**DESCRIPTION**

The **AC Quantum Voltmeter** is a programmable Josephson voltage standard system applicable for the highest level of precision voltage measurements from DC up to kHz frequencies. It was developed by the Physikalisch-Technische Bundesanstalt Braunschweig (PTB) in cooperation with the companies esz AG and Supracon AG. It facilitates a variety of voltage calibrations and measuring functions:

- **Primary DC & AC Josephson voltage standard** up to kHz frequencies,
- **Calibration of calibrators,**
- **Calibration of secondary voltage standards,**
- **Calibration of voltmeter linearity,**
- **Calibration of thermal converters** (optional),
- **Voltage source** with ultimate precision and lowest noise level

The **AC Quantum Voltmeter** consists of the following components:

1. **10 V programmable JVS array chip**
2. **Cryoprobe with magnetic shield**
3. **Compact 70 GHz microwave source**
4. **Programmable 20 channel bias source**
5. **Control electronics with optical isolation unit**
6. **Nanovoltmeter as DC null detector**
7. **Sampler** for AC voltage measurements
8. **Waveform generator** with synchronisation unit
9. **Multiplexer** with polarity switch
10. **Host computer with control software**
11. **Sensors** for temperature, humidity, and pressure
12. **Optional:** Liquid helium Dewar,
    GPS 10 MHz frequency reference

**PROGRAMMABLE JOSEPHSON VOLTAGE STANDARD ARRAY**

The centre piece of the **AC Quantum Voltmeter** is a 10 Volt programmable Josephson voltage standard circuit

- **Number of Josephson junctions:** 69632
- **Maximum output voltage:** ±10.1 V
- **Operating frequency:** 70 GHz
- **Zero & first order Shapiro step:** 1 mA
- **Bias current:** ±6 mA
- **Voltage increment:** 145 μV

<table>
<thead>
<tr>
<th>V</th>
<th>Josephson voltage</th>
<th>K_{790}</th>
<th>Josephson constant</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>programmable integer</td>
<td>f</td>
<td>microwave frequency</td>
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</table>
**SPECIFICATIONS**

DC voltage up to ±10 V

- Typical calibration accuracy (direct comparison to a second Josephson voltage standard)
  
  \[ \pm 1 \text{nV} @ 10 \text{V} \quad \Delta V/V_{10V} = 1 \times 10^{-10} \]

- Typical calibration accuracy of DC voltage standards, e.g. Fluke 732B (limited by the noise of the DC voltage standard)
  
  \[ \pm 100 \text{nV} @ 10 \text{V} \quad \Delta V/V_{10V} = 1 \times 10^{-8} \]

AC voltage up to 1 kHz frequencies

- Typical calibration accuracy (direct comparison of two 4-sample Josephson waveforms)
  
  \[ \pm 200 \text{nV} @ 20 \text{Vpp}, 1 \text{kHz} \quad \Delta V/V = 2 \times 10^{-8} \]

- Typical calibration accuracy of calibrators, e.g. Fluke 5720A (limited by the noise of the calibrator)
  
  \[ \Delta V/V = 5 \times 10^{-7} @ \quad V \leq 7.2 \text{V(rms)}, \quad f \leq 2 \text{kHz}, \quad 10 \text{second measuring time} \]

**CALIBRATION MODES [Samples]**

- AC reference standard (e.g. FLUKE 5720A)
  
  Measured calibrator RMS voltages with type A uncertainty for three AC frequencies

- DC reference standard (e.g. FLUKE 732B)
  
  Software interface for DC voltage standards