Patent Pending

Data sheet

Main Internal Antenna

Part No. : AMMAL004

	Designed	Checked		Approved
Date	/	/	/	/

Revision no	Content	Page	Date	Name
0	First, documented	-	2016.12.22	H.W. Oh
1	Add LTE Band's Specification and Characteristics Modify Soldering Land Pattern	2, 4~11 12	2017.11.30	H.W. Oh
2	Band 14 added	2, 5, 8	2019.6.18	P.J. Jeong
3	LoRa data added	2, 5, 9	2019.7.2	P.J. Jeong
4	Reliability test update	32	2019.7.9	P.J. Jeong
5	US / EU band switching information update	15~26	2020.4.7	P.J. Jeong
6	Sub6, CV2X application update	28~31	2021.5.28	P.J. Jeong
7	B71 application update	32~35	2021.6.18	P.J. Jeong

RoHS

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Designed	Checked		Approved
21. 6. 18	21. 6. 18	21. 6. 18	21. 6. 18

Notes
The contents of this data sheet are subject to change without notice. Please confirm the specifications and delivery conditions when placing your order.

1. SPECIFICATIONS

1.1. Electrical Specifications

ITEM	LTE12	LTE17	LTE14	LTE20	LTE5	Remark
Frequency [MHz]	699~716 729~746	704~716 734~746	758~768 788~798	791~821 832~862	824~849 869~894	Notes :1)
Peak Gain[dBi]	2.34	1.97	2.77	2.09	1.94	Notes :1)
Eff.[%] @Avg.	63.86	65.48	84.91	64.40	61.11	Notes :1)
ITEM	**LoRa**	**LTE8**	**LTE3**	**LTE2**	**LTE1**	**Remark**
Frequency [MHz]	868 915	880~915 925~960	1710~1785 1805~1880	1850~1910 1930~1990	1920~1980 2110~2170	Notes :1)
Peak Gain[dBi]	2.82	1.31	3.14	2.98	3.01	Notes :1)
Eff.[%] @Avg.	77.95	49.08	71.95	74.08	76.96	Notes :1)

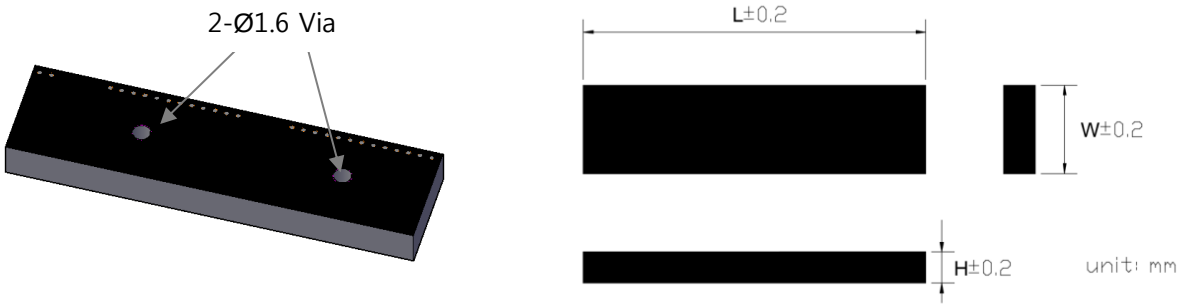
ITEM	LTE4	LTE23	LTE40	LTE7	Remark
Frequency [MHz]	1710~1755 2110~2155	2000~2020 2180~2200	2300~2400	2500~2690	Notes :1)
Peak Gain[dBi]	3.24	3.12	1.85	1.46	Notes :1)
Eff.[%] @Avg.	65.18	73.71	71.38	58.28	Notes :1)
VSWR	4.0 : 1				Notes :1)
	TBD				Notes :2)
Polarization	Linear				Notes :1)
Azimuth Beam Pattern	Omni-directional				Notes :1)
Impedance	50 Ω				Notes :1)

※ Notes:1) Measured on the AMOTECH test board (141x50x1.6T)

Notes:2) Measured on the matched AMOTECH manual jig.

1.2. Mechanical Specifications

Electrode	Copper	-
Dimensions (L x W x H)	35.0(L) x 9.0(W) x 3.2(H)	mm
Operating Temperature	-40 ~ +125	℃

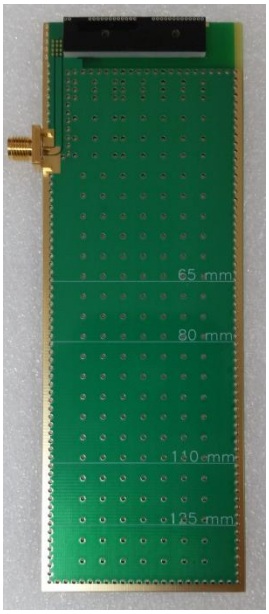


1.3 Marking

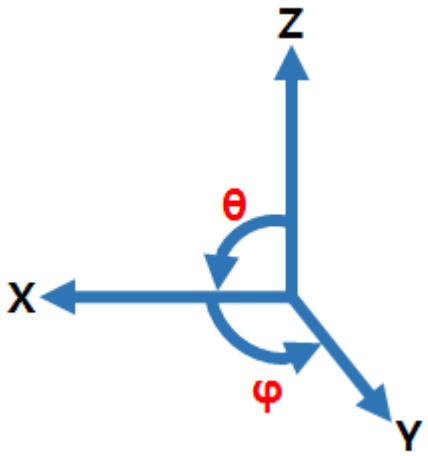
●	:	1 pin positon
L004	:	Model No.
YY	:	Year (ex: 2015 → 15)
WW	:	Week (ex: 1st week→01, 7th week→07)

2. MEASUREMENT

2.1. SET for Measurement



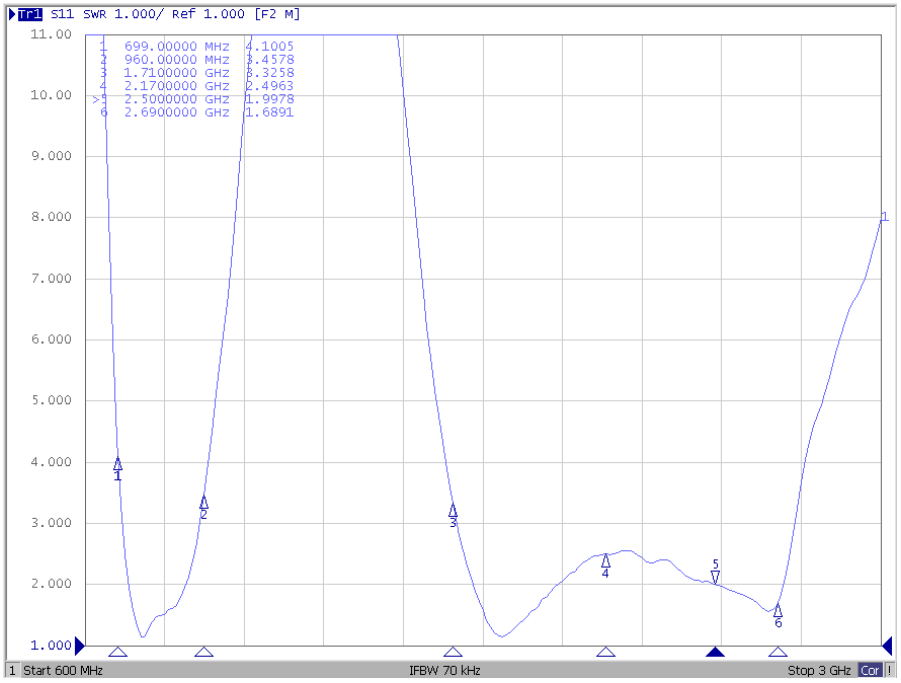
Board size mm: 141x50x1.6T



Antenna Radiation coordinate system

2.2. Electrical Characteristic

◆ ***S_{11}(VSWR)***



- VSWR @ EV Board -

2.3. Radiation Characteristic

- Measurement Result

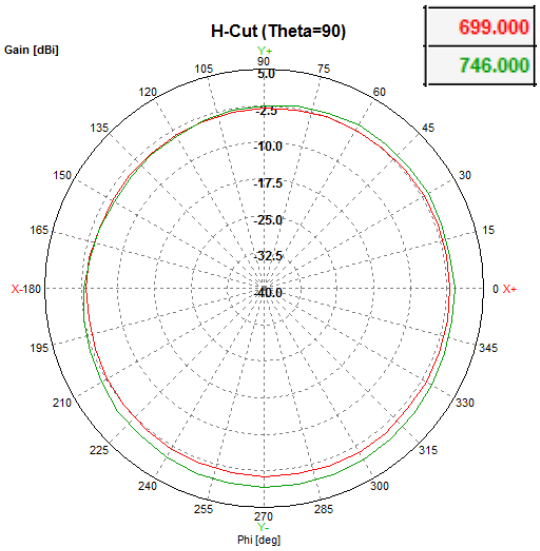
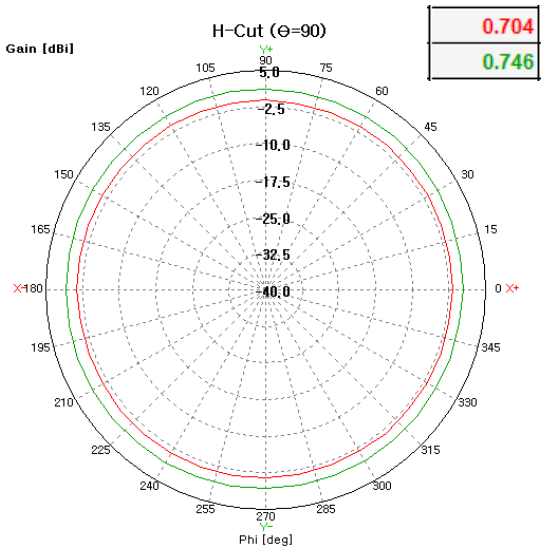
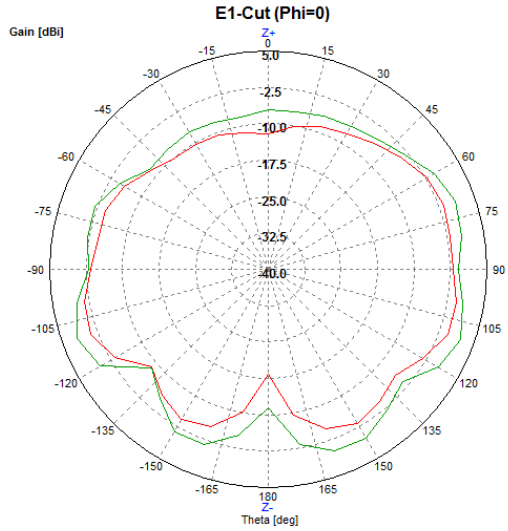
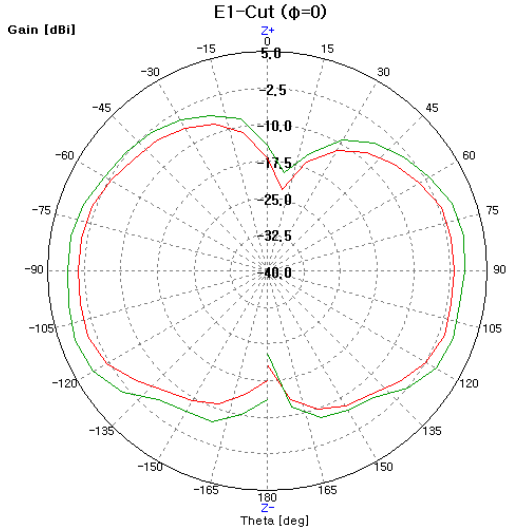
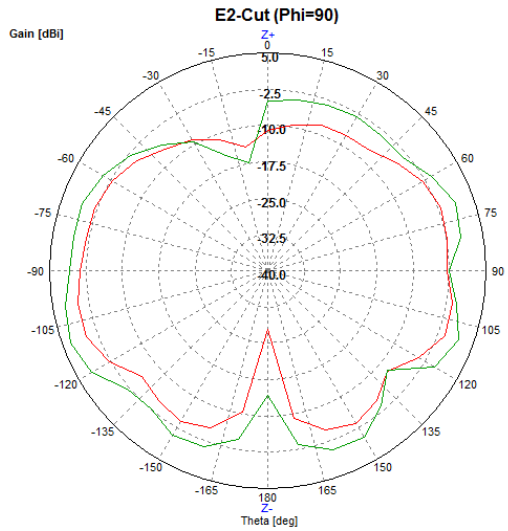
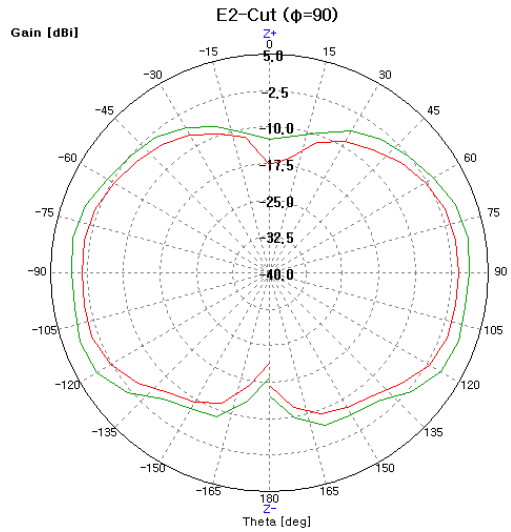
Band	Frequency [MHz]	EFF.[%]	Avg. (dBi)	Peak (dBi)
LTE12	699	45.71	-3.40	0.05
	716	60.14	-2.21	0.40
	729	68.51	-1.64	2.34
	746	81.10	-0.91	1.97
LTE17	704	47.72	-3.21	-0.77
	716	60.14	-2.21	0.40
	734	72.98	-1.37	1.45
	746	81.10	-0.91	1.97
LTE14	758	87.31	-0.59	2.44
	768	86.24	-0.64	2.48
	788	76.25	-1.18	1.96
	798	89.84	-0.47	2.77
LTE20 (EU Digital Dividend)	791	77.29	-1.12	1.87
	821	54.37	-2.65	0.72
	832	58.62	-2.32	1.13
	862	67.34	-1.72	2.09
LTE5 (GSM850)	824	54.36	-2.65	0.70
	849	66.10	-1.80	1.84
	869	63.80	-1.95	1.94
	894	60.18	-2.21	1.64
LoRa	868	64.56	-1.90	1.82
	915	59.15	-2.28	1.45
LTE8 (E-GSM)	880	55.22	-2.58	1.31
	915	59.15	-2.28	1.45
	925	52.72	-2.78	1.08
	960	42.95	-3.67	0.15

- Remark
  - 6mx3mx3m Anechoic Chamber
  - Matching on the standard test board (141 x 50 mm)
  - Temp. : 25℃ / Humidity : 50~55%

Band	Frequency [MHz]	EFF.[%]	Avg. (dBi)	Peak (dBi)
LTE3 (DCS)	1710	58.66	-2.32	1.32
	1785	77.95	-1.08	3.03
	1805	69.83	-1.56	2.73
	1880	81.38	-0.89	3.14
LTE2 (PCS)	1850	77.03	-1.13	2.98
	1910	79.65	-0.99	2.88
	1930	70.77	-1.5	2.42
	1990	68.89	-1.62	2.21
LTE1 (IMT)	1920	76.33	-1.17	2.63
	1980	70.31	-1.53	2.12
	2110	79.87	-0.98	2.79
	2170	81.36	-0.9	3.01
LTE4 (AWS)	1710	58.66	-2.32	1.32
	1755	62.29	-2.06	2.5
	2110	79.87	-0.98	2.79
	2155	59.91	-2.23	3.24
LTE23	2000	67.01	-1.74	2.04
	2020	71.69	-1.45	2.64
	2180	71.73	-1.44	2.48
	2200	84.42	-0.74	3.12
LTE40	2300	67.71	-1.69	1.85
	2400	75.05	-1.25	1.48
LTE7 (IMT-E)	2500	63.49	-1.97	1.33
	2570	63.78	-1.95	1.46
	2620	60.09	-2.21	1.14
	2690	45.78	-3.39	0.08

- Remark
  - 6mx3mx3m Anechoic Chamber
  - Matching on the standard test board (141 x 50 mm)
  - Temp. : 25℃ / Humidity : 50~55%

2.4. Radiation patterns

	LTE12	LTE17
XY plane		
XZ plane		
YZ plane		

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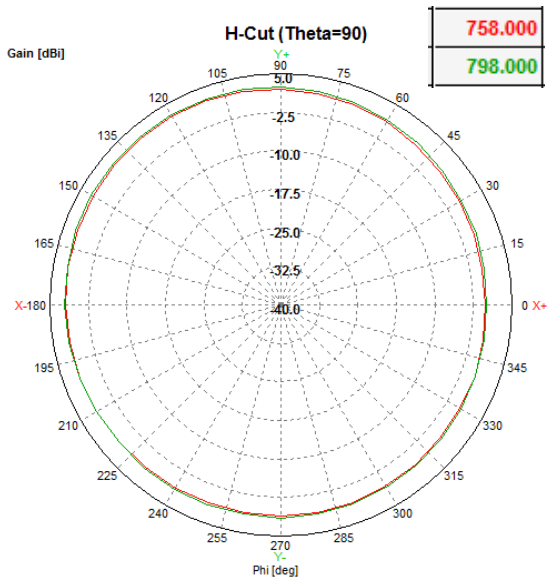
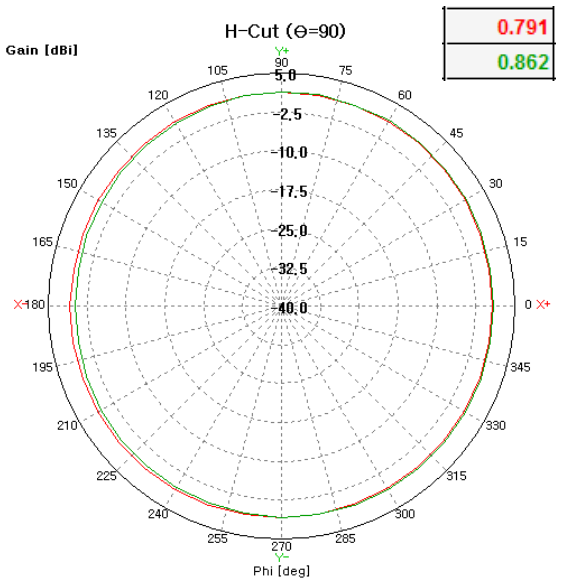
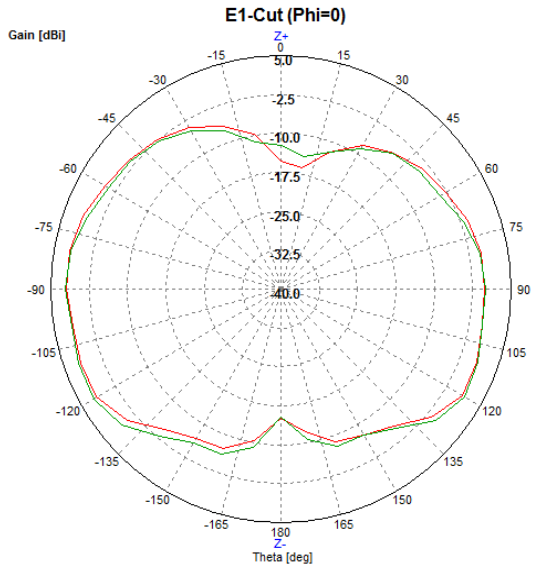
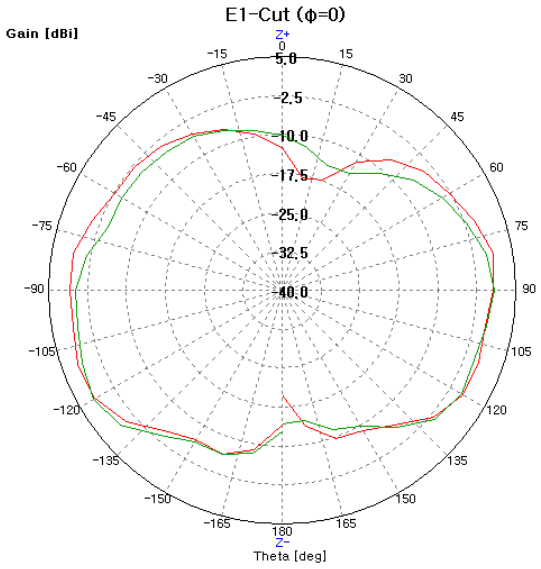
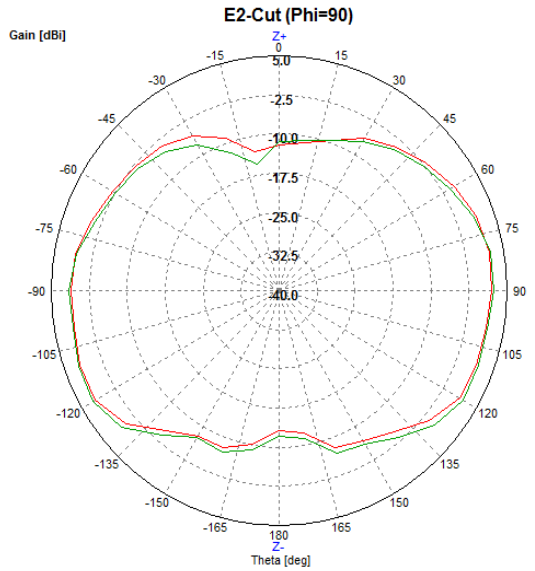
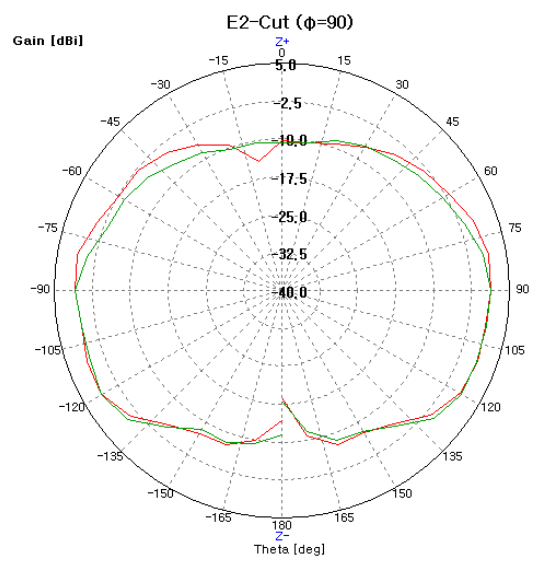
XY plane		
XZ plane		
YZ plane		

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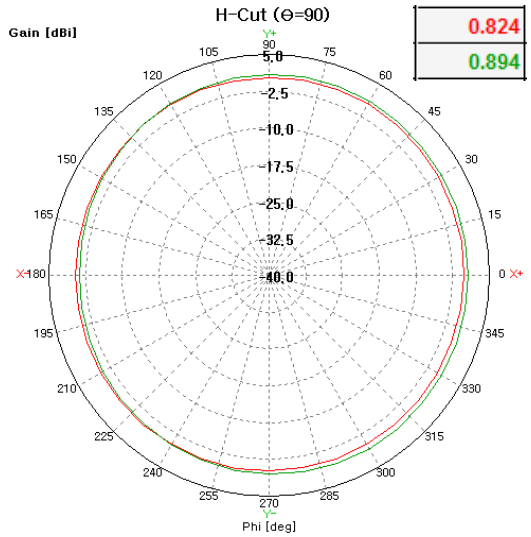
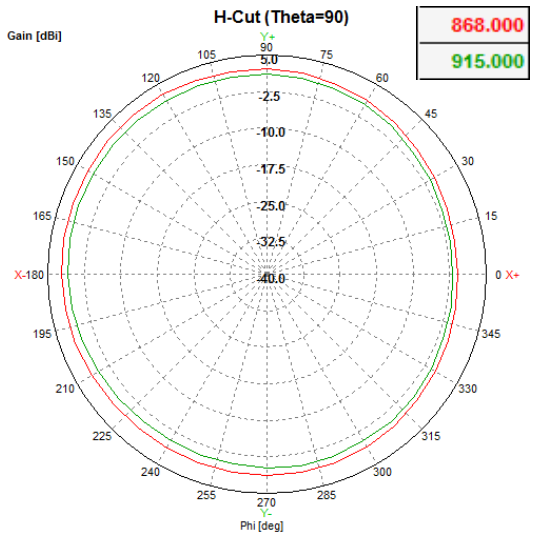
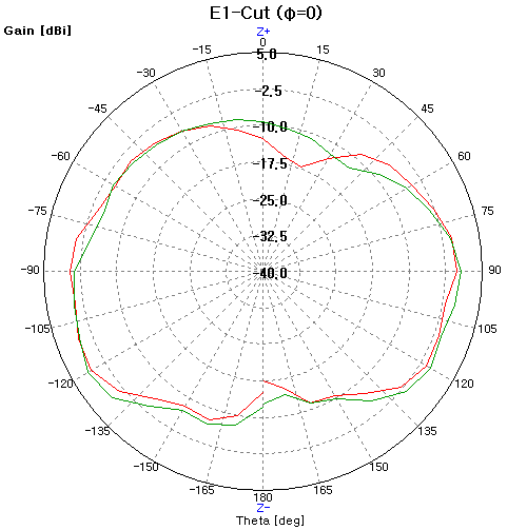
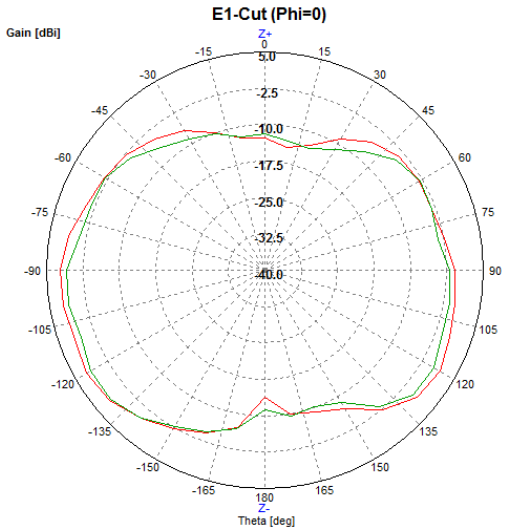
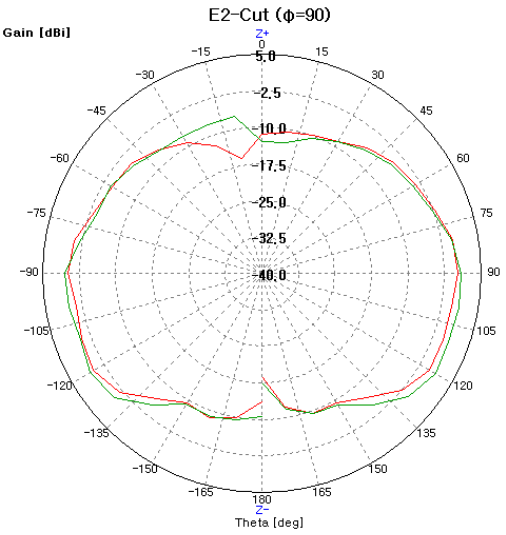
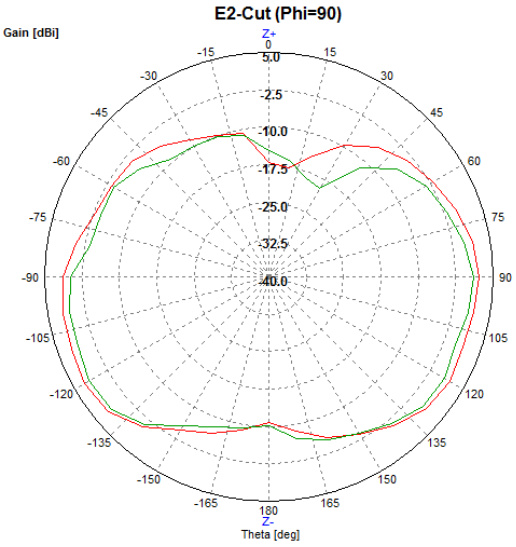
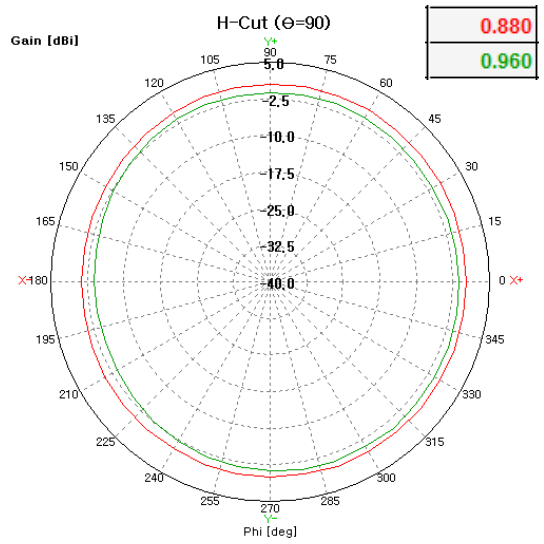
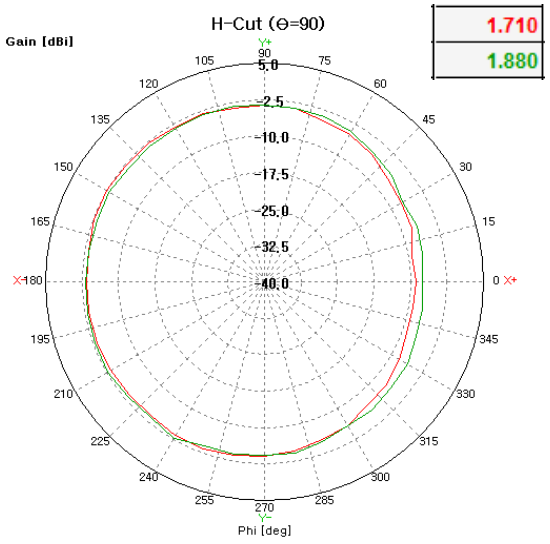
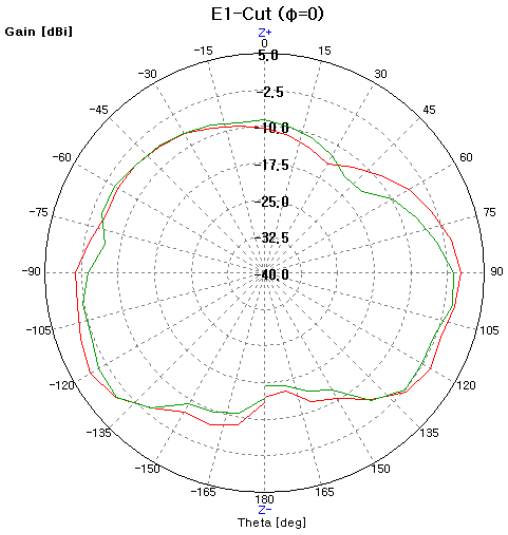
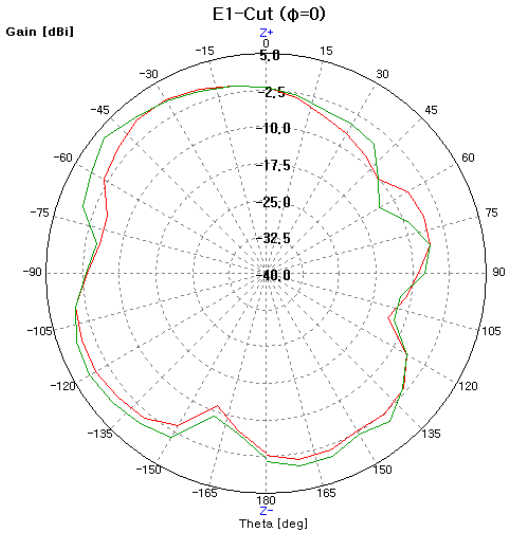
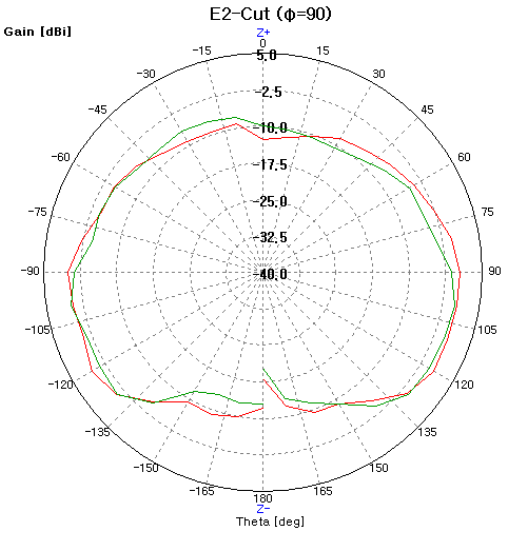
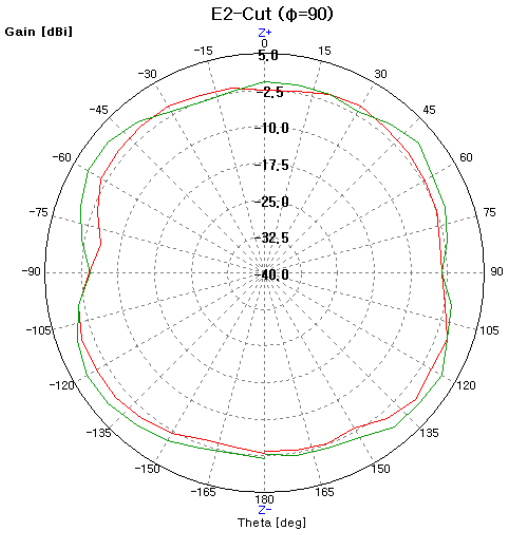
XY plane		
XZ plane		
YZ plane		

	LTE8 (E-GSM)	LTE3 (DCS)
XY plane		
XZ plane		
YZ plane		

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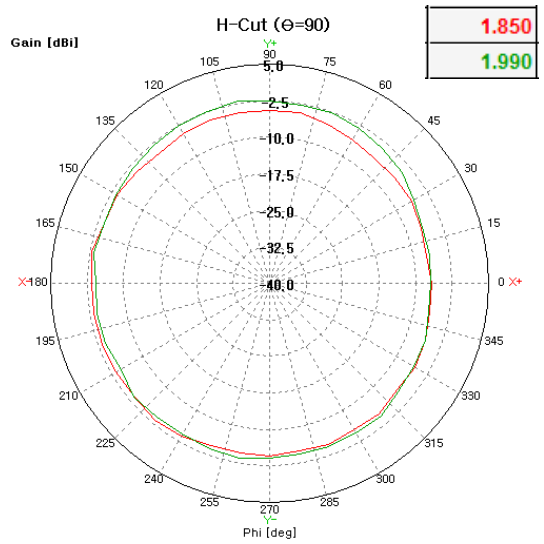
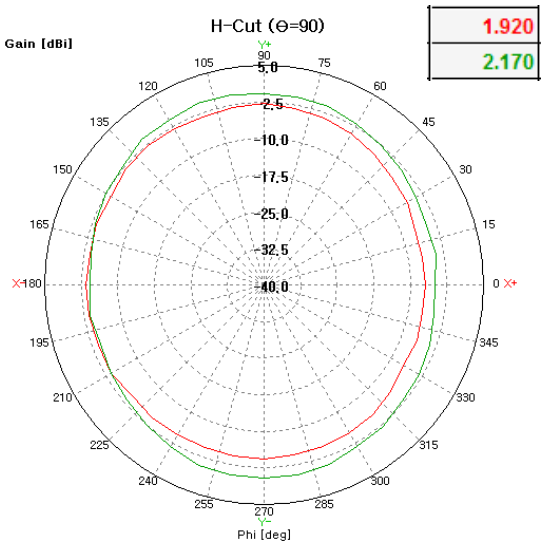
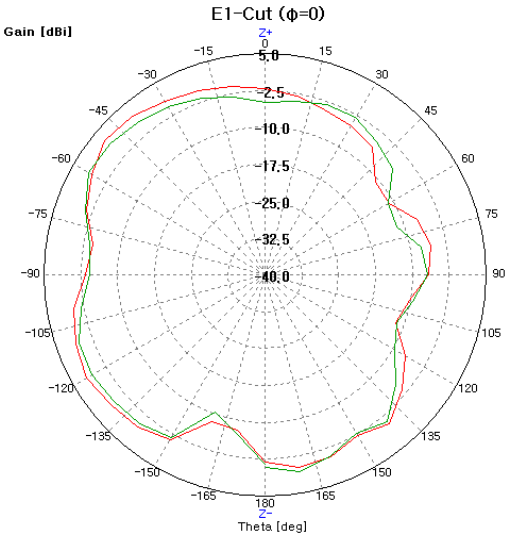
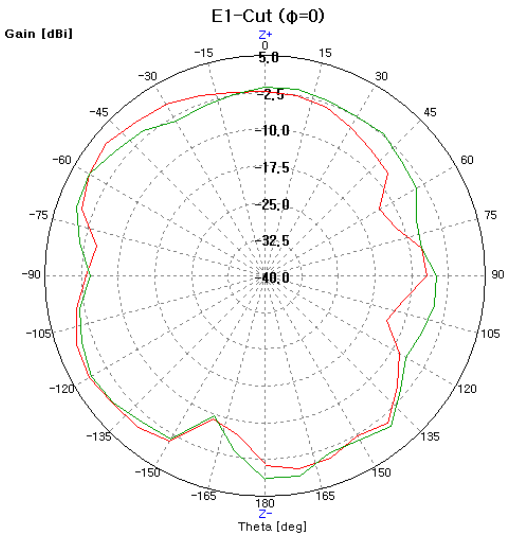
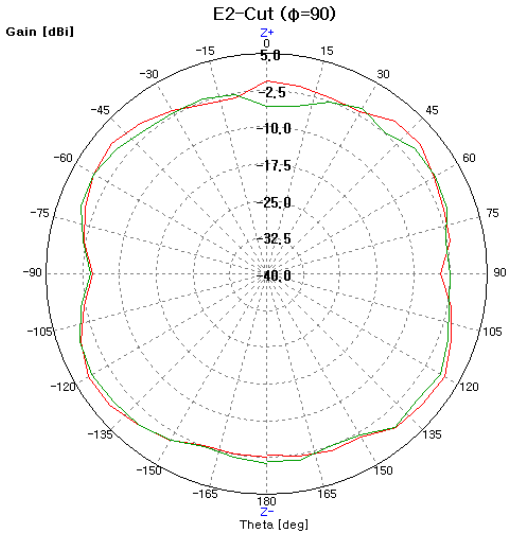
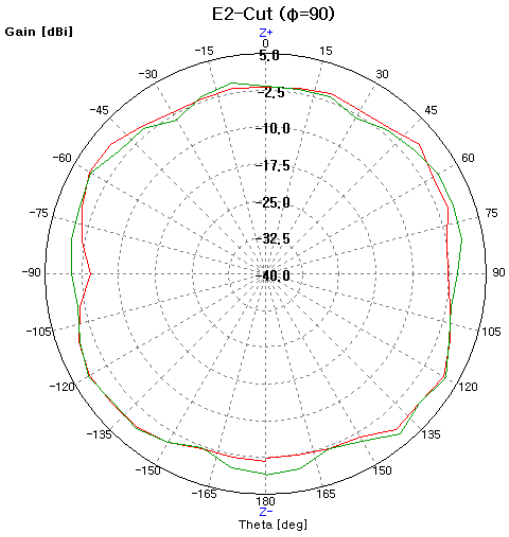
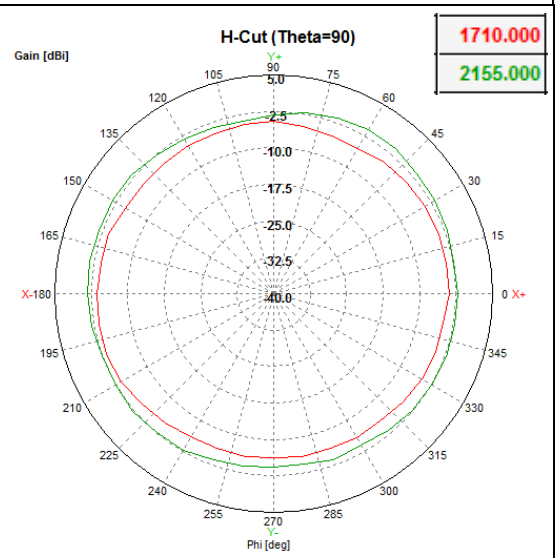
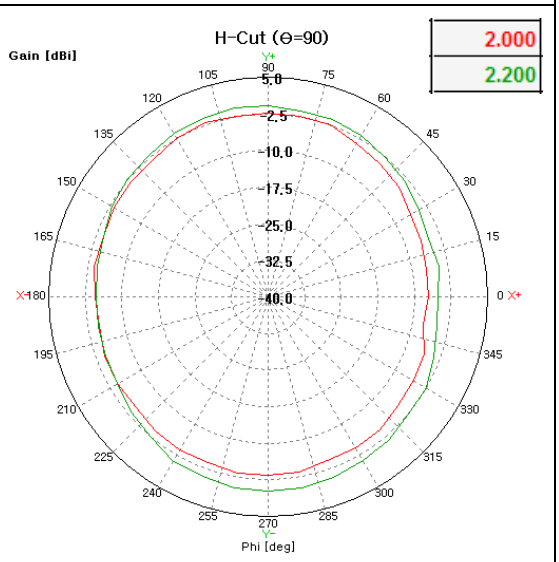
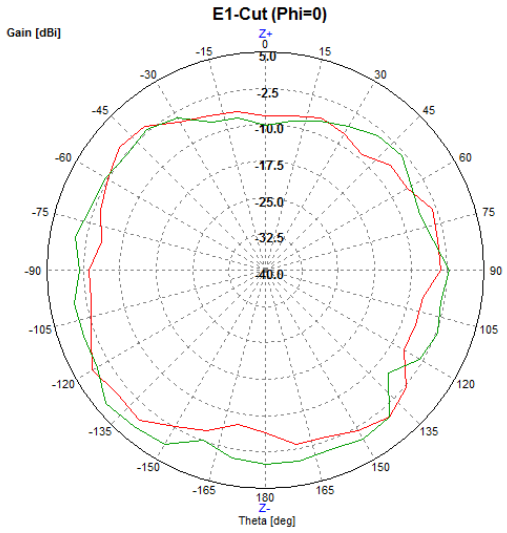
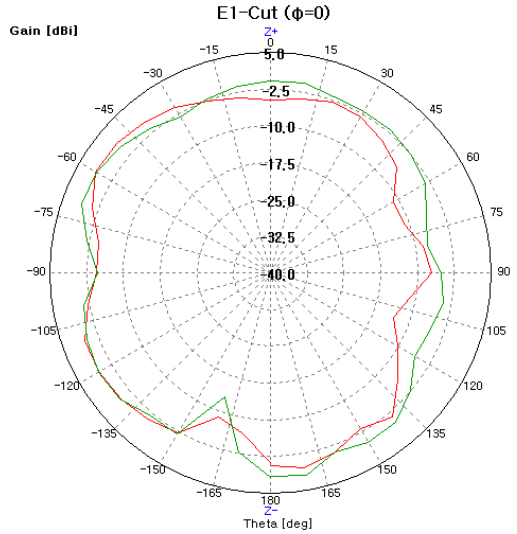
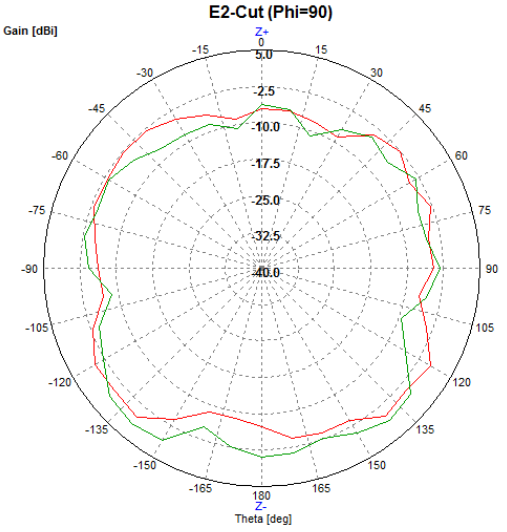
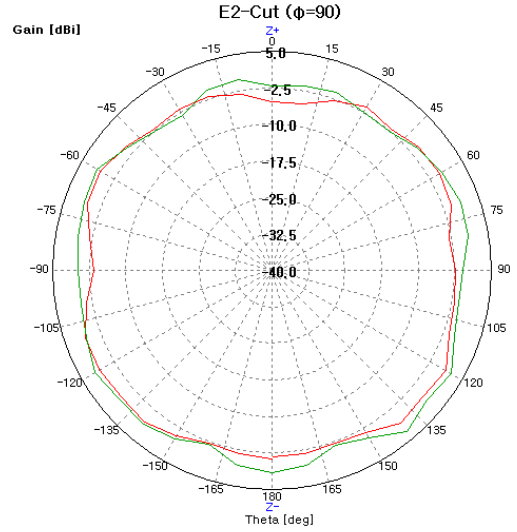
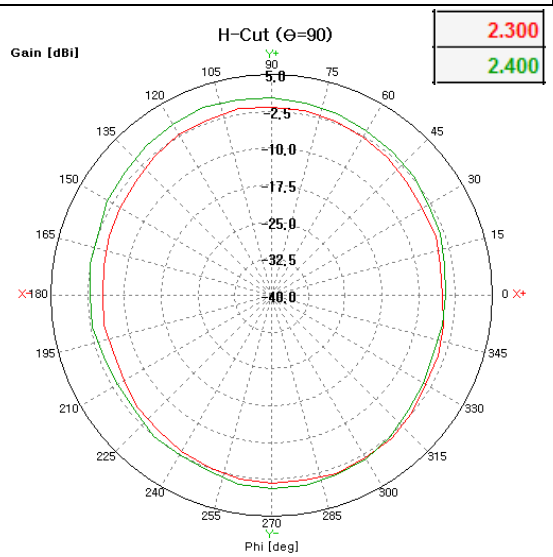
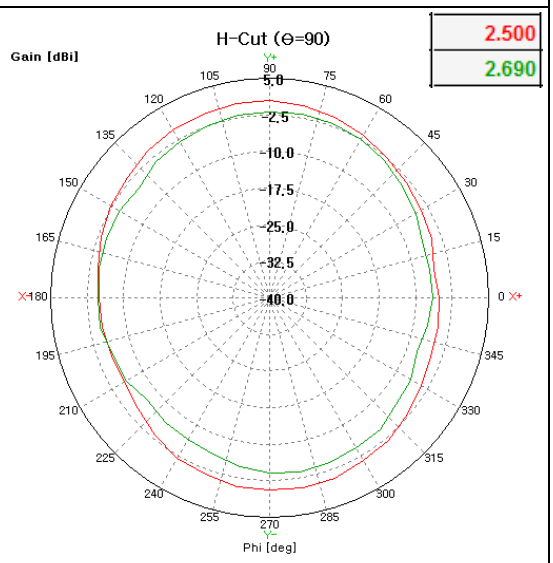
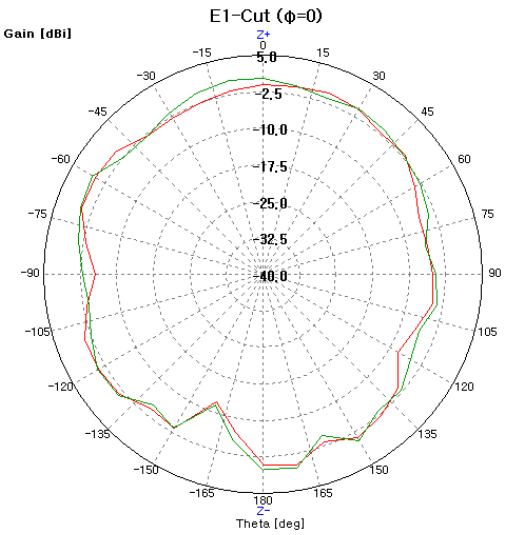
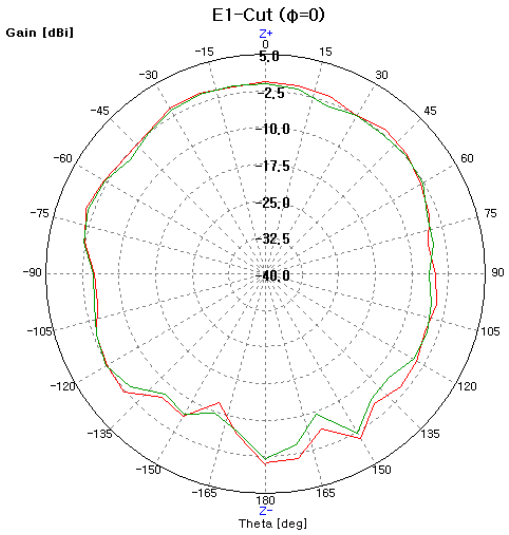
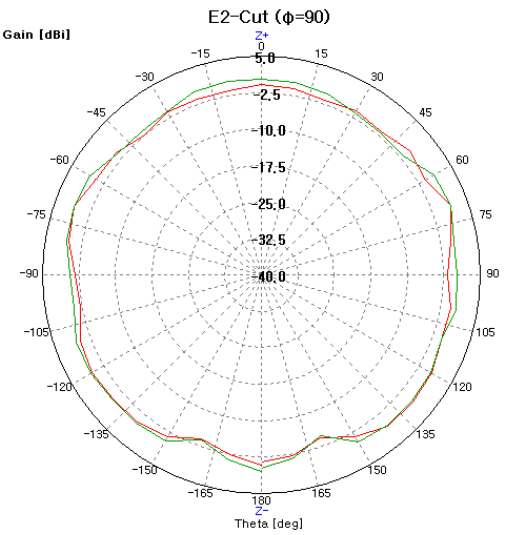
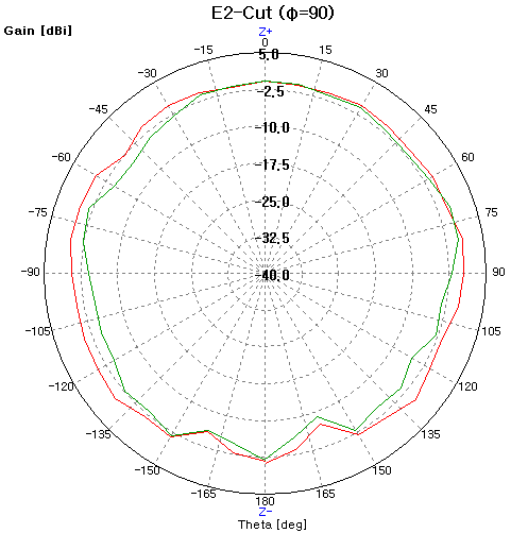
XY plane		
XZ plane		
YZ plane		

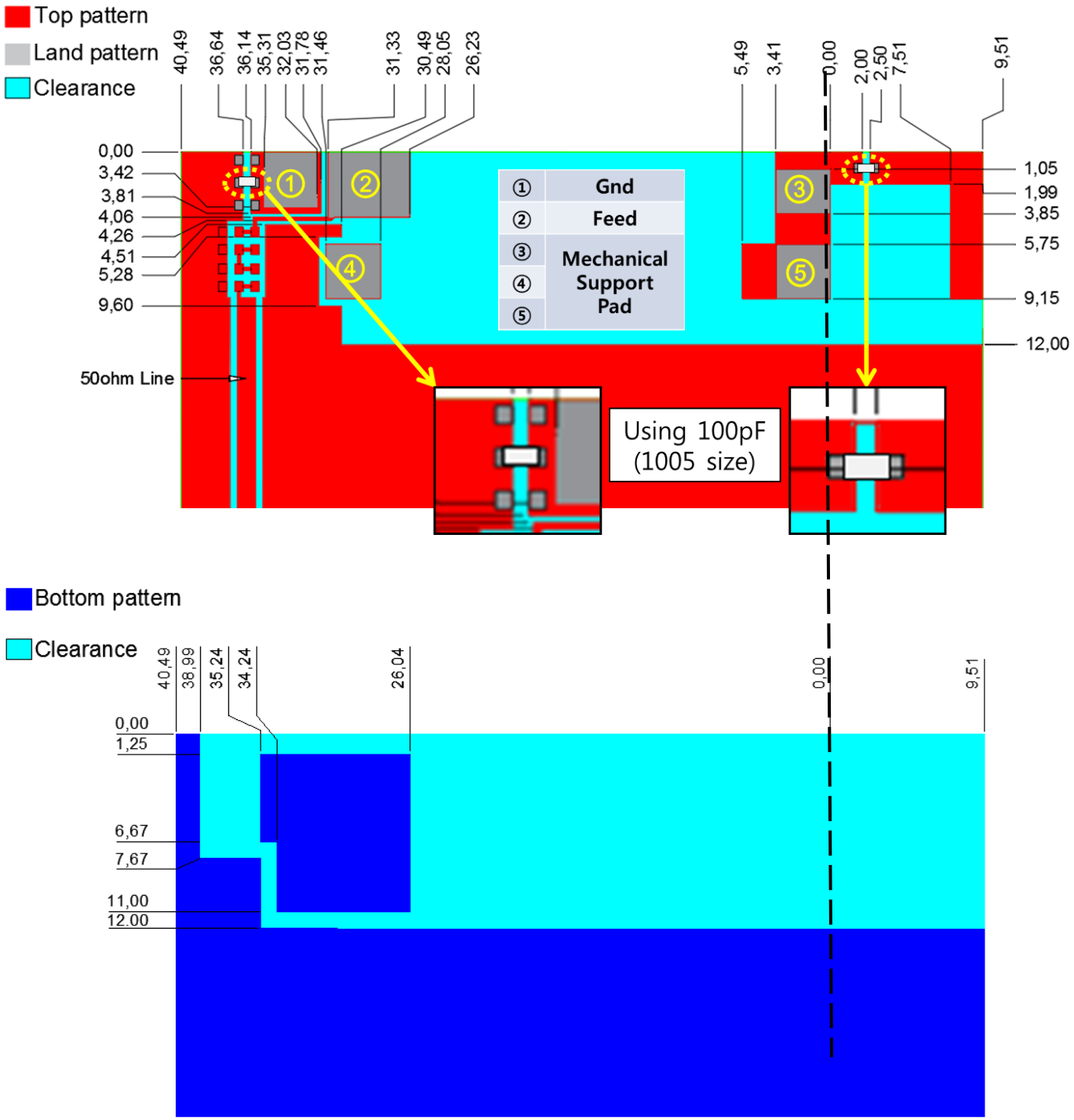
	LTE4	LTE23
XY plane		
XZ plane		
YZ plane		

	LTE40	LTE7 (IMT-E)
XY plane		
XZ plane		
YZ plane		

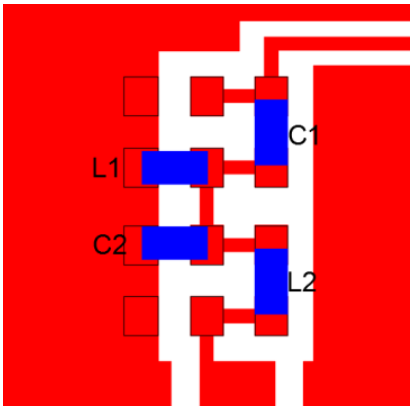
3. SOLDERING RECOMMENDATIONS

3.1. Soldering Land Pattern @ global Band

*** PCB Thickness (mm): FR4 1.6T**



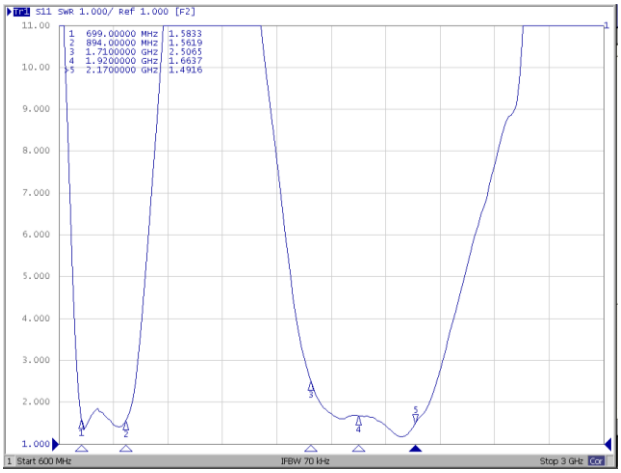
3.2. Matching circuit @ global band



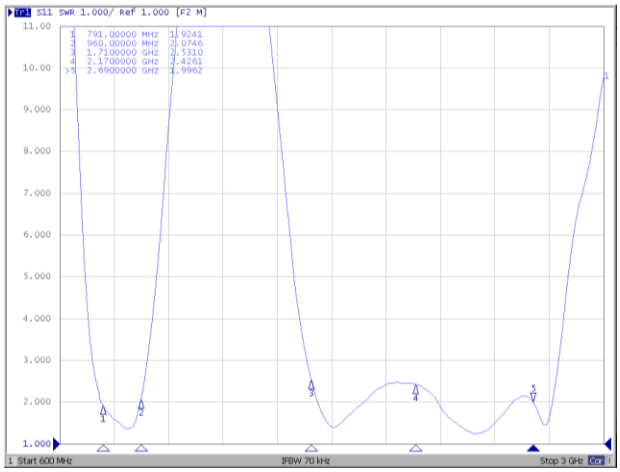
C1 (Series)	2.2 pF
C2 (Shunt)	0.5 pF
L1 (Shunt)	DNI
L2 (Series)	1.8 nH

3.3. US / EU Band switching

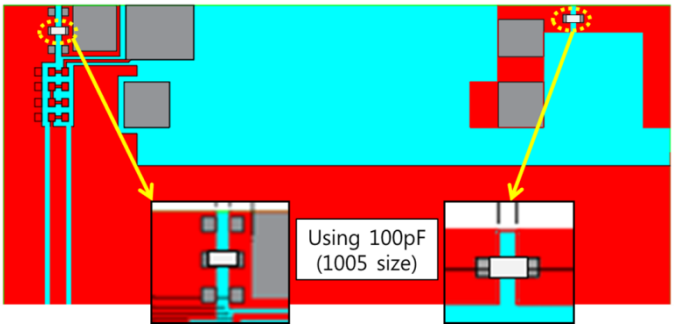
*** same antenna but different matching circuit (US/EU)**

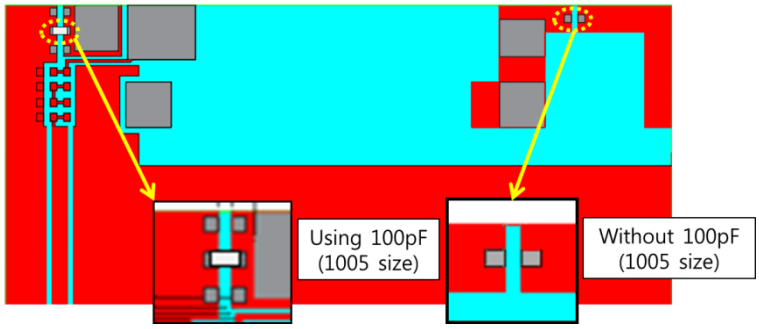


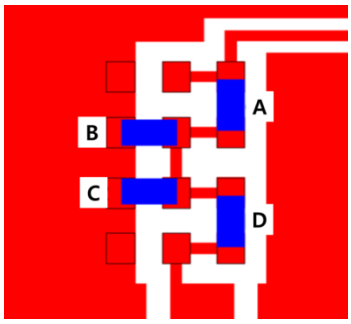
- US Band VSWR @ EV Board -



- EU Band VSWR @ EV Board -







- Matching Circuit -

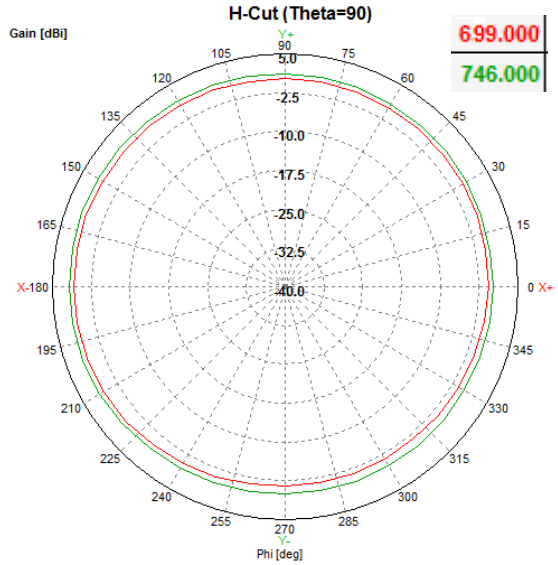
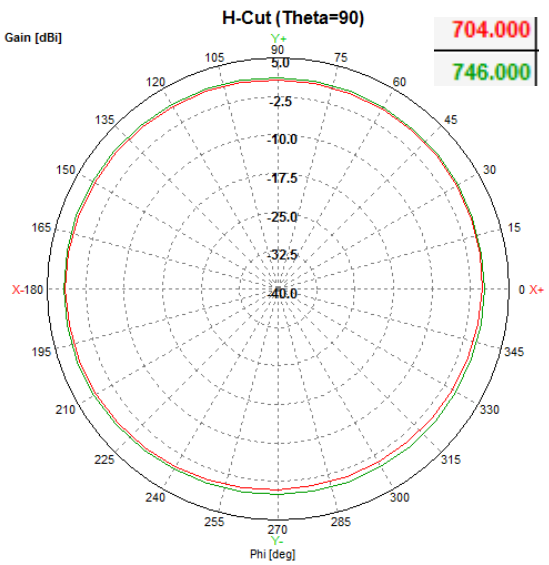
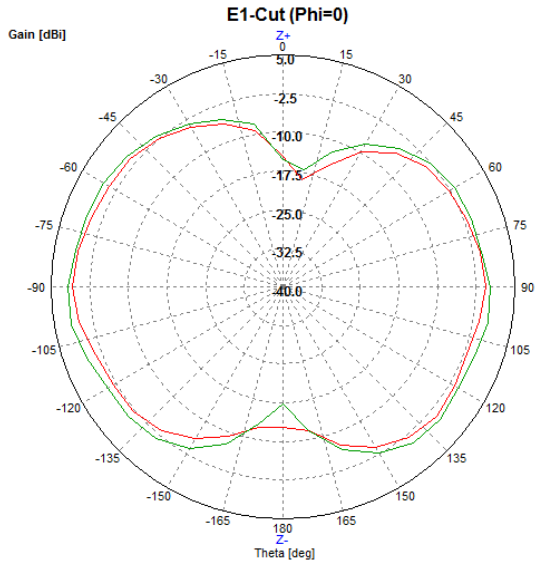
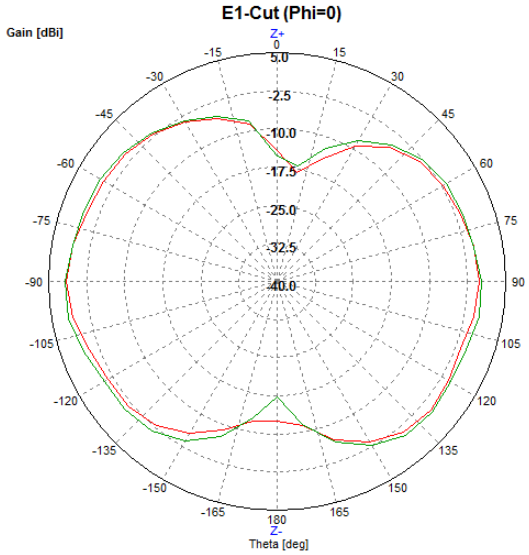
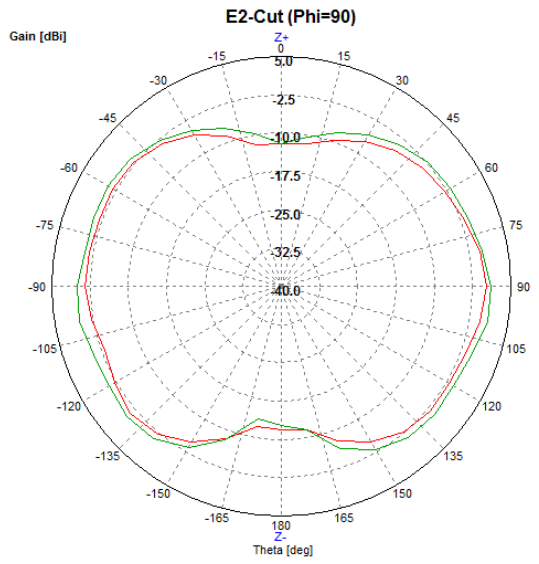
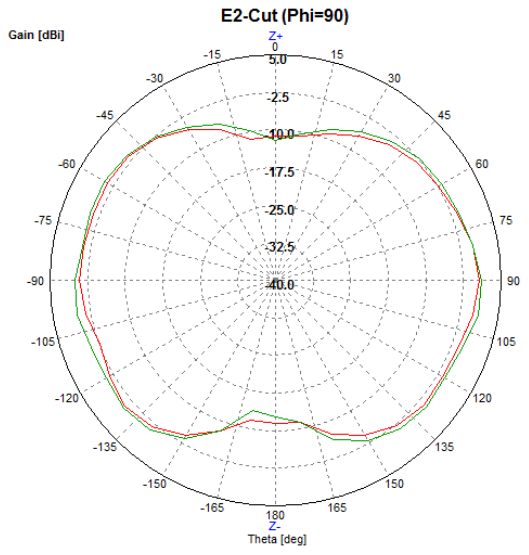
	US Band	EU Band
A (Series)	2pF	2.4pF
B (Shunt)	1pF	DNI
C (Shunt)	12nH	0.5pF
D (Series)	3.3nH	2.7nH

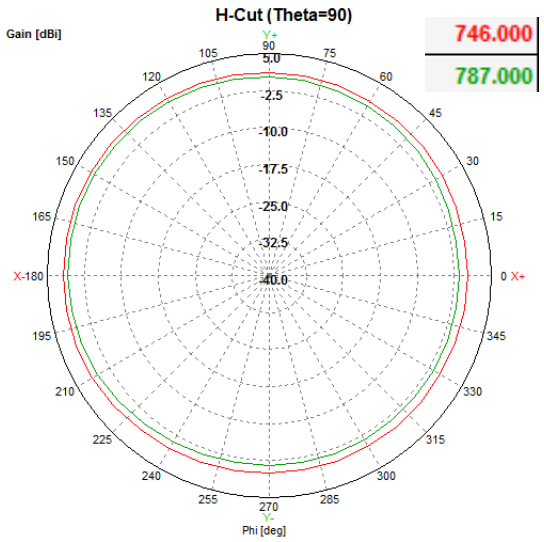
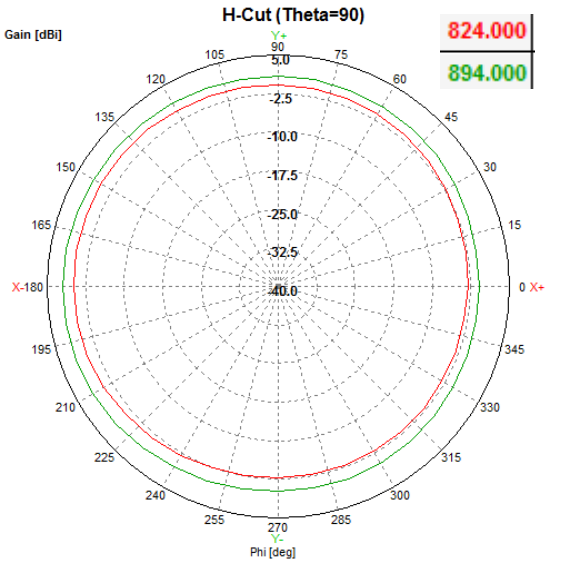
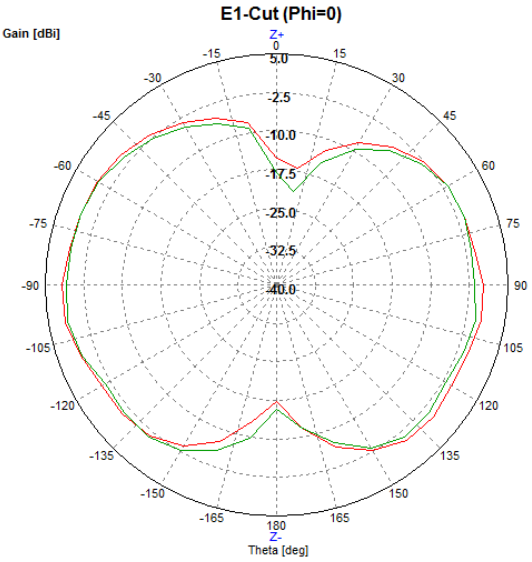
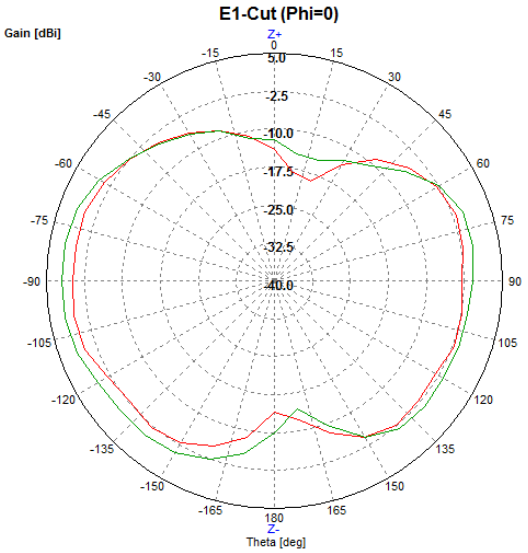
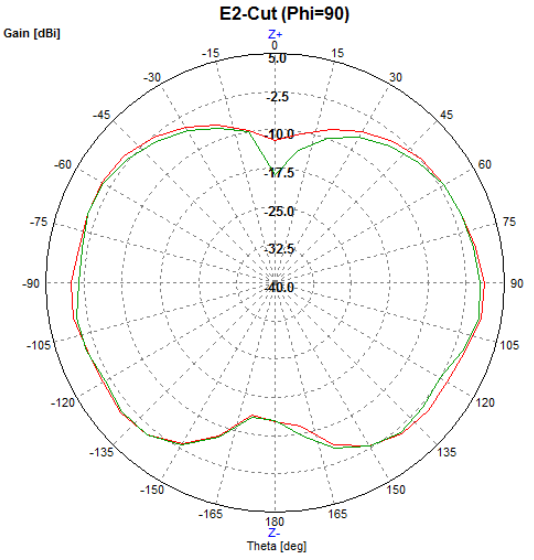
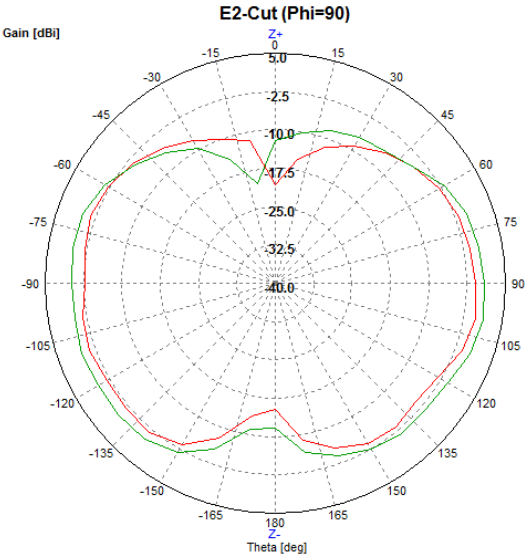
- Measurement Result @ US Band

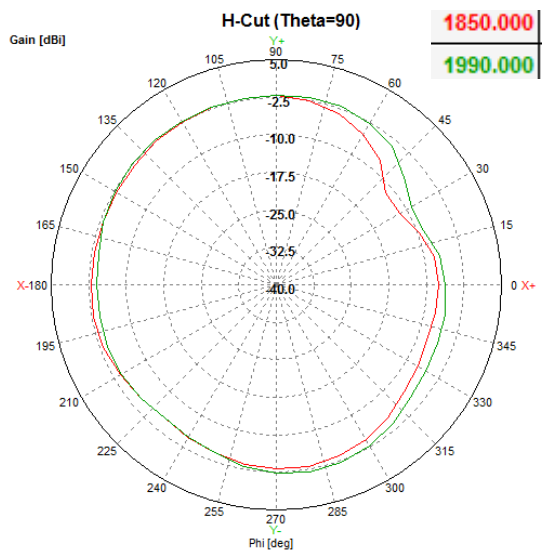
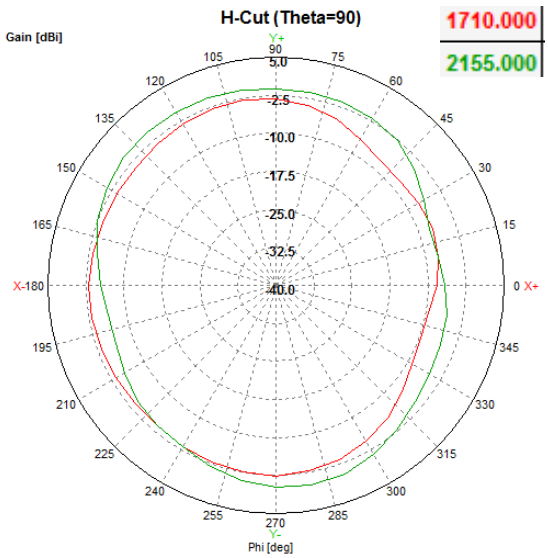
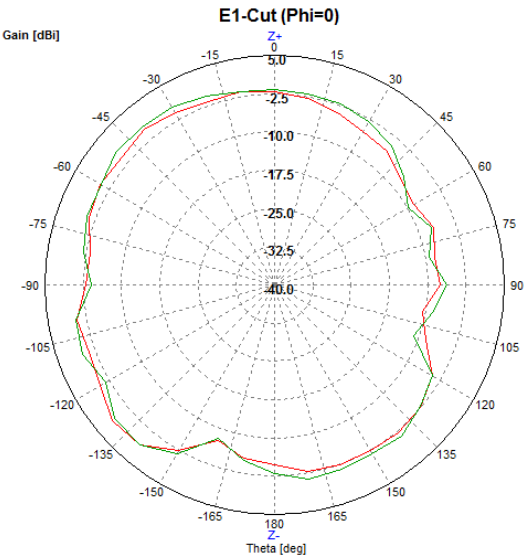
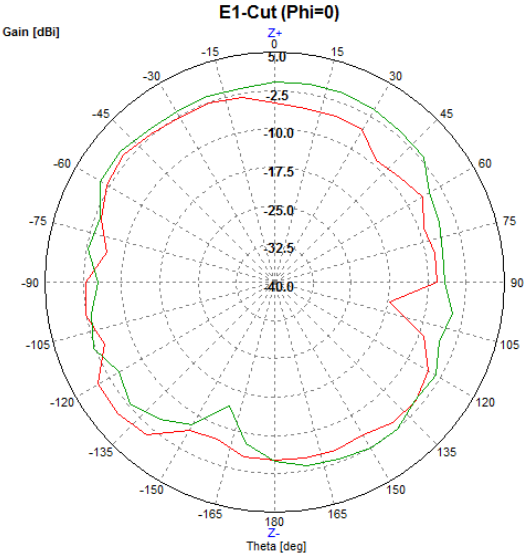
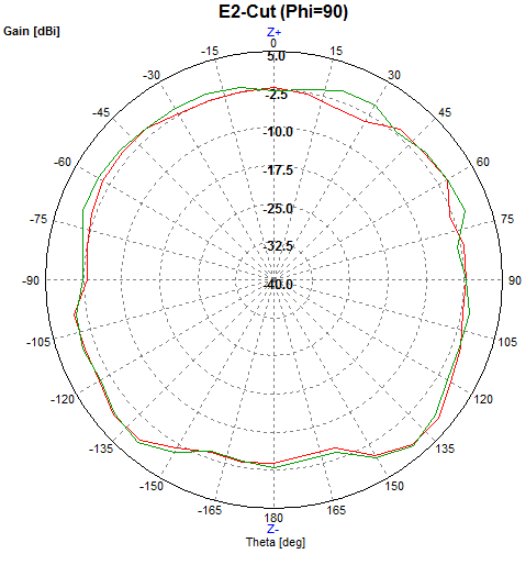
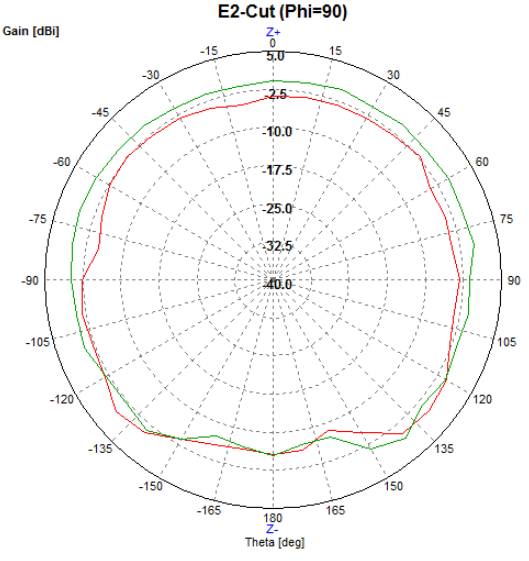
Band	Frequency [MHz]	EFF. [%]	Avg. (dBi)	Peak (dBi)
LTE12	699	60.71	-2.17	0.94
	716	78.50	-1.05	2.07
	729	78.42	-1.06	1.96
	746	79.23	-1.01	1.84
LTE17	704	68.06	-1.67	1.46
	716	78.50	-1.05	2.07
	734	79.09	-1.02	1.93
	746	79.23	-1.01	1.84
LTE13	746	79.23	-1.01	1.84
	756	77.94	-1.08	1.77
	777	67.94	-1.68	1.35
	787	69.35	-1.59	1.51
GSM850 LTE5 WCDMA5	824	54.73	-2.62	0.58
	849	74.22	-1.29	1.77
	869	69.49	-1.58	1.43
	894	78.91	-1.03	2.16
LTE2 WCDMA2	1850	65.97	-1.81	2.99
	1910	71.03	-1.49	3.12
	1930	64.57	-1.90	2.60
	1990	72.18	-1.42	2.87
WCDMA4	1710	45.97	-3.38	1.02
	1755	67.93	-1.68	2.91
	2110	74.80	-1.26	2.20
	2155	64.62	-1.90	0.98

- Remark
  - 6mx3mx3m Anechoic Chamber
  - Matching on the standard test board (141 x 50 mm)
  - Temp. : 25℃ / Humidity : 50~55%

* 2D Radiation patterns @ US Band

	LTE12	LTE17
H plane		
E1 plane		
E2 plane		

	LTE13	GSM850/LTE5/WCDMA5
H plane		
E1 plane		
E2 plane		

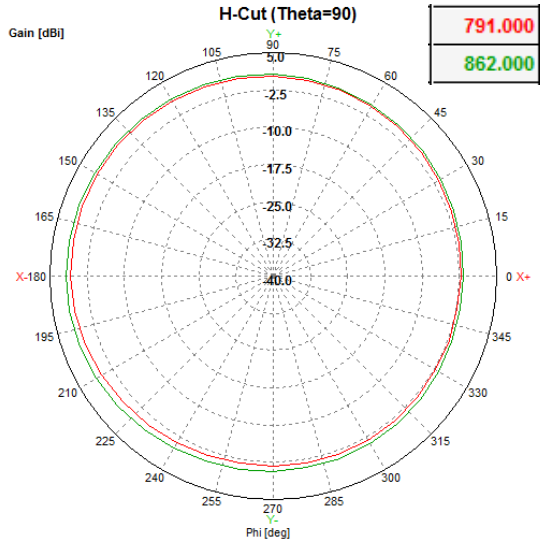
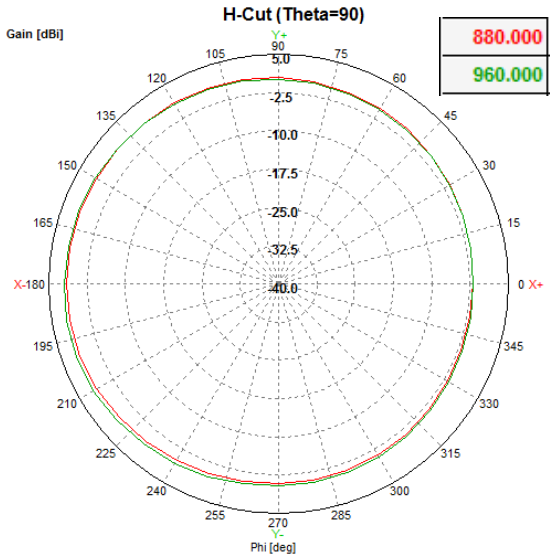
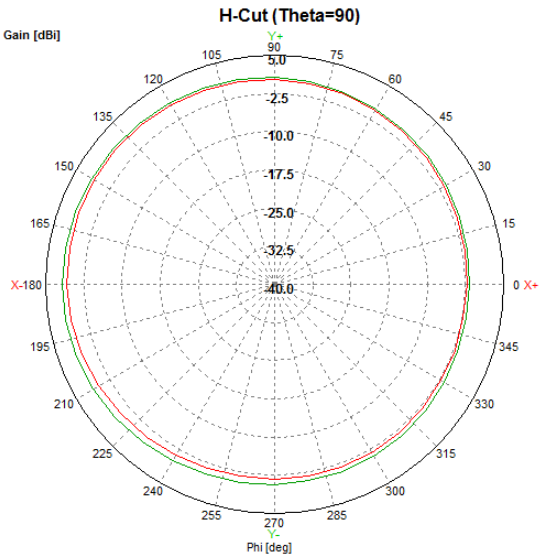
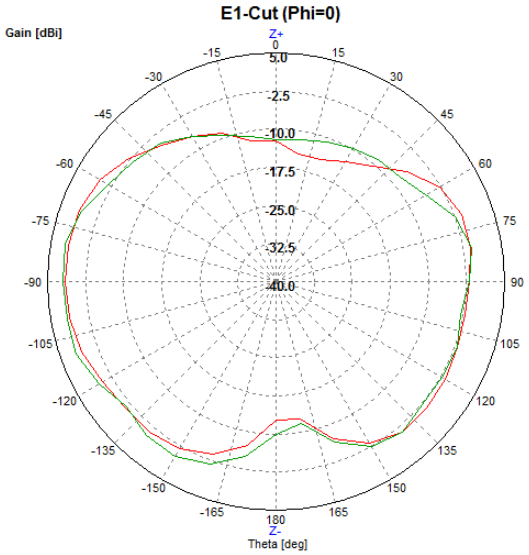
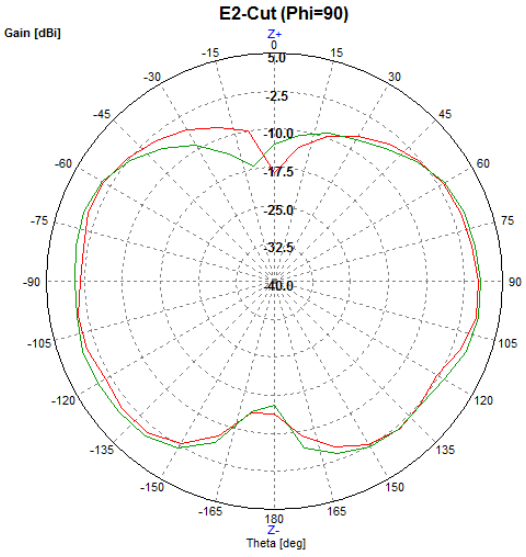
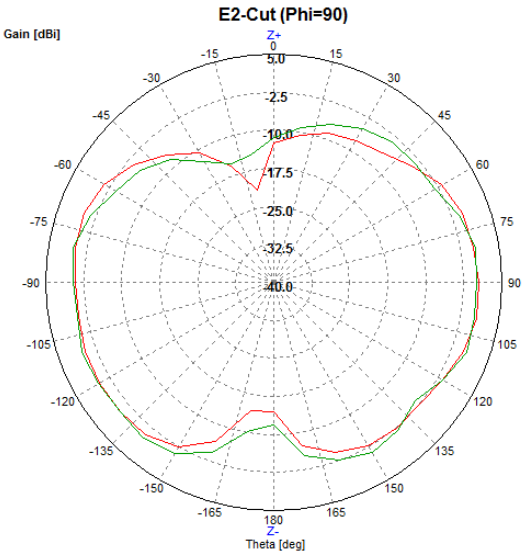
	LTE2/WCMA2	WCDMA4
H plane		
E1 plane		
E2 plane		

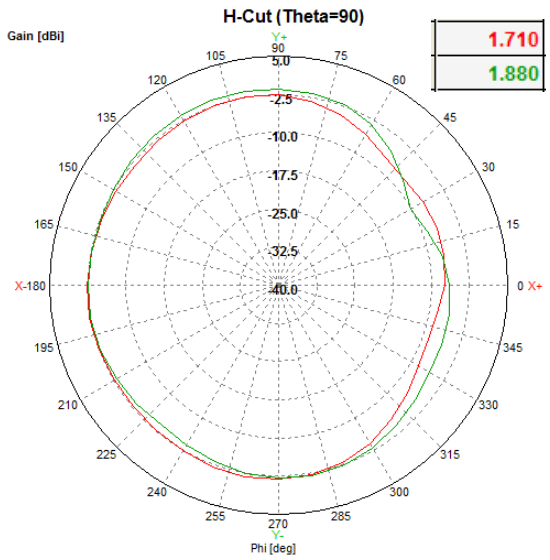
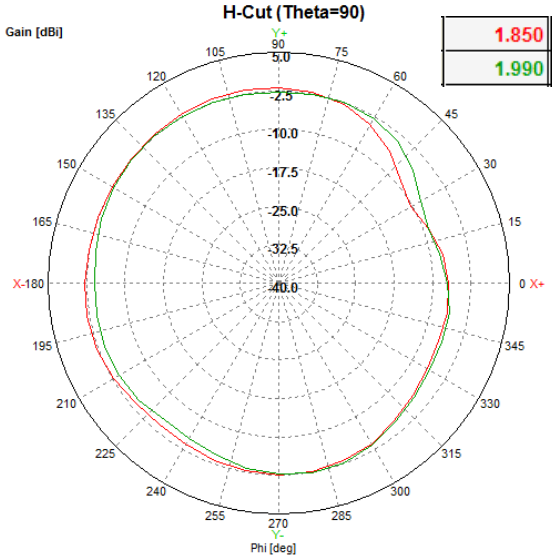
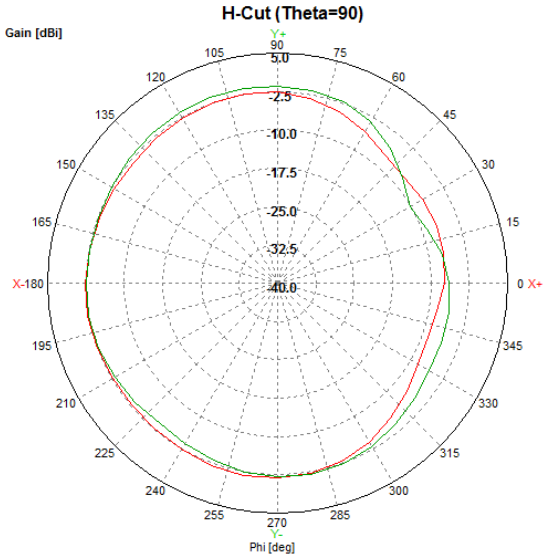
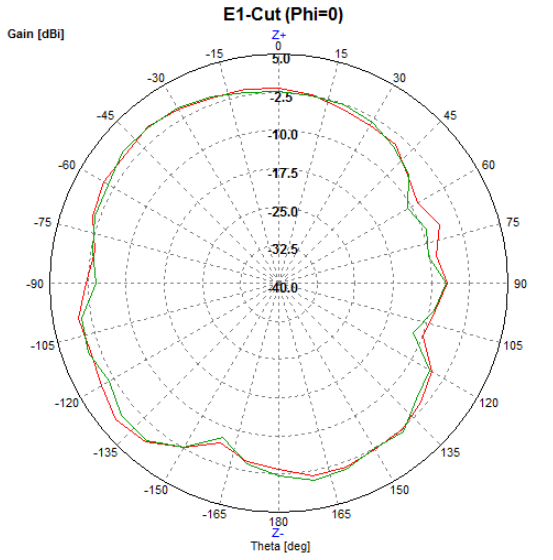
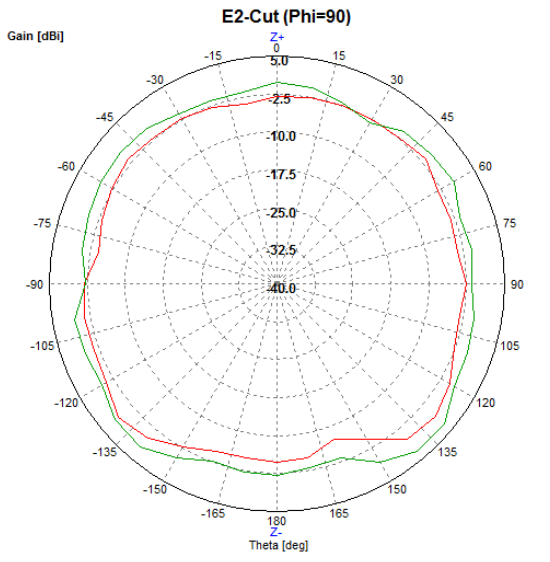
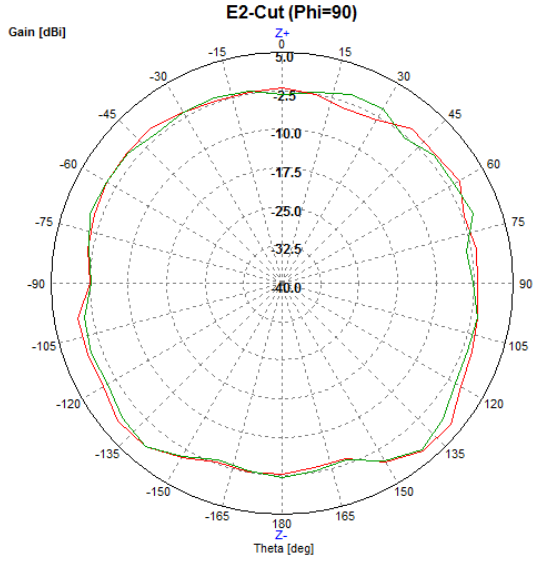
- Measurement Result @ EU Band

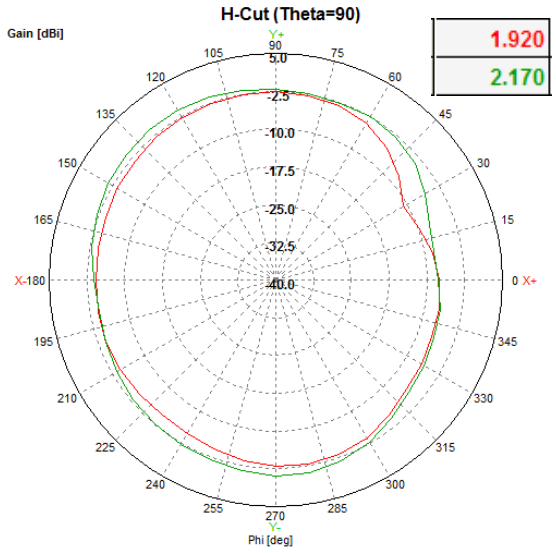
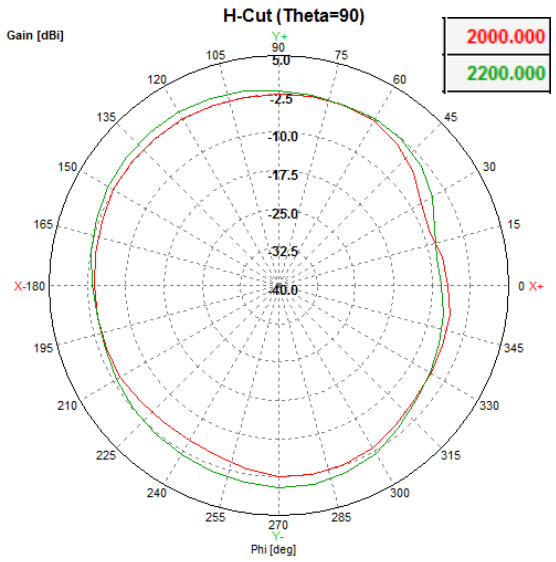
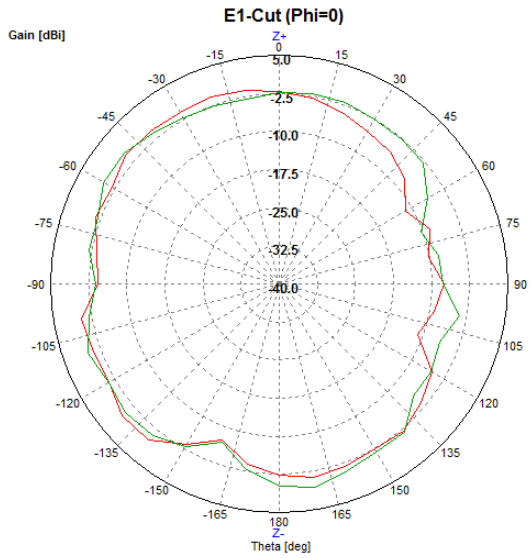
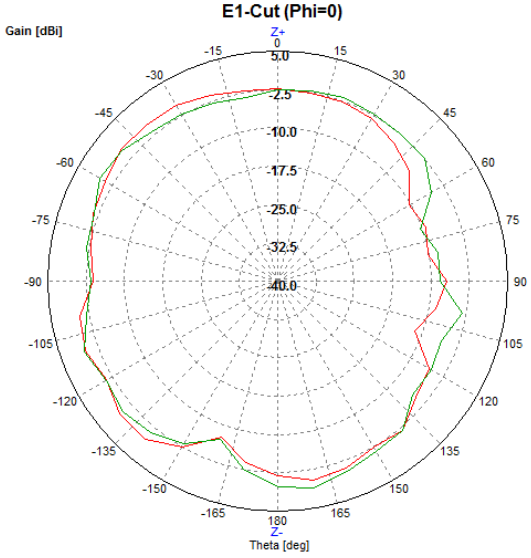
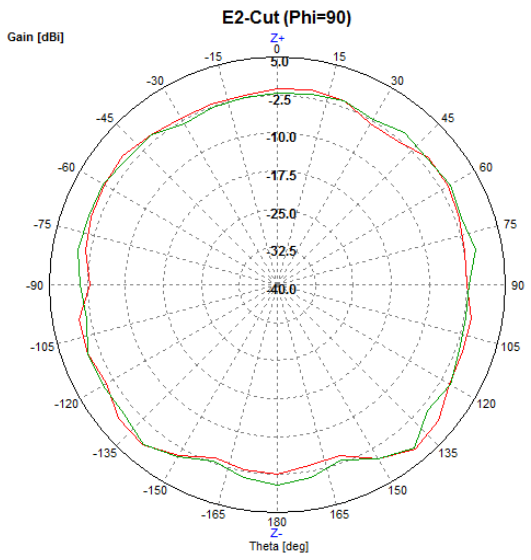
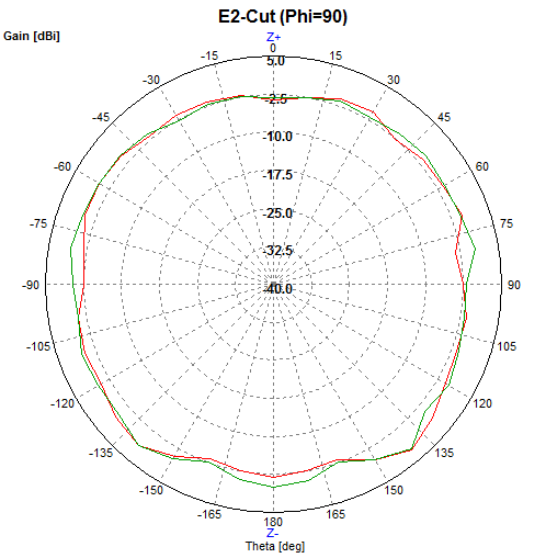
Band	Frequency [MHz]	EFF. [%]	Avg. (dBi)	Peak (dBi)
LTE20	791	67.68	-1.70	1.39
	821	57.94	-2.37	0.82
	832	62.10	-2.07	1.13
	862	77.74	-1.09	1.95
GSM900	880	70.76	-1.50	1.78
	915	86.29	-0.64	2.91
	925	77.47	-1.11	2.51
	960	71.42	-1.46	2.34
DCS	1710	52.29	-2.82	1.19
	1785	71.39	-1.46	2.85
	1805	62.12	-2.07	2.41
	1880	80.01	-0.97	3.66
PCS	1850	72.89	-1.37	3.31
	1910	70.72	-1.5	3.09
	1930	65.4	-1.84	2.69
	1990	65.82	-1.82	2.55
WCDMA	1920	64.10	-1.93	2.67
	1980	68.24	-1.66	2.69
	2110	65.83	-1.82	2.27
	2170	66.93	-1.74	2.18
LTE23	2000	66.35	-1.78	2.66
	2020	66.58	-1.77	2.81
	2180	69.92	-1.55	2.42
	2200	71.33	-1.47	2.51
LTE40	2300	71.61	-1.45	1.85
	2400	71.52	-1.46	1.7
LTE7	2500	61.76	-2.09	0.90
	2570	68.36	-1.65	1.32
	2620	48.84	-3.11	0.36
	2690	43.00	-3.67	0.43

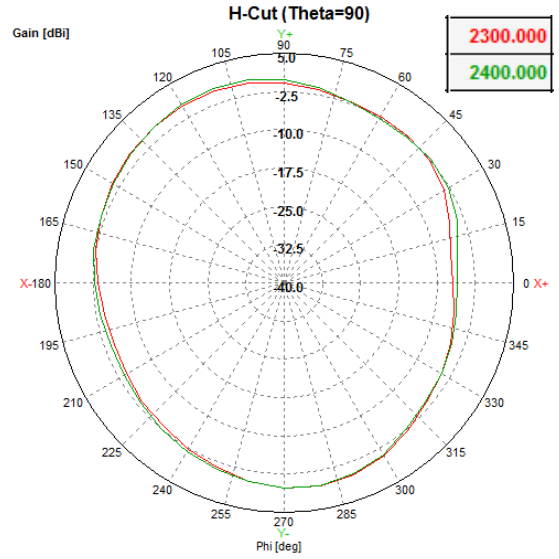
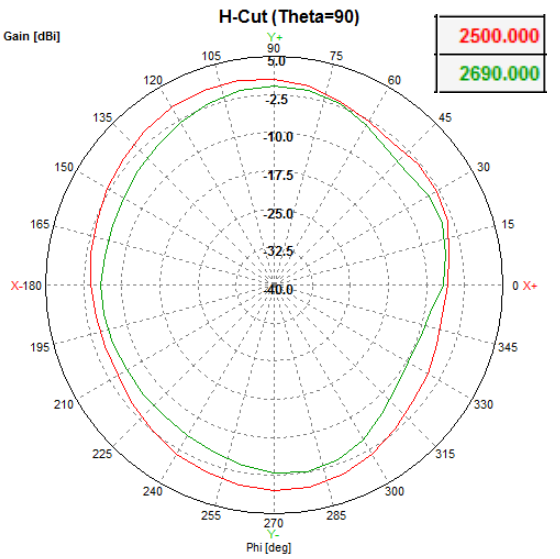
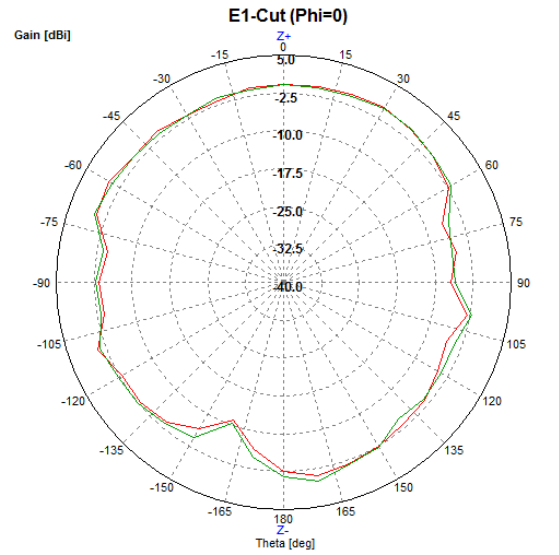
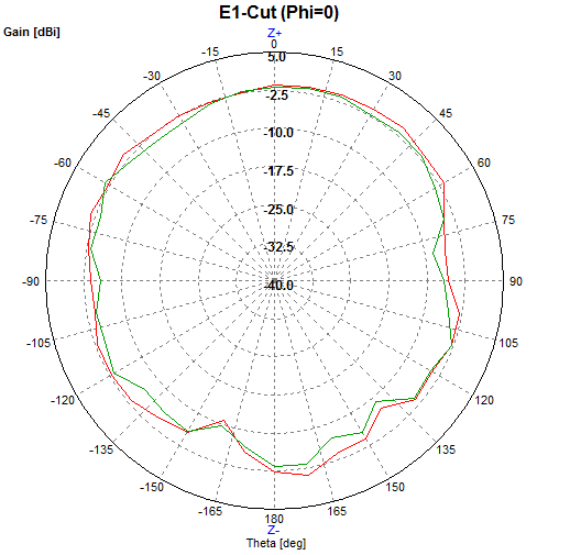
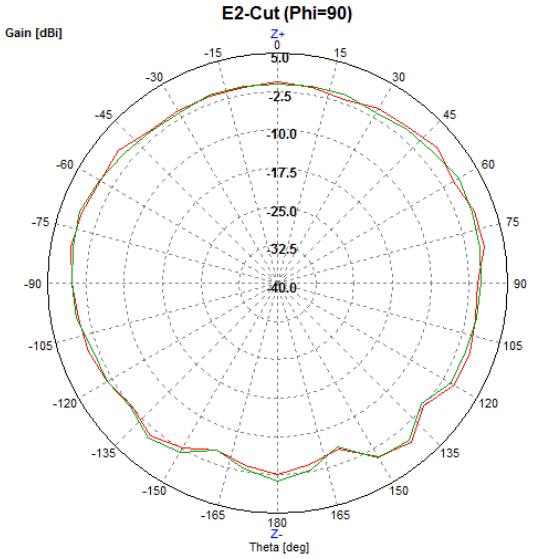
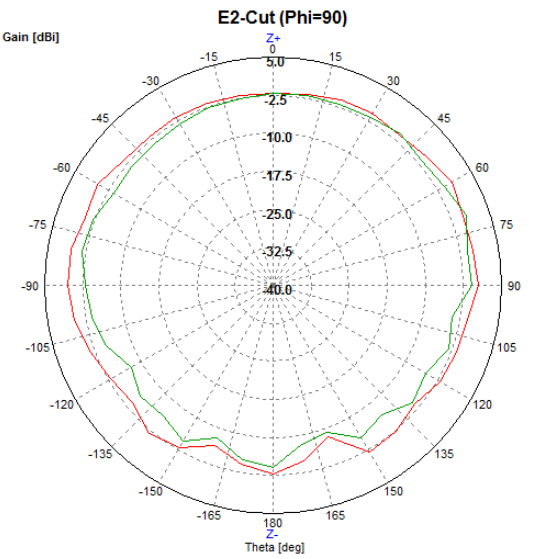
- Remark
  - 6mx3mx3m Anechoic Chamber
  - Matching on the standard test board (141 x 50 mm)
  - Temp. : 25℃ / Humidity : 50~55%

* 2D Radiation patterns @ EU Band

	LTE20	GSM 900
H plane		
E1 plane		
E2 plane		

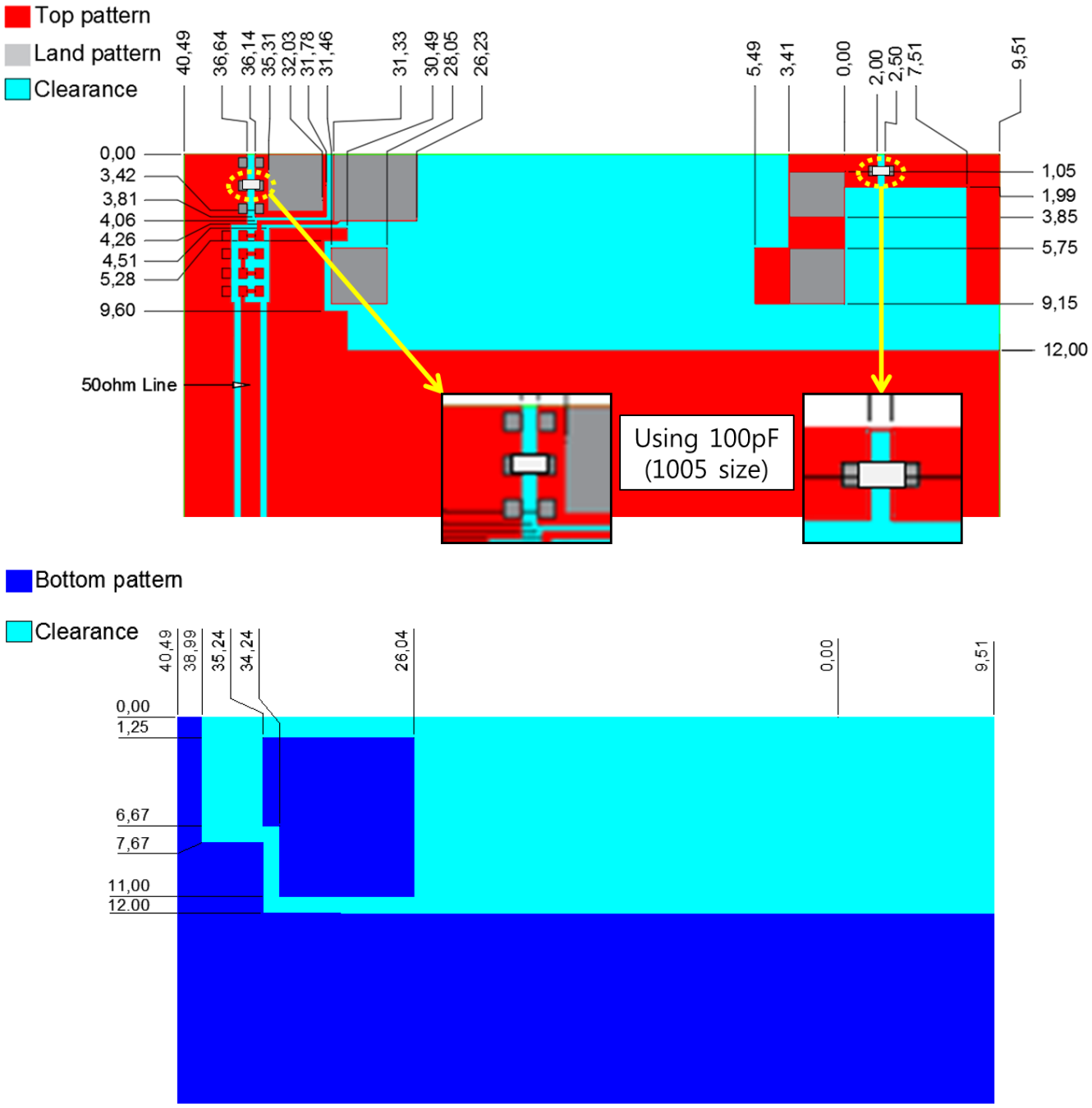
	DCS	PCS
H plane		
E1 plane		
E2 plane		

	WCDMA	LTE23
H plane		
E1 plane		
E2 plane		

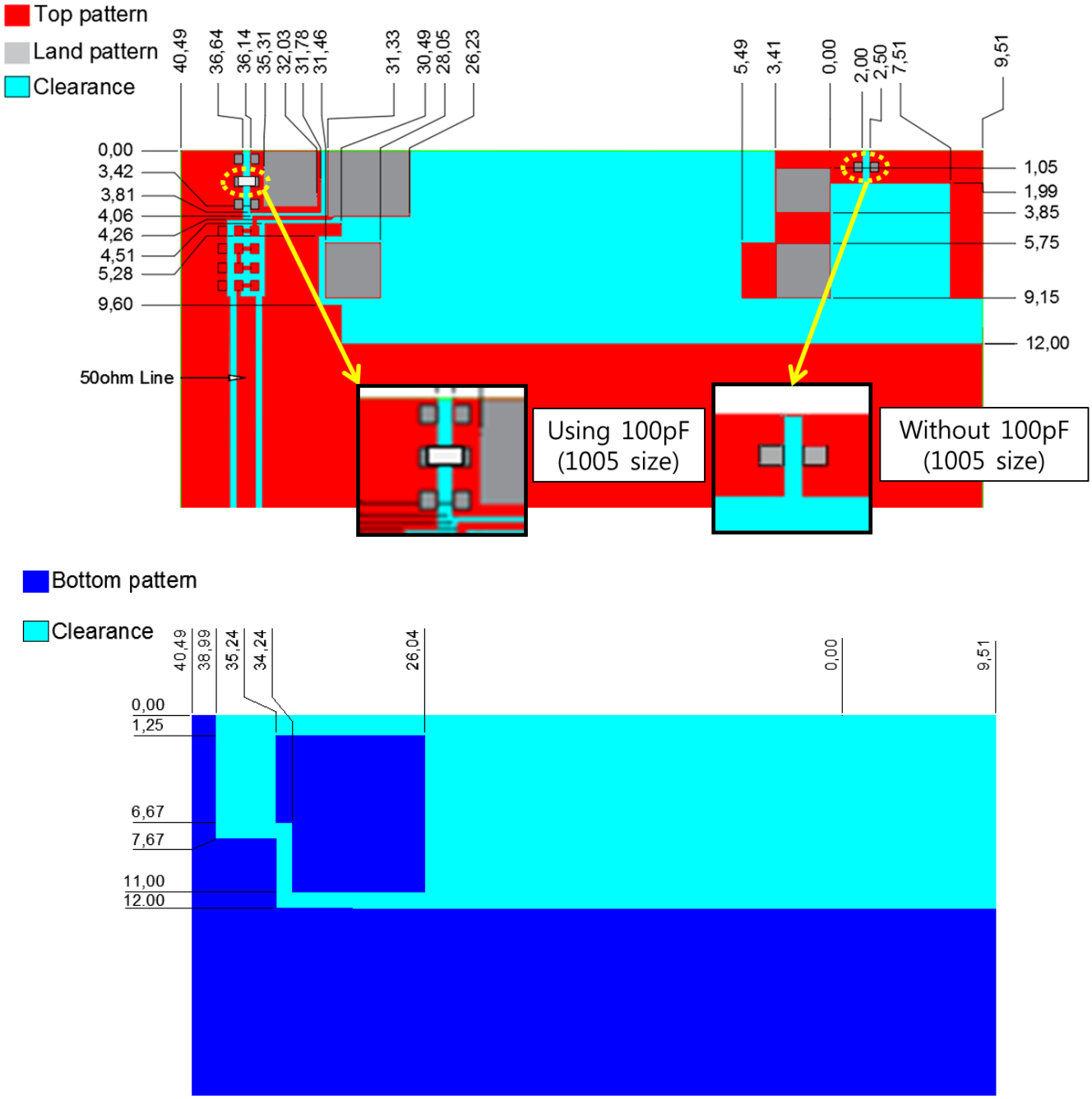
	LTE40	LTE7
H plane		
E1 plane		
E2 plane		

3.3.1 Soldering Land Pattern @ US Band / EU Band

*** PCB Thickness (mm): FR4 1.6T**

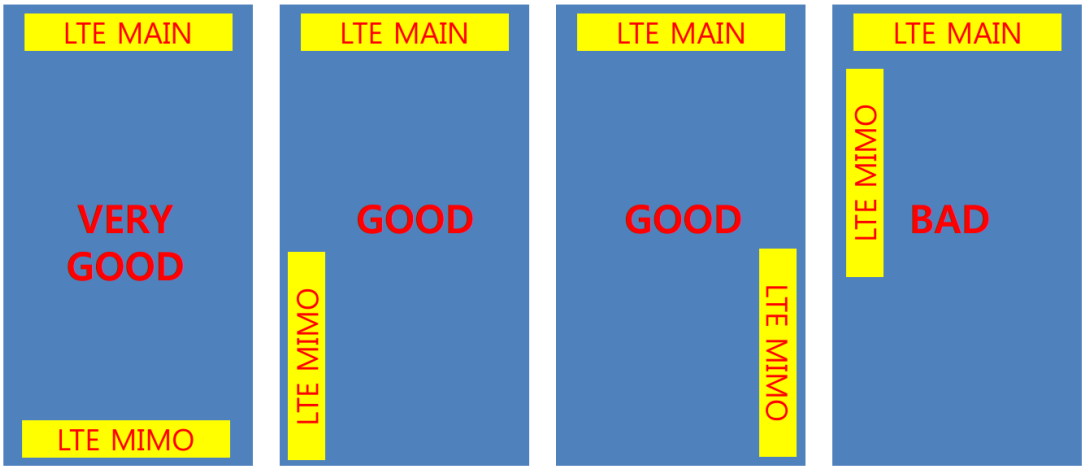


- Soldering Land Pattern @ US Band -



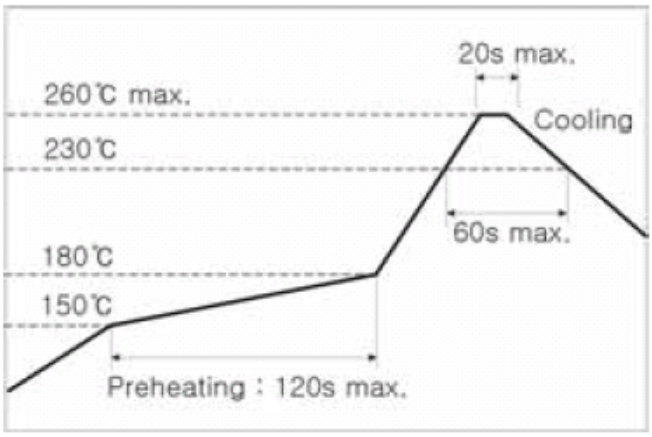
- Soldering Land Pattern @ EU Band -

3.4. Recommended position for LTE Main/MIMO Antenna



3.5. Soldering Profile

Solder paste : Sn/Ag/Cu:96.5/3.0/0.5



This product is designed for reflow soldering only. Do not use flow (wave) soldering.

① Use non-activated flux (Cl content 0.2% max.)

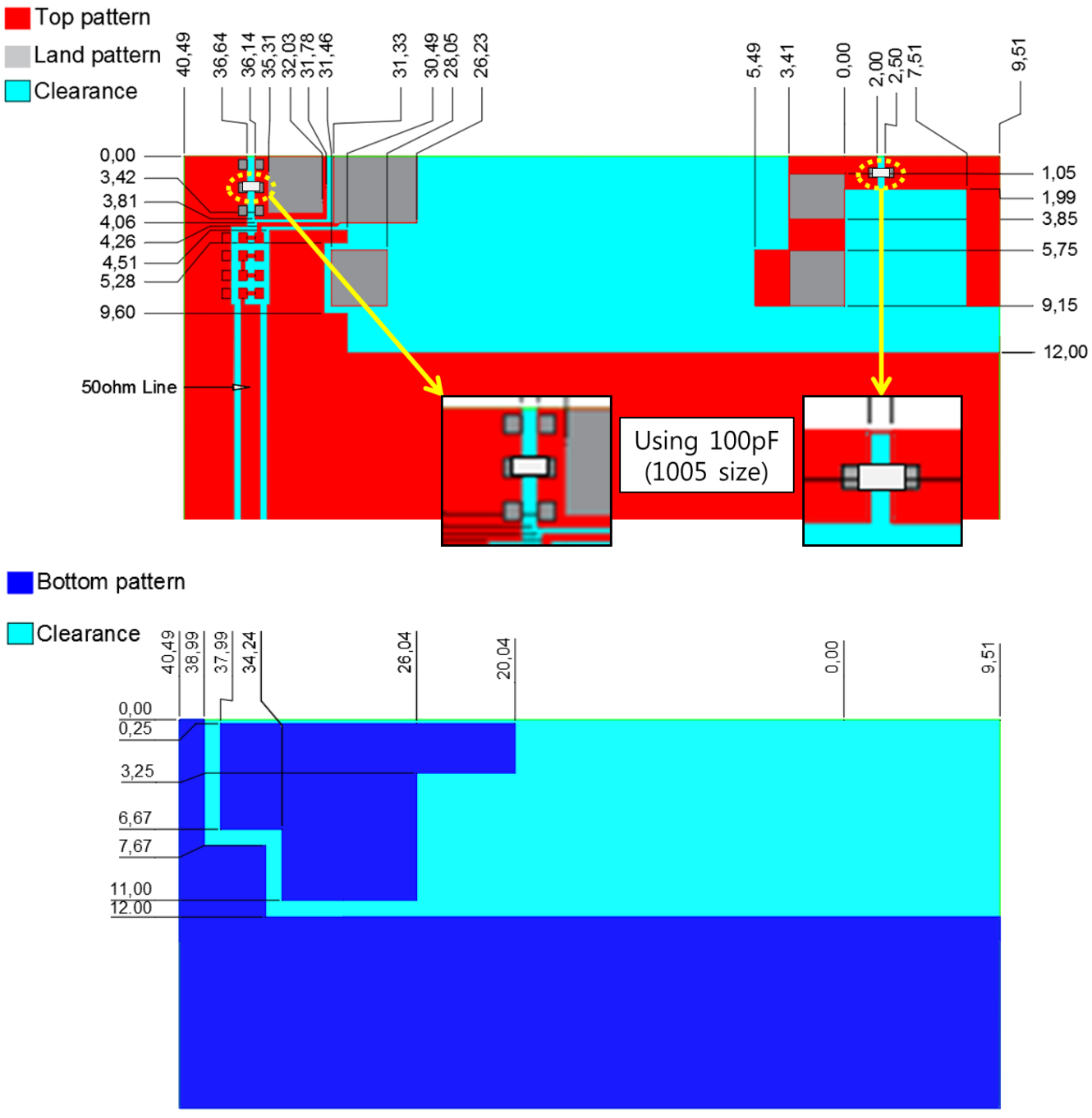
② Follow the recommended soldering conditions to avoid damage.

③ Reflow-cycle is max. 3times.

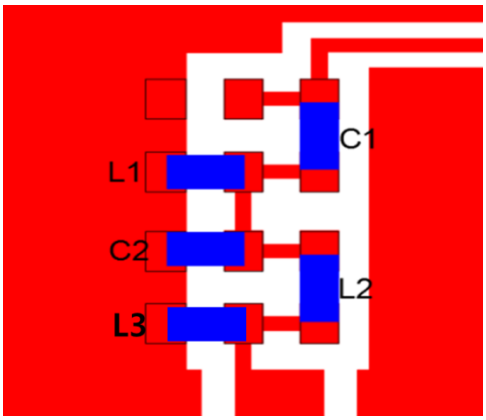
4. Sub 6 & CV2X application

4.1. Soldering Land Pattern @ Global Band & Sub6, V2X

*** PCB Thickness (mm): FR4 1.6T**

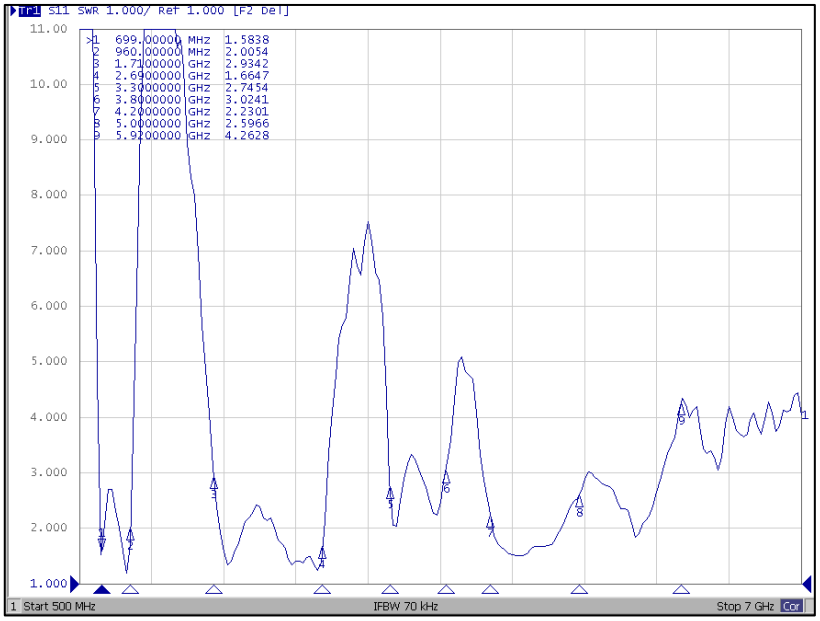


4.2. Matching circuit



C1 (Series)	2.2 pF
L1 (Shunt)	15 nH
C2 (Shunt)	0.5pF
L2 (Series)	1.5 nH
L3 (Shunt)	18 nH

4.3. VSWR



- Global Band & Sub6 CV2X VSWR @ EV Board

4.4. Radiation Characteristic

- Measurement Result

Band	Frequency [MHz]	EFF.[%]	Avg. (dBi)	Peak (dBi)
LTE12	699	50.2	-2.99	-0.93
	716	62.59	-2.03	-0.14
	729	60.85	-2.16	-0.18
	746	61.16	-2.14	0.08
LTE28	703	41.59	-3.81	-1.42
	748	46.59	-3.32	-1.14
	758	45.99	-3.37	-1.12
	803	39.22	-4.06	-1.35
LTE20 (EU Digital Dividend)	791	51.69	-2.87	0.14
	821	46.13	-3.36	-0.21
	832	48.7	-3.13	-0.17
	862	62.73	-2.03	0.69
LTE5 (GSM850)	824	46.67	-3.31	-0.2
	849	62.13	-2.07	0.65
	869	59.64	-2.24	0.46
	894	72.37	-1.4	1.37
LTE8 (E-GSM)	880	59.89	-2.23	0.54
	915	78.56	-1.05	1.79
	925	75.72	-1.21	1.68
	960	67.34	-1.72	1.68

- Remark
  - 6mx3mx3m Anechoic Chamber
  - Matching on the standard test board (141 x 50 mm)
  - Temp. : 25℃ / Humidity : 50~55%

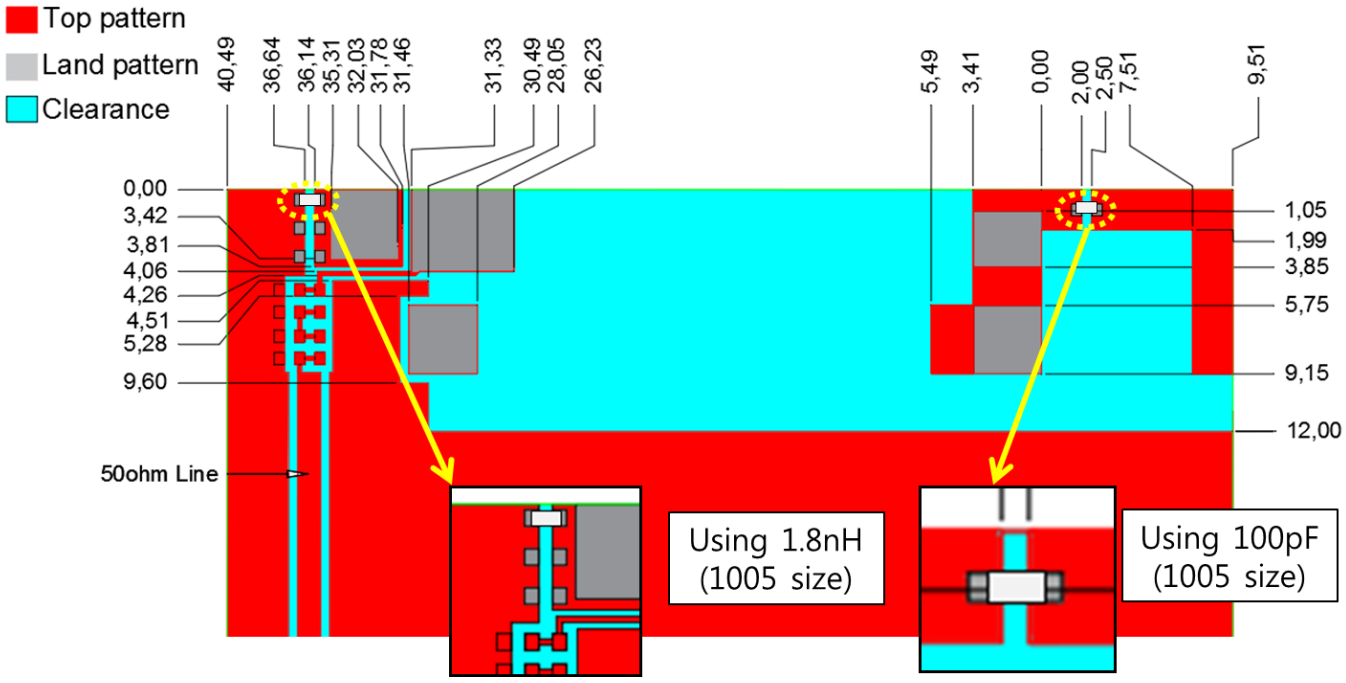
Band	Frequency [MHz]	EFF.[%]	Avg. (dBi)	Peak (dBi)
LTE3 (DCS)	1710	58.98	-2.29	2.02
	1785	65.65	-1.83	2.2
	1805	62.79	-2.02	2.05
	1880	78.63	-1.04	2.59
LTE2 (PCS)	1850	66.49	-1.77	2.05
	1910	76.33	-1.17	2.36
	1930	64.6	-1.9	1.59
	1990	71.98	-1.43	2.2
LTE1 (IMT)	1920	69.72	-1.57	1.98
	1980	74.19	-1.3	2.33
	2110	62.23	-2.06	1.17
	2170	63.17	-1.99	1.41
LTE4 (AWS)	1710	58.98	-2.29	2.02
	1755	65.91	-1.81	2.19
	2110	62.23	-2.06	1.17
	2155	64.72	-1.89	1.33
LTE7 (IMT-E)	2500	59.99	-2.22	1.95
	2570	66.92	-1.74	1.97
	2620	51.98	-2.84	0.82
	2690	24.53	-6.1	-2.62
LTE52, LTE42	3300	23.87	-6.22	-0.27
	3400	29.34	-5.33	-1.5
	3600	42.42	-3.72	0.85
N78	3300	23.87	-6.22	-0.27
	3550	47.77	-3.21	1.44
	3800	59.14	-2.28	2.91
N77	3300	23.87	-6.22	-0.27
	3750	51.31	-2.9	1.79
	4200	38.91	-4.1	2.31
N79	4400	48.93	-3.1	2.34
	4700	48.04	-3.18	4.23
	5000	44.88	-3.48	3.49
N46	5150	34.86	-4.58	-0.21
	5925	20.01	-6.99	-1.1
CV2X	5850	13.52	-8.69	-2.49
	5925	20.01	-6.99	-1.1

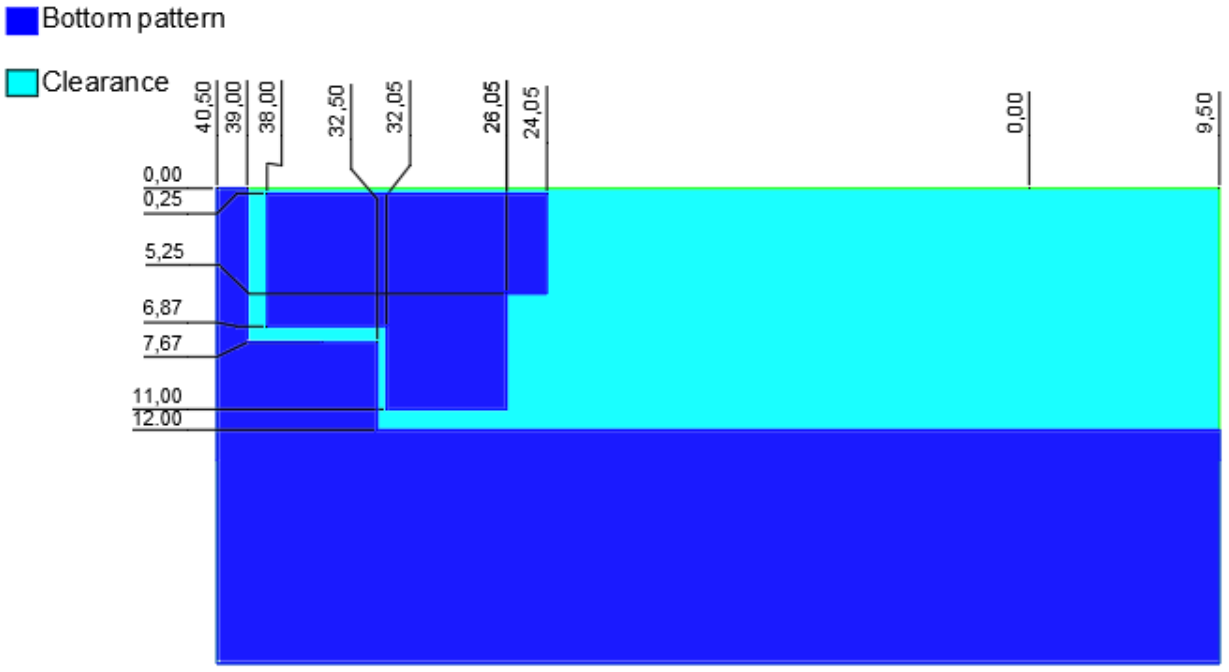
- Remark
  - 6mx3mx3m Anechoic Chamber
  - Matching on the standard test board (141 x 50 mm)
  - Temp. : 25℃ / Humidity : 50~55%

5. B71 & global band application

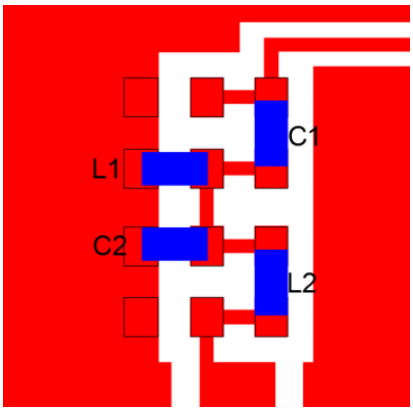
5.1. Soldering Land Pattern @ B71 & Global Band

*** PCB Thickness (mm): FR4 1.6T**



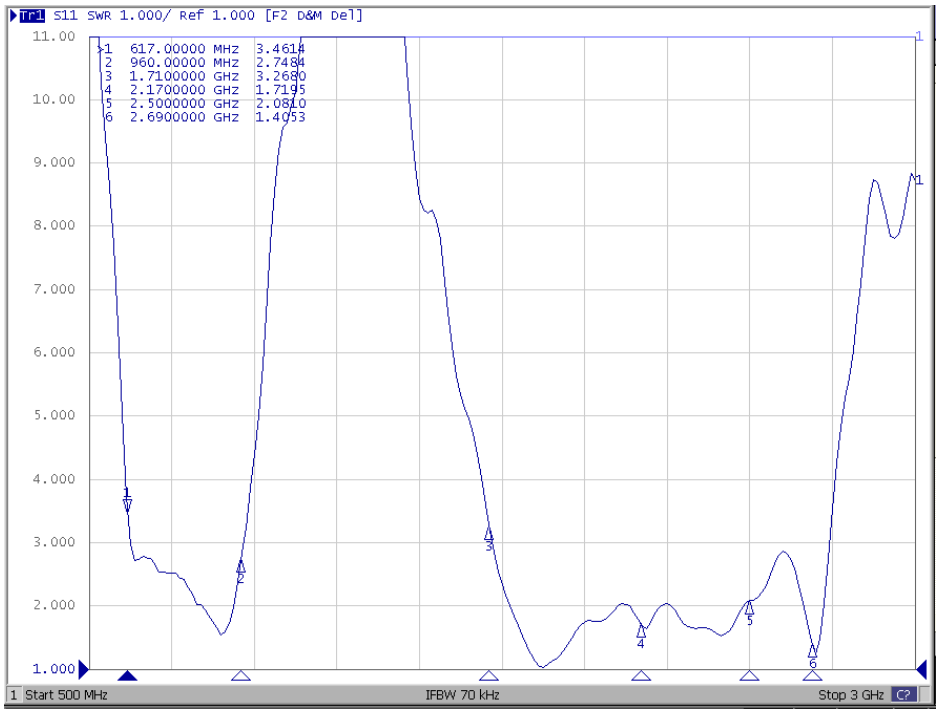


5.2. Matching circuit



C1 (Series)	2.2 pF
C2 (Shunt)	0.5 pF
L1 (Shunt)	18 nH
L2 (Series)	2.2 nH

5.3. VSWR



- B71 & Global Band VSWR @ EV Board

5.4. Radiation Characteristic

- Measurement Result

Band	Frequency [MHz]	EFF.[%]	Avg. (dBi)	Peak (dBi)
LTE71	617	41.24	-3.85	-0.5
	652	41.98	-3.77	-0.21
	663	50.00	-3.01	-0.19
	698	44.16	-3.55	-0.54
LTE12	699	44.11	-3.56	-0.55
	716	47.73	-3.21	-0.26
	729	48.54	-3.14	-0.28
	746	50.45	-2.97	-0.31
LTE28	703	44.29	-3.54	-0.52
	748	52.08	-2.83	-0.19
	758	54.8	-2.61	-0.07
	803	52.36	-2.81	-0.08
LTE20 (EU Digital Dividend)	791	55.54	-2.55	0.13
	821	50.58	-2.96	0.22
	832	55.21	-2.58	0.04
	862	62.85	-2.02	1.17
LTE5 (GSM850)	824	51.40	-2.89	0.19
	849	62.84	-2.02	1.2
	869	59.47	-2.26	0.92
	894	69.12	-1.6	1.59
LTE8 (E-GSM)	880	57.76	-2.38	0.76
	915	66.11	-1.8	1.45
	925	57.41	-2.41	0.91
	960	52.3	-2.81	0.56

- Remark
  - 6mx3mx3m Anechoic Chamber
  - Matching on the standard test board (141 x 50 mm)
  - Temp. : 25℃ / Humidity : 50~55%

Band	Frequency [MHz]	EFF.[%]	Avg. (dBi)	Peak (dBi)
LTE3 (DCS)	1710	43.12	-3.65	0.72
	1785	58.83	-2.3	1.74
	1805	57.89	-2.37	1.76
	1880	70.32	-1.53	2.69
LTE2 (PCS)	1850	63.77	-1.95	2.35
	1910	66.47	-1.77	2.34
	1930	59.71	-2.24	1.8
	1990	61.35	-2.12	1.58
LTE1 (IMT)	1920	60.47	-2.18	1.82
	1980	62.48	-2.04	1.6
	2110	57.97	-2.37	1.29
	2170	68.15	-1.67	2.98
LTE4 (AWS)	1710	43.12	-3.65	0.72
	1755	52.2	-2.82	1.4
	2110	57.97	-2.37	1.29
	2155	74.74	-1.26	3.02
LTE23	2000	59.1	-2.28	1.47
	2020	61.29	-2.13	1.75
	2180	64.66	-1.89	2.91
	2200	60.05	-2.22	2.08
LTE40	2300	54.14	-2.66	0.24
	2400	50.21	-2.99	0.11
LTE7 (IMT-E)	2500	41.54	-3.81	-0.15
	2570	53.41	-2.72	0.32
	2620	30.83	-5.11	-2.3
	2690	33.47	-4.75	-0.17

- Remark
  - 6mx3mx3m Anechoic Chamber
  - Matching on the standard test board (141 x 50 mm)
  - Temp. : 25℃ / Humidity : 50~55%

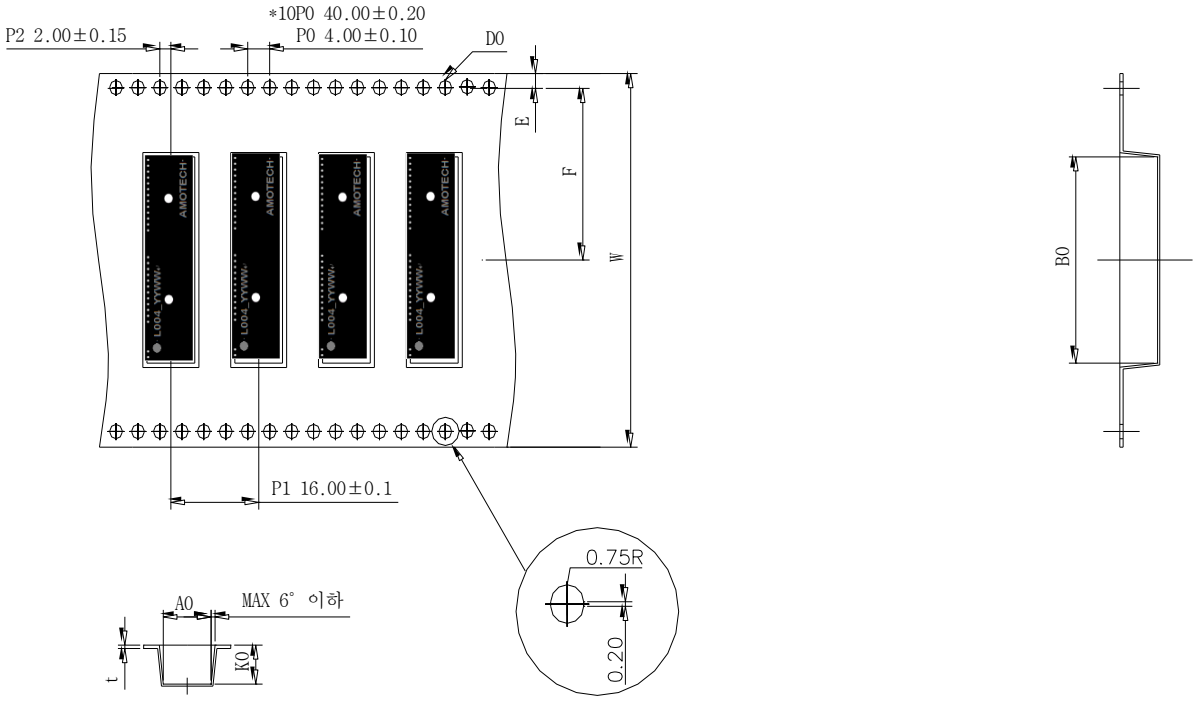
6. Reliability test

No.	Test Items	Test Condition	Requirement
1	High Temperature Exposure	+125±3℃, 96Hrs	1. No visible defects. 2. Satisfy VSWR spec.
2	Temperature Cycling	-40℃/30min ↔ +125℃/30min, 10 Cycle	1. No visible defects. 2. Satisfy VSWR spec.
3	Biased Humidity	- Humidity: 85%RH - Temperature: 85℃ - Time: 1000Hrs	1. No visible defects. 2. Satisfy VSWR spec.
4	Mechanical Shock	- Peak 100g - Duration 6 ms - X.Y.Z each 3 times	1. No visible defects. 2. Satisfy VSWR spec.
5	Vibration	- 5-55-5 ㎐, 1 Octave/min - Amp.=1.5mm,acceleration=2x9.8 ㎨(G) - Crossover Freq.=18 ㎐	1. No visible defects. 2. Satisfy VSWR spec.
6	ESD	- ESD Level: 8KV, - Mode: Contact discharge, 100 times	1. No visible defects. 2. Satisfy VSWR spec.
7	Adhesion Strength of Soldering	- Used of push pull gauge	1. Spec (Min: 5Kgf)
8	Solderability	- Dipping 250±5℃ / 5 sec	1. No visible defects.
9	Board Flex	- 2mm, Duration time: 1min - No open parts, No crack at soldering points	1. No visible defects. 2. Satisfy VSWR spec.

7. PACKING

7.1 Tape Dimension (unit : mm)

7.1.1 Size



A0	9.40±0.10	E	1.75±0.10
B0	35.50±0.10	F	26.20±0.10
K0	3.70±0.10	W	56.00±0.30
D0	1.50±0.1	t	0.40±0.05

7.1.2 Surface resistance

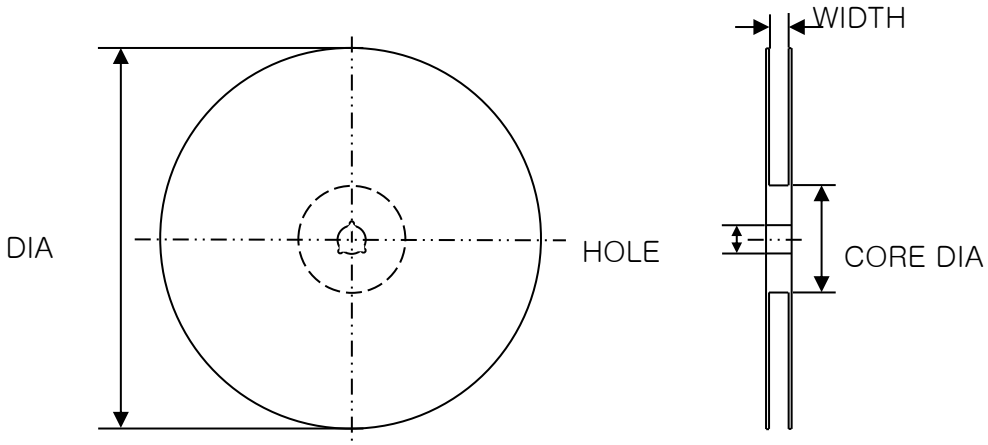
1) Carrier tape : Max $10^{11}\Omega$

2) Cover tape : Max $10^{11}\Omega$

3) Reel : Max $10^{11}\Omega$

7.2 Description of Reel

7.2.1 Size



ITEM	DIA	WIDTH	CORE DIA	HOLE
Size(mm)	330.0 ±2	57.5 ± 1.0	80.0 ± 1.0	13.0 ± 0.3

7.2.2 Material

1) Plastic reel : GPPS (General Purpose Poly Styrene) resin

7.3 Description of Packing Box

7.3.1 Reel

Size: 56 (W), Dia. Φ330 (mm)

Quantity: 1,000ea/reel

7.3.2 Inner Box

Size: 368 (W) x 346 (D) x 65 (T) (mm)

Quantity: 1 reel (1,000 ea/reel × 1 reel = 1,000 ea)

7.3.3 Outer Box

Size: 405 (W) x 360 (D) x 300 (T) (mm)

Quantity: 4 Inner Box (1,000 ea/Inner Box × 4 Inner Box=4,000 ea)

8. Caution and Warranty

8.1 Chip antennas must avoid shock and drop, to prevent damage of the antenna.

8.2 Chip antennas should be used within 12 months after delivery, antennas older than 12 months should be checked for solderability before using