

# Test Report

## Electromagnetic Compatibility

<b>Product</b>	Underwater Drone		
<b>Name and address of the applicant</b>	Blueye Robotics AS Transittgata 10 7042 Trondheim, Norway		
<b>Name and address of the manufacturer</b>	Blueye Robotics AS Transittgata 10 7042 Trondheim, Norway		
<b>Model</b>	Pioneer		
<b>Rating</b>	Battery operated with chargeable battery pack, 14.8V (4S5P Li-ion battery)		
<b>Trademark</b>	-		
<b>Serial number</b>	P2-B7-04		
<b>Additional information</b>	-		
<b>Tested according to</b>	EN 55032:2012 + AC:2013 EN 55024:2010 FCC CFR 47 Part 15B		
<b>Order number</b>	372611		
<b>Tested in period</b>	2018-06-19 – 2018-06-20, 2018-08-14 – 2018.08.15 and 2018-08-23		
<b>Issue date</b>	2019-04-10		
<b>Name and address of the testing laboratory</b>	<div> <div> <b>Nemko Group</b>  Nemko AS  Gaustadalléen 30,  P.O.Box 73 Blindern,  0314 Oslo, Norway </div> <div> TEL: +47 22 96 03 30  FAX: +47 22 96 05 50 </div> <div>     NORWEGIAN ACCREDITATION TEST 033 </div> </div> <p>An accredited technical test executed under the Norwegian accreditation scheme</p>		
<div> <div>   Prepared by [Thomas Dangle] </div> <div>   Approved by [Tore Løvlien] </div> </div>			
<p>This report shall not be reproduced except in full without the written approval of Nemko.  Opinions and interpretations expressed within this report are not part of the current accreditation.  This report was originally distributed electronically with digital signatures. For more information contact Nemko.</p>			

## REPORT REVISIONS

Revision #	Date	Order #	Description
00	2018-11-16	340630	First issued
01	2019-04-10	372611	Revised with Conducted Emissions test with the Charger



### **THIS REPORT APPLIES ONLY TO THE ITEM(S) AND CONFIGURATION(S) TESTED.**

It is the manufacturer's responsibility to assure the additional production units of this product are manufactured with identical electrical and mechanical components. The manufacturer is responsible to the authorities for any modifications made to the product, which result in non-compliance to the relevant regulations.

Nemko authorizes the above named Customer to reproduce this report provided it is reproduced in its entirety. Any reproduction of parts of this report requires approval in writing from Nemko.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Nemko accepts no responsibility for damages suffered by any third party as a result of decisions made or actions based on this report.

Opinions expressed within this report regarding general assessments and qualifications for PASS or FAIL to the standards limits and requirements, are not part of the current accreditation. Neither is opinions expressed regarding model variants covered by the testing performed in this report.

Deviations from, additions to, or exclusions from the test specifications are described in "Testing Report Summary".

## DESCRIPTION OF TESTED ITEM(S)

Product description.....:	Underwater drone
Model/type.....:	Pioneer
Serial number.....:	P2-B7-04
Operating voltage.....:	Normal voltage 14.8V (4S5P Li-ion battery)
Maximum power/current.....:	-
Insulation class.....:	N/A, battery power
Highest clock frequency.....:	1.2 GHz
Hardware version.....:	B7
Software version.....:	0.1.171

Mounting position.....:	<input checked="" type="checkbox"/> Table top equipment (when charging the battery) <input type="checkbox"/> Wall/ceiling mounted equipment <input type="checkbox"/> Floor standing equipment <input type="checkbox"/> Handheld equipment <input type="checkbox"/> Rack mounted equipment <input type="checkbox"/> Console equipment <input checked="" type="checkbox"/> Other: Under sea water
-------------------------	---

## INPUT/OUTPUT PORTS

Port name and description	Cable		
	> 3m	Attached during test	Shielded
Communication Tether (for remote control)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

## OPERATING MODES

No.	Description	Applied for testing	
		Emissions	Immunity
1	Charging (when connecting to the Charger adapter)	<input checked="" type="checkbox"/>	<input type="checkbox"/>
2	Video and data streaming	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	10% Lighting and 20% motors in air (normal operation mode)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

## ACCESSORIES USED DURING TEST

Description	Manufacturer	Type
WSU (remote control)	Blueye Robotics AS	-
Charger	Blueye Robotics AS	-
AC/DC Power Adapter (to the Charger)	FSP Group Inc	FSP230-AJAN3
Laptop pc or Tablet/Smartphone with Wifi (for video streaming)	Any	-

## MODEL VARIANTS

The following model variants have been inspected and are confirmed to be identical or believed to be less disposed with regard to electromagnetic compatibility.

Model/type	Comment	Tested
Pioneer	-	<input checked="" type="checkbox"/>

## PHOTOS AND DRAWINGS


Copy of marking label.....:	-	
Photo of the test item.....:		
Drawing of test setup.....:	-	

## OTHER INFORMATION

Modifications to the test item.....:	-
Additional information.....:	The charging function is tested together with the Charger adapter and is stated in test report 340630-02 TRF EMC Charger Adapter

Note: This equipment has been tested with certain cable types and cable configurations. Any changes to these parameters when installed may influence on the EMC properties of this equipment

## TEST ENVIRONMENT

Test laboratory.....:	<input type="checkbox"/> GAUSTAD (Gaustadalleen 30, N-0314 Oslo, Norway) <input checked="" type="checkbox"/> KJELLER (Instituttveien 6, N-2007 Kjeller, Norway)
Laboratory accreditation.....:	 <b>Norsk Akkreditering – TEST 033</b> P06 – Electromagnetic Compatibility
Environmental ref. conditions.....:	<p>The climatic conditions during the tests are within limits specified by the manufacturer for the operation of the product and the test equipment.  The climatic conditions during tests are within the following limits:</p> <p><b>Ambient temperature:</b> 15 – 35 °C  <b>Relative humidity:</b> 25 – 75 %RH  <b>Atmospheric pressure:</b> 86 – 106 kPa</p> <p>If explicitly required by the test standard, or the requirements are tighter than the above; the climatic conditions are recorded and documented separately in this test report.</p>
Calibration.....:	<p>All instruments used in the tests of this test report are calibrated and traceable to national or international standards. Between calibrations test set-ups are controlled and verified on a regular basis by intermediate checks to ensure, with 95% confidence that the instruments remain within their calibrated levels.</p> <p>The instrumentation accuracy is within limits agreed by the IEC/CTL and defined by Nemko reference document TM-NO/301.</p>
Measurement uncertainties.....:	<p>EMC uncertainty is specified in CISPR 16-4-2. Only if our uncertainty is larger than the maximum value UCISPR, the uncertainty is added to the measurement result.</p> <p>EMC test uncertainties for transient immunity are kept within the requirements of the relevant basic standard.</p> <p>Further information about measurement uncertainties is provided on request</p>

## POWER SUPPLY SYSTEM UTILISED

Power supply voltage.....:	<div> <input type="checkbox"/> 240V AC 50Hz  <input type="checkbox"/> 230V AC 50Hz  <input type="checkbox"/> 200V AC 60Hz  <input type="checkbox"/> 115V AC 60Hz </div> <div> <input type="checkbox"/> 400V 3NAC 50Hz  <input type="checkbox"/> 230V 3AC 50Hz  <input type="checkbox"/> 12V DC  <input type="checkbox"/> 24V DC  <input checked="" type="checkbox"/> Battery powered </div>
	<input type="checkbox"/> The power supply voltage has been selected after a maximum disturbance investigation over the product's rated voltage range. Voltage: Frequency:
Grounding conditions .....	<input checked="" type="checkbox"/> Not grounded <input type="checkbox"/> Ground is received from its power supply connection <input type="checkbox"/> Additional chassis grounding

## EVALUATION OF PERFORMANCE

### PERFORMANCE TESTS

Performance checks.....:	Motors running and video streaming on air
Performance tests.....:	Motors running and video streaming on air
Monitoring during tests.....:	Visual monitoring the motors with a camera and using a laptop pc for video streaming via the WSU
<p>Note 1: Performance check is a short functional test carried out during or after a technical test to confirm that the equipment operates.</p> <p>Note 2: Performance test is a measurement or a group of measurements carried out during and/or after a technical test to confirm that the equipment complies with selected parameters as defined in the equipment standard.</p> <p>Note 3: Monitoring during tests describes which functions were monitored and how.</p>	

### PERFORMANCE CRITERIA

Performance criteria is.....:	<input checked="" type="checkbox"/> based on the applied product standard <input type="checkbox"/> based on a declaration from the customer
Criterion A.....:	The device shall continue to operate as intended both during and after the test. No degradation of performance or loss of function is allowed below the expected performance level of the device
Criterion B.....:	The device shall continue to operate as intended after the test. No degradation of performance or loss of function is allowed below the expected performance level of the device
Criterion C.....:	Temporary loss of function during test is allowed, provided the function is self-recoverable or can be restored by the operation of the controls

Note: In the subsequent test sections of this report, the required and actual specimen performance during immunity testing is indicated by the nomenclatures as given by the table above (A, B or C).

## TEST REPORT SUMMARY

### APPLIED STANDARDS

Standards	Titles
<b>EN 55032:2012 + AC:2013</b>	<i>Electromagnetic compatibility of multimedia equipment - Emission requirements</i>
<b>EN 55024:2010</b>	<i>Information technology equipment - Immunity characteristics - Limits and methods of measurement</i>
<b>FCC CFR 47 Part 15</b>	<i>Digital devices - Unintentional radiators, Class B Digital Device</i>

### TEST SUMMARY

Requirements – Tests	Reference standards	Verdict
Conducted Emissions	EN 55032:2012 + AC:2013 CISPR 16-2-1:2014, Ed.3.0 FCC CFR 47 Part 15B ANSI C63.4-2014	PASS
Conducted Emissions (Telecom Port)	EN 55032:2012 + AC:2013 CISPR 16-2-1:2014, Ed.3.0	N/A
Radiated Emissions (30MHz-1000MHz)	EN 55032:2012 + AC:2013 FCC CFR 47 Part 15B CISPR 16-2-3:2014, Ed.3.2	PASS
Radiated Emissions (Above 1GHz)	EN 55032:2012 + AC:2013 FCC CFR 47 Part 15B CISPR 16-2-3:2014, Ed.3.2	PASS
Electrostatic Discharge (ESD) Immunity	EN 55024:2010 EN 61000-4-2:2009, Ed.2.0	PASS
Radiated RF Disturbance Immunity	EN 55024:2010 EN 61000-4-3:2010, Ed.3.2	PASS
Electric Fast Transients Immunity	EN 55024:2010 EN 61000-4-4:2012, Ed.3.0	PASS
Surge Immunity	EN 55024:2010 EN 61000-4-5:2014, Ed.3.0	N/A
Conducted RF Disturbance Immunity	EN 55024:2010 EN 61000-4-6:2014, Ed.4.0	PASS
Power Frequency Magnetic Field Immunity	EN 55024:2010 EN 61000-4-8:2010, Ed.2.0	PASS
Dips and Interruptions Immunity	EN 55024:2010 EN 61000-4-11:2004, Ed.2.0	N/A

- PASS : Tested and complied with the requirements  
 FAIL : Tested and failed the requirements  
 N/A : Test not relevant to this specimen (evaluated by the test laboratory)  
 – : Test not performed (instructed by the applicant)  
 \* : An asterisk (\*) placed after the verdict in the Result column indicates test items that are not within Nemko's scope of accreditation  
 # : A grid (#) placed after the verdict in the Result column indicates test items that are only partly covered by Nemko's scope of accreditation. Further information is detailed in the test section

## NOTES

Note 1: Product standards with dated references to basic standards may have been performed by Nemko AS according to the newest edition of the basic standard. This may impact the compliance criteria or technical performance of the test, still this is considered to be adequate as long as the test is expected to confirm compliance to the intention of the product standard. The table above lists the actual editions of the basic standards which have been used during testing.

Note 2: The choice of immunity test levels could be higher than those specified by the reference standards when we take into account the nature of the specimen and its intended use, or based on customer requests.



# Test Results

# CONDUCTED EMISSIONS

## TEST DESCRIPTION

### Method

The reference method for this test is listed in the table under clause TEST SUMMARY.

### Set-up

The measurement was performed at the power supply terminal of the specimen. Nominal supply voltage was provided.

The specimen was energized and in normal operating mode during the measurement.

- ☐ The specimen and its cables were elevated 10 cm above a ground plane.
- ☐ The specimen and its cables were elevated 40 cm above a ground plane.
- ☒ The specimen and its cables were placed 40 cm from a vertical ground plane, 80 cm over ground plane.
- ☐ The specimen was mounted directly on, and bonded to a ground plane. Cables and auxiliary equipment were elevated by 1 cm
- ☒ The specimen was connected to an Artificial Mains Network (AMN) by its power supply cable, which was adjusted to 100cm length by folding.
- ☐ The specimen was connected to an Artificial Mains Network (AMN) by a 0.8 m shielded power supply cable directly connected to the AMN

### Conditions

- ☐ Frequency range was 9kHz – 30MHz.
- ☐ Frequency range was 10kHz – 30MHz.
- ☒ Frequency range was 150kHz – 30MHz.

The measuring bandwidth is 200Hz in the frequency range 9 kHz – 150 kHz. Measurement was made with a 100 Hz step size and 100 ms dwell time.

The measuring bandwidth is 9 kHz in the frequency range 150 kHz – 30 MHz. Measurement was made with a 4.5 kHz step size and 20 ms dwell time.

Measurement uncertainty:  $\pm 3.8$  dB (9 kHz – 150 kHz);  $\pm 3.5$  dB (150 kHz – 30 MHz)

### Instruments used during measurement

Instrument list: [AMN: R&S / ENV216 \(LR-1665\) \(11/2019\)](#)  
[EMI Receiver: R&S / ESCI 3 \(N-4259\) \(10/2019\)](#)

### Conformity

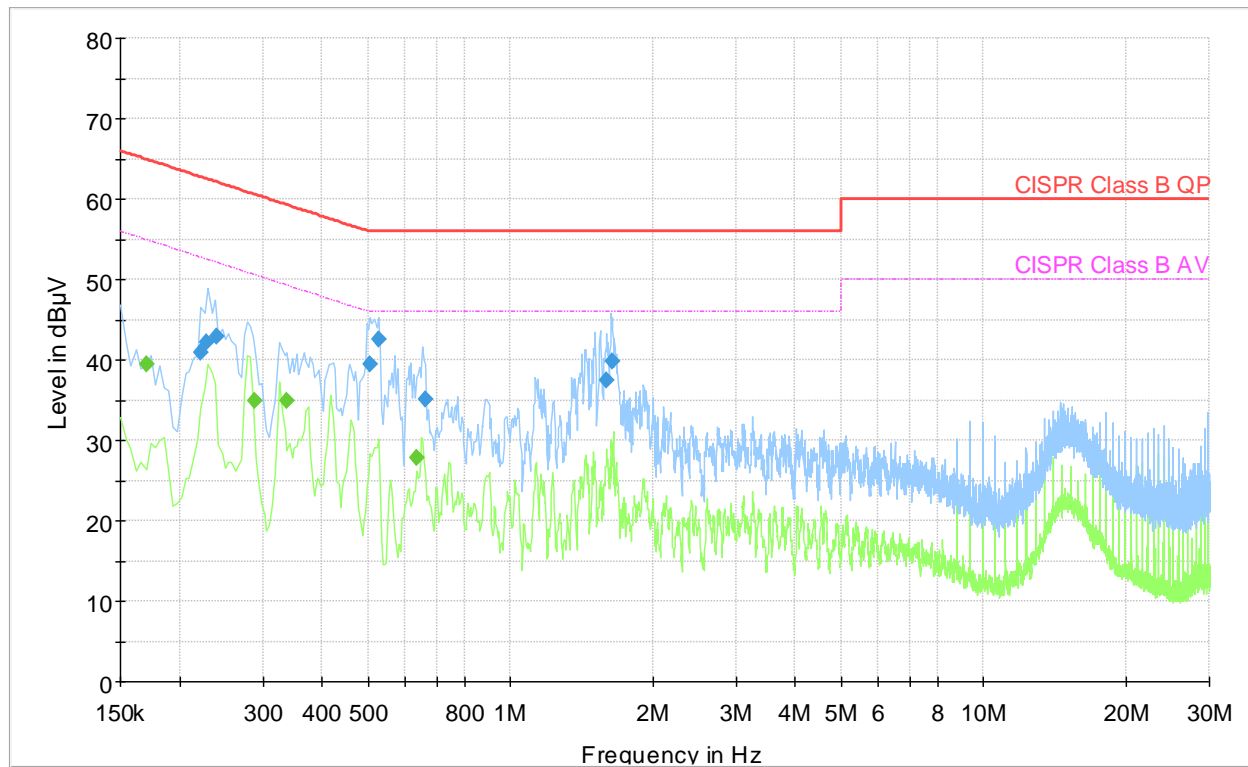
Verdict: **PASS**

Test engineer: **THT**

## EMISSION SPECTRUM

Direct charging with the drone, 230V AC 50Hz

Full Spectrum



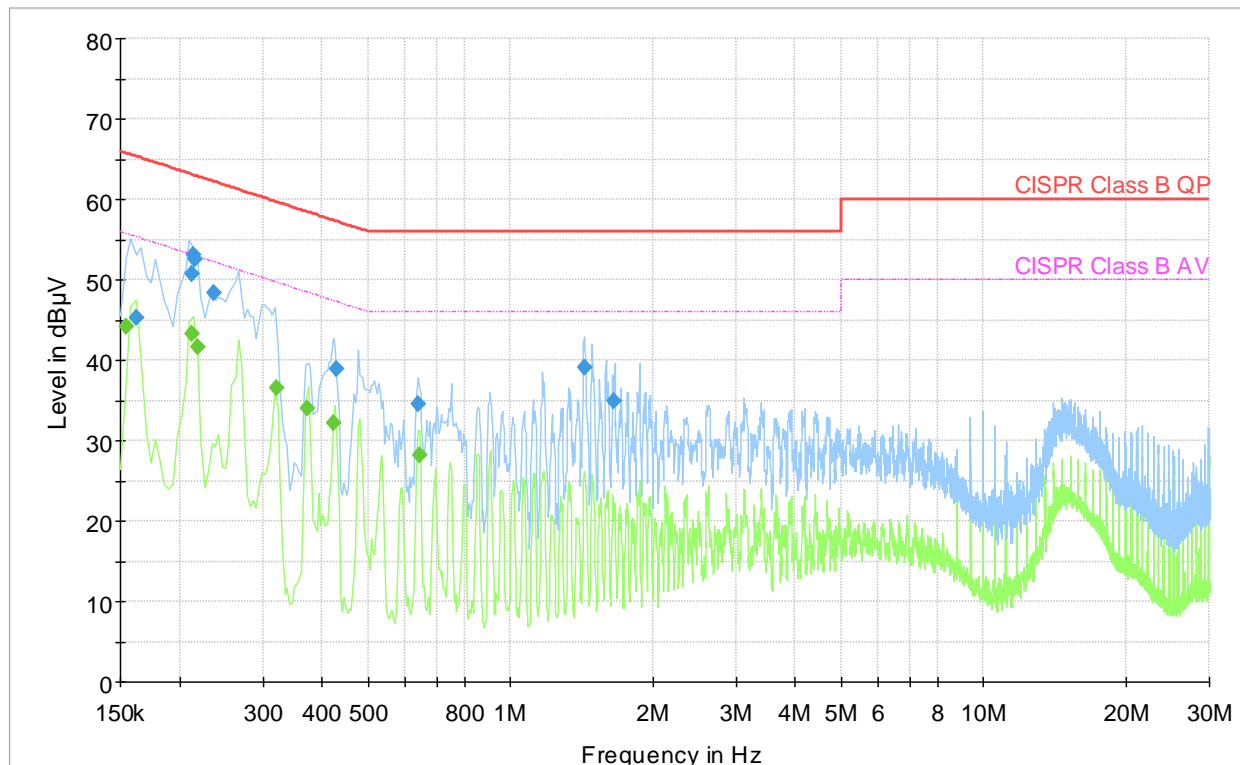
## MEASUREMENT DATA

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter
0.170	---	39.53	54.96	15.43	1000	9	N	OFF
0.222	40.94	---	62.74	21.80	1000	9	L1	OFF
0.228	42.17	---	62.52	20.36	1000	9	L1	OFF
0.240	42.84	---	62.10	19.25	1000	9	L1	OFF
0.288	---	34.93	50.58	15.65	1000	9	N	OFF
0.336	---	34.94	49.30	14.36	1000	9	N	OFF
0.504	39.40	---	56.00	16.60	1000	9	L1	OFF
0.528	42.51	---	56.00	13.49	1000	9	N	OFF
0.636	---	27.84	46.00	18.16	1000	9	N	OFF
0.660	35.06	---	56.00	20.94	1000	9	N	OFF
1.600	37.52	---	56.00	18.48	1000	9	N	OFF
1.644	39.79	---	56.00	16.21	1000	9	L1	OFF

## EMISSION SPECTRUM

Direct charging with the drone, 120V AC 60Hz

Full Spectrum



## MEASUREMENT DATA

Frequency (MHz)	QuasiPeak (dBμV)	Average (dBμV)	Limit (dBμV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter
0.154	---	44.16	55.78	11.62	1000	9	N	OFF
0.162	45.22	---	65.36	20.14	1000	9	L1	OFF
0.212	50.81	---	63.13	12.31	1000	9	N	OFF
0.212	---	43.27	53.13	9.86	1000	9	L1	OFF
0.214	53.01	---	63.05	10.04	1000	9	L1	OFF
0.216	52.49	---	62.97	10.48	1000	9	L1	OFF
0.218	---	41.58	52.90	11.31	1000	9	L1	OFF
0.236	48.32	---	62.24	13.91	1000	9	L1	OFF
0.320	---	36.54	49.71	13.17	1000	9	L1	OFF
0.372	---	33.99	48.46	14.47	1000	9	N	OFF
0.424	---	32.12	47.37	15.25	1000	9	L1	OFF
0.428	38.83	---	57.29	18.47	1000	9	L1	OFF
0.640	34.49	---	56.00	21.51	1000	9	N	OFF
0.644	---	28.12	46.00	17.88	1000	9	N	OFF
1.436	39.11	---	56.00	16.89	1000	9	L1	OFF
1.660	34.87	---	56.00	21.14	1000	9	L1	OFF

## RADIATED EMISSIONS (30MHZ-1000MHZ)

### TEST DESCRIPTION

#### Method

The reference method for this test is listed in the table under clause TEST SUMMARY.

#### Set-up

The measurements were performed in a semi-anechoic chamber (SAC). Nominal supply voltage was provided.

The specimen was energized and in normal operating mode during the measurement.

- ☐ The specimen and its cables were elevated 10 cm above the site ground plane, and placed in the centre of the turntable.
- ☒ The specimen and its cables were placed on a table 80 cm above the site ground plane and placed in the centre of the turntable.

The measuring antenna was located 10 meters from the specimen. Measurements were performed with a hybrid bilog antenna. Antenna elevation = 100-400 cm above the ground reference plane. Specimen rotation = 0-360°.

#### Conditions

The measuring bandwidth is 120 kHz in the frequency range 30 MHz – 1000 MHz. Frequency sweeps with RBW = 120 kHz and VBW = 1 MHz was applied with a sweep time of 20 ms (step size resolution < 60 kHz).

Measurement uncertainty:  $\pm 4.1$  dB (30 MHz – 200 MHz);  $\pm 4.2$  dB (200 MHz – 1000 MHz)

#### Instruments used during measurement

Instrument list:      Antenna, bilog: Sunol / JB3 (N-4525) (11/2019)  
                                 EMI Receiver: R&S / ESU40 (LR-1639) (11/2019)  
                                 Preamplifier: Sonoma / 310N (LR-1686) (07/2019)

#### Conformity

Verdict:

PASS

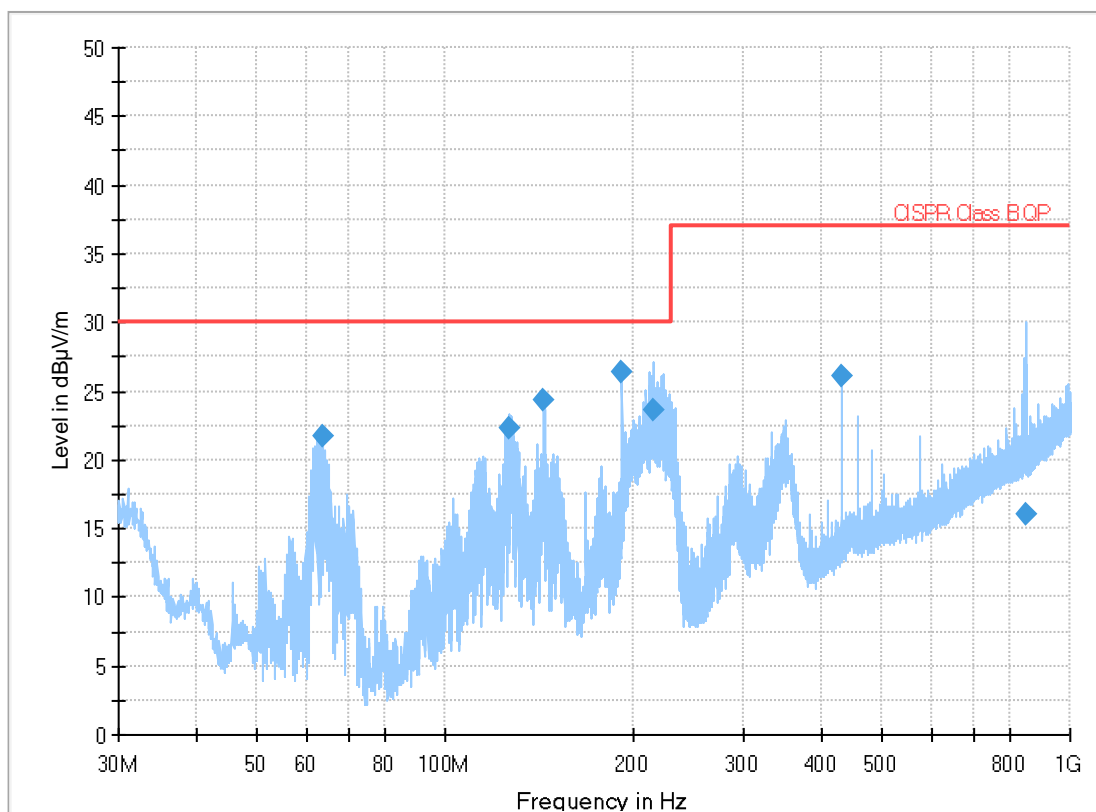
Test engineer:

TD

## EMISSION SPECTRUM

Streaming with light off and all motors off:

Full Spectrum

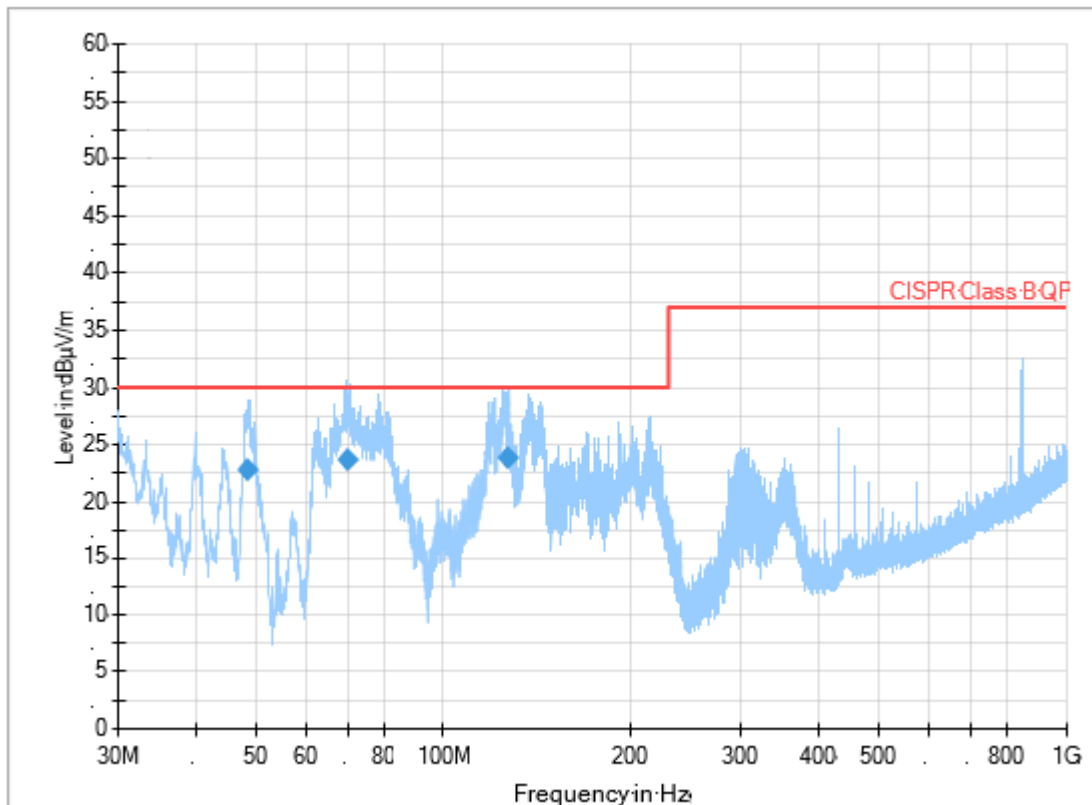


## MEASUREMENTS DATA

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
63.602828	21.74	30.00	8.26	1000.0	120.000	147.0	V	166.0	-23.9
126.600939	22.37	30.00	7.63	1000.0	120.000	410.0	V	155.0	-17.1
144.000300	24.29	30.00	5.71	1000.0	120.000	396.0	V	24.0	-17.6
191.999450	26.41	30.00	3.59	1000.0	120.000	99.0	V	162.0	-18.2
215.850039	23.65	30.00	6.35	1000.0	120.000	101.0	V	216.0	-18.9
431.997761	26.06	37.00	10.94	1000.0	120.000	410.0	V	336.0	-13.0
851.154644	16.07	37.00	20.93	1000.0	120.000	329.0	V	346.0	-5.9

## EMISSION SPECTRUM

Streaming with 10% light on and 20% motors on:



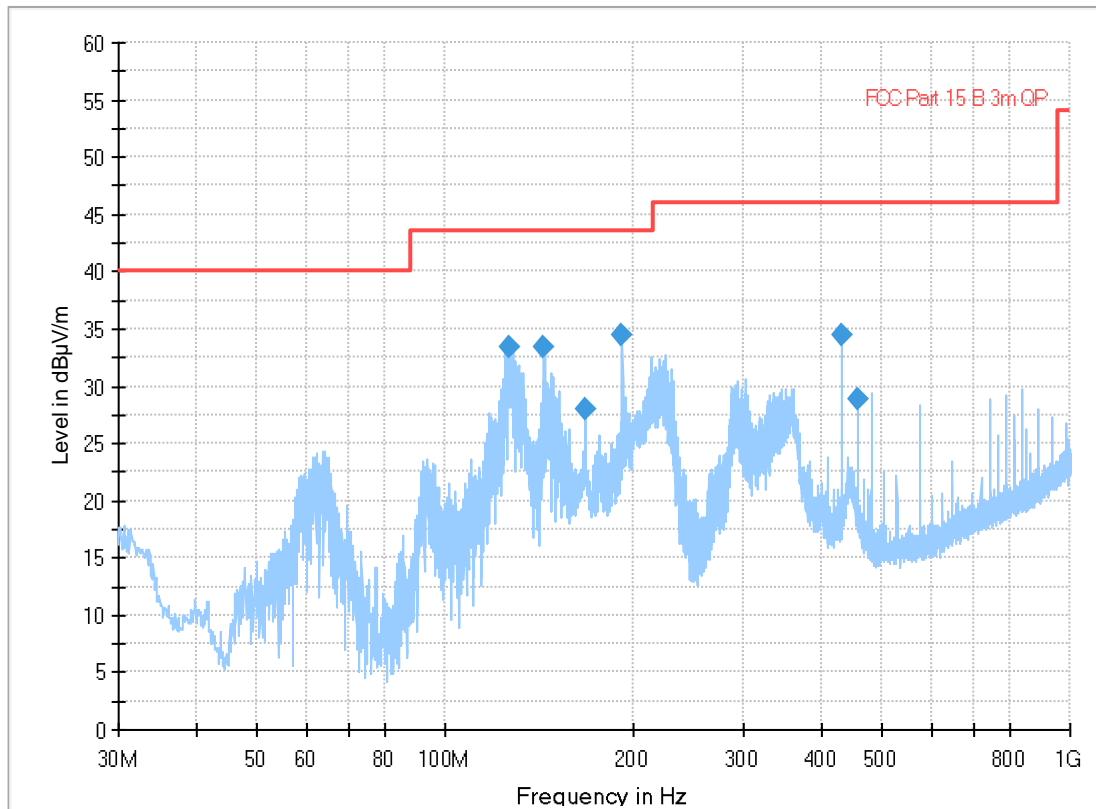
## MEASUREMENTS DATA

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
48.507211	22.68	30.00	7.32	1000.0	120.000	248.0	V	66.0	-20.8
69.899389	23.69	30.00	6.31	1000.0	120.000	147.0	V	327.0	-23.9
127.277100	23.73	30.00	6.27	1000.0	120.000	357.0	H	11.0	-17.1

## EMISSION SPECTRUM

Streaming with light off and all motors off:

Full Spectrum



## MEASUREMENTS DATA

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
126.601650	33.34	43.50	10.16	1000.0	120.000	255.0	H	45.0	-17.4
144.000050	33.42	43.50	10.08	1000.0	120.000	196.0	H	241.0	-17.9
168.000100	27.93	43.50	15.57	1000.0	120.000	276.0	V	9.0	-19.1
192.000350	34.53	43.50	8.97	1000.0	120.000	106.0	H	110.0	-18.5
431.999000	34.53	46.00	11.47	1000.0	120.000	128.0	V	62.0	-13.5
456.001250	28.90	46.00	17.10	1000.0	120.000	117.0	V	69.0	-12.9



# RADIATED EMISSIONS (ABOVE 1GHZ)

## TEST DESCRIPTION

### Method

The reference method for this test is listed in the table under clause TEST SUMMARY.

### Set-up

Nominal supply voltage was provided. The specimen was energized and in normal operating mode during the measurement.

☒ The measurements were performed in a semi-anechoic chamber (SAC) (calibrated volume: D=1.5m / H=2.0m).

☐ The measurements were performed in a fully anechoic room (FAR) (calibrated volume: D=1.2m / H=2.0m).

☐ The specimen and its cables were elevated 10 cm above the site ground plane and placed in the centre of the turntable.

☒ The specimen and its cables were placed on a table 80 cm above the site ground plane and placed in the centre of the turntable.

The reference ground plane was covered with ferrite absorbers in the reflecting area between the specimen and the measuring antenna.

The measuring antenna was located 3 meters from the specimen. Measurements were performed with a double-ridged guide horn antenna. Antenna elevation = fixed at centre of specimen height. Specimen rotation = 0-360°.

### Frequency range:

- ☐ 1-2 GHz  
☐ 1-5 GHz  
☒ 1-6 GHz  
☒ 1-12 GHz

### Highest internal frequency of specimen:

- ☐ Below 108MHz  
☐ Between 108MHz and 500MHz  
☐ Between 500MHz and 1000MHz  
☒ Above 1000MHz

The measuring bandwidth is 1 MHz in the above frequency range. Frequency sweeps with RBW = 1 MHz and VBW = 1 MHz was applied with a sweep time of 100 ms (proper segmentation of the frequency range was applied to obtain step size resolution < 500 kHz).

Measurement uncertainty: ± 4.8 dB

### Instruments used during measurement

Instrument list: Antenna Horn: ETS / 3117-PA (LR-1717) (12/2018)  
EMI Receiver: R&S / ESU40 (LR-1639) (11/2019)

### Conformity

Verdict:

PASS

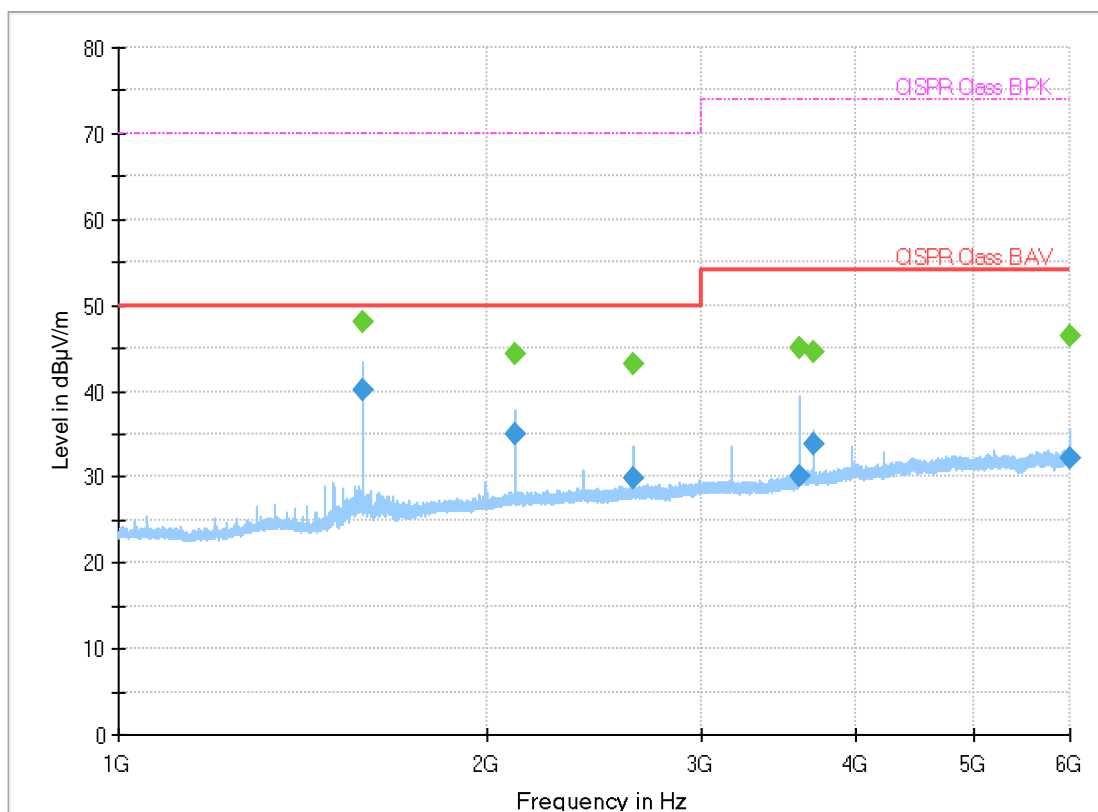
Test engineer:

TD

## EMISSION SPECTRUM (VERTICAL POLARIZATION)

Streaming with light off and all motors off:

Full Spectrum



VP

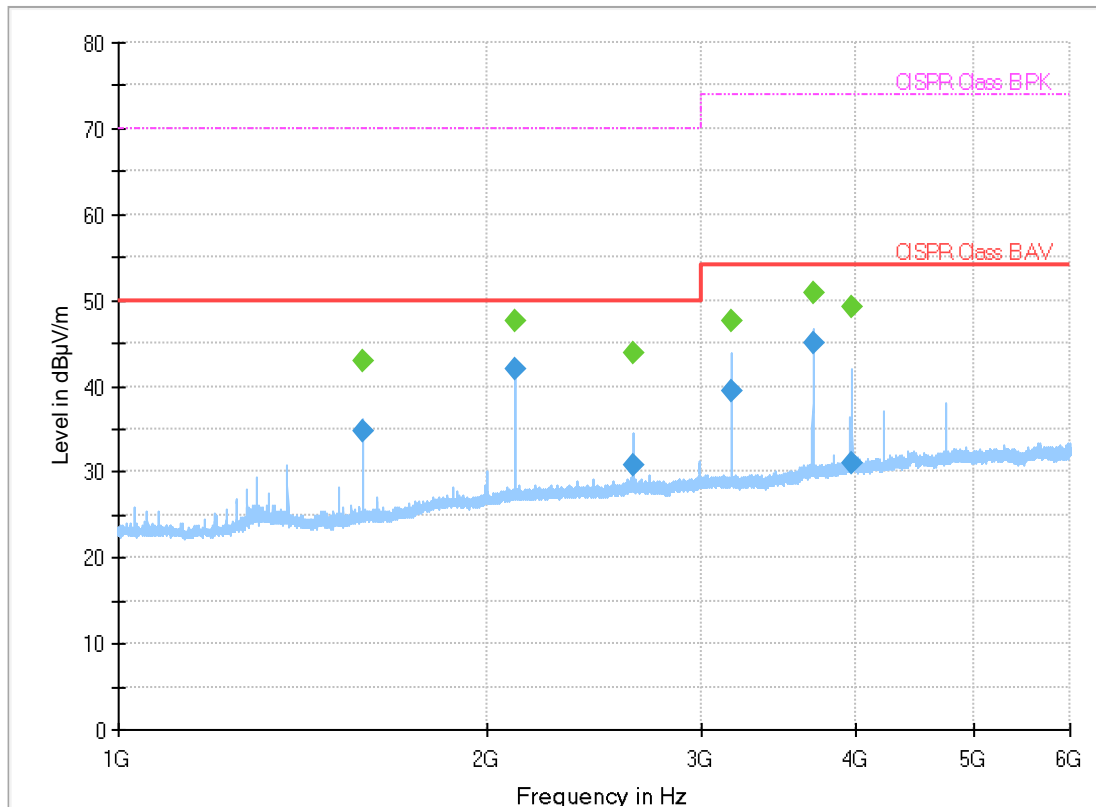
## MEASUREMENTS DATA

Frequency (MHz)	Average (dBμV/m)	MaxPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
1583.939333	---	48.06	70.00	21.94	1000.0	1000.000	99.0	V	1.0
1583.939333	40.18	---	50.00	9.82	1000.0	1000.000	99.0	V	1.0
2111.978000	---	44.29	70.00	25.71	1000.0	1000.000	99.0	V	0.0
2111.978000	34.98	---	50.00	15.02	1000.0	1000.000	99.0	V	0.0
2639.988000	29.80	---	50.00	20.20	1000.0	1000.000	99.0	V	5.0
2639.988000	---	43.09	70.00	26.91	1000.0	1000.000	99.0	V	5.0
3600.000000	---	45.00	74.00	29.00	1000.0	1000.000	99.0	V	4.0
3600.000000	30.17	---	54.00	23.83	1000.0	1000.000	99.0	V	4.0
3695.935333	33.93	---	54.00	20.07	1000.0	1000.000	99.0	V	3.0
3695.935333	---	44.46	74.00	29.54	1000.0	1000.000	99.0	V	3.0
5999.878500	---	46.35	74.00	27.65	1000.0	1000.000	99.0	V	327.0
5999.878500	32.19	---	54.00	21.81	1000.0	1000.000	99.0	V	327.0

## EMISSION SPECTRUM (HORIZONTAL POLARIZATION)

Streaming with light off and all motors off:

Full Spectrum



HP

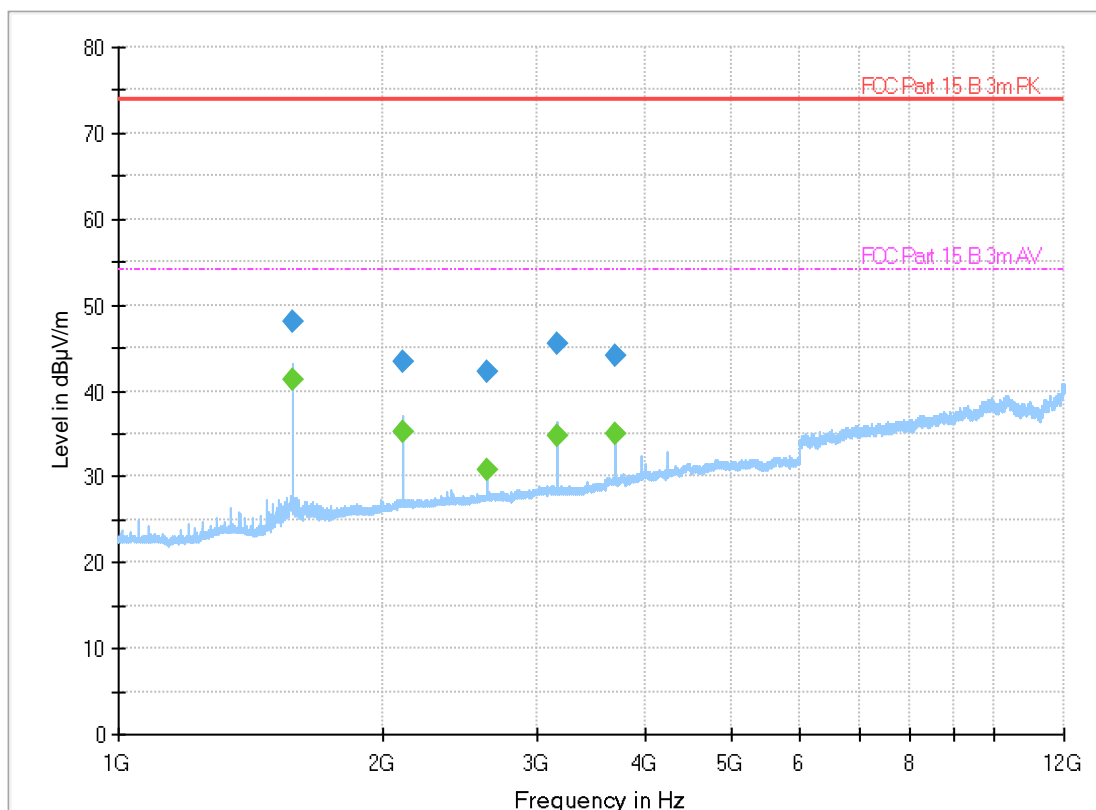
## MEASUREMENTS DATA

Frequency (MHz)	Average (dBμV/m)	MaxPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
1584.042333	---	42.89	70.00	27.11	1000.0	1000.000	99.0	H	318.0
1584.042333	34.74	---	50.00	15.26	1000.0	1000.000	99.0	H	318.0
2112.076000	---	47.51	70.00	22.49	1000.0	1000.000	99.0	H	306.0
2112.076000	42.05	---	50.00	7.95	1000.0	1000.000	99.0	H	306.0
2639.951000	30.85	---	50.00	19.15	1000.0	1000.000	99.0	H	19.0
2639.951000	---	43.77	70.00	26.23	1000.0	1000.000	99.0	H	19.0
3168.059000	39.41	---	54.00	14.59	1000.0	1000.000	99.0	H	2.0
3168.059000	---	47.54	74.00	26.46	1000.0	1000.000	99.0	H	2.0
3696.045000	---	50.79	74.00	23.21	1000.0	1000.000	99.0	H	44.0
3696.045000	45.00	---	54.00	9.00	1000.0	1000.000	99.0	H	44.0
3984.038667	---	49.18	74.00	24.82	1000.0	1000.000	99.0	H	18.0
3984.038667	30.97	---	54.00	23.03	1000.0	1000.000	99.0	H	18.0

## EMISSION SPECTRUM (VERTICAL POLARIZATION)

Streaming with light off and all motors off:

Full Spectrum



VP

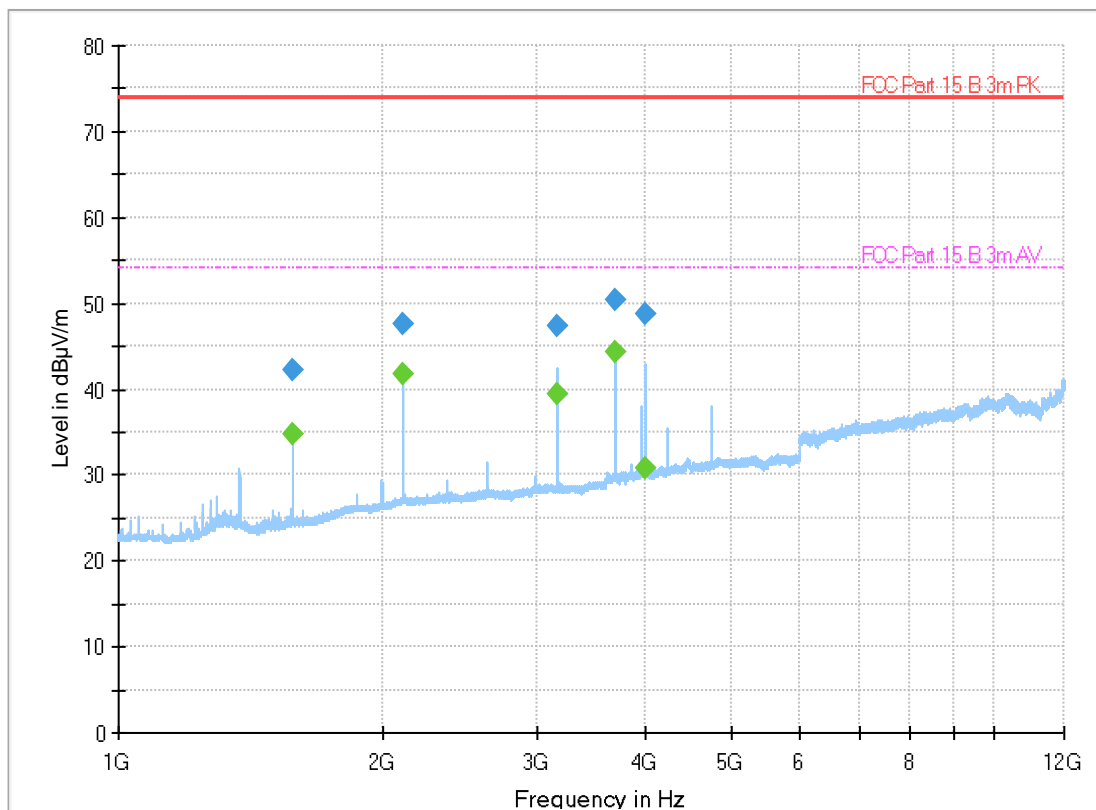
## MEASUREMENTS DATA

Frequency (MHz)	MaxPeak (dBμV/m)	Average (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
1583.996000	---	41.30	54.00	12.70	1000.0	1000.000	99.0	V	6.0
1583.996000	47.94	---	74.00	26.06	1000.0	1000.000	99.0	V	6.0
2111.991000	---	35.26	54.00	18.74	1000.0	1000.000	99.0	V	5.0
2111.991000	43.50	---	74.00	30.50	1000.0	1000.000	99.0	V	5.0
2639.983000	42.30	---	74.00	31.70	1000.0	1000.000	99.0	V	345.0
2639.983000	---	30.81	54.00	23.19	1000.0	1000.000	99.0	V	345.0
3167.980500	---	34.66	54.00	19.34	1000.0	1000.000	99.0	V	337.0
3167.980500	45.55	---	74.00	28.45	1000.0	1000.000	99.0	V	337.0
3695.996000	44.15	---	74.00	29.85	1000.0	1000.000	99.0	V	16.0
3695.996000	---	35.10	54.00	18.90	1000.0	1000.000	99.0	V	16.0

## EMISSION SPECTRUM (HORIZONTAL POLARIZATION)

Streaming with light off and all motors off:

Full Spectrum



HP

## MEASUREMENTS DATA

Frequency (MHz)	MaxPeak (dBμV/m)	Average (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
1583.984000	42.13	---	74.00	31.87	1000.0	1000.000	99.0	H	326.0
1583.984000	---	34.77	54.00	19.23	1000.0	1000.000	99.0	H	326.0
2111.992000	47.63	---	74.00	26.37	1000.0	1000.000	99.0	H	311.0
2111.992000	---	41.77	54.00	12.23	1000.0	1000.000	99.0	H	311.0
3168.002000	---	39.48	54.00	14.52	1000.0	1000.000	99.0	H	1.0
3168.002000	47.42	---	74.00	26.58	1000.0	1000.000	99.0	H	1.0
3695.980500	---	44.24	54.00	9.76	1000.0	1000.000	99.0	H	49.0
3695.980500	50.44	---	74.00	23.56	1000.0	1000.000	99.0	H	49.0
3983.987000	---	30.88	54.00	23.12	1000.0	1000.000	99.0	H	0.0
3983.987000	48.67	---	74.00	25.33	1000.0	1000.000	99.0	H	0.0

# ELECTROSTATIC DISCHARGE (ESD) IMMUNITY

## TEST DESCRIPTION

### Method

The reference method for this test is listed in the table under clause TEST SUMMARY.

### Set-up

The specimen was energized and in normal operating condition.

- ☐ Floor standing equipment. Specimen was elevated 10 cm above the ground reference plane.
- ☒ Table top equipment. Specimen was placed on a test table 80 cm above the reference ground plane.  
A horizontal coupling plane (HCP) of 160x80 cm was placed on the test table, just beneath the specimen, and connected to the reference plane via a cable with two 470kΩ resistors located one in each end of the cable. The specimen was separated from the HCP by a 0.5mm insulating support.

A vertical coupling plane (VCP) of 50x50 cm was placed 10 cm from the specimen exterior. This VCP is connected to the reference plane via a cable with two 470kΩ resistors located one in each end of the cable.

The ESD generator's reference ground was connected to the reference ground plane.

### Procedure

- ☒ Indirect contact discharges were applied to the mid edge of the VCP.
- ☒ Indirect contact discharges were applied to the mid edge of the HCP.
- ☒ Direct contact discharges were applied to various selected test points of the specimen at conductive surfaces,
- ☒ Direct air discharges were applied to various selected test points of the specimen at non-conductive surfaces.

Discharges were applied at increasing levels to each test point.

Uncertainty figures: Peak voltage: ± 10 %; Transient shape: ± 30 %

A functional test was performed before and after the exposure. The specimen was observed during exposure in order to detect unintended responses.

### Instruments used during measurement

Instrument list: **ESD Generator: EMTest / ESD30N (N-4643) (03/2019)**

Temperature:	<b>23 °C</b>
Humidity:	<b>43 %RH</b>
Atmos. pressure:	<b>1003 hPA</b>

### Conformity

Verdict:	<b>PASS</b>
Test engineer:	<b>TD</b>

## PHOTO OF SELECTED TEST POINTS

## DETAILED TEST LOG

Test Point	Applied Level [kV]	Discharge Type	Discharges per test level	Required Criteria	Complied Criteria	Result
Enclosure, plastic parts	$\pm 4, \pm 8$	Air	10	B	A	PASS
Camera, glass	$\pm 4, \pm 8$	Air	10	B	A	PASS
Cables	$\pm 4, \pm 8$	Air	10	B	A	PASS
Cover, metallic parts	$\pm 2, \pm 4$	Contact	10	B	A	PASS
All metallic screws	$\pm 2, \pm 4$	Contact	10	B	A	PASS
HCP	$\pm 2, \pm 4$	Contact	10	B	A	PASS
VCP	$\pm 2, \pm 4$	Contact	10	B	A	PASS

Note: ND = No Discharge, indicates discharge attempts, which have given no actual observable discharge.

## OBSERVATIONS

No malfunctions were recorded during or after the applied test(s).  
 Observations showed no unintended responses during test(s).

# RADIATED RF DISTURBANCE IMMUNITY

## TEST DESCRIPTION

### Method

The reference method for this test is listed in the table under clause TEST SUMMARY.

### Set-up

The tests were performed at 3 meter antenna distance in an anechoic chamber.

- ☐ The specimen was placed on a Styrofoam support 10 cm above the floor.  
☒ The specimen was placed on a Styrodur/styrofoam table 80 cm above the floor.

The specimen was placed within the calibrated volume, and the cables connected to the specimen was arranged so that 100 cm of each cable was exposed to the electromagnetic field.  
Interconnecting cables specified  $\leq 300$  cm whose length exceeded 100 cm were bundled to achieve 100 cm length.  
Interconnecting cables specified  $> 300$  cm and other cables connected to the specimen are exposed for 100 cm, and the remaining cable length was decoupled with the use of ferrites.

### Procedure

The specimen was exposed to the RF electromagnetic field generated by one or more antennas. The polarization of the field requires testing each side of the specimen twice, once with the antenna horizontally and again with the antenna vertically. The antenna height during test was 150 cm.

Exposed side of the specimen:

- ☒ 0° (front) ☐ Top (handheld)  
☒ 90° ☐ Bottom (handheld)  
☒ 180° (rear)  
☒ 270°

Frequency sweep rate:

- ☒ 1% step with 3 sec dwell time  
☐  $1.5 \times 10^{-3}$  decades/sec (80 – 1000MHz)  
☐  $0.5 \times 10^{-3}$  decades/sec (1000 – 2000MHz)  
☐ Other:

Frequency range:

- ☒ 80MHz – 1000MHz  
☐ 1400MHz – 2000MHz  
☒ 1000MHz – 3000MHz  
☐ 80MHz – 2000MHz  
☐ 80MHz – 6000MHz

Modulation:

- ☒ 80% AM @ 1000Hz  
☐ 80% AM @ 400Hz  
☐ 50% PM @ 217Hz

Uncertainty figures:

Field level:  $\pm 2.4$  dB

A functional test was performed before and after the exposure. The specimen was observed during exposure in order to detect unintended responses.

### Instruments used during measurement

Instrument list: Amplifier, RF: R&S / BBA150-BC500 (LR-1720) (N/A)  
Amplifier, RF: R&S / BBA150-D110E100 (LR-1721) (N/A)  
Antenna Log-periodic: AR / ATR80M6G (LR-1724) (N/A)  
Field Meter: ETS / HI-6113 (LR-1723) (N/A)  
Field probe: ETS / HI-6153 (LR-1722) (04/2019)  
Generator, RF: R&S / SMB100A (LR-1688) (06/2019)  
Power Sensor: R&S / NRP6AN (LR-1718) (03/2019)  
Power Sensor: R&S / NRP6AN (LR-1719) (03/2019)

### Conformity

Verdict:

PASS

Test engineer:

TD



## DETAILED TEST LOG

Frequency range [MHz]	Field strength [V/m]	Polarization	Required Criteria	Complied Criteria	Result
80 - 1000	3	HOR	A	A	PASS
80 - 1000	3	VER	A	A	PASS
1000 - 3000	3	HOR	A	A	PASS
1000 - 3000	3	VER	A	A	PASS

## OBSERVATIONS

No malfunctions were recorded during or after the applied test(s).  
Observations showed no unintended responses during test(s).

# ELECTRIC FAST TRANSIENTS IMMUNITY

## TEST DESCRIPTION

### Method

The reference method for this test is listed in the table under clause TEST SUMMARY.

### Set-up

Mains power was supplied to the specimen via the coupling network. The specimen was energized and in normal operating condition.

- ☒ The specimen and its cables were elevated 10 cm above the reference ground plane.
- ☐ Artificial hand was applied during test (for location see photos).

### Procedure

Transients were applied at increasing levels to each single line at the AC or DC input port using a coupling network, and to relevant signal ports using a capacitive coupling clamp.

#### Duration:

- ☐ 1 minute
- ☐ 2 minutes
- ☒ 5 minutes

#### Repetition frequency:

- ☒ 5kHz
- ☐ 100kHz

#### Uncertainty figures:

Peak voltage:  $\pm 10\%$   
Transient shape:  $\pm 30\%$

A functional test was performed before and after the exposure. The specimen was observed during exposure in order to detect unintended responses.

### Instruments used during measurement

Instrument list: Coupling Clamp, EFT/B: Haefely / IP4A (LR-1638) (N/A)  
Generator: EMTest / UCS 500 N7 (LR-1608) (05/2020)

### Conformity

Verdict:

PASS

Test engineer:

TD

## DETAILED TEST LOG

Port	Applied Level [kV]	Injection Method	Required Criteria	Complied Criteria	Result
Signal Port (Communication Tether)	$\pm 0.5\text{kV}$	CLAMP	B	A	PASS

## OBSERVATIONS

No malfunctions were recorded during or after the applied test(s).  
Observations showed no unintended responses during test(s).

# CONDUCTED RF DISTURBANCE IMMUNITY

## TEST DESCRIPTION

### Method

The reference method for this test is listed in the table under clause TEST SUMMARY.

### Set-up

Mains power was supplied to the specimen via the coupling network. The specimen was energized and in normal operating condition.

- ☒ The specimen was elevated 10 cm above the reference ground plane.
- ☒ Cables were elevated 5 cm above the reference ground plane.
- ☐ Artificial hand was applied during test (for location see photos).

All specimen ports, which are not subject to testing, are furnished with decoupling networks to achieve RF isolation of the specimen during test. A return path was created according to the priority given in §7.2 of the reference standard.

### Procedure

Disturbance was applied via a coupling/decoupling network (CDN) or an electromagnetic coupling clamp (EM Clamp) to each port separately.

#### Frequency range:

- ☒ 150kHz – 80MHz
- ☐ 150kHz – 230MHz
- ☐ Spot frequencies

#### Modulation:

- ☒ 80% AM @ 1000Hz
- ☐ 80% AM @ 400Hz
- ☐ 50% PM @ 217Hz

#### Frequency sweep rate:

- ☒ 1% step with 3 sec dwell time
- ☐  $1.5 \times 10^{-3}$  decades/sec
- ☐ Other:

Measurement uncertainty:  $\pm 2.8$  dB (150 kHz – 26 MHz);  $\pm 3.7$  dB (26 MHz – 80 MHz)

A functional test was performed before and after the exposure. The specimen was observed during exposure in order to detect unintended responses.

### Instruments used during measurement

Instrument list: Amplifier, RF: AR / 75A250 (N-3816) (N/A)  
 EM Clamp: FCC / F-2031-23mm (LR-1482) (N/A)  
 Generator, signal: R&S / SMB100A (LR-1649) (05/2019)  
 Power Meter: R&S / NRP2 (LR-1652) (10/2019)

### Conformity

Verdict: **PASS**

Test engineer: **TD**

## DETAILED TEST LOG

Tested Port	Injection Method	Return Path	Applied Level [Vrms]	Required Criteria	Complied Criteria	Result
Signal Port (Communication Tether)	EM CLAMP	Capacitive	3 Vrms	A	A	PASS

☐ Additional tests were performed at discrete spot frequencies with 10Vrms test level. Spot frequencies which were tested are; 2 MHz, 3 MHz, 4 MHz, 6,2 MHz, 8,2 MHz, 12,6 MHz, 16,5 MHz, 18,8 MHz, 22 MHz and 25 MHz.

## OBSERVATIONS

No malfunctions were recorded during or after the applied test(s).  
 Observations showed no unintended responses during test(s).

# POWER FREQUENCY MAGNETIC FIELDS IMMUNITY

## TEST DESCRIPTION

### Method

The reference method for this test is listed in the table under clause TEST SUMMARY.

### Set-up

The specimen was energized during test.

The tests were performed with a single squared 100x100 cm coil. The specimen was placed in the centre of the coil above a ground reference plane.

### Procedure

The specimen was exposed to the magnetic field of a magnitude and frequency as specified below. Then the coil orientation was changed to repeat the testing in the 3 orthogonal axes (X, Y and Z).

Duration:

☐ 1 minute

☒ 5 minutes

☐ Time necessary for a full operating cycle:

Uncertainty figures:

Field level:  $\pm 2.5\%$

Frequency:  $\pm 1\%$

Distortion:  $<2\%$

A functional test was performed before and after the exposure. The specimen was observed during exposure in order to detect unintended responses.

### Instruments used during measurement

Instrument list: Current Transformer: EMTes / MC 2630 (LR-1618) (N/A)  
Generator: EMTes / UCS 500 N7 (LR-1608) (05/2020)  
Magnetic coil: EMTes / MS100N (LR-1611) (N/A)  
Motorized Variac: EMTes / MV 2616 (LR-1610) (05/2020)

### Conformity

Verdict: PASS

Test engineer: TD

## DETAILED TEST LOG

Axis [X/Y/Z]	Field Strength [A/m]	Field Frequency	Required Criteria	Complied Criteria	Result
X	10	AC 50Hz	A	A	PASS
Y	10	AC 50Hz	A	A	PASS
Z	10	AC 50Hz	A	A	PASS
X	10	AC 60Hz	A	A	PASS
Y	10	AC 60Hz	A	A	PASS
Z	10	AC 60Hz	A	A	PASS

## OBSERVATIONS

No malfunctions were recorded during or after the applied test(s).

Observations showed no unintended responses during test(s).

# Annexes

## PHOTOS

Test set-up for EMC emissions measurements	

Accessories:	