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# FUJI IGBT Modules U Series

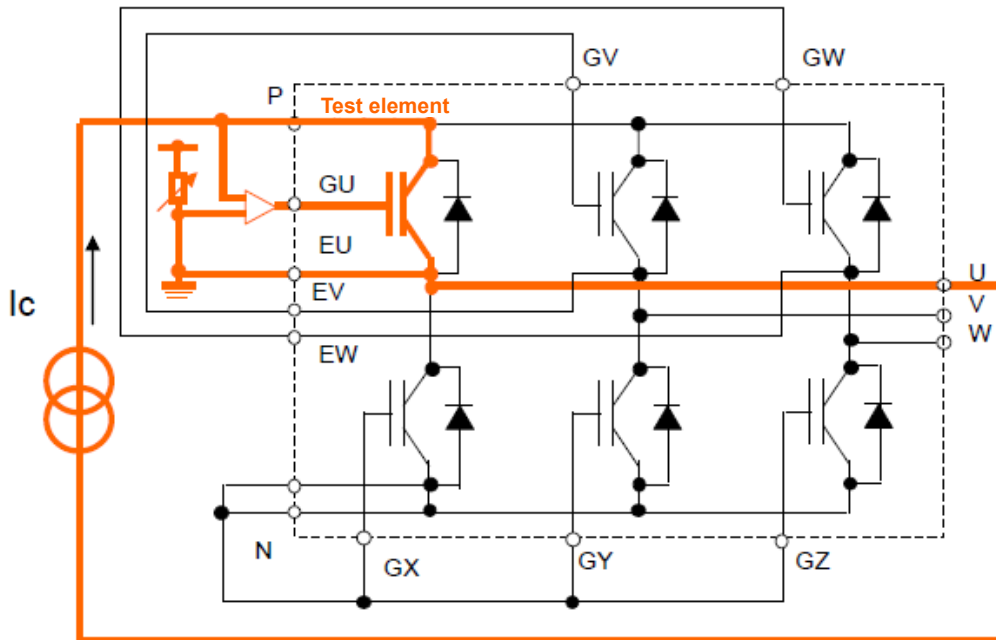
## Technical Documents

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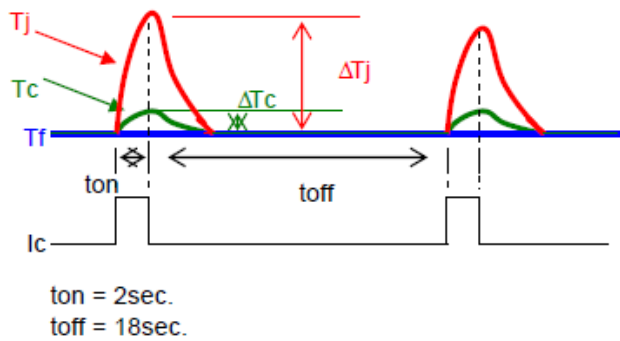
Power cycle capability .....	MT5Z02525c
RBSOA, SCSOA .....	MT5F13198
High current output-characteristics .....	MT5F13582
Short circuit current vs $V_{GE}$ characteristics .....	MT5F14993
2 in one-package module parallel connection application .....	MT5F14514
Switching loss, $dv/dt$ vs $C_{GE}$ , $R_G$ .....	MT5F14571
$-V_{GE}$ vs switching loss characteristics .....	MT5F13288
Dependence of blocking and junction temp. ....	MT5F13015
$V_{CES}$ vs $T_j$ characteristics .....	MT5F14432
$-di_c/dt$ vs $T_j$ characteristics .....	MT5F14433
Dynamic avalanche voltage vs $T_j$ characteristics .....	MT5F14434
Transient thermal impedance .....	MT5F14621

# - Fuji IGBT Module U and V Series -

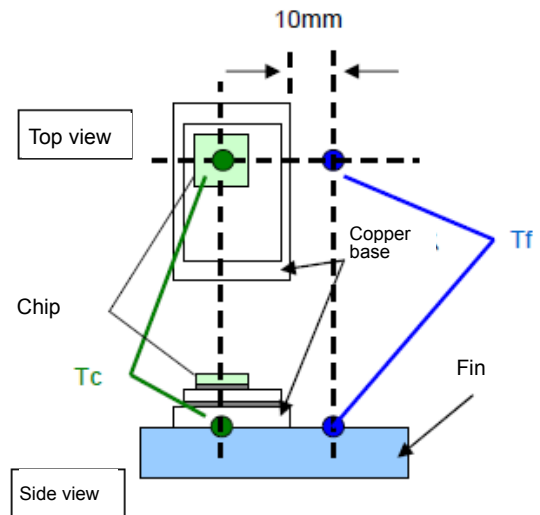
$\Delta T_j$  power cycle test method and lifetime curve (technical reference material)



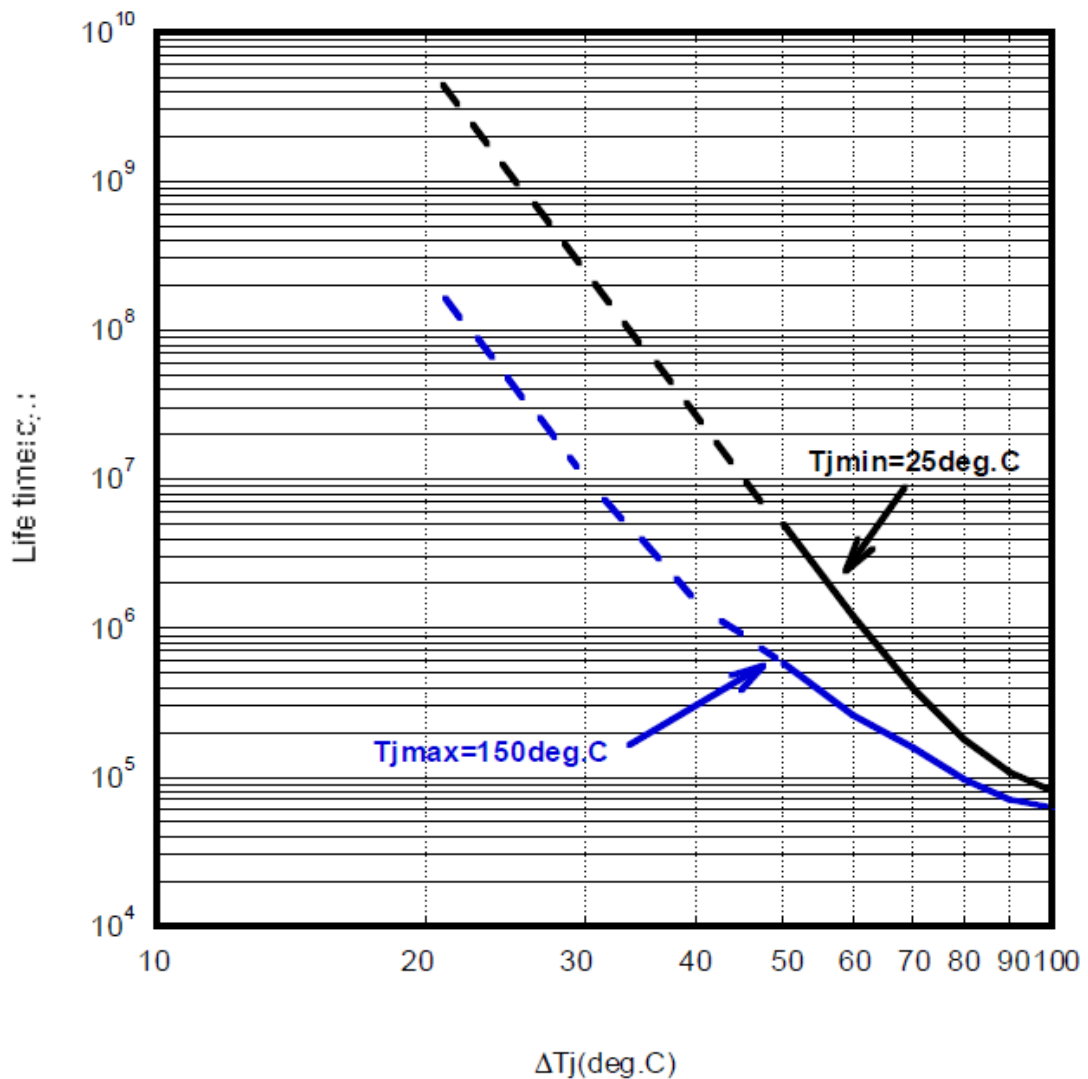
Test equivalent circuit



Current flow pattern of  $\Delta T_j$  power cycle and temperature change



Tc and Tf measurement positions

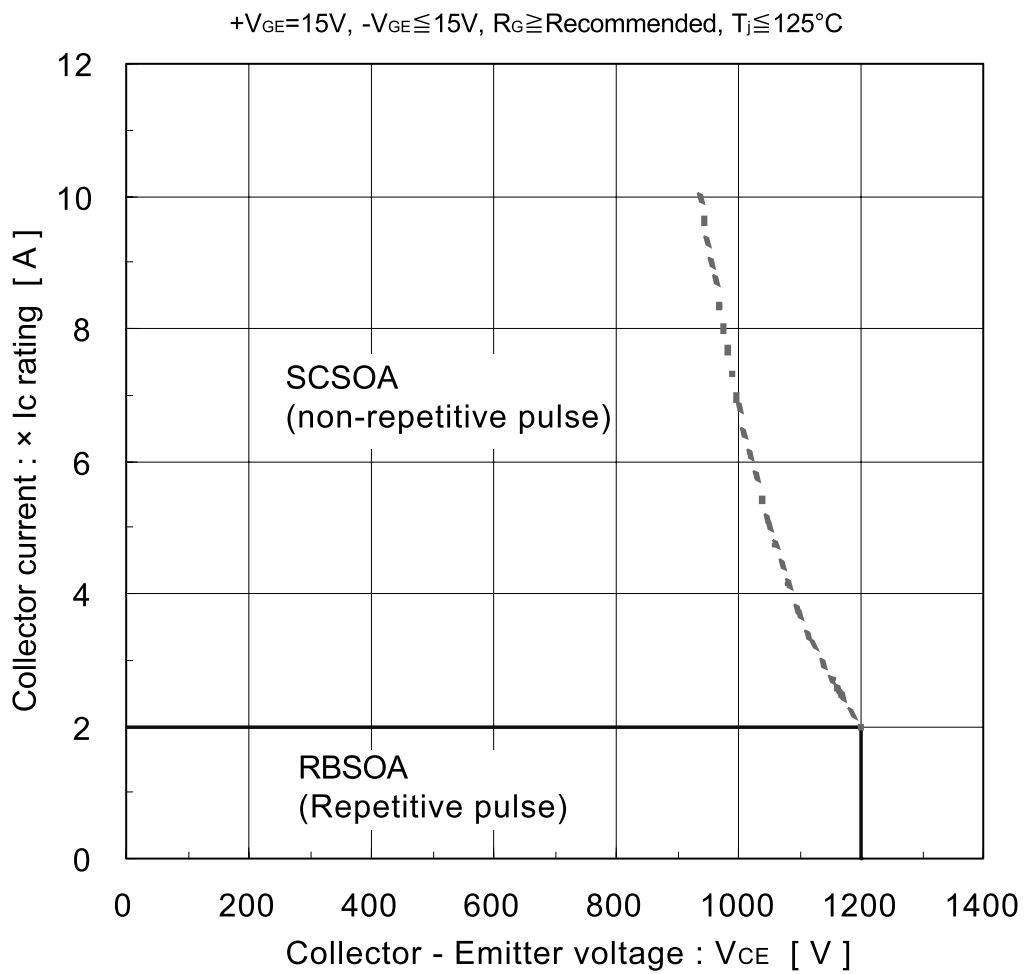


**$\Delta T_j$  Power cycling life time curve**

- \*1) The judgment criterion for failure is the point when the test element becomes open or short.
- \*2) The radiation fin and module are mounted according to our test standards.
- \*3) The capacity data in the lifetime curve is the one when the failure rate is 1% in the Weibull analysis.
- \*4) The capacity data in the lifetime curve shows the result of multiple models.
- \*5) The dotted lines show the estimated lifetime, not the guaranteed value.
- \*6) The IGBT (FWD) chips connected in parallel are not included.

# FUJI IGBT Modules U Series

## RBSOA, SCSOA 1200V



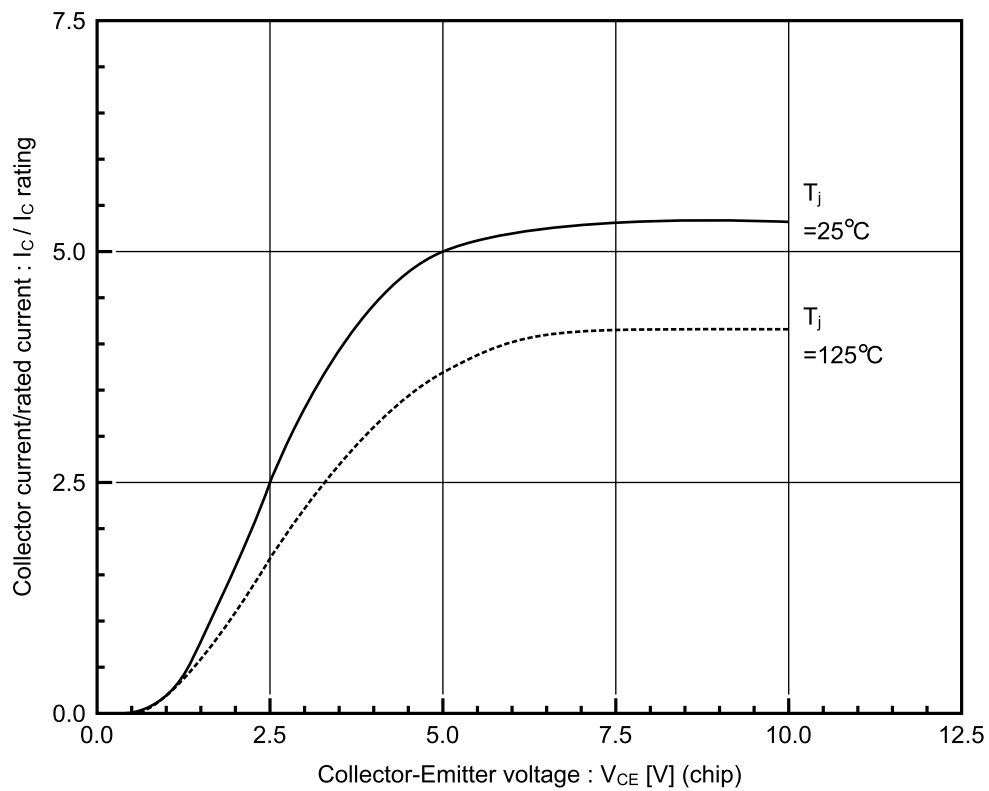
# FUJI IGBT Modules U Series

## High current output-characteristics 1200V Typical value

Conditions:  $T_j=25/125^{\circ}\text{C}$

$V_{GE}=15\text{V}$

Not include internal-drop voltage due to internal-resistance of module.



# FUJI IGBT Modules U Series

## Short circuit vs $V_{GE}$ characteristics 1200V

Sample: 2MBI150UA-120, 2MBI200UB-120, 2MBI300UD-120

Conditions:  $V_{DC}=600V$

$+V_{GE}=8, 10, 13, 15, 18V$

$-V_{GE}=15V$

$T_j=125^{\circ}C$

$R_G$  (Recommended value) = 2.2 $\Omega$  (2MBI150UA-120)

3.0 $\Omega$  (2MBI200UB-120)

1.1 $\Omega$  (2MBI300UD-120)

Results:  $V_{GE} - I_{SC}$  characteristics ..... Fig. 1

Definition of  $I_{SC}$ : Saturated current at short circuit condition

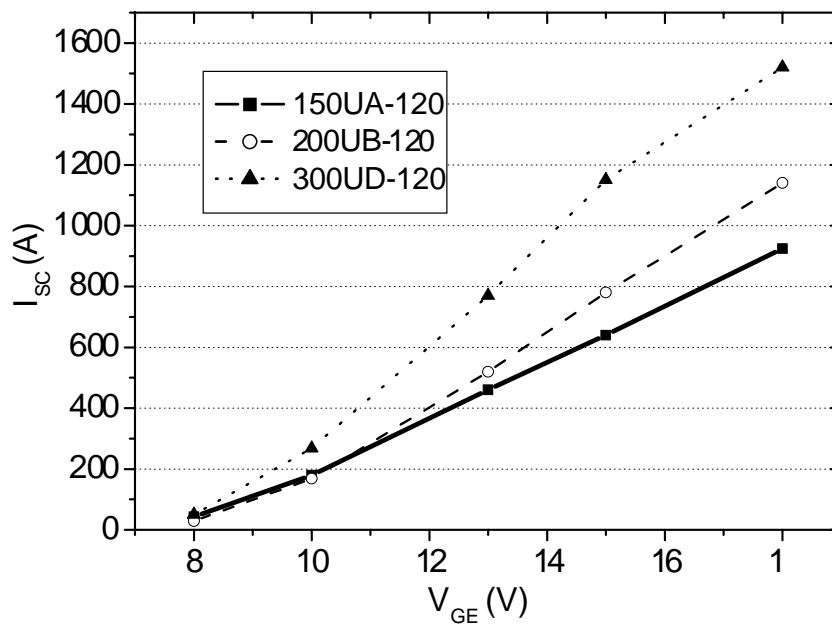
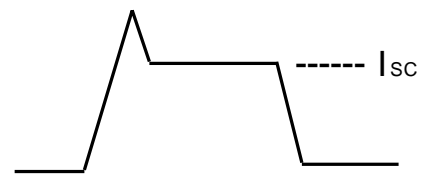


Fig. 1  $V_{GE} - I_{SC}$  characteristics

Waveforms: 2MBI150UA-120 ..... Fig. 2 to Fig. 6

2MBI200UB-120 ..... Fig. 7 to Fig. 11

2MBI300UD-120 ..... Fig. 12 to Fig. 16

2MBI150UA-120

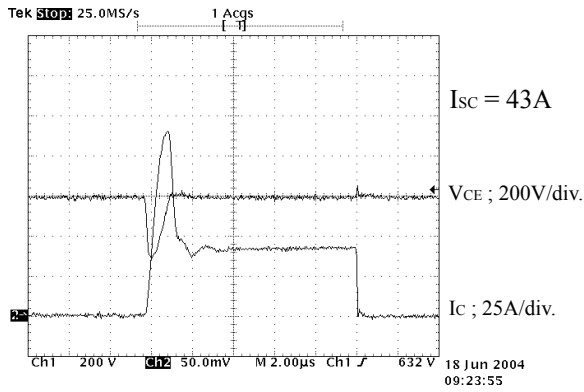


Fig. 2  $V_{GE}=8V$

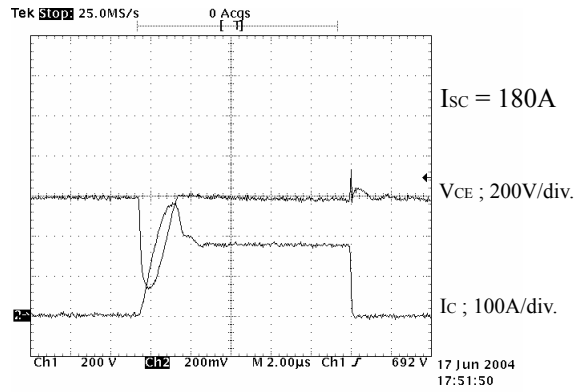


Fig. 3  $V_{GE}=10V$

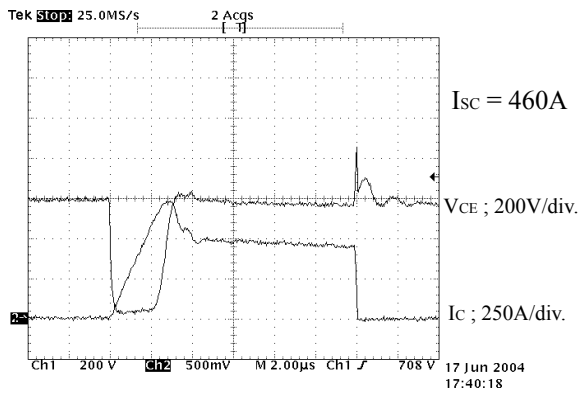


Fig. 4  $V_{GE}=13V$

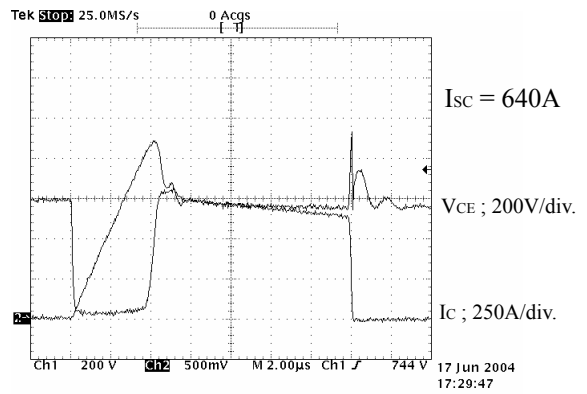


Fig. 5  $V_{GE}=15V$

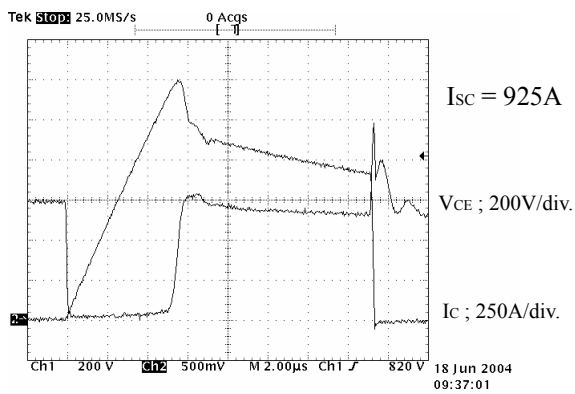


Fig. 6  $V_{GE}=18V$

2MBI200UB-120

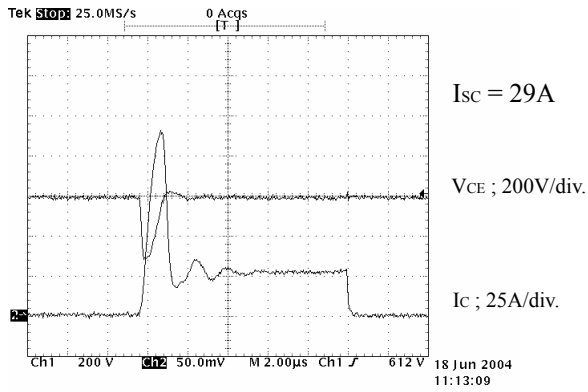


Fig. 7  $V_{GE}=8V$

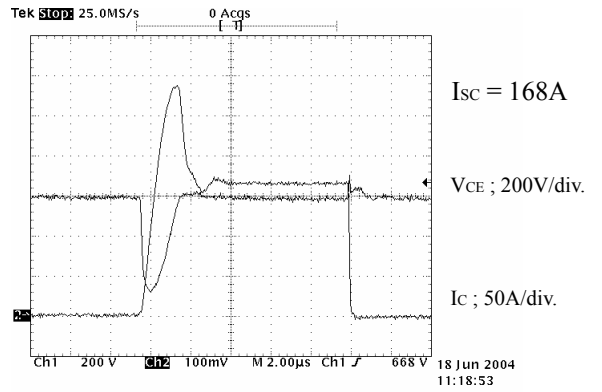


Fig. 8  $V_{GE}=10V$

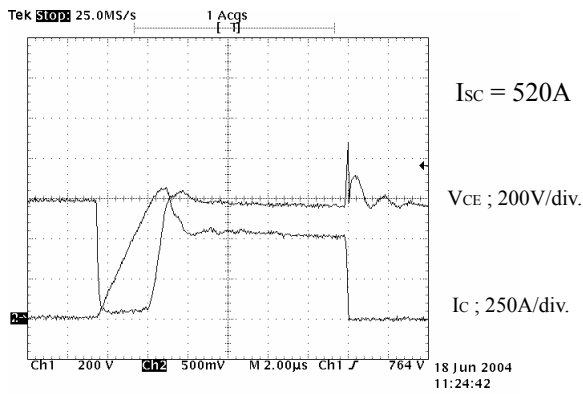


Fig. 9  $V_{GE}=13V$

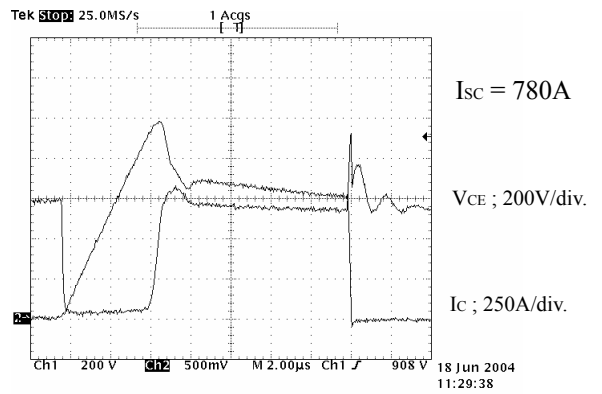


Fig. 10  $V_{GE}=15V$

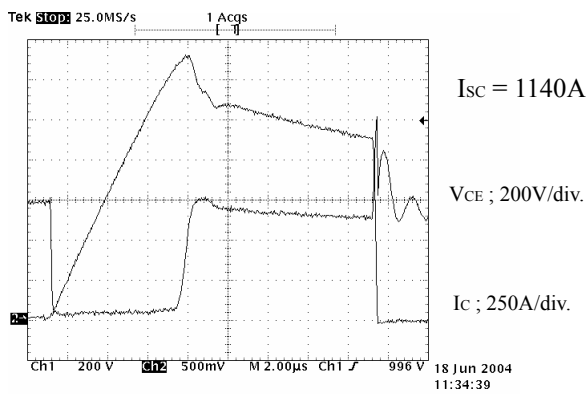


Fig. 11  $V_{GE}=18V$



2MBI300UD-120

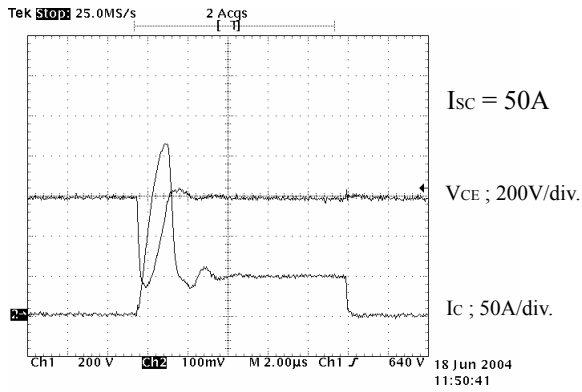


Fig. 12  $V_{GE}=8V$

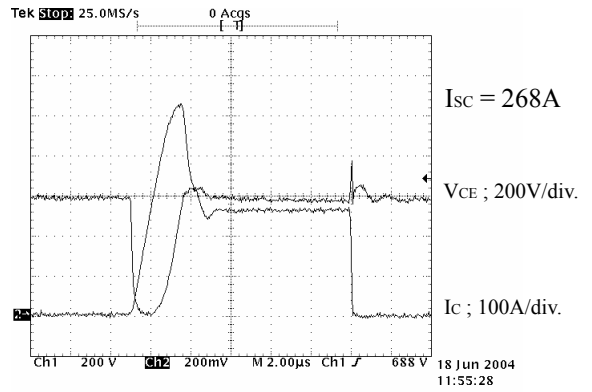


Fig. 13  $V_{GE}=10V$

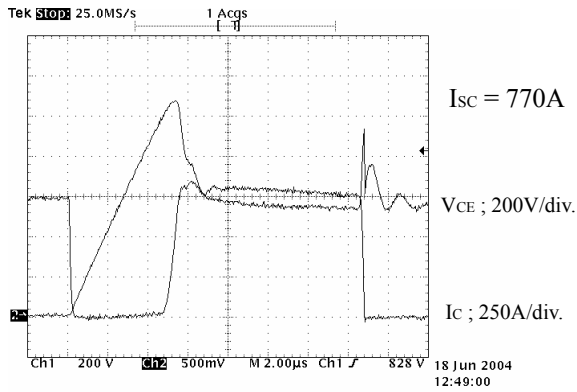


Fig. 14  $V_{GE}=13V$

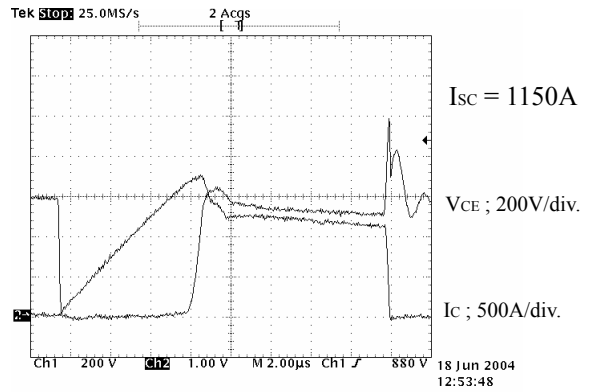


Fig. 15  $V_{GE}=15V$

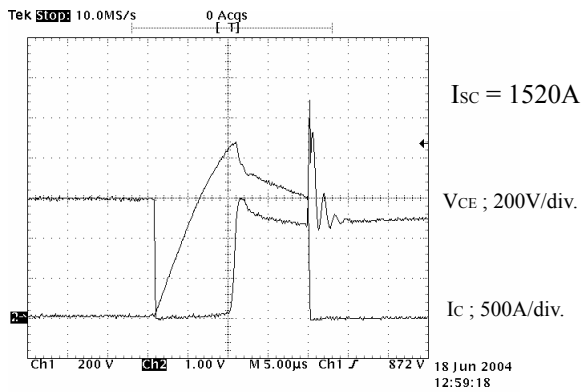
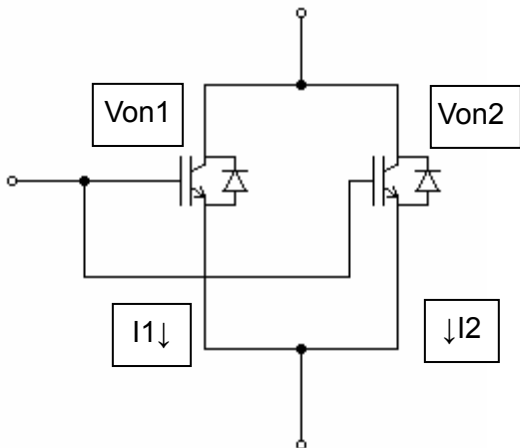


Fig. 16  $V_{GE}=18V$

## FUJI IGBT Modules U Series

### 2 in one-package module parallel connection application 1200V

#### Current imbalance in parallel connection

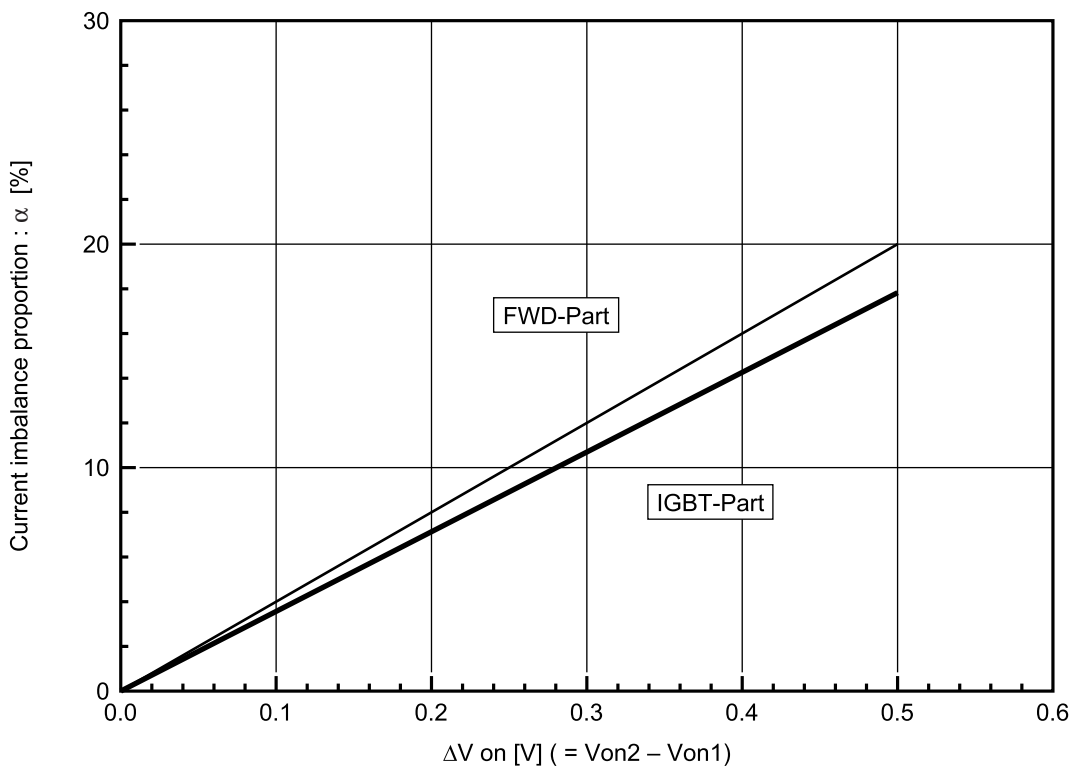


Configuration and equation

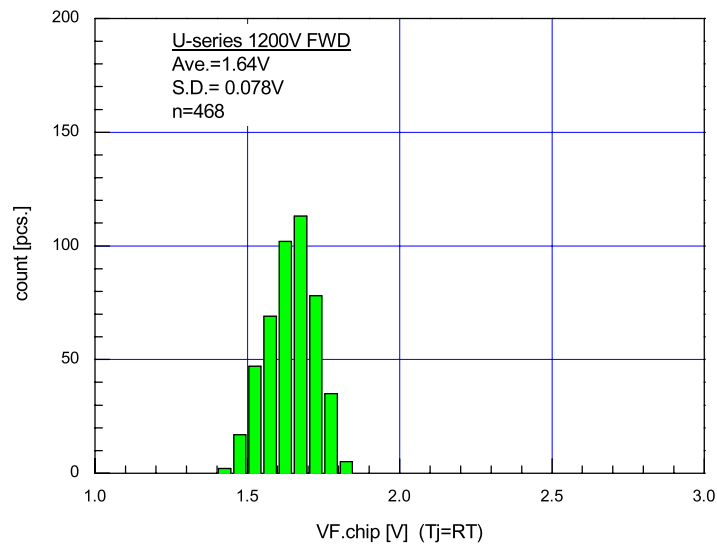
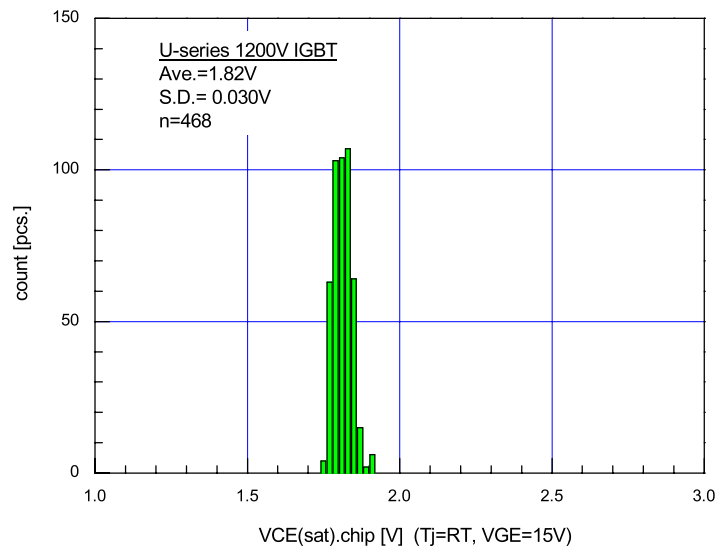
$$\Delta V_{on} = V_{on2} - V_{on1}$$

Current imbalance was caused by difference between  $V_{on1}$  and  $V_{on2}$ , current will be divided to  $I_1$  and  $I_2$  respectively. In this case, the current imbalance rate is defined as following equation.

$$\alpha = [I_1 / I_c(\text{ave}) - 1] \times 100(\%)$$



## V<sub>CE(sat)</sub>, V<sub>F</sub> distribution



Von distribution

### Parallel connection application (Von classification)

Applicable types: 2MBI300UC-120, 2MBI300UD-120, 2MBI300UE-120, 2MBI450UE-120

Spec.	V <sub>CE(sat)</sub> rank	V <sub>F</sub> rank	Current Imbalance rate (Derating rate for parallel connection)
Standard	0.5V	0.5V	20% maximum
Selection (-03)	0.3V 1-rank	0.25 – 0.3V 4-rank	13% maximum

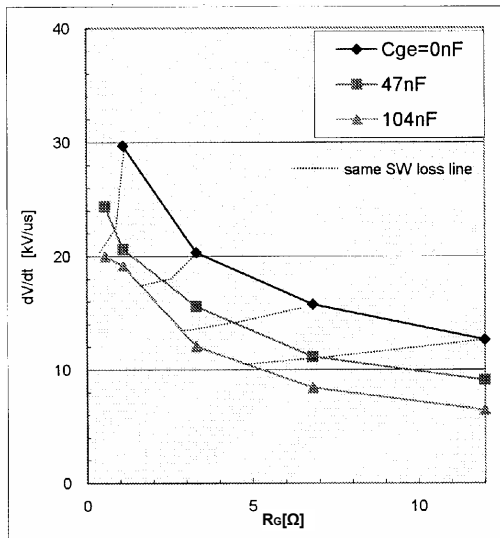
The standard part can be used to parallel connection application with 20% of current imbalance rate. If lower current imbalance rate is necessary, selection version (-03 at end of type number) is recommended. In this case, same rank device must be used to same arm of inverter leg.

# FUJI IGBT Modules U Series

## Switching loss, dv/dt vs $C_{GE}$ , $R_G$ 6MBI450U-120

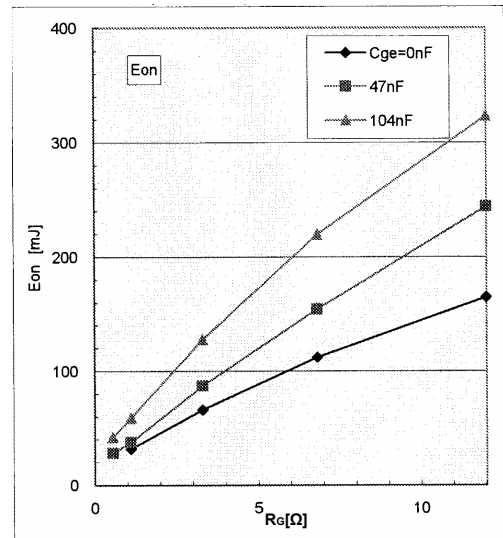
### Reverse recovery dv/dt

Sample: 6MBI450U-120 #38001-11 Y-phase drive  
 $T_j=25^\circ\text{C}$ ,  $V_{cc}=800\text{V}$ ,  $I_c=22.5\text{A}$  (5% of rating)  
 $V_{GE}=\pm 15\text{V}$ ,  $L_s=45\text{nH}$ , Snubber C=0



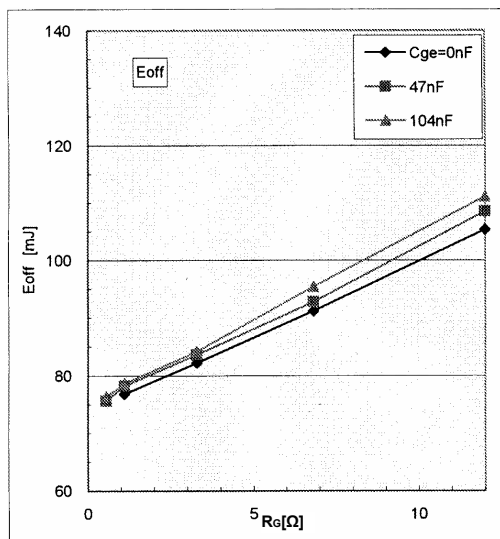
### Switching loss Eon

$T_j=125^\circ\text{C}$ ,  $V_{cc}=600\text{V}$ ,  $I_c=450\text{A}$   
 $V_{GE}=\pm 15\text{V}$ ,  $L_s=75\text{nH}$ , Snubber C=0



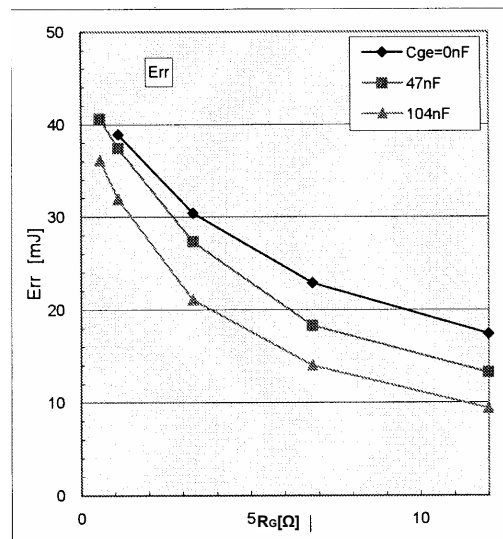
### Switching loss Eoff

$T_j=125^\circ\text{C}$ ,  $V_{cc}=600\text{V}$ ,  $I_c=450\text{A}$   
 $V_{GE}=\pm 15\text{V}$ ,  $L_s=75\text{nH}$ , Snubber C=0



### Switching loss Err

$T_j=125^\circ\text{C}$ ,  $V_{cc}=600\text{V}$ ,  $I_c=450\text{A}$   
 $V_{GE}=\pm 15\text{V}$ ,  $L_s=75\text{nH}$ , Snubber C=0

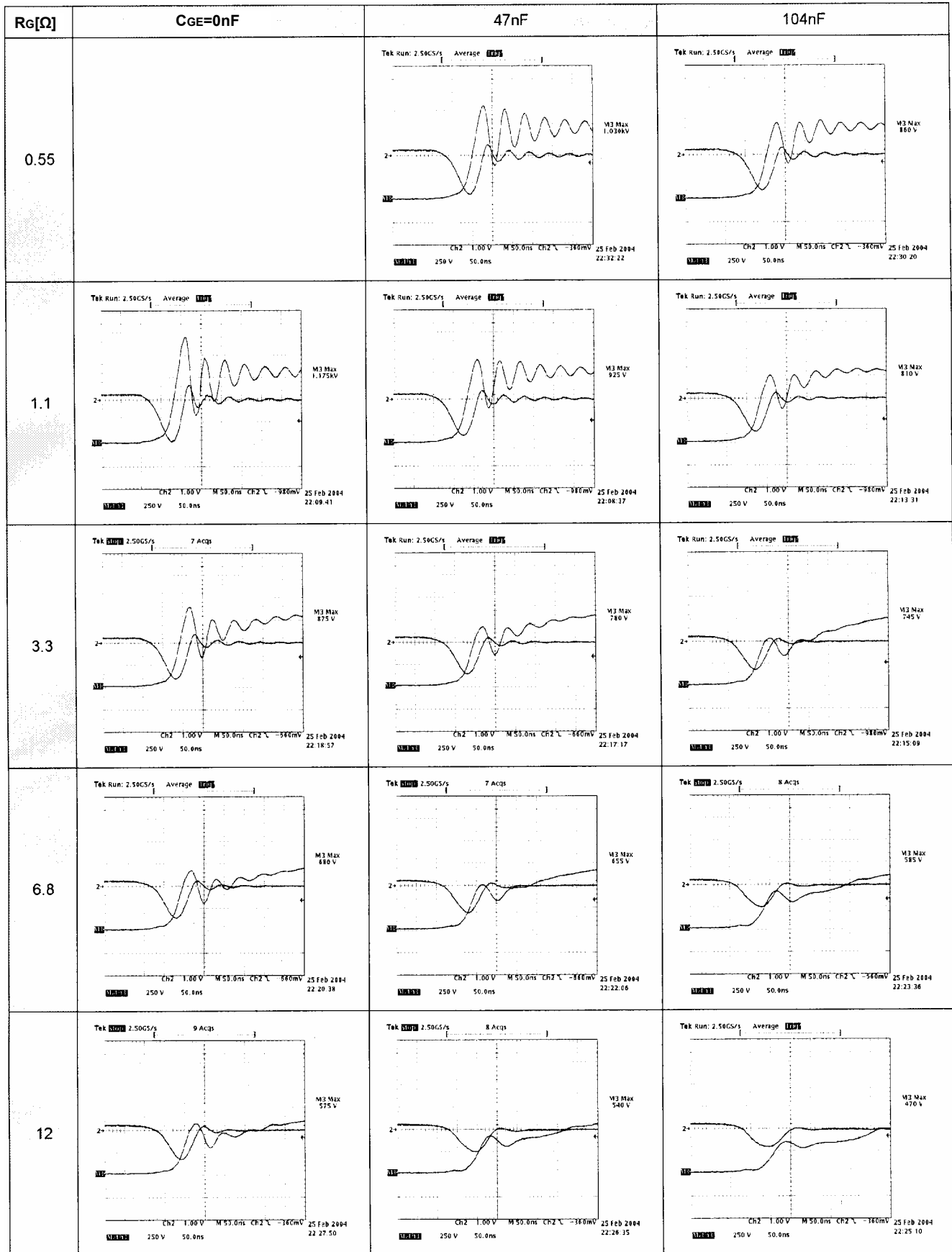


- In order to reduce dv/dt or oscillation at reverse recovery, additional  $C_{GE}$  and smaller  $R_G$  are effective.
- In order to keep same switching loss, ( $C_{GE}$  as same as  $C_{ies}$ ) +  $(0.7 \times R_G)$ , or ( $C_{GE}$  of  $2 \times C_{ies}$ ) +  $(0.5 \times R_G)$  are recommended. These are same manner also for other 1200V U-series IGBT module.

### Reverse recovery dv/dt

Sample: 6MBI450U-120 #38001-11 Y-phase drive

Tj=25°C, Vcc=800V, Ic=22.5A, VGE=±15V, Ls=45nH, Snubber C=0



# Eon (Latest sample)

Sample: 6MBI450U-120 #38001-11 Y-phase drive

Tj=125°C, Vcc=600V, Ic=450A, VGE=±15V, Ls=75nH, Snubber C=0

Rg[Ω]	Cge=0nF	47nF	104nF
0.55			
1.1			
3.3			
6.8			
12			

# Eoff (Latest sample)

Sample: 6MBI450U-120 #38001-11 Y-phase drive

Tj=125°C, Vcc=600V, Ic=450A, VGE=±15V, Ls=75nH, Snubber C=0

Rg[Ω]	CGE=0nF	47nF	104nF
0.55			
1.1			
3.3			
6.8			
12			

### Err (Latest sample)

Sample: 6MBI450U-120 #38001-11 Y-phase drive

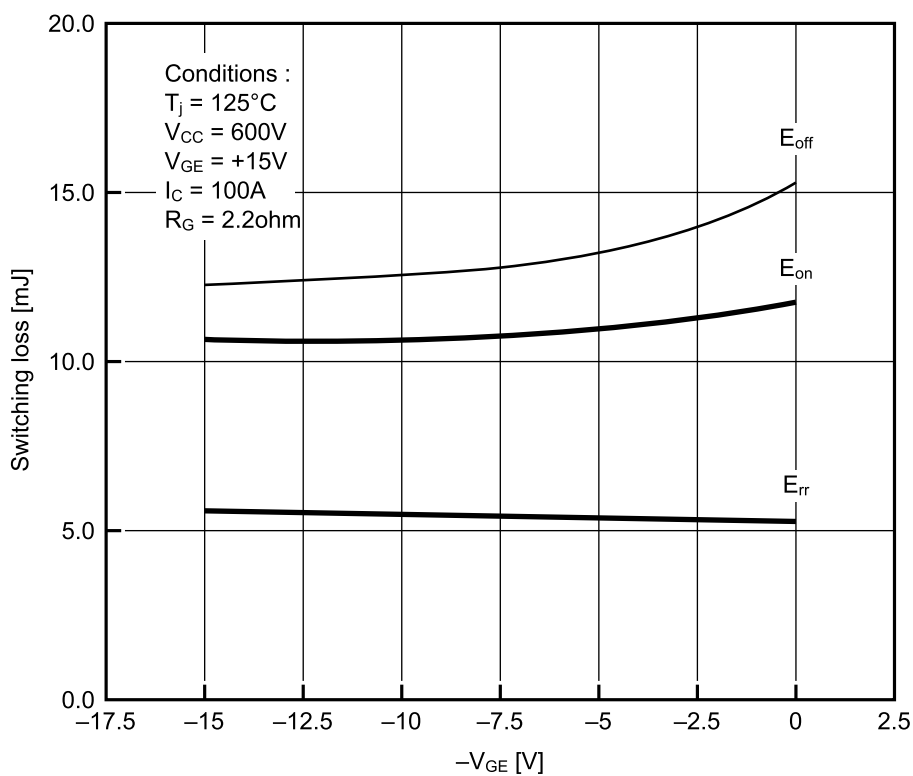
Tj=125°C, Vcc=600V, Ic=450A, VGE=±15V, Ls=75nH, Snubber C=0

Rg[Ω]	Cge=0nF	47nF	104nF
0.55			
1.1			
3.3			
6.8			
12			



## FUJI IGBT Modules U Series

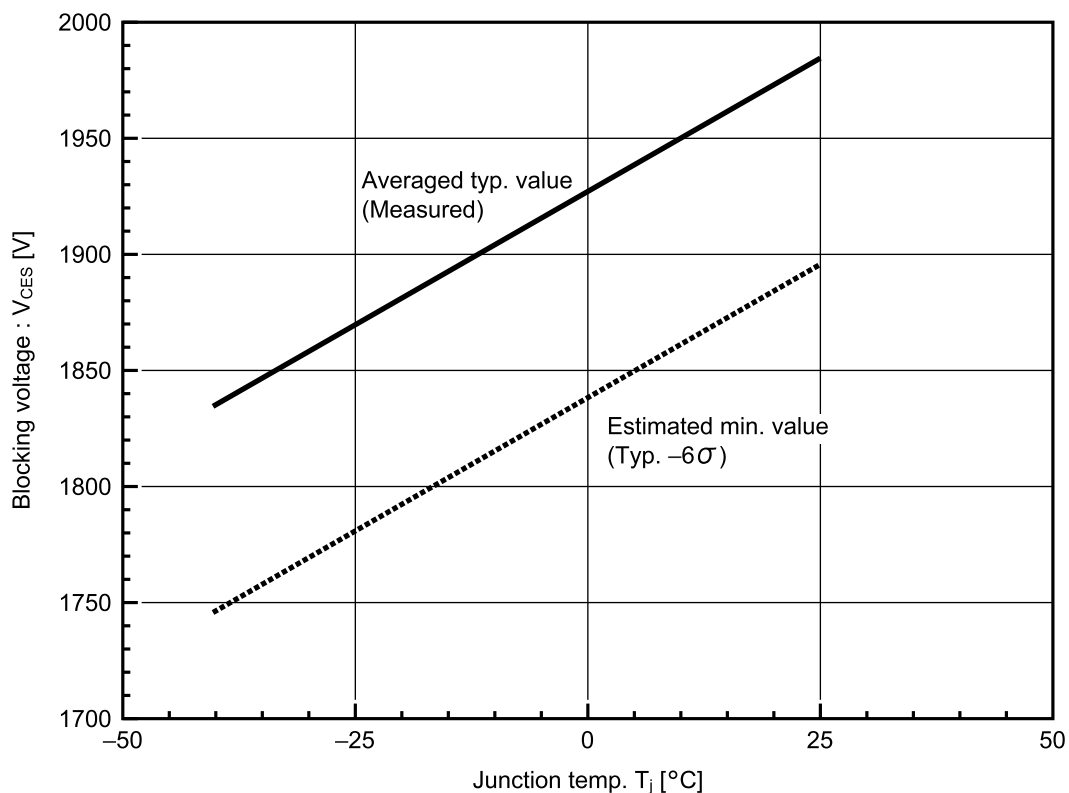
### -V<sub>GE</sub> vs switching loss characteristics 6MBI150UB-120



# FUJI IGBT Modules U Series

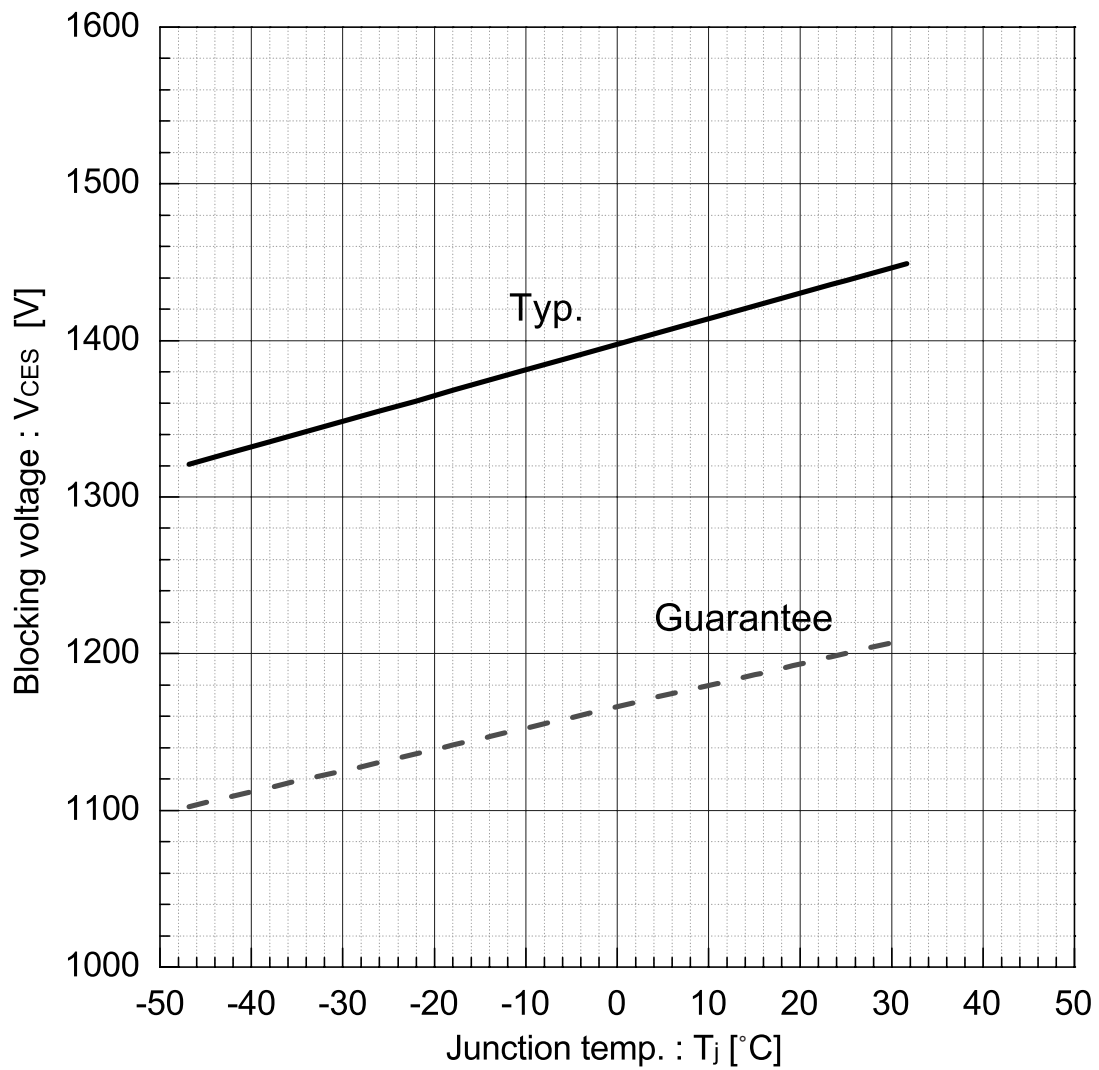
## Dependence of blocking voltage and junction temp. 1700V

For 1700V-U series (Engineering samples), such as 6MBI450U-170 and others.



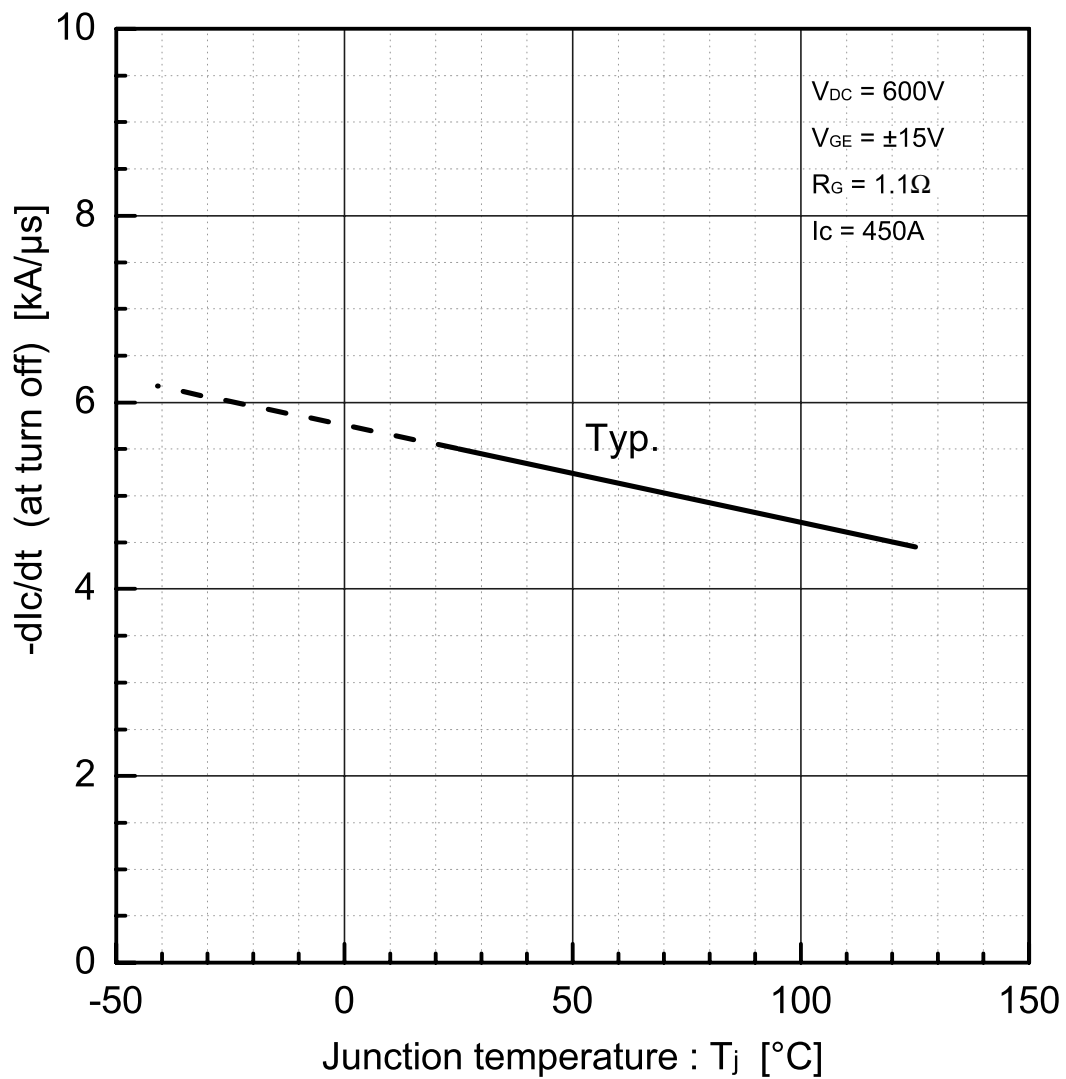
# FUJI IGBT Modules U Series

## $V_{CES}$ vs $T_j$ characteristics 1200V



## FUJI IGBT Modules U Series

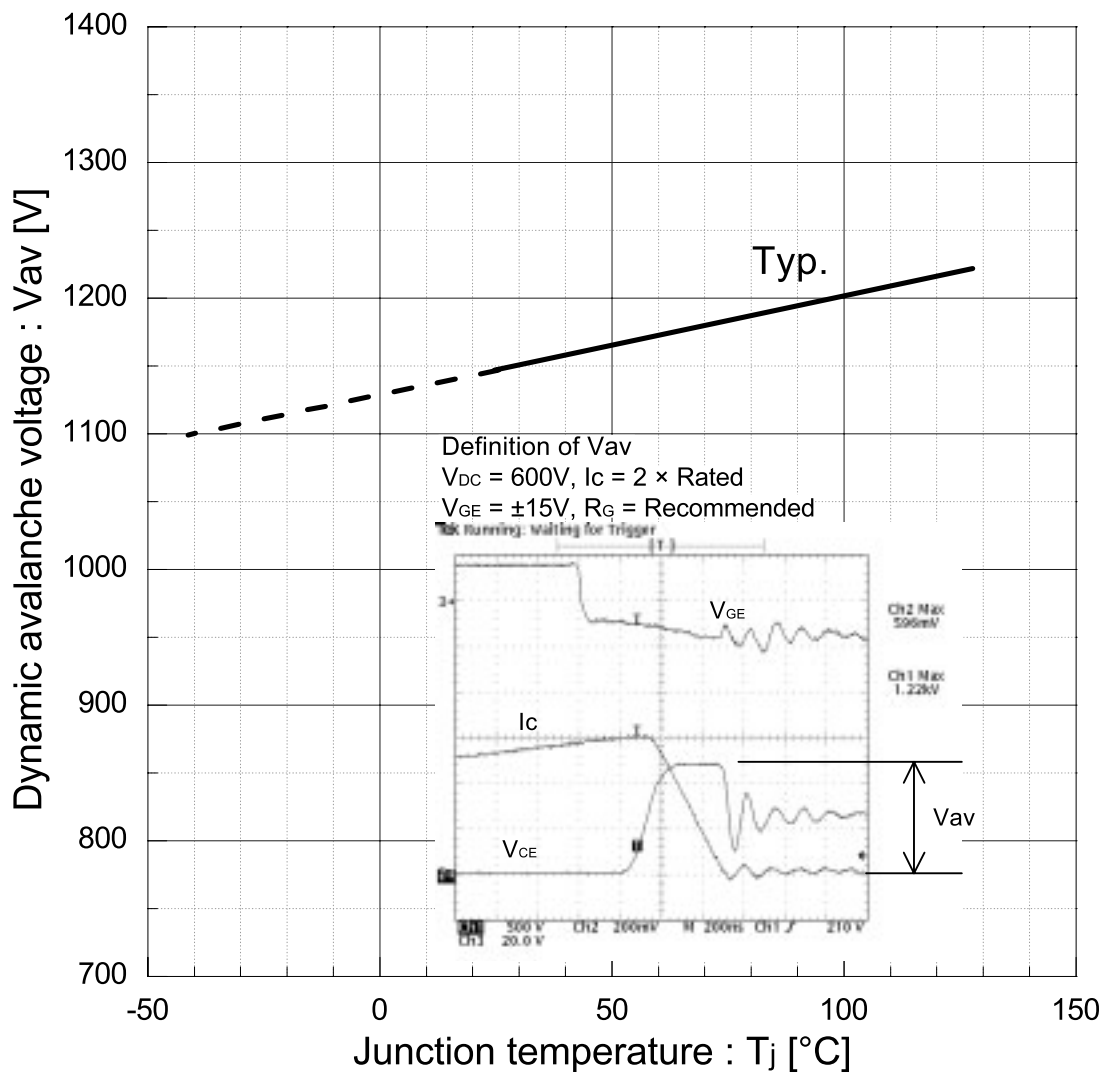
### -di/dt vs T<sub>j</sub> characteristics 1200V, 6MBI450U-120



## FUJI IGBT Modules U Series

### Dynamic avalanche voltage vs $T_j$ characteristics

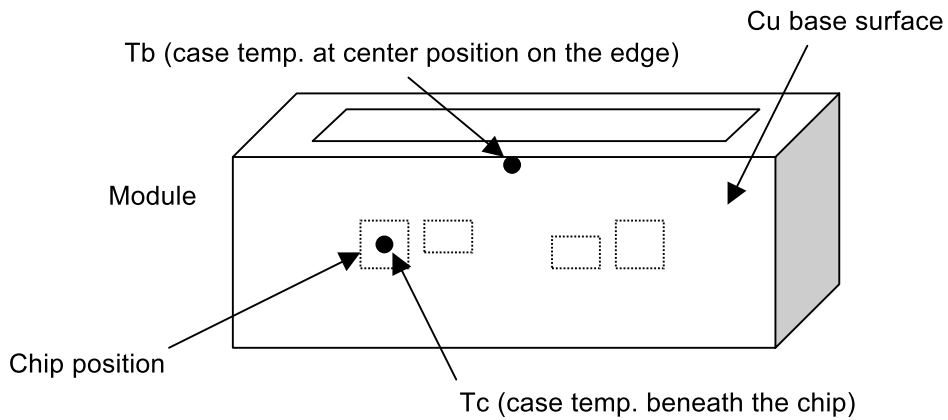
1200V 6MBI450U-120



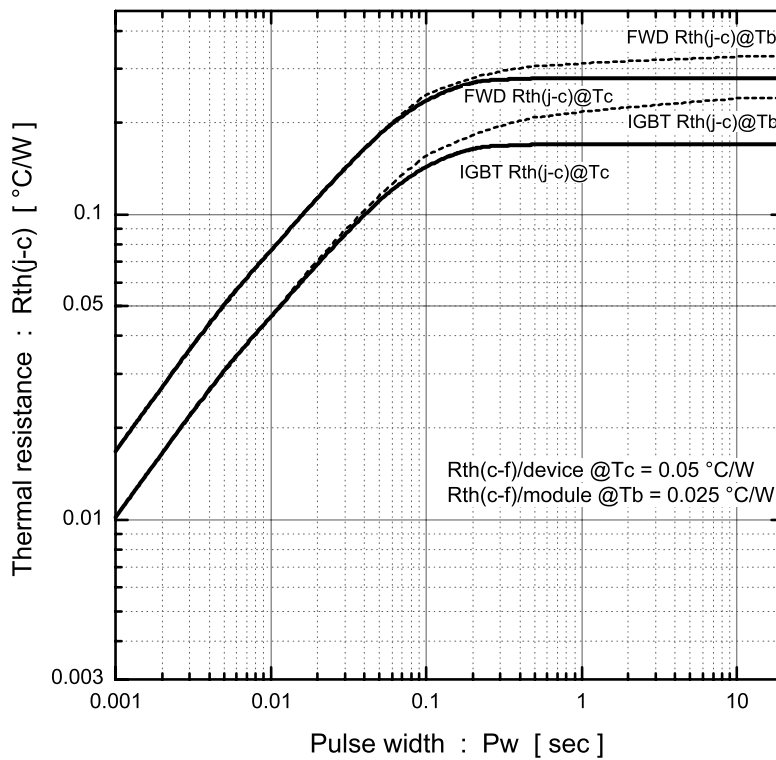
# FUJI IGBT Modules U Series

## Transient thermal impedance Calculated value

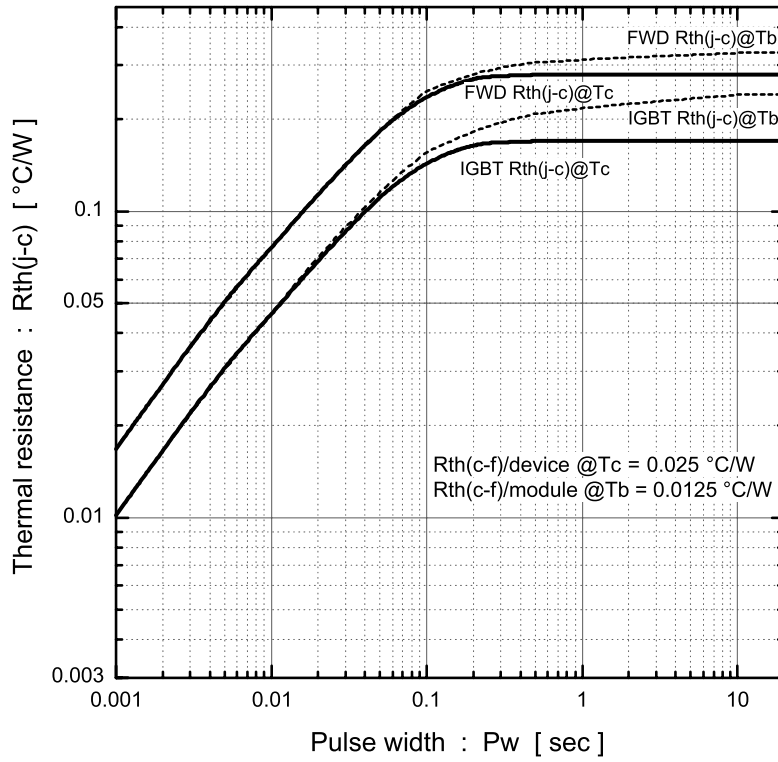
### Definition of case temperature position



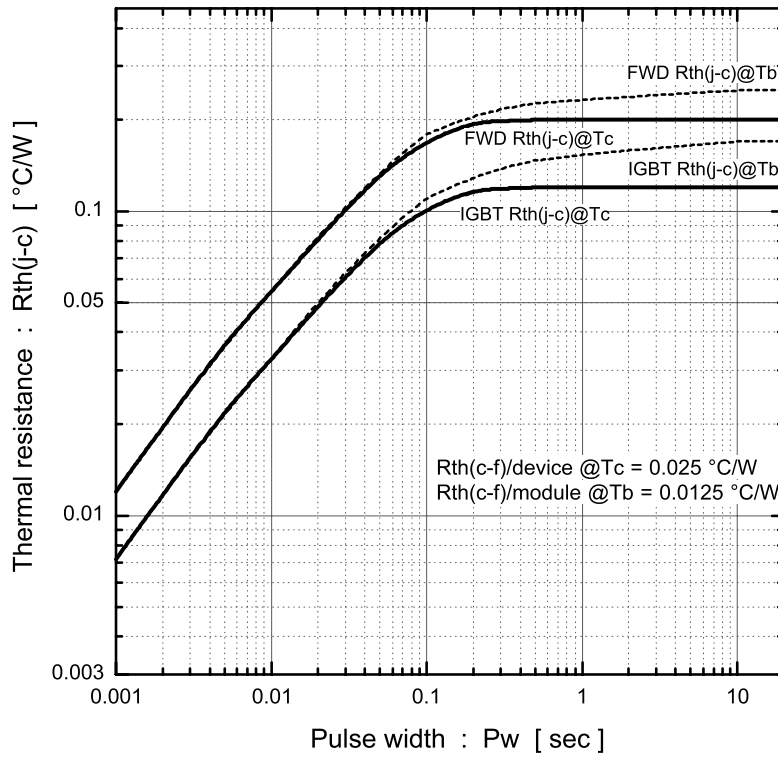
### 2MBI150UA-120 Rth(j-c)



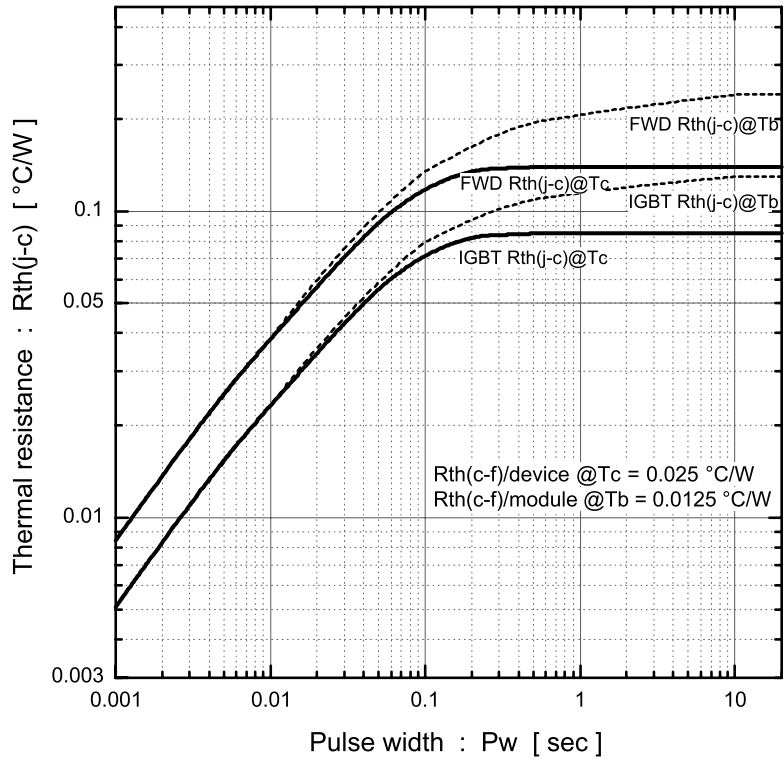
**2MBI150UB-120 Rth(j-c)**



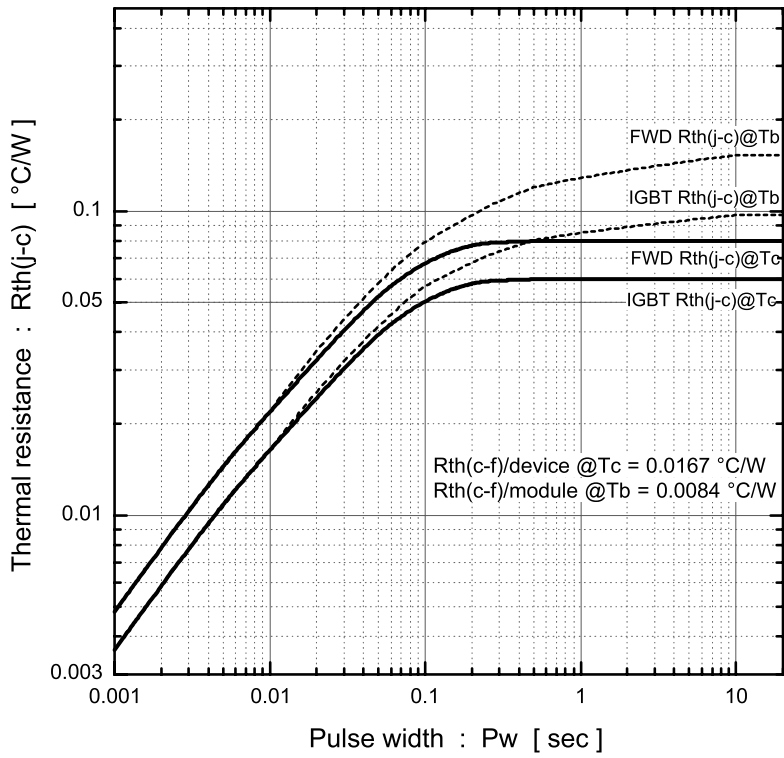
**2MBI200UB-120 Rth(j-c)**



**2MBI300UC-120 Rth(j-c)**

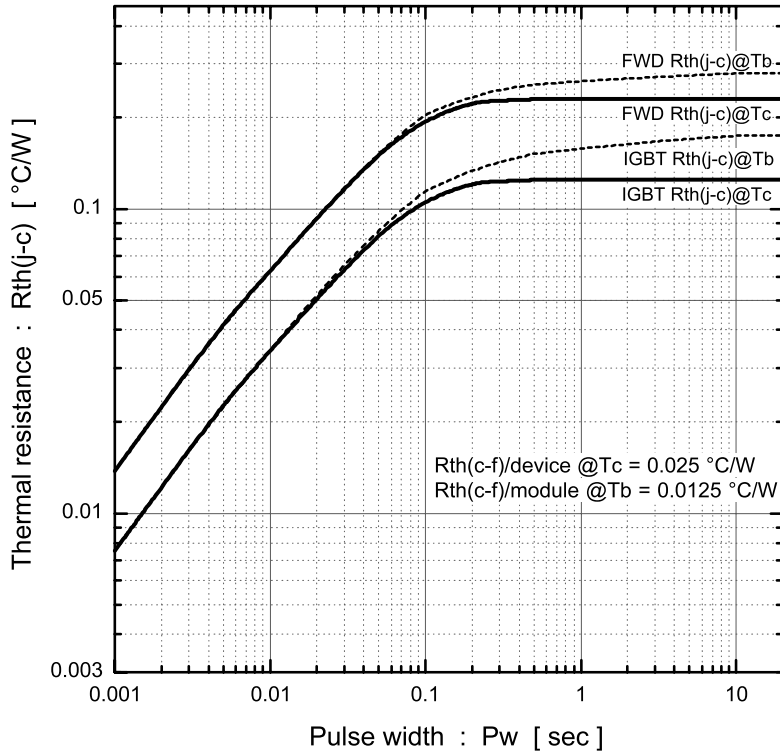


**2MBI450UE-120 Rth(j-c)**

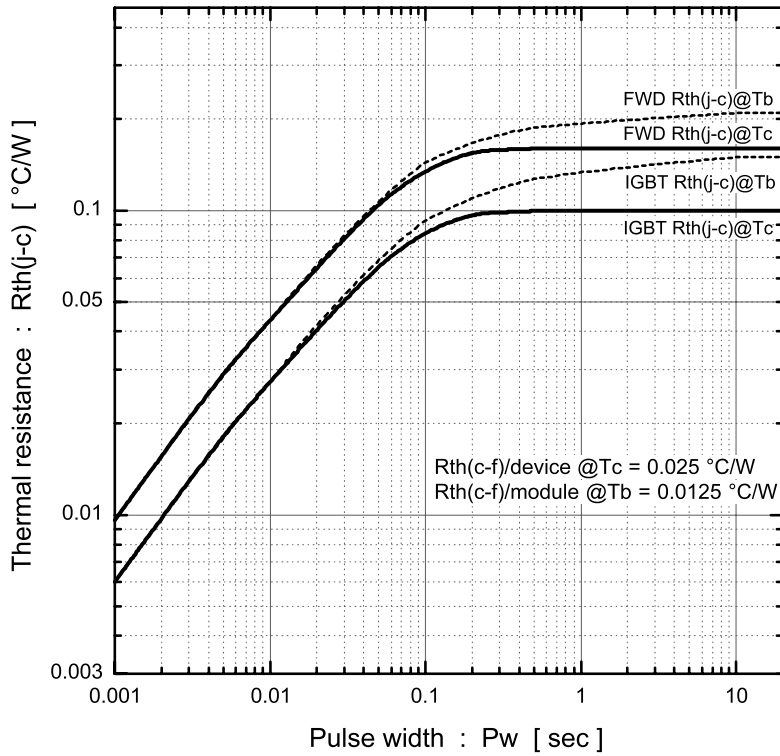




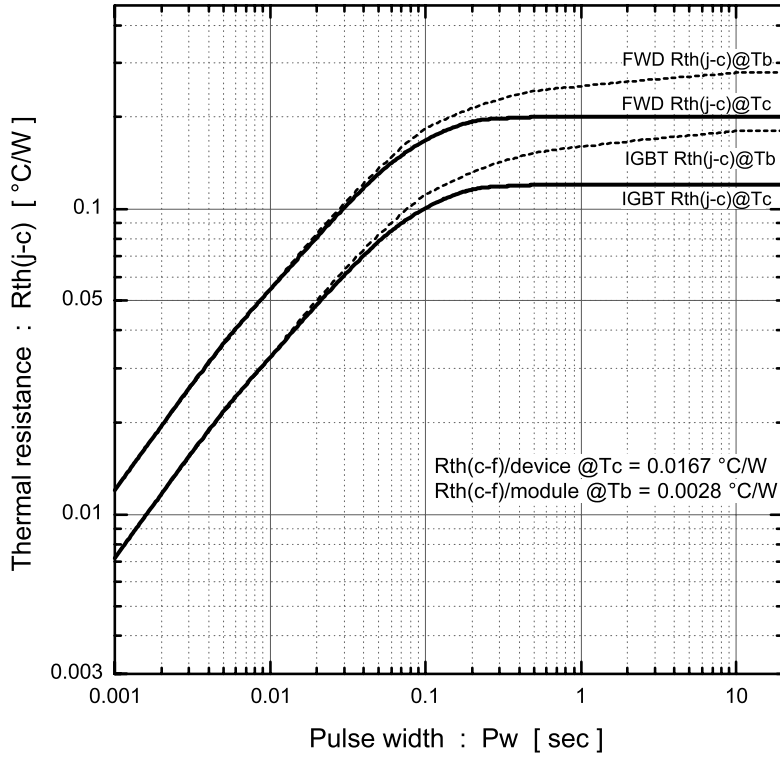
**2MBI300U2B-060 Rth(j-c)**



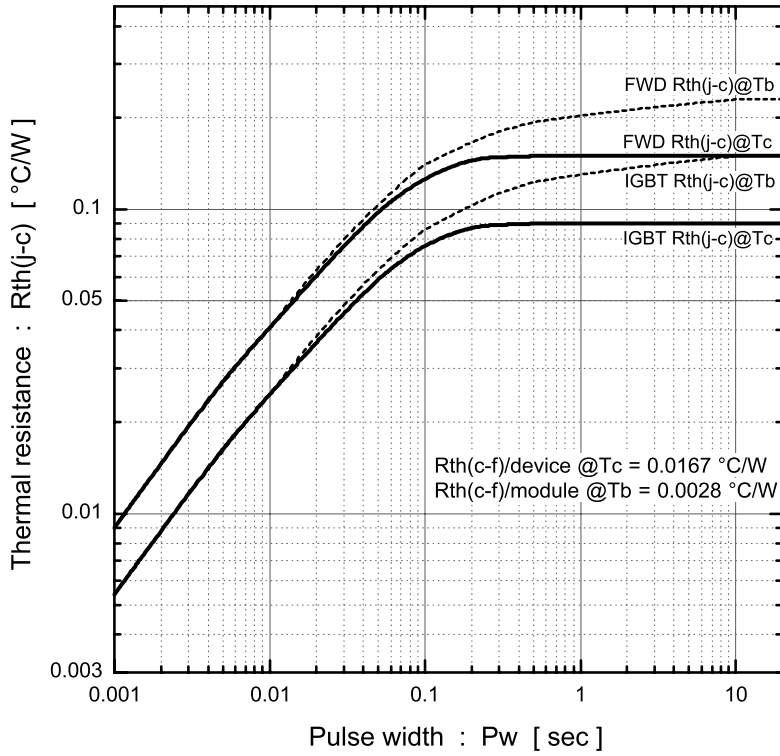
**2MBI400U2B-060 Rth(j-c)**



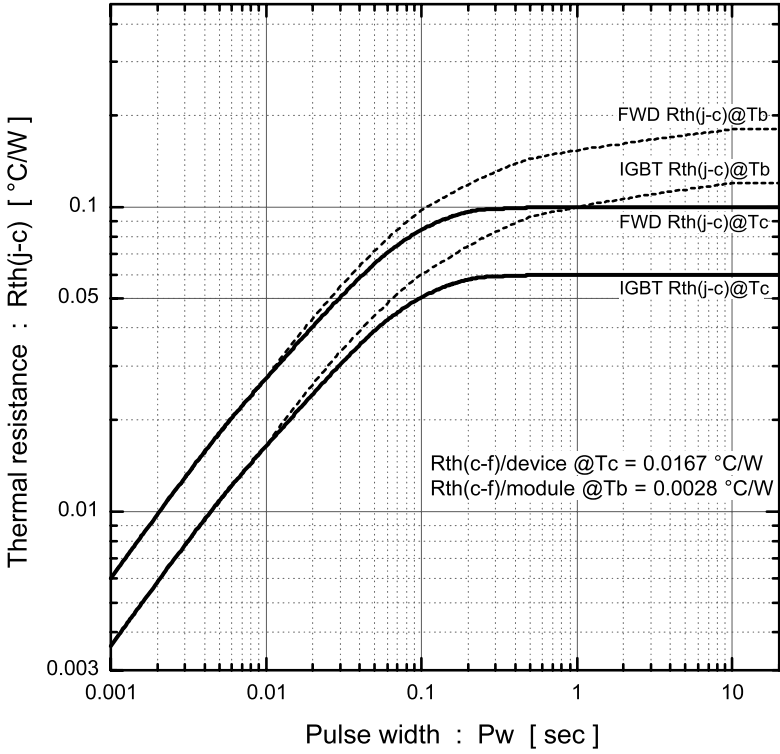
**6MBI225U-120 Rth(j-c)**



**6MBI300U-120 Rth(j-c)**



6MBI450U-120 Rth(j-c)



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  - Measurement equipment
  - Machine tools
  - Audiovisual equipment
  - Electrical home appliances
  - Personal equipment
  - Industrial robots etc.
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  - 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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