



Toshiba Discrete Products (Small-signal Devices): Announcement about Change of Production Site for Domestic Products

TOSHIBA

October 9, 2019

H440-9J-008P-E

- Discrete Semiconductor Quality & Reliability Engineering Department
- Quality Assurance Department, Himeji Operations – Semiconductor

Discrete Semiconductor Division

Toshiba Electronic Devices & Storage Corporation

- Quality Assurance Department

Kaga Toshiba Electronics Corporation

Confidential

Abbreviation list

Kaga:	Kaga Toshiba Electronics Corporation
Nogata:	Nogata Operations Buzen Toshiba Electronics Corporation
Himehan:	Himeji Operations – Semiconductor Toshiba Electronic Devices & Storage Corporation

1. Background of our proposal for production site change

We wish to express our sincerest appreciation for your continued patronage to our semiconductors.

We are now shifting the production of our discrete semiconductors (small-signal devices) to an overseas assembly site, the Thailand factory, where the setup of the latest facilities was completed after the flooding in 2011. The new factory has prepared a broad lineup of packages, established a supply system of the products for consumer use and automotive use, and started supplying them. (The Thailand factory has been proactively promoting 100% halogen-free products, 100% Pb-free outer plating, and Cu wire use so as to improve productivity, enhance competitiveness in price, and address environmental needs.)

Since new products are basically to be manufactured in overseas sites, the production scale in Japan will be reducing. Against this backdrop, with a view to maintaining production, ensuring a steady supply, and improving productivity, we are proposing a change of domestic production site.

2. Details of the change

【Change of production site】

Our main packages, which are currently manufactured at Kaga and Nogata, will be produced at Nogata only. Positioning Nogata as the largest assembly factory of small-signal devices in Japan, we will seek to enhance the supply system. Furthermore, we will prevent productivity decline which could be caused by decentralized production sites and maintain a steady supply.

* There are already some products whose specifications show both Kaga and Nogata as production sites.

3. Packages subjected to the change

The change will apply to packages of US6, S-Mini (products with frame of 42 alloy), SMV, SM6, and SMQ.

Schedule: The change will start from April 2020.

See the attachment for the list of product types (US6, S-Mini (products with frame of 42 alloy), SMV, SM6, and SMQ).

Differences before and after the change

Changes in 5M1E

Changes resulting from the change from Kaga to Nogata products are shown below.

5M1E	Change point
Man	To be changed (Operator who has received equivalent training)
Machine	To be changed (Machine of the same model, change of site (place))
Measurement	No change (Measuring instrument with the same functions)
Method	No change
Material	No change
Environment	To be changed (Production line which has been used for manufacturing other semiconductors)

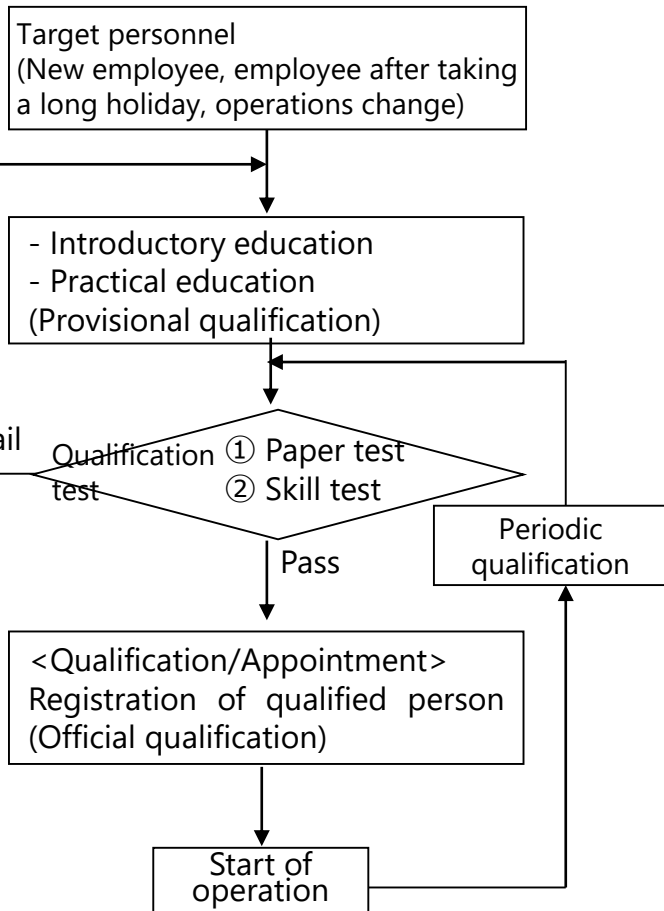
Both Kaga and Nogata have a proven track record of production. Himehan handles quality services and serves as a contact to cope with complaints and quality issues for Nogata products. The change of production site will not affect the product quality including electrical characteristics and reliability.

Verification of the change points

1) Change in operator

Nogata operators are educated as follows. Based on the operator qualification system, educated operators are engaged in operations.

《Operator qualification flow》



《Operator's skill level》

Rank	Skill level	Criteria
A	<ul style="list-style-type: none"> - Able to maintain equipment including processing parts - Understands the safety control and able to correct failure points - Able to switch the package 	The skill level is determined according to the results of paper test and skill test. ※ The chief foreman makes judgment based on the skill, experience and work performance of the operator.
B	<ul style="list-style-type: none"> - Able to adjust a machine with trouble - Able to take action against quality abnormalities - Able to regularly check machines 	
C	<ul style="list-style-type: none"> - Able to run and daily check equipment - Able to judge pass/fail of products 	
D	<ul style="list-style-type: none"> - Has finished the introductory education (Under OJT) 	

《Educational material》

Education is provided by using

- Operational procedures (check sheets), machine manuals
- Inspection criteria, abnormality handling standards, past failures, etc.

Verification of the change points

2) Education on quality and automotive products

Education on automotive products, as well as quality, is provided to the staff and operators. Details of education for Nogata operators are shown below.

Scene of training session



Employees are re-acknowledging the importance of the quality of automotive products.

Educational material

品質導入教育

5-1. 車載品質とは

不適合品が顧客へ与える影響

【機能喪失時、人命に関わる】

想像して下さい

- ・ 走る ... 突然エンジンが止まったら？
突然加速したら？
- ・ 止まる ... ブレーキが利がなかったら？
突然かかったら？
- ・ 曲がる ... ハンドルが曲がらなかったら？
突然曲がったら？
- ・ 安全 ... エアバッグが作動しなかったら？
突然作動したら？

機能喪失時
人命に関わる

TOSHIBA 豊前東芝は変わり続ける。No.1、Plus1、そしてOnly1！

1pcの部品不良が車としての重要故障に繋がる

TOSHIBA 豊前東芝は変わり続ける。No.1、Plus1、そしてOnly1！

Education history

Education on automotive products is provided to the managements/staff/operators to raise awareness of the importance of the quality of automotive products. They are educated periodically (once a year) as well as when they are appointed to a new work place.

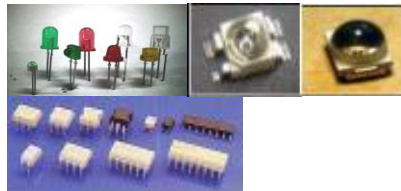
Verification of the change points

3) Nogata's profile

The company profile of Nogata is shown below. Himehan is in charge of the quality.



Buzen Toshiba Head Office (Buzen Area)



Location: 760 Kutsugawa, Buzen-shi, Fukuoka
Capital stock: 160 million yen
Site area: 67,345 m²
Number of employees: About 450
Products: Opto devices
Production scale: About 120 million pieces/month



Buzen Toshiba (Nogata Area)



Location: 1891-1 Kamishinnyuu, Nogata-shi, Fukuoka
Site area: 13,303 m²
Number of employees: About 110
Products: Small-signal devices, power devices
Production scale: About 280 million pieces/month

Verification of the change points

4) Work environment

The following table shows the environment of operation line's processing points and general rooms. The environmental standards have been established by each factory based on Toshiba's common guidelines. There are no significant differences before and after the change.

	Processing point		General room (Testing room)	
	Kaga	Nogata	Kaga	Nogata
Standard for dust control (Count of particles of 0.5 μ m or more)	1,000/cf or less	1,000/cf or less	100,000/cf or less	100,000/cf or less
Standard for ESD control	ESD is controlled under Toshiba's common standards (Specification: \pm 100V or less). (Items including wrist straps, antistatic shoes, antistatic mats, SUS chains, EBP signs, chairs, etc. are also defined and controlled.)			
Standard for temperature/humidity control	20~30°C 20~70%RH	20~30°C 20~70%RH	20~30°C 20~70%RH	20~30°C 20~70%RH

Verification of the change points

5) Dust, ESD, temperature, and humidity

Averages of actual values of dust, ESD, temperature, and humidity are shown below. There are no major changes before and after the transfer.

	General room (Testing room)			
	Kaga		Nogata	
Result of dust count (Count of particles of 0.5 μ m or more)	5820/cf		5745/cf	
ESD	5V		4V	
Temperature and humidity	25°C	50%RH	24°C	48%RH

Control item

Control plan (QC process flow)

The same control plan has been applied to Kaga and Nogata. There are no differences before and after the change.

Manufacture Production		Items Controlled/Inspected	Check Frequency
Flow Chart	Process		
	(Chip) (Frame) Die Bonding	Temperature	Once / Day
	(Bonding Wire) Wire Bonding	Temperature, Bonding Strength	Once / Day Once / Week
	Appearance Inspection	Bonding Status	Once / 2h
	(Molding Resin) Molding	Temperature	Once / Week
	Removing Burr		
	Solder Plating	Plating Thickness	Once / Day
	Lead Cutting & Bending		
	Testing	Electrical Characteristics	
	Marking		
	Appearance Inspection		
	(Taping Material) Taping		
	(Packing Material) Packing		
	Quality Monitoring	Electrical Characteristics Reliability Test	
	Shipping		
Symbol	▽:Storage ○:Operation □:100%Test ◻: Sampling inspection ◻Δ:Special check ○—□ :Check		

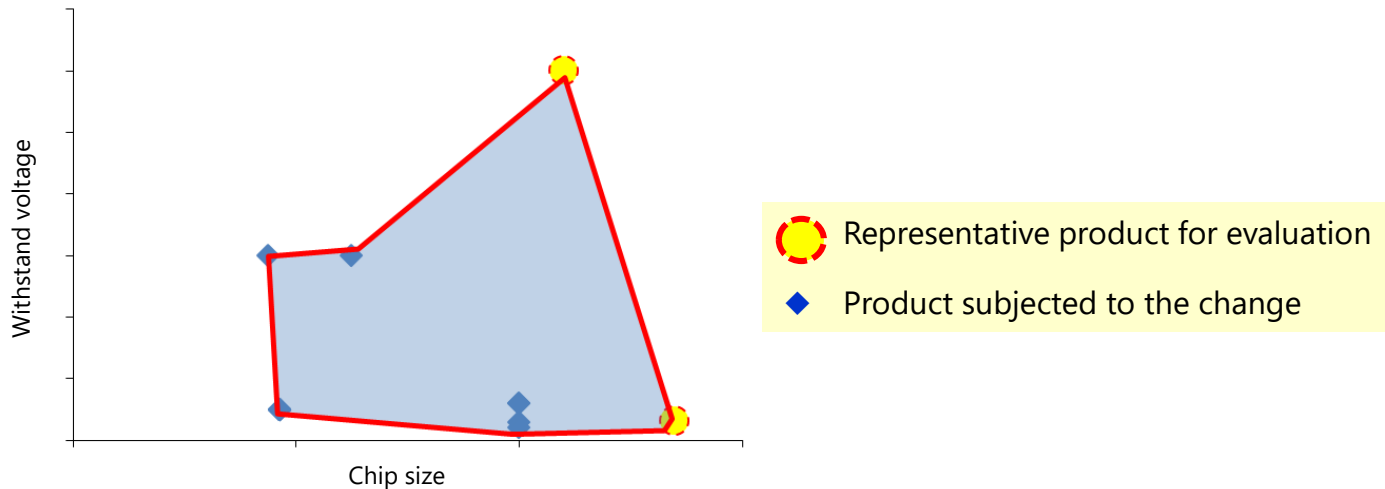
Evaluation based on the change points

1) Selection of representative products

Representative products were picked out for evaluation.

In order to evaluate the package, a product that has the largest chip and a product that has the highest withstand voltage were selected as representatives.

Package	Representative product	Criteria for selection
US6	HN2D02FU SSM6J08FU	Product with the highest withstand voltage Product with the largest chip



Evaluation based on the change points

2) Comparison in wire bonding (Representative product: SSM6J08FU (US6))

The pull strength of bonding wire and the width of deformed bonding ball were checked. No differences were found in process capability and no problems were found.

(n=10 pcs×3 lots)

Process		Wire bonding	
Important control item		Pull strength	Deformed ball width
Cpk	Kaga	2.15	1.75
	Nogata	2.27	1.92

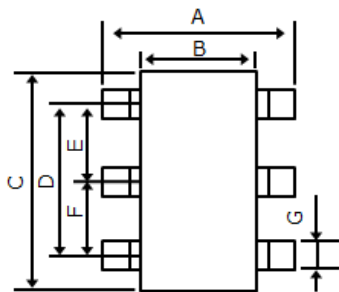
Evaluation based on the change points

3) Comparison in product dimensions (Representative product: SSM6J08FU (US6))

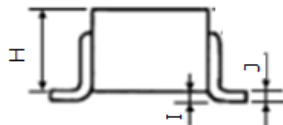
Product dimensions were measured. No differences were found in process capability and no problems were found.

(n=10 pcs×3 lots)

Production site	Item	A (mm)	B (mm)	C (mm)	D (mm)	E (mm)	F (mm)	G (mm)	H (mm)	I (mm)	J (mm)
Kaga	Avg	2.119	1.250	1.978	1.293	0.644	0.650	0.215	0.942	0.048	0.120
	Cp	2.33	6.72	5.89	3.64	-	-	8.88	4.08	1.79	4.47
	Cpk	1.88	6.72	5.25	3.40	-	-	7.75	2.34	1.73	1.79
Nogata	Avg	2.096	1.248	1.969	1.301	0.662	0.639	0.226	0.938	0.064	0.112
	Cp	5.64	7.20	13.74	5.49	-	-	4.98	4.49	2.53	7.13
	Cpk	5.46	7.07	11.64	5.39	-	-	4.86	2.74	1.82	1.76
Specification		2.0~2.2	1.15~1.35	1.8~2.2	1.2~1.4	0.65typ	0.65typ	0.15~0.3	0.8~1.0	0~0.1	0.10~0.20
Judgment		OK	OK	OK	OK	OK	OK	OK	OK	OK	OK



* Specification with upper and lower limits: Cpk, Cp, Average
 * Specification with either limit: Cp, Average
 * Typ. value: Average



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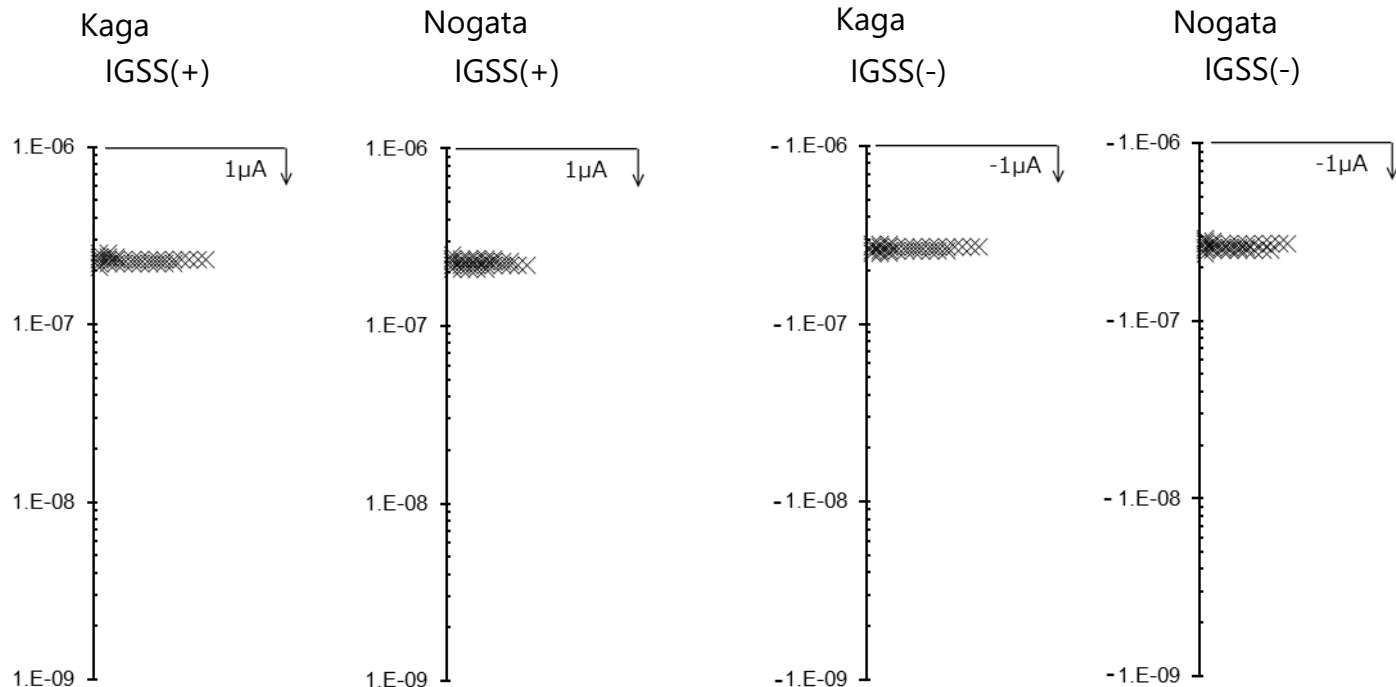
Evaluation based on the change points

4) Comparison in initial characteristics (Representative product: SSM6J08FU (US6))

Initial characteristics (electrical characteristics) were measured. The measurements fell within the specifications. No differences were found in the results and no problems were found.

(n=10 pcs×3 lots) Ta=25°C

Item	Symbol	Test conditions	Specification (TD)				Kaga product		Nogata product	
			Min	Typ	Max	Unit	Average	Cpk	Average	Cpk
Gate leakage current	IGSS(+)	VGS=12V VDS=0	-	-	1	μA	0.228	28.18	0.226	23.42
Gate leakage current	IGSS(-)	VGS=-12V VDS=0	-	-	-1	μA	-0.266	29.95	-0.262	21.10



Evaluation based on the change points

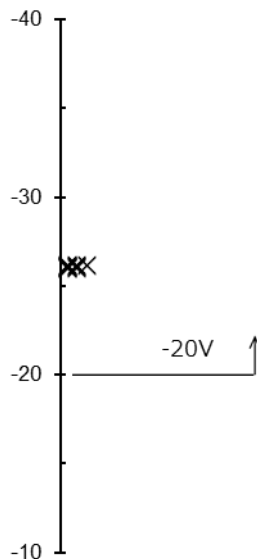
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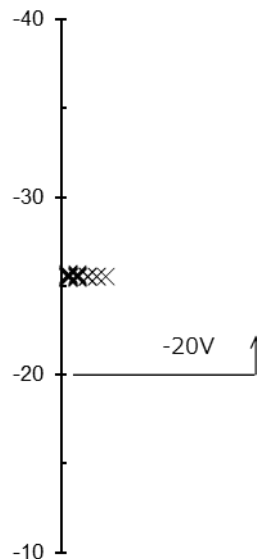
(n=10 pcs×3 lots) Ta=25°C

Item	Symbol	Test conditions	Specification (TD)				Kaga product		Nogata product	
			Min	Typ	Max	Unit	Average	Cpk	Average	Cpk
Drain-Source breakdown voltage	V(BR)DSS	ID=-1mA VGS=0	-20	-	-	V	-26.1	30.80	-25.5	35.11
	V(BR)DSX	ID=-1mA VGS=12V	-8	-	-	V	-16.0	32.21	-15.4	35.76

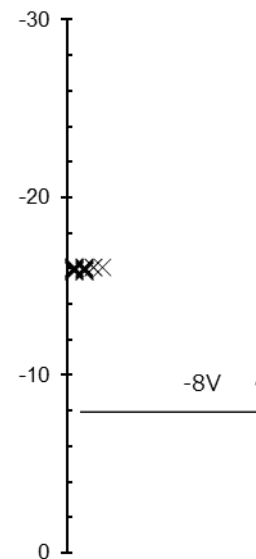
Kaga
V(BR)DSS



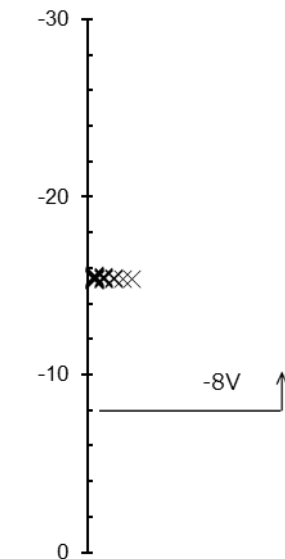
Nogata
V(BR)DSS



Kaga
V(BR)DSX



Nogata
V(BR)DSX



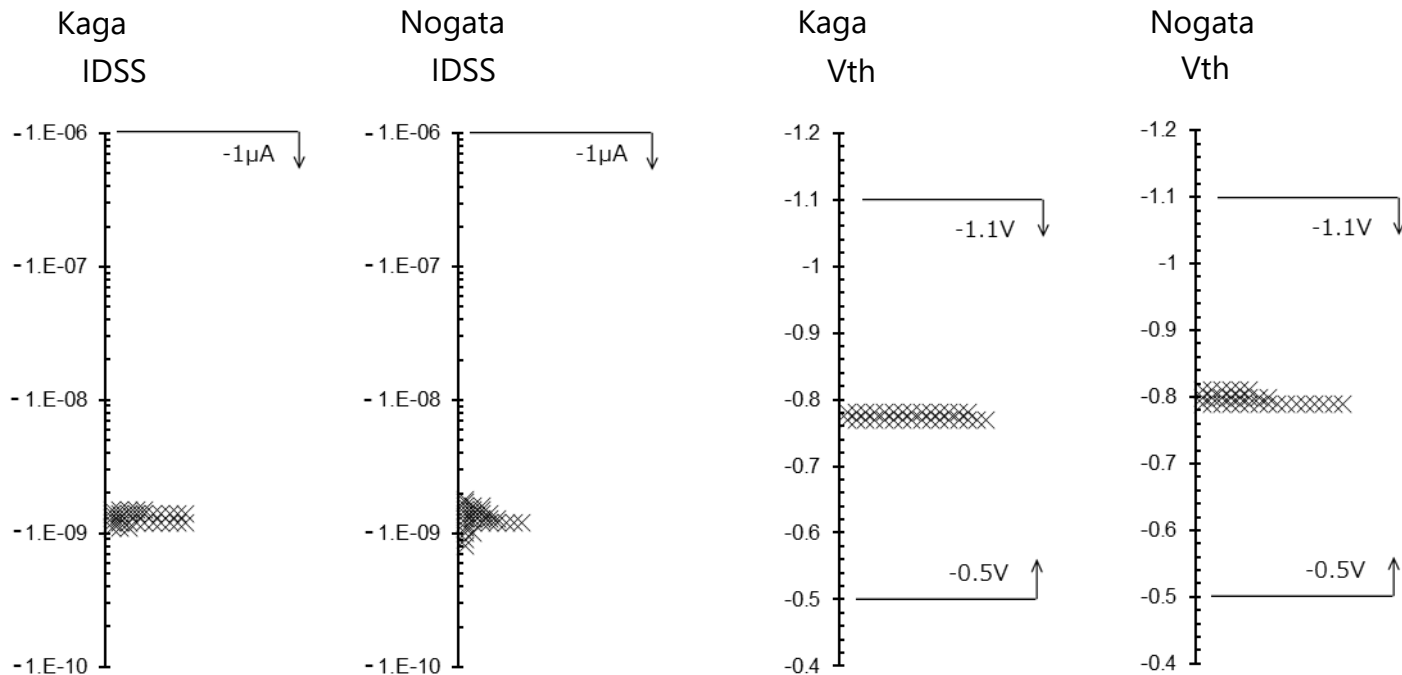
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Item	Symbol	Test conditions	Specification (TD)				Kaga product		Nogata product	
			Min	Typ	Max	Unit	Average	Cpk	Average	Cpk
Drain cut-off current	IDSS	VDS=-20V VGS=0	-	-	-1	μA	-0.00131	2498.9	-0.00131	1441.3
Gate threshold voltage	Vth	VDS=-3V ID=-0.1mA	-0.5	-	-1.1	V	-0.775	18.04	-0.797	12.33



Evaluation based on the change points

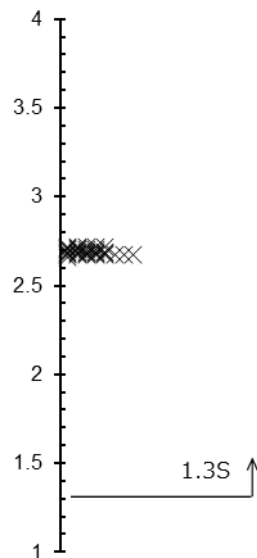
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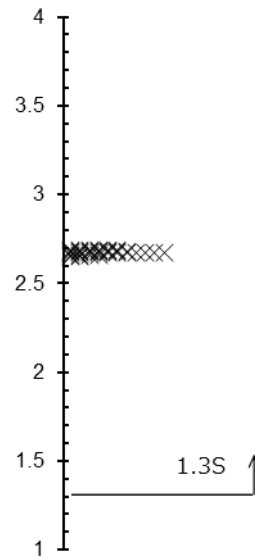
(n=10 pcs×3 lots) Ta=25°C

Item	Symbol	Test conditions	Specification (TD)				Kaga product		Nogata product	
			Min	Typ	Max	Unit	Average	Cpk	Average	Cpk
Forward transfer admittance	Yfs	VDS=-3V ID=-0.65A	1.3	2.7	-	S	2.690	24.58	2.674	39.5
Drain-Source ON resistance	RDS (ON1)	ID=-0.65A VGS=-4V	-	140	180	mΩ	135.3	6.54	141.7	7.96

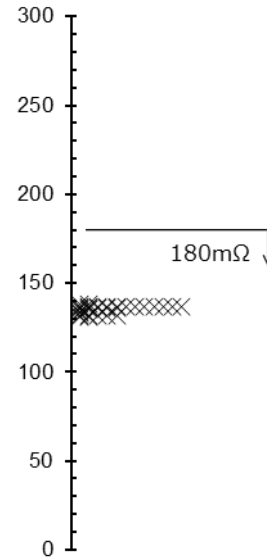
Kaga
|Yfs|



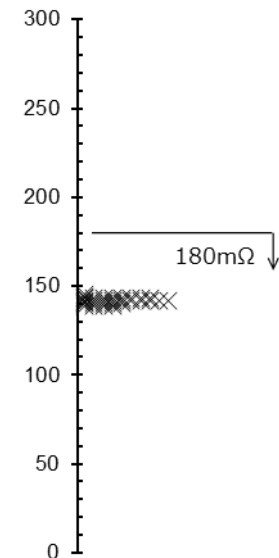
Nogata
|Yfs|



Kaga
RDS(ON1)



Nogata
RDS(ON1)



Evaluation based on the change points

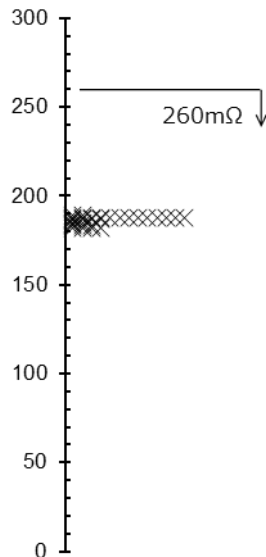
4) Comparison in initial characteristics (Representative product: SSM6J08FU (US6))

Initial characteristics (electrical characteristics) were measured. The measurements fell within the specifications. No differences were found in the results and no problems were found.

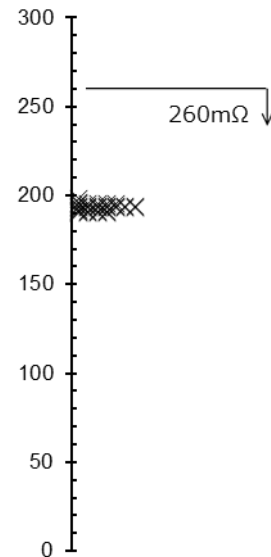
(n=10 pcs×3 lots) Ta=25°C

Item	Symbol	Test conditions	Specification (TD)				Kaga product		Nogata product	
			Min	Typ	Max	Unit	Average	Cpk	Average	Cpk
Drain-Source ON resistance	RDS (ON2)	ID=-0.65A VGS=-2.5V	-	200	260	mΩ	186.2	10.17	193.1	11.27
Drain-Source ON resistance	RDS (ON3)	ID=-0.65A VGS=-2.0V	-	260	460	mΩ	248.4	26.28	258.0	25.45

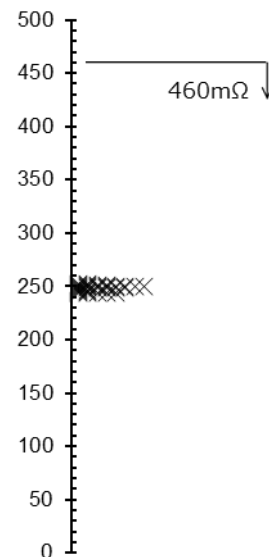
Kaga
RDS(ON2)



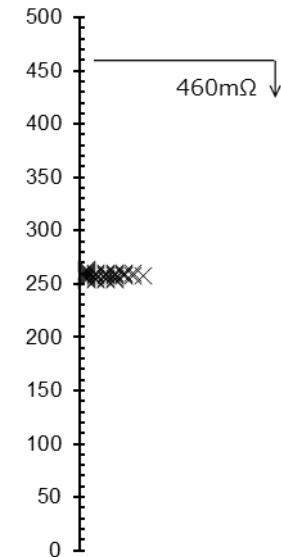
Nogata
RDS(ON2)



Kaga
RDS(ON3)

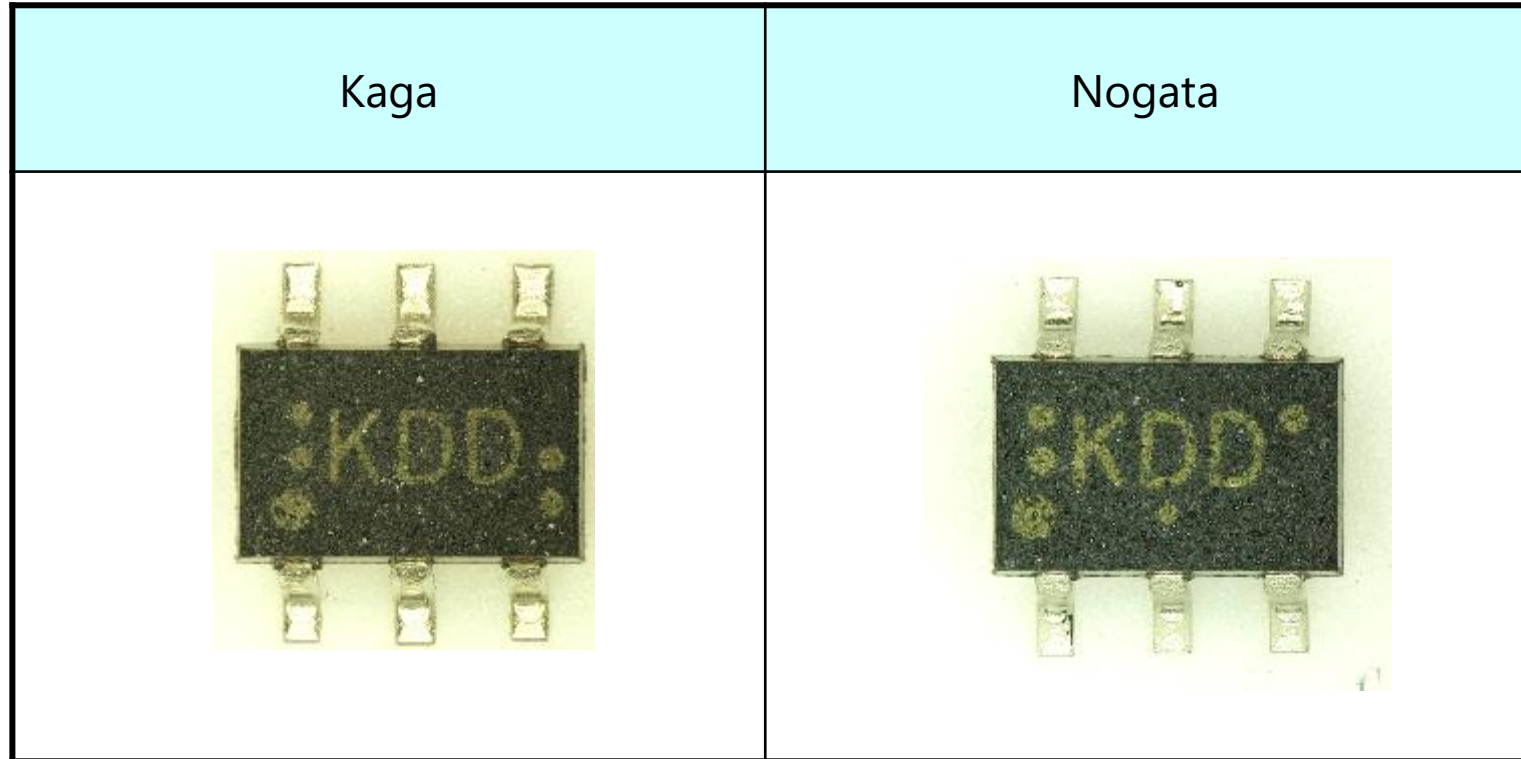


Nogata
RDS(ON3)



Evaluation based on the change points

5) Comparison in product appearance (Representative product: SSM6J08FU (US6))

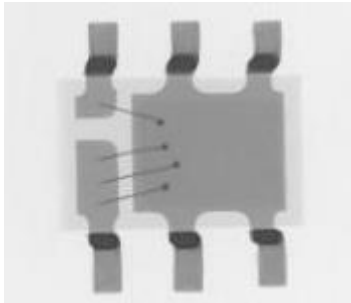

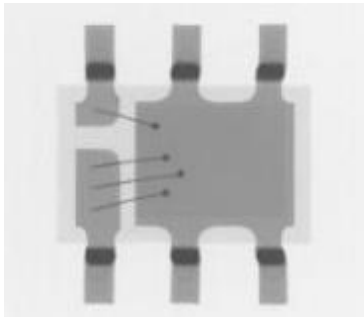
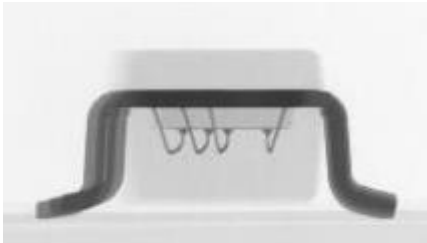


No problems were found in product appearance.

[Item checked: Mark legibility, mark specifications, broken letters, surface of molding resin]

Evaluation based on the change points

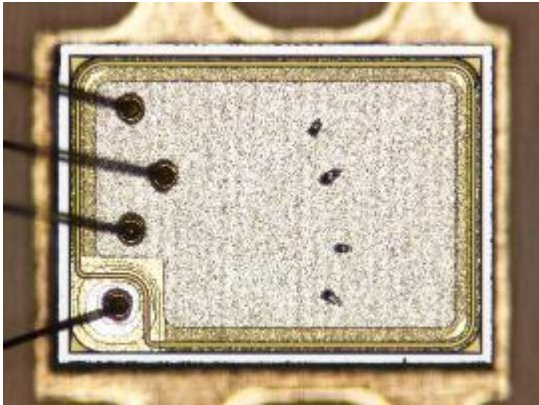
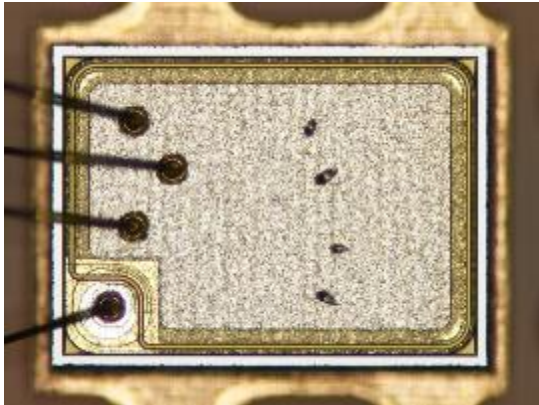
6) Comparison in product by X-ray (Representative product: SSM6J08FU (US6))

	Kaga	Nogata
Overall view	 X-ray overall view of the Kaga product. The image shows a central component with four vertical leads extending from the top and bottom. Three arrows point to specific features on the left side of the component.	
Shape of wire loop	 X-ray view of the wire loop for the Kaga product. The wire forms a U-shape with a flat top section and curved ends.	
		 X-ray overall view of the Nogata product. The image shows a central component with four vertical leads extending from the top and bottom. Three arrows point to specific features on the left side of the component.
		 X-ray view of the wire loop for the Nogata product. The wire forms a U-shape with a flat top section and curved ends, appearing identical to the Kaga product.

Products were x-rayed. No problems were found.
[Item checked: Wire sweep, wire shape]

Evaluation based on the change points

7) Analysis on conforming products (Representative product: SSM6J08FU (US6))

Kaga	Nogata
 A microscopic image of a square chip with a gold border. Four black wires are attached to the left side of the chip. The chip surface is light-colored with some dark spots.	 A microscopic image of a square chip with a gold border, identical to the one from Kaga. Four black wires are attached to the left side of the chip. The chip surface is light-colored with some dark spots.

Conforming products were analyzed. No problems were found.
[Item checked: Bonding position, state of wire-to-chip joint]

Evaluation based on the change points

8) Reliability evaluation (Representative product: SSM6J08FU (US6))

Reliability was evaluated. No problems were found.

No.	Test item	Test conditions	Sample size (pcs)	Test time	Number of defectives
1	Pressure cooker test	121°C/203kPa (100%), unsaturated	n=10 pcs×3 lots	24 hours	0/30 pcs
2	Temperature cycling test	-65°C (30 min)~150°C (30 min)	n=10 pcs×3 lots	100 cycles	0/30 pcs

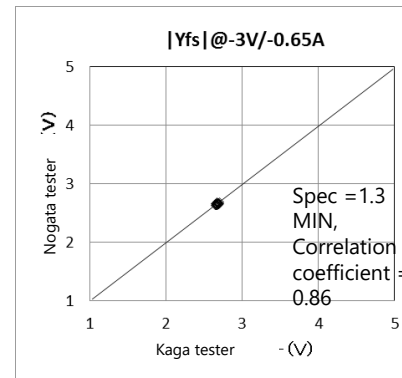
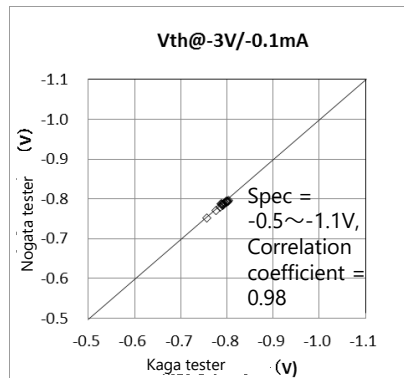
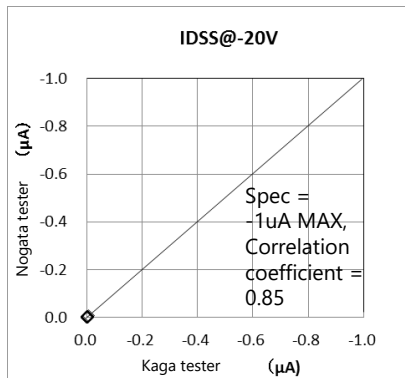
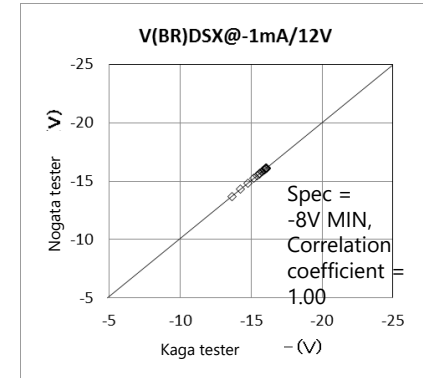
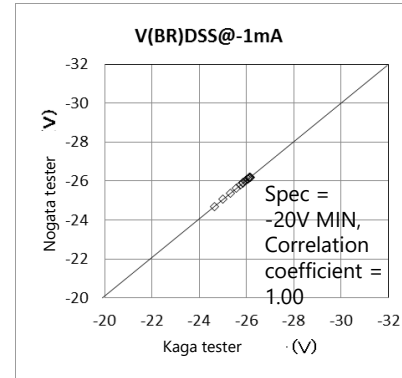
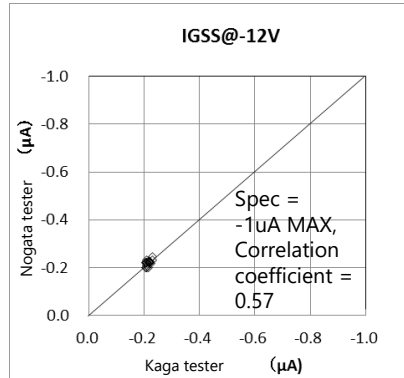
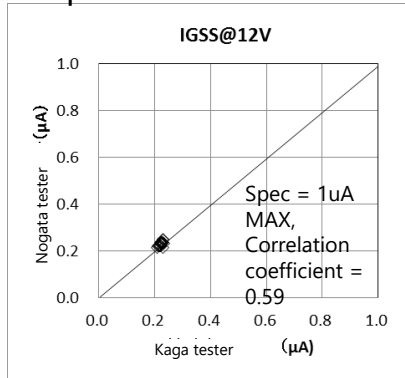
Samples were pretreated for the tests.

The test conditions are based on the standards (JEITA)EIAJ ED-4701. The judgment was made in accordance with the electrical characteristics specifications of the technical data.

Evaluation based on the change points

9) Check on correlation between testers (Representative product: SSM6J08FU (US6))

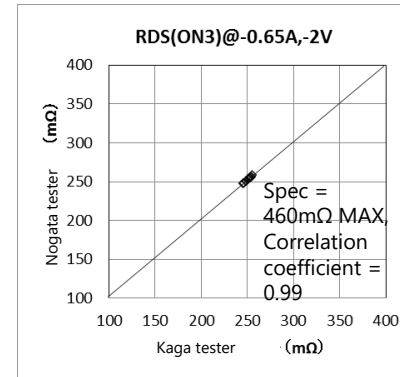
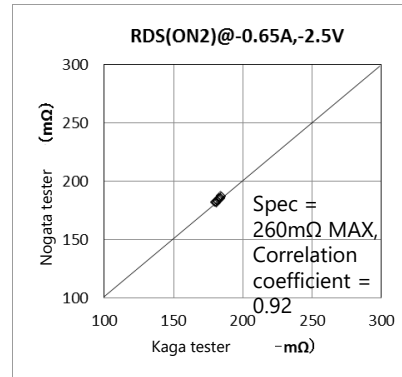
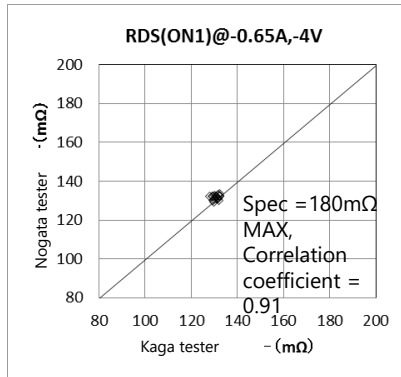
The correlation between testers of both production sites was checked. Neither differences nor problems were found.



Evaluation based on the change points

9) Check on correlation between testers (Representative product: SSM6J08FU (US6))

The correlation between testers of both production sites was checked. Neither differences nor problems were found.



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END

Our Semiconductor and Storage products
will always be a driving force to change the world

Toshiba Electronic Devices and Storage, together with our customers, will accelerate our future journey.
We aim to be a company that will be chosen for our pioneering technology and spirit embedded in our products.

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