

# ANTENNA TEST REPORT

## Test Place

Company Name	UL Japan, Inc. Ise EMC Lab.
Address	4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 Japan
Telephone Number	+81-596-24-8999

## Equipment Under Test (EUT)

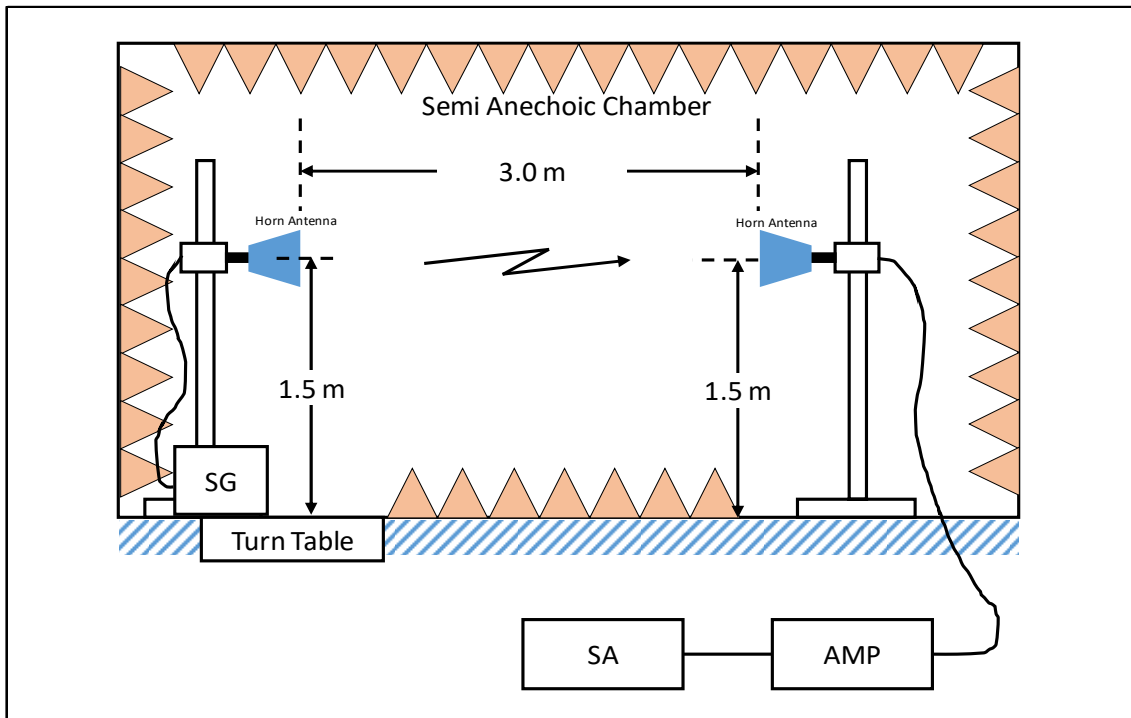
Description	BLE ECU
Manufacturer	DENSO CORPORATION
Model Number	17EAD
Frequency of Operation	2400 MHz to 2483.5 MHz
Antenna Type	Inverted F or Loop Antenna

## Test Procedure

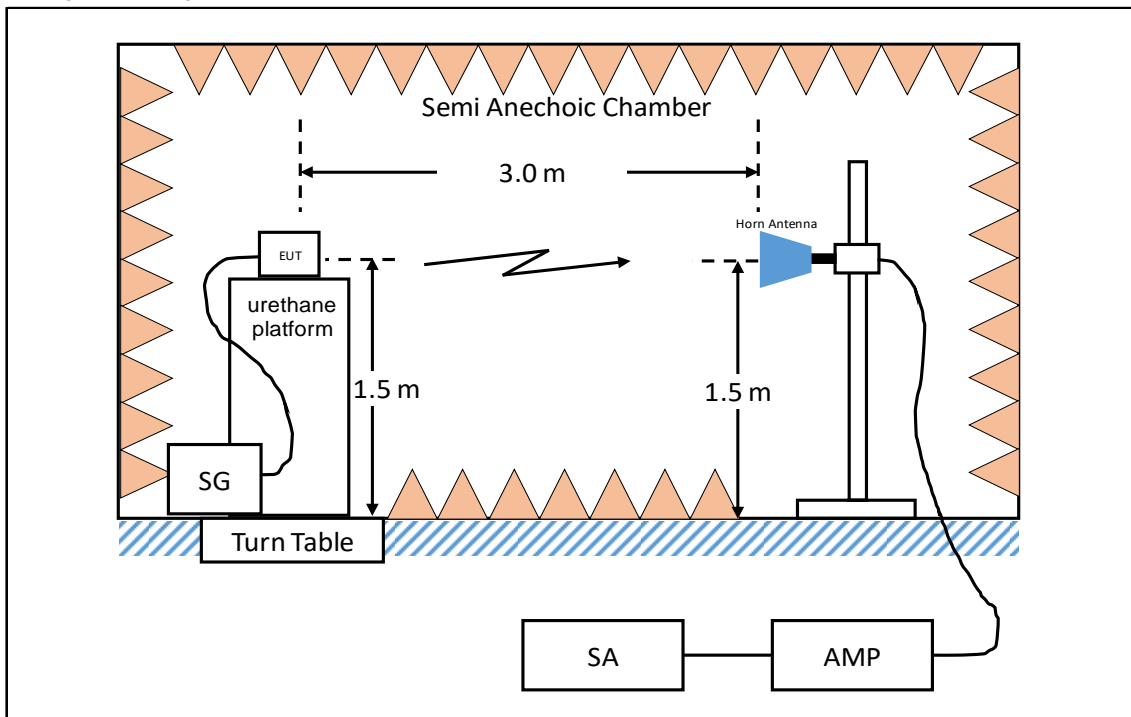
Test configuration	EUT was placed on a platform of nominal size, 0.5 m by 0.5 m, raised 1.5 m above the conducting ground plane. The measurements were performed for both vertical and horizontal antenna polarization with the Spectrum Analyzer. The setup are shown in Figure 1.
Test procedure	Step 1 The tests have been measured in semi anechoic chamber at the distance of 3 m between the Substitution Antenna and the measuring Antenna, both Antennas were placed for the height 1.5 m. The Substitution Antenna has been connected to the Signal Generator. Step 2 The output power of the Signal Generator was setting value calculated by compensating the finite difference in the Antenna gain of Substitution Antenna. Step 3 The electric field strength at the distance of 3 m is received via the measurement antenna, and the reference value at that time is measured with a spectrum analyzer. Step 4 The measurements were performed for both vertical and horizontal antenna polarization. Step 5 Exchanged the Substitution Antenna to the EUT, the output power of the Signal Generator was setting value calculated by 0 dBm at the input of EUT. Step 6 The EUT was rotated a full revolution and recorded the electric field strength for each degree. Step 7 Calculate and record the difference from the value recorded in Step 6 to the value recorded in Step 3. Step 8 The measurement in steps 5 to 7 repeated with both vertical and horizontal antenna polarization, each position of XY, YZ and ZX-plane of EUT.

**Figure 1: Test Setup**

**Setup for step 1 to 4**



**Setup after step 5**



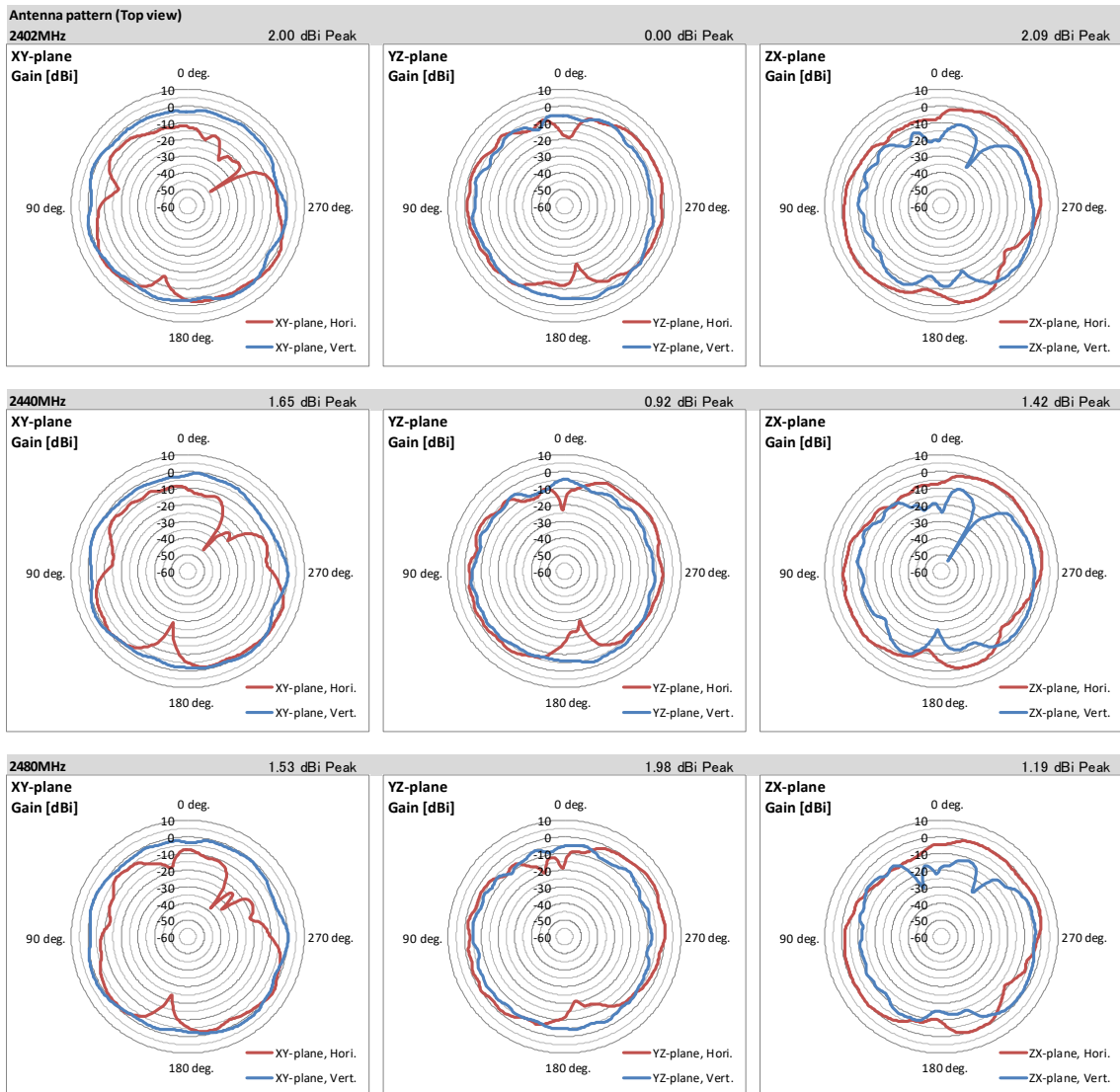
- SG: Signal Generator
- SA: Spectrum Analyzer
- AMP: Pre Amplifier

# Test Data, Result

## Antenna Pattern and Gain

Test place  
Semi Anechoic Chamber  
Date  
Temperature / Humidity  
Engineer  
Mode

Ise EMC Lab.  
No.2  
April 13, 2023  
23 deg. C / 40 % RH  
Tetsuro Yoshida  
Inverted F Antenna



Antenna gain [UNIT: dBi]

Peak	2402.0	2440.0	2480.0
Frequency [MHz]	2402.0	2440.0	2480.0
Peak gain	2.09	1.65	1.98

Average		2402.0	2440.0	2480.0
Frequency [MHz]		2402.0	2440.0	2480.0
XY-plane	Hori.	-4.05	-4.62	-5.22
	Vert.	-1.44	-1.32	-0.86
	Avg (H/V)	-2.55	-2.66	-2.52
YZ-plane	Hori.	-3.82	-3.74	-3.07
	Vert.	-5.34	-5.75	-6.00
	Avg (H/V)	-4.52	-4.63	-4.29
ZX-plane	Hori.	-1.83	-2.21	-2.66
	Vert.	-7.80	-7.83	-7.12
	Avg (H/V)	-3.86	-4.17	-4.34
Total		-3.57	-3.73	-3.63

Hori. : Horizontal  
Vert. : Vertical

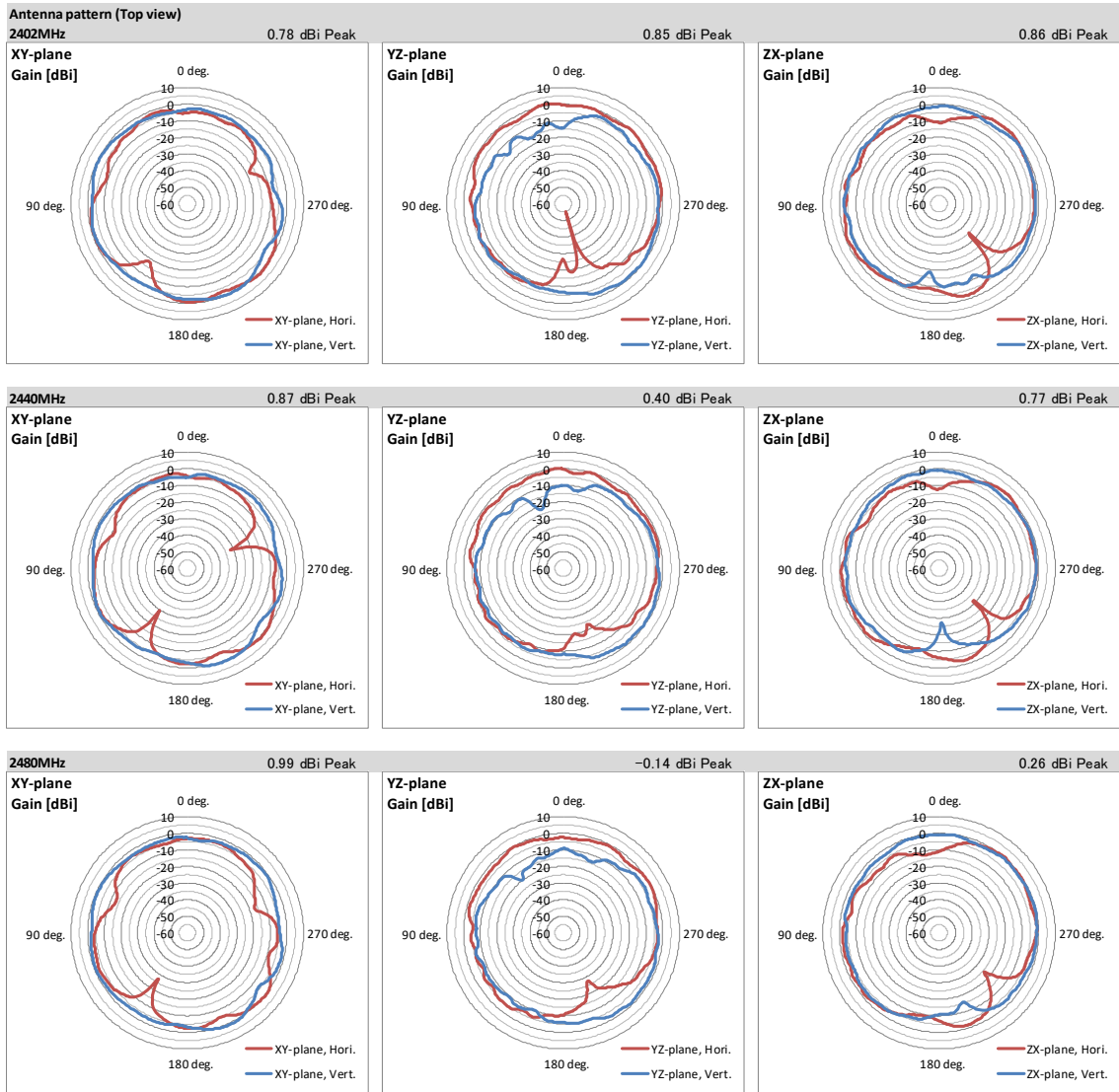
Average : Result of averaging the true value of the value of each degree of angle.

Yellow highlighted area: Maximum Antenna Gain [dBi]

## Antenna Pattern and Gain

Test place  
Semi Anechoic Chamber  
Date  
Temperature / Humidity  
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Mode

Ise EMC Lab.  
No.2  
April 13, 2023  
23 deg. C / 40 % RH  
Tetsuro Yoshida  
Loop Antenna



Antenna gain [UNIT: dBi]				
<b>Peak</b>				
Frequency [MHz]	2402.0	2440.0	2480.0	
Peak gain	0.86	0.87	0.99	
<b>Average</b>				
Frequency [MHz]	2402.0	2440.0	2480.0	
XY-plane	Hori.	-3.72	-4.16	-4.53
	Vert.	-2.69	-2.59	-2.08
	Avg (H/V)	-3.17	-3.31	-3.14
YZ-plane	Hori.	-3.14	-3.93	-3.79
	Vert.	-4.96	-5.36	-5.87
	Avg (H/V)	-3.96	-4.59	-4.70
ZX-plane	Hori.	-3.67	-3.56	-3.70
	Vert.	-3.38	-3.32	-2.69
	Avg (H/V)	-3.52	-3.43	-3.17
Total	-3.54	-3.74	-3.61	

Hori. : Horizontal  
Vert. : Vertical

Average : Result of averaging the true value of the value of each degree of angle.

Yellow highlighted area: Maximum Antenna Gain [dBi]

## **Test Instruments**

### **Test Equipment**

<b>Test Item</b>	<b>Local ID</b>	<b>LIMS ID</b>	<b>Description</b>	<b>Manufacturer</b>	<b>Model</b>	<b>Serial</b>	<b>Last Calibration Date</b>	<b>Cal Int</b>
APG	MAEC-01	141998	AC1_Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 10m	DA-06881	2022/06/28	24
APG	MOS-27	141566	Thermo-Hygrometer	CUSTOM. Inc	CTH-201	A08Q26	2023/01/13	12
APG	MMM-09	141533	DIGITAL HiTESTER	HIOKI E.E. CORPORATION	3805	51201195	2023/01/18	12
APG	MJM-25	142226	Measure, Tape, Steel	KOMELON	KMC-36	-	-	-
APG	COTS-MEMI-02	178648	EMI measurement program	TSJ (Techno Science Japan)	TEPTO-DV	-	-	-
APG	MAEC-01-SVSWR	141994	AC1_Semi Anechoic Chamber(SVSWR)	TDK	Semi Anechoic Chamber 10m	DA-06881	2021/04/05	24
APG	MHA-05	141511	Horn Antenna 1-18GHz	Schwarzbeck Mess-Elektronik OHG	BBHA9120D	253	2022/09/20	12
APG	MCC-217	141393	Microwave Cable	Junkosha	MWX221	1604S254(1 m) / 1608S088(5 m)	2022/08/02	12
APG	MPA-10	141579	Pre Amplifier	Keysight Technologies Inc	8449B	3008A02142	2023/02/14	12
APG	MSA-22	141978	Spectrum Analyzer	Keysight Technologies Inc	E4448A	MY46180899	2023/03/06	12
APG	MSG-17	141897	Signal Generator	Keysight Technologies Inc	N5182B	MY56200024	2022/11/07	12
APG	MCC-244	197219	Microwave cable	Huber+Suhner	SF126E/11PC35/11 PC35/2000MM	536999/126E	2023/03/09	12
APG	MHA-30	141514	Horn Antenna 1-18GHz	Schwarzbeck Mess-Elektronik OHG	BBHA9120D	01611	2022/06/22	12

**\*Hyphens for Last Calibration Date and Cal Int (month) are instruments that Calibration is not required (e.g. software), or instruments checked in advance before use.**

**The expiration date of the calibration is the end of the expired month.**

**As for some calibrations performed after the tested dates, those test equipment have been controlled by means of an unbroken chains of calibrations.**

**All equipment is calibrated with valid calibrations. Each measurement data is traceable to the national or international standards.**

**Test item: APG: Antenna Pattern and Gain**