

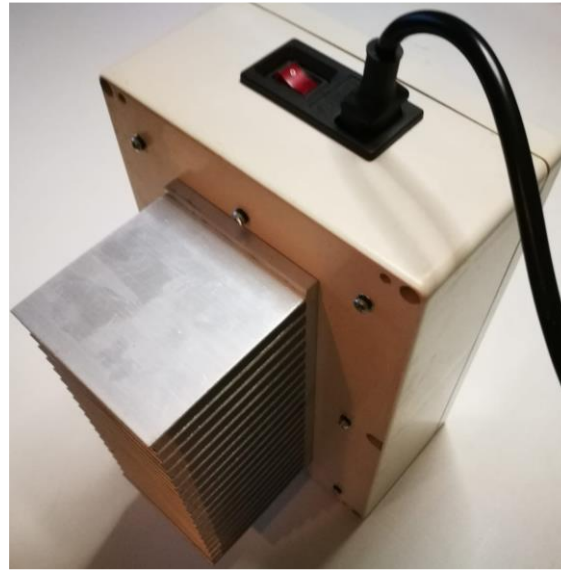
Proficiency Test of Current Harmonics Measurements PTC(HARM-CUR-50-2000-II)

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Rev. 0

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Travelling Sample for harmonic current generation



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

General information

- Number of participants: 8
- Start date: Week 44/2022
- Stop date: Week 41/2023
- Issues faced:
 - Delay in sending test reports to the Coordinator
- Scheme of the proficiency test PTC(HARM-CUR-50-2000):
<https://www.dinfo.unifi.it/vp-436-schemes-of-the-proficiency-tests.html>

Measurement procedure

- Harmonic current measurement is carried out according to §6.3 of EN 61000-3-2:2019.
- Set the test observation period $T_{\text{obs}} = 10 \text{ s}$ (or larger)
- After measurement check that the value of the harmonic of order 1 (at the 50 Hz fundamental frequency) is $256.00 \text{ mA} \pm 15.00 \text{ mA}$. If the measured value is outside the specified 241.00 mA to 271.00 mA interval, then immediately contact the Coordinator. The interlaboratory comparison is temporarily postponed until the cause of this out-of-tolerance measured value is clarified and appropriate corrective actions are undertaken.
- Supply voltage is 230 V (rms)

Harmonics to be measured

Table 1: Table to be used for recording the harmonic currents measurement results. Column four shall be filled up by the Laboratory, the other columns (two, three, five and six) will be filled up by the Coordinator.

1	2	3	4	5	6
Harmonic order	x^* mA	s^* mA	x mA	z	ζ
3	-	-		-	-
7	-	-		-	-
11	-	-		-	-
15	-	-		-	-
19	-	-		-	-
23	-	-		-	-
27	-	-		-	-
31	-	-		-	-
35	-	-		-	-
39	-	-		-	-

Reference values

- Reference values are:
 - x^* reference value of the current harmonic at a given frequency
 - s^* standard deviation of the current harmonic at a given frequency
 - σ_{PT} standard deviation obtained by the Coordinator dividing by 3 (see §8.1.2 of ISO 13528:2015) the maximum reproducibility error reported in §6.3.3.2 of EN 61000-3-2:2019.
- x^* and s^* are obtained through the robust statistical analysis in terms of robust mean and robust standard deviation

Robust statistical analysis

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

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

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

} Initial reference value

$\delta = 1,5s^*$

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

} Transformed set of data

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

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

} New reference value
(iterative algorithm)



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

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

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

- Performance statistics z quantifies relative performance of each laboratory compared to the participating laboratories

Performance statistic ζ

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

$$\zeta_i = \frac{x_i - x^*}{\sigma_{PT}}$$

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

- Performance statistics ζ quantifies performance of each laboratory compared to the expected reproducibility reported in §6.3.3.2 of EN 61000-3-2:2019

Reproducibility

- The maximum reproducibility error is $1\% \cdot I_{in} + 10 \text{ mA}$ where I_{in} is the average value, over the observation period, of the total input current
- The total input current of the travelling sample is approximately 500 mA then the maximum reproducibility error is 15 mA and $\sigma_{PT} = 5 \text{ mA}$.
- **Differences in measurement results that are less than standard measurement reproducibility are deemed to be negligible**

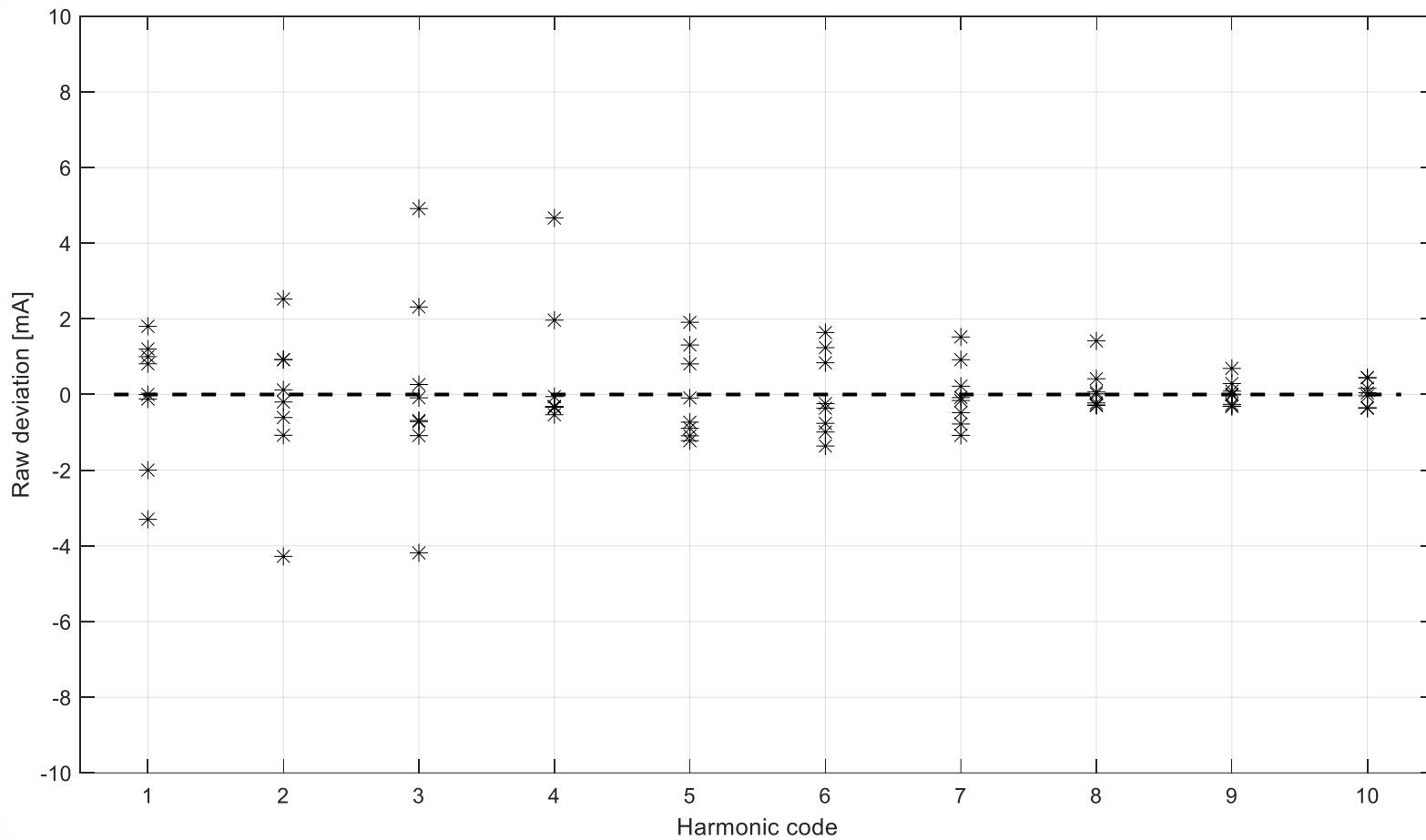
Results

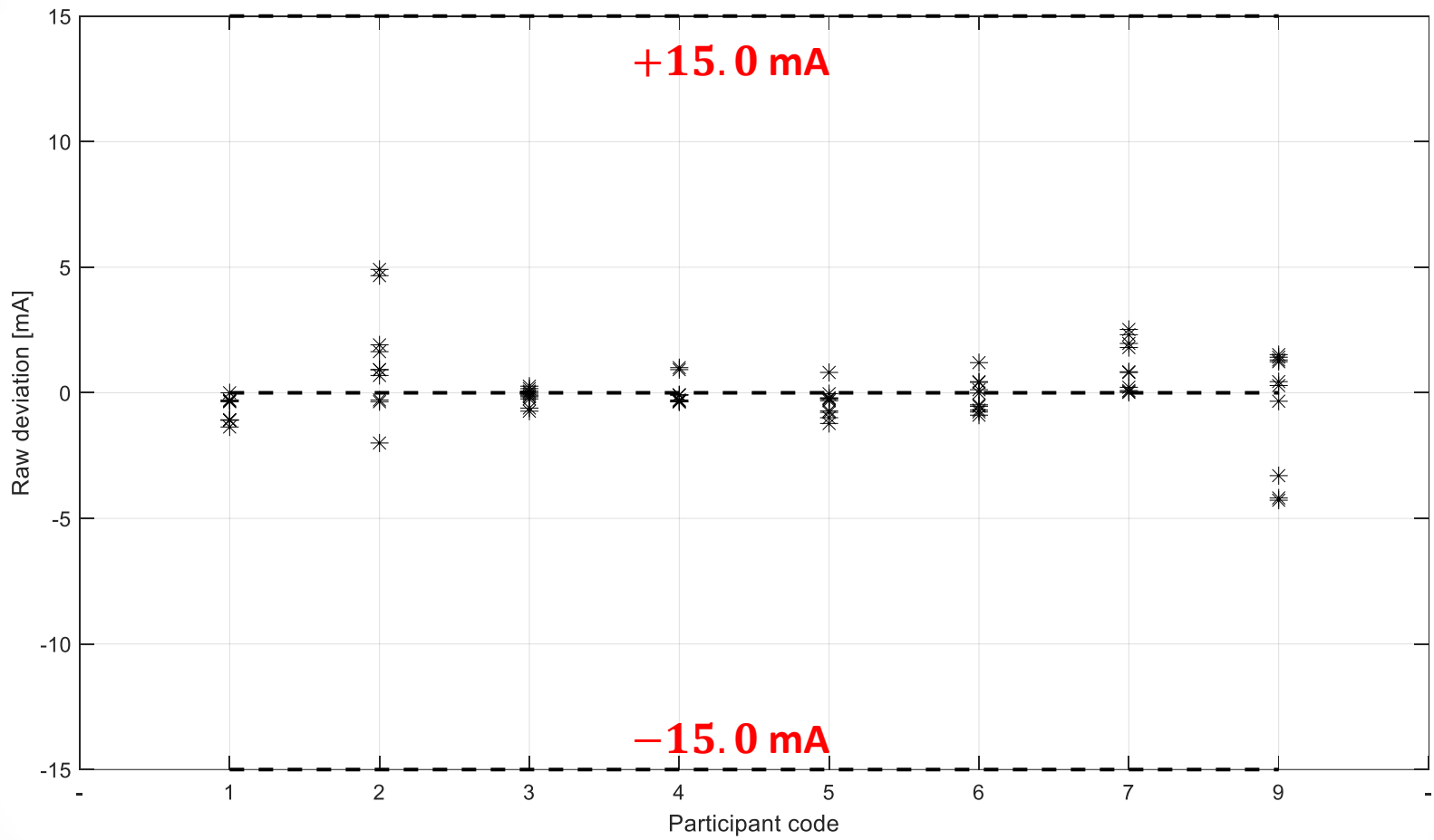
Harmonic code to frequency conversion

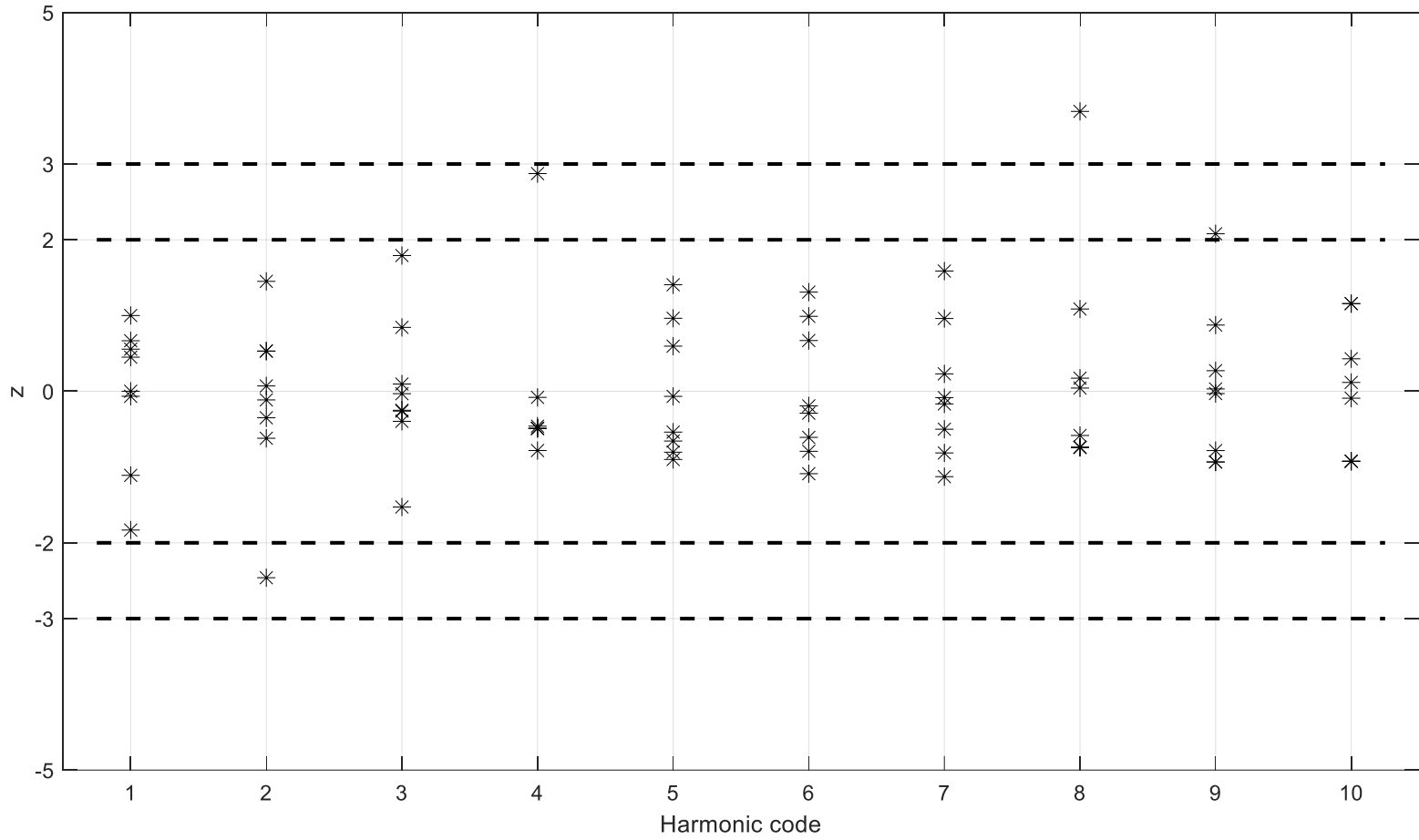
Harmonic code	Frequency Hz
1	150
2	350
3	550
4	750
5	950
6	1150
7	1350
8	1550
9	1750
10	1950

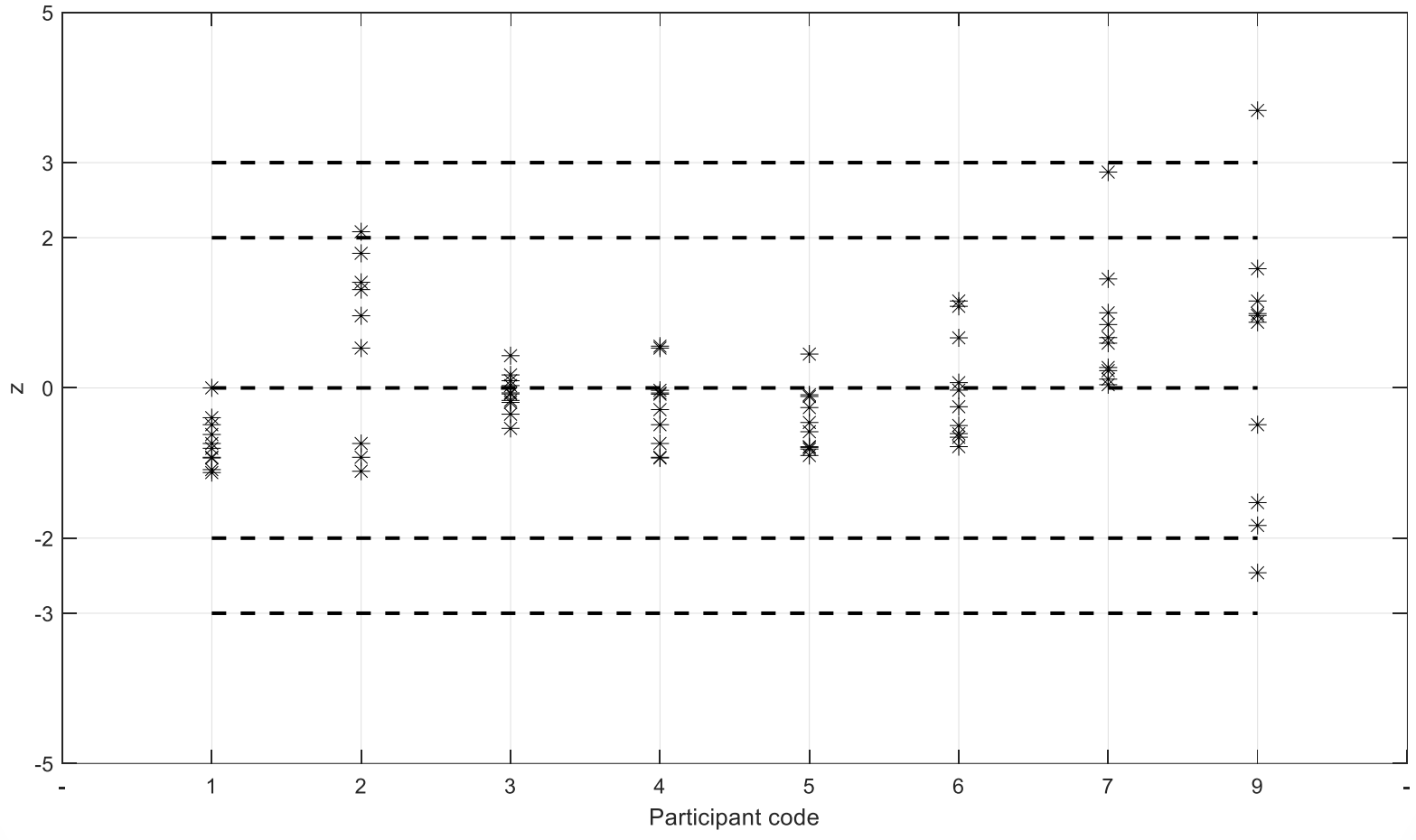
Interpretation of results

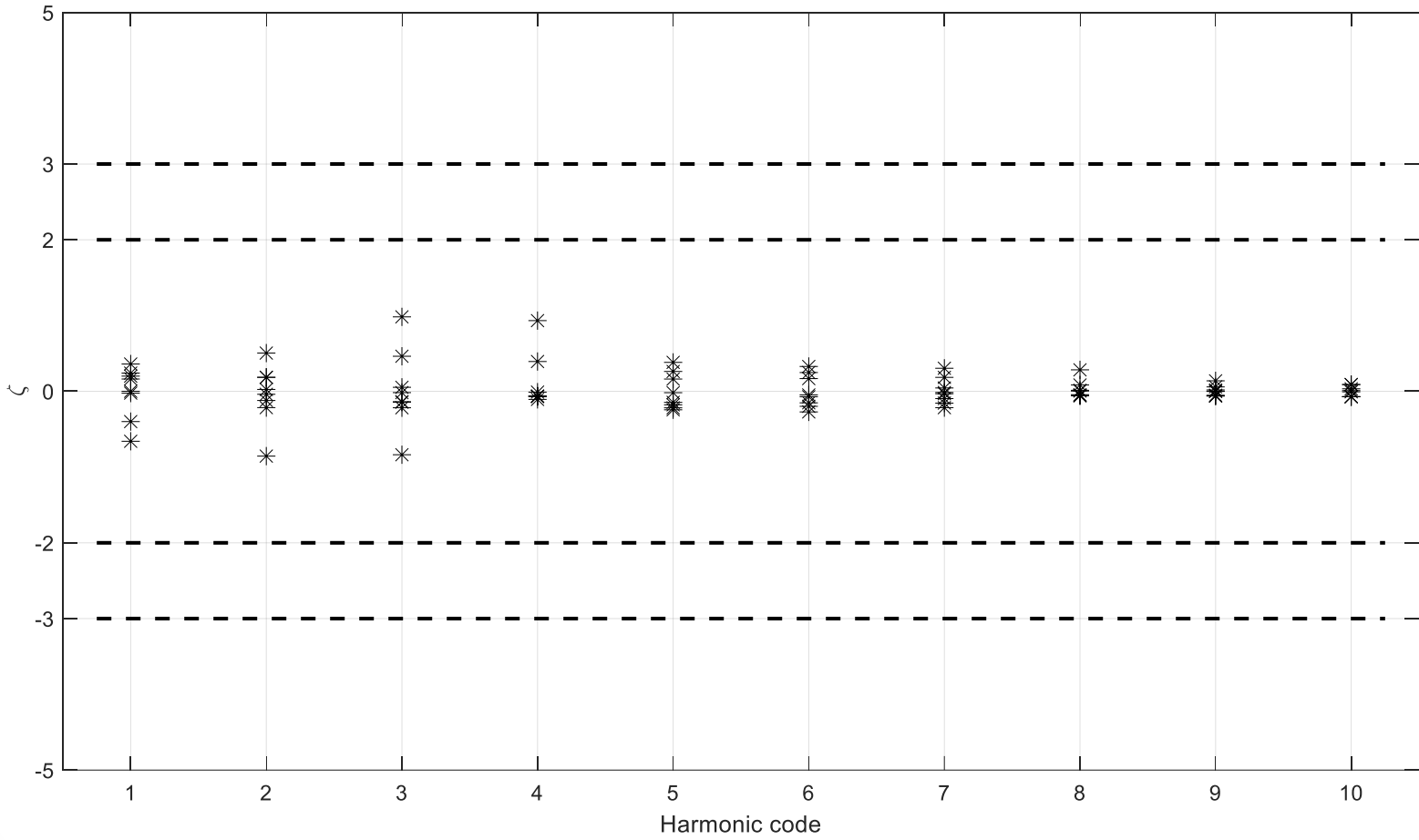
- Results are reported as:
 - Raw deviation between x_i , the measurement result of the i -th laboratory at a given frequency, and x^* reference value of the electric field at the same frequency
 - Performance statistic z_i of the i -th laboratory at a given frequency
 - Performance statistic ζ_i of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

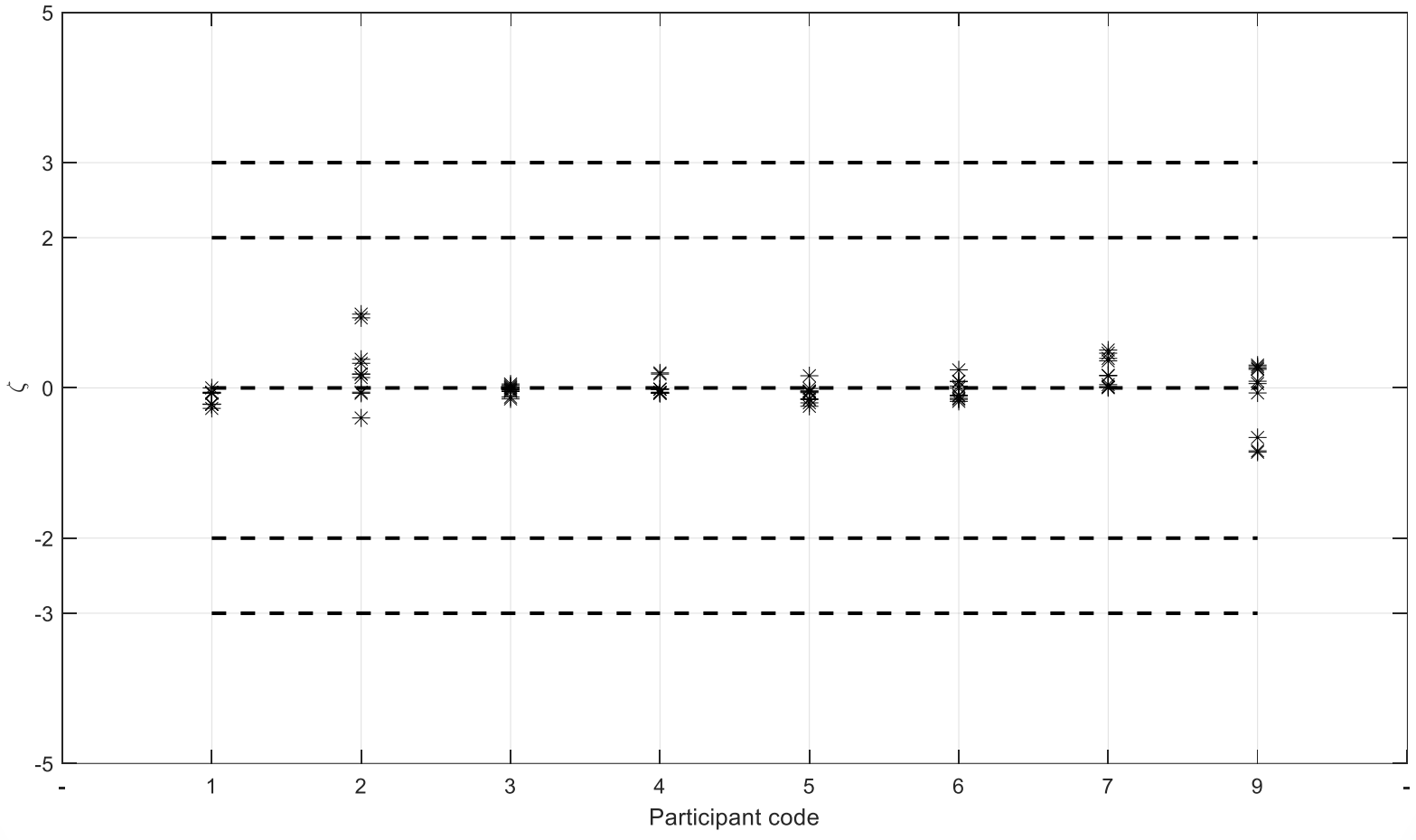












Harmonic	Frequency	x^*	s^*
#	Hz	mA	mA
3	150	239.0	1.8
7	350	174.1	1.7
11	550	94.1	2.7
15	750	45.3	0.7
19	950	41.1	1.4
23	1150	31.4	1.3
27	1350	19.1	1.0
31	1550	17.3	0.4
35	1750	14.3	0.3
39	1950	9.4	0.4

Remarks

- The measurement results provided by the 8 participants at the 10 measurement frequencies selected by the Coordinator are within -5 mA to $+5$ mA from the reference values
- 80 measurement results were provided by the participants and 3 warning and 1 action signals were issued, all based on z performance statistics
- Warning and action signals based on z performance statistics are an indication of relative performance of one participant with respect to the average of all participants
- No anomaly was detected based on ζ performance statistic, thus indicating that all participating laboratories provided measurement results compatible with the expected reproducibility (see §6.3.3.2 of EN 61000-3-2:2019)
- The measurement results provided by ALL laboratories are well within the expected reproducibility of ± 15.0 mA
- The robust standard deviation s^* is comprised between 0.3 mA and 2.7 mA
- **Since all measurement results are within the expected reproducibility warning and action signals based on z statistics should NOT be interpreted as a noncompliance with EN 61000-3-2 standard**