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

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Rev. 0

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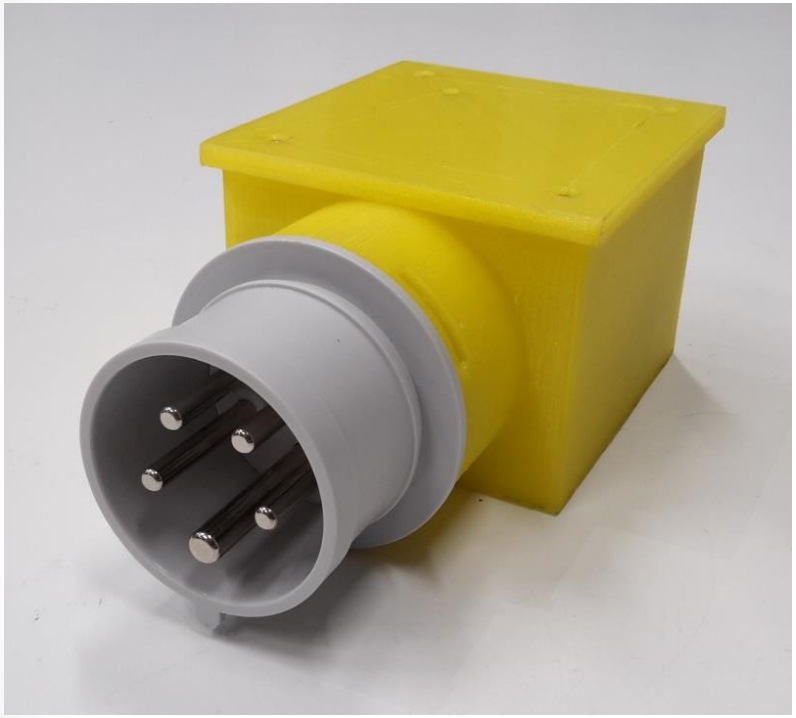
Travelling Sample for the 9 kHz to 30 MHz frequency range (Conducted Emission)



General information

- Number of participants: 17
- Start date: Jan. 2020 (WK4)
- Stop date: Jul. 2020 (WK 30)
- Issues faced: COVID 19 pandemic
  - Pandemic caused delays in sample transportation
  - Some participants were in lockdown for a few weeks
  - Change of scheduling: 4 participants had to change the date for measurements, 1 participant cancelled participation
  - The overall delay can be estimated in four weeks
- Scheme of the proficiency test PTC(CE-9k-30M-V):

  https://www.dinfo.unifi.it/vp-436-schemes-of-the-proficiency-tests.html

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 on line 1, 2 and 3 and neutral conductors is measured. A total number of twenty (40) measurements (four conductors times ten frequencies) is reported to the Coordinator by the Laboratory.

Sequence of operations

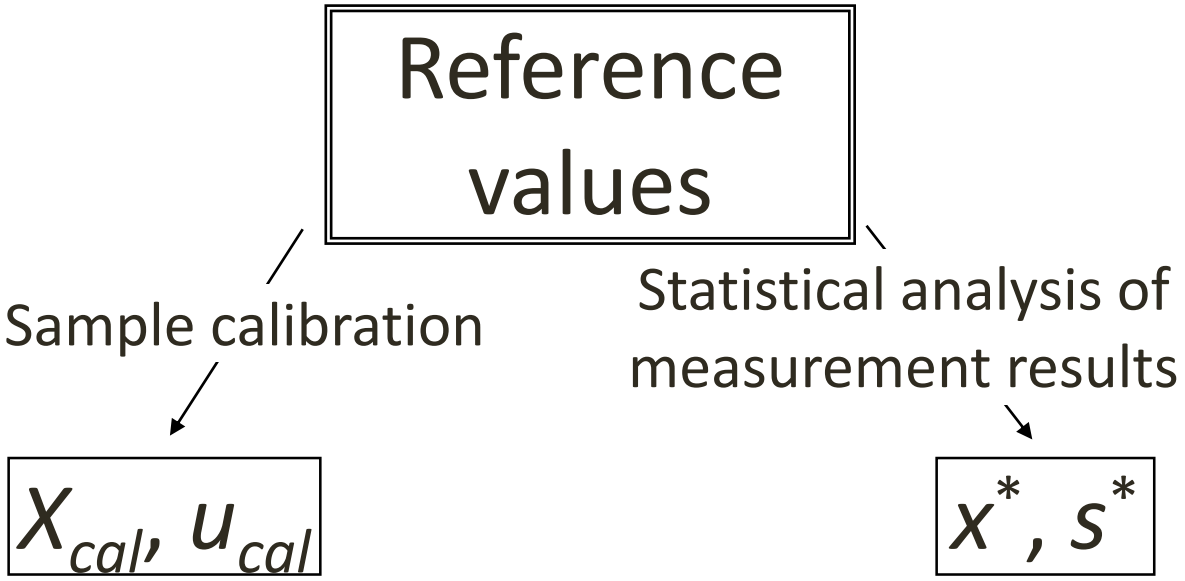
- Connect the Sample to the EUT port of the AMN;
- Power up the AMN;
- Measure the amplitude of the ten harmonics selected by the Coordinator by using the EMI receiver set with average detector;
- Power off the AMN;
- Disconnect the Sample from the AMN.

NOTE: Since the Sample plug is rated for 16 A and most of the AMN receptacles are rated for 32 A a self-constructed adapter has been realized by most of the laboratories. If the adapter length is less than about 40 cm then its influence is negligible.

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 lines-to-ground ($x_{line1,2,3}$) 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 ζ (Participant)

- Performance statistic ζ (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}

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

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

Performance statistic *z'* (Coordinator)

- Performance statistic *z'* (clause 7.8.1 of ISO 13528:2015) that the Coordinator applies as self-check

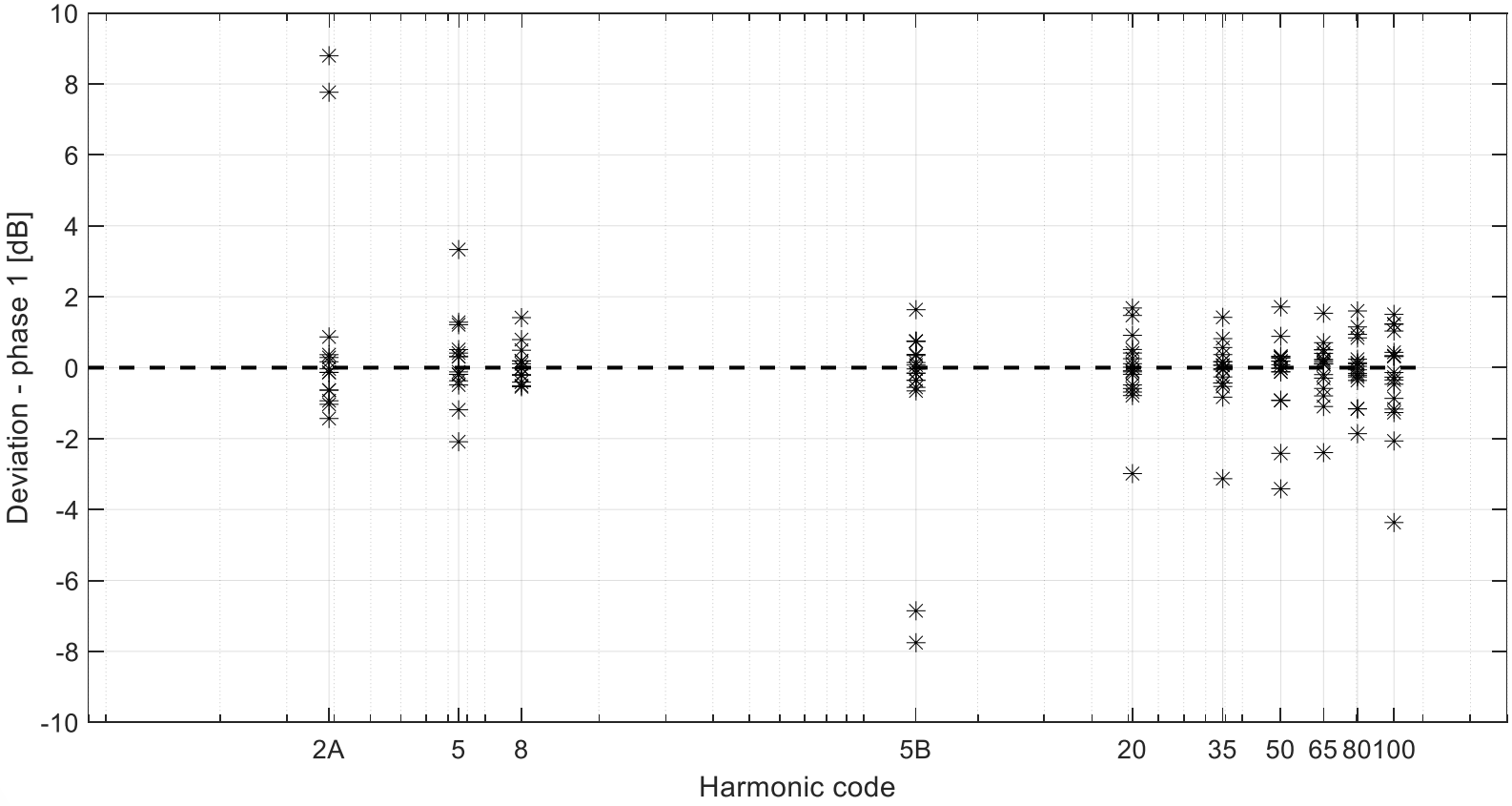
$$z' = \frac{X_{cal} - x^*}{\sqrt{u_{cal}^2 + \left(\frac{1{,}25 \cdot s^*}{\sqrt{p}}\right)^2}}$$

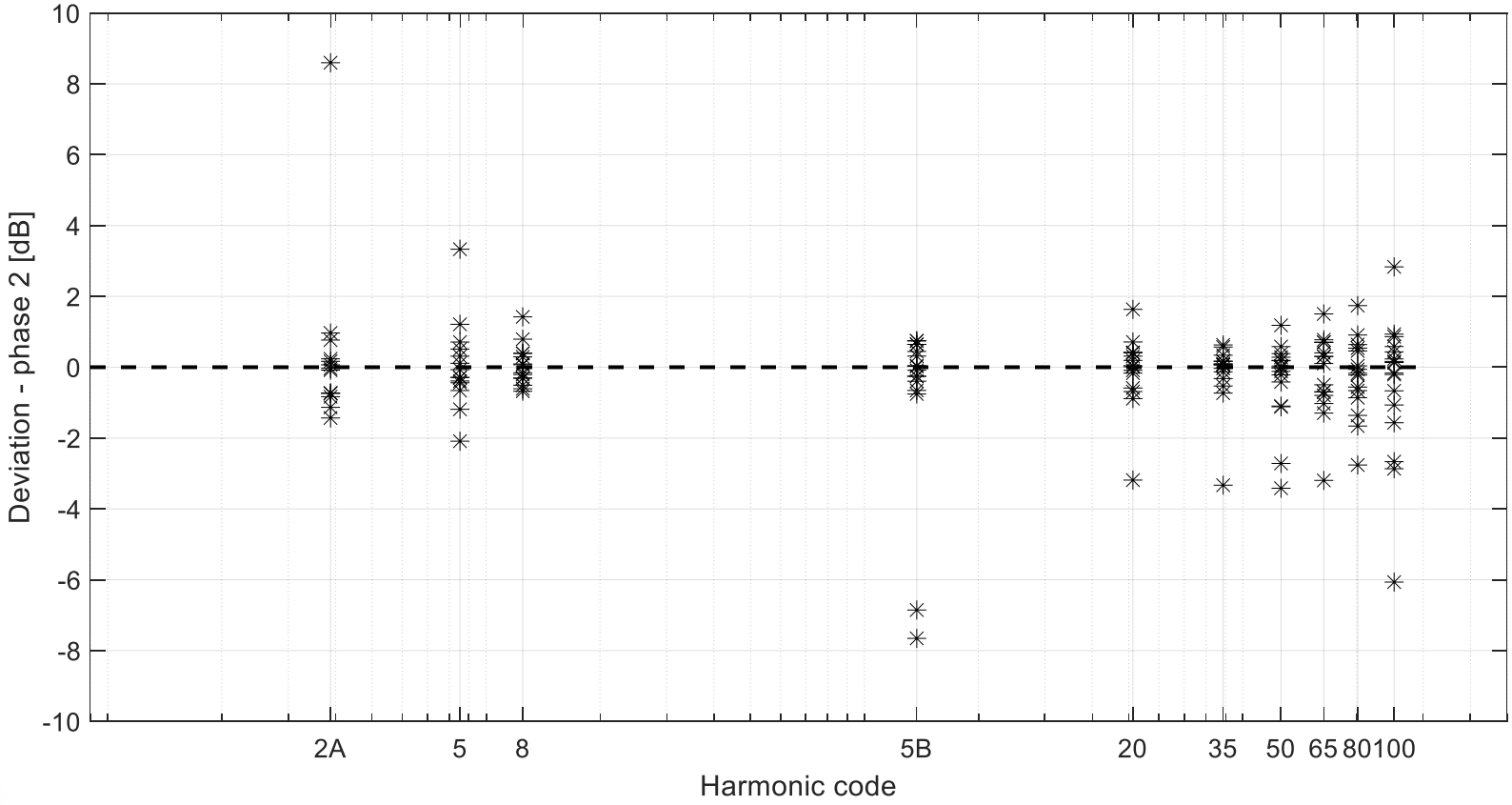
$$\begin{cases} 2 < |z'| < 3 \Rightarrow warning \\ 3 < |z'| \Rightarrow action \end{cases}$$

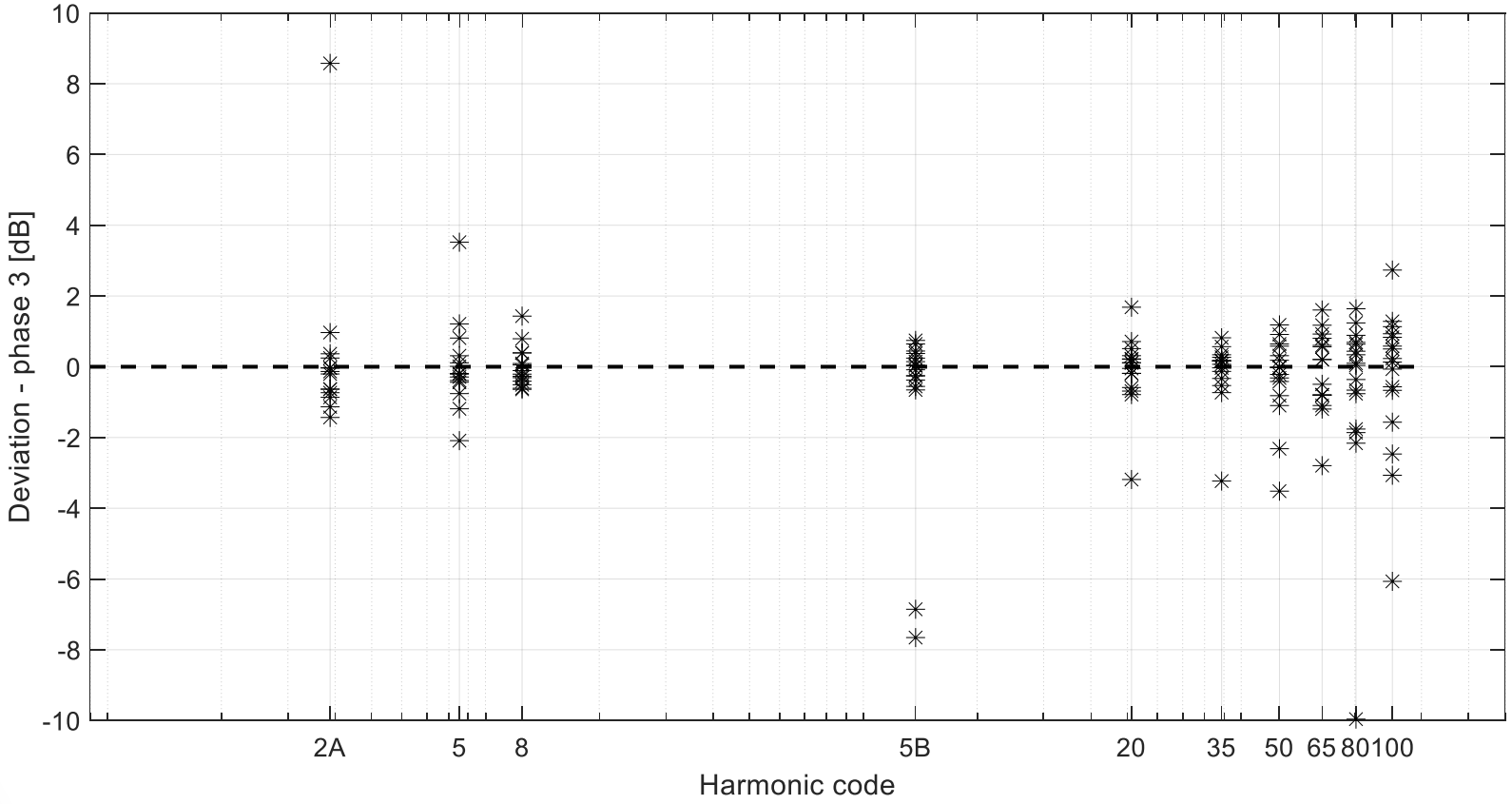
Results

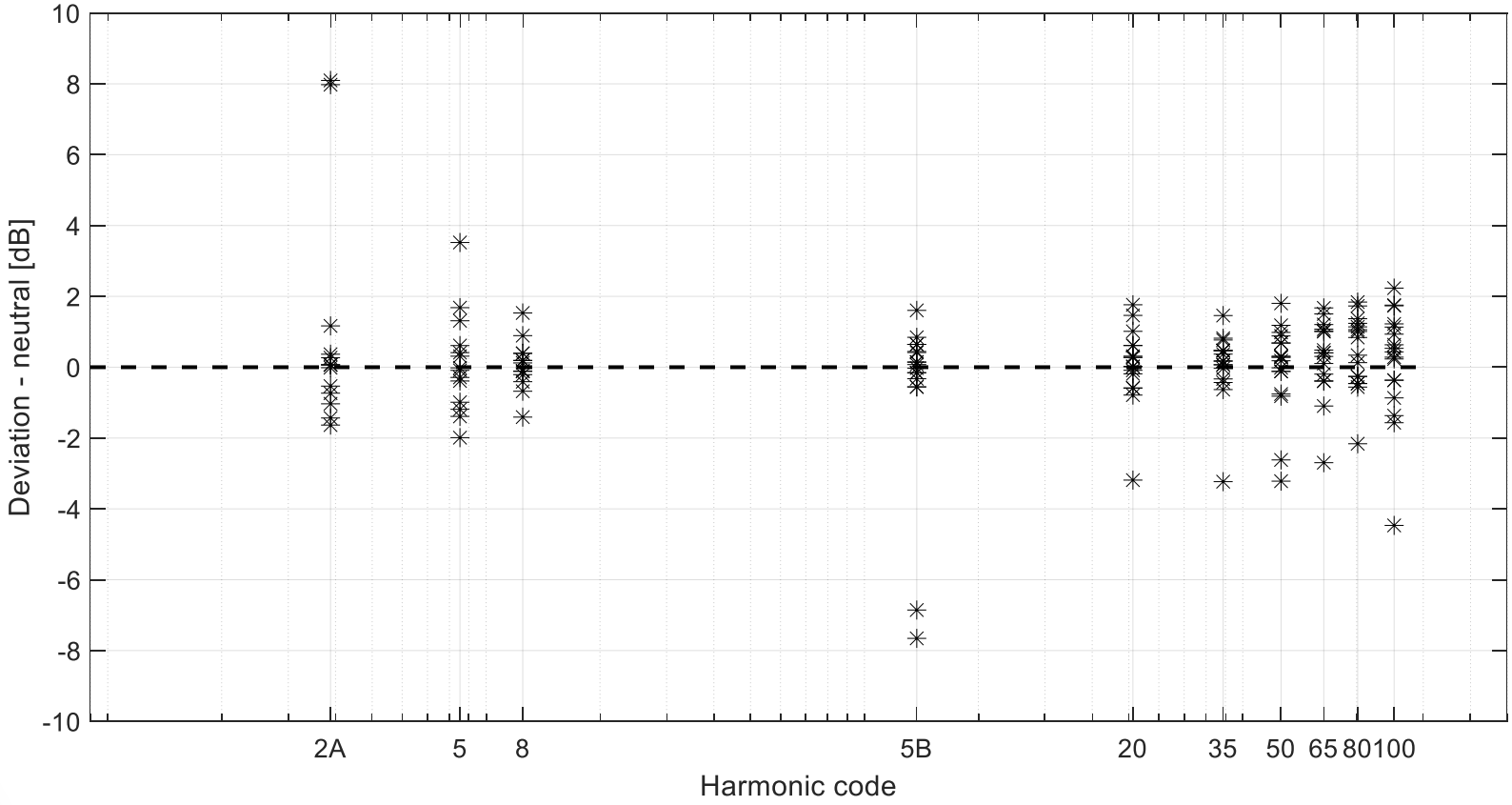
Harmonic code to frequency conversion

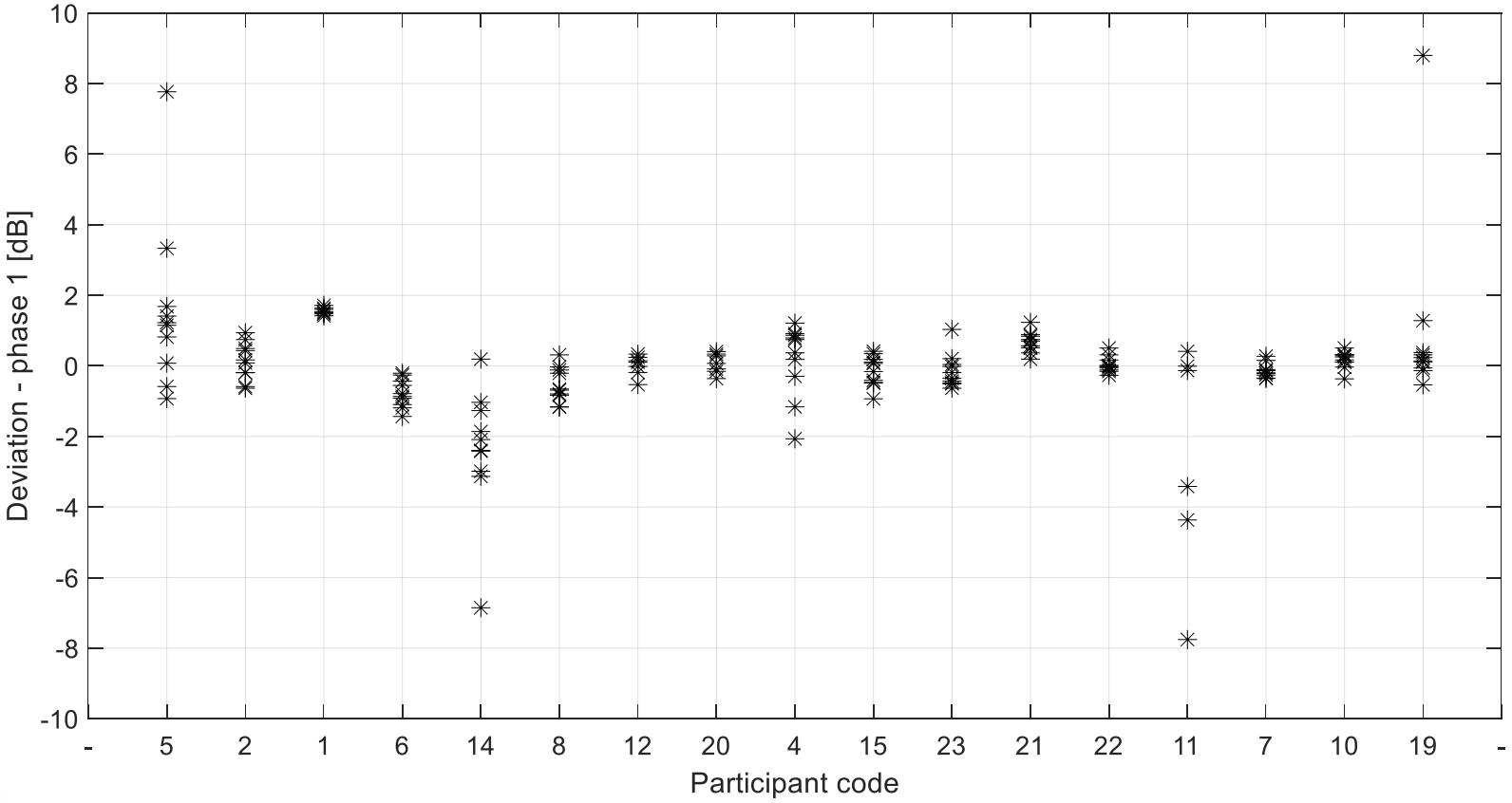
Band	Harmonic #	Frequency MHz
A	2	0.0388
A	5	0.0853
A	8	0.1250
B	5	1.3750
B	20	5.125
B	35	8.875
B	50	12.625
B	65	16.375
B	80	20.125
B	100	25.125

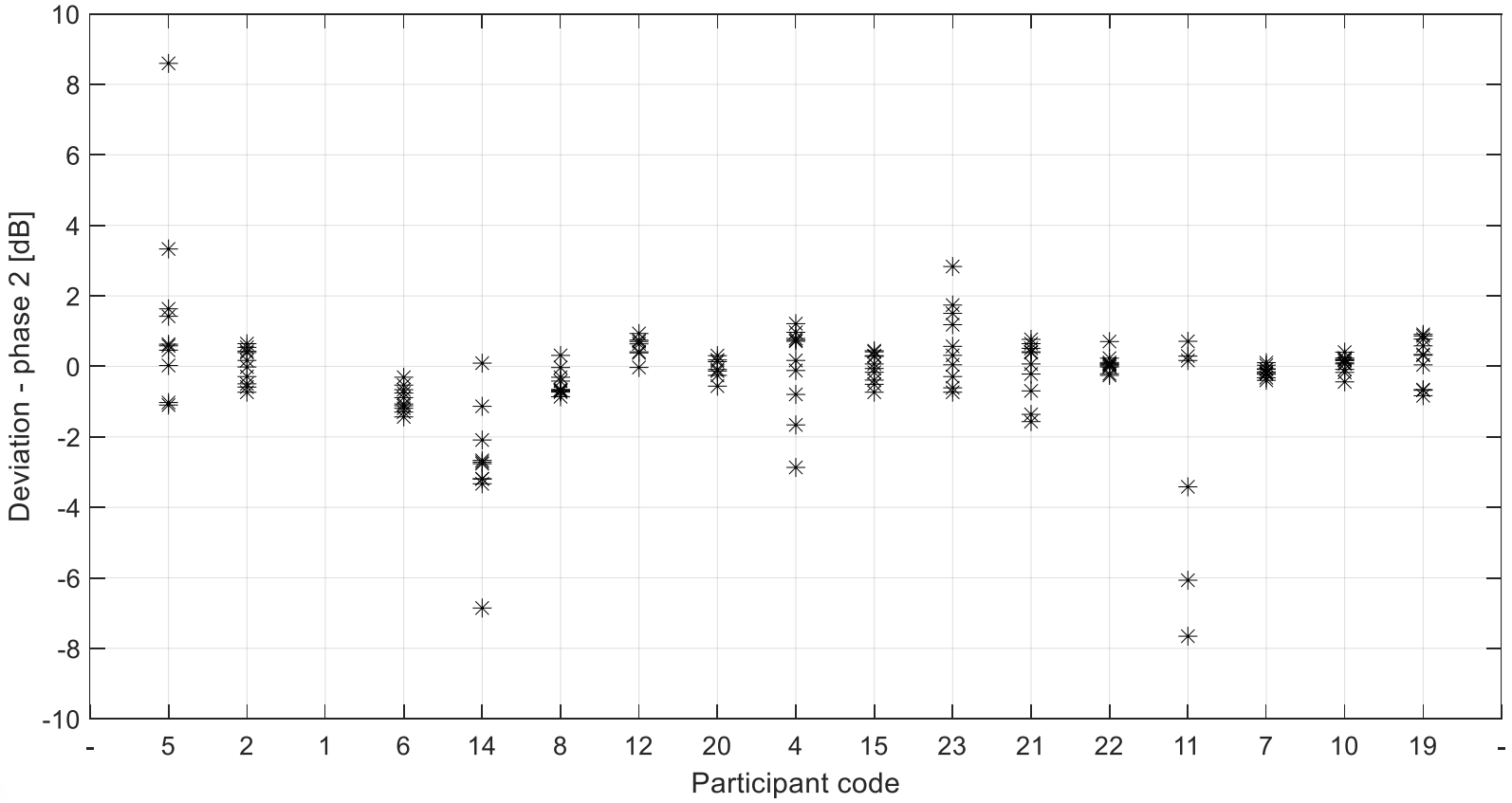

Deviation - phase 1 [dB]
10
8
6
4
2
0
-2
-4
-6
-8
-10
2A
5
8
5B
20
35
50
65
80
100
Harmonic code

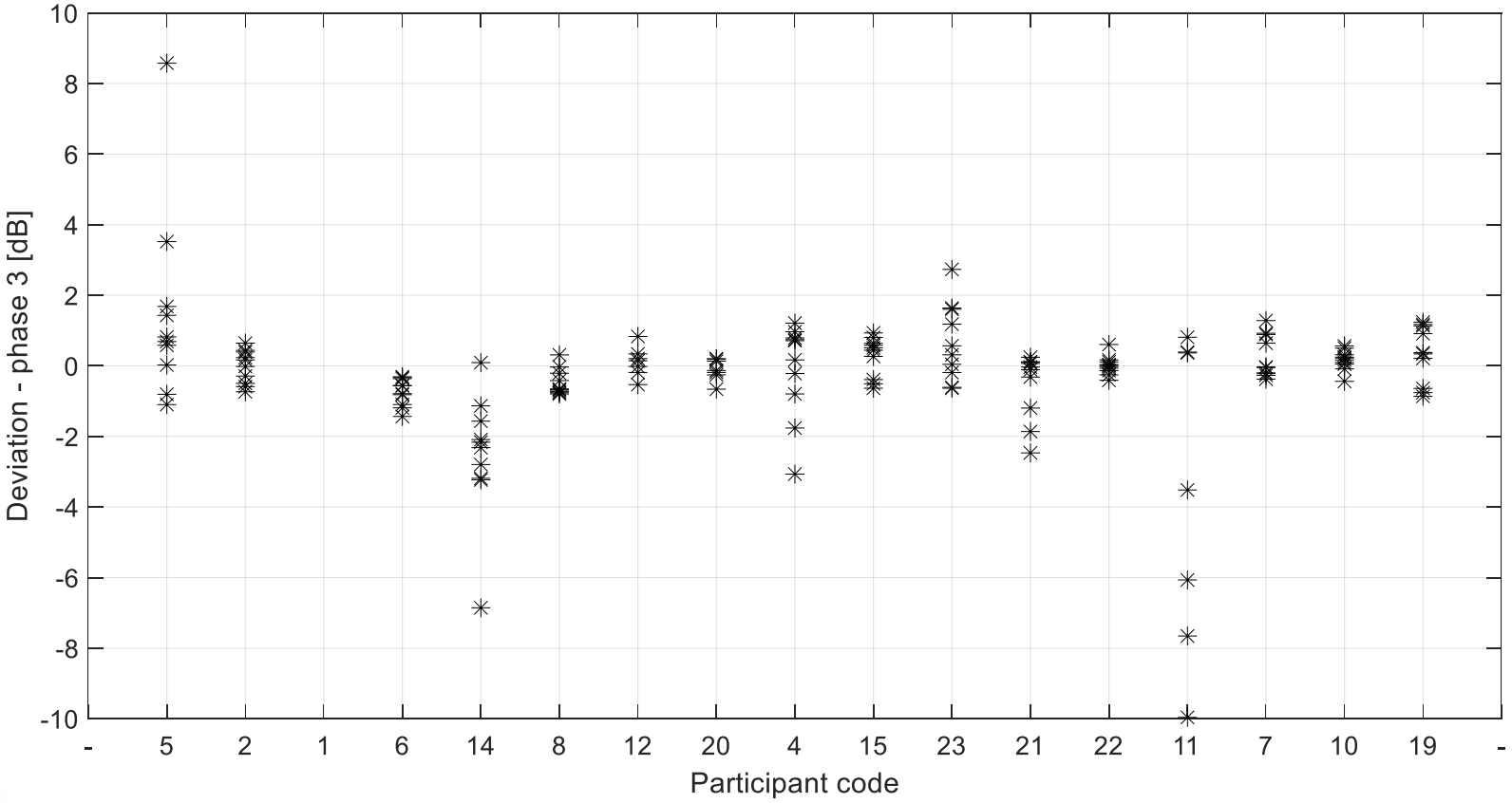

Deviation - phase 2 [dB]
10
8
6
4
2
0
-2
-4
-6
-8
-10
2A
5
8
5B
20
35
50
65
80
100
Harmonic code

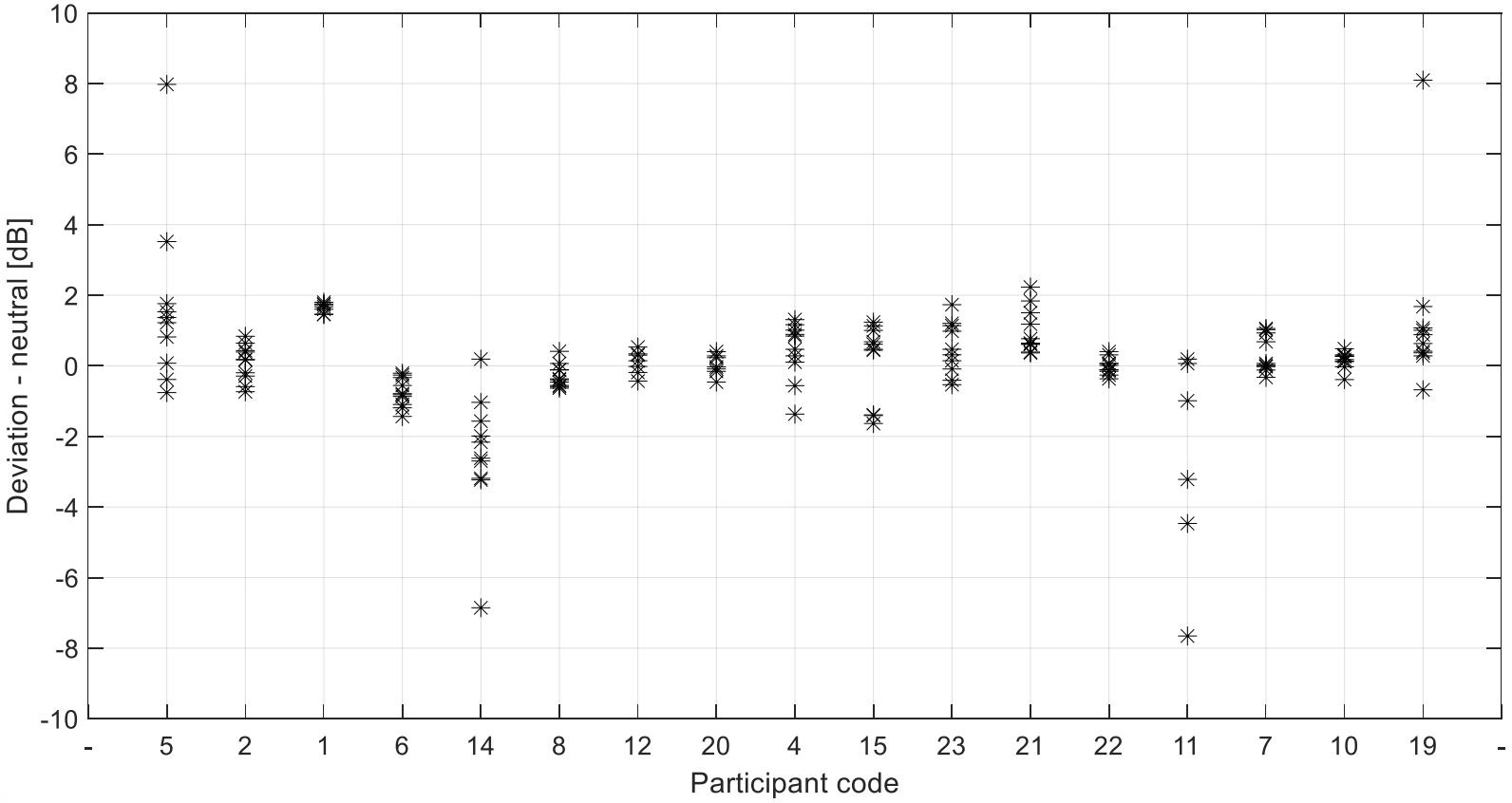

Deviation - phase 3 [dB]
10
8
6
4
2
0
-2
-4
-6
-8
-10
2A
5
8
5B
20
35
50
65
80
100
Harmonic code

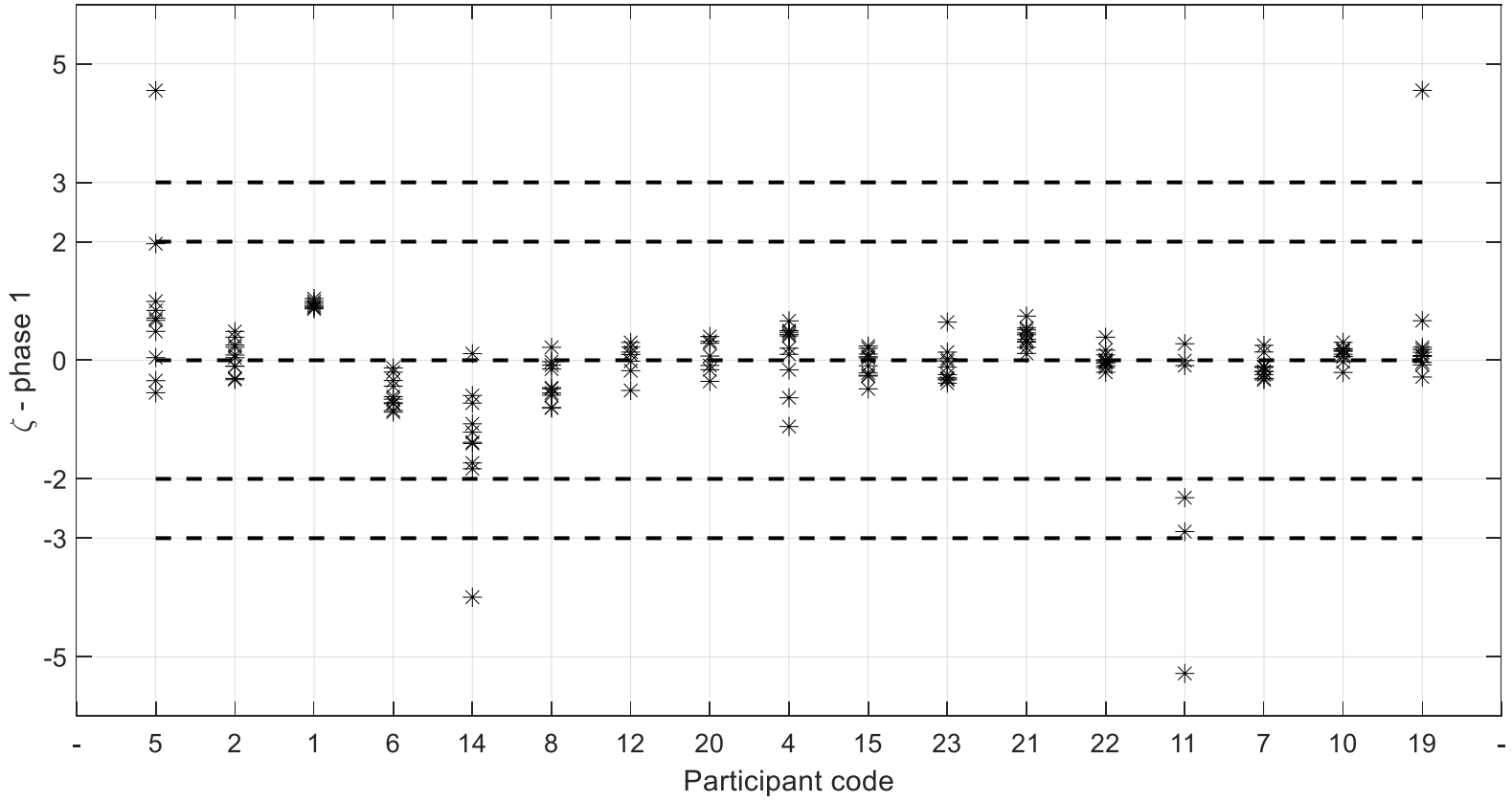

10
8
6
4
2
0
-2
-4
-6
-8
-10
Deviation - neutral [dB]
2A
5
8
5B
20
35
50
65
80
100
Harmonic code

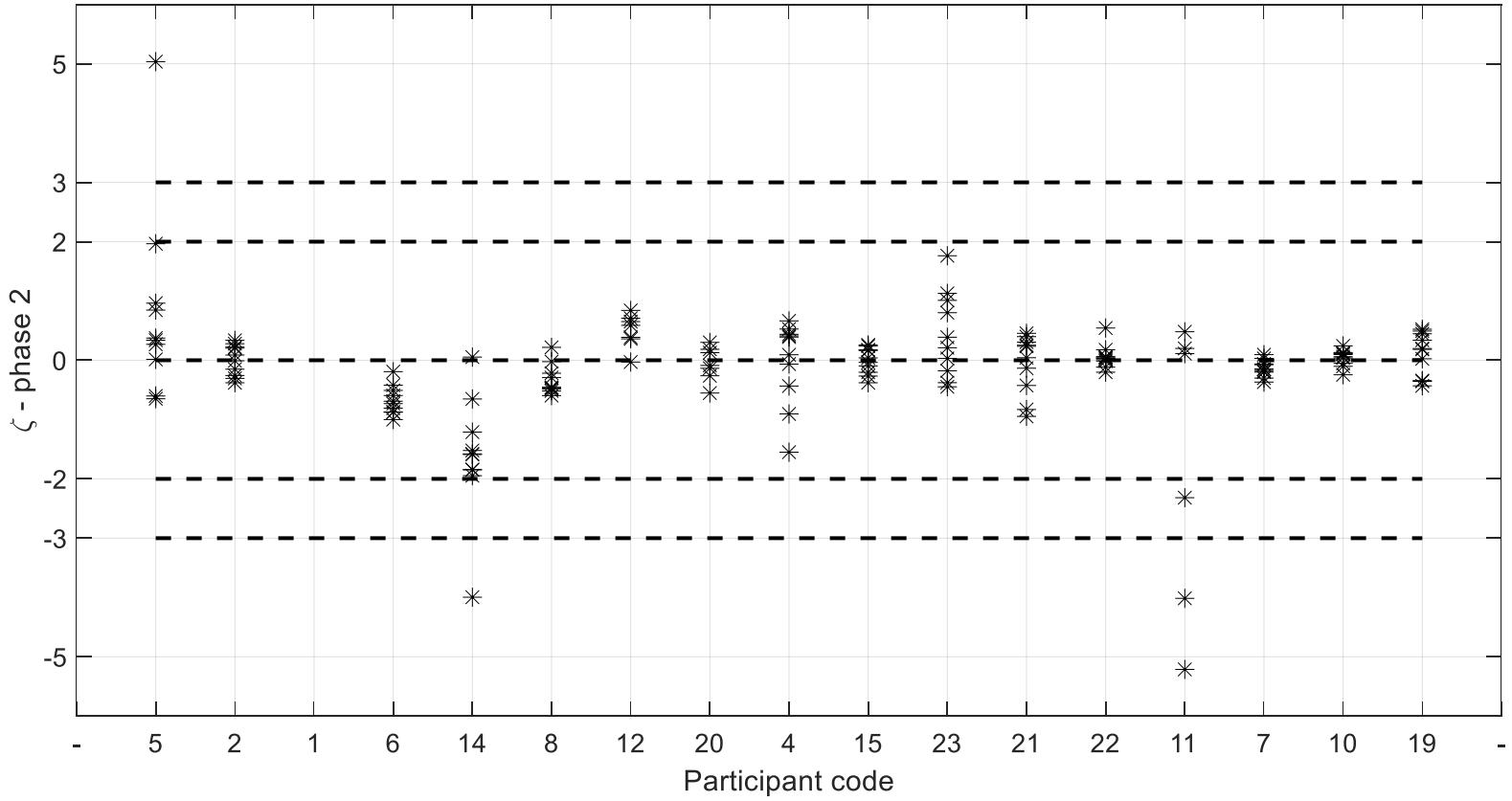

Deviation - phase 1 [dB]
10
8
6
4
2
0
-2
-4
-6
-8
-10
-
5
2
1
6
14
8
12
20
4
15
23
21
22
11
7
10
19
-
Participant code

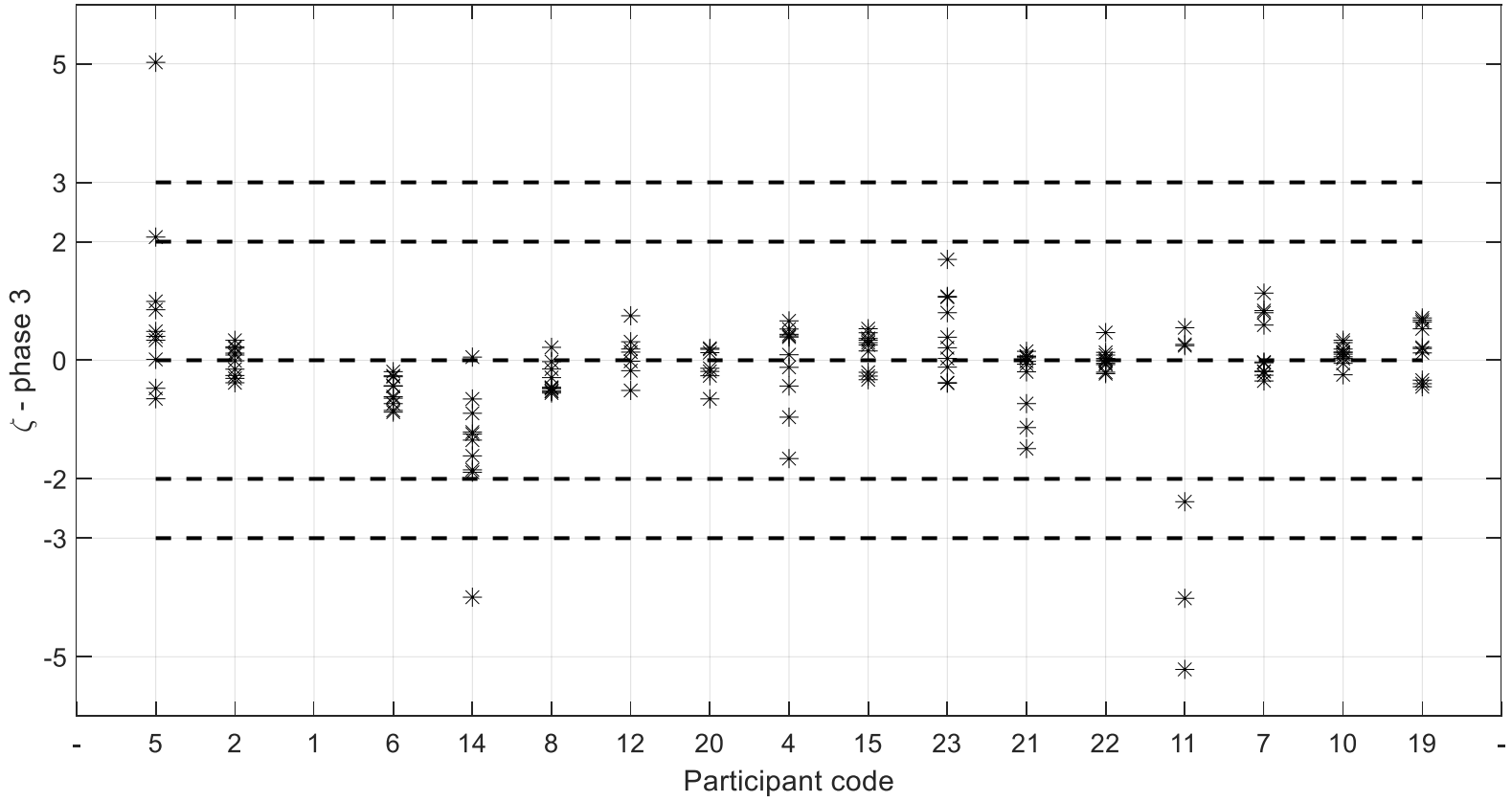

Deviation - phase 2 [dB]
10
8
6
4
2
0
-2
-4
-6
-8
-10
-
5
2
1
6
14
8
12
20
4
15
23
21
22
11
7
10
19
-
Participant code

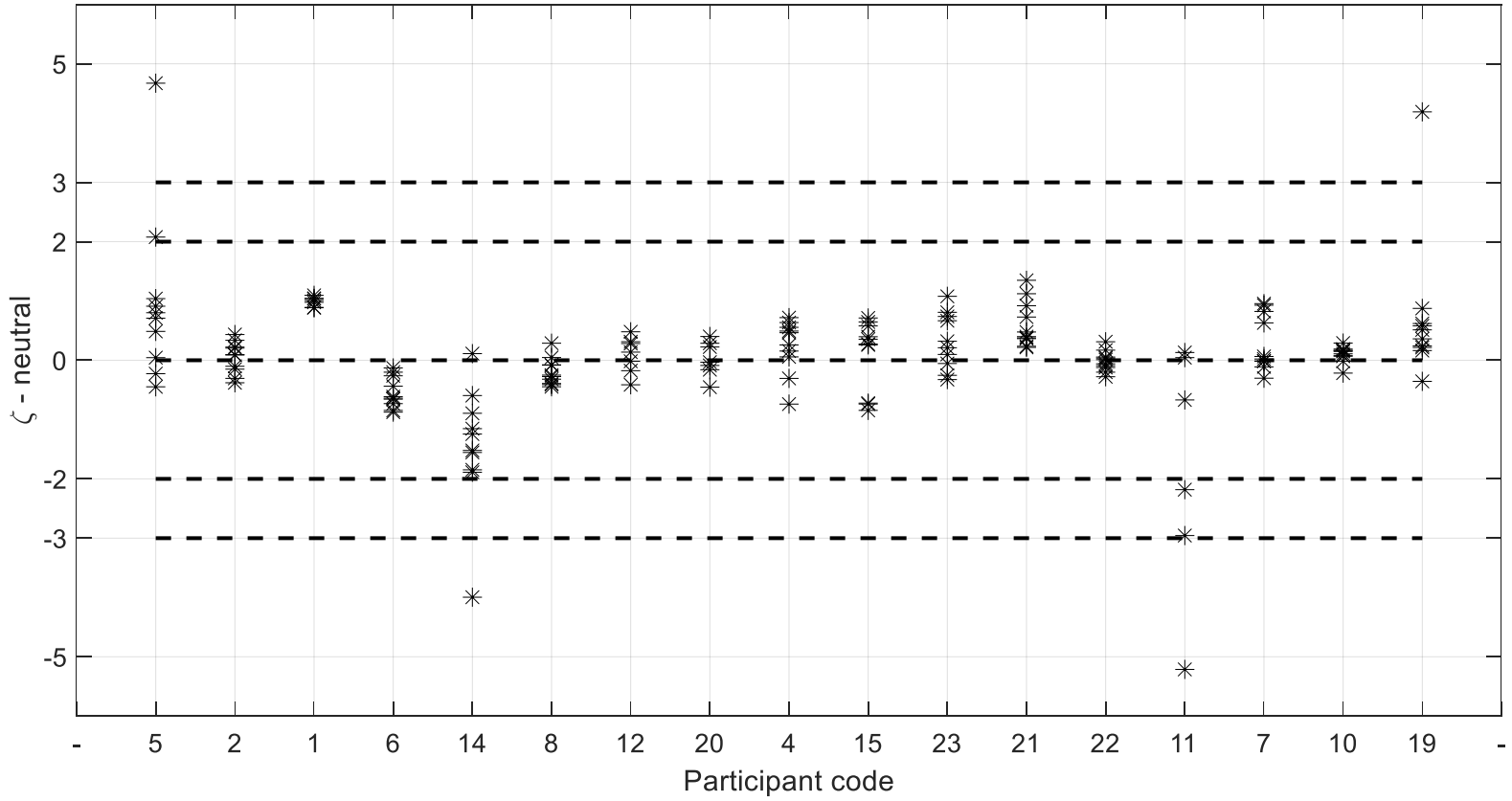

Deviation - phase 3 [dB]
10
8
6
4
2
0
-2
-4
-6
-8
-10
-
5
2
1
6
14
8
12
20
4
15
23
21
22
11
7
10
19
-
Participant code

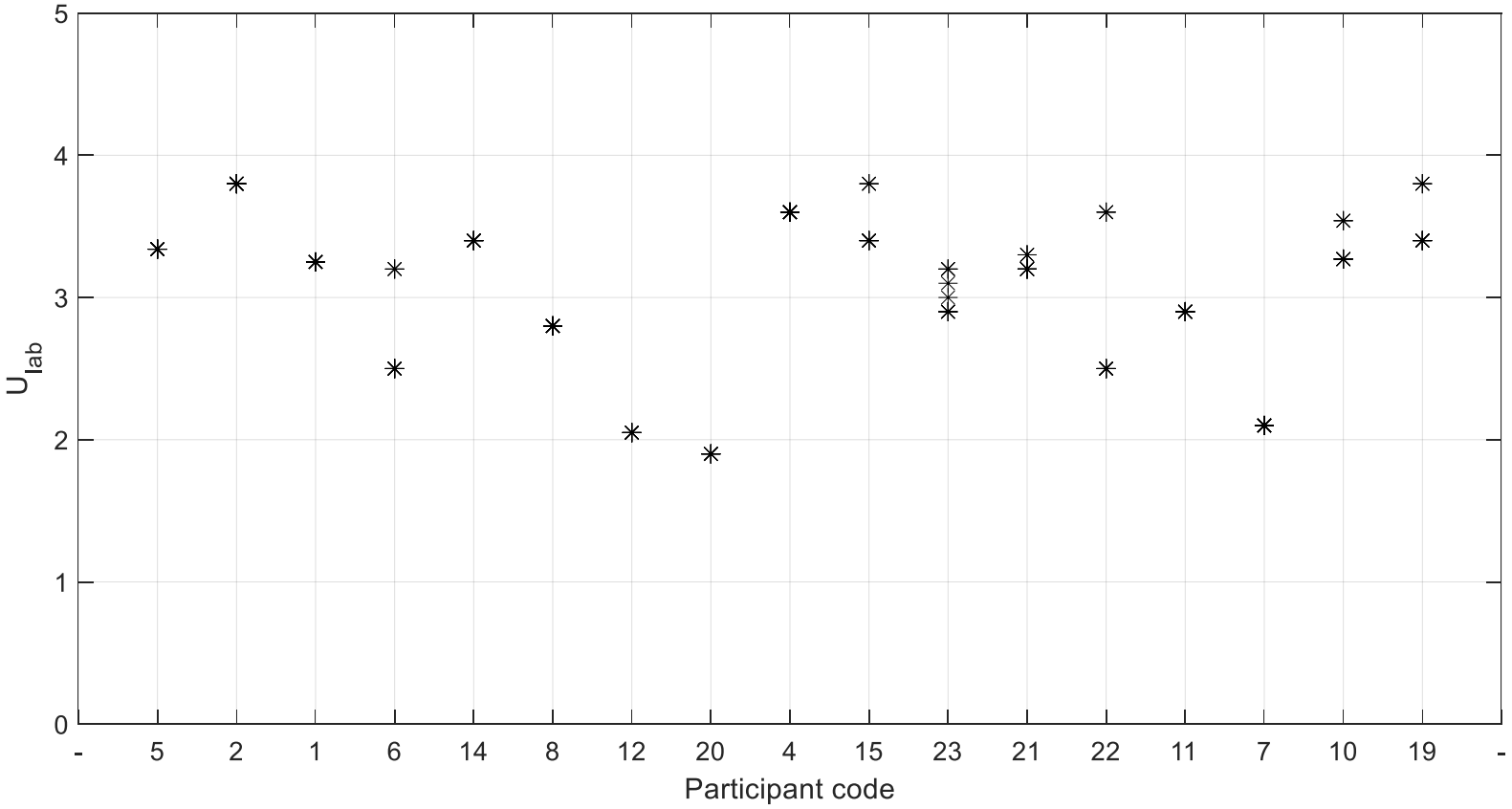

Deviation - neutral [dB]
10
8
6
4
2
0
-2
-4
-6
-8
-10
-
5
2
1
6
14
8
12
20
4
15
23
21
22
11
7
10
19
-
Participant code


ζ - phase 1
5
3
2
0
-2
-3
-5
-
5
2
1
6
14
8
12
20
4
15
23
21
22
11
7
10
19
-
Participant code


ζ - phase 2
5
3
2
0
-2
-3
-5
-
5
2
1
6
14
8
12
20
4
15
23
21
22
11
7
10
19
-
Participant code


ζ - phase 3
5
3
2
0
-2
-3
-5
-
5
2
1
6
14
8
12
20
4
15
23
21
22
11
7
10
19
-
Participant code


ζ - neutral
5
3
2
0
-2
-3
-5
-
5
2
1
6
14
8
12
20
4
15
23
21
22
11
7
10
19
-
Participant code


5
4
3
2
1
0
U_{lab}
-
5
2
1
6
14
8
12
20
4
15
23
21
22
11
7
10
19
-
Participant code

Ref. vales – comparison

f MHz	*u* dB	*X* - *x** dB	*s** dB	*z'*
0.03875	1.25	-0.4	1.1	-0.3
0.08525	1.25	-0.1	0.9	0.0
0.125	1.25	-0.1	0.5	-0.1
1.375	1.25	-0.6	0.7	-0.5
5.125	1.25	-0.4	0.9	-0.3
8.875	1.25	-0.4	0.6	-0.4
12.625	1.25	-0.1	0.8	-0.1
16.375	1.25	0.0	1.0	0.0
20.125	1.25	-0.1	1.1	-0.1
25.125	1.25	-0.3	1.3	-0.2

Remarks

- The reference values obtained from calibration of the Sample and from robust statistical analysis are compatible each other (maximum deviation 0.6 dB, over ten frequencies).
- The measurement results provided by the 17 participants at the 10 measurement frequencies selected by the Coordinator are within –10 dB to +10 dB from the reference values. Most of measurement results are within –2 dB to +2 dB from the reference values.
- 630 measurement results were provided by the participants and 24 signals (warning and action) were issued
- The standard measurement uncertainty declared by the laboratories is comprised between nearly 1 dB and 2 dB, robust standard deviation s^* is less than 1.3 dB.