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Voltage Metrology with Superconductive Electronics

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Josephson's discovery in 1962 of the quantum behavior of superconducting junctions enabled a revolution in precision voltage measurement that replaced electrochemical cells, which are artifact standards whose behavior depends upon environmental conditions, with quantum-based standards, whose values are intrinsically accurate and can be reproduced anywhere. Many technological advances in junction fabrication, superconducting integrated circuit technology, bias techniques, and instrumentation were required to achieve the present generation of practical ac and dc voltage standard systems. Quantum-based 10 V programmable Josephson voltage standards and 2 V rms Josephson arbitrary waveform synthesizers are now used in a wide range of metrology applications, calibration laboratories and precision measurement experiments. For metrology, these systems are used for measuring dc and ac voltage, ac power, and impedance. They are also key instruments in precision measurement experiments of mass and temperature to determine more accurate values of the Planck and Boltzmann constants. I will review major technological advances with a focus on the superconducting devices and circuits and describe the current state-of-the-art research and development in superconductive analog and digital circuits that may lead to improved precision measurement of voltage and low-distortion signals for rf communications.

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