

ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT



EUT Description Environmental Sensor

Applicant: Logitech Far East Ltd.
#2 Creation Rd. 4, Science-Based Ind. Park Hsinchu Taiwan,
R.O.C.

Manufacturer: Logitech Europe S.A.
EPFL – Quartier de l'Innovation Daniel Borel Innovation
Center, 1015 Lausanne, Switzerland.

Brand Name: logi, logitech, Logitech

Model No.: VR0041

Report Number: TERF2507002452E2

FCC ID JNZVR0041

Date of EUT Received: N/A, the test results are fully leveraged from test report number
TERF2507002456E2, for more details please refer to section 2
in this report.

Date of Test: N/A, the test results are fully leveraged from test report number
TERF2507002456E2, for more details please refer to section 2
in this report.

Issue Date: October 17, 2025

Approved By

Arno Hsieh

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 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
TERF2507002452E2	00	Original	October 17, 2025	Karen Huang	

Note:

- 1、The remark "" indicates modification of the report upon requests from certification body.
- 2、Variant information of trademarks is provided by the applicant, test results of this report are applicable to the sample EUT(s) received.
And are assessed as electrically identical in RF characteristics, therefore, no further assessment required for the variant(s).

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1 GENERAL INFORMATION

1.1 Product Description

EUT Description	Environmental Sensor
Brand Name:	logi, logitech, Logitech
Model No.:	VR0041
Hardware Version:	PB2
Firmware Version:	1.0.138
EUT Series No.:	2528CGE401C8
Power Supply:	3.6 Vdc
Test Software (Name/Version)	Tera Trem V4.106

1.2 RF Specification

Radio Technology:	LoRa
Frequency Range:	125kHz: 902.3 – 914.9MHz 500kHz: 903 –914.2 MHz
Channel number:	125kHz: 64 channels 500kHz: 8 channels
Modulation type:	CCS
Transmit Power:	125kHz: 18.65 dBm (Average) 500kHz: 18.76 dBm (Average)

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1.3 Antenna Designation

Antenna Type	Freq. (MHz)	Peak Antenna Gain (dBi)
Metal Antenna	902~928	0.57

Note:

1. Pre-scanned was done on the above antennas, measurements were demonstrated by using the antenna with the highest gain as the worst case scenarios.
2. The antenna information is provided by the applicant, and the laboratory shall not be held liable for the accuracy, completeness, or reliability of any applicant-supplied data.
3. The antenna complies with part 15.203 requirement and no consideration of replacement. Please see EUT photo for details.

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1.4 Operating Frequencies

902~928 MHz (125kHz)	
CH	Freq. (MHz)
0	902.3
1	902.5
2	902.7
3	902.9
4	903.1
5	903.3
6	903.5
7	903.7
8	903.9
9	904.1
10	904.3
11	904.5
12	904.7
13	904.9
14	905.1
15	905.3
16	905.5
17	905.7
18	905.9
19	906.1
20	906.3
21	906.5
22	906.7
23	906.9
24	907.1
25	907.3
26	907.5
27	907.7
28	907.9
29	908.1
30	908.3
31	908.5

902~928 MHz (125kHz)	
CH	Freq. (MHz)
32	908.7
33	908.9
34	909.1
35	909.3
36	909.5
37	909.7
38	909.9
39	910.1
40	910.3
41	910.5
42	910.7
43	910.9
44	911.1
45	911.3
46	911.5
47	911.7
48	911.9
49	912.1
50	912.3
51	912.5
52	912.7
53	912.9
54	913.1
55	913.3
56	913.5
57	913.7
58	913.9
59	914.1
60	914.3
61	914.5
62	914.7
63	914.9

902~928 MHz (500kHz)	
CH	Freq. (MHz)
0	903
1	904.6
2	906.2
3	907.8
4	909.4
5	911
6	912.6
7	914.2

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1.5 EUT Availability and The Worst Test Modes

- 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 The field strength of radiated emission was measured as the EUT positioned in different orthogonal planes (E1/E2/H) based on actual usage of the EUT to pre-scan the emissions for determining the worst case scenario.
- 4 The EUT is a hybrid system.
- 5 Investigation has been done on all the possible configurations for searching the worst case.

CONDUCTED TEST				
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	DATA RATE (bit/s)
LoRa SF7 125kHz	0 to 63	0,30,63	CSS	5470
LoRa SF8 125kHz	0 to 63	0,30,63	CSS	3125
LoRa SF9 125kHz	0 to 63	0,30,63	CSS	1760
LoRa SF10 125kHz	0 to 63	0,30,63	CSS	980
LoRa SF8 500kHz	0 to 7	0,3,7	CSS	12500

TRANSMIT RADIATED EMISSION TEST (BELOW 1 GHz)				
MODE	FREQUENCY BAND(MHz)	TESTED FREQUENCY(MHz)	MODULATION	DATA RATE (Mbps)
LoRa SF7 125kHz	0 to 63	0,30,63	CSS	5470
LoRa SF8 125kHz	0 to 63	0,30,63	CSS	3125
LoRa SF9 125kHz	0 to 63	0,30,63	CSS	1760
LoRa SF10 125kHz	0 to 63	0,30,63	CSS	980
LoRa SF8 500kHz	0 to 7	0,3,7	CSS	12500

TRANSMIT RADIATED EMISSION TEST (ABOVE 1 GHz)				
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	DATA RATE (Mbps)
LoRa SF7 125kHz	0 to 63	0,30,63	CSS	5470
LoRa SF8 125kHz	0 to 63	0,30,63	CSS	3125
LoRa SF9 125kHz	0 to 63	0,30,63	CSS	1760
LoRa SF10 125kHz	0 to 63	0,30,63	CSS	980
LoRa SF8 500kHz	0 to 7	0,3,7	CSS	12500

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2 SUMMARY OF TEST RESULTS

FCC Rules	Description Of Test	Result	Note
§15.207(a)	AC Power Line Conducted Emission	Compliant	
§15.215(c)	Emission Bandwidth	Compliant	
§15.247(b)(3)	Maximum Output Power	Compliant	
§15.247(f)	Power spectral density	Compliant	
§15.247(f)	Time of Occupancy	Compliant	
§15.247(a)(1)	Channel Separation	Compliant	
§15.247(f)	Number of Hopping Channels	Compliant	
§15.205 §15.209 §15.247(d)	Unwanted Emission	Compliant	
§15.203	Antenna Requirement	Compliant	

Note

1. N/S Indicates whether item(s) being newly tested [N] or spot checked [S].
2. Items other than newly tested [N] are leveraged from test report TERF2507002456E2.

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2.1 Test Methodology of Applied Standards

FCC Part 15, Subpart C §15.247

FCC KDB 558074 D01 15.247 Meas. Guidance v05r02

ANSI C63.10:2020.

2.2 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
	+/-	4.1 dB	30MHz - 1000MHz
	+/-	3.37 dB	1GHz - 18GHz
	+/-	3.83 dB	18GHz - 40GHz
Polarization: Horizontal	+/-	1.89 dB	9kHz~30MHz
	+/-	4.1 dB	30MHz - 1000MHz
	+/-	3.37 dB	1GHz - 18GHz
	+/-	3.83 dB	18GHz - 40GHz
Radiated Spurious Emission	+/-	2 dB	33GHz-50GHz
	+/-	1.59 dB	50GHz-60GHz
	+/-	1.71 dB	60GHz-90GHz
	+/-	1.64 dB	90GHz-140GHz
	+/-	3.84 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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2.3 Test Facility

Laboratory	Test Site Address	Test Site Name	FCC Designation Number / Registration 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 / 891563	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 / 200037	
		SAC C		
		SAC D		
		SAC G		
		Conducted A		
		Conducted B		
		Conducted C		
		Conducted D		
		Conducted E		
		Conducted F		
		Conducted G		
Note: The test site name is noted on the equipment list to indicate where the measurements were conducted.				

Temperature:	22.3~23.1	°C	Relative Humidity:	52~63	%
Test site	Conducted F		Test Start:	09/26/2025	
Test Engineer:	Willy Jiang		Test Done:	10/13/2025	

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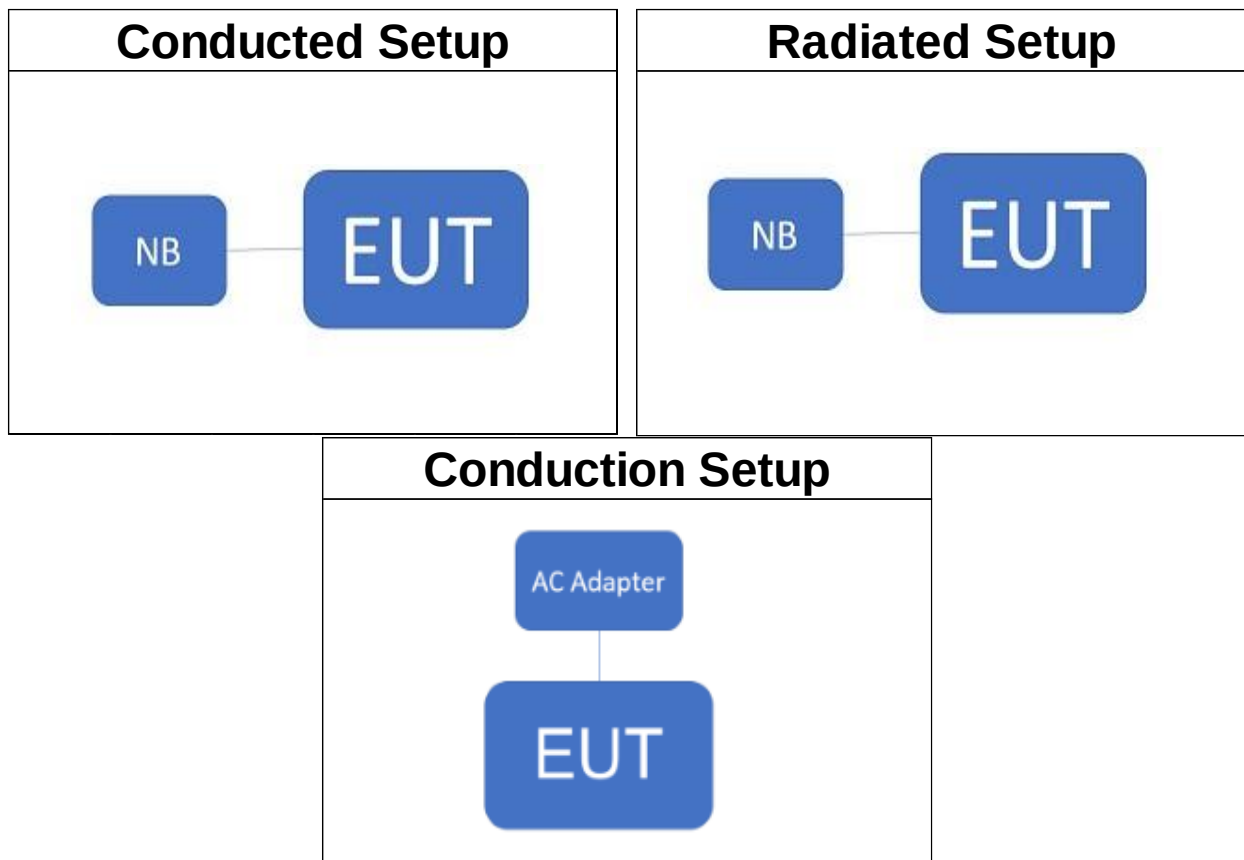
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3 CONTROL UNIT(S) AND PERIPHERAL(S)

3.1 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. 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.

3.2 Diagrams



3.3 List

Conducted Emission Test Site: Conducted F					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL. (mm/dd/yyyy)	CAL DUE. (mm/dd/yyyy)
Notebook	Lenovo	T14	P0003332	N/A	N/A
Type C USB cable	PowerSync	CUBCVARA0010	N/A	N/A	N/A
Radiated Emission Test Site: SAC C					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL. (mm/dd/yyyy)	CAL DUE. (mm/dd/yyyy)
Notebook	Lenovo	T470	P0001293	N/A	N/A
USB Cable	I Max	USB-C1200	N/A	N/A	N/A

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AC Power-Line Conducted Emission Test Site: Conduction C					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL. (mm/dd/yyyy)	CAL DUE. (mm/dd/yyyy)
Adapter	XIAOMI	MDY-09-ED	N/A	N/A	N/A
USB Cable	I Max	USB-C1200	N/A	N/A	N/A

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4 TEST INSTRUMENT

4.1 Conducted Measurement

Conducted Emission Test Site: Conducted F					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL. (mm/dd/yyyy)	CAL DUE. (mm/dd/yyyy)
Attenuator	Marvelous	MVE2213-10	RF04	11/14/2024	11/13/2025
Attenuator	Woken	WATT-218FS-10	RF12	11/14/2024	11/13/2025
DC Block	PASTERNAK	PE8210	RF38	11/14/2024	11/13/2025
Power Meter	Anritsu	ML2496A	2138005	09/22/2025	09/21/2026
Power Sensor	Anritsu	MA2411B	1911395	09/22/2025	09/21/2026
Power Sensor	Anritsu	MA2411B	1911396	09/22/2025	09/21/2026
Spectrum Analyzer	KEYSIGHT	N9010B	MY63440390	02/13/2025	02/12/2026
Test Software	SGS Taiwan	Radio Test Software	Ver.21	N.C.R	N.C.R

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4.2 Radiated Measurement

Radiated Emission Test Site: SAC C					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL. (mm/dd/yyyy)	CAL DUE. (mm/dd/yyyy)
3m Site NSA	SGS	966 chamber C	N/A	03/02/2025	03/01/2026
Active Loop Antenna	COM-POWER	AL-130R	10160105	12/11/2024	12/10/2025
Attenuator	Woken	WATT-218FS-10	RF11	11/14/2024	11/13/2025
Broadband Antenna	SCHWARZBECK	VULB 9168	9168-300	11/06/2024	11/05/2025
Coaxial Cable	EMCI+Huber Suhner	RG 214/U+EMC104- SM-SM- 6000+EMC105-SM- SM-12000+15	W13.01+150813+2 310002+15	11/14/2024	11/13/2025
EMI Test Receiver	R&S	ESU 40	100363	05/06/2025	05/05/2026
Horn Antenna	Schwarzbeck	BBHA9120D	1187	02/05/2025	02/04/2026
Lowpass Filter	Woken	EWT-56-0019	RF163	11/14/2024	11/13/2025
Notch Filter	Titan Microwave	T04N800100050S0 1	RF212	11/14/2024	11/13/2025
Pre-Amplifier	EMC Instruments	EMC118A45SE	980789	11/14/2024	11/13/2025
Pre-Amplifier	EMC Instruments	EMC330	980091	11/14/2024	11/13/2025
Spectrum Analyzer	KEYSIGHT	N9010B	MY63440390	02/13/2025	02/12/2026
Test Software	audix	e3	E3 20923 SGS Ver.9 (C)	N.C.R	N.C.R

4.3 Emission from AC power line

AC Power-Line Conducted Emission Test Site: Conduction C					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL. (mm/dd/yyyy)	CAL DUE. (mm/dd/yyyy)
Coaxial Cable	EC Lab	RF-HY-CAB-250	RF-HY-CAB-250-01	03/27/2025	03/26/2026
EMI Test Receiver	R&S	ESCI	101342	04/23/2025	04/22/2026
LISN	SCHWARZBECK Mess-Elektronik	NSLK8127	974	06/30/2025	06/29/2026
Pulse Limiter	EC Lab	VTSD 9561F-N	485	03/27/2025	03/26/2026
Test Software	audix	e3	E3 20923 SGS Ver.9 (C)	N.C.R	N.C.R

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

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5 REGULATORY REQUIREMENTS

5.1 Emission Bandwidth

Intentional radiators of hybrid system must be designed to ensure their 20 dB emission bandwidth stays within the designated frequency band, as specified in the applicable regulations.

5.2 Channel Separation

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

5.3 Number Of Hopping Channels

This is the factor to determine applicable Maximum Output Power and Time of Occupancy.

5.4 Maximum Output Power

The limit for conducted output power is 1Watt.

5.5 Power Spectral Density

The power spectral density conducted from the intentional radiator to the antenna due to the digital modulation operation of the hybrid system, with the frequency hopping operation turned off, shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

5.6 Time Of Occupancy (Dwell Time)

The frequency hopping operation of the hybrid system, with the direct sequence or digital modulation operation turned-off, shall have an average time of occupancy on any frequency not to exceed 0.4 seconds within a time period in seconds equal to the number of hopping frequencies employed multiplied by 0.4.

5.7 Out Of Band 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. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

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5.8 Unwanted 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. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

In addition, radiated emissions which fall in the restricted bands must also comply with the limit as below.

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: The lower limit shall apply at the transition frequencies.

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5.9 AC Power Line Conducted Emission

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

Frequency range MHz	Limits dB(uV)	
	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.		

5.10 Antenna Requirements

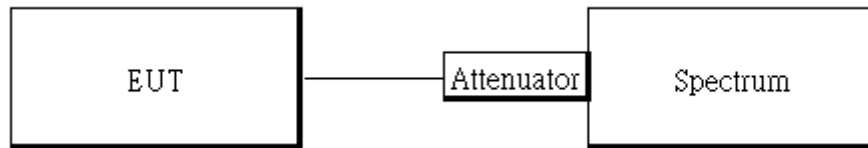
An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply 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.

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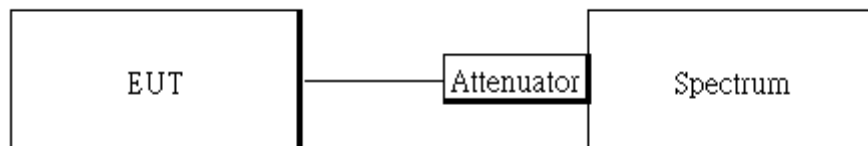
6 TEST CONFIGURATION

6.1 Emission Bandwidth



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% of OBW and without going below 1kHz,
VBW $\geq 3 \times$ RBW,
Span= 2 to 5 times OBW,
Sweep=auto,
Detector = Peak, and Max hold.
4. Use the 99% power bandwidth and X dB bandwidth mode function of the spectrum analyzer and set to 20dB
5. Repeat above procedures until all test default channel is completed.

6.2 Channel Separation

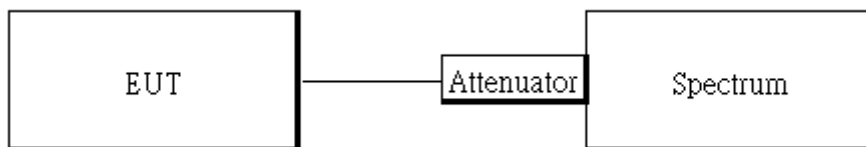


1. Place the EUT on the table and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
3. Set the spectrum analyzer as
center frequency = middle of hopping channel
RBW = approximately 30% of the channel spacing,
VBW $\geq 1/10$ of RBW.
Adjust Span to Wide enough to capture the peaks of two adjacent channels.
Sweep = auto.
4. Max hold. Mark 3 Peaks of hopping channel and record the 3 peaks frequency.

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6.3 Number Of Hopping Channels



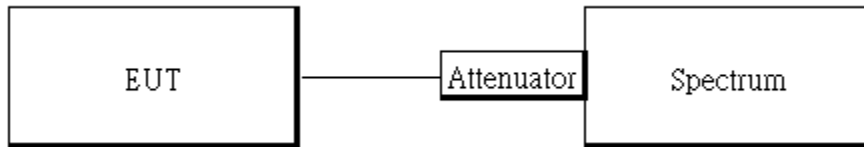
1. Place the EUT on the table and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
3. Set the spectrum analyzer as
Span = The frequency band of operation.
RBW = less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller;
VBW $\geq$ 1/10 of RBW;
Detector = Peak
Sweep = auto
4. Max hold, view and count how many channels in the band.

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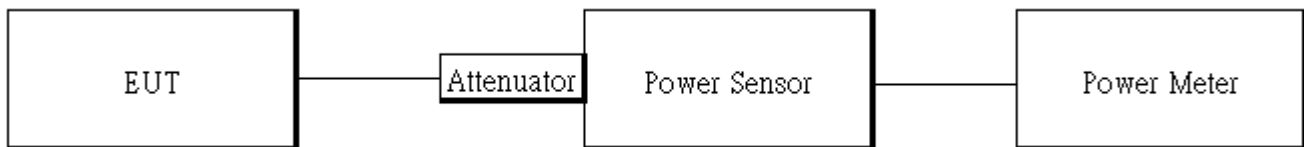
6.4 Maximum Output Power

6.4.1 Duty Cycle:



1. Place the EUT on the table and set it in transmitting mode.
2. Set the spectrum analyzer as
Center Frequency = fundamental frequency
RBW = 8MHz,
VBW = 8MHz,
Detector = Peak
span = Zero
3. Allow trace to fully stabilize.
4. Use the delta marker function to determine the ON and OFF times.

6.4.2 Maximum Output Power

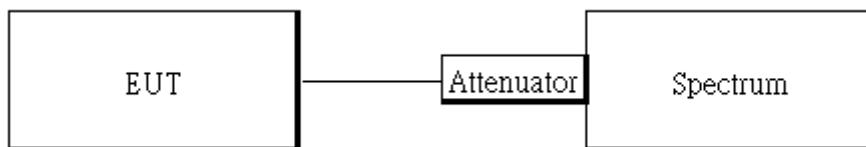


1. Place the EUT on the table and set it in transmitting mode.
2. Duty cycle of test signal is < 98 %, duty factor shall be considered.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the power meter or spectrum. (Max Hold, Detector = Peak, RBW ≥ 20dB bandwidth)
4. Record the max. reading.
5. Repeat above procedures until all default test channel is completed.

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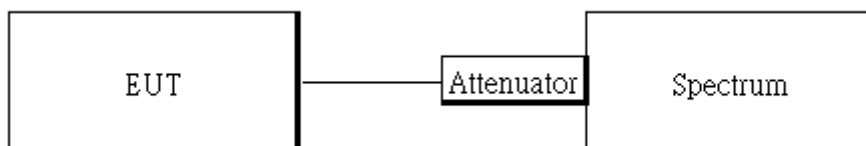
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6.5 Maximum Power Spectral Density



1. Set analyzer center frequency to channel center frequency.
2. Set the span >1.5 times the channel bandwidth.
3. Set the RBW = 3 kHz. & the VBW = 10 kHz
4. Set Detector = average
5. Sweep time = auto couple.
6. Set Trace mode = average
7. Allow trace to fully stabilize.
8. Use the peak marker function to determine the maximum amplitude level.

6.6 Time Of Occupancy (Dwell Time)



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

center frequency = operating frequency

RBW ≤ channel spacing and where possible RBW should be set >> 1 / T, where T is the expected transmission time per hop.

VBW ≥ 3 X RBW,

Span = 0Hz,

Detector = Peak,

Adjust Sweep = Number of Hopping Channels * 0.4s

4. Repeat above procedures until all frequency of the interest measured were complete.

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台灣檢驗科技股份有限公司

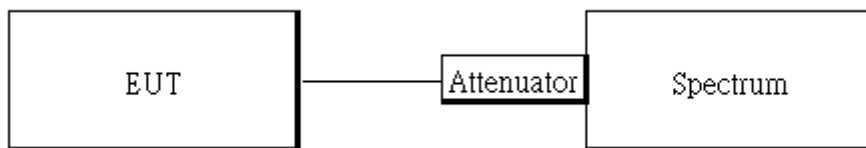
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6.7 Out Of Band Emission



6.7.1 Conducted Band Edge:

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 spectrum analyzer.
4. Set the spectrum analyzer as
center frequency = operating frequency.
RBW=100 kHz,
VBW=300 kHz,
Sweep = auto
5. Mark the highest readings of the emissions outside of 902-928 MHz.
6. Repeat above procedures until all frequency measured were complete.

6.7.2 Conducted Spurious Emission:

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

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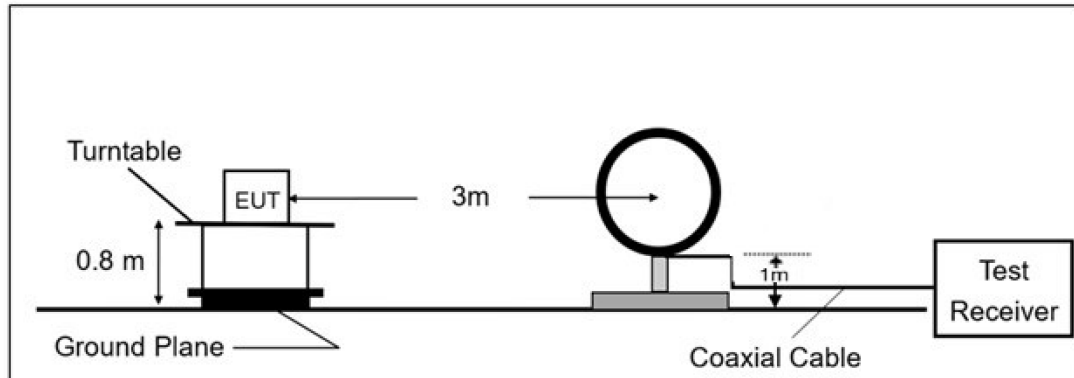
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6.8 Unwanted Emission

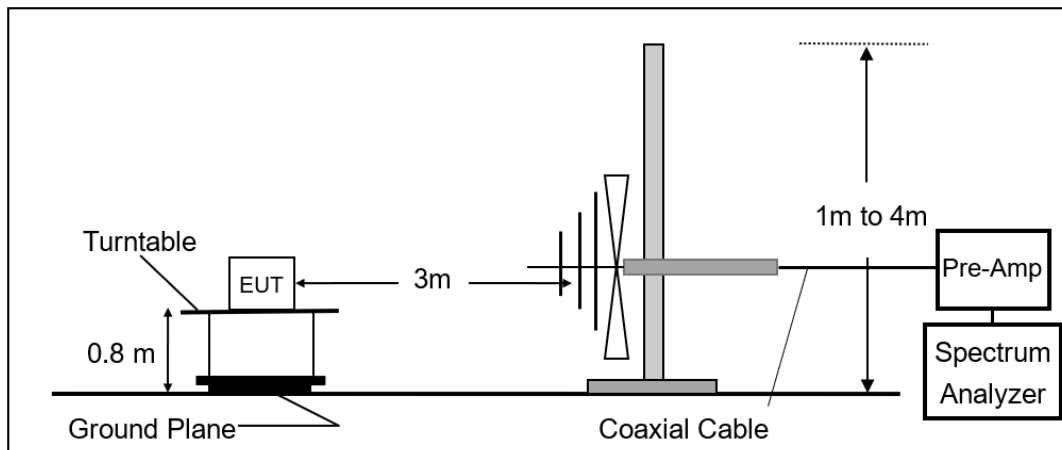
Radiated emission below 30MHz is measured in a 9m*6m*6m semi-anechoic chamber, the measurements correspond to those obtained at an open-field test site.

There is a comparison data of both open-field test site and semi-Anechoic chamber, and the result came out very similar.

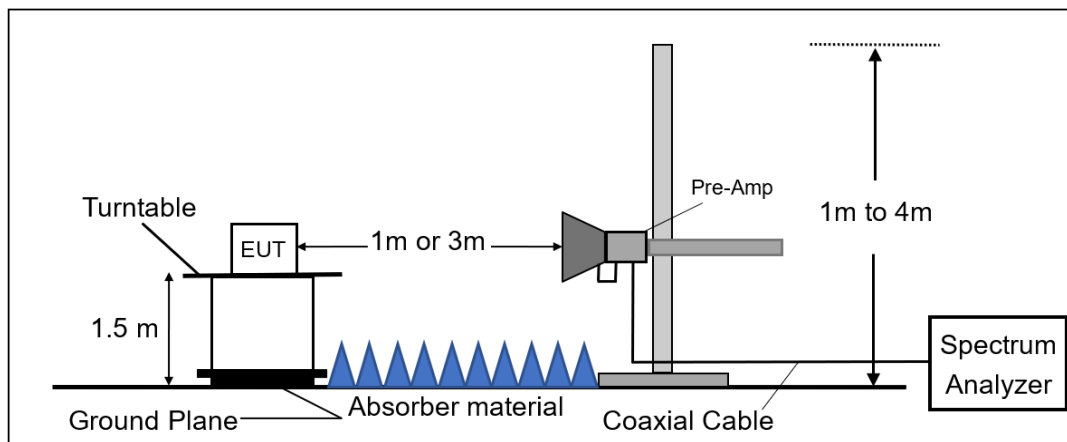
Radiated Emission Test Set-Up, Frequency Below 30MHz.



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



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



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1. The EUT was placed on a turn table with 0.8m for frequency < 1GHz and 1.5m for frequency > 1GHz above ground plane.
2. The turn table shall rotate 360 degrees to determine the position of maximum emission level.
3. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emissions.
4. Set the spectrum analyzer as RBW=100 kHz and VBW=300 kHz for Peak Detector (PK) at frequency between 30MHz and 1 GHz.
5. Use receiver mode as RBW=120 kHz for Quasi-peak (QP) at frequency between 30MHz and 1 GHz.
6. Set the spectrum analyzer as RBW=1 MHz, VBW=3 MHz, Detector= Peak for Maximum Emission Measurements at frequency above 1 GHz.
7. Set the spectrum analyzer as RBW=1 MHz, VBW ≥ 1/T, Detector= Peak for Maximum Emission Measurements at frequency above 1 GHz.
8. 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.
9. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
10. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
11. Repeat above procedures until all default test channel measured were complete.

Note: The emissions from 9 kHz to 30MHz was pre-scanned as 20dB lower than the limits and hence not reported.

6.8.1 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:

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

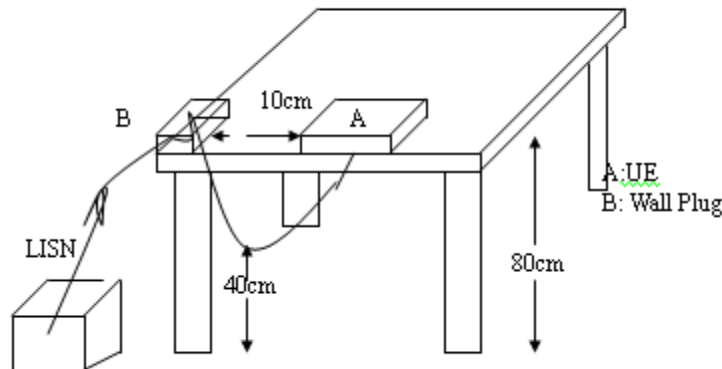
Where FS = Field Strength(dBμV/m) CL = Cable Attenuation Factor (Cable Loss) (dB)
 RA = Reading Amplitude(dBμV) AG = Amplifier Gain (dB)
 AF = Antenna Factor (dBμV/m)

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

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6.9 AC Power Line Conducted Emission



1. The conducted emission tests were performed at the designated test site using a setup in accordance with ANSI C63.10.
2. The EUT was placed on a non-conductive table that is 0.8 meters above the ground plane. Conducted emissions were measured in the frequency range from 0.15 MHz to 30 MHz using CISPR Quasi-Peak and Average detector modes. The two LISNs provided 50 μ H / 50 ohm coupling impedance for the measuring instrument. Both lines of the power mains connected to the EUT were checked for maximum conducted interference.
3. The AC/DC power adaptor of the EUT was connected to the LISN. The EUT was positioned flush with the rear edge of the table, with a minimum 0.4-meter distance from the shielding wall.
4. The LISNs were connected to the power source and configured according to the test requirements.
5. The maximum emission levels were investigated for each mode of operation. The six highest emissions were further maximized to ensure compliance.
6. The above procedures were repeated for all power supply configurations of the EUT.

Level = Read Level + Factor

Factor = (LISN, ISN, or current probe)Factor + Cable Loss +Attenuator

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7 TEST RESULTS

7.1 Emission Bandwidth

7.1.1 20dB Bandwidth

LoRa SF7 125kHz mode

Frequency (MHz)	20dB BW (MHz)
902.3	0.1409
908.3	0.1415
914.9	0.1411

LoRa SF8 125kHz mode

Frequency (MHz)	20dB BW (MHz)
902.3	0.1433
908.3	0.1464
914.9	0.1407

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LoRa SF9 125kHz mode

Frequency (MHz)	20dB BW (MHz)
902.3	0.14
908.3	0.1384
914.9	0.1392

LoRa SF10 125kHz mode

Frequency (MHz)	20dB BW (MHz)
902.3	0.1392
908.3	0.1374
914.9	0.1383

LoRa SF8 500kHz mode

Frequency (MHz)	20dB BW (MHz)
903	0.5502
907.8	0.5559
914.2	0.5523

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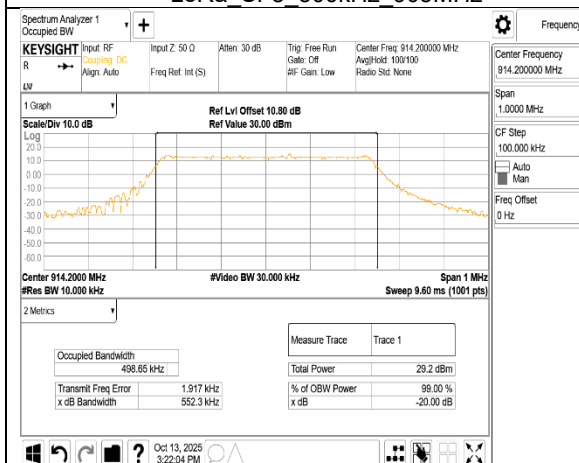
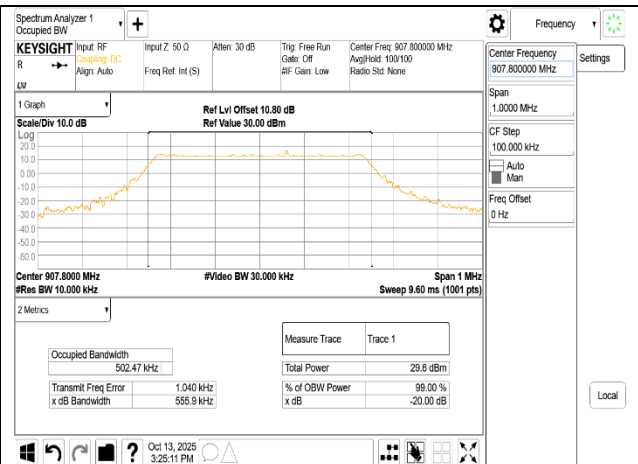
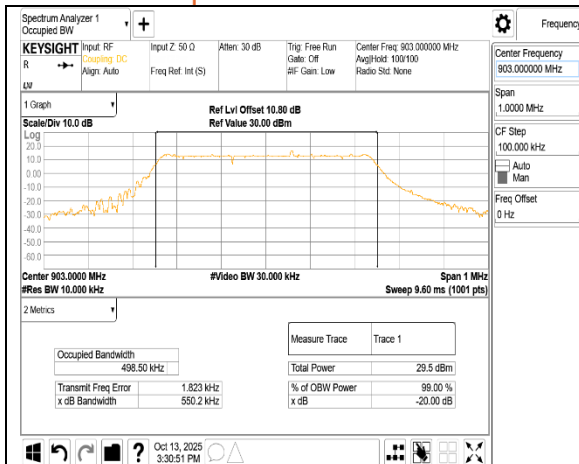
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7.1.2 99% Bandwidth

LoRa SF7 125kHz mode

Frequency (MHz)	99%Bandwidth (MHz)
902.3	0.12686
908.3	0.12573
914.9	0.12641

LoRa SF8 125kHz mode

Frequency (MHz)	99%Bandwidth (MHz)
902.3	0.1259
908.3	0.12506
914.9	0.12564

LoRa SF9 125kHz mode

Frequency (MHz)	99%Bandwidth (MHz)
902.3	0.12552
908.3	0.12436
914.9	0.12486

LoRa SF10 125kHz mode

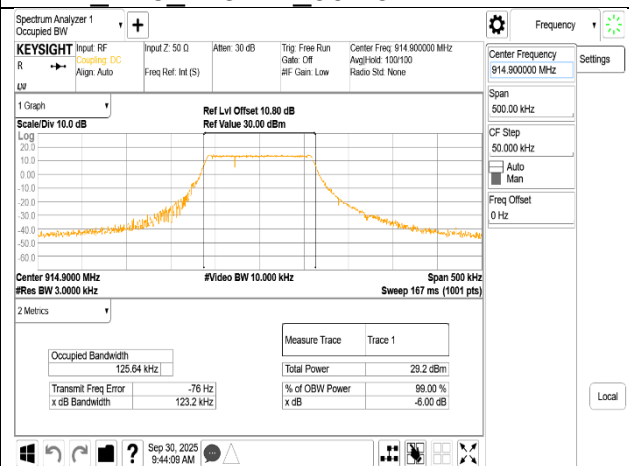
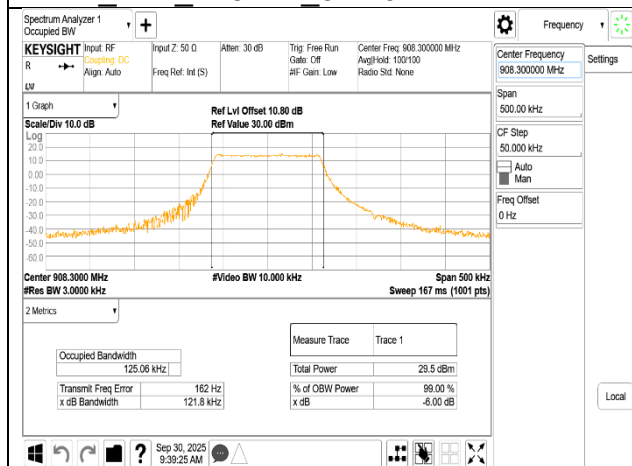
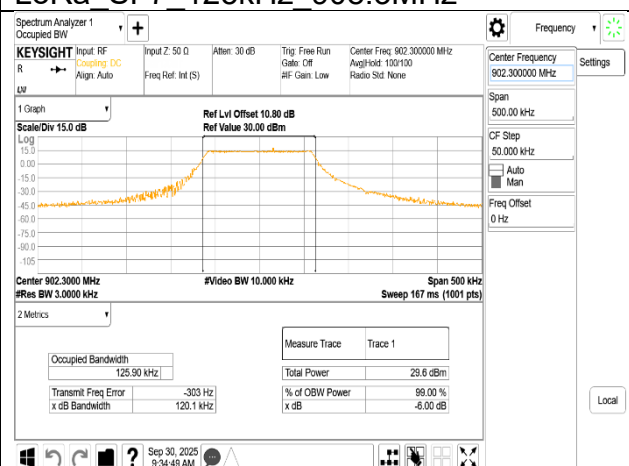
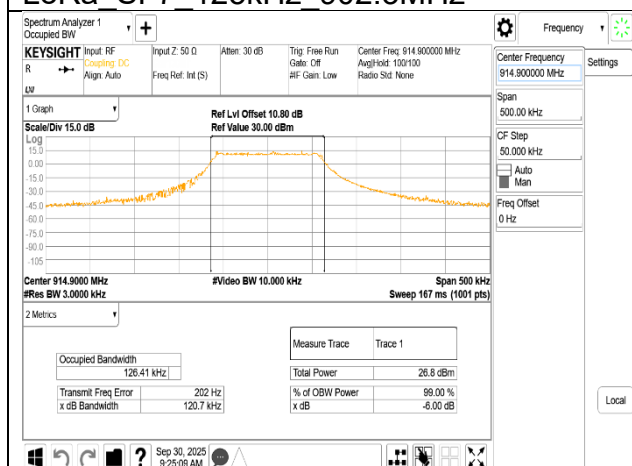
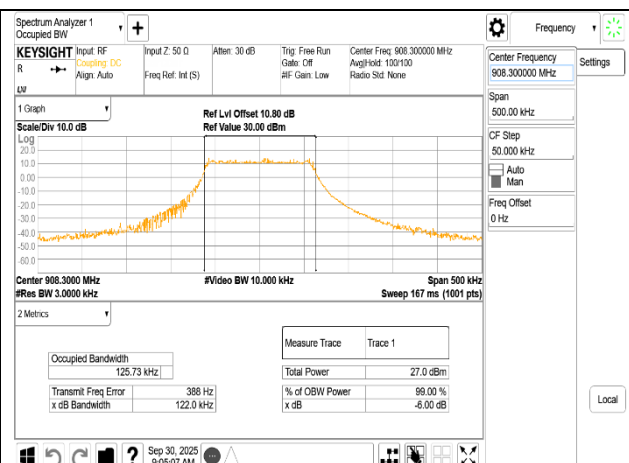
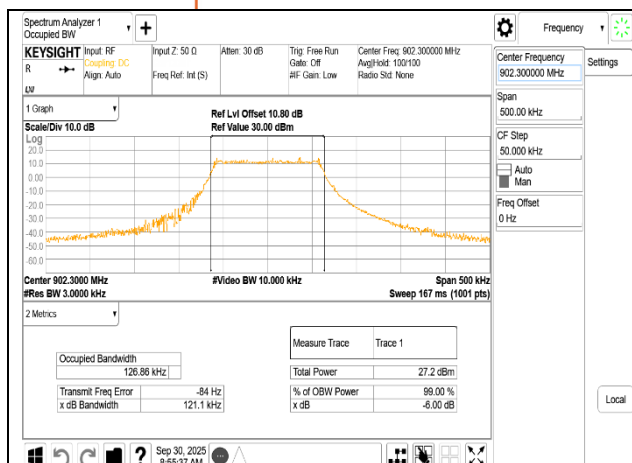
Frequency (MHz)	99%Bandwidth (MHz)
902.3	0.12515
908.3	0.12507
914.9	0.12504

LoRa SF8 500kHz mode

Frequency (MHz)	99%Bandwidth (MHz)
903	0.50136
907.8	0.50343
914.2	0.50065

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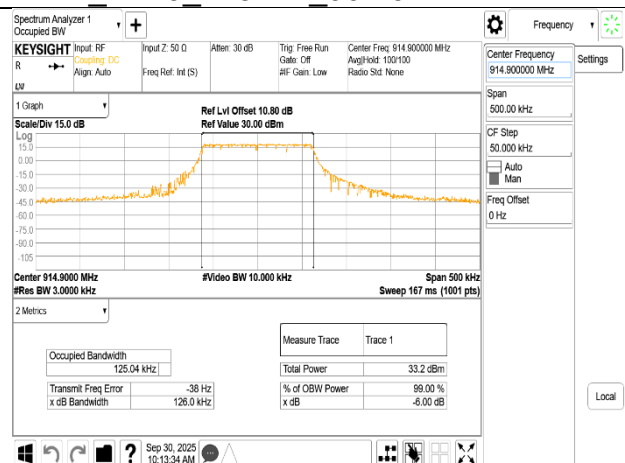
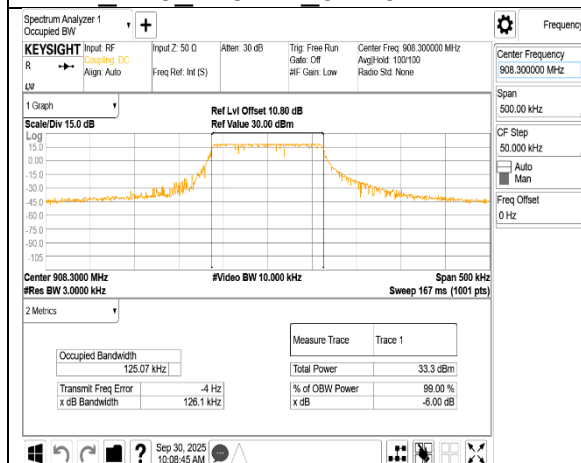
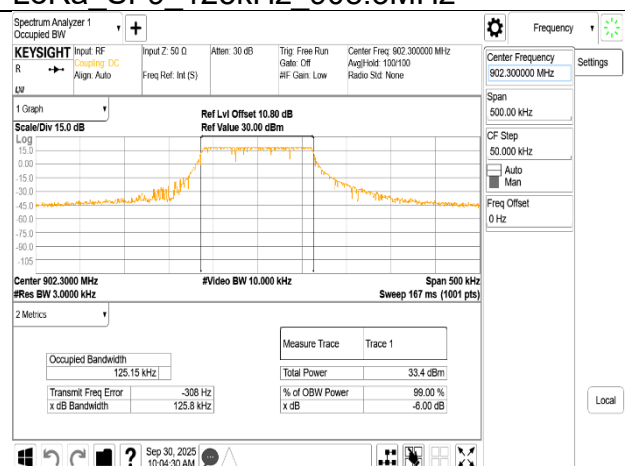
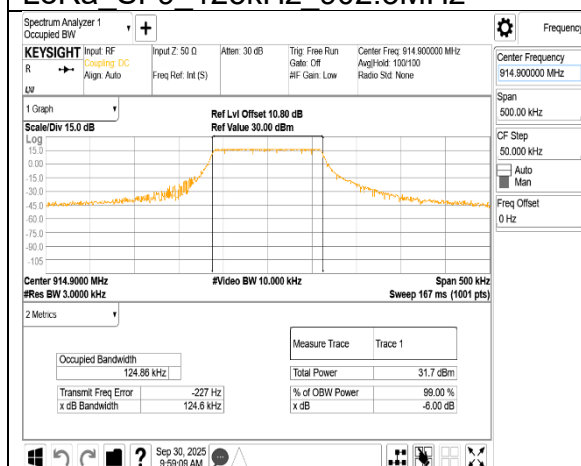
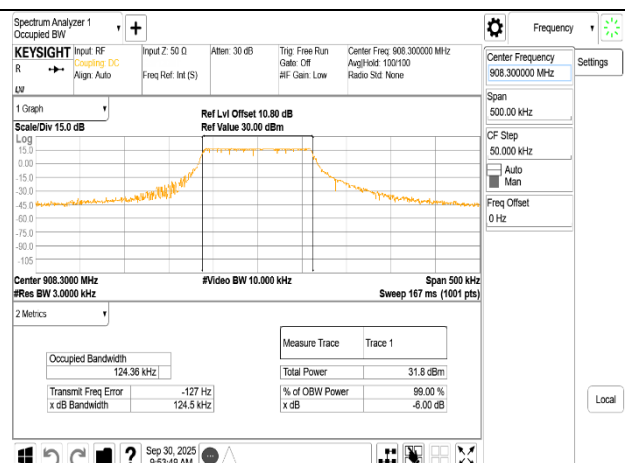
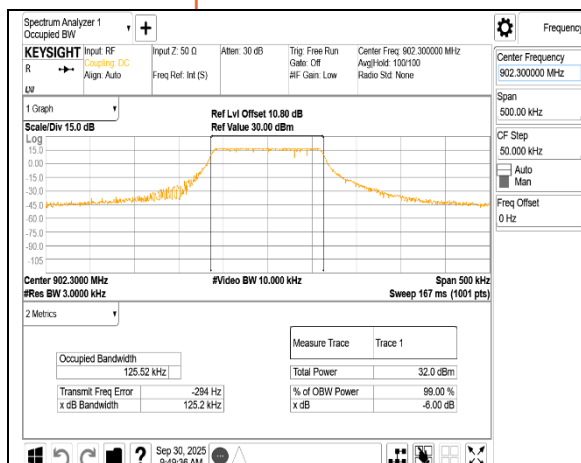
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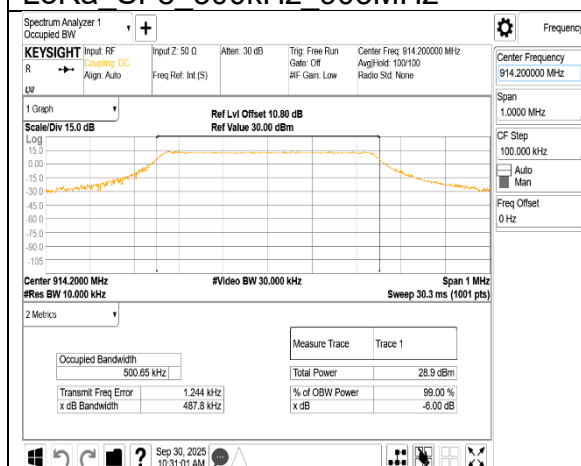
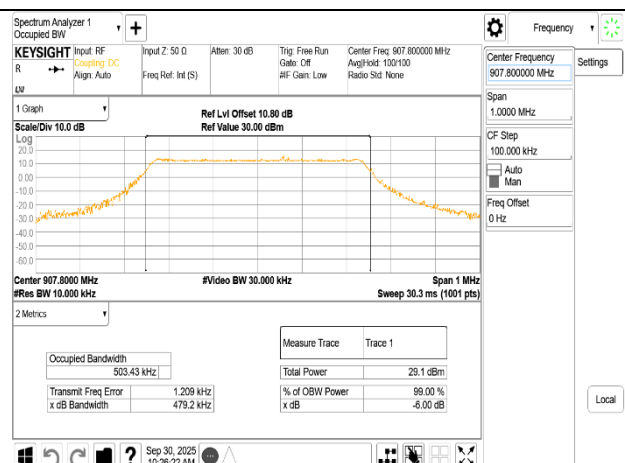
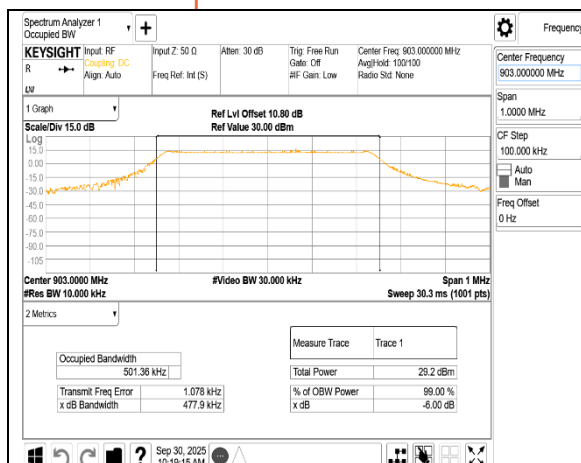
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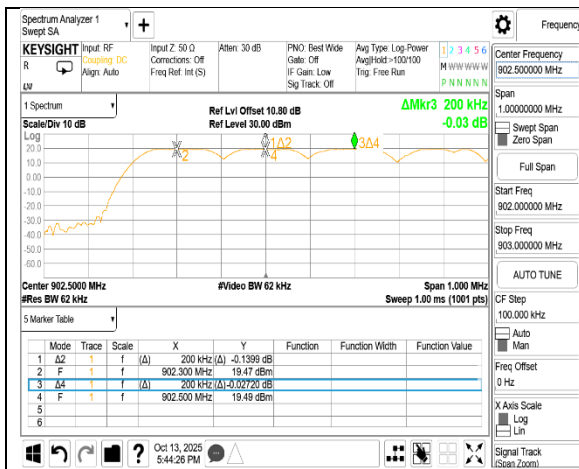
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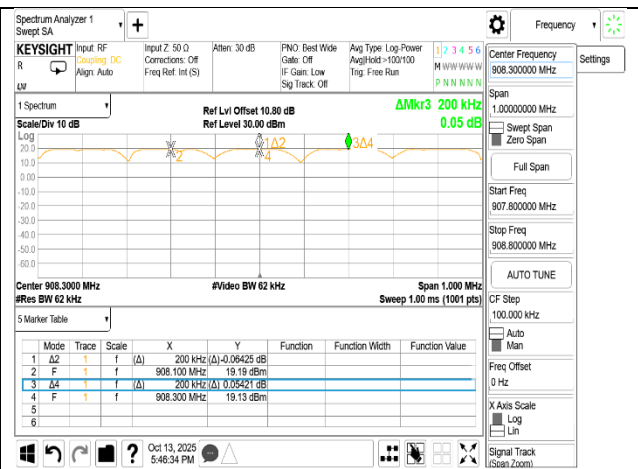
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7.2 Channel Separation

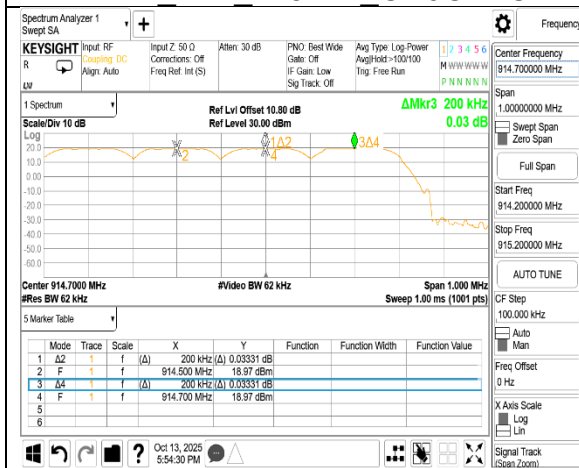
Mode	Channel separation	Limit	Result
125kHz	200kHz	≥ 25 kHz or 20dB bandwidth	PASS
500kHz	1.6MHz		PASS



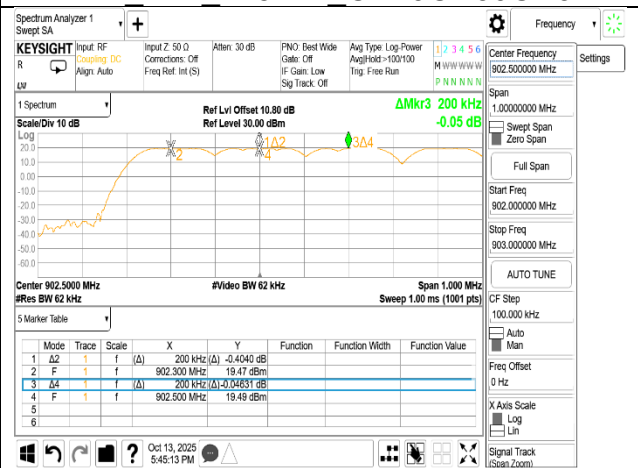
LoRa SF7 125kHz CH0CH1CH2



LoRa SF7 125kHz CH29CH30CH31



LoRa SF7 125kHz CH61CH62CH63

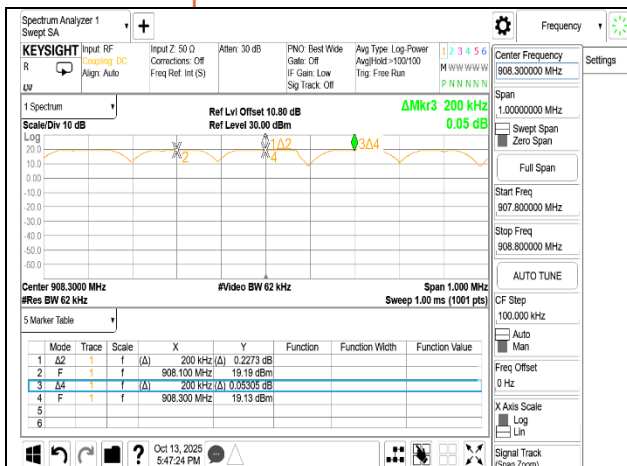


LoRa SF8 125kHz CH0CH1CH2

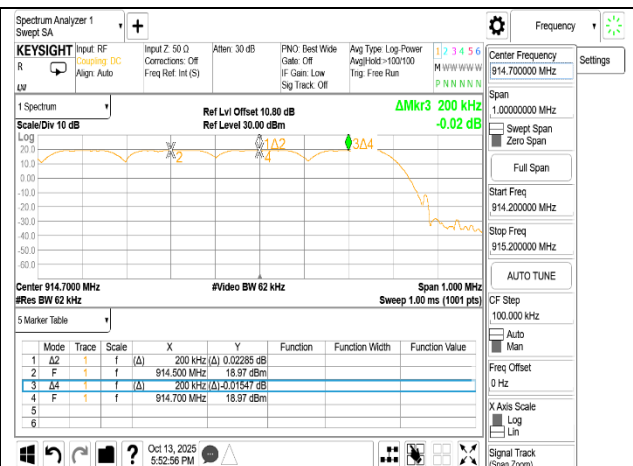
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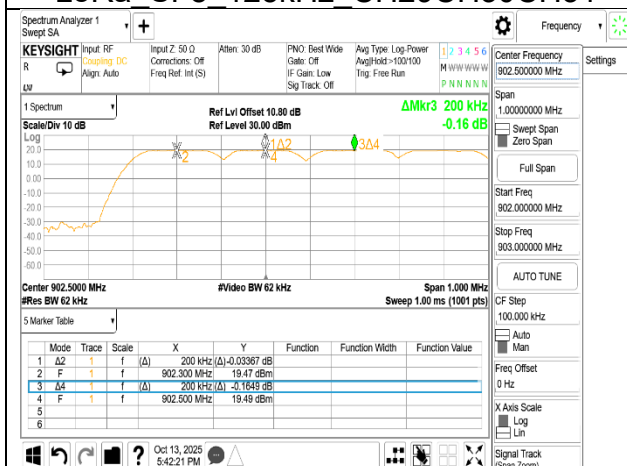
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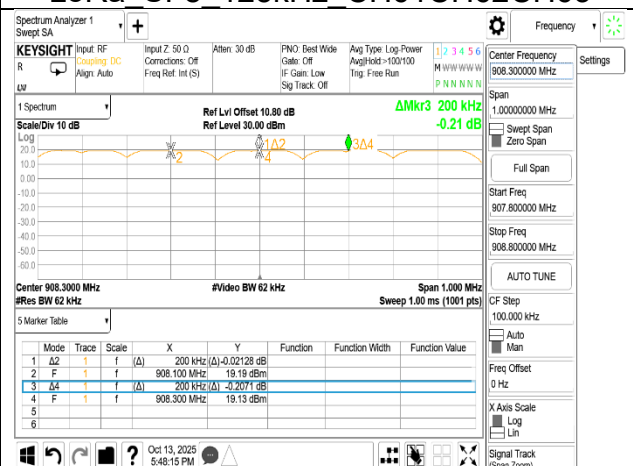
LoRa SF8 125kHz CH29CH30CH31



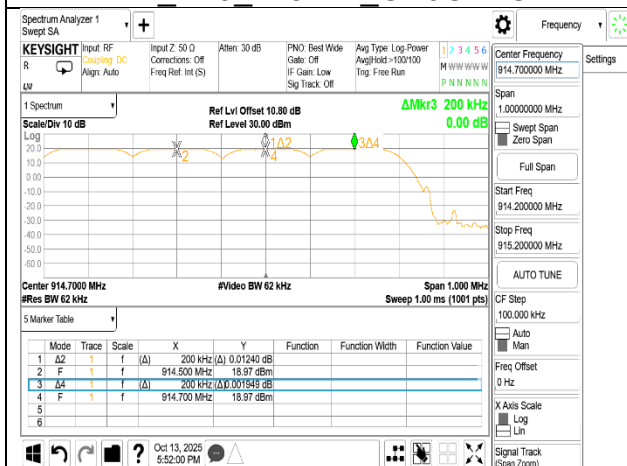
LoRa SF8 125kHz CH61CH62CH63



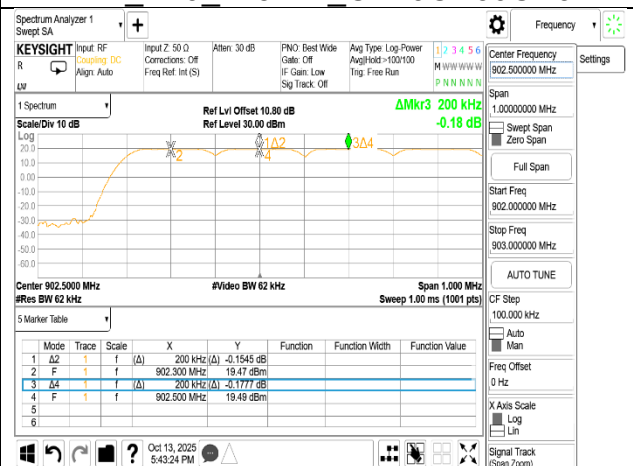
LoRa SF9 125kHz CH0CH1CH2



LoRa SF9 125kHz CH29CH30CH31



LoRa SF9 125kHz CH61CH62CH63



LoRa SF10 125kHz CH0CH1CH2

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7.3 Number Of Hopping Frequency

Tabular Data of Total Channel Number

	Mode	Channel Number
902 – 928 MHz	SF7_125kHz	64
	SF8_125kHz	64
	SF9_125kHz	64
	SF10_125kHz	64
	SF8_500kHz	8

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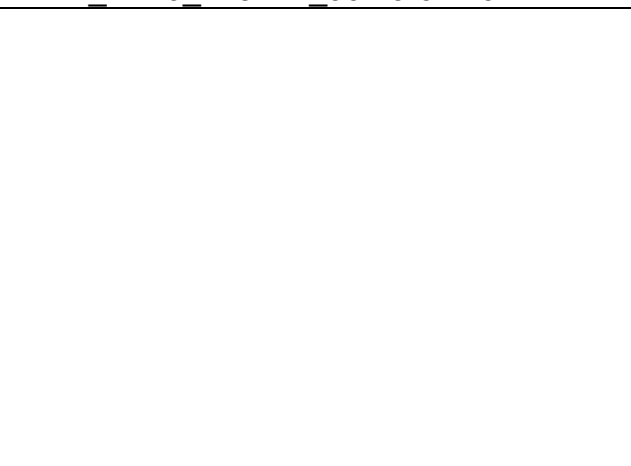
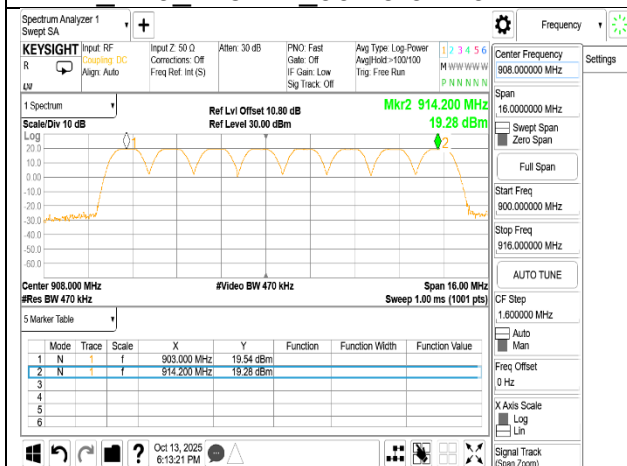
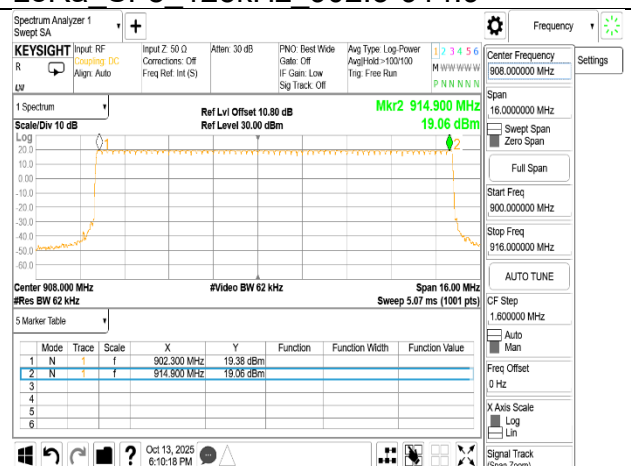
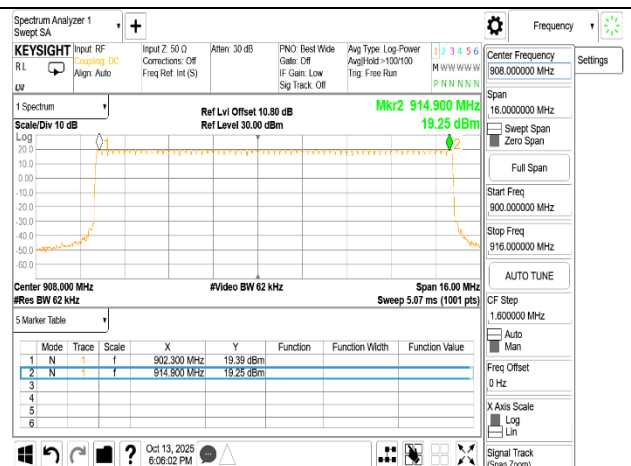
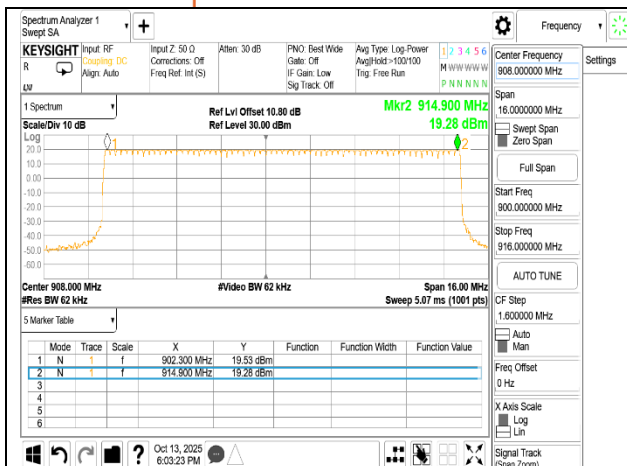
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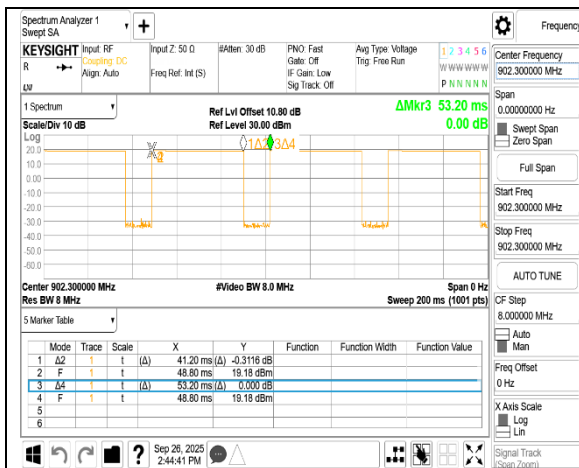
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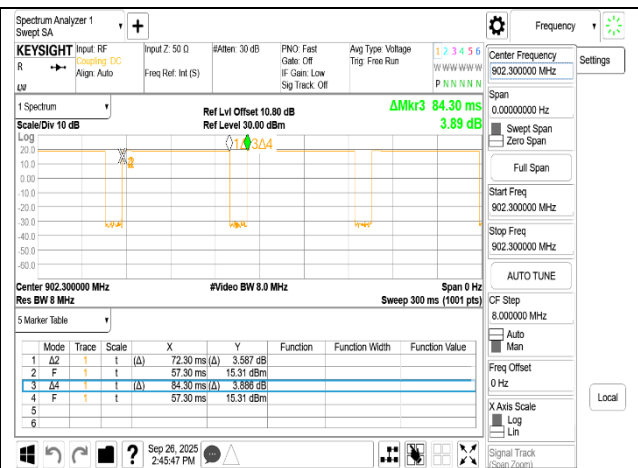
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7.4 Duty Cycle & Maximum Output Power

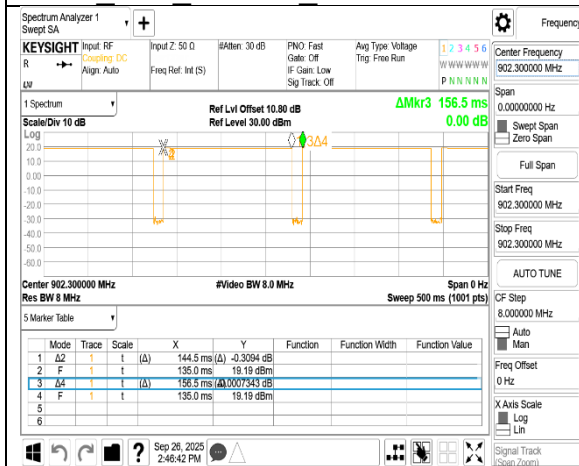
Mode	Duty Cycle (%) = Ton / (Ton+Toff)	Duty Factor (dB) =10*log (1/Duty Cycle)	1/T (kHz)	VBW setting (kHz)
LoRa SF7 125kHz	77.44	1.11	0.02	1.00
LoRa SF8 125kHz	85.77	0.67	0.01	1.00
LoRa SF9 125kHz	92.33	0.35	0.01	1.00
LoRa SF10 125kHz	96.33	0.16	0.00	1.00
LoRa SF8 500kHz	60.34	2.19	0.06	1.00



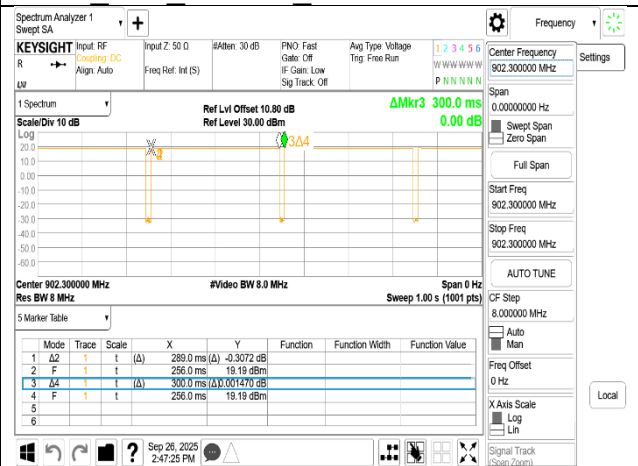
LoRa SF7 125kHz 902.3MHz



LoRa SF8 125kHz 902.3MHz



LoRa SF9 125kHz 902.3MHz

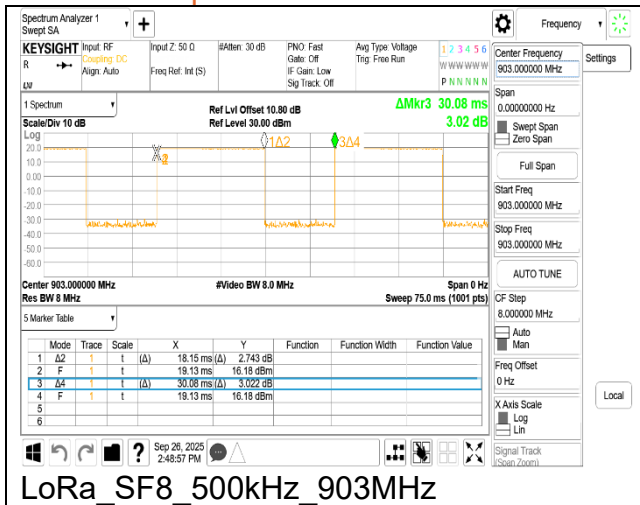


LoRa SF10 125kHz 902.3MHz

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LoRa SF7 125kHz mode:

CH	Frequency (MHz)	Power Setting	Peak Output Power (dBm)	Required Limit (dBm)
0	902.3	20	18.72	30
30	908.3	20	18.59	30
63	914.9	20	18.43	30
CH	Frequency (MHz)	Power Setting	Avg. Output Power (dBm)	Required Limit (dBm)
0	902.3	20	18.08	30
30	908.3	20	17.96	30
63	914.9	20	17.72	30

***Note:**

1.Measured by power meter, cable loss 10.8 dB + Duty cycle factor has been offseted to the power meter for Avg. power and cable loss has been offseted for Peak power measurement.

LoRa SF8 125kHz mode:

CH	Frequency (MHz)	Power Setting	Peak Output Power (dBm)	Required Limit (dBm)
0	902.3	20	18.66	30
30	908.3	20	18.53	30
63	914.9	20	18.38	30
CH	Frequency (MHz)	Power Setting	Avg. Output Power (dBm)	Required Limit (dBm)
0	902.3	20	18.02	30
30	908.3	20	17.88	30
63	914.9	20	17.75	30

***Note:**

1.Measured by power meter, cable loss 10.8 dB + Duty cycle factor has been offseted to the power meter for Avg. power and cable loss has been offseted for Peak power measurement.

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LoRa SF9 125kHz mode:

CH	Frequency (MHz)	Power Setting	Peak Output Power (dBm)	Required Limit (dBm)
0	902.3	20	18.71	30
30	908.3	20	18.57	30
63	914.9	20	18.41	30
CH	Frequency (MHz)	Power Setting	Avg. Output Power (dBm)	Required Limit (dBm)
0	902.3	20	18.65	30
30	908.3	20	18.51	30
63	914.9	20	18.36	30

***Note:**

1.Measured by power meter, cable loss 10.8 dB + Duty cycle factor has been offseted to the power meter for Avg. power and cable loss has been offseted for Peak power measurement.

LoRa SF10 125kHz mode:

CH	Frequency (MHz)	Power Setting	Peak Output Power (dBm)	Required Limit (dBm)
0	902.3	20	18.70	30
30	908.3	20	18.55	30
63	914.9	20	18.42	30
CH	Frequency (MHz)	Power Setting	Avg. Output Power (dBm)	Required Limit (dBm)
0	902.3	20	18.63	30
30	908.3	20	18.50	30
63	914.9	20	18.33	30

***Note:**

1.Measured by power meter, cable loss 10.8 dB + Duty cycle factor has been offseted to the power meter for Avg. power and cable loss has been offseted for Peak power measurement.

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LoRa SF8 500kHz mode:

CH	Frequency (MHz)	Power Setting	Peak Output Power (dBm)	Required Limit (dBm)
0	903	20	18.89	30
3	907.8	20	18.78	30
7	914.2	20	18.62	30
CH	Frequency (MHz)	Power Setting	Avg. Output Power (dBm)	Required Limit (dBm)
0	903	20	18.76	30
3	907.8	20	18.65	30
7	914.2	20	18.50	30

***Note:**

1.Measured by power meter, cable loss 10.8 dB + Duty cycle factor has been offseted to the power meter for Avg. power and cable loss has been offseted for Peak power measurement.

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7.5 Maximum Power Spectral Density

LoRa SF7 125kHz mode

Frequency (MHz)	RF Power Density (dBm/3kHz)	Duty factor	RF Power Density (dBm/3kHz)	Maximum Limit (dBm/3kHz)	Result
902.3	3.69	1.11	4.80	8	PASS
908.3	3.24	1.11	4.35	8	PASS
914.9	3.40	1.11	4.51	8	PASS

***Note:**

1.cable loss as 10.8 dB that offsets in the spectrum

LoRa SF8 125kHz mode

Frequency (MHz)	RF Power Density (dBm/3kHz)	Duty factor	RF Power Density (dBm/3kHz)	Maximum Limit (dBm/3kHz)	Result
902.3	3.909	0.67	4.58	8	PASS
908.3	3.919	0.67	4.59	8	PASS
914.9	3.706	0.67	4.37	8	PASS

***Note:**

1.cable loss as 10.8 dB that offsets in the spectrum

LoRa SF9 125kHz mode

Frequency (MHz)	RF Power Density (dBm/3kHz)	Duty factor	RF Power Density (dBm/3kHz)	Maximum Limit (dBm/3kHz)	Result
902.3	4.306	0.35	4.65	8	PASS
908.3	4.31	0.35	4.66	8	PASS
914.9	4.098	0.35	4.44	8	PASS

***Note:**

1.cable loss as 10.8 dB that offsets in the spectrum

LoRa SF10 125kHz mode

Frequency (MHz)	RF Power Density (dBm/3kHz)	Duty factor	RF Power Density (dBm/3kHz)	Maximum Limit (dBm/3kHz)	Result
902.3	4.578	0.16	4.74	8	PASS
908.3	5.291	0.16	5.45	8	PASS
914.9	5.19	0.16	5.35	8	PASS

***Note:**

1.cable loss as 10.8 dB that offsets in the spectrum

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LoRa SF8 500kHz mode

Frequency (MHz)	RF Power Density (dBm/3kHz)	Duty factor	RF Power Density (dBm/3kHz)	Maximum Limit (dBm/3kHz)	Result
903	-2.654	2.19	-0.46	8	PASS
907.8	-3.556	2.19	-1.36	8	PASS
914.2	-3.16	2.19	-0.97	8	PASS

***Note:**

1.cable loss as 10.8 dB that offsets in the spectrum

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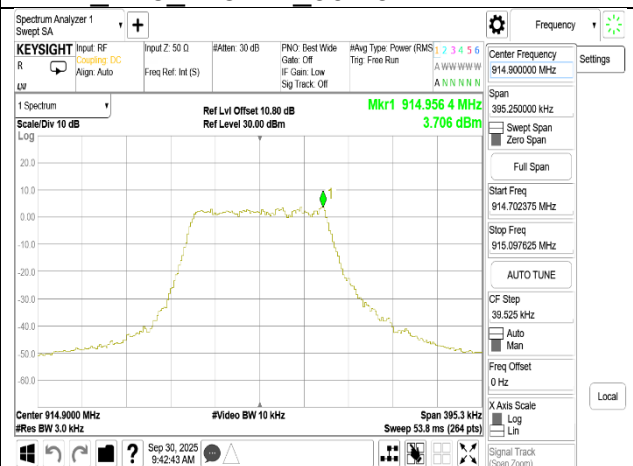
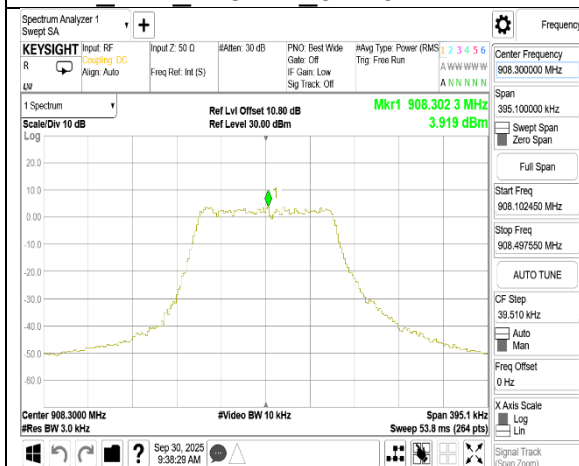
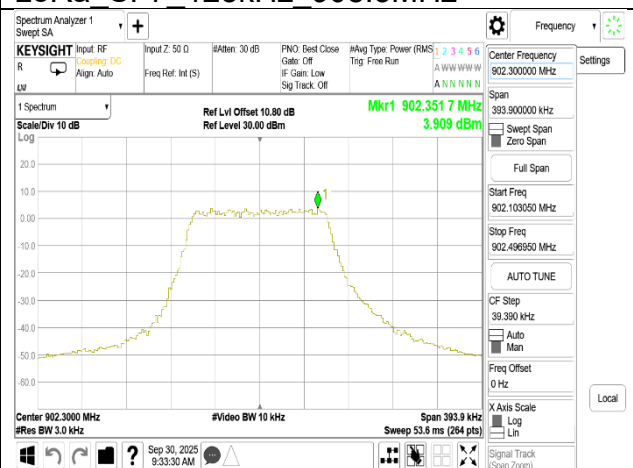
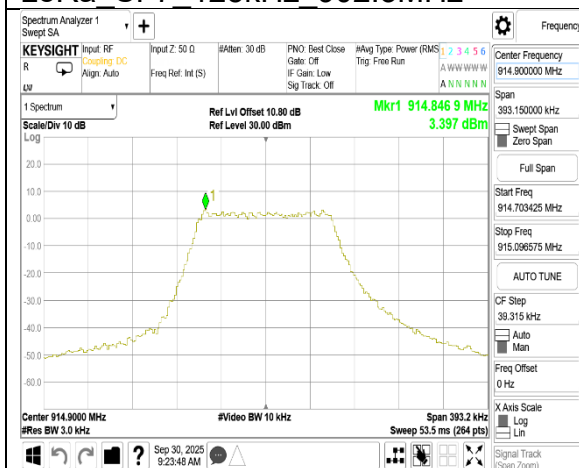
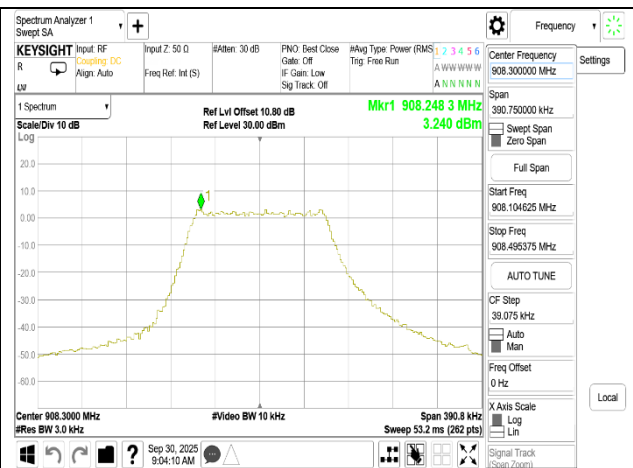
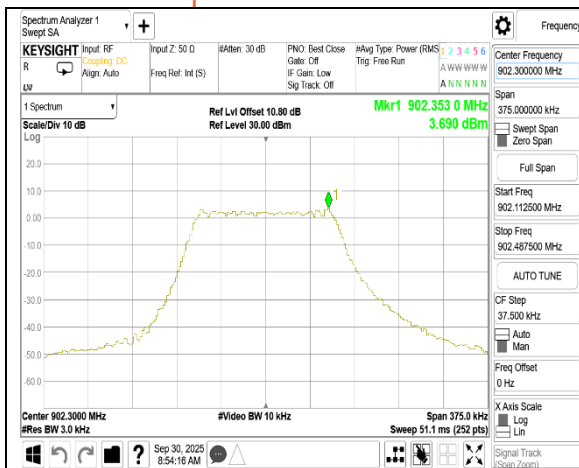
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