TEST REPORT Total Radiated Power (TRP) Test Measured in Antenna Full-anechoic Room (A-FAR)	
Report Reference No. ..... : Date of issue:..... : Total number pages: ..... :	EMC-24-TRP-6876-102 20 May 2025 16
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Testing location:	
Tested by..... : Reviewed by..... :	J. van der Merwe jaco.van.der.merwe@signify.com +31 (0)611882384
Testing location/ address ..... :	Signify Netherlands B.V., EMC & wireless connectivity lab High Tech Campus 26, 5656 AE Eindhoven, The Netherlands
Date of receipt of test item ..... : Date(s) of performance of tests... :	13-Aug-2024 14-Aug-2024
General remarks: A cross ☒ in a rectangular shape means that this option is applied.	

Table of Contents:

Description of DUT

Model / Type reference ..... :	Final horticulture luminaire TLF20 4160 3.6 RWLB 277-400V WC2 QB SP luminaire, 12NC929003965044 tested for total radiated power (TRP).
Supplementary information ..... :	---

Summary of test configuration

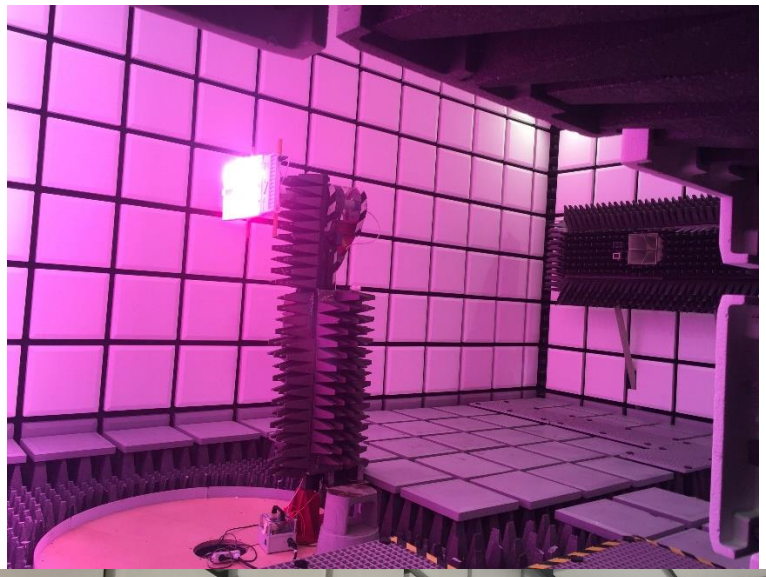
Test configuration

Testing is performed in a fully-anechoic (antenna) room. TRP is calculated based on 3D radiation pattern measurement on a grid with 15º increments in both azimuth and elevation angles. Measured EIRP data are processed towards TRP in line with the procedure outlines in [1].

DUT specific configurations

Test distance ..... :	☐	3 m
	☒	4.56 m
	☐	Other:
Supplementary information ..... :	The test distance should be larger than 2.5×maximum luminaire dimension as described.	
Transmitted power ..... :	0, 4, and 10 dBm	
Communication type ..... :	☐	GPRS 2G
	☐	Other:
Communication channels ..... :	☒	Zigbee Channels 11, 18 and 26 and BLE channels 27, 38, and 39
	☐	Wi-Fi
	☐	Other:
Operating modes ..... :	No.	Operating mode of test item
	1	Zigbee channels 11, 18, and 26 at 0dBm transmit power
	2	Zigbee channels 11, 18, and 26 at 4dBm transmit power
	3	Zigbee channels 11, 18, and 26 at 10dBm transmit power
	4	BLE channels 37, 38, and 39 at 0dBm transmit power

DUT specific configurations pictures

Measurements with modules mounted in luminaire



TRP from A-FAR measurement system

Measurement # / Configuration	P_{TX}	CH	MHz	TRP	$EIRP_{4dirs,min}$	$EIRP_{alldirs,min}$	$EIRP_{hem,min}$	$Gain_{effective}$
1a-c Zigbee channels 11, 18, and 26 at 0dBm transmit power	0 dBm	11	2405	-3.2 dBm	-10.1 dBm	-13.2 dBm	-10.8 dBm	+5.3 dBi
		18	2440	-3.6 dBm	-10.8 dBm	-12.0 dBm	-10.8 dBm	+4.9 dBi
		26	2480	-4.0 dBm	-9.2 dBm	-12.3 dBm	-12.2 dBm	+4.1 dBi
2a-c Zigbee channels 11, 18, and 26 at 4dBm transmit power	4 dBm	11	2405	+0.0 dBm	-7.2 dBm	-9.2 dBm	-7.4 dBm	+4.0 dBi
		18	2440	-0.2 dBm	-7.4 dBm	-8.6 dBm	-7.5 dBm	+4.0 dBi
		26	2480	+0.1 dBm	-4.8 dBm	-8.6 dBm	-8.1 dBm	+4.0 dBi
3a-c Zigbee channels 11, 18, and 26 at 10dBm transmit power	10 dBm	11	2405	+2.6 dBm	-3.6 dBm	-5.9 dBm	-3.9 dBm	+0.0 dBi
		18	2440	+2.8 dBm	-4.1 dBm	-5.3 dBm	-4.3 dBm	+0.5 dBi
		26	2480	+3.8 dBm	-0.9 dBm	-4.6 dBm	-4.1 dBm	+1.3 dBi
4a-c BLE channels 37, 38, and 39 at 0dBm transmit power	0 dBm	37	2402	-2.3 dBm	-9.0 dBm	-10.9 dBm	-9.5 dBm	+6.2 dBi
		38	2426	-3.5 dBm	-9.8 dBm	-12.2 dBm	-12.1 dBm	+5.2 dBi
		39	2480	-4.7 dBm	-9.7 dBm	-13.3 dBm	-12.8 dBm	+3.5 dBi

The definitions for the listed minimum EIRP values is given in the next section.

Calculated Ranges

In the table in the previous section we listed a number of minimum EIRP values needed for range calculations. The minimum EIRP will result in the maximum range that can be guaranteed. The specific EIRP used is determined by the use scenario, or more specifically, the relative positions of the two radios that will occur in typical installations. The most general expression for range calculation is

$$R = \left(\frac{c}{4\pi f}\right) \cdot \sqrt{\frac{EIRP_{radio1}(\Omega_{radio1-radio2})}{P_{TX,radio1,m}} \cdot \frac{EIRP_{radio2}(\Omega_{radio2-radio1})}{P_{TX,radio2,m}} \cdot \frac{P_{TX,radio1/radio2}}{S_{radio2/radio1}}}$$

where the m in $P_{TX,radio1,m}$ refers to the value of the transmit power level of the radio (1 in this case) during the EIRP measurement.

Three scenarios are of interest to use:

1. Luminaire-to-luminaire communication where the two radios hangs at the same height parallel to ground. In this case the EIRP (pattern) values in the plane parallel to the ground is of interest for Ω in the above expression. Patterns measured in an anechoic chamber can have very deep dips (minimum values) that does not occur outside the chamber as they are negated by close-range reflections in typical installations. For this reason it is typical to average patterns over a small angle – we chose a typical value of 30º. A figure showing this averaging effect is included in the "Antenna pattern results" section below. This averaged value in the horizontal plane is listed as $EIRP^{**}_{alldirs,min}$ in the table in the previous section. Another simplification can be to only consider the four directions normal to the luminaire in the horizontal plane as these will be the directions to the nearest luminaires in a grid. These values are listed as $EIRP_{4dirs,min}$.
2. Another scenario of interest concerns the communication between an overhead luminaire and a gateway mounted below against a wall. In these the luminaire radiation in directions covered by the bottom hemisphere of the luminaire and the top hemisphere of the gateway is of interest. The bottom hemisphere minimum EIRP values of the luminaire is listed above as $EIRP_{hem,min}$.
3. The final scenario of interest concerns the BLE commissioning of the luminaires and therefore again concerns the bottom hemisphere pattern of the luminaire, i.e. $EIRP_{hem,min}$.

Luminaire-to-luminaire range

Transmit power level	4 Directions minimum range		All directions minimum range	
0 dBm	CH 11	173 m	CH 11	85 m
	CH 18	145 m	CH 18	110 m
	CH 26	206 m	CH 26	101 m
4 dBm	CH 11	212 m	CH 11	134 m
	CH 18	364 m	CH 18	152 m
	CH 26	472 m	CH 26	149 m

10 dBm	CH 11	244 m	CH 11	143 m
	CH 18	214 m	CH 18	162 m
	CH 26	440 m	CH 26	188 m

Luminaire-to-gateway range

From the measurement report for the gateway we get the minimum EIRP values over the top hemisphere listed in the table below.

Minimum EIRP in top hemisphere		
CH11	CH18	CH25
-2 dBm	-6.5 dBm	-5 dBm

From these we can calculate the minimum luminaire-to-gateway ranges for the three channels listed in the table below.

Top hemisphere of gateway and bottom hemisphere of luminaire

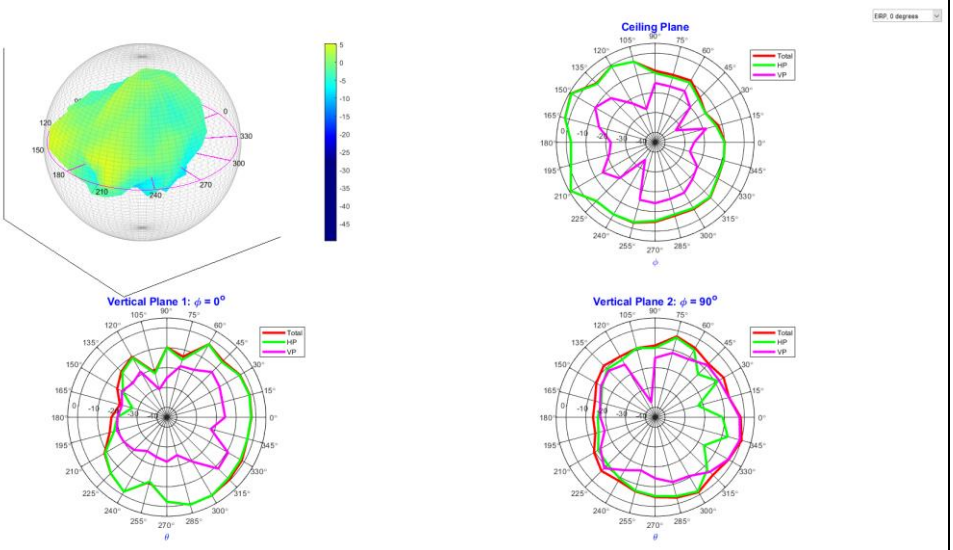
Transmit power level	**0 dBm**	**4 dBm**	**10 dBm**
Ch11	161 m	238 m	356 m
Ch18	95 m	138 m	200 m
Ch 26	94 m	151 m	239 m

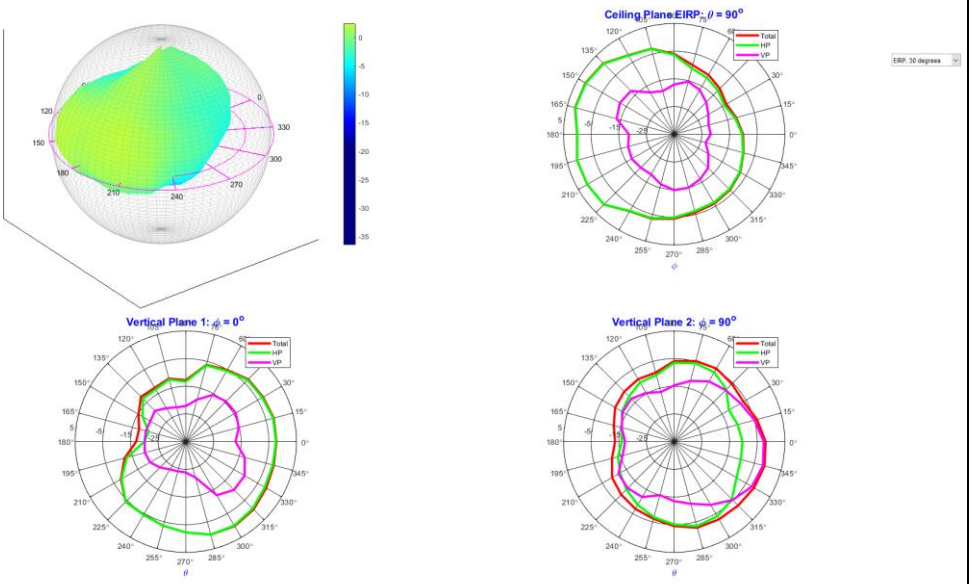
BLE-to-mobile phone range

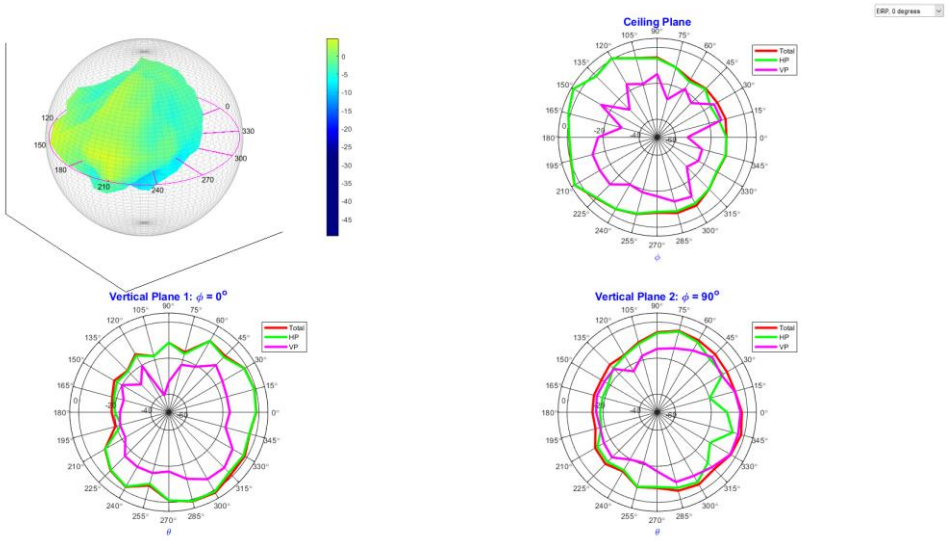
Range is calculated for the mobile phone as transmitter and the luminaire as receiver. It is assumed that the mobile phone transmits 0 dBm. The luminaire receiver has a sensitivity of -96 dBm.

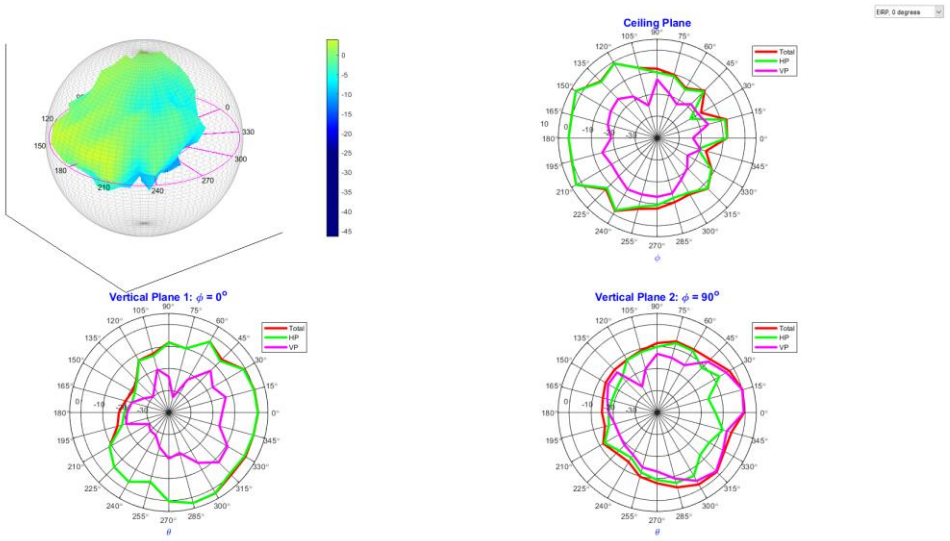
BLE transmit power level	**0 dBm**
Ch 37	210 m
Ch 38	153 m
Ch 39	139 m

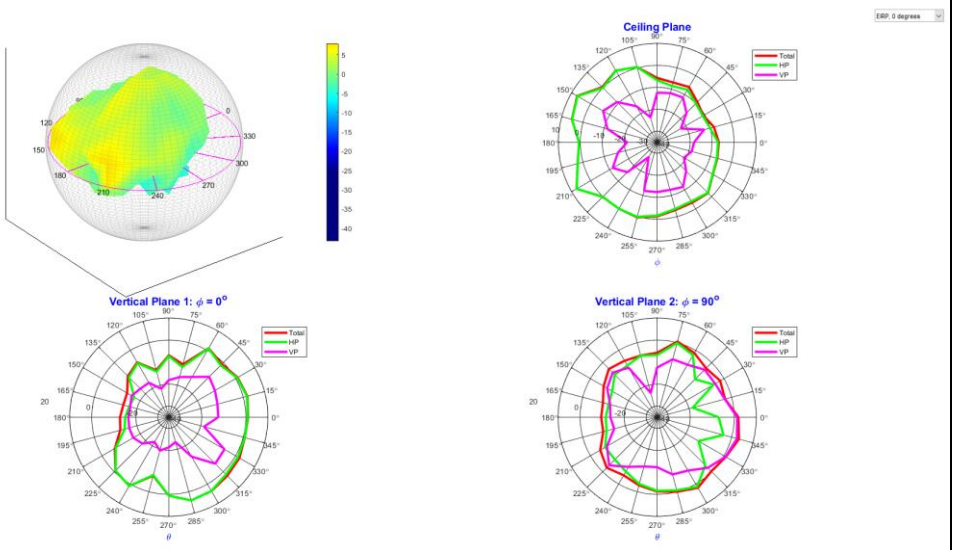
Antenna pattern results

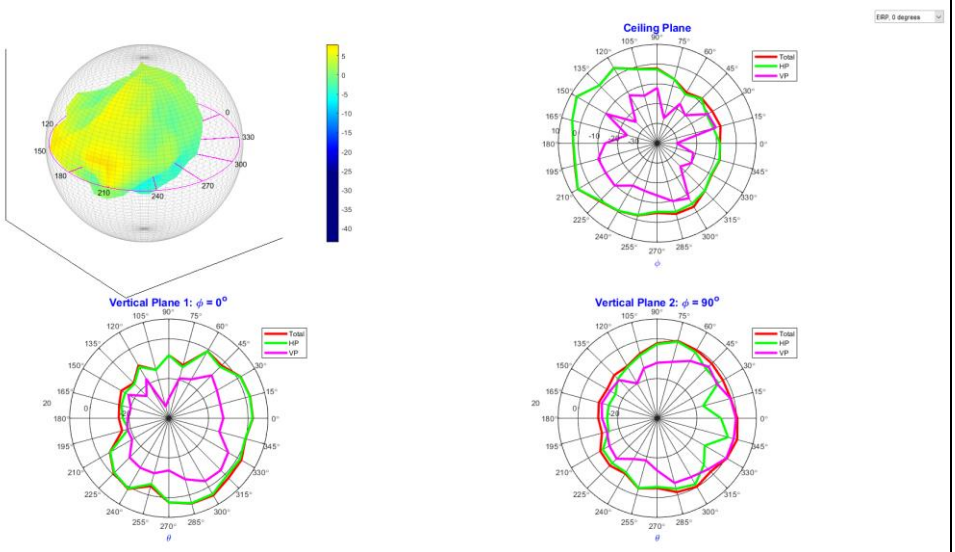
EIRP Measurement 1a:	Zigbee with 0dBm transmit power
Channel 11, P_{TX} = 0 dBm	

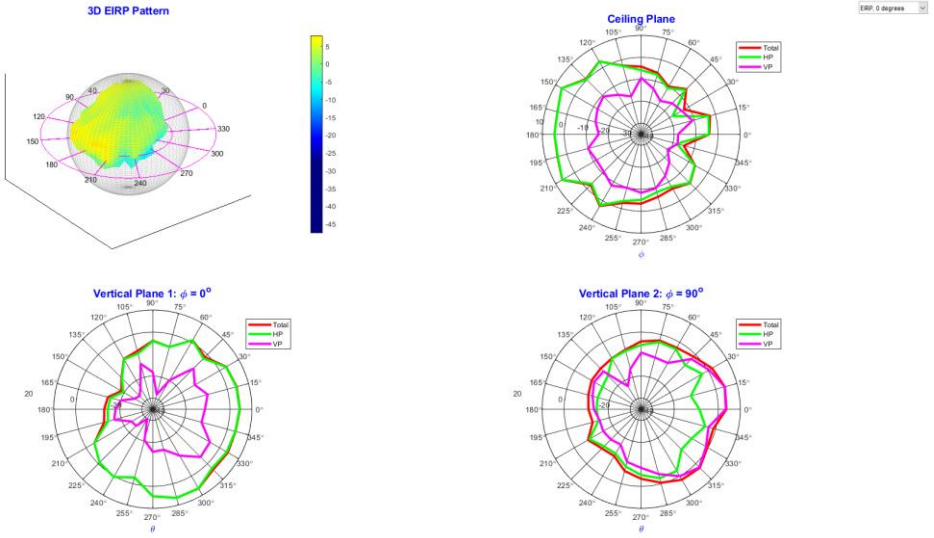
EIRP Measurement 1a:	Zigbee with 0dBm transmit power – now with all patterns averaged over 30º
Channel 11, P_{TX} = 0 dBm	

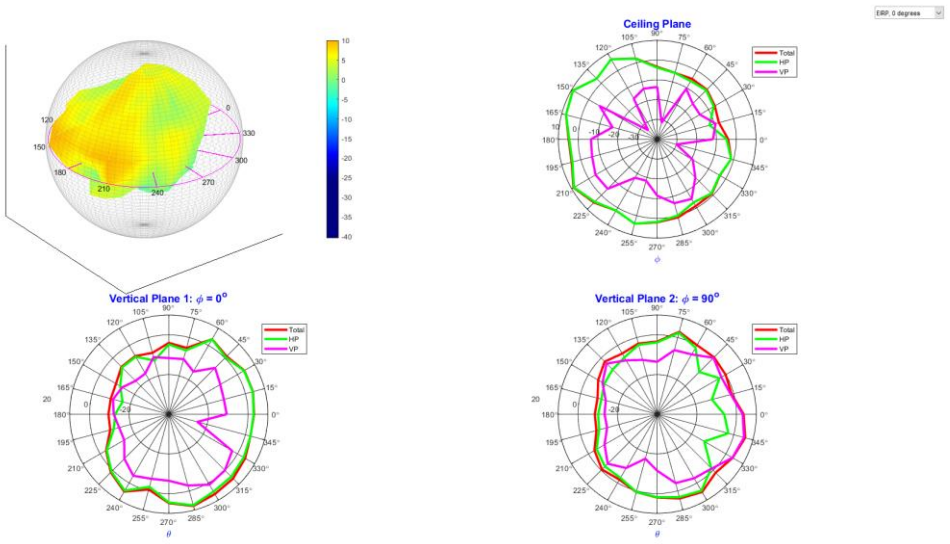
EIRP Measurement 1b:	Zigbee with 0dBm transmit power
Channel 18, P_{TX} = 0 dBm	

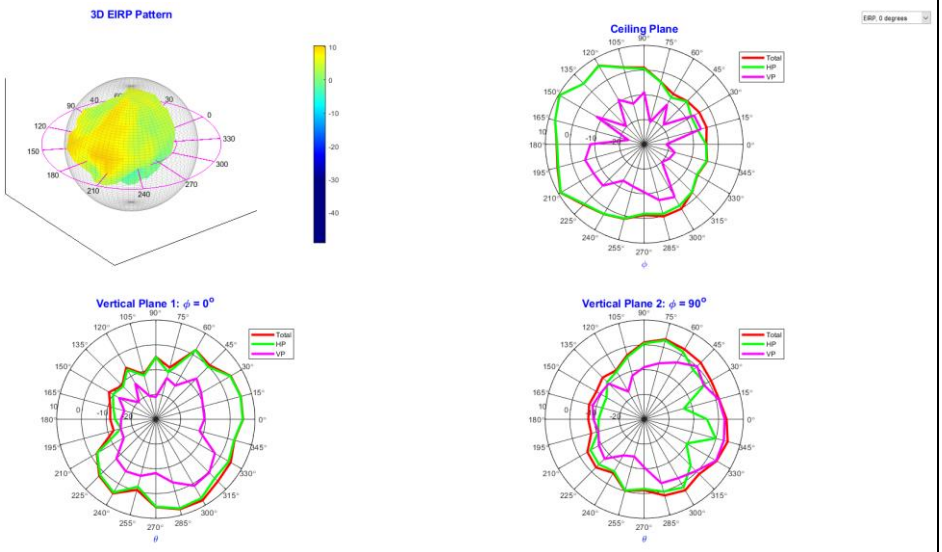
EIRP Measurement 1c:	Zigbee with 0dBm transmit power
Channel 26, P_{TX} = 0 dBm	

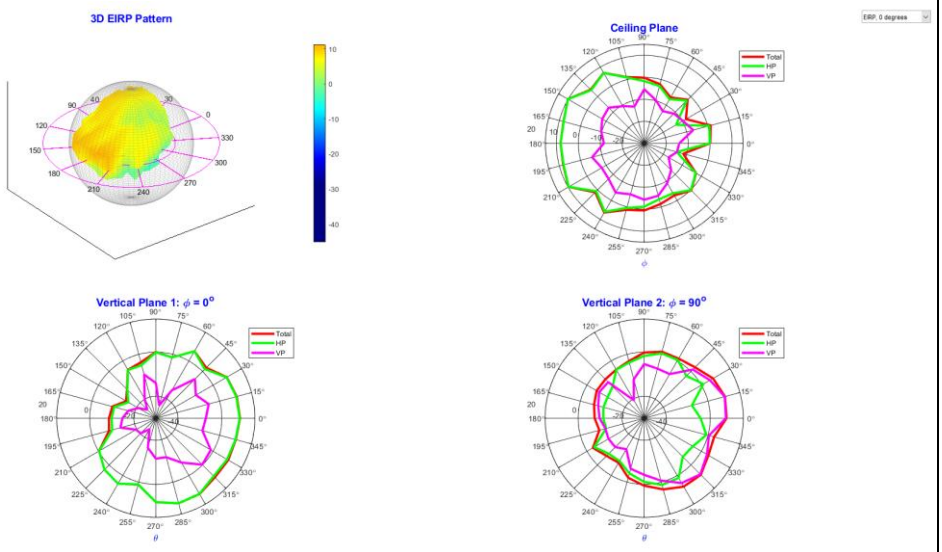
EIRP Measurement 2a:	Zigbee with 4dBm transmit power
Channel 11, P_{TX} = 4 dBm	

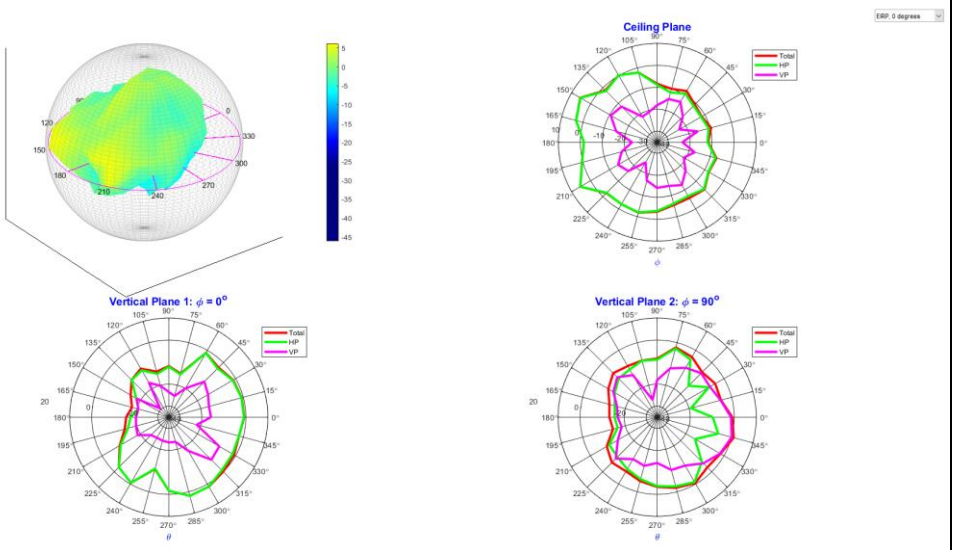
EIRP Measurement 2b:	Zigbee with 4dBm transmit power
Channel 18, P_{TX} = 4 dBm	

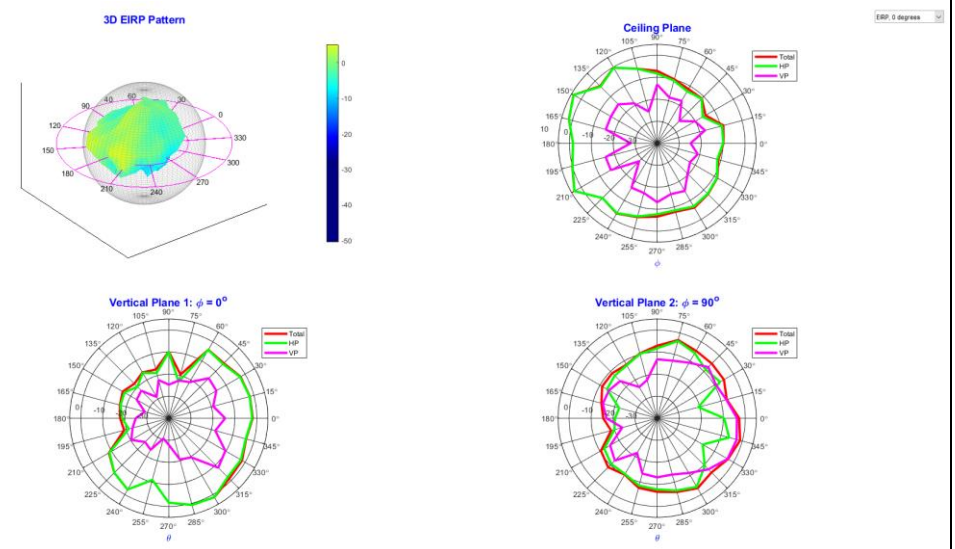
EIRP Measurement 2c:	Zigbee with 4dBm transmit power
Channel 26, P_{TX} = 4 dBm	

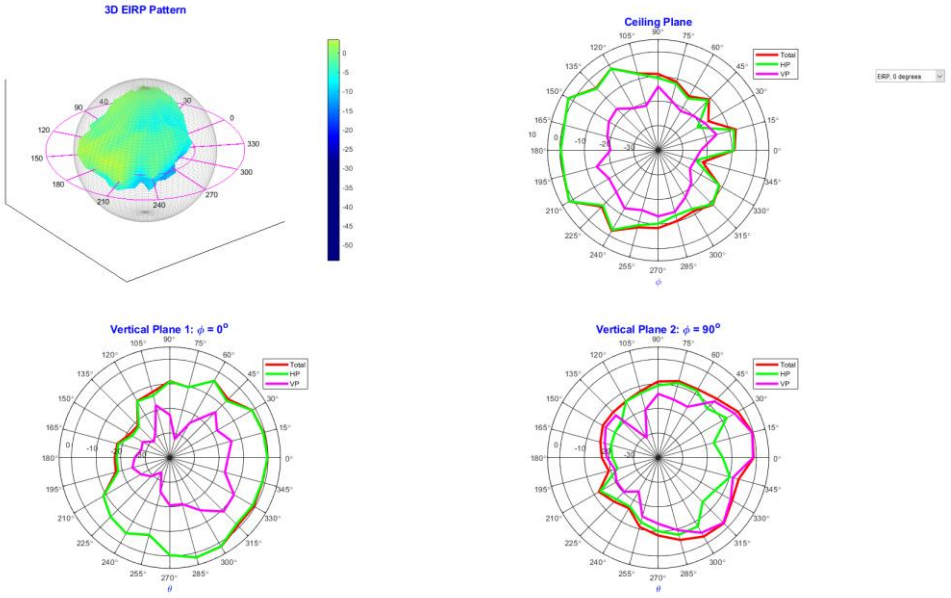
EIRP Measurement 3a:	Zigbee with 10dBm transmit power
Channel 11, P_{TX} = 10 dBm	

EIRP Measurement 3b:	Zigbee with 10dBm transmit power
Channel 18, P_{TX} = 10 dBm	

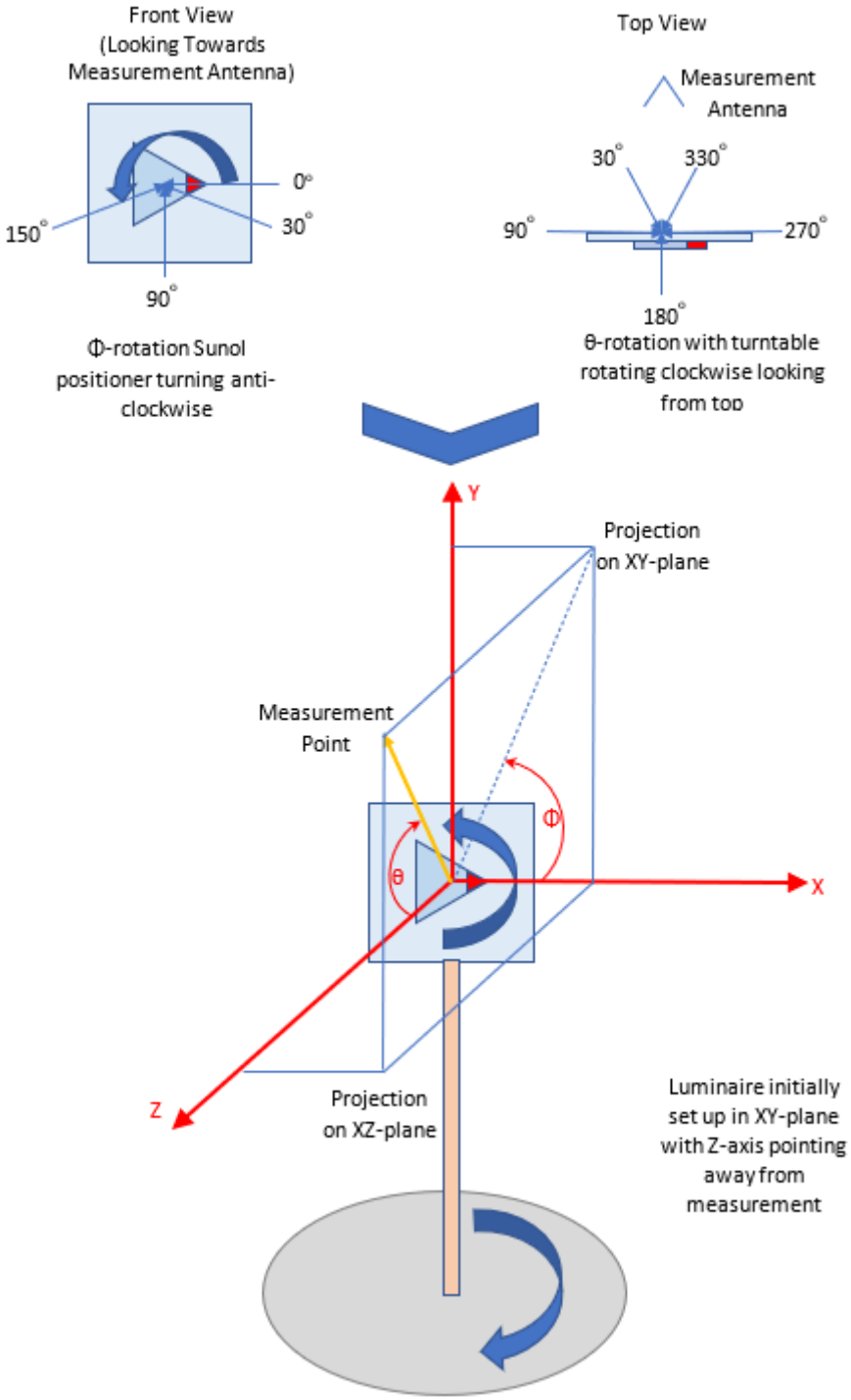
EIRP Measurement 3c:	Zigbee with 10dBm transmit power
Channel 26, P_{TX} = 10 dBm	

EIRP Measurement 4a:	BLE with 0dBm transmit power
Channel 37, P_{TX} = 0 dBm	

EIRP Measurement 4b:	BLE with 0dBm transmit power
Channel 38, P_{TX} = 0 dBm	

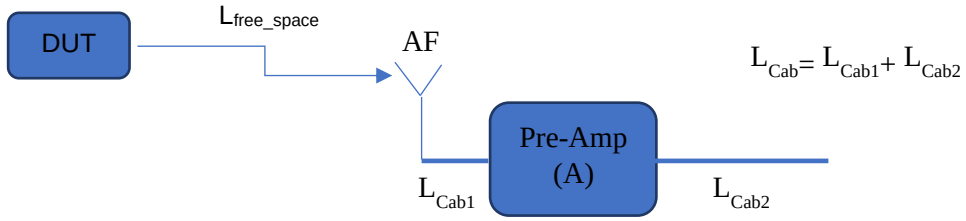
EIRP Measurement 4c:	BLE with 0dBm transmit power
Channel 39, P_{TX} = 0 dBm	

Reference System



Appendix 1: TRP Measurement Procedure

First measure the effective isotropic radiated power (EIRP):



$$EIRP_{dBm} = P_{meas,dBm} + L_{free-space,dB} - G_{dB} - (A_{dB} - L_{Cab,dB})$$

with

- $P_{meas,dBm}$ are the measurement power values.
- G_{dB} is the antenna gain obtained for the appropriate polarization using.
- $A_{dB} - L_{Cab,dB}$ is the fixed loss/gain factor of all cables, preamplifier, and switches connected between the antenna connector and the connector of the spectrum analyser.
- $L_{free-space,dB}$ is the free-space path loss at the measurement distance d_{meas}

$$L_{free-space,dB} = 20 \cdot log10\left(\frac{4\pi d_{meas}}{\lambda}\right)$$

The TRP is then calculated from the EIRP measured for the two polarizations as follows:

$$TRP = \frac{1}{4\pi}\int_{\theta=0}^{\pi}\int_{\phi=0}^{2\pi}(EiRP_{\theta}(\theta,\phi) + EiRP_{\phi}(\theta,\phi))sin(\theta)d\phi d\theta \cong \frac{\pi}{2NM}\sum_{i=1}^{N-1}\sum_{j=0}^{M-1}(EiRP_{\theta}(\theta_i,\phi_j) + EiRP_{\phi}(\theta_i,\phi_j))sin(\theta_i)$$

or

$$TRP \cong \frac{\pi}{2NM}\sum_{i=1}^{N-1}\sum_{j=0}^{M-1}\left[EiRP_{\theta}(\theta_i,\phi_j) + EiRP_{\phi}(\theta_i,\phi_j)\right]\sin(\theta_i)$$

References

[1]	Test Plan for Wireless Device Over-the-Air Performance: Method of Measurement for Radiated RF Power and Receiver Performance. Revision 3.3.2, September 2014, http://www.ctia.org/certification.