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Wireless test report – 391251-1R1TRFWL

Applicant:

Base Engineering Inc.

Product name:	FCC ID:	IC Registration number:
ASK Ranger II	N8KASKZ21A	6657A-ASKZ21A

Model:	Model variants:
ASKZ2100HH	ASKZ2000HH, ASKZ1900HH, ASKZ1800HH, ASKZ1700HH, ASKZ1600HH, ASKZ1500HH, ASKZ1400HH, ASKZ1300HH, ASKZ1200HH, ASKZ1100HH, ASKZ1000HH, ASKZ900HH, ASKZ800HH, ASKZ700HH, ASKZ600HH, ASKZ500HH, ASKZ400HH, ASKZ300HH, ASKZ200HH, ASKZ100HH

Specifications:

FCC Part 15, Subpart C, §15.231

Periodic operation in the band 40.66–40.70 MHz and above 70 MHz.

RSS-210 Annex A.1, Issue 10, December 2019

Licence-Exempt Radio Apparatus: Category I Equipment. Momentarily operated devices

Date of issue: February 3, 2021

Andrey Adelberg, Senior EMC/Wireless Specialist
Tested by


Signature

David Duchesne, Senior EMC/Wireless Specialist
Reviewed by


Signature

Test location(s)

Company name	Nemko Canada Inc.
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Province	Ontario
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Country	Canada
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Toll free	+1 800 563 6336
Website	www.nemko.com
Site number	FCC: CA2040; IC: 2040A-4 (3 m SAC)

Limits of responsibility

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.
This test report has been completed in accordance with the requirements of ISO/IEC 17025. All results contain in this report are within Nemko Canada's ISO/IEC 17025 accreditation.

Copyright notification

Table of contents

Section 1. Report summary

1.1 Applicant and manufacturer

Company name	Base Engineering Inc.
Address	600 Rothesay Avenue, Saint John, NB, Canada, E2H 2H1

1.2 Test specifications

FCC 47 CFR Part 15, Subpart C, Clause 15.231	Periodic operation in the band 40.66–40.70 MHz and above 70 MHz
RSS-210 Annex A.1, Issue 10, December 2019	Licence-Exempt Radio Apparatus: Category I Equipment. Momentarily operated devices

1.3 Test methods

ANSI C63.10 v2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
RSS-Gen, Issue 5, March 2019	General Requirements for Compliance of Radio Apparatus

1.4 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was performed against all relevant requirements of the test standard except as noted in section 1.5 below. Results obtained indicate that the product under test complies in full with the requirements tested. The test results relate only to the items tested.

See "Summary of test results" for full details.

1.5 Exclusions

None

1.6 Test report revision history

Table 1.6-1: *Test report revision history*

Revision #	Date of issue	Details of changes made to test report
TRF	June 9, 2020	Original report issued
R1TRF	February 3, 2021	Applicant and manufacturer name was updated

Section 2. Summary of test results

2.1 FCC Part 15 Subpart C, general requirements test results

Table 2.1-1: *FCC general result summary*

Part	Test description	Verdict
§15.207(a)	Conducted limits	Pass
§15.31(e)	Variation of power source	Pass
§15.31(m)	Number of tested frequencies	Pass
§15.203	Antenna requirement	Pass

Notes: EUT is a battery and cradle-charging operated device, the testing was performed while being charged.

2.2 FCC Part 15 Subpart C, intentional radiators test results

Table 2.2-1: *FCC Intentional result summary*

Part	Test description	Verdict
§15.231(a)	Conditions for intentional radiators to comply with periodic operation	Pass
§15.231(b)	Field strength of emissions	Pass
§15.231(c)	Emission bandwidth	Pass
§15.231(d)	Requirements for devices operating within 40.66–40.70 MHz band	Not applicable[1]
§15.231(e)	Conditions for intentional radiators to comply with periodic operation	Not applicable

Notes: [1]EUT does not operate in 40.66–40.70 MHz band

2.3 IC RSS-GEN, Issue 5, test results

Table 2.3-1: *RSS Gen result summary*

Part	Test description	Verdict
7.3	Receiver radiated emission limits	Not applicable
7.4	Receiver conducted emission limits	Not applicable
6.7	Occupied bandwidth (or 99% emission bandwidth) and x dB bandwidth	Pass
6.9	Operating bands and selection of test frequencies	Pass
8.8	AC power-line conducted emissions limits	Pass

Notes: [1] According to sections 5.2 and 5.3 of RSS-Gen, Issue 5 the EUT does not have a stand-alone receiver neither scanner receiver, therefore exempt from receiver requirements.

2.4 ISED RSS-210, Issue 10, test results

Table 2.4-1: *RSS 210 result summary*

Section	Test description	Verdict
A.1.1	Technical requirements	Pass
A.1.2	Field strengths	Pass
A.1.3	Bandwidth of momentary signals	Pass
A.1.4	Reduced field strengths	Not applicable

Notes: None

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	February 20, 2020
Nemko sample ID number	1, 4

3.2 EUT information

Product name	ASK Ranger II
Model	ASKZ2100HH
Model variants	ASKZ2000HH, ASKZ1900HH, ASKZ1800HH, ASKZ1700HH, ASKZ1600HH, ASKZ1500HH, ASKZ1400HH, ASKZ1300HH, ASKZ1200HH, ASKZ1100HH, ASKZ1000HH, ASKZ900HH, ASKZ800HH, ASKZ700HH, ASKZ600HH, ASKZ500HH, ASKZ400HH, ASKZ300HH, ASKZ200HH, ASKZ100HH
Serial number	AR14129
Part number	ASKZ2100HH
Firmware version	A.1.0.0 (normal operation); T.1.0.0 (test version)
Software version	N/A

3.3 Technical information

Applicant IC company number	6657A
IC UPN number	ASKZ21A
All used IC test site(s) Reg. number	2040A-4
RSS number and Issue number	RSS-210 Issue 10, Annex A.1
Frequency band	260–470 MHz
Frequency Min (MHz)	433.86 MHz
Frequency Max (MHz)	433.86 MHz
RF power Max (W)	N/A
Field strength, dBµV/m @ 3 m	67.23 (average) and 87 (peak)
Measured BW (kHz) (99%)	99.5
Type of modulation	ASK
Emission classification (F1D, G1D, D1D)	99K5K1D
Transmitter spurious, dBµV/m @ 3 m	47.54 (Average) and 67.31 (peak) @ 1301 MHz
Power requirements	3.3 V rechargeable battery Charging on cradle powered from AC/DC adapter or 12V from auxiliary power outlet
Antenna information	Internal antenna with 3.0 dBi gain

3.4 Product description and theory of operation

The Wireless Control System is comprised of two major components; the handheld device (ASK Ranger II) and the receiver unit. The handheld device is the portable unit which the operator keeps by his side and presses buttons to send wireless commands back to the receiver to make the desired operational changes. When a button is pressed on the handheld device a wireless control signal is sent to the receiver unit to engage and disengage its voltage output channels.

3.5 EUT exercise details

EUT was provided with test firmware that turned the radio on full transmission power when the ON button was pressed, and turned the radio off when the OFF button was pressed.

3.6 EUT setup diagram

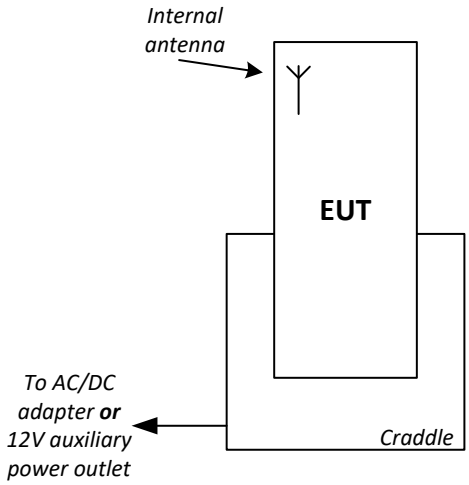


Figure 3.6-1: *Setup diagram*

3.7 EUT sub assemblies

Table 3.7-1: *EUT sub assemblies*

Description	Brand name	Model/Part number	Serial number
Remote	BASE engineering	ASK Ranger II / ASKZ2100HH	AR14129
Cradle	BASE engineering	Cradle / DOC3000	N/A
AC/DC adapter	Circuit test	ATS018T-W120U / RPR-120-A6-P5	None

Section 4. Engineering considerations

4.1 Modifications incorporated in the EUT

There were no modifications performed to the EUT during this assessment.

4.2 Technical judgment

Model variants have to do with how many buttons are on the faceplate. For example: ASKZ**21**00HH model has 21 buttons and ASKZ**1**00HH model variant has only 1 button. RF circuitry is identical on all model variants. ASKZ2100HH was selected as a representative sample for the compliance testing.

4.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 5. Test conditions

5.1 Atmospheric conditions

Temperature	15–30 °C
Relative humidity	20–75 %
Air pressure	860–1060 mbar

When it is impracticable to carry out tests under these conditions, a note to this effect stating the ambient temperature and relative humidity during the tests shall be recorded and stated.

5.2 Power supply range

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage, or any of the declared voltages ±5 %, for which the equipment was designed.

Section 6. Measurement uncertainty

6.1 Uncertainty of measurement

UKAS Lab 34 and TIA-603-B have been used as guidance for measurement uncertainty reasonable estimations with regards to previous experience and validation of data. Nemko Canada, Inc. follows these test methods in order to satisfy ISO/IEC 17025 requirements for estimation of uncertainty of measurement for wireless products.

Measurement uncertainty budgets for the tests are detailed below. Measurement uncertainty calculations assume a coverage factor of K = 2 with 95% certainty.

Table 6.1-1: *Measurement uncertainty*

Test name	Measurement uncertainty, dB
All antenna port measurements	0.55
Conducted spurious emissions	1.13
Radiated spurious emissions	3.78
AC power line conducted emissions	3.55

Section 7. Test equipment

7.1 Test equipment list

Table 7.1-1: *Equipment list*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
3 m EMI test chamber	TDK	SAC-3	FA002047	1 year	January 24, 2021
Flush mount turntable	Sunol	FM2022	FA002082	—	NCR
Controller	Sunol	SC104V	FA002060	—	NCR
Antenna mast	Sunol	TLT2	FA002061	—	NCR
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 26	FA002043	1 year	May 8, 2020
Preamp (1–18 GHz)	ETS Lindgren	124334	FA002877	1 year	November 4, 2020
Bilog antenna (20–3000 MHz)	Sunol	JB3	FA002108	1 year	January 14, 2021
50 Ω coax cable	Huber + Suhner	None	FA003099	1 year	May 10, 2020
Horn antenna (1–18 GHz)	EMCO	3115	FA000825	1 year	October 31, 2020
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 26	FA002043	1 year	May 8, 2020
61505 AC source	Chroma	61509	FA003036	—	VOU
3 m EMI test chamber	TDK	SAC-3	FA002047	1 year	January 24, 2021

Note: NCR - no calibration required, VOU - verify on use

Section 8. Testing data

8.1 FCC 15.31(e) Variation of power source

8.1.1 Definitions and limits

For intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. For battery operated equipment, the equipment tests shall be performed using a new battery.

8.1.2 Test date

Start date	February 21, 2020

8.1.3 Observations, settings and special notes

None

8.1.4 Test data

EUT Power requirements:	☒ AC	☐ DC	☒ Battery
If EUT is an AC or a DC powered, was the noticeable output power variation observed?	☐ YES	☒ NO	☐ N/A
If EUT is battery operated, was the testing performed using fresh batteries?	☐ YES	☐ NO	☒ N/A
If EUT is rechargeable battery operated, was the testing performed using fully charged batteries?	☒ YES	☐ NO	☐ N/A

8.2 FCC 15.31(m) and RSS-Gen 6.9 Number of frequencies

8.2.1 Definitions and limits

FCC:
Measurements on intentional radiators or receivers shall be performed and, if required, reported for each band in which the device can be operated with the device operating at the number of frequencies in each band specified in the following table.

ISED:
Except where otherwise specified, measurements shall be performed for each frequency band of operation for which the radio apparatus is to be certified, with the device operating at the frequencies in each band of operation shown in table below. The frequencies selected for measurements shall be reported in the test report.

Table 8.2-1: *Frequency Range of Operation*

Frequency range over which the device operates (in each band)	Number of test frequencies required	Location of measurement frequency inside the operating frequency range
1 MHz or less	1	Center (middle of the band)
1–10 MHz	2	1 near high end, 1 near low end
Greater than 10 MHz	3	1 near high end, 1 near center and 1 near low end

Note: "near" means as close as possible to or at the centre / low end / high end of the frequency range over which the device operates.

8.2.2 Test date

Start date	February 21, 2020

8.2.3 Observations, settings and special notes

EUT is non-channelized equipment and operates only on one frequency

8.2.4 Test data

Table 8.2-2: *Test channels selection*

Start of Frequency range, MHz	End of Frequency range, MHz	Frequency range bandwidth, MHz	Low channel, MHz	Mid channel, MHz	High channel, MHz
260	470	210	–	433.86	–

8.3 FCC 15.203 and RSS-Gen, section 6.8 Antenna requirement

8.3.1 Definitions and limits

FCC:
An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

ISED:
The applicant for equipment certification shall provide a list of all antenna types that may be used with the transmitter, where applicable (i.e. for transmitters with detachable antenna), indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna. The test report shall demonstrate the compliance of the transmitter with the limit for maximum equivalent isotropically radiated power (e.i.r.p.) specified in the applicable RSS, when the transmitter is equipped with any antenna type, selected from this list.

For expediting the testing, measurements may be performed using only the antenna with highest gain of each combination of transmitter and antenna type, with the transmitter output power set at the maximum level. However, the transmitter shall comply with the applicable requirements under all operational conditions and when in combination with any type of antenna from the list provided in the test report.

8.3.2 Test date

Start date	February 21, 2020

8.3.3 Observations, settings and special notes

None

8.3.4 Test data

Must the EUT be professionally installed?	☐ YES	☒ NO	
Does the EUT have detachable antenna(s)?	☐ YES	☒ NO	
If detachable, is the antenna connector(s) non-standard?	☐ YES	☐ NO	☒ N/A

8.4 FCC 15.207(a) and RSS-Gen 8.8 AC power line conducted emissions limits

8.4.1 Definitions and limits

FCC:
Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 µH/50 Ω line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

ISED:
A radio apparatus that is designed to be connected to the public utility (AC) power line shall ensure that the radio frequency voltage, which is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz, shall not exceed the limits in table below.

Unless the requirements applicable to a given device state otherwise, for any radio apparatus equipped to operate from the public utility AC power supply either directly or indirectly (such as with a battery charger), the radio frequency voltage of emissions conducted back onto the AC power lines in the frequency range of 0.15 MHz to 30 MHz shall not exceed the limits shown in table below. The more stringent limit applies at the frequency range boundaries.

Table 8.4-1: *Conducted emissions limit*

Frequency of emission, MHz	Conducted limit, dBµV	
	Quasi-peak	Average**
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

Note: ** - The level decreases linearly with the logarithm of the frequency.*
*** - A linear average detector is required.*

8.4.2 Test date

Start date	February 25, 2020

8.4.3 Observations, settings and special notes

The EUT was set up as tabletop configuration.

The spectral scan has been corrected with transducer factors (i.e. cable loss, LISN factors, and attenuators) for determination of compliance.

A preview measurement was generated with the receiver in continuous scan mode. Emissions detected within 6 dB or above limit were re-measured with the appropriate detector against the correlating limit and recorded as the final measurement.

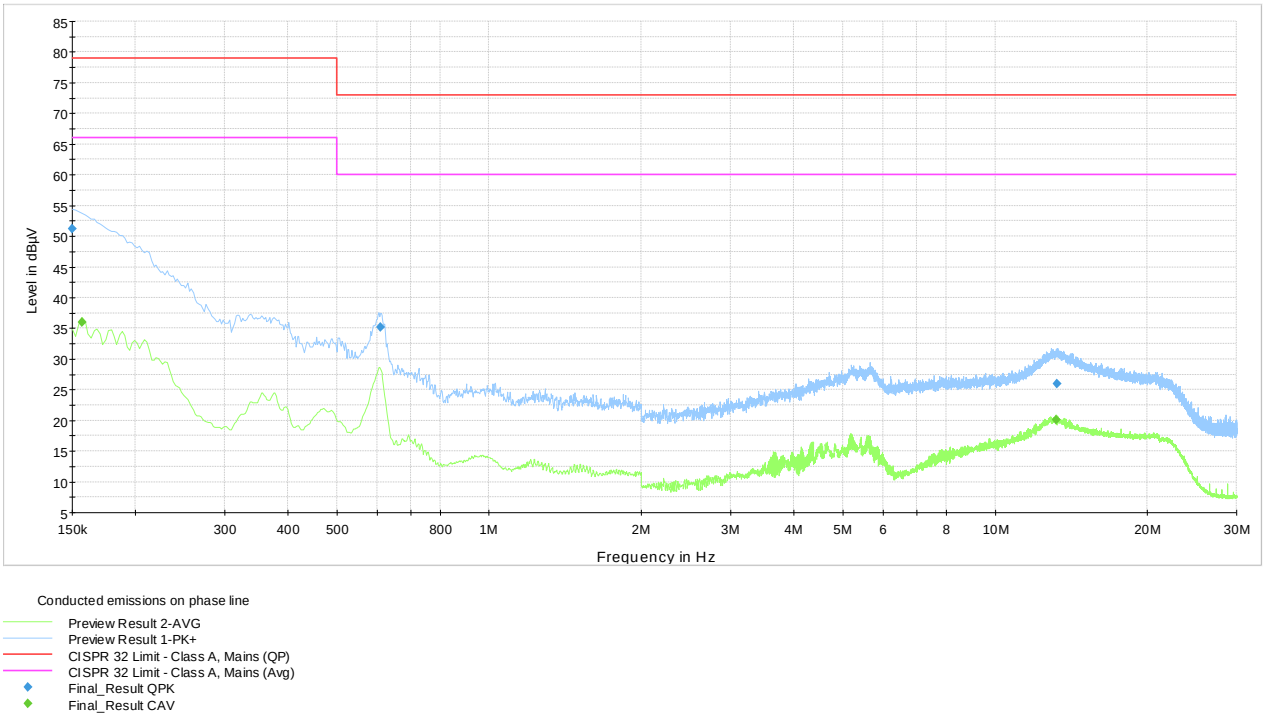
Receiver settings for preview measurements:

Resolution bandwidth	9 kHz
Video bandwidth	30 kHz
Detector mode	Peak and Average
Trace mode	Max Hold
Measurement time	1000 ms

Receiver settings for final measurements:

Resolution bandwidth	9 kHz
Video bandwidth	30 kHz
Detector mode	Quasi-Peak and Average
Trace mode	Max Hold
Measurement time	1000 ms

8.4.4 Test data



Plot 8.4-1: *Conducted emissions on phase line*

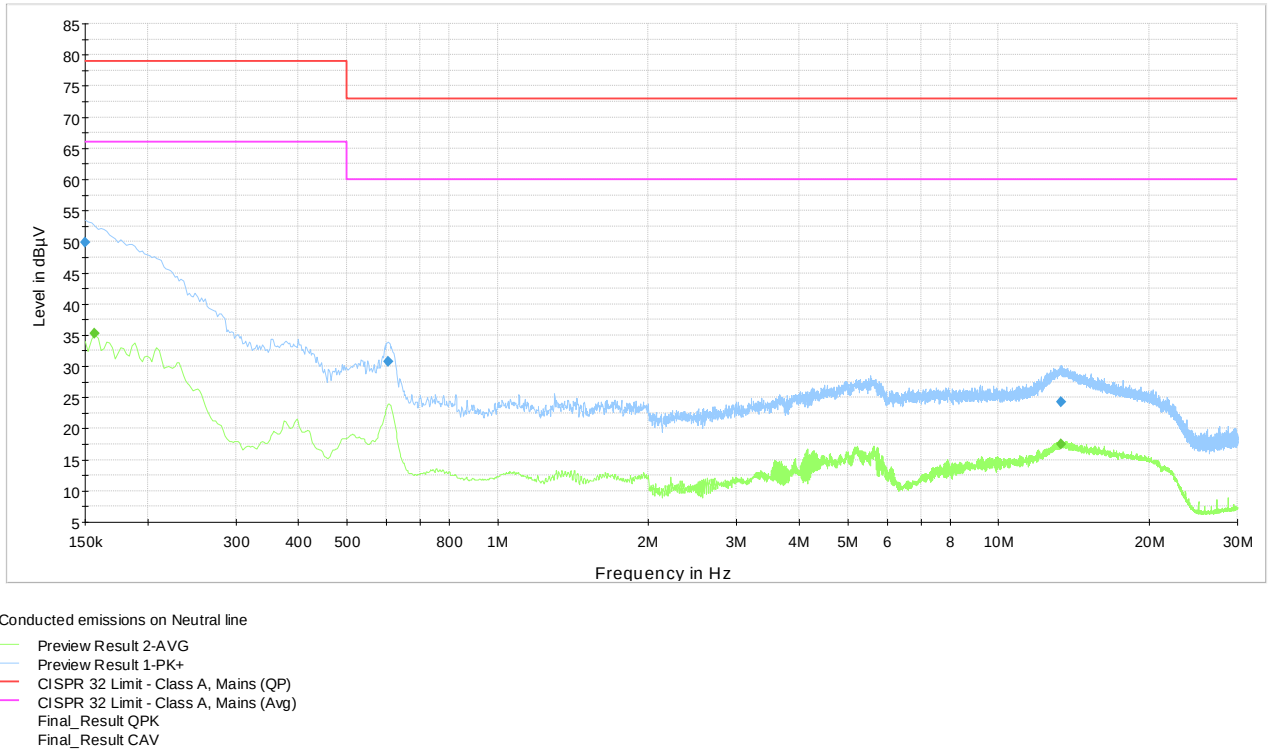
Table 8.4-2: *Quasi-Peak conducted emissions results on phase line*

Frequency, MHz	Q-Peak result, dBµV	Correction, dB	Limit, dBµV	Margin, dB
0.150000	51.15	9.80	66.00	14.85
0.609000	35.18	9.90	56.00	20.82
13.249000	25.98	10.50	60.00	34.02

Note: 43.5 dBµV = 23.2 dBµV (receiver reading) + 10.1 dB (LISN factor IL) + 0.2 dB (cable loss) + 10 dB (attenuator)

Table 8.4-3: *Average conducted emissions results on phase line*

Frequency, MHz	Average result, dBµV	Correction, dB	Limit, dBµV	Margin, dB
0.156750	36.04	9.90	55.83	19.79
13.219750	20.09	10.50	50.00	29.91



Plot 8.4-2: *Conducted emissions on neutral line*

Table 8.4-4: *Quasi-Peak conducted emissions results on neutral line*

Frequency, MHz	Q-Peak result, dBµV	Correction, dB	Limit, dBµV	Margin, dB
0.150000	49.87	9.80	66.00	16.13
0.604500	30.77	9.90	56.00	25.23
13.348000	24.26	10.50	60.00	35.74

Note: 43.5 dBµV = 23.2 dBµV (receiver reading) + 10.1 dB (LISN factor IL) + 0.2 dB (cable loss) + 10 dB (attenuator)

Table 8.4-5: *Average conducted emissions results on neutral line*

Frequency, MHz	Average result, dBµV	Correction, dB	Limit, dBµV	Margin, dB
0.156750	35.34	9.90	55.83	20.49
13.325500	17.48	10.50	50.00	32.52

8.5 FCC 15.231(a) and RSS-210 A.1.1 Conditions for intentional radiators to comply with periodic operation

8.5.1 Definitions and limits

FCC:

(a) The provisions of this section are restricted to periodic operation within the band 40.66–40.70 MHz and above 70 MHz. Except as shown in paragraph (e) of this section, the intentional radiator is restricted to the transmission of a control signal such as those used with alarm systems, door openers, remote switches, etc. Continuous transmissions, voice, video and the radio control of toys are not permitted. Data is permitted to be sent with a control signal. The following conditions shall be met to comply with the provisions for this periodic operation:

(1) A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released.

(2) A transmitter activated automatically shall cease transmission within 5 seconds after activation.

(3) Periodic transmissions at regular predetermined intervals are not permitted. However, polling or supervision transmissions, including data, to determine system integrity of transmitters used in security or safety applications are allowed if the total duration of transmissions does not exceed more than two seconds per hour for each transmitter. There is no limit on the number of individual transmissions, provided the total transmission time does not exceed two seconds per hour.

(4) Intentional radiators which are employed for radio control purposes during emergencies involving fire, security, and safety-of-life, when activated to signal an alarm, may operate during the pendency of the alarm condition.

(5) Transmission of set-up information for security systems may exceed the transmission duration limits in paragraphs (a)(1) and (a)(2) of this section, provided such transmissions are under the control of a professional installer and do not exceed ten seconds after a manually operated switch is released or a transmitter is activated automatically. Such set-up information may include data.

ISED:

Devices shall comply with the following for momentary operation:

(a) A manually operated transmitter shall be equipped with a push-to-operate switch and be under manual control at all times during transmission. When released, the transmitter shall cease transmission within no more than 5 seconds of being released.

(b) A transmitter that has been activated automatically shall cease transmission within 5 seconds of activation.

(c) Periodic transmissions at regular, predetermined intervals are not permitted, except as specified in Section A.1.4. However, polling or supervision transmissions that determine system integrity of transmitters used in security or safety applications are permitted, provided the total duration of transmission does not exceed 2 seconds per hour for each transmitter.

(d) Intentional radiators used for radio control during emergencies involving fire, security of goods (e.g. burglar alarms), and safety-of-life, when activated to signal an alarm, may operate during the interval of the alarm condition.

8.5.2 Test summary

Start date	February 21, 2020

8.5.3 Observations, settings and special notes

None

8.5.4 Test data

☒ EUT is a manually triggered transmitter
☐ EUT is an automatically triggered transmitter

☒ EUT is not a periodic transmitter

☐ The EUT usage is for radio control purposes during emergencies
☒ The EUT usage is not for radio control purposes during emergencies

☐ The EUT transmits set-up information
☒ The EUT does not transmit set-up information

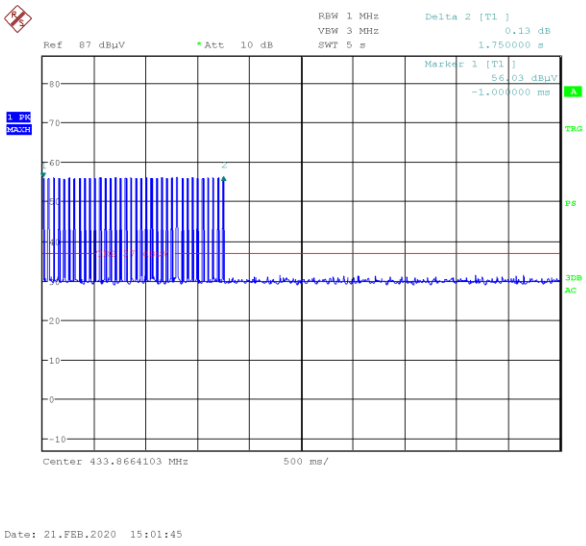


Figure 8.5-1: *Manually triggered transmission duration*

The radio transmits when both the 'enable' and the 'data' signals are high. This results in a 0.26 ms period ON time before the packet begins, followed by a 9.30 ms Manchester encoded period (giving a 50% duty cycle on all data), and ending with another 0.26 ms ON time.
In handheld type 1, a button push activates the radio transmission. Packets are transmitted at a period of 50 ms while the button is pressed. When the button is released a train of 30 packets is transmitted at a period of 50 ms.

Table 8.5-1: *Transmission duration results*

Frequency, MHz	Transmission duration, s	Maximum limit, s	Margin, s
433.86	1.75	5.00	3.25

8.6 FCC 15.231(b) and RSS-210 A.1.2 Field strength of emissions

8.6.1 Definitions and limits

FCC:

(b) In addition to the provisions of §15.205 the field strength of emissions from intentional radiators operated under this section shall not exceed the following table.

1) The field strength limits in the table below are specified at a distance of 3 meters. The tighter limits apply at the band edges.
2) Intentional radiators operating under the provisions of this section shall demonstrate compliance with the limits on the field strength of emissions, as shown in the above table, based on the average value of the measured emissions. As an alternative, compliance with the limits in the above table may be based on the use of measurement instrumentation with a CISPR quasi-peak detector. The specific method of measurement employed shall be specified in the application for equipment authorization. If average emission measurements are employed, the provisions in §15.35 for averaging pulsed emissions and for limiting peak emissions apply. Further, compliance with the provisions of §15.205 shall be demonstrated using the measurement instrumentation specified in that section.
3) The limits on the field strength of the spurious emissions in the table below are based on the fundamental frequency of the intentional radiator. Spurious emissions shall be attenuated to the average (or, alternatively, CISPR quasi-peak) limits shown in this table or to the general limits shown in §15.209, whichever limit permits a higher field strength.

ISED:

a. The field strength of emissions from momentarily operated intentional radiators shall not exceed the limits in table below, based on the average value of the measured emissions. The requirements of the "Pulsed operation" section of RSS-Gen apply for averaging pulsed emissions and limiting peak emissions.
Alternatively, compliance with the limits in the table below may be demonstrated using an International Special Committee on Radio Interference (CISPR) quasi‑peak detector.

b. Unwanted emissions shall be 10 times below the fundamental emissions field strength limits in the table below or comply with the limits specified in RSS-Gen, whichever is less stringent.

Table 8.6-1: *Field strength limits*

Fundamental frequency	Field strength of fundamental		Field strength of spurious emissions	
(MHz)	**(µV/m)**	**(dBµV/m)**	**(µV/m)**	**(dBµV/m)**
40.66–40.70[1]	2,250	67.0	225	47.0
70–130	1,250	61.9	125	41.9
130–174	1,250 to 3,750*	61.9 to 71.5*	125 to 375*	41.9 to 51.5*
174–260[2]	3,750	71.5	375	51.5
260–470[2]	3,750 to 12,500*	71.5 to 81.9*	375 to 1,250*	51.5 to 61.9*
Above 470	12,500	81.9	1,250	61.9

** Linear interpolation with frequency F in MHz:*
For 130–174 MHz: Field Strength (µV/m) = (56.82 × F) – 6136
For 260–470 MHz: Field Strength (µV/m) = (41.67 × F) – 7083

Notes: *[1]The levels applicable to FCC only.*
[2]Frequency bands 225–328.6 MHz and 335.4–399.9 MHz are designated for the exclusive use of the Government of Canada. Manufacturers should be aware of possible harmful interference and degradation of their licence-exempt radio equipment in these frequency bands.

Table 8.6-2: *FCC §15.209 and RSS-Gen – Radiated emission limits*

Frequency, MHz	Field strength of emissions		Measurement distance, m
	µV/m	dBµV/m	
30–88	100	40.0	3
88–216	150	43.5	3
216–960	200	46.0	3
above 960	500	54.0	3

Notes: In the emission table above, the tighter limit applies at the band edges.
For frequencies above 1 GHz the limit on peak RF emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test

Table 8.6-3: *ISED restricted frequency bands*

MHz	MHz	MHz	GHz
0.090–0.110	12.57675–12.57725	399.9–410	7.25–7.75
0.495–0.505	13.36–13.41	608–614	8.025–8.5
2.1735–2.1905	16.42–16.423	960–1427	9.0–9.2
3.020–3.026	16.69475–16.69525	1435–1626.5	9.3–9.5
4.125–4.128	16.80425–16.80475	1645.5–1646.5	10.6–12.7
4.17725–4.17775	25.5–25.67	1660–1710	13.25–13.4
4.20725–4.20775	37.5–38.25	1718.8–1722.2	14.47–14.5
5.677–5.683	73–74.6	2200–2300	15.35–16.2
6.215–6.218	74.8–75.2	2310–2390	17.7–21.4
6.26775–6.26825	108–138	2483.5–2500	22.01–23.12
6.31175–6.31225	149.9–150.05	2655–2900	23.6–24.0
8.291–8.294	156.52475–156.52525	3260–3267	31.2–31.8
8.362–8.366	156.7–156.9	3332–3339	36.43–36.5
8.37625–8.38675	162.0125–167.17	3345.8–3358	Above 38.6
8.41425–8.41475	167.72–173.2	3500–4400	
12.29–12.293	240–285	4500–5150	
12.51975–12.52025	322–335.4	5350–5460	

Note: Certain frequency bands listed in this table and above 38.6 GHz are designated for licence-exempt applications. These frequency bands and the requirements that apply to related devices are set out in the 200 and 300 series of RSSs.

Table 8.6-4: *FCC restricted frequency bands*

MHz	MHz	MHz	GHz
0.090–0.110	16.42–16.423	399.9–410	4.5–5.15
0.495–0.505	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225	123–138	2200–2300	14.47–14.5
8.291–8.294	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675	156.7–156.9	2690–2900	22.01–23.12
8.41425–8.41475	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025	240–285	3345.8–3358	36.43–36.5
12.57675–12.57725	322–335.4	3600–4400	Above 38.6
13.36–13.41			

8.6.2 Test summary

Start date	February 21, 2020

8.6.3 Observations, settings and special notes

The spectrum was searched from 30 MHz to the 10th harmonic. Radiated measurements were performed at a distance of 3 m.
EUT is a hand-held device, therefore the worst-case results of 3-axis measurements were reported.
Average radiated emissions were obtained by subtracting duty cycle / correction factor from the peak measurement results.
Spectrum analyser settings for peak spurious radiated emissions (except for harmonics) within restricted bands:

Resolution bandwidth	100 kHz (below 1 GHz); 1 MHz (above 1 GHz)
Video bandwidth	300 kHz (below 1 GHz); 3 MHz (above 1 GHz)
Detector mode	Peak
Trace mode	Max Hold

8.6.4 Test data

Duty cycle/average factor calculations

§15.35(c) When the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed; the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds.

$$Duty\ cycle\ or\ average\ factor = 20 \times \log_{10}\left(\frac{Tx_{100ms}}{100_{ms}}\right)$$

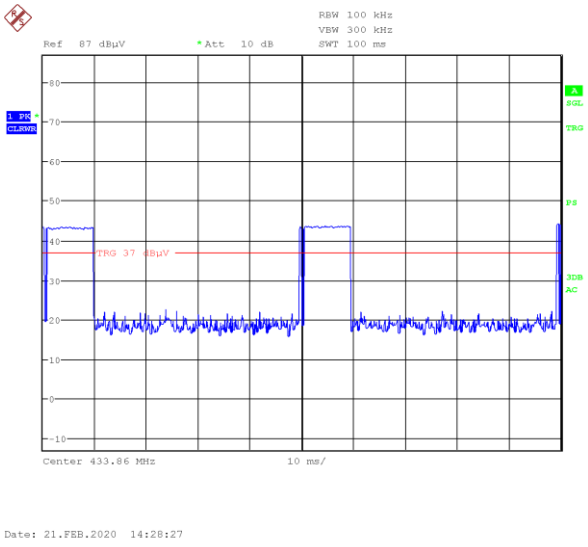


Figure 8.6-1: *Transmission within 100 ms*

EUT is using Manchester data encoding technique, that gives a 50% duty cycle on all data. 100 ms windows consists of two transmission bursts (with preambles) and just one preamble of third burst. Preamble length is 388.4 µs and data burst length is 9.07 ms (or 4.55 ms due to 50% Manchester encoding)
Duty cycle correction factor calculation: $20 \times \text{Log}_{10}[(3 \times 0.3884 + 2 \times 4.55) / 100] = -19.77$ dB

Table 8.6-5: *Radiated field strength measurement results*

Frequency, MHz	Peak field strength, dBµV/m	Peak limit, dBµV/m	Margin, dB	Duty cycle factor, dB	Average field strength, dBµV/m	Average limit, dBµV/m	Margin, dB
433.86	87.00	100.82	13.82	-19.77	67.23	80.82	13.59
867.75	61.20	80.82	19.62	-19.77	41.43	60.82	19.39
1301.35	67.31	74.00	6.69	-19.77	47.54	54.00	6.46
1735.35	58.06	80.82	22.76	-19.77	38.29	60.82	22.53
2169.00	61.73	80.82	19.09	-19.77	41.96	60.82	18.86
2603.35	55.83	80.82	24.99	-19.77	36.06	60.82	24.76
3037.35	58.74	80.82	22.08	-19.77	38.97	60.82	21.85
3471.00	56.45	80.82	24.37	-19.77	36.68	60.82	24.14
3905.35	57.99	74.00	16.01	-19.77	38.22	54.00	15.78
4338.65	52.96	74.00	21.04	-19.77	33.19	54.00	20.81

*Notes: Field strength includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable. Frequencies in **bold** are within restricted bands.*

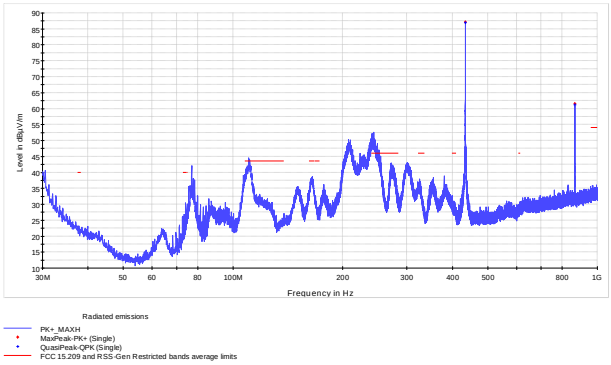


Figure 8.6-2: *Spurious emissions below 1 GHz*

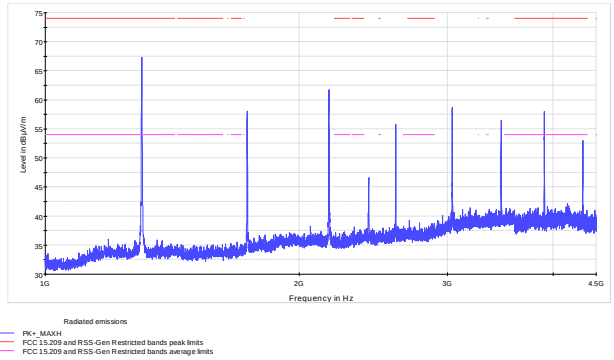


Figure 8.6-3: *Spurious emissions above 1 GHz*

Note: Spurious emissions (not harmonics of fundamental) exceeding the limit line were verified as digital emissions and are exempt from this assessment.

8.7 FCC 15.231(c) and RSS-210 A.1.3 Emission bandwidth of momentary signals

8.7.1 Definitions and limits

FCC:
The bandwidth of the emission shall be no wider than 0.25 % of the center frequency for devices operating above 70 MHz and below 900 MHz. For devices operating above 900 MHz, the emission shall be no wider than 0.5 % of the center frequency. Bandwidth is determined at the points 20 dB down from the modulated carrier.

ISED:
The 99% bandwidth of momentarily operated devices shall be less or equal to 0.25% of the centre frequency for devices operating between 70 MHz and 900 MHz. For devices operating above 900 MHz, the 99% bandwidth shall be less or equal to 0.5% of the centre frequency.

8.7.2 Test summary

Start date	February 21, 2020

8.7.3 Observations, settings and special notes

Limit: 0.25 % of 433.86 MHz is 1.085 MHz
Spectrum analyser settings:

Resolution bandwidth	≥ 1 % of emission bandwidth
Video bandwidth	≥ 3 × RBW
Frequency span	Wider than emission bandwidth
Detector mode	Peak

8.7.4 Test data

Table 8.7-1: *20 dB bandwidth measurement result*

20 dB bandwidth, kHz	Limit, kHz	Margin, kHz
74.04	1085	1010.96

Table 8.7-2: *99 % occupied bandwidth measurement result*

99 % occupied bandwidth, kHz	Limit, kHz	Margin, kHz
99.52	1085	985.48

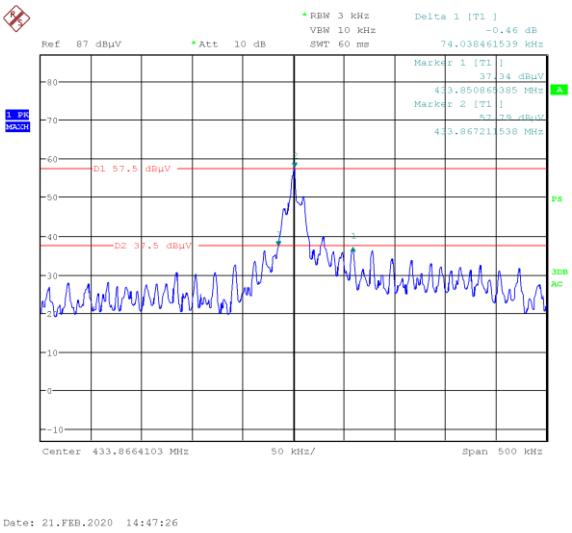


Figure 8.7-1: *20 dB occupied bandwidth*

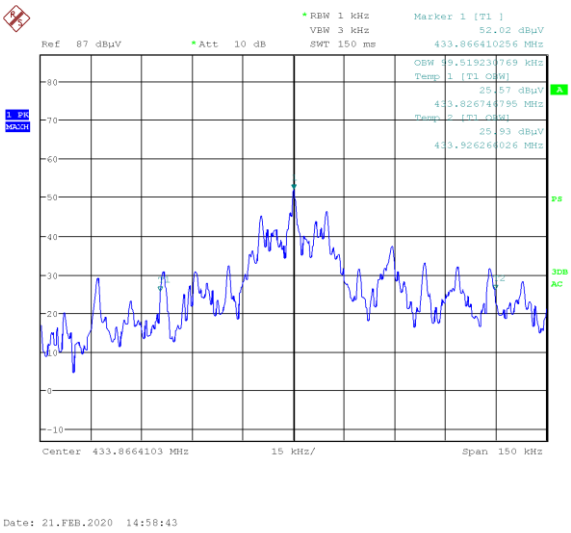
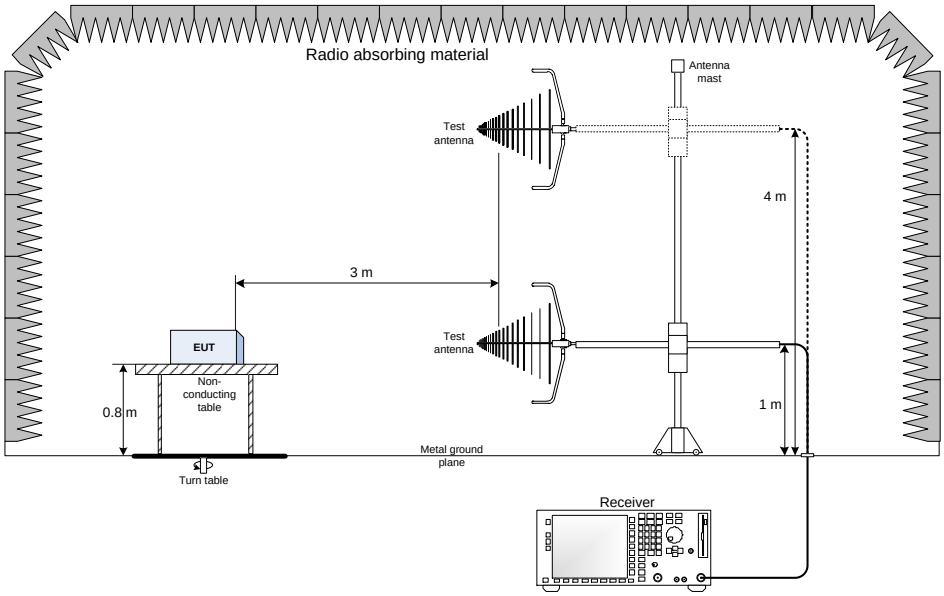


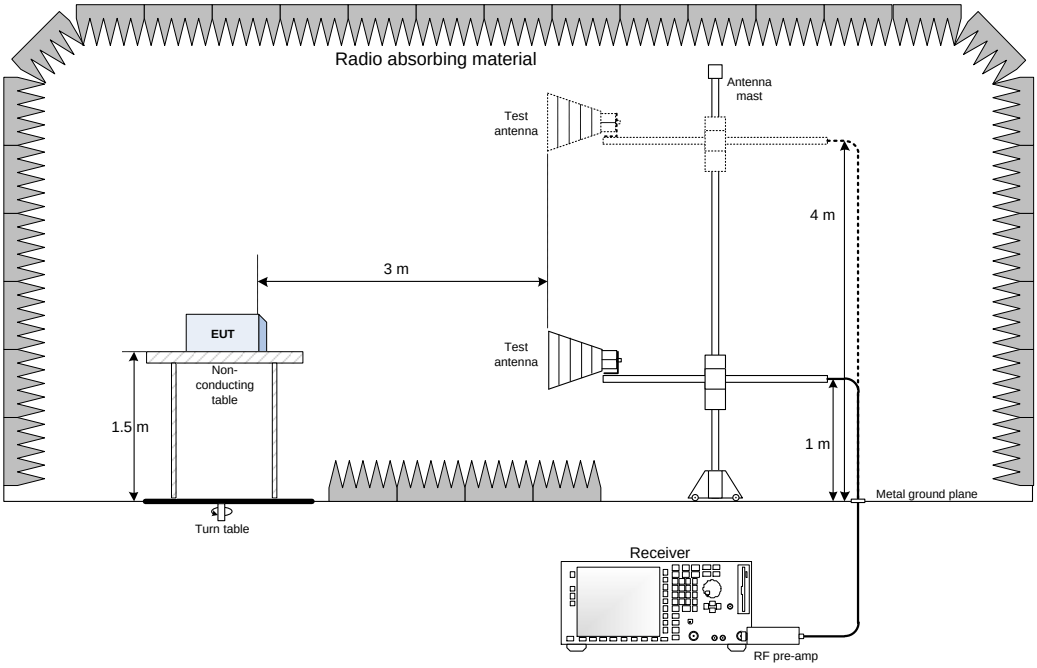
Figure 8.7-2: *99 % occupied bandwidth*

Section 9. Block diagrams of test set-ups

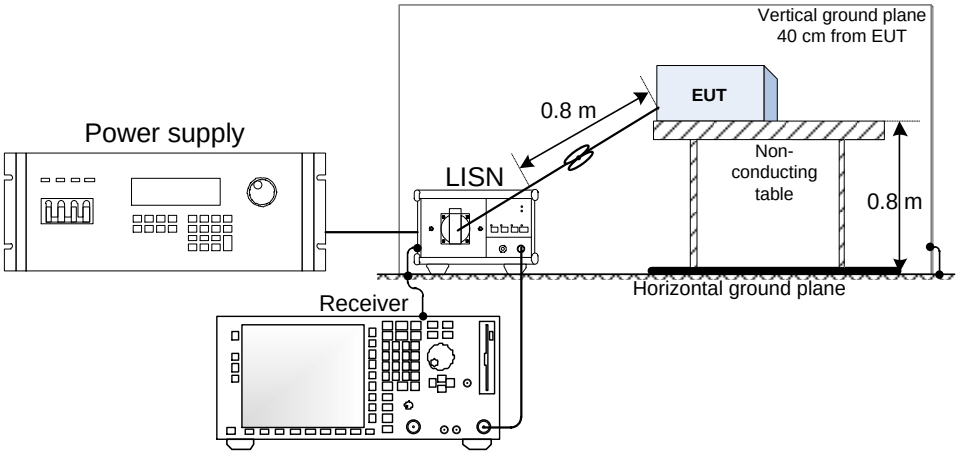
9.1 Radiated emissions set-up for frequencies below 1 GHz



9.2 Radiated emissions set-up for frequencies above 1 GHz



9.3 Conducted emissions set-up



9.4 Antenna port set-up