

3-3 Qualification test results

(1) Electrical characteristics

As comparison results of VGE(th), VCE(sat) and VF between SZF and Omachi products, no obvious difference was confirmed. Please refer to fig.(1).

(2) Solder joint analysis

The solder joint layers under the DCB substrate and the chips were observed by using scanning acoustic tomography. As results, no obvious difference was confirmed. Please refer to photo(2),(3).

(3) AL-wire bonding characteristics

As comparison results of AL-wire shape and pull force test, no obvious difference was confirmed shown as photo(4).

(4) Reliability test results

Considering the influence of assembly, two kinds of reliability tests were selected and carried out. As a result, SZF products passed all the reliability tests.

(a) Environment test : Please refer to table(2).

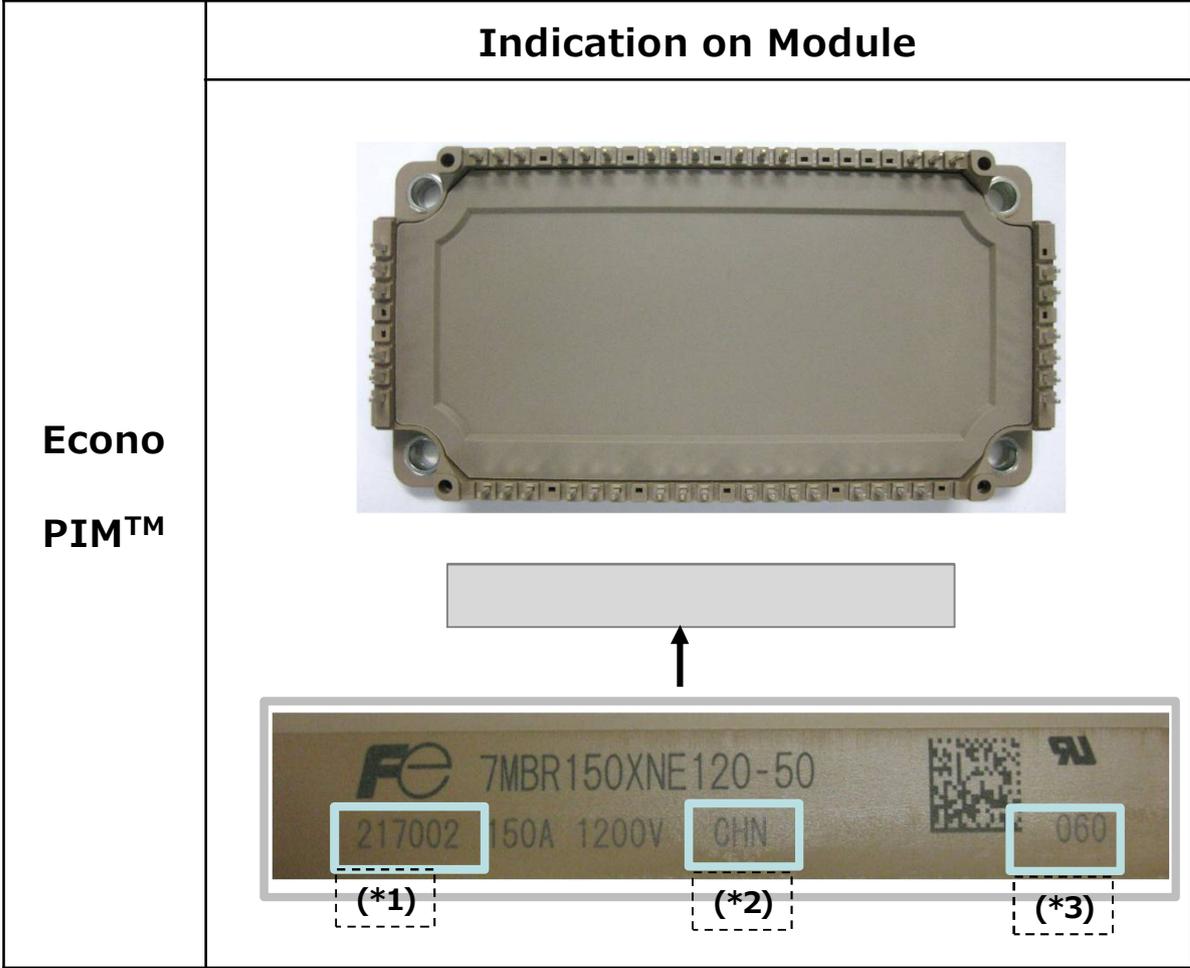
4. Products changing schedule

We would like to start these changing from October 2021.

Approval				
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(Note : EconoPIM™ is registered trademark of Infineon Technologies AG, Germany)

(*1)

	1st 2 digit	Next 1 digit	Next 3 digit
Omachi products	Last 2 digit of product year	Product month	Production LOT number
SZF products	Last 2 digit of product year	Product month	Production LOT number

(*2)

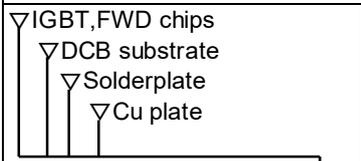
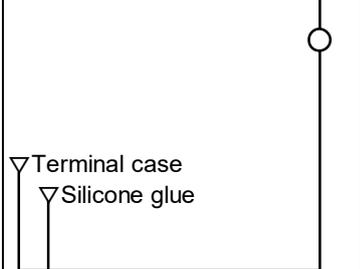
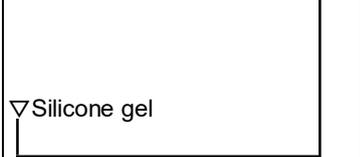
Omachi products	: JAPAN O
SZF products	: CHN

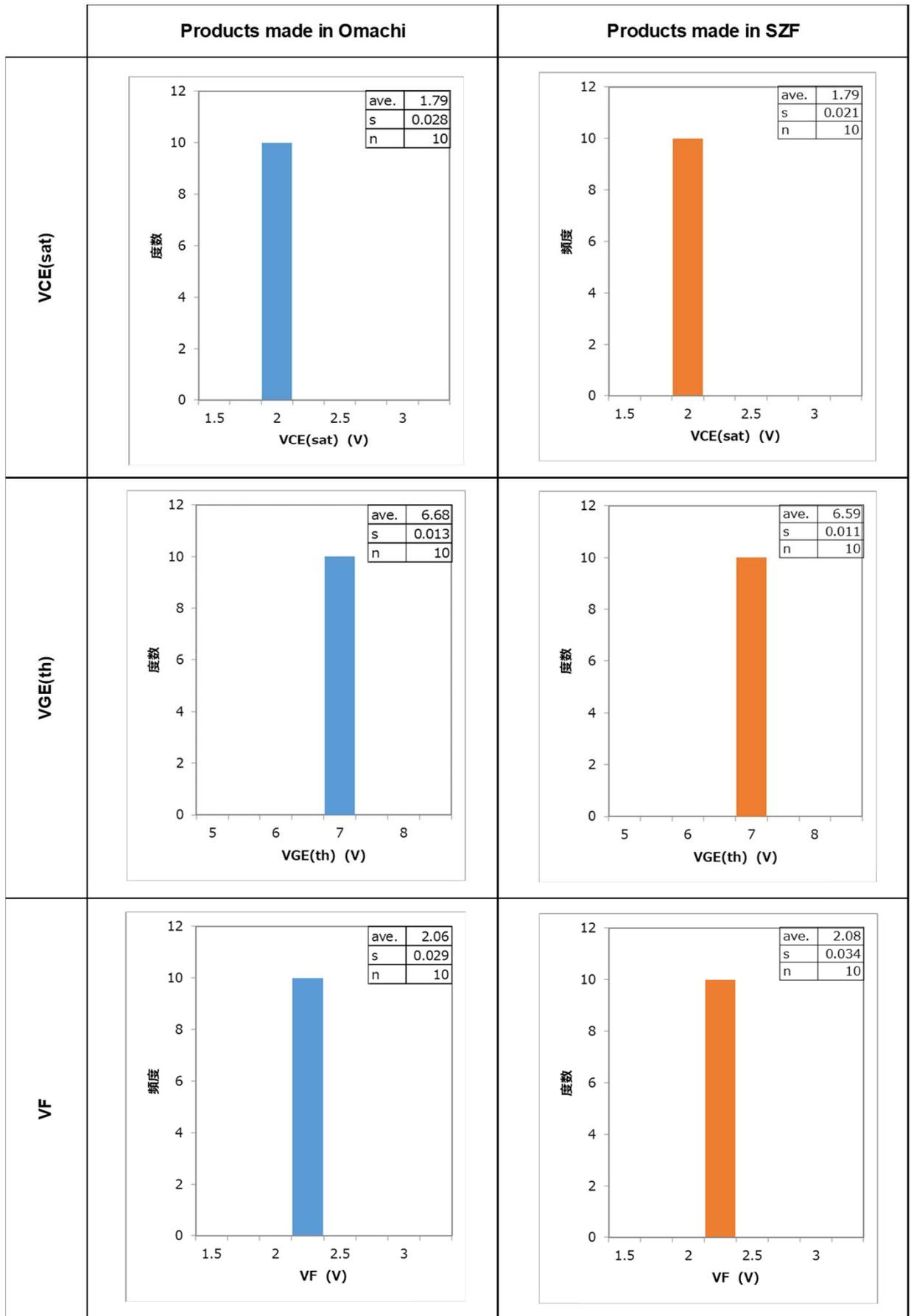
(*3)

	3 digit
Omachi products	Serial number in the production Lot
SZF products	Serial number in the production Lot

Photo(1) Indication on Module

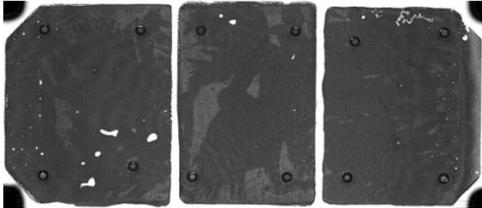
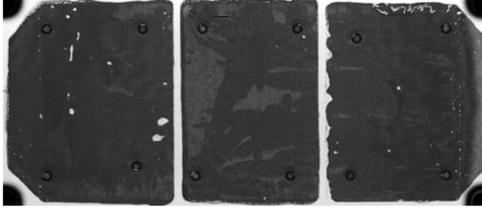
Table(1) Process comparison between Omachi and SZF

Process flow	Process name	Process condition & control limit etc	At present facilities
	Chip mounting and Soldering	Same as Omachi	Same design as Omachi
	Case gluing	Same as Omachi	Same design as Omachi
	Laser marking	Same as Omachi	Same design as Omachi
	AL-wire bonding_1	Same as Omachi	Same design as Omachi
	AL-wire bonding_2	Same as Omachi	Same design as Omachi
	Silicone gel injection and gel curing	Same as Omachi	Same design as Omachi
	Cover-lid assembly (with glue curing)	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



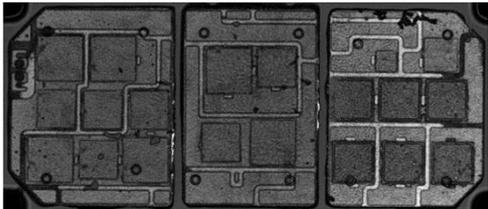
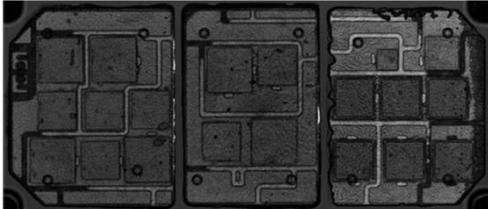
Fig(1) Comparison results of electrical characteristic

Sample 7MBR150XNE120-50

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

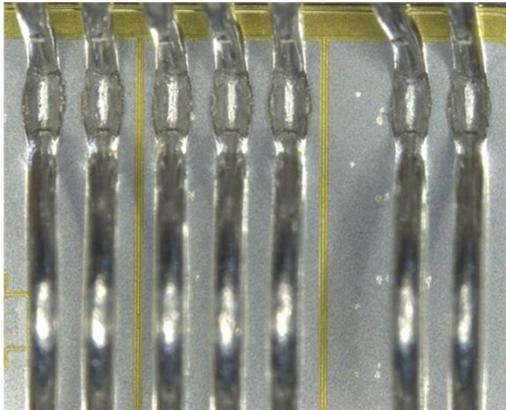
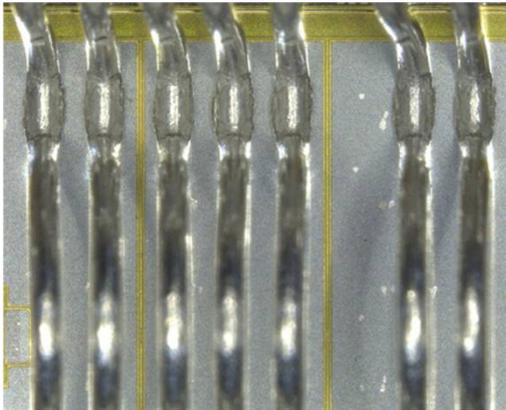
Photo(2) Comparison results of solder joint analysis(Under the DCB)

Sample 7MBR150XNE120-50

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

Photo(3) Comparison results of solder joint analysis(Under the chips)

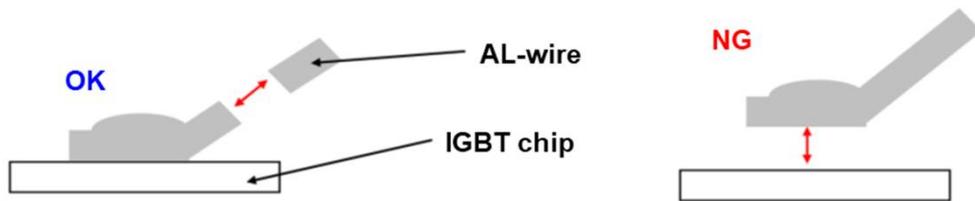
Sample : 7MBR150XNE120-50

	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	1031	C	No1	1050	C
	No2	1050	C	No2	1068	C
	No3	1048	C	No3	1050	C
	No4	1064	C	No4	1060	C
	No5	1047	C	No5	1053	C
	No6	1039	C	No6	1045	C
	No7	1069	C	No7	1035	C
	No8	1063	C	No8	1024	C
	No9	1060	C	No9	1029	C
	No10	1053	C	No10	1035	C
	Ave	1052		Ave	1044.9	
σ	11.9		σ	14.0		

(Target: Pulling strength \geq 800gf)

Photo(4) Comparison results of AL-wire bonding characteristics

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 bond joint

Table(2) Reliability test results

Test categories	Test items	Test methods and conditions	Reference norms JEITA ED-4701	Test result	
				Number of Sample	Number of failure
Environment tests	1 Temperature Cycle	Test temp. : $\left\{ \begin{array}{l} \text{Low temp. } -40 \pm 10 \text{ deg.C} \\ \text{High temp. } 125 \pm 15/-0 \text{ deg.C} \end{array} \right.$ Dwell time : High ~ Low 70min. 70min. Number of cycles : 100 cycles	Test Method 105A	5	0
	2 Temperature Humidity Bias (IGBT/FWD)	Test temp. : $85 \pm 2 \text{ deg.C}$ Relative humidity : $85 \pm 5\%$ Bias voltage : $V_{CE} = 0.8 \times V_{CES}$ Bias method : Applied DC voltage to C-E $V_{GE} = 0V$ Test duration : 1000hrs.	Test Method 102A Condition code C	5	0

Table(3) Failure Criteria

Item	Characteristic	Symbol	Failure criteria		Unit	Note	
			Lower limit	Upper limit			
Electrical characteristic	Leakage current	I_{CES}	-	USL $\times 2$	μA		
	Gate leakage current	$\pm I_{GES}$	-	USL $\times 2$	nA		
	Gate threshold voltage	$V_{GE(th)}$	LSL $\times 0.8$	USL $\times 1.2$	V		
	Saturation voltage	$V_{CE(sat)}$	-	USL $\times 1.2$	V		
	Forward voltage	V_F	-	USL $\times 1.2$	V		
	Thermal resistance	IGBT	ΔV_{CE}	-	USL $\times 1.2$	mV	
		FWD	ΔV_F	-	USL $\times 1.2$	mV	
	Isolation voltage	V_{iso}	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.