

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)

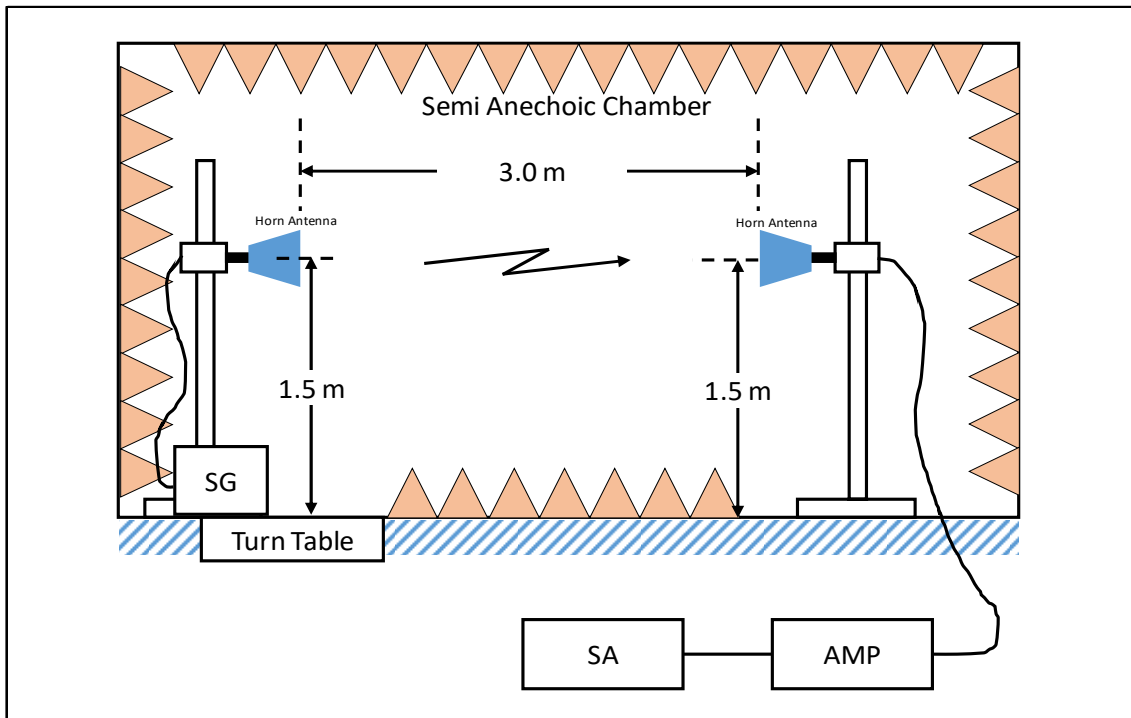
Description	BLE ECU
Manufacturer	DENSO CORPORATION
Model Number	17EAD
Frequency of Operation	2400 MHz to 2483.5 MHz
Antenna Type	Inverted F or Loop Antenna

Test Procedure

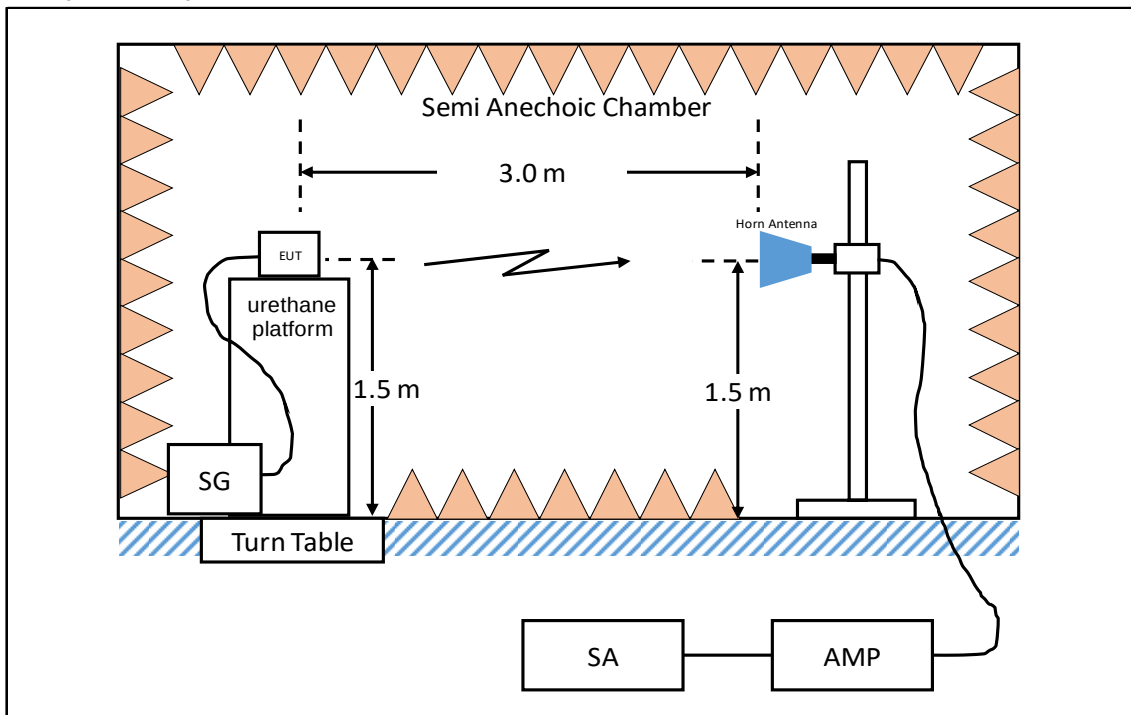
Test configuration	EUT was placed on a platform of nominal size, 0.5 m by 0.5 m, raised 1.5 m above the conducting ground plane. The measurements were performed for both vertical and horizontal antenna polarization with the Spectrum Analyzer. The setup are shown in Figure 1.
Test procedure	Step 1 The 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



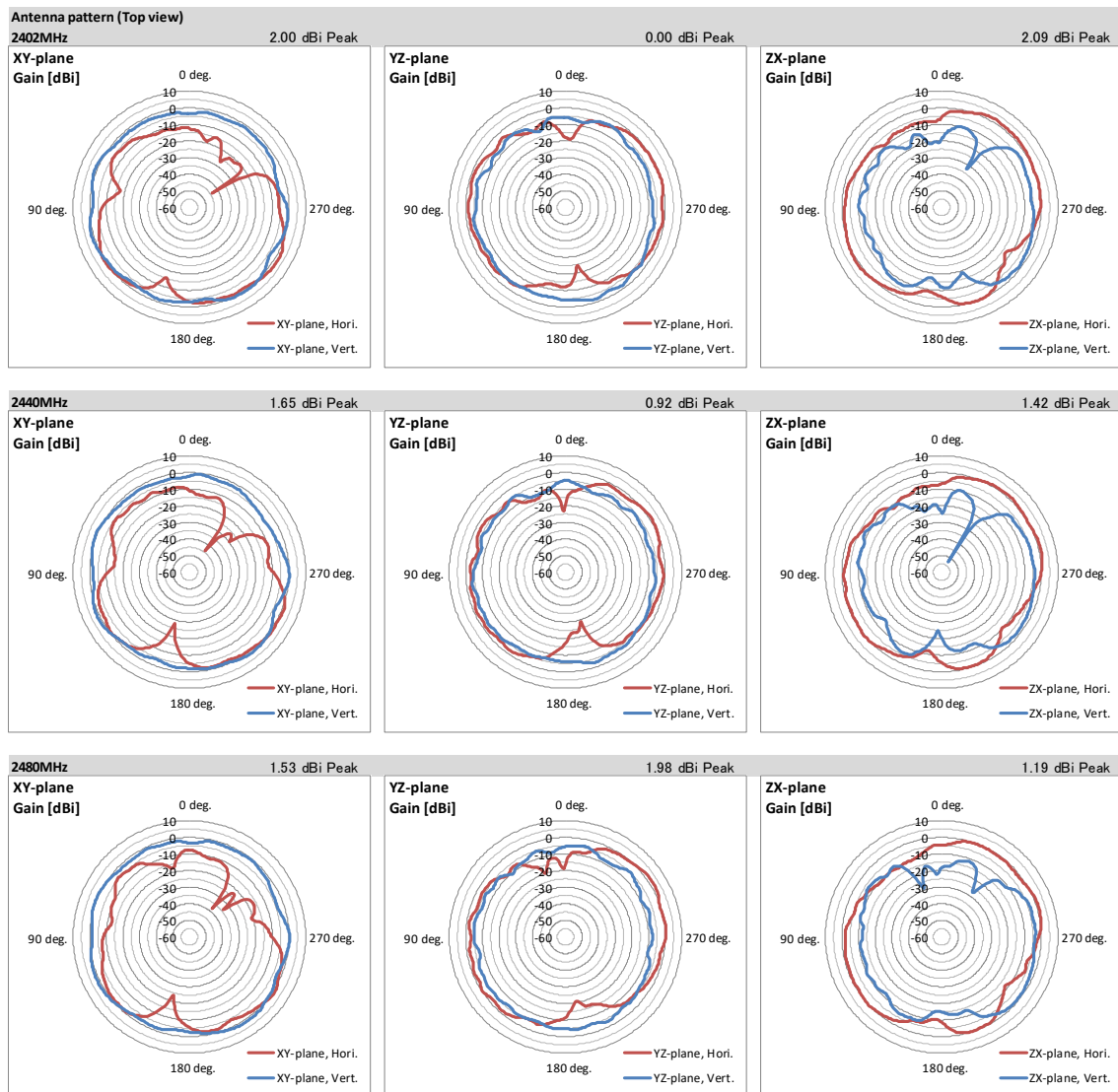
SG: Signal Generator
SA: Spectrum Analyzer
AMP: Pre Amplifier

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]			
Peak gain	2.09	1.65	1.98

Average	2402.0	2440.0	2480.0
Frequency [MHz]			
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

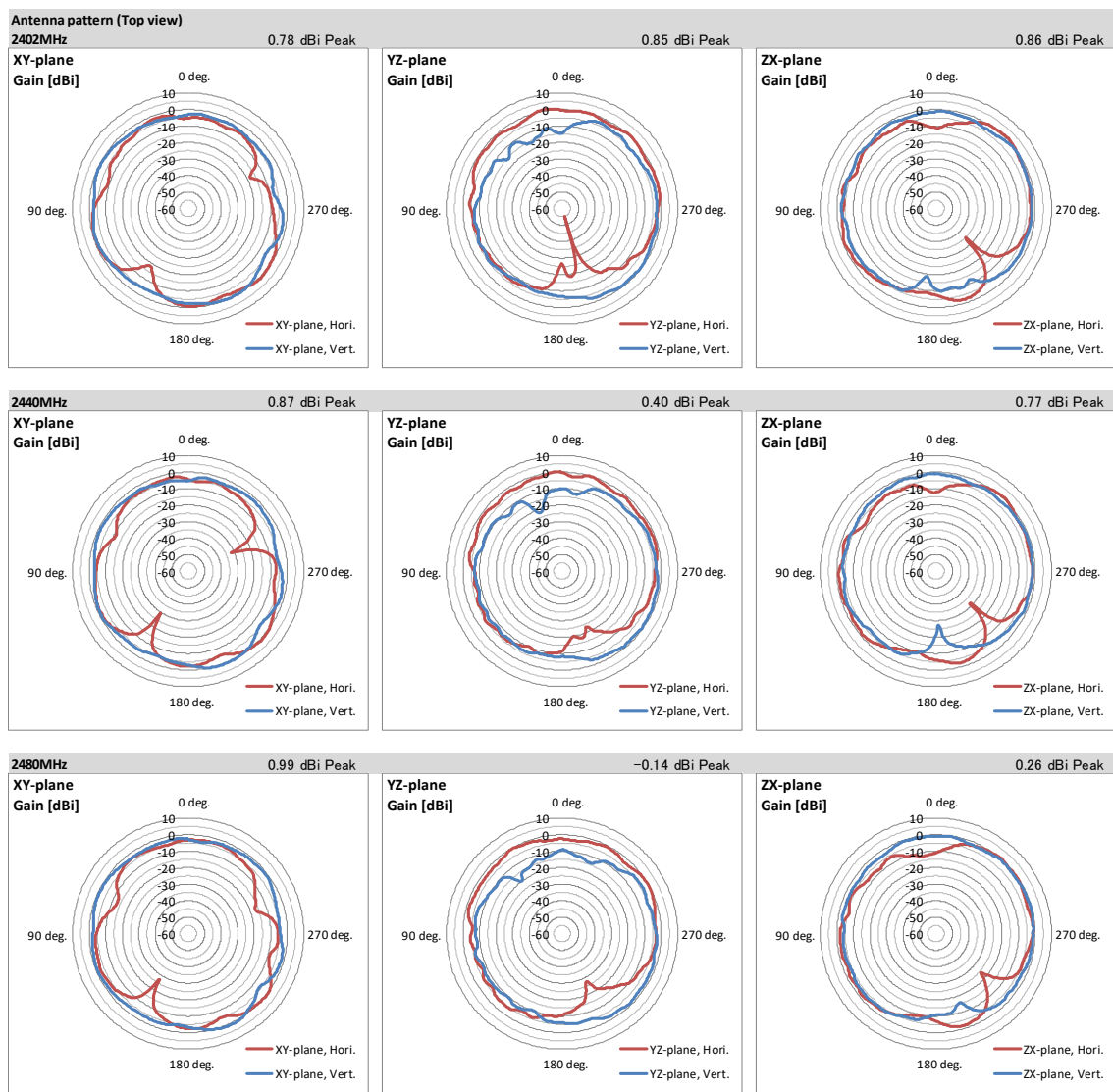
Average : Result of averaging the true value of the value of each degree of angle.

Yellow highlighted area: Maximum Antenna Gain [dBi]

Antenna Pattern and Gain

Test place
Semi Anechoic Chamber
Date
Temperature / Humidity
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Ise EMC Lab.
No.2
April 13, 2023
23 deg. C / 40 % RH
Tetsuro Yoshida
Loop Antenna



Antenna gain [UNIT: dBi]

Peak	2402.0	2440.0	2480.0
Frequency [MHz]			
Peak gain	0.86	0.87	0.99

Average				
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

Test Item	Local ID	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Cal Int
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