

Project 46-4

On-wafer S-parameter Measurements of Millimetre-wave Semiconductor Devices

Objectives

To evaluate the reproducibility of on-wafer S-parameter measurements at millimetre-wave frequencies through an interlaboratory comparison.

Background

On-wafer S-parameter measurements are essential for the development and validation of semiconductor devices operating at millimetre-wave frequencies. However, measurements at these frequencies present significant challenges, particularly due to the limited measurement traceability above 110 GHz.

Comparing results across laboratories and operators can help demonstrate measurement equivalence and offer valuable insights into the reproducibility of these measurements across different facilities. This, in turn, supports greater confidence in measurement data at these elevated frequencies.

Standardization Needs

There is currently no widely adopted published standard for on-wafer measurements, largely due to the complexity of these measurements.

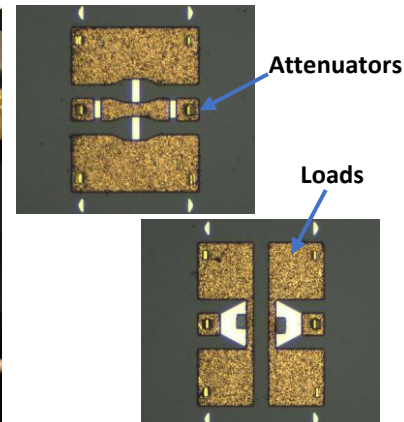
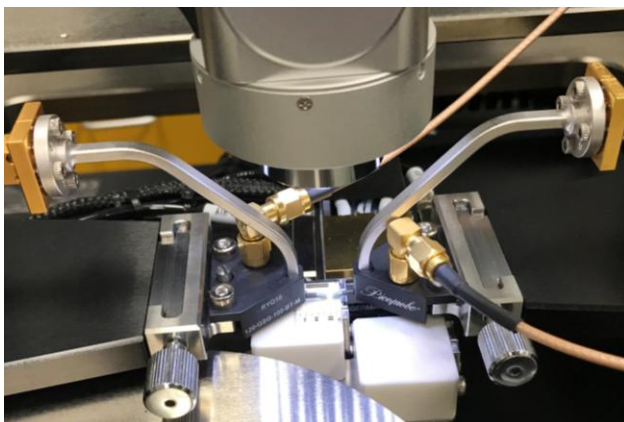
IEEE MTT-S has an active working group, P2822, titled “Recommended Practice for Microwave, Millimetre-Wave and THz On-Wafer Calibration, De-Embedding and Measurements”, which is developing a recommended practice for on-wafer measurements. This work aims to support this standardization activity.

In addition, statistical analysis of participant results will be conducted in accordance with ISO/TS 5725.

Work Programme

This project involves an interlaboratory comparison of on-wafer S-parameter measurements of passive planar circuits. The study will focus on the D-band (110 GHz–170 GHz), which is widely used in 5G communications, particularly for wireless backhaul links. Other frequency bands, up to 220 GHz, are also of interest where participating laboratories have the required measurement capability.

A detailed measurement protocol will be produced by NPL, specifying measurement settings such as frequency step size, IF bandwidth, RF power level, chuck materials, data format, and recommended probe pitch sizes.



Left: On-wafer S-parameter measurement setup at NPL; Right: Example DUTs.

Deliverables and Dissemination

- To report the results of this interlaboratory comparison at an international conference (e.g. the ARFTG Microwave Measurement Conference).
- To present the study to the IEEE MTT-S P2822 Working Group for consideration of incorporating elements of this work into the recommended practice.
- Paper publication to disseminate the results of this project

Funding

Participants fund their own involvement in the project.

International Participation

- NPL (UK)
- KRIS (South Korea)
- NICT (Japan)
- ITRI (Taiwan)
- MPI (Taiwan)

Confirmed participants in this interlaboratory comparison are listed above.

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