ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT

Applicant:	HORNCHE CORPORATION No. 23, Ln. 350, Nanshang Rd., Guishan Dist., Taoyuan City, Taiwan
Manufacturer:	HORNCHE CORPORATION No. 23, Ln. 350, Nanshang Rd., Guishan Dist., Taoyuan City, Taiwan
Product Name:	Easylube Nexus Remote Wireless Control Automatic Lubricator
Brand Name:	Easylube
Model No.:	250 Nexus
Report Number:	TERF2305001189ER
FCC ID	2BA73ELNEXUS
Date of EUT Received:	May 05, 2023
Date of Test:	May 08, 2023～February 19, 2024
Issue Date:	February 19, 2024

Approved By _____
Jim Chang

We hereby certify that:

The above equipment was tested by SGS Taiwan Ltd. Central RF Lab The test data, data evaluation, test procedures, and equipment configurations shown in this report were made in accordance with the procedures given in ANSI C63.10:2013 and the energy emitted by the sample EUT comply with FCC rule part §15.247.

The results of this report relate only to the sample identified in this report.

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Revision History

Report Number	Revision	Description	Issue Date	Revised By	Remark
TERF2305001189ER	00	Original	January 16, 2024	Celery Wei	
TERF2305001189ER	01	1. Revise antenna information 2. Revise modulation 3. Revise description of conduction test result 4. Add PSD and Dwell time in test mode 5. Revise description in section 7.5, 8.1, 9.3, 12.2, 13.3 and 15.3 6. Revise Measurement Result in section 9.4, 10.4, 11.4 and 14.4	January 29, 2024	Celery Wei	*
TERF2305001189ER	02	Revise comment	February 6, 2024	Celery Wei	*
TERF2305001189ER	03	Revise comment	February 19, 2024	Celery Wei	*

Note:

1、 The remark "*" indicates modification of the report upon requests from certification body.

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1 GENERAL INFORMATION

1.1 Product description

Product Name:	Easylube Nexus Remote Wireless Control Automatic Lubricator
Brand Name:	Easylube
Model No.:	250 Nexus
EUT Series No.:	4YN1-2
Power Supply:	6Vdc
Test Software (Name/Version)	Windows10 cmd

1.2 RF Specification

Radio Technology:	LoRa
Frequency Range:	902.3MHz-927.5MHz
Channel number:	127
Modulation type:	FSK
Transmit Power:	16.16 dBm (Peak)
Dwell Time:	<= 0.4s
Operating Mode:	Point-to-Point

1.3 Antenna Designation

Antenna Type	Brand	Antenna Model No.	Antenna Gain
PCB	Unictron	W935D1	4.5
Note: Antenna information is provided by the applicant.			

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1.4 Test Methodology of Applied Standards

FCC Part 15, Subpart C §15.247
FCC KDB 558074 D01 15.247 Meas Guidance v05r02
ANSI C63.10:2013

1.5 Test Facility

Laboratory	Test Site Address	Test Site Name	FCC Designation number	IC CAB identifier
SGS Taiwan Ltd. Central RF Lab. (TAF code 3702)	No.134, Wu Kung Road, New Taipei Industrial Park, Wuku District, New Taipei City, Taiwan.	SAC 1	TW0027	TW3702
		SAC 2		
		SAC 3		
		Conduction 1		
		Conducted 1		
		Conducted 2		
		Conducted 3		
		Conducted 4		
		Conducted 5		
		Conducted 6		
	No.2, Keji 1st Rd., Guishan District, Taoyuan City, Taiwan 333	Conduction C	TW0028	
		SAC C		
		SAC D		
		SAC G		
		Conducted A		
		Conducted B		
		Conducted C		
		Conducted D		
		Conducted E		
		Conducted F		
		Conducted G		

Note: Test site name is remarked on the equipment list in each section of this report as an indication where measurements occurred in specific test site and address.

1.6 Special Accessories

There are no special accessories used while test was conducted.

1.7 Equipment Modifications

There was no modification incorporated into the EUT.

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2 SYSTEM TEST CONFIGURATION

2.1 EUT Configuration

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner which intends to maximize its emission characteristics in a continuous normal application.

2.2 EUT Exercise

An engineering test mode (software/firmware) that applicant provided was utilized to manipulate the EUT into transmit, selection of the test channel, and modulation scheme.

2.3 Test Procedure

2.3.1 Conducted Emissions

The EUT is a placed on a table which is 0.8 m above ground plane. Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz. The CISPR Quasi-Peak and Average detector mode is employed. The two LISNs provide 50uH/50 ohm of coupling impedance for the measuring instrument. Both lines of the power mains connected to the EUT were checked for maximum conducted interference.

2.3.2 Conducted Test (RF)

The active antenna port of the unlicensed wireless device is connected to the spectrum analyzer with attenuator to protect the instrumentation. If a second antenna port is available, it is tested at one operating frequency, with other port(s) appropriately terminated, to verify it has similar output characteristics as the fully tested port.

2.3.3 Radiated Emissions

The EUT is a placed on a turn table. For emissions testing at or below 1 GHz, the table height shall be 0.8 m above the reference ground plane. For emission measurements above 1 GHz, the table height shall be 1.5 m. The turn table shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the max. emission, the relative positions of this transmitter (EUT) was rotated through three orthogonal axes and measurement procedures for electric field radiated emissions above 1 GHz the EUT measurement is to be made “while keeping the antenna in the ‘cone of radiation’ from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response.” is still within the 3dB illumination BW of the measurement antenna.

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2.4 Measurement Results Explanation Example

2.4.1 Radiated Emission Test Sites For Measurements From 9 kHz To 30 MHz

Radiated emission below 30MHz is measured in a 9m*6m*6m semi-anechoic chamber, the measurements correspond to those obtained at an open-field test site.
There is a comparison data of both open-field test site and semi-Anechoic chamber, and the result came out very similar.

2.4.2 For all conducted test items:

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuation factor between EUT conducted port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly EUT RF output level.

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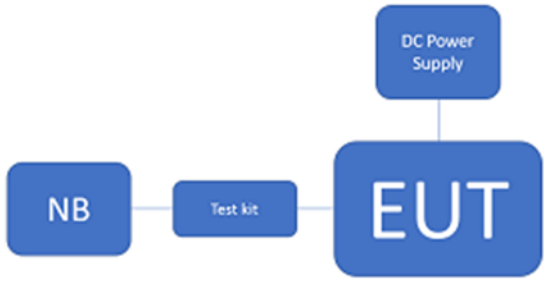
2.5 Test Configuration

Conducted Setup	Radiated Setup
	

2.6 Control Unit(s)

Conducted Emission Test Site: Conducted 1					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Notebook	Lenovo	T470	PF-0WAG50 17/11	N/A	N/A
Test Kit	MICROCHIP	WLR089	N/A	N/A	N/A

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3 SUMMARY OF TEST RESULTS

FCC Rules	Description Of Test	Result
§15.207(a)	AC Power Line Conducted Emission	Not Required
§15.247(a)(1)(i)	Emission Bandwidth	Compliant
§15.247(a)(1)(i)	Number of Hopping Frequency	Compliant
§15.247(a)(1)	Frequency Separation	Compliant
§15.247(b)(2)	Peak Output Power	Compliant
§15.247(a)(1)(i)	Time of Occupancy	Compliant
§15.205 §15.209 §15.247(d)	Conducted & Radiated Band Edge and Spurious Emission	Compliant
§15.203	Antenna Requirement	Compliant

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4 DESCRIPTION OF TEST MODES

4.1 Operating Frequencies

902~928 MHz													
CH	Freq. (MHz)	CH	Freq. (MHz)	CH	Freq. (MHz)	CH	Freq. (MHz)	CH	Freq. (MHz)	CH	Freq. (MHz)	CH	Freq. (MHz)
0	902.3	20	906.3	40	910.3	60	914.3	80	918.3	100	922.3	120	926.3
1	902.5	21	906.5	41	910.5	61	914.5	81	918.5	101	922.5	121	926.5
2	902.7	22	906.7	42	910.7	62	914.7	82	918.7	102	922.7	122	926.7
3	902.9	23	906.9	43	910.9	63	914.9	83	918.9	103	922.9	123	926.9
4	903.1	24	907.1	44	911.1	64	915.1	84	919.1	104	923.1	124	927.1
5	903.3	25	907.3	45	911.3	65	915.3	85	919.3	105	923.3	125	927.3
6	903.5	26	907.5	46	911.5	66	915.5	86	919.5	106	923.5	126	927.5
7	903.7	27	907.7	47	911.7	67	915.7	87	919.7	107	923.7		
8	903.9	28	907.9	48	911.9	68	915.9	88	919.9	108	923.9		
9	904.1	29	908.1	49	912.1	69	916.1	89	920.1	109	924.1		
10	904.3	30	908.3	50	912.3	70	916.3	90	920.3	110	924.3		
11	904.5	31	908.5	51	912.5	71	916.5	91	920.5	111	924.5		
12	904.7	32	908.7	52	912.7	72	916.7	92	920.7	112	924.7		
13	904.9	33	908.9	53	912.9	73	916.9	93	920.9	113	924.9		
14	905.1	34	909.1	54	913.1	74	917.1	94	921.1	114	925.1		
15	905.3	35	909.3	55	913.3	75	917.3	95	921.3	115	925.3		
16	905.5	36	909.5	56	913.5	76	917.5	96	921.5	116	925.5		
17	905.7	37	909.7	57	913.7	77	917.7	97	921.7	117	925.7		
18	905.9	38	909.9	58	913.9	78	917.9	98	921.9	118	925.9		
19	906.1	39	910.1	59	914.1	79	918.1	99	922.1	119	926.1		

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4.2 The Worst Test Modes and Channel Details

1 The EUT has been tested under operating condition.
2 Test program used to control the EUT for staying in continuous transmitting and receiving mode is programmed.
3 Investigation has been done on all the possible configurations for searching the worst case.

ANTNNA PORT CONDUCTED TEST			
MODE	AVAILABLE FREQUENCY	TESTED FREQUENCY	MODULATION
Peak Output Power			
125KHz	CH0 ~ CH126	CH0, CH63, CH126	FSK
20dB Band Width, Spurious Emission			
125KHz	CH0 ~ CH126	CH0, CH63, CH126	FSK
Band Edge			
125KHz	CH0 ~ CH126	CH0, CH126	FSK
Frequency Separation			
125KHz	CH0 ~ CH126	CH0, CH1, CH2	FSK
Number of Hopping Frequency			
125KHz	CH0 ~ CH126	CH0 ~ CH126	FSK
Time of Occupancy(Dwell time, Channel disagrees)			
125KHz	CH0 ~ CH126	CH63	FSK

TRANSMIT RADIATED EMISSION TEST (BELOW 1 GHz)			
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION
125KHz	0 to 126	0,63,126	FSK
TRANSMIT RADIATED EMISSION TEST (ABOVE 1 GHz)			
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION
125KHz	0 to 126	0,63,126	FSK

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5 MEASUREMENT UNCERTAINTY

Test Items	Uncertainty		
AC Power Line Conducted Emission	+/-	1.54	dB
Output Power measurement	+/-	0.97	dB
Emission Bandwidth	+/-	1.38	Hz
Conducted emission measurement	+/-	0.77	dB
Frequency Separation	+/-	1.48	Hz
Number of hopping frequency	+/-	1.48	Hz
Time of Occupancy	+/-	1.48	Hz
Temperature	+/-	0.6	°C
Humidity	+/-	3	%
DC / AC Power Source	+/-	1	%

Radiated Spurious Emission Measurement Uncertainty				
Polarization: Vertical	**+/-**	**1.89**	**dB**	9kHz~30MHz
	+/-	**4.15**	**dB**	30MHz - 1000MHz
	+/-	**3.43**	**dB**	1GHz - 18GHz
	+/-	**3.86**	**dB**	18GHz - 40GHz
Polarization: Horizontal	**+/-**	**1.89**	**dB**	9kHz~30MHz
	+/-	**4.02**	**dB**	30MHz - 1000MHz
	+/-	**3.43**	**dB**	1GHz - 18GHz
	+/-	**3.86**	**dB**	18GHz - 40GHz
Radiated Spurious Emission	**+/-**	**2**	**dB**	33GHz-50GHz
	+/-	**1.59**	**dB**	50GHz-60GHz
	+/-	**1.7**	**dB**	60GHz-90GHz
	+/-	**1.64**	**dB**	90GHz-140GHz
	+/-	**3.83**	**dB**	140GHz-220GHz

Note:

1. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.
2. The conformity assessment statement in this report is based solely on the test results, measurement uncertainty is excluded.

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6 MEASUREMENT EQUIPMENT USED

6.1 Conducted Measurement

Conducted Emission Test Site: Conducted 1					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
EXA Spectrum Analyzer	KEYSIGHT	N9010B	MY59071571	06/07/2023	06/06/2024
Test Software	SGS	Radio Test Software	Ver. 21	N.C.R	N.C.R
Power Meter	Anritsu	ML2496A	1242004	10/24/2023	10/23/2024
Power Sensor	Anritsu	MA2411B	1207365	10/24/2023	10/23/2024
Power Sensor	Anritsu	MA2411B	1207368	10/24/2023	10/23/2024
DC Power Supply	HILA	DP-3003N	11233K0716024	03/17/2023	03/16/2024
Attenuator	Mini-Circuits	BW-S10W2+	2	12/13/2022	12/12/2023
Attenuator	Mini-Circuits	BW-S10W2+	2	12/12/2023	12/11/2024
DC Block	Mini-Circuits	BLK-18-S+	1	12/13/2022	12/12/2023
DC Block	Mini-Circuits	BLK-18-S+	1	12/12/2023	12/11/2024

6.2 Radiated Measurement

Radiated Emission Test Site: SAC 1					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Loop Antenna	ETS.LINDGREN	6502	148045	10/13/2023	10/12/2024
Horn Antenna	SCHWARZBECK	BBHA9120D	D803	12/30/2022	12/29/2023
Horn Antenna	SCHWARZBECK	BBHA9120D	D803	01/12/2024	01/11/2025
Bi-log Antenna	TESEO	CBL 6112D	35242 & AT-N0555	12/27/2022	12/26/2023
Bi-log Antenna	TESEO	CBL 6112D	35242 & AT-N0555	12/18/2023	12/17/2024
EXA Spectrum Analyzer	KEYSIGHT	N9010B	MY60242081	10/17/2023	10/16/2024
Test Software	Audix	e3	Ver. 9.210616	N.C.R	N.C.R
Site Cal	SGS	SAC 1	N/A	08/31/2023	08/30/2024
Pre-Amplifier	HP	8447D	2944A09469	08/31/2023	08/30/2024
Pre-Amplifier	EMCI	EMC118A45SEE	980933	07/31/2023	07/30/2024
Bandreject Filter 800-1000	Micro-Tronics	EWT	M1	12/13/2022	12/12/2023
Band Reject Filter 800-1000	Titan	T04N800100050S01	23040703-6	12/12/2023	12/11/2024
1.3G-15GHz High Pass Filter	WI	WHKX10-1066-80SS	20	12/13/2022	12/12/2023
1.3G High Pass Filter	Woken	WHKX10-1066	20	12/12/2023	12/11/2024
Coaxial Cable	EMCI	EMC104-SM-SM-8000+EMC106-SM-SM-7600	RX Cable 9K-18G(160125+150817)	09/12/2023	09/11/2024

NOTE: *N.C.R refers to Not Calibrated Required.*

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7 CONDUCTED EMISSION TEST

7.1 Standard Applicable

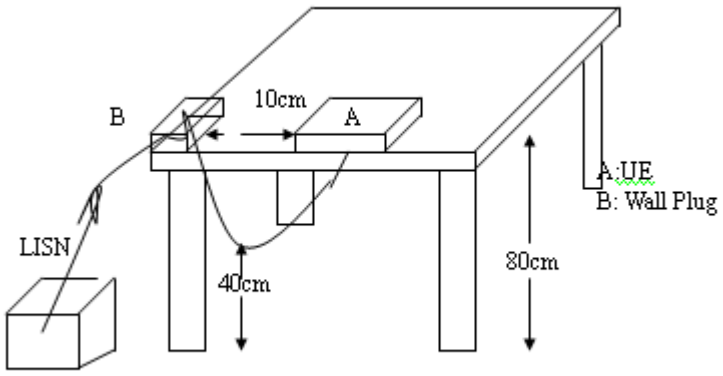
Frequency within 150 kHz to 30MHz shall not exceed the limit table as below.

Frequency range MHz	Limits (dBuV)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56	56 to 46
0.50 to 5	56	46
5 to 30	60	50
Note 1.The lower limit shall apply at the transition frequencies 2.The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz.		

7.2 EUT Setup:

1. The conducted emission tests were performed in the test site, using the setup in accordance with the ANSI C63.10:2013.
2. The AC/DC Power adaptor of EUT was plug-in LISN. The EUT was placed flushed with the rear of the table.
3. The LISN was connected with 120Vac/60Hz power source.

7.3 Test Set-up:



7.4 Measurement Procedure

1. The EUT was placed on a table which is 0.8m above ground plane.
2. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
3. Repeat above procedures until all frequency measured were complete.

7.5 Measurement Result

N/A; Powered from Lithium battery.

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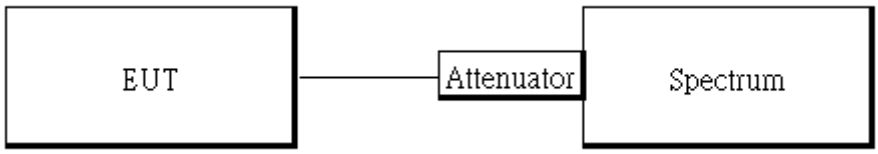
8 EMISSION BANDWIDTH

8.1 Standard Applicable

For frequency hopping systems operating in the 902 MHz-928 MHz no limit for 20dB bandwidth.

8.2 Test Setup



8.3 Measurement Procedure:

1. Place the EUT on the table and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
3. Set the spectrum analyzer as
   RBW=1% to 5% OBW,
   VBW = 3 x RBW,
   Span= large enough to capture all products of the modulation process,
   Sweep=auto,
   Detector = Peak, and Max hold for 20dB Bandwidth test.
4. Mark the peak frequency and –20dB (upper and lower) frequency and Turn on the 99% bandwidth function, max reading.
5. Repeat above procedures until all test default channel is completed.

8.4 20dB Bandwidth

CH	20 dB BW (MHz)	2/3 BW (MHz)
Low	0.1383	0.09
Mid	0.1372	0.09
High	0.1384	0.09

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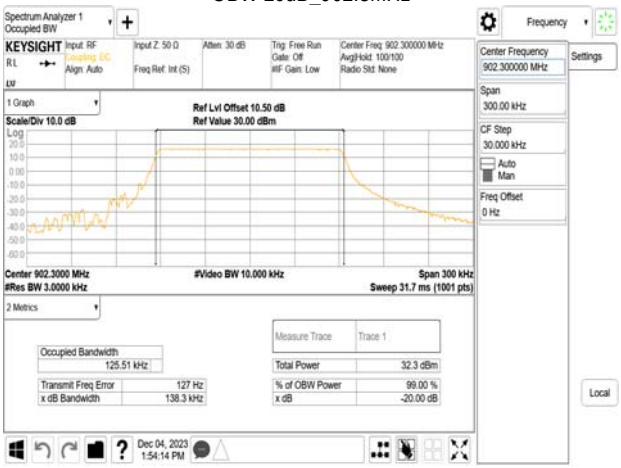
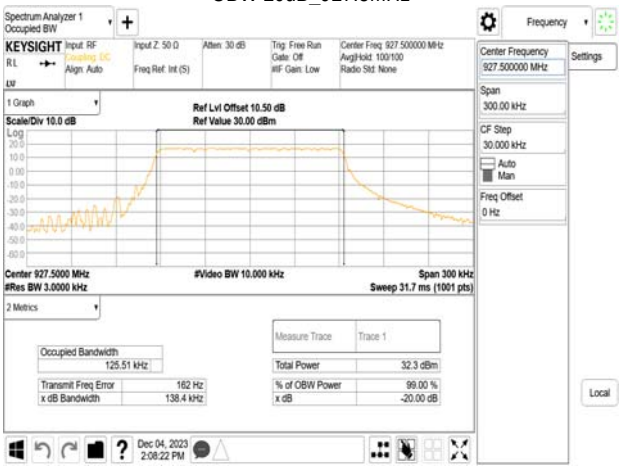
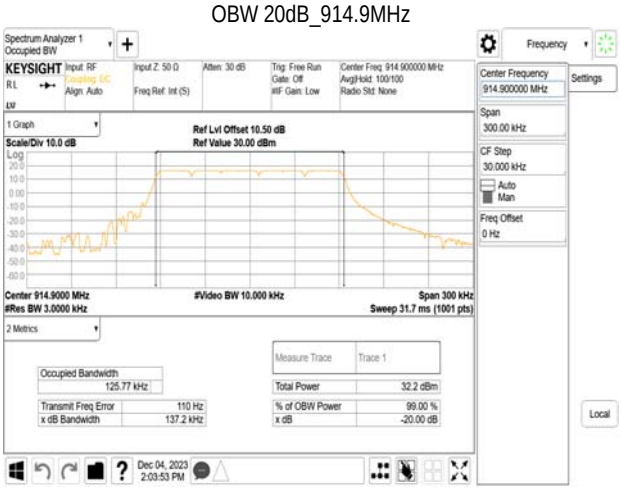
OBW 20dB_902.3MHz



OBW 20dB_927.5MHz



OBW 20dB_914.9MHz



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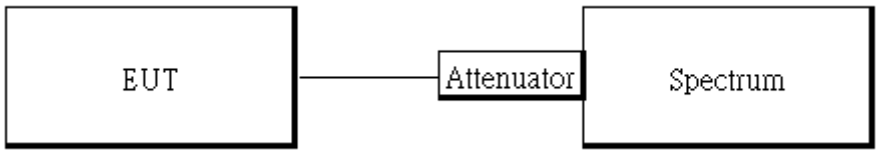
9 NUMBER OF HOPPING FREQUENCY

9.1 Standard Applicable

Frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies.
if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies.
The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

9.2 Test Setup



9.3 Measurement Procedure:

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows ANSI C63.10:2013.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
4. Set spectrum analyzer Start= 902MHz, Stop = 930MHz, Sweep = auto.
5. Set the spectrum analyzer as RBW< 30% Freq. spacing or the 20 dB bandwidth, whichever is smaller, VBW ≥ RBW, Detector = Peak
6. Max hold, view and count how many channel in the band.

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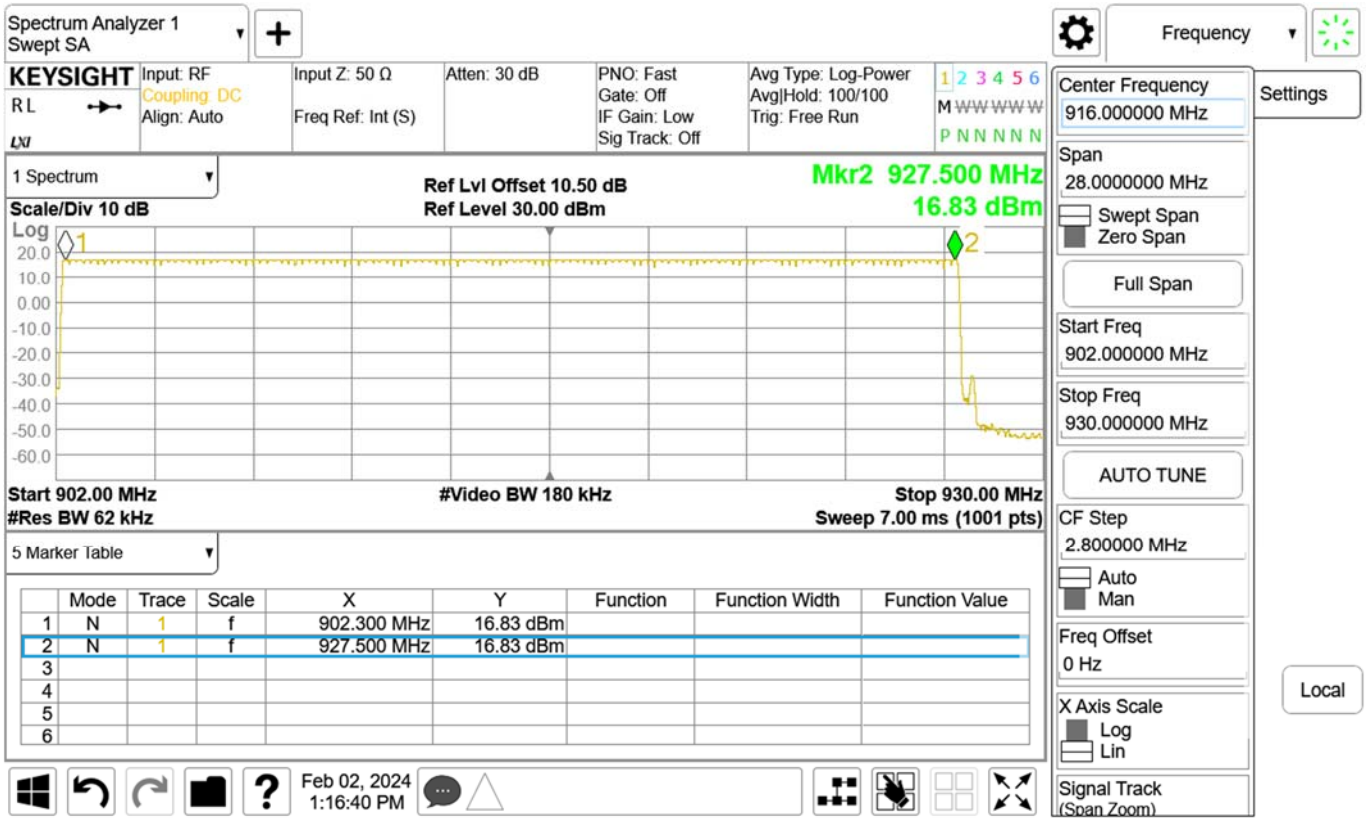
9.4 Measurement Result:

Frequency		Measured Quantity of Hopping Channel
Start (MHz)	Stop (MHz)	
902	930	127



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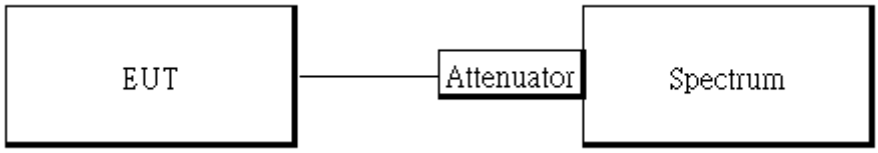
10 FREQUENCY SEPARATION

10.1 Standard Applicable

Frequency hopping systems shall have hopping channel carrier frequencies separated by minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

10.2 Test Setup



10.3 Measurement Procedure

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows ANSI C63.10:2013.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
4. Set center frequency of spectrum analyzer = middle of hopping channel.
5. Set the RBW approximately 30% of the channel spacing, VBW ≥ RBW.
6. Adjust Span to Wide enough to capture the peaks of two adjacent channels.
7. Sweep = auto.
8. Max hold. Mark 3 Peaks of hopping channel and record the 3 peaks frequency.

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10.4 Measurement Result

Channel	Channel Frequency (MHz)	Measured Channel Separation (KHz)	Limit	Result
0	902.3	200	≧ 25KHz or 20dB bandwidth	Pass
1	902.5	200		Pass
2	902.7	200		Pass

CH0CH1CH2

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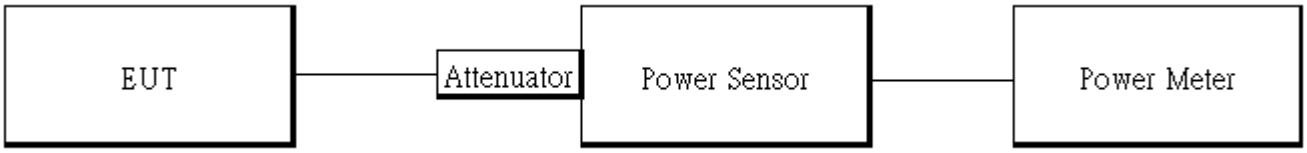
11 PEAK OUTPUT POWER MEASUREMENT

11.1 Standard Applicable

For frequency hopping systems operating in the 902-928 MHz band employing at least 50 hopping channels, conducted output power shall not exceed 1Watt.
For systems employing less than 50 hopping channels, conducted output power shall not exceed 0.25Watt.

11.2 Test Setup



11.3 Measurement Procedure:

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows ANSI C63.10.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the power meter or spectrum. (Max Hold, Detector = Peak, RBW >=20dB bandwidth)
4. Record the max. reading.
5. Repeat above procedures until all default test channel is completed.

11.4 Measurement Result

125kHz(Peak):

CH	Freq. (MHz)	Power set	Peak Output Power (dBm)	Output Power (mW)	Limit (mW)
Low	902.3	19	16.06	40.365	1000
Mid	914.9	19	16.02	39.994	1000
High	927.5	19	**16.16**	41.305	1000

125kHz(Average):

CH	Freq. (MHz)	Power set	Avg. Power (dBm)	Duty Factor (dB)	Average Power +Factor (dBm)	Output Power (mW)	Limit (mW)
Low	902.3	19	15.92	0.10	16.02	39.963	1000
Mid	914.9	19	15.88	0.10	15.98	39.597	1000
High	927.5	19	15.98	0.10	16.08	40.519	1000

**Note: Max. Output include tune up tolerance Power measured by using average detector.*

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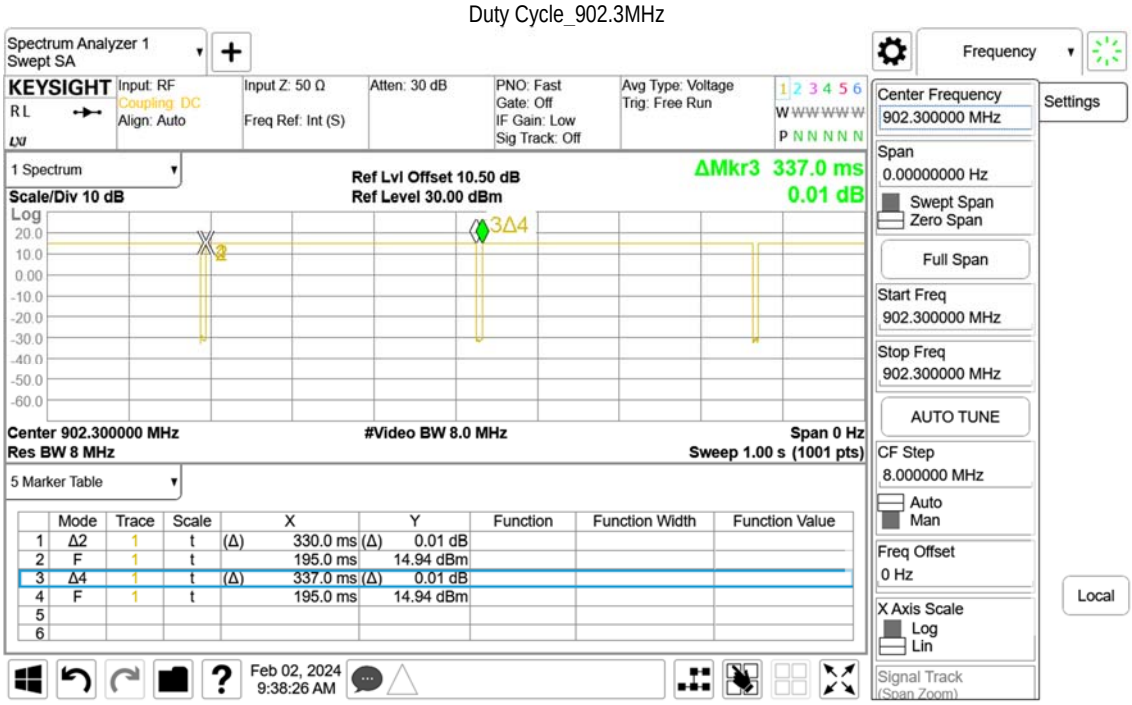
Duty Cycle (%) = Ton / (Ton+Toff)	Duty Factor (dB) =10*log (1/Duty Cycle)	1/T (kHz)	VBW setting (kHz)
97.80	0.10	0.00	1.00

Duty Cycle_902.3MHz



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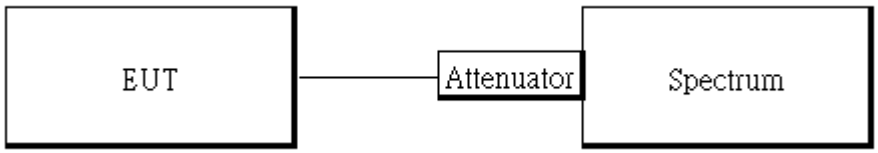
12 TIME OF OCCUPANCY (DWELL TIME)

12.1 Standard Applicable

Frequency hopping systems operating in the 902MHz-928MHz. The average time of occupancy on any frequency shall not greater than 0.4 s within a period of 20 seconds.

12.2 Test Setup



12.3 Measurement Procedure:

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows ANSI C63.10:2013.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
4. Set center frequency of spectrum analyzer = operating frequency.
5. Set the spectrum analyzer as RBW, VBW=100kHz, 300kHz, Span = 0Hz, Detector = Peak, Adjust Sweep = 50ms.
6. Repeat above procedures until all frequency of the interest measured were complete.

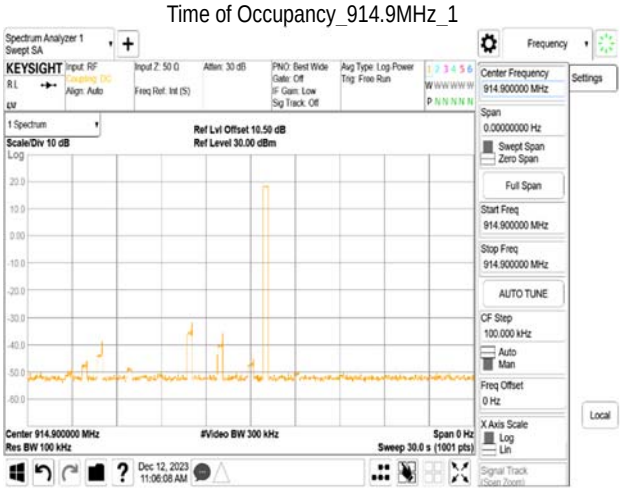
12.4 Tabular Result of the Measurement:

LoRa_125kHz

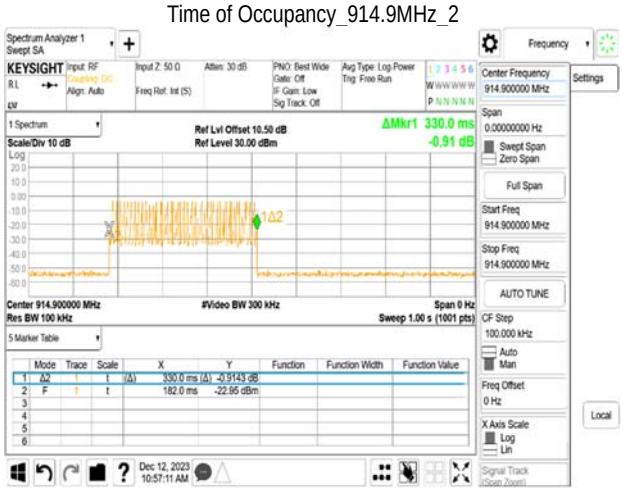
Channel	Measurement Result (ms)	Limit (ms)
Mid	330.00	400

12.5 Measurement Result:

Time of Occupancy_914.9MHz_1



Time of Occupancy_914.9MHz_2



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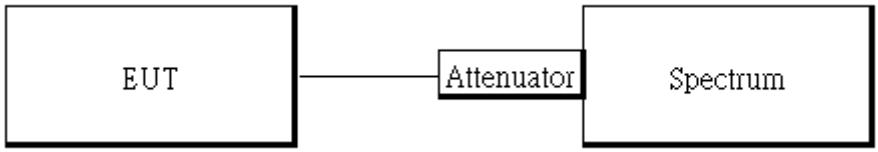
13 CONDUCTED BAND EDGES AND SPURIOUS EMISSION MEASUREMENT

13.1 Standard Applicable

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. 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).

13.2 Test Setup



13.3 Measurement Procedure

Conducted Band Edge:

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows ANSI C63.10:2013.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
4. Set center frequency of spectrum analyzer = operating frequency.
5. Set the spectrum analyzer as RBW=100 kHz, VBW=300 kHz, Sweep = auto
6. Mark Peak and record the max. level.
7. Repeat above procedures until all frequency measured were complete.

Conducted Spurious Emission:

1. To connect Antenna Port of EUT to Spectrum.
2. The testing follows ANSI C63.10:2013.
3. Set RBW = 100 kHz & VBW = 300 kHz, Detector =Peak, Sweep = Auto
4. Allow trace to fully stabilize.
5. Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.
6. Repeat above procedures until all default test channel measured were complete.

NOTE: cable loss as 10.5 dB that offsets in the spectrum

13.4 Measurement Result

See next page for test plots.

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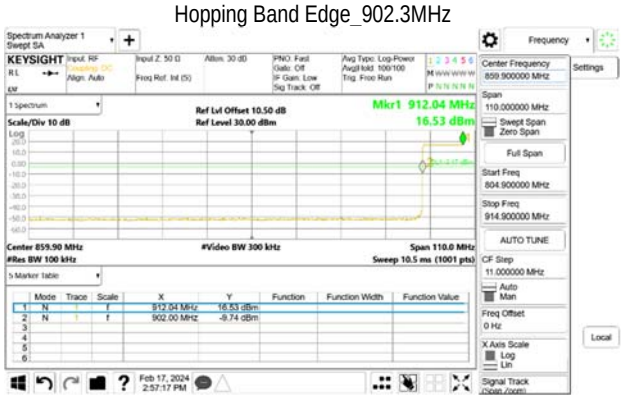
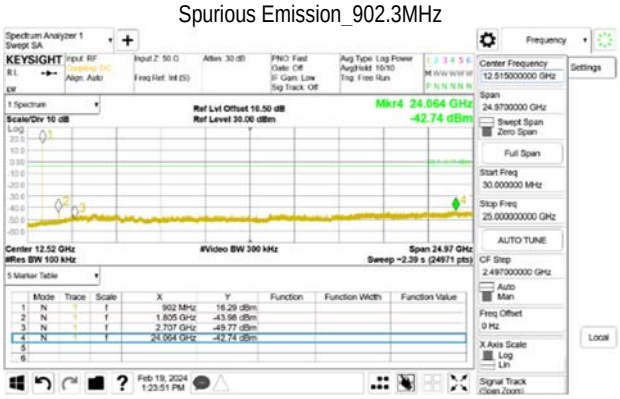
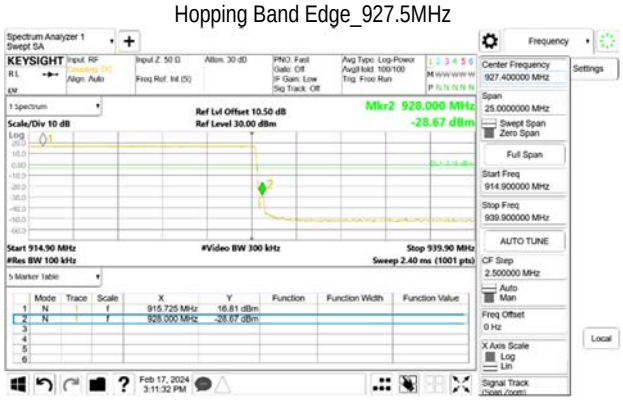
Hopping Band Edge_902.3MHz



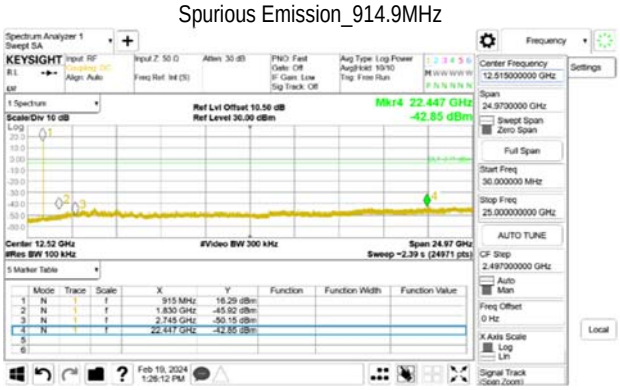
Spurious Emission_902.3MHz



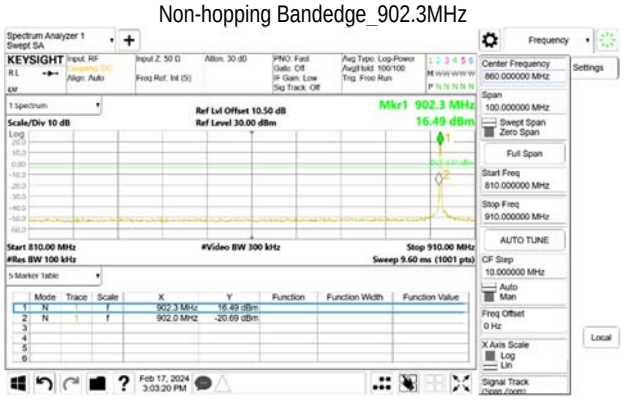
Hopping Band Edge_927.5MHz



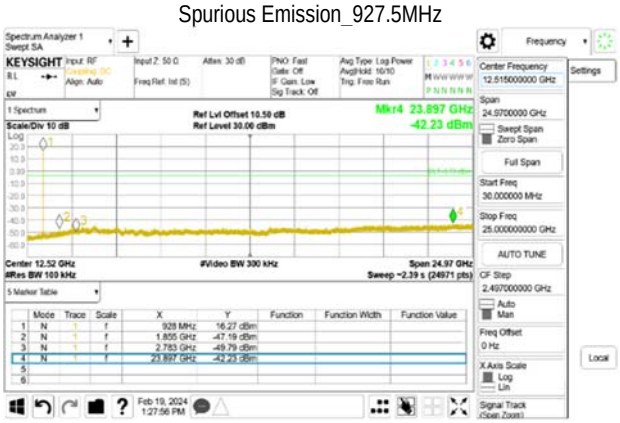
Spurious Emission_914.9MHz



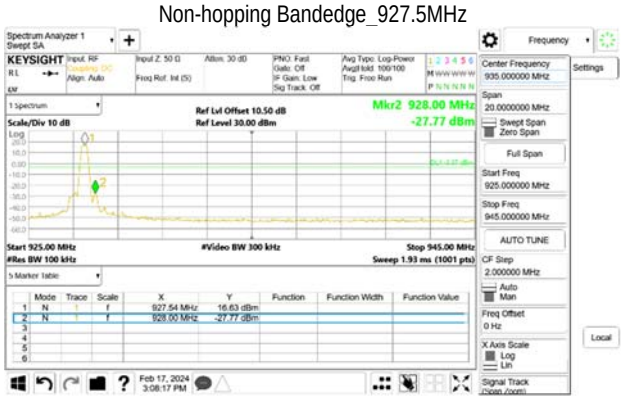
Non-hopping Bandedge_902.3MHz



Spurious Emission_927.5MHz



Non-hopping Bandedge_927.5MHz



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14 RADIATED EMISSION MEASUREMENT

14.1 Standard Applicable

14.1.1 Duty Cycle Correction Factor

According to 15. 35(c), 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. As an alternative (provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 second interval during which the field strength is at its maximum value. The exact method of calculating the average field strength shall be submitted with any application for certification.

14.1.2 Spurious Emission

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. In addition, radiated emissions which fall in the restricted bands must also comply with the §15.209 and limit as below.
And according to §15.33(a) (1), for an intentional radiator operates below 10GHz, the frequency range of measurements: to the tenth harmonic of the highest fundamental frequency or to 40GHz, whichever is lower.

Frequency (MHz)	Field strength (microvolts/meter)	Distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Note:

1. *The lower limit shall apply at the transition frequencies.*

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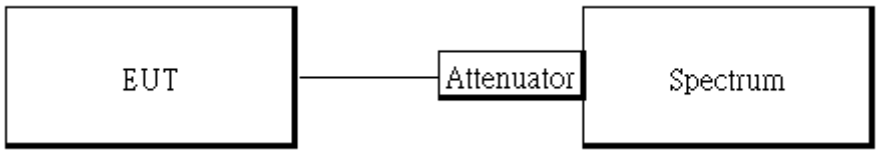
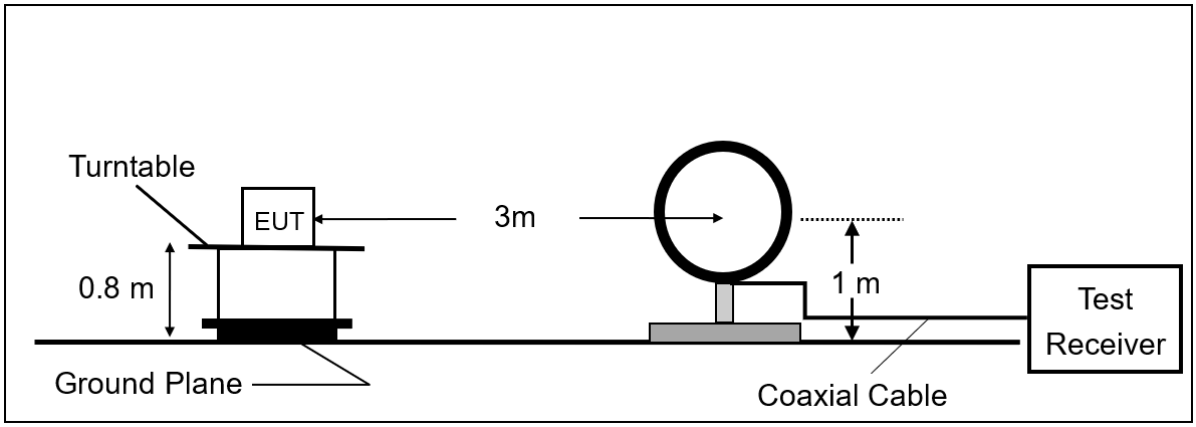
14.2 Test Setup

14.2.1 Duty Cycle Correction Factor

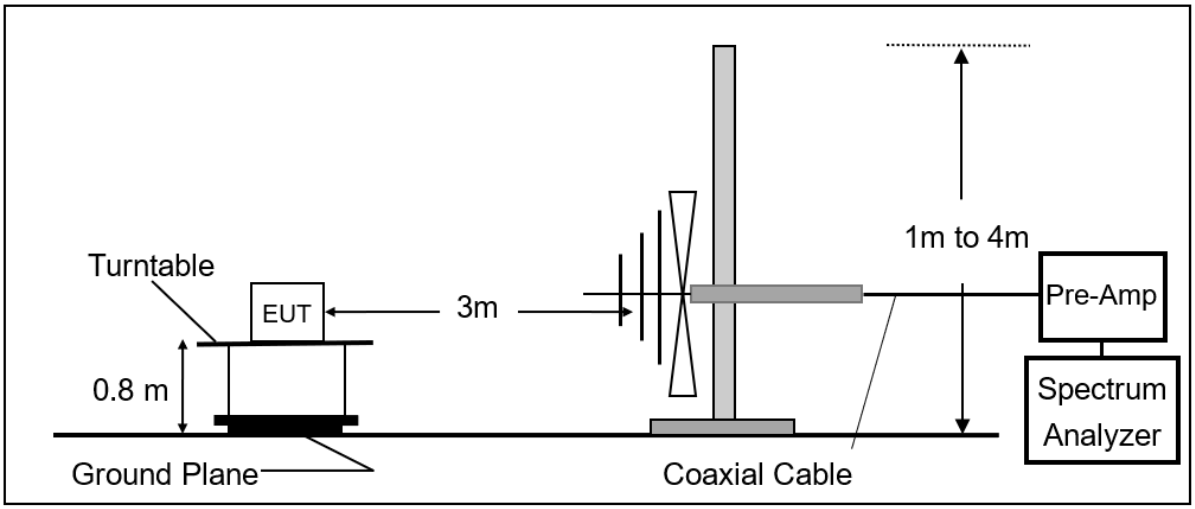


14.2.2 Radiated Emission

(A) Radiated Emission Test Set-Up, Frequency Below 30MHz.



(B) Radiated Emission Test Set-Up, Frequency From 30MHz to 1000MHz.



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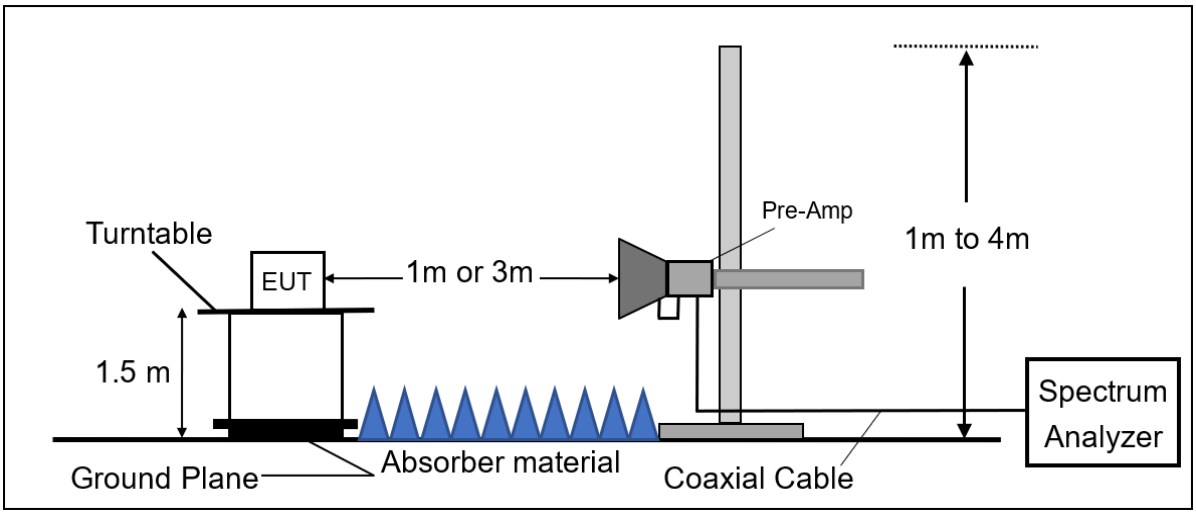
(C) Radiated Emission Test Set-Up, Frequency Above 1 GHz.



14.3 Measurement Procedure

14.3.1 Duty Cycle Correction Factor

7. Adjust and configure any EUT switches, controls, or input data streams to ensure that the EUT is transmitting or encoded to obtain the "worst-case" pulse ON time.
8. The testing follows ANSI C63.10:2013.
9. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
10. Set center frequency of spectrum analyzer = operating frequency.
11. Set the spectrum analyzer as RBW, VBW=100KHz, 300KHz, Span = 0Hz , Detector = Peak,

    Adjust Sweep=100ms.
12. Repeat above procedures until all frequency of the interest measured were complete.

14.3.2 Radiated Emission

1. The testing follows the Measurement Procedure of ANSI C63.10:2013.
2. The EUT was placed on a turn table with 0.8m for frequency< 1GHz and 1.5m for frequency> 1GHz above ground plane.
3. The turn table shall rotate 360 degrees to determine the position of maximum emission level.
4. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emissions.
5. Set the spectrum analyzer as RBW=100 kHz and VBW=300 kHz for Peak Detector (PK) at frequency between 30MHz and 1 GHz.
6. Use receiver mode as RBW=120 kHz for Quasi-peak (QP) at frequency between

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30MHz and 1 GHz.

7. Set the spectrum analyzer as RBW=1 MHz, VBW=3 MHz for Maximum Emission Measurements at frequency above 1 GHz.
8. According to C63.10:2013 Section 7.5 Procedure for determining the average value of pulsed emissions with duty cycle correction factor 20 log (T_{on}/100ms).
9. When measurement procedures for electric field radiated emissions above 1 GHz the EUT measurement is to be made "while keeping the antenna in the 'cone of radiation' from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response." is still within the 3dB illumination BW of the measurement antenna.
10. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
11. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
12. Repeat above procedures until all default test channel measured were complete.

14.4 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain and Duty Cycle Correction Factor (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CL - AG$$

Where *FS = Field Strength*
RA = Reading Amplitude
AF = Antenna Factor
CL = Cable Attenuation Factor (Cable Loss)
AG = Amplifier Gain

*The limit of the emission level is expressed in dBuV/m, which converts 20*log(uV/m)*

Actual FS(dBμV/m) = SPA. Reading level(dBμV) + Factor(dB)

Factor(dB) = Antenna Factor(dBμV/m) + Cable Loss(dB) – Pre_Amplifier Gain(dB)

Average value(dBμV/m)=Peak Actual FS(dBμV/m)+ Duty Cycle Correction Factor(dB)

Duty Cycle Correction Factor(dB) = 20 log (T_{on}/100 ms)

14.5 Test Results of Radiated Spurious Emissions form 9 kHz to 30 MHz

The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit per 15.31(o) was not reported.

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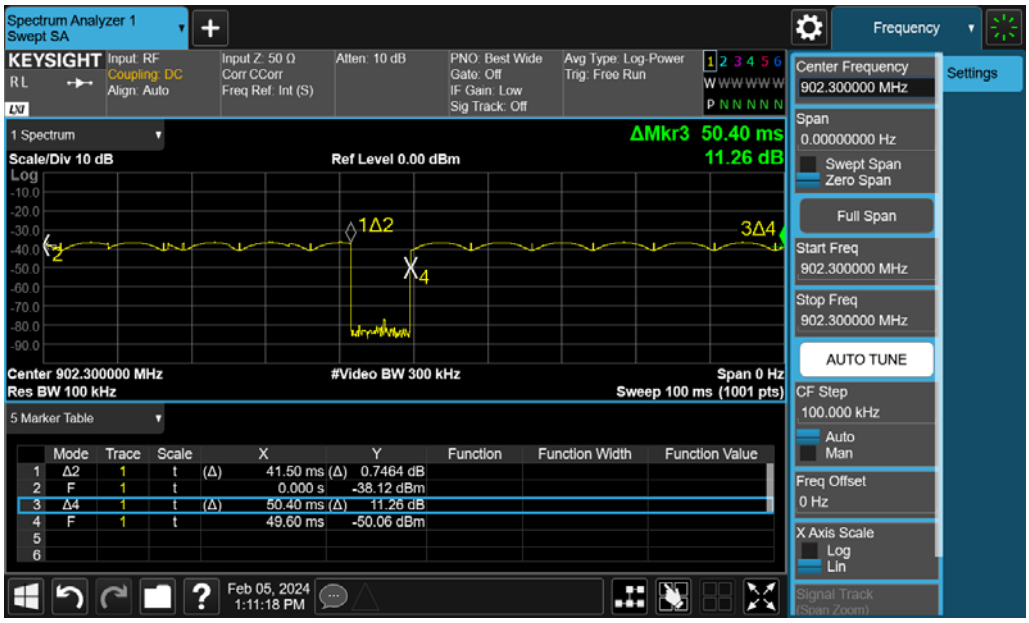
14.6 Measurement Result:

14.6.1 Duty Cycle Correction Factor

FSK

Time ON of 100ms: 91.900 ms
Duty Cycle=91.9ms / 100ms= 0.919
Duty Cycle correction factor=20 LOG 0.919 = -0.73 dB

14.6.2 Duty Cycle test plot



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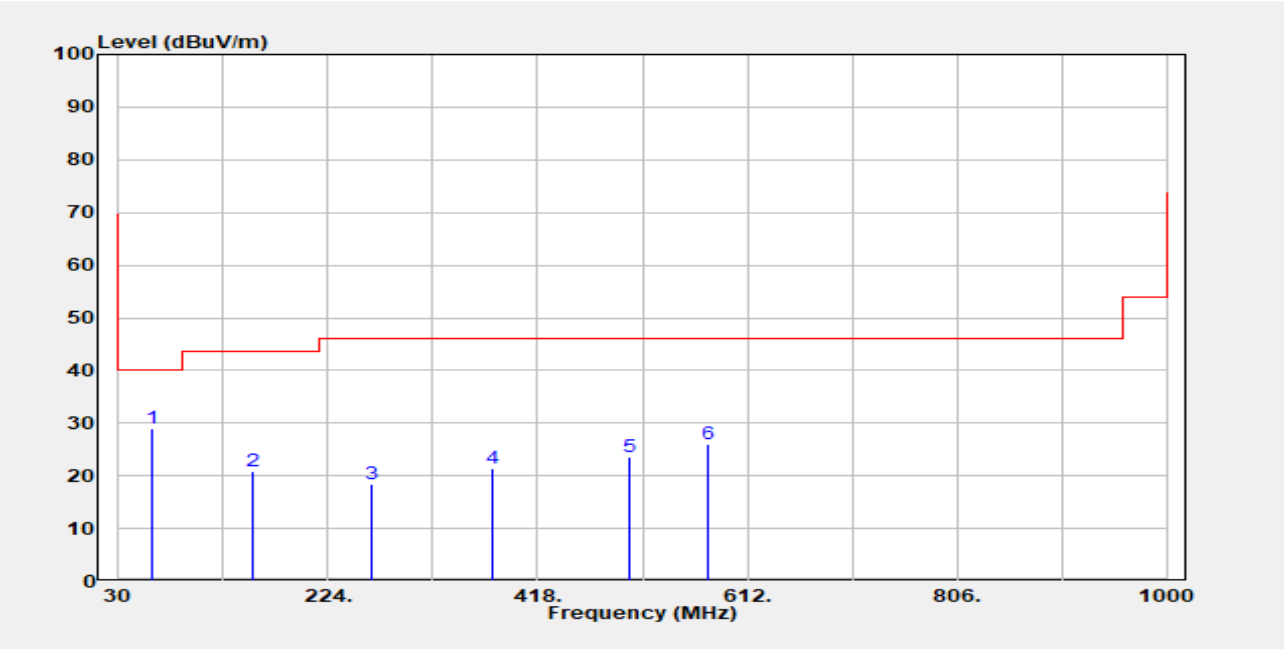
14.6.3 Radiated Spurious Emission

Report Number	:TERF2305001189ER	Test Site	:SAC 1
Operation Mode	:FSK	Test Date	:2023-11-21
Test Frequency	:902.3 MHz	Temp./Humi.	:25℃/54%
Test Mode	:Tx	Antenna Pol.	:Vertical
EUT Pol	:H Plane	Engineer	:Cooper Hsu



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
61.07	Peak	47.42	-18.40	29.02	40.00	-10.98
154.28	Peak	34.36	-13.38	20.98	43.50	-22.52
264.98	Peak	27.48	-8.97	18.51	46.00	-27.49
376.64	Peak	29.37	-7.87	21.49	46.00	-24.51
502.86	Peak	29.07	-5.53	23.54	46.00	-22.46
575.69	Peak	30.12	-3.98	26.14	46.00	-19.86

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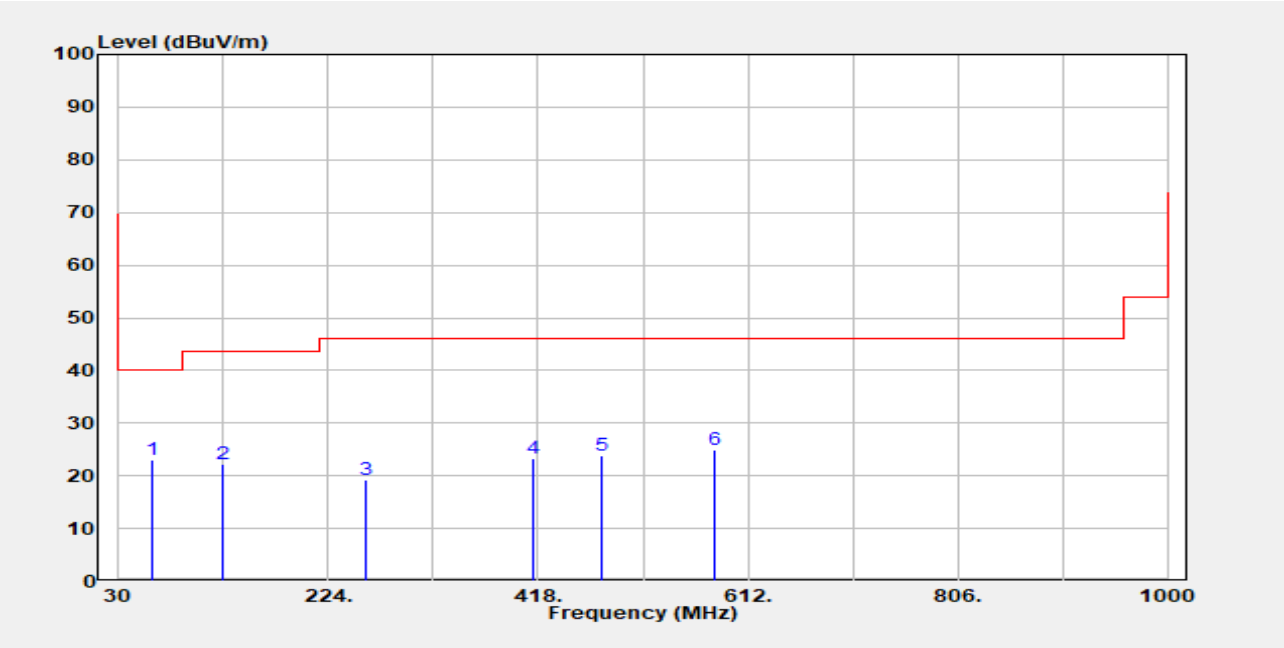
Report Number	:TERF2305001189ER	Test Site	:SAC 1
Operation Mode	:FSK	Test Date	:2023-11-21
Test Frequency	:902.3 MHz	Temp./Humi.	:25℃/54%
Test Mode	:Tx	Antenna Pol.	:Horizontal
EUT Pol	:H Plane	Engineer	:Cooper Hsu



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
61.07	Peak	41.45	-18.40	23.05	40.00	-16.95
126.13	Peak	34.21	-11.89	22.32	43.50	-21.18
258.18	Peak	28.14	-8.83	19.31	46.00	-26.69
412.56	Peak	29.67	-6.38	23.30	46.00	-22.70
476.65	Peak	29.50	-5.76	23.74	46.00	-22.26
581.51	Peak	28.76	-3.91	24.85	46.00	-21.15

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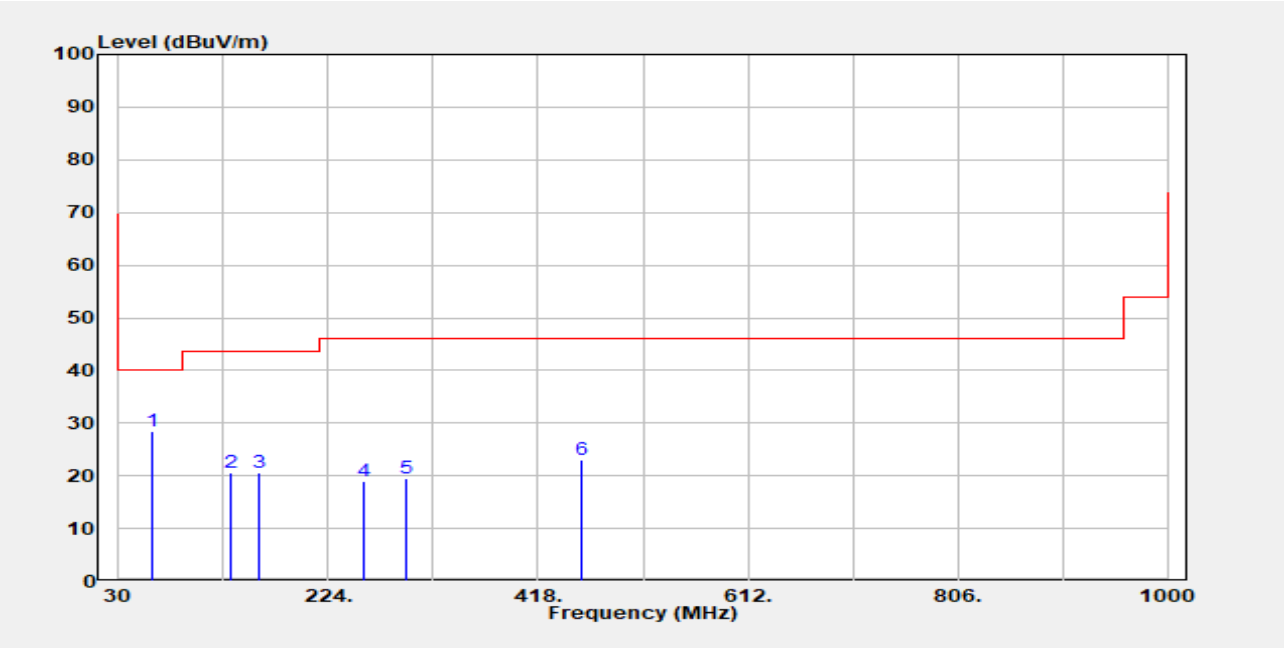
Report Number	:TERF2305001189ER	Test Site	:SAC 1
Operation Mode	:FSK	Test Date	:2023-11-21
Test Frequency	:914.9 MHz	Temp./Humi.	:25℃/54%
Test Mode	:Tx	Antenna Pol.	:Vertical
EUT Pol	:H Plane	Engineer	:Cooper Hsu



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
61.07	Peak	46.97	-18.40	28.57	40.00	-11.43
133.89	Peak	32.66	-12.08	20.58	43.50	-22.92
160.11	Peak	34.03	-13.54	20.50	43.50	-23.00
257.21	Peak	27.96	-8.96	19.00	46.00	-27.00
296.05	Peak	28.81	-9.32	19.48	46.00	-26.52
458.20	Peak	29.18	-6.17	23.01	46.00	-22.99

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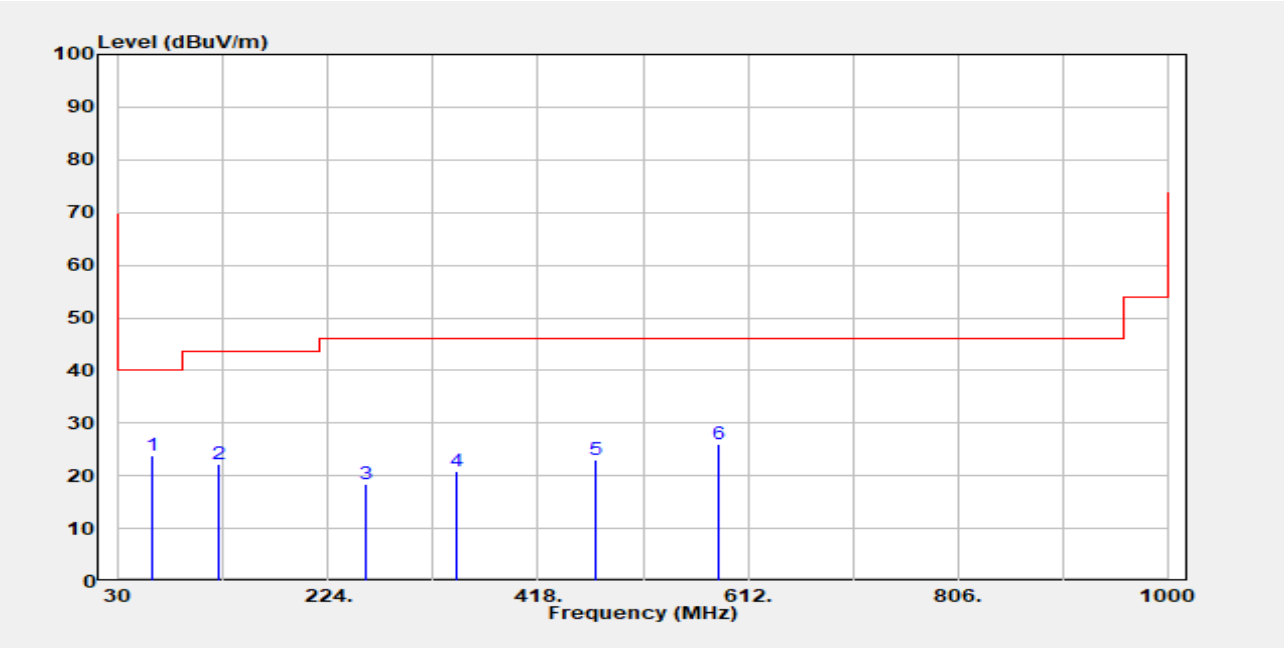
Report Number	:TERF2305001189ER	Test Site	:SAC 1
Operation Mode	:FSK	Test Date	:2023-11-21
Test Frequency	:914.9 MHz	Temp./Humi.	:25℃/54%
Test Mode	:Tx	Antenna Pol.	:Horizontal
EUT Pol	:H Plane	Engineer	:Cooper Hsu



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
61.07	Peak	42.31	-18.40	23.91	40.00	-16.09
123.21	Peak	34.13	-11.88	22.25	43.50	-21.25
259.15	Peak	27.14	-8.70	18.44	46.00	-27.56
341.68	Peak	29.29	-8.44	20.84	46.00	-25.16
471.79	Peak	28.78	-5.82	22.96	46.00	-23.04
584.42	Peak	29.87	-3.92	25.95	46.00	-20.05

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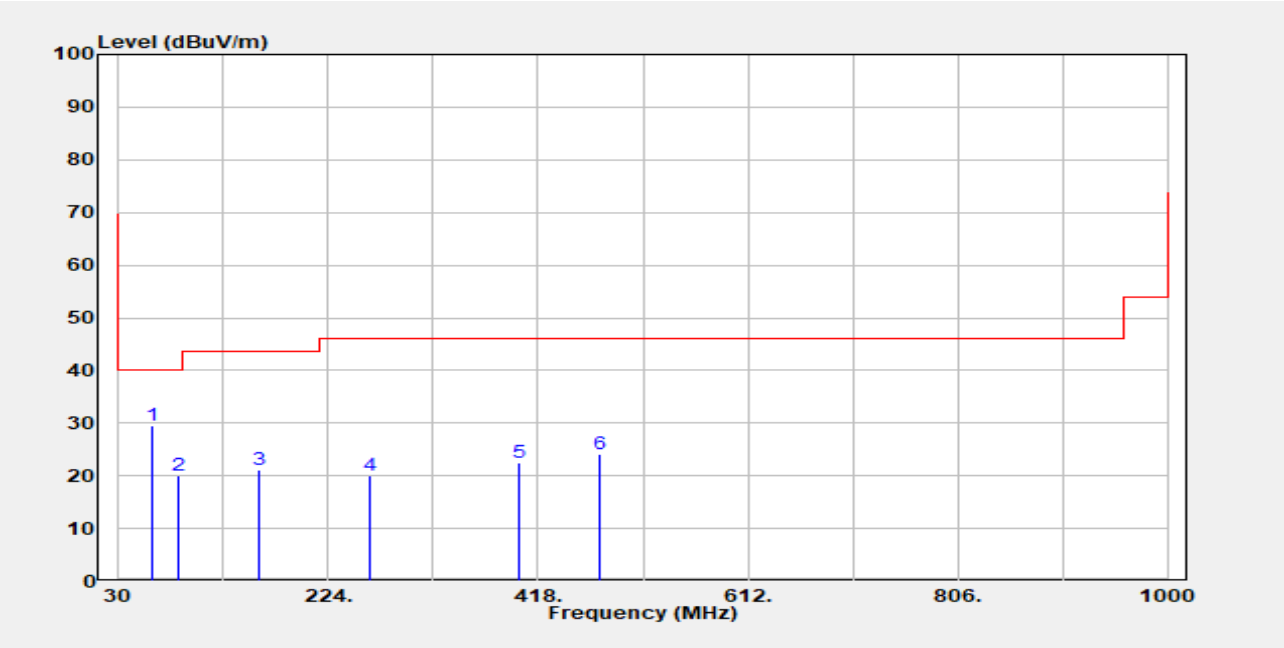
Report Number	:TERF2305001189ER	Test Site	:SAC 1
Operation Mode	:FSK	Test Date	:2023-11-21
Test Frequency	:927.5 MHz	Temp./Humi.	:25℃/54%
Test Mode	:Tx	Antenna Pol.	:Vertical
EUT Pol	:H Plane	Engineer	:Cooper Hsu



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
61.07	Peak	47.89	-18.40	29.49	40.00	-10.51
84.37	Peak	36.38	-16.31	20.08	40.00	-19.92
159.14	Peak	34.50	-13.47	21.03	43.50	-22.47
262.06	Peak	28.76	-8.75	20.01	46.00	-25.99
399.94	Peak	29.46	-6.98	22.48	46.00	-23.52
475.68	Peak	29.99	-5.77	24.22	46.00	-21.78

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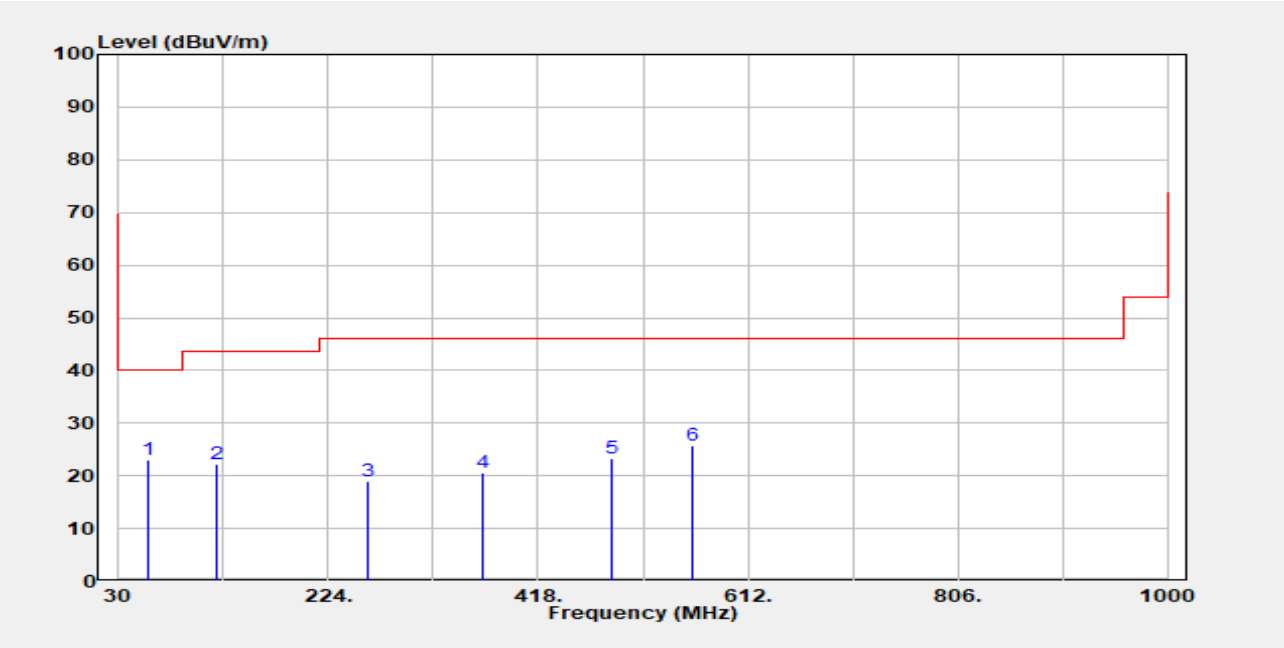
Report Number	:TERF2305001189ER	Test Site	:SAC 1
Operation Mode	:FSK	Test Date	:2023-11-21
Test Frequency	:927.5 MHz	Temp./Humi.	:25℃/54%
Test Mode	:Tx	Antenna Pol.	:Horizontal
EUT Pol	:H Plane	Engineer	:Cooper Hsu



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
57.19	Peak	41.14	-18.22	22.92	40.00	-17.08
120.30	Peak	34.05	-11.91	22.15	43.50	-21.35
261.09	Peak	27.75	-8.67	19.07	46.00	-26.93
366.93	Peak	28.59	-7.88	20.71	46.00	-25.29
486.36	Peak	28.79	-5.54	23.25	46.00	-22.75
561.12	Peak	29.89	-4.16	25.73	46.00	-20.27

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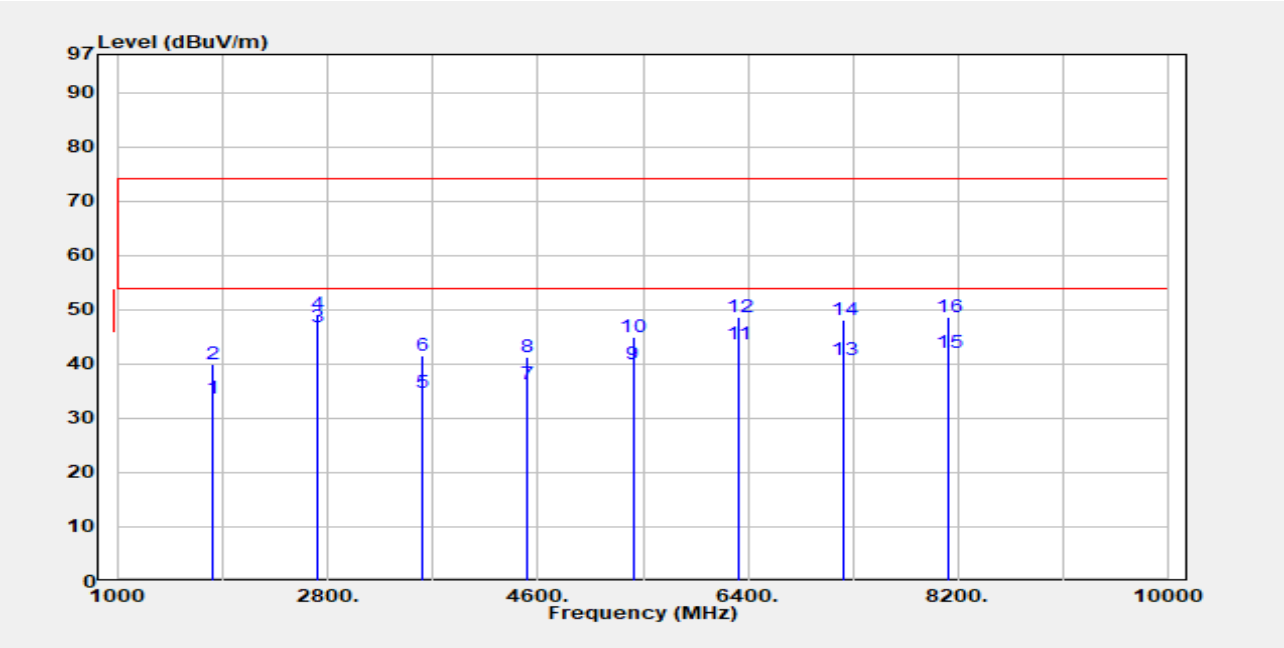
Report Number	:TERF2305001189ER	Test Site	:SAC 1
Operation Mode	:FSK	Test Date	:2023-11-21
Test Frequency	:902.3 MHz	Temp./Humi.	:25℃/54%
Test Mode	:Tx	Antenna Pol.	:Vertical
EUT Pol	:H Plane	Engineer	:Cooper Hsu



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
1804.60	Peak	45.57	-5.68	39.89	74.00	-34.11
2706.90	Peak	51.87	-2.79	49.08	74.00	-24.93
3609.20	Peak	42.40	-0.76	41.64	74.00	-32.36
4511.50	Peak	40.56	0.66	41.22	74.00	-32.78
5413.80	Peak	42.56	2.38	44.94	74.00	-29.06
6316.10	Peak	44.01	4.61	48.62	74.00	-25.38
7218.40	Peak	40.70	7.28	47.98	74.00	-26.02
8120.70	Peak	40.67	7.98	48.65	74.00	-25.35

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Freq. MHz	Detector Mode AV	Peak Actual FS (dBµV/m)	Duty Cycle Factor (dB)	Average Value (dBuV/m)	Average Limit@3m (dBuV/m)	Margin (dB)
1804.600	Average	39.89	-0.73	39.16	54.00	-14.84
2706.900	Average	49.08	-0.73	48.35	54.00	-5.65
3609.200	Average	41.64	-0.73	40.91	54.00	-13.09
4511.500	Average	41.22	-0.73	40.49	54.00	-13.51
5413.800	Average	44.94	-0.73	44.21	54.00	-9.79
6316.100	Average	48.62	-0.73	47.89	54.00	-6.11
7218.400	Average	47.98	-0.73	47.25	54.00	-6.75
8120.700	Average	48.65	-0.73	47.92	54.00	-6.08

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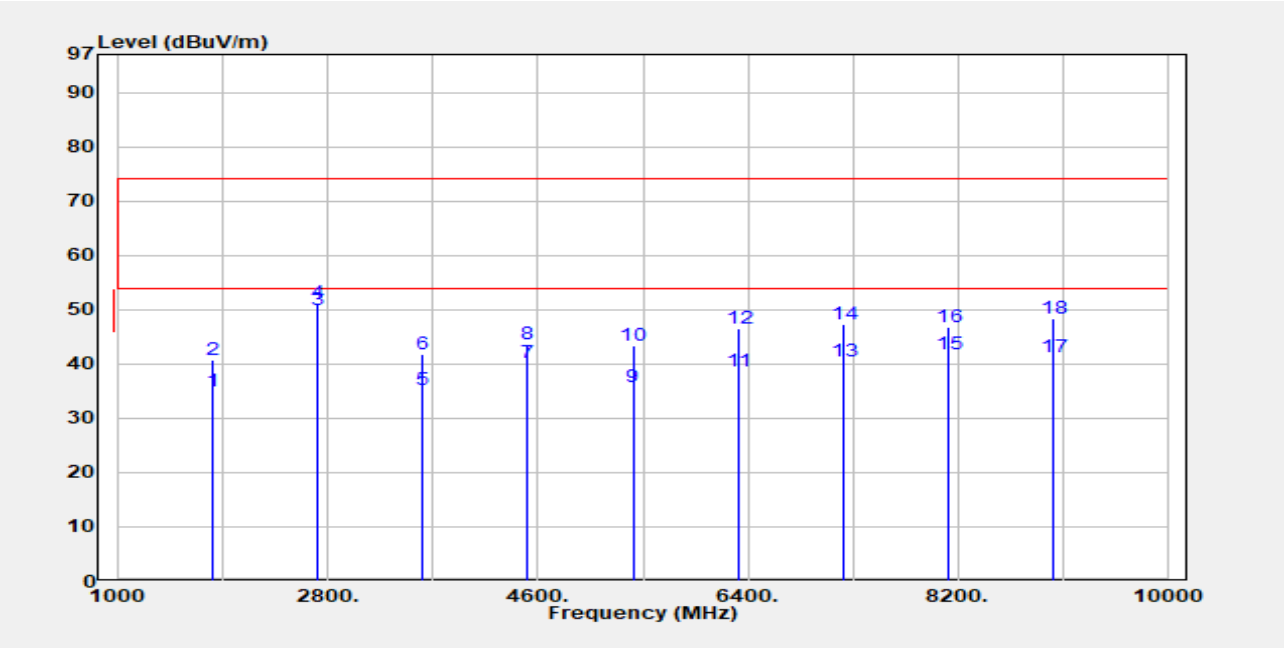
Report Number	:TERF2305001189ER	Test Site	:SAC 1
Operation Mode	:FSK	Test Date	:2023-11-21
Test Frequency	:902.3 MHz	Temp./Humi.	:25℃/54%
Test Mode	:Tx	Antenna Pol.	:Horizontal
EUT Pol	:H Plane	Engineer	:Cooper Hsu



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
1804.60	Peak	46.45	-5.68	40.77	74.00	-33.23
2706.90	Peak	54.12	-2.79	51.33	74.00	-22.68
3609.20	Peak	42.67	-0.76	41.91	74.00	-32.09
4511.50	Peak	43.05	0.66	43.71	74.00	-30.29
5413.80	Peak	41.00	2.38	43.38	74.00	-30.62
6316.10	Peak	41.92	4.61	46.53	74.00	-27.47
7218.40	Peak	40.06	7.28	47.34	74.00	-26.66
8120.70	Peak	38.71	7.98	46.69	74.00	-27.31
9023.00	Peak	41.11	7.29	48.40	74.00	-25.60

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Freq. MHz	Detector Mode AV	Peak Actual FS (dBμV/m)	Duty Cycle Factor (dB)	Average Value (dBuV/m)	Average Limit@3m (dBuV/m)	Margin (dB)
1804.600	Average	40.77	-0.73	40.04	54.00	-13.96
2706.900	Average	51.33	-0.73	50.60	54.00	-3.40
3609.200	Average	41.91	-0.73	41.18	54.00	-12.82
4511.500	Average	43.71	-0.73	42.98	54.00	-11.02
5413.800	Average	43.38	-0.73	42.65	54.00	-11.35
6316.100	Average	46.53	-0.73	45.80	54.00	-8.20
7218.400	Average	47.34	-0.73	46.61	54.00	-7.39
8120.700	Average	46.69	-0.73	45.96	54.00	-8.04
9023.000	Average	48.40	-0.73	47.67	54.00	-6.33

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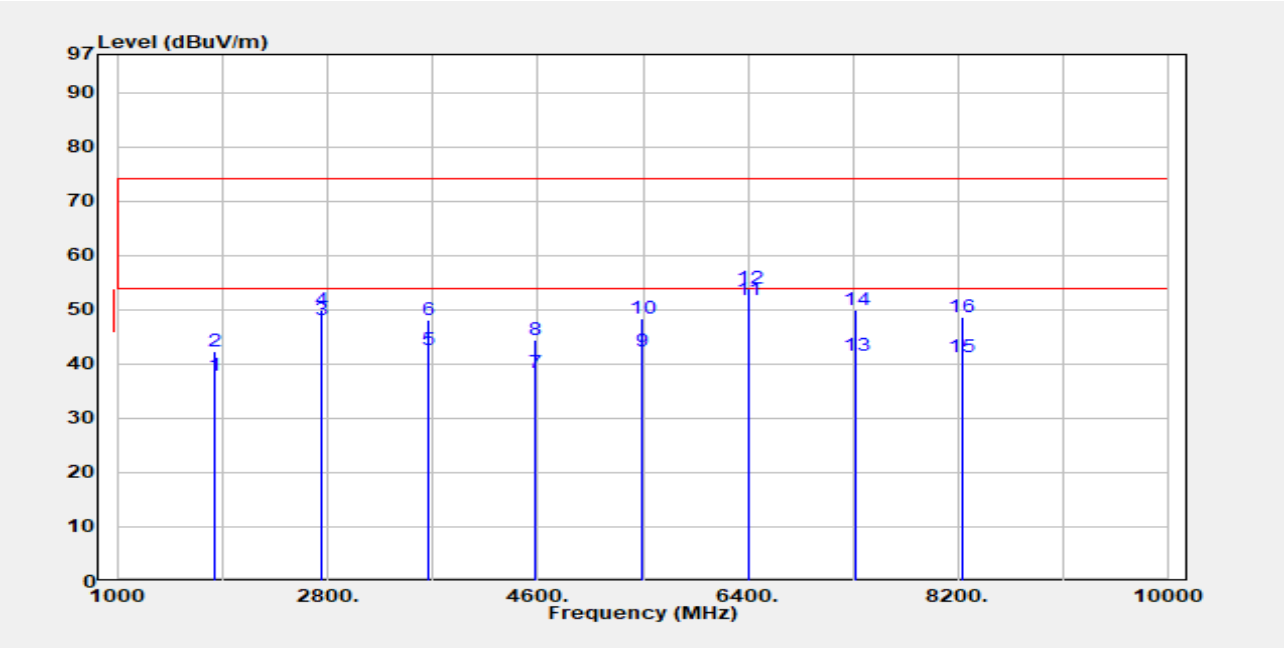
Report Number	:TERF2305001189ER	Test Site	:SAC 1
Operation Mode	:FSK	Test Date	:2023-11-21
Test Frequency	:914.9 MHz	Temp./Humi.	:25℃/54%
Test Mode	:Tx	Antenna Pol.	:Vertical
EUT Pol	:H Plane	Engineer	:Cooper Hsu



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
1829.80	Peak	47.82	-5.57	42.25	74.00	-31.75
2744.70	Peak	52.55	-2.50	50.05	74.00	-23.95
3659.60	Peak	48.37	-0.34	48.03	74.00	-25.97
4574.50	Peak	43.67	0.81	44.48	74.00	-29.52
5489.40	Peak	45.79	2.70	48.49	74.00	-25.51
6404.30	Peak	48.89	5.07	53.96	74.00	-20.04
7319.20	Peak	42.29	7.66	49.95	74.00	-24.05
8234.10	Peak	41.32	7.28	48.60	74.00	-25.40

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Freq. MHz	Detector Mode AV	Peak Actual FS (dBμV/m)	Duty Cycle Factor (dB)	Average Value (dBuV/m)	Average Limit@3m (dBuV/m)	Margin (dB)
1829.800	Average	42.25	-0.73	41.52	54.00	-12.48
2744.700	Average	50.05	-0.73	49.32	54.00	-4.68
3659.600	Average	48.03	-0.73	47.30	54.00	-6.70
4574.500	Average	44.48	-0.73	43.75	54.00	-10.25
5489.400	Average	48.49	-0.73	47.76	54.00	-6.24
6404.300	Average	53.96	-0.73	53.23	54.00	-0.77
7319.200	Average	49.95	-0.73	49.22	54.00	-4.78
8234.100	Average	48.60	-0.73	47.87	54.00	-6.13

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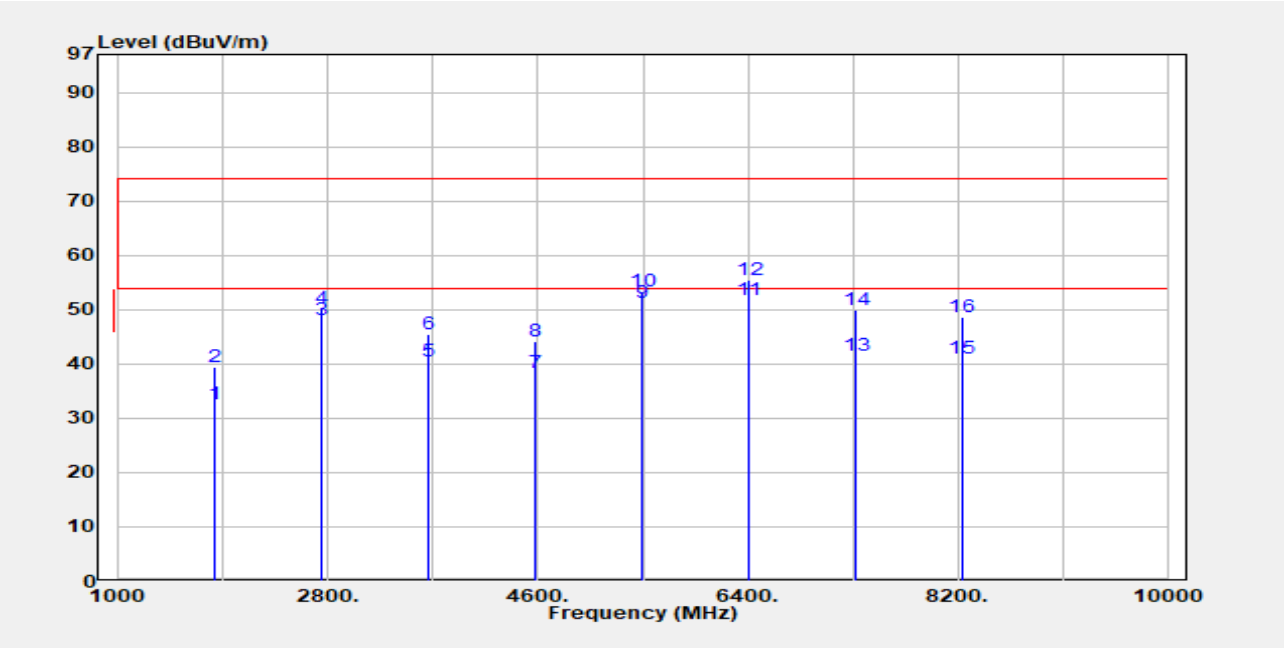
Report Number	:TERF2305001189ER	Test Site	:SAC 1
Operation Mode	:FSK	Test Date	:2023-11-21
Test Frequency	:914.9 MHz	Temp./Humi.	:25℃/54%
Test Mode	:Tx	Antenna Pol.	:Horizontal
EUT Pol	:H Plane	Engineer	:Cooper Hsu



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
1829.80	Peak	44.90	-5.57	39.33	74.00	-34.67
2744.70	Peak	52.70	-2.50	50.20	74.00	-23.80
3659.60	Peak	45.80	-0.34	45.46	74.00	-28.54
4574.50	Peak	43.30	0.81	44.11	74.00	-29.89
5489.40	Peak	50.53	2.70	53.23	74.00	-20.77
6404.30	Peak	49.01	5.07	54.08	74.00	-18.42
7319.20	Peak	42.29	7.66	49.95	74.00	-24.05
8234.10	Peak	41.32	7.28	48.60	74.00	-25.40

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Freq. MHz	Detector Mode AV	Peak Actual FS (dBμV/m)	Duty Cycle Factor (dB)	Average Value (dBuV/m)	Average Limit@3m (dBuV/m)	Margin (dB)
1829.800	Average	39.33	-0.73	38.60	54.00	-15.40
2744.700	Average	50.20	-0.73	49.47	54.00	-4.53
3659.600	Average	45.46	-0.73	44.73	54.00	-9.27
4574.500	Average	44.11	-0.73	43.38	54.00	-10.62
5489.400	Average	53.23	-0.73	52.50	54.00	-1.50
6404.300	Average	54.08	-0.73	53.35	54.00	-0.65
7319.200	Average	49.95	-0.73	49.22	54.00	-4.78
8234.100	Average	48.60	-0.73	47.87	54.00	-6.13

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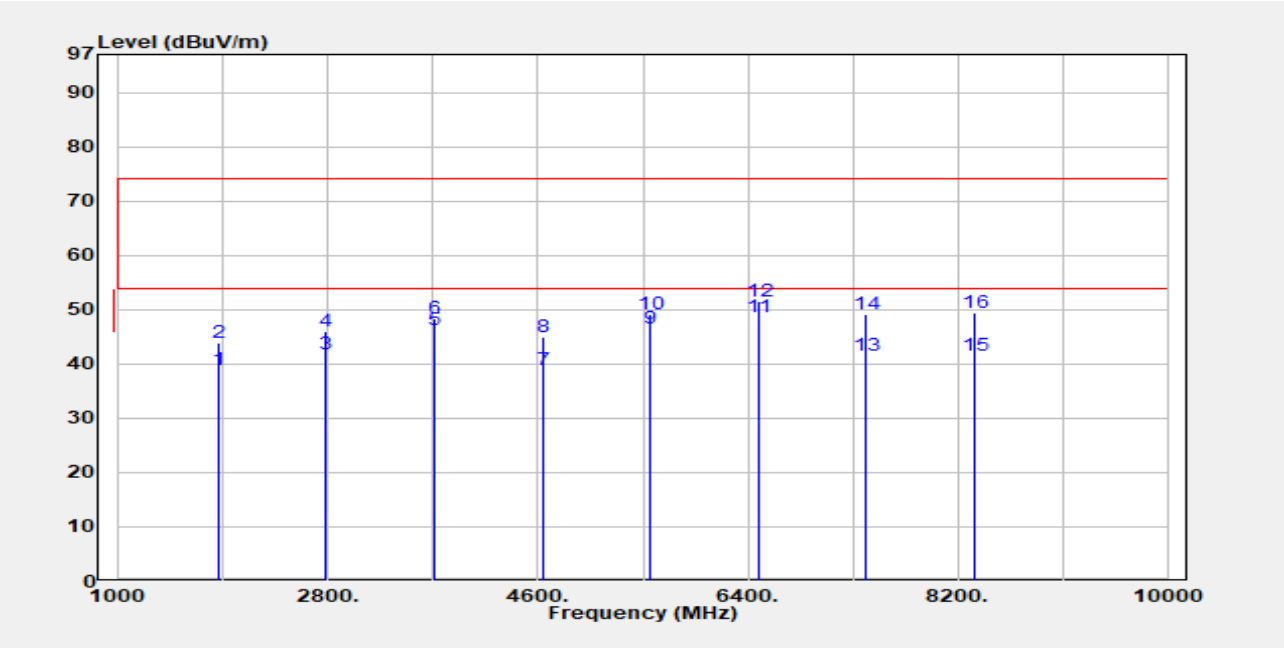
Report Number	:TERF2305001189ER	Test Site	:SAC 1
Operation Mode	:FSK	Test Date	:2023-11-21
Test Frequency	:927.5 MHz	Temp./Humi.	:25℃/54%
Test Mode	:Tx	Antenna Pol.	:Vertical
EUT Pol	:H Plane	Engineer	:Cooper Hsu



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
1855.00	Peak	49.25	-5.46	43.79	74.00	-30.21
2782.50	Peak	48.30	-2.27	46.03	74.00	-27.97
3710.00	Peak	48.91	-0.50	48.41	74.00	-25.59
4637.50	Peak	43.69	1.15	44.84	74.00	-29.16
5565.00	Peak	46.53	2.55	49.08	74.00	-24.92
6492.50	Peak	46.40	5.19	51.59	74.00	-22.41
7420.00	Peak	41.51	7.59	49.10	74.00	-24.90
8347.50	Peak	42.23	7.09	49.32	74.00	-24.68

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Freq. MHz	Detector Mode AV	Peak Actual FS (dBµV/m)	Duty Cycle Factor (dB)	Average Value (dBuV/m)	Average Limit@3m (dBuV/m)	Margin (dB)
1855.000	Average	43.79	-0.73	43.06	54.00	-10.94
2782.500	Average	46.03	-0.73	45.30	54.00	-8.70
3710.000	Average	48.41	-0.73	47.68	54.00	-6.32
4637.500	Average	44.84	-0.73	44.11	54.00	-9.89
5565.000	Average	49.08	-0.73	48.35	54.00	-5.65
6492.500	Average	51.59	-0.73	50.86	54.00	-3.14
7420.000	Average	49.10	-0.73	48.37	54.00	-5.63
8347.500	Average	49.32	-0.73	48.59	54.00	-5.41

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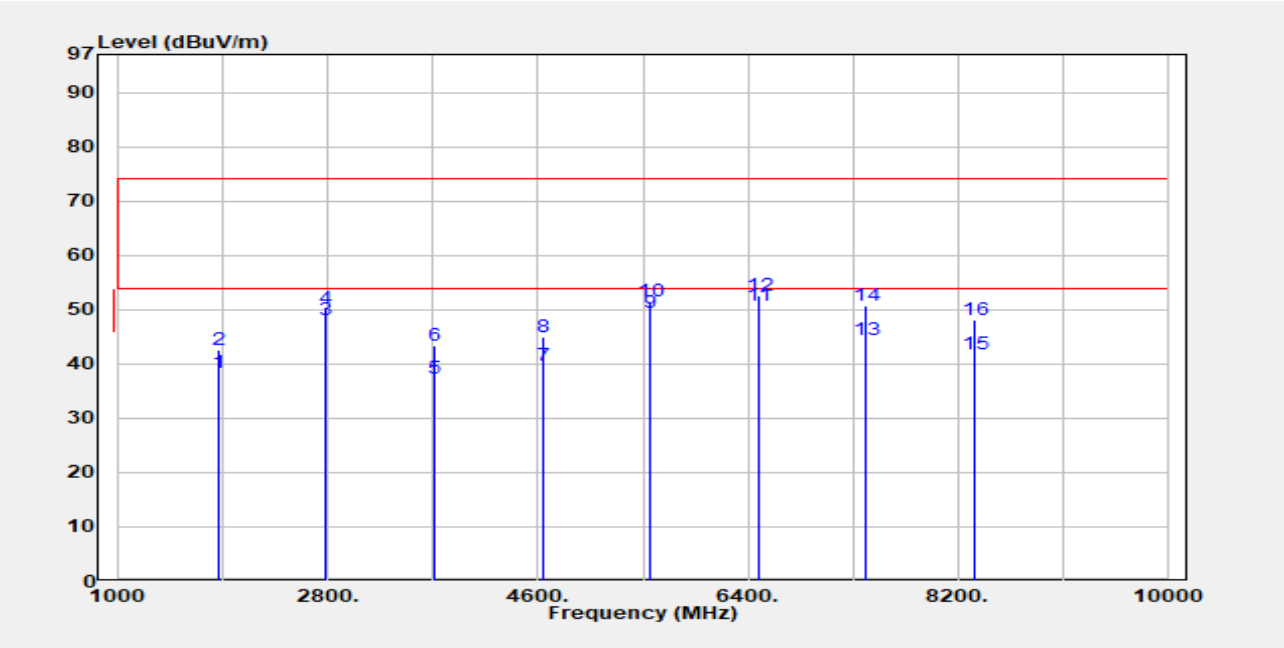
Report Number	:TERF2305001189ER	Test Site	:SAC 1
Operation Mode	:FSK	Test Date	:2023-11-21
Test Frequency	:927.5 MHz	Temp./Humi.	:25℃/54%
Test Mode	:Tx	Antenna Pol.	:Horizontal
EUT Pol	:H Plane	Engineer	:Cooper Hsu



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
1855.00	Peak	48.03	-5.46	42.57	74.00	-31.43
2782.50	Peak	52.40	-2.27	50.13	74.00	-23.87
3710.00	Peak	43.78	-0.50	43.28	74.00	-30.72
4637.50	Peak	43.79	1.15	44.94	74.00	-29.06
5565.00	Peak	48.84	2.55	51.39	74.00	-22.61
6492.50	Peak	47.28	5.19	52.47	74.00	-21.53
7420.00	Peak	43.03	7.59	50.62	74.00	-23.38
8347.50	Peak	40.96	7.09	48.05	74.00	-25.95

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Freq. MHz	Detector Mode AV	Peak Actual FS (dBμV/m)	Duty Cycle Factor (dB)	Average Value (dBuV/m)	Average Limit@3m (dBuV/m)	Margin (dB)
1855.000	Average	42.57	-0.73	41.84	54.00	-12.16
2782.500	Average	50.13	-0.73	49.40	54.00	-4.60
3710.000	Average	43.28	-0.73	42.55	54.00	-11.45
4637.500	Average	44.94	-0.73	44.21	54.00	-9.79
5565.000	Average	51.39	-0.73	50.66	54.00	-3.34
6492.500	Average	52.47	-0.73	51.74	54.00	-2.26
7420.000	Average	50.62	-0.73	49.89	54.00	-4.11
8347.500	Average	48.05	-0.73	47.32	54.00	-6.68

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15 ANTENNA REQUIREMENT

15.1 Standard Applicable

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 carrier current devices or to devices operated under the provisions of §§ 15.211, 15.213, 15.217, 15.219, 15.221, or § 15.236. Further, 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.

15.2 Antenna Connected Construction:

The antenna complies with this requirement and no consideration of replacement. Please see EUT photo for details.

~ End of Report ~

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