Josephson standards for a new AC quantum voltage infrastructure (in the scope of the ACQ-PRO EMPIR project)

P. Durandetto¹, A. Sosso¹, M. Bauer², J. Herick², O. Kieler² and R. Behr²

¹ I.N.Ri.M. - Istituto Nazionale di Ricerca Metrologica, Torino, Italy
² PTB - Physikalisch-Technische Bundesanstalt, Braunschweig, Germany

What is ACQ-PRO?

Propagation of AC quantum voltage standards between NMIs

Objectives

To investigate common devices in industry and scientific research institutes at different voltages and frequencies up to which level these instruments are useful as transfer standards for quantum AC voltage comparisons.

AC-Quantum Voltmeter at PTB

Two different AC-QVMs employed:

1. Commercially available Fluke 5700A 
   Source to drive a programmable 2 V array with 16384 junctions (14 bits) operating at 70 GHz

2. Five LeCroy/Agilent 1184 modules, each having 4 output channels, to drive a programmable 10 V array with 69632 junctions (22 bits, 11.6 us) operating at 70 GHz

Differential measurement PQS-DUT

Deletion of ringing points close to the transients

Reconstruction: (PQS-DUT)_{PROM} + PQS_{exact}

70 GHz phase-locked oscillator: MIMW5 Zöllner SQUID
Sampler: NI PXI5922A
PQS waveform: 50 samples per period
Phase shift by “clock-detuning”

Real-time indirect comparison of AC-QVM and JAWS

JAWS (pulse-driven JVS) at PTB

Two JAWS systems employed for different voltage ranges:

1 V JAWS
63000 triple-stacked junctions
8 arrays (4 chips)
4 x 2 channel waveform generators
1 x 8-channel IV-Box

Compared with

2 x 100 mV JAWS
15000 triple-stacked junctions
2 arrays (1 chip)
1 x 2-channel PPG Sympol
1 x 2-channel waveform generator
1 x 2-channel IV-Box

4 parameters per array:
• Positive and negative pulse amplitude
• Compensation signal amplitude and phase

Differential measurement JAWS-DUT

Phase adjustment

JAWS of the difference signal

Sampled: NI PXI5922A / Lock-in amplifier
Phase shift by “clock-detuning”

Indirect comparison of AC-QVM and JAWS

JAWS or

AC-QVM

Sampler

DUT

JAWS

AC-QVM

Fluke 5700A

AV = 5 ± 15 ppm

AV = 10 ± 50 µV

AV = 0.01 ± 0.30 µV, k=1

AV = (0.63 ± 0.42) µV, k=1

DUT waveform alternately sent to either AC-QVM 1 or AC-QVM 2 by means of a software-controlled switch

Without LC Filter

With LC Filter

Glitches!

POWQ (PT-0100-QM)

POWQ + Bar

POWQ @ 1 V and 1.25 kHz

POWQ (PT-0100-QM)

POWQ @ 1 V and 1.25 kHz

POWQ = Bar

Drift corrected!

PDGWQ + low-pass filter

Further investigation is required!