Fuji IGBT Module V Series 1200V Family

Technical Notes

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JANUARY 2015

RBSOA and SCSOA

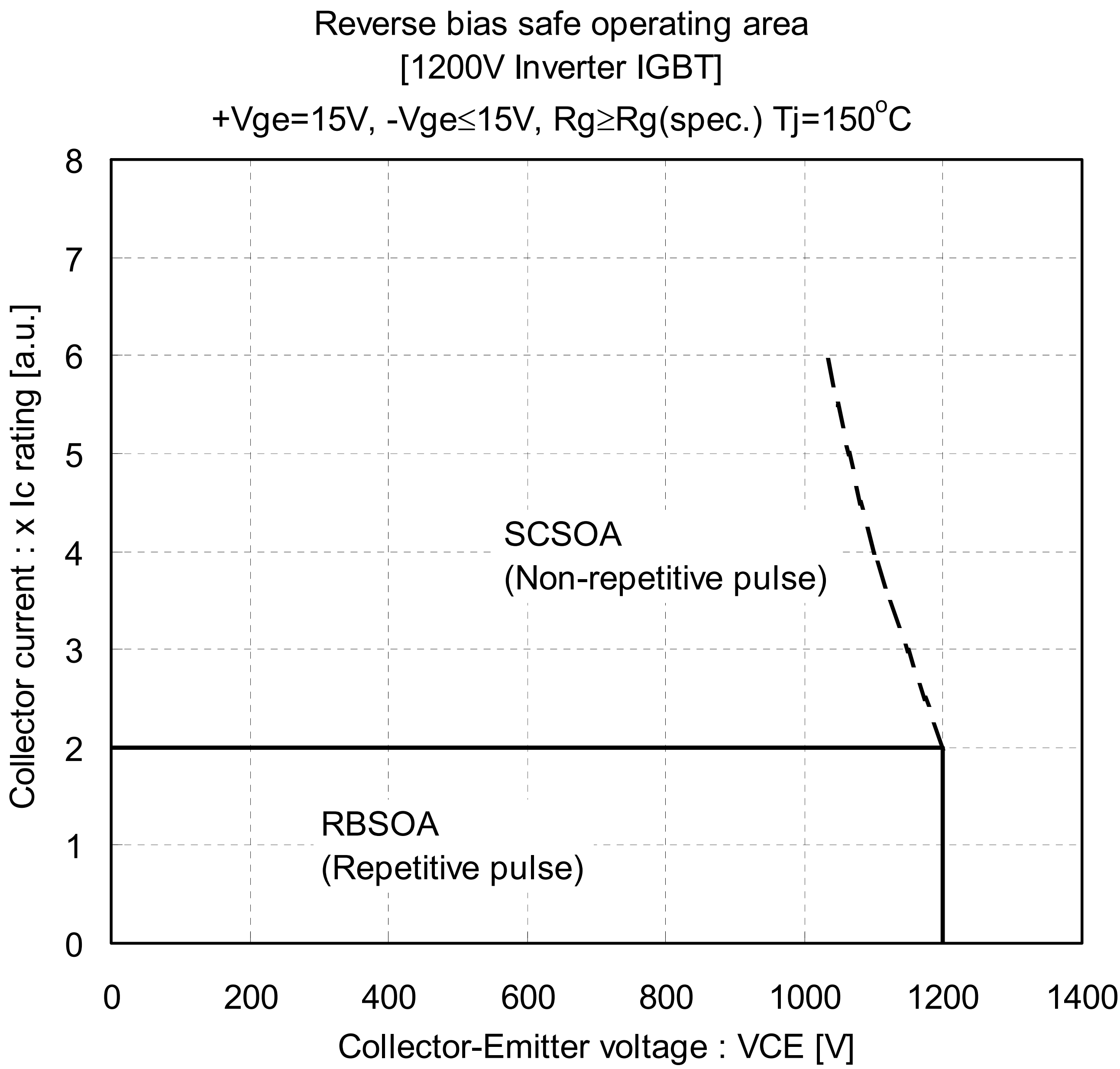


Fig. RBSOA and SCSOA

Technical data: MT5F24325

− Fuji IGBT Module V Series 1200V Family −

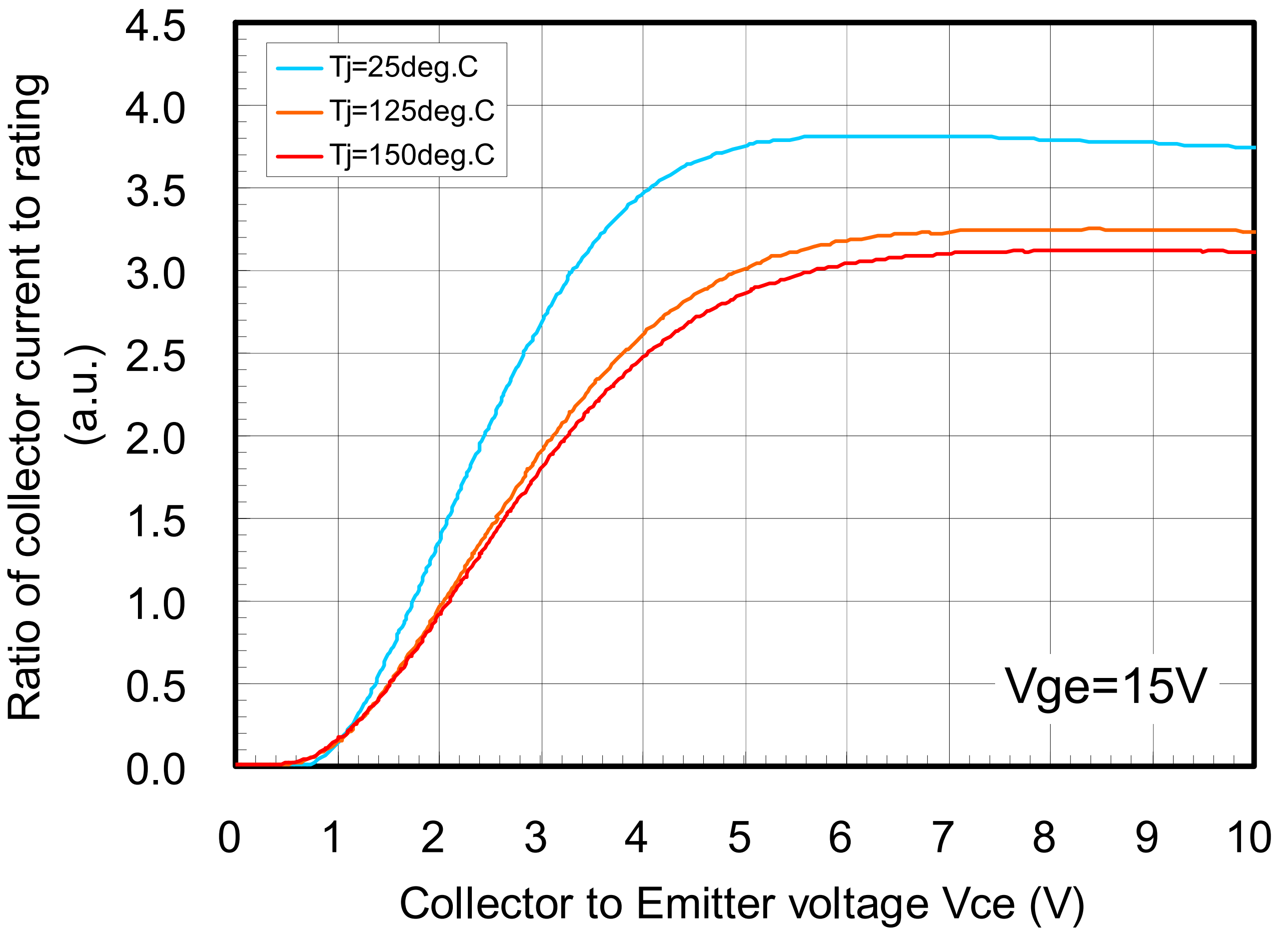
High current output characteristics

V series 1200V product family

Conditions: Tj = 25°C, 125°C and 150°C

Vge = 15 V

Note: This data shows the typical waveforms of chip characteristics. The effect of the internal resistance of the module is not included



Technical data: MT5F24326

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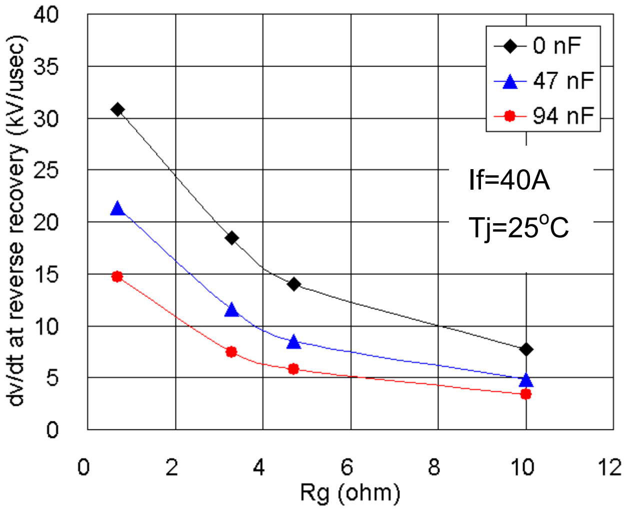
− Fuji IGBT Module V Series 1200V Family −

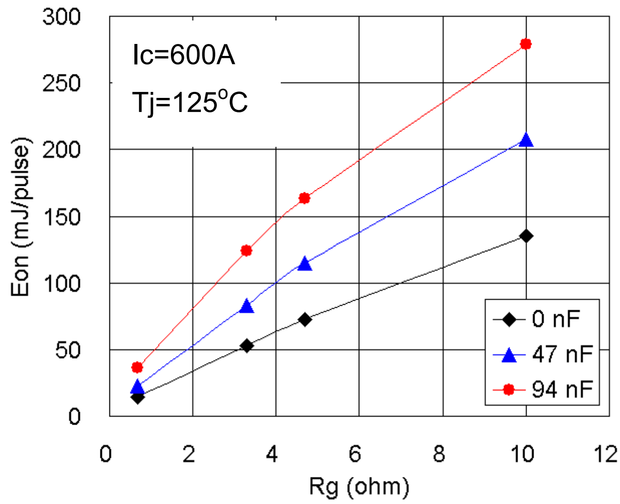
Switching energy and Reverse recovery dV/dt with combination of Rg and Cge

Type name: 2MBI600VN-120-50

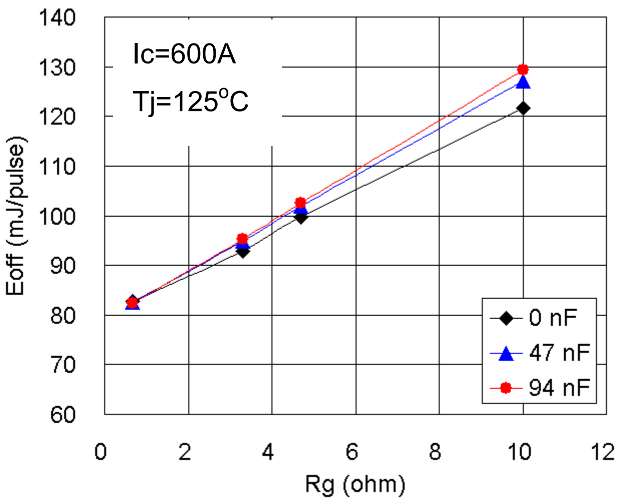
Conditions: Vdc=600V, Ic, If=40A and/or 600A, Vge=+/-15V, Cge=0, 47, 94nF, Tj=25°C or 125°C



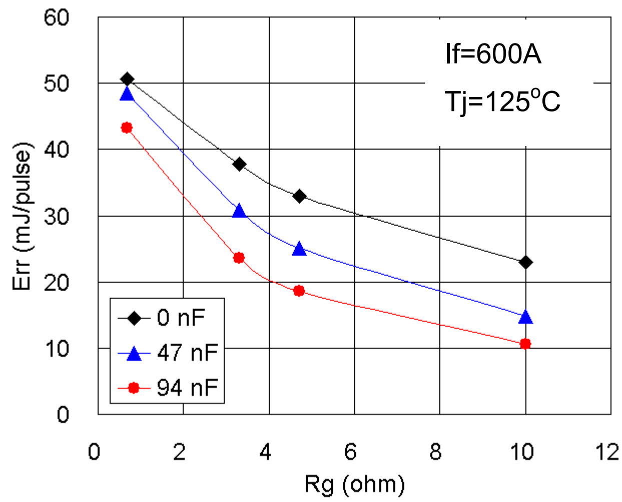
(a) Rg dependence of reverse recovery dv/dt



(b) Rg dependence of turn-on loss



(c) Rg dependence of turn-off loss



(d) Rg dependence of reverse recovery loss

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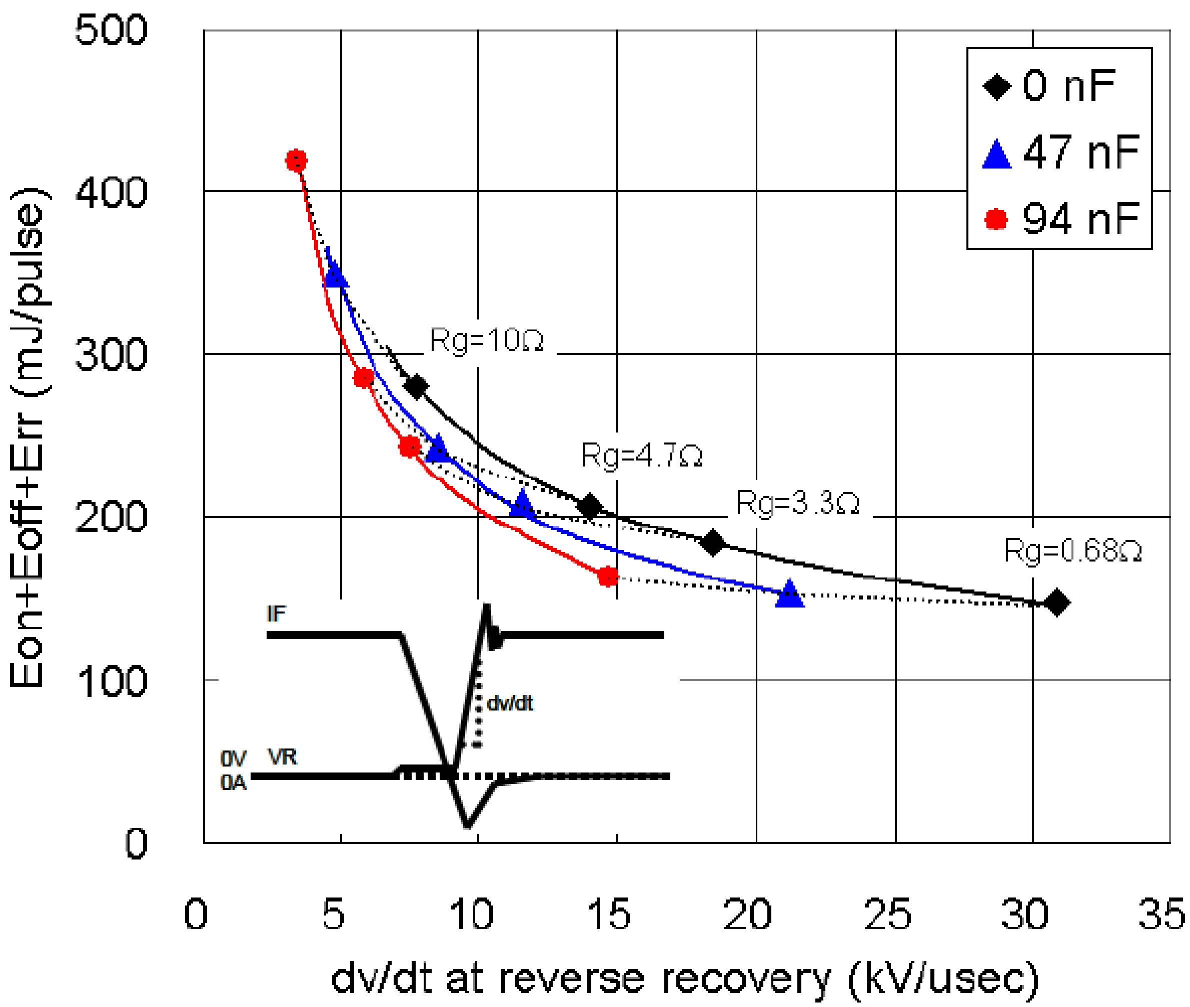
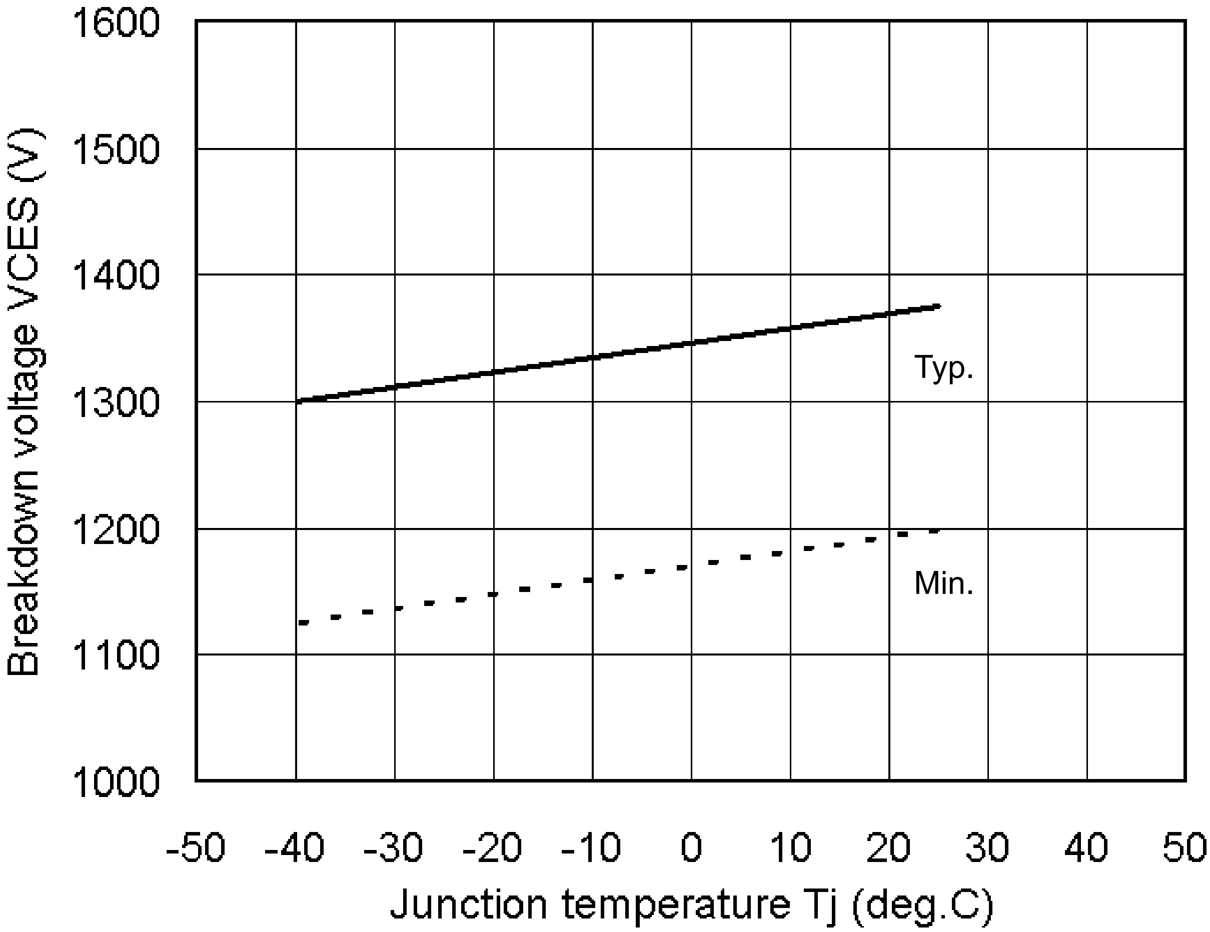


Cge and Rg Dependence for Sum of Switching Loss and Reverse Recovery dv/dt

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 achive 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,

− Fuji IGBT Module V Series 1200V Family −

Junction breakdown voltage VCES and junction temperature Tj



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 dominatant physics of junction breakdownAt 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 breakfown voltage if the target application have chances of low temperature operation and/or start-up.

Technical data: MT5F24327

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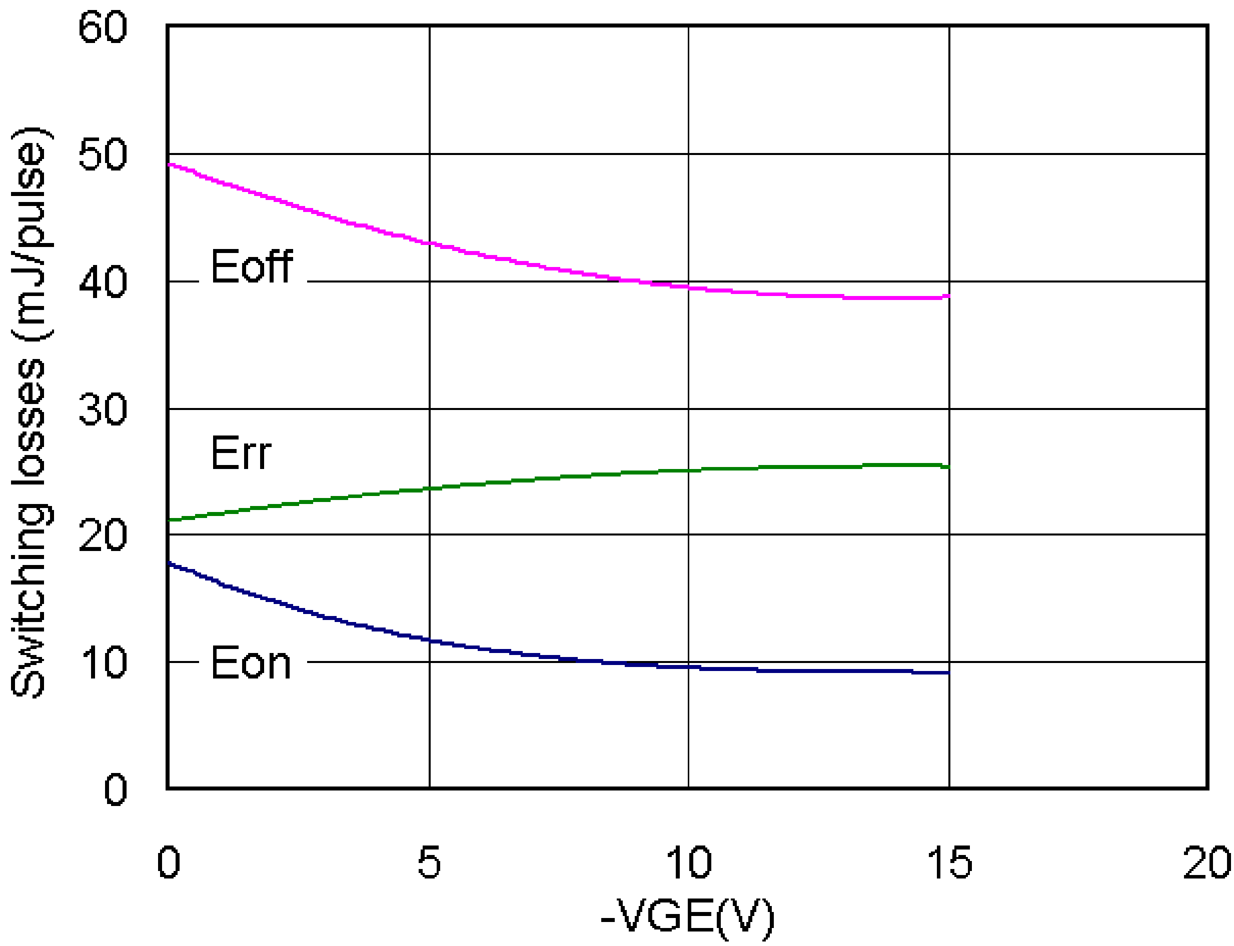
− Fuji IGBT Module V Series 1200V Family −

-Vge and switching loss characteristics

Type name: 2MBI300VN-120-50

Conditions: Vdc=600V, Ic=300A, Vge=+15V,, Rg=0.92Ω



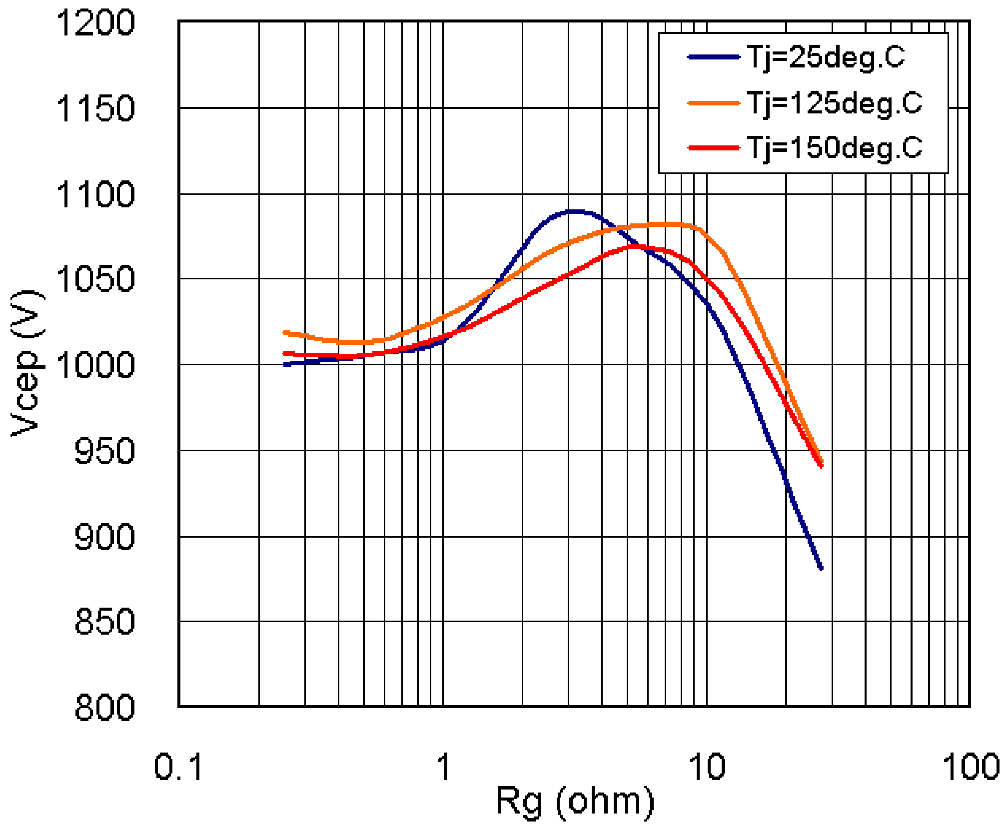
Technical data: MT5F21212

− Fuji IGBT Module V Series 1200V Family −

Gate resistance dependence of surge voltage

Type name: 2MBI450VN-120-50

Conditions: Vdc=600V, Ic=450A, Vge=+/-15V, Ls=70nH,



Gate Resistance Dependence of Turn-off Surge Voltage

The surge voltage, especially at IGBT turn off, depends on the gate resistance. As showin in the figure above figure shows, the surge voltage is able to control with the gate resistance but the curveshave peaks depending on the junction temperature,.. Although detailed reasons for this relation are not described here, the background of such behaviors have already been analyzed and published. The primary reason of such behavior is the interaction of two silicon physcs in IGBT chip; 1) the carriers stored in the drift region and 2) Current throuhg MOS channel[1)].

This chart also indicates that the increasing the gate resistance is not only the method to solve turn-off spike voltage issue.The decrease of the gate resistance may also have an effect

Reference :

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

Technical data: MT5F24328

− Fuji IGBT Module V Series 1200V Family −

-dIc/dt at turn-off and Tj characteristics

- 2MBI600VN-120-50

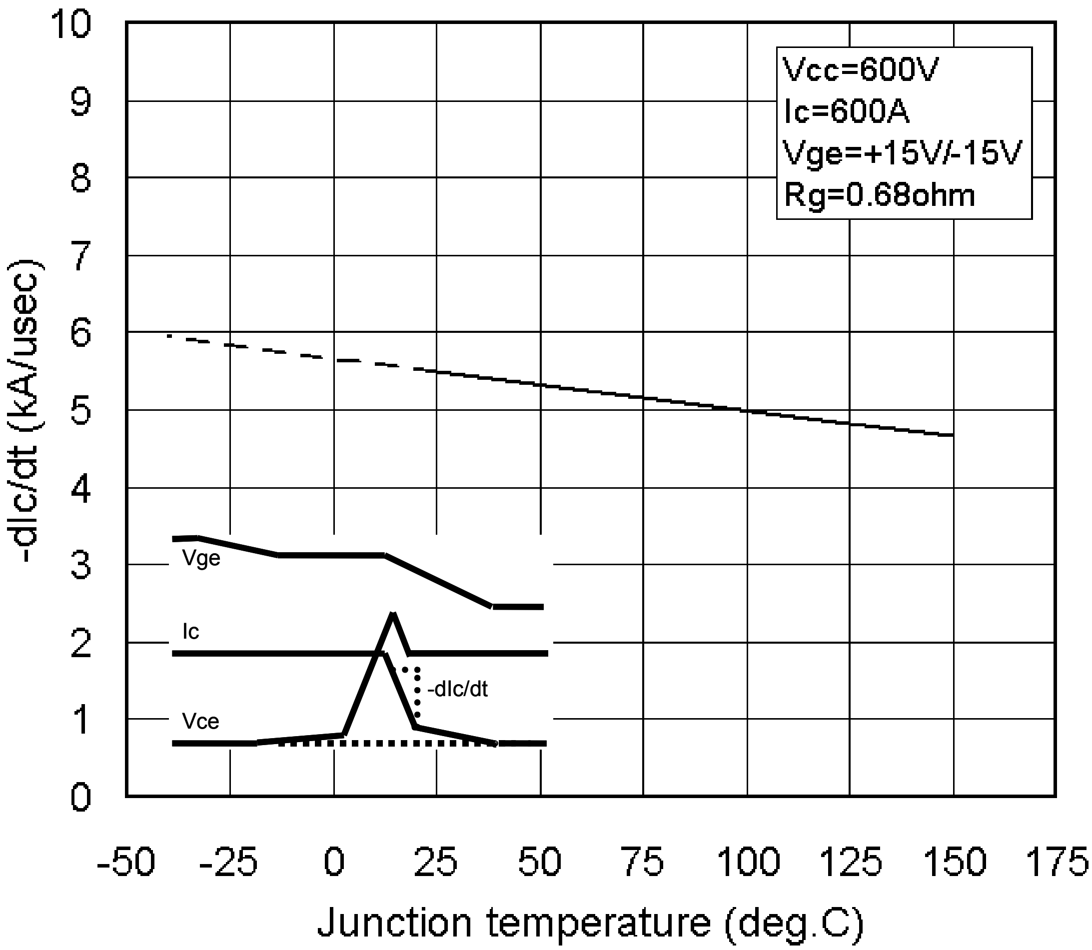


Fig. -dIc/dt at Turn-Off and Tj Characteristics

Technical data: MT5F24329

− Fuji IGBT Module V Series 1200V Family −

Dynamic avalanche voltage Vav and Tj characteristics

Type name: 2MBI600VN-120-50

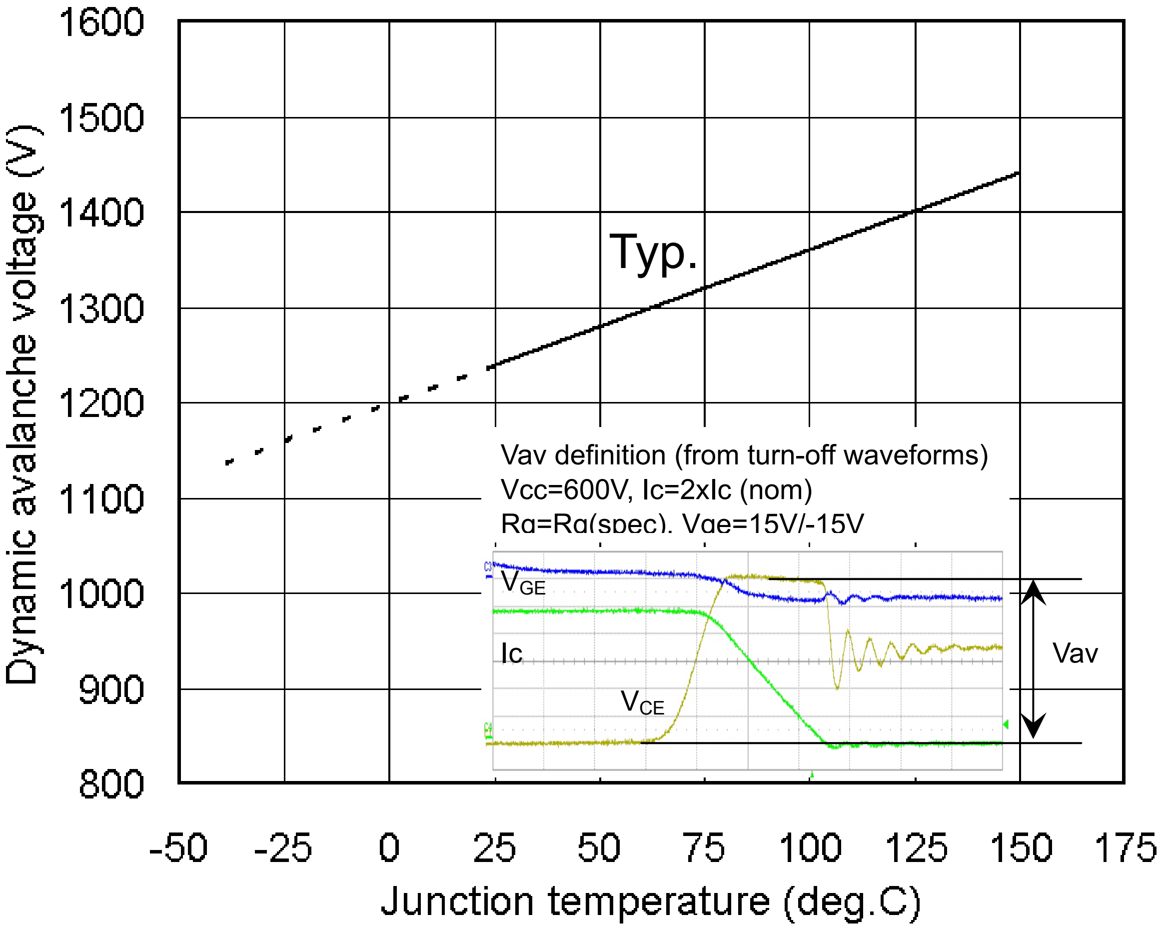


Fig. Dynamic Avalanche Voltage (Vav) as function of Tj

Technical data: MT5F24330

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－ Fuji IGBT Module V Series 1200V Family －

Parallel connection of 2in1 package modules

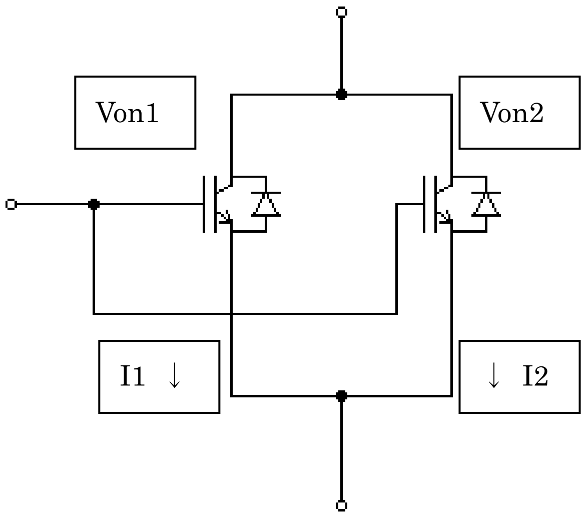
Circuit configuration and formula

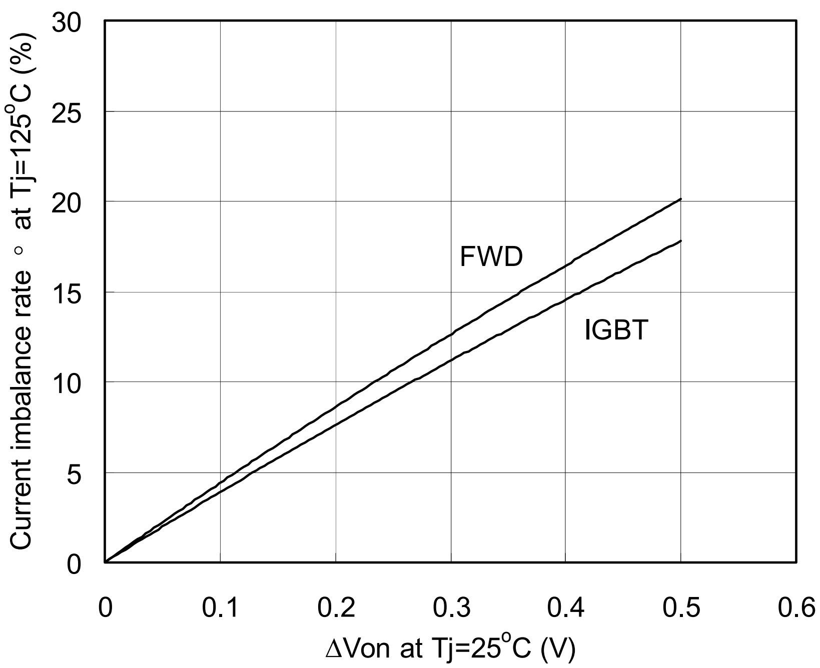
ΔVon=|Von2-Von1| (Von2>Von1)

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.

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





Δ Von and current imbalance rate

When nIGBT 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.

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

Technical data: MT5F24335

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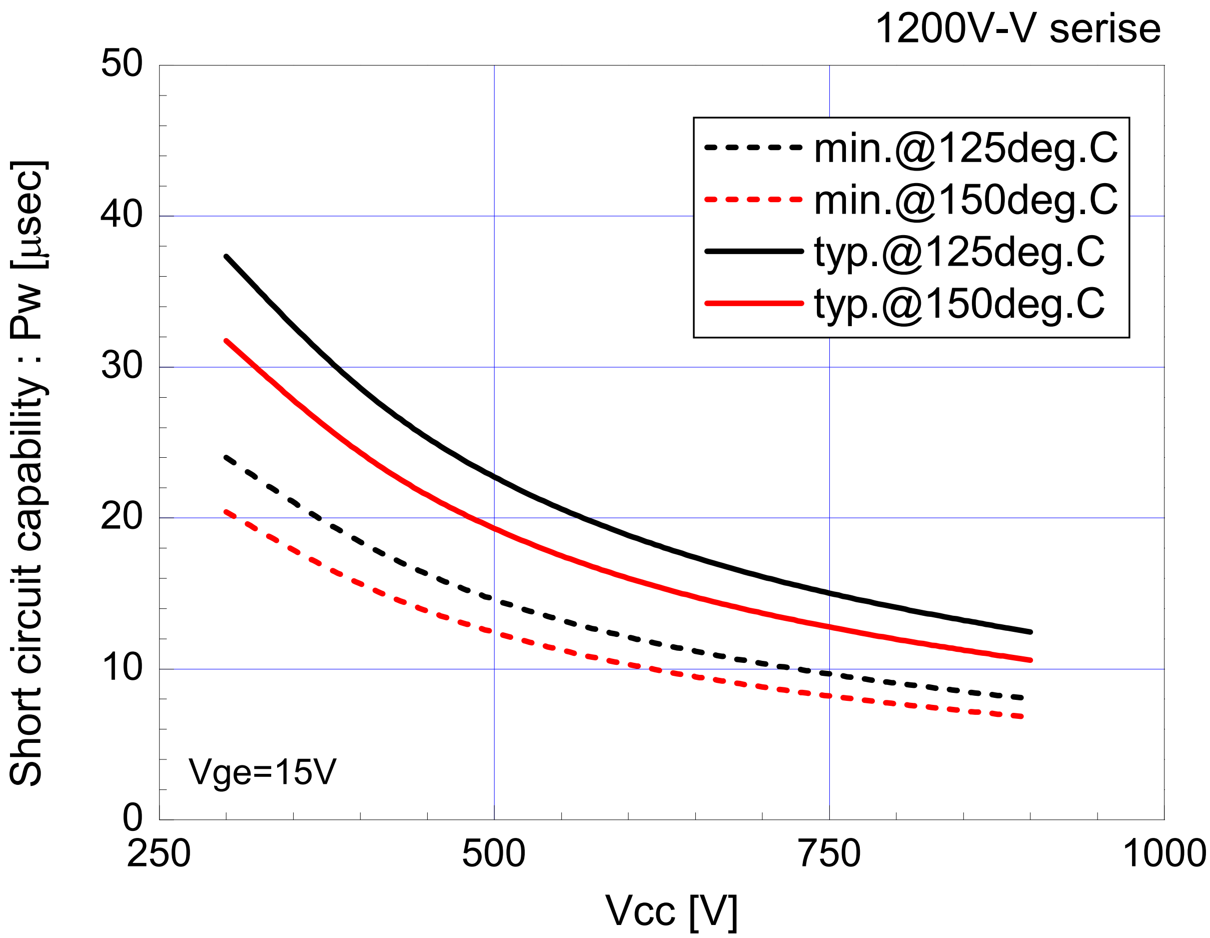


Fig. Relation between applied voltage and short-circuit capacity (1200V Family)

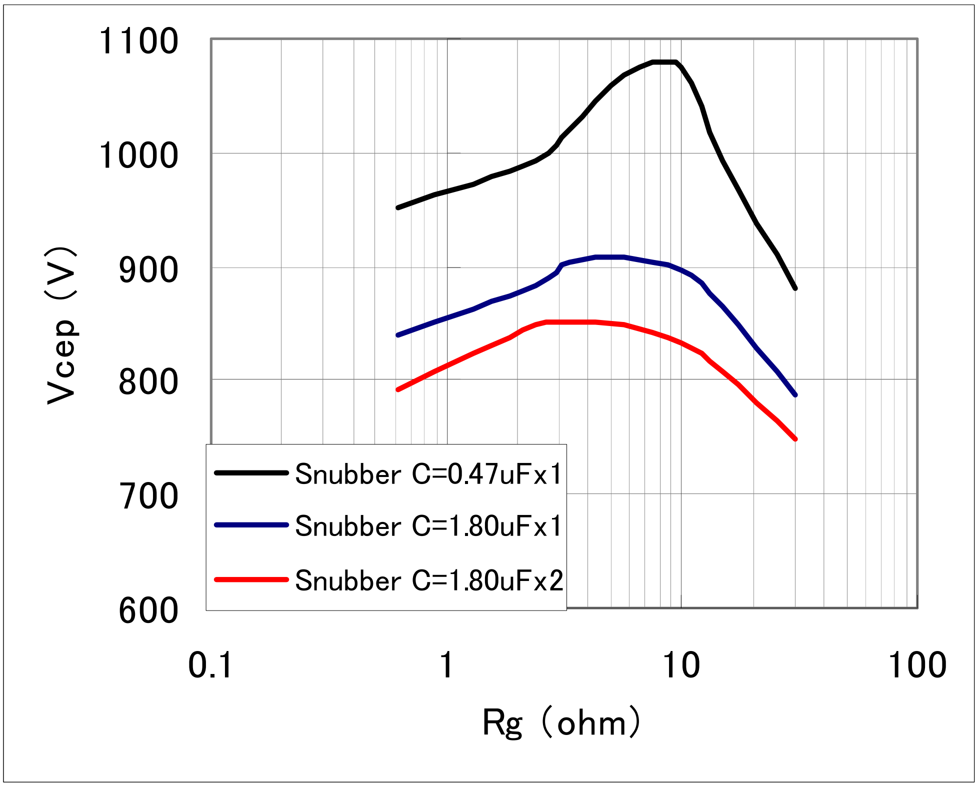
Technical data: MT5F24336

－ Fuji IGBT Module V Series 1200V Family －

Gate resistance dependence of surge voltage

Type name : 2MBI600VE-120-50

Conditions : Vdc=600V, Ic=600A, Vge=+/-15V, Tj=25deg.C, Rg=vari.



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.

Technical data : MT5F26530

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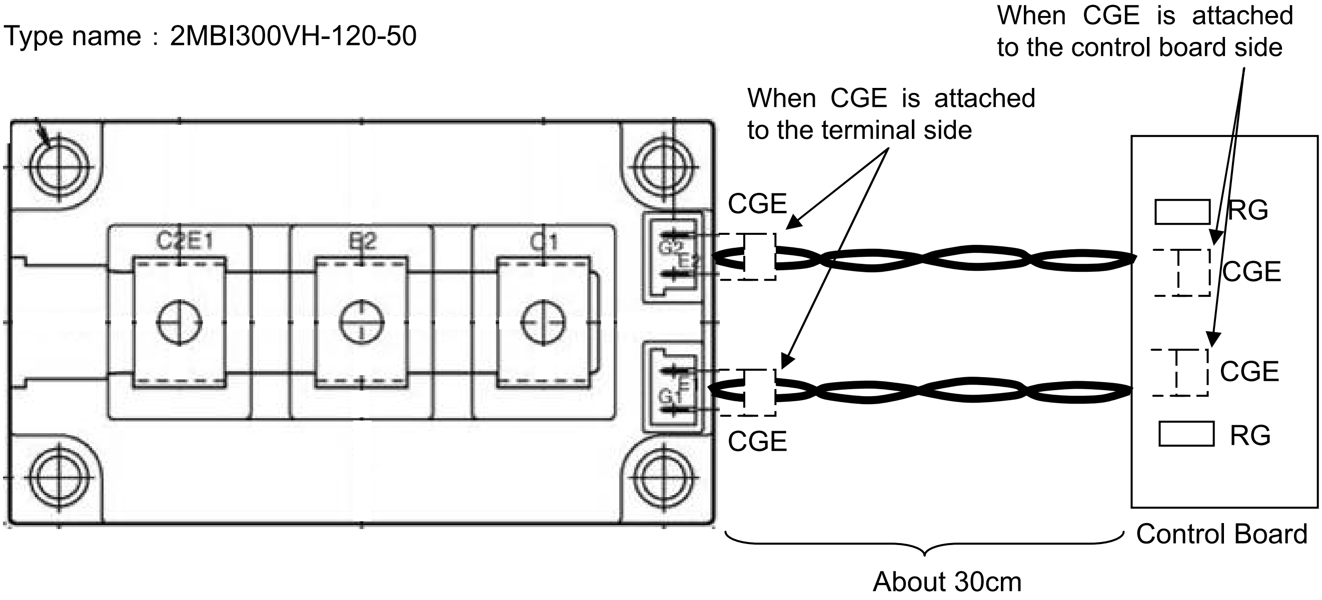
－　Fuji IGBT Module V Series　1200V Family　－

Radiation noise comparison by the difference in a gate capacitance connection position

Type name：2MBI300VH-120-50



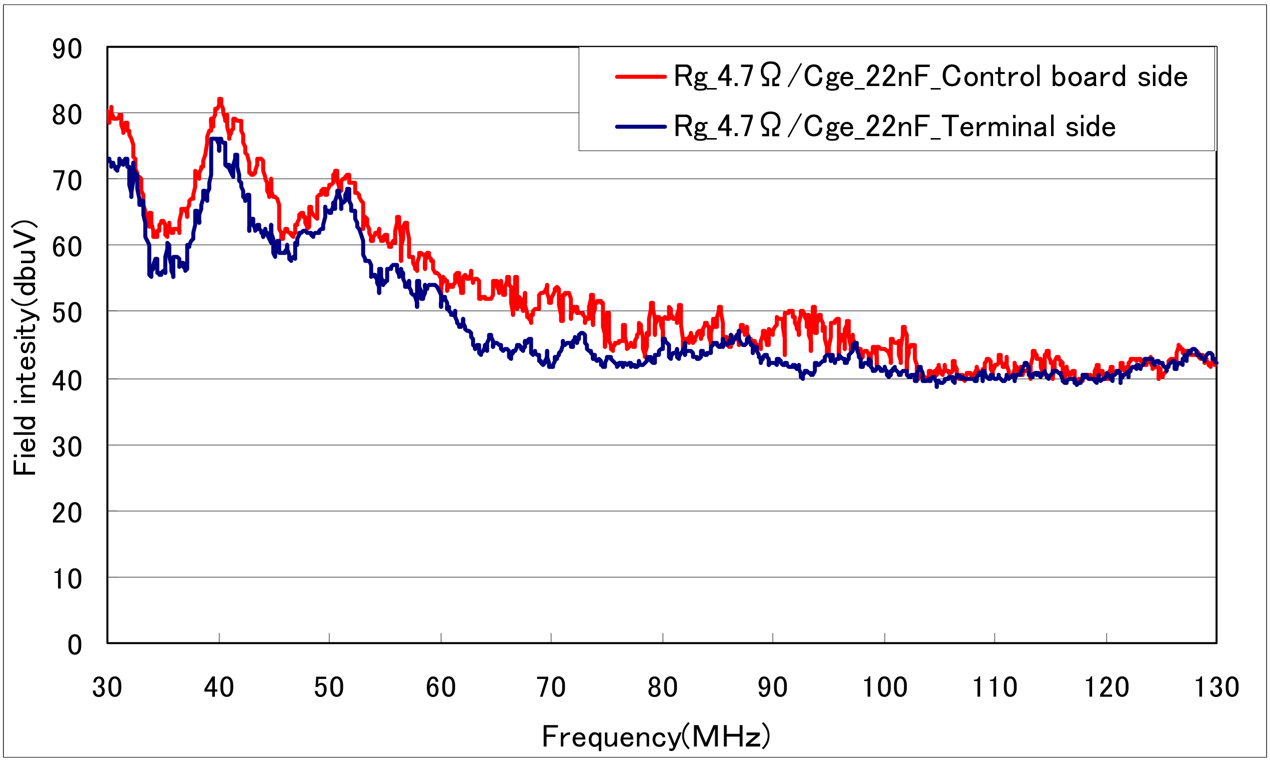


Figure　Radiation noise comparison by the difference in a gate capacitance connection position

As shown in the above figure, the higher noise reduction effect is acquired by connecting Cge to the module terminal side.

Technical data：MT5F25003

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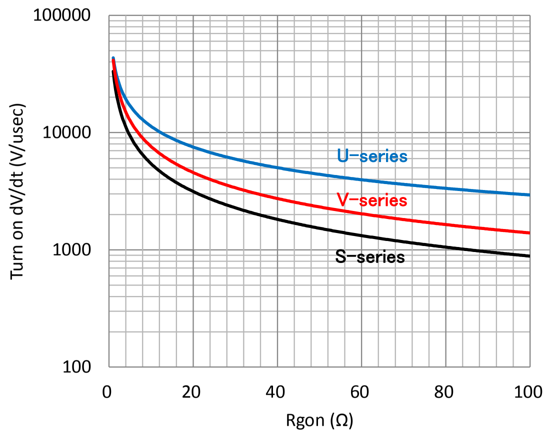
－ Fuji IGBT module S,U,V-series 1200V －

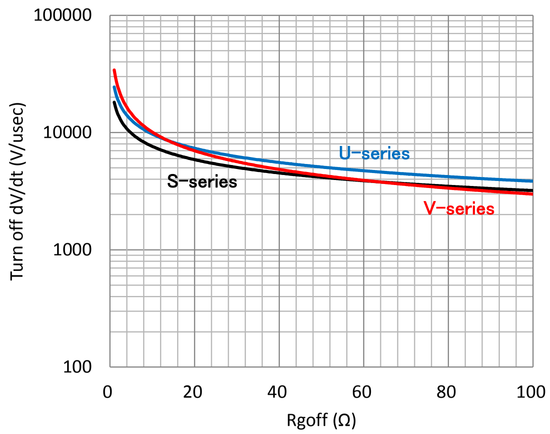
Rg-dV/dt dependency of S,U,V-series

Test module : 2MBI75S-120, 2MBI75U4A-120, 2MBI75VA-120-50

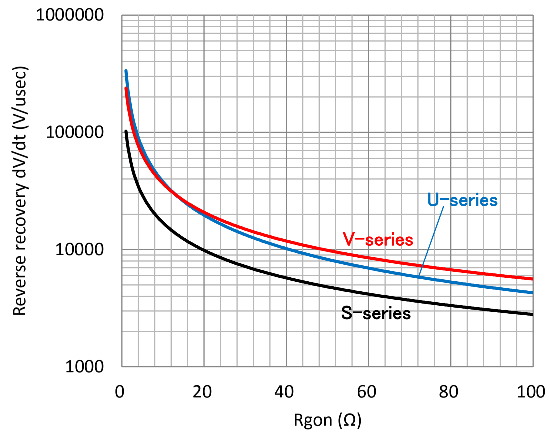
Test condition : Vdc=600V, Ic=7.5A(turn on, reverse recovery),75A(turn off), Vge=+/-15V, Tj=25deg.C, Rg=vari.



Rgon vs. Turn on dV/dt



Rgoff vs. Turn off dV/dt



Rgon vs. Reverse recovery dV/dt

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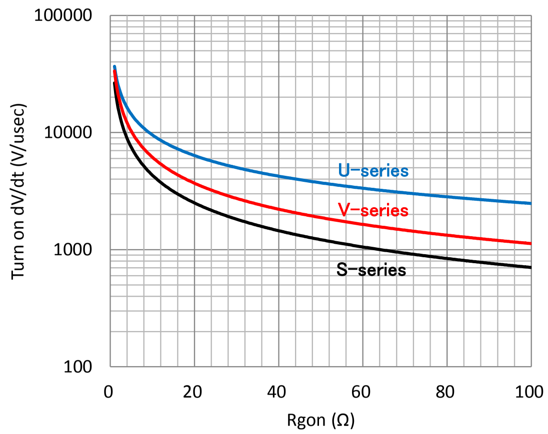
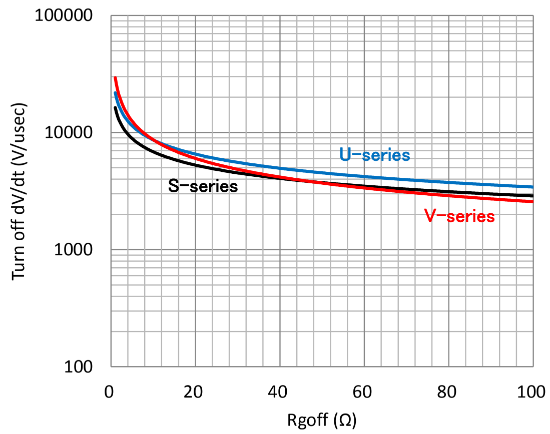
Test module : 2MBI100S-120, 2MBI100SC-120, 2MBI100U4A-120-50, 2MBI100VA-120-50

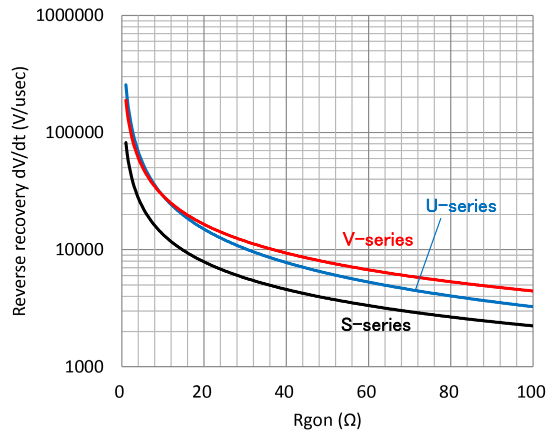
Test condition : Vdc=600V, Ic=10A(turn on, reverse recovery),100A(turn off), Vge=+/-15V, Tj=25deg.C, Rg=vari.



Rgon vs. Turn on dV/dt



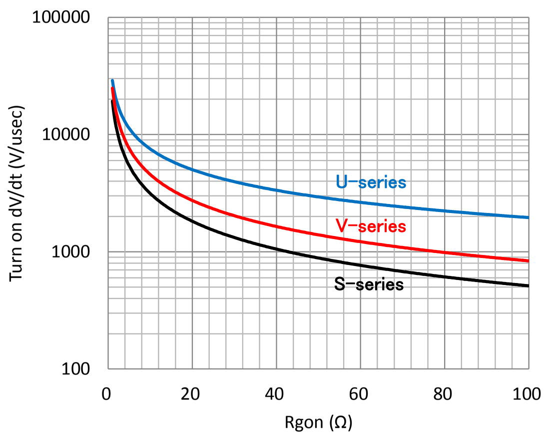
Rgoff vs. Turn off dV/dt



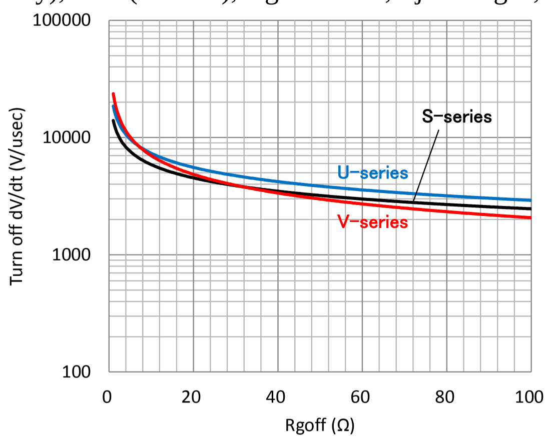
Rgon vs. Reverse recovery dV/dt

Test module : 2MBI150S-120, 2MBI150SC-120, 2MBI150U4A-120-50, 2MBI150VA-120-50, 2MBI150VB-120-50

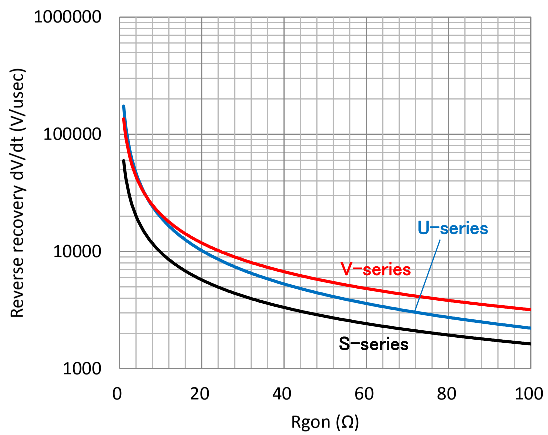
Test condition : Vdc=600V, Ic=15A(turn on, reverse recovery),150A(turn off), Vge=+/-15V, Tj=25deg.C, Rg=vari.



Rgon vs. Turn on dV/dt



Rgoff vs. Turn off dV/dt



Rgon vs. Reverse recovery dV/dt

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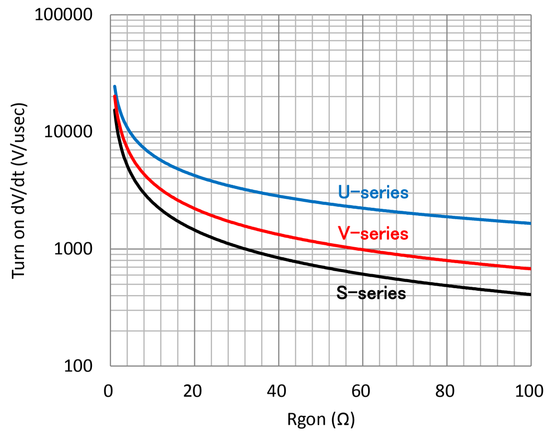
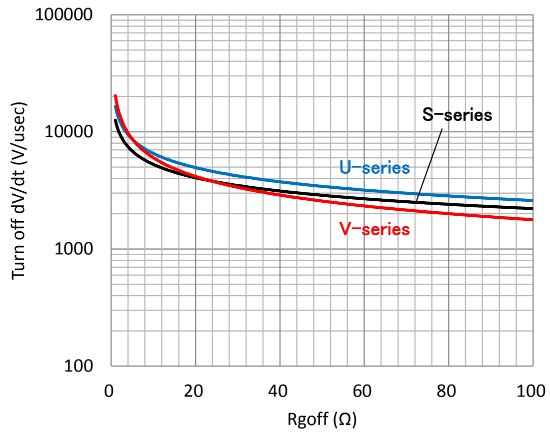
Test module : 2MBI200S-120, 2MBI200SB-120, 2MBI200U4B-120-50, 2MBI200U4H-120-50, 2MBI200VB-120-50, 2MBI200VH-120-50

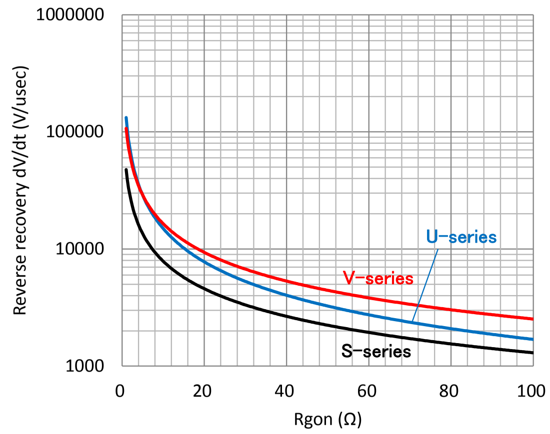
Test condition : Vdc=600V, Ic=20A(turn on, reverse recovery),200A(turn off), Vge=+/-15V, Tj=25deg.C, Rg=vari.



Rgon vs. Turn on dV/dt



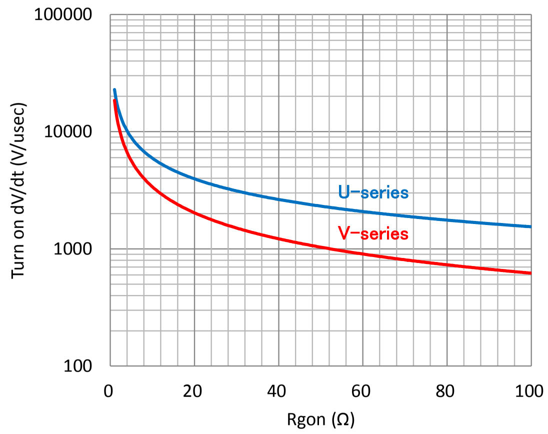
Rgoff vs. Turn off dV/dt



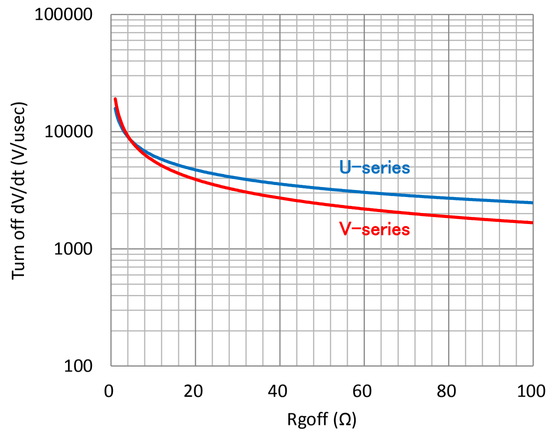
Rgon vs. Reverse recovery dV/dt

Test module : 2MBI225U4J-120-50, 2MBI225U4N-120-50, 2MBI225VJ-120-50, 2MBI225VN-120-50

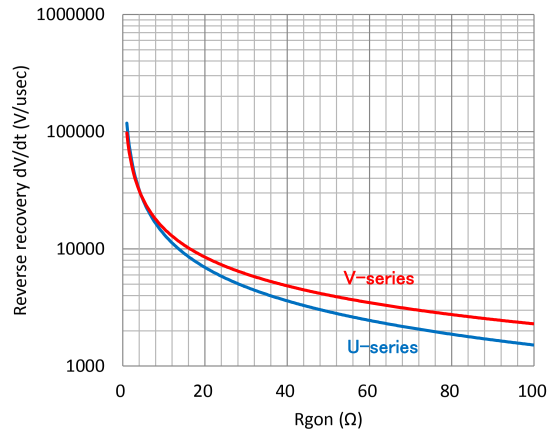
Test condition : Vdc=600V, Ic=22.5A(turn on, reverse recovery),225A(turn off), Vge=+/-15V, Tj=25deg.C, Rg=vari.



Rgon vs. Turn on dV/dt



Rgoff vs. Turn off dV/dt



Rgon vs. Reverse recovery dV/dt

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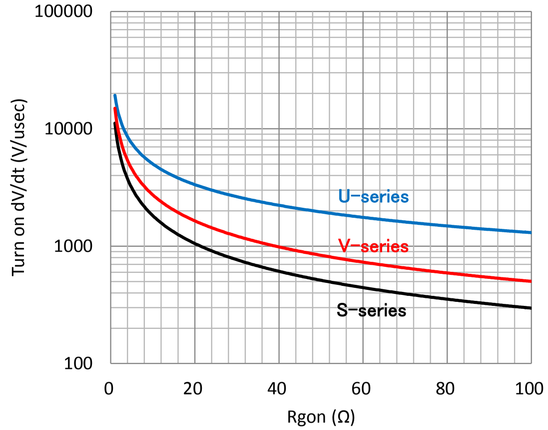
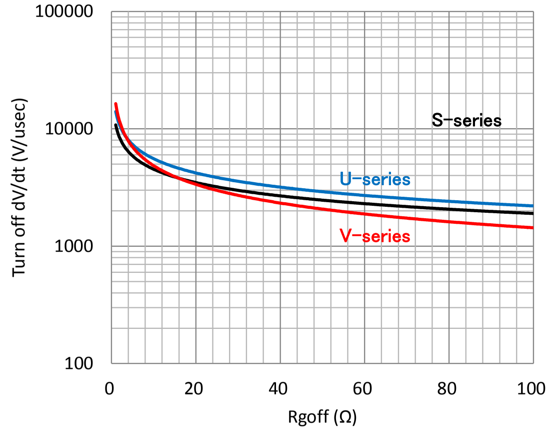
Test module : 2MBI300S-120, 2MBI300U4D-120-50, 2MBI300U4E-120, 2MBI300U4H-120-50, 2MBI300U4J-120-50, 2MBI300U4N-120-50, 2MBI300VD-120-50, 2MBI300VE-120-50, 2MBI300VH-120-50, 2MBI300VJ-120-50, 2MBI300VN-120-50

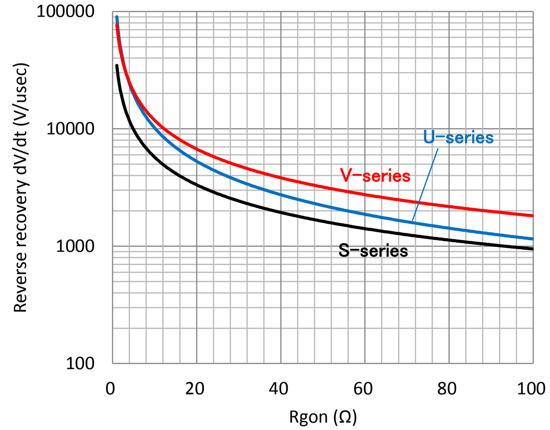
Test condition : Vdc=600V, Ic=30A(turn on, reverse recovery),300A(turn off), Vge=+/-15V, Tj=25deg.C, Rg=vari.



Rgon vs. Turn on dV/dt



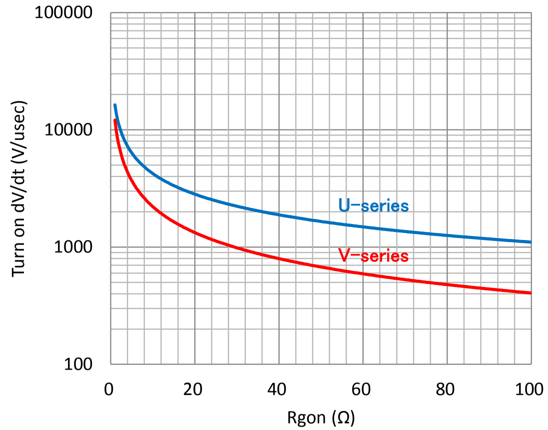
Rgoff vs. Turn off dV/dt



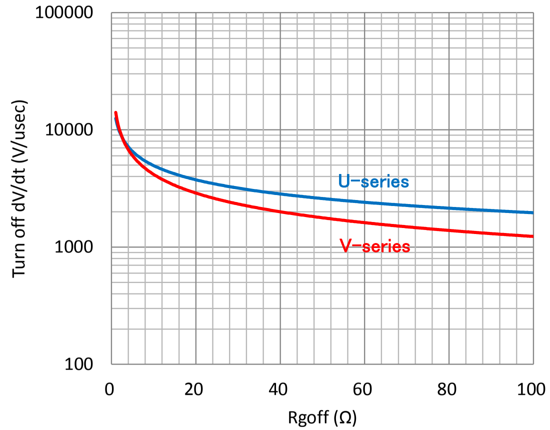
Rgon vs. Reverse recovery dV/dt

Test module : 2MBI400U4H-120-50, 2MBI400VD-120-50

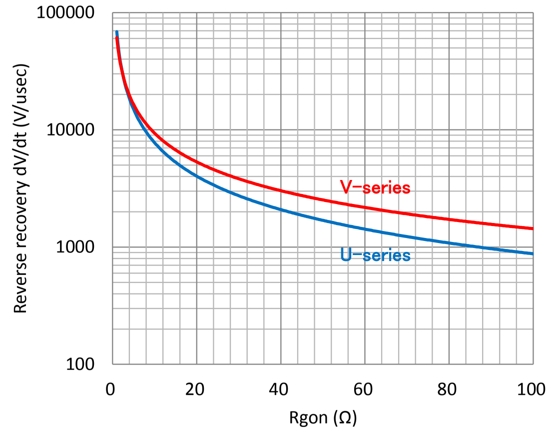
Test condition : Vdc=600V, Ic=40A(turn on, reverse recovery),400A(turn off), Vge=+/-15V, Tj=25deg.C, Rg=vari.



Rgon vs. Turn on dV/dt



Rgoff vs. Turn off dV/dt



Rgon vs. Reverse recovery dV/dt

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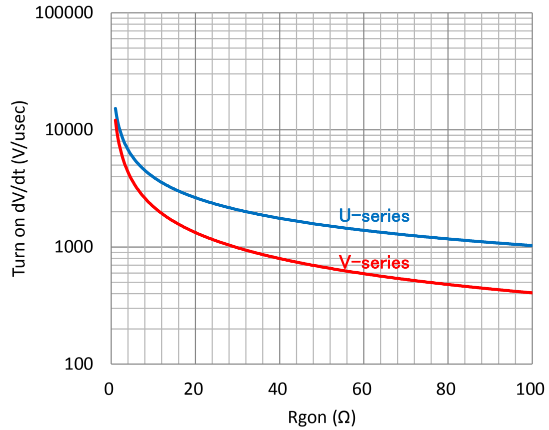
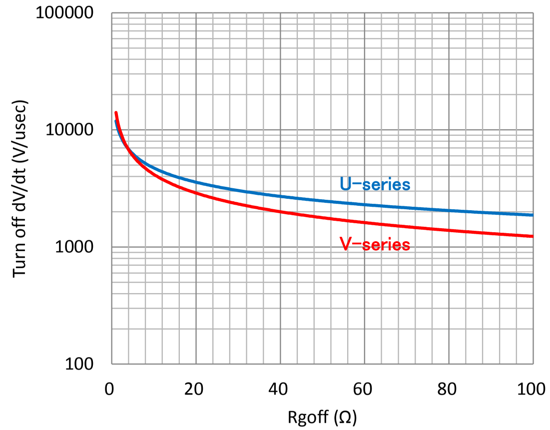
Test module : 2MBI450U4E-120, 2MBI450U4J-120-50, 2MBI450U4N-120-50, 2MBI450VE-120-50, 2MBI450VH-120-50, 2MBI450VJ-120-50, 2MBI450VN-120-50

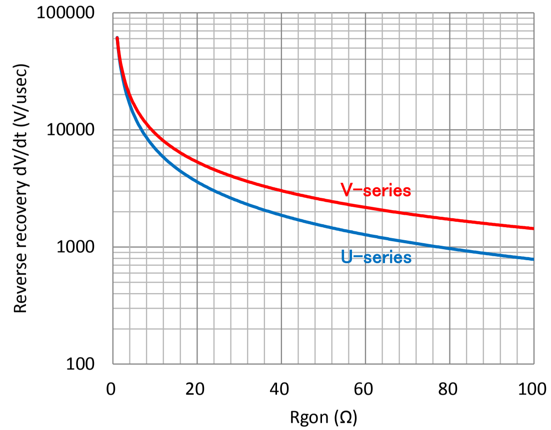
Test condition : Vdc=600V, Ic=45A(turn on, reverse recovery),450A(turn off), Vge=+/-15V, Tj=25deg.C, Rg=vari.



Rgon vs. Turn on dV/dt



Rgoff vs. Turn off dV/dt



Rgon vs. Reverse recovery dV/dt

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WARNING

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   - Communications equipment (terminal devices)
   - Measurement equipment
   - Machine tools
   - Audiovisual equipment
   - Electrical home appliances
   - Personal equipment
   - Industrial robots etc.

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   - Trunk communications equipment
   - Traffic-signal control equipment
   - Gas leakage detectors with an auto-shut-off feature
   - Emergency equipment for responding to disasters and anti-burglary devices
   - Safety devices
   - Medical equipment

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   - Aeronautic equipment
   - Nuclear control equipment
   - Submarine repeater equipment

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