Fuji Electric
Innovating Energy Technology

Fuji IGBT Modules for Wind power system

2021.12

Device Application Technology Dept.
Sales Division
Semiconductors Business Group

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■Fuji's solutions for Wind power system

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Topology in Wind power system

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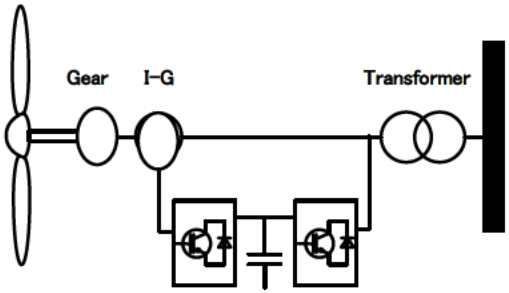
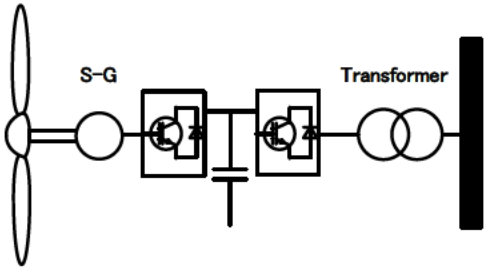
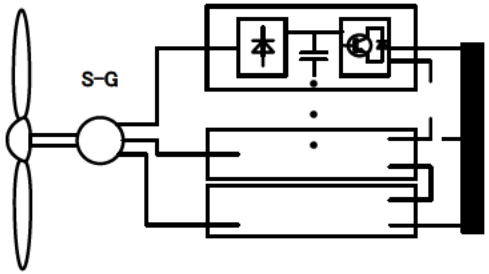
Topology	Double	Direct	Direct + Multi level
Configuration			
Efficiency	89%	90%	93%
Cost	100%	98～100%	90～95%
Quality	Low	High	High
Gear box	Need	Not need	Not need
Step up Transformer	Need	Need	Not need
Generator	Induction	Synchronous	Synchronous + Multi winding
Converter capacity	15～30%	100%	100%
IGBT	1700V/450A～1000A	1700V/1000A～3600A	3300V/150A～400A

Wind turbine systems will be changed to direct drive system from double fed drive system depend on the high efficiency and without gear box.

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Outline view of double fed Wind turbine

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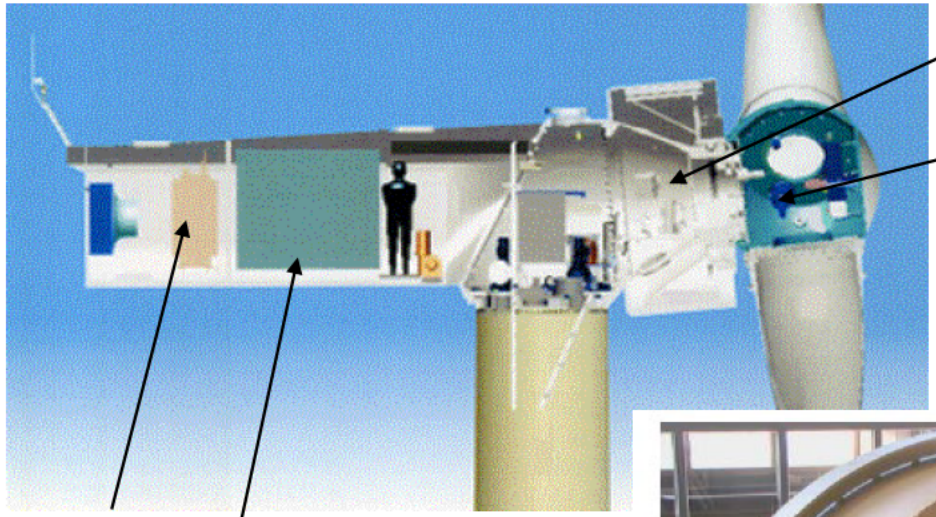


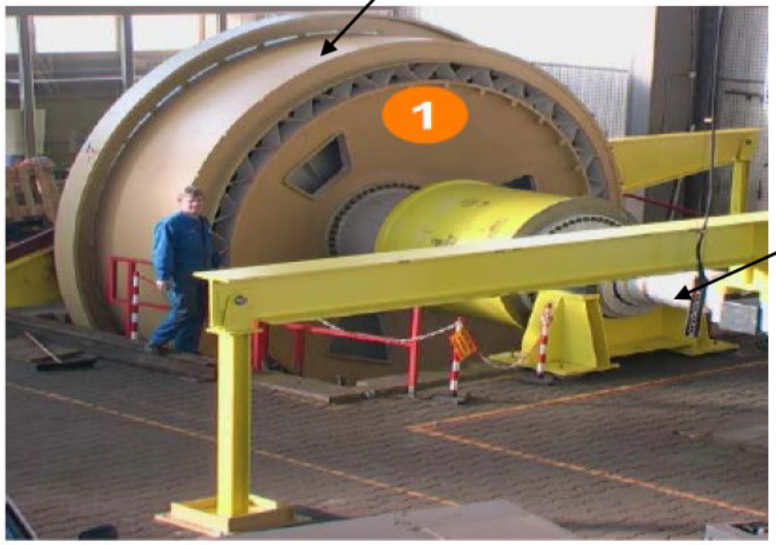
Generator

Gear box

Transformer

Converter

1.2MW Induction generator



Gear box

DC motor for controlling gear box

Double fed systems have
large gear box and large generator.

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Comparison of double fed system and direct drive system

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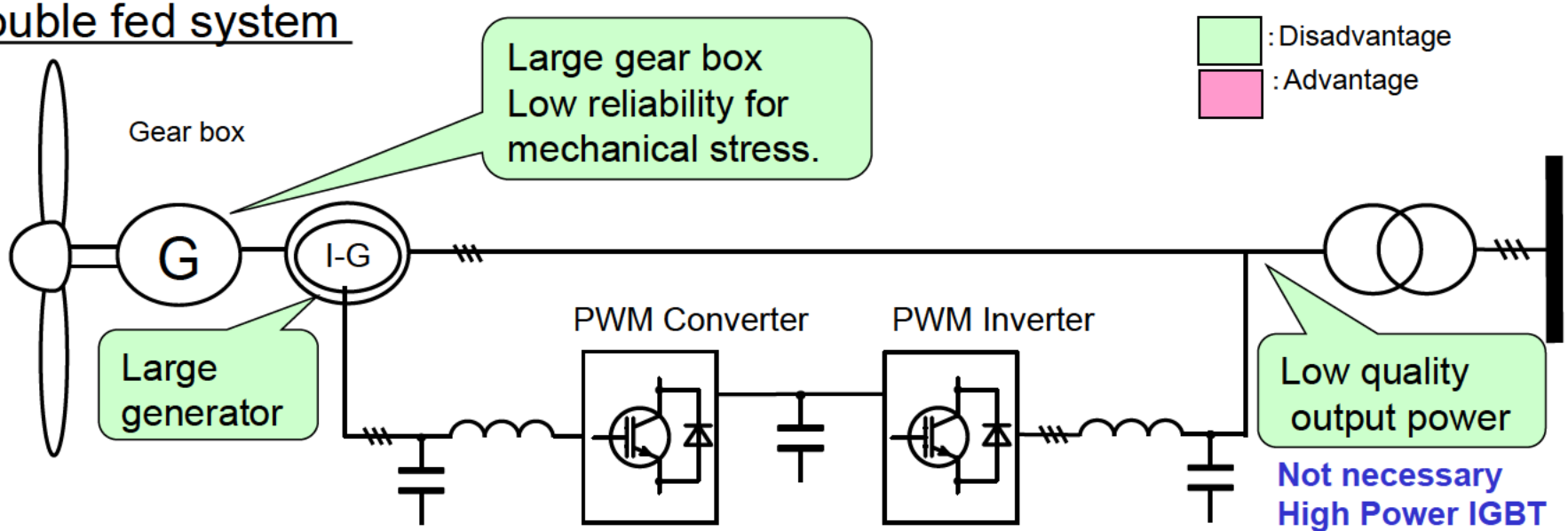
Double fed system



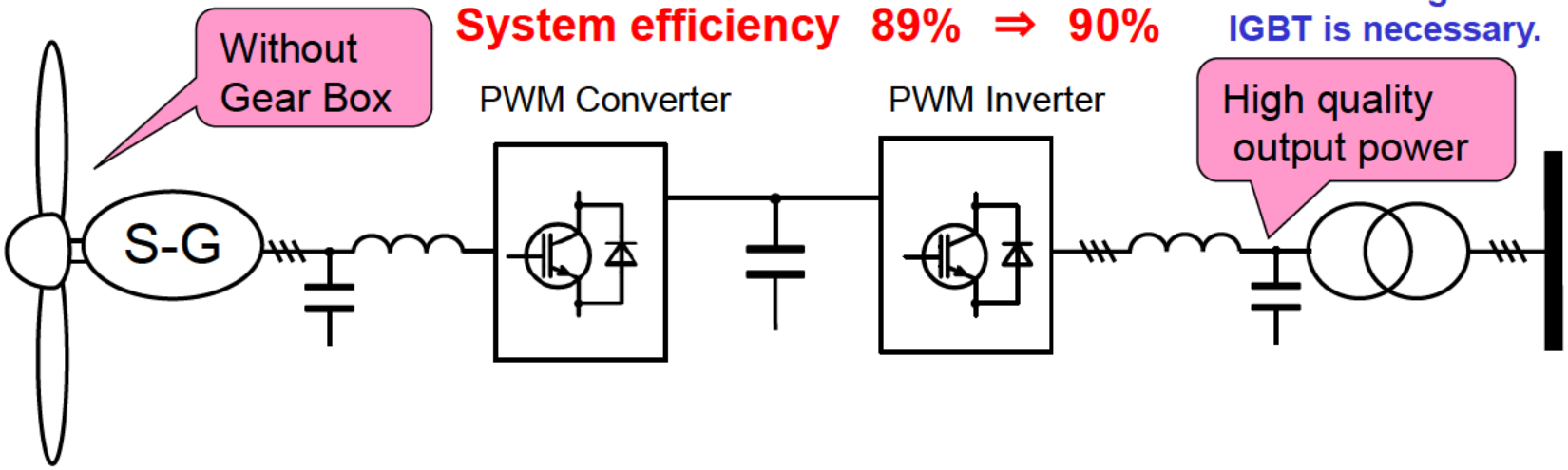
Not necessary High Power IGBT

⇓

3times rating current IGBT is necessary.

Direct drive system

System efficiency 89% ⇒ 90%



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Comparison of direct drive system and multi level system

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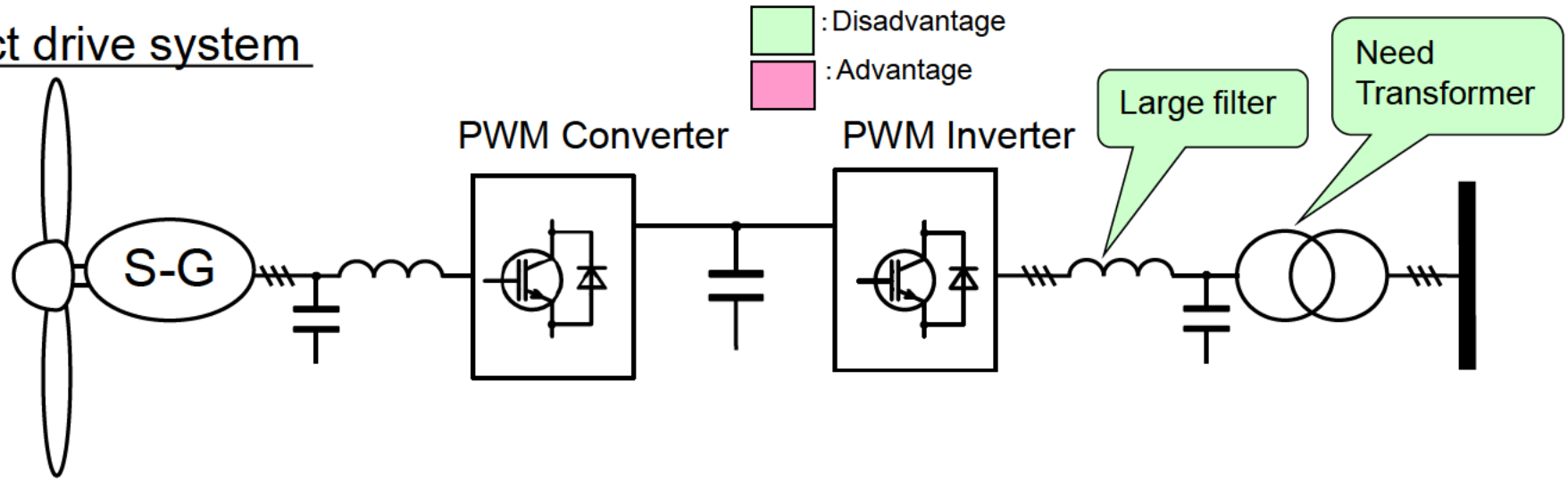
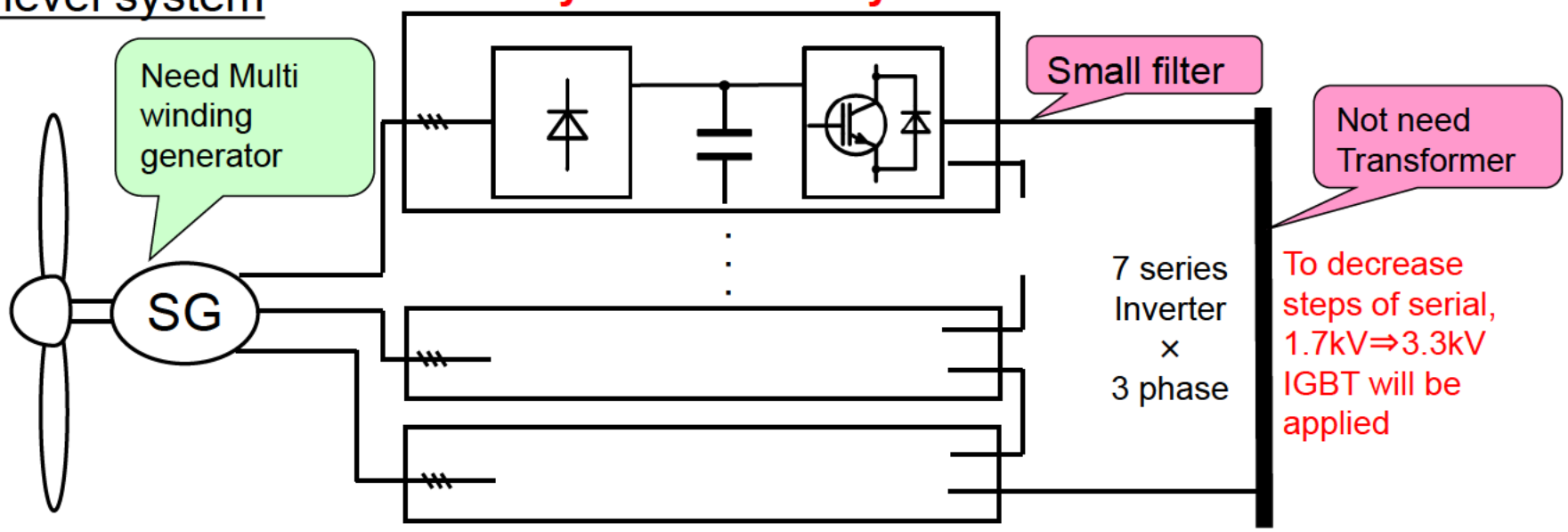
Direct drive system



Multi level system

System efficiency 90% ⇒ 93%



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Fuji IGBT modules for Wind power system

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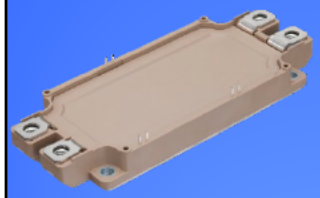
Dual XT

M254, M285
Size:150 x 62 x 17mm

M254

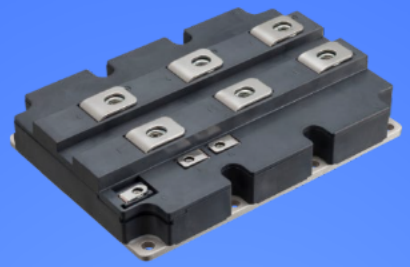


M285

HPM (1in1, 2in1, 3.3kV module)

M151, M155
Size:130 x 140 x 38mm

M152, M156
Size:190 x 140 x 38mm

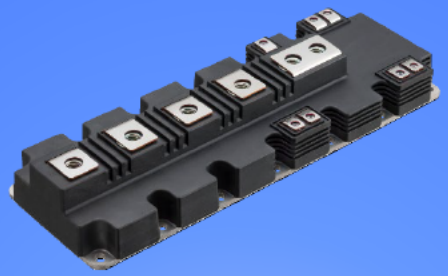


M256, M278
Size:130 x 140 x 38mm

PrimePACK™

M271
Size:172 x 89 x 38mm

M272
Size:250 x 89 x 38mm



M291
Size:250 x 89 x 38mm

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Fuji IGBT module for Wind power system - Dual XT

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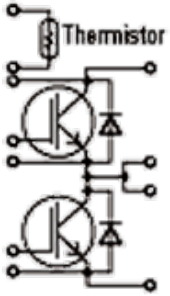
	V series		X series		Voltage	Package	Equivalent circuit
	Device type※1	Current	Device type※1	Current			
Dual XT	2MBI**VN-170-50 2MBI**VN-170-80	300A 450A 550A	2MBI**XNA170-50	225A 300A 450A	1700V	M254:150 x 62 x 17mm Solder pins 	
	–	–	2MBI600XNG170-50	600A	1700V		
	–	–	2MBI600XNE170-50	600A	1700V	M285:150 x 62 x 17mm Press fit pins 	
	2MBI**VX-170-50 2MBI**VX-170-80	225A 300A 450A 550A	2MBI**XNB170-50	225A 300A 450A	1700V	M282:150 x 62 x 17mm Press fit pins 	
	–	–	2MBI600XNH170-50	600A	1700V		
	–	–	2MBI600XNF170-50	600A	1700V	M286:150 x 62 x 17mm Press fit pins 	

※1 “**” is rated current.

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Fuji IGBT module for Wind power system - 1in1, 2in1

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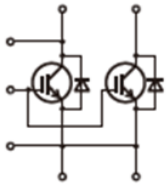
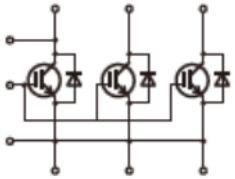
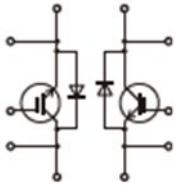
	V series				Voltage	Package	Equivalent circuit
	Cu-base plate		AlSiC-base plate				
	Device type※1	Current	Device type※1	Current			
1in1	1MBI**VC-170E	1200A 1600A 2400A	1MBI**VR-170E	1200A 1600A 2400A	1700V	M151:Cu-baseplate M155:AlSiC-baseplate 130 x 140 x 38mm 	
	1MBI**VD-170E	2400A 3600A	1MBI**VS-170E	2400A 3600A	1700V	M152:Cu-baseplate M156:AlSiC-baseplate 190 x 140 x 38mm 	

※1 “**” is rated current.

	V series				Voltage	Package	Equivalent circuit
	Cu-base plate		AlSiC-base plate				
	Device type※1	Current	Device type※1	Current			
2in1	2MBI**VG-170E	600A 800A 1200A	2MBI**VT-170E	600A 800A 1200A	1700V	M256:Cu-baseplate M278:AlSiC-baseplate 130 x 140 x 38mm 	

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Fuji IGBT module for Wind power system - 3.3kV module

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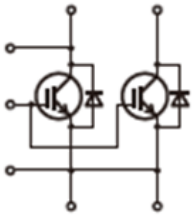
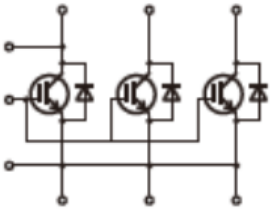
	Device type※1 (U series)	Current	Voltage	Package	Equivalent circuit
3.3kV module	1MBI**UG-330	800A 1000A	3300V	M155:AlSiC-baseplate 130 x 140 x 38mm 	
	1MBI1000UG-330B	1000A	3300V		
	1MBI**UE-330	1200A 1500A	3300V	M156:AlSiC-baseplate 190 x 140 x 38mm 	
	1MBI1500UE-330B	1500A	3300V		

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Fuji IGBT module for Wind power system - PrimePACK™

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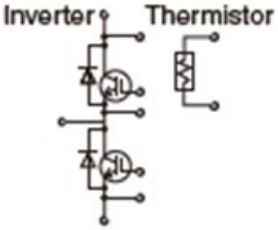
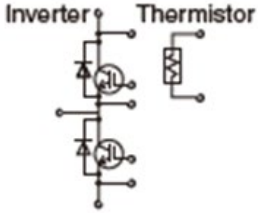
	V series				Voltage	Package	Equivalent circuit
	Low switching loss		Soft turn off				
	Device type※1	Current	Device type	Current			
PrimePACK™	2MBI650VXA-170E-50 2MBI650VXA-170E-80 2MBI650VXA-170E-54 2MBI650VXA-170EA-50 2MBI650VXA-170EA-80 2MBI650VXA-170EA-54	650A	–	–	1700V	M271:172 x 89 x 38mm	
	2MBI**VXB-170E-50 2MBI**VXB-170E-80 2MBI**VXB-170E-54	1000A 1400A	–	–	1700V	M272:250 x 89 x 38mm	
	2MBI1000VXB-170EA-50 2MBI1000VXB-170EA-80 2MBI1000VXB-170EA-54	1000A	2MBI1400VXB-170P-50 2MBI1400VXB-170P-80 2MBI1400VXB-170P-54	1400A	1700V		

※1 "**" is rated current.

	X series		Voltage	Package	Equivalent circuit
	Low switching loss				
	Device type※1	Current			
PrimePACK™	2MBI650XXA170-50	650A	1700V	M271:172 x 89 x 38mm	
	2MBI1200XXE170-50	1200A	1700V		
	2MBI**XXB170-50	1000A 1400A	1700V	M272:250 x 89 x 38mm	
	2MBI1800XXF170-50	1800A	1700V		
	2MBI1800XXG170-50	1800A	1700V	M291:250 x 89 x 38mm	

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Fuji IGBT modules for Wind power system

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■IGBT modules proposal for Double fed system

Wind Power Converter	Package	Rotor side			Grid side		
		IGBT Module		Number of Parallel	IGBT Module		Number of Parallel
		V series	X series		V series	X series	
1.5MW	Dual XT	2MBI450VN-170-50	2MBI450XNA170-50	6	2MBI450VN-170-50	2MBI450XNA170-50	3
		–	2MBI600XNG170-50	4	–	2MBI600XNG170-50	2
	PrimePACK™	2MBI1000VXB-170E-50	2MBI1000XXB170-50	3	2MBI1000VXB-170E-50	2MBI1000XXB170-50	1
		2MBI1400VXB-170P-50	2NBI1400XXB170-50	2	2MBI1400VXB-170P-50	2NBI1400XXB170-50	1
		–	2MBI1800XXF170-50	1	–	2MBI1800XXF170-50	1
		–	2MBI1800XXG170-50	1	–	2MBI1800XXG170-50	1
	HPM	1MBI1600VC-170E	–	2	1MBI1600VC-170E	–	1
2.0MW	Dual XT	2MBI450VN-170-50	2MBI450XNA170-50	8	2MBI450VN-170-50	2MBI450XNA170-50	4
		–	2MBI600XNG170-50	6	–	2MBI600XNG170-50	3
	PrimePACK™	2MBI1000VXB-170E-50	2MBI1000XXB170-50	4	2MBI1000VXB-170E-50	2MBI1000XXB170-50	2
		2MBI1400VXB-170P-50	2NBI1400XXB170-50	3	2MBI1400VXB-170P-50	2NBI1400XXB170-50	2
		–	2MBI1800XXF170-50	1	–	2MBI1800XXF170-50	1
		–	2MBI1800XXG170-50	1	–	2MBI1800XXG170-50	1
	HPM	1MBI2400VC-170E	–	2	1MBI2400VC-170E	–	1
		1MBI2400VD-170E	–	2			

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Fuji IGBT modules for Wind power system

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■IGBT modules proposal for Direct drive system

Wind Power Converter	Package	Rotor side			Grid side		
		IGBT Module		Number of Parallel	IGBT Module		Number of Parallel
		V series	X series		V series	X series	
1.5MW	PrimePACK™	2MBI1000VXB-170E-50	2MBI1000XXB170-50	3	2MBI1000VXB-170E-50	2MBI1000XXB170-50	2
		2MBI1400VXB-170E-50	2NBI1400XXB170-50	2	2MBI1400VXB-170E-50	2NBI1400XXB170-50	2
		–	2MBI1800XXF170-50	1	–	2MBI1800XXF170-50	1
		–	2MBI1800XXG170-50	1	–	2MBI1800XXG170-50	1
	HPM	1MBI1200VC-170E	–	2	1MBI1600VC-170E	–	1
		1MBI2400VC-170E	–	1	1MBI2400VC-170E	–	1
		1MBI2400VD-170E	–	1	1MBI2400VD-170E	–	1
2.0MW	PrimePACK™	2MBI1000VXB-170E-50	2MBI1000XXB170-50	3	2MBI1000VXB-170E-50	2MBI1000XXB170-50	3
		2MBI1400VXB-170E-50	2NBI1400XXB170-50	2	2MBI1400VXB-170E-50	2NBI1400XXB170-50	2
		–	2MBI1800XXF170-50	1	–	2MBI1800XXF170-50	1
		–	2MBI1800XXG170-50	1	–	2MBI1800XXG170-50	1
	HPM	1MBI2400VC-170E	–	1	1MBI1600VC-170E	–	1
		1MBI2400VD-170E	–	1			

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Introduction of GDU for Wind power system (V_{CES} = 1700V)

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Package	I_C rating (A)	IGBT part No.	Driver part No.
Dual XT	225	2MBI225XNA170-50	2DUC51008CXE1
	300	2MBI300VN-170-50	
		2MBI300XNA170-50	
	450	2MBI450VN-170-50	
		2MBI450XNA170-50	
	550	2MBI550VN-170-50	
	600	2MBI600XNG170-50	
		2MBI600XNE170-50	
PrimePACK™	650	2MBI650VXA-170E-50	2DUD51008CFP*
		2MBI650XXA170-50	
	1000	2MBI1000VXB-170E-50	
		2MBI1000XXB170-50	
	1400	2MBI1400VXB-170E-50	
		2MBI1400VXB-170P-50	
		2MBI1400XXB170-50	
	1800	2MBI1800XXF170-50	2DUD51008CFP3
		2MBI1800XXG170-50	2DUD51008DFQ1

TAMURA
https://www.tamuracorp.com/electronics/en/

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Introduction of GDU for Wind power system (V_{CES} = 1700V)

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power integrations

http://igbt-driver.com/

Package	I_C rating (A)	IGBT part No.	Driver part No.	"xx" (driver version)
Dual XT	300	2MBI300VN-170-50	2SP0115T2xx -2MBI300VN-170-50	A0, A0C, B0, B0C
	450	2MBI450VN-170-50	2SP0115T2xx -2MBI450VN-170-50	
	550	2MBI550VN-170-50	2SP0115T2xx -2MBI550VN-170-50	
PrimePACK™	650	2MBI650VXA-170E-50	2SP0320xx -2MBI650VXA-170E-50	T2A0, T2A0C, V2A0, V2A0C
	1000	2MBI1000VXB-170E-50	2SP0320xx -2MBI1000VXB-170E-50	
	1400	2MBI1400VXB-170E-50	2SP0320xx -2MBI1400VXB-170E-50	
		2MBI1400VXB-170P-50	2SP0320xx -2MBI1400VXB-170P-50	
	1800	2MBI1800XXF170-50	2SP0320xx -2MBI1800XXF170-50	

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Introduction of GDU for Wind power system (V_{CES} = 1700V)

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Package	I_C rating (A)	IGBT part No.	Driver part No.		
			Hybrid IC type	Mounted unit type	Mounted unit type with clamp circuit
Dual XT	225	2MBI225XNA170-50	VLA546, VLA551K, VLA597	VLA598-01R	VLA598-11R
	300	2MBI300VN-170-50	VLA546, VLA551K, VLA597		
		2MBI300XNA170-50	VLA546, VLA551K, VLA597		
	450	2MBI450VN-170-50	VLA574, VLA500K, VLA597		
		2MBI450XNA170-50	VLA546, VLA551K, VLA597		
	550	2MBI550VN-170-50	VLA574, VLA500K, VLA597		
	600	2MBI600XNG170-50	VLA546, VLA597		
		2MBI600XNE170-50	VLA546, VLA597		
PrimePACK™	650	2MBI650VXA-170E-50	VLA574, VLA500K, VLA591	–	–
		2MBI650XXA170-50	VLA574, VLA500K, VLA597		VLA593-11R
	1000	2MBI1000VXB-170E-50	VLA574, VLA552, VLA591		–
		2MBI1000XXB170-50	VLA574, VLA500K, VLA591		VLA593-11R
	1400	2MBI1400VXB-170E-50	VLA574, VLA552, VLA591		–
		2MBI1400VXB-170P-50	VLA574, VLA552, VLA591		–
		2MBI1400XXB170-50	VLA574, VLA500K, VLA591		VLA593-11R
	1800	2MBI1800XXF170-50	VLA574, VLA552, VLA591		VLA593-11R
		2MBI1800XXG170-50	VLA574, VLA552, VLA591		–

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http://www.idc-com.co.jp/

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Introduction of Snubber capacitors

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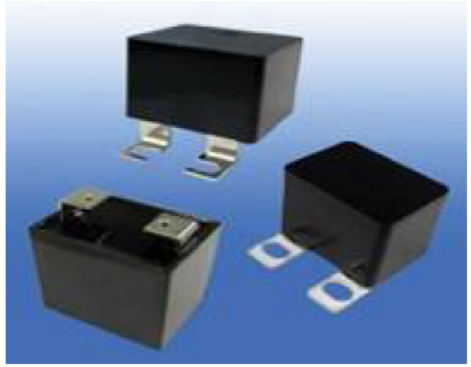
$$C_S = \frac{L * I_o^2}{(V_{CEP} - E_d)^2}$$

L: Main circuit wiring parasitic inductance
I_o: Collector current at IGBT turn-off
V_{CEP}: Snubber capacitor peak voltage
E_d: DC supply voltage



Module rating		DC line inductance	snubber capacitance
V_{CES}	I_c		
1200V/1700V	450A	0.08 μH	4.7 μF
	1000A	0.07 μH	6.8μF
	1400A	0.06 μH	12 μF
	2400A	0.046 μH	27 μF
	3600A	0.046 μH	47 μF

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