



FCC RADIO TEST REPORT

FCC ID : IHDT56XL1
Equipment : Mobile 5G MOD
Brand Name : Motorola
Model Name : MD1005G
Applicant : Motorola Mobility LLC
222 W,Merchandise Mart Plaza, Chicago IL 60654 USA
Manufacturer : Motorola Mobility LLC
222 W,Merchandise Mart Plaza, Chicago IL 60654 USA
Standard : FCC 47 CFR Part 2, and 30

The product was received on May 15, 2019 and testing was started from May 20, 2019 and completed on Jun 18, 2019. We, SPORTON INTERNATIONAL INC., would like to declare that the tested sample has been evaluated in accordance with the test procedures ANSI C63.26-2015 and has been in compliance with the applicable technical standards.

The report must not be used by the client to claim product certification, approval, or endorsement by TAF or any agency of government.

The test results in this report apply exclusively to the tested model / sample. Without written approval of SPORTON INTERNATIONAL INC. EMC & Wireless Communications Laboratory, the test report shall not be reproduced except in full.

Approved by: William Chen

SPORTON INTERNATIONAL INC. EMC & Wireless Communications Laboratory
No. 52, Huaya 1st Rd., Guishan Dist., Taoyuan City, Taiwan (R.O.C.)



Table of Contents

History of this test report.....	3
Summary of Test Result.....	4
1 General Description	5
1.1 Feature of Equipment Under Test.....	5
1.2 Product Specification of Equipment Under Test	5
1.3 Modification of EUT	6
1.4 Testing Location	6
1.5 Applied Standards	6
2 Test Configuration of Equipment Under Test	7
2.1 Test Mode.....	7
2.2 Connection Diagram of Test System	8
2.3 Support Unit used in test configuration	8
2.4 Measurement Results Explanation Example	9
2.5 Far Field Condition for Frequency above 18GHz.....	9
2.6 Frequency List of Low/Middle/High Channels.....	10
3 Radiated Test Items	11
3.1 Measuring Instruments.....	11
3.2 Test Setup	11
3.3 Test Result of Radiated Test.....	12
3.4 EIRP Measurement	13
3.5 Occupied Bandwidth	14
3.6 Radiated Spurious Emission Measurement.....	15
3.7 Frequency Stability Measurement.....	16
4 List of Measuring Equipment.....	17
5 Uncertainty of Evaluation.....	18
Appendix A. Test Results of EIRP and Radiated Test	
Appendix B. R&S Mixer Certificate	



History of this test report

Report No.	Version	Description	Issued Date
FG890514-05E	01		Jun. 19, 2019

Summary of Test Result

Report Clause	Ref Std. Clause	Test Items	Limit	Result (PASS/FAIL)	Remark
3.4	§2.1046 §30.202	EIRP Measurement	+43dBm	Pass	-
3.5	§2.1049	Occupied Bandwidth	Not Applicable	Reporting only	-
3.6	§2.1053 §30.203	Radiated Spurious Emission	-5dBm/MHz -13dBm/MHz	Pass	-
3.7	§2.1055	Frequency Stability for Temperature & Voltage	Within the band	Pass	-

Declaration of Conformity:

The test results with all measurement uncertainty excluded are presented in accordance with the regulation limits or requirements declared by manufacturers.

Comments and Explanations:

The declared of product specification for EUT presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification.

Reviewed by: Louis Wu

Report Producer: Yung Hsu

1 General Description

1.1 Feature of Equipment Under Test

Product Feature & Specification	
Equipment	Mobile 5G MOD
Brand Name	Motorola
Model Name	MD1005G
FCC ID	IHDT56XL1
IMEI Code	353310080024793
EUT supports Radios application	LTE/5G NR
HW Version	DVT2
EUT Stage	Identical Prototype

Remark: The above EUT's information was declared by manufacturer.

Specification of Accessories	
USB Cable 1	Brand Name : Motorola
	Model Name : SC18C46623

Supported Unit Used in Test Configuration and System	
AC Adapter 1	Brand Name : Motorola
	Model Name : SC-51
	Manufacturer : Salom
AC Adapter 2	Brand Name : Motorola
	Model Name : SC-51
	Manufacturer : Chenyang
Mobile Phone	Brand Name : Motorola
	FCC ID : IHDT56WB1

1.2 Product Specification of Equipment Under Test

Product Specification subjective to this standard	
Device Category in Part 30	Mobile station
Tx Frequency	NR band n261: 27.5GHz ~ 28.35GHz NR band n260: 37GHz ~ 40GHz
Rx Frequency	NR band n261: 27.5GHz ~ 28.35GHz NR band n260: 37GHz ~ 40GHz
Support Bandwidth	50 MHz and 100 MHz
Maximum Number of contiguous CC	4
Maximum Aggregated Bandwidth	400MHz
Antenna Info	NR 1x4 patch array antenna for each module
Type of Modulation	CP-OFDM: QPSK / 16QAM / 64QAM DFT-s-OFDM: Not supported

1.3 Modification of EUT

No modifications are made to the EUT during all test items.

1.4 Testing Location

Test Site	SPORTON INTERNATIONAL INC.
Test Site Location	No.58, Aly. 75, Ln. 564, Wenhua 3rd, Rd., Guishan Dist., Taoyuan City, Taiwan (R.O.C.) TEL: +886-3-327-0868 FAX: +886-3-327-0855
Test Site No.	Sporton Site No. 03CH10-HY

Note: The test site complies with ANSI C63.4 2014 requirement.

FCC designation No. : TW1190 / TW0007

1.5 Applied Standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

- ♦ FCC 47 CFR Part 2, 30
- ♦ ANSI C63.26-2015
- ♦ FCC KDB 971168 D01 Power Meas. License Digital Systems v03r01

Remark:

1. All test items were verified and recorded according to the standards and without any deviation during the test.
2. This EUT has also been tested and complied with the requirements of FCC Part 15, Subpart B, recorded in a separate test report.



2 Test Configuration of Equipment Under Test

EUT has total 4 millimeter wave antenna modules and up to 2 beams operation for each module.

EUT is configured to radiate at rated maximum EIRP with both 2 beams ON mode at the same time.

Any antenna module cannot transmit simultaneously with the other antenna modules.

Preliminary EIRP test was performed for all beam configurations in the anechoic chamber at the manufacturer's facility, the all preliminary test results and test details are illustrated in "IHDT56XL1_OpDes_detailed reference for the simulation report", and the worst beam-pairs were identified.

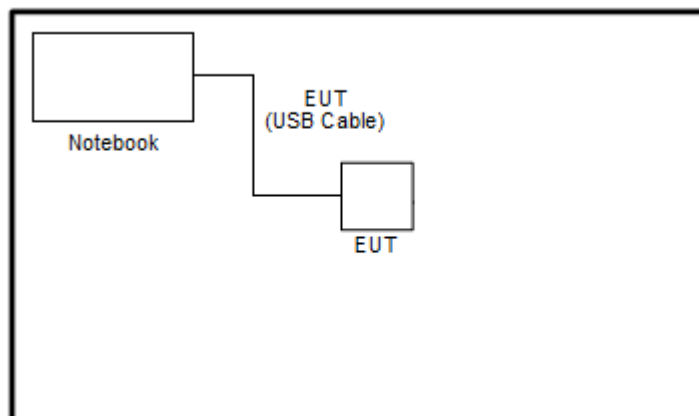
The NR radio operation is controlled via software tool QRCT v4.0.

2.1 Test Mode

For radiated measurement, the pre-scan is performed to find the worst cases EUT position.

Test Items	Band	Bandwidth (MHz)			Modulation			RB #			Test Channel		
		50	100	400	QPSK	16QAM	64QAM	1	-	Full	L	M	H
Spurious Emission	n261	Worst Case									V		
Remark	1. The mark “v” means that this configuration is chosen for testing 2. The device is investigated from 30MHz to 100GHz of fundamental signal for radiated spurious emission test under different RB size and modulations in exploratory test. Subsequently, only the worst case emissions are reported. 3. All the radiated test cases were performed with built-in battery.												

2.2 Connection Diagram of Test System



2.3 Support Unit used in test configuration

Item	Equipment	Trade Name	Model No.	FCC ID	Data Cable	Power Cord
1.	Notebook	Lenovo	N/A	N/A	N/A	N/A

2.4 Measurement Results Explanation Example

According to ANSI C63.26-2015 Section 5.2.7

$$\text{EIRP (dBm)} = \text{E(dBuV/m)} + 20\log(D) - 104.8.$$

where D is the measurement distance (in the far field region) in m.

$$\text{E (dBuV/m)} = \text{Spectrum Reading Level (dBm)} + \text{Antenna Factor (dB/m)} + \text{Cable Loss (dB)} + 107$$

Hence, the spectrum analyzer *Offset* is derived including RF cable loss and antenna factor.

$$\text{Offset} = \text{Antenna Factor (dB/m)} + \text{Cable Loss (dB)} + 107 + 20\log(D) - 104.8$$

The conversion loss of RF mixer is also included by the mixer table of spectrum analyzer when measurement frequency is above 40GHz.

Example :

$$\begin{aligned} \text{Offset} &= \text{Antenna Factor (dB/m)} + \text{Cable Loss (dB)} + 107 + 20\log(D) - 104.8 \\ &= 40.1 + 2.2 + 107 + 20\log(1) - 104.8 \\ &= 44.5 \text{ (dB)} \end{aligned}$$

2.5 Far Field Condition for Frequency above 18GHz

Horn Antenna	Frequency (GHz)	Antenna Dimension A (mm)	Wavelength (λ) (m)	Far field R (m) $\geq 2A^2/\lambda$	Measurement Distance (D) (m)	Distance Factor 20log(D) (dB)
BBHA 9170	18	60	0.0167	0.43	1	0.00
	40	60	0.0075	0.96		
QWH-UPRR00	40	48	0.0075	0.61	1	0.00
	60	48	0.0050	0.92		
QWH-EPRR00	60	31	0.0050	0.38	1	0.00
	90	31	0.0033	0.58		
QWH-FPRR00	90	21	0.0033	0.26	1	0.00
	140	21	0.0021	0.41		



2.6 Frequency List of Low/Middle/High Channels

NR Band n261 Channel and Frequency List				
BW [MHz]	Channel/Frequency(MHz)	Lowest	Middle	Highest
50	Frequency	27525	27925	28325
100	Frequency	27550	27925	28300
400	Frequency 1	27550	27775	28000
	Frequency 2	27650	27875	28100
	Frequency 3	27750	27975	28200
	Frequency 4	27850	28075	28300

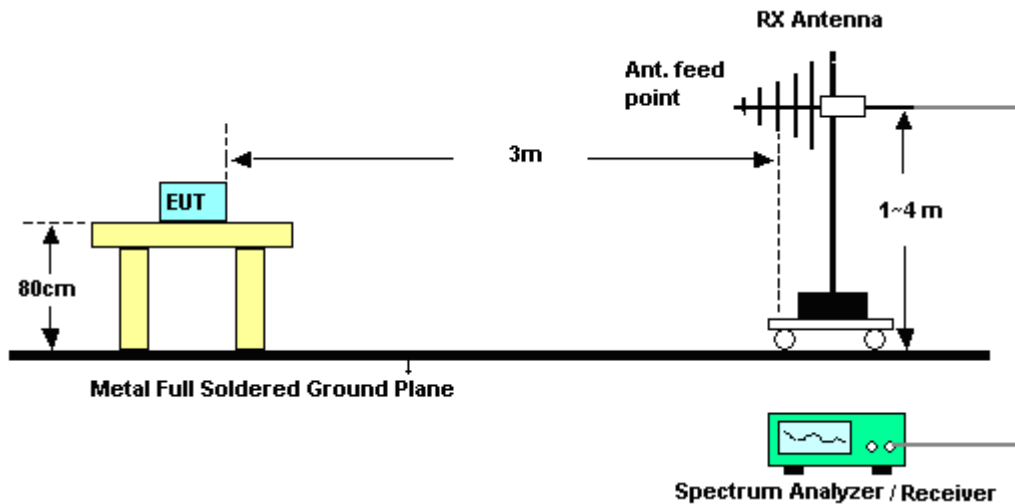
3 Radiated Test Items

3.1 Measuring Instruments

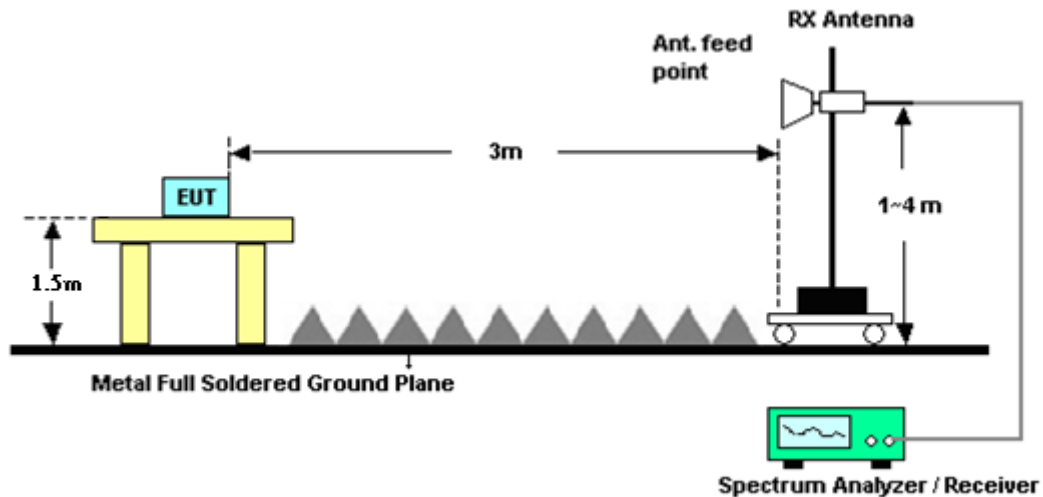
See list of measuring instruments of this test report.

3.2 Test Setup

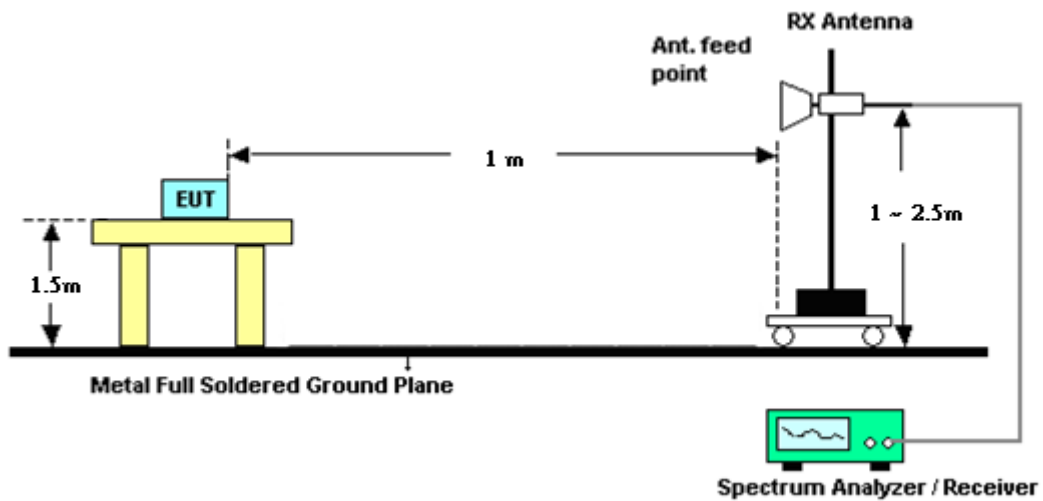
For radiated emissions from 30MHz to 1GHz



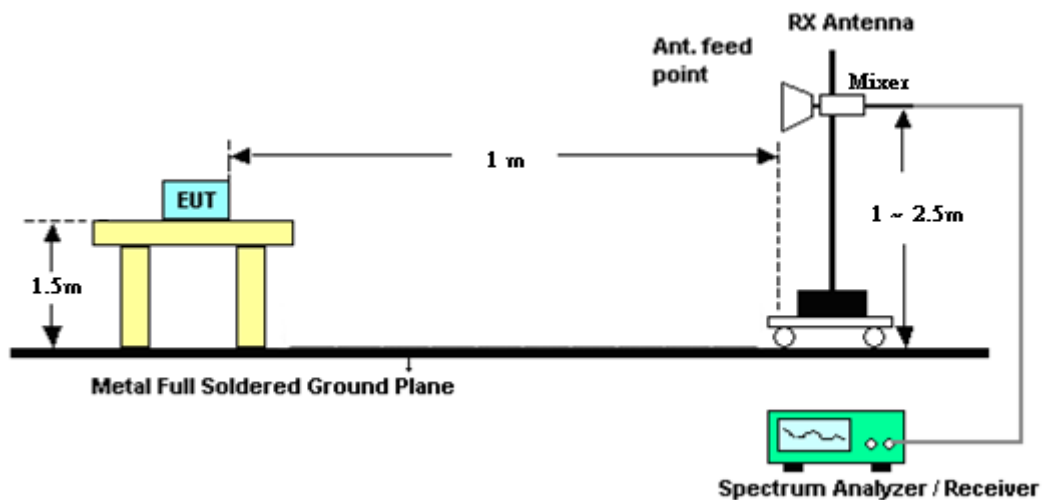
For radiated emissions 1GHz to 18GHz



For radiated emissions above 18GHz



For radiated emissions above 40GHz



3.3 Test Result of Radiated Test

Please refer to Appendix A.



3.4 EIRP Measurement

3.4.1 Description of EIRP Measurement

For mobile stations, the average power of the sum of all antenna elements is limited to a maximum EIRP of +43 dBm.

3.4.2 Test Procedures

1. Set EUT at maximum output power.
2. Select lowest, middle, and highest channels for each band and different modulation.
3. Enable channel power function of spectrum analyzer
4. Set frequency would like to be investigated.
5. Set Detector = RMS
6. Set Trace mode = trace average
7. Set Sweep time = auto couple
8. Set sweep points $\geq 2 \times \text{Span/RBW}$
9. Set sweep count 100 and wait until the trace to be stabilized
10. Make the measurement with the spectrum analyzer's RBW = 1MHz, VBW = 3MHz, taking the record of maximum spurious emission.
11. Measure and record the power level from the spectrum analyzer.
12. The test result is calculated according to

ANSI C63.26-2015 Section 5.2.7

$\text{EIRP (dBm)} = \text{E(dBuV/m)} + 20\log(D) - 104.8.$

where D is the measurement distance (in the far field region) in m.

$\text{E (dBuV/m)} = \text{Spectrum Level (dBm)} + \text{Antenna Factor (dB/m)} + \text{Cable Loss (dB)} + 107$

That is, set the spectrum offset including sum of

$\text{Antenna Factor (dB/m)} + \text{Cable Loss (dB)} + 107 + 20\log(D) - 104.8$



3.5 Occupied Bandwidth

3.5.1 Description of Occupied Bandwidth Measurement

This is for reporting only.

The occupied bandwidth is the width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to a specified percentage 0.5% of the total mean transmitted power.

3.5.2 Test Procedures

The testing follows ANSI C63.26-2015 Section 5.4.4

1. The spectrum analyzer center frequency is set to the nominal EUT channel center frequency.
The span range for the spectrum analyzer shall be at least 1.5 times the anticipated OBW.
2. The nominal resolution bandwidth (RBW) shall be in the range of 1 to 5 % of the anticipated OBW, and the VBW shall be at least 3 times the RBW.
3. Set the detection mode to peak, and the trace mode to max hold.
4. Use the 99 % power bandwidth function of the spectrum analyzer and report the measured bandwidth.

3.6 Radiated Spurious Emission Measurement

3.6.1 Description of Radiated Spurious Emission Measurement

The spectrum is scanned from 30 MHz up to 100GHz.

The conductive power or the total radiated power of any emission outside a licensee's frequency block shall be -13 dBm/MHz or lower. However, in the bands immediately outside and adjacent to the licensee's frequency block, having a bandwidth equal to 10 percent of the channel bandwidth, the conductive power or the total radiated power of any emission shall be -5 dBm/MHz or lower.

3.6.2 Test Procedures

1. Set EUT at maximum output power..
2. Select lowest, middle, and highest channels for each band and different modulation.
3. Measure and record the power level from the spectrum analyzer.
4. Set frequency would like to be investigated.
5. Set Detector = RMS
6. Set Trace mode = trace average
7. Set Sweep time = auto couple
8. Set sweep points $\geq 2 \times \text{Span/RBW}$
9. Set sweep count 100 and wait until the trace to be stabilized
10. Make the measurement with the spectrum analyzer's RBW = 1MHz, VBW = 3MHz, taking the record of maximum spurious emission.
11. For measurement from 30MHz to 18GHz,
An antenna was substituted in place of the EUT and was driven by a signal generator.
Tune the output power of signal generator to the same emission level with EUT maximum spurious emission. Take record of output power and repeat for another polarization.
12. For measurement above 18GHz, the test result is calculated according to
ANSI C63.26-2015 Section 5.2.7 and 5.7.3 and 5.7.4
$$\text{EIRP (dBm)} = \text{E(dBuV/m)} + 20\log(D) - 104.8.$$
where D is the measurement distance (in the far field region) in m.
$$\text{E (dBuV/m)} = \text{Spectrum Level (dBm)} + \text{Antenna Factor (dB/m)} + \text{Cable Loss (dB)} + 107$$
That is, set the spectrum offset including sum of
$$\text{Antenna Factor (dB/m)} + \text{Cable Loss (dB)} + 107 + 20\log(D) - 104.8$$
13. The conversion loss of RF mixer is also included in conversion loss table of the spectrum analyzer when measurement frequency is above 40GHz.



3.7 Frequency Stability Measurement

3.7.1 Description of Frequency Stability Measurement

The frequency stability shall be measured by variation of ambient temperature and variation of primary supply voltage to ensure that the fundamental emission stays within the authorized frequency block.

3.7.2 Test Procedures for Temperature Variation

The testing follows FCC KDB 971168 D01 v03r01 Section 9.

1. The EUT was set up in the thermal chamber.
2. With power OFF, the temperature was decreased to -30°C and the EUT was stabilized before testing. Power was applied and the maximum change in frequency was recorded within one minute.
3. With power OFF, the temperature was raised in 10°C step up to 50°C. The EUT was stabilized at each step for at least half an hour. Power was applied and the maximum frequency change was recorded within one minute.

3.7.3 Test Procedures for Voltage Variation

The testing follows FCC KDB 971168 D01 v03r01 Section 9.

1. The EUT was placed in a temperature chamber at 20° C.
2. The power supply voltage to the EUT was varied from 85% to 115% of the nominal value measured at the input to the EUT.
3. The variation in frequency was measured for the worst case.

4 List of Measuring Equipment

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
Amplifier	SONOMA	310N	187311	9kHz~1GHz	Oct. 23, 2018	May 20, 2019~ Jun. 18, 2019	Oct. 22, 2019	Radiation (03CH10-HY)
Bilog Antenna	TESEQ	CBL 6111D&00800 N1D01N-06	37059&01	30MHz~1GHz	Oct. 13, 2018	May 20, 2019~ Jun. 18, 2019	Oct. 12, 2019	Radiation (03CH10-HY)
Horn Antenna	SCHWARZBE CK	BBHA 9120 D	9120D-1325	1GHz ~ 18GHz	Oct. 02, 2018	May 20, 2019~ Jun. 18, 2019	Oct. 01, 2019	Radiation (03CH10-HY)
SHF-EHF Horn Antenna	SCHWARZBE CK	BBHA 9170	BBHA9170251	18GHz ~ 40GHz	Nov. 20, 2018	May 20, 2019~ Jun. 18, 2019	Nov. 19, 2019	Radiation (03CH10-HY)
Hygrometer	TECEPIL	DTM-303B	TP140320	N/A	Nov. 05, 2018	May 20, 2019~ Jun. 18, 2019	Nov. 04, 2019	Radiation (03CH10-HY)
Preamplifier	Keysight	83017A	MY53270078	1GHz~26.5GHz	Oct. 28, 2018	May 20, 2019~ Jun. 18, 2019	Oct. 27, 2019	Radiation (03CH10-HY)
Spectrum Analyzer	Keysight	N9010A	MY54200485	10Hz ~ 44GHz	Nov. 02, 2018	May 20, 2019~ Jun. 18, 2019	Nov. 01, 2019	Radiation (03CH10-HY)
Spectrum Analyzer	Rohde & Schwarz	FSV30	103738	9kHz~30GHz	May 23, 2019	May 24, 2019~ Jun. 18, 2019	May 22, 2020	Thermal (TH02-HY)
Software	Audix	E3 6.2009-8-24	RK-001042	N/A	N/A	May 20, 2019~ Jun. 18, 2019	N/A	Radiation (03CH10-HY)
Controller	EMEC	EM 1000	N/A	Control Turn table & Ant Mast	N/A	May 20, 2019~ Jun. 18, 2019	N/A	Radiation (03CH10-HY)
Antenna Mast	EMEC	AM-BS-4500- B	N/A	1~4m	N/A	May 20, 2019~ Jun. 18, 2019	N/A	Radiation (03CH10-HY)
Turn Table	EMEC	TT 2200	N/A	0~360 Degree	N/A	May 20, 2019~ Jun. 18, 2019	N/A	Radiation (03CH10-HY)
*Mixer	Rohde & Schwarz	FS-Z60	100986	40 ~ 60 GHz	Oct. 31, 2018	May 20, 2019~ Jun. 18, 2019	Oct. 30, 2021	Radiation (03CH10-HY)
*Mixer	Rohde & Schwarz	FS-Z90	101811	60 ~ 90 GHz	Jul. 16, 2018	May 20, 2019~ Jun. 18, 2019	Jul. 16, 2021	Radiation (03CH10-HY)
*Mixer	Rohde & Schwarz	FS-Z140	101128	90 ~ 140 GHz	Sep. 03, 2018	May 20, 2019~ Jun. 18, 2019	Sep. 02, 2021	Radiation (03CH10-HY)
Standard Horn Antenna	Quinstar	QWH-UPRR0 0	923600007	40 ~ 60 GHz	Aug. 17, 2018	May 20, 2019~ Jun. 18, 2019	Aug. 16, 2021	Radiation (03CH10-HY)
Standard Horn Antenna	Quinstar	QWH-EPRR0 0	784600034	60 ~ 90 GHz	Aug. 17, 2018	May 20, 2019~ Jun. 18, 2019	Aug. 16, 2021	Radiation (03CH10-HY)
Standard Horn Antenna	Quinstar	QWH-FPRR0 0	923800008	90 ~ 140 GHz	Aug. 17, 2018	May 20, 2019~ Jun. 18, 2019	Aug. 16, 2021	Radiation (03CH10-HY)
Loop Antenna	Rohde & Schwarz	HFH2-Z2	100488	9 kHz~30 MHz	Nov. 23, 2017	May 20, 2019~ Jun. 18, 2019	Nov. 22, 2019	Radiation (03CH10-HY)

Note:

(*) Equipment manufacturer's Calibration Certificate.

5 Uncertainty of Evaluation

Uncertainty of Radiated Emission Measurement (30 MHz ~ 1000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2U_c(y)$)	3.17
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Uncertainty of Radiated Emission Measurement (1 GHz ~ 18 GHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2U_c(y)$)	3.48
--	------

Uncertainty of Radiated Emission Measurement (18 GHz ~ 40 GHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2U_c(y)$)	4.00
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Uncertainty of Radiated Emission Measurement (40 GHz ~ 100 GHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2U_c(y)$)	5.80
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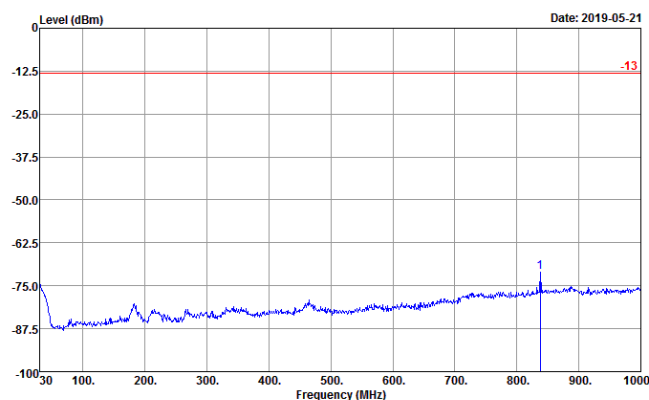
Appendix A. Test Results of EIRP and Radiated Test

Spurious Emission

There is no significant spurious emission signal found for frequency started from 9kHz up to 18GHz.
Only the noise floor is reported.

NR Band n261 (30MHz-1GHz)

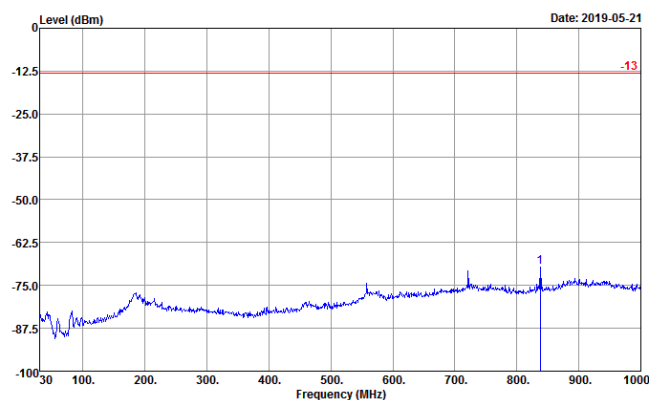
Horizontal



Site : 03CH10-HY
Condition : -13 EIRP_WO HORIZONTAL
Project : 890514-05
: n261

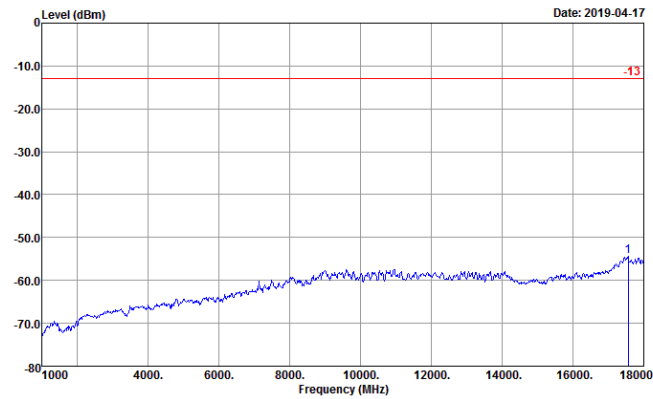
	Freq	Level	Over Limit	Limit Line	Read Level
	MHz	dBm	dB	dBm	dBm
1	838.01	-70.89	-57.89	-13.00	-76.67

Vertical



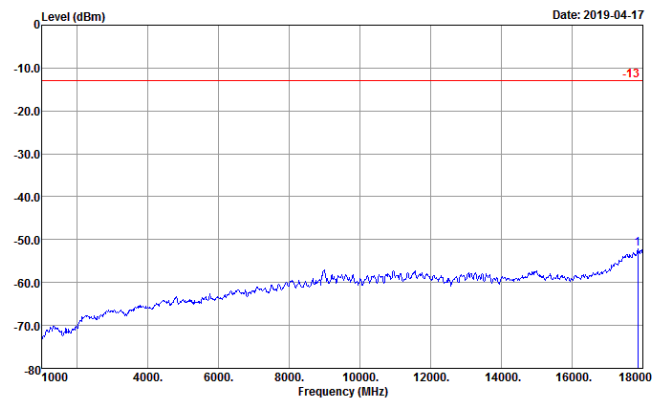
Site : 03CH10-HY
Condition : -13 EIRP_WO VERTICAL
Project : 890514-05
: n261

	Freq	Level	Over Limit	Limit Line	Read Level
	MHz	dBm	dB	dBm	dBm
1	838.01	-69.63	-56.63	-13.00	-76.28

**NR Band n261 (1GHz-18GHz)****Horizontal**

Site : 03CH10-HY
Condition : -13 EIRP_WO HORIZONTAL
Project : 930415-07

	Freq	Level	Over Limit	Limit Line	Read Level
	MHz	dBm	dB	dBm	dBm
1	17558.00	-54.33	-41.33	-13.00	-64.50

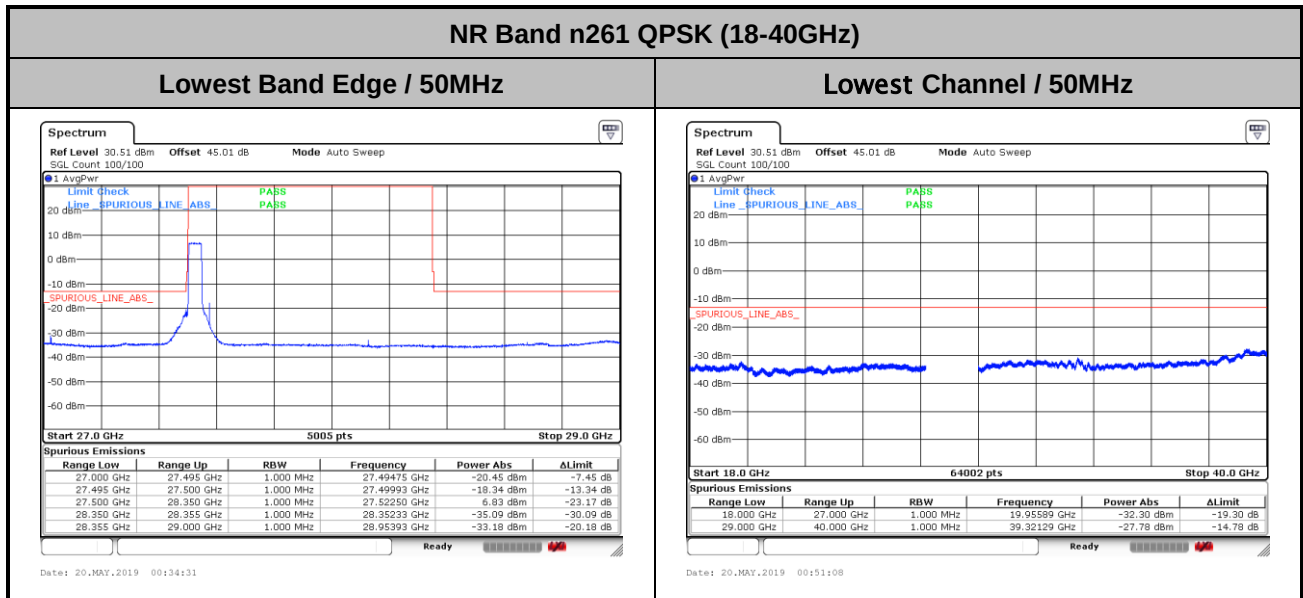
Vertical

Site : 03CH10-HY
Condition : -13 EIRP_WO VERTICAL
Project : 930415-07

	Freq	Level	Over Limit	Limit Line	Read Level
	MHz	dBm	dB	dBm	dBm
1	17864.00	-52.25	-39.25	-13.00	-65.17

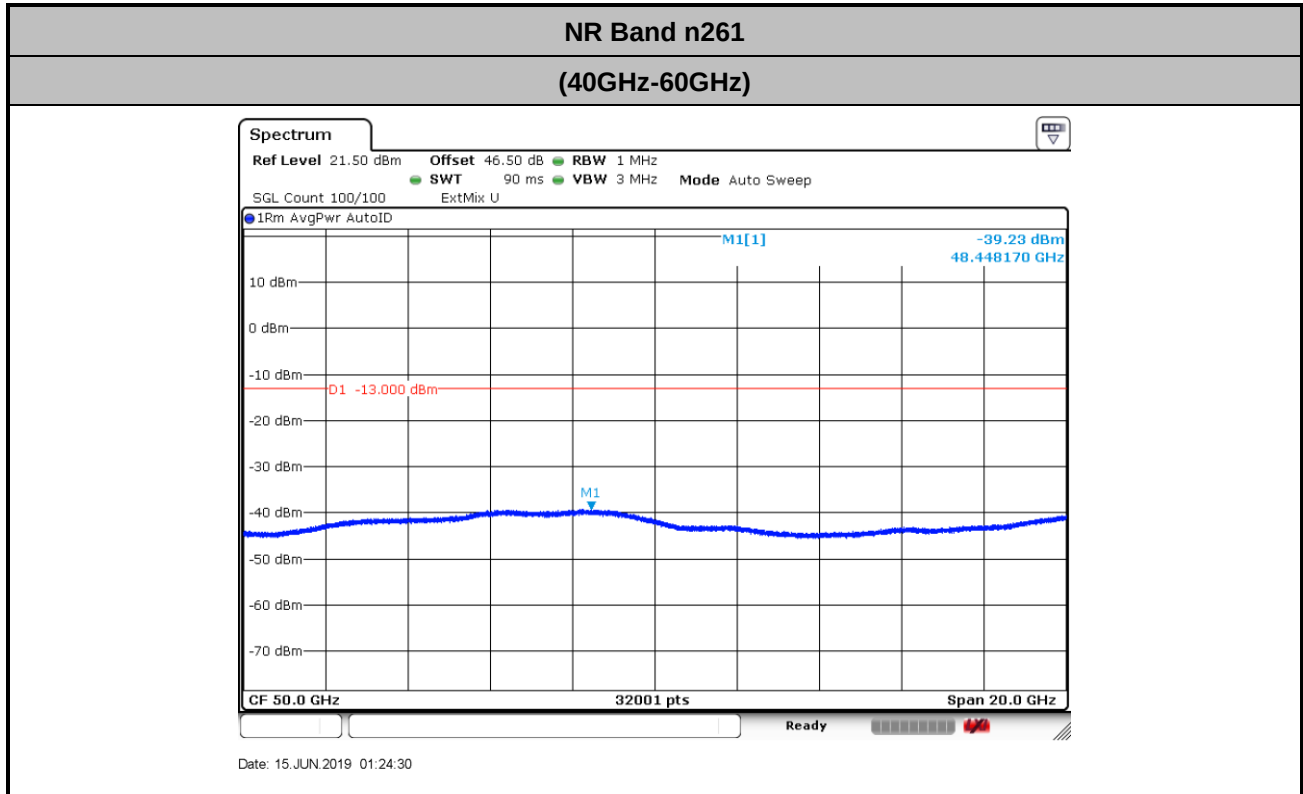


Spurious emission between 18GHz to 40GHz worst case plot is reported as following.

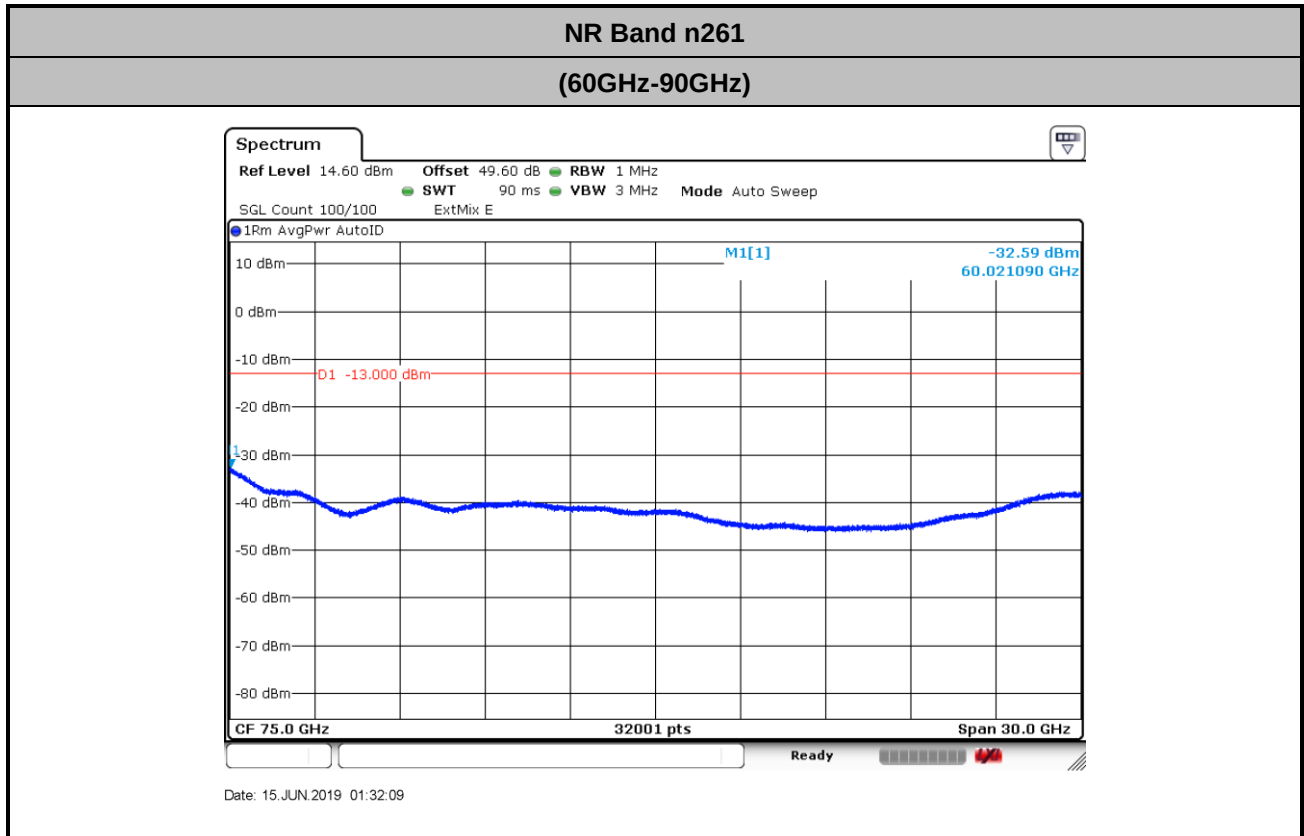




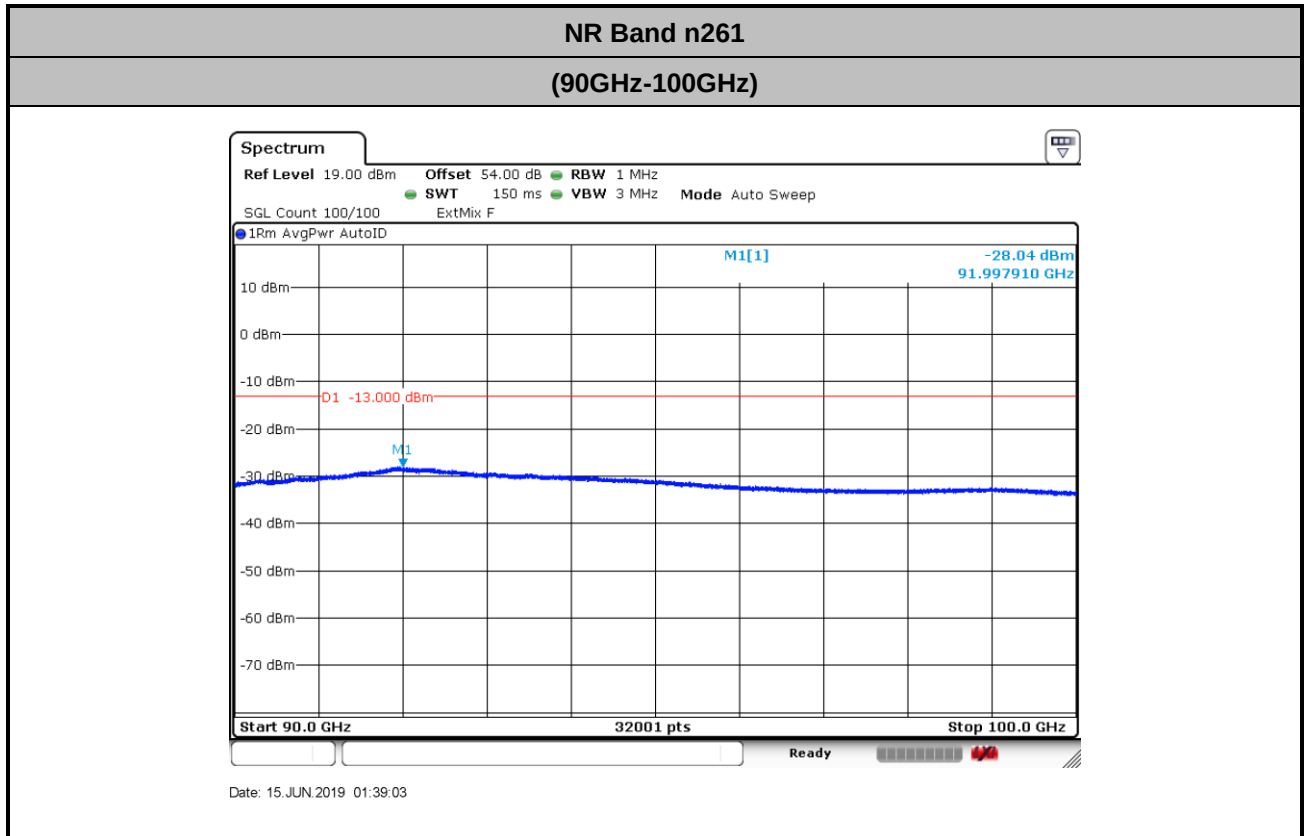
There is no significant spurious emission signal found for frequency started from 40GHz up to 100GHz.
Only the noise floor is reported.



$$\begin{aligned} \text{Offset} &= \text{Antenna Factor (dB/m)} + \text{Cable Loss (dB)} + 107 + 20\log(D) - 104.8 \\ &= 42.1 + 2.2 + 107 + 20\log(1) - 104.8 = 46.5 \text{ (dB)} \end{aligned}$$



$$\begin{aligned} \text{Offset} &= \text{Antenna Factor (dB/m)} + \text{Cable Loss (dB)} + 107 + 20\log(D) - 104.8 \\ &= 45.2 + 2.2 + 107 + 20\log(1) - 104.8 = 49.6 \text{ (dB)} \end{aligned}$$



$$\begin{aligned} \text{Offset} &= \text{Antenna Factor (dB/m)} + \text{Cable Loss (dB)} + 107 + 20\log(D) - 104.8 \\ &= 49.6 + 2.2 + 107 + 20\log(1) - 104.8 = 54.0 \text{ (dB)} \end{aligned}$$



Appendix B. R&S Mixer Certificate



Calibration Certificate

Kalibrierschein

Certificate Number **24-0060-100986-01**

Zertifikatsnummer

Unit Data

Item Harmonic Mixer, 40 GHz to 60 GHz
Gegenstand

Manufacturer RPG
Hersteller

Type RPG FS-Z60
Typ

Material Number 1048.0171.02
Materialnummer

Serial Number 100986
Seriennummer

Asset Number
Inventarnummer

This calibration certificate documents, that the named item is tested and measured against defined specifications. Measurement results are located usually in the corresponding interval with a probability of approx. 95% (coverage factor $k = 2$). Calibration is performed with test equipment and standards directly or indirectly traceable by means of approved calibration techniques to the PTB/DKD or other national/international standards, which realize the physical units of measurement according to the International System of Units (SI). In all cases where no standards are available, measurements are referenced to standards of the R&S laboratories. Principles and methods of calibration correspond with EN ISO/IEC 17025. This calibration certificate may not be reproduced other than in full. Calibration certificates without signatures are not valid. The user is obliged to have the object recalibrated at appropriate intervals.

Order Data

Customer
Auftraggeber

Order Number
Bestellnummer

Date of Receipt
Eingangsdatum

Dieser Kalibrierschein dokumentiert, dass der genannte Gegenstand nach festgelegten Vorgaben geprüft und gemessen wurde. Die Messwerte lagen im Regelfall mit einer Wahrscheinlichkeit von annähernd 95% im zugeordneten Werteintervall (Erweiterte Messunsicherheit mit $k = 2$). Die Kalibrierung erfolgte mit Messmitteln und Normalen, die direkt oder indirekt durch Ableitung mittels anerkannter Kalibriertechniken rückgeführt sind auf Normale der PTB/DKD oder anderer nationaler/internationaler Standards zur Darstellung der physikalischen Einheiten in Übereinstimmung mit dem Internationalen Einheitensystem (SI). Wenn keine Normale existieren, erfolgt die Rückführung auf Bezugsnormale der R&S-Laboratorien. Grundsätze und Verfahren der Kalibrierung beziehen sich auf EN ISO/IEC 17025. Dieser Kalibrierschein darf nur vollständig und unverändert weiterverbreitet werden. Kalibrierscheine ohne Unterschriften sind ungültig. Für die Einhaltung einer angemessenen Frist zur Wiederholung der Kalibrierung ist der Benutzer verantwortlich.

Performance

Place and Date of Calibration
Ort und Datum der Kalibrierung

Meckenheim, 2018-10-31

Scope of Calibration
Umfang der Kalibrierung

Standard Calibration

Statement of Compliance (Incoming)
Konformitätsaussage (Anlieferung)

New device

Statement of Compliance (Outgoing)
Konformitätsaussage (Auslieferung)

All measured values are within the data sheet specifications.

Extend of Calibration Documents
Umfang des Kalibrierdokuments

**2 pages Calibration Certificate
5 pages Outgoing Results**

Radiometer Physics GmbH; Meckenheim

Date of Issue
Ausstellungsdatum

2018-11-05

Head of Laboratory
Laborleitung

Schulze

Person Responsible
Bearbeiter

Heinze

Page (Seite) 1/2
Vers2010-05-05/
RPG2014-02-28

Calibration Method
Kalibrieranweisung

RPG-PAQA-TN-2014-002

Relative Humidity **20 % - 80 %**
Relative Luftfeuchte

Ambient Temperature
Umgebungstemperatur

(23 ⁺⁷₋₃) °C

Working standards used (having a significant effect on the accuracy)
Verwendete Gebrauchsnormale (mit signifikantem Einfluss auf die Genauigkeit)

Item Gegenstand	Type Typ	Serial Number Seriennummer	Calibration Certificate Number Kalibrierscheinnummer	Cal. Due Kalibr. bis
Vector Network Analyzer	R&S® ZVA67	101097	20-300432406	2020-07-21
Powersensor	R&S® NRP-Z55	140093	20-300426315	2019-05-17
Powersensor	R&S® NRP-Z57	101423	20-541799	2019-04-27
Calibration Kit	WR19	U10001	24-0060-U10001-01	2019-02-01

UGB1 A compliance statement may be possible where a confidence level of less than 95 % is acceptable.
Die Bestätigung der Konformität ist möglich, sofern ein Grad des Vertrauens von weniger als 95 % akzeptabel ist.

UGB2 A non-compliance statement may be possible where a confidence level of less than 95 % is acceptable.
Die Bestätigung der Nicht-Konformität ist möglich, sofern ein Grad des Vertrauens von weniger als 95 % akzeptabel ist.

Ref.: ILAC-G8:03/2009 'Guidelines on the Reporting of Compliance with Specification'.

Notes

Anmerkungen

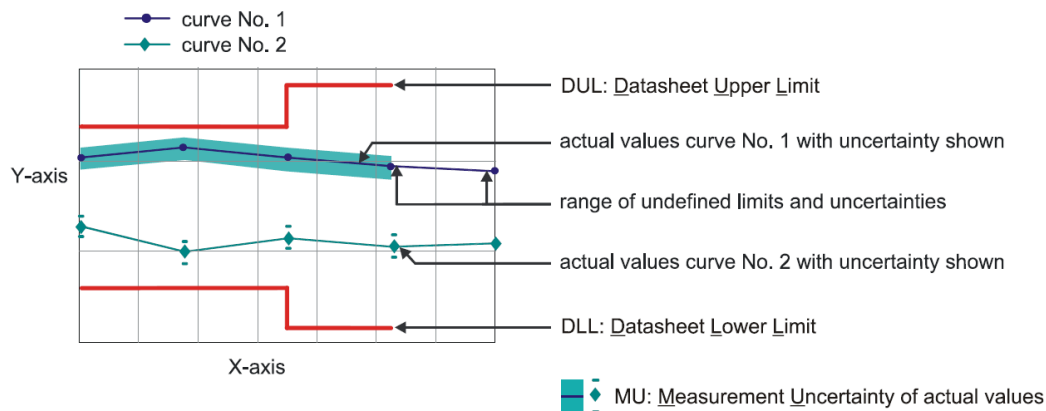
If the new product is stored under the climate conditions as specified in the data sheet upon delivery, the product's accuracy is not significantly affected within 12 month after its calibration in our factory. In this case, the recommended calibration interval starts on the date when the product is actually put into operation.

Outgoing Results

The following abbreviations may be used in this document

{a}	No measurement uncertainty stated because the errors always add together. So it is sure that a measurement result evaluated as "PASS" is pass.
{b}	The measurement uncertainty depends on the measurement result. The stated measurement uncertainty is valid for the close area around the specification. Measurement results outside the close area have a higher measurement uncertainty but are within the specification.
{c}	Functional test, therefore no measurement uncertainty is stated.
{d}	Typical value, refer to performance test.
{e}	The measurement uncertainty is taken into account when setting the measuring system.
DL or DT	Data Limit for symmetrical tolerance limits
DLL	Datasheet Lower Limit
DUL	Datasheet Upper Limit
MU	Measurement Uncertainty
MLL or MLV	Measurement Uncertainty Lower Value
MUL or MUV	Measurement Uncertainty Upper Value
Nom.	Nominal Value
Dev.	Deviation
MErr.	Measurement Error
Act.	Actual Value
UGB	Uncertainty Guard Band: Measuring uncertainty violates the data (spec.) limit.
UGB1	Measurement results marked as UGB1 show conformity with a probability of >50 % and <95 %.
UGB2	Measurement results marked as UGB2 show non-conformity with a probability of >50 % and <95 %.
DU	Datasheet Uncertainty

Explanation of charts



Software used for measurement**Item Type**

Measurement Studio Professional Edition
MixerCertification

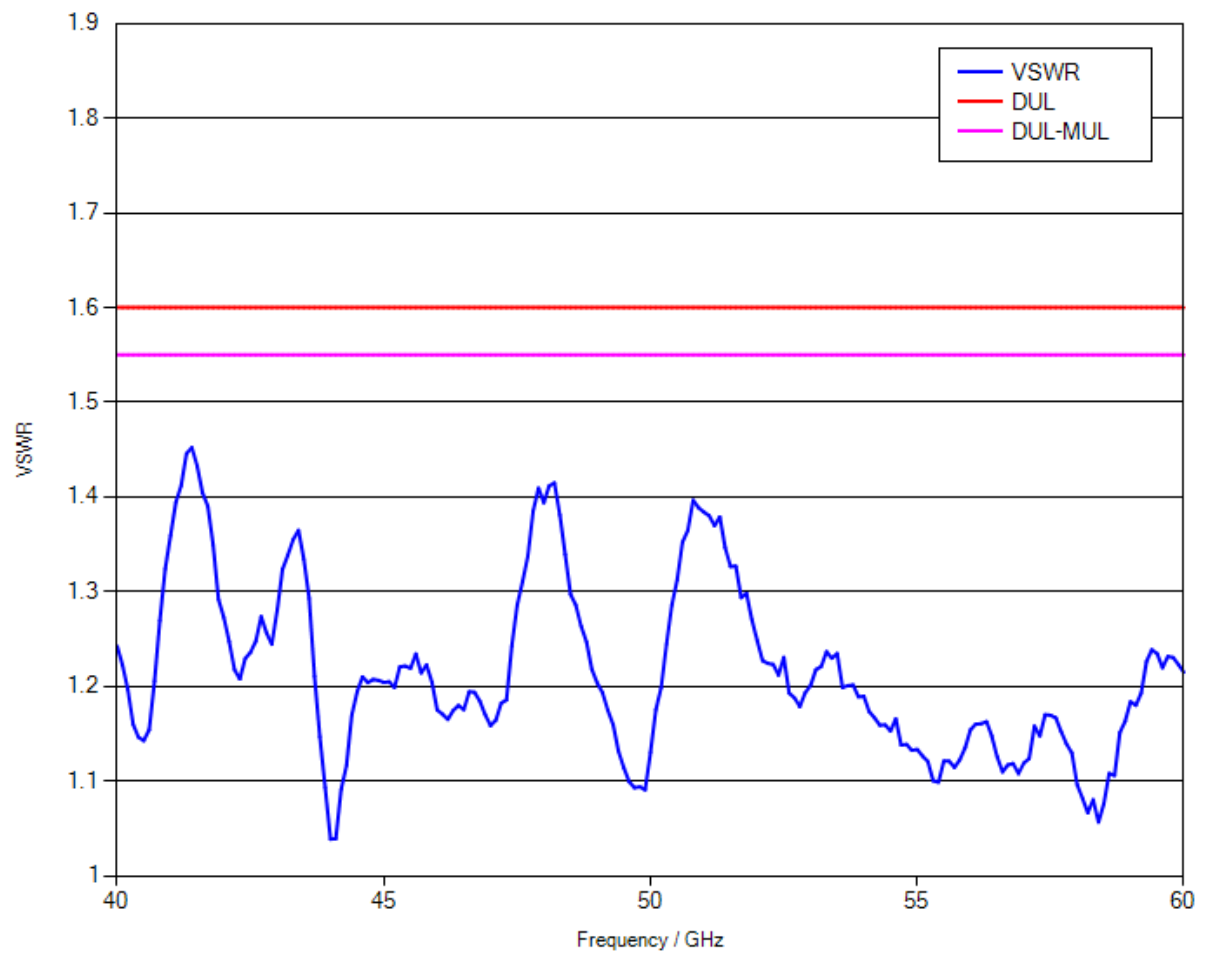
Version

2013
7_09

Remark

1.1 RF Input – VSWR

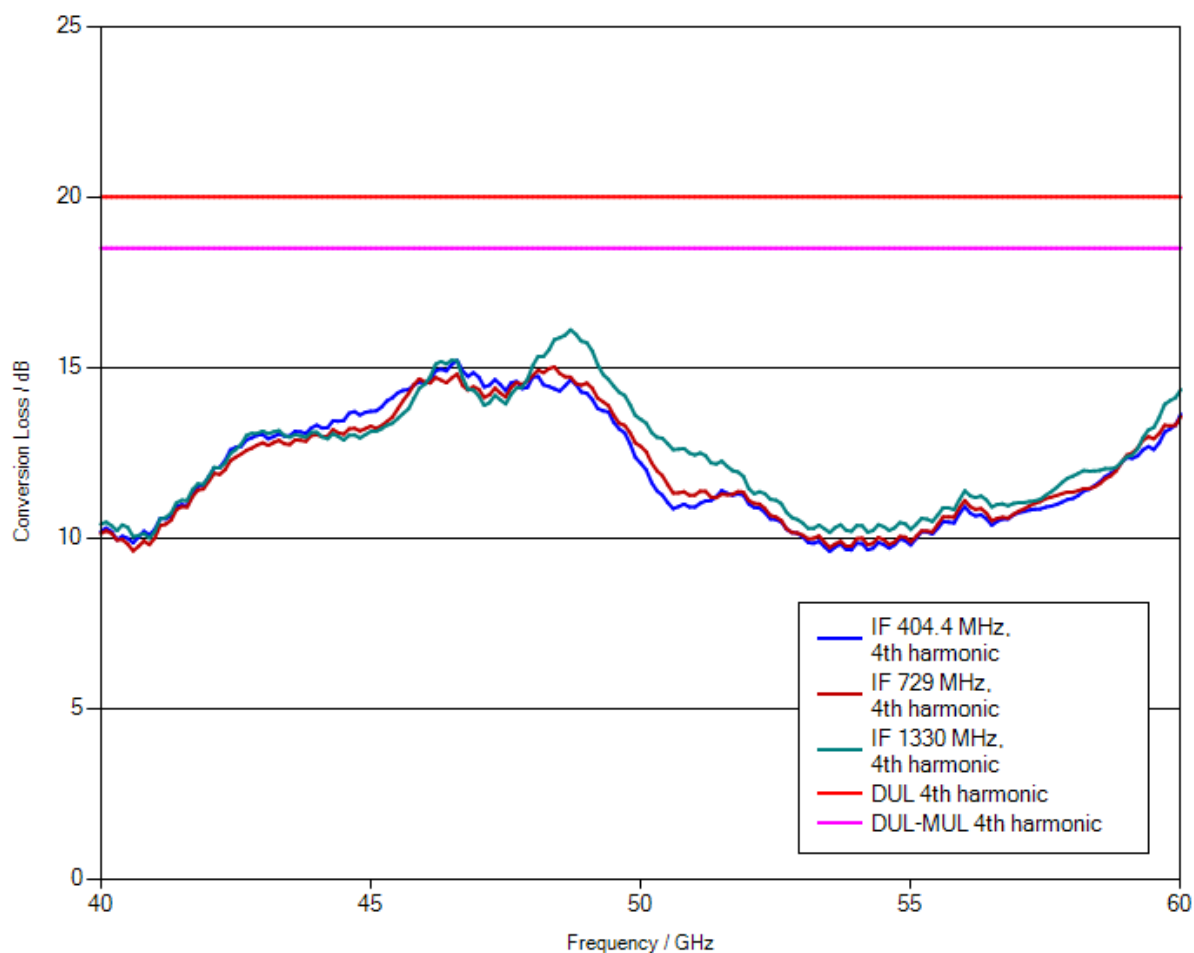
Measurement uncertainty: 0.05 (VSWR)



1.2 Conversion loss

LO level +13 dBm nominal
Bias 0 A

Measurement uncertainty: 1.5 dB



Note: Numeric calibration data can be found attached to the PDF file of the calibration certificate. Click the “paper clip” symbol to display the file.

The file has been renamed for safety reasons.

When downloading the file onto your PC, please delete the “.file” extension and unzip the data.

1.3 Frequency response within 1 GHz

	DUL	Actual (worst case)	Evaluation
IF = 404.4 MHz, 4th harmonic	4 dB	2.32 dB	PASS
IF = 729 MHz, 4th harmonic	4 dB	1.99 dB	PASS
IF = 1330 MHz, 4th harmonic	4 dB	2.14 dB	PASS

Calibration Certificate

Kalibrierschein

Certificate Number **24-0090-101811-01**

Zertifikatsnummer

Unit Data

Item
Gegenstand **Harmonic Mixer, 60 GHz to 90 GHz**

Manufacturer
Hersteller **ROHDE & SCHWARZ**

Type
Typ **R&S® FS-Z90**

Material Number
Materialnummer **1048.0371.02** Serial Number
Seriennummer **101811**

Asset Number
Inventarnummer

This calibration certificate documents, that the named item is tested and measured against defined specifications. Measurement results are located usually in the corresponding interval with a probability of approx. 95% (coverage factor $k = 2$). Calibration is performed with test equipment and standards directly or indirectly traceable by means of approved calibration techniques to the PTB/DKD or other national/international standards, which realize the physical units of measurement according to the International System of Units (SI). In all cases where no standards are available, measurements are referenced to standards of the R&S laboratories. Principles and methods of calibration correspond with EN ISO/IEC 17025. This calibration certificate may not be reproduced other than in full. Calibration certificates without signatures are not valid. The user is obliged to have the object recalibrated at appropriate intervals.

Order Data

Customer
Auftraggeber

Order Number
Bestellnummer

Date of Receipt
Eingangsdatum

Performance

Place and Date of Calibration
Ort und Datum der Kalibrierung

Scope of Calibration
Umfang der Kalibrierung

Statement of Compliance
(Incoming)
Konformitätsaussage
(Anlieferung)

Statement of Compliance
(Outgoing)
Konformitätsaussage
(Auslieferung)

Extend of Calibration Documents
Umfang des Kalibrierdokuments

Meckenheim, 2018-07-16

Standard Calibration

New device

All measured values are within the data sheet specifications.

**2 pages Calibration Certificate
5 pages Outgoing Results**

Dieser Kalibrierschein dokumentiert, dass der genannte Gegenstand nach festgelegten Vorgaben geprüft und gemessen wurde. Die Messwerte lagen im Regelfall mit einer Wahrscheinlichkeit von annähernd 95% im zugeordneten Werteintervall (Erweiterte Messunsicherheit mit $k = 2$). Die Kalibrierung erfolgte mit Messmitteln und Normalen, die direkt oder indirekt durch Ableitung mittels anerkannter Kalibriertechniken rückgeführt sind auf Normale der PTB/DKD oder anderer nationaler/internationaler Standards zur Darstellung der physikalischen Einheiten in Übereinstimmung mit dem Internationalen Einheitensystem (SI). Wenn keine Normale existieren, erfolgt die Rückführung auf Bezugsnormale der R&S-Laboratorien. Grundsätze und Verfahren der Kalibrierung beziehen sich auf EN ISO/IEC 17025. Dieser Kalibrierschein darf nur vollständig und unverändert weiterverbreitet werden. Kalibrierscheine ohne Unterschriften sind ungültig. Für die Einhaltung einer angemessenen Frist zur Wiederholung der Kalibrierung ist der Benutzer verantwortlich.

Radiometer Physics GmbH; Meckenheim

Date of Issue
Ausstellungsdatum

2018-07-19

Head of Laboratory
Laborleitung

Ceru

Person Responsible
Bearbeiter

Grossmindorf

Page (Seite) 1/2
Vers2010-05-05/
RPG2014-02-28

Material Number 1048.0371.02

Serial Number 101811

Certificate Number 24-0090-101811-01

Calibration Method
KalibrieranweisungAmbient Temperature
Umgebungstemperatur

RPG-PAQA-TN-2014-002

(23 ⁺⁷/₋₃) °CRelative Humidity 20 % - 80 %
Relative LuftfeuchteWorking standards used (having a significant effect on the accuracy)
Verwendete Gebrauchsnormale (mit signifikantem Einfluss auf die Genauigkeit)

Item Gegenstand	Type Typ	Serial Number Seriennummer	Calibration Certificate Number Kalibrierscheinnummer	Cal. Due Kalibr. bis
Vector Network Analyzer	R&S® ZVA67	101097	20-300432406	2020-07-21
Powersensor	R&S® NRP-Z55	140093	20-300426315	2019-05-17
Powersensor	R&S® NRP-Z58	101063	20-611462	2018-07-21
Calibration kit	WR12	E10001	RPG-PAQA-TN-2014-005	2019-02-01

UGB1 A compliance statement may be possible where a confidence level of less than 95 % is acceptable.
Die Bestätigung der Konformität ist möglich, sofern ein Grad des Vertrauens von weniger als 95 % akzeptabel ist.

UGB2 A non-compliance statement may be possible where a confidence level of less than 95 % is acceptable.
Die Bestätigung der Nicht-Konformität ist möglich, sofern ein Grad des Vertrauens von weniger als 95 % akzeptabel ist.

Ref.: ILAC-G8:03/2009 'Guidelines on the Reporting of Compliance with Specification'.

Notes
Anmerkungen

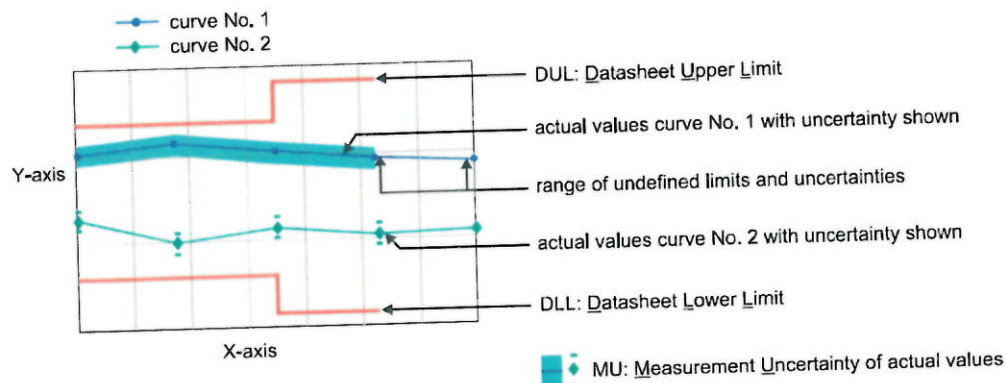
If the new product is stored under the climate conditions as specified in the data sheet upon delivery, the product's accuracy is not significantly affected within 12 month after its calibration in our factory. In this case, the recommended calibration interval starts on the date when the product is actually put into operation.

Outgoing Results

The following abbreviations may be used in this document

{a}	No measurement uncertainty stated because the errors always add together. So it is sure that a measurement result evaluated as "PASS" is pass.
{b}	The measurement uncertainty depends on the measurement result. The stated measurement uncertainty is valid for the close area around the specification. Measurement results outside the close area have a higher measurement uncertainty but are within the specification.
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MUL or MUV	Measurement Uncertainty Upper Value
Nom.	Nominal Value
Dev.	Deviation
MErr.	Measurement Error
Act.	Actual Value
UGB	Uncertainty Guard Band: Measuring uncertainty violates the data (spec.) limit.
UGB1	Measurement results marked as UGB1 show conformity with a probability of >50 % and <95 %.
UGB2	Measurement results marked as UGB2 show non-conformity with a probability of >50 % and <95 %.
DU	Datasheet Uncertainty

Explanation of charts



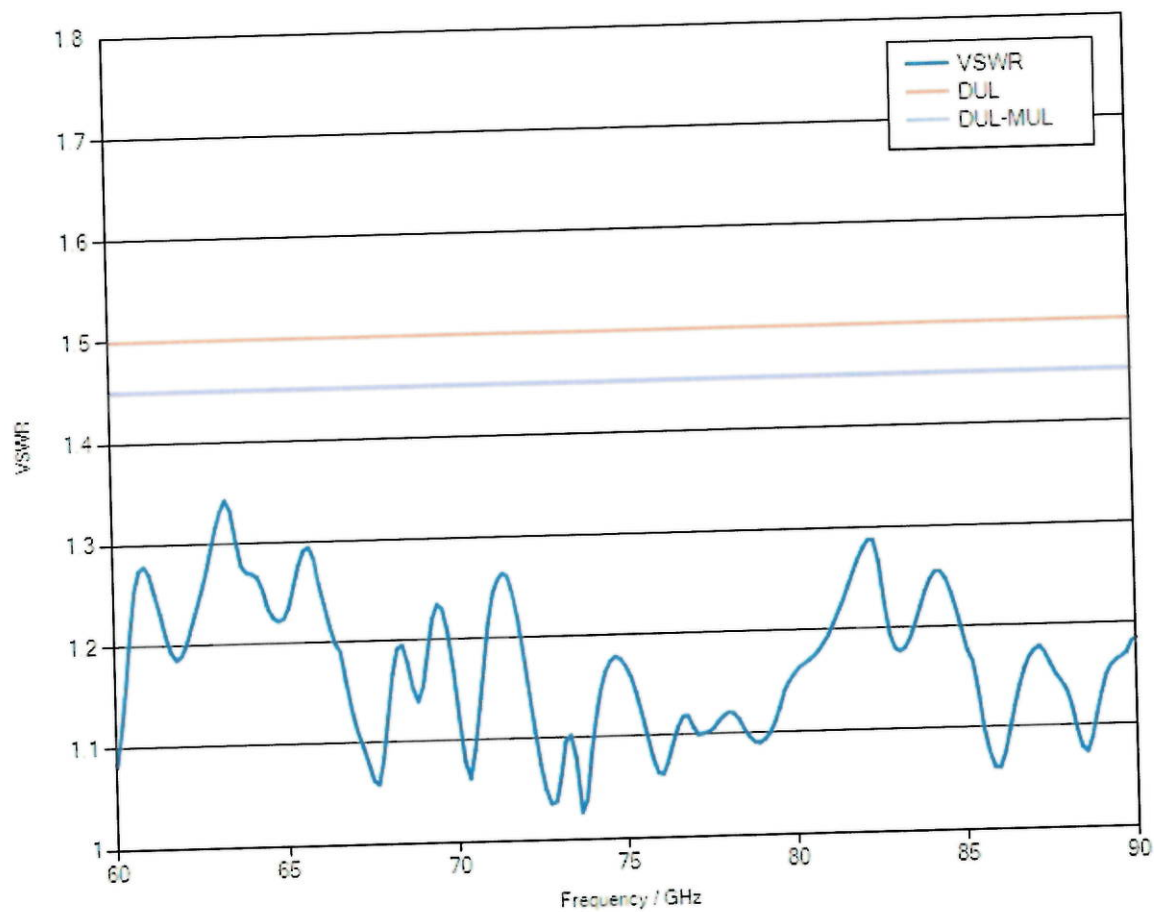
Software used for measurement
Item Type
Measurement Studio Professional Edition
MixerCertification

Version
2013
7_08

Remark

1.1 RF Input – VSWR

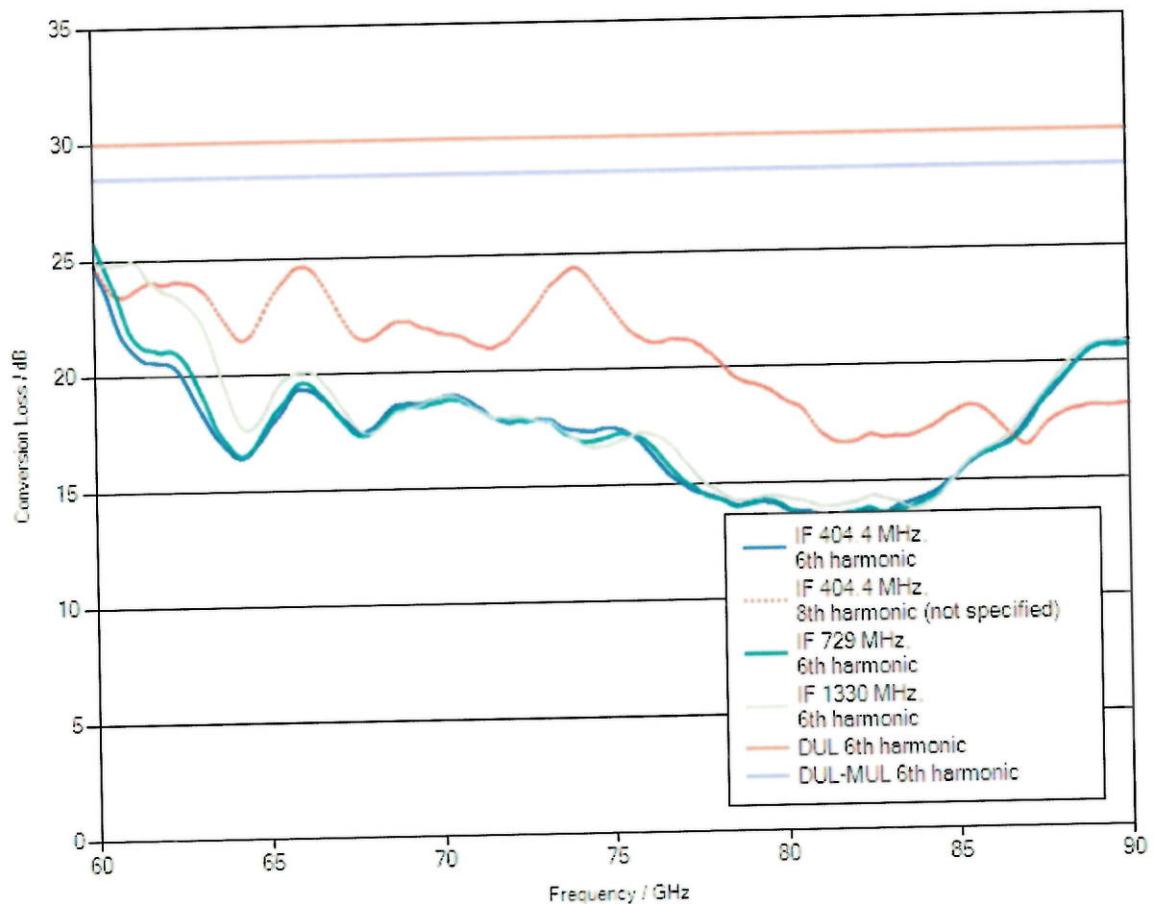
Measurement uncertainty: 0.05 (VSWR)



1.2 Conversion loss

LO level +14 dBm nominal
Bias 0 A

Measurement uncertainty: 1.5 dB



Note: Numeric calibration data can be found attached to the PDF file of the calibration certificate.
Click the "paper clip" symbol to display the file.

The file has been renamed for safety reasons.
When downloading the file onto your PC, please delete the ".file" extension and unzip the data.

1.3 Frequency response within 1 GHz

	DUL	Actual (worst case)	Evaluation
IF = 404.4 MHz, 6th harmonic	6 dB	3.29 dB	PASS
IF = 404.4 MHz, 8th harmonic	not specified	2.25 dB	not specified
IF = 729 MHz, 6th harmonic	6 dB	3.47 dB	PASS
IF = 1330 MHz, 6th harmonic	6 dB	3.84 dB	PASS



Calibration Certificate

Kalibrierschein

Certificate Number 24-0140-101128-01

Zertifikatsnummer

Unit Data

Item
Gegenstand
Harmonic Mixer, 90 GHz to 140 GHz

Manufacturer
Hersteller
RPG

Type
Typ
RPG FS-Z140

Material Number
Materialnummer
3622.0708.02

Serial Number
Seriennummer
101128

Asset Number
Inventarnummer

This calibration certificate documents, that the named item is tested and measured against defined specifications. Measurement results are located usually in the corresponding interval with a probability of approx. 95% (coverage factor $k = 2$). Calibration is performed with test equipment and standards directly or indirectly traceable by means of approved calibration techniques to the PTB/DKD or other national/international standards, which realize the physical units of measurement according to the International System of Units (SI). In all cases where no standards are available, measurements are referenced to standards of the R&S laboratories. Principles and methods of calibration correspond with EN ISO/IEC 17025. This calibration certificate may not be reproduced other than in full. Calibration certificates without signatures are not valid. The user is obliged to have the object recalibrated at appropriate intervals.

Order Data

Customer
Auftraggeber

Order Number
Bestellnummer

Date of Receipt
Eingangsdatum

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Performance

Place and Date of Calibration
Ort und Datum der Kalibrierung

Meckenheim, 2018-09-03

Scope of Calibration
Umfang der Kalibrierung

Standard Calibration

Statement of Compliance
(Incoming)
Konformitätsaussage
(Anlieferung)

New device

Statement of Compliance
(Outgoing)
Konformitätsaussage
(Auslieferung)

All measured values are within the data sheet specifications.

Extend of Calibration Documents
Umfang des Kalibrierdokuments

**2 pages Calibration Certificate
5 pages Outgoing Results**

Radiometer Physics GmbH; Meckenheim

Date of Issue
Ausstellungsdatum

2018-09-06

Head of Laboratory
Laborleitung

Schulze

Person Responsible
Bearbeiter

Dick

Calibration Method
Kalibrieranweisung

RPG-PAQA-TN-2014-002

Relative Humidity **20 % - 80 %**
Relative Luftfeuchte

Ambient Temperature
Umgebungstemperatur

(23 ⁺⁷₋₃) °C**Working standards used (having a significant effect on the accuracy)**

Verwendete Gebrauchsnormale (mit signifikantem Einfluss auf die Genauigkeit)

Item Gegenstand	Type Typ	Serial Number Seriennummer	Calibration Certificate Number Kalibrierscheinnummer	Cal. Due Kalibr. bis
Vector Network Analyzer	R&S® ZVA67	101097	20-300432406	2020-07-21
Powersensor	R&S® NRP-Z55	140093	20-300426315	2019-05-17

UGB1 A compliance statement may be possible where a confidence level of less than 95 % is acceptable.

Die Bestätigung der Konformität ist möglich, sofern ein Grad des Vertrauens von weniger als 95 % akzeptabel ist.

UGB2 A non-compliance statement may be possible where a confidence level of less than 95 % is acceptable.

Die Bestätigung der Nicht-Konformität ist möglich, sofern ein Grad des Vertrauens von weniger als 95 % akzeptabel ist.

Ref.: ILAC-G8:03/2009 'Guidelines on the Reporting of Compliance with Specification'.

Notes

Anmerkungen

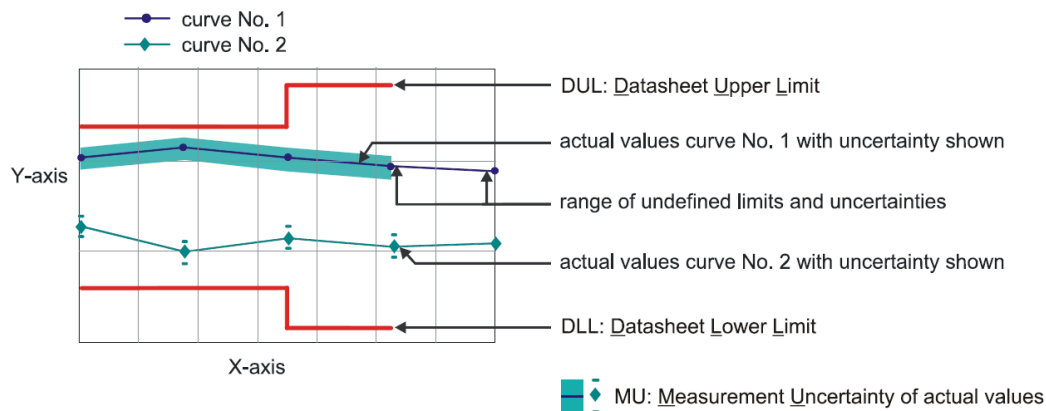
If the new product is stored under the climate conditions as specified in the data sheet upon delivery, the product's accuracy is not significantly affected within 12 month after its calibration in our factory. In this case, the recommended calibration interval starts on the date when the product is actually put into operation.

Outgoing Results

The following abbreviations may be used in this document

{a}	No measurement uncertainty stated because the errors always add together. So it is sure that a measurement result evaluated as "PASS" is pass.
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MU	Measurement Uncertainty
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Nom.	Nominal Value
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MErr.	Measurement Error
Act.	Actual Value
UGB	Uncertainty Guard Band: Measuring uncertainty violates the data (spec.) limit.
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UGB2	Measurement results marked as UGB2 show non-conformity with a probability of >50 % and <95 %.
DU	Datasheet Uncertainty

Explanation of charts



Software used for measurement**Item Type**

Measurement Studio Professional Edition
MixerCertification

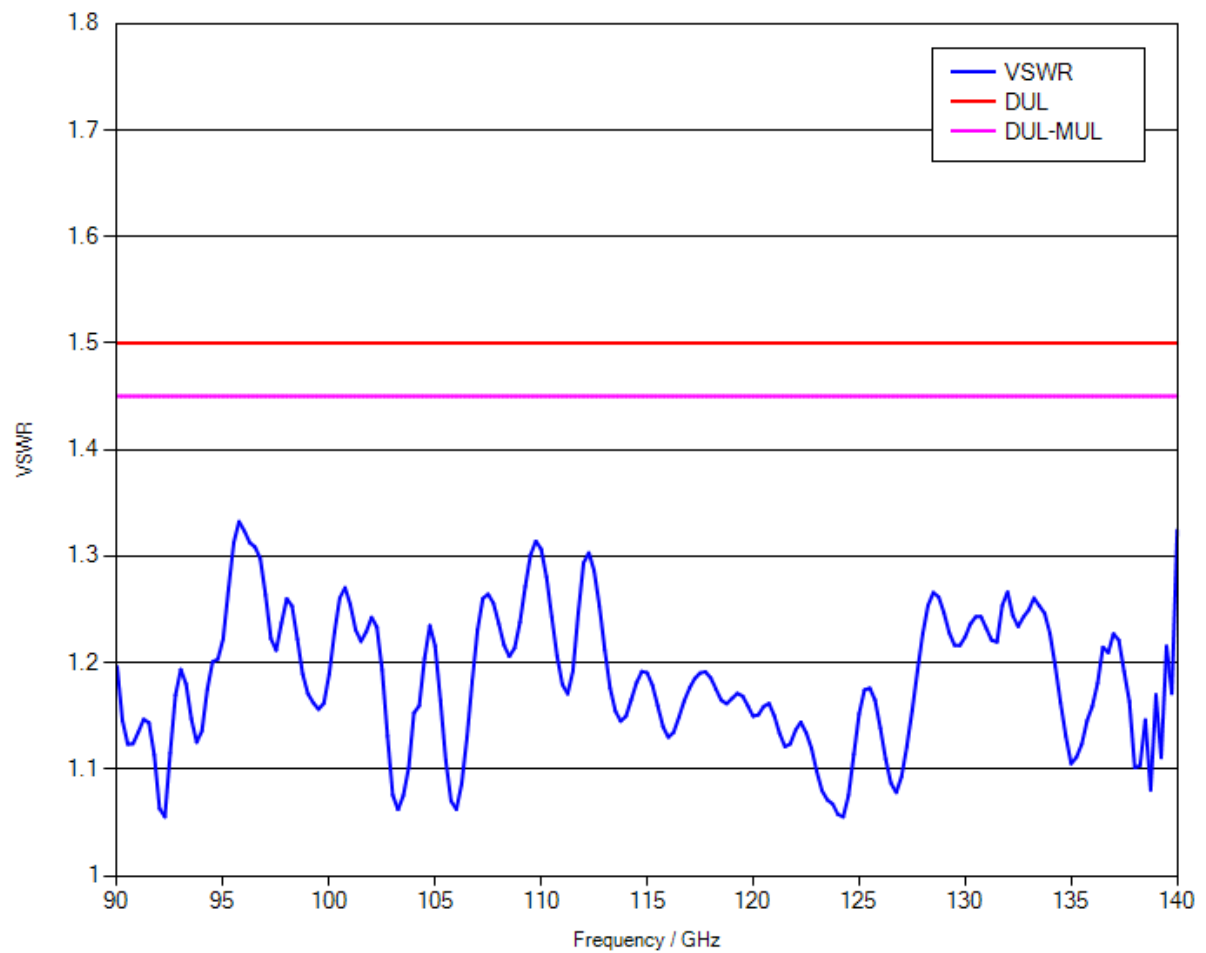
Version

2013
7_09

Remark

1.1 RF Input – VSWR

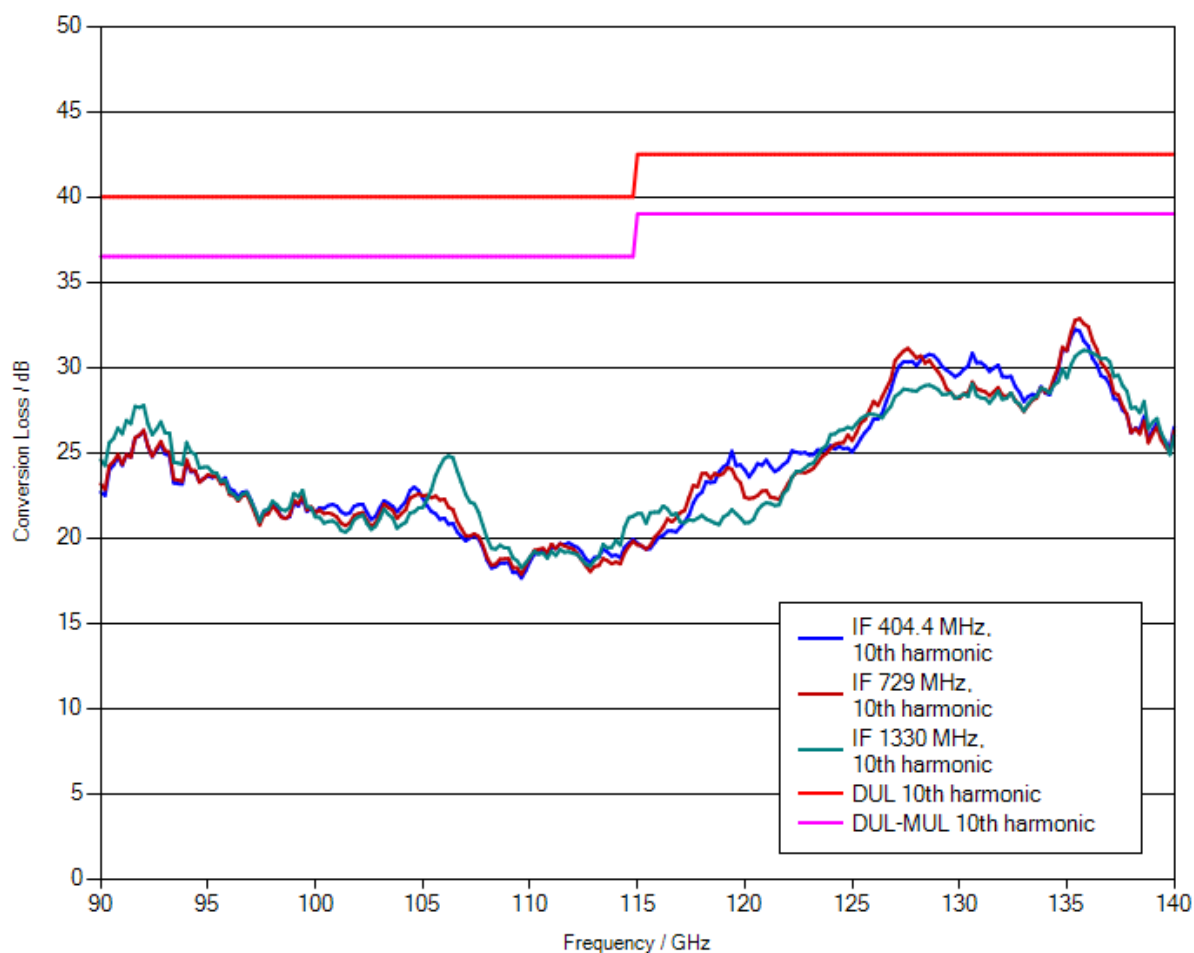
Measurement uncertainty: 0.05 (VSWR)



1.2 Conversion loss

LO level +14 dBm nominal
Bias 0 A

Measurement uncertainty: 3.5 dB



Note: Numeric calibration data can be found attached to the PDF file of the calibration certificate. Click the “paper clip” symbol to display the file.

The file has been renamed for safety reasons.

When downloading the file onto your PC, please delete the “.file” extension and unzip the data.

1.3 Frequency response within 1 GHz

	DUL	Actual (worst case)	Evaluation
IF = 404.4 MHz, 10th harmonic	6 dB	2.8 dB	PASS
IF = 729 MHz, 10th harmonic	6 dB	2.75 dB	PASS
IF = 1330 MHz, 10th harmonic	6 dB	2.62 dB	PASS