FCC RADIO TEST REPORT

FCC ID	:	**ZAT-1312PSIP-2**
Equipment	:	**CC1312PSIP**
Brand Name	:	**Texas Instruments**
Model Name	:	**CC1312PSIPMOT2**
Applicant	:	**Texas Instruments Incorporated 12500 TI BLVD., Dallas, Texas, 75243**
Manufacturer	:	**Texas Instruments Incorporated 12500 TI BLVD., Dallas, Texas, 75243**
Standard	:	**FCC Part 15 Subpart C §15.247**

The product was received on Sep. 27, 2023 and testing was performed from Oct. 03, 2023 to Oct. 16, 2023. We, Sporton International Inc. Wensan Laboratory, would like to declare that the tested sample has been evaluated in accordance with the test procedures and has been in compliance with the applicable technical standards.

The test results in this report apply exclusively to the tested model / sample. Without written approval from Sporton International Inc. Wensan Laboratory, the test report shall not be reproduced except in full.

Louis Wu

Approved by: Louis Wu

Sporton International Inc. Wensan Laboratory
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History of this test report

Report No.	Version	Description	Issue Date
FR341305-01A	01	Initial issue of report	Nov. 13, 2023
FR341305-01A	02	Revised Appendix C This report is an updated version, replacing the report issued on Nov. 13, 2023	Dec. 27, 2023

Summary of Test Result

Report Clause	Ref Std. Clause	Test Items	Result (PASS/FAIL)	Remark
3.1	15.247(a)(2)	6dB Bandwidth	Pass	-
3.1	2.1049	99% Occupied Bandwidth	Reporting only	-
3.2	15.247(b)(3) 15.247(b)(4)	Output Power	Pass	-
3.3	15.247(e)	Power Spectral Density	Pass	-
3.4	15.247(d)	Conducted Band Edges and Spurious Emission	Pass	-
3.5	15.247(d)	Radiated Band Edges and Spurious Emission	Pass	1.39 dB under the limit at 457.50 MHz
3.6	15.207	AC Conducted Emission	Pass	4.10 dB under the limit at 0.16 MHz
3.7	15.203	Antenna Requirement	Pass	-

Conformity Assessment Condition:

1. The test results (PASS/FAIL) with all measurement uncertainty excluded are presented against the regulation limits or in accordance with the requirements stipulated by the applicant/manufacturer who shall bear all the risks of non-compliance that may potentially occur if measurement uncertainty is taken into account.
2. The measurement uncertainty please refer to each test result in the section “Measurement Uncertainty”.

Disclaimer:

The product specifications of the EUT presented in the test report that may affect the test assessments are declared by the manufacturer who shall take full responsibility for the authenticity.

Reviewed by: Danny Lee

Report Producer: Rachel Hsieh

1 General Description

1.1 Product Feature of Equipment Under Test

Product Feature
General Specs WB-DSSS, 30 kbps (480 ksps), 195 kHz Deviation, 2-GFSK, 784 kHz RX Bandwidth

Antenna Information				
	Brand	**Antenna Type**	**Model**	**915MHz Gain**
1	TI	Integrated PCB antenna	LP-EM-CC1312PSIP antenna	+2.69 dBi
2	Kaadas	Flexi PCB antenna	K1	-5.82 dBi
3	Leederson	Integrated PCB antenna	L1	-4.51 dBi
4	Leederson	Integrated PCB antenna	L2	-1.83 dBi
5	Leederson	Stanced antenna	L3	-9.48 dBi
6	Leederson	Stanced antenna	L4	+0.37 dBi
7	Leederson	Integrated PCB antenna	L5	-1.74 dBi
8	Pulse	External whip antenna	W5017	+0.90 dBi
9	Johanson Technology	Chip antenna	0900AT43A0070	-0.50 dBi
10	Johanson Technology	Chip antenna	0915AT43A0026	+1.0 dBi
11	Pulse	Wire antenna	W3113	+0.80 dBi

Remark:

1. The EUT uses the Integrated PCB antenna from Texas Instruments (Antenna #1)
2. The EUT's information above is declared by manufacturer. Please refer to Disclaimer in report summary.

1.2 Modification of EUT

No modifications made to the EUT during the testing.

1.3 Testing Location

Test Site	Sporton International Inc. EMC & Wireless Communications Laboratory
Test Site Location	No.52, Huaya 1st Rd., Guishan Dist., Taoyuan City 333, Taiwan (R.O.C.) TEL: +886-3-327-3456 FAX: +886-3-328-4978
Test Site No.	**Sporton Site No.**
	CO05-HY (TAF Code: 1190)
Remark	The AC Conducted Emission test item subcontracted to Sporton International Inc. EMC & Wireless Communications Laboratory.

Note: The test site complies with ANSI C63.4 2014 requirement.

Test Site	Sporton International Inc. Wensan Laboratory
Test Site Location	No.58, Aly. 75, Ln. 564, Wenhua 3rd, Rd., Guishan Dist., Taoyuan City 333010, Taiwan (R.O.C.) TEL: +886-3-327-0868 FAX: +886-3-327-0855
Test Site No.	**Sporton Site No.**
	TH05-HY, 03CH13-HY

Note: The test site complies with ANSI C63.4 2014 requirement.

FCC designation No.: TW1190 and TW3786

1.4 Applicable Standards

According to the specifications declared by the manufacturer, the EUT must comply with the requirements of the following standards:

- FCC Part 15 Subpart C §15.247
- FCC KDB Publication No. 558074 D01 15.247 Meas Guidance v05r02
- FCC KDB 414788 D01 Radiated Test Site v01r01
- ANSI C63.10-2013

Remark:

1. All the test items were validated and recorded in accordance with the standards without any modification during the testing.
2. The TAF code is not including all the FCC KDB listed without accreditation.
3. This EUT has also been tested and complied with the requirements of FCC Part 15, Subpart B, recorded in a separate test report.

2 Test Configuration of Equipment Under Test

2.1 Carrier Frequency Channel

Frequency Band	Channel	Freq. (MHz)
902-928 MHz	01	915.00

2.2 Test Mode

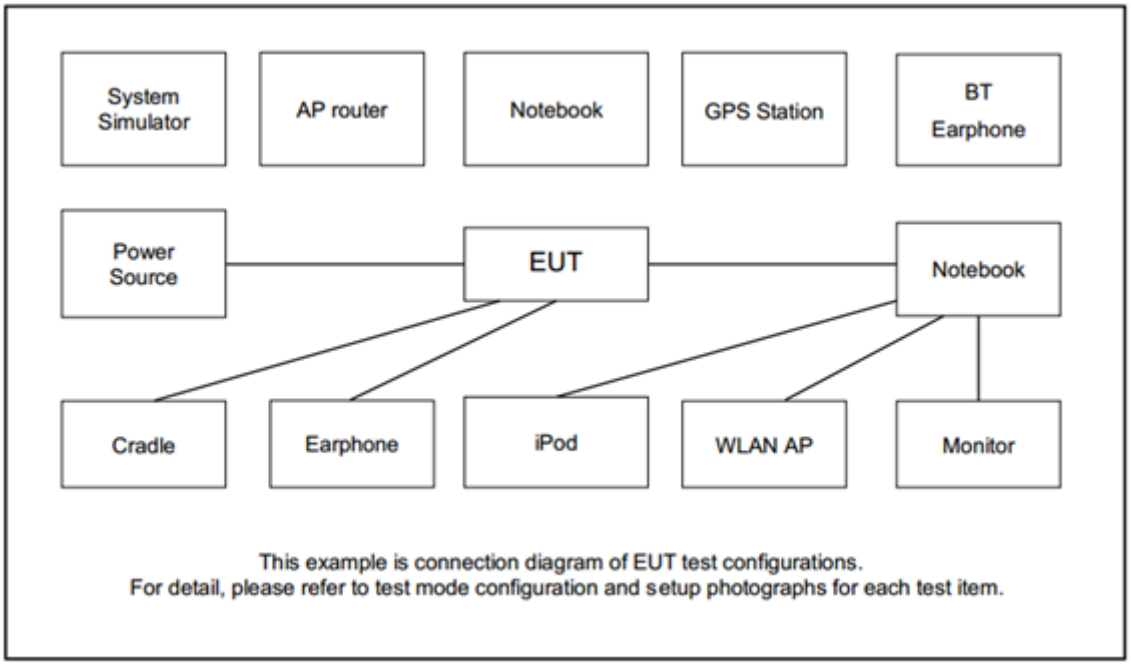
a. The EUT has been associated with peripherals and configuration operated in a manner tended to maximize its emission characteristics in a typical application. Frequency range investigated: conduction emission (150 kHz to 30 MHz), radiation emission (9 kHz to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower). For radiated measurement, the measured emission level of the EUT was maximized by rotating the EUT on a turntable, adjusting the orientation of the EUT and EUT antenna in three orthogonal axis (X: flat, Y: portrait, Z: landscape), and adjusting the measurement antenna orientation, following C63.10 exploratory test procedures and only the worst case emissions were reported in this report.

b. AC power line Conducted Emission was tested under maximum output power.

The following summary table is showing all test modes to demonstrate in compliance with the standard.

Summary table of Test Cases	
Test Item	**Data Rate / Modulation**
Conducted Test Cases	**WB-DSSS / 2-GFSK**
	Mode 1: WB-DSSS Tx CH01_915 MHz_30kbps
Radiated Test Cases	Mode 1: WB-DSSS Tx CH01_915 MHz_30kbps
AC Conducted Emission	Mode 1: WB-DSSS TX + USB Cable (Charging from Notebook)

2.3 Connection Diagram of Test System



2.4 Support Unit used in test configuration and system

Item	Equipment	Brand Name	Model Name	FCC ID	Data Cable	Power Cord
1.	WLAN AP	ASUS	RT-AC66U	MSQ-RTAC66U	N/A	Unshielded, 1.8 m
2.	Notebook	DELL	Latitude 3420	FCC DoC	N/A	AC I/P: Unshielded, 1.2 m DC O/P: Shielded, 1.8 m
3.	Notebook	Acer	N18Q13	PD9AX201NG	N/A	AC I/P: Unshielded, 1.2 m DC O/P: Shielded, 1.8 m
4.	iPod	Apple	A1285	FCC DoC	Shielded, 1.0 m	N/A
5.	Fixture 1	Texas Instruments	LP-XDS110	N/A	N/A	N/A
6.	Fixture 2	Texas Instruments	LP-EM-CC1312PSIP	N/A	N/A	N/A

2.5 EUT Operation Test Setup

The RF test items, utility “SmartRF Studio 7 v2.29.0” was installed in Notebook which was programmed in order to make the EUT get into the engineering modes to provide channel selection, power level, data rate and the application type and for continuous transmitting signals.

2.6 Measurement Results Explanation Example

For all conducted test items:

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

Example :

The spectrum analyzer offset is derived from RF cable loss and attenuator factor.

Offset = RF cable loss + attenuator factor.

Following shows an offset computation example with cable loss 4.2 dB and 10 dB attenuator.

Offset(dB) = RF cable loss(dB) + attenuator factor(dB).

= 4.2 + 10 = 14.2 (dB)

3 Test Result

3.1 6dB and 99% Bandwidth Measurement

3.1.1 Limit of 6dB and 99% Bandwidth

The minimum 6 dB bandwidth shall be at least 500 kHz.

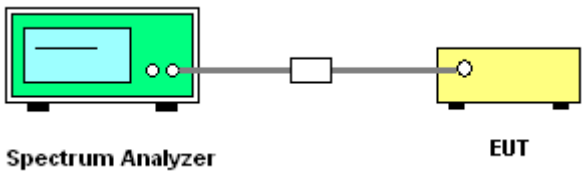
3.1.2 Measuring Instruments

Please refer to the measuring equipment list in this test report.

3.1.3 Test Procedures

1. The testing follows the ANSI C63.10 Section 6.9.3 (OBW) and 11.8.1 (6dB BW).
2. The RF output of EUT is connected to the spectrum analyzer by RF cable and attenuator. The path loss is compensated to the results for each measurement.
3. Set the maximum power setting and enable the EUT to transmit continuously.
4. Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 100 kHz. Set the Video bandwidth (VBW) = 300 kHz. In order to make an accurate measurement. The 6dB bandwidth must be greater than 500 kHz.
5. For 99% Bandwidth Measurement, the spectrum analyzer's resolution bandwidth (RBW) is set 1-5% of the emission bandwidth and set the Video bandwidth (VBW) ≥ 3 * RBW.
6. Measure and record the results in the test report.

3.1.4 Test Setup



3.1.5 Test Result of 6dB Bandwidth

Please refer to Appendix A.

3.1.6 Test Result of 99% Occupied Bandwidth

Please refer to Appendix A.

3.2 Output Power Measurement

3.2.1 Limit of Output Power

For systems using digital modulation in the 2400-2483.5 MHz, the limit for output power is 30 dBm. If transmitting antenna of directional gain greater than 6 dBi is used, the peak output power from the intentional radiator shall be reduced below the above stated value by the amount in dB that the directional gain of the antenna exceeds 6 dBi. In case of point-to-point operation, the limit has to be reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

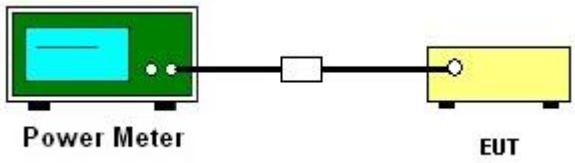
3.2.2 Measuring Instruments

Please refer to the measuring equipment list in this test report.

3.2.3 Test Procedures

1. For Peak Power, the testing follows ANSI C63.10 Section 11.9.1.3 PKPM1.
2. For Average Power, the testing follows ANSI C63.10 Section 11.9.2.3.2 Method AVGPM-G
3. The RF output of EUT is connected to the power meter by RF cable and attenuator.
4. The path loss is compensated to the results for each measurement.
5. Set the maximum power setting and enable the EUT to transmit continuously.
6. Measure the conducted output power and record the results in the test report.

3.2.4 Test Setup



3.2.5 Test Result of Peak Output Power

Please refer to Appendix A.

3.2.6 Test Result of Average Output Power (Reporting Only)

Please refer to Appendix A.

3.3 Power Spectral Density Measurement

3.3.1 Limit of Power Spectral Density

The peak power spectral density shall not be greater than 8 dBm in any 3 kHz band at any time interval of continuous transmission.

3.3.2 Measuring Instruments

Please refer to the measuring equipment list in this test report.

3.3.3 Test Procedures

1. The testing follows the ANSI C63.10 Section 11.10.2 Method PKPSD.
2. The RF output of EUT is connected to the spectrum analyzer by RF cable and attenuator. The path loss is compensated to the results for each measurement.
3. Set the maximum power setting and enable the EUT to transmit continuously.
4. Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 3 kHz. Video bandwidth (VBW) = 10 kHz. In order to make an accurate measurement, set the span to 1.5 times DTS Channel Bandwidth. (6 dB BW)
5. Detector = peak, Sweep time = auto couple, Trace mode = max hold, Allow trace to fully stabilize. Use the peak marker function to determine the maximum power level.
6. Measure and record the results in the test report.
7. The Measured power density (dBm)/ 100 kHz is a reference level and is used as 20 dBc down limit line for Conducted Band Edges and Conducted Spurious Emission.

3.3.4 Test Setup

3.3.5 Test Result of Power Spectral Density

Please refer to Appendix A.

3.4 Conducted Band Edges and Spurious Emission Measurement

3.4.1 Limit of Conducted Band Edges and Spurious Emission

All harmonics/spurious must be at least 20 dB down from the highest emission level within the authorized band.

3.4.2 Measuring Instruments

Please refer to the measuring equipment list in this test report.

3.4.3 Test Procedure

1. The testing follows the ANSI C63.10 Section 11.11.3 Emission level measurement.
2. The RF output of EUT is connected to the spectrum analyzer by RF cable and attenuator. The path loss is compensated to the results for each measurement.
3. Set the maximum power setting and enable the EUT to transmit continuously.
4. Set RBW = 100 kHz, VBW = 300 kHz, Peak Detector. Unwanted Emissions measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz when maximum peak conducted output power procedure is used. 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.
5. Measure and record the results in the test report.
6. The RF fundamental frequency should be excluded against the limit line in the operating frequency band.

3.4.4 Test Setup

3.4.5 Test Result of Conducted Band Edges Plots

Please refer to Appendix A.

3.4.6 Test Result of Conducted Spurious Emission Plots

Please refer to Appendix A.

3.5 Radiated Band Edges and Spurious Emission Measurement

3.5.1 Limit of Radiated Band Edges and Spurious Emission

In any 100 kHz bandwidth outside the intentional radiator frequency band, all harmonics/spurious must be at least 20 dB below the highest emission level within the authorized band. If the output power of this device is measured by spectrum analyzer, the attenuation 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 limits as below.

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30.0	30	30
30 – 88	100	3
88 – 216	150	3
216 - 960	200	3
Above 960	500	3

3.5.2 Measuring Instruments

Please refer to the measuring equipment list in this test report.

3.5.3 Test Procedures

1. The testing follows the ANSI C63.10 Section 11.12.1 Radiated emission measurements.
2. Measure the conducted output power (in dBm) using the peak detector.
3. Add the maximum transmit antenna gain (in dBi) to the measured output power level to determine the EIRP.
4. Add the appropriate maximum ground reflection factor to the EIRP (6 dB for frequencies ≤ 30 MHz; 4.7 dB for frequencies between 30 MHz and 1000 MHz, inclusive; and 0 dB for frequencies > 1000 MHz).
5. Convert the resultant EIRP to an equivalent electric field strength using the following relationship:

   E = EIRP − 20 log d + 104.8,

   where

   E is the electric field strength in dBμV/m

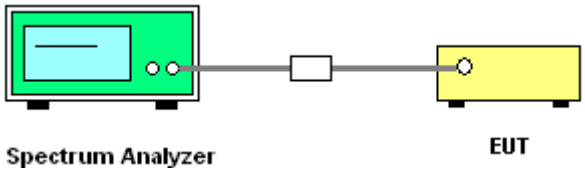
   EIRP is the equivalent isotropically radiated power in dBm

   d is the specified measurement distance in 3m
6. Compare the resultant electric field strength level with the applicable regulatory limit.
7. Corrected Reading for conducted spurious emission: Antenna Factor + Cable Loss + Read Level = Level
8. Perform the cabinet radiated spurious emission test.
9. The EUT is arranged to its worst case and then tune the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level.
10. The EUT is placed on a turntable with 0.8 meter for frequency below 1 GHz and 1.5 meter for frequency above 1 GHz respectively above ground.
11. The EUT is set 3 meters away from the receiving antenna, which is mounted on the top of a variable height antenna tower.
12. Corrected Reading for cabinet radiated spurious emission: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level
13. Radiated testing below 1 GHz is performed by adjusting the antenna tower from 1 m to 4 m and by rotating the turn table from 0 degree to 360 degrees to find the peak maximum hold reading. When there is no suspected emission found and the emission level is with at least 6 dB margin against QP limit line, the position is marked as “-“.
14. Radiated testing above 1 GHz is performed by adjusting the antenna tower from 1 m to 4 m and by rotating the turn table from 0 degree to 360 degrees to find the peak maximum hold reading for scanning all frequencies. When there is no suspected emission found and the harmonic emission level is with at least 6 dB margin against average limit line, the position is marked as “-“.

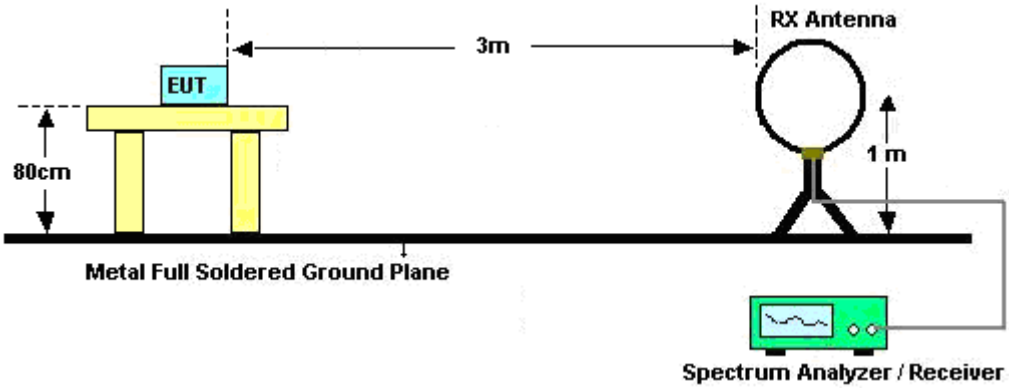
15. Use the following spectrum analyzer settings:
    (1) Span shall wide enough to fully capture the emission being measured;
    (2) Set RBW = 100 kHz for f < 1 GHz; VBW ≥ RBW; Sweep = auto; Detector function = peak; Trace = max hold;
    (3) Set RBW = 1 MHz, VBW = 3 MHz for f ≥ 1 GHz for peak measurement.
    (4) For average measurement when no duty cycling mode:
    • VBW = 10 Hz, when duty cycle is no less than 98 percent.
    • VBW ≥ 1/T, when duty cycle is less than 98 percent where T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.

3.5.4 Test Setup

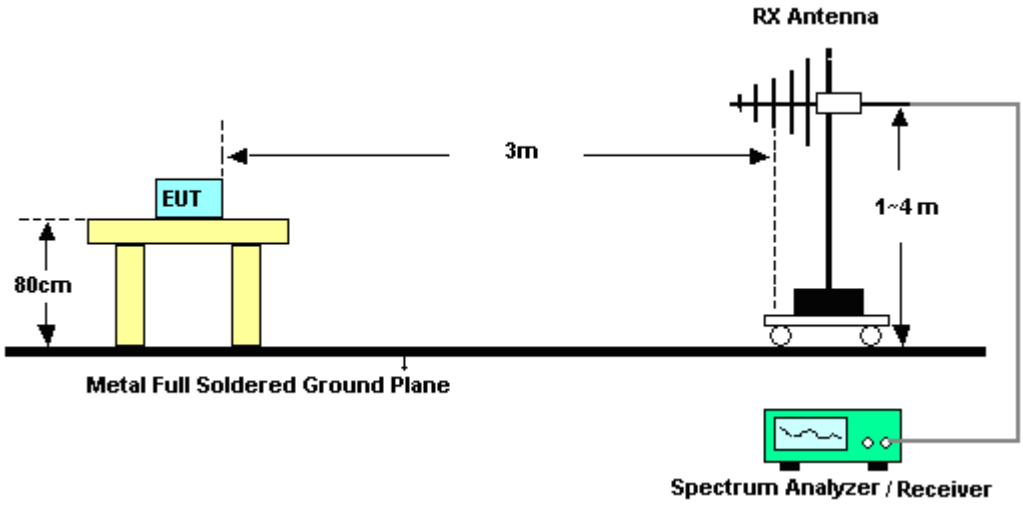
For Conducted Measurement Setup:



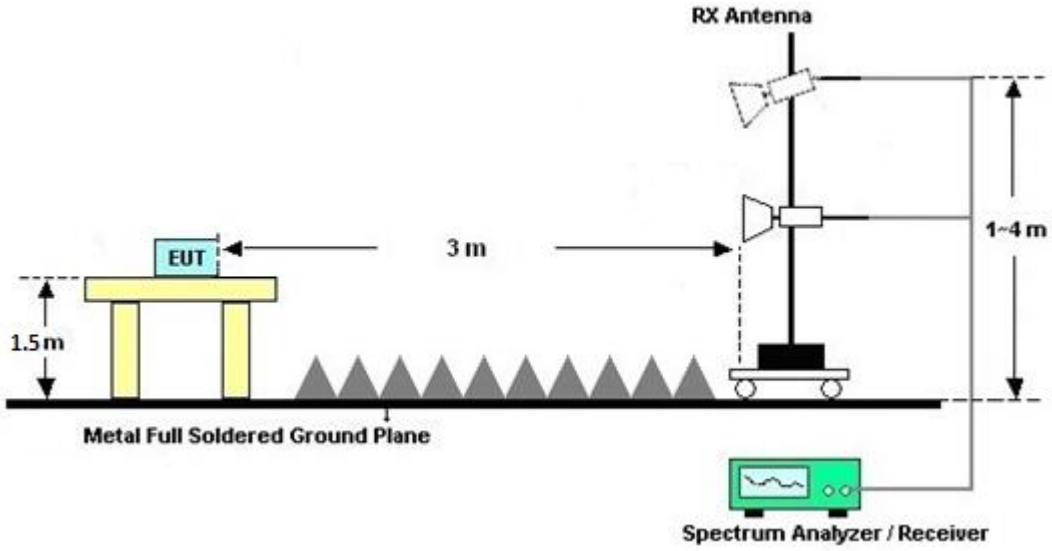
For radiated test below 30MHz



For radiated test from 30MHz to 1GHz



For radiated test above 1GHz



3.5.5 Test Results of Radiated Spurious Emissions (9 kHz ~ 30 MHz)

The low frequency, which starts from 9 kHz to 30 MHz, is pre-scanned and the result which is 20 dB lower than the limit line is not reported.

There is adequate comparison measurement of both open-field test site and alternative test site - semi-Anechoic chamber according to 414788 D01 Radiated Test Site v01r01, and the result comes out very similar.

3.5.6 Test Result of Conduced Spurious at Band Edges in the Restricted Band

Please refer to Appendix C and D.

3.5.7 Test Result of Conduced Spurious Emission in the Restricted Band

Please refer to Appendix C and D.

3.5.8 Test Result of Cabinet Radiated Spurious at Band Edges

Please refer to Appendix E and F.

3.5.9 Test Result of Cabinet Radiated Spurious Emission (30 MHz ~ 10th Harmonic)

Please refer to Appendix E and F.

3.5.10 Duty Cycle

Please refer to Appendix G.

3.6 AC Conducted Emission Measurement

3.6.1 Limit of AC Conducted Emission

For equipment that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table.

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

*Decreases with the logarithm of the frequency.

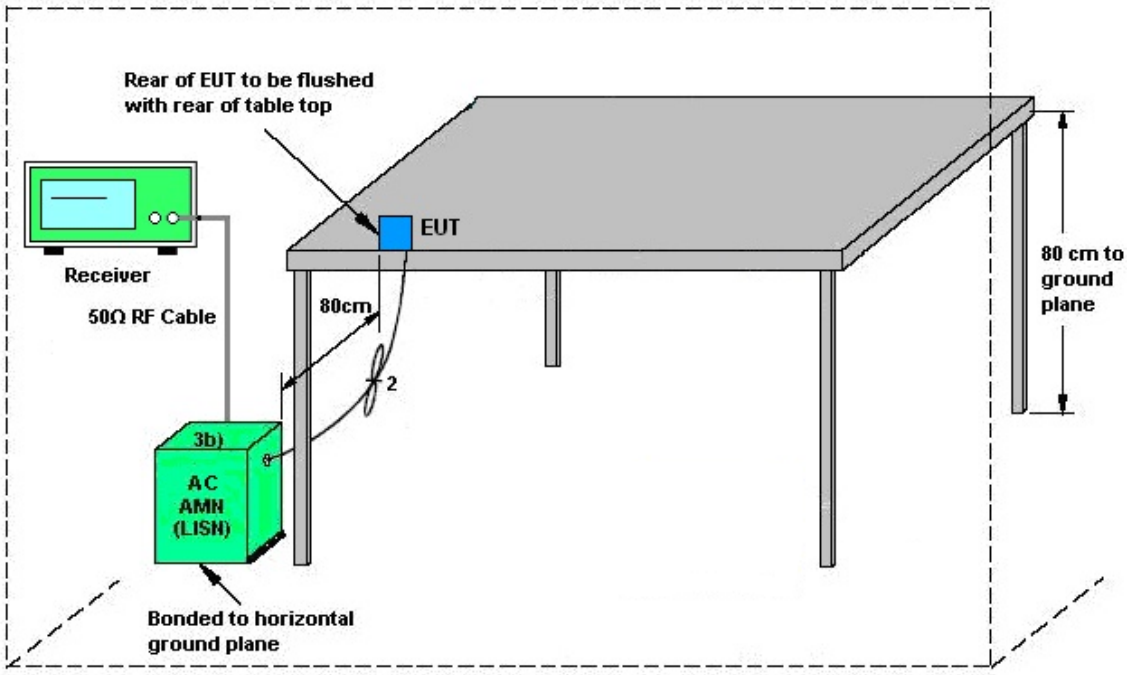
3.6.2 Measuring Instruments

Please refer to the measuring equipment list in this test report.

3.6.3 Test Procedures

1. The EUT is placed 0.4 meter away from the conducting wall of the shielding room, and is kept at least 80 centimeters from any other grounded conducting surface.
2. Connect EUT to the power mains through a line impedance stabilization network (LISN).
3. All the support units are connecting to the other LISN.
4. The LISN provides 50 ohm coupling impedance for the measuring instrument.
5. The FCC states that a 50 ohm, 50 microhenry LISN shall be used.
6. Both Line and Neutral shall be tested in order to find out the maximum conducted emission.
7. The frequency range from 150 kHz to 30 MHz is scanned.
8. Set the test-receiver system to Peak Detect Function and specified bandwidth (IF Bandwidth = 9 kHz) with Maximum Hold Mode. Then measurement is also conducted by Average Detector and Quasi-Peak Detector Function respectively.

3.6.4 Test Setup



AMN = Artificial mains network (LISN)
AE = Associated equipment
EUT = Equipment under test
ISN = Impedance stabilization network

3.6.5 Test Result of AC Conducted Emission

Please refer to Appendix B.

3.7 Antenna Requirements

3.7.1 Standard Applicable

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 rule.

3.7.2 Antenna Anti-Replacement Construction

An embedded-in antenna design is used.

4 List of Measuring Equipment

Instrument	Brand Name	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
Loop Antenna	Rohde & Schwarz	HFH2-Z2	100315	9 kHz~30 MHz	Feb. 28, 2023	Oct. 05, 2023~ Oct. 06, 2023	Feb. 27, 2024	Radiation (03CH13-HY)
Bilog Antenna	TESEQ	CBL 6111D & 00800N1D01N -06	40103 & 07	30MHz~1GHz	Apr. 23, 2023	Oct. 05, 2023~ Oct. 06, 2023	Apr. 22, 2024	Radiation (03CH13-HY)
Horn Antenna	SCHWARZBECK	BBHA 9120 D	9120D-1326	1GHz~18GHz	Aug. 17, 2023	Oct. 05, 2023~ Oct. 06, 2023	Aug. 16, 2024	Radiation (03CH13-HY)
Amplifier	SONOMA	310N	187282	9kHz~1GHz	Dec. 14, 2022	Oct. 05, 2023~ Oct. 06, 2023	Dec. 13, 2023	Radiation (03CH13-HY)
EMI Test Receiver	Agilent	N9038A(MXE)	MY53290045	20MHz~8.4GHz	Apr. 25, 2023	Oct. 05, 2023~ Oct. 06, 2023	Apr. 24, 2024	Radiation (03CH13-HY)
Spectrum Analyzer	Keysight	N9010A	MY55370526	10Hz~44GHz	Mar. 23, 2023	Oct. 05, 2023~ Oct. 06, 2023	Mar. 22, 2024	Radiation (03CH13-HY)
Preamplifier	MITEQ	AMF-7D-0010 1800-30-10P	1590074	1GHz~18GHz	May 16, 2023	Oct. 05, 2023~ Oct. 06, 2023	May 15, 2024	Radiation (03CH13-HY)
Preamplifier	EM Electronics	EM01G18G	060803	1GHz~18GHz	Jan. 10, 2023	Oct. 05, 2023~ Oct. 06, 2023	Jan. 09, 2024	Radiation (03CH13-HY)
Filter	Wainwright	WLK4-1000-15 30-8000-40SS	SN4	1.53GHz Low Pass Filter	Jun. 14, 2023	Oct. 05, 2023~ Oct. 06, 2023	Jun. 13, 2024	Radiation (03CH13-HY)
Filter	Wainwright	WHKX12-935-1000-15000-40 ST	SN1	1GHz High Pass Filter	Apr. 27, 2023	Oct. 05, 2023~ Oct. 06, 2023	Apr. 26, 2024	Radiation (03CH13-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	803951/2	9kHz~30MHz	Mar. 07, 2023	Oct. 05, 2023~ Oct. 06, 2023	Mar. 06, 2024	Radiation (03CH13-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 126E	0030/126E	30MHz~18GHz	Feb. 08, 2023	Oct. 05, 2023~ Oct. 06, 2023	Feb. 07, 2024	Radiation (03CH13-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 104	804793/4	30MHz~18GHz	Feb. 08, 2023	Oct. 05, 2023~ Oct. 06, 2023	Feb. 07, 2024	Radiation (03CH13-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 104	MY24961/4	30MHz~18GHz	Feb. 08, 2023	Oct. 05, 2023~ Oct. 06, 2023	Feb. 07, 2024	Radiation (03CH13-HY)
Antenna Mast	EMEC	AM-BS-4500-B	N/A	1m~4m	N/A	Oct. 05, 2023~ Oct. 06, 2023	N/A	Radiation (03CH13-HY)
Turn Table	EMEC	TT2000	N/A	0~360 Degree	N/A	Oct. 05, 2023~ Oct. 06, 2023	N/A	Radiation (03CH13-HY)
Software	Audix	N/A	RK-001124	N/A	N/A	Oct. 05, 2023~ Oct. 06, 2023	N/A	Radiation (03CH13-HY)

Instrument	Brand Name	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
AC Power Source	ChainTek	APC-1000W	N/A	N/A	N/A	Oct. 16, 2023	N/A	Conduction (CO05-HY)
EMI Test Receiver	Rohde & Schwarz	ESR3	102388	9kHz~3.6GHz	Dec. 01, 2022	Oct. 16, 2023	Nov. 30, 2023	Conduction (CO05-HY)
LISN	Rohde & Schwarz	ENV216	100080	9kHz~30MHz	Dec. 01, 2022	Oct. 16, 2023	Nov. 30, 2023	Conduction (CO05-HY)
LISN	Rohde & Schwarz	ENV216	100081	9kHz~30MHz	Nov. 17, 2022	Oct. 16, 2023	Nov. 16, 2023	Conduction (CO05-HY)
Software	Rohde & Schwarz	EMC32	N/A	N/A	N/A	Oct. 16, 2023	N/A	Conduction (CO05-HY)
Pulse Limiter	SCHWARZBECK	VTSD 9561-F N	00691	9kHz-200MHz	Jul. 28, 2023	Oct. 16, 2023	Jul. 27, 2024	Conduction (CO05-HY)
LISN Cable	MVE	RG-400	260260	N/A	Dec. 29, 2022	Oct. 16, 2023	Dec. 28, 2023	Conduction (CO05-HY)
Spectrum Analyzer	ROHDE & SCHWARZ	FSV40	101565	10Hz~40GHz	Dec. 26, 2022	Oct. 12, 2023	Dec. 25, 2023	CSE (TH05-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 126E	0058/126E	30MHz~18GHz	Feb. 08, 2023	Oct. 12, 2023	Feb. 07, 2024	CSE (TH05-HY)
Filter	Wainwright	WHKX12-1080-1200-15000-60ST	SN5	1.2GHz High Pass Filter	Jun. 14, 2023	Oct. 12, 2023	Jun. 13, 2024	CSE (TH05-HY)
Power Meter	Anritsu	ML2495A	0932001	N/A	Sep. 08, 2023	Oct. 03, 2023~ Oct. 12, 2023	Sep. 07, 2024	Conducted (TH05-HY)
Power Sensor	Anritsu	MA2411B	0846202	300MHz~40GHz	Sep. 08, 2023	Oct. 03, 2023~ Oct. 12, 2023	Sep. 07, 2024	Conducted (TH05-HY)
Signal Analyzer	Rohde & Schwarz	FSV40	101566	10Hz~40GHz	Aug. 23, 2023	Oct. 03, 2023~ Oct. 12, 2023	Aug. 22, 2024	Conducted (TH05-HY)

5 Measurement Uncertainty

Uncertainty of Conducted Emission Measurement (150 kHz ~ 30 MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**3.5 dB**

Uncertainty of Radiated Emission Measurement (30 MHz ~ 1000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**6.5 dB**

Uncertainty of Radiated Emission Measurement (1000 MHz ~ 6000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**4.4 dB**

Uncertainty of Radiated Emission Measurement (6000 MHz ~ 18000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**4.8 dB**

Appendix A. Test Result of Conducted Test Items

Test Engineer:	Mina Liu	Temperature:	21~25	°C
Test Date:	2023/10/3 ~ 2023/10/12	Relative Humidity:	51~54	%

TEST RESULTS DATA
6dB and 99% Occupied Bandwidth

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	99% Occupied BW (MHz)	6dB BW (MHz)	6dB BW Limit (MHz)	Pass/Fail
WB-DSSS	30 kbps	1	01	915	0.715	0.554	0.50	Pass

TEST RESULTS DATA
Peak Power Table

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	Peak Conducted Power (dBm)	Conducted Power Limit (dBm)	DG (dBi)	EIRP Power (dBm)	EIRP Power Limit (dBm)	Pass /Fail
WB-DSSS	30 kbps	1	1	915	13.80	30.00	2.69	16.49	36.00	Pass

TEST RESULTS DATA
Average Power Table
(Reporting Only)

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	Average Conducted Power (dBm)	Conducted Power Limit (dBm)	DG (dBi)	EIRP Power (dBm)	EIRP Power Limit (dBm)	Pass /Fail
WB-DSSS	30 kbps	1	01	915	13.55	30.00	2.69	16.24	36.00	Pass

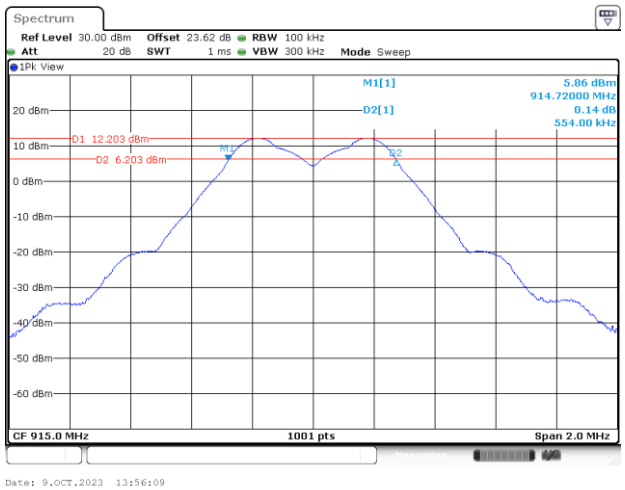
TEST RESULTS DATA
Peak Power Density

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	Peak PSD (dBm /100kHz)	Peak PSD (dBm /3kHz)	DG (dBi)	Peak PSD Limit (dBm /3kHz)	Pass/Fail
WB-DSSS	30 kbps	1	01	915	12.23	6.39	2.69	8.00	Pass

Note: PSD (dBm/ 100kHz) is a reference level used for Conducted Band Edges and Conducted Spurious Emission 20dBc limit.

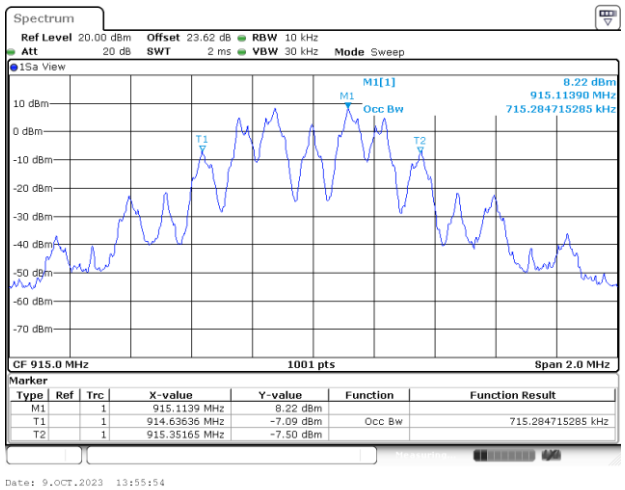
6dB Bandwidth

6 dB Bandwidth Plot on Channel 01



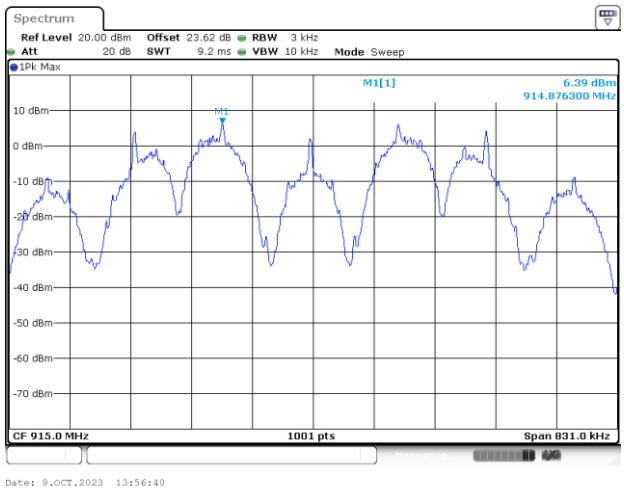
99% Occupied Bandwidth

99% Occupied Bandwidth Plot on Channel 01

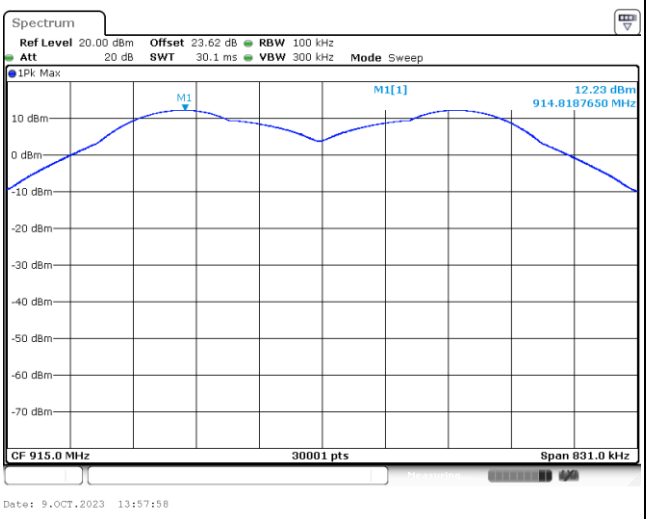
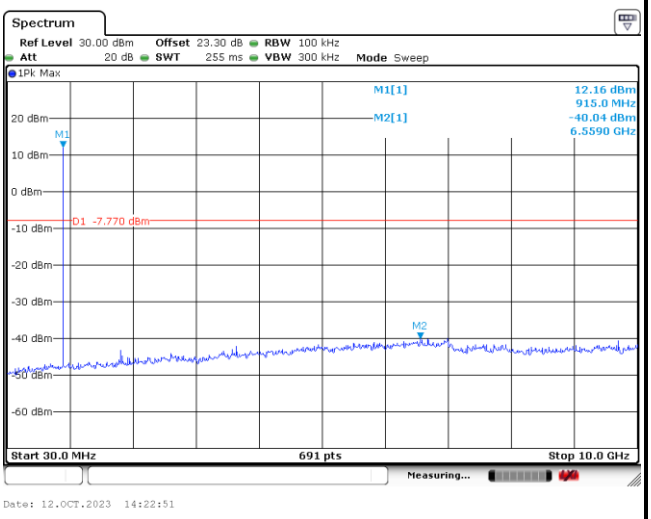
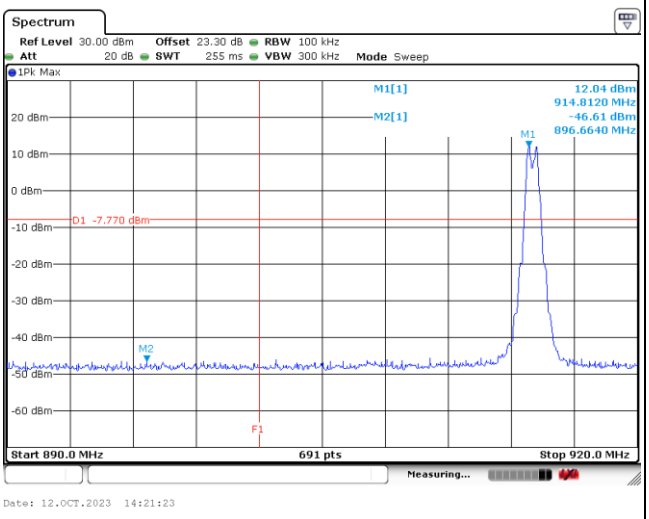
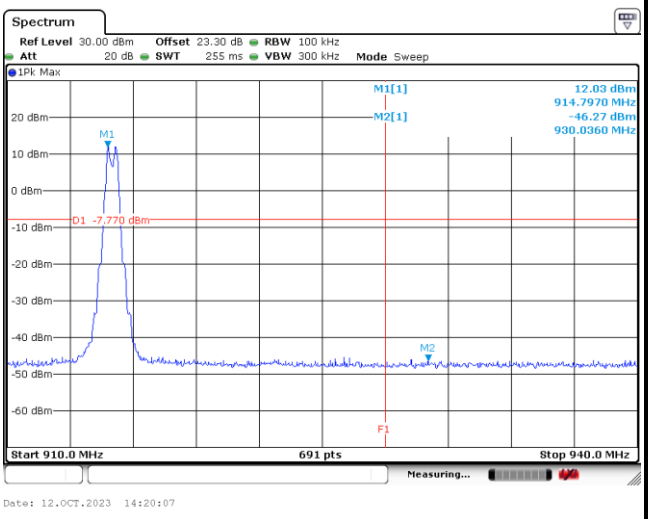


Note: The occupied channel bandwidth is maintained within the band of operation for all of the modulations.

Power Spectral Density (dBm/3kHz)

Power Density (dBm/3kHz) Plot Channel 01	
	

Band Edge and Spurious Emission

100kHz PSD reference Level Plot	Spurious Emission 30MHz~10GHz Plot
	
Band Edge Plot	**Band Edge Plot**
	

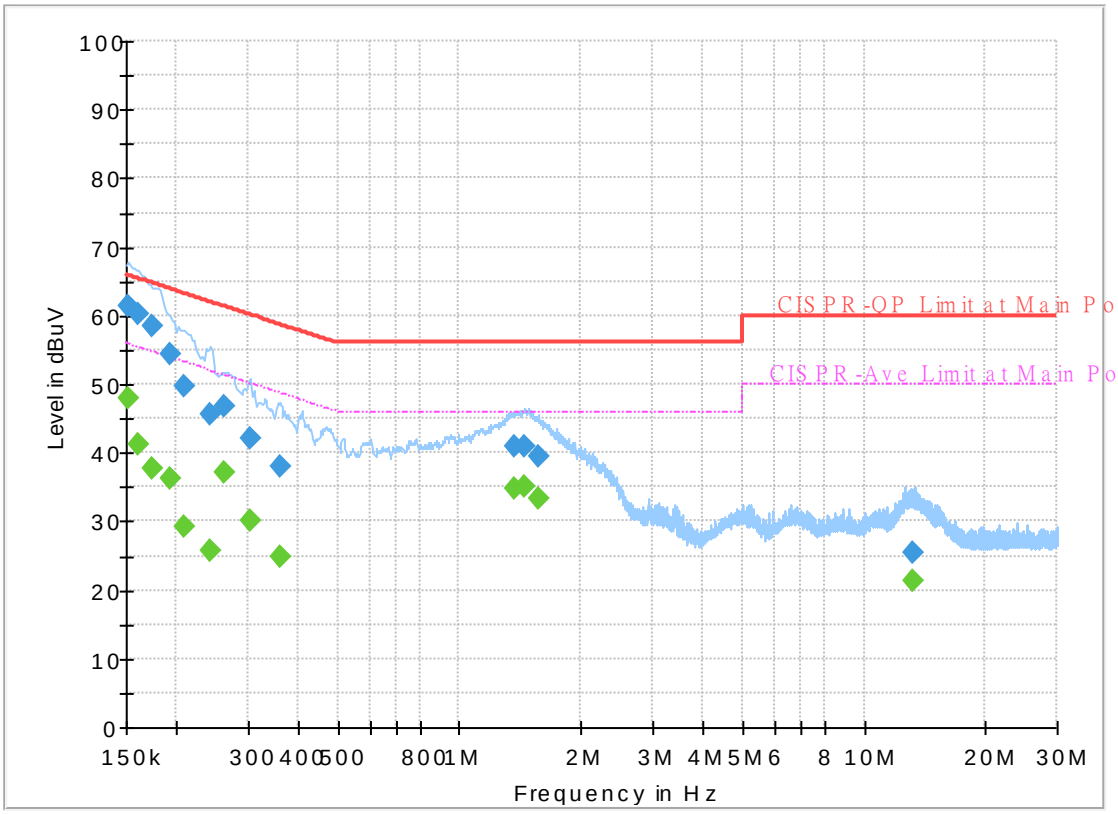
Appendix B. AC Conducted Emission Test Results

Test Engineer :	Calvin Wang	**Temperature :**	23~26℃
		Relative Humidity :	45~55%

EUT Information

Report NO :	341305-01
Test Mode :	Mode 1
Test Voltage :	Power From System
Phase :	Line

Full Spectrum



Final_Result

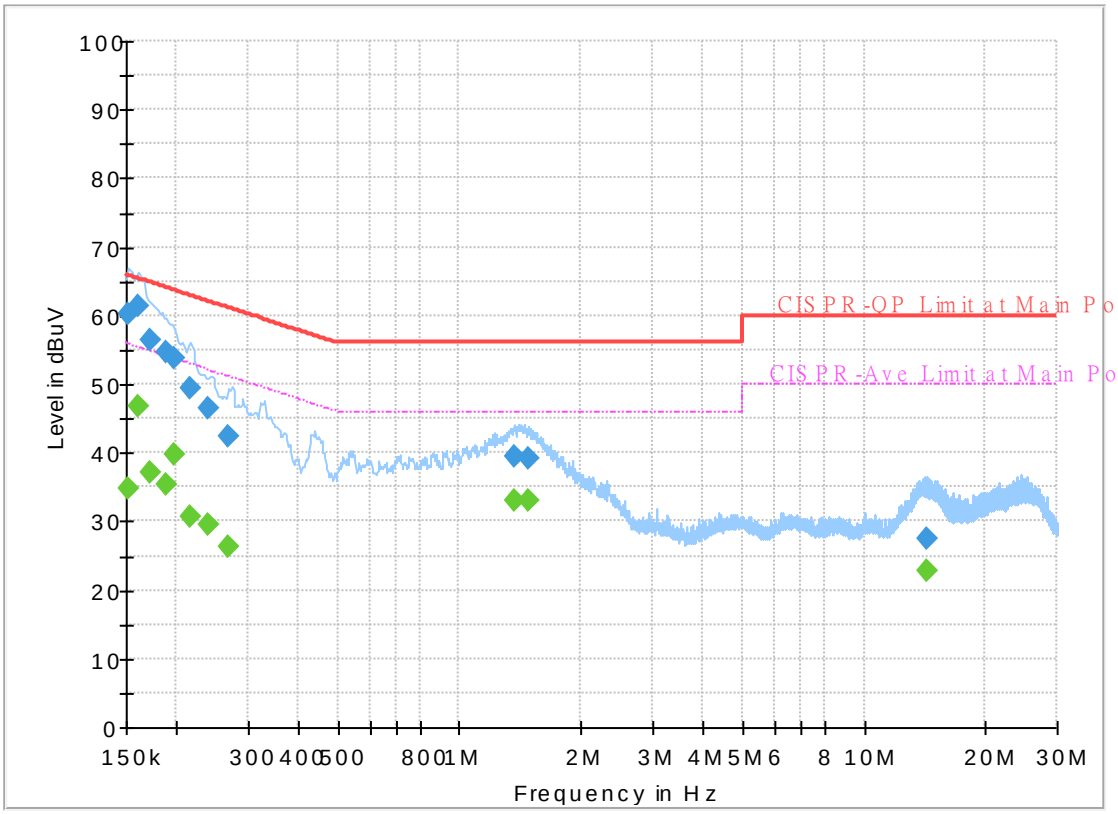
Frequency (MHz)	QuasiPeak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Line	Filter	Corr. (dB)
0.152250	---	47.82	55.88	8.06	L1	OFF	19.8
0.152250	61.31	---	65.88	4.57	L1	OFF	19.8
0.161250	---	41.21	55.40	14.19	L1	OFF	19.8
0.161250	60.20	---	65.40	5.20	L1	OFF	19.8
0.174750	---	37.86	54.73	16.87	L1	OFF	19.8
0.174750	58.48	---	64.73	6.25	L1	OFF	19.8
0.192750	---	36.40	53.92	17.52	L1	OFF	19.8
0.192750	54.53	---	63.92	9.39	L1	OFF	19.8
0.208500	---	29.13	53.27	24.14	L1	OFF	19.8
0.208500	49.78	---	63.27	13.49	L1	OFF	19.8
0.242250	---	25.66	52.02	26.36	L1	OFF	19.8
0.242250	45.58	---	62.02	16.44	L1	OFF	19.8
0.262500	---	37.00	51.35	14.35	L1	OFF	19.8
0.262500	46.90	---	61.35	14.45	L1	OFF	19.8
0.303000	---	30.26	50.16	19.90	L1	OFF	19.8
0.303000	42.11	---	60.16	18.05	L1	OFF	19.8
0.359250	---	24.83	48.75	23.92	L1	OFF	19.8
0.359250	38.12	---	58.75	20.63	L1	OFF	19.8
1.369500	---	34.73	46.00	11.27	L1	OFF	19.8
1.369500	41.02	---	56.00	14.98	L1	OFF	19.8
1.455000	---	35.13	46.00	10.87	L1	OFF	19.8

1.455000	40.87	---	56.00	15.13	L1	OFF	19.8
1.576500	---	33.22	46.00	12.78	L1	OFF	19.9
1.576500	39.41	---	56.00	16.59	L1	OFF	19.9
13.281000	---	21.20	50.00	28.80	L1	OFF	19.9
13.281000	25.38	---	60.00	34.62	L1	OFF	19.9

EUT Information

Report NO :	341305-01
Test Mode :	Mode 1
Test Voltage :	Power From System
Phase :	Neutral

Full Spectrum



Final_Result

Frequency (MHz)	QuasiPeak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Line	Filter	Corr. (dB)
0.152250	---	34.85	55.88	21.03	N	OFF	19.8
0.152250	60.32	---	65.88	5.56	N	OFF	19.8
0.161250	---	46.68	55.40	8.72	N	OFF	19.8
0.161250	61.30	---	65.40	4.10	N	OFF	19.8
0.172500	---	37.00	54.84	17.84	N	OFF	19.8
0.172500	56.55	---	64.84	8.29	N	OFF	19.8
0.188250	---	35.36	54.11	18.75	N	OFF	19.8
0.188250	54.76	---	64.11	9.35	N	OFF	19.8
0.197250	---	39.82	53.73	13.91	N	OFF	19.8
0.197250	53.82	---	63.73	9.91	N	OFF	19.8
0.215250	---	30.61	53.00	22.39	N	OFF	19.8
0.215250	49.48	---	63.00	13.52	N	OFF	19.8
0.240000	---	29.50	52.10	22.60	N	OFF	19.8
0.240000	46.38	---	62.10	15.72	N	OFF	19.8
0.269250	---	26.17	51.14	24.97	N	OFF	19.8
0.269250	42.44	---	61.14	18.70	N	OFF	19.8
1.374000	---	32.92	46.00	13.08	N	OFF	19.8
1.374000	39.44	---	56.00	16.56	N	OFF	19.8
1.477500	---	32.93	46.00	13.07	N	OFF	19.8
1.477500	39.32	---	56.00	16.68	N	OFF	19.8
14.286750	---	22.70	50.00	27.30	N	OFF	20.0

14.286750	**27.42**	**---**	**60.00**	**32.58**	**N**	**OFF**	**20.0**

Appendix C. Conducted Spurious Emission

Test Engineer :	Ken Wu	Temperature :	24.2~25.3°C
		Relative Humidity :	58~67%

<14 dBm and antenna gain 2.69 dBi>

WB-DSSS, 30 kbps (480 ksps), 195 kHz Deviation, 2-GFSK, 784 kHz RX Bandwidth

(30 MHz ~ 1 GHz)

Mode	Note	Frequency (MHz)	Level (dBm)	Over Limit (dB)	Limit Line (dBm)	Read Level (dBm)	Antenna Factor (dBi)	Path Loss (dB)	MIMO Factor (dB)	Grounding Factor (dB)	Peak QP. (P/Q)
CH 01 915 MHz		457.5	-50.59	-1.39	-49.2	-58.5	2.69	0.52	0	4.7	P
		771.8	-55.68	-6.48	-49.2	-63.85	2.69	0.78	0	4.7	P
		867.7	-53.46	-4.26	-49.2	-61.66	2.69	0.81	0	4.7	P
		901.3	-53.47	-4.27	-49.2	-61.75	2.69	0.89	0	4.7	P
	*	915	20.55	-	-	12.27	2.69	0.89	0	4.7	P
		931.4	-52.74	-3.54	-49.2	-61.07	2.69	0.94	0	4.7	P
		963.6	-50.42	-9.22	-41.2	-58.75	2.69	0.94	0	4.7	P
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.										

WB-DSSS, 30 kbps (480 ksps), 195 kHz Deviation, 2-GFSK, 784 kHz RX Bandwidth

(1 GHz ~ 10 GHz)

Mode	Note	Frequency	Level	Over	Limit	Read	Antenna	Path	MIMO	Grounding	Peak
				Limit	Line	Level	Gain	Loss	Factor	Factor	Avg.
		(MHz)	(dBm)	(dB)	(dBm)	(dBm)	(dBi)	(dB)	(dB)	(dB)	(P/A)
CH 01 915 MHz		1372.5	-56.22	-35.02	-21.2	-60.58	2.69	1.67	0	0	P
	#	1830	-38.58	-	-	-42.44	2.69	1.17	0	0	P
		2745	-48.01	-26.81	-21.2	-51.84	2.69	1.14	0	0	P
		3660	-37.63	-16.43	-21.2	-41.55	2.69	1.23	0	0	P
		3660	-43.13	-1.93	-41.2	-47.05	2.69	1.23	0	0	A
		4575	-53.09	-31.89	-21.2	-56.86	2.69	1.08	0	0	P
		7320	-60.57	-39.37	-21.2	-64.65	2.69	1.39	0	0	P
		8235	-69.53	-48.33	-21.2	-73.79	2.69	1.57	0	0	P
		9150	-65.47	-44.27	-21.2	-69.86	2.69	1.7	0	0	P
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.										

Note symbol

*	**Fundamental Frequency** which can be ignored. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.
#	The unwanted signal can be ignored since it falls within the non-restricted band and meet the requirements of 15.247 (d).
!	Test result is **over limit** line.
P/A	**P**eak or **A**verage
H/V	**H**orizontal or **V**ertical

A calculation example for conducted spurious emission is shown as below:

	Note	Frequency	Level	Over	Limit	Read	Antenna	Path	MIMO	Grounding	Peak
				Limit	Line	Level	Factor	Loss	Factor	Factor	Avg.
		(MHz)	(dBm)	(dB)	(dBm)	(dBm)	(dBi)	(dB)	(dB)	(dB)	(P/A)
CH 01 912.75 MHz		1825.5	-38.76	-17.56	-21.2	-42.5	2.69	1.05	0	0	P
		1825.5	-42.33	-1.13	-41.2	-46.07	2.69	1.05	0	0	A

1. Path Loss(dB) = Cable loss(dB) + Filter loss(dB) + Attenuator loss(dB)
2. Level(dBm) =

Antenna Factor(dBi) + Path Loss(dB) + Read Level(dBm)

3. Over Limit(dB) = Level(dBm) – Limit Line(dBm)

For Peak Limit @ 1825.5 MHz:

1. Level(dBm)

= Antenna Factor(dBi) + Path Loss(dB) + Read Level(dBm)

= 2.69(dBi) + 1.05(dB) – 42.5(dBm)

= -38.76 (dBm)

2. Over Limit(dB)

= Level(dBm) – Limit Line(dBm)

= -38.76(dBm) +21.2(dBm)

= -17.56(dB)

For Average Limit @ 1825.5MHz:

1. Level(dBm)

= Antenna Factor(dBi) + Path Loss(dB) + Read Level(dBm)

= 2.69(dBi) + 1.05(dB) – 46.07(dBm)

= -42.33 (dBm)

2. Over Limit(dB)

= Level(dBm) – Limit Line(dBm)

= -42.33(dBm) + 41.2(dBm)

= -1.13(dB)

Both peak and average measured complies with the limit line, so test result is "PASS".

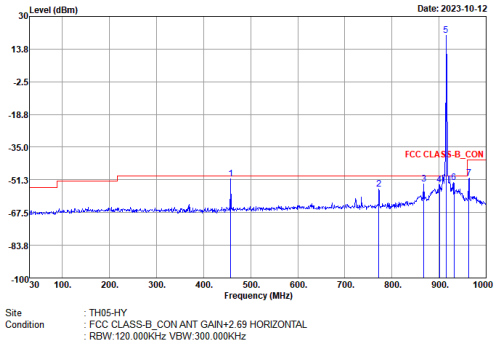
Appendix D. Conducted Spurious Emission Plots

Test Engineer :	Ken Wu	**Temperature :**	24.2~25.3°C
		Relative Humidity :	58~67%

<14 dBm and antenna gain 2.69 dBi>

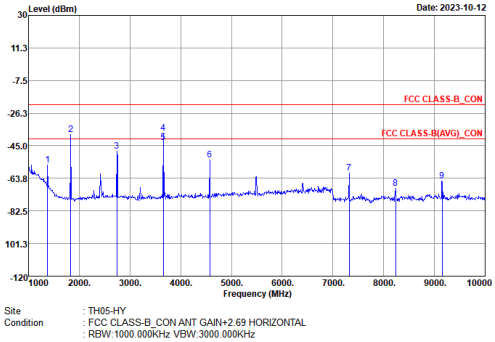
WB-DSSS, 30 kbps (480 ksps), 195 kHz Deviation, 2-GFSK, 784 kHz RX Bandwidth

(30 MHz ~ 1 GHz)

	902 MHz ~ 928 MHz
	CH01 915 MHz
Peak **QP**	

WB-DSSS, 30 kbps (480 ksps), 195 kHz Deviation, 2-GFSK, 784 kHz RX Bandwidth

(1 GHz ~ 10 GHz)

	902 MHz ~ 928 MHz
	CH01 915 MHz
Peak Avg.	

Remark: The unwanted signal of 2nd Harmonic in plot falls within the non-restricted band and meet the requirements of 15.247 (d).

Appendix E. Cabinet Radiated Spurious Emission

Test Engineer :	Jacky Hung	Temperature :	20~26°C
		Relative Humidity :	40~65%

<14 dBm>

WB-DSSS, 30 kbps (480 ksps), 195 kHz Deviation, 2-GFSK, 784 kHz RX Bandwidth

(30 MHz ~ 1 GHz @ 3m)

Mode	Note	Frequency (MHz)	Level (dBµV/m)	Margin (dB)	Limit Line (dBµV/m)	Read Level (dBµV)	Antenna Factor (dB/m)	Path Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
CH01 915MHz		120.18	22.33	-21.17	43.5	35.62	17.57	1.29	32.15	-	-	P	H
		264.09	25.45	-20.55	46	35.39	20.37	1.75	32.06	-	-	P	H
		288.12	26.01	-19.99	46	37.08	19.17	1.82	32.06	-	-	P	H
		552	35.22	-10.78	46	39.31	25.66	2.35	32.1	-	-	P	H
		903.4	33.01	-12.99	46	32.38	28.97	3.01	31.35	-	-	P	H
	*	915	63.58	-	-	62.66	29.14	3.04	31.26	100	357	P	H
		954.5	33.17	-12.83	46	30.16	30.84	3.09	30.92			P	H
													H
													H
		31.35	21.8	-18.2	40	28.72	24.4	0.84	32.16	-	-	P	V
		135.84	18.21	-25.29	43.5	31.28	17.71	1.32	32.1	-	-	P	V
		263.82	20.65	-25.35	46	30.59	20.37	1.75	32.06	-	-	P	V
		552	30.65	-15.35	46	34.74	25.66	2.35	32.1	-	-	P	V
		833.4	31.07	-14.93	46	31.39	28.46	2.9	31.68	-	-	P	V
	*	915	55.68	-	-	54.76	29.14	3.04	31.26	100	135	P	V
		951.7	32.89	-13.11	46	30.12	30.63	3.09	30.95	-	-	P	V
													V
													V

Remark

1. No other spurious found.
2. All results are PASS against limit line.
3. The emission position marked as "-" means no suspected emission found and emission level has at least 6dB margin against limit or emission is noise floor only.

WB-DSSS, 30 kbps (480 ksps), 195 kHz Deviation, 2-GFSK, 784 kHz RX Bandwidth

(1 GHz ~ 10 GHz @ 3m)

Mode	Note	Frequency (MHz)	Level (dBµV/m)	Margin (dB)	Limit Line (dBµV/m)	Read Level (dBµV)	Antenna Factor (dB/m)	Path Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
		2745	35.47	-38.53	74	59.33	28.1	5.47	57.43	-	-	P	H
		3660	37.84	-36.16	74	60.02	29.74	6.39	58.31	-	-	P	H
													H
													H
													H
													H
													H
CH01													H
915MHz		2745	35.34	-38.66	74	59.2	28.1	5.47	57.43	-	-	P	V
		3660	37.75	-36.25	74	59.93	29.74	6.39	58.31	-	-	P	V
													V
													V
													V
													V
													V
													V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line. 3. The emission position marked as "-" means no suspected emission found with sufficient margin against limit line or noise floor only.												

Note symbol

*	**Fundamental Frequency** which can be ignored. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.
!	Test result is **Margin** line.
P/A	**P**eak or **A**verage
H/V	**H**orizontal or **V**ertical

A calculation example for radiated spurious emission is shown as below:

Mode	Note	Frequency (MHz)	Level (dBμV/m)	Margin (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Path Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
CH 01		2390	55.45	-18.55	74	54.51	32.22	4.58	35.86	103	308	P	H
2402MHz		2390	43.54	-10.46	54	42.6	32.22	4.58	35.86	103	308	A	H

1. Path Loss(dB) = Cable loss(dB) + Filter loss(dB) + Attenuator loss(dB)
2. Level(dBμV/m) =

Antenna Factor(dB/m) + Path Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)

3. Margin(dB) = Level(dBμV/m) – Limit Line(dBμV/m)

For Peak Limit @ 2390MHz:

1. Level(dBμV/m)

= Antenna Factor(dB/m) + Path Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)

= 32.22(dB/m) + 4.58(dB) + 54.51(dBμV) – 35.86 (dB)

= 55.45 (dBμV/m)

2. Margin(dB)

= Level(dBμV/m) – Limit Line(dBμV/m)

= 55.45(dBμV/m) – 74(dBμV/m)

= -18.55(dB)

For Average Limit @ 2390MHz:

1. Level(dBμV/m)

= Antenna Factor(dB/m) + Path Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)

= 32.22(dB/m) + 4.58(dB) + 42.6(dBμV) – 35.86 (dB)

= 43.54 (dBμV/m)

2. Margin(dB)

= Level(dBμV/m) – Limit Line(dBμV/m)

= 43.54(dBμV/m) – 54(dBμV/m)

= -10.46(dB)

Both peak and average measured complies with the limit line, so test result is "PASS".

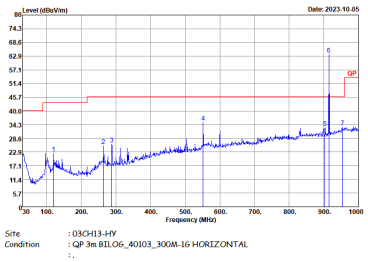
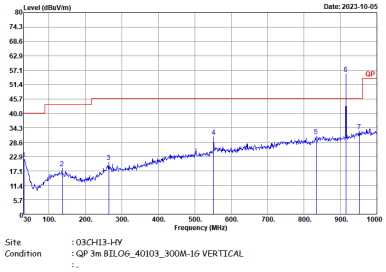
Appendix F. Cabinet Radiated Spurious Emission Plots

Test Engineer :	Jacky Hung	Temperature :	20~26°C
		Relative Humidity :	40~65%

<14 dBm>

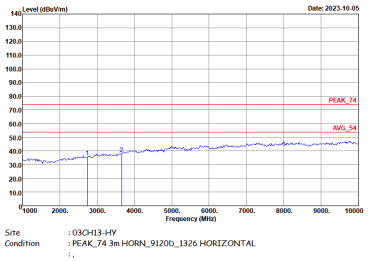
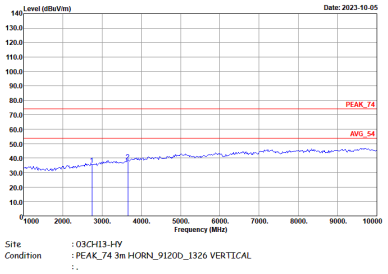
WB-DSSS, 30 kbps (480 ksps), 195 kHz Deviation, 2-GFSK, 784 kHz RX Bandwidth

(30 MHz ~ 1 GHz @ 3m)

	CH01 915 MHz	
	Horizontal	Vertical
Peak / QP		

WB-DSSS, 30 kbps (480 ksps), 195 kHz Deviation, 2-GFSK, 784 kHz RX Bandwidth

(1 GHz ~ 10 GHz @ 3m)

	CH01 915 MHz	
	Horizontal	**Vertical**
Peak **Avg.**		

Appendix G. Duty Cycle Plots

Band	Duty Cycle(%)	T(us)	1/T(kHz)	VBW Setting
WB-DSSS	100.00	-	-	10Hz

WB-DSSS