Bundesnetzagentur
BNetzA-CAB-14/21-09

DAkkS Deutsche Akkreditierungsstelle D-PL-11020-03-04

SGS Germany GmbH

Test Report No.: U0VU0003

FCC ID: 2AVOXFZRI60

Order No.: U0VU **Pages:** 47

Client:	Porsche eBike Performance GmbH Testing Department
Equipment Under Test:	FAZUA RIDE 60 Pedelec Drive System
Manufacturer / Importer:	Porsche eBike Performance GmbH
Task:	Compliance with the customer selected test cases of the requirements mentioned below:
Test Specification(s): [covered by accreditation]	• FCC 47 CFR Part 15 §15.107 §15.109 • ICES-003 Issue 7
Result:	The EUT complies with the customer selected test cases of the test specifications.

The results relate only to the items tested as described in this test report.

approved by:	**Date**	**Signature**
Wössner Group Leader	May 24, 2023	

This document was signed electronically.

CONTENTS

1 Result Summary

This report presents the test procedures used and the results obtained during the performance of an FCC 47 CFR Part 15 and ICES-003 test program. The test program was conducted to assess the ability of the tested sample to successfully satisfy the requirements specified in the references listed in Section 2 of this report.

Tables of Results:

Phenomena	Reference	Frequency range	Criteria	Verdict [1]
Conducted Emission AC power port [2]	FCC 47 CFR Part 15 §15.107	150 kHz – 30 MHz	Class B	NR [4]
Radiated Emission Electric Field	FCC 47 CFR Part 15 §15.109	30 MHz - 1 GHz	Class B	P
Radiated Emission Electric Field	FCC 47 CFR Part 15 §15.109	1 GHz – 26 GHz [3]	Class B	P
Conducted Emission AC power port[2]	ICES-003	150 kHz – 30 MHz	Class B	NR [4]
Radiated Emission Electric Field	ICES-003	30 MHz - 1 GHz	Class B	P
Radiated Emission Electric Field	ICES-003	1 GHz – 26 GHz[3]	Class B	P

1 **P** (Pass): test object meets the requirement; **F** (Fail): test object does not meet the requirement; **NA**: test case does not apply to the test object; **NR**: test case is not requested by the client; **NP**: test case was not performed

2 According ANSI C.63.4 chapter 7.1: If the EUT normally receives power from another device that in turn connects to the public-utility ac power lines, measurements shall be made on that device with the EUT in operation to ensure that the device continues to comply with the appropriate limits while providing the EUT with power. If the EUT is operated only from internal or dedicated batteries, with no provisions for connection to the public utility ac power lines (600 VAC or less) to operate the EUT (such as an adapter), then ac power-line conducted measurements are not required.

3 See chapt. 4.2.4; Clock frequencies of the EUT resulting in determination of frequency range

4 Important note: according customer declaration:
The EMC test of the charger (Model STC-8207LD) was done by UL.
Please see test report no. 4790315306-2-1. With this test, the test items conducted disturbance and radiated disturbance (emission tests) are settled and are to be recognised.

2 References

2.1 Specification(s)

[1] FCC 47 CFR Part 15:
Code of Federal Regulations. Title 47: Telecommunication Part 15: Radio Frequency Devices

[2] Industry Canada ICES-003 Issue 7; Information Technology Equipment (ITE) – Limits and methods of measurement

[3] ANSI C63.4:2014, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

[4] FCC Public Notice DA 09-2478; Nov 25, 2009; Office of Engineering and Technology Clarifies Use of Recently Published ASC C63®

[5] Measurement Standards for Compliance Testing of Intentional and Unintentional Radiators under Part 15

[6] ICES-Gen - General Requirements for Compliance of Interference-Causing Equipment

2.2 Glossary

AC	Alternating Current
AMN	Artificial Mains Network
AV	Average Detector
DC	Direct Current
EMC	Electromagnetic Compatibility
EUT	Equipment Under Test
HW	Hardware
LISN	Line Impedance Stabilization Network
QP	Quasi Peak Detector

2.3 Information concerning FCC Equipment Authorization and Labelling

CERTIFICATION (47 CFR Section 2.907)
Certification is the most rigorous approval process for RF Devices with the greatest potential to cause harmful interference to radio services. It is an equipment authorization issued by an FCC-recognized Telecommunication Certification Body (TCB) based on an evaluation of the supporting documentation and test data submitted by the responsible party (e.g., the manufacturer or importer) to the TCB. Testing is performed by an FCC-recognized accredited testing laboratory. Information including the technical parameters and descriptive information for all certified equipment is posted on a Commission-maintained public database. In addition, equipment subject to approval using the Supplier's Declaration of Conformity (SDoC) procedure can optionally use the Certification procedure.

SUPPLIER'S DECLARATION OF CONFORMITY (47 CFR Section 2.906) → SDoC
Supplier's Declaration of Conformity (SDoC) is a procedure that requires the party responsible for compliance ensure that the equipment complies with the appropriate technical standards. The responsible party, who must be located in the United States, is not required to file an equipment authorization application with the Commission or a TCB. Equipment authorized under the SDoC procedure is not listed in a Commission database. However, the responsible party or any other party marketing the equipment must provide a test report and other information demonstrating compliance with the rules upon request by the Commission. The responsible party has the option to use the certification procedure in place of the SDoC procedure.

The key FCC rule sections for SDoC are:
a. Section 2.906 Supplier's Declaration of Conformity
b. Section 2.909 Responsible party
c. Section 2.931 Responsibilities
d. Section 2.938 Retention of records
e. Section 2.1072 Limitations on Supplier's Declaration of Conformity
f. Section 2.1074 Identification
g. Section 2.1077 Compliance Information

See Guidance on the use of SDoC in 896810 D01 SDoC v02 and 896810 D02 SDoC FAQ v01r02 .

As the EMC-Lab of SGS Germany GmbH is an FCC-recognized accredited testing laboratory, this test report can be used as basis for both procedures.

Based on **§15.3** the following description for locations and its emission classes is defined:

(h) **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.

(i) **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.

Based on **§15.105** the relevant **information to the limit class** has to be included in the manual.

Guidelines for **labeling and user information for RF** devices are contained in the following documents:
- 784748 D01 General labeling and Notification v09r01 provides general guidance for Part 15 and Part 18 labeling and user information.
- 748748 D02 e labeling v02 provides guidelines for displaying label information electronically (e-label).

See also important summarized information in FCC public notice DA 19-91, February 15, 2019.

For guidance concerning **integration of aleady FCC-certified wireless transmitter modules in host systems** see 996369 D04 Module Integration Guide v01 Modular Transmitter Integration Guide – Guidence for Host Product Manufacturers.

2.4 Information concerning ICES Equipment Authorization

2.4.1 ICES-Gen compliance

In addition to this standard, the requirements of ICES-Gen shall apply, except where a requirement in ICES-Gen contradicts a requirement in this standard, in which case this standard shall take precedence. However, where a requirement in one of the normative references specified in section 2.3 of ICES 003 issue 7 contradicts a requirement in ICES-Gen, then ICES-Gen shall take precedence (unless otherwise stated in this standard).

2.4.2 ITE or digital apparatus that incorporates radio modules

Products subject to this standard that include functionality for radiocommunication shall meet the provisions and requirements of both this standard and relevant Radio Standard Specifications (RSSs), as applicable to the specific radiocommunication technology. A reference to the corresponding RSS report within the ICES-003 report will fulfil this requirement for the purpose of this standard.
However, where the radio functionality is achieved by integrating an already certified radio module, there is no need for a reference to the corresponding RSS report. Instead, the ICES-003 report shall demonstrate the product's compliance with the requirements applicable to the host of an already certified radio module, in accordance with Radio Standards Procedure RSP-100, *Certification of Radio Apparatus and Broadcasting Equipment*, and RSS-Gen, *General Requirements for Compliance of Radio Apparatus*. These requirements include compliance with RSS-102, *Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)*, for RF exposure, and specific labelling requirements for the host product.

The emissions from the radio transmitter shall not be considered when evaluating the compliance with the limits specified in ICES-003: see ICES-Gen.

2.4.3 Labelling and user manual requirements

The requirements specified in ICES-Gen shall apply. An example ISED compliance label, to be placed on each unit of an equipment model (or in the user manual, if allowed), is given below:

CAN ICES-003(*) / NMB-003(*)

* Insert either "A" or "B", but not both, to identify the applicable Class of the device used for compliance verification.

The above label is only an example. The specific format is left to the manufacturer to decide, as long as the label includes the required information, in accordance with ICES-Gen.

Innovation, Science and Economic Development Canada ICES-003 Compliance Label:
CAN ICES-3 (*)/NMB-3(*)
* Insert either "A" or "B" but not both to identify the applicable Class of ITE.

3 General Information

3.1 Identification of Client

Porsche eBike Performance GmbH
Testing Department
Marie-Curie-Straße 6
85521 Ottobrunn, Germany

3.2 Test Laboratory

SGS Germany GmbH
Hofmannstraße 50
81379 München, Germany

3.3 Time Schedule

Delivery of EUT: Apr 13, 2023
Start of test: Apr 13, 2023
End of test: Apr 13, 2023

3.4 Participants

Name	Function
Harald Linhardt	Accredited testing, Editor
Sascha Adler	Operating of EUT, Setup of EUT, Supervision of EUT-functionality
Sebastian Boß	Operating of EUT, Setup of EUT, Supervision of EUT-functionality

3.5 Environmental conditions

During the measurement, the environmental conditions were within the listed ranges:
Temperature: 20 - 26 °C
Humidity: 30 - 60 %

4 Equipment Under Test

All information regarding the EUT(s) was provided by the customer and has been approved by customer during report-review-process.

Test item description ..... :	FAZUA RIDE 60 Pedelec Drive System
Trade Mark .... :	FAZUA
Manufacturer / Importer .. .. :	Porsche eBike Performance GmbH
Model/Type .... :	RIDE 60
Number of tested samples ... :	One EPAC with integrated components, see below
Serial Number(s) .... :	Motor: DRIVE UNIT, SN 0310110010007228
	Battery: ENERGY 430, SN 02ES320010000049
	Display: LED HUB L, SN 0310130020016132
	Remote: RING CONTROL, SN 0310131010006755
Ratings .... :	Input: 100 – 240 V AC / 50 – 60 Hz / 145 W
	DC Output: 43,2 V / 3 A

The **FAZUA RIDE 60 Pedelec Drive System** (abbrv. RIDE 60) is an electric motor support system for pedelecs (EPAC). Porsche eBike Performance GmbH develops and produces RIDE 60 in Ottobrunn (GER) and sells it to Original Equipment Manufacturers (OEM) as a component for pedelecs. The EPAC has a modular design configuration to achieve a high level of flexibility for the OEM. RIDE 60 is compatible with frame designs for mountain, road, gravel and city bikes and support level can be set according to the user's needs.

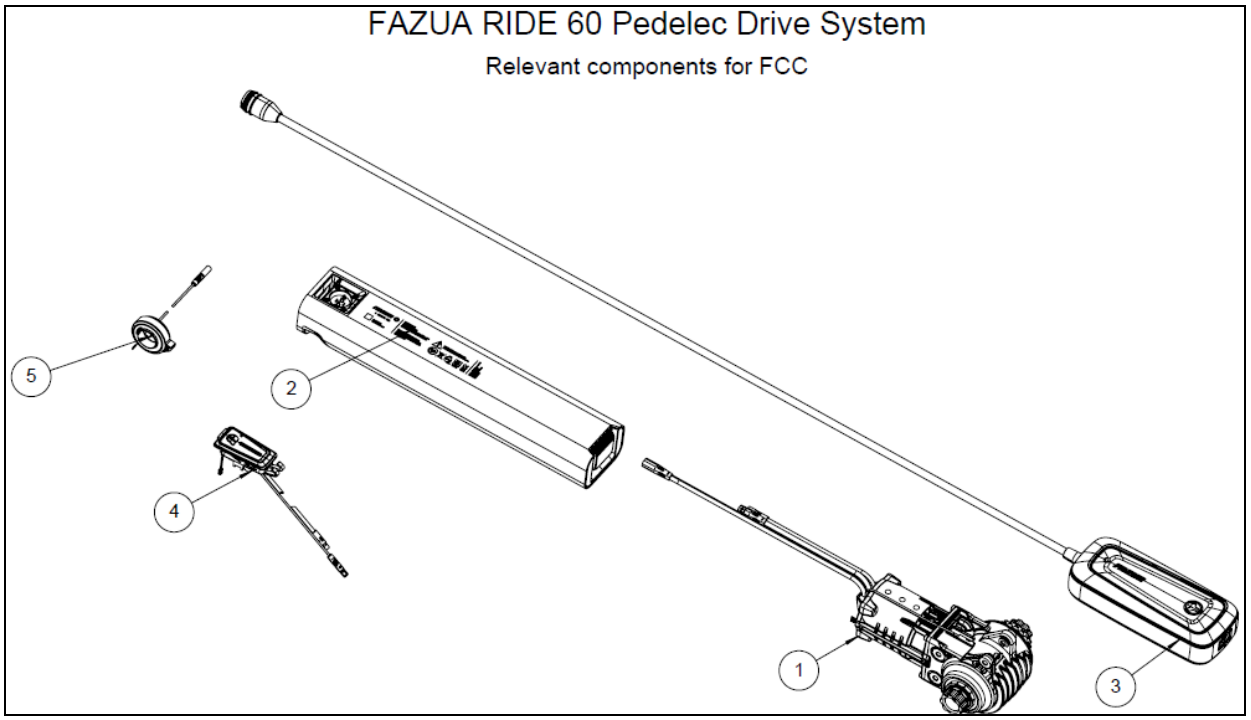


Figure 4-1: Relevant components for FCC of FAZUA RIDE 60 Pedelec Drive System

Pos.	Component	Name of Sales item	Article number	Description
1	Drive Unit	DRIVE UNIT SB	10A 101 000 A	Motor-Gear-Unit with integrated torque sensor
2	Battery	ENERGY 430	20A 101 000 A	removable battery, connected to energy cable
3	Charger	CHARGER 3A	21A 101 000 A	For charging the battery, already FCC compliant
4	Display	LED HUB L	30A 102 200 A	mounted in the frame; with BLE module which is FCC compliant
5	Remote	RING CONTROL	31A 101 000 A	mounted on the handlebar, controls the display

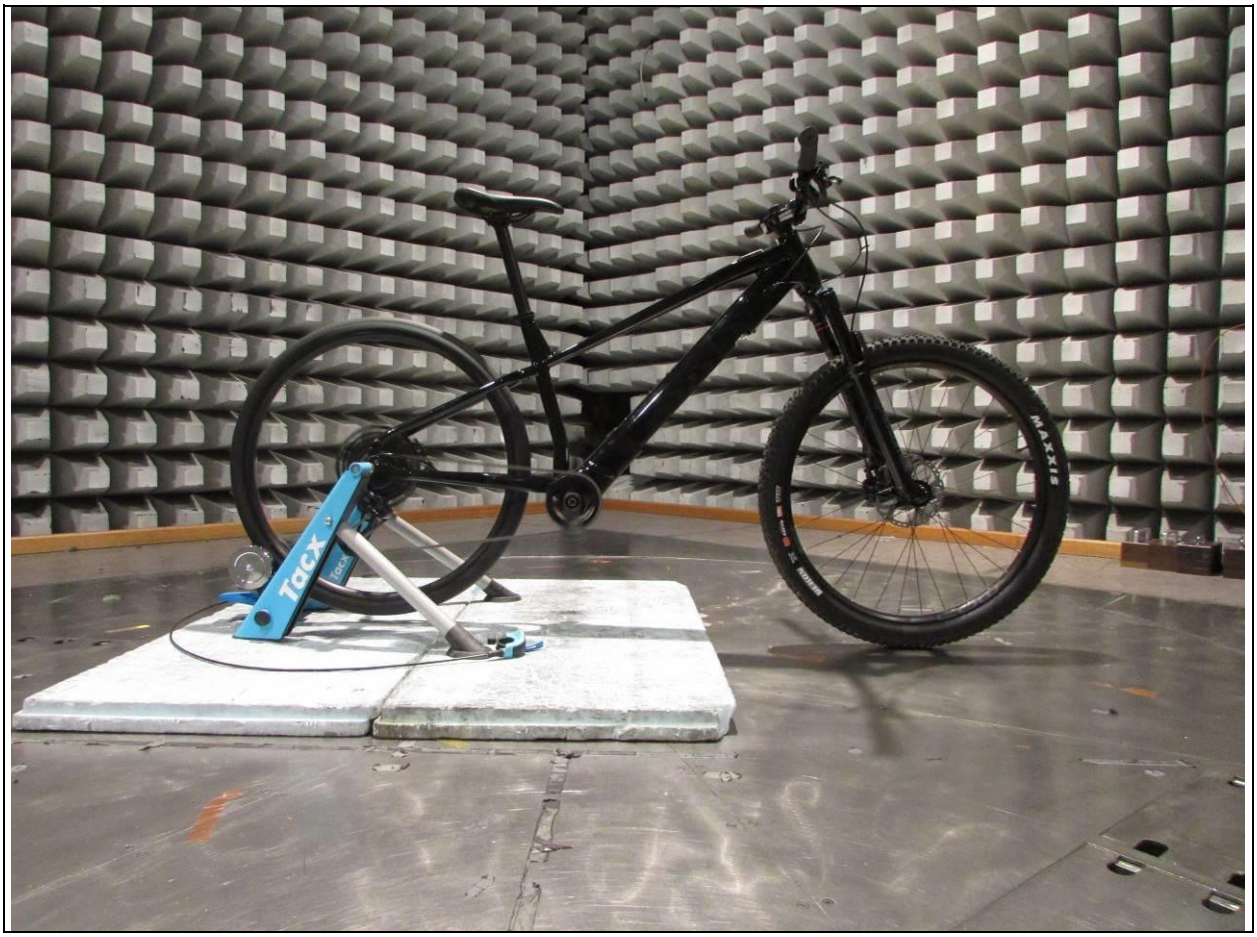


Figure 4-2: EPAC with RIDE 60

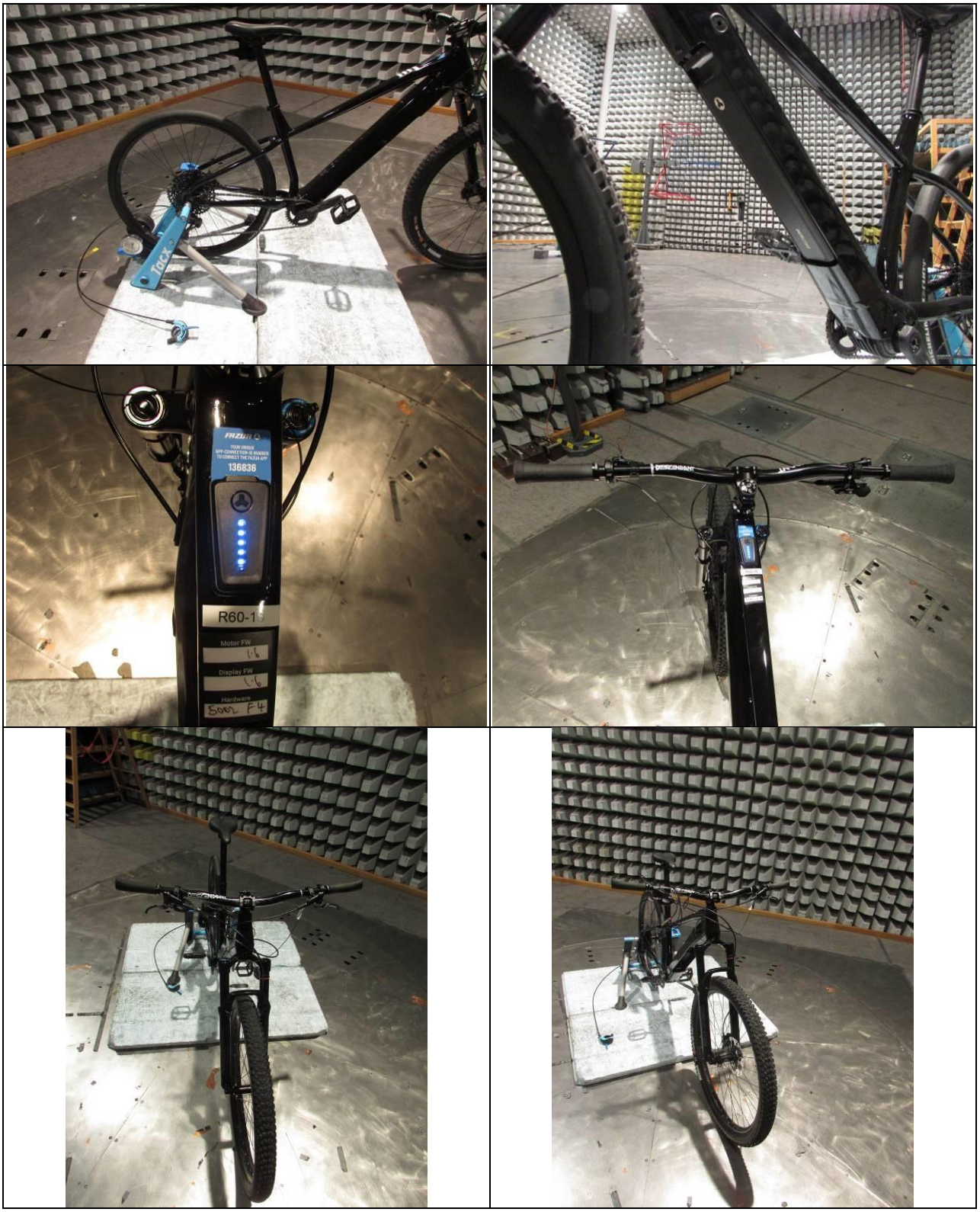


Figure 4-3: EPAC with RIDE 60

Figure 4-4: Copy of type plate EPAC with RIDE 60 – internal label, for description of testbike only

Figure 4-5: Motor: DRIVE UNIT, with type product label FCC information

Please note: Since the battery is a component from an external supplier, the product label change has not yet been implemented in the real product. The label is applied by laser engraving. The product label will be changed according to the template once FCC certification is completed.

Figure 4-6: Battery: ENERGY 430, with product label

Figure 4-7: Display: LED HUB L, with product label incl. FCC information

Figure 4-8: Display: LED HUB L, with product label incl. FCC information

Figure 4-9: Charger: CHARGER 3A, Model STC-8207LD, with product label incl. FCC information

Figure 4-10: Remote: RING CONTROL, with product label incl. FCC information

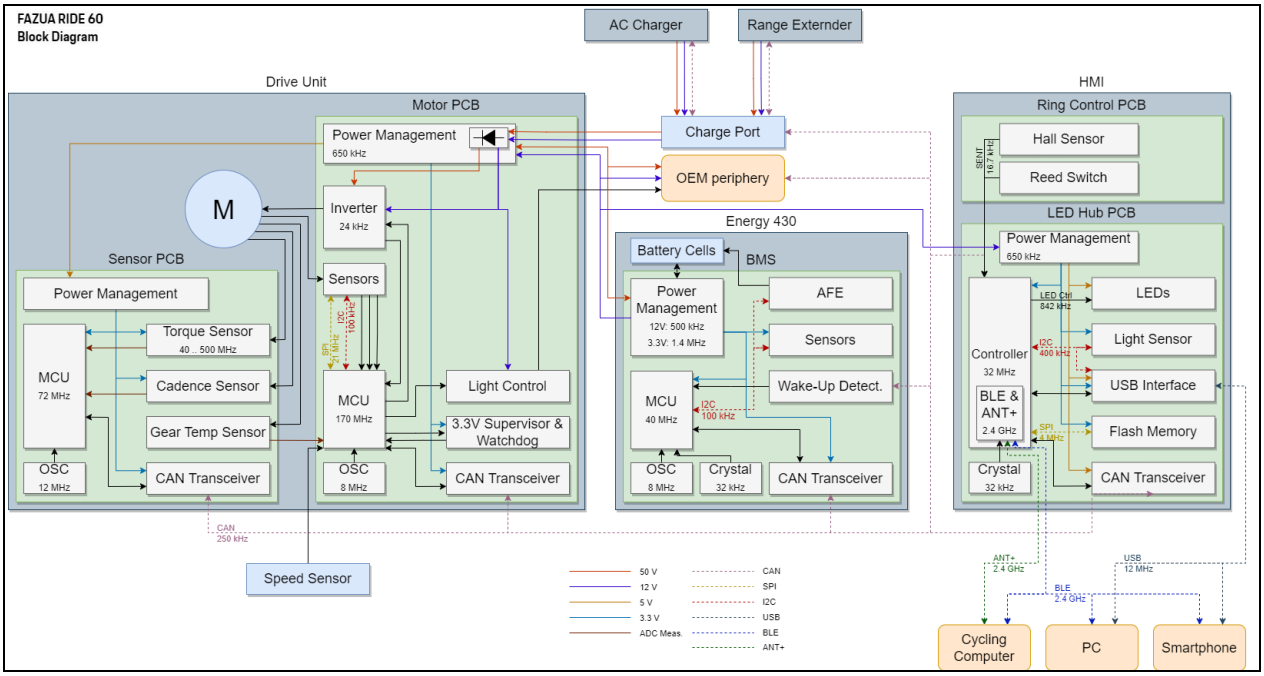


Figure 4-11: Block diagram of function

4.1 Operational conditions

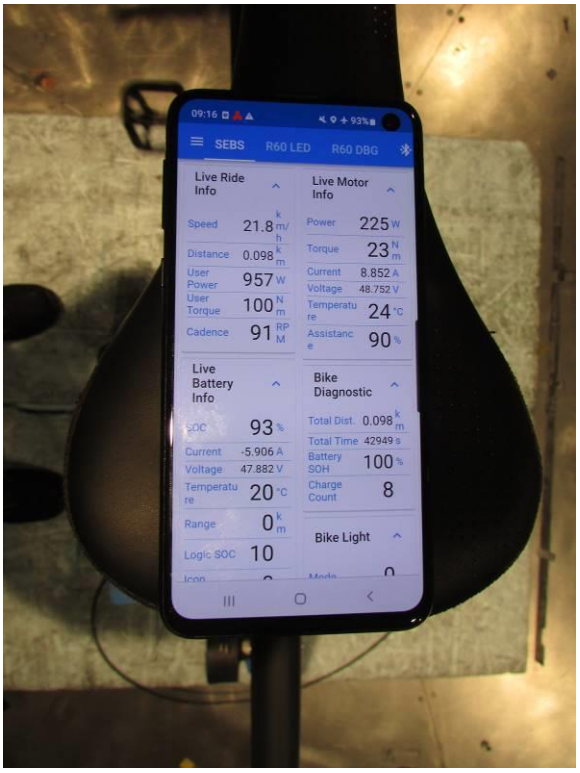
4.1.1 Software

Software necessary for operating, controlling and monitoring the EUT:

Name	Identification Code/Issue	Task
FAZUA Debug App	V0.0.1-rc1-128	Configuration, controls and monitors the parameters of the EUT

4.1.2 Operation modes

☐ Normal operation



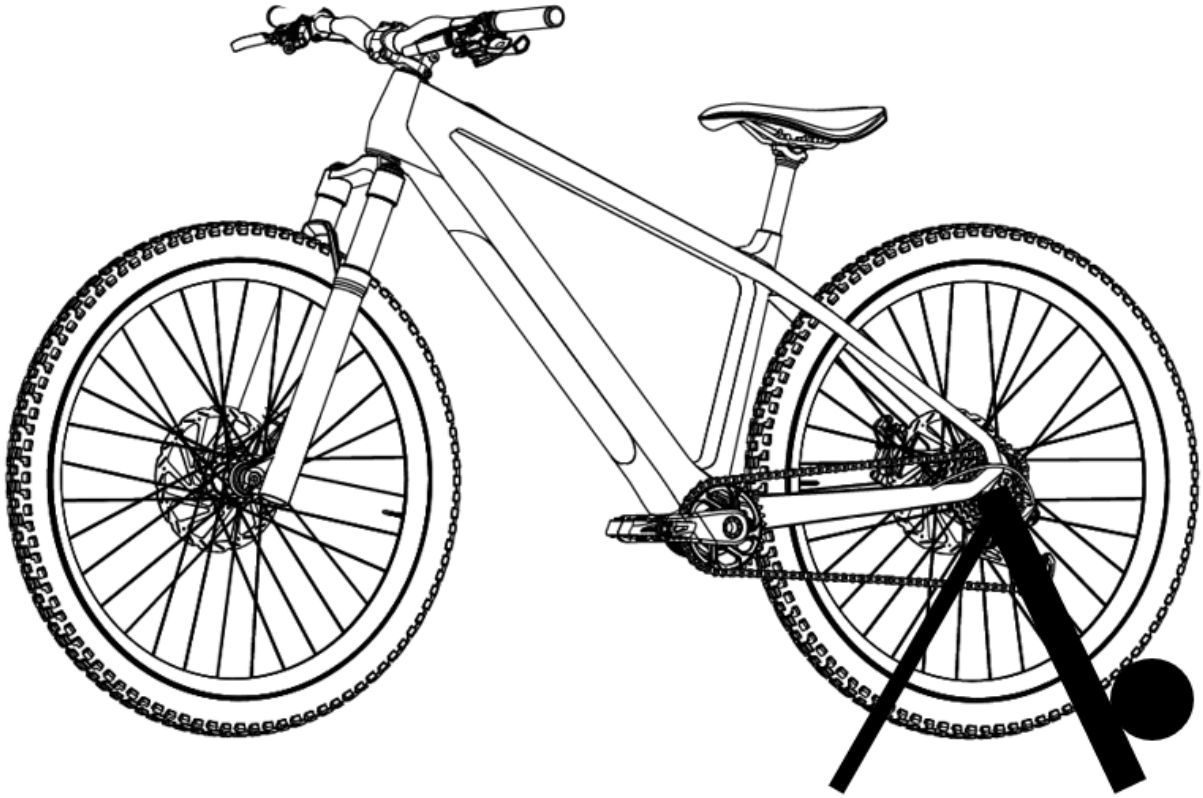
The operation mode on EPAC during test: Support Level 2

☒ Other operation:

Operation mode 1 .....: The operation mode on EPAC during test: Support Level 2

Operation mode 2 .....: ---

4.1.3 Comments on the support level



Mode	approx. 225 W
Motor speed	approx. 3000 RPM
Motor torque	approx. 1,0 Nm
Gear (11-fold)	Gear 3
Speed (EPAC)	22,0 km/h
Controlling of motor during testing	via Bluetooth connection between LED Hub and mobile phone (BLE) → FAZUA Debug App
Roller dynamometer	Training bike stand (Tacx)

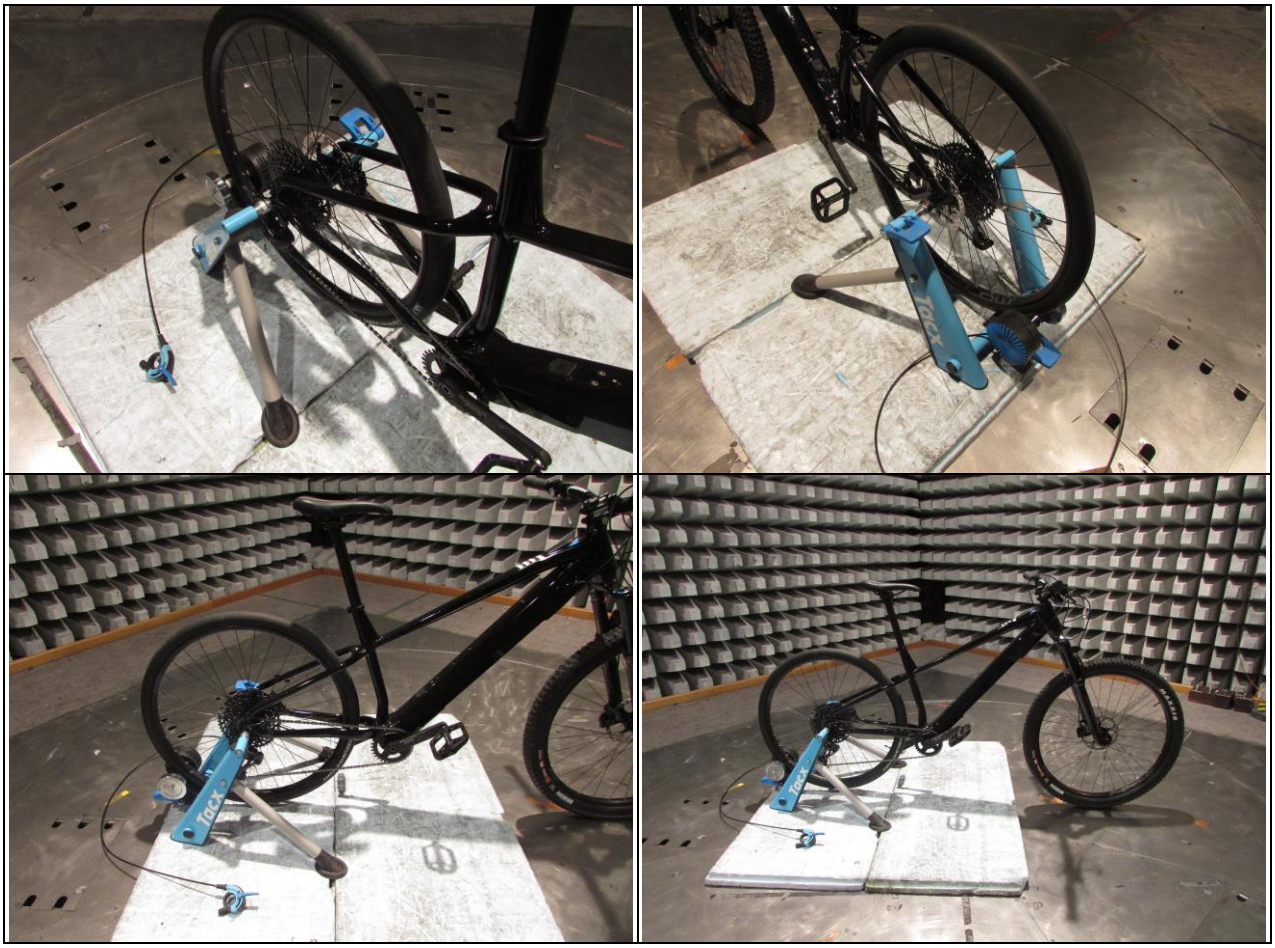


Figure 4-12: EPAC in the training bike stand (Tacx)

4.2 Hardware Configuration

4.2.1 Components of the EUT

Name	Identification Code/Issue/Serial Number	Interface type	Qty
EPAC	Representative Test Bike from Porsche eBike Performance GmbH		1
Motor	AN 10A101000A SN 0310110010007228	Higo, Z205AGP00AW0220 Higo, Z610CMP00DZ0220 Higo, Z610CGP00DZ0335 Cusmade, 0606CM	1
Battery	AN 20A101000A SN 02ES320010000049	Rosenberger, M4K204-16C002B5-Y Higo, Z610CMP00DZ115	1
Display	AN 30A102300A	Higo, Z306QMP00EA0195	1

	SN 0310130020016132	Cusmade, WH-A002-EU021	
Remote	AN 31A101000A SN 0310131010006755	Higo, Z306QGP00SF1000	1
Charger*	AN 21A101000A SN 8207LD-220117-12345	Rosenberger, C001-02-1000-D Charge Port: Rosenberger M4S102-16C002A5-Y Higo, Z610CGP00DZ190	1

* Important note: according customer declaration:
The EMC test of the charger (Model STC-8207LD) was done by UL.
Please see test report no. 4790315306-2-1. With this test, the test items conducted disturbance and radiated disturbance (emission tests) are covered.

4.2.2 Interface description

4.2.2.1 Power supply port

Power Supply	Type (AC/DC)	Voltage	Frequency	Current	Power
Rated voltage range	AC	100 - 240 V	50 / 60 Hz		
Tested voltage	---	---	---		
Internal power supply in EPAC from battery to peripery components (e.g. display, remote)	DC	12 V	-	2 A	24 W
Internal power supply in EPAC from battery to motor	DC	43,2 V	-	10 A	432 W

4.2.2.2 Earthing and Grounding connections [5]

Type	Task	Connected to	Test E/I/NA
---	---	---	NA

4.2.2.3 Communication [6] and signal [7] ports

Type	Bit rate/frequency/ Signal	Task	Connected to

5 Safety ground, functional earth, specific ground connections

6 Connections to communication networks, analog, Ethernet, antenna, wireless, GPS,

7 Signalling, monitoring and control ports

CAN	250 kHz	Communication	To the main drive system controller for communication between remote, battery, motor
I2C	100 kHz	Communication	To the motor electronics (motor PCB), battery electronics (BMS)
I2C	400 kHz	Communication	To the display electronics (LED Hub PCB)
USB	12 MHz	Communication	To the FAZUA Service Toolbox for update a new firmware revision or configuration, controls and monitors the drive system parameters
BLE	2.4 GHz	Communication	To the FAZUA Service Toolbox for update a new firmware revision or configuration, controls and monitors the drive system parameters
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4.2.3 Cabling

Name	Identification Code/Issue/ Serial Number	shield	Description of Connection / plug type	length	Quantity
NA*					

* Not applicable during this test. A communication cable was not required in this test, as communication was exclusively via BLE (please see notes in 4.2.2.3)

4.2.4 Clock frequencies of the EUT resulting in determination of frequency range

System / Sub-system	Highest clock frequency	Comment
Bluetooth module	2.4 GHz	Bluetooth module provide communication with external device like smartphone. The module during test is certified with FCC ID X8WBC840M

The result of the table above with the highest frequency of internal source is basis of the determination of the necessity of measurement above 1 GHz. 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.
See **FCC §15.33 a)** for relevant frequency range of **intentional radiators**.
See **FCC §15.33 b)** for relevant frequency range of **unintentional radiators**.

See e.g. the following table taken from FCC §15.33 b) 1)[8]

Highest frequency generated or used in the device or on which the device operates or tunes (MHz)	**Upper frequency of measurement range (MHz)**
Below 1.705	30
1.705-108	1000
108-500	2000
500-1000	5000
Above 1000	5th harmonic of the highest frequency or 40 GHz, whichever is lower

[8] Similar to ICES-003 Table 3

FAZUA RIDE 60 Clock Frequencies:

Clock Frequencies

PCB	Component	typ. clock frequency
BMS	MCU - external oscillator	8 MHz
BMS	MCU - external crystal	32.768 kHz
BMS	MCU - system clock	40 MHz
Motor PCB	MCU - external oscillator	8 MHz
Motor PCB	MCU - system clock	170 MHz (STM32G473) / 168 MHz (STM32F415)
LED Hub, Control Hub	BLE Module - sleep crystal	32.768 kHz
LED Hub, Control Hub	BLE Module - system clock	32 MHz
LED Hub, Control Hub	BLE Module - BLE transceiver	2.4 GHz
Torque Sensor	Measurement coils	40 - 500 MHz
Torque Sensor	MCU - external oscillator	12 MHz
Torque Sensor	MCU - system clock	72 MHz

Power Switching Frequencies

PCB	Component	typ. power switching frequency
BMS	12 V Step-Down Converter	500 kHz
BMS	3.3 V Step-Down Converter	1.4 MHz
Motor PCB	H-Bridge	24.06 kHz
Motor PCB	5 V Step-Down Converter	650 kHz
Motor PCB	3.3 V Step-Down Converter	650 kHz
LED Hub, Control Hub	5 V Step-Down Converter	650 kHz

Communication Frequencies

PCB	Bus	typ. switching frequency
BMS	I2C	100 kHz
Motor PCB	SPI	21.25 MHz (STM32G473) / 21 MHz (STM32F415)
Motor PCB	I2C	100 kHz
LED Hub	LED Control	842.1 kHz (312 ns low, 875 ns high)
LED Hub, Control Hub	SPI	4 MHz
LED Hub, Control Hub	I2C	400 kHz
LED Hub, Control Hub	USB	12 MHz (USB 2.0 Full Speed - 12 Mb/s)

Communication Frequencies

PCB	**Bus**	**typ. switching frequency**
LED Hub, Ring Control (Si7213)	SENT	≤ 16.7 kHz (shortest nibble: 12 x 5 us ticks)
BMS, Motor PCB, LED Hub, Control Hub, Torque Sensor	CAN	250 kHz

4.2.5 External protection devices or measures

EMC relevant external protection devices or measures specified in the user's manual (e.g. over-voltage, shielding, bonding and grounding).

None

4.2.6 Modifications during the test

None

4.2.7 Operation and monitoring equipment

Name / Identification	Task	Availability [9] C/L
FAZUA Debug App, V0.0.1-rc1-128	Configuration, controls and monitors the parameters of the EUT	C

The FAZUA Debug App is not part of the EUT but serve exclusively for the monitoring of the EPAC parameters during the test.

The EUT was operated/monitored using a customer supplied test setup. Customer equipment used to operate and monitor the EUT(s) is not included in the equipment lists of this test report.

4.3 Deviations from Standard

None

[9] C: Provided by the customer, L: Available at laboratory

5 Test Equipment

5.1 Test Facility

The EMC-tests are carried out in the EMC-laboratory of SGS Germany, Consumer and Retail, Hofmannstraße 50, 81379 München, Germany.

Chamber	1	2	3	4 / 5	6	7
Dimensions (net)	17.7 * 10.8 * 6.8 m	9.6 * 8.5 * 5.3 m	7.4 * 6.6 * 5.2 m	4.1 * 3.5 * 3.5m	6.4 * 4.3 * 4.3m	4.58 * 4.28 * 3.01m
Max. Door Exit (w x h)	2.9 * 3.86 m	3.9 * 4.0 m	2.0 * 2.7 m	0.9 * 2.25 m	1.8 * 3.0 m	1.2 * 2.050 m
Shielding material	Sheet steel (Thick-ness:1.5mm on floor, 1.0 mm on walls and ceiling)	Sheet steel	Sheet steel	Sheet steel	Sheet steel	Sheet steel
Absorbers	Hybrid absorbers on walls and ceiling (TDK), length 1 m	Hybrid absorbers on walls and ceiling (E+C), length 0.5 m	Hybrid absorbers on walls and ceiling (E+C), length 0.3 m	Without absorbers	Without absorbers	Hybrid absorbers on walls and ceiling
Floor	Metallic ground plane floor load: 12 t/m²	Metallic ground plane floor load: 1.5 t/m²	Metallic ground plane floor load: 1 t/m²	Metallic ground plane	Metallic ground plane	Metallic ground plane
Turntable	∅ 4 m / 7 t	∅ 3.2 m / 1.5 t	∅ 2.0 m / 1 t			
Listings		VCCI-listed Reg. No. R-12623, G-10266			VCCI-listed Reg. No. C-12866 T-11942	
Specials	***Emission*:** ***30 – 1000 MHz (d = 10 m)*** - NSA acc. to: · CISPR 16-1-4 · ANSI C63.4 ***1 – 18 GHz (d = 3 m)*** Site VSWR 1 – 18 GHz acc. to CISPR 16-1-4	***Emission*:** ***30 – 1000 MHz (d = 3 m)*** - NSA acc. to: · CISPR 16-1-4 · ANSI C63.4 ***1 – 18 GHz (d = 3 m)*** Site VSWR 1 – 18 GHz acc. to CISPR 16-1-4	***Emission*:** ***30 – 1000 MHz (d = 3 m)*** - NSA acc. to: · CISPR 16-1-4 · ANSI C63.4 ***1 – 18 GHz (d = 3 m)*** Site VSWR 1 – 18 GHz acc. to CISPR 16-1-4			For automotive components only
	Immunity: Field uniformity 27 – 6000 MHz acc. IEC/EN 61000-4-3	***Immunity:*** Field uniformity 80 – 6000 MHz acc. IEC/EN 61000-4-3	***Immunity:*** Field uniformity 80 – 6000 MHz acc. IEC/EN 61000-4-3			

FCC (Federal Communication Commission): Recognition by Bundesnetzagentur (BNetzA-CAB-14/21-09) and Designation as **CAB (Conformity Assessment Body):** Designation Number DE0013; Test firm Registration #: 366296
Designation **KBA** (**Kraftfahrt-Bundesamt**) as Technical Service category A and D. Registration Number: KBA-P 00083-97
CB Testing Laboratory under the responsibility of SGS CEBEC as National Certification Body and to carry out testing within the **IECEE CB Scheme.**
Designation No. for **RRA** (Radio Research Agency) in **Korea; EU0145**
VCCI Member No. 2793

5.2 Measurement Uncertainty

As far as the underlying standards include requirements concerning the uncertainty of measuring instruments or measuring methods, they are met.

The expanded measurement uncertainty of the measuring chain was calculated for all relevant tests according to the “ISO Guide to the expression of uncertainty in measurement (GUM)”. The tables below shows the relevant uncertainties.

Emission

Test	U_{LAB}	Test	U_{LAB}
Conducted emission 9 kHz – 150 kHz CISPR 32 / CISPR 25	+2.2 dB / -2.5 dB	Conducted emission 150 kHz – 30 MHz CISPR 32 / CISPR 25 / FCC	+2.2 dB / -2.5 dB
Radiated emission H-Field 9 kHz – 30 MHz CISPR 11/36	+2.9 dB / -4.0 dB	Disturbance power 30 – 300 MHz CISPR 14-1	+3.1 dB / -3.8 dB
Radiated Emission 30 – 1000 MHz CISPR 32 / FCC	+3.1 dB / -3.9 dB	Radiated Emission 1 – 6 GHz CISPR 32 / FCC	+3.9 dB / -5.2 dB
Radiated Emission, ESA 30 – 1000 MHz CISPR 25 / ECE R10	+3.6 dB / -4.8 dB	Radiated Emission, Vehicle 30 – 1000 MHz CISPR 12 / ECE R10	+3.1 dB / -4.0 dB
Radiated Emission 6 – 18 GHz FCC	+4.2 dB / -5.7 dB	Radiated Emission 18 – 40 GHz FCC	+5.1 dB / -7.5 dB
Harmonics IEC 61000-3-2 IEC 61000-3-12	+ 0.6 dB / -0.6 dB	Flicker IEC 61000-3-3 IEC 61000-3-11	+ 0.6 dB / -0.6 dB
DC voltages with multimeter	+0,05% / -0,05%	DC currents with multimeter	+0,68% / -0,68%
Voltages with Oscilloscope	+3.33% / -3.25%		

Note: CISPR 32 includes also CISPR 11, CISPR 14-1, CISPR 15, IEC 61000-6-3, IEC 61000-6-4 if single tests are applicable in those standards.

Immunity

Test	U_{LAB}	Test	U_{LAB}
ESD IEC 6100-4-2 / ISO 10605	+1.0 dB / -1.1 dB	Radiated Immunity 20 – 1000 MHz IEC 61000-4-3	+3.7 / -4.4.dB
Radiated Immunity 1 – 18 GHz IEC 61000-4-3	+2.7 / -3.4.dB	Burst/EFT IEC 61000-4-4	+2.3 dB / -3.1 dB
Surge IEC 61000-4-5	+0.8 dB / -0.9 dB	Conducted immunity HF with CDN IEC 61000-4-6	+2.7 / -3.6 dB
Conducted immunity HF with clamp IEC 61000-4-6	+2.9 / -3.9 dB	Conducted immunity HF with current clamp IEC 61000-4-6	+2.7 / -3.6 dB
Radiated Immunity magnetic field 50 Hz, IEC 61000-4-8	+1.9 / -2.3 dB	Voltage Dips/Interruptions, IEC 61000-4-11 IEC 61000-4-34	+0.8 / -1.2 dB
Radiated immunity ALSE ISO 11452-2	+1.9 dB / -2.1 dB	BCI ISO 11452-4	+2.7 dB / -3.6 dB
Stripline / TEM ISO 11452-5/3,	+1.6 dB / -1.8 dB		

Expanded uncertainty:

Conducted emission	0.15 – 30 MHz	+ 2.2 dB / -2.5 dB
Radiated emission	30 – 1000 MHz	+3.1 dB / -3.9 dB
Radiated emission	1 – 6 GHz	+3.9 dB / -5.2 dB
Radiated emission	6 – 18 GHz	+4.2 dB / -5.7 dB
Radiated emission	18 – 40 GHz	+5.1 dB / -7.5 dB

5.3 Statement of Conformity & Decision Rule

If not otherwise stated, the Decision Rule is considered in different ways.

Emission based on CISPR 11, CISPR 14-1, CISPR 15, CISPR 32, CISPR 36, IEC 61000-6-3, IEC 61000-6-4:
The decision rule for statement of conformity is based on U_{CISPR} given in CISPR 16-4-2. The relevant MIU (Measurement Instrumentation Uncertainty) calculations U_{LAB} of the EMC-lab for the single emission tests is below U_{CISPR}. Therefore, it can be considered that the measurement result is valid without any need of adaption and e.g., a result of 0 dB to the limit can be stated as pass.

All other emission tests:
For all other emission tests, the relevant MIU have been calculated by the EMC-lab and U_{LAB} keep typical levels. In this case, the “Binary Statement for Simple Acceptance Rule” acc. 4.2.1 of ILAC G8:2019 is applied. The result can be considered to be passed if the measurement value is at least equal to the limit. Probability is only 50% in this case. If the measured value is below the limit by the amount of the measurement uncertainty, the risk of an incorrect assumption is already reduced to 2.5%.

Immunity
The calculated MIU U_{LAB} of the test levels are according to the requirements of the corresponding test standards. As the influence of the characteristics of the test disturbance is not known and the DUT shows non-linear system behavior in most cases, no decision rule can be stated for immunity tests.

6 Test Conditions and Results

The test results in the report refer exclusively to the test object described in section 4 and the test period in section 3.3. The results apply to the sample(s) as received.

6.1 Conducted disturbance (150 kHz to 30 MHz)

Phenomena	Reference	Frequency Range	Criteria	Verdict [1]
Conducted Emission AC Power Ports	FCC 47 CFR Part 15 §15.107	150 kHz – 30 MHz	Class A / B	NR [4]
Conducted Emission AC Power Ports	ICES-003	150 kHz – 30 MHz	Class A / B	NR [4]

6.2 Radiated disturbances (30 MHz to 1000 MHz)

Phenomena	Reference	Frequency Range	Criteria	Verdict [1]
Radio Disturbance Electric Field	FCC 47 CFR Part 15 §15.109	30 MHz - 1 GHz distance 3 m	Class B	P
Radio Disturbance Electric Field	ICES-003	30 MHz - 1 GHz distance 3 m	Class B	P

(The radiated emission limits < 1 GHz of FCC 47 CFR Part 15 §15.109 Class A/B are not identical with ICES-003 class A/B but ICES 003-limits are covered by §15.109.)

Tested by : H.Linhardt

Test date : 2023-04-13 Test location : EMC chamber No. 02

Test procedure:

Radiated measurements are performed in a semi-anechoic chamber meeting the normalized site attenuation of ANSI C63.4 and listed with the FCC. The applicable frequency spectrum is scanned with a calibrated RF measuring system using an appropriate broadband antenna and an EMI-receiver/spectrum analyzer and compared to the required limits. The measuring instrument performs the field strength calculations automatically. The measuring software provides resident AF and CF figures for individual antennas and cables. The receiver/analyzer is set to "peak" mode from 30 MHz to 1 GHz. On any emission of concern, the receiver is set to quasi-peak mode.

“Maximization” of each suspect frequency is accomplished by a combination of a 360° azimuth search using a turntable and varying the antenna to ground plane height from 1 m to 4 m. Also, both the vertical and horizontal polarization is scanned in the required frequency range per ANSI C63.4.
Maximization of emission results starts at 0° of the turn table with antenna in horizontal polarization is set to 1 m. While the turntable slowly moves to 360°, the spectrum analyzer is sweeping from 30 to 1000 MHz and maximum data is recorded. Antenna is set to 2 m and turntable slowly moves back to 0° while the spectrum analyzer is sweeping again. This is repeated until the antenna height of 4 m is reached.
The antenna polarization is set to vertical and the procedure described above is repeated.
For each frequency, the measuring software stores the maximum level as well as the corresponding settings of turntable and antenna. An azimuth resolution of about 3° is realized using this method.
At least the six highest frequencies are selected automatically by the software for performing the final measurements.
At each of these frequencies the turntable as well as the antenna is set to the corresponding settings. Then the antenna is slowly moved 50 cm down/up related to initial position while the receiver is measuring at this frequency. The highest emission level and the corresponding height are recorded. At this final position, the measurement is performed with quasi-peak detector. Exploratory emission measurements are to be performed considering operation states and cable arrangement to evaluate configuration with highest emission levels (C63.4, Clause 8.3.1 and 8.3.2).
Table-top equipment is arranged 80 cm above ground plane.

EMC-Test-SW: EMC32 version 10.60.20 (R&S)

Sample Calculation with all conversion and correction factors used:

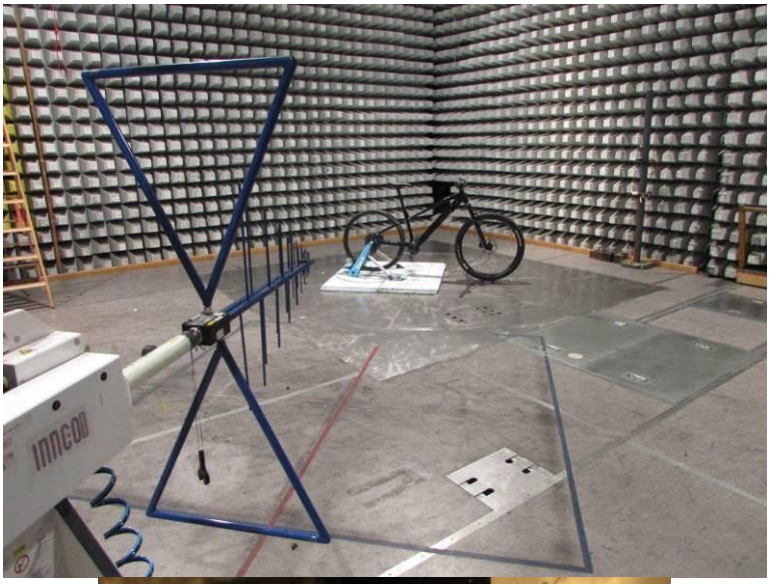
$\sum CF = CF_{Cables} + CF_{Antenna}$

Instruments and accessories

ID	Description	Manufacturer	Model	Serial No.	Status	Cal. date	Due date
P0337	EMC chamber 2	Siemens			chk		
P1283	Mast (MZ2)	innco GmbH	MA 4740-XPET	MA4000/170/ 13470706/L	cnn		
P1284	Controller	innco GmbH	CO 3000	CO3000/914/ 37830316/L	cnn		
P2685	EMI receiver (MZ4)	R&S	ESR7	102505	cal	May 31, 2022	May 2024
P2150	coax cable 3m (for MZ2)		RG214U		ind		
P0018	antenna (MZ 2)	Chase	CBL6111A + 4dB	1566 + CM7710	cal	May 26, 2021	May 2023

cal = Calibration, car = Calibration restricted use, chk = Check, chr = Check restricted use, cpu = Check prior to use, calchk = Calibration and check, ind = for indication only, cnn = Calibration not necessary, service = Wartung (Service), man = Maintenance, calservice = Calibration & Service, chkservice = Check & Service, calchkservice = Calibration & Check & Service

Photo documentation of the test set-up:



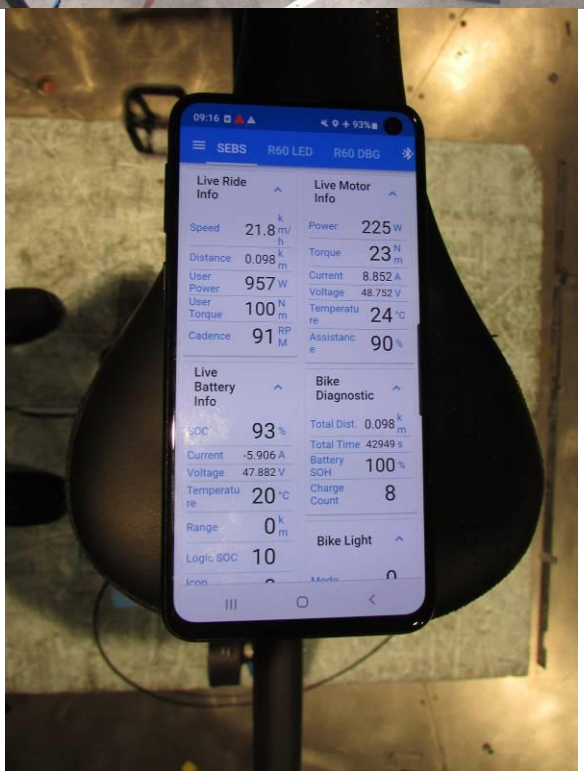


Figure 6-1: test setup for Radiated disturbances 30 MHz to 1000 MHz

Figure 6-2: test setup for Radiated disturbances 30 MHz to 1000 MHz

Result:

verdict:	**pass**

For detailed results, please see below.

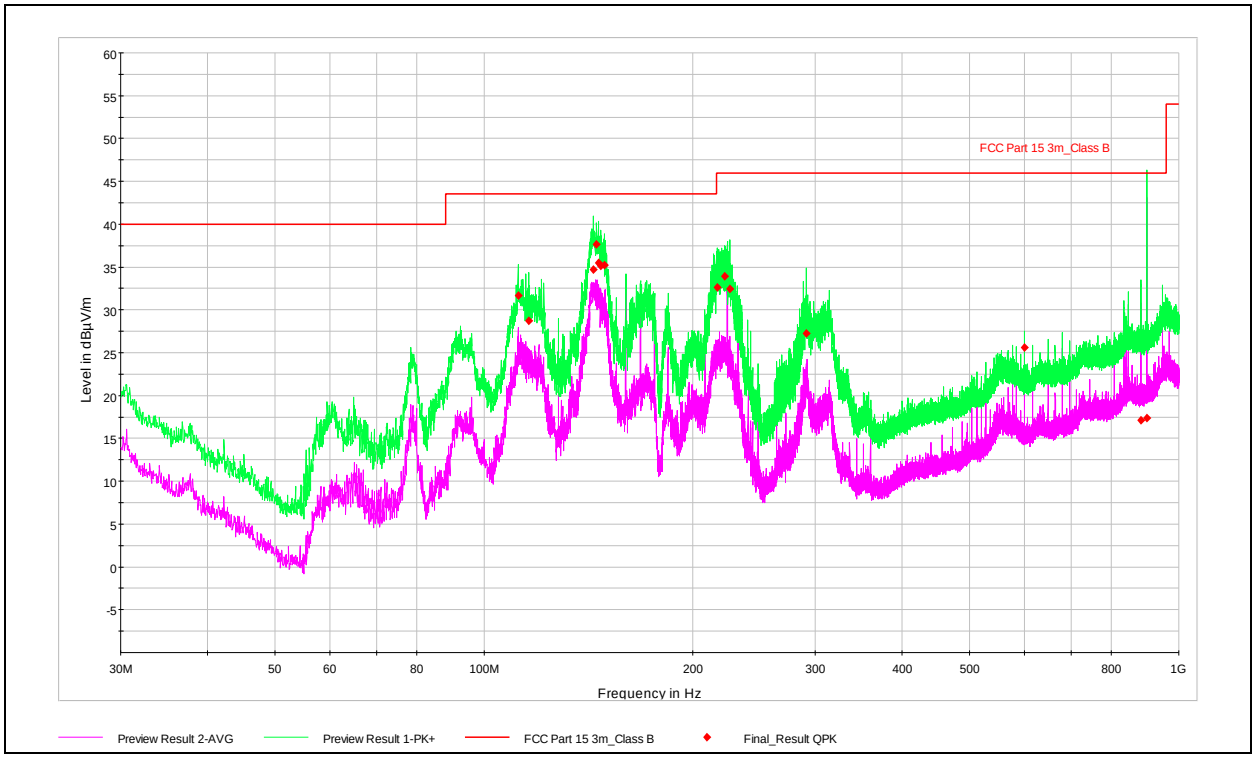


Figure 6-3: Graphical presentation Radiated disturbances 30 MHz to 1000 MHz

Result table:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
111.965000	31.68	43.50	11.82	15000.0	120.000	107.0	V	322.0	12
115.942000	28.76	43.50	14.74	15000.0	120.000	121.0	V	105.0	13
143.684000	34.68	43.50	8.82	15000.0	120.000	193.0	H	253.0	12
145.236000	37.62	43.50	5.88	15000.0	120.000	210.0	H	102.0	12
146.157500	35.51	43.50	7.99	15000.0	120.000	225.0	H	101.0	12
147.321500	35.17	43.50	8.33	15000.0	120.000	189.0	H	103.0	12
149.019000	35.18	43.50	8.32	15000.0	120.000	182.0	H	102.0	12
216.531000	32.59	46.00	13.41	15000.0	120.000	183.0	H	103.0	10
221.914500	33.93	46.00	12.07	15000.0	120.000	110.0	H	110.0	11
226.037000	32.47	46.00	13.53	15000.0	120.000	125.0	H	110.0	11
290.978500	27.25	46.00	18.75	15000.0	120.000	121.0	H	134.0	15
600.020500	25.62	46.00	20.38	15000.0	120.000	194.0	H	124.0	22
882.436000	17.09	46.00	28.91	15000.0	120.000	125.0	V	1.0	26
899.459500	17.34	46.00	28.66	15000.0	120.000	175.0	V	274.0	26

6.3 Radiated disturbances (1 GHz to 26 GHz)

Phenomena	Reference	Frequency Range	Criteria	Verdict [1]
Radio Disturbance Electric Field	FCC 47 CFR Part 15 §15.109	1 GHz – 26 GHz Distance 3 m	Class B	P
Radio Disturbance Electric Field	ICES-003	1 GHz - 26 GHz Distance 3 m	Class B	P

(The radiated emission limits > 1 GHz for AV-detector of FCC 47 CFR Part 15 §15.109 Class A/B are identical with ICES-003 class A/B. In addition, ICES-003 requires also a peak-limit with 20 dB above relevant AV-limit.)

Tested by : H.Linhardt

Test date : 2023-04-13 Test location : EMC chamber No. 02

Test Execution

Radiated measurements are performed in a semi-anechoic chamber meeting the normalized site attenuation of ANSI C63.4 as well as the Site VSWR requirements of CISPR16 and listed with the FCC. The applicable frequency spectrum is scanned with a calibrated RF measuring system using an appropriate broadband antenna and an EMI-receiver/spectrum analyzer and compared to the required limits. The measuring instrument performs the field strength calculations automatically. The measuring software provides resident AF and CF figures for individual antennas and cables. The receiver/analyzer is set to "peak" mode in the relevant frequency range. On any emission of concern, the receiver is set to average mode.

For EUTs having a size larger than the beamwidth of the antenna, appropriate countermeasures shall be taken, e.g. increasing the measuring distance or different antenna positions (lateral) to scan the complete surface of EUT.
"Maximization" of each suspect frequency is accomplished by a combination of a 360° azimuth search using a turntable and varying the antenna to ground plane height from 1 m to 4 m. Both, the vertical and horizontal polarization is scanned in the required frequency range per ANSI C63.4.
Maximization of emission results starts at 0° of the turn table with antenna in horizontal polarization is set to 1 m. While the turntable slowly moves to 360°, the spectrum analyzer is sweeping from 1 to 26 GHz and maximum data is recorded. Antenna is set to 1.5 m and turntable slowly moves back to 0° while the spectrum analyzer is sweeping again. This is repeated until the antenna height of 4 m is reached (step: 0.5m).
The antenna polarization is set to vertical and the procedure described above is repeated.
For each frequency, the measuring software stores the maximum level as well as the corresponding settings of turntable and antenna. An azimuth resolution of about 3° is realized using this method.
At least the six highest frequencies are selected automatically by the software for performing the final measurements. At each of these frequencies the turntable as well as the antenna is set to the corresponding settings. Then the antenna is slowly moved 25 cm down/up related to initial position while the receiver is measuring at this frequency. The highest emission level and the corresponding height are recorded. At this final position, the measurement is performed with average detector.
Exploratory emission measurements are to be performed considering operation states and cable arrangement to evaluate configuration with highest emission levels (C63.4, Clause 8.3.1 and 8.3.2).
Final measurements were performed acc C63.4, clause 8.3.2.2 aimed at the emission source for receiving the maximum signal.

Table-top equipment is arranged 80 cm above ground plane.

EMC-Test-SW: EMC32 version 10.60.20 (R&S)

Sample Calculation with all conversion and correction factors used:
$\sum CF = CF_{Cables} + CF_{Antenna} + CF_{Preamplifier}$

Instruments and accessories 1 – 18 GHz

ID	Description	Manufacturer	Model	Serial No.	Status	Cal. date	Due date
P2258	coax cable 5m, rugged-ized (MZ2)	Suhner	Sucoflex 104A	507078/4A	chk	Nov 02, 2022	Nov 2023
P1326	EMI receiver	R&S	ESU26	100058	cal	Mar 25, 2022	Mar 2024
P1575	antenna (MZ2)	R&S	HL050	100097	cal	Jul 06, 2022	Jul 2024
P1590	preamplifier (MZ2)	Kuhne electronic	KU LNA BB 202 A		cal	Mar 31, 2022	Mar 2024
P0337	EMC chamber 2	Siemens			chk		
P1283	Mast (MZ2)	innco GmbH	MA 4740-XPET	MA4000/170/ 13470706/L	cnn		
P1284	Controller	innco GmbH	CO 3000	CO3000/914/ 37830316/L	cnn		

cal = Calibration, car = Calibration restricted use, chk = Check, chr = Check restricted use, cpu = Check prior to use, calchk = Calibration and check, ind = for indication only, cnn = Calibration not necessary, service = Wartung (Service), man = Maintenance, calservice = Calibration & Service, chkservice = Check & Service, calchkservice = Calibration & Check & Service

Instruments and accessories 18 –26 GHz

ID	Description	Manufacturer	Model	Serial No.	Status	Cal. date	Due date
P0337	EMC chamber 2	Siemens			chk		
P1326	EMI receiver	R&S	ESU26	100058	cal	Mar 25, 2022	Mar 2024
P1148	antenna (horn 18 - 40GHz)	Emco	3116	9904-2425	cal	May 09, 2022	May 2024
P1197	preamplifier 18-40GHz	B&Z Technolo-gies	BZR-18004000-280834-252525	15132	cal	Mar 30, 2023	Mar 2025
P2080	coax cable 40 GHz, 5m	Rosenberger Micro-Coax	LA1-036-5000	38/16-001	cal	Mar 30, 2023	Mar 2025
P1283	Mast (MZ2)	innco GmbH	MA 4740-XPET	MA4000/170/ 13470706/L	cnn		
P1284	Controller	innco GmbH	CO 3000	CO3000/914/ 37830316/L	cnn		

cal = Calibration, car = Calibration restricted use, chk = Check, chr = Check restricted use, cpu = Check prior to use, calchk = Calibration and check, ind = for indication only, cnn = Calibration not necessary, service = Wartung (Service), man = Maintenance, calservice = Calibration & Service, chkservice = Check & Service, calchkservice = Calibration & Check & Service

Photo documentation of the test set-up:

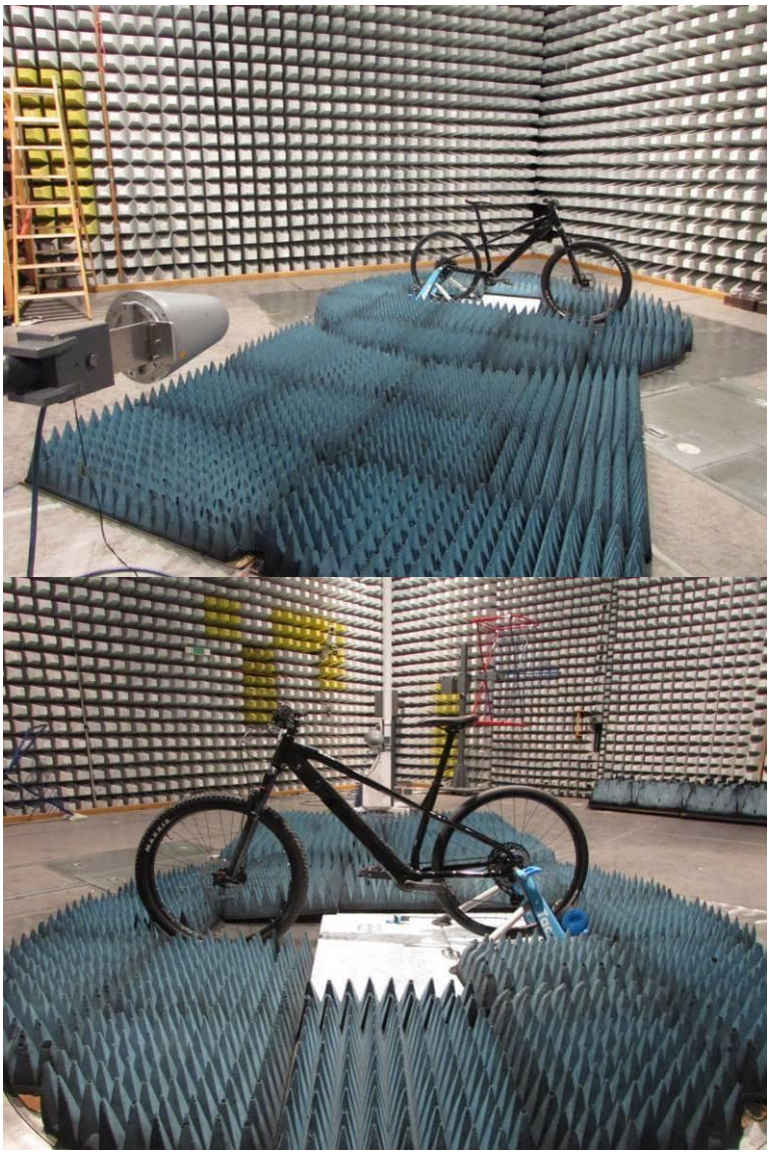


Figure 6-4: test setup for radiated disturbances 1 GHz to 18 GHz

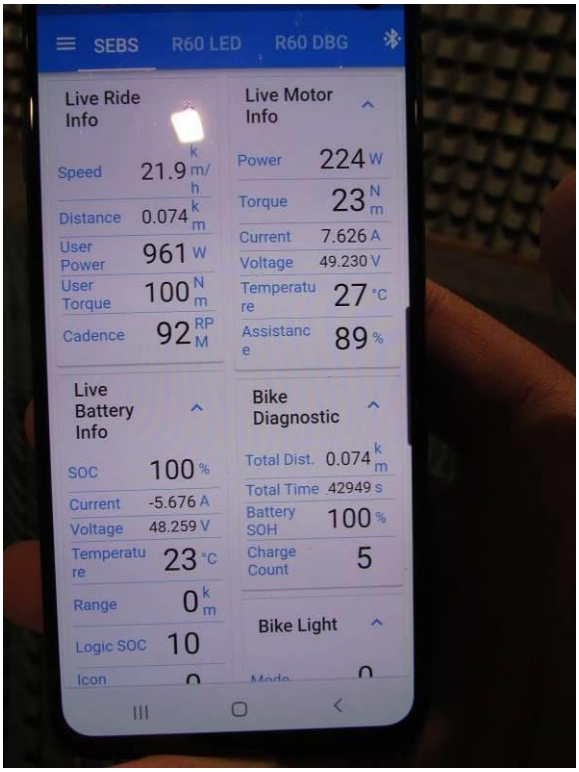


Figure 6-5: test setup for radiated disturbances 1 GHz to 18 GHz – OP Mode

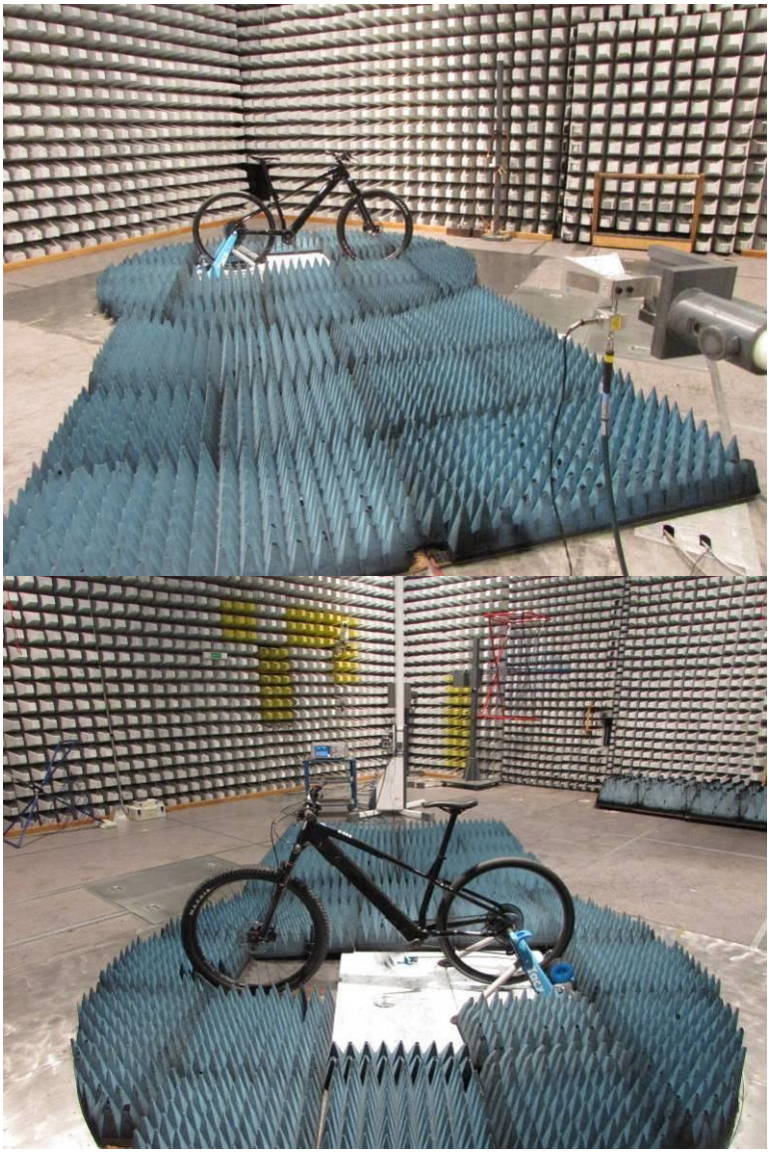


Figure 6-6: test setup for radiated disturbances 18 GHz to 26 GHz

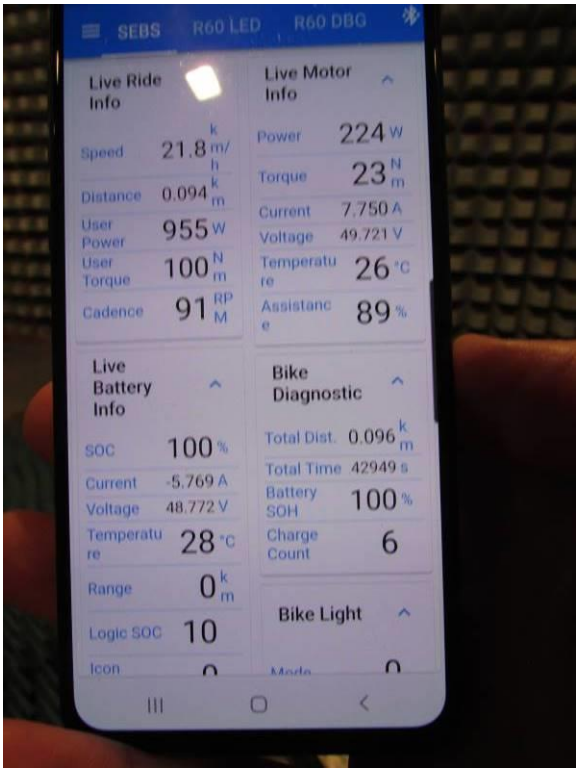


Figure 6-7: test setup for radiated disturbances 18 GHz to 26 GHz – OP Mode

Result:

verdict:	**pass**

For detailed results, please see below.

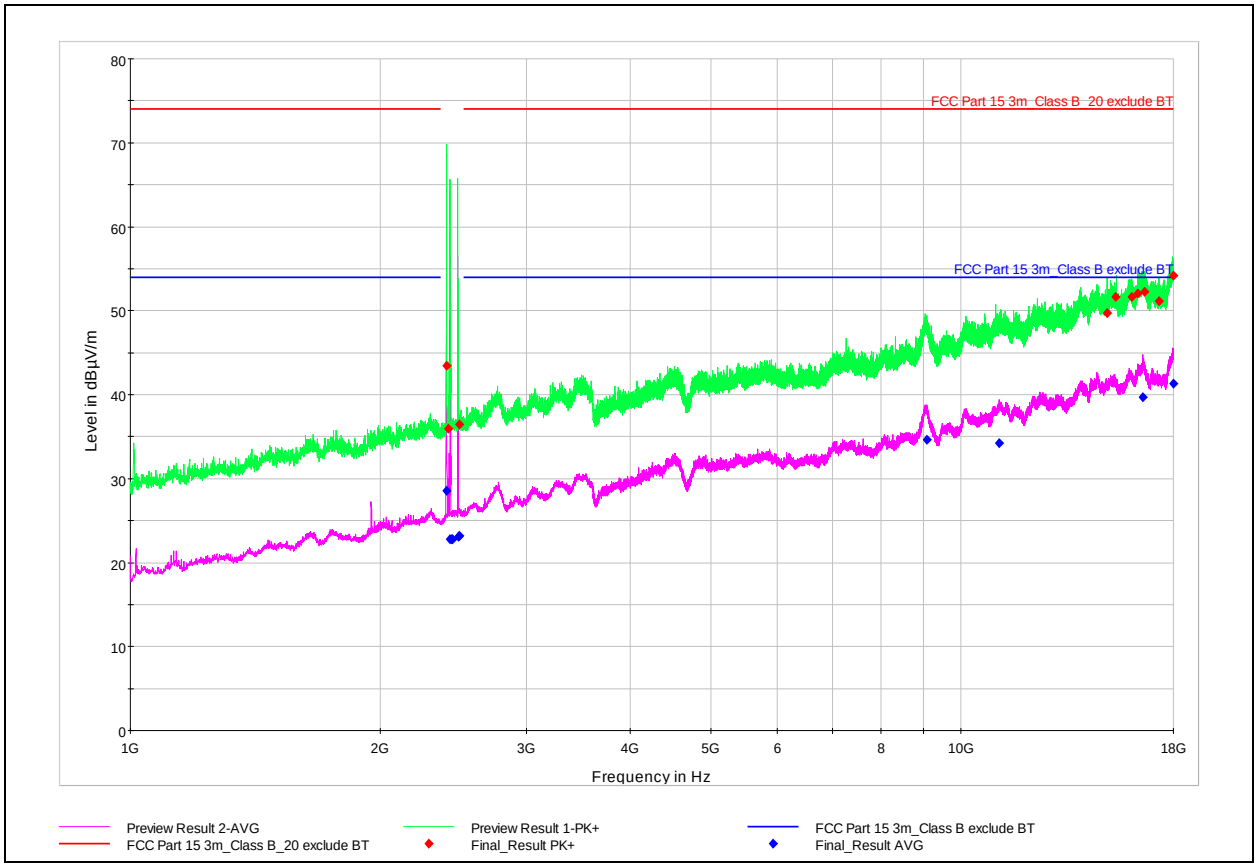


Figure 6-8: Graphical presentation Radiated disturbances 1 GHz to 18 GHz

Result table:

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
2402.133333	---	28.58	54.00	25.42	1000.0	1000.000	303.0	V	37.0
2403.566667	43.42	---	74.00	30.58	1000.0	1000.000	280.0	V	37.0
2410.966667	35.94	---	74.00	38.06	1000.0	1000.000	116.0	H	68.0
2427.300000	---	22.81	54.00	31.19	1000.0	1000.000	222.0	H	88.0
2434.400000	---	22.78	54.00	31.22	1000.0	1000.000	116.0	H	69.0
2441.400000	---	22.79	54.00	31.21	1000.0	1000.000	125.0	V	326.0
2481.600000	---	23.05	54.00	30.95	1000.0	1000.000	181.0	V	255.0
2488.033333	---	23.16	54.00	30.84	1000.0	1000.000	276.0	H	306.0
2490.000000	36.42	---	74.00	37.58	1000.0	1000.000	225.0	V	255.0
9091.166667	---	34.65	54.00	19.35	1000.0	1000.000	303.0	V	16.0
11096.266667	---	34.22	54.00	19.78	1000.0	1000.000	100.0	H	327.0
14974.300000	49.76	---	74.00	24.24	1000.0	1000.000	125.0	V	233.0
15344.200000	51.60	---	74.00	22.40	1000.0	1000.000	102.0	H	140.0
16023.966667	51.67	---	74.00	22.33	1000.0	1000.000	325.0	V	87.0
16302.433333	52.04	---	74.00	21.96	1000.0	1000.000	125.0	H	213.0
16553.833333	---	39.65	54.00	14.35	1000.0	1000.000	125.0	H	245.0
16603.200000	52.28	---	74.00	21.72	1000.0	1000.000	300.0	V	335.0
17298.766667	51.09	---	74.00	22.91	1000.0	1000.000	225.0	V	120.0
17983.866667	---	41.31	54.00	12.69	1000.0	1000.000	275.0	H	135.0
17983.966667	54.20	---	74.00	19.80	1000.0	1000.000	116.0	H	28.0

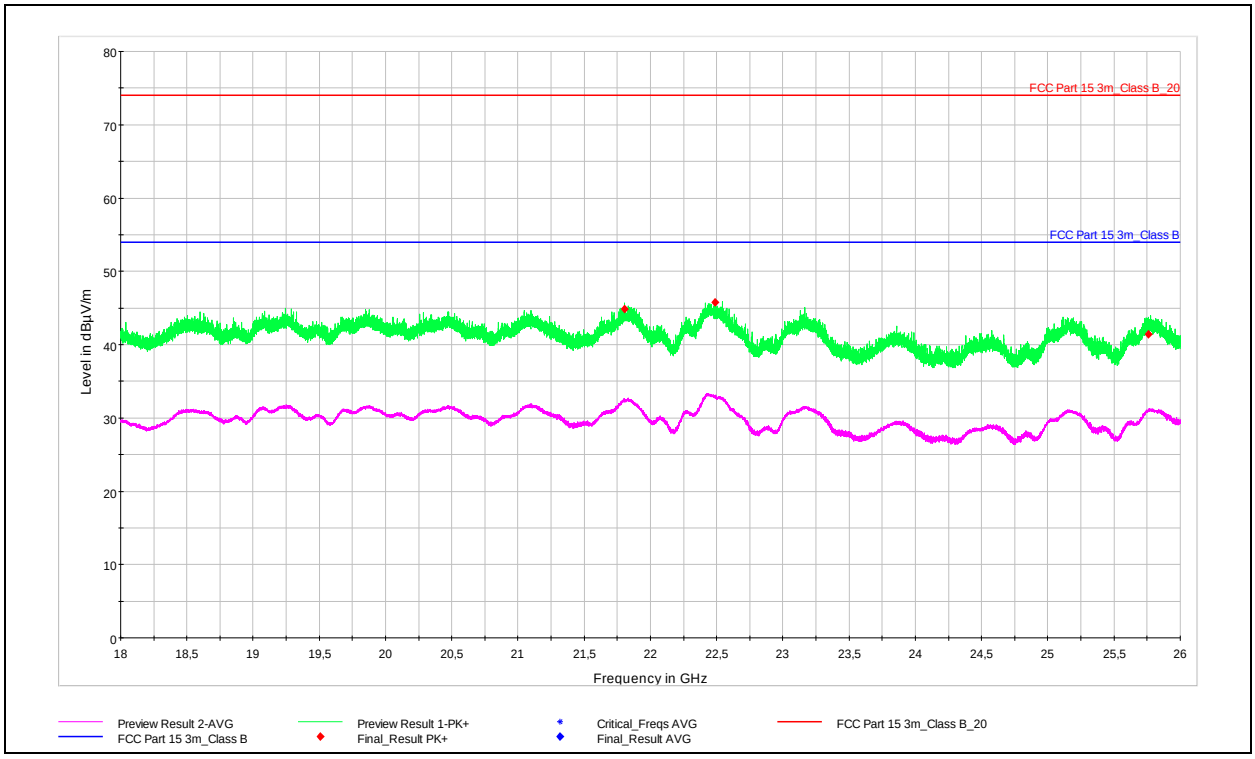


Figure 6-9: Graphical presentation Radiated disturbances 18 GHz to 26 GHz

Result table:

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
21802.400000	44.89	---	74.00	29.11	1000.0	1000.000	278.0	V	300.0
22487.600000	45.73	---	74.00	28.27	1000.0	1000.000	309.0	H	224.0
25761.600000	41.39	---	74.00	32.61	1000.0	1000.000	100.0	V	87.0

End of Test Report

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