Publishable Summary for 17SIP06 FAME VNA
Traceable, Faster and More Accurate Measurement Software for Vector Network Analysers

Overview

FAME VNA has successfully embedded the present state-of-the-art in Vector Network Analysers (VNA) calibration and uncertainty calculation methods in a user-friendly measurement software. These methods were initially developed during the recently completed EMRP project (SIB62 HFCircuits) and aimed at improving the accuracy of VNA measurement to support the metrological needs of present-generation of high-frequency electrical circuits. The dissemination of these advanced techniques to calibration laboratories was found inadequate, and the Primary Supporter of the project, DARE!!, recognised this. FAME VNA measurement software allows industrial laboratories such as DARE!! to employ a state-of-the-art calibration and uncertainty calculation software for daily calibration services and forms a critical element in the transfer of NMI-level accuracy to industrial end-users.

Need

The FAME VNA software has improved measurement quality and accuracy, while reducing the costs of VNA calibrations. To support the Primary Supporter DARE!! in providing high accuracy measurement services to customers was of great importance. At the same time, competitive pricing due to market competition imposed a clear need to reduce calibration costs while increasing the accuracy. This has led to the development of advanced data analysis module, allowing fast and sophisticated in-depth metrological evaluations.

It was a common practice for the calibration of VNA to be a manual task. In particular, processing measurement data and making the complex calculations for uncertainty values was done using excel sheets. A fully automated data calibration and uncertainty calculation module has greatly simplified state-of-the-art VNA measurements. The FAME software resolved these issues by including a data calibration module that supports the latest calibration methods with improved accuracy. Automated data processing forms a key element responsible for reduced the overall calibration time and costs, resulting in increased capacity of the laboratory. This module supports correct and accurate evaluation of a large amount of measurement data and includes advanced error-correction techniques. Automation of all the necessary steps required for accredited VNA calibration services, FAME enables industrial end-users to realize NMI-level accuracy while avoiding the complexity.

Objectives

This project aims to provide calibration software and a training course that can be used for VNA calibration and uncertainty calculations. The objectives of the project are as follows:

1. Integrate the JRP SIB62 HFCircuits outputs, i.e. characterisation of VNA setups, characterisation of calibration uncertainties reflection coefficients and the new guideline protocols into a software program in order to improve the calibration process of the relevant industries by increasing reliability, improving uncertainty and reducing overall calibration time.
2. Test and validate this software in a commercial environment and transfer the required knowledge (in particular related to the new calculation and data processing techniques) as necessary for using the software in a commercial environment
3. Organise seminar event to disseminate knowledge of this software to other calibration laboratories in Europe, with the aim to ensure further market uptake.

Results

VSL has developed measurement software FAME in compliance with objective 1 that supports methods for VNA calibration and uncertainty calculation as developed in joint research project (JRP) SIB62 HFCircuits.

Objective 1 - Integrate the JRP SIB62 HFCircuits outputs, i.e. characterisation of VNA setups, characterisation of calibration uncertainties reflection coefficients and the new guideline protocols into a software program in order to improve the calibration process of the relevant industries by increasing reliability, improving uncertainty and reducing overall calibration time.

FAME includes advanced data analysis module that enables fast and in-depth metrological evaluations. The software also includes a data calibration module that supports the latest calibration methods with improved accuracy. Furthermore, automated data processing has significantly reduced the overall calibration costs, while increasing reliability, improving uncertainty and reducing overall calibration time by allowing calibration laboratories to offer NMI-level accuracy to customers.

The project has achieved the following results:

Improved efficiency
The overall measurement time can be significantly reduced, leading to cost reduction for calibrations and increasing calibration capacity. Cost-drivers are essential in any industry, and with the software, the costs for calibrating a VNA is reduced by almost 50%, which is achieved mainly by faster measurements, automated data processing and due to the fact that extensive manual computations for error-correction and uncertainty estimation have become obsolete. For the laboratories using the VNA software, these reductions translate to a decrease in personnel costs, increased production capacity and a decrease in equipment depreciation and maintenance costs. This project, therefore, contributes to increased competitiveness of European industry.

Increased accuracy
For organisations that want to be able to perform calibration services under ISO17025 accreditation, having operational software that operates according to the requirements of this accreditation can have significant advantages. It can reduce the risk of non-compliance during the accreditation procedure. Besides, it can reduce the time that personnel need to work on the accreditation procedures, leading to additional cost reductions. For laboratories that are not accredited, this software can be used to substantiate claims regarding the quality of the calibration services.

Furthermore, FAME has undergone an in-depth and extensive validation to be compliant with objective 2 of the project.

Objective 2 - Test and validate this software in a commercial environment and transfer the required knowledge (in particular related to the new calculation and data processing techniques) as necessary for using the software in a commercial environment.

With strong collaboration between VSL and the Primary Supporter DARE!!, the VNA software is thoroughly tested and validated in Primary Supporters laboratory. This provided VSL with critical feedback for further improvements and resulted in development of a software product that meets all requirements of a commercial calibration laboratory. An online workshop was organised to transfer the knowledge necessary for using the software to DARE!! laboratory technicians.

VSL also organised an online seminar event to disseminate knowledge of this software to other stake-holders such as national metrology institutes, instrument manufacturers and calibration laboratories in Europe, with the aim to ensure further market uptake, in compliance with objective 3.

Objective 3 - Organise seminar event to disseminate knowledge of this software to other calibration laboratories in Europe, with the aim to ensure further market uptake.

To increase market uptake and disseminate the knowledge of the software, additional supporting materials such as training course, a product brochure and dedicated website were designed.

Impact

Strong collaboration between VSL and the primary supporter, led to the development of a software that significantly improved the VNA calibration process by increasing reliability, improving uncertainty and reducing overall calibration time. For example: at VSL, a specific calibration that took four hours for completion, now with the new software is completed within two hours. As the uncertainty calculation process is fully automated, the operator now has more time for qualitative metrological evaluation and with this also increase the reliability of the service. This collaboration resulted in a software product that meets all the requirements of a commercial calibration laboratory and enhancing the chances for broader market up-take. For example: a measurement report module is specially designed to enable laboratory technicians to generate calibration data in a format as required for the calibration certificate directly with the software and avoid further time-consuming data processing.

To further enhance the impact of the project, VSL developed a dedicated product website, brochure and organised online webinar event and keen interest in RF measurement community was generated. The webinar was attended by 15 VNA measurement experts from several leading NMIs, RF instrument manufacturers and secondary calibration laboratories.

The project has achieved the following impact:

Support for product development and R&D by more accurate calibrated VNA-instruments
Product design and specifications are significantly improved when measurement accuracy is enhanced. The trade between customers and suppliers of products used in the high-frequency electronics communities will be advanced on a technical and financial level. The technical improvements will come about due to improved measurement traceability processes made available, that will, in turn, enable manufacturers to specify products more precisely. More accurate product specifications will impact areas such as systems' design and tests that will provide financial benefits for the supplier and the customer (by reduced product prices). Examples include products used in consumer electronics (such as computers and mobile telephones), breast cancer detection (using radio frequency (RF) and microwaves) and security systems (using passive millimetre- and submillimetre-wave imaging). VNA instruments with multiple ports will enable calibration using the same software, which can facilitate more accurate measurements to the industry while reducing measurement time.

Replication potential
The VNA measurement software is compatible with most high-end VNAs as sold by leading VNA manufacturers. Furthermore, usage of existing calibration kits is supported by including manufacturers' calibration kit reference database in VNA software. Users are also able to add dedicated calibration kit reference files for their calibration kits. This function is especially useful for end-users requiring high calibration accuracy by using data-based reference files. These reference files can come from NMI calibrations and are traceable to SI units, hence provide a direct route to traceability. Care is taken to ensure compatibility of VNA software with existing VNAs, calibration kits and equipment in order to facilitate up-take from a larger group of stakeholders and end-users.

The Primary Supporter, DARE!!, is the first laboratory implementing this software and served as the ideal candidate to test the VNA software in the actual calibration environment. Furthermore, VSL actively approached other calibration laboratories in Europe to utilise the replication potential of the software.

<table>
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1. VSL, Netherlands</td><td>External Funded Partners:</td><td>Unfunded Partners:</td></tr>
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