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Innovating Energy Technology

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Basics of Understanding Datasheet

June, 2016

Device Application Technology Dept.
Semiconductors Div, Sales Group
Fuji Electric. Co., Ltd.

Get Datasheets from the WEB

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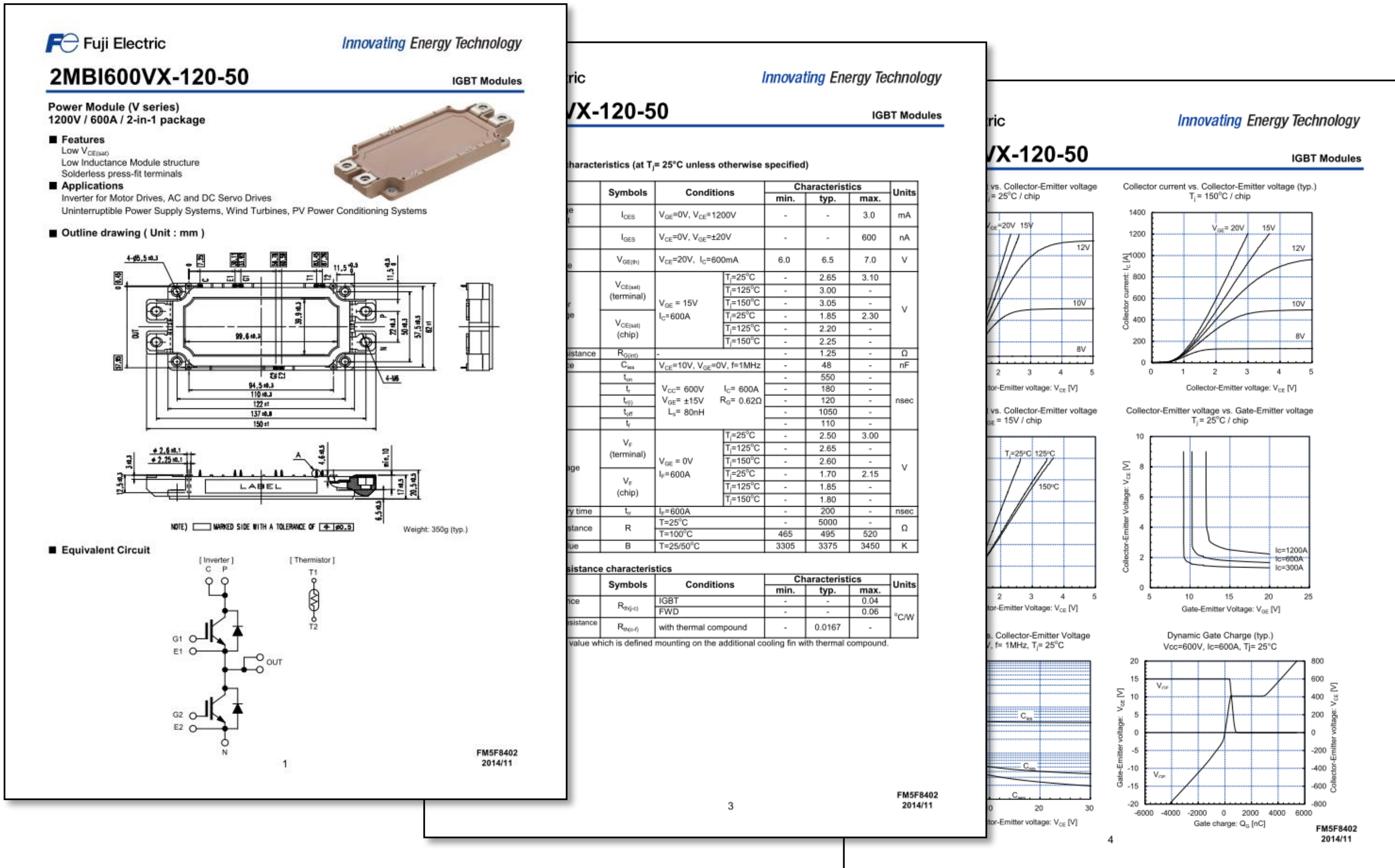
Datasheets can be downloaded from Fuji Electric Semiconductor web site.

www.fujielectric.com/products/semiconductor/



Maximum Voltage

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■ **Absolute Maximum Ratings (at T_C= 25°C unless otherwise specified)**

Items		Symbols	Conditions		Maximum Ratings	Units
Collector-Emitter voltage		V_{CES}			1200	V
Gate-Emitter voltage		V_{GES}			±20	V
Collector current		I_C	Continuous	T_C=25°C	750	A
				[illegible]	[illegible]	
		I_C pulse	1ms		1200	
		$-I_C$			600	
		$-I_C$ pulse	1ms		1200	
Collector powe[illegible]		[illegible]	[illegible]		[illegible]	[illegible]
Junction tempe[illegible]		T_j			175	
Operating junct[illegible] temperature (under switching conditions)		[illegible]			[illegible]	°C
Case temperature		T_c			125	
Storage temperature		T_{stg}			-40 ~ 125	
Isolation voltage	between terminal and copper base (*1)	V_{iso}	AC: 1min.		2500	VAC
	between thermistor and others (*2)					
Screw Torque	Mounting (*3)	-			3.5	N m
	Terminals (*4)	-			4.5	

(*1) All terminals should be connected together during the test.
(*2) Two thermistor terminals should be connected together, other terminals should be connected together and shorted [illegible]
(*3) Recomm[illegible]
(*4) Recommendable Value : 3.5-4.5 Nm (M6)

V_{CES} : Maximum collector-emitter voltage with zero gate-emitter bias.

V_{GES} : Maximum gate-emitter voltage with zero emitter-collector bias. Electric strength of gate is low because of MOS-gate structure. **Need to take measures against static electricity.** (Withstand voltage against static electricity is less than 1kV. Don't touch the gate pins with bare hands.)

V_{iso} : Maximum effective value of the sine-wave voltage between the terminals and the heat sink, when all terminals are shorted.
Metallic-base is insulated from circuit by the thin ceramic substrate. **Don't drop the module at handling.** (There is danger of getting an electric shock when the substrate cracks.)

Maximum Current

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■ **Absolute Maximum Ratings (at T_C= 25°C unless otherwise specified)**

Items	Symbols	Conditions		Maximum Ratings	Units
Collector-Emitter voltage	V_{CES}			1200	V
Gate-Emitter voltage	V_{GES}			±20	V
Collector current	I_C	Continuous	T_C=25°C	750	A
			T_C=100°C	600	
	I_C pulse	1ms		1200	
	$-I_C$			600	
	$-I_C$ pulse	1ms		1200	
Collector power dissipation	P_C	1 device		3750	W
Junction temperature	T_j			175	
Storage temperature	T_{stg}			-40 ~ 125	
Isolation voltage	V_{iso}	AC: 1min.		2500	VAC
Screw Torque	-			3.5	N m
				4.5	

I_C : Maximum continuous DC collector current.
More than five times of ratings current flows during accident such as short circuit etc.

$$I_C = (T_{jmax} - T_C) / (V_{CE(sat)} * R_{th(j-c)})$$

This value just represents IGBT DC behavior, can be a reference of choosing IGBT, but not yardstick.
----- Infineon

(*4) Recommendable Value : 3.5-4.5 Nm (M6)

I_C pulse : Maximum pulse collector current (Turn on pulse current)

$-I_C$ / $-I_C$ pulse : Maximum continuous DC collector current / pulse current of anti-parallel diode

→ See also "Short circuit capability" and "RBSOA"

Maximum Power Dissipation

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■ **Absolute Maximum Ratings (at T_C= 25°C unless otherwise specified)**

Items		Symbols	Conditions		Maximum Ratings	Units
Collector-Emitter voltage		V_{CES}			1200	V
Gate-Emitter voltage		V_{GES}			±20	V
Collector current		I_C	Continuous	T_C=25°C	750	A
				T_C=100°C	600	
		I_C pulse	1ms		1200	
		$-I_C$			600	
		$-I_C$ pulse	1ms		1200	
Collector power dissipation		P_C	1 device		3750	W
Junction temperature		T_j			175	
Operating junction temperature (under switching conditions)		T_{jop}				
Case temperature		T_c				
Storage temperature		T_{stg}				
Isolation voltage	between terminal and copper base (*1)	V_{iso}	AC: 1min.		2500	VAC
	between thermistor and others (*2)					
Screw Torque	Mounting (*3)	-			3.5	N m
	Terminals (*4)	-			4.5	

(*1) All terminals should be connected together during the test.
(*2) Two thermistor terminals should be connected together, other terminals should be connected together and shorted to base plate during the test.
(*3) Recommendable Value : 2.5-3.5 Nm (M5)
(*4) Recommendable Value : 3.5-4.5 Nm (M6)

$$P_C = (T_{j(max)} - 25^oC) / R_{th(j-c)}$$
$$= (175 - 25) / 0.04 = 3750$$

Maximum Temperature

■ Absolute Maximum Ratings (at T_C= 25°C unless otherwise specified)

Items	Symbols	Conditions	Maximum Ratings	Units
Co…	V_{CES}		[illegible]	
Gate-Emitter voltage	V_{GES}		±20	V
	I_C	Continuous T_C=25°C	750	
Collector current	I_C pulse	1ms	1200	A
	$-I_C$		600	
	$-I_C$ pulse	1ms	1200	
Collector power dissipation	P_C	1 device	3750	W
Junction temperature	T_j		175	°C
Operating junction temperature (under switching conditions)	T_{jop}		150	°C
Case temperature	T_c		125	°C
Storage temperature	T_{stg}		-40 ~ 125	°C
Isolation voltage: between terminal and copper base (*1)	V_{iso}	AC: 1min.	2500	VAC
Isolation voltage: between thermistor and others (*2)	V_{iso}	AC: 1min.	[illegible]	VAC
Screw Torque: Mounting (*3)	-		[illegible]	N m
Screw Torque: Terminals (*4)	-		[illegible]	N m

(*1) All terminals should be connected together during the test.
(*2) Two thermistor terminals should be connected together, other terminals should be connected together and shorted to base plate during the test.
(*3) Recommendable Value : 2.5-3.5 Nm (M5)
(*4) Recommendable Value : 3.5-4.5 Nm (M6)

T_j : $T_{j(max)}$ The maximum junction temperature of the die including thermal ripples under limited and non-cyclic operation condition

T_{jop} : The maximum junction temperature of the die including thermal ripples during continuous, repetitive and/or cyclic operation

T_c : Case temperature during continuous operation. Especially base plate temperature is defined.

T_{stg} : Temperature range for storage or transportation, when there is no electrical load on the terminals

Definition of Tjop and Tj(max)

Below table shows example of the allowed temperature ranges to operate in.

Never exceed $T_{j(max)}$.

		T_{jop}	$T_{j(max)}$
Maximum temperature		150°C	175°C
Guaranteed	Static	✓	✓
	Switching	✓	✓
	RBSOA	✓	-
	SCSOA	✓	-
Operating condition		Continuous regular load	Non-cyclic overload

Example: Overload condition

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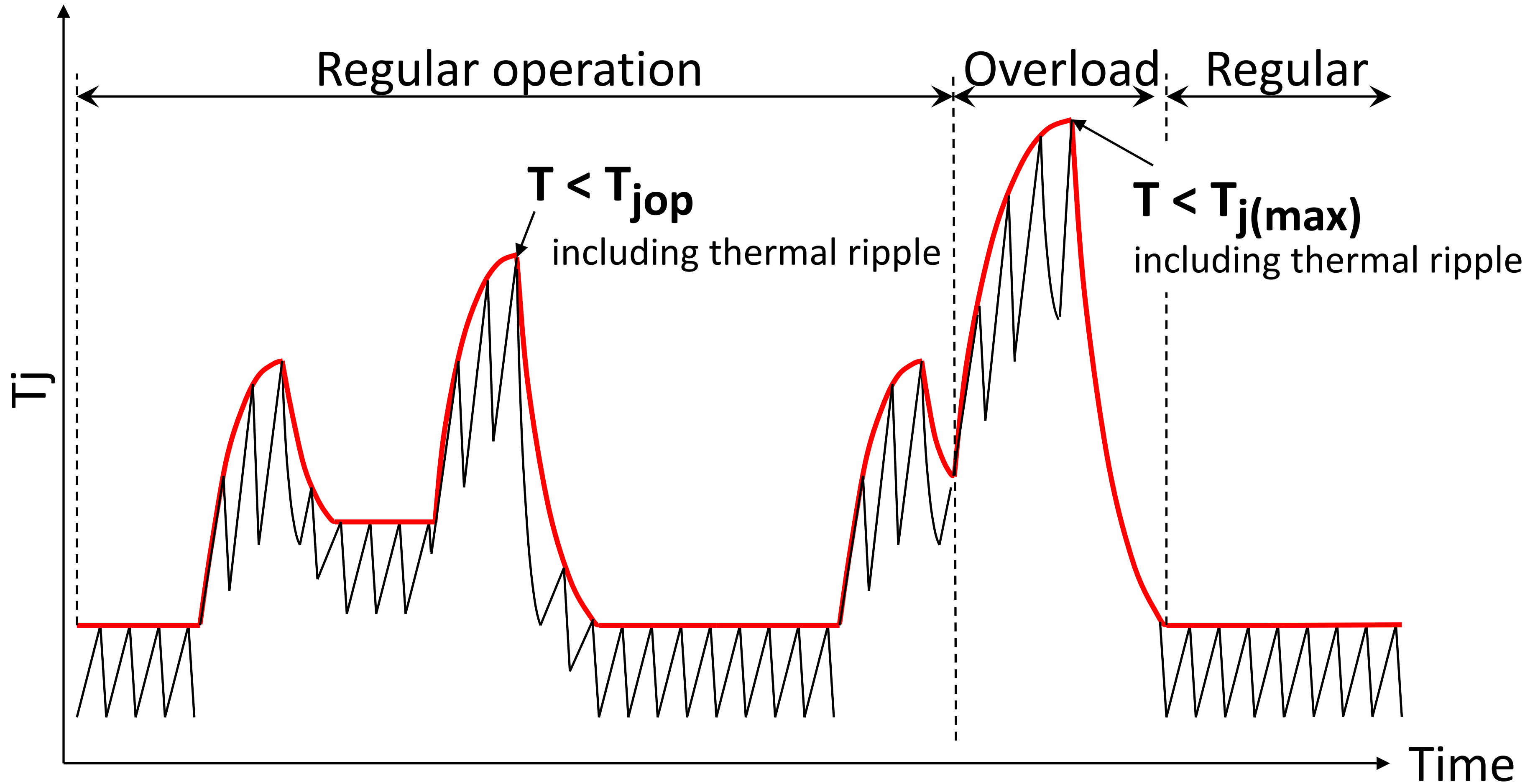
Regular operation → Overload → Regular operation

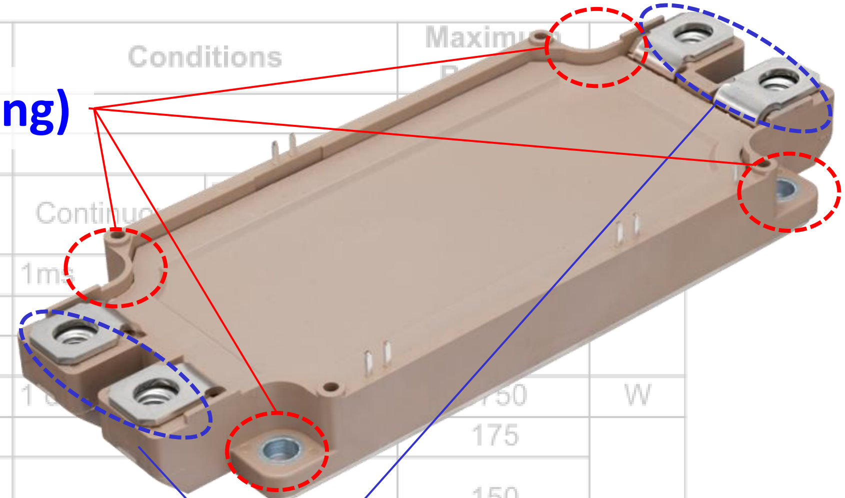


Screw Torque

■ Absolute Maximum Ratings (at T_C= 25°C unless otherwise specified)

Items		Symbols	Conditions	Maxim...	
Collector-Emitter volta...					
Gate-Emitter voltage		V_{GES}			
Collector current		I_C	Continu...		
		I_C pulse	1ms		
		$-I_C$			
		$-I_C$ pulse			
Collector power dissipation		P_C	1 ...	...50	W
Junction temperature		T_j		175	°C
Operating junction temperature (under switching conditions)		T_{jop}		150	
Case temperature		T_c		125	
Storage temperature		T_{stg}			
Isolation voltage	between terminal and copper base (*1)	V_{iso}	AC: 1min.	2500	VAC
	between thermistor and others (*2)				
Screw Torque	Mounting (*3)	-		3.5	N m
	Terminals (*4)	-		4.5	

(*1) All terminals should be connected together during the test.
(*2) Two thermistor terminals should be connected together, other terminals should be connected together and shorted to base plate during the test.
(*3) Recommendable Value : 2.5-3.5 Nm (M5)
(*4) Recommendable Value : 2.5-4.5 Nm (M6)



Screw Torque (Mounting)

Screw Torque (Terminals)

Please refer to mounting instructions
www.fujielectric.com/products/semiconductor/model/igbt/mounting/

Soldering Condition

Recommended soldering conditions for Fuji IGBT module products

1. Products range

   All of Fuji IGBT products

2. Applicable part

   Tab or pin type Control (sub) terminals of standard product
   All terminals of SIL, PIM-C product
   All pin terminals of Econo-series product

3. Recommended soldering condition at the terminal

   260 +- 5C / 10 +-1 sec. (by Solder bath)

   350 +- 10C / 3 +- 0.5 sec. (by Soldering iron)

Ref.No.: MT5F15147

Current Characteristics

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■ **Electrical characteristics (at T_j= 25°C unless otherwise specified)**

Items	Symbols	Conditions		Characteristics min.	Characteristics typ.	Characteristics max.	Units
Zero gate voltage Collector current	I_{CES}	V_{GE}=0V, V_{CE}= 1200V		-	-	3.0	mA
Gate-Emitter leakage current	I_{GES}	V_{CE}=0V, V_{GE}=±20V		-	-	600	nA
Gate-Emitter threshold voltage	$V_{GE(th)}$	V_{CE}=20V, I_C=600mA		6.0	6.5	7.0	V
Collector-Emitter saturation voltage	$V_{CE(sat)}$ (terminal)	V_{GE}= 15V, I_C= 600A	T_j=25°C	-	2.65	3.10	V
			T_j=125°C	-	3.00	-	
			[illegible]	[illegible]	[illegible]	[illegible]	
	$V_{CE(sat)}$ (chip)		[illegible]	[illegible]	[illegible]	[illegible]	
			T_j=125°C	-	2.20	-	
			T_j=150°C	-	2.25	-	
Internal gate resistance	$R_{G(int)}$	-		-	1.25	-	Ω
Input capacitance	C_{ies}	V_{CE}=10V, V_{GE}=0V, f=1MHz		-	48	-	nF
Turn-on time	t_{on}	V_{CC}= 600V, V_{GE}= ±15V, L_s= 80nH	I_C= 600A, [illegible]	-	550	-	nsec
	t_r			[illegible]	[illegible]	[illegible]	
	$t_{r(i)}$			-	120	-	
Turn-off time	t_{off}			[illegible]	[illegible]	[illegible]	
	t_f			-	110	-	
Forward on voltage	V_F (terminal)	V_{GE} = 0V, I_F= 600A	T_j=25°C	-	2.50	3.00	V
			T_j=125°C	-	2.65	-	
			T_j=150°C	-	2.60	-	
	V_F (chip)		T_j=25°C	-	1.70	2.15	
			T_j=125°C	-	1.85	-	
			T_j=150°C	-	1.80	-	
Reverse recovery time	t_{rr}	I_F= 600A		-	200	-	nsec
Thermistor Resistance	R	T=25°C		-	5000	-	Ω
		T=100°C		465	495	520	
Thermistor B value	B	T=25/50°C		3305	3375	3450	K

I_{CES} : Collector current with zero gate-emitter bias when a specific collector-emitter voltage is applied.

I_{GES} : Gate to emitter current with collector-emitter shorted when a specific gate-emitter voltage is applied.

Voltage Characteristics

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■ Electrical characteristics (at T_j= 25°C unless otherwise specified)

$V_{GE(th)}$: Threshold gate-emitter voltage at which collector current start to flow

If gate-voltage exceeds $V_{GE(th)}$ by malfunction of circuit etc, IGBT will be erroneous ON.

				Characteristics min.	typ.	max.	Units
Ze[illegible] Collector current	[illegible]	[illegible] 1200V		-	-	3.0	mA
Gate-Emitter leakage current	I_{GES}	V_{CE}=0V, V_{GE}=±20V		-	-	600	nA
Gate-Emitter threshold voltage	$V_{GE(th)}$	V_{CE}=20V, I_C=600mA		6.0	6.5	7.0	V
Collector-Emitter saturation voltage	$V_{CE(sat)}$ (terminal)	V_{GE} = 15V, I_C=600A	T_j=25°C	-	2.65	3.10	V
			T_j=125°C	-	3.00	-	
			T_j=150°C	-	3.05	-	
	$V_{CE(sat)}$ (chip)		T_j=25°C	-	1.85	2.30	
			T_j=125°C	-	2.20	-	
			T_j=150°C	-	2.25	-	
Internal gate resistance	$R_{G(int)}$	-		-	1.25	-	Ω
Input capacitance	C_{ies}	V_{CE}=10V, V_{GE}=0V, f=1MHz		-	48	-	nF
Turn-on time	t_{on}	V_{CC}=600V, [illegible] 600A, V_{GE}= ±15[illegible], L_s= 80nH		[illegible]	[illegible]	[illegible]	[illegible]
	t_r			-	180	-	
	$t_{r(i)}$			[illegible]	[illegible]	[illegible]	
Turn-off time	t_{off}			-	1050	-	
	t_f			-	110	-	
Forward on voltage	V_F (terminal)	V_{GE} = 0V, I_F=600A	T_j=25°C	-	2.50	3.00	V
			T_j=125°C	-	2.65	-	
			T_j=150°C	-	2.60	-	
	V_F (chip)		T_j=25°C	-	1.70	2.15	
			T_j=125°C	-	1.85	-	
			T_j=150°C	-	1.80	-	
Reverse recovery time	t_{rr}	I_F=600A		-	200	-	nsec
Thermistor Resistance	R	T=25°C		-	5000	-	Ω
		T=100°C		465	495	520	
Thermistor B value	B	T=25/50°C		3305	3375	3450	K

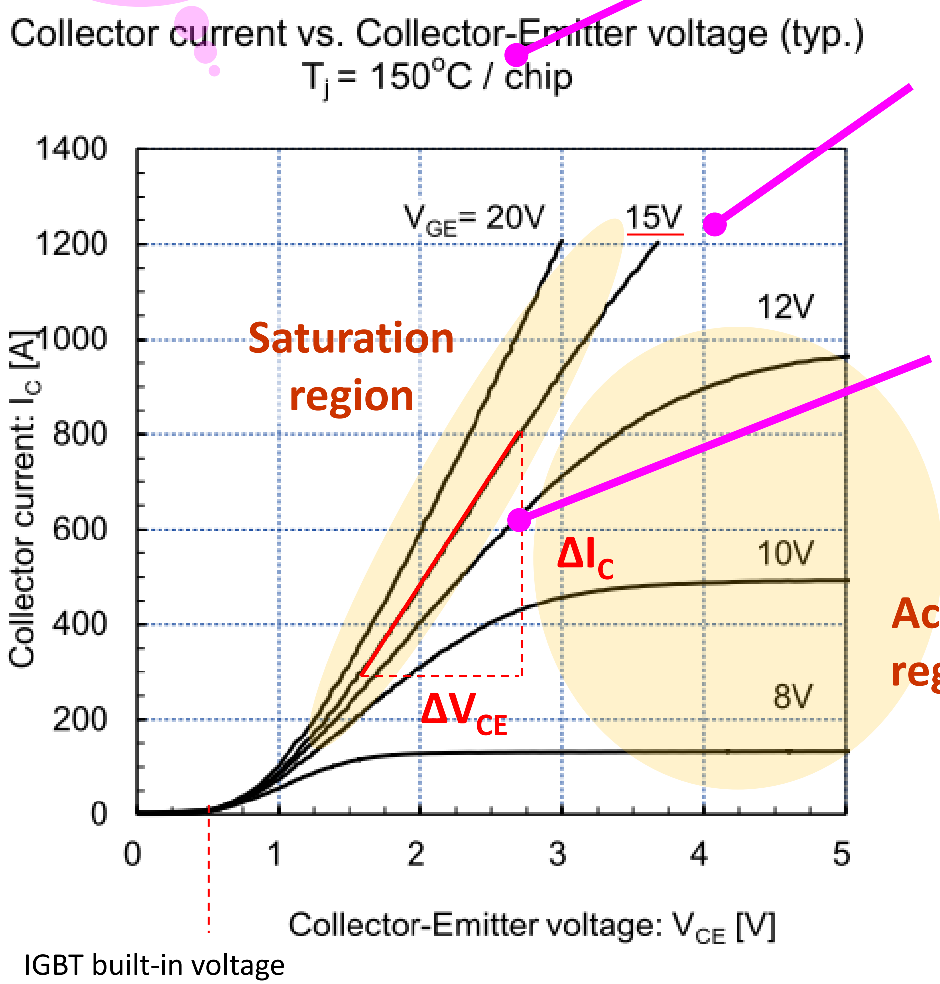
$V_{CE(sat)}$ / V_F : Saturation value of Gate-emitter voltage of IGBT or forward voltage of FWD at a specific condition.

Use these values for power loss calculation.

IGBT Output Characteristics

Use these data for loss calculation and cooling design

Be careful with provided temperature conditions.



Recommended VGE : 15V±10%

Small V_{GE} → High $V_{CE(sat)}$, Increase of Loss

ON-resistance

$R_{on} = \Delta V_{CE} / \Delta I_C$

Active region

Increase conduction loss

Don't use IGBT in this region

IGBT Output Characteristics

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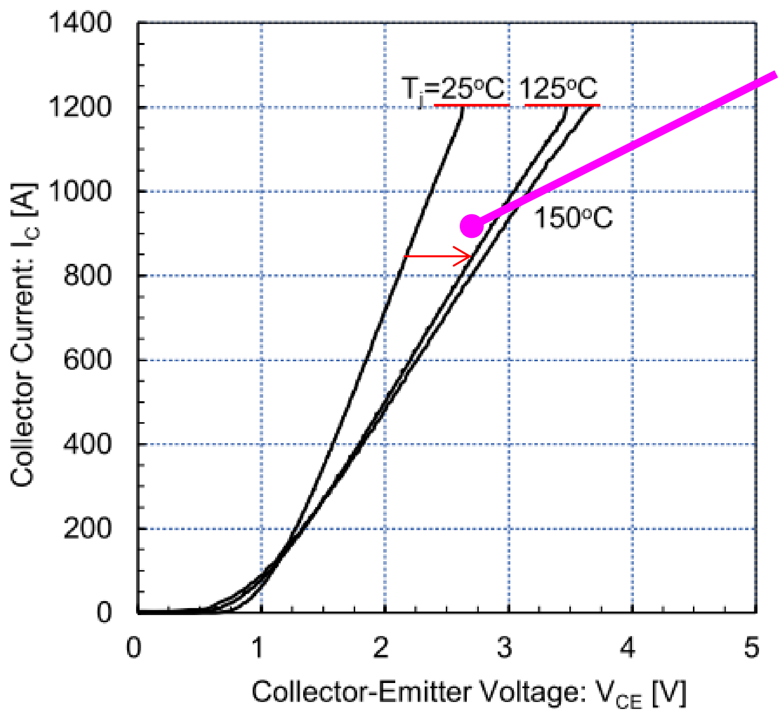
Collector current vs. Collector-Emitter voltage
V_{GE} = 15V / chip



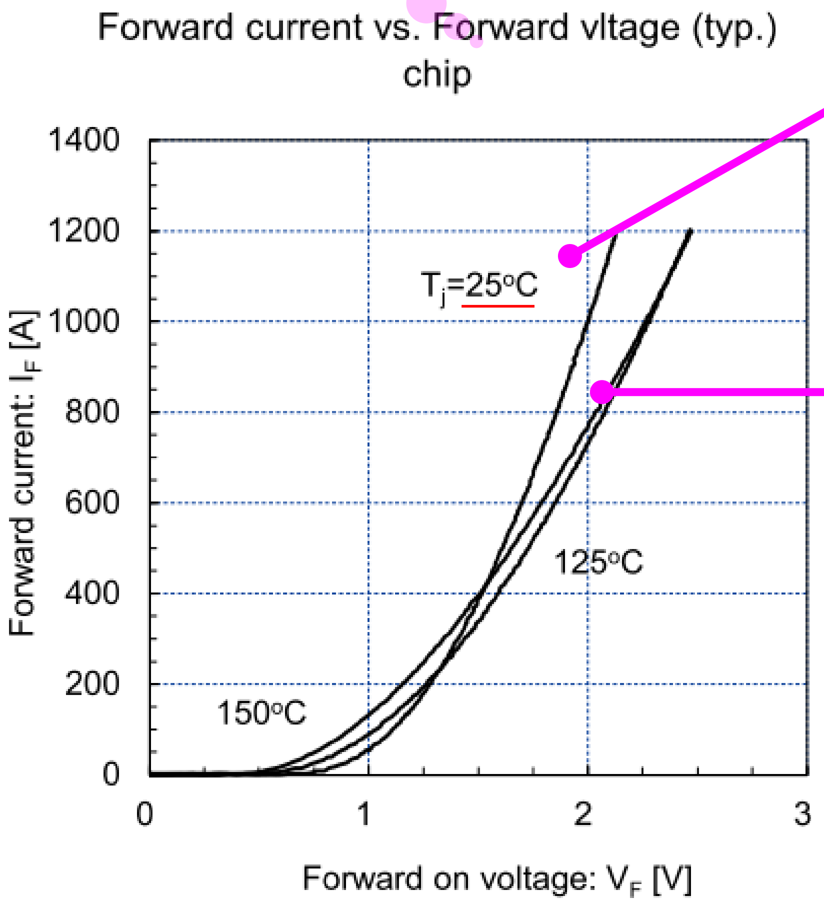
Fuji IGBT has positive temperature coefficient.

High T_j → High $V_{CE(sat)}$

This feature is good for paralleling of IGBT modules.

FWD Output Characteristics

Necessary data for loss calculation, cooling design (thermal rating).



Be careful with provided temperature conditions.

Fuji FWD has positive temperature coefficient in large current region.

Output Characteristics MOSFET vs IGBT

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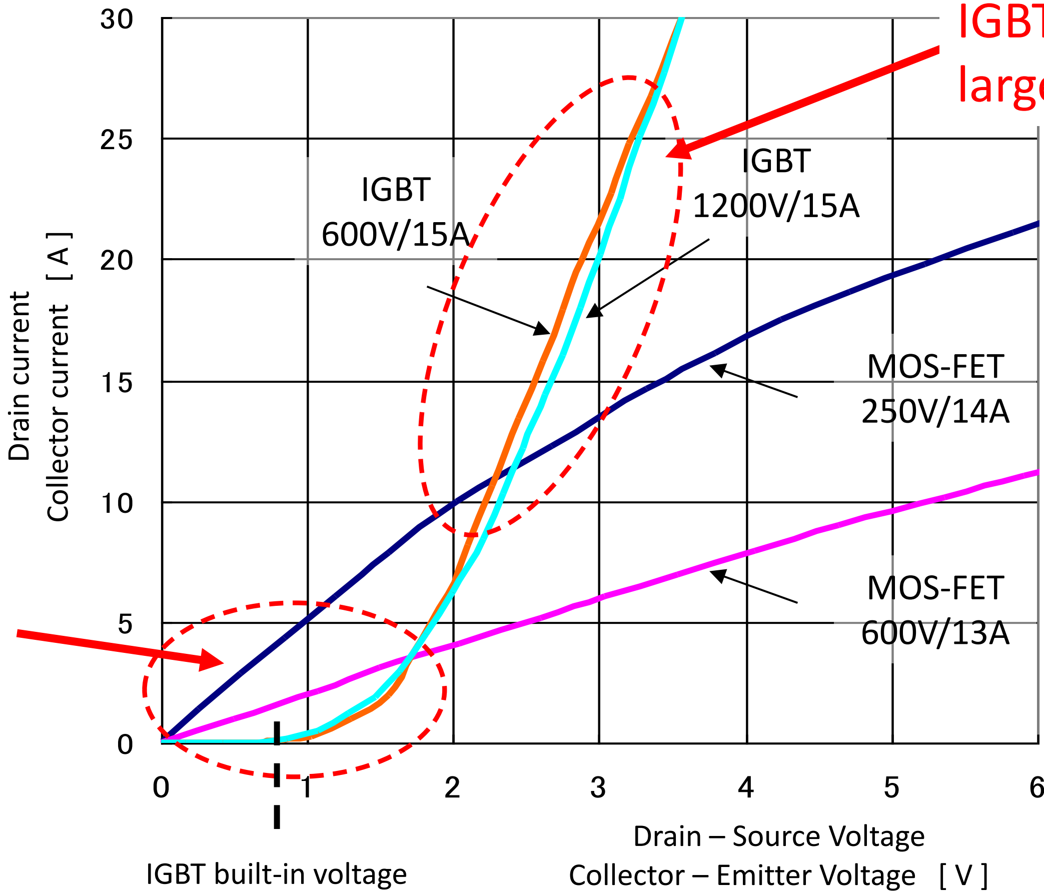
Output characteristics of 15A class module

IGBT has advantage in large current area.



MOS-FET has advantage in small current area.

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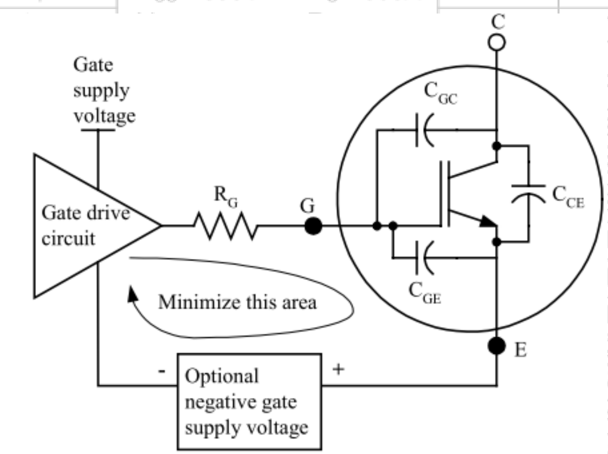
MT5F32726

■ **Electrical characteristics (at T_j= 25°C unless otherwise specified)**

C_{ies} : Gate-emitter capacitance, when a specified voltage is applied between the gate and emitter as well as between the collector and emitter, with the collector and emitter shorted in AC.
Use the Q_G characteristics for drive circuit design, because input capacitance strongly depends on Collector-Emitter voltage.

Items	Symbols	Conditions	Characteristics min.	Characteristics typ.	Characteristics max.	Units
Input capacitance	C_{ies}	V_{CE}=10V, V_{GE}=0V, f=1MHz	-	48	-	nF



$$C_{ies} = C_{GE} + C_{GC}$$

$$C_{res} = C_{GC}$$

$$C_{oes} = C_{CE} + C_{GC}$$

Gate Charge(Q_G) Characteristics

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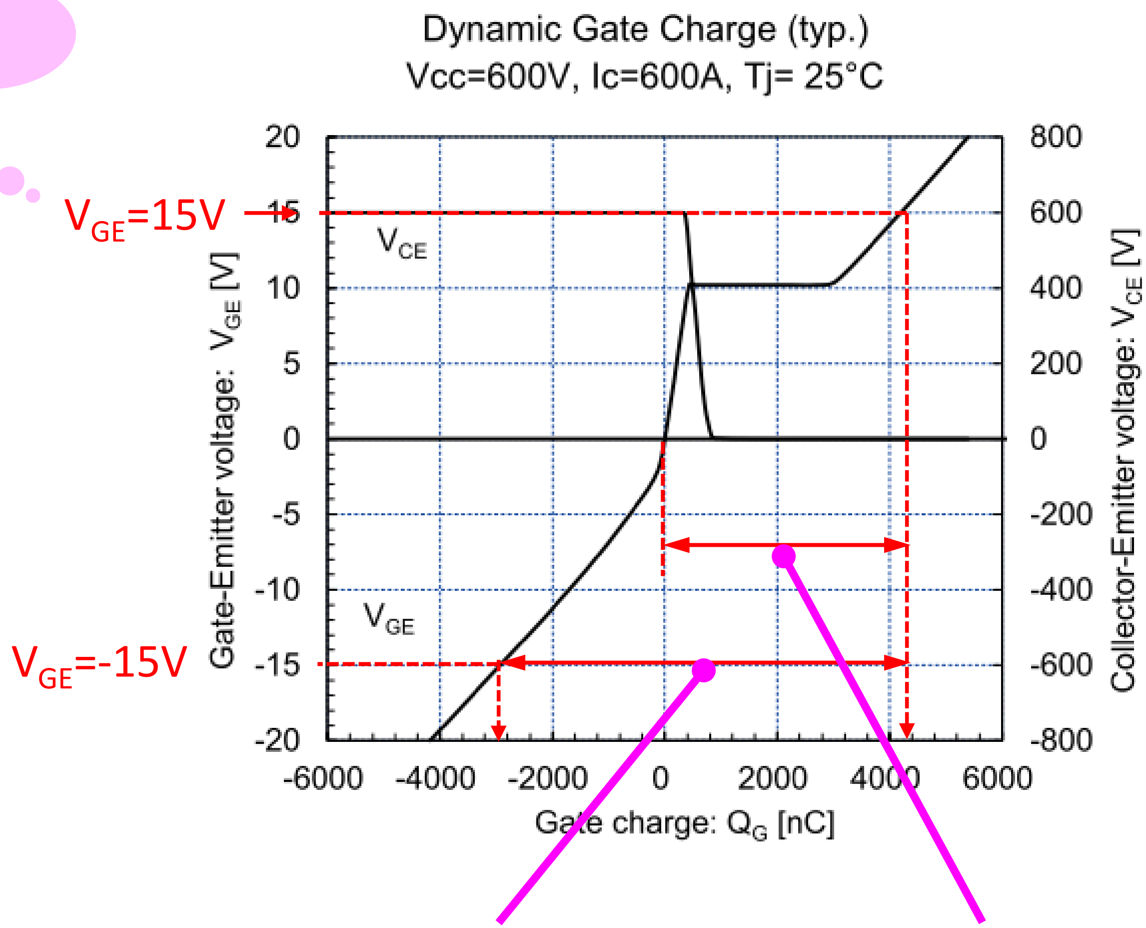
Necessary data for drive circuit
(Current and thermal rating)

Gate drive power
(= gate resistance loss)

$$P = fc \times Q_G \times V_{GE}$$



Quantity of electric charge for gate charging **-15V～15V**

Quantity of electric charge for gate charging **0V～15V**

Definition of Switching Time

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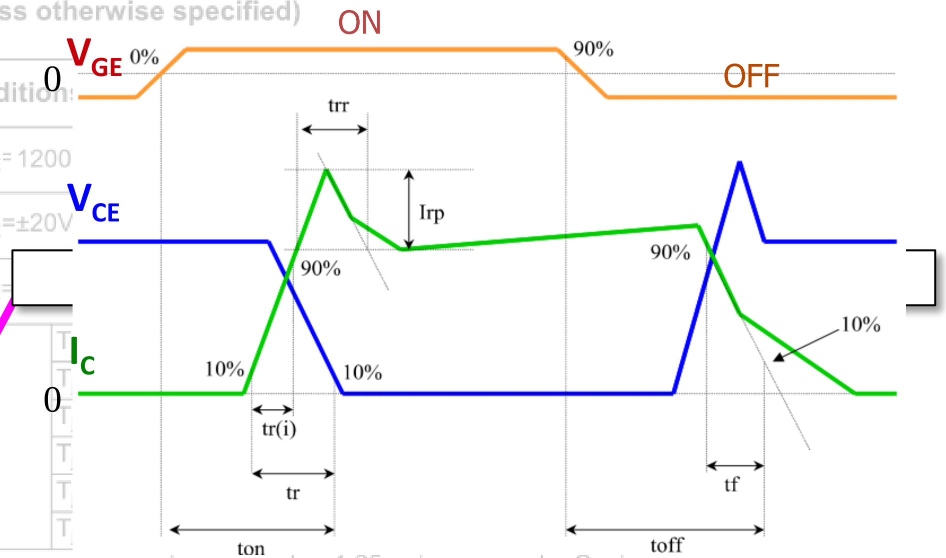
■ Electrical characteristics (at T_j= 25°C unless otherwise specified)



Items	Symbols	Conditions					
Zero gate voltage Collector current	I_{CES}	V_{GE}=0V, V_{CE}=1200					
Gate-Emitter leakage current	I_{GES}	V_{CE}=0V, V_{GE}=±20V					
Gate-Emitter threshold voltage	$V_{GE(th)}$	V_{CE}=20V, I_C=					
Collector-Emitter saturation voltage	$V_{CE(sat)}$ (terminal)	V_{GE} = 15V I_C=600A	T				
			T				
			T				
	$V_{CE(sat)}$ (chip)		T				
			T				
			T				
Internal gate resistance	$R_{G(int)}$	-		-	1.25	-	Ω
Input capacitance	C_{ies}	V_{CE}=10V, V_{GE}=0V, f=1MHz		-	48	-	nF
Turn-on time	t_{on}	V_{CC}= 600V I_C= 600A V_{GE}= ±15V R_G= 0.62Ω L_s= 80nH		-	550	-	nsec
	t_r			-	180	-	
	$t_{r(i)}$			-	120	-	
Turn-off time	t_{off}			-	1050	-	
	t_f			-	110	-	
Forward on voltage	V_F (terminal)	V_{GE} = 0V I_F=600A	T_j=25°C	-	2.50	3.00	V
			T_j=125°C	-	2.65	-	
			T_j=150°C	-	2.60	-	
	V_F (chip)		T_j=25°C	-	1.70	2.15	
			T_j=125°C	-	1.85	-	
			T_j=150°C	-	1.80	-	
Reverse recovery time	t_{rr}	I_F=600A		-	200	-	nsec
Thermistor Resistance	R	T=25°C		-	5000	-	Ω
		T=100°C		465	495	520	
Thermistor B value	B	T=25/50°C		3305	3375	3450	K

The value indicated on a catalog is a standard gate resistance value.

This is not manufacturer's recommended value.

Switching Losses

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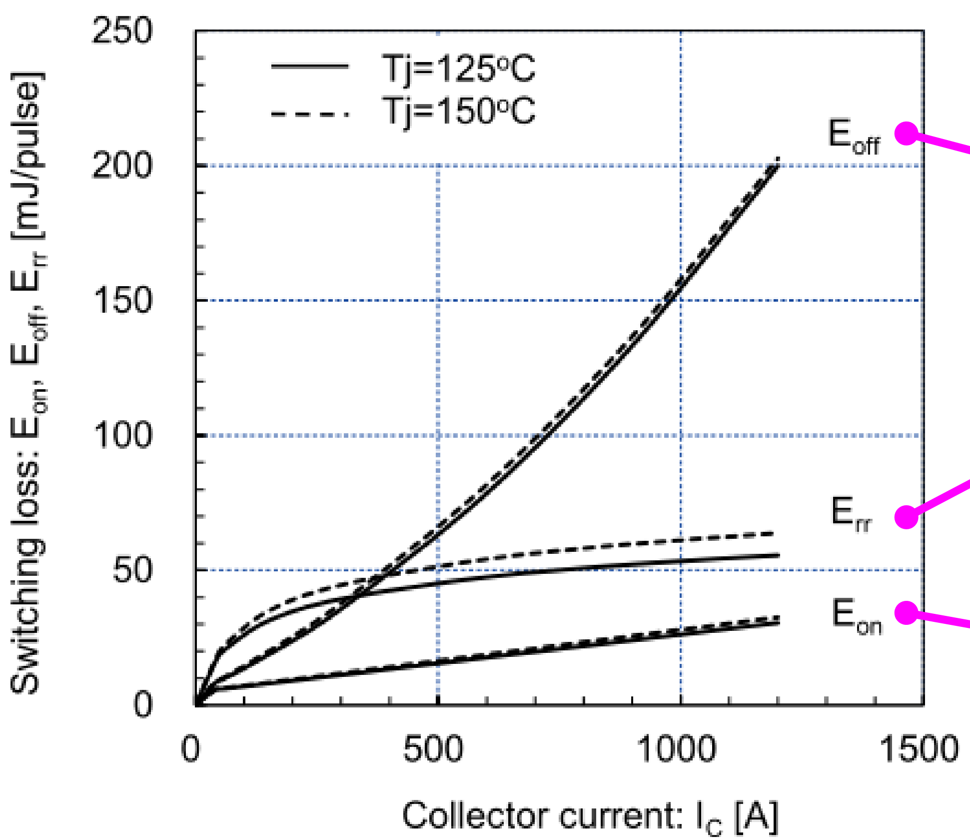
Necessary data for loss calculation, cooling design (thermal rating).

Switching losses are proportional to DC bus voltage

Switching loss vs. Collector current (typ.)
Vcc=600V, VGE=±15V, Rg=0.62Ω, Tj=125°C, 150°C



E_{off} : **IGBT Turn-off loss**

E_{rr} : **FWD Reverse-recovery loss**

E_{on} : **IGBT Turn-on loss**

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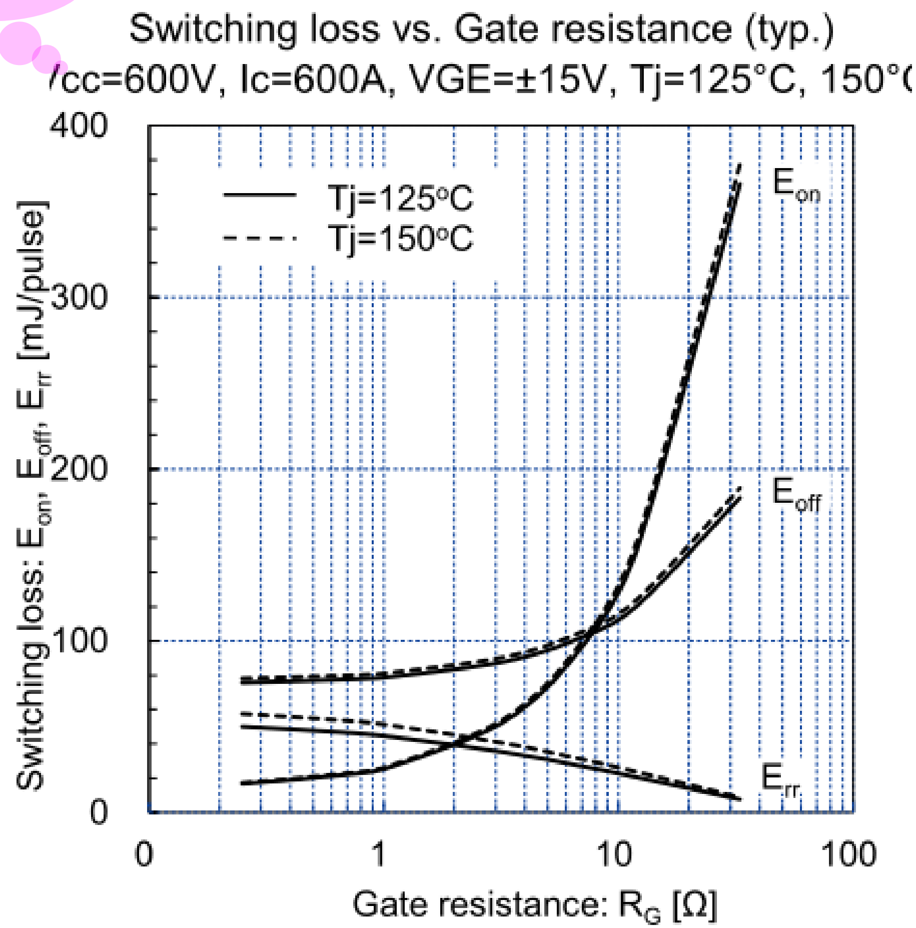
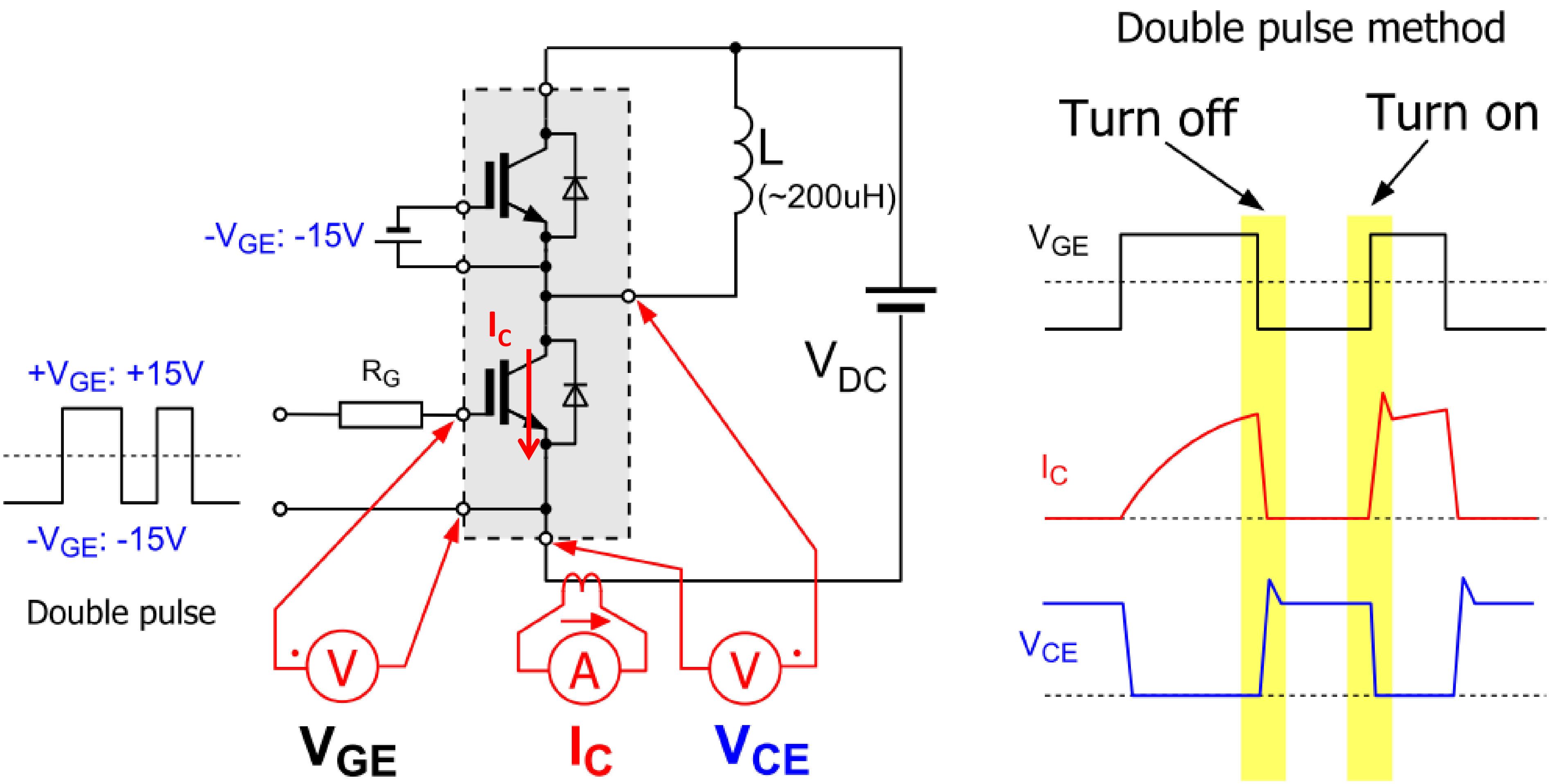
Switching Loss vs Gate Resistance

Necessary data for loss calculation, cooling design (thermal rating).



Turn-on & Turn-off Measurement

Lower arm turn-on and turn-off measurement



Turn-on Waveform (IGBT)

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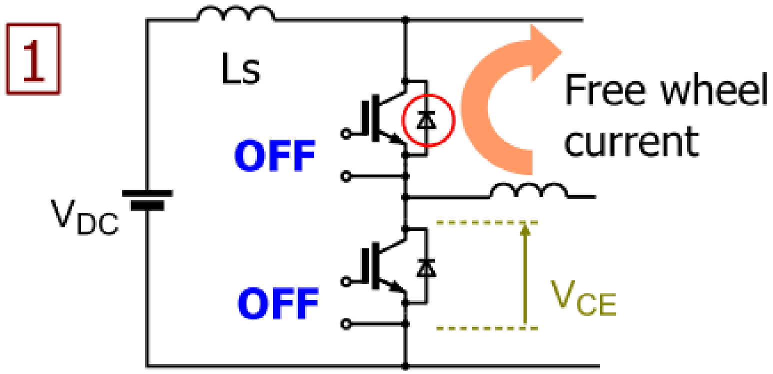
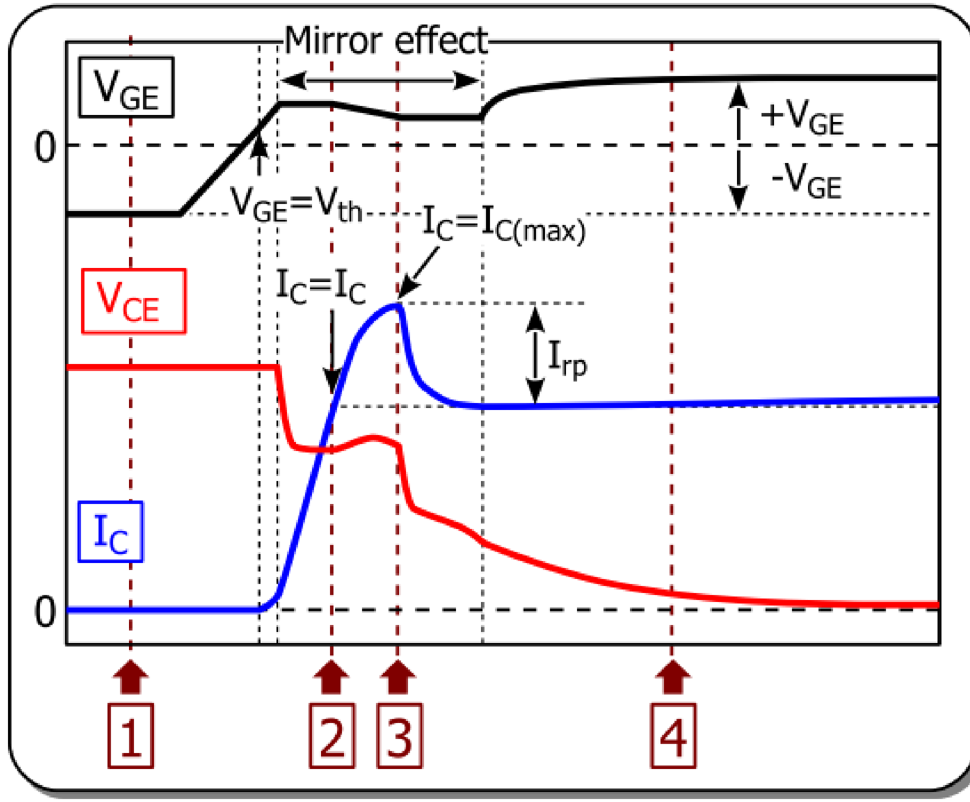
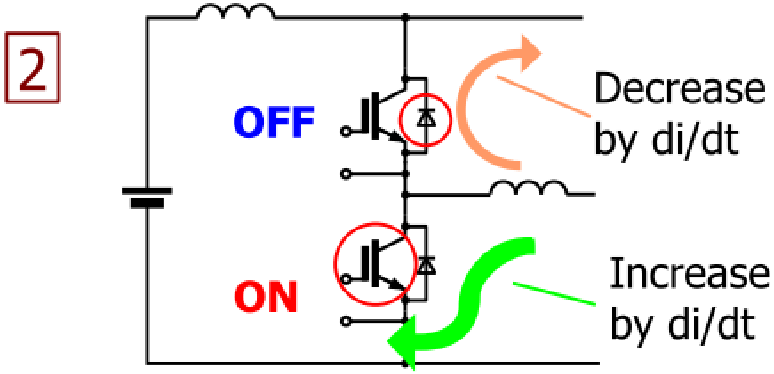
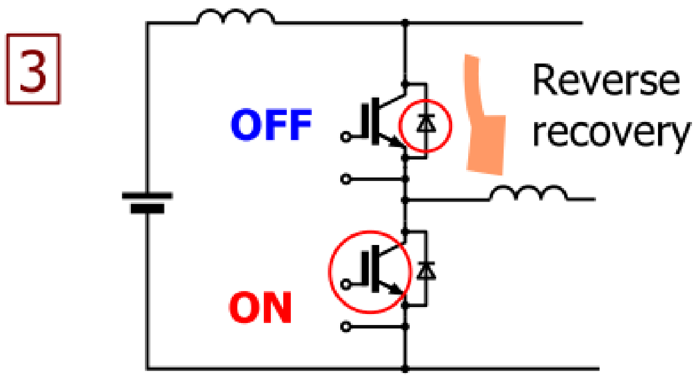
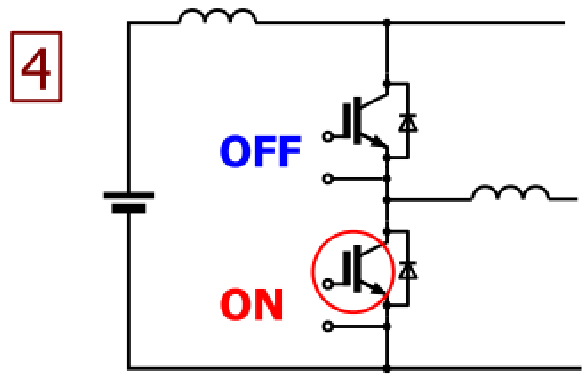


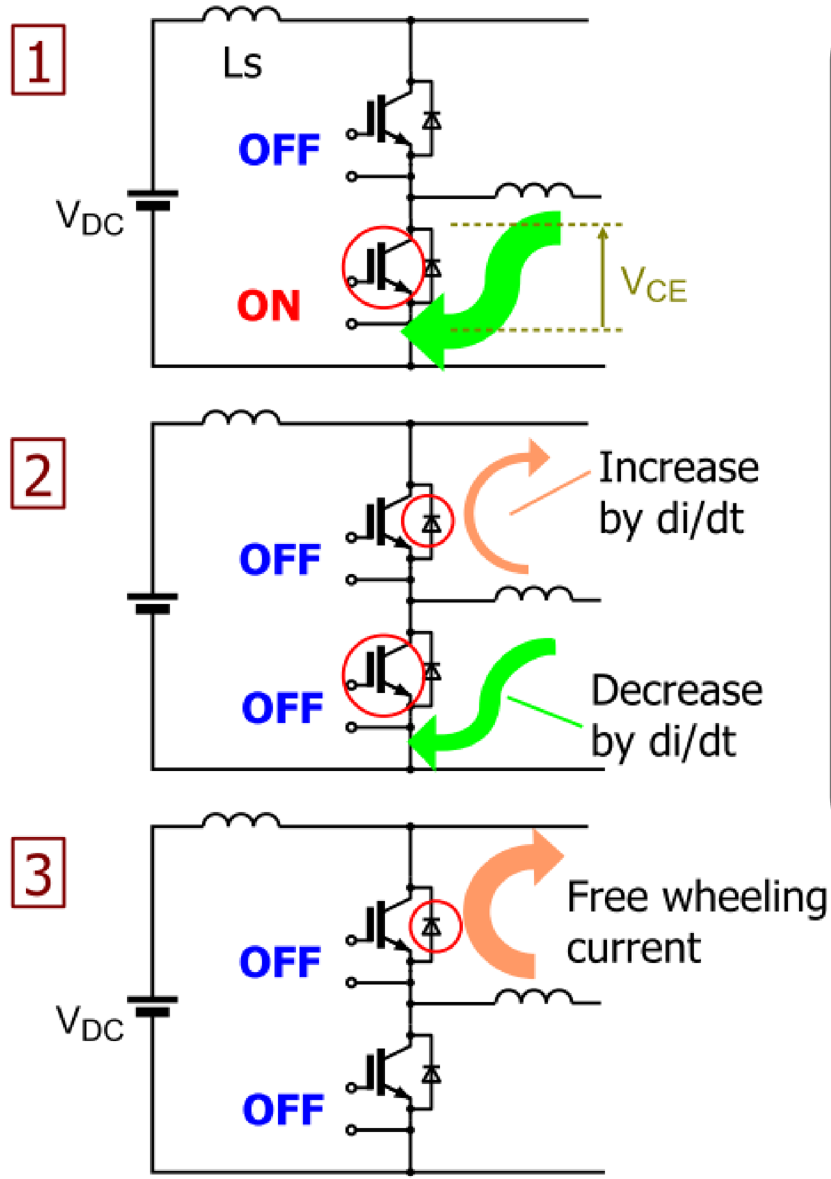


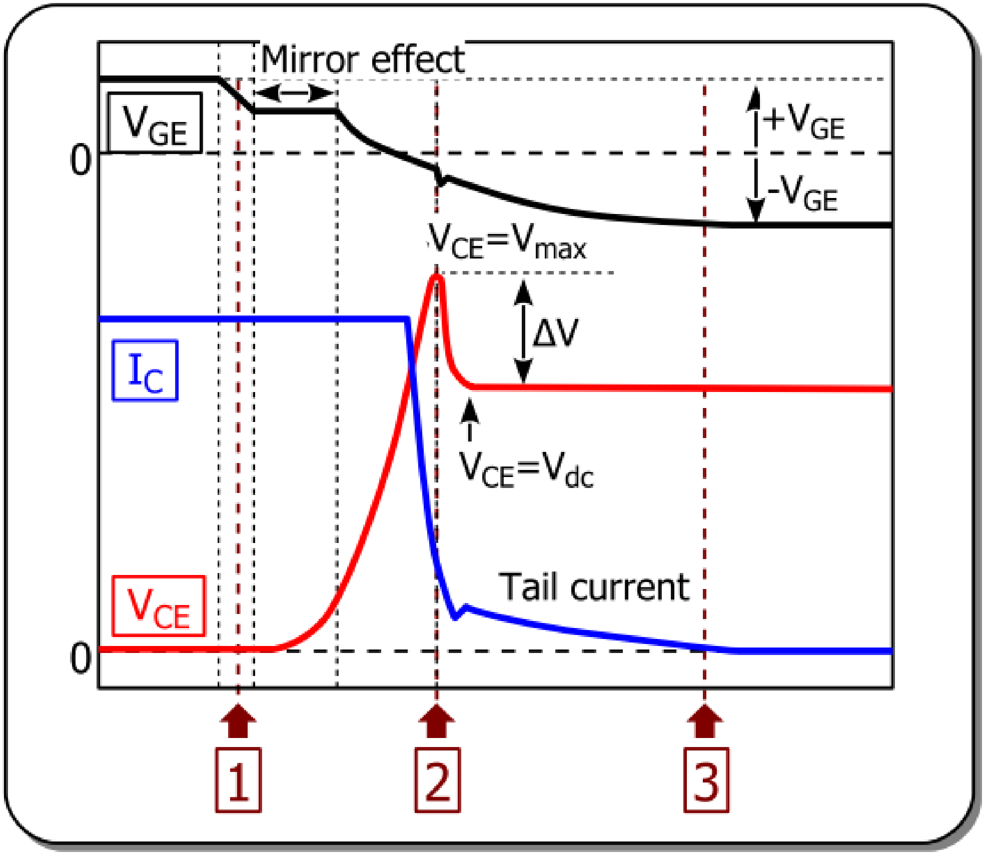






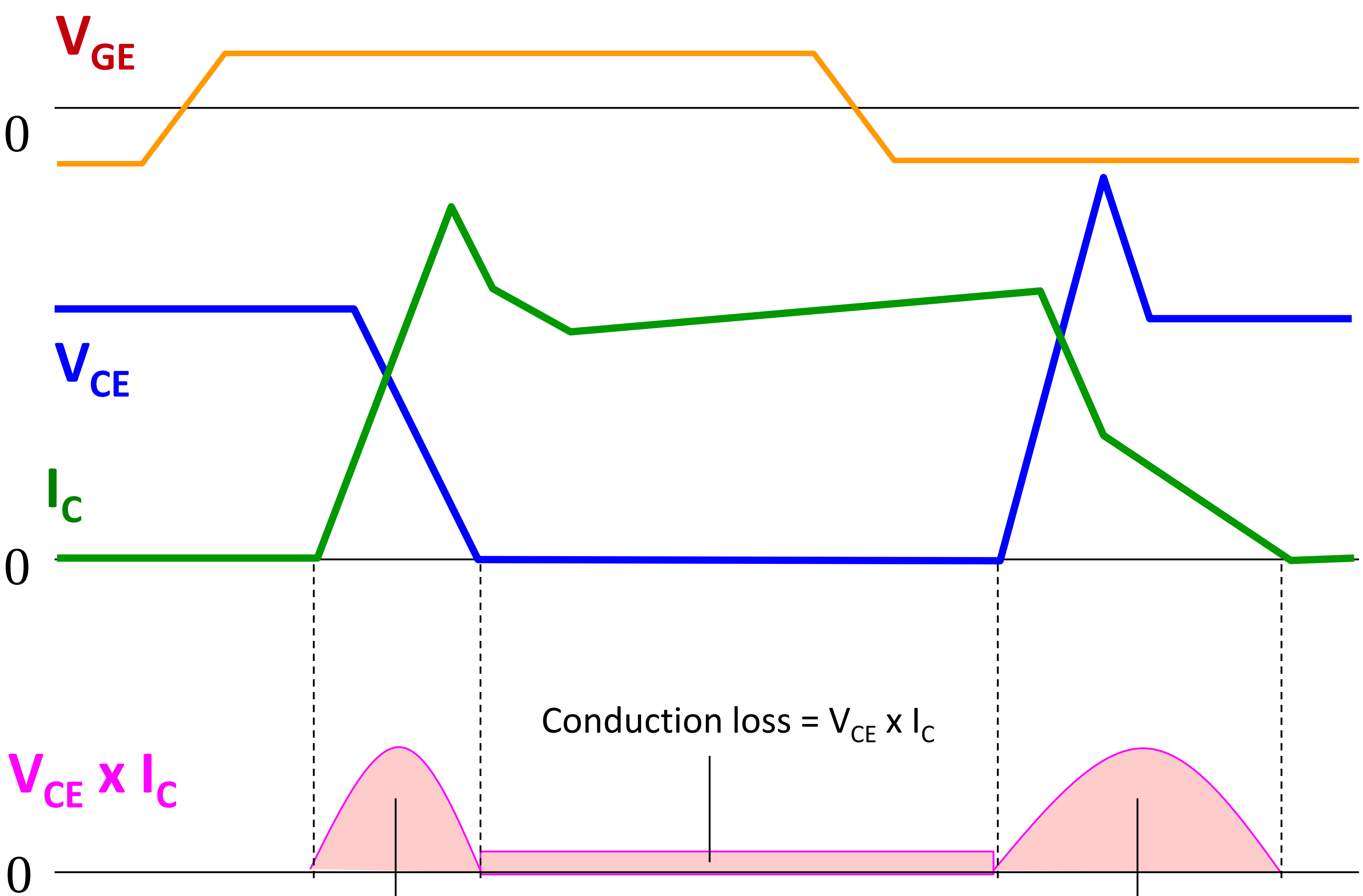
Turn-off Waveform (IGBT)





$$Vcep = V_{DC} + Ls\,(-di/dt)$$

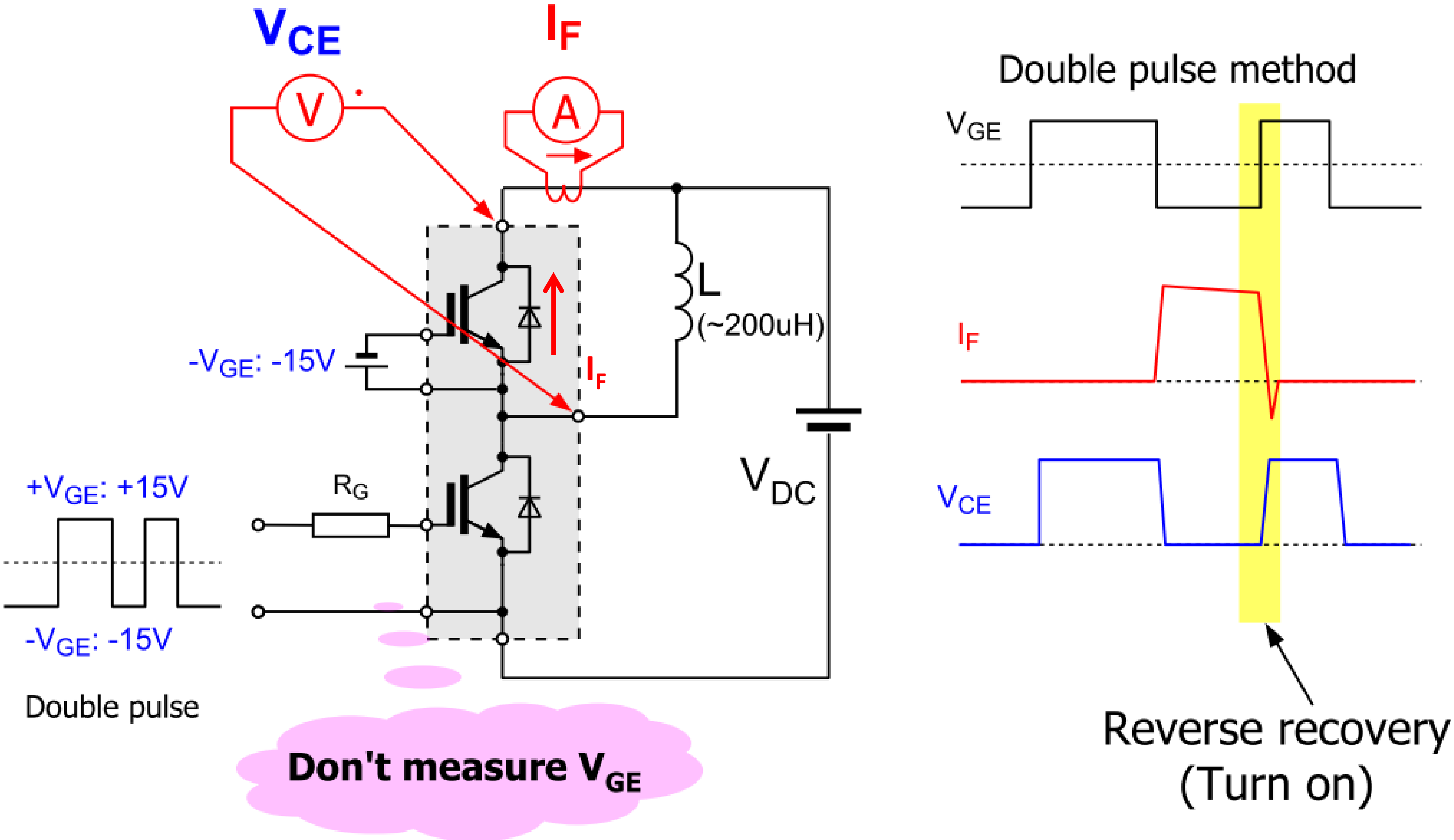
Definition of Switching Loss



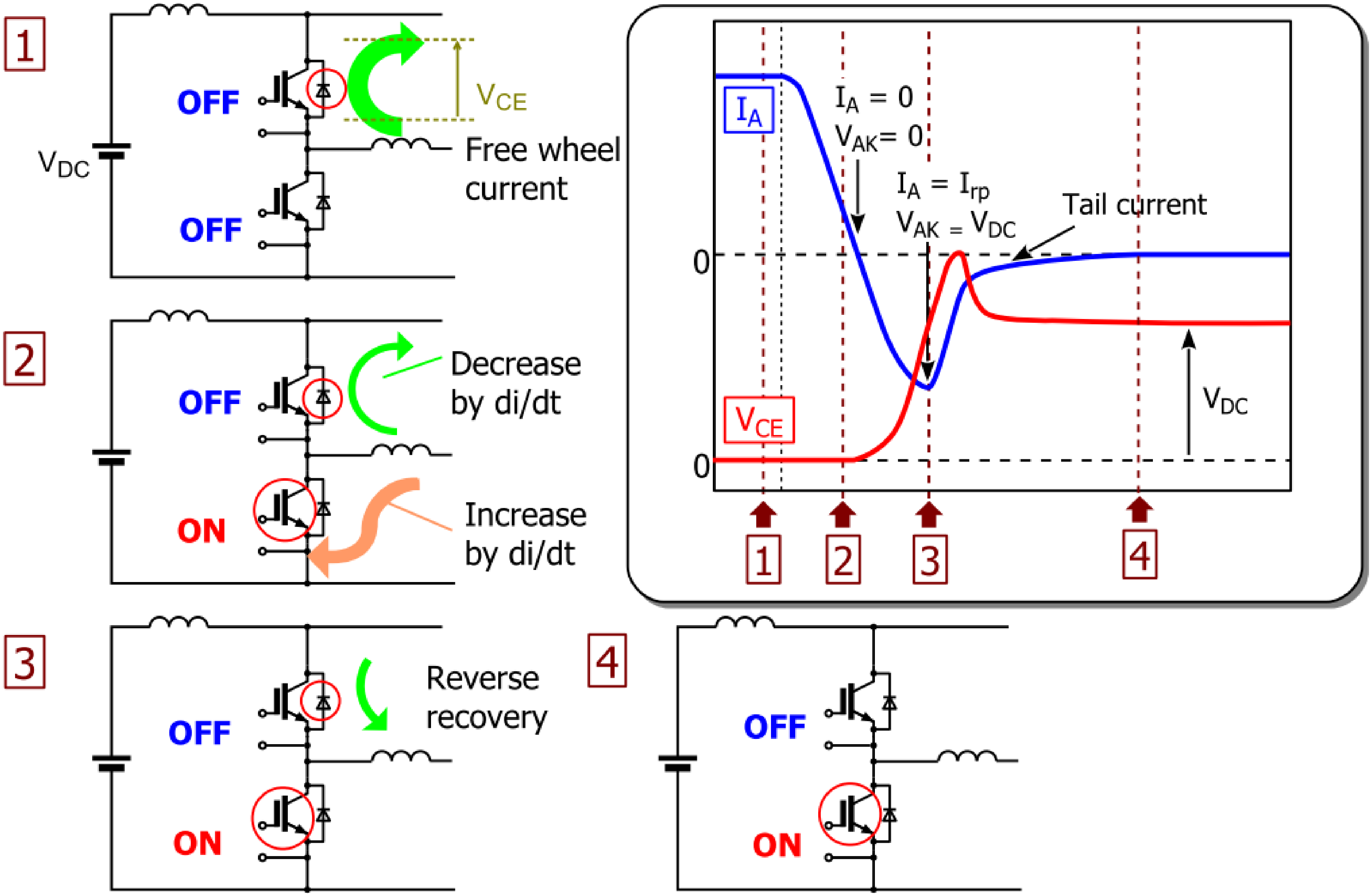
$$E_{\mathrm{on}} = \int V_{\mathrm{CE}} \cdot I_{\mathrm{C}}\, dt \quad \text{(J)}$$

$$E_{\mathrm{off}} = \int V_{\mathrm{CE}} \cdot I_{\mathrm{C}}\, dt \quad \text{(J)}$$

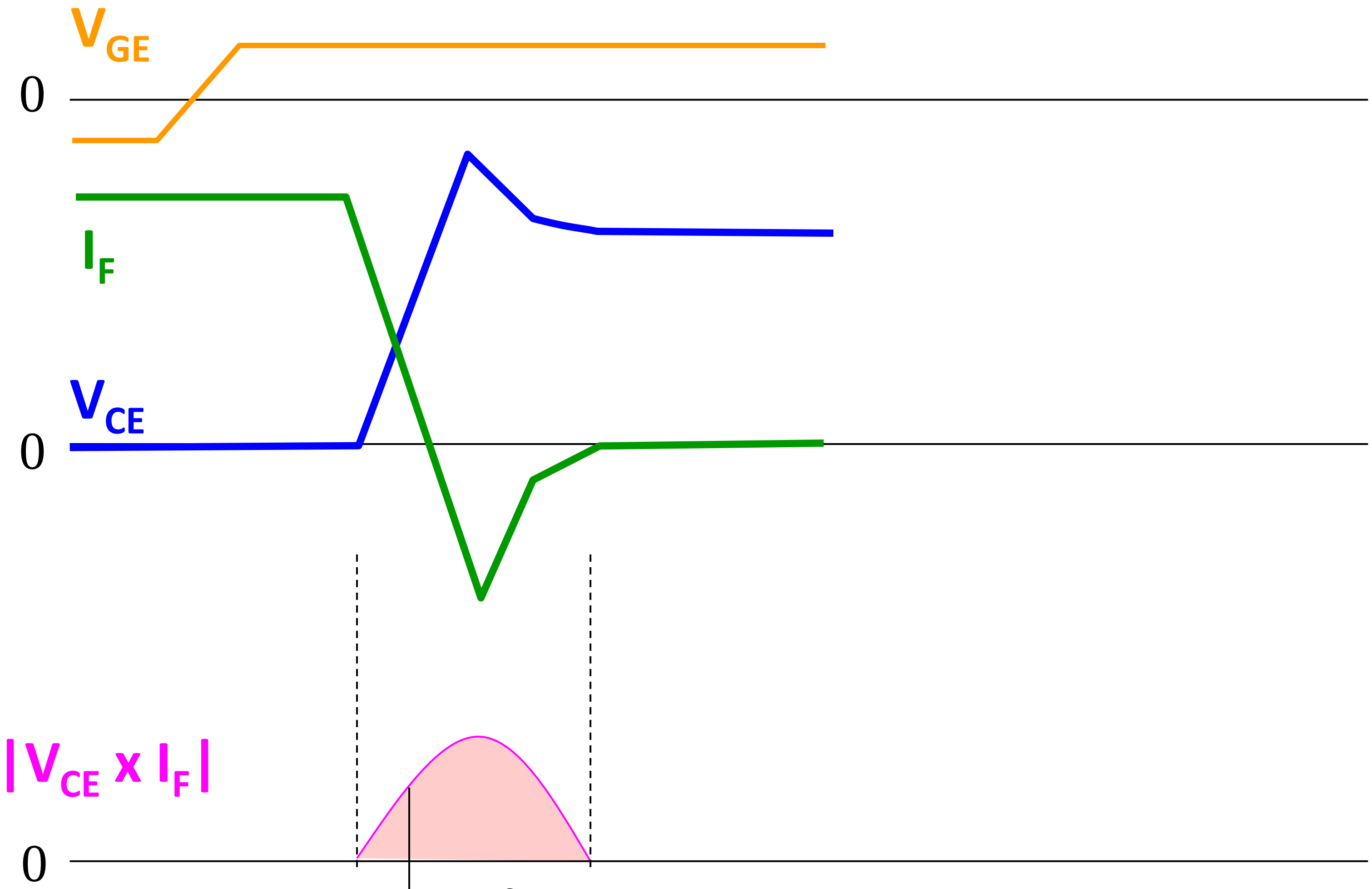
Reverse Recovery Measurement



Reverse Recovery Waveform (FWD)



Definition of Switching Loss



$$E_{rr} = \int |V_{CE} \cdot I_F| \, dt \text{ (J)}$$

Thermal Characteristics

Fuji Electric
Innovating Energy Technology

5. Thermal resistance characteristics

Items	Symbols	Conditions	Characteristics			Units
			min.	typ.	max.	
Thermal resistance (1device)	$R_{th(j-c)}$	IGBT	-	-	0.04	°C/W
		FWD	-	-	0.06	
Contact thermal resistance (1device) (*1)	$R_{th(c-f)}$	with thermal compound	-	0.0167	-	

(*1) This is the value which is defined mounting on the additional cooling fin with thermal compound.

$R_{th(j-c)}$: Thermal resistance between the junction (chip) and the case (bottom of base plate)

$R_{th(c-f)}$: Thermal resistance between the case and the surface of heatsink when the IGBT is mounted on a heat sink with a thermal grease

→ See also "Definition of Thermal Model"

Thermal Resistance Junction to Case

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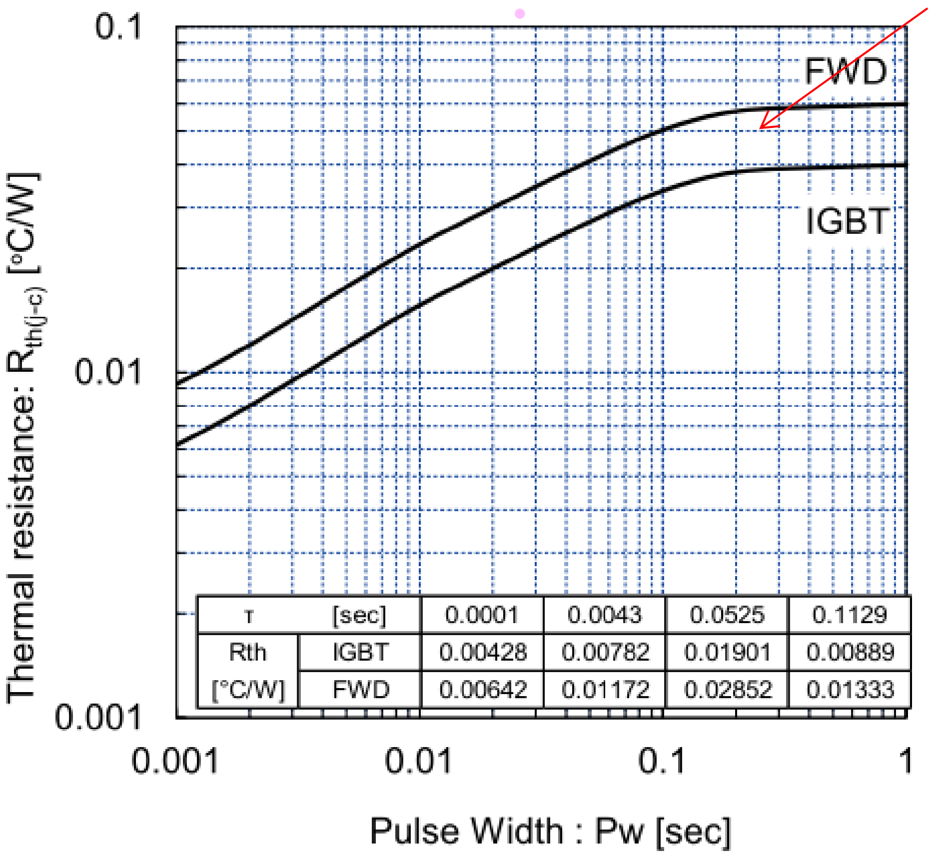
Innovating Energy Technology

Necessary data for cooling design (thermal rating).



τ	[sec]	0.0001	0.0043	0.0525	0.1129
Rth [°C/W]	IGBT	0.00428	0.00782	0.01901	0.00889
	FWD	0.00642	0.01172	0.02852	0.01333

Junction to case thermal resistance value is almost saturated within one second.

$R_{th(j\text{-}c)}(\infty)$

Thermal resistance at steady-state

Thermal resistance value is inversely proportional to die size.

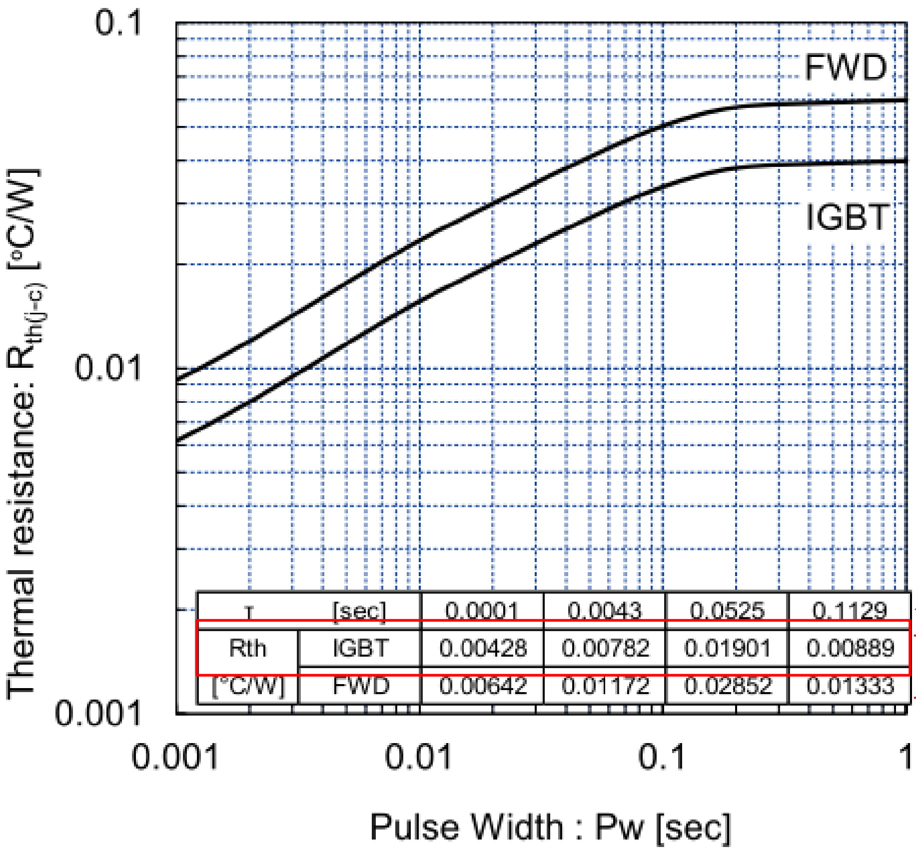
FWD thermal resistance is larger than IGBT.

→ Be careful in case of rectifier usage (**PWM-converter** etc.) that require the high duty to the diode.

Transient Thermal Impedance

Thermal resistance curve $R_{th(j\text{-}c)}(t)$ is represented by Foster Equivalent Network Model.

Foster parameters (r_n, τ_n) are provided in datasheet.



τ	[sec]	0.0001	0.0043	0.0525	0.1129
Rth	IGBT	0.00428	0.00782	0.01901	0.00889
[°C/W]	FWD	0.00642	0.01172	0.02852	0.01333

Foster equivalent

$$R_{\mathrm{th(j-c)}}(t) = \sum_{n-1}^{4} r_n \left\{ 1 - \exp\left(-\frac{t}{\tau_n} \right) \right\}$$

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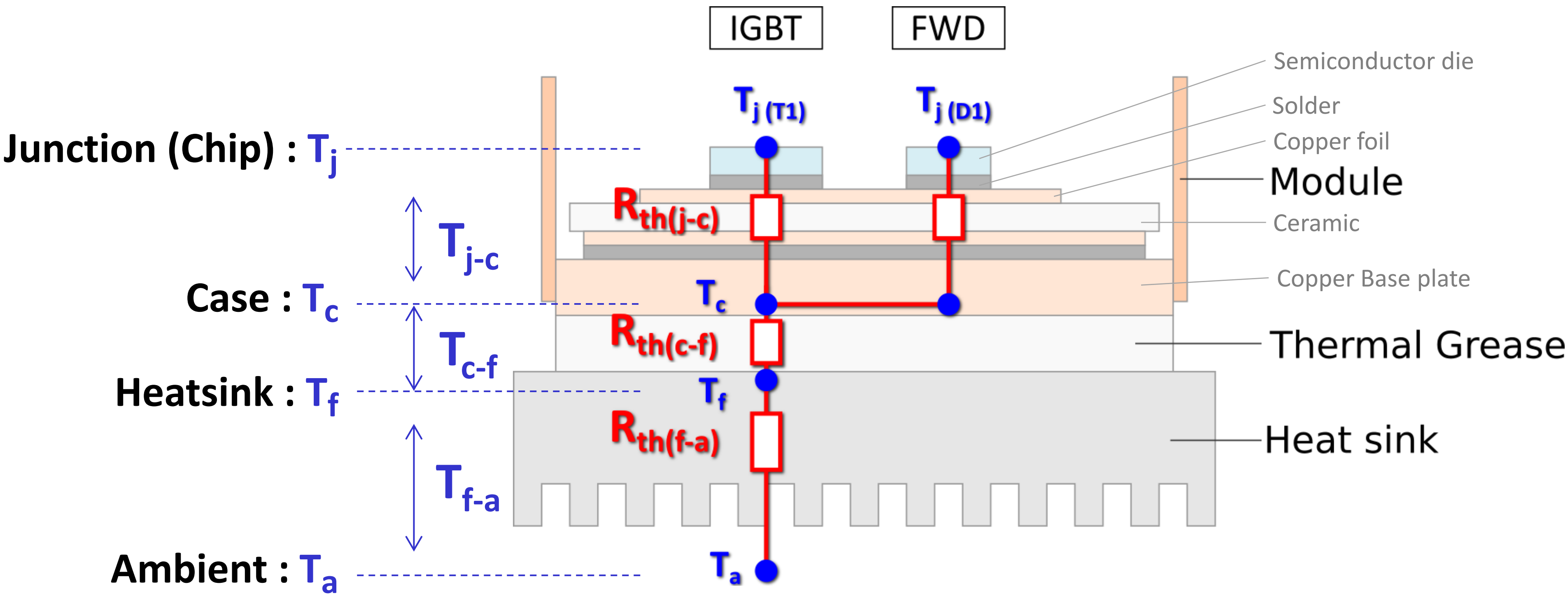
MT5F32726

Definition of Thermal Model



Case temperature T_c: Surface of Cu base plate under the chip

Heat sink temperature T_f: Surface of the heatsink under the chip

NTC - Thermistor

Fuji Electric
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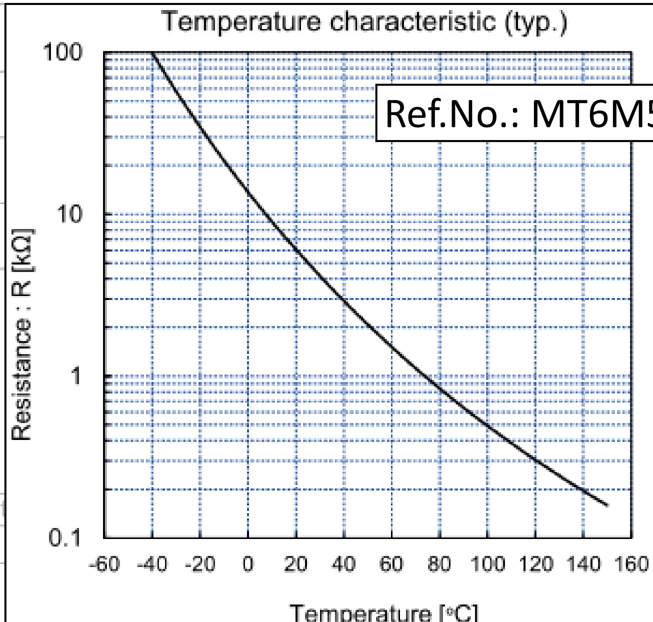
■ Electrical characteristics (at T_j= 25°C unless otherwise specified)



Items	Symbols	Conditions	min.	typ.	max.	Units
Zero gate voltage Collector current					3.0	mA
Gate-Emitter leakage current				-	600	nA
Gate-Emitter threshold voltage				6.5	7.0	V
Collector-Emitter saturation voltage				2.65	3.10	V
				3.00	-	
				3.05	-	
				1.85	2.30	
				2.20	-	
				2.25	-	
Internal gate resist				1.25	-	Ω
Input capacitance				48	-	nF
Turn-on time				550	-	
				180	-	
	$t_{r(i)}$	V_{GE}= ±15V R_G= 0.62Ω	-	120	-	
Turn-off time				1050	-	
	t_f			110	-	
Forward on voltage	V_F (terminal)	T_j=25°C	-	2.50	3.0	
		T_j=125°C		2.65		
	V_F (chip)	I_F=600A T_j=25°C	-	1.70	2.1	
		T_j=125°C	-	1.85	-	
		T_j=150°C	-	1.80	-	
Reverse recovery time	t_{rr}	I_F=600A	-	200	-	nsec
Thermistor Resistance	R	T=25°C	-	5000	-	Ω
		T=100°C	465	495	520	
Thermistor B value	B	T=25/50°C	3305	3375	3450	K

R : Thermistor resistance at specified temperature

B : Temperature coefficient of the resistance ($B_{25/50}$)

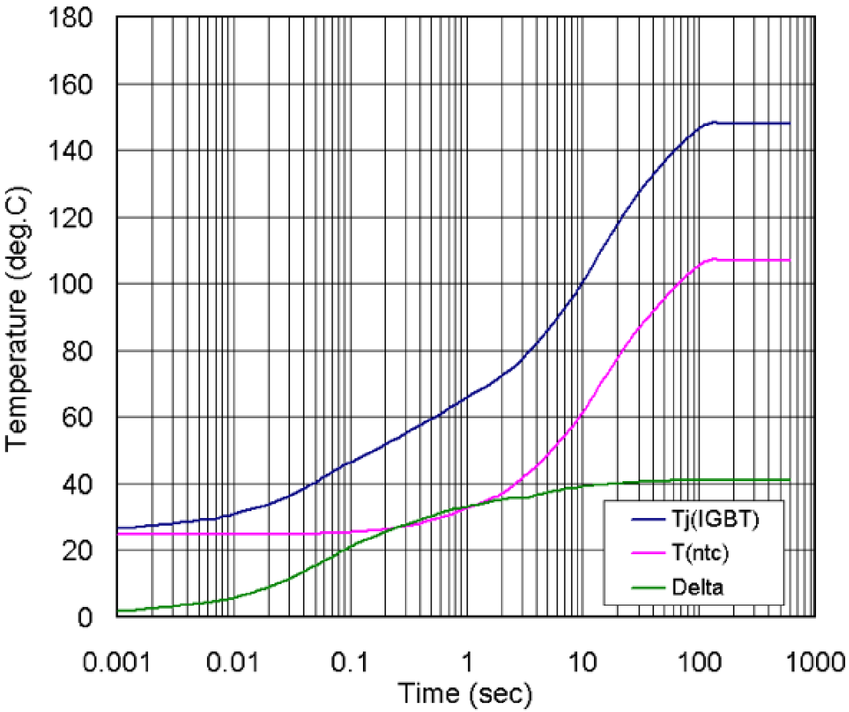
$$R(T) = R_{25} \exp\left\{ B_{25/T} \left(\frac{1}{T} - \frac{1}{298.15} \right) \right\}$$

$$B_{25/50} = \ln\left(\frac{R_{50}}{R_{25}} \right) \Big/ \left(\frac{1}{323.15} - \frac{1}{298.15} \right)$$

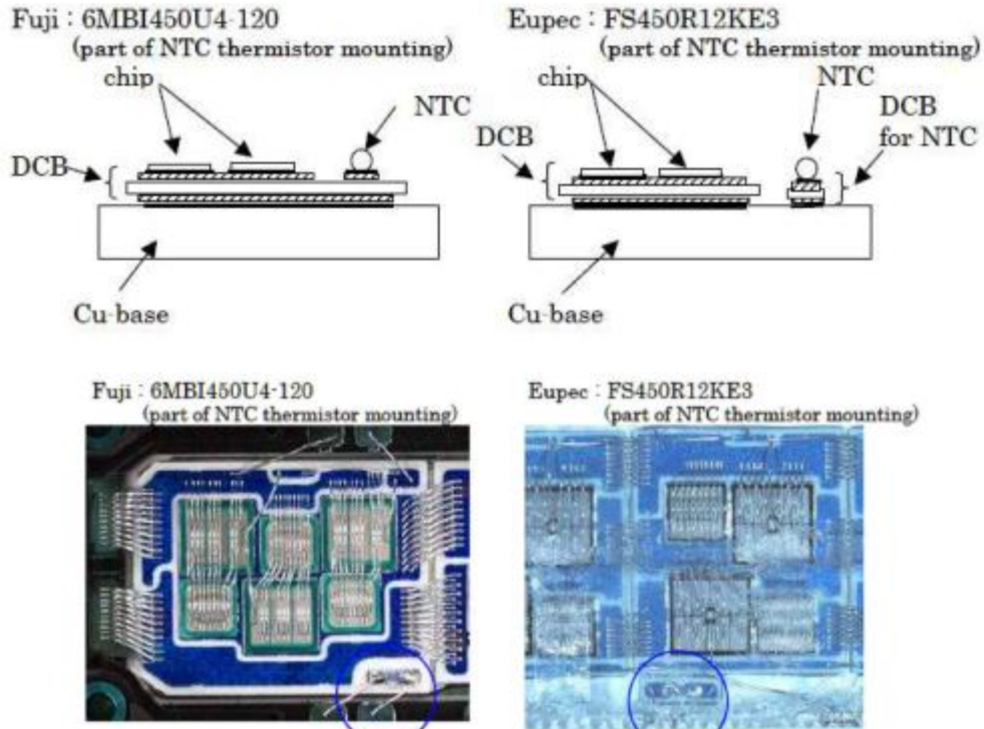
NTC - Thermistor

Ref.No.: MT5F19496

2MBI300VJ-120-50



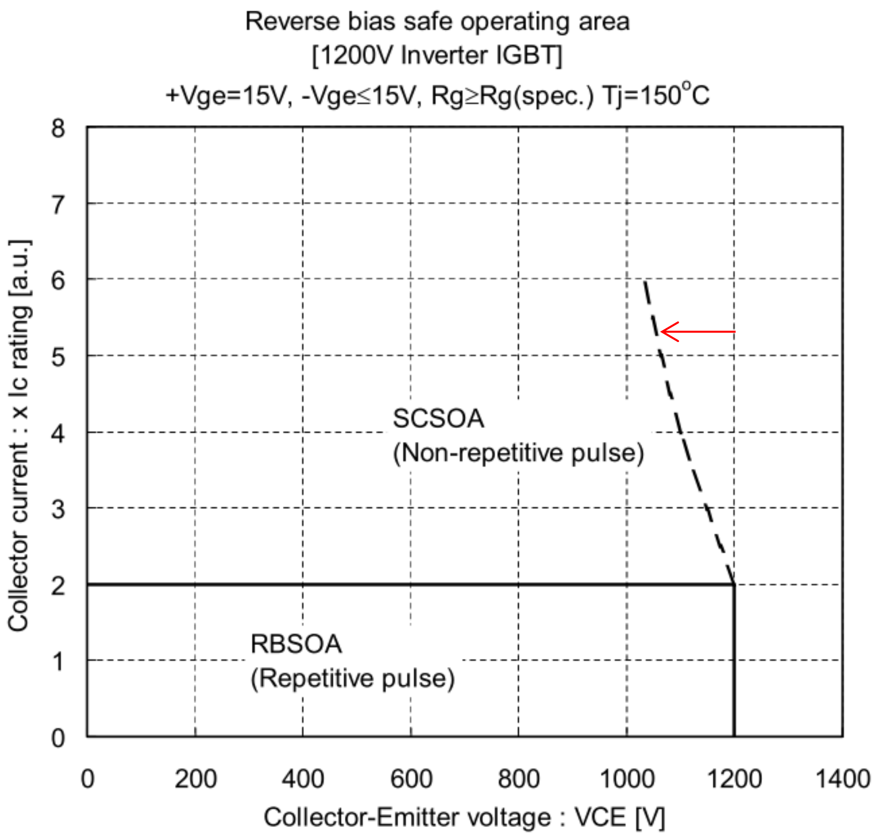
Transient thermal behavior of NTC thermister and IGBT Junction Temperature

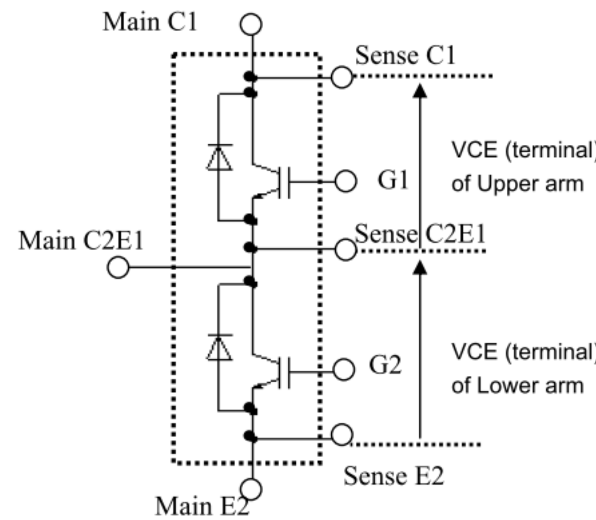


*NTC themistor is mounted on DCB plate.

*NTC thermistor is mounted on indipendent DCB plate.

RBSOA, SCSOA





Fuji defined V_{CE} value at the module terminal by using Sense C1 and Sense C2E1 for upper arm and Sense C2E1 and Sense E2 for Lower arm.

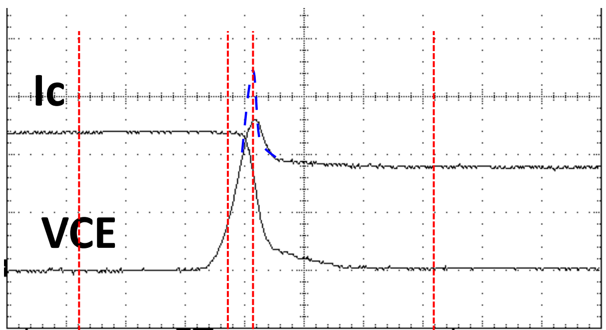
Switching characteristics of V_{CE} also is defined between Sense C1 and Sense C2E1 for Upper arm and Sense C2E1 and Sense E2 for Lower arm.

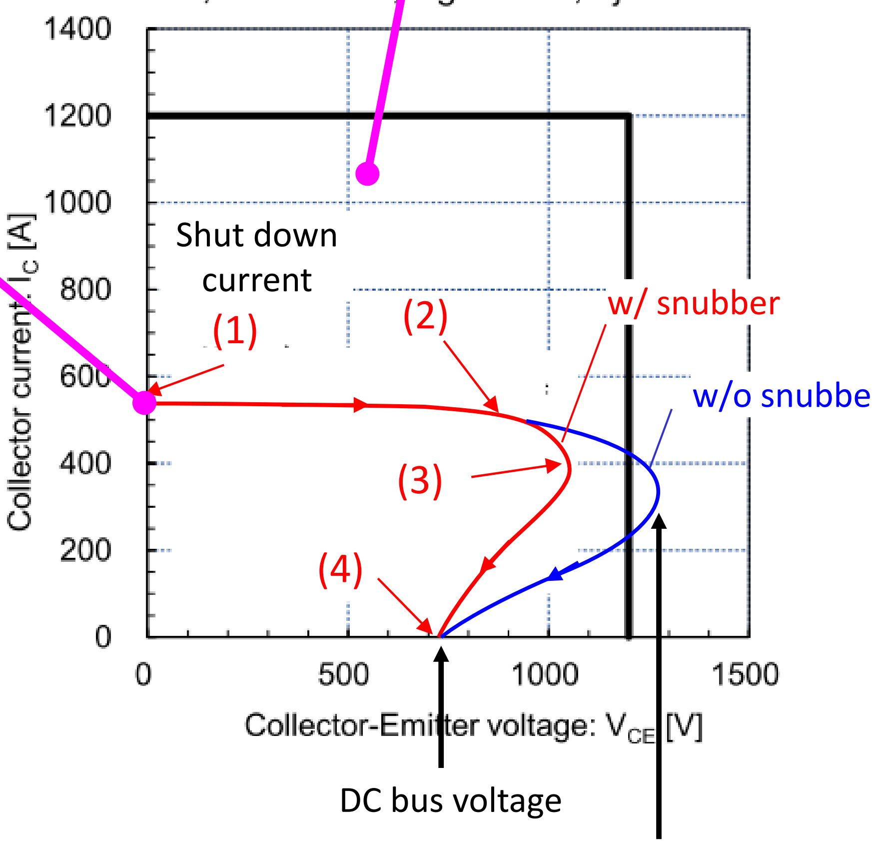
The maximum voltage is reduced at the higher current region because the chip voltage is higher than the terminal voltage due to the internal stray inductance L and the switching current di/dt (V = L*di/dt).

Reverse Bias Safe Operating Area (RBSOA)

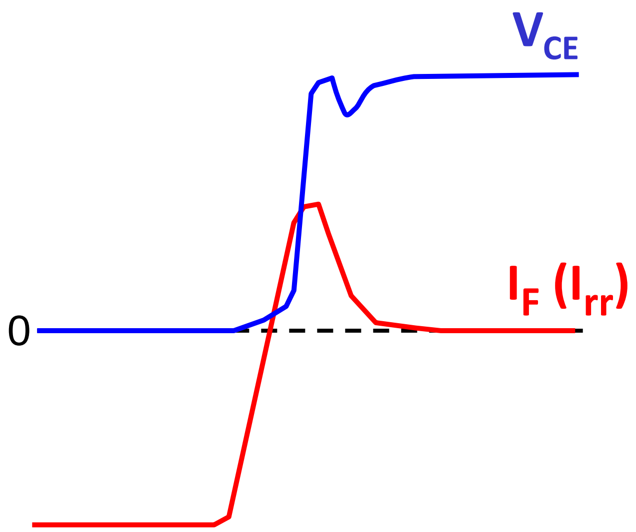
Necessary data for designing the drive condition and the snubber main circuit.

Current-Voltage switching locus during turn off operation (reverse bias is applied).
The locus may not exceed the RBSOA.

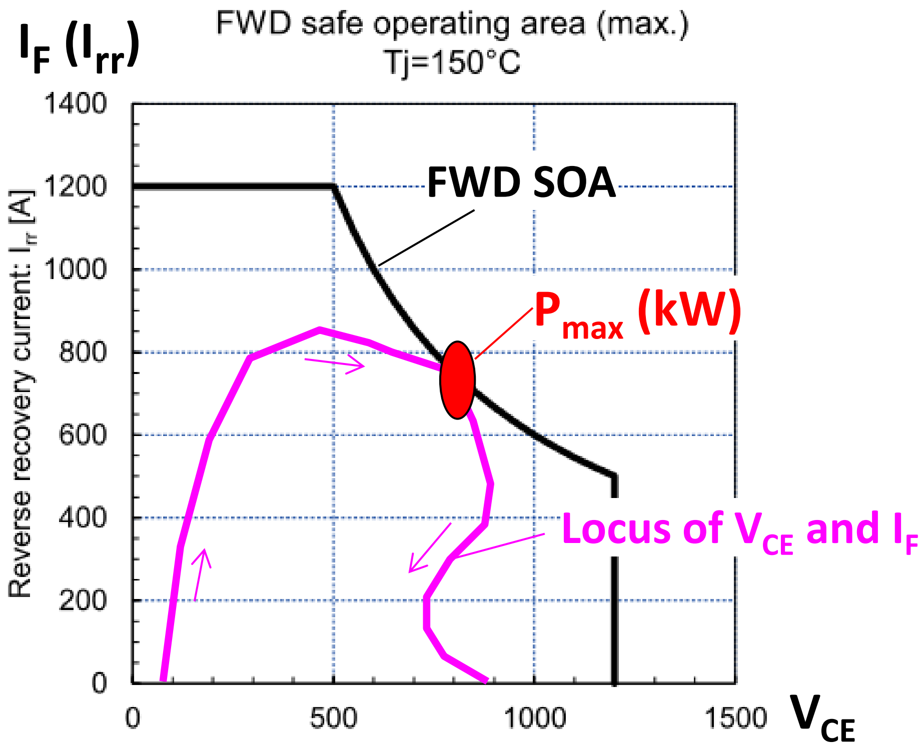




FWD SOA: P_{max}



Waveforms during reverse recovery

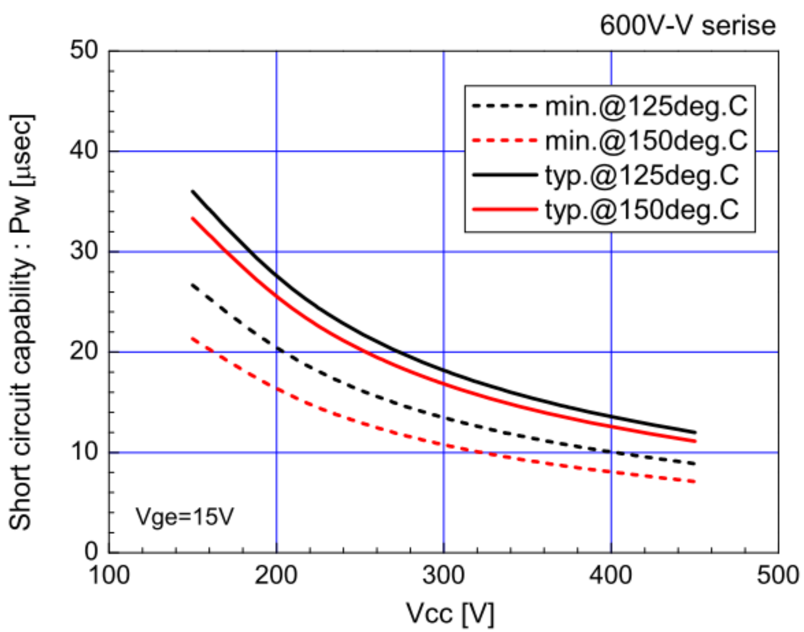


These figures show Fuji's definition of FWD SOA (Safe Operating Area) and P_{max}.

Guaranteed FWD SOA is shown in datasheet or spec sheet.

Locus of V_{CE} and I_F during reverse recovery may not exceed the the FWD SOA .

Short Circuit Capability (V-series)



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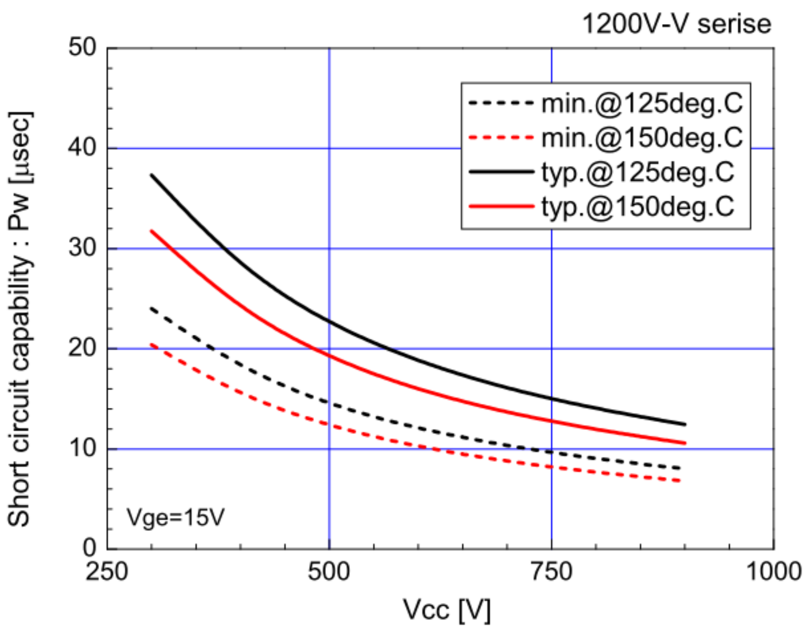

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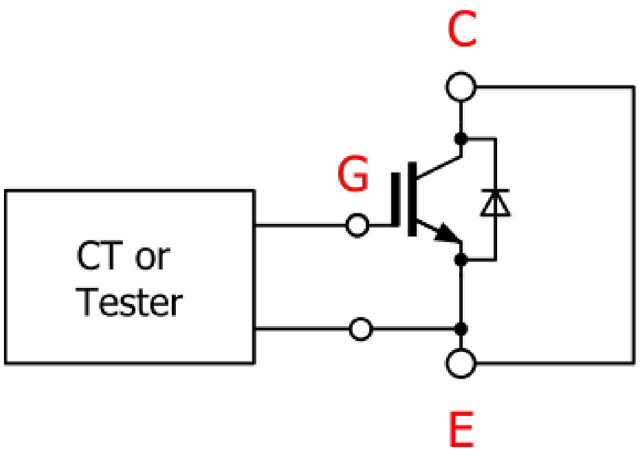
Vge: higher → SC current: larger → SC capability: shorter

IGBT Test Procedures

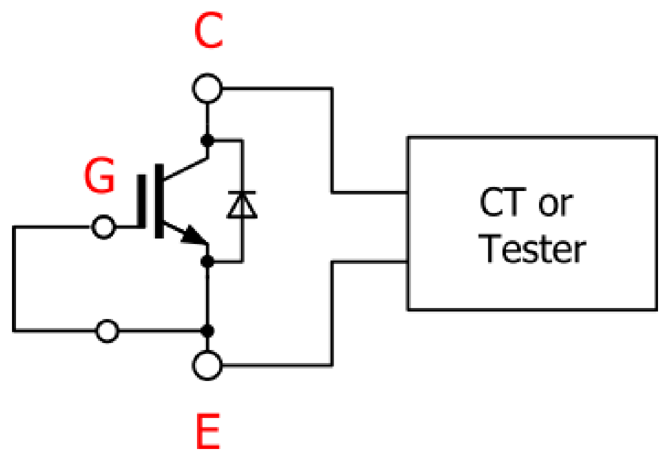
(1) G-E Check



- Short C and E terminal
- Measure leakage current or resistance between G and E terminal.

If the device is normal, the leakage current should be within a few hundred nano-Amps.
(or several tens MW)

(2) C-E Check



- Short G and E terminal
- Measure leakage current or resistance between C and E terminal.

If the device is normal, the leakage current should be within the maximum ICES in the datasheet.
(or several tens MW)

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