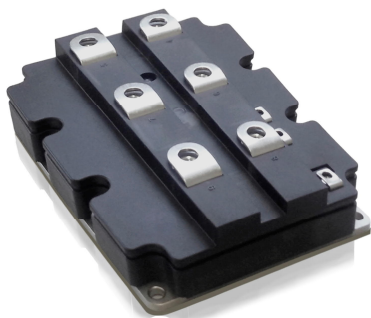


# 5SNA 1800E330400

## HiPak IGBT module



- $V_{CE} = 3300 \text{ V}$
- $I_C = 1800 \text{ A}$
- Ultra-low loss TSPT+ technology
- Very soft switching FCE diode with increased diode area
- Exceptional ruggedness and highest current rating
- AlSiC base-plate for high power cycling capability
- AlN substrate for low thermal resistance
- Recognized under UL1557, File E196689

Maximum rated values <sup>1)</sup>

| Parameter                      | Symbol       | Conditions                                                                                                                                        | min | max   | Unit          |
|--------------------------------|--------------|---------------------------------------------------------------------------------------------------------------------------------------------------|-----|-------|---------------|
| Collector-emitter voltage      | $V_{CES}$    | $V_{GE} = 0 \text{ V}$ , $T_{vj} \geq 25 \text{ °C}$                                                                                              |     | 3300  | V             |
|                                |              | $V_{GE} = 0 \text{ V}$ , $T_{vj} = -40 \text{ °C}$                                                                                                |     | 3000  |               |
| DC collector current           | $I_C$        | $T_C = 98 \text{ °C}$ , $T_{vj} = 150 \text{ °C}$                                                                                                 |     | 1800  | A             |
| Peak collector current         | $I_{CM}$     | $t_p = 1 \text{ ms}$                                                                                                                              |     | 3600  | A             |
| Gate-emitter voltage           | $V_{GES}$    |                                                                                                                                                   | -20 | 20    | V             |
| DC forward current             | $I_F$        |                                                                                                                                                   |     | 1800  | A             |
| Peak forward current           | $I_{FRM}$    | $t_p = 1 \text{ ms}$                                                                                                                              |     | 3600  | A             |
| Surge current                  | $I_{FSM}$    | $V_R = 0 \text{ V}$ , $T_{vj \text{ start}} = 150 \text{ °C}$ ,<br>$t_p = 10 \text{ ms}$ , half-sinewave                                          |     | 14300 | A             |
| IGBT short circuit SOA         | $t_{psc}$    | $V_{CC} = 2500 \text{ V}$ , $V_{CEM \text{ CHIP}} \leq 3300 \text{ V}$<br>$V_{GE} \leq 15 \text{ V}$ , $T_{vj \text{ start}} \leq 150 \text{ °C}$ |     | 10    | $\mu\text{s}$ |
| Isolation voltage              | $V_{isol}$   | 1 min, $f = 50 \text{ Hz}$                                                                                                                        |     | 6000  | V             |
| Junction temperature           | $T_{vj}$     |                                                                                                                                                   |     | 175   | °C            |
| Junction operating temperature | $T_{vj(op)}$ |                                                                                                                                                   | -40 | 150   | °C            |
| Case temperature               | $T_C$        |                                                                                                                                                   | -40 | 125   | °C            |
| Storage temperature            | $T_{stg}$    |                                                                                                                                                   | -50 | 125   | °C            |
| Mounting torques <sup>2)</sup> | $M_s$        | Base-heatsink, M6 screws                                                                                                                          | 4   | 6     | Nm            |
|                                | $M_{t1}$     | Main terminals, M8 screws                                                                                                                         | 8   | 10    |               |
|                                | $M_{t2}$     | Auxiliary terminals, M4 screws                                                                                                                    | 2   | 3     |               |

<sup>1)</sup> Maximum rated values indicate limits beyond which damage to the device may occur per IEC 60747<sup>2)</sup> For detailed mounting instructions refer to Document No. 5SYA 2039

# IGBT characteristic values <sup>3)</sup>

| Parameter                                          | Symbol               | Conditions                                                                                                                                                                     | min                            | typ  | max  | Unit |    |
|----------------------------------------------------|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|------|------|------|----|
| Collector (-emitter) breakdown voltage             | V <sub>(BR)CES</sub> | V <sub>GE</sub> = 0 V, I <sub>C</sub> = 10 mA                                                                                                                                  | T <sub>vj</sub> = 150 °C       | 3300 |      | V    |    |
|                                                    |                      |                                                                                                                                                                                | T <sub>vj</sub> = 25 °C        | 3300 |      |      |    |
|                                                    |                      |                                                                                                                                                                                | T <sub>vj</sub> = -40 °C       | 3000 |      |      |    |
| Collector-emitter <sup>4)</sup> saturation voltage | V <sub>CE sat</sub>  | I <sub>C</sub> = 1800 A, V <sub>GE</sub> = 15 V                                                                                                                                | T <sub>vj</sub> = 25 °C        |      | 2.3  | 2.7  | V  |
|                                                    |                      |                                                                                                                                                                                | T <sub>vj</sub> = 125 °C       |      | 2.75 | 3.2  |    |
|                                                    |                      |                                                                                                                                                                                | T <sub>vj</sub> = 150 °C       |      | 2.9  |      |    |
| Collector cut-off current                          | I <sub>CES</sub>     | V <sub>CE</sub> = 3300 V, V <sub>GE</sub> = 0 V                                                                                                                                | T <sub>vj</sub> = 25 °C        |      |      | 1    | mA |
|                                                    |                      |                                                                                                                                                                                | T <sub>vj</sub> = 125 °C       |      | 22   |      |    |
|                                                    |                      |                                                                                                                                                                                | T <sub>vj</sub> = 150 °C       |      | 120  |      |    |
| Gate leakage current                               | I <sub>GES</sub>     | V <sub>CE</sub> = 0 V, V <sub>GE</sub> = ± 20 V, T <sub>vj</sub> = 125 °C                                                                                                      | -500                           |      | 500  | nA   |    |
| Gate-emitter threshold voltage                     | V <sub>GE(TO)</sub>  | I <sub>C</sub> = 240 mA, V <sub>CE</sub> = V <sub>GE</sub> , T <sub>vj</sub> = 25 °C                                                                                           | 6.7                            |      | 8.7  | V    |    |
| Gate charge                                        | Q <sub>ge</sub>      | I <sub>C</sub> = 1800 A, V <sub>CE</sub> = 1800 V, V <sub>GE</sub> = -15 V ..15 V                                                                                              |                                | 18   |      | µC   |    |
| Input capacitance                                  | C <sub>ies</sub>     | V <sub>CE</sub> = 25 V, V <sub>GE</sub> = 0 V, f = 1 MHz, T <sub>vj</sub> = 25 °C                                                                                              |                                | 239  |      | nF   |    |
| Internal gate resistance                           | R <sub>Gint</sub>    |                                                                                                                                                                                |                                | 0.83 |      | Ω    |    |
| Turn-on delay time                                 | t <sub>d(on)</sub>   | V <sub>CC</sub> = 1800 V, I <sub>C</sub> = 1800 A,<br>R <sub>G</sub> = 1.2 Ω, C <sub>GE</sub> = 330 nF,<br>V <sub>GE</sub> = ±15 V, L <sub>σ</sub> = 100 nH,<br>inductive load | T <sub>vj</sub> = 25 °C        |      | 1120 | ns   |    |
|                                                    |                      |                                                                                                                                                                                | T <sub>vj</sub> = 150 °C       |      | 1120 |      |    |
| Rise time                                          | t <sub>r</sub>       |                                                                                                                                                                                | T <sub>vj</sub> = 25 °C        |      | 310  | ns   |    |
|                                                    |                      |                                                                                                                                                                                | T <sub>vj</sub> = 150 °C       |      | 320  |      |    |
| Turn-off delay time                                | t <sub>d(off)</sub>  |                                                                                                                                                                                | T <sub>vj</sub> = 25 °C        |      | 2890 | ns   |    |
|                                                    |                      |                                                                                                                                                                                | T <sub>vj</sub> = 150 °C       |      | 3470 |      |    |
| Fall time                                          | t <sub>f</sub>       |                                                                                                                                                                                | T <sub>vj</sub> = 25 °C        |      | 350  | ns   |    |
|                                                    |                      |                                                                                                                                                                                | T <sub>vj</sub> = 150 °C       |      | 420  |      |    |
| Turn-on switching energy                           | E <sub>on</sub>      | V <sub>CC</sub> = 1800 V, I <sub>C</sub> = 1800 A,<br>R <sub>G</sub> = 1.2 Ω, C <sub>GE</sub> = 330 nF,<br>V <sub>GE</sub> = ±15 V, L <sub>σ</sub> = 100 nH,<br>inductive load | T <sub>vj</sub> = 25 °C        |      | 3.50 | J    |    |
|                                                    |                      |                                                                                                                                                                                | T <sub>vj</sub> = 125 °C       |      | 4.30 |      |    |
|                                                    |                      |                                                                                                                                                                                | T <sub>vj</sub> = 150 °C       |      | 4.55 |      |    |
| Turn-off switching energy                          | E <sub>off</sub>     | V <sub>CC</sub> = 1800 V, I <sub>C</sub> = 1800 A,<br>R <sub>G</sub> = 4.7 Ω, C <sub>GE</sub> = 330 nF,<br>V <sub>GE</sub> = ±15 V, L <sub>σ</sub> = 100 nH,<br>inductive load | T <sub>vj</sub> = 25 °C        |      | 3.00 | J    |    |
|                                                    |                      |                                                                                                                                                                                | T <sub>vj</sub> = 125 °C       |      | 4.00 |      |    |
|                                                    |                      |                                                                                                                                                                                | T <sub>vj</sub> = 150 °C       |      | 4.25 |      |    |
| Short circuit current                              | I <sub>SC</sub>      | V <sub>CC</sub> = 2500 V, V <sub>GE</sub> = 15 V                                                                                                                               | T <sub>vj start</sub> = 150 °C | 6600 |      | A    |    |

<sup>3)</sup> Characteristic values according to IEC 60747 – 9

<sup>4)</sup> Collector-emitter saturation voltage is given at chip level

## Diode characteristic values <sup>5)</sup>

| Parameter                     | Symbol           | Conditions                                                                                                                                                                                                |                          | min | typ  | max  | Unit |
|-------------------------------|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|-----|------|------|------|
| Forward voltage <sup>6)</sup> | V <sub>F</sub>   | I <sub>F</sub> = 1800 A                                                                                                                                                                                   | T <sub>vj</sub> = 25 °C  |     | 2.0  | 2.45 | V    |
|                               |                  |                                                                                                                                                                                                           | T <sub>vj</sub> = 125 °C |     | 2.2  | 2.65 |      |
|                               |                  |                                                                                                                                                                                                           | T <sub>vj</sub> = 150 °C |     | 2.15 |      |      |
| Peak reverse recovery current | I <sub>RM</sub>  | V <sub>CC</sub> = 1800 V, I <sub>F</sub> = 1800 A,<br>V <sub>GE</sub> = ±15 V, R <sub>G</sub> = 1.2 Ω,<br>C <sub>GE</sub> = 330 nF,<br>di / dt = 6.7 kA/μs,<br>L <sub>σ</sub> = 100 nH,<br>inductive load | T <sub>vj</sub> = 25 °C  |     | 2340 |      | A    |
|                               |                  |                                                                                                                                                                                                           | T <sub>vj</sub> = 125 °C |     | 2750 |      |      |
|                               |                  |                                                                                                                                                                                                           | T <sub>vj</sub> = 150 °C |     | 3010 |      |      |
| Recovered charge              | Q <sub>rr</sub>  |                                                                                                                                                                                                           | T <sub>vj</sub> = 25 °C  |     | 1260 |      | μC   |
|                               |                  |                                                                                                                                                                                                           | T <sub>vj</sub> = 125 °C |     | 2060 |      |      |
|                               |                  |                                                                                                                                                                                                           | T <sub>vj</sub> = 150 °C |     | 2400 |      |      |
| Reverse recovery time         | t <sub>rr</sub>  |                                                                                                                                                                                                           | T <sub>vj</sub> = 25 °C  |     | 850  |      | ns   |
|                               |                  |                                                                                                                                                                                                           | T <sub>vj</sub> = 125 °C |     | 1080 |      |      |
|                               |                  |                                                                                                                                                                                                           | T <sub>vj</sub> = 150 °C |     | 1220 |      |      |
| Reverse recovery energy       | E <sub>rec</sub> |                                                                                                                                                                                                           | T <sub>vj</sub> = 25 °C  |     | 1.40 |      | J    |
|                               |                  |                                                                                                                                                                                                           | T <sub>vj</sub> = 125 °C |     | 2.30 |      |      |
|                               |                  |                                                                                                                                                                                                           | T <sub>vj</sub> = 150 °C |     | 2.60 |      |      |

<sup>5)</sup> Characteristic values according to IEC 60747 – 2

<sup>6)</sup> Forward voltage is given at chip level

## Package properties <sup>7)</sup>

| Parameter                                               | Symbol                | Conditions                                                                | min  | typ   | max   | Unit       |
|---------------------------------------------------------|-----------------------|---------------------------------------------------------------------------|------|-------|-------|------------|
| IGBT thermal resistance junction to case                | $R_{th(j-c)IGBT}$     |                                                                           |      |       | 0.009 | K/W        |
| Diode thermal resistance junction to case               | $R_{th(j-c)DIODE}$    |                                                                           |      |       | 0.014 | K/W        |
| IGBT thermal resistance <sup>2)</sup> case to heatsink  | $R_{th(c-s)IGBT}$     | IGBT per switch, $\lambda$ grease = $1\text{W}/\text{m} \times \text{K}$  |      | 0.007 |       | K/W        |
| Diode thermal resistance <sup>2)</sup> case to heatsink | $R_{th(c-s)DIODE}$    | Diode per switch, $\lambda$ grease = $1\text{W}/\text{m} \times \text{K}$ |      | 0.010 |       | K/W        |
| Partial discharge extinction voltage                    | $V_e$                 | $f = 50 \text{ Hz}, Q_{PD} \leq 10 \text{ pC}$ (acc. To IEC 61287)        | 2600 |       |       | V          |
| Comparative tracking index                              | CTI                   |                                                                           | 600  |       |       |            |
| Module stray inductance                                 | $L_\sigma \text{ CE}$ |                                                                           |      | 8     |       | nH         |
| Resistance, terminal-chip                               | $R_{CC'+EE'}$         | $T_C = 25 \text{ °C}$                                                     |      | 0.055 |       | m $\Omega$ |
|                                                         |                       | $T_C = 125 \text{ °C}$                                                    |      | 0.075 |       |            |
|                                                         |                       | $T_C = 150 \text{ °C}$                                                    |      | 0.080 |       |            |

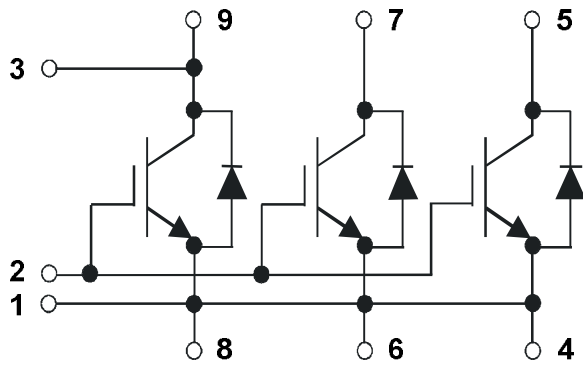
<sup>2)</sup> For detailed mounting instructions refer to Document No. 5SYA 2039

## Mechanical properties <sup>7)</sup>

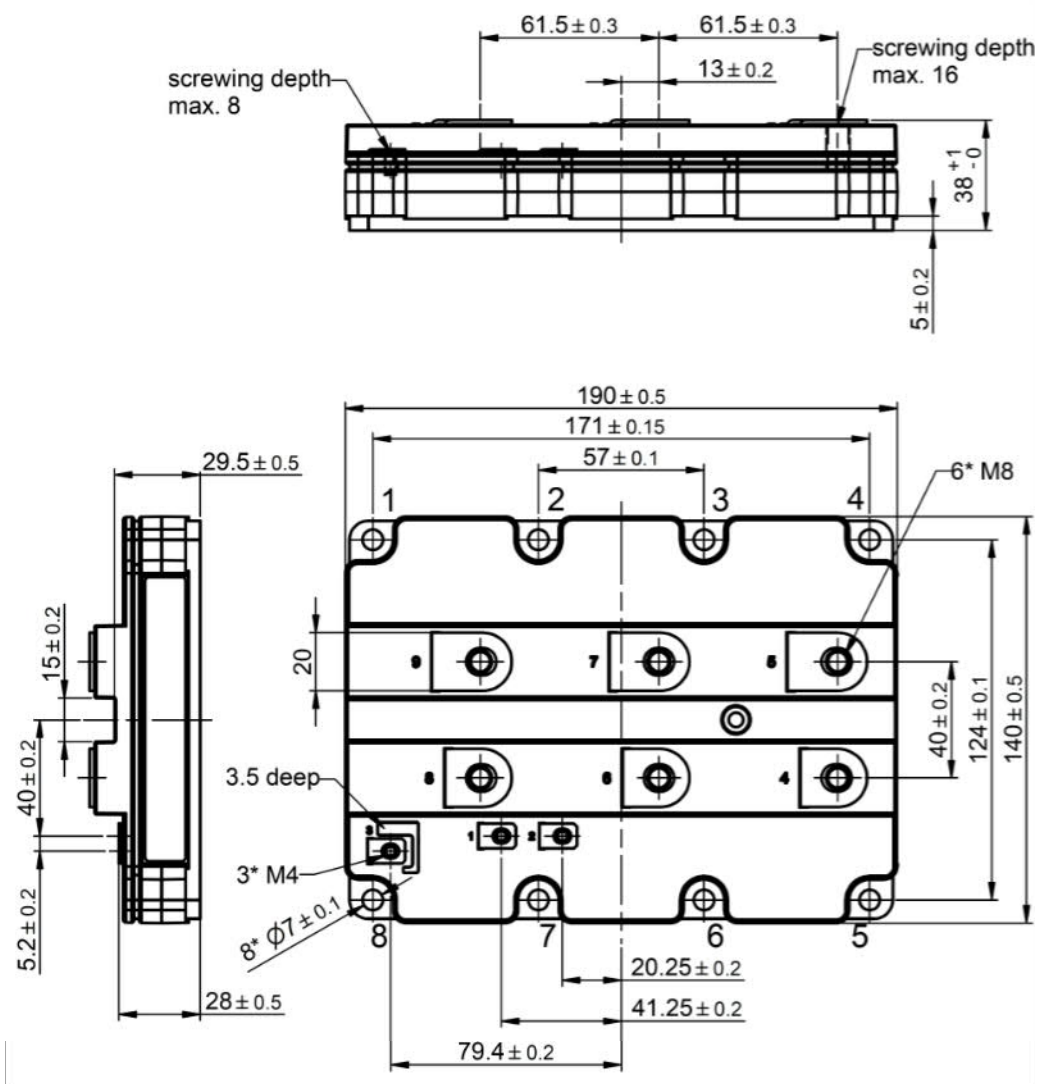
| Parameter                 | Symbol    | Conditions                              | min            | typ            | max | Unit |
|---------------------------|-----------|-----------------------------------------|----------------|----------------|-----|------|
| Dimensions                | L x W x H | Typical                                 |                | 190 x 140 x 38 |     | mm   |
| Clearance distance in air | $d_a$     | according to IEC 60664-1 and EN 50124-1 | Term. to base: | 23             |     | mm   |
|                           |           |                                         | Term. to term: | 19             |     |      |
| Surface creepage distance | $d_s$     | according to IEC 60664-1 and EN 50124-1 | Term. to base: | 28.2           |     | mm   |
|                           |           |                                         | Term. to term: | 28.2           |     |      |
| Mass                      | m         |                                         |                | 1190           |     | g    |

<sup>7)</sup> Package and mechanical properties according to IEC 60747 – 15

## Electrical configuration



## Outline drawing (mm)



Note: This is an electrostatic sensitive device, please observe the international standard IEC 60747-1, chap. VIII. This product has been designed and qualified for Industrial Level.

Fig. 1 Typical on-state characteristics, chip level

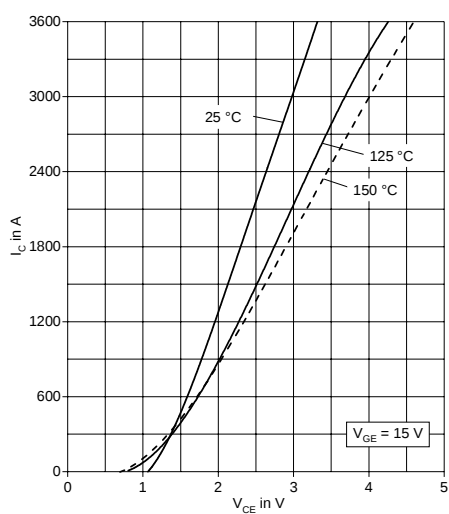


Fig. 2 Typical transfer characteristics, chip level

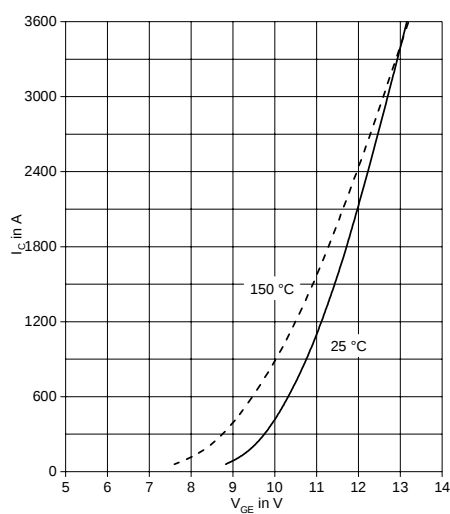


Fig. 3 Typical output characteristics, chip level

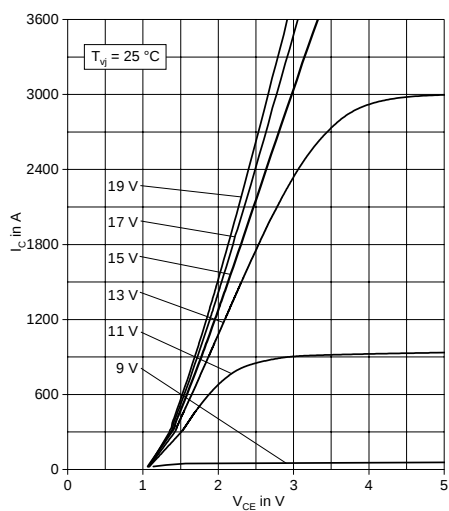


Fig. 4 Typical output characteristics, chip level

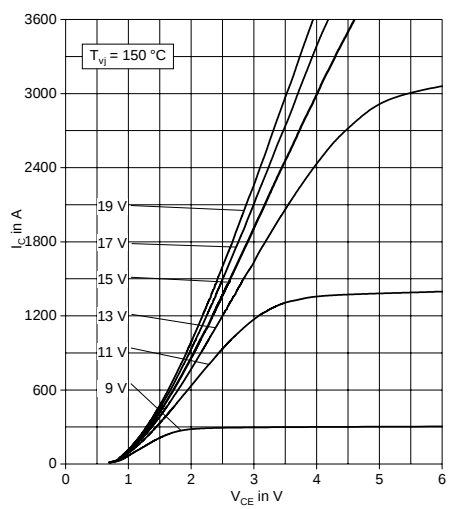


Fig. 5 Typical switching energies per pulse vs. collector current

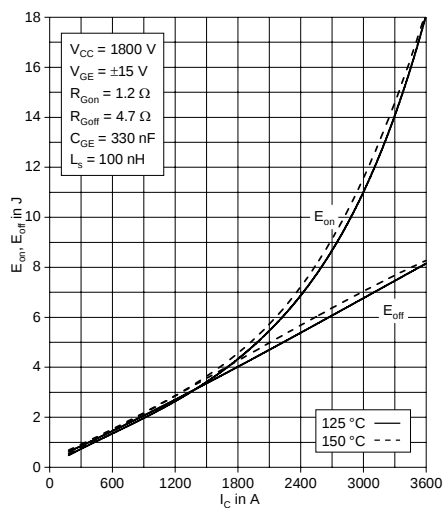


Fig. 6 Typical switching energies per pulse vs. gate resistor

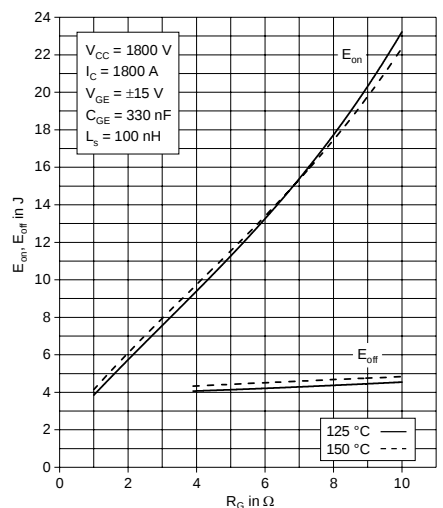


Fig. 7 Typical switching times vs. collector current

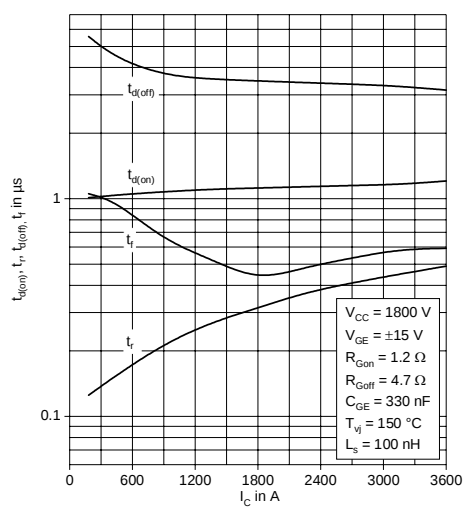


Fig. 9 Typical gate charge characteristics

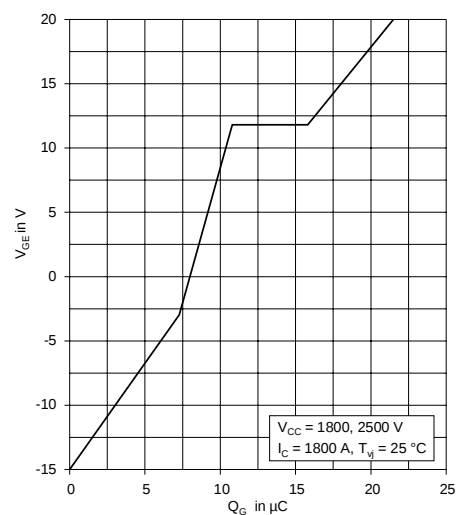


Fig. 11 Typical diode forward characteristics chip level

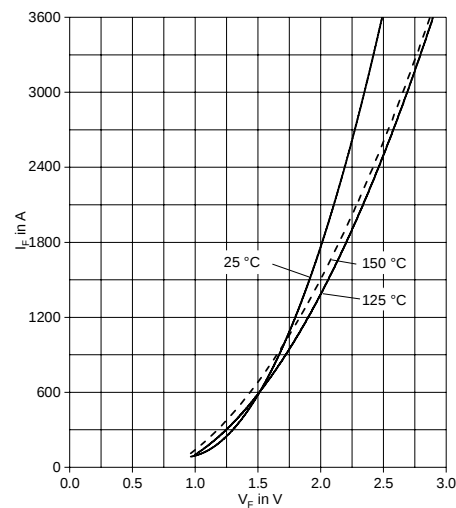


Fig. 8 Typical switching times vs. gate resistor

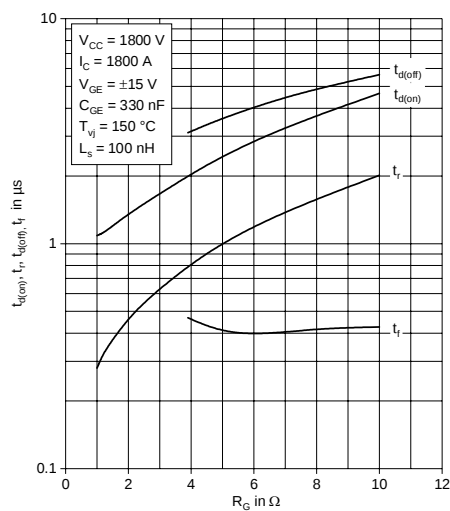


Fig. 10 Turn-off safe operating area (RBSOA)

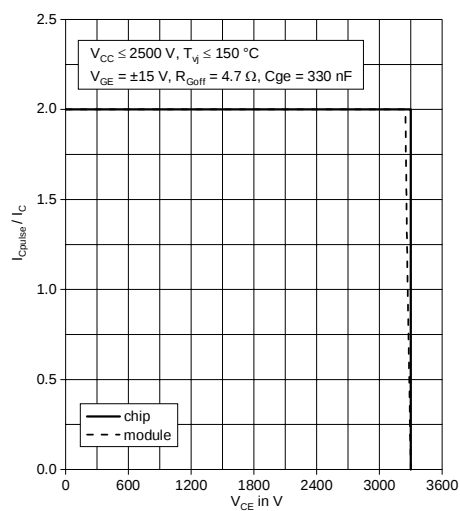


Fig. 12 Typical reverse recovery characteristics vs. forward current

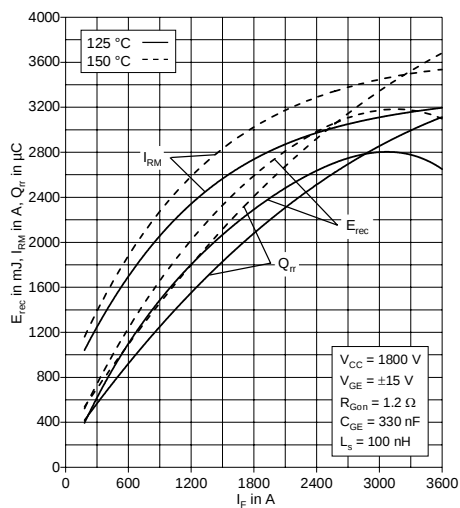


Fig. 13 Typical reverse recovery characteristics vs. di/dt

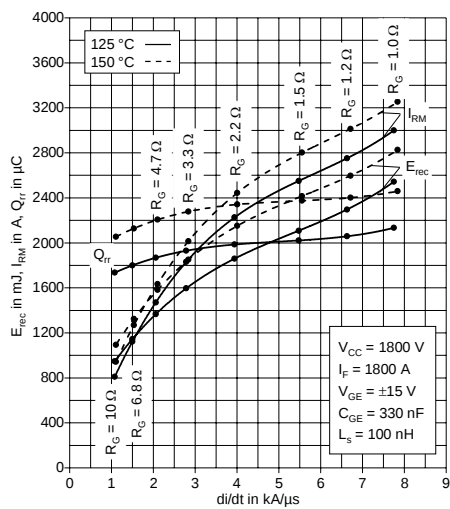


Fig. 15 Thermal impedance vs. time

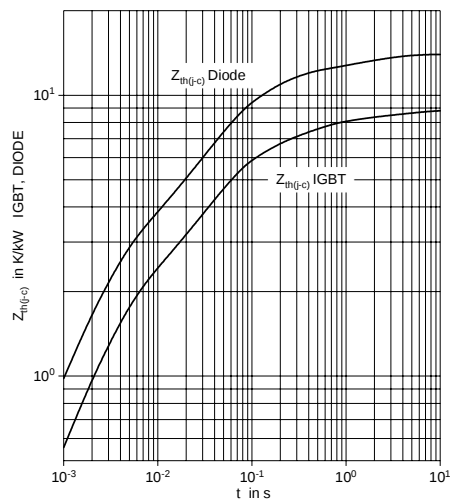
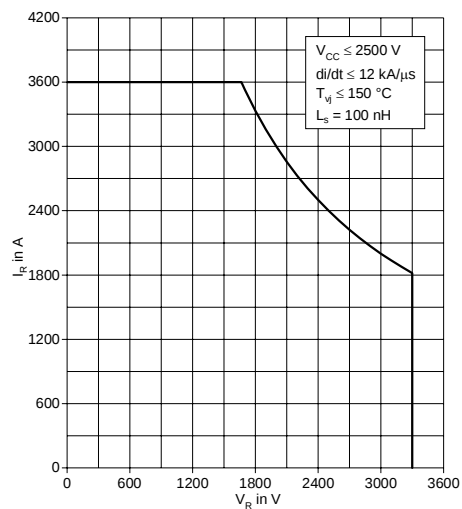


Fig. 14 Safe operating area diode (SOA)



Analytical function of the transient thermal resistance

$$Z_{th(j-c)}(t) = \sum_{i=1}^n R_i(1 - e^{-t/\tau_i})$$

| i     | 1        | 2     | 3     | 4     | 5     |
|-------|----------|-------|-------|-------|-------|
| IGBT  | Ri(K/kW) | 1.631 | 4.286 | 2.089 | 0.855 |
|       | τi(ms)   | 2.986 | 48.79 | 364.8 | 3593  |
| DIODE | Ri(K/kW) | 2.441 | 4.23  | 5.055 | 2.253 |
|       | τi(ms)   | 2.434 | 36.51 | 116.2 | 1641  |

Related documents:

- 5SYA 2039 Mounting Instructions for HiPak modules
- 5SYA 2042 Failure rates of IGBT modules due to cosmic rays
- 5SYA 2043 Load – cycle capability of HiPaks
- 5SYA 2045 Thermal runaway during blocking
- 5SYA 2053 Applying IGBT
- 5SYA 2057 IGBT diode safe operating area (SOA)
- 5SYA 2058 Surge currents for IGBT diodes
- 5SYA 2093 Thermal design of IGBT modules
- 5SYA 2098 Paralleling of IGBT modules

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