INL Standards and Calibration Laboratories (S&CL) - Our Road to the Josephson Junction

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Abstract

This paper goes through a history of the DC voltage reference standards used at the INL S&CL (and most primary labs) and the factors that lead to our desire to purchase a Josephson Junction (JJ). The paper covers saturated cells, zener references, and the Josephson array. A brief discussion on the theory of operation is given for saturated cells and zener references along with the estimated uncertainties obtained with each at the INL S&CL. A brief overview of the contributions to the uncertainty budget for our zener references is discussed with reference made to the individual contributors that we wished to improve upon and why. The ever increasing need to lower our expanded uncertainty leads into discussion of the JJ.

The discussion of the JJ is a very basic presentation of the theory (JJ 101) behind the JJ and how it is used in a system as a DC voltage reference. The discussion opens with a mention of the Josephson Effect discovered by Brian Josephson and a brief discussion of what he predicted. The very basics of the theory of a single junction are discussed with progression to an array of junctions. Additional components necessary to form a measurement system are briefly discussed. An overview of the process for a single measurement of a zener reference by the JJ is given. The discussion concludes with the INL S&CL estimated uncertainty of the measurement process using the Josephson array.

This paper includes some pictures illustrating the different DC voltage references and also includes some pictures and discussion meant to add a touch of humor and lighten the presentation should it be selected.