



**Technical Report to the FCC and ISED Regarding
Gentex Corporation - Homelink© 5**

**Model: UAHLCD
FCC ID: NZLUAHLCD
ISED: 4112A-UAHLCD**

**Emission Designator: 1M09G1D
2/22/21**

A report concerning approval for Gentex Corporation Homelink® model UAHLCD
Please issue grant immediately upon review.

Measurements Made by:

Measurements Reviewed by:

Bolay Pannell
Senior EMC Test Engineer
Gentex Corporation

Dan Brasier
Corporate Labs Development Engineer
Gentex Corporation

Report Prepared, Approved, and Submitted by:

Brian Miller
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Test Report Revision

REV Number	Date	Author	Description
1.0	2/21/21	Brian Miller	Initial Release.

Results relate only to the items tested as received.

Compliance has been evaluated based on the Lab Manual section 7.6.2. The decision rule used regarding measurement uncertainty was to determine results solely on whether the measured values met the defined acceptance criteria without factoring in measurement uncertainty values.

1. General Information

1.1. Product Description

The Gentex Corporation HomeLink® HL5 Universal Garage Door Opener is a low-power transceiver OEM device that is installed into the automobile rearview mirror. The installation is provided by trained technicians during the course of the manufacture of the automobile. It is powered by the 12 Volt system of the automobile.

This Universal Garage Door Opener has the capability to

1. Learn the frequency and bit code format of the user's existing garage door remote control devices
2. Transmit and receive frequency hopping spread spectrum in the 902 to 928 MHz band using an internal antenna as per Federal Communications Commission "Code of Federal Regulations", Title 47, Part 15.247
3. Transmit and receive frequency digital transmission system in the 2402 to 2480MHz band using an internal antenna as per Federal Communications Commission "Code of Federal Regulations", Title 47, Part 15.247.

The unit is designed for the periodic operation of a control signal, which typically activates a garage door opener receiver.

The unit is supplied to the automobile manufacturer without harness. For testing purposes a typical assembly and 2-conductor cable harness were used to power to the unit.

The three-button HomeLink® unit replaces up to three hand-held transmitters. In addition to the typical operation of the garage door, the unit will learn the radio frequency codes of other transmitter types to activate entry door locks, estate gates, security systems, and home or office lighting.

The antenna system is an integral part of the unit. It cannot be altered nor replaced by the user. Service of this system is only available from the Automobile Manufacturer's Dealerships and Gentex Corporation.

1.2. Related Grants

This device will have functionality that is covered under 47 CFR 15.231. The device will have a FCC ID # of NZLUAHLCD and an ISED ID # of 4112A-UAHLCD under both rule parts. Separate reports were submitted for functionality covered under 47 CFR 15.231 and 47 CFR 15.247 DSS requirements.

1.3. Test Methodology

Radiated Emissions testing was performed according to ANSI C63.10:2013. The power source for this product is a 12V automotive vehicle battery.

Conducted measurements were performed using a power supply.

Measurements were performed per FCC OET KDB 558074.

The unit is supplied to the automobile manufacturer without harness. For testing purposes a 2-conductor cable harness was used to interface to the unit. The unit ground is provided through the negative terminal of the harness.

1.4. Test Facility

The 3-meter semi-anechoic chamber where these measurements were taken, is located on the grounds of Gentex Corporation's Corporate Labs, in the city of Zeeland, county of Ottawa, state of Michigan, United States of America.

For radiated measurements above 1 GHz, RF absorbing material is placed between the antenna and EUT in accordance with ANSI C63.4:2014 Section 5.5 and chamber manufacturer's instructions.

The 3m chamber has been added to our A2LA scope of accreditation on 05/20/2016 and includes accreditation to ANSI C63.4:2014 and ANSI C63.10:2013. The report filed with ISED, dated February 11, 2015, was accepted via a letter dated February 11, 2015. Our 3m chamber is registered with the ISED under Site# 4112A-2 and FCC under registration number 357351.

Corporate Mailing/Shipping Address

Gentex Corporation
600 N. Centennial Street
Zeeland, MI 49464

Site Address

Gentex Corporation
380 Riley Street
Zeeland, MI 49423

1.5. Accreditation

The Gentex Corporate EMC Lab is accredited to ISO/IEC 17025 by the American Association for Laboratory Accreditation (A2LA). Our laboratory scope and accreditation certificate #[2529.01](#) are available from their web site www.a2la.org. Our scope of accreditation covers ANSI C63.4:2014, ANSI C63.10:2013, and Radiated Emissions at 3m, FCC 47 CFR Part 15, ISED RSS-210, and ISED RSS-247 Issue 2.

2. Product Labeling

2.1. Identifiers

The FCC Identifier assigned is FCC ID: NZLUAHLCD. The ISED certification number is 4112A-UAHLCD. These identifiers will be labeled on the product housing.

The label will be placed on the exterior of the HL housing using laser etching that will permanently affix the label.

Because of the small size of the device and because the installation is inside a portion of the automobile, the following statements will appear in the user's manual. Refer to attachment "Users Manual.pdf" for the entire text of the user's manual.

"This device complies with FCC rules Part 15 and with ISED RSS-247 Issue 2. Operation is subject to the following two conditions:

- (1) This device may not cause harmful interference,
- (2) This device must accept any interference that may be received including interference that may cause undesired operation.

WARNING: The transmitter has been tested and complies with FCC and ISED rules. Changes or modifications not expressly approved by the party responsible for the compliance could void the user's authority to operate the device."

The term "ISED:" before the certification/registration number only signifies that ISED technical specifications were met.

2.2. Label Drawing and Location on Product

The label drawing and location of the label on the assembly is included in the "Label Location.pdf" attachment.

3. Test Configuration

Radiated Emission measurements presented in the report were made in accordance with ANSI C63.10:2013. The EUT was placed on a 1 x 1.5m non-metallic table elevated 80cm above a conducting ground plane for measurements below 1GHz and elevated to 1.5m for measurements above 1GHz. The harness was run straight down from the center of the turntable to a power supply sitting at the base of the table.

For radiated measurements above 1 GHz, RF absorbing material is placed between the antenna and EUT in accordance with ANSI C63.4:2014 Section 5.5 and chamber manufacturer's instructions.

For conducted measurements, a non-metallic table approximately 80cm x 90cm, 85cm above the floor was used.

4. Block Diagram

For system block diagram please refer to attachment named "HLV Block Diagram.pdf"

5. Powerline Conducted Emissions Measurements

Powerline Conducted Measurements are not required for this product as the part is powered via 12V battery.

6. Emissions Data

6.1. Date(s) Tested: 2/16/21 – 2/20/21

6.2. Test Method Deviations: None.

6.3. Temperature and Humidity conditions

	Measured Value	Unit
Temperature	22.2	°C
Humidity	41.5	%R.H.

6.4. Summary of Results (Part 15.247)

Measurement		Margin	Frequency
Worst Case Spurious Emission	60.39dBuV/m	13.61	17360MHz
Maximum 6dB BW	731kHz	231kHz	-
Maximum 99% BW	1094kHz	594kHz	-
Band Edge	29.5dBuV/m	24.5dB	2483.5MHz
Power Spectral Density	-7.82dBm	15.82	2402MHz
Peak Output Power	-7.89dBm	30.78dB	2402MHz

- **DTS (6dB) Bandwidth:** Per FCC 15.247(a)(2) and RSS-247 paragraph 5.2 (a), the minimum 6dB bandwidth shall be at least 500kHz for all systems using digital modulation techniques.
- **Band Edge Measurement Requirement:** Per section 15.247(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. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a).
- **Measurement Uncertainty:** The standard uncertainty of measurement has been determined in accordance with the ISO Guide to the Expression of Uncertainty in Measurements. The estimation of measurement uncertainty reported is the expanded uncertainty for a coverage factor of k=2.26 and confidence interval of approximately 95%.

Expanded Uncertainty $U_{(k=2.26)}$ is as follows:

- Radiated Emissions – Bicon (30-250 MHz): 4.5 dB
- Radiated Emissions – LPA (250-1000 MHz): 4.1 dB
- Radiated Emissions – DRWG (1-18 GHz): 5.0 dB
- Conducted Emissions: 0.9 dB
- Frequency: 0.15ppm

6.5. Test Equipment Setup and Procedure**6.5.1. Test Equipment Used for Conducted Measurement**

Description	Model #	ID Number	Cal Due
Rohde & Schwarz EMI Receiver	ESR26	6595	10/12/21
Cable	KB18-N1S1-36	CBL 119	4/30/21

6.5.2. Test Equipment Used for Radiated Measurement Equipment

Description	Model #	ID Number	Cal Due
EMCO Biconical Antenna [30-250 MHz]	3110B	H6187	7/16/21
EMCO LPA Antenna [250-1000MHz]	3148	H6192	7/16/21
Com-Power Double Ridged Guide [1-18GHz]	AH-118	7182	12/4/21
ETS-Lindgren Double Ridged Waveguide [10-40GHz]	3116C	7257	3/18/22
Rohde & Schwarz EMI Receiver	ESR26	6595	10/12/21
Cables, attenuator and port feed through	various	CF GCL	4/30/21
Miteq Preamplifier	AMF-4D-0050100-24-10P	S/N:2053240	12/31/21
3m Chamber SW	N/A	SW30	3/31/21

6.5.3. Test Equipment Setup and Procedure

EMI Receiver Settings Emissions:

Detector Function :Peak
Resolution Bandwidth :100kHz (below 1GHz)
:1MHz (above 1GHz)
Video Bandwidth: :300kHz (below 1GHz)
:3MHz (above 1GHz)

EMI Receiver (in Spectrum Analyzer mode) Settings Occupied Bandwidth:

Detector :Peak
Resolution Bandwidth :1 MHz (to determine peak level)
:10 kHz (to determine occupied bandwidth)
Video Bandwidth :3 MHz (to determine peak level)
:30 kHz (to determine occupied bandwidth)

Spectrum Analyzer Settings for Conducted measurements:

Detector Function :Peak
Resolution Bandwidth :120kHz (below 1GHz)
:1MHz (above 1GHz)
Video Bandwidth: :300kHz (below 1GHz)
:3MHz (above 1GHz)

For the testing, the EUT was placed at the center of a non-conducting table 80cm above the ground plane pursuant to ANSI C63.10:2013 for stand-alone equipment. The 2-conductor harness was run straight down from the center of the turntable to a power supply sitting at the base of the table.

Equipment is placed in one of the three orthogonal orientations, End, Side, and Flat. These orientations are described below in Figure 6.2.3

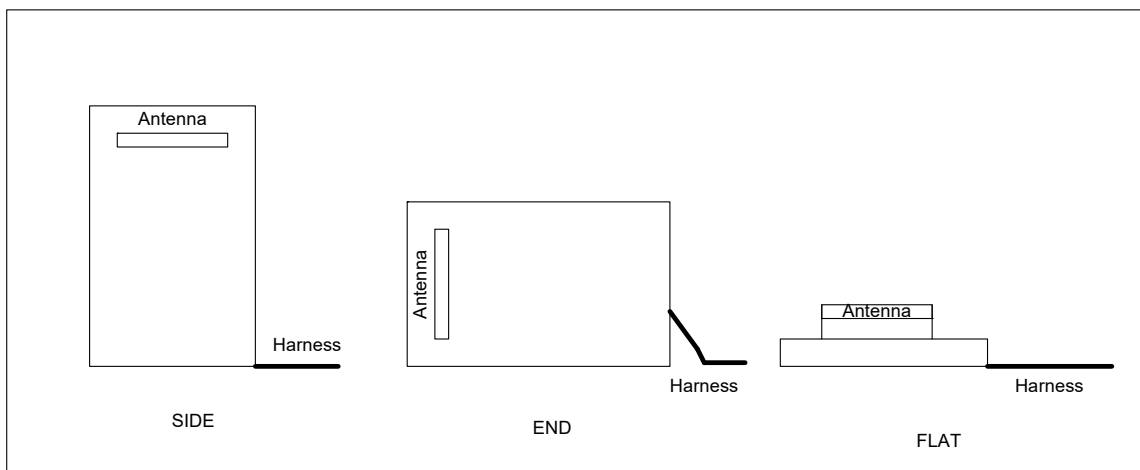


Figure 6.2.3 EUT Orthogonal Orientations

While in the prescribed orientation, the vertical antenna positioner sweeps in elevation from 1 to 4m in height until the operator finds the peak. The 3m turntable is then rotated

through 360 degrees until a peak is found. The table is stopped at the peak location and the peak in elevation re-verified. Procedure is repeated for applicable orientations/measurement antenna polarizations.

6.6. Measured Data – See Appendix A

7. Formulas and Sample Calculations

7.1. Calculation of ISED Limits from RSS-247 and 47 CFR Part 15.247

The Peak Tx Spurious Emissions limit for the fundamental is given by:
Limit dBuV/m = 1W ERP = 127.38 dBuV/m, which is the fundamental limit.

The Rx Spurious Emissions limit for the fundamental is given by:
Limit dBuV/m = $20 \cdot \log(200 \mu\text{V/m}) = 46.0 \text{ dBuV/m}$

The Rx Spurious Emissions limit for the harmonics is given by:
Limit dBuV/m = $20 \cdot \log(500 \mu\text{V/m}) = 54.0 \text{ dBuV/m}$

8. Other Attachments and Description

8.1. User Manual

Please refer to attachment "User_Manual_English.pdf" and "User_Manual_French.pdf".

8.2. Schematics/ Tuning Information

For schematics please refer to attachment "Schematic.pdf".

8.3. Theory of Operation

Please refer to attachment "HomeLink with HomeLink Connect Theory of Operation - BLE.pdf"

8.4. Label Drawing and Location on Complete Assembly

For a drawing of the label and position of the label on the finished assembly refer to "Label Location.pdf".

8.5. Photos

For exterior photos, refer to exhibit "exterior photographs.pdf".

For interior photos, refer to exhibit "interior photographs.pdf".

For test setup photos, refer to exhibit "test setup photographs.pdf".

Appendix A

A. Radiated (Tx) Measurements

DUT Transmitting at 2402MHz (Fundamental) –

Average and Peak Measurements 2402MHz

Frequency (MHz)	Orientation (Flat/End/Side)	Measurement Polarization (H/V)	Peak Measurement (dBuV/m)	Peak Limit (dBuV/m)	Margin (dB)	Average Measurement (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)
2402	Side	H	90.69	127.3	36.61	88.49	-	-
4804	Side	H	52.84	74.0	21.16	44.88	54.0	9.12
7206	Side	H	51.49	74.0	22.51	39.3	54.0	14.70
9608	Side	H	53.15	74.0	20.85	40.89	54.0	13.11
12010	Side	V	54.18	74.0	19.82	41.94	54.0	12.06
14412	Side	V	55.6	74.0	18.40	43.17	54.0	10.83
16814	Side	V	57.85	74.0	16.15	45.69	54.0	8.31
19216	Side	V	50.59	74.0	23.41	38.72	54.0	15.28
21618	Side	H	49.41	74.0	24.59	37.63	54.0	16.37
24020	Side	H	50.63	74.0	23.37	38.65	54.0	15.35

DUT Transmitting at 2440MHz (Fundamental) – FCC 15.247

Average and Peak Measurements 2440MHz

Frequency (MHz)	Orientation (Flat/End/Side)	Measurement Polarization (H/V)	Peak Measurement (dBuV/m)	Peak Limit (dBuV/m)	Margin (dB)	Average Measurement (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)
2440	Side	V	92.7	127.3	34.60	90.55	-	-
4880	Side	V	55.36	74.0	18.64	48	54.0	6.00
7320	Side	H	46.8	74.0	27.20	34.78	54.0	19.22
9760	Side	H	50.24	74.0	23.76	37.25	54.0	16.75
12200	Side	V	53.67	74.0	20.33	41.05	54.0	12.95
14640	Side	H	54.73	74.0	19.27	42.02	54.0	11.98
17080	Side	V	57.2	74.0	16.80	45.21	54.0	8.79
19520	Side	V	52.71	74.0	21.29	39.61	54.0	14.39
21960	Side	V	49.73	74.0	24.27	36.94	54.0	17.06
24400	Side	V	50.56	74.0	23.44	38.31	54.0	15.69

DUT Transmitting at 2480MHz (Fundamental) – FCC 15.247

Average and Peak Measurements 2480MHz

Frequency (MHz)	Orientation (Flat/End/Side)	Measurement Polarization (H/V)	Peak Measurement (dBuV/m)	Peak Limit (dBuV/m)	Margin (dB)	Average Measurement (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)
2480	Side	V	92.16	127.3	35.14	89.82	-	-
4960	Side	V	53.49	74.0	20.51	46.48	54.0	7.52
7440	Side	V	48.91	74.0	25.09	36.92	54.0	17.08
9920	Side	H	50.32	74.0	23.68	37.92	54.0	16.08
12400	Side	H	51.98	74.0	22.02	39.78	54.0	14.22
14880	Side	H	54.78	74.0	19.22	42.39	54.0	11.61
17360	Side	V	60.39	74.0	13.61	47.88	54.0	6.12
19840	Side	V	52.57	74.0	21.43	39.84	54.0	14.16
22320	Side	H	50.51	74.0	23.49	37.44	54.0	16.56
24800	Side	H	50.89	74.0	23.11	37.74	54.0	16.26

Occupied Bandwidth Measurement (FCC Part 15.247)

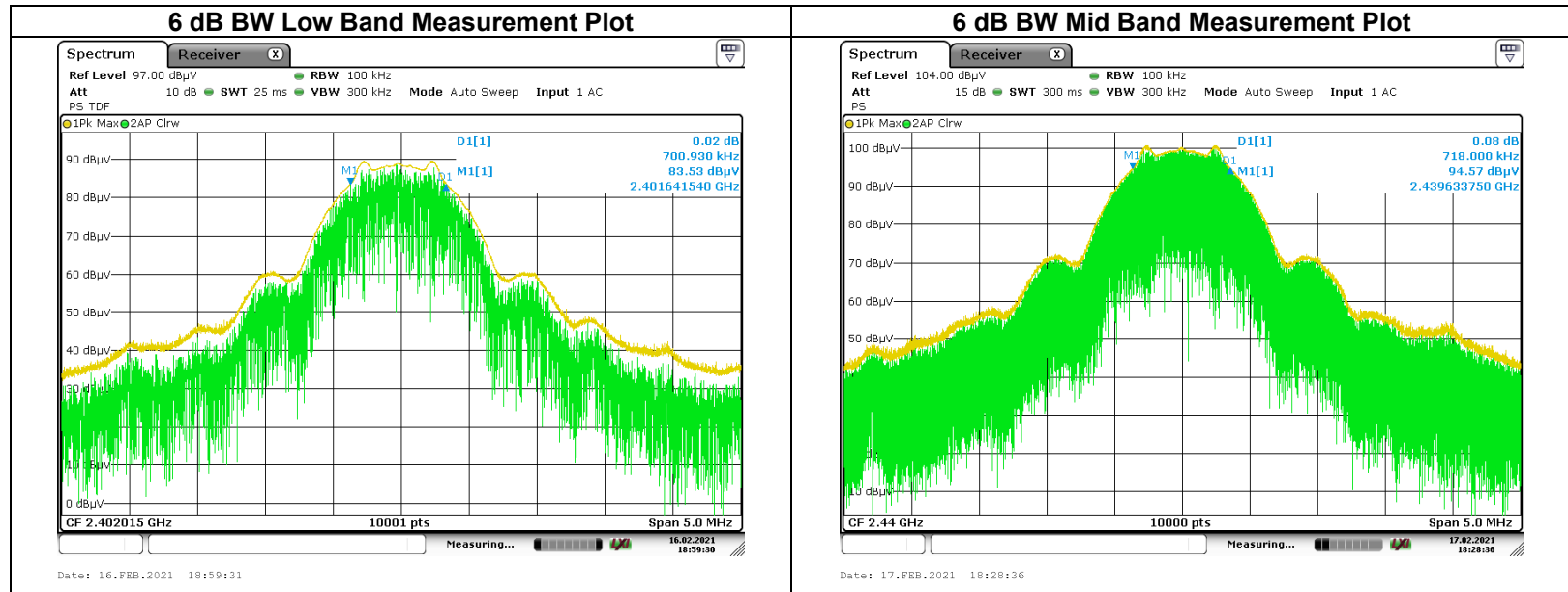
6dB Bandwidth Requirement: Per 15.247(a)(2) and RSS-247 paragraph 5.2 (a), the minimum 6dB bandwidth shall be at least 500kHz for all systems using digital modulation techniques.

The DUT was allowed to transmit continuously. The transmit channel was set separately to low, middle, and high channels. In measurement of the 20dB bandwidth, the transmit frequency was set to low, middle and high hopping channels. The resolution band width (RBW) was set to 100kHz resolution bandwidth, and the span was set to approximately 3 times the 6dB bandwidth.

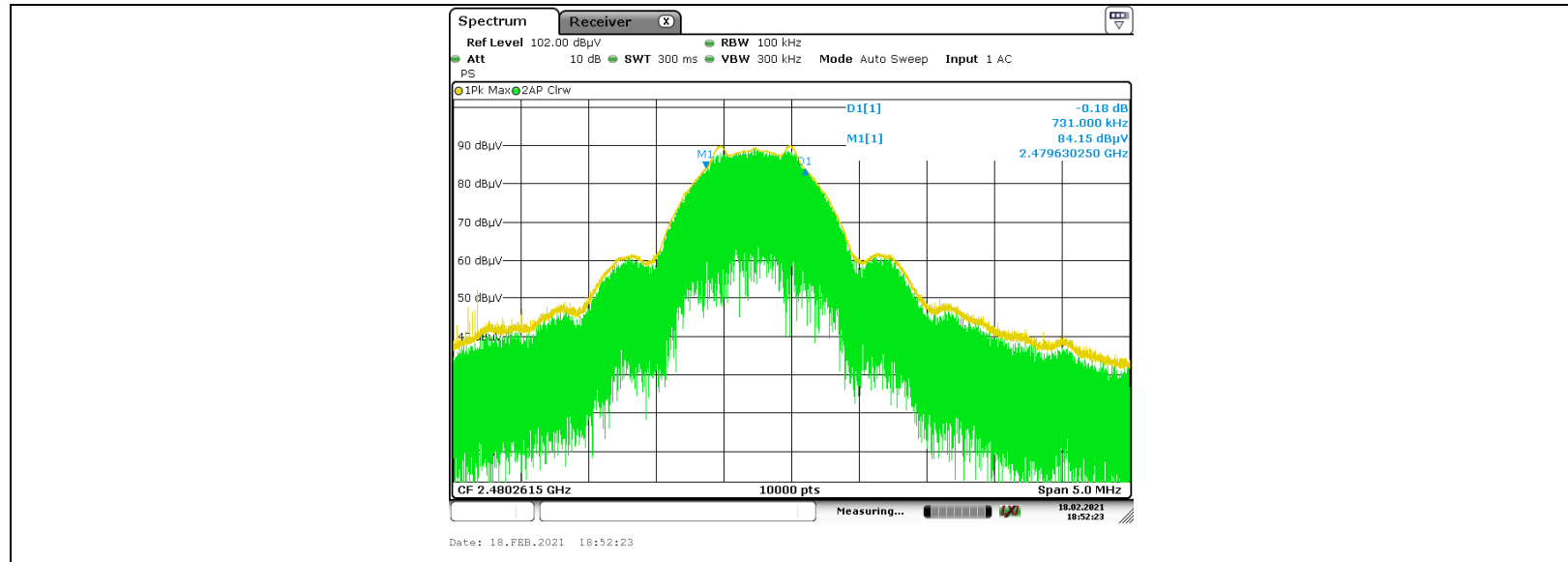
The plots show that the maximum 6dB bandwidth was 731kHz, which is within limit. The 99% bandwidth was measured to be 1094kHz.

BW Results

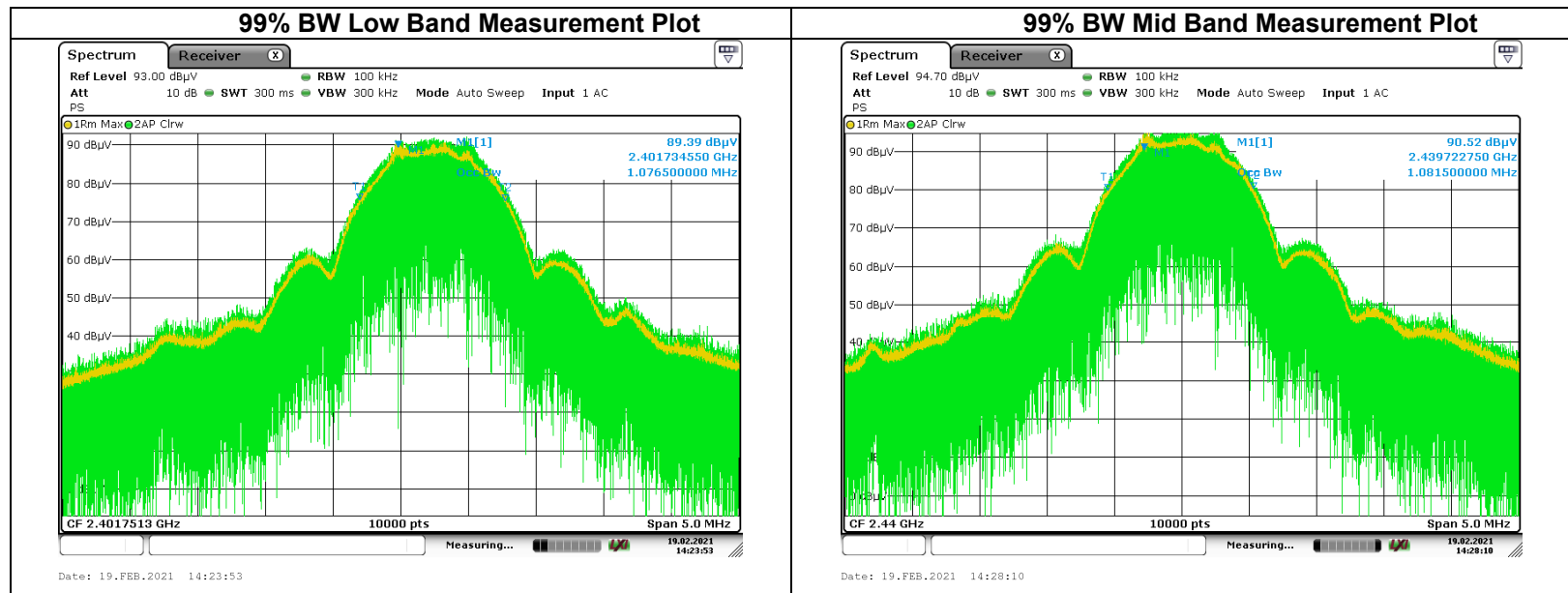
Channel #	Frequency (MHz)	6dB Bandwidth (kHz)	99% Bandwidth (kHz)	Limit (kHz)	Result
0	2402	700.9	1077	>500	Pass
19	2440	718	1083	>500	Pass
39	2480	731	1094	>500	Pass

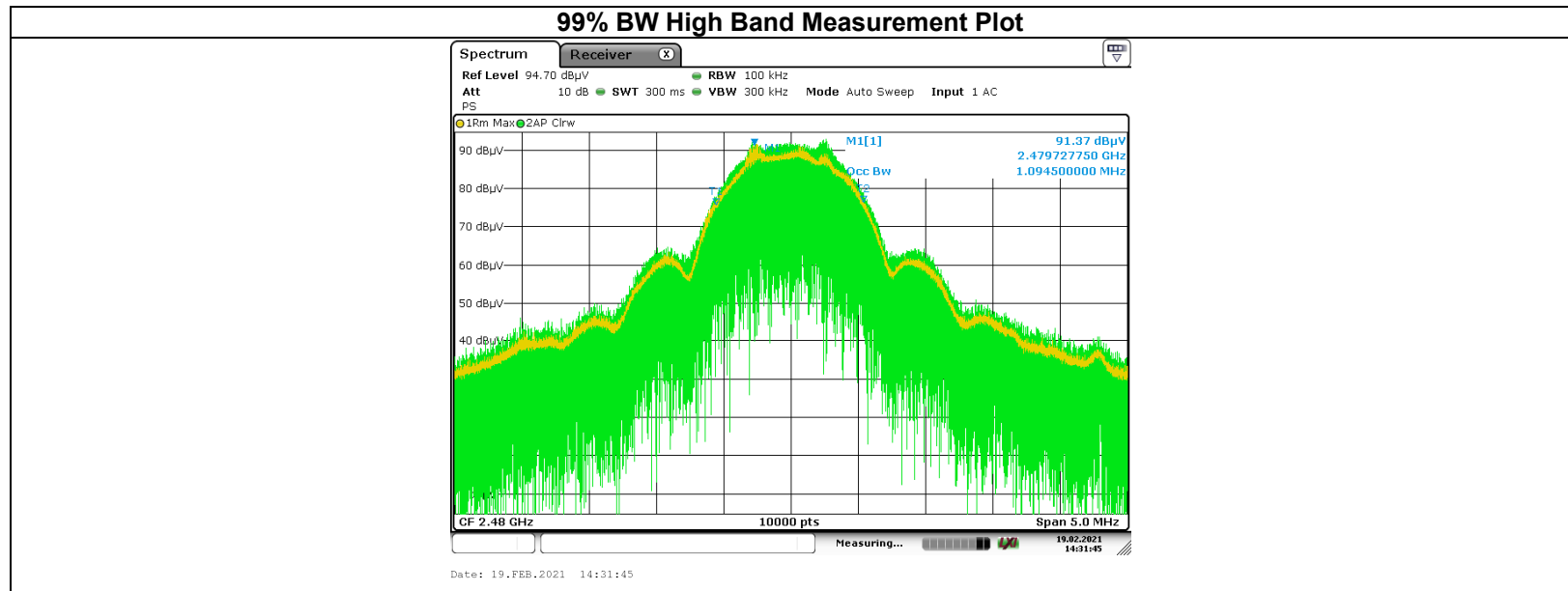


6 dB BW High Band Measurement Plot



99% BW Results





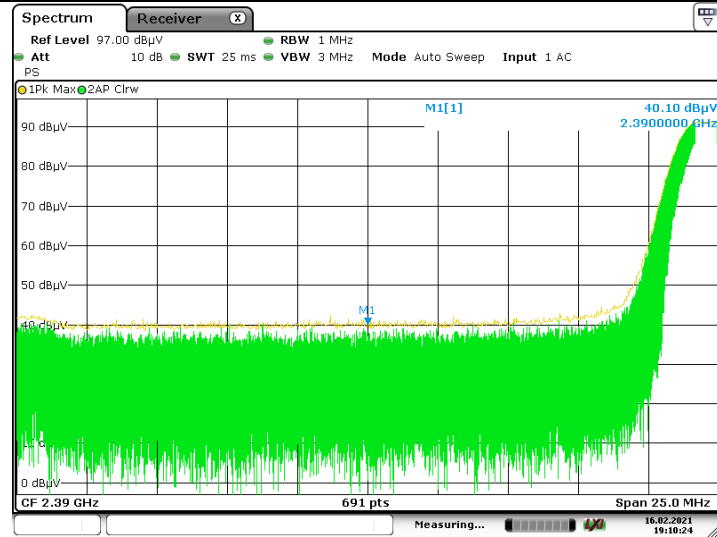
Band Edge Measurement (FCC Part 15.247)

Per section 15.247(d) and RSS-247 paragraph 5.5, 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. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a).

This measurement is a radiated measurement. Prior to the measurement the EUT is placed into continuous transmit at the low, or high channel via a communications board attached to the EUT.

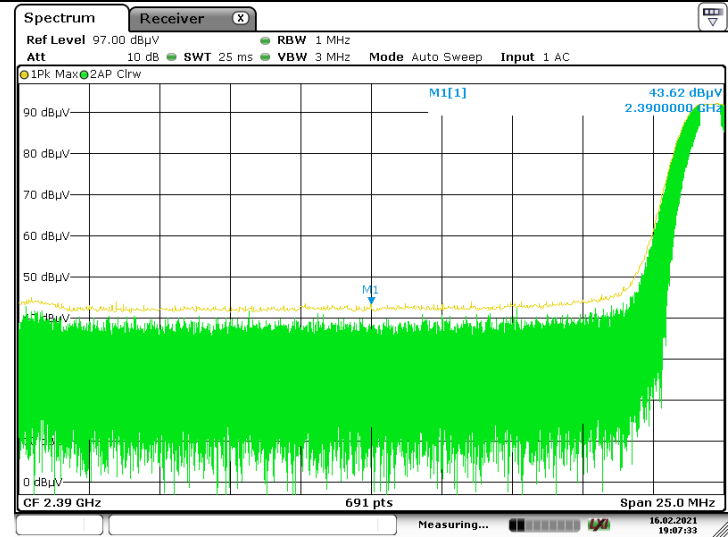
For the Low Frequency Band Edge, emissions are at least 20dB below the fundamental for frequencies less than 2402MHz as shown by the plots below. For the High Frequency Band Edge, emissions are within the general limits as shown by the plots below.

Low End Band Edge - Horizontal

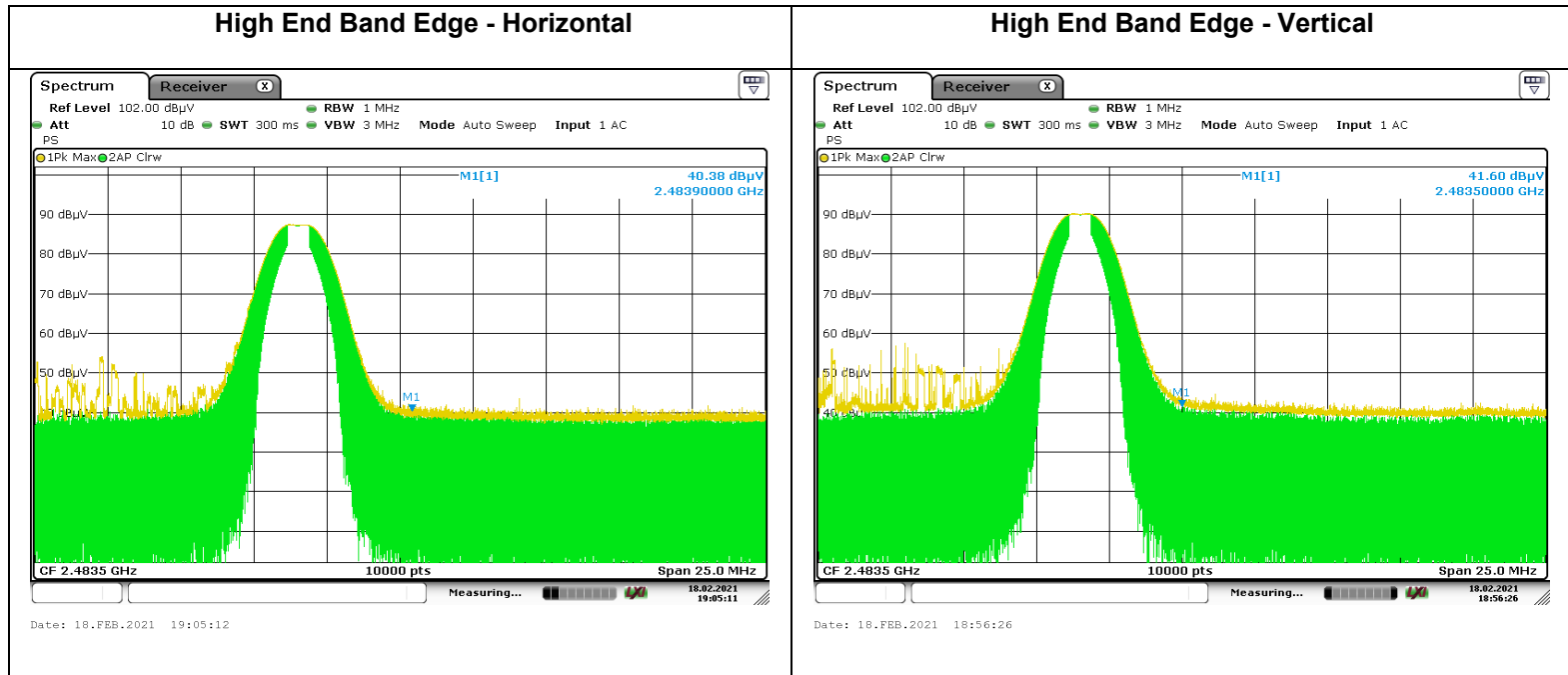


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Low End Band Edge - Vertical



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Peak Power (FCC Part 15.247)

Per FCC section 15.247(b)(3) and RSS 247 Para 5.4 (d)., for systems using digital modulation the maximum peak output conducted power shall not be greater than 1.0W (30dBm). Per FCC section 15.247(b)(4) and RSS 247 Para 5.4 (d), this limit is based on the use of antennas with directional gains that do not exceed 6dBi. Since the limit allows for a 6dBi antenna gain, the maximum EIRP can be increased by 6dB to 4 Watt (36dBm).

This measurement is a conducted measurement. Prior to the measurement the EUT is placed in continuous transmit on the low, middle, or high channel via a communications board attached to the EUT.

Peak power was measured with the transmitter set separately at 2402MHz, 2440MHz, and also 2480MHz. For each of the frequencies, the peak power was less than 30dBm. At 2402MHz the peak power was -7.89dBm, at 2440MHz the peak power was -8.6dBm, and at 2480MHz the peak power was -8.85dBm, as shown in the plots below.

Channel #	Frequency (MHz)	Power Output (dBm)	Limit (dBm)	Result
0	2402	-7.89	30	Pass
19	2440	-8.6	30	Pass
39	2480	-8.85	30	Pass

Power Spectral Density (FCC Part 15.247)

Per FCC section 15.247(e) and RSS 247 Para 5.2 (b), the peak power spectral density from the intentional radiator shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

This measurement is a conducted measurement. Prior to the measurement the EUT is placed into continuous transmit mode at the low, middle, or high channel via a communications board attached to the EUT.

In measurement of the power spectral density, the RBW was set to 100kHz. The peak detector and 'Max-Hold' function were engaged. With the span set to 3MHz, the sweep time was set to Auto.

Channel #	Frequency (MHz)	Measurement PPSD (dBm)	Limit (dBm)	Result
0	2402	-7.82	8	Pass
19	2440	-8.56	8	Pass
39	2480	-8.74	8	Pass