GENTEX CORPORATION

Technical Report to the FCC and ISED Regarding Gentex Corporation - HomeLink© V

Model: UAHL5E
FCC ID: NZLUAHL5E
ISED: 4112A-UAHL5E

Emission Designator: 29K2L1D
3/8/22

A report concerning approval for Gentex Corporation HomeLink® model UAHL5E
Please issue grant immediately upon review.

Measurements Made by:

Bolay Pannell
Digitally signed by Bolay Pannell
Date: 2022.03.09 09:20:33 -05'00'

Bolay Pannell
Laboratory Validation Engineer III
Gentex Corporation

Measurements Reviewed by:

Daniel Brasier
Digitally signed by Daniel Brasier
Date: 2022.03.09 08:55:10 -05'00'

Dan Brasier
Laboratory Development Engineer II
Gentex Corporation

Report Prepared, and Submitted by:

Brian Miller
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Date: 2022.03.08 17:50:47 -05'00'

Brian Miller
Laboratory Group Leader – Regulatory II
Gentex Corporation

Report Approved by:

Jason Vargo Laboratory Lab Manager I
Digitally signed by Jason Vargo Laboratory Lab Manager I
Date: 2022.03.09 07:00:20 -05'00'

Jason Vargo
Laboratory Manager I
Gentex Corporation

Test Report Revision

REV Number	Date	Author	Description
1.0	3/8/22	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® HLV Universal Garage Door Opener is a low-power transceiver OEM device that is installed into an overhead area of the automobile. 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 and
2. Reproduce and transmit the frequency and bit code format to remotely operate the user's garage door.

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 unit is only operational when the user depresses the control button. It becomes inactive after release of the control button.

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 15.247. The device will have FCC ID # of NZLUAHL5E and ISED ID # of 4112A-UAHL5E under both rule parts. A separate report is submitted for functionality covered under 47 CFR 15.247.

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, thus conducted emissions measurements are not required.

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.

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.

Tabletop testing was conducted on a 3m turntable described in the site recertification report. 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	Site Address
Gentex Corporation	Gentex Corporation
600 N. Centennial Street	380 Riley Street
Zeeland, MI 49464	Zeeland, MI 49464

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.

2. Product Labeling

2.1. Identifiers

The FCC Identifier assigned is FCC ID: NZLUAHL5E. The ISED certification number is 4112A-UAHL5E. These identifiers will be labeled on the product housing.

The label will be imprinted on the exterior of the mirror housing using molding tool 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-210. 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.

ISED: 4112A-UAHL5E FCC ID: NZLUAHL5E MODEL: UAHL5E

2.2. Label Drawing and Location on Product

The label drawing is included in the "Label.pdf" attachment.

A diagram showing the 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.

4. Block Diagram

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

5. Conducted Emissions Measurements

Conducted Measurements are not required for this product.

6. Radiated Emissions Data

6.1. Date(s) Tested: 3/2/22 – 3/4/22

6.2. Test Method Deviations: None

6.3. Temperature and Humidity conditions

	Measured Value	Unit
Temperature	23.5	ºC
Humidity	37.3	%R.H.

6.4. Summary of Results

Measurement		Margin	Frequency - Duty Cycle
Worst Case Peak Emission	83.37 dBuV/m	11.95 dB	310MHz - 30%
Worst Case Average Emission	73.5 dBuV/m	1.82 dB	310MHz - 50%
Worst Case Harmonic	51.4 dBuV/m	2.38 dB	576MHz - (288MHz - 50%)
Worst Case Restricted Band Emission	48.7 dBuV/m	5.28 dB	3440MHz - (430MHz – 50%)
Maximum -20 dB Occupied BW	8.3kHz	711.74kHz	288MHz - 30%
Maximum 99% Occupied BW	29.2kHz	690.8kHz	288MHz - 30%
Delta of Field Strength with Supply Voltage of 6-18V	0.11 dB	N/A	310MHz - 30%

- This module exhibits pulsed operation characteristics.
- The device does not operate when the input voltage is below 7V and power reduced to 83.0 dBuV/m at 7V.
- The device was found to be incapable of operating in restricted bands.
- The device deactivated in less than 5 seconds after the activation button is depressed.

- **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): 4.7 dB
  - Radiated Emissions – LPA (250-1000 MHz): 5.6 dB
  - Radiated Emissions – DRWG (26.5 GHz): 4.7 dB
  - Frequency: 0.15ppm

6.5. Test Equipment Setup and Procedure

6.5.1. Test Equipment Used

7. Description	Model #	ID Number	Cal Due
EMCO LPA Antenna [250-1000MHz]	3148	H6192	5/3/24
Com-Power Double Ridged Waveguide [1-18GHz]	AHA-118	8893	11/25/22
Rohde & Schwarz EMI Receiver	ESR26	6595	10/23/22
Cables, attenuator and port feed through	various	CF GCL	4/30/22
3m Chamber SW	N/A	SW30	3/31/22
HomeLink5 Diagnostic Application	N/A	SW44	VBU

EMI Receiver Settings Emissions:

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

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

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

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 6.2.1.

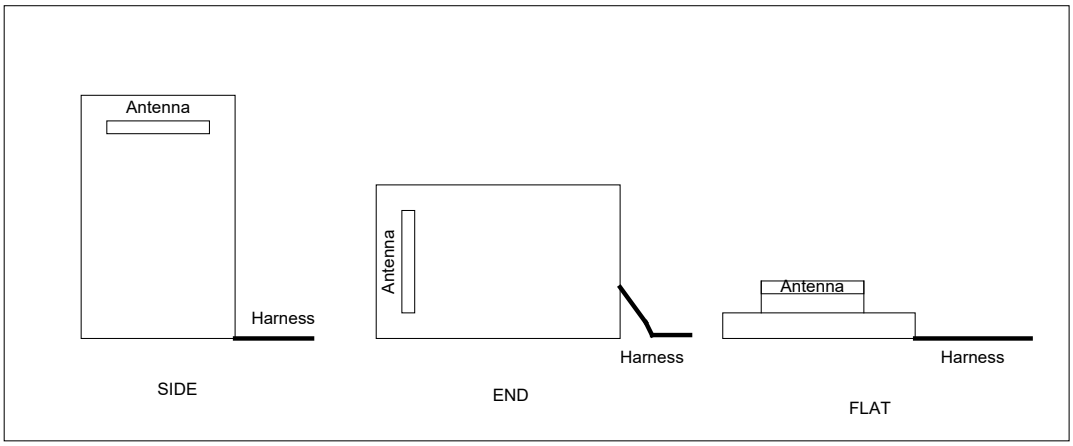


Figure 6.2.1 EUT Orthogonal Orientations

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.

7.1. Measured Data – See Appendix A

8. Verification of Non-Operation in Restricted Bands

An exercise was undergone by the product Software Design team to verify that the device was not able to learn and thereby transmit in a restricted band. During this exercise, it was found that the device firmware prevents the device from learning any frequency within 1MHz of any restricted band listed in RSS-210 Issue 9, Table 1 and 47 CFR 15.205.
This exercise is described as follows:

HomeLink Operating Frequencies

HomeLink is designed to transmit from 286 – 440 MHz, with the exception of two regions:

- 321 – 336.4 MHz
- 398.9 – 411 MHz

HomeLink will only transmit at frequencies it is able to train to, therefore to verify HomeLink does not **transmit** outside the designated regions, it must be verified that HomeLink does not **train** to signals outside the designated regions.

To verify this, the Agilent E4421B signal generator was set up to output a 400 Hz square wave with 100% modulation depth and amplitude -5.00 dBm. It was then verified that HomeLink would train to this signal only when it was transmitted at the proper frequencies. Specifically, the various frequencies in the vicinity of the banned region boundaries were tested, and verified that HomeLink trained when it saw a signal at a valid frequency, and did not train when it saw a signal at a banned frequency. In the instances where HomeLink trained to a valid frequency, it was then verified that HomeLink transmitted at that same frequency.

One thing that should be noted: HomeLink margin of error is approximately 100 kHz. Therefore the HomeLink may not adhere to the specified limits with absolute precision. This is why the FCC banned frequencies are guard-banded by 1MHz. For example, the FCC bans transmissions below 285MHz. By setting HomeLink's lower limit to 286 MHz, it guarantees that HomeLink will not operate below 285 MHz, and in all likelihood, HomeLink will not operate below 285.8MHz.

In addition to the banned frequencies, there also exists certain "harmonic avoidance frequency regions" which HomeLink will train to, but will shift the transmit frequency so as not to generate harmonics at particular frequencies. All these frequency regions are listed below, and the table on the following pages shows the exact frequencies tested.

FCC Banned Regions	Harmonic Avoidance Regions
(HomeLink does not train to the following frequencies) 240 – 285 MHz 322 – 335.4 MHz 399.9 – 410 MHz	(HomeLink trains to the following frequencies but transmits on the edges of these bands) 303.5 MHz – 307.5 MHz

Frequency (MHz)	Part 15 Status	Result	Pass/Fail	Comments
285.0	banned	would not train	Pass	
285.5	allowed (guard band region)	would not train	Pass	
286.0	allowed (guard band region)	trained	Pass	
287.0	allowed	trained	Pass	
303.5	allowed	trained	Pass	
304.0	allowed	trained	Pass	Frequency shifted to 303.5 MHz
304.5	allowed	trained	Pass	Frequency shifted to 303.5 MHz
305.0	allowed	trained	Pass	Frequency shifted to 303.5 MHz
305.5	allowed	trained	Pass	Frequency shifted to 303.5 MHz
306.0	allowed	trained	Pass	Frequency shifted to 307.5 MHz
306.5	allowed	trained	Pass	Frequency shifted to 307.5 MHz
307.0	allowed	trained	Pass	Frequency shifted to 307.5 MHz
307.5	allowed	trained	Pass	
319.0	allowed	trained	Pass	
320.0	allowed	trained	Pass	
320.5	allowed	trained	Pass	
321.0	allowed (guard band region)	trained	Pass	
322.0	banned	would not train	Pass	

Frequency (MHz)	Part 15 Status	Result	Pass/Fail	Comments
323.0	banned	would not train	Pass	
324.0	banned	would not train	Pass	
325.0	banned	would not train	Pass	
326.0	banned	would not train	Pass	
327.0	banned	would not train	Pass	
328.0	banned	would not train	Pass	
329.0	banned	would not train	Pass	
330.0	banned	would not train	Pass	
331.0	banned	would not train	Pass	
332.0	banned	would not train	Pass	
333.0	banned	would not train	Pass	
334.0	banned	would not train	Pass	
335.0	banned	would not train	Pass	
336.0	allowed (guard band region)	would not train	Pass	
337.0	allowed (guard band region)	trained	Pass	
338.0	allowed	trained	Pass	
398.0	allowed	trained	Pass	
399.0	allowed (guard band region)	would not train	Pass	While this is a valid frequency, HomeLink guardbands this region to ensure it doesn't train to 399.9 MHz
399.5	allowed (guard band region)	would not train	Pass	While this is a valid frequency, HomeLink guardbands this region to ensure it doesn't train to 399.9 MHz
400.0	banned	would not train	Pass	
401.0	banned	would not train	Pass	
402.0	banned	would not train	Pass	
403.0	banned	would not train	Pass	
404.0	banned	would not train	Pass	
405.0	banned	would not train	Pass	
406.0	banned	would not train	Pass	
407.0	banned	would not train	Pass	
408.0	banned	would not train	Pass	
409.0	banned	would not train	Pass	
410.0	banned	would not train	Pass	
410.5	allowed (guard band region)	would not train	Pass	
411.0	allowed (guard band region)	would not train	Pass	
411.5	allowed	trained	Pass	
412.0	allowed	trained	Pass	
439.0	allowed	trained	Pass	
440.0	allowed	trained	Pass	
440.5	allowed	would not train	Pass	HomeLink only operates up to 440 MHz
441.0	allowed	would not train	Pass	HomeLink only operates up to 440 MHz
442.0	allowed	would not train	Pass	HomeLink only operates up to 440 MHz

9. Verification of De-activation after 5 seconds

An exercise was undergone by the product Software Design team to verify that the device was deactivated appropriately. This device stops transmitting after 1.099s once the activation button is released.

10. Formulas and Sample Calculations

10.1. Adjustment to account for duty cycle

The EMI Receiver used for making the measurements in this report automatically corrects for cable correction and antenna factors using values stored in memory taken from the most recent calibration (in the case of antenna factors), periodic cable loss measurements, and preamplifier gain.

Formula 1: FS(dBuV/m) = M(dBuV) + AF(dB/m) + CF(dB) – AG(dB)

The presented field strength is computed by the EMI Receiver by taking the measured level and adding to it the antenna factor and cable loss corrections. The measurements presented were gathered using the EMI Receiver's peak-hold capability.

Formula 2: Average Level(dBuV/m) = Peak Level (dBuV/m) + duty cycle factor(dB).

The peak measurement is adjusted to an average level by a duty cycle described below.

The duty cycle factor to apply is determined for the duty cycles of 30%, 50%, and 80% as follows:

For 30% (0.30): duty cycle factor (dB) = 20*Log(0.3) = -10.46
For 50% (0.50): duty cycle factor(dB) = 20*Log(0.5) = -6.02
For 80% (0.80): duty cycle factor(dB) = 20*Log(0.8) = -1.94

Example calculation:
With the EUT programmed with a 30% duty cycle a measurement of 74 dBuV/m is taken (about 5000 uV/m), the adjusted level would be:

74 + (-10.46) = 63.54 dBuV/m (example)

10.2. Calculation of ISED Limits from Table 4, RSS-210 and 47 CFR Part 15.231

The prescribed limit in the range of 260 MHz to 470 MHz is stated as a linear interpolation between 3750 uV/m and 12500 uV/m. The equation used to calculate the limit using this criterion is:

FCC limit = 41.67 * f – 7083.33
(Where 'f' is the measurement frequency in MHz.)

The limit is dBuV/m is then:

dB limit = 20 * log10(FCC limit uV/m) = 20*log10(41.67*f – 7083.33)
(log10 is used to indicated the use of a base 10 logarithm)

This results in the following limits for the fundamentals:

288MHz	20*log10(4917.6)	= 73.8 dBuV/m
310MHz	20*log10(5834.4)	= 75.3 dBuV/m
390MHz	20*log10(9168.0)	= 79.2 dBuV/m
433MHz	20*log10(10959.8)	= 80.8 dBuV/m

11. Other Attachments and Description

11.1. User Manual

Please refer to attachment “User_manual.pdf”.

11.2. Schematics / Tuning Information

For schematics please refer to exhibit “Schematics.pdf”.

11.3. Emission Designation

According to TRC-43, the emission designation for this product is 29K2L1D. Where “29K2” is the highest measured occupied bandwidth, “L” indicates the device uses pulse width modulation, “1” indicates the modulation as being single channel, digital information and “D” indicates that data is being transmitted.

11.4. Theory of Operation

Please refer to attachment “Theory of operation”

11.5. Label Drawing and Location on Complete Assembly

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

11.6. Photos

For interior photos, refer to exhibit “Interior Photographs”.

For exterior photos, refer to exhibit “Exterior Photographs”.

For test setup photos, refer to exhibit “Test Setup Photographs”.

Appendix A

A. Measurements of Fundamentals and Harmonics

Measurements described in this section were taken according to ANSI C63.10-2013 on the Gentex Corporation 3m test table.
* Measurements include Cable corrections and Antenna Factors

1. DUT Tuned to Fund 288MHz

Frequency (MHz)	Orientation (Flat/End/Side)	Measurement Polarization (H/V)	Duty Cycle (%)	Measurement* (dBuV/m)	FCC Peak Limit (dBuV/m)	Margin-Peak (dB)	Duty Cycle Correction (dB)	Average Level (dBuV/m)	FCC Average Limit (dBuV/m)	Margin-Average (dB)
288	Side	H	30	77.87	93.8	**15.96**	-10.5	67.4	73.8	6.42
288	Side	H	50	73.78	93.8	20.05	-6.0	67.8	73.8	**6.07**
288	Side	H	80	67.41	93.8	26.42	-1.9	65.5	73.8	8.36

2. DUT Tuned to Fund 310MHz

Frequency (MHz)	Orientation (Flat/End/Side)	Measurement Polarization (H/V)	Duty Cycle (%)	Measurement* (dBuV/m)	FCC Peak Limit (dBuV/m)	Margin-Peak (dB)	Duty Cycle Correction (dB)	Average Level (dBuV/m)	FCC Average Limit (dBuV/m)	Margin-Average (dB)
310	Side	H	30	83.37	95.3	**11.95**	-10.5	72.9	75.3	2.41
310	Side	H	50	79.52	95.3	15.80	-6.0	73.5	75.3	**1.82**
310	Side	H	80	72.48	95.3	22.84	-1.9	70.5	75.3	4.78

3. DUT Tuned to Fund 365MHz

Frequency (MHz)	Orientation (Flat/End/Side)	Measurement Polarization (H/V)	Duty Cycle (%)	Measurement* (dBuV/m)	FCC Peak Limit (dBuV/m)	Margin-Peak (dB)	Duty Cycle Correction (dB)	Average Level (dBuV/m)	FCC Average Limit (dBuV/m)	Margin-Average (dB)
365	Side	H	30	85.54	98.2	**12.66**	-10.5	75.1	78.2	3.11
365	Side	H	50	81.37	98.2	16.83	-6.0	75.3	78.2	**2.85**
365	Side	H	80	75.67	98.2	22.53	-1.9	73.7	78.2	4.46

4. DUT Tuned to Fund 430MHz

Frequency (MHz)	Orientation (Flat/End/Side)	Measurement Polarization (H/V)	Duty Cycle (%)	Measurement* (dBuV/m)	FCC Peak Limit (dBuV/m)	Margin-Peak (dB)	Duty Cycle Correction (dB)	Average Level (dBuV/m)	FCC Average Limit (dBuV/m)	Margin-Average (dB)
430	Side	V	30	87.21	100.7	**13.49**	-10.5	76.8	80.7	3.94
430	Side	V	50	83.91	100.7	16.79	-6.0	77.9	80.7	**2.81**
430	Side	V	80	78.13	100.7	22.57	-1.9	76.2	80.7	4.50

5. DUT Tuned to Har_288MHz

Frequency (MHz)	Orientation (Flat/End/Side)	Measurement Polarization (H/V)	Duty Cycle (%)	Measurement* (dBuV/m)	FCC Peak Limit (dBuV/m)	Margin-Peak (dB)	Duty Cycle Correction (dB)	Average Level (dBuV/m)	FCC Average Limit (dBuV/m)	Margin-Average (dB)
576	Side	H	30	59.87	73.8	**13.93**	-10.5	49.4	53.8	4.39
576	Side	H	50	57.47	73.8	16.36	-6.0	51.4	53.8	**2.38**
576	Side	H	80	50.72	73.8	23.11	-1.9	48.8	53.8	5.05
864	Side	V	30	52.7	73.8	21.13	-10.5	42.2	53.8	11.59
864	Side	V	50	53.37	73.8	20.46	-6.0	47.3	53.8	6.48
864	Side	V	80	49.61	73.8	24.22	-1.9	47.7	53.8	6.16
1152	Side	V	30	39.04	74.0	34.96	-10.5	28.6	54.0	25.42
1152	Side	V	50	36.5	74.0	37.50	-6.0	30.5	54.0	23.52
1152	Side	V	80	34.75	74.0	39.25	-1.9	32.8	54.0	21.19
1440	Side	H	30	48.1	74.0	25.90	-10.5	37.6	54.0	16.36
1440	Side	H	50	46	74.0	28.00	-6.0	40.0	54.0	14.02
1440	Side	H	80	40.71	74.0	33.29	-1.9	38.8	54.0	15.23
1728	Side	H	30	44.82	74.0	29.18	-10.5	34.4	54.0	19.64
1728	Side	H	50	43	74.0	31.00	-6.0	37.0	54.0	17.02
1728	Side	H	80	39.16	74.0	34.84	-1.9	37.2	54.0	16.78
2016	Side	H	30	50.49	73.8	23.34	-10.5	40.0	53.8	13.80
2016	Side	H	50	47.43	73.8	26.40	-6.0	41.4	53.8	12.42
2016	Side	H	80	41.95	73.8	31.88	-1.9	40.0	53.8	13.82
2304	Side	V	30	46.69	74.0	27.31	-10.5	36.2	54.0	17.77
2304	Side	V	50	45.87	74.0	28.13	-6.0	39.8	54.0	14.15
2304	Side	V	80	41.9	74.0	32.10	-1.9	40.0	54.0	14.04
2592	Side	H	30	54.24	74.0	19.76	-10.5	43.8	54.0	10.22
2592	Side	H	50	50.25	74.0	23.75	-6.0	44.2	54.0	9.77
2592	Side	H	80	42.85	74.0	31.15	-1.9	40.9	54.0	13.09
2880	Side	H	30	52.7	74.0	21.30	-10.5	42.2	54.0	11.76
2880	Side	H	50	51.8	74.0	22.20	-6.0	45.8	54.0	8.22
2880	Side	H	80	47.17	74.0	26.83	-1.9	45.2	54.0	8.77

6. DUT Tuned to Har_310MHz

Frequency (MHz)	Orientation (Flat/End/Side)	Measurement Polarization (H/V)	Duty Cycle (%)	Measurement* (dBuV/m)	FCC Peak Limit (dBuV/m)	Margin-Peak (dB)	Duty Cycle Correction (dB)	Average Level (dBuV/m)	FCC Average Limit (dBuV/m)	Margin-Average (dB)
620	Side	V	30	52.09	75.3	23.21	-10.5	41.6	55.3	13.67
620	Side	V	50	49.1	75.3	26.20	-6.0	43.1	55.3	12.22
620	Side	V	80	44.9	75.3	30.40	-1.9	43.0	55.3	12.34
930	Side	V	30	48.82	74.0	25.18	-10.5	38.4	54.0	15.64
930	Side	V	50	46.57	74.0	27.43	-6.0	40.5	54.0	13.45
930	Side	V	80	45.18	74.0	28.82	-1.9	43.2	54.0	10.76
1240	Side	V	30	41.62	74.0	32.38	-10.5	31.2	54.0	22.84
1240	Side	H	50	39.13	74.0	34.87	-6.0	33.1	54.0	20.89
1240	Side	H	80	35.89	74.0	38.11	-1.9	34.0	54.0	20.05
1550	Side	H	30	44.41	74.0	29.59	-10.5	34.0	54.0	20.05
1550	Side	H	50	42.05	74.0	31.95	-6.0	36.0	54.0	17.97
1550	Side	H	80	39.58	74.0	34.42	-1.9	37.6	54.0	16.36
1860	Side	H	30	44.52	75.3	30.78	-10.5	34.1	55.3	21.24
1860	Side	H	50	42.34	75.3	32.96	-6.0	36.3	55.3	18.98
1860	Side	H	80	39.4	75.3	35.90	-1.9	37.5	55.3	17.84
2170	Side	H	30	47.25	74.0	26.75	-10.5	36.8	54.0	17.21
2170	Side	H	50	43.97	74.0	30.03	-6.0	37.9	54.0	16.05
2170	Side	H	80	39.98	74.0	34.02	-1.9	38.0	54.0	15.96
2480	Side	V	30	51.38	74.0	22.62	-10.5	40.9	54.0	13.08
2480	Side	V	50	48.36	74.0	25.64	-6.0	42.3	54.0	11.66
2480	Side	V	80	43.56	74.0	30.44	-1.9	41.6	54.0	12.38
2790	Side	H	30	45.87	74.0	28.13	-10.5	35.4	54.0	18.59
2790	Side	H	50	43.03	74.0	30.97	-6.0	37.0	54.0	16.99
2790	Side	H	80	40.09	74.0	33.91	-1.9	38.2	54.0	15.85
3100	Side	V	30	58.96	75.3	**16.34**	-10.5	48.5	55.3	6.80
3100	Side	V	50	55.97	75.3	19.33	-6.0	49.9	55.3	**5.35**
3100	Side	V	80	50.91	75.3	24.39	-1.9	49.0	55.3	6.33

7. DUT Tuned to Har_365MHz

Frequency (MHz)	Orientation (Flat/End/Side)	Measurement Polarization (H/V)	Duty Cycle (%)	Measurement* (dBuV/m)	FCC Peak Limit (dBuV/m)	Margin-Peak (dB)	Duty Cycle Correction (dB)	Average Level (dBuV/m)	FCC Average Limit (dBuV/m)	Margin-Average (dB)
730	Side	V	30	46.32	78.2	31.88	-10.5	35.9	58.2	22.34
730	Side	V	50	45.99	78.2	32.21	-6.0	40.0	58.2	18.23
730	Side	V	80	44.18	78.2	34.02	-1.9	42.2	58.2	15.96
1095	Side	V	30	39.27	74.0	34.73	-10.5	28.8	54.0	25.19
1095	Side	V	50	36.98	74.0	37.02	-6.0	31.0	54.0	23.04
1095	Side	V	80	34.66	74.0	39.34	-1.9	32.7	54.0	21.28
1460	Side	V	30	41.44	74.0	32.56	-10.5	31.0	54.0	23.02
1460	Side	V	50	39.82	74.0	34.18	-6.0	33.8	54.0	20.20
1460	Side	V	80	36.63	74.0	37.37	-1.9	34.7	54.0	19.31
1825	Side	V	30	44.81	74.0	29.19	-10.5	34.4	54.0	19.65
1825	Side	V	50	42.25	74.0	31.75	-6.0	36.2	54.0	17.77
1825	Side	V	80	40.13	74.0	33.87	-1.9	38.2	54.0	15.81
2190	Side	H	30	46.56	74.0	27.44	-10.5	36.1	54.0	17.90
2190	Side	H	50	44.91	74.0	29.09	-6.0	38.9	54.0	15.11
2190	Side	H	80	42.07	74.0	31.93	-1.9	40.1	54.0	13.87
2555	Side	H	30	48.34	74.0	25.66	-10.5	37.9	54.0	16.12
2555	Side	H	50	45.29	74.0	28.71	-6.0	39.3	54.0	14.73
2555	Side	H	80	41.58	74.0	32.42	-1.9	39.6	54.0	14.36
2920	Side	H	30	53.71	74.0	20.29	-10.5	43.3	54.0	10.75
2920	Side	H	50	51.23	74.0	22.77	-6.0	45.2	54.0	8.79
2920	Side	H	80	47.24	74.0	26.76	-1.9	45.3	54.0	8.70
3285	Side	H	30	50.49	74.0	23.51	-10.5	40.0	54.0	13.97
3285	Side	H	50	47.66	74.0	26.34	-6.0	41.6	54.0	12.36
3285	Side	H	80	43.87	74.0	30.13	-1.9	41.9	54.0	12.07
3650	Side	H	30	57.16	74.0	**16.84**	-10.5	46.7	54.0	7.30
3650	Side	H	50	54.46	74.0	19.54	-6.0	48.4	54.0	**5.56**
3650	Side	H	80	50.36	74.0	23.64	-1.9	48.4	54.0	5.58

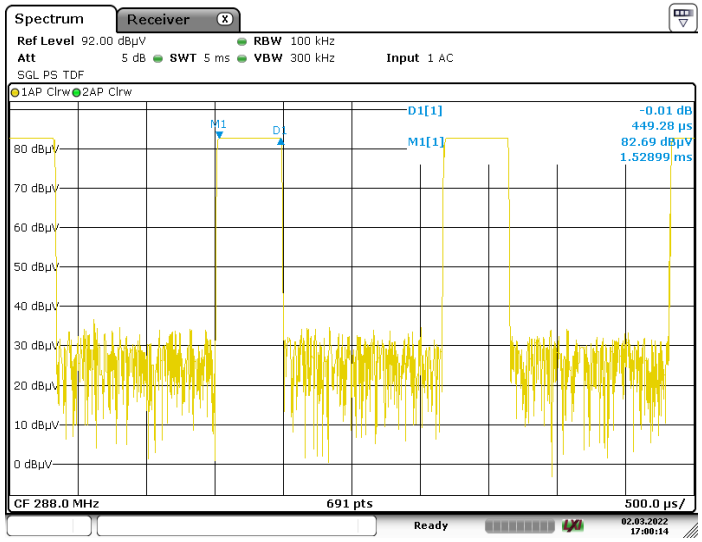
8.DUT Tuned to Har_430MHz

Frequency (MHz)	Orientation (Flat/End/Side)	Measurement Polarization (H/V)	Duty Cycle (%)	Measurement* (dBuV/m)	FCC Peak Limit (dBuV/m)	Margin-Peak (dB)	Duty Cycle Correction (dB)	Average Level (dBuV/m)	FCC Limit (dBuV/m)	Margin (dB)
860	Side	V	30	48.42	80.8	32.38	-10.5	38.0	60.8	22.84
860	Side	V	50	46.5	80.8	34.30	-6.0	40.5	60.8	20.32
860	Side	V	80	45.13	80.8	35.67	-1.9	43.2	60.8	17.61
1290	Side	V	30	47.23	74.0	26.77	-10.5	36.8	54.0	17.23
1290	Side	V	50	43.7	74.0	30.30	-6.0	37.7	54.0	16.32
1290	Side	V	80	40.07	74.0	33.93	-1.9	38.1	54.0	15.87
1720	Side	H	30	43.49	74.0	30.51	-10.5	33.0	54.0	20.97
1720	Side	H	50	41.18	74.0	32.82	-6.0	35.2	54.0	18.84
1720	Side	H	80	39.16	74.0	34.84	-1.9	37.2	54.0	16.78
2150	Side	H	30	46.9	80.8	33.90	-10.5	36.4	60.8	24.36
2150	Side	H	50	44.29	80.8	36.51	-6.0	38.3	60.8	22.53
2150	Side	H	80	41.13	80.8	39.67	-1.9	39.2	60.8	21.61
2580	Side	V	30	53.01	74.0	20.99	-10.5	42.6	54.0	11.45
2580	Side	V	50	50.26	74.0	23.74	-6.0	44.2	54.0	9.76
2580	Side	V	80	45.45	74.0	28.55	-1.9	43.5	54.0	10.49
3010	Side	H	30	51.42	74.0	22.58	-10.5	41.0	54.0	13.04
3010	Side	H	50	48.74	74.0	25.26	-6.0	42.7	54.0	11.28
3010	Side	H	80	44.67	74.0	29.33	-1.9	42.7	54.0	11.27
3440	Side	V	30	57.74	74.0	**16.26**	-10.5	47.3	54.0	6.72
3440	Side	V	50	54.74	74.0	19.26	-6.0	48.7	54.0	**5.28**
3440	Side	V	80	50.43	74.0	23.57	-1.9	48.5	54.0	5.51
3870	Side	V	30	44.71	74.0	29.29	-10.5	34.3	54.0	19.75
3870	Side	V	50	40.21	74.0	33.79	-6.0	34.2	54.0	19.81
3870	Side	V	80	37.44	74.0	36.56	-1.9	35.5	54.0	18.50
4300	Side	H	30	53.31	74.0	20.69	-10.5	42.9	54.0	11.15
4300	Side	H	50	51.5	74.0	22.50	-6.0	45.5	54.0	8.52
4300	Side	H	80	48.36	74.0	25.64	-1.9	46.4	54.0	7.58

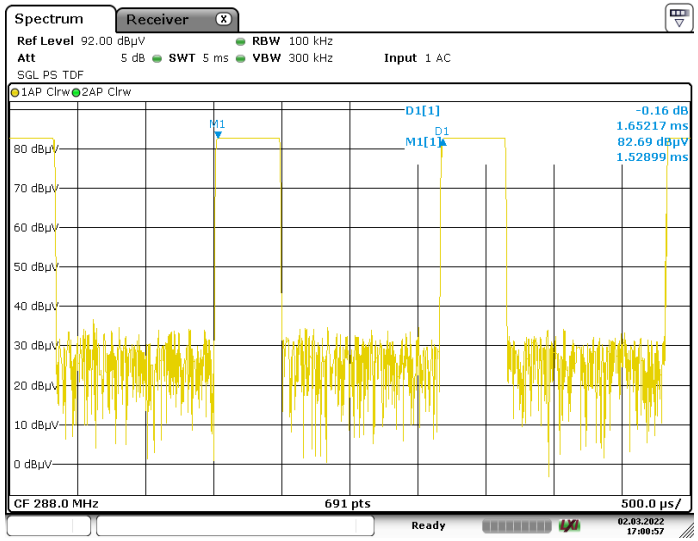
8. Pulsed Operation

The Homelink© transmitter tested here transmits pulses using amplitude modulation with varying duty cycle. Verification of pulse operation at 30, 50 and 80% duty cycles is provided here. Measurements were taken at 288 MHz with the span set to zero on the R&S ESR26 EMI Receiver. The modulation frequency is 500Hz.

a. 30% Duty Cycle

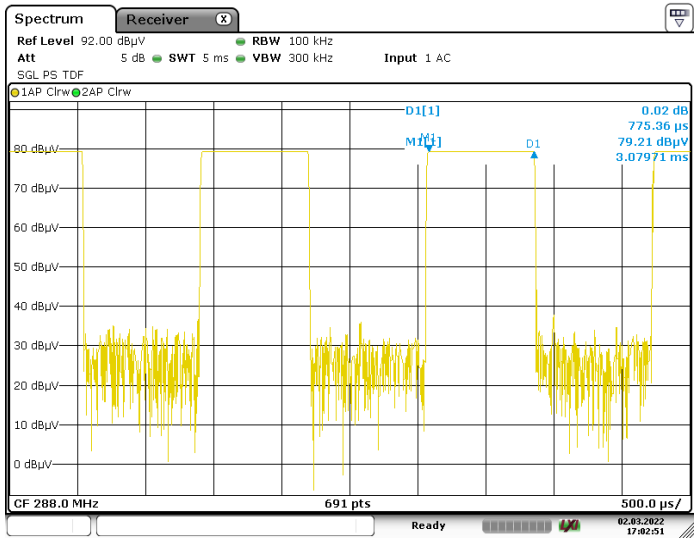


Date: 2.MAR.2022 17:00:14



Date: 2.MAR.2022 17:00:57

b. 50% Duty Cycle



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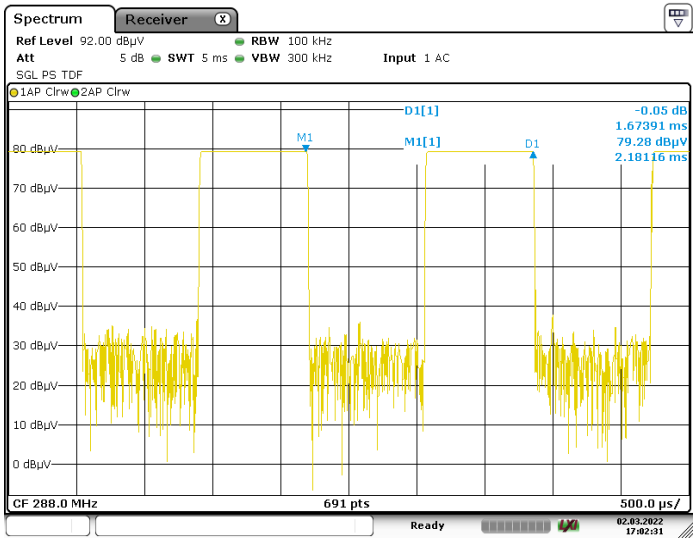

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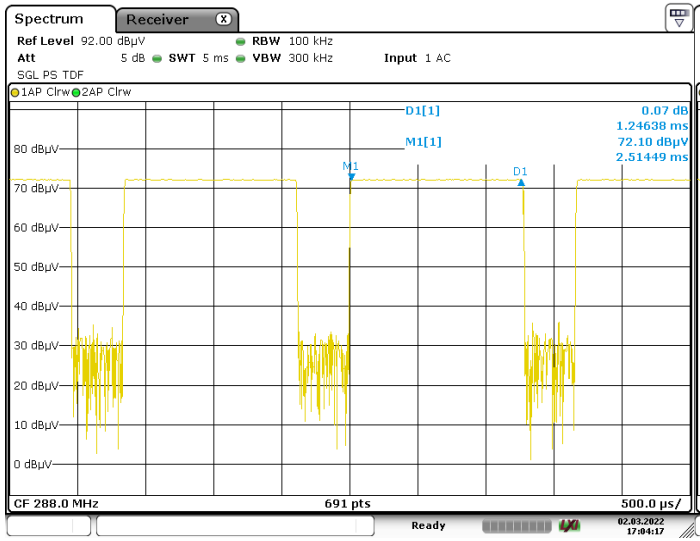
c. 80% Duty Cycle



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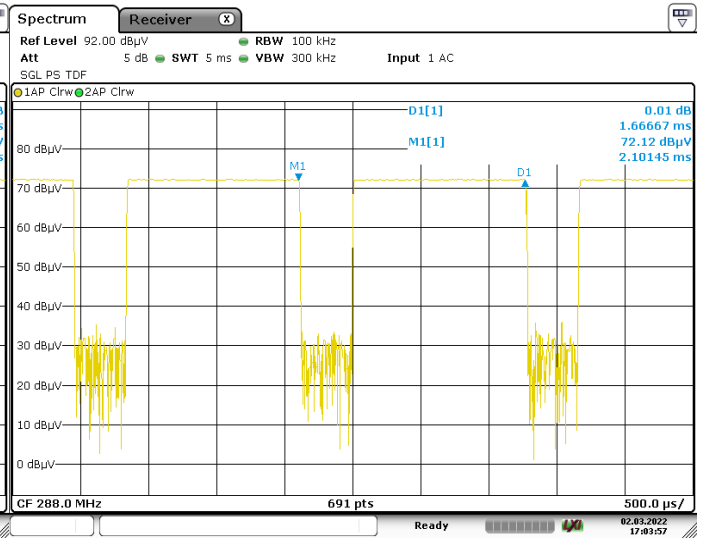


Date: 2.MAR.2022 17:03:58

9. Occupied Bandwidth

Occupied bandwidth measurements were taken at 288, 310, 365 and 430MHz. The occupied bandwidth was determined using the -20dB and 99% measurement methods.

a. -20dB Occupied Bandwidth Measurement

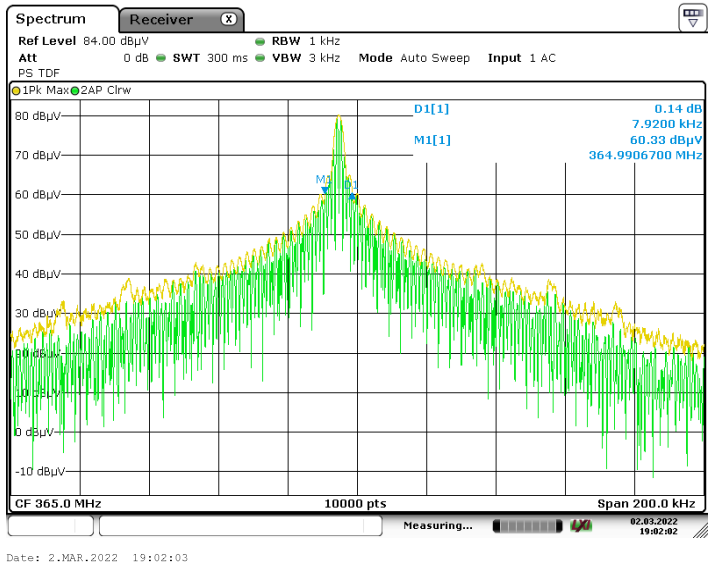
-20dB Occupied Bandwidth				
Frequency (MHz)	Duty Cycle (%)	Occupied Bandwidth (kHz)	Limit (kHz)	Margin
288	30	8.26	720	**711.74**
	50	5.84	720	714.16
	80	4.72	720	715.28
310	30	8.10	775	766.90
	50	5.56	775	769.44
	80	4.74	775	770.26
365	30	7.92	912.5	904.58
	50	5.66	912.5	906.84
	80	4.76	912.5	907.74
430	30	9.46	1082.5	1073.04
	50	5.62	1082.5	1076.88
	80	4.80	1082.5	1077.70

b. 99% Occupied Bandwidth Measurement

99% Occupied Bandwidth				
Frequency (MHz)	Duty Cycle (%)	Occupied Bandwidth (kHz)	Limit (kHz)	Margin
288	30	29.20	720	**690.80**
	50	17.18	720	702.82
	80	17.56	720	702.44
310	30	23.84	775	751.16
	50	15.82	775	759.18
	80	18.00	775	757.00
365	30	23.34	912.5	889.16
	50	15.20	912.5	897.30
	80	17.36	912.5	895.14
430	30	23.54	1082.5	1058.96
	50	17.38	1082.5	1065.12
	80	17.82	1082.5	1064.68

C. Example of Occupied Bandwidth measurement

365MHz 30%

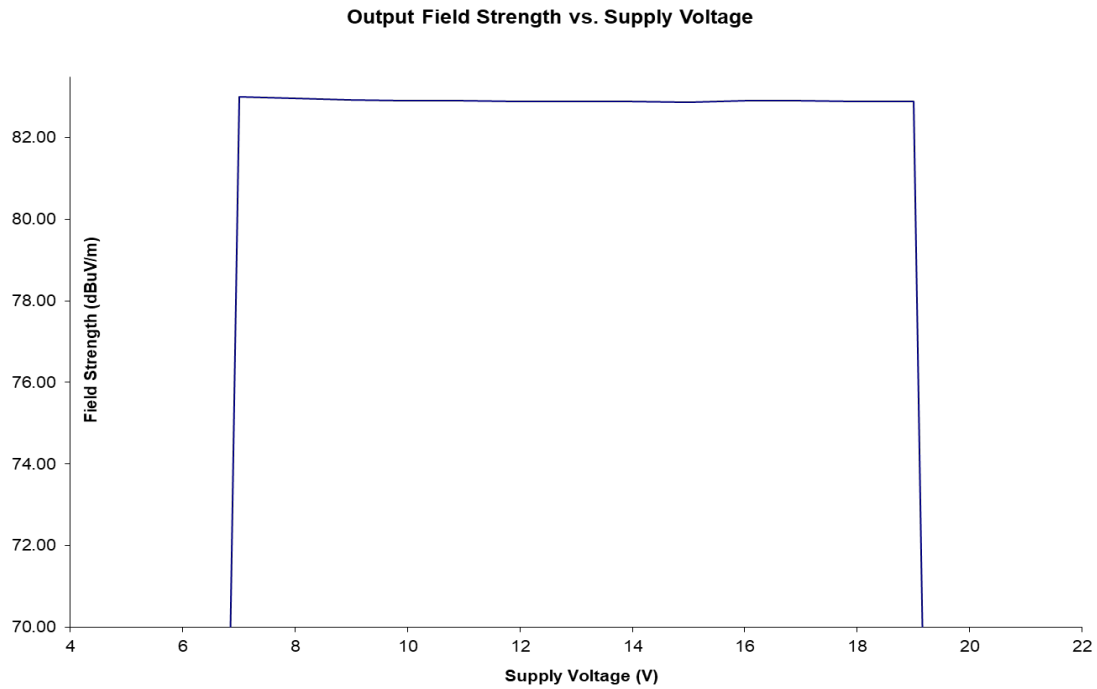


Measuring Occupied Bandwidth at –20dB points20

10. Variation of Supply Voltage

Measurements of the variation in output field strength due to variation in the supply voltage were taken in accordance with 15.231(e). The DUT was configured to transmit at the peak frequency, 310MHz, 30% Duty Cycle. Values presented are not corrected for duty cycle.

a. Plot of output power over supply voltage



b. Output Power as a Function of Supply Voltage

Voltage	Field Strength (dBuV/m)	Frequency (MHz)
5	0.00	310
7	83.00	
8	82.97	
9	82.93	
10	82.92	
11	82.91	
12	82.90	
13	82.90	
14	82.89	
15	82.88	
16	82.91	
17	82.92	
18	82.90	
19	82.89	
20	0.00	