S5E 64/128/256/512GB MCP (V6 512Gb iTLC) Package Qualification Report for X2L Line

23rd Dec., 2022 | Samsung Memory

SAMSUNG

General Product Information

Wafer & Assembly site

- Wafer : Xi`an(X2L), Assembly : Onyang

Part # & APN

- 64GB : (Part #) KLBCG1R5DB-E0U3, (APN #) 335S00611
- 128GB : (Part #) KLBDG2R5DB-E0U3, (APN #) 335S00612
- 256GB : (Part #) KLBEG4R5DB-E0U3, (APN #) 335S00613
- 512GB : (Part #) KLBFG8R5DB-E0U3, (APN #) 335S00614

PCB Information

- 0.135mm / 4layer / SR material : MG3
- EMI shielding site : ASE
- PCB supplier
  - 64/256GB : Daeduck Electronics (DDE)
  - 128/512GB : Simmtech (SIM)

Die stacking information

- 64GB : 1Die / 128GB : 2Die / 256GB : 4Die / 512GB : 8Die

64/128/256/512GB
Package Reliability Qualification Report

S5E MCP Package Reliability for X2L Line : Mini Qualification

Density	ITEM	Stress Condition	PCB Vendor	Sample Size	Result
64GB	**Pre-conditioning**	JESD22-A113 (L3 w/ 4 x IR)	Daeduck Electronics (DDE)	75ea @ 3PKGLot	**Pass (0F/225)**
	Temperature Cycling (TC)	-55℃ to 125℃ @ 300 Cycle (JESD22-A104)		25ea @ 3PKGLot	**Pass (0F/75)**
	Hot Temperature Storage (HTS)	150℃, @ 500hr (JESD22-A103)		25ea @ 3PKGLot	**600hr Pass (0F/75)**
	Biased HAST (BHAST)	110℃ / 85% @ 264hr With Max Bias (JESD22-A110)		25ea @ 3PKGLot	**Pass (0F/75)**
	ESD	HBM: ≥1KV @All Pins (JS-001-2014)		3ea @ 3PKGLot	**HBM: 1.5KV Pass (0F/9)**
		CDM: ≥250V @All Pins (JS-002-2014)			**CDM: 500V Pass (0F/9)**
	Latch-Up Test (LU)	Class II (JESD78)		3ea @ 3PKGLot	**Pass (0F/9)**
128GB	**Pre-conditioning**	JESD22-A113 (L3 w/ 4 x IR)	Simmtech (SIM)	75ea @ 3PKGLot	**Pass (0F/225)**
	Temperature Cycling (TC)	-55℃ to 125℃ @ 300 Cycle (JESD22-A104)		25ea @ 3PKGLot	**Pass (0F/75)**
	Hot Temperature Storage (HTS)	150℃, @ 500hr (JESD22-A103)		25ea @ 3PKGLot	**600hr Pass (0F/75)**
	Biased HAST (BHAST)	110℃ / 85% @ 264hr With Max Bias (JESD22-A110)		25ea @ 3PKGLot	**Pass (0F/75)**
	ESD	HBM: ≥1KV @All Pins (JS-001-2014)		3ea @ 3PKGLot	**HBM: 1.5KV Pass (0F/9)**
		CDM: ≥250V @All Pins (JS-002-2014)			**CDM: 500V Pass (0F/9)**
	Latch-Up Test (LU)	Class II (JESD78)		3ea @ 3PKGLot	**Pass (0F/9)**

S5E MCP Package Reliability for X2L Line : Full Qualification

Density	ITEM	Stress Condition	PCB Vendor	Sample Size	Result
256GB	**Pre-conditioning**	JESD22-A113 (L3 w/ 4 x IR)	Daeduck Electronics (DDE)	276ea @ 3PKGLot	**Pass (0F/828)**
	Temperature Cycling (TC)	-55℃ to 125℃ @ 700 Cycle (JESD22-A104)		77ea @ 3PKGLot	**Pass (0F/231)**
	Hot Temperature Storage (HTS)	150℃, @ 500hr (JESD22-A103)		45ea @ 3PKGLot	**600hr Pass (0F/135)**
	Unbiased HAST (UHAST)	110℃/85%, @ 264hr (JESD22-A110)		77ea @ 3PKGLot	**Pass (0F/231)**
	Biased HAST (BHAST)	110℃ / 85% @ 264hr With Max Bias (JESD22-A110)		77ea @ 3PKGLot	**Pass (0F/231)**
	ESD	HBM: ≥1KV @All Pins (JS-001-2014) CDM: ≥250V @All Pins (JS-002-2014)		3ea @ 3PKGLot	**HBM: 1.5KV Pass (0F/9)** **CDM: 500V Pass (0F/9)**
	Latch-Up Test (LU)	Class II (JESD78)		3ea @ 3PKGLot	**Pass (0F/9)**
512GB	**Pre-conditioning**	JESD22-A113 (L3 w/ 4 x IR)	Simmtech (SIM)	276ea @ 3PKGLot	**Pass (0F/828)**
	Temperature Cycling (TC)	-55℃ to 125℃ @ 700 Cycle (JESD22-A104)		77ea @ 3PKGLot	**Pass (0F/231)**
	Hot Temperature Storage (HTS)	150℃, @ 500hr (JESD22-A103)		45ea @ 3PKGLot	**600hr Pass (0F/135)**
	Unbiased HAST (UHAST)	110℃/85%, @ 264hr (JESD22-A110)		77ea @ 3PKGLot	**Pass (0F/231)**
	Biased HAST (BHAST)	110℃ / 85% @ 264hr With Max Bias (JESD22-A110)		77ea @ 3PKGLot	**Pass (0F/231)**
	ESD	HBM: ≥1KV @All Pins (JS-001-2014) CDM: ≥250V @All Pins (JS-002-2014)		3ea @ 3PKGLot	**HBM: 1.5KV Pass (0F/9)** **CDM: 500V Pass (0F/9)**
	Latch-Up Test (LU)	Class II (JESD78)		3ea @ 3PKGLot	**Pass (0F/9)**

64/128/256/512GB
Package Process Qualification Report

Package Process Qualification

Summary

Stress Test		Stress Condition	Number of Package Lots	Sample Size per Lot	Duration	Criteria	Reference	Result
Shadow Moiré		Absolute max warpage Convex(+)/Concave(-) Temp at max warpage Refer to 2.2.5	2	5	30'C to 260'C 4x IR cycles	-	Refer to 1.3.2 1.3.3, 1.3.4 JESD22-B112A	**0F / 10**
Bond Pull Strength		Reference spec Paragraph 3	3	36 wires (5units/Lot)	NA	min 2.0g	MIL-STD-883 M2011	**0F / 150**
Bond Shear		Reference spec Paragraph 4	3	36 bonds (5units/Lot)	NA	min 6.3g	JESD22-B116 AEC-Q100	**0F / 150**
Tape Adhesion Test		Ta=25'C, 4B - Level to Pass, refer to 2.2.4	3	20	NA	> 4B	ASTM D-3359	**0F / 60**
Delamination check by SAT		Check after preconditioning test	3	20	NA	zero		**0F / 128**
Contact Resistance check for shield		Check after preconditioning test	3	20	NA	< 0.6 Ohm-mm	Refer to 2.2.6	**0F / 60**
Physical Dimension	**Width**	Refer to 2.2.3	3	20	Meet outline dimension tolerances	9.0±0.05mm	Refer to 1.3.2, 1.3.3, 1.3.4	**0F / 60**
	Length		3	20		13.3±0.05mm		**0F / 60**
	Z max		3	20		max 0.9mm (512GB) max 0.87mm		**0F / 60**
	Pre bump		3	20		0.05±0.02mm		**0F / 60**
	Body Thickness		3	20		0.8±0.025mm (512GB) 0.77±0.025mm		**0F / 60**

Package Process Qualification

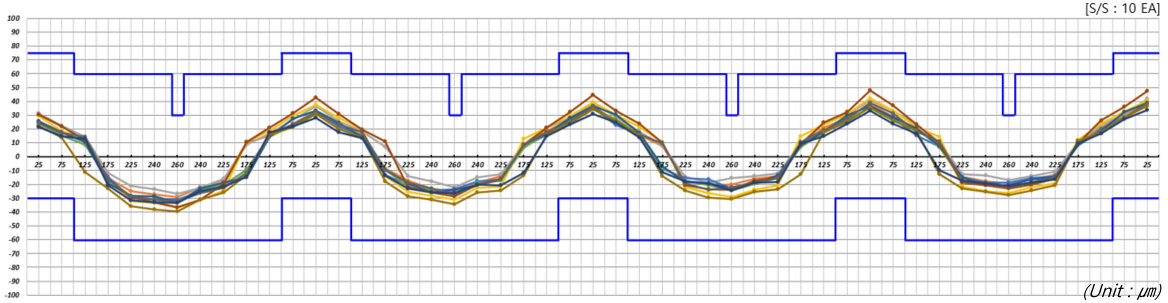
Shadow Moire Measurement Result (0F / 10)

Concave Warpage
Warp Polarity : (-)

Convex Warpage
Warp Polarity : (+)

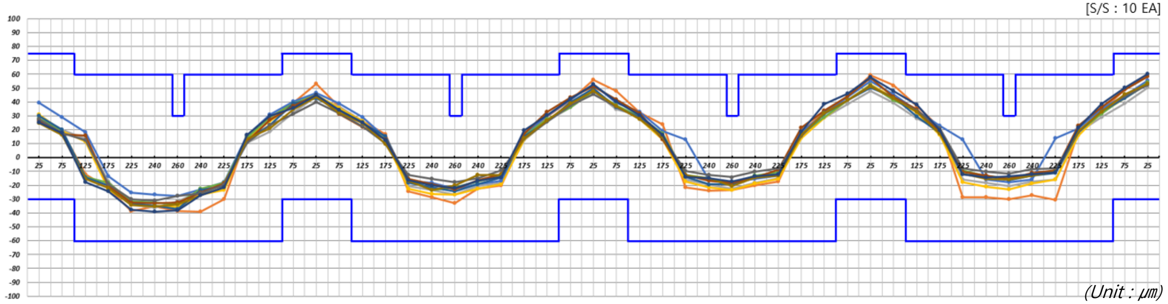
(um)

512GB PKG Condition : PKG Shield + T/O
Reflow : 4 cycles


[S/S : 10 EA]
(Unit : μm)

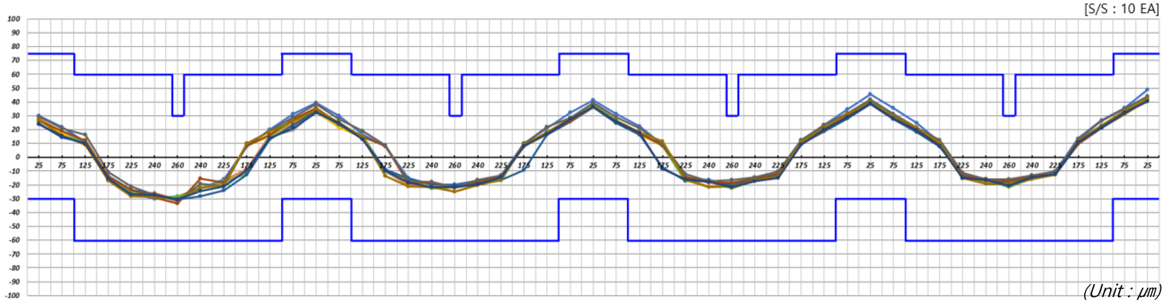
Measurement	1st RT	1st PT	2nd RT	2nd PT	3rd RT	3rd PT	4th RT	4th PT	Final RT
Average	26.1	-33.3	34.0	-27.0	36.6	-23.6	38.4	-21.9	39.1
Min / Max	22 / 31	-40 / -27	28 / 43	-34 / -22	31 / 45	-31 / -16	33 / 48	-28 / -17	34 / 48

256GB PKG Condition : PKG Shield + T/O
Reflow : 4 cycles


[S/S : 10 EA]
(Unit : μm)

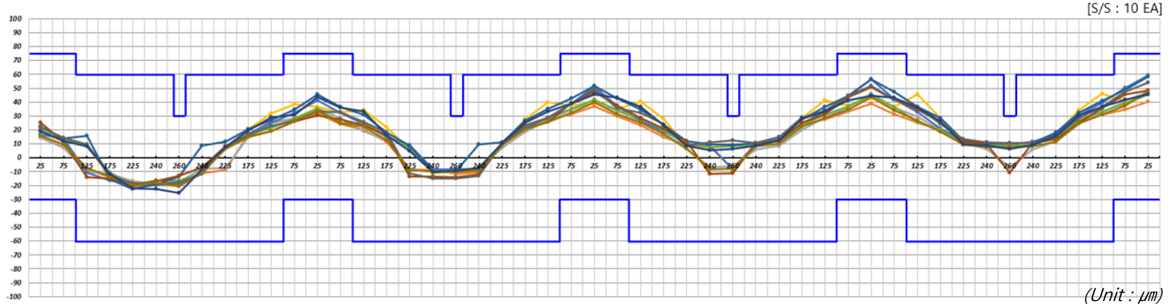
Measurement	1st RT	1st PT	2nd RT	2nd PT	3rd RT	3rd PT	4th RT	4th PT	Final RT
Average	29.2	-33.7	45.0	-23.9	50.0	-19.7	53.4	-18.0	54.9
Min / Max	25 / 39	-38 / -28	40 / 53	-33 / -18	46 / 56	-24 / -14	48 / 59	-30 / -12	50 / 60

128GB PKG Condition : PKG Shield + T/O
Reflow : 4 cycles


[S/S : 10 EA]
(Unit : μm)

Measurement	1st RT	1st PT	2nd RT	2nd PT	3rd RT	3rd PT	4th RT	4th PT	Final RT
Average	26.8	-30.4	34.7	-22.1	37.6	-20.1	40.3	-19.1	42.5
Min / Max	24 / 30	-34 / -28	32 / 39	-25 / -20	36 / 41	-23 / -16	38 / 46	-22 / -16	40 / 48

64GB PKG Condition : PKG Shield + T/O
Reflow : 4 cycles


[S/S : 10 EA]
(Unit : μm)

Measurement	1st RT	1st PT	2nd RT	2nd PT	3rd RT	3rd PT	4th RT	4th PT	Final RT
Average	19.2	-18.2	36.7	-10.8	44.4	0.2	47.7	5.6	49.1
Min / Max	14 / 25	-25 / -13	30 / 45	-15 / -8	37 / 52	-11 / 12	39 / 57	-11 / 11	40 / 59

Package Process Qualification

Bond Pull Strength (0F / 150)

Spec	min 2.0gf	
①	10wire x 2unit	
MAX	3.621	3.721
AVG	3.372	3.235
MIN	3.192	2.911
STD	0.120	0.241
Ppk	2.19	

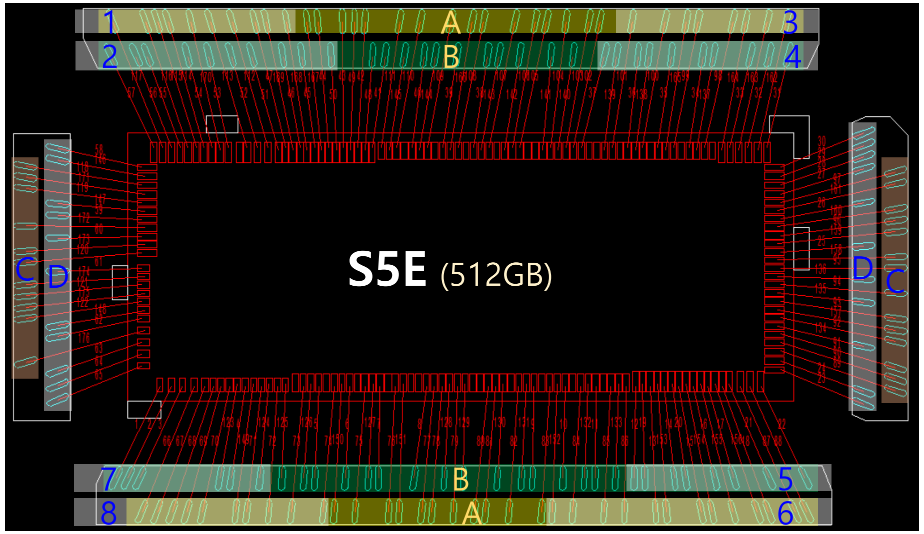
Spec	min 2.0gf	
②	10wire x 2unit	
MAX	4.410	4.263
AVG	4.233	4.073
MIN	4.079	3.874
STD	0.137	0.145
Ppk	4.48	

Spec	min 2.0gf		
A	50wires x 3Lot		
MAX	4.113	4.085	4.103
AVG	3.584	3.490	3.457
MIN	2.992	2.821	2.877
STD	0.331	0.338	0.367
Ppk	*(normal 1.45)		

Spec	min 2.0gf	
③	8wire x 2unit	
MAX	3.249	3.379
AVG	3.119	3.059
MIN	2.962	2.831
STD	0.113	0.211
Ppk	2.18	

Spec	min 2.0gf	
④	10wire x 2unit	
MAX	4.309	4.309
AVG	4.166	4.166
MIN	3.855	3.855
STD	0.143	0.143
Ppk	3.06	

Spec	min 2.0gf	
C	40wires x 2Lot	
MAX	3.951	3.962
AVG	3.625	3.616
MIN	3.371	3.359
STD	0.151	0.143
Ppk	3.73	



Spec	min 2.0gf	
D	40wires x 2Lot	
MAX	4.741	4.426
AVG	4.102	4.035
MIN	3.645	3.669
STD	0.198	0.132
Ppk	*(normal 4.05)	

256GB	Long	Short
S5E	72wires	72wires
MAX	3.951	4.331
AVG	3.503	3.964
MIN	2.984	3.649
STD	0.215	0.147
Ppk	2.33	4.45

128GB	Long	Short
S5E	72wires	72wires
MAX	3.903	4.615
AVG	3.441	4.115
MIN	2.700	3.342
STD	0.245	0.171
Ppk	1.96	4.12

64GB	Long	Short
S5E	64wires	64wires
MAX	3.903	4.615
AVG	3.441	4.115
MIN	2.700	3.342
STD	0.245	0.171
Ppk	2.12	5.12

Spec	min 2.0gf	
⑧	10wire x 2unit	
MAX	4.158	4.143
AVG	3.982	4.007
MIN	3.819	3.832
STD	0.108	0.102
Ppk	6.45	

Spec	min 2.0gf	
⑦	6wire x 2unit	
MAX	4.834	4.746
AVG	4.498	4.311
MIN	4.216	4.074
STD	0.261	0.236
Ppk	3.12	

Spec	min 2.0gf		
B	50wires x 3Lot		
MAX	4.602	4.561	4.666
AVG	4.199	4.159	4.156
MIN	3.868	3.766	3.741
STD	0.138	0.152	0.194
Ppk	2.24		

Spec	min 2.0gf	
⑥	13wire x 2unit	
MAX	3.878	3.589
AVG	3.623	3.474
MIN	3.435	3.281
STD	0.144	0.088
Ppk	3.71	

Spec	min 2.0gf	
⑤	8wire x 2unit	
MAX	4.272	4.147
AVG	4.109	3.941
MIN	3.908	3.740
STD	0.121	0.150
Ppk	4.28	

512GB	min 2.0gf		
NAND	50wires x 3Lot		
MAX	4.613	4.559	4.590
AVG	4.355	4.365	4.332
MIN	4.001	4.156	4.097
STD	0.113	0.085	0.103
Ppk	7.75		

256GB	min 2.0gf		
NAND	50wires x 3Lot		
MAX	5.024	4.947	4.741
AVG	4.720	4.550	4.421
MIN	4.352	4.006	4.165
STD	0.146	0.177	0.127
Ppk	4.40		

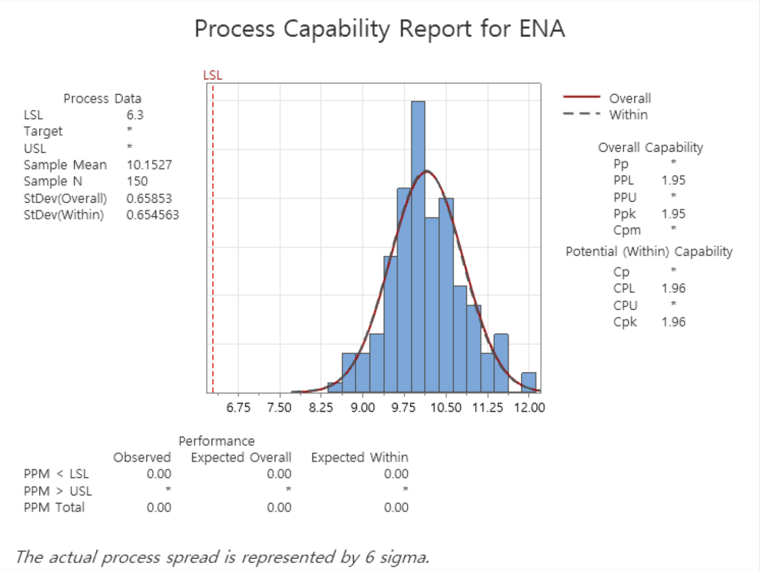
128GB	min 2.0gf		
NAND	50wires x 3Lot		
MAX	4.391	4.315	4.615
AVG	4.137	4.079	4.141
MIN	4.000	3.872	3.342
STD	0.092	0.121	0.258
Ppk	4.66		

64GB	min 2.0gf		
NAND	50wires x 3Lot		
MAX	4.424	4.493	4.582
AVG	4.111	4.145	4.213
MIN	3.777	3.841	3.793
STD	0.142	0.144	0.165
Ppk	4.63		

Package Process Qualification

Bond Shear (0F / 150)

Ball Size avg. : 35.97um			
minimum Sample Average ↓			
512GB	Min 6.3gf		
S5E	50wires x 3Lot		
MAX	11.612	11.947	11.494
AVG	10.170	10.279	10.009
MIN	8.845	8.951	8.543
STD	0.620	0.583	0.746
Ppk	1.95		



Process Capability Report for ENA

Process Data

LSL	6.3
Target	*
USL	*
Sample Mean	10.1527
Sample N	150
StDev(Overall)	0.65853
StDev(Within)	0.654563

Overall Capability

Pp	*
PPL	1.95
PPU	*
Ppk	1.95
Cpm	*

Potential (Within) Capability

Cp	*
CPL	1.96
CPU	*
Cpk	1.96

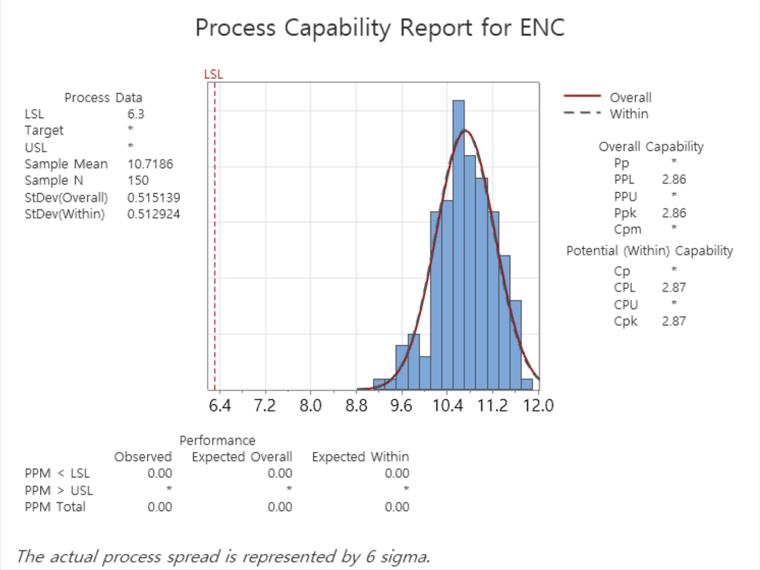
Performance

	Observed	Expected Overall	Expected Within
PPM < LSL	0.00	0.00	0.00
PPM > USL	*	*	*
PPM Total	0.00	0.00	0.00

The actual process spread is represented by 6 sigma.

* minimum Individual Shear Reading : 0.3gf

Ball Size avg. : 36.18um			
minimum Sample Average ↓			
128GB	Min 6.3gf		
S5E	50wires x 3Lot		
MAX	11.666	11.630	11.788
MIN	9.392	9.289	9.616
AVG	10.631	10.697	10.827
STD	0.548	0.521	0.463
Ppk	2.86		



Process Capability Report for ENC

Process Data

LSL	6.3
Target	*
USL	*
Sample Mean	10.7186
Sample N	150
StDev(Overall)	0.515139
StDev(Within)	0.512924

Overall Capability

Pp	*
PPL	2.86
PPU	*
Ppk	2.86
Cpm	*

Potential (Within) Capability

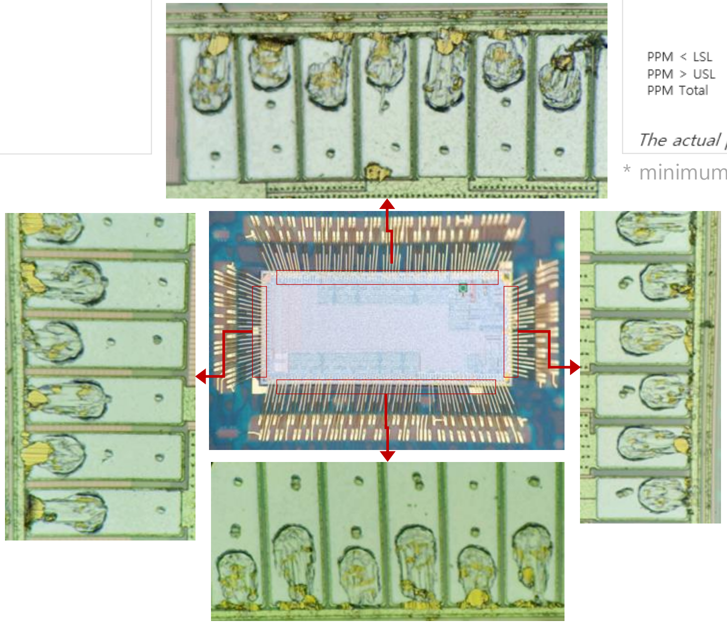
Cp	*
CPL	2.87
CPU	*
Cpk	2.87

Performance

	Observed	Expected Overall	Expected Within
PPM < LSL	0.00	0.00	0.00
PPM > USL	*	*	*
PPM Total	0.00	0.00	0.00

The actual process spread is represented by 6 sigma.

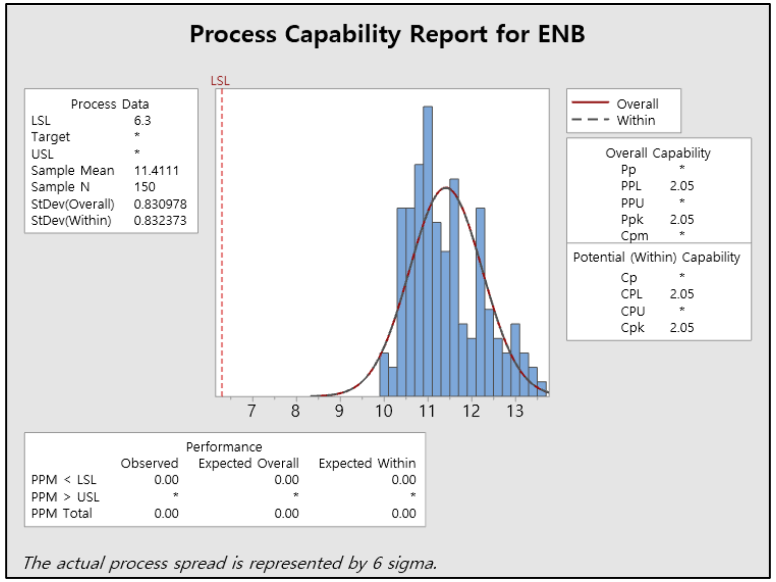
* minimum Individual Shear Reading : 0.3gf



Package Process Qualification

Bond Shear (0F / 150)

Ball Size avg. : 36.5um			
minimum Sample Average ↓			
256GB	Min 6.3gf		
S5E	50wires x 3Lot		
MAX	13.427	13.101	13.576
AVG	10.251	10.310	10.005
MIN	11.552	11.397	11.327
STD	0.894	0.781	0.814
Ppk	2.05		



Process Capability Report for ENB

Process Data	
LSL	6.3
Target	*
USL	*
Sample Mean	11.4111
Sample N	150
StDev(Overall)	0.830978
StDev(Within)	0.832373

Overall Capability	
Pp	*
PPL	2.05
PPU	*
Ppk	2.05
Cpm	*

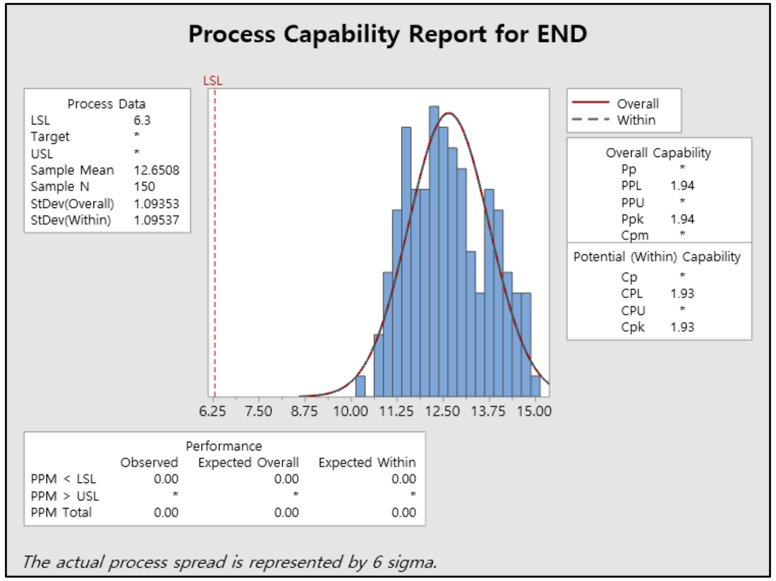
Potential (Within) Capability	
Cp	*
CPL	2.05
CPU	*
Cpk	2.05

Performance	Observed	Expected Overall	Expected Within
PPM < LSL	0.00	0.00	0.00
PPM > USL	*	*	*
PPM Total	0.00	0.00	0.00

The actual process spread is represented by 6 sigma.

* minimum Individual Shear Reading : 0.3gf

Ball Size avg. : 36.9um			
minimum Sample Average ↓			
64GB	Min 6.3gf		
S5E	50wires x 3Lot		
MAX	14.781	14.814	14.926
MIN	10.259	10.841	10.912
AVG	12.635	12.680	12.650
STD	1.178	1.105	1.013
Ppk	1.93		



Process Capability Report for END

Process Data	
LSL	6.3
Target	*
USL	*
Sample Mean	12.6508
Sample N	150
StDev(Overall)	1.09353
StDev(Within)	1.09537

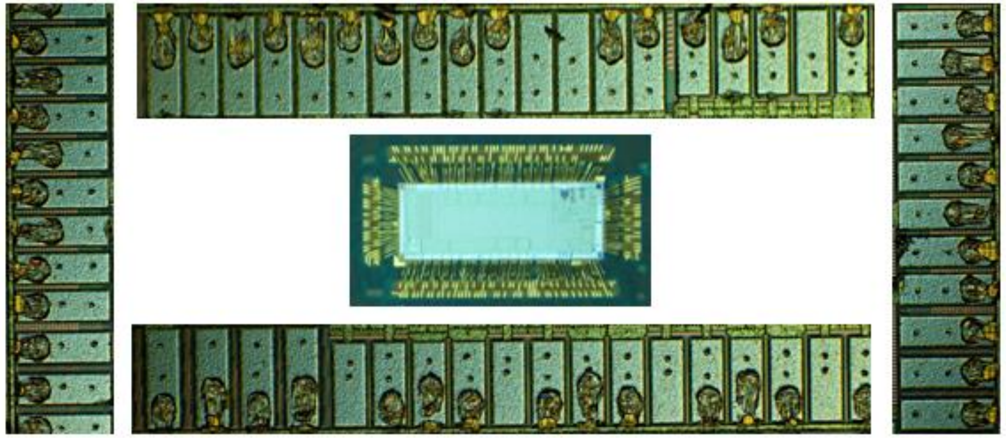
Overall Capability	
Pp	*
PPL	1.94
PPU	*
Ppk	1.94
Cpm	*

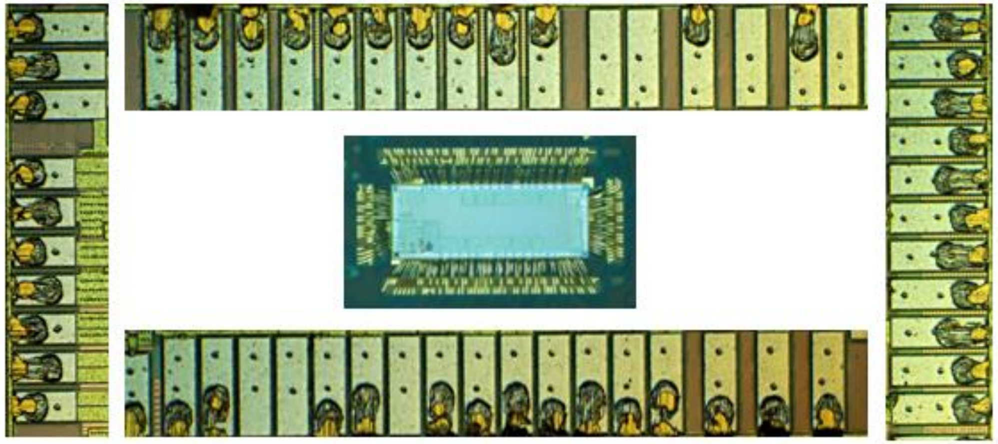
Potential (Within) Capability	
Cp	*
CPL	1.93
CPU	*
Cpk	1.93

Performance	Observed	Expected Overall	Expected Within
PPM < LSL	0.00	0.00	0.00
PPM > USL	*	*	*
PPM Total	0.00	0.00	0.00

The actual process spread is represented by 6 sigma.

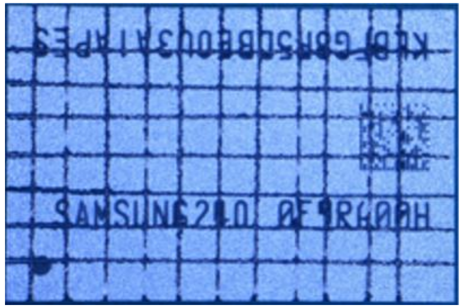
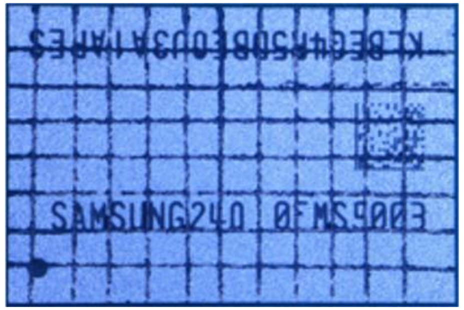
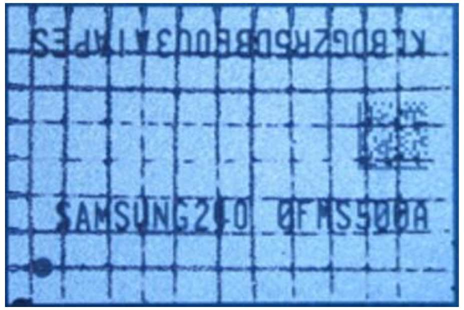
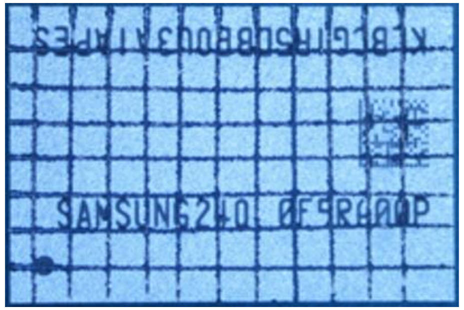
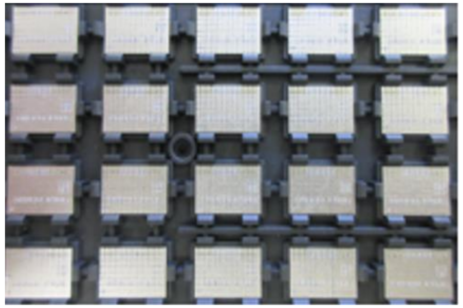
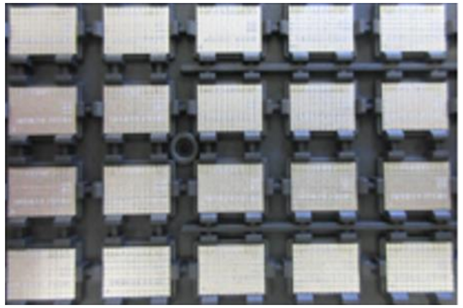
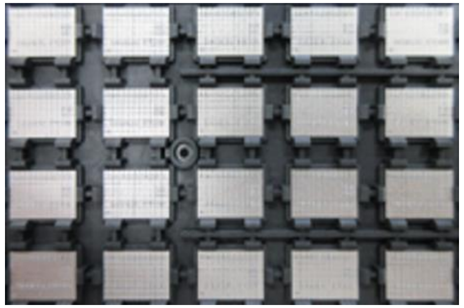
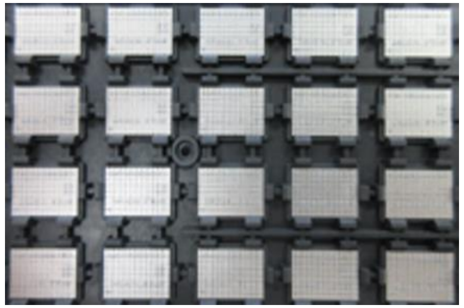
* minimum Individual Shear Reading : 0.3gf





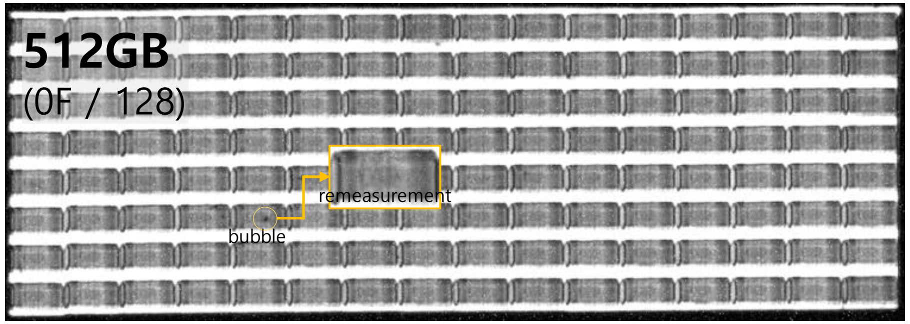
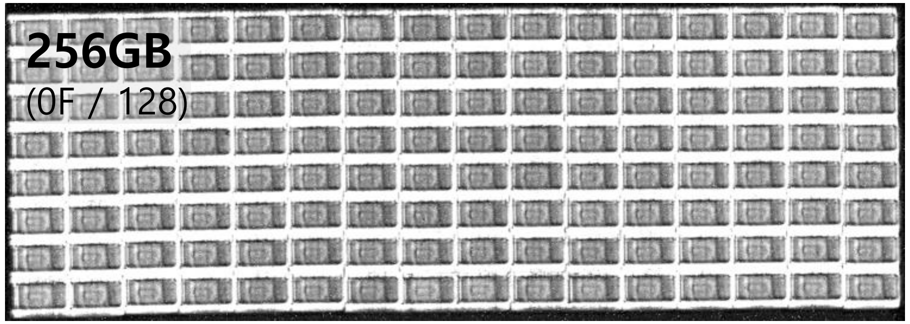
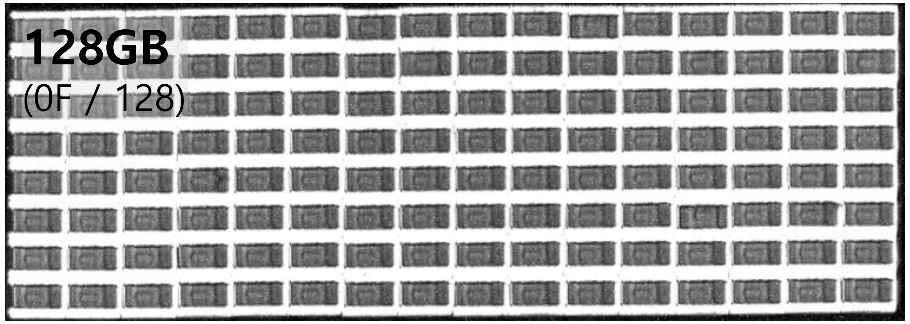
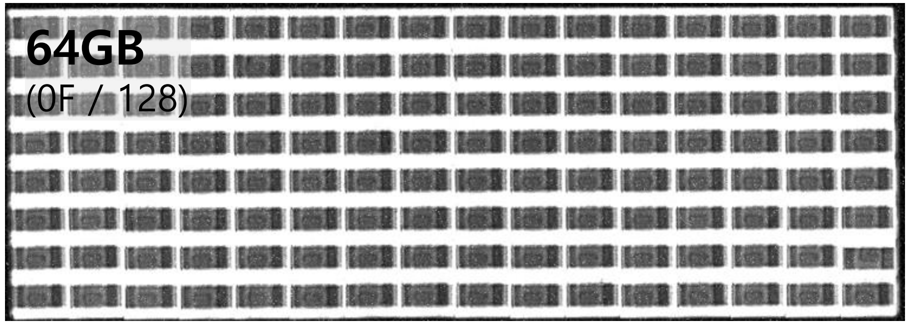
Package Process Qualification

Tape Adhesion Test (0F / 60)

Category	512GB	256GB	128GB	64GB
Criteria	Classification : >4B (Percent Area Removed : < 5% with Hatching jig (1mm gap))			
Sample Size	0F / 20 * 3Lot	0F / 20 *3Lot	0F / 20 * 3Lot	0F / 20 * 3Lot
Peel Off Image #1				
Peel Off Image #2				

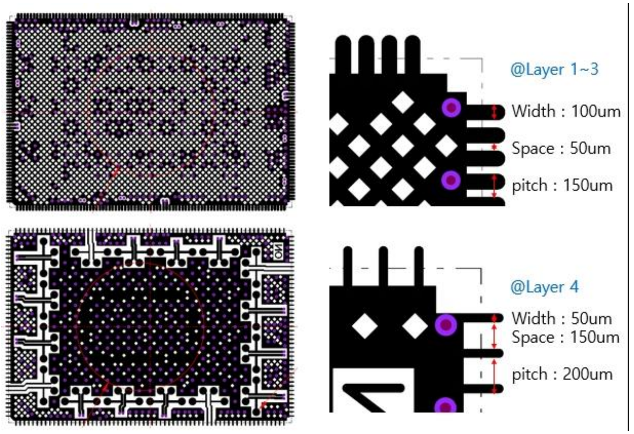
Package Process Qualification

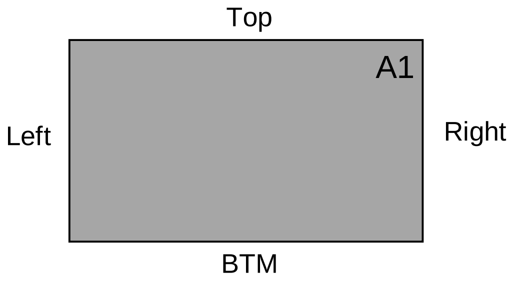
Delamination check (0F / 128)

Criteria	Delamination zero after preconditioning(L3, x4 reflow) test	
SAT Image	 **512GB** (0F / 128) 	 **256GB** (0F / 128)
	 **128GB** (0F / 128)	 **64GB** (0F / 128)

Contact Resistance Check for Shield (0F / 60)

4-Wire Instrument Model Name Forcing Current (A)	Test Vehicle Design	Reverse Polarity Repeatability	Position	Layer	min	avg	Max	stdev
Ni supplier / PXI machine Current Soucing : 1A	L1~L3 pitch : 150um . L1 < 4.0 Ohm . L2 < 4.0 Ohm . L3 < 4.0 Ohm L4 pitch : 200um . L4 < 3.0 Ohm	-0.23%	Top side (60pcs)	L1	0.050	0.060	0.072	0.004
				L2	0.066	0.073	0.082	0.004
				L3	0.052	0.060	0.068	0.004
				L4	0.114	0.132	0.158	0.011
			Left side (60pcs)	L1	0.073	0.093	0.106	0.006
				L2	0.086	0.102	0.112	0.005
				L3	0.077	0.092	0.104	0.006
				L4	0.165	0.206	0.248	0.017
			Btm side (60pcs)	L1	0.054	0.060	0.068	0.003
				L2	0.064	0.070	0.083	0.004
				L3	0.050	0.058	0.065	0.004
				L4	0.101	0.129	0.160	0.010
			Right Side (60pcs)	L1	0.084	0.095	0.108	0.005
				L2	0.091	0.102	0.113	0.005
				L3	0.084	0.093	0.105	0.005
				L4	0.178	0.206	0.253	0.015





Package Process Qualification

Physical Dimension (0F / 60)

Category	512GB			256GB			128GB			64GB		
Width	Spec	9.00±0.05	0F / 60	Spec	9.00±0.05	0F / 60	Spec	9.00±0.05	0F / 60	Spec	9.00±0.05	0F / 60
	MAX	8.9954		MAX	8.994		MAX	8.994		MAX	8.993	
	AVG	8.990		AVG	8.989		AVG	8.989		AVG	8.989	
	MIN	8.977		MIN	8.972		MIN	8.972		MIN	8.975	
	STD	0.004		STD	0.005		STD	0.005		STD	0.004	
Length	Spec	13.30±0.05	0F / 60	Spec	13.30±0.05	0F / 60	Spec	13.30±0.05	0F / 60	Spec	13.30±0.05	0F / 60
	MAX	13.307		MAX	13.304		MAX	13.301		MAX	13.302	
	AVG	13.298		AVG	13.293		AVG	13.295		AVG	13.295	
	MIN	13.293		MIN	13.283		MIN	13.282		MIN	13.282	
	STD	0.003		STD	0.005		STD	0.005		STD	0.005	
Z max	SPEC	Max 0.9mm	0F / 60	SPEC	Max 0.87mm	0F / 60	SPEC	Max 0.87mm	0F / 60	SPEC	Max 0.87mm	0F / 60
	MAX	0.849		MAX	0.821		MAX	0.823		MAX	0.826	
	AVG	0.829		AVG	0.803		AVG	0.799		AVG	0.797	
	MIN	0.810		MIN	0.785		MIN	0.782		MIN	0.774	
	STDEV	0.007		STDEV	0.007		STDEV	0.006		STDEV	0.007	
Pre-bump	Spec	0.05±0.02	0F / 60	Spec	0.05±0.02	0F / 60	Spec	0.05±0.02	0F / 60	Spec	0.05±0.02	0F / 60
	MAX	0.0592		MAX	0.0582		MAX	0.0577		MAX	0.057	
	AVG	0.052		AVG	0.056		AVG	0.054		AVG	0.053	
	MIN	0.0485		MIN	0.0532		MIN	0.0496		MIN	0.05	
	STD	0.002		STD	0.001		STD	0.002		STD	0.002	
Body thickness	SPEC	0.8±0.025mm	0F / 60	SPEC	0.77±0.025mm	0F / 60	SPEC	0.77±0.025mm	0F / 60	SPEC	0.77±0.025mm	0F / 60
	MAX	0.819		MAX	0.788		MAX	0.791		MAX	0.794	
	AVG	0.799		AVG	0.770		AVG	0.773		AVG	0.774	
	MIN	0.780		MIN	0.752		MIN	0.756		MIN	0.752	
	STDEV	0.007		STDEV	0.007		STDEV	0.006		STDEV	0.007	