

## Primary Josephson Voltage Standard System - JVS 7000

### *JVS 7000 Primary Josephson Voltage Standard System:*

#### *The Standard for Ultimate Precision*

PREMA offers complete state-of-the-art Primary DC Voltage Standard Systems, including 1-Volt and 10-Volt Josephson Junction Array Voltage Standard Chips with Carrier and Cryoprobe. The outstanding quality of these products is based upon 30 years of PREMA expertise in design, development, fabrication, test and calibration of high end DC measuring instruments and ultra precision AD converters. PREMA also has 20 years of experience in complete ASIC fabrication.

#### *Easy Calibration with Direct Traceability*

The PREMA Primary Josephson Voltage Standard JVS 7000 is a PC and manually controlled system to facilitate a variety of DC voltage calibration and measuring functions: Calibrating your secondary DC-reference Zeners, calibrating your working standards, checking linearity and accuracy of DC-voltmeters and DC-calibrators. Since the PREMA JVS 7000 implements the world wide adopted SI Volt representation through the Josephson quantum physics phenomenon, it achieves direct traceability for your secondary DC standards, such as the Fluke 734A, right at your calibration lab. Repetitive shipment of your Zener references to any national laboratory such as PTB or NIST becomes obsolete.

#### *Highly Automated Instrumentation*

The PREMA JVS 7000 includes specialized microwave components, the 7040 Current/Voltage Source, the 7041 Bias Power Supply, the 7042 Bias Control, the 7050 Precision Scanner, voltage sensing electronics and the null detector. All instruments used, including the PREMA JVS Carrier and Cryoprobe, on which the PREMA Josephson Junction Array Chip is mounted for immersion into liquid helium, are manufactured and supplied according to PTB/NIST designs or specifications.

#### *Well Suited Windows Software*

The PREMA 7070 System Software allows remote control of the complete system. It provides automatic calibration of secondary DC standards, voltmeters and calibrators and in addition continuous tracking of these calibrations. Thus, the PREMA JVS 7000 operates as an ultra high precision 5ppb Quantum Voltmeter - the PREMA QVM.

### *JVS 7000 Josephson Junction Array Chip*

#### *The SI Volt and the Josephson Effect*

The PREMA Josephson Junction Array (JJA) Voltage Standard Chip provides the ultimate accuracy for representation and maintenance of the SI Volt. In the 1980's the "AC Josephson Effect" together with the definition of the "Josephson Constant"  $K_J$ -90 were both adopted world wide as the fundamental standard for DC voltage [1]. That quantum physics phenomenon was described first by Brian D. Josephson in 1962, when he derived an equation for determining the current flow through a tunnel junction formed by a thin insulating barrier separating two superconductors.

#### *State-of-the-art superconductor technology*

Only a few foundries around the world are able to manufacture JJA circuits. PREMA offers this highly sophisticated technology to every high precision calibration laboratory all over the world: 10 Volt and 1 Volt Josephson Junction Array Chips are manufactured at the IPHT according to the specifications of the PTB - the internationally renowned German National Institute of Standards and Technology [2] - and are distributed world wide by PREMA.

#### *Long lifetime and stable operation*

Each PREMA Josephson Junction Array is thoroughly tested, characterized and certified by the PTB prior to delivery. The all niobium full wafer manufacturing process - continuously reviewed and improved by the IPHT- provides long lifetime JJA chips for stable operation, impervious to moisture and thermal cycling.

#### *JVS 7000 Carrier and Cryoprobe*

The PREMA JJA chips provide stable voltage steps at an RF frequency range between 70 and 75 GHz. They are mounted on a special IPHT designed FR-4 fiber epoxy glass chip carrier to ease installation. The oversized circular waveguide of the cryoprobe is made of German silver with a very low microwave attenuation of 1 dB/m. Equipped with WR-12 waveguide flanges, a standard interface is provided for different primary voltage standard systems.



PREMA Josephson Voltage Standard JVS 7000

*JVS 7001/7010 Josephson Junction Array Chip Specifications*

|                               |   |   |
|-------------------------------|---|---|
|                               | 10 V Array Chip                           | 1 V Array Chip                            |
| Chip size                     | 25 by 11 mm <sup>2</sup>                  | 19 by 5 mm <sup>2</sup>                   |
| Number of Junctions           | 13,920 JJs                                | 2,400 JJs                                 |
| Operating range               | -11V to +11V                              | -2.5V to +2.5V                            |
| Technology                    | refractory all niobium full wafer process | refractory all niobium full wafer process |
| Operating temperature         | 4.2 K                                     | 4.2 K                                     |
| Operating frequency           | 70 - 75 GHz                               | 70 - 75 GHz                               |
| Lead and bond wire resistance | < 3 Ohm                                   | < 3 Ohm                                   |
| Order No.                     | JVS 7010                                  | JVS 7001                                  |

***JVS 7000 System Components***

*JVS 7040 Current/Voltage Source*

Voltage sensing bias source, sweep triangle wave 0.1 Hz to 20 Hz, current 0 to 0.3 mA, voltage 0±13 Vdc, optically isolated, PC controlled.

*JVS 7041 Bias Power Supply*

Transformers for the 115/230V at 60/50Hz power line.

*JVS 7042 Bias Control*

Optically isolated PC interface, supply prestabilization.

*JVS 7050 Precision Scanner*

Low thermal EMF 8 channel precision scanner, for remote selection of references, DVMs or calibrators to be calibrated, PC controlled.

*JVS 7060 Client AC Line Power Switch*

Mains switch, PC controlled, 8 channel, for automatic switch to battery supply of 1 out of 8 Zener references.

*JVS 7070 System Software*

Complete system control, various virtual scope functions, comprehensive online help and system diagnosis functions, online documentation, data history management, running under Windows 95/98.

*JVS 6048 High Precision Nanovoltmeter*

PREMA digital voltmeter 6048, 8 « digits resolution, 20 mV to 20 V, stability 0.5 ppm/24 h, sensitivity 1 nV.

*JVS 5017 High Precision Scanning DVM*

PREMA digital voltmeter 5017/SC, 7« digits resolution, 20-channel scanner, 300 mV to 1.000 V, 300 W to 30 MW , direct temperature measurement via RTD, stability 6 ppm/24 h, sensitivity 10 nV and 10 µW .

*Microwave RF Unit*

Gunn diode 70 (75) GHz RF oscillator, bias tuning ± 50 MHz minimum, bias pushing 200 MHz/V typical, bias power supply, PC controlled, power output 60 mW, low thermal drift, isolator, directional coupler, harmonic mixer, motor driven level set attenuator.

*Source Locking Counter*

Automatic source locking, resolution 10kHz, source locking frequency range 10 MHz to 110 GHz, 200 ms phase lock time, 60 - 90 GHz remote sense.

*Rubidium Frequency Reference*

High stability 10 MHz ref. sine output, aging ± 5 x 10<sup>-11</sup> / month, accuracy ± 5 x 10<sup>-9</sup> / year at 25°C.

*GPS Frequency Reference (alternative)*

Ultra high stability frequency reference system, antenna, coaxial cable, converter, RS232 interface, 10 MHz ref. sine output, accuracy ± 1 x 10<sup>-12</sup> /24h avg.

*Optional JVS 7000 System Components*

*Computer System*

Up-to-date PC - PCI-IDE Interface - CD ROM drive, 2 parallel ports, IEEE488-GPIB interface, colour monitor, keyboard, mouse, Windows 95/98, Printer.

*Oscilloscope*

2 channel I / V Oscilloscope, X / Y display, vertical sensitivity Ch1 - 1 mV/div and Ch2 - 10 µV/div.

*ZENER Voltage Reference Standard*

FLUKE 734B DC reference standard, enclosure with 4 independent cells, 10V and 1.018V each, adj. ± 2mV for 10V, stability 0.3ppm/month at 23 ± 1 °C.

*Liquid Helium Dewar*

Top dewar flange compatible with JVS cryoprobe assembly, 100 liter capacity, 32 mm neck diameter, dewar outer diameter 700 mm, height 1.405 mm, rugged all welded multi shield construction, absolute pressure relief valve for air cargo safety, minimum loss storage and transportation of liquid He, typically 6 weeks continuous operation on one 100-liter dewar.

+ second 100 liter liquid Helium dewar

+ Liquid Helium level gauge

+ 19" rack, desk, chair

[1] B.N.Taylor and T.J.Witt, "New international electrical reference standards based on the Josephson and quantum Hall effects", Metrologia, vol26,1989.

[2] R.Behr, H.Schulze, F.Müller, J.Niemeyer (all PTB), "Josephson arrays at 70GHz for conventional and programmable voltage standards", Proceedings of the CPEM'98, Conference Digest, p439, 1998.