# Proficiency Testing of Conducted Emission Measurements PTC(CE-9k-30M-VIII)

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Rev. 0

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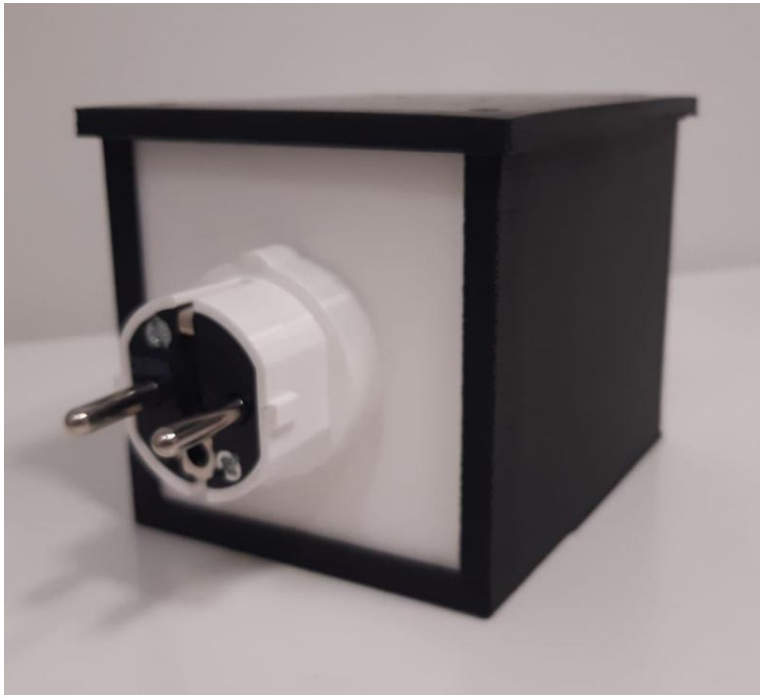
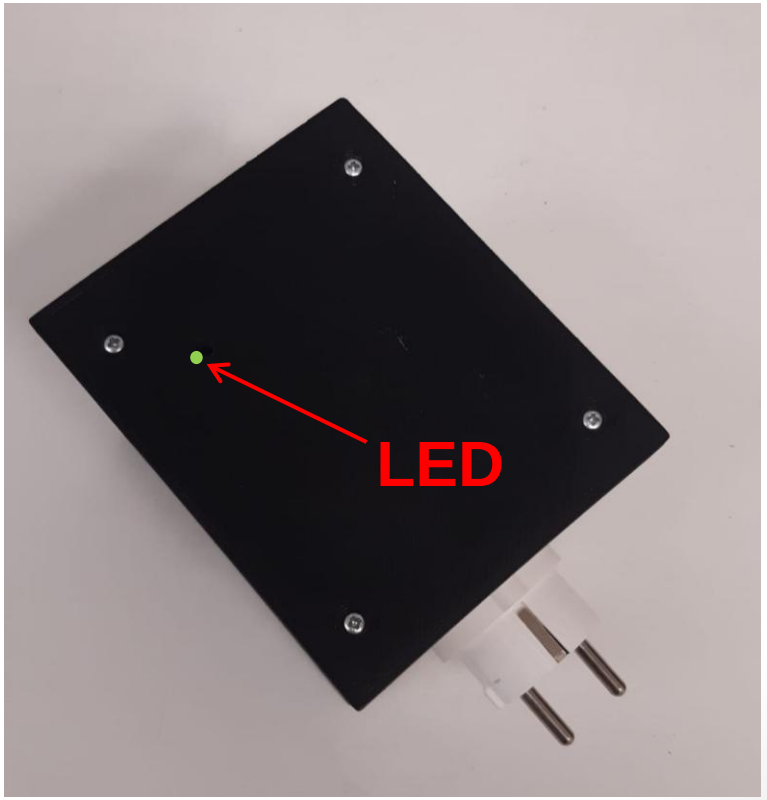
# Travelling Sample for the 9 kHz to 30 MHz frequency range (Conducted Emission)





# General information

- Number of participants: 19
- Start date: November 2023
- Stop date: December 2024
- Scheme of the proficiency test PTC(CE-9k-30M-VII):
  https://www.dinfo.unifi.it/vp-436-schemes-of-the-proficiency-tests.html
- Issues faced:
  - Some laboratories issued the report (annex C) with a severe delay (several months) with respect the expected date (1 week after measurements).
  - 1 multi-site laboratory was severely delayed in performing measurements with respect to the scheduled weeks (nearly 3 months). The PT closed with the same delay.

# Measurement procedure

- Voltage measurement by using the AMN and EMI receiver is preceded by a preliminary check of one harmonic generated by the Sample.
- Measurement by using the AMN and EMI receiver are performed according to §7.4.2 of EN 55016-2-1:2014 and next amendments, by using a V-type Artificial Mains Network (AMN).
- The Laboratory measures the amplitude of ten (10) harmonics selected by the Coordinator in the frequency range between 9 kHz and 30 MHz (i.e., covering both band A and band B). The disturbance injected by the Sample in line and neutral conductors is measured. A total number of twenty (20) measurements (two conductors times ten frequencies) is reported to the Coordinator by the Laboratory.

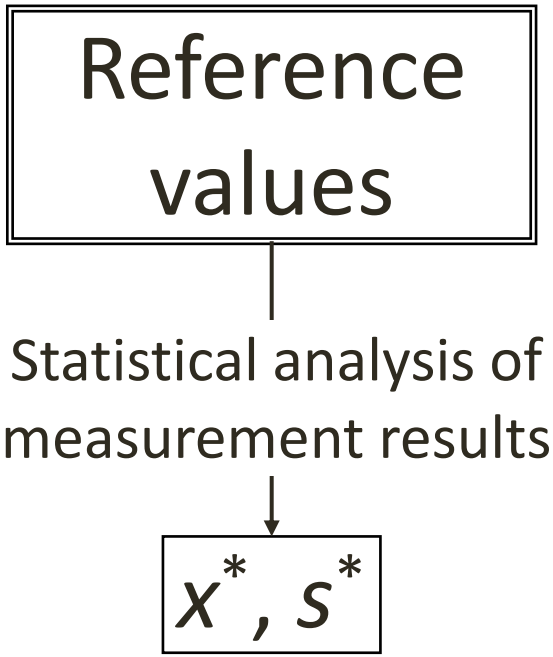
# Sequence of operations

- Connect the Sample to the EUT port of the AMN;
- Power up the AMN;
- Measure the amplitude of the ten harmonics selected by the Coordinator by using the EMI receiver set with average detector;
- Power off the AMN;
- Disconnect the Sample from the AMN.

# Measurement result

- The measurement result provided by the Laboratory consists of:
  - The estimate *x*, expressed in dB(µV), of the amplitude of the selected harmonics, measured both line-to-ground ($x_{line}$) and neutral-to-ground ($x_{neutral}$);
  - The expanded uncertainty of the estimate *x*, $U_{lab}$, expressed in dB and obtained multiplying the combined standard uncertainty by the coverage factor $k = 2$ (which corresponds to a coverage probability of about 95 % assuming normal distribution).

# Reference values



# Statistical (robust) 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 13528:2005

# Performance statistic $\zeta$ (Participant)

- Performance statistic $\zeta$ (clause 9.6 of ISO 13528:2015) that the Coordinator applies to the Participant providing the measurement result $x_i$ with standard uncertainty $u_{xi}$

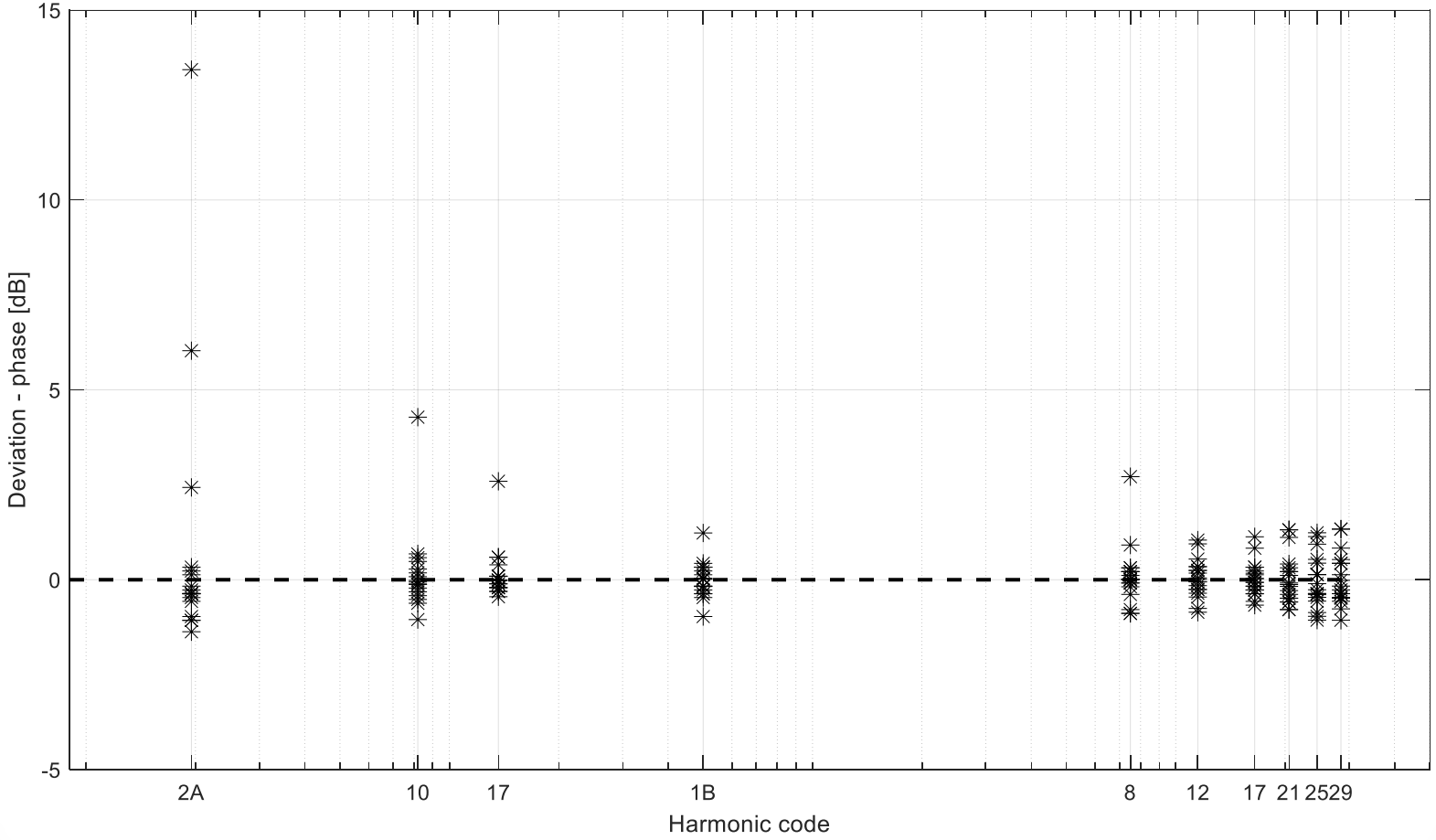
$$\zeta_i = \frac{x_i - X}{\sqrt{u_{xi}^2 + u_X^2}} \qquad X = x^*, u_X = \frac{1{,}25 \cdot s^*}{\sqrt{p}}$$

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

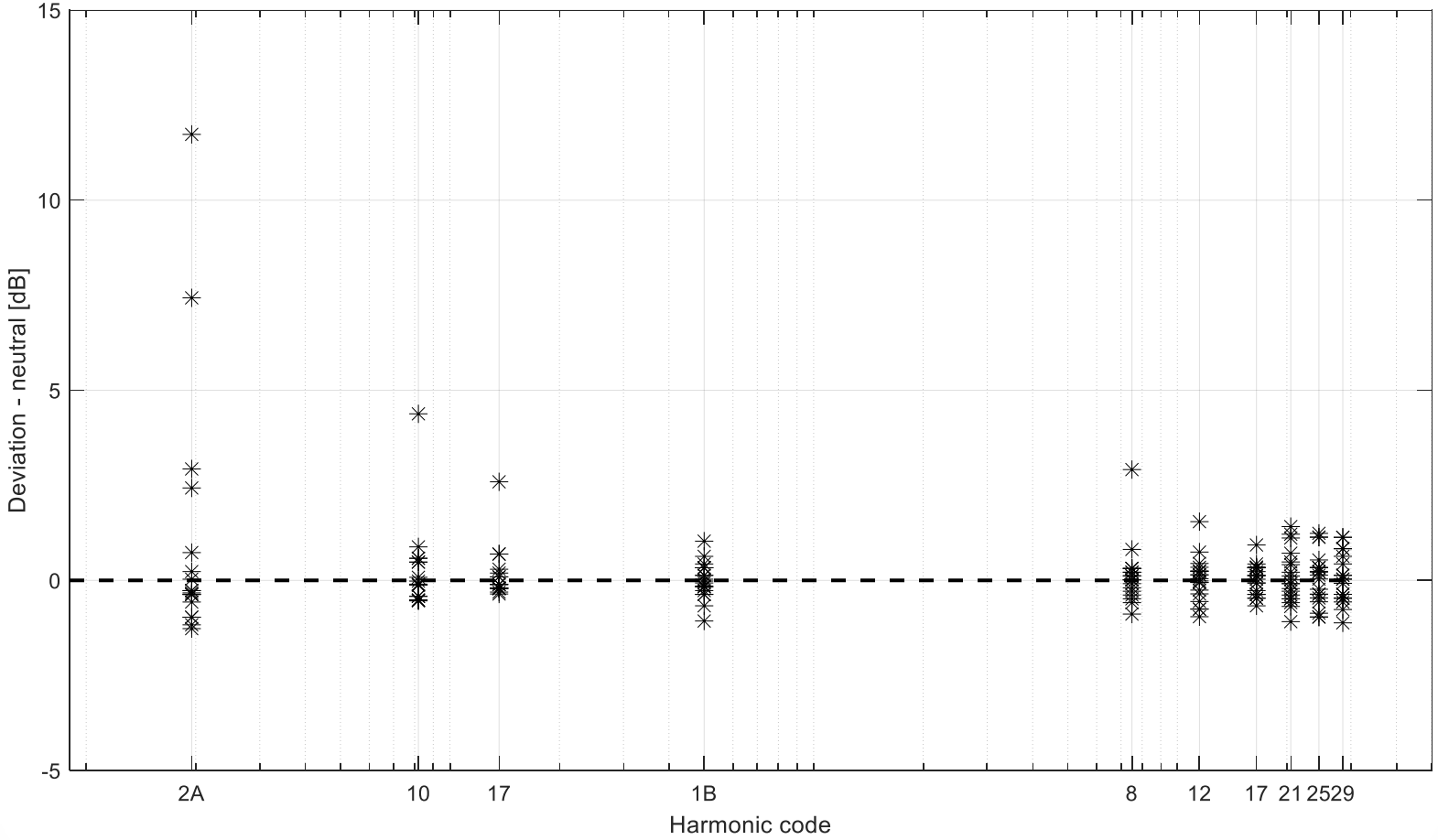
# Results

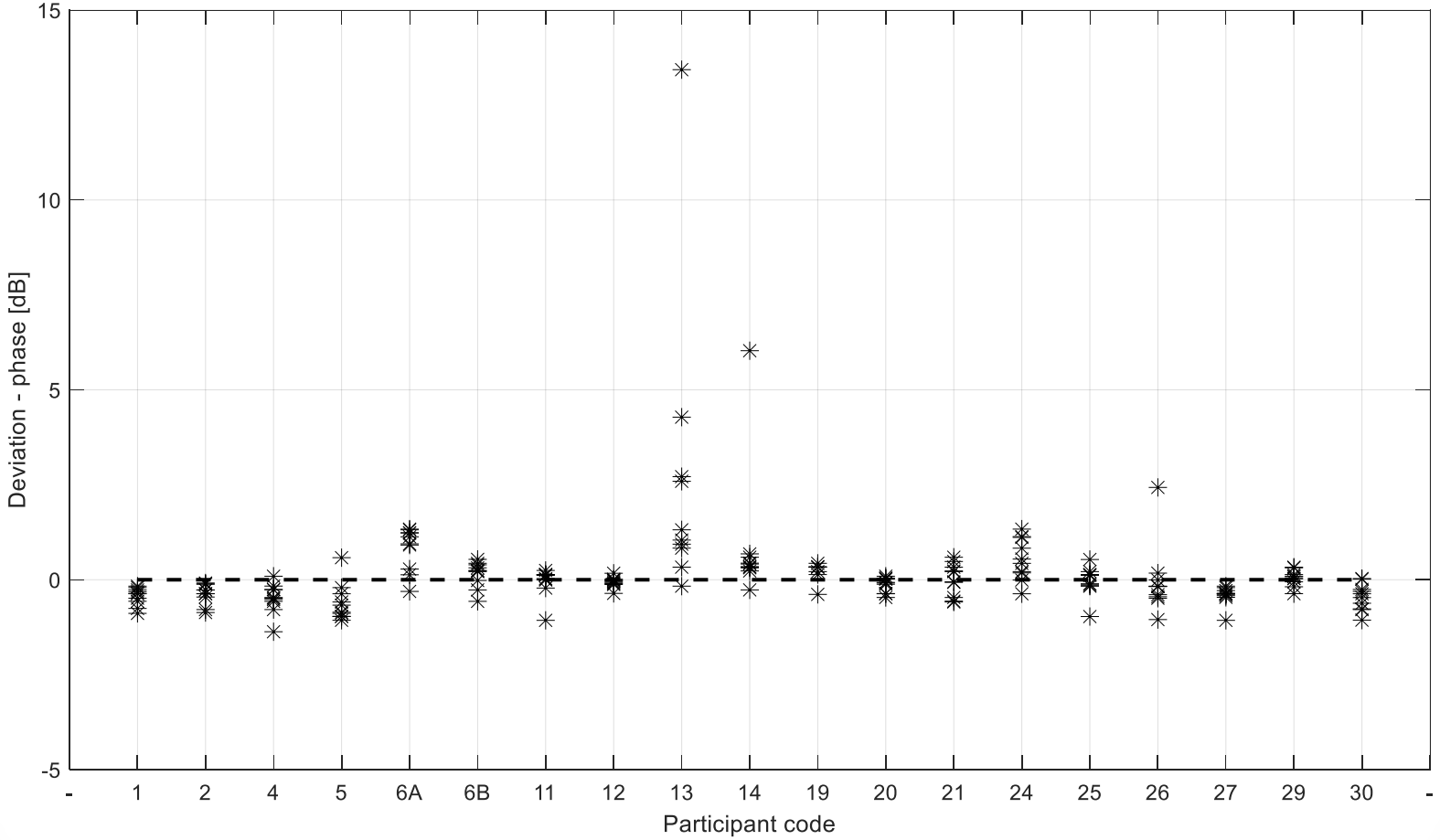
# Harmonic code to frequency conversion

| Band | Harmonic # | Frequency MHz |
|---|---|---|
| A | 2 | 0.0195 |
| A | 10 | 0.0819 |
| A | 17 | 0.1365 |
| B | 1 | 0.5000 |
| B | 8 | 7.500 |
| B | 12 | 11.500 |
| B | 17 | 16.500 |
| B | 21 | 20.500 |
| B | 25 | 24.500 |
| B | 29 | 28.500 |

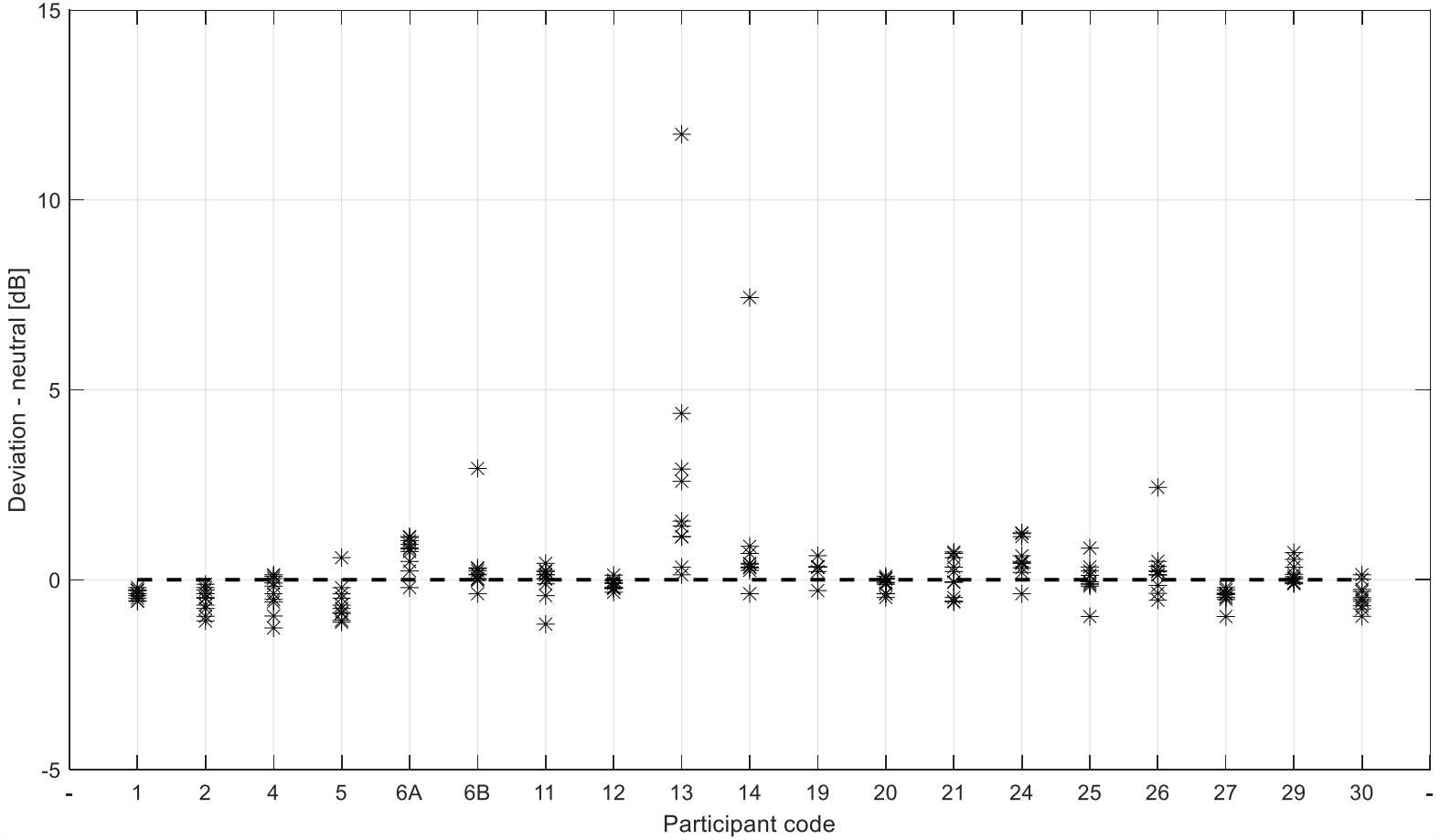

15
10
5
0
-5
Deviation - phase [dB]
2A
10
17
1B
8
12
17
21
25
29
Harmonic code

# Conducted Emission 9 kHz – 30 MHz

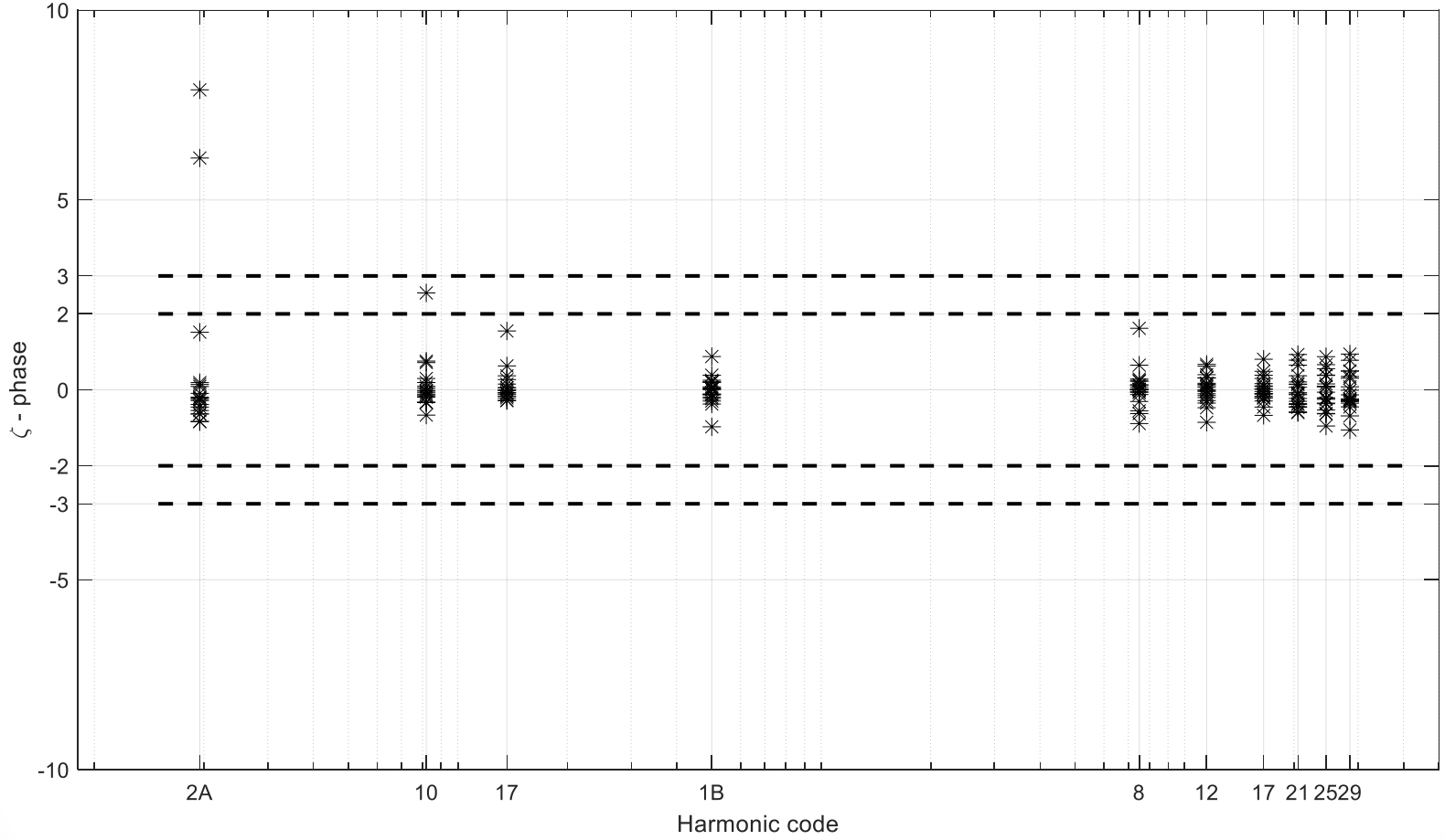




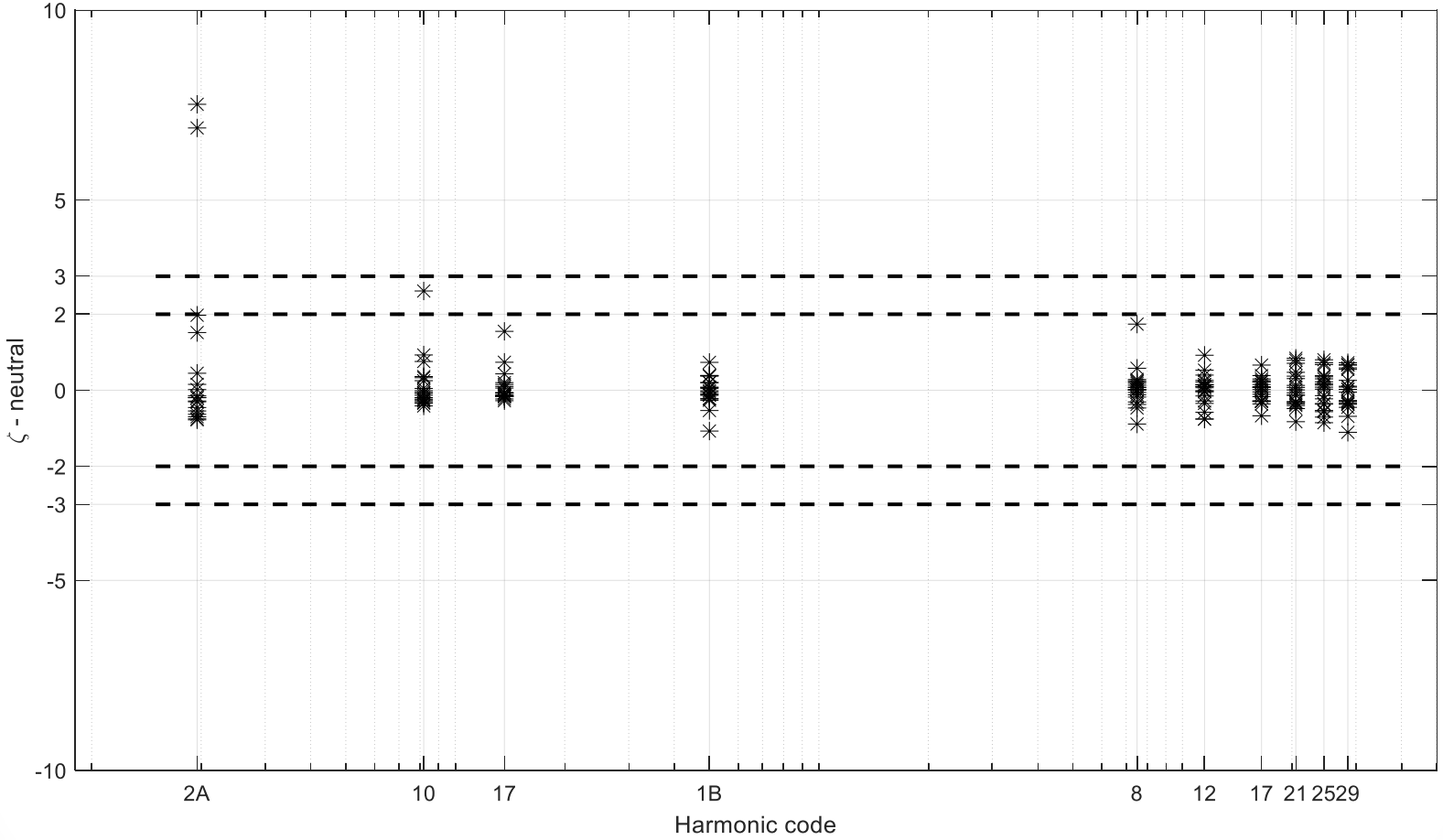

Conducted Emission 9 kHz – 30 MHz

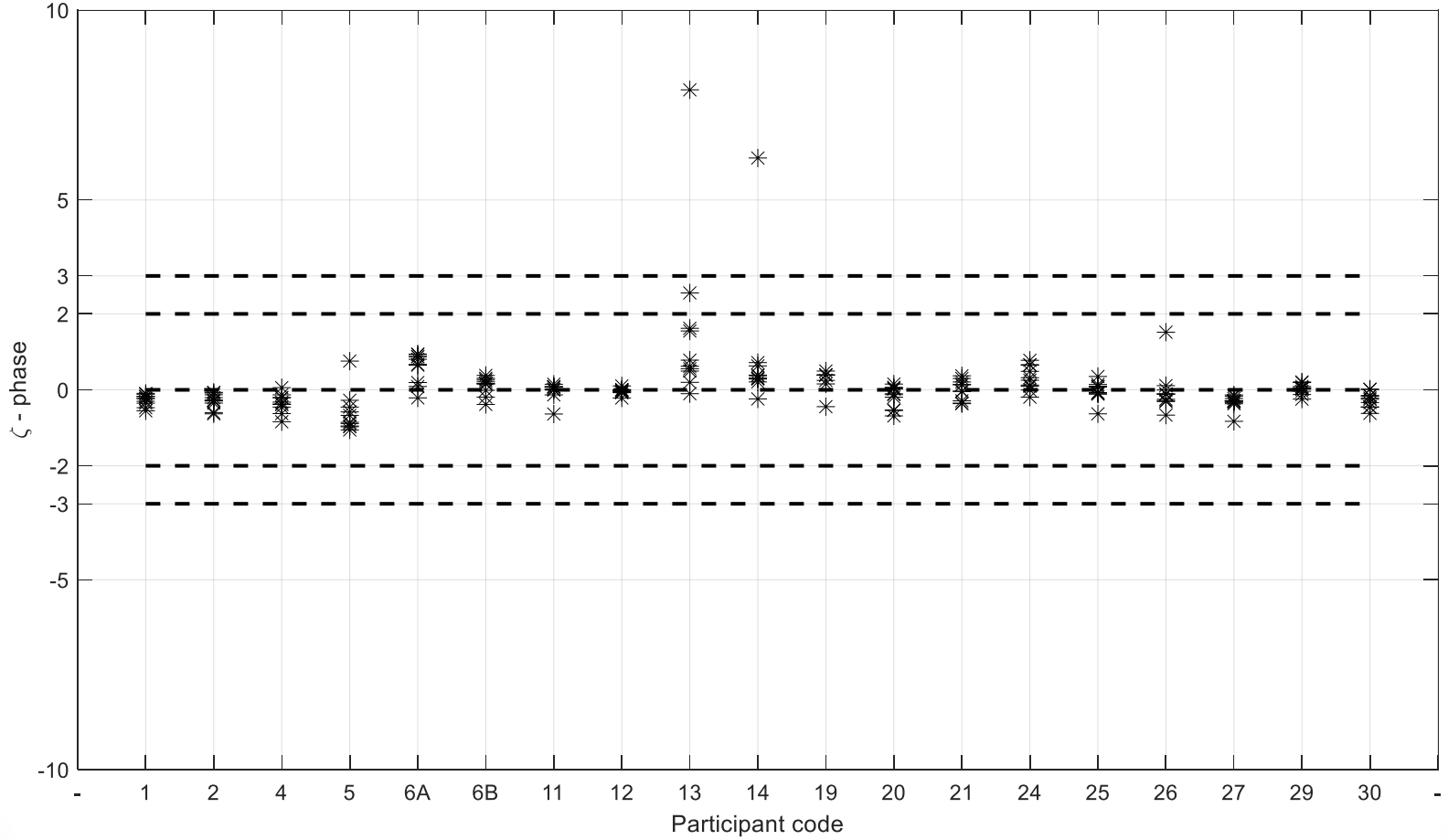

15
10
5
0
-5
Deviation - neutral [dB]
-
1
2
4
5
6A
6B
11
12
13
14
19
20
21
24
25
26
27
29
30
-
Participant code

# Conducted Emission 9 kHz – 30 MHz

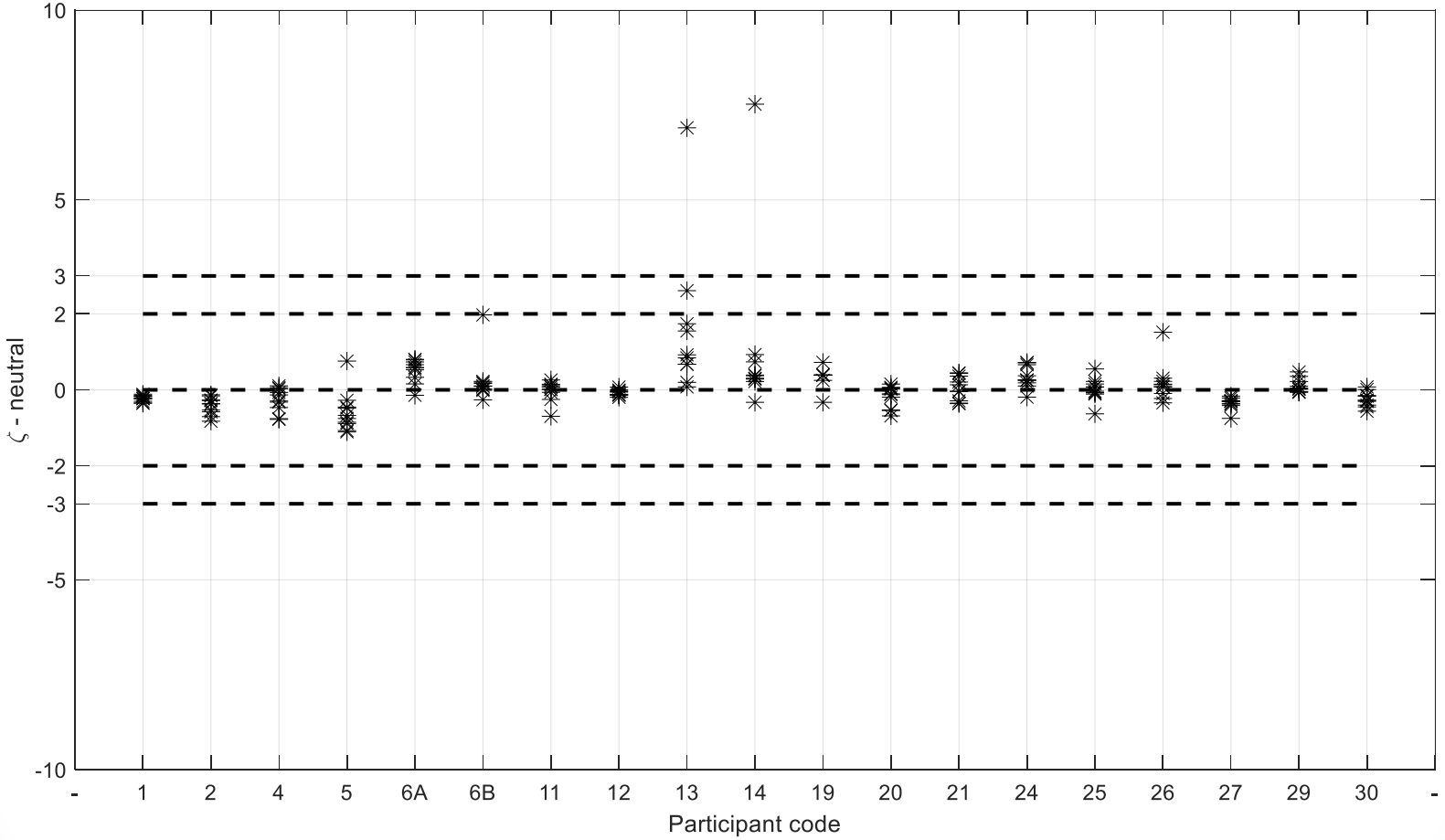


# Conducted Emission 9 kHz – 30 MHz

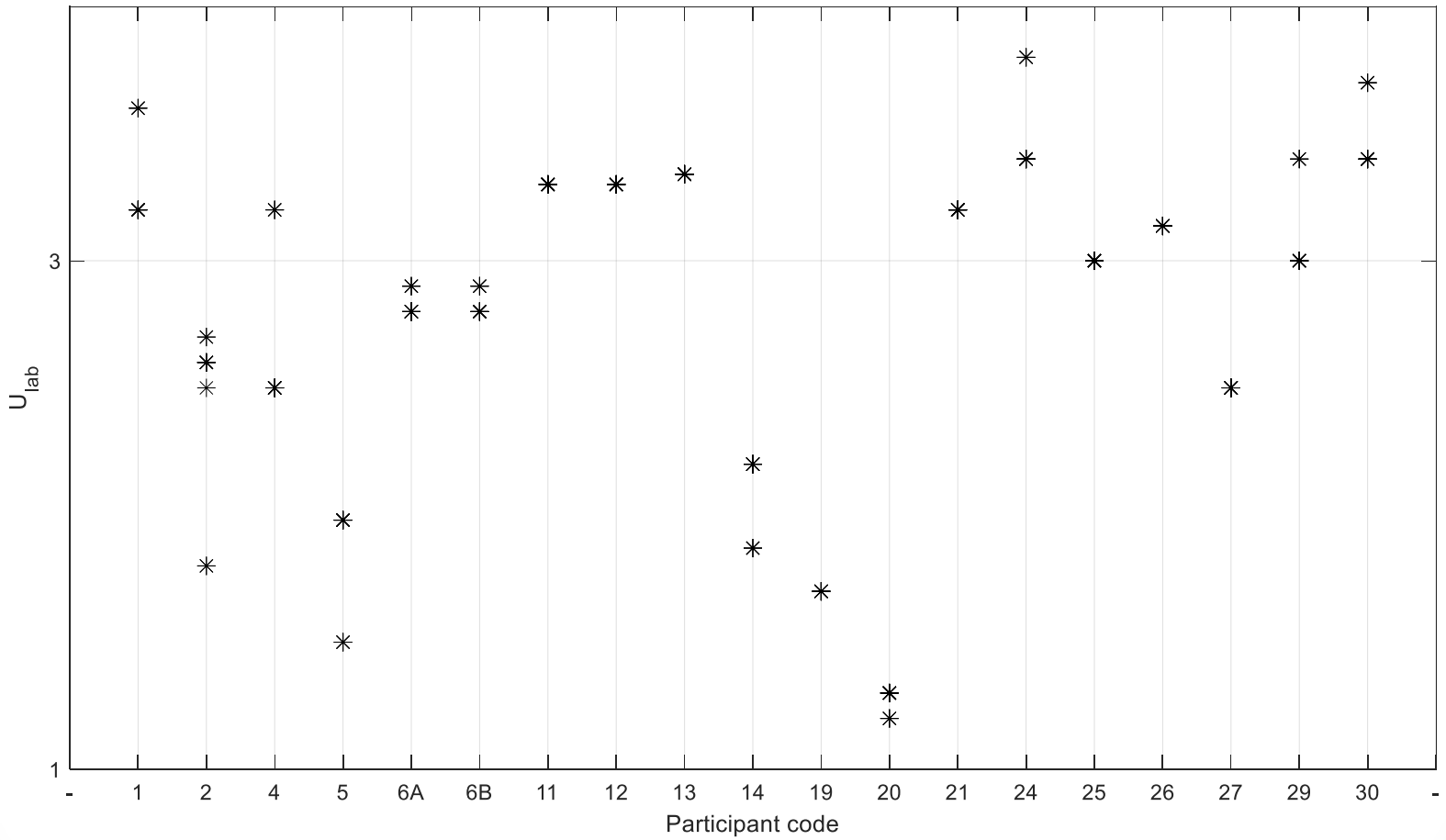





Conducted Emission 9 kHz – 30 MHz




Conducted Emission 9 kHz – 30 MHz


$U_{lab}$
3
1
-
1
2
4
5
6A
6B
11
12
13
14
19
20
21
24
25
26
27
29
30
-
Participant code

# Reproducibility as quantified by robust standard deviation *s**

| *f* MHz | *s** dB |
|---|---|
| 0.0195 | 1.1 |
| 0.0819 | 0.5 |
| 0.1365 | 0.3 |
| 0.5 | 0.4 |
| 7.5 | 0.4 |
| 11.5 | 0.5 |
| 16.5 | 0.4 |
| 20.5 | 0.7 |
| 24.5 | 0.7 |
| 28.5 | 0.7 |

# Remarks

- The measurement results provided by the 19 participants at the 10 measurement frequencies selected by the Coordinator are approximately within –2 dB to +14 dB from the reference values. Most of measurement results are within –2 dB to +2 dB from the reference values.
- 374 measurement results were provided by the participants and 6 signals (2 warning and 4 action) were issued.
- The standard measurement uncertainty declared by the laboratories is comprised approximately between 0.6 dB and 1.9 dB, robust standard deviation $s^*$ is less than 1.1 dB.