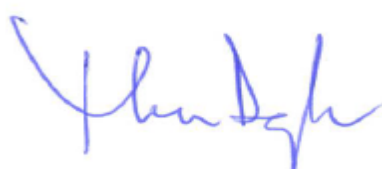


Test Report

Electromagnetic Compatibility

Product	Blueye Charger to Blueye Pioneer underwater drone		
Name and address of the applicant	Blueye Robotics AS Transittgata 10 7042 Trondheim, Norway		
Name and address of the manufacturer	Blueye Robotics AS Transittgata 10 7042 Trondheim, Norway		
Model	Blueye Charger		
Rating	Input Input 19,5 V DC, 4 A (Power supplied from an AC/DC 100-240V AC 50/60Hz) Output 16,8 V DC, 2,5 A – for Blueye Smart Battery USB Outputs 5 V DC - Surface unit charging port: 2,1 A (Middle port) - Top and bottom USB charging port: 400mA		
Trademark	Blueye		
Serial number	6018 – See product marking.		
Additional information	-		
Tested according to	EN 55032:2012 + AC:2013 EN 55024:2010 FCC CFR 47 Part 15		
Order number	340630		
Tested in period	2018-04-10 – 2018-04-11, 2018-09-26 – 2018-09-27, 2018-10-29 and 2018-11-19		
Issue date	2018-11-22		
Name and address of the testing laboratory	Nemko Group Nemko AS Gaustadalléen 30, P.O.Box 73 Blindern, 0314 Oslo, Norway TEL: +47 22 96 03 30 FAX: +47 22 96 05 50  		
An accredited technical test executed under the Norwegian accreditation scheme			
 Prepared by [Thomas Dangelé]  Approved by [Tore Løvlien]			
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REPORT REVISIONS

Revision #	Date	Order #	Description
00	2018-11-22	340630	First issued



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.

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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.....:	Charger for the Smart Blueye Battery
Model/type.....:	Blueye Charger
Serial number.....:	6018 – See product marking
Operating voltage.....:	19.5V DC (Power supplied from an AC/DC 100-240 VAC 50/60 Hz)
Maximum power/current.....:	19.5V DC 4A
Insulation class.....:	EUT with external insulated AC/DC power supply (Class II)
Highest clock frequency.....:	876 kHz
Hardware version.....:	6
Software version.....:	-

Mounting position.....:	☒ Table top equipment ☐ Wall/ceiling mounted equipment ☐ Floor standing equipment ☐ Handheld equipment ☐ Rack mounted equipment ☐ Console equipment ☐ Other:
-------------------------	--

INPUT/OUTPUT PORTS

Port name and description	Cable		
	> 3m	Attached during test	Shielded
DC mains input (Power from the AC/DC Adapter)	☐	☒	☐
DC output for battery charging inside the drone	☐	☒	☐
DC output for battery charging outside the drone	☐	☒	☐
3 x USB ports for USB charging devices (only one during testing)	☐	☒	☐

OPERATING MODES

No.	Description	Applied for testing	
		Emissions	Immunity
1	USB device charging	☒	☒
2	Direct charging with the battery inside the drone	☒	☒
3	Indirect charging with the battery outside the drone	☒	☒

ACCESSORIES USED DURING TEST

Description	Manufacturer	Type
Drone	Blueye Robotics AS	-
AC/DC Power Adapter	FSP Group Inc	FSP230-AJAN3
USB device for charging	Any	-

PHOTOS AND DRAWINGS

Copy of marking label.....:	-	
Photo of the test item.....:	See photo in separate document	
Drawing of test setup.....:	-	

OTHER INFORMATION

Modifications to the test item.....:	Snap on ferrites need to be added on both the USB cable and the cable connected to the drone. See the photos above
Additional information.....:	There is a manual switch to prevent charging two batteries at the same time.

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.....:	☐ GAUSTAD (Gaustadalleen 30, N-0314 Oslo, Norway)
	☒ KJELLER (Instituttveien 6, N-2007 Kjeller, Norway)
Laboratory accreditation.....:	 Norsk Akkreditering – TEST 033 P06 – Electromagnetic Compatibility
Environmental ref. conditions.....:	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: Ambient temperature: 15 – 35 °C Relative humidity: 25 – 75 %RH Atmospheric pressure: 86 – 106 kPa 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.
Calibration.....:	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. The instrumentation accuracy is within limits agreed by the IECEE/CTL and defined by Nemko reference document TM-NO/301.
Measurement uncertainties.....:	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. EMC test uncertainties for transient immunity are kept within the requirements of the relevant basic standard. Further information about measurement uncertainties is provided on request

POWER SUPPLY SYSTEM UTILISED

Power supply voltage.....:	☐ 240V AC 50Hz ☒ 230V AC 50Hz ☐ 200V AC 60Hz ☒ 115V AC 60Hz	☐ 400V 3NAC 50Hz ☐ 230V 3AC 50Hz ☐ 12V DC ☐ 24V DC
	☐ The power supply voltage has been selected after a maximum disturbance investigation over the product's rated voltage range. Voltage: Frequency:	
Grounding conditions	☐ Not grounded ☒ Ground is received from its power supply connection ☐ Additional chassis grounding	

EVALUATION OF PERFORMANCE

PERFORMANCE TESTS

Performance checks.....:	Battery charging in both cases: direct charging with the battery inside the drone and indirect charging when the battery is outside the drone.
Performance tests.....:	Charging function in both cases
Monitoring during tests.....:	Visual monitoring with a camera inside the emc test chamber
Note 1: Performance check is a short functional test carried out during or after a technical test to confirm that the equipment operates. 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. Note 3: Monitoring during tests describes which functions were monitored and how.	

PERFORMANCE CRITERIA

Performance criteria is.....:	☒ based on the applied product standard
	☐ 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
EN 55032:2012 + AC:2013	<i>Electromagnetic compatibility of multimedia equipment - Emission requirements</i>
EN 55024:2010	<i>Information technology equipment - Immunity characteristics - Limits and methods of measurement</i>
FCC CFR 47 Part 15	<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 15 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 15 CISPR 16-2-3:2014, Ed.3.2	PASS
Radiated Emissions (Above 1GHz)	EN 55032:2012 + AC:2013 FCC CFR 47 Part 15 CISPR 16-2-3:2014, Ed.3.2	N/A
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	PASS
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	N/A
Dips and Interruptions Immunity	EN 55024:2010 EN 61000-4-11:2004, Ed.2.0	PASS

- 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: ± 3.8 dB (9 kHz – 150 kHz); ± 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

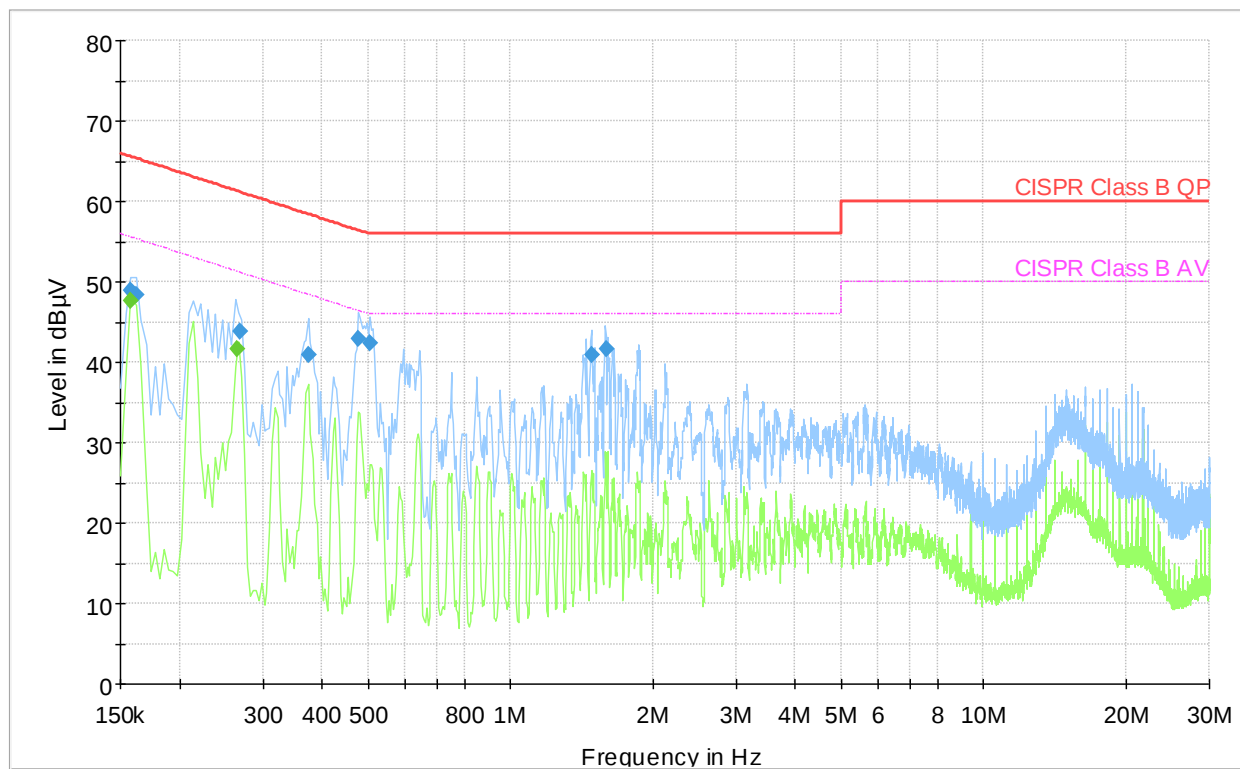
Verdict: PASS

Test engineer: THT

EMISSION SPECTRUM

Charging outside the drone, 230V AC 50Hz

Full Spectrum



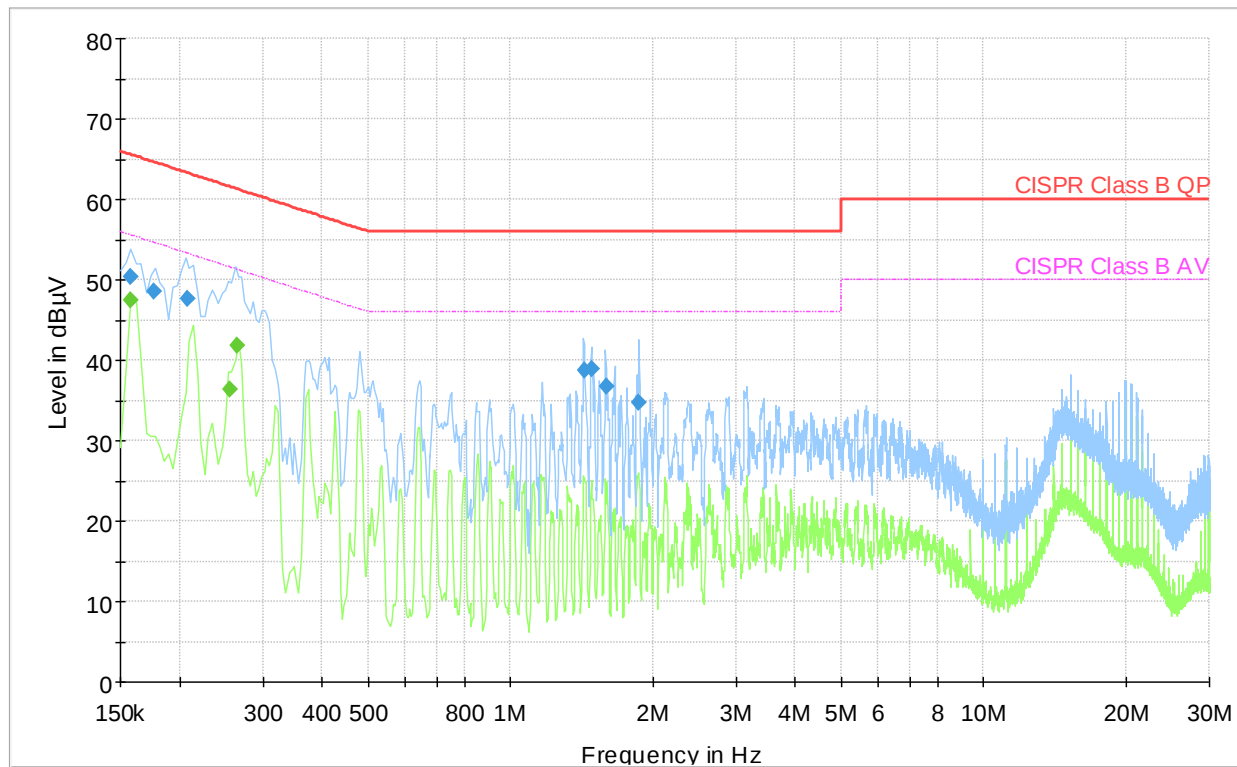
MEASUREMENT DATA

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter
0.158	48.99	---	65.57	16.58	1000	9	N	OFF
0.158	---	47.60	55.57	7.97	1000	9	L1	OFF
0.162	48.40	---	65.36	16.96	1000	9	N	OFF
0.264	---	41.60	51.31	9.70	1000	9	N	OFF
0.268	43.81	---	61.18	17.37	1000	9	N	OFF
0.376	40.99	---	58.37	17.38	1000	9	N	OFF
0.476	42.92	---	56.41	13.49	1000	9	L1	OFF
0.504	42.35	---	56.00	13.65	1000	9	N	OFF
1.484	40.94	---	56.00	15.06	1000	9	L1	OFF
1.592	41.66	---	56.00	14.34	1000	9	L1	OFF

EMISSION SPECTRUM

Charging outside the drone, 120V AC 60Hz

Full Spectrum



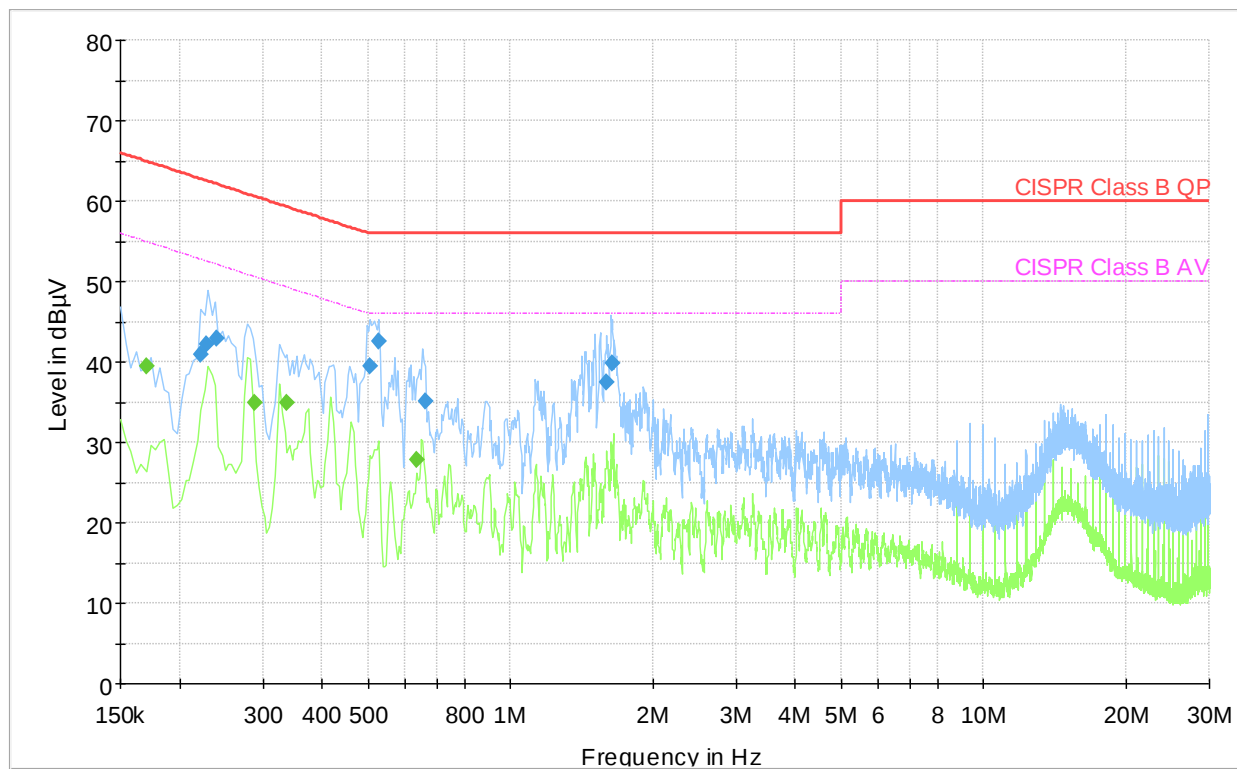
MEASUREMENT DATA

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter
0.158	---	47.41	55.57	8.16	1000	9	L1	OFF
0.158	50.31	---	65.57	15.26	1000	9	L1	OFF
0.176	48.54	---	64.67	16.13	1000	9	L1	OFF
0.208	47.61	---	63.29	15.68	1000	9	L1	OFF
0.256	---	36.41	51.56	15.15	1000	9	N	OFF
0.264	---	41.90	51.31	9.40	1000	9	N	OFF
1.432	38.81	---	56.00	17.19	1000	9	L1	OFF
1.488	38.94	---	56.00	17.06	1000	9	L1	OFF
1.592	36.80	---	56.00	19.20	1000	9	N	OFF
1.864	34.82	---	56.00	21.18	1000	9	L1	OFF

EMISSION SPECTRUM

Direct charging with the drone, 230V AC 50Hz

Full Spectrum



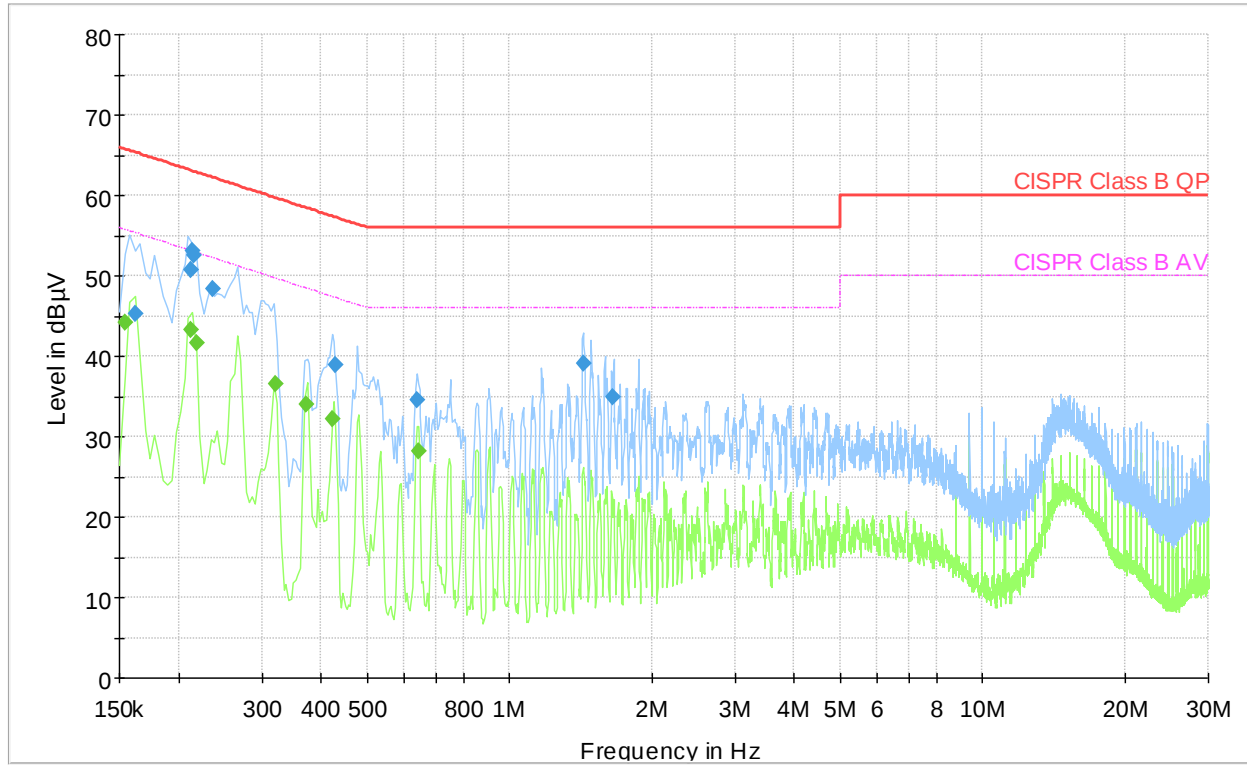
MEASUREMENT DATA

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: ± 4.1 dB (30 MHz – 200 MHz); ± 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

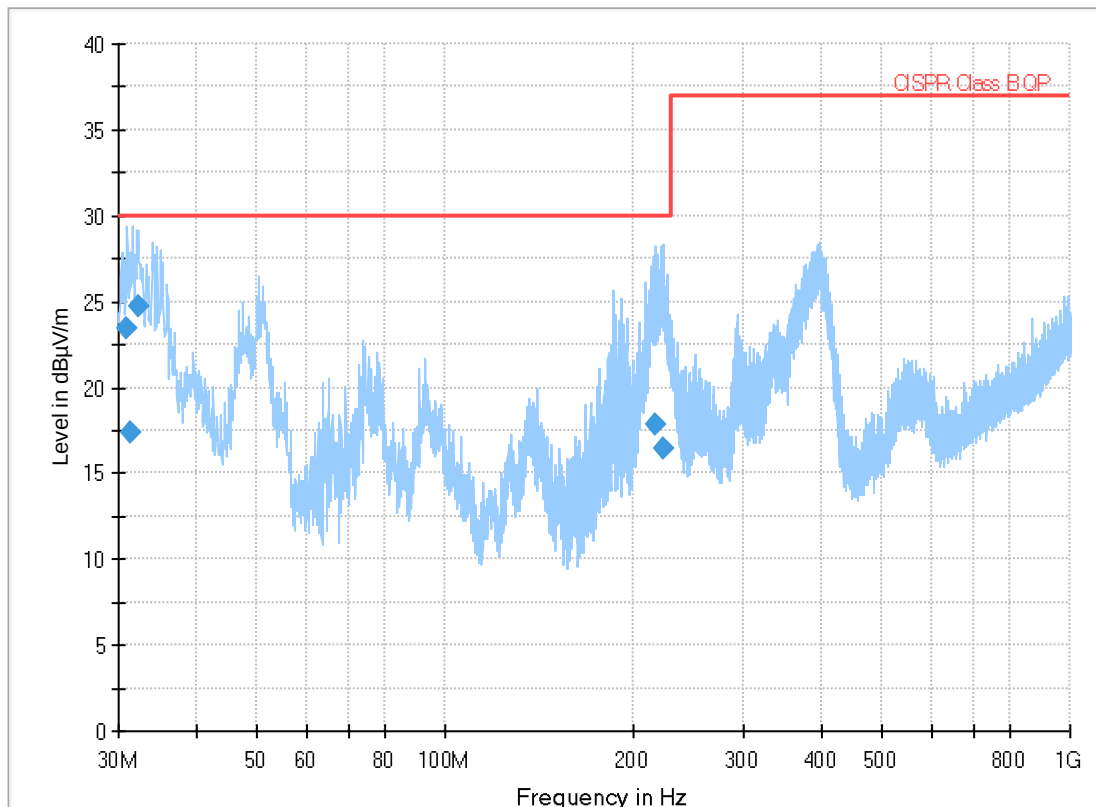
Test engineer:

TD

EMISSION SPECTRUM

Charging outside the drone, 230V AC 50Hz

Full Spectrum



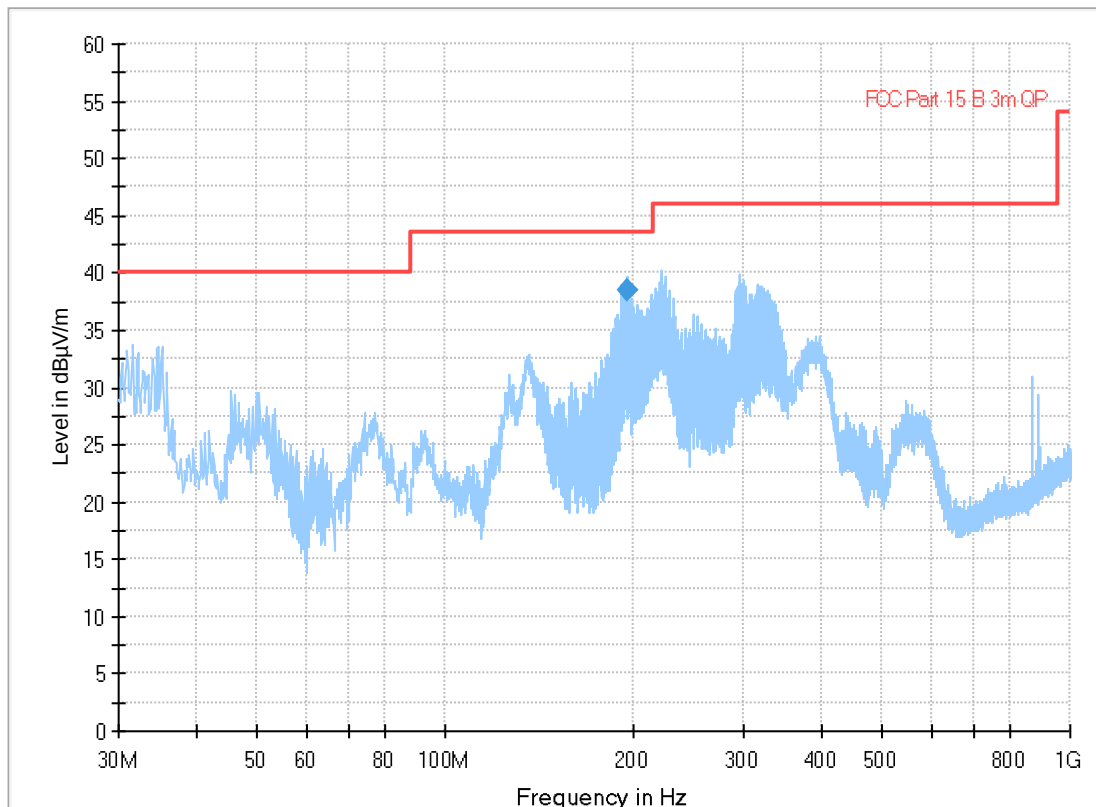
MEASUREMENTS DATA

Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
30.993050	23.42	30.00	6.58	1000.0	120.000	103.0	V	2.0	-11.2
31.355178	17.32	30.00	12.68	1000.0	120.000	154.0	V	258.0	-11.5
32.205706	24.78	30.00	5.22	1000.0	120.000	99.0	V	76.0	-12.2
217.571344	17.79	30.00	12.21	1000.0	120.000	373.0	H	82.0	-19.1
223.318789	16.47	30.00	13.53	1000.0	120.000	300.0	H	78.0	-19.2

EMISSION SPECTRUM

Charging outside the drone, 120V AC 60Hz

Full Spectrum



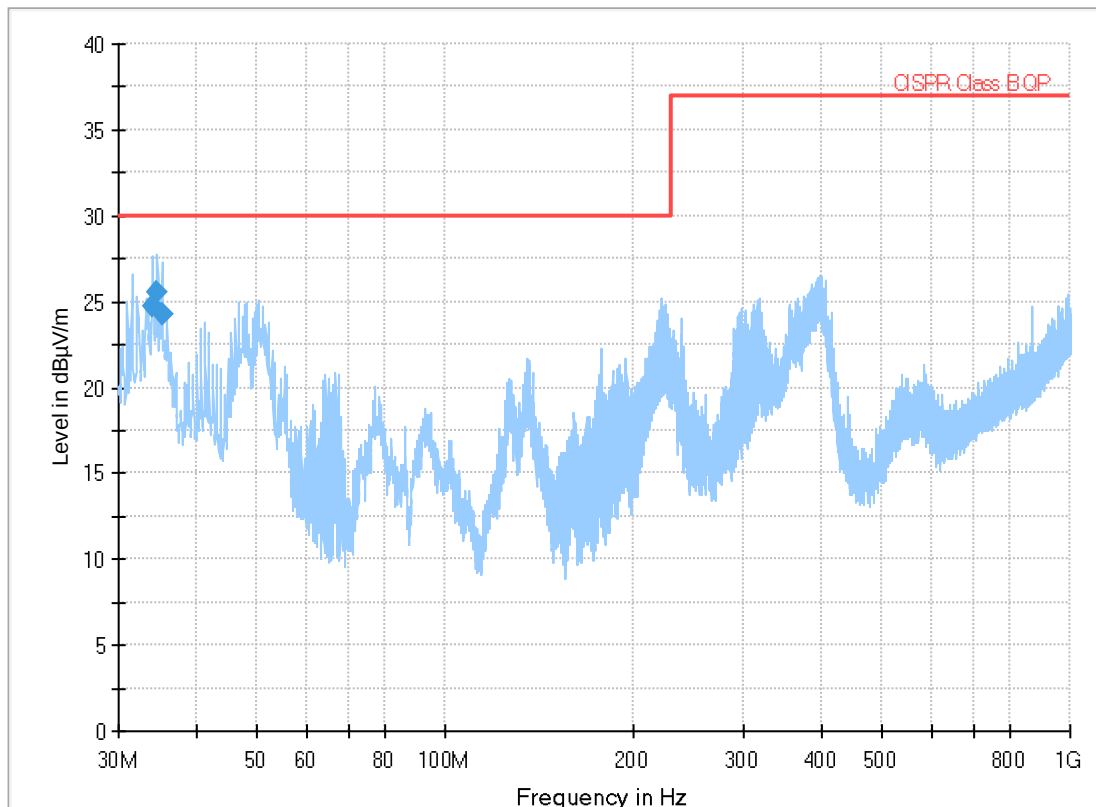
MEASUREMENTS DATA

Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
195.108800	38.54	43.50	4.96	1000.0	120.000	102.0	H	88.0	-18.2

EMISSION SPECTRUM

Direct charging with the drone, 230V AC 50Hz

Full Spectrum



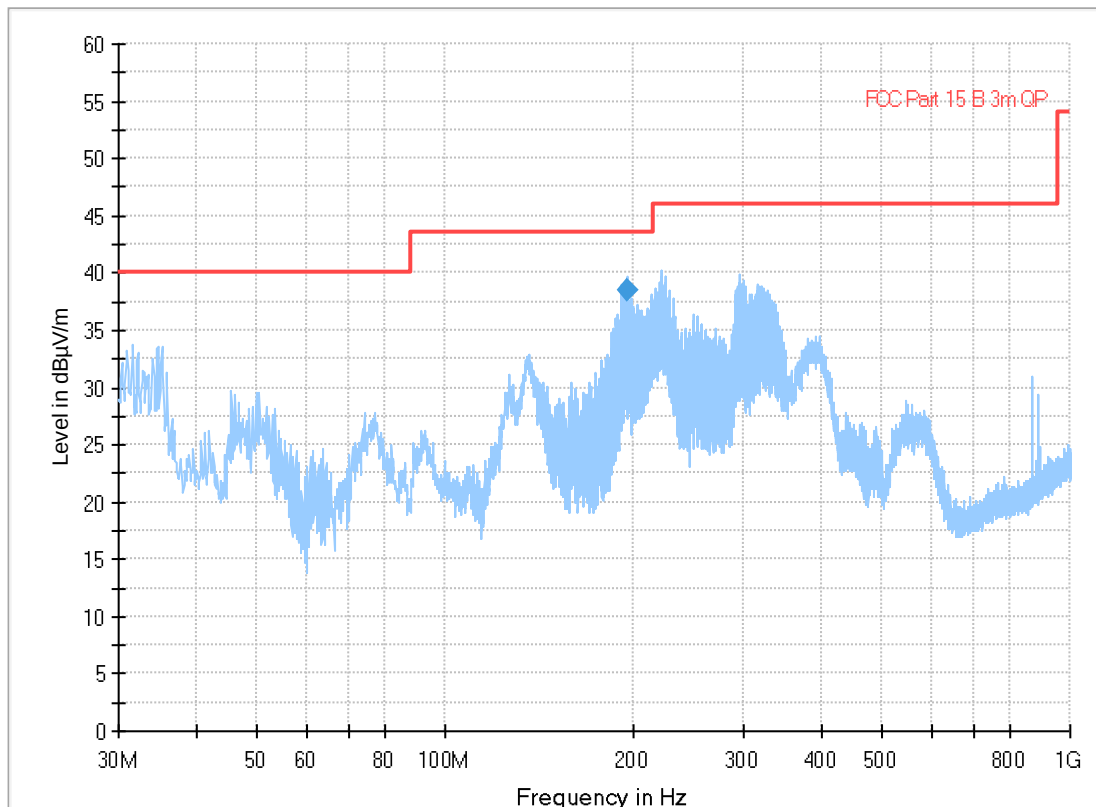
MEASUREMENTS DATA

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
33.996728	24.78	30.00	5.22	1000.0	120.000	103.0	V	0.0	-13.6
34.600756	25.58	30.00	4.42	1000.0	120.000	103.0	V	0.0	-14.1
35.210872	24.21	30.00	5.79	1000.0	120.000	103.0	V	24.0	-14.6

EMISSION SPECTRUM

Direct charging with the drone, 120V AC 60Hz

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)
195.108800	38.54	43.50	4.96	1000.0	120.000	102.0	H	88.0	-18.2

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:	23 °C
Humidity:	37 %RH
Atmos. pressure:	1003 hPA

Conformity

Verdict:	PASS
Test engineer:	THT

PHOTO OF SELECTED TEST POINTS

See photo in separate document

- ★ = Contact discharge points
- ★ = Air discharge points

Detailed Test Log

Direct charging with the drone:

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
All cable	$\pm 4, \pm 8$	Air	10	B	A	PASS
LEDs	$\pm 4, \pm 8$	Air	10	B	A	PASS
Connector, metallic parts	$\pm 2, \pm 4$	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

Charging outside the drone:

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
All cable	$\pm 4, \pm 8$	Air	10	B	A	PASS
LEDs	$\pm 4, \pm 8$	Air	10	B	A	PASS
Connector, metallic parts	$\pm 2, \pm 4$	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 ≤ 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
- ☐ 1.5×10^{-3} decades/sec (80 – 1000MHz)
- ☐ 0.5×10^{-3} decades/sec (1000 – 2000MHz)
- ☐ Other:

Frequency range:

- ☐ 80MHz – 1000MHz
- ☐ 1400MHz – 2000MHz
- ☐ 2000MHz – 2700MHz
- ☒ 80MHz – 3000MHz
- ☐ 80MHz – 6000MHz

Modulation:

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

Uncertainty figures:

Field level: ± 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-1719) (03/2019)
Power Sensor: R&S / NRP6AN (LR-1718) (03/2019)

Conformity

Verdict:

PASS

Test engineer:

TD

DETAILED TEST LOG

Direct charging with the drone

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

Charging outside the drone

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: [Generator: EMTest / UCS 500 N7 \(LR-1608\) \(05/2020\)](#)

Conformity

Verdict: **PASS**

Test engineer: **THT**

DETAILED TEST LOG

Direct charging with the drone

Port	Applied Level [kV]	Injection Method	Required Criteria	Complied Criteria	Result
AC Input Port (N+L1+PE)	$\pm 0.5\text{kV}$	CDN	B	A	PASS
AC Input Port (N+L1+PE)	$\pm 1\text{kV}$	CDN	B	A	PASS

Charging outside the drone

Port	Applied Level [kV]	Injection Method	Required Criteria	Complied Criteria	Result
AC Input Port (N+L1+PE)	$\pm 0.5\text{kV}$	CDN	B	A	PASS
AC Input Port (N+L1+PE)	$\pm 1\text{kV}$	CDN	B	A	PASS

OBSERVATIONS

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

SURGE 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

Procedure

The surge test was only applied to the supply terminals.

Differential mode surges were applied line-to-neutral and line-to-line, with a source impedance of 2Ω. Common mode surges were applied line-to-ground and neutral-to-ground, with a source impedance of 12Ω.

Phase angles:	Repetition rate:	Impulses per test level:	Uncertainty figures:
☒ 0° ☐ N/A (DC)	☐ 20 sec.	☒ 5 impulses	Peak voltage: ± 10 %
☒ 90°	☒ 60 sec.	☐ Other:	Rise time: ± 30 %
☒ 180°	☐ Other:		Duration: ± 20 %
☒ 270°			

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: Generator: EMTest / UCS 500 N7 (LR-1608) (05/2020)

Conformity

Verdict: PASS

Test engineer: THT/TD

DETAILED TEST LOG

Direct charging with the drone

Line	Source impedance	CDN	Applied Level [kV]	Required Criteria	Complied Criteria	Result
AC Input Port (N to PE)	12Ω	MCN	±0.5kV	B	A	PASS
AC Input Port (N to PE)	12Ω	MCN	±1kV	B	A	PASS
AC Input Port (N to PE)	12Ω	MCN	±2kV	B	A	PASS
AC Input Port (L1 to PE)	12Ω	MCN	±0.5kV	B	A	PASS
AC Input Port (L1 to PE)	12Ω	MCN	±1kV	B	A	PASS
AC Input Port (L1 to PE)	12Ω	MCN	±2kV	B	A	PASS
AC Input Port (N to L1)	2Ω	MCN	±0.5kV	B	A	PASS
AC Input Port (N to L1)	2Ω	MCN	±1kV	B	A	PASS

Note: MCN = Mains coupling network; ICN = Coupling network for interconnecting lines; D = Direct coupling (shielded lines)

Charging outside the drone

Line	Source impedance	CDN	Applied Level [kV]	Required Criteria	Complied Criteria	Result
AC Input Port (N to PE)	12Ω	MCN	±0.5kV	B	A	PASS
AC Input Port (N to PE)	12Ω	MCN	±1kV	B	A	PASS
AC Input Port (N to PE)	12Ω	MCN	±2kV	B	A	PASS
AC Input Port (L1 to PE)	12Ω	MCN	±0.5kV	B	A	PASS
AC Input Port (L1 to PE)	12Ω	MCN	±1kV	B	A	PASS
AC Input Port (L1 to PE)	12Ω	MCN	±2kV	B	A	PASS
AC Input Port (N to L1)	2Ω	MCN	±0.5kV	B	A	PASS
AC Input Port (N to L1)	2Ω	MCN	±1kV	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
- ☐ 1.5×10^{-3} decades/sec
- ☐ Other:

Measurement uncertainty: ± 2.8 dB (150 kHz – 26 MHz); ± 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)
 CDN: TESEQ / CDN-M316 (LR-1653) (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: **THT**

DETAILED TEST LOG

Direct charging with the drone

Tested Port	Injection Method	Return Path	Applied Level [Vrms]	Required Criteria	Complied Criteria	Result
AC Input Port	CDN-M3	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.

Charging outside the drone

Tested Port	Injection Method	Return Path	Applied Level [Vrms]	Required Criteria	Complied Criteria	Result
AC Input Port	CDN-M3	Capacitive	3 Vrms	A	A	PASS

OBSERVATIONS

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

VOLTAGE DIPS AND INTERRUPTIONS IMMUNITY

TEST DESCRIPTION

Method

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

Set-up

Only the general laboratory conditions were applied. No special requirements are defined for the configuration of the specimen. The main supply port of the specimen was connected to the power simulator system which generates the dips and interruptions. The specimen was energized and in normal operating condition.

Procedure

The specimen was subject to voltage reductions a given number of times, separated by a sufficient interval for the specimen to recover. The reductions were fired at different phase angles according to the requirements of the test standard.

Repetition rate:

- ☐ 10 sec.
☒ 20 sec.
☐ Other:

Repetitions:

- ☒ 3 occurrences.
☐ Other:

Phase angle:

- ☐ N/A (DC supply).
☐ Only at 0°.
☐ Only at zero crossings (0° and 180°).
☐ 0-270°; each 90°.
☒ 0-315°; each 45°.

Measurement uncertainty: Voltage level: $\pm 5\%$; Zero crossing control: $\pm 10^\circ$; Phase relationship: $\pm 10^\circ$

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: Generator: EMTest / UCS 500 N7 (LR-1608) (05/2020)
Motorized Variac: EMTest / MV 2616 (LR-1610) (05/2020)

Conformity

Verdict: PASS

Test engineer: THT

DETAILED TEST LOG

Direct charging with the drone

Voltage Reduction	Voltage Levels		Duration [cycles]	Required Criteria	Complied Criteria	Result
	Nominal	Test				
30% Dip	230	161	25	B	A	PASS
60% Dip	230	92	25	B	A	PASS
>95% Dip	230	0	0.5/1	B	A	PASS
100% Interruption	230	0	250	B	B ¹	PASS

¹ The charging function is interrupted and EUT restarted by itself.

Charging outside the drone

Voltage Reduction	Voltage Levels		Duration [cycles]	Required Criteria	Complied Criteria	Result
	Nominal	Test				
30% Dip	230	161	25	B	A	PASS
60% Dip	230	92	25	B	A	PASS
>95% Dip	230	0	0.5/1	B	A	PASS
100% Interruption	230	0	250	B	B ¹	PASS

¹ The charging function is interrupted and EUT restarted by itself.

OBSERVATIONS

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

¹ The charging function is interrupted during 5sec interruptions but the EUT restarted by itself.

Annexes

PHOTOS

Test set-up for EMC emissions measurements	
See photo in separate document	

Test set-up for EMC immunity tests	
See photo in separate document	