

Calibration Services

Application Note AN 001

The Rosenberger calibration laboratory offers two types of calibration services, the **Factory Calibration** and the **Accredited Calibration**.

Products

- Calibration Kit
- Calibration Standard
- Verification Kit
- Verification Standard
- Traceability Kit
- Traceability Standard
- Attenuator
- Connector Gauge
- Torque Wrench (Calibration Kit type)

Each of the above mentioned products comes with a calibration certificate when explicitly mentioned in the specific datasheet. Measurement results and uncertainties are included.

Optional delivery is the Accredited Calibration. In this case the product is calibrated in the Rosenberger calibration laboratory that is accredited by the German accreditation body DAkkS (Deutsche Akkreditierungsstelle) according to DIN EN ISO 17025. Calibration Certificates issued by an accredited calibration laboratory are worldwide accepted to demonstrate that measurement results are traceable to national / international standards.

Dimensional- and mechanical measurements and the calibration of Sliding Loads are not available under the Rosenberger DAkkS accreditation. If these devices are delivered as part of a calibration kit and an accredited calibration was ordered a separate Factory Calibration Certificate is issued.

The following tables show in detail the standard technical services and the documents that are included if a Factory Calibration or the optional Accredited Calibration is ordered. Other services and documents are available on request.

For some products a Testing can be offered if a calibration is not needed.

Accredited Calibration services can be performed in the **Rosenberger Calibration Laboratory** for the connector systems:

- RPC-N 50 Ohm
- RPC-N 75 Ohm
- RPC-3.50
- RPC-2.92
- 7-16

For some other connector systems accredited calibrations can be **subcontracted to another DAkkS accredited calibration laboratory**:

- RPC-2.40
- RPC-1.85
- RPC-7

Calibration Kits for all other connector systems include a Factory Calibration only. These calibration results are traceable to Rosenberger standards. National / international standards are not available.

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Calibration Kits and single Calibration Standards *Kalibrier Kits und einzelne Kalibrierstandards*

Services performed on new devices *Leistungen bei Neuteilen*

	Factory Calibration <i>Werkskalibrierung</i>	Accredited Calibration <i>Akkreditierte Kalibrierung</i> (DKD/DAkKS ISO 17025)	Testing
Visual Inspection <i>Optische Kontrolle</i>	X	X	X
Gauging No documented values <i>Prüfung der Anschlußmaße</i> <i>Keine Messwertdokumentation</i>	X	X	X
Electrical measurements <i>Elektrische Messungen</i> Open, Short	Measurands Phase	Measurands Phase and Return Loss	Measurands Phase
Load, Thru, Adapter, Mismatch	Return Loss	Phase and Return Loss	Return Loss
Coaxial orientation	1	4	1
Electrical measurements <i>Elektrische Messungen</i> Sliding Load	Measurand Effective Return Loss *2	Not available *1	Not available
Dimensional measurements <i>Mechanische Messungen</i> Air Line:	Measurands Length and Diameter of inner and outer conductor	Not available *1	Not available
Dimensional measurements <i>Mechanische Messungen</i> Gauge	Measurand Gauge error (at two significant recessions)	Not available *1	Not available
Mechanical measurements <i>Mechanische Messungen</i> Torque Wrench	Measurand Torque	Not available *1	Not available
Measurement frequencies *3 <i>Messfrequenzen</i>	100 MHz steps *4	100 MHz steps *4	100 MHz steps *4
Model Based Standard Definitions	Individual optimized	Individual optimized	General values
Data Based Standard Definitions	Not available	X	Not available

*1 Not under DAkKS accreditation. Separate Factory Calibration Certificate.

Nicht unter DAkKS Akkreditierung. Getrennter Werkskalibrierschein.

*2 Acc. EURAMET cg-12, Version 2.0 (03/2011), chapter 6.2.1. Sliding Load specific frequency range.

Gem. EURAMET cg-12, Version 2.0 (03/2011), Kapitel 6.2.1. Sliding Load spezifischer Frequenzbereich.

*3 Other frequencies on request. Lowest available frequency is 9 kHz.

Andere Frequenzen auf Anfrage. Die niedrigste mögliche Frequenz beträgt 9 kHz.

*4 Maximum Kit frequency:

Up to 4 GHz: 25 MHz to max Kit frequency in 25 MHz steps, e.g. BNC

Up to 12 GHz: 50 MHz to max Kit frequency in 50 MHz steps, e.g. N 75 Ω

Bis 4 GHz: 25 MHz bis zur maximalen Kit Frequenz in 25 MHz Schritten, z.B. BNC

Bis 12 GHz: 50 MHz bis zur maximalen Kit Frequenz in 50 MHz Schritten, e.g. N 75 Ω

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Documentation Dokumentation

	Factory Calibration <i>Werkskalibrierung</i>	Accredited Calibration <i>Akkreditierte Kalibrierung</i> (DKD/DAkkS ISO 17025)	Testing
Document Title <i>Bezeichnung</i>	„Calibration Certificate“	“Calibration Certificate” (DAkkS/DKD)	“Certificate of Testing”
Printed Measurement Values incl. filing <i>Ausgedruckte Messwerte incl. Archivierung</i>	X	X	Not available
Tabular Measurement Values Measurement Uncertainties Data Sheet Specification Limits Compliance Statements *5, *6 <i>Tabellarische Messergebnisse Messunsicherheiten Datenblatt Spezifikationsgrenzen Konformitätsaussage</i>	Open, Short (Phase) Load, Thru, Adapter, Mismatch (Return Loss) In 1 GHz steps	Open, Short (Phase) Load, Thru, Adapter, Mismatch (Return Loss) In 1 GHz steps	Not available
Graphical Measurement Values <i>Grafische Messergebnisse</i>	Open, Short (Phase Error) Load, Thru, Adapter, Mismatch (Return Loss) All Measurement frequencies	Open, Short (Phase Error) Load, Thru, Adapter, Mismatch (Return Loss) All Measurement frequencies	Not available
Tabular Measurement Values and Measurement Uncertainties <i>Tabellarische Messergebnisse und Messunsicherheiten</i>		Open, Short, Load, Thru, Adapter, Mismatch (Return Loss + Phase) All Measurement frequencies	Not available
Graphical Measurement Values <i>Grafische Messergebnisse</i>	Sliding Load (Effective Return Loss *2)	Not available *1	Not available
Tabular Measurement Values Measurement Uncertainties <i>Tabellarische Messergebnisse Messunsicherheiten</i>	Air Line, Gauge (Dimensional measurands) Torque Wrench (Mechanical measurands)	Not available *1	Not available
Specification Limits <i>Spezifikationsgrenzen</i>	See above	See above	General information

*5 Factory Calibration: Measured results are directly compared to the specification limits. Measurement uncertainties are not taken into account.

Factory Calibration: Messergebnisse werden direkt mit den spezifizierten Grenzwerten verglichen. Messunsicherheiten werden nicht berücksichtigt.

*6 Accredited Calibration: According to Guideline DAkkS-DKD-5
Akkreditierte Kalibrierung: Gemäß Richtlinie DAkkS-DKD-5

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	Factory Calibration Werkskalibrierung	Accredited Calibration Akkreditierte Kalibrierung (DKD/DAkkS ISO17025)	Testing
Description of the measurement method <i>Beschreibung des Messverfahrens</i>	X	X	Not available
Traceability Information Angabe der Rückführbarkeit	X	X	X
List of Working Standards used <i>Liste der Gebrauchsnormale</i>	X	*7	X
Service Report <i>Servicebericht</i>	X	X	Not available
Calibration Label <i>Kalibrieraufkleber</i>	„Calibrated“	DAkkS specific *6	Not available
Actual Standard Definition Cards with optimized Model Based Standard Definitions Aktuelle Standard Definition Cards mit optimierten Model Based Standard Definitions	X	X	Not available
USB stick with Standard Definitions USB Stick mit Standard Definitions	Model based *8	Model based *8 + Data based *8	Not available

*7 According to the Sample Calibration Certificate in Guideline DAkkS-DKD-5 no List of Working Standards is used
Gemäß Musterkalibrierschein in der Richtlinie DAkkS-DKD-5 wird keine Liste der Gebrauchsnormale verwendet

*8 Keysight/ Agilent PNA family and R&S ZVA, ZNB family. Other VNAs on request.
Keysight/ Agilent/ PNA Familie und R&S ZVA, ZNB Familie. Andere VNAs auf Anfrage.

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Re-Calibrations Re-Kalibrierungen

The Calibration Services described are not only available for new Rosenberger products but also as Re-Calibrations of products from Rosenberger and other manufacturers.

Additional Services at a Re-Calibration Weitere Leistungen einer Re-Kalibrierung

	Factory Calibration Werkskalibrierung	Accredited Calibration Akkreditierte Kalibrierung (DKD/DAkKS ISO 17025)	Testing
Cleaning <i>Reinigung</i>	X	X	X
Incoming status: measurements before adjustment, repair and replacement, if possible. <i>Anlieferungszustand: Messungen vor Justierung, Reparatur oder Austausch, falls möglich.</i>	X	X	Not available

Please always use the most actual version of this document!

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Statements of Conformity Konformitätsbewertung

The new ISO/IEC 17025:2017 standard [1] includes some noteworthy changes regarding reporting statements of conformity (chapter 7.8.6). In comparison to the previous version, the laboratory shall document the decision rule employed, taking into account the level of risk (such as false accept and false reject and statistical assumptions). The following paragraphs provide detailed information about the decision rule and conformance probability.

Decision Rule Entscheidungsregel

Factory Calibration:

Measurement results and their corresponding uncertainties are reported in the calibration certificate. In addition, compliance with specification is also stated. However, measurement uncertainties are not taken into account. If the measured value is at or within specification limits the status of compliance is reported as "Pass", otherwise the compliance status is reported as "Fail".

Accredited Calibration:

Measurement results and their corresponding uncertainties are reported in the calibration certificate. Additionally, compliance with specification is also stated according to ILAC-G8:03/2009 [3]. The statement of compliance is based on a 95 % coverage probability for the expanded uncertainty and reported as follows:

Pass	Case 1 (ILAC-G8:03/2009)	Compliance
*	Case 2 (ILAC-G8:03/2009)	It is not possible to state compliance using a 95 % coverage probability for the expanded uncertainty although the measurement result is below the limit.
**	Case 3 (ILAC-G8:03/2009)	It is not possible to state non-compliance using a 95 % coverage probability for the expanded uncertainty although the measurement result is above the limit.
Fail	Case 4 (ILAC-G8:03/2009)	Non-Compliance

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Conformance Probability Konformitätswahrscheinlichkeit

The following comments and formulas on conformance probability were taken from the BIPM document JCGM 106:2012 "Evaluation of measurement data – The role of measurement uncertainty in conformity assessment" [2].

Assume that a quantity of interest Y is measured, yielding a best estimate y and an associated standard uncertainty $u(y) = u$. Then, the probability p_c that Y lies in the interval $[T_L, T_U]$, given a normal probability density function (PDF), is

$$p_c = \Phi\left(\frac{T_U - y}{u}\right) - \Phi\left(\frac{T_L - y}{u}\right) \quad (1)$$

where $y = y(\eta_m)$ and

$$\Phi(z) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^z e^{-\frac{t^2}{2}} dt \quad (2)$$

is the standard normal distribution function. For a one-sided tolerance interval with a single upper tolerance limit T_U , equation (1) reduces to

$$p_c = \Phi\left(\frac{T_U - y}{u}\right). \quad (3)$$

Similarly, the conformance probability for a one-sided tolerance interval with a single lower tolerance limit T_L , is

$$p_c = 1 - \Phi\left(\frac{T_L - y}{u}\right). \quad (4)$$

In computing coverage probabilities and conformance probabilities, one often has to evaluate integrals of normal PDFs between finite or semi-infinite limits. Such integrals as in equation (2) cannot be evaluated in closed form and are therefore evaluated numerically and tabulated. The normal distribution is also known as Gaussian distribution.

The above equations require quantities and uncertainties to be expressed in linear units. S-parameter measurement quantities and associated uncertainties expressed in logarithmic units have to be converted to linear units in order to ensure the symmetry of the coverage interval.

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Figure 1 shows a one-sided tolerance interval with a single upper tolerance limit T_U .

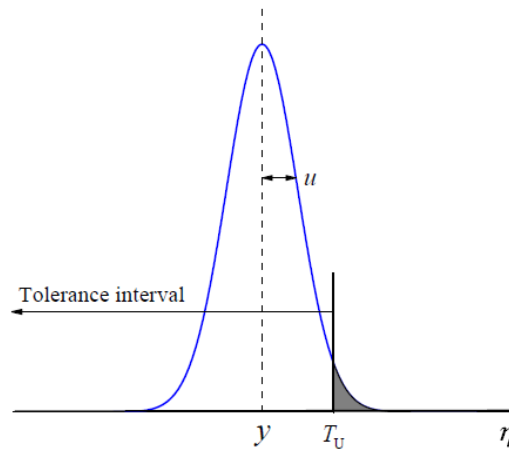


Figure 1: One-sided tolerance interval with a single upper tolerance limit T_U .
Conforming values of Y lie in the interval $\eta \leq T_U$.

General considerations

Accepting or rejecting an item when the measured value of its property of interest is close to a tolerance limit may result in an incorrect decision and lead to undesirable consequences. Such incorrect decisions are generally of two kinds in the case of a single upper tolerance limit as illustrated in figure 2, outcomes (b) and (c).

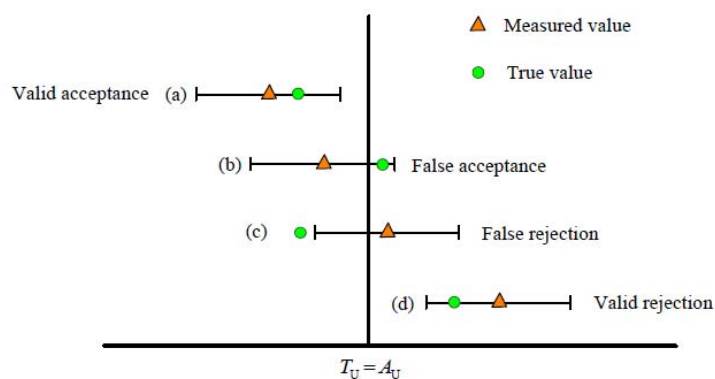


Figure 2: Simple acceptance decision rule near an upper tolerance limit T_U , with four 95 % coverage intervals.

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Conformance Probability

For a given one-sided tolerance interval with a single upper tolerance limit T_U and a measurement value y with an associated standard uncertainty $u(y) = u$, the conformance probability p_c can be calculated using equation (3). The table below shows the conformance probability p_c for the four cases stated in figure 2 on the assumption that the measurand is characterized by a normal PDF.

(a)	Valid acceptance	Item accepted		$p_c \geq 97.5 \%$
(b)	False acceptance	“Consumer’s risk” R_C^*	$R_C^* = 1 - p_c$	$2.5 \% < p_c < 97.5 \%$
(c)	False rejection	“Producer’s risk” R_P^*	$R_P^* = p_c$	$2.5 \% < p_c < 97.5 \%$
(d)	Valid rejection	Item rejected		$p_c \leq 2.5 \%$

Example

The magnitude of the reflection coefficient Γ of a load is measured at the frequency of 1 GHz, yielding a best estimate $|\Gamma| = 0.033$ with associated standard uncertainty $u(|\Gamma|) = 0.005$. Specification requires $|\Gamma| \leq 0.04$. Then from equation (3), $p_c = \Phi\left(\frac{0.040 - 0.033}{0.005}\right) = \Phi(1.4) = 0.919$. There is a 91.9 % probability that the device conforms to specification.

References

- [1] General requirements for the competence of testing and calibration laboratories (ISO/IEC 17025:2017); German and English version EN ISO/IEC 17025:2017.
- [2] Joint Committee for Guides in Metrology, JCGM 106: 2012; Evaluation of measurement data – The role of measurement uncertainty in conformity assessment (BIPM, 2012), available in <http://www.bipm.org/en/publications/guides/>
- [3] ILAC-G8:03/2009, “Guidelines on the Reporting of Compliance with Specification,” International Laboratory Accreditation Cooperation (ILAC), 2009, available at <http://ilac.org/publications-and-resources/ilac-guidance-series/>

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Joachim Schubert	28/10/14	Herbert Babinger	04/09/19	c00	14S367	Reiner Oppelt	21/08/19
Rosenberger Hochfrequenztechnik GmbH & Co. KG P.O.Box 1260 D-84526 Tittmoning Germany www.rosenberger.com					Tel. : +49 8684 18-0 Email : info@rosenberger.com		Page 9 / 9