Fuji IGBT Module V Series 1700V Family

Technical Notes

Fuji Electric
Innovating Energy Technology

same as 1200V

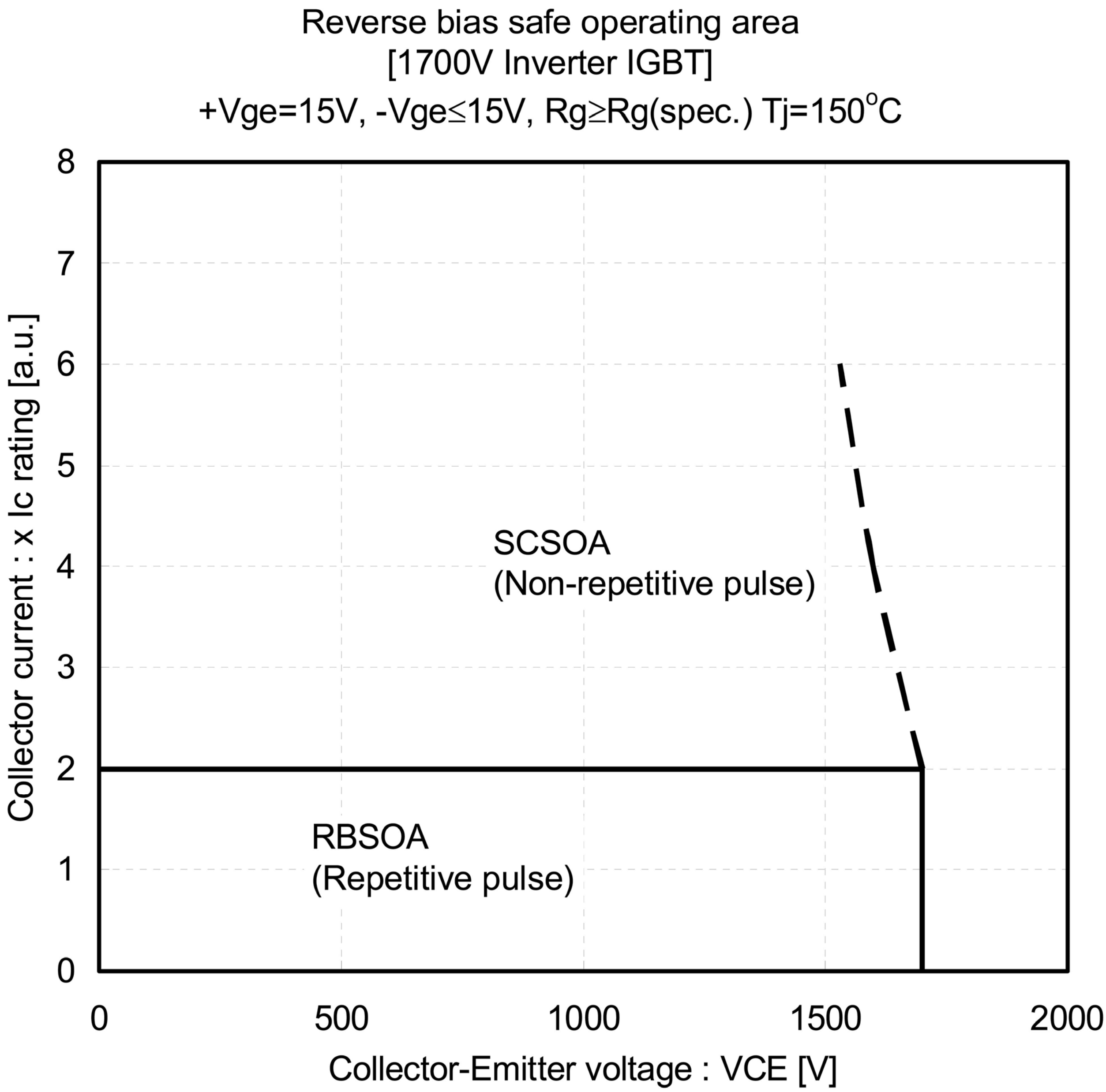

Fig. RBSOA and SCSOA

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High current output characteristics

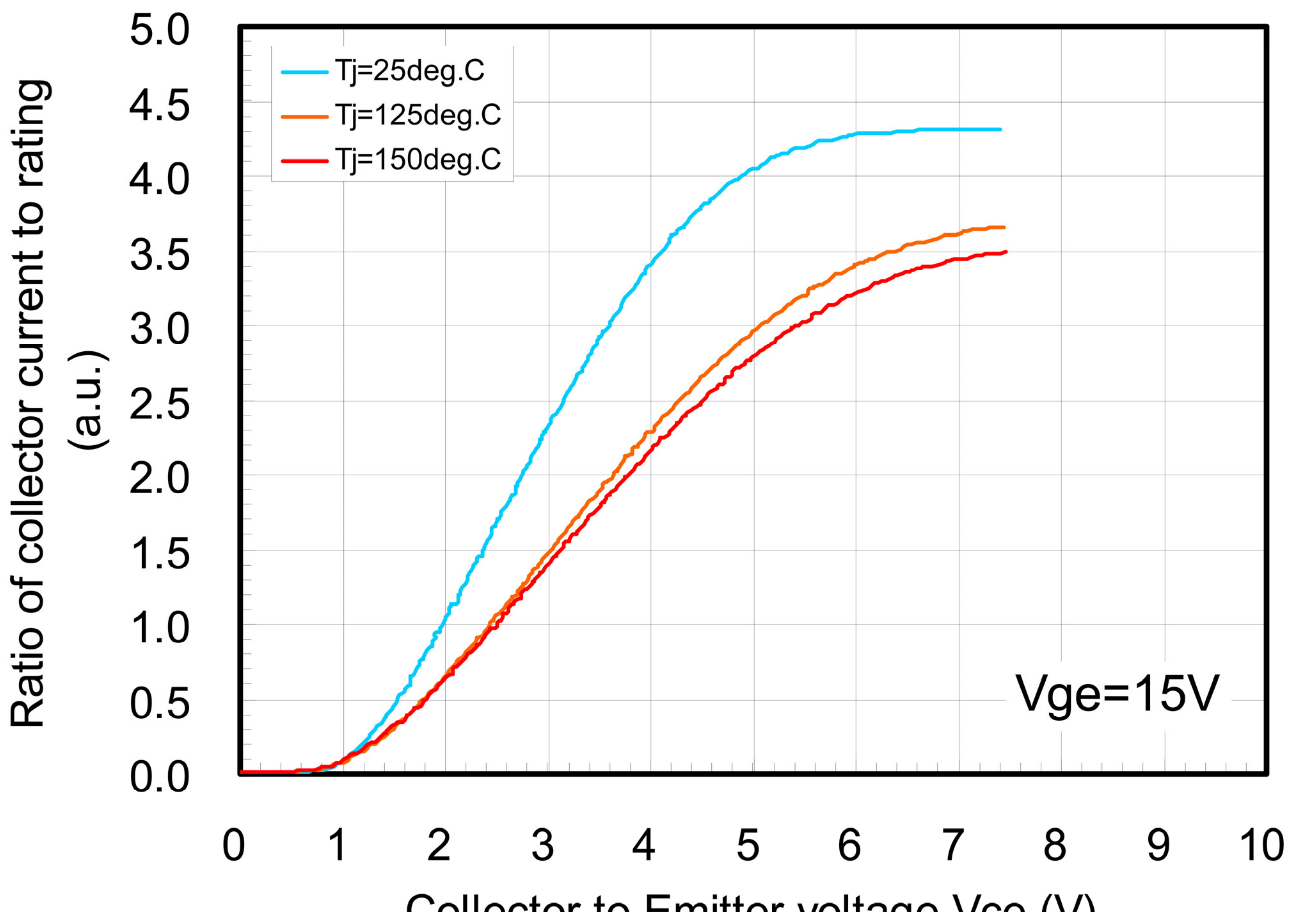
V series 1700V product family

Conditions: Tj=25°C, 125°C and 150°C

Vge=15V

same as 1200V

Note 1: This data shows the typical waveform of 2MBI650VXA-170E-50 and the values of chips that do not include the internal resistance of the module.



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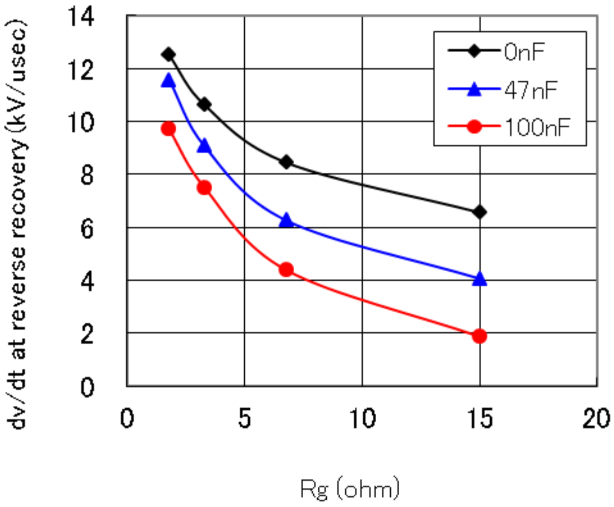
Switching energy and Reverse recovery dV/dt with combination of Rg and Cge

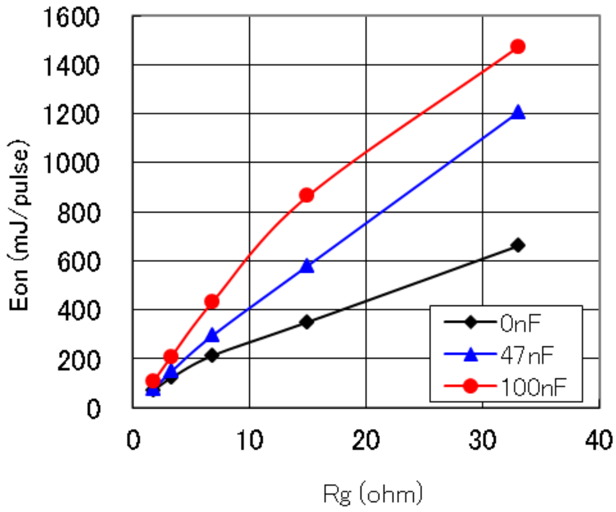
Type name : 2MBI550VN-170-50

Conditions : Vdc=900V, Ic, If=550A, Vge=+/-15V, Rg=vari., Cge=0, 47, 100nF

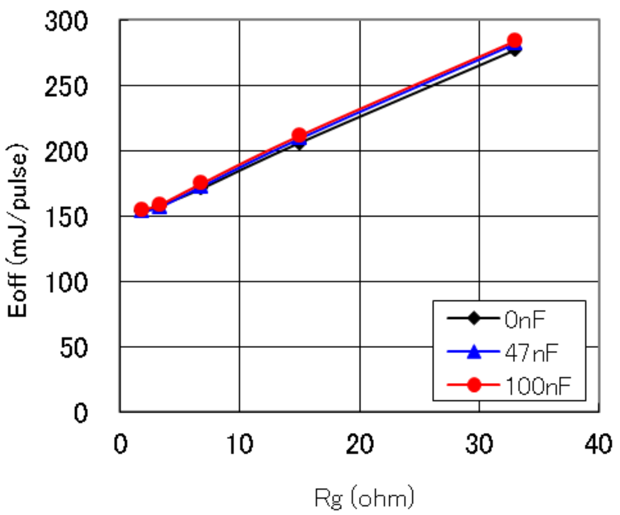
Tj=25℃ or 125℃



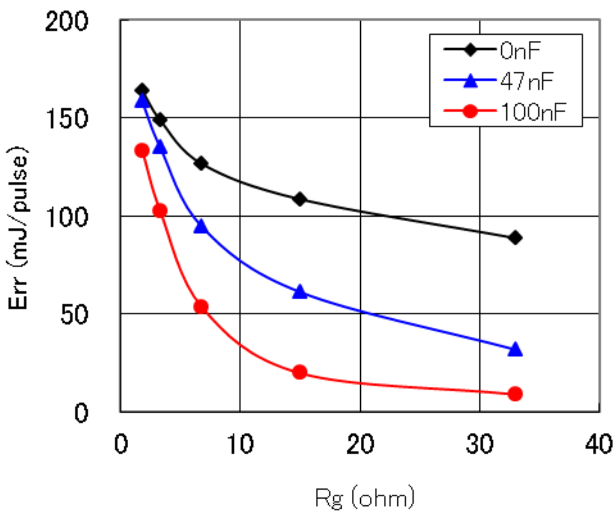
(a) Rg dependence of reverse recovery dv/dt



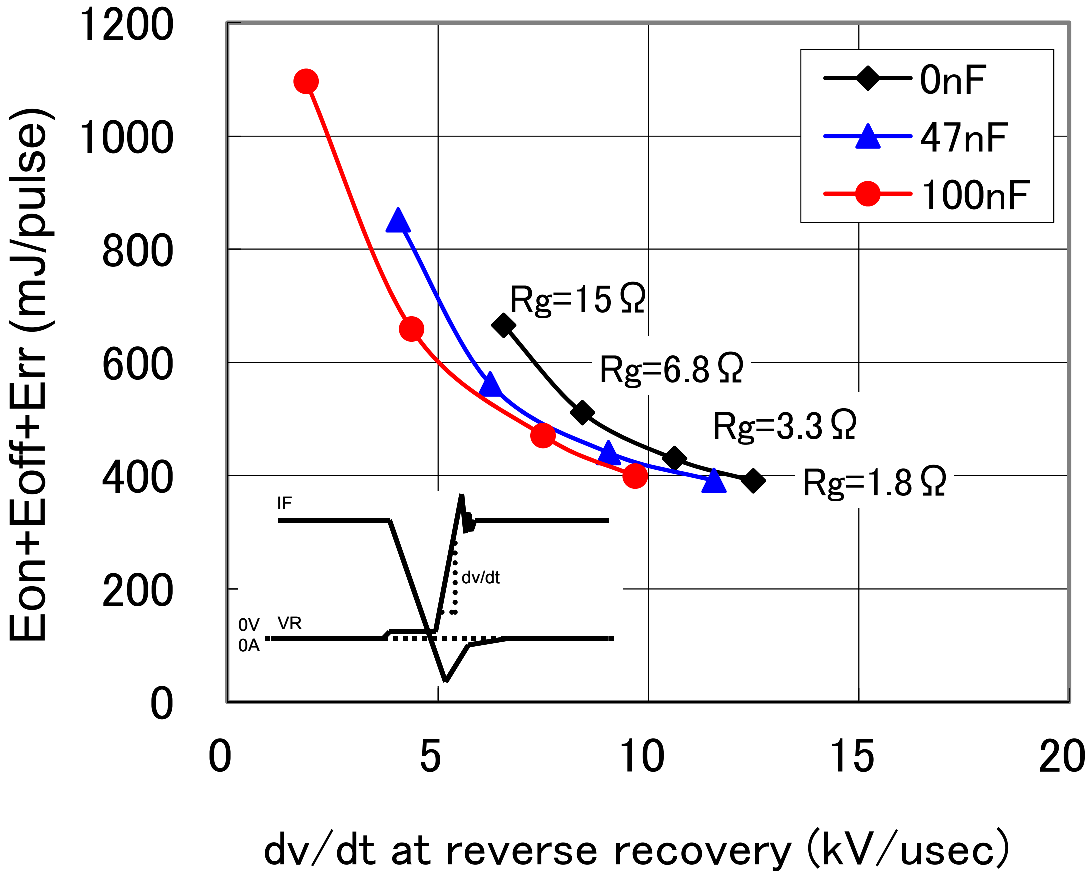
(b) Rg dependence of turn-on loss



(c) Rg dependence of turn-off loss



(d) Rg dependence of reverse recovery loss



Additional external capacitance between IGBT gate and emitter terminals has an effect of improving the trade off between reverse recovery dv/dt and total switching energy as shown in above chart. However, simply add Cge slows down the IGBT significantly and it results penalty of increasing the switching loss. Therefore, the combination of extra-Cge and reduction of the gate resistance (Rg) is recommended to achieve the highest performance of lower dV/dt as well as keep switching energy low. Typical Cge and Rg values for initial guess are : 2x of Cies in our datasheet and 1/2 Rg of your original design, however, experimental confirmation in practical application is recommended.

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Junction breakdown voltage VCES and junction temperature Tj

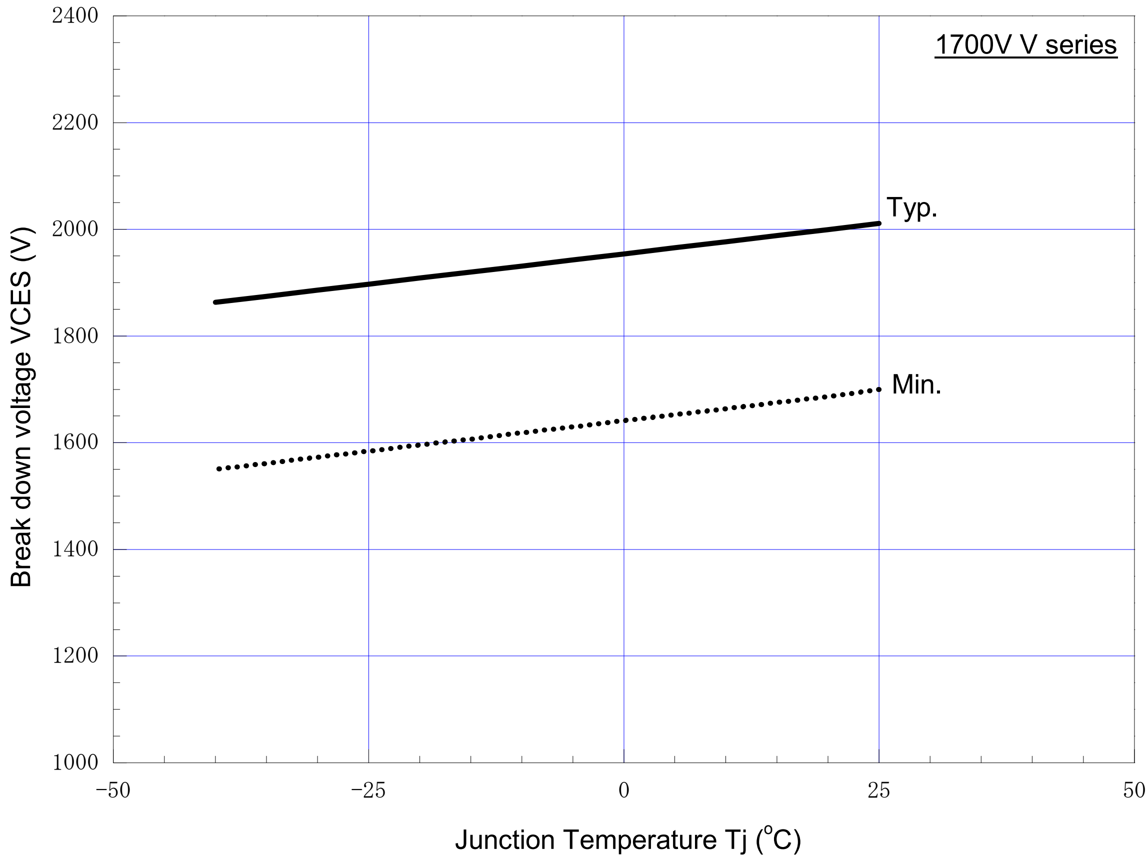

Fig. Junction Temperature Dependence of Junction Breakdown Voltage

In general, the breakdown voltage of power semiconductor devices have liner function to the junction temperature if "Impact ionization" and "Avalanche multiplication" are dominant physics of junction breakdown At low temperature, the carriers in drift region are relatively easier to have high velocity because of less scattering due to lattice vibration so that the impact ionization ratio increases. Therefore, the breakdown voltage of the power semiconductor device becomes lower at low temperature. The temperature effect shown in the above figure should be taken into account into practical design not to exceed breakdown voltage if the target applications have chances of low temperature operation and/or start-up.

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-Vge and switching loss characteristics

Type name：2MBI550VN-170-50

Conditions：Vcc=900V, Vge=+15V, -Vge=vari., Rg=3.3Ω, Tj=125℃, Ic=550A

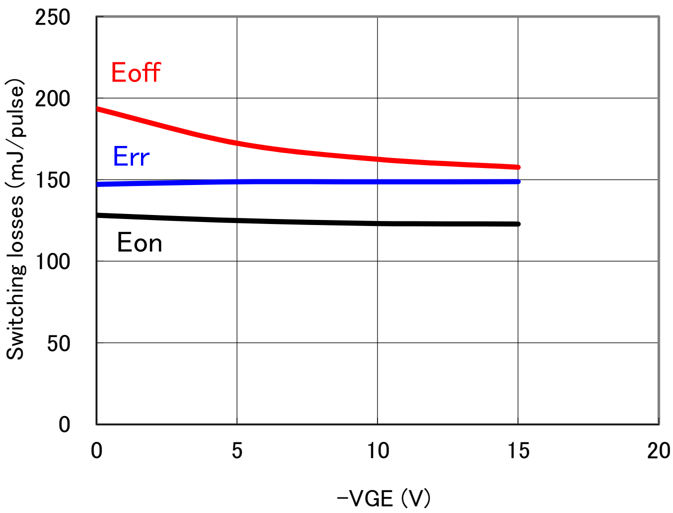

Fig. –Vge and switching loss characteristics

－ Fuji IGBT Module V Series 1700V Family －

Gate resistance dependence of surge voltage

Type name : 2MBI550VN-170-50

Conditions : Vdc=900V, Ic=550A, Vge=+/-15V, Tj=vari., Rg=vari.

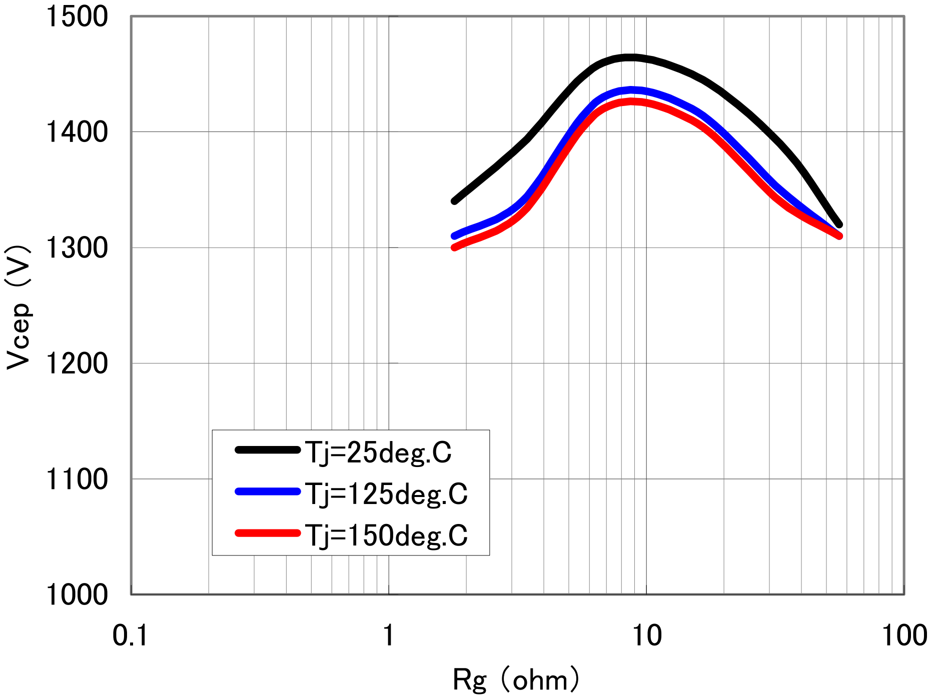

Fig. Gate Resistance Dependence of Turn-off Surge Voltage

The surge voltage, especially at IGBT turn off, depends on the gate resistance. As shown in the figure above figure shows, the surge voltage is able to control with the gate resistance but the curve shave peaks depending on the junction temperature. The primary reason of such behavior is the interaction of two silicon physics in IGBT chip; 1) the carriers stored in the drift region and 2) Current through MOS channel[1).

Reference :

1) Y. Onozawa et al., "Investigation of carrier streaming effect for the low spike fast IGBT turn-off", Proc. ISPSD, pp173-176, 2006.

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-dIc/dt at turn-off and Tj characteristics

Type name : 2MBI550VN-170-50

Conditions : Vcc=900V, Vge=+15V/-15V, Rg=3.3Ω, Tj=vari., Ic=550A

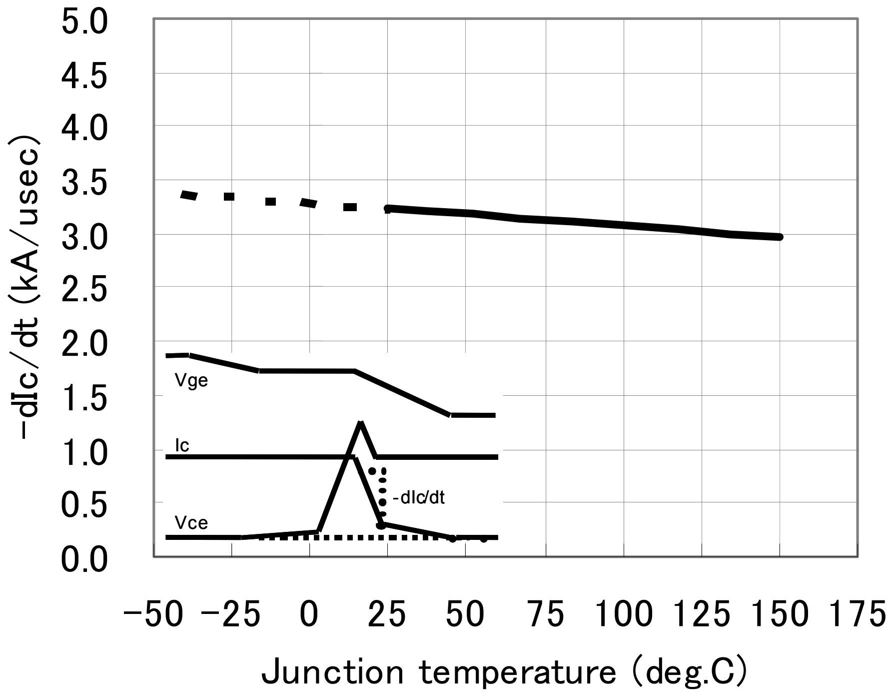

Fig. –dIc/dt at Turn-off and Tj Characteristics

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Parallel connection of 2in1 package modules

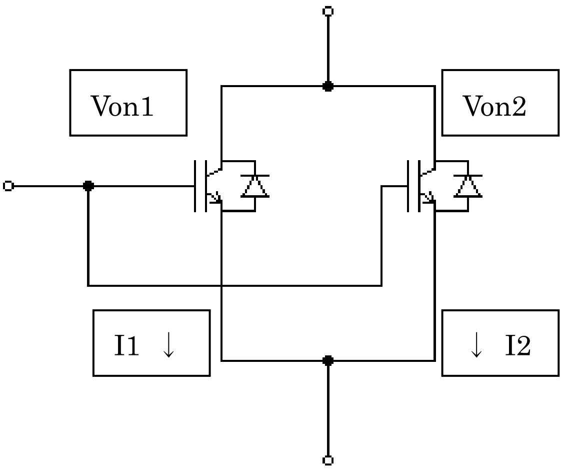
Circuit configuration and formula

ΔVon=|Von2-Von1| (Von2>Von1)

Ic (ave)=(I1+I2)/2

Current imbalance is caused by the difference between Von1 and Von2, and current is divided into I1 and I2. In this case, the current imbalance can be obtained from the following calculating formula.

$$\alpha = \left(\frac{I_1}{I_{C(ave)}} - 1 \right) \times 100 \quad (\%)$$



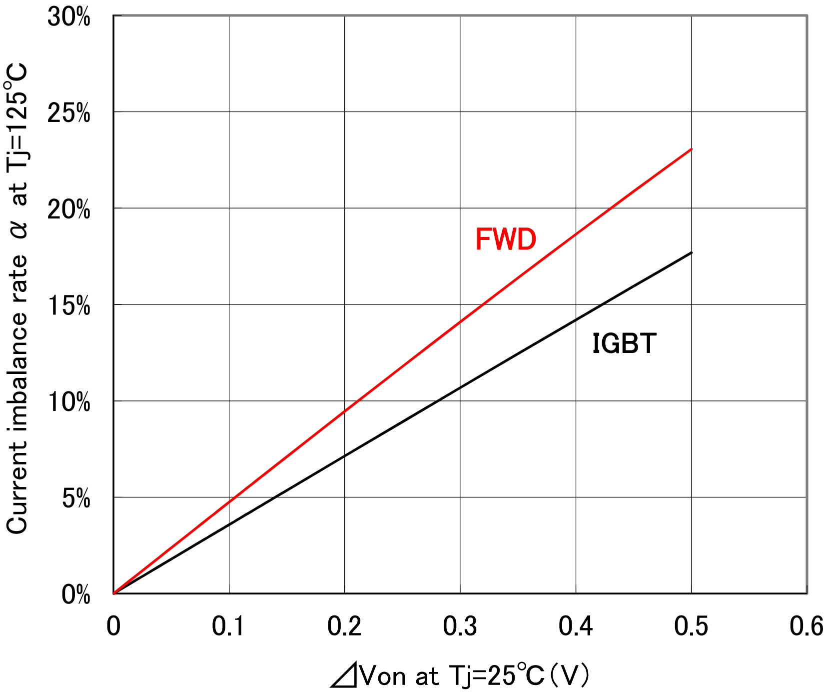


Fig. Δ Von and current imbalance rate

When n IGBT modules are connected in parallel, the maximum allowable current ΣI can be expressed in the following formula by using the current imbalance rate α at two-parallel connection. This maximum allowable current ΣI is used for reference only.

$$\sum I = I_{C(\max)} \left[1 + (n-1) \frac{\left(1 - \frac{\alpha}{100}\right)}{\left(1 + \frac{\alpha}{100}\right)} \right]$$

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Short circuit capacity

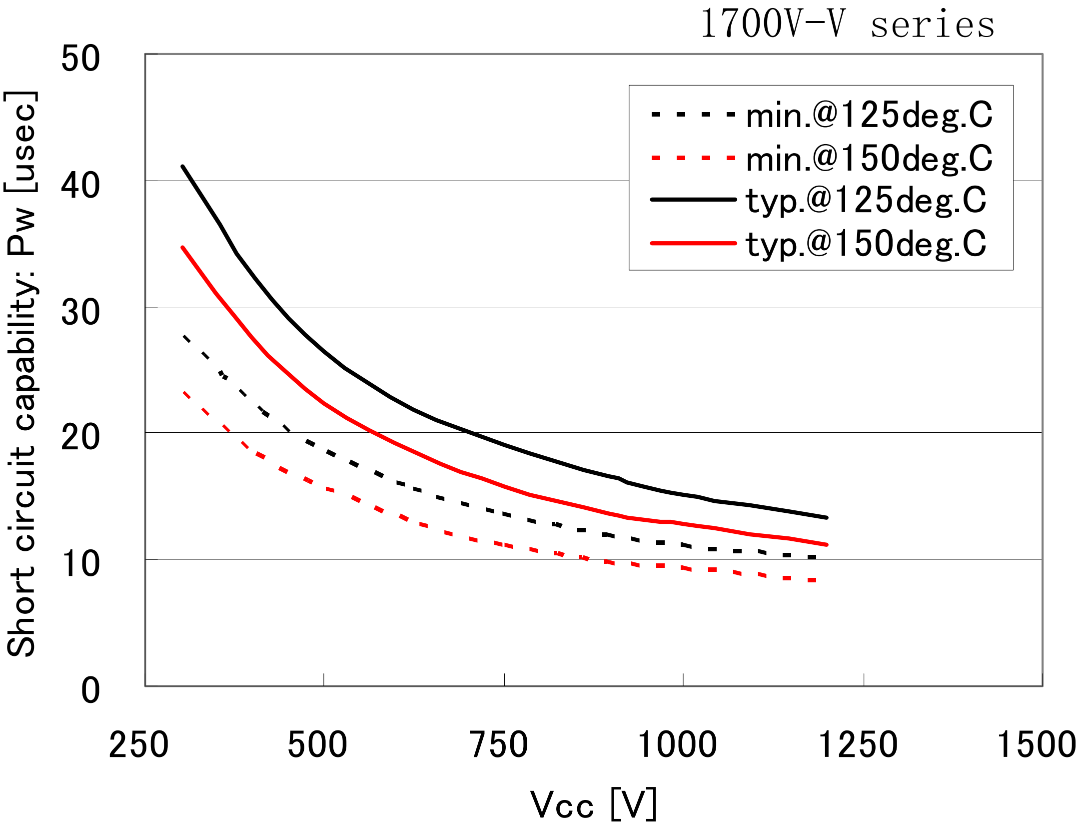

Fig. Relation between applied voltage and short-circuit capacity (1700V Family)

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