FCC Measurement/Technical Report on

Thermal Imager
t872
t871
t868

Contains FCC ID: TFB-TIWI1-01
Contains IC: 5969A-TIWI101

Test Report Reference: MDE_TESTO_1510_FCCa

Test Laboratory:
7layers GmbH
Borsigstrasse 11
40880 Ratingen
Germany

DAkkS Deutsche Akkreditierungsstelle D-PL-12140-01-01

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1 APPLIED STANDARDS AND TEST SUMMARY

1.1 APPLIED STANDARDS

Applicable FCC Rules

Prepared in accordance with the requirements of FCC Rules and Regulations as listed in 47 CFR Ch.1 Parts 2 and 15 (10-1-15 Edition). The following subparts are applicable to the results in this test report.

Part 2, Subpart J - Equipment Authorization Procedures, Certification

Part 15, Subpart B – Unintentional Radiators

§ 15.107 Conducted limits

§ 15.109 Radiated emission limits; general requirements

Note:
ANSI C63.4–2014 is applied.

Summary Test Results:

The EUT complied with all performed tests as listed in chapter 1.3 Measurement Summary / Signatures.

1.2 FCC-IC CORRELATION TABLE

Correlation of measurement requirements for Information Technology Equipment (ITE) from FCC and IC

Measurement	FCC reference	IC reference
Conducted Emissions (AC Power Line)	§15.107	ICES-003 Issue 6: 6.1
Radiated Spurious Emissions	§15.109	ICES-003 Issue 6: 6.2

Remarks:

1. FCC Part 15 subpart B, ICES 003 and CISPR 22 contain different definitions of Class A and Class B limits, i.e. which class is applicable to which kind of EUT.
   ICES 003 and CISPR 22 distinguish between the location where the EUT is intended to operate whilst FCC refers to the method of commercial distribution (distributive trades).
2. The correct assignment of the appropriate class to the concrete EUT is not scope of this test report!
3. A radio apparatus that is specifically subject to an Industry Canada Radio Standard Specification (RSS) and which contains an ITE is not subject to ICES-003 provided the ITE is used only to enable operation of the radio apparatus and the ITE does not control additional functions or capabilities.
4. ISM (Industrial, Scientific or Medical) radio frequency generators, though they may contain ITE, are excluded from the definition of ITE and are not subject to ICES-003. They are instead subject to the Interference-Causing Equipment Standard ICES-001, which specifically addresses ISM radio frequency generators.

1.3 MEASUREMENT SUMMARY / SIGNATURES

47 CFR CHAPTER I FCC PART 15 Subpart B § 15.107

Conducted Emissions at AC mains
The measurement was performed according to ANSI C63.4 **Final Result**

OP-Mode AC mains connection, Test setup	**Setup**	**FCC Class B**	**IC Class B**
via auxilliary equipment, stand-alone	Setup_aa01_ACDC	Passed	Passed
	Setup_ba01_ACDC	Passed	Passed
	Setup_ca01_ACDC	Passed	Passed
via connected computer device, computer peripheric	Setup_aa01_CP	Passed	Passed
	Setup_ba01_CP	Passed	Passed
	Setup_ca01_CP	Passed	Passed

47 CFR CHAPTER I FCC PART 15 Subpart B § 15.109

Radiated Emissions
The measurement was performed according to ANSI C63.4 **Final Result**

OP-Mode AC mains connection, Measurement range, Test setup	**Setup**	**FCC Class B**	**IC Class B**
via auxilliary equipment, 1 GHz - 13 GHz, stand-alone	Setup_aa01_ACDC	Passed	Passed
via auxilliary equipment, 30 MHz - 1 GHz, stand-alone	Setup_aa01_ACDC	Passed	Passed
	Setup_ba01_ACDC	Passed	Passed
	Setup_ca01_ACDC	Passed	Passed
via connected computer device, 1 GHz - 13 GHz, computer peripheric	Setup_aa01_CP	Passed	Passed
via connected computer device, 30 MHz - 1 GHz, computer peripheric	Setup_aa01_CP	Passed	Passed
	Setup_ba01_CP	Passed	Passed
	Setup_ca01_CP	Passed	Passed

N/A: Not applicable
N/P: Not performed

MARCO KULLIK
2016.08.25
16:32:22 +02'00'

(responsible for accreditation scope)
Dipl.-Ing. Marco Kullik

DANIEL GALL
2016.08.25
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(responsible for testing and report)
Dipl.-Ing. Daniel Gall

2 ADMINISTRATIVE DATA

2.1 TESTING LABORATORY

Company Name:	7layers GmbH
Address:	Borsigstr. 11 40880 Ratingen Germany

This facility has been fully described in a report submitted to the FCC and accepted under the registration number 96716.

This facility has been fully described in a report submitted to the IC and accepted under the registration number: Site# 3699A-1.

The test facility is also accredited by the following accreditation organisation:

Laboratory accreditation no:	DAkkS D-PL-12140-01-01
Responsible for accreditation scope:	Dipl.-Ing. Marco Kullik
Report Template Version:	2016-06-07

2.2 PROJECT DATA

Responsible for testing and report:	Dipl.-Ing. Daniel Gall
Employees who performed the tests:	documented internally at 7Layers
Date of Report:	2016-08-25
Testing Period:	2016-07-15 to 2016-07-21

2.3 APPLICANT DATA

Company Name:	testo SE & Co. KGaA
Address:	Testo Str. 1 79853 Lenzkirch Germany
Contact Person:	Mr. Udo Spiwoks

2.4 MANUFACTURER DATA

Company Name:	Please see applicant data
Address:	
Contact Person:	

3 TEST OBJECT DATA

3.1 GENERAL EUT DESCRIPTION

Kind of Device product description	Thermal imager with integrated Bluetooth Low Energy and WLAN.
Product name	Thermal imager
Type	t872 t871 t868
Declared EUT data by the supplier	
Power Supply Type	DC (USB)
Nominal Voltage / Frequency	120 V 60 Hz AC, 5 V DC
Test Voltage / Frequency	120 V 60 Hz AC
Highest internal frequency	Bluetooth Low Energy transmitter on 2480 MHz
General Description	The EUT is a thermal imager with integrated Bluetooth Low Energy and WLAN in the modes b and g (20 MHz nominal bandwidth). There are different variants of the EUT, that, according to the customer, differ only in the used camera and display.
Ports	Enclosure USB (micro)

The main components of the EUT are listed and described in chapter 3.2 EUT Main components.

3.2 EUT MAIN COMPONENTS

Sample Name	Sample Code	Description
DE1101014aa01	aa01	Sample of variant t872
Sample Parameter	**Value**	
Serial No.	60700832	
HW Version	CPU 0460 0969: 4.3 Mainboard with WCR 0460 1404 01: 4.0.b	
SW Version	0.00.245	
Comment		

Sample Name	Sample Code	Description
DE1101014ba01	ba01	Sample of variant t868
Sample Parameter	**Value**	
Serial No.	60700887	
HW Version	CPU 0460 0969: 4.3 Mainboard with WCR 0460 1404 01: 4.0.b	
SW Version	0.00.245	
Comment		

Sample Name	Sample Code	Description
DE1101014ca01	ca01	Sample of variant t871
Sample Parameter	**Value**	
Serial No.	60700827	
HW Version	CPU 0460 0969: 4.3 Mainboard with WCR 0460 1404 01: 4.0.b	
SW Version	0.00.245	
Comment		

3.3 ANCILLARY EQUIPMENT

For the purposes of this test report, ancillary equipment is defined as equipment which is used in conjunction with the EUT to provide operational and control features to the EUT. It is necessary to configure the system in a typical fashion, as a customer would normally use it. But nevertheless Ancillary Equipment can influence the test results.

Device	**Details (Manufacturer, Type Model, OUT Code)**	**Description**
USB cable	CABLETECH TECHNOLOGY, Type A – Type Micro B, 1.95m length	USB cable sold together with EUT

3.4 AUXILIARY EQUIPMENT

For the purposes of this test report, auxiliary equipment is defined as equipment which is used temporarily to enable operational and control features especially used for the tests of the EUT which is not used during normal operation or equipment that is used during the tests in combination with the EUT but is not subject of this test report. It is necessary to configure the system in a typical fashion, as a customer would normally use it.
But nevertheless Auxiliary Equipment can influence the test results.

Device	**Details (Manufacturer and Model, HW, SW, S/N)**	**Description**
ACDC1	ANSMANN Model: 2109-3015, MFD: 160402, - , -	USB AC / DC adaptor (DE1101014ACDC)
Laptop	Fujitsu Lifebook Eseries E781, 2012-03, Win7 Prof. Engl., DSCK013817	Computer for computer peripheral setup
ACDC Laptop	Fujitsu Ltd. PJW1942NA, - , - , 13300281B	AC / DC power supply for auxiliary computer
TFT	LG L17MB-P, - , - , 412WAPL0U560	TFT Display for computer peripheral setup
Mouse	Logitech M-BT58, - , - , HC60915A2XC	Mouse for computer peripheral setup
Keyboard	CHERRY RS 6000 USB ON, - , - , G 0000273 2P28	Keyboard for computer peripheral setup

3.5 EUT SETUPS

This chapter describes the combination of EUTs and equipment used for testing. The rationale for selecting the EUTs, ancillary and auxiliary equipment and interconnecting cables, is to test a representative configuration meeting the requirements of the referenced standards.

Setup	Combination of EUTs	Description and Rationale
Setup_aa01_ACDC	DE1101014aa01, USB cable, ACDC1	AC / DC charger setup variant t872
Setup_aa01_CP	DE1101014aa01, USB cable, Laptop, ACDC Laptop, TFT, Mouse, Keyboard	Computer Peripheral setup variant t872
Setup_ba01_ACDC	DE1101014a01, USB cable, ACDC1	AC / DC charger setup variant t868
Setup_ba01_CP	DE1101014aa01, USB cable, Laptop, ACDC Laptop, TFT, Mouse, Keyboard	Computer Peripheral setup variant t868
Setup_ca01_ACDC	DE1101014aa01, USB cable, ACDC1	AC / DC charger setup variant t871
Setup_ca01_CP	DE1101014aa01, USB cable, Laptop, ACDC Laptop, TFT, Mouse, Keyboard	Computer Peripheral setup variant t871

3.6 OPERATING MODES

This chapter describes the operating modes of the EUTs used for testing.

AC / DC charger setup: The EUT is activated, the camera is on and charging.

Computer Peripheral Setup: The EUT is activated and the Display data of the EUT is transferred by USB to the auxiliary laptop.

3.7 PRODUCT LABELLING

3.7.1 FCC ID LABEL

Please refer to the documentation of the applicant.

3.7.2 LOCATION OF THE LABEL ON THE EUT

Please refer to the documentation of the applicant.

4 TEST RESULTS

4.1 CONDUCTED EMISSIONS AT AC MAINS

Standard **FCC Part 15 Subpart B**

The test was performed according to:
ANSI C63.4

4.1.1 TEST DESCRIPTION

The test set-up was made in accordance to the general provisions of ANSI C 63.4
The Equipment Under Test (EUT) was setup in a shielded room to perform the conducted emissions measurements in a typical installation configuration. The EUT was powered from 50µH || 50 Ohm Line Impedance Stabilization Network (LISN). The LISN's unused connections were terminated with 50 Ohm loads.

The measurement procedure consists of two steps. It is implemented into the EMI test software EMC-32 from R&S.

Step 1: Preliminary scan
Intention of this step is, to determine the conducted EMI-profile of the EUT.
EMI receiver settings:
- Detector: Peak – Maxhold & Average
- Frequency range: 150 kHz – 30 MHz
- Frequency steps: 2.5 kHz
- IF–Bandwidth: 9 kHz
- Measuring time / Frequency step: 100 ms (FFT-based)
- Measurement on phase + neutral lines of the power cords

On basis of this preliminary scan the highest amplitudes and the corresponding frequencies relative to the limit are identified. Emissions above the limit and emissions which are in the 10 dB range below the limit are considered.

Step 2: Final measurement
Intention of this step is, to determine the highest emissions with the settings defined in the test specification for the frequencies identified in step 1.
EMI receiver settings:
- Detector: Quasi-Peak
- IF Bandwidth: 9 kHz
- Measuring time: 1 s / frequency

At each frequency determined in step 1, four measurements are performed in the following combinations:
1) Neutral lead - reference ground (PE grounded)
2) Phase lead - reference ground (PE grounded)
3) Neutral lead - reference ground (PE floating)
4) Phase lead - reference ground (PE floating)

The highest value is reported.

4.1.2TEST REQUIREMENTS / LIMITS

FCC Part 15, Subpart B, §15.107

Class B:

Frequency (MHz)	QP Limits (dBµV)	AV Limits (dBµV)
0.15 – 0.5	66 - 56	56 - 46
0.5 - 5	56	46
5 - 30	60	50

Class A:

Frequency (MHz)	QP Limits (dBµV)	AV Limits (dBµV)
0.15 – 0.5	79	66
0.5 - 30	73	60

4.1.3TEST PROTOCOL

Temperature: 26 °C
Air Pressure: 1008 hPa
Humidity: 45 %
AC/DC adapter

Sample	Power line	PE	Frequency [kHz]	Level [dBµV]	Detector	Limit [dBµV]	Margin [dB]
aa01	N	GND	159.0	57.2	QP	65.5	8.3
aa01	N	GND	159.0	38.6	AV	55.5	17.0
aa01	N	GND	199.5	52.5	QP	63.6	11.1
aa01	N	GND	237.8	36.5	AV	52.2	15.7
aa01	N	GND	237.8	51.1	QP	62.2	11.1
aa01	N	GND	278.3	39.3	AV	50.9	11.6
aa01	N	GND	278.3	47.8	QP	60.9	13.0
aa01	N	GND	316.5	34.6	AV	49.8	15.2
aa01	L1	GND	316.5	47.2	QP	59.8	12.6
aa01	N	GND	357.0	45.9	QP	58.8	12.9
ba01	-	-	-	-	-	-	-
ca01	-	-	-	-	-	-	-

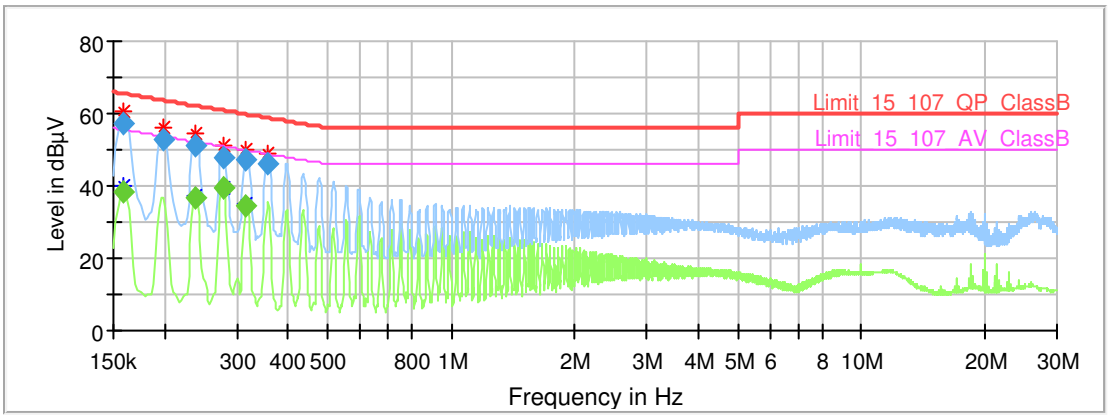
Temperature: 26 °C
Air Pressure: 1008 hPa
Humidity: 45 %
Computer Peripheral

Sample	Power line	PE	Frequency [kHz]	Level [dBµV]	Detector	Limit [dBµV]	Margin [dB]
aa01	N	GND	152.3	50.7	QP	65.9	15.2
aa01	N	GND	172.5	46.2	QP	64.8	18.6
aa01	N	GND	199.5	42.9	QP	63.6	20.7
aa01	N	GND	282.8	39.9	QP	60.7	20.8
aa01	N	FLO	471.8	39.3	QP	56.5	17.2
ba01	N	GND	152.3	50.9	QP	65.9	15.0
ba01	N	GND	161.3	49.7	QP	65.4	15.7
ba01	N	GND	192.8	45.6	QP	63.9	18.3
ba01	N	GND	264.8	40.6	QP	61.3	20.7
ba01	N	GND	341.3	42.5	QP	59.2	16.6
ba01	N	GND	451.5	38.6	QP	56.9	18.3
ca01	N	FLO	152.3	49.1	QP	65.9	16.8
ca01	N	FLO	172.5	46.1	QP	64.8	18.8
ca01	N	FLO	267.0	40.9	QP	61.2	20.3
ca01	L1	FLO	471.8	35.8	QP	56.5	20.7
ca01	N	GND	642.8	37.7	QP	56.0	18.4

Remark: Please see next sub-clause for the measurement plot.

4.1.4MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, "WORST CASE")

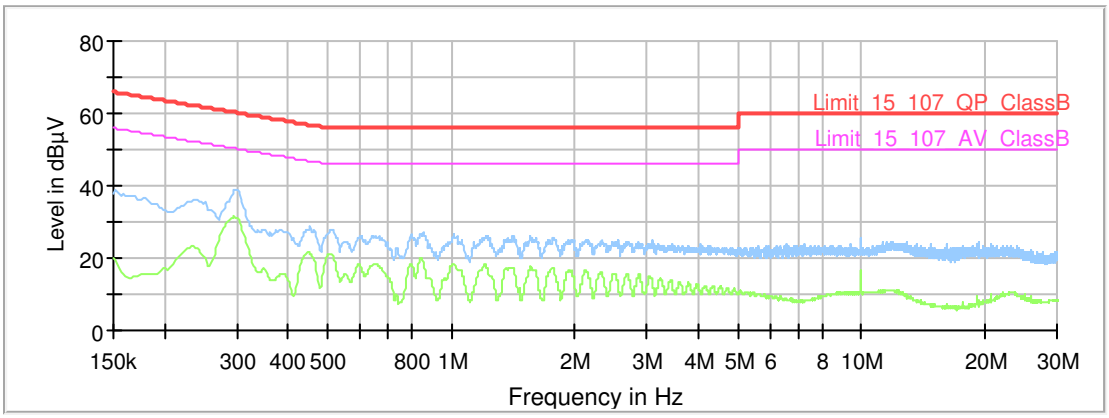
AC mains connection = via auxilliary equipment, Test setup = stand-alone



Final_Result

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
0.159000	57.21	---	65.52	8.31	1000.0	9.000	N	GND	10.1
0.159000	---	38.55	55.52	16.97	1000.0	9.000	N	GND	10.1
0.199500	52.52	---	63.63	11.11	1000.0	9.000	N	GND	10.1
0.237750	---	36.47	52.17	15.70	1000.0	9.000	N	GND	10.1
0.237750	51.12	---	62.17	11.05	1000.0	9.000	N	GND	10.1
0.278250	---	39.28	50.87	11.59	1000.0	9.000	N	GND	10.1
0.278250	47.83	---	60.87	13.04	1000.0	9.000	N	GND	10.1
0.316500	---	34.63	49.80	15.17	1000.0	9.000	N	GND	10.1
0.316500	47.21	---	59.80	12.59	1000.0	9.000	L1	GND	10.1
0.357000	45.94	---	58.80	12.86	1000.0	9.000	N	GND	10.1

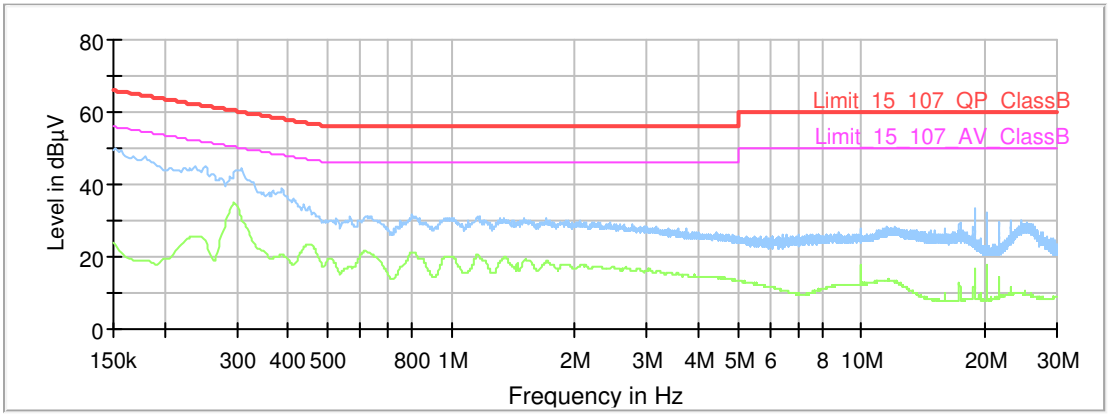
Sample aa01



Final_Result

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
---	---	---	---	---	---	---			---

Sample ba01

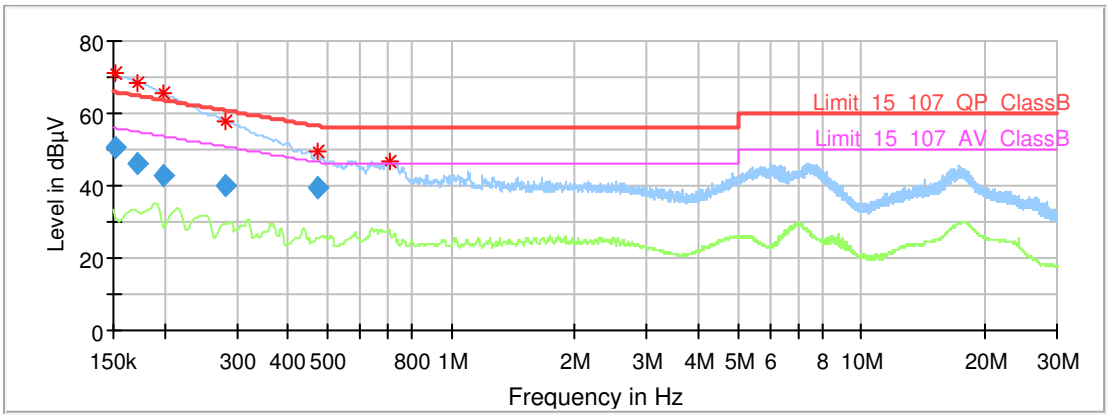


Final_Result

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
---	---	---	---	---	---	---			---

Sample ca01

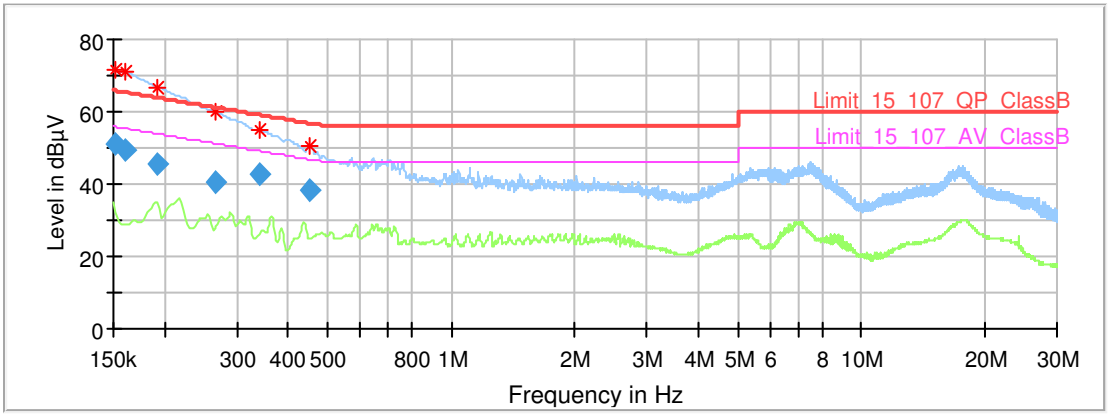
AC mains connection = via connected computer device, Test setup = computer peripheric



Final_Result

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
0.152250	50.71	---	65.88	15.16	1000.0	9.000	N	GND	10.1
0.172500	46.23	---	64.84	18.61	1000.0	9.000	N	GND	10.1
0.199500	42.90	---	63.63	20.73	1000.0	9.000	N	GND	10.1
0.282750	39.92	---	60.73	20.82	1000.0	9.000	N	GND	10.1
0.471750	39.33	---	56.48	17.15	1000.0	9.000	N	FLO	10.1

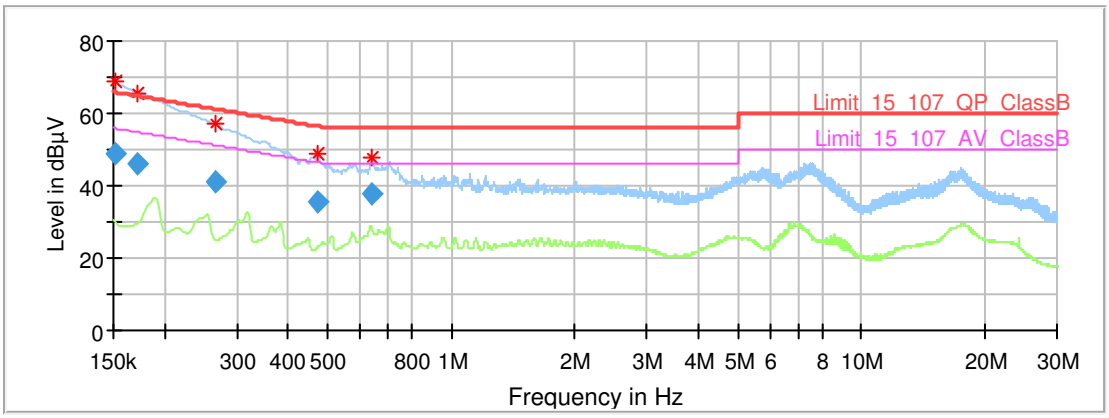
Sample aa01



Final_Result

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
0.152250	50.92	---	65.88	14.96	1000.0	9.000	N	GND	10.1
0.161250	49.67	---	65.40	15.72	1000.0	9.000	N	GND	10.1
0.192750	45.62	---	63.92	18.30	1000.0	9.000	N	GND	10.1
0.264750	40.58	---	61.28	20.70	1000.0	9.000	N	GND	10.1
0.341250	42.53	---	59.17	16.64	1000.0	9.000	N	GND	10.1
0.451500	38.58	---	56.85	18.27	1000.0	9.000	N	GND	10.1

Sample ba01



Final_Result

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
0.152250	49.11	---	65.88	16.77	1000.0	9.000	N	FL	10.1
0.172500	46.08	---	64.84	18.76	1000.0	9.000	N	FL	10.1
0.267000	40.91	---	61.21	20.30	1000.0	9.000	N	FL	10.1
0.471750	35.82	---	56.48	20.66	1000.0	9.000	L1	FL	10.1
0.642750	37.65	---	56.00	18.35	1000.0	9.000	N	GN	10.1

Sample ca01

4.1.5TEST EQUIPMENT USED

Conducted Emissions

4.2 RADIATED EMISSIONS

Standard **FCC Part 15 Subpart B**

The test was performed according to:
ANSI C63.4

4.2.1TEST DESCRIPTION

The test set-up was made in accordance to the general provisions of ANSI C63.4 in a typical installation configuration. The Equipment Under Test (EUT) was set up on a non-conductive table 1.0 x 2.0 m² in the semi-anechoic chamber. The influence of the EUT support table that is used between 30–1000 MHz was evaluated.
The measurement procedure is implemented into the EMI test software EMC32 from R&S. Exploratory tests are performed at 3 orthogonal axes to determine the worst-case orientation of a body-worn or handheld EUT. The final test on all kind of EUTs is also performed at 3 axes. A pre-check is performed while the EUT is powered from a DC power source.

1. Measurement above 30 MHz and up to 1 GHz

Step 1: Preliminary scan
This is a preliminary test to identify the highest amplitudes relative to the limit.
Settings for step 1:
- Antenna distance: 3 m
- Detector: Peak-Maxhold / Quasipeak (FFT-based)
- Frequency range: 30 – 1000 MHz
- Frequency steps: 30 kHz
- IF–Bandwidth: 120 kHz
- Measuring time / Frequency step: 100 ms
- Turntable angle range: –180° to 90°
- Turntable step size: 90°
- Height variation range: 1 – 3 m
- Height variation step size: 2 m
- Polarisation: Horizontal + Vertical

Intention of this step is, to determine the radiated EMI-profile of the EUT. Afterwards the relevant emissions for the final measurement are identified.

Step 2: Adjustment measurement
In this step the accuracy of the turntable azimuth and antenna height will be improved. This is necessary to find out the maximum value of every frequency.
For each frequency, which was determined the turntable azimuth and antenna height will be adjusted. The turntable azimuth will slowly vary by ± 45° around this value. During this action, the value of emission is continuously measured. The turntable azimuth at the highest emission will be recorded and adjusted. In this position, the antenna height will also slowly vary by ± 100 cm around the antenna height determined. During this action, the value of emission is also continuously measured. The antenna height of the highest emission will also be recorded and adjusted.
- Detector: Peak – Maxhold
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 100 ms
- Turntable angle range: ± 45 ° around the determined value

- Height variation range: ± 100 cm around the determined value
- Antenna Polarisation: max. value determined in step 1

Step 3: Final measurement with QP detector
With the settings determined in step 3, the final measurement will be performed:
EMI receiver settings for step 4:
- Detector: Quasi-Peak (< 1 GHz)
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 1 s

After the measurement a plot will be generated which contains a diagram with the results of the preliminary scan and a chart with the frequencies and values of the results of the final measurement.

3. Measurement above 1 GHz
The following modifications apply to the measurement procedure for the frequency range above 1 GHz:
Step 1:
The Equipment Under Test (EUT) was set up on a non-conductive support (tilt device) at 1.5 m height in the fully-anechoic chamber.
All steps were performed with one height (1.5 m) of the receiving antenna only.
The EUT is turned during the preliminary measurement across the elevation axis, with a step size of 90 °.
The turn table step size (azimuth angle) for the preliminary measurement is 45 °.
Step 2:
Due to the fact, that in this frequency range the test is performed in a fully anechoic room, the height scan of the receiving antenna instep 2 is omitted. Instead of this, a maximum search with a step size ± 45° for the elevation axis is performed.
The turn table azimuth will slowly vary by ± 22.5°.
The elevation angle will slowly vary by ± 45°
EMI receiver settings (for all steps):
- Detector: Peak, Average
- IF Bandwidth = 1 MHz
Step 3:
Spectrum analyser settings for step 3:
- Detector: Peak / Average
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 1 MHz
- Measuring time: 1 s

4.2.2TEST REQUIREMENTS / LIMITS

FCC Part 15, Subpart B, §15.109, Radiated Emission Limits

Class B:

Frequency (MHz)	Limit (µV/m)	Measurement distance (m)	Limits (dBµV/m)
30 – 88	100@3m	3	40.0@3m
88 – 216	150@3m	3	43.5@3m
216 – 960	200@3m	3	46.0@3m
960 - 26000	500@3m	3	54.0@3m
26000 - 40000	500@3m	1	54.0@3m

Class A:

Frequency (MHz)	Limit (µV/m)	Measurement distance (m)	Limits (dBµV/m)
30 – 88	90@10m	3	39.1@10m
88 – 216	150@10m	3	43.5@10m
216 – 960	210@10m	3	46.4@10m
960 - 26000	300@10m	3	49.5@10m
26000 - 40000	300@10m	1	49.5@10m

The measured values for Class A and for Class B (> 26 GHz) measurements are corrected with an inverse linear distance extrapolation factor (20 dB/decade).

§15.35(b) ..., there is also a limit on the radio frequency emissions, as measured using instrumentation with a peak detector function, corresponding to 20 dB above the maximum permitted average limit....

Used conversion factor: Limit (dBµV/m) = 20 log (Limit (µV/m)/1µV/m)

4.2.3TEST PROTOCOL

Ambient temperature: 26-30 °C
Air Pressure: 1007-1008 hPa
Humidity: 41-45 %
AC/DC adapter

Sample	Spurious Freq. [MHz]	Spurious Level [dBµV/m]	Detector	RBW [kHz]	Limit [dBµV/m]	Margin to Limit [dB]
ad01	30.0	24.8	QP	120.0	54.0	29.2
ad01	331.8	28.4	QP	120.0	46.0	17.6
ba01	331.9	29.3	QP	120.0	46.0	16.7
ca01	332.0	31.5	QP	120.0	46.0	14.5

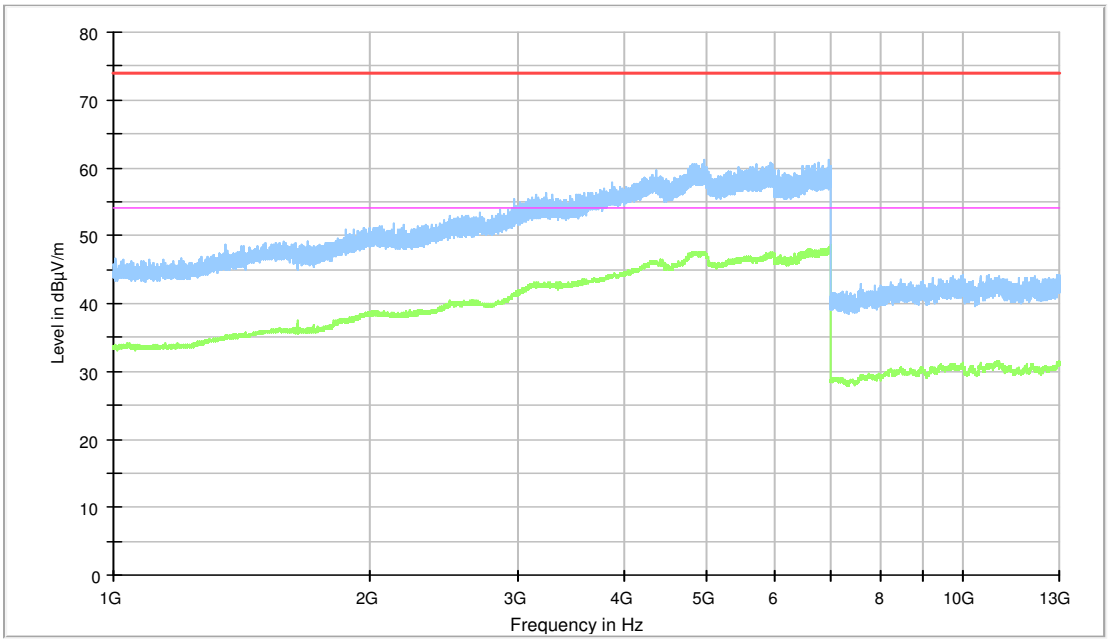
Ambient temperature: 26-30 °C
Air Pressure: 1007-1008 hPa
Humidity: 41-45 %
Computer Peripheral Setup

Sample	Spurious Freq. [MHz]	Spurious Level [dBµV/m]	Detector	RBW [kHz]	Limit [dBµV/m]	Margin to Limit [dB]
ad01	193.9	34.5	QP	120.0	43.5	9.0
ad01	378.6	40.0	QP	120.0	46.0	6.0
ad01	663.9	26.1	QP	120.0	46.0	19.9
ad01	748.5	34.1	QP	120.0	46.0	11.9
ad01	924.1	29.3	QP	120.0	46.0	16.7

Remark: Please see next sub-clause for the measurement plot.

4.2.4MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, "WORST CASE")

AC mains connection = via auxilliary equipment, Measurement range = 1 GHz - 13 GHz, Test setup = stand-alone



Final_Result

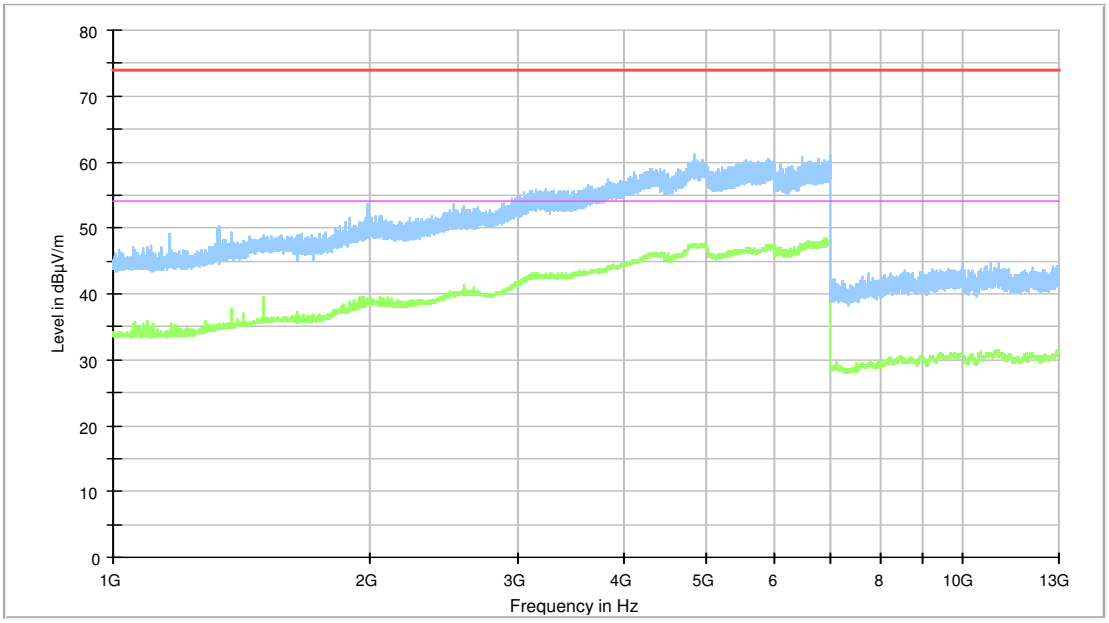
Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
---	---	---	---	---	---	---	---		---

(continuation of the "Final_Result" table from column 15 ...)

Frequency (MHz)	Corr. (dB)
---	---

Sample aa01

AC mains connection = via connected computer device, Measurement range = 1 GHz - 13 GHz, Test setup = computer peripheric



Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
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(continuation of the "Final_Result" table from column 15 ...)

Frequency (MHz)	Corr. (dB)
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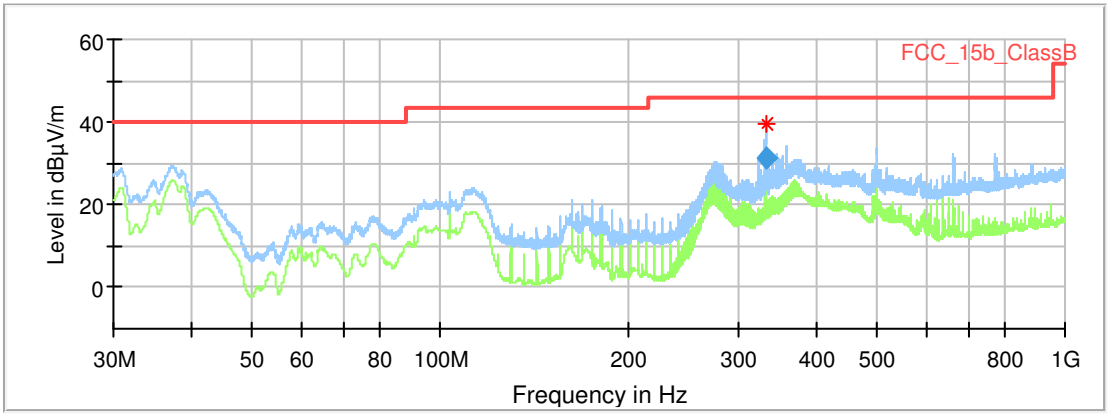
Sample aa01

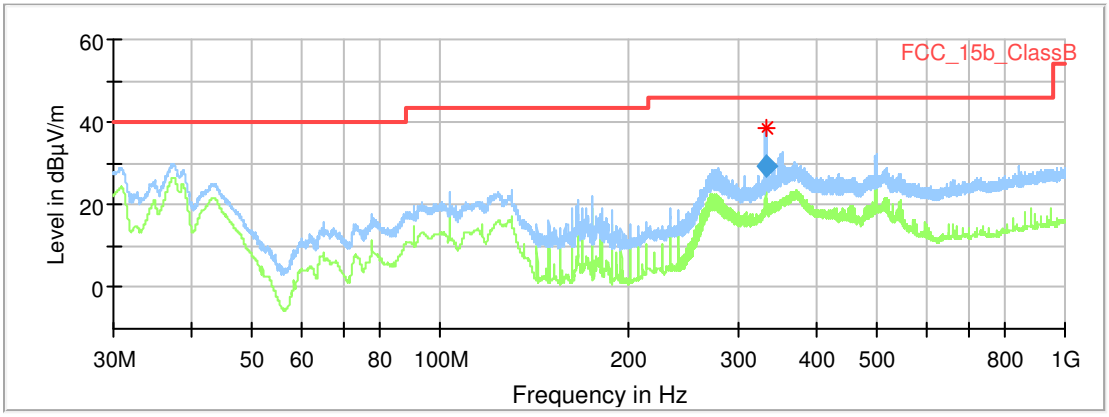
AC mains connection = via auxilliary equipment, Measurement range = 30 MHz - 1 GHz, Test setup = stand-alone



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
331.980000	31.45	46.00	14.55	1000.0	120.000	108.0	H	-96.0

Sample ca01



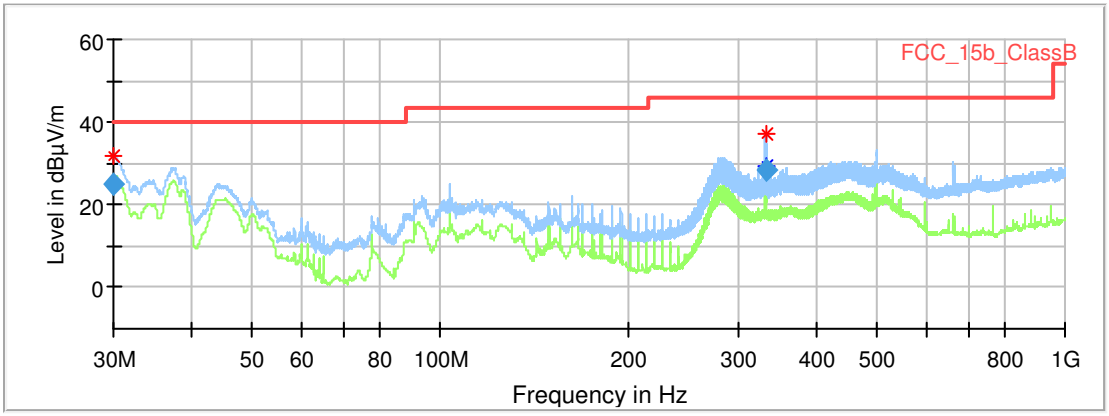
Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
331.860000	29.33	46.00	16.67	1000.0	120.000	103.0	H	93.0

Sample ba01

Common Information

Test Description:	Radiated Emissions 30 MHz - 1 GHz
Test Standard	FCC15b Class B
Operating Conditions:	camera active
Operator Name:	URO
Comment:	120 V / 60 Hz ; with ACDC Charger

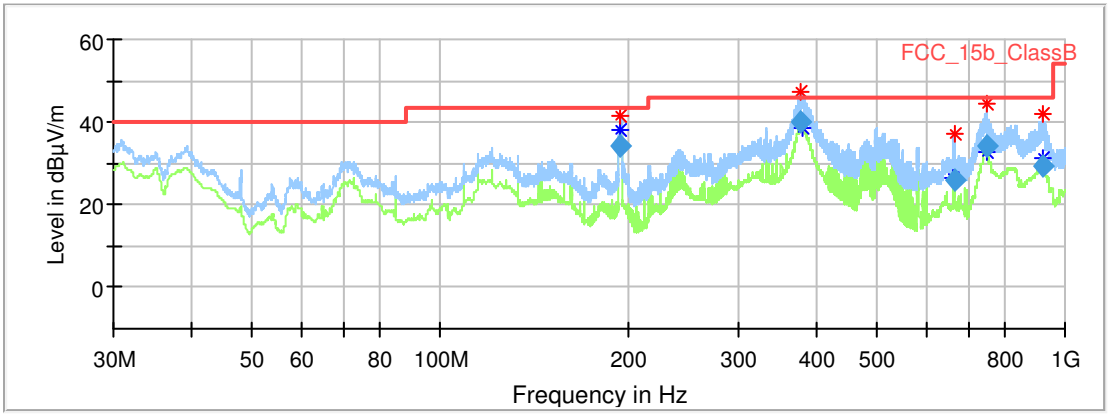


Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
30.000000	24.82	40.00	15.18	1000.0	120.000	103.0	V	-165.0	19.2
331.800000	28.42	46.00	17.58	1000.0	120.000	103.0	H	80.0	14.6

Sample aa01

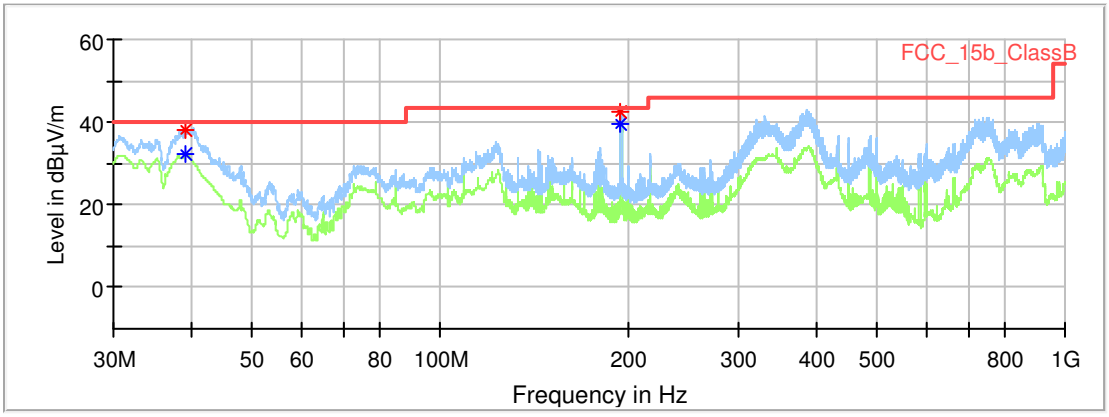
AC mains connection = via connected computer device, Measurement range = 30 MHz - 1 GHz, Test setup = computer peripheric



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
193.680000	34.48	43.50	9.02	1000.0	120.000	100.0	V	32.0	9.2
378.570000	39.96	46.00	6.04	1000.0	120.000	110.0	H	-199.0	15.9
663.900000	26.08	46.00	19.92	1000.0	120.000	254.0	V	-182.0	21.9
748.470000	34.09	46.00	11.91	1000.0	120.000	164.0	H	88.0	23.2
924.120000	29.27	46.00	16.73	1000.0	120.000	106.0	V	-17.0	25.7

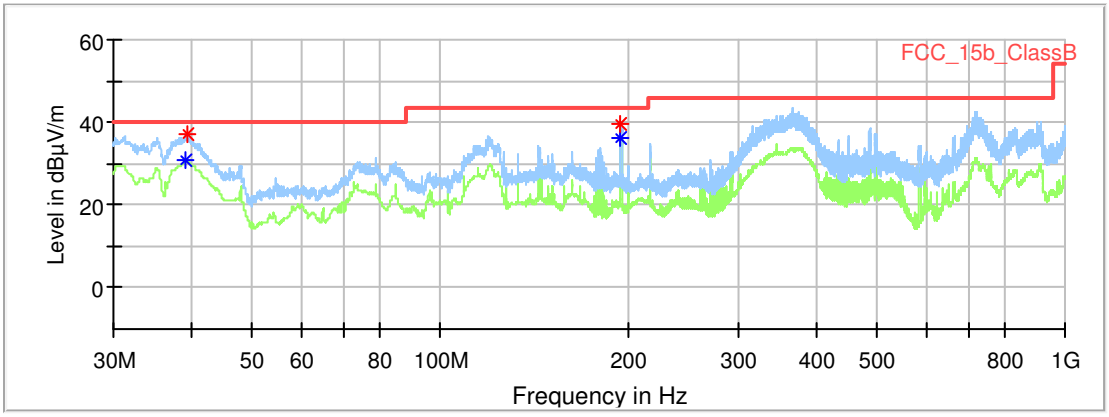
Sample aa01



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
---	---	---	---	---	---	---		---

Sample ba01



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Band width (kHz)	Height (cm)	Pol	Azimuth (deg)
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Sample ca01

4.2.5TEST EQUIPMENT USED

Radiated Emissions

5 TEST EQUIPMENT

1 Conducted Emissions
Shielded Room 02

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
1.1	ESH 3-Z5	Two-Line V-Network	Rohde & Schwarz	828304/029	2015-03	2017-03
1.2	ESR 7	EMI Receiver / Spectrum Analyzer	Rohde & Schwarz	101424	2014-11	2016-11
1.3	Shielded Room 02	Shielded Room for conducted testing, 12qm	Frankonia	-		
1.4	Opus10 THI (8152.00)	ThermoHygro Datalogger 02 (Environ)	Lufft Mess- und Regeltechnik GmbH	7489	2015-02	2017-02
1.5	ESH 3-Z5	Two-Line V-Network	Rohde & Schwarz	829996/002	2015-03	2017-03
1.6	Opus10 TPR (8253.00)	ThermoAirpressure Datalogger 13 (Environ)	Lufft Mess- und Regeltechnik GmbH	13936	2015-02	2017-02
1.7	Chroma 6404	AC Power Source	Chroma ATE INC.	64040001304		

2 Radiated Emissions

Lab to perform radiated emission tests

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
2.1	3160-09	Standard Gain / Pyramidal Horn Antenna 26.5 GHz	EMCO Elektronic GmbH	00083069		
2.2	WHKX 7.0/18G-8SS	High Pass Filter	Wainwright	09		
2.3	5HC3500/18000-1.2-KK	High Pass Filter	Trilithic	200035008		
2.4	Datum MFS	Rubidium Frequency Normal MFS	Datum GmbH	002	2015-08	2016-08
2.5	Fully Anechoic Room	8.80m x 4.60m x 4.05m (l x w x h)	Albatross Projects	P26971-647-001-PRB		
2.6	AM 4.0	Antenna mast	Maturo GmbH	AM4.0/180/11920513		
2.7	ESR 7	EMI Receiver / Spectrum Analyzer	Rohde & Schwarz	101424	2014-11	2016-11
2.8	TT 1.5 WI	Turn Table	Maturo GmbH	-		
2.9	Anechoic Chamber	10.58 x 6.38 x 6.00 m³	Frankonia	none	2014-01	2017-01
2.10	Fluke 177	Digital Multimeter 03 (Multimeter)	Fluke Europe B.V.	86670383	2016-02	2018-02
2.11	ESIB 26	Spectrum Analyzer	Rohde & Schwarz	830482/004	2015-12	2017-12
2.12	Tilt device Maturo (Rohacell)	Antrieb TD1.5-10kg	Maturo GmbH	TD1.5-10kg/024/3790709		
2.13	5HC2700/12750-1.5-KK	High Pass Filter	Trilithic	9942012		
2.14	AS 620 P	Antenna mast	HD GmbH	620/37		
2.15	NRV-Z1	Sensor Head A	Rohde & Schwarz	827753/005	2016-05	2017-05
2.16	4HC1600/12750-1.5-KK	High Pass Filter	Trilithic	9942011		
2.17	ASP 1.2/1.8-10 kg	Antenna Mast	Maturo GmbH	-		

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
2.18	JS4-18002600-32-5P	Broadband Amplifier 18 GHz - 26 GHz	Miteq	849785		
2.19	JS4-00101800-35-5P	Broadband Amplifier 30 MHz - 18 GHz	Miteq	896037		
2.20	HL 562	Ultralog new biconicals	Rohde & Schwarz	830547/003	2015-06	2018-06
2.21	Opus10 THI (8152.00)	ThermoHygro Datalogger 12 (Environ)	Lufft Mess- und Regeltechnik GmbH	12482	2015-03	2017-03
2.22	JS4-00102600-42-5A	Broadband Amplifier 30 MHz - 26 GHz	Miteq	619368		
2.23	HFH2-Z2	Loop Antenna	Rohde & Schwarz	829324/006	2014-11	2017-11
2.24	FSW 43	Spectrum Analyzer	Rohde & Schwarz	103779	2014-11	2016-11
2.25	Opus10 TPR (8253.00)	ThermoAirpressure Datalogger 13 (Environ)	Lufft Mess- und Regeltechnik GmbH	13936	2015-02	2017-02
2.26	Chroma 6404	AC Power Source	Chroma ATE INC.	64040001304		
2.27	3160-10	Standard Gain / Pyramidal Horn Antenna 40 GHz	EMCO Elektronic GmbH	00086675		
2.28	HL 562 Ultralog	Log.-per. Antenna	Rohde & Schwarz	100609	2016-04	2019-04
2.29	PAS 2.5 - 10 kg	Antenna Mast	Maturo GmbH	-		
2.30	HF 907	Double-ridged horn	Rohde & Schwarz	102444	2015-05	2018-05

The calibration interval is the time interval between “Last Calibration” and “Calibration Due”

6 ANTENNA FACTORS, CABLE LOSS AND SAMPLE CALCULATIONS

This chapter contains the antenna factors with their corresponding path loss of the used measurement path for all antennas as well as the insertion loss of the LISN.

6.1 LISN R&S ESH3-Z5 (150 KHZ – 30 MHZ)

Frequency		Corr.	LISN insertion loss ESH3-Z5	cable loss (incl. 10 dB atten-uator)
MHz		dB	dB	dB
0,15		10,1	0,1	10,0
5		10,3	0,1	10,2
7		10,5	0,2	10,3
10		10,5	0,2	10,3
12		10,7	0,3	10,4
14		10,7	0,3	10,4
16		10,8	0,4	10,4
18		10,9	0,4	10,5
20		10,9	0,4	10,5
22		11,1	0,5	10,6
24		11,1	0,5	10,6
26		11,2	0,5	10,7
28		11,2	0,5	10,7
30		11,3	0,5	10,8

Sample calculation

U_{LISN} (dB µV) = U (dB µV) + Corr. (dB)
U = Receiver reading
LISN Insertion loss = Voltage Division Factor of LISN
Corr. = sum of single correction factors of used LISN, cables, switch units (if used)
Linear interpolation will be used for frequencies in between the values in the table.

6.2 ANTENNA R&S HFH2-Z2 (9 KHZ – 30 MHZ)

Frequency	AF HFH-Z2)	Corr.	cable loss 1 (inside chamber)	cable loss 2 (outside chamber)	cable loss 3 (switch unit)	cable loss 4 (to receiver)	distance corr. (-40 dB/ decade)	d_{Limit} (meas. distance (limit)	d_{used} (meas. distance (used)
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB	m	m
0,009	20,50	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,01	20,45	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,015	20,37	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,02	20,36	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,025	20,38	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,03	20,32	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,05	20,35	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,08	20,30	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,1	20,20	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,2	20,17	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,3	20,14	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,49	20,12	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,490001	20,12	-39,6	0,1	0,1	0,1	0,1	-40	30	3
0,5	20,11	-39,6	0,1	0,1	0,1	0,1	-40	30	3
0,8	20,10	-39,6	0,1	0,1	0,1	0,1	-40	30	3
1	20,09	-39,6	0,1	0,1	0,1	0,1	-40	30	3
2	20,08	-39,6	0,1	0,1	0,1	0,1	-40	30	3
3	20,06	-39,6	0,1	0,1	0,1	0,1	-40	30	3
4	20,05	-39,5	0,2	0,1	0,1	0,1	-40	30	3
5	20,05	-39,5	0,2	0,1	0,1	0,1	-40	30	3
6	20,02	-39,5	0,2	0,1	0,1	0,1	-40	30	3
8	19,95	-39,5	0,2	0,1	0,1	0,1	-40	30	3
10	19,83	-39,4	0,2	0,1	0,2	0,1	-40	30	3
12	19,71	-39,4	0,2	0,1	0,2	0,1	-40	30	3
14	19,54	-39,4	0,2	0,1	0,2	0,1	-40	30	3
16	19,53	-39,3	0,3	0,1	0,2	0,1	-40	30	3
18	19,50	-39,3	0,3	0,1	0,2	0,1	-40	30	3
20	19,57	-39,3	0,3	0,1	0,2	0,1	-40	30	3
22	19,61	-39,3	0,3	0,1	0,2	0,1	-40	30	3
24	19,61	-39,3	0,3	0,1	0,2	0,1	-40	30	3
26	19,54	-39,3	0,3	0,1	0,2	0,1	-40	30	3
28	19,46	-39,2	0,3	0,1	0,3	0,1	-40	30	3
30	19,73	-39,1	0,4	0,1	0,3	0,1	-40	30	3

Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr. (dB)
U = Receiver reading
AF = Antenna factor
Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)
distance correction = -40 * LOG (d_{Limit}/ d_{used})
Linear interpolation will be used for frequencies in between the values in the table.
Table shows an extract of values

6.3 ANTENNA R&S HL562 (30 MHZ – 1 GHZ)

(d_{Limit} = 3 m)

Frequency	AF R&S HL562	Corr.	cable loss 1 (inside chamber)	cable loss 2 (outside chamber)	cable loss 3 (switch unit)	cable loss 4 (to receiver)	distance corr. (-20 dB/ decade)	d_{Limit} (meas. distance (limit)	d_{used} (meas. distance (used)
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB	m	m
30	18,6	0,6	0,29	0,04	0,23	0,02	0,0	3	3
50	6,0	0,9	0,39	0,09	0,32	0,08	0,0	3	3
100	9,7	1,2	0,56	0,14	0,47	0,08	0,0	3	3
150	7,9	1,6	0,73	0,20	0,59	0,12	0,0	3	3
200	7,6	1,9	0,84	0,21	0,70	0,11	0,0	3	3
250	9,5	2,1	0,98	0,24	0,80	0,13	0,0	3	3
300	11,0	2,3	1,04	0,26	0,89	0,15	0,0	3	3
350	12,4	2,6	1,18	0,31	0,96	0,13	0,0	3	3
400	13,6	2,9	1,28	0,35	1,03	0,19	0,0	3	3
450	14,7	3,1	1,39	0,38	1,11	0,22	0,0	3	3
500	15,6	3,2	1,44	0,39	1,20	0,19	0,0	3	3
550	16,3	3,5	1,55	0,46	1,24	0,23	0,0	3	3
600	17,2	3,5	1,59	0,43	1,29	0,23	0,0	3	3
650	18,1	3,6	1,67	0,34	1,35	0,22	0,0	3	3
700	18,5	3,6	1,67	0,42	1,41	0,15	0,0	3	3
750	19,1	4,1	1,87	0,54	1,46	0,25	0,0	3	3
800	19,6	4,1	1,90	0,46	1,51	0,25	0,0	3	3
850	20,1	4,4	1,99	0,60	1,56	0,27	0,0	3	3
900	20,8	4,7	2,14	0,60	1,63	0,29	0,0	3	3
950	21,1	4,8	2,22	0,60	1,66	0,33	0,0	3	3
1000	21,6	4,9	2,23	0,61	1,71	0,30	0,0	3	3

(d_{Limit} = 10 m)

30	18,6	-9,9	0,29	0,04	0,23	0,02	-10,5	10	3
50	6,0	-9,6	0,39	0,09	0,32	0,08	-10,5	10	3
100	9,7	-9,2	0,56	0,14	0,47	0,08	-10,5	10	3
150	7,9	-8,8	0,73	0,20	0,59	0,12	-10,5	10	3
200	7,6	-8,6	0,84	0,21	0,70	0,11	-10,5	10	3
250	9,5	-8,3	0,98	0,24	0,80	0,13	-10,5	10	3
300	11,0	-8,1	1,04	0,26	0,89	0,15	-10,5	10	3
350	12,4	-7,9	1,18	0,31	0,96	0,13	-10,5	10	3
400	13,6	-7,6	1,28	0,35	1,03	0,19	-10,5	10	3
450	14,7	-7,4	1,39	0,38	1,11	0,22	-10,5	10	3
500	15,6	-7,2	1,44	0,39	1,20	0,19	-10,5	10	3
550	16,3	-7,0	1,55	0,46	1,24	0,23	-10,5	10	3
600	17,2	-6,9	1,59	0,43	1,29	0,23	-10,5	10	3
650	18,1	-6,9	1,67	0,34	1,35	0,22	-10,5	10	3
700	18,5	-6,8	1,67	0,42	1,41	0,15	-10,5	10	3
750	19,1	-6,3	1,87	0,54	1,46	0,25	-10,5	10	3
800	19,6	-6,3	1,90	0,46	1,51	0,25	-10,5	10	3
850	20,1	-6,0	1,99	0,60	1,56	0,27	-10,5	10	3
900	20,8	-5,8	2,14	0,60	1,63	0,29	-10,5	10	3
950	21,1	-5,6	2,22	0,60	1,66	0,33	-10,5	10	3
1000	21,6	-5,6	2,23	0,61	1,71	0,30	-10,5	10	3

Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr. (dB)
U = Receiver reading
AF = Antenna factor
Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)
distance correction = -20 * LOG (d_{Limit}/ d_{used})
Linear interpolation will be used for frequencies in between the values in the table.
Tables show an extract of values.

6.4 ANTENNA R&S HF907 (1 GHZ – 18 GHZ)

Frequency	AF R&S HF907	Corr.	cable loss 1 (relay + cable inside chamber)	cable loss 2 (outside chamber)	cable loss 3 (switch unit, atten-uator & pre-amp)	cable loss 4 (to receiver)		
MHz	dB (1/m)	dB	dB	dB	dB	dB		
1000	24,4	-19,4	0,99	0,31	-21,51	0,79		
2000	28,5	-17,4	1,44	0,44	-20,63	1,38		
3000	31,0	-16,1	1,87	0,53	-19,85	1,33		
4000	33,1	-14,7	2,41	0,67	-19,13	1,31		
5000	34,4	-13,7	2,78	0,86	-18,71	1,40		
6000	34,7	-12,7	2,74	0,90	-17,83	1,47		
7000	35,6	-11,0	2,82	0,86	-16,19	1,46		

Frequency	AF R&S HF907	Corr.	cable loss 1 (relay inside chamber)	cable loss 2 (inside chamber)	cable loss 3 (outside chamber)	cable loss 4 (switch unit, atten-uator & pre-amp)	cable loss 5 (to receiver)	used for FCC 15.247
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB	
3000	31,0	-23,4	0,47	1,87	0,53	-27,58	1,33	
4000	33,1	-23,3	0,56	2,41	0,67	-28,23	1,31	
5000	34,4	-21,7	0,61	2,78	0,86	-27,35	1,40	
6000	34,7	-21,2	0,58	2,74	0,90	-26,89	1,47	
7000	35,6	-19,8	0,66	2,82	0,86	-25,58	1,46	

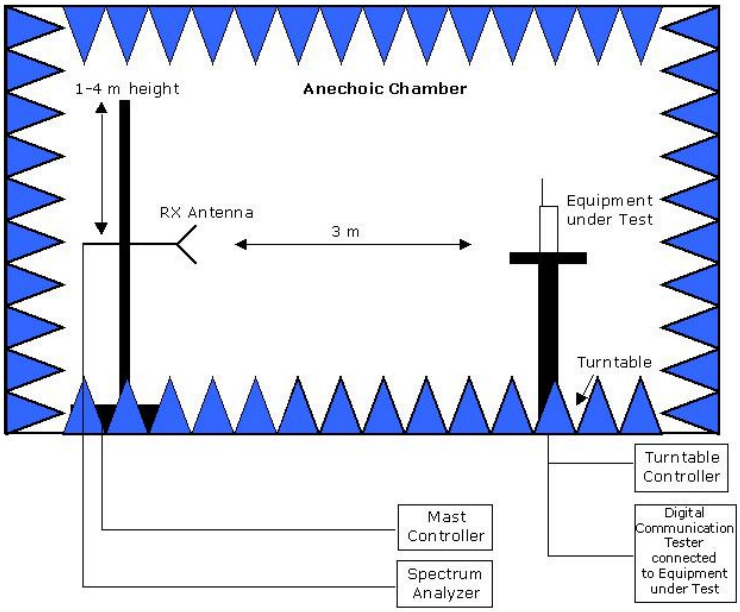
Frequency	AF R&S HF907	Corr.	cable loss 1 (relay inside chamber)	cable loss 2 (High Pass)	cable loss 3 (pre-amp)	cable loss 4 (inside chamber)	cable loss 5 (outside chamber)	cable loss 6 (to receiver)
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB	dB
7000	35,6	-57,3	0,56	1,28	-62,72	2,66	0,94	1,46
8000	36,3	-56,3	0,69	0,71	-61,49	2,84	1,00	1,53
9000	37,1	-55,3	0,68	0,65	-60,80	3,06	1,09	1,60
10000	37,5	-56,2	0,70	0,54	-61,91	3,28	1,20	1,67
11000	37,5	-55,3	0,80	0,61	-61,40	3,43	1,27	1,70
12000	37,6	-53,7	0,84	0,42	-59,70	3,53	1,26	1,73
13000	38,2	-53,5	0,83	0,44	-59,81	3,75	1,32	1,83
14000	39,9	-56,3	0,91	0,53	-63,03	3,91	1,40	1,77
15000	40,9	-54,1	0,98	0,54	-61,05	4,02	1,44	1,83
16000	41,3	-54,1	1,23	0,49	-61,51	4,17	1,51	1,85
17000	42,8	-54,4	1,36	0,76	-62,36	4,34	1,53	2,00
18000	44,2	-54,7	1,70	0,53	-62,88	4,41	1,55	1,91

Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr. (dB)
U = Receiver reading
AF = Antenna factor
Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)
Linear interpolation will be used for frequencies in between the values in the table.
Tables show an extract of values.

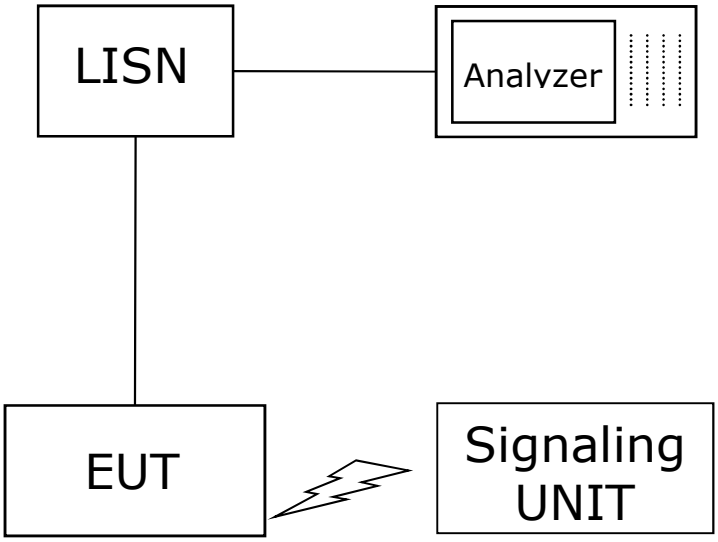
7 SETUP DRAWINGS

Setup Drawings



Remark: Depending on the frequency range suitable antenna types, attenuators or preamplifiers are used.

Setup in the Anechoic chamber. For measurements below 1 GHz the ground was replaced by a conducting ground plane.



Setup in the shielded room for conducted measurements at AC mains port

8 MEASUREMENT UNCERTAINTIES

Test Case	Parameter	Uncertainty
Conducted Emissions at AC mains	Voltage	± 3.4 dB
Radiated Emissions	Field Strength	± 5.5 dB

9 PHOTO REPORT

Please see separate photo report.