BIPM.EM-K10.b, SIM.EM.BIPM-K10.b and SIM.EM.BIPM-K10.b.1

### Key comparison BIPM.EM-K10.b

**MEASURAND:** DC voltage, Josephson standards, **NOMINAL VALUE:** 10 V

<table>
<thead>
<tr>
<th>Lab i</th>
<th>$x_i$ / nV</th>
<th>$u_i$ / nV</th>
<th>Date of measurement</th>
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</table>

$x_i$: result of measurement carried out by laboratory $i$ expressed as the difference from the BIPM value

$u_i$: combined standard uncertainty of $x_i$

(1) initial result
(2) final result following technical improvements during the comparison
Key comparison SIM.EM.BIPM-K10.b

MEASURAND : DC voltage, Josephson standards
NOMINAL VALUE : 10 V

SIM.EM.BIPM-K10.b is a bilateral key comparison between NIST and NRC conducted from August 13 to August 17, 2007.

\( d_{\text{NIST-NRC}} \): reported difference between NIST CJVS (Compact Josephson Voltage Standard) and NRC JVS

\( U_{\text{NIST-NRC}} \): expanded uncertainty \((k = 2)\) of \( d_{\text{NIST-NRC}} \)

\( d_{\text{NIST-NRC}} = -0.28 \text{ nV} \)
\( U_{\text{NIST-NRC}} = 2.07 \text{ nV} \)

Key comparison SIM.EM.BIPM-K10.b.1

MEASURAND : DC voltage, Josephson standards
NOMINAL VALUE : 10 V

SIM.EM.BIPM-K10.b.1 is a bilateral key comparison between INMETRO and NIST conducted in June 2009.

\( d_{\text{INMETRO-NIST}} \): reported difference between INMETRO JVS and NIST CJVS

\( u_{\text{INMETRO-NIST}} \): combined standard uncertainty of \( d_{\text{INMETRO-NIST}} \)

\( d_{\text{INMETRO-NIST}} = 0.54 \text{ nV} \)
\( u_{\text{INMETRO-NIST}} = 1.48 \text{ nV} \)
Key comparison BIPM.EM-K10.b

**MEASURAND:** DC voltage, Josephson standards  
**NOMINAL VALUE:** 10 V

Key comparison reference value: the BIPM value.  
Since 2004, its standard uncertainty has been evaluated to be typically 0.04 nV and is included in the $u_i$'s values.

The degree of equivalence of each laboratory with respect to the reference value is given by a pair of terms: $D_i = x_i$ and its expanded uncertainty ($k = 2$), $U_i = 2u_i$, both expressed in nV.

When required, the degree of equivalence between two laboratories $i$ and $j$ can be computed by two terms: $D_{ij} = D_i - D_j = (x_i - x_j)$ and its expanded uncertainty ($k = 2$), $U_{ij}$, both expressed in nV.

$U_{ij} = 2\left[u_i^2 + u_j^2 - 2\text{cov}(i,j)\right]^{1/2}$, where $\text{cov}(i,j)$ is the estimated covariance that takes into account the correlation introduced by the BIPM measurements.

Linking SIM.EM.BIPM-K10.b to BIPM.EM-K10.b

The degree of equivalence of NIST with respect to the reference value is given by a pair of terms: $D_{\text{NIST}} = (d_{\text{NIST-NRC}} + D_{\text{NRC}})$ and its expanded uncertainty ($k = 2$), $U_{\text{NIST}}$, both expressed in nV.

$U_{\text{NIST}} = \left(U_{\text{NIST-NRC}}^2 + U_{\text{NRC}}^2\right)^{1/2}$.

No pair-wise degrees of equivalence involving NIST have been explicitely computed.

Linking SIM.EM.BIPM-K10.b.1 to BIPM.EM-K10.b

The degree of equivalence of INMETRO with respect to the reference value is given by a pair of terms: $D_{\text{INMETRO}} = (d_{\text{INMETRO-NIST}} + D_{\text{NIST}})$ and its expanded uncertainty ($k = 2$), $U_{\text{INMETRO}}$, both expressed in nV.

$U_{\text{INMETRO}} = 2\left[u_{\text{INMETRO-NIST}}^2 + (U_{\text{NIST}}/2)^2\right]^{1/2}$. The values taken for NIST are the most recent ones (2009).

No pair-wise degrees of equivalence involving INMETRO have been explicitely computed.
BIPM.EM-K10.b, SIM.EM.BIPM-K10.b and SIM.EM.BIPM-K10.b.1

DC voltage, Josephson standards, 10 V
Matrix of equivalence

<table>
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<th>Lab i</th>
<th>$D_i$ / nV</th>
<th>$U_i$ / nV</th>
</tr>
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<td>LNE*</td>
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</table>

Only the most recent comparison is retained

* The degrees of equivalence are computed using the final result following technical improvements in the comparison setup
BIPM.EM-K10.b, SIM.EM.BIPM-K10.b and K10.b.1 10 V Josephson standards
Degrees of equivalence [$D_i$ and its expanded uncertainty ($k = 2$), $U_i$]

Red diamonds: participants in BIPM.EM-K10.b
Green triangle: participant in SIM.EM.BIPM-K10.b
Blue circle: participant in SIM.EM.BIPM-K10.b.1

$U_{LNE} = 0.2$ nV

The BIPM key comparison database, March 2015