

## IGBT Modules

- Temperature protection provided by directly detecting the junction temperature of the IGBTs
- Low power loss and soft switching
- High performance and high reliability IGBT with overheating protection
- Higher reliability because of a big decrease in number of parts in built-in control circuit

[illegible]

**FM6M1912c**  
**2023/03**

# 6MBP50XAA065-50

IGBT Modules

## Absolute maximum ratings

 $T_C=25^{\circ}\text{C}$ ,  $T_{vj}=25^{\circ}\text{C}$ ,  $V_{CC}=15\text{V}$  unless otherwise specified

| Items                                  |                          | Symbol     | Conditions         | Min. | Max.         | Units              |
|----------------------------------------|--------------------------|------------|--------------------|------|--------------|--------------------|
| Collector-Emitter voltage              |                          | $V_{CES}$  | *1                 | -    | 650          | V                  |
| Short circuit voltage                  |                          | $V_{SC}$   | *2                 | 200  | 400          | V                  |
| Inverter                               | Collector current        | $I_C$      | DC                 | -    | 50           | A                  |
|                                        |                          | $I_{CP}$   | 1ms                | -    | 100          | A                  |
|                                        |                          | $-I_C$     | Duty=100% *3       | -    | 50           | A                  |
|                                        | Total power dissipation  | $P_{tot}$  | IGBT 1 device *4   | -    | 211          | W                  |
| Brake                                  | Collector current        | $I_C$      | DC                 | -    | -            | A                  |
|                                        |                          | $I_{CP}$   | 1ms                | -    | -            | A                  |
|                                        | Forward current of diode | $I_F$      |                    | -    | -            | A                  |
|                                        | Total power dissipation  | $P_{tot}$  | IGBT 1 device *4   | -    | -            | W                  |
| Supply voltage of pre-driver           |                          | $V_{CC}$   | *5                 | -0.5 | 20           | V                  |
| Input signal voltage                   |                          | $V_{in}$   | *6                 | -0.5 | $V_{CC}+0.5$ | V                  |
| Alarm signal voltage                   |                          | $V_{ALM}$  | *7                 | -0.5 | $V_{CC}$     | V                  |
| Alarm signal current                   |                          | $I_{ALM}$  | *8                 | -    | 20           | mA                 |
| Virtual junction temperature           |                          | $T_{vj}$   |                    | -    | 175          | $^{\circ}\text{C}$ |
| Operating virtual junction temperature |                          | $T_{vjop}$ |                    | -    | 150          | $^{\circ}\text{C}$ |
| Operating case temperature             |                          | $T_c$      |                    | -20  | 125          | $^{\circ}\text{C}$ |
| Storage temperature                    |                          | $T_{stg}$  |                    | -40  | 125          | $^{\circ}\text{C}$ |
| Solder temperature                     |                          | $T_{sol}$  | *9                 | -    | 260          | $^{\circ}\text{C}$ |
| Isolating voltage                      |                          | $V_{isol}$ | *10                | -    | 2500         | Vrms               |
| Mounting torque of screws to heat sink |                          | $M_s$      | Mounting(M4)       | 1.3  | 1.7          | Nm                 |
| Mounting torque of screws to terminals |                          | $M_t$      | Main terminals(M4) | -    | -            | Nm                 |

### Notes

\*1:  $V_{CES}$  shall be applied to the input voltage between terminal P-(U,V, W) and (U,V, W)-N.

\*2: In the case of the load inductance to be over 1 $\mu\text{H}$ .

\*3: Duty=150 $^{\circ}\text{C}/R_{th(l-c)D}/(I_F \times V_F \text{ Max.}) \times 100$ 

\*4:  $P_{tot}=150^{\circ}\text{C}/R_{th(l-c)Q}$ 

\*5:  $V_{CC}$  shall be applied to the input voltage between terminal No.3 and 1, 6 and 4, 9 and 7, 11 and 10.

\*6:  $V_{in}$  shall be applied to the input voltage between terminal No.2 and 1, 5 and 4, 8 and 7, 12~14 and 10.

\*7:  $V_{ALM}$  shall be applied to the voltage between terminal No.15 and 10.

\*8:  $I_{ALM}$  shall be applied to the input current to terminal No.15.

\*9: Immersion time 10 $\pm$ 1sec. 1 time.

\*10: Terminal to base, 50/60Hz sine wave 1 min. All terminals should be connected together during the test.

## Electrical characteristics

### Main circuit

 $T_{vj}=25^{\circ}\text{C}$ ,  $V_{CC}=15\text{V}$  unless otherwise specified

| Item                  |                                       | Symbol        | Conditions                                               |          | Min. | Typ. | Max. | Units   |
|-----------------------|---------------------------------------|---------------|----------------------------------------------------------|----------|------|------|------|---------|
| Inverter              | Collector current at off signal input | $I_{CES}$     | $V_{CE} = 650V$                                          |          | -    | -    | 1.0  | mA      |
|                       | Collector-Emitter saturation voltage  | $V_{CE(sat)}$ | $I_C = 50A$                                              | Terminal | -    | -    | 1.60 | V       |
|                       |                                       |               |                                                          | Chip     | -    | 1.15 | -    | V       |
|                       | Forward voltage of FWD                | $V_F$         | $I_F = 50A$                                              | Terminal | -    | -    | 2.00 | V       |
| Chip                  |                                       |               |                                                          | -        | 1.50 | -    | V    |         |
| Brake                 | Collector current at off signal input | $I_{CES}$     | $V_{CE} = -V$                                            |          | -    | -    | -    | mA      |
|                       | Collector-Emitter saturation voltage  | $V_{CE(sat)}$ | $I_C = -A$                                               | Terminal | -    | -    | -    | V       |
|                       |                                       |               |                                                          | Chip     | -    | -    | -    | V       |
|                       | Forward voltage of FWD                | $V_F$         | $I_F = -A$                                               | Terminal | -    | -    | -    | V       |
| Chip                  |                                       |               |                                                          | -        | -    | -    | V    |         |
| Switching time<br>*11 |                                       | $t_{on}$      | $I_C = 50A \quad T_{vj}=150^{\circ}C$                    |          | 0.5  | -    | -    | $\mu s$ |
|                       |                                       | $t_{d(on)}$   |                                                          |          | 0.5  | -    | -    | $\mu s$ |
|                       |                                       | $t_{off}$     | $V_{DC} = 300V$                                          |          | -    | -    | 2.0  | $\mu s$ |
|                       |                                       | $t_{d(off)}$  |                                                          |          | -    | -    | 1.7  | $\mu s$ |
|                       |                                       | $t_{rr}$      | $I_F = 50A \quad T_{vj}=150^{\circ}C$<br>$V_{DC} = 300V$ |          | -    | -    | 0.5  | $\mu s$ |

\*11: Turn on time ( $t_{on}$ ) =  $t_{d(on)} + t_r$ , Turn off time ( $t_{off}$ ) =  $t_{d(off)} + t_f$

# 6MBP50XAA065-50

IGBT Modules

## ● Control circuit

 $T_{vj}=25^{\circ}\text{C}$ ,  $V_{CC}=15\text{V}$  unless otherwise specified

| Item                                               | Symbol          | Conditions                                                      |     | Min. | Typ. | Max. | Units |
|----------------------------------------------------|-----------------|-----------------------------------------------------------------|-----|------|------|------|-------|
| Supply current of P-side pre-driver (per one unit) | $I_{ccp}$       | Switching frequency ( $f_{sw}$ ) = 0~15kHz<br>$T_C$ = -20~125°C |     | -    | -    | 10   | mA    |
| Supply current of N-side pre-driver                | $I_{ccn}$       |                                                                 |     | -    | -    | 27   | mA    |
| Input sinal threshold voltage                      | $V_{inth(on)}$  | $V_{in}$ -GND                                                   | ON  | 1.2  | 1.4  | 1.6  | V     |
|                                                    | $V_{inth(off)}$ |                                                                 | OFF | 1.5  | 1.7  | 1.9  | V     |

## ● Protection circuit

 $T_{vj}=25^{\circ}\text{C}$ ,  $V_{CC}=15\text{V}$  unless otherwise specified

| Item                                                 | Symbol          | Conditions                                                   | Min. | Typ. | Max. | Units              |
|------------------------------------------------------|-----------------|--------------------------------------------------------------|------|------|------|--------------------|
| Over current protection level                        | $I_{oc}$        | $T_{vj}=150^{\circ}\text{C}$                                 | 75   | -    | -    | A                  |
| Over current protection delay time                   | $t_{doc}$       | $T_{vj}=150^{\circ}\text{C}$                                 | -    | 4.0  | -    | $\mu\text{s}$      |
| Short circuit protection delay time                  | $t_{dsc}$       | $T_{vj}=150^{\circ}\text{C}$                                 | -    | 1.0  | -    | $\mu\text{s}$      |
| IGBT chips over heating protection temperature level | $T_{joh}$       | Surface of IGBT chips                                        | 175  | -    | -    | $^{\circ}\text{C}$ |
| Over heating protection hysteresis                   | $T_{ih}$        |                                                              | -    | 20   | -    | $^{\circ}\text{C}$ |
| Under voltage protection level                       | $V_{uv}$        |                                                              | 11.0 | -    | 12.5 | V                  |
| Under voltage protection hysteresis                  | $V_h$           |                                                              | 0.2  | 0.5  | -    | V                  |
| Alarm signal hold time                               | $t_{alm(oc)}$   | ALM-GND                                                      | 1.0  | 2.0  | 2.4  | ms                 |
|                                                      | $t_{alm(uv)}$   | $T_c = -20\sim 125^{\circ}\text{C}$ $V_{cc} \geq 10\text{V}$ | 3.5  | 4.0  | 4.5  | ms                 |
|                                                      | $t_{alm(tjoh)}$ |                                                              | 7.0  | 8.0  | 9.0  | ms                 |
| Alarm signal voltage                                 | $V_{almh}$      | ALM-GND, without protection                                  | 14.5 | -    | 15.0 | V                  |
| Resistance for current limit                         | $R_{alm}$       |                                                              | 960  | -    | 1570 | $\Omega$           |

## ■ Thermal resistance characteristics ( $T_c = 25^{\circ}\text{C}$ )

| Item                                     | Symbol        | Min. | Typ. | Max. | Units |
|------------------------------------------|---------------|------|------|------|-------|
| Thermal resistance junction to case *12  | Inverter IGBT | -    | -    | 0.71 | K/W   |
|                                          | Inverter FWD  |      |      | 0.9  | K/W   |
|                                          | Brake IGBT    | -    | -    | -    | K/W   |
|                                          | Brake FWD     | -    | -    | -    | K/W   |
| Thermal resistance case to heat sink *13 | $R_{th(c-s)}$ | -    | 0.05 | -    | K/W   |

\*12: For 1 device, the measurement point of the case is just under the chip.

\*13: This is the value which is defined mounting on the additional heat sink with 1 W/(m·K) thermal grease.

## ■ Noise immunity ( $V_{DC}=300\text{V}$ , $V_{CC}=15\text{V}$ )

| Item                          | Conditions                                                                                         | Min.      | Typ. | Max. | Units |
|-------------------------------|----------------------------------------------------------------------------------------------------|-----------|------|------|-------|
| Common mode rectangular noise | Pulse width 1 $\mu\text{s}$ , polarity $\pm$ , 10min.<br>Judge: no over-current, no miss operating | $\pm 2.0$ | -    | -    | kV    |

## ■ Recommended operating conditions

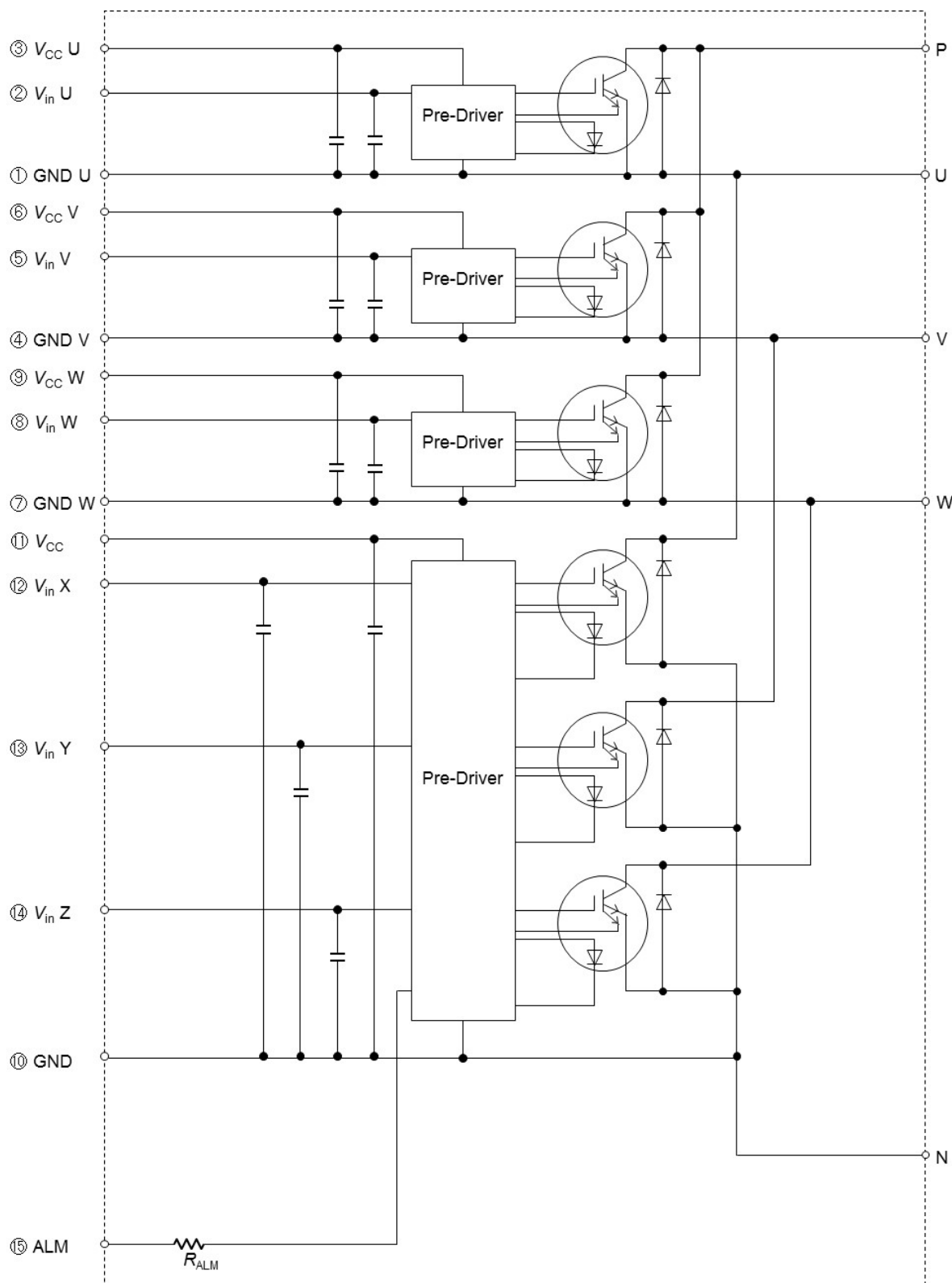
| Item                                                       | Symbol     | Min. | Typ. | Max. | Units         |
|------------------------------------------------------------|------------|------|------|------|---------------|
| DC bus voltage                                             | $V_{DC}$   | -    | -    | 400  | V             |
| Power supply voltage of pre-driver                         | $V_{CC}$   | 13.5 | 15.0 | 16.5 | V             |
| Switching frequency of IPM                                 | $f_{sw}$   | -    | -    | 20.0 | kHz           |
| Arm short through blocking time for IPM's input signal *14 | $t_{dead}$ | 1.5  | -    | -    | $\mu\text{s}$ |
| Screw torque (M4)                                          | -          | 1.3  | -    | 1.7  | Nm            |

\*14:  $t_{dead} = t_{off} - t_{d(on)}$

# 6MBP50XAA065-50

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## ■ Block diagram



Pre-drivers include following functions

1. Amplifier for driver
2. Short circuit protection
3. Under voltage lockout circuit
4. Over current protection
5. IGBT chip over heating protection

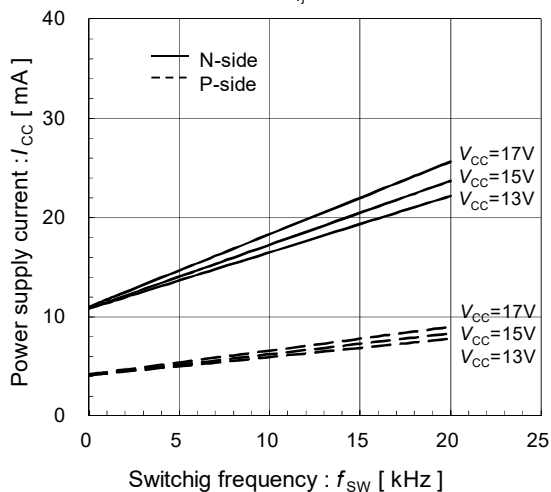
# 6MBP50XAA065-50

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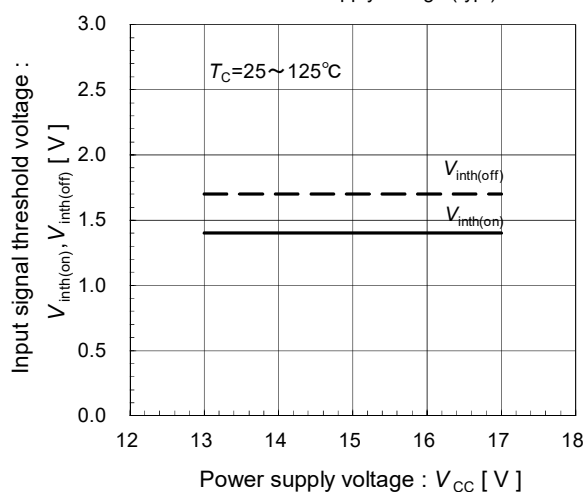
## ■ Characteristics (representative)

### ● Control circuit

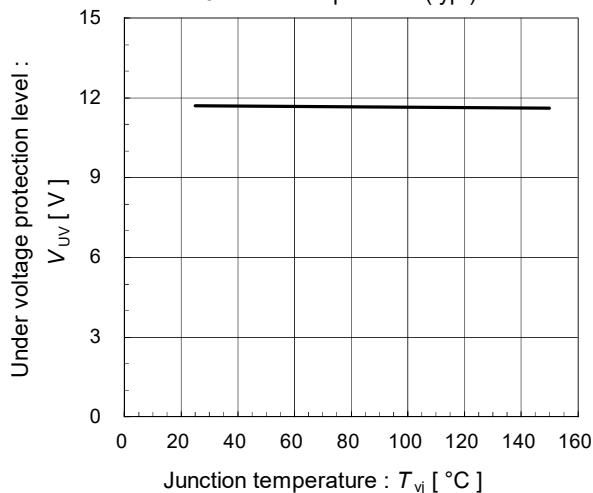
Power supply current vs. Switching frequency (typ.)  
 $T_{vj} = 25^\circ\text{C}$



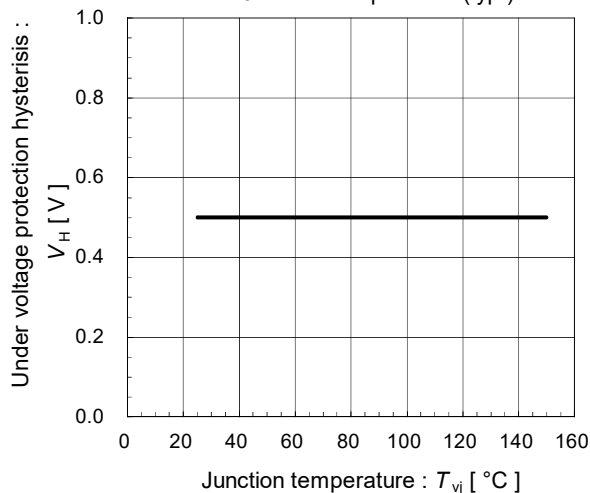
Input signal threshold voltage  
vs. Power supply voltage (typ.)



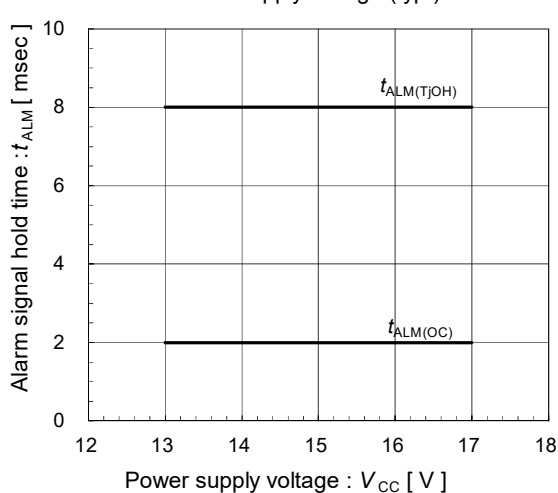
Under voltage protection level  
vs. Junction temperature (typ.)



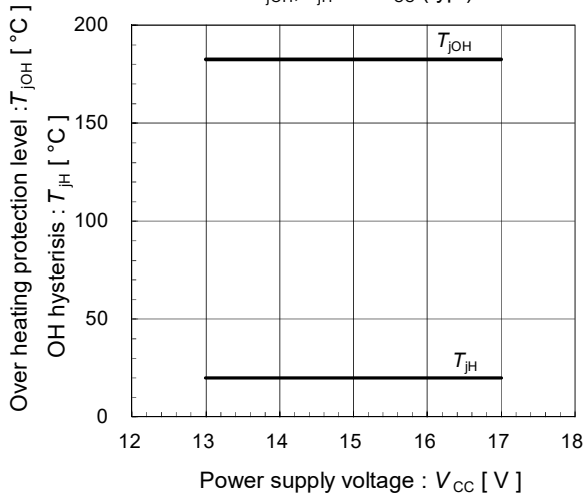
Under voltage protection hysteresis  
vs. Junction temperature (typ.)



Alarm signal hold time  
vs. Power supply voltage (typ.)



Over heating characteristics  
 $T_{JOH}, T_{JH}$  vs.  $V_{CC}$  (typ.)

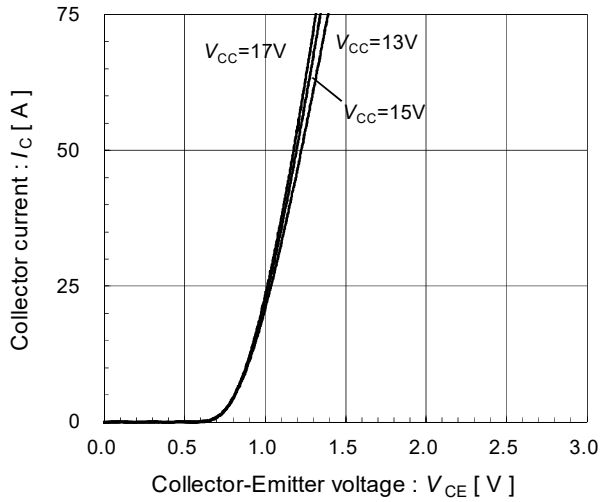


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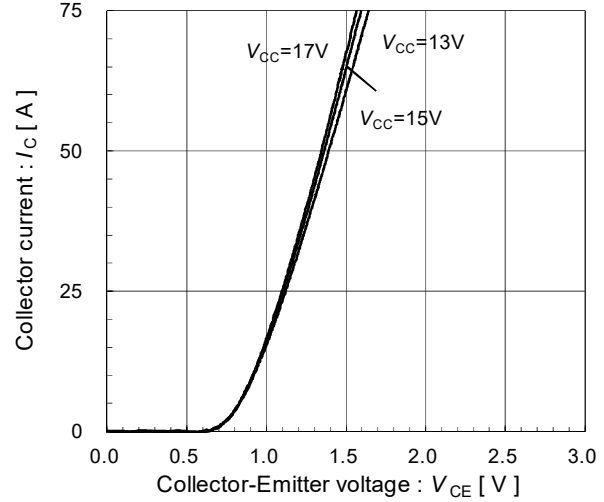
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## ● Inverter

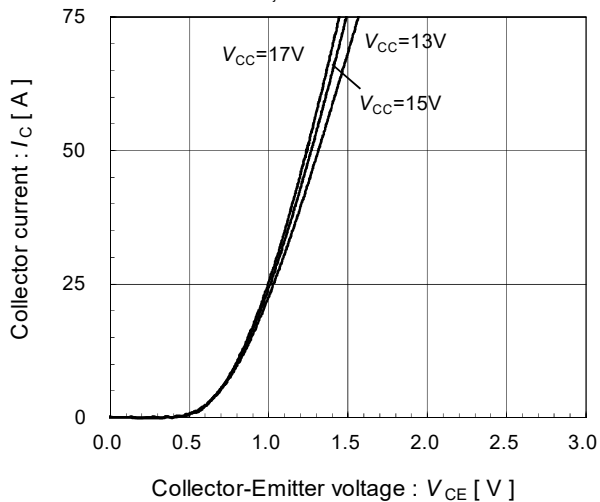
Collector current vs. Collector-Emitter voltage (typ.)  
 $T_{vj}=25^{\circ}\text{C}$  [ Chip ]



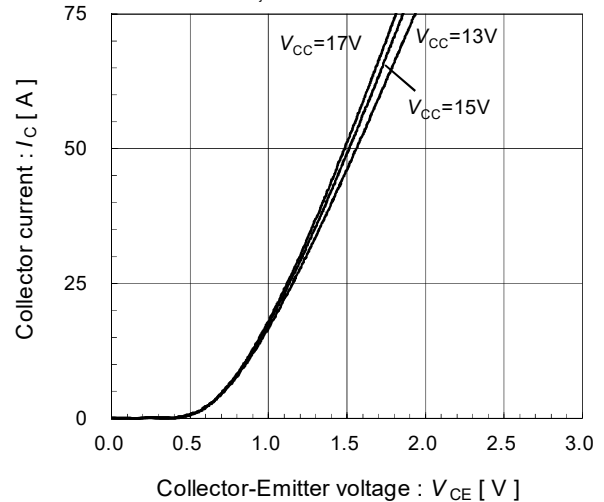
Collector current vs. Collector-Emitter voltage (typ.)  
 $T_{vj}=25^{\circ}\text{C}$  [ Terminal ]



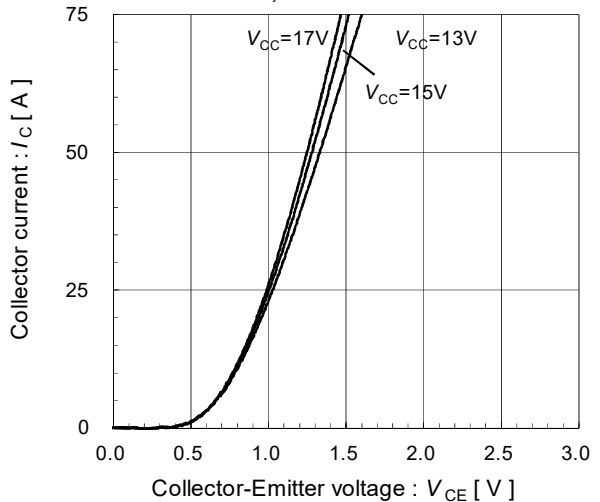
Collector current vs. Collector-Emitter voltage (typ.)  
 $T_{vj}=125^{\circ}\text{C}$  [ Chip ]



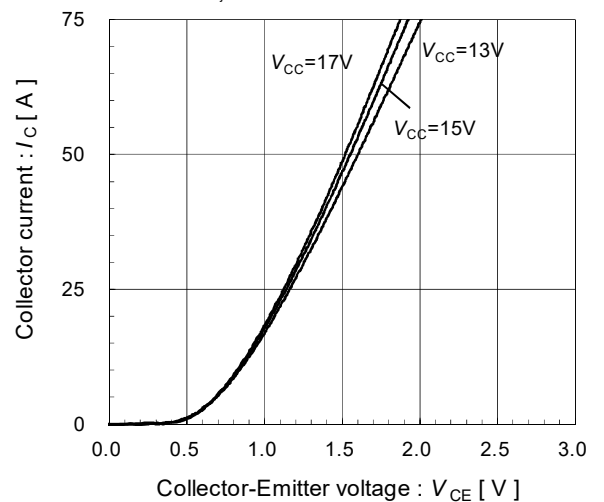
Collector current vs. Collector-Emitter voltage (typ.)  
 $T_{vj}=125^{\circ}\text{C}$  [ Terminal ]



Collector current vs. Collector-Emitter voltage (typ.)  
 $T_{vj}=150^{\circ}\text{C}$  [ Chip ]



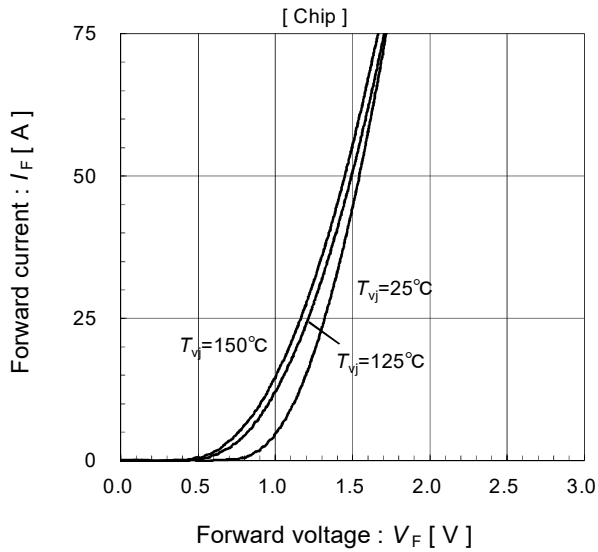
Collector current vs. Collector-Emitter voltage (typ.)  
 $T_{vj}=150^{\circ}\text{C}$  [ Terminal ]



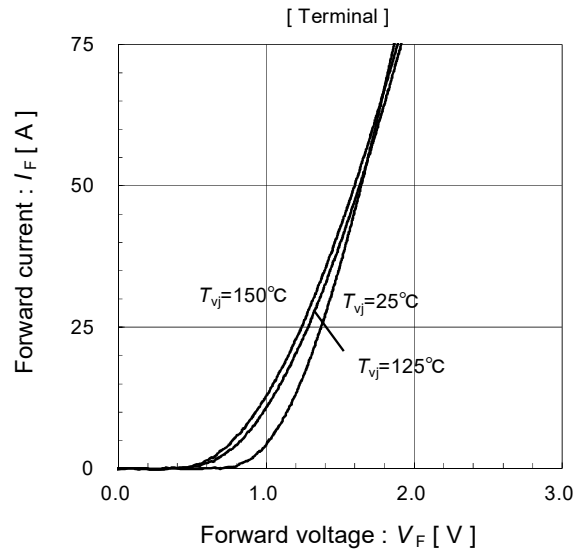
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Forward current vs. Forward voltage (typ.)

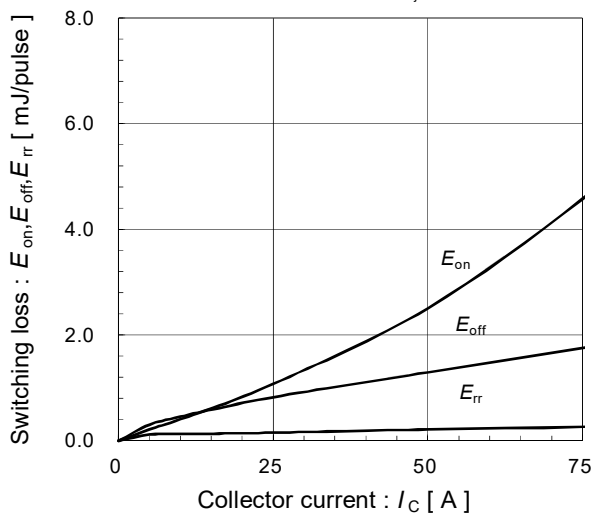


Forward current vs. Forward voltage (typ.)



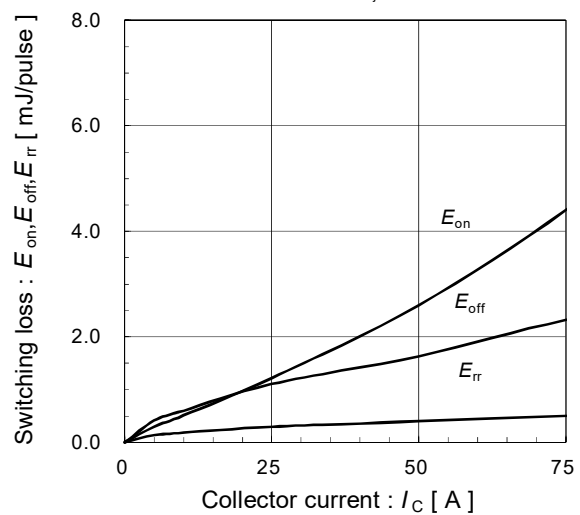
Switching loss vs. Collector current (typ.)

$V_{DC}=300\text{V}, V_{CC}=15\text{V}, T_{vj}=25^{\circ}\text{C}$



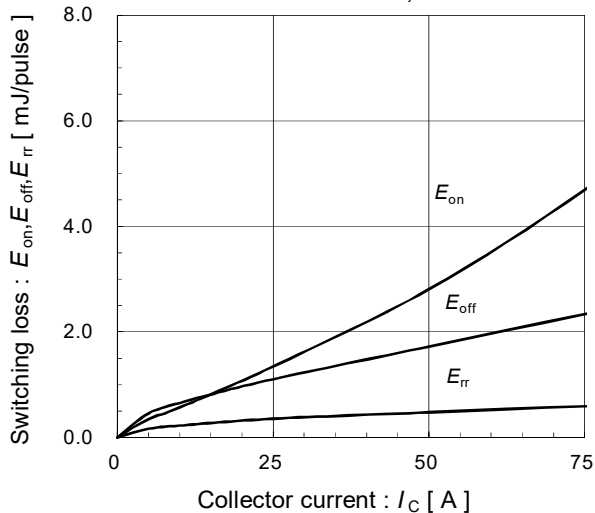
Switching loss vs. Collector current (typ.)

$V_{DC}=300\text{V}, V_{CC}=15\text{V}, T_{vj}=125^{\circ}\text{C}$



Switching loss vs. Collector current (typ.)

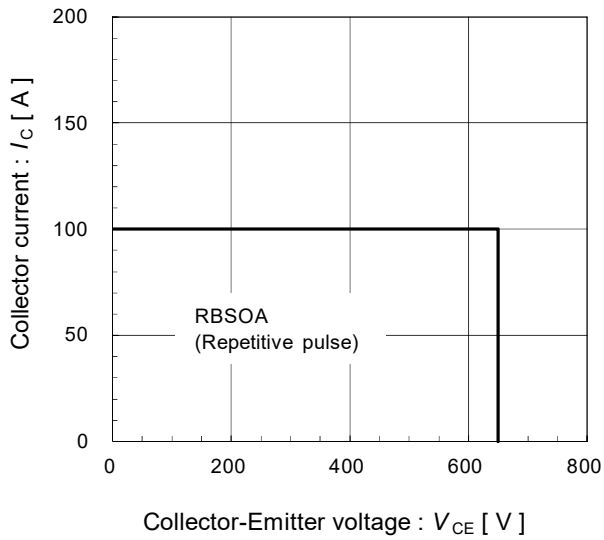
$V_{DC}=300\text{V}, V_{CC}=15\text{V}, T_{vj}=150^{\circ}\text{C}$



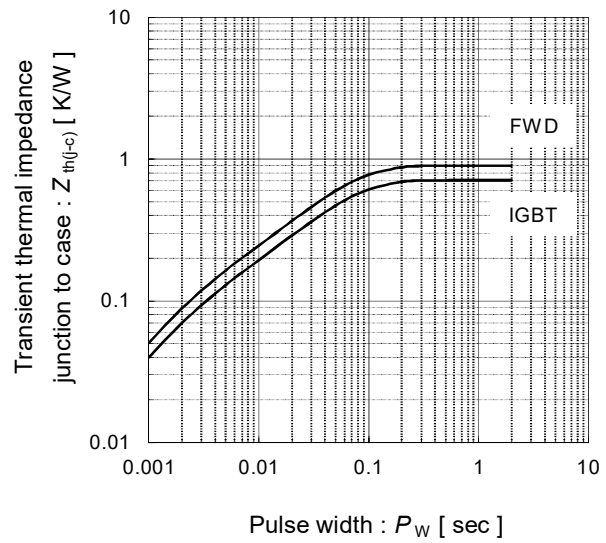
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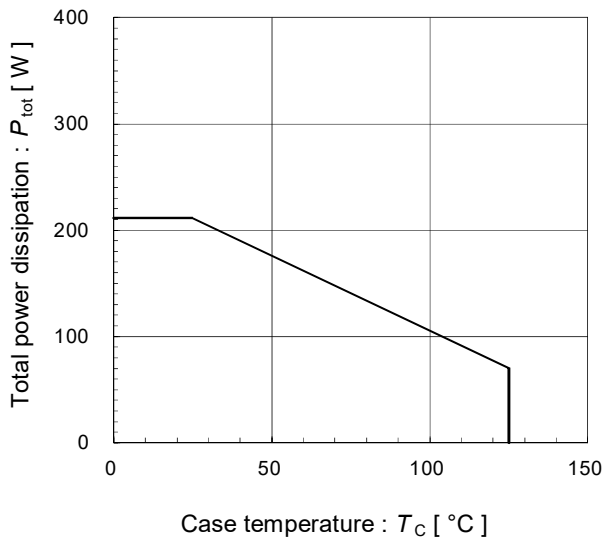
Reversed biased safe operating area (max.)  
 $V_{CC}=15V, T_{vj}=150^{\circ}C$



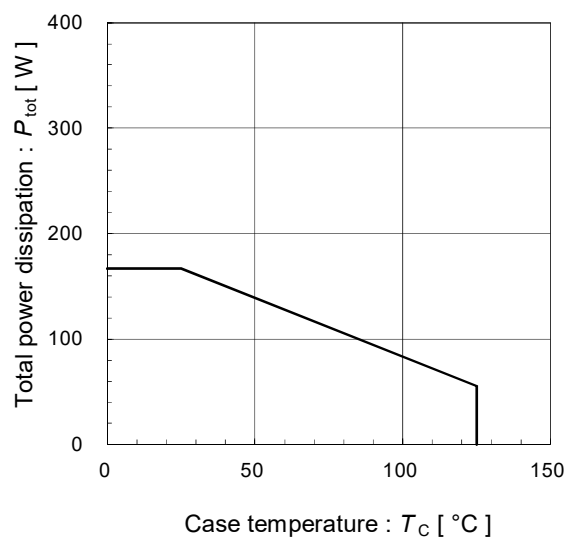
Transient thermal resistance (max.)



Power derating for IGBT (max.)  
 [ per device ]



Power derating for FWD (max.)  
 [ per device ]

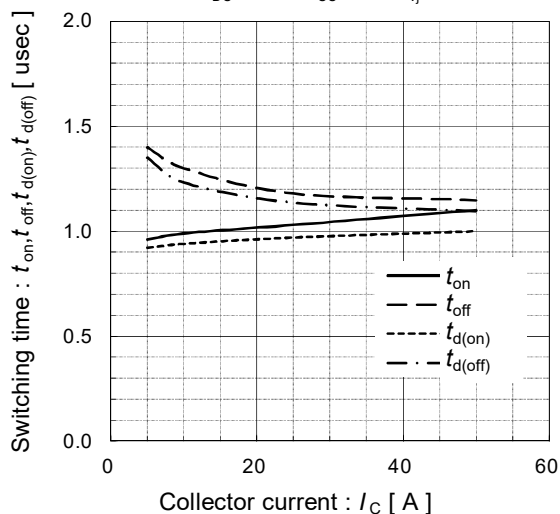


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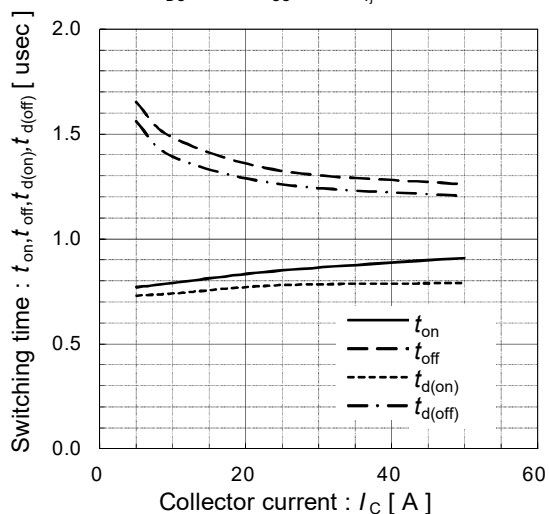
Switching time vs. Collector current (typ.)

$V_{DC}=300V, V_{CC}=15V, T_{vj}=25^{\circ}C$



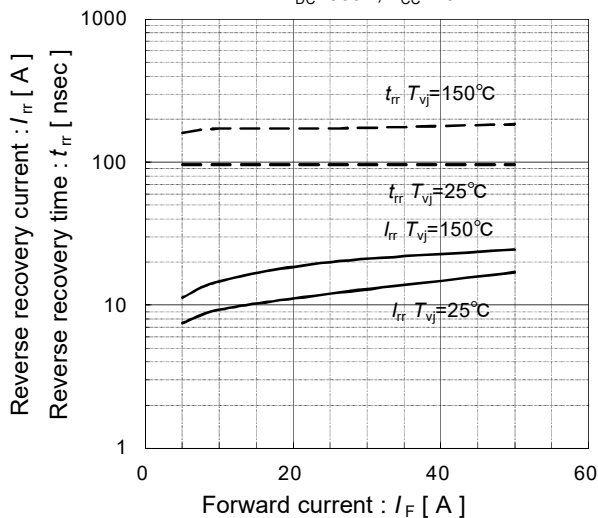
Switching time vs. Collector current (typ.)

$V_{DC}=300V, V_{CC}=15V, T_{vj}=150^{\circ}C$



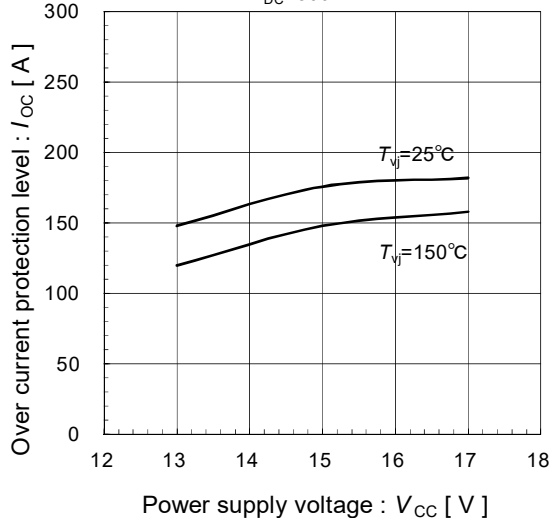
Reverse recovery characteristics (typ.)

$V_{DC}=300V, V_{CC}=15V$



Over current protection vs. Power supply voltage (typ.)

$V_{DC}=300V$



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| 3 アプリケーションマニュアル      | <a href="http://www.fujielectric.co.jp/products/semiconductor/model/igbt/application/">www.fujielectric.co.jp/products/semiconductor/model/igbt/application/</a> |
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| 5 マウンティングインストラクション   | <a href="http://www.fujielectric.co.jp/products/semiconductor/model/igbt/mounting/">www.fujielectric.co.jp/products/semiconductor/model/igbt/mounting/</a>       |
| 6 IGBT 損失シミュレーションソフト | <a href="http://www.fujielectric.co.jp/products/semiconductor/model/igbt/simulation/">www.fujielectric.co.jp/products/semiconductor/model/igbt/simulation/</a>   |
| 7 富士電機技報             | <a href="http://www.fujielectric.co.jp/products/semiconductor/journal/">www.fujielectric.co.jp/products/semiconductor/journal/</a>                               |
| 8 製品のお問い合わせ          | <a href="http://www.fujielectric.co.jp/products/semiconductor/contact/">www.fujielectric.co.jp/products/semiconductor/contact/</a>                               |
| 9 改廃のお知らせ            | <a href="http://www.fujielectric.co.jp/products/semiconductor/discontinued/">www.fujielectric.co.jp/products/semiconductor/discontinued/</a>                     |

#### Global

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| 1 Semiconductors General Catalog               | <a href="http://www.fujielectric.com/products/semiconductor/catalog/">www.fujielectric.com/products/semiconductor/catalog/</a>                               |
| 2 Product Information                          | <a href="http://www.fujielectric.com/products/semiconductor/model/">www.fujielectric.com/products/semiconductor/model/</a>                                   |
| 3 Application Manuals                          | <a href="http://www.fujielectric.com/products/semiconductor/model/igbt/application/">www.fujielectric.com/products/semiconductor/model/igbt/application/</a> |
| 4 Design Support                               | <a href="http://www.fujielectric.com/products/semiconductor/model/igbt/technical/">www.fujielectric.com/products/semiconductor/model/igbt/technical/</a>     |
| 5 Mounting Instructions                        | <a href="http://www.fujielectric.com/products/semiconductor/model/igbt/mounting/">www.fujielectric.com/products/semiconductor/model/igbt/mounting/</a>       |
| 6 IGBT Loss Simulation Software                | <a href="http://www.fujielectric.com/products/semiconductor/model/igbt/simulation/">www.fujielectric.com/products/semiconductor/model/igbt/simulation/</a>   |
| 7 Fuji Electric Journal                        | <a href="http://www.fujielectric.com/products/semiconductor/journal/">www.fujielectric.com/products/semiconductor/journal/</a>                               |
| 8 Contact                                      | <a href="http://www.fujielectric.com/contact/">www.fujielectric.com/contact/</a>                                                                             |
| 9 Revised and discontinued product information | <a href="http://www.fujielectric.com/products/semiconductor/discontinued/">www.fujielectric.com/products/semiconductor/discontinued/</a>                     |

#### 中国

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| 1 半导体综合目录     | <a href="http://www.fujielectric.com.cn/products/semiconductor/catalog/">www.fujielectric.com.cn/products/semiconductor/catalog/</a>                               |
| 2 产品信息        | <a href="http://www.fujielectric.com.cn/products/semiconductor/model/">www.fujielectric.com.cn/products/semiconductor/model/</a>                                   |
| 3 应用手册        | <a href="http://www.fujielectric.com.cn/products/semiconductor/model/igbt/application/">www.fujielectric.com.cn/products/semiconductor/model/igbt/application/</a> |
| 4 技术信息        | <a href="http://www.fujielectric.com.cn/products/semiconductor/model/igbt/technical/">www.fujielectric.com.cn/products/semiconductor/model/igbt/technical/</a>     |
| 5 安装说明书       | <a href="http://www.fujielectric.com.cn/products/semiconductor/model/igbt/mounting/">www.fujielectric.com.cn/products/semiconductor/model/igbt/mounting/</a>       |
| 6 IGBT 损耗模拟软件 | <a href="http://www.fujielectric.com.cn/products/semiconductor/model/igbt/simulation/">www.fujielectric.com.cn/products/semiconductor/model/igbt/simulation/</a>   |
| 7 富士电机技报      | <a href="http://www.fujielectric.com.cn/products/semiconductor/journal/">www.fujielectric.com.cn/products/semiconductor/journal/</a>                               |
| 8 产品咨询        | <a href="http://www.fujielectric.com/contact/">www.fujielectric.com/contact/</a>                                                                                   |
| 9 产品更改和停产信息   | <a href="http://www.fujielectric.com.cn/products/semiconductor/discontinued/">www.fujielectric.com.cn/products/semiconductor/discontinued/</a>                     |