







# TEST REPORT

## No. AR19-0047332-01

performed in accordance with

FCC Rules: Code of Federal Regulations (CFR) no. 47  
Part 15 Subpart B Section 15.107 and 15.109

<b>PRODUCT</b>	IoT device for environmental monitoring with multiprotocol wireless communication functions for smart energy meter
<b>MODEL(s) TESTED</b>	  <p>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 that may cause undesired operation.</p> <p>DiCEworld s.r.l. via della Guastalla 5, 20122 Milano</p> <p>Model name: DiCE SMART Input: 5V --- 2.1A 10.5W FCC ID: 2AVO5PF1000001 S/N: 007-WWYY-000001</p>     <p>Made in Italy</p>
<b>FCC ID</b>	2AVO5PF1000001
<b>TRADE MARK(s)</b>	DICEWORLD

<b>APPLICANT</b>	DICEWORLD S.r.l. ~ Via della Guastalla, 5 ~ 20122 Milano
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Tested by	Alessandro Macri <i>[Laboratory technician]</i>	
Approved by	Giovanni Di Turi <i>[Laboratory manager]</i>	

### Revision Sheet

Release No.	Date	Revision Description
Rev. 0	2020-09-18	First edition Digital signed - AR19-0047332-01_TR_FCC 15.107&109 - DICEWORLD - DICE

The results of tests and checks reported in this Test Report refer exclusively to the samples tested and described in the Report itself.  
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The authenticity of this Test Report and its contents can be verified by contacting IMQ S.p.A., responsible for this Test Report.

## 1. GENERAL DATA

SAMPLE		
Samples received on	2019-12-18	(Item(s) sampled and sent by applicant)
IMQ reference samples	BEM	98220
Samples tested No.	1	
Object under analysis recognition	<b>Not carried out</b> Except where stated, characteristics of products were taken from client description and were not verified by the laboratory	
Date of acceptance of test item	2019-12-18	
TEST LOCATION		
Testing dates	2019-12-18 ÷ 2019-12-19	
Testing laboratory.	IMQ S.p.A. - Via Quintiliano, 43 – I-20138 Milano	
Testing site	Via Quintiliano, 43 – I-20138 Milano	
ENVIRONMENTAL CONDITIONING		
<b>Parameter</b>	<b>Measured</b>	
Ambient Temperature	24.0 ÷ 25.0 °C	
Relative Humidity	46 ÷ 58 %	
Atmospheric Pressure	1005 ÷ 1007 mbar	
The laboratory is monitored by a continuous environmental conditions measurements system. Temperature, humidity and pressure data are recorded on a weekly basis and stored in local archive.		
REMARKS		
Throughout this report a point is used as the decimal separator. The ability or reliability of this product to perform its intended function in a particular application has not been investigated. IMQ declines any responsibility derived from missing or wrong information provided aside by the applicant.		

## 2. REFERENCE DOCUMENT

	DOCUMENT	DATE	TITLE
<input checked="" type="checkbox"/>	47 CFR Part 15	2015	Radio Frequency Device
<input checked="" type="checkbox"/>	ANSI C63.4	2014	Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
<input type="checkbox"/>	ANSI C63.10	2013	American National Standard for Testing Unlicensed Wireless Devices

### 3. UNIT UNDER TEST (EUT) DETAILS

#### GENERAL DATA

MODEL (basic)	Description
DiCE SMART	Wi-Fi and ZigBee modules integrate in IoT device for environmental monitoring with multiprotocol wireless communication functions
VARIANTS (derived)	Description
/	/

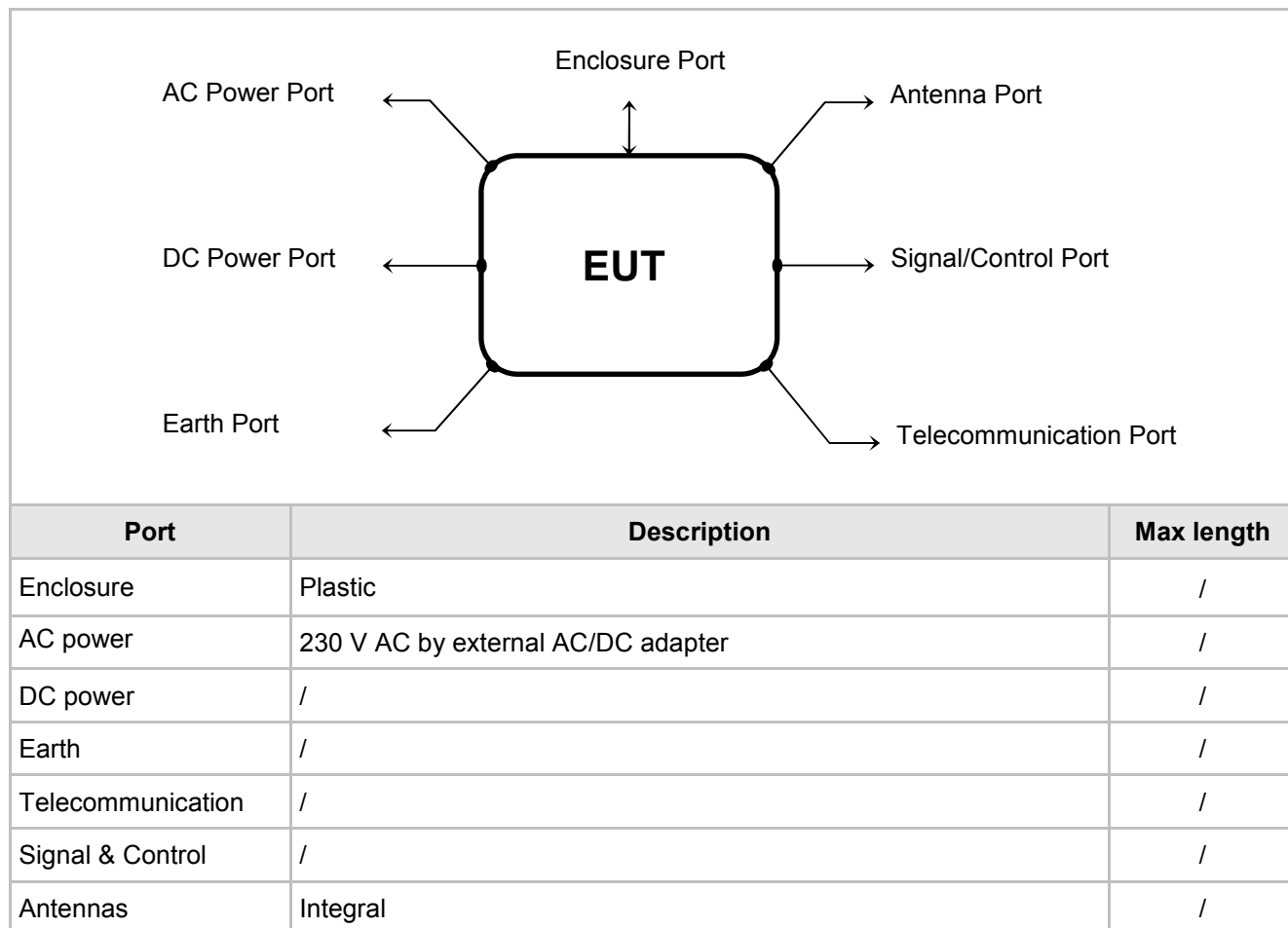
FCC ID	2AVO5PF1000001
Contain module with FCC ID	QOQWGM160P QOQMGM13P

Manufacturer	DICEWORLD S.r.l. ~ Via della Guastalla, 5 ~ 20122 Milano
Assembly plant(s)	FAE TECHNOLOGY S.p.A. ~ Via C. Battisti, 136 ~ 24025 Gazzaniga (BG)

Type of equipment	DTS - Digital transmission equipment (Wi-Fi and ZigBee module)
Operating frequency	2400 ÷ 2483.5 MHz
Max RF radiated power	111.28 dBμV/m @3m (ZigBee module, worst case)
Modulation	/
Channels	11 usable channels for Wi-Fi (20 MHz spacing) 15 usable channels for ZigBee (5 MHz spacing)
Antenna	Integral

## 4. TEST CONFIGURATION OF UNIT UNDER TEST

### EUT PORTS



### STATE OF THE EUT DURING TESTS

Ref.	Mode	Description
#1	Operating	Continuous transmission with all radio modules in transmission mode (testing mode only)
Remarks		The device has been set to operate in transmission only for testing and simultaneous transmission is not possible during normal operation.

## SUPPORT EQUIPMENT

Defined as equipment needed for correct operation or loading of the EUT, but not considered as tested:

Equipment	Manufacturer	Model
PC with dedicated software for RF transmission management	/	/
Evaluation board	Silicon Labs	BRD4001A Rev A01

## ELECTROMAGNETICALLY RELEVANT COMPONENTS

Component	No.	Manufacturer	Model
Wi-Fi module	1	SILICON LABS	WGM160PX22KGA2
ZigBee module	1	SILICON LABS	MGM13P12HGAV2
Main board	1	FAE TECHNOLOGY	20183018_V3
LED board	1	FAE TECHNOLOGY	20183018_V2
AC/DC adapter	1	MLF	MLS-B260502100UU

## RFI SUPPRESSION DEVICES

Component	No.	Manufacturer	Model
/	/	/	/

## EMI PROTECTION DEVICES

Component	No.	Manufacturer	Model
/	/	/	/

## EUT TECHNICAL DOCUMENTATION

Document	Reference
/	/

## 5. METHODS OF MEASUREMENT

All compliance measurements have been carried out using the procedures described in the standard ANSI C63.4:2014, ANSI C63.10:2013 and Section 15.31 of CFR47 Part 15 – Subpart A (General).

Additional test requirements have been adopted according to the reference Section indicated in the § 6 of this test report.

### FREQUENCY RANGE INVESTIGATED

Conducted emission tests : from 150 kHz to 30 MHz.

Radiated emission tests: from 9 kHz to 12.36GHz

## 6. SUMMARY OF TEST RESULTS

POSSIBLE TEST CASE VERDICTS:	
Test object meets the requirement	PASS
Test object does not meet the requirement	FAIL
Test case does not apply to the test object	N.A.
Test not performed	N.P.

CFR47 Part 15	TITLE	RESULT
§ 15.107	Conducted emission	PASS
§ 15.109	Radiated disturbances	PASS

## 7. TEST RESULTS

### 7.1 CONDUCTED EMISSION

TEST REQUIREMENT	
Test setup	ANSI C63.4
Frequency range	150 kHz ÷ 30 MHz
IF bandwidth	9 kHz
EMC class	B
Limits	section 15.107
EUT operating condition	#1
Remark	None
Testing dates	2019-12-19

TEST RESULT
The EUT meets the requirements of sections 15.107.

TEST PROCEDURE
<ol style="list-style-type: none"> <li>1) The EUT was placed on a wooden table of size, 80 cm by 80 cm, raised 80 cm in which is located 40 cm away from the vertical wall the shielded room.</li> <li>2) Each EUT power cord input cord was individually connected through a 50Ω/50μH LISN to the input power source.</li> <li>3) Exploratory measurements were made to identify the frequency of the emission that had the highest amplitude relative to the limit by operating the EUT in a range of typical modes of operation, cable position, and with a typical system equipment configuration and arrangement. Based on the exploratory tests of the EUT, the one EUT cable configuration and arrangement and mode of operation that had produced the emission with the highest amplitude relative to the limit was selected for the final measurement.</li> <li>4) The final test on all current-carrying conductors of all of the power cords to the equipment that comprises the EUT (but not the cords associated with other non-EUT equipment is the system) was then performed over the frequency range of 0.15 MHz to 30 MHz.</li> <li>5) The measurements were made with the detector set to PEAK and AVERAGE amplitude within a bandwidth of 10 kHz during the measurements.</li> <li>6) The measurements with Quasi-Peak detector are performed only for frequencies for which the Peak values are <math>\geq</math> (Q.P. limit - 6 dB).</li> </ol>

# Conducted emission

Port under test

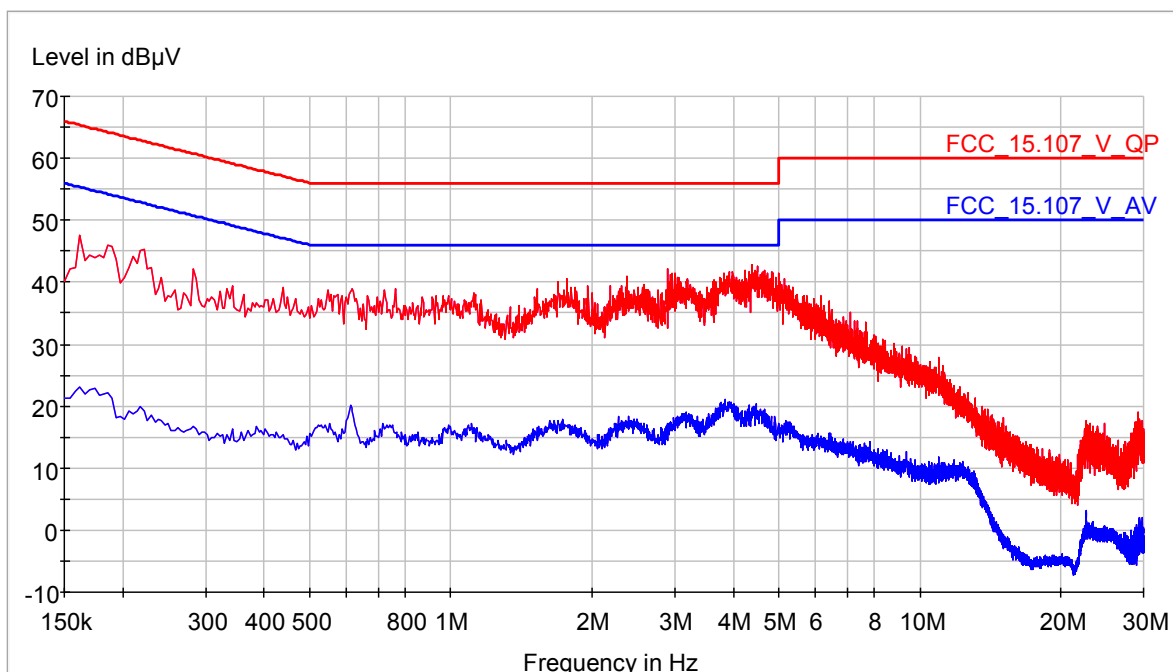
AC mains

N

☐ Quasi-Peak detector (X marked points)

☒ Peak detector

☒ Average detector



Port under test

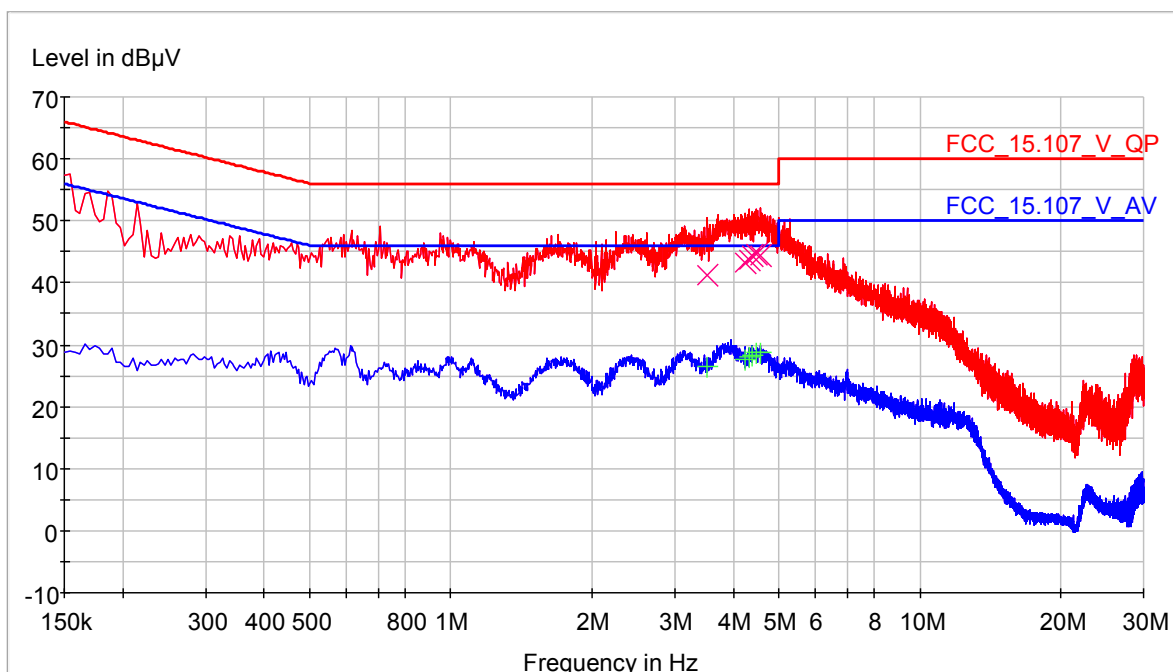
AC mains

L1

☒ Quasi-Peak detector (X marked points)

☒ Peak detector

☒ Average detector (+ marked points)



Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Line	Margin QP (dB)	Margin AV (dB)	Limit QP (dB)	Limit AV (dB)
3.530000	41.2	26.5	1000.0	9.000	L1	14.8	19.5	56	46
4.238000	43.3	27.6	1000.0	9.000	L1	12.7	18.4	56	46
4.330000	43.8	28.0	1000.0	9.000	L1	12.2	18	56	46
4.390000	44.3	28.4	1000.0	9.000	L1	11.7	17.6	56	46
4.486000	44.5	28.8	1000.0	9.000	L1	11.5	17.2	56	46
4.570000	44.4	28.7	1000.0	9.000	L1	11.6	17.3	56	46

## 7.2 RADIATED DISTURBANCES

TEST REQUIREMENT	
Test setup	ANSI C63.4
Test facility	Semi-anechoic chamber
Test distance	3 meters
Frequency range	9 kHz to 12.36 GHz
IF bandwidth (below 30 MHz)	9 kHz
IF bandwidth (below 1,000 MHz)	120 kHz
IF bandwidth (above 1,000 MHz)	1 MHz
Deviation to test procedure	None
Limits	sections 15.109
EUT operating condition	#1
Remark	(*) In accordance with part 15.31 (f) (2), where the measurement distance was specified to be 30 or 300 meters, a correction factor was applied in order to permit measurement to be performed at a separation distance. The applied formula for limits at 3 meter is: Extrapolation (dB) = $40\log(300\text{meter} / 3\text{meter}) = +80\text{db}$ Extrapolation (dB) = $40\log(30\text{meter} / 3\text{meter}) = +40\text{db}$
Testing dates	2019-12-18 ÷ 2019-12-19

## TEST RESULT

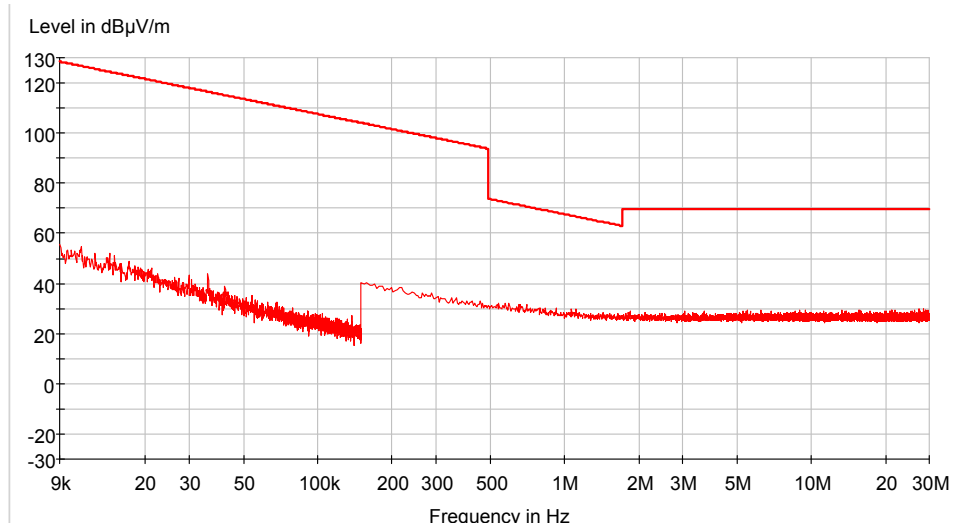
The EUT meets the requirements of sections 15.109

LIMITS FOR SPURIOUS		
Band of operations	Limit $\mu\text{V/m}$	Limit $\text{dB}\mu\text{V/m}$
30÷88 MHz	100	40
88÷216 MHz	150	43,5
216÷960 MHz	200	46
Above 960MHz	500	54

**TEST PROCEDURE**

- 1) The EUT was placed on turntable which is 0.8 m above the ground plane
- 2) The turntable shall rotate from 0° to 360° degrees to determine the position of maximum emission level.
- 3) The EUT is positioned 3 m away from the receiving antenna which varied from 1 to 4 m to find the highest emission.
- 4) The measurements were made with the detector set to PEAK and AVERAGE amplitude within a bandwidth of 100 kHz below 1000 MHz and 1 MHz above 1000 MHz.
- 5) The receiving antenna was positioned in both horizontal and vertical polarization.
- 6) The measurements with Quasi-Peak detector, below 1000 MHz are performed only for frequencies for which the Peak values are  $\geq$  (Q.P. limit – 6 dB).

### Worst case measurement result 9 kHz÷30 MHz



### Worst case Radiated emission 30 – 1000 MHz

Port

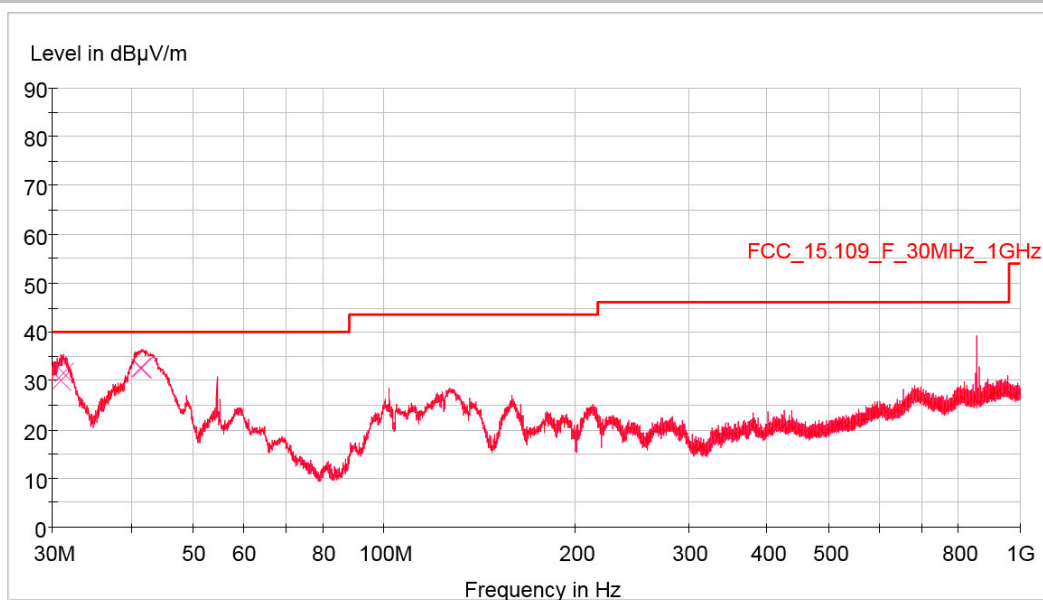
Enclosure

Antenna Vertical

☒ Quasi-Peak detector (X marked points)

☒ Peak detector

☐ Average detector (+ marked points)



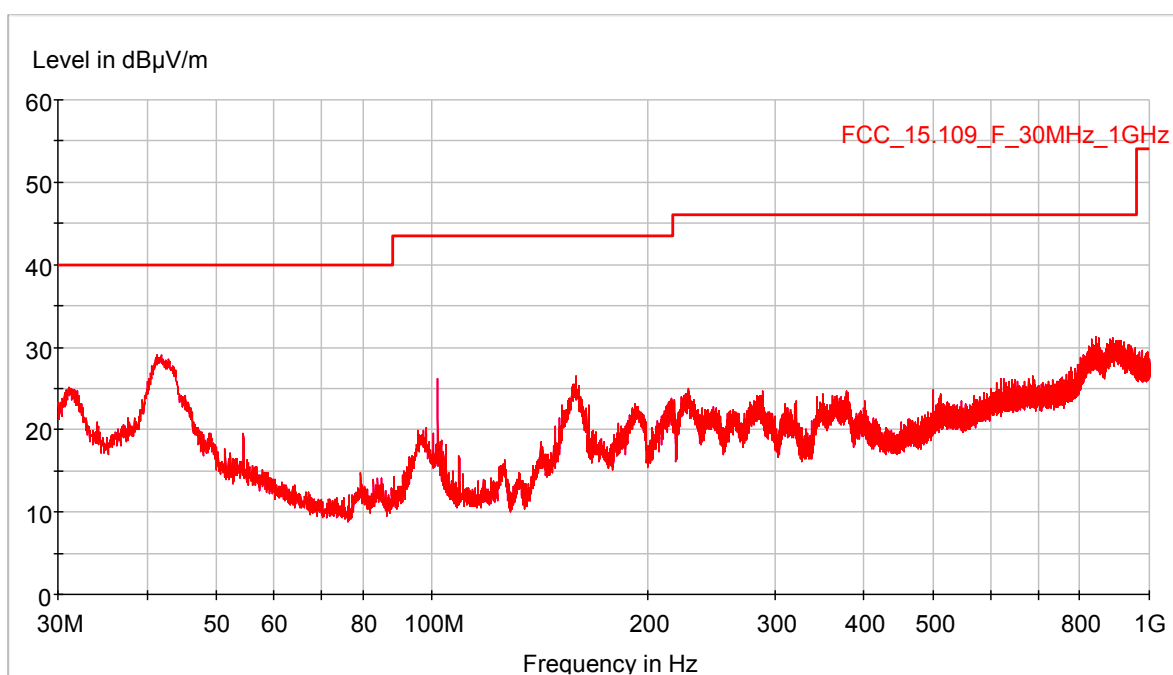
Frequency (MHz)	QuasiPeak (dBµV/m)	Bandwidth (kHz)	Polarization	Limit QP (dB)	Margin QP (dB)
31.000000	30.2	120.000	V	9.8	40
31.240000	31.5	120.000	V	8.5	40
31.260000	31.3	120.000	V	8.7	40
41.360000	32.6	120.000	V	7.4	40
41.480000	32.7	120.000	V	7.3	40
41.490000	32.6	120.000	V	7.4	40

## Worst case Radiated emission 30 – 1000 MHz

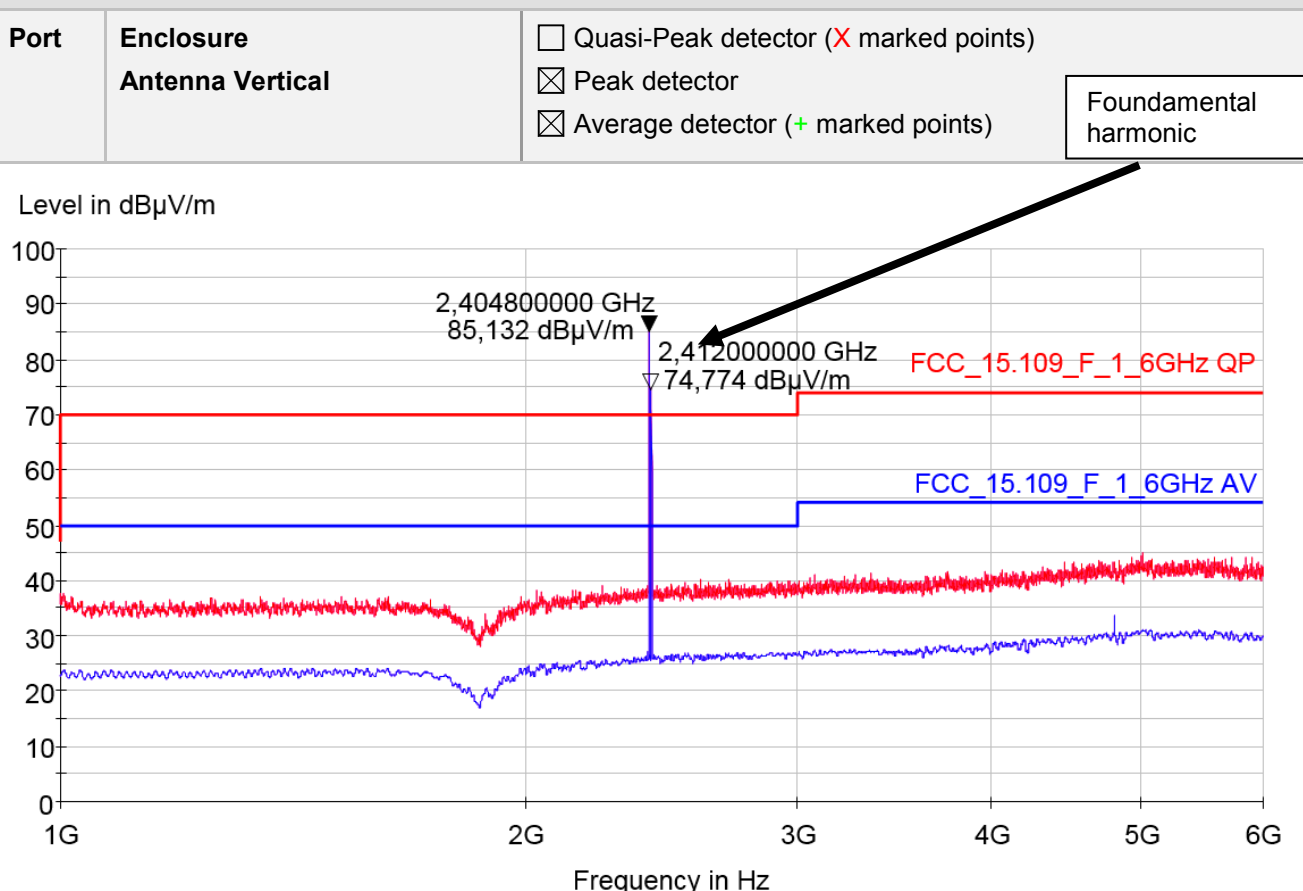
Port

Enclosure

Antenna Horizontal

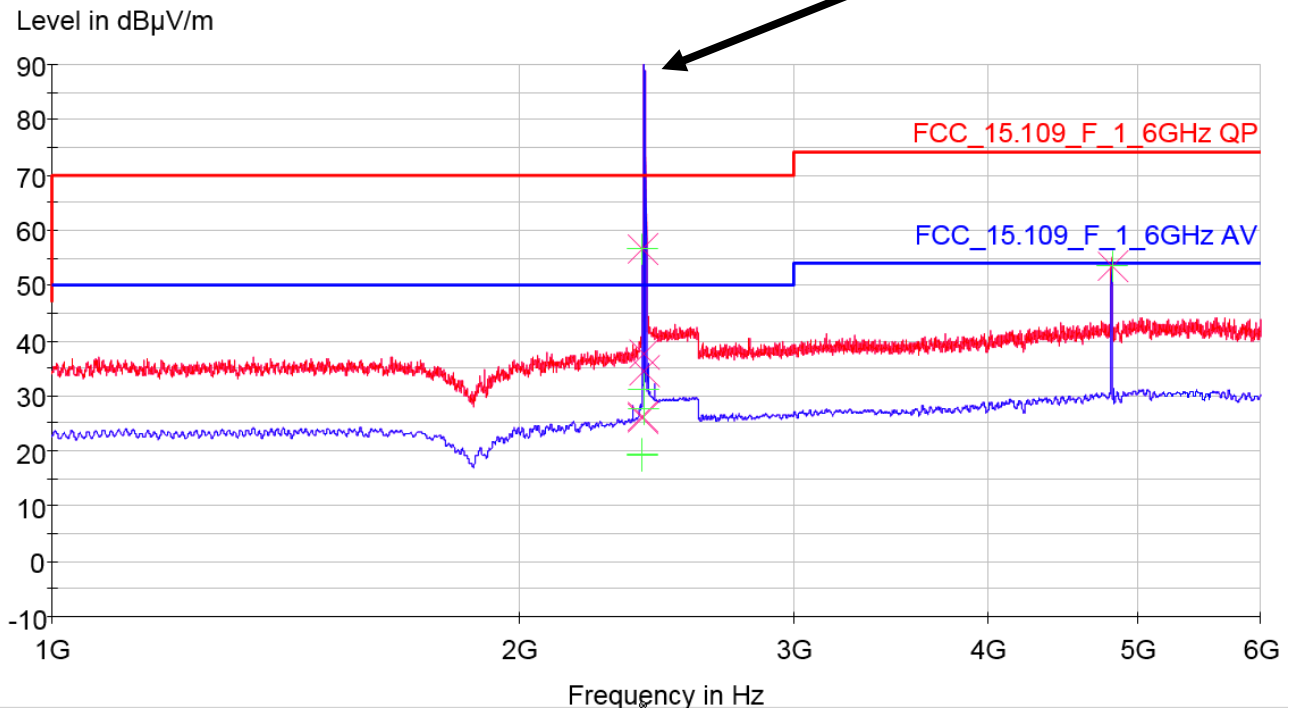
☐ Quasi-Peak detector (X marked points)☒ Peak detector☐ Average detector (+ marked points)

**Worst case Radiated emission 1-6 GHz**



Worst case Radiated emission 1-6 GHz

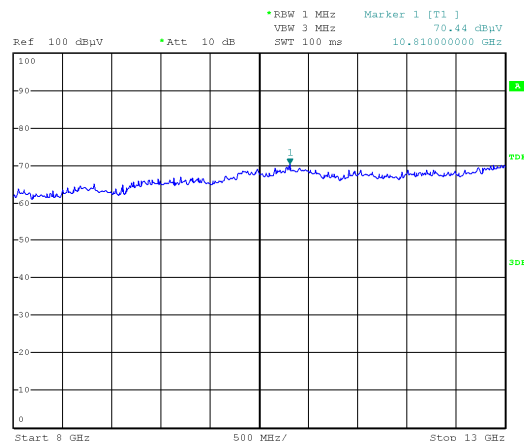
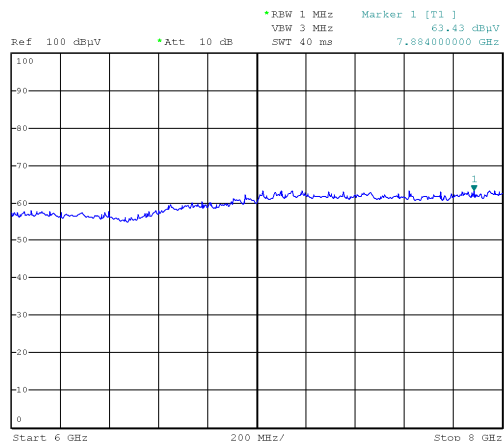
Port	Enclosure Antenna Horizontal	<input checked="" type="checkbox"/> Quasi-Peak detector (X marked points) <input checked="" type="checkbox"/> Peak detector <input checked="" type="checkbox"/> Average detector (+ marked points)	<div> Fundamental harmonic </div>
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Frequency (MHz)	QuasiPeak (dB $\mu$ V/m)	Average (dB $\mu$ V/m)	Bandwidth (kHz)	Pol.	Limit QP (dB)	Limit AV (dB)	Margin QP (dB)	Margin AV (dB)
4810.00000	53.5	53.3	1000.00	H	20.5	0.7	74	54

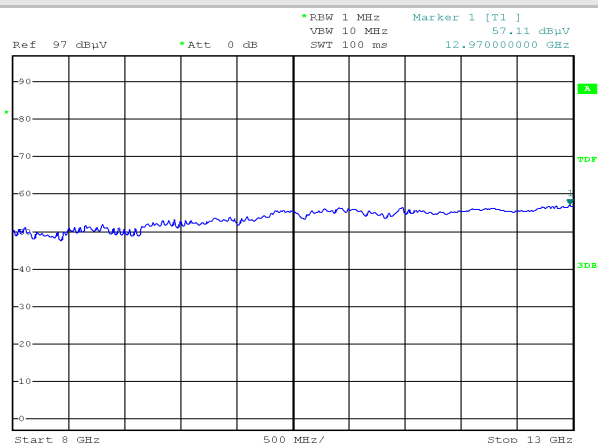
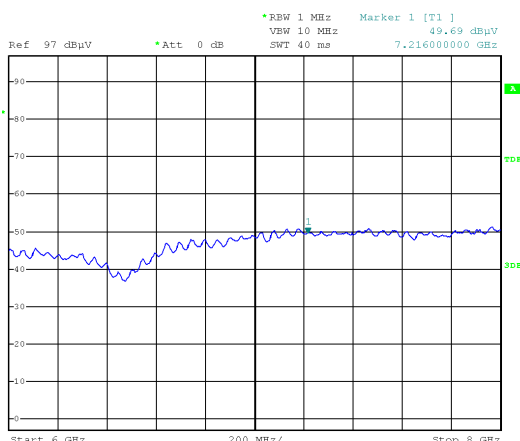
### Worst case measurement result >6,000 MHz (Peak)

#### Worst case – V antenna



### Worst case measurement result >6,000 MHz (Average)

#### Worst case – V antenna



### Tabular worst case measurement result >6,000 MHz (PK & AV)

#### PEAK RESULT (RBW=1MHz; VBW=3MHz)

Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correct reading	PK Limit (AV + 20dB)		Margin
(MHz)	(dBμV)	(dB@3m)	(dB)	(dB)	(dBμV/m)	(μV/m)	(dBμV/m)	(dB)
f>6000	No significant values were found					5000	74	---

#### AVERAGE RESULT (RBW=1MHz; VBW=10Hz)

Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correct reading	AV Limit		Margin
(MHz)	(dBμV)	(dB@3m)	(dB)	(dB)	(dBμV/m)	(μV/m)	(dBμV/m)	(dB)
f>6000	No significant values were found (see also above plots)					500	54	---

See above the measurements plots.

## 8. MEASUREMENTS AND TESTS UNCERTAINTY

Unless otherwise stated the uncertainties for the tests and measurements are evaluated in according to IMQ Operational Instruction IO-LAB-001 and IO-LAB-004. and requirement of NIST Technical Note 1297 and NIS 81: 1994 “The Treatment of Uncertainty in EMC Measurements”

The expanded uncertainty was calculated for all measurements and tests listed in this test report according to CISPR 16-4-2 “Specification for radio disturbance and immunity measuring apparatus and methods – Part 4-2: Uncertainty in EMC Measurements”, with UKAS document LAB 34 and is documented in the quality system accordance to ISO/IEC 17025.

Internal Procedure PG-037 ensures that the requirements for traceability of calibrations, of all test equipment requiring calibration, and calibration intervals are met.

Methods/Standard	Parameter	Expanded Uncertainty	Unit	Confidence level
Continuous disturbance	QP detector 9 – 150 kHz	2.5	dB	95%
	QP detector 150 k – 30 MHz	2.6	dB	95%
	QP detector using Voltage Probe	2.5	dB	95%
	QP detector using ISN	3.2	dB	95%
	QP detector using Current Probe	2.2	dB	95%
Radiated disturbance	QP detector (30 MHz - 100 MHz) H polarization	4.3	dB	95%
	QP detector (30 MHz - 100 MHz) V polarization	4.2	dB	95%
	QP detector (100 MHz - 200 MHz) H polarization	3.4	dB	95%
	QP detector (100 MHz - 200 MHz) V polarization	4.8	dB	95%
	QP detector (200 MHz - 1000 MHz) H polarization	3.9	dB	95%
	QP detector (200 MHz - 1000 MHz) V polarization	3.8	dB	95%
	P detector 1 - 6 GHz	4.8	dB	95%
	P detector 6 - 18 GHz	5.1	dB	95%
	P detector 18 - 26 GHz	5.0	dB	95%
	P detector 26 - 40 GHz	5.2	dB	95%

## 9. LIST OF MEASURING EQUIPMENT AND CALIBRATION INFORMATION

Measurement of conducted electromagnetic disturbance					
Instrument	Manufacturer	Model	IMQ Ref.	Cal. Date	Cal. Due
Shielded chamber	/	/	P-00491	/	/
EMI Receiver	ROHDE & SCHWARZ	ESU 8	S-05562	2019-07-09	2020-07-31
LISN 3 phases	ROHDE & SCHWARZ	ESH2-Z5	S-02314	2019-05-21	2020-05-31
Pulse limiter	ROHDE & SCHWARZ	ESH3-Z2	S-02206	2019-05-21	2020-05-31
ISN network	ROHDE & SCHWARZ	ENY41	S-04970	2018-12-18	2019-12-31
EMI cable	/	/	S-05489	2019-05-27	2020-05-31
Software	ROHDE & SCHWARZ	EMC 32 Vers. 8.52.0	W-00083-E	/	/
PC	/	/	H-00164	/	/

Measurement of radiated electromagnetic disturbance					
Instrument	Manufacturer	Model	IMQ Ref.	Cal. Date	Cal. Due
Shielded anechoic chamber	SIDT	/	P-01709	2019-10-21	2020-10-31
Turntable controller unit	FRANKONIA	FCTAM01	P-02486	/	/
Mast antenna	FRANKONIA	FAM4	P-02488	/	/
EMI Receiver	ROHDE & SCHWARZ	ESU 8	S-05562	2019-07-09	2020-07-31
Spectrum analyzer	ROHDE & SCHWARZ	FSP40	S-03629	2019-11-06	2020-11-30
Loop Antenna	ROHDE & SCHWARZ	HFH2-Z2	S02508	2019-08-06	2020-08-31
Log antenna	ARA	LPB-2513 (30MHz - 1GHz)	S-02385	2017-06-08	2020-06-30
Horn Antenna	SCHWARZBECK	BBHA 9120D	S03463	2019-07-21	2020-07-31
Preamplifier	Hewlett Packard	HP 8449B	S03542	2019-03-27	2020-03-31
EMI cable	/	EMI1 RG 214/U	S-05040	2019-05-27	2020-05-31
Control / DAQ Software	ROHDE & SCHWARZ	EMC 32 Vers. 8.52	W-00199/E	/	/
PC	/	/	H-00165	/	/

END OF REPORT