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Nemko EMV Testzentrum

FCC TEST REPORT / IC TEST REPORT

APPLICANT

Company:	**Siemens Switzerland Ltd.**
Address:	**Theilerstrasse 1a** **CH – 6300 Zug (Switzerland)**
Witness(es) at tests:	-

EQUIPMENT UNDER TEST (EUT)

Equipment:	**Climatix WLAN Stick**
Model/Type:	**POL903.00/100**
Serial No.:	**0000045**

TEST

Arrival of EUT:	**2019-07-31**
Date of measurement:	**2019-08-07; 2019-08-08; 2019-08-14; 2019-08-19**
Standards:	**47 CFR Part 15, Subpart B** **ICES-003 Issue 6**
limit class:	**class B**
Results:	**Passed - Details see test result summary**
Performed by:	**F. Hupbauer**

LABORATORY

Test site:	**Nemko GmbH & Co. KG, Pfinztal, Germany**
FCC Reg. No.:	**973501**
IC File No.:	**10921A**

TEST REPORT

Identification No.:	**FC-2006-400939**	
Date of Report:	**2020-07-06**	
Provided by:	**F. Hupbauer**	F. Hupbauer
	Person responsible	**Signature**
Approved by:	**Dipl.-Ing. P. Lukas**	P. Lukas
	Person responsible	**Signature**

FCC TRF / Rev 9.1

Index of the test report:

1 General information

1.1 Description of Equipment under test (EUT)

The EuT is an 802.11b/g/n 2.4GHz WiFi USB Stick. The EuT is supplied via USB.

1.2 Internal frequency

Maximum internal frequency (base unit and EuT)	2.4 GHz

1.3 Equipment configuration

Devices often consists of systems with no fixed configuration. The kind, number and installation of different subassemblies within the equipment may vary from system to system. To realistically simulate EMC conditions (related both to emission and immunity), the equipment assembly shall represent a typical installation as specified by the manufacturer. Such tests shall be carried out as type tests under normal conditions as specified by the manufacturer. The equipment was tested in one configuration.

1.3.1 Assembly of EUT

If an EUT has a variety of internal and external configurations, the type tests were made with one or more typical configurations that represent normal use. All types of modules are tested at least once.

Item	Component	Serial number	Description
1	Climatix WLAN Stick	0000045	Standard firmeware

1.3.2 Auxiliary equipment

When a variety of devices is provided for use with the EUT, at least one of each type of device was selected to simulate actual operating conditions. Auxiliary devices may be simulated.

Item	Auxiliary devices	max. length of cable	Description
1	Ethernet / USB Gateway	-	Emtrion ROCKem-IOT1-Base
2	Access Point	-	HEKATRON
3	Ethernet switch	-	NETGEAR FS108
4	Laptop	-	HP EliteBook 8470w

1.3.3 EUT software during test

The software used for simulating the different modes of operation is documented below. This software represents the estimated worst-case operating mode for normal application.

Item	Software version	Description
1	-	Standard firmeware

1.4 Operating status (OS)

OS I) **The EUT is connected to an Ethernet gateway via USB. A wireless access point provides the remote station for a permanent 2.4GHz WiFi transmission.**

Gateway and access point are connected to a laptop via a network switch.

On the PC runs a client´s software for monitoring the EUT and the data transmission.

Supply voltage of the EUT: 5 V DC via USB
Supply voltage of the Gateway: 115V / 60Hz

The operational conditions of the EUT was be determined by the manufacturer according to the typical use of the EUT with respect to the expected highest level of emission.

1.5 Project history

test report (Ident.-No.)	date of report	modification of the EuT	Change in standard in clause:
FC-2006-400939	2020-07-06	delivery status	initial test report

1.6 Labelling information

The EuT had been tested against FCC §15 / ICES-003 class B limits.

U.S. only:

The device under test shall bear the following statement in a conspicuous location on the device:

This device complies with Part 15 of the FCC Rules.
Operation is subject to the following two conditions:

(1) this device may not cause harmful interference, and

(2) this device must accept any interference received, including interference's that may cause undesirable operation.

Canada only:

Each unit of an ITE model shall bear a label which represents the manufacturer's or importer's Self-Declaration of Compliance (SDoC) to Industry Canada ICES-003:

"CAN ICES-3 (*)/NMB-3(*)"
* Insert either "A" or "B" but not both to identify the applicable Class of ITE.

1.7 Test equipment

See list of test equipment in chapter 9.

1.8 definitions limit class

Class A digital device:

A digital device that is marketed for use in a commercial, industrial or business environment, exclusive of a device which is marketed for use by the general public or is intended to be used in the home.

Class B digital device:

A digital device that is marketed for use in a residential environment notwithstanding use in commercial, business and industrial environments. Examples of such devices include, but are not limited to, personal computers, calculators, and similar electronic devices that are marketed for use by the general public.

Information to the user

(a) For a Class A digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

Note:
This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

(b) For a Class B digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

Note:
This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.

- Increase the separation between the equipment and receiver.

- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

- Consult the dealer or an experienced radio/TV technician for help.

1.9 General

The tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with:

47 CFR Part 15, Subpart B

ICES-003 Issue 6

The test methods have been in accordance with 47 CFR Part 15 and RSS where applicable.

☒ Production Unit
☐ Pre-production Unit

THIS TEST REPORT RELATES ONLY TO THE ITEM(S) AND CONFIGURATIONS TESTED.
Deviations from, additions to, or exclusions from the test specifications are described in "Test results".

TEST REPORT NO.: FC-2006-400939

2 Test Report Summary

2.1 Standards

Federal Communications Commission	**47 CFR Part 15, Subpart B**
Interference-Causing Equipment Standard	**ICES-003 Issue 6**
limit class	**class B**

2.2 Results

Environmental phenomena	Port / Test module		Basic standard and test setup	Limit class	Result
Conducted emission	Input and output power ports	EC	see chapter test module EC.	**B**	**Passed.**
Radiated field	Enclosure 30 - 200 MHz	ER low	see chapter test module ER low.	**B**	**Passed.**
Radiated field	Enclosure 200 - 1000 MHz	ER high	see chapter test module ER high.	**B**	**Passed.**
Radiated field	Enclosure 1 - 6 GHz	ER2 low	see chapter test module ER2 low.	**B**	**Passed.**
Radiated field	Enclosure 6 - 18 GHz	ER2 high	see chapter test module ER2 high.	**B**	**Passed.**
Radiated field	Enclosure 18 - 30 GHz	ER3	see chapter test module ER3.	**B**	**Passed.**

For details (e.g. date of standards) see chapter test modules.

3 Measurement of conducted emission

3.1 Standards

Federal Communications Commission	**47 CFR Part 15, Subpart B**
Interference-Causing Equipment Standard	**ICES-003 Issue 6**
limit class	**class B**
Measurement standard	**ANSI C63.4: 2014**
Internal procedure	**QMA-5.4.1-11**
Frequency range	**0.15 - 30 MHz**
Limits FCC	**§15.107; class B**
Limits IC	**ICES-003 clause 6.1; class B**
Test uncertainty U95	**4.06 dB (9 kHz - 150 kHz)** **3.58 dB (150 kHz - 30 MHz)**

3.2 Measurement equipment

	Equipment	Ident. No.	Type	Manufacturer
☒	*Artificial mains network, 1ph*	1-0072	ESH3-Z5	Rohde & Schwarz
☐	*Artificial mains network, 3ph*	1-0037	ESH2-Z5	Rohde & Schwarz
☐	*8-wire ISN CAT3*	1-0850	ISN CAT 3 8158	Schwarzbeck
☒	*Pulse limiter*	1-0054	ESH3-Z2	Rohde & Schwarz
☐	*Passive probe*	1-0092	ESH2-Z3	Rohde & Schwarz
☐	*Pulse limiter*	1-0101	ESH3-Z2	Rohde & Schwarz
☐	*Measuring receiver*	1-0069	ESHS 10	Rohde & Schwarz
☒	*Measuring receiver*	1-0604	ESU8	Rohde & Schwarz
☐	*EMI-Software ES-K1*	1-0071	ES-K1	Rohde & Schwarz
☒	*EMI-Software RadiMation*	1-0624	RM 2018.2.8	DARE
☐	*Current clamp*	1-0353	EZ-17	Rohde & Schwarz
☐	*M2 - CDN*	1-0094	FCC-801-M2-16	FCC
☐	*M3 - CDN*	1-0083	FCC-801-M3-16	FCC
☐	*M5 - CDN*	1-0374	L-801 M5	Lüthi
☐	*conical test adaptor*	1-0765	Konus EN 55015	Erika Fiedler
☒	*Antenna cable 2*	1-0364	RF 214-N/7	Kabelwerk Eupen
☒	*Coaxial cable (to SAC)*	1-0365	Aircom plus	SSB electronic
☒	*Semi anechoic chamber*	1-0361	-	R&M München

3.3 Test set-up

The test set-up was realized in a shielded chamber according to the above-mentioned standard.

The test has been performed as following:

1) Preview test: Peak- and Average-Detector; measuring time 100 ms; frequency step 2,5 kHz; all lines; protection earth grounded.

2) Find frequencies with maximum emission:

   ⇒ Acceptance-analysis: Limit minus 10 dB

   ⇒ Peak-reduction: 20 Peaks in frequency range 150 kHz - 30 MHz

3) Final test; Quasi-Peak and Average-Detector; measuring time 1 s; at the critical frequencies.

3.4 Test methods and limits

The test was performed according to ANSI C63.4-2014 inside a shielded room where the floor and one of the walls of the test site comprised the reference ground plane (RGP). The test was performed at the AC input of the supplied AC/DC converter. For the duration of the test EUT and external supply were placed on a non-conductive support 0.8 m high 0.4 m apart from the vertical RGP (see fig. 3). The excess lengths of the cables of the EUT were made into bundles 30 - 40 cm in length. The power input cable of the external supply was connected to an artificial mains network. The test was performed separately on each phase and on the neutral wire also.
The disturbances were first examined by performing a spectrum scan by using a peak detector. The general procedure in the conducted disturbance emission test is that no further measurements are necessary if the disturbance levels measured by using the peak detector are below the limit value defined for the measurement performed by using an average detector. If not, then at the test frequencies concerned the measurement is performed also by using a quasi-peak detector. If the disturbance levels measured by using the quasi-peak detector are below the limit value defined for the measurement performed by using an average detector, then measurements by using the average detector are not necessary.

The frequency and amplitude of the six highest ac power-line conducted emissions relative to the limit, measured over all the current-carrying conductors of the EUT power cords, and the operating frequency or frequency to which the EUT is tuned (if appropriate) are reported, unless such emissions are more than 20 dB below the limit. AC power-line conducted emissions measurements were carried out separately only on each of the phase (“hot”) line(s) and (if used) on the neutral line(s), but not on the ground [protective earth] line(s). If fewer than six emission frequencies are within 20 dB of the limit, the noise level of the measuring instrument at representative frequencies is reported. The specific conductor of the power-line cord for each of the reported emissions is identified in the table below.

3.5 Subpart B - FCC Part 15.107 / ICES-003 class B limit values

Frequency MHz	Quasi-peak dBµV	Average dBµV
0.15 - 0.5	66 to 56 *)	56 to 46 *)
0.5 - 5	56	46
5 - 30	60	50
The lower limit applies at the band edges.		
*Decreases with the logarithm of the frequency.		

3.6 Settings receiver

Ref. Level:	80 dBuVrms	Measure time:	100 ms
Attenuator:	10 dB	Sweep time:	Auto [120 ms]
RBW:	9 kHz	Step freq:	Linear: 0.002250 MHz steps
Preamp:	0 dB		

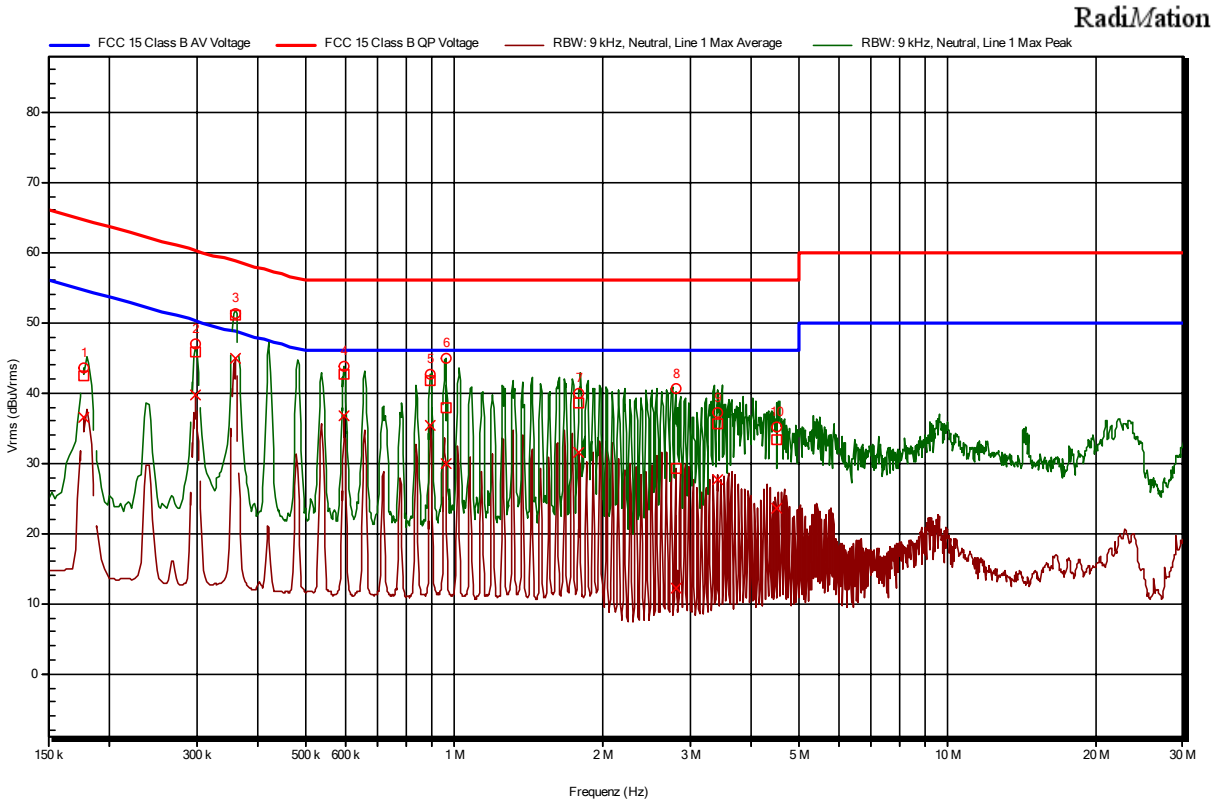
3.7 Test result

Power ports **AC input**

OS	Diagram	Remarks	Result
I)	378129-50EC	Measurement at mains port of the AC/DC Converter of the Gateway Supplied with 115 V / 60 Hz.	**Passed.**

3.8 Diagrams and tables

3.8.1 Diagram 378129-50EC



3.8.2 Table Final Measurements 378129-50EC_fin QP

Peak Number	Frequency	Quasi-Peak	Quasi-Peak Limit	Quasi-Peak Difference	Transducer	LISN
1	0,177000 MHz	42,55 dBuVrms	64,63 dBuVrms	-22,08 dB	9,97 db	Line 1
2	0,298500 MHz	45,94 dBuVrms	60,28 dBuVrms	-14,34 dB	9,98 db	Line 1
3	0,359250 MHz	51,09 dBuVrms	58,75 dBuVrms	-7,65 dB	9,99 db	Line 1
4	0,597750 MHz	42,76 dBuVrms	56,00 dBuVrms	-13,24 dB	10,01 db	Line 1
5	0,897000 MHz	41,75 dBuVrms	56,00 dBuVrms	-14,25 dB	10,03 db	Line 1
6	0,960000 MHz	37,82 dBuVrms	56,00 dBuVrms	-18,18 dB	10,03 db	Line 1
7	1,792500 MHz	38,55 dBuVrms	56,00 dBuVrms	-17,45 dB	10,10 db	Line 1
8	2,825250 MHz	29,23 dBuVrms	56,00 dBuVrms	-26,77 dB	10,16 db	Line 1
9	3,410250 MHz	35,69 dBuVrms	56,00 dBuVrms	-20,31 dB	10,19 db	Line 1
10	4,488000 MHz	33,26 dBuVrms	56,00 dBuVrms	-22,74 dB	10,24 db	Line 1

3.8.3 Table Final Measurements 378129-50EC_fin AV

Peak Number	Frequency	Average	Average Limit	Average Difference	Transducer	LISN
1	0,177000 MHz	36,54 dBuVrms	54,63 dBuVrms	-18,08 dB	9,97 db	Line 1
2	0,298500 MHz	39,75 dBuVrms	50,28 dBuVrms	-10,53 dB	9,98 db	Line 1
3	0,359250 MHz	44,93 dBuVrms	48,75 dBuVrms	-3,81 dB	9,99 db	Line 1
4	0,597750 MHz	36,75 dBuVrms	46,00 dBuVrms	-9,25 dB	10,01 db	Line 1
5	0,897000 MHz	35,42 dBuVrms	46,00 dBuVrms	-10,58 dB	10,03 db	Line 1
6	0,960000 MHz	30,05 dBuVrms	46,00 dBuVrms	-15,95 dB	10,03 db	Line 1
7	1,792500 MHz	31,53 dBuVrms	46,00 dBuVrms	-14,47 dB	10,10 db	Line 1
8	2,825250 MHz	12,25 dBuVrms	46,00 dBuVrms	-33,75 dB	10,16 db	Line 1
9	3,410250 MHz	27,75 dBuVrms	46,00 dBuVrms	-18,25 dB	10,19 db	Line 1
10	4,488000 MHz	23,49 dBuVrms	46,00 dBuVrms	-22,51 dB	10,24 db	Line 1

For calculating the disturbance voltage U and the Margin the following formulas were employed:

$U = U_M + CF$ with: $CF = a_{Cb1} + a_{Cb2} + a_{PL}$

CF Correction factor (All transducers)
U Value in dBµV
U_M Measured value at receiver input in dBµV
a_{CB} Cable loss in dB
a_{PL} Attenuation Pulse limiter in dB

Difference = Result - Limit

Test module ER low (30 - 200 MHz)

4 Measurement of radiated field

4.1 Standards

Federal Communications Commission	**47 CFR Part 15, Subpart B**
Interference-Causing Equipment Standard	**ICES-003 Issue 6**
limit class	**class B**
Measurement standard	**ANSI C63.4: 2014**
Internal procedure	**QMA-5.4.1-12**
Frequency range	**30 - 200 MHz**
Limits FCC	**§15.109; class B**
Limits IC	**ICES-003 clause 6.2; class B**
Test uncertainty U95	**4.17 dB (30 - 200 MHz) horizontal** **4.77 dB (30 - 200 MHz) vertical**

4.2 Measurement equipment

	Equipment	Ident. No.	Type	Manufacturer
☒	Biconical antenna HK116	1-0040	HK116	Rohde & Schwarz
☐	Log.-per. antenna	1-0055	HL223	Rohde & Schwarz
☐	Trilog antenna	1-0200	VULB 9163	Schwarzbeck
☒	Antenna mast	1-0807	MA4000-XPET	Innco
☒	Turntable	1-0080	DS 420	H. Deisel
☒	Controller	1-0806	CO3000	Innco
☐	Antenna cable 1	1-0363	RF 214-N/7	Kabelwerk Eupen
☒	Antenna cable 2	1-0364	RF 214-N/7	Kabelwerk Eupen
☒	Coaxial cable (to FAC)	1-0619	SF 106	Huber & Suhner
☒	Measuring receiver	1-0604	ESU 8	Rohde & Schwarz
☐	Spectrum analyser	1-0611	FSV 40	Rohde & Schwarz
☐	Attenuator	1-0994	BW-N3W5+	mini cricuits
☒	Attenuator	1-0995	UNAT-6+	mini cricuits
☐	Attenuator	1-0870	BW-N10W5+	mini cricuits
☐	Attenuator	1-0871	BW-N10W5+	mini cricuits
☐	EMI-Software ES-K1	1-0071	ES-K1	Rohde & Schwarz
☒	EMI-Software RadiMation	1-0624	RM 2018.2.8	DARE
☒	Semi anechoic chamber	1-0361	-	R&M München

4.3 Test set-up

The test set-up was realized in a semi anechoic chamber according to the above-mentioned standard. The position of the receiving antenna and the EUT in the semi-anechoic chamber is shown in the figure. **ANNEX B**

The test has been performed as following:

1) Preview test; Peak-Detector; measuring time 20 ms; frequency range from 30 MHz to 200 MHz; frequency step 30 kHz; antenna height from 1,00 m up to 4,00 m; horizontal and vertical polarization; antenna-to-EUT azimuth 0 up to 360 degrees in steps of 22.5 degrees.

2) Find frequencies with maximum emission:

   ⇒ Acceptance-analyze: Limit minus 20 dB; Because of the dimensions of the FAR the measurements have been performed at a distance of 3 m.

   ⇒ According to §15.31 of CFR 47 (Code of Federal Regulations Title 47; Volume 1; Chapter I; Subchapter A) measurements at frequencies at or above 30 MHz may be performed at a distance other than what is specified provided: measurements are not made in the near field except where it can be shown that near field measurements are appropriate due to the characteristics of the device; and it can be demonstrated that the signal levels needed to be measured at the distance employed can be detected by the measurement equipment.

   ⇒ While performing measurements at a distance other than that specified, the **limit line** was extrapolated to the specified distance using an extrapolation factor of 20 dB/decade (inverse linear-distance for field strength measurements; inverse-linear-distance-squared for power density measurements). An inverse proportionality of 20 dB per decade was used to normalize the limit line to the specified distance for determine compliance.

   ⇒ Peak-reduction of highest peaks in frequency range 31,680 MHz - 31,680 MHz

3) Final test; Quasi-Detector; measuring time 1 s; at frequencies from step 2); Search maximum: vary antenna height and azimuth (rotate turntable) to find the maximum field strength readings.

4) Manual test of selected frequencies which meet the criterion 2).

4.4 Test method and limits

The test was performed in a test chamber according to ANSI C63.4-2014. The EUT was placed on a non-conductive 0.8 m high support standing on the turntable (see fig. 1, 2).
In order to find the maximum levels of the disturbance radiation the angle of the turntable, the height of the measuring antenna and the lay-out of the EUT cables were varied during the tests. The test was performed separately with the measuring antenna being both in horizontal and vertical polarizations.

For ITE unintentional radiators, the frequency and amplitude of the six highest radiated emissions relative to the limit and independent of antenna polarization are reported in the table below, unless such emissions are more than 20 dB below the limit.

For unintentional radiators other than ITE, for each of the frequencies to which the device is tuned, the frequency and amplitude of the six highest radiated emissions relative to the limit and the operating frequency, or frequency to which the EUT is tuned (if appropriate), are reported in the table below unless such emissions are more than 20 dB below the limit.

4.5 Subpart B - FCC Part 15.109 / ICES-003 class B limit values

Frequency MHz	Quasi-peak µV/m	Quasi-peak dB(µV/m) @3 m	Average dB(µV/m) @3 m
30 - 88	100 @3 m	40.00 @3 m	-
88 - 216	150 @3 m	43.52 @3 m	-
216 - 960	200 @3 m	46.02 @3 m	-
960 - 1000	500 @3 m	53.98 @3 m	-
In the emission tables above, the tighter limit applies at the band edges.			

4.6 Settings receiver

Ref. Level:	80 dBuVrms	VBW:	Auto [120 kHz]
Attenuator:	10 dB	Sweep time:	Auto [120 ms]
RBW:	120 kHz	Step freq:	Linear: 30,000 kHz steps
Preamp:	10 dB	Measure time:	20 ms
Antenna distance:	3 m	Antenna tower:	1,00 m - 4,00 m

Of those disturbances above (L -20 dB), where L is the limit level in logarithmic units, at least the disturbance levels and the frequencies of the 6 highest disturbances is recorded. The antenna polarization for each reported disturbance is recorded.

4.7 Internal generated or used frequency for intentional radiators

The highest internal source of an EUT is defined as the highest frequency generated or used within the EUT or on which the EUT operates or tunes.

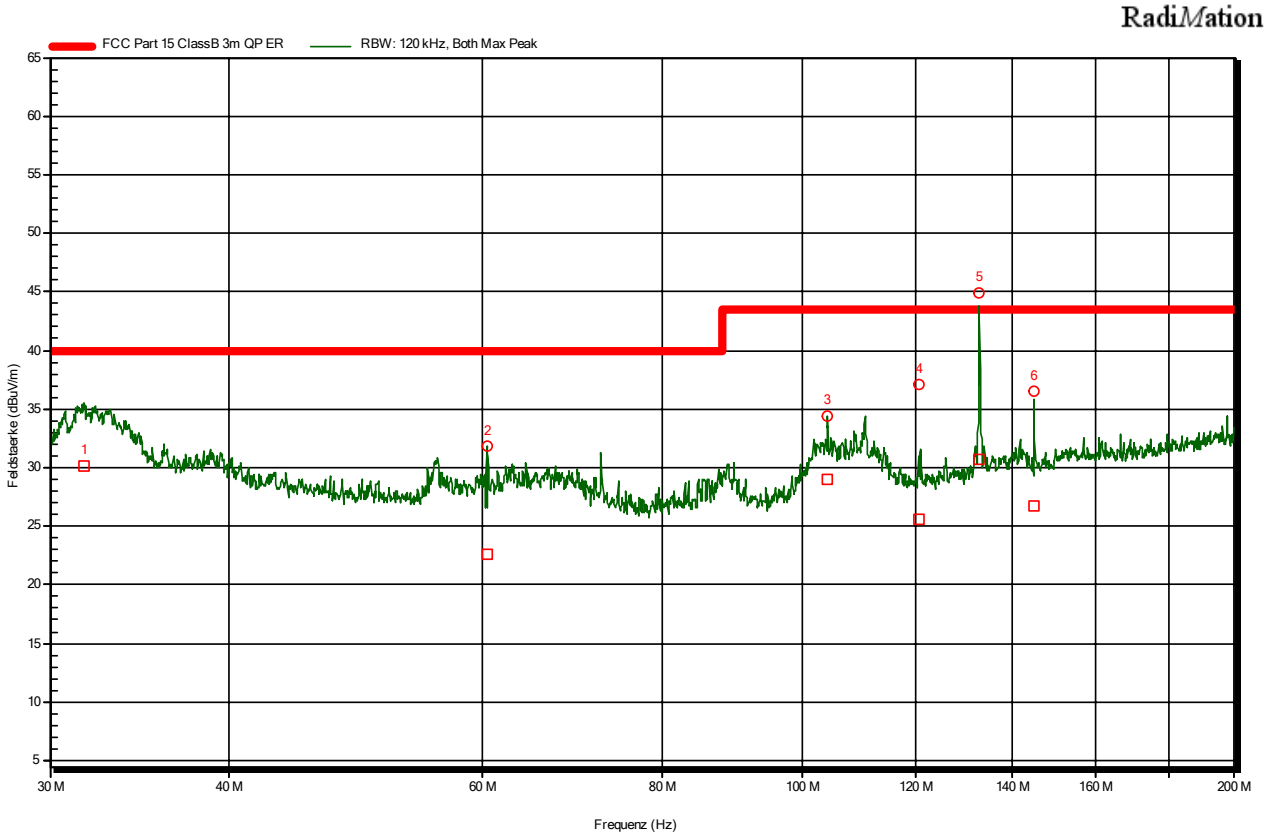
	Highest frequency generated or used in the device or on which the device operates or tunes (MHz)	Upper frequency of measurement range
☒	**9 kHz - 10 GHz**	The measurement is made up to 10 times the highest frequency or 40 GHz, whichever is less.
☐	**10 - 30 GHz**	The measurement is made up to 5 times the highest frequency or 100 GHz, whichever is less.
☐	**30 - 95 GHz**	The measurement is made up to 5 times the highest frequency or 200 GHz, whichever is less.
☐	**> 95 GHz**	The measurement is made up to 3 times the highest frequency or 750 GHz, whichever is less.

4.8 Test result

OS	Diagram	Remarks	Result
I)	378129-30ER	-	**Passed.**

4.9 Diagrams and tables

4.9.1 Diagram 378129-30ER



4.9.2 Table Final measurements 378129-30ER QP

Frequency	Quasi-Peak	Quasi-Peak Limit	Quasi-Peak Difference	Angle	Height	Polarization
31,680 MHz	30,17 dBuV/m	40,00 dBuV/m	-9,83 dB	134,0 Grad	1,00 m	Vertical
60,390 MHz	22,60 dBuV/m	40,00 dBuV/m	-17,40 dB	22,0 Grad	2,50 m	Vertical
104,160 MHz	28,96 dBuV/m	43,50 dBuV/m	-14,54 dB	22,0 Grad	1,00 m	Vertical
120,780 MHz	25,53 dBuV/m	43,50 dBuV/m	-17,97 dB	270,0 Grad	2,50 m	Horizontal
132,840 MHz	30,76 dBuV/m	43,50 dBuV/m	-12,74 dB	112,0 Grad	2,50 m	Horizontal
144,930 MHz	26,66 dBuV/m	43,50 dBuV/m	-16,84 dB	247,0 Grad	4,00 m	Horizontal

For calculating the disturbance voltage U and the Margin the following formulas were employed:

$U = U_M + CF$ with: $CF = a_{Cb1} + a_{Cb2} + a_{An}$

CF	Correction factor (All transducers)
U	Value in dBµV/m
U_M	Measured value at receiver input in dBµV/m
a_{CB}	Cable loss in dB
a_{An}	Antenna correction factor in dB

Difference = Result - Limit

5 Measurement of radiated field

5.1 Standards

Federal Communications Commission	**47 CFR Part 15, Subpart B**
Interference-Causing Equipment Standard	**ICES-003 Issue 6**
limit class	**class B**
Measurement standard	**ANSI C63.4: 2014**
Internal procedure	**QMA-5.4.1-12**
Frequency range	**200 - 1000 MHz**
Limits FCC	**§15.109; class B**
Limits IC	**ICES-003 clause 6.2; class B**
Test uncertainty U95	**4.54 dB (200 - 1000 MHz) horizontal** **5.02 dB (200 - 1000 MHz) vertical**

5.2 Measurement equipment

	Equipment	Ident. No.	Type	Manufacturer
☐	Biconical antenna HK116	1-0040	HK116	Rohde & Schwarz
☒	Log.-per. antenna	1-0055	HL223	Rohde & Schwarz
☐	Trilog antenna	1-0200	VULB 9163	Schwarzbeck
☒	Antenna mast	1-0807	MA4000-XPET	Innco
☒	Turntable	1-0080	DS 420	H. Deisel
☒	Controller	1-0806	CO3000	Innco
☒	Antenna cable 2	1-0364	RF 214-N/7	Kabelwerk Eupen
☒	Coaxial cable (to FAC)	1-0619	SF 106	Huber & Suhner
☒	Measuring receiver	1-0604	ESU 8	Rohde & Schwarz
☐	Spectrum analyser	1-0611	FSV 40	Rohde & Schwarz
☐	Attenuator	1-0994	BW-N3W5+	mini cricuits
☐	Attenuator	1-0995	UNAT-6+	mini cricuits
☐	Attenuator	1-0870	BW-N10W5+	mini cricuits
☐	Attenuator	1-0871	BW-N10W5+	mini cricuits
☒	EMI-Software RadiMation	1-0624	RM 2018.2.8	DARE
☒	Semi anechoic chamber	1-0361	-	R&M München

5.3 Test set-up

The test set-up was realized in a semi anechoic chamber according to the above-mentioned standard. The position of the receiving antenna and the EUT in the semi-anechoic chamber is shown in the figure. **ANNEX B**

The test has been performed as following:

1) Preview test; Peak-Detector; measuring time 10 ms; frequency range from 200 MHz to 1000 MHz, frequency 30 kHz; antenna height from 1,00 m up to 4,00 m; horizontal and vertical polarization; antenna-to-EUT azimuth 0 up to 360 degrees in steps of 22.5 degrees.

2) Find frequencies with maximum emission:

   ⇒ Acceptance-analyze: Limit minus 20 dB; Because of the dimensions of the FAR the measurements have been performed at a distance of 3 m.

   ⇒ According to §15.31 of CFR 47 (Code of Federal Regulations Title 47; Volume 1; Chapter I; Subchapter A) measurements at frequencies at or above 30 MHz may be performed at a distance other than what is specified provided: measurements are not made in the near field except where it can be shown that near field measurements are appropriate due to the characteristics of the device; and it can be demonstrated that the signal levels needed to be measured at the distance employed can be detected by the measurement equipment.

   ⇒ While performing measurements at a distance other than that specified, the **limit line** was extrapolated to the specified distance using an extrapolation factor of 20 dB/decade (inverse linear-distance for field strength measurements; inverse-linear-distance-squared for power density measurements). An inverse proportionality of 20 dB per decade was used to normalize the limit line to the specified distance for determine compliance.

   ⇒ Peak-reduction of highest peaks in frequency range 200,000 MHz - 1,000 GHz

3) Final test; Quasi-Detector; measuring time 1 s; at frequencies from step 2); Search maximum: vary antenna height and azimuth (rotate turntable) to find the maximum field strength readings.

4) Manual test of selected frequencies which meet the criterion 2).

5.4 Test method and limits

The test was performed in a test chamber according to ANSI C63.4-2014. The EUT was placed on a non-conductive 0.8 m high support standing on the turntable (see fig. 1, 2).
In order to find the maximum levels of the disturbance radiation the angle of the turntable, the height of the measuring antenna and the lay-out of the EUT cables were varied during the tests. The test was performed separately with the measuring antenna being both in horizontal and vertical polarizations.

For ITE unintentional radiators, the frequency and amplitude of the six highest radiated emissions relative to the limit and independent of antenna polarization are reported in the table below, unless such emissions are more than 20 dB below the limit.

For unintentional radiators other than ITE, for each of the frequencies to which the device is tuned, the frequency and amplitude of the six highest radiated emissions relative to the limit and the operating frequency, or frequency to which the EUT is tuned (if appropriate), are reported in the table below unless such emissions are more than 20 dB below the limit.

5.5 Subpart B - FCC Part 15.109 / ICES-003 class B limit values

Frequency MHz	Quasi-peak µV/m	Quasi-peak dB(µV/m) @3 m	Average dB(µV/m) @3 m
30 - 88	100 @3 m	40.00 @3 m	-
88 - 216	150 @3 m	43.52 @3 m	-
216 - 960	200 @3 m	46.02 @3 m	-
960 - 1000	500 @3 m	53.98 @3 m	-
In the emission tables above, the tighter limit applies at the band edges.			

5.6 Internal generated or used frequency for intentional radiators

The highest internal source of an EUT is defined as the highest frequency generated or used within the EUT or on which the EUT operates or tunes.

	Highest frequency generated or used in the device or on which the device operates or tunes (MHz)	Upper frequency of measurement range
☒	**9 kHz - 10 GHz**	The measurement is made up to 10 times the highest frequency or 40 GHz, whichever is less.
☐	**10 - 30 GHz**	The measurement is made up to 5 times the highest frequency or 100 GHz, whichever is less.
☐	**30 - 95 GHz**	The measurement is made up to 5 times the highest frequency or 200 GHz, whichever is less.
☐	**> 95 GHz**	The measurement is made up to 3 times the highest frequency or 750 GHz, whichever is less.

5.7 Settings receiver

Ref. Level:	80 dBuVrms	VBW:	Auto [120 kHz]
Attenuator:	10 dB	Sweep time:	Auto [120 ms]
RBW:	120 kHz	Step freq:	Linear: 30,000 kHz steps
Preamp:	10 dB	Measure time:	10 ms
Antenna distance:	3 m	Antenna tower:	1,00 m - 4,00 m

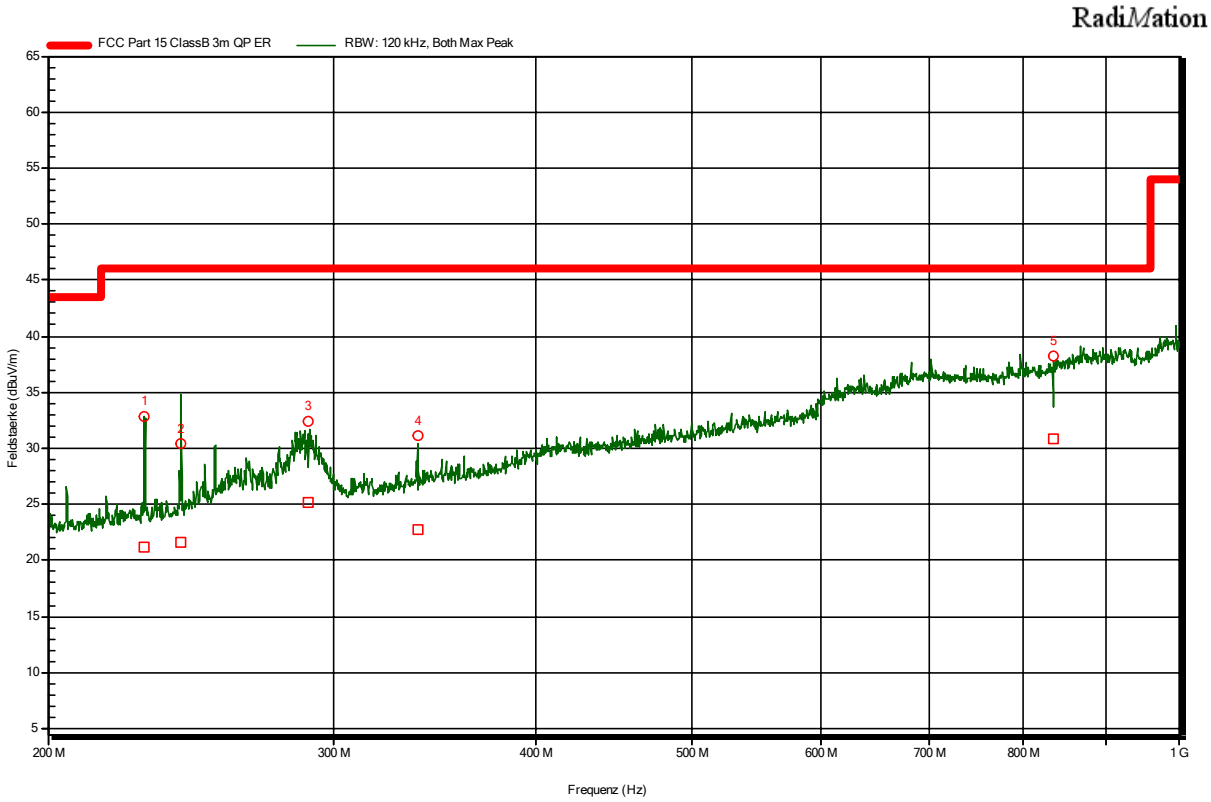
Of those disturbances above (L -20 dB), where L is the limit level in logarithmic units, at least the disturbance levels and the frequencies of the 5 highest disturbances is recorded. The antenna polarization for each reported disturbance is recorded.

5.8 Test result

OS	Diagram	Remarks	Result
I)	378129-31ER	-	**Passed.**

5.9 Diagrams and tables

5.9.1 Diagram 378129-31ER



5.9.2 Table Final measurements 378129-31ER QP

Frequency	Quasi-Peak	Quasi-Peak Limit	Quasi-Peak Difference	Angle	Height	Polarization
229,490 MHz	21,20 dBuV/m	46,00 dBuV/m	-24,80 dB	157,0 Grad	2,50 m	Vertical
241,520 MHz	21,59 dBuV/m	46,00 dBuV/m	-24,41 dB	89,0 Grad	2,50 m	Horizontal
289,790 MHz	25,21 dBuV/m	46,00 dBuV/m	-20,79 dB	90,0 Grad	1,00 m	Horizontal
338,180 MHz	22,78 dBuV/m	46,00 dBuV/m	-23,22 dB	157,0 Grad	1,00 m	Horizontal
834,470 MHz	30,81 dBuV/m	46,00 dBuV/m	-15,19 dB	0,0 Grad	2,50 m	Vertical

For calculating the disturbance voltage U and the Margin the following formulas were employed:

$U = U_M + CF$ with: $CF = a_{Cb1} + a_{Cb2} + a_{An}$

CF	Correction factor (All transducers)
U	Value in dBµV/m
U_M	Measured value at receiver input in dBµV/m
a_{CB}	Cable loss in dB
a_{An}	Antenna correction factor in dB

Difference = Result - Limit

Test module ER2 low (1 - 6 GHz)

6 Measurement of radiated field

6.1 Standards

Federal Communications Commission	**47 CFR Part 15, Subpart B**
Interference-Causing Equipment Standard	**ICES-003 Issue 6**
limit class	**class B**
Measurement standard	**ANSI C63.4: 2014**
Internal procedure	**QMA-5.4.1-40**
Frequency range	**1000 - 6000 MHz**
Limits FCC	**§15.109; class B**
Limits IC	**ICES-003 clause 6.2; class B**
Test uncertainty U95	**7.03 dB (1 - 6 GHz)**

6.2 Measurement equipment

	Equipment	Ident. No.	Type	Manufacturer
☐	Log.-per. antenna	1-0614	STLP9148	Schwarzbeck
☒	Horn antenna	1-0772	BBHA 9120D	Schwarzbeck
☐	Trilog antenna	1-0200	VULB 9163	Schwarzbeck
☒	Antenna mast	1-0807	MA4000-XPET	Innco
☐	Coaxial cable	1-1037	AK 9515H	Schwarzbeck
☒	Pre amplifier	1-0615	BBV 9718	Schwarzbeck
☒	Coaxial cable	1-0620	SF 106	Huber & Suhner
☒	Coaxial cable (to FAC)	1-0619	SF 106	Huber & Suhner
☒	Measuring receiver	1-0604	ESU 8	Rohde & Schwarz
☐	Spectrum analyser	1-0611	FSV 40	Rohde & Schwarz
☒	EMI-Software RadiMation	1-0624	RM 2018.2.8	DARE
☒	Turntable	1-0080	DS 420	H. Deisel
☒	Controller	1-0806	CO3000	Innco
☒	Semi anechoic chamber	1-0361	-	R&M München

6.3 Test set-up

The test set-up was realized in a semi anechoic chamber according to the above-mentioned standard. The position of the receiving antenna and the EUT in the semi-anechoic chamber is shown in the figure. **Annex B**

The test has been performed as following:

1) Preview test; Peak-Detector; measuring time 10 ms; frequency range from 1000 MHz to 6,000 GHz; frequency step 250 kHz; antenna height from 1,00 m up to 1,00 m; horizontal and vertical polarization; antenna-to-EUT azimuth 0 up to 360 degrees in steps of 15 degrees.

2) Find frequencies with maximum emission:

   ⇒ Acceptance-analyze: Limit minus 20 dB; Because of the dimensions of the FAR the measurements have been performed at a distance of 3,00 m.

   ⇒ According to §15.31 of CFR 47 (Code of Federal Regulations Title 47; Volume 1; Chapter I; Subchapter A) measurements at frequencies at or above 30 MHz may be performed at a distance other than what is specified provided: measurements are not made in the near field except where it can be shown that near field measurements are appropriate due to the characteristics of the device; and it can be demonstrated that the signal levels needed to be measured at the distance employed can be detected by the measurement equipment.

   ⇒ While performing measurements at a distance other than that specified, the **limit line** was extrapolated to the specified distance using an extrapolation factor of 20 dB/decade (inverse linear-distance for field strength measurements; inverse-linear-distance-squared for power density measurements). An inverse proportionality of 20 dB per decade was used to normalize the limit line to the specified distance for determine compliance.

   ⇒ Peak-reduction: 0 Peaks frequency range 1,000 GHz - 6,000 GHz

3) Final test; Peak- und Average-Detector; measuring time 1 s; at frequencies from step 2); Search maximum: vary antenna height and azimuth (rotate turntable) to find the maximum field strength readings.

4) If there are more than 10 peaks within the 10 dB margin a manual test with all settings is necessary to find the maximum field strength readings.

6.4 Test method and limits

The test was performed in a test chamber according to ANSI C63.4-2014. The EUT was placed on a non-conductive 0.8 m high support standing on the turntable (see fig. 1, 2).
In order to find the maximum levels of the disturbance radiation the angle of the turntable, the height of the measuring antenna and the lay-out of the EUT cables were varied during the tests. The test was performed separately with the measuring antenna being both in horizontal and vertical polarizations.

For ITE unintentional radiators, the frequency and amplitude of the six highest radiated emissions relative to the limit and independent of antenna polarization are reported in the table below, unless such emissions are more than 20 dB below the limit.

For unintentional radiators other than ITE, for each of the frequencies to which the device is tuned, the frequency and amplitude of the six highest radiated emissions relative to the limit and the operating frequency, or frequency to which the EUT is tuned (if appropriate), are reported in the table below unless such emissions are more than 20 dB below the limit.

6.5 Subpart B - FCC Part 15.109 / ICES-003 class B limit values

Frequency MHz	Peak µV/m	Peak dB(µV/m) @3 m	Average dB(µV/m) @3 m
1000 - 18000	-	73.98 @3 m	53.98 @3 m

6.6 Settings receiver

Ref. Level:	80 dBuVrms	VBW:	1 MHz
Attenuator:	Auto [50,00 dB]	Sweep time:	30 s
RBW:	1 MHz	Step freq:	Linear: 250,000 kHz steps
Preamp:	0,00 dB	Measure time:	10 ms
Antenna distance:	3,00 m	Antenna tower:	1,00 m - 1,00 m

Of those disturbances above (L -20 dB), where L is the limit level in logarithmic units, at least the disturbance levels and the frequencies of the 7 highest disturbances is recorded. The antenna polarization for each reported disturbance is recorded.

6.7 Internal generated or used frequency for <u>intentional</u> radiators

The highest internal source of an EUT is defined as the highest frequency generated or used within the EUT or on which the EUT operates or tunes.

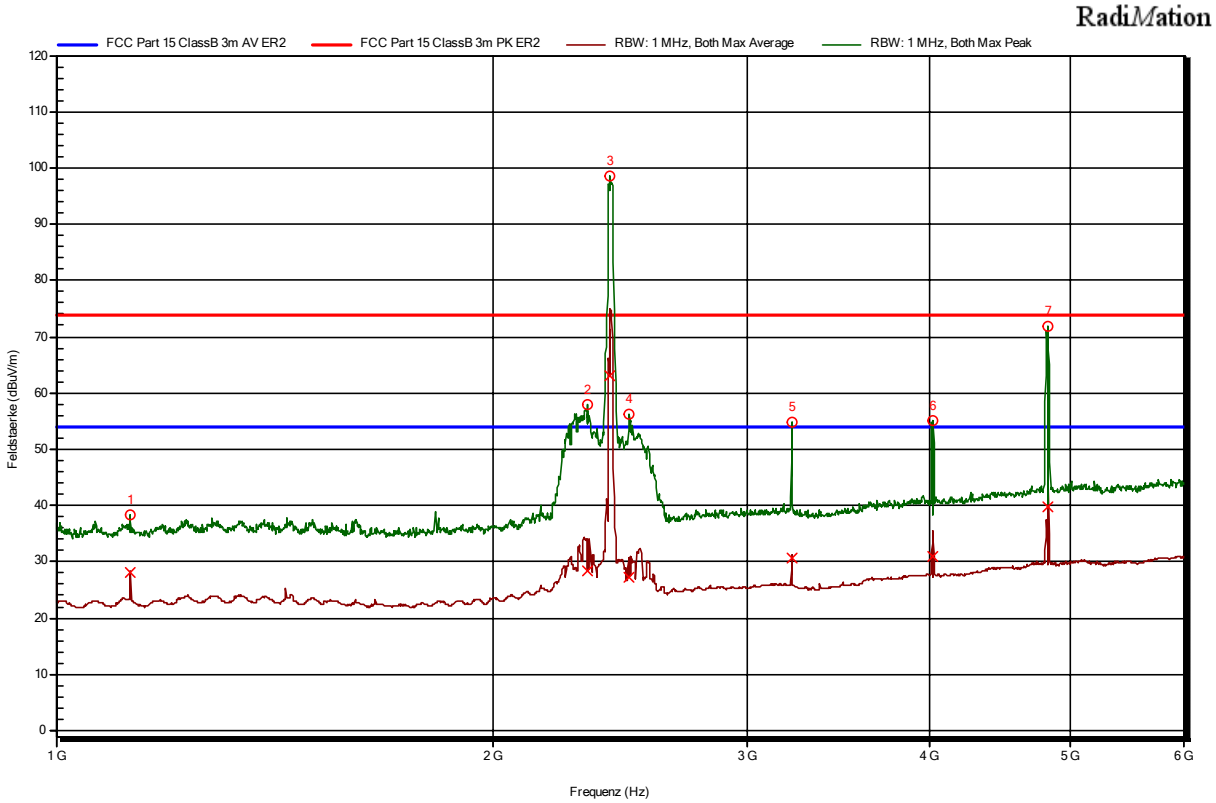
	Highest frequency generated or used in the device or on which the device operates or tunes (MHz)	Upper frequency of measurement range
☒	**9 kHz - 10 GHz**	The measurement is made up to 10 times the highest frequency or 40 GHz, whichever is less.
☐	**10 - 30 GHz**	The measurement is made up to 5 times the highest frequency or 100 GHz, whichever is less.
☐	**30 - 95 GHz**	The measurement is made up to 5 times the highest frequency or 200 GHz, whichever is less.
☐	**> 95 GHz**	The measurement is made up to 3 times the highest frequency or 750 GHz, whichever is less.

6.8 Test result

OM	Diagram	Remarks	Result
I)	378129-41ER2	-	**Passed.**

6.9 Diagrams and tables

6.9.1 Diagram 378129-41ER2



6.9.2 Table Final measurements 378129-41ER2 PK

Frequency	Peak	Peak Limit	Peak Difference	Angle	Height	Polarization
1,125 GHz	38,40 dBuV/m	73,98 dBuV/m	-35,58 dB	135,0 Grad	1,00 m	Horizontal
2,328 GHz	57,86 dBuV/m	73,98 dBuV/m	-16,12 dB	247,0 Grad	1,00 m	Horizontal
2,408 GHz *)	98,46 dBuV/m	-	-	247,0 Grad	1,00 m	Horizontal
2,487 GHz	56,10 dBuV/m	73,98 dBuV/m	-17,88 dB	270,0 Grad	1,00 m	Horizontal
3,216 GHz	54,83 dBuV/m	73,98 dBuV/m	-19,15 dB	157,0 Grad	1,00 m	Horizontal
4,024 GHz	55,19 dBuV/m	73,98 dBuV/m	-18,79 dB	135,0 Grad	1,00 m	Horizontal
4,824 GHz	71,82 dBuV/m	73,98 dBuV/m	-2,16 dB	270,0 Grad	1,00 m	Horizontal

*) Fundamental frequency

6.9.3 Table Final measurements 378129-41ER2 AV

Frequency	Average	Average Limit	Average Difference	Angle	Height	Polarization
1,125 GHz	28,00 dBuV/m	53,98 dBuV/m	-25,98 dB	135,0 Grad	1,00 m	Horizontal
2,328 GHz	28,48 dBuV/m	53,98 dBuV/m	-25,50 dB	247,0 Grad	1,00 m	Horizontal
2,408 GHz *)	62,97 dBuV/m	-	-	247,0 Grad	1,00 m	Horizontal
2,487 GHz	27,28 dBuV/m	53,98 dBuV/m	-26,70 dB	270,0 Grad	1,00 m	Horizontal
3,216 GHz	30,67 dBuV/m	53,98 dBuV/m	-23,31 dB	157,0 Grad	1,00 m	Horizontal
4,024 GHz	30,88 dBuV/m	53,98 dBuV/m	-23,10 dB	135,0 Grad	1,00 m	Horizontal
4,824 GHz	39,77 dBuV/m	53,98 dBuV/m	-14,21 dB	270,0 Grad	1,00 m	Horizontal

*) Fundamental frequency

For calculating the disturbance voltage U and the Margin the following formulas were employed:

$U = U_M + CF$ with: $CF = a_{Cb1} + a_{Cb2} + a_{An} - a_{PA}$

CF	Correction factor (All transducers)
U	Value in dBµV/m
U_M	Measured value at receiver input in dBµV/m
a_{CB}	Cable loss in dB
a_{An}	Antenna correction factor in dB
a_{PA}	Preamplifier gain in dB

Difference = Result - Limit

Test module ER2 high (6 - 18 GHz)

7 Measurement of radiated field

7.1 Standards

Federal Communications Commission	**47 CFR Part 15, Subpart B**
Interference-Causing Equipment Standard	**ICES-003 Issue 6**
limit class	**class B**
Measurement standard	**ANSI C63.4: 2014**
Internal procedure	**QMA-5.4.1-40**
Frequency range	**6000 - 18000 MHz**
Limits FCC	**§15.109; class B**
Limits IC	**ICES-003 clause 6.2; class B**
Test uncertainty U95	**16.46 dB (6 - 18 GHz)**

7.2 Measurement equipment

	Equipment	Ident. No.	Type	Manufacturer
☐	Log.-per. antenna	1-0614	STLP9148	Schwarzbeck
☒	Horn antenna	1-0772	BBHA 9120D	Schwarzbeck
☐	Trilog antenna	1-0200	VULB 9163	Schwarzbeck
☒	Antenna mast	1-0807	MA4000-XPET	Innco
☐	Coaxial cable	1-1037	AK 9515H	Schwarzbeck
☒	Pre amplifier	1-0615	BBV 9718	Schwarzbeck
☒	Coaxial cable	1-0620	SF 106	Huber & Suhner
☒	Coaxial cable (to FAC)	1-0619	SF 106	Huber & Suhner
☒	Measuring receiver	1-0604	ESU 8	Rohde & Schwarz
☐	Spectrum analyser	1-0611	FSV 40	Rohde & Schwarz
☒	EMI-Software RadiMation	1-0624	RM 2018.2.8	DARE
☒	Turntable	1-0080	DS 420	H. Deisel
☒	Controller	1-0806	CO3000	Innco
☒	Semi anechoic chamber	1-0361	-	R&M München

7.3 Test set-up

The test set-up was realized in a semi anechoic chamber according to the above-mentioned standard. The position of the receiving antenna and the EUT in the semi-anechoic chamber is shown in the figure. **Annex B**

The test has been performed as following:

1) Preview test; Peak-Detector; measuring time 1 ms; frequency range from 1000 MHz to 7,439 GHz; frequency step 250 kHz; antenna height from 1 m up to 1 m; horizontal and vertical polarization; antenna-to-EUT azimuth 0 up to 360 degrees in steps of 15 degrees.

2) Find frequencies with maximum emission:

   ⇒ Acceptance-analyze: Limit minus 20 dB; Because of the dimensions of the FAR the measurements have been performed at a distance of 3 m.

   ⇒ According to §15.31 of CFR 47 (Code of Federal Regulations Title 47; Volume 1; Chapter I; Subchapter A) measurements at frequencies at or above 30 MHz may be performed at a distance other than what is specified provided: measurements are not made in the near field except where it can be shown that near field measurements are appropriate due to the characteristics of the device; and it can be demonstrated that the signal levels needed to be measured at the distance employed can be detected by the measurement equipment.

   ⇒ While performing measurements at a distance other than that specified, the **limit line** was extrapolated to the specified distance using an extrapolation factor of 20 dB/decade (inverse linear-distance for field strength measurements; inverse-linear-distance-squared for power density measurements). An inverse proportionality of 20 dB per decade was used to normalize the limit line to the specified distance for determine compliance.

   ⇒ Peak-reduction: 0 Peaks frequency range 7,031 GHz - 7,439 GHz

3) Final test; Peak- und Average-Detector; measuring time 1 s; at frequencies from step 2); Search maximum: vary antenna height and azimuth (rotate turntable) to find the maximum field strength readings.

4) If there are more than 10 peaks within the 10 dB margin a manual test with all settings is necessary to find the maximum field strength readings.

7.4 Test method and limits

The test was performed in a test chamber according to ANSI C63.4-2014. The EUT was placed on a non-conductive 0.8 m high support standing on the turntable (see fig. 1, 2).
In order to find the maximum levels of the disturbance radiation the angle of the turntable, the height of the measuring antenna and the lay-out of the EUT cables were varied during the tests. The test was performed separately with the measuring antenna being both in horizontal and vertical polarizations.

For ITE unintentional radiators, the frequency and amplitude of the six highest radiated emissions relative to the limit and independent of antenna polarization are reported in the table below, unless such emissions are more than 20 dB below the limit.

For unintentional radiators other than ITE, for each of the frequencies to which the device is tuned, the frequency and amplitude of the six highest radiated emissions relative to the limit and the operating frequency, or frequency to which the EUT is tuned (if appropriate), are reported in the table below unless such emissions are more than 20 dB below the limit.

7.5 Subpart B - FCC Part 15.109 / ICES-003 class B limit values

Frequency MHz	Peak µV/m	Peak dB(µV/m) @3 m	Average dB(µV/m) @3 m
1000 - 18000	-	73.98 @3 m	53.98 @3 m

7.6 Settings receiver

Ref. Level:	80 dBuVrms	VBW:	1 MHz
Attenuator:	Auto [0 dB]	Sweep time:	680 ms
RBW:	1 MHz	Step freq:	Fixed step count: 20001 steps per Band
Preamp:	0 dB	Measure time:	1 ms
Antenna distance:	3 m	Antenna tower:	1 m - 1 m

Of those disturbances above (L -20 dB), where L is the limit level in logarithmic units, at least the disturbance levels and the frequencies of the 6 highest disturbances is recorded. The antenna polarization for each reported disturbance is recorded.

7.7 Internal generated or used frequency for <u>intentional</u> radiators

The highest internal source of an EUT is defined as the highest frequency generated or used within the EUT or on which the EUT operates or tunes.

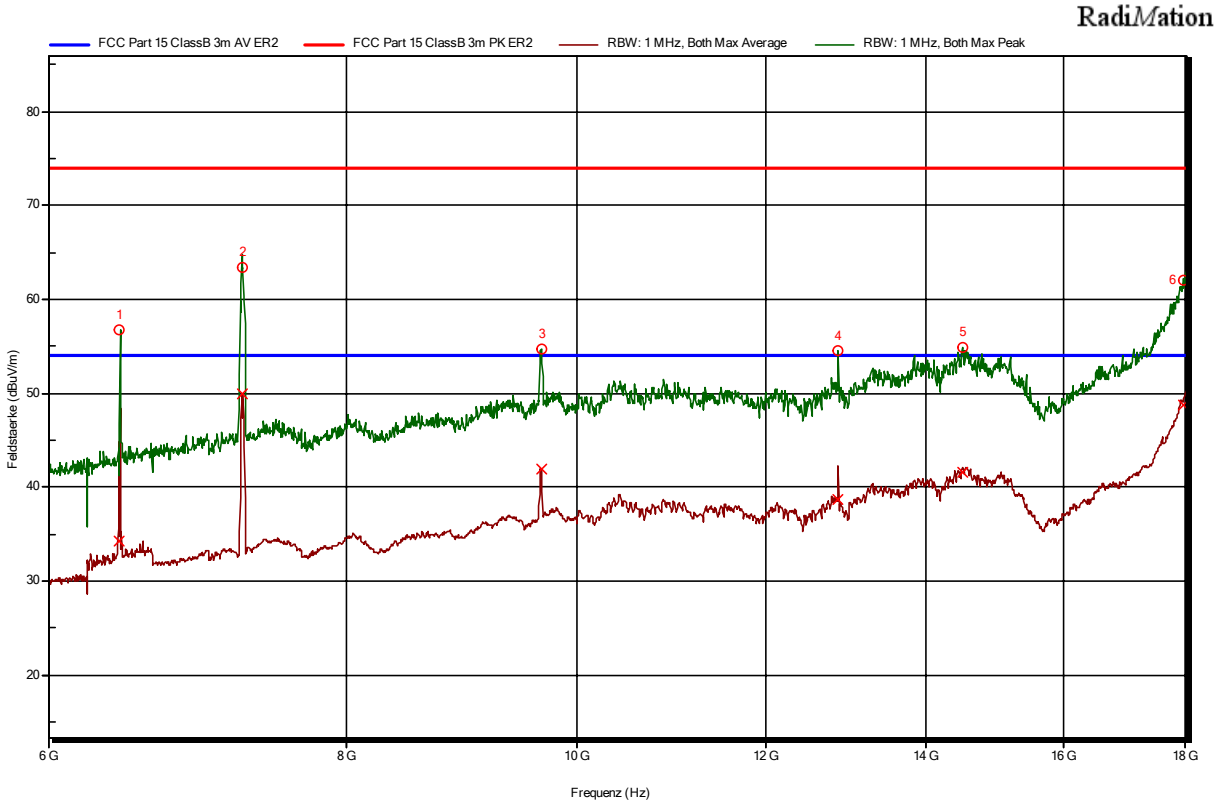
	Highest frequency generated or used in the device or on which the device operates or tunes (MHz)	Upper frequency of measurement range
☒	**9 kHz - 10 GHz**	The measurement is made up to 10 times the highest frequency or 40 GHz, whichever is less.
☐	**10 - 30 GHz**	The measurement is made up to 5 times the highest frequency or 100 GHz, whichever is less.
☐	**30 - 95 GHz**	The measurement is made up to 5 times the highest frequency or 200 GHz, whichever is less.
☐	**> 95 GHz**	The measurement is made up to 3 times the highest frequency or 750 GHz, whichever is less.

7.8 Test result

OM	Diagram	Remarks	Result
I)	378129-46ER2	-	**Passed.**

7.9 Diagrams and tables

7.9.1 Diagram 378129-46ER2



7.9.2 Table Final measurements 378129-46ER2 PK

Frequency	Peak	Peak Limit	Peak Difference	Angle	Height	Polarization
6,431 GHz	56,77 dBuV/m	73,98 dBuV/m	-17,21 dB	67,00 Grad	1 m	Horizontal
7,240 GHz	63,34 dBuV/m	73,98 dBuV/m	-10,64 dB	201,00 Grad	1 m	Vertical
9,658 GHz	54,79 dBuV/m	73,98 dBuV/m	-19,19 dB	201,00 Grad	1 m	Vertical
12,864 GHz	54,53 dBuV/m	73,98 dBuV/m	-19,45 dB	0,00 Grad	1 m	Horizontal
14,506 GHz	54,84 dBuV/m	73,98 dBuV/m	-19,14 dB	202,00 Grad	1 m	Horizontal
17,949 GHz	62,05 dBuV/m	73,98 dBuV/m	-11,93 dB	247,00 Grad	1 m	Horizontal

7.9.3 Table Final measurements 378129-46ER2 AV

Frequency	Average	Average Limit	Average Difference	Angle	Height	Polarization
6,431 GHz	34,33 dBuV/m	53,98 dBuV/m	-19,65 dB	67,00 Grad	1 m	Horizontal
7,240 GHz	50,00 dBuV/m	53,98 dBuV/m	-3,98 dB	201,00 Grad	1 m	Vertical
9,658 GHz	41,96 dBuV/m	53,98 dBuV/m	-12,02 dB	201,00 Grad	1 m	Vertical
12,864 GHz	38,77 dBuV/m	53,98 dBuV/m	-15,21 dB	0,00 Grad	1 m	Horizontal
14,506 GHz	41,65 dBuV/m	53,98 dBuV/m	-12,33 dB	202,00 Grad	1 m	Horizontal
17,949 GHz	48,69 dBuV/m	53,98 dBuV/m	-5,29 dB	247,00 Grad	1 m	Horizontal

For calculating the disturbance voltage U and the Margin the following formulas were employed:

$U = U_M + CF$ with: $CF = a_{Cb1} + a_{Cb2} + a_{An} - a_{PA}$

CF	Correction factor (All transducers)
U	Value in dBµV/m
U_M	Measured value at receiver input in dBµV/m
a_{CB}	Cable loss in dB
a_{An}	Antenna correction factor in dB
a_{PA}	Preamplifier gain in dB

Difference = Result - Limit

Test module ER3 (18 - 30 GHz)

8 Measurement of radiated field

8.1 Standards

Federal Communications Commission	**47 CFR Part 15, Subpart B**
Interference-Causing Equipment Standard	**ICES-003 Issue 6**
limit class	**class B**
Measurement standard	**ANSI C63.4: 2014**
Internal procedure	**QMA-5.4.1-40**
Frequency range	**18 - 40 GHz**
Limits FCC	**§15.109; class B**
Limits IC	**ICES-003 clause 6.2; class B**
Test uncertainty U95	**17.35 dB (18 - 40 GHz)**

8.2 Measurement equipment

	Equipment	Ident. No.	Type	Manufacturer
☒	horn antenna	1-0770	BBHA 9170	Schwarzbeck
☐	horn antenna	1-0771	BBHA 9170	Schwarzbeck
☒	Antenna cable	1-0782	FB142A	Huber & Suhner
☒	Antenna mast	1-0807	MA4000-XPET	Innco
☒	Pre amplifier	1-0781	BBV 9721	Schwarzbeck
☐	Coaxial cable (to FAC)	1-0619	SF 106	Huber & Suhner
☒	Spectrum analyser	1-0611	FSV 40	Rohde & Schwarz
☒	EMI-Software RadiMation	1-0624	RM 2018.2.8	DARE
☒	Turntable	1-0080	DS 420	H. Deisel
☒	Controller	1-0806	CO3000	Innco
☒	Semi anechoic chamber	1-0361	-	R&M München

8.3 Test set-up

The test set-up was realized in a semi anechoic chamber according to the above-mentioned standard. The position of the receiving antenna and the EUT in the semi-anechoic chamber is shown in the figure. **ANNEX B**

The test has been performed as following:

1) Preview test; Peak-Detector; measuring time 1 ms; frequency range from 18000 MHz to 30,000 GHz, frequency step 250 kHz; antenna height from 1 m up to 1 m; horizontal and vertical polarization; antenna-to-EUT azimuth 0 up to 360 degrees in steps of 15 degrees.

2) Find frequencies with maximum emission:

   ⇒ Acceptance-analyze: Limit minus 20 dB; Because of the dimensions of the FAR the measurements have been performed at a distance of 3 m.

   ⇒ According to §15.31 of CFR 47 (Code of Federal Regulations Title 47; Volume 1; Chapter I; Subchapter A) measurements at frequencies at or above 30 MHz may be performed at a distance other than what is specified provided: measurements are not made in the near field except where it can be shown that near field measurements are appropriate due to the characteristics of the device; and it can be demonstrated that the signal levels needed to be measured at the distance employed can be detected by the measurement equipment.

   ⇒ While performing measurements at a distance other than that specified, the **limit line** was extrapolated to the specified distance using an extrapolation factor of 20 dB/decade (inverse linear-distance for field strength measurements; inverse-linear-distance-squared for power density measurements). An inverse proportionality of 20 dB per decade was used to normalize the limit line to the specified distance for determine compliance.

   ⇒ Peak-reduction: 0 Peaks frequency range 18,000 GHz - 30,000 GHz

3) Final test; Peak- und Average-Detector; measuring time 1 s; at frequencies from step 2); Search maximum: vary antenna height and azimuth (rotate turntable) to find the maximum field strength readings.

4) If there are more than 10 peaks within the 10 dB margin a manual test with all settings is necessary to find the maximum field strength readings.

8.4 Test method and limits

The test was performed in a test chamber according to ANSI C63.4-2014. The EUT was placed on a non-conductive 0.8 m high support standing on the turntable (see fig. 1, 2).
In order to find the maximum levels of the disturbance radiation the angle of the turntable, the height of the measuring antenna and the lay-out of the EUT cables were varied during the tests. The test was performed separately with the measuring antenna being both in horizontal and vertical polarizations.

For ITE unintentional radiators, the frequency and amplitude of the six highest radiated emissions relative to the limit and independent of antenna polarization are reported in the table below, unless such emissions are more than 20 dB below the limit.

For unintentional radiators other than ITE, for each of the frequencies to which the device is tuned, the frequency and amplitude of the six highest radiated emissions relative to the limit and the operating frequency, or frequency to which the EUT is tuned (if appropriate), are reported in the table below unless such emissions are more than 20 dB below the limit.

8.5 Subpart B - FCC Part 15.109 / ICES-003 class B limit values

Frequency MHz	Peak µV/m	Peak dB(µV/m) @3 m	Average dB(µV/m) @3 m
18000 - 30000	-	73.98 @3 m	53.98 @3 m

8.6 Settings

Ref. Level:	80 dBuVrms	VBW:	1 MHz
Attenuator:	Auto [0 dB]	Sweep time:	30 s
RBW:	1 MHz	Step freq:	Fixed step count: 20001 steps per Band
Preamp:	0 dB	Measure time:	1 ms
Antenna distance:	3 m	Antenna tower:	1 m - 1 m

Of those disturbances above (L -20 dB), where L is the limit level in logarithmic units, at least the disturbance levels and the frequencies of the 0 highest disturbances is recorded. The antenna polarization for each reported disturbance is recorded.

8.7 Internal generated or used frequency for <u>intentional</u> radiators

The highest internal source of an EUT is defined as the highest frequency generated or used within the EUT or on which the EUT operates or tunes.

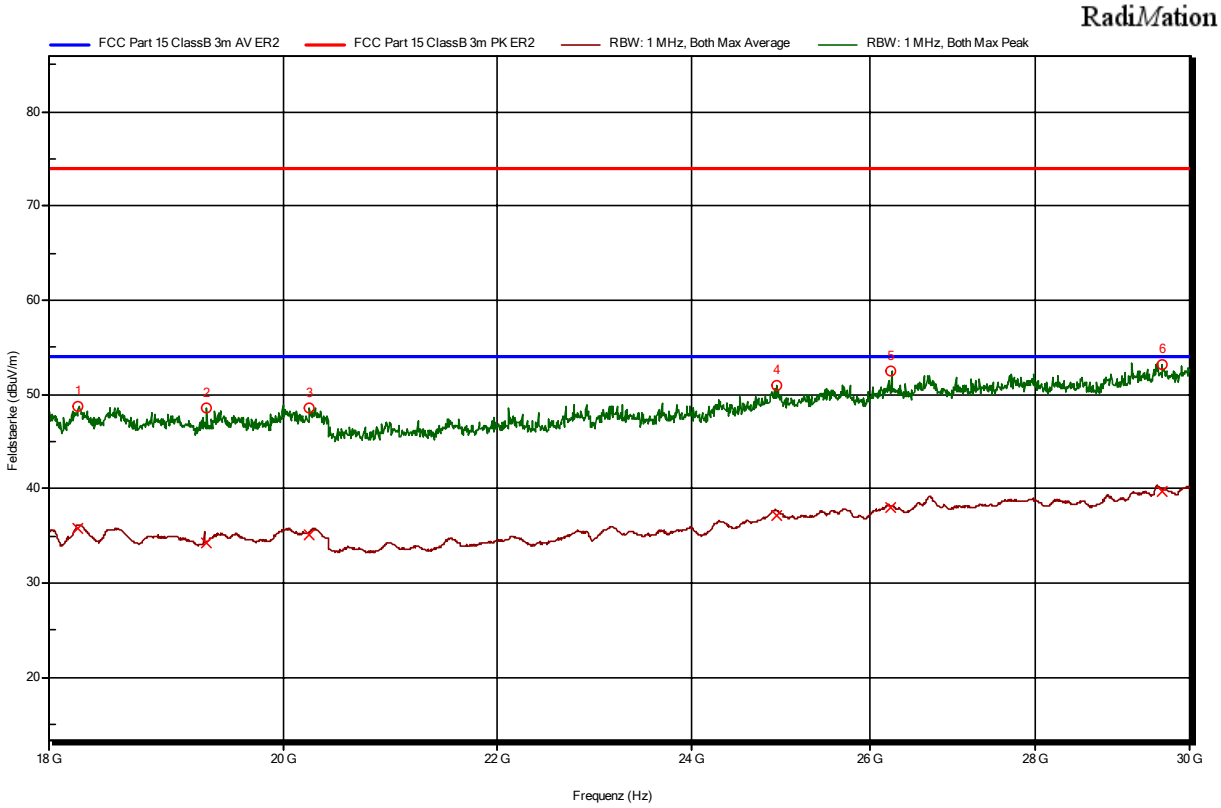
	Highest frequency generated or used in the device or on which the device operates or tunes (MHz)	Upper frequency of measurement range
☒	**9 kHz - 10 GHz**	The measurement is made up to 10 times the highest frequency or 40 GHz, whichever is less.
☐	**10 - 30 GHz**	The measurement is made up to 5 times the highest frequency or 100 GHz, whichever is less.
☐	**30 - 95 GHz**	The measurement is made up to 5 times the highest frequency or 200 GHz, whichever is less.
☐	**> 95 GHz**	The measurement is made up to 3 times the highest frequency or 750 GHz, whichever is less.

8.8 Test result

OM	Diagram	Remarks	Result
I)	378129-47ER2	-	**Passed.**

8.9 Diagrams and tables

8.9.1 Diagram 378129-47ER2



8.9.2 Table Final measurements 378129-47ER3 PK

Frequency	Peak	Peak Limit	Peak Difference	Angle	Height	Polarization
18,247 GHz	48,75 dBuV/m	73,98 dBuV/m	-25,23 dB	45,00 Grad	1 m	Horizontal
19,321 GHz	48,55 dBuV/m	73,98 dBuV/m	-25,43 dB	224,00 Grad	1 m	Vertical
20,230 GHz	48,63 dBuV/m	73,98 dBuV/m	-25,35 dB	0,00 Grad	1 m	Horizontal
24,934 GHz	50,91 dBuV/m	73,98 dBuV/m	-23,07 dB	90,00 Grad	1 m	Horizontal
26,247 GHz	52,51 dBuV/m	73,98 dBuV/m	-21,47 dB	179,00 Grad	1 m	Vertical
29,623 GHz	53,22 dBuV/m	73,98 dBuV/m	-20,76 dB	134,00 Grad	1 m	Vertical

8.9.3 Table Final measurements 378129-47ER3 AV

Frequency	Average	Average Limit	Average Difference	Angle	Height	Polarization
18,247 GHz	35,74 dBuV/m	53,98 dBuV/m	-18,24 dB	45,00 Grad	1 m	Horizontal
19,321 GHz	34,34 dBuV/m	53,98 dBuV/m	-19,64 dB	224,00 Grad	1 m	Vertical
20,230 GHz	35,18 dBuV/m	53,98 dBuV/m	-18,8 dB	0,00 Grad	1 m	Horizontal
24,934 GHz	37,22 dBuV/m	53,98 dBuV/m	-16,76 dB	90,00 Grad	1 m	Horizontal
26,247 GHz	37,98 dBuV/m	53,98 dBuV/m	-16 dB	179,00 Grad	1 m	Vertical
29,623 GHz	39,78 dBuV/m	53,98 dBuV/m	-14,2 dB	134,00 Grad	1 m	Vertical

For calculating the disturbance voltage U and the Margin the following formulas were employed:

$U = U_M + CF$ with: $CF = a_{Cb1} + a_{Cb2} + a_{An} - a_{PA}$

CF	Correction factor (All transducers)
U	Value in dBµV/m
U_M	Measured value at receiver input in dBµV/m
a_{CB}	Cable loss in dB
a_{An}	Antenna correction factor in dB
a_{PA}	Preamplifier gain in dB

Difference = Result - Limit

9 Test equipment used

To facilitate inclusion on each page of the test equipment used for related tests, each item of test equipment and ancillaries are identified (numbered) by the test house.

Inv.-Nr.	Instrument/ ancillary	Manufacturer	Type	Serial number	Cal. Date	Cal. Due
1-0037	Artificial mains network, 3ph	Rohde & Schwarz	ESH2-Z5	882394/019	2018-10	2019-10
1-0040	Biconical antenna	Rohde & Schwarz	HK116	888945/007	2017-07	2020-07
1-0054	Pulse limiter	Rohde & Schwarz	ESH3-Z2	3MSE/0099	2018-09	2019-09
1-0055	LogPer antenna	Rohde & Schwarz	HL223	826517/014	2017-07	2020-07
1-0069	Measuring receiver	Rohde & Schwarz	ESHS 10	839698/016	2018-09	2019-09
1-0072	Artificial mains network, 1ph	Rohde & Schwarz	ESH3-Z5	840062/001	2018-09	2019-09
1-0080	Turntable	H. Deisel	DS 420	1361114	N / A	N / A
1-0200	Trilog antenna	Schwarzbeck	VULB 9163	VULB 9163-107	2019-02	2022-02
1-0361	Semi anechoic chamber	Reinhold & Mahla	3m	1124	2017-06	2020-06
1-0364	Antenna cable 2	Kabelwerk Eupen	CMS / RG 214-N/7	none	2016-09	2019-09
1-0604	EMI test receiver	Rohde & Schwarz	ESU8	100203	2018-09	2019-09
1-0611	Spectrum analyzer	Rohde & Schwarz	FSV 40	100898	2018-09	2019-09
1-0614	Log.-per. antenna	Schwarzbeck	STLP 9148	STLP 9148-133	2016-11	2019-11
1-0615	Pre amplifier	Schwarzbeck	BBV-9718	BBV 9718-191	2018-09	2019-09
1-0619	Coaxial cable (to SAC)	Huber+Suhner	SF106/2x11N-651/2m	70168/6	2016-09	2019-09
1-0620	Antenna cable 3	Huber+Suhner	SF106/2x11N-651/3m	70619/6	2016-09	2019-09
1-0624	EMI-Software Radimation	DARE	Radimation	not applicable	N / A	N / A
1-0770	Horn antenna	Schwarzbeck	BBHA 9170	BBHA 9170-477	2018-06	2021-06
1-0771	Horn antenna	Schwarzbeck	BBHA 9170	BBHA 9170-476	2018-03	2021-03
1-0772	Horn antenna	Schwarzbeck	BBHA 9120D	BBHA 9120D-972	2018-03	2021-03
1-0781	Pre amplifier	Schwarzbeck	BBV 9721	BBV 9721-001	2018-09	2019-09
1-0782	Antenna cable	Huber & Suhner	FB142A1060002020	75193-01	2017-10	2020-10
1-0794	Coaxial cable	Rosenberger	FB142A0010002020	65627-01	2017-10	2020-10
1-0806	Controller	Innco	CO 3000	821/34571114/L	N / A	N / A
1-0807	Antenna mast	Innco	MA-400-XPET	4681114	N / A	N / A
1-0870	10 dB Attenuator	mini circiuts	BW-N10W5+	1429	2016-09	2019-09
1-0871	10 dB Attenuator	mini circiuts	BW-N10W5+	1414	2016-09	2019-09
1-0925	Coaxial cable	HARBOUR	RG316 MIL	#003	2016-09	2019-09
1-0927	Coaxial cable	HARBOUR	RG316 MIL	#005	2016-09	2019-09
1-0993	6 dB Attenuator	mini circiuts	BW-N6W5+	1725	2017-10	2020-10
1-0994	3 dB Attenuator	mini circiuts	BW-N3W5+	1734	2017-10	2020-10
1-0995	6 dB Attenuator	mini circiuts	UNAT-6+	15542	2017-09	2021-09
1-1012	Coaxial cable	Rosenberger	LA2-018-2000	010-1964471 0001	2018-09	2021-09
1-1037	Coaxial cable	Schwarzbeck	AK 9515H	AK 9515H #91	2018-09	2021-09

Annex A

EUT / technical data

General Information			**Description**	
Enclosure			plastic	
Dimensions			5 x 2 x 1 cm	
input voltage				
Nominal voltage	Frequency	Neutral	PE	Nominal Current
5 V	DC	☒ without	☒ without	100 mA
output voltage				
Nominal voltage	Frequency	Neutral	PE	Nominal Current
none	-	☐ without	☐ without	A

Interface (I/O, LAN, USB)			
I/O and communication ports	No.	Shielded	max. Length
USB	1	☒	<3 m
Process measurement and control ports	No.	Shielded	max. Length
none	-	☐	m

Interface Cables	**Length**	**Shielded**	**Type**	**Special**
none	m	☐	Round	☐

Protective earth connection		
Cross-section	max. Length	Description
-	-	-

Table 1	**Description of EUT / Technical data**

Figure 1 EUT / type label

Figure 2 EUT / set up - test module EC (spurious conducted 150 kHz - 30 MHz)

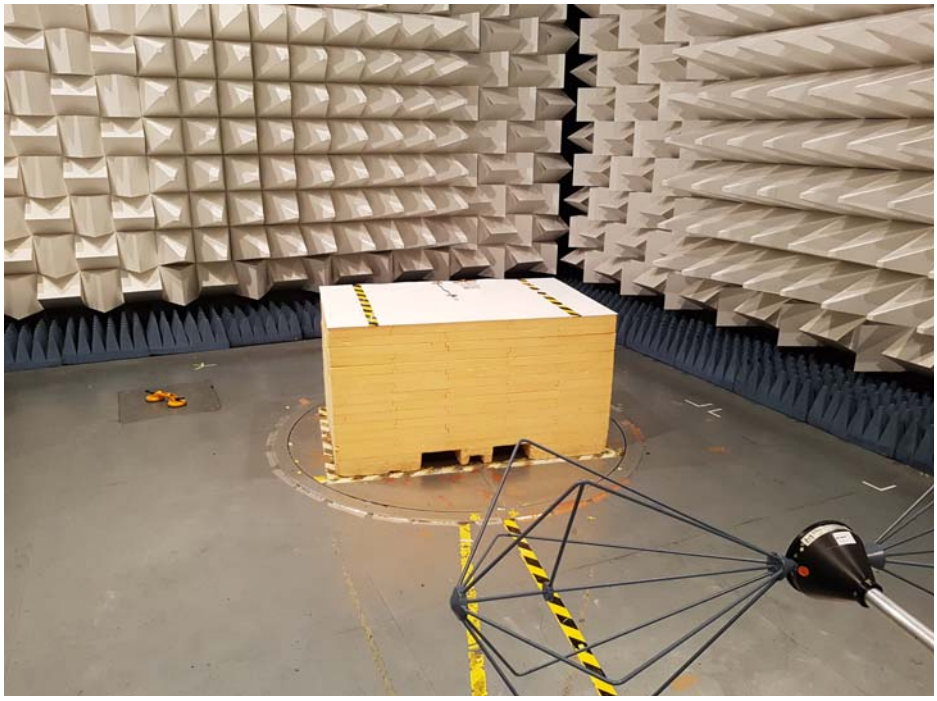


Figure 3 EUT / set up - test module ER low (radiated emissions 30 - 200 MHz)

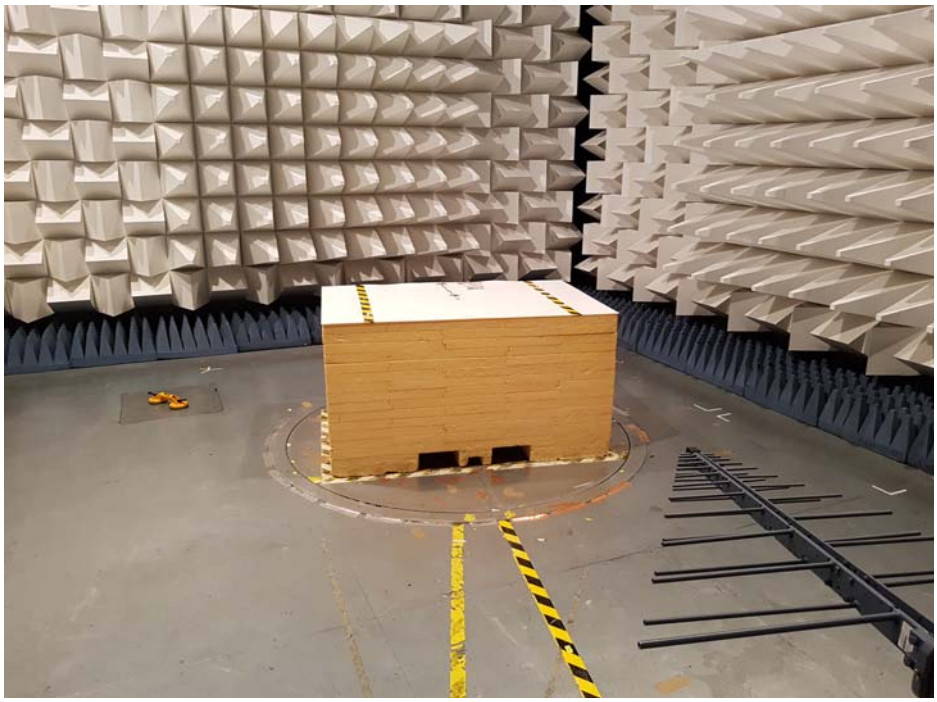


Figure 4 EUT / set up - test module ER high (radiated emissions 200 - 1000 MHz)

Figure 5 EUT / set up - test module ER2 (radiated emissions 1 - 18 GHz)

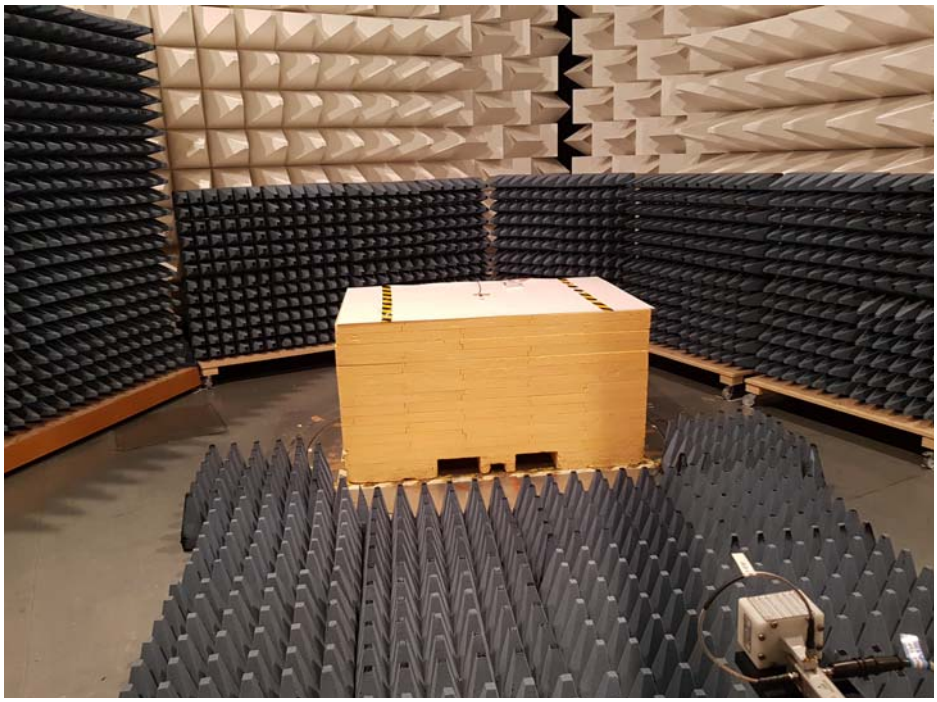


Figure 6 EUT / set up - test module ER3 (radiated emissions 18 - 30 GHz)

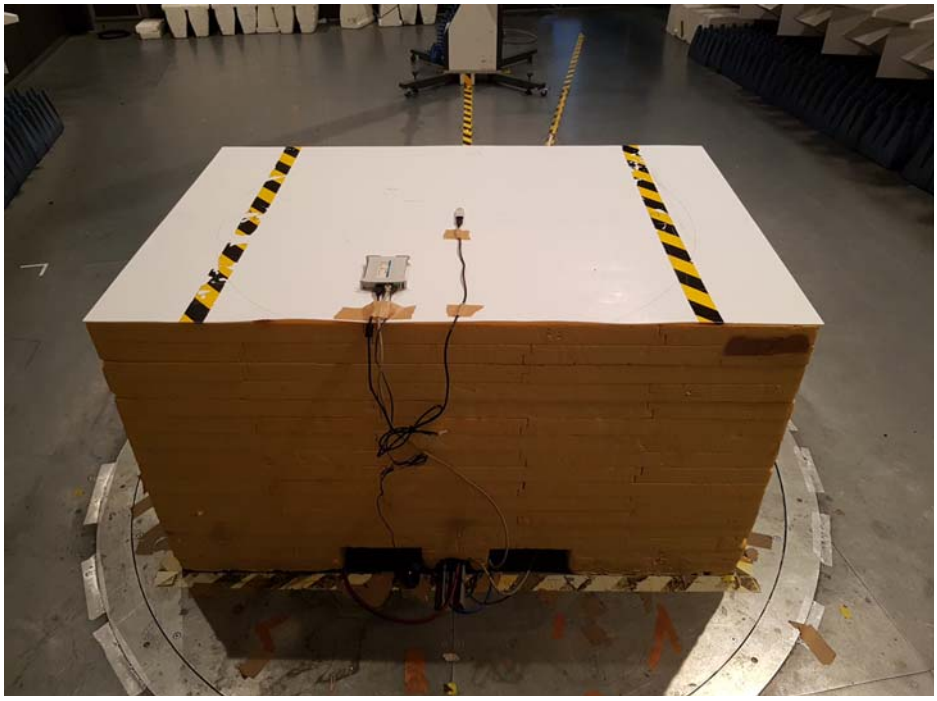


Figure 7 **EUT / set up and cable lay out**

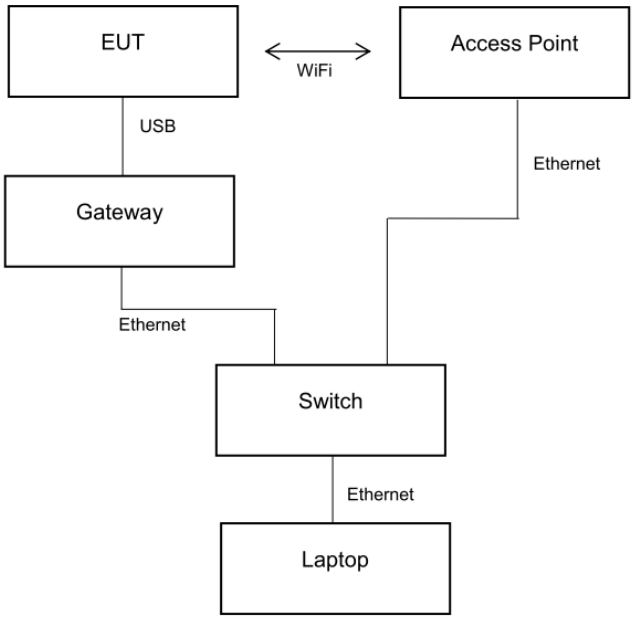


Figure 8 **Block diagramm**

Annex B

Arrangement in the semi anechoic chamber

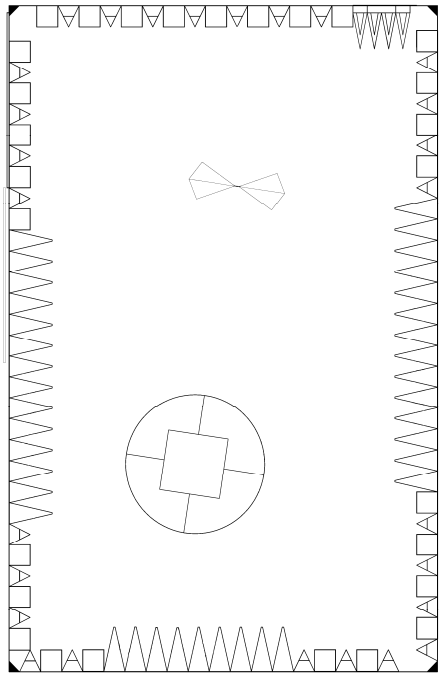


Figure 9 Set-up - ER (30 - 200 MHz)

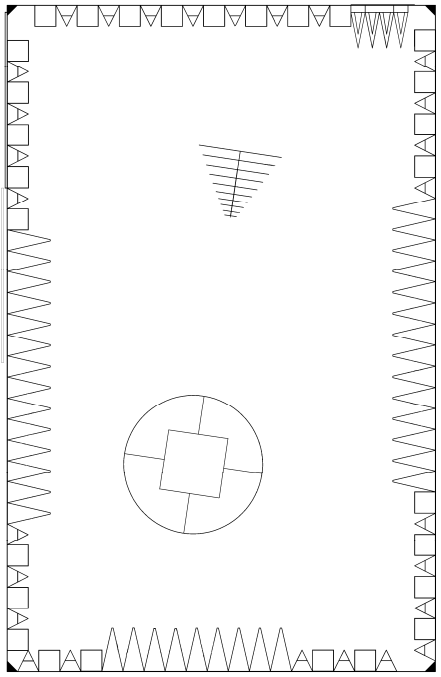


Figure 10 Set-up - ER (200 - 1000 MHz)

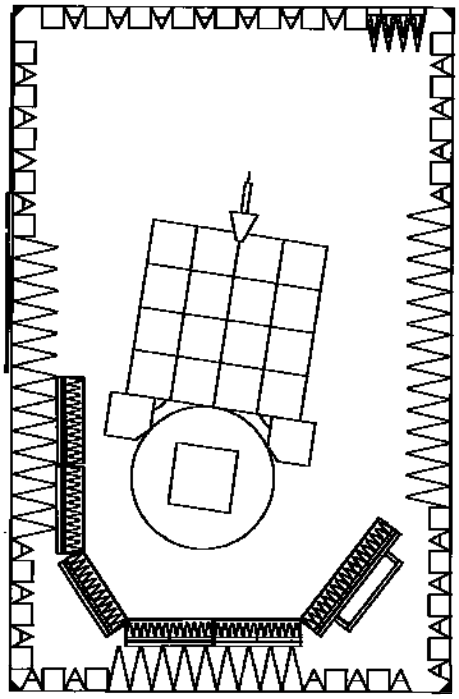


Figure 11 Set-up - ER2 (1 - 18 GHz)

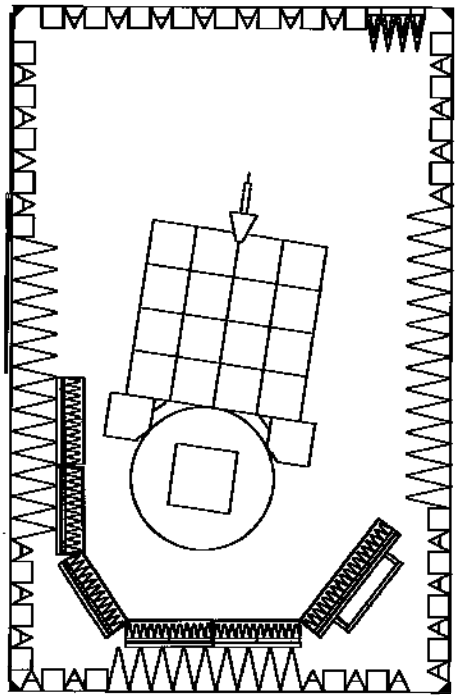


Figure 12 Set-up - ER3 (18 - 30 GHz)