Fuji Electric
Innovating Energy Technology

Confidential

To GSK CNC Equipment CO.,Ltd

0. PCN 006-20-FE

Approval of additional factory for IPM production

1. Scope of PCN

Improvement of production capacity and risk avoidance.
Addition Shenzhen Factory in China to current Omachi Factory in Japan.

2. Products to be affected

Product type name : 7MBP75RA120-55, 6MBP50RA120-55

3. Description of the products changing and its evaluation results

3-1 Key point

(1) Chemicals & Materials :

The chemicals & materials (except for printed circuit board and packing trays) to be used for the IPM assembling in Fuji Electric Shenzhen Factory in China (hereinafter SZF) are purchased with same spec as Fuji Electric Power Semiconductor Omachi Factory(hereinafter Omachi factory).

(a) Printed circuit board(PCB) :

Adding the second supplier. The circuit pattern dimension, layout, specification of characteristics and size is not changed although color of PCB surface is slightly changed. Please refer to photo(2) and table(1) on page 4.

(b) Packing tray :

Adding the second supplier. The specification of characteristics and size are not changed although color of them is slightly changed. Please refer to photo(3) on page 5.

(2) Equipment :

All of the equipment and the test equipment provided for the production & test process in SZF are the same design and performances as compared with Omachi factory. Please refer to table(2) on page 6.

(3) Process & Conditions :

The process flow, the process conditions and the control limits of the production in SZF are the same as in Omachi factory. Please refer to table(2) on page 6.

3-2 Intension of the change

In order to respond the customer demand stably, Fuji completed setting up the assembling production line in SZF in terms of the delivery flexibility and also avoiding the risks of disasters like an earthquake. 7MBP75RA120-55 and 6MBP50RA120-55 for other companies have been produced in SZF, they are ready for supply to your company.

REVISIONS

3-3 Qualification test result

(1) Electrical characteristic
As a comparison result of VCE(sat) and VF, Ioc, VUV between SZF products and the Omachi products, no obvious difference was conformed. Please refer to fig.(1) on page 7.

(2) Solder joint analysis
The solder joint layer between the DCB substrate and the chips was observed by using scanning acoustic tomography. As a result, no obvious difference was confirmed. Please refer to photo(4),(5) on page 8.

(3) Al bond joint analysis
The Al bond joint layer was observed after sheering off the Al wire. As a result, no obvious difference was confirmed shown as photo(6) on page 9.

(4) Reliability test result
The following four reliability tests were selected and implemented as a study result of FMEA analysis.

(a) Environment test: Please refer to page 10 ~ 15.
(b) Endurance test : Please refer to page 10 ~ 15.
From investigation results of (a),(b), SZF products passed reliability tests.

(c) Vibration test for the box with condition of a=0.59G, f=3 ~ 200Hz, 90min.
(d) Drop test with the condition of 60cm higher position from the ground.
From investigation results of (c),(d), no electrical and physical damage was confirmed. We are confident that the additional packing tray has no negative impact for the quality and reliability.

From these qualification test results of the representative product(7MBP75RA120-55), it was concluded that SZF target products have same characteristics and reliability with Omachi products.

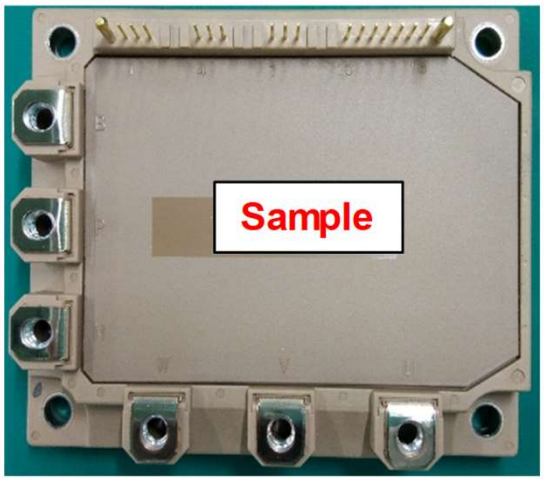
4. Products changing schedule

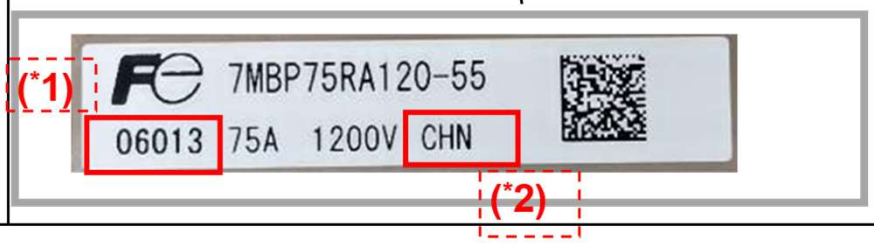
We would like to start these changing from October 2020.

Approval				
Document originator	T. Mori	T. Mori	Date	July 8th, 2020
Document check	H. Sakamoto	H. Sakamoto	Date	July 8th, 2020
Document approval	K. Nakada	K. Nakada	Date	July 8th, 2020

Module Quality Assurance Section 2
Quality Assurance Dept. Production Div.
Electronic Devices Business Group
Fuji Electric Co., Ltd.
4-18-1 Tsukama Matsumoto Nagano Japan

IPM	New label





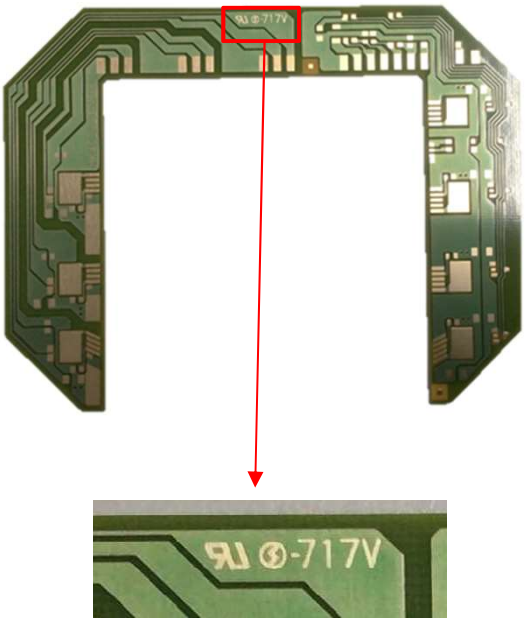
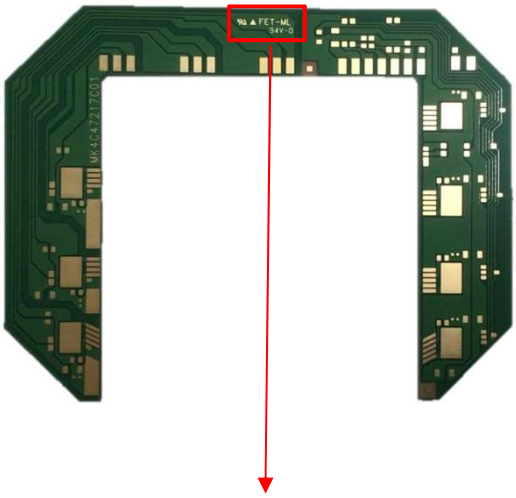
*1)

	1st one digit	Next 1 digit	Next 3 digit
Omachi products	Last one digit of product year	Product month	Sequential number
SZF products	Last one digit of product year	Product month	Sequential number

*2)

Omachi products : JAPAN O
SZF products : CHN

Photo(1) Label description

Existing	Addition
P611 PCB Photo  UL Certification number	P611 PCB Photo   UL Certification number

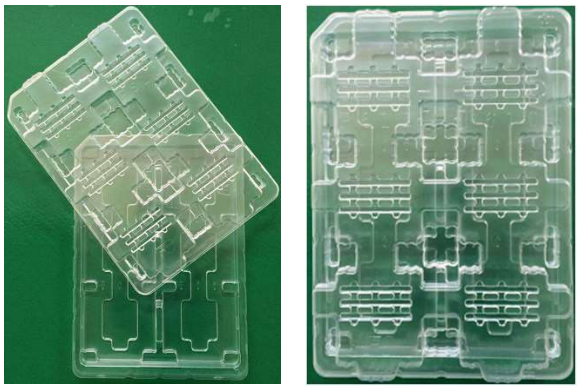
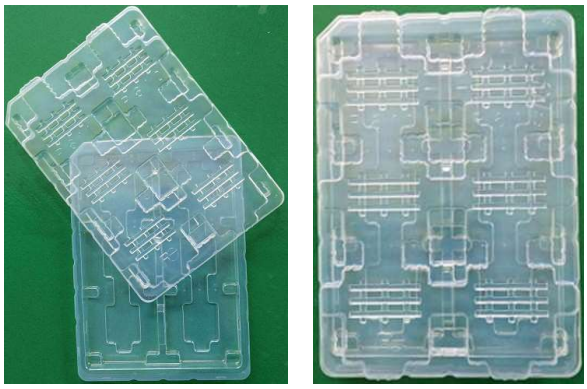
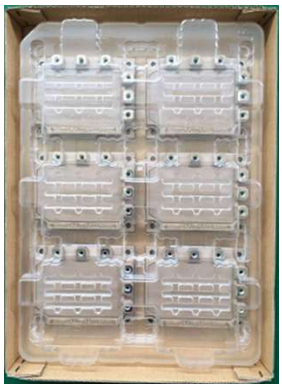
- Additional PCB has same specification of characteristics and size with existing.
- Color of PCB surface is slightly changed.

Photo(2) Visual inspection result of PCB

Table(1) PCB material comparison table

Item	Existing	Addition
Base material	FR4 Halogen-free	←
Circuit pattern	Cu	←
Resist	Resin	←
Au plating	Flash Au plating	←
Through-hole filling	Resin	←

PKG : P611

	Existing	Addition
Tray		
Packing		

- Additional trays have same specification of characteristics and size with existing.
- Color of PCB surface is slightly changed.

Photo(3) Visual inspection result of packing trays

Table(2) Process copmarison between Omachi factory and SZF

Process flow	process name	Process condition & control limit etc	At present facilities
▽IGBT,FWD chips ▽DBC substrate ▽Solderplate ▽Cu plate ▽Temperature detection IC			
	Chip mounting and Soldering	Same as Omachi	Same design as Omachi
▽Printing cuicuit boad ▽Cotrol IC			
	Chip mounting and Soldering	Same as Omachi	Same design as Omachi
▽Epoxi gule			
	PC board gluing	Same as Omachi	Same design as Omachi
	AL-wire bonding (300um:power circuit)	Same as Omachi	Same design as Omachi
	AL-wire bonding (125um:control circuit)	Same as Omachi	Same design as Omachi
▽Terminal case ▽Silicone glue ▽Cream solder			
	Case gluing	Same as Omachi	Same design as Omachi
	Terminal soldering	Same as Omachi	Same design as Omachi
▽Silicone gel			
	Silicone gel injection and gel curing	Same as Omachi	Same design as Omachi
▽Lid ▽Silicone glue			
	Cover-lid assembly (with glue curing)	Same as Omachi	Same design as Omachi
	Labeling	Same as Omachi	Same design as Omachi
	Outgoing test, Visual inspection	Same as Omachi	Same design as Omachi
	Packing, Shipment	Same as Omachi	Same design as Omachi

Sample 7MBP75RA120-55

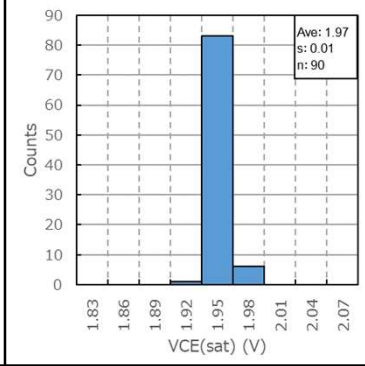
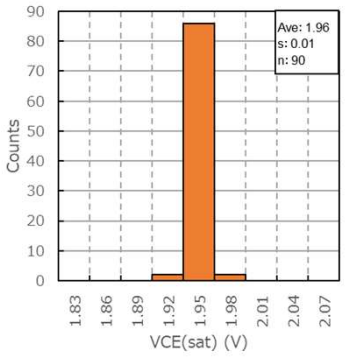
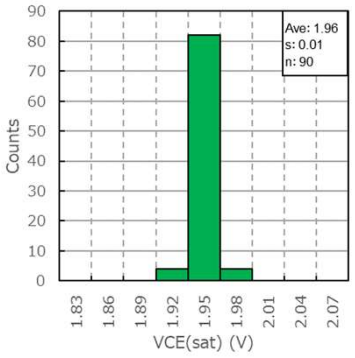
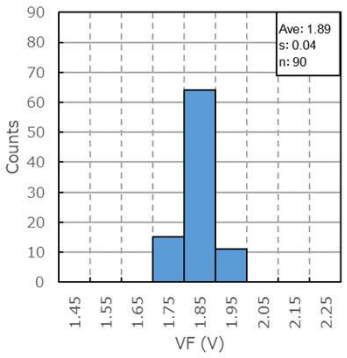
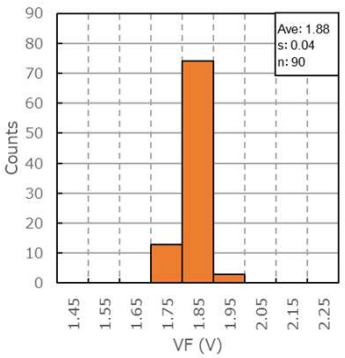
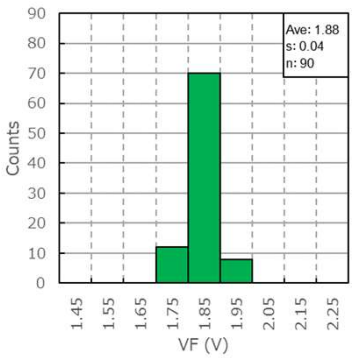
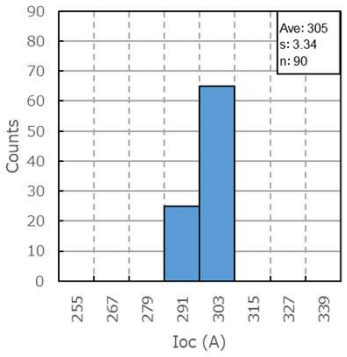
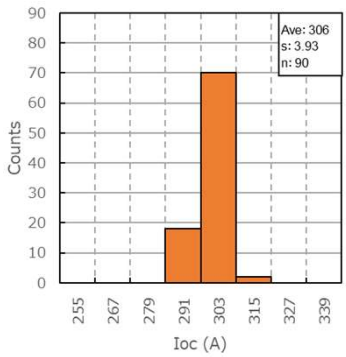
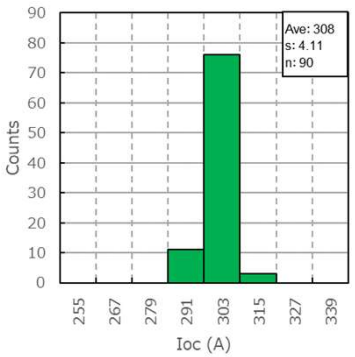
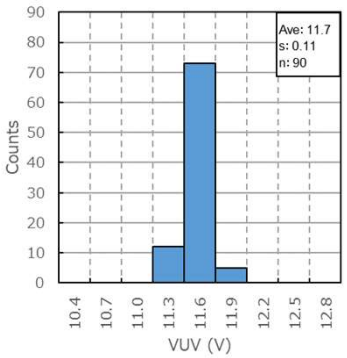
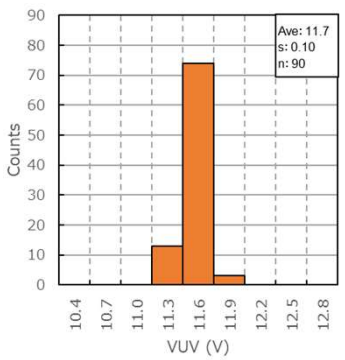
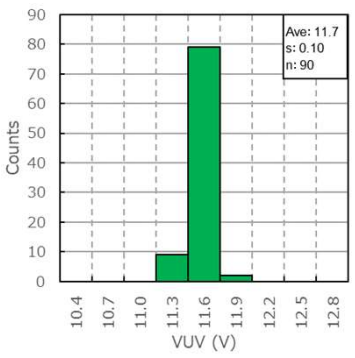
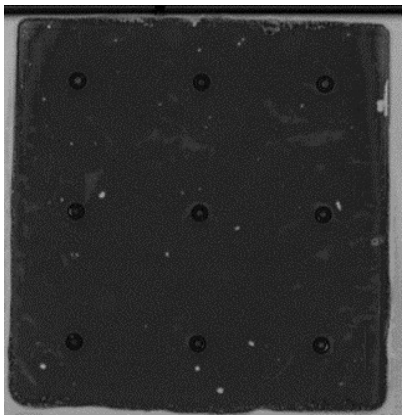
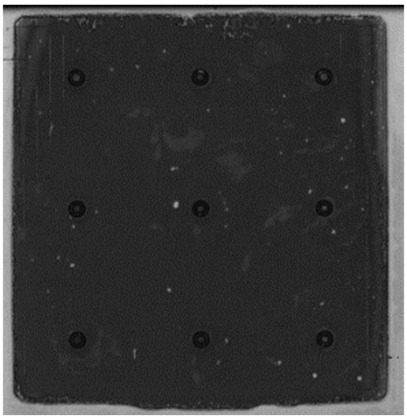
	Products made in Omachi (PCB : Existing)	Products made in SZF (PCB : Existing)	Products made in SZF (PCB : Addition)
VCE(sat)			
VF			
Ioc			
VUV			

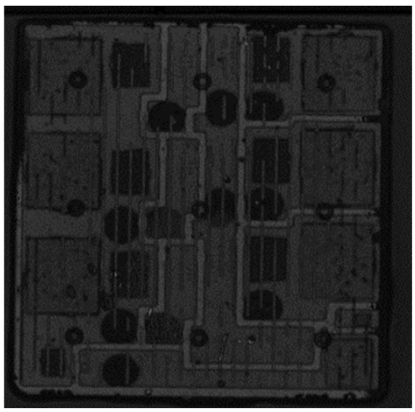
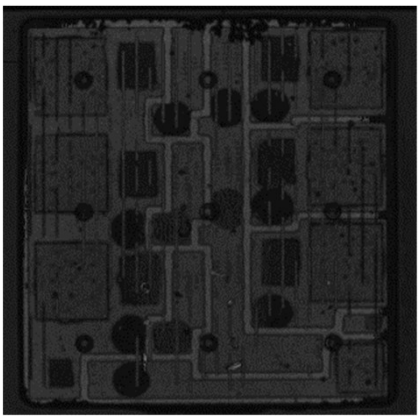
Fig.(1) Comparison results of electrical characteristic

Sample 7MBP75RA120-55

	Products made in Omachi	Products made in SZF
Solder joint analysis (Under the DCB)		

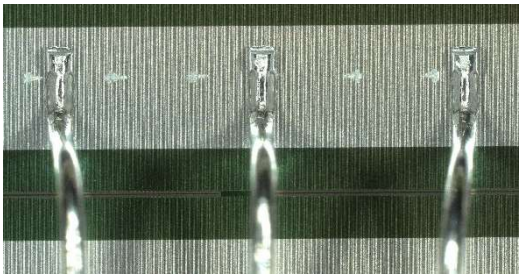
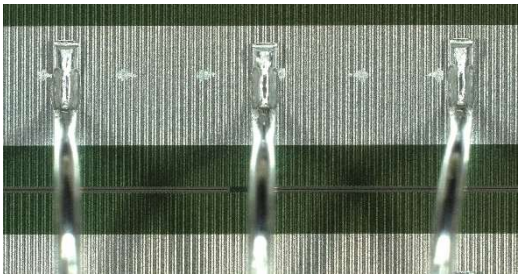
Photo(4) Comparison results of solder joint analysis(Under the DCB)

Sample 7MBP75RA120-55

	Products made in Omachi	Products made in SZF
Solder joint analysis (Under the chip)		

Photo(5) Comparison results of solder joint analysis(Under the chip)

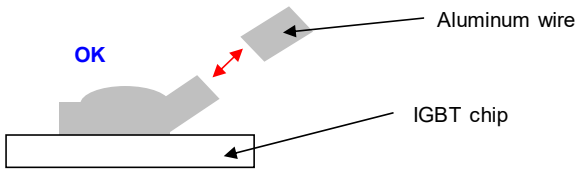
Sample 7MBP75RA120-55

	Products made in Omachi			Products made in SZF		
Aluminum wire junction form comparison						
Tensile strength (gf)	Sample No	Pulling strength(gf)	Failure mode	Sample No	Pulling strength(gf)	Failure mode
	No1	420	C	No1	410	C
	No2	410	C	No2	400	C
	No3	410	C	No3	410	C
	No4	400	C	No4	400	C
	No5	410	C	No5	420	C
	No6	410	C	No6	410	C
	No7	400	C	No7	410	C
	No8	420	C	No8	420	C
	No9	410	C	No9	410	C
	No10	410	C	No10	400	C
	Ave	410		Ave	409	
	σ	6.7		σ	7.4	

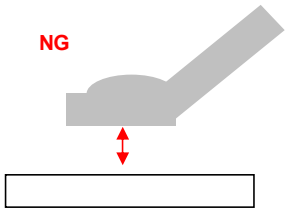
(Target:Pulling strength>=300gf)

Photo(6) Comparison results of withstand capability against the pulling force

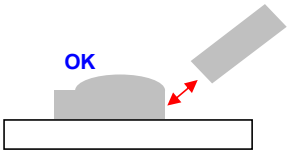
Tensile strength and failure mode



Mode C : Broken at the middle of wire



Mode A : Lifted off from the joint interface



Mode B : Broken at the neck of the bound joint

Table(3) Reliability test results

Test cate-gories	Test items	Test methods and conditions	Reference norms EIAJ ED-4071	Number of sample	Acceptance number	Number of failure
Environment test	Temperature Cycle	Test temp. : Low temp. -40 +/-5 ℃ High temp. 125 +/-5 ℃ RT 5~35 ℃ Dwell time : High ~ RT ~ Low ~ RT 1hrs. 0.5hrs. 1hrs. 0.5hrs. Number of cycles : 100 cycles	Test Method 105	Products made in Omachi (PCB:Existing): 5 Products made in SZF (PCB:Existing): 5 Products made in SZF (PCB:Addition): 5	(1 : 0)	Products made in Omachi (PCB:Existing): 0 Products made in SZF (PCB:Existing): 0 Products made in SZF (PCB:Addition): 0
Endurance test	High Temperature reverse bias	Test temp. : Ta= 125 +/-5 ℃ (Tj≦ 150℃) Bias Voltage : VC=0.8 x VCES Bias Method : Applied DC voltage to C-E Vcc=15V test duration : 1000 hr.	Test Method 101	Products made in Omachi (PCB:Existing): 5 Products made in SZF (PCB:Existing): 5 Products made in SZF (PCB:Addition): 5	(1 : 0)	Products made in Omachi (PCB:Existing): 0 Products made in SZF (PCB:Existing): 0 Products made in SZF (PCB:Addition): 0

Table(4) Failure Criteria

Item	Characteristic		Symbol	Failure criteria		Unit	Note
				Lower limit	Upper limit		
Electrical characteristic	Leakage current		ICES	-	USLX2.0	V	
	Saturation voltage		VCE(sat)	-	USLX1.2	V	
	Forward voltage		VF	-	USLX1.2	V	
	Thermal resistance	IGBT	dVCE	-	USLX1.2	mV	
		FWD	dVF	-	USLX1.2	mV	
	Over Current Protection		Ioc	LSLX0.8	USLX1.2	A	
	Alarm signal hold time		tALM	LSLX0.8	USLX1.2	ms	
	Over heating Protection		TcOH	LSLX0.8	USLX1.2	℃	
	Isolation voltage		Viso	Broken insulation		-	
Visual inspection	Visual inspection Peeling Plating and the others		-	The visual sample		-	

LSL : Lower specified limit.
USL : Upper specified limit.

Note : Each parameter measurement read-outs shall be made after stabilizing the components at room ambient for 2 hours minimum, 24 hours maximum after removal from the tests. And in case of the wetting tests, for example, moisture resistance tests, each component shall be made wipe or dry completely before the measurement.

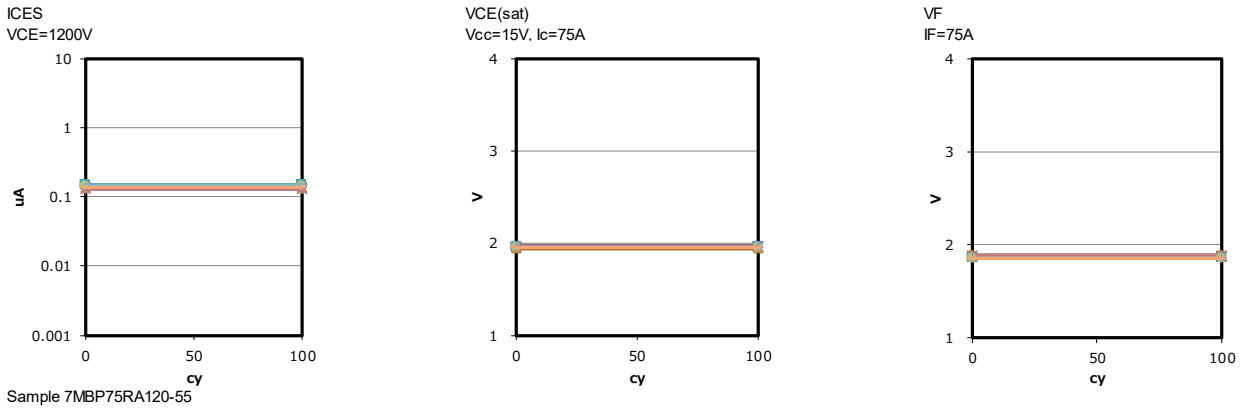


Fig.(2) Static characteristic data of P611 in the temperature cycling test(Omachi, PCB : Existing)

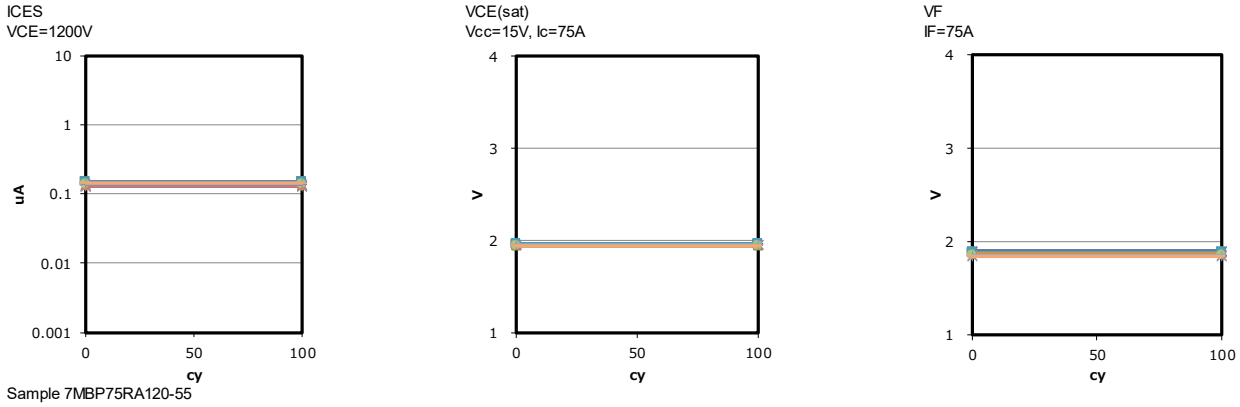


Fig.(3) Static characteristic data of P611 in the temperature cycling test(SZF, PCB : Existing)

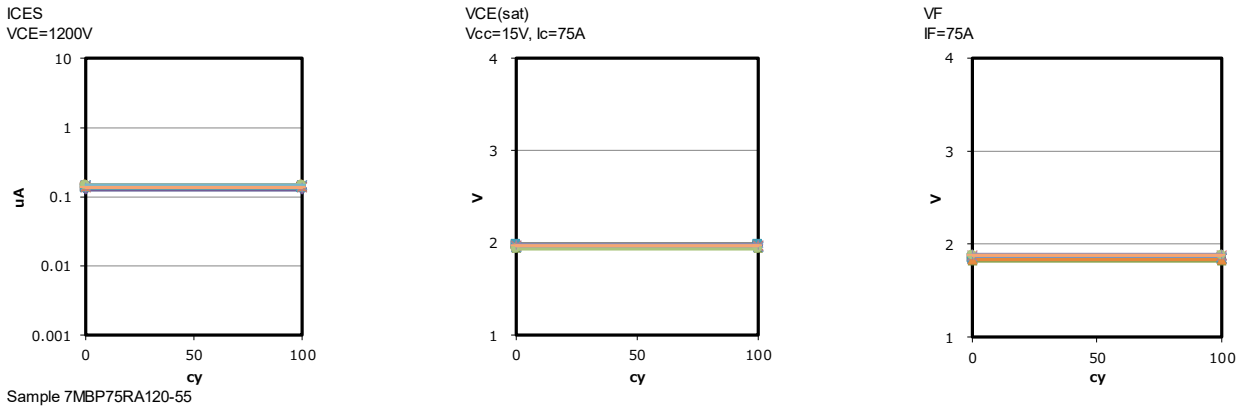
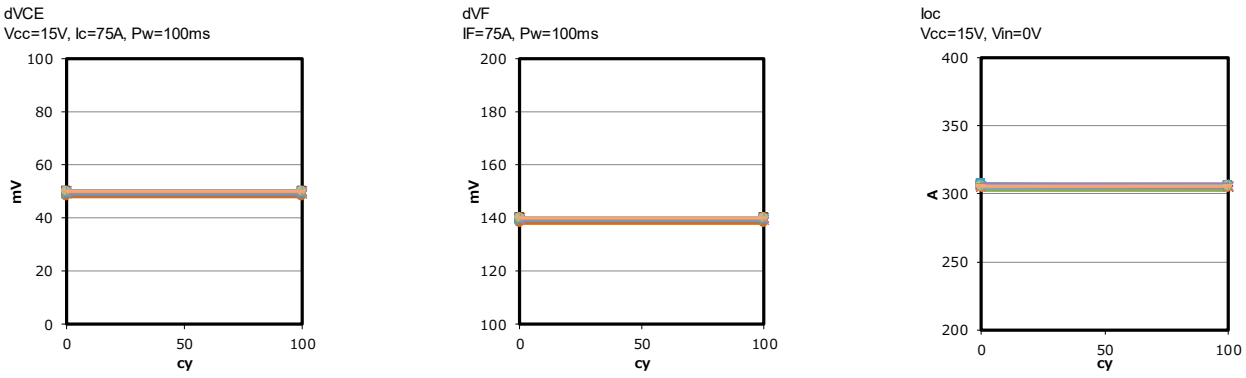
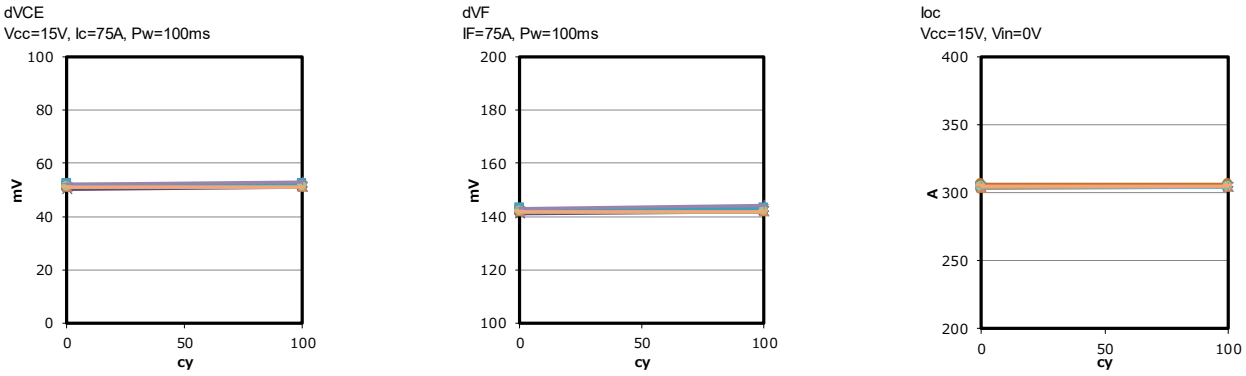


Fig.(4) Static characteristic data of P611 in the temperature cycling test(SZF, PCB : Addition)



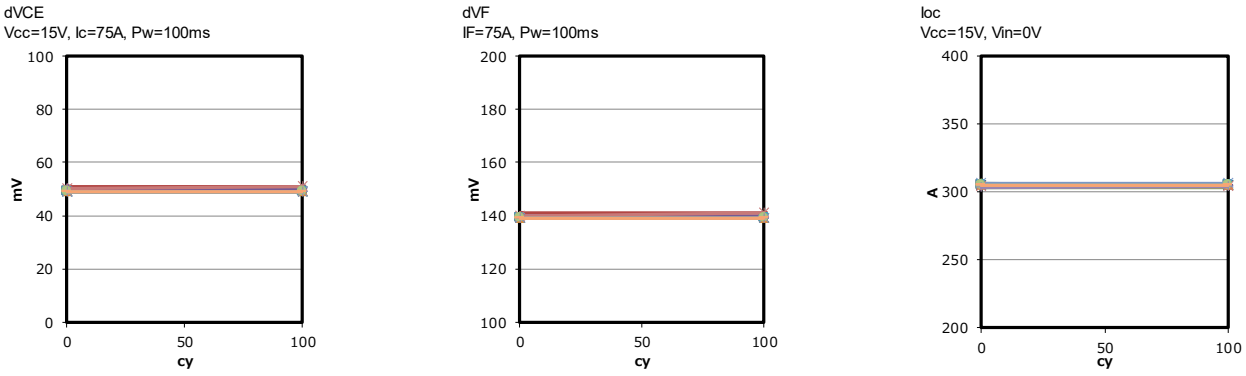
Sample 7MBP75RA120-55

Fig.(5) Static characteristic data of P611 in the temperature cycling test(Omachi, PCB : Existing)



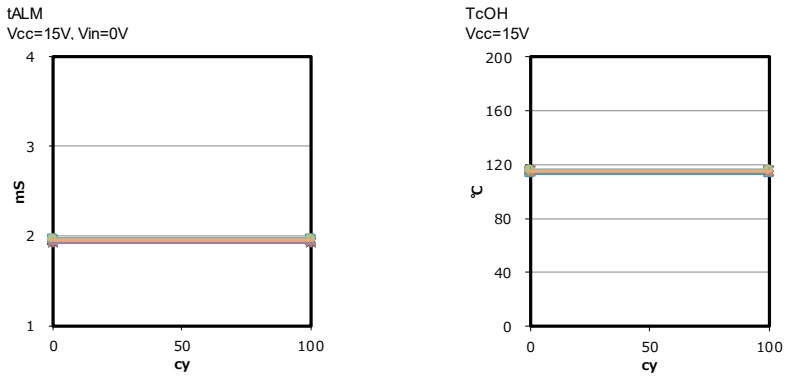
Sample 7MBP75RA120-55

Fig.(6) Static characteristic data of P611 in the temperature cycling test(SZF, PCB : Existing)



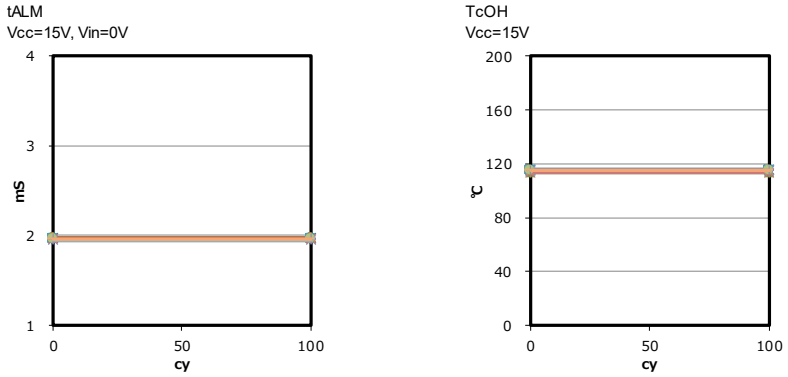
Sample 7MBP75RA120-55

Fig.(7) Static characteristic data of P611 in the temperature cycling test(SZF, PCB : Addition)



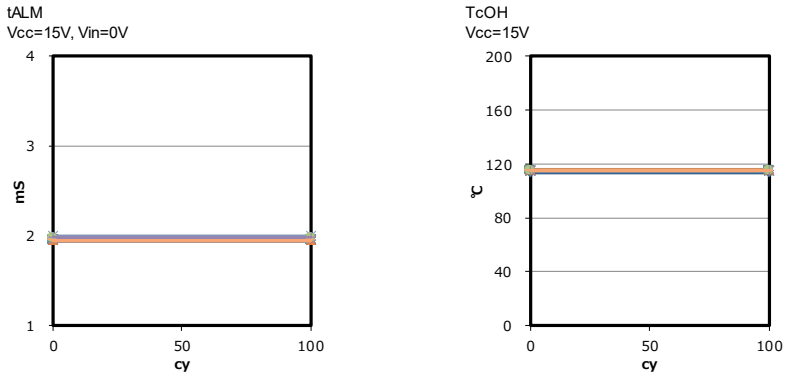
Sample 7MBP75RA120-55

Fig.(8) Static characteristic data of P611 in the temperature cycling test(Omachi, PCB : Existing)



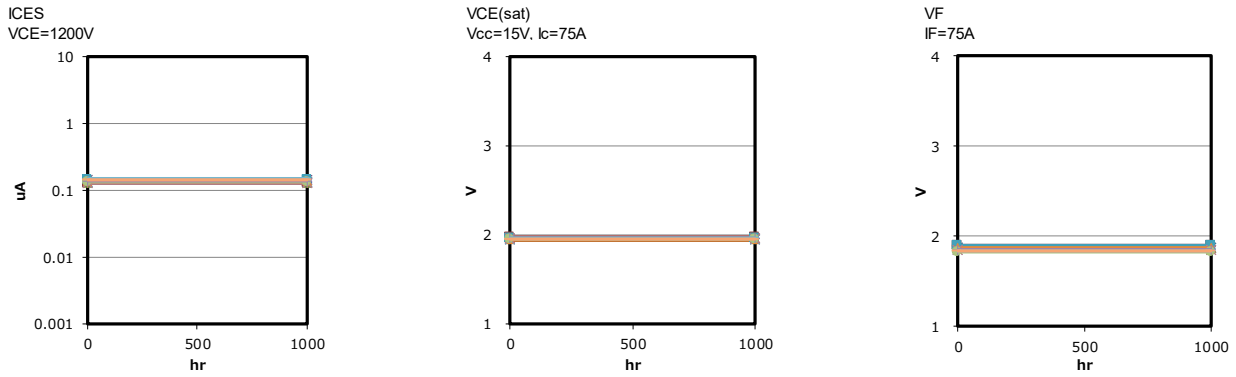
Sample 7MBP75RA120-55

Fig.(9) Static characteristic data of P611 in the temperature cycling test(SZF, PCB : Existing)



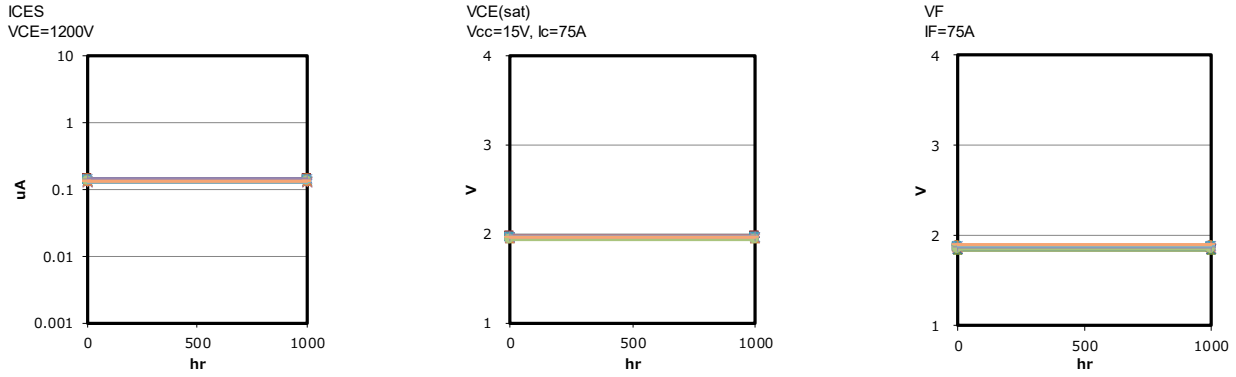
Sample 7MBP75RA120-55

Fig.(10) Static characteristic data of P611 in the temperature cycling test(SZF, PCB : Addition)



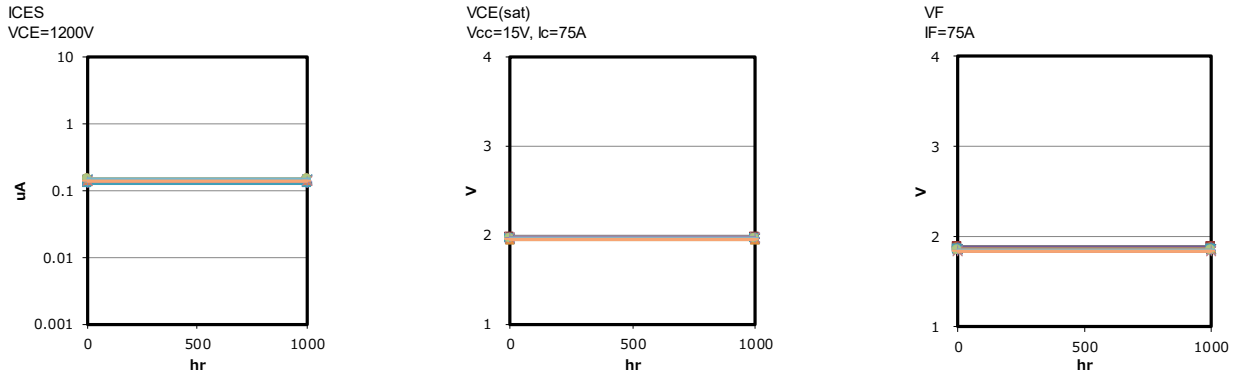
Sample 7MBP75RA120-55

Fig.(11) Static characteristic data of P611 in the high temperature reverse bias test(Omachi, PCB : Existing)



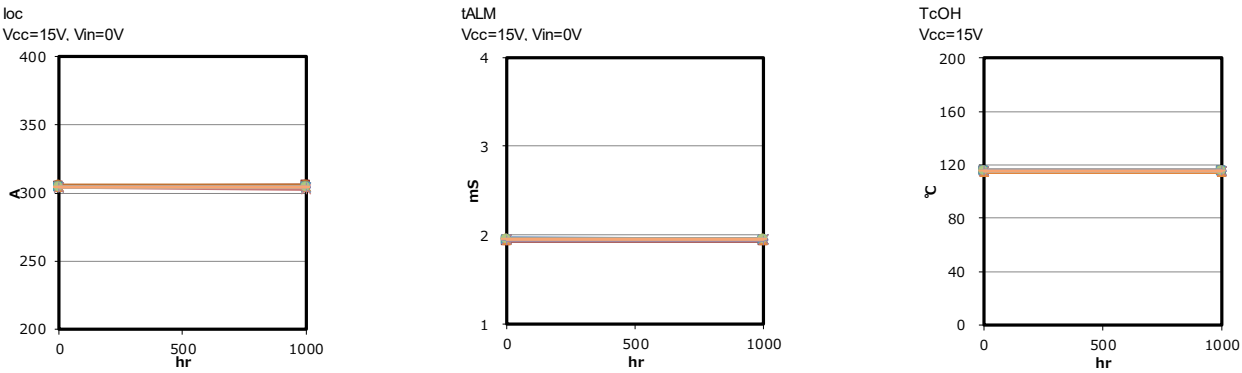
Sample 7MBP75RA120-55

Fig.(12) Static characteristic data of P611 in the high temperature reverse bias test(SZF, PCB : Existing)



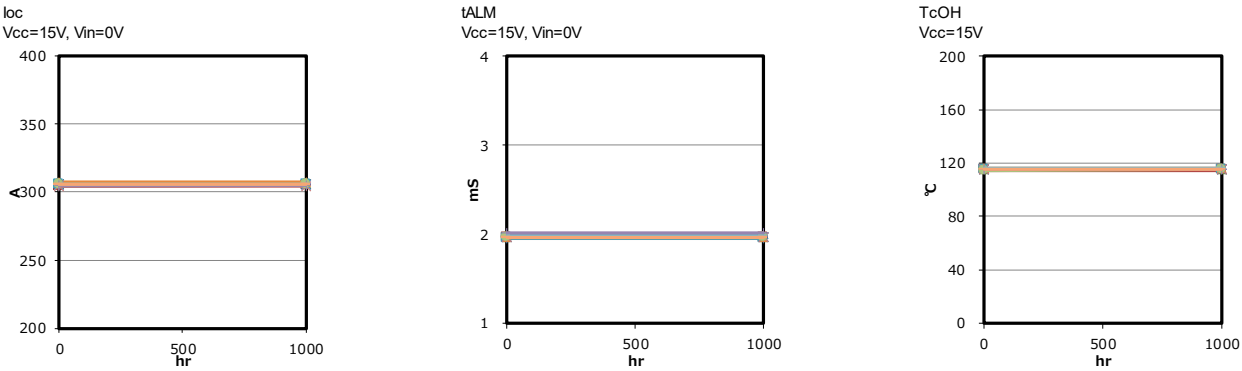
Sample 7MBP75RA120-55

Fig.(13) Static characteristic data of P611 in the high temperature reverse bias test(SZF, PCB : Addition)



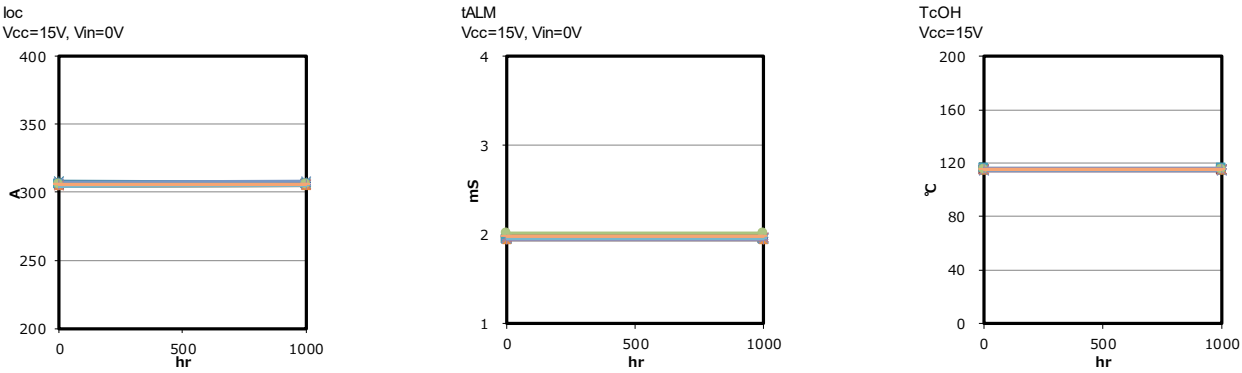
Sample 7MBP75RA120-55

Fig.(14) Static characteristic data of P611 in the high temperature reverse bias test(Omachi, PCB : Existing)



Sample 7MBP75RA120-55

Fig.(15) Static characteristic data of P611 in the high temperature reverse bias test(SZF, PCB : Existing)



Sample 7MBP75RA120-55

Fig.(16) Static characteristic data of P611 in the high temperature reverse bias test(SZF, PCB : Addition)