Bilateral comparison of radiated emission measurements

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Abstract. The objective of this study is to perform a proficiency testing by bilateral comparison of radiated emission measurements between accredited laboratories. The results show that both laboratories are in conformity with the criterion of acceptance proposed by a comparison, which is the uniformity between the measured values according to normalized error ratio.

1. Introduction
The electrical and optical laboratory of Institute for Technological Research, IPT, and the integration and testing laboratory of National Institute For Space Research, INPE, started in April 2013 a bilateral measuring electromagnetic interference radiated. The comparison was carried out in accordance with CISPR 22:2006 [1] providing an important result to participants as required by the standard ISO/IEC 17025:2005 [2] – “Item 5.9 Assuring the quality of test and calibration results; b) participation in interlaboratory comparison.” – The comparison of the results was done according to ISO 13528:2005 [3] (Statistical methods for use in proficiency testing by interlaboratory comparisons.)

The comparison allowed each participating laboratory to evaluate their working routines, the performance of their technicians in using different equipment, from a bias of measured results with respect to the reference value.

2. Methodology
Bilateral comparison for measuring electromagnetic field radiated during the second quarter of 2013. The laboratories involved measurements performed using a standard noise source, as shown in figure 1, which was used in the vertical and horizontal position. In the figure the noise emitter is positioned in vertical polarization. For horizontal polarization turn 90 degree the noise emitter leaving the button red (on/off) upper face.
The setup of the radiated emissions was installed in accordance with CISPR 22, the results were sent to the coordinating laboratory, IPT. The reference value was considered to be the value obtained by INPE, measurement antenna INPE is traced to the ETS-Lindgren laboratory that is accredited American network A2LA (American Association for Laboratory Accreditation) and the receiver is tracked RBC (Brazilian Calibration Network).

The frequency bands have been agreed in advance by both laboratories as per table 1.

| Band | Frequency (MHz) |
|------|----------------|
| 01   | 40.0 – 60.0    |
| 02   | 540.0- 560.0   |
| 03   | 940.0- 960.0   |

The reference value for comparison was obtained by averaging the values of each track performed by the reference laboratory. Evaluation of measures was performed using the ISO 13528 [3] standard error, we constructed a diagram to identify laboratories with standard errors and the reference value for each test. The normalized error (En) is defined by equation (1). The evaluation criteria of the standard error were made by its value module, so that $\lvert E_n \rvert \leq 1$ the result is satisfactory and $\lvert E_n \rvert > 1$ the result is questionable.

$$E_N = \frac{M_{LAB}-M_{REF}}{(U_{LAB}^2+U_{REF}^2)^{\frac{1}{2}}}$$

Where:

- $M_{LAB}$ is the measure of laboratory IPT;
- $M_{REF}$ is the measure of laboratory INPE;
- $U_{LAB}$ is the uncertainty of laboratory IPT;
- $U_{REF}$ is the uncertainty of laboratory INPE.

2.1. Measurement protocol of radiated emission
The measurements were carried out using standard noise emitter in two positions, vertical and horizontal transmission, positioned in the center of the table to 3.0 m from the antenna and maximum values recorded.

To perform the comparison, optimizing test time, the band was divided into three frequency bands with a width of 20 MHz each, repeating each measurement three times at the beginning, middle and end of the frequency established by the CISPR 22 (30.0 MHz to 1.0 GHz). As shown in Table 1.

The quasi-peak detector was used to measure the electromagnetic waves (dBuV/m).

3. Results and Comments

Table 2 presents field measurements of the participant (M\textsubscript{LAB}) and reference (M\textsubscript{REF}) laboratory, taking into account the uncertainty of each laboratory (U\textsubscript{LAB} = 4.6) and (U\textsubscript{REF} = 6.4) and the standard error module (En). The values obtained indicate standard error result in accordance with criteria of this comparison.

| Noise emitter polarization | Band | M\textsubscript{LAB} (dBµV/m) | M\textsubscript{REF} (dBµV/m) | |Enl|
|---------------------------|------|-------------------------------|-------------------------------|------|
| Vertical                  | 01   | 44.73                         | 45.53                         | 0.10 |
|                           | 02   | 73.93                         | 73.63                         | 0.04 |
|                           | 03   | 67.60                         | 65.40                         | 0.24 |
| Horizontal                | 01   | 39.27                         | 39.43                         | 0.02 |
|                           | 02   | 71.73                         | 67.30                         | 0.56 |
|                           | 03   | 67.17                         | 63.53                         | 0.46 |

Figure 2 shows the setup used for testing radiated emissions showing the position of the antenna, turntable and noise emitter at a certain moment of the test.

Figure 3 shows the result of a complete measurement in accordance of the standard CISPR 22 with the noise emitter positioned vertically and the reception antenna polarized horizontally.
4. Conclusion
The realization of bilateral comparison on measures of electromagnetic field radiated provided sufficient information, from calculations of standard errors, the two laboratories are in accordance with the criteria established by this comparison, showing that the tests between these laboratories are consistent with each other.

References
[1] CISPR22:2006 Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement;
[2] ISO/IEC 17025:2005 General requirements for the competence of testing and calibration laboratories;
[3] ISO 13528:2005 Statistical methods for use in proficiency testing by interlaboratory comparisons.