# Establishing a High-Frequency Evaluation Platform to Support Foundry-Grade Quality

**— Improving GaN MMIC Design Verification Through Highly Reproducible On-Wafer Measurements —**

## Electronics and Telecommunications Research Institute

**Through the utilization of Anritsu's Vector Network Analyzer (VNA), an evaluation platform for GaN MMICs has been established.**

**This platform enables highly reproducible measurements across millimeter-wave and sub-THz frequencies for consistent design verification.**


ETRI Electronics and Telecommunications Research Institute

### Overview

The Electronics and Telecommunications Research Institute (ETRI) is one of Korea's leading research institutes in the fields of information and communications technology, electronics, and semiconductors. The institute is engaged in research on compound semiconductor technologies for millimeter-wave and sub-THz applications, as well as next-generation communications technologies.

GaN MMIC-based high-frequency device development requires broadband characterization beyond the operating frequency band. Evaluation of harmonic frequency ranges is also important for improving design accuracy and performance prediction. On-wafer measurements are widely used for this purpose. However, at millimeter-wave and sub-THz frequencies, measurement results are highly sensitive to probe contact conditions and measurement system effects, making it difficult to maintain measurement reproducibility and data consistency. As operating frequencies continue to increase, evaluation platforms that enable accurate correlation between simulation results and measured data become increasingly important.

To address these challenges, ETRI deployed the Anritsu VectorStar™ ME7838G broadband vector network analyzer, which supports single-sweep measurements for frequencies up to 220 GHz. Using a single measurement platform, ETRI established an on-wafer evaluation platform capable of characterizing devices from millimeter-wave to sub-THz frequencies under consistent test conditions.

This article describes the challenges of on-wafer measurements in high-frequency device development, the evaluation platform established by ETRI, and its contribution to GaN MMIC design verification.

## Challenges of High-Frequency On-Wafer Characterization

Achieving consistent measurement results becomes increasingly challenging as device operating frequencies extend into the millimeter-wave and sub-THz bands.

In on-wafer measurements, slight variations in probe contact or alignment, impedance discontinuities, and parasitic effects can directly affect S-parameter results. As a result, obtaining consistent results, even from the same device, can be difficult. These variations may also reduce correlation between simulation results and measured data.

At frequencies above 100 GHz, the impact of reference-plane definition and probe-contact repeatability becomes even more significant. Minimizing measurement variation therefore becomes a critical challenge in device characterization. This creates a need for broadband measurements under tightly controlled test conditions.

## Establishing a Broadband On-Wafer Evaluation Platform

To address these challenges, ETRI deployed the Anritsu VectorStar™ ME7838G broadband vector network analyzer.

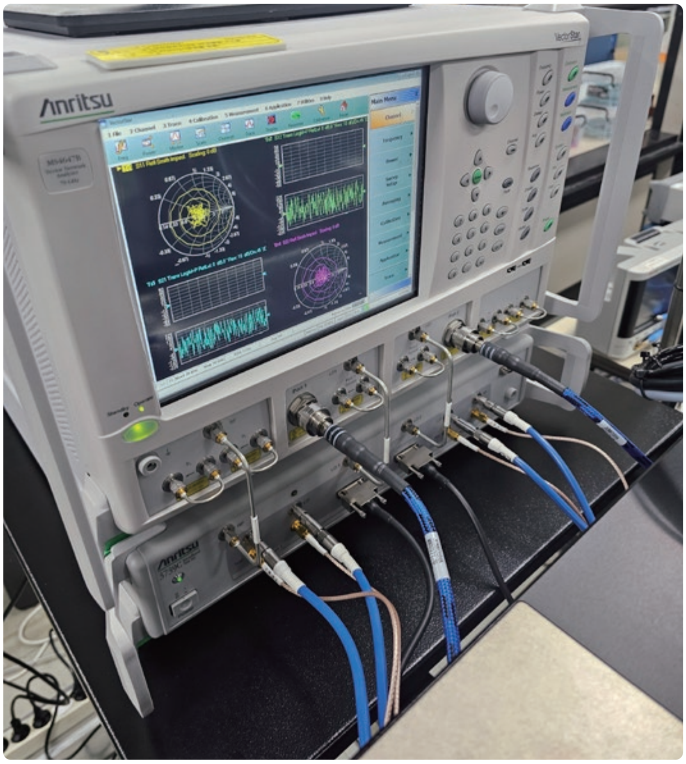
The ME7838G supports single-sweep measurements for frequencies up to 220 GHz on a single measurement platform, eliminating the need to switch measurement systems between frequency bands. This allows device characterization from millimeter-wave to sub-THz frequencies under consistent test conditions while simplifying comparison and analysis of measurement data.

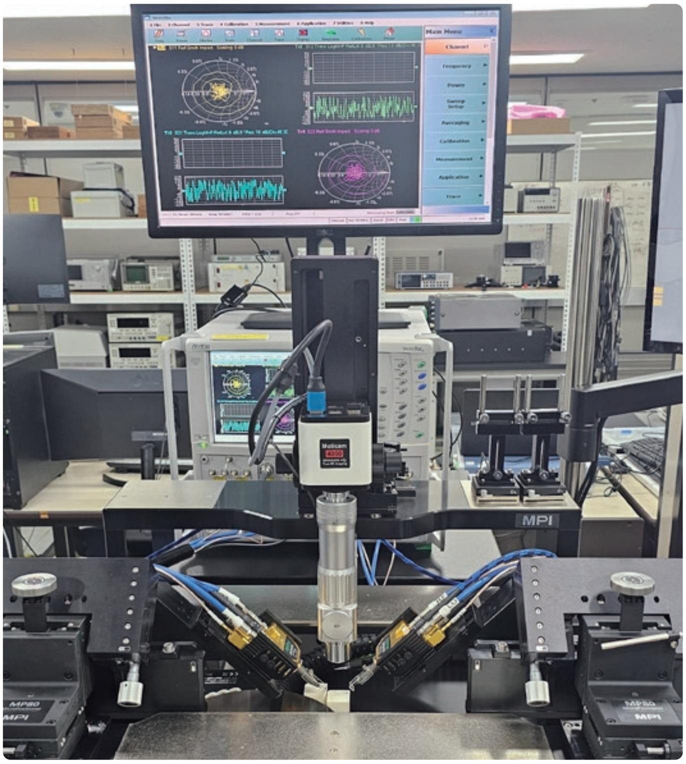
The system also supports advanced calibration techniques and is compatible with industry-standard measurement environments.

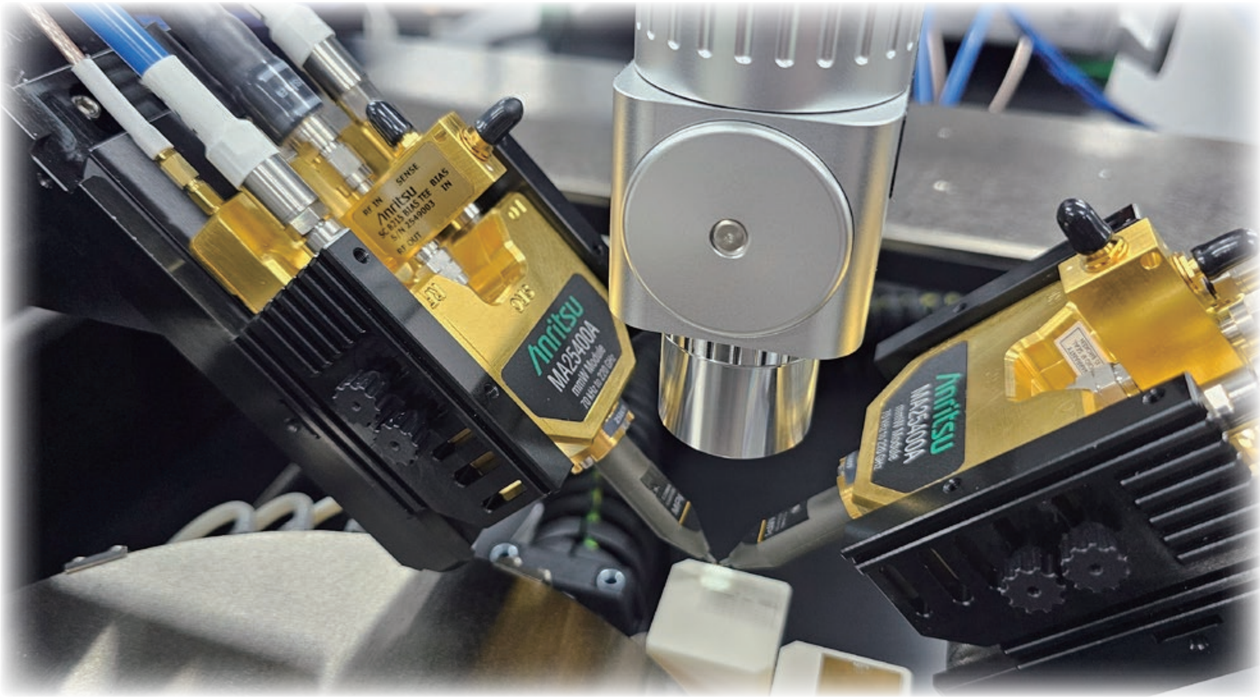
In addition, four-port measurements, differential S-parameter analysis, and TDR extend characterization beyond individual devices to include packages and interconnect structures. These capabilities allow devices and their associated interconnect structures to be evaluated on the same platform.

## Evaluation Platform for Reliable Design Verification

Following deployment of the ME7838G, ETRI established calibration protocols, applied de-embedding techniques, and standardized measurement conditions and procedures. These efforts enabled the acquisition of reproducible measurement data under consistent test conditions, regardless of the user or measurement session.






## Measurement Data for More Reliable Design Verification

High-frequency device design relies on comparison between simulation results and measured data to refine models and optimize design parameters. When measurement data contain significant variation, it becomes difficult to determine whether discrepancies originate from the device itself or from the measurement conditions.

The evaluation platform established by ETRI provides highly reproducible measurement data, enabling more accurate correlation between simulation results and measured data. This improves characterization of device performance and the accuracy of model validation.

## Broadband Evaluation for More Efficient Design and Analysis

The ME7838G enables characterization from millimeter-wave to sub-THz frequencies on a single platform.

Eliminating the need to switch measurement systems between frequency bands simplifies comparison and analysis of the acquired data. Four-port measurements, differential S-parameter analysis, and TDR further extend evaluation beyond individual devices to include packages and interconnect structures.

Design verification, characterization, and analysis can therefore be performed on a common platform.

## For Future High-Frequency Device Development

Research and development for 6G and next-generation satellite communications is expanding into frequency ranges beyond the millimeter-wave frequencies. This increases the importance of measurement data that can be accurately correlated with simulation results.

The evaluation platform established by ETRI applies not only to current GaN MMIC characterization but also to future device development at millimeter-wave and sub-THz frequencies.

As development moves toward higher frequencies, the platform provides the measurement capability required to validate design results throughout the development cycle.