TÜVRheinland®

Produkte
Products

Prüfbericht - Nr.: *Test Report No.:*	**14050540 001**	**Seite 1 von 16** *Page 1 of 16*
Auftraggeber: *Client:*	**Zepp Labs, Inc** **75 E. Santa Clara Street.Floor 6, San Jose**	
Gegenstand der Prüfung: *Test Item:*	**HEAD Tennis Sensor Powered by ZEPP**	
Bezeichnung: *Identification:*	**ZTH1**	**Serien-Nr.:** *Serial No.:* **Engineering sample**
Wareneingangs-Nr.: *Receipt No.:*	**A000599660-001** **A000593888-005**	**Eingangsdatum:** *Date of Receipt:* **04.07.2017**
Prüfort: *Testing Location:*	**TÜV Rheinland Hong Kong Ltd.** 3-4, 11/F., Fou Wah Industrial Building, 10-16 Pun Shan Street, Tsuen Wan, N.T., Hong Kong **Hong Kong Productivity Council** HKPC Building, 78 Tat Chee Avenue, Kowloon, Hong Kong	
Zustand des Prüfgegenstandes bei Anlieferung: *Condition of test item at delivery:*	Test samples are not damaged and suitable for testing.	
Prüfgrundlage: *Test Specification:*	**FCC Part 15 Subpart C** **RSS-247 Issue 2** **ANSI C63.10-2013**	
Prüfergebnis: *Test Results:*	**Das vorstehend beschriebene Gerät wurde geprüft und entspricht oben genannter Prüfgrundlage.** The above mentioned product was tested and **passed**.	
Prüflaboratorium: *Testing Laboratory:*	**TÜV Rheinland Hong Kong Ltd.** 3-4, 11/F., Fou Wah Industrial Building, 10-16 Pun Shan Street, Tsuen Wan, N.T., Hong Kong	

geprüft/ *tested by:*			**kontrolliert/** *reviewed by:*		
11.07.2017	Mika Chan Project Manager		11.07.2017	Sharon Li Unit Senior Manager	
Datum *Date*	**Name/Stellung** *Name/Position*	**Unterschrift** *Signature*	**Datum** *Date*	**Name/Stellung** *Name/Position*	**Unterschrift** *Signature*

Sonstiges: Other Aspects	**FCC ID: 2AE6VZTH1** **IC: 20328-ZTH1**

Abkürzungen:				*Abbreviations:*			
	P(ass)	=	*entspricht Prüfgrundlage*		*P(ass)*	=	*passed*
	F(ail)	=	*entspricht nicht Prüfgrundlage*		*F(ail)*	=	*failed*
	N/A	=	*nicht anwendbar*		*N/A*	=	*not applicable*
	N/T	=	*nicht getestet*		*N/T*	=	*not tested*

Table of Content

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Product information

Manufacturers declarations

	Transceiver
Operating frequency range	2402 - 2480 MHz
Type of modulation	GFSK
Number of channels	40
Channel separation	2 MHz
Type of antenna	PCB Antenna
Antenna gain (dBi)	2.0 dBi
Power level	fix
Type of equipment	stand alone radio device
Connection to public utility power line	No
Nominal voltage	V_{nor}: 3.7 VDC
Independent Operation Modes	Transmitting

Product function and intended use

The equipment under test (EUT) is a Bluetooth low energy device.

FCC ID: 2AE6VZTH1/ IC: 20328-ZTH1

Models	Product description
ZTH1	HEAD Tennis Sensor Powered by ZEPP

Submitted documents

Circuit Diagram
Block Diagram
Technical Description
User manual
Label

Independent Operation Modes

The basic operation modes are:

- Transmitting mode.

For further information refer to User Manual

Related Submittal(s) Grants

This is a single application for certification of the transmitter.

Remark

The test results in this test report are only relevant to the tested sample and does not involve any assessment in the production.

Test Set-up and Operation Mode

Principle of Configuration Selection

Emission: The equipment under test (EUT) was configured to measure its highest possible radiation level. The test modes were adapted accordingly in reference to the instructions for use.

Test Operation and Test Software

Test operation should refer to test methodology.

- During test, Channel & Power Controlling Software provided by the customer was used to control the operating channel as well as the output power level. The RF output power was selected according to the instruction given by the manufacturer. The setting of the RF output power expected by the customer shall be fixed on the firmware of the final end product.

Special Accessories and Auxiliary Equipment

The product has been tested together with the following additional accessories:

- AC-DC adaptor Model: A1399 Input: 100-240 VAC 50/60 Hz 150mA Output: 5.0VDC 1000mA) (Provided by the TUV)

Countermeasures to achieve EMC Compliance

- none

Test Methodology

Radiated Emission

The radiated emission measurements of the transmitter part were performed according to the procedures in ANSI C63.10-2013.

For measurement below 1GHz - the equipment under test (EUT) was placed at the middle of the 80 cm height turntable. For measurement above 1GHz - the EUT was placed at the middle of the 1.5 m height turntable and RF absorbing material was placed on ground plane between turntable and measuring antenna. During the testing, the EUT was operated standalone and arranged for maximum emissions. The EUT was tested in three orthogonal planes.

The investigation is performed with the EUT rotated 360°, the antenna height scanned between 1m and 4m, and the antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations. Repeat the measurement steps until the maximum emissions were obtained.

All radiated tests were performed at an antenna to EUT with 3 meters distance, unless stated otherwise in particular parts of this test report.

Field Strength Calculation

The field strength at 3 m was established by adding the meter reading of the spectrum analyzer to the factors associated with antenna correction factor, cable loss, preamplifiers and filter attenuation.

The equation is expressed as follow:

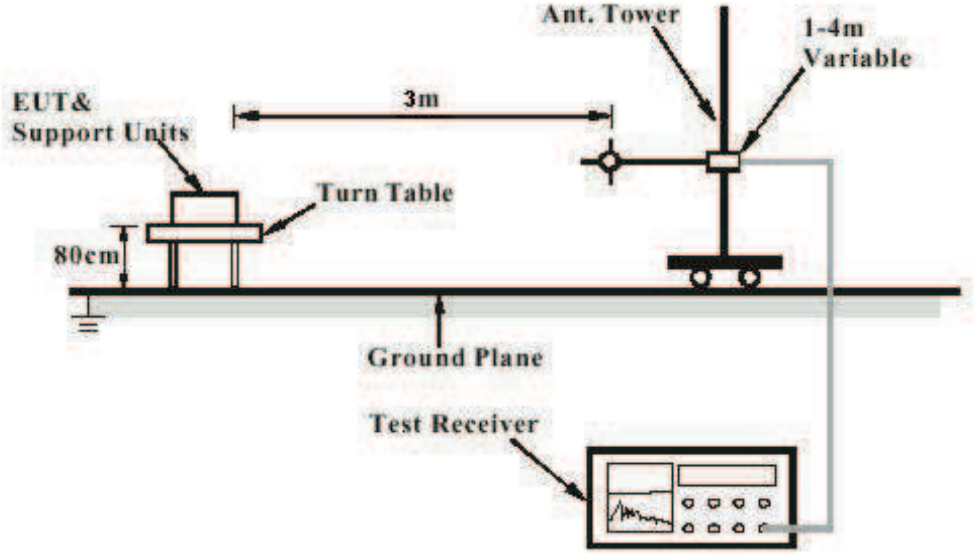
FS = R + AF + CF + FA – PA

Where FS = Field Strength in dBuV/m at 3 meters.
R = Reading of Spectrum Analyzer in dBuV.
AF = Antenna Factor in dB.
CF = Cable Attenuation Factor in dB.
FA = Filter Attenuation Factor in dB.
PA = Preamplifier Factor in dB.

FA and PA are only be used for the measuring frequency above 1 GHz.

Test Setup Diagram

Diagram of Measurement Configuration for Radiation Test



Note: Measurements above 1 GHz are done with a table height of 1.5m. In addition, there is RF absorbing material on the floor of the test site for above 1GHz measurement.

Diagram of Measurement Equipment Configuration for Mains Conduction Measurement (if applicable)

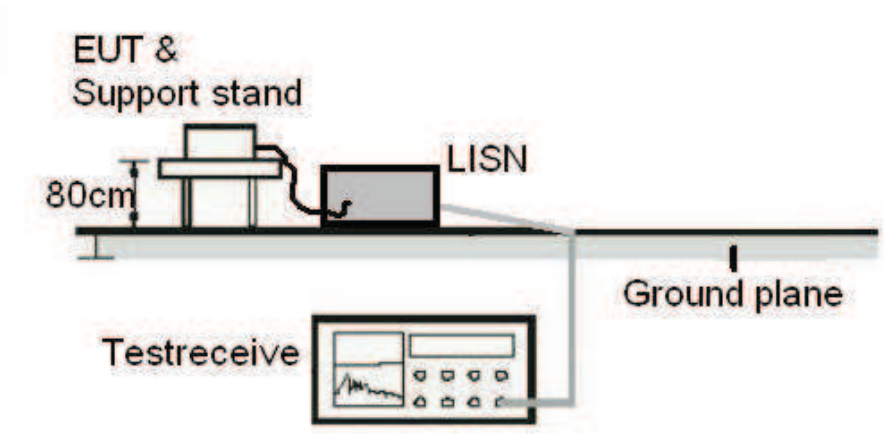
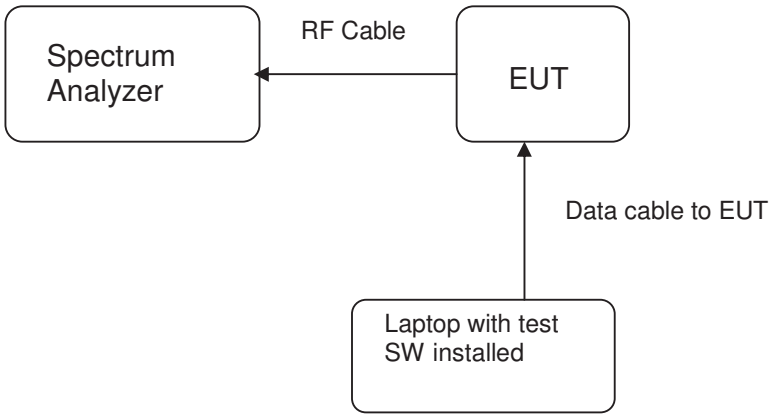


Diagram of Equipment Configuration for Antenna-port Conducted Measurement (if applicable)



List of Test and Measurement Instruments

Hong Kong Productivity Council (FCC/ IC Registration number: 90656/ 4780A-1)

Radiated Emission

Equipment	Manufacturer	Type	Cal. Date	Due Date
Semi-anechoic Chamber	Frankonia	Nil	25-Apr-17	25-Apr-18
Test Receiver	R & S	ESU26	11-Jul-17	11-Jul-18
Active Loop Antenna	EMCO	6502	27-Oct-16	27-Oct-17
Bi-conical Antenna	R & S	HK116	7-Jun-16	7-Jun-18
Log Periodic Antenna	R & S	HL223	31-May-16	31-May-18
Standard Gain Horn	ETS-Lindgren	3160-07	3-Mar-16	3-Mar-18
Standard Gain Horn	ETS-Lindgren	3160-08	3-Mar-16	3-Mar-18
Standard Gain Horn	ETS-Lindgren	3160-10	3-Mar-16	3-Mar-18
Double-Ridged Waveguide Horn	EMCO	3116	17-Jun-16	17-Jun-18
Double-Ridged Waveguide Horn	EMCO	3117	22-Jun-16	22-Jun-18
Coaxial cable	Harbour	LL335	10-Jun-16	10-Jun-18
High Frequency Cable	Pasternack	PE3VNA4001-3M	27-Jan-17	27-Jan-18
Microwave amplifer 0.5-26.5GHz, 25dB gain	HP	83017A	18-Jul-16	18-Jul-18
Preamplifier 18GHz to 40GHz with cable (EMC656)	A.H. Systems, Inc.	PAM-1840VH	27-Jan-17	27-Jan-18
High Pass Filter (cutoff freq. =1000MHz)	Trilithic	23042	28-Oct-15	28-Oct-17

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Radio Test

Equipment	Manufacturer	Type	Cal. Date	Due Date
Spectrum Analyzer	R & S	FSP30	15-Oct-16	15-Oct-17

Measurement Uncertainty

The estimated combined standard uncertainty for power-line conducted emissions measurements is ±2.42dB.

The estimated combined standard uncertainty for radiated emissions measurements is ±4.81dB (9kHz to 30MHz) and ±4.62dB (30MHz to 200MHz) and ±5.67dB (200MHz to 1000MHz) and is ±5.07dB (1GHz to 8.2GHz) and ±4.58dB (8.2GHz to 12.4GHz) and ±4.78dB (12.4GHz to 18GHz)

The estimated combined standard uncertainty for antenna conducted emission is ±2.1dB

The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor of k=2, which for the level of confidence is approximately 95%.

Results FCC Part 15 – Subpart C / RSS-247 Issue 2

FCC 15.203 – Antenna Requirement 1		Pass
FCC Requirement:	No antenna other than that furnished by the responsible party shall be used with the device	
Results:	a) Antenna type: b) Manufacturer and model no: c) Peak Gain:	Integral PCB antenna N/A 2.0 dBi
Verdict:	Pass	

FCC 15.204 – Antenna Requirement 2	N/A
FCC Requirement:	An intentional radiator may be operated only with the antenna with which it is authorized. If an antenna is marketed with the intentional radiator, it shall be of a type which is authorized with the intentional radiator.
Results:	Only one integral antenna can be used.
Verdict:	N/A

RSS-Gen 6.3 – External Control	Pass
IC Requirement:	The device shall not have any external controls accessible to the user that enable it to be adjusted, selected or programmed to operate in violation of the limits prescribed in the applicable RSS.
Results:	The device does not have any transmitter external controls accessible to the user that can be adjusted and operated in violation of the limits of this standard.
Verdict:	Pass

RSS-Gen 8.3 – Antenna Requirement		Pass
IC Requirement:	When a measurement at the antenna connector is used to determine RF output power, the effective gain of the device's antenna shall be stated, based on measurement or on data from the antenna manufacturer.	
Results:	a) Antenna type: b) Manufacturer c) model no d) Gain with reference to an isotropic radiator:	Integral PCB antenna N/A N/A 2.0 dBi
Verdict:	Pass	

FCC 15.207/ RSS-Gen 8.8 – Conducted Emission on AC Mains **Pass**

Requirement: 15.207(a)/ RSS-Gen 8.8

Results: Pass

Live measurement

Frequency range (MHz)	Frequency (MHz)	Quasi-peak dBµV	Average dBµV	Limit QP (dBµV)	Limit AV (dBµV)	Verdict
0,15 – 0,5	0.251	39.1	32.2	66 - 56	56 - 46	Pass
> 0,5 - 5	0.582	40.3	35.6	56	46	Pass
	0.750	41.6	36.4			
> 5 - 30	No peak found	---	---	60	50	Pass

Neutral measurement

Frequency range (MHz)	Frequency (MHz)	Quasi-peak dBµV	Average dBµV	Limit QP (dBµV)	Limit AV (dBµV)	Verdict
0,15 – 0,5	0.162	36.8	21.3	66 - 56	56 - 46	Pass
> 0,5 - 5	0.580	37.5	30.5	56	46	Pass
	0.678	39.3	32.5			
> 5 - 30	No peak found	---	---	60	50	Pass

Results: Pre-scan has been conducted to determine the worst-case mode from all possible combinations between available modulations and data rate.

The radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150kHz to 30MHz does not exceed the limits. For test Results plots refer to Appendix 1

FCC 15.247 (a)(2) / RSS-247 5.2 – 6dB Bandwidth Measurement **Pass**

FCC Requirement: Systems using digital modulation techniques may operate in the 902 – 928 MHz, 2400 – 2483.5 MHz, and 5725 – 5850 MHz bands. The minimum 6dB bandwidth shall be at least 500kHz.

Test Specification : ANSI C63.10 – 2013
Mode of operation : TX mode
Port of testing : Temporary antenna port
Detector : Peak
Supply voltage : 3.7 Vdc
Temperature : 23ºC
Humidity : 50%

Results: For test protocols please refer to Appendix 1

Channel frequency (MHz)	6 dB left (MHz)	6 dB right (MHz)	6dB bandwidth (kHz)
2402	2401.610	2402.332	722.0
2442	2441.612	2442.332	720.0
2480	2479.608	2480.332	724.0

RSS-Gen 6.6 – Occupied Bandwidth	**Pass**

FCC/ IC Requirement : N/A

Test Specification : RSS-Gen
Mode of operation : Tx mode
Port of testing : Temporary antenna port
Detector : Peak
Supply voltage : 3.7 Vdc
Temperature : 23ºC
Humidity : 50%

Results: Pre-scan has been conducted to determine the worst-case mode from all possible combinations between available modulations and packet types.

For test protocols refer to Appendix 1.

Frequency (MHz)	Left (MHz)	Right (MHz)	99% bandwidth (MHz)
2402	2401.450	2402.530	1.080
2442	2441.450	2442.530	1.080
2480	2479.440	2480.530	1.090

FCC 15.247(b)(3) / RSS-247 5.4 – Maximum Peak Couducted Output Power	**Pass**

FCC Requirement: For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850MHz bands: 1 Watt (30dBm)

Test Specification : ANSI C63.10 – 2013
Mode of operation : TX mode
Port of testing : Temporary antenna port
Detector : Peak
Supply voltage : 3.7 Vdc
Temperature : 23ºC
Humidity : 50%

Results: For test protocols please refer to Appendix 1

Frequency (MHz)	Measured Output Power (dBm)	Limit (W/dBm)	Verdict
2402	7.22	1 / 30.0	Pass
2440	6.51	1 / 30.0	Pass
2480	5.62	1 / 30.0	Pass

FCC 15.247(e) / RSS-247 5.2 – Power Spectral Density	Pass

FCC Requirement: For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

Test Specification : ANSI C63.10 – 2013
Mode of operation : TX mode
Port of testing : Temporary antenna port
Detector : Peak
Supply voltage : 3.7 Vdc
Temperature : 23ºC
Humidity : 50%

Results: For test protocols please refer to Appendix 1.

Operating frequency (MHz)	Power density (dBm)	Limit (dBm)	Verdict
2402	6.48	8.0	Pass
2442	5.81	8.0	Pass
2480	4.88	8.0	Pass

FCC 15.247(d) / RSS-247 5.5 – Spurious Conducted Emissions	Pass

Test Specification : ANSI C63.10 – 2013
Mode of operation : TX mode
Port of testing : Temporary antenna port
Detector : Peak
Supply voltage : 3.7 Vdc
Temperature : 23 ºC
Humidity : 50 %

FCC Requirement: 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.

Results: Pre-scan has been conducted to determine the worst-case mode from all possible combinations between available modulations and data rate.

Only the worst cases is shown below. For test protocols refer to Appendix 1

Operating frequency (MHz)	Spurious frequency (MHz)	Spurious Level (dBm)	Reference value (dBm)	Delta (dB)	Verdict
2402	4800	-40.91	6.48	-47.39	Pass
2442	9280	-40.19	5.81	-46.00	Pass
2480	8220	-41.42	4.88	-46.30	Pass

FCC 15.205/ RSS-Gen 8.9 – Radiated Emissions in Restricted Frequency Bands **Pass**

Test Specification : ANSI C63.10 – 2013
Mode of operation : TX mode
Port of testing : Enclosure
Detector : Peak
Supply voltage : 3.7 Vdc
Temperature : 23ºC
Humidity : 50%

FCC Requirement: In any 100kHz bandwidth outside the frequency band at least 20dB below the highest level of the desired power. In addition, radiated emissions which fall in the restricted bands, as defined in section15.205(a), must also comply with the radiated emission limits specified in section 15.205(c).

Results: Pre-scan has been conducted to determine the worst-case mode from all possible combinations between available modulations and data rate.

All three transmit frequency modes comply with the field strength within the restricted bands. There is no spurious found below 30MHz.

Mode: 2402MHz TX Vertical Polarization

Freq MHz	Level dBuV/m	Limit/ Detector dBuV/m
4804.320	57.27	74.0 / PK
4803.717	49.13	54.0 / AV

Mode: 2402 MHz TX Horizontal Polarization

Freq MHz	Level dBuV/m	Limit/ Detector dBuV/m
4803.358	53.92	74.0 / PK
4803.743	41.62	54.0 / AV

Mode: 2442 MHz TX Vertical Polarization

Freq MHz	Level dBuV/m	Limit/ Detector dBuV/m
4884.455	54.77	74.0 / PK
4883.846	45.12	54.0 / AV

Mode: 2442 MHz TX Horizontal Polarization

Freq MHz	Level dBuV/m	Limit/ Detector dBuV/m
4883.493	55.35	74.0 / PK
4883.814	43.63	54.0 / AV

Mode: 2480MHz TX Vertical Polarization

Freq MHz	Level dBuV/m	Limit/ Detector dBuV/m
4960.657	56.13	74.0 / PK
4959.855	48.01	54.0 / AV

Mode: 2480 MHz TX Horizontal Polarization

Freq	Level	Limit/ Detector

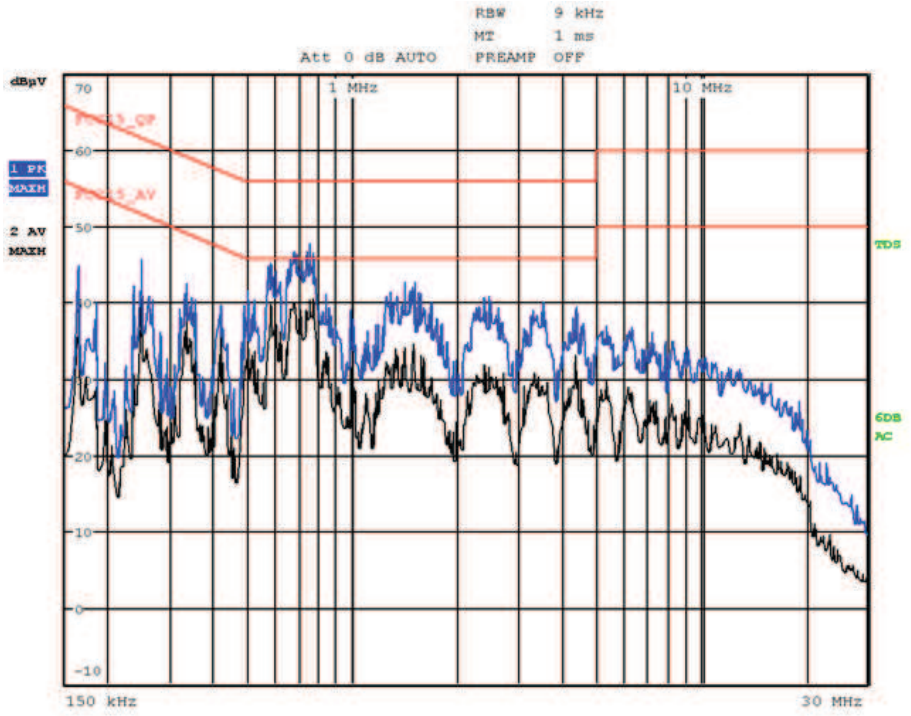
MHz	dBuV/m	dBuV/m
4960.301	56.83	74.0 / PK
4959.852	48.95	54.0 / AV

Appendix 1

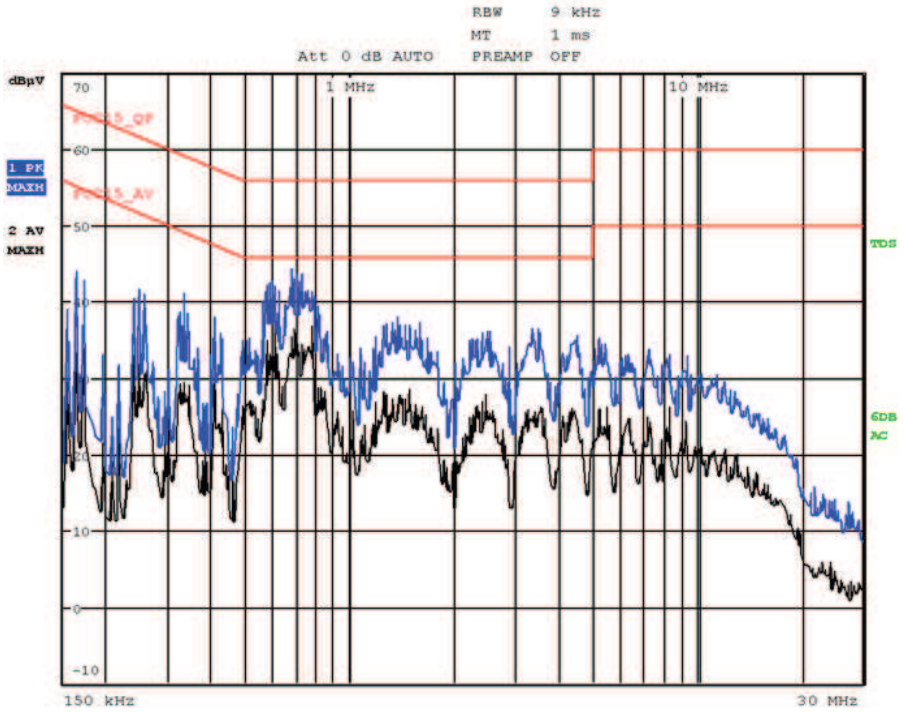
Test Results

AC Mains Conducted Emission

Mode: TX mode; Line: L1

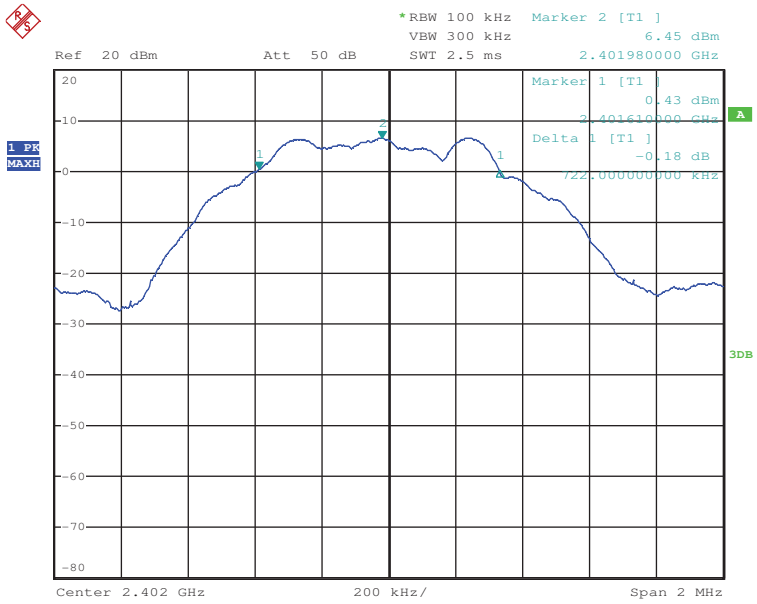


Mode: TX mode; Line: N



6 dB Bandwidth Measurement

TX frequency: 2402MHz



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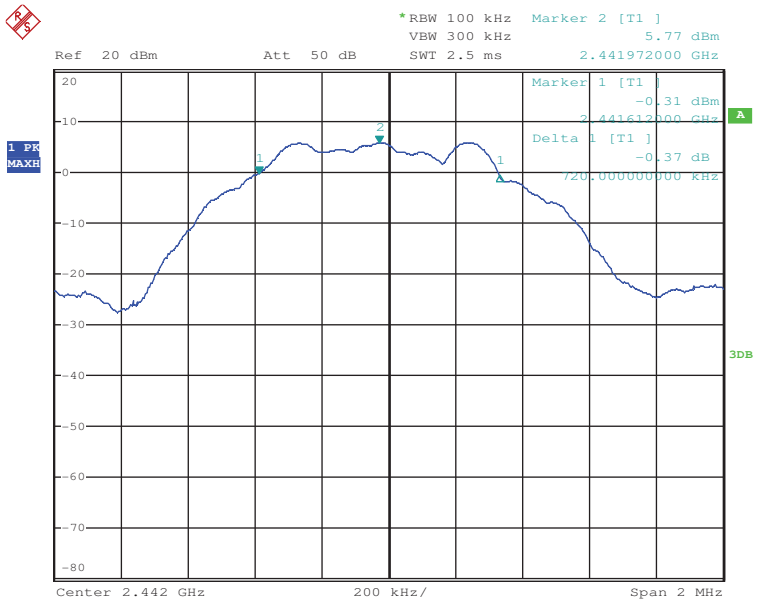
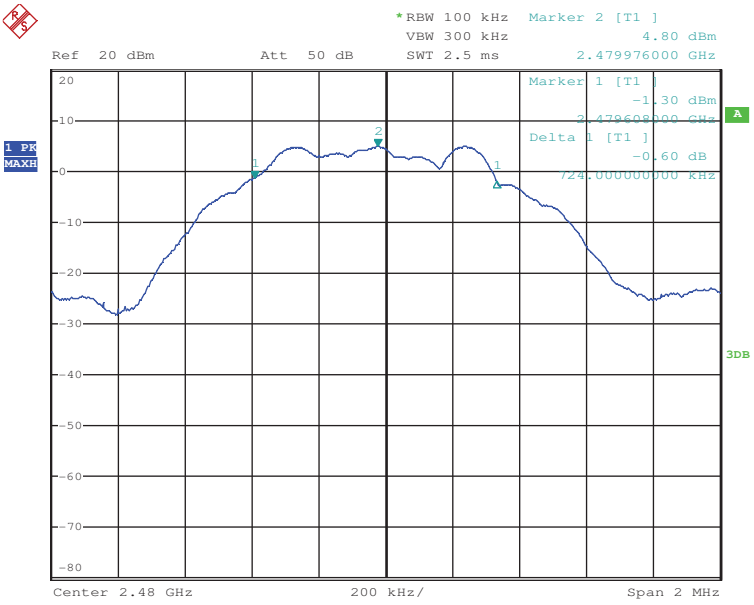
TX frequency: 2442MHz



Date: 13.JUL.2017 14:27:50

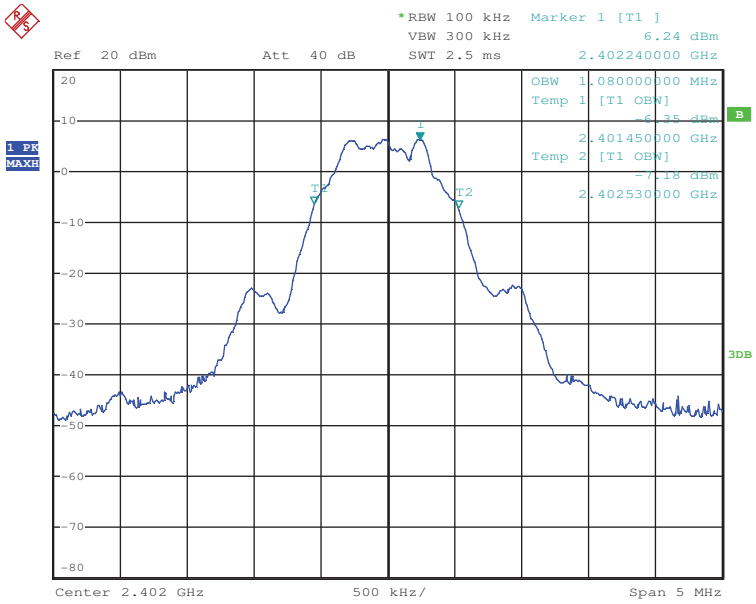
TX frequency: 2480MHz



Date: 13.JUL.2017 14:30:17

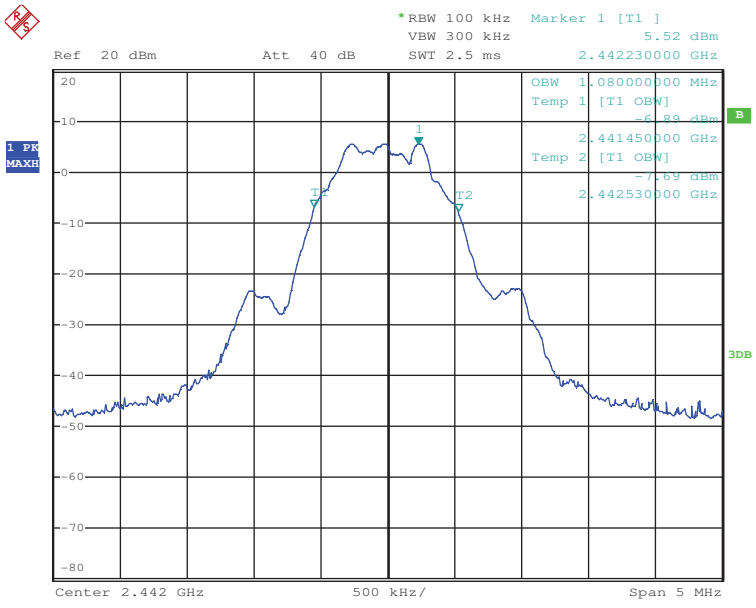
Occupied Bandwidth

TX frequency: 2402MHz



Date: 13.JUL.2017 16:15:25

TX frequency: 2442MHz



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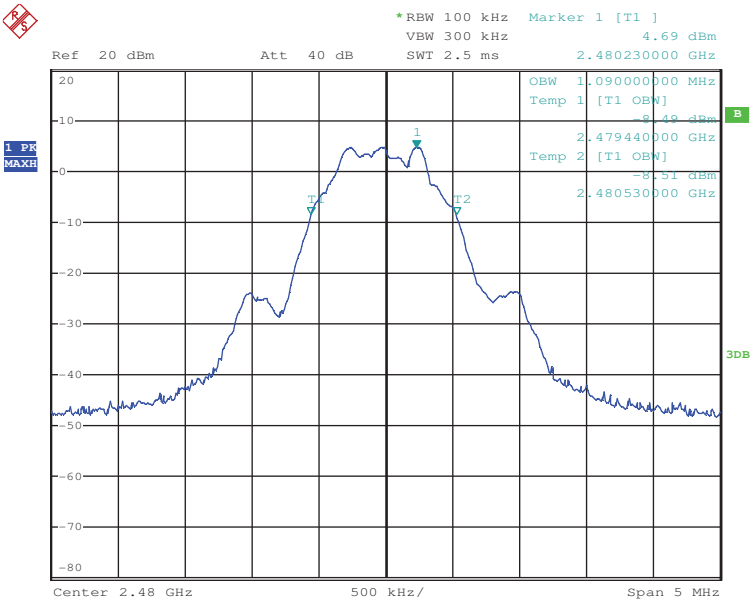
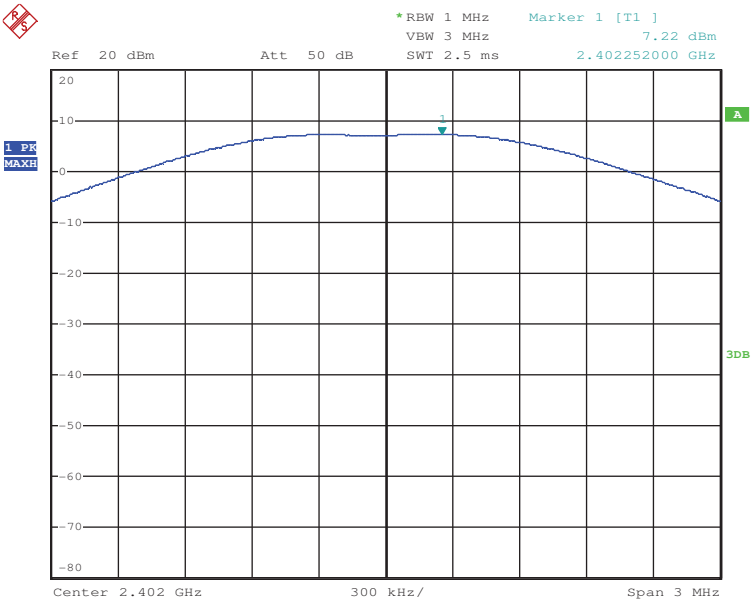
TX frequency: 2480MHz



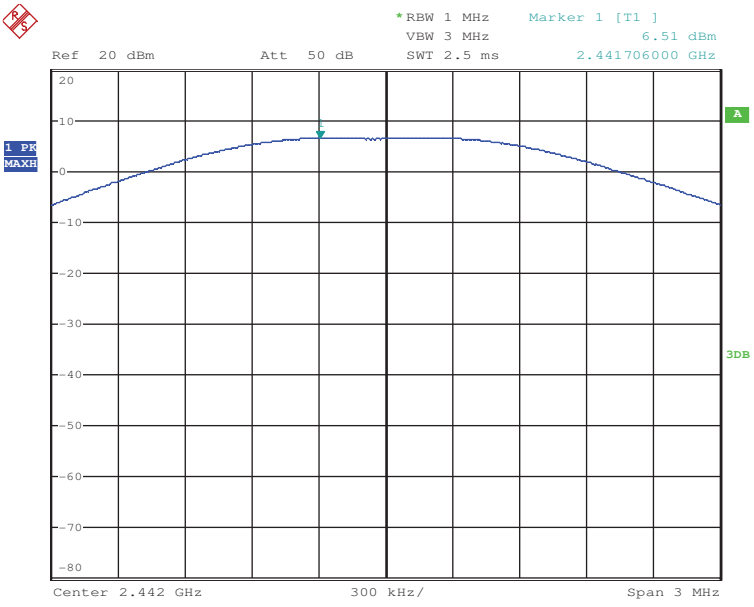
Date: 13.JUL.2017 16:17:37

Maximum Peak Conducted Output power

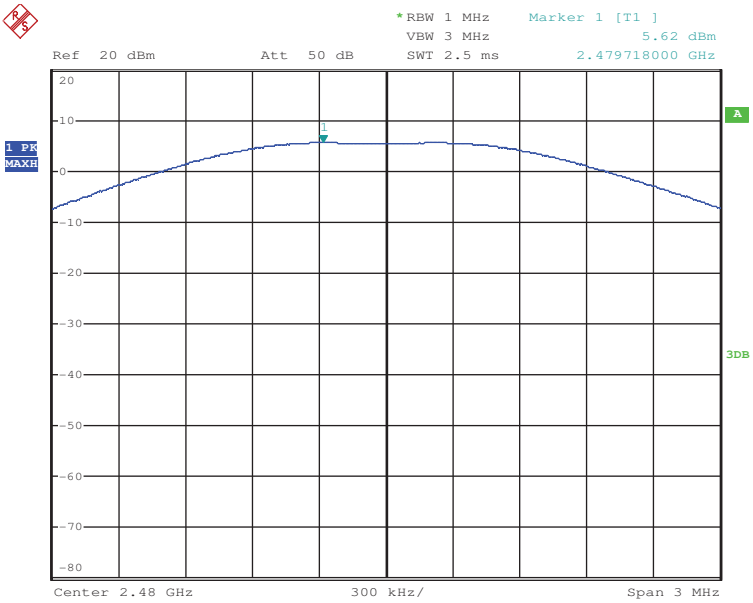
TX frequency: 2402MHz



TX frequency: 2442MHz

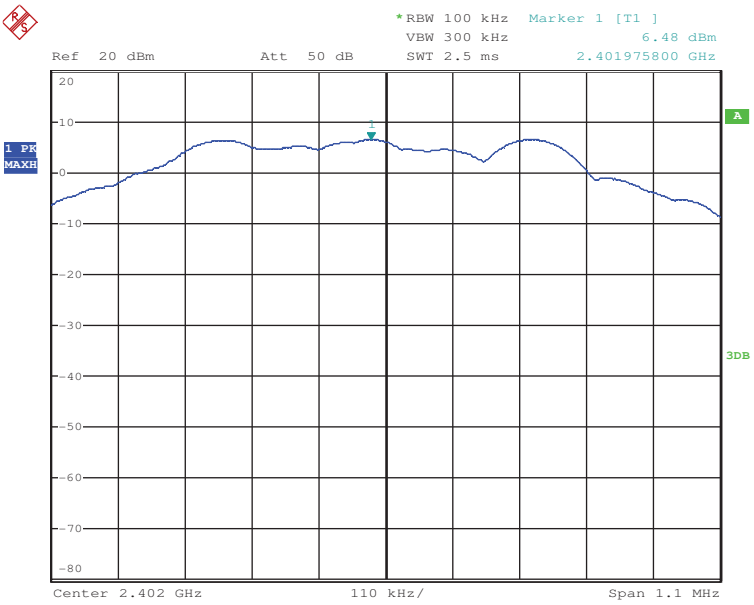


TX frequency: 2480MHz

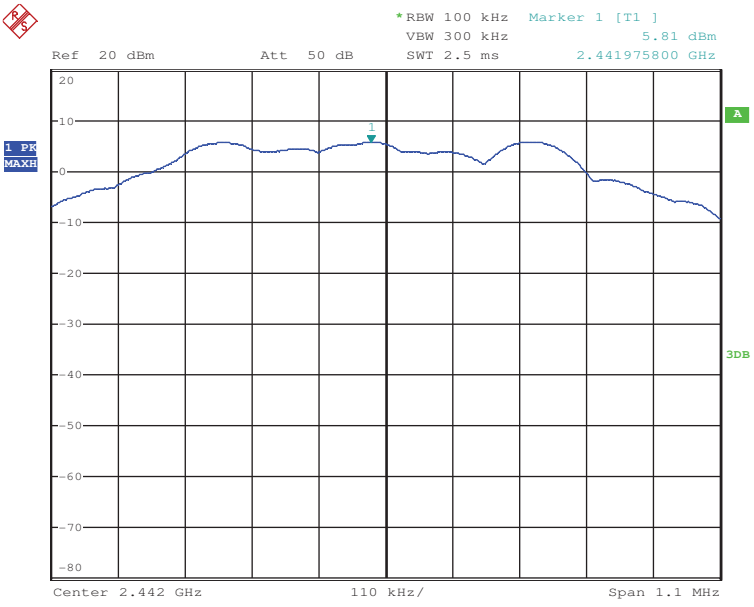


Power Spectral Density

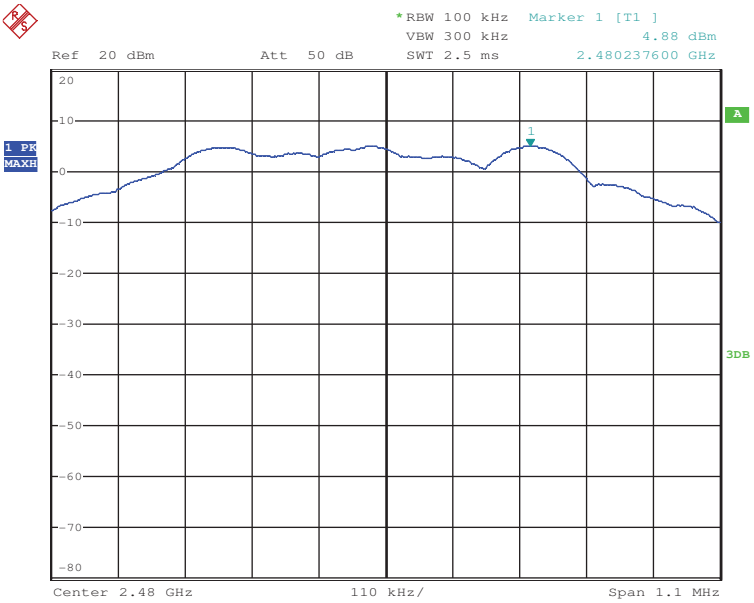
TX frequency: 2402MHz



TX frequency: 2442MHz

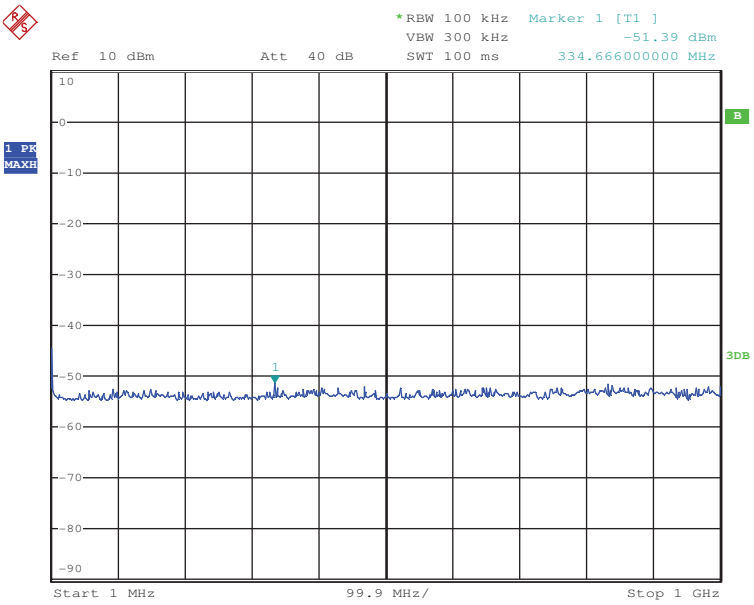


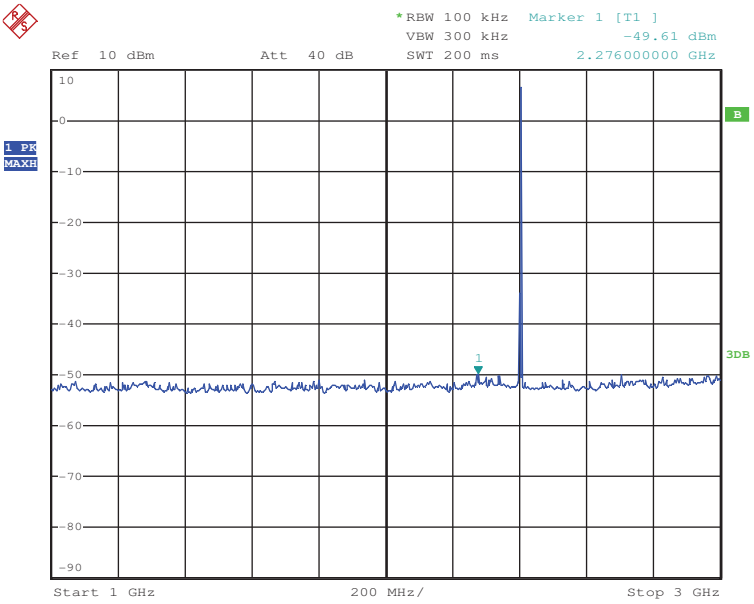
TX frequency: 2480MHz

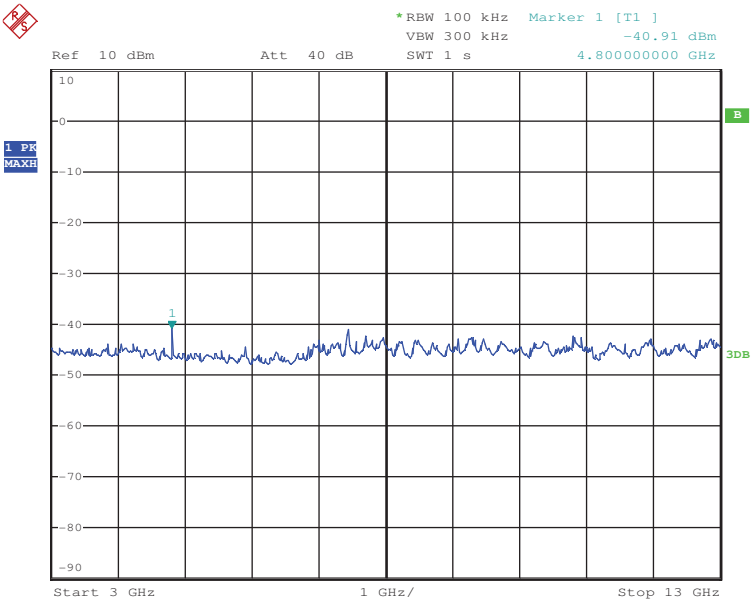


Spurious Conducted Emissions

TX frequency: 2402MHz



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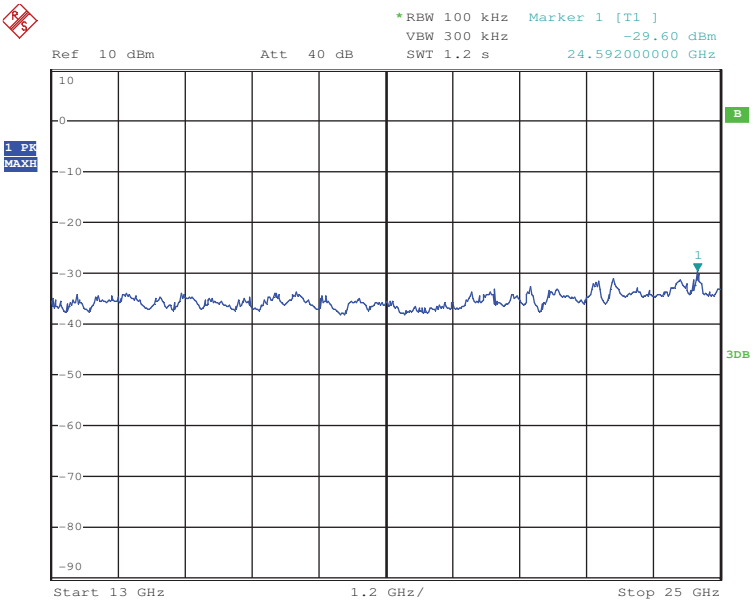
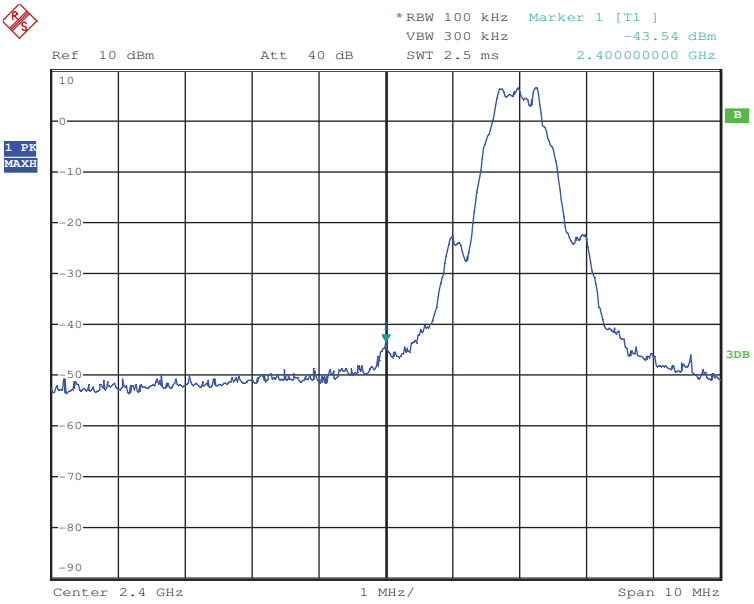
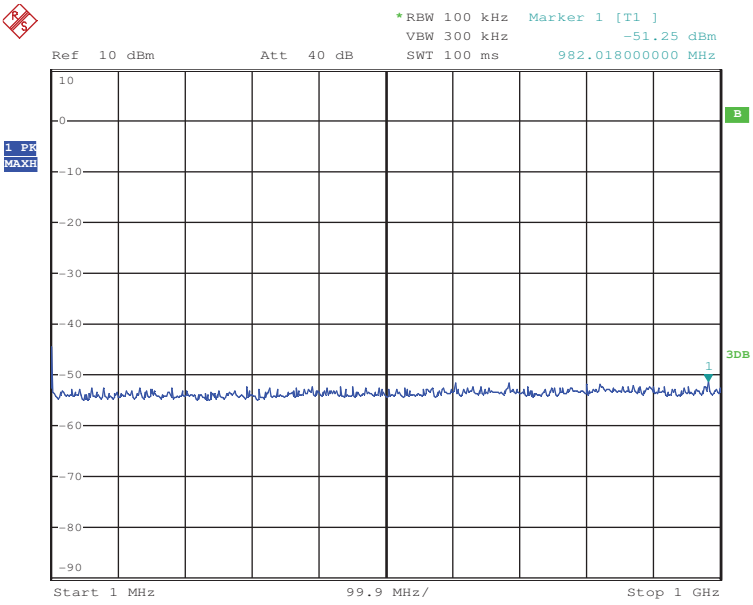
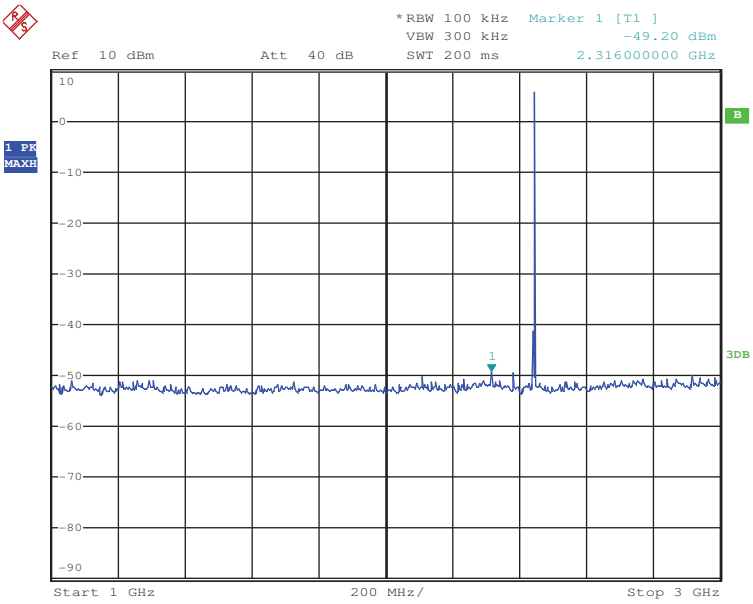
Marker 1 [T1]
VBW 300 kHz
-40.91 dBm
Ref 10 dBm
Att 40 dB
SWT 1 s
4.800000000 GHz
1 PK
MAXH
B
3DB
Start 3 GHz
1 GHz/
Stop 13 GHz

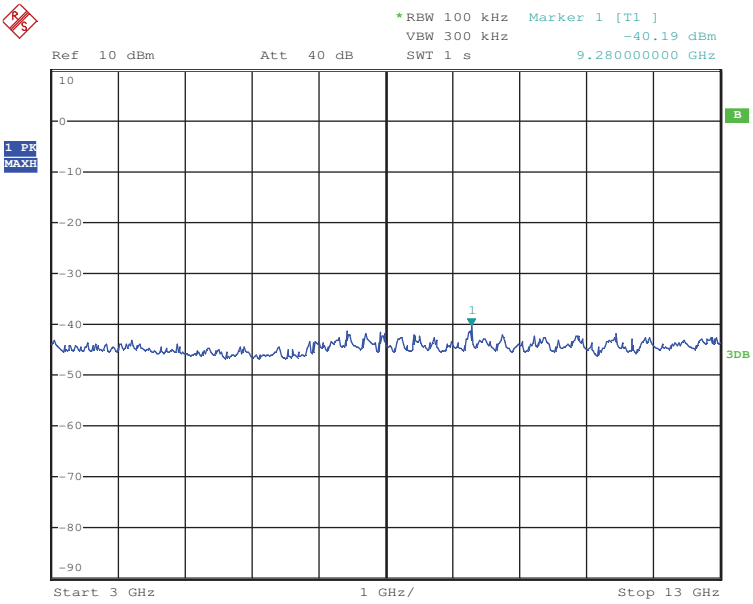

*RBW 100 kHz
Marker 1 [T1]
VBW 300 kHz
-29.60 dBm
Ref 10 dBm
Att 40 dB
SWT 1.2 s
24.592000000 GHz
1 PK
MAXH
B
3DB
Start 13 GHz
1.2 GHz/
Stop 25 GHz

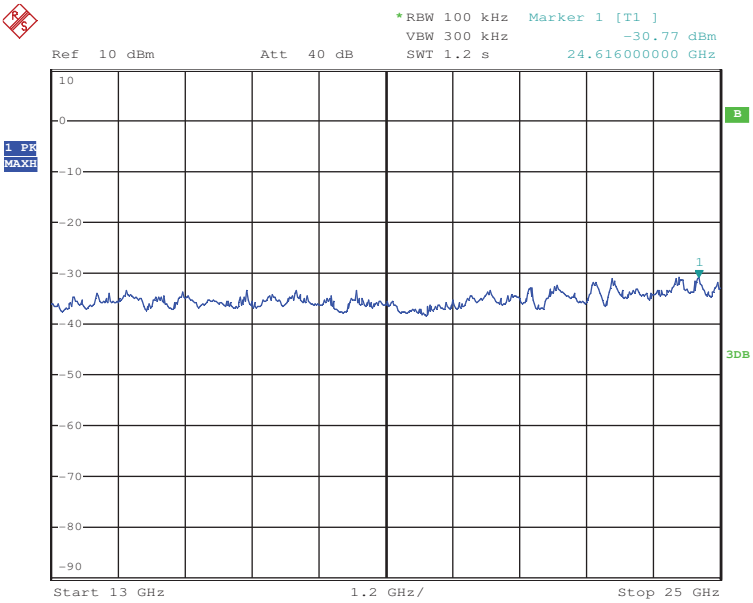

*RBW 100 kHz
VBW 300 kHz
SWT 2.5 ms
Marker 1 [T1]
-43.54 dBm
2.400000000 GHz
Ref 10 dBm
Att 40 dB
1 PK
MAXH
B
3DB
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
Center 2.4 GHz
1 MHz/
Span 10 MHz

TX frequency: 2442MHz

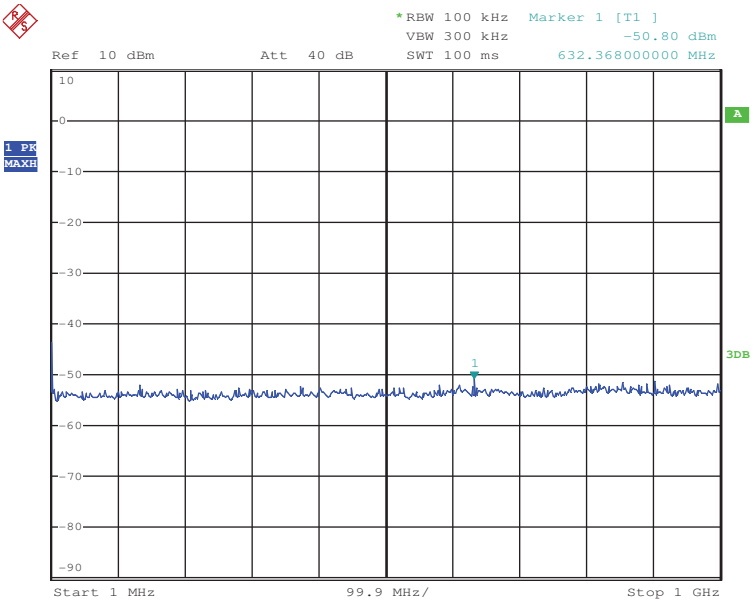


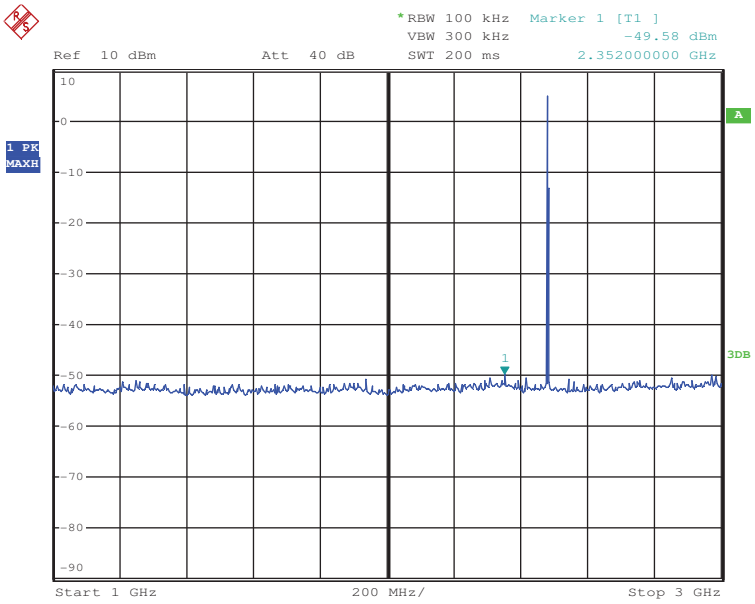


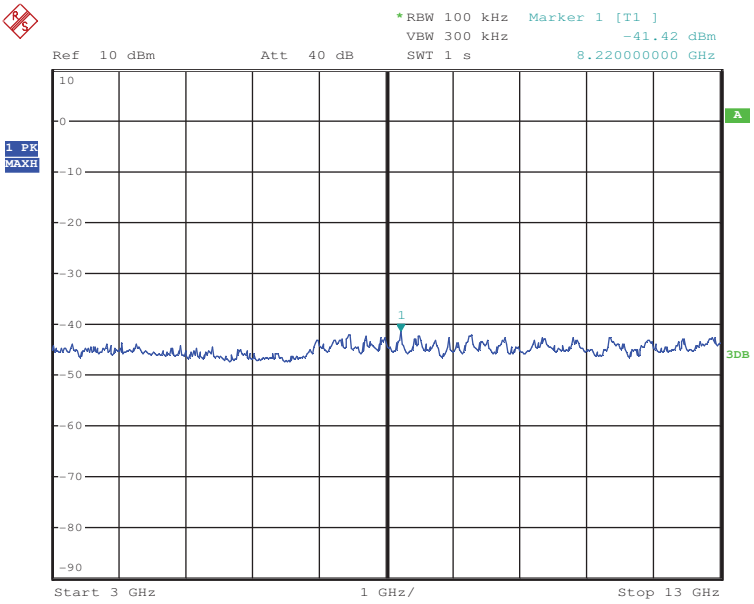

*RBW 100 kHz
Marker 1 [T1]
VBW 300 kHz
-40.19 dBm
Ref 10 dBm
Att 40 dB
SWT 1 s
9.280000000 GHz
1 PK
MAXH
B
3DB
Start 3 GHz
1 GHz/
Stop 13 GHz

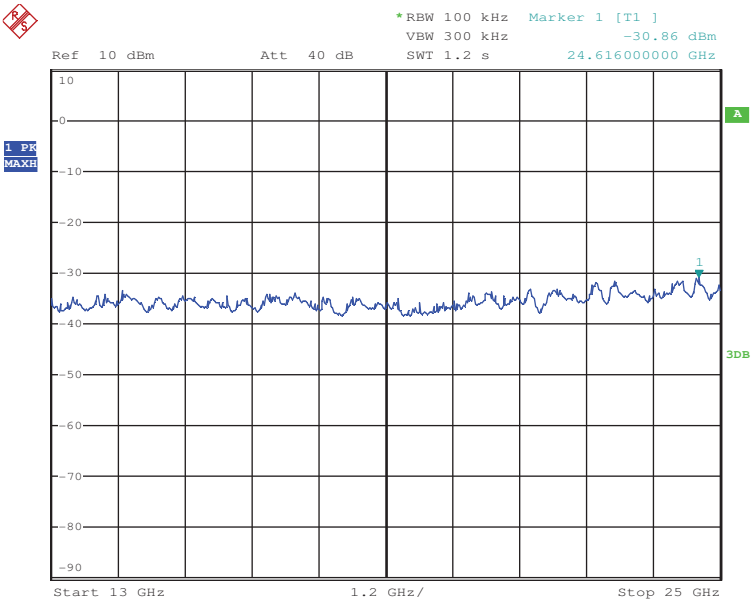

*RBW 100 kHz
Marker 1 [T1]
VBW 300 kHz
-30.77 dBm
Ref 10 dBm
Att 40 dB
SWT 1.2 s
24.616000000 GHz
1 PK
MAXH
B
3DB
Start 13 GHz
1.2 GHz/
Stop 25 GHz

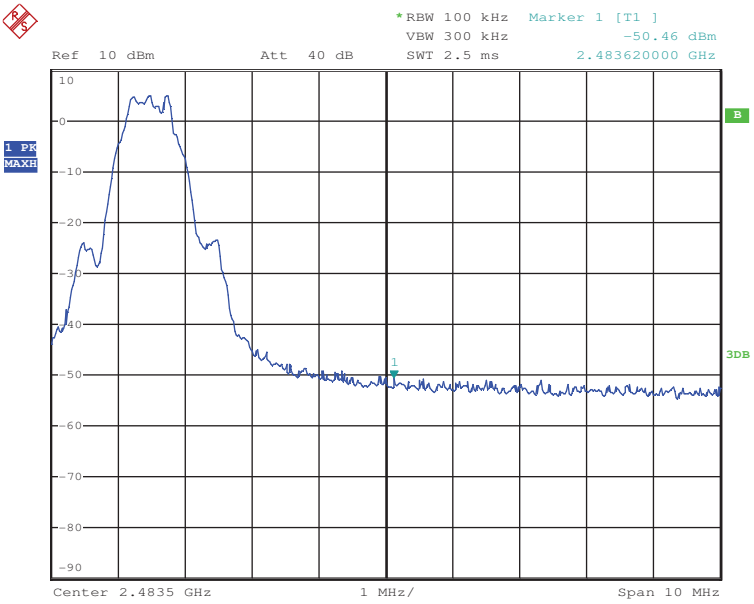
TX frequency: 2480MHz






*RBW 100 kHz
Marker 1 [T1]
VBW 300 kHz
-41.42 dBm
Ref 10 dBm
Att 40 dB
SWT 1 s
8.220000000 GHz
1 PK
MAXH
A
3DB
Start 3 GHz
1 GHz/
Stop 13 GHz


*RBW 100 kHz
Marker 1 [T1]
VBW 300 kHz
-30.86 dBm
Ref 10 dBm
Att 40 dB
SWT 1.2 s
24.616000000 GHz
1 PK
MAXH
A
3DB
Start 13 GHz
1.2 GHz/
Stop 25 GHz


*RBW 100 kHz
Marker 1 [T1]
VBW 300 kHz
-50.46 dBm
Ref 10 dBm
Att 40 dB
SWT 2.5 ms
2.483620000 GHz
1 PK
MAXH
B
3DB
Center 2.4835 GHz
1 MHz/
Span 10 MHz