



COMPAL ELECTRONICS, INC.

No. 581 & 581-1, Ruiguang Rd., Neihu District Taipei City 11492, Taiwan

Report No: Karoo24/2023/1A
Page 1 of 24

Test Report

Product Type: Karoo 24 Bicycle Head Unit
Company Name: SRAM, LLC / Hammerhead Inc

Report No: Karoo24/2023/1A
Issue Date: 2023/10/20
Prepared for: Kyle Brenner

Test Engineer: WenRen Lee
Test Date: 2023/10/15
Test Engineer Signature: 李文仁



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1. Test Description

Conducted and Radiated testing of Hammerhead Karoo 24 was performed to determine antenna gain of each custom antenna.

2. Test Equipment

Conducted Tests			
Equipment	Manufacturer	Model	Cal Date
VNA	Agilent	E5071C	2023-01-05
Radiated Tests			
Equipment	Manufacturer	Model	Cal Date
VNA	Agilent	E5071C	2023-01-05
Ref Antenna	ETS-LINDGREN	3164-10-01	2023-01-05
RF Chamber	ETS-LINDGREN	AMS-8500	2023-01-05

Table 1



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3. Antenna Description

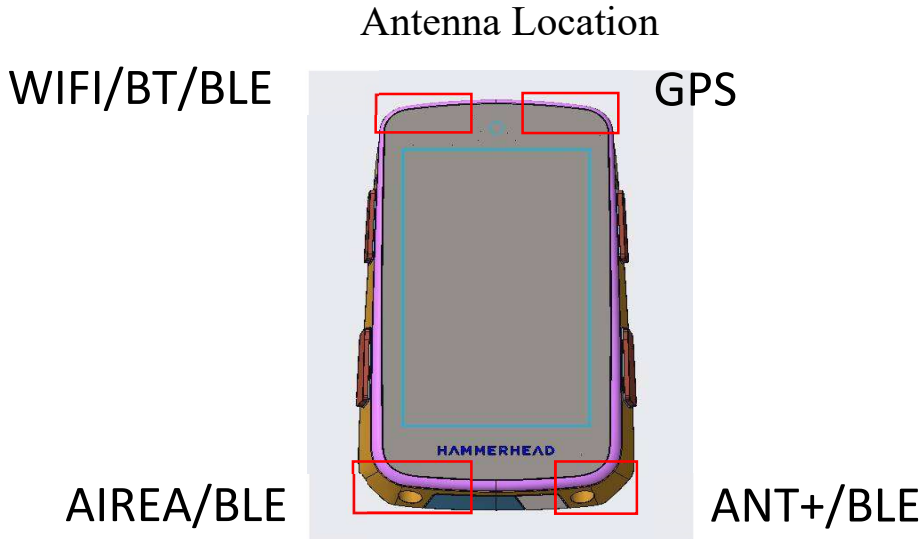
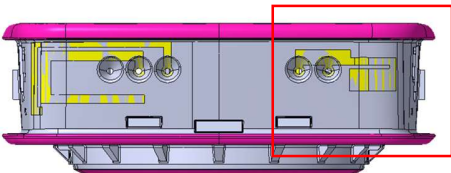
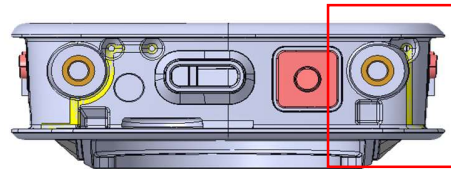


Fig A

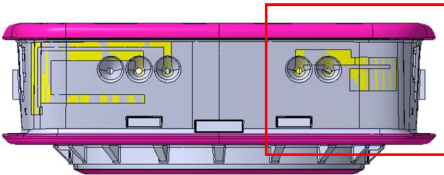
WIFI (#SRAMK240001) - PIFA



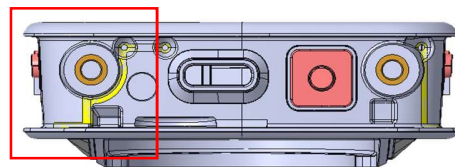
ANT+/BLE (#SRAMK240003) - Monopole



BT/BLE (#SRAMK240001) - PIFA



AIREA/BLE (#SRAMK240004) - PIFA



GPS (#SRAMK240002) - PIFA

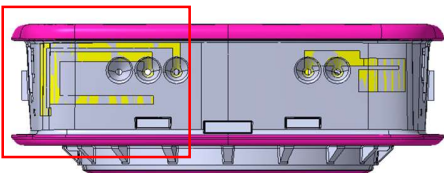


Fig B



4. Conducted Measurements

WCN3950			Max. conductive Target power including Chip Tolerance (+/-1.5dB)		
Band	Protocol	Rate	Production Chipset Max. power	based on pre-certification result Production Power will be including tolerance	DVT suggestion power setting
2.4G	802.11b	1M	18.5dBm	14dBm	13
		11M	18.5dBm	14dBm	13
	802.11g	6M	16.5dBm	15dBm	14
		54M	16.5dBm	15dBm	14
	802.11n/ac. HT20/VHT20	MCS 0-3	16.5dBm	15dBm	14
		MCS 4-7	16.5dBm	15dBm	14
	802.11n/ac, HT20/VHT40	MCS 0-3	15.5dBm	15dBm	14
		MCS 4-7	14.5dBm	14.5dBm	13
MCS8		13.5dBm	13.5dBm	12	
5G	802.11a	6M	16.5dBm	Band1/2/3 : 14dBm Band4: 11dBm	Band1/2/3 : 13 Band4: 10
		54M	15.5dBm	Band1/2/3 : 14dBm Band4: 11dBm	Band1/2/3 : 13 Band4: 10
	802.11n HT20	MCS0-3	16.5dBm	Band1/2/3 : 14dBm Band4: 11dBm	Band1/2/3 : 13 Band4: 10
		MCS4-7	14.5dBm	Band1/2/3 : 14dBm Band4: 11dBm	Band1/2/3 : 13 Band4: 10
	802.11n HT40	MCS0-3	15.5dBm	Band1/2/3 : 14dBm Band4: 11dBm	Band1/2/3 : 13 Band4: 10
		MCS4-8	12.5dBm	Band1/2/3 : 12.5dBm Band4: 11dBm	Band1/2/3 : 11 Band4: 10
	802.11ac VHT20	MCS0-3	16.5dBm	Band1/2/3 : 14dBm Band4: 11dBm	Band1/2/3 : 13 Band4: 10
		MCS4-7	14.5dBm	Band1/2/3 : 14dBm Band4: 11dBm	Band1/2/3 : 13 Band4: 10
	802.11ac VHT40	MCS0-3	16.5dBm	Band1/2/3 : 14dBm Band4: 11dBm	Band1/2/3 : 13 Band4: 10
		MCS4-7	14.5dBm	Band1/2/3 : 14dBm Band4: 11dBm	Band1/2/3 : 13 Band4: 10
		MCS8-9	12.5dBm	Band1/2/3 : 12.5dBm Band4: 11dBm	Band1/2/3 : 11 Band4: 10
	802.11ac VHT80	MCS0-3	15.5dBm	Band1/2/3 : 14dBm Band4: 11dBm	Band1/2/3 : 13 Band4: 10
		MCS4-7	12.5dBm	Band1/2/3 : 12.5dBm Band4: 11dBm	Band1/2/3 : 11 Band4: 10
		MCS8-9	11.5dBm	Band1/2/3 : 11.5dBm Band4: 11dBm	Band1/2/3 : 10 Band4: 10
	2.4G	BT BDR	Class1.5	11dBm	4-6dBm



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	BT EDR		9dBm	2-5dBm	PL8
	BT LE 1M		8dBm	-1~2dBm	PL7

Table 2a

ANT+ / AIREA			
Band	Protocol	pwr max. setting	Max. conductive Target power including Tolerance
2.4G	ANT+	5	5-7dBm
	AIREA		5-7dBm

Table 2b



5. Radiated efficiency and peak gain summary

WIFI - SRAMK240001		Antenna performance		
band	Frequency (MHz)	Peak gain (dBi)	Avg. Gain (dBi)	efficiency (%)
2.4G	2412	1.78	-3.37	46
	2442	2.01	-3.23	47.5
	2472	2.08	-3.43	45.4
5G	5180	0.71	-4.36	36.4
	5240	0.70	-4.42	36.1
	5500	1.07	-3.67	43
	5745	1.19	-3.92	40.6
	5825	1.21	-3.80	41.7
BT - SRAMK240001		Antenna performance		
band	Frequency (MHz)	Peak gain (dBi)	Avg. Gain (dBi)	efficiency (%)
2.4G	2402	1.78	-3.37	46
	2442	2.01	-3.23	47.5
	2480	2.08	-3.43	45.4
GPS - SRAMK240002		Antenna performance		
band	Frequency (MHz)	Peak gain (dBi)	Avg. Gain (dBi)	efficiency (%)
L5	1176.45	-1.39	-4.10	38.9
L1	1575.46	0.58	-3.53	44.4
ANT+ - SRAMK240003		Antenna performance		
band	Frequency (MHz)	Peak gain (dBi)	Avg. Gain (dBi)	efficiency (%)
2.4G	2402	0.24	-4.17	38.3
	2442	0.66	-3.64	43.3
	2480	0.35	-4.23	37.8
AIREA - SRAMK240004		Antenna performance		
band	Frequency (MHz)	Peak gain (dBi)	Avg. Gain (dBi)	efficiency (%)
2.4G	2402	1.44	-4.00	39.8
	2442	2.09	-3.58	43.9
	2480	2.23	-3.58	43.9

Table 3



6. Radiated Tests

a. WIFI, BT

WIFI		Antenna performance		
band	Frequency (MHz)	Peak gain (dBi)	Avg. Gain (dBi)	efficiency (%)
2.4G	2412	1.78	-3.37	46
	2442	2.01	-3.23	47.5
	2472	2.08	-3.43	45.4
5G	5180	0.71	-4.36	36.4
	5240	0.70	-4.42	36.1
	5500	1.07	-3.67	43
	5745	1.19	-3.92	40.6
	5825	1.21	-3.80	41.7

BT		Antenna performance		
band	Frequency (MHz)	Peak gain (dBi)	Avg. Gain (dBi)	efficiency (%)
2.4G	2402	1.78	-3.37	46
	2442	2.01	-3.23	47.5
	2480	2.08	-3.43	45.4

Table 4

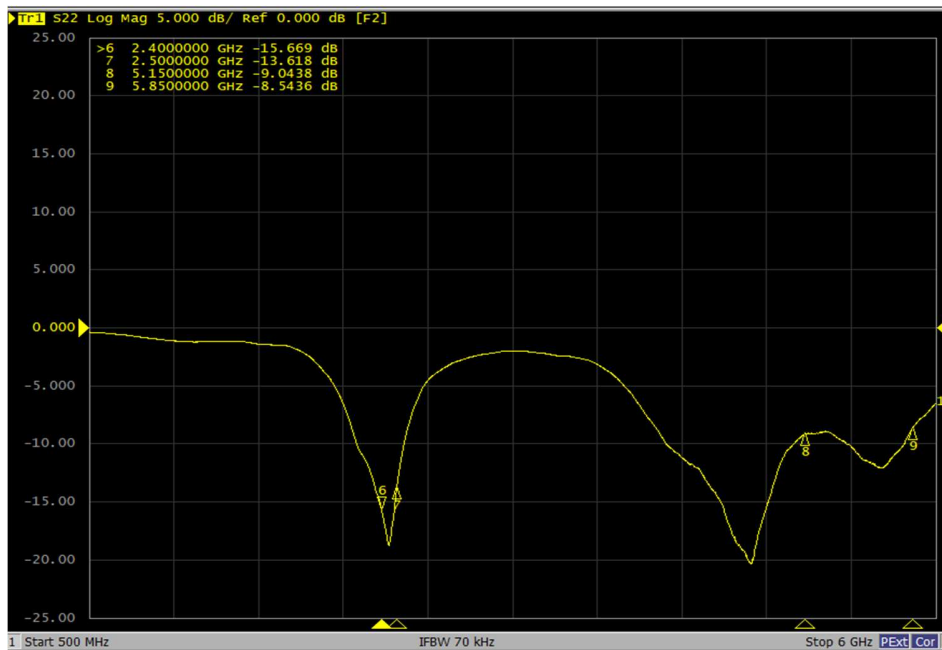


Fig C

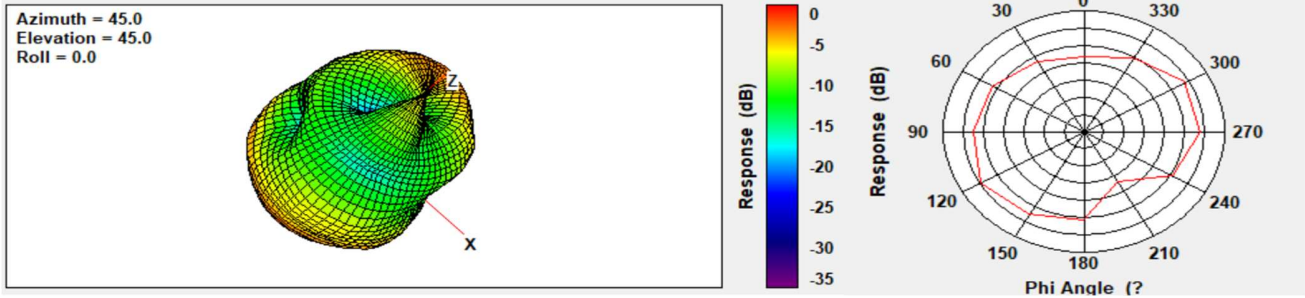


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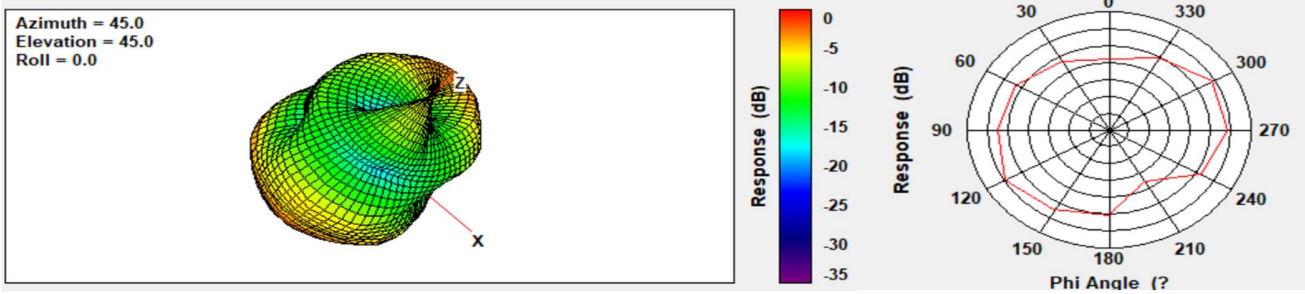
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WIFI-2.4G-HORIZONTAL POLARIZATION

2412MHz



2442 MHz



2472 MHz



Fig D

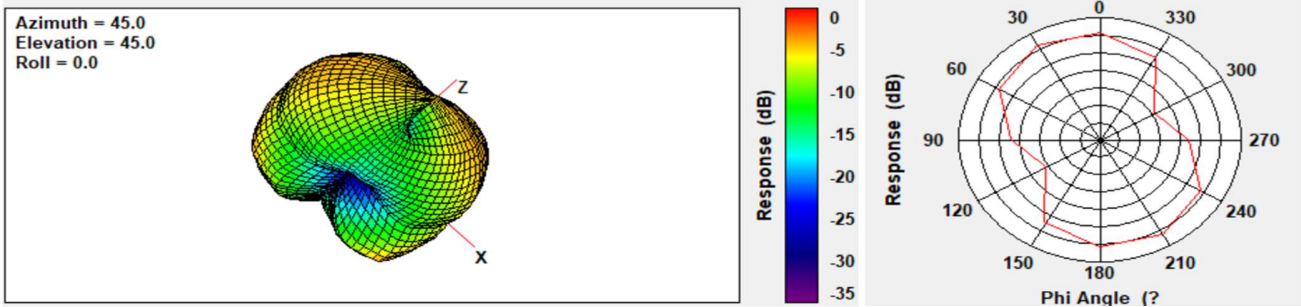


COMPAL ELECTRONICS, INC.

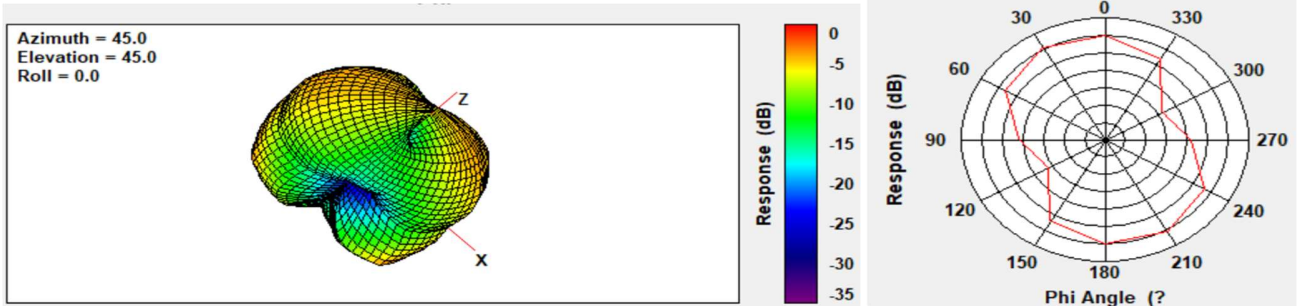
No. 581 & 581-1, Ruiguang Rd., Neihu District Taipei City 11492, Taiwan

WIFI-2.4G-VERTICAL POLARIZATION

2412MHz



2442MHz



2472MHz

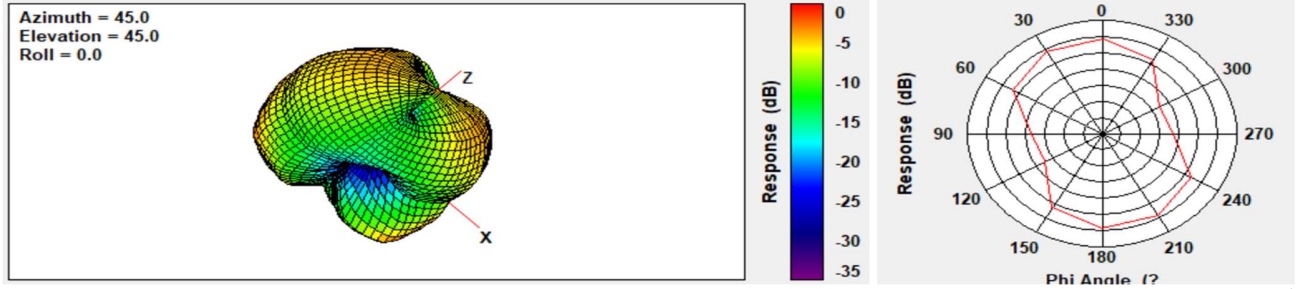


Fig E

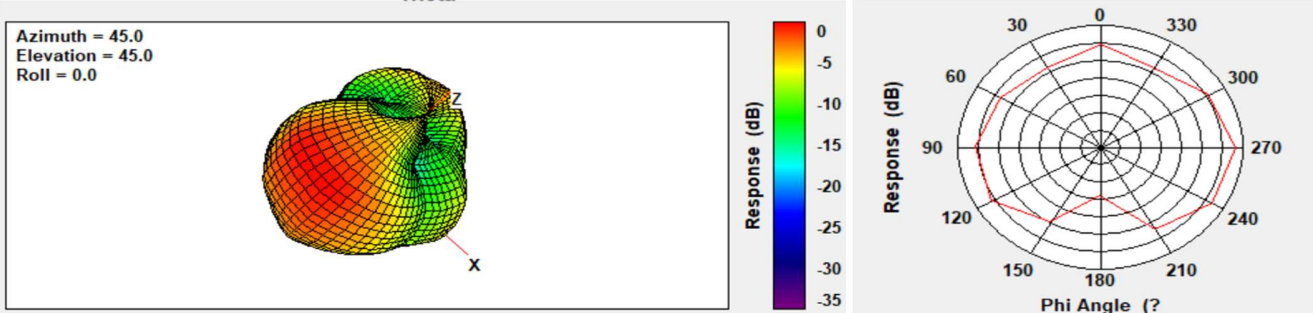


COMPAL ELECTRONICS, INC.

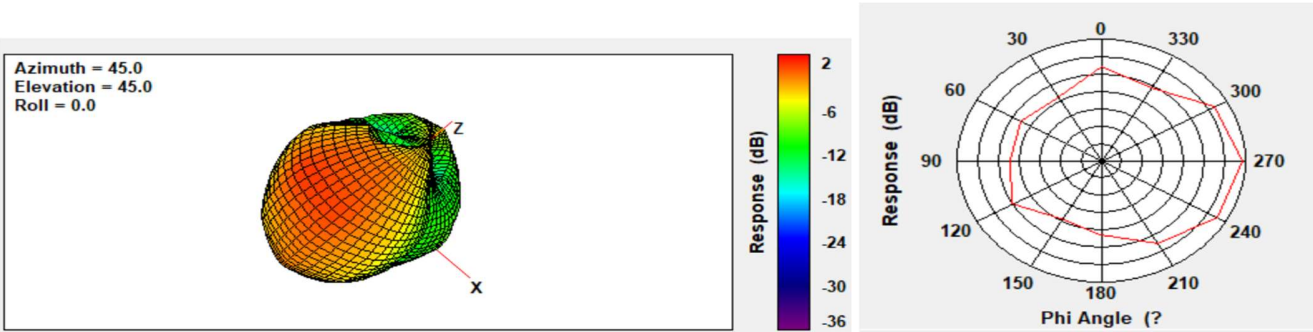
No. 581 & 581-1, Ruiguang Rd., Neihu District Taipei City 11492, Taiwan

WIFI-5G-HORIZONTAL POLARIZATION

5180MHz



5500MHz



5825MHz

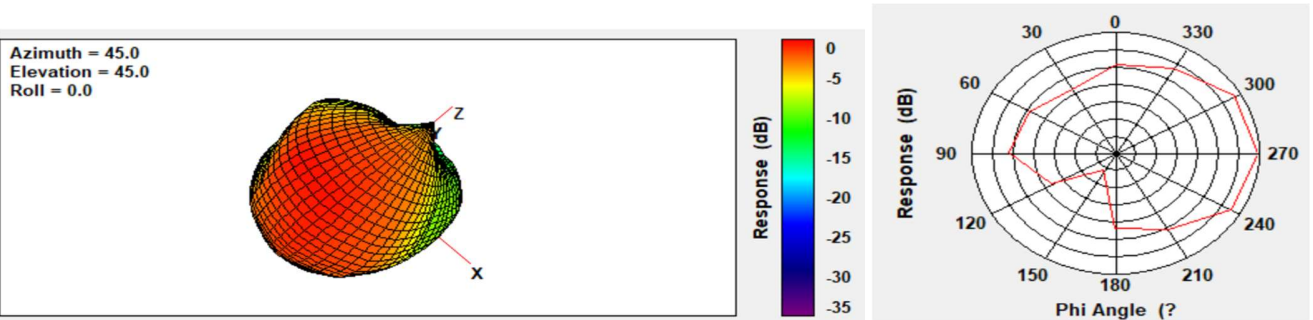


Fig F

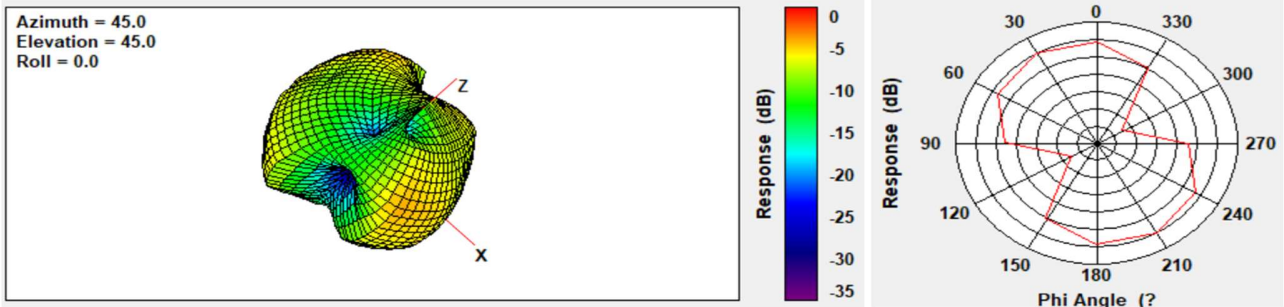


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WIFI-5G-VERTICAL POLARIZATION

5180MHz



5500MHz



5825MHz



Fig G

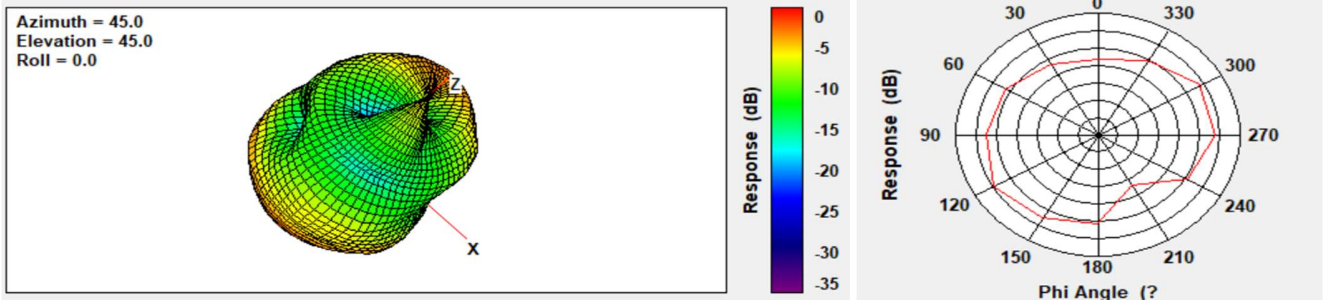


COMPAL ELECTRONICS, INC.

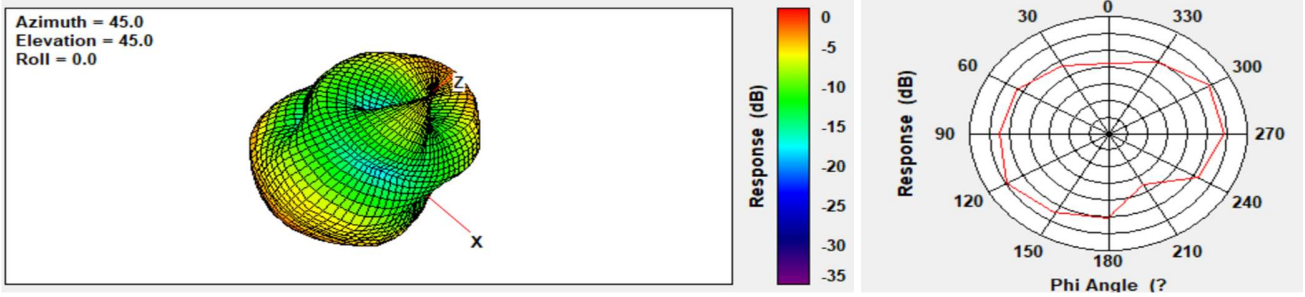
No. 581 & 581-1, Ruiguang Rd., Neihu District Taipei City 11492, Taiwan

BT-2.4G-HORIZONTAL POLARIZATION

2402MHz



2442MHz



2480MHz

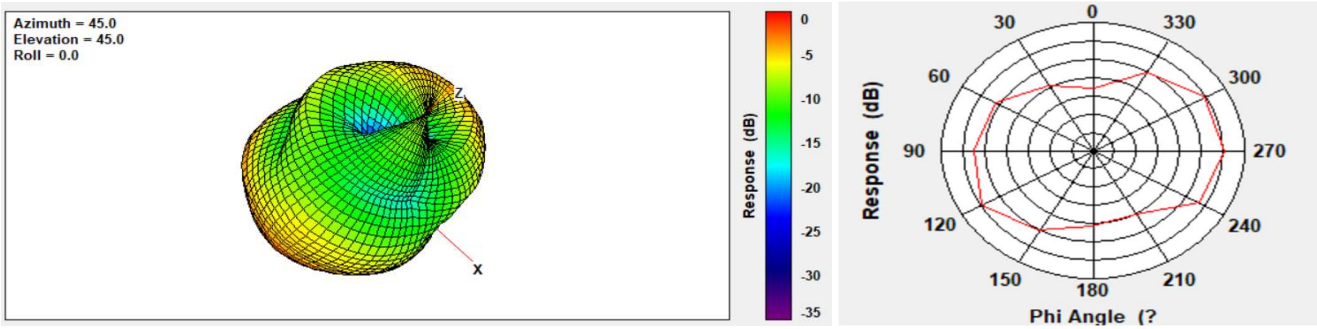


Fig H

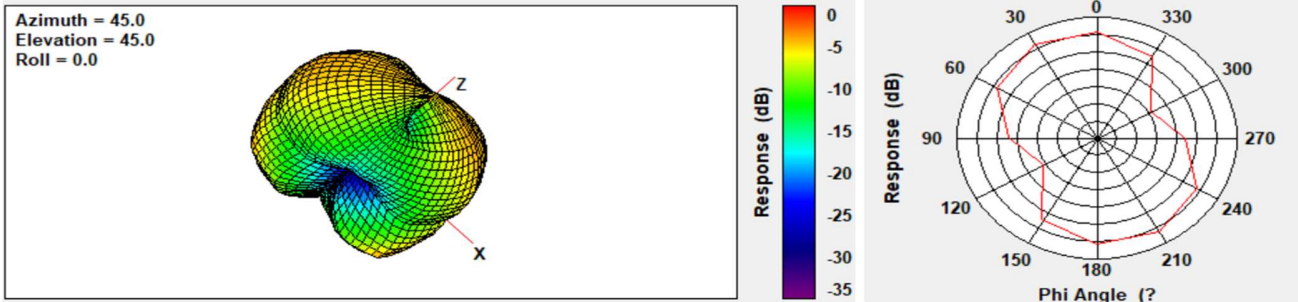


COMPAL ELECTRONICS, INC.

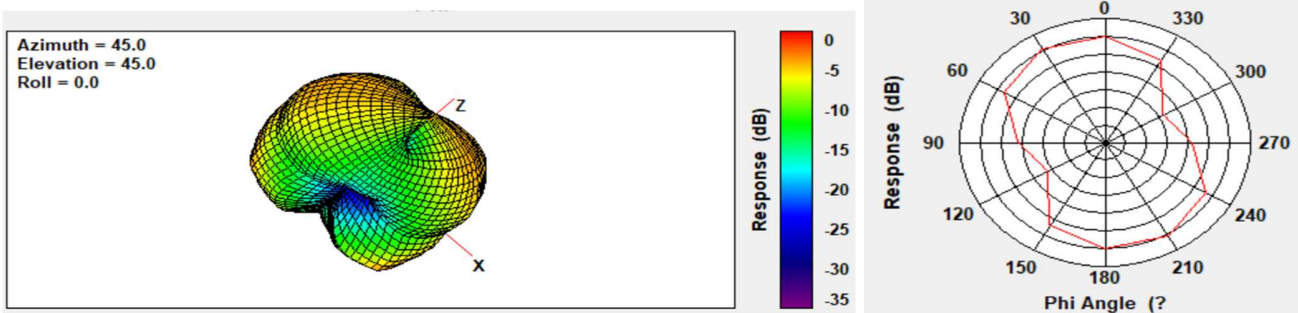
No. 581 & 581-1, Ruiguang Rd., Neihu District Taipei City 11492, Taiwan

BT-2.4G-VERTICAL POLARIZATION

2402MHz



2442MHz



2480MHz

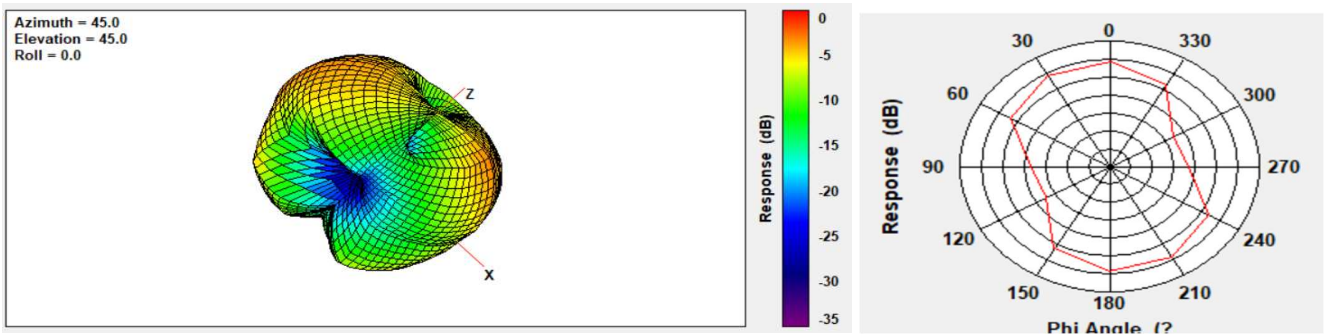


Fig I



b. GPS

GPS		Antenna performance		
band	Frequency (MHz)	Peak gain (dBi)	Avg. Gain (dBi)	efficiency (%)
L5	1176.45	-1.39	-4.10	38.9
L1	1575.46	0.58	-3.53	44.4

Table 5

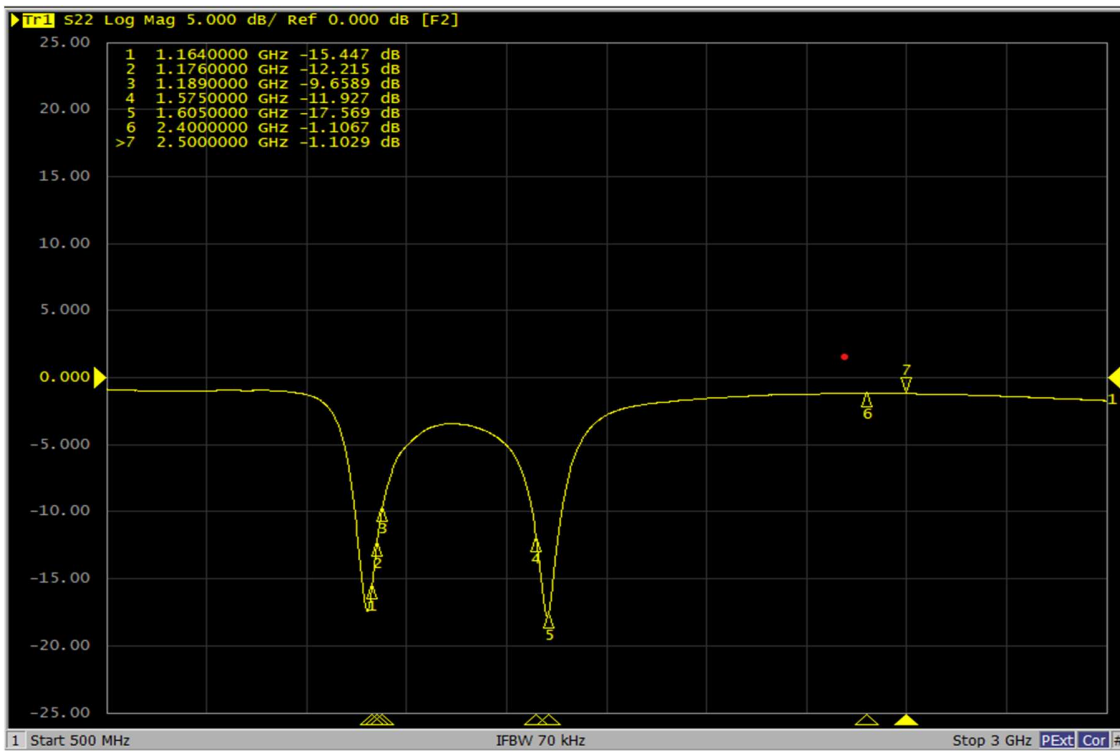


Fig J

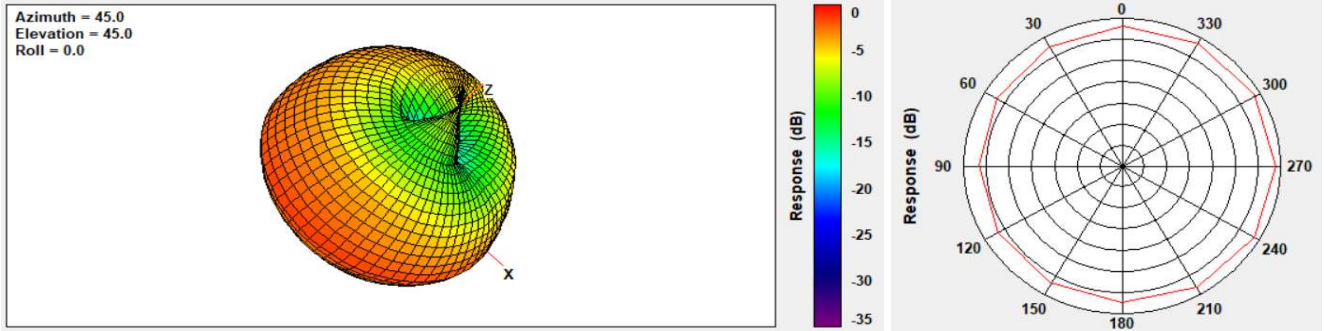


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GPS-HORIZONTAL POLARIZATION

1176.5MHz



1575.5MHz

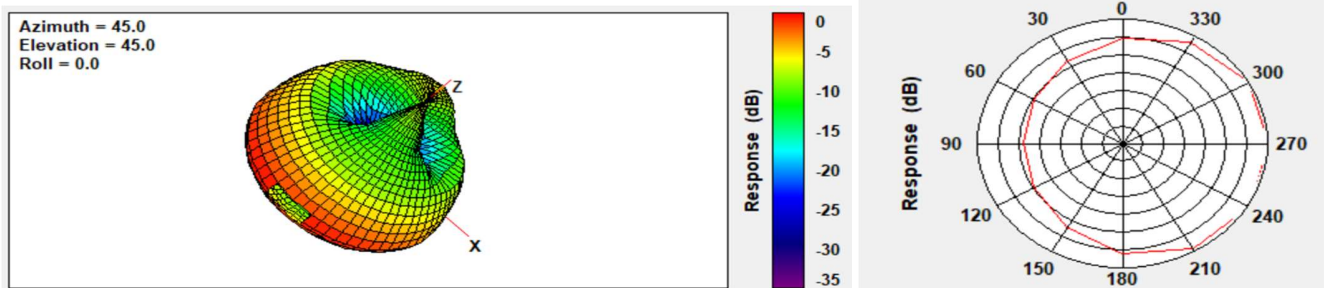


Fig K

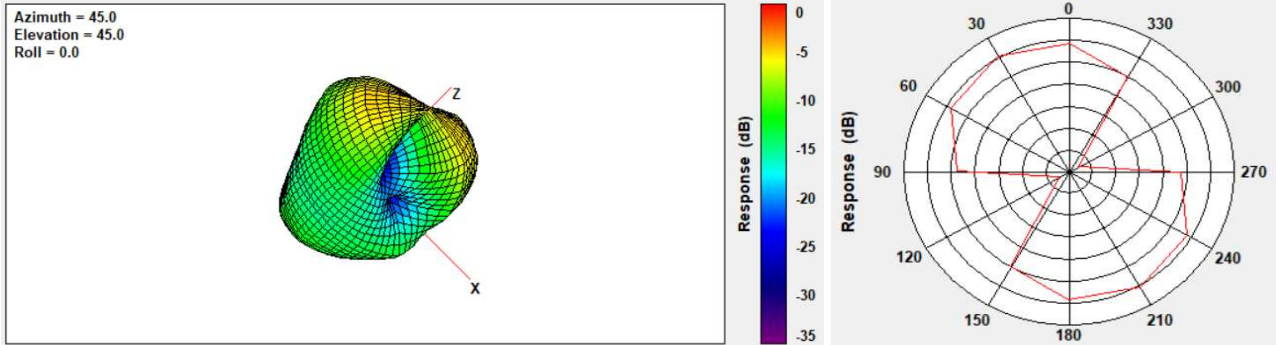


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GPS-VERTICAL POLARIZATION

1176.5MHz



1575.5MHz

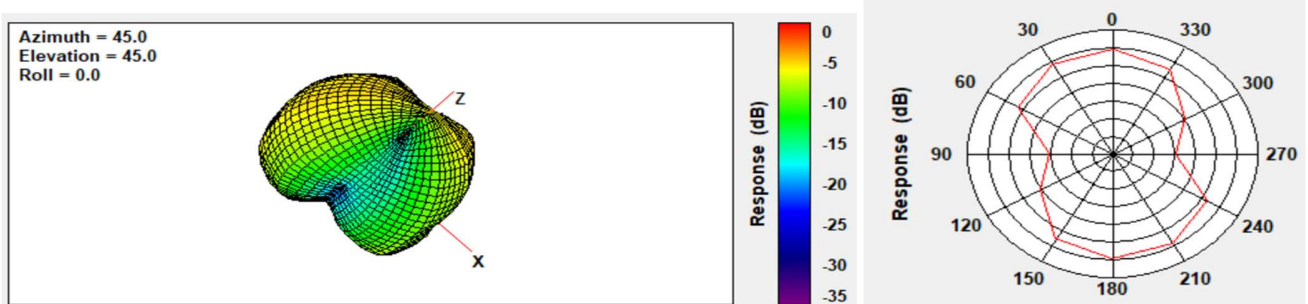


Fig L



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c. ANT+

ANT+		Antenna performance		
band	Frequency (MHz)	Peak gain (dBi)	Avg. Gain (dBi)	efficiency (%)
2.4G	2402	0.24	-4.17	38.3
	2442	0.66	-3.64	43.3
	2480	0.35	-4.23	37.8

Table 6

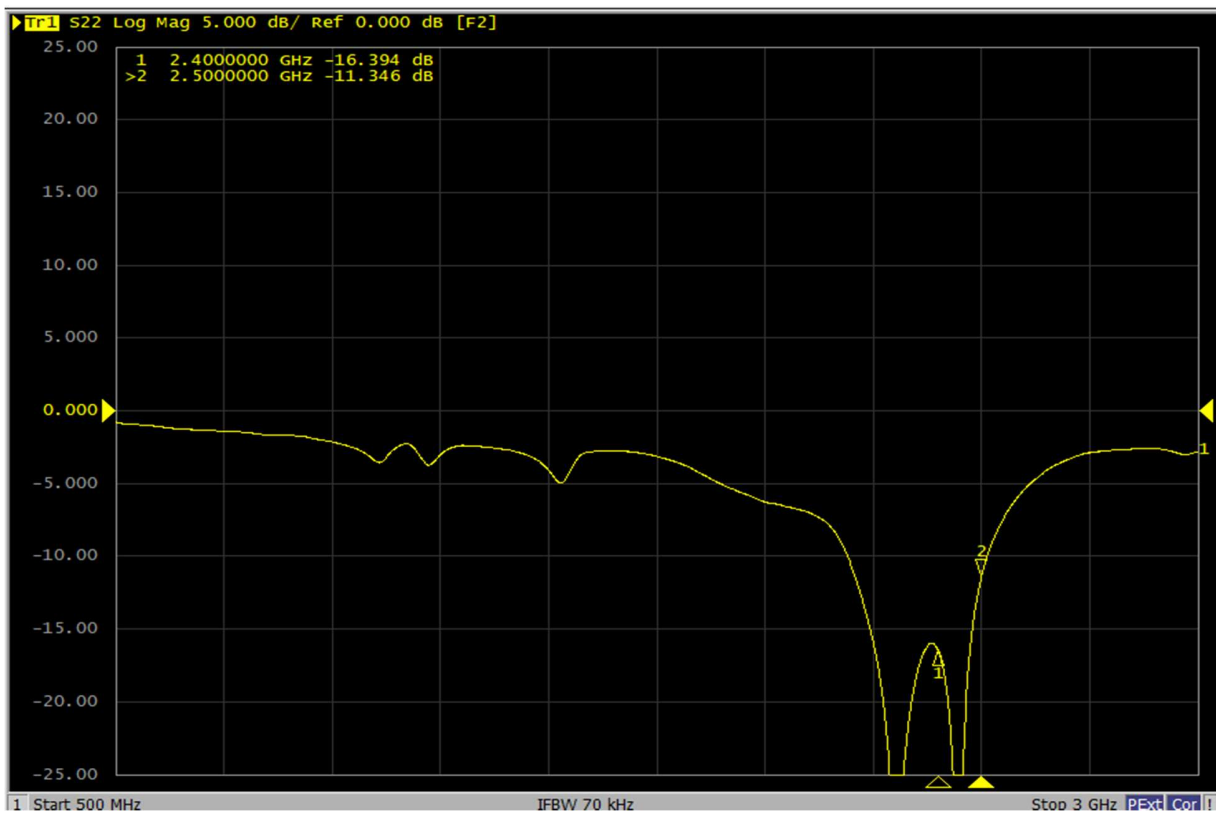


Fig M

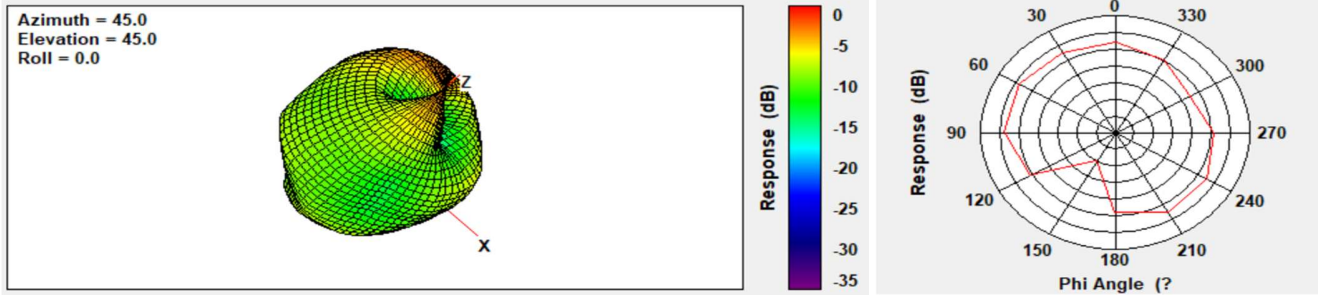


COMPAL ELECTRONICS, INC.

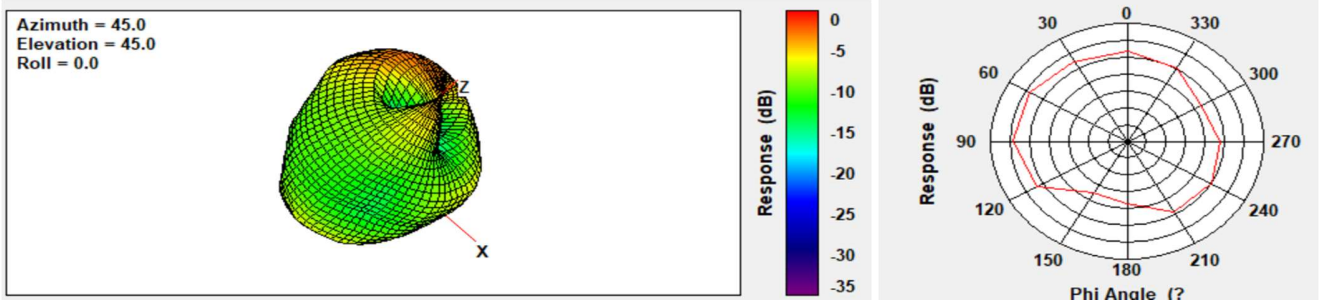
No. 581 & 581-1, Ruiguang Rd., Neihu District Taipei City 11492, Taiwan

ANT+-2.4G-HORIZONTAL POLARIZATION

2402MHz



2442MHz



2480MHz

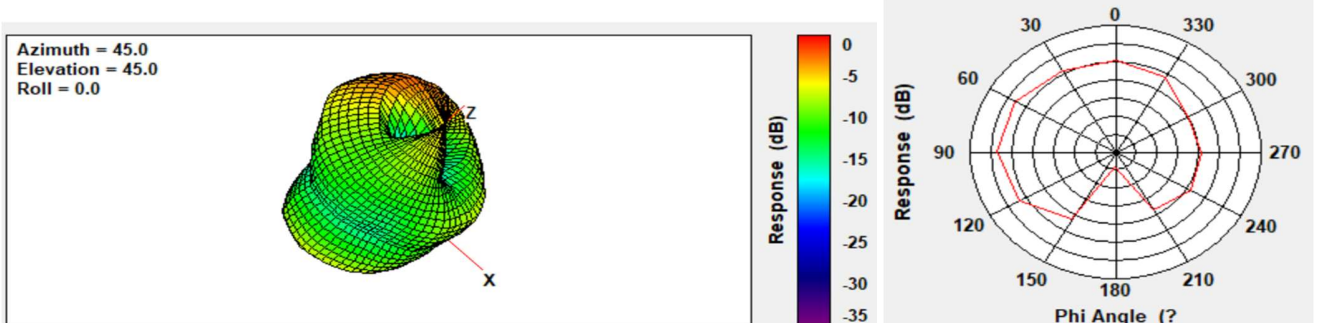


Fig N



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ANT+-2.4G-VERTICAL POLARIZATION

2402MHz



2442MHz



2480MHz

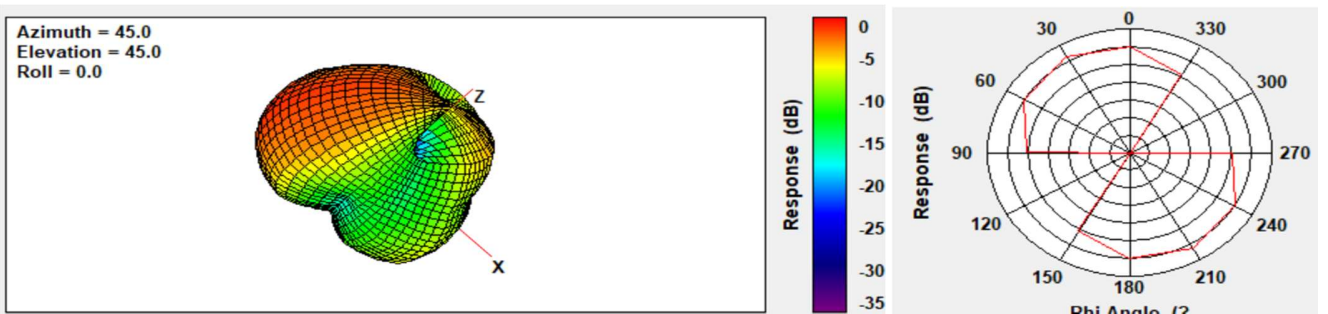


Fig O



d. AIREA (SRAMLink/IEEE 802.15.4)

AIREA		Antenna performance		
band	Frequency (MHz)	Peak gain (dBi)	Avg. Gain (dBi)	efficiency (%)
2.4G	2402	1.44	-4.00	39.8
	2442	2.09	-3.58	43.9
	2480	2.23	-3.58	43.9

Table 7



Fig P

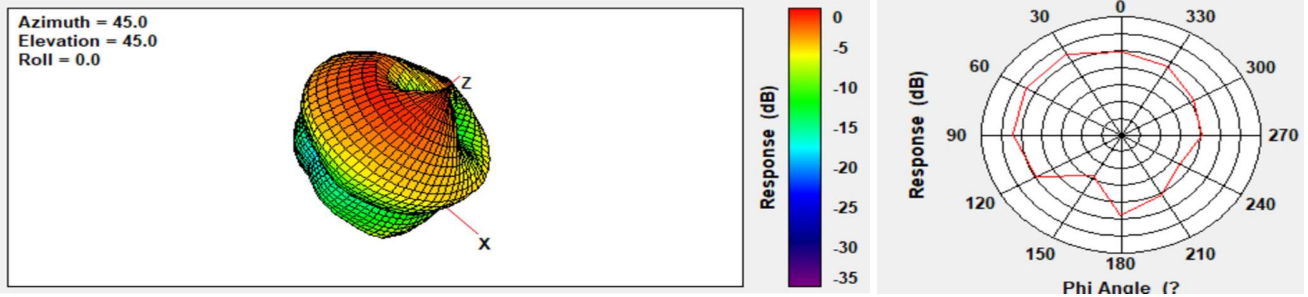


COMPAL ELECTRONICS, INC.

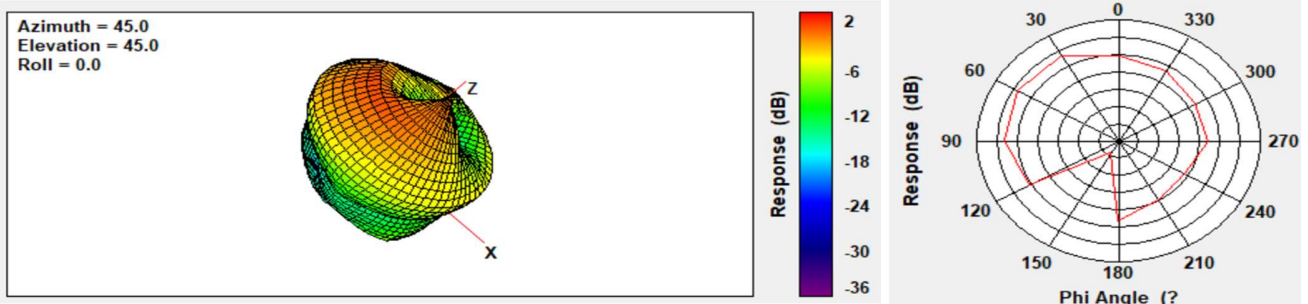
No. 581 & 581-1, Ruiguang Rd., Neihu District Taipei City 11492, Taiwan

SRAM-2.4G-HORIZONTAL POLARIZATION

2402MHz



2442MHz



2480MHz

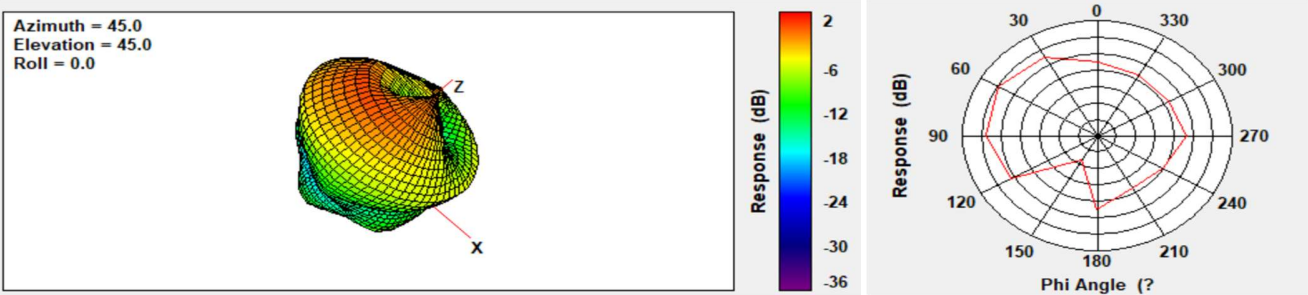


Fig Q

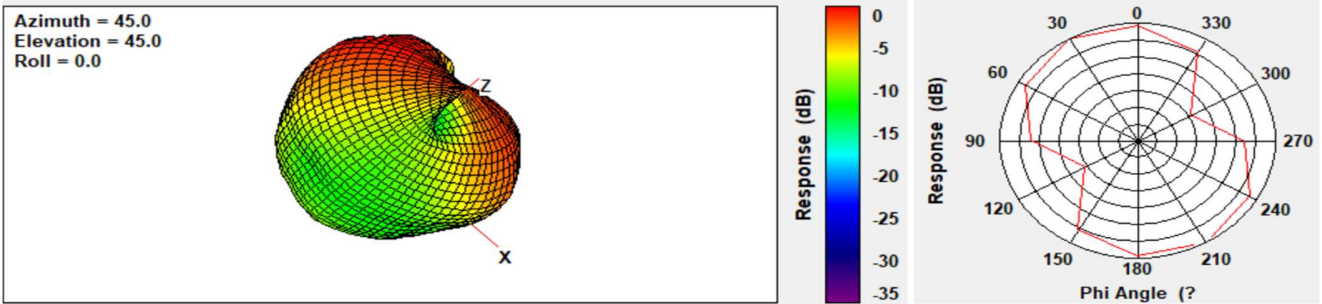


COMPAL ELECTRONICS, INC.

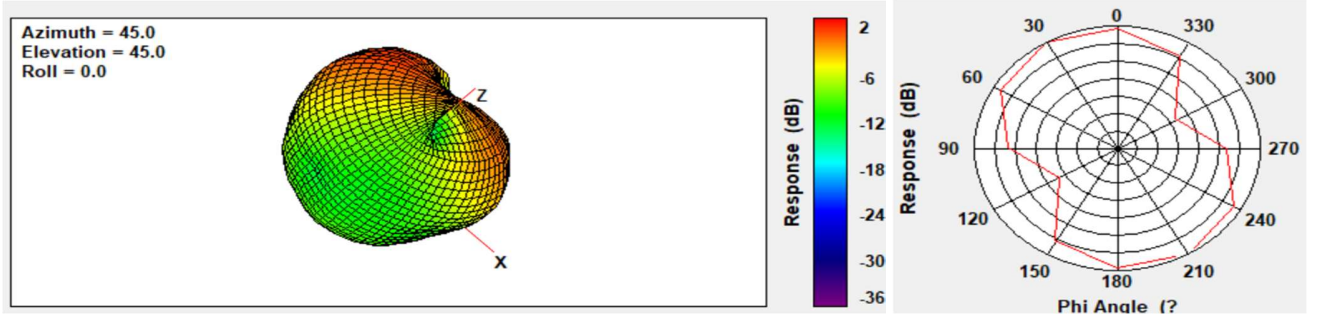
No. 581 & 581-1, Ruiguang Rd., Neihu District Taipei City 11492, Taiwan

SRAM-2.4G-VERTICAL POLARIZATION

2402MHz



2442MHz



2480MHz

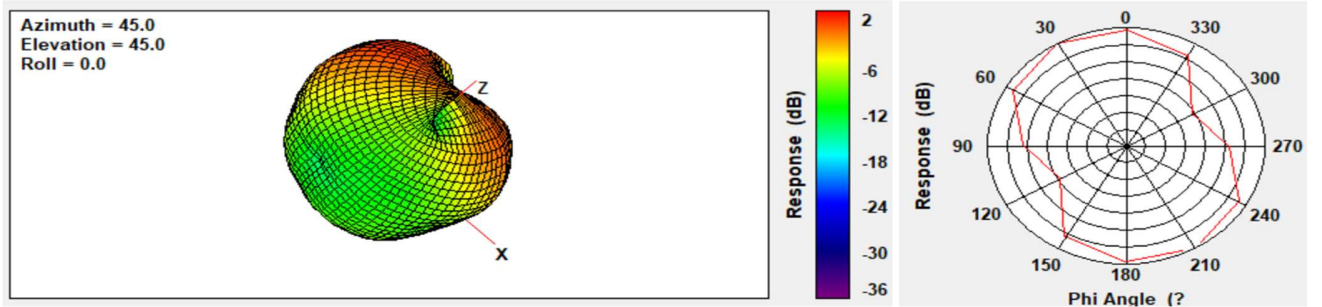


Fig R



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7. Appendix – Setup Photos

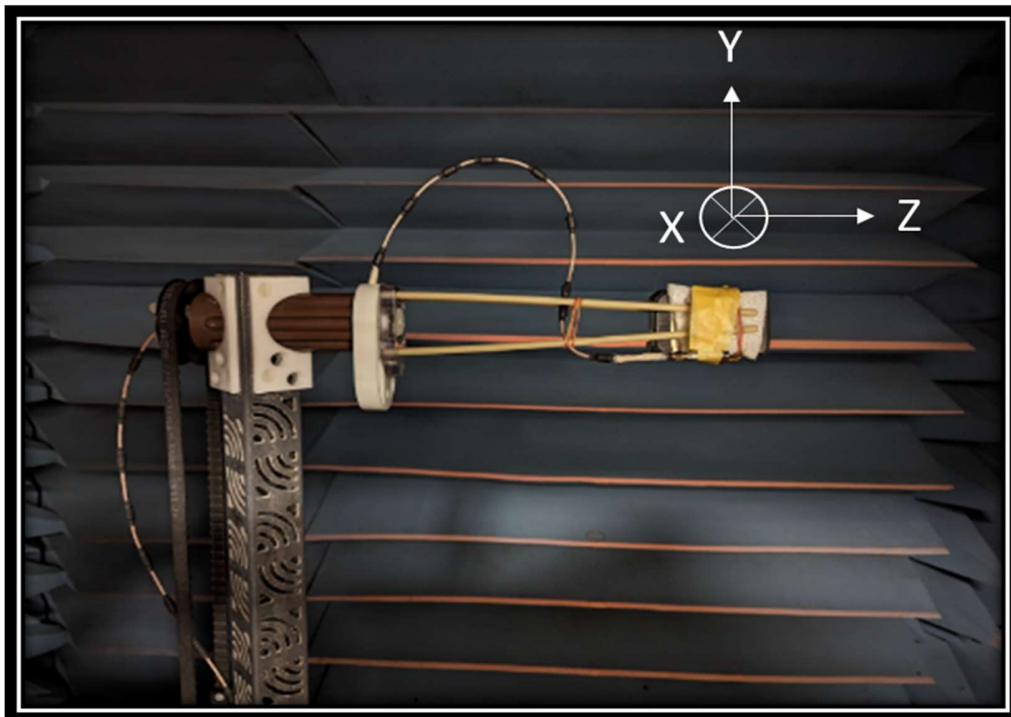
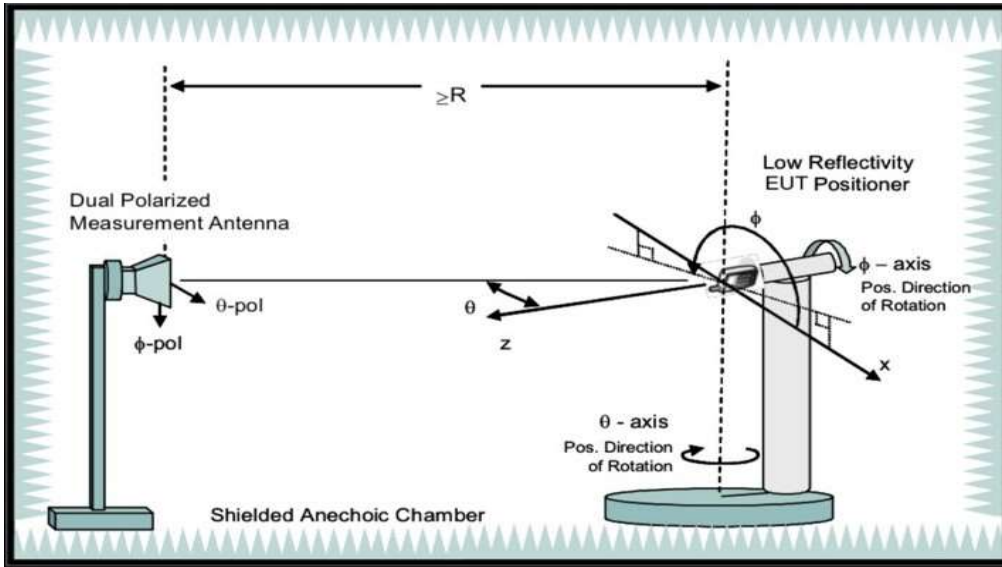


Fig S