

Table of Contents

1. Standards, reference documents and applicable test methods	3
2. General conditions, competences and guarantees	3
3. Environmental Conditions.....	3
4. Test samples.....	3
5. EUT features	4
6. Remarks and comments.....	4
7. Test Verdicts summary.....	4
8. Document Revision History	4
Annex A. Test & System Description	5
A.1 TEST CONDITIONS	5
A.2 MEASUREMENT SYSTEM	5
A.3 TEST EQUIPMENT LIST.....	5
A.4 MEASUREMENT UNCERTAINTY EVALUATION.....	6
A.4.1 Aperture Probe Gain Characterization	6
A.4.2 EUT Measurement.....	6
A.5 POWER SENSOR CONSIDERATION AND PULSE RESPONSE.....	7
Annex B. Test Results.....	8
B.1 DUTY CYCLE	8
B.2 EIRP & POWER DENSITY	13
Annex C. Aperture Probe Antenna Characterization.....	17
C.1 DESCRIPTION OF THE ANTENNA.....	17
C.2 DERIVATION OF CHARACTERIZATION EQUATIONS	17
C.3 CHARACTERIZATION PROCEDURE	18
C.4 CHARACTERIZATION RESULTS AND VALIDATION	19
C.4.1 Far-Field Distance.....	19
C.4.2 Probe Gain.....	19
C.4.3 Validation.....	20
Annex D. Photographs.....	21

1. Standards, reference documents and applicable test methods

1. FCC 47 CFR part 2 – Subpart C – §15.255 Operation within the band 57-64 GHz.

2. General conditions, competences and guarantees

- ✓ Intel Mobile Communications Wireless RF Lab (Intel WRF Lab) is a testing laboratory accredited by the American Association for Laboratory Accreditation (A2LA).
- ✓ Intel Mobile Communications Wireless RF Lab (Intel WRF Lab) is an Accredited Test Firm listed by the FCC, with Designation Number FR0011.
- ✓ Intel WRF Lab only provides testing services and is committed to providing reliable, unbiased test results and interpretations.
- ✓ Intel WRF Lab is liable to the client for the maintenance of the confidentiality of all information related to the item under test and the results of the test.
- ✓ Intel WRF Lab has developed calibration and proficiency programs for its measurement equipment to ensure correlated and reliable results to its customers.
- ✓ This report is only referred to the item that has undergone the test.
- ✓ This report does not imply an approval of the product by the Certification Bodies or competent Authorities.
- ✓ Complete or partial reproduction of the report cannot be made without written permission of Intel WRF Lab.

3. Environmental Conditions

- ✓ At the site where the measurements were performed the following limits were not exceeded during the tests:

Temperature	22°C ± 2°C
Humidity	50% ± 5%

4. Test samples

Sample	Control #	Description	Model	Serial #	Date of reception
#01	15052702.S01	Laptop	Dell P58G	ZAU7002850	2015-05-21
	15052702.S02	AC/DC Adapter	Dell DA45NM131	CN-04H6NV-48661-46R-11M1-A01	2015-05-21

5. EUT features

These are the detailed bands and modes supported by the equipment under Test:

WiGig	60GHz (58.320 – 62.640 GHz)
802.11b/g/n	2.4GHz (2400.0 – 2483.5 MHz)
802.11a/n/ac	5.2GHz (5150.0 – 5350.0 MHz) 5.6GHz (5470.0 – 5725.0 MHz) 5.8GHz (5725.0 – 5850.0 MHz)
BDR/EDR v2.1 Bluetooth LE v4.0	2.4GHz (2400.0 – 2483.5 MHz)

6. Remarks and comments

1. This report documents the results of radiated measurements of the EIRP and the resulting power density of a radio device operating in the 60 GHz unlicensed band.
2. Dell model P58G is the regulatory model number. This identical host is also marketed under the name Dell Latitude 7350. In the report we refer only to P58G model.

7. Test Verdicts summary

N/A

8. Document Revision History

Revision #	Date	Modified by	Details
Rev. 00	2015-05-29	W. El Hajj	First Issue
Rev. 01	2015-06-29	W. El Hajj	Editorial changes Added measurements for channels 1 and 3, and Power Added Sensor pulse response measurement
Rev. 02	2015-07-22	W. El Hajj	Editorial changes. Modifications to address FCC comments: <ul style="list-style-type: none"> • Comment 1: The word “either” in the section B.1 is deleted. • Comment 2: In the section B.2, added explanation on the way how the free-space attenuation is used in the calculation. • Comment 3: Captions added below each graph in Page 16.
Rev. 03	2015-08-05	W. El Hajj	Editorial changes: A statement is added in paragraph 6 concerning the Dell model number information.
Rev. 04	2015-08-31	J.M. Fortes	Added column for conducted power in results tables in B.2.

Annex A. Test & System Description

A.1 Test Conditions

The EUT is an Intel Wireless Gigabit radio model 17265NGW, FCC ID PD917265NG, installed in a Dell P58G convertible 2 in 1 laptop.

The antenna is an integral phased array antenna with a maximum gain of 15.45 dBi.

The DUT was set to transmit at highest power on MCS1 with 50% duty cycle using proprietary software (Intel DRTU version 1.7.6-1123).

A.2 Measurement system

A Thorlabs Motorized Travel Stage controlled by software is used to maintain a consistent and accurate placement of the probe.

Absorber material covering up to 110GHz is placed around the support structures and alignment fixture to reduce reflections, scattering and perturbations.

The Aperture Probe is aligned with the boresight of the EUT antenna. The probe is scanned over X / Y / Polarization to maximize the emissions level.

The channel power is measured and recorded for all channels, then $P_t \cdot G_t$, Power density and EIRP are calculated as described below.

The measurement distance is varied from 10 to 20 cm in 1-cm steps and the power and results of subsequent calculations are recorded for each distance. The distance corresponds to the separation between the antenna plane of the EUT and the aperture plane of the probe.

A.3 Test Equipment List

ID#	Device	Type/Model	Serial Number	Manufacturer	Cal. Date	Cal. Due Date
0014	Power Sensor (DC -67 GHz)	NRP-Z57	00152266	Rohde & Schwarz	2015-05-06	2017-05-06
0015	Spectrum analyzer	FSU67	100092	Rohde & Schwarz	2013-11-12	2015-11-12
0016	Signal Generator	SMF100A	102117	Rohde & Schwarz	2014-03-11	2016-03-11
0066	Standard Horn Antenna	FH-SG-075-25	20012	RPG	Calibration Not Required	
0331	Aperture Probe antenna	15EWG1.85	J215060133	A-Info	Characterized Internally	
0063	MULTIPLIER ASSEMBLY 40-220GHz	AFM-40-220	394	RPG	Calibration Not Required	

Note: The Duty cycle is measured using the FSU67 spectrum analyzer and a standard horn antenna. The FSU67 covers (20Hz-67GHz) frequency range, therefore the measurement is performed directly without a need to an external mixer.

A.4 Measurement Uncertainty Evaluation

The Total Measurement Uncertainty is of **1.26 dB**. This value is obtained by calculating first the Aperture Probe Gain Measurement Uncertainty (see A.4.1) and then using this value with the other uncertainty sources to deduce the total Uncertainty (see A.4.2).

A.4.1 Aperture Probe Gain Characterization

3 Antennas Gain Method / Probe Characterization

Source of Uncertainty	Value [dB]	Probability Distribution	Divisor	Sensitivity Coefficient	Expanded Uncertainty [dB]
Mismatch VSWR SG Block 1.1 - TR 1.5	0.08	U-shaped	1.414	1	0.06
Mismatch VSWR TR 1.5 - PM 1.35	0.26	U-shaped	1.414	1	0.18
Insertion Loss transition	0.40	rectangular	1.732	1	0.23
Mismatch VSWR SG Block 1.1 - Antenna Block 1.1	0.02	U-shaped	1.414	1	0.01
Mismatch VSWR Antenna Block 1.1 - TR 2	0.14	U-shaped	1.414	1	0.10
Mismatch VSWR TR 2 - PM 1.35	0.44	U-shaped	1.414	1	0.31
Position of the phase centre (Receiving Ant.)	0.13	rectangular	1.732	1	0.08
Linearity (included in Repeatability)	0.000	rectangular	1.732	1	0.00
Zero Offset	0.211	rectangular	1.732	1	0.12
Repeatability (Relative Power Meas.)	0.01	rectangular	1.732	1	0.01
Meas Noise	0.043	rectangular	1.732	1	0.02
Combined Standard Uncertainty					0.47
Expanded Uncertainty (k=2)*					0.93

A.4.2 EUT Measurement.

Source of Uncertainty	Value [dB]	Probability Distribution	Divisor	Sensitivity Coefficient	Expanded Uncertainty [dB]
Meas. Antenna Gain Rx Aperture Probe	0.93	rectangular	1.732	1	0.47
Mismatch VSWR Block Antenna 2 - PM 1.35	0.44	U-shaped	1.414	1	0.31
Power Meter Accuracy	0.25	rectangular	1.732	1	0.14
Range Length (near/far field condition)	0.00	rectangular	1.732	1	0.00
Position of the phase center (Receiving Ant.)	0.13	rectangular	1.732	1	0.08
Ambient temperature impact	0.10	normal	1	1	0.10
Repeatability	0.20	normal	1	1	0.20
Zero Offset	0.144	rectangular	1.732	1	0.08
Meas Noise	0.019	rectangular	1.732	1	0.01
Combined Standard Uncertainty					0.63
Expanded Uncertainty (k=2)*					1.26

SG : Signal Generator TR : Transition PM : Power Meter

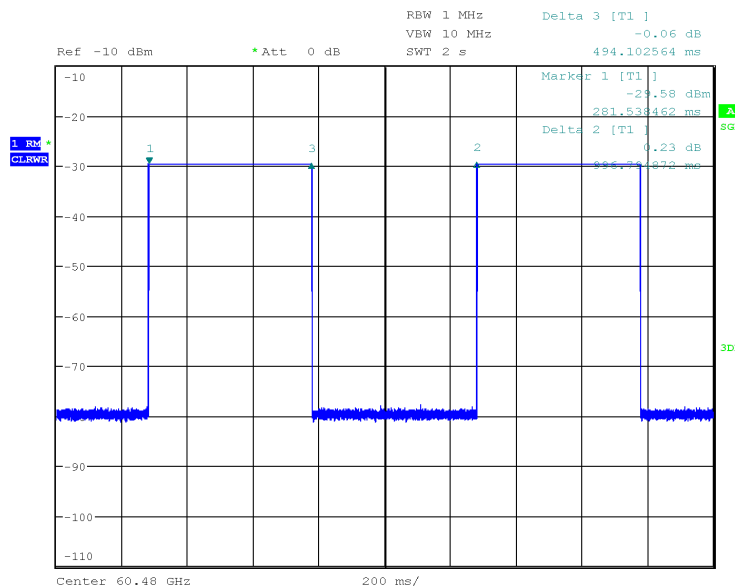
* The expanded Measurement Uncertainty with coverage factor (k=2) corresponds to a confidence level of 95%.

A.5 Power Sensor Consideration and Pulse Response

The averaging settings of the power meter / power sensor combination must be adjusted to respond properly to the modulation bursts and burst period.

The power sensor is connected to the microwave signal generator. The output frequency of the generator is set to 60.48 GHz corresponding to EUT channel 2. The generator is adjusted for pulse modulation using the nominal timing values for the Duty cycle across the Burst Period (500 msec ON, 1000 msec Period). The Duty cycle is verified by measurement (see figure below) using the FSU67 spectrum analyzer.

Description	ON Time (ms)	Period (ms)	Duty Cycle Linear	Duty Cycle Correction (dB)
Nominal Duty Cycle over Burst Period	500	1000	0.5	3
Measured Nominal Duty Cycle over Burst Period	494.102564	996.794872	0.4957	3.0479



Date: 18.JUN.2015 19:20:06

The power meter averaging number is then adjusted to provide a stable measurement (after the published settling time has elapsed).

Pulse modulation is then turned off, the delta between Modulation OFF and ON is measured, and compared to the expected measured value of $10 * \text{Log}(\text{Measured Nominal duty cycle across Burst period}) = 3.0479 \text{ dB}$.

An averaging number of 64000 provided measurements stable to within approximately 0.018 dB (3.0479-3.03dB) for the EUT's nominal pulse characteristics documented above. The power sensor showed a measured difference of 3.03 dB, between CW and modulated.

Description	Pulse Modulation OFF	Pulse Modulation ON	Measured Difference (dB)
Average Power (dBm)	-29.63	-32.66	3.03

Note: The output average level of the mm-Wave generator is adjusted to be similar to the lowest power value obtained during the EIRP measurement. This confirms the measurement averaging stability at the measured power levels.

Annex B. Test Results

B.1 Duty Cycle

Test procedure

Duty cycle is calculated as $[(ON\ Time)/Period]$.

The Duty cycle within the Burst is multiplied by the Duty cycle over the Burst Period to derive the Duty Cycle.

The duty cycle of the EUT modulation is measured, and used to provide the duty cycle correction factor.

$$Duty\ Cycle\ Correction\ Factor = 10 * \log(Duty\ Cycle)$$

Where:

Duty Cycle Correction Factor is (dB)

Duty Cycle is (Linear)

The Duty cycle is measured using the FSU67 spectrum analyzer and a standard horn antenna. The FSU67 covers (20Hz-67GHz) frequency range. Therefore the measurement is performed directly without a need to an external mixer.

Results tables

Channel 1

Description	ON Time (ms)	Period (ms)	Duty Cycle Linear
Duty Cycle Within Burst	1.991506	2.046635	0.973
Duty Cycle over Burst period	496.794872	1003.205	0.495
Duty Cycle			0.48187
Duty Cycle Correction (dB)			3.1707

Channel 2

Description	ON Time (ms)	Period (ms)	Duty Cycle Linear
Duty Cycle Within Burst	1.998397	2.067308	0.967
Duty Cycle over Burst period	496.794872	1000	0.497
Duty Cycle			0.48023
Duty Cycle Correction (dB)			3.1855

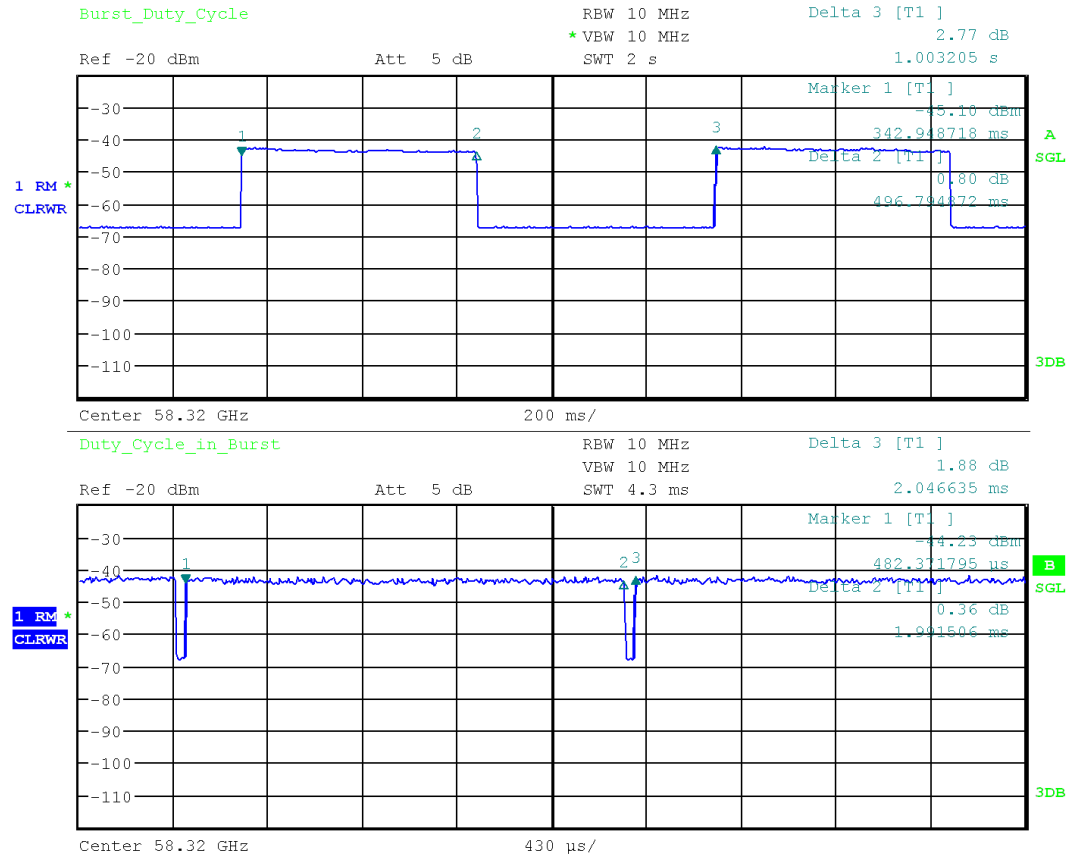
Channel 3

Description	ON Time (ms)	Period (ms)	Duty Cycle Linear
Duty Cycle Within Burst	1.984615	2.060417	0.963
Duty Cycle over Burst period	496.794872	1003.205	0.495
Duty Cycle			0.4799
Duty Cycle Correction (dB)			3.2149

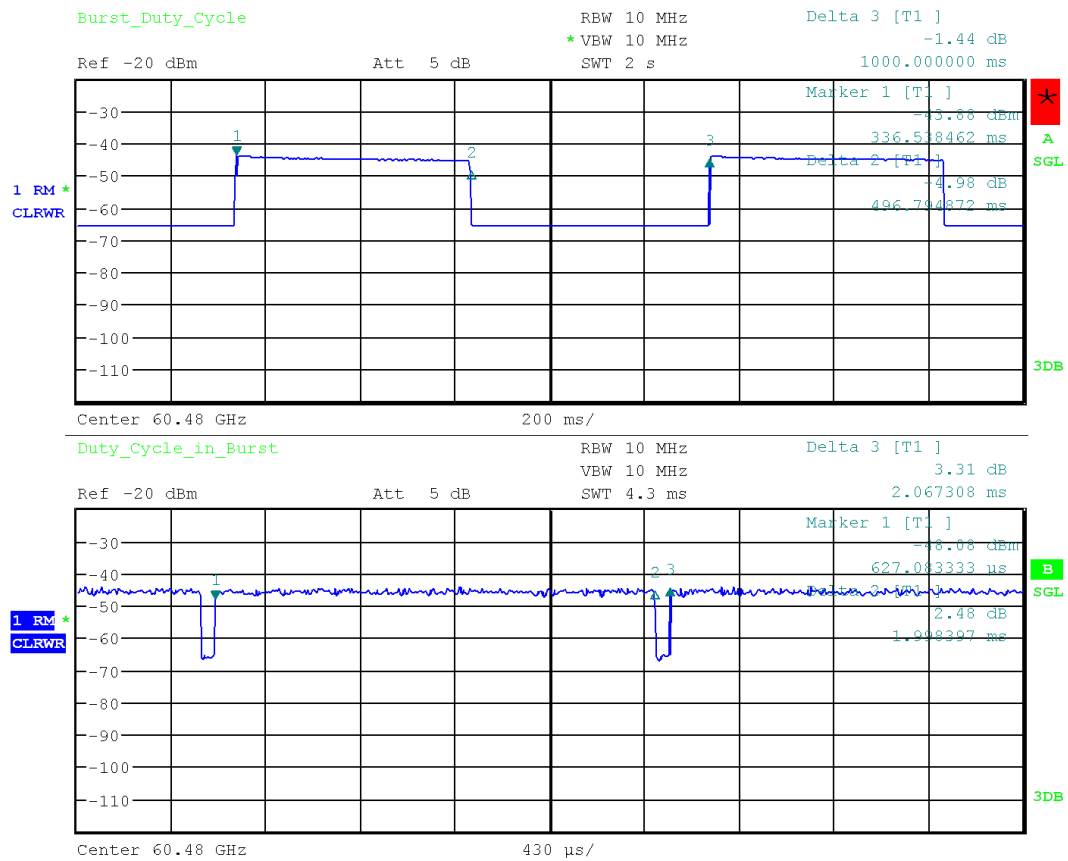
Results screenshot

Duty Cycle

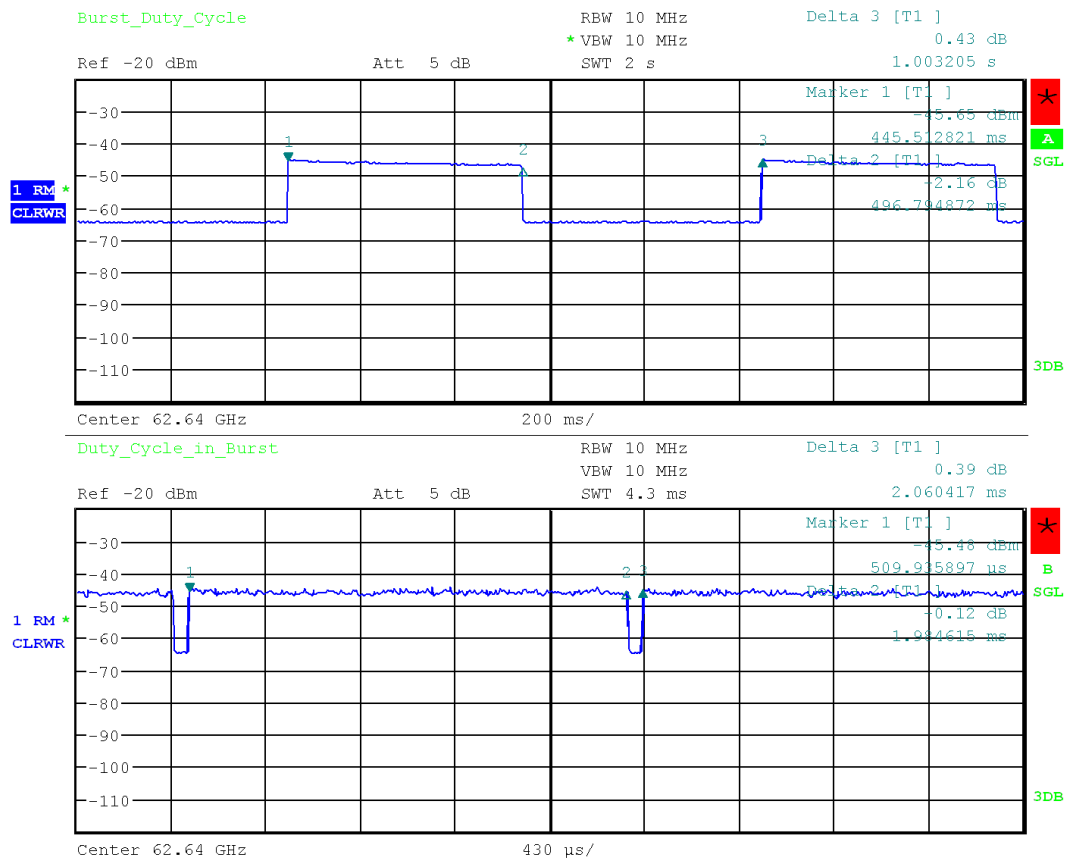
Channel 1



Date: 22.MAY.2015 17:00:23

Channel 2

Date: 22.MAY.2015 18:02:49

Channel 3

Date: 22.MAY.2015 18:18:13

B.2 EIRP & Power Density

Test procedure

The radiated emission level is measured with the aperture probe antenna connected to a power sensor.

Using the far-field Friis equation:

$$\frac{P_R}{P_T} = G_T G_R \left(\frac{\lambda}{4\pi D} \right)^2$$

the measured power P_R is converted to $P_T * G_T$ using the same equation in logarithmic domain:

$$(P_T * G_T) = P_R - G_R + \text{Free Space Attenuation (dB)}$$

Where the:

$$\text{Free space Attenuation (dB)} = 20 \text{Log} \left(\frac{4\pi D}{\lambda} \right)$$

and:

$(P_T * G_T)$ is (dBm) (P_T is the transmitted power and G_T the emission antenna Gain)

D is in (m)

P_R is in (dBm)

G_R is the small aperture probe antenna Gain in (dBi)

λ is the wavelength in (m)

$P_T * G_T$ is converted to power density using:

$$\text{Power Density} = \frac{P_T G_T}{4\pi D^2}$$

Where:

Power Density is in (mW/cm²)

$P_T * G_T$ is in (mW)

D is in (cm)

$P_T * G_T$ is also converted to EIRP during the ON time of the burst using:

$$\text{EIRP} = (P_T * G_T) + \text{Duty Cycle Correction Factor}$$

Where:

EIRP is in (dBm)

$P_T * G_T$ is in (dBm)

Duty Cycle Correction Factor is in (dB)

Results tables
Channel 1

EUT antenna gain = 15.30dBi

Freq (GHz)	Meas. Distance (cm)	Small Aperture Probe Gain G_R (dBi)	Free Space Att. (dB)	Meas Avg Power P_R (dBm)	$P_T * G_T$ (dBm)	$P_T * G_T$ (mW)	Power Density (mW/cm ²)	Duty Cycle Corr. (dB)	EIRP (dBm)	Cond Power (dBm)
58.32	10	5.37	47.76	-26.65	15.74	37.48	0.02983	3.1707	18.91	3.61
58.32	11	5.37	48.59	-27.44	15.78	37.81	0.02487	3.1707	18.95	3.65
58.32	12	5.37	49.34	-27.80	16.17	41.42	0.02289	3.1707	19.34	4.04
58.32	13	5.37	50.04	-28.37	16.30	42.63	0.02007	3.1707	19.47	4.17
58.32	14	5.37	50.68	-28.79	16.52	44.88	0.01822	3.1707	19.69	4.39
58.32	15	5.37	51.28	-29.14	16.77	47.53	0.01681	3.1707	19.94	4.64
58.32	16	5.37	51.84	-29.70	16.77	47.54	0.01478	3.1707	19.94	4.64
58.32	17	5.37	52.37	-30.13	16.87	48.61	0.01338	3.1707	20.04	4.74
58.32	18	5.37	52.86	-30.65	16.84	48.35	0.01187	3.1707	20.01	4.71
58.32	19	5.37	53.33	-31.13	16.83	48.23	0.01063	3.1707	20.00	4.70
58.32	20	5.37	53.78	-31.49	16.92	49.19	0.00979	3.1707	20.09	4.79

Channel 2

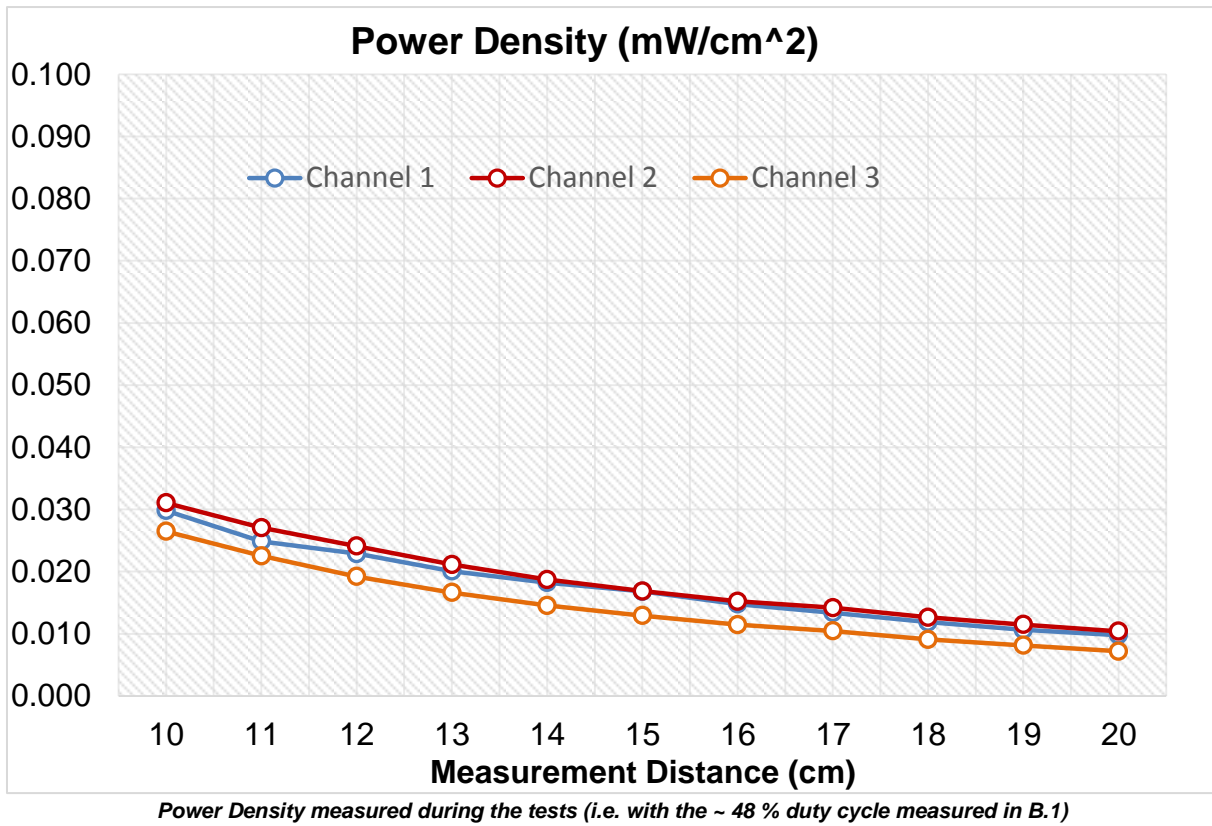
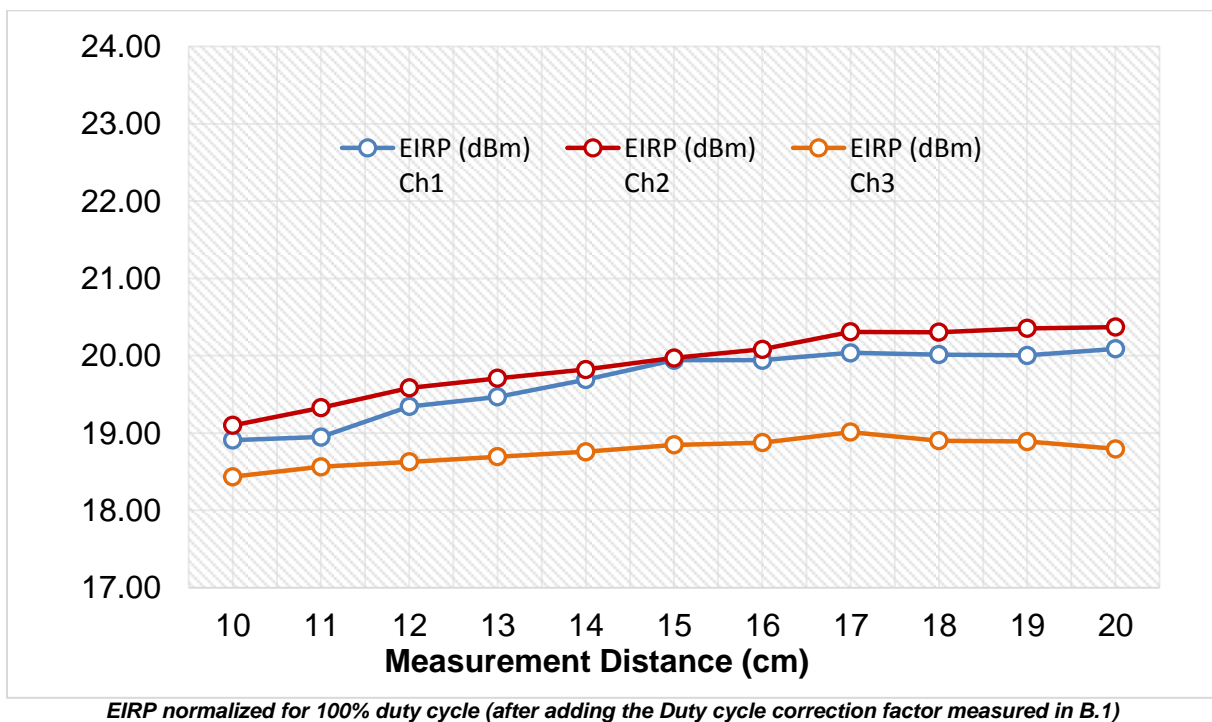
EUT antenna gain = 15.45dBi

Freq (GHz)	Meas. Distance (cm)	Small Aperture Probe Gain G_R (dBi)	Free Space Att. (dB)	Meas Avg Power P_R (dBm)	$P_T * G_T$ (dBm)	$P_T * G_T$ (mW)	Power Density (mW/cm ²)	Duty Cycle Corr. (dB)	EIRP (dBm)	Cond Power (dBm)
60.48	10	5.86	48.07	-26.30	15.91	39.03	0.03106	3.1855	19.10	3.65
60.48	11	5.86	48.90	-26.90	16.14	41.13	0.02705	3.1855	19.33	3.88
60.48	12	5.86	49.66	-27.40	16.40	43.63	0.02411	3.1855	19.58	4.13
60.48	13	5.86	50.35	-27.97	16.52	44.90	0.02114	3.1855	19.71	4.26
60.48	14	5.86	51.00	-28.50	16.64	46.10	0.01872	3.1855	19.82	4.37
60.48	15	5.86	51.60	-28.95	16.79	47.71	0.01687	3.1855	19.97	4.52
60.48	16	5.86	52.16	-29.40	16.90	48.94	0.01521	3.1855	20.08	4.63
60.48	17	5.86	52.68	-29.70	17.12	51.56	0.0142	3.1855	20.31	4.86
60.48	18	5.86	53.18	-30.20	17.12	51.52	0.01265	3.1855	20.30	4.85
60.48	19	5.86	53.65	-30.62	17.17	52.11	0.01149	3.1855	20.35	4.90
60.48	20	5.86	54.09	-31.05	17.18	52.30	0.0104	3.1855	20.37	4.92

Channel 3

EUT antenna gain = 15.00dBi

Freq (GHz)	Meas. Distance (cm)	Small Aperture Probe Gain G_R (dBi)	Free Space Att. (dB)	Meas Avg Power P_R (dBm)	$P_T * G_T$ (dBm)	$P_T * G_T$ (mW)	Power Density (mW/cm ²)	Duty Cycle Corr. (dB)	EIRP (dBm)	Cond Power (dBm)
62.64	10	7.56	48.38	-25.60	15.22	33.26	0.02646	3.2149	18.43	3.43
62.64	11	7.56	49.21	-26.30	15.35	34.25	0.02253	3.2149	18.56	3.56
62.64	12	7.56	49.96	-26.99	15.41	34.77	0.01922	3.2149	18.63	3.63
62.64	13	7.56	50.66	-27.62	15.48	35.30	0.01662	3.2149	18.69	3.69
62.64	14	7.56	51.30	-28.20	15.54	35.82	0.01454	3.2149	18.76	3.76
62.64	15	7.56	51.90	-28.71	15.63	36.56	0.01293	3.2149	18.85	3.85
62.64	16	7.56	52.46	-29.24	15.66	36.82	0.01145	3.2149	18.88	3.88
62.64	17	7.56	52.99	-29.63	15.80	38.00	0.01046	3.2149	19.01	4.01
62.64	18	7.56	53.48	-30.24	15.68	37.02	0.00909	3.2149	18.90	3.90
62.64	19	7.56	53.95	-30.72	15.67	36.93	0.00814	3.2149	18.89	3.89
62.64	20	7.56	54.40	-31.26	15.58	36.14	0.00719	3.2149	18.79	3.79

Results graph**Power Density****EIRP**

Annex C. Aperture Probe Antenna Characterization

C.1 Description of the Antenna

The measuring antenna is an open-ended waveguide as specified in IEEE Std C95.3-2002 Clause 5.5.1.1.3 Small apertures. The aperture probe antenna consists of a 19 cm straight section of WR15 rectangular waveguide with a standard UG-385/U flange at one end. The aperture dimensions are (1.88 x 3.76 mm²).

C.2 Derivation of characterization equations

Indeed, the ratio between the received power and the transmitted power between a pair of antennas is expressed in terms of their gains as follow:

$$G_T G_R = \frac{P_R}{P_T} \left(\frac{4\pi D}{\lambda} \right)^2$$

Converting from linear to logarithmic domain yields:

$$G_T + G_R = P_R - P_T + 20\text{Log}\left(\frac{4\pi D}{\lambda}\right)$$

Converting from wavelength in meters to frequency in GHz yields:

$$G_T + G_R = P_R - P_T + 20\text{Log}(D) + 20\text{Log}(f) + 32.44 \quad (1)$$

Where:

G_T is the gain of the transmit antenna (dBi)

G_R is the gain of the receive antenna (dBi)

P_R is the power received (dBm)

P_T is the power transmitted (dBm)

D is the distance between the antennas (m)

f is the frequency (GHz)

The individual far-field gain of each of three different antennas can be determined from three path loss measurements made under identical far-field conditions using the three different antennas taken in pairs. Three path loss measurements ($P_{R12} - P_T$), ($P_{R13} - P_T$) and ($P_{R23} - P_T$) are sufficient to simultaneously solve for three unknowns G_1 , G_2 and G_3 .

The Equation (1) is applied to each of the three path loss measurement as follows applied

$$A = G_1 + G_2 = P_{R12} - P_T + 20\text{Log}(D) + 20\text{Log}(f) + 32.44 \quad (2)$$

$$B = G_1 + G_3 = P_{R13} - P_T + 20\text{Log}(D) + 20\text{Log}(f) + 32.44 \quad (3)$$

$$C = G_2 + G_3 = P_{R23} - P_T + 20\text{Log}(D) + 20\text{Log}(f) + 32.44 \quad (4)$$

Where:

$A = (G_1 + G_2)$ is the sum of the gains of Antennas 1 and 2

$B = (G_1 + G_3)$ is the sum of the gains of Antennas 1 and 3

$C = (G_2 + G_3)$ is the sum of the gains of Antennas 2 and 3

P_{R12} is the power received when measuring Antennas 1 and 2 (dBm)

P_{R13} is the power received when measuring Antennas 1 and 3 (dBm)

P_{R23} is the power received when measuring Antennas 2 and 3 (dBm)

P_T is the transmitted power (dBm)

D is the distance between the antennas (m)

f is the frequency (GHz)

The gain of each individual antenna is calculated as follows:

$$G_1 = 0.5 (A + B - C) \quad (5)$$

$$G_2 = 0.5 (A + C - B) \quad (6)$$

$$G_3 = 0.5 (B + C - A) \quad (7)$$

Where:

G_1 is the gain of Antenna 1 (dBi)

G_2 is the gain of Antenna 2 (dBi)

G_3 is the gain of Antenna 3 (dBi)

A is the result of applying Equation (2)

B is the result of applying Equation (3)

C is the result of applying Equation (4)

C.3 Characterization Procedure

1. Allow the signal source, power sensor and power meter to warm up as specified by the manufacturer of the instruments.
2. Adjust the instruments to the applicable frequency. Connect the power sensor to the output of the source. Measure and record Power Transmitted.
3. Connect the first pair of antennas to their respective source (Tx antenna) and power sensor (Rx antenna). Place the antennas at the selected far-field separation distance in a bore-sight configuration using a laser level to align the antennas. Measure and record Power Received.
4. Repeat step 3 for each pair of antennas.
5. Calculate the antenna gains by applying Equations (2) through (7).

C.4 Characterization Results and Validation

C.4.1 Far-Field Distance

The gain reduction (relative to the far-field gain G^∞) of an antenna is estimated as a function of normalized distance.

The normalized distance is given in terms of $n = d\lambda/a^2$ where d is distance, λ is wavelength and a is the largest aperture dimension. The far-field gain holds for distances greater than about $(8a^2)/\lambda$ ($n > 8$).

Note that for the verification we use three aperture antennas, the far field distance is therefore calculated using the largest aperture dimension among the three antennas (in our case it is the antenna 1) and $a = 5mm$.

The minimum far field distance is calculated for each channel as follow:

Frequency (GHz)	Wavelength λ (m)	Largest aperture dimension a (m)	Ratio (a^2/λ)	Minimum distance d (cm)
58.32	0.005144033	0.005	0.00486	3.888
60.48	0.004960317	0.005	0.00504	4.032
62.64	0.004789272	0.005	0.00522	4.176

We decide therefore to do the characterization at **15 cm**.

C.4.2 Probe Gain

The probe under verification is noted **Antenna 3** with Gain G_3 . The antennas 1 and 2 are used to perform the characterization. The verification procedure (see § 12.3) is applied as follow:

1st Path Loss measurement → In Tx : Antenna 1 / In Rx : Antenna 2

Channel	PT (dBm)	PR12 (dBm)	D (m)	f (GHz)	G1+G2 (dBi)
1	5.01	-30.53	0.15	58.32	15.74
2	7.34	-29.41	0.15	60.48	14.84
3	7.04	-28.28	0.15	62.64	16.58

2nd Path Loss measurement → In Tx : Antenna 2 / In Rx : Antenna 3

Channel	PT (dBm)	PR23 (dBm)	D (m)	f (GHz)	G2+G3 (dBi)
1	5.01	-35.3	0.15	58.32	10.97
2	7.34	-32.93	0.15	60.48	11.32
3	7.04	-30.66	0.15	62.64	14.199

3rd Path Loss measurement → In Tx : Antenna 1 / In Rx : Antenna 3

Channel	PT (dBm)	PR13 (dBm)	D (m)	f (GHz)	G1+G3 (dBi)
1	5.01	-30.76	0.15	58.32	15.51
2	7.34	-29.01	0.15	60.48	15.24
3	7.04	-27.35	0.15	62.64	17.51

The measured gains are deduced and showed as follows:

Antenna	Channel 1 Gain (dBi)	Channel 2 Gain (dBi)	Channel 3 Gain (dBi)
Aperture Antenna 1	10.14	9.38	9.94
Aperture Antenna 2	5.60	5.46	6.63
<i>Open Ended Waveguide Probe Antenna</i>	5.37	5.86	7.56

C.4.3 Validation

The measured gain of the original probe antenna is compared to the realized gain from a theoretical model of common open-ended waveguide apertures with a two-to-one aspect ratio, i.e., a /b = 2, provided by IEEE Std C95.3 Clause 5.5.1.1.3 equation (4)

Channel	Frequency (GHz)	Dimension a (m)	Theoretical Gain (dBi) $10 \log(21.6 \cdot f[GHz] \cdot a)$	Measured Gain (dBi)	Delta to Theoretical Gain (dB)
1	58.32	0.00376	6.75	5.37	1.38
2	60.48	0.00376	6.91	5.86	1.05
3	62.64	0.00376	7.06	7.56	0.50

Annex D. Photographs

Test Setup

