



승 인 원

부품명	Chip Antenna	제품이미지
부품PN	ACS2450ICAMEB	 상측면  하측면
사용자	디젠	
SEC CODE		
Revision	VER.1.0 12월 10일	
제조사	파트론	

MSL	LEAD FREE	BFRs-Free, Halogen-Free
MSL 1		

기안	개발팀장 [결재]	품질팀장 [합의]
김홍기		
김홍기	전찬익	민남식
12/10	12/10	12/11

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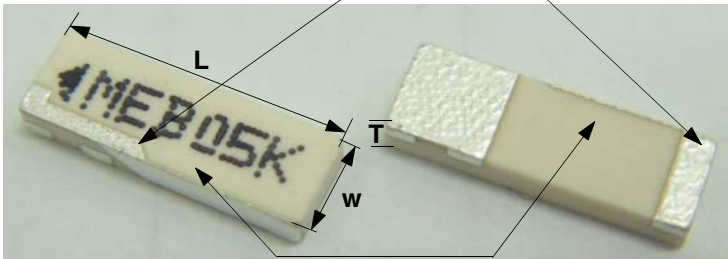
[illegible]

2. 부품의 개요 및 치수 규격

2.1 부품개요

본 제품은 유전체 무선 통신 기기 내장형 칩 안테나로 직방의 형상을 갖는 유전체에 은(Ag) 도금으로 패턴을 형성하여 특성을 구현한다.

2.2 부품 치수규격

형 태	Only Bulk Ceramic					
재 질	Dielectric Block		Mg ₂ SiO ₄ (Magnesium Silicate)			
	전극 Paste		은(Ag)			
크 기 [mm]	L = 9.0 ± 0.1 (CPK:2.79)					
	W = 3.0 ± 0.1 (CPK:2.28)					
	T = 1.2 ± 0.1 (CPK:2.38)					
평탄도	0.04 (소체기준)					
MSL LEVEL	MSL LEVEL 1					
ESD LEVEL	15 KV 이상 (HBM CLASS 3B)					
Version	Revision 1.0		Top-Side View		Bottom-Side View	
전기적 특성 (CTF)	특성	VSWR(CTF)	주 기	시 료 수	CPK	비 고
	2400MHz	1.0 ~ 3.0:1	전수검사	전수	8.53	4,6,15 Page
	2485MHz	1.0 ~ 3.0:1	전수검사	전수	7.86	4,6,15 Page

3. 중점 관리 항목(CTQ)

- 아래 항목에 대하여 중점관리 항목으로 지정하여 관리한다.

제품의 CTQ 항목	SPEC	검사주기 또는 시료수	측정 계측기
소성온도	1350 ± 15 °C	1일 3회 검사	온도센서
건조온도	200 ± 15 °C	1일 3회 검사	온도센서
소부로온도	900 ± 25 °C	1일 3회 검사	온도센서

제품의 CTF 항목	지정 사유
단품 측정 SWR	제품의 전기적 특성을 분별하는 주요 변수임
단품 측정 치수	치수 정밀도가 칩 안테나의 특성의 핵심적 항목임

- 아래 항목에 대하여 주의를 요함.

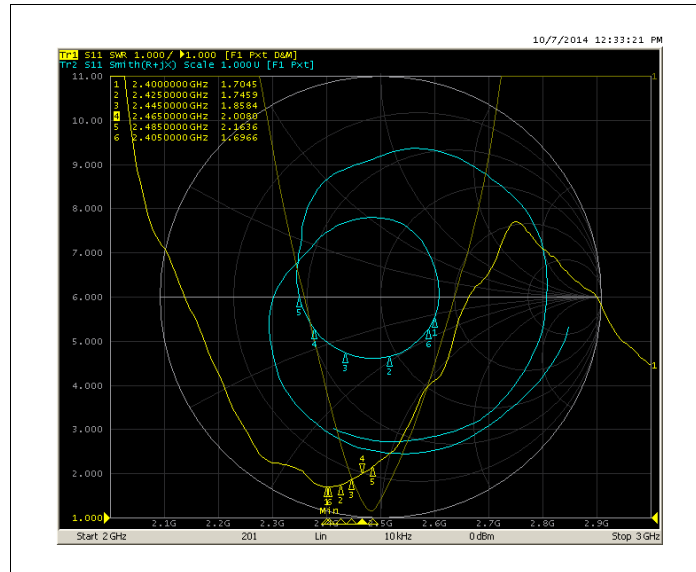
항 목	내 용
보 관	상온에 장시간 보관 시 밀봉하여 보관
동 작	임의의 설계 변경 시 특성이 변경될 수 있음

4. 전기적 특성

4.1 시료 실장 측정

항 목				특 성
Frequency Range [MHz]				2400 ~2485
SWR [Max]				3.0 : 1 (Typ 2.5 : 1)
Input Impedance [Ω]				50 Ohm
Polarization				Linear
Gain [dBi]	Total Gain (Peak / Avg) [dBi]			-2.05 / -7.48
	Azimuth	Theta	Peak	-3.92
			Average	-8.72
		Phi	Peak	-3.00
			Average	-9.74
	Elevation 1	Theta	Peak	-6.04
			Average	-10.94
		Phi	Peak	0.89
			Average	-4.87
	Elevation 2	Theta	Peak	-0.31
			Average	-5.19
		Phi	Peak	-3.71
			Average	-9.15

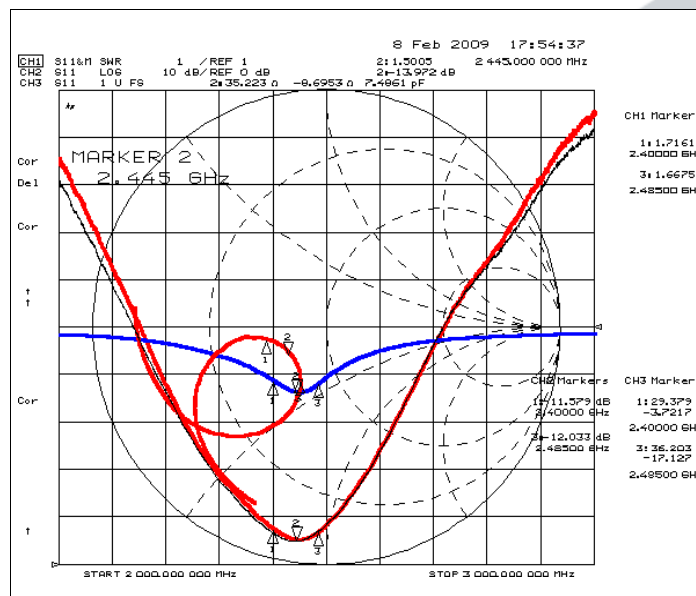
4.2 시료 실장 측정 그래프



4.3 수동 지그 측정

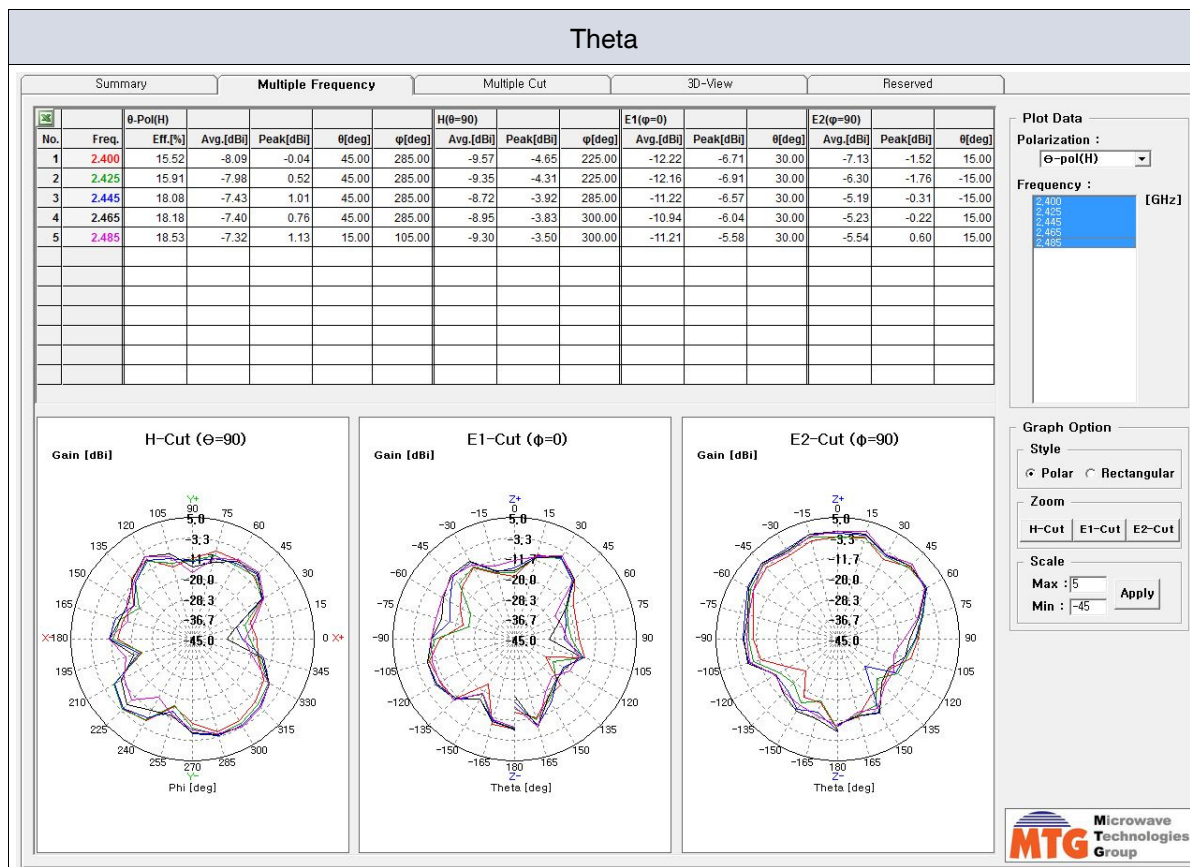
항 목	특 성
Frequency Range [MHz]	2400 ~ 2485
Lower frequency(2400 MHz) SWR [Min~Max]	1.0 ~ 3.0 : 1 (Typ 2.0 : 1)
Upper frequency(2485 MHz) SWR [Min~Max]	1.0 ~ 3.0 : 1 (Typ 2.0 : 1)

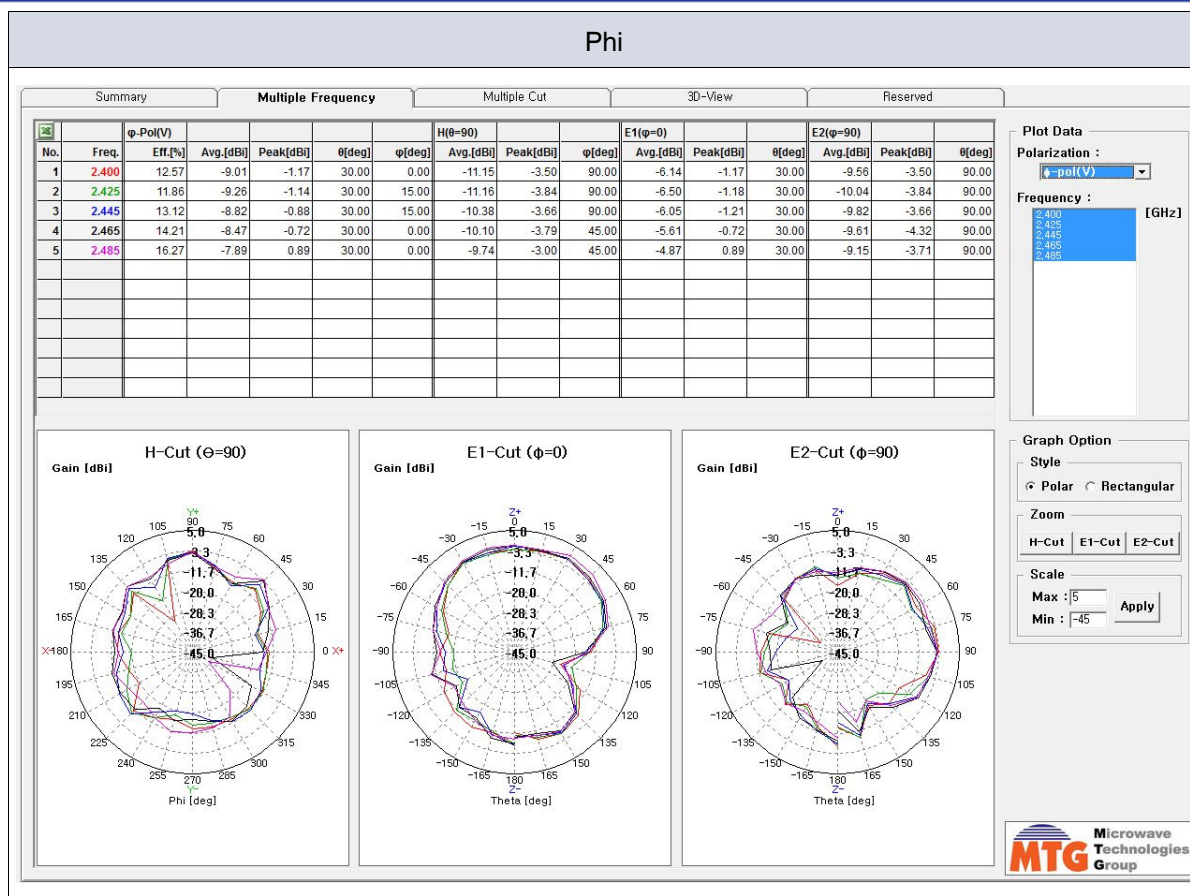
4.4 수동 지그 측정 그래프



4.5 방사 패턴

Azimuth Plane	Elevation1 Plane	Elevation2 Plane
Theta	Vertical field of measured plane	
Phi	Horizontal field of measured plane	

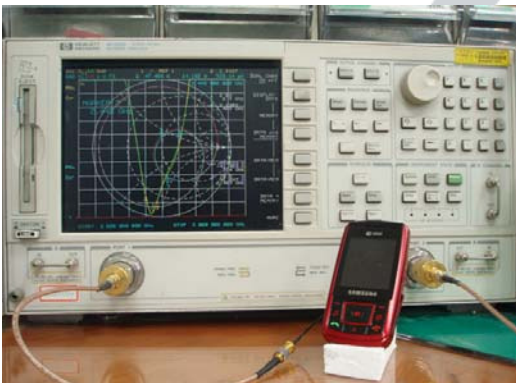
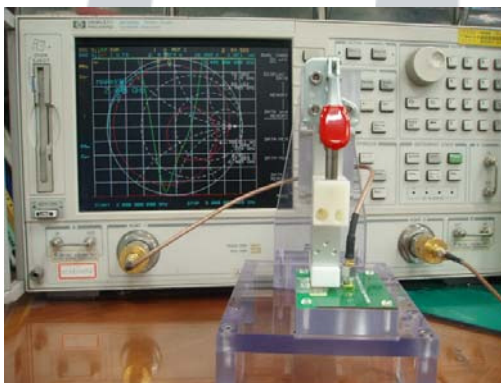




5. 시험 방법

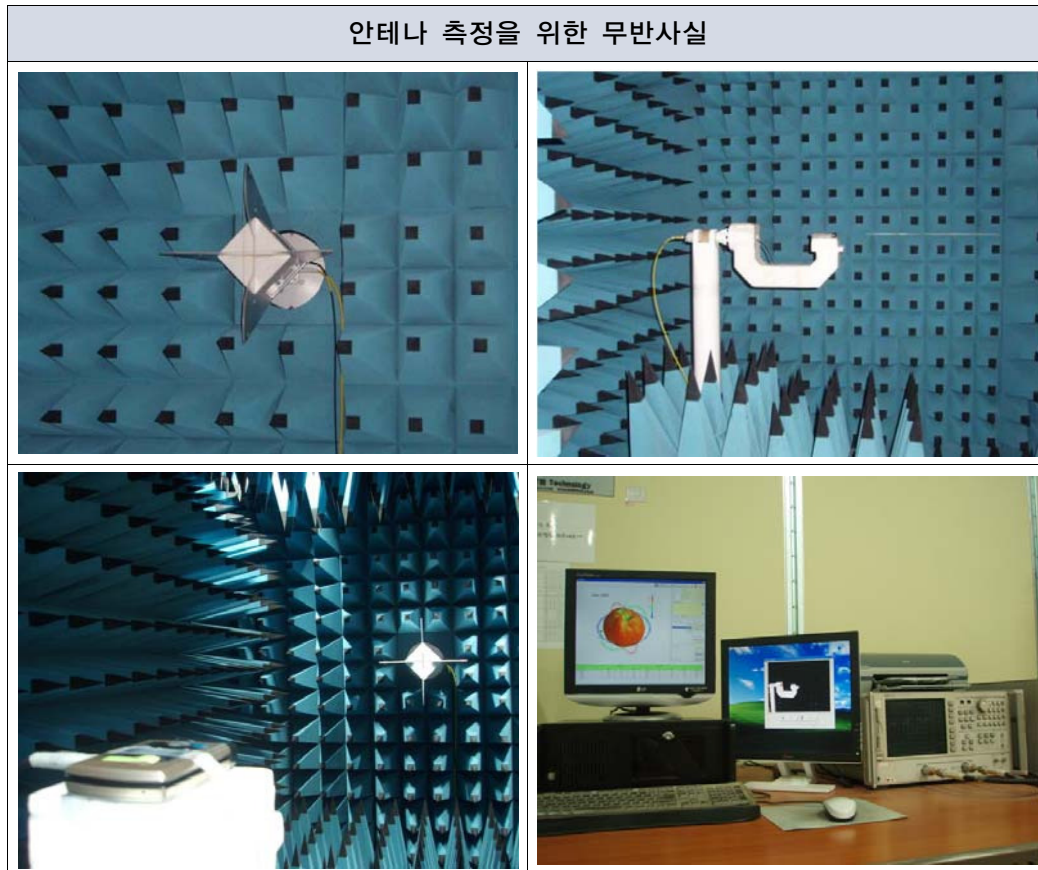
5.1 SWR / Return Loss

Network Analyzer를 이용하여 SWR / Return Loss를 측정하며 표본 샘플을 선별 수동 측정 지그 또는 자동화 검사장비를 이용하여 양품과 불량품을 선별한다.

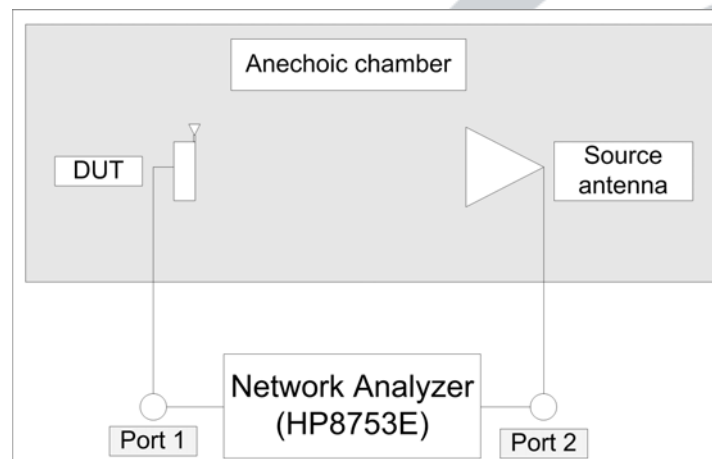
	시료 측정 조건	수동 지그 측정 조건
Network Analyzer	Agilent HP8753E or Advantest R3765CH	Agilent HP8753E or Advantest R3765CH
Cable	RF cable (300 mm)	RF cable (300 mm)
Test condition		

5.2 이득

당사가 보유한 전파 무반사실에서 상기 4.1에서 측정된 시료를 이용하여 안테나 이득을 측정한다.

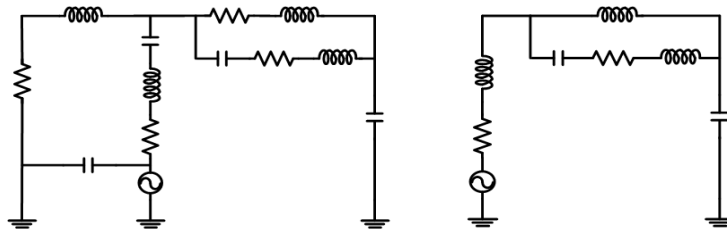


5.3 이득 측정을 위한 회로 구성도



6. 내부 회로 구성도

본 제품은 유전체를 재료로 한 직방형의 소체 표면에 은(Ag) 패턴의 구조적인 변경을 통하여 아래와 같은 구조적인 등가회로의 매칭 값을 조절하여 성능을 구현하는 RF 부품이다.



〈3패드 구조〉

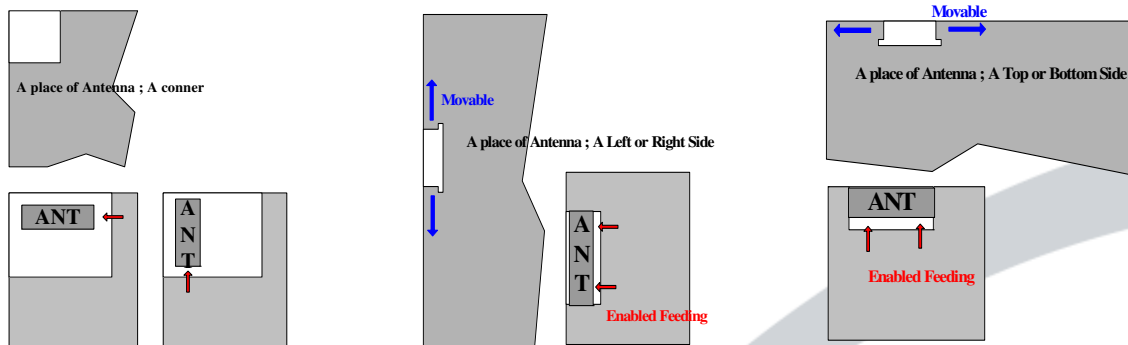
〈2패드 구조〉

7. 기본 동작 및 응용 방식

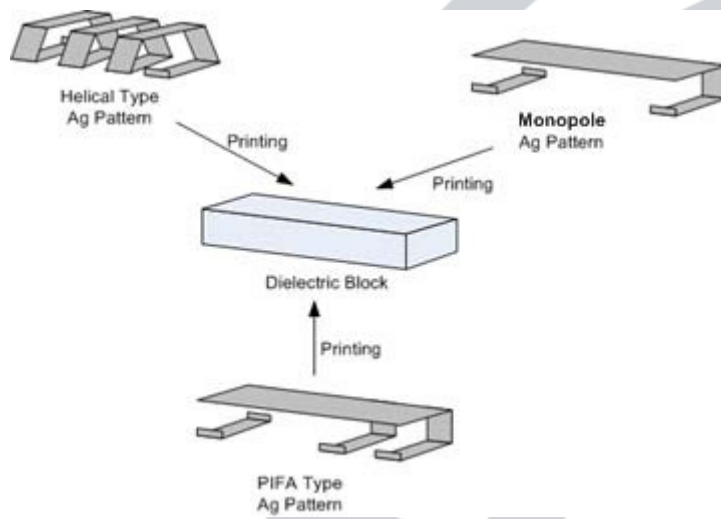
본 제품은 무선 통신 기기 내장형 유전체 칩 안테나로 전송선로를 따라 진행해 온 전기적 신호를 자유공간파(FREE SPACE WAVE)로 변환하는 장치이다.

본 제품은 원하는 어떠한 위치에도 실장이 가능하며 실장 조건에 따라 그 설계를 달리 한다.

다만 본 제품은 방사 부품으로 주변 경계 조건에 따라 그 특성을 달리 하므로 위치 선정에 각별한 주의를 기울여야 한다.

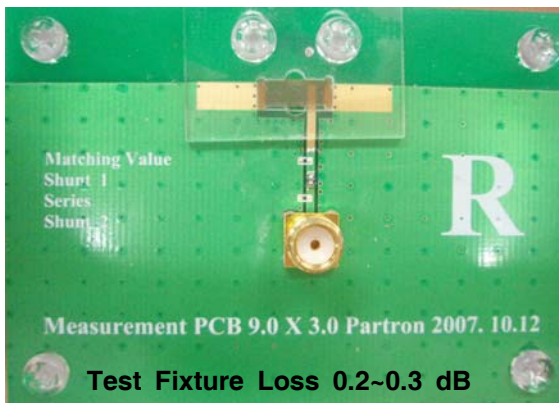


본 제품은 실장 주변 조건에 맞추어 아래와 같이 다양한 안테나 형태로 설계 변경이 용이하다.



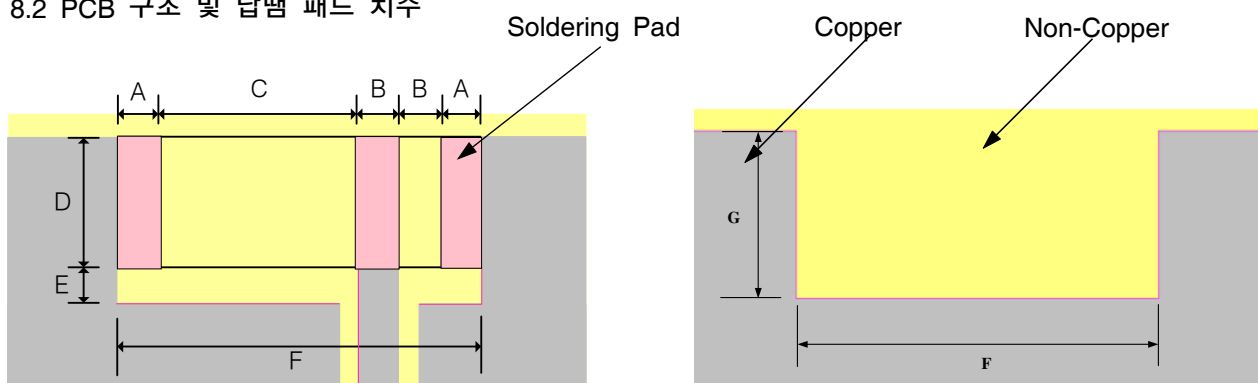
8. 측정 지그 사양

8.1 수동 측정 지그와 그라운드 조건



※ Ev B'd 와 수동 측정 지그는 동일함.(Ev B'd는 접촉 방식이 납땜, 수동 측정 지그는 동편 접촉 방식)

8.2 PCB 구조 및 납땜 패드 치수



Top Layout

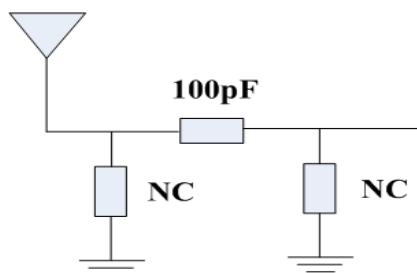
Bottom Pattern

Parameter	A	B	C	D	E	F	G
Value[mm]	1.1	1.0	5.0	3.2	1.0	9.2	4.2

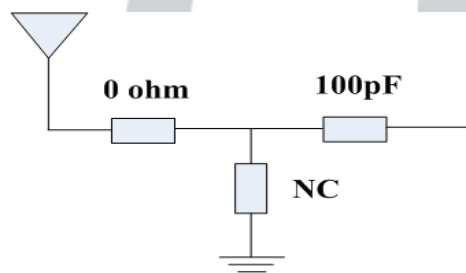
Unit ; mm

Unless specified tolerances are ± 0.05

8.3 매칭 회로와 기본값



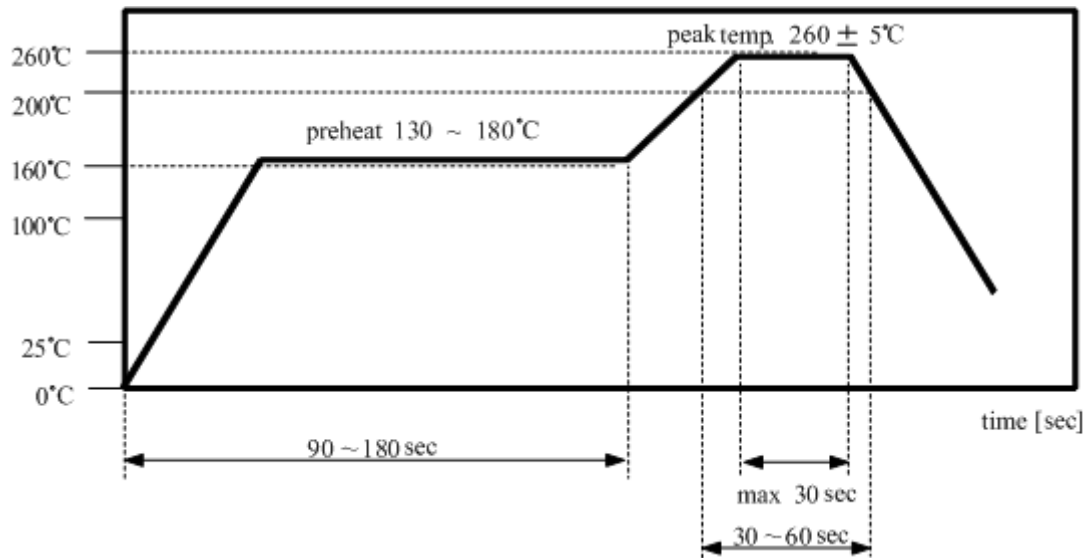
π Matching



T Matching

9. 표준 열경화 조건(REFLOW PROFILE)

9.1 표준 열경화(Reflow) 조건

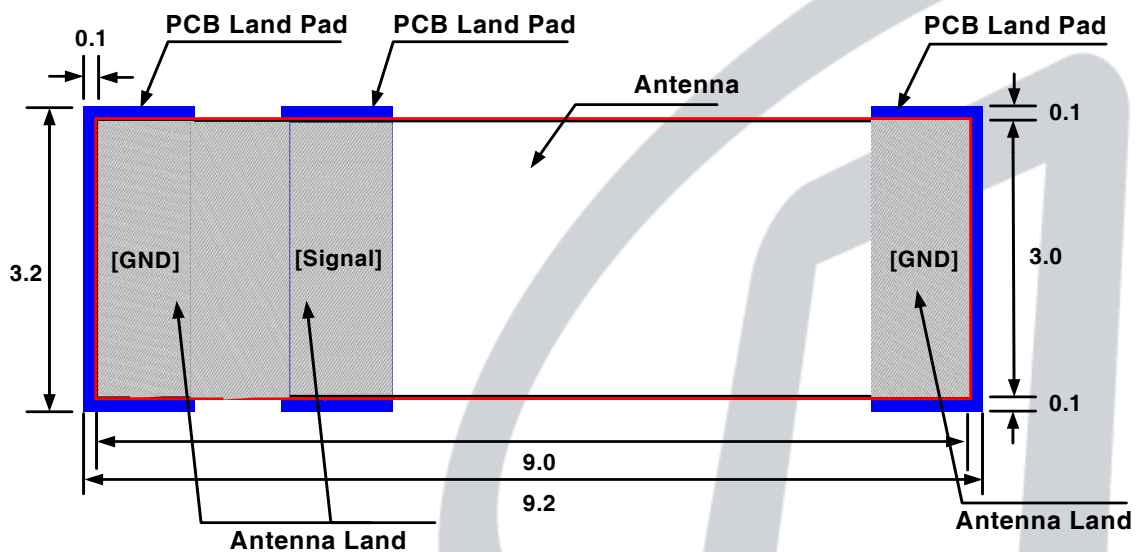


9.2 수동 납땜 (납땜 인두기를 사용할 경우)

예 열 : 120°C / 시 간 : 60 ~ 300 sec.
인두온도 : $340 \pm 5^{\circ}\text{C}$ / 시 간 : 각 단 최대 5 sec.

9.3 PCB 패턴 설계 제안

PCB 패드 패턴은 제시한 안테나의 패드 치수보다 아래 그림에서 보여지는 것과 같이 0.1 mm 이상 외각으로 확장된 형태로 설계된다.



10. 초기 검사 성적서

검사항목	Frequency [MHz]		치수 [mm]		
규격	SWR 3.0 Max		W = 3.0±0.1	L = 9.0±0.1	T = 1.2±0.1
	2400 MHz	2485 MHz			
1	1.71	1.66	3.03	9.02	1.21
2	1.64	1.73	3.02	9.01	1.22
3	1.64	1.72	3.02	9.02	1.22
4	1.67	1.71	3.01	9.01	1.21
5	1.65	1.73	3.02	8.99	1.24
6	1.59	1.78	3.04	9.00	1.23
7	1.77	1.59	3.01	9.03	1.22
8	1.57	1.77	3.01	9.00	1.23
9	1.57	1.80	3.04	9.02	1.23
10	1.63	1.73	3.03	9.02	1.24
11	1.65	1.78	3.02	9.01	1.21
12	1.62	1.71	3.02	9.00	1.22
13	1.58	1.78	3.04	8.99	1.21
14	1.62	1.77	3.01	9.01	1.23
15	1.70	1.64	3.01	9.01	1.24
16	1.58	1.72	3.02	9.00	1.23
17	1.58	1.74	3.01	9.01	1.22
18	1.62	1.75	3.04	9.00	1.22
19	1.65	1.71	3.03	9.02	1.21
20	1.58	1.79	3.02	9.01	1.21
Min	1.57	1.59	3.01	8.99	1.21
Max	1.77	1.8	3.04	9.03	1.24
X	1.63	1.73	3.02	9.01	1.22
σ	0.05	0.05	0.01	0.01	0.01
Cpk	8.53	7.86	2.28	2.79	2.38
판정	Ok	Ok	Ok	Ok	Ok

11. 신뢰성 보증조건

11.1 환경 시험

항목	시 험 조 건	판정기준
PCT	+121±5 °C, RH=100%, 96 hr	시험 후 4.3 항의 특성 규격을 만족해야 함
저온동작	-40±3 °C에서 1시간 방치 후 시험온도 상태에서 측정	
저온방치	-40±3 °C, 120 hr 방치	
내습동작	+85±3 °C, RH 85%에서 1시간 방치 후 시험온도 상태에서 측정	
내습방치	+85±3 °C, RH 85%, 120 hr 방치	

11.2 열충격 , 열경화 시험

항목	조 건	판정기준
열충격	조 건 : -40±3 °C/min ↔ +85±3 °C/min 시험 CYCLE : 32 cycle 온도변환시간 : 5 min 미만일 것	시험 후 4.3 항의 특성 규격을 만족해야 함
열경화	Pre Heating : 200±5 °C, 30~60 sec Peak Heating : 260±5 °C, 30 sec Max 초기측정 후 1회, 환경시험 후 3회 실시	

11.3 기계적 시험

항목	조 건	판정기준
진동시험	주파수 : 10~500 Hz, 가속도 : 10×9.8 m/s ² (G) Sweep time : 15 min, X.Y.Z each 5 times	시험 후 4.3 항의 특성 규격을 만족해야 함
낙하시험	- 조건 : 152 cm에서 낙하 지그를 이용하여 18회 자유낙하 (6면 3회) - 지그 : 120 ±20 g 플라스틱 지그 사용 - 바닥 : 콘크리트 또는 철판	

*진동 및 낙하시험은 Ev B'd 납땜하여 실시할 것

11.4 MSL LEVEL 시험

1) JEDEC J-STD-020C 조건

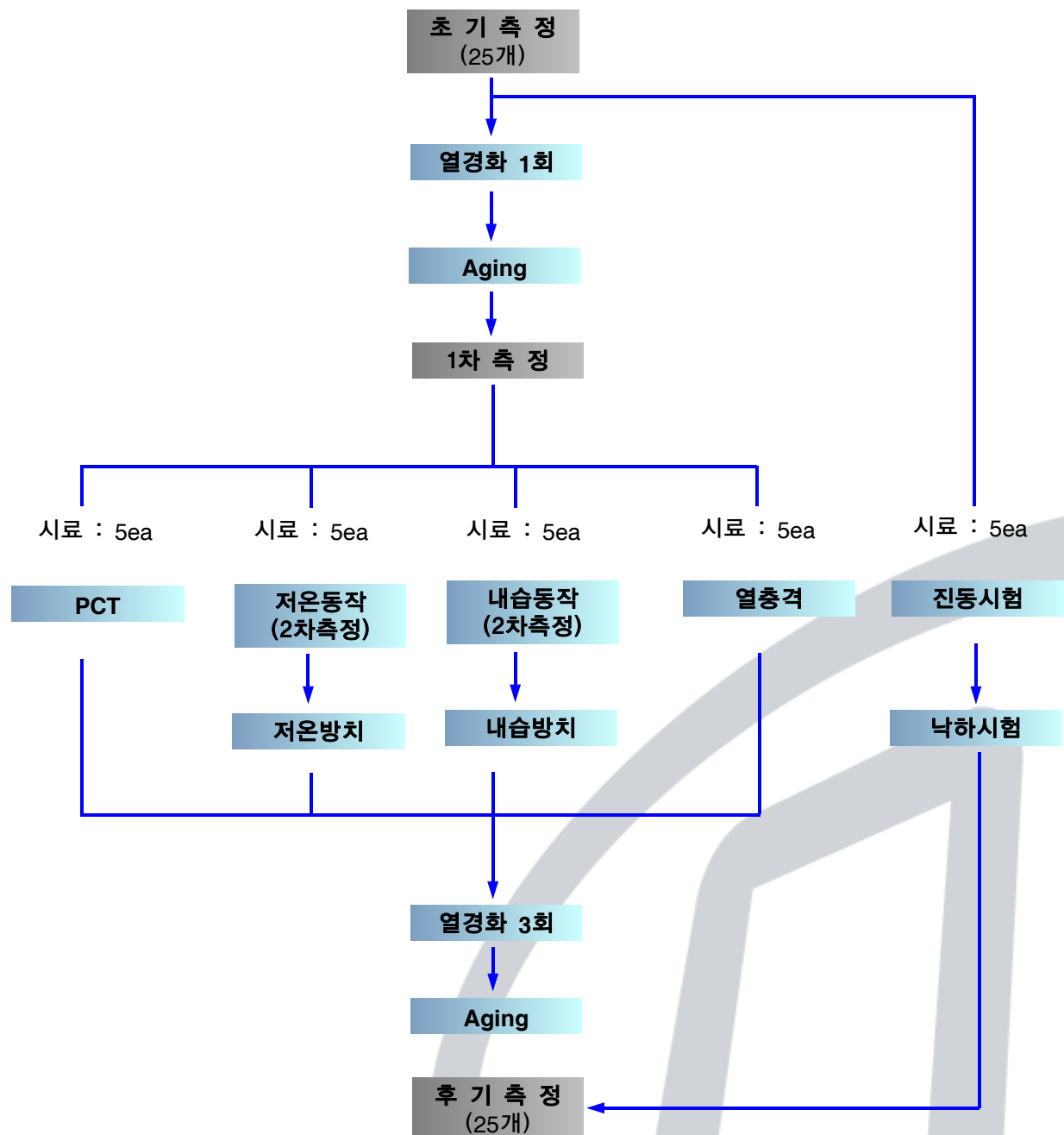
	Floor Life		Soak Requirements	
	Time	Conditions	Time	Conditions
1	Unlimited	= < 30 °C / RH 85%	168+5 / -0	= < 85 °C / RH 85%

2) Test 조건

항목	조 건	비고
Soak Requirements	+85±3 °C, RH 85%, 168 hr 방치 후 Aging없이 Reflow 3회 실시	시험 후 4.3 항의 특성 규격을 만족해야 함

11.5 신뢰성 시험 FLOW

신뢰성 시험 순서

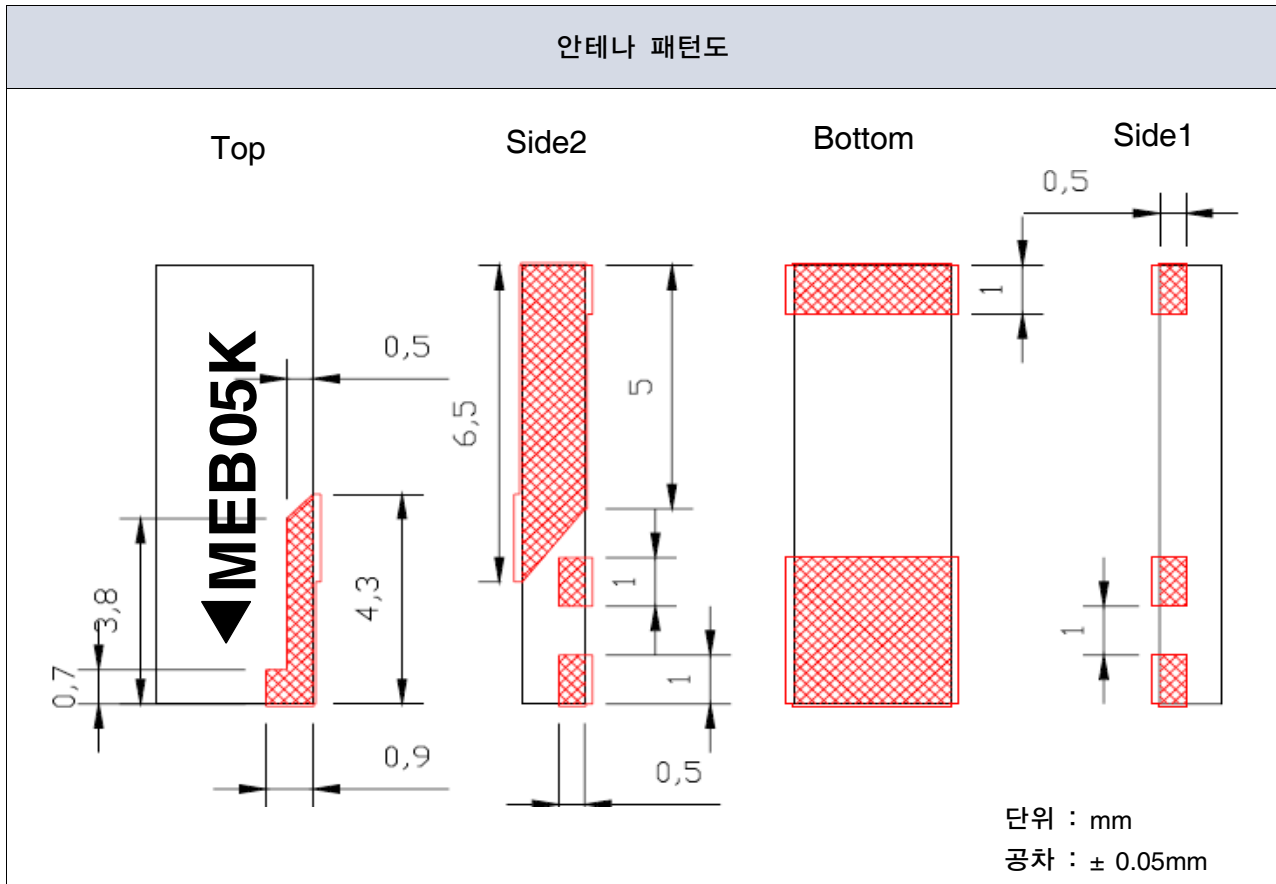


※Aging : 상온상습에 1시간 방치

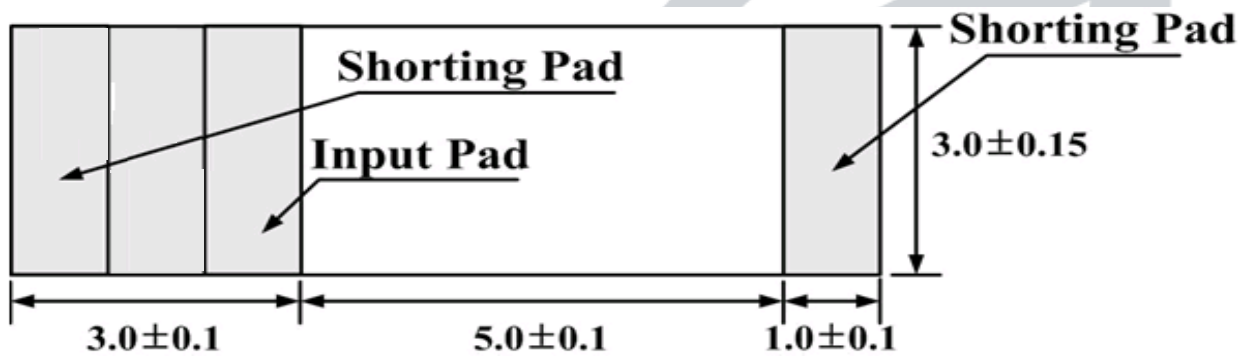
※진동 및 낙하시험은 부품을 PCB에 실장하여 시험

12. 기구적 특성

12.1 안테나 패턴 도면



12.2 Pin name



12.3 LOT 번호 표기법

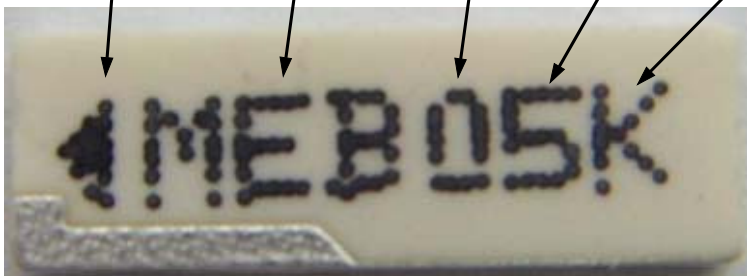
0	5	K
①	②	③

- ① 연도 : 1 - 2001, 2 - 2002 9 - 2009, 0 - 2010
 ② 월 : 1 - 1월, 2 - 2월 A - 10월, B - 11월, C - 12월
 ③ 일 : 1 - 1일, 2 - 2일 T - 29일, U - 30일, V - 31일

12.4 마킹 사양

실물 사진

Input Mark
Serial
Year
Month
Date



◀	MEB	0	5	K
①	②	③	④	⑤

- ① 안테나 급전 방향
 ② 모델 약자
 ③ 연도 : 1 - 2001, 2 - 2002 9 - 2009, 0 - 2010
 ④ 월 : 1 - 1월, 2 - 2월 A - 10월, B - 11월, C - 12월
 ⑤ 일 : 1 - 1일, 2 - 2일 T - 29일, U - 30일, V - 31일

12.5 마킹 종류

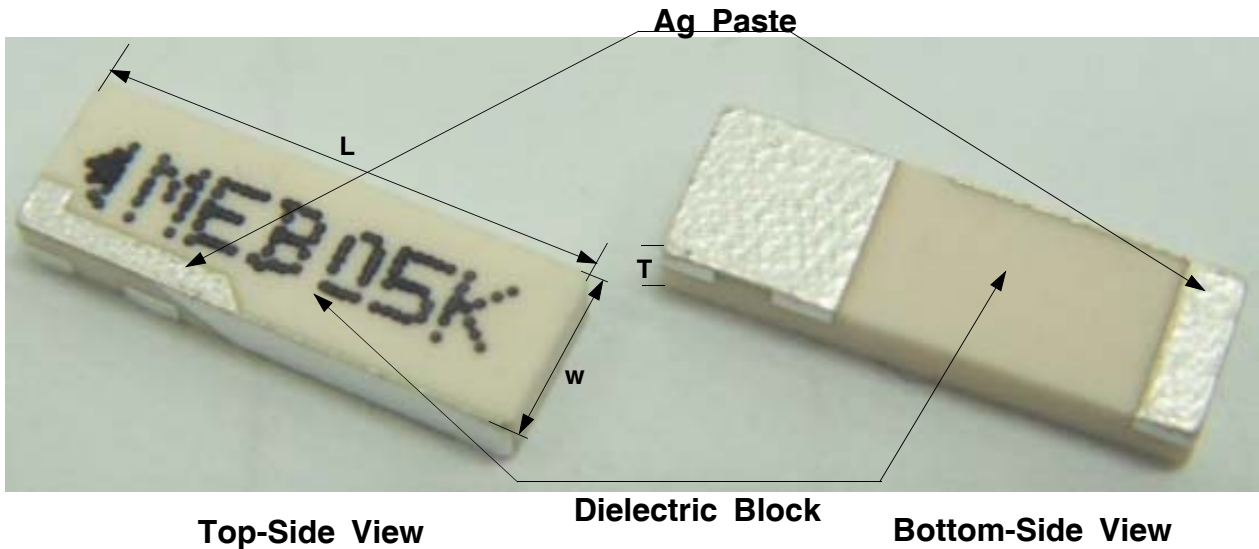
잉크 마킹 - 검정 잉크 사용

13. 구조 및 재질

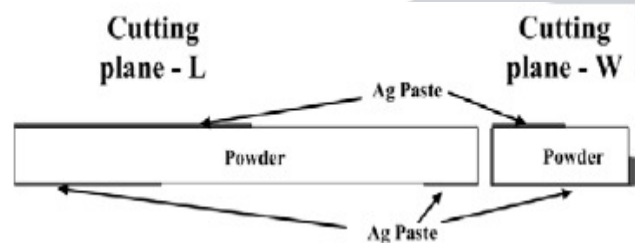
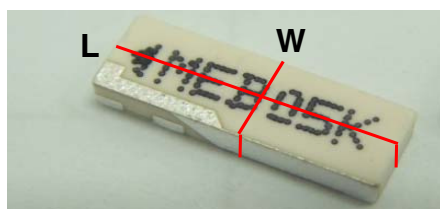
13.1 구현방법

직방체의 형상을 갖는 유전체 소체에 은(Ag) 도금으로 패턴을 형성하여 특성을 구현함.

13.2 구 조



13.3 내부 단면도



13.4 재 질

구 분	재질	제조사	사양
유전체	POWDER	후지	
패턴	은(Ag) 도금	마이크로엠	인쇄두께 : TYP 10 μm
패드	은(Ag) 도금	마이크로엠	인쇄두께 : Min 10 μm (TYP 16~20 μm)

14. 주의 사항

14.1 온도 조건

	온도범위	단위
사용온도	-40 ~ +100	℃
보관온도	-40 ~ + 70	℃

14.2 시험 온도조건

	항목	온도범위
사용온도	저온	-75 ℃에서 24시간 정상동작
	고온	+150 ℃에서 24시간 정상동작
보관온도	저온	-75 ℃에서 1000 hr 방치 시 정상동작
	고온	+85 ℃에서 1000 hr 방치 시 정상동작

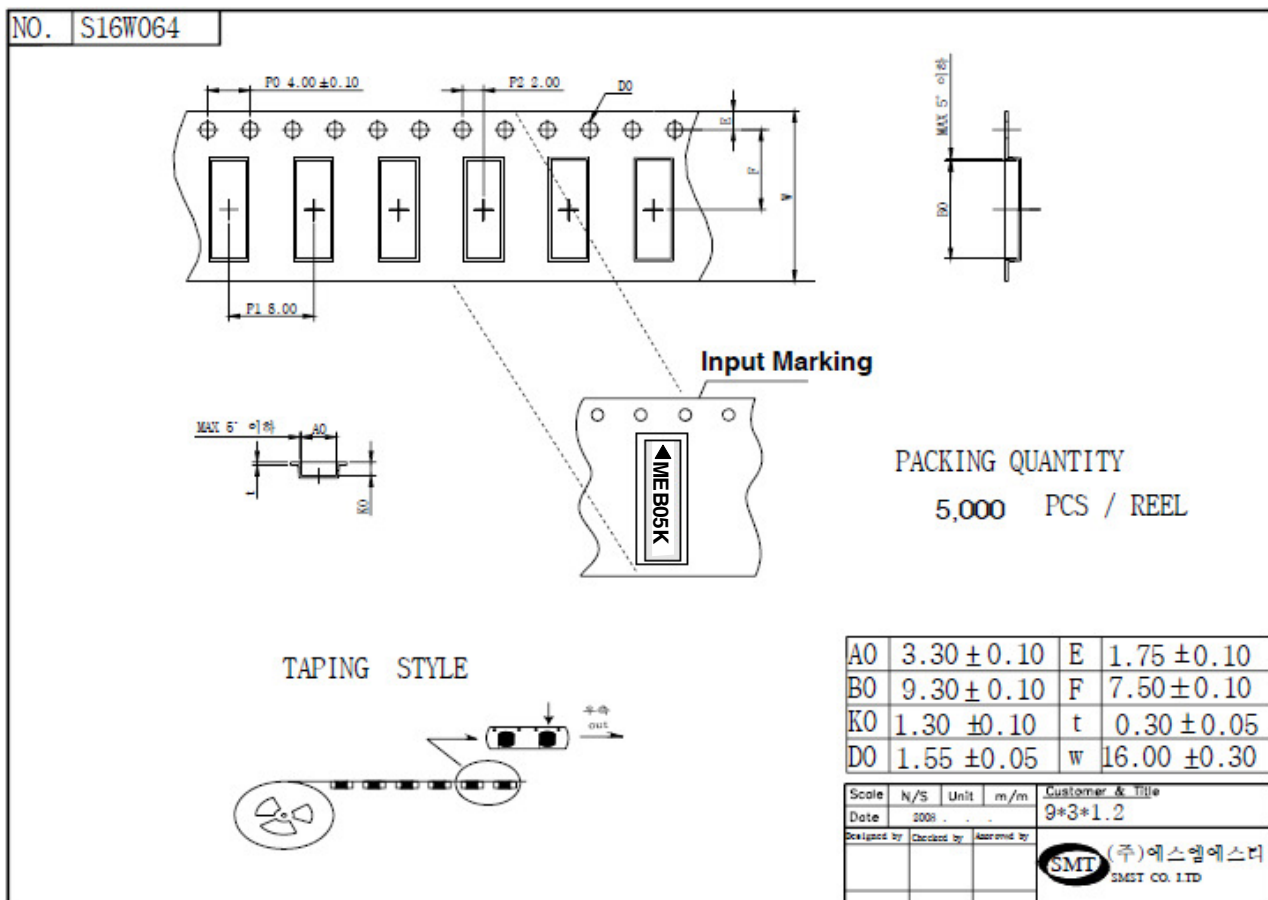
* 고온 방치 시 포장재 보관온도 문제로 85 ℃ 이상 불가함.

15. 포장 사양

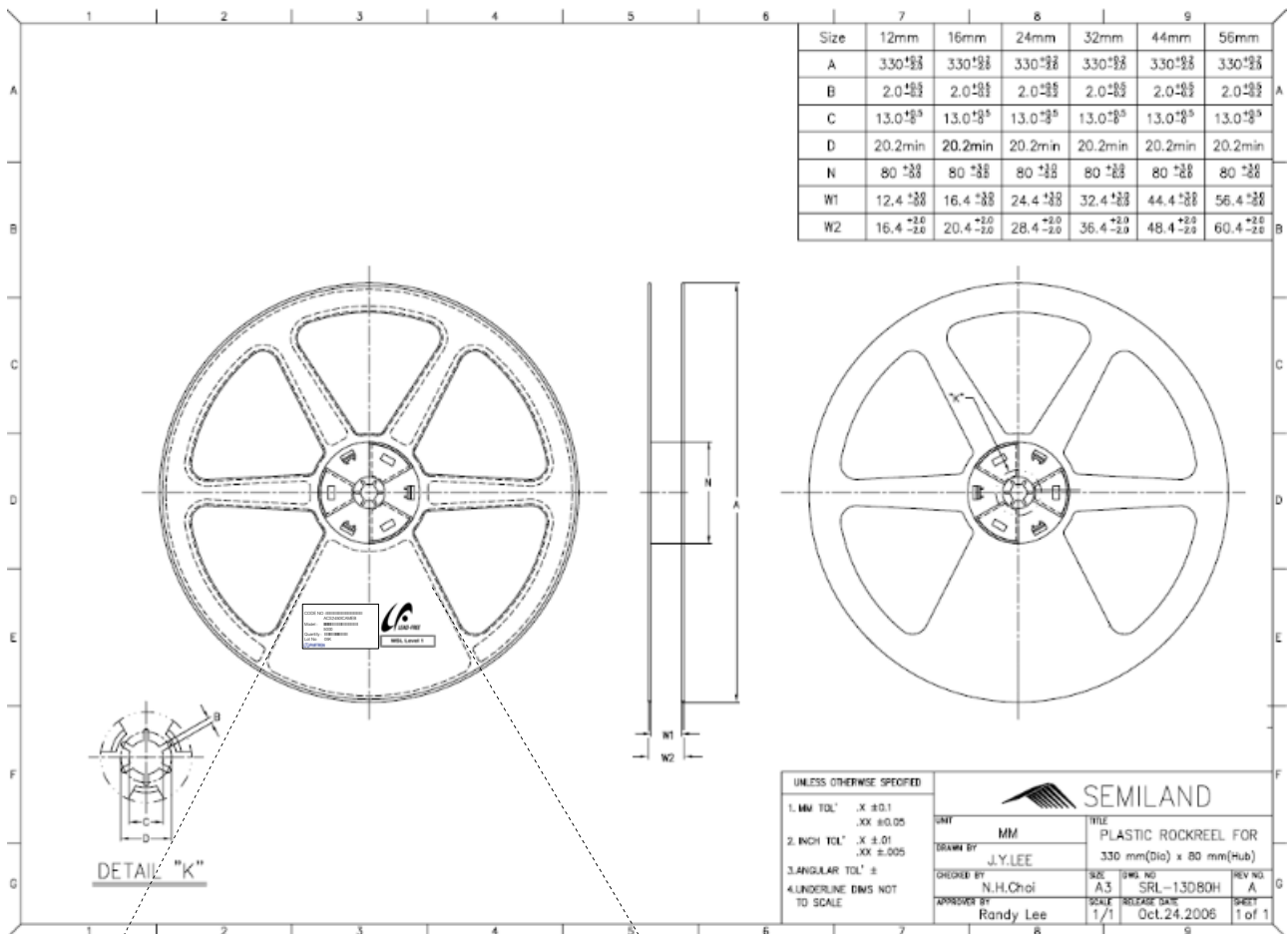
15.1 Carrier/Reel 사양

품목	재질	표면저항	정전기 발생량	포장방식
Carrier	A-PET	Typical $10^8 \Omega$	10V MAX	열 압착식
Cover 테이프	PET	Typical $10^8 \Omega$	30V MAX	
Reel	PS	Typical $10^8 \Omega$	30V MAX	-

15.1.1 Carrier 사양



14.1.2 Reel 사양



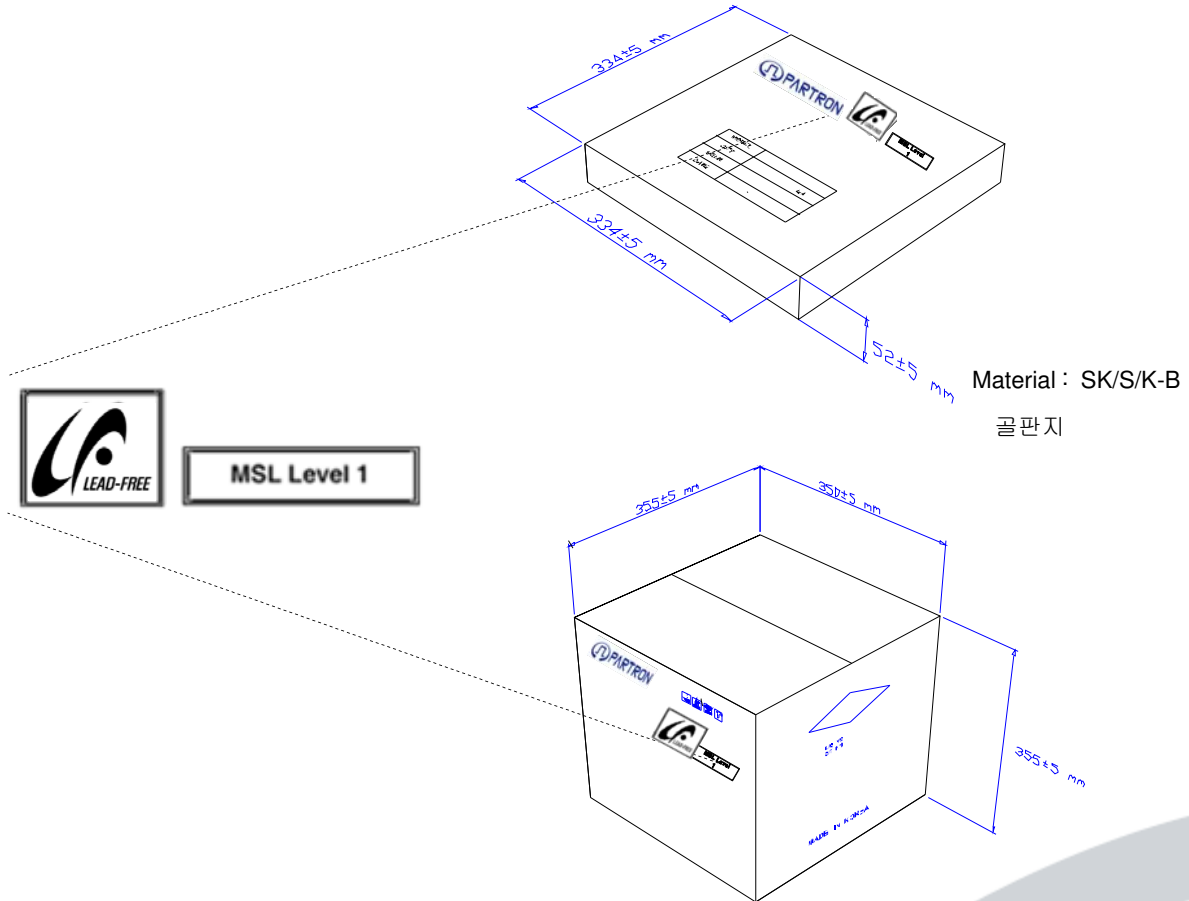
CODE NO :
ACS2450ICAMEB
Model :
5000
Quantity :
Lot No 05K

PARTRON



MSL Level 1

15.2 Box 사양



15.3 포장 실물 사진



Reel 사진



내상 박스 사진



외상 박스 사진



Reel / 내상 박스 라벨




외상 박스 라벨

16. 관리공정도

제품			발행 /개정		품질관리공정도				관리번호	기안	심의	결정		
CHIP ANTENNA			Issued	04.04.06					Revised	05.04.03 <td>PRCP-C001</td> <td></td> <td></td> <td></td>	PRCP-C001			
투입자재	FLOW CHART		공정명	요인관리					품질특성관리					
	준비	본공정		설비명	관리항목	조건	관리주기	기록관리	관리항목	관리한계	검사방법	관리주기	기록관리	조치사항
세라믹 파우더		◇	수입검사						수축율 유전율	작업지도서 참조	Micrometer Network	10개/LOT	C/sheet	반품
파우더 윤활제	○		분말	Mixer					혼합	파우더: 윤활제	저울	혼합시	-	폐기
		○	성형 CTQ공정 (무게,치수)	프레스	양압 금형상태	작업지도서 참조	매LOT 1회/일	parameter C/SHEET	치수 무게 밀도 외관	작업지도서 참조	Micrometer 저울 Calculated Visual	5/100개 검사 10개/LOT	LOT CARD	폐기
		○	소성	소성로	SETTER 외관 온도 PROFILE	작업지도서 참조	전수 2회/일 1회/월	C/sheet						
		◇	소체 CTQ공정 (치수)						폭 길이 모양	검사지도서 참조	Micrometer Calipers 목시	20개/LOT 20개/LOT 전수	C/sheet	폐기
AG PASTE		○	SIDE1 패드 인쇄 CTQ공정 (인쇄치수)	인쇄기 screen	스퀴즈 속도 /압력 SNAP	작업지도서 참조	1회/일	-	PATTERN 치수 외관	작업지도서 참조	측정기 현미경	10개/3Jig	c/sheet	재작업
		○	건조	건조기 건조Jig	온도 Belt speed	작업지도서 참조	1회/주	Parameter	건조상태 인쇄상태 파손	작업지도서 참조	목시	전수검사	Lot card	재작업

제품		발행 /개정		품질관리공정도					관리번호	기안	심의	결정		
CHIP ANTENNA		Issued	04.04.06.						PRCP-C001					
투입자재	FLOW CHART		공정명	요인관리					품질특성관리					
	준비	본공정		설비명	관리항목	조건	관리주기	기록관리	관리항목	관리한계	검사방법	관리주기	기록관리	조치사항
AG PASTE			SIDE 2 패드 인쇄 CTQ공정 (인쇄치수)	인쇄기 screen	스퀴즈 속도 /압력 SNAP	작업지도서 참조	1회/일	-	PATTERN치수 외관	작업지도서 참조	측정기 현미경	10개 /3Jig	c/sheet	재작업
			건조	건조기 건조Jig	온도 Belt speed	작업지도서 참조	1회/주	Parameter	건조상태 인쇄상태 파손	작업지도서 참조	목시	전수검사	Lot card	재작업
			소부	소부로 mesh망	온도 Belt speed	작업지도서 참조	1회/주	Parameter C/Sheet	소체파손 오염	작업지도서 참조	목시	전수	Lot card	폐기 재작업
AG PASTE			TOP 인쇄 CTQ공정 (인쇄치수)	인쇄기 screen	스퀴즈 속도 /압력 SNAP	작업지도서 참조	1회/일	-	PATTERN치수	작업지도서 참조	측정기	10개 /3Jig	c/sheet	재작업
			건조	건조기 건조Jig	온도 Belt speed	작업지도서 참조	1회/주	Parameter	건조상태 인쇄상태 파손	작업지도서 참조	목시	전수검사	Lot card	재작업
AG PASTE			BOTTOM 패드 인쇄 CTQ공정 (인쇄치수)	인쇄기 screen	스퀴즈 속도 /압력 SNAP	작업지도서 참조	1회/일	-	PATTERN치수 외관	작업지도서 참조	측정기 현미경	10개 /3Jig	c/sheet	재작업

제품		발행 / 개정		품질관리공정도					관리번호	기안	심의	결정		
CHIP ANTENNA		Issued	04.04.06.						PRCP-C001					
투입자재	FLOW CHART		공정명	요인관리					품질특성관리					
	준비	본공정		설비명	관리항목	조건	관리주기	기록관리	검사항목	관리한계	검사방법	관리주기	기록관리	조치사항
			건조	건조기 건조Jig	온도 Belt speed	작업지도서 참조	1회/주	Parameter	건조상태 인쇄상태 파손	작업지도서 참조	목시	전수검사	Lot card	재작업
			소부	소부로 mesh망	온도 Belt speed	작업지도서 참조	1회/주	Parameter C/Sheet	소체파손 오염	작업지도서 참조	목시	전수	Lot card	폐기 재작업
			외관검사						제품외관	한도견본 작업지도서 참조	목시 현미경	전수	Lot card 생산일보	폐기 수리
			MARKING	마킹기					마킹외관	한도견본	목시	전수	Lot card 생산일보	재작업 폐기
			특성검사 CTF공정	NETWORK 검사지그	교정상태	작업지도서 참조	1회/반	C/sheet	전기적 특성	작업지도서 참조	Network	전수	Lot card 생산일보	폐기 수리
			외관검사						제품외관 제품치수	한도견본 작업지도서 참조	목시 현미경	전수	Lot card 생산일보	폐기 수리
Carrier cover reel			Taping						수량 역삽 외관	작업지도서 참조	수작업	전수	Lot card 생산일보	재작업
			출하검사	NETWORK 검사지그	교정상태	작업지도서 참조	1회/반	C/sheet	전기적특성 제품외관 포장상태	검사지도서	Network 현미경 목시	작업 지도서	성적서	return 폐기
포장 box label			포장	bar code printer					포장상태 기종혼입 포장수량	포장작업 지도서	목시	전수	-	재작업
			포장검사						포장상태 기종혼입 포장수량	포장작업 지도서	목시	전수	-	return

17. 유해물질 성적서

17.1 Ceramic Powder

Parts Name	iM-K8
Tester Organization	SGS Testing KOREA co. Ltd.
Measurement Tester	Please see the 'method' in the test report
Measurement Data	Please see the report under the table



Test Report No. SHAEIC1417328401 Date: 13 Sep 2014 Page 1 of 7

WUXI INANOTECH CO., LTD.
NO.518-3 ZHONGSHU ROAD, WUXI, JIANGSU, CHINA (214174)

The following sample(s) was/were submitted and identified on behalf of the clients as : CERAMIC POWDER


SGS Job No.: SP14-028034 - 2H
Model No.: iM-K8
Composition: Mg2SiO4, SiTiO3
Date of Sample Received: 10 Sep 2014
Testing Period: 10 Sep 2014 - 13 Sep 2014
Test Requested: Selected test(s) as requested by client.
Test Method: Please refer to next page(s).
Test Results: Please refer to next page(s).
Conclusion: Based on the performed tests on submitted samples, the results of Lead, Mercury, Cadmium, Hexavalent chromium, Polybrominated biphenyls (PBB), Polybrominated diphenyl ethers (PBDE) comply with the limits as set by REACH Directive 2011/65/EU Annex II, recasting 2002/95/EC.

Signed for and on behalf of
SGS-CSTC LM.

Serena Wang
Approved Signatory



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Test Report No. SHAEIC1417328401 Date: 13 Sep 2014 Page 2 of 7

Test Results

Test Result Description:

Specimen No.	SGS Sample ID	Description
SH1	SH14-173284-001	Grey powder

Remarks:


- (1) 1 mg/kg = 0.0001%
- (2) MDL = Method Detection Limit
- (3) ND = Not Detected (< MDL)
- (4) * = Not Regulated

RoHS Directive 2011/65/EU


Test Method:

- (1) With reference to IEC 62321-4:2013, determination of Cadmium by ICP-OES.
- (2) With reference to IEC 62321-4:2013, determination of Lead by ICP-OES.
- (3) With reference to IEC 62321-4:2013, determination of Mercury by ICP-OES.
- (4) With reference to IEC 62321-4:2013, determination of Hexavalent Chromium by Colorimetric Method using UV-Vis.
- (5) With reference to IEC 62321-4:2013, determination of PBBs and PBDEs by GC-MS.

Test Item(s)	Limit	Unit	MDL	Det.
Cadmium (Cd)	100	mg/kg	2	ND
Lead (Pb)	1000	mg/kg	2	ND
Mercury (Hg)	1000	mg/kg	2	ND
Hexavalent Chromium (Cr(VI))	1000	mg/kg	2	ND
Sum of PBBs	1000	mg/kg	-	ND
Monobromobiphenyl	-	mg/kg	5	ND
Dibromobiphenyl	-	mg/kg	5	ND
Tribromobiphenyl	-	mg/kg	5	ND
Tetrabromobiphenyl	-	mg/kg	5	ND
Pentabromobiphenyl	-	mg/kg	5	ND
Hexabromobiphenyl	-	mg/kg	5	ND
Heptabromobiphenyl	-	mg/kg	5	ND
Octabromobiphenyl	-	mg/kg	5	ND
Nonabromobiphenyl	-	mg/kg	5	ND
Decabromobiphenyl	-	mg/kg	5	ND
Sum of PBDEs	1000	mg/kg	-	ND
Monobromodiphenyl ether	-	mg/kg	5	ND



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Test Report No. SHAEIC1417328401 Date: 13 Sep 2014 Page 3 of 7

Test Item(s)	Limit	Unit	MDL	Det.
Dibromodiphenyl ether	-	mg/kg	5	ND
Tribromodiphenyl ether	-	mg/kg	5	ND
Tetrabromodiphenyl ether	-	mg/kg	5	ND
Pentabromodiphenyl ether	-	mg/kg	5	ND
Hexabromodiphenyl ether	-	mg/kg	5	ND
Heptabromodiphenyl ether	-	mg/kg	5	ND
Octabromodiphenyl ether	-	mg/kg	5	ND
Nonabromodiphenyl ether	-	mg/kg	5	ND
Decabromodiphenyl ether	-	mg/kg	5	ND

Notes:

(1) The maximum permissible limit is quoted from directive 2011/65/EU, Annex II

Element(s)


Test Method: With reference to US EPA Method 3052:1996, analysis was performed by ICP-OES.

Test Item(s)	Unit	MDL	Det.
Antimony (Sb)	mg/kg	10	ND


Halogen

Test Method: With reference to EN 14582: 2007, analysis was performed by Ion Chromatograph (IC).

Test Item(s)	Unit	MDL	Det.
Chlorine (Cl)	mg/kg	50	ND
Bromine (Br)	mg/kg	50	ND



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Test Report No. SHAEIC1417328401 Date: 13 Sep 2014 Page 4 of 7


ATTACHMENTS

RoHS Testing Flow Chart

1) Name of the person who made testing: Bob Zhang/Star Wang/Shara Wang/Gary Xu
2) Name of the person in charge of testing: Jan Shi/Summer Jin/Jessy Huang
3) These samples were dissolved totally by pre-conditioning method according to below flow chart. (C²⁺ and PBBs/PBDEs test method excluded)

```

graph TD
    A[Sample Preparation] --> B[Sample Measurement]
    B --> C[Pb/Cd/Hg]
    B --> D[PBBs/PBDEs]
    B --> E[Cr6+]
    C --> F[Add digestion with microwave/ hotplate]
    F --> G[Filtration]
    G --> H[Solution]
    H --> I[ICP-OES]
    I --> J[DATA]
    G --> K[Residue]
    K --> L[1) Alkali Fusion / Dry Ashing  
2) Add to dissolve]
    L --> I
    D --> M[Sample solvent extraction]
    M --> N[Concentration/ Dilution of extraction solution]
    N --> O[Filtration]
    O --> P[GC/MS]
    P --> Q[DATA]
    E --> R[Nonmetallic material]
    E --> S[Metallic material]
    R --> T[Adding digestion reagent]
    T --> U[Heating to 90-95°C for extraction]
    U --> V[Filtration and pH adjustment]
    V --> W[Adding 1,5-diphenylcarbazide for color development]
    W --> X[UV-Vis]
    X --> Y[DATA]
    S --> Z[Positive Spot test]
    Z --> AA[Boiling water extraction]
    AA --> AB[Adding 1,5-diphenylcarbazide for color development]
    AB --> AC[A red color indicates the presence of Cr6+. If necessary, confirm with UV-Vis.]
    AC --> AD[DATA]
  
```



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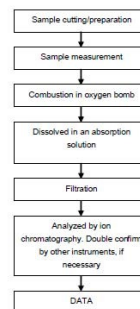
Test Report

ATTACHMENTS

No. SHAEC1417328401 Date: 13 Sep 2014 Page 6 of 7

Halogen Testing (oxygen bomb) Flow Chart

- 1) Name of the person who made testing: Sisily Yin
2) Name of the person in charge of testing: Linda U

[illegible]

17.2 Ag Paste

Parts Name	DNF2010C
Tester Organization	SGS Testing KOREA co. Ltd.
Measurement Tester	Please see the 'method' in the test report
Measurement Data	Please see the report under the table

SGS

Test Report No. F800101LF-CTSAIAA14-28567

Issued Date : 2014. 08. 17

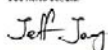
Page 1 of 6

DNAJOO ELECTRONICS MATERIALS CO., LTD.
148 Seohyeon-ro
Seungnam-si, Gyeonggi-do
Korea

The following sample(s) was/were submitted and identified by/on behalf of the client as:

SGS File No. : AYAA14-28567
Product Name : Ag Paste
Item No./Part No. : N/A
Client Reference Data : DNF2010C(Y140409),DNF2010(Y140407),DNF2010(Y140401)
Received Date : 2014. 08. 09
Test Period : 2014. 08. 10 to 2014. 08. 17
Report Comments : By the applicant's request, item No. part No. is a client reference information are stated/added on report.
Test Results : For further details, please refer to following page(s)

SGS Korea Co., Ltd.



Jeff Jang / Chemical Lab Mgr

SGS

Test Report No. F800101LF-CTSAIAA14-28567

Issued Date : 2014. 08. 17

Page 2 of 6

Sample No. : AYAA14-28567-001
Sample Description : Ag Paste
Item No./Part No. : N/A
Materials : N/A

Trace Metals

Test Item	Unit	Test Method	MDL	Results
Lead (Pb)	mg/kg	With reference to IEC 62321:2013, ICP	5	N.D.
Cadmium (Cd)	mg/kg	With reference to IEC 62321:2013, ICP	0.5	N.D.
Mercury (Hg)	mg/kg	With reference to IEC 62321:2013, ICP	2	N.D.
Measured Chromium (Cr) (Pb)	mg/kg	With reference to IEC 62321:2013, ICP	1	N.D.


Testing Method

Test Item	Unit	Test Method	MDL	Results
Vanadium(V) pentoxide	mg/kg	With reference to IEC 62321:2013, GC-MS	5	N.D.
Diarsenic trioxide	mg/kg	With reference to IEC 62321:2013, GC-MS	5	N.D.
Trisarsenic trioxide	mg/kg	With reference to IEC 62321:2013, GC-MS	5	N.D.
Pentabismuth trioxide	mg/kg	With reference to IEC 62321:2013, GC-MS	5	N.D.
Hexabismuth trioxide	mg/kg	With reference to IEC 62321:2013, GC-MS	5	N.D.
Heptabismuth trioxide	mg/kg	With reference to IEC 62321:2013, GC-MS	5	N.D.
Octabismuth trioxide	mg/kg	With reference to IEC 62321:2013, GC-MS	5	N.D.
Nonabismuth trioxide	mg/kg	With reference to IEC 62321:2013, GC-MS	5	N.D.
Decabismuth trioxide	mg/kg	With reference to IEC 62321:2013, GC-MS	5	N.D.
Undecabismuth trioxide	mg/kg	With reference to IEC 62321:2013, GC-MS	5	N.D.
Dodecabismuth trioxide	mg/kg	With reference to IEC 62321:2013, GC-MS	5	N.D.
Tridecabismuth trioxide	mg/kg	With reference to IEC 62321:2013, GC-MS	5	N.D.
Tetradecabismuth trioxide	mg/kg	With reference to IEC 62321:2013, GC-MS	5	N.D.
Pentadecabismuth trioxide	mg/kg	With reference to IEC 62321:2013, GC-MS	5	N.D.
Hexadecabismuth trioxide	mg/kg	With reference to IEC 62321:2013, GC-MS	5	N.D.
Heptadecabismuth trioxide	mg/kg	With reference to IEC 62321:2013, GC-MS	5	N.D.
Octadecabismuth trioxide	mg/kg	With reference to IEC 62321:2013, GC-MS	5	N.D.
Nonadecabismuth trioxide	mg/kg	With reference to IEC 62321:2013, GC-MS	5	N.D.
Eicosa-bismuth trioxide	mg/kg	With reference to IEC 62321:2013, GC-MS	5	N.D.

Testing Method

Test Item	Unit	Test Method	MDL	Results
Chromium(VI)	mg/kg	BS EN 14883:2007, IC	30	N.D.
Bromine	mg/kg	BS EN 14883:2007, IC	30	N.D.

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The Company is not responsible for the results of the analysis if the sample is not representative of the material or if the sample is not properly prepared or if the sample is not properly stored or if the sample is not properly handled or if the sample is not properly identified or if the sample is not properly labeled or if the sample is not properly marked or if the sample is not properly sealed or if the sample is not properly packaged or if the sample is not properly transported or if the sample is not properly received or if the sample is not properly stored or if the sample is not properly handled or if the sample is not properly identified or if the sample is not properly labeled or if the sample is not properly marked or if the sample is not properly sealed or if the sample is not properly packaged or if the sample is not properly transported or if the sample is not properly received or if the sample is not properly stored or if the sample is not properly handled or if the 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<p>SGS</p> <p>Test Report No. F800101LF-CTSAIAA14-28567 Issued Date : 2014. 08. 17 Page 3 of 6</p> <p>NOTE: (1) N.D. = Not detected (<MDL) (2) mg/kg = ppm (3) MDL = Method Detection Limit (4) - = No regulation (5) Negative = Undetectable / Positive = Detectable (6) "+" = Qualitative analysis (No Unit) (7) "+" = Boiling-water-extraction Negative = Absence of Cr(VI) coating Positive = Presence of Cr(VI) coating; the detected concentration in boiling-water-extraction solution is equal or greater than 0.02 mg/kg with 50 cm² sample surface area.</p> <p>Picture of Sample as Received:</p> 	<p>SGS</p> <p>Test Report No. F800101LF-CTSAIAA14-28567 Issued Date : 2014. 08. 17 Page 4 of 6</p> <p>Flow Chart of Digestion</p> <pre> graph TD A[Cutting/Preparation] --> B[Sample Measurement] B --> C[Cd,Pb] B --> D[Hg] C --> E[Decomposition under closed(microwave) or open(acid digestion) system by suitable acid for each sample matrix.] D --> F[Decomposition under closed(microwave) system by suitable acid for each sample matrix.] E --> G[Filtration] F --> G G --> H[Solution] G --> I[Residue] H --> J[ICP-AES] I --> K[Alkali Fusion] </pre> <table border="1"> <thead> <tr> <th>Sample material</th><th>Digestion Acid</th></tr> </thead> <tbody> <tr> <td>Metal:Fe, Cu, Al, etc.</td><td>Aqua regia, HCl, HNO₃</td></tr> <tr> <td>Plastic</td><td>HNO₃, HCl, HF, HClO₄</td></tr> <tr> <td>Silver</td><td>HNO₃, H₂SO₄</td></tr> <tr> <td>Solder, Au, Pt, Pd, Sb, Sn</td><td>Aqua regia</td></tr> <tr> <td>Glass</td><td>HNO₃, HCl, HF</td></tr> <tr> <td>Ti, Zr, W, Mo, Si, Hf, Nb, Ta</td><td>HNO₃, HCl, HF</td></tr> <tr> <td>Sn (as IEC 62321)</td><td>HNO₃, HCl, H₂SO₄, HBr</td></tr> <tr> <td>Others</td><td>Any acid</td></tr> </tbody> </table> <p>The samples were dissolved totally by pre-conditioning method according to above flow chart. Section Chief : Gisaee Yi</p>	Sample material	Digestion Acid	Metal:Fe, Cu, Al, etc.	Aqua regia, HCl, HNO ₃	Plastic	HNO ₃ , HCl, HF, HClO ₄	Silver	HNO ₃ , H ₂ SO ₄	Solder, Au, Pt, Pd, Sb, Sn	Aqua regia	Glass	HNO ₃ , HCl, HF	Ti, Zr, W, Mo, Si, Hf, Nb, Ta	HNO ₃ , HCl, HF	Sn (as IEC 62321)	HNO ₃ , HCl, H ₂ SO ₄ , HBr	Others	Any acid
Sample material	Digestion Acid																		
Metal:Fe, Cu, Al, etc.	Aqua regia, HCl, HNO ₃																		
Plastic	HNO ₃ , HCl, HF, HClO ₄																		
Silver	HNO ₃ , H ₂ SO ₄																		
Solder, Au, Pt, Pd, Sb, Sn	Aqua regia																		
Glass	HNO ₃ , HCl, HF																		
Ti, Zr, W, Mo, Si, Hf, Nb, Ta	HNO ₃ , HCl, HF																		
Sn (as IEC 62321)	HNO ₃ , HCl, H ₂ SO ₄ , HBr																		
Others	Any acid																		

17.3 Marking Ink(Black Ink)

Parts Name	IR/IC-270BK INK
Tester Organization	SGS Testing KOREA co. Ltd.
Measurement Tester	Please see the 'method' in the test report
Measurement Data	Please see the report under the table

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YANTAI PARTRON ELECTRONICS CO.,LTD

353# MUXIN ROAD ECONOMIC DEVELOPMENT ZONE MUPING YANTAI SHANDONG CHINA

The following sample(s) was/were submitted and identified on behalf of the clients as: INK

SGS Job No.: TP13-006510 - TJ
Model No.: IR-2708K
Date of Sample Received: 23 Dec 2013
Testing Period: 23 Dec 2013 - 26 Dec 2013
Test Method: Selected test(s) as requested by client.
Test Results: Please refer to next page(s).
Conclusion: Based on the performed tests on submitted samples, the results of Lead, Mercury, Cadmium, Hexavalent chromium, Polychlorinated biphenyls (PCBs), Polychlorinated biphenyl ethers (PBDE) comply with the limits as set by RoHS Directive 2011/65/EU Annex II; recasting 2002/95/EC.

Signed for and on behalf of
SGS-CSTC Ltd.

Reabeca Zhou
Approved Signatory

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Test Item(s)	Limit	Unit	MDL	%2
Dibromodiphenyl ether	-	mg/kg	5	ND
Tribromodiphenyl ether	-	mg/kg	5	ND
Tetrabromodiphenyl ether	-	mg/kg	5	ND
Pentabromodiphenyl ether	-	mg/kg	5	ND
Hexabromodiphenyl ether	-	mg/kg	5	ND
Heptabromodiphenyl ether	-	mg/kg	5	ND
Octabromodiphenyl ether	-	mg/kg	5	ND
Nonabromodiphenyl ether	-	mg/kg	5	ND
Decabromodiphenyl ether	-	mg/kg	5	ND

Notes:

(1) The maximum permissible limit is quoted from directive 2011/65/EU, Annex II.

Halogen

Test Method: With reference to EN 14582: 2007, analysis was performed by Ion Chromatograph (IC).

Test Item(s)	Unit	MDL	%2
Chlorine (Cl)	mg/kg	50	ND
Bromine (Br)	mg/kg	50	ND

Elements

Test Method: With reference to US EPA Method 3052:1996, analysis was performed by ICP-OES.

Test Item(s)	Unit	MDL	%2
Antimony (Sb)	mg/kg	10	ND

Result shown is of the total weight of wet sample

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Test Results:

Test Part Description:

Specimen No. SGS Sample ID Description
SN1 TSN13-013085.002 black ink







Remarks:

(1) 1 mg/kg = 0.0001%
(2) MDL = Method Detection Limit
(3) ND = Not Detected (< MDL)
(4) "*" = Not Regulated

RoHS Directive 2011/65/EU

Test Method: (1) With reference to IEC 62321-5:2013, determination of Cadmium by ICP-OES.
(2) With reference to IEC 62321-5:2013, determination of Lead by ICP-OES.
(3) With reference to IEC 62321-4:2013, determination of Mercury by ICP-OES.
(4) With reference to IEC 62321-2:2008, determination of Hexavalent Chromium by Colorimetric Method using UV-Vis.
(5) With reference to IEC 62321-2:2008, determination of PBBs and PBDEs by GC-MS.

Test Item(s)	Limit	Unit	MDL	%2
Cadmium (Cd)	100	mg/kg	2	ND
Lead (Pb)	1000	mg/kg	2	ND
Mercury (Hg)	1000	mg/kg	2	ND
Hexavalent Chromium (Cr(VI))	1000	mg/kg	2	ND
Sum of PBBs	1000	mg/kg	-	ND
Monobromodiphenyl	-	mg/kg	5	ND
Dibromodiphenyl	-	mg/kg	5	ND
Tribromodiphenyl	-	mg/kg	5	ND
Tetrabromodiphenyl	-	mg/kg	5	ND
Pentabromodiphenyl	-	mg/kg	5	ND
Hexabromodiphenyl	-	mg/kg	5	ND
Heptabromodiphenyl	-	mg/kg	5	ND
Octabromodiphenyl	-	mg/kg	5	ND

<div style="text-align: center;">  </div> <p>Test Report No. TSNEC1301308502 Date: 26 Dec 2013 Page 5 of 7</p> <p>ATTACHMENTS</p> <p style="text-align: center;">Halogen Testing Flow Chart</p> <p>1) Name of the person who made testing: Angeli Yao 2) Name of the person in charge of testing: Rex Zhu</p> <div style="border: 1px solid black; padding: 5px; margin: 5px auto; width: 80%;"> <p style="text-align: center;">Sample cutting/preparation</p> <p style="text-align: center;">↓</p> <p style="text-align: center;">Sample measurement</p> <p style="text-align: center;">↓</p> <p style="text-align: center;">Combustion in oxygen bomb</p> <p style="text-align: center;">↓</p> <p style="text-align: center;">Dissolved in an absorption solution</p> <p style="text-align: center;">↓</p> <p style="text-align: center;">Filtration</p> <p style="text-align: center;">↓</p> <p style="text-align: center;">Analyzed by ion chromatography. Double confirm by other instruments, if necessary</p> <p style="text-align: center;">↓</p> <p style="text-align: center;">DATA</p> </div> <div style="text-align: right; font-size: small; margin-top: 20px;"> <p>This document is issued by the Company subject to its standard conditions of service printed elsewhere, available on request or accessible at http://www.sgsgroup.com, and, conditions, SGS and its subsidiaries, further documents subject to Terms and Conditions for Electronic Documents or other documents as indicated. This document is subject to the limitation of its use and the validity of the data and information contained therein. The Company's sole responsibility is to its client and this document does not constitute part of a transaction or any other legal or contractual relationship. The document cannot be reproduced except in full without prior written approval of the Company. The document is for internal use only and is not to be distributed outside the Company.</p> <p>SGS Mission, No.41 The 5th Avenue TEDA, Tianjin, China 300407 T: (86-22) 6338800 F: (86-22) 6339202 www.cn.sgs.com e: sgs.cn@sgs.com 中国·天津泰达商务技术区第五大道41号SGS大厦 邮编: 300407 T: (86-22) 6338800 F: (86-22) 6339202</p> <p style="text-align: right;">Member of the SGS Group (SGS SA)</p> </div>	<div style="text-align: center;">  </div> <p>Test Report No. TSNEC1301308502 Date: 26 Dec 2013 Page 6 of 7</p> <p>ATTACHMENTS</p> <p style="text-align: center;">Elementary Testing Flow Chart</p> <p>1) Name of the person who made testing: Aaron Wang 2) Name of the person in charge of testing: Cindy Yin</p> <div style="border: 1px solid black; padding: 5px; margin: 5px auto; width: 80%;"> <p style="text-align: center;">Sample cutting/preparation</p> <p style="text-align: center;">↓</p> <p style="text-align: center;">Sample measurement</p> <p style="text-align: center;">↓</p> <p style="text-align: center;">Acid digestion</p> <p style="text-align: center;">↓</p> <p style="text-align: center;">Filtration</p> <p style="text-align: center;">↓</p> <p style="text-align: center;">Solution</p> <p style="text-align: center;">↓</p> <p style="text-align: center;">ICP-OES/AAAS</p> <p style="text-align: center;">↓</p> <p style="text-align: center;">DATA</p> </div> <div style="text-align: right; font-size: small; margin-top: 20px;"> <p>This document is issued by the Company subject to its standard conditions of service printed elsewhere, available on request or accessible at http://www.sgsgroup.com, and, conditions, SGS and its subsidiaries, further documents subject to Terms and Conditions for Electronic Documents or other documents as indicated. This document is subject to the limitation of its use and the validity of the data and information contained therein. The Company's sole responsibility is to its client and this document does not constitute part of a transaction or any other legal or contractual relationship. The document cannot be reproduced except in full without prior written approval of the Company. The document is for internal use only and is not to be distributed outside the Company.</p> <p>SGS Mission, No.41 The 5th Avenue TEDA, Tianjin, China 300407 T: (86-22) 6338800 F: (86-22) 6339202 www.cn.sgs.com e: sgs.cn@sgs.com 中国·天津泰达商务技术区第五大道41号SGS大厦 邮编: 300407 T: (86-22) 6338800 F: (86-22) 6339202</p> <p style="text-align: right;">Member of the SGS Group (SGS SA)</p> </div>
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