

Pacific Industrial Company, LTD.

TEST REPORT

SCOPE OF WORK:

47 CFR FCC Part 15.231 – Radio Spectrum report

Model:

PMV-E003

REPORT NUMBER

210200039TWN-001

ISSUE DATE

Feb. 22, 2021

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Radio Spectrum TEST REPORT

Applicant:	Pacific Industrial Company, LTD. 1300-1, Yokoi, Godo-cho, Anpachi-gun, Gifu 503-2397, Japan
Product:	TPMS (Tire Pressure Monitoring System Transmitter)
Model No.:	PMV-E003
FCC ID:	PAXPMVE003
Test Method/ Standard:	47 CFR FCC Part 15.231
Test By:	Intertek Testing Services Taiwan Ltd., Hsinchu Laboratory No. 11, Lane 275, Ko-Nan 1 Street, Chia-Tung Li, Shiang-Shan District, Hsinchu City, Taiwan



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Revision History

Report No.	Issue Date	Revision Summary
210200039TWN-001	Feb. 22, 2021	Original report

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Summary of Test Data

Test Requirement	Applicable Rule	Result
Radiated Emission test	15.231(e), 15.209	Pass
Measured bandwidth	15.231(c)	Pass
Timing requirement of manually operated transmitter	15.231(e)	Pass
Conducted Emission test	15.207	N/A
Antenna Requirement	15.203	Pass

Note: Please note that the test results with statement of conformity, the decision rules which are based on: Safety Testing: the specification, standard or IEC Guide 115.

Other Testing: the specification, standard and not taking into account the measurement uncertainty.

1. General Information**1.1 Identification of the EUT**

Product:	TPMS (Tire Pressure Monitoring System Transmitter)
Model No.:	PMV-E003
Operating Frequency:	314.975 MHz
Rated Power:	DC 3V
Power Cord:	N/A
Sample receiving date:	2021/02/02
Sample condition:	Workable
Test Date(s):	2021/02/04 ~ 2021/02/18

1.2 Antenna description

Antenna Type : Metal Antenna
Connector Type : Fixed

2. Test specifications

2.1 Test standard

The EUT was performed according to the procedures in FCC Part 2.1053 and the requirement in FCC Part 15 Subpart C Section 15.231.

2.2 Operation mode

The EUT was supplied with DC 3V from battery.

TX mode: EUT powered on and transmit signal continued.

The signal is maximized through rotation and placement in the three orthogonal axes.



X axis



Y axis



Z axis

After verifying three axes, we found the maximum electromagnetic field was occurred at Z axis. The final test data was executed under this configuration.

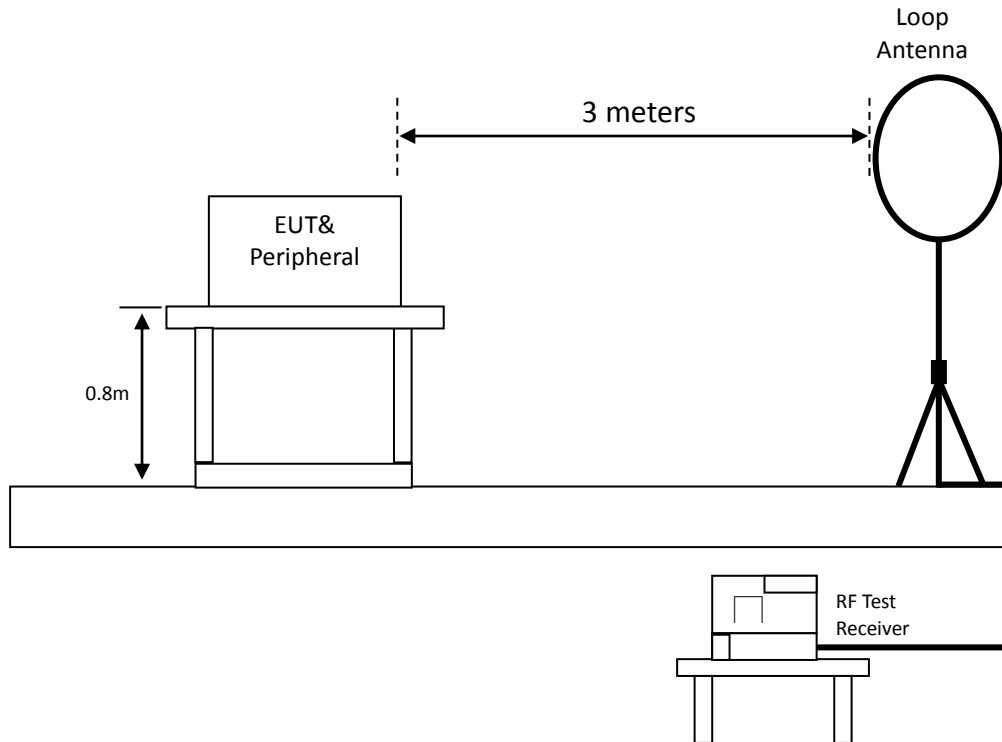
2.3 Peripherals equipment

Peripherals	Brand	Model No.	Serial No.	Data cable
Battery	maxell	CR2050HR	N/A	N/A

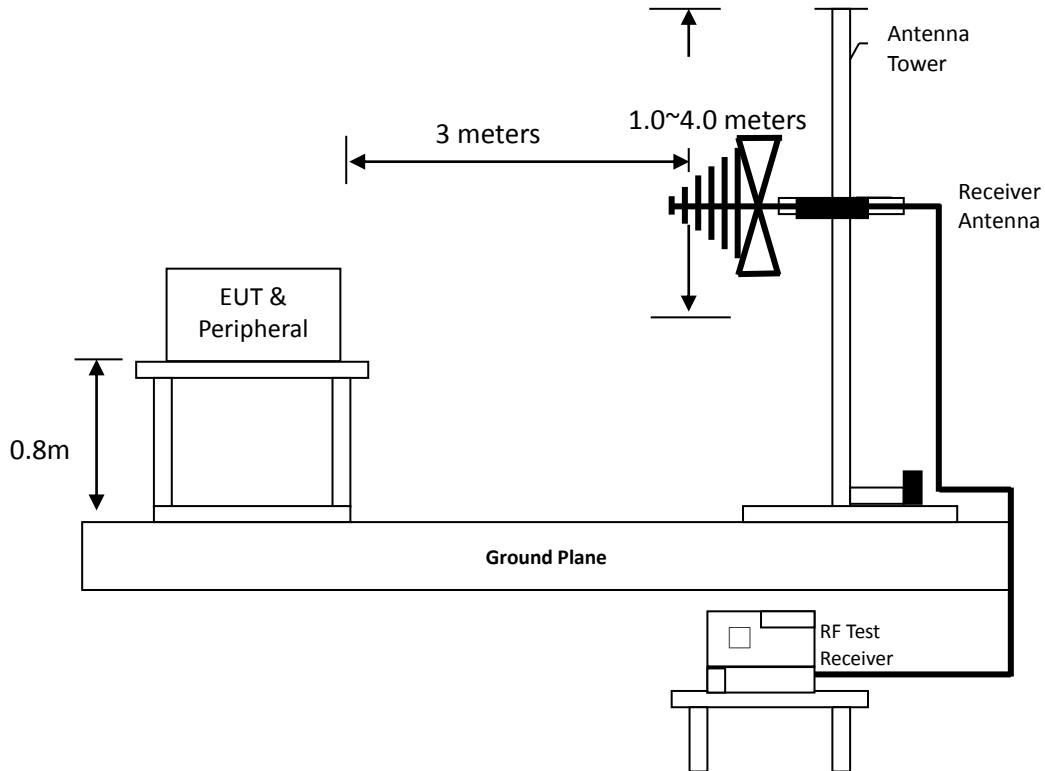
3. Radiated emission test FCC 15.231 (b)

3.1 Test setup & procedure

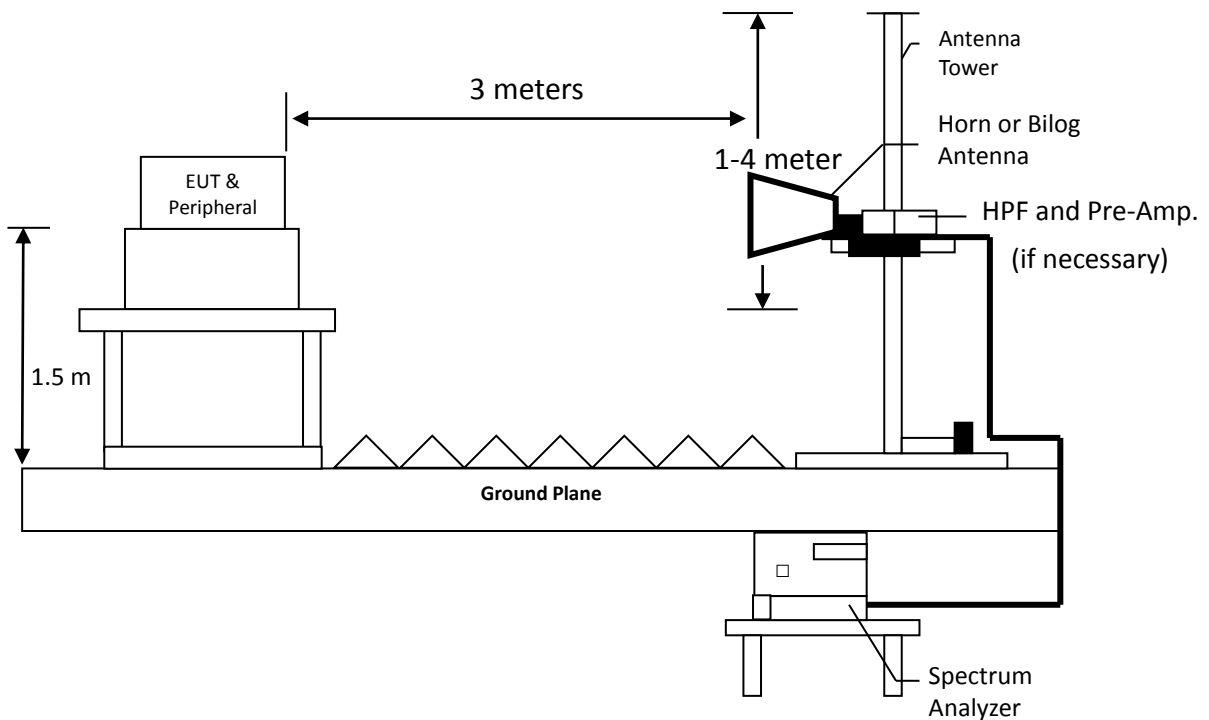
3.1.1 Radiated emission from 9kHz to 30MHz uses Loop Antenna:



3.1.2 Radiated emission below 1GHz using Bilog Antenna



3.1.3 Radiated emission above 1GHz using Horn Antenna



3.2 Radiated emission limit

3.2.1 Fundamental and harmonics emission limits

Frequency (MHz)	Field Strength of Fundamental		Field Strength of Harmonics	
	(uV/m@3 m)	(dBuV/m@3 m)	(uV/m@3 m)	(dBuV/m@3 m)
314.975	2416.26	67.66	241.62	47.66

3.2.2 General radiated emission limit

The spurious Emission shall test through the 10th harmonic. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a).

Frequency MHz	15.209 Limits (dBµV/m@3m)
30-88	40
88-216	43.5
216-960	46
Above 960	54

Remark:

1. In the above table, the tighter limit applies at the band edges.
2. Distance refers to the distance in meters between the measuring instrument antenna and the closed point of any part of the device or system

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3.3 Radiated emission test data FCC 15.231

3.3.1 Measurement results: Fundamental emission

Temperature: 26 °C

Relative Humidity: 65 %

Test date: 2021/2/4

Mode	Frequency (MHz)	Spectrum Analyzer Detector	Antenna Polarization	Correction Factor (dB/m)	Reading (dBμV)	Corrected Reading (dBμV/m)	Limit @ 3 m (dBμV/m)	Margin (dB)
ASK	314.975	PK	V	22.30	43.78	66.08	87.66	-21.58
	314.975	AV	V	-	-	48.58	67.66	-19.08
	314.975	PK	H	22.30	51.12	73.42	87.66	-14.24
	314.975	AV	H	-	-	55.92	67.66	-11.74
FSK	314.975	PK	V	22.30	44.64	66.94	87.66	-20.72
	314.975	AV	V	-	-	49.44	67.66	-18.22
	314.975	PK	H	22.30	50.15	72.45	87.66	-15.21
	314.975	AV	H	-	-	54.95	67.66	-12.71

Remark: Correction Factor = Antenna Factor + Cable Loss

Note: AV Corrected Reading = PK Corrected Reading + Duty cycle correction factor (-17.5)

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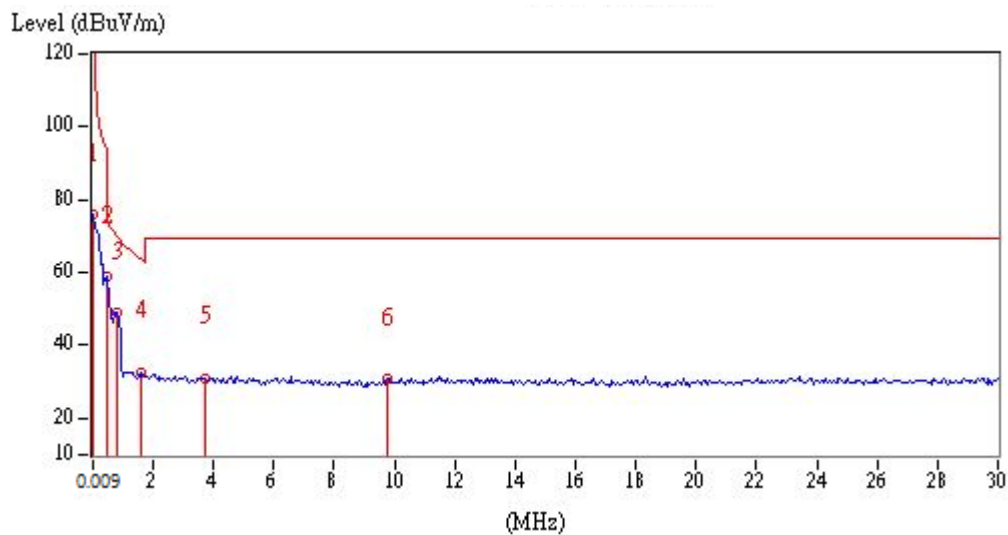
3.3.2 Measurement results: frequencies equal to or less than 1 GHz

Temperature: 21 °C
 Relative Humidity: 62 %
 Test date: 2021/2/9

9kHz – 30MHz (Mode: ASK)

Antenna Polarization	Frequency (MHz)	Spectrum Analyzer Detector	Correction Factor (dB/m)	Reading (dBμV)	Corrected Reading (dBμV/m)	Limit @ 3 m (dBμV/m)	Margin (dB)
Perpendicular	0.01	AV	18.29	57.55	75.84	127.60	-51.76
Perpendicular	0.49	AV	18.44	40.32	58.77	93.80	-35.03
Perpendicular	0.79	QP	18.46	30.50	48.96	69.65	-20.69
Perpendicular	1.57	QP	18.48	14.31	32.79	63.69	-30.90
Perpendicular	3.73	QP	18.75	12.38	31.13	69.54	-38.41
Perpendicular	9.79	QP	20.27	10.46	30.73	69.54	-38.81

Remark: Corr. Factor = Antenna Factor + Cable Loss

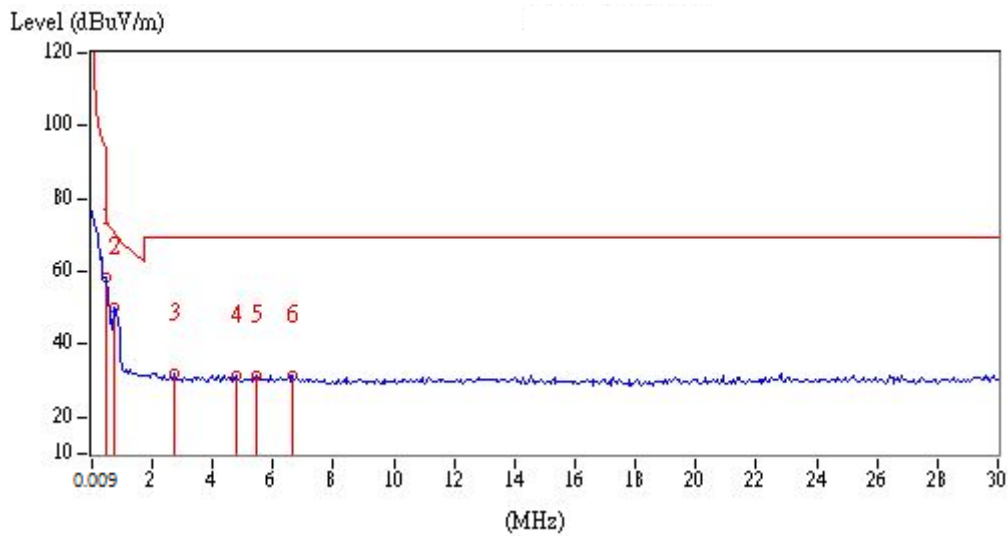


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9kHz – 30MHz (Mode: ASK)

Antenna Polarization	Frequency (MHz)	Spectrum Analyzer Detector	Correction Factor (dB/m)	Reading (dBμV)	Corrected Reading (dBμV/m)	Limit @ 3 m (dBμV/m)	Margin (dB)
Parallel	0.49	AV	18.44	39.75	58.19	93.80	-35.61
Parallel	0.73	QP	18.45	31.84	50.29	70.34	-20.05
Parallel	2.71	QP	18.49	13.72	32.21	69.54	-37.33
Parallel	4.81	QP	19.15	12.41	31.56	69.54	-37.98
Parallel	5.47	QP	19.48	11.70	31.18	69.54	-38.36
Parallel	6.67	QP	19.79	11.73	31.51	69.54	-38.03

Remark: Corr. Factor = Antenna Factor + Cable Loss

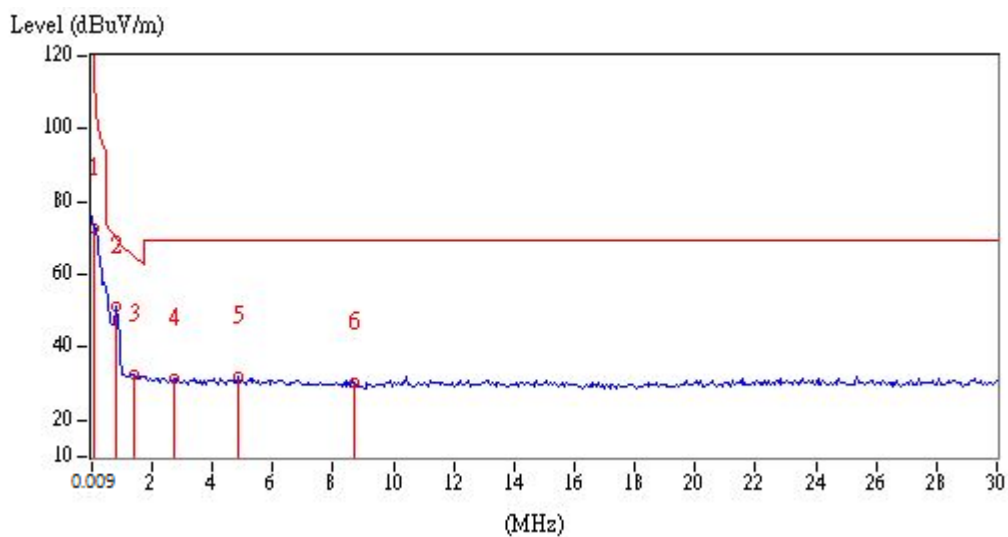


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9kHz – 30MHz (Mode: ASK)

Antenna Polarization	Frequency (MHz)	Spectrum Analyzer Detector	Correction Factor (dB/m)	Reading (dBμV)	Corrected Reading (dBμV/m)	Limit @ 3 m (dBμV/m)	Margin (dB)
Ground-parallel	0.07	AV	18.37	54.19	72.56	110.70	-38.14
Ground-parallel	0.79	QP	18.46	32.62	51.08	69.65	-18.57
Ground-parallel	1.39	QP	18.47	14.25	32.72	64.74	-32.02
Ground-parallel	2.71	QP	18.49	13.09	31.58	69.54	-37.96
Ground-parallel	4.87	QP	19.17	12.98	32.15	69.54	-37.39
Ground-parallel	8.71	QP	19.81	10.62	30.43	69.54	-39.11

Remark: Corr. Factor = Antenna Factor + Cable Loss

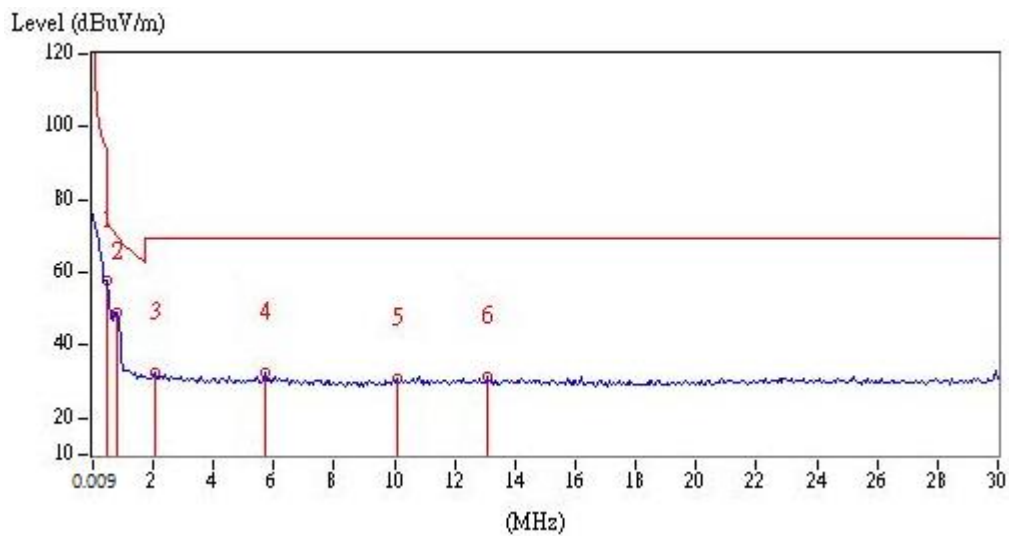


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9kHz – 30MHz (Mode: FSK)

Antenna Polarization	Frequency (MHz)	Spectrum Analyzer Detector	Correction Factor (dB/m)	Reading (dB μ V)	Corrected Reading (dB μ V/m)	Limit @ 3 m (dB μ V/m)	Margin (dB)
Perpendicular	0.49	AV	18.44	39.60	58.04	93.80	-35.76
Perpendicular	0.79	QP	18.46	30.71	49.17	69.65	-20.48
Perpendicular	2.05	QP	18.48	13.90	32.38	69.54	-37.16
Perpendicular	5.71	QP	19.62	13.05	32.66	69.54	-36.88
Perpendicular	10.09	QP	20.41	10.29	30.70	69.54	-38.84
Perpendicular	13.09	QP	20.59	10.69	31.28	69.54	-38.26

Remark: Corr. Factor = Antenna Factor + Cable Loss

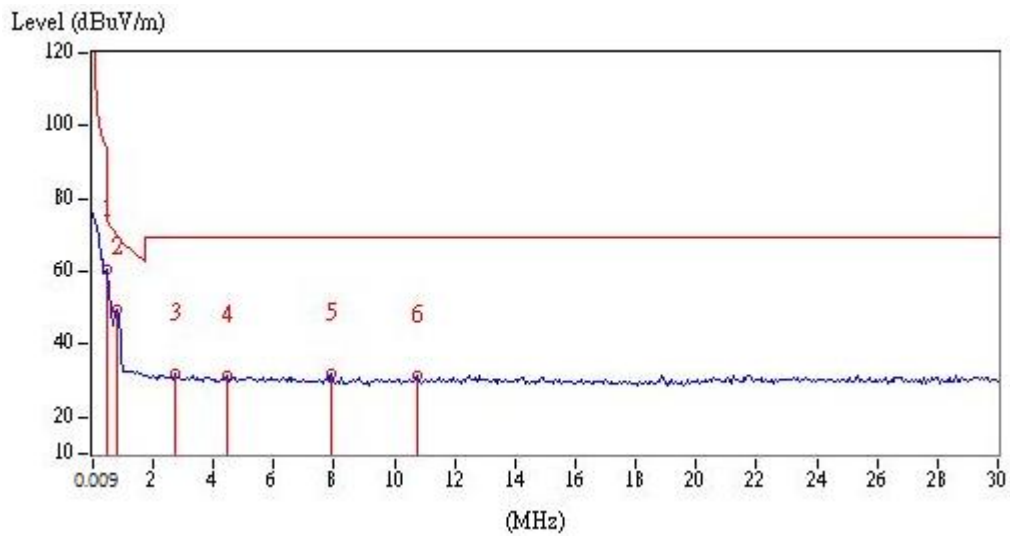


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9kHz – 30MHz (Mode: FSK)

Antenna Polarization	Frequency (MHz)	Spectrum Analyzer Detector	Correction Factor (dB/m)	Reading (dB μ V)	Corrected Reading (dB μ V/m)	Limit @ 3 m (dB μ V/m)	Margin (dB)
Parallel	0.49	AV	18.44	41.92	60.36	93.80	-33.44
Parallel	0.79	QP	18.46	31.41	49.87	69.65	-19.78
Parallel	2.71	QP	18.49	13.49	31.98	69.54	-37.56
Parallel	4.45	QP	19.02	12.33	31.35	69.54	-38.19
Parallel	7.93	QP	19.80	12.15	31.95	69.54	-37.59
Parallel	10.75	QP	20.45	11.06	31.50	69.54	-38.04

Remark: Corr. Factor = Antenna Factor + Cable Loss

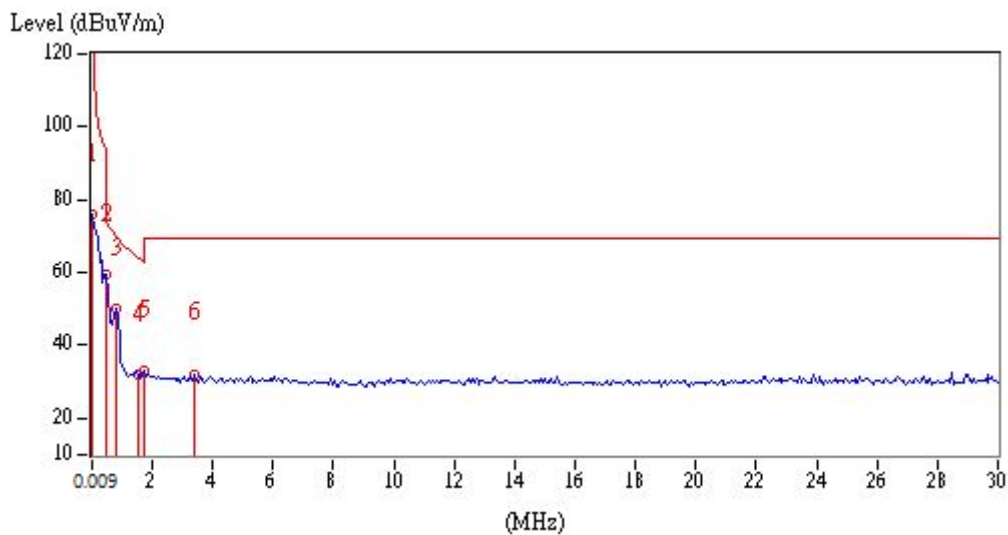


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9kHz – 30MHz (Mode: FSK)

Antenna Polarization	Frequency (MHz)	Spectrum Analyzer Detector	Correction Factor (dB/m)	Reading (dBμV)	Corrected Reading (dBμV/m)	Limit @ 3 m (dBμV/m)	Margin (dB)
Ground-parallel	0.01	AV	18.29	57.70	75.99	127.60	-51.61
Ground-parallel	0.49	AV	18.44	41.26	59.71	93.80	-34.09
Ground-parallel	0.79	QP	18.46	31.56	50.02	69.65	-19.63
Ground-parallel	1.51	QP	18.48	13.38	31.86	64.02	-32.16
Ground-parallel	1.75	QP	18.48	14.53	33.01	69.54	-36.53
Ground-parallel	3.37	QP	18.62	13.65	32.27	69.54	-37.27

Remark: Corr. Factor = Antenna Factor + Cable Loss



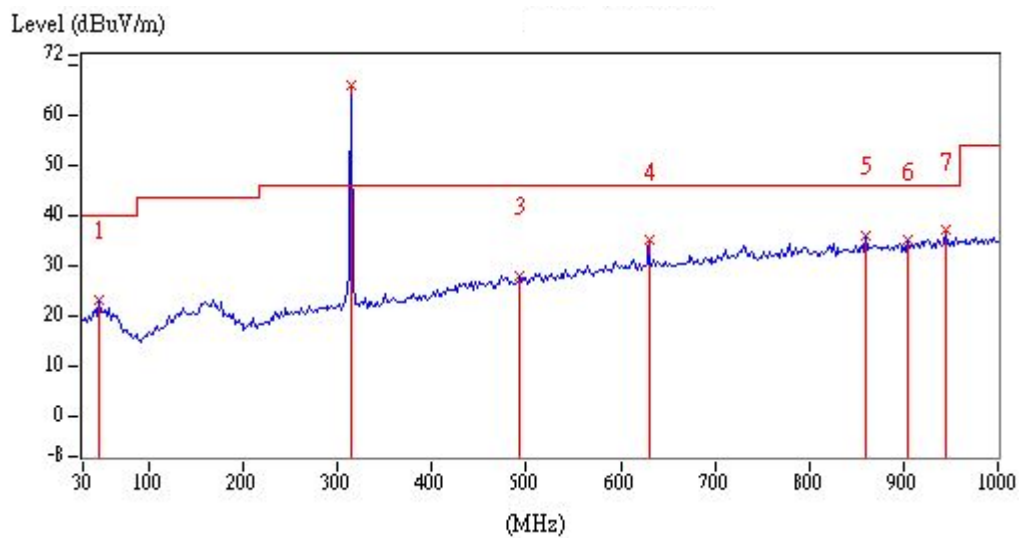
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Temperature: 26 °C
 Relative Humidity: 55 %
 Test date: 2021/2/4

30MHz – 1GHz (Mode: ASK)

Antenna Polarization	Frequency (MHz)	Spectrum Analyzer Detector	Correction Factor (dB/m)	Reading (dBμV)	Corrected Reading (dBμV/m)	Limit @ 3 m (dBμV/m)	Margin (dB)
Vertical	47.46	QP	21.30	1.98	23.29	47.66	-24.37
Vertical	493.66	QP	26.88	1.21	28.09	47.66	-19.57
Vertical	629.96	QP	29.70	5.41	35.11	47.66	-12.55
Vertical	860.32	QP	33.00	3.14	36.15	47.66	-11.51
Vertical	904.94	QP	33.46	1.62	35.09	47.66	-12.57
Vertical	944.94	QP	34.21	2.83	37.04	47.66	-10.62

Remark: Corr. Factor = Antenna Factor + Cable Loss

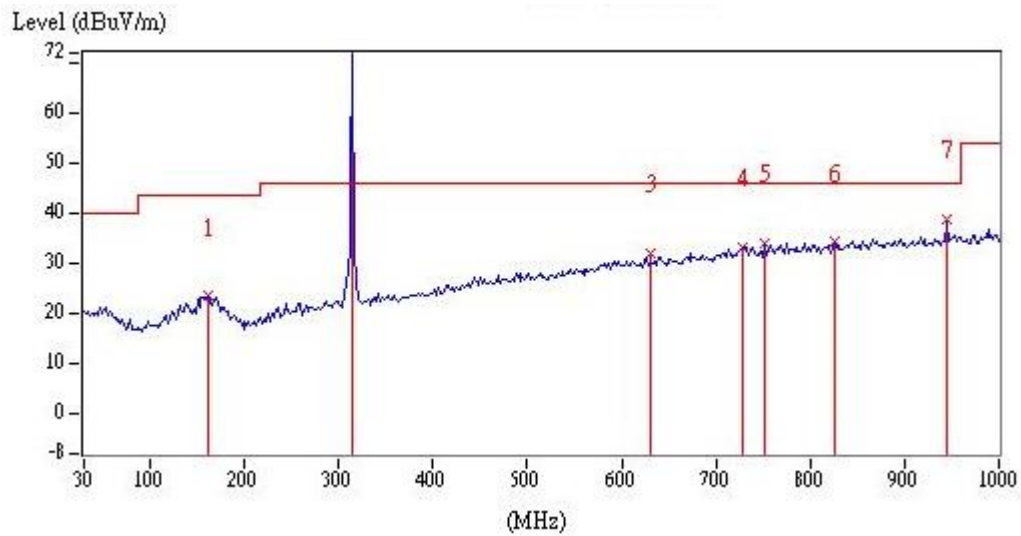


TEST REPORT

30MHz – 1GHz (Mode: ASK)

Antenna Polarization	Frequency (MHz)	Spectrum Analyzer Detector	Correction Factor (dB/m)	Reading (dB μ V)	Corrected Reading (dB μ V/m)	Limit @ 3 m (dB μ V/m)	Margin (dB)
Horizontal	161.92	QP	21.28	2.27	23.55	47.66	-24.11
Horizontal	629.96	QP	29.70	2.46	32.16	47.66	-15.50
Horizontal	728.40	QP	31.31	1.94	33.25	47.66	-14.41
Horizontal	751.68	QP	31.85	2.29	34.13	47.66	-13.53
Horizontal	825.40	QP	32.65	1.56	34.21	47.66	-13.45
Horizontal	944.94	QP	34.21	4.62	38.83	47.66	-8.83

Remark: Corr. Factor = Antenna Factor + Cable Loss

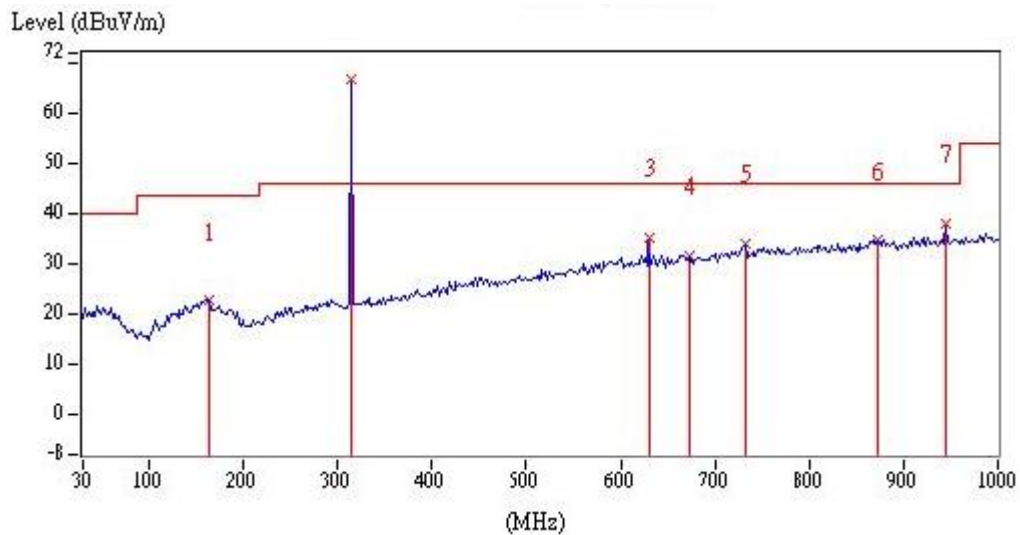


TEST REPORT

30MHz – 1GHz (Mode: FSK)

Antenna Polarization	Frequency (MHz)	Spectrum Analyzer Detector	Correction Factor (dB/m)	Reading (dB μ V)	Corrected Reading (dB μ V/m)	Limit @ 3 m (dB μ V/m)	Margin (dB)
Vertical	163.86	QP	21.22	1.39	22.62	43.50	-20.88
Vertical	629.96	QP	29.70	5.66	35.36	47.66	-12.30
Vertical	674.08	QP	30.30	1.43	31.73	47.66	-15.93
Vertical	732.28	QP	31.40	2.66	34.07	47.66	-13.59
Vertical	871.96	QP	33.11	1.65	34.76	47.66	-12.90
Vertical	944.94	QP	34.21	3.98	38.19	47.66	-9.47

Remark: Corr. Factor = Antenna Factor + Cable Loss

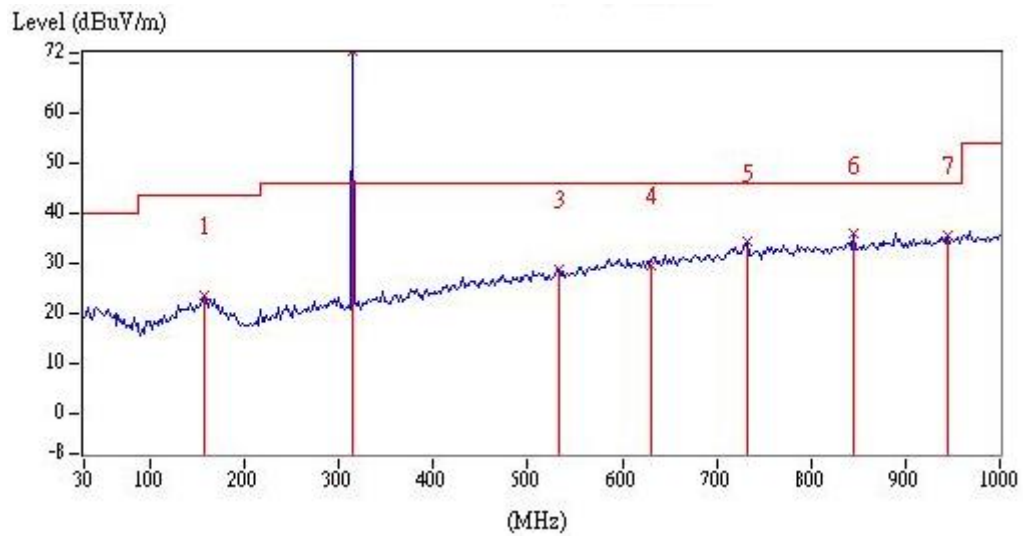


TEST REPORT

30MHz – 1GHz (Mode: FSK)

Antenna Polarization	Frequency (MHz)	Spectrum Analyzer Detector	Correction Factor (dB/m)	Reading (dBμV)	Corrected Reading (dBμV/m)	Limit @ 3 m (dBμV/m)	Margin (dB)
Horizontal	158.04	QP	21.28	2.50	23.78	47.66	-23.88
Horizontal	532.46	QP	27.61	1.25	28.86	47.66	-18.80
Horizontal	629.96	QP	29.70	0.00	29.70	47.66	-17.96
Horizontal	732.28	QP	31.40	2.80	34.20	47.66	-13.46
Horizontal	844.80	QP	32.85	3.04	35.89	47.66	-11.77
Horizontal	944.94	QP	34.21	1.47	35.69	47.66	-11.97

Remark: Corr. Factor = Antenna Factor + Cable Loss



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3.3.3 Measurement results: frequency above 1GHz

Temperature: 18 °C
 Relative Humidity: 63 %
 Test date: 2021/2/17

Mode	Frequency (MHz)	Spectrum Analyzer Detector	Antenna Polarization	Correction Factor (dB/m)	Reading (dBμV)	Corrected Reading (dBμV/m)	Limit @ 3 m (dBμV/m)	Margin (dB)
ASK	1259.92	PK	V	4.28	36.51	40.79	74.00	-33.21
	1574.90	PK	V	5.96	38.94	44.90	74.00	-29.10
	1889.88	PK	V	7.32	45.44	52.76	74.00	-21.24
	2204.86	PK	V	8.90	46.23	55.13	74.00	-18.87
	2204.86	AV	V	---	---	37.63	54.00	-16.37
	2519.84	PK	V	10.56	36.14	46.70	74.00	-27.30
	2834.82	PK	V	11.85	45.15	57.00	74.00	-17.00
	2834.82	AV	V	---	---	39.50	54.00	-14.50
	3149.80	PK	V	12.52	44.26	56.78	74.00	-17.22
	3149.80	AV	V	---	---	39.28	54.00	-14.72
	1259.92	PK	H	4.28	34.56	38.84	74.00	-35.16
	1574.90	PK	H	5.96	34.51	40.47	74.00	-33.53
	1889.88	PK	H	7.32	37.45	44.77	74.00	-29.23
	2204.86	PK	H	8.90	48.50	57.40	74.00	-16.60
	2204.86	AV	H	---	---	39.90	54.00	-14.10
	2519.84	PK	H	10.56	38.64	49.20	74.00	-24.80
	2834.82	PK	H	11.85	40.45	52.30	74.00	-21.70
	3149.80	PK	H	12.52	39.08	51.60	74.00	-22.40

Remark: Correction Factor = Antenna Factor + Cable Loss + High Pass Filter Loss - Pre_Amplifier Gain

Note: AV Corrected Reading = PK Corrected Reading + Duty cycle correction factor (-17.50)

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Mode	Frequency (MHz)	Spectrum Analyzer Detector	Antenna Polarization	Correction Factor (dB/m)	Reading (dBμV)	Corrected Reading (dBμV/m)	Limit @ 3 m (dBμV/m)	Margin (dB)
FSK	1259.92	PK	H	4.28	34.85	39.13	74.00	-34.87
	1574.90	PK	H	5.96	39.62	45.58	74.00	-28.42
	1889.88	PK	V	7.32	40.75	48.07	74.00	-25.93
	2204.86	PK	V	8.90	49.10	58.00	74.00	-16.00
	2204.86	AV	V	---	---	40.50	54.00	-13.50
	2519.84	PK	V	10.56	35.49	46.05	74.00	-27.95
	2834.82	PK	V	11.85	45.35	57.20	74.00	-16.80
	2834.82	AV	V	---	---	39.70	54.00	-14.30
	3149.80	PK	V	12.52	45.38	57.90	74.00	-16.10
	3149.80	AV	V	---	---	40.40	54.00	-13.60
	1259.92	PK	V	4.28	33.24	37.52	74.00	-36.48
	1574.90	PK	V	5.96	37.31	43.27	74.00	-30.73
	1889.88	PK	H	7.32	37.56	44.88	74.00	-29.12
	2204.86	PK	H	8.90	48.30	57.20	74.00	-16.80
	2204.86	AV	H	---	---	39.70	54.00	-14.30
	2519.84	PK	H	10.56	39.54	50.10	74.00	-23.90
	2834.82	PK	H	11.85	41.35	53.20	74.00	-20.80
	2834.82	AV	H	---	---	35.70	54.00	-18.30
3149.80	PK	H	12.52	39.04	51.56	74.00	-22.44	

Remark: Correction Factor = Antenna Factor + Cable Loss + High Pass Filter Loss - Pre_Amplifier Gain

Note: AV Corrected Reading = PK Corrected Reading + Duty cycle correction factor (-17.50)

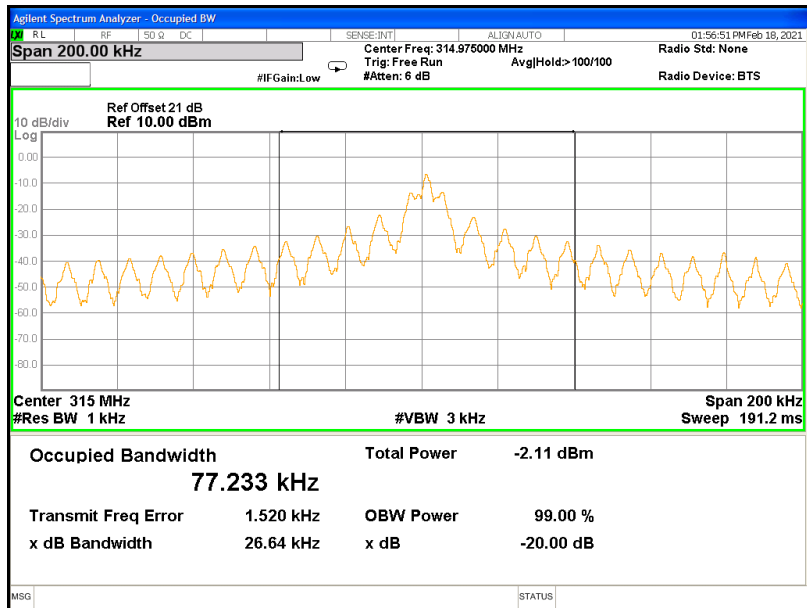
TEST REPORT**4. Measured bandwidth FCC 15.231(C)**

Temperature: 22 °C
Relative Humidity: 59 %
Test date: 2021/2/18

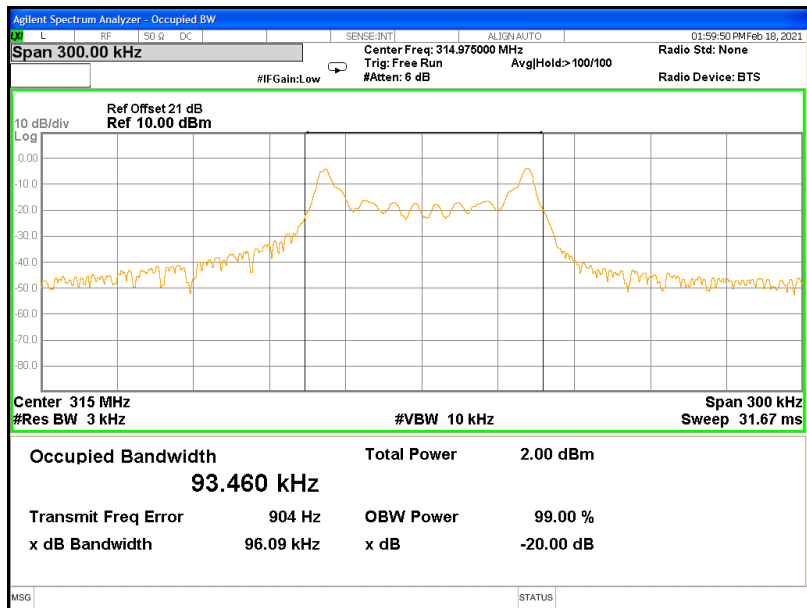
The bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating above 70MHz and below 900MHz. Bandwidth is determined at the points 20dB down from the modulated carrier.

Mode	Frequency (MHz)	20dB Occupied Bandwidth (MHz)	Limit (MHz)	Result
ASK	314.975	0.027	0.787	Pass
FSK	314.975	0.096	0.787	Pass

20dB Occupied Bandwidth@ASK



20dB Occupied Bandwidth@FSK



5. Timing requirement of operated transmitter

Devices operated under the provisions of this paragraph shall be provided with a means for automatically limiting operation so that the duration of each transmission shall not be greater than one second and the silent period between transmissions shall be at least 30 times the duration of the transmission but in no case less than 10 seconds.

Transmitter Pulse Duration@ASK



Transmitter Pulse Duration@FSK



6. Conducted emission FCC 15.207

Since the EUT is not connected to AC source, therefore, the test can be waived.

Appendix A: Test equipment list

Test Equipment/ Test site	Brand	Model No.	Serial No.	Calibration Date	Next Calibration Date
EMI Test Receiver	Rohde & Schwarz	ESR7	101822	2020/08/18	2021/08/17
Signal Analyzer	Agilent	N9030A	MY51380492	2020/08/17	2021/08/16
Active Loop Antenna	SCHWARZBECK MESS-ELEKTRONIC	FMZB1519	1519-067	2020/04/13	2021/04/12
Broadband Antenna	SHWARZBECK	VULB 9168	9168-172	2020/06/02	2021/06/01
Horn Antenna (1-18G)	SHWARZBECK	BBHA 9120 D	9120D-456	2021/01/11	2022/01/10
Pre-Amplifier (1-20G)	AML	AML0120L3401	0419-114	2020/12/16	2021/12/15
966-2(A) Cable	SUHNER	SMA / EX 100	N/A	2020/08/17	2021/08/16
966-2(B) Cable	SUHNER	SUCOFLEX 104P	CB0005	2020/08/17	2021/08/16
20dB Attenuator	Mini-Circuits	BW-S20W5+	N/A	2020/05/27	2021/05/26
966-2_3m Semi-Anechoic Chamber	966_2	CEM-966_2	N/A	2020/02/23	2021/02/22
Test software	ADT	Radiated test system	V7.5.14	NCR	NCR

Appendix B: Measurement Uncertainty

This uncertainty represents an expanded uncertainty expressed at approximately the 95 % confidence level using a coverage factor of $k=2$.

Item	Uncertainty
Timing requirement of manually operated transmitter	1.27 dB
Occupied Bandwidth	7.78 %
Radiated disturbances from 9kHz~30MHz in a semi-anechoic chamber at a distance of 3m	3.70 dB
Vertically polarized radiated disturbances from 30MHz~1GHz in a semi-anechoic chamber at a distance of 3m	5.16 dB
Horizontally polarized radiated disturbances from 30MHz~1GHz in a semi-anechoic chamber at a distance of 3m	5.02 dB
Radiated disturbances from 1GHz~18GHz in a semi-anechoic chamber at a distance of 3m	5.17 dB
AC Power Line Conducted Emission	3.08 dB