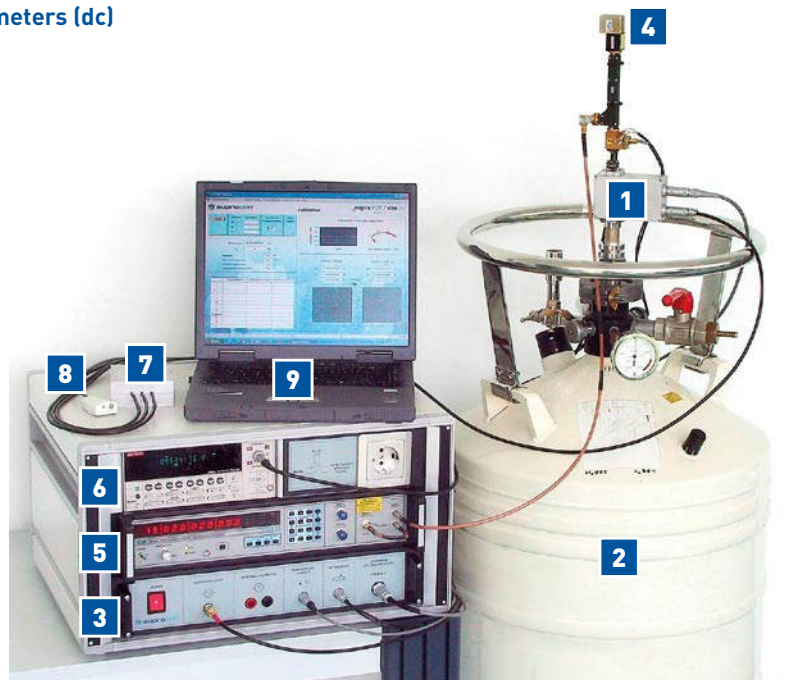# supraVOLTcontrol

Josephson Voltage Standard

DESCRIPTION

supraVOLTcontrol is a complete 3-channel microprocessor controlled 10 V Josephson voltage standard (**JVS**) system developed in the Institute for Physical High Technology Jena (IPHT). It facilitates a variety of dc voltage calibrations and measuring functions:

- ► **Calibration of secondary voltage standards**
- ► **Calibration of linearity and accuracy of voltmeters (dc)**

in the voltage range of 0 to +/-10 V.

supraVOLTcontrol consists of the following components:

1. **Cryoprobe with JVS circuit**
2. Liquid **He Dewar** or **Cryocooler** (optional)
3. **JVS Electronics** unit
4. **Microwave electronics** unit includes: 75 GHz Gunn oscillator, isolator, directional coupler, mixer, voltage controlled attenuator
5. **EIP source locking microwave counter**
6. Keithley nanovoltmeter as **Null detector**
7. 3-channel **Polarity reversal switch**
8. Sensors for temperature, humidity and barometric pressure
9. Host computer with IEEE interface

GPS 10 MHz reference frequency receiver (optional)

SPECIFICATIONS

Typical calibration accuracy
(direct comparison to a second Josephson voltage standard)

$\pm$ 4nV @ 10V $\qquad \Delta V/V_{10V} = 4 \times 10^{-10}$

Typical calibration accuracy of secondary voltage standards
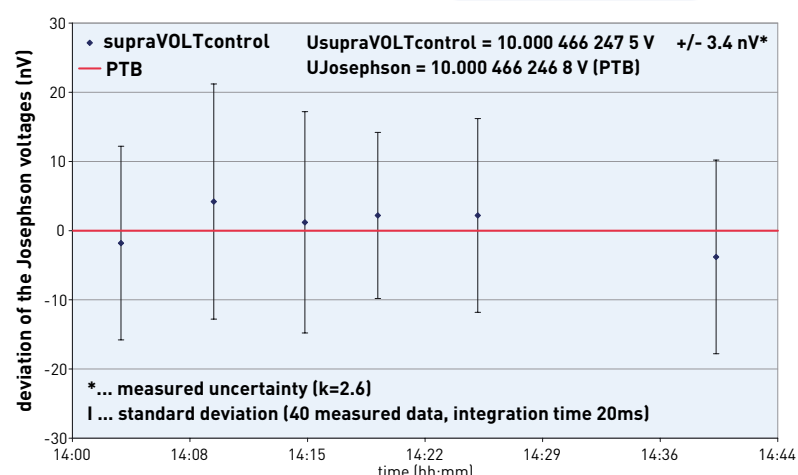(limited by the noise of the secondary voltage standard)

$\pm$ 20 nV @ 1V $\qquad \Delta V/V_{1V} = 2 \times 10^{-8}$
$\pm$ 100 nV @ 10V $\qquad \Delta V/V_{10V} = 1 \times 10^{-8}$

Thermal voltage of wires and reversal switch

< 10nV @ all 3 channels

Typical gain factor g of external voltmeter
(depends on the type of voltmeter)

$\Delta g/g < 3 \times 10^{-7}$

deviation of the Josephson voltages (nV)

◆ **supraVOLTcontrol** $\qquad U_{supraVOLTcontrol} = 10.000\ 466\ 247\ 5$ V $\quad$ +/- 3.4 nV*
—— **PTB** $\qquad U_{Josephson} = 10.000\ 466\ 246\ 8$ V (PTB)

*... measured uncertainty (k=2.6)
I ... standard deviation (40 measured data, integration time 20ms)

time (hh:mm)

Direct comparison of supraVOLTcontrol with the Josephson voltage standard of the Physika-lisch-Technische Bundesanstalt (PTB) @ 10V. The measured voltage difference corresponds to an accuracy of 7×10^{-11} with a measurement uncertainty of 3.4×10^{-10}.

The information contained in this document is subject to change without notice at any time.

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JOSEPHSON VOLTAGE STANDARD CIRCUIT

- ► Chip carrier with a 10 Volt Josephson voltage standard circuit.
- ► 10 Volt Josephson voltage standard circuit with 19700 SIS Josephson junctions (JJ), the operating frequency is 75 GHz.
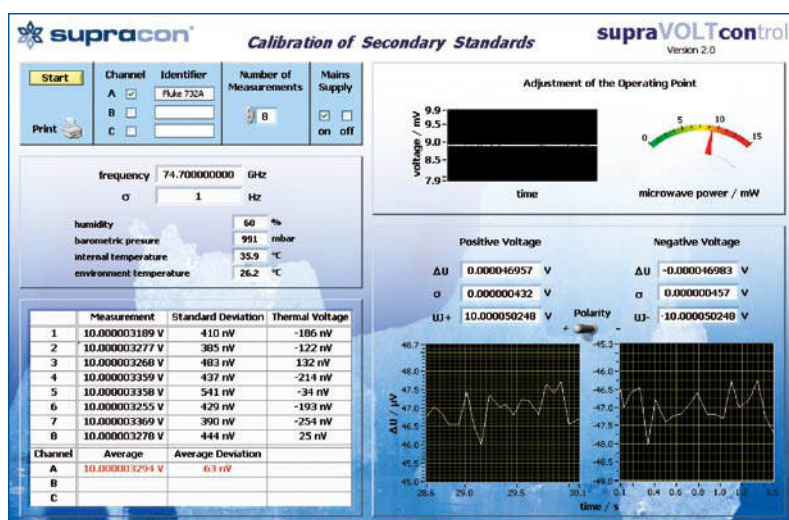
$$V = n / K_{J90} \times f$$

definition in 1990: $K_{J90} = 483.597,9 \, \text{GHz} / \text{V}$

V	Josephson voltage	K_{J90}	Josephson constant
n	integer	f	operating frequency

With this formula the voltage will be traced back to a frequency, and frequencies can be controlled extraordinary precisely.
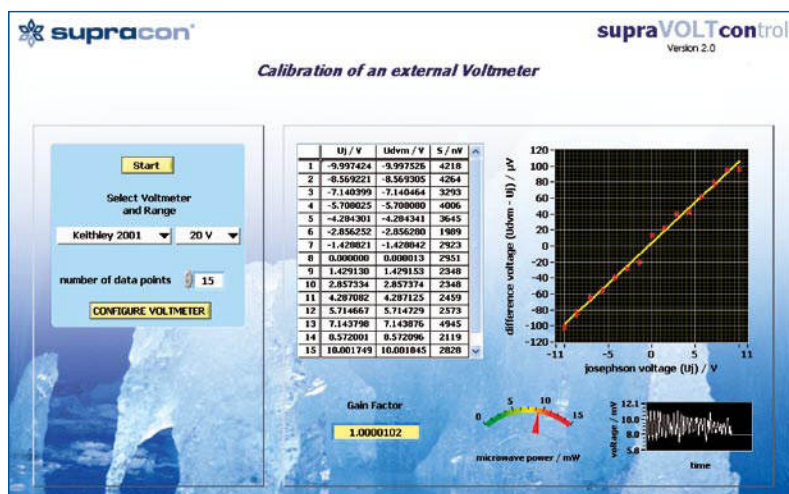
CALIBRATION MODES

▲ DC reference standards (e.g. FLUKE 732A)

◄ **supraVOLTcontrol** calibration of dc reference voltages

▲ external voltmeters (e.g. Keithley 2001)

◄ **supraVOLTcontrol** calibration of linearity and gain factor

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