EN 301 091-1 v2.1.1 and EN 301 091-2 v2.1.1

AS REFERENCED BY TEST PLAN 11647276-TP1V6

TEST REPORT

FOR

MILLIMETERWAVE E-BAND RADAR SENSOR DEVELOPMENT BOARD

MODEL SERIES: AWR1843BOOST, IWR1843BOOST

REPORT NUMBER: 12554995-E1V2

ISSUE DATE: JULY 31, 2019

Prepared for
TEXAS INSTRUMENTS
12500 TI BLVD.
DALLAS
TEXAS, 75243, USA

Prepared by
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Revision History

Rev.	Issue Date	Revisions	Revised By
V1	7/19/2019	Initial Issue	M. Heckrotte
V2	7/31/2019	Update Test Plan Reference & add Model Number	Conan Cheung

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME:	TEXAS INSTRUMENTS 12500 TI BLVD. DALLAS, TX 75243, USA
EUT DESCRIPTION:	MMWAVE E-BAND RADAR SENSOR DEVELOPMENT BOARD
MODEL SERIES:	AWR1843BOOST, IWR1843BOOST
SERIAL NUMBERS:	5498400022 (Rev. A) & 5727000006 (Rev. B)
DATE TESTED:	JANUARY 17, 2019 – APRIL 17, 2019

APPLICABLE STANDARDS	
STANDARDS	**TEST RESULTS**
EN 301 091-1 v2.1.1 and EN 301 091-2 v2.1.1 as referenced by Test Plan 11647276-TP1V6	Complies

UL Verification Services Inc. tested the above equipment in accordance with the requirements set forth in the above standards. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. All samples tested were in good operating condition throughout the entire test program. Measurement Uncertainties are published for informational purposes only and were not taken into account unless noted otherwise.

This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of the U.S. government.

Approved & Released For
UL Verification Services Inc. By:

MICHAEL HECKROTTE
PRINCIPAL ENGINEER
UL Verification Services Inc.

Tested By:

GIA-PIAO CHIN
TEST ENGINEER
UL Verification Services Inc.

2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with EN 301 091-1 v2.1.1, EN 301 091-2 v2.1.1 and EN 303 396 v1.1.1, as referenced by Test Plan 11647276-TP1V6.

In this report the EN 301 091-1 v2.1.1 and EN 301 091-2 v2.1.1 standards are collectively referred to as EN 301 091.

3. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 47173 Benicia Street, Fremont, California, USA.

The test sites and measurement facilities used to collect data are located at 47173 and 47266 Benicia Street, Fremont, California, USA. Line conducted emissions are measured only at the 47173 address. The following table identifies which facilities were utilized for radiated emission measurements documented in this report. Specific facilities are also identified in the test results sections.

47173 Benicia Street	47266 Benicia Street	47658 Kato Rd
☐ Chamber A	☐ Chamber D	☒ Chamber I
☒ Chamber B	☐ Chamber E	☐ Chamber J
☐ Chamber C	☐ Chamber F	☒ Chamber K
	☐ Chamber G	☐ Chamber L
	☐ Chamber H	

The above test sites and facilities are covered under FCC Test Firm Registration # 208313.

UL Verification Services Inc. is accredited by NVLAP, Laboratory Code 200065-0.

The Laboratory's Scope of Accreditation does not include EN 301 091-1 v2.1.1, EN 301 091-2 v2.1.1 or EN 303 396 v1.1.1.

4. CALIBRATION AND UNCERTAINTY

4.1. MEASURING INSTRUMENT CALIBRATION

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations, and is traceable to recognized national standards.

4.2. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

PARAMETER	UNCERTAINTY
Radio Frequency	±3.5 x 10^(-8)
Radiated RF power (up to 40 GHz)	±5.3 dB
Radiated RF power (above 40 up to 66 GHz)	±5.1 dB
Radiated RF power (above 66 up to 100 GHz)	±5.4 dB
Radiated RF power (above 100 GHz)	±5.0 dB
Temperature	±0.9 deg C
Humidity	±4.5 % RH
DC and low frequency voltages	±0.45 %

Uncertainty figures are valid to a confidence level of 95%.

5. EQUIPMENT UNDER TEST

5.1. DESCRIPTION OF EUT

See Test Plan 11647276-TP1V6.

5.2. OUTPUT POWER

The highest Mean Output Power is 23.63 dBm EIRP over normal and extreme temperature conditions.

The highest Peak Output Power is 27.07 dBm EIRP over normal and extreme temperature conditions.

5.3. SOFTWARE AND FIRMWARE

The software used on the support laptop is mmWave Studio 2.0.0.2 and the DFP package is mmwave_dfp_01.02.00.01 for the 18xx series.

A test script with 300 MHz operating bandwidth, transmitting maximum power was provided and used at all RF tests.

Texas Instruments mmWave_Demo.Visualizer ver 3.1.0 software was utilized for the Receiver In-band, Out-of-band and Remote-band Signals Handling test.

5.4. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

PERIPHERAL SUPPORT EQUIPMENT LIST			
Description	**Manufacturer**	**Model**	**Serial Number**
Laptop	Dell	E7450	713FR72
Laptop Power Supply	Dell	DA130PE-00	CN-OJU012-48661-12E-DYX1-A04
5VDC 3A Adapter	CUI Japan	EMSA050300	----
5VDC 2A Adapter	Volgen	KTPS10-05020WA	-----
Data Capture Board	TI	DCA1000EVM	3718DCA1000EVM0102

I/O CABLES

I/O Cable List						
Cable No	**Port**	**# of Identical Ports**	**Connector Type**	**Cable Type**	**Cable Length (m)**	**Remarks**
1	AC	1	3-prong	Unshielded	0.9	--
2	DC	1	Barrel	Unshielded	1.8	--
3	AC	1	3-prong	Unshielded	-	--
4	DC	1	Barrel	Unshielded	1.5	--
5	AC	1	3-prong	Unshielded	-	--
6	DC	1	Barrel	Unshielded	1.5	Ferrite on DC
7	60-Pin	1	60-Pin	Flat Ribbon	0.08	--
8	USB	2	USB 2.0 Male - USB mini	Shielded	0.9	--

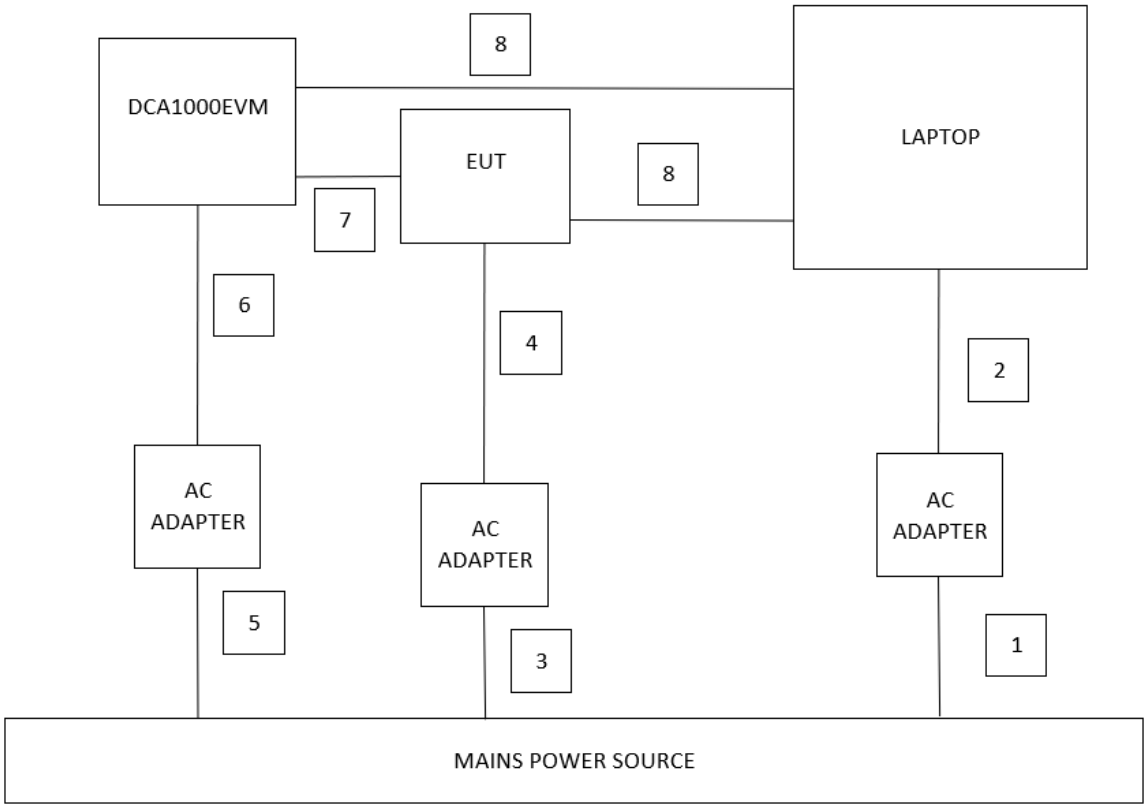
TEST SETUP

The EUT is connected to a laptop computer. Software within the computer is used to configure and exercise the EUT.

SETUP DIAGRAM FOR TESTS

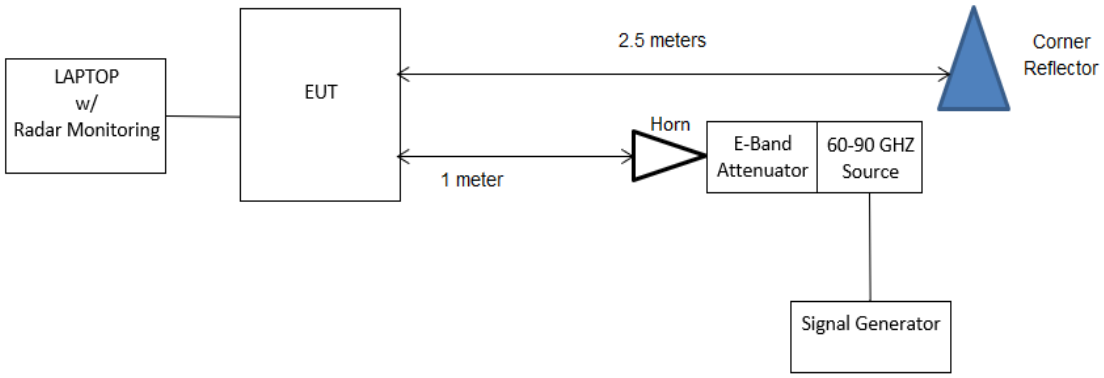
RF TESTS

Note: Laptop/USB cables and Laptop power supply were removed for Radiated emissions testing in chamber.



SETUP DIAGRAM FOR TEST

RECEIVER IN-BAND, OUT-OF-BAND AND REMOTE-BAND SIGNALS HANDLING



6. TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment was utilized for the tests documented in this report:

Test Equipment List				
Description	**Manufacturer**	**Model**	**S/N or Local ID**	**Cal Due**
PXA Signal Analyzer	Agilent	N9030A	T313	1/25/2020
PSG Analog Signal Generator, 250KHz to 50GHz	Keysight	E8257D	PRE0160761	8/13/2019
60-90 GHz Horn	C M i	HO12R	H12-2	9/20/2019
60-90 GHz Downconverter	OML	C12H1DC01	180530-1	CNR
Isolator, 60-90 GHz	Millitech	FBI-12-RSES0	A18672	CNR
RF Diode Detector, 60-90 GHz	Millitech	DET-12-RPFW0	A18672	CNR
Power Sensor, 75-110 GHz	Agilent	W8486A	T411	8/15/19
P-Series Power Meter	Keysight	N1913A	PRE0078027	1/30/2020
Digital Signal Analyzer, 8 GHz	Agilent	DSA90804A	PRE0079430	8/10/2019
Low Pass Filter, 10 MHz	Solar Electric Co.	6623-10	T417	9/25/2019
Voltage Amplifier, 200 MHz	FEMTO	HVA-200M-40-B	PRE0184145	CNR
0.01 – 26.5 GHz Amplifier	Agilent	83006A	12020	9/25/2019
Horn antenna, 33-50 GHz	C M i	HO22R	--	CNR
LNA, 40-50 GHz	Spacek Labs	SL4510-33-4W	14J05	9/24/2019
50-75 GHz Horn	C M i	HO15R	H15-1	9/20/2019
LNA, 50-75 GHz	Vivatech	VTLNA-15-6018-FB	2013051	CNR
50-75 GHz Downconverter	OML	C15H1DC01	PRE0180075	CNR
75-110 GHz Horn	C M i	HO10R	H10-1	9/20/2019
LNA, 75-110 GHz	Spacek	SLW-22-5	15J04	CNR
75-110 GHz Downconverter	OML	C10H1DC01	PRE0180076	CNR
110-170 GHz Horn	C M i	HO6R	H06-1	9/20/2019
LNA 110-170 GHz	VivaTech	VTLNA-01S01	2015085	CNR
110-170 GHz Downconverter	VDI	SAX 228	PRE0175814	CNR
170-260 GHz Horn	C M i	HO4R	H04-1	9/20/2019
170-260 GHz Downconverter	VDI	SAX 229	PRE0175628	CNR
ESW EMI Test Receiver 44 GHz	Rohde & Schwartz	ESW44	PRE0179375	5/8/2019
Hybrid Antenna, 30MHz to 3GHz	SunAR	JB3	PRE0184052	10/24/2019
Amplifier, 9kHz to 1GHz, 32dB	Sonoma Instruments	310	PRE0186650	12/13/2019
Antenna, Horn 1-18GHz	ETS Lingren	3117	T344	4/30/2019
1-18 GHz Amplifier	Amplical	AMP1G18-35	T1569	6/3/2019
44 GHz Test Receiver	Rohde & Schwartz	ESW	PRE0179378	5/8/2019
HF Switch Box & Preamps 18-40 GHz	UL	---	PRE0183142	7/3/2019
Antenna, Horn 18 to 26.5GHz	ARA	MWH-1826/B	T448	3/13/2019
Antenna, Horn 26.5 to 40GHz	ARA	MWH-2640/B	T445	3/13/2019
60-90 GHz Source	VDI	SGX 213	PRE0165570	CNR
60-90 GHz Rotary Attenuator	Flann Microwave	26110	T1687	CNR
50-75 GHz Power Sensor	Agilent	V8486A	T433	9/6/2019
Signal Generator, 250kHz-40 GHz	Agilent	E8257D	T181	2/7/2020
Environmental Chamber	Cincinnati Sub Zero	ZP8	T754	4/2/2019
Digital Multimeter	Fluke	77 IV	30860448	4/20/2019
UL EMC Radiated Software	Version	Rev. 9.5.22		

All horn antennas at and above the 33-50 GHz band are standard gain horns. In accordance with C63.10 clause 4.4.3 (a) these antennas do not need to be calibrated. UL measures the critical dimensions on an annual basis and checks for damage and deterioration before each test.

C63.10 clause 4.4.3 a) Standard gain horns need not be periodically recalibrated, unless damage or deterioration is suspected or known to have occurred. If a standard gain horn is not periodically recalibrated, then its critical dimensions (see IEEE Std 1309-2005) shall be verified and documented on an annual basis.

7. APPLICABLE LIMITS AND TEST RESULTS

7.1. DUTY CYCLE

LIMIT

None, for reporting purposes only.

TEST PROCEDURE

The fundamental is measured using a Standard Gain Horn Antenna, Low Noise Amplifier and Downconverter feeding a Diode Detector connected to an Oscilloscope. Pulse widths, burst lengths, and periods are measured, then the duty cycle is calculated.

The total Duty Cycle is calculated as the duty cycle across bursts multiplied by the duty cycle within each burst.

The duty cycle factor is calculated as:

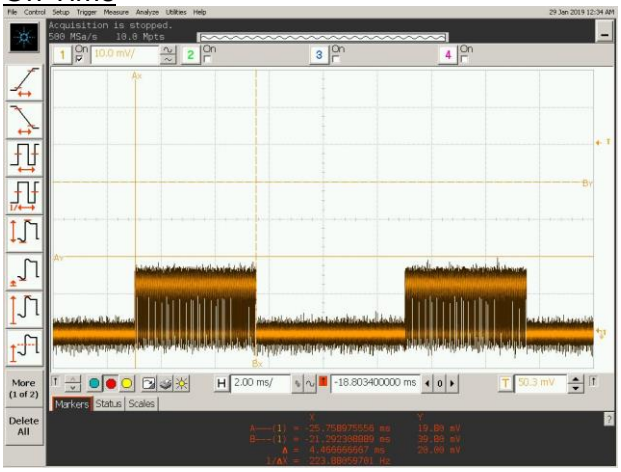
Duty Cycle Factor (dB) = 10 * Log (1 / x)
Where X = Duty Cycle (linear)

RESULTS

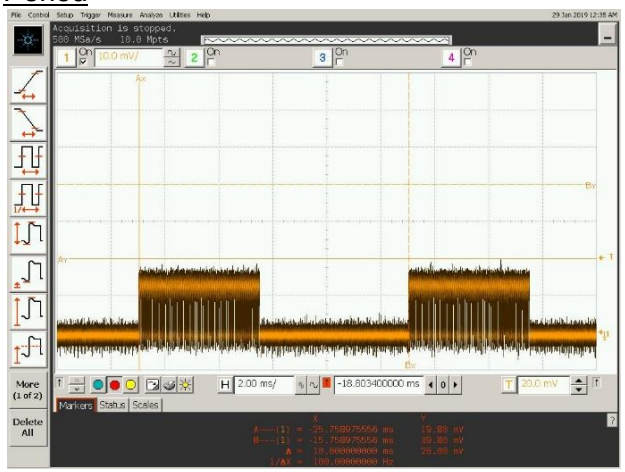
BETWEEN BURSTS				WITHIN BURST				TOTAL		
ON Time (msec)	Period (msec)	Duty Cycle (lin)		ON Time (msec)	Period (msec)	Duty Cycle (lin)		Duty Cycle (lin)	Duty Cycle (%)	Correction Factor (dB)
4.466	10	0.447		29	35.11	0.826		0.37	36.89	4.33

Between Bursts

On Time

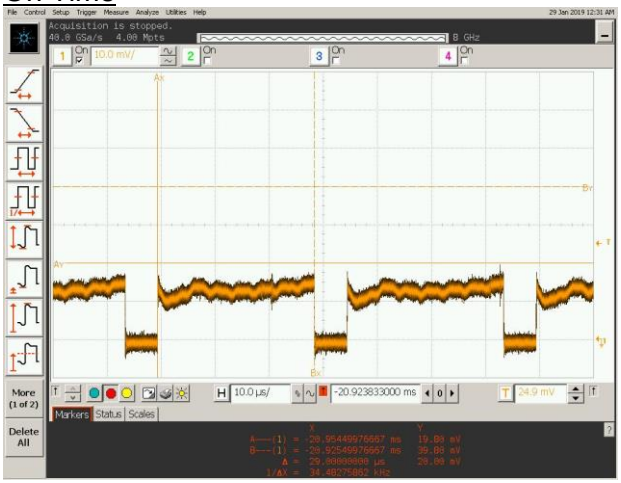


Period

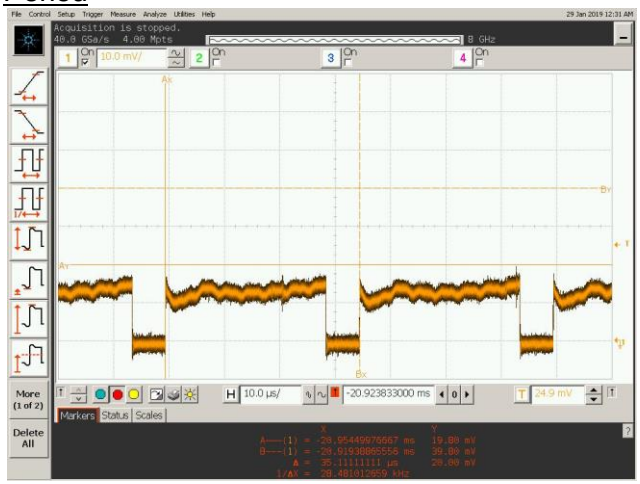


Within Burst

On Time



Period



7.2. OPERATING FREQUENCY RANGE

LIMITS

EN 301 091 Clause 4.3.1.3

The upper and lower limits of the operating frequency range shall meet the following conditions:
$F_L \geq 76$ GHz
$F_H \leq 77$ GHz

TEST PROCEDURE

The operating frequency range is measured as the -23 dBc BW. A manual measurement and an automatic measurement are made in far-field conditions. Automatic measurements are made in near-field conditions over extreme temperatures using an environmental chamber. Automatic measurements utilize the spectrum analyzer internal Occupied Bandwidth measurement routine.

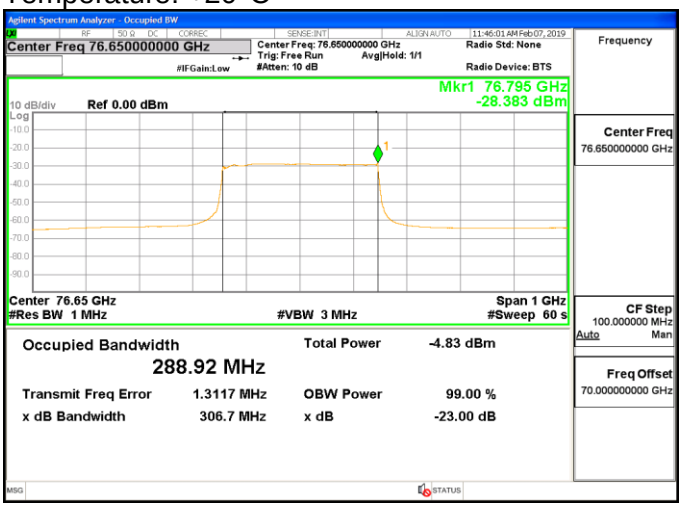
RESULTS

Temp. (°C)	Center Freq (GHz)	Freq Error (GHz)	F_L (GHz)	F_L Limit (GHz)	Result Pass/Fail	F_H (GHz)	F_H Limit (GHz)	Result Pass/Fail	-23 dB Bandwidth (GHz)
Normal			76.496	≥ 76	Pass	76.803	≤ 77	Pass	0.3070
Normal	76.65	0.00132	76.498	≥ 76	Pass	76.805	≤ 77	Pass	0.3067
-20	76.65	0.00384	76.499	≥ 76	Pass	76.808	≤ 77	Pass	0.3089
60	76.65	-0.00114	76.497	≥ 76	Pass	76.801	≤ 77	Pass	0.3043

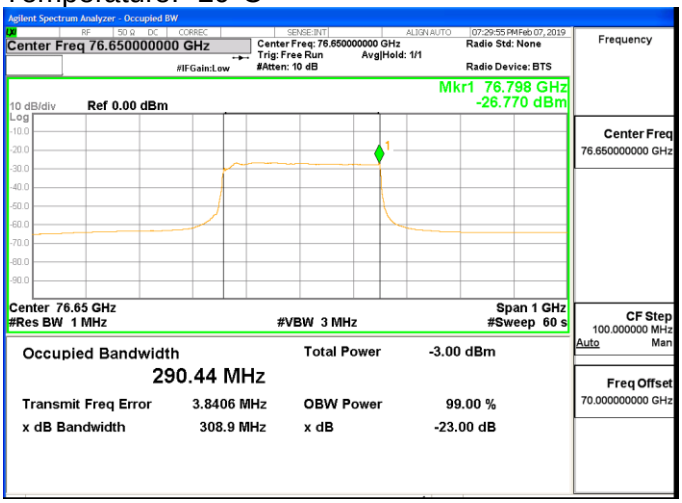
Normal Condition – Manual Measurement

Automatic Measurement in Environment Chamber

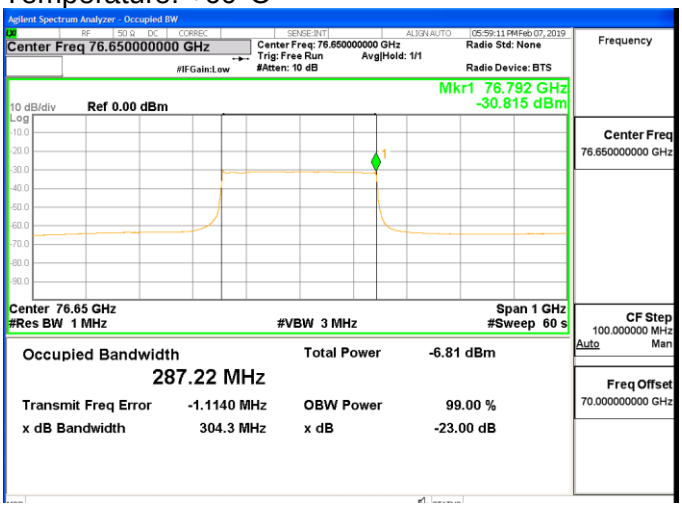
Temperature: +20°C



Temperature: -20°C



Temperature: +60°C



7.3. MEAN POWER

LIMIT

EN 301 091 Clause 4.3.2.3

The mean power shall not be greater than the limits in table 2.

Table 2: Mean power [i.2]

	EUTs others than pulsed radar	Pulsed radar
mean power (e.i.r.p.)	50 dBm	23,5 dBm
NOTE: For the purposes of this measurement, the averaging time shall be not greater than 100 ms. If the result varies through the EUT cycle time the maximum value shall be taken as the result.		

For constant pattern scanning antennas measured with the scanning inhibited (clause 4.3.5 of ETSI EN 303 396 [1]), the mean power shall be calculated from the measured result $P_{MEASURED}$ as shown in table 3.

Table 3: Mean power calculation (constant pattern scanning antenna)

	EUTs others than pulsed radar		Pulsed radar	
Illumination time t (see note 1)	t ≤ 100 ms	t > 100 ms	t ≤ 100 ms	t > 100 ms
mean power (e.i.r.p) (see note 2)	$P_{MEASURED}$ + 10 log(D)	$P_{MEASURED}$	$P_{MEASURED}$ + 10 log(D)	$P_{MEASURED}$
NOTE 1: t is the illumination time defined in ETSI EN 303 396 [1]. NOTE 2: D is the antenna scan duty factor defined in ETSI EN 303 396 [1]. As D is smaller than 1 (i.e. 100 %), the log(D) value is negative and leads to a decrease in the result.				

The antenna does not scan, therefore the limit is 50 dBm EIRP.

TEST PROCEDURE

EN 303 396 Clause 6.2.5

The fundamental signal is measured in far-field conditions using a Standard Gain Horn Antenna, Low Noise Amplifier and Power Sensor.

The fundamental signal is then measured in near-field conditions using the same test setup situated outside an environmental chamber. Without moving the near-field setup, the delta between the near-field raw measurements and the far-field corrected measurements is then applied to tests at extreme temperatures.

The measured power level is converted to EIRP using the Friis equation:

$EIRP = P_T * G_T = (P_R / G_R) * (4 * Pi * D / \lambda)^2$

where,

P_R is the received power
G_R is the gain of the receive measurement antenna
D is the measurement distance
λ is the wavelength

Notes: Calculations are made in the log form equivalent to the linear form listed above.

FAR FIELD BOUNDARY CALCULATIONS

The far-field boundary is given as:

$R_{far\ field} = (2 * L^2) / \lambda$

where,

L = Largest Antenna Dimension, including the reflector, in meters
λ = wavelength in meters

The dimension of integral Tx patch antenna is 8.8 mm x 5.8 mm.

Frequency (GHz)	L (m)	Lambda (m)	R (Far Field) (m)
76	0.0105	0.0039	0.0559
77	0.0105	0.0039	0.0566

The dimension of receiving Rx E-band horn antenna is 22.9 mm x 30 mm.

Frequency (GHz)	L (m)	Lambda (m)	R (Far Field) (m)
76	0.0378	0.0039	0.7239
77	0.0378	0.0039	0.7335

Radiated power measurements are performed at a 1.5 meter test distance.

RESULTS

Environmental Conditon	Frequency (GHz)	Meas. Power (dBm)	Meas. Distance (m)	Corr Meas (dBm EIRP)	Duty Cycle Corr Fact (dB)	Mean Power (dBm EIRP)	Temp Chamber Factor (dB)	Mean Power Limit (dBm EIRP)	Margin (dB)
Far Field Ambient	76.5	-1.98	1.5	19.15	4.33	23.48		50	-26.52
Chamber Ambient	76.5	0.83				23.48	22.65	50	-26.52
-20°C	76.5	0.98				23.63		50	-26.37
+60°C	76.5	0.76				23.41		50	-26.59

7.4. PEAK POWER

LIMIT

EN 301 091 Clause 4.3.3.3

The peak power for EUT with fixed beam or scanning antenna shall not be greater than 55 dBm.

TEST PROCEDURE

EN 303 396 Clause 6.2.4

The fundamental signal is measured in far-field conditions using a Standard Gain Horn Antenna, Downconverter and Pre-amplifier.

The fundamental signal is then measured in near-field conditions using the same test setup situated outside an environmental chamber situated outside an environmental chamber. Without moving the near-field setup, the delta between the near-field raw measurements and the far-field corrected measurements is then applied to tests at extreme temperatures.

RESULTS

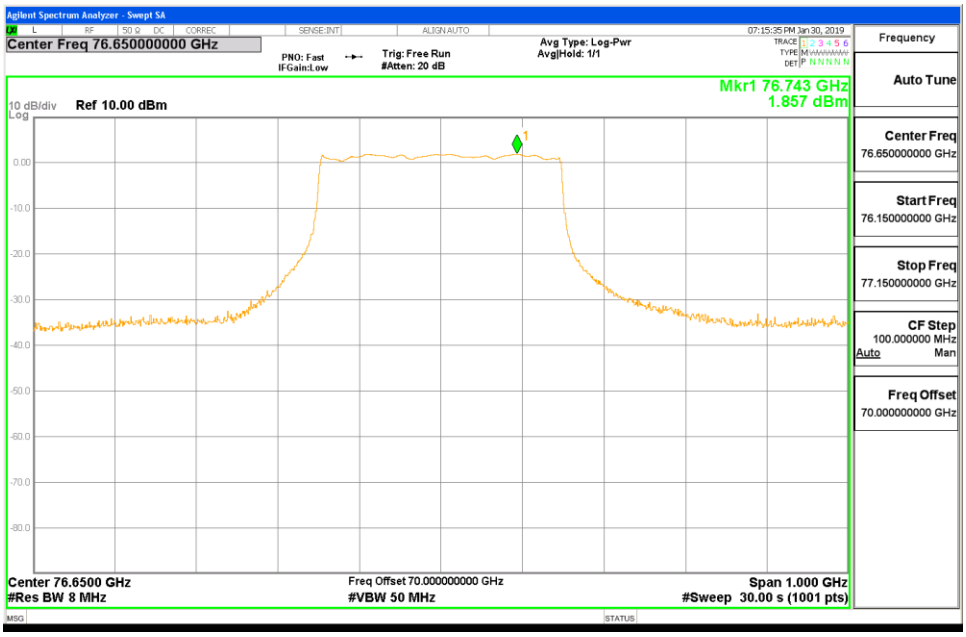
Normalized Sweep Rate Correction Factor:

FMCW Width (MHz)	Ramp Time (us)	Sweep Rate (MHz/us)	Sweep Rate (Hz/s)	RBW (Hz)	Normalized Sweep Rate (lin)	Amplitude Loss (lin)	Amplitude Loss (dB)
307	29	10.586	1.06E+13	8.00E+06	0.17	0.999	-0.012

Environmental Condition	Frequency (GHz)	Meas. Power (dBm)	Meas. Dist (m)	Corr Meas (dBm EIRP)	Norm. Swp Rate Corr. Factor (dB)	Peak Power (dBm EIRP)	Temp Chamber Factor (dB)	Peak Pwr Limit (dBm EIRP)	Margin (dB)
Far Field Ambient	76.743	1.86	1.5	25.28	0.012	25.29		55	-29.71
Chamber Ambient	76.506	0.41				25.29	24.87	55	-29.71
-20°C	76.565	2.20				27.07		55	-27.93
+60°C	76.505	-1.32				23.55		55	-31.45

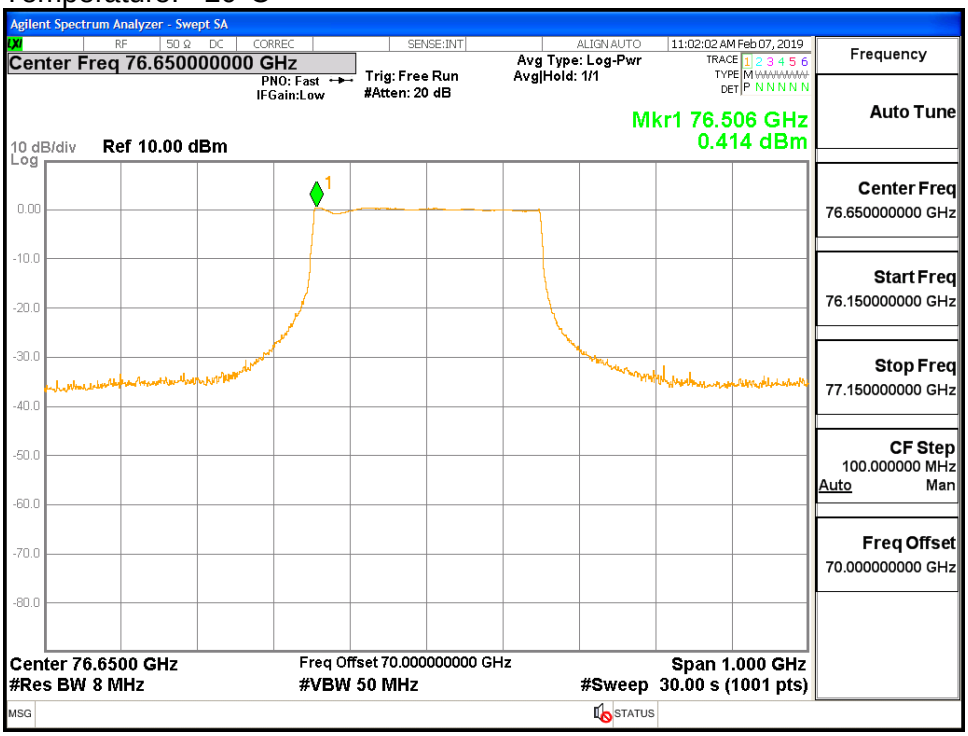
RESULTS

Normal Condition – Far Field

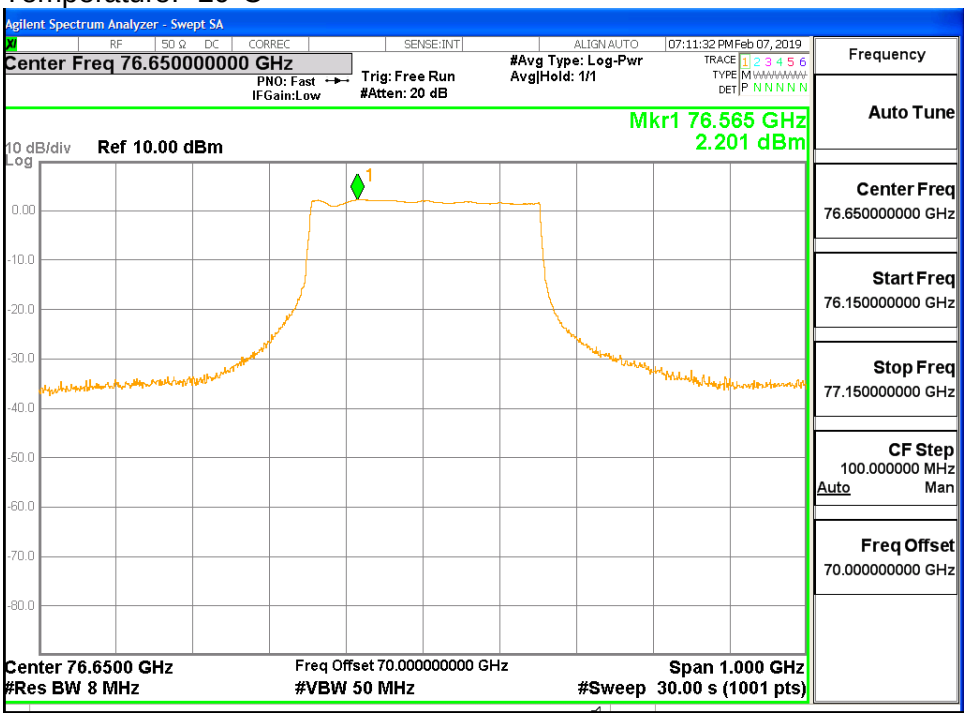


Environment Chamber – Near Field

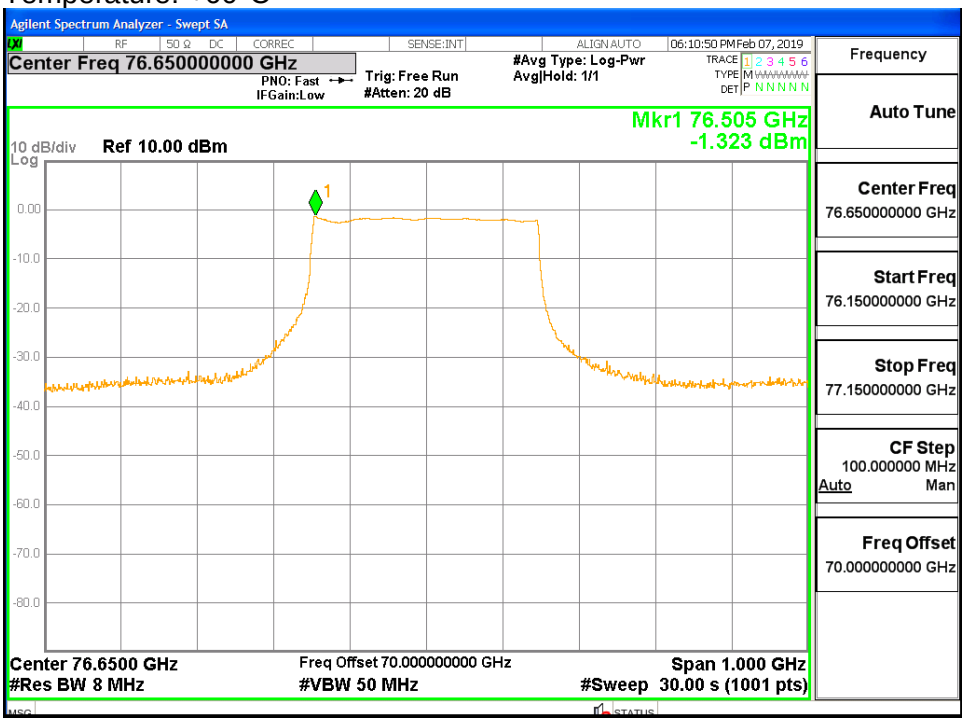
Temperature: +20°C



Temperature: -20°C



Temperature: +60°C



7.5. UNWANTED EMISSIONS IN THE OUT OF BAND DOMAIN

LIMIT

EN 301 091 Clause 4.3.4.3

The RMS mean power spectral density radiated in the calculated out-of-band domain (between F_1 to f_L and f_H to F_2 band) shall not be greater than the values given in table 4.

Table 4: Limits for out-of-band radiation [i.4]

Frequency [GHz]	RMS mean power spectral density [dBm/MHz]
$F_1 \leq f < f_L$	0
$f_H < f \leq F_2$	0

The values f_L and f_H are the results of the operating frequency range conformance test, see clause 4.3.1.4.

The values F_1 and F_2 are calculated as in ETSI EN 303 396 [1], clause 6.2.11.

NOTE: The out-of-band domain may be larger or smaller than the maximum permitted range of operation.

TEST PROCEDURE

EN 303 396 Clause 6.2.11

OOB emissions are measured in far-field conditions using a Standard Gain Horn Antenna, Downconverter and Pre-amplifier.

RESULTS

Meas. Band	Frequency (GHz)	Meas. Power (dBm)	Meas. Dist (m)	Corr Meas (dBm/MHz EIRP)	Duty Cycle Corr Fact (dB)	OOB Power (dBm/MHz EIRP)	OOB Limit (dBm/MHz EIRP)	Margin (dB)
OOB LOW	76.496	-62.14	1.50	-28.10	4.33	-23.77	0	-23.77
OOB HIGH	76.803	-61.14	1.50	-26.96	4.33	-22.63	0	-22.63

OOB LOW

OOB HIGH

7.6. UNWANTED EMISSIONS IN THE SPURIOUS DOMAIN

LIMIT

EN 301 091 Clause 4.3.5.3

The effective radiated power of any radiated spurious emission shall be not greater than the values given in table 5.

Table 5: Limits of radiated spurious emissions [i.4]

Frequency range (MHz)	Limit values for spurious radiation	Detector type
47 to 74	-54 dBm e.r.p.	Quasi-Peak
87,5 to 118	-54 dBm e.r.p.	Quasi-Peak
174 to 230	-54 dBm e.r.p.	Quasi-Peak
470 to 790	-54 dBm e.r.p.	Quasi-Peak
otherwise in band 30 to 1 000	-36 dBm e.r.p.	Quasi-Peak
f > 1 000 to 300 000 (see note)	-30 dBm e.i.r.p.	RMS
NOTE: Measurement is only required up to the 2nd harmonic of the fundamental frequency (as defined in CEPT/ERC/REC 74-01 [i.4]). In this case, the upper frequency limit up to which measurements are performed is 154 GHz.		

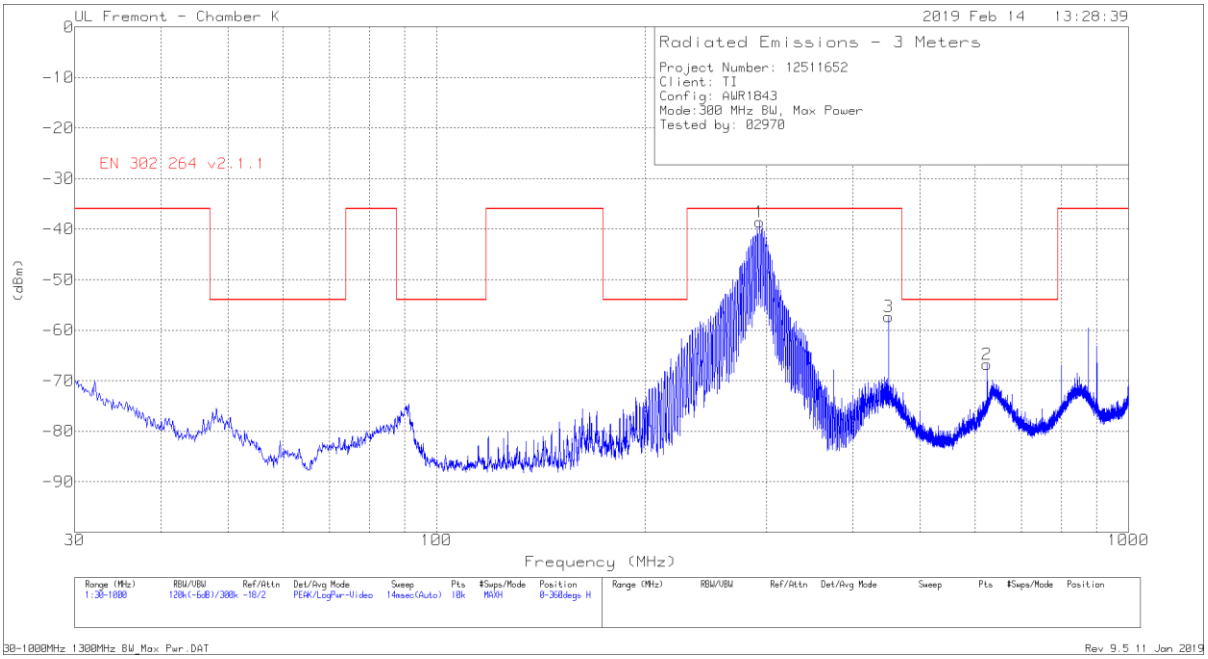
TEST PROCEDURE

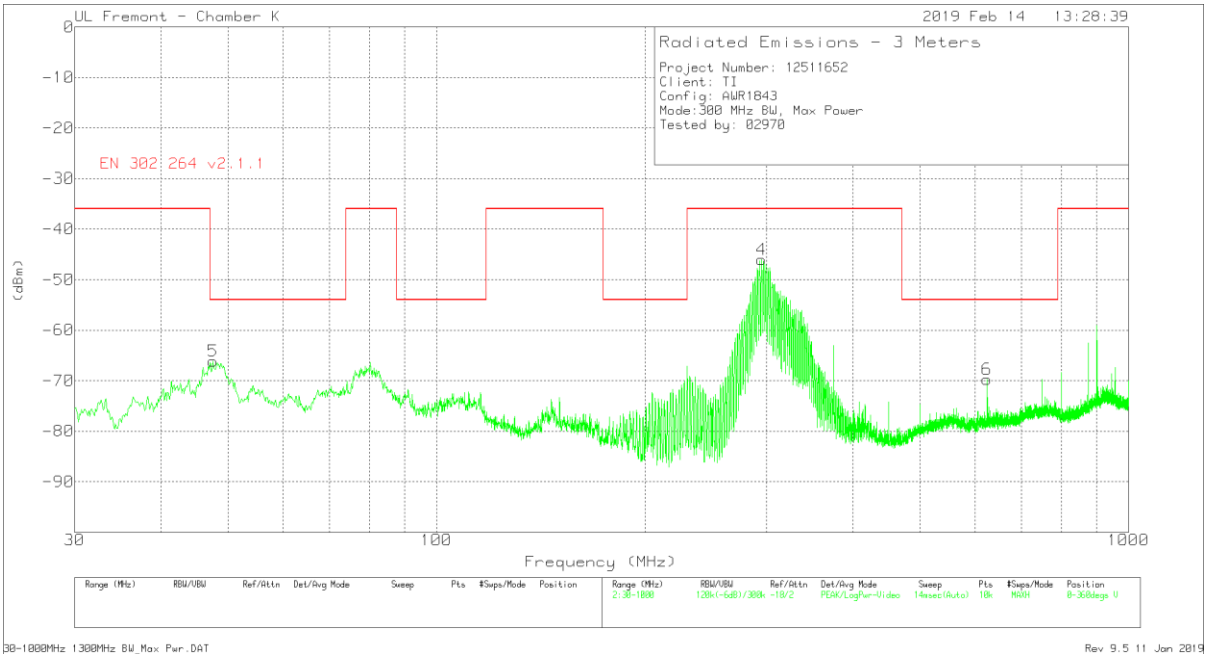
EN 303 396 Clause 6.3.10

RESULTS

7.6.1. TX UNWANTED EMISSIONS, 30 - 1000 MHz

TX UNWANTED EMISSIONS, 30 - 1000 MHz (Rev. B Board)





TX UNWANTED EMISSIONS, 30 - 1000 MHz (Rev. B Board)

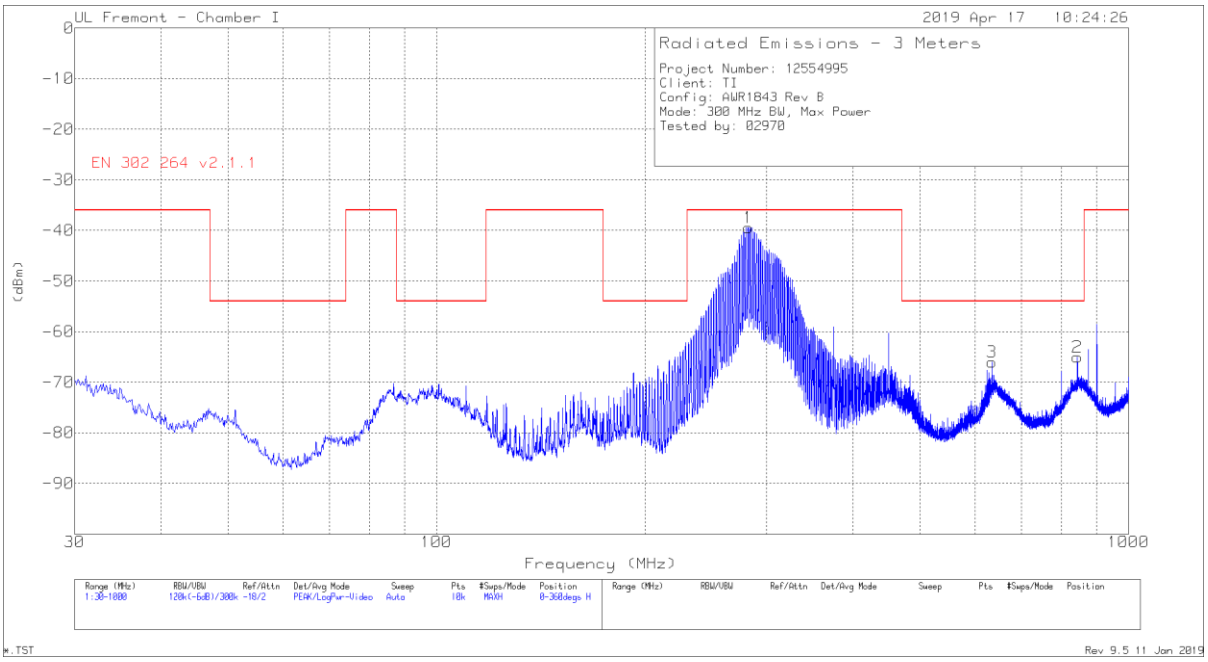
Radiated Emissions

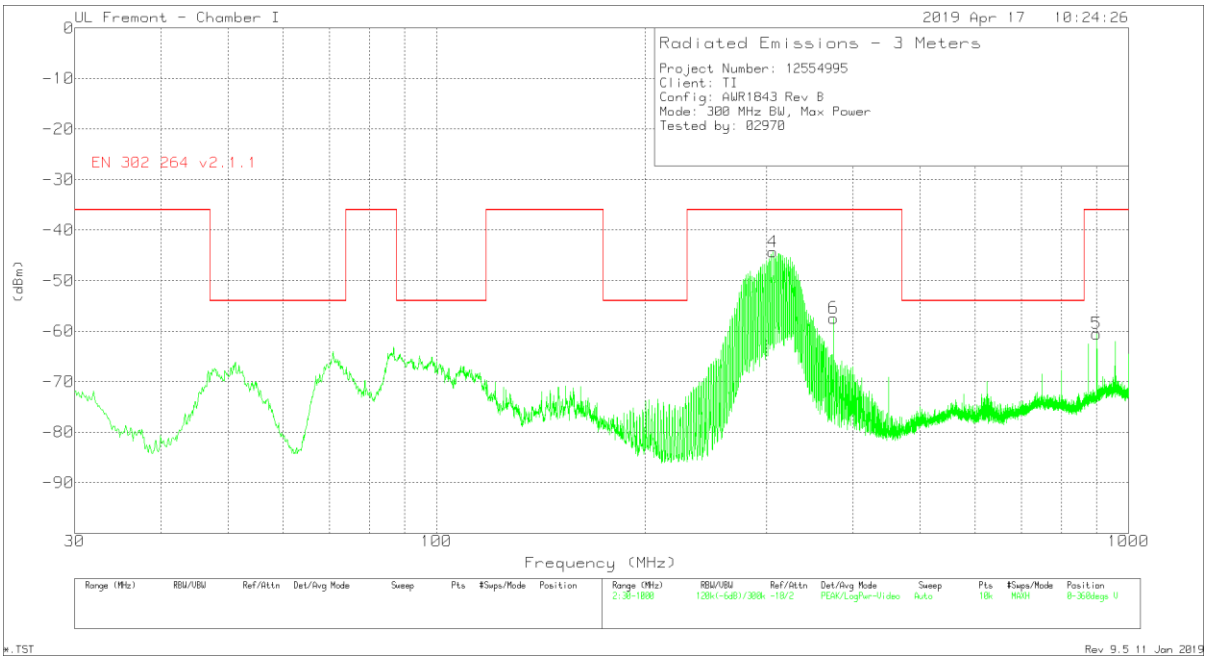
Marker	Frequency (MHz)	Meter Reading (dBm)	Det	AF PRE0184052 (dB/m)	Amp/Cbl (dB)	Amp/Cbl (dB)	Corrected Reading (dBm)	EN 301 091 v2.1.1 Qp Limit (dBm)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	292.9359	-35.27	Pk	19.2	-29.8	8.3	-37.57	-	-	5	188	H
1	292.9359	-39.89	Qp	19.2	-29.8	8.3	-42.19	-36	-6.19	5	188	H
2	624.985	-70.67	Pk	25.3	-28.8	9.7	-64.47	-	-	145	129	H
2	624.985	-73.26	Qp	25.3	-28.8	9.7	-67.06	-54	-13.06	145	129	H
3	449.975	-62.47	Pk	22.7	-29.2	12.9	-56.07	-	-	352	206	H
3	449.975	-64.06	Qp	22.7	-29.2	12.9	-57.66	-36	-21.66	352	206	H
4	295.3151	-40.91	Pk	19.2	-29.8	8.1	-43.41	-	-	323	100	V
4	292.9359	-39.89	Qp	19.2	-29.8	7.8	-42.69	-36	-6.69	323	100	V
5	47.8257	-55.4	Pk	14.6	-31.4	7.7	-64.5	-	-	0	114	V
5	47.8716	-60.69	Qp	14.6	-31.4	7.7	-69.79	-54	-15.79	0	114	V
6	625.008	-73.01	Pk	25.3	-28.8	6.7	-69.81	-	-	273	284	V
6	625.008	-77.79	Qp	25.3	-28.8	6.7	-74.59	-54	-20.59	273	284	V

Pk - Peak detector
Qp - Quasi-Peak detector

30-1000MHz 300MHz BW_Max Pwr.DAT
Rev 9.5 11 Jan 2019

TX UNWANTED EMISSIONS, 30 - 1000 MHz (Rev. C Board)





TX UNWANTED EMISSIONS, 30 - 1000 MHz (Rev. C Board)

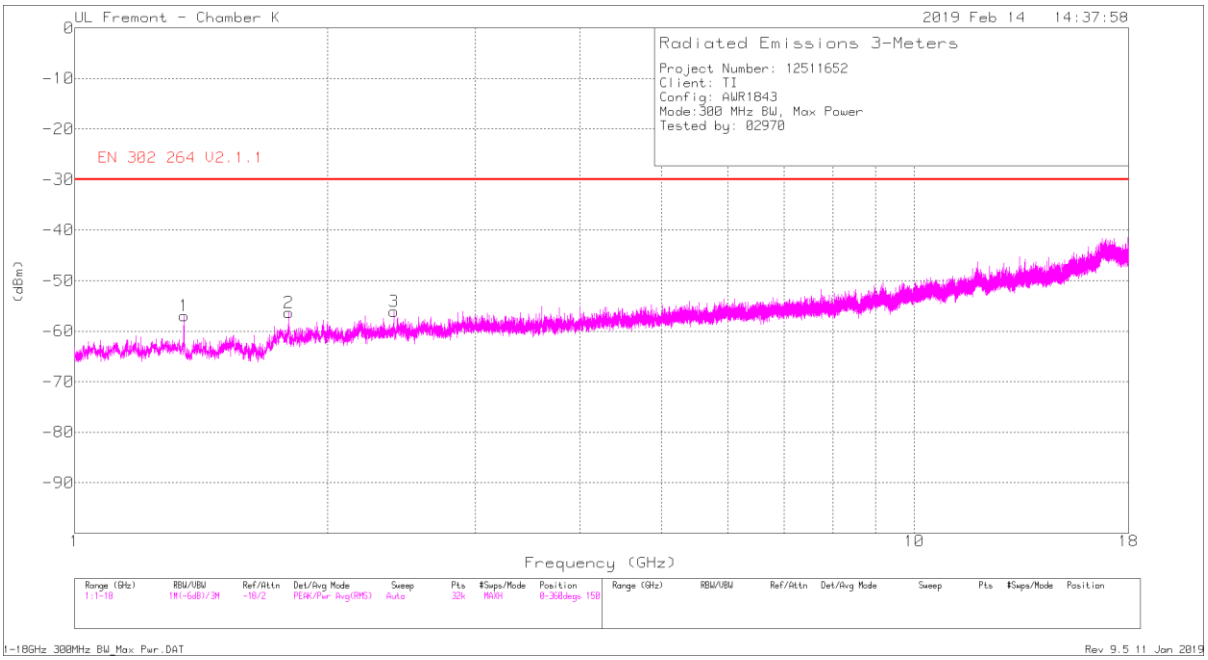
Radiated Emissions

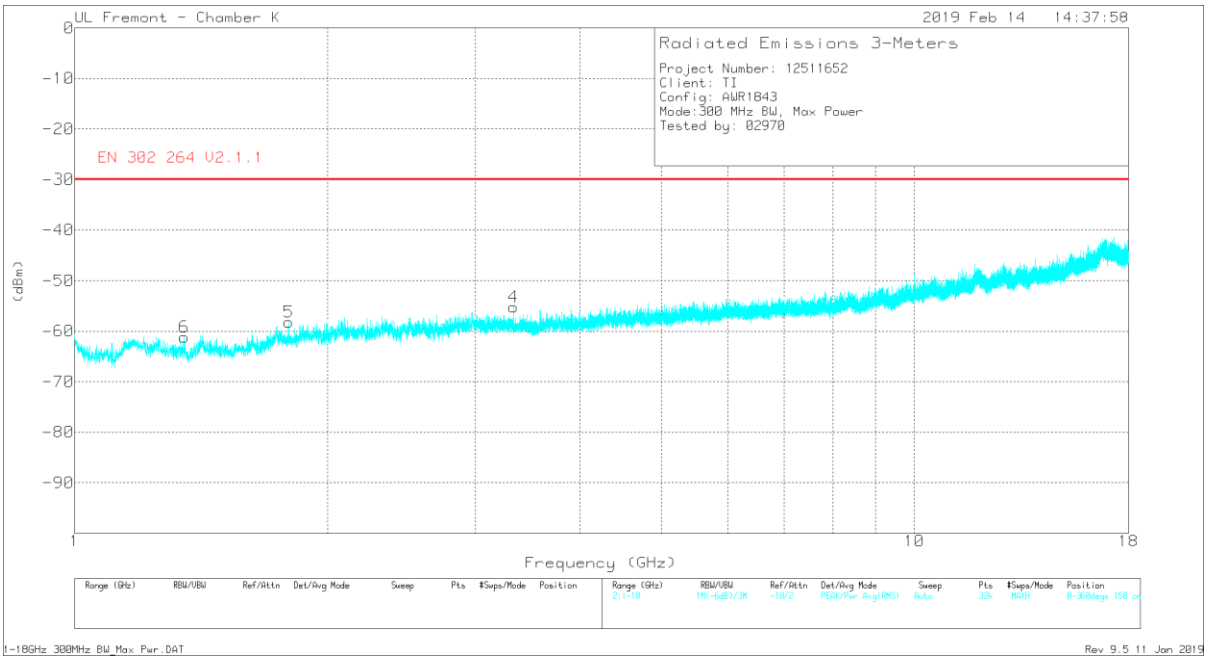
Frequency (MHz)	Meter Reading (dBm)	Det	AF PRE0184971 (dB/m)	Amp Cbl (dB)	Amp/Cbl (dB)	Corrected Reading (dBm)	EN 302 264 v2.1.1 - Qp Limit	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
288.1309	-37.74	Pk	19.2	-29.8	9.4	-38.94	--	-	225	176	H
288.1309	-39.91	Qp	19.2	-29.8	9.4	-41.11	-36	-5.11	225	176	H
843.186	-80.02	Pk	27.6	-27.9	11.5	-68.82	-	-	233	232	H
843.686	-80.21	Qp	27.6	-27.9	11.5	-69.01	-54	-15.01	233	232	H
635.022	-74.34	Pk	25.5	-29	12.5	-65.34	-	-	233	189	H
634.9808	-79.72	Qp	25.5	-29	12.5	-70.72	-54	-16.72	233	189	H
293.1011	-55.27	Pk	19.2	-29.8	7.8	-58.07	-	-	146	226	V
294.1011	-44.39	Qp	19.2	-29.8	7.8	-47.19	-36	-11.19	146	226	V
899.9685	-68.06	Pk	28	-27.5	8.3	-59.26	-	-	205	200	V
899.953	-69.73	Qp	28	-27.5	8.3	-60.93	-36	-24.93	205	200	V
374.982	-63.3	Pk	20.8	-29.5	10.1	-61.9	-	-	121	216	V
374.9928	-63.96	Qp	20.8	-29.5	10.1	-62.56	-36	-26.56	121	216	V

Pk - Peak detector
Qp - Quasi-Peak detector

*.TST
Rev 9.5 11 Jan 2019

7.6.2. TX UNWANTED EMISSIONS, 1 - 18 GHz





TX UNWANTED EMISSIONS, 1 - 18 GHz

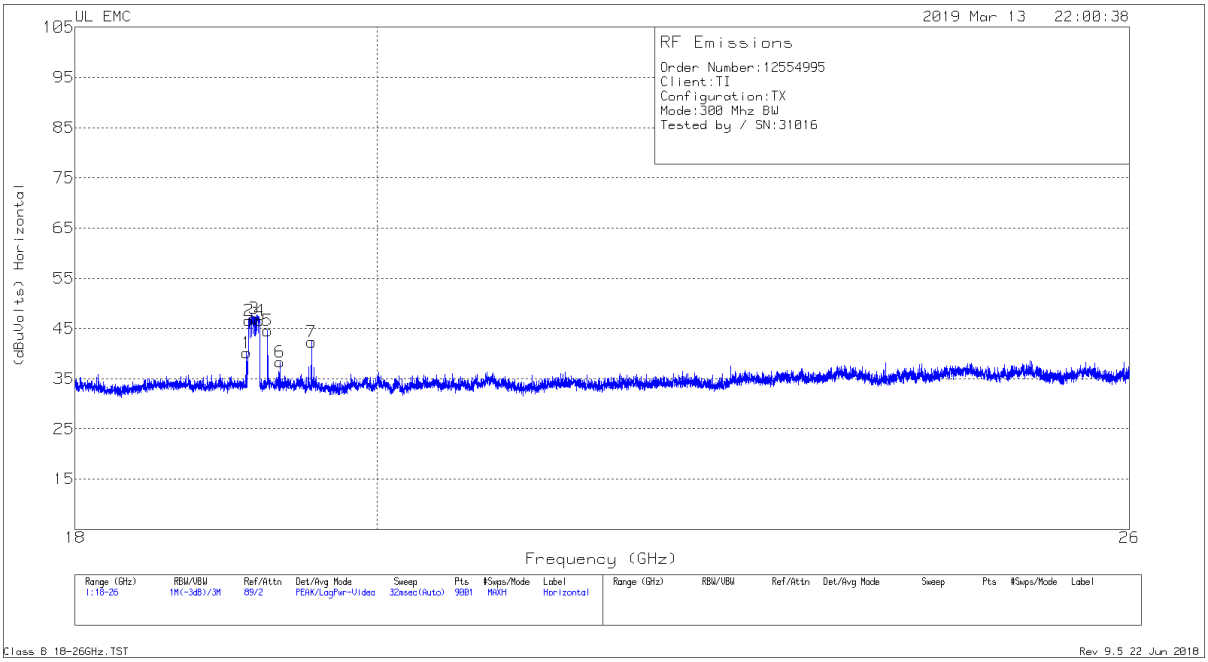
Radiated Emissions

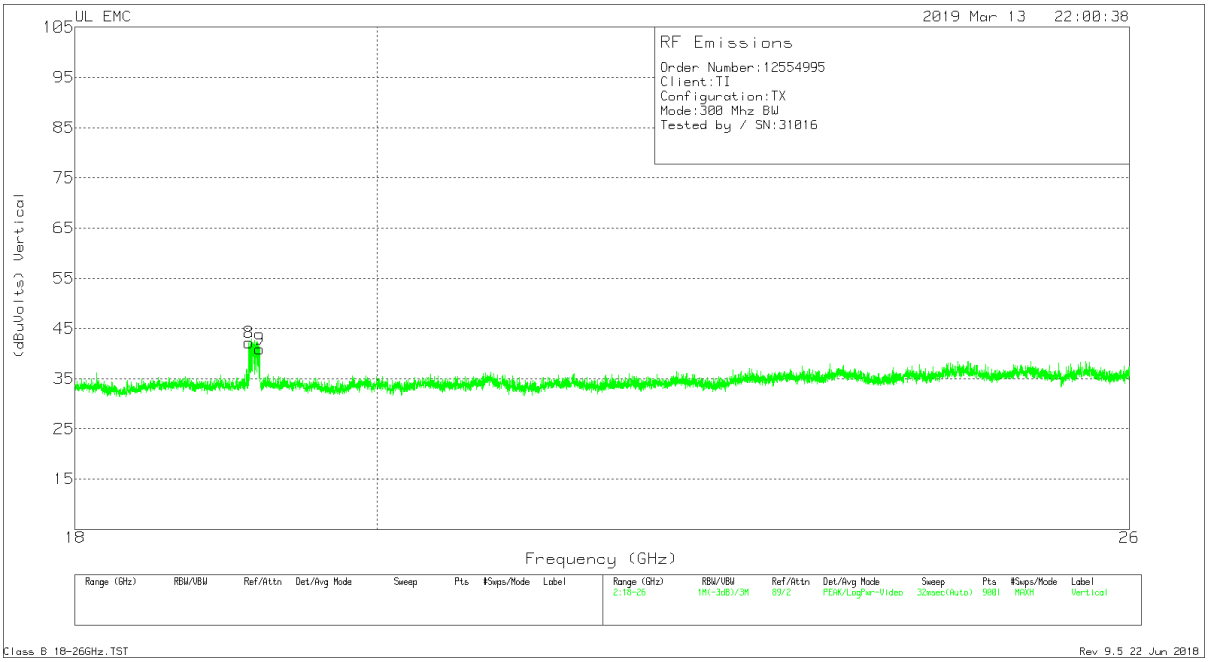
Marker	Frequency (GHz)	Meter Reading (dBm)	Det	AF T344 (dB/m)	Amp/Cbl (dB)	Amp/Cbl (dB)	Corrected Reading (dBm)	EN 301 091 V2.1.1 Avg Limit (dBm)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	1.35	-61.5	Pk	29.4	-35.5	10	-57.6	-	-	72	125	H
1	1.35	-63.45	Av	29.4	-35.5	10	-59.55	-30	-29.55	72	125	H
2	1.8	-61.4	Pk	30.1	-35.4	11.7	-55	-	-	313	158	H
2	1.8	-65.28	Av	30.1	-35.4	11.7	-58.88	-30	-28.55	313	158	H
3	2.4	-66.67	Pk	32	-35.3	11.4	-58.57	-	-	20	118	H
3	2.4	-70.15	Av	32	-35.3	11.4	-62.05	-30	-32.05	20	118	H
4	3.328	-73.65	Pk	32.8	-33.3	11	-63.15	-	-	225	190	V
4	3.33	-77.81	Av	32.8	-33.3	11.1	-67.21	-30	-37.21	225	190	V
5	1.8	-64.51	Pk	30.1	-35.4	11.1	-58.71	-	-	178	149	V
5	1.8	-69.41	Av	30.1	-35.4	11.1	-63.61	-30	-33.61	178	149	V
6	1.35	-66.36	Pk	29.4	-35.5	9.8	-62.66	-	-	224	142	V
6	1.35	-69.57	Av	29.4	-35.5	9.8	-65.87	-30	-35.87	224	142	V

PK - Peak
Av - Average detection

1-18GHz 300MHz BW_Max Pwr.DAT
Rev 9.5 11 Jan 2019

7.6.3. TX UNWANTED EMISSIONS, 18 - 26 GHz





Radiated Emissions

Pre-scan Trace Markers

Marker	Freq (GHz)	Meter Reading (dBuV)	Det	AF PRE0182188 (dB/m)	Amp/Cbl/20 dB Pad (dB)	Dist Corr (dB)	Corrected Reading (dBuVolts)
1	19.108	74.07	Pk	33	-37.4	-9.5	40.17
2	19.124	80.32	Pk	33.2	-37.4	-9.5	46.62
3	19.16	80.61	Pk	33.3	-37.4	-9.5	47.01
4	19.198	80.23	Pk	33.1	-37.2	-9.5	46.63
5	19.251	77.95	Pk	33.3	-37.2	-9.5	44.55
6	19.332	71.51	Pk	33.2	-36.9	-9.5	38.31
7	19.548	75.73	Pk	33.1	-37	-9.5	42.33
8	19.124	75.98	Pk	33.2	-37.5	-9.5	42.18
9	19.198	74.5	Pk	33.1	-37.2	-9.5	40.9

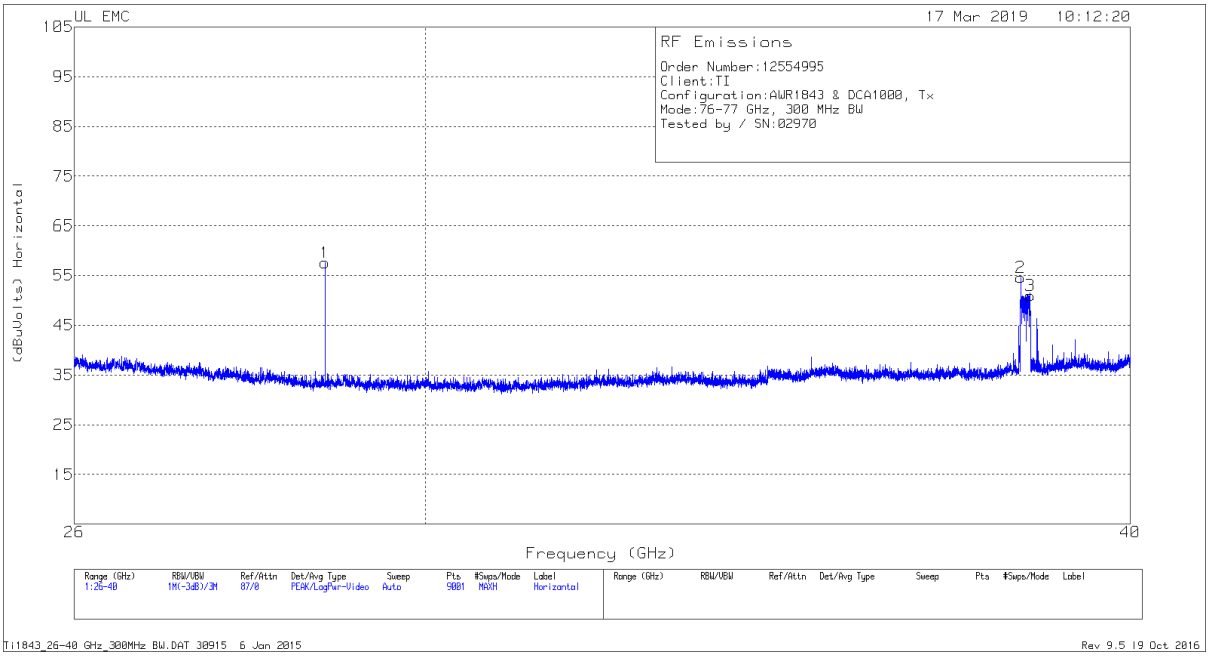
Pk - Peak detector
Class B 18-26GHz.TST
Rev 9.5 22 Jun 2018

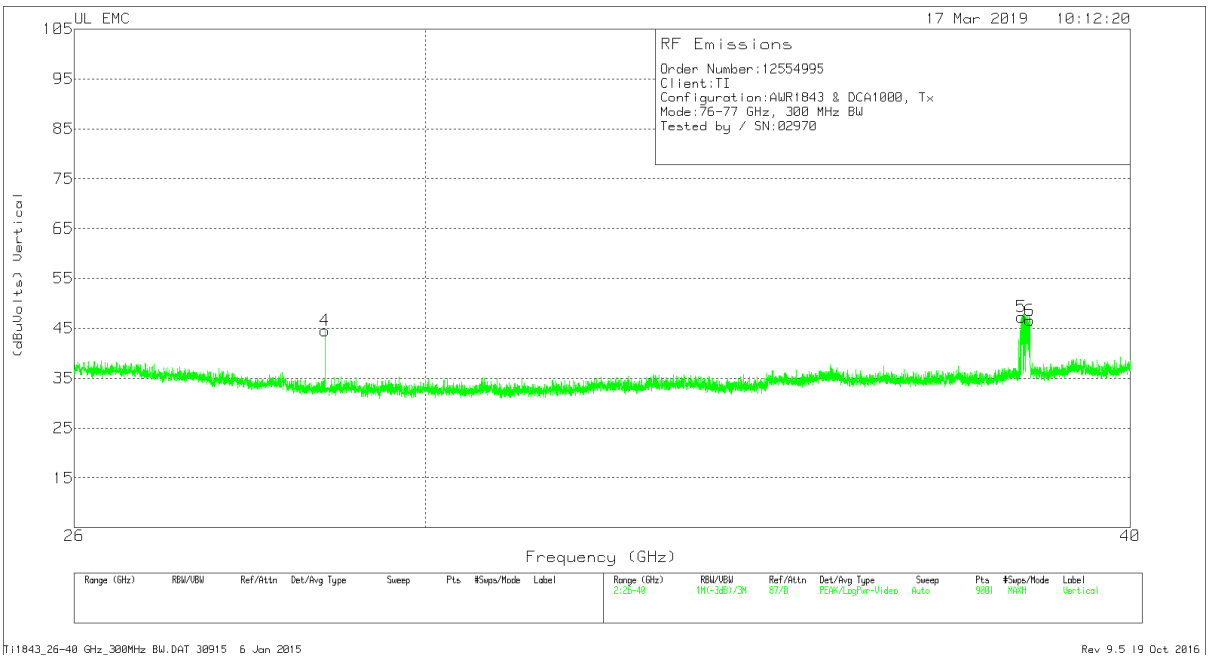
Mrker	Freq. (GHz)	Meter Reading (dBuV)	Det	T90 AF (dB/m)	Amp/Cbl/ 20 dB Pad (dB)	Dist Corr (dB)	Corr. Reading (dBuV)	Convert dBuV to dBm	Corr. Reading (dBm)	Av Limit (dBm)	Margin (dBm)	Polarity
2*	19.124	58.23	Av	33.2	-37.5	-9.5	44.43	-95.2	-50.77	-30	-20.77	H
4*	19.198	55.49	Av	33.1	-37.2	-9.5	41.89	-95.2	-53.31	-30	-23.31	H
8*	19.124	58.50	Av	33.2	-37.5	-9.5	44.7	-95.2	-50.5	-30	-20.5	V
9*	19.198	55.28	Av	33.1	-37.2	-9.5	41.68	-95.2	-53.52	-30	-23.52	V

Av - Average detection
Class B 18-26GHz.TST
Rev 9.5 22 Jun 2018

*Markers 2,4,8,9 are subharmonics of fundamental signals and also FMCW modulated signals, the measurement method of FMCW signal was applied at test.

7.6.4. TX UNWANTED EMISSIONS, 26 - 40 GHz





Radiated Emissions

Pre-scan Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	T90 AF (dB/m)	Amp/Cbl (dB)	Dist Corr (dB)	Corrected Reading (dBuVolts)
1	28.798	63.28	Pk	35.8	-32	-9.5	57.58
2	38.248	59.38	Pk	37.1	-32.4	-9.5	54.58
3	38.396	55.75	Pk	37.1	-32.4	-9.5	50.95
4	28.798	50.24	Pk	35.8	-32	-9.5	44.54
5	38.258	52.08	Pk	37.1	-32.4	-9.5	47.28
6	38.395	51.39	Pk	37.1	-32.4	-9.5	46.59

Pk - Peak detector

Radiated Emissions

Marker	Freq. (GHz)	Meter Reading (dBuV)	Det	T90 AF (dB/m)	Amp/Cbl (dB)	Dist Corr (dB)	Corr. Reading (dBuV)	Convert dBuV to dBm	Corr. Reading (dBm)	Limit (dBm)	Margin (dBm)	Polarity
1	28.798	63.77	Av	35.8	-32	-9.5	58.07	-95.2	-37.13	-30	-7.13	H
2*	38.248	48.39	Av	37.1	-32.4	-9.5	43.59	-95.2	-51.61	-30	-21.61	H
3*	38.397	36.26	Av	37.1	-32.4	-9.5	31.46	-95.2	-63.74	-30	-33.74	H
4	28.798	51.55	Av	35.8	-32	-9.5	45.85	-95.2	-49.35	-30	-19.35	V
5*	38.248	44.35	Av	37.1	-32.4	-9.5	39.55	-95.2	-55.65	-30	-25.65	V
6*	38.397	32.89	AV	37.1	-32.4	-9.5	28.09	-95.2	-67.11	-30	-37.11	V

Av - Average detection
Ti1843_26-40 GHz_300MHz BW.DAT 30915 6 Jan 2015
Rev 9.5 19 Oct 2016

*Markers 2,3,5,6 are subharmonics of fundamental signals and also FMCW modulated signals, the measurement method of FMCW signal was applied at test.

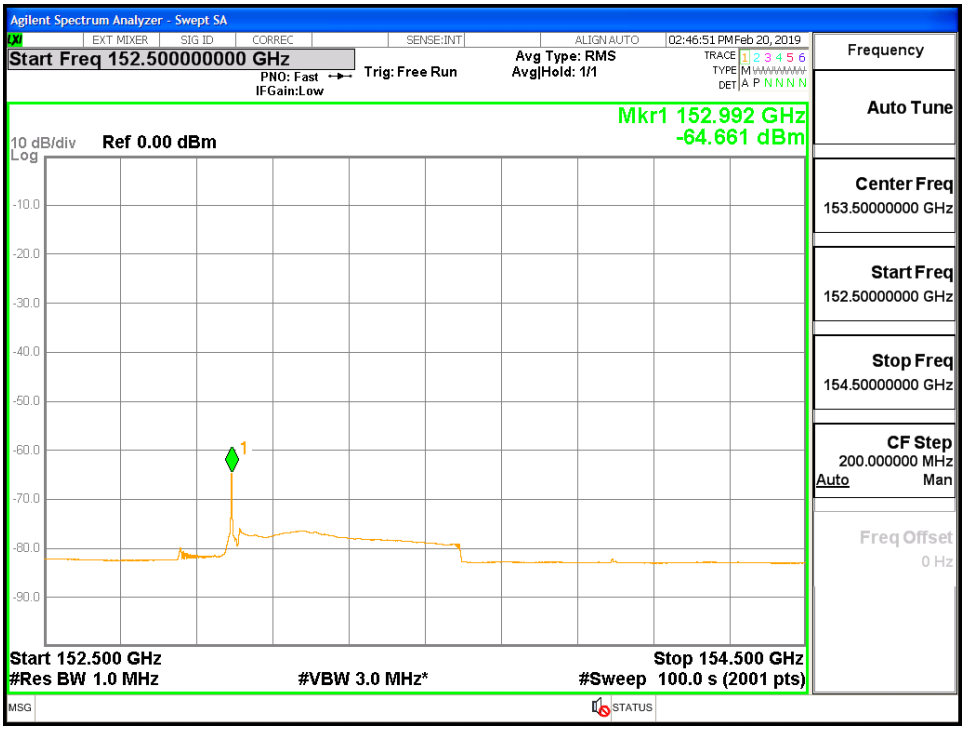
7.6.5. TX UNWANTED EMISSIONS, 40 - 154 GHz

No unwanted emission above the noise floor of PXA was detected, using Average detection on the following bands:

- 40 - 50 GHz
- 50 - 75 GHz
- 75 - 76 GHz
- 77 - 110 GHz

The following emission was detected within the 110 - 154 GHz band.

Frequency (GHz)	Meas. Av Pwr (dBm)	Meas. Dist. (m)	Avg Pwr EIRP (dBm EIRP)	Limit (dBm EIRP)	Margin (dB)
152.992	-64.66	1	-33.88	-30	-3.88



*152.992 GHz signal is harmonic of fundamental signal and also FMCW modulated signal, the measurement method of FMCW signal was applied at test.

7.7. RECEIVER SPURIOUS EMISSIONS

LIMIT

EN 301 091 Clause 4.4.2.3

The effective radiated power of any narrowband receiver spurious emission shall be not greater than the values given in table 6.

Table 6: Narrowband spurious emission limits for receivers [i.4]

Frequency range	Limit	Detector type
30 MHz to 1 GHz	-57 dBm (e.r.p.)	Quasi-Peak
above 1 GHz to 300 GHz (see note)	-47 dBm (e.i.r.p.)	RMS
NOTE: Measurement is only required up to the 2nd harmonic of the fundamental frequency (as defined in CEPT/ERC/REC 74-01 [i.4]). In this case, the upper frequency limit up to which measurements are performed is 154 GHz.		

Wideband receiver spurious emissions shall be not greater than the values given in table 7.

Table 7: Wideband spurious emission limits for receivers [i.4]

Frequency range	Limit	Detector type
30 MHz to 1 GHz	-47 dBm/MHz (e.r.p.)	Quasi-Peak
above 1 GHz to 300 GHz (see note)	-37 dBm/MHz (e.i.r.p.)	RMS
NOTE: Measurement is only required up to the 2nd harmonic of the fundamental frequency (as defined in CEPT/ERC/REC 74-01 [i.4]). In this case, the upper frequency limit up to which measurements are performed is 154 GHz.		

TEST PROCEDURE

EN 303 396 Clause 6.2.12

RESULT

Not applicable Per 11647276-TP1V6.

7.8. RECEIVER IN-BAND, OUT-OF-BAND AND REMOTE-BAND SIGNALS HANDLING

LIMIT

EN 301 091 Clause 4.4.3.3

The EUT shall achieve the wanted performance criterion, see clause 4.2.2, in the presence of unwanted signals defined in table 8.

The unwanted signal transmitter shall be able to transmit continuous wave signals at specific frequencies, as described in table 8.

Table 8: Unwanted signal for 76-77 GHz sensors

	In-band signal	OOB signal	Remote-band signal
Frequency	Centre frequency (f_c) of the EUT modulated signal (see clause 4.3.1)	$f = f_c \pm F$	$f = f_c \pm 10 \times F$
Signal level field strength at the EUT	55 mV/m	173 mV/m	173 mV/m
Equivalent EIRP at 10 m	10 dBm	20 dBm	20 dBm
F: permitted frequency bandwidth (1 GHz)			

TEST SETUP

EN 303 396 Clause 6.3.12.2

TEST PROCEDURE

EN 303 396 Clause 6.3.12.3

PERFORMANCE CRITERION

During and after the application of the unwanted signal, the EUT shall indicate the distance to the target within 20 cm of the distance indicated prior to the application of the unwanted signal.

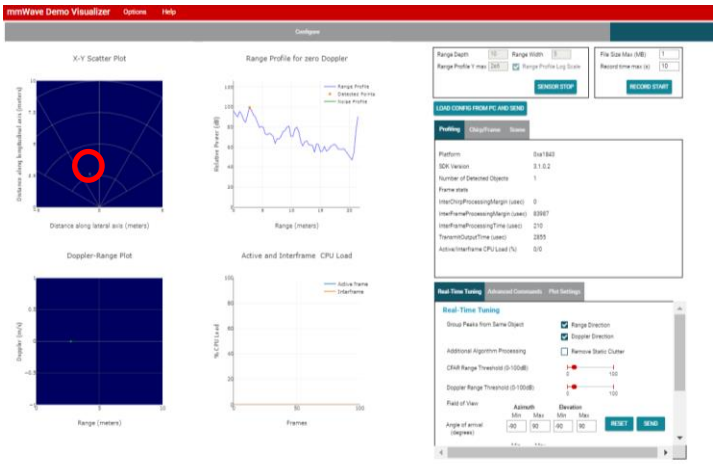
RESULTS

No changes in the Range Profile, X-Y Scatter Plot or Doppler Range Plot were observed during the application of the unwanted signals in the chart below, relative to the corresponding indications with no interference signal present.

Signal	Unwanted Frequency (GHz)	+10 dBm EIRP Results	+20 dBm EIRP Results
In Band	76.65	Pass	--
Remote Band	66.65	--	Pass
Out of Band	75.65	--	Pass
Out of Band	77.65	--	Pass
Remote Band	86.65	--	Pass

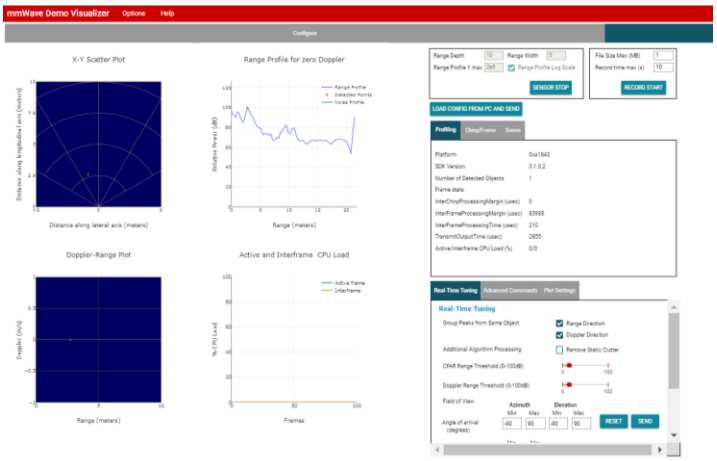
RESULTS

NO INTERFERENCE SIGNAL



O = Target

76.65 GHz IN BAND +10 dBm INTERFERENCE SIGNAL

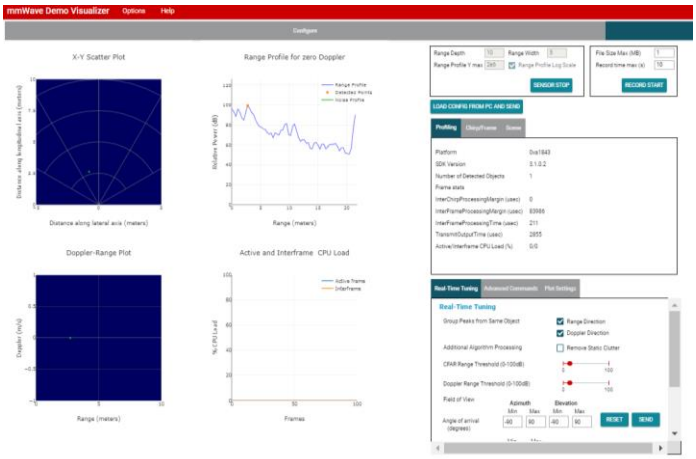


66.65 GHz REMOTE BAND +20 dBm INTERFERENCE SIGNAL

75.65 GHz OUT-OF-BAND +20 dBm INTERFERENCE SIGNAL

77.65 GHz OUT-OF-BAND +20 dBm INTERFERENCE SIGNAL

86.65 GHz REMOTE BAND +20 dBm INTERFERENCE SIGNAL



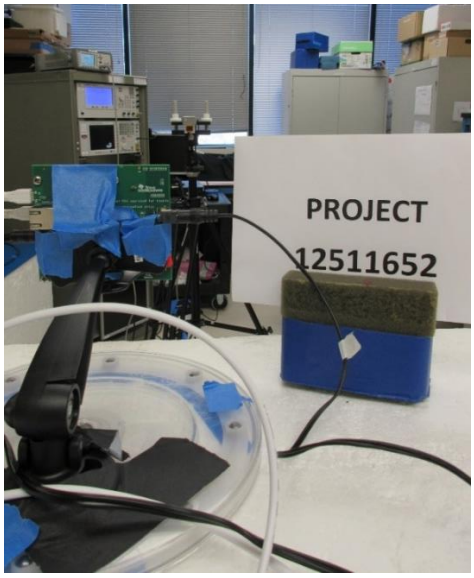
8. SETUP PHOTOS

12511652 on the photos is for internal used only, the actual Project No. is 12554995.

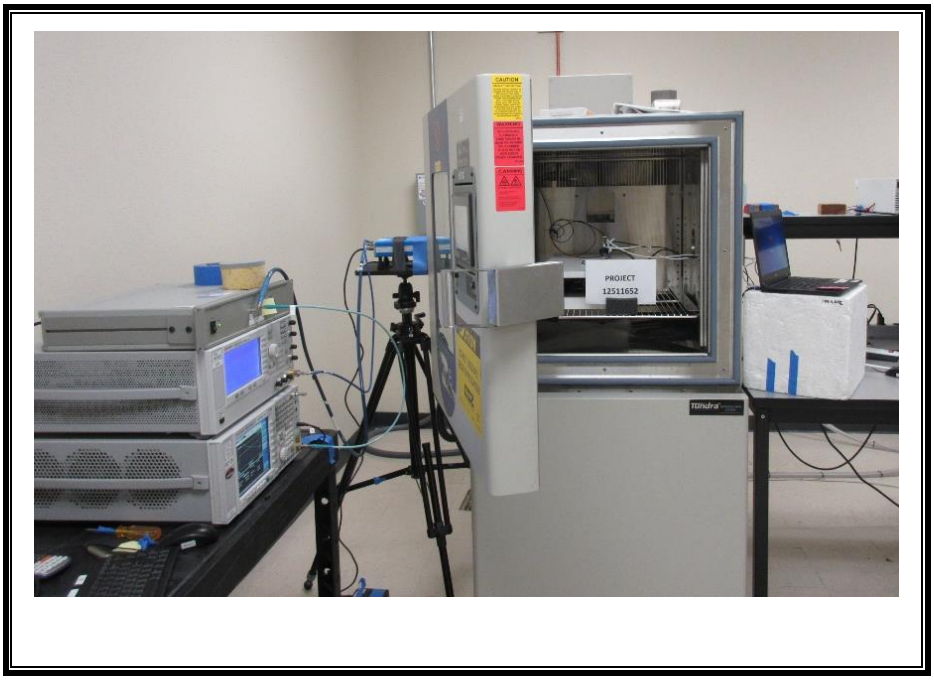
RADIATED RF MEASUREMENT SETUP

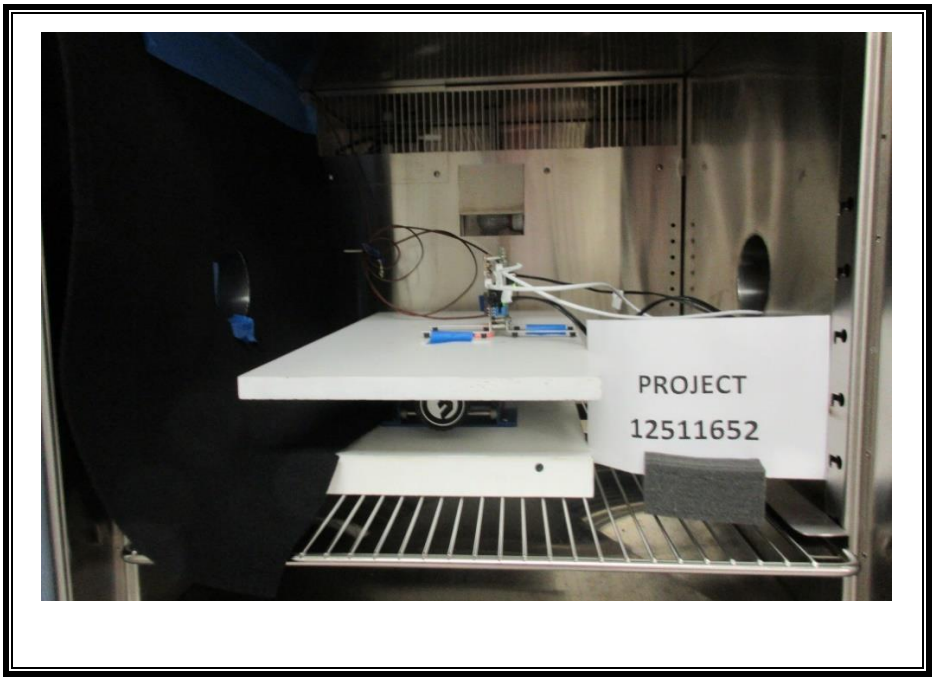
FRONT PHOTO

BACK PHOTO



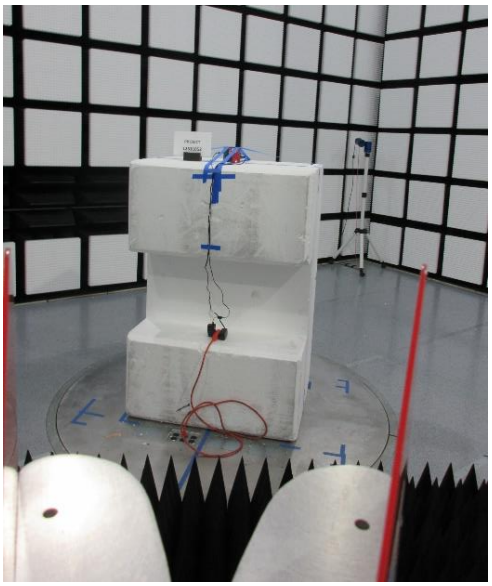
TEMPERATURE CHAMBER



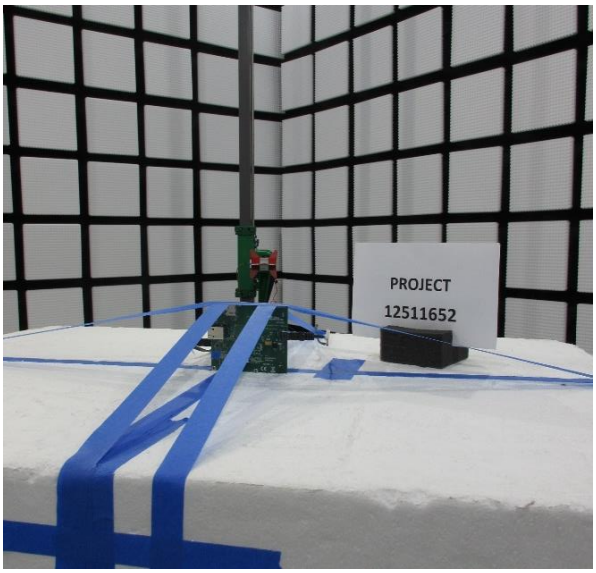


RADIATED EMISSIONS

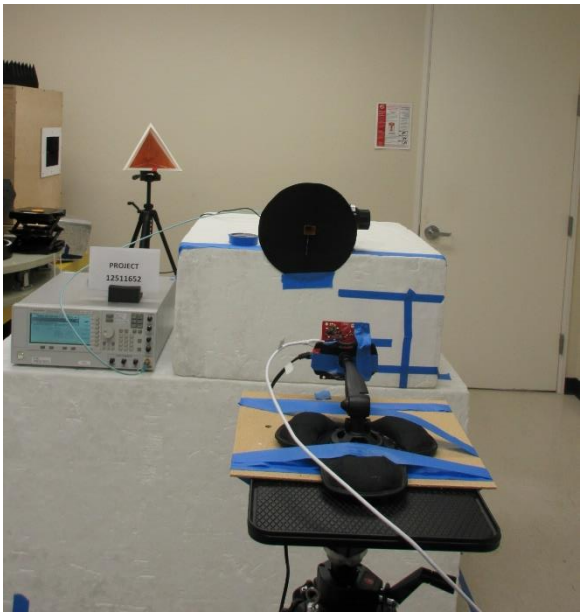
FRONT PHOTO



BACK PHOTO



RECEIVER IN-BAND, OUT OF BAND AND REMOTE BAND SIGNALS HANDLING



END OF REPORT