



TEST REPORT

Test Report No. : UL-RPT-RP-11909763-3716-FCC-UNII2A

Applicant : SIEMENS AG
Model No. : MPCIE-R1-ABGNAC-U4
FCC ID : LYHRAPACV1
Technology : WLAN 5 GHz
Test Standard(s) : FCC Parts 15.207 & 15.407(b)(6)

For details of applied tests refer to test result summary

1. This test report shall not be reproduced in full or partial, without the written approval of UL International Germany GmbH.
2. The results in this report apply only to the sample tested.
3. The test results in this report are traceable to the national or international standards.
4. Test Report Version 1.0
5. Result of the tested sample: **PASS**

Prepared by: Krume, Ivanov
Title: Laboratory Engineer
Date: 21 February 2020

Approved by: Ajit, Phadtare
Title: Lead Test Engineer
Date: 21 February 2020



Deutsche
Akkreditierungsstelle
D-PL-19381-02-00

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The tests reported herein have been performed in
accordance with its' terms of accreditation.

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1. Customer Information

1.1.Applicant Information

Company Name:	SIEMENS AG
Company Address:	Östliche Rheinbrückenstr. 50, 76187 Karlsruhe, Germany
Contact Person:	Dr. Malgorzata Janson
Contact E-Mail Address:	malgorzata.janson@siemens.com
Contact Phone No.:	+ 49 721 595 2606

1.2.Manufacturer Information

Company Name:	SIEMENS AG
Company Address:	76181 Karlsruhe, Germany
Contact Person:	Mr. Kilian Löser
Contact E-Mail Address:	kilian.loeser@siemens.com
Contact Phone No.:	+49 911 895-5363

2. Summary of Testing

2.1. General Information

Applied Standards

Specification Reference:	47CFR15.407 and 47CFR15.403
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart E (Unlicensed National Information Infrastructure Devices) – Sections 15.403 and 15.407
Specification Reference:	47CFR15.207
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Sections 15.207
Test Firm Registration:	399704

Location

Location of Testing:	UL International Germany GmbH Hedelfinger Str. 61 70327 Stuttgart Germany
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Date information

Order Date:	26 September 2017
EUT arrived:	26 January 2018
Test Dates:	17 February 2020 to 18 February 2020
EUT returned:	-/-

2.2. Summary of Test Results

Clause	Measurement (5.25-5.35 GHz band)	Complied	Did not comply	Not performed	Not applicable
Part 15.207 / Part 15.407(b)(6)	Transmitter AC Conducted Emissions	☒	☐	☐	☐
Part 15.403(i)	Transmitter 26 dB Emission Bandwidth ^(Note 1)	☐	☐	☒	☐
Part 15.35(c)	Transmitter Duty Cycle ^(Note 1)	☐	☐	☒	☐
Part 15.407(a)(2)	Transmitter Maximum Conducted Output Power ^(Note 1)	☐	☐	☒	☐
Part 15.407(a)(2)	Transmitter Power Spectral Density ^(Note 1)	☐	☐	☒	☐
Part 15.407(b)/15.209(a)	Transmitter Out of Band Conducted Emissions ^(Note 1)	☐	☐	☒	☐
Part 15.407(b)/15.209(a)	Transmitter Out of Band Radiated Emissions ^(Note 1)	☐	☐	☒	☐
Part 15.407(b)/15.209(a)	Transmitter Band Edge Radiated Emissions ^(Note 1)	☐	☐	☒	☐
Part 15.407(g)	Transmitter Frequency Stability ^(Note 2) (Temperature & Voltage Variation)	☐	☐	☐	☒
Part 15.407(h)(1)	Transmitter Power Control	☐	☐	☐	☒

Note:

1. Refer separate test report : UL-RPT-RP11909763-3716A.pdf
2. As per applicant's user manual Frequency stability is better than 20 ppm which ensures that the signal remains in the allocated bands under all operational conditions stated in the user manual.

2.3. Methods and Procedures

Reference:	ANSI C63.10-2013
Title:	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
Reference:	KDB 174176 D01 Line Conducted FAQ v01r01 June 3, 2015
Title:	AC Power-Line Conducted Emissions Frequently Asked Questions

2.4. Deviations from the Test Specification

For the measurements contained within this test report, there were no deviations from, additions to, or exclusions from the test specification identified above.

3. Equipment Under Test (EUT)

3.1. Identification of Equipment Under Test (EUT)

Brand Name:	SIEMENS
Model Name or Number:	MPCIE-R1-ABGNAC-U4
Model Type:	A5E36528526
Serial/ Fixed IP Number:	192.168.0.70 (AC Conducted Test Sample)
Hardware Version Number:	1
Software Version Number:	V02.00.00
FCC ID:	LYHRAPACV1

3.2. Description of EUT

The equipment under test was a 4 X 4 MIMO radio module supporting WLAN 2.4 GHz & WLAN 5 GHz technologies.

3.3. Modifications Incorporated in the EUT

No modifications were applied to the EUT during testing.

3.4. Additional Information Related to Testing

Technology Tested:	WLAN (IEEE 802.11a,n, ac)		
Type of Unit:	Transceiver		
Test Evaluation Board Power Supply Requirement(s):	Nominal	24.0 V DC	
	Minimum	16.8 V DC	
	Maximum	31.2 V DC	
EUT Power Supply Requirement(s):	Power Range	3.3 V DC ± 5 %	520 mA
	Power Range	5.0 V DC ± 5 %	700 mA
Supported Modulation Types:	BPSK, QPSK, 16QAM, 64QAM, 256QAM		
Supported Data rates:	802.11a	6, 9, 12, 18, 24, 36 ,48 & 54 Mbit/s (SISO or MIMO)	
	802.11n HT20	MCS0 to MCS7 (1 spatial stream) MCS8 to MCS15 (2 spatial streams) MCS16 to MCS23 (3 spatial streams) MCS24 to MCS31 (4 spatial streams)	
	802.11n HT40	MCS0 to MCS7 (1 spatial stream) MCS8 to MCS15 (2 spatial streams) MCS16 to MCS23 (3 spatial streams) MCS24 to MCS31 (4 spatial streams)	
	802.11ac HT20	MCS0 to MCS8 (up to 4 spatial streams)	
	802.11ac HT40	MCS0 to MCS9 (up to 4 spatial streams)	
	802.11ac HT80	MCS0 to MCS9 (up to 4 spatial streams)	
Antenna Gain:	Refer Section 3.5		
Transceiver Frequency Band:	5250 MHz to 5350 MHz [U-NII-2A Band]		

3.5. Antenna Information

Antenna type with highest antenna gain amongst supported radiation pattern was used for the EUT testing:

Antenna Group:	23 dBi Antenna Group
Antenna Radiation Type:	Directed
Antenna Model Number:	ANT793-8DK
Antenna Gain:	23 dBi @ 5 GHz
Antenna Cable Loss:	8.8 dB @ 5 GHz
Effective Antenna Gain:	14.2 dBi @ 5 GHz
Antenna Beamwidth:	55°H / 55°V
Antenna Connector Type:	N
Manufacturer Article Number:	6GK5793-8DK00-0AA0
Batch Number:	02 722467

3.6. Support Equipment

The following support equipment was used to exercise the EUT during testing:

A. Support Equipment (In-house)

Item	Description	Brand Name	Model Name or Number	Serial Number
1	Laptop	Lenovo	L560	MP-16X73B 16/11

B. Support Equipment (Manufacturer supplied)

Item	Description	Brand Name	Model Name or Number	Serial Number
1	DC Power Supply Cable (Length: 0.5 m Quantity: 2 Pcs)	--	Standard 2 wire cable	--
2	M12- RJ45 Ethernet Cable (Length: 2 m Quantity: 2 Pcs)	SIEMENS	LEONI L INDUSTRIAL ETHERNET FLEXIBLE 6XV1870-2E	--
3	N-N Connector Antenna Cable (Length: 10 m Quantity: 4 Pcs)	SIEMENS Simatic Net Antenna Cable	6XV1875-5AN10 J39	--
4	Test Evaluation Board (Quantity: 2 Pcs)	SIEMENS	A5E36374290-AE GTW 18 94V-0	--
5	UMCC- N Connector Cable (Length: 0.25 m Quantity: 4 Pcs)	SIEMENS	--	--
6	N Connector-50 Ω Terminations (Quantity: 4 Pcs)	SIEMENS	--	--
7	SIMATIC PS 307 Power Supply (Input: AC 120 /230 V 2.3 /1.2 A 50-60 Hz) (Output: DC 24 V 5 A) (Quantity: 1 Pcs)	SIEMENS	6ES7307-1EA01- 0AA0	YSU/HO 165357

4. Operation and Monitoring of the EUT during Testing

4.1. Operating Mode

The EUT was tested in the following operating mode(s):

☒ **Continuously transmitting modulated carrier with the following settings:**

- **Maximum Power Settings*: PWL 18**
- **Test Channel*: 56**
- **Worst Case*: n(HT20)-MCS 1-MIMO 1+2+3+4 mode**

*Multiple supported modulation schemes, nominal channel bandwidths and SISO/MIMO configurations were initially investigated to determine the above mentioned worst case data rates in terms of highest output power & widest bandwidth.

4.2. Configuration and Peripherals

The EUT was tested in the following configuration(s):

- **EUT Power Supply:**
 - o For AC Conducted measurement EUT(the radio module) was mounted on Test Evaluation Board. Using Siemens SIMATIC PS 307 Power Supply, 24 V DC was supplied to this board; which in turn supplying 3.3 V DC to EUT.
- **Test Mode Activation:**
 - o For continuous transmit tests the EUT was controlled using the chipset manufacturers 'cli' console over tera-term and putty. This was run from within the terminal application on the EUT. The application was used to enable continuous transmission mode and to select the test channel, data rate and modulation scheme as required.
- **AC Conducted Emissions Measurements:**
 - o For AC conducted emission measurements, tests were performed with MIMO Port 1+2+3+4, connected with the UMCC- N Connector Cable + N-N Connector Antenna Cable to each of the antenna.
 - o The Toyo EMI Software EP5/CE Ver 4.0.1. was used for these measurements.

4.3. Used RF Cables

For AC conducted emission measurements performed with 4 Antennas, EUT ports were connected with following RF cables to the 10 m Antenna Cable which in turn connected to each of the antenna.

For further details refer Section 3. B.

Antenna Group Type	EUT to Antennas Cable Details
	MIMO Mode Port 1+2+3+4
23 dBi Antenna Group	UMCC- N Connector Cables + N-N Connector Antenna Cables (10 m)*
*As per applicant's declaration 23 dBi Antenna Group radiated tests have been carried out with N-N Connector Antenna Cable (10 m) having maximum loss of 8.8 dB @ 5 GHz bands. An RF level offset was entered in GUI settings to compensate the loss of those N-N Connector Antenna Cable.	

5. Measurements, Examinations and Derived Results

5.1. General Comments

Measurement uncertainties are evaluated in accordance with current best practice. Our reported expanded uncertainties are based on standard uncertainties, which are multiplied by an appropriate coverage factor to provide a statistical confidence level of approximately 95%. Please refer to Section 6 *Measurement Uncertainty* for details.

In accordance with DAkkS requirements all the measurement equipment is on a calibration schedule. All equipment was within the calibration period on the date of testing.

5.2. Test Results

5.2.1. Transmitter AC Conducted Spurious Emissions

Test Summary:

Test Engineers:	Krume Ivanov & Bernd Woerl	Test Dates:	17 & 18 February 2020
Test Sample Serial Number:	192.168.0.70		
Test Site Identification	SR 7/8		

FCC Reference:	Part 15.207
Test Method Used:	ANSI C63.10 Section 6.2 / FCC KDB 174176 and notes below

Environmental Conditions:

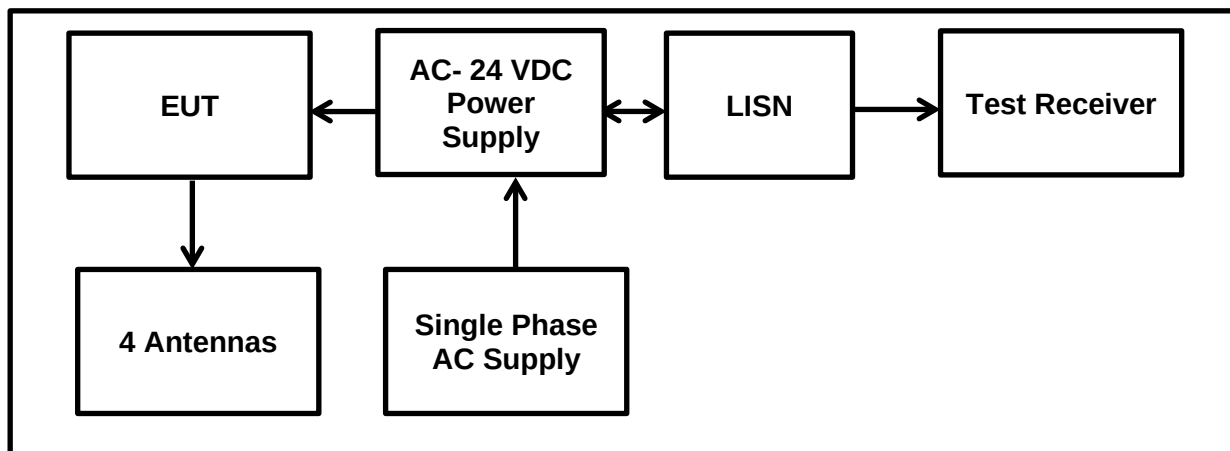
Temperature (°C):	21 to 23
Relative Humidity (%):	34 to 40

Settings of the Instrument

Detector	Quasi Peak/ Average Peak
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Notes:

- Measurement software used: Toyo EMI Software; CE measurement software EP5/CE Ver 4.0.1.
- The EUT was powered by supplying 24 V DC via SIEMENS SIMATIC PS 307 Power Supply.
- In accordance with FCC KDB 174176 Q4; the SIEMENS SIMATIC PS 307 Power Supply was connected to 120 VAC 60 Hz single phase supply via a LISN.
- In accordance with FCC KDB 174176 Q4; the SIEMENS SIMATIC PS 307 Power Supply was connected to 240 VAC 60 Hz single phase supply via a LISN.
- AC conducted tests were performed with the EUT set to the worst case mode:
 - MIMO Port 1+2+3+4 employing maximum possible Antennas
 - maximum power level setting (PWL 18) | n-Mode | Data rate: MCS1 | Bandwidth: 20 MHz | Channel 56 (5280 MHz)
- Measurements were performed in shielded room (SR7/ 8 Asset Number 1603671). The EUT was placed at a height of 80 cm above the reference ground plane and in a distance of 40 cm from the vertical ground plane at the edge of the table.
- Pre-scans were performed and markers placed on the highest live and neutral measured levels. Final measurements were performed on the marker frequencies and the results entered into the tables below.
- All other emissions shown on the pre-scan plot were investigated and found to be ambient or >20 dB below the applicable limit or below the measurement system noise floor.
- The final measured value, for the given emission, in the table below incorporates the cable loss. Calculation: Level = test receiver reading + path loss (cable attenuation + correction LISN).

Transmitter AC Conducted Spurious Emissions (continued)**Test setup:**

Transmitter AC Conducted Spurious Emissions (continued)**Results: Live (L1) / Quasi Peak / 120 VAC 60 Hz / 23 dBi Antenna Group**

Frequency [MHz]	Line Phase	Reading QP [dB(μV)]	Correction Factor [dB]	Level QP [dB(μV)]	Limit QP [dB(μV)]	Margin QP [dB]	Result
0.16303	Live (L1)	29.5	9.9	39.4	65.3	25.9	Complied
0.22365	Live (L1)	27.0	9.9	36.9	62.7	25.8	Complied
0.33537	Live (L1)	23.8	9.8	33.6	59.3	25.7	Complied
3.59519	Live (L1)	24.7	9.9	34.6	56.0	21.4	Complied
10.23246	Live (L1)	15.7	10.0	25.7	60.0	34.3	Complied
16.55912	Live (L1)	18.7	10.1	28.8	60.0	31.2	Complied

Results: Live (L1) / Average / 120 VAC 60 Hz / 23 dBi Antenna Group

Frequency [MHz]	Line Phase	Reading AV [dB(μV)]	Correction Factor [dB]	Level AV [dB(μV)]	Limit AV [dB(μV)]	Margin AV [dB]	Result
0.16303	Live (L1)	16.4	9.9	26.3	55.3	29.0	Complied
0.22365	Live (L1)	15.9	9.9	25.8	52.7	26.9	Complied
0.33537	Live (L1)	10.8	9.8	20.6	49.3	28.7	Complied
3.59519	Live (L1)	9.6	9.9	19.5	46.0	26.5	Complied
10.23246	Live (L1)	11.6	10.0	21.6	50.0	28.4	Complied
16.55912	Live (L1)	9.4	10.1	19.5	50.0	30.5	Complied

Result: Pass

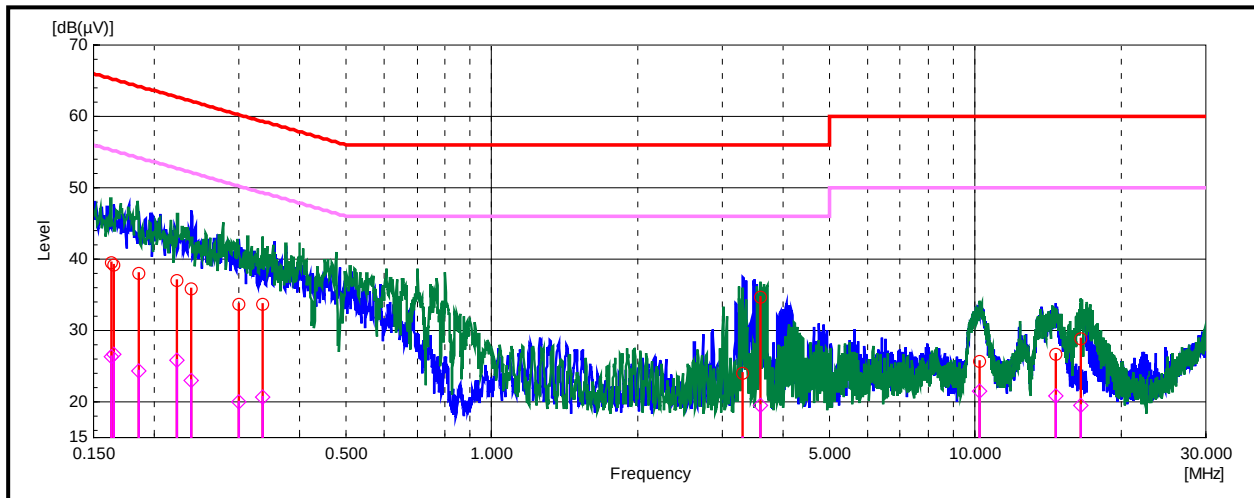
Transmitter AC Conducted Spurious Emissions (continued)**Results: Neutral (N) / Quasi Peak / 120 VAC 60 Hz / 23 dBi Antenna Group**

Frequency [MHz]	Line Phase	Reading QP [dB(μV)]	Correction Factor [dB]	Level QP [dB(μV)]	Limit QP [dB(μV)]	Margin QP [dB]	Result
0.16553	Neutral (N)	29.2	9.9	39.1	65.2	26.1	Complied
0.18657	Neutral (N)	28.0	9.9	37.9	64.2	26.3	Complied
0.23918	Neutral (N)	25.9	9.9	35.8	62.1	26.3	Complied
0.30030	Neutral (N)	23.9	9.8	33.7	60.2	26.5	Complied
3.31062	Neutral (N)	14.1	9.9	24.0	56.0	32.0	Complied
14.69539	Neutral (N)	16.5	10.1	26.6	60.0	33.4	Complied

Results: Neutral (N) / Average / 120 VAC 60 Hz / 23 dBi Antenna Group

Frequency [MHz]	Line Phase	Reading AV [dB(μV)]	Correction Factor [dB]	Level AV [dB(μV)]	Limit AV [dB(μV)]	Margin AV [dB]	Result
0.16553	Neutral (N)	16.8	9.9	26.7	55.2	28.5	Complied
0.18657	Neutral (N)	14.4	9.9	24.3	54.2	29.9	Complied
0.23918	Neutral (N)	13.0	9.9	22.9	52.1	29.2	Complied
0.30030	Neutral (N)	10.3	9.8	20.1	50.2	30.1	Complied
3.31062	Neutral (N)	2.7	9.9	12.6	46.0	33.4	Complied
14.69539	Neutral (N)	10.7	10.1	20.8	50.0	29.2	Complied

Result: Pass

Transmitter AC Conducted Spurious Emissions (continued)**Plot: Live and Neutral Line / 120 VAC 60 Hz / 23 dBi Antenna Group**

Note: The plots show the max hold (peak detector) pre-scan results measured. Blue graph represents the result of the N-Line; green graph - the results for L1-Line. The bar graphs indicate the final measurement result applying the dedicated detector at selected frequencies for each limit line (red cycle for quasi peak limit; violet cycle for average limit).

Legend (Conducted Emissions)	
Items	Description
	Blue graph is the result of peak measurement phase L
	Green graph is the result of peak measurement phase N
	Limit line Quasi-Peak
	Limit line Average
	Final item Quasi-Peak
	Final item Average

Transmitter AC Conducted Spurious Emissions (continued) :**Results: Live (L1) / Quasi Peak / 240 VAC 60 Hz / 23 dBi Antenna Group**

Frequency [MHz]	Line Phase	Reading QP [dB(μV)]	Correction Factor [dB]	Level QP [dB(μV)]	Limit QP [dB(μV)]	Margin QP [dB]	Result
0.16653	Live (L1)	29.5	9.9	39.4	65.1	25.7	Complied
0.19459	Live (L1)	27.0	9.9	36.9	63.8	26.9	Complied
0.21713	Live (L1)	26.2	9.9	36.1	62.9	26.8	Complied
0.34790	Live (L1)	22.4	9.8	32.2	59.0	26.8	Complied
3.63527	Live (L1)	16.1	9.9	26.0	56.0	30.0	Complied
13.65331	Live (L1)	8.4	10.1	18.5	60.0	41.5	Complied

Results: Live (L1) / Average / 240 VAC 60 Hz / 23 dBi Antenna Group

Frequency [MHz]	Line Phase	Reading AV [dB(μV)]	Correction Factor [dB]	Level AV [dB(μV)]	Limit AV [dB(μV)]	Margin AV [dB]	Result
0.16653	Live (L1)	19.3	9.9	29.2	55.1	25.9	Complied
0.19459	Live (L1)	10.7	9.9	20.6	53.8	33.2	Complied
0.21713	Live (L1)	10.0	9.9	19.9	52.9	33.0	Complied
0.34790	Live (L1)	10.0	9.8	19.8	49.0	29.2	Complied
3.63527	Live (L1)	4.5	9.9	14.4	46.0	31.6	Complied
13.65331	Live (L1)	2.0	10.1	12.1	50.0	37.9	Complied

Result: Pass

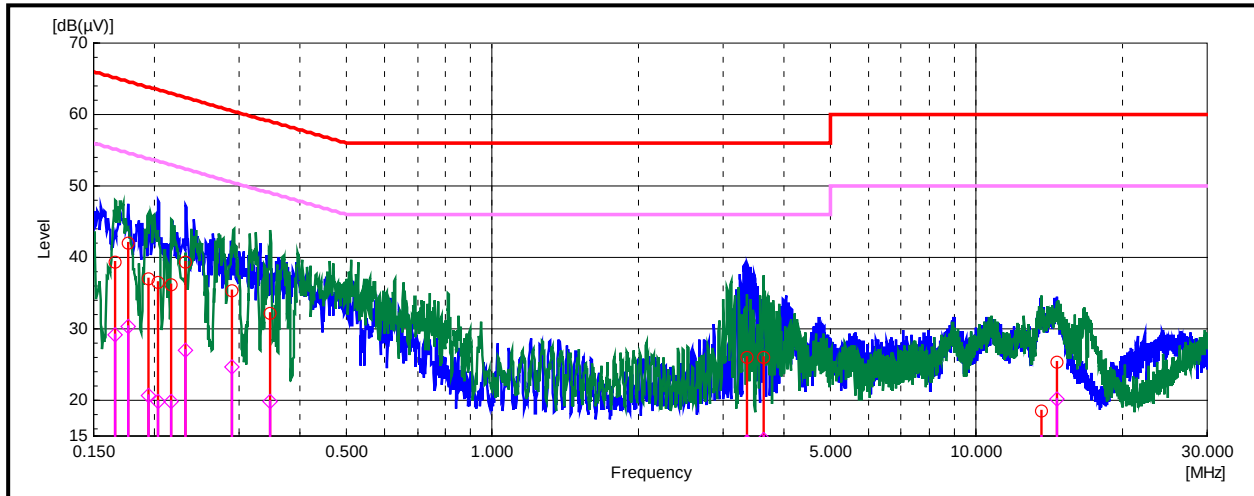
Transmitter AC Conducted Spurious Emissions (continued)**Results: Neutral (N) / Quasi Peak / 240 VAC 60 Hz / 23 dBi Antenna Group**

Frequency [MHz]	Line Phase	Reading QP [dB(μV)]	Correction Factor [dB]	Level QP [dB(μV)]	Limit QP [dB(μV)]	Margin QP [dB]	Result
0.17655	Neutral (N)	32.0	9.9	41.9	64.6	22.7	Complied
0.20411	Neutral (N)	26.6	9.9	36.5	63.4	26.9	Complied
0.23267	Neutral (N)	29.5	9.9	39.4	62.4	23.0	Complied
0.28978	Neutral (N)	25.6	9.8	35.4	60.5	25.1	Complied
3.36273	Neutral (N)	16.1	9.9	26.0	56.0	30.0	Complied
14.66533	Neutral (N)	15.3	10.1	25.4	60.0	34.6	Complied

Results: Neutral (N) / Average / 240 VAC 60 Hz / 23 dBi Antenna Group

Frequency [MHz]	Line Phase	Reading AV [dB(μV)]	Correction Factor [dB]	Level AV [dB(μV)]	Limit AV [dB(μV)]	Margin AV [dB]	Result
0.17655	Neutral (N)	20.4	9.9	30.3	54.6	24.3	Complied
0.20411	Neutral (N)	9.9	9.9	19.8	53.4	33.6	Complied
0.23267	Neutral (N)	17.2	9.9	27.1	52.4	25.3	Complied
0.28978	Neutral (N)	14.9	9.8	24.7	50.5	25.8	Complied
3.36273	Neutral (N)	4.3	9.9	14.2	46.0	31.8	Complied
14.66533	Neutral (N)	10.1	10.1	20.2	50.0	29.8	Complied

Result: Pass

Transmitter AC Conducted Spurious Emissions (continued)**Plot: Live and Neutral Line / 240 VAC 60 Hz / 23 dBi Antenna Group**

Note: The plots show the max hold (peak detector) pre-scan results measured. Blue graph represents the result of the N-Line; green graph - the results for L1-Line. The bar graphs indicate the final measurement result applying the dedicated detector at selected frequencies for each limit line (red circle for quasi peak limit; violet circle for average limit).

Legend (Conducted Emissions)	
Items	Description
	Blue graph is the result of peak measurement phase L
	Green graph is the result of peak measurement phase N
	Limit line Quasi-Peak
	Limit line Average
	Final item Quasi-Peak
	Final item Average

6. Measurement Uncertainty

The expression of uncertainty of a measurement result allows realistic comparison of results with reference values and limits given in specifications and standards.

The uncertainty of the result may need to be taken into account when interpreting the measurement results.

The reported expanded uncertainties below are based on a standard uncertainty multiplied by an appropriate coverage factor such that a confidence level of approximately 95% is maintained. For the purposes of this document “approximately” is interpreted as meaning “effectively” or “for most practical purposes”.

Measurement Type	Confidence Level (%)	Calculated Uncertainty
AC Conducted Spurious Emissions	95%	±2.49 dB

The methods used to calculate the above uncertainties are in line with those recommended within the various measurement specifications. Where measurement specifications do not include guidelines for the evaluation of measurement uncertainty the published guidance of the appropriate accreditation body is followed.

7. Used equipment

Test site: SR 7/8

ID	Manufacturer	Type	Model	Serial	Cal Date	Cal. Cycle
22	Rohde & Schwarz	Artificial Mains	ESH3-Z5	831767/014	2019-07-09	12
23	Rohde & Schwarz	Artificial Mains	ESH3-Z5	831767/013	2019-07-09	12
28	Rohde & Schwarz	Passive Probe	ESH2-Z3	none	2019-07-11	12
215	Rohde & Schwarz	Artificial Mains Network	ESH2-Z5	879675/002	2019-07-05	12
349	Rohde & Schwarz	Receiver, EMI Test	ESIB7	836697/009	2019-07-10	12
351	Rohde & Schwarz	network, Artificial Mains	ESH3-Z5	862770/018	2019-07-08	12
370	Rohde & Schwarz	Current probe	EZ-17	833335/010	2019-07-11	24
564	Teseq	Impedance stabilisation network (ISN)	ISN T800	26076	2019-07-08	24
565	Teseq	Impedance stabilisation network (ISN)	ISN ST08	26575	2019-07-09	12
616	Rohde & Schwarz	ISN	ENY81-CA6	101656	2019-07-09	12
-/-	Testo	Thermo-Hygrometer	608-H1	08	lab verification	n/a
1603671	Siemens Matsushita Components	shielded room		B83117- A1421-T162	n/a	n/a

8. Report Revision History

Version Number	Revision Details		
	Page No(s)	Clause	Details
1.0	24	-	Initial Version