SMT Tchnology and Reliability for 01005

최 종 우 선임연구원
(삼성전기)

SMT Technology and Reliability for 01005

April 04, 2007

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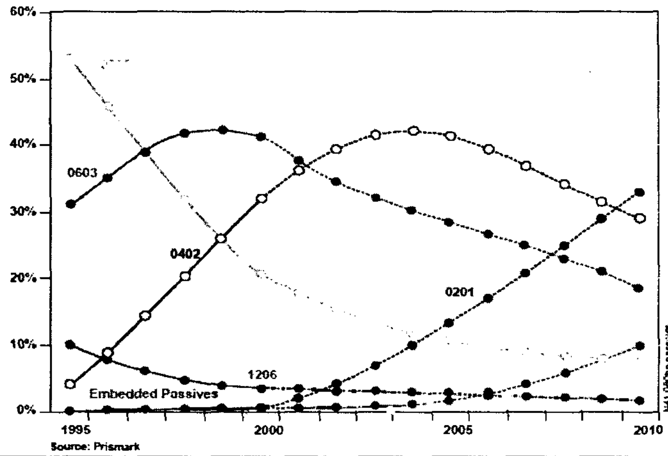
OUTLINE

- Introduction
- Mass Product Test
- Print Shift Test
- Mount Shift Test
- Land Gap & Mask Aperture
- Shear Test

INTRODUCTION

Market Share



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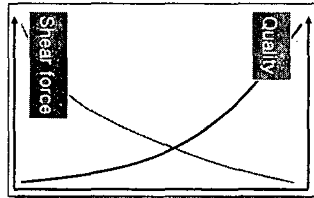
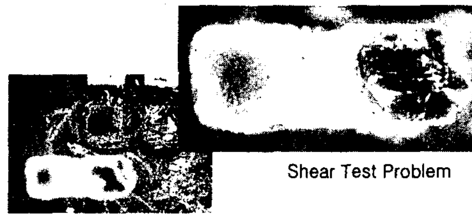
PROCESS KEY FACTORS & ISSUE

■ Materials and Process Factors

Factor	Chip	PCB	Metal mask	Printing	Mounting
Item	Chip size Pocket size	Land size Land position	Open position Open rate	Accuracy Solder amount	Accuracy Force control
Focus				Metal mask	

■ Defect and Reliability Problem





Shear Test Problem

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EXPERIMENTAL PROCEDURE

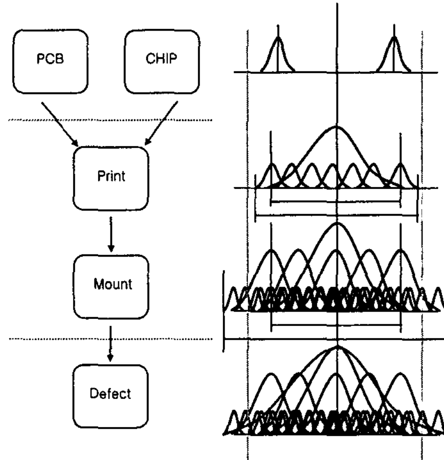
1. 개별 Factor 에 대한 분산(산포) 확인
   대상 Factor : 재료 – PCB, Chip

2. 공정(인쇄, 장착) 오차에 의한 불량 발생 범위 검증
   (공정 오차가 얼마 만큼이면 불량이 발생하는가?)
   대상 Factor : 공정 – 인쇄, 장착

3. 전체 재료 및 공정의 오차에 의한 불량률 검증
   (검토 조건 및 공정에 대한 절대 평가)
   즉, 평가 대상 공정은 재료와 공정 능력이 위와 같을 때
   불량이 몇 PPM 발생할 수 있는 공정이다.

4. PCB설계 및 MASK 설계에 의한 불량 변동 영향 파악
   (주어진 재료 및 공정에 대해 불량을 최소화 할 수 있는
   설계 조건 제시)

5. 최적 설계 조건에서 개별 재료 및 공정의 개선 방향 설정.



TEST PLAN

■ **검토 진행 순서**

검증 단계(4 M)	1.재료(Material) 오차	2.공정(Machine) 오차	3.설계(Method) 조건
검증 항목	CHIP, PCB	PRINTER, MOUNTER	LAND, MASK
검증 내용	CHIP SIZE : X축 ,Y축 (Cpk) PCB :INDEX, LAND SIZE(Cpk)	인쇄 정밀도 : Cmk 장착 정밀도 : Cmk	LAND SIZE, LAND GAP MASK OPEN, MASK 두께

■ **불량 발생 조건 검증(재료 및 공정 조건 검토)**

- 불량 수준 : 10 ppm
- 불량 검증 Sample 수량 / 신뢰도 : 62,204/95%, 42,952/90%, 23,623/80%, 12,277/70%
- 재료 오차 검증 : 재료의 품질 수준 검증 (Chip, PCB)
- 설비 Cmk 검증 : Manual 대비 실제 측정값 확인 (PRINTER, MOUNTER)
- 공정 오차에 의한 불량 발생 범위 검증
  - 인쇄 오차에 의한 불량 검증 : 0㎛, 20㎛, 40㎛, 60㎛, 80㎛, 100㎛
  - 장착 오차에 의한 불량 검증 : 0㎛, 20㎛, 40㎛, 60㎛, 80㎛, 100㎛

	0㎛	20㎛	40㎛	60㎛	80㎛	100㎛
PRINTER	PPM	PPM	PPM	PPM	PPM	PPM
MOUNTER	PPM	PPM	PPM	PPM	PPM	PPM

<기초 공정 능력 분석>

단계	SPEC	공정 능력
재료	– ㎛	Cpk :
	– ㎛	Cpk :
공정	– ㎛	Cmk :
	– ㎛	Cmk :
예상 공정 불량률 (Ppk)		PPM

■ **불량 발생 조건 검증(설계 검토)**

설계 검토 항목	인자(Factor)	수준(Level)
PCB 설계	LAND SIZE	200*200㎛, 200*150㎛, 200*120㎛
	LAND GAP	50㎛, 60㎛, 70㎛ 80㎛, 90㎛
MASK 설계	MASK OPEN	60%, 80%, 100%
	MASK 두께	60㎛,

MACHINE AND MATERIAL

- CHIP MOUNTER
  MAKER : SIEMENS X-SERIES (X-3)
  USE IN CLEAN ROOM DEMO MACHINE
- SCREEN PRINTER
  MAKER : PANASONIC SP60P-M
  USE IN CLEAN ROOM PRODUCT LINE1 AND LINE3 MACHINE
- REFLOW MACHINE
  MAKER : BTU
  USE IN CLEAN ROOM PRODUCT LINE1 AND LINE3 MACHINE
- METAL MASK
  MAKER : BON-MARK IN JAPAN
  METHOD : ELECTRO FORM (NI/Cr/Sus) - PLATING METHOD
- SOLDER PASTE
  MAKER : SENJU IN JAPAN
  PARTICLE SIZE : 15㎛ ~ 25㎛ (FLUX CONTAIN 11.5 %)

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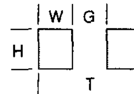
PCB & MASK DESIGN FOR MASS TEST

PCB LAND DESIGN (Unit : ㎛)

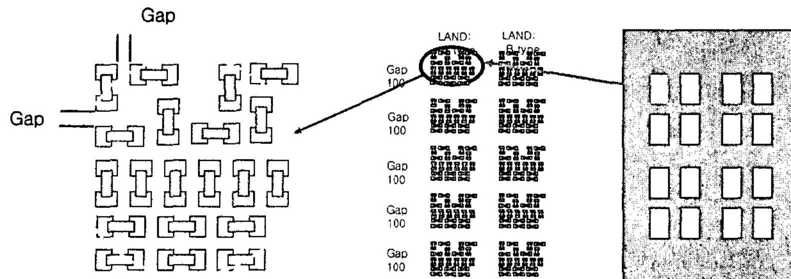
TYPE	H	W	G	T
B Type	200	150	150	450



LAND GAP : 100㎛

METAL MASK DESING (Unit : ㎛)

LAND	TYPE	OPEN RATE	H'	W'
B-b Type		0.78	180	130



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MASS TEST PLAN SUMMARY

■ Test for Mass Product

Chips per PCB	PCBs	Amount Chip	Chip Maker
3,200 Chip	10 PCB	32,000 Chip	SEM

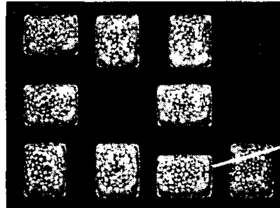
■ Test for Print Shift Test

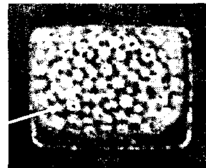
Chips per PCB	PCBs	Amount Chip	Chip Maker	Shift Step
3,200 Chip	5 PCB	16,000 Chip	SEM	20,40,60,80,100㎛

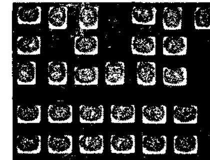
■ Test for Mount Shift Test

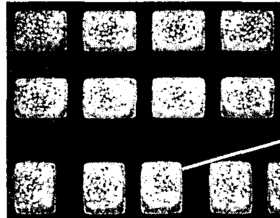
Chips per PCB	PCBs	Amount Chip	Chip Maker	Shift Step
3,200 Chip	5 PCB	16,000 Chip	SEM	20,40,60,80,100㎛

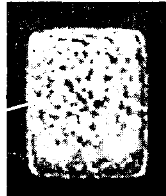
AFTER PRINTING FOR MASS TEST









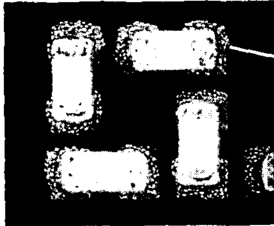


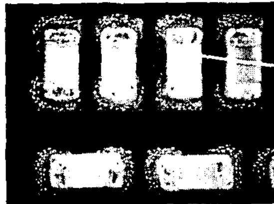
PRINT CONDITION
SPEED: 20mm/s
ANGLE: 60 degree
PRESSURE: 17 N
SNAP OFF : 0.5mm

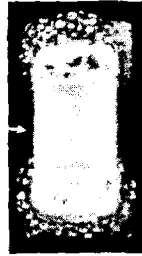
SOLDER PASTE
PARTICLE SIZE:15㎛ ~ 25㎛
Viscosity : 200 Pa.s
FLUX CONTAIN : 11.5 %

MASK THICKNESS : 0.06mm
METHOD : ELECTRO FORM

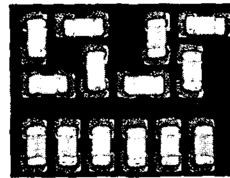
AFTER MOUNT FOR MASS TEST







CHIP SIZE : 400*200 ㎛
LAND SIZE : 200*150 ㎛
MOUNT FORCE : 1N



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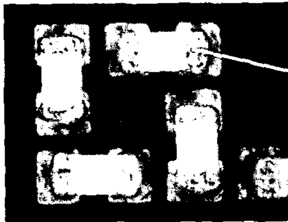
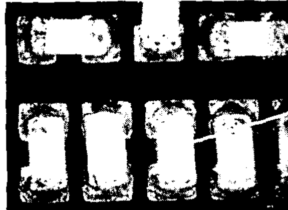
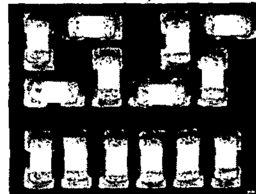
AFTER REFLOW FOR MASS TEST





CHIP SIZE : 400*200 ㎛
LAND SIZE : 200 *150 ㎛
MOUNT FORCE : 1N



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DEFECT RATE AND PICK UP ERROR FOR MASS TEST

■ **Defect Rate (After Reflow)**

Chips per PCB	PCBs	Amount Chip	Chip Maker	Defect
3,200 Chip	10 PCB	32,000 Chip	SEM	ZERO ppm

■ **Pick up Error Data**

# of PCB	Chip	Pick- err	Vision err	Total err
1	3200	2	1	3
2	3200	7	2	9
3	3200	8	2	10
4	3200	9	3	12
5	3200	1	1	2
6	3200	3	1	4
7	3200	3	1	4
8	3200	12	0	12
9	3200	2	0	2
10	3200	1	0	1
SUM	32000	48	11	59

	Pick-up (%)
1	99.91
2	99.72
3	99.68
4	99.63
5	99.93
6	99.88
7	99.88
8	99.63
9	99.94
10	99.97
MIN	99.63
MAX	99.97
AVE	99.82
STD	0.14

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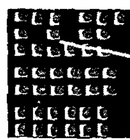
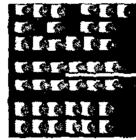
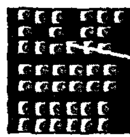
PRINT SHIFT TEST AFTER PRINT



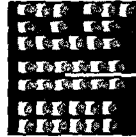
20 ㎛ SHIFT

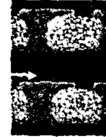


80 ㎛ SHIFT

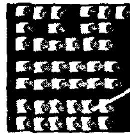


40 ㎛ SHIFT





100 ㎛ SHIFT



60 ㎛ SHIFT

X-DIRECTION OFF SET ONLY

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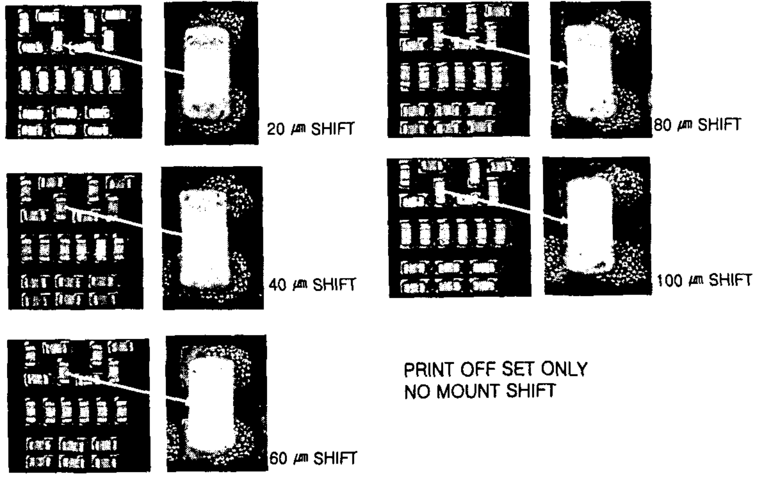
PRINT SHIFT TEST AFTER MOUNT



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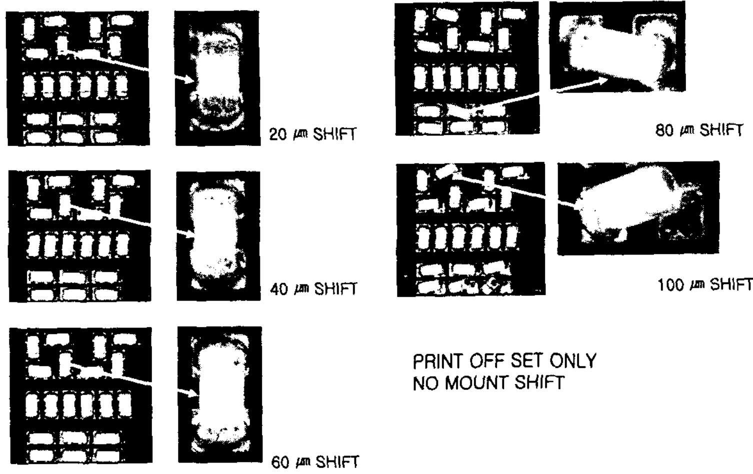
PRINT SHIFT TEST AFTER REFLOW



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PRINT SHIFT TEST DEFECT RATE AND CONCLUSION

■ **DEFECT RATE**

SHIFT RANGE	AMOUNT OF TEST	DEFECT	DEFECT RATE
20㎛ SHIFT	3,200 Chip	2	625ppm
40㎛ SHIFT	3,200 Chip	0	0ppm
60㎛ SHIFT	3,200 Chip	0	0ppm
80㎛ SHIFT	3,200 Chip	Uncountable	-
100㎛ SHIFT	3,200 Chip	Uncountable	-

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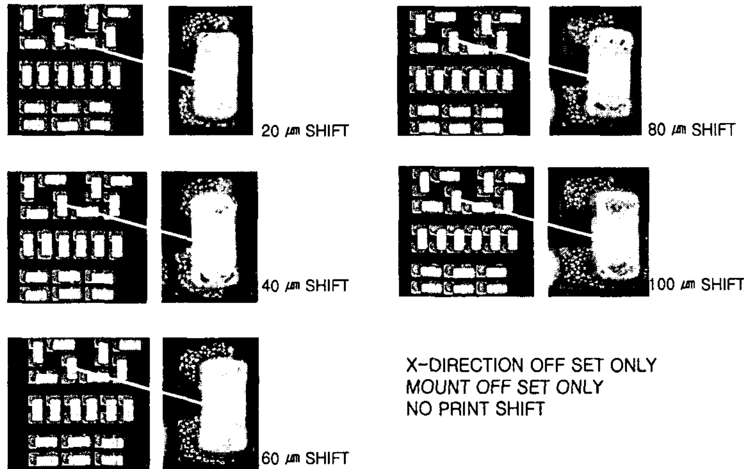
MOUNT SHIFT TEST AFTER MOUNT



X-DIRECTION OFF SET ONLY
MOUNT OFF SET ONLY
NO PRINT SHIFT

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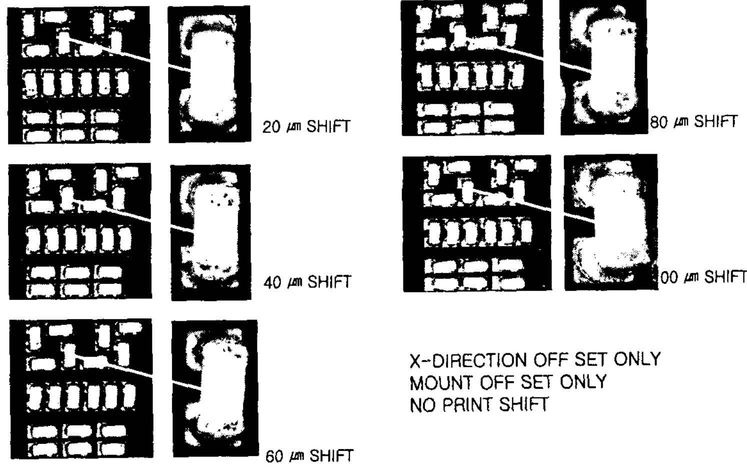

MOUNT SHIFT TEST DEFECT RATE

■ DEFECT RATE

SHIFT RANGE	AMOUNT OF TEST	DEFECT	DEFECT RATE
20㎛ SHIFT	3,200 Chip	6	1875ppm
40㎛ SHIFT	3,200 Chip	0	0
60㎛ SHIFT	3,200 Chip	0	0
80㎛ SHIFT	3,200 Chip	Uncountable	-
100㎛ SHIFT	3,200 Chip	Uncountable	-

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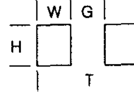
PCB & MASK DESIGN FOR GAP TEST

PCB LAND DESIGN (Unit : ㎛)

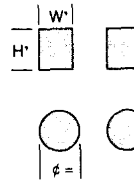
TYPE	H	W	G	T
B type	200	150	150	450
C type	200	120	160	400



Gap	50	60	70	80	90

METAL MASK DESIGN (Unit : ㎛)

LAND	TYPE	OPEN RATE	H'	W'
B type	B-a type	1	200	150
	B-b type	0.78	180	130
	B-c type	0.59	160	110
	B-d type	0.59	CIRCLE ¢ = 150	
C type	C-a type	1	200	120
	C-b type	0.83	180	110
	C-c type	0.67	160	100
	C-d type	0.47	CIRCLE ¢ = 120	



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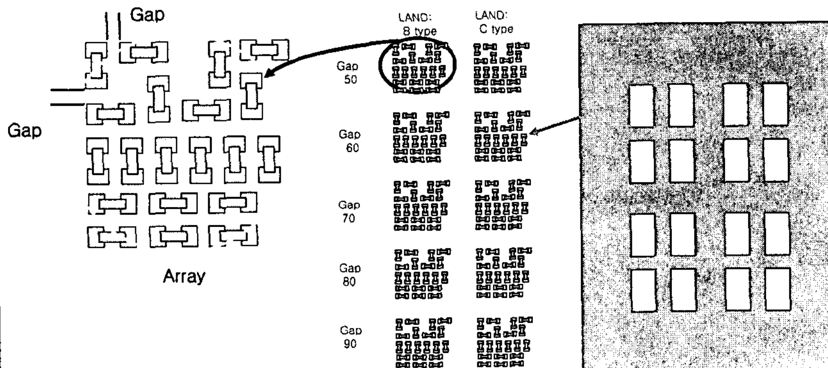
PCB DESIGN FOR GAP TEST



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GAP TEST PLAN SUMMARY

■ **Gap Test for Design Condition**

Chips per PCB	PCBs	Amount Chip	Chip Maker
1,600 Chip	10 PCB	16,000 Chip	Chip A / Chip B

■ **Gap Test for Reliability**

Chips per PCB	PCBs	Amount Chip	Chip Maker
480 Chip	4 PCB	1,920 Chip	Chip A / Chip B

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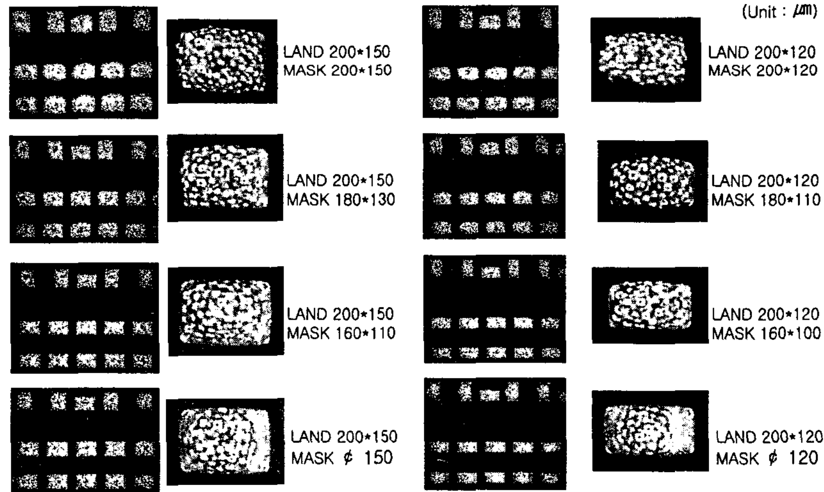
AFTER PRINT FOR GAP TEST



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AFTER MOUNT FOR GAP TEST (EX. mask 80% open)

Land B Type (Unit : ㎛)

LAND 200*150 MASK 180*130 LAND GAP 50㎛	LAND 200*150 MASK 180*130 LAND GAP 60㎛	LAND 200*150 MASK 180*130 LAND GAP 70㎛	LAND 200*150 MASK 180*130 LAND GAP 80㎛	LAND 200*150 MASK 180*130 LAND GAP 90㎛

Land C Type

LAND 200*150 MASK 180*110 LAND GAP 50㎛	LAND 200*150 MASK 180*110 LAND GAP 60㎛	LAND 200*150 MASK 180*110 LAND GAP 70㎛	LAND 200*150 MASK 180*110 LAND GAP 80㎛	LAND 200*150 MASK 180*110 LAND GAP 90㎛

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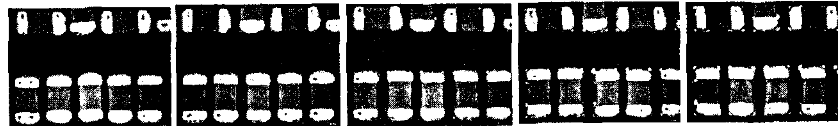
AFTER REFLOW FOR GAP TEST (EX. mask 80% open)

Land B Type (Unit : ㎛)

LAND 200*150 MASK 180*130 LAND GAP 50㎛	LAND 200*150 MASK 180*130 LAND GAP 60㎛	LAND 200*150 MASK 180*130 LAND GAP 70㎛	LAND 200*150 MASK 180*130 LAND GAP 80㎛	LAND 200*150 MASK 180*130 LAND GAP 90㎛

Land C Type



LAND 200*150 MASK 180*110 LAND GAP 50㎛	LAND 200*150 MASK 180*110 LAND GAP 60㎛	LAND 200*150 MASK 180*110 LAND GAP 70㎛	LAND 200*150 MASK 180*110 LAND GAP 80㎛	LAND 200*150 MASK 180*110 LAND GAP 90㎛

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AFTER REFLOW DEFECT

MAIN DEFECT

1.CHIP SKEW : ○

2.SHORT : ○

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DEFECT RATE

LAND SIZE 200*150

LAND GAP	MASK OPEN 100%	MASK OPEN 80%	MASK OPEN 60%	MASK OPEN 60%
GAP 50㎛	U/C	1ea	1ea	1ea
GAP 60㎛	2ea	0	0	0
GAP 70㎛	0	0	0	0
GAP 80㎛	4ea	0	0	0
GAP 90㎛	0	6ea	0	0

LAND SIZE 200*120

LAND GAP	MASK OPEN 100%	MASK OPEN 83%	MASK OPEN 67%	MASK OPEN 47%
GAP 50㎛	U/C	8ea	1ea	0
GAP 60㎛	3ea	0	0	1ea
GAP 70㎛	0	0	1ea	0
GAP 80㎛	0	0	0	0
GAP 90㎛	0	0	0	0

* Notice) Rate of Defect : 5000 ppm/ea

□ : Design Safety Zone

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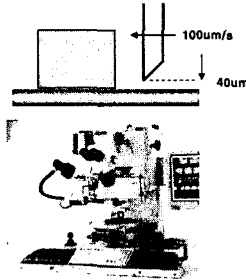
RELIABILITY TEST [Joint Strength]

1. 접합강도 측정

- Test Method : Shear Test
- Testing M/C : Dage4000
- Condition
  Shear Speed : 100um/sec
  Shear Height : 40 um
- 측정수량 : 각 조건별 30회



2. 파단모드 관찰

- 파단모드 (6종)
  Land 박리/ Solder 파단/ Chip 파단/ Chip + Land 박리/ Chip + Solder 파단 / Solder + Land 박리

3. 단면 관찰

- 각 시험 조건 별 솔더링 상태 및 단면 관찰

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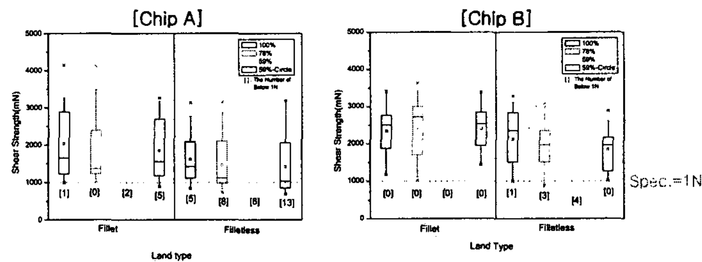
접합강도



- Fillet Type이 Filletless Type에 비해 NG 수량이 적음
- Chip A : Below 1N인 시편 중 84%는 Chip 파단, 16%는 Chip 파단+Land 박리
- Chip B : Filletless Type에서만 NG 발생
  Below 1N인 시편 중 75%는 Land 박리,
  25%는 Land 박리+Solder 파단

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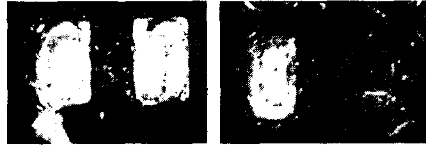
참고) 파단 사진 (1N 미만인 경우)

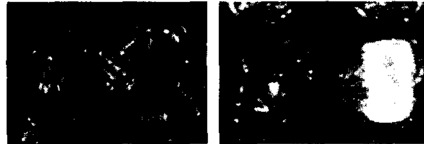
Chip A



Chip 파단 Chip 파단 + Land 박리

	Chip A
Chip 파단	35
Chip 파단 + Land 박리	7
1N 이하 발생 총계	42

Chip B



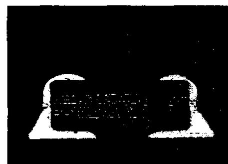
Land 박리 Land박리 + Solder 파단

	Chip B
Land 박리	6
Land 박리 + Solder 파단	2
1N 이하 발생 총계	8

참고) 단면 사진

Chip A Chip B

Fillet (100%)



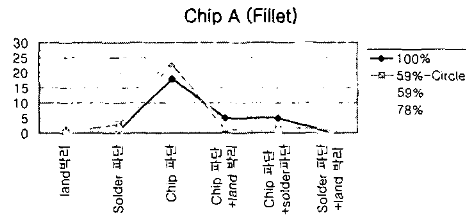
Filletless (100%)

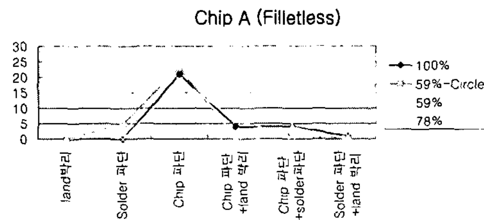
Solder 젖음이 좋지 못함.

파단모드 판정기준

판단기준	사 진	판단기준	사 진
1.Land 박리		4.Chip 파단 +Land 박리	
2.Solder 파단		5.Chip 파단 +Solder파단	
3.Chip 파단		6.Solder 파단 +Land 박리	

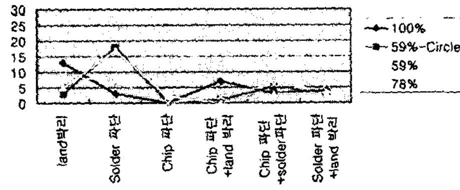
파단모드 정리 (Chip A)



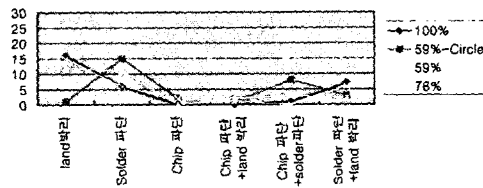


파단모드 정리 (Chip B)

Chip B (Fillet)



Chip B (Filletless)



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