Proficiency Test of Radiated Emission Measurements PTC(AUTO_015M_1000M) – ALSE Test Method

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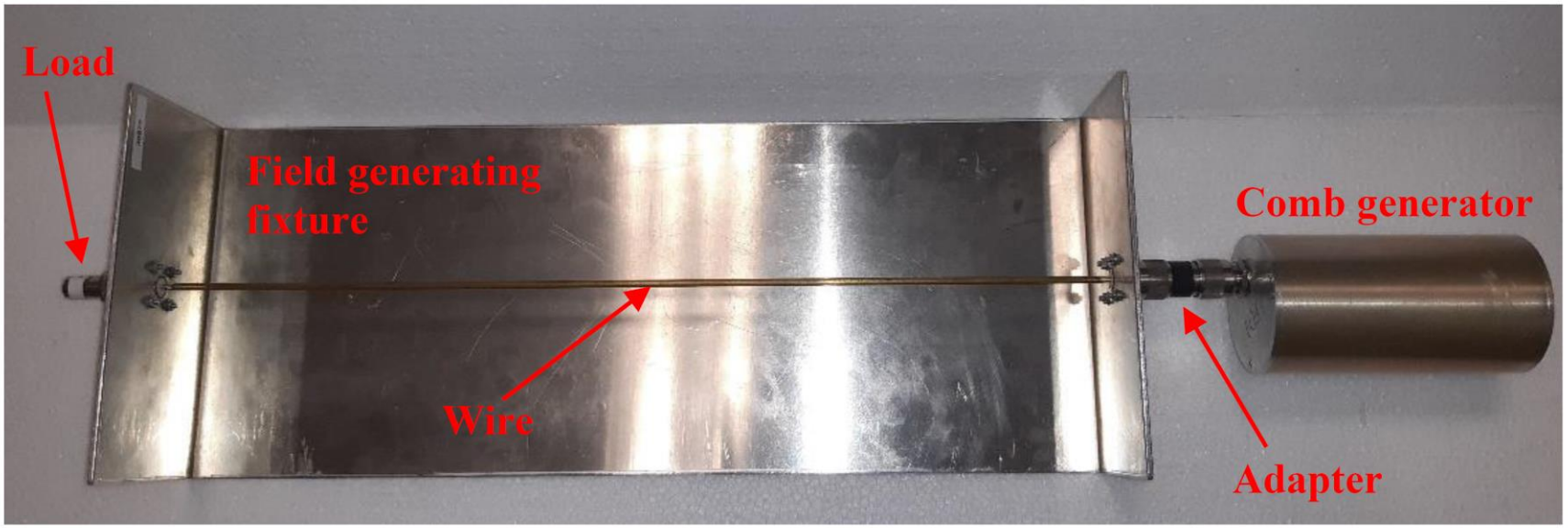
C. Carobbi Università degli Studi di Firenze, Dipartimento di Ingegneria dell'Informazione, Firenze, Italy

Travelling Sample for the 150 kHz to 1000 MHz frequency range



Detailed description is in clause 6. of the scheme of the proficiency test.

General information

- Number of participants: 19
- Start date: Dec. 2020
- Stop date: Jul. 2021
- Issues faced:
  - Crack in a solder joint of the travelling sample detected, by Sample inspection, by the testing laboratory making measurements in week 21. The crack did not prevent the successful preliminary verification of the correct operation of the Sample. Measurement results provided by the testing laboratories in the previous weeks do not exhibit any significant anomaly. The solder joint has been fixed by the same laboratory which detected the issue. No delay caused by this issue.
  - Delay of several weeks in issuing the test report by some test laboratories which impacted on the closing of the proficiency test
- Scheme of the proficiency test PTC(AUTO_015M_1000M): https://www.dinfo.unifi.it/vp-436-schemes-of-the-proficiency-tests.html

Measurement procedure

- Field measurement must be preceded by a preliminary verification of the correct operation of the Sample. If the preliminary verification is successful then the Laboratory can pass to the next step, i.e. the radiated emission measurement.
- Measurement of the field generated by the Sample is carried out by using different receiving antennas, depending on the measurement frequency.
- Distance *d* from the wire of the field-generating fixture to the reference of the receiving antenna is 1000 mm (horizontal). The EMI receiver's detector shall be set to average. Details of the measurement setup not specified here are provided by §6.4 of CISPR 25:2002-08, §6.4 of CISPR 25:2008-03/Ec1:2009-01 and §6.5 of CISPR 25:2016-10/COR1:2017-10 in the frequency range from 150 kHz to 1 GHz. The use of the same measuring instrumentation and setup as used for ordinary testing activity is recommended.
- The measurement result provided by the Laboratory shall be the estimate *x*, expressed in dB(µV/m), of each electric field-strength harmonic.

Measurement procedure

- Frequency range 150 kHz to 30 MHz

The scope of the measurement is to obtain an estimate of the electric field strength, in dB(µV/m), emitted by the Sample and sensed by a vertical monopole antenna at 1 m distance from the wire of the field-generating fixture. The reference of the monopole antenna for distance measurement is the rod.

- Frequency range 30 MHz to 300 MHz

The scope of the measurement is to obtain an estimate of the electric field strength, in dB(µV/m), emitted by the Sample and sensed by a biconical antenna at 1 m distance from the wire of the field-generating fixture. Both vertical polarization and horizontal polarization are measured. The estimate of the electric field strength shall be the maximum reading between the two polarizations. The reference of the biconical antenna for distance measurement is the phase center.

- Frequency range 300 MHz to 1000 MHz

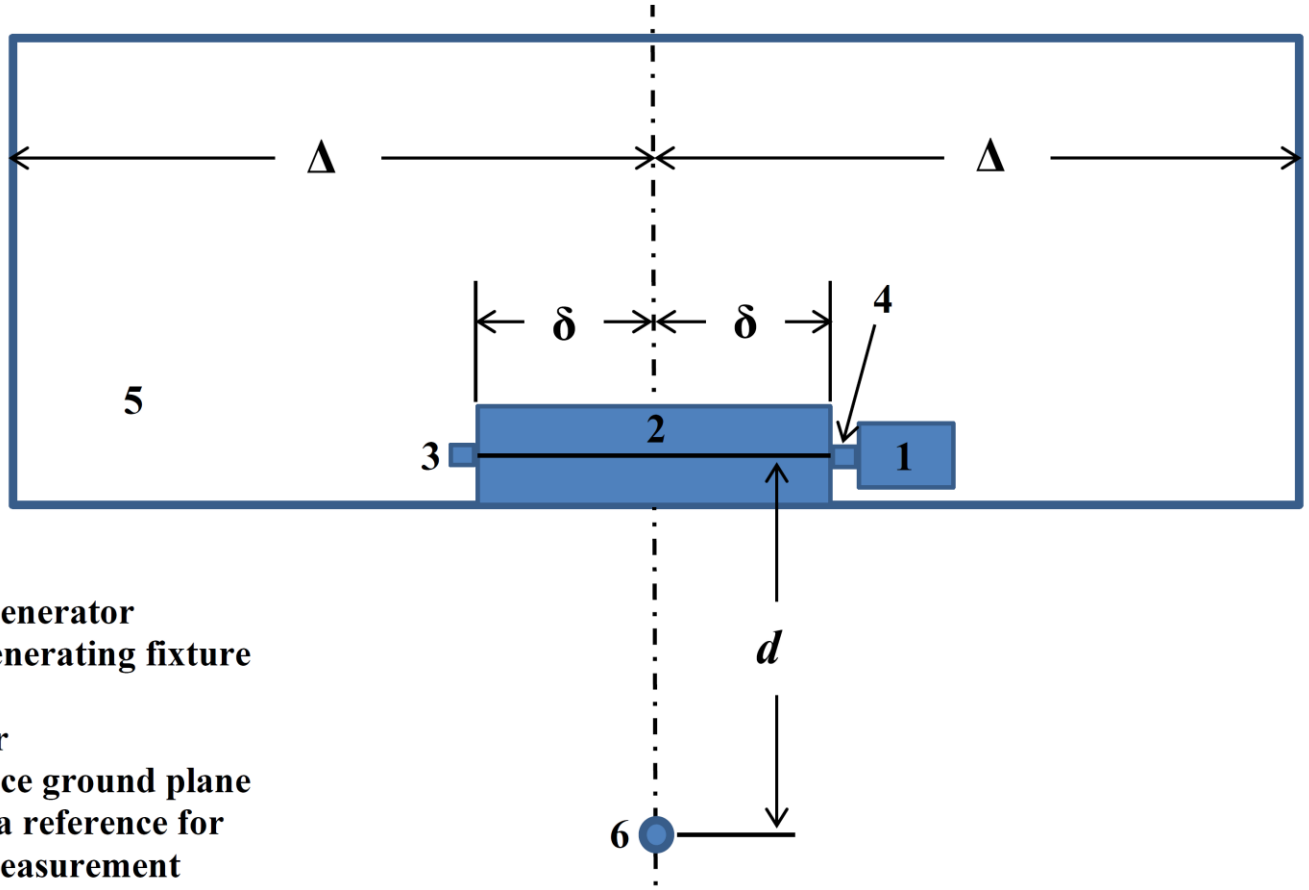
The scope of the measurement is to obtain an estimate of the electric field strength, in dB(µV/m), emitted by the Sample and sensed by a log-periodic antenna at 1 m distance from the wire of the field-generating fixture. Both vertical polarization and horizontal polarization are measured. The estimate of the electric field strength shall be the maximum reading between the two polarizations. The reference of the log-periodic antenna for distance measurement is the tip.

- If a bilog receiving antenna is employed in the frequency range from 30 MHz to 1000 MHz then the antenna reference shall be the one used for antenna calibration.

General recommendations

- Minimize common mode current along the receiving antenna cable by routing the cable perpendicular to the wire of the Sample and parallel to the floor.
- Check possible intermodulation effects when using the monopole antenna by inserting an attenuator (e.g. 6 dB) between the output of the comb generator output and the input of the field generating fixture (the receiver reading should decrease by no more than 6 dB).
- Check the balance of the biconical antenna by rotating it by 180° (the receiver reading should not significantly vary). Repeat the check in horizontal polarization and in vertical polarization.
- Take measures to assure good electrical contact between the field-generating fixture and the reference ground plane by cleaning the respective surfaces, clamping the fixture to the table and using metallic tape to increase the contact surface.

Measurement setup



1 – comb generator
2 – field-generating fixture
3 – load
4 – adapter
5 – reference ground plane
6 – antenna reference for distance measurement

Measurement frequencies

Table 1: Table to be used for recording the electromagnetic field measurement result *x*. Column seven shall be filled up by the Laboratory, the other columns (five, six and eight) will be filled up by the Coordinator.

1	2	3	4	5	6	7	8
Receiving antenna	**Comb generator**	**Harmonic #**	**Frequency** MHz	***x**** dB(µV/m)	***s**** dB	***x*** dB(µV/m)	***z***
Monopole	LF01	2	0,375	-	-		-
Monopole	LF01	6	1,375	-	-		-
Monopole	LF01	25	6,125	-	-		-
Monopole	LF01	109	27,125	-	-		-
Biconical	HF01	8	40	-	-		-
Biconical	HF01	20	100	-	-		-
Biconical	HF01	44	220	-	-		-
Log-periodic	HF01	80	400	-	-		-
Log-periodic	HF01	140	700	-	-		-
Log-periodic	HF01	190	950	-	-		-

Reference values

- Reference values are:
  - x^* reference value of the electric field at a given frequency
  - s^* standard deviation of the electric field at a given frequency
- x^* and s^* are obtained through the robust statistical analysis in terms of robust mean and robust standard deviation

Robust statistical analysis

$x_1, x_2, \ldots, x_i, \ldots, x_p$ } Raw data (p participants)

$x^* = \text{median of } x_i \qquad (i = 1, 2, \ldots, p)$

$s^* = 1{,}483 \text{ median of } |x_i - x^*| \qquad (i = 1, 2, \ldots, p)$

} Initial reference value

$\delta = 1{,}5 s^*$

$$x_i^* = \begin{cases} x^* - \delta, & \text{if } x_i < x^* - \delta \\ x^* + \delta, & \text{if } x_i > x^* + \delta \\ x_i, & \text{otherwise} \end{cases}$$

} Transformed set of data

$$x^* = \sum x_i^* / p$$

$$s^* = 1{,}134 \sqrt{\sum \left(x_i^* - x^*\right)^2 / (p - 1)}$$

} New reference value (iterative algorithm)

Excerpt from Annex C, algorithm A of ISO 13528:2015

Performance statistic *z*

- Performance statistic *z* (clause 9.4.1 of ISO 13528:2015) that the Coordinator applies to the Participant providing the measurement result x_i

$$z_i = \frac{x_i - x^*}{s^*}$$

$$\begin{cases} 2 < |z_i| < 3 \Rightarrow warning \\ 3 < |z_i| \Rightarrow action \end{cases}$$

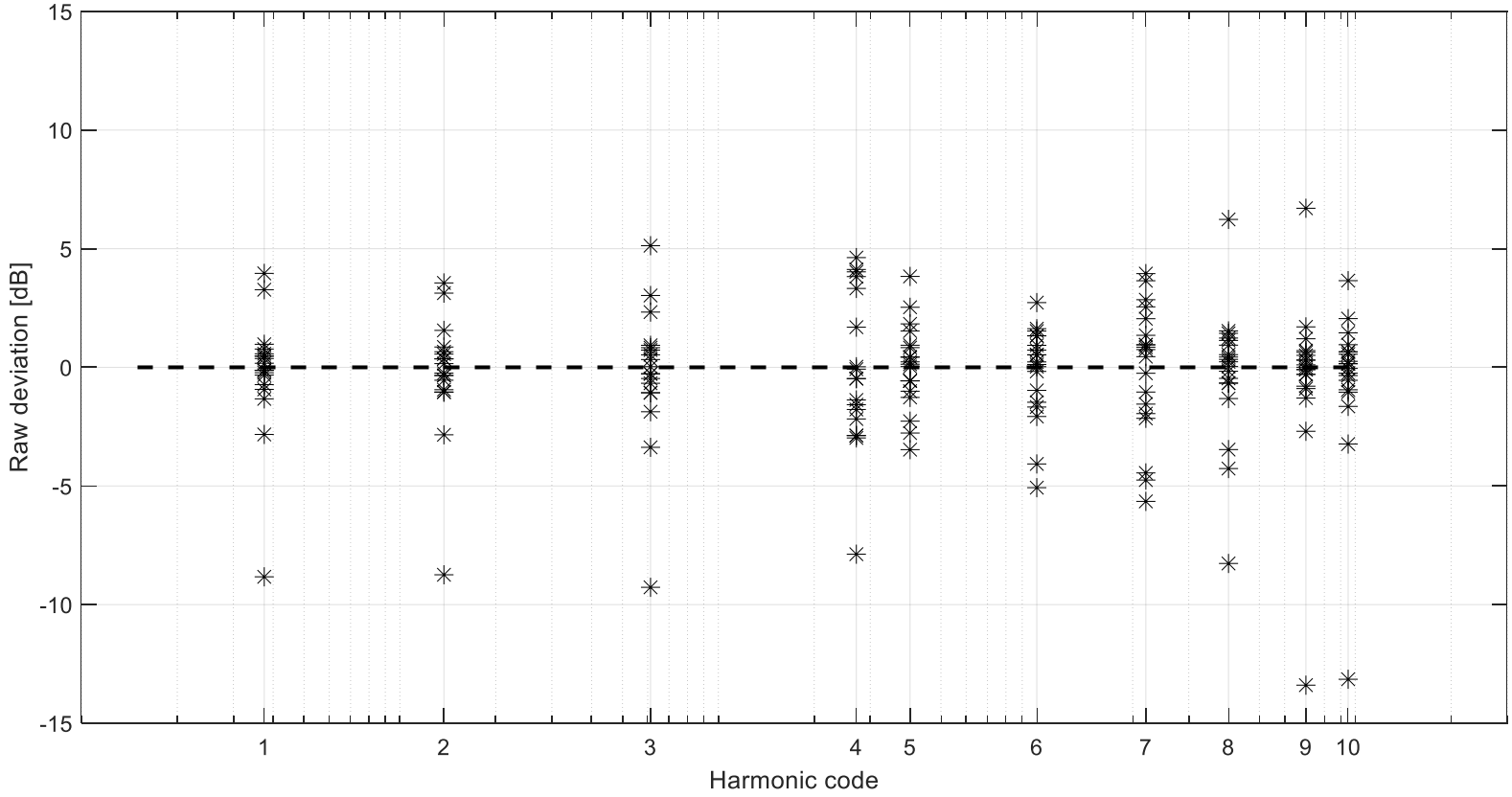
Results

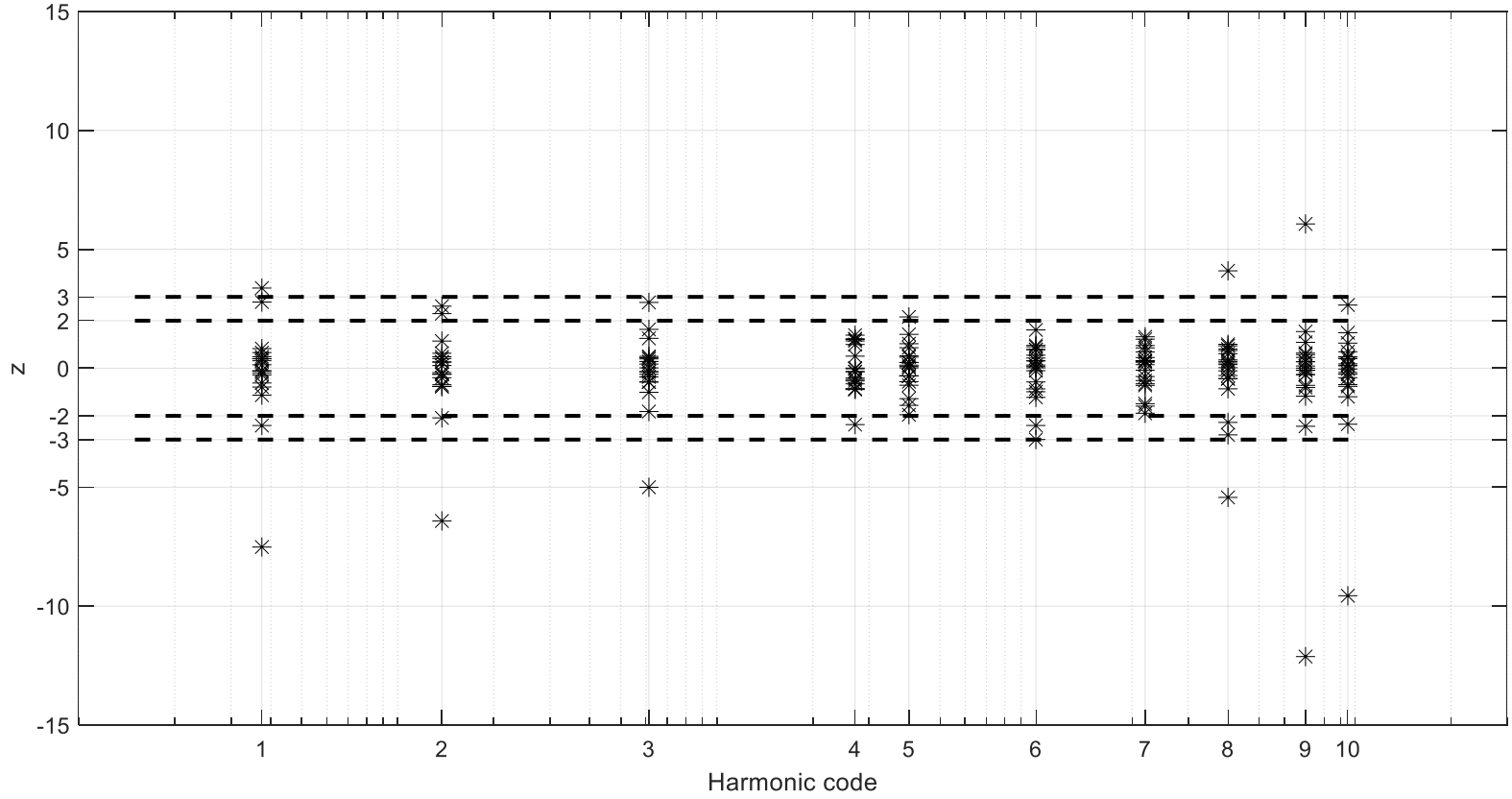
Harmonic code to frequency conversion

Receiving antenna	Harmonic code	Frequency MHz
Monopole	1	0,375
Monopole	2	1,375
Monopole	3	6,125
Monopole	4	27,125
Biconical	5	40
Biconical	6	100
Biconical	7	220
Log-periodic	8	400
Log-periodic	9	700
Log-periodic	10	950

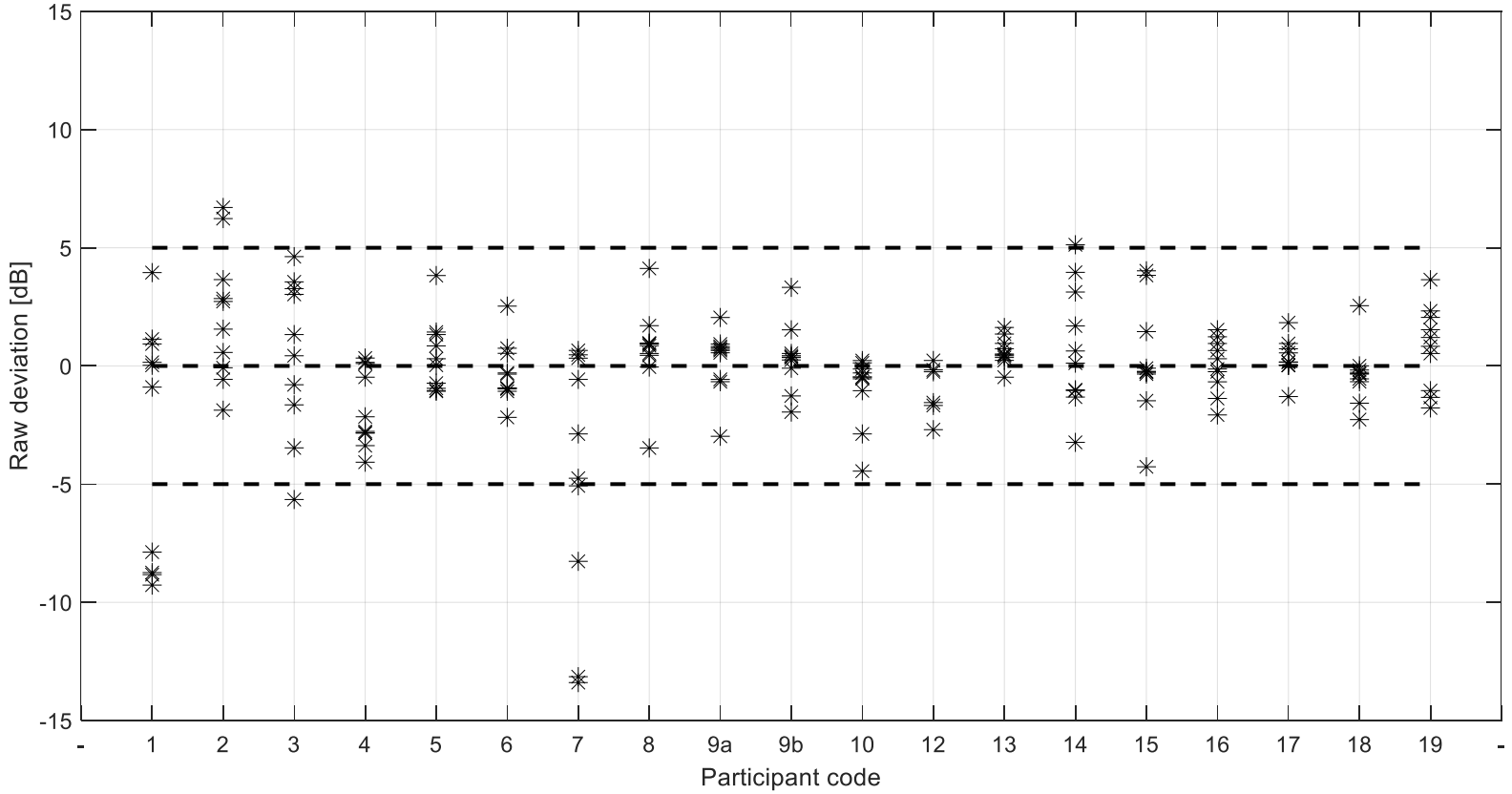
Interpretation of results

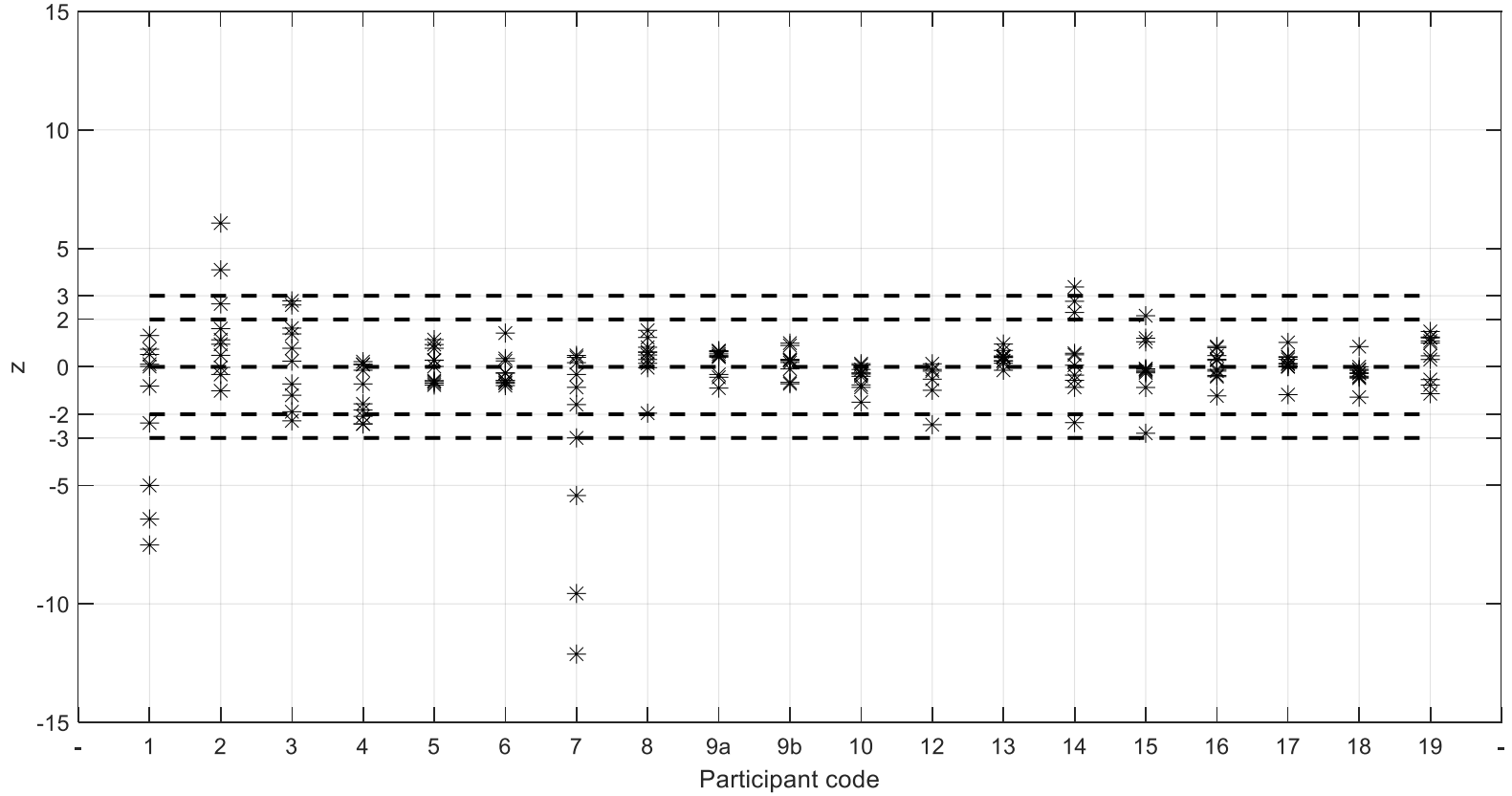
- Results are reported as:
  - Raw deviation between x_i, the measurement result of the i-th laboratory at a given frequency, and x^* reference value of the electric field at the same frequency
  - Performance statistic z_i of the i-th laboratory at a given frequency


15
10
5
0
-5
-10
-15
Raw deviation [dB]
1
2
3
4
5
6
7
8
9
10
Harmonic code


15
10
5
3
2
0
-2
-3
-5
-10
-15
z
1
2
3
4
5
6
7
8
9
10
Harmonic code

Radiated emission 150 kHz – 1000 MHz




15
10
5
3
2
0
-2
-3
-5
-10
-15
z
-
1
2
3
4
5
6
7
8
9a
9b
10
12
13
14
15
16
17
18
19
-
Participant code

LAB(#)	Antennas and chamber	Connection of the RGP to the shielding enclosure	Antenna cable routing	Connection of the fixture to the RGP	Notes
1	ROD and BILOG, Fully Anechoic	WALL	According to NOTE 1 of 7.e)	CONDUCTIVE TAPE	
2	ROD and BILOG, Semi-Anechoic	FLOOR	According to NOTE 1 of 7.e) above 30 MHz	CONDUCTIVE TAPE	Missing RGP extension to ROD antenna
3	ROD, BICONICAL and LPDA, Semi-anechoic	WALL	Not reported	CONDUCTIVE TAPE	Chamber lined with specific arrangement of absorbing material
4	ROD, BICONICAL and LPDA, Fully anechoic	WALL	According to NOTE 1 of 7.e) above 30 MHz	SIMPLE CONTACT	
5	ROD, BICONICAL and LPDA, Semi anechoic	FLOOR	According to NOTE 1 of 7.e)	CONDUCTIVE TAPE	
6	ROD, BICONICAL and LPDA, Fully anechoic		According to NOTE 1 of 7.e) above 30 MHz	CLAMPS	Wide (compared to counterpoise size) RGP extension to ROD antenna. Ferrited antenna cables.
7	ROD, BICONICAL and LPDA, Semi anechoic	FLOOR	Not or partially according to NOTE 1 of 7.e)	CONDUCTIVE TAPE	Bonding to conductive floor of ROD antenna counterpoise
8	ROD and BILOG, Semi-Anechoic	FLOOR	Not or partially according to NOTE 1 of 7.e)	CONDUCTIVE TAPE	Testing laboratory reports that at 40 MHz and 100 MHz results are very sensitive to the arrangement of cable and antenna.
9a	ROD, BICONICAL and LPDA, Semi anechoic	FLOOR	According to NOTE 1 of 7.e)	CONDUCTIVE TAPE	
9b	ROD, BICONICAL and LPDA, Semi anechoic	WALL	According to NOTE 1 of 7.e)	CONDUCTIVE TAPE	
10	ROD, BICONICAL and LPDA, Semi anechoic	WALL	Not or partially according to NOTE 1 of 7.e)	CONDUCTIVE TAPE	
12	ROD and BILOG, Fully Anechoic	WALL	According to NOTE 1 of 7.e)	CONDUCTIVE TAPE	
13	ROD, BICONICAL and LPDA, Semi anechoic	FLOOR	Not or partially according to NOTE 1 of 7.e)	CONDUCTIVE TAPE	
14	ROD, BICONICAL and LPDA, Semi anechoic	WALL	According to NOTE 1 of 7.e) above 30 MHz	SIMPLE CONTACT	Narrow (compared to counterpoise size) RGP extension to ROD antenna
15	ROD, BICONICAL and LPDA, Semi anechoic	WALL	Not or partially according to NOTE 1 of 7.e)	CONDUCTIVE TAPE	Bonding to conductive floor of ROD antenna counterpoise
16	ROD, BICONICAL and LPDA, Fully anechoic	WALL	According to NOTE 1 of 7.e)	CONDUCTIVE TAPE	Testing laboratory reports that metallic clamps may affect measurement results at high frequency, then decided to use conductive tape
17	ROD, BICONICAL and LPDA, Semi anechoic	WALL	According to NOTE 1 of 7.e)	CONDUCTIVE TAPE	
18	ROD and BILOG, Semi-Anechoic	WALL	According to NOTE 1 of 7.e)	CONDUCTIVE TAPE	
19	Not reported	Not reported	Not reported	Not reported	

Remarks

- The measurement results provided by the 19 participants at the 10 measurement frequencies selected by the Coordinator are within –15 dB to +10 dB from the reference values. Most of measurement results are within –5 dB to +5 dB from the reference values.
- 186 measurement results were provided by the participants and 23 signals (14 warning and 9 action) were issued