Test Report
Electromagnetic Compatibility

Product	IoT gateway for cellular connection and data communication from and to different type of devices
Name and address of the applicant	Telenor Connexion AB Box 3081, SE-169 03 Solna, Sweden
Name and address of the manufacturer	Telenor Connexion AB Box 3081, SE-169 03 Solna, Sweden
Model	ECB02_C
Rating	3.5 – 4.2 VDC, Max 3W
Trademark	Telenor
Additional information	/
Tested according to	FCC CFR 47 Subpart 15B ISED Canada ICES-003, Issue 7
Project number	467274
Tested in period	2022-11-29 to 2023-03-09 2024-06-25
Issue date	2024-06-26
Name and address of the testing laboratory	Nemko Scandinavia AS Philip Pedersens vei 11, 1366 Lysaker, Norway

An accredited technical test executed under the Norwegian accreditation scheme

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Approved by [Roy Uggerud]

REPORT REVISIONS

Report Edition	Date	Project	Description
REP006529	2023-06-21	467274	First issued
REP006529-3	2024-06-25	467274	Conducted emissions included
REP006529-3	2024-08-06	467274	Deleted 24Vdc and 54Vdc as the product is 3.5Vdc – 4.2Vdc
REP006529-3	2024-08-16	467274	Removed Annex

DESCRIPTION OF TESTED ITEM(S)

Product description..... :	The EUT is a multipurpose communication boards with cellular and GNSS technology. The EUT also har connection for RS232, RS485, Digital I/O, USB and CANbus. The EUT also has several onboard LEDs and sensors. During all testing, except Surge and ESD, the device has been connected to a laptop which has been used to energize and supervise all interfaces via a proprietary LabVIEW program. For ESD and Surge, the EUT has been reprogrammed with a special FW, and been supervised via the onboard LEDs. The software allows for having either cellular or GNSS running, not both.

Model/type ..... :	ECB02_C
Serial number..... :	Prototypes
Operating voltage..... :	3.5 – 4.2 VDC
Maximum power/current..... :	Max 3W
Insulation class ..... :	III
Highest clock frequency ..... :	582MHz
Hardware version..... :	ECB02_C V1
Software version ..... :	BIST_EBC02_C_0.3.6
FCC id	2BAKCECB02C
Contains FCC id	XMR202005BG95M5 (BG95) XMR201909EG95NAX (EG95NAX)

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

RF CHARACTERISTICS OF THE TRANSMITTER

See the following Nemko reports for full details on RF transmitters:

LTE	REP004402	According to EN 301 908
GNSS	REP004403	According to EN 303 413

CRITICAL MODULES/PARTS

Description	Manufacturer	Type
MCU	NXP	MIMXRT1061CVL5B
Modem	Quectel	BG95 M5
Modem	Quectel	EG95 EX
Modem	Quectel	EG95 NAX
MM Connector	Wurth	690367292676
RJ45	Molex	955406888
Power Socket	Weidmuller	1874690000 alt. 1870500000
PCB	NCAB	/

ACCESSORIES USED DURING TEST

Description	Manufacturer	Type
Laptop computer	Lenovo	Legion
CAN to USB adapter	Kvaser	U100
2x UART-USB adapters	-	-
POE Injector	Trendnet	TPE-115GI /EU
POE Switch	Zyxel	GS1900-10HP

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
ECB02C	Full test	☒

INPUT/OUTPUT PORTS

Port name and description	Cable		
	Longer than 3m	Attached during test	Shielded
DC	☒	☒	☐
Ethernet	☒	☒	☐
RS232	☒	☒	☐
RS485	☒	☒	☐
USB	☒	☒	☒
CANBUS	☒	☒	☐
Digital IO	☒	☒	☐
Sensor Feed	☒	☒	☐
Power via Minimodule Connector	☒	☒	☐
Power via Power Terminal	☒	☒	☐

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

OPERATING MODES

OP no.	Description	Applied for testing	
		Emissions	Immunity
OP1	Active and communicating, wireless disabled	☒	☐
OP2	Active and communicating, wireless enabled	☒	☐

POWER SUPPLY CONDITIONS

The following nominal power supply conditions have been tested:

PC no.	Voltage	Frequency	Type	Ground terminal
PC2	4 V	☐ AC 50Hz / ☐ AC 60Hz / ☒ DC	☐ 3AC / ☐ 3ACN / ☐ PoE	☐ PE / ☒ GND / ☐ None

All DC sources where supplied with 120V/60Hz AC.

PHOTOS AND DRAWINGS

Copy of marking label..... :	/

Photo of the test item ..... :	See photos

OTHER INFORMATION

Modifications ..... :	/
Additional information ..... :	Power source was supplied with 120V 60Hz.

TEST ENVIRONMENT

Test laboratory ..... :	☒ KJELLER (Instituttveien 6, N-2007 Kjeller, Norway) ☐ LYSAKER (Philip Pedersens vei 11, N-1366 Lysaker, Norway)
Laboratory accreditation ..... :	NORWEGIAN ACCREDITATION TEST 033 **Norsk Akkreditering – TEST 033** P06 – Electromagnetic Compatibility
Environmental 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.
Measurement uncertainties..... :	Uncertainty in EMC emission measurements stated in this report are calculated from the standard measurement uncertainties multiplied by the coverage factor k=2. It was determined in accordance with CISPR 16-4-2. The true value is in the corresponding interval with a probability of 95%. Uncertainties for continuous immunity tests are calculated based on the same principles as for EMC emission uncertainties. For Harmonics and Flicker measurements the measurement uncertainty is calculated based on the same principles as for EMC emission uncertainties. Uncertainties for transient immunity are kept within the requirements of the relevant basic standard. *Further information about measurement uncertainties is provided on request.*
Decision rules ..... :	As specified by CISPR 16-4-2; if our measurement uncertainty U_{LAB} is less than or equal to U_{CISPR} , compliance is deemed to occur if no measured disturbance level exceeds the limit hence “PASS” is indicated, and non-compliance is deemed to occur if any measured disturbance level exceeds the limits hence “FAIL” is indicated. For continuous immunity tests, uncertainties are not considered when applying the calibrated test levels. Tests are performed at the test levels specified by the test standard. PASS and FAIL decisions are based on behaviour observations of the specimen. For transient immunity tests, uncertainties are not considered if the test equipment is kept within the requirements of the relevant basic standard. Tests are performed at the test levels specified by the test standard. PASS and FAIL decisions are based on behaviour observations of the specimen. For Harmonics and Flicker measurements the measurement uncertainty is considered, and measurements are marked if necessary. In doing so, the associated uncertainty of measurement has been considered. *Further information about decision rules is provided on request.*

TEST REPORT SUMMARY

APPLIED STANDARDS

Standards	Titles
FCC CFR 47 Subpart 15B	*Digital devices - Unintentinal radiators, Class B Digital Device*
ISED Canada ICES-003, Issue 7	*Spectrum Management and Telecommunications Policy. Interference-Causing Equipment Standard. Information Technology Equipment (Including Digital Apparatus - Limits and Methods of Measurement (Issue 7, June 2020)*

TEST SUMMARY

Requirements – Tests	Reference standards	Verdict
Conducted Emissions	FCC CFR 47 Subpart 15B:0 ISED Canada ICES-003, Issue 7:0 FCC Part 12.107 per ANSI C63.4-2014	PASS
Radiated Emissions (Below 1GHz)	FCC CFR 47 Subpart 15B:0 ISED Canada ICES-003, Issue 7:0 FCC Part 12.109 per ANSI C63.4-2014	PASS
Radiated Emissions (Above 1GHz)	FCC CFR 47 Subpart 15B:0 ISED Canada ICES-003, Issue 7:0 FCC Part 12.109 per ANSI C63.4-2014	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

ABOUT REFERENCE STANDARDS AND TEST LEVELS

Product standards with dated references to basic standards may have been performed according to the newest edition of the basic standard. This may impact the compliance criteria or technical performance of the test, still this is adequate if 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.

The choice of immunity test levels could be higher than those specified by the reference standards when we consider the nature of the specimen and its intended use or based on customer requests.

NOTES

None

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: ± 3.7 dB (9 kHz – 150 kHz); ± 3.3 dB (150 kHz – 30 MHz)

Instruments used during measurement

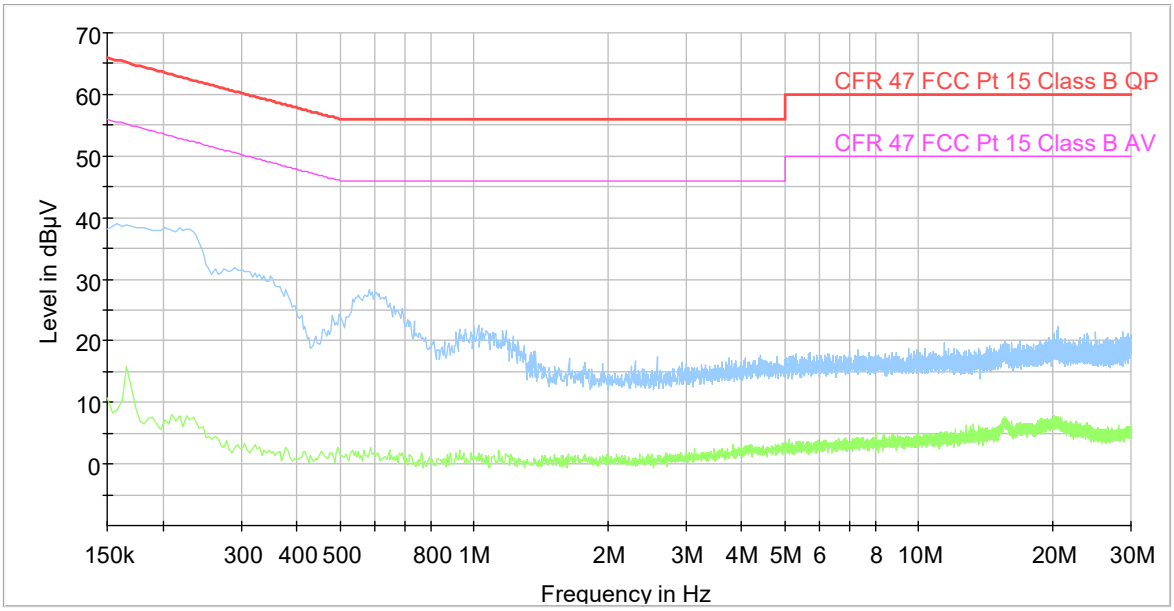
Instrument list:
AMN: R&S / ENV216 (LR-1665) (11/2023)
EMI Receiver: R&S / ESCI 3 (N-4259) (12/2023)
AC Power Source: Agilent Technoligies / 6812B (LR-1515) (N/A)
ACDC-converter BANDRIDGE BE0650 (N/A) N/A)

Conformity

Verdict:	PASS
Test engineer:	JGER

ECB02C – PC2 – OP1
CONDUCTED EMISSION SPECTRUM

Full Spectrum



Preview Result 2-AVG
PK+
CFR 47 FCC Pt 15 Class B QP
Final_Result QPK
Preview Result 1-PK+
AVG
CFR 47 FCC Pt 15 Class B AV
Final_Result CAV

Final_Result

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)	Comment
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RADIATED EMISSIONS (BELOW 1GHZ)

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.
☐ Ferrite clamps type CMAD were applied to cables leaving the test volume.
☐ A CDNE was applied to the power supply cable.

Antenna type = Hybrid bilog antenna
Antenna elevation = 100-400 cm above the ground reference plane.
Specimen rotation = 0-360º.

☐ Band-stop filter(s) was used to suppress the wanted RF transmission band to protect the measurement equipment.

Frequency range:	Measurement distance:
☐ 30-300MHz	☒ 3m
☒ 30-1000MHz	☐ 5m
☐ Other:	☐ 10m

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: ± 4.9 dB (3m distance in SAC10); ± 4.6 dB (3m distance in SAC3); ± 4.6 dB (10m distance in SAC10)

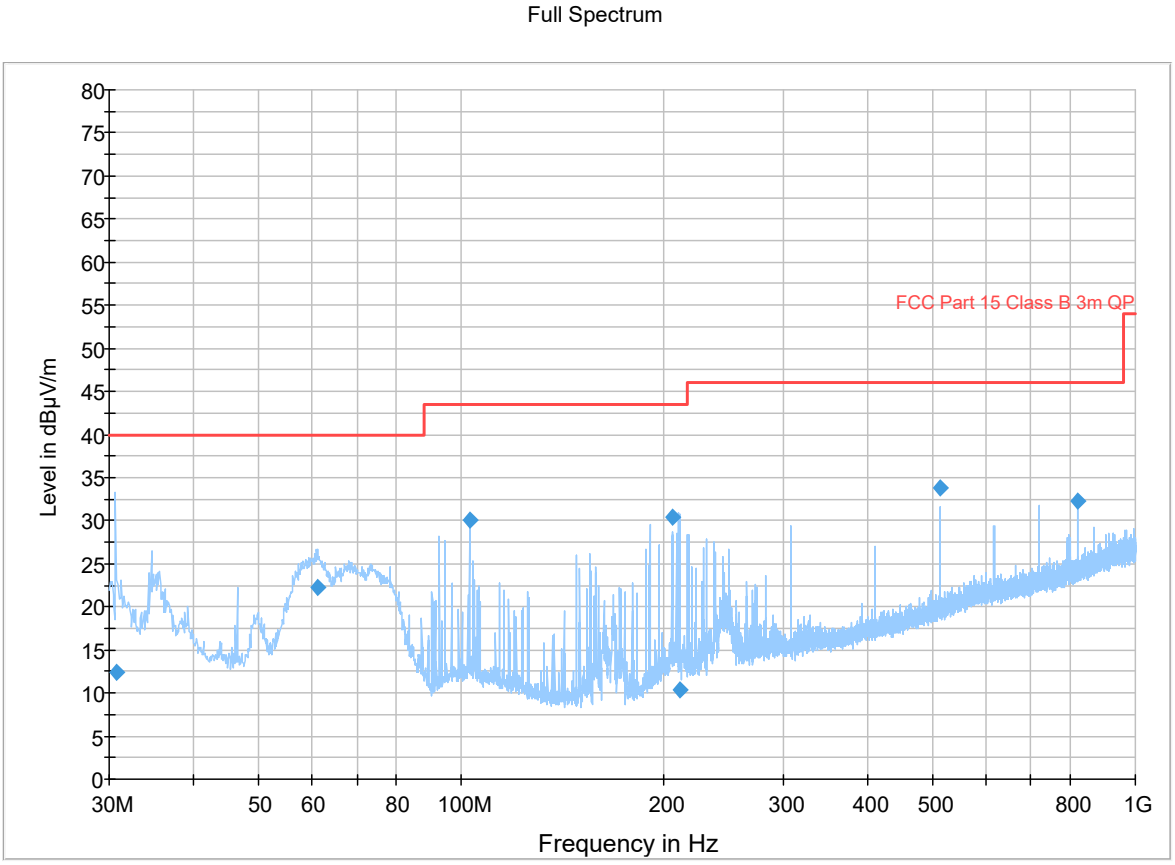
Instruments used during measurement

Instrument list:
Antenna, Hybrid: Schwarzbeck / VULB 9163 (LR-1616) (05/2023)
EMI Receiver: R&S / ESU40 (LR-1639) (01/2024)
Preamplifier: Sonoma / 310N (LR-1686) (08/2023)
AC Power Source: Agilent Technoligies / 6812B (LR-1515) (N/A)

Conformity

Verdict:	PASS
Test engineer:	DGW

ECB02C – PC2 – OP1
EMISSION 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/m)
30.726106	12.40	40.00	27.61	15000.0	120.000	287.0	V	281.0	-15.8
61.305082	22.30	40.00	17.70	15000.0	120.000	132.0	V	92.0	-13.9
102.865666	30.10	43.50	13.40	15000.0	120.000	100.0	V	296.0	-14.3
205.714356	30.45	43.50	13.05	15000.0	120.000	132.0	H	143.0	-13.7
210.678440	10.37	43.50	33.13	15000.0	120.000	217.0	H	19.0	-13.6
514.305088	33.76	46.00	12.24	15000.0	120.000	110.0	V	328.0	-5.5
822.888726	32.27	46.00	13.73	15000.0	120.000	118.0	V	303.0	-0.5

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 specimen and its cables were elevated 10 cm above the floor and placed in the centre of the turntable.
☒ The specimen and its cables were placed on a table 80 cm above the floor and placed in the centre of the turntable.

Facility:
☐ 3m semi-anechoic chamber (SAC3) with extra floor absorbers* (calibrated volume: D=2.0m / H=2.0m).
☒ 10m semi-anechoic chamber (SAC10) with extra floor absorbers* (calibrated volume: D=1.5m / H=2.0m).
☐ 3m fully anechoic room (FAR3) (calibrated volume: D=1.2m / H=2.0m).

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

Measurement distance = ☒ 3m.
Antenna elevation = fixed at centre of specimen height.
Specimen rotation = 0-360º.
Measurements were performed with a double-ridged guide horn antenna.

☐ Band-stop filter(s) was used to suppress the wanted RF transmission band to protect the measurement equipment.

Frequency range:	Highest internal frequency of specimen:
☐ 1-2GHz	☐ Below 108MHz
☐ 1-5GHz	☐ Between 108MHz and 500MHz
☒ 1-6GHz	☐ Between 500MHz and 1000MHz
☒ 1-12GHz	☐ 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: ± 5.1 dB

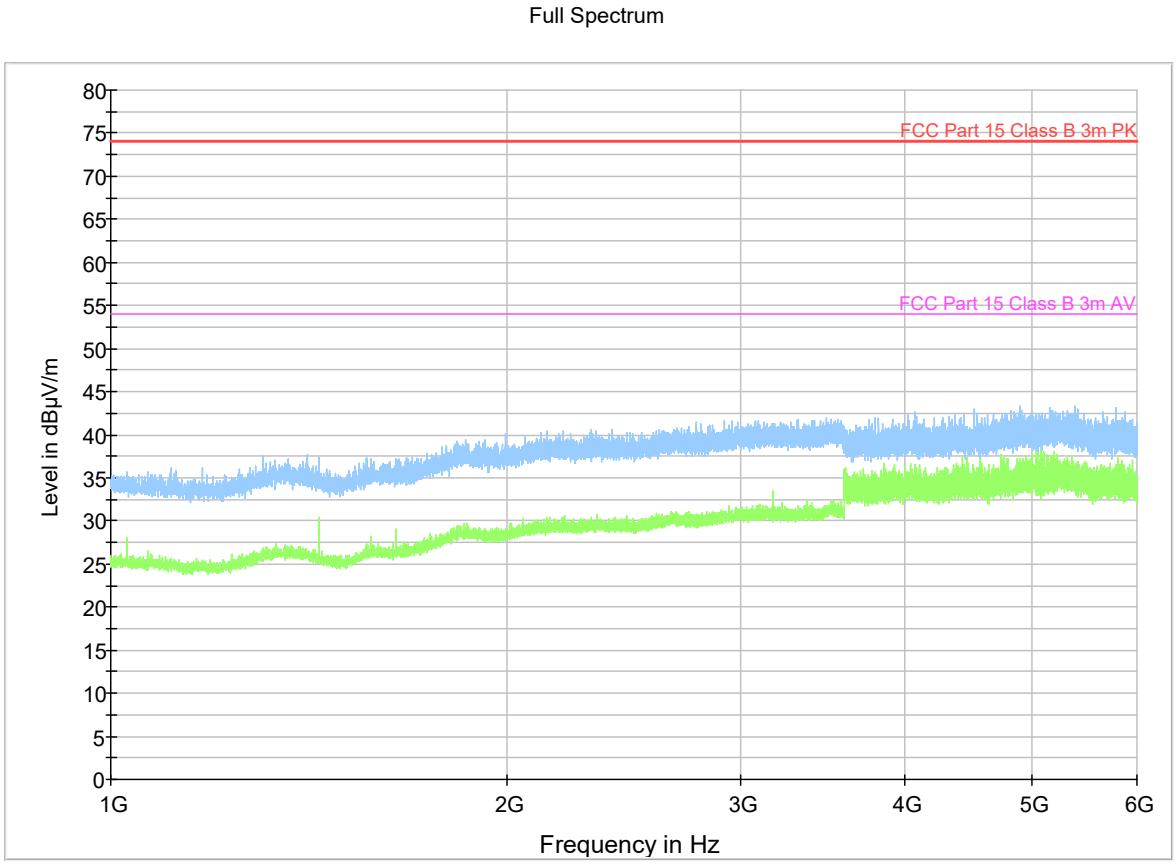
Instruments used during measurement

Instrument list:
Antenna, Horn: ETS / 3117 (LR-1717) (12/2027)
EMI Receiver: R&S / ESU40 (LR-1639) (01/2024)
Preamplifier: ETS / 3117-PA (LR-1757) (08/2023)
AC Power Source: Agilent Technoligies / 6812B (LR-1515) (N/A)

Conformity

Verdict:	PASS
Test engineer:	DGW

ECB02C – PC2 – OP1
EMISSION SPECTRUM (HORIZONTAL POLARIZATION)



MEASUREMENTS DATA

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
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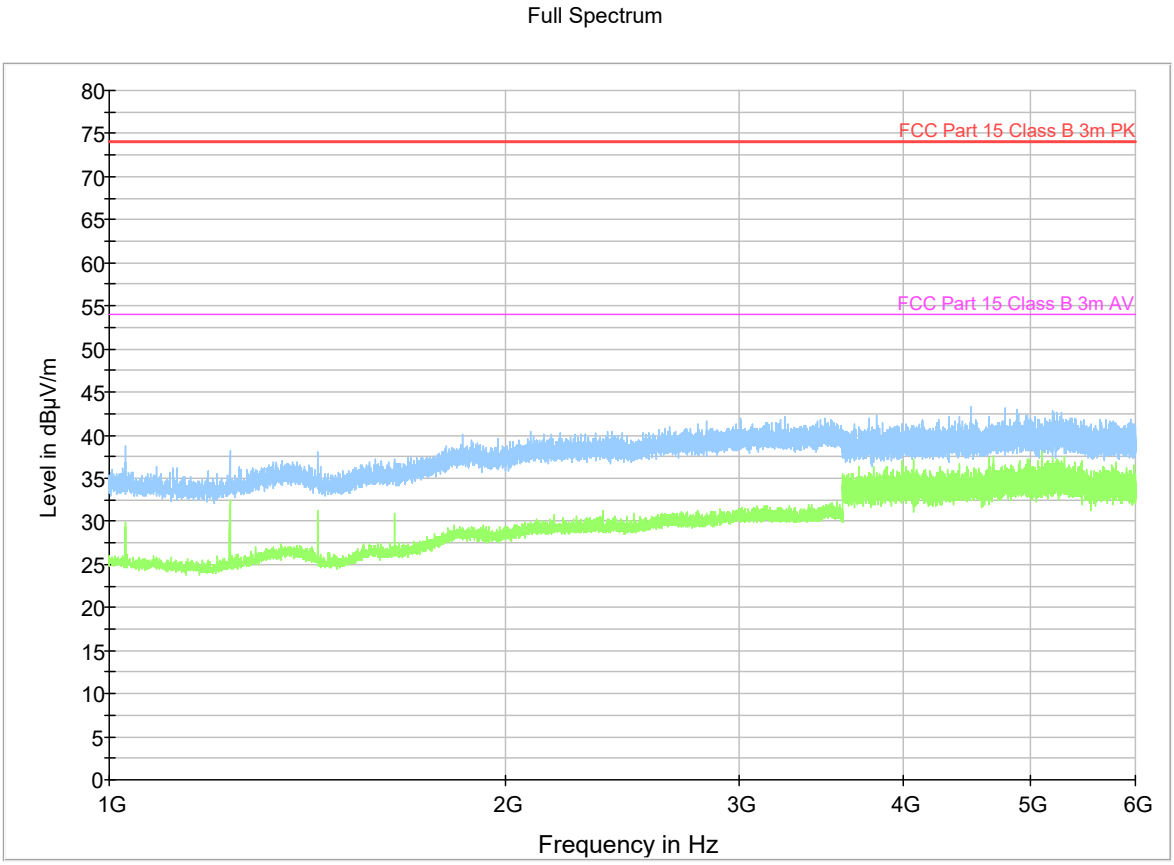
EMISSION SPECTRUM (VERTICAL POLARIZATION)



MEASUREMENTS DATA

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
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