

Client: Vutiliti

Date: 28 Feb 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

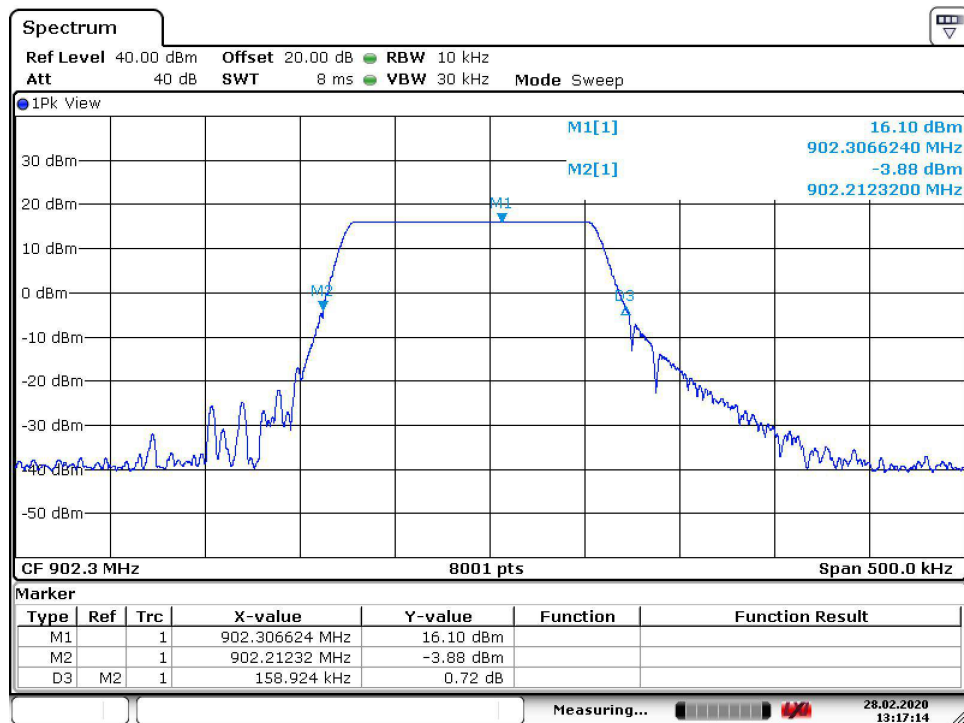
Requirement: 20dB Bandwidth less than 500kHz

Tech: CL Payne

Low Channel: 902.3

20dB Bandwidth = 158.924kHz

Result: Pass



Date: 28.FEB.2020 13:17:14

Client: Vutiliti

Date: 28 Feb 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

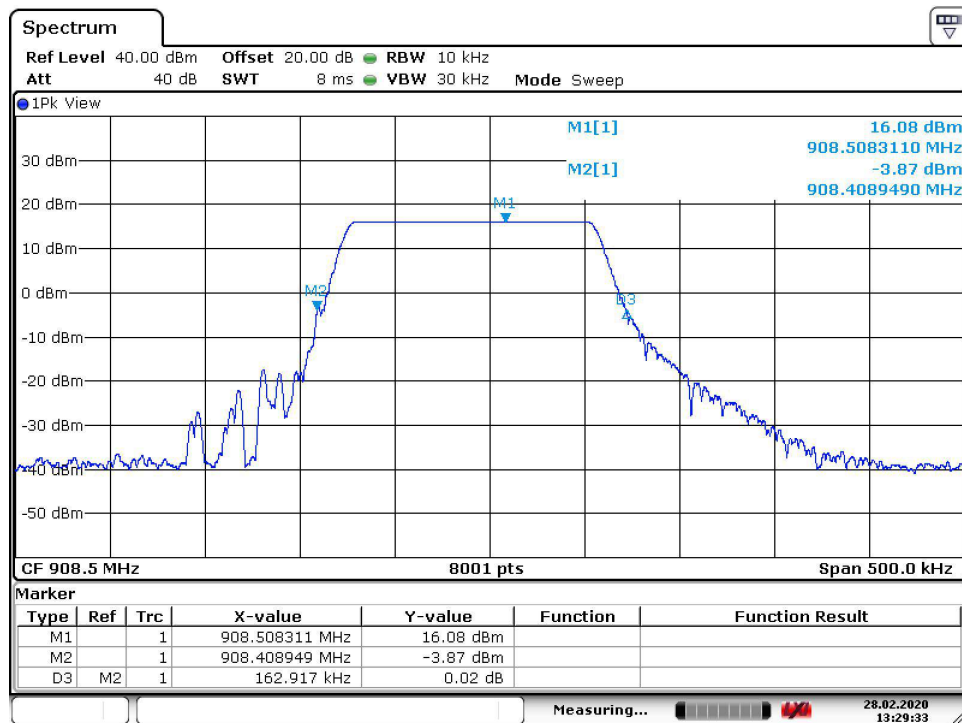
Requirement: 20dB Bandwidth less than 500kHz

Tech: CL Payne

Middle Channel: 908.5

20dB Bandwidth = 162.917kHz

Result: Pass



Date: 28.FEB.2020 13:29:33

Client: Vutiliti

Date: 28 Feb 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

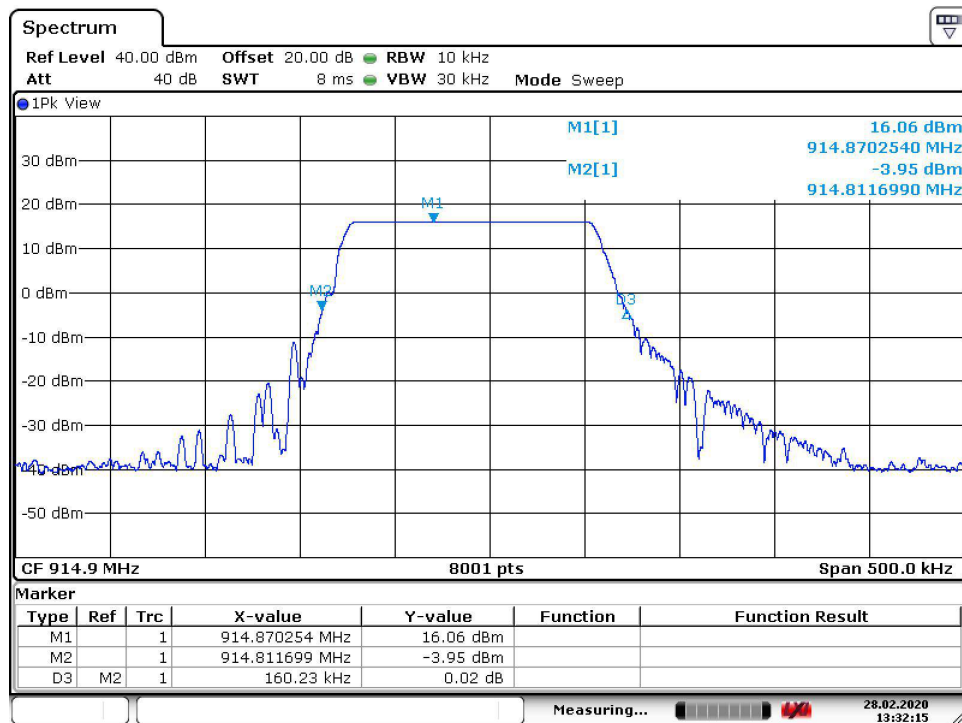
Requirement: 20dB Bandwidth less than 500kHz

Tech: CL Payne

High Channel: 914.9

20dB Bandwidth = 160.230kHz

Result: Pass



Date: 28.FEB.2020 13:32:15

Conducted spurious emissions shall be measured for the transmit frequency, per 5.5 and 5.6, and at the maximum transmit powers.

Connect the primary antenna port through an attenuator to the spectrum analyzer input; in the results, account for all losses between the unlicensed wireless device output and the spectrum analyzer. The instrument shall span 30 MHz to 10 times the operating frequency in GHz, with a resolution bandwidth of 100 kHz, video bandwidth of 300 kHz, and a coupled sweep time with a peak detector. The band 30 MHz to the highest frequency may be split into smaller spans, as long as the entire spectrum is covered.

Requirement: FCC Part 15.247 Clause (d)

- (d) 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.

Client: Vutiliti

Date: 7 Mar 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

Requirement: Conducted spurious emission <20dB of peak

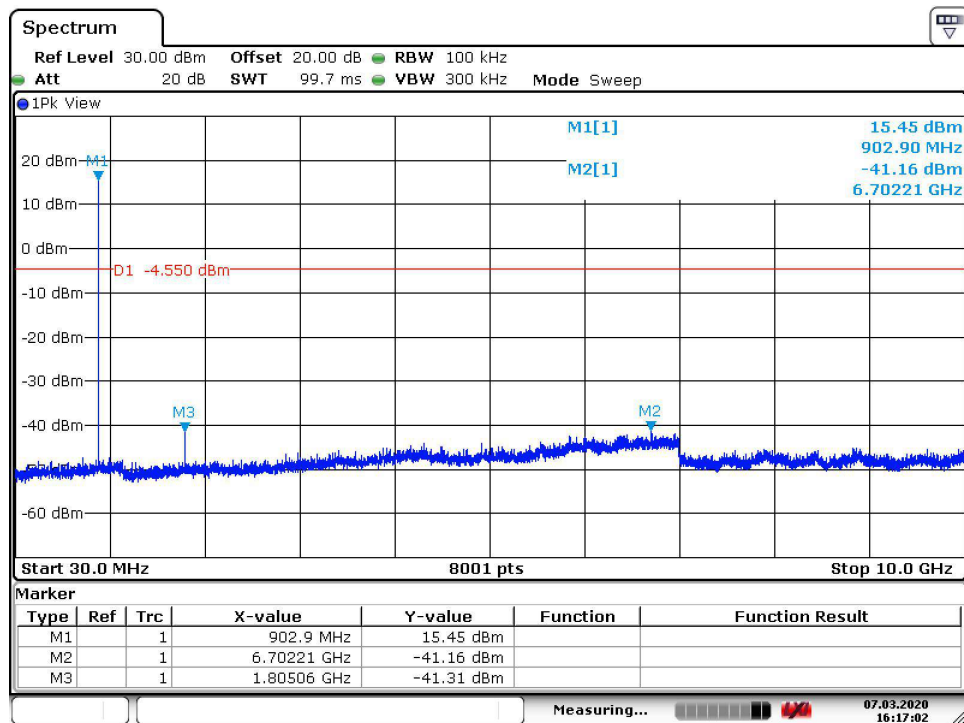
Tech: CL Payne

Low Channel: 902.3

Maximum Reading = 15.45 dBm

Requirement = -4.55dBm

Result: Pass



Date: 7.MAR.2020 16:17:02

Client: Vutiliti

Date: 7 Mar 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

Requirement: Conducted spurious emission <20dB of peak

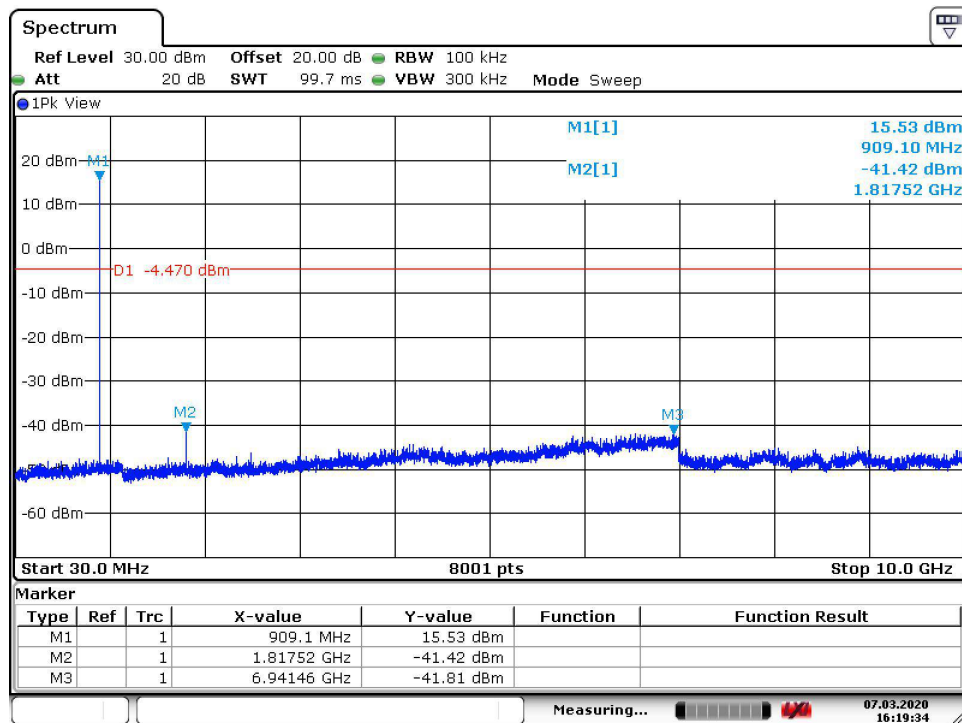
Tech: CL Payne

Middle Channel: 908.5

Maximum Reading = 15.53 dBm

Requirement = -4.47dBm

Result: Pass



Date: 7.MAR.2020 16:19:34

Client: Vutiliti

Date: 7 Mar 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

Requirement: Conducted spurious emission <20dB of peak

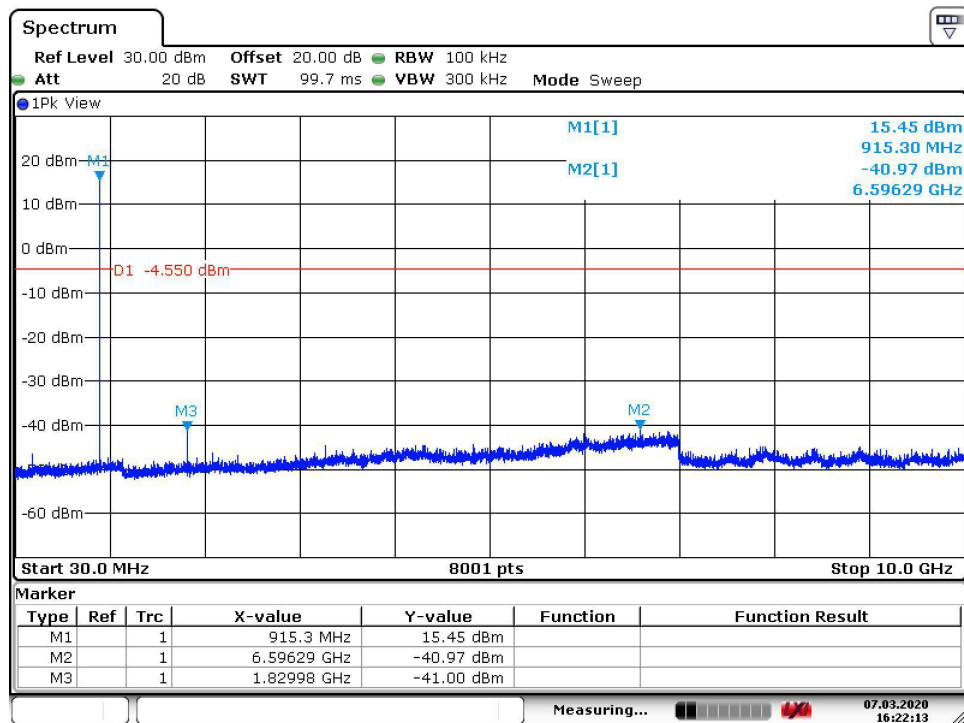
Tech: CL Payne

High Channel: 914.9

Maximum Reading = 15.45 dBm

Requirement = -4.55dBm

Result: Pass



Date: 7.MAR.2020 16:22:12

An additional consideration when performing conducted measurements of restricted-band emissions is that unwanted emissions radiating from the EUT cabinet, control circuits, power leads, or intermediate circuit elements will likely go undetected in a conducted measurement configuration. To address this concern, a radiated test shall be performed to ensure that emissions emanating from the EUT cabinet (rather than from the antenna port) also comply with the applicable limits.

For these cabinet radiated spurious emission measurements, the EUT transmit antenna may be replaced with a termination matching the nominal impedance of the antenna. Procedures for performing radiated measurements are specified in 6.3, 6.5, and 6.6. All detected emissions shall comply with the applicable requirements.

This test is required for any spurious emission or modulation product that falls in an Unrestricted Band, as defined in Section 15.209. It must be performed with the highest gain of each type of antenna proposed for use with the EUT. Use the following spectrum analyzer settings:

Span	=	wide enough to fully capture the emission being measured
RBW	=	1 MHz for $f \geq 1$ GHz, 100 kHz for $f < 1$ GHz
VBW	=	$\geq$ RBW
Sweep	=	auto
Detector function	=	peak
Trace	=	max hold

Follow the guidelines in ANSI C63.10-2013 with respect to maximizing the emission by rotating the EUT, measuring the emission while the EUT is situated in three orthogonal planes (if appropriate), adjusting the measurement antenna height and polarization, etc. A pre-amp and a high pass filter are required for this test, in order to provide the measuring system with sufficient sensitivity. Allow the trace to stabilize. The peak reading of the emission, after being corrected by the antenna factor, cable loss, pre-amp gain, etc., is the peak field strength, which must comply with the limit specified in Section 15.35(b). Submit this data.

Now repeat the measurement using the average detector of the spectrum analyzer. Submit this data.

Note 1: Limit listed is the general limit as specified in 15.209 in order to show compliance with the restricted bands of operation as well as the out of band limit in 15.247. No other identifiable signals were observed in the restricted bands as specified in 15.205.

Note 2: Highest frequency investigated was the tenth harmonic of the fundamental, no radiated emissions were detected above the 3rd harmonic.

Note 3: This module can operate with the BLE and the LoRa (125kHz FHSS) simultaneously OR the BLE and the LoRa (500kHz DTS) simultaneously. The worst case of each is listed within this test report by associated transmitter. Therefore, the following data sheets are organized by 125kHz LoRa plus BLE, Low, Mid, High Channels, and X, Y, Z axis.

Note 4: For radiated spurious testing the transmitter module used the onboard BTLE chip antenna and the 2inch SMA antenna for the LoRa 125kHz FHSS and the LoRa 500kHz DTS.

Note 5: Both the 2 Inch and 8 Inch antennas were evaluated and showed no significant difference in output power. Both antennas have a published gain of 2dBi.

Requirement: FCC Part 15.247 Clause (d)

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, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required.

Client: Vutiliti

Date: 7 Mar 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

Requirement: General limit of 15.209

Tech: CL Payne

Low Channel: 902.3 LoRa 125kHz FHSS

Low Channel: 2402 BLE

EUT Axis = X

Receive Ant = Horizontal

Result: Pass

RADIATED SPURIOUS								
Freq (MHz)	Meter (dBuV/m)	Pre-Amp (dB)	Cable (dB)	Antenna (dB)	Corrected (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Type
1804.600	55.9	26.2	3.3	27.1	60.13	74.0	-13.87	PK
1804.600	44.8	26.2	3.3	27.1	49.03	54.0	-4.97	AVE
2706.900	40.6	26.2	4.2	30.1	48.68	74.0	-25.32	PK
2706.900	26.5	26.2	4.2	30.1	34.60	54.0	-19.40	AVE
3609.200	41.4	26.1	5.0	31.2	51.46	74.0	-22.54	PK
3609.200	27.8	26.1	5.0	31.2	37.91	54.0	-16.09	AVE
4511.500	41.7	25.8	5.8	32.0	53.77	74.0	-20.23	PK
4511.500	28.5	25.8	5.8	32.0	40.59	54.0	-13.41	AVE
4804.000	41.1	25.7	5.9	33.1	54.44	74.0	-19.56	PK
4804.000	28.1	25.7	5.9	33.1	41.43	54.0	-12.57	AVE
7218.400	40.7	25.3	7.5	36.5	59.41	74.0	-14.59	PK
7218.400	27.0	25.3	7.5	36.5	45.74	54.0	-8.26	AVE
8120.700	41.3	25.2	8.1	37.5	61.76	74.0	-12.24	PK
8120.700	27.6	25.2	8.1	37.5	48.06	54.0	-5.94	AVE

Client: Vutiliti

Date: 7 Mar 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

Requirement: General limit of 15.209

Tech: CL Payne

Low Channel: 902.3 LoRa 125kHz FHSS

Low Channel: 2402 BLE

EUT Axis = X

Receive Ant = Vertical

Result: Pass

RADIATED SPURIOUS								
Freq (MHz)	Meter (dBuV/m)	Pre-Amp (dB)	Cable (dB)	Antenna (dB)	Corrected (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Type
1804.600	51.1	26.2	3.3	27.1	55.31	74.0	-18.69	PK
1804.600	40.6	26.2	3.3	27.1	44.79	54.0	-9.21	AVE
2706.900	40.9	26.2	4.2	30.1	49.00	74.0	-25.00	PK
2706.900	26.6	26.2	4.2	30.1	34.68	54.0	-19.32	AVE
3609.200	41.5	26.1	5.0	31.2	51.60	74.0	-22.40	PK
3609.200	27.8	26.1	5.0	31.2	37.93	54.0	-16.07	AVE
4511.500	42.0	25.8	5.8	32.0	54.03	74.0	-19.97	PK
4511.500	28.5	25.8	5.8	32.0	40.54	54.0	-13.46	AVE
4804.000	41.6	25.7	5.9	33.1	54.92	74.0	-19.08	PK
4804.000	28.1	25.7	5.9	33.1	41.43	54.0	-12.57	AVE
7218.400	40.8	25.3	7.5	36.5	59.46	74.0	-14.54	PK
7218.400	27.1	25.3	7.5	36.5	45.85	54.0	-8.15	AVE
8120.700	41.5	25.2	8.1	37.5	61.99	74.0	-12.01	PK
8120.700	27.6	25.2	8.1	37.5	48.03	54.0	-5.97	AVE

Client: Vutiliti

Date: 7 Mar 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

Requirement: General limit of 15.209

Tech: CL Payne

Low Channel: 902.3 LoRa 125kHz FHSS

EUT Axis = Y

Low Channel: 2402 BLE

Receive Ant = Horizontal

Result: Pass

RADIATED SPURIOUS								
Freq (MHz)	Meter (dBuV/m)	Pre-Amp (dB)	Cable (dB)	Antenna (dB)	Corrected (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Type
1804.600	40.1	26.2	3.3	27.1	44.29	74.0	-29.71	PK
1804.600	26.5	26.2	3.3	27.1	30.72	54.0	-23.28	AVE
2706.900	39.8	26.2	4.2	30.1	47.90	74.0	-26.10	PK
2706.900	26.5	26.2	4.2	30.1	34.56	54.0	-19.44	AVE
3609.200	41.4	26.1	5.0	31.2	51.50	74.0	-22.50	PK
3609.200	27.8	26.1	5.0	31.2	37.90	54.0	-16.10	AVE
4511.500	42.5	25.8	5.8	32.0	54.55	74.0	-19.45	PK
4511.500	28.4	25.8	5.8	32.0	40.49	54.0	-13.51	AVE
4804.000	41.9	25.7	5.9	33.1	55.24	74.0	-18.76	PK
4804.000	28.1	25.7	5.9	33.1	41.44	54.0	-12.56	AVE
7218.400	41.0	25.3	7.5	36.5	59.70	74.0	-14.30	PK
7218.400	27.0	25.3	7.5	36.5	45.70	54.0	-8.30	AVE
8120.700	41.7	25.2	8.1	37.5	62.16	74.0	-11.84	PK
8120.700	27.5	25.2	8.1	37.5	47.96	54.0	-6.04	AVE

Client: Vutiliti

Date: 7 Mar 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

Requirement: General limit of 15.209

Tech: CL Payne

Low Channel: 902.3 LoRa 125kHz FHSS

EUT Axis = Y

Low Channel: 2402 BLE

Receive Ant = Vertical

Result: Pass

RADIATED SPURIOUS								
Freq (MHz)	Meter (dBuV/m)	Pre-Amp (dB)	Cable (dB)	Antenna (dB)	Corrected (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Type
1804.600	40.3	26.2	3.3	27.1	44.46	74.0	-29.54	PK
1804.600	26.6	26.2	3.3	27.1	30.83	54.0	-23.17	AVE
2706.900	40.2	26.2	4.2	30.1	48.27	74.0	-25.73	PK
2706.900	26.6	26.2	4.2	30.1	34.66	54.0	-19.34	AVE
3609.200	41.1	26.1	5.0	31.2	51.20	74.0	-22.80	PK
3609.200	27.9	26.1	5.0	31.2	37.96	54.0	-16.04	AVE
4511.500	42.0	25.8	5.8	32.0	54.03	74.0	-19.97	PK
4511.500	28.5	25.8	5.8	32.0	40.55	54.0	-13.45	AVE
4804.000	41.5	25.7	5.9	33.1	54.79	74.0	-19.21	PK
4804.000	28.1	25.7	5.9	33.1	41.44	54.0	-12.56	AVE
7218.400	41.3	25.3	7.5	36.5	60.04	74.0	-13.96	PK
7218.400	27.0	25.3	7.5	36.5	45.71	54.0	-8.29	AVE
8120.700	41.0	25.2	8.1	37.5	61.46	74.0	-12.54	PK
8120.700	27.6	25.2	8.1	37.5	48.02	54.0	-5.98	AVE

Client: Vutiliti

Date: 7 Mar 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

Requirement: General limit of 15.209

Tech: CL Payne

Low Channel: 902.3 LoRa 125kHz FHSS

EUT Axis = Z

Low Channel: 2402 BLE

Receive Ant = Horizontal

Result: Pass

RADIATED SPURIOUS								
Freq (MHz)	Meter (dBuV/m)	Pre-Amp (dB)	Cable (dB)	Antenna (dB)	Corrected (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Type
1804.600	39.9	26.2	3.3	27.1	44.10	74.0	-29.90	PK
1804.600	26.5	26.2	3.3	27.1	30.67	54.0	-23.33	AVE
2706.900	40.4	26.2	4.2	30.1	48.48	74.0	-25.52	PK
2706.900	26.4	26.2	4.2	30.1	34.50	54.0	-19.50	AVE
3609.200	41.8	26.1	5.0	31.2	51.90	74.0	-22.10	PK
3609.200	27.8	26.1	5.0	31.2	37.90	54.0	-16.10	AVE
4511.500	42.3	25.8	5.8	32.0	54.35	74.0	-19.65	PK
4511.500	28.4	25.8	5.8	32.0	40.48	54.0	-13.52	AVE
4804.000	41.5	25.7	5.9	33.1	54.82	74.0	-19.18	PK
4804.000	28.0	25.7	5.9	33.1	41.34	54.0	-12.66	AVE
7218.400	40.4	25.3	7.5	36.5	59.06	74.0	-14.94	PK
7218.400	27.0	25.3	7.5	36.5	45.69	54.0	-8.31	AVE
8120.700	41.2	25.2	8.1	37.5	61.64	74.0	-12.36	PK
8120.700	27.5	25.2	8.1	37.5	47.95	54.0	-6.05	AVE

Client: Vutiliti

Date: 7 Mar 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

Requirement: General limit of 15.209

Tech: CL Payne

Low Channel: 902.3 LoRa 125kHz FHSS

EUT Axis = Z

Low Channel: 2402 BLE

Receive Ant = Vertical

Result: Pass

RADIATED SPURIOUS								
Freq (MHz)	Meter (dBuV/m)	Pre-Amp (dB)	Cable (dB)	Antenna (dB)	Corrected (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Type
1804.600	39.6	26.2	3.3	27.1	43.79	74.0	-30.21	PK
1804.600	26.5	26.2	3.3	27.1	30.69	54.0	-23.31	AVE
2706.900	39.8	26.2	4.2	30.1	47.90	74.0	-26.10	PK
2706.900	26.4	26.2	4.2	30.1	34.50	54.0	-19.50	AVE
3609.200	41.2	26.1	5.0	31.2	51.30	74.0	-22.70	PK
3609.200	27.7	26.1	5.0	31.2	37.80	54.0	-16.20	AVE
4511.500	42.0	25.8	5.8	32.0	54.05	74.0	-19.95	PK
4511.500	28.4	25.8	5.8	32.0	40.45	54.0	-13.55	AVE
4804.000	41.2	25.7	5.9	33.1	54.54	74.0	-19.46	PK
4804.000	28.0	25.7	5.9	33.1	41.34	54.0	-12.66	AVE
7218.400	40.5	25.3	7.5	36.5	59.21	74.0	-14.79	PK
7218.400	27.0	25.3	7.5	36.5	45.71	54.0	-8.29	AVE
8120.700	41.1	25.2	8.1	37.5	61.56	74.0	-12.44	PK
8120.700	27.5	25.2	8.1	37.5	47.96	54.0	-6.04	AVE

Client: Vutiliti

Date: 7 Mar 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

Requirement: General limit of 15.209

Tech: CL Payne

Mid Channel: 905.8 LoRa 125kHz FHSS

EUT Axis = X

Mid Channel: 2440 BLE

Receive Ant = Horizontal

Result: Pass

RADIATED SPURIOUS								
Freq (MHz)	Meter (dBuV/m)	Pre-Amp (dB)	Cable (dB)	Antenna (dB)	Corrected (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Type
1817.000	47.2	26.2	3.3	27.2	51.52	74.0	-22.48	PK
1817.000	36.4	26.2	3.3	27.2	40.74	54.0	-13.26	AVE
2725.500	40.4	26.2	4.2	30.1	48.56	74.0	-25.44	PK
2725.500	26.7	26.2	4.2	30.1	34.83	54.0	-19.17	AVE
3634.000	41.5	26.1	5.0	31.2	51.68	74.0	-22.32	PK
3634.000	27.7	26.1	5.0	31.2	37.83	54.0	-16.17	AVE
4542.500	41.9	25.8	5.8	32.2	54.07	74.0	-19.93	PK
4542.500	28.4	25.8	5.8	32.2	40.59	54.0	-13.41	AVE
4880.000	41.5	25.6	6.0	33.4	55.14	74.0	-18.86	PK
4880.000	28.2	25.6	6.0	33.4	41.91	54.0	-12.09	AVE
7320.000	40.7	25.3	7.5	36.7	59.63	74.0	-14.37	PK
7320.000	27.1	25.3	7.5	36.7	46.02	54.0	-7.98	AVE
8176.500	40.8	25.1	8.2	37.5	61.30	74.0	-12.70	PK
8176.500	27.1	25.1	8.2	37.5	47.63	54.0	-6.37	AVE

Client: Vutiliti

Date: 7 Mar 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

Requirement: General limit of 15.209

Tech: CL Payne

Mid Channel: 905.8 LoRa 125kHz FHSS

EUT Axis = X

Mid Channel: 2440 BLE

Receive Ant = Vertical

Result: Pass

RADIATED SPURIOUS								
Freq (MHz)	Meter (dBuV/m)	Pre-Amp (dB)	Cable (dB)	Antenna (dB)	Corrected (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Type
1817.000	40.2	26.2	3.3	27.2	44.51	74.0	-29.49	PK
1817.000	26.8	26.2	3.3	27.2	31.05	54.0	-22.95	AVE
2725.500	41.0	26.2	4.2	30.1	49.17	74.0	-24.83	PK
2725.500	26.7	26.2	4.2	30.1	34.84	54.0	-19.16	AVE
3634.000	41.1	26.1	5.0	31.2	51.25	74.0	-22.75	PK
3634.000	27.6	26.1	5.0	31.2	37.74	54.0	-16.26	AVE
4542.500	41.6	25.8	5.8	32.2	53.79	74.0	-20.21	PK
4542.500	28.3	25.8	5.8	32.2	40.49	54.0	-13.51	AVE
4880.000	42.5	25.6	6.0	33.4	56.17	74.0	-17.83	PK
4880.000	28.3	25.6	6.0	33.4	41.97	54.0	-12.03	AVE
7320.000	40.7	25.3	7.5	36.7	59.57	74.0	-14.43	PK
7320.000	27.2	25.3	7.5	36.7	46.12	54.0	-7.88	AVE
8176.500	40.5	25.1	8.2	37.5	61.02	74.0	-12.98	PK
8176.500	27.2	25.1	8.2	37.5	47.70	54.0	-6.30	AVE

Client: Vutiliti

Date: 7 Mar 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

Requirement: General limit of 15.209

Tech: CL Payne

Mid Channel: 905.8 LoRa 125kHz FHSS

EUT Axis = Y

Mid Channel: 2440 BLE

Receive Ant = Horizontal

Result: Pass

RADIATED SPURIOUS								
Freq (MHz)	Meter (dBuV/m)	Pre-Amp (dB)	Cable (dB)	Antenna (dB)	Corrected (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Type
1817.000	40.1	26.2	3.3	27.2	44.40	74.0	-29.60	PK
1817.000	26.6	26.2	3.3	27.2	30.90	54.0	-23.10	AVE
2725.500	40.2	26.2	4.2	30.1	48.34	74.0	-25.66	PK
2725.500	26.6	26.2	4.2	30.1	34.74	54.0	-19.26	AVE
3634.000	41.1	26.1	5.0	31.2	51.25	74.0	-22.75	PK
3634.000	27.7	26.1	5.0	31.2	37.80	54.0	-16.20	AVE
4542.500	42.0	25.8	5.8	32.2	54.16	74.0	-19.84	PK
4542.500	28.4	25.8	5.8	32.2	40.58	54.0	-13.42	AVE
4880.000	42.1	25.6	6.0	33.4	55.77	74.0	-18.23	PK
4880.000	28.3	25.6	6.0	33.4	41.94	54.0	-12.06	AVE
7320.000	40.7	25.3	7.5	36.7	59.64	74.0	-14.36	PK
7320.000	27.1	25.3	7.5	36.7	45.99	54.0	-8.01	AVE
8176.500	41.0	25.1	8.2	37.5	61.52	74.0	-12.48	PK
8176.500	27.1	25.1	8.2	37.5	47.63	54.0	-6.37	AVE

Client: Vutiliti

Date: 7 Mar 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

Requirement: General limit of 15.209

Tech: CL Payne

Mid Channel: 905.8 LoRa 125kHz FHSS

EUT Axis = Y

Mid Channel: 2440 BLE

Receive Ant = Vertical

Result: Pass

RADIATED SPURIOUS								
Freq (MHz)	Meter (dBuV/m)	Pre-Amp (dB)	Cable (dB)	Antenna (dB)	Corrected (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Type
1817.000	40.8	26.2	3.3	27.2	45.12	74.0	-28.88	PK
1817.000	26.9	26.2	3.3	27.2	31.22	54.0	-22.78	AVE
2725.500	40.5	26.2	4.2	30.1	48.67	74.0	-25.33	PK
2725.500	26.8	26.2	4.2	30.1	34.94	54.0	-19.06	AVE
3634.000	41.4	26.1	5.0	31.2	51.54	74.0	-22.46	PK
3634.000	28.1	26.1	5.0	31.2	38.22	54.0	-15.78	AVE
4542.500	42.1	25.8	5.8	32.2	54.30	74.0	-19.70	PK
4542.500	28.8	25.8	5.8	32.2	41.02	54.0	-12.98	AVE
4880.000	42.1	25.6	6.0	33.4	55.77	74.0	-18.23	PK
4880.000	28.7	25.6	6.0	33.4	42.37	54.0	-11.63	AVE
7320.000	40.5	25.3	7.5	36.7	59.45	74.0	-14.55	PK
7320.000	27.4	25.3	7.5	36.7	46.27	54.0	-7.73	AVE
8176.500	40.9	25.1	8.2	37.5	61.47	74.0	-12.53	PK
8176.500	27.3	25.1	8.2	37.5	47.84	54.0	-6.16	AVE

Client: Vutiliti

Date: 7 Mar 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

Requirement: General limit of 15.209

Tech: CL Payne

Mid Channel: 905.8 LoRa 125kHz FHSS

EUT Axis = Z

Mid Channel: 2440 BLE

Receive Ant = Horizontal

Result: Pass

RADIATED SPURIOUS								
Freq (MHz)	Meter (dBuV/m)	Pre-Amp (dB)	Cable (dB)	Antenna (dB)	Corrected (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Type
1817.000	41.1	26.2	3.3	27.2	45.38	74.0	-28.62	PK
1817.000	26.6	26.2	3.3	27.2	30.90	54.0	-23.10	AVE
2725.500	37.9	26.2	4.2	30.1	46.04	74.0	-27.96	PK
2725.500	26.5	26.2	4.2	30.1	34.64	54.0	-19.36	AVE
3634.000	41.4	26.1	5.0	31.2	51.54	74.0	-22.46	PK
3634.000	27.6	26.1	5.0	31.2	37.77	54.0	-16.23	AVE
4542.500	41.8	25.8	5.8	32.2	53.94	74.0	-20.06	PK
4542.500	28.4	25.8	5.8	32.2	40.56	54.0	-13.44	AVE
4880.000	42.1	25.6	6.0	33.4	55.77	74.0	-18.23	PK
4880.000	28.2	25.6	6.0	33.4	41.91	54.0	-12.09	AVE
7320.000	40.8	25.3	7.5	36.7	59.74	74.0	-14.26	PK
7320.000	27.1	25.3	7.5	36.7	45.98	54.0	-8.02	AVE
8176.500	41.2	25.1	8.2	37.5	61.73	74.0	-12.27	PK
8176.500	27.0	25.1	8.2	37.5	47.53	54.0	-6.47	AVE

Client: Vutiliti

Date: 7 Mar 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

Requirement: General limit of 15.209

Tech: CL Payne

Mid Channel: 905.8 LoRa 125kHz FHSS

EUT Axis = Z

Mid Channel: 2440 BLE

Receive Ant = Vertical

Result: Pass

RADIATED SPURIOUS								
Freq (MHz)	Meter (dBuV/m)	Pre-Amp (dB)	Cable (dB)	Antenna (dB)	Corrected (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Type
1817.000	40.0	26.2	3.3	27.2	44.30	74.0	-29.70	PK
1817.000	26.6	26.2	3.3	27.2	30.87	54.0	-23.13	AVE
2725.500	39.9	26.2	4.2	30.1	47.99	74.0	-26.01	PK
2725.500	26.6	26.2	4.2	30.1	34.69	54.0	-19.31	AVE
3634.000	41.1	26.1	5.0	31.2	51.25	74.0	-22.75	PK
3634.000	27.6	26.1	5.0	31.2	37.79	54.0	-16.21	AVE
4542.500	41.9	25.8	5.8	32.2	54.06	74.0	-19.94	PK
4542.500	28.4	25.8	5.8	32.2	40.59	54.0	-13.41	AVE
4880.000	41.8	25.6	6.0	33.4	55.49	74.0	-18.51	PK
4880.000	28.3	25.6	6.0	33.4	41.97	54.0	-12.03	AVE
7320.000	40.5	25.3	7.5	36.7	59.37	74.0	-14.63	PK
7320.000	27.1	25.3	7.5	36.7	46.02	54.0	-7.98	AVE
8176.500	40.8	25.1	8.2	37.5	61.33	74.0	-12.67	PK
8176.500	27.1	25.1	8.2	37.5	47.63	54.0	-6.37	AVE

Client: Vutiliti

Date: 7 Mar 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

Requirement: General limit of 15.209

Tech: CL Payne

High Channel: 914.9 LoRa 125kHz FHSS

EUT Axis = X

High Channel: 2480 BLE

Receive Ant = Horizontal

Result: Pass

RADIATED SPURIOUS								
Freq (MHz)	Meter (dBuV/m)	Pre-Amp (dB)	Cable (dB)	Antenna (dB)	Corrected (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Type
1829.800	40.9	26.2	3.3	27.3	45.31	74.0	-28.69	PK
1829.800	28.0	26.2	3.3	27.3	32.41	54.0	-21.59	AVE
2744.700	40.6	26.2	4.2	30.1	48.79	74.0	-25.21	PK
2744.700	26.8	26.2	4.2	30.1	34.99	54.0	-19.01	AVE
3659.600	40.5	26.1	5.1	31.2	50.71	74.0	-23.29	PK
3659.600	27.4	26.1	5.1	31.2	37.60	54.0	-16.40	AVE
4574.500	39.6	25.8	5.8	32.3	51.93	74.0	-22.07	PK
4574.500	28.1	25.8	5.8	32.3	40.43	54.0	-13.57	AVE
4960.000	41.8	25.6	6.0	33.7	55.82	74.0	-18.18	PK
4960.000	28.6	25.6	6.0	33.7	42.62	54.0	-11.38	AVE
7440.000	41.0	25.3	7.6	36.8	60.16	74.0	-13.84	PK
7440.000	27.5	25.3	7.6	36.8	46.66	54.0	-7.34	AVE

Client: Vutiliti

Date: 7 Mar 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

Requirement: General limit of 15.209

Tech: CL Payne

High Channel: 914.9 LoRa 125kHz FHSS

EUT Axis = X

High Channel: 2480 BLE

Receive Ant = Vertical

Result: Pass

RADIATED SPURIOUS								
Freq (MHz)	Meter (dBuV/m)	Pre-Amp (dB)	Cable (dB)	Antenna (dB)	Corrected (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Type
1829.800	57.3	26.2	3.3	27.3	61.71	74.0	-12.29	PK
1829.800	45.6	26.2	3.3	27.3	50.01	54.0	-3.99	AVE
2744.700	42.0	26.2	4.2	30.1	50.19	74.0	-23.81	PK
2744.700	34.0	26.2	4.2	30.1	42.19	54.0	-11.81	AVE
3659.600	35.1	26.1	5.1	31.2	45.31	74.0	-28.69	PK
3659.600	21.4	26.1	5.1	31.2	31.61	54.0	-22.39	AVE
4574.500	41.6	25.8	5.8	32.3	53.93	74.0	-20.07	PK
4574.500	28.0	25.8	5.8	32.3	40.33	54.0	-13.67	AVE
4960.000	36.3	25.6	6.0	33.7	50.32	74.0	-23.68	PK
4960.000	26.8	25.6	6.0	33.7	40.82	54.0	-13.18	AVE
7440.000	40.3	25.3	7.6	36.8	59.46	74.0	-14.54	PK
7440.000	27.3	25.3	7.6	36.8	46.46	54.0	-7.54	AVE

Client: Vutiliti

Date: 7 Mar 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

Requirement: General limit of 15.209

Tech: CL Payne

High Channel: 914.9 LoRa 125kHz FHSS

EUT Axis = Y

High Channel: 2480 BLE

Receive Ant = Horizontal

Result: Pass

RADIATED SPURIOUS								
Freq (MHz)	Meter (dBuV/m)	Pre-Amp (dB)	Cable (dB)	Antenna (dB)	Corrected (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Type
1829.800	40.9	26.2	3.3	27.3	45.32	74.0	-28.68	PK
1829.800	26.5	26.2	3.3	27.3	30.95	54.0	-23.05	AVE
2744.700	40.2	26.2	4.2	30.1	48.39	74.0	-25.61	PK
2744.700	26.4	26.2	4.2	30.1	34.61	54.0	-19.39	AVE
3659.600	41.2	26.1	5.1	31.2	51.43	74.0	-22.57	PK
3659.600	27.3	26.1	5.1	31.2	37.51	54.0	-16.49	AVE
4574.500	41.9	25.8	5.8	32.3	54.24	74.0	-19.76	PK
4574.500	28.0	25.8	5.8	32.3	40.34	54.0	-13.66	AVE
4960.000	42.2	25.6	6.0	33.7	56.20	74.0	-17.80	PK
4960.000	28.7	25.6	6.0	33.7	42.68	54.0	-11.32	AVE

Client: Vutiliti

Date: 7 Mar 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

Requirement: General limit of 15.209

Tech: CL Payne

High Channel: 914.9 LoRa 125kHz FHSS

EUT Axis = Y

High Channel: 2480 BLE

Receive Ant = Vertical

Result: Pass

RADIATED SPURIOUS								
Freq (MHz)	Meter (dBuV/m)	Pre-Amp (dB)	Cable (dB)	Antenna (dB)	Corrected (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Type
1829.800	49.4	26.2	3.3	27.3	53.83	74.0	-20.17	PK
1829.800	38.9	26.2	3.3	27.3	43.30	54.0	-10.70	AVE
2744.700	39.7	26.2	4.2	30.1	47.93	74.0	-26.07	PK
2744.700	26.5	26.2	4.2	30.1	34.72	54.0	-19.28	AVE
3659.600	40.9	26.1	5.1	31.2	51.11	74.0	-22.89	PK
3659.600	27.4	26.1	5.1	31.2	37.59	54.0	-16.41	AVE
4574.500	42.2	25.8	5.8	32.3	54.48	74.0	-19.52	PK
4574.500	28.1	25.8	5.8	32.3	40.43	54.0	-13.57	AVE
4960.000	42.4	25.6	6.0	33.7	56.42	74.0	-17.58	PK
4960.000	28.7	25.6	6.0	33.7	42.73	54.0	-11.27	AVE
5489.400	40.9	25.5	6.3	34.4	56.06	74.0	-17.94	PK
5489.400	28.7	25.5	6.3	34.4	43.90	54.0	-10.10	AVE
7440.000	41.1	25.3	7.6	36.8	60.30	74.0	-13.70	PK
7440.000	27.3	25.3	7.6	36.8	46.47	54.0	-7.53	AVE

Client: Vutiliti

Date: 7 Mar 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

Requirement: General limit of 15.209

Tech: CL Payne

High Channel: 914.9 LoRa 125kHz FHSS

EUT Axis = Z

High Channel: 2480 BLE

Receive Ant = Horizontal

Result: Pass

RADIATED SPURIOUS								
Freq (MHz)	Meter (dBuV/m)	Pre-Amp (dB)	Cable (dB)	Antenna (dB)	Corrected (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Type
1829.800	48.1	26.2	3.3	27.3	52.48	74.0	-21.52	PK
1829.800	37.9	26.2	3.3	27.3	42.30	54.0	-11.70	AVE
2744.700	39.8	26.2	4.2	30.1	47.99	74.0	-26.01	PK
2744.700	26.4	26.2	4.2	30.1	34.61	54.0	-19.39	AVE
3659.600	41.1	26.1	5.1	31.2	51.31	74.0	-22.69	PK
3659.600	27.3	26.1	5.1	31.2	37.49	54.0	-16.51	AVE
4574.500	41.8	25.8	5.8	32.3	54.10	74.0	-19.90	PK
4574.500	28.0	25.8	5.8	32.3	40.32	54.0	-13.68	AVE
4960.000	42.3	25.6	6.0	33.7	56.31	74.0	-17.69	PK
4960.000	28.7	25.6	6.0	33.7	42.67	54.0	-11.33	AVE
7440.000	40.9	25.3	7.6	36.8	60.06	74.0	-13.94	PK
7440.000	27.3	25.3	7.6	36.8	46.42	54.0	-7.58	AVE
8234.100	40.6	25.1	8.2	37.5	61.22	74.0	-12.78	PK
8234.100	27.0	25.1	8.2	37.5	47.57	54.0	-6.43	AVE

Client: Vutiliti

Date: 7 Mar 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

Requirement: General limit of 15.209

Tech: CL Payne

Mid Channel: 914.9 LoRa 125kHz FHSS

EUT Axis = Z

Mid Channel: 2480 BLE

Receive Ant = Vertical

Result: Pass

RADIATED SPURIOUS								
Freq (MHz)	Meter (dBuV/m)	Pre-Amp (dB)	Cable (dB)	Antenna (dB)	Corrected (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Type
1829.800	48.8	26.2	3.3	27.3	53.21	74.0	-20.79	PK
1829.800	38.9	26.2	3.3	27.3	43.33	54.0	-10.67	AVE
2744.700	40.2	26.2	4.2	30.1	48.38	74.0	-25.62	PK
2744.700	26.4	26.2	4.2	30.1	34.60	54.0	-19.40	AVE
3659.600	41.7	26.1	5.1	31.2	51.88	74.0	-22.12	PK
3659.600	27.3	26.1	5.1	31.2	37.49	54.0	-16.51	AVE
4574.500	41.6	25.8	5.8	32.3	53.90	74.0	-20.10	PK
4574.500	28.0	25.8	5.8	32.3	40.33	54.0	-13.67	AVE
4960.000	42.8	25.6	6.0	33.7	56.82	74.0	-17.18	PK
4960.000	28.6	25.6	6.0	33.7	42.66	54.0	-11.34	AVE
5489.400	41.9	25.5	6.3	34.4	57.09	74.0	-16.91	PK
5489.400	28.7	25.5	6.3	34.4	43.86	54.0	-10.14	AVE

11.12.2 Antenna-port conducted measurements

11.12.2.1 General

Antenna-port conducted measurements may also be used as an alternative to radiated measurements for determining compliance in the restricted frequency bands requirements. If conducted measurements are performed, then proper impedance matching must be ensured and an additional radiated test for cabinet/case emissions is required.

11.12.2.2 General procedure for conducted measurements in restricted bands

The general procedure for conducted measurements in restricted bands is as follows:

- a) Measure the conducted output power (in dBm) using the detector specified by the appropriate regulatory agency (see 11.12.2.3 through 11.12.2.5 for guidance regarding measurement procedures for determining quasi-peak, peak, and average conducted output power, respectively).
- b) Add the maximum transmit antenna gain (in dBi) to the measured output power level to determine the EIRP (see 11.12.2.6 for guidance on determining the applicable antenna gain).
- c) 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).
- d) For MIMO devices, measure the power of each chain and sum the EIRP of all chains in linear terms (i.e., watts and mW).
- e) Convert the resultant EIRP to an equivalent electric field strength using the following relationship:

$$E = \text{EIRP} - 20 \log d + 104.8$$

where

E is the electric field strength in dB μ V/m

EIRP is the equivalent isotropically radiated power in dBm

d is the specified measurement distance in m

- f) Compare the resultant electric field strength level with the applicable regulatory limit.
- g) Perform the radiated spurious emission test.

15.247 (d) Restricted Bands - *continued*

Note: With respect to steps e) and f) a limit line (EIRP) based upon the dBuV/m limit was calculated and put on the plots to satisfy the requirement of step f) above. Formula is: $(E + 20 \log d) - 104.8 = (\text{EIRP limit})$. The appropriate correction factor from step c) was included in the final calculation.

Limit Calculation:

Formula: $E - 104.8 + 20\log(3) - \text{antenna gain} - \text{ground reflection factor}$

30 MHz - 88 MHz	$40 - 104.8 + 20\log(d) - 2 - 4.7$	= -61.96 dBm
88 MHz - 216 MHz	$43 - 104.8 + 20\log(d) - 2 - 4.7$	= -58.96 dBm
216 MHz - 960 MHz	$46 - 104.8 + 20\log(d) - 2 - 4.7$	= -55.96 dBm
960 MHz - 1000 MHz	$54 - 104.8 + 20\log(d) - 2 - 4.7$	= -47.96 dBm
> 1000 MHz	$54 - 104.8 + 20\log(d) - 2 - 0$	= -43.26 dBm

Note: (d) = Measurement distance in meters = 3 meters

Requirement: FCC Part 15.247 Clause (d)

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) (see §15.205(c)).

Client: Vutiliti

Date: 9 Mar 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

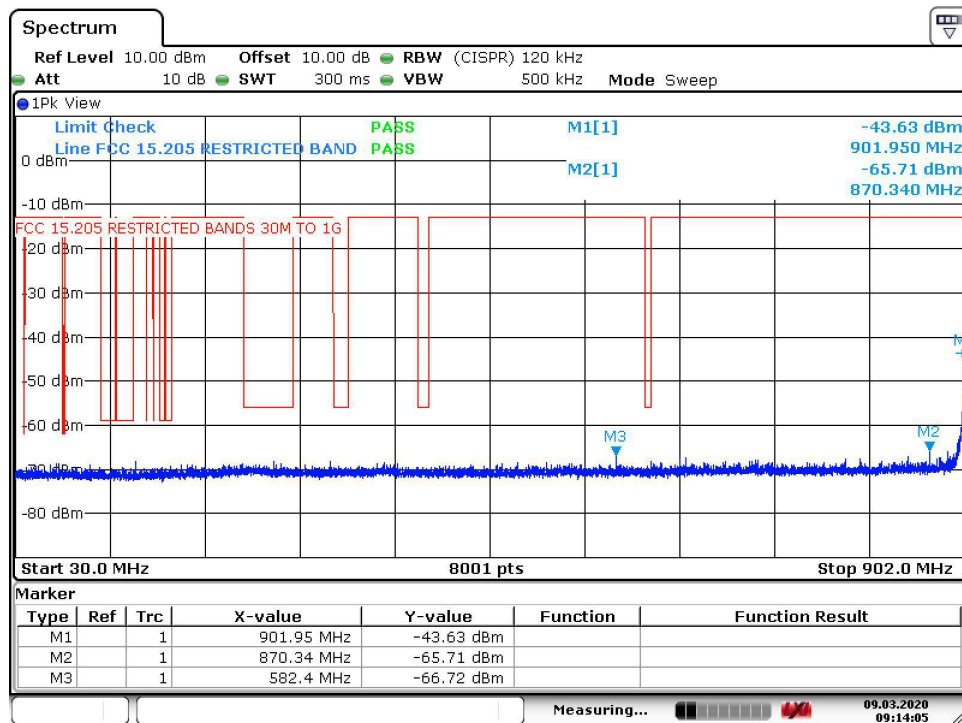
Requirement: Emissions Below Restricted Band Limits

Tech: CL Payne

Low Channel: 902.3

Frequency Range: 30MHz to 902MHz

Result: Pass



Date: 9.MAR.2020 09:14:05

Client: Vutiliti

Date: 9 Mar 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

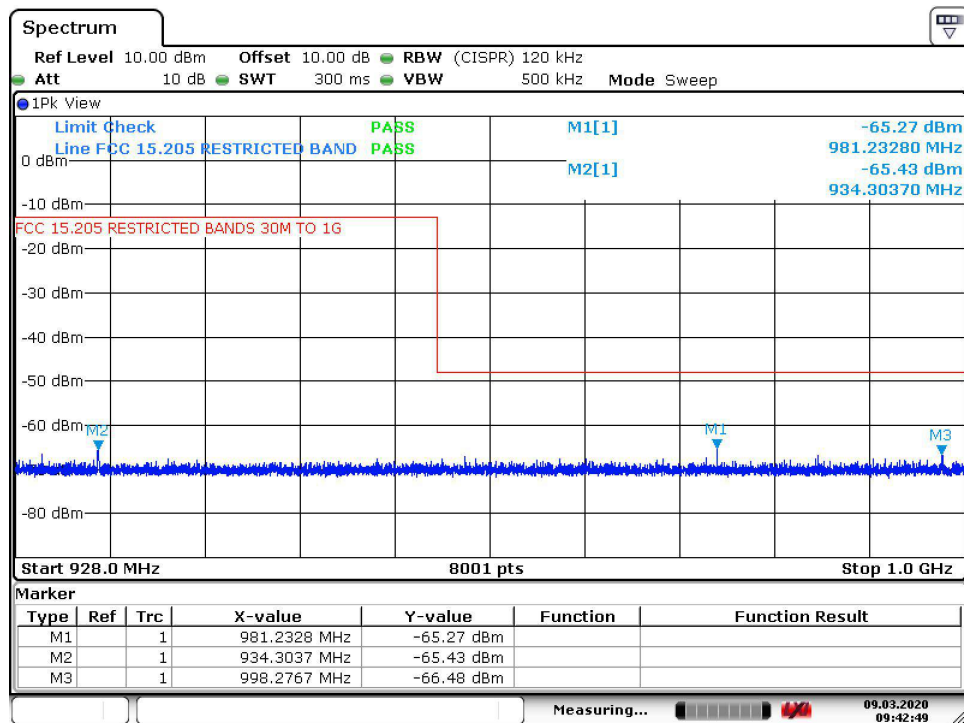
Requirement: Emissions Below Restricted Band Limits

Tech: CL Payne

Low Channel: 902.3

Frequency Range: 928MHz to 1000MHz

Result: Pass



Date: 9.MAR.2020 09:42:49

Client: Vutiliti

Date: 9 Mar 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

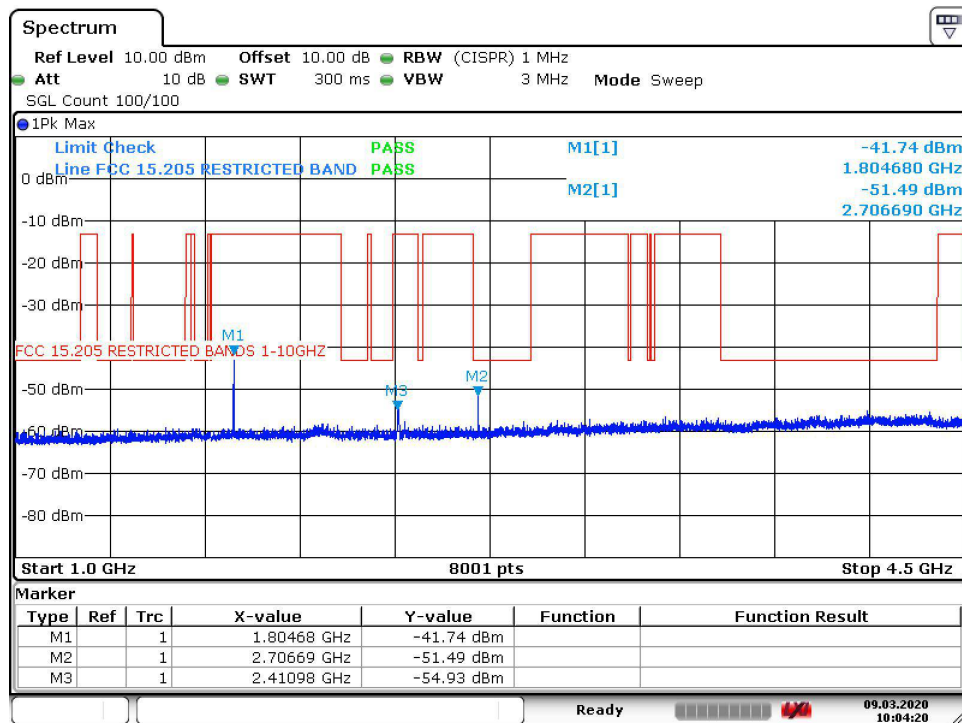
Requirement: Emissions Below Restricted Band Limits

Tech: CL Payne

Low Channel: 902.3

Frequency Range: 1000MHz to 4500MHz

Result: Pass



Date: 9.MAR.2020 10:04:20

Client: Vutiliti

Date: 9 Mar 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

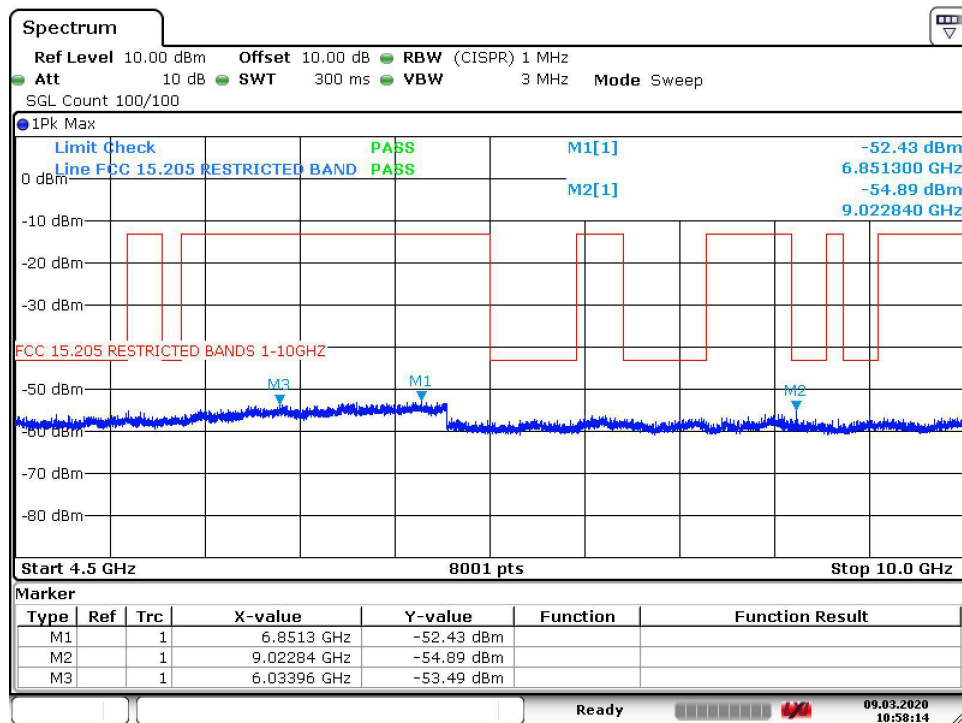
Requirement: Emissions Below Restricted Band Limits

Tech: CL Payne

Low Channel: 902.3

Frequency Range: 4500MHz to 10000MHz

Result: Pass



Date: 9.MAR.2020 10:58:14

Client: Vutiliti

Date: 9 Mar 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

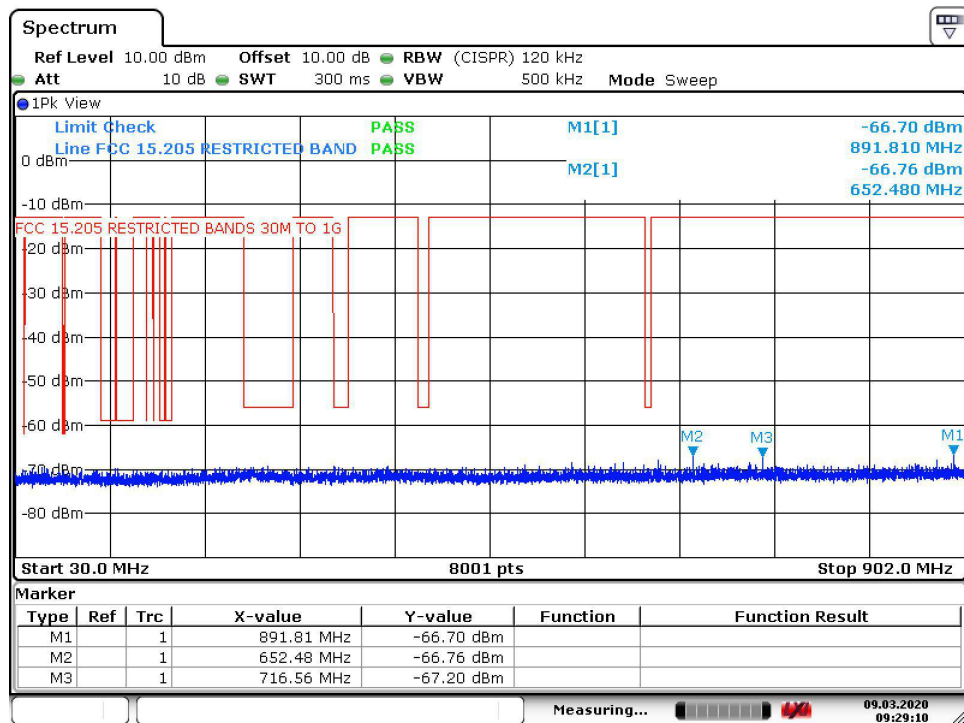
Requirement: Emissions Below Restricted Band Limits

Tech: CL Payne

Middle Channel: 908.5

Frequency Range: 30MHz to 902MHz

Result: Pass



Date: 9.MAR.2020 09:29:10

Client: Vutiliti

Date: 9 Mar 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

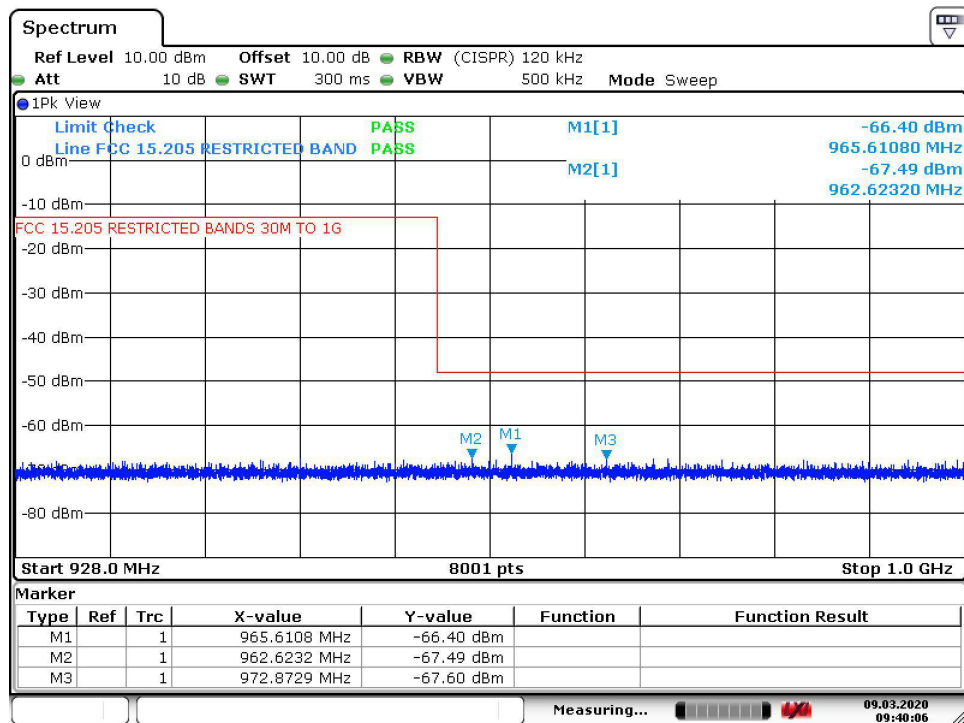
Requirement: Emissions Below Restricted Band Limits

Tech: CL Payne

Middle Channel: 908.5

Frequency Range: 928MHz to 1000MHz

Result: Pass



Date: 9.MAR.2020 09:40:06

Client: Vutiliti

Date: 9 Mar 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

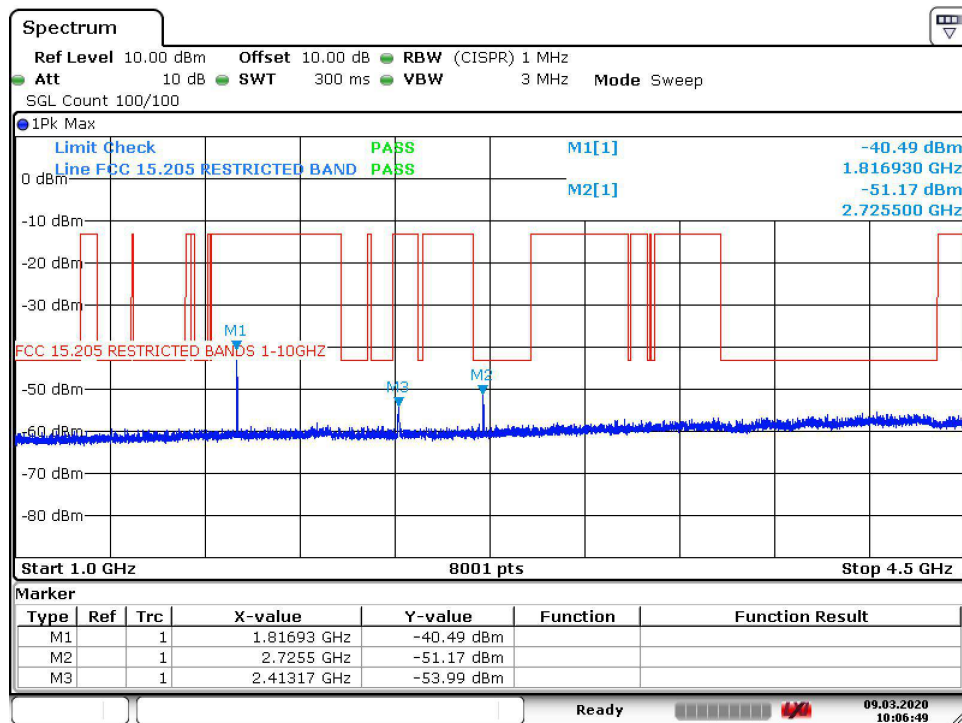
Requirement: Emissions Below Restricted Band Limits

Tech: CL Payne

Middle Channel: 908.5

Frequency Range: 1000MHz to 4500MHz

Result: Pass



Date: 9.MAR.2020 10:06:49

Client: Vutiliti

Date: 9 Mar 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

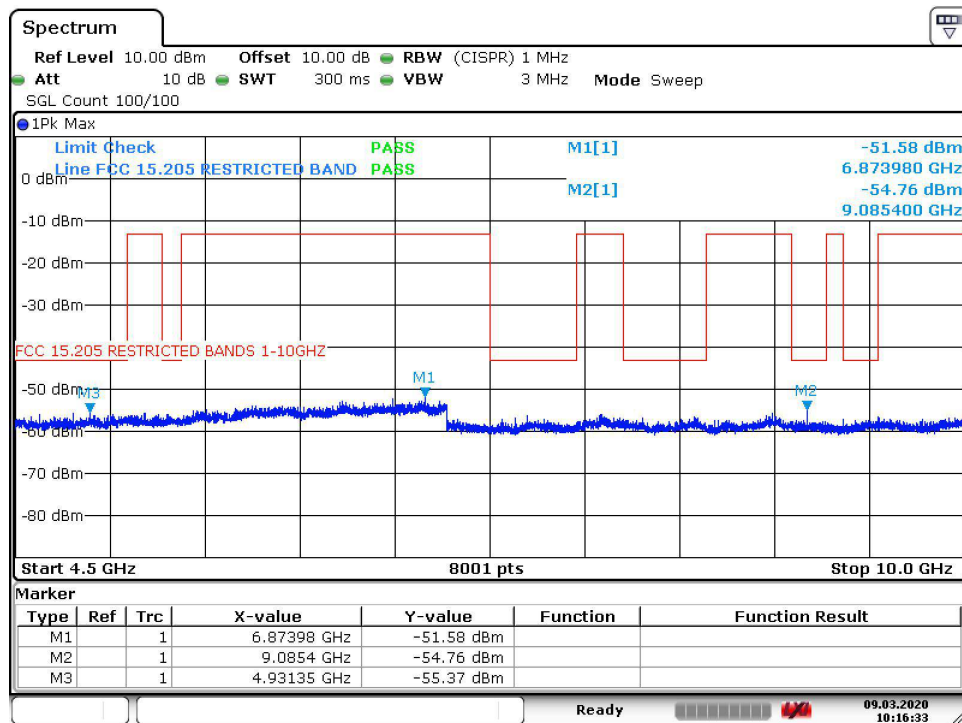
Requirement: Emissions Below Restricted Band Limits

Tech: CL Payne

Middle Channel: 908.5

Frequency Range: 4500MHz to 10000MHz

Result: Pass



Date: 9.MAR.2020 10:16:33

Client: Vutiliti

Date: 9 Mar 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

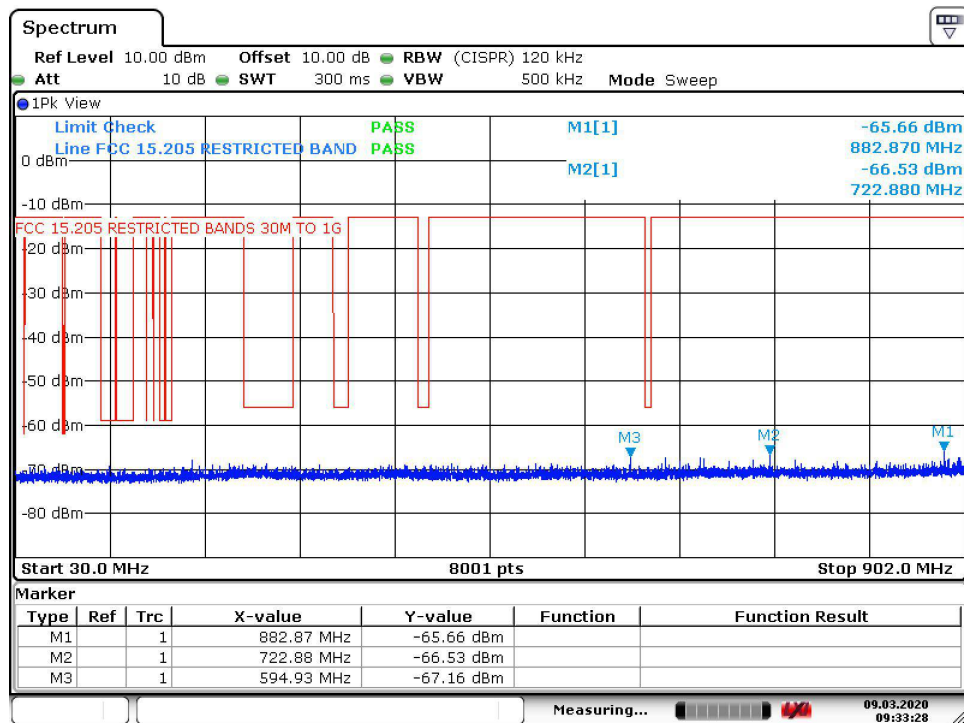
Requirement: Emissions Below Restricted Band Limits

Tech: CL Payne

High Channel: 914.9

Frequency Range: 30MHz to 902MHz

Result: Pass



Date: 9.MAR.2020 09:33:28

Client: Vutiliti

Date: 9 Mar 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

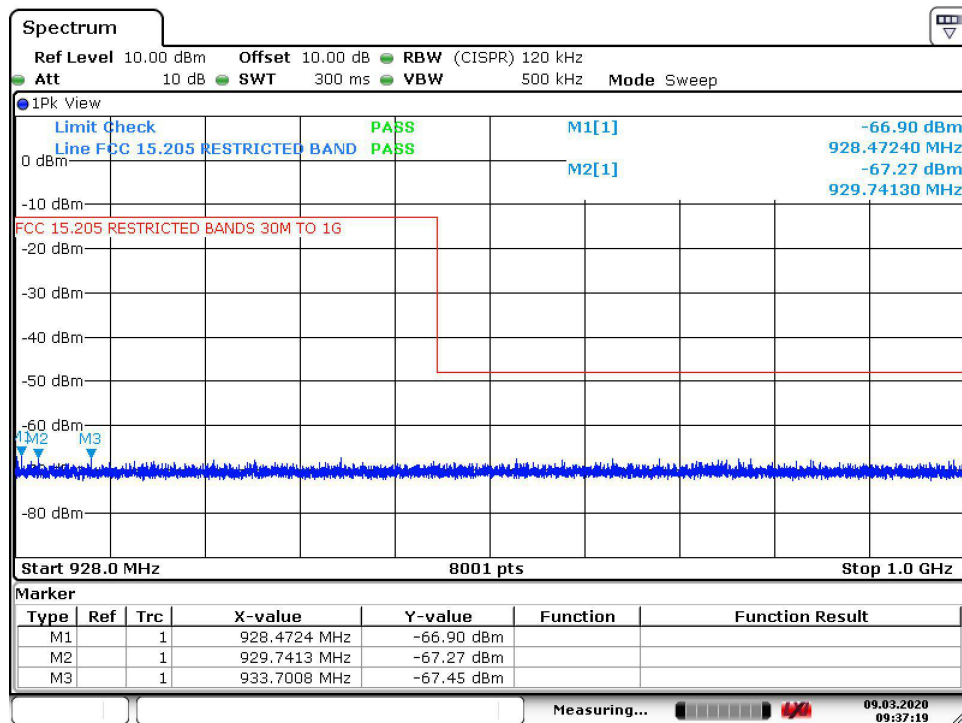
Requirement: Emissions Below Restricted Band Limits

Tech: CL Payne

High Channel: 914.9

Frequency Range: 928MHz to 1000MHz

Result: Pass



Date: 9.MAR.2020 09:37:19

Client: Vutiliti

Date: 9 Mar 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

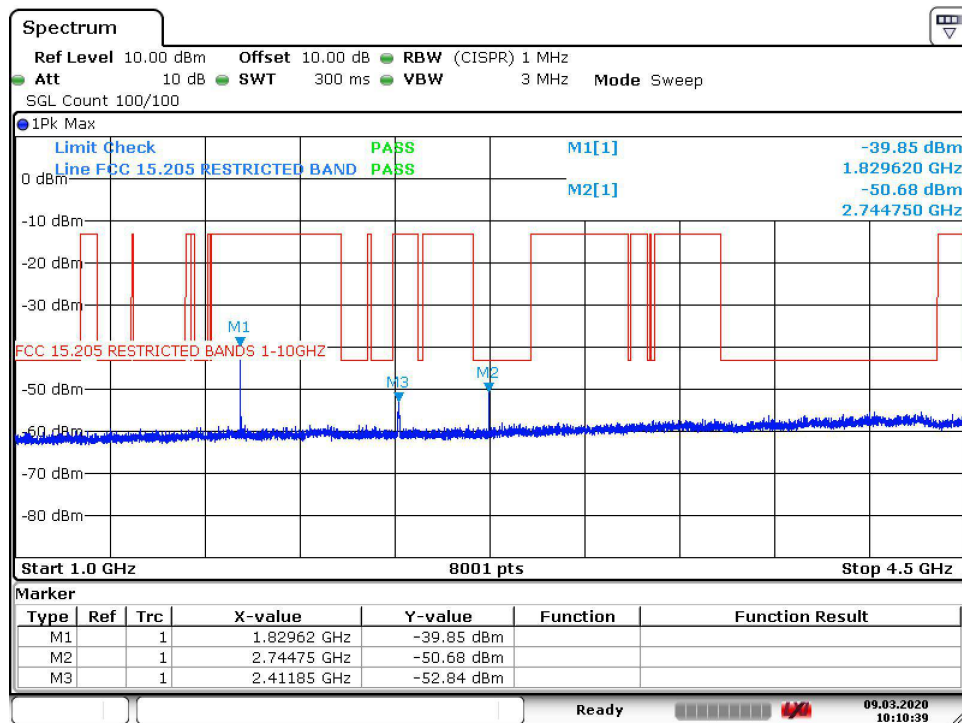
Requirement: Emissions Below Restricted Band Limits

Tech: CL Payne

High Channel: 914.9

Frequency Range: 1000MHz to 4500MHz

Result: Pass



Date: 9.MAR.2020 10:10:39

Client: Vutiliti

Date: 9 Mar 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

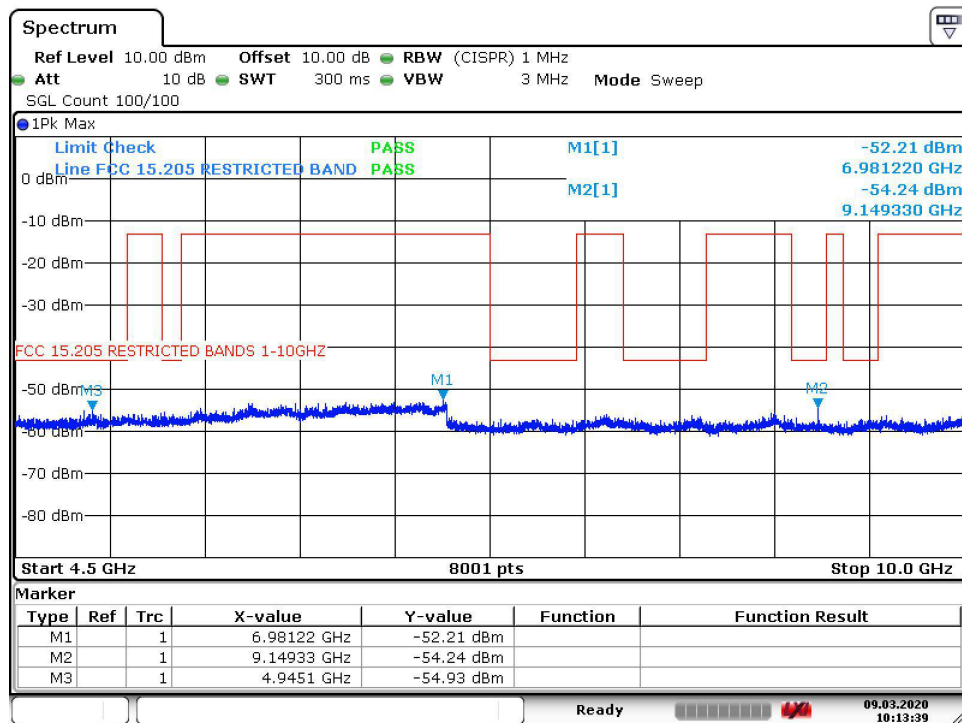
Requirement: Emissions Below Restricted Band Limits

Tech: CL Payne

High Channel: 914.9

Frequency Range: 4500MHz to 10000MHz

Result: Pass



Date: 9.MAR.2020 10:13:39

15.247 (g) Short Burst Systems KDB 558074 (9,c,2)

For short burst systems, describe how the EUT complies with the requirement that it be designed to be capable of operating as a true frequency hopping system. Specifically, the device shall comply with the equal frequency use and pseudorandom hopping sequence requirement when transmitting in short bursts, and shall be designed to comply when presented with continuous data (or information) stream.

Provided in Operational Description for Confidentiality

15.247 (h) Coordination with other FHSS Systems KDB 558074 (9,c,3)

Describe how the EUT complies with the requirement that it not have the ability to be coordinated with other FHSS systems in an effort to avoid the simultaneous occupancy of individual hopping frequencies by multiple transmitters.

Provided in Operational Description for Confidentiality

End of Report UT06070B-004