

Gate Driver Modules that bring out the performance of **SiC** gate drive



SUSTAINABLE
DEVELOPMENT
GOALS

Rev B



Index

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2) Introduction of One Tamura

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Gate Driver Modules that bring out the performance of **SiC** gate drive

1-1. Why ??



Transformer Technology



Circuit design Technology



Potting Technology



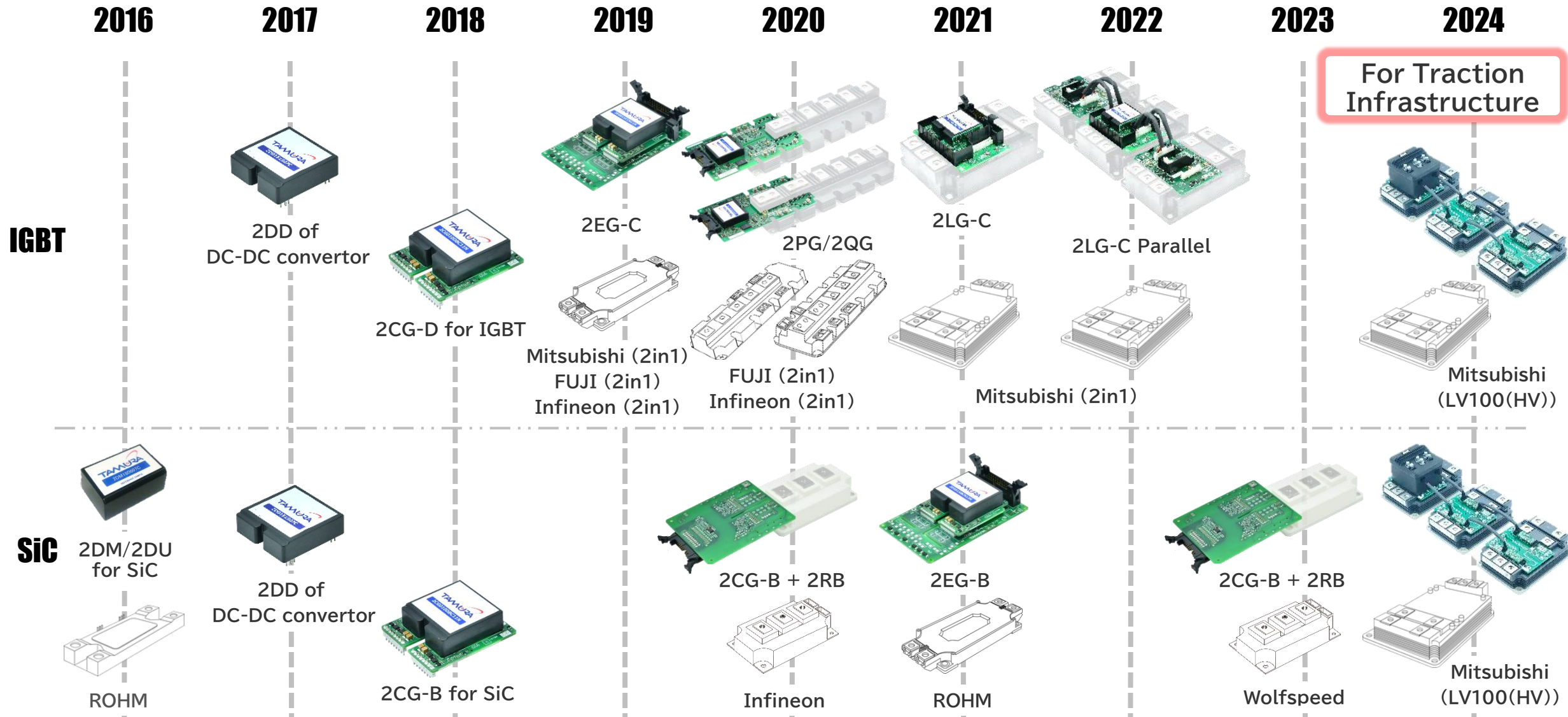
EMI/EMC Solution



Market Awareness

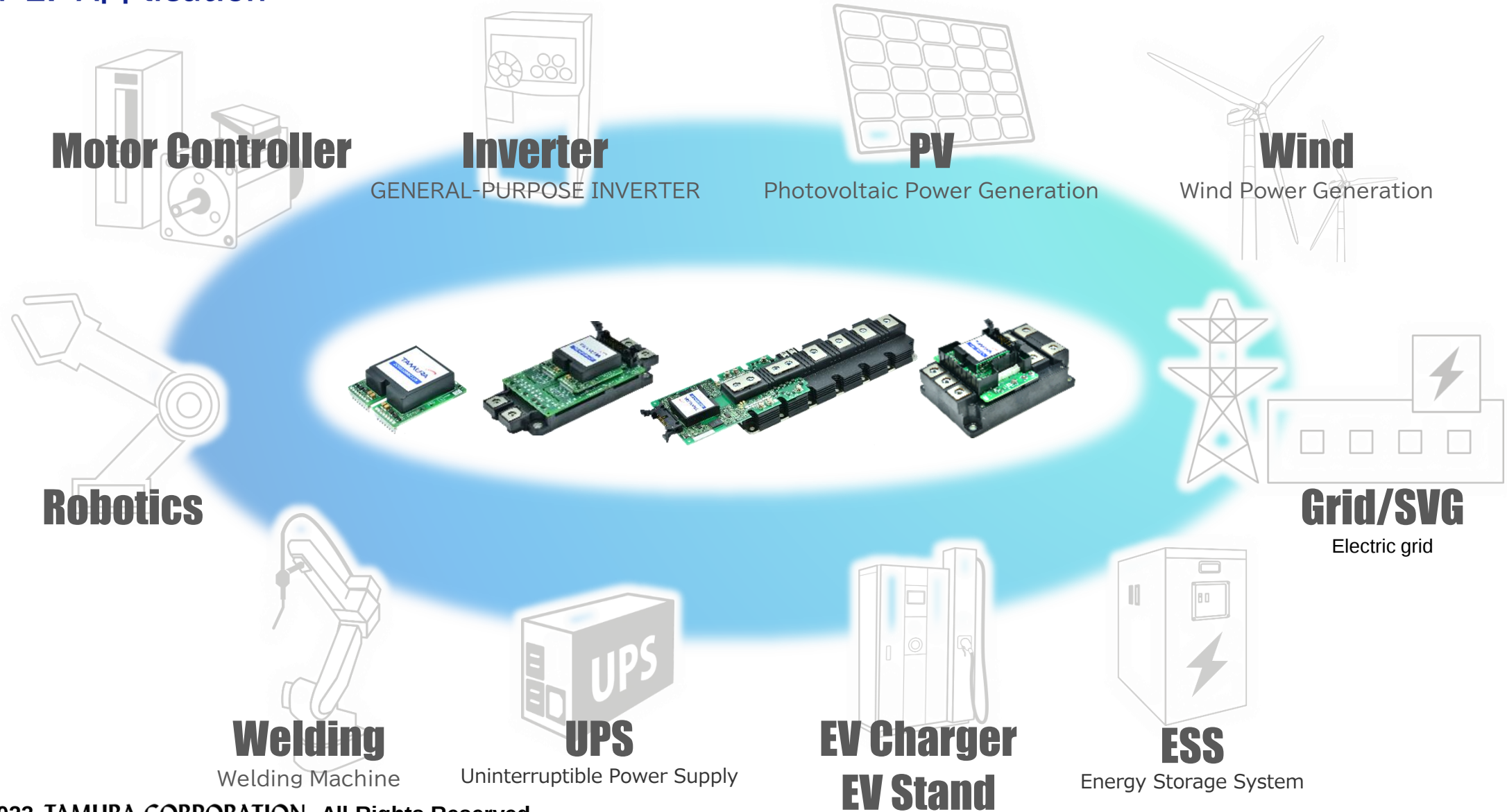
Gate Driver Modules that bring out the performance of **SiC** gate drive

1-1. When ??



Gate Driver Modules that bring out the performance of **SiC** gate drive

1-2. Application



Gate Driver Modules that bring out the performance of **SiC** gate drive

1-3. Product Configuration

Product

DC/DC Converter

Gate Driver Module

Gate Driver Unit

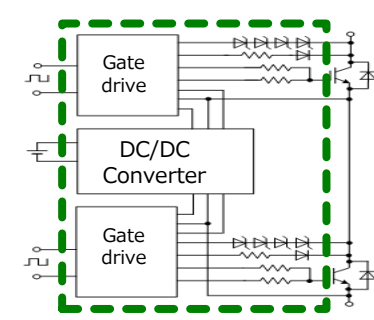
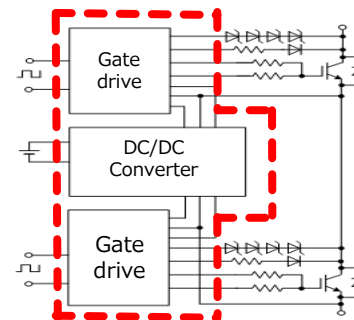
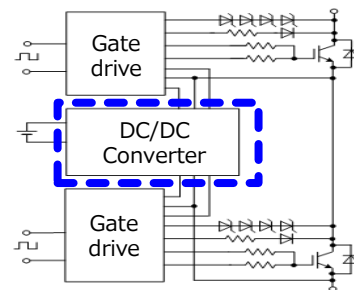
Function

**2in1 PM designated
DC/DC Converter**

**DC/DC Converter
+ Gate drive**

**Gate Driver Module
+ Gate resistors
Protective function**

Block diagram



Appearance



2DD series



2CG-B/D series



Gate Driver Modules that bring out the performance of SiC gate drive

1-4. Features of Gate Driver Modules

Features of All-SiC Power Module

Feature① Short circuit tolerance is lower than Si

Feature② Low threshold voltage VGS (th) (1V~3V)

Feature③ VGS(+) :On resistance does not decrease at 15V
VGS(−) :Low tolerance (Less than −5~4V)

Feature④ dV/dt can be set high

Feature⑤ High frequency operation is possible

Gate Driver
Module
solves all
problems!

Gate Driver Modules that bring out the performance of **SiC** gate drive

1-4. Features of Gate Driver Modules

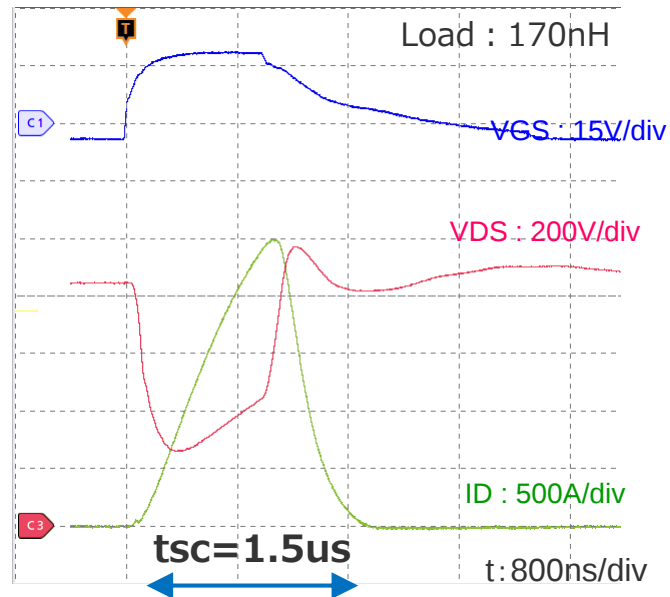
Feature ① Short circuit tolerance is lower than Si

----- Small chip area -----

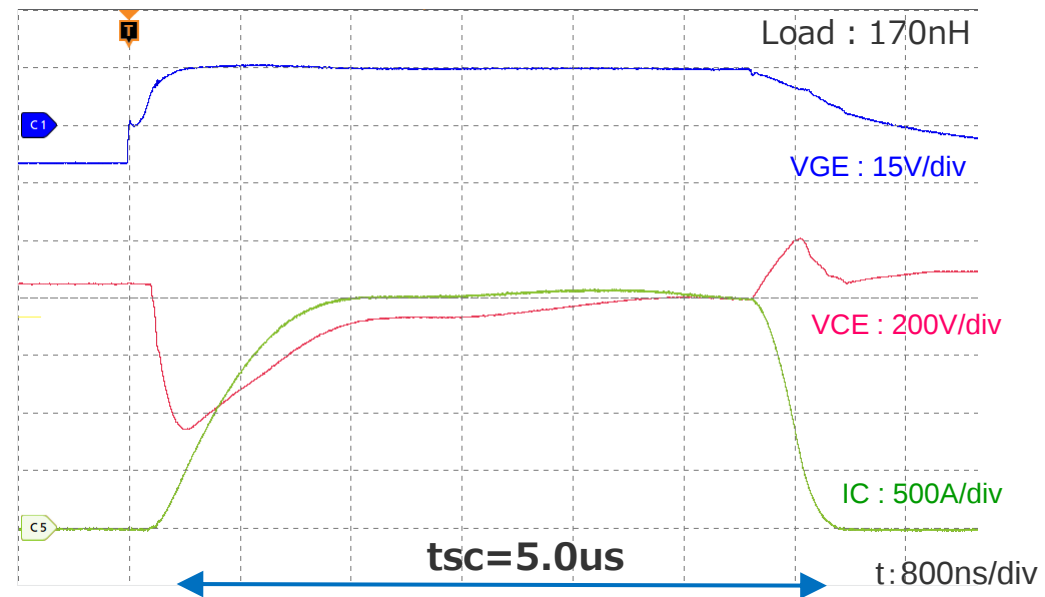
- Wide band gap
- High breakdown voltage
- High temperature operation

Support with a gate driver ... Short-circuit mask time (tsc) adjustment function

SiC power module (1200V 300A)
Waveform with shorted load



IGBT power module (1200V 300A)
Waveform with shorted load



Adjustable with external capacitor capacity

Optimal value of SiC : 1.0~3.0us

Optimal value of IGBT : 3.0~7.0us

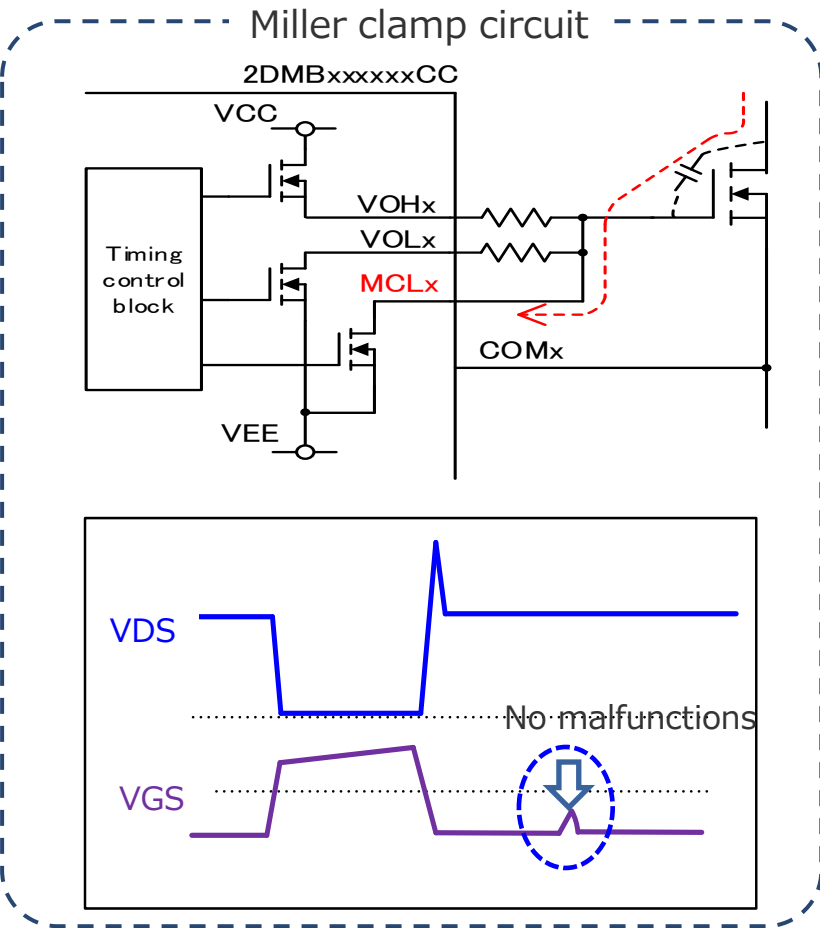
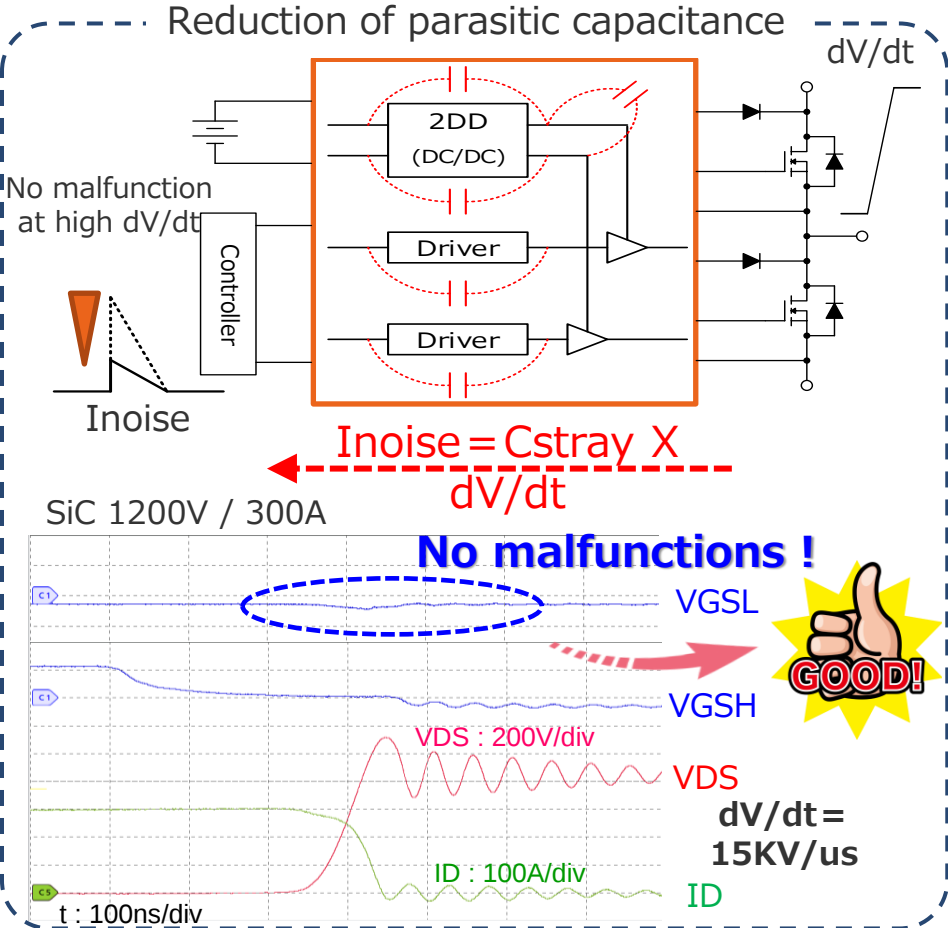
Gate Driver Modules that bring out the performance of **SiC** gate drive

1-4. Features of Gate Driver Modules

Feature② Low threshold voltage VGS (th)
(1V~3V)

--- IGBT is 6V~7V --- Beware of malfunctions from IGBT

Support with a gate driver ... Reduction of parasitic capacitance and Miller clamp circuit



Gate Driver Modules that bring out the performance of **SiC** gate drive

1-4. Features of Gate Driver Modules

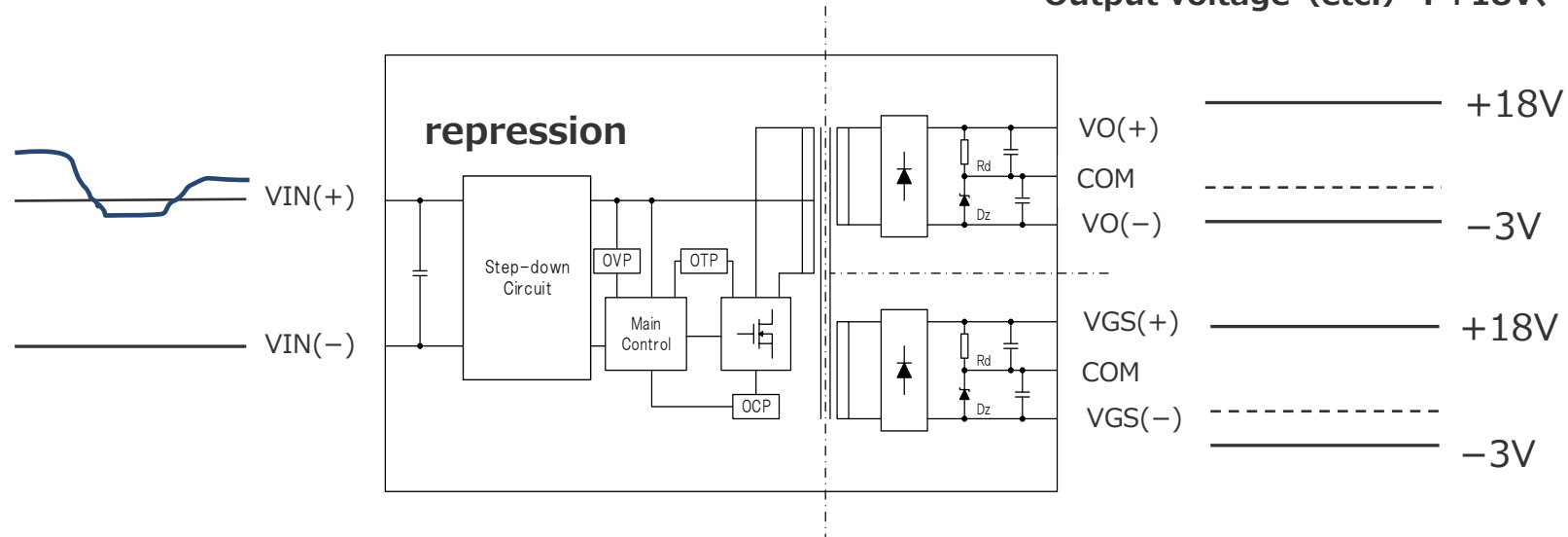
Feature③ VGS(+) : On resistance does not decrease at 15V
VGS(-) : Low tolerance (Less than -5~4V)

--- IGBT's Gate driver cannot be used

Support with a gate driver ... Constant voltage control of VGS

Input voltage : 13V~28V

Output voltage (etc.) : +18V, -3V



Controls the gate voltage to be constant even for input fluctuations
The gate voltage is constant even for output fluctuations
(SW frequency, QG of power module)

**Improved SiC reliability
Low loss operation**

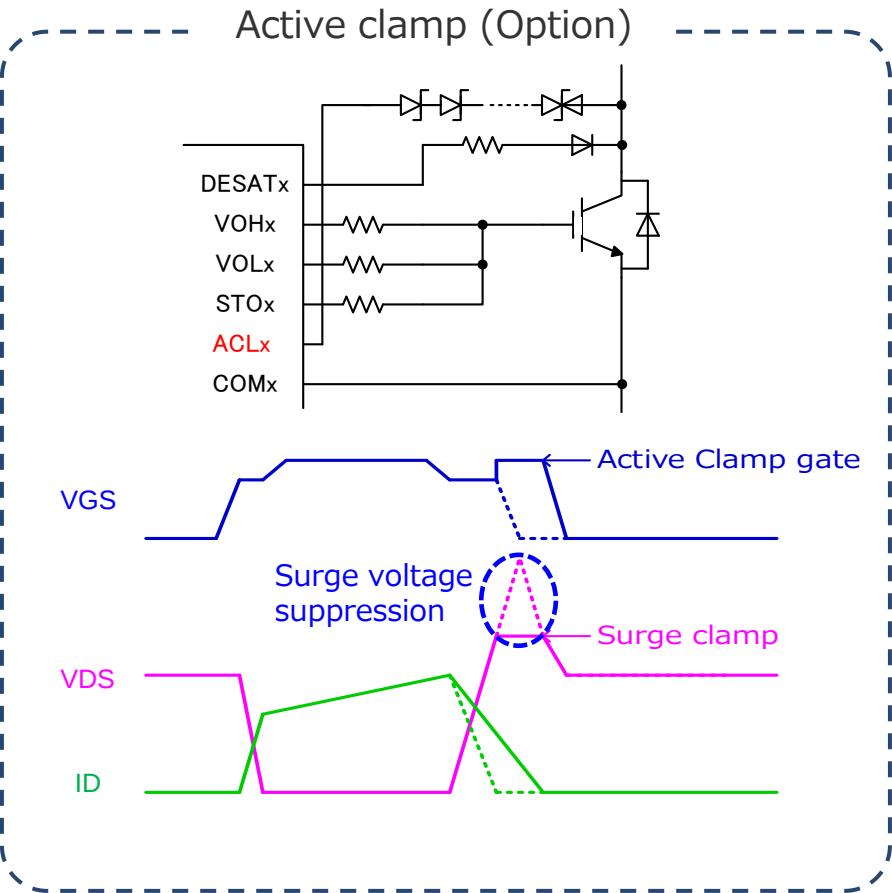
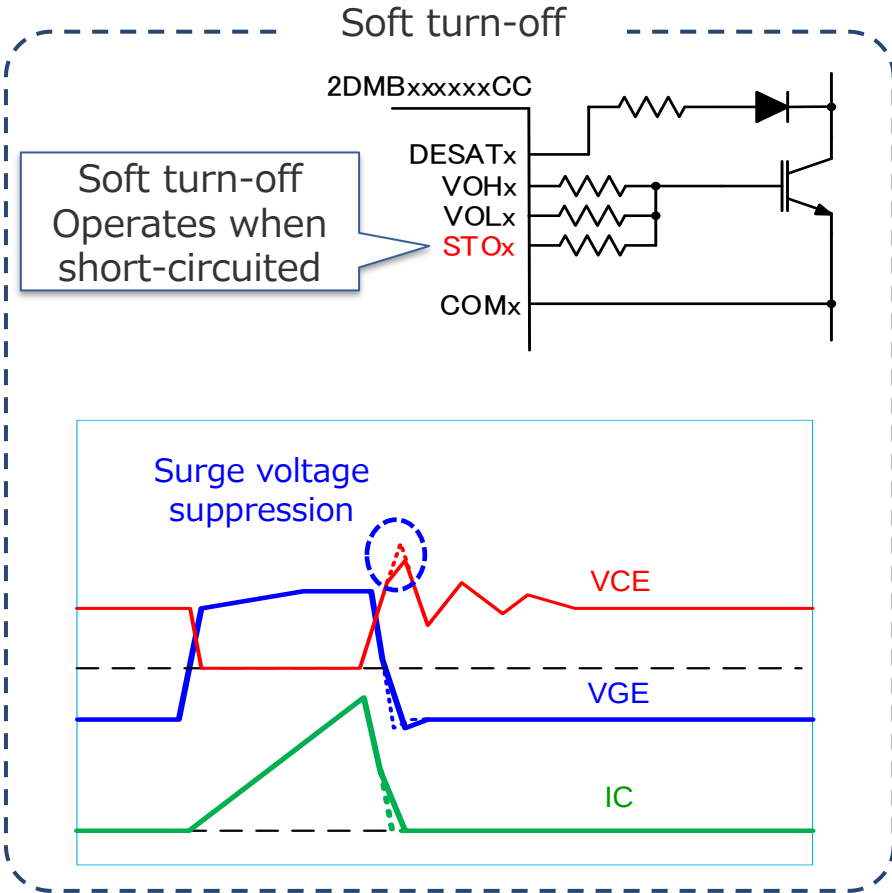
Gate Driver Modules that bring out the performance of **SiC** gate drive

1-4. Features of Gate Driver Modules

Feature④ dV/dt can be set high

Turn-on: Recovery current is small
Turn-off: No tail current

Support with a gate driver ... Ability to suppress surge voltage with high dV/dt
(Soft turn-off, Active clamp)



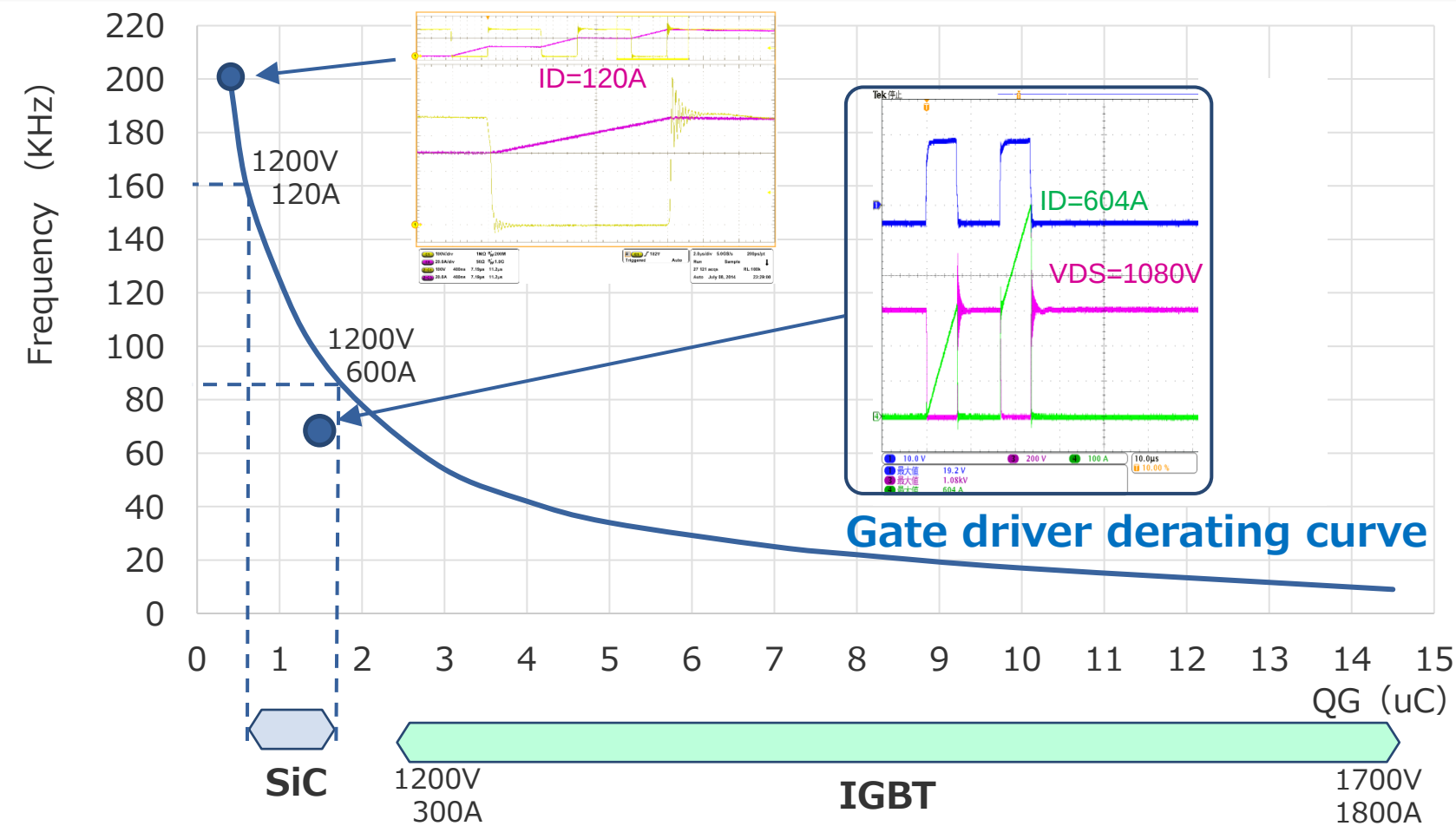
Gate Driver Modules that bring out the performance of **SiC** gate drive

1-4. Features of Gate Driver Modules

Feature⑤ High frequency operation is possible

----- Drive power needs to be increased

Support with a gate driver ... Output capacity considering SiC power module



Gate Driver Modules that bring out the performance of **SiC** gate drive

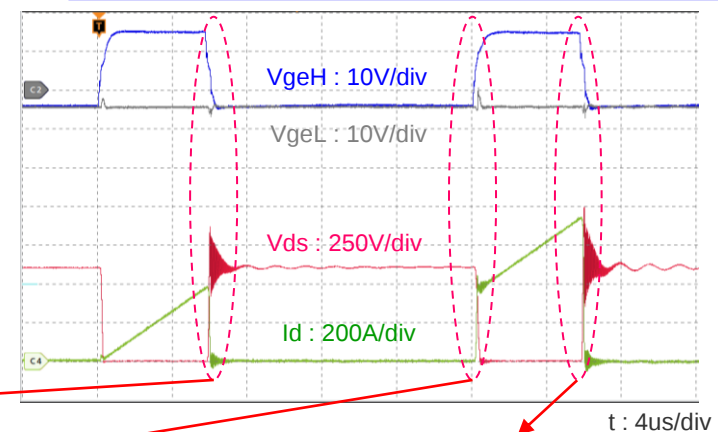
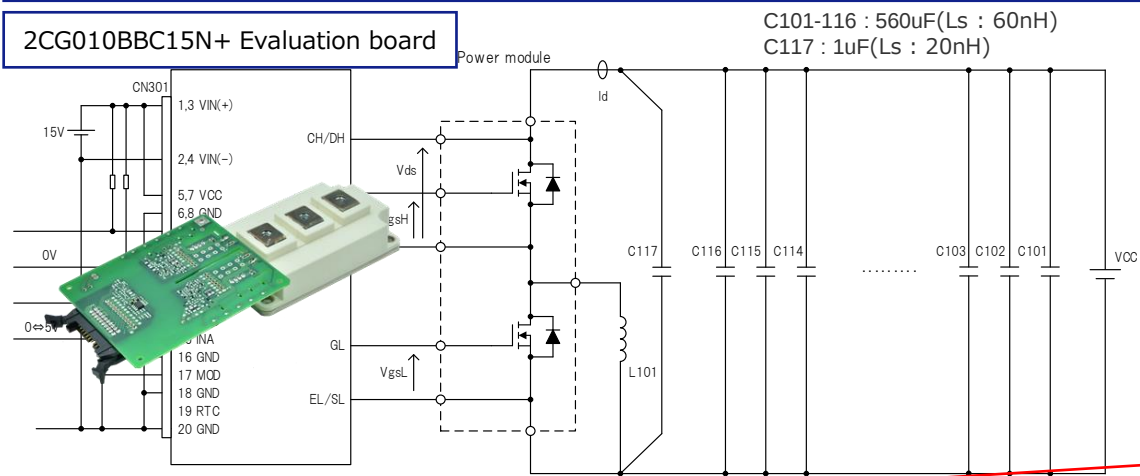
1-5. Gate drive waveform of SiC power module (2 Pulse test)

SiC MOSFET : FF3MR12KM1

Highly stable gate drive with proprietary drive circuit and miller clamp circuit (patent pending)

DC Link : 600V, Ron : 4.3Ω, Roff : 3.6Ω, Upper arm, Tj=25°C

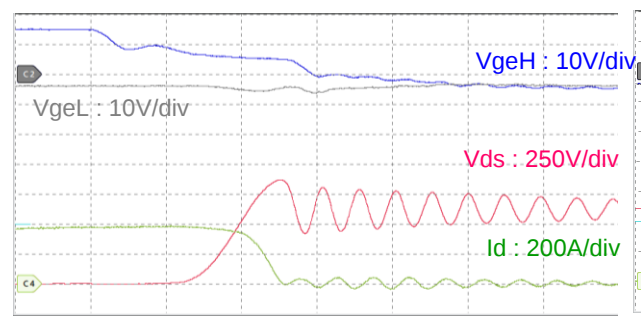
2CG010BBC15N+ Evaluation board



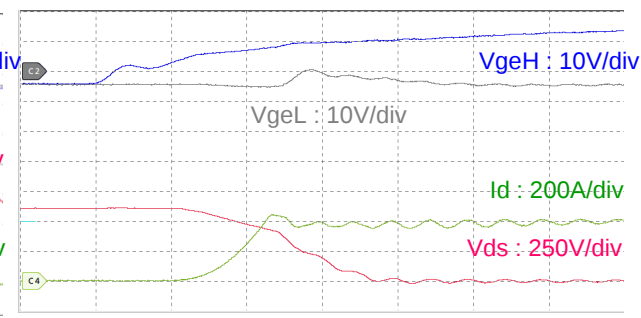
Turn OFF / Ic =375A

Turn ON / Ic =375A

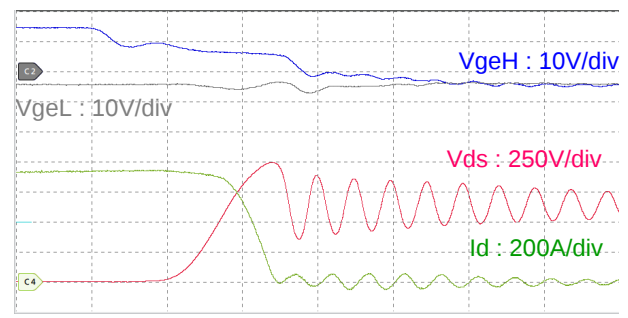
Turn OFF / Ic =750A



Item	Measurement value	
Vdsp	866	V
dV/dt	8.8	kV/us
di/dt	6.2	kA/us
Eoff	13	mJ



Item	Measurement value	
dV/dt	4.6	kV/us
di/dt	5.0	kA/us
Eon	19	mJ



Item	Measurement value	
Vdsp	992	V
dV/dt	9.2	kV/us
di/dt	10.3	kA/us
Eoff	33	mJ

Gate Driver Modules that bring out the performance of **SiC** gate drive

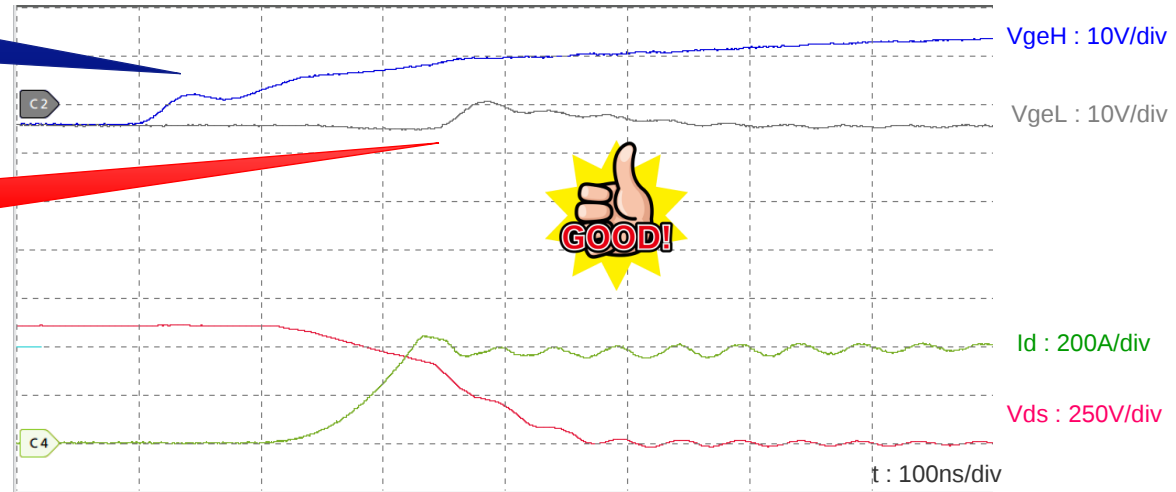
1-5. 2 Pulse test (Enlarged waveform)

SiC MOSFET : FF3MR12KM1

Turn ON / $I_c = 375A$

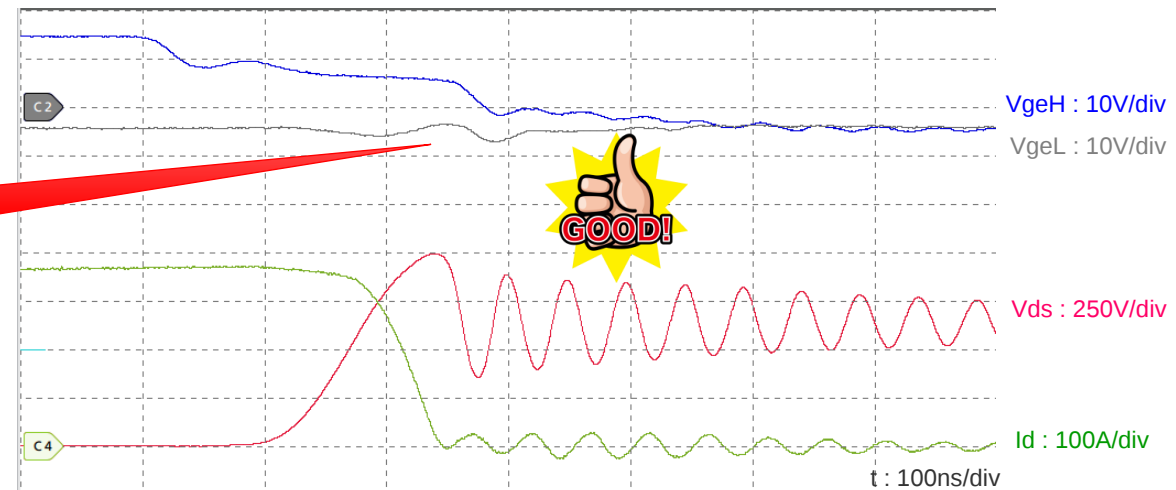
SW side gate (turn ON)
No ringing and no overshoot

OFF side gate
Stable L state without malfunction



Turn OFF / $I_c = 750A$

OFF side gate
Stable L state without malfunction

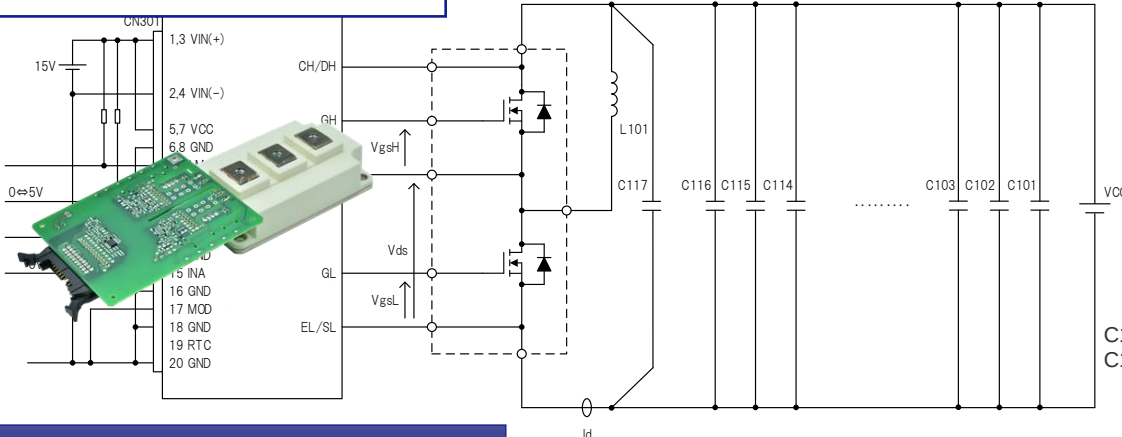


Gate Driver Modules that bring out the performance of SiC gate drive

1-5. Gate drive waveform of SiC power module (Short circuit test)

DC Link : 600V, Ron : 4.3Ω, Roff : 3.6Ω, Lower arm, Tj=25°C

2CG010BBC15N+ Evaluation board



SiC MOSFET : FF3MR12KM1

This driver suppresses the Vds peak voltage in the short circuit by our original circuit technology, and can control the mask time to prevent false short circuit detection. (Patent pending)

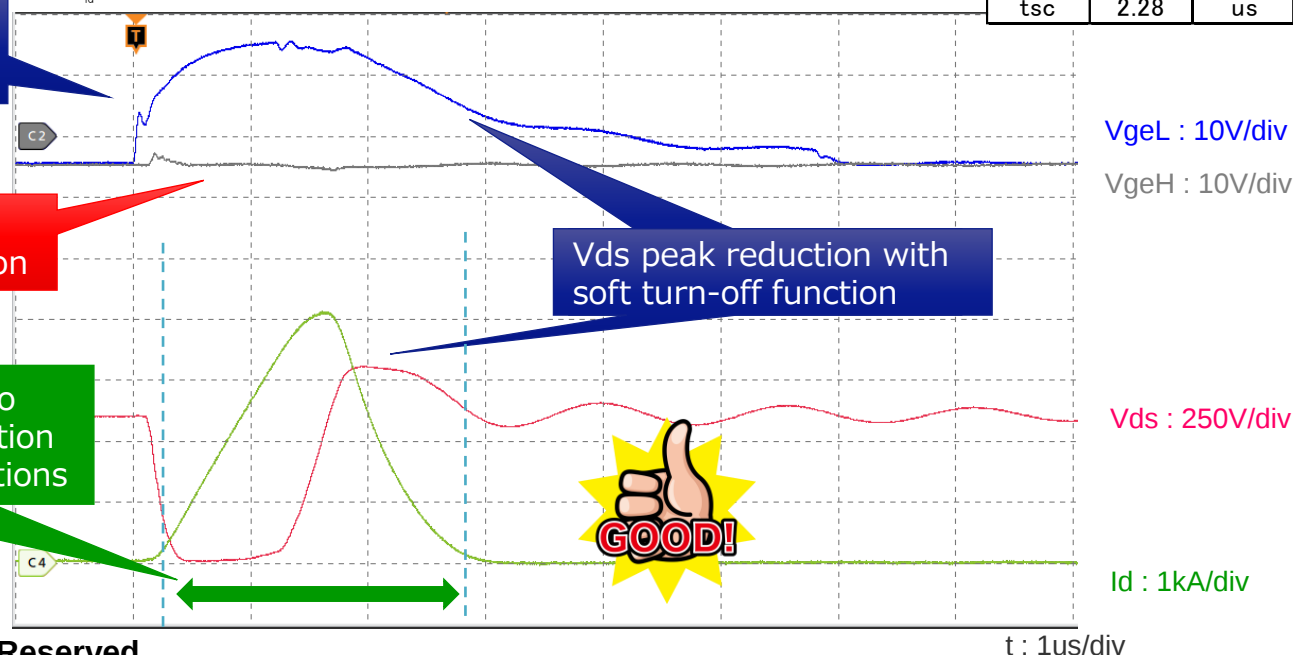
C101-116 : 560uF(Ls : 60nH)
C117 : 1uF(Ls : 20nH)

Item	Measurement value	
Vdsp	806	V
Idp	4124	A
tsc	2.28	us

SW side gate (turn ON)
No ringing and no overshoot

OFF side gate
Stable L state without malfunction

Constant control of mask time to prevent false short circuit detection regardless of short circuit conditions



Vds peak reduction with soft turn-off function



Gate Driver Modules that bring out the performance of **SiC** gate drive



1-6. Comparison and expansion

Advantage of Tamura Gate driver modules (2CG-B / 2CG-D)

Item	TAMURA	Company A (4W)	Advantages
Power module	SiC-MOSFET /IGBT	IGBT	○
Input Voltage	13.5-26.4V	14.5-15.5V	○
Output Voltage	+15V/-10V +15V/-15V +18V/-4V +18V/-2V +15V/-4V	+15V/-10V	○
Peak output current	±43A	±35A	○
Frequency	150kHz (Max)	100kHz (Max)	○
Isolation capacitance	12pF(TYP)	22pF	○
CMTI	70kV/us	50kV/us	○
Protection	Soft turn off Active Clamp Miller Clamp	Active Clamp	○

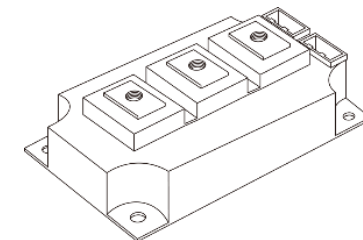
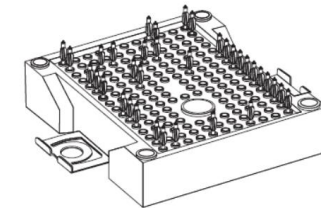
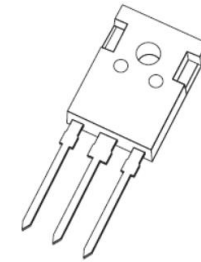
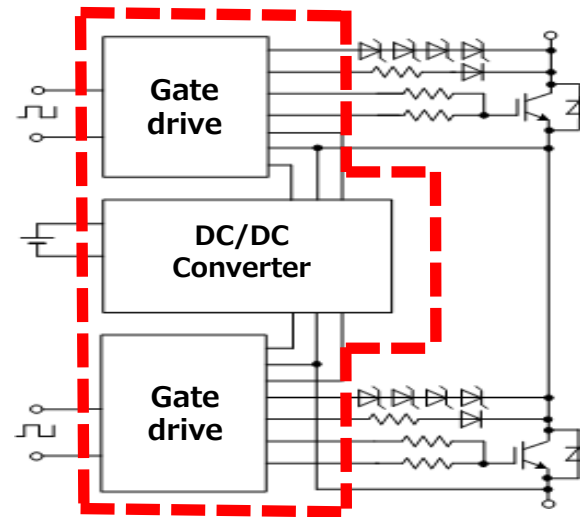
Gate Driver Modules that bring out the performance of **SiC** gate drive

1-6. Comparison and expansion

Deployment example of Tamura Gate driver modules (2CG-B / 2CG-D)



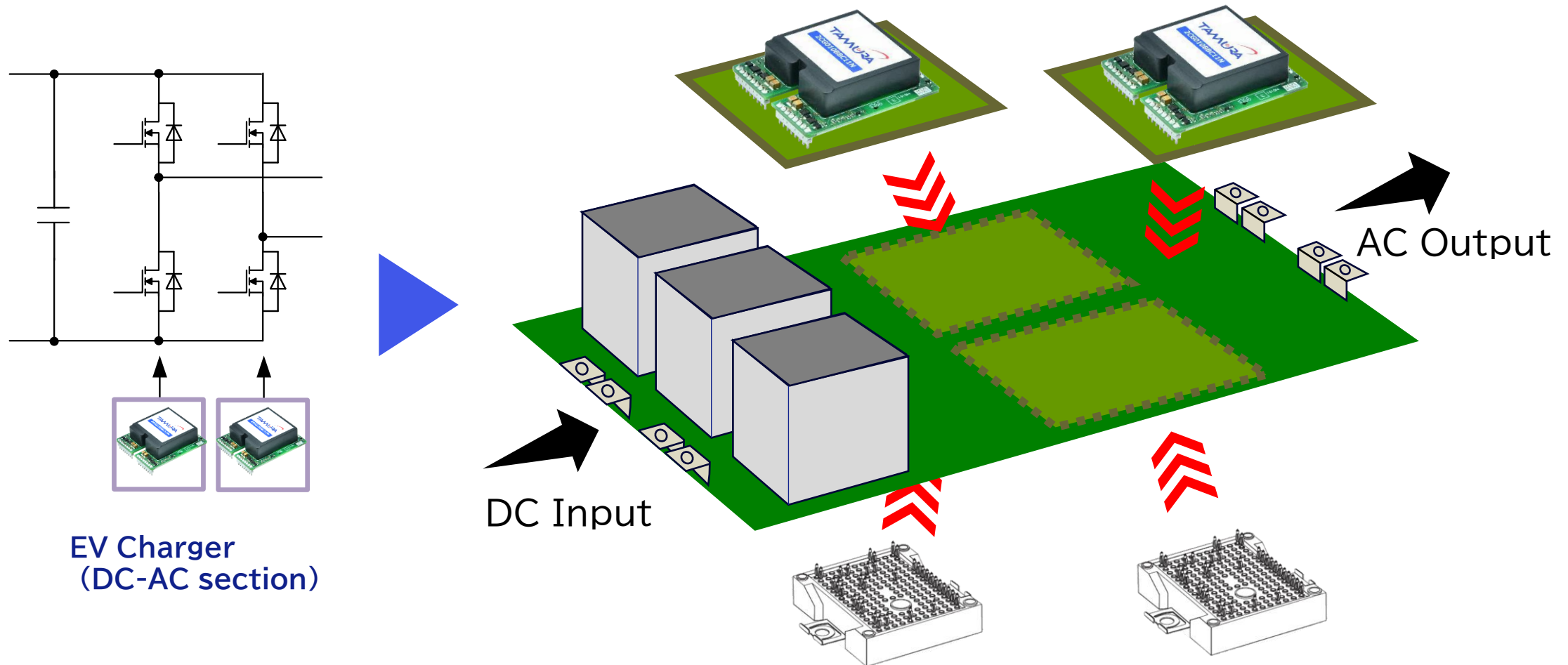
Gate Driver Module



Gate Driver Modules that bring out the performance of SiC gate drive

1-6. Comparison and expansion

Deployment example of Tamura Gate driver modules (2CG-B / 2CG-D)



Gate Driver Modules that bring out the performance of **SiC** gate drive



1-7. Product Line-up

Gate Driver Module 2CG-B / 2CB-D series

		MODEL					
		2CG010BBC11N	2CG010BBC12N	2CG010BBC13N	2CG010BBC14N	2CG010BBC15N	2CG010DBC11N
Output	Output voltage(+)	+15V	+15V	+18V	+18V	+15V	+15V
	Output voltage(-)	-10V	-15V	-4V	-2V	-4V	-10V
	Output power/1ch	4.0W	3.3W	3.5W	3.2W	3.0W	4.0W
	Number of output	2					
	Peak output current	±43A					
Input	Input voltage	DC13~28V					
	Logic input voltage	DC3.3V, 5V					
Insulation	Withstand voltage	Primary to secondary AC5KV / Secondary to secondary AC4KV					
	Partial discharge extinction voltage	2400V peak or more					
Function	Mode select	Direct mode / Half bridge mode					
	DESAT protection	Yes					
	Soft turn off	Yes					
	Active clamp	No					Yes
	Miller clamp	Yes					No

Gate Driver Modules that bring out the performance of SiC gate drive

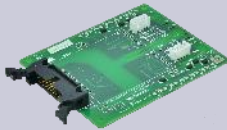
1-7. Product Line-up (power module correspondence table) / ROHM

Package	Ic	Part No	Gate Driver Unit	Gate Driver Module	DC-DC
			2EG-B 	2CG-B 	2DD 
Vce = 1200V					
 C type	80	BSM080D12P2C008	-	2CG010BBC13N	2DD180407C
	120	BSM120D12P2C005	-		
	180	BSM180D12P3C007	-		
 E type	180	BSM180D12P2E002	2EG01XBxN13N	2CG010BBC13N	2DD180407C
	300	BSM300D12P2E001	2EG01XBxN13N		
	300	BSM300D12P3E005	2EG01XBxN14N	2CG010BBC14N	2DD180206C
 G type	400	BSM400D12P2G003	2EG01XBxN13N	2CG010BBC13N	2DD180407C
	400	BSM400D12P3G002	2EG01XBxN14N	2CG010BBC14N	2DD180206C
	600	BSM600D12P3G001	2EG01XBxN14N		
Vce = 1700V					
 E type	250	BSM250D17P2E004	2EG01XBxN13N	2CG010BBC13N	2DD180407C

x: Signal input voltage selectable " C " => 3.3~15V " D " => 15V

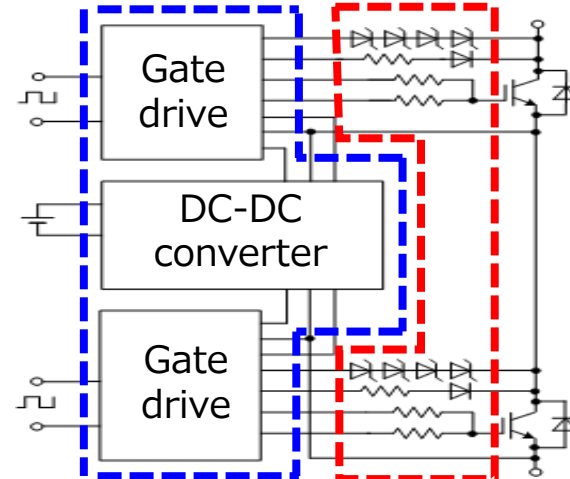
Gate Driver Modules that bring out the performance of **SiC** gate drive

1-7. Product Line-up (power module correspondence table) / Infineon

Package	I _D	Part No	TAMURA Driver			
			Evaluation board	2CG-B	2DD	
	V _{D-S} = 1200V					
	250	FF6MR12KM1		2RB020BB	2CG010BBC15N (+15/-4V) 	2DD1504xxC (+15V/-4V) 
		FF6MR12KM1P				
	375	FF3MR12KM1				
		FF3MR12KM1P				
	500	FF2MR12KM1				
		FF2MR12KM1P				
	V _{D-S} = 2000V					
	250	FF6MR20KM1H		2RB020BB	2CG010BBC13N (+18/-4V) 	2DD180407C (+18V/-4V) 
		FF6MR20KM1HP				
	375	FF4MR20KM1H				
		FF4MR20KM1HP				
	500	FF3MR20KM1H				
		FF3MR20KM1HP				



Gate Driver Module
(2CG-B series)



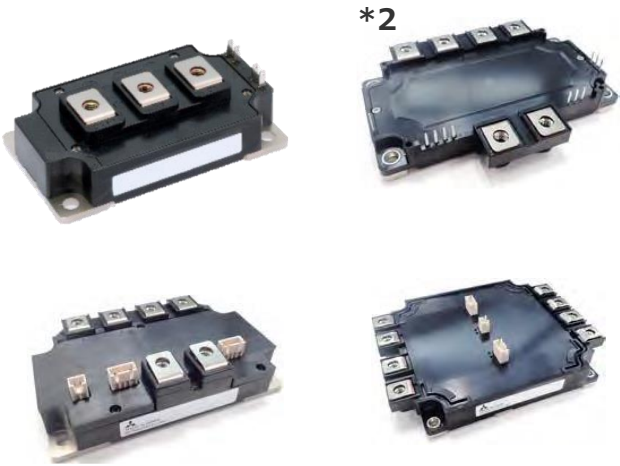
Evaluation board
(2RB series)



Can be connected directly !

Gate Driver Modules that bring out the performance of SiC gate drive

1-7. Product Line-up (power module correspondence table) / Mitsubishi Electric

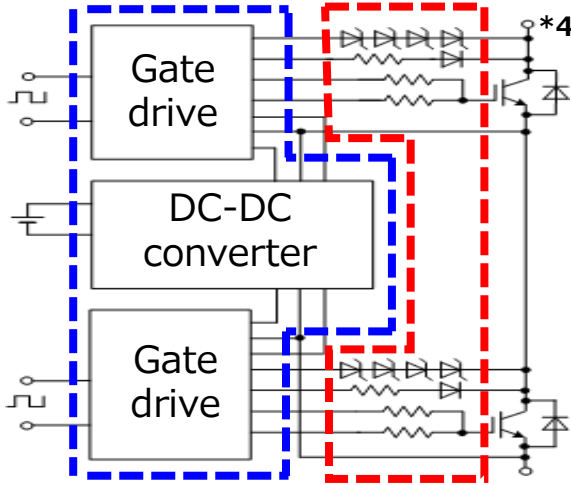


I _D	Part No	Evaluation board	Gate Driver Module	DC-DC	
		V _{DS} =1200V			
300	FMF300BXZ-24B	*1 *4		2CG010BBC11N	2DD151008C
	FMF400BX-24B	*2		2CG010BBC12N	2DD151507C
400	FMF400BXZ-24B	*1 *4		2CG010DBC11N	
	FMF400DY-24B	Can be connected directly			
600	FMF600DXZ-24B	*3 *4			
800	FMF800DX-24B	*2			
	FMF800DXZ-24B	*3 *4			
1200	FMF1200DXZ-24B				
		V _{DS} =1700V			
300	FMF300DXZ-34B	*3 *4	2CG010BBC11N 2CG010BBC12N 2CG010DBC11N	2DD151008C 2DD151507C	

- *1: It is necessary to branch the lead wire of the gate signal from the evaluation board.
- *2: A connection board with the SiC power module is required.
- *3: A lead wire with a connector is required.
- *4: SC terminal is not supported. However, we can propose external circuit for SC terminal.



Gate Driver Module



Evaluation board
2RB020BB

Can be connected directly !



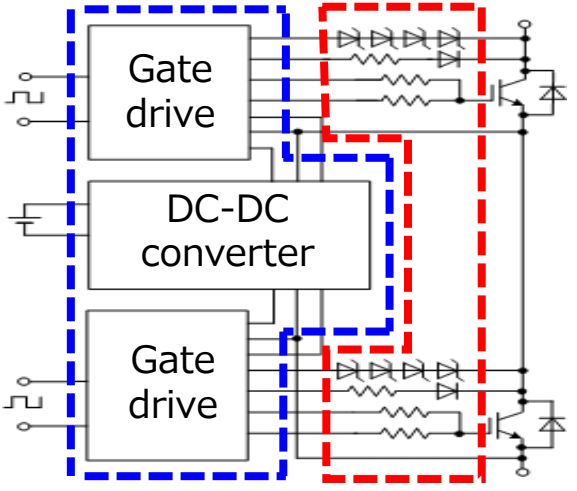
Gate Driver Modules that bring out the performance of **SiC** gate drive

1-7. Product Line-up (power module correspondence table) / Wolfspeed

Package	I _D	Part No	TAMURA Driver			
			Evaluation board	2CG-B	2DD	
	V _{D-S} = 1200V					
	120	CAS120M12BM2		2RB020BB	2CG010BBC15N (+15/-4V) 	2DD1504xxC (+15V/-4V) 
	175	CAS175M12BM3				
	300	CAS300M12BM2				
	350	CAS350M12BM3				
	530	CAS530M12BM3				
		CAB530M12BM3				
	V _{D-S} = 1700V					
	225	CAS300M17BM2		2RB020BB	2CG010BBC15N (+15/-4V)	2DD1504xxC (+15V/-4V)



Gate Driver Module
(2CG-B series)



Evaluation board
(2RB series)



Can be connected directly !

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 ~ ROHM / Infineon / Mitsubishi / Wolfspeed ~

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Appendix) Contact person

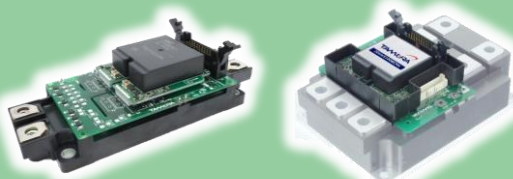
Introduction of One Tamura (General application)

Device technology



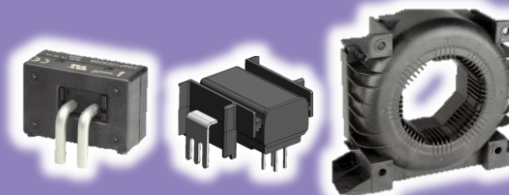
Novel Crystal Technology, Inc.

Gate driver Circuit technology



Gate Driver Unit

Module technology Current sensor



Soldering technology



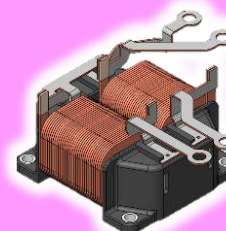
Electric Chemicals
Soldering material
Die attach material
TIM material

Power electronics technology and main products

Reflow soldering system



Automotive reactor



Reactor for PF
(2 in 1)

Passive components

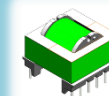


Reactor Trans Coil

Large reactor/
transformer



Toroidal coil



SW-Trans

Please visit our website!



Home



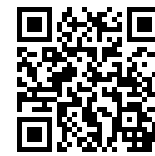
Contact



Catalog



Linkedin



Digi-Key



Mouser



Energize the Future 100th

CORPORATE GOVERNANCE REPORT



Tamura's mascot "Quenu"