

Wi-Fi/Bluetooth SF Antenna

2.4GHz in-bandwidth Performance Measurement Results

Toyota Trailer Camera ECU
Model: TA-220-TUND-MX
FCC ID: 2BS75-TA220MX
IC ID: 216B-TA220MX

No. EGR-9967-00
29 June 2022
Yokowo Co., Ltd.

Approved	Confirmed	Issued
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1. Purpose:

To review the Measurement Results of the 2.4GHz In-Bandwidth Performance of the Wi-Fi/Bluetooth Antenna

2. Conclusion:

The 2.4GHz Peak Gain and In-Band Performance has a Peak Gain of less than 5[dBi] and an Average Gain of less than 4[dBi].

3. Specifications:

3-1. Wi-Fi-1/Bluetooth:

Wi-Fi/Bluetooth		
使用周波数帯 Frequency range	Wi-Fi	2400MHz~2485MHz
偏波 Polarization	Bluetooth	
アンテナ利得 Antenna Gain	垂直偏波 Vertical polarization	
Elevation θ : 88°, ϕ :135~225°	Peak Gain	Min. 2 dBi
(※2)	Average Gain	Min. 1 dBi
VSWR	Max. 2.0	
出力インピーダンス Output impedance (※3)	50±10 Ω	
アイソレーション Isolation	Wi-Fi to Bluetooth (※2)	Min. 10 dB
※1: ϕ 1000mm 地板上にて Measuring the ϕ 1000mm ground plate. ※2: 2.5DS-QFB/1.5DS-QFB 150mm 相当 Use 150mm cable. ※3 上限は、アンテナのVSWRによる。 ※3 The upper limit is defined by the VSWR of the antenna		

3-2. Wi-Fi-2:

WiFi		
使用周波数帯 Frequency range	2400MHz~2485MHz	
偏波 Polarization	垂直偏波 Vertical polarization	
アンテナ利得 Antenna Gain Elevation θ : 88°, ϕ :135~225° (※2)	Peak Gain	Min. 2 dBi
	Average Gain	Min. 1 dBi
VSWR	Max. 2.0	
出力インピーダンス Output impedance (※3)	50±10 Ω	
※1: ϕ 1000mm 地板上にて Measuring the ϕ 1000mm ground plate.		
※2: 2.5DS-QFB/1.5DS-QFB 150mm 相当 Use 150mm cable.		
※3 上限は、アンテナのVSWRによる。		
※3 The upper limit is defined by the VSWR of the antenna		

4. Measurement Conditions:

Measurement Date : 23 June 2022
Measurement Location : Yokowo Co., Ltd. Site #5
Tester : Yuta Nakatani
Measurement Devices :

	Calibration Date	Calibration Due Date
Network Analyzer (N5221B Keysight)	2022/2/4	2023/2/3
AMP (83006A Keysight)	Calibration is not necessary (*1)	
Coupler (86205A Keysight)	Calibration is not necessary (*1)	
PIN Semiconductor Switch (P9402A Keysight)	Calibration is not necessary (*1)	
Transmitting Antenna	BBHX 9120E (Made by SCHWARZBECK)	Calibration is not necessary (*1)
Reference Antenna	BBHA 9120D (Made by SCHWARZBECK)	2022/2/14 2023/2/13

*1; Corrections are done in Network.

Software : Antenna Radiation Pattern Measurement System (Microwave Factory Co., Ltd.)

5. Measurement System:

The Measurement was done at Site #5 at Yokowo Co., Ltd.

The Antenna to be measure was placed on a $\phi 1000\text{mm}$ Circular Ground Plane and then placed in the Center of a Turn Table

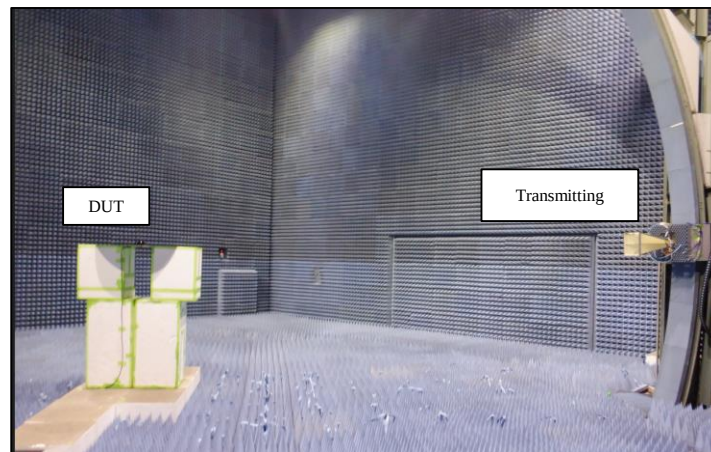
With the Transmitting Antenna at a Horizontal Plane at the Ground Plane Height (90°) and aligned with the 88° location

The Transmitting Antenna transmitting in a Vertical Polarization and the Gain Data was measured at $\theta = 88^\circ$, and the $\Phi = 360\text{deg}$

The Measurement Frequencies being 2400MHz, 2440MHz, 2485MHz (In-Band) and 4823MHz (Second Harmonic) using a

BBHA 9120 D (Made by SCHWARZBECK) as the Reference Antenna

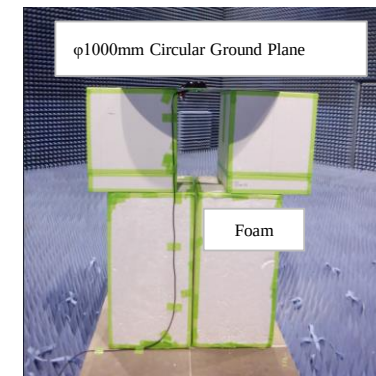
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Measurement System



DUT Location



Ground Plane Location

6. Measurement Results:

		SPEC	Media	Measurement Data (In Band)			Measurement Data(2nd Harmonic)	
				2400 MHz	2440 MHz	2485 MHz		4823 MHz
Vertical Antenna Gain ^{*1*2}	Peak Gain of $\phi 135^{\circ}$ to 225°	Min. 2 [dBi]	Wi-Fi-1	3.87 [dBi]	4.20 [dBi]	4.04 [dBi]	Peak Gain of $\phi 0^{\circ}$ to 360° ^{*1*2}	-2.96 [dBi]
			Wi-Fi-2	4.60 [dBi]	4.61 [dBi]	4.36 [dBi]		-2.03 [dBi]
			Bluetooth	3.57 [dBi]	3.86 [dBi]	3.76 [dBi]		-1.15 [dBi]
	Average Gain of $\phi 135^{\circ}$ to 225°	Min. 1 [dBi]	Wi-Fi-1	2.73 [dBi]	2.97 [dBi]	2.64 [dBi]	Average Gain of $\phi 0^{\circ}$ to 360° ^{*1*2}	-6.93 [dBi]
			Wi-Fi-2	3.59 [dBi]	3.74 [dBi]	3.58 [dBi]		-8.64 [dBi]
			Bluetooth	2.42 [dBi]	2.68 [dBi]	2.51 [dBi]		-5.33 [dBi]

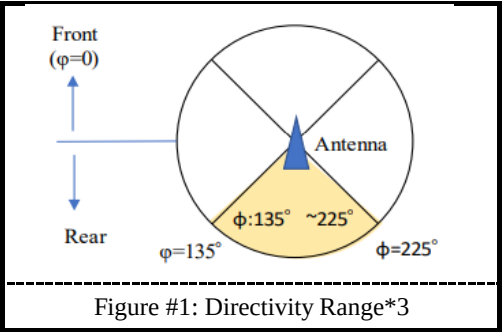


Figure #1: Directivity Range*3

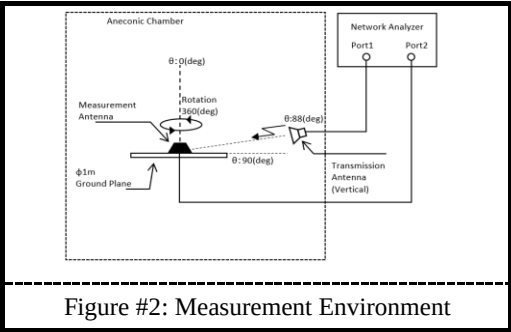


Figure #2: Measurement Environment

- *1 On Ground Plane (φ1m GND plane) at Yokowo Chamber
- *2 In Plane of $\theta = 88^{\circ}$
- *3 Antenna Front Direction is $\phi = 0^{\circ}$

●Antenna Directionality (θ=88°):

