

Co-Location Test Report

According to

**47 CFR Part 15C,
RSS-247, RSS-Gen**

DUT Name: RDY
Model No. : ADY1
Customer: Sandvik Mining and Construction Oy
Address: Taivalkatu 8, P.O. Box 165, FI-15101 Lahti, Finland
Summary IN COMPLIANCE
Date of Reception: 14.11.2023
Date(s) of Test(s): 3.1.2024 – 10.1.2024

Tested by Test Engineer


Pekka Pulkkinen

Approved by Technical Manager


Jukka Rauma

The test report shall not be reproduced except in full, without the written approval of the laboratory. This report is only for the equipment which is described in page 4.

CONTENTS

1. General Information	3
2. Test Samples	4
3. Configuration and Operation Modes	7
4. Test equipment.....	8
5. Uncertainties	8
6. Sample emission level calculation	9
7. Test conditions	10
8. Summary.....	12
9. Tx spurious emissions, radiated	13

Document Version History	Date of issue	Comments	Approved by
v0.1	6.6.2024	Initial version	
v1.0	25.6.2024	Approved version	Jukka Rauma
v2.0	24.9.2024	Second approved version, Amendment1. Antenna gains corrected according customer declaration. EUT and test setup pictures moved to separate Annex1	Jukka Rauma

1. General Information

Test Engineer: Pekka Pulkkinen

Location:

Test Firm Name	Eurofins Electric & Electronics Finland Oy (EEEF)
Test Site	Yrttipellontie, Peltola
Address of Test Site	Yrttipellontie 6, 90230 Oulu, Finland
FCC Designation number	FI0008
FCC site registration number	771880
ISED number	29576
CAB Identifier	T290

Customer: Sandvik Mining and Construction Oy
Taivalkatu 8, P.O. Box 165, FI-15101 Lahti, Finland
Ilkka Lehmusvirta
tel: +358 40 578 4868
ilkka.lehmusvirta@sandvik.com

Climate Conditions: Temperature: 15 - 35 °C
Air pressure: 860 - 1060 hPa
Humidity: 30-60 rH%
These limits were not exceeded during testing.

2. Test Samples

General description:

Machine mounted device that enables remote monitoring of the machine. During machine operation, device collects and transmits operation and location information.

Test sample:

Sample number	Serial number	Manufacturer	DUT Type	Model	HW version	SW version
3848ER004	SVTG223000028	Haltian Oy	Remote monitoring unit	ADY1	ADY_04, APP_02	2023.11.02.1_ar dy_v2

Description	RDY monitoring device	
Model	ADY1	
Additional Model(s)	-	
Brand Name(s)	RDY	
Hardware Version(s)	ADY_04, APP_02	
Software Version(s)	2023.11.02.1_ardy_v2	
FCC ID	2BD5URDY	
IC	31800-RDY	
Contains FCC ID	XPYUBX20VA01	
Contains IC	8595A-UBX20VA01	
Equipment type	End Product	
Radio type	Transceiver	
Assigned frequency bands	GSM 850: UL = 824 - 849 MHz, DL = 869 - 894 MHz GSM 1900.: UL = 1850 - 1910 MHz, DL = 1930 - 1990 MHz LTE FDD2: UL = 1850 - 1910 MHz, DL = 1930 - 1990 MHz LTE FDD4: UL = 1710 - 1755 MHz, DL = 2110 - 2155 MHz LTE FDD5: UL = 824 - 849 MHz, DL = 869 - 894 MHz LTE FDD7: UL = 2500 - 2570 MHz, DL = 2620 - 2690 MHz LTE FDD12: UL = 699 - 716 MHz, DL = 729 - 746 MHz LTE FDD13: UL = 777 - 787 MHz, DL = 746 - 756 MHz LTE FDD25: UL = 1850 - 1915 MHz, DL = 1930 - 1995 MHz LTE FDD26: UL = 814 - 849 MHz, DL = 859 - 894 MHz LTE FDD66: UL = 1710 - 1780 MHz, DL = 2110 - 2200 MHz LTE FDD85: UL = 698 - 716 MHz, DL = 728 - 746 MHz Bluetooth: 2400.0 MHz - 2483.5 MHz	
Radio technologies	GSM + LTE + Bluetooth LE	
Operating modes	LTE B2 + Bluetooth LE 1 Mbps ch19	
Modulation	GMSK (GSM/GPRS), 8PSK (EDGE), QPSK (NB-IoT), GFSK (Bluetooth LE)	
Multislot class	33	
Number of modules	1	
Radio Module (cellular)	Type	LTE, GSM, GNSS radio module
	Model	Sara R422M10S-01B-01
	Manufacturer	U-Blox
	HW Version	-
	SW Version	Modem 01.24, Application A01.10
	FCC ID	XPYUBX20VA01
	IC ID	8595A-UBX20VA01
Antenna (cellular)	Type	Cellular antenna – GSM. LTE, 2G/3G/4G/5G
	Model	SR4L034-R
	Manufacturer	Antenova
	Gain	Peak gain: +2.4 dBi (698-960 / 1710-2170 / 2300-2400 / 2500-2690 MHz) (customer declaration)
Antenna (Bluetooth LE)	Type	Quad band, dual feed chip antenna: 2.4/1.561/1.575/1.602 GHz
	Model	2450AD47A1590
	Manufacturer	Johanson
	Gain	Peak gain: +1.8 dBi (Bluetooth LE), -2.1 dBi (GNSS) (customer declaration)

Supply Voltage	V _{NOM}	3.6 VDC
AC/DC-Adaptor	None	
Manufacturer	Haltian Oy Yrttipellontie 1 D, 90230, Oulu, Finland	

3. Configuration and Operation Modes

Test Modes

Mode	Description
LTE NB-IoT, FDD B2	Channel = 1880 MHz, ch 18900 Mode = Transmit Modulation = QPSK Uplink subcarrier spacing = 15 kHz Subcarriers (UL) = 1 Start SC= 0 MCS, TBS = 6
BLE 1 Mbps	Mode = Transmit Modulation = GFSK Spreading = None Packet type = PRBS9 Duty cycle = 63%
Comment: Test mode LTE NB-IoT FDD B2 was tested separately along with Bluetooth LE, 1 Mbps 2440 MHz on simultaneously.	

Test Frequencies

Designator	Mode	Channel	Frequency [MHz]
F1	Tx	LTE B2, EARFCN 18900	1880
F2	Tx	BLE mid channel	2440

Test/configuration software

Manufacturer	Name	Version
Haltian Oy	HEAT Tokyo	2019.10.22.1

4. Test equipment

Radiated emission

New ID	Manufacturer	Equipment type	Description	Serial	Calibration information	Next calibration
G4C265	Rohde & Schwarz	ESW26	EMI test receiver	101324	6.7.2023	6.7.2024
G4C273	Frankonia	ALX-4000E	Broadband Antenna, 25MHz-4GHz with 6dB (50-A-MFN-06) att.	00816+1531	22.1.2024	22.1.2027
G4C292	Rohde & Schwarz	TS-LNA 1840	RF Preamplifier 18 to 40 GHz	100841	9.6.2022	9.6.2024
G4C298	Rohde & Schwarz	CMW500	Wideband radio communication tester	170980	29.6.2023	29.6.2024
G4C469	Rohde & Schwarz	TS_PRE2	RF Preamplifier	101541	9.6.2022	9.6.2024
G4C294	Rohde & Schwarz	Antenna	Horn Antenna -> 40GHz	101067	4.11.2022	4.11.2025
G4C576	Rohde & Schwarz	HF907	Double-Ridged Waveguide Horn Antenna 800MHz-18GHz	100163	9.8.2022	9.8.2025

Test software

Description	Manufacturer	Name	Version
EMC Software	Rohde & Schwarz	EMC32	10.60.20

5. Uncertainties

Description	Expanded Uncertainty (k=2)
Radiated emission ≤ 1 GHz	4,62
Radiated emission > 1 GHz	5,72

6. Sample emission level calculation

The following is a description of term and a sample calculation, as appears in the radiated emissions data table. The numbers used in the calculation are for example only. There is no direct correlation to the specific data taken for the product described in this document:

Reading:

This is the reading obtained on the spectrum analyzer in dBuV.

A.F.:

This is the antenna factor for the receiving antenna. It is a conversion factor, which converts electric fields strength to voltages, which can be measured directly on the spectrum analyzer. It is treated as a loss in dB. RF path losses, including RF cables and preamplifiers, have been included with the A.F to simplify the calculations. The antenna factor is used in calculations as follows:

$$\text{Reading on Analyzer (dBuV)} + \text{A.F. (dB/m)} = \text{Net field strength (dBuV/m)}$$

Net:

This is the net field strength measurement (as shown above).

Limit:

This is the FCC Class B radiated emission limit (in units of dBuV/m). The FCC limits are given in units of uV/m. The following formula is used to convert the units of uV/m to dbuV/m:

$$\text{Limit (dBuV/m)} = 20 * \log(\text{uV/m})$$

Margin :

This is the margin of compliance below the FCC limit. The units are given in dB. A negative margin indicates the emission was below the limit. A positive margin indicates that the emission exceeds the limit.

Example only:

Reading + AF	= Net Reading :	Net reading – FCC limit	= Margin
+ 21.5 dBuV + 26 dB/m	= 47.5 dBuV/m :	47.5 dBuV/m – 57.0 dBuV/m	= -9.5 dB

7. Test conditions

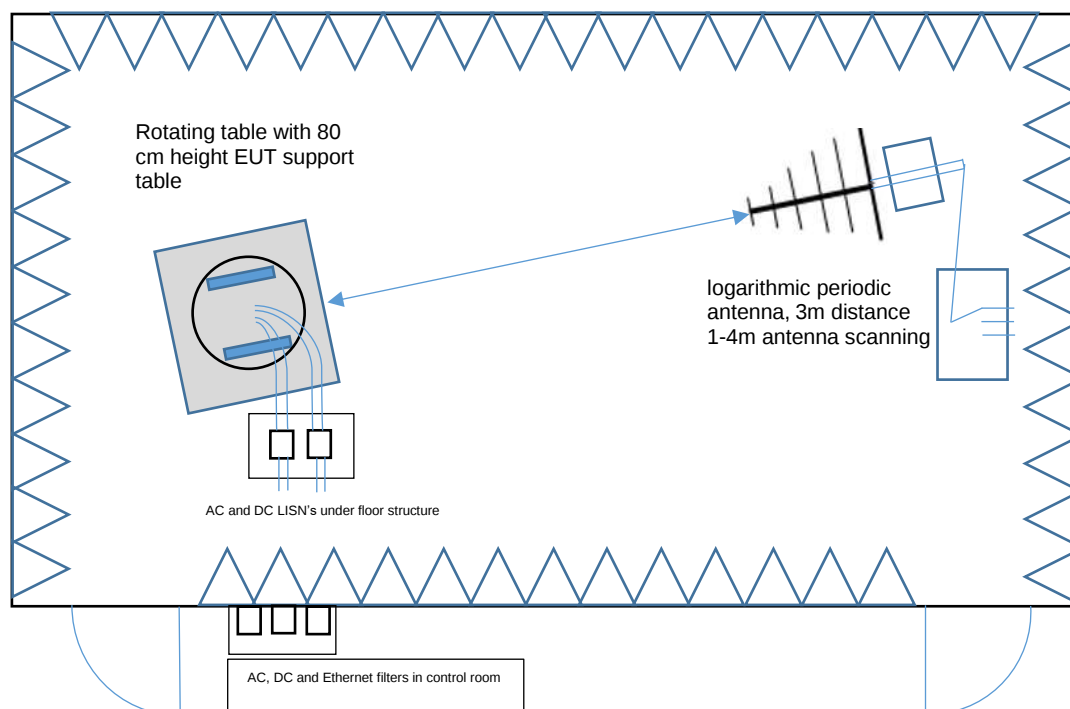
All radiated tests were performed in a semi-anechoic chamber, where the measurement antenna (Bilog antenna for the range between 30 MHz to 1000 MHz, 1 GHz-18 GHz Double-ridged horn antenna and 18 GHz-40 GHz horn antenna) is located at a distance of 3 m.

The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360° and the antenna height (all antennas) was varied from 1 to 4 meters to find the maximum radiated emission.

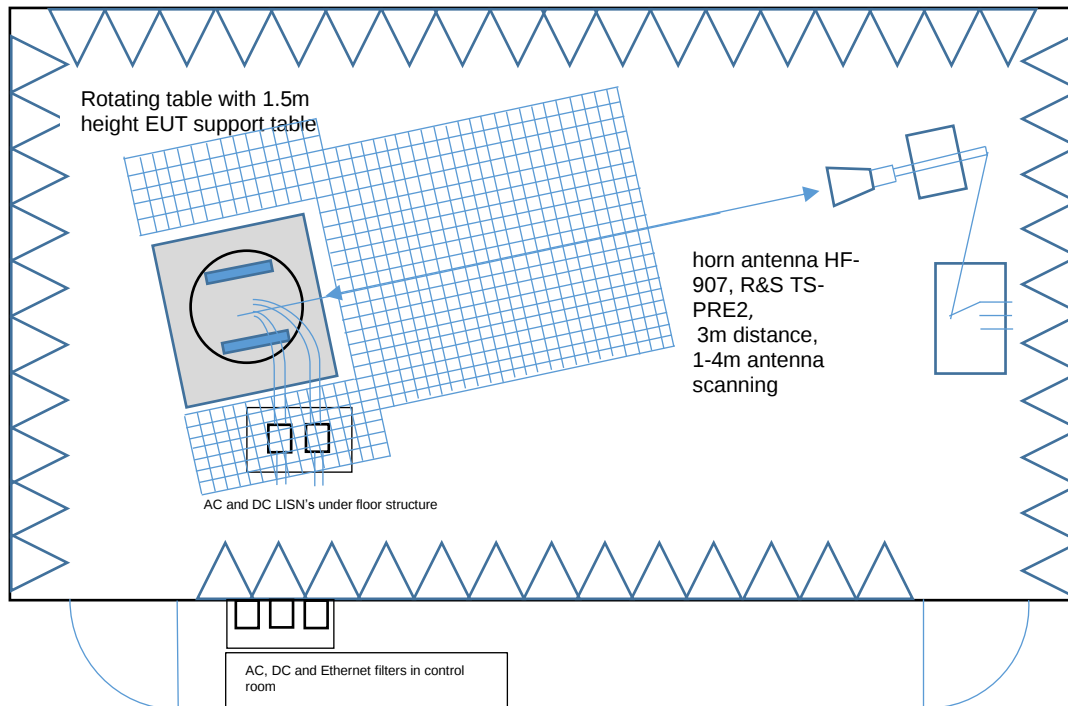
Measurements were made in both horizontal and vertical planes of polarization.

A resolution bandwidth / video bandwidth of 100 kHz / 300 kHz was used for frequencies below 1 GHz and 1 MHz / 3 MHz for frequencies above 1 GHz.

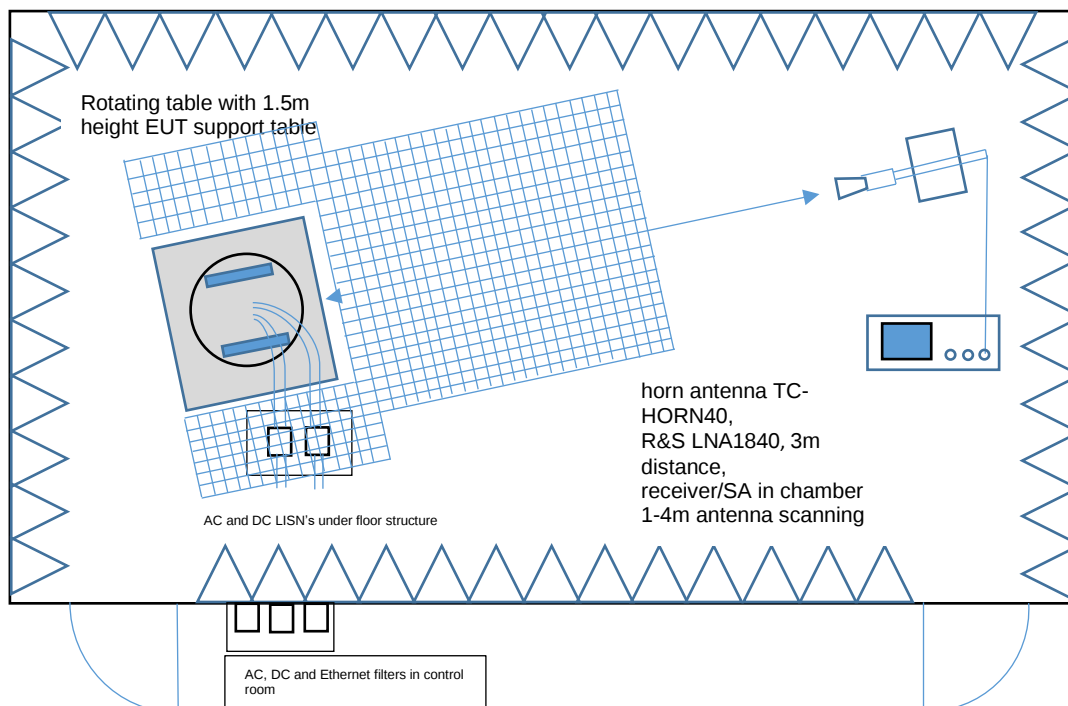
Radiated measurements setup from 30 MHz to 1 GHz:



Radiated measurements setup from 1 GHz to 18 GHz:



Radiated measurements setup from 18 GHz to 26 / 40 GHz:



8. Summary

FCC 47 CFR Part 15C				
Product Standard Reference	Requirement	Reference Method	Result	Remarks
FCC § 15.247(d)	Transmitter radiated spurious emissions	ANSI C63.10-2013	PASS	
Comment: Above standards have been selected for tests because they have the stringest spurious emission limits when considering all built-in radio technologies.				
Possible Test Case Verdicts PASS = Test object does meet the requirements FAIL = Test object does not meet the requirements N/T = Required by standard but not tested N/R = Not required by standard for the test object				

9. Tx spurious emissions, radiated

Reference: FCC § 15.247(d), FCC §15.209, ISSED RSS-Gen Issue 5 A2 (section 6.13)

Test method: ANSI C63.10-2013 (6.4, 6.5, 6.6 & 11.12)

Limits				
Frequency range (MHz)	Detector	Field strength (uV/m)	Field strength (dBuV/m)	Measurement distance (m)
0.009 – 0.09	Average	2400/F(kHz)	-	300
0.09 – 0.110	Quasi-Peak	2400/F(kHz)	-	300
0.110 – 0.490	Average	2400/F(kHz)	-	300
0.490 – 1.705	Quasi-Peak	24000/F(kHz)	-	30
1.705 – 30.0	Quasi-Peak	30	-	30
30 - 88	Quasi-Peak	100	40	3
88 – 216	Quasi-Peak	150	43.5	3
216 – 960	Quasi-Peak	200	46	3
960 - 1000	Quasi-Peak	500	54	3
>1000	Average	500	54	3

Test procedure 30 MHz -1 GHz

1. EUT is placed on a non conducting support at the center of a turn table 0.8m above the ground
2. EUT set to test mode
3. The receiver is set to peak detection with max hold
4. The EUT is rotated through 360 degrees (orientation varied), measurements were made in both horizontal and vertical planes of polarization
5. Found peak values were further maximized by adjusting turntable position $\pm 22,5$ degrees around detected value and scanning the antenna height 1 to 4m
6. For maximized values, final measurement was done with the corresponding final detector.

Test procedure > 1 GHz

1. EUT is placed on a non conducting support at the center of a turn table 1.5m above the ground
2. EUT set to test mode
3. The receiver is set to peak detection with max hold
4. The EUT is rotated through 360 degrees (orientation varied), measurements were made in both horizontal and vertical planes of polarization.
5. Found peak values were further maximized by adjusting turntable position $\pm 22,5$ degrees around detected value and scanning the antenna height 1 to 4m
6. For maximized values, final measurement was done with the corresponding final detector.

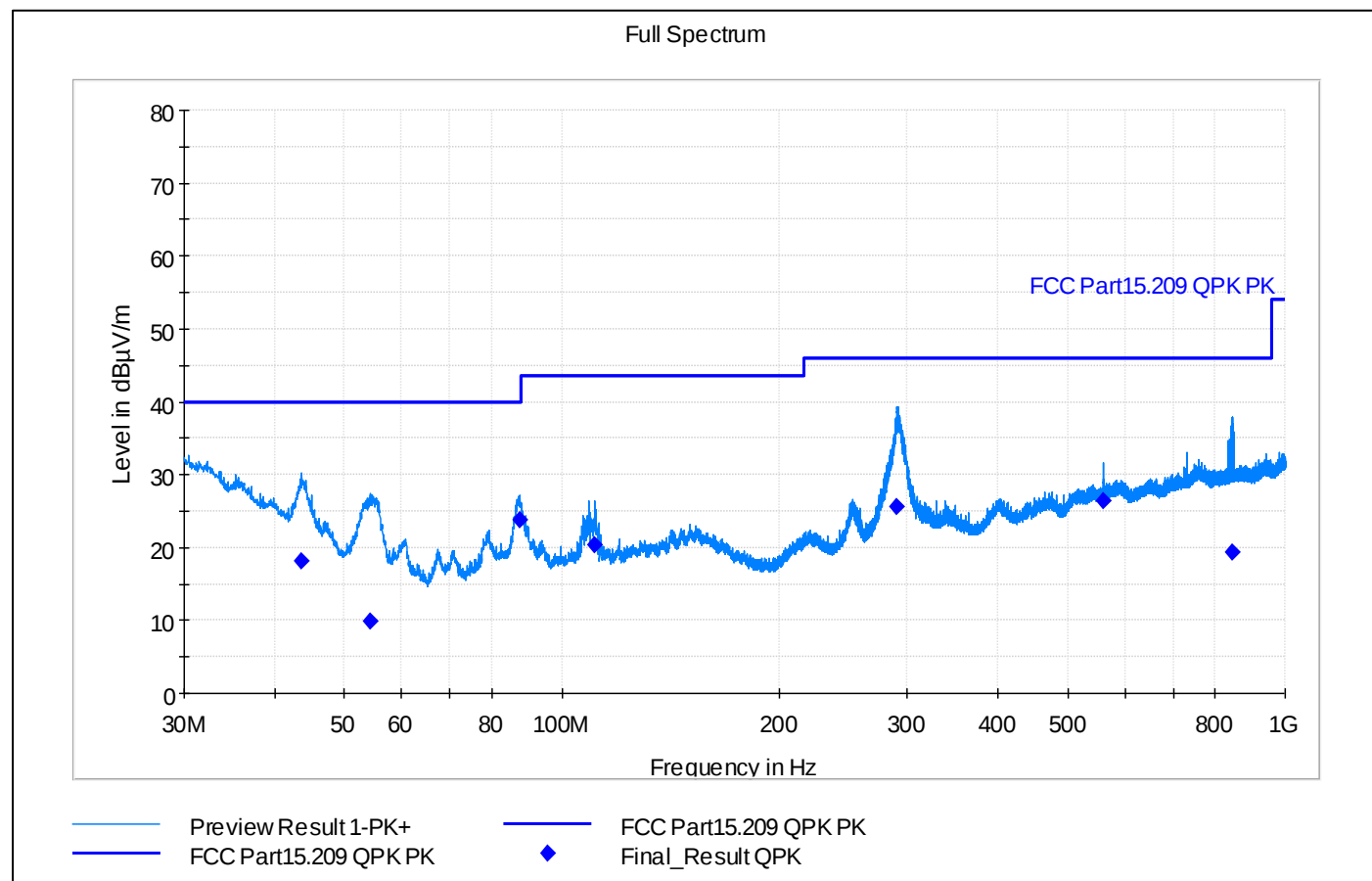
For average radiated emission measurements above 1000 MHz, there is also a limit corresponding to 20 dB above the indicated values in the table is specified when measuring with peak detector function. RSS-247: Attenuation below the general field strength limits specified in RSS-Gen is not required.

The field strength is calculated by adding correction factor to the measured level from the spectrum analyzer. This correction factor includes antenna factor, cable loss and pre-amplifiers gain.

Test summary

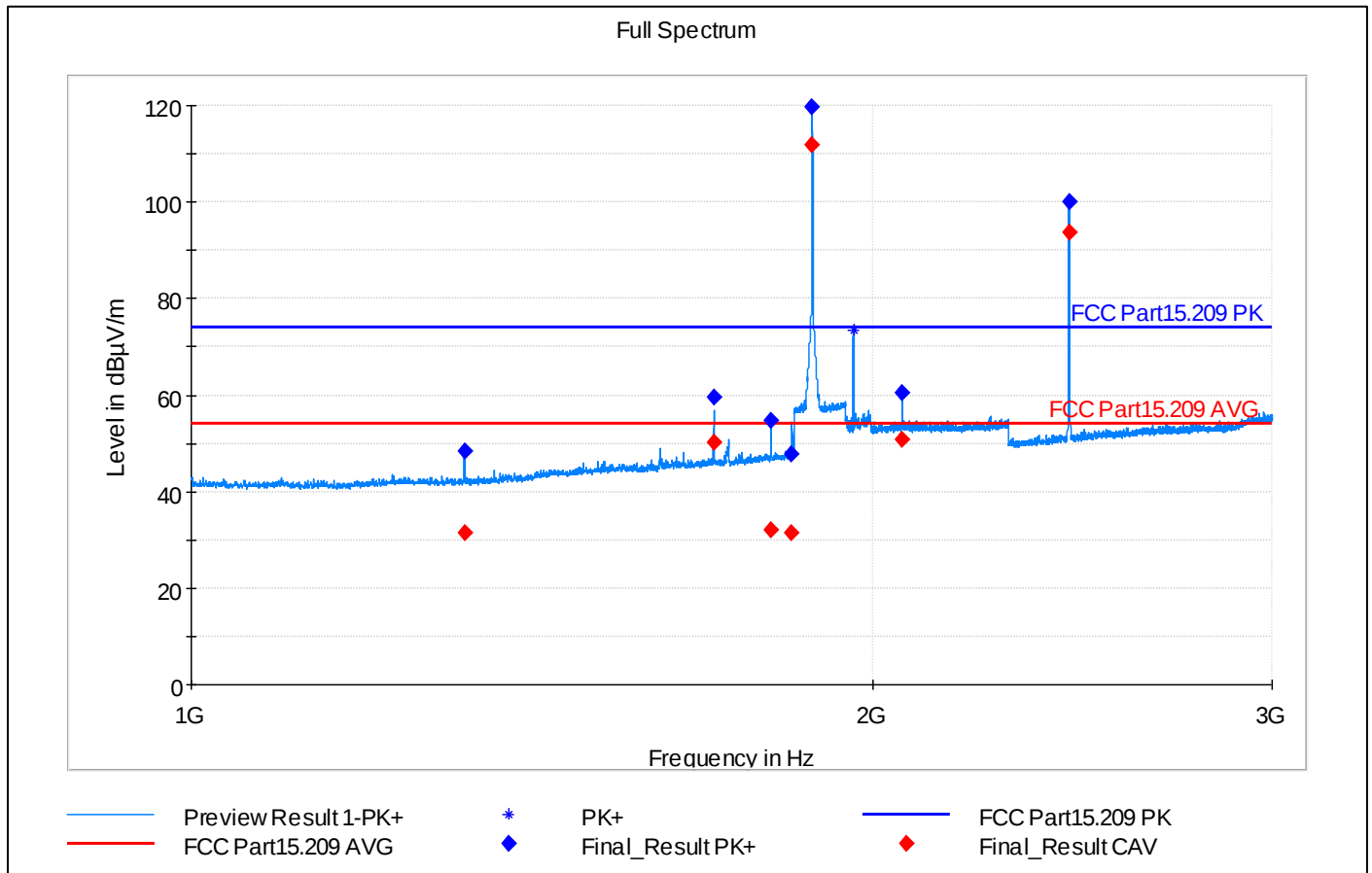
Operation mode(s)	Configuration	Test Verdict
LTE B2 + Bluetooth LE 1 Mbps	3848ER004	PASS

Mid channel, 30 MHz – 1 GHz



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
43.650000	18.19	40.00	21.81	15000.0	120.000	252.0	V	247.0	0.0	20.2	PASS
54.240000	9.84	40.00	30.16	15000.0	120.000	324.0	V	292.0	90.0	16.2	PASS
87.210000	23.70	40.00	16.30	15000.0	120.000	170.0	V	272.0	90.0	16.8	PASS
110.820000	20.44	43.50	23.06	15000.0	120.000	98.0	V	262.0	0.0	17.0	PASS
290.790000	25.50	46.00	20.50	15000.0	120.000	104.0	H	281.0	90.0	19.9	PASS
560.070000	26.50	46.00	19.50	15000.0	120.000	101.0	V	292.0	0.0	25.2	PASS
845.160000	19.42	46.00	26.58	15000.0	120.000	366.0	V	227.0	0.0	27.8	PASS

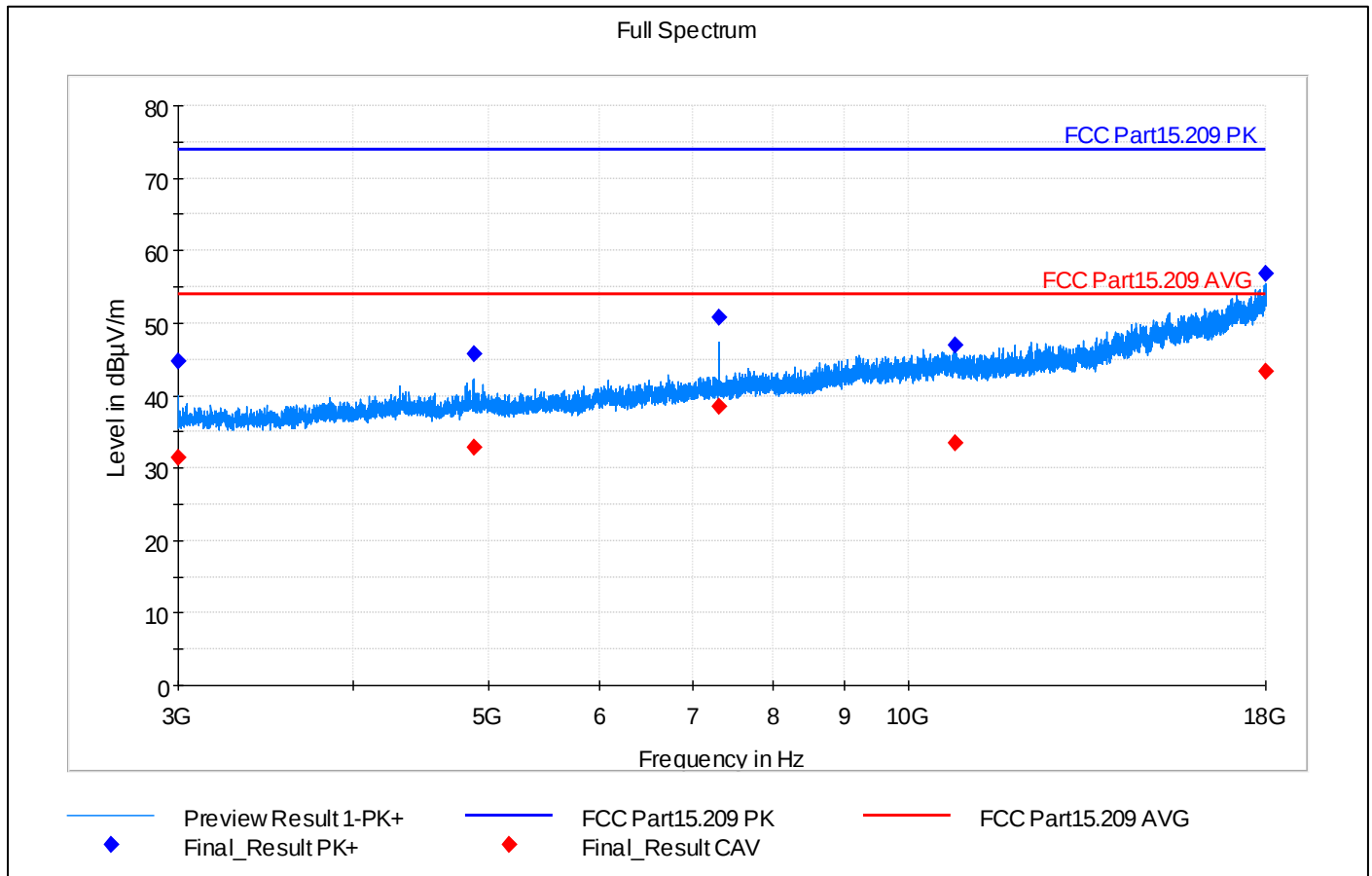
Mid channel, 1-3 GHz


Note: Frequency 1960,000 MHz is excluded from spurious domain measurements and ignored. See table below.

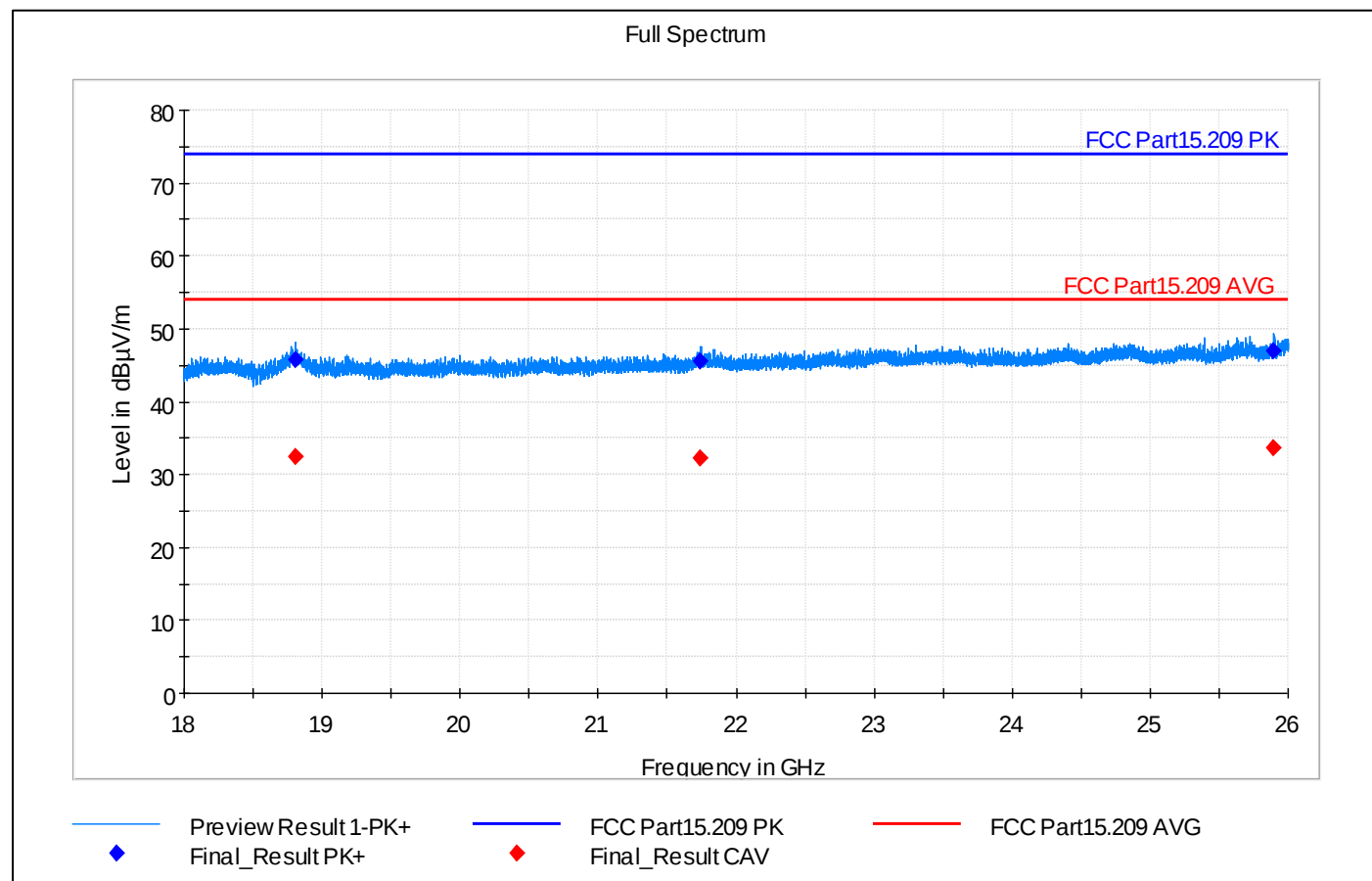
Frequency (MHz)	Comment
1960.000000	CMW500 Band 2 downlink signal ***IGNORED***

Final Result

Frequency (MHz)	MaxPeak (dBμV/m)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
1320.250000	---	31.54	54.00	22.46	15000.0	1000.000	204.0	H	1.0	90.0	31.8	PASS
1320.250000	48.36	---	74.00	25.64	15000.0	1000.000	204.0	H	1.0	90.0	31.8	PASS
1701.000000	---	50.27	54.00	3.73	15000.0	1000.000	101.0	H	-12.0	90.0	34.8	PASS
1701.000000	59.52	---	74.00	14.48	15000.0	1000.000	101.0	H	-12.0	90.0	34.8	PASS
1803.000000	---	31.91	54.00	22.09	15000.0	1000.000	158.0	H	-22.0	90.0	35.3	PASS
1803.000000	54.66	---	74.00	19.34	15000.0	1000.000	158.0	H	-22.0	90.0	35.3	PASS
1841.500000	47.82	---	74.00	26.18	15000.0	1000.000	310.0	H	-19.0	90.0	35.6	PASS
1841.500000	---	31.30	54.00	22.70	15000.0	1000.000	310.0	H	-19.0	90.0	35.6	PASS
1880.000000	119.70	---	74.00	-45.70	15000.0	1000.000	117.0	H	-15.0	90.0	35.9	Fundamental NB-IoT TX signal
1880.000000	---	111.78	54.00	-57.78	15000.0	1000.000	117.0	H	-15.0	90.0	35.9	Fundamental NB-IoT TX signal
2059.000000	---	50.92	54.00	3.08	15000.0	1000.000	122.0	H	95.0	90.0	37.7	PASS
2059.000000	60.38	---	74.00	13.62	15000.0	1000.000	122.0	H	95.0	90.0	37.7	PASS
2440.250000	---	93.59	54.00	-39.59	15000.0	1000.000	134.0	H	321.0	90.0	38.9	Fundamental BLE TX signal
2440.250000	99.95	---	74.00	-25.95	15000.0	1000.000	134.0	H	321.0	90.0	38.9	Fundamental BLE TX signal

Mid channel, 3–18 GHz

Final_Result

Frequency (MHz)	MaxPeak (dBμV/m)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
3000.000000	44.80	---	74.00	29.20	15000.0	1000.000	122.0	H	92.0	90.0	5.0	PASS
3000.000000	---	31.48	54.00	22.52	15000.0	1000.000	122.0	H	92.0	90.0	5.0	PASS
4879.500000	---	32.89	54.00	21.11	15000.0	1000.000	104.0	H	294.0	90.0	10.1	PASS
4879.500000	45.70	---	74.00	28.30	15000.0	1000.000	104.0	H	294.0	90.0	10.1	PASS
7319.250000	50.85	---	74.00	23.15	15000.0	1000.000	164.0	V	159.0	0.0	15.2	PASS
7319.250000	---	38.43	54.00	15.57	15000.0	1000.000	164.0	V	159.0	0.0	15.2	PASS
10793.750000	46.89	---	74.00	27.11	15000.0	1000.000	158.0	H	197.0	0.0	21.5	PASS
10793.750000	---	33.55	54.00	20.45	15000.0	1000.000	158.0	H	197.0	0.0	21.5	PASS
17984.000000	56.77	---	74.00	17.23	15000.0	1000.000	222.0	V	286.0	0.0	39.1	PASS
17984.000000	---	43.24	54.00	10.76	15000.0	1000.000	222.0	V	286.0	0.0	39.1	PASS

Mid channel, 18–26 GHz

Final_Result

Frequency (MHz)	MaxPeak (dBμV/m)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
18808.500000	45.75	---	74.00	28.25	3000.0	1000.000	173.0	V	315.0	0.0	23.5	PASS
18808.500000	---	32.45	54.00	21.55	3000.0	1000.000	173.0	V	315.0	0.0	23.5	PASS
21745.000000	45.49	---	74.00	28.51	3000.0	1000.000	230.0	H	120.0	90.0	24.8	PASS
21745.000000	---	32.20	54.00	21.80	3000.0	1000.000	230.0	H	120.0	90.0	24.8	PASS
25899.000000	---	33.69	54.00	20.31	3000.0	1000.000	367.0	H	310.0	0.0	26.9	PASS
25899.000000	46.86	---	74.00	27.14	3000.0	1000.000	367.0	H	310.0	0.0	26.9	PASS

