			normal			7.37	
U	Expanded uncertainty			normal (k=2)			14.74	

Table C.4.12 – Uncertainty budget for FP7050 measurement with 30 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Power delivered to the antenna	3.3471	(%)	Normal	1.00	0.50	1.67	∞
B	Antenna gain	25.8925	(%)	Normal	2.00	0.50	6.47	∞
B	Antenna / probe separation distance	1.0000	(%)	Rectangular	1.73	1.00	0.58	∞
B	E-field non-uniformity	5.0000	(%)	Rectangular	1.73	1.00	2.89	∞
B	Positional effects (repeatability)	0.0235	(%)	Normal	1.00	1.00	0.02	∞
A	Probe readings	0.2108	(%)	Normal	1.00	1.00	0.21	19
Uc(CF)	Combined uncertainty			normal			7.31	
U	Expanded uncertainty			normal (k=2)			14.62	

Table C.4.13 – Uncertainty budget for FP7050 measurement with 30 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Power delivered to the antenna	3.4093	(%)	Normal	1.00	0.50	1.70	∞
B	Antenna gain	20.2264	(%)	Normal	2.00	0.50	5.06	∞
B	Antenna / probe separation distance	1.0000	(%)	Rectangular	1.73	1.00	0.58	∞
B	E-field non-uniformity	5.0000	(%)	Rectangular	1.73	1.00	2.89	∞
B	Positional effects (repeatability)	0.0139	(%)	Normal	1.00	1.00	0.01	∞
A	Probe readings	0.2795	(%)	Normal	1.00	1.00	0.28	19
Uc(CF)	Combined uncertainty			normal			6.10	
U	Expanded uncertainty			normal (k=2)			12.20	

Table C.4.14 – Uncertainty budget for FP7050 measurement with 30 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Power delivered to the antenna	7.6885	(%)	Normal	1.00	0.50	3.84	∞
B	Antenna gain	20.2264	(%)	Normal	2.00	0.50	5.06	∞
B	Antenna / probe separation distance	1.0000	(%)	Rectangular	1.73	1.00	0.58	∞
B	E-field non-uniformity	5.0000	(%)	Rectangular	1.73	1.00	2.89	∞
B	Positional effects (repeatability)	0.0031	(%)	Normal	1.00	1.00	0.00	∞
A	Probe readings	0.2113	(%)	Normal	1.00	1.00	0.21	19
Uc(CF)	Combined uncertainty			normal			7.00	
U	Expanded uncertainty			normal (k=2)			14.01	

Table C.4.15 – Uncertainty budget for FP7050 measurement with 100 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Power delivered to the antenna	3.4388	(%)	Normal	1.00	0.50	1.72	∞
B	Antenna gain	20.2264	(%)	Normal	2.00	0.50	5.06	∞
B	Antenna / probe separation distance	1.0000	(%)	Rectangular	1.73	1.00	0.58	∞
B	E-field non-uniformity	5.0000	(%)	Rectangular	1.73	1.00	2.89	∞
B	Positional effects (repeatability)	0.0139	(%)	Normal	1.00	1.00	0.01	∞
A	Probe readings	0.0301	(%)	Normal	1.00	1.00	0.03	19
Uc(CF)	Combined uncertainty			normal			6.10	
U	Expanded uncertainty			normal (k=2)			12.20	

Table C.4.16 – Uncertainty budget for FP7050 measurement with 100 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Power delivered to the antenna	7.6894	(%)	Normal	1.00	0.50	3.84	∞
B	Antenna gain	20.2264	(%)	Normal	2.00	0.50	5.06	∞
B	Antenna / probe separation distance	1.0000	(%)	Rectangular	1.73	1.00	0.58	∞
B	E-field non-uniformity	5.0000	(%)	Rectangular	1.73	1.00	2.89	∞
B	Positional effects (repeatability)	0.0031	(%)	Normal	1.00	1.00	0.00	∞
A	Probe readings	0.0280	(%)	Normal	1.00	1.00	0.03	19
Uc(CF)	Combined uncertainty			normal			7.00	
U	Expanded uncertainty			normal (k=2)			14.00	

C.5 – METAS Uncertainty Budgets

Table C.5.1 – Uncertainty budget for FL7018 measurement with 10 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Antenna Factor (Reference Antenna)	0.5000	(dB)	Normal	2.00	11.51	2.88	
B	Phase center uncertainty	0.0000	(dB)	Rectangular	1.73	11.51	0.00	
B	Powermeter Calibration	0.0070	()	Normal	2.00	50.00	0.18	
B	Powermeter mismatch during calibration	0.0290	(dB)	U-shaped	1.41	5.76	0.12	
B	Powermeter Stability during calibration	0.0100	(dB)	Rectangular	1.73	5.76	0.03	
B	Powermeter Stability during measurement	0.0100	(dB)	Normal	1.73	5.76	0.03	
B	Homogeneity	0.0140	()	Normal	1.00	100.00	1.40	
A	Reading of probe (from the software)	0.0020	()	Normal	1.00	100.00	0.20	10
A	Experimental standard uncertainty (n meas.)	0.0008	()	Normal	1.00	100.00	0.08	20
Uc(CF)	Combined uncertainty			normal			3.22	
U	Expanded uncertainty			normal (k=2)			6.43	

Table C.5.2 – Uncertainty budget for FL7018 measurement with 10 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Antenna Factor (Reference Antenna)	0.5000	(dB)	Normal	2.00	11.51	2.88	
B	Phase center uncertainty	0.0000	(dB)	Rectangular	1.73	11.51	0.00	
B	Powermeter Calibration	0.0070	()	Normal	2.00	50.00	0.18	
B	Powermeter mismatch during calibration	0.0131	(dB)	U-shaped	1.41	5.76	0.05	
B	Powermeter Stability during calibration	0.0100	(dB)	Rectangular	1.73	5.76	0.03	
B	Powermeter Stability during measurement	0.0100	(dB)	Normal	1.73	5.76	0.03	
B	Homogeneity	0.0140	()	Normal	1.00	100.00	1.40	
A	Reading of probe (from the software)	0.0020	()	Normal	1.00	100.00	0.20	10
A	Experimental standard uncertainty (n meas.)	0.0050	()	Normal	1.00	100.00	0.50	20
Uc(CF)	Combined uncertainty			normal			3.25	
U	Expanded uncertainty			normal (k=2)			6.50	

Table C.5.3 – Uncertainty budget for FL7018 measurement with 10 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Antenna Factor (Reference Antenna)	0.4500	(dB)	Normal	2.00	11.51	2.59	
B	Phase center uncertainty	0.1100	(dB)	Rectangular	1.73	11.51	0.73	
B	Powermeter Calibration	0.0080	()	Normal	2.00	50.00	0.20	
B	Powermeter mismatch during calibration	0.0217	(dB)	U-shaped	1.41	5.76	0.09	
B	Powermeter Stability during calibration	0.0100	(dB)	Rectangular	1.73	5.76	0.03	
B	Powermeter Stability during measurement	0.0100	(dB)	Normal	1.73	5.76	0.03	
B	Homogeneity	0.0140	()	Normal	1.00	100.00	1.40	
A	Reading of probe (from the software)	0.0020	()	Normal	1.00	100.00	0.20	10
A	Experimental standard uncertainty (n meas.)	0.0010	()	Normal	1.00	100.00	0.10	20
Uc(CF)	Combined uncertainty			normal			3.05	
U	Expanded uncertainty			normal (k=2)			6.10	

Table C.5.4 – Uncertainty budget for FL7018 measurement with 10 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Antenna Factor (Reference Antenna)	0.4500	(dB)	Normal	2.00	11.51	2.59	
B	Phase center uncertainty	0.1100	(dB)	Rectangular	1.73	11.51	0.73	
B	Powermeter Calibration	0.0090	()	Normal	2.00	50.00	0.23	
B	Powermeter mismatch during calibration	0.0174	(dB)	U-shaped	1.41	5.76	0.07	
B	Powermeter Stability during calibration	0.0100	(dB)	Rectangular	1.73	5.76	0.03	
B	Powermeter Stability during measurement	0.0100	(dB)	Normal	1.73	5.76	0.03	
B	Homogeneity	0.0140	()	Normal	1.00	100.00	1.40	
A	Reading of probe (from the software)	0.0020	()	Normal	1.00	100.00	0.20	10
A	Experimental standard uncertainty (n meas.)	0.0010	()	Normal	1.00	100.00	0.10	20
Uc(CF)	Combined uncertainty			normal			3.05	
U	Expanded uncertainty			normal (k=2)			6.10	

Table C.5.5 – Uncertainty budget for FL7018 measurement with 30 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Antenna Factor (Reference Antenna)	0.5000	(dB)	Normal	2.00	11.51	2.88	
B	Phase center uncertainty	0.0000	(dB)	Rectangular	1.73	11.51	0.00	
B	Powermeter Calibration	0.0070	()	Normal	2.00	50.00	0.18	
B	Powermeter mismatch during calibration	0.0290	(dB)	U-shaped	1.41	5.76	0.12	
B	Powermeter Stability during calibration	0.0100	(dB)	Rectangular	1.73	5.76	0.03	
B	Powermeter Stability during measurement	0.0100	(dB)	Normal	1.73	5.76	0.03	
B	Homogeneity	0.0140	()	Normal	1.00	100.00	1.40	
A	Reading of probe (from the software)	0.0020	()	Normal	1.00	100.00	0.20	10
A	Experimental standard uncertainty (n meas.)	0.0030	()	Normal	1.00	100.00	0.30	20
Uc(CF)	Combined uncertainty			normal			3.23	
U	Expanded uncertainty			normal (k=2)			6.46	

Table C.5.6 – Uncertainty budget for FL7018 measurement with 30 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Antenna Factor (Reference Antenna)	0.5000	(dB)	Normal	2.00	11.51	2.88	
B	Phase center uncertainty	0.0000	(dB)	Rectangular	1.73	11.51	0.00	
B	Powermeter Calibration	0.0070	()	Normal	2.00	50.00	0.18	
B	Powermeter mismatch during calibration	0.0131	(dB)	U-shaped	1.41	5.76	0.05	
B	Powermeter Stability during calibration	0.0100	(dB)	Rectangular	1.73	5.76	0.03	
B	Powermeter Stability during measurement	0.0100	(dB)	Normal	1.73	5.76	0.03	
B	Homogeneity	0.0140	()	Normal	1.00	100.00	1.40	
A	Reading of probe (from the software)	0.0020	()	Normal	1.00	100.00	0.20	10
A	Experimental standard uncertainty (n meas.)	0.0010	()	Normal	1.00	100.00	0.10	20
Uc(CF)	Combined uncertainty			normal			3.21	
U	Expanded uncertainty			normal (k=2)			6.43	

Table C.5.7 – Uncertainty budget for FL7018 measurement with 30 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Antenna Factor (Reference Antenna)	0.4500	(dB)	Normal	2.00	11.51	2.59	
B	Phase center uncertainty	0.1100	(dB)	Rectangular	1.73	11.51	0.73	
B	Powermeter Calibration	0.0080	()	Normal	2.00	50.00	0.20	
B	Powermeter mismatch during calibration	0.0217	(dB)	U-shaped	1.41	5.76	0.09	
B	Powermeter Stability during calibration	0.0100	(dB)	Rectangular	1.73	5.76	0.03	
B	Powermeter Stability during measurement	0.0100	(dB)	Normal	1.73	5.76	0.03	
B	Homogeneity	0.0140	()	Normal	1.00	100.00	1.40	
A	Reading of probe (from the software)	0.0020	()	Normal	1.00	100.00	0.20	10
A	Experimental standard uncertainty (n meas.)	0.0020	()	Normal	1.00	100.00	0.20	20
Uc(CF)	Combined uncertainty			normal			3.06	
U	Expanded uncertainty			normal (k=2)			6.11	

Table C.5.8 – Uncertainty budget for FL7018 measurement with 30 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Antenna Factor (Reference Antenna)	0.4500	(dB)	Normal	2.00	11.51	2.59	
B	Phase center uncertainty	0.1100	(dB)	Rectangular	1.73	11.51	0.73	
B	Powermeter Calibration	0.0090	()	Normal	2.00	50.00	0.23	
B	Powermeter mismatch during calibration	0.0174	(dB)	U-shaped	1.41	5.76	0.07	
B	Powermeter Stability during calibration	0.0100	(dB)	Rectangular	1.73	5.76	0.03	
B	Powermeter Stability during measurement	0.0100	(dB)	Normal	1.73	5.76	0.03	
B	Homogeneity	0.0140	()	Normal	1.00	100.00	1.40	
A	Reading of probe (from the software)	0.0020	()	Normal	1.00	100.00	0.20	
A	Experimental standard uncertainty (n meas.)	0.0030	()	Normal	1.00	100.00	0.30	
Uc(CF)	Combined uncertainty			normal			3.06	
U	Expanded uncertainty			normal (k=2)			6.13	

Table C.5.9 – Uncertainty budget for FL7018 measurement with 100 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Antenna Factor (Reference Antenna)	0.5000	(dB)	Normal	2.00	11.51	2.88	
B	Phase center uncertainty	0.0000	(dB)	Rectangular	1.73	11.51	0.00	
B	Powermeter Calibration	0.0070	()	Normal	2.00	50.00	0.18	
B	Powermeter mismatch during calibration	0.0290	(dB)	U-shaped	1.41	5.76	0.12	
B	Powermeter Stability during calibration	0.0100	(dB)	Rectangular	1.73	5.76	0.03	
B	Powermeter Stability during measurement	0.0100	(dB)	Normal	1.73	5.76	0.03	
B	Homogeneity	0.0300	()	Normal	1.00	100.00	3.00	
A	Reading of probe (from the software)	0.0020	()	Normal	1.00	100.00	0.20	10
A	Experimental standard uncertainty (n meas.)	0.0010	()	Normal	1.00	100.00	0.10	20
Uc(CF)	Combined uncertainty			normal			4.17	
U	Expanded uncertainty			normal (k=2)			8.34	

Table C.5.10 – Uncertainty budget for FL7018 measurement with 100 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Antenna Factor (Reference Antenna)	0.5000	(dB)	Normal	2.00	11.51	2.88	
B	Phase center uncertainty	0.0000	(dB)	Rectangular	1.73	11.51	0.00	
B	Powermeter Calibration	0.0070	()	Normal	2.00	50.00	0.18	
B	Powermeter mismatch during calibration	0.0131	(dB)	U-shaped	1.41	5.76	0.05	
B	Powermeter Stability during calibration	0.0100	(dB)	Rectangular	1.73	5.76	0.03	
B	Powermeter Stability during measurement	0.0100	(dB)	Normal	1.73	5.76	0.03	
B	Homogeneity	0.0300	()	Normal	1.00	100.00	3.00	
A	Reading of probe (from the software)	0.0020	()	Normal	1.00	100.00	0.20	10
A	Experimental standard uncertainty (n meas.)	0.0010	()	Normal	1.00	100.00	0.10	20
Uc(CF)	Combined uncertainty			normal			4.17	
U	Expanded uncertainty			normal (k=2)			8.34	

Table C.5.11 – Uncertainty budget for FL7018 measurement with 100 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Antenna Factor (Reference Antenna)	0.4500	(dB)	Normal	2.00	11.51	2.59	
B	Phase center uncertainty	0.2400	(dB)	Rectangular	1.73	11.51	1.60	
B	Powermeter Calibration	0.0080	()	Normal	2.00	50.00	0.20	
B	Powermeter mismatch during calibration	0.0217	(dB)	U-shaped	1.41	5.76	0.09	
B	Powermeter Stability during calibration	0.0100	(dB)	Rectangular	1.73	5.76	0.03	
B	Powermeter Stability during measurement	0.0100	(dB)	Normal	1.73	5.76	0.03	
B	Homogeneity	0.0300	()	Normal	1.00	100.00	3.00	
A	Reading of probe (from the software)	0.0020	()	Normal	1.00	100.00	0.20	10
A	Experimental standard uncertainty (n meas.)	0.0300	()	Normal	1.00	100.00	3.00	20
Uc(CF)	Combined uncertainty			normal			5.23	
U	Expanded uncertainty			normal (k=2)			10.46	

Table C.5.12 – Uncertainty budget for FL7018 measurement with 100 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Antenna Factor (Reference Antenna)	0.4500	(dB)	Normal	2.00	11.51	2.59	
B	Phase center uncertainty	0.2400	(dB)	Rectangular	1.73	11.51	1.60	
B	Powermeter Calibration	0.0090	()	Normal	2.00	50.00	0.23	
B	Powermeter mismatch during calibration	0.0174	(dB)	U-shaped	1.41	5.76	0.07	
B	Powermeter Stability during calibration	0.0100	(dB)	Rectangular	1.73	5.76	0.03	
B	Powermeter Stability during measurement	0.0100	(dB)	Normal	1.73	5.76	0.03	
B	Homogeneity	0.0300	()	Normal	1.00	100.00	3.00	
A	Reading of probe (from the software)	0.0020	()	Normal	1.00	100.00	0.20	10
A	Experimental standard uncertainty (n meas.)	0.0040	()	Normal	1.00	100.00	0.40	20
Uc(CF)	Combined uncertainty			normal			4.30	
U	Expanded uncertainty			normal (k=2)			8.61	

Table C.5.13 – Uncertainty budget for FP7050 measurement with 30 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Antenna Factor (Reference Antenna)	0.5000	(dB)	Normal	2.00	11.51	2.88	
B	Phase center uncertainty	0.0000	(dB)	Rectangular	1.73	11.51	0.00	
B	Powermeter Calibration	0.0070	()	Normal	2.00	50.00	0.18	
B	Powermeter mismatch during calibration	0.0290	(dB)	U-shaped	1.41	5.76	0.12	
B	Powermeter Stability during calibration	0.0100	(dB)	Rectangular	1.73	5.76	0.03	
B	Powermeter Stability during measurement	0.0100	(dB)	Normal	1.73	5.76	0.03	
B	Homogeneity	0.0140	()	Normal	1.00	100.00	1.40	
A	Reading of probe (from the software)	0.0050	()	Normal	1.00	100.00	0.50	10
A	Experimental standard uncertainty (n meas.)	0.0040	()	Normal	1.00	100.00	0.40	20
Uc(CF)	Combined uncertainty			normal			3.27	
U	Expanded uncertainty			normal (k=2)			6.54	

Table C.5.14 – Uncertainty budget for FP7050 measurement with 30 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Antenna Factor (Reference Antenna)	0.5000	(dB)	Normal	2.00	11.51	2.88	
B	Phase center uncertainty	0.0000	(dB)	Rectangular	1.73	11.51	0.00	
B	Powermeter Calibration	0.0070	()	Normal	2.00	50.00	0.18	
B	Powermeter mismatch during calibration	0.0131	(dB)	U-shaped	1.41	5.76	0.05	
B	Powermeter Stability during calibration	0.0100	(dB)	Rectangular	1.73	5.76	0.03	
B	Powermeter Stability during measurement	0.0100	(dB)	Normal	1.73	5.76	0.03	
B	Homogeneity	0.0140	()	Normal	1.00	100.00	1.40	
A	Reading of probe (from the software)	0.0050	()	Normal	1.00	100.00	0.50	10
A	Experimental standard uncertainty (n meas.)	0.0040	()	Normal	1.00	100.00	0.40	20
Uc(CF)	Combined uncertainty			normal			3.27	
U	Expanded uncertainty			normal (k=2)			6.54	

Table C.5.15 – Uncertainty budget for FP7050 measurement with 30 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Antenna Factor (Reference Antenna)	0.4500	(dB)	Normal	2.00	11.51	2.59	
B	Phase center uncertainty	0.1100	(dB)	Rectangular	1.73	11.51	0.73	
B	Powermeter Calibration	0.0080	()	Normal	2.00	50.00	0.20	
B	Powermeter mismatch during calibration	0.0217	(dB)	U-shaped	1.41	5.76	0.09	
B	Powermeter Stability during calibration	0.0100	(dB)	Rectangular	1.73	5.76	0.03	
B	Powermeter Stability during measurement	0.0100	(dB)	Normal	1.73	5.76	0.03	
B	Homogeneity	0.0140	()	Normal	1.00	100.00	1.40	
A	Reading of probe (from the software)	0.0050	()	Normal	1.00	100.00	0.50	10
A	Experimental standard uncertainty (n meas.)	0.0030	()	Normal	1.00	100.00	0.30	20
Uc(CF)	Combined uncertainty			normal			3.10	
U	Expanded uncertainty			normal (k=2)			6.20	

Table C.5.16 – Uncertainty budget for FP7050 measurement with 30 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Antenna Factor (Reference Antenna)	0.4500	(dB)	Normal	2.00	11.51	2.59	
B	Phase center uncertainty	0.1100	(dB)	Rectangular	1.73	11.51	0.73	
B	Powermeter Calibration	0.0090	()	Normal	2.00	50.00	0.23	
B	Powermeter mismatch during calibration	0.0174	(dB)	U-shaped	1.41	5.76	0.07	
B	Powermeter Stability during calibration	0.0100	(dB)	Rectangular	1.73	5.76	0.03	
B	Powermeter Stability during measurement	0.0100	(dB)	Normal	1.73	5.76	0.03	
B	Homogeneity	0.0140	()	Normal	1.00	100.00	1.40	
A	Reading of probe (from the software)	0.0050	()	Normal	1.00	100.00	0.50	
A	Experimental standard uncertainty (n meas.)	0.0030	()	Normal	1.00	100.00	0.30	
Uc(CF)	Combined uncertainty			normal			3.10	
U	Expanded uncertainty			normal (k=2)			6.20	

Table C.5.17 – Uncertainty budget for FP7050 measurement with 100 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Antenna Factor (Reference Antenna)	0.5000	(dB)	Normal	2.00	11.51	2.88	
B	Phase center uncertainty	0.0000	(dB)	Rectangular	1.73	11.51	0.00	
B	Powermeter Calibration	0.0070	()	Normal	2.00	50.00	0.18	
B	Powermeter mismatch during calibration	0.0290	(dB)	U-shaped	1.41	5.76	0.12	
B	Powermeter Stability during calibration	0.0100	(dB)	Rectangular	1.73	5.76	0.03	
B	Powermeter Stability during measurement	0.0100	(dB)	Normal	1.73	5.76	0.03	
B	Homogeneity	0.0300	()	Normal	1.00	100.00	3.00	
A	Reading of probe (from the software)	0.0005	()	Normal	1.00	100.00	0.05	10
A	Experimental standard uncertainty (n meas.)	0.0010	()	Normal	1.00	100.00	0.10	20
Uc(CF)	Combined uncertainty			normal			4.16	
U	Expanded uncertainty			normal (k=2)			8.33	

Table C.5.18 – Uncertainty budget for FP7050 measurement with 100 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Antenna Factor (Reference Antenna)	0.5000	(dB)	Normal	2.00	11.51	2.88	
B	Phase center uncertainty	0.0000	(dB)	Rectangular	1.73	11.51	0.00	
B	Powermeter Calibration	0.0070	()	Normal	2.00	50.00	0.18	
B	Powermeter mismatch during calibration	0.0131	(dB)	U-shaped	1.41	5.76	0.05	
B	Powermeter Stability during calibration	0.0100	(dB)	Rectangular	1.73	5.76	0.03	
B	Powermeter Stability during measurement	0.0100	(dB)	Normal	1.73	5.76	0.03	
B	Homogeneity	0.0300	()	Normal	1.00	100.00	3.00	
A	Reading of probe (from the software)	0.0005	()	Normal	1.00	100.00	0.05	10
A	Experimental standard uncertainty (n meas.)	0.0010	()	Normal	1.00	100.00	0.10	20
Uc(CF)	Combined uncertainty			normal			4.16	
U	Expanded uncertainty			normal (k=2)			8.33	

Table C.5.19 – Uncertainty budget for FP7050 measurement with 100 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Antenna Factor (Reference Antenna)	0.4500	(dB)	Normal	2.00	11.51	2.59	
B	Phase center uncertainty	0.2400	(dB)	Rectangular	1.73	11.51	1.60	
B	Powermeter Calibration	0.0080	()	Normal	2.00	50.00	0.20	
B	Powermeter mismatch during calibration	0.0217	(dB)	U-shaped	1.41	5.76	0.09	
B	Powermeter Stability during calibration	0.0100	(dB)	Rectangular	1.73	5.76	0.03	
B	Powermeter Stability during measurement	0.0100	(dB)	Normal	1.73	5.76	0.03	
B	Homogeneity	0.0300	()	Normal	1.00	100.00	3.00	
A	Reading of probe (from the software)	0.0005	()	Normal	1.00	100.00	0.05	10
A	Experimental standard uncertainty (n meas.)	0.0010	()	Normal	1.00	100.00	0.10	20
Uc(CF)	Combined uncertainty			normal			4.28	
U	Expanded uncertainty			normal (k=2)			8.56	

Table C.5.20 – Uncertainty budget for FP7050 measurement with 100 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Antenna Factor (Reference Antenna)	0.4500	(dB)	Normal	2.00	11.51	2.59	
B	Phase center uncertainty	0.2400	(dB)	Rectangular	1.73	11.51	1.60	
B	Powermeter Calibration	0.0090	()	Normal	2.00	50.00	0.23	
B	Powermeter mismatch during calibration	0.0174	(dB)	U-shaped	1.41	5.76	0.07	
B	Powermeter Stability during calibration	0.0100	(dB)	Rectangular	1.73	5.76	0.03	
B	Powermeter Stability during measurement	0.0100	(dB)	Normal	1.73	5.76	0.03	
B	Homogeneity	0.0300	()	Normal	1.00	100.00	3.00	
A	Reading of probe (from the software)	0.0016	()	Normal	1.00	100.00	0.16	10
A	Experimental standard uncertainty (n meas.)	0.0050	()	Normal	1.00	100.00	0.50	20
Uc(CF)	Combined uncertainty			normal			4.31	
U	Expanded uncertainty			normal (k=2)			8.62	

C.6 – CMI Uncertainty Budgets

Table C.6.1 – Uncertainty budget for FL7018 measurement with 10 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Power meter accuracy	4.0	%	Normal	2.00	0.50	1.00	Inf.
B	Mismatch	0.3	%	U-shaped	1.41	1.00	0.21	Inf.
B	Harmonics	0.0	%	Rectangular	1.73	1.00	0.00	Inf.
B	Characteristic impedance of TEM cell	4.5	%	Rectangular	1.73	0.50	1.30	Inf.
B	Standing waves in TEM cell	3.5	%	U-shaped	1.41	1.00	2.48	Inf.
B	Non-uniformity of the field	5.0	%	Rectangular	1.73	1.00	2.89	Inf.
B	Septum distance	1.5	%	Rectangular	1.73	1.00	0.87	Inf.
A	Experimental standard uncertainty	0.0	%	Normal	1.00	1.00	0.05	9
Uc(CF)	Combined uncertainty			normal			4.24	>10000
U	Expanded uncertainty			normal (k=2)			8.49	

Table C.6.2 – Uncertainty budget for FL7018 measurement with 10 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Power meter accuracy	4.0	%	Normal	2.00	0.50	1.00	Inf.
B	Mismatch	0.5	%	U-shaped	1.41	1.00	0.35	Inf.
B	Harmonics	0.5	%	Rectangular	1.73	1.00	0.29	Inf.
B	Characteristic impedance of TEM cell	4.5	%	Rectangular	1.73	0.50	1.30	Inf.
B	Standing waves in TEM cell	3.8	%	U-shaped	1.41	1.00	2.70	Inf.
B	Non-uniformity of the field	8.0	%	Rectangular	1.73	1.00	4.62	Inf.
B	Septum distance	1.5	%	Rectangular	1.73	1.00	0.87	Inf.
A	Experimental standard uncertainty	0.1	%	Normal	1.00	1.00	0.13	9
Uc(CF)	Combined uncertainty			normal			5.68	>10000
U	Expanded uncertainty			normal (k=2)			11.37	

Table C.6.3 – Uncertainty budget for FL7018 measurement with 10 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Power meter accuracy	2.8	%	Normal	2.00	0.50	0.70	Inf.
B	Mismatch sensor - coupler	0.5	%	U-shaped	1.41	1.00	0.35	Inf.
B	Mismatch antenna - coupler	0.3	%	U-shaped	1.41	1.00	0.21	Inf.
B	Coupler power ratio	4.7	%	Normal	2.00	0.50	1.18	Inf.
B	Antenna gain	12.0	%	Normal	2.00	0.50	3.00	Inf.
B	Positional effects	2.0	%	Rectangular	1.73	1.00	1.16	Inf.
B	Reflections in chamber	0.5	%	U-shaped	1.41	1.00	0.35	Inf.
B	Reflections from probe holder	3.0	%	U-shaped	1.41	1.00	2.13	Inf.
A	Experimental standard uncertainty	0.0	%	Normal	1.00	1.00	0.01	9
Uc(CF)	Combined uncertainty			normal			4.13	>10000
U	Expanded uncertainty			normal (k=2)			8.25	

Table C.6.4 – Uncertainty budget for FL7018 measurement with 10 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Power meter accuracy	3.0	%	Normal	2.00	0.50	0.75	Inf.
B	Mismatch sensor - coupler	0.5	%	U-shaped	1.41	1.00	0.35	Inf.
B	Mismatch antenna - coupler	0.3	%	U-shaped	1.41	1.00	0.21	Inf.
B	Coupler power ratio	4.7	%	Normal	2.00	0.50	1.18	Inf.
B	Antenna gain	12.0	%	Normal	2.00	0.50	3.00	Inf.
B	Positional effects	2.0	%	Rectangular	1.73	1.00	1.16	Inf.
B	Reflections in chamber	0.5	%	U-shaped	1.41	1.00	0.35	Inf.
B	Reflections from probe holder	3.0	%	U-shaped	1.41	1.00	2.13	Inf.
A	Experimental standard uncertainty	0.0	%	Normal	1.00	1.00	0.02	9
Uc(CF)	Combined uncertainty			normal			4.14	>10000
U	Expanded uncertainty			normal (k=2)			8.27	

Table C.6.5 – Uncertainty budget for FL7018 measurement with 30 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Power meter accuracy	4.0	%	Normal	2.00	0.50	1.00	Inf.
B	Mismatch	0.3	%	U-shaped	1.41	1.00	0.21	Inf.
B	Harmonics	0.0	%	Rectangular	1.73	1.00	0.00	Inf.
B	Characteristic impedance of TEM cell	4.5	%	Rectangular	1.73	0.50	1.30	Inf.
B	Standing waves in TEM cell	3.5	%	U-shaped	1.41	1.00	2.48	Inf.
B	Non-uniformity of the field	5.0	%	Rectangular	1.73	1.00	2.89	Inf.
B	Septum distance	1.5	%	Rectangular	1.73	1.00	0.87	Inf.
A	Experimental standard uncertainty	0.1	%	Normal	1.00	1.00	0.05	9
Uc(CF)	Combined uncertainty			normal			4.24	>10000
U	Expanded uncertainty			normal (k=2)			8.49	

Table C.6.6 – Uncertainty budget for FL7018 measurement with 30 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Power meter accuracy	4.0	%	Normal	2.00	0.50	1.00	Inf.
B	Mismatch	0.5	%	U-shaped	1.41	1.00	0.35	Inf.
B	Harmonics	4.0	%	Rectangular	1.73	1.00	2.31	Inf.
B	Characteristic impedance of TEM cell	4.5	%	Rectangular	1.73	0.50	1.30	Inf.
B	Standing waves in TEM cell	3.8	%	U-shaped	1.41	1.00	2.70	Inf.
B	Non-uniformity of the field	8.0	%	Rectangular	1.73	1.00	4.62	Inf.
B	Septum distance	1.5	%	Rectangular	1.73	1.00	0.87	Inf.
A	Experimental standard uncertainty	0.1	%	Normal	1.00	1.00	0.11	9
Uc(CF)	Combined uncertainty			normal			6.13	>10000
U	Expanded uncertainty			normal (k=2)			12.26	

Table C.6.7 – Uncertainty budget for FL7018 measurement with 30 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Power meter accuracy	2.8	%	Normal	2.00	0.50	0.70	Inf.
B	Mismatch sensor - coupler	0.5	%	U-shaped	1.41	1.00	0.35	Inf.
B	Mismatch antenna - coupler	0.3	%	U-shaped	1.41	1.00	0.21	Inf.
B	Coupler power ratio	4.7	%	Normal	2.00	0.50	1.18	Inf.
B	Antenna gain	12.0	%	Normal	2.00	0.50	3.00	Inf.
B	Positional effects	2.0	%	Rectangular	1.73	1.00	1.16	Inf.
B	Reflections in chamber	0.5	%	U-shaped	1.41	1.00	0.35	Inf.
B	Reflections from probe holder	3.0	%	U-shaped	1.41	1.00	2.13	Inf.
A	Experimental standard uncertainty	0.0	%	Normal	1.00	1.00	0.01	9
Uc(CF)	Combined uncertainty			normal			4.13	>10000
U	Expanded uncertainty			normal (k=2)			8.25	

Table C.6.8 – Uncertainty budget for FL7018 measurement with 30 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Power meter accuracy	3.0	%	Normal	2.00	0.50	0.75	Inf.
B	Mismatch sensor - coupler	0.5	%	U-shaped	1.41	1.00	0.35	Inf.
B	Mismatch antenna - coupler	0.3	%	U-shaped	1.41	1.00	0.21	Inf.
B	Coupler power ratio	4.7	%	Normal	2.00	0.50	1.18	Inf.
B	Antenna gain	12.0	%	Normal	2.00	0.50	3.00	Inf.
B	Positional effects	2.0	%	Rectangular	1.73	1.00	1.16	Inf.
B	Reflections in chamber	0.5	%	U-shaped	1.41	1.00	0.35	Inf.
B	Reflections from probe holder	3.0	%	U-shaped	1.41	1.00	2.13	Inf.
A	Experimental standard uncertainty	0.2	%	Normal	1.00	1.00	0.15	9
Uc(CF)	Combined uncertainty			normal			4.14	>10000
U	Expanded uncertainty			normal (k=2)			8.28	

Table C.6.9 – Uncertainty budget for FL7018 measurement with 100 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Power meter accuracy	4.0	%	Normal	2.00	0.50	1.00	Inf.
B	Mismatch	0.3	%	U-shaped	1.41	1.00	0.21	Inf.
B	Harmonics	1.0	%	Rectangular	1.73	1.00	0.58	Inf.
B	Characteristic impedance of TEM cell	4.5	%	Rectangular	1.73	0.50	1.30	Inf.
B	Standing waves in TEM cell	3.5	%	U-shaped	1.41	1.00	2.48	Inf.
B	Non-uniformity of the field	5.0	%	Rectangular	1.73	1.00	2.89	Inf.
B	Septum distance	1.5	%	Rectangular	1.73	1.00	0.87	Inf.
A	Experimental standard uncertainty	0.0	%	Normal	1.00	1.00	0.02	9
Uc(CF)	Combined uncertainty			normal			4.28	>10000
U	Expanded uncertainty			normal (k=2)			8.56	

Table C.6.10 – Uncertainty budget for FL7018 measurement with 100 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Power meter accuracy	2.8	%	Normal	2.00	0.50	0.70	Inf.
B	Power meter linearity	0.8	%	Rectangular	1.73	0.50	0.23	Inf.
B	Mismatch sensor - coupler	0.5	%	U-shaped	1.41	1.00	0.35	Inf.
B	Mismatch antenna - coupler	0.3	%	U-shaped	1.41	1.00	0.21	Inf.
B	Coupler power ratio	4.7	%	Normal	2.00	0.50	1.18	Inf.
B	Antenna gain	12.0	%	Normal	2.00	0.50	3.00	Inf.
B	Positional effects	2.0	%	Rectangular	1.73	1.00	1.16	Inf.
B	Reflections in chamber	0.5	%	U-shaped	1.41	1.00	0.35	Inf.
B	Reflections from probe holder	3.0	%	U-shaped	1.41	1.00	2.13	Inf.
A	Experimental standard uncertainty	0.0	%	Normal	1.00	1.00	0.01	9
Uc(CF)	Combined uncertainty			normal			4.13	>10000
U	Expanded uncertainty			normal (k=2)			8.27	

Table C.6.11 – Uncertainty budget for FL7018 measurement with 100 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Power meter accuracy	3.0	%	Normal	2.00	0.50	0.75	Inf.
B	Power meter linearity	0.8	%	Rectangular	1.73	0.50	0.23	Inf.
B	Mismatch sensor - coupler	0.5	%	U-shaped	1.41	1.00	0.35	Inf.
B	Mismatch antenna - coupler	0.3	%	U-shaped	1.41	1.00	0.21	Inf.
B	Coupler power ratio	4.7	%	Normal	2.00	0.50	1.18	Inf.
B	Antenna gain	12.0	%	Normal	2.00	0.50	3.00	Inf.
B	Positional effects	2.0	%	Rectangular	1.73	1.00	1.16	Inf.
B	Reflections in chamber	0.5	%	U-shaped	1.41	1.00	0.35	Inf.
B	Reflections from probe holder	3.0	%	U-shaped	1.41	1.00	2.13	Inf.
A	Experimental standard uncertainty	0.0	%	Normal	1.00	1.00	0.02	9
Uc(CF)	Combined uncertainty			normal			4.14	>10000
U	Expanded uncertainty			normal (k=2)			8.28	

Table C.6.12 – Uncertainty budget for FP7050 measurement with 30 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Power meter accuracy	4.0	%	Normal	2.00	0.50	1.00	Inf.
B	Mismatch	0.3	%	U-shaped	1.41	1.00	0.21	Inf.
B	Harmonics	0.0	%	Rectangular	1.73	1.00	0.00	Inf.
B	Characteristic impedance of TEM cell	4.5	%	Rectangular	1.73	0.50	1.30	Inf.
B	Standing waves in TEM cell	3.5	%	U-shaped	1.41	1.00	2.48	Inf.
B	Non-uniformity of the field	5.0	%	Rectangular	1.73	1.00	2.89	Inf.
B	Septum distance	1.5	%	Rectangular	1.73	1.00	0.87	Inf.
A	Experimental standard uncertainty	0.1	%	Normal	1.00	1.00	0.14	9
Uc(CF)	Combined uncertainty			normal			4.25	>10000
U	Expanded uncertainty			normal (k=2)			8.49	

Table C.6.13 – Uncertainty budget for FP7050 measurement with 30 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Power meter accuracy	4.0	%	Normal	2.00	0.50	1.00	Inf.
B	Mismatch	0.5	%	U-shaped	1.41	1.00	0.35	Inf.
B	Harmonics	3.8	%	Rectangular	1.73	1.00	2.20	Inf.
B	Characteristic impedance of TEM cell	4.5	%	Rectangular	1.73	0.50	1.30	Inf.
B	Standing waves in TEM cell	3.8	%	U-shaped	1.41	1.00	2.70	Inf.
B	Non-uniformity of the field	8.0	%	Rectangular	1.73	1.00	4.62	Inf.
B	Septum distance	1.5	%	Rectangular	1.73	1.00	0.87	Inf.
A	Experimental standard uncertainty	0.1	%	Normal	1.00	1.00	0.13	9
Uc(CF)	Combined uncertainty			normal			6.09	>10000
U	Expanded uncertainty			normal (k=2)			12.17	

Table C.6.14 – Uncertainty budget for FP7050 measurement with 30 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Power meter accuracy	2.8	%	Normal	2.00	0.50	0.70	Inf.
B	Mismatch sensor - coupler	0.5	%	U-shaped	1.41	1.00	0.35	Inf.
B	Mismatch antenna - coupler	0.3	%	U-shaped	1.41	1.00	0.21	Inf.
B	Coupler power ratio	4.7	%	Normal	2.00	0.50	1.18	Inf.
B	Antenna gain	12.0	%	Normal	2.00	0.50	3.00	Inf.
B	Positional effects	2.0	%	Rectangular	1.73	1.00	1.16	Inf.
B	Reflections in chamber	0.5	%	U-shaped	1.41	1.00	0.35	Inf.
B	Reflections from probe holder	3.0	%	U-shaped	1.41	1.00	2.13	Inf.
A	Experimental standard uncertainty	0.1	%	Normal	1.00	1.00	0.06	9
Uc(CF)	Combined uncertainty			normal			4.13	>10000
U	Expanded uncertainty			normal (k=2)			8.25	

Table C.6.15 – Uncertainty budget for FP7050 measurement with 30 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Power meter accuracy	3.0	%	Normal	2.00	0.50	0.75	Inf.
B	Mismatch sensor - coupler	0.5	%	U-shaped	1.41	1.00	0.35	Inf.
B	Mismatch antenna - coupler	0.3	%	U-shaped	1.41	1.00	0.21	Inf.
B	Coupler power ratio	4.7	%	Normal	2.00	0.50	1.18	Inf.
B	Antenna gain	12.0	%	Normal	2.00	0.50	3.00	Inf.
B	Positional effects	2.0	%	Rectangular	1.73	1.00	1.16	Inf.
B	Reflections in chamber	0.5	%	U-shaped	1.41	1.00	0.35	Inf.
B	Reflections from probe holder	3.0	%	U-shaped	1.41	1.00	2.13	Inf.
A	Experimental standard uncertainty	0.1	%	Normal	1.00	1.00	0.12	9
Uc(CF)	Combined uncertainty			normal			4.14	>10000
U	Expanded uncertainty			normal (k=2)			8.27	

Table C.6.16 – Uncertainty budget for FP7050 measurement with 100 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Power meter accuracy	4.0	%	Normal	2.00	0.50	1.00	Inf.
B	Mismatch	0.3	%	U-shaped	1.41	1.00	0.21	Inf.
B	Harmonics	0.1	%	Rectangular	1.73	1.00	0.06	Inf.
B	Characteristic impedance of TEM cell	4.5	%	Rectangular	1.73	0.50	1.30	Inf.
B	Standing waves in TEM cell	3.5	%	U-shaped	1.41	1.00	2.48	Inf.
B	Non-uniformity of the field	5.0	%	Rectangular	1.73	1.00	2.89	Inf.
B	Septum distance	1.5	%	Rectangular	1.73	1.00	0.87	Inf.
A	Experimental standard uncertainty	0.1	%	Normal	1.00	1.00	0.14	9
Uc(CF)	Combined uncertainty			normal			4.25	>10000
U	Expanded uncertainty			normal (k=2)			8.49	

Table C.6.17 – Uncertainty budget for FP7050 measurement with 100 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Power meter accuracy	2.8	%	Normal	2.00	0.50	0.70	Inf.
B	Power meter linearity	0.8	%	Rectangular	1.73	0.50	0.23	Inf.
B	Mismatch sensor - coupler	0.5	%	U-shaped	1.41	1.00	0.35	Inf.
B	Mismatch antenna - coupler	0.3	%	U-shaped	1.41	1.00	0.21	Inf.
B	Coupler power ratio	4.7	%	Normal	2.00	0.50	1.18	Inf.
B	Antenna gain	12.0	%	Normal	2.00	0.50	3.00	Inf.
B	Positional effects	2.0	%	Rectangular	1.73	1.00	1.16	Inf.
B	Reflections in chamber	0.5	%	U-shaped	1.41	1.00	0.35	Inf.
B	Reflections from probe holder	3.0	%	U-shaped	1.41	1.00	2.13	Inf.
A	Experimental standard uncertainty	0.0	%	Normal	1.00	1.00	0.01	9
Uc(CF)	Combined uncertainty			normal			4.13	>10000
U	Expanded uncertainty			normal (k=2)			8.27	

Table C.6.18 – Uncertainty budget for FP7050 measurement with 100 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Power meter accuracy	3.0	%	Normal	2.00	0.50	0.75	Inf.
B	Power meter linearity	0.8	%	Rectangular	1.73	0.50	0.23	Inf.
B	Mismatch sensor - coupler	0.5	%	U-shaped	1.41	1.00	0.35	Inf.
B	Mismatch antenna - coupler	0.3	%	U-shaped	1.41	1.00	0.21	Inf.
B	Coupler power ratio	4.7	%	Normal	2.00	0.50	1.18	Inf.
B	Antenna gain	12.0	%	Normal	2.00	0.50	3.00	Inf.
B	Positional effects	2.0	%	Rectangular	1.73	1.00	1.16	Inf.
B	Reflections in chamber	0.5	%	U-shaped	1.41	1.00	0.35	Inf.
B	Reflections from probe holder	3.0	%	U-shaped	1.41	1.00	2.13	Inf.
A	Experimental standard uncertainty	0.0	%	Normal	1.00	1.00	0.03	9
Uc(CF)	Combined uncertainty			normal			4.14	>10000
U	Expanded uncertainty			normal (k=2)			8.28	

C.7 VSL Uncertainty Budgets

Table C.7.1 Example of measurement uncertainty calculation table for calibrating the transfer standard probe in the micro TEM cell (micro TEM cell at 1 GHz)

Contributions:	parameter	unit	value	U_i	dist	$u(x_i)$	C_i	$[C_i]$	$u_i(y)$ (V/m)	$u(x_i)^2$
Field strength reading	E_m	V/m	20.000	none						
Resolution UUT	δE_{res}	V/m	0.000	0.005	uniform	0.00289	1		0.0029	0.00000833
Distance Septum-wall	d	mm	29.70	0.10	uniform	0.05774	0.6336044	$V.m^{-1}.mm^{-1}$	0.0366	0.00133818
Power reading	P_m	W	0.006324	none						
Non-linearity of power sensor	$k(A)$		1.000	0.002	normal 2s	0.001	9.4090246	$V.m^{-1}$	0.0094	0.00008853
Frequency response of power sensor	$k_1(f)$		1.000	0.017	normal 2s	0.0085	9.4084078	$V.m^{-1}$	0.0800	0.00639544
Frequency dependant attenuation of the cell	$k_2(f)$		1.008	0.005	normal 2s	0.0025	9.335651	$V.m^{-1}$	0.0233	0.00054471
Mismatch losses	M_{tot}		1.000	0.0002	U-shaped	0.00014	9.4090246	$V.m^{-1}$	0.0009	0.00000177
TEM Cell impedance	Z_L	Ω	50.00	0.20	uniform	0.11547	0.1881805	$V.m^{-1}.\Omega^{-1}$	0.0217	0.00047216
Standing waves	δ_{SW}		0.000	0.01	U-shaped	0.00707	18.818	$V.m^{-1}$	0.1331	0.01770595
Form factor	$f(x, y)$		0.990	0.00570	uniform	0.00329	19.008131	$V.m^{-1}$	0.0626	0.00391298
Calculated field strength (intermediate result)	E	V/m	18.818							
Type-A: independent repeat measurements	E_n	V/m	18.818	0.01	normal 1s	0.01	1		0.0080	0.00006400
RESULT						$u(y)$	k	$U(y)$		
Normalised field strength (result)	E_n	V/m	18.818			0.17473	2.00	0.349	V/m	0.03053205
						Relative	$U(y)/E$	0.019	rel	

Table C.7.2 Example of measurement uncertainty calculation table for calibrating the transfer standard probe in the micro TEM cell (micro TEM cell at 2.45 GHz)

Contributions:	parameter	unit	value	U_i	dist	$u(x_i)$	C_i	$[C_i]$	$u_i(y)$ (V/m)	$u(x_i)^2$
Field strength reading	E_m	V/m	20.000	none						
Resolution UUT	δE_{res}	V/m	0.000	0.005	uniform	0.00289	1		0.0029	0.00000833
Distance Septum-wall	d	mm	29.70	0.10	uniform	0.05774	0.6221862	$V.m^{-1}.mm^{-1}$	0.0359	0.00129039
Power reading	P_m	W	0.006109	none						
Non-linearity of power sensor	$k(A)$		1.000	0.002	normal 2s	0.001	9.2394655	$V.m^{-1}$	0.0092	0.00008537
Frequency response of power sensor	$k_1(f)$		1.000	0.017	normal 2s	0.0085	9.2272653	$V.m^{-1}$	0.0784	0.00615154
Frequency dependant attenuation of the cell	$k_2(f)$		1.008	0.005	normal 2s	0.0025	9.1948966	$V.m^{-1}$	0.0230	0.00052841
Mismatch losses	M_{tot}		1.000	0.003	U-shaped	0.00014	9.2394655	$V.m^{-1}$	0.0209	0.00043708
TEM Cell impedance	Z_L	Ω	50.00	0.20	uniform	0.11547	0.1847893	$V.m^{-1}.\Omega^{-1}$	0.0213	0.00045529
Standing waves	δ_{SW}		0.000	0.04	U-shaped	0.00707	18.479	$V.m^{-1}$	0.5227	0.27317671
Form factor	$f(x, y)$		0.990	0.00570	uniform	0.00329	18.665587	$V.m^{-1}$	0.0614	0.00377322
Calculated field strenght (intermediate result)	E	V/m	18.479							
Type-A: independent repeat measurements	E_n	V/m	18.479	0.01	normal 1s	0.01	1		0.0080	0.00006400

RESULT						$u(y)$	k	$U(y)$		
Normalised field strength (result)	E_n	V/m	18.479			0.53476	2.00	1.070	V/m	0.28597035
						Relative	$U(y)/E$	0.058	rel	

Measurement uncertainty calculation tables for calibrating the travelling standard probe in the tapered cell.

Table C.7.3

Measurement at frequency 1GHz, Tapered cell, FL7018, 10V/m				
Source of uncertainty		Type of uncertainty	Estimated value (%)	Degree of freedom
Correction factor of the field generator	CF	B	0.93	Inf.
Sensor position	d_2	B	0.39	Inf.
Power measurement	P	B	0.52	Inf.
Field uniformity	$f(x, y)$	B	1.91	Inf.
Coupling between EUT and test cell	k_c	B	1.95	Inf.
Power meter resolution	δP_{res}	B	0.13	Inf.
Travelling probe resolution	δE_{res}	B	0.06	Inf.
Repeatability		A	0.02	9
Overall combined uncertainty:			2.96	>10000
Expanded uncertainty (k=2):			5.92	

Table C.7.4

Measurement at frequency 2.45GHz, Tapered cell, FL7018, 10V/m				
Source of uncertainty		Type of uncertainty	Estimated value (%)	Degree of freedom
Correction factor of the field generator	CF	B	2.98	Inf.
Sensor position	d_s	B	0.39	Inf.
Power measurement	P	B	0.52	Inf.
Field uniformity	$f(x, y)$	B	4.20	Inf.
Coupling between EUT and test cell	k_c	B	3.10	Inf.
Power meter resolution	δP_{res}	B	0.13	Inf.
Travelling probe resolution	δE_{res}	B	0.06	Inf.
Repeatability		A	0.02	9
Overall combined uncertainty:			6.05	>10000
Expanded uncertainty (k=2):			12.10	

Table C.7.5

Measurement at frequency 1GHz, Tapered cell, FL7018, 30V/m				
Source of uncertainty		Type of uncertainty	Estimated value (%)	Degree of freedom
Correction factor of the field generator	CF	B	0.93	Inf.
Sensor position	d_s	B	0.39	Inf.
Power measurement	P	B	0.52	Inf.
Field uniformity	$f(x, y)$	B	1.91	Inf.
Coupling between EUT and test cell	k_c	B	1.95	Inf.
Power meter resolution	δP_{res}	B	0.13	Inf.
Travelling probe resolution	δE_{res}	B	0.02	Inf.
Repeatability		A	0.02	9
Overall combined uncertainty:			2.96	>10000
Expanded uncertainty (k=2):			5.92	

Table C.7.6

Measurement at frequency 2.45GHz, Tapered cell, FL7018, 30V/m				
Source of uncertainty		Type of uncertainty	Estimated value (%)	Degree of freedom
Correction factor of the field generator	CF	B	2.98	Inf.
Sensor position	d_s	B	0.39	Inf.
Power measurement	P	B	0.52	Inf.
Field uniformity	$f(x, y)$	B	4.20	Inf.
Coupling between EUT and test cell	k_c	B	3.10	Inf.
Power meter resolution	δP_{res}	B	0.13	Inf.
Travelling probe resolution	δE_{res}	B	0.02	Inf.
Repeatability		A	0.02	9
Overall combined uncertainty:			6.05	>10000
Expanded uncertainty (k=2):			12.10	

Table C.7.7

Measurement at frequency 1GHz, Tapered cell, FL7050, 30V/m				
Source of uncertainty		Type of uncertainty	Estimated value (%)	Degree of freedom
Correction factor of the field generator	CF	B	0.93	Inf.
Sensor position	d_s	B	0.39	Inf.
Power measurement	P	B	0.52	Inf.
Field uniformity	$f(x, y)$	B	1.91	Inf.
Coupling between EUT and test cell	k_c	B	1.95	Inf.
Power meter resolution	δP_{res}	B	0.13	Inf.
Travelling probe resolution	δE_{res}	B	0.02	Inf.
Repeatability		A	0.30	9
Overall combined uncertainty:			2.97	>10000
Expanded uncertainty (k=2):			5.95	

Table C.7.8

Measurement at frequency 2.45GHz, Tapered cell, FL7050, 30V/m				
Source of uncertainty		Type of uncertainty	Estimated value (%)	Degree of freedom
Correction factor of the field generator	CF	B	2.98	Inf.
Sensor position	d_s	B	0.39	Inf.
Power measurement	P	B	0.52	Inf.
Field uniformity	$f(x, y)$	B	4.20	Inf.
Coupling between EUT and test cell	k_c	B	3.10	Inf.
Power meter resolution	δP_{res}	B	0.13	Inf.
Travelling probe resolution	δE_{res}	B	0.02	Inf.
Repeatability		A	0.30	9
Overall combined uncertainty:			6.06	>10000
Expanded uncertainty (k=2):			12.11	

C.8 NIM Uncertainty Budgets

Table C.8.1 – Uncertainty budget for FL7018 measurement with 10 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Repeatability (standard)	2.3293	%	Normal	1.00	1.00	2.33	
B	Mismatch error at input of directional coupler	0.0345	%	U-shaped	1.41	1.00	0.02	
B	Mismatch at directional coupler to standard-gain horn connection	0.1613	%	U-shaped	1.41	1.00	0.11	
B	Mismatch error at forward power sensor	0.1728	%	U-shaped	1.41	1.00	0.12	
B	Mismatch error at reverse power sensor	0.2536	%	U-shaped	1.41	1.00	0.18	
B	Insertion loss error for directional coupler	0.5773	%	Normal	1.00	1.00	0.58	
B	Forward coupling coefficient error for directional coupler	1.1579	%	Normal	1.00	1.00	1.16	
B	Reverse coupling coefficient error for directional coupler	1.1579	%	Normal	1.00	1.00	1.16	
B	Spacing error	1.8474	%	Rectangular	1.73	1.00	1.07	
B	Alignment error (up and down)	0.9253	%	Rectangular	1.73	1.00	0.53	
B	Alignment error (left and right)	0.2767	%	Rectangular	1.73	1.00	0.16	
B	Power measurement error for forward power sensor	0.8788	%	Rectangular	1.73	1.00	0.51	
B	Power measurement error for reverse power sensor	0.8788	%	Rectangular	1.73	1.00	0.51	
B	Power linearity error for forward power sensor	0.2536	%	Rectangular	1.73	1.00	0.15	
B	Power linearity error for reverse power sensor	0.2536	%	Rectangular	1.73	1.00	0.15	
B	Residual ground reflections error	0.0000	%	Rectangular	1.73	1.00	0.00	
B	Thermal error for coaxial cables	0.0000	%	Rectangular	1.73	1.00	0.00	
B	Coaxial cable flexing error	0.0000	%	Rectangular	1.73	1.00	0.00	
B	Multiple reflections error	2.8964	%	Rectangular	1.73	1.00	1.67	
B	Cart error	4.9663	%	Rectangular	1.73	1.00	2.87	
B	Standard-gain horn error	5.9254	%	Rectangular	1.73	1.00	3.43	
Uc(CF)	Combined uncertainty			normal			5.77	
U	Expanded uncertainty			normal (k=2)			11.54	

Table C.8.2 – Uncertainty budget for FL7018 measurement with 10 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Repeatability (standard)	2.3293	%	Normal	1.00	1.00	2.33	
B	Mismatch error at input of directional coupler	0.1613	%	U-shaped	1.41	1.00	0.11	
B	Mismatch at directional coupler to standard-gain horn connection	0.7860	%	U-shaped	1.41	1.00	0.56	
B	Mismatch error at forward power sensor	0.2074	%	U-shaped	1.41	1.00	0.15	
B	Mismatch error at reverse power sensor	0.6700	%	U-shaped	1.41	1.00	0.47	
B	Insertion loss error for directional coupler	0.5773	%	Normal	1.00	1.00	0.58	
B	Forward coupling coefficient error for directional coupler	1.1579	%	Normal	1.00	1.00	1.16	
B	Reverse coupling coefficient error for directional coupler	1.1579	%	Normal	1.00	1.00	1.16	
B	Spacing error	3.4666	%	Rectangular	1.73	1.00	2.00	
B	Alignment error (up and down)	0.2190	%	Rectangular	1.73	1.00	0.13	
B	Alignment error (left and right)	1.7185	%	Rectangular	1.73	1.00	0.99	
B	Power measurement error for forward power sensor	0.8788	%	Rectangular	1.73	1.00	0.51	
B	Power measurement error for reverse power sensor	0.8788	%	Rectangular	1.73	1.00	0.51	
B	Power linearity error for forward power sensor	0.2536	%	Rectangular	1.73	1.00	0.15	
B	Power linearity error for reverse power sensor	0.2536	%	Rectangular	1.73	1.00	0.15	
B	Residual ground reflections error	0.0000	%	Rectangular	1.73	1.00	0.00	
B	Thermal error for coaxial cables	0.0000	%	Rectangular	1.73	1.00	0.00	
B	Coaxial cable flexing error	0.0000	%	Rectangular	1.73	1.00	0.00	
B	Multiple reflections error	3.8006	%	Rectangular	1.73	1.00	2.20	
B	Cart error	3.1811	%	Rectangular	1.73	1.00	1.84	
B	Standard-gain horn error	5.9254	%	Rectangular	1.73	1.00	3.43	
Uc(CF)	Combined uncertainty			normal			5.88	
U	Expanded uncertainty			normal (k=2)			11.75	

Table C.8.3 – Uncertainty budget for FL7018 measurement with 30 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Repeatability (standard)	2.3293	%	Normal	1.00	1.00	2.33	
B	Mismatch error at input of directional coupler	0.0345	%	U-shaped	1.41	1.00	0.02	
B	Mismatch at directional coupler to standard-gain horn connection	0.1613	%	U-shaped	1.41	1.00	0.11	
B	Mismatch error at forward power sensor	0.1728	%	U-shaped	1.41	1.00	0.12	
B	Mismatch error at reverse power sensor	0.2536	%	U-shaped	1.41	1.00	0.18	
B	Insertion loss error for directional coupler	0.5773	%	Normal	1.00	1.00	0.58	
B	Forward coupling coefficient error for directional coupler	1.1579	%	Normal	1.00	1.00	1.16	
B	Reverse coupling coefficient error for directional coupler	1.1579	%	Normal	1.00	1.00	1.16	
B	Spacing error	1.8474	%	Rectangular	1.73	1.00	1.07	
B	Alignment error (up and down)	0.9253	%	Rectangular	1.73	1.00	0.53	
B	Alignment error (left and right)	0.2767	%	Rectangular	1.73	1.00	0.16	
B	Power measurement error for forward power sensor	0.8788	%	Rectangular	1.73	1.00	0.51	
B	Power measurement error for reverse power sensor	0.8788	%	Rectangular	1.73	1.00	0.51	
B	Power linearity error for forward power sensor	0.2536	%	Rectangular	1.73	1.00	0.15	
B	Power linearity error for reverse power sensor	0.2536	%	Rectangular	1.73	1.00	0.15	
B	Residual ground reflections error	0.0000	%	Rectangular	1.73	1.00	0.00	
B	Thermal error for coaxial cables	0.0000	%	Rectangular	1.73	1.00	0.00	
B	Coaxial cable flexing error	0.0000	%	Rectangular	1.73	1.00	0.00	
B	Multiple reflections error	2.8964	%	Rectangular	1.73	1.00	1.67	
B	Cart error	4.9663	%	Rectangular	1.73	1.00	2.87	
B	Standard-gain horn error	5.9254	%	Rectangular	1.73	1.00	3.43	
Uc(CF)	Combined uncertainty			normal			5.77	
U	Expanded uncertainty			normal (k=2)			11.54	

Table C.8.4 – Uncertainty budget for FL7018 measurement with 30 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Repeatability (standard)	2.3293	%	Normal	1.00	1.00	2.33	
B	Mismatch error at input of directional coupler	0.1613	%	U-shaped	1.41	1.00	0.11	
B	Mismatch at directional coupler to standard-gain horn connection	0.7860	%	U-shaped	1.41	1.00	0.56	
B	Mismatch error at forward power sensor	0.2074	%	U-shaped	1.41	1.00	0.15	
B	Mismatch error at reverse power sensor	0.6700	%	U-shaped	1.41	1.00	0.47	
B	Insertion loss error for directional coupler	0.5773	%	Normal	1.00	1.00	0.58	
B	Forward coupling coefficient error for directional coupler	1.1579	%	Normal	1.00	1.00	1.16	
B	Reverse coupling coefficient error for directional coupler	1.1579	%	Normal	1.00	1.00	1.16	
B	Spacing error	3.4666	%	Rectangular	1.73	1.00	2.00	
B	Alignment error (up and down)	0.2190	%	Rectangular	1.73	1.00	0.13	
B	Alignment error (left and right)	1.7185	%	Rectangular	1.73	1.00	0.99	
B	Power measurement error for forward power sensor	0.8788	%	Rectangular	1.73	1.00	0.51	
B	Power measurement error for reverse power sensor	0.8788	%	Rectangular	1.73	1.00	0.51	
B	Power linearity error for forward power sensor	0.2536	%	Rectangular	1.73	1.00	0.15	
B	Power linearity error for reverse power sensor	0.2536	%	Rectangular	1.73	1.00	0.15	
B	Residual ground reflections error	0.0000	%	Rectangular	1.73	1.00	0.00	
B	Thermal error for coaxial cables	0.0000	%	Rectangular	1.73	1.00	0.00	
B	Coaxial cable flexing error	0.0000	%	Rectangular	1.73	1.00	0.00	
B	Multiple reflections error	3.8006	%	Rectangular	1.73	1.00	2.20	
B	Cart error	3.1811	%	Rectangular	1.73	1.00	1.84	
B	Standard-gain horn error	5.9254	%	Rectangular	1.73	1.00	3.43	
Uc(CF)	Combined uncertainty			normal			5.88	
U	Expanded uncertainty			normal (k=2)			11.75	

Table C.8.5 – Uncertainty budget for FL7018 measurement with 100 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Repeatability (standard)	2.3293	%	Normal	1.00	1.00	2.33	
B	Mismatch error at input of directional coupler	0.0345	%	U-shaped	1.41	1.00	0.02	
B	Mismatch at directional coupler to standard-gain horn connection	0.1613	%	U-shaped	1.41	1.00	0.11	
B	Mismatch error at forward power sensor	0.1728	%	U-shaped	1.41	1.00	0.12	
B	Mismatch error at reverse power sensor	0.2536	%	U-shaped	1.41	1.00	0.18	
B	Insertion loss error for directional coupler	0.5773	%	Normal	1.00	1.00	0.58	
B	Forward coupling coefficient error for directional coupler	1.1579	%	Normal	1.00	1.00	1.16	
B	Reverse coupling coefficient error for directional coupler	1.1579	%	Normal	1.00	1.00	1.16	
B	Spacing error	1.8474	%	Rectangular	1.73	1.00	1.07	
B	Alignment error (up and down)	0.9253	%	Rectangular	1.73	1.00	0.53	
B	Alignment error (left and right)	0.2767	%	Rectangular	1.73	1.00	0.16	
B	Power measurement error for forward power sensor	0.8788	%	Rectangular	1.73	1.00	0.51	
B	Power measurement error for reverse power sensor	0.8788	%	Rectangular	1.73	1.00	0.51	
B	Power linearity error for forward power sensor	0.2536	%	Rectangular	1.73	1.00	0.15	
B	Power linearity error for reverse power sensor	0.2536	%	Rectangular	1.73	1.00	0.15	
B	Residual ground reflections error	0.0000	%	Rectangular	1.73	1.00	0.00	
B	Thermal error for coaxial cables	0.0000	%	Rectangular	1.73	1.00	0.00	
B	Coaxial cable flexing error	0.0000	%	Rectangular	1.73	1.00	0.00	
B	Multiple reflections error	2.8964	%	Rectangular	1.73	1.00	1.67	
B	Cart error	4.9663	%	Rectangular	1.73	1.00	2.87	
B	Standard-gain horn error	5.9254	%	Rectangular	1.73	1.00	3.43	
Uc(CF)	Combined uncertainty			normal			5.77	
U	Expanded uncertainty			normal (k=2)			11.54	

Table C.8.6 – Uncertainty budget for FL7018 measurement with 100 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Repeatability (standard)	2.3293	%	Normal	1.00	1.00	2.33	
B	Mismatch error at input of directional coupler	0.1613	%	U-shaped	1.41	1.00	0.11	
B	Mismatch at directional coupler to standard-gain horn connection	0.7860	%	U-shaped	1.41	1.00	0.56	
B	Mismatch error at forward power sensor	0.2074	%	U-shaped	1.41	1.00	0.15	
B	Mismatch error at reverse power sensor	0.6700	%	U-shaped	1.41	1.00	0.47	
B	Insertion loss error for directional coupler	0.5773	%	Normal	1.00	1.00	0.58	
B	Forward coupling coefficient error for directional coupler	1.1579	%	Normal	1.00	1.00	1.16	
B	Reverse coupling coefficient error for directional coupler	1.1579	%	Normal	1.00	1.00	1.16	
B	Spacing error	3.4666	%	Rectangular	1.73	1.00	2.00	
B	Alignment error (up and down)	0.2190	%	Rectangular	1.73	1.00	0.13	
B	Alignment error (left and right)	1.7185	%	Rectangular	1.73	1.00	0.99	
B	Power measurement error for forward power sensor	0.8788	%	Rectangular	1.73	1.00	0.51	
B	Power measurement error for reverse power sensor	0.8788	%	Rectangular	1.73	1.00	0.51	
B	Power linearity error for forward power sensor	0.2536	%	Rectangular	1.73	1.00	0.15	
B	Power linearity error for reverse power sensor	0.2536	%	Rectangular	1.73	1.00	0.15	
B	Residual ground reflections error	0.0000	%	Rectangular	1.73	1.00	0.00	
B	Thermal error for coaxial cables	0.0000	%	Rectangular	1.73	1.00	0.00	
B	Coaxial cable flexing error	0.0000	%	Rectangular	1.73	1.00	0.00	
B	Multiple reflections error	3.8006	%	Rectangular	1.73	1.00	2.20	
B	Cart error	3.1811	%	Rectangular	1.73	1.00	1.84	
B	Standard-gain horn error	5.9254	%	Rectangular	1.73	1.00	3.43	
Uc(CF)	Combined uncertainty			normal			5.88	
U	Expanded uncertainty			normal (k=2)			11.75	

Table C.8.7 – Uncertainty budget for FP7050 measurement with 30 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Repeatability (standard)	2.3293	%	Normal	1.00	1.00	2.33	
B	Mismatch error at input of directional coupler	0.0345	%	U-shaped	1.41	1.00	0.02	
B	Mismatch at directional coupler to standard-gain horn connection	0.1613	%	U-shaped	1.41	1.00	0.11	
B	Mismatch error at forward power sensor	0.1728	%	U-shaped	1.41	1.00	0.12	
B	Mismatch error at reverse power sensor	0.2536	%	U-shaped	1.41	1.00	0.18	
B	Insertion loss error for directional coupler	0.5773	%	Normal	1.00	1.00	0.58	
B	Forward coupling coefficient error for directional coupler	1.1579	%	Normal	1.00	1.00	1.16	
B	Reverse coupling coefficient error for directional coupler	1.1579	%	Normal	1.00	1.00	1.16	
B	Spacing error	1.8474	%	Rectangular	1.73	1.00	1.07	
B	Alignment error (up and down)	0.9253	%	Rectangular	1.73	1.00	0.53	
B	Alignment error (left and right)	0.2767	%	Rectangular	1.73	1.00	0.16	
B	Power measurement error for forward power sensor	0.8788	%	Rectangular	1.73	1.00	0.51	
B	Power measurement error for reverse power sensor	0.8788	%	Rectangular	1.73	1.00	0.51	
B	Power linearity error for forward power sensor	0.2536	%	Rectangular	1.73	1.00	0.15	
B	Power linearity error for reverse power sensor	0.2536	%	Rectangular	1.73	1.00	0.15	
B	Residual ground reflections error	0.0000	%	Rectangular	1.73	1.00	0.00	
B	Thermal error for coaxial cables	0.0000	%	Rectangular	1.73	1.00	0.00	
B	Coaxial cable flexing error	0.0000	%	Rectangular	1.73	1.00	0.00	
B	Multiple reflections error	2.8964	%	Rectangular	1.73	1.00	1.67	
B	Cart error	4.9663	%	Rectangular	1.73	1.00	2.87	
B	Standard-gain horn error	5.9254	%	Rectangular	1.73	1.00	3.43	
Uc(CF)	Combined uncertainty			normal			5.77	
U	Expanded uncertainty			normal (k=2)			11.54	

Table C.8.8 – Uncertainty budget for FP7050 measurement with 30 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Repeatability (standard)	2.3293	%	Normal	1.00	1.00	2.33	
B	Mismatch error at input of directional coupler	0.1613	%	U-shaped	1.41	1.00	0.11	
B	Mismatch at directional coupler to standard-gain horn connection	0.7860	%	U-shaped	1.41	1.00	0.56	
B	Mismatch error at forward power sensor	0.2074	%	U-shaped	1.41	1.00	0.15	
B	Mismatch error at reverse power sensor	0.6700	%	U-shaped	1.41	1.00	0.47	
B	Insertion loss error for directional coupler	0.5773	%	Normal	1.00	1.00	0.58	
B	Forward coupling coefficient error for directional coupler	1.1579	%	Normal	1.00	1.00	1.16	
B	Reverse coupling coefficient error for directional coupler	1.1579	%	Normal	1.00	1.00	1.16	
B	Spacing error	3.4666	%	Rectangular	1.73	1.00	2.00	
B	Alignment error (up and down)	0.2190	%	Rectangular	1.73	1.00	0.13	
B	Alignment error (left and right)	1.7185	%	Rectangular	1.73	1.00	0.99	
B	Power measurement error for forward power sensor	0.8788	%	Rectangular	1.73	1.00	0.51	
B	Power measurement error for reverse power sensor	0.8788	%	Rectangular	1.73	1.00	0.51	
B	Power linearity error for forward power sensor	0.2536	%	Rectangular	1.73	1.00	0.15	
B	Power linearity error for reverse power sensor	0.2536	%	Rectangular	1.73	1.00	0.15	
B	Residual ground reflections error	0.0000	%	Rectangular	1.73	1.00	0.00	
B	Thermal error for coaxial cables	0.0000	%	Rectangular	1.73	1.00	0.00	
B	Coaxial cable flexing error	0.0000	%	Rectangular	1.73	1.00	0.00	
B	Multiple reflections error	3.8006	%	Rectangular	1.73	1.00	2.20	
B	Cart error	3.1811	%	Rectangular	1.73	1.00	1.84	
B	Standard-gain horn error	5.9254	%	Rectangular	1.73	1.00	3.43	
Uc(CF)	Combined uncertainty			normal			5.88	
U	Expanded uncertainty			normal (k=2)			11.75	

Table C.8.9 – Uncertainty budget for FP7050 measurement with 30 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Repeatability (standard)	3.5142	%	Normal	1.00	1.00	3.51	
B	Mismatch error at input of directional coupler	0.7048	%	Rectangular	1.41	1.00	0.50	
B	Mismatch at directional coupler to standard-gain horn connection	1.4378	%	U-shaped	1.41	1.00	1.02	
B	Mismatch error at forward power sensor	0.6700	%	Normal	1.41	1.00	0.47	
B	Mismatch error at reverse power sensor	1.2395	%	Normal	1.41	1.00	0.88	
B	Insertion loss error for directional coupler	0.5773	%	Normal	1.00	1.00	0.58	
B	Forward coupling coefficient error for directional coupler	1.1579	%	Normal	1.00	1.00	1.16	
B	Reverse coupling coefficient error for directional coupler	1.1579	%	Normal	1.00	1.00	1.16	
B	Spacing error	1.6015	%	Normal	1.73	1.00	0.93	
B	Alignment error (up and down)	1.8122	%	Normal	1.73	1.00	1.05	
B	Alignment error (left and right)	1.7068	%	Normal	1.73	1.00	0.99	
B	Power measurement error for forward power sensor	0.8788	%	Normal	1.73	1.00	0.51	
B	Power measurement error for reverse power sensor	0.8788	%	Normal	1.73	1.00	0.51	
B	Power linearity error for forward power sensor	0.2536	%	Normal	1.73	1.00	0.15	
B	Power linearity error for reverse power sensor	0.2536	%	Normal	1.73	1.00	0.15	
B	Residual ground reflections error	0.0000	%	Normal	1.73	1.00	0.00	
B	Thermal error for coaxial cables	0.0000	%	Normal	1.73	1.00	0.00	
B	Coaxial cable flexing error	0.0000	%	Normal	1.73	1.00	0.00	
B	Multiple reflections error	2.9319	%	Normal	1.73	1.00	1.69	
B	Cart error	4.1718	%	Normal	1.73	1.00	2.41	
B	Standard-gain horn error	5.9254	%	Normal	1.73	1.00	3.43	
Uc(CF)	Combined uncertainty			normal			6.45	
U	Expanded uncertainty			normal (k=2)			12.89	

Table C.8.10 – Uncertainty budget for FP7050 measurement with 100 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Repeatability (standard)	2.3293	%	Normal	1.00	1.00	2.33	
B	Mismatch error at input of directional coupler	0.0345	%	U-shaped	1.41	1.00	0.02	
B	Mismatch at directional coupler to standard-gain horn connection	0.1613	%	U-shaped	1.41	1.00	0.11	
B	Mismatch error at forward power sensor	0.1728	%	U-shaped	1.41	1.00	0.12	
B	Mismatch error at reverse power sensor	0.2536	%	U-shaped	1.41	1.00	0.18	
B	Insertion loss error for directional coupler	0.5773	%	Normal	1.00	1.00	0.58	
B	Forward coupling coefficient error for directional coupler	1.1579	%	Normal	1.00	1.00	1.16	
B	Reverse coupling coefficient error for directional coupler	1.1579	%	Normal	1.00	1.00	1.16	
B	Spacing error	1.8474	%	Rectangular	1.73	1.00	1.07	
B	Alignment error (up and down)	0.9253	%	Rectangular	1.73	1.00	0.53	
B	Alignment error (left and right)	0.2767	%	Rectangular	1.73	1.00	0.16	
B	Power measurement error for forward power sensor	0.8788	%	Rectangular	1.73	1.00	0.51	
B	Power measurement error for reverse power sensor	0.8788	%	Rectangular	1.73	1.00	0.51	
B	Power linearity error for forward power sensor	0.2536	%	Rectangular	1.73	1.00	0.15	
B	Power linearity error for reverse power sensor	0.2536	%	Rectangular	1.73	1.00	0.15	
B	Residual ground reflections error	0.0000	%	Rectangular	1.73	1.00	0.00	
B	Thermal error for coaxial cables	0.0000	%	Rectangular	1.73	1.00	0.00	
B	Coaxial cable flexing error	0.0000	%	Rectangular	1.73	1.00	0.00	
B	Multiple reflections error	2.8964	%	Rectangular	1.73	1.00	1.67	
B	Cart error	4.9663	%	Rectangular	1.73	1.00	2.87	
B	Standard-gain horn error	5.9254	%	Rectangular	1.73	1.00	3.43	
Uc(CF)	Combined uncertainty			normal			5.77	
U	Expanded uncertainty			normal (k=2)			11.54	

Table C.8.11 – Uncertainty budget for FP7050 measurement with 100 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Repeatability (standard)	2.3293	%	Normal	1.00	1.00	2.33	
B	Mismatch error at input of directional coupler	0.1613	%	U-shaped	1.41	1.00	0.11	
B	Mismatch at directional coupler to standard-gain horn connection	0.7860	%	U-shaped	1.41	1.00	0.56	
B	Mismatch error at forward power sensor	0.2074	%	U-shaped	1.41	1.00	0.15	
B	Mismatch error at reverse power sensor	0.6700	%	U-shaped	1.41	1.00	0.47	
B	Insertion loss error for directional coupler	0.5773	%	Normal	1.00	1.00	0.58	
B	Forward coupling coefficient error for directional coupler	1.1579	%	Normal	1.00	1.00	1.16	
B	Reverse coupling coefficient error for directional coupler	1.1579	%	Normal	1.00	1.00	1.16	
B	Spacing error	3.4666	%	Rectangular	1.73	1.00	2.00	
B	Alignment error (up and down)	0.2190	%	Rectangular	1.73	1.00	0.13	
B	Alignment error (left and right)	1.7185	%	Rectangular	1.73	1.00	0.99	
B	Power measurement error for forward power sensor	0.8788	%	Rectangular	1.73	1.00	0.51	
B	Power measurement error for reverse power sensor	0.8788	%	Rectangular	1.73	1.00	0.51	
B	Power linearity error for forward power sensor	0.2536	%	Rectangular	1.73	1.00	0.15	
B	Power linearity error for reverse power sensor	0.2536	%	Rectangular	1.73	1.00	0.15	
B	Residual ground reflections error	0.0000	%	Rectangular	1.73	1.00	0.00	
B	Thermal error for coaxial cables	0.0000	%	Rectangular	1.73	1.00	0.00	
B	Coaxial cable flexing error	0.0000	%	Rectangular	1.73	1.00	0.00	
B	Multiple reflections error	3.8006	%	Rectangular	1.73	1.00	2.20	
B	Cart error	3.1811	%	Rectangular	1.73	1.00	1.84	
B	Standard-gain horn error	5.9254	%	Rectangular	1.73	1.00	3.43	
Uc(CF)	Combined uncertainty			normal			5.88	
U	Expanded uncertainty			normal (k=2)			11.75	

Table C.8.12 – Uncertainty budget for FP7050 measurement with 100 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Repeatability (standard)	3.5142	%	Normal	1.00	1.00	3.51	
B	Mismatch error at input of directional coupler	0.7048	%	Rectangular	1.41	1.00	0.50	
B	Mismatch at directional coupler to standard-gain horn connection	1.4378	%	U-shaped	1.41	1.00	1.02	
B	Mismatch error at forward power sensor	0.6700	%	Normal	1.41	1.00	0.47	
B	Mismatch error at reverse power sensor	1.2395	%	Normal	1.41	1.00	0.88	
B	Insertion loss error for directional coupler	0.5773	%	Normal	1.00	1.00	0.58	
B	Forward coupling coefficient error for directional coupler	1.1579	%	Normal	1.00	1.00	1.16	
B	Reverse coupling coefficient error for directional coupler	1.1579	%	Normal	1.00	1.00	1.16	
B	Spacing error	1.6015	%	Normal	1.73	1.00	0.93	
B	Alignment error (up and down)	1.8122	%	Normal	1.73	1.00	1.05	
B	Alignment error (left and right)	1.7068	%	Normal	1.73	1.00	0.99	
B	Power measurement error for forward power sensor	0.8788	%	Normal	1.73	1.00	0.51	
B	Power measurement error for reverse power sensor	0.8788	%	Normal	1.73	1.00	0.51	
B	Power linearity error for forward power sensor	0.2536	%	Normal	1.73	1.00	0.15	
B	Power linearity error for reverse power sensor	0.2536	%	Normal	1.73	1.00	0.15	
B	Residual ground reflections error	0.0000	%	Normal	1.73	1.00	0.00	
B	Thermal error for coaxial cables	0.0000	%	Normal	1.73	1.00	0.00	
B	Coaxial cable flexing error	0.0000	%	Normal	1.73	1.00	0.00	
B	Multiple reflections error	2.9319	%	Normal	1.73	1.00	1.69	
B	Cart error	4.1718	%	Normal	1.73	1.00	2.41	
B	Standard-gain horn error	5.9254	%	Normal	1.73	1.00	3.43	
Uc(CF)	Combined uncertainty			normal			6.45	
U	Expanded uncertainty			normal (k=2)			12.89	

C.9 NIST Uncertainty Budgets

Table C.9.1 – Description of Individual Uncertainties for the Anechoic Chamber Measurements

Description of individual uncertainty		Type	Distribution
1	Near zone transmitting antenna gain	B	Rectangular
2	Multipath reflections within anechoic chamber	B	Rectangular
3	Power sensor measurement	B	Normal
4	Passive measurements, couplers, waveguides, etc.	B	Normal
5	Antenna alignment, separation measurements	B	Rectangular
6	Data standard deviation – repeated measurements	A	Normal

Table C.9.2 – Individual Uncertainties for FP7050 at 30 V/m

Description of individual uncertainty		Standard uncertainty (in %) at			
		1 GHz	2.45 GHz	10 GHz	18 GHz
1	Near zone transmitting antenna gain	5.9	5.9	5.9	5.9
2	Multipath reflections within anechoic chamber	4.7	4.7	4.7	4.7
3	Power sensor measurement	3.0	3.0	3.0	3.0
4	Passive measurements, couplers, waveguides, etc.	3.0	3.0	3.0	3.0
5	Antenna alignment, separation measurements	4.0	4.0	4.0	4.0
6	Data standard deviation – repeated measurements	1.7	2.2	2.5	3.1
	Total uncertainty	6.7	6.9	7.0	7.2

Table C.9.3 – Individual Uncertainties for FP7050 at 100 V/m

Description of individual uncertainty		Standard uncertainty (in %) at			
		1 GHz	2.45 GHz	10 GHz	18 GHz
1	Near zone transmitting antenna gain	5.9	5.9	5.9	5.9
2	Multipath reflections within anechoic chamber	4.7	4.7	4.7	4.7
3	Power sensor measurement	3.0	3.0	3.0	3.0
4	Passive measurements, couplers, waveguides, etc.	3.0	3.0	3.0	3.0
5	Antenna alignment, separation measurements	4.0	4.0	4.0	4.0
6	Data standard deviation – repeated measurements	0.5	3.1	1.9	3.9
	Total uncertainty	6.5	7.2	6.8	7.6

Table C.9.4 – Individual Uncertainties for FL7018 at 10 V/m

Description of individual uncertainty		Standard uncertainty (in %) at			
		1 GHz	2.45 GHz	10 GHz	18 GHz
1	Near zone transmitting antenna gain	5.9	5.9	5.9	5.9
2	Multipath reflections within anechoic chamber	4.7	4.7	4.7	4.7
3	Power sensor measurement	3.0	3.0	3.0	3.0
4	Passive measurements, couplers, waveguides, etc.	3.0	3.0	3.0	3.0
5	Antenna alignment, separation measurements	4.0	4.0	4.0	4.0
6	Data standard deviation – repeated measurements	3.5	3.2	7.4	14.2
	Total uncertainty	7.4	7.2	9.9	15.6

Table C.9.5 – Individual Uncertainties for FL7018 at 30 V/m

Description of individual uncertainty		Standard uncertainty (in %) at			
		1 GHz	2.45 GHz	10 GHz	18 GHz
1	Near zone transmitting antenna gain	5.9	5.9	5.9	5.9
2	Multipath reflections within anechoic chamber	4.7	4.7	4.7	4.7
3	Power sensor measurement	3.0	3.0	3.0	3.0
4	Passive measurements, couplers, waveguides, etc.	3.0	3.0	3.0	3.0
5	Antenna alignment, separation measurements	4.0	4.0	4.0	4.0
6	Data standard deviation – repeated measurements	5.1	3.6	2.9	10.7
	Total uncertainty	8.3	7.4	7.1	12.5

Table C.9.6 – Individual Uncertainties for FL7018 at 100 V/m

Description of individual uncertainty		Standard uncertainty (in %) at			
		1 GHz	2.45 GHz	10 GHz	18 GHz
1	Near zone transmitting antenna gain	5.9	5.9	5.9	5.9
2	Multipath reflections within anechoic chamber	4.7	4.7	4.7	4.7
3	Power sensor measurement	3.0	3.0	3.0	3.0
4	Passive measurements, couplers, waveguides, etc.	3.0	3.0	3.0	3.0
5	Antenna alignment, separation measurements	4.0	4.0	4.0	4.0
6	Data standard deviation – repeated measurements	3.7	4.2	1.9	14.4
	Total uncertainty	7.5	7.7	6.8	15.8

C.10 NMIA Uncertainty Budgets

Table C.10.1 – Uncertainty budget for FL7018 measurement with 10 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Voltage ratio +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	u_i (CF) +/-	Degs of Freedom Vi or Veff
A	Field meter reading	0.0011		Normal	1.00	1.00	0.00	20
B	GTEM calibration	0.0812		Normal	1.97	1.00	0.04	243
B	Power reading at GTEM input	0.0010		Normal	1.00	1.00	0.00	3
B	Drift in GTEM	0.0116		Rectangular	1.73	1.00	0.01	50
B	Position change from transfer probe to DUT	0.0100		Rectangular	1.73	1.00	0.01	3
B	Power meter linearity	0.0020		Normal	2.00	1.00	0.00	50
B	DUT reading drift	0.0100		Rectangular	1.73	1.00	0.01	50
B	Switches connection variability	0.0023		Rectangular	1.73	1.00	0.00	50
B	Read DUT, random & quantisation	0.0100		Rectangular	1.73	1.00	0.01	3
B	Resolution of signal generator	0.0023		Rectangular	1.73	1.00	0.00	50
B	Uncertainty in frequency	0.0000		Normal	2.00	1.00	0.00	50
B	Harmonics	0.0032		Normal	2.00	1.00	0.00	50
u_c (CF)	Combined standard uncertainty			normal			0.04	
U	Expanded uncertainty			normal (k=2)			0.09	
U dB	Expanded uncertainty dB		%	normal (k=2)			8.61	

Table C.10.2 – Uncertainty budget for FL7018 measurement with 10 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	System Constant	2.3293	% V	Normal	2.00	1.00	1.1646	30
B	Spurious Signals	0.5012	% V	Rectangular	1.732	1.00	0.2894	30
	Tx power meter							
A	noise	0.0140	% V	Normal	1.00	1.00	0.0140	9
B	resolution	0.0020	% V	Rectangular	1.73	1.00	0.0012	50
B	linearity 0.2% power	0.1000	% V	Normal	2.60	1.00	0.0384	30
B	connector	0.1152	% V	Rectangular	1.73	1.00	0.0665	30
	Device Under Test							
B	resolution	0.1000	% V	Rectangular	1.73	1.00	0.0577	50
A	noise	0.0310	% V	Normal	1.00	1.00	0.0310	9
B	trolley face reflection	0.1190	% V	Rectangular	1.73	1.00	0.0687	30
B	Boom reflections	0.7440	% V	Normal	1.00	1.00	0.7440	3
A	Averaging wavelengths	0.0860	% V	Normal	1.00	1.00	0.0860	4
B	Probe field effects	1.1579	% V	Normal	1.00	1.00	1.1579	10
B	Probe volume (field uniformity)	0.3332	% V	Rectangular	1.73	1.00	0.0000	30
B	Chamber effects	0.5773	% V	Rectangular	1.73	1.00	0.3333	30
B	Humidity	0.0006	% V	Rectangular	1.73	1.00	0.0003	50
B	Air	0.0028	% V	Rectangular	1.73	1.00	0.0016	50
B	zero setting 2 mm	0.8070	% V	Rectangular	1.73	1.00	0.4659	30
B	resolution 0.1 mm	0.0035	% V	Rectangular	1.73	1.00	0.0020	50
B	linearity .05 mm	0.0201	% V	Normal	2.50	1.00	0.0080	50
Uc(CF)	Combined uncertainty			normal			1.92	
U	Expanded uncertainty			normal (k=2)			3.84	

Note: NMIA did not submit results at 10 GHz for field strength 10 V/m

Table C.10.3 – Uncertainty budget for FL7018 measurement with 10 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	System Constant	2.3293	% V	Normal	2.00	1.00	1.1646	30
B	Spurious Signals	0.5012	% V	Rectangular	1.732	1.00	0.2894	30
B	Tx wall reflection	0.5005	% V	Rectangular	1.732	1.00	0.2890	30
	Tx power meter							
A	noise	0.0680	% V	Normal	1.00	1.00	0.0680	9
B	resolution	0.0020	% V	Rectangular	1.73	1.00	0.0012	50
B	linearity 0.2% power	0.1000	% V	Normal	2.60	1.00	0.0385	30
B	connector	0.1152	% V	Rectangular	1.73	1.00	0.0665	50
	Device Under Test							
B	resolution	0.1000	% V	Rectangular	1.73	1.00	0.0577	50
A	noise	0.0260	% V	Normal	1.00	1.00	0.0260	9
B	trolley face reflection	0.3000	% V	Rectangular	1.73	1.00	0.1732	30
B	Boom reflections	0.6000		Normal	1.00	1.00	0.6000	3
A	Averaging wavelengths	0.0220	% V	Normal	1.00	1.00	0.0220	4
B	Probe field effects	1.1579	% V	Normal	1.00	1.00	1.1579	10
B	Probe volume (field uniformity)	0.3332	% V	Rectangular	1.73	1.00	0.0000	30
B	Chamber effects	0.5773	% V	Rectangular	1.73	1.00	0.3333	30
B	Humidity	0.0006	% V	Rectangular	1.73	1.00	0.0003	50
B	air	0.0028	% V	Rectangular	1.73	1.00	0.0016	50
B	zero setting 2 mm	0.8070	% V	Rectangular	1.73	1.00	0.4659	30
B	resolution 0.1 mm	0.0035	% V	Rectangular	1.73	1.00	0.0020	50
B	linearity .05 mm	0.0201	% V	Normal	2.50	1.00	0.0080	50
Uc(CF)	Combined uncertainty			normal			1.90	
U	Expanded uncertainty			normal (k=2)			3.79	

Table C.10.4 – Uncertainty budget for FL7018 measurement with 30 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Voltage ratio +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	u _i (CF) +/-	Degs of Freedom Vi or Veff
A	Field meter reading	0.0009		Normal	1.00	1.00	0.00	20
B	GTEM calibration	0.0812		Normal	1.97	1.00	0.04	243
B	Power reading at GTEM input	0.0010		Normal	1.00	1.00	0.00	3
B	Drift in GTEM	0.0116		Rectangular	1.73	1.00	0.01	50
B	Position change from transfer probe to DUT	0.0100		Rectangular	1.73	1.00	0.01	3
B	Power meter linearity	0.0020		Normal	2.00	1.00	0.00	50
B	DUT reading drift	0.0100		Rectangular	1.73	1.00	0.01	50
B	Switches connection variability	0.0023		Rectangular	1.73	1.00	0.00	50
B	Read DUT, random & quantisation	0.0100		Rectangular	1.73	1.00	0.01	3
B	Resolution of signal generator	0.0023		Rectangular	1.73	1.00	0.00	50
B	Uncertainty in frequency	0.0000		Normal	2.00	1.00	0.00	50
B	Harmonics	0.0032		Normal	2.00	1.00	0.00	50
u _c (CF)	Combined standard uncertainty			normal			0.04	
U	Expanded uncertainty			normal (k=2)			0.09	
U	Expanded uncertainty		%	normal (k=2)			8.61	

Table C.10.5 – Uncertainty budget for FL7018 measurement with 30 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	System Constant	2.3293	% V	Normal	2.00	1.00	1.1646	30
B	Spurious Signals	0.5012	% V	Rectangular	1.732	1.00	0.2894	30
	Tx power meter							
A	noise	0.0410	% V	Normal	1.00	1.00	0.0410	9
B	resolution	0.0020	% V	Rectangular	1.73	1.00	0.0012	50
B	linearity 0.2% power	0.1000	% V	Normal	2.60	1.00	0.0384	30
B	connector	0.1152	% V	Rectangular	1.73	1.00	0.0665	30
	Device Under Test							
B	resolution	0.0333	% V	Rectangular	1.73	1.00	0.0192	50
A	noise	0.0140	% V	Normal	1.00	1.00	0.0140	9
B	trolley face reflection	0.1190	% V	Rectangular	1.73	1.00	0.0687	30
B	Boom reflections	0.7440	% V	Normal	1.00	1.00	0.7440	3
A	Averaging wavelengths	0.0350	% V	Normal	1.00	1.00	0.0350	4
B	Probe field effects	1.1579	% V	Normal	1.00	1.00	1.1579	10
B	Probe volume (field uniformity)	0.3332	% V	Rectangular	1.73	1.00	0.0000	30
B	Chamber effects	0.5773	% V	Rectangular	1.73	1.00	0.3333	30
B	Humidity	0.0006	% V	Rectangular	1.73	1.00	0.0003	50
B	air	0.0028	% V	Rectangular	1.73	1.00	0.0016	50
B	zero setting 2 mm	0.8070	% V	Rectangular	1.73	1.00	0.4659	30
B	resolution 0.1 mm	0.0035	% V	Rectangular	1.73	1.00	0.0020	50
B	linearity .05 mm	0.0201	% V	Normal	2.50	1.00	0.0080	50
Uc(CF)	Combined uncertainty			normal			1.92	
U	Expanded uncertainty			normal (k=2)			3.84	

Note: NMIA did not submit results at 10 GHz or 18 GHz for field strength 30 V/m

Table C.10.6 – Uncertainty budget for FL7018 measurement with 100 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Voltage ratio +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	u_i (CF) +/-	Degs of Freedom V_i or V_{eff}
B	Standard uncertainty at 30 V/m	0.0431		Normal	1.00	1.00	0.04	0
A	Field meter reading	0.0056		Normal	1.00	1.00	0.01	10
B	Power reading at GTEM input	0.0010		Normal	1.00	1.00	0.00	3
B	Drift in GTEM	0.0116		Rectangular	1.73	1.00	0.01	50
B	Position change from transfer probe to DUT	0.0100		Rectangular	1.73	1.00	0.01	3
B	Power meter linearity	0.0040		Normal	2.00	1.00	0.00	50
B	DUT reading drift	0.0100		Rectangular	1.73	1.00	0.01	50
B	Switches connection variability	0.0023		Rectangular	1.73	1.00	0.00	50
B	Read DUT, random & quantisation	0.0100		Rectangular	1.73	1.00	0.01	3
B	Resolution of signal generator	0.0023		Rectangular	1.73	1.00	0.00	50
B	Uncertainty in frequency	0.0000		Normal	2.00	1.00	0.00	50
B	Harmonics	0.0032		Normal	2.00	1.00	0.00	50
u_c (CF)	Combined standard uncertainty			normal			0.05	
U	Expanded uncertainty			normal (k=2)			0.09	
U	Expanded uncertainty		%	normal (k=2)			9.04	

Table C.10.7 – Uncertainty budget for FL7018 measurement with 100 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	System Constant	2.3293	% V	Normal	2.00	1.00	1.1646	30
B	Spurious Signals	0.5012	% V	Rectangular	1.732	1.00	0.2894	30
	Tx power meter							
A	noise	0.0110	% V	Normal	1.00	1.00	0.0110	9
B	resolution	0.0020	% V	Rectangular	1.73	1.00	0.0012	50
B	linearity 0.2% power	0.1000	% V	Normal	2.60	1.00	0.0384	30
B	connector	0.1152	% V	Rectangular	1.73	1.00	0.0665	50
	Device Under Test							
B	resolution	0.0100	% V	Rectangular	1.73	1.00	0.0058	50
A	noise	0.0130	% V	Normal	1.00	1.00	0.0130	9
B	trolley face reflection	0.1190	% V	Rectangular	1.73	1.00	0.0687	30
B	Boom reflections	0.7440	% V	Normal	1.00	1.00	0.7440	3
A	Averaging wavelengths	0.0410	% V	Normal	1.00	1.00	0.0410	4
B	Probe field effects	1.1579	% V	Normal	1.00	1.00	1.1579	10
B	Probe volume (field uniformity)	0.3332	% V	Rectangular	1.73	1.00	0.0000	30
B	Chamber effects	0.5773	% V	Rectangular	1.73	1.00	0.3333	30
B	Humidity	0.0006	% V	Rectangular	1.73	1.00	0.0003	50
B	air	0.0028	% V	Rectangular	1.73	1.00	0.0016	50
B	zero setting 2 mm	0.8070	% V	Rectangular	1.73	1.00	0.4659	30
B	resolution 0.1 mm	0.0035	% V	Rectangular	1.73	1.00	0.0020	50
B	linearity .05 mm	0.0201	% V	Normal	2.50	1.00	0.0080	50
Uc(CF)	Combined uncertainty			normal			1.92	
U	Expanded uncertainty			normal (k=2)			3.83	

Note: NMIA did not submit results at 10 GHz or 18 GHz for field strength 100 V/m

Table C.10.8 – Uncertainty budget for FP7050 measurement with 30 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Voltage ratio +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	u _i (CF) +/-	Degs of Freedom Vi or Veff
A	Field meter reading	0.0027		Normal	1.00	1.00	0.00	20
B	GTEM calibration	0.0812		Normal	1.97	1.00	0.04	243
B	Power reading at GTEM input	0.0010		Normal	1.00	1.00	0.00	3
B	Drift in GTEM	0.0116		Rectangular	1.73	1.00	0.01	50
B	Position change from transfer probe to DUT	0.0100		Rectangular	1.73	1.00	0.01	3
B	Power meter linearity	0.0020		Normal	2.00	1.00	0.00	50
B	Effect of metallic housing on probe	0.0200		Rectangular	1.73	1.00	0.01	50
B	DUT reading drift	0.0100		Rectangular	1.73	1.00	0.01	50
B	Switches connection variability	0.0023		Rectangular	1.73	1.00	0.00	50
B	Read DUT, random & quantisation	0.0100		Rectangular	1.73	1.00	0.01	3
B	Resolution of signal generator	0.0023		Rectangular	1.73	1.00	0.00	50
B	Uncertainty in frequency	0.0000		Normal	2.00	1.00	0.00	50
B	Harmonics	0.0032		Normal	2.00	1.00	0.00	50
u _c (CF)	Combined standard uncertainty			normal			0.04	
U	Expanded uncertainty			normal (k=2)			0.09	
U	Expanded uncertainty		%	normal (k=2)			8.93	

Table C.10.9 – Uncertainty budget for FP7050 measurement with 30 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit %	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	System Constant	2.3293	% V	Normal	2.00	1.00	1.1646	30
B	Spurious Signals	0.5012	% V	Rectangular	1.732	1.00	0.2894	30
	Tx power meter							
A	noise	0.0460	% V	Normal	1.00	1.00	0.0460	9
B	resolution	0.0020	% V	Rectangular	1.73	1.00	0.0012	50
B	linearity 0.2% power	0.1000	% V	Normal	2.60	1.00	0.0384	30
B	connector	0.1152	% V	Rectangular	1.73	1.00	0.0665	30
	Device Under Test							
B	resolution	0.0333	% V	Rectangular	1.73	1.00	0.0192	50
A	noise	0.4790	% V	Normal	1.00	1.00	0.4790	9
B	7050 box reflection	0.0450	% V	Normal	1.00	1.00	0.0450	3
B	support reflection	1.8310	% V	Normal	1.00	1.00	1.8310	3
B	trolley face reflection	0.0500	% V	Rectangular	1.73	1.00	0.0289	30
A	Averaging waves	0.3410	% V	Rectangular	1.73	1.00	0.1969	4
B	Probe field effects	1.1579	% V	Normal	1.00	1.00	1.1579	10
B	Probe volume (field uniformity)	0.3332	% V	Rectangular	1.73	1.00	0.1924	30
B	Chamber effects	0.5773	% V	Rectangular	1.73	1.00	0.3333	30
B	Humidity	0.0006	% V	Rectangular	1.73	1.00	0.0003	50
B	air	0.0028	% V	Rectangular	1.73	1.00	0.0016	50
B	zero setting 2 mm	0.8070	% V	Rectangular	1.73	1.00	0.4659	30
B	resolution 0.1 mm	0.0035	% V	Rectangular	1.73	1.00	0.0020	50
B	linearity .05 mm	0.0201	% V	Normal	2.50	1.00	0.0080	50
Uc(CF)	Combined uncertainty			normal			2.60	
U	Expanded uncertainty			normal (k=2)			5.21	

Note: NMIA did not submit results at 10 GHz or 18 GHz for field strength 30 V/m

Table C.10.10 – Uncertainty budget for FP7050 measurement with 100 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Voltage ratio +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	u_i (CF) +/-	Degs of Freedom V_i or V_{eff}
B	Standard uncertainty at 30 V/m	0.0447		Normal	1.00	1.00	0.04	272
A	Field meter reading	0.0056		Normal	1.00	1.00	0.01	10
B	Power reading at GTEM input	0.0010		Normal	1.00	1.00	0.00	3
B	Drift in GTEM	0.0116		Rectangular	1.73	1.00	0.01	50
B	Position change from transfer probe to DUT	0.0100		Rectangular	1.73	1.00	0.01	3
B	Power meter linearity	0.0040		Normal	2.00	1.00	0.00	50
B	Effect of metallic housing on probe	0.0200		Rectangular	1.73	1.00	0.01	50
B	DUT reading drift	0.0100		Rectangular	1.73	1.00	0.01	50
B	Switches connection variability	0.0023		Rectangular	1.73	1.00	0.00	50
B	Read DUT, random & quantisation	0.0100		Rectangular	1.73	1.00	0.01	3
B	Resolution of signal generator	0.0023		Rectangular	1.73	1.00	0.00	50
B	Uncertainty in frequency	0.0000		Normal	2.00	1.00	0.00	50
B	Harmonics	0.0032		Normal	2.00	1.00	0.00	50
u_c (CF)	Combined standard uncertainty			normal			0.05	
U	Expanded uncertainty			normal (k=2)			0.10	
U	Expanded uncertainty		%	normal (k=2)			9.62	

Table C.10.11 – Uncertainty budget for FP7050 measurement with 100 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	System Constant	2.3293	% V	Normal	2.00	1.00	1.1646	30
B	Spurious Signals	0.5012	% V	Rectangular	1.732	1.00	0.2894	30
	Tx power meter							
A	noise	0.0110	% V	Normal	1.00	1.00	0.0110	9
B	resolution	0.0020	% V	Rectangular	1.73	1.00	0.0012	50
B	linearity 0.2% power	0.1000	% V	Normal	2.60	1.00	0.0384	30
B	connector	0.1152	% V	Rectangular	1.73	1.00	0.0665	30
	Device Under Test							
B	resolution	0.0100	% V	Rectangular	1.73	1.00	0.0058	50
A	noise	0.0380	% V	Normal	1.00	1.00	0.0380	9
B	7050 box reflection	0.0450	% V	Normal	1.00	1.00	0.0450	3
B	support reflection	1.8310	% V	Normal	1.00	1.00	1.8310	3
B	trolley face reflection	0.0500	% V	Rectangular	1.73	1.00	0.0289	30
A	Averaging waves	0.1480	% V	Rectangular	1.73	1.00	0.0855	4
B	Probe field effects	1.1579	% V	Normal	1.00	1.00	1.1579	10
B	Probe area (field uniformity)	0.3332	% V	Rectangular	1.73	1.00	0.0000	30
B	Chamber effects	0.5773	% V	Rectangular	1.73	1.00	0.3333	30
B	Humidity	0.0006	% V	Rectangular	1.73	1.00	0.0003	50
B	air	0.0028	% V	Rectangular	1.73	1.00	0.0016	50
B	zero setting 2 mm	0.8070	% V	Rectangular	1.73	1.00	0.4659	30
B	resolution 0.1 mm	0.0035	% V	Rectangular	1.73	1.00	0.0020	50
B	linearity .05 mm	0.0201	% V	Normal	2.50	1.00	0.0080	50
Uc(CF)	Combined uncertainty			normal			2.55	
U	Expanded uncertainty			normal (k=2)			5.09	

Note: NMIA did not submit results at 10 GHz or 18 GHz for field strength 100 V/m

C.11 KRISS Uncertainty Budgets

Table C.11.1 – Uncertainty budget for FL7018 measurement with 10 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Uncertainty in the directional coupler insertion loss	0.0035	Linear	Normal	1.00	0.38	0.13	Inf
B	Uncertainty in the directional coupler coupling coefficient	3.2177	Linear	Normal	1.00	5.81E-04	0.19	Inf
B	System drift of power meter	5.E-05	W	Rectangular	1.73	45	0.12	Inf
B	Power meter and sensor uncertainties	0.0104	Linear	Normal	1.00	0.52	0.54	Inf
B	Uncertainties in determining the gains of the antenna	0.3305	Linear	Normal	1.00	0.04	1.21	Inf
B	Probe positioning error	0.0100	m	Rectangular	1.73	0.15	0.09	Inf
B	Mismatch between input/output device	0.0070	Linear	Normal	1.00	0.12	0.09	Inf
B	Field uniformity in the area to which the probe is exposed	0.0000	V/m	Normal	1.00	0.10	0.00	Inf
B	Probe fixture contribution	1.0480	V/m	Rectangular	1.73	0.06	3.49	Inf
B	Standing waves caused by nonideal anechoic environment (reflections)	0.1048	V/m	Normal	1.00	0.10	1.05	Inf
B	Standing waves between the probe and transmitting antenna	0.1048	V/m	Rectangular	1.73	0.06	0.35	Inf
B	Meter reading	0.0027	V/m	Normal	1.00	0.10	0.03	Inf
A	Repeatability of correction factor	0.0259	Linear	Normal	1.00	1.00	2.59	4
Uc(CF)	Combined uncertainty			Normal			5	42
U	Expanded uncertainty			Normal (k=2)			9	

Table C.11.2 – Uncertainty budget for FL7018 measurement with 10 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Uncertainty in the directional coupler insertion loss	0.0057	Linear	Normal	1.00	0.33	0.19	Inf
B	Uncertainty in the directional coupler coupling coefficient	3.9934	Linear	Normal	1.00	4.70E-04	0.19	Inf
B	System drift of power meter	0.0002	W	Rectangular	1.73	9.25	0.12	Inf
B	Power meter and sensor uncertainties	0.0162	Linear	Normal	1.00	0.52	0.85	Inf
B	Uncertainties in determining the gains of the antenna	1.2874	Linear	Normal	1.00	0.01	1.21	Inf
B	Probe positioning error	0.0100	m	Rectangular	1.73	0.24	0.14	Inf
B	Mismatch between input/output device	0.0100	Linear	Normal	1.00	0.03	0.03	Inf
B	Field uniformity in the area to which the probe is exposed	0.0000	V/m	Normal	1.00	0.10	0.00	Inf
B	Probe fixture contribution	0.2106	V/m	Rectangular	1.73	0.06	0.70	Inf
B	Standing waves caused by nonideal anechoic environment (reflections)	0.3158	V/m	Normal	1.00	0.10	3.16	Inf
B	Standing waves between the probe and transmitting antenna	0.0421	V/m	Rectangular	1.73	0.06	0.14	Inf
B	Meter reading	0.0021	V/m	Normal	1.00	0.11	0.02	Inf
A	Repeatability of correction factor	0.0289	Linear	Normal	1.00	1.00	2.89	4
Uc(CF)	Combined uncertainty			Normal			5	25
U	Expanded uncertainty			Normal (k=2)			9	

Table C.11.3 – Uncertainty budget for FL7018 measurement with 10 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Uncertainty in the directional coupler insertion loss	0.0090	Linear	Normal	1.00	0.16	0.14	Inf
B	Uncertainty in the directional coupler coupling coefficient	3.7805	Linear	Normal	1.00	4.03E-04	0.15	Inf
B	System drift of power meter	0.0002	W	Rectangular	1.73	7.49	0.10	Inf
B	Power meter and sensor uncertainties	0.0170	Linear	Normal	1.00	0.42	0.72	Inf
B	Uncertainties in determining the gains of the antenna	3.8390	Linear	Normal	1.00	0.00	0.98	Inf
B	Probe positioning error	0.0100	m	Rectangular	1.73	0.12	0.07	Inf
B	Mismatch between input/output device	0.0100	Linear	Normal	1.00	0.01	0.01	Inf
B	Field uniformity in the area to which the probe is exposed	0.0000	V/m	Normal	1.00	0.10	0.00	Inf
B	Probe fixture contribution	0.3413	V/m	Rectangular	1.73	0.06	1.14	Inf
B	Standing waves caused by nonideal anechoic environment (reflections)	0.2133	V/m	Normal	1.00	0.10	2.13	Inf
B	Standing waves between the probe and transmitting antenna	0.0341	V/m	Rectangular	1.73	0.06	0.11	Inf
B	Meter reading	0.0050	V/m	Normal	1.00	0.09	0.04	Inf
A	Repeatability of correction factor	0.0367	Linear	Normal	1.00	1.00	3.67	5
Uc(CF)	Combined uncertainty			Normal			5	12
U	Expanded uncertainty			Normal (k=2)			9	

Table C.11.4 – Uncertainty budget for FL7018 measurement with 10 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Uncertainty in the directional coupler insertion loss	0.0090	Linear	Normal	1.00	0.28	0.25	Inf
B	Uncertainty in the directional coupler coupling coefficient	3.7805	Linear	Normal	1.00	7.14E-04	0.27	Inf
B	System drift of power meter	0.0002	W	Rectangular	1.73	13.28	0.17	Inf
B	Power meter and sensor uncertainties	0.0246	Linear	Normal	1.00	0.76	1.88	Inf
B	Uncertainties in determining the gains of the antenna	7.0667	Linear	Normal	1.00	0.002	1.74	Inf
B	Probe positioning error	0.0100	m	Rectangular	1.73	0.22	0.13	Inf
B	Mismatch between input/output device	0.0100	Linear	Normal	1.00	0.02	0.02	Inf
B	Field uniformity in the area to which the probe is exposed	0.0000	V/m	Normal	1.00	0.10	0.00	Inf
B	Probe fixture contribution	0.3024	V/m	Rectangular	1.73	0.06	1.01	Inf
B	Standing waves caused by nonideal anechoic environment (reflections)	0.3024	V/m	Normal	1.00	0.10	3.02	Inf
B	Standing waves between the probe and transmitting antenna	0.0605	V/m	Rectangular	1.73	0.06	0.20	Inf
B	Meter reading	0.0037	V/m	Normal	1.00	0.15	0.06	Inf
A	Repeatability of correction factor	0.0295	Linear	Normal	1.00	1.00	2.95	4
Uc(CF)	Combined uncertainty			Normal			5	34
U	Expanded uncertainty			Normal (k=2)			10	

Table C.11.5 – Uncertainty budget for FL7018 measurement with 30 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Uncertainty in the directional coupler insertion loss	0.0035	Linear	Normal	1.00	0.39	0.14	Inf
B	Uncertainty in the directional coupler coupling coefficient	3.2177	Linear	Normal	1.00	5.99E-04	0.19	Inf
B	System drift of power meter	0.0002	W	Rectangular	1.73	9.66	0.12	Inf
B	Power meter and sensor uncertainties	0.0104	Linear	Normal	1.00	0.53	0.56	Inf
B	Uncertainties in determining the gains of the antenna	0.3305	Linear	Normal	1.00	0.04	1.24	Inf
B	Probe positioning error	0.0100	m	Rectangular	1.73	0.23	0.13	Inf
B	Mismatch between input/output device	0.0070	Linear	Normal	1.00	0.13	0.09	Inf
B	Field uniformity in the area to which the probe is exposed	0.0000	V/m	Normal	1.00	0.03	0.00	Inf
B	Probe fixture contribution	3.2400	V/m	Rectangular	1.73	0.02	3.60	Inf
B	Standing waves caused by nonideal anechoic environment (reflections)	0.3240	V/m	Normal	1.00	0.03	1.08	Inf
B	Standing waves between the probe and transmitting antenna	0.3240	V/m	Rectangular	1.73	0.02	0.36	Inf
B	Meter reading	0.0041	V/m	Normal	1.00	0.04	0.01	Inf
A	Repeatability of correction factor	0.0212	Linear	Normal	1.00	1.00	2.12	4
Uc(CF)	Combined uncertainty			Normal			5	84
U	Expanded uncertainty			Normal (k=2)			9	

Table C.11.6 – Uncertainty budget for FL7018 measurement with 30 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Uncertainty in the directional coupler insertion loss	0.0057	Linear	Normal	1.00	0.34	0.19	Inf
B	Uncertainty in the directional coupler coupling coefficient	3.9934	Linear	Normal	1.00	4.84E-04	0.19	Inf
B	System drift of power meter	0.0002	W	Rectangular	1.73	9.50	0.12	Inf
B	Power meter and sensor uncertainties	0.0162	Linear	Normal	1.00	0.54	0.87	Inf
B	Uncertainties in determining the gains of the antenna	1.2874	Linear	Normal	1.00	0.01	1.25	Inf
B	Probe positioning error	0.0100	m	Rectangular	1.73	0.25	0.14	Inf
B	Mismatch between input/output device	0.0100	Linear	Normal	1.00	0.03	0.03	Inf
B	Field uniformity in the area to which the probe is exposed	0.0000	V/m	Normal	1.00	0.03	0.00	Inf
B	Probe fixture contribution	0.6492	V/m	Rectangular	1.73	0.02	0.72	Inf
B	Standing waves caused by nonideal anechoic environment (reflections)	0.9738	V/m	Normal	1.00	0.03	3.25	Inf
B	Standing waves between the probe and transmitting antenna	0.1298	V/m	Rectangular	1.73	0.02	0.14	Inf
B	Meter reading	0.0055	V/m	Normal	1.00	0.04	0.02	Inf
A	Repeatability of correction factor	0.0268	Linear	Normal	1.00	1.00	2.68	4
Uc(CF)	Combined uncertainty			Normal			5	33
U	Expanded uncertainty			Normal (k=2)			9	

Table C.11.7 – Uncertainty budget for FL7018 measurement with 30 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Uncertainty in the directional coupler insertion loss	0.0090	Linear	Normal	1.00	0.16	0.15	Inf
B	Uncertainty in the directional coupler coupling coefficient	3.7805	Linear	Normal	1.00	4.17E-04	0.16	Inf
B	System drift of power meter	0.0002	W	Rectangular	1.73	7.76	0.10	Inf
B	Power meter and sensor uncertainties	0.0170	Linear	Normal	1.00	0.44	0.74	Inf
B	Uncertainties in determining the gains of the antenna	3.8390	Linear	Normal	1.00	0.00	1.02	Inf
B	Probe positioning error	0.0100	m	Rectangular	1.73	0.13	0.07	Inf
B	Mismatch between input/output device	0.0100	Linear	Normal	1.00	0.02	0.02	Inf
B	Field uniformity in the area to which the probe is exposed	0.0000	V/m	Normal	1.00	0.03	0.00	Inf
B	Probe fixture contribution	1.0600	V/m	Rectangular	1.73	0.02	1.18	Inf
B	Standing waves caused by nonideal anechoic environment (reflections)	0.6625	V/m	Normal	1.00	0.03	2.21	Inf
B	Standing waves between the probe and transmitting antenna	0.1060	V/m	Rectangular	1.73	0.02	0.12	Inf
B	Meter reading	0.0034	V/m	Normal	1.00	0.03	0.01	Inf
A	Repeatability of correction factor	0.0383	Linear	Normal	1.00	1.00	3.83	5
Uc(CF)	Combined uncertainty			Normal			5	11
U	Expanded uncertainty			Normal (k=2)			10	

Table C.11.8 – Uncertainty budget for FL7018 measurement with 30 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Uncertainty in the directional coupler insertion loss	0.0090	Linear	Normal	1.00	0.30	0.27	Inf
B	Uncertainty in the directional coupler coupling coefficient	3.7805	Linear	Normal	1.00	7.51E-04	0.28	Inf
B	System drift of power meter	0.0002	W	Rectangular	1.73	13.98	0.18	Inf
B	Power meter and sensor uncertainties	0.0246	Linear	Normal	1.00	0.80	1.98	Inf
B	Uncertainties in determining the gains of the antenna	7.0667	Linear	Normal	1.00	0.003	1.83	Inf
B	Probe positioning error	0.0100	m	Rectangular	1.73	0.23	0.13	Inf
B	Mismatch between input/output device	0.0100	Linear	Normal	1.00	0.02	0.02	Inf
B	Field uniformity in the area to which the probe is exposed	0.0000	V/m	Normal	1.00	0.03	0.00	Inf
B	Probe fixture contribution	0.9552	V/m	Rectangular	1.73	0.02	1.06	Inf
B	Standing waves caused by nonideal anechoic environment (reflections)	0.9552	V/m	Normal	1.00	0.03	3.18	Inf
B	Standing waves between the probe and transmitting antenna	0.1910	V/m	Rectangular	1.73	0.02	0.21	Inf
B	Meter reading	0.0092	V/m	Normal	1.00	0.05	0.05	Inf
A	Repeatability of correction factor	0.0286	Linear	Normal	1.00	1.00	2.86	4
Uc(CF)	Combined uncertainty			Normal			5	43
U	Expanded uncertainty			Normal (k=2)			10	

Table C.11.9 – Uncertainty budget for FL7018 measurement with 100 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Uncertainty in the directional coupler insertion loss	0.0035	Linear	Normal	1.00	0.39	0.13	Inf
B	Uncertainty in the directional coupler coupling coefficient	3.2177	Linear	Normal	1.00	5.89E-04	0.19	Inf
B	System drift of power meter	0.0002	W	Rectangular	1.73	9.69	0.12	Inf
B	Power meter and sensor uncertainties	0.0111	Linear	Normal	1.00	0.53	0.59	Inf
B	Uncertainties in determining the gains of the antenna	0.3305	Linear	Normal	1.00	0.04	1.22	Inf
B	Probe positioning error	0.0100	m	Rectangular	1.73	0.77	0.44	Inf
B	Mismatch between input/output device	0.0070	Linear	Normal	1.00	0.12	0.09	Inf
B	Field uniformity in the area to which the probe is exposed	0.0018	V/m	Normal	1.00	0.01	0.00	Inf
B	Probe fixture contribution	10.6200	V/m	Rectangular	1.73	0.01	3.54	Inf
B	Standing waves caused by nonideal anechoic environment (reflections)	1.0620	V/m	Normal	1.00	0.01	1.06	Inf
B	Standing waves between the probe and transmitting antenna	1.0620	V/m	Rectangular	1.73	0.01	0.35	Inf
B	Meter reading	0.0060	V/m	Normal	1.00	0.01	0.01	Inf
A	Repeatability of correction factor	0.0228	Linear	Normal	1.00	1.00	2.28	4
Uc(CF)	Combined uncertainty			Normal			5	65
U	Expanded uncertainty			Normal (k=2)			9	

Table C.11.10 – Uncertainty budget for FL7018 measurement with 100 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Uncertainty in the directional coupler insertion loss	0.0057	Linear	Normal	1.00	0.33	0.19	Inf
B	Uncertainty in the directional coupler coupling coefficient	3.9934	Linear	Normal	1.00	4.78E-04	0.19	Inf
B	System drift of power meter	0.0002	W	Rectangular	1.73	9.40	0.12	Inf
B	Power meter and sensor uncertainties	0.0162	Linear	Normal	1.00	0.53	0.86	Inf
B	Uncertainties in determining the gains of the antenna	1.2874	Linear	Normal	1.00	0.01	1.23	Inf
B	Probe positioning error	0.0100	m	Rectangular	1.73	0.48	0.27	Inf
B	Mismatch between input/output device	0.0100	Linear	Normal	1.00	0.03	0.03	Inf
B	Field uniformity in the area to which the probe is exposed	0.0000	V/m	Normal	1.00	0.01	0.00	Inf
B	Probe fixture contribution	2.1400	V/m	Rectangular	1.73	0.01	0.71	Inf
B	Standing waves caused by nonideal anechoic environment (reflections)	3.2100	V/m	Normal	1.00	0.01	3.21	Inf
B	Standing waves between the probe and transmitting antenna	0.4280	V/m	Rectangular	1.73	0.01	0.14	Inf
B	Meter reading	0.0101	V/m	Normal	1.00	0.01	0.01	Inf
A	Repeatability of correction factor	0.0274	Linear	Normal	1.00	1.00	2.74	4
Uc(CF)	Combined uncertainty			Normal			5	30
U	Expanded uncertainty			Normal (k=2)			9	

Table C.11.11 – Uncertainty budget for FL7018 measurement with 100 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Uncertainty in the directional coupler insertion loss	0.0090	Linear	Normal	1.00	0.16	0.15	Inf
B	Uncertainty in the directional coupler coupling coefficient	3.7805	Linear	Normal	1.00	4.14E-04	0.16	Inf
B	System drift of power meter	0.0002	W	Rectangular	1.73	7.70	0.10	Inf
B	Power meter and sensor uncertainties	0.0170	Linear	Normal	1.00	0.43	0.74	Inf
B	Uncertainties in determining the gains of the antenna	3.8390	Linear	Normal	1.00	0.00	1.01	Inf
B	Probe positioning error	0.0100	m	Rectangular	1.73	0.25	0.15	Inf
B	Mismatch between input/output device	0.0100	Linear	Normal	1.00	0.01	0.01	Inf
B	Field uniformity in the area to which the probe is exposed	0.0000	V/m	Normal	1.00	0.01	0.00	Inf
B	Probe fixture contribution	3.5067	V/m	Rectangular	1.73	0.01	1.17	Inf
B	Standing waves caused by nonideal anechoic environment (reflections)	2.1917	V/m	Normal	1.00	0.01	2.19	Inf
B	Standing waves between the probe and transmitting antenna	0.3507	V/m	Rectangular	1.73	0.01	0.12	Inf
B	Meter reading	0.0160	V/m	Normal	1.00	0.01	0.01	Inf
A	Repeatability of correction factor	0.0367	Linear	Normal	1.00	1.00	3.67	5
Uc(CF)	Combined uncertainty			Normal			5	12
U	Expanded uncertainty			Normal (k=2)			9	

Table C.11.12 – Uncertainty budget for FL7018 measurement with 100 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Uncertainty in the directional coupler insertion loss	0.0090	Linear	Normal	1.00	0.29	0.26	Inf
B	Uncertainty in the directional coupler coupling coefficient	3.7805	Linear	Normal	1.00	7.40E-04	0.28	Inf
B	System drift of power meter	0.0002	W	Rectangular	1.73	13.77	0.18	Inf
B	Power meter and sensor uncertainties	0.0246	Linear	Normal	1.00	0.79	1.95	Inf
B	Uncertainties in determining the gains of the antenna	7.0667	Linear	Normal	1.00	0.003	1.81	Inf
B	Probe positioning error	0.0100	m	Rectangular	1.73	1.01	0.58	Inf
B	Mismatch between input/output device	0.0100	Linear	Normal	1.00	0.02	0.02	Inf
B	Field uniformity in the area to which the probe is exposed	0.5174	V/m	Normal	1.00	0.01	0.52	Inf
B	Probe fixture contribution	3.1360	V/m	Rectangular	1.73	0.01	1.05	Inf
B	Standing waves caused by nonideal anechoic environment (reflections)	3.1360	V/m	Normal	1.00	0.01	3.14	Inf
B	Standing waves between the probe and transmitting antenna	0.6272	V/m	Rectangular	1.73	0.01	0.21	Inf
B	Meter reading	0.0140	V/m	Normal	1.00	0.02	0.02	Inf
A	Repeatability of correction factor	0.0259	Linear	Normal	1.00	1.00	2.59	4
Uc(CF)	Combined uncertainty			Normal			5	58
U	Expanded uncertainty			Normal (k=2)			10	

Table C.11.13 – Uncertainty budget for FP7050 measurement with 30 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Uncertainty in the directional coupler insertion loss	0.0035	Linear	Normal	1.00	0.37	0.13	Inf
B	Uncertainty in the directional coupler coupling coefficient	3.2177	Linear	Normal	1.00	5.59E-04	0.18	Inf
B	System drift of power meter	5.E-05	W	Rectangular	1.73	43	0.12	Inf
B	Power meter and sensor uncertainties	0.0104	Linear	Normal	1.00	0.50	0.52	Inf
B	Uncertainties in determining the gains of the antenna	0.3305	Linear	Normal	1.00	0.04	1.16	Inf
B	Probe positioning error	0.0100	m	Rectangular	1.73	0.19	0.11	Inf
B	Mismatch between input/output device	0.0070	Linear	Normal	1.00	0.12	0.08	Inf
B	Field uniformity in the area to which the probe is exposed	0.0000	V/m	Normal	1.00	0.03	0.00	Inf
B	Probe fixture contribution	3.0241	V/m	Rectangular	1.73	0.02	3.36	Inf
B	Standing waves caused by nonideal anechoic environment (reflections)	0.5141	V/m	Normal	1.00	0.03	1.71	Inf
B	Standing waves between the probe and transmitting antenna	0.6048	V/m	Rectangular	1.73	0.02	0.67	Inf
B	Meter reading	0.1021	V/m	Normal	1.00	0.03	0.34	Inf
A	Repeatability of correction factor	0.0225	Linear	Normal	1.00	1.00	2.25	4
Uc(CF)	Combined uncertainty			Normal			5	72
U	Expanded uncertainty			Normal (k=2)			9	

Table C.11.14 – Uncertainty budget for FP7050 measurement with 30 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Uncertainty in the directional coupler insertion loss	0.0057	Linear	Normal	1.00	0.32	0.19	Inf
B	Uncertainty in the directional coupler coupling coefficient	3.9934	Linear	Normal	1.00	4.64E-04	0.19	Inf
B	System drift of power meter	0.0002	W	Rectangular	1.73	9.12	0.12	Inf
B	Power meter and sensor uncertainties	0.0162	Linear	Normal	1.00	0.52	0.83	Inf
B	Uncertainties in determining the gains of the antenna	1.2874	Linear	Normal	1.00	0.01	1.20	Inf
B	Probe positioning error	0.0100	m	Rectangular	1.73	0.24	0.14	Inf
B	Mismatch between input/output device	0.0100	Linear	Normal	1.00	0.03	0.03	Inf
B	Field uniformity in the area to which the probe is exposed	0.0000	V/m	Normal	1.00	0.03	0.00	Inf
B	Probe fixture contribution	0.6228	V/m	Rectangular	1.73	0.02	0.69	Inf
B	Standing waves caused by nonideal anechoic environment (reflections)	0.9342	V/m	Normal	1.00	0.03	3.11	Inf
B	Standing waves between the probe and transmitting antenna	0.1246	V/m	Rectangular	1.73	0.02	0.14	Inf
B	Meter reading	0.1100	V/m	Normal	1.00	0.03	0.38	Inf
A	Repeatability of correction factor	0.0286	Linear	Normal	1.00	1.00	2.86	4
Uc(CF)	Combined uncertainty			Normal			5	25
U	Expanded uncertainty			Normal (k=2)			9	

Table C.11.15 – Uncertainty budget for FP7050 measurement with 30 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Uncertainty in the directional coupler insertion loss	0.0090	Linear	Normal	1.00	0.19	0.17	Inf
B	Uncertainty in the directional coupler coupling coefficient	3.7805	Linear	Normal	1.00	4.83E-04	0.18	Inf
B	System drift of power meter	0.0002	W	Rectangular	1.73	8.99	0.12	Inf
B	Power meter and sensor uncertainties	0.0170	Linear	Normal	1.00	0.51	0.86	Inf
B	Uncertainties in determining the gains of the antenna	3.8390	Linear	Normal	1.00	0.003	1.18	Inf
B	Probe positioning error	0.0100	m	Rectangular	1.73	0.15	0.09	Inf
B	Mismatch between input/output device	0.0100	Linear	Normal	1.00	0.02	0.02	Inf
B	Field uniformity in the area to which the probe is exposed	0.0000	V/m	Normal	1.00	0.03	0.00	Inf
B	Probe fixture contribution	1.2288	V/m	Rectangular	1.73	0.02	1.37	Inf
B	Standing waves caused by nonideal anechoic environment (reflections)	0.7680	V/m	Normal	1.00	0.03	2.56	Inf
B	Standing waves between the probe and transmitting antenna	0.1229	V/m	Rectangular	1.73	0.02	0.14	Inf
B	Meter reading	0.1040	V/m	Normal	1.00	0.03	0.36	Inf
A	Repeatability of correction factor	0.0321	Linear	Normal	1.00	1.00	3.21	4
Uc(CF)	Combined uncertainty			Normal			5	16
U	Expanded uncertainty			Normal (k=2)			9	

Table C.11.16 – Uncertainty budget for FP7050 measurement with 30 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Uncertainty in the directional coupler insertion loss	0.0090	Linear	Normal	1.00	0.18	0.16	Inf
B	Uncertainty in the directional coupler coupling coefficient	3.7805	Linear	Normal	1.00	4.58E-04	0.17	Inf
B	System drift of power meter	0.0002	W	Rectangular	1.73	8.52	0.11	Inf
B	Power meter and sensor uncertainties	0.0246	Linear	Normal	1.00	0.49	1.21	Inf
B	Uncertainties in determining the gains of the antenna	7.0667	Linear	Normal	1.00	0.002	1.12	Inf
B	Probe positioning error	0.0100	m	Rectangular	1.73	0.14	0.08	Inf
B	Mismatch between input/output device	0.0100	Linear	Normal	1.00	0.01	0.01	Inf
B	Field uniformity in the area to which the probe is exposed	0.0000	V/m	Normal	1.00	0.03	0.00	Inf
B	Probe fixture contribution	0.5820	V/m	Rectangular	1.73	0.02	0.65	Inf
B	Standing waves caused by nonideal anechoic environment (reflections)	0.5820	V/m	Normal	1.00	0.03	1.94	Inf
B	Standing waves between the probe and transmitting antenna	0.1164	V/m	Rectangular	1.73	0.02	0.13	Inf
B	Meter reading	0.1155	V/m	Normal	1.00	0.03	0.37	Inf
A	Repeatability of correction factor	0.0372	Linear	Normal	1.00	1.00	3.72	5
Uc(CF)	Combined uncertainty			Normal			5	11
U	Expanded uncertainty			Normal (k=2)			9	

Table C.11.17 – Uncertainty budget for FP7050 measurement with 100 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Uncertainty in the directional coupler insertion loss	0.0035	Linear	Normal	1.00	0.37	0.13	Inf
B	Uncertainty in the directional coupler coupling coefficient	3.2177	Linear	Normal	1.00	5.63E-04	0.18	Inf
B	System drift of power meter	0.0002	W	Rectangular	1.73	9.26	0.12	Inf
B	Power meter and sensor uncertainties	0.0111	Linear	Normal	1.00	0.50	0.56	Inf
B	Uncertainties in determining the gains of the antenna	0.3305	Linear	Normal	1.00	0.04	1.17	Inf
B	Probe positioning error	0.0100	m	Rectangular	1.73	0.65	0.38	Inf
B	Mismatch between input/output device	0.0070	Linear	Normal	1.00	0.12	0.08	Inf
B	Field uniformity in the area to which the probe is exposed	0.0017	V/m	Normal	1.00	0.01	0.00	Inf
B	Probe fixture contribution	10.1452	V/m	Rectangular	1.73	0.01	3.38	Inf
B	Standing waves caused by nonideal anechoic environment (reflections)	1.7247	V/m	Normal	1.00	0.01	1.72	Inf
B	Standing waves between the probe and transmitting antenna	2.0290	V/m	Rectangular	1.73	0.01	0.68	Inf
B	Meter reading	0.0338	V/m	Normal	1.00	0.01	0.03	Inf
A	Repeatability of correction factor	0.0235	Linear	Normal	1.00	1.00	2.35	4
Uc(CF)	Combined uncertainty			Normal			5	65
U	Expanded uncertainty			Normal (k=2)			9	

Table C.11.18 – Uncertainty budget for FP7050 measurement with 100 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Uncertainty in the directional coupler insertion loss	0.0057	Linear	Normal	1.00	0.33	0.19	Inf
B	Uncertainty in the directional coupler coupling coefficient	3.9934	Linear	Normal	1.00	4.74E-04	0.19	Inf
B	System drift of power meter	0.0002	W	Rectangular	1.73	9.31	0.12	Inf
B	Power meter and sensor uncertainties	0.0162	Linear	Normal	1.00	0.53	0.85	Inf
B	Uncertainties in determining the gains of the antenna	1.2874	Linear	Normal	1.00	0.01	1.22	Inf
B	Probe positioning error	0.0100	m	Rectangular	1.73	0.47	0.27	Inf
B	Mismatch between input/output device	0.0100	Linear	Normal	1.00	0.03	0.03	Inf
B	Field uniformity in the area to which the probe is exposed	0.0000	V/m	Normal	1.00	0.01	0.00	Inf
B	Probe fixture contribution	2.1200	V/m	Rectangular	1.73	0.01	0.71	Inf
B	Standing waves caused by nonideal anechoic environment (reflections)	3.1800	V/m	Normal	1.00	0.01	3.18	Inf
B	Standing waves between the probe and transmitting antenna	0.4240	V/m	Rectangular	1.73	0.01	0.14	Inf
B	Meter reading	0.0338	V/m	Normal	1.00	0.01	0.04	Inf
A	Repeatability of correction factor	0.0316	Linear	Normal	1.00	1.00	3.16	4
Uc(CF)	Combined uncertainty			Normal			5	21
U	Expanded uncertainty			Normal (k=2)			10	

Table C.11.19 – Uncertainty budget for FP7050 measurement with 100 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Uncertainty in the directional coupler insertion loss	0.0090	Linear	Normal	1.00	0.19	0.17	Inf
B	Uncertainty in the directional coupler coupling coefficient	3.7805	Linear	Normal	1.00	4.93E-04	0.19	Inf
B	System drift of power meter	0.0002	W	Rectangular	1.73	9.17	0.12	Inf
B	Power meter and sensor uncertainties	0.0170	Linear	Normal	1.00	0.52	0.88	Inf
B	Uncertainties in determining the gains of the antenna	3.8390	Linear	Normal	1.00	0.003	1.20	Inf
B	Probe positioning error	0.0100	m	Rectangular	1.73	0.30	0.17	Inf
B	Mismatch between input/output device	0.0100	Linear	Normal	1.00	0.02	0.02	Inf
B	Field uniformity in the area to which the probe is exposed	0.0000	V/m	Normal	1.00	0.01	0.00	Inf
B	Probe fixture contribution	4.1760	V/m	Rectangular	1.73	0.01	1.39	Inf
B	Standing waves caused by nonideal anechoic environment (reflections)	2.6100	V/m	Normal	1.00	0.01	2.61	Inf
B	Standing waves between the probe and transmitting antenna	0.4176	V/m	Rectangular	1.73	0.01	0.14	Inf
B	Meter reading	0.0363	V/m	Normal	1.00	0.01	0.04	Inf
A	Repeatability of correction factor	0.0358	Linear	Normal	1.00	1.00	3.58	4
Uc(CF)	Combined uncertainty			Normal			5	13
U	Expanded uncertainty			Normal (k=2)			10	

Table C.11.20 – Uncertainty budget for FP7050 measurement with 100 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Uncertainty in the directional coupler insertion loss	0.0090	Linear	Normal	1.00	0.18	0.16	Inf
B	Uncertainty in the directional coupler coupling coefficient	3.7805	Linear	Normal	1.00	4.64E-04	0.18	Inf
B	System drift of power meter	0.0002	W	Rectangular	1.73	8.64	0.11	Inf
B	Power meter and sensor uncertainties	0.0246	Linear	Normal	1.00	0.50	1.22	Inf
B	Uncertainties in determining the gains of the antenna	7.0667	Linear	Normal	1.00	0.002	1.13	Inf
B	Probe positioning error	0.0100	m	Rectangular	1.73	0.63	0.36	Inf
B	Mismatch between input/output device	0.0100	Linear	Normal	1.00	0.01	0.01	Inf
B	Field uniformity in the area to which the probe is exposed	0.3245	V/m	Normal	1.00	0.01	0.32	Inf
B	Probe fixture contribution	1.9667	V/m	Rectangular	1.73	0.01	0.66	Inf
B	Standing waves caused by nonideal anechoic environment (reflections)	1.9667	V/m	Normal	1.00	0.01	1.97	Inf
B	Standing waves between the probe and transmitting antenna	0.3933	V/m	Rectangular	1.73	0.01	0.13	Inf
B	Meter reading	0.0363	V/m	Normal	1.00	0.01	0.04	Inf
A	Repeatability of correction factor	0.0371	Linear	Normal	1.00	1.00	3.71	5
Uc(CF)	Combined uncertainty			Normal			5	11
U	Expanded uncertainty			Normal (k=2)			9	

C.12 TUBITAK-UME Uncertainty Budgets

Table C.12.1 – Uncertainty budget for FL7018 measurement with 10 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) dB	Degs of Freedom Vi or Veff
B	Mismatch at coupler to standard-gain horn connection	0.0307	dB	U-shaped	1.41	1.00	0.02	∞
B	Mismatch error at forward power sensor	0.0090	dB	U-shaped	1.41	1.00	0.01	∞
B	Mismatch error at reflected power sensor	0.0090	dB	U-shaped	1.41	1.00	0.01	∞
B	Mismatch error at input of directional coupler	0.0330	dB	U-shaped	1.41	1.00	0.02	∞
B	Spacing error	0.0200	dB	Rectangular	1.73	1.00	0.01	∞
B	Alignment error	0.2000	dB	Rectangular	1.73	1.00	0.12	∞
B	Power sensor error	0.0490	dB	Rectangular	1.73	1.00	0.03	∞
B	Power meter error	0.0500	dB	Rectangular	1.73	1.00	0.03	∞
B	Directional coupler error	0.1600	dB	Rectangular	1.73	1.00	0.09	∞
B	Residual ground reflections error	0.1000	dB	Rectangular	1.73	1.00	0.06	∞
B	Multiple reflections error	0.0500	dB	Rectangular	1.73	1.00	0.03	∞
B	Standard-gain horn error	0.5000	dB	Normal	1.00	1.00	0.50	∞
B	Thermal error for coaxial cables	0.0600	dB	Rectangular	1.73	1.00	0.03	∞
B	Coaxial cable flexing error	0.0600	dB	Rectangular	1.73	1.00	0.03	∞
B	Amplifier gain fluctuation	0.0400	dB	Rectangular	1.73	1.00	0.02	∞
A	Repeatability	0.0030	dB	Normal	1.00	1.00	0.00	9
Uc(CF)	Combined uncertainty			normal			0.53	∞
U	Expanded uncertainty			normal (k=2)			1.06	

Table C.12.2 – Uncertainty budget for FL7018 measurement with 10 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) dB	Degs of Freedom Vi or Veff
B	Mismatch at coupler to standard-gain horn connection	0.0483	dB	U-shaped	1.41	1.00	0.03	∞
B	Mismatch error at forward power sensor	0.0280	dB	U-shaped	1.41	1.00	0.02	∞
B	Mismatch error at reflected power sensor	0.0280	dB	U-shaped	1.41	1.00	0.02	∞
B	Mismatch error at input of directional coupler	0.0899	dB	U-shaped	1.41	1.00	0.06	∞
B	Spacing error	0.0200	dB	Rectangular	1.73	1.00	0.01	∞
B	Alignment error	0.2000	dB	Rectangular	1.73	1.00	0.12	∞
B	Power sensor error	0.0530	dB	Rectangular	1.73	1.00	0.03	∞
B	Power meter error	0.0500	dB	Rectangular	1.73	1.00	0.03	∞
B	Directional coupler error	0.1800	dB	Rectangular	1.73	1.00	0.10	∞
B	Residual ground reflections error	0.1000	dB	Rectangular	1.73	1.00	0.06	∞
B	Multiple reflections error	0.0500	dB	Rectangular	1.73	1.00	0.03	∞
B	Standard-gain horn error	0.5000	dB	Normal	1.00	1.00	0.50	∞
B	Thermal error for coaxial cables	0.0600	dB	Rectangular	1.73	1.00	0.03	∞
B	Coaxial cable flexing error	0.0600	dB	Rectangular	1.73	1.00	0.03	∞
B	Amplifier gain fluctuation	0.0400	dB	Rectangular	1.73	1.00	0.01	∞
A	Repeatability	0.0024	dB	Normal	1.00	1.00	0.00	9
Uc(CF)	Combined uncertainty			normal			0.54	∞
U	Expanded uncertainty			normal (k=2)			1.08	

Table C.12.3 – Uncertainty budget for FL7018 measurement with 10 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) dB	Degs of Freedom Vi or Veff
B	Mismatch at coupler to standard-gain horn connection	0.0418	dB	U-shaped	1.41	1.00	0.03	∞
B	Mismatch error at forward power sensor	0.0450	dB	U-shaped	1.41	1.00	0.03	∞
B	Mismatch error at reflected power sensor	0.0450	dB	U-shaped	1.41	1.00	0.03	∞
B	Mismatch error at input of directional coupler	0.0899	dB	U-shaped	1.41	1.00	0.06	∞
B	Spacing error	0.0200	dB	Rectangular	1.73	1.00	0.01	∞
B	Alignment error	0.2000	dB	Rectangular	1.73	1.00	0.12	∞
B	Power sensor error	0.0660	dB	Rectangular	1.73	1.00	0.04	∞
B	Power meter error	0.0500	dB	Rectangular	1.73	1.00	0.03	∞
B	Directional coupler error	0.2500	dB	Rectangular	1.73	1.00	0.14	∞
B	Residual ground reflections error	0.1000	dB	Rectangular	1.73	1.00	0.06	∞
B	Multiple reflections error	0.0500	dB	Rectangular	1.73	1.00	0.03	∞
B	Standard-gain horn error	0.5500	dB	Normal	1.00	1.00	0.55	∞
B	Thermal error for coaxial cables	0.0600	dB	Rectangular	1.73	1.00	0.03	∞
B	Coaxial cable flexing error	0.0600	dB	Rectangular	1.73	1.00	0.03	∞
B	Amplifier gain fluctuation	0.1500	dB	Rectangular	1.73	1.00	0.09	∞
A	Repeatability	0.0187	dB	Normal	1.00	1.00	0.02	9
Uc(CF)	Combined uncertainty			normal			0.60	∞
U	Expanded uncertainty			normal (k=2)			1.20	

Table C.12.4 – Uncertainty budget for FL7018 measurement with 10 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) dB	Degs of Freedom Vi or Veff
B	Mismatch at coupler to standard-gain horn connection	0.0483	dB	U-shaped	1.41	1.00	0.03	∞
B	Mismatch error at forward power sensor	0.0660	dB	U-shaped	1.41	1.00	0.05	∞
B	Mismatch error at reflected power sensor	0.0660	dB	U-shaped	1.41	1.00	0.05	∞
B	Mismatch error at input of directional coupler	0.0899	dB	U-shaped	1.41	1.00	0.06	∞
B	Spacing error	0.0200	dB	Rectangular	1.73	1.00	0.01	∞
B	Alignment error	0.2000	dB	Rectangular	1.73	1.00	0.12	∞
B	Power sensor error	0.1080	dB	Rectangular	1.73	1.00	0.06	∞
B	Power meter error	0.0500	dB	Rectangular	1.73	1.00	0.03	∞
B	Directional coupler error	0.3000	dB	Rectangular	1.73	1.00	0.17	∞
B	Residual ground reflections error	0.1000	dB	Rectangular	1.73	1.00	0.06	∞
B	Multiple reflections error	0.0500	dB	Rectangular	1.73	1.00	0.03	∞
B	Standard-gain horn error	0.5500	dB	Normal	1.00	1.00	0.55	∞
B	Thermal error for coaxial cables	0.0600	dB	Rectangular	1.00	1.00	0.06	∞
B	Coaxial cable flexing error	0.0600	dB	Rectangular	1.00	1.00	0.06	∞
B	Amplifier gain fluctuation	0.2000	dB	Rectangular	1.00	1.00	0.20	∞
A	Repeatability	0.0030	dB	Normal	1.00	1.00	0.00	9
Uc(CF)	Combined uncertainty			normal			0.64	∞
U	Expanded uncertainty			normal (k=2)			1.28	

Table C.12.5 – Uncertainty budget for FL7018 measurement with 30 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) dB	Degs of Freedom Vi or Veff
B	Mismatch at coupler to standard-gain horn connection	0.0307	dB	U-shaped	1.41	1.00	0.02	∞
B	Mismatch error at forward power sensor	0.0090	dB	U-shaped	1.41	1.00	0.01	∞
B	Mismatch error at reflected power sensor	0.0090	dB	U-shaped	1.41	1.00	0.01	∞
B	Mismatch error at input of directional coupler	0.0330	dB	U-shaped	1.41	1.00	0.02	∞
B	Spacing error	0.0200	dB	Rectangular	1.73	1.00	0.01	∞
B	Alignment error	0.2000	dB	Rectangular	1.73	1.00	0.12	∞
B	Power sensor error	0.0490	dB	Rectangular	1.73	1.00	0.03	∞
B	Power meter error	0.0500	dB	Rectangular	1.73	1.00	0.03	∞
B	Directional coupler error	0.1600	dB	Rectangular	1.73	1.00	0.09	∞
B	Residual ground reflections error	0.1000	dB	Rectangular	1.73	1.00	0.06	∞
B	Multiple reflections error	0.0500	dB	Rectangular	1.73	1.00	0.03	∞
B	Standard-gain horn error	0.5000	dB	Normal	1.00	1.00	0.50	∞
B	Thermal error for coaxial cables	0.0600	dB	Rectangular	1.73	1.00	0.03	∞
B	Coaxial cable flexing error	0.0600	dB	Rectangular	1.73	1.00	0.03	∞
B	Amplifier gain fluctuation	0.0400	dB	Rectangular	1.73	1.00	0.02	∞
A	Repeatability	0.0024	dB	Normal	1.00	1.00	0.00	9
Uc(CF)	Combined uncertainty			normal			0.53	∞
U	Expanded uncertainty			normal (k=2)			1.06	

Table C.12.6 – Uncertainty budget for FL7018 measurement with 30 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) dB	Degs of Freedom Vi or Veff
B	Mismatch at coupler to standard-gain horn connection	0.0483	dB	U-shaped	1.41	1.00	0.03	∞
B	Mismatch error at forward power sensor	0.0280	dB	U-shaped	1.41	1.00	0.02	∞
B	Mismatch error at reflected power sensor	0.0280	dB	U-shaped	1.41	1.00	0.02	∞
B	Mismatch error at input of directional coupler	0.0899	dB	U-shaped	1.41	1.00	0.06	∞
B	Spacing error	0.0200	dB	Rectangular	1.73	1.00	0.01	∞
B	Alignment error	0.2000	dB	Rectangular	1.73	1.00	0.12	∞
B	Power sensor error	0.0530	dB	Rectangular	1.73	1.00	0.03	∞
B	Power meter error	0.0500	dB	Rectangular	1.73	1.00	0.03	∞
B	Directional coupler error	0.1800	dB	Rectangular	1.73	1.00	0.10	∞
B	Residual ground reflections error	0.1000	dB	Rectangular	1.73	1.00	0.06	∞
B	Multiple reflections error	0.0500	dB	Rectangular	1.73	1.00	0.03	∞
B	Standard-gain horn error	0.5000	dB	Normal	1.00	1.00	0.50	∞
B	Thermal error for coaxial cables	0.0600	dB	Rectangular	1.73	1.00	0.03	∞
B	Coaxial cable flexing error	0.0600	dB	Rectangular	1.73	1.00	0.03	∞
B	Amplifier gain fluctuation	0.0400	dB	Rectangular	2.73	1.00	0.01	∞
A	Repeatability	0.0026	dB	Normal	1.00	1.00	0.00	9
Uc(CF)	Combined uncertainty			normal			0.54	∞
U	Expanded uncertainty			normal (k=2)			1.08	

Table C.12.7 – Uncertainty budget for FL7018 measurement with 30 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) dB	Degs of Freedom Vi or Veff
B	Mismatch at coupler to standard-gain horn connection	0.0418	dB	U-shaped	1.41	1.00	0.03	∞
B	Mismatch error at forward power sensor	0.0450	dB	U-shaped	1.41	1.00	0.03	∞
B	Mismatch error at reflected power sensor	0.0450	dB	U-shaped	1.41	1.00	0.03	∞
B	Mismatch error at input of directional coupler	0.0899	dB	U-shaped	1.41	1.00	0.06	∞
B	Spacing error	0.0200	dB	Rectangular	1.73	1.00	0.01	∞
B	Alignment error	0.2000	dB	Rectangular	1.73	1.00	0.12	∞
B	Power sensor error	0.0660	dB	Rectangular	1.73	1.00	0.04	∞
B	Power meter error	0.0500	dB	Rectangular	1.73	1.00	0.03	∞
B	Directional coupler error	0.2500	dB	Rectangular	1.73	1.00	0.14	∞
B	Residual ground reflections error	0.1000	dB	Rectangular	1.73	1.00	0.06	∞
B	Multiple reflections error	0.0500	dB	Rectangular	1.73	1.00	0.03	∞
B	Standard-gain horn error	0.5500	dB	Normal	1.00	1.00	0.55	∞
B	Thermal error for coaxial cables	0.0600	dB	Rectangular	1.73	1.00	0.03	∞
B	Coaxial cable flexing error	0.0600	dB	Rectangular	1.73	1.00	0.03	∞
B	Amplifier gain fluctuation	0.1500	dB	Rectangular	1.73	1.00	0.09	∞
A	Repeatability	0.0047	dB	Normal	1.00	1.00	0.00	9
Uc(CF)	Combined uncertainty			normal			0.60	∞
U	Expanded uncertainty			normal (k=2)			1.20	

Table C.12.8 – Uncertainty budget for FL7018 measurement with 30 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) dB	Degs of Freedom Vi or Veff
B	Mismatch at coupler to standard-gain horn connection	0.0483	dB	U-shaped	1.41	1.00	0.03	∞
B	Mismatch error at forward power sensor	0.0660	dB	U-shaped	1.41	1.00	0.05	∞
B	Mismatch error at reflected power sensor	0.0660	dB	U-shaped	1.41	1.00	0.05	∞
B	Mismatch error at input of directional coupler	0.0899	dB	U-shaped	1.41	1.00	0.06	∞
B	Spacing error	0.0200	dB	Rectangular	1.73	1.00	0.01	∞
B	Alignment error	0.2000	dB	Rectangular	1.73	1.00	0.12	∞
B	Power sensor error	0.1080	dB	Rectangular	1.73	1.00	0.06	∞
B	Power meter error	0.0500	dB	Rectangular	1.73	1.00	0.03	∞
B	Directional coupler error	0.3000	dB	Rectangular	1.73	1.00	0.17	∞
B	Residual ground reflections error	0.1000	dB	Rectangular	1.73	1.00	0.06	∞
B	Multiple reflections error	0.0500	dB	Rectangular	1.73	1.00	0.03	∞
B	Standard-gain horn error	0.5500	dB	Normal	1.00	1.00	0.55	∞
B	Thermal error for coaxial cables	0.0600	dB	Rectangular	1.00	1.00	0.06	∞
B	Coaxial cable flexing error	0.0600	dB	Rectangular	1.00	1.00	0.06	∞
B	Amplifier gain fluctuation	0.2000	dB	Rectangular	1.00	1.00	0.20	∞
A	Repeatability	0.0024	dB	Normal	1.00	1.00	0.00	9
Uc(CF)	Combined uncertainty			normal			0.64	∞
U	Expanded uncertainty			normal (k=2)			1.28	

Table C.12.9 – Uncertainty budget for FL7018 measurement with 100 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) dB	Degs of Freedom Vi or Veff
B	Mismatch at coupler to standard-gain horn connection	0.0307	dB	U-shaped	1.41	1.00	0.02	∞
B	Mismatch error at forward power sensor	0.0090	dB	U-shaped	1.41	1.00	0.01	∞
B	Mismatch error at reflected power sensor	0.0090	dB	U-shaped	1.41	1.00	0.01	∞
B	Mismatch error at input of directional coupler	0.0330	dB	U-shaped	1.41	1.00	0.02	∞
B	Spacing error	0.0200	dB	Rectangular	1.73	1.00	0.01	∞
B	Alignment error	0.2000	dB	Rectangular	1.73	1.00	0.12	∞
B	Power sensor error	0.0490	dB	Rectangular	1.73	1.00	0.03	∞
B	Power meter error	0.0500	dB	Rectangular	1.73	1.00	0.03	∞
B	Directional coupler error	0.1600	dB	Rectangular	1.73	1.00	0.09	∞
B	Residual ground reflections error	0.1000	dB	Rectangular	1.73	1.00	0.06	∞
B	Multiple reflections error	0.0500	dB	Rectangular	1.73	1.00	0.03	∞
B	Standard-gain horn error	0.5000	dB	Normal	1.00	1.00	0.50	∞
B	Thermal error for coaxial cables	0.0600	dB	Rectangular	1.73	1.00	0.03	∞
B	Coaxial cable flexing error	0.0600	dB	Rectangular	1.73	1.00	0.03	∞
B	Amplifier gain fluctuation	0.1500	dB	Rectangular	1.73	1.00	0.09	∞
A	Repeatability	0.0119	dB	Normal	1.00	1.00	0.01	9
Uc(CF)	Combined uncertainty			normal			0.54	∞
U	Expanded uncertainty			normal (k=2)			1.08	

Table C.12.10 – Uncertainty budget for FL7018 measurement with 100 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) dB	Degs of Freedom Vi or Veff
B	Mismatch at coupler to standard-gain horn connection	0.0483	dB	U-shaped	1.41	1.00	0.03	∞
B	Mismatch error at forward power sensor	0.0280	dB	U-shaped	1.41	1.00	0.02	∞
B	Mismatch error at reflected power sensor	0.0280	dB	U-shaped	1.41	1.00	0.02	∞
B	Mismatch error at input of directional coupler	0.0899	dB	U-shaped	1.41	1.00	0.06	∞
B	Spacing error	0.0200	dB	Rectangular	1.73	1.00	0.01	∞
B	Alignment error	0.2000	dB	Rectangular	1.73	1.00	0.12	∞
B	Power sensor error	0.0530	dB	Rectangular	1.73	1.00	0.03	∞
B	Power meter error	0.0500	dB	Rectangular	1.73	1.00	0.03	∞
B	Directional coupler error	0.1800	dB	Rectangular	1.73	1.00	0.10	∞
B	Residual ground reflections error	0.1000	dB	Rectangular	1.73	1.00	0.06	∞
B	Multiple reflections error	0.0500	dB	Rectangular	1.73	1.00	0.03	∞
B	Standard-gain horn error	0.5000	dB	Normal	1.00	1.00	0.50	∞
B	Thermal error for coaxial cables	0.0600	dB	Rectangular	1.73	1.00	0.03	∞
B	Coaxial cable flexing error	0.0600	dB	Rectangular	1.73	1.00	0.03	∞
B	Amplifier gain fluctuation	0.1500	dB	Rectangular	2.73	1.00	0.05	∞
A	Repeatability	0.0023	dB	Normal	1.00	1.00	0.00	9
Uc(CF)	Combined uncertainty			normal			0.54	∞
U	Expanded uncertainty			normal (k=2)			1.08	

Table C.12.11 – Uncertainty budget for FL7018 measurement with 100 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) dB	Degs of Freedom Vi or Veff
B	Mismatch at coupler to standard-gain horn connection	0.0418	dB	U-shaped	1.41	1.00	0.03	∞
B	Mismatch error at forward power sensor	0.0450	dB	U-shaped	1.41	1.00	0.03	∞
B	Mismatch error at reflected power sensor	0.0450	dB	U-shaped	1.41	1.00	0.03	∞
B	Mismatch error at input of directional coupler	0.0899	dB	U-shaped	1.41	1.00	0.06	∞
B	Spacing error	0.0200	dB	Rectangular	1.73	1.00	0.01	∞
B	Alignment error	0.2000	dB	Rectangular	1.73	1.00	0.12	∞
B	Power sensor error	0.0660	dB	Rectangular	1.73	1.00	0.04	∞
B	Power meter error	0.0500	dB	Rectangular	1.73	1.00	0.03	∞
B	Directional coupler error	0.2500	dB	Rectangular	1.73	1.00	0.14	∞
B	Residual ground reflections error	0.1000	dB	Rectangular	1.73	1.00	0.06	∞
B	Multiple reflections error	0.0500	dB	Rectangular	1.73	1.00	0.03	∞
B	Standard-gain horn error	0.5500	dB	Normal	1.00	1.00	0.55	∞
B	Thermal error for coaxial cables	0.0600	dB	Rectangular	1.73	1.00	0.03	∞
B	Coaxial cable flexing error	0.0600	dB	Rectangular	1.73	1.00	0.03	∞
B	Amplifier gain fluctuation	0.2500	dB	Rectangular	1.73	1.00	0.14	∞
A	Repeatability	0.0057	dB	Normal	1.00	1.00	0.01	9
Uc(CF)	Combined uncertainty			normal			0.61	∞
U	Expanded uncertainty			normal (k=2)			1.22	

Table C.12.12 – Uncertainty budget for FL7018 measurement with 100 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) dB	Degs of Freedom Vi or Veff
B	Mismatch at coupler to standard-gain horn connection	0.0483	dB	U-shaped	1.41	1.00	0.03	∞
B	Mismatch error at forward power sensor	0.0660	dB	U-shaped	1.41	1.00	0.05	∞
B	Mismatch error at reflected power sensor	0.0660	dB	U-shaped	1.41	1.00	0.05	∞
B	Mismatch error at input of directional coupler	0.0899	dB	U-shaped	1.41	1.00	0.06	∞
B	Spacing error	0.0200	dB	Rectangular	1.73	1.00	0.01	∞
B	Alignment error	0.2000	dB	Rectangular	1.73	1.00	0.12	∞
B	Power sensor error	0.1080	dB	Rectangular	1.73	1.00	0.06	∞
B	Power meter error	0.0500	dB	Rectangular	1.73	1.00	0.03	∞
B	Directional coupler error	0.3000	dB	Rectangular	1.73	1.00	0.17	∞
B	Residual ground reflections error	0.1000	dB	Rectangular	1.73	1.00	0.06	∞
B	Multiple reflections error	0.0500	dB	Rectangular	1.73	1.00	0.03	∞
B	Standard-gain horn error	0.5500	dB	Normal	1.00	1.00	0.55	∞
B	Thermal error for coaxial cables	0.0600	dB	Rectangular	1.00	1.00	0.06	∞
B	Coaxial cable flexing error	0.0600	dB	Rectangular	1.00	1.00	0.06	∞
B	Amplifier gain fluctuation	0.2500	dB	Rectangular	1.00	1.00	0.25	∞
A	Repeatability	0.0107	dB	Normal	1.00	1.00	0.01	9
Uc(CF)	Combined uncertainty			normal			0.66	∞
U	Expanded uncertainty			normal (k=2)			1.32	

Table C.12.13 – Uncertainty budget for FP7050 measurement with 30 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) dB	Degs of Freedom Vi or Veff
B	Mismatch at coupler to standard-gain horn connection	0.0307	dB	U-shaped	1.41	1.00	0.02	∞
B	Mismatch error at forward power sensor	0.0090	dB	U-shaped	1.41	1.00	0.01	∞
B	Mismatch error at reflected power sensor	0.0090	dB	U-shaped	1.41	1.00	0.01	∞
B	Mismatch error at input of directional coupler	0.0330	dB	U-shaped	1.41	1.00	0.02	∞
B	Spacing error	0.0200	dB	Rectangular	1.73	1.00	0.01	∞
B	Alignment error	0.2000	dB	Rectangular	1.73	1.00	0.12	∞
B	Power sensor error	0.0490	dB	Rectangular	1.73	1.00	0.03	∞
B	Power meter error	0.0500	dB	Rectangular	1.73	1.00	0.03	∞
B	Directional coupler error	0.1600	dB	Rectangular	1.73	1.00	0.09	∞
B	Residual ground reflections error	0.1000	dB	Rectangular	1.73	1.00	0.06	∞
B	Multiple reflections error	0.0500	dB	Rectangular	1.73	1.00	0.03	∞
B	Standard-gain horn error	0.5000	dB	Normal	1.00	1.00	0.50	∞
B	Thermal error for coaxial cables	0.0600	dB	Rectangular	1.73	1.00	0.03	∞
B	Coaxial cable flexing error	0.0600	dB	Rectangular	1.73	1.00	0.03	∞
B	Amplifier gain fluctuation	0.0400	dB	Rectangular	1.73	1.00	0.02	∞
A	Repeatability	0.0103	dB	Normal	1.00	1.00	0.01	9
Uc(CF)	Combined uncertainty			normal			0.53	∞
U	Expanded uncertainty			normal (k=2)			1.06	

Table C.12.14 – Uncertainty budget for FP7050 measurement with 30 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) dB	Degs of Freedom Vi or Veff
B	Mismatch at coupler to standard-gain horn connection	0.0483	dB	U-shaped	1.41	1.00	0.03	∞
B	Mismatch error at forward power sensor	0.0280	dB	U-shaped	1.41	1.00	0.02	∞
B	Mismatch error at reflected power sensor	0.0280	dB	U-shaped	1.41	1.00	0.02	∞
B	Mismatch error at input of directional coupler	0.0899	dB	U-shaped	1.41	1.00	0.06	∞
B	Spacing error	0.0200	dB	Rectangular	1.73	1.00	0.01	∞
B	Alignment error	0.2000	dB	Rectangular	1.73	1.00	0.12	∞
B	Power sensor error	0.0530	dB	Rectangular	1.73	1.00	0.03	∞
B	Power meter error	0.0500	dB	Rectangular	1.73	1.00	0.03	∞
B	Directional coupler error	0.1800	dB	Rectangular	1.73	1.00	0.10	∞
B	Residual ground reflections error	0.1000	dB	Rectangular	1.73	1.00	0.06	∞
B	Multiple reflections error	0.0500	dB	Rectangular	1.73	1.00	0.03	∞
B	Standard-gain horn error	0.5000	dB	Normal	1.00	1.00	0.50	∞
B	Thermal error for coaxial cables	0.0600	dB	Rectangular	1.73	1.00	0.03	∞
B	Coaxial cable flexing error	0.0600	dB	Rectangular	1.73	1.00	0.03	∞
B	Amplifier gain fluctuation	0.0400	dB	Rectangular	2.73	1.00	0.01	∞
A	Repeatability	0.0078	dB	Normal	1.00	1.00	0.01	9
Uc(CF)	Combined uncertainty			normal			0.54	∞
U	Expanded uncertainty			normal (k=2)			1.08	

Table C.12.15 – Uncertainty budget for FP7050 measurement with 30 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) dB	Degs of Freedom Vi or Veff
B	Mismatch at coupler to standard-gain horn connection	0.0418	dB	U-shaped	1.41	1.00	0.03	∞
B	Mismatch error at forward power sensor	0.0450	dB	U-shaped	1.41	1.00	0.03	∞
B	Mismatch error at reflected power sensor	0.0450	dB	U-shaped	1.41	1.00	0.03	∞
B	Mismatch error at input of directional coupler	0.0899	dB	U-shaped	1.41	1.00	0.06	∞
B	Spacing error	0.0200	dB	Rectangular	1.73	1.00	0.01	∞
B	Alignment error	0.2000	dB	Rectangular	1.73	1.00	0.12	∞
B	Power sensor error	0.0660	dB	Rectangular	1.73	1.00	0.04	∞
B	Power meter error	0.0500	dB	Rectangular	1.73	1.00	0.03	∞
B	Directional coupler error	0.2500	dB	Rectangular	1.73	1.00	0.14	∞
B	Residual ground reflections error	0.1000	dB	Rectangular	1.73	1.00	0.06	∞
B	Multiple reflections error	0.0500	dB	Rectangular	1.73	1.00	0.03	∞
B	Standard-gain horn error	0.5500	dB	Normal	1.00	1.00	0.55	∞
B	Thermal error for coaxial cables	0.0600	dB	Rectangular	1.73	1.00	0.03	∞
B	Coaxial cable flexing error	0.0600	dB	Rectangular	1.73	1.00	0.03	∞
B	Amplifier gain fluctuation	0.1500	dB	Rectangular	1.73	1.00	0.09	∞
A	Repeatability	0.0159	dB	Normal	1.00	1.00	0.02	9
Uc(CF)	Combined uncertainty			normal			0.60	∞
U	Expanded uncertainty			normal (k=2)			1.20	

Table C.12.16 – Uncertainty budget for FP7050 measurement with 30 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) dB	Degs of Freedom Vi or Veff
B	Mismatch at coupler to standard-gain horn connection	0.0483	dB	U-shaped	1.41	1.00	0.03	∞
B	Mismatch error at forward power sensor	0.0660	dB	U-shaped	1.41	1.00	0.05	∞
B	Mismatch error at reflected power sensor	0.0660	dB	U-shaped	1.41	1.00	0.05	∞
B	Mismatch error at input of directional coupler	0.0899	dB	U-shaped	1.41	1.00	0.06	∞
B	Spacing error	0.0200	dB	Rectangular	1.73	1.00	0.01	∞
B	Alignment error	0.2000	dB	Rectangular	1.73	1.00	0.12	∞
B	Power sensor error	0.1080	dB	Rectangular	1.73	1.00	0.06	∞
B	Power meter error	0.0500	dB	Rectangular	1.73	1.00	0.03	∞
B	Directional coupler error	0.3000	dB	Rectangular	1.73	1.00	0.17	∞
B	Residual ground reflections error	0.1000	dB	Rectangular	1.73	1.00	0.06	∞
B	Multiple reflections error	0.0500	dB	Rectangular	1.73	1.00	0.03	∞
B	Standard-gain horn error	0.5500	dB	Normal	1.00	1.00	0.55	∞
B	Thermal error for coaxial cables	0.0600	dB	Rectangular	1.00	1.00	0.06	∞
B	Coaxial cable flexing error	0.0600	dB	Rectangular	1.00	1.00	0.06	∞
B	Amplifier gain fluctuation	0.2000	dB	Rectangular	1.00	1.00	0.20	∞
A	Repeatability	0.0166	dB	Normal	1.00	1.00	0.02	9
Uc(CF)	Combined uncertainty			normal			0.64	∞
U	Expanded uncertainty			normal (k=2)			1.28	

Table C.12.17 – Uncertainty budget for FP7050 measurement with 100 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) dB	Degs of Freedom Vi or Veff
B	Mismatch at coupler to standard-gain horn connection	0.0307	dB	U-shaped	1.41	1.00	0.02	∞
B	Mismatch error at forward power sensor	0.0090	dB	U-shaped	1.41	1.00	0.01	∞
B	Mismatch error at reflected power sensor	0.0090	dB	U-shaped	1.41	1.00	0.01	∞
B	Mismatch error at input of directional coupler	0.0330	dB	U-shaped	1.41	1.00	0.02	∞
B	Spacing error	0.0200	dB	Rectangular	1.73	1.00	0.01	∞
B	Alignment error	0.2000	dB	Rectangular	1.73	1.00	0.12	∞
B	Power sensor error	0.0490	dB	Rectangular	1.73	1.00	0.03	∞
B	Power meter error	0.0500	dB	Rectangular	1.73	1.00	0.03	∞
B	Directional coupler error	0.1600	dB	Rectangular	1.73	1.00	0.09	∞
B	Residual ground reflections error	0.1000	dB	Rectangular	1.73	1.00	0.06	∞
B	Multiple reflections error	0.0500	dB	Rectangular	1.73	1.00	0.03	∞
B	Standard-gain horn error	0.5000	dB	Normal	1.00	1.00	0.50	∞
B	Thermal error for coaxial cables	0.0600	dB	Rectangular	1.73	1.00	0.03	∞
B	Coaxial cable flexing error	0.0600	dB	Rectangular	1.73	1.00	0.03	∞
B	Amplifier gain fluctuation	0.1500	dB	Rectangular	1.73	1.00	0.09	∞
A	Repeatability	0.0019	dB	Normal	1.00	1.00	0.00	9
Uc(CF)	Combined uncertainty			normal			0.54	∞
U	Expanded uncertainty			normal (k=2)			1.07	

Table C.12.18 – Uncertainty budget for FP7050 measurement with 100 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) dB	Degs of Freedom Vi or Veff
B	Mismatch at coupler to standard-gain horn connection	0.0483	dB	U-shaped	1.41	1.00	0.03	∞
B	Mismatch error at forward power sensor	0.0280	dB	U-shaped	1.41	1.00	0.02	∞
B	Mismatch error at reflected power sensor	0.0280	dB	U-shaped	1.41	1.00	0.02	∞
B	Mismatch error at input of directional coupler	0.0899	dB	U-shaped	1.41	1.00	0.06	∞
B	Spacing error	0.0200	dB	Rectangular	1.73	1.00	0.01	∞
B	Alignment error	0.2000	dB	Rectangular	1.73	1.00	0.12	∞
B	Power sensor error	0.0530	dB	Rectangular	1.73	1.00	0.03	∞
B	Power meter error	0.0500	dB	Rectangular	1.73	1.00	0.03	∞
B	Directional coupler error	0.1800	dB	Rectangular	1.73	1.00	0.10	∞
B	Residual ground reflections error	0.1000	dB	Rectangular	1.73	1.00	0.06	∞
B	Multiple reflections error	0.0500	dB	Rectangular	1.73	1.00	0.03	∞
B	Standard-gain horn error	0.5000	dB	Normal	1.00	1.00	0.50	∞
B	Thermal error for coaxial cables	0.0600	dB	Rectangular	1.73	1.00	0.03	∞
B	Coaxial cable flexing error	0.0600	dB	Rectangular	1.73	1.00	0.03	∞
B	Amplifier gain fluctuation	0.1500	dB	Rectangular	2.73	1.00	0.05	∞
A	Repeatability	0.0019	dB	Normal	1.00	1.00	0.00	9
Uc(CF)	Combined uncertainty			normal			0.54	∞
U	Expanded uncertainty			normal (k=2)			1.08	

Table C.12.19 – Uncertainty budget for FP7050 measurement with 100 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) dB	Degs of Freedom Vi or Veff
B	Mismatch at coupler to standard-gain horn connection	0.0418	dB	U-shaped	1.41	1.00	0.03	∞
B	Mismatch error at forward power sensor	0.0450	dB	U-shaped	1.41	1.00	0.03	∞
B	Mismatch error at reflected power sensor	0.0450	dB	U-shaped	1.41	1.00	0.03	∞
B	Mismatch error at input of directional coupler	0.0899	dB	U-shaped	1.41	1.00	0.06	∞
B	Spacing error	0.0200	dB	Rectangular	1.73	1.00	0.01	∞
B	Alignment error	0.2000	dB	Rectangular	1.73	1.00	0.12	∞
B	Power sensor error	0.0660	dB	Rectangular	1.73	1.00	0.04	∞
B	Power meter error	0.0500	dB	Rectangular	1.73	1.00	0.03	∞
B	Directional coupler error	0.2500	dB	Rectangular	1.73	1.00	0.14	∞
B	Residual ground reflections error	0.1000	dB	Rectangular	1.73	1.00	0.06	∞
B	Multiple reflections error	0.0500	dB	Rectangular	1.73	1.00	0.03	∞
B	Standard-gain horn error	0.5500	dB	Normal	1.00	1.00	0.55	∞
B	Thermal error for coaxial cables	0.0600	dB	Rectangular	1.73	1.00	0.03	∞
B	Coaxial cable flexing error	0.0600	dB	Rectangular	1.73	1.00	0.03	∞
B	Amplifier gain fluctuation	0.2500	dB	Rectangular	1.73	1.00	0.14	∞
A	Repeatability	0.0090	dB	Normal	1.00	1.00	0.01	9
Uc(CF)	Combined uncertainty			normal			0.61	∞
U	Expanded uncertainty			normal (k=2)			1.22	

Table C.12.20 – Uncertainty budget for FP7050 measurement with 100 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) dB	Degs of Freedom Vi or Veff
B	Mismatch at coupler to standard-gain horn connection	0.0483	dB	U-shaped	1.41	1.00	0.03	∞
B	Mismatch error at forward power sensor	0.0660	dB	U-shaped	1.41	1.00	0.05	∞
B	Mismatch error at reflected power sensor	0.0660	dB	U-shaped	1.41	1.00	0.05	∞
B	Mismatch error at input of directional coupler	0.0899	dB	U-shaped	1.41	1.00	0.06	∞
B	Spacing error	0.0200	dB	Rectangular	1.73	1.00	0.01	∞
B	Alignment error	0.2000	dB	Rectangular	1.73	1.00	0.12	∞
B	Power sensor error	0.1080	dB	Rectangular	1.73	1.00	0.06	∞
B	Power meter error	0.0500	dB	Rectangular	1.73	1.00	0.03	∞
B	Directional coupler error	0.3000	dB	Rectangular	1.73	1.00	0.17	∞
B	Residual ground reflections error	0.1000	dB	Rectangular	1.73	1.00	0.06	∞
B	Multiple reflections error	0.0500	dB	Rectangular	1.73	1.00	0.03	∞
B	Standard-gain horn error	0.5500	dB	Normal	1.00	1.00	0.55	∞
B	Thermal error for coaxial cables	0.0600	dB	Rectangular	1.00	1.00	0.06	∞
B	Coaxial cable flexing error	0.0600	dB	Rectangular	1.00	1.00	0.06	∞
B	Amplifier gain fluctuation	0.2500	dB	Rectangular	1.00	1.00	0.25	∞
A	Repeatability	0.0049	dB	Normal	1.00	1.00	0.00	9
Uc(CF)	Combined uncertainty			normal			0.66	∞
U	Expanded uncertainty			normal (k=2)			1.32	

C.13 NMIJ Uncertainty Budgets

Table C.13.1 – Uncertainty budget for FL7018 measurement with 10 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Transfer probe calibration	2.9250	%	Normal	1.00	1.00	2.93	54.14
A	Probe readout stability	0.2750	%	Normal	1.00	1.00	0.28	99
B	input power reproduction	0.4616	%	Rectangular	1.73	0.50	0.13	999
A	Probe under calibration readout stability	0.0781	%	Normal	1.00	1.00	0.08	9
B	Probe alignment	0.3721	%	Rectangular	1.73	1.00	0.21	999
A	data variation	0.9631	%	Normal	1.00	1.00	0.96	9
Uc(CF)	Combined uncertainty			normal			3.10	64
U	Expanded uncertainty			normal (k=2)			6.21	

Table C.13.2 – Uncertainty budget for FL7018 measurement with 10 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	E-field calculated by simulator (FEKO)	0.1900	%	Rectangular	1.73	1.00	0.11	999
B	Horn antenna gain	2.9200	%	Normal	1.00	0.50	1.46	999
B	S21 of coaxial to waveguide adapter	1.0090	%	Normal	1.00	1.00	1.01	999
B	Correction factor of the power sensor	1.0500	%	Normal	1.00	1.00	1.05	999
B	S21 of high-power attenuator	1.4676	%	Normal	1.00	1.00	1.47	999
A	repeatability of displayed value of power sensor	2.4772	%	Normal	1.00	0.50	1.24	14
A	repeatability of displayed value of power meter	0.3601	%	Normal	1.00	0.50	0.18	14
B	reflections from walls of anechoic chamber	0.2500	%	U-shaped	1.41	1.00	0.18	999
A	repeatability of probe connection	0.6629	%	Normal	1.00	1.00	0.66	4
Uc(CF)	Combined uncertainty			normal			2.91	314
U	Expanded uncertainty			normal (k=2)			5.82	

Note: NMIJ did not submit results at 10 GHz or 18 GHz for field strength 10 V/m

Table C.13.3 – Uncertainty budget for FL7018 measurement with 30 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Transfer probe calibration	2.8796	%	Normal	1.00	1.00	2.88	53.91
A	Probe readout stability	0.3500	%	Normal	1.00	1.00	0.35	99
B	input power reproduction	0.4616	%	Rectangular	1.73	0.50	0.13	999
A	Probe under calibration readout stability	0.3711	%	Normal	1.00	1.00	0.37	9
B	Probe alignment	0.3721	%	Rectangular	1.73	1.00	0.21	999
A	data variation	0.7040	%	Normal	1.00	1.00	0.70	9
Uc(CF)	Combined uncertainty			normal			3.02	64
U	Expanded uncertainty			normal (k=2)			6.04	

Table C.13.4 – Uncertainty budget for FL7018 measurement with 30 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	E-field calculated by simulator (FEKO)	0.1900	%	Rectangular	1.73	1.00	0.11	999
B	Horn antenna gain	2.9200	%	Normal	1.00	0.50	1.46	999
B	S21 of coaxial to waveguide adapter	1.0090	%	Normal	1.00	1.00	1.01	999
B	Correction factor of the power sensor	1.0500	%	Normal	1.00	1.00	1.05	999
B	S21 of high-power attenuator	1.4676	%	Normal	1.00	1.00	1.47	999
A	repeatability of displayed value of power sensor	2.4772	%	Normal	1.00	0.50	1.24	14
A	repeatability of displayed value of power meter	0.3601	%	Normal	1.00	0.50	0.18	14
B	reflections from walls of anechoic chamber	0.2500	%	U-shaped	1.41	1.00	0.18	999
A	repeatability of probe connection	0.8292	%	Normal	1.00	1.00	0.83	4
Uc(CF)	Combined uncertainty			normal			2.95	254
U	Expanded uncertainty			normal (k=2)			5.90	

Note: NMIJ did not submit results at 10 GHz or 18 GHz for field strength 30 V/m

Table C.13.5 – Uncertainty budget for FL7018 measurement with 100 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Transfer probe calibration	2.8796	%	Normal	1.00	1.00	2.88	53.91
B	Linearity of the field transfer probe	5.1962	%	Rectangular	1.73	1.00	3.00	999
A	Probe readout stability	0.4810	%	Normal	1.00	1.00	0.48	99
B	input power reproduction	0.4616	%	Rectangular	1.73	0.50	0.13	999
A	Probe under calibration readout stability	0.0335	%	Normal	1.00	1.00	0.03	9
B	Probe alignment	0.3721	%	Rectangular	1.73	1.00	0.21	999
A	data variation	1.8022	%	Normal	1.00	1.00	1.80	9
Uc(CF)	Combined uncertainty			normal			4.56	172
U	Expanded uncertainty			normal (k=2)			9.13	

Note: NMIJ only submitted results at 1 GHz for field strength 100 V/m

Table C.13.6 – Uncertainty budget for FP7050 measurement with 30 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
A	Dipole AF calibration	2.3293	%	Normal	1.00	1.00	2.33	27
B	Power measurement	1.9500	%	Normal	1.00	0.50	0.98	999
B	Reproduction of Eact	0.4616	%	Rectangular	1.73	0.50	0.13	999
B	Dipole coupling effect	2.3293	%	Rectangular	1.73	0.50	0.67	999
B	Alignment	1.1905	%	Rectangular	1.73	1.00	0.69	999
A	Probe readout stability	1.2120	%	Normal	1.00	1.00	1.21	9
A	Field transfer probe data variation	0.6788	%	Normal	1.00	1.00	0.68	9
Uc(CF)	Combined uncertainty			normal			3.04	63
U	Expanded uncertainty			normal (k=2)			6.08	

Table C.13.7 – Uncertainty budget for FP7050 measurement with 30 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	E-field calculated by simulator (FEKO)	0.1900	%	Rectangular	1.73	1.00	0.11	999
B	Horn antenna gain	2.9200	%	Normal	1.00	0.50	1.46	999
B	S21 of coaxial to waveguide adapter	1.0090	%	Normal	1.00	1.00	1.01	999
B	Correction factor of the power sensor	1.0500	%	Normal	1.00	1.00	1.05	999
B	S21 of high-power attenuator	1.4676	%	Normal	1.00	1.00	1.47	999
A	repeatability of displayed value of power sensor	2.4772	%	Normal	1.00	0.50	1.24	14
A	repeatability of displayed value of power meter	0.3601	%	Normal	1.00	0.50	0.18	14
B	reflections from walls of anechoic chamber	0.2500	%	U-shaped	1.41	1.00	0.18	999
A	repeatability of probe connection	0.4033	%	Normal	1.00	1.00	0.40	5
Uc(CF)	Combined uncertainty			normal			2.86	362
U	Expanded uncertainty			normal (k=2)			5.72	

Note: NMIJ did not submit results at 10 GHz or 18 GHz for field strength 30 V/m, nor did NMIJ submit any results at 100 V/m for the FP7050 probe.

C.14 VNIIFTRI Uncertainty Budgets

Table C.14.1 – Uncertainty budget for FL7018 measurement with 10 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Calibration factor of standard power flux density	8.00	%	Normal	2.00	0.50	2.00	
B	Receiver Nonlinearity	0.20	%	Rectangular	1.73	1.00	0.12	
B	Free space area and absorbing material	2.00	%	U-shaped	1.41	1.00	1.41	
B	Probe positioning	0.50	%	Rectangular	1.73	1.00	0.29	
A	Random Uncertainty	0.04	%	Normal	1.00	1.00	0.04	
A	non-uniformity of a field	1.08	%	Normal	1.00	1.00	1.08	
Uc(CF)	Combined uncertainty			normal			2.70	
U	Expanded uncertainty			normal (k=2)			5.39	

Table C.14.2 – Uncertainty budget for FL7018 measurement with 10 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Calibration factor of standard power flux density	8.00	%	Normal	2.00	0.50	2.00	
B	Receiver Nonlinearity	0.20	%	Rectangular	1.73	1.00	0.12	
B	Free space area and absorbing material	1.50	%	U-shaped	1.41	1.00	1.06	
B	Probe positioning	0.50	%	Rectangular	1.73	1.00	0.29	
A	Random Uncertainty	0.04	%	Normal	1.00	1.00	0.04	
A	non-uniformity of a field	1.42	%	Normal	1.00	1.00	1.42	
Uc(CF)	Combined uncertainty			normal			2.69	
U	Expanded uncertainty			normal (k=2)			5.38	

Table C.14.3 – Uncertainty budget for FL7018 measurement with 10 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Calibration factor of standard power flux density	8.00	%	Normal	2.00	0.50	2.00	
B	Receiver Nonlinearity	0.20	%	Rectangular	1.73	1.00	0.12	
B	Free space area and absorbing material	1.50	%	U-shaped	1.41	1.00	1.06	
B	Probe positioning	0.50	%	Rectangular	1.73	1.00	0.29	
A	Random Uncertainty	0.02	%	Normal	1.00	1.00	0.02	
A	non-uniformity of a field	3.94	%	Normal	1.00	1.00	3.94	
Uc(CF)	Combined uncertainty			normal			4.55	
U	Expanded uncertainty			normal (k=2)			9.11	

Table C.14.4 – Uncertainty budget for FL7018 measurement with 10 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Calibration factor of standard power flux density	8.0000	%	Normal	2.00	0.50	2.00	
B	Receiver Nonlinearity	0.2000	%	Rectangular	1.73	1.00	0.12	
B	Free space area and absorbing material	1.5000	%	U-shaped	1.41	1.00	1.06	
B	Probe positioning	0.5000	%	Rectangular	1.73	1.00	0.29	
A	Random Uncertainty	0.0200	%	Normal	1.00	1.00	0.02	
A	non-uniformity of a field	1.2100	%	Normal	1.00	1.00	1.21	
Uc(CF)	Combined uncertainty			normal			2.59	
U	Expanded uncertainty			normal (k=2)			5.17	

Table C.14.5 – Uncertainty budget for FL7018 measurement with 30 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Calibration factor of standard power flux density	8.00	%	Normal	2.00	0.50	2.00	
B	Receiver Nonlinearity	0.20	%	Rectangular	1.73	1.00	0.12	
B	Free space area and absorbing material	2.00	%	U-shaped	1.41	1.00	1.41	
B	Probe positioning	0.50	%	Rectangular	1.73	1.00	0.29	
A	Random Uncertainty	0.05	%	Normal	1.00	1.00	0.05	
A	non-uniformity of a field	0.93	%	Normal	1.00	1.00	0.93	
Uc(CF)	Combined uncertainty			normal			2.64	
U	Expanded uncertainty			normal (k=2)			5.28	

Table C.14.6 – Uncertainty budget for FL7018 measurement with 30 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Calibration factor of standard power flux density	8.00	%	Normal	2.00	0.50	2.00	
B	Receiver Nonlinearity	0.20	%	Rectangular	1.73	1.00	0.12	
B	Free space area and absorbing material	1.50	%	U-shaped	1.41	1.00	1.06	
B	Probe positioning	0.50	%	Rectangular	1.73	1.00	0.29	
A	Random Uncertainty	0.04	%	Normal	1.00	1.00	0.04	
A	non-uniformity of a field	0.75	%	Normal	1.00	1.00	0.75	
Uc(CF)	Combined uncertainty			normal			2.41	
U	Expanded uncertainty			normal (k=2)			4.81	

Table C.14.7 – Uncertainty budget for FL7018 measurement with 30 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Calibration factor of standard power flux density	8.00	%	Normal	2.00	0.50	2.00	
B	Receiver Nonlinearity	0.20	%	Rectangular	1.73	1.00	0.12	
B	Free space area and absorbing material	1.50	%	U-shaped	1.41	1.00	1.06	
B	Probe positioning	0.50	%	Rectangular	1.73	1.00	0.29	
A	Random Uncertainty	0.01	%	Normal	1.00	1.00	0.01	
A	non-uniformity of a field	4.01	%	Normal	1.00	1.00	4.01	
Uc(CF)	Combined uncertainty			normal			4.62	
U	Expanded uncertainty			normal (k=2)			9.23	

Table C.14.8 – Uncertainty budget for FL7018 measurement with 30 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Calibration factor of standard power flux density	8.0000	%	Normal	2.00	0.50	2.00	
B	Receiver Nonlinearity	0.2000	%	Rectangular	1.73	1.00	0.12	
B	Free space area and absorbing material	1.5000	%	U-shaped	1.41	1.00	1.06	
B	Probe positioning	0.5000	%	Rectangular	1.73	1.00	0.29	
A	Random Uncertainty	0.0300	%	Normal	1.00	1.00	0.03	
A	non-uniformity of a field	1.0400	%	Normal	1.00	1.00	1.04	
Uc(CF)	Combined uncertainty			normal			2.51	
U	Expanded uncertainty			normal (k=2)			5.02	

Table C.14.9 – Uncertainty budget for FL7018 measurement with 100 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Calibration factor of standard power flux density	8.0000	%	Normal	2.00	0.50	2.00	
B	Receiver Nonlinearity	0.2000	%	Rectangular	1.73	1.00	0.12	
B	Free space area and absorbing material	2.0000	%	U-shaped	1.41	1.00	1.41	
B	Probe positioning	0.5000	%	Rectangular	1.73	1.00	0.29	
A	Random Uncertainty	0.0400	%	Normal	1.00	1.00	0.04	
A	non-uniformity of a field	1.1500	%	Normal	1.00	1.00	1.15	
Uc(CF)	Combined uncertainty			normal			2.72	
U	Expanded uncertainty			normal (k=2)			5.45	

Table C.14.10 – Uncertainty budget for FL7018 measurement with 100 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Calibration factor of standard power flux density	8.0000	%	Normal	2.00	0.50	2.00	
B	Receiver Nonlinearity	0.2000	%	Rectangular	1.73	1.00	0.12	
B	Free space area and absorbing material	1.5000	%	U-shaped	1.41	1.00	1.06	
B	Probe positioning	0.5000	%	Rectangular	1.73	1.00	0.29	
A	Random Uncertainty	0.0200	%	Normal	1.00	1.00	0.02	
A	non-uniformity of a field	0.9700	%	Normal	1.00	1.00	0.97	
Uc(CF)	Combined uncertainty			normal			2.48	
U	Expanded uncertainty			normal (k=2)			4.97	

Table C.14.11 – Uncertainty budget for FL7018 measurement with 100 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Calibration factor of standard power flux density	8.0000	%	Normal	2.00	0.50	2.00	
B	Receiver Nonlinearity	0.2000	%	Rectangular	1.73	1.00	0.12	
B	Free space area and absorbing material	1.5000	%	U-shaped	1.41	1.00	1.06	
B	Probe positioning	0.5000	%	Rectangular	1.73	1.00	0.29	
A	Random Uncertainty	0.0200	%	Normal	1.00	1.00	0.02	
A	non-uniformity of a field	3.7100	%	Normal	1.00	1.00	3.71	
Uc(CF)	Combined uncertainty			normal			4.36	
U	Expanded uncertainty			normal (k=2)			8.71	

Table C.14.12 – Uncertainty budget for FL7018 measurement with 100 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Calibration factor of standard power flux density	8.0000	%	Normal	2.00	0.50	2.00	
B	Receiver Nonlinearity	0.2000	%	Rectangular	1.73	1.00	0.12	
B	Free space area and absorbing material	1.5000	%	U-shaped	1.41	1.00	1.06	
B	Probe positioning	0.5000	%	Rectangular	1.73	1.00	0.29	
A	Random Uncertainty	0.0200	%	Normal	1.00	1.00	0.02	
A	non-uniformity of a field	1.1300	%	Normal	1.00	1.00	1.13	
Uc(CF)	Combined uncertainty			normal			2.55	
U	Expanded uncertainty			normal (k=2)			5.10	

Table C.14.13 – Uncertainty budget for FP7050 measurement with 30 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Calibration factor of standard power flux density	8.00	%	Normal	2.00	0.50	2.00	
B	Receiver Nonlinearity	0.20	%	Rectangular	1.73	1.00	0.12	
B	Free space area and absorbing material	2.00	%	U-shaped	1.41	1.00	1.41	
B	Probe positioning	0.50	%	Rectangular	1.73	1.00	0.29	
A	Random Uncertainty	0.29	%	Normal	1.00	1.00	0.29	
A	non-uniformity of a field	0.98	%	Normal	1.00	1.00	0.98	
Uc(CF)	Combined uncertainty			normal			2.67	
U	Expanded uncertainty			normal (k=2)			5.34	

Table C.14.14 – Uncertainty budget for FP7050 measurement with 30 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Calibration factor of standard power flux density	8.00	%	Normal	2.00	0.50	2.00	
B	Receiver Nonlinearity	0.20	%	Rectangular	1.73	1.00	0.12	
B	Free space area and absorbing material	1.50	%	U-shaped	1.41	1.00	1.06	
B	Probe positioning	0.50	%	Rectangular	1.73	1.00	0.29	
A	Random Uncertainty	0.32	%	Normal	1.00	1.00	0.32	
A	non-uniformity of a field	1.11	%	Normal	1.00	1.00	1.11	
Uc(CF)	Combined uncertainty			normal			2.56	
U	Expanded uncertainty			normal (k=2)			5.12	

Table C.14.15 – Uncertainty budget for FP7050 measurement with 30 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Calibration factor of standard power flux density	8.0000	%	Normal	2.00	0.50	2.00	
B	Receiver Nonlinearity	0.2000	%	Rectangular	1.73	1.00	0.12	
B	Free space area and absorbing material	1.5000	%	U-shaped	1.41	1.00	1.06	
B	Probe positioning	0.5000	%	Rectangular	1.73	1.00	0.29	
A	Random Uncertainty	0.4200	%	Normal	1.00	1.00	0.42	
A	non-uniformity of a field	0.3800	%	Normal	1.00	1.00	0.38	
Uc(CF)	Combined uncertainty			normal			2.35	
U	Expanded uncertainty			normal (k=2)			4.71	

Table C.14.16 – Uncertainty budget for FP7050 measurement with 30 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Calibration factor of standard power flux density	8.00	%	Normal	2.00	0.50	2.00	
B	Receiver Nonlinearity	0.20	%	Rectangular	1.73	1.00	0.12	
B	Free space area and absorbing material	1.50	%	U-shaped	1.41	1.00	1.06	
B	Probe positioning	0.50	%	Rectangular	1.73	1.00	0.29	
A	Random Uncertainty	0.28	%	Normal	1.00	1.00	0.28	
A	non-uniformity of a field	0.66	%	Normal	1.00	1.00	0.66	
Uc(CF)	Combined uncertainty			normal			2.39	
U	Expanded uncertainty			normal (k=2)			4.79	

Table C.14.17 – Uncertainty budget for FP7050 measurement with 100 V/m indication at 1 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Calibration factor of standard power flux density	8.00	%	Normal	2.00	0.50	2.00	
B	Receiver Nonlinearity	0.20	%	Rectangular	1.73	1.00	0.12	
B	Free space area and absorbing material	2.00	%	U-shaped	1.41	1.00	1.41	
B	Probe positioning	0.50	%	Rectangular	1.73	1.00	0.29	
A	Random Uncertainty	0.04	%	Normal	1.00	1.00	0.04	
A	non-uniformity of a field	0.87	%	Normal	1.00	1.00	0.87	
Uc(CF)	Combined uncertainty			normal			2.62	
U	Expanded uncertainty			normal (k=2)			5.24	

Table C.14.18 – Uncertainty budget for FP7050 measurement with 100 V/m indication at 2.45 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Calibration factor of standard power flux density	8.00	%	Normal	2.00	0.50	2.00	
B	Receiver Nonlinearity	0.20	%	Rectangular	1.73	1.00	0.12	
B	Free space area and absorbing material	1.50	%	U-shaped	1.41	1.00	1.06	
B	Probe positioning	0.50	%	Rectangular	1.73	1.00	0.29	
A	Random Uncertainty	0.03	%	Normal	1.00	1.00	0.03	
A	non-uniformity of a field	0.96	%	Normal	1.00	1.00	0.96	
Uc(CF)	Combined uncertainty			normal			2.48	
U	Expanded uncertainty			normal (k=2)			4.96	

Table C.14.19 – Uncertainty budget for FP7050 measurement with 100 V/m indication at 10 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Calibration factor of standard power flux density	8.00	%	Normal	2.00	0.50	2.00	
B	Receiver Nonlinearity	0.20	%	Rectangular	1.73	1.00	0.12	
B	Free space area and absorbing material	1.50	%	U-shaped	1.41	1.00	1.06	
B	Probe positioning	0.50	%	Rectangular	1.73	1.00	0.29	
A	Random Uncertainty	0.04	%	Normal	1.00	1.00	0.04	
A	non-uniformity of a field	0.66	%	Normal	1.00	1.00	0.66	
Uc(CF)	Combined uncertainty			normal			2.38	
U	Expanded uncertainty			normal (k=2)			4.76	

Table C.14.20 – Uncertainty budget for FP7050 measurement with 100 V/m indication at 18 GHz

Type of Uncertainty	Source of Uncertainty	Value +/-	Unit	Probability Distribution	Divisor	Sensitivity Ci	Ui (CF) +/- %	Degs of Freedom Vi or Veff
B	Calibration factor of standard power flux density	8.00	%	Normal	2.00	0.50	2.00	
B	Receiver Nonlinearity	0.20	%	Rectangular	1.73	1.00	0.12	
B	Free space area and absorbing material	1.50	%	U-shaped	1.41	1.00	1.06	
B	Probe positioning	0.50	%	Rectangular	1.73	1.00	0.29	
A	Random Uncertainty	0.03	%	Normal	1.00	1.00	0.03	
A	non-uniformity of a field	0.52	%	Normal	1.00	1.00	0.52	
Uc(CF)	Combined uncertainty			normal			2.34	
U	Expanded uncertainty			normal (k=2)			4.69	

Appendix D – Stability of Travelling Standards

D.1 - Background

One of the duties of the Pilot Laboratory is to confirm the suitability and stability of the travelling comparison devices. To this end the probes have been measured ten times at NPL over the course of the comparison. The initial measurements were performed to both verify the correct operation of the probes. These measurements are reported to demonstrate the stability of the probes over the duration of the comparison.

The mean of NPL's measurements is used when determining the KCRV.

D.2 - Mechanical Condition

On delivery from the supplier the probes were checked for mechanical tolerances. These checks were carried out during each subsequent NPL measurement.

D.3 - Pilot Laboratory Measurements

The graphs in Figs D.1 – D.20 show the results of the NPL measurements plotted as a function of time in months from the start of the comparison. The uncertainty bars shown in the graphs are at the 1-sigma level.

Figs D.1 – D.12 are the measurements taken on the FL7018 probe. For the most part, the measurements look to be consistent, certainly within the 95 % confidence level, and there would be no obvious outliers were this data alone to be used to obtain a reference value.

Figs D.13 – D.20 are the measurements taken on the FP7050 probe. These show a clear drift in the device over the period of the comparison. The drift can be characterized as a straight-line fit across the data and is shown in the graphs – see Appendix E for how this line and its uncertainty is obtained.

Only the pilot laboratory measurements should be used to determine this fit because the conditions of measurement are known to be the same each time and the only variable is the condition of the probe under test. The participants' reported data can then be corrected to a single point in time so that they may be compared against one another.

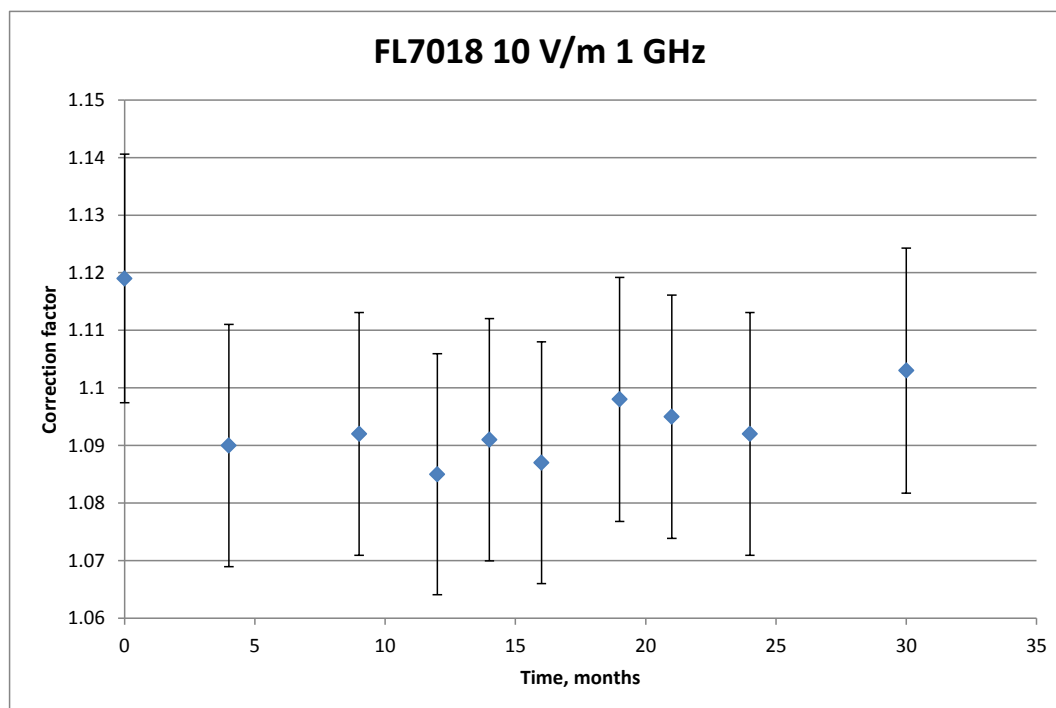


Fig D.1 – NPL measurements of the correction factor for the FL7018 probe in field strength 10 V/m at 1 GHz

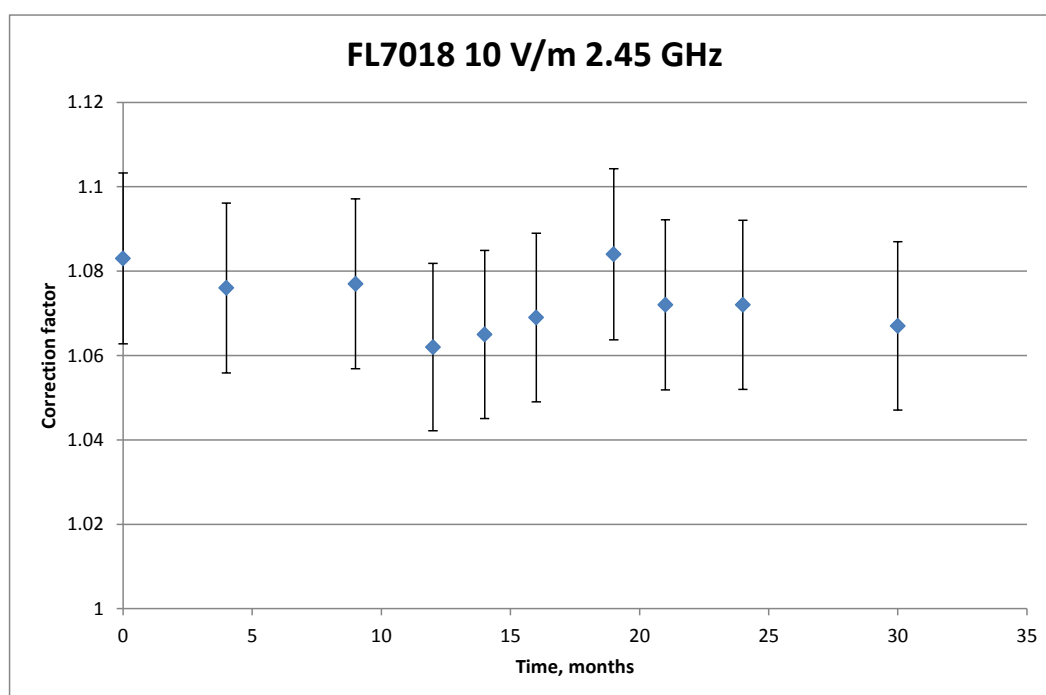


Fig D.2 – NPL measurements of the correction factor for the FL7018 probe in field strength 10 V/m at 2.45 GHz

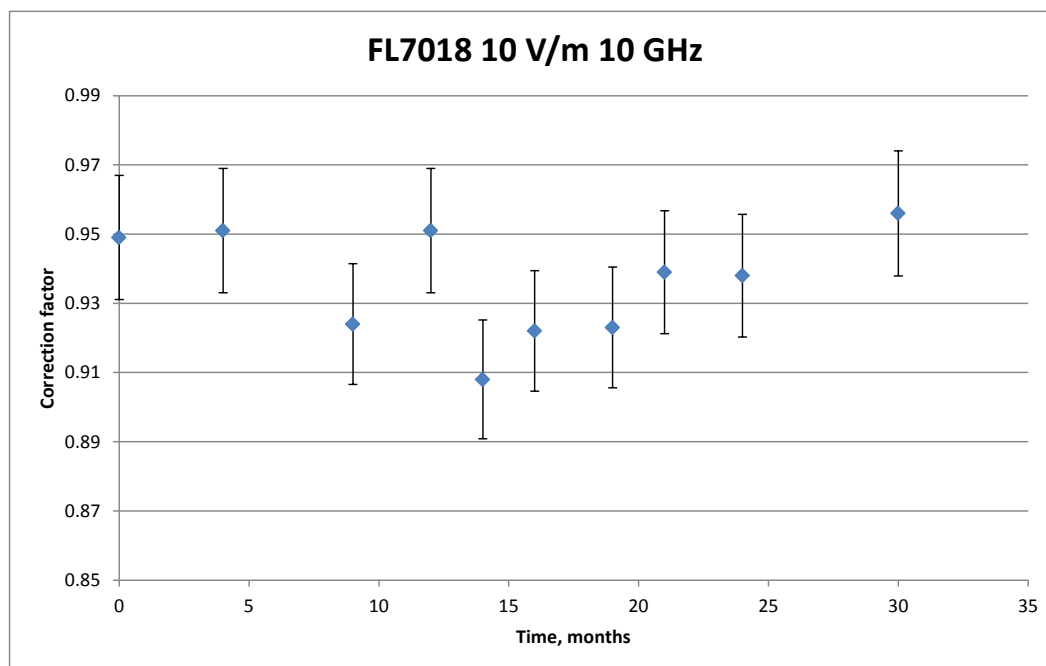


Fig D.3 – NPL measurements of the correction factor for the FL7018 probe in field strength 10 V/m at 10 GHz

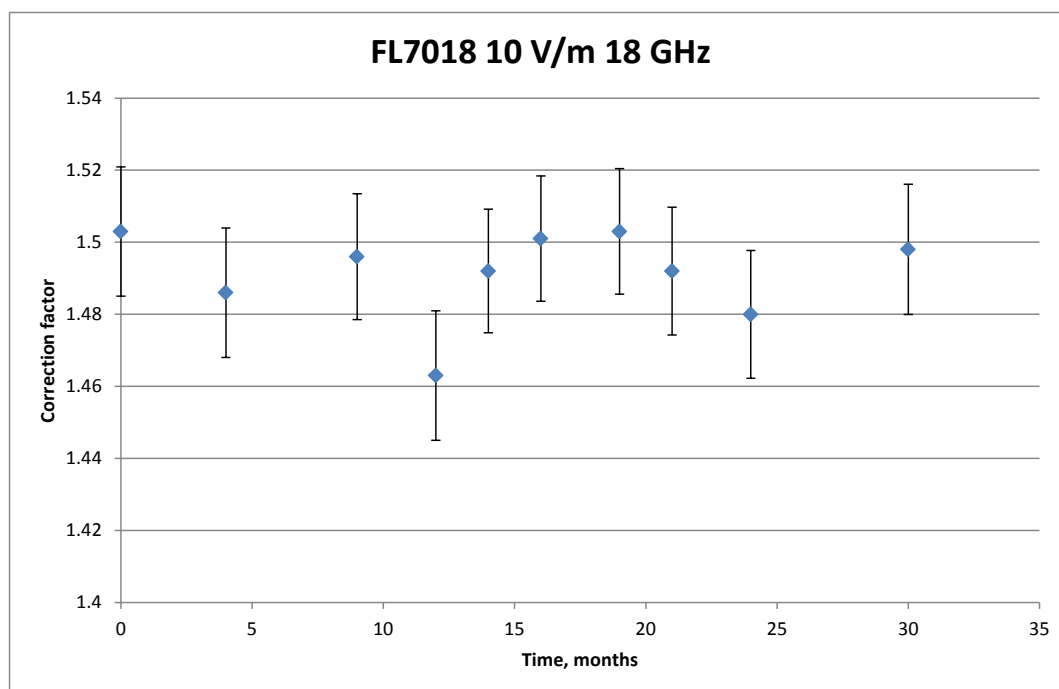


Fig D.4 – NPL measurements of the correction factor for the FL7018 probe in field strength 10 V/m at 18 GHz

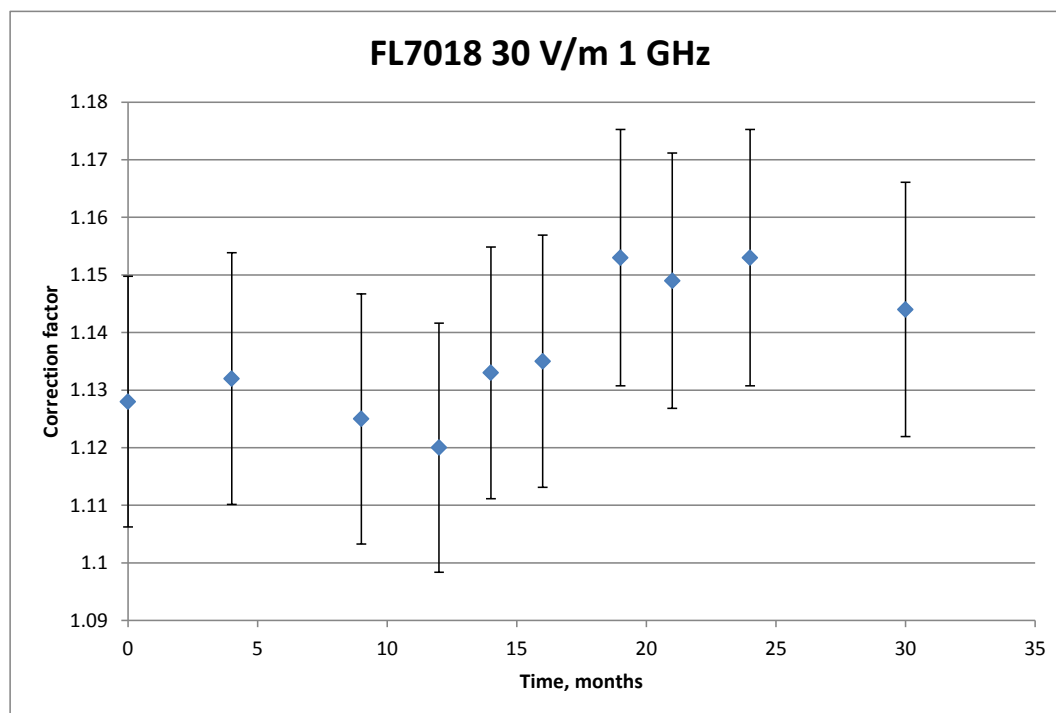


Fig D.5 – NPL measurements of the correction factor for the FL7018 probe in field strength 30 V/m at 1 GHz

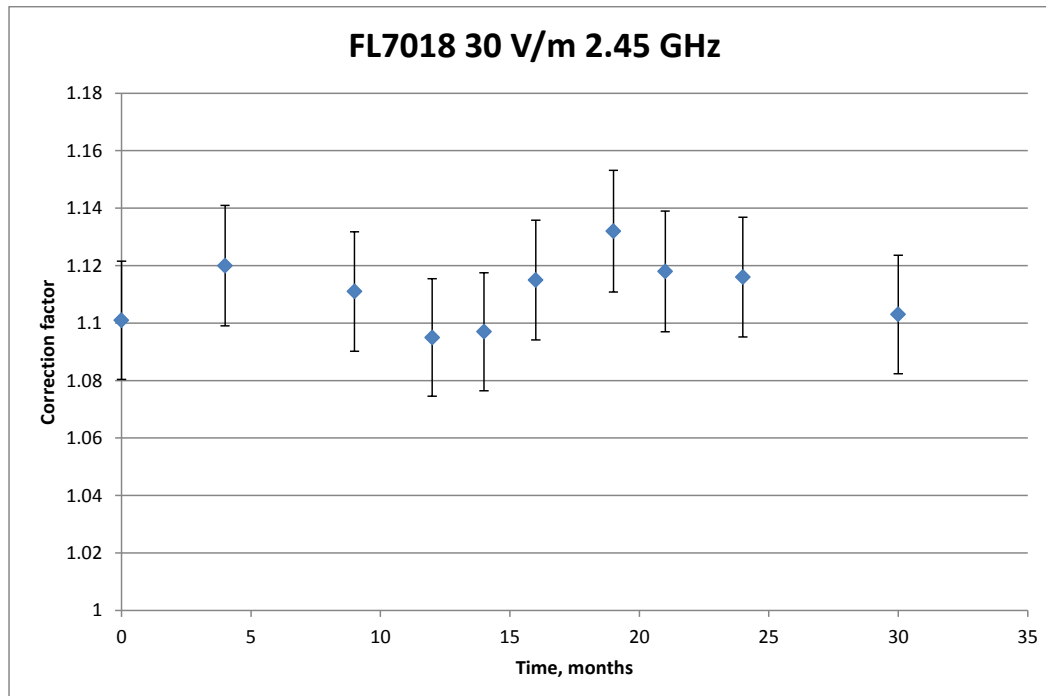


Fig D.6 – NPL measurements of the correction factor for the FL7018 probe in field strength 30 V/m at 2.45 GHz

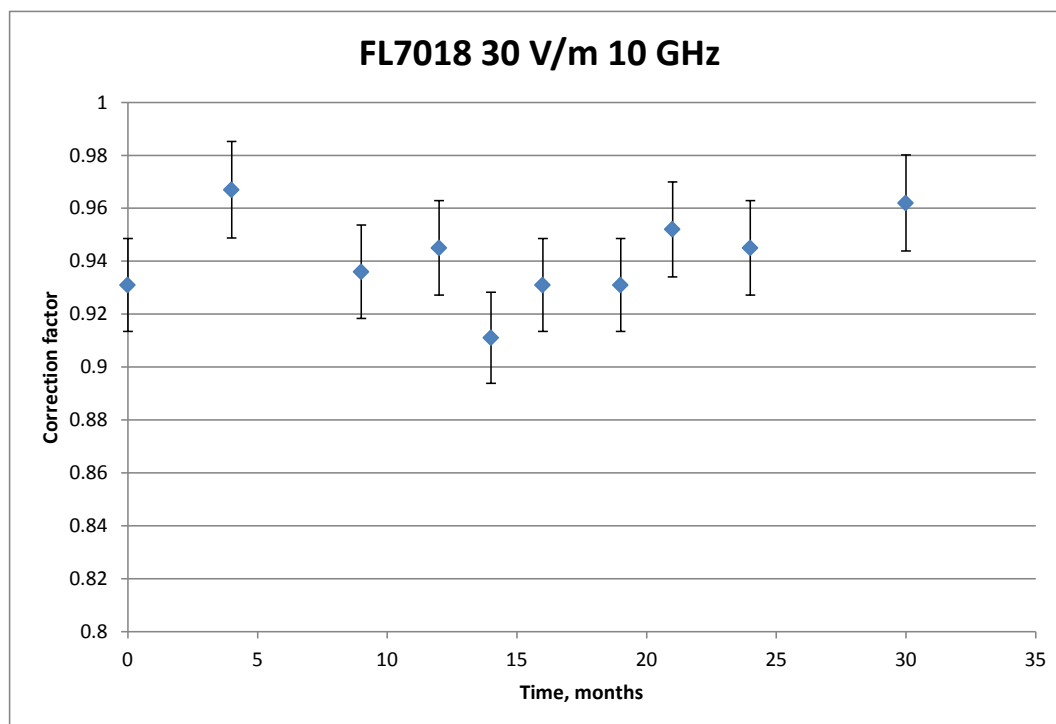


Fig D.7 – NPL measurements of the correction factor for the FL7018 probe in field strength 30 V/m at 10 GHz

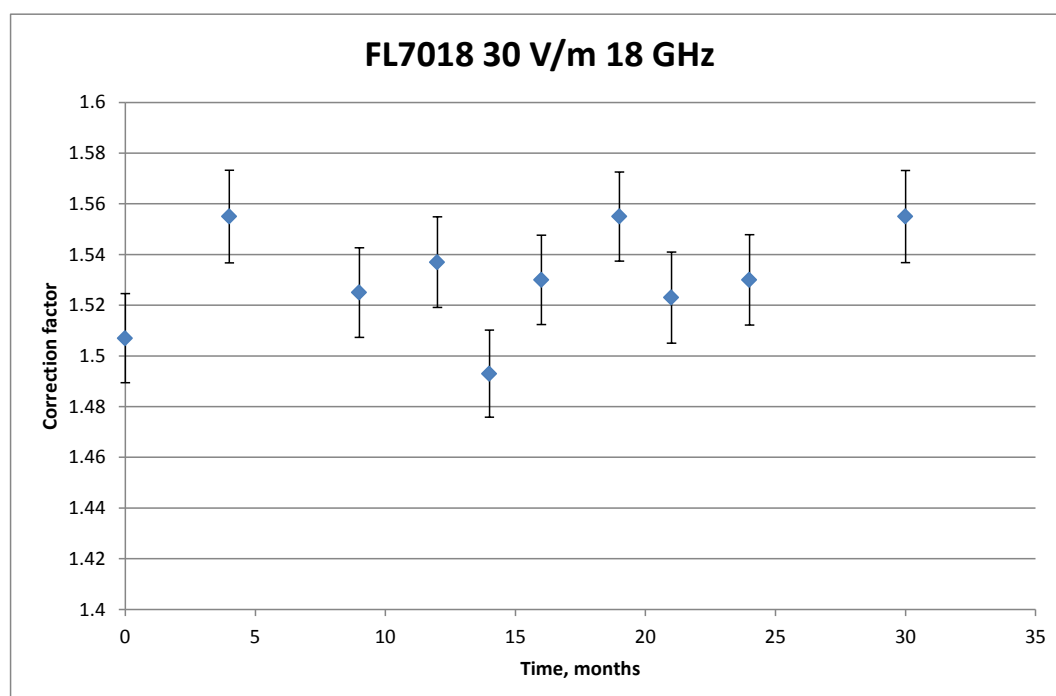


Fig D.8 – NPL measurements of the correction factor for the FL7018 probe in field strength 30 V/m at 18 GHz

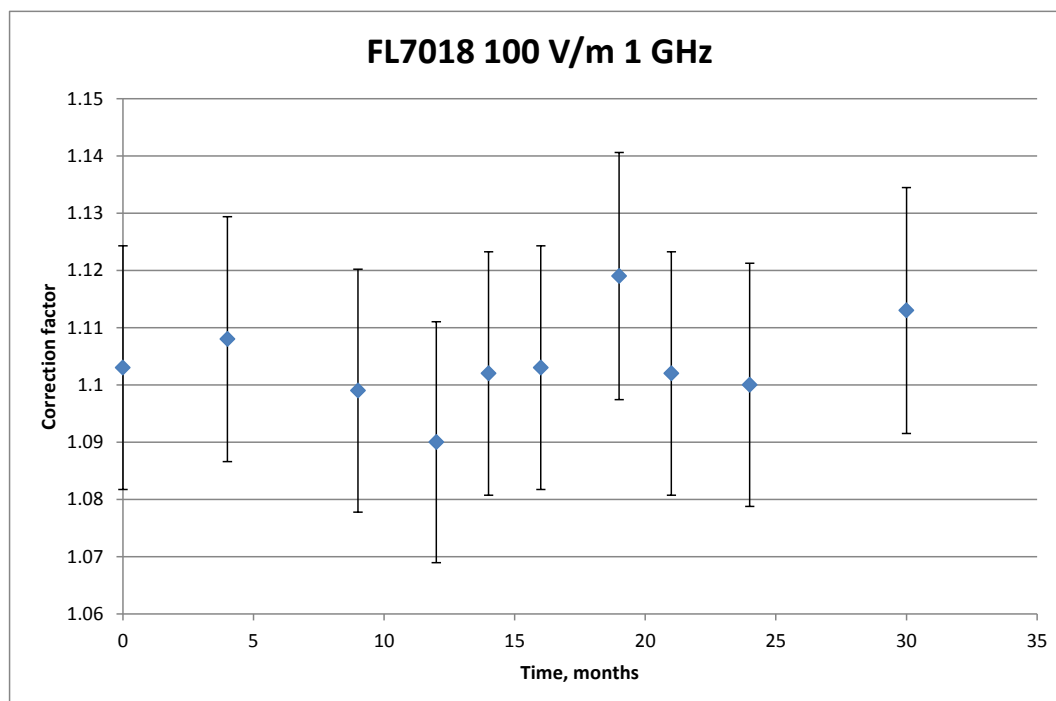


Fig D.9 – NPL measurements of the correction factor for the FL7018 probe in field strength 100 V/m at 1 GHz

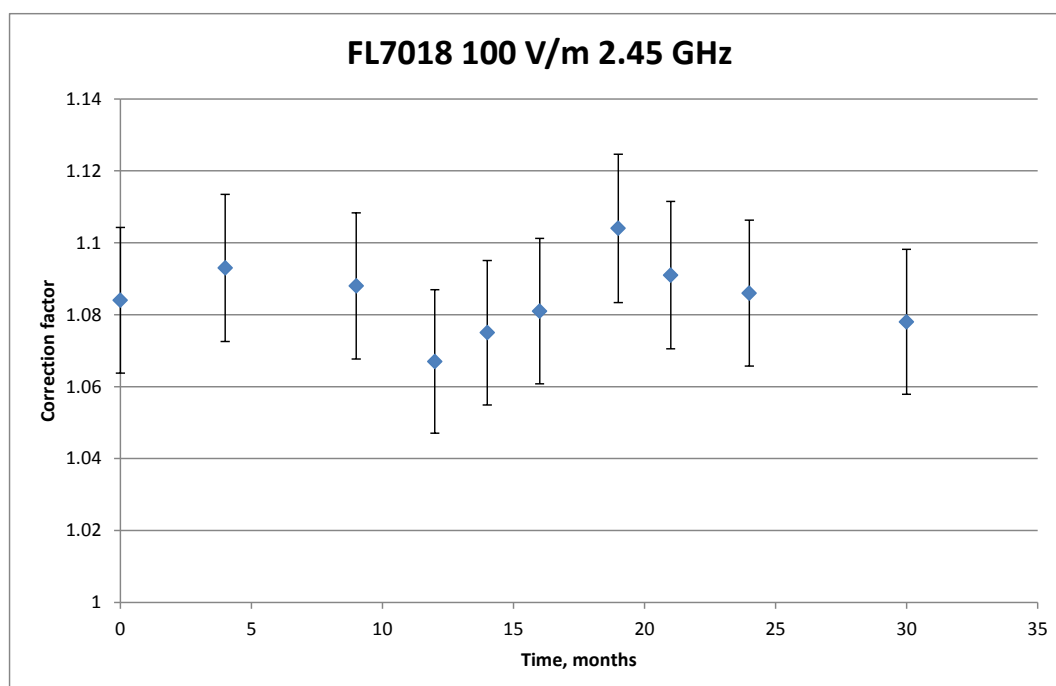


Fig D.10 – NPL measurements of the correction factor for the FL7018 probe in field strength 100 V/m at 2.45 GHz

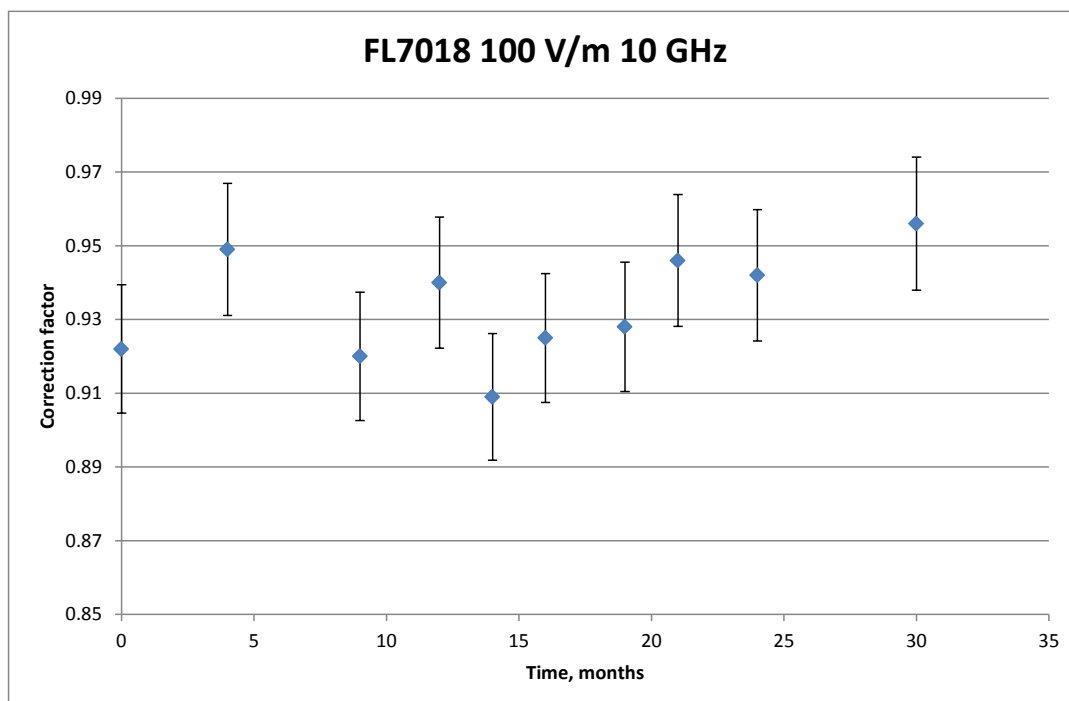


Fig D.11 – NPL measurements of the correction factor for the FL7018 probe in field strength 100 V/m at 10 GHz

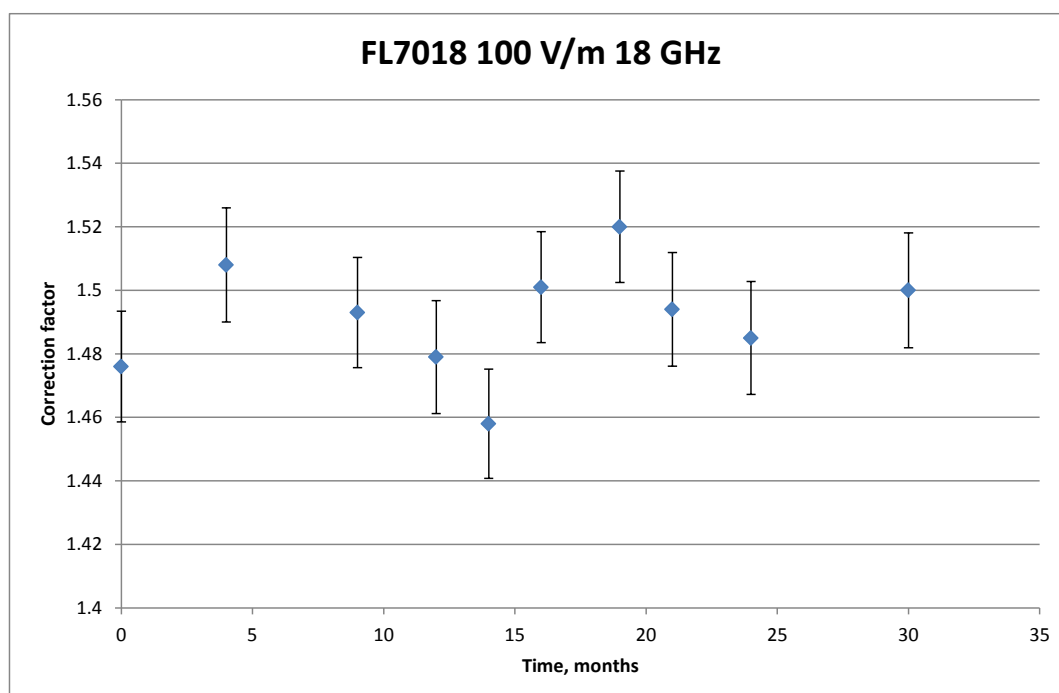


Fig D.12 – NPL measurements of the correction factor for the FL7018 probe in field strength 100 V/m at 18 GHz

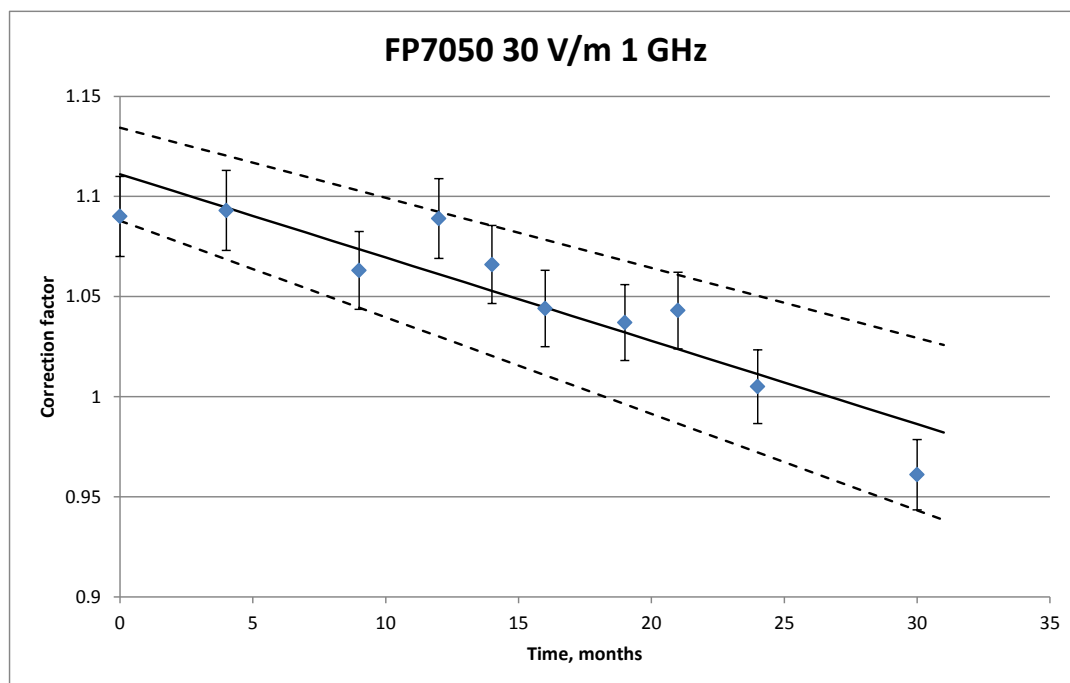


Fig D.13 – NPL measurements of the correction factor for the FP7050 probe in field strength 30 V/m at 1 GHz with estimated drift

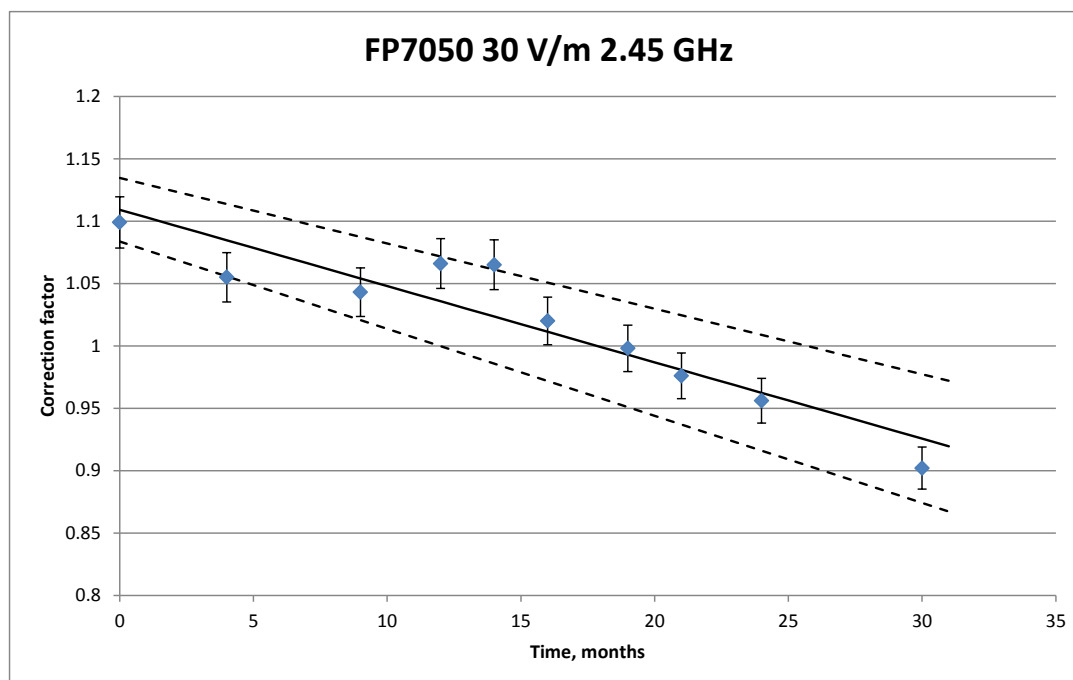


Fig D.14 – NPL measurements of the correction factor for the FP7050 probe in field strength 30 V/m at 2.45 GHz with estimated drift

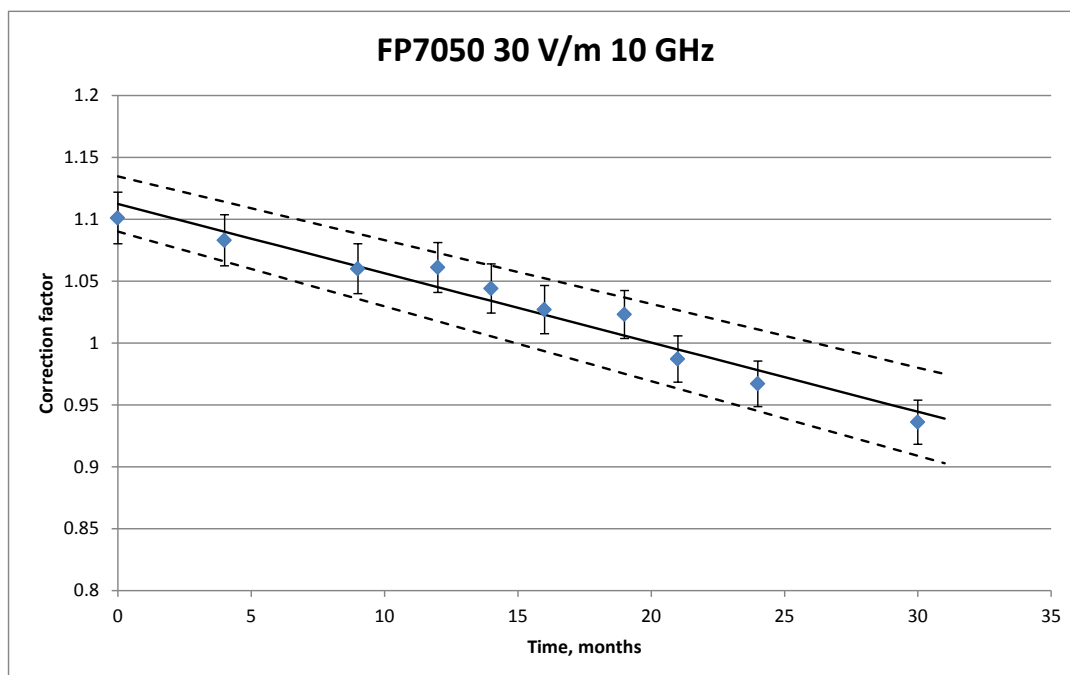


Fig D.15 – NPL measurements of the correction factor for the FP7050 probe in field strength 30 V/m at 10 GHz with estimated drift

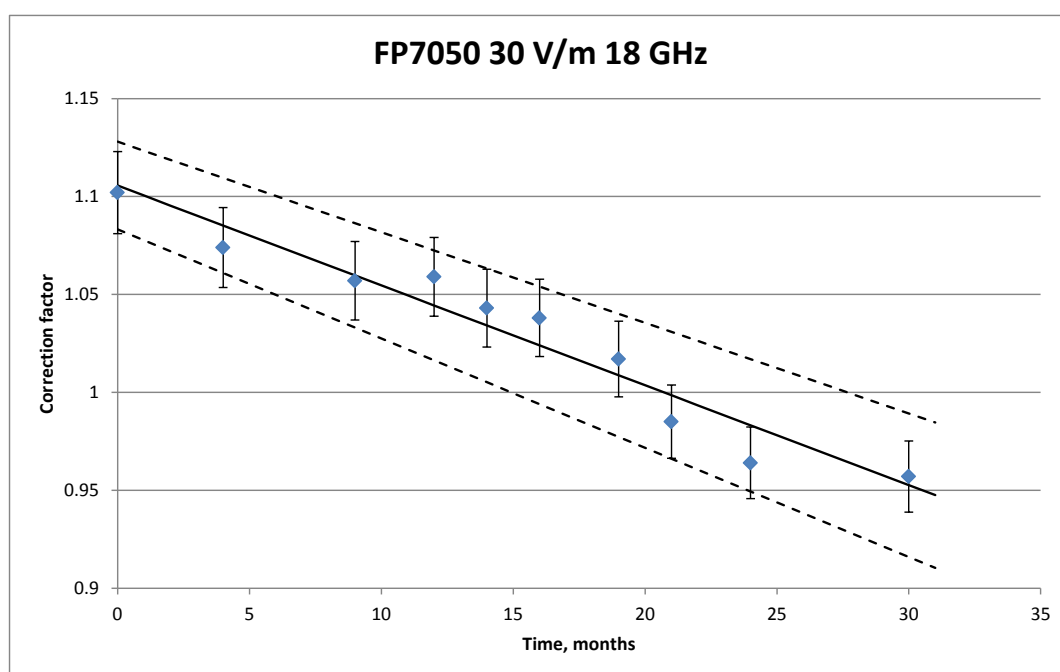


Fig D.16 – NPL measurements of the correction factor for the FP7050 probe in field strength 30 V/m at 18 GHz with estimated drift

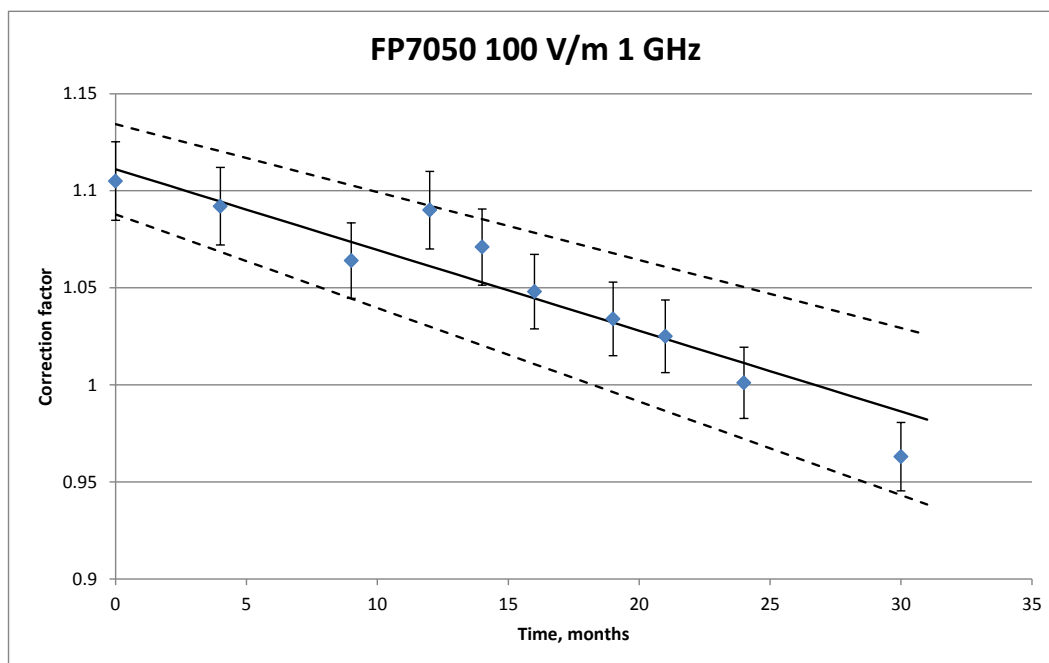


Fig D.17 – NPL measurements of the correction factor for the FP7050 probe in field strength 100 V/m at 1 GHz with estimated drift

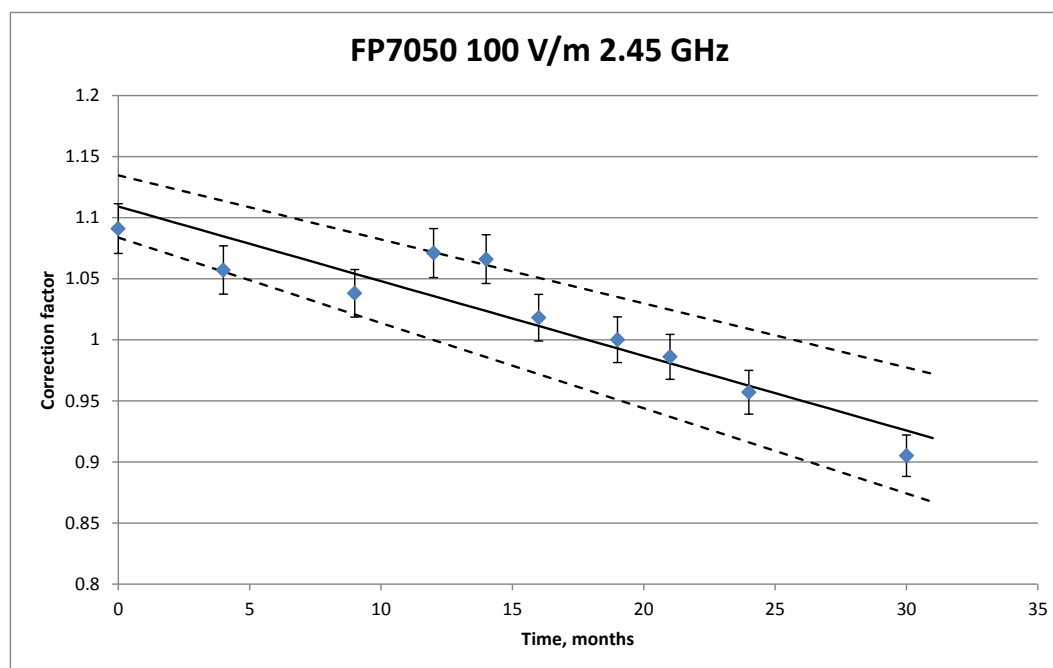


Fig D.18 – NPL measurements of the correction factor for the FP7050 probe in field strength 100 V/m at 2.45 GHz with estimated drift

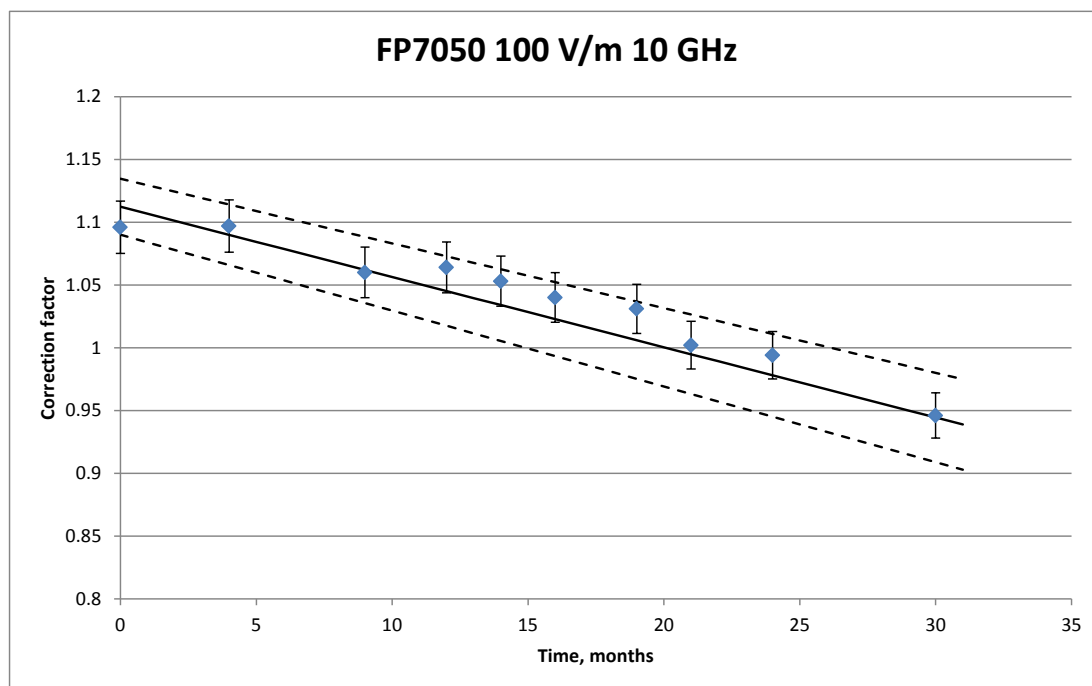


Fig D.19 – NPL measurements of the correction factor for the FP7050 probe in field strength 100 V/m at 10 GHz with estimated drift

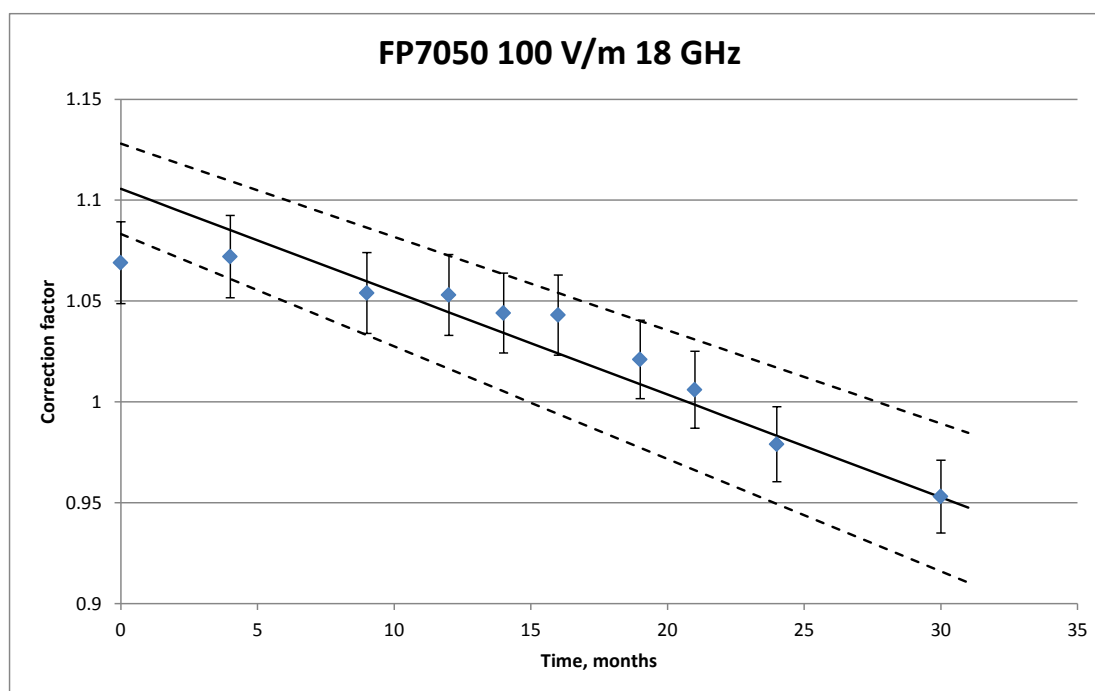


Fig D.20 – NPL measurements of the correction factor for the FP7050 probe in field strength 100 V/m at 18 GHz with estimated drift

Appendix E - Least Squares Estimate for the Linear Time-Varying Contribution to the KCRV

E.1 Equations for determining gradient and y-intercept

The equations for determining the gradient, m , and the y-intercept, c , of a straight line of the form $y = mx + c$ representing a set of data are well known from regression theory.

Using the least-squares technique, the gradient can be estimated using

$$m = \frac{\sum x_i y_i - \frac{1}{N} \sum x_i \sum y_i}{\sum x_i^2 - \frac{1}{N} (\sum x_i)^2} \quad (\text{E.1})$$

and the y-intercept estimated using

$$c = \bar{y} - m\bar{x}. \quad (\text{E.2})$$

In this exercise, x_i represents the time in months since a reference month (equivalent to Δt elsewhere in this report) and y_i represents the reported correction factors used to estimate the time-varying KCRV.

E.2 Derivation of the gradient and y-intercept uncertainties

There will be two sources of errors in the gradient and y-intercept uncertainties: (i) from the error in the fit and (ii) from the uncertainties in the data used to estimate the fit.

Consider first the errors in the fit. For this stage of the derivation, the variables x_i and y_i are treated as correlated statistical observations and any associated uncertainty is ignored.

Let $\hat{y}_i$ be the vertical coordinate of the best-fit line with x-coordinate x_i so

$$\hat{y}_i \equiv mx_i + c, \quad (\text{E.3})$$

then the error between the actual vertical point y_i and the fitted point is given by

$$e_i \equiv y_i - \hat{y}_i. \quad (\text{E.4})$$

Now define s^2 as an estimator for the variance in e_i ,

$$s^2 = \sum_{i=1}^N \frac{e_i^2}{N-2}, \quad (\text{E.5})$$

where N is the number of points used to estimate the line fit parameters.

The standard errors in m and c are [E.1, E.2]

$$e^2(m) = \frac{s^2}{\sum_{i=1}^N (x_i - \bar{x})^2} \quad (\text{E.6})$$

and

$$e^2(c) = s^2 \left(\frac{1}{N} + \frac{\bar{x}^2}{\sum_{i=1}^N (x_i - \bar{x})^2} \right), \quad (\text{E.7})$$

where $\bar{x}$ represents the arithmetic mean of all x_i .

Turning attention now to the uncertainties in the data used to estimate the fit, from the law of propagation of uncertainty [E.3], the uncertainty associated with the gradient, $u(m)$, can be estimated using

$$u^2(m) = \sum \left(\frac{\partial m}{\partial x_i} \right)^2 u^2(x_i) + \sum \left(\frac{\partial m}{\partial y_i} \right)^2 u^2(y_i).$$

In this portion of the exercise, the individual contributions x_i and y_i are treated as independent and uncorrelated. The uncertainty $u^2(x_i) = 0$ because this is a representation of time rather than a measurement so the uncertainty is reduced to

$$u^2(m) = \sum \left(\frac{\partial m}{\partial y_i} \right)^2 u^2(y_i). \quad (\text{E.8})$$

The sensitivity coefficient derivative is

$$\frac{\partial m}{\partial y_i} = \frac{x_i - \frac{1}{N} \sum x_i}{\sum x_i^2 - \frac{1}{N} (\sum x_i)^2}. \quad (\text{E.9})$$

Combining this along with the error in fitting, this results in a total uncertainty for the gradient of

$$u^2(m) = \sum \left(\frac{x_i - \frac{1}{N} \sum x_i}{\sum x_i^2 - \frac{1}{N} (\sum x_i)^2} \right)^2 u^2(y_i) + e^2(m). \quad (\text{E.10})$$

In the case where correlation exists, (E.8) becomes

$$u^2(m) = \mathbf{J}\mathbf{V}_m\mathbf{J}^T + e^2(m), \quad (\text{E.11})$$

where $\mathbf{V}_m$ is the correlation matrix containing the uncertainties and covariances of the inputs y_i and $\mathbf{J}$ is the Jacobian matrix containing elements derived using (E.9). The $\mathbf{T}$ superscript denotes the matrix transpose.

The uncertainty in the y -intercept can be similarly derived. In order to do so, express (E.2) as a function of uncorrelated variables x_i and y_i :

$$c = \frac{1}{N} \sum y_i - \frac{1}{N} \sum x_i \frac{\sum x_i y_i - \frac{1}{N} \sum x_i \sum y_i}{\sum x_i^2 - \frac{1}{N} (\sum x_i)^2}. \quad (\text{E.12})$$

As before, the law of propagation of uncertainty can be applied, along with inclusion of the error due to the line fit, to obtain an estimate of the uncertainty in the y -intercept:

$$u^2(c) = \sum \left(\frac{\partial c}{\partial y_i} \right)^2 u^2(y_i) + e^2(c), \quad (\text{E.13})$$

in the uncorrelated case, where

$$\frac{\partial c}{\partial y_i} = \sum u^2(y_i) \left(\frac{1}{N} - \frac{1}{N} \sum x_i \frac{x_i - \frac{1}{N} \sum x_i}{\sum x_i^2 - \frac{1}{N} (\sum x_i)^2} \right)^2. \quad (\text{E.14})$$

Where the inputs are correlated, (E.11) can be used to determine $u^2(c)$ by substituting $e^2(c)$ for $e^2(m)$ and using a Jacobian matrix with elements derived using (E.13).

E.3 References

- [E.1] Acton, F. S., "Analysis of Straight-Line Data," New York: Dover, 1966
- [E.2] Gonick, L. & Smith, W., "The Cartoon Guide to Statistics," New York: Harper Perennial, 1993
- [E.3] JCGM 100:2008, "Evaluation of measurement data – Guide to the expression of uncertainty in measurement," BIPM, September 2008