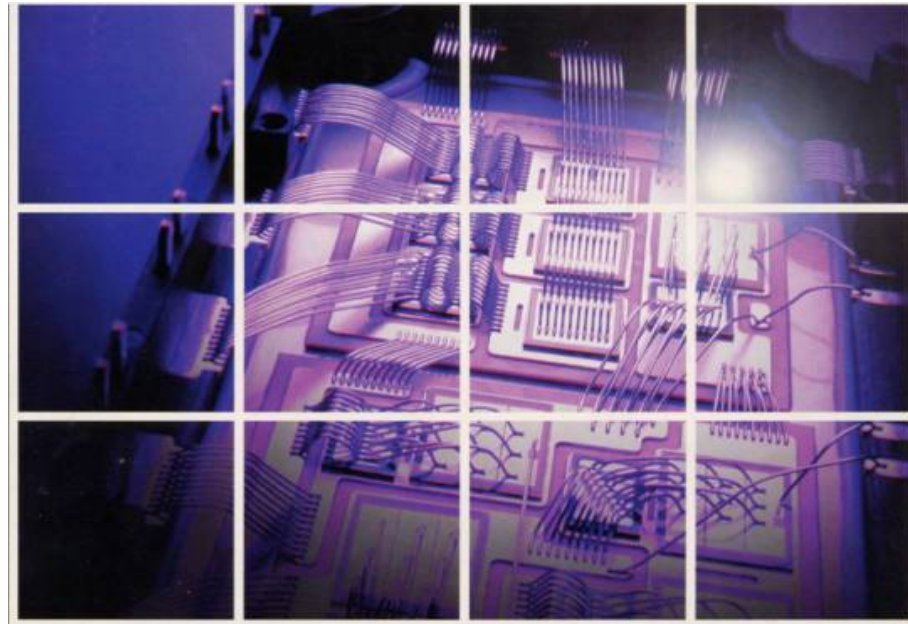


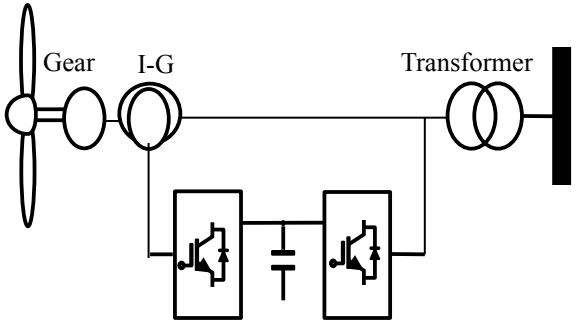
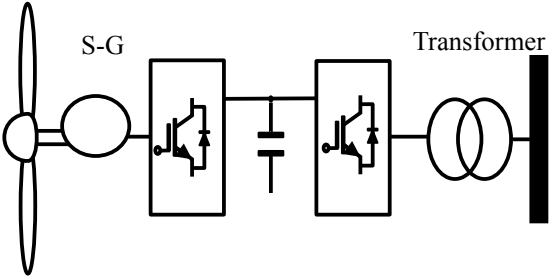
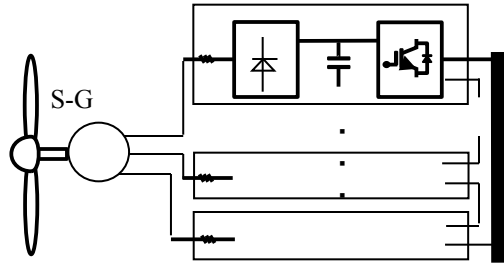
# *Fuji IGBT modules for wind power system*



Device Application Technology Dept.  
Semiconductor Sales Div.  
Global Sales Group

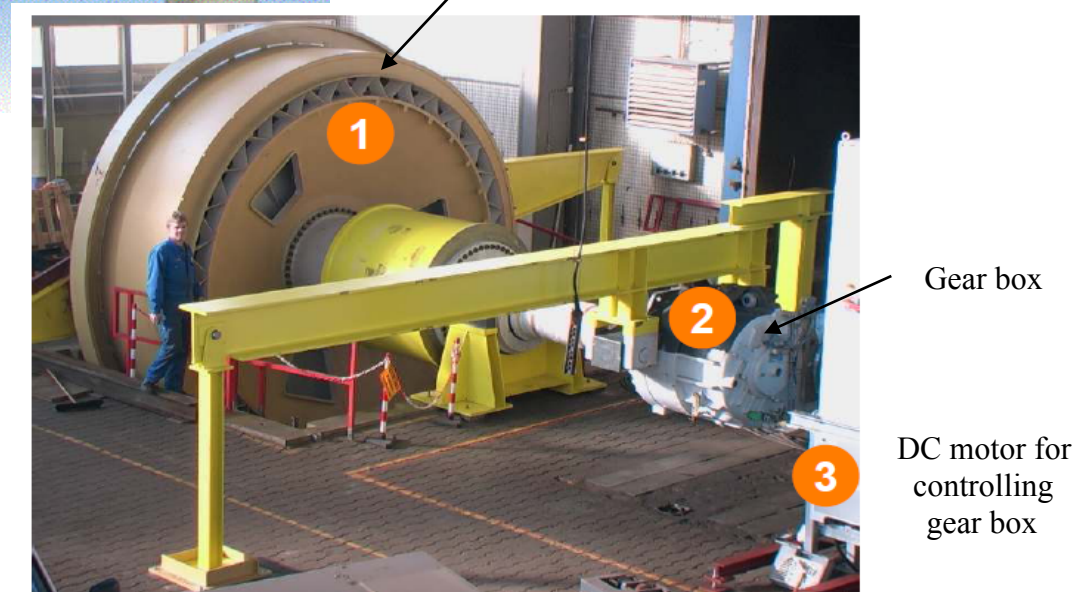
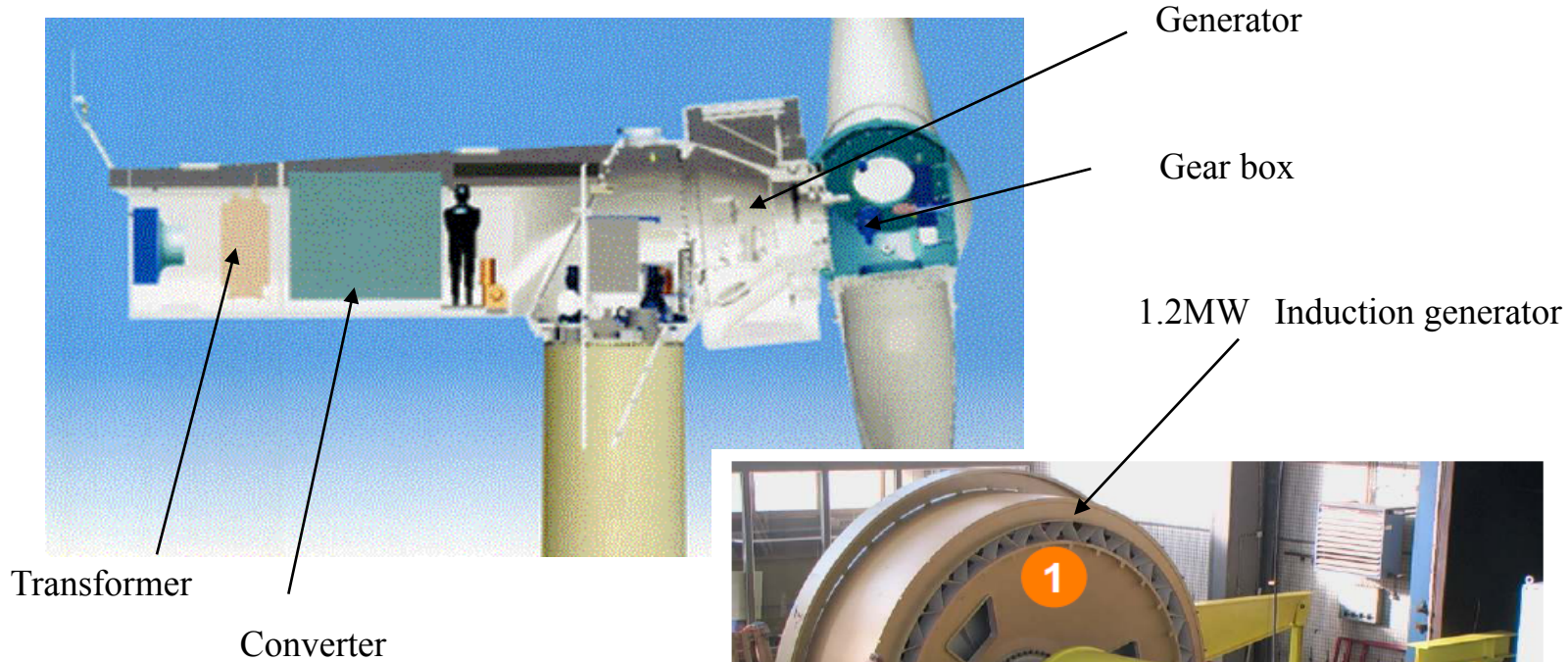
- Topology in wind power system
- Fuji IGBT modules for wind power system
- Fuji solution in Gate Driver Unit (GDU)
- Fuji solution

# Topology in wind power system

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.

# Outline view of double fed wind turbine

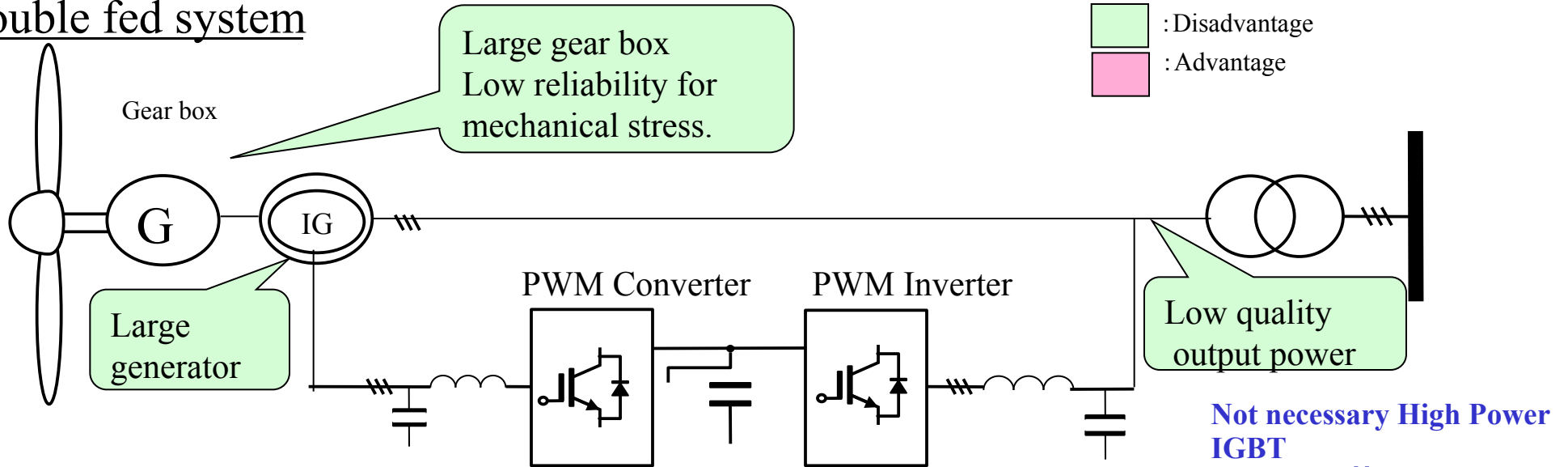


Double fed systems have large gear box and large generator.

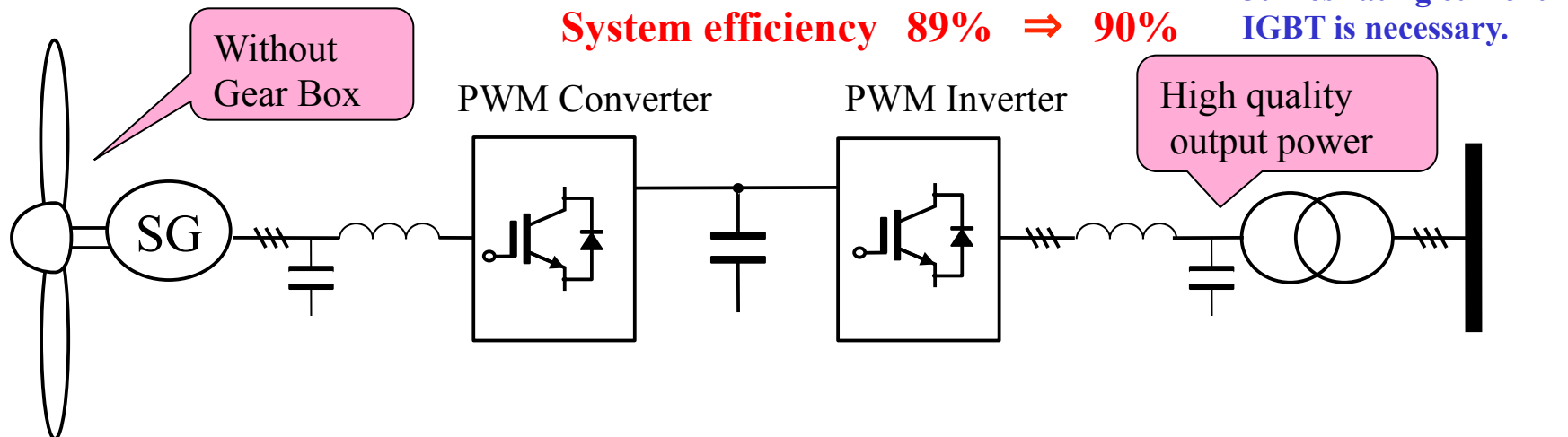
# Comparison of double fed system and direct drive system

: Disadvantage  
 : Advantage

## Double fed system



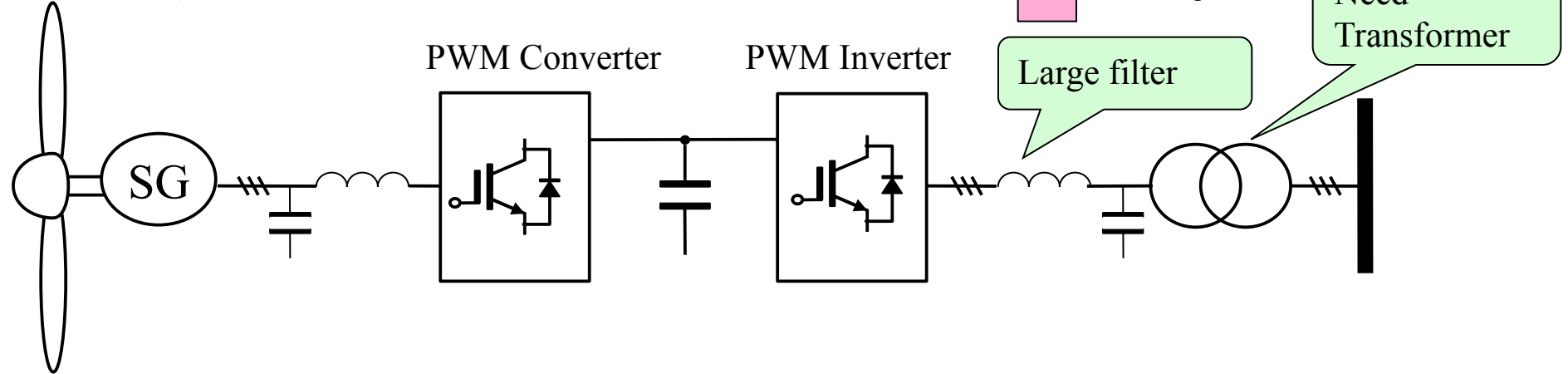
## Direct drive system



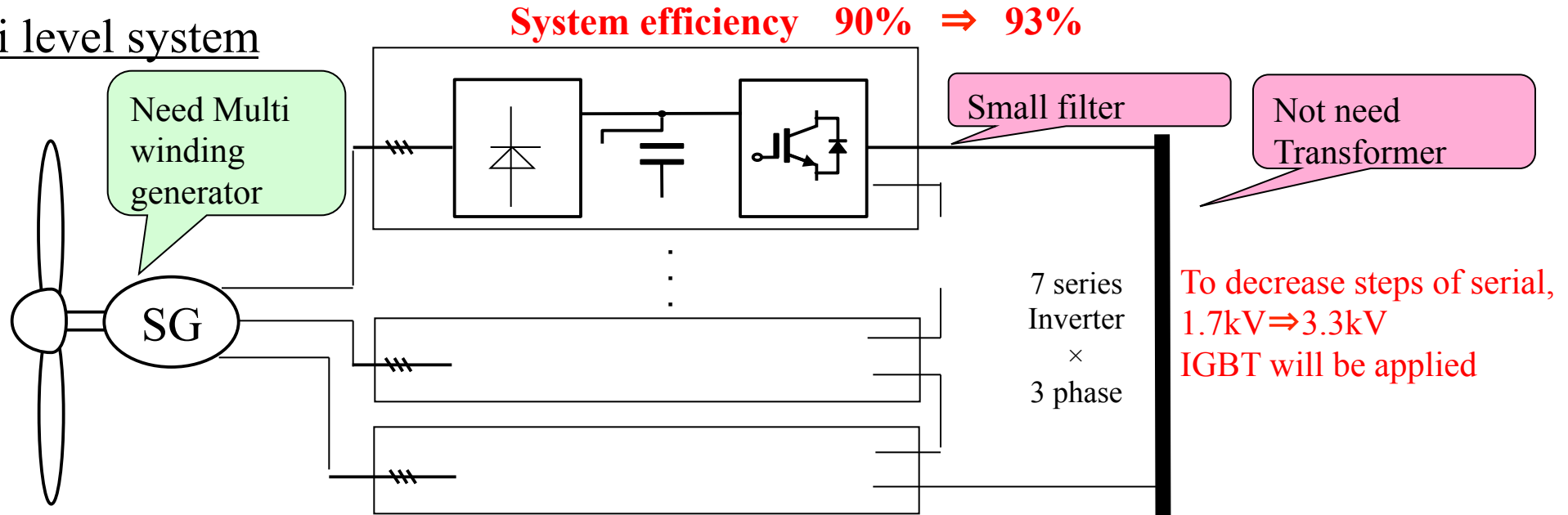
# Comparison of direct drive system and multi level system

: Disadvantage  
 : Advantage

## Direct drive system



## Multi level system



- Topology in wind power system
- **Fuji IGBT modules for wind power system**
- Fuji solution in Gate Driver Unit (GDU)
- Fuji solution



# Fuji IGBT modules for wind power system

## ■IGBT modules proposal for Double fed system

Wind Power Converter	Package	Rotor side		Grid side	
		IGBT P/N	Number of Parallel	IGBT P/N	Number of Parallel
1.5MW	Dual XT	2MBI450VN-170-50	3	2MBI450VN-170-50	3
	EconoPACK™+	6MBI450V-170-50	1	6MBI450V-170-50	1
	PrimePACK™	2MBI1000VXB-170E-50	2	2MBI1000VXB-170E-50	2
		2MBI1400VXB-170P-50	2	2MBI1400VXB-170P-50	2
	HPM	1MBI1600VC-170E	1	1MBI1600VC-170E	1
2.0MW	Dual XT	2MBI450VN-170-50	4	2MBI450VN-170-50	4
	PrimePACK™	2MBI1000VXB-170E-50	3	2MBI1000VXB-170E-50	3
		2MBI1400VXB-170P-50	2	2MBI1400VXB-170P-50	2
	HPM	1MBI2400VC-170E	1	1MBI1600VC-170E	1
		1MBI2400VD-170E	1		

Note: EconoPACK™+ and PrimePACK™ are registered trademarks of Infineon Technology AG, Germany.



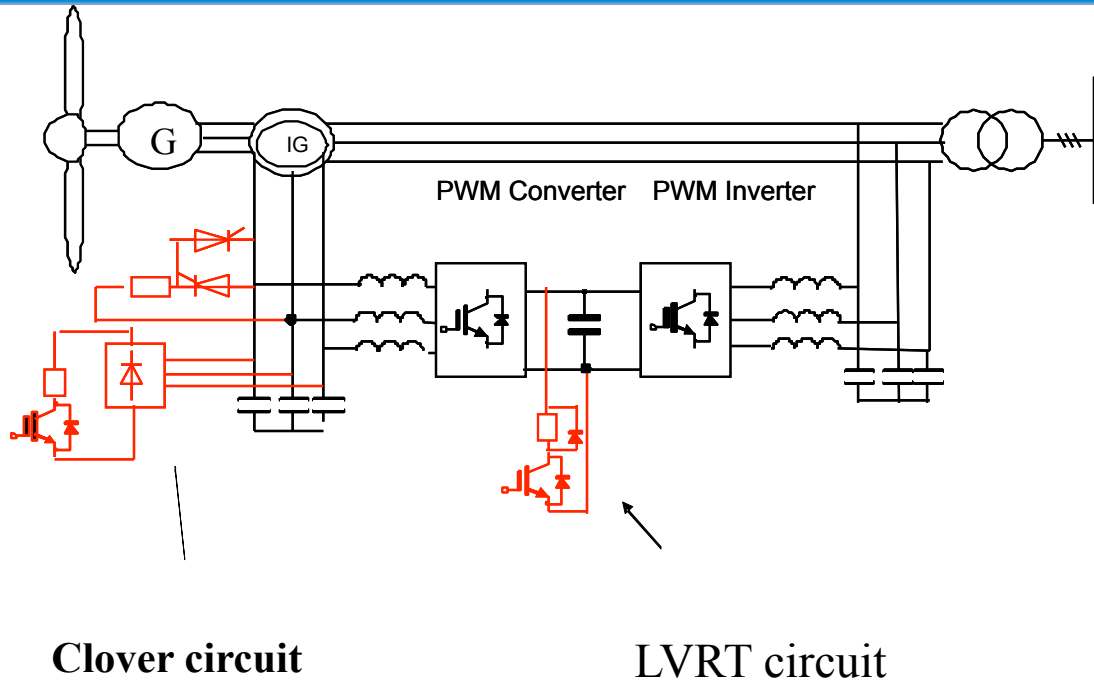
# Fuji IGBT modules for wind power system

## ■IGBT modules proposal for Direct drive system

Wind Power Converter	Package	Rotor side		Grid side	
		IGBT P/N	Number of Parallel	IGBT P/N	Number of Parallel
1.5MW	PrimePACK™	2MBI1000VXB-170E-50	3	2MBI1000VXB-170E-50	2
		2MBI1400VXB-170E-50	2	2MBI1400VXB-170E-50	2
	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	3	2MBI1000VXB-170E-50	3
		2MBI1400VXB-170E-50	2	2MBI1400VXB-170E-50	2
	HPM	1MBI2400VC-170E	1	1MBI1600VC-170E	1
		1MBI2400VD-170E	1		

Note: PrimePACK™ are registered trademarks of Infineon Technology AG, Germany.

# LVRT: Low Voltage Ride Through Circuit



## IGBT modules proposal for LVRT

	Type Name	Curret	Votage
1in1 Module	1MBI1200VC-170E	1200A	1700V
	1MBI1600VC-170E	1600A	
	1MBI2400VC-170E	1200A	
	1MBI2400VD-170E	2400A	1700V
	1MBI3600VD-170E	3600A	
2in1 Module	2MBI600VG-170E	600A	1700V
	2MBI800VG-170E	800A	
	2MBI1200VG-170E	1200A	

	Type Name	Curret	Votage
1in1 Module	1MBI1200VR-170E	1200A	1700V
	1MBI1600VR-170E	1600A	
	1MBI2400VR-170E	1200A	
	1MBI2400VS-170E	2400A	1700V
	1MBI3600VS-170E	3600A	
2in1 Module	2MBI600VT-170E	600A	1700V
	2MBI800VT-170E	800A	
	2MBI1200VT-170E	1200A	

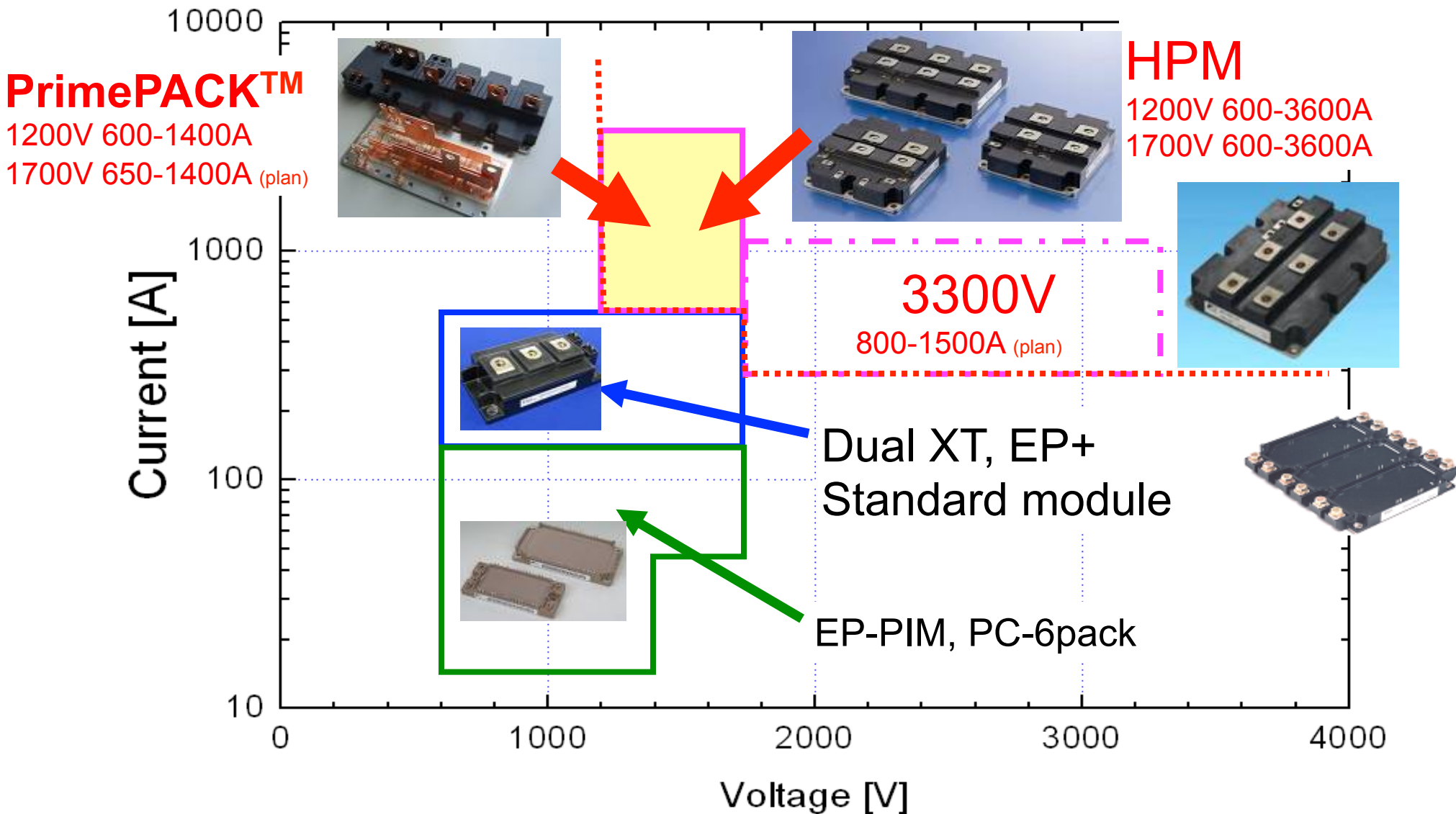
Conventional system had be used the clover circuit.

It can not be possible to supply to out put power for grid line, because DC bus voltage is zero voltage at clover circuit operating,

It can be possible to supply to out put power for grid line, because DC bus voltage is kept at LVRT circuit operating.

Therefore this system is more higher reliability system.

# Fuji IGBT modules for wind power system



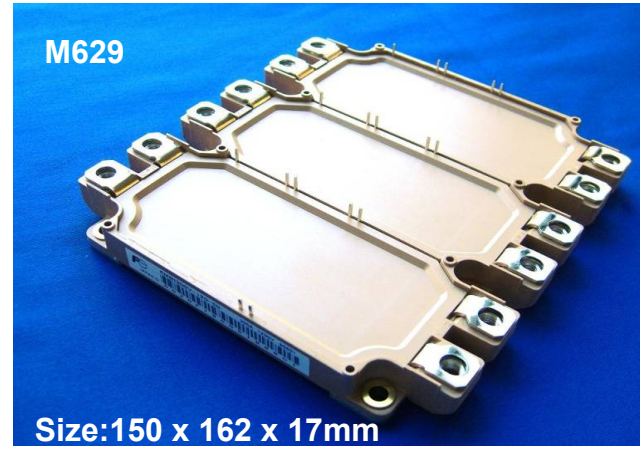
Note: PrimePACK™ are registered trademarks of Infineon Technology AG, Germany.

# Fuji IGBT modules for wind power system

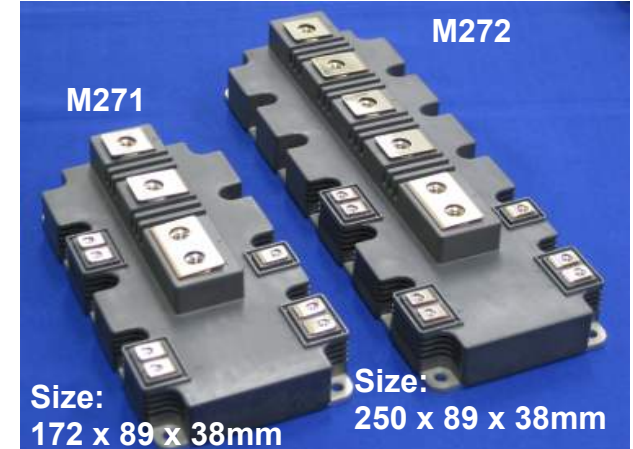
## Dual XT



## EconoPACK™+ 6in1



## PrimePACK™



## HPM 1in1 (1200~2400A)



## HPM 1in1 (2400~3600A)



## 3.3kV



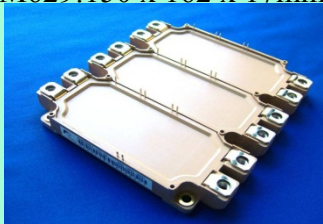
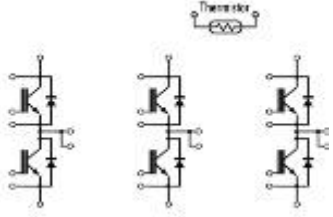

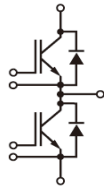

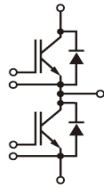
Note: EconoPACK™+ and PrimePACK™ are registered trademarks of Infineon Technology AG, Germany.

# Fuji IGBT module for wind power - EconoPACK™+, Dual XT

Note: EconoPACK™+ are registered trademarks of Infineon Technology AG, Germany.

## Feature

- ✓ Low power dissipation with V-silicon chipset
- ✓ Extra thermal design ( $T_{jmax} = 175^{\circ}\text{C}$  repetitive guarantee)
- ✓ 2 kinds of pin connection for Dual XT (Solder/Spring)


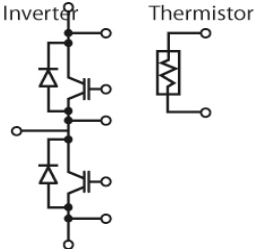

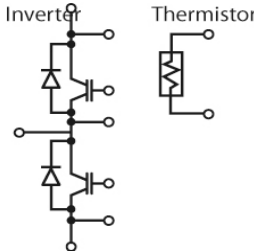
	IGBT P/N	Current	Voltage	Package	Equivalent circuit	Base plate	Isolation
EconoPACK™+	6MBI300V-170-50	300A	1700V	M629:150 x 162 x 17mm 		Copper (Cu)	$\text{Al}_3\text{O}_2$ Viso=4.0kV/60s
	6MBI450V-170-50	450A	1700V				
Dual XT	2MBI300VN-170-50	300A	1700V	M254:150 x 62 x 17mm  <b>Solder pin type</b>		Copper (Cu)	$\text{Al}_3\text{O}_2$ Viso=4.0kV/60s
	2MBI450VN-170-50	450A	1700V				
	2MBI550VN-170-50	550A	1700V				
	2MBI550VJ-170-50	550A	1700V	M260:150 x 62 x 17mm  <b>Spring type</b>			



# Fuji IGBT module for wind power system - PrimePACK™

## Feature

- ✓ Low power dissipation with V-silicon chipset
- ✓ Extra thermal design ( $T_{jmax}=175^{\circ}\text{C}$  repetitive guarantee)
- ✓ Low inductance and good current balance package
- ✓ Long-term reliability (CTI > 600, High  $T_c$  capability)


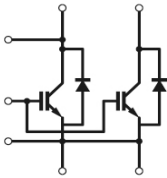

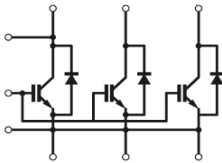
	IGBT part No.	Current	Voltage	Package	Equivalent circuit	Base plate	Isolation
PrimePACK™	2MBI650VXA-170E-50	650A	1700V	M271:172 x 89 x 38mm 		Copper (Cu)	$\text{Al}_3\text{O}_2$ Viso=4.0kV/60s
	2MBI1000VXB-170E-50	1000A	1700V	M272:250 x 89 x 38mm 		Copper (Cu)	$\text{Al}_3\text{O}_2$ Viso=4.0kV/60s
	2MBI1400VXB-170E-50	1400A	1700V				
	2MBI1400VXB-170P-50	1400A	1700V				

Note: PrimePACK™ are registered trademarks of Infineon Technology AG, Germany.

# Fuji IGBT module for wind power system - HPM(1in1)

## Feature

- ✓ Low power dissipation with V-silicon chipset
- ✓ Extra thermal design ( $T_{jmax}=175^{\circ}\text{C}$ ), SiN-DCB
- ✓ Low inductance and good current balance package
- ✓ Long-term reliability (CTI > 600, High  $T_c$  capability)
- ✓ 1700V-3600A max rating


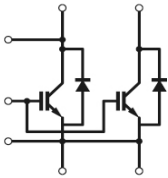

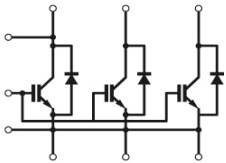
	IGBT part No.	Current	Voltage	Package	Equivalent circuit	Base plate	Isolation
1in1	1MBI1200VC-170E	1200A	1700V	M151:130 x 140 x 38mm 		Copper (Cu)	$\text{Si}_3\text{N}_4$ Viso=4.0kV/60s
	1MBI1600VC-170E	1600A	1700V				
	1MBI2400VC-170E	2400A	1700V				
1in1	1MBI2400VD-170E	2400A	1700V	M152:190 x 140 x 38mm 		Copper (Cu)	$\text{Si}_3\text{N}_4$ Viso=4.0kV/60s
	1MBI3600VD-170E	3600A	1700V				



# Fuji IGBT module for wind power system - HPM(1in1)

## Feature

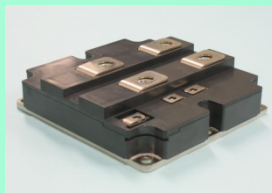
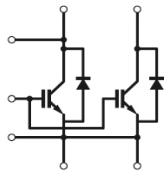
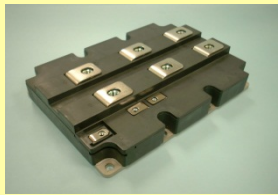
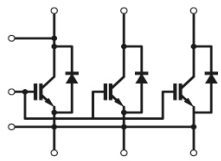
- ✓ Low power dissipation with V-silicon chipset
- ✓ Extra thermal design ( $T_{jmax}=175^{\circ}\text{C}$ ), AlSiC base plate
- ✓ Low inductance and good current balance package
- ✓ Long-term reliability (CTI > 600, High Tc capability)
- ✓ 1700V-3600A max rating

	IGBT part No.	Current	Voltage	Package	Equivalent circuit	Base plate	Isolation
1in1	1MBI1200VR-170E	1200A	1700V	M155:130 x 140 x 38mm 		AlSiC	AlN Viso=4.0kV/60s
	1MBI1600VR-170E	1600A	1700V				
	1MBI2400VR-170E	2400A	1700V				
	1MBI2400VS-170E	2400A	1700V	M156:190 x 140 x 38mm 		AlSiC	AlN Viso=4.0kV/60s
	1MBI3600VS-170E	3600A	1700V				

# Fuji IGBT module for wind power system - 3.3kV module

## Feature

- ✓ Trench gate structure for reducing  $V_{ce(sat)}$
- ✓ FS (field-stop) structure for fast switching and low  $V_{ce(sat)}$
- ✓ High ruggedness even at  $T_j = 150^{\circ}\text{C}$  operation
- ✓ High tracking (CTI > 600) special resin for high  $V_{iso}$  guarantee
- ✓ High thermal cycling life time with AlSiC base plate

	IGBT part No.	Current	Voltage	Package	Equivalent circuit	Base plate	Isolation
1in1	1MBI800UG-330	800A	3300V	M155:130 x 140 x 38mm 		AlSiC	AlN $V_{iso}=6.0\text{kV}/60\text{s}$
	1MBI1000UG-330	1000A	3300V				
	1MBI1200UE-330	1200A	3300V	M156:190 x 140 x 38mm 		AlSiC	AlN $V_{iso}=6.0\text{kV}/60\text{s}$
	1MBI1500UE-330	1500A	3300V				

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- Topology in wind power system
- Fuji IGBT modules for wind power system
- **Fuji solution in Gate Driver Unit (GDU)**
- Fuji solution

# Fuji solution in GDU

	IC rating	IGBT P/N (example)	Driver type (example)	Driver type (example)
Dual XT	300A	2MBI300VN-170-50	2SP0115T2Ax-17	VLA546**
	450A	2MBI450VN-170-50	2SP0115T2Ax-17	VLA500K
	550A	2MBI550VN-170-50	2SP0115T2Ax-17	VLA500K
EP+	300A	6MBI300V-170-50		
	450A	6MBI450V-170-50		
PrimePACK™	650A	2MBI650VXA-170E-50	2SP0320x2Ax-2MBI650VXA-170E-50	VLA500K
	1000A	2MBI1000VXB-170E-50	2SP0320x2Ax-2MBI1000VXB-170E-50	VLA539
	1400A	2MBI1400VXB-170E-50	2SP0320x2Ax-2MBI1400VXB-170E-50	VLA539
	1400A	2MBI1400VXB-170P-50	2SP0320x2Ax-2MBI1400VXB-170P-50	VLA539
HPM	1200A	1MBI1200VC-170E		VLA539
	1600A	1MBI1600VC-170E		VLA539
	2400A	1MBI2400VC-170E		
	2400A	1MBI2400VD-170E		
	3600A	1MBI3600VD-170E		
3.3kV	800A	1MBI800UG-330		
	1000A	1MBI1000UG-330		
	1200A	1MBI1200UE-330		
	1500A	1MBI1500UE-330		

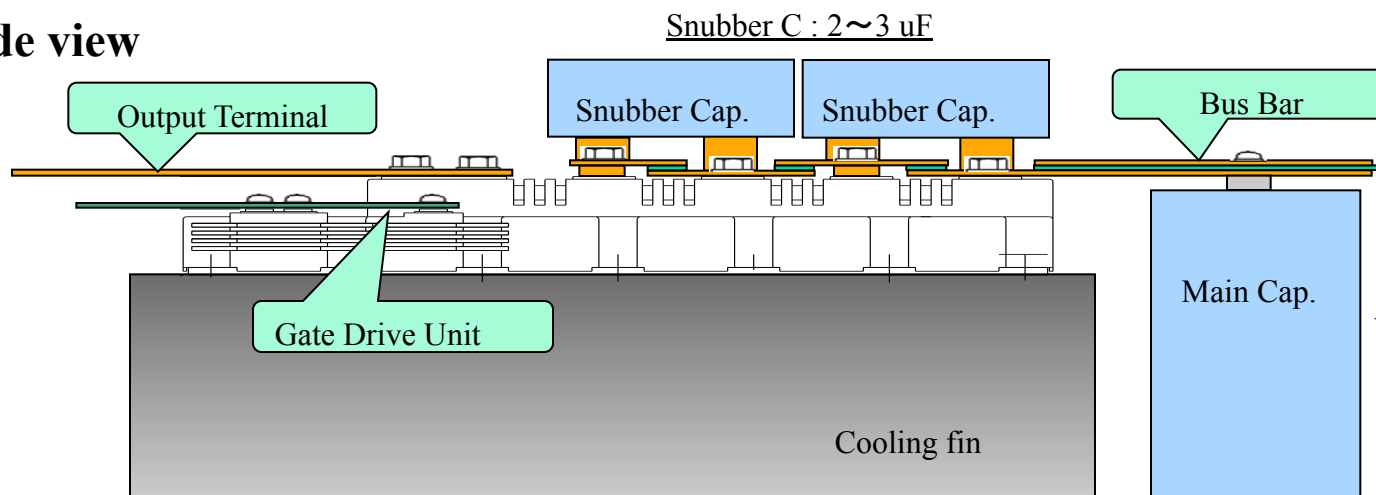
Note: PrimePACK™ are registered trademarks of Infineon Technology AG, Germany.

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- Topology in wind power system
- Fuji IGBT modules for wind power system
- Fuji solution in Gate Driver Unit (GDU)
- **Fuji solution**

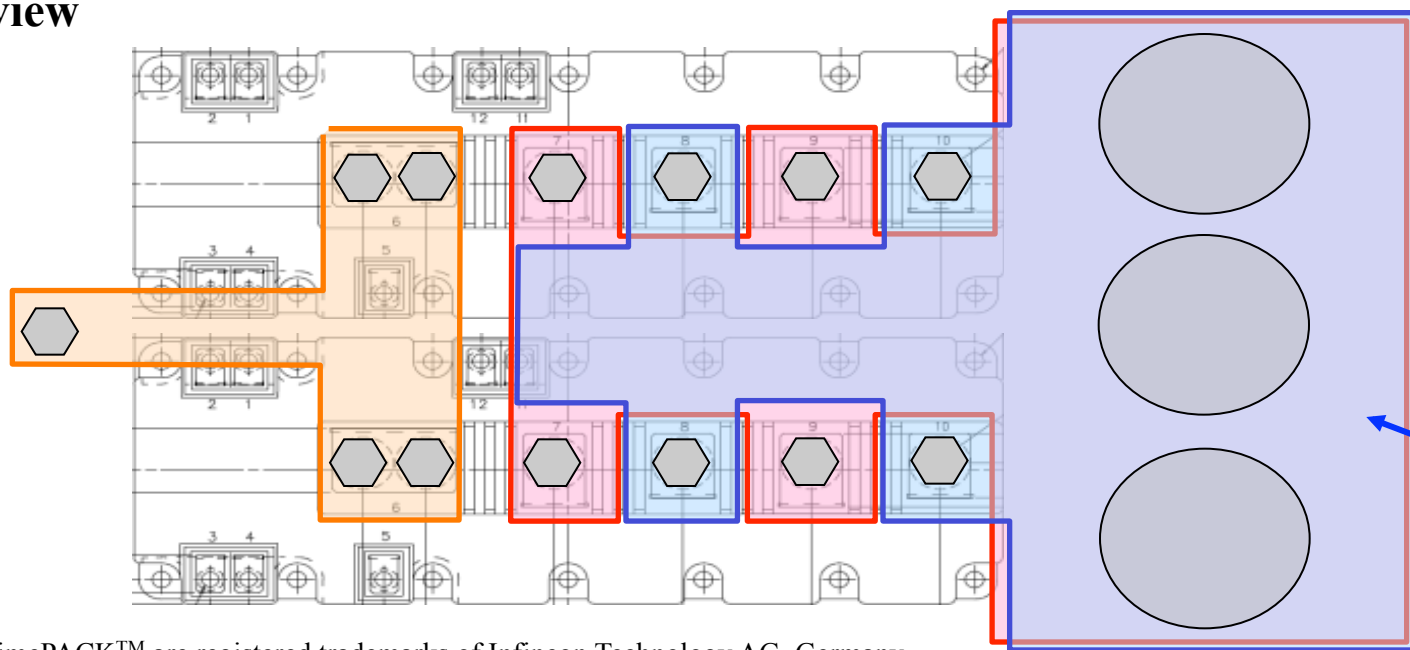
# Fuji solution – PrimePACK™ 2 parallel

## Side view



**PrimePACK™ can easily construct inverter circuit . This figure shows the example.**

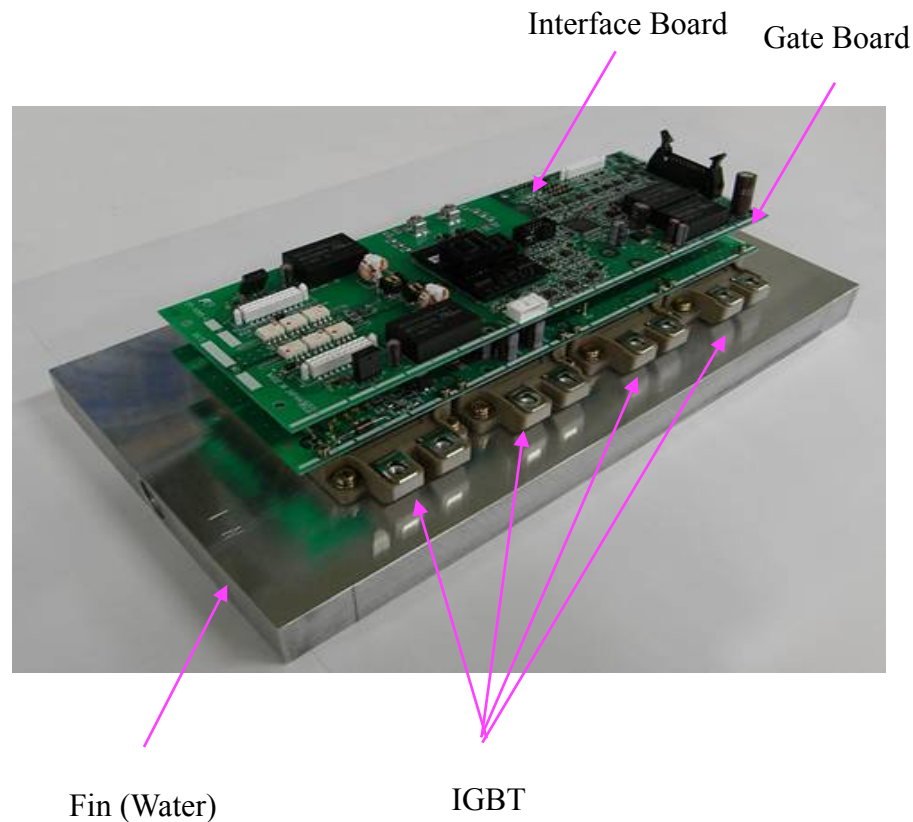
## Top view



**Laminate bus bar to realize low leakage inductance.**

Note: PrimePACK™ are registered trademarks of Infineon Technology AG, Germany.

# Fuji solution – Dual XT 4 parallel



**2MBI450VN-170-50 4P**



# Snubber capacitors

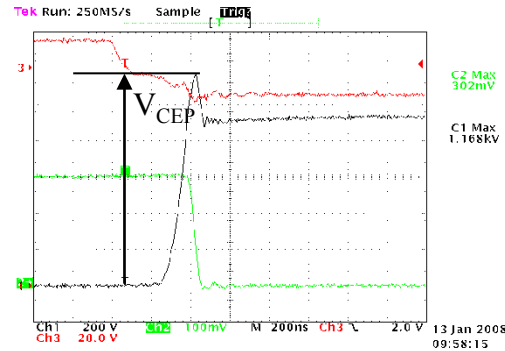
$$C_S = \frac{L * I_o^2}{(V_{CEP} - E_d)^2}$$

L: Main circuit wiring parasitic inductance

I<sub>o</sub>: Collector current at IGBT turn-off

V<sub>CEP</sub>: Snubber capacitor peak voltage

E<sub>d</sub>: DC supply voltage



Module rating		DC line inductance	snubber capacitance
V <sub>ces</sub>	I <sub>c</sub>		
1200V/1700V	450A	0.08 μH	4.7 μF
	1000A	0.07 μH	6.8 μF
	1400A	0.06 μH	12 μF
	2400A	0.046 μH	27 μF
	3600A	0.046 μH	47 μF