Calibration Procedure for Cryogenic Noise Measurements

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In microwave measurement, there are three kinds of errors: random errors, drift errors and systematic errors. Since systematic errors, which arise from the effects of cable, adapters, etc, are repeatable, microwave engineers usually measure multiple fully known devices called standards to de-embed the effects of these systematic errors. The most popular calibration techniques for calibration of scattering parameter measurements are Short-Open-Load-Thru(SOLT), Thru-Reflect-Line(TRL), and the use of Electronic Calibration(Ecal) Module. However, each of these techniques requires that the Vector Network Analyzer(VNA) be connected to different standards for calibration, before a Device Under Test(DUT) can be measured accurately. It is impossible to do such calibration in the cryostat at cryogenic temperature, because cryostat is a closed container at cryogenic temperature and, practically speaking, it cannot be opened to connect or disconnect the standards to do calibration. Hence, reference plane usually ends at the outside surface of the cryostat.

My summer project is designing a technique to do calibration inside of the cryostat. Such technique is able to move the reference plane from the surface of the cryostat to the DUT’s cable terminations. The design process includes software simulation, RF circuit building, and the final test. The test of my technique can be divided into two steps. The first step is testing my technique inside and outside the cryostat at room temperature. The second step is testing my technique inside the cryostat at cryogenic temperature. After finishing the measurement, I will apply my method to do noise measurements. I will compare the results with the former non-calibration results to see how systematic errors affect the accuracy of the measurement, whether the removal of systematic errors can help us get more accurate conclusion.