Proficiency Testing of Radiated Emission Measurements PTC(RE-30-6000)

Firenze, 3rd of November 2015
Rev. 1, 6th of November 2015

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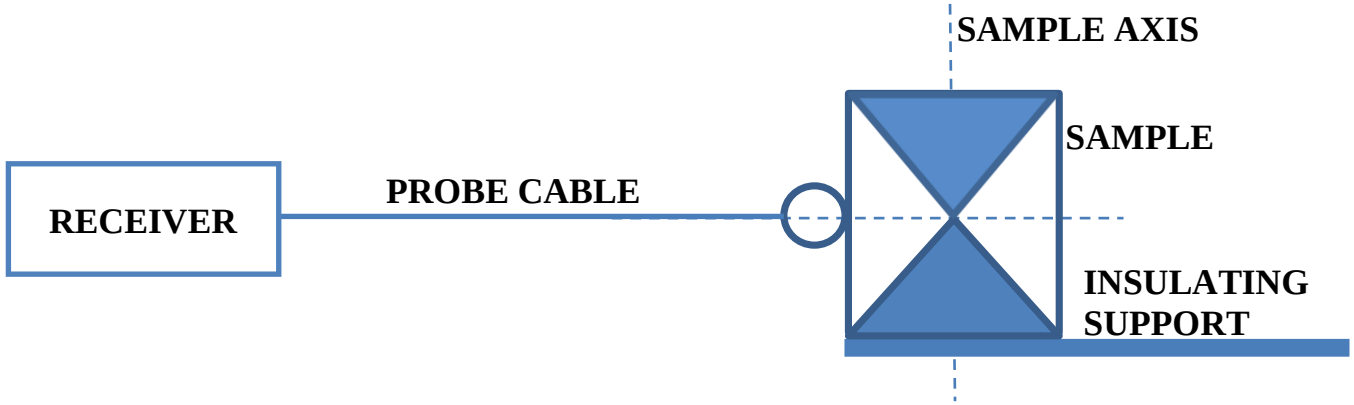
Travelling Sample for the 30 MHz to 6 GHz frequency range (Radiated Emission)

Preliminary verification

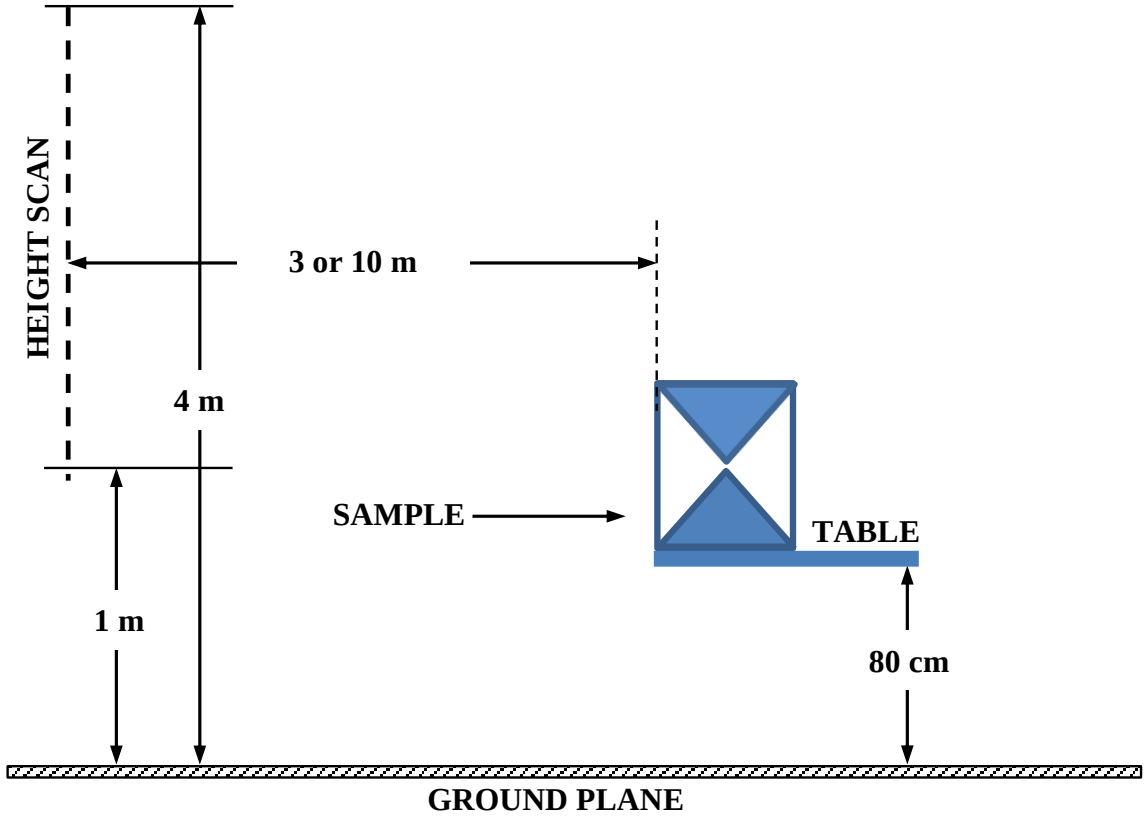


Harmonic #	Frequency MHz	P_{ref} dBm	P_m dBm	Δ dB
20	1000	–55	Measured value	Deviation

Verification of the power that the probe delivers to the receiver

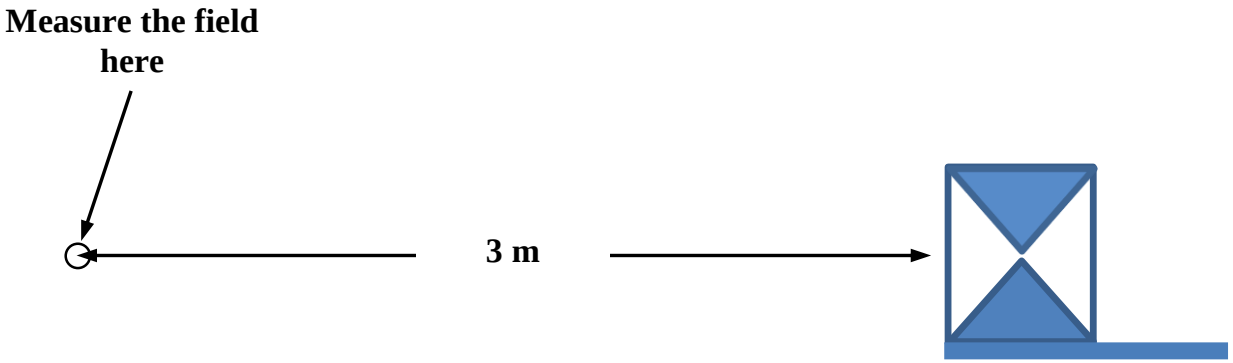
$|\Delta| < 6$ dB

Measurement setup



30 to 1000 MHz frequency rage, semi-anechoic room (3 or 10 m)

Measurement setup



30 to 1000 MHz and 1000 to 6000 MHz frequency ranges in a fully-anechoic room

General information

- Number of participants: 9
- Start date: February 2015
- Stop date: October 2015
- Issues faced: Four weeks delay in reporting to the Coordinator from two laboratories (minor issue)
- Scheme of the proficiency test PTC(RE-30-6000): http://www.emc.unifi.it/CMpro-v-p-26.html

Measurement procedure: preliminary verification

- Radiated electromagnetic field measurement must be preceded by a preliminary verification of the correct operation of the Sample by using the magnetic field probe provided by the Coordinator, a short section of coaxial cable (length less than 1 m, not provided by the coordinator) and a receiver (spectrum analyzer or EMI receiver). The verification shall be as follows:
  - Connect the probe to the input of the receiver through the short section of coaxial cable.
  - Put the Sample on the same table used for radiated emission testing of table-top equipment.
  - Turn on the Sample. The Sample shall be fed by its internal battery (the Sample shall not be connected with the power supply).
  - Place the probe in the position sketched in slide 3. In particular the probe shall be positioned so that its cable is perpendicular to the axis of the Sample and at half height of the Sample. The plane of the loop shall be the one containing the probe cable and the axis of the Sample. The probe shall touch the plastic wall of the Sample.
  - Use your hand to support the probe. No special care is required.
  - Measure the power P_m that the probe delivers to the input of the receiver at the frequency of the 20th harmonic (about 1000 MHz). Register the values of P_m (in dBm, rounded to the integer) in the table in slide 3. Calculate and annotate the deviation Δ (in dB, rounded to the integer).
  - Verify that:
    - The measured power decreases by at least 20 dB rotating the probe by 90°;
    - $-6\ dB < \Delta < 6\ dB$

Measurement procedure: 30 – 1000 MHz, semi-anechoic room

- The scope of the measurement is to obtain the best estimate and measurement uncertainty of the maximum electric field strength, in dB(µV/m), emitted by the Sample in vertical polarization at the specified horizontal distance from the Sample (3 or 10 m) at a height between 1 and 4 m above the reflecting ground plane, see slide 4. The reference of the Sample for distance measurement is the plastic wall of the Sample. The use of the same measuring instrumentation as that used for radiated emission tests in the corresponding frequency range is recommended. Measurement frequencies are selected by the Coordinator.
- Measurement procedure is according to §7.3 of CISPR 16-2-3:2010.

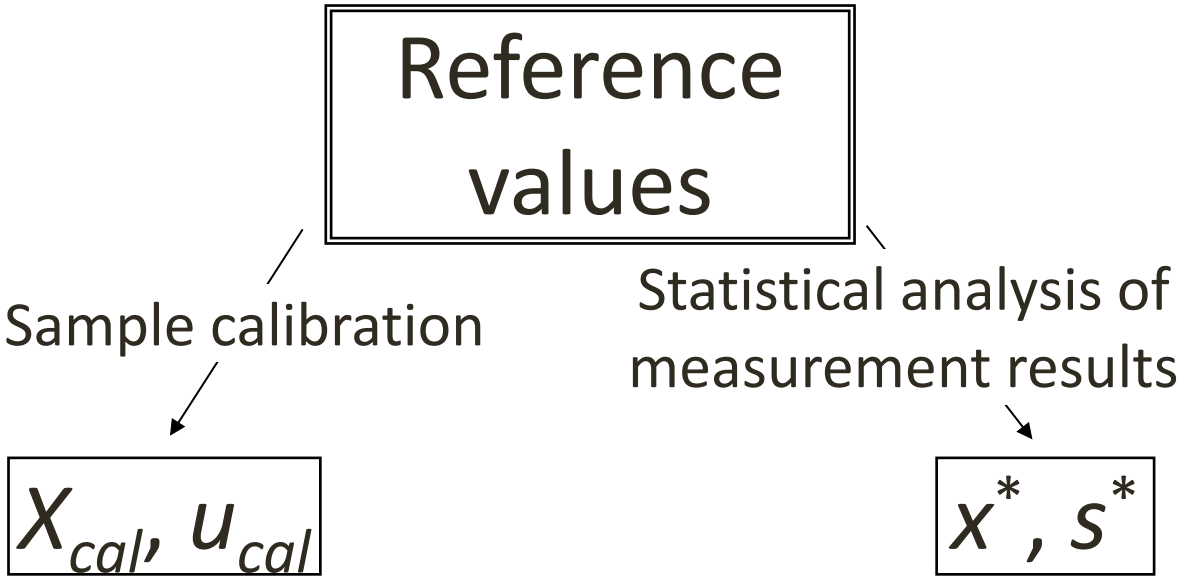
Measurement procedure: 30 – 1000 MHz and 1000-6000 MHz, fully-anechoic room

- The scope of the measurement is to obtain the best estimate and measurement uncertainty of the electric field strength, in dB(µV/m), emitted by the Sample at 3 m distance from the Sample in the boresight direction. The reference of the Sample for distance measurements is the plastic wall of the Sample facing the receiving antenna. The use of the same measuring instrumentation as that used for radiated emission tests in the corresponding frequency range is recommended. Measurement frequencies are selected by the Coordinator.
- Measurement procedure is according to §7.4 of CISPR 16-2-3:2010 and §7.6 of CISPR 16-2-3:2010.

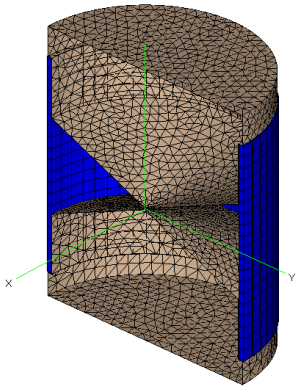
Other instructions

- It is up to the Laboratory to charge the battery before preliminary verification and measurement. Handle the Sample with care.
- The EMI receiver's detector shall be set to average.
- The measurement result provided by the Laboratory shall be:
  - The estimate *x*, expressed in dB(µV/m), of the amplitude of the selected harmonics;
  - 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).
- The Laboratory may assign a different value of U_{lab} to each measured frequency.
- The measured disturbance electric field strength *x*, in dB(µV/m), shall be rounded up to 1 decimal figure (e.g. 68,5 dB(µV/m)). Measurement uncertainty U_{lab}, in dB, shall be rounded up to 2 significant figures (e.g. 3,2 dB).

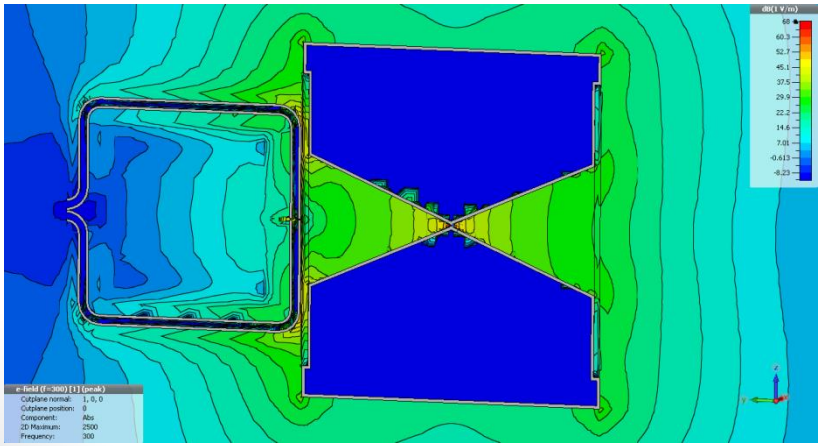
Reference values

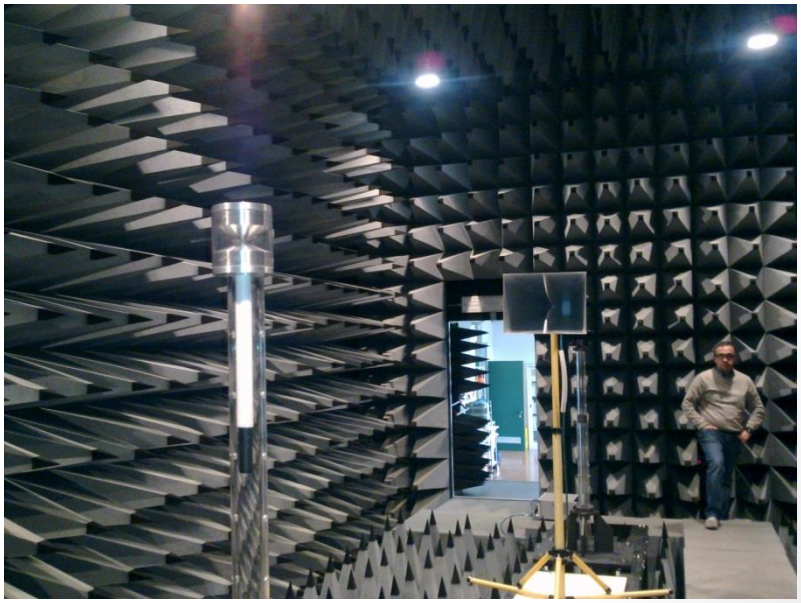


Sample calibration (RE)

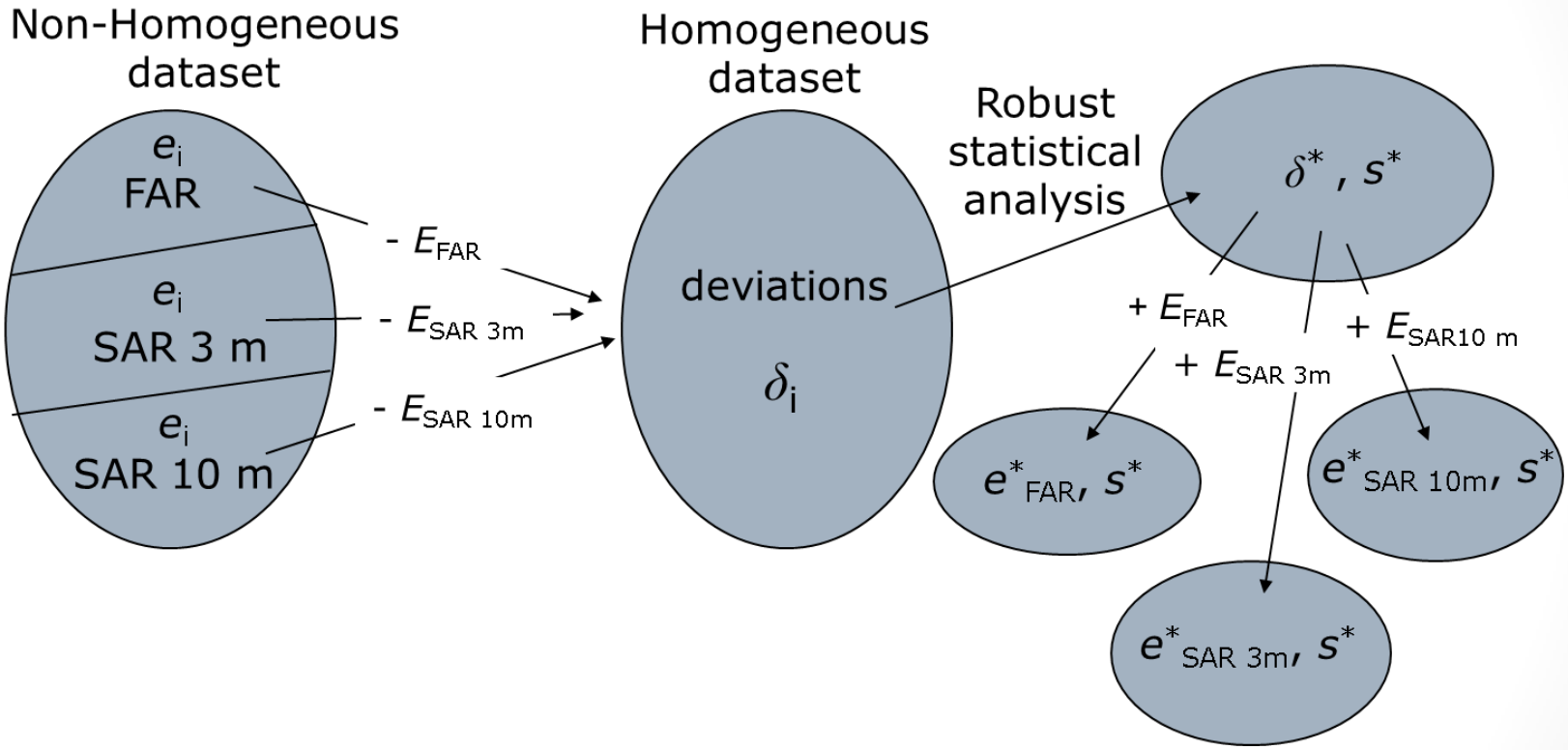


The **e.m. model of the antenna is validated** through near field (LF) and far field (HF) measurements.
E-field is predicted by using the e.m. model and source calibration.





Inhomogeneous data



E_{FAR}, $E_{SAR\ 3m}$, $E_{SAR\ 10m}$ = predicted 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 7.7 of ISO 13528) that the Coordinator applies to the Participant providing the measurement result x_i with standard uncertainty u_{xi}

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

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

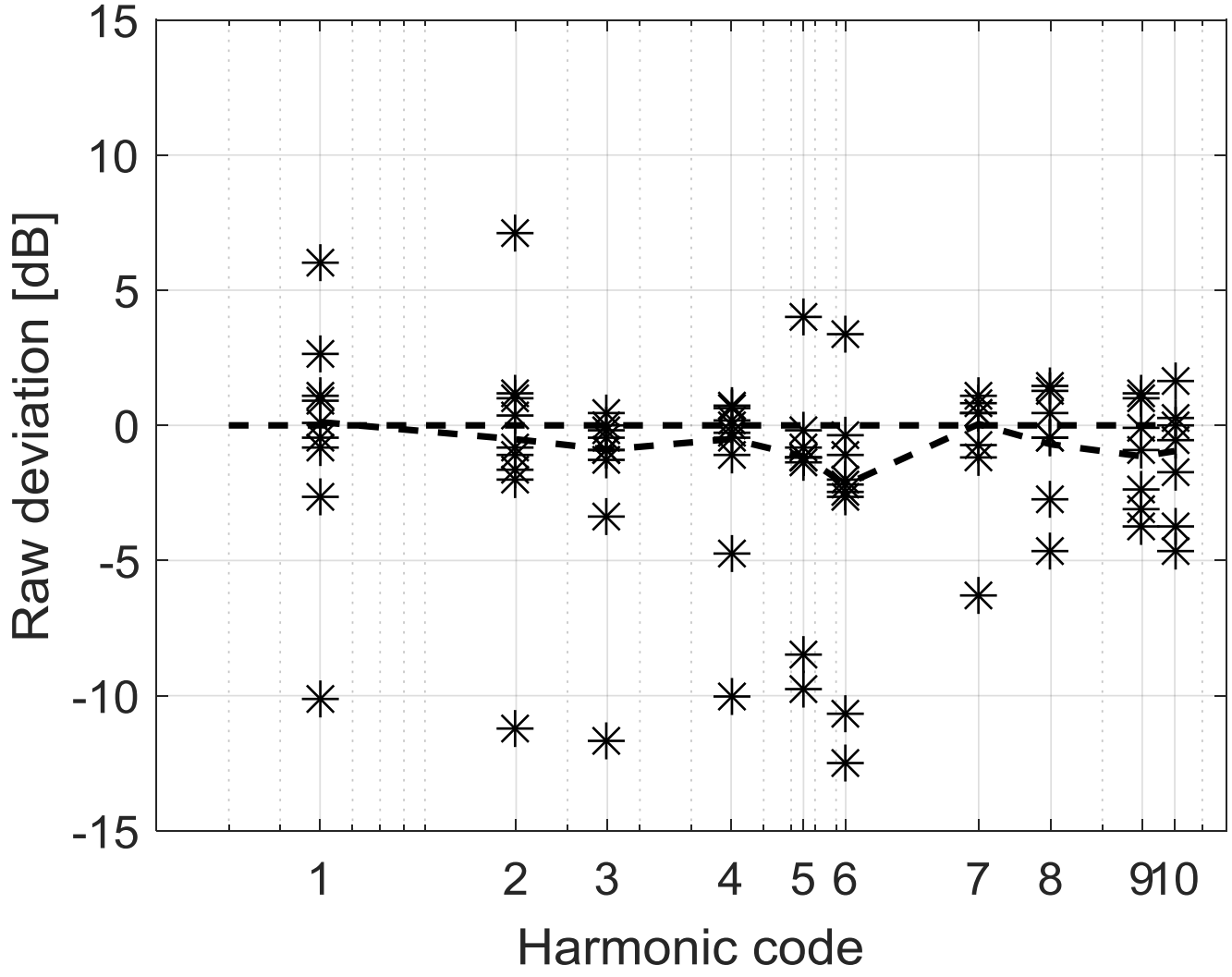
Performance statistic *z'* (Coordinator)

- Performance statistic *z'* (clause 5.7 of ISO 13528) that the Coordinator applies as self-check

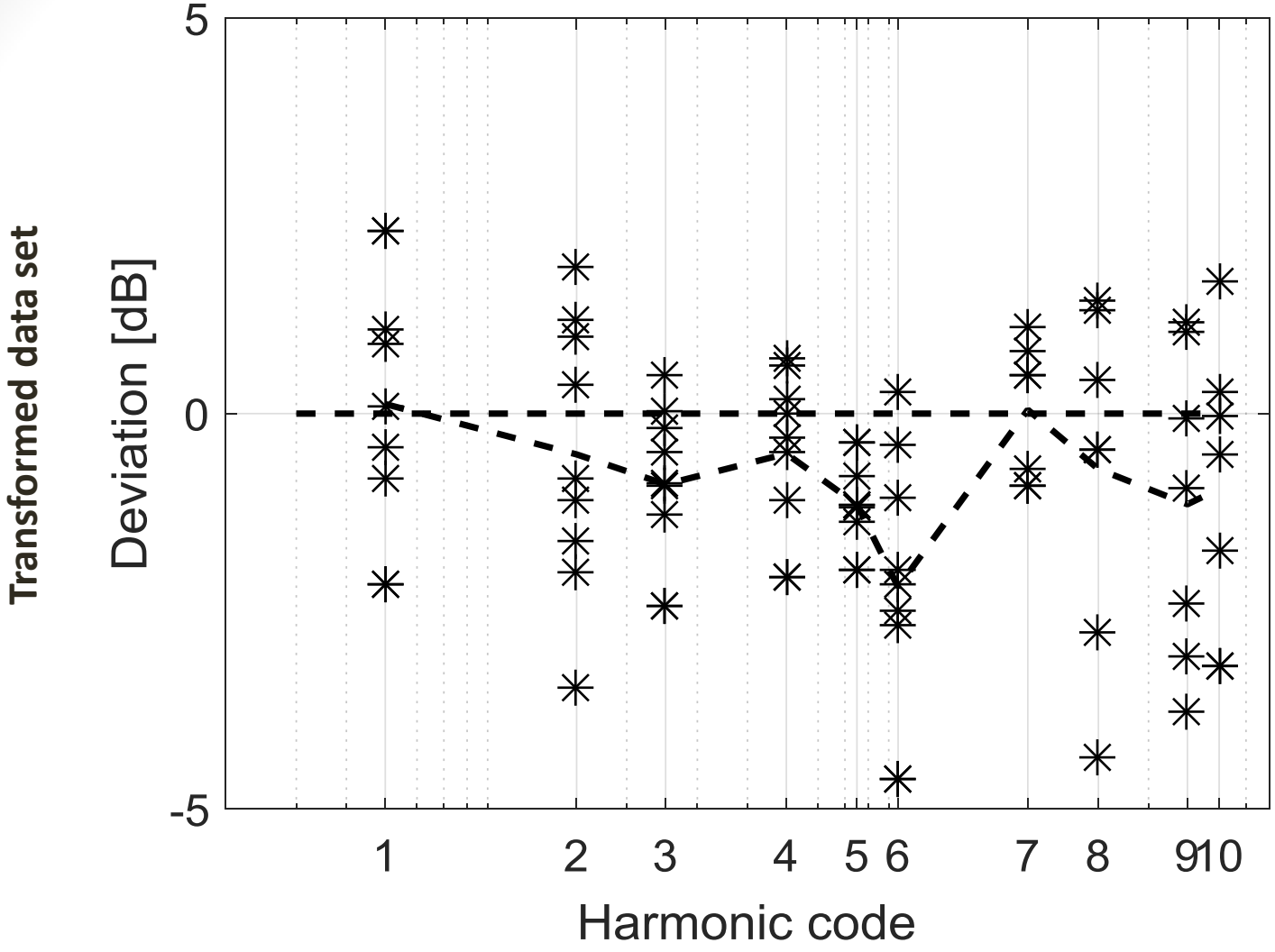
$$z' = \frac{X_{cal} - x^*}{\sqrt{u_{cal}^2 + \left(\frac{1{,}25 \cdot s^*}{\sqrt{p}}\right)^2}}$$

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

Results



1 = 50M - 2 = 150M - 3 = 250M - 4 = 500M - 5 = 750M - 6 = 950M - 7 = 2000M - 8 = 3000M - 9 = 5000M - 10 = 6000M



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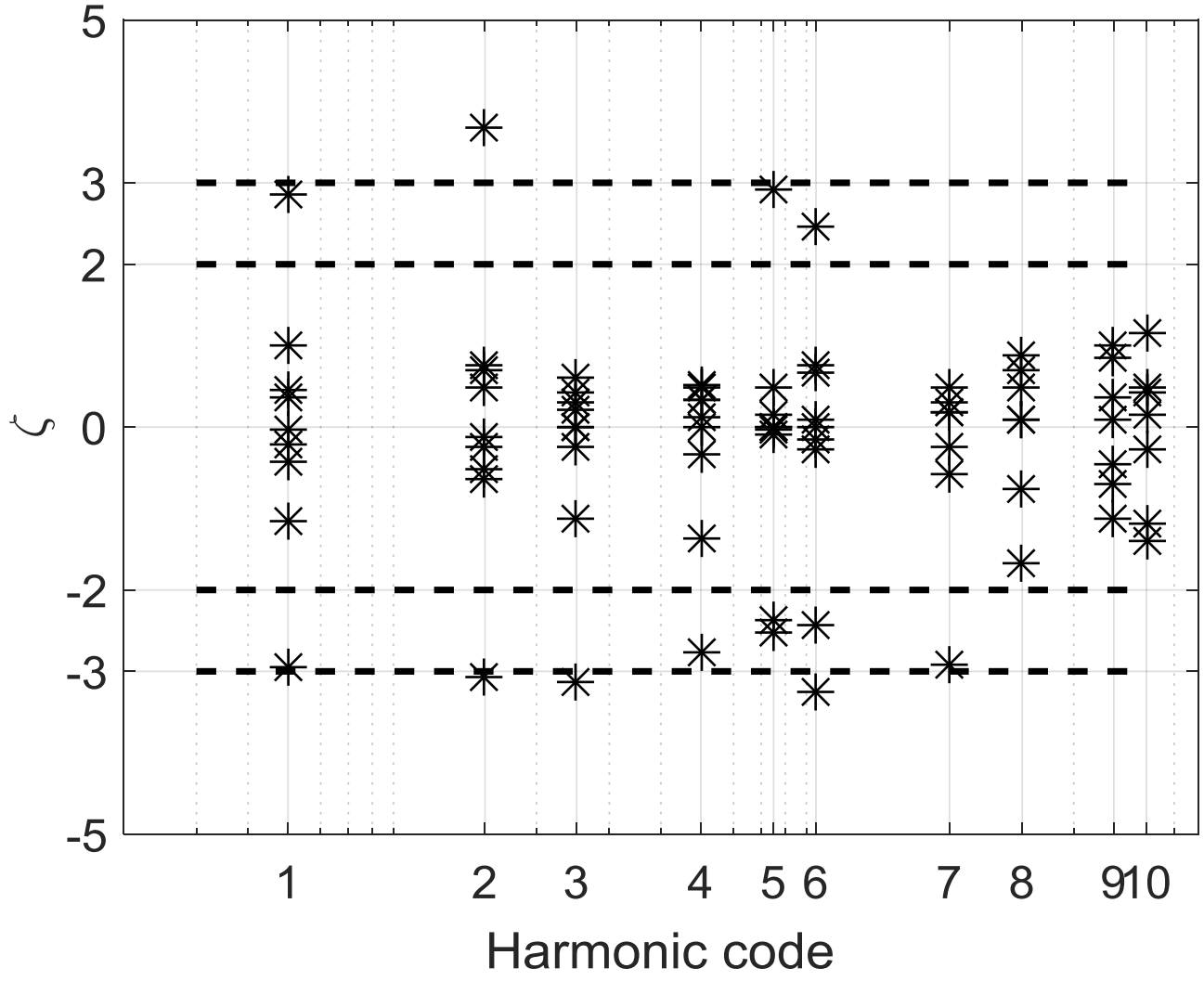

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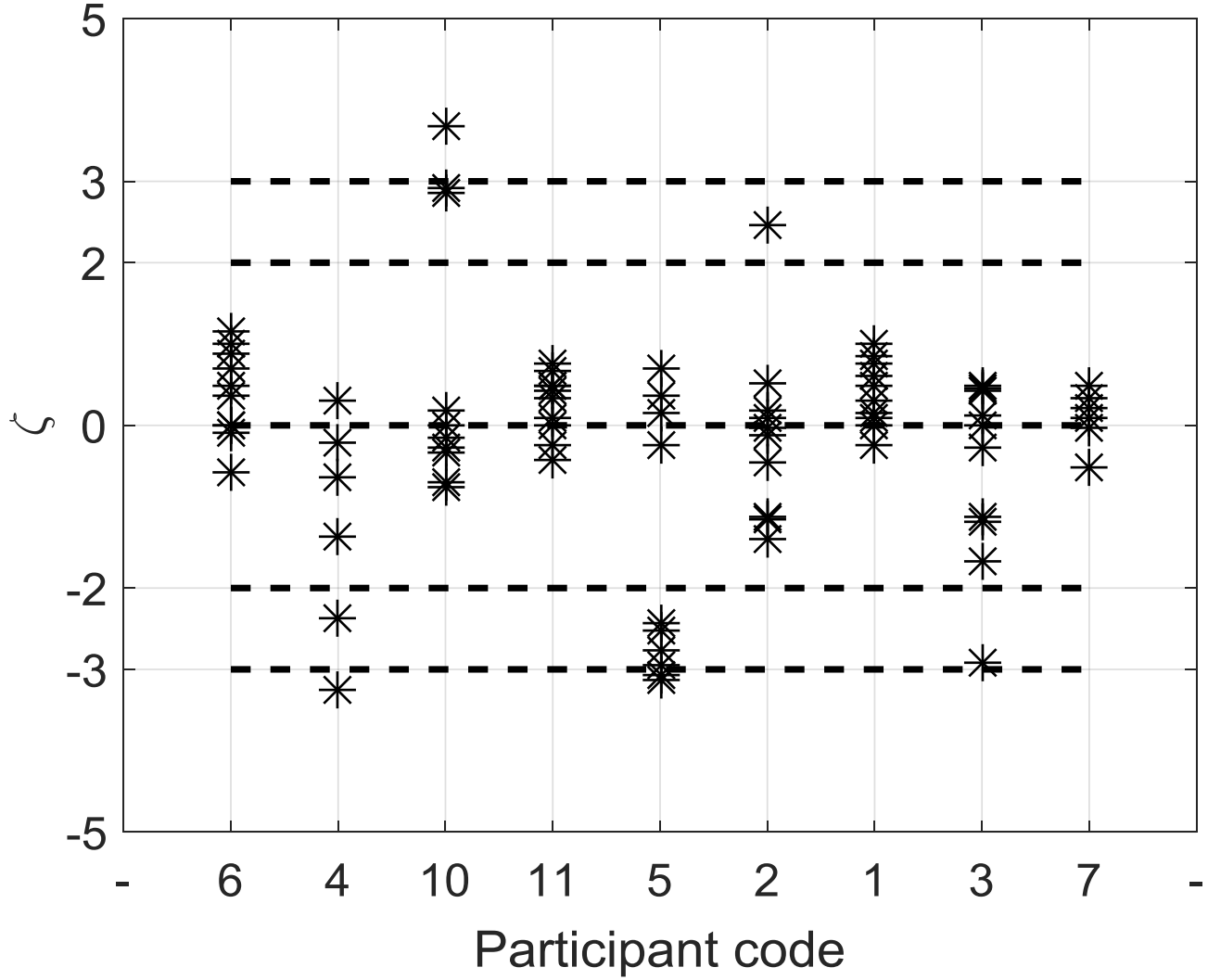
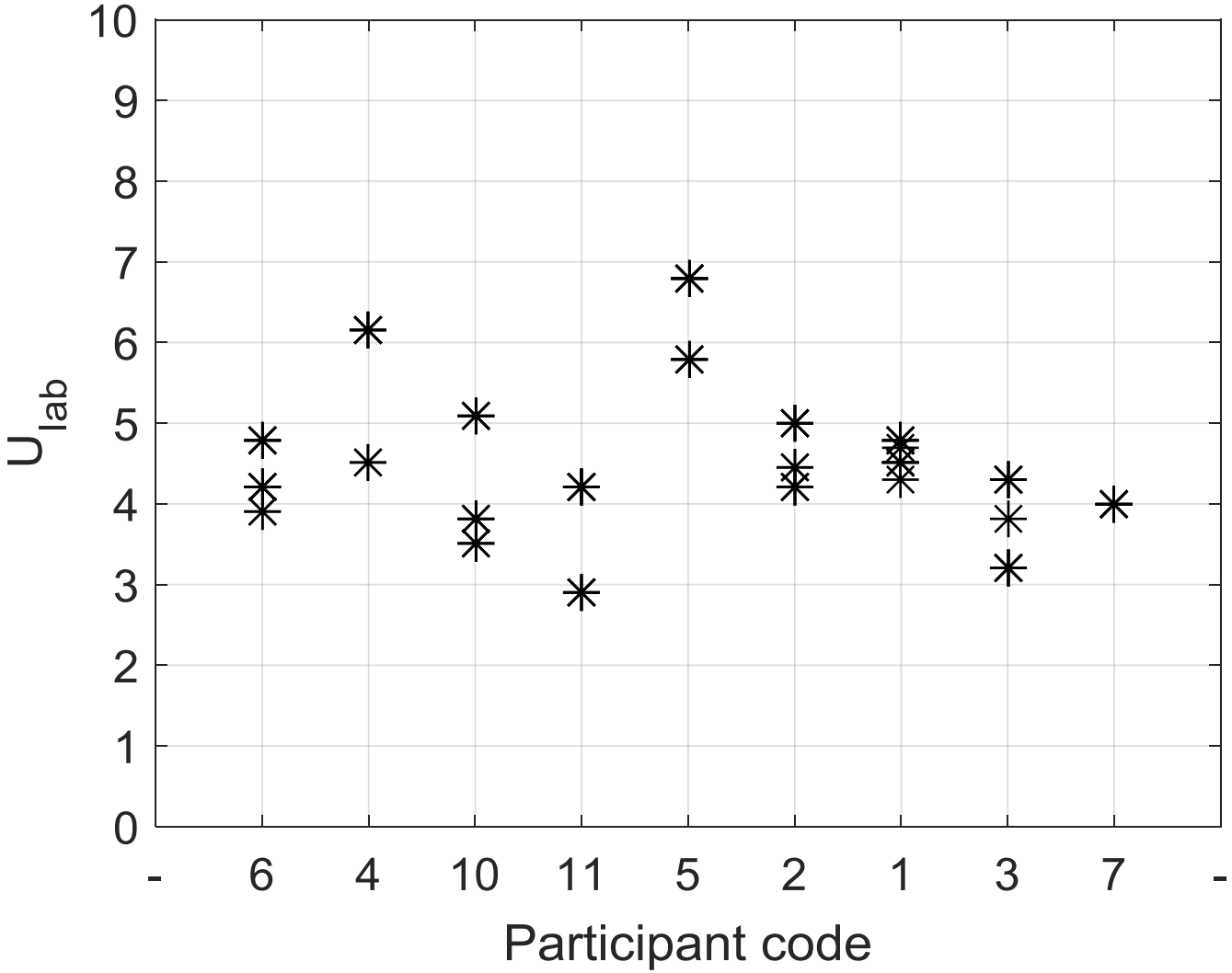

5
3
2
0
-2
-3
-5
ζ
-
6
4
10
11
5
2
1
3
7
-
Participant code


10
9
8
7
6
5
4
3
2
1
0
U_{lab}
-
6
4
10
11
5
2
1
3
7
-
Participant code

Ref. vales – comparison

f MHz	X_{cal} dB(µV)	U dB	δ^* dB(µV)	s^* dB	z' 1
50	0	2.2	0.1	1.9	-0.1
150	0	2.2	-0.5	2.0	0.4
250	0	2.2	-0.9	1.2	0.7
500	0	3.8	-0.5	1.2	0.3
750	0	3.8	-1.1	0.7	0.6
950	0	3.8	-2.2	1.9	1.1
2000	0	2.8	0.0	1.0	0.0
3000	0	2.8	-0.7	2.4	0.4
5000	0	2.8	-1.1	2.2	0.7
6000	0	2.8	-1.0	2.1	0.6

The original set of non-homogeneous data is transformed into a set of deviations from the calibrated reference values (see slide 14). The reference value for the deviations (X_{cal} in the table above) is zero.

Remarks

- The reference values obtained from calibration of the Sample and from robust statistical analysis are compatible each other (maximum deviation 2.2 dB, performance statistic *z*' less than 1.1 over ten frequencies).
- The raw measurement results provided by the nine participants at the ten measurement frequencies selected by the Coordinator are within –13 dB to +7 dB from the reference values. The transformed data set values are within –5 dB to +2.5 dB from the reference.
- Nine warning signals and four action signals are detected over eightytwo measurement results.
- Two laboratories did not perform measurements over 1 GHz.
- Four laboratories do not exhibit any anomaly.
- Standard measurement uncertainty declared by the laboratories comprised between nearly 1.5 dB and 3.5 dB, robust standard deviation s^* between 0.7 dB and 2.4 dB.