

Product Group: Vishay Foil Resistors

Bulk Acoustic Wave Resonator Calibration in a Dilution Refrigerator



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Bulk Acoustic Wave resonators (BAW) calibration in a dilution refrigerator

Industry/Application Area Frequency Generation and Standards

Product Used: VSMP Series (Z-Foil) VSMP0805, 50 Ω

The Challenge

In order to characterize Bulk Acoustic Wave (BAW) resonators being used in a dilution refrigerator, they need to be calibrated. While the calibration process is similar to what would be done for BAW resonators in microwave devices, the dilution fridge application presents a number of special problems, including the extremely cold environment, the non-access to the BAW once the cooling process has started, and the necessity for a 50 Ω resistor, to be used as a standard, capable of operating reliably at cryogenic temperatures. Consequently the challenge here is twofold. First, to provide a host for the BAW within the dilution fridge and its three standards, and secondly to characterize the behaviour of the 50 Ω standard.

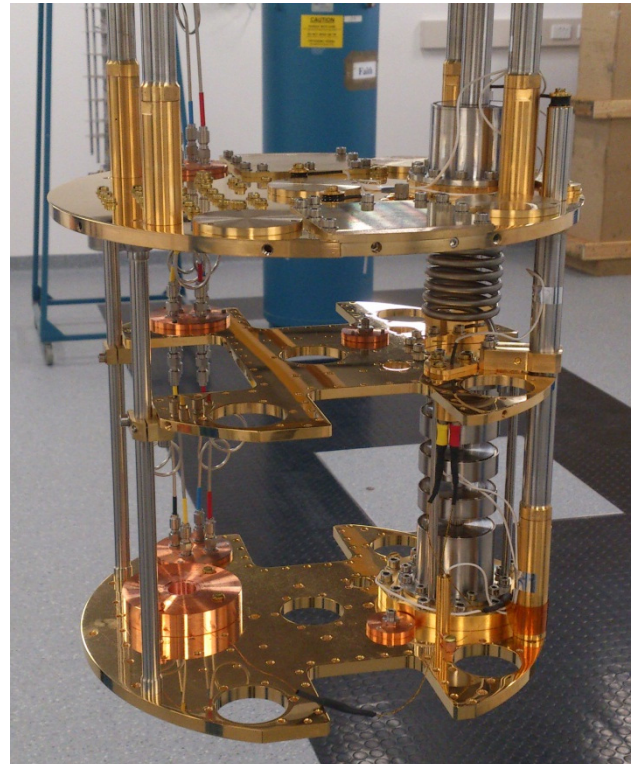


Fig. 1: Opened BlueFors dilution fridge

The Solution

We designed an evaluation board to characterize the BAW resonator. The board needed to implement the calibration test set. We terminated the BAW with three standards: a short (0Ω), an open circuit, and a 50Ω termination, for which a 50Ω VSMP0805 Bulk Metal Foil resistor was used. The full characterization of the BAW's properties needed to be made at cryogenic temperatures. The BlueFors dilution fridge cools down to a minimum temperature of roughly 17 millikelvin in 24 hours. Once the temperature of interest is reached, the 50Ω standard has to remain as stable as possible during the calibration procedure.

The User Explains

The properties of BAWs vary with temperature and in general their performance is inversely proportional to temperature. Four SMA ports were required for the experiment. Three of them were for the calibration set and one for the measured BAW in reflection. Once the temperature is settled, the impedance analyzer is used to make the calibration. The critical point is that the 50Ω resistor should remain as stable as possible to have reliable calibration.

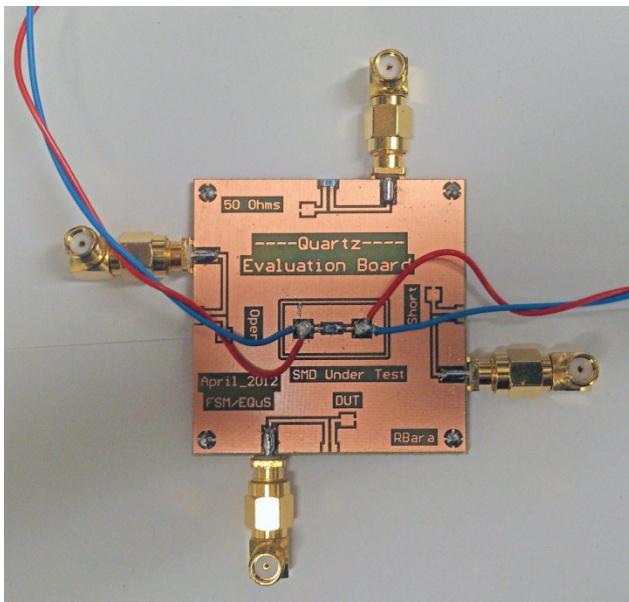


Fig.2: BAW board to be cooled



Fig.3: BAW on board

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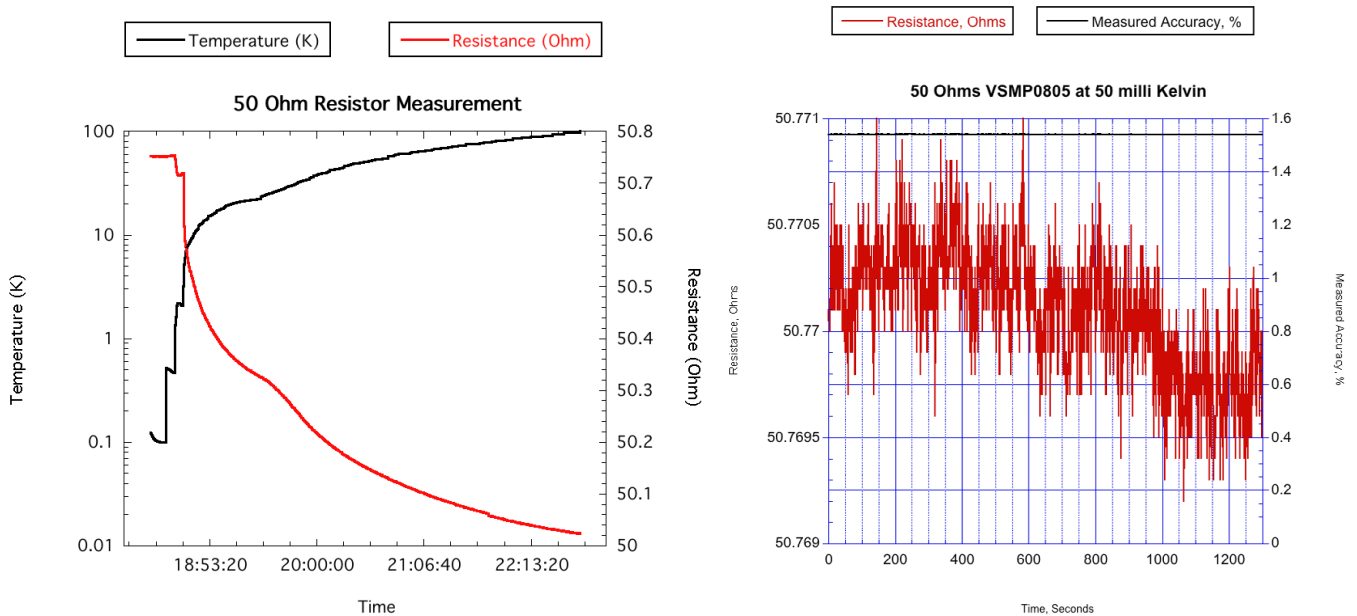


Fig.4: VSMP0805 warm-up from 0.1 Kelvin to 100 Kelvin and 50 mK

“In conclusion, the 50 Ω VSMP0805 resistor from VPG gave us very satisfactory results. The resistor showed very reasonable change in accuracy from room temperature to 50 mK as well as good stability. The VSMP0805 played a critical role in allowing us to properly characterize the BAW in a cryogenic environment.”

Contact Information

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