Addition of Wide frame assembly line (High Efficiency Production Line) for HTSOP-J8 (LSI)

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AP production Headquarters
LSI Engineering Div.

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Addition of Wide frame assembly line (High Efficiency Production Line) for HTSOP-J8 (LSI)

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1. Background

<Background>

Fortunately, we received many orders for HTSOP-J8. So the production load factor is increasing. We will build a high efficiency line to provide stable production support.

<Purpose>

To increase production capacity and keep stable production support,
add HTSOP-J8 high efficiency production line using higher number of products per frame.

Current line's Package name	Assy line	Test line
HTSOP-J8	Semi wide product line (Current Production line)	Current Test line

Package name After changing	Assy line	Test line
HTSOP-J8	Semi wide product line (Current Production line) High efficiency Production line	Current Test line (No change)

<Changing Schedule>

After getting approval from customers, apply this changing.

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2. 4M comparison

Highly efficiency production line's equipment type(Same method) and materials are changed from current production line.

			Semi wide production line (Current production line)	Highly efficiency production line	Changing point	Verification
Package name			HTSOP-J8	HTSOP-J8	None	No change
Device			Please refer device list	New device name	**Yes**	Add U or V word
Factory	Assy	Factory	Rohm Philippine（REPI)	Same as current	None	Factory has not been changed
		Country	Philippine	Same as current		
		Employee	4,000 people	Same as current		
		Clean level	Please refer below	Same as current		
		(DB~WB)	Class 10,000	Same as current		
		(Mold)	Class 10,000	Same as current		
	Test	Factory	Rohm Philippine（REPI)	Same as current	None	Same TEST process line
		Country	Philippine	Same as current		
Man	Assy		Operator certified as an automotive grade by Rohm	Same as current	None	Operator has not been changed
	Test		Operator certified as an automotive grade by Rohm	Same as current		
Machine	Assy	Die bonding	Full auto die bonder machine	Same as current	**Yes**	Machine type of each process is different from current one but same method/grade as current one and full auto. No problem.
		Wire bonding	Full auto wire bonder machine	Same as current		
		Mold press	Full auto mold press	Same as current		
		Damber cut	Full auto dambar cut machine	Same as current		
		Plating	Full auto plating machine	Same as current		
		Marking	Full auto laser marking machine	Same as current		
		Lead forming	Full auto lead forming machine	Same as current		
	Test	Handler	Full auto handler	Same as current	None	Same TEST process line
		Tester	Full auto tester	Same as current		
	Taping		Full auto taping machine	Same as current		
Method	Assy	Process flow	Rohm automotive production line	Same as current	None	All process is same method.
		Die bonding	Solder bonding/Ag paste dispense method	Same as current		
		Wire bonding	Ultra sonic with thermal compression method	Same as current		
		Mold press	Transfer mold method	Same as current		
		Plating	Electro plating method	Same as current		
	Test		Socket contact method	Same as current	None	Test line isn't changed
Material			Please refer attachment	Please refer attachment	**Yes**	Please refer attachment

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2. 4M comparison

<Device name comparison >

Current semi wide production line and Highly efficiently production line will have different device name.
The character U or V is added to the device name of Highly efficiently production line.

	Semi wide production line (Current production line)	Highly efficiency production line	Changing point	Verification
Device	BD00FC0EEFJ-ME2	BD00FC0UEFJ-ME2	**Yes**	Add U or V character

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2. 4M comparison

<Material comparison>

Lead frame (strip size only), die attach material, mold resin material is changed.

		Semi wide production line (Current production line)	Highly efficiency production line	Changing point	Verification
Lead frame	Strip Size	190.8mm x 43 mm	269.5mm x 83mm	**Yes**	Please check attachment
	Inner design	Depends on device	Same as current	None	Only strip size is changed. Base metal material, surface plating, inner design isn't changed
	Base metal material	Cu alloy	Cu alloy	None	
	Surface plating	Ag spot plating	Ag spot plating	None	
Die attach material		Ag paste type A	Ag paste type B	**Yes**	Please check attachment
		Solder type A	Solder type A	None	No change
Wire material		Au/Cu	Au/Cu	None	No change
Mold resin material		Halogen Free Epoxy resin type A	Halogen Free Epoxy resin type B	**Yes**	Please check attachment
Outer plating material		100%Sn	100%Sn	None	No change
Marking		Laser marking	Laser marking	None	Marking words、font type/sizeare no change
Emboss tape		Rohm standard emboss tape	Rohm standard emboss tape	None	No change
Shipping reel		Rohm standard reel	Rohm standard reel	None	No change
Packing material for shipping		Rohm standard cardboard	Rohm standard cardboard	None	No change

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3. Package outer & inner comparison

Package outer, marking spec, inner design is no change.

Item	Semi wide production line (Current production line)	Higher efficiency production line
Outer		※This picture's marking is different because of dummy sample. Mass production sample is no change
Inner (X-ray)		

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4. How to identify semi wide line / high efficiency line products

It is possible to identify current semi wide line products or high efficiency line products by the characters in the 1-pin mark on the product surface.

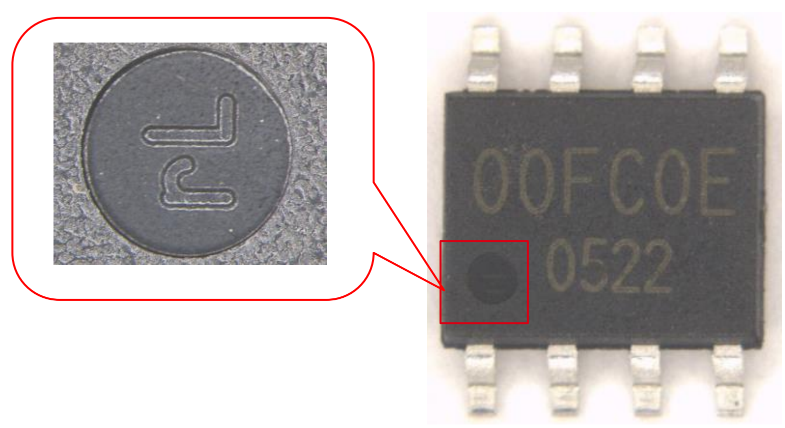
How to identify current semi wide line products / high efficiency line products

It can be identified by the 1-pin mark on the surface of product.

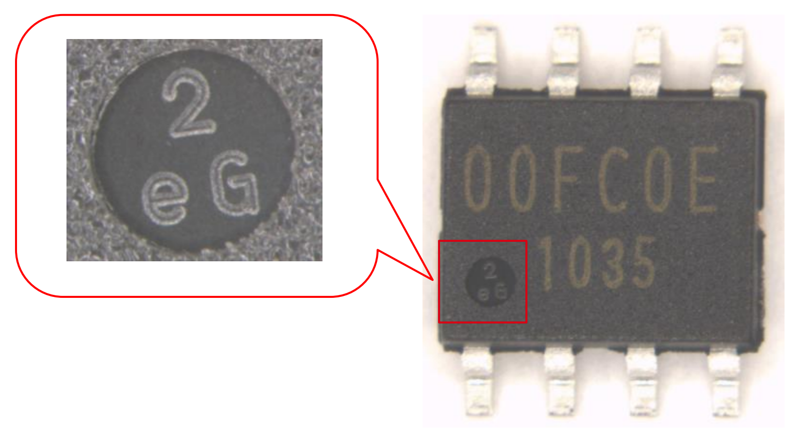
・current line products : 2 characters
・high efficiency line products : 3 characters

<example（device: BD00FC0EEFJ-ME2）>

<Semi wide production line products (Current) >



< high efficiency line products >



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5. Process flow comparison

No change process flow. And test process, shipping spec is also no change.

Semi wide production line (Current production line)	Highly efficiency production line
Incoming wafer	Incoming wafer
Wafer mount	Wafer mount
Dicing	Dicing
Dicing inspection	Dicing inspection
Incoming lead frame	Incoming lead frame
Incoming die attach material	Incoming die attach material
Die bonding	Die bonding
Paste cure(Ag paste only)	Paste cure(Ag paste only)
Die bonding inspection	Die bonding inspection
Plasma	Plasma
Incoming wire	Incoming wire
Wire bonding	Wire bonding
Wire bonding inspection	Wire bonding inspection
Incoming mold resin	Incoming mold resin
Molding	Molding
Molding inspection	Molding inspection
Mold cure	Mold cure
(Continue to right side)	(Continue to right side)
Tie bar cut	Tie bar cut
Reflow	Reflow
Deflash	Deflash
Plating	Plating
Plating inspection	Plating inspection
Baking	Baking
X-ray inspection	X-ray inspection
Laser marking	Laser marking
Lead forming	Lead forming
O/S, FT electrical characteristic 100% measuring	O/S, FT electrical characteristic 100% measuring
100% visual inspection	100% visual inspection
Incoming emboss tape	Incoming emboss tape
Packing	Packing
Shipping inspection	Shipping inspection
Shipping	Shipping

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6. Material comparison

<Lead frame comparison>

Only lead frame strip size is changed. Inner design and plating spec are no change. Regarding verification results for lead frame strip size change, please refer attachment.

Item	Semi wide production line (Current production line)	Highly efficiency production line
Package	HTSOP-J8	HTSOP-J8
Factory	Philippine（REPI）	Philippine（REPI）
Lead frame strip size	Strip size: 190.8mm x 43 mm	Strip size: 269.5mm x 83mm
Lead frame material (Base metal/Surface plating)	Cu alloy / Ag spo plating	
Inner design		

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6. Material comparison

＜Die attach material (Ag paste) ＞

To reduce thermal stress at Reflow process, lower elastic modulus paste has been selected for highly efficiency production line. Regarding verification results for die bonding/wire bonding, please refer attachment.

Item			Semi wide production line (Current)	Highly efficiency production line	Changing point	Concerned point
Main material			Epoxy	Epoxy/Acryl	**Yes**	Degas make lead frame surface Dirty.
Ag filler contents		%	75.0	76.5	**Yes**	1st open because wire bonding force is reduced by soft die attach paste.
Electrical resistance		Ω・cm	$\sigma x10^{-4}$	$5\sigma x10^{-3}$ Ω・cm	**Yes**	Over electrical characteristics spec by electrical conductivity change
Viscosity		s	19 (2.5rpm)	12 (5rpm)	**Yes**	・Lead short by paste bridge caused by paste scatter or stringy paste. ・Thermal shut down by paste/ lead frame delamination caused by thin paste thickness.
Tg		Pa・s	110	28	**Yes**	・Thermal shut down by paste/ lead frame delamination caused by increasing thermal expand coefficiency. ・Over electrical characteristics spec by thermal stress change.
Thermal expand coefficiency	α1	ppm	50	86	**Yes**	
	α2	ppm	95	200		
Elastic modulus	RT	MPa	11500	2800	**Yes**	1st open because wire bonding force is reduced by soft die attach paste.
Thermal conductivity		W/mK	1.5	2.0	**Yes**	Over electrical characteristics spec by thermal conductivity change.
Chloride ion contents		ppm	6	<5	**Yes**	Corrosion risk become low so no problem.

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6. Material comparison

＜Mold resin material＞

To reduce reflow stress, low elastic modulus/low water absorption mold resin is selected for highly efficiency production line. Regarding verification results for resin injection in mold process, please refer attachment.

item			Semi wide production line (Current)	Highly efficiency Production line	Changing point	Concerned point
Main material			Epoxy	Epoxy	None	No change
Filler type			Silica	Silica	None	No change
Spiral flow		cm	105	110	**Yes**	Breakdown by void
Gel time (175℃)		s	45	35	**Yes**	Break down by void or wire open by wire sweep because resin gel time is short.
Tg		℃	130	125	**Yes**	Thermal shut down by paste/leadframe delamination because increasing α2 resion.
Thermal Expand coefficiency	α1	ppm	9.0	9.0	None	No change
	α2	ppm	37	38	**Yes**	Thermal shut down by paste/ lead frame delamination caused by increasing thermal expand coefficiency.
Bending Elastic Modulus	RT	MPa	24000	23500	**Yes**	Die crack by FT Force or pick up in taping
	260℃	MPa	800	600		
Bending Strength	RT	GPa	180	160		
	260℃	GPa	20	16		
Water absorption	Boil	wt%	0.14	0.13	**Yes**	Reflow stress become lower. No problem
Electrical conductivity		μS/cm	＜80	＜150	**Yes**	Over electrical characteristics spec by Electrical conductivity change.
Chloride ion contents		ppm	＜30	＜20	**Yes**	Corrosion risk become low so no problem.

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<Lead frame change>

Based on DRBFM and process evaluation item,
the result is no problem. For details, please refer attachment.

Changing point	Concerned point	Evaluation item	Pn/N	Results	Judgment	Page
Strip size change 190.8mm x 43 mm →269.5mm x 83mm	1st/2nd open by weak lead frame clamp at wire bonding process.	･Wire bonding process margin evaluation	0/30 wires	1st ball/2nd bonding is No problem in production Margin.	**Pass**	p.16
	Easy to deform lead frame, and caused solder mount NG by leak mold resin to heatsink	･Outer dimension measurement	0/10 pcs	Cpk>1.67 and no problem	**Pass**	p.20
	Sn plating thickness become over spec	･Sn plating thickness measurement	0/60 leads	Cpk>1.67 and no problem	**Pass**	p.19
	Void is occurred because mold injection time is longer and resin become harder.	･Mold margin evaluation	-	No void in production margin	**Pass**	p.17
	Wire sweep is occurred because mold injection time is longer and resin become harder.	･Mold margin evaluation	-	No wire sweep in production margin	**Pass**	p.17

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7. Verification of changing points

<Die attach material change>

Based on DRBFM and process evaluation item, the result is no problem. For details, please refer attachment.

Changing point	Concerned point	Evaluation item	Pn/N	Results	Judgment	Page
Epoxy →Epoxy/Acryl change	Degas make lead frame surface dirty, and paste/lead frame Delamination is occurred.	･MSL	0/24pcs	No delamination	**Pass**	p.25
	Degas make lead frame surface dirty, and caused wire open	･MSL	0/24pcs	No delamination	**Pass**	p.25
Elastic modulus lower 11500→2800MPa	1st open because wire bonding force is reduced by soft die attach paste.	･Wire bonding margin evaluation (1st ball shear strength check)	0/30 wires	1st ball shear strength is no problem in production margin	**Pass**	p.16
Increase electrical resistance $\sigma x10^{-4}$ Ω･cm →5 $\sigma x10^{-3}$ Ω･cm	Over electrical characteristics spec by electrical conductivity change	･Electrical characteristic measurement	0/100 (Representative device)	Cpk>1.67 measured by representative device. Objected Device will be measured by evaluation lot.	**Pass**	p.22
Tg lower (-82℃) /Increase thermal expand coefficiency (α1:72%, α2:111% up)	Thermal shut down by paste/ lead frame delamination caused by increasing thermal expand coefficiency.	･MSL	0/24pcs	No delamination	**Pass**	p.25
	Over electrical characteristics spec by thermal stress change.	･Electrical characteristic measurement	0/100 (Representative device)	Cpk>1.67 measured by representative device. Objected Device will be measured by evaluation lot.	**Pass**	p.22
Increase thermal conductivity	Over thermal characteristics Spec by thermal conductivity change	･Thermal resistance Measurement comparison (Current production line vs highly efficient production line)	-	According to representative device, thermal resistance of higher efficient production line is 2.8℃/W higher than current one. Objected device will be measured by evaluation lot.	**Pass**	p.24
Viscosity change	Lead short by paste bridge caused by paste scatter or stringy paste.	･Die bonding margin evaluation	-	No paste scatter or stringy paste in production margin	**Pass**	p.15
	Thermal shut down by paste/ lead frame delamination caused by thin paste thickness	･MSL	0/24pcs	No delamination	**Pass**	p.25

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7. Verification of changing points

<Mold resin change>

Based on DRBFM and process evaluation item, the result is no problem. For details, please refer attachment.

Changing point	Concerned point	Evaluation item	Pn/N	Results	Judgment	Page
Increase thermal expand coefficiency α2: 2.7% up	Thermal shut down by paste/ lead frame delamination caused by increasing thermal expand coefficiency.	・MSL	0/24pcs	No delamination	**Pass**	p.25
	Over electrical characteristics spec by electrical conductivity change	・Electrical characteristic Measurement	0/100 (Representative device)	Cpk>1.67 measured by representative device. Objected device will be measured by evaluation lot.	**Pass**	p.22
Spiral flow 4.8% longer	Breakdown by void	・Mold margin evaluation	-	No void in production margin	**Pass**	p.17
Gel time 29% shorter	Break down by void or wire open by wire sweep because resin gel time is short.	・Mold margin evaluation	-	No void/wire sweep NG in production margin	**Pass**	p.17
Lower Tg t→ t-5℃	Thermal shut down by paste/lead frame delamination because increasing α2 region.	・MSL	0/24pcs	No delamination	**Pass**	p.25
Lower bending elastic modulus 25℃: 2.1% down 260℃:33.3% down	Die crack by FT Force or pick up in taping	・SAT evaluation On chip	0/24pcs	No die cracks	**Pass**	p.21
Lower water absorption 7.7% down	Thermal shut down by paste/ lead frame delamination caused by water distribution in product.	・MSL	0/24pcs	No delamination	**Pass**	p.25
Higher electrical conductivity	Over electrical characteristics spec by Electrical conductivity change.	・Electrical characteristic Measurement	0/100 (Representative device)	Cpk>1.67 measured by representative device. Objected device will be measured by evaluation lot.	**Pass**	p.22

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<Die bonding evaluation>

To verify paste viscosity change, conduct Die bonding margin evaluation. Paste spread・height is no problem and no stringy paste/paste scattering is occurred. There is no problem.

【Evaluation contents】
Package: HTSOP-J8 (High efficiency production line)
Device: Dummy chip (Chip size: 2.7x2.1x0.3tmm [MAX chip size])

【Judgment standard】
・Paste spread: ≧ 60% of chip side
・Paste height: (Chip size t、Paste height x)
A mode: x<1/2t, B mode:1/2t<x<2/3t, C mode:2/3t<x

【Evaluation condition】

Dispense pressure (MPa)					
-100	-50	Center	+50	+100	+150
1	2	3	4	5	6

Production control (conditions 2–4)

Condition	1	2	3	4	5	6
Paste appearance	Can’t dispense **C mode**	A mode	A mode	A mode	A mode	A mode
Paste Spread		A mode	A mode	A mode	A mode	A mode
Paste height (Chip X)		A mode	A mode	A mode	A mode	A mode
Paste height (Chip Y)		A mode	A mode	A mode	B mode	C mode

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8. Process evaluation results

<Wire bonding 1st bonding evaluation>

**To verify lower elastic modulus paste, conduct 1st bonding margin evaluation.
Ball shear strength・ball appearance are no problem and No under PAD is occurred.**

【Evaluation contents】

Package : HTSOP-J8 (High efficiency production line)

Wire:Auφ30um Evaluation Qty : N=30 balls

【Judgment standard】

- ・Ball appearance: No decentering or smash ball
- ・Ball size/thickness:75±5um/15±5um
- ・Ball shear strength: ≧200 mN and exist Au residue or Al slide trace
- ・No under pad crack

【Evaluation condition】

		USG Current (mA)				
		-20	-10	Center	+10	+20
Force	+5	6				7
	-5		2		3	
	Center			1		
	+5		5		4	
	+10	9				8

Production control

Condition			1	2	3	4	5	6	7	8	9
Ball appearance	Size	x	75.3	73.7	74.7	77.0	74.7	73.3	77.7	81.7	74.0
		y	76.0	73.3	75.7	77.3	75.0	73.3	77.7	81.0	75.0
	Thickness	t	18.0	20.7	17.3	15.7	18.3	20.7	15.7	13.0	19.7
	Appearance										
Ball shear	Strength (mN)	Average	452.8	468.5	457.0	460.0	448.3	447.9	448.5	472.8	444.1
		Max	460.7	501.5	485.1	488.9	463.6	469.4	488.6	510.4	470.2
		Min	438.8	421.4	424.5	431.8	428.8	427.7	77.7	416.5	402.1
	Mode										
Under pad	Appearance										
	Pn/N		0/30	0/30	0/30	0/30	0/30	0/30	0/30	0/30	0/30
Judgment			**OK**	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**	**NG**	**OK**

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<Wire bonding 2nd bonding evaluation>

To verify lead frame strip size changing effect, conduct 2nd bonding margin evaluation. Pull strength・peel test are no problem.

【Evaluation contents】

Package : HTSOP-J8 (High efficiency production line)

Wire:Auφ30um　Evaluation Qty　:　N=30 wires

【Judgment standard】

・Appearance : No peeled off

・Peel test : Exist crescent residue

・Pull strength : ≧40 mN

【Evaluation condition】

		USG Current (mA)				
		-20	-10	Center	+10	+20
Force	+5	6				7
	-5		2		3	
	Center			1		
	+5		5		4	
	+10	9				8

Production control

Condition		1	2	3	4	5	6	7	8	9
Appearance										
Peel test										
Pull strength(mN)	Average	122.6	123.5	120.7	123.2	121.5	126.0	123.1	120.1	120.7
	Max	133.6	150.8	143.5	142.5	133.3	141.6	146.4	147	134.1
	Min	112.0	107.9	104.3	103.9	111.1	111.4	104.6	105.2	106.1
Judgment		OK	OK	OK	OK	OK	OK	OK	OK	OK

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8. Process evaluation result

<Mold evaluation>

To verify lead frame strip size and short gel time/spiral flow mold resin, conduct injection speed/pressure margin evaluation.Wire sweep/void are no problem.

【Evaluation contents】

Package : HTSOP-J8 (High efficiency production line) Wire:Auφ25um

Evaluation Qty : N=576pcs

【Judgment standard】

・Wire sweep ≦10%

・Void≦0.5mm

Production control

		Transfer speed / mm/sec				
		0.10	0.25	0.50	0.75	1.00
Prunger Pressure / kN	15.0	9.5%				7.1%
	17.5		5.0%		5.9%	
	19.7			7.0%		
	22.5		8.6%		6.2%	
	25.0	13.7%				8.1%

Production control

		2nd Transfer speed / mm/sec				
		0.10	0.25	0.50	0.75	1.00
Prunger Pressure / kN	15.0					
	17.5					
	19.7					
	22.5					
	25.0					

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8. Process evaluation results

<Sn plating thickness measurement>

**To verify lead frame strip size, conduct Sn plating thickness measurement.
Sn plating thickness is Cpk > 1.67 and no problem.**

【Evaluation contents】

Package : HTSOP-J8 (High efficiency production line)

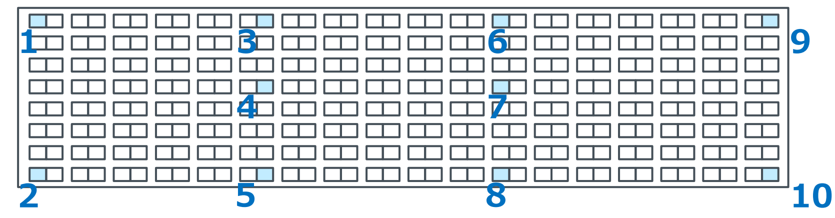
Evaluation Qty : 60 leads (10 pcs×6 leads/pc)

【Judgment standard】

Plating thickness: 8~20 um

【Sampling point】

Please refer sampling location below.



【Result】 (Unit: um)

	Sampling point										Total	Cpk
	1	2	3	4	5	6	7	8	9	10		
Average	12.1	12.1	11.5	11.9	10.9	11.9	12.1	11.0	12.0	12.0	11.8	1.72
Max	12.7	13.1	12.3	12.2	11.7	12.7	12.9	12.2	12.9	12.9	13.1	
Min	11.0	10.5	10.7	11.4	10.2	11.1	11.4	10.1	11.5	11.0	10.1	
σ	0.70	0.97	0.57	0.33	0.55	0.71	0.49	0.72	0.50	0.60	0.73	

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8. Process evaluation results

<Solder wettability evaluation>

Zero cross time was under 3.0s, so there is no problem with the solder wettability.

【Evaluation contents】

Package : HTSOP-J8 (High efficiency production line)

Method : Meniscograph method

(Solder Bath:Sn-3Ag-0.5Cu、245℃)

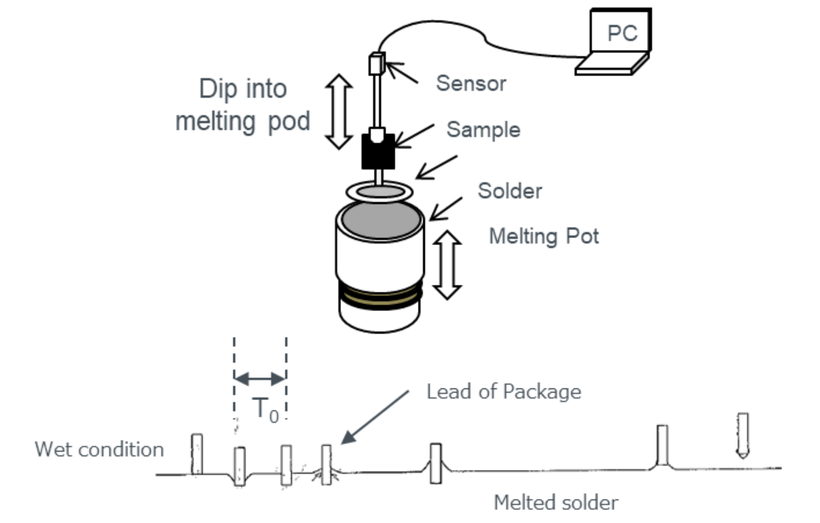
Qty : 5 pcs

【Judgement standard】

Zero cross time(T0)≦3s (EIAJ ED-4701/303)

[Solder wettability test]

Use Meniscograph method and measure zero cross time.



【Evaluation result 】

(unit : s)

	1	2	3	4	5	Ave.	Max.	Min.	Judgement
Zero cross time T0 [s]	2.0	2.0	1.9	2.1	2.3	2.1	2.3	1.9	**PASS**

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8. Process evaluation results

<Outer dimension measurement>

**To verify lead frame strip size, conduct outer dimension measurement.
Cpk > 1.67 and no problem.**

【Evaluation contents】

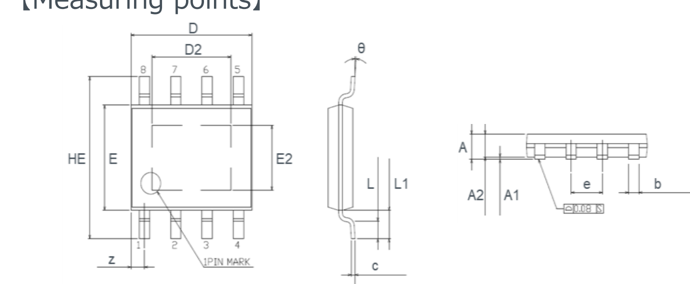
Package : HTSOP-J8

Evaluation Qty : 10 pcs

【Judgment standard】

Cpk≧1.67 for each dimension

【Measuring points】



<Current production line>

	A	A1	A2	D	D2	HE	E	E2	b	c	e	L	L1	z	θ
	1.0 Max.	0.08±0.08	0.85±0.05	4.9±0.1	(3.2)	6.0±0.2	3.9±0.1	(2.4)	0.42 +0.05/-0.04	0.17 +0.05/-0.03	1.27	0.65±0.15	1.05±0.2	0.545	4°+6°/-4°
Ave.	0.98	0.12	0.86	4.95	3.11	6.00	3.89	2.33	0.41	0.17	1.27	0.59	1.07	0.56	3.28
Max.	0.98	0.13	0.86	5.04	3.14	6.02	3.90	2.37	0.42	0.17	1.28	0.61	1.12	0.58	3.56
Min.	0.97	0.11	0.84	4.87	3.08	5.98	3.87	2.25	0.40	0.16	1.26	0.58	1.05	0.52	3.08
σ	0.00	0.01	0.01	0.06	0.02	0.01	0.01	0.03	0.01	0.01	0.00	0.01	0.02	0.02	0.15
Cpk	1.80	2.20	2.16	1.80	-	7.22	2.77	-	1.97	1.69	-	3.82	2.95	-	7.12

(unit : mm)

<High efficiency production line>

	A	A1	A2	D	D2	HE	E	E2	b	c	e	L	L1	z	θ
	1.0 Max.	0.08±0.08	0.85±0.05	4.9±0.1	(3.2)	6.0±0.2	3.9±0.1	(2.4)	0.42 +0.05/-0.04	0.17 +0.05/-0.03	1.27	0.65±0.15	1.05±0.2	0.545	4°+6°/-4°
Ave.	0.95	0.13	0.85	5.03	3.17	6.02	3.87	2.39	0.41	0.16	1.27	0.66	1.08	0.61	3.50
Max.	0.96	0.14	0.86	5.07	3.22	6.04	3.88	2.41	0.42	0.17	1.28	0.69	1.11	0.66	4.06
Min.	0.93	0.12	0.84	5.00	3.15	6.00	3.85	2.36	0.41	0.16	1.26	0.64	1.06	0.55	2.93
σ	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.02	0.02	0.03	0.40
Cpk	1.82	2.09	2.22	3.24	-	5.14	2.47	-	2.98	1.75		2.37	3.10	-	2.90

(unit : mm)

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8. Process evaluation results

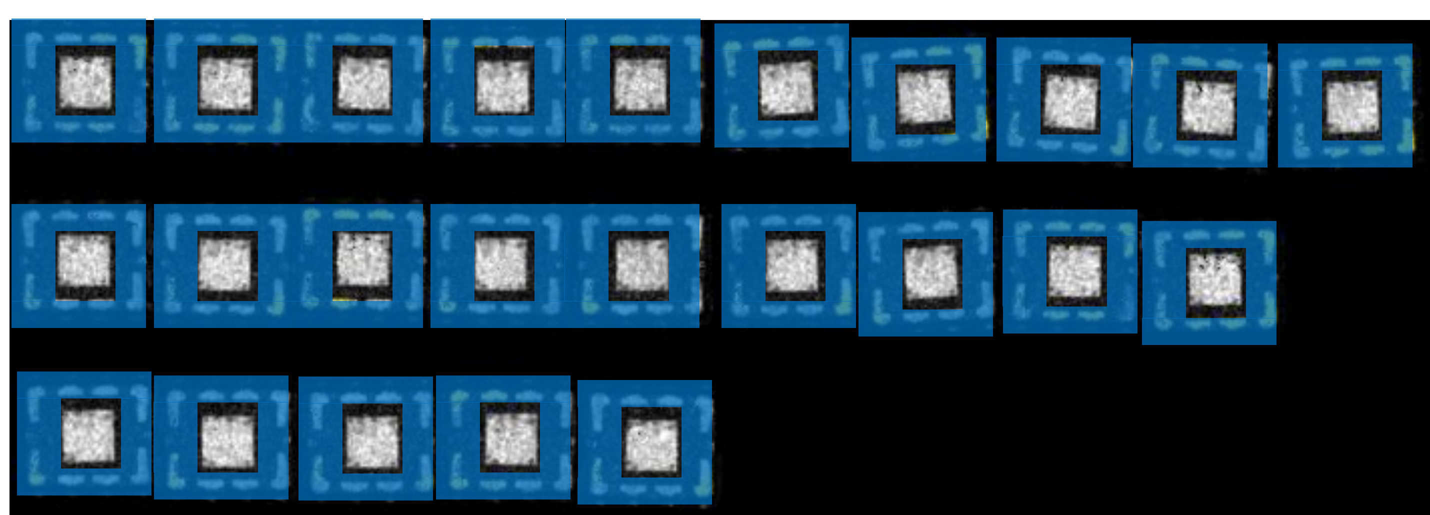
<SAT evaluation on chip surface>

As a result of the SAT evaluation on chip surface, we have confirmed that there is no problem with the low elasticity of the mold resin.

【Judgement contents】
Package : current semi wide line/high efficiency line
Device : representative model
Qty : N=24pcs

【Judgement standard】
・appearance : No pellet crack

【SAT result】



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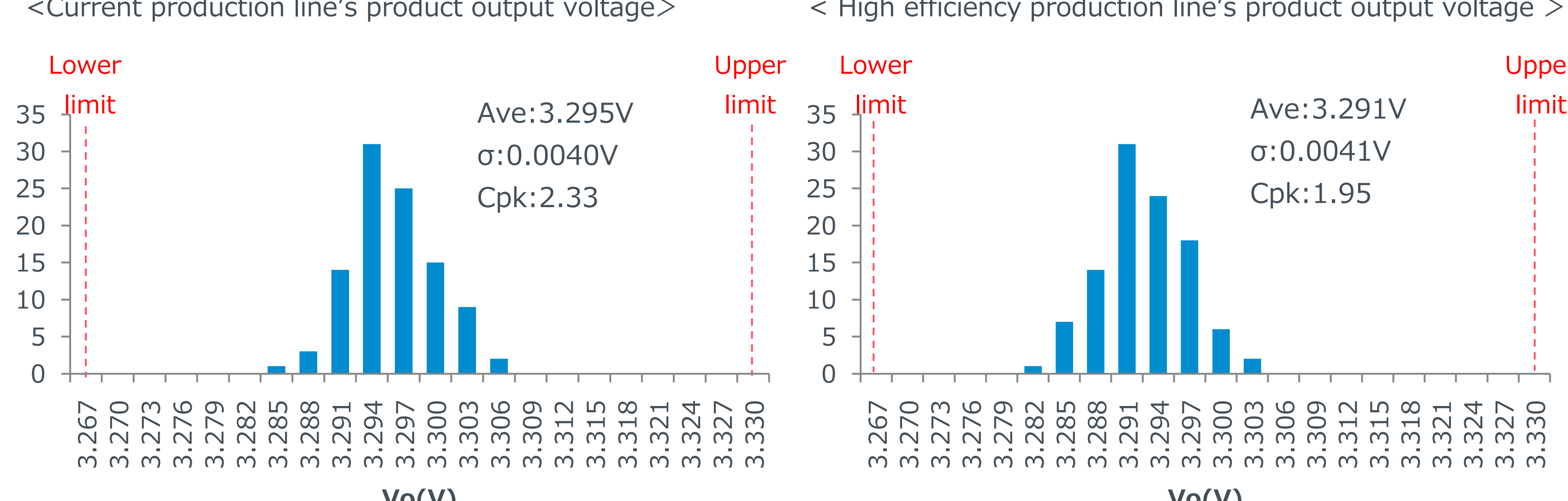
8. Process evaluation results

＜Electrical characteristic measurement＞

To verify mold/die attach paste change, conduct important electrical characteristic measurement (Output voltage) by representative device. Cpk > 1.67 and no problem.

【Evaluation contents】

- Package : HTSOP-J8
- Device : BD33FC0EEFJ-M
- Judgment standard : 3.3+/-1 % V, and Cpk ≧1.67
- Measurement Qty : N=100pcs



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8. Process evaluation results

＜Thermal resistance measurement＞

To verify die attach paste change, compare current production line's product with highly efficiency production line's one about thermal resistance by representative device. Thermal resistance of highly efficiency production line's product is about 2.8℃/W higher than current production line's one.
Objected devices will be measured by evaluation lot.

【Measuring condition】

Package	: HTSOP-J8
Device	: BD50HA3EEFJ
Measuring machine	: T3Ster (MentorGraphics)
Environment	: JESD51-2A
Substrate	: Rohm 4 layers substrate

Substrate information

Rohm 4 layers substrate

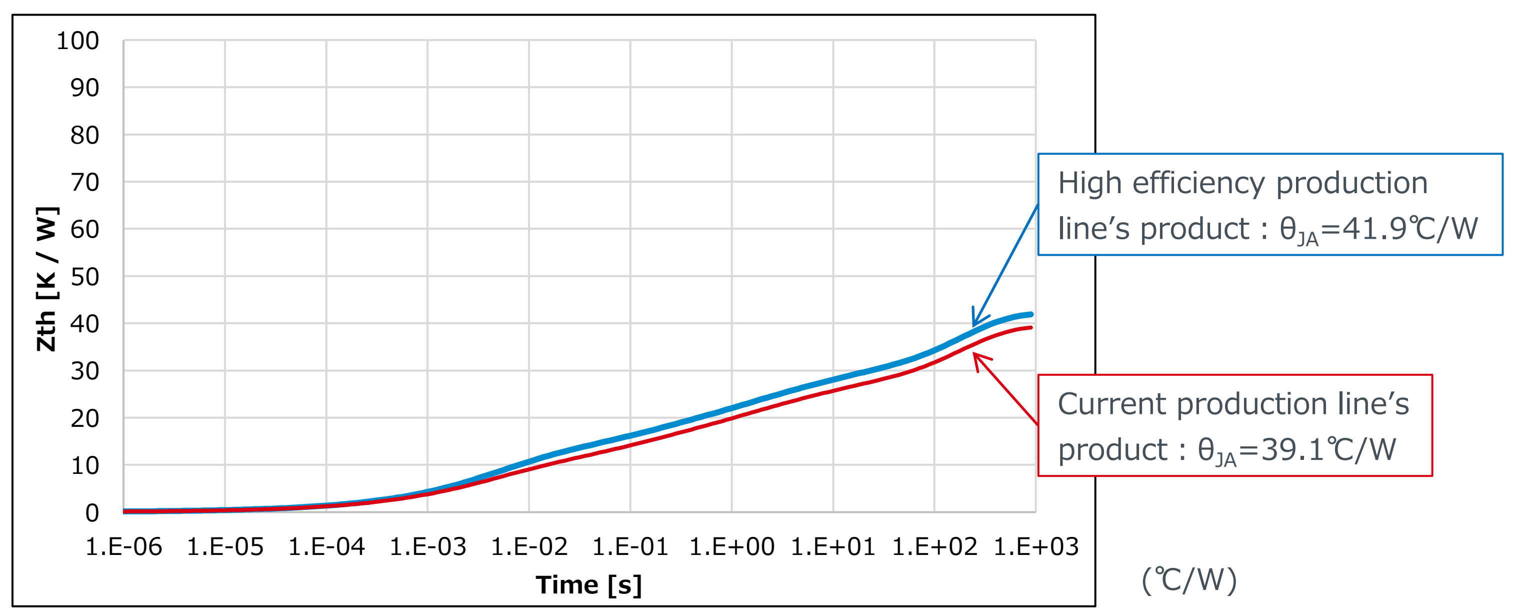
: FR4(Glass epoxy) substrate

114.3mm×76.2mm×1.6mmt

1st layer: Cupper foil, land pattern＋wiring for measuring

2nd、3rd、backside layer: Cupper foil, 74.2mm×74.2mm

【Result】



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<MSL>

To verify mold/die attach paste change, conduct MSL test by following JEDEC. No delamination is found and no problem.

【Evaluation contents】

Package : HTSOP-J8 (High efficiency production line)
Device : BD4271EFJ-C
Evaluation Qty : N=24pcs

【Pre-condition】

MSL	JEDEC LEVEL 1
Drying	125℃ 24h
Moisture	85℃ 85% 168h
Reflow	Pb free profile (260℃) 3 times

【Judgment standard】 IPC/JEDEC J-STD-020E

	Judgment standard/ Evidence of judgment standard	JEDEC Table No.
Chip (surface)	No delamination ／To avoid wire open	6.2.1.1a
Island (Surface)	No delamination at down bonding area／To avoid wire open ※Objected devices are not applicable because of no down bonding.	6.2.1.1b
Paste/Island Interface	Delamination area < 50% in initial condition and no change after MSL. (”High heat radiation” or “Ohmic contact at chip backside” device is applicable) ／To avoid heat radiation grade down or non-ohmic contact.	6.2.1.1d
Inner lead (Surface)	Delamination area < 100%. If 100% delamination is found, conduct quality assurance Test and judge by electrical characteristic／To avoid wire open	6.2.1.1e

【Result】

Measuring point	Chip (Surface)	Island (Surface)	Paste/Island Interface	Judgment
Pn/N	0/24	0/24	0/24	**Pass**

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8. Process evaluation results

We conducted reliability test based on JEDEC. There is no problem.

【Evaluation contents】

Package : HTSOP-J8 (High efficiency production line)
Device : BD4271EFJ-C
Evaluation Qty : N=24pcs

【Judgment standard】

IPC/JEDEC J-STD-020E

【Result】

Chip (surface)	Paste-Island interface	Inner lead (surface)
0/24	0/24	0/24

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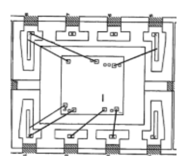
9. Comparison of process evaluation result

Compared current production line and high efficiency production line, each process is equivalent.

■ Evaluation device information

- ・Device name : BD00FC0EEFJ-ME2
- ・Chip size: 1.81x1.91x0.30tmm
- ・Wire: Au28 um (the wire layout is shown on the right)

<Wire layout>



Pn : the number of defects

Process	Check item	Judgement standard	Qty	Evaluation result (Pn/n)		Judgement	item
				Semi wide production line (Current)	High efficiency line		
Die bonding	Paste spread/scatter	≧60%/side, No scatter	288 pcs	0/288pcs	0/288pcs	**Pass**	P.28
	Paste height	≦two-thirds of die height	288 pcs	0/288pcs	0/288pcs	**Pass**	
	Hajiki test	≧80% Si chip residue	30pcs	0/30pcs	0/30pcs	**Pass**	
Wire bonding	Ball size	Within ROHM standard (X, Y: 60±10um Z: 14±5um)	30 wire	0/30 wire	0/30 wire	**Pass**	P.29
	Ball shear test	Strength:≧300mN exist Au residue or Al slide trace	30 wire	Cpk=1.81	Cpk=1.85	**Pass**	
	appearance/ no crack under PAD	No decentering or smash ball /no crack under PAD	30 wire	0/30 wire	0/30 wire	**Pass**	
	2nd pull strength	≧0.06N	30 wire	Cpk=1.70	Cpk=1.72	**Pass**	P.30
	2^{nd}appearance/peel test	No peeled off and exist crescent residue	30 wire	0/30 wire	0/30 wire	**Pass**	
Mold	Wire sweep	≦ 10%	15pcs	Cpk=2.14	Cpk=3.30	**Pass**	P.31
	Inner void	Void ≦ 0.5mm	288pcs	0/288pcs	0/288pcs	**Pass**	
Plating	Plating thickness	8~20 um	60 lead	Cpk=1.73	Cpk=1.78	**Pass**	P.32
	Solder wettability test	Zero cross time ≦ 0.3s	5pcs	0/5pcs	0/5pcs	**Pass**	
Lead forming	Appearance	Based on visual inspection criteria	100pcs	0/100pcs	0/100pcs	**Pass**	P.33

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9. Comparison of process evaluation result

<DB process>

The results show that appearance and bonding strength are equivalent.

Check item	Judgement standard	result		judgement
		Semi wide production line (Curent)	High efficiency production line	
Paste spread/scatter	≧60%/side, No scatter	Pn/N = 0/288 pcs	Pn/N = 0/288 pcs	**Pass**
Paste height	≦two-thirds of die height	Pn/N = 0/288 pcs	Pn/N = 0/288 pcs	**Pass**
Hajiki test	≧80% Si chip residue	Pn/N = 0/30 pcs	Pn/N = 0/30 pcs	**Pass**

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9. Comparison of process evaluation result

<WB process (1)>

The results show that ball size and ball shear strength are equivalent.

Check item	Judgement standard	result: Semi wide production line (Current)	result: High efficiency production line	Judgement
Ball size	・X, Y: 60±10um ・Z: 14±5um	see table below	see table below	**pass**
Ball shear test	Strength:≧300mN exist Au residue or Al slide trace	see table below	see table below	**pass**

Ball size: Semi wide production line (Current)

	X	Y	Z
Ave	62.1	62.4	14.0
MAX	65.0	65.1	15.8
MIN	59.0	60.0	12.8
σ	1.1	1.1	0.92
Cpk	2.39	2.30	1.81

Pn/N = 0/30 wire [um]

Ball size: High efficiency production line

	X	Y	Z
Ave	61.8	61.4	15.1
MAX	63.6	63.5	16.1
MIN	59.8	59.1	14.2
σ	1.1	1.1	0.7
Cpk	2.48	2.60	1.85

Pn/N = 0/30 wire [um]

Ball shear test: Semi wide production line (Current)

	Strength [N]	Shear mode
Ave	0.43	Exist Au residue
MAX	0.49	
MIN	0.38	
σ	0.02	
Cpk	1.81	

Pn/N = 0/30 wire

Ball shear test: High efficiency production line

	Strength [N]	Shear mode
Ave	0.42	Exist Au residue
MAX	0.48	
MIN	0.38	
σ	0.02	
Cpk	1.85	

Pn/N = 0/30 wire

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9. Comparison of process evaluation result

<WB process (2)>

The results show that no crack under PADs and wire appearance/pull strength are equivalent.

Check item	Judgement standard	result		Judgement
		Semi wide production line (Current)	High efficiency production line	
Appearance no crack under PAD	No decentering or smash ball /no crack under PAD	No decentering/smash No crack under PAD Pn/N = 0/30 wire	No decentering/smash No crack under PAD Pn/N = 0/30 wire	**Pass**
2nd pull strength	≧0.06N	strength[N] Ave 0.13 Max 0.14 Min 0.09 σ 0.013 Cpk 1.70 Pn/N = 0/30 wire	strength[N] Ave 0.09 Max 0.10 Min 0.08 σ 0.010 Cpk 1.72 Pn/N = 0/30 wire	**Pass**
2nd appearance peel test	No peeled off and exist crescent residue	2nd appearance: No peeled off Peel test: exist crescent residue Pn/N = 0/30 wire	2nd appearance: No peeled off Peel test: exist crescent residue Pn/N = 0/30 wire	**Pass**

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9. Comparison of process evaluation result

<Mold process >

The results show that MOLD process is equivalent.

Check item	Judgement standard	result		Judgement
		Semi wide production line (Current)	High efficiency production line	
Wire sweep	≦ 10%	Ave 2.00 Max 4.70 Min 0.50 σ 1.2 Cpk 2.14 [%] Pn/N = 0/15 pcs	Ave 1.93 Max 3.20 Min 0.30 σ 0.81 Cpk 3.30 [%] Pn/N = 0/15 pcs	**Pass**
Inner void	Void ≦ 0.5mm	No inner void Pn/N = 0/288 pcs	No inner void Pn/N = 0/288 pcs	**Pass**

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9. Comparison of process evaluation result

<Plating process>

The results show that plating thickness and solder wettability are equivalent.

<table>
<tr><th rowspan="2">Check item</th><th rowspan="2">Judgement standard</th><th colspan="2">result</th><th rowspan="2">Judgement</th></tr>
<tr><th>Semi wide production line (Current)</th><th>High efficiency production line</th></tr>
<tr><td>Plating thickness</td><td>8~20 um</td>
<td><table><tr><td>Ave</td><td>13.2</td></tr><tr><td>Max</td><td>15.19</td></tr><tr><td>Min</td><td>11.36</td></tr><tr><td>σ</td><td>1.0</td></tr><tr><td>Cpk</td><td>1.73</td></tr></table>[um]
Pn/N = 0/60 lead</td>
<td><table><tr><td>Ave</td><td>11.04</td></tr><tr><td>Max</td><td>12.18</td></tr><tr><td>Min</td><td>10.07</td></tr><tr><td>σ</td><td>0.57</td></tr><tr><td>Cpk</td><td>1.78</td></tr></table>[um]
Pn/N = 0/60 lead</td>
<td>Pass</td></tr>
<tr><td>Solder wettability test</td><td>Zero cross time ≦ 0.3s
(EIAJ ED-4701/303)</td>
<td><table><tr><td>No.</td><td>Zero cross time</td></tr><tr><td>1</td><td>2.03</td></tr><tr><td>2</td><td>2.16</td></tr><tr><td>3</td><td>2.06</td></tr><tr><td>4</td><td>1.97</td></tr><tr><td>5</td><td>2.16</td></tr><tr><td>Ave</td><td>2.07</td></tr><tr><td>Max</td><td>2.16</td></tr><tr><td>Min</td><td>1.70</td></tr></table>[s]
Pn/N = 0/5 pcs</td>
<td><table><tr><td>No.</td><td>Zero cross time</td></tr><tr><td>1</td><td>2.21</td></tr><tr><td>2</td><td>1.85</td></tr><tr><td>3</td><td>2.26</td></tr><tr><td>4</td><td>1.70</td></tr><tr><td>5</td><td>1.86</td></tr><tr><td>Ave</td><td>1.98</td></tr><tr><td>Max</td><td>2.26</td></tr><tr><td>Min</td><td>1.70</td></tr></table>[s]
Pn/N = 0/5 pcs</td>
<td>Pass</td></tr>
</table>

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9. Comparison of process evaluation result

<Lead forming process>

The results show that product appearance is equivalent.

Check item	Judgement standard	result		Judgement
		Semi wide production line (Current)	High efficiency production line	
Appearance	Appearance criteria (crack, marking identification, no lead deformation)	C / D / B / A / A / B / C / D Top / Back side / Side No appearance defects (Pn/N = 0/100 pcs)	C / D / B / A / A / B / C / D Top / Back side / Side No appearance defects (Pn/N = 0/100 pcs)	**Pass**

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10. Comparison of characteristics

<Selecting Device for Electrical and heat radiation characteristic evaluation >

The following device are selected in consideration of their electrical and heat radiation characteristics.

1. Electrical characteristic

Due to change mold materials, check if the stress change on the chip affects the electrical characteristics.

【Key factors】

- Device with high stress on the chip
  →Large chip size
- Device with high sensitivity to stress
  →LDO regulator device

2. Heat radiation characteristic

Check the impact of changes in Ag-paste on the heat radiation characteristic

【key factors】

- Chip size
  →Max/Min size device are selected
- Device with high sensitivity heat generation
  → LDO and swithing regulator device

< Representative device >

BD00FC0EEFJ-ME2
BD33IA5EEFJ-ME2
BD90620EFJ-CE2

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10. Comparison of characteristics

<Stress simulation analysis for the relationship between chip size and the stress>

As a result of this simulation, the stress on the chip due to the mold resin change decreased for each chip size, so the effect on the electrical characteristics considered to be small.

【Simulation contents】

Package : current line/high efficiency line
Device : see figure at right
analysis soft : midasNFX (linear model)
analysis condition : 175℃→25℃

Application	LDO regulator		Switching regulator
Device	BD33IA5EEFJ-ME2	BD00FC0EEFJ-ME2	BD90620EFJ-CE2
Chipsize	0.80mm x 0.75mm	1.81mm x 1.91mm	2.80mm x 2.00mm
Simulation model (1/4model)	Chip / Mold resin / Leadframe		

Device name	BD33IA5EEFJ-ME2	BD00FC0EEFJ-M	BD90620EFJ-CE2
Chip size	0.80mm x 0.75mm	1.81mm x 1.91mm	2.80mm x 2.00mm
High efficiency production line	Max stress Max stress:263.3MPa	Max stress Max stress :328.7MPa	Lead frame, Chip, Mold resin, Max stress Max stress :344.1MPa
Semi wide production line (Current)	Max stress Max stress :282.2MPa	Max stress Max stress :342.2MPa	Max stress Max stress :357.7MPa
Stress reduction rate	▲6.7%	▲3.9%	▲3.6%

midas NFX
SOLID STRS
VON MISES , N/mm^2

The larger the chip size, the more stress on the chip.
High efficiency line products reduce the stress on the chip due to the difference in hardness of the mold resin.

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10. Comparison of characteristics

＜ Electrical characteristics of BD00FC0EEFJ-ME2＞

For following device, all of the important factors of electrical characteristics are satisfied Cpk＞1.67.
The results show that current/high efficiency line products are equivalent

■ Evaluation condition

・Device ：BD00FC0EEFJ-ME2（LDO regulator）

・Qty : Current production line :N=278 pcs, high efficiency production line : N=5697 pcs

Measurement items	spec			result				Judgement
				σ		Cpk		
	Min	Typ.	Max	Current line	High efficiency line	Current line	High efficiency line	
Shutdown current [uA]	-	0	5	0.019	0.011	6.02	14.24	**Pass**
Bias current [mA]	-	0.5	2.5	0.0084	0.0094	6.32	6.51	**Pass**
Output voltage (VCC=4V)[V]	Vo×0.99	Vo	Vo×1.01	0.0050	0.0043	3.43	4.22	**Pass**
Output voltage (VCC=36V)[V]	Vo×0.99	Vo	Vo×1.01	0.0050	0.0047	4.35	4.59	**Pass**
Input/output voltage difference[mV]	-	300	500	0.0046	0.0032	2.91	5.30	**Pass**
Input stability [mV]	-	20	80	0.8	0.9	4.61	3.90	**Pass**
Output stability[mV]	-	30	60	1.8	1.8	2.22	3.21	**Pass**
EN bias current[uA]	-	25	50	0.36	0.40	3.83	3.63	**Pass**

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< Comparison of thermal resistance>

Compare current production line with high efficiency production line by 3 different chip size devices about thermal resistance. High efficiency production line' s sample is max 2.5℃/W higher than current production line. Please cooperate to judge this effect for customer's application.

【Measuring condition】

Package : HTSOP-J8 current semi wide production line with high efficiency production line
Device : Please refer below
Measuring tool : T3Ster(MentorGraphics)
Standard : JESD51-2A
Board : Rohm 4-layers board

Substrate's information
Rohm 4-layers substrate: FR4(Glass epoxy) board
114.3mm×76.2mm×1.6mmt
Surface cupper layer land pattern＋wiring for measure
2nd /3rd /Backside cupper layer 74.2mm×74.2mm

Device	Chip size	Difference of thermal resistance (current production line with high efficiency production line)
BD33IA5EEFJ-ME2	0.80mm × 0.75mm	△2.0℃/W
BD00FC0EEFJ-ME2	1.81mm × 1.91mm	△2.1℃/W
BD90620EFJ-CE2	2.80mm × 2.00mm	△2.2℃/W

Measurement variation is ≦10%, Max 2.5℃/W.

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We conducted reliability test based on AEC-Q100. There is no problem.

<Sample>

Package : HTSOP-J8（High efficiency production line）
Device : BD4271EFJ-C
Pre-condition : MSL1 (125℃/24h ⇒85℃/85% 168h ⇒ Reflow 260℃ peak（3 times））

<Result>

Item	Condition	Result	Analysis of good sample	Analysis item
TC	-65℃⇔150℃ 500cyc	0/22	0/2	Passivation crack, Wire crack
PCT	121℃ 100% 2atm 192h	0/22	0/2	Al PAD corrosion
HAST	130℃ 85% w/bias 192h	0/22	0/2	Al PAD corrosion
HST	150℃ 2000h	0/22	0/2	Wire open by kirkendal void

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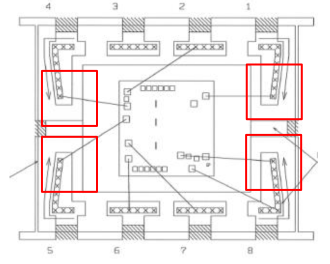
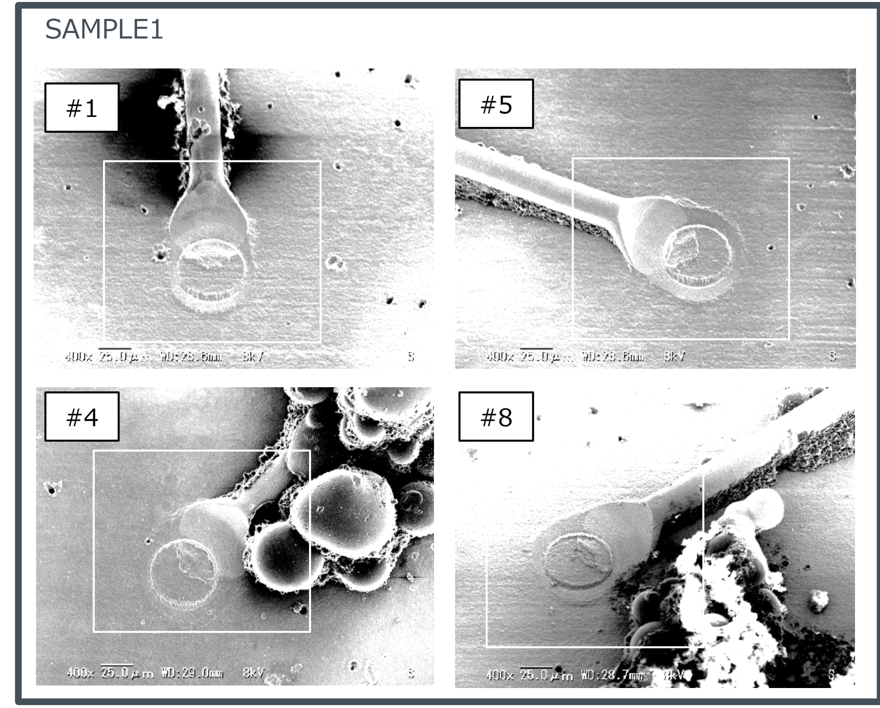
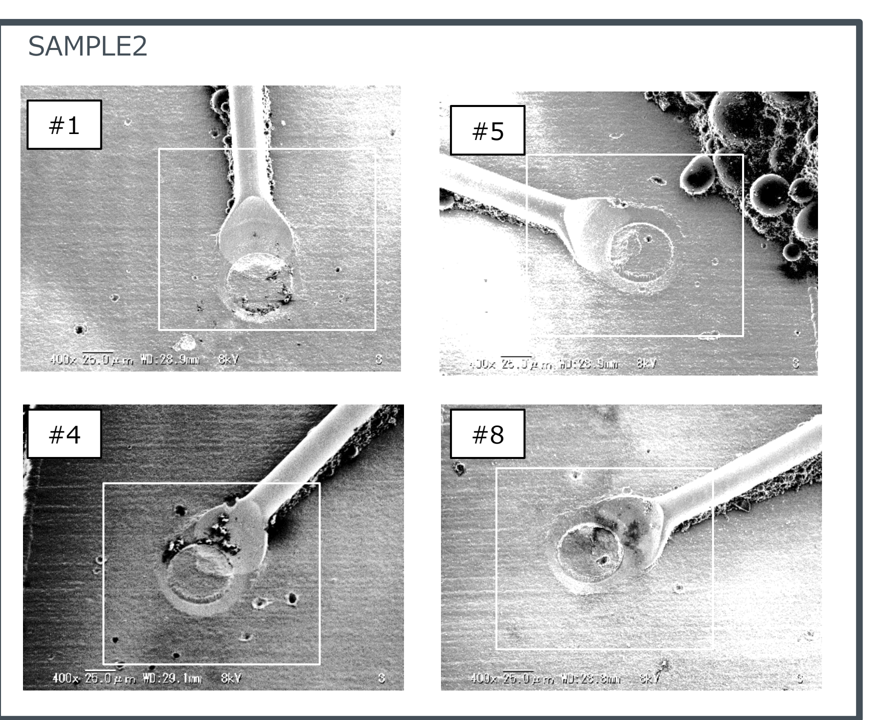
<TC 500cyc Analysis of good sample (1)>

TC 500cyc, there are no crack at 2nd bond. There is no problem.

- Judgment standard : No crack at 2nd bond position
- Number of samples : N=2pcs
- Method : Mold opening ⇒ SEM (×400)







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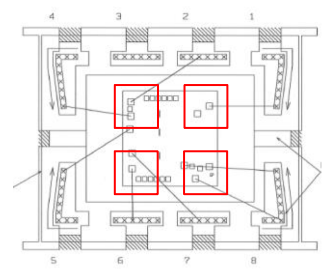
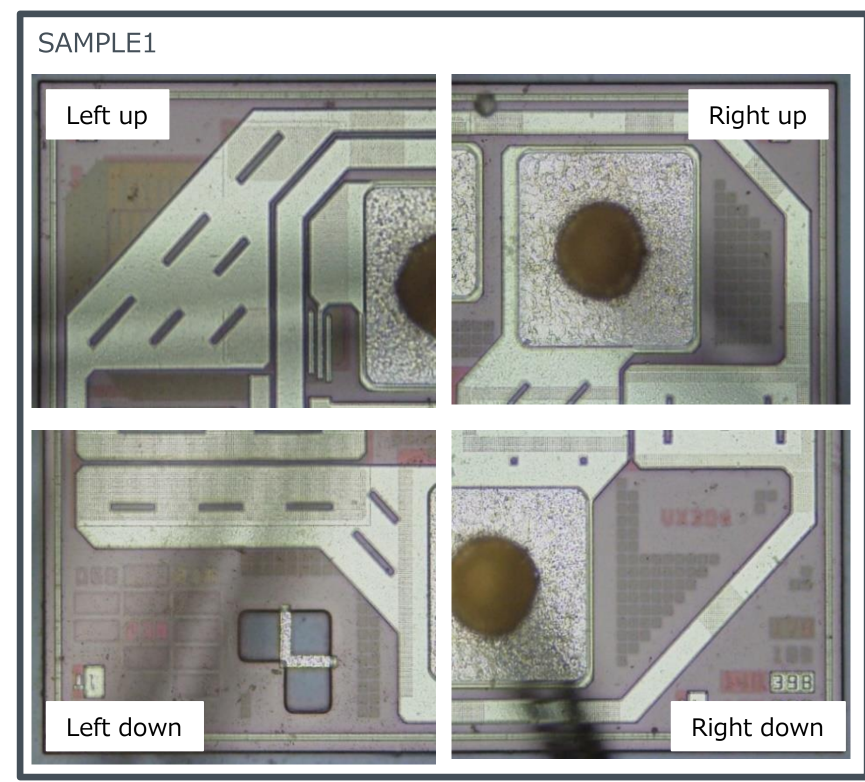
11. Quality assurance test results

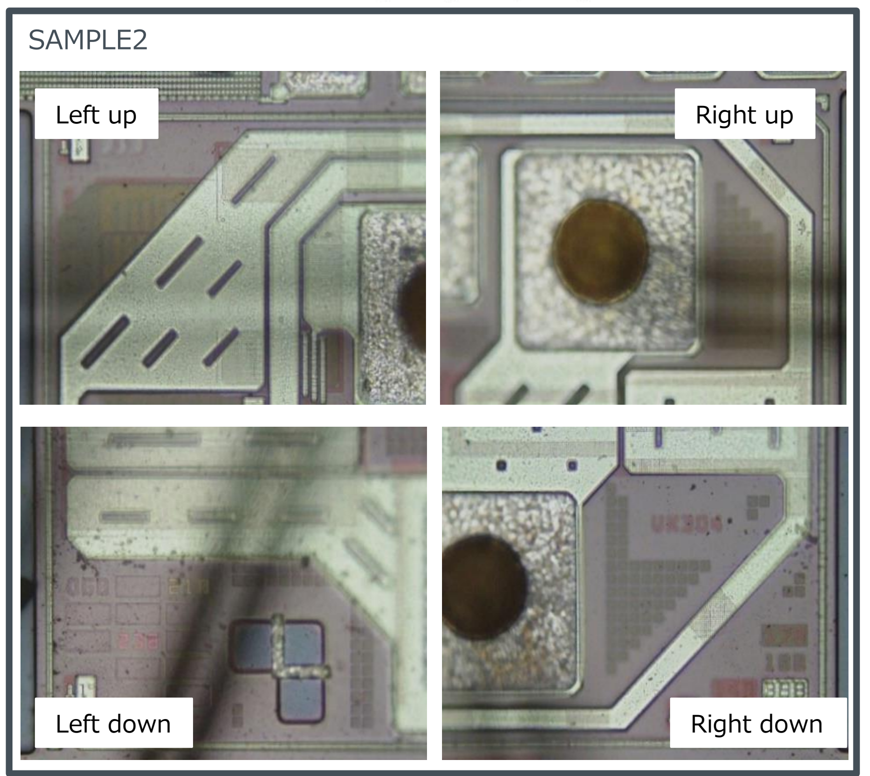
<TC 500cyc Analysis of good sample (2)>

TC 500cyc, there are no passivation crack. There is no problem.

- Judgment standard : No passivation crack
- Number of samples : N=2pcs
- Method : Mold opening ⇒ Microscope (×200)







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<PCT 192h Analysis of good sample (1)>

PCT192h、thare are no PAD corrosion. There is no problem.

- ■Judgment standard：No PAD corrosion
- ■Number of samples　：N=2pcs
- ■Method：Mold opening ⇒ Microscope （×200）

Picture	PAD			
SAMPLE1 ①②③④⑤⑥⑦⑧	①	②	③	④
	⑤	⑥	⑦	⑧
SAMPLE2	①	②	③	④
	⑤	⑥	⑦	⑧

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<PCT 192 h Analysis of good sample (2)>

PCT192h, WB share test is no problem.

- Judgment standard : Above 200mN (Share strength), with Au remain or Al slide.
- Number of samples : N=2pcs
- Method : Mold opening ⇒ Microscope (×200)

Picture	PAD			
SAMPLE1	① 324.7mN	② 354.2mN	③ 366.5mN	④ 348.7mN
	⑤ 341.1mN	⑥ 314.1mN	⑦ 365.6mN	⑧ 346.6mN
SAMPLE2	① 347.6mN	② 359.7mN	③ 361.8mN	④ 353.9mN
	⑤ 384.3mN	⑥ 340.3mN	⑦ 372.2mN	⑧ 368.4mN

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<HAST 192 h Analysis of good sample (1)>

HAST192h, there are no PAD corrosion. There is no problem.

- ■Judgment standard : No PAD corrosion
- ■Number of samples : N=2pcs
- ■Method : Mold opening ⇒ Microscope (×200)

Picture (IC)	PAD			
SAMPLE1	①	②	③	④
	⑤	⑥	⑦	⑧
SAMPLE2	①	②	③	④
	⑤	⑥	⑦	⑧

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11. Quality assurance test results

<HAST 192 h Analysis of good sample (2)>

HAST192h, WB share test is no problem.

■Judgment standard : Above 200mN (Share strength), with Au remain or Al slide.
■Number of samples : N=2pcs
■Method : Mold opening ⇒ Microscope （×200)

Picture (IC)	PAD			
SAMPLE1	① 324.7mN	② 354.2mN	③ 366.5mN	④ 348.7mN
	⑤ 341.1mN	⑥ 314.1mN	⑦ 365.6mN	⑧ 346.6mN
SAMPLE2	① 347.6mN	② 359.7mN	③ 361.8mN	④ 353.9mN
	⑤ 384.3mN	⑥ 340.3mN	⑦ 372.2mN	⑧ 368.4mN

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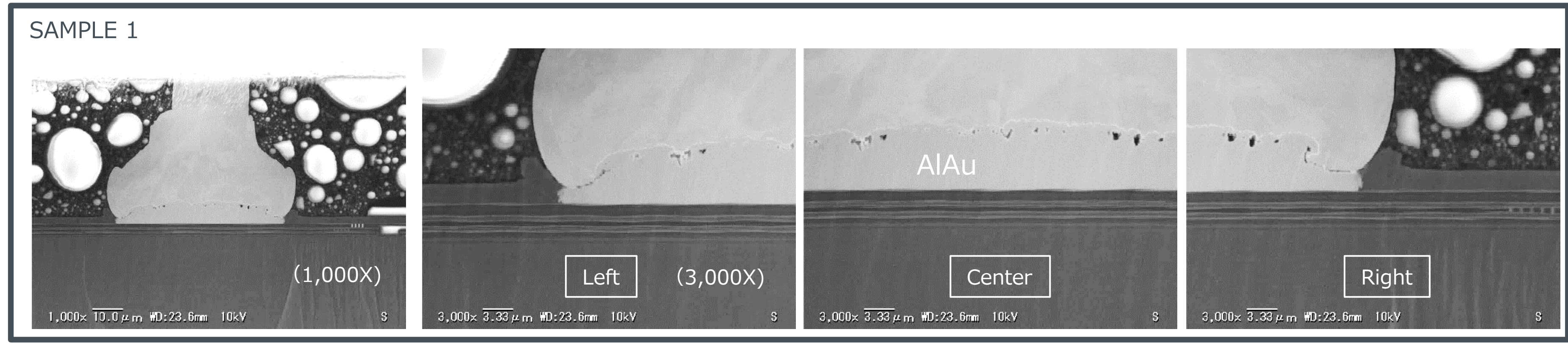
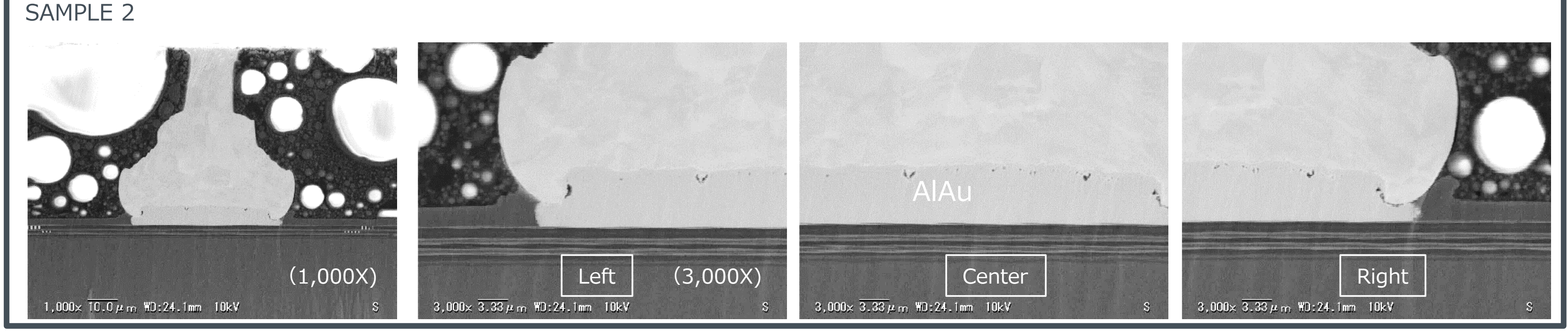
<HST 2000 h Analysis of good sample >

HST2000h, there are no crack by kirkendal void. There is no problem.

- ■Judgment standard : No crack by kirkendal void
- ■Number of samples : N=2pcs
- ■Method : cross section polishing ⇒ SEM (×1000)





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12. Summary

・ To increase production capacity, add HTSOP-J8 high efficiency production line using higher number of products per frame.

・Based on DRBFM, check risk and list up process evaluation/Quality assurance test items. All results are no problem. Electrical characteristics is also no problem.

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信頼性試験結果報告

Reliability Test Result

2021年 7月 8日 Rev. J-2

LSI事業本部 LSI高品質設計部
LSI Business Unit,
LSI High Quality Design Division
矢野 茂秀 S.Yano

機種/TYPE :BDxxIC0MEFJ-M

形状/PACKAGE :HTSOP-J8

【 信頼性試験結果 】

試験項目 ITEM	試験方法 METHOD	試験時間 DURATION	ｻﾝﾌﾟﾙ数 n (pcs)	不良数 pn (pcs)
半田耐熱性 <#2> Resistance to soldering heat	加湿処理後、赤外線ﾘﾌﾛｰ加熱(ﾋﾟｰｸ260℃) After the moisture soaking treatment,carry out the soldering heat stress(IR reflow :peak260℃) JEITA ED4701-301	10s	22	0
プレッシャークッカー <#1> Pressure Cooker	121℃ / 100% (2.026x10^{5}Pa) に放置 Storage at 121℃/100% (2.026x10^{5}Pa)	192h	22	0
温度サイクル <#1> Temperature Cycling	Tstg min (30min) / Tstg max (30min) JEITA ED4701-105	500cycles	22	0
高温保存 High Temperature Storage	Tstg max に放置 Storage at Tstg max JEITA ED4701-201	2000h	22	0
低温保存 Low Temperature Storage	Tstg min に放置 Storage at Tstg min JEITA ED4701-202	2000h	22	0
高温高湿保存 <#1> Temperature Humidity Storage	85℃ / 85% に放置 Place at 85℃/85% JEITA ED4701-103	2000h	22	0
高温高湿バイアス <#1> Temperature Humidity Bias	85℃ / 85% にて通電 JEITA ED4701-102 Apply the specified voltage at 85℃/85%	2000h	22	0
高温動作 High Temperature Operation Life	Topr max にて通電 JEITA ED4701-101 Apply the specified voltage at Topr max	2000h	22	0

【 強度試験結果 】

試験項目 ITEM	試験方法 METHOD	試験時間 DURATION	ｻﾝﾌﾟﾙ数 n (pcs)	不良数 pn (pcs)
端子強度 (引っ張り)試験 Terminal strength	Pull force = 1N JEITA ED4701-401	10s	5	0
半田付け性試験 Solderability	浸漬温度 215℃、鉛半田 Dipping temperature 215℃, (Pb) JEITA ED4701-303	10s	22	0
	浸漬温度 245℃、鉛フリー半田 Dipping temperature 245℃, (Pb free) JEITA ED4701-303	5s	22	0
静電破壊 Electro Static Discharge	C=100pF、R=1.5kΩ、3times、±2000V HBM (Human Body Model) JS-001 (JEITA ED4701-304)	-	5	0
	C=200pF、R=0Ω、3times、±100V MM (Machine Model)	-	5	0
	±750V CDM (Charged Device Model) JS-002	-	5	0
ラッチアップ試験 Latch Up	パルス電流注入方法、トリガーパルス電流 ±100mA Pulse current injection、trigger pulse current ±100mA JESD78 (JEITA ED4701-306)	-	5	0

<<#1>> の試験項目につきましては、前処理として半田耐熱性試験を3回行った後に各試験を行います。
Soldering Heat examination is executed 3 times for the precondition.

<<#2>> 加湿処理 一般品 :85℃ 85% 168h / 防湿梱包品 : 30℃ 70% 192h
Moisture soaking treatment Standard : 85℃ 85% 168h / Dry packing : 30℃ 70% 192h