

Vector Network Analyzer Traceability

Verification Kit

AND

Calibration Kit

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- Reference Standards
 - A Calibration Kit
 - A set of bead-less airlines
 - A Calibrated step attenuator or a set of calibrated fixed attenuators
 - A traceability Kit
- Mathematical Models and Calibration

continued

- Uncertainty Evaluation – General
- Uncertainty Evaluation for 1 port
Uncertainty in magnitude
 - Uncertainty in phase
 - Effective load match, Γ_L
- Uncertainty Evaluation for 2 port
 - Reflection U_{VRC}
 - Transmission U_{TM}

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- Calculation of Uncertainty
- Experimental Verification

Calibration Kit

- At least one calibration kit for each connector kit.
- The OEM Calibration Kits will normally suffice.
- Each kit should contain a good short circuit standard capable of supporting the inner-conductor of a beadless reference air line, 1 for each sex of the connectors

Beadless Airline

- At least 1 beadless reference airline is required for each connector type.
- The beadless airline supplied as part of the VNA manufacturer's verification kit, if its dimensions are suitably certified, i.e. traceable to national standards.

Calibrated Attenuator Steps

- Used to verify the linearity of the VNA with respect to RF attenuation.
 - A series of calibrated fixed attenuators (e.g. 3, 6, 10, 20, 30, 30 dB attenuators) or set that will produce steps up to 90 dB
 - Recommended a programmable step attenuator, calibrated at 1 frequency in the range of interest.

TRACEABILITY KIT

- A Traceability Kit
 - Purpose - To demonstrate traceability to national standards on a continuing basis.
 - The contents of this kit have to be agreed with the accreditation body. A2LA
 - A kit for each connector type

Mathematical Models

- Different mathematical models and associated calibration measurements are used to cause a VNA to meet full operational specifications (the so-called calibration of the VNA).

Common Models

- OSLS_T – 2 Port error-correction calibration procedure that determines the “error coefficients” with subsequent measurements of precisely known Open, Short, Sliding Load and Thru calibration standards.

Common Model

- TRL – 2 Port error-correction calibration procedure that determines the “error coefficients” with subsequent measurements of precisely known Thru, Reflect (Short), Line calibration standards.
- LRL – Line, Reflect (Short), Line
- SSL_o – 1 Port Offset Short, Short, Offset Load_{fixed}

Uncertainty and Uncertainty Evaluations

- Detailed discussion of the typical uncertainty terms used in VNA measurements uncertainty analyses.
- Appendix A – Detailed uncertainty budgets for some 1 and 2 port measurement examples.

Experimental Verification

- The traceability kit is the link to establish traceability to national standards.
 - Used to verify experimentally that the calibrated VNA yields similar results as obtained from an accredited calibration laboratory.
 - If the values are inconsistent ($>$ the RSS of the 2 uncertainties) between the measured values and the calibration data. Find the cause or expand the uncertainty.

Conclusion

- A2LA adopt the Euramet document as approved guidance for labs and assessors.
- Establish a MAC sub-committee to create A2LA's definition of the **Traceability Kit** for each connector type and how they will be used, i.e. used in a check standard scheme.

Conclusion continued

- Small Sub-committee made up of at least 1 representative from each stake-holder group.
- Require that Verification Kits, Calibration Kits, and the additional components that would make up the **Traceability Kit**, be accredited calcs.