

Highly insulated module with Trench/Fieldstop IGBT3 and emitter controlled 3 diode**Features**

- Electrical features
 - $V_{CES} = 6500\text{ V}$
 - $I_{C\text{nom}} = 500\text{ A} / I_{CRM} = 1000\text{ A}$
 - LOW $V_{CE,sat}$
- Mechanical features
 - ALSiC base plate for increased thermal cycling capability
 - Extended storage temperature down to $T_{stg} = -55\text{ °C}$
 - High creepage and clearance distances
 - Package with enhanced insulation of 10.4 kV AC 60 s
 - Package with CTI > 600

**Potential applications**

- Traction drives
- Medium-voltage converters

Product validation

- Qualified for industrial applications according to the relevant tests of IEC 60747, 60749 and 60068

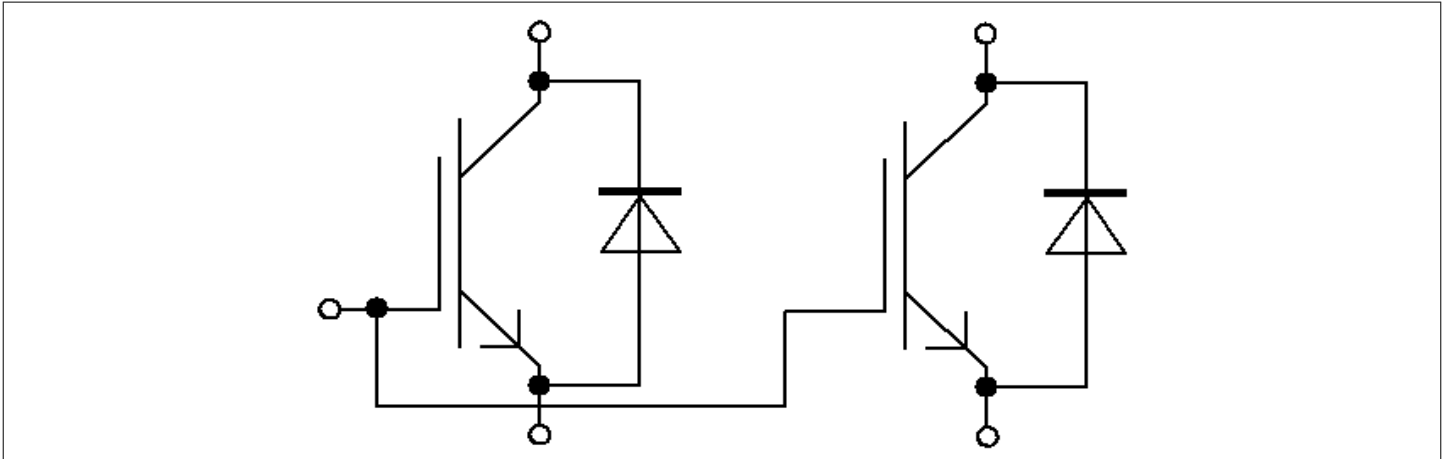
Description

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1 Package

Table 1 Insulation coordination

| Parameter | Symbol | Note or test condition | Values | Unit |
|--------------------------------------|-------------|---------------------------------------|--------|------|
| Isolation test voltage | V_{ISOL} | RMS, $f = 50$ Hz, $t = 60$ s | 10.4 | kV |
| Partial discharge extinction voltage | V_{isol} | RMS, $f = 50$ Hz, Q_{PD} typ. 10 pC | 5.1 | kV |
| DC stability | $V_{CE(D)}$ | $T_{vj}=25^{\circ}C$, 100 Fit | 3800 | V |
| Material of module baseplate | | | AlSiC | |
| Internal isolation | | basic insulation (class 1, IEC 61140) | AlN | |
| Creepage distance | d_{Creep} | terminal to heatsink | 64.0 | mm |
| Creepage distance | d_{Creep} | terminal to terminal | 56.0 | mm |
| Clearance | d_{Clear} | terminal to heatsink | 40.0 | mm |
| Clearance | d_{Clear} | terminal to terminal | 26.0 | mm |
| Comparative tracking index | CTI | | >600 | |

Table 2 Characteristic values

| Parameter | Symbol | Note or test condition | Values | | | Unit | |
|--|---------------|--|-----------|------|------|-------------|----|
| | | | Min. | Typ. | Max. | | |
| Stray inductance module | L_{sCE} | | | 20 | | nH | |
| Module lead resistance, terminals - chip | $R_{AA'+CC'}$ | $T_C=25^{\circ}C$, per switch | | 0.18 | | m Ω | |
| Module lead resistance, terminals - chip | $R_{CC'+EE'}$ | $T_C=25^{\circ}C$, per switch | | 0.18 | | m Ω | |
| Storage temperature | T_{stg} | | -55 | | 125 | $^{\circ}C$ | |
| Mounting torque for module mounting | M | - Mounting according to valid application note | M6, Screw | 4.25 | | 5.75 | Nm |
| Terminal connection torque | M | - Mounting according to valid application note | M4, Screw | 1.8 | | 2.1 | Nm |
| | | | M8, Screw | 8 | | 10 | |
| Weight | G | | | 1000 | | g | |

2 IGBT, Inverter

Table 3 Maximum rated values

| Parameter | Symbol | Note or test condition | Values | Unit | |
|---------------------------|-----------|------------------------|-------------------------|------|---|
| Collector-emitter voltage | V_{CES} | | $T_{vj} = -50^{\circ}C$ | 5900 | V |
| | | | $T_{vj} = 25^{\circ}C$ | 6500 | |
| | | | $T_{vj} = 125^{\circ}C$ | 6500 | |

(table continues...)

Table 3 (continued) Maximum rated values

| Parameter | Symbol | Note or test condition | Values | Unit |
|-----------------------------------|-----------|---|----------|------|
| Continuous DC collector current | I_{CDC} | $T_{vj\ max} = 150\ ^\circ C$ $T_C = 80\ ^\circ C$ | 500 | A |
| Repetitive peak collector current | I_{CRM} | $t_p = 1\ ms$ | 1000 | A |
| Gate-emitter peak voltage | V_{GES} | | ± 20 | V |

Table 4 Characteristic values

| Parameter | Symbol | Note or test condition | Values | | | Unit |
|--------------------------------------|---------------|---|--------------------------|-------|------|----------|
| | | | Min. | Typ. | Max. | |
| Collector-emitter saturation voltage | $V_{CE\ sat}$ | $I_C = 500\ A, V_{GE} = 15\ V$ | $T_{vj} = 25\ ^\circ C$ | 3.00 | 3.40 | V |
| | | | $T_{vj} = 125\ ^\circ C$ | 3.70 | 4.20 | |
| Gate threshold voltage | V_{GETh} | $I_C = 70\ mA, V_{CE} = V_{GE}, T_{vj} = 25\ ^\circ C$ | 5.40 | 6 | 6.60 | V |
| Gate charge | Q_G | $V_{GE} = \pm 15\ V, V_{CE} = 3600\ V$ | | 20 | | μC |
| Internal gate resistor | R_{Gint} | $T_{vj} = 25\ ^\circ C$ | | 1.1 | | Ω |
| Input capacitance | C_{ies} | $f = 1000\ kHz, T_{vj} = 25\ ^\circ C, V_{CE} = 25\ V, V_{GE} = 0\ V$ | | 135 | | nF |
| Reverse transfer capacitance | C_{res} | $f = 1000\ kHz, T_{vj} = 25\ ^\circ C, V_{CE} = 25\ V, V_{GE} = 0\ V$ | | 2.1 | | nF |
| Collector-emitter cut-off current | I_{CES} | $V_{CE} = 6500\ V, V_{GE} = 0\ V$ $T_{vj} = 25\ ^\circ C$ | | | 5 | mA |
| Gate-emitter leakage current | I_{GES} | $V_{CE} = 0\ V, V_{GE} = 20\ V, T_{vj} = 25\ ^\circ C$ | | | 400 | nA |
| Turn-on delay time (inductive load) | t_{don} | $I_C = 500\ A, V_{CE} = 3600\ V, V_{GE} = \pm 15\ V, R_{Gon} = 1.5\ \Omega$ | $T_{vj} = 25\ ^\circ C$ | 0.640 | | μs |
| | | | $T_{vj} = 125\ ^\circ C$ | 0.650 | | |
| Rise time (inductive load) | t_r | $I_C = 500\ A, V_{CE} = 3600\ V, V_{GE} = \pm 15\ V, R_{Gon} = 1.5\ \Omega$ | $T_{vj} = 25\ ^\circ C$ | 0.180 | | μs |
| | | | $T_{vj} = 125\ ^\circ C$ | 0.200 | | |
| Turn-off delay time (inductive load) | t_{doff} | $I_C = 500\ A, V_{CE} = 3600\ V, V_{GE} = \pm 15\ V, R_{Goff} = 10\ \Omega$ | $T_{vj} = 25\ ^\circ C$ | 7.300 | | μs |
| | | | $T_{vj} = 125\ ^\circ C$ | 7.600 | | |
| Fall time (inductive load) | t_f | $I_C = 500\ A, V_{CE} = 3600\ V, V_{GE} = \pm 15\ V, R_{Goff} = 10\ \Omega$ | $T_{vj} = 25\ ^\circ C$ | 0.400 | | μs |
| | | | $T_{vj} = 125\ ^\circ C$ | 0.500 | | |
| Turn-on time (resistive load) | t_{on_R} | $I_C = 500\ A, V_{CE} = 2000\ V, V_{GE} = \pm 15\ V, R_{Gon} = 1.5\ \Omega$ | 1.62 | | | μs |
| Turn-on energy loss per pulse | E_{on} | $I_C = 500\ A, V_{CE} = 3600\ V, L_\sigma = 280\ nH, V_{GE} = \pm 15\ V, R_{Gon} = 1.5\ \Omega, di/dt = 2000\ A/\mu s (T_{vj} = 125\ ^\circ C)$ | $T_{vj} = 25\ ^\circ C$ | 2800 | | mJ |
| | | | $T_{vj} = 125\ ^\circ C$ | 4300 | | |
| Turn-off energy loss per pulse | E_{off} | $I_C = 500\ A, V_{CE} = 3600\ V, L_\sigma = 280\ nH, V_{GE} = \pm 15\ V, R_{Goff} = 10\ \Omega, dv/dt = V/\mu s (T_{vj} = 125\ ^\circ C)$ | $T_{vj} = 25\ ^\circ C$ | 2400 | | mJ |
| | | | $T_{vj} = 125\ ^\circ C$ | 2800 | | |

(table continues...)

Table 4 (continued) Characteristic values

| Parameter | Symbol | Note or test condition | Values | | | Unit | |
|--|------------|---|--|------|------|------|------------------|
| | | | Min. | Typ. | Max. | | |
| SC data | I_{SC} | $V_{GE} \leq 15 \text{ V}$, $V_{CC} = 4500 \text{ V}$, $V_{CEmax} = V_{CES} - L_{sCE} \cdot di/dt$ | $t_p \leq 10 \mu\text{s}$, $T_{vj} \leq 125 \text{ }^\circ\text{C}$ | | 3000 | | A |
| Thermal resistance, junction to case | R_{thJC} | per IGBT | | | 13.1 | | K/kW |
| Thermal resistance, case to heat sink | R_{thCH} | per IGBT, $\lambda_{grease} = 1 \text{ W}/(\text{m}^2\text{K})$ | | | 13.2 | | K/kW |
| Temperature under switching conditions | T_{vjop} | | -50 | | 125 | | $^\circ\text{C}$ |

3 Diode, Inverter

Table 5 Maximum rated values

| Parameter | Symbol | Note or test condition | Values | Unit | |
|---------------------------------|-------------|---|---------------------------------------|---------------|-----------------------|
| Repetitive peak reverse voltage | V_{RRM} | | $T_{vj} = -50 \text{ }^\circ\text{C}$ | 5900 | V |
| | | | $T_{vj} = 25 \text{ }^\circ\text{C}$ | 6500 | |
| | | | $T_{vj} = 125 \text{ }^\circ\text{C}$ | 6500 | |
| Continuous DC forward current | I_F | | 500 | A | |
| Repetitive peak forward current | I_{FRM} | $t_p = 1 \text{ ms}$ | 1000 | A | |
| I^2t - value | I^2t | $t_p = 10 \text{ ms}$, $V_R = 0 \text{ V}$ | $T_{vj} = 125 \text{ }^\circ\text{C}$ | 210 | kA^2s |
| Maximum power dissipation | P_{RQM} | $T_{vj} = 125 \text{ }^\circ\text{C}$ | 2000 | kW | |
| Minimum turn-on time | t_{onmin} | | 10 | μs | |

Table 6 Characteristic values

| Parameter | Symbol | Note or test condition | Values | | | Unit | |
|-------------------------------|----------|--|---------------------------------------|------|------|------|---------------|
| | | | Min. | Typ. | Max. | | |
| Forward voltage | V_F | $I_F = 500 \text{ A}$, $V_{GE} = 6500 \text{ V}$ | $T_{vj} = 25 \text{ }^\circ\text{C}$ | | 3.00 | 3.50 | V |
| | | | $T_{vj} = 125 \text{ }^\circ\text{C}$ | | 2.95 | 3.50 | |
| Peak reverse recovery current | I_{RM} | $V_R = 3600 \text{ V}$, $I_F = 500 \text{ A}$, $V_{GE} = -15 \text{ V}$, $-di_F/dt = 2000 \text{ A}/\mu\text{s}$ ($T_{vj} = 125 \text{ }^\circ\text{C}$) | $T_{vj} = 25 \text{ }^\circ\text{C}$ | | 730 | | A |
| | | | $T_{vj} = 125 \text{ }^\circ\text{C}$ | | 800 | | |
| Recovered charge | Q_r | $V_R = 3600 \text{ V}$, $I_F = 500 \text{ A}$, $V_{GE} = -15 \text{ V}$, $-di_F/dt = 2000 \text{ A}/\mu\text{s}$ ($T_{vj} = 125 \text{ }^\circ\text{C}$) | $T_{vj} = 25 \text{ }^\circ\text{C}$ | | 570 | | μC |
| | | | $T_{vj} = 125 \text{ }^\circ\text{C}$ | | 1050 | | |

(table continues...)

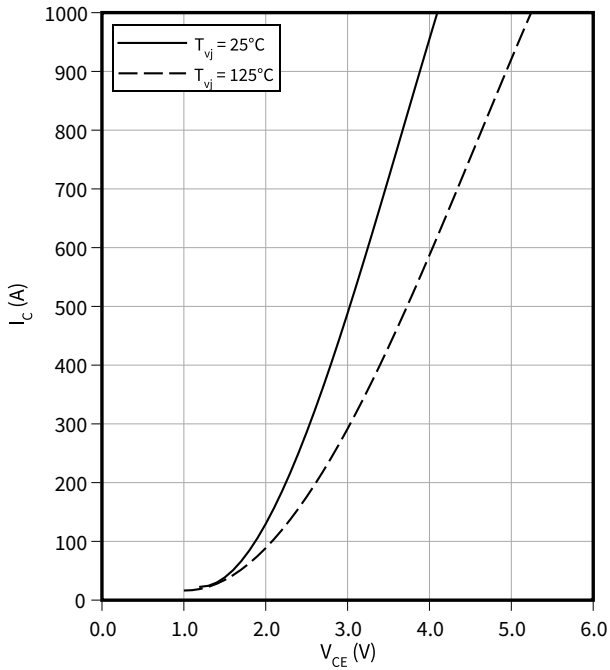
Table 6 (continued) Characteristic values

| Parameter | Symbol | Note or test condition | Values | | | Unit |
|--|------------|---|--------------------------|------|------|------|
| | | | Min. | Typ. | Max. | |
| Reverse recovery energy | E_{rec} | $V_R = 3600\text{ V}$, $I_F = 500\text{ A}$, $V_{GE} = -15\text{ V}$, $-di_F/dt = 2000\text{ A}/\mu\text{s}$ ($T_{vj} = 125\text{ °C}$) | $T_{vj} = 25\text{ °C}$ | 930 | | mJ |
| | | | $T_{vj} = 125\text{ °C}$ | 2000 | | |
| Thermal resistance, junction to case | R_{thJC} | per diode | | | 27.9 | K/kW |
| Thermal resistance, case to heat sink | R_{thCH} | per diode, $\lambda_{grease} = 1\text{ W}/(\text{m}^*\text{K})$ | | 21.0 | | K/kW |
| Temperature under switching conditions | T_{vjop} | | -50 | | 125 | °C |

4 Characteristics diagrams

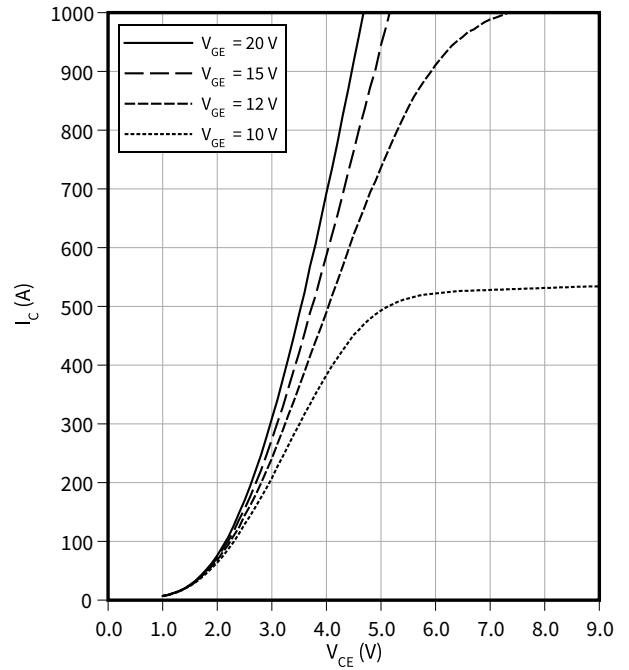
output characteristic (typical), IGBT, Inverter

$I_C = f(V_{CE})$
 $V_{GE} = 15 \text{ V}$



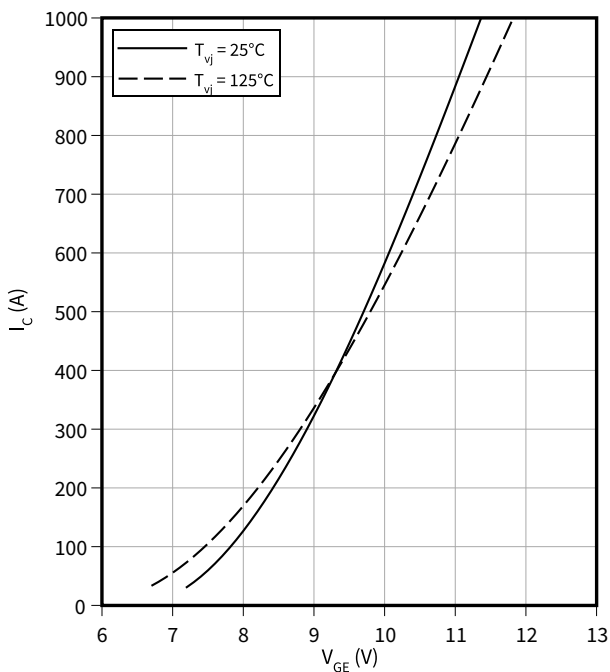
output characteristic (typical), IGBT, Inverter

$I_C = f(V_{CE})$
 $T_{vj} = 125 \text{ °C}$



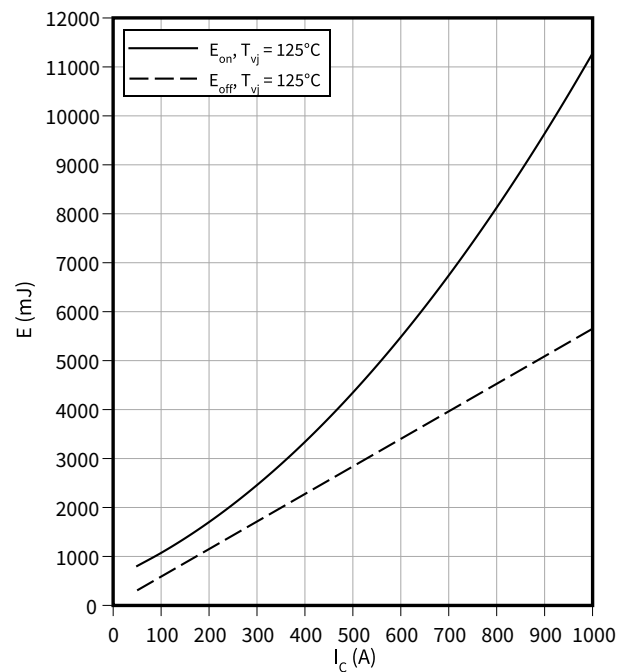
transfer characteristic (typical), IGBT, Inverter

$I_C = f(V_{GE})$
 $V_{CE} = 20 \text{ V}$



switching losses (typical), IGBT, Inverter

$E = f(I_C)$
 $R_{Goff} = 10 \text{ } \Omega$, $R_{Gon} = 1.5 \text{ } \Omega$, $V_{CE} = 3600 \text{ V}$, $V_{GE} = \pm 15 \text{ V}$

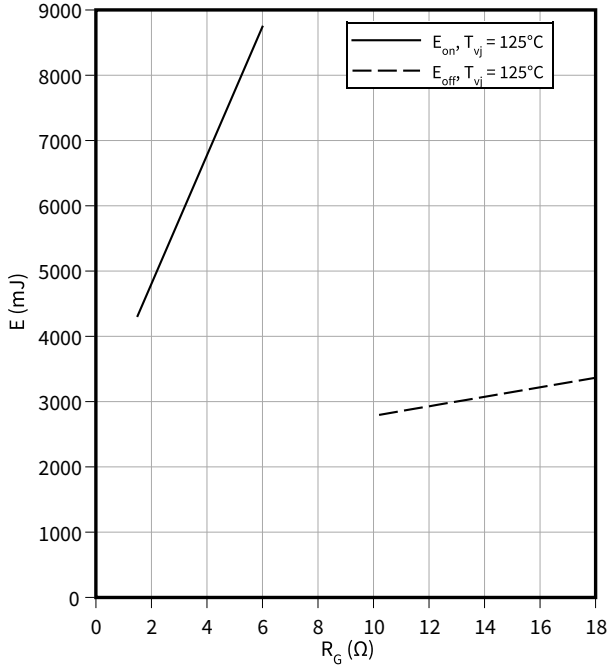


4 Characteristics diagrams

switching losses (typical), IGBT, Inverter

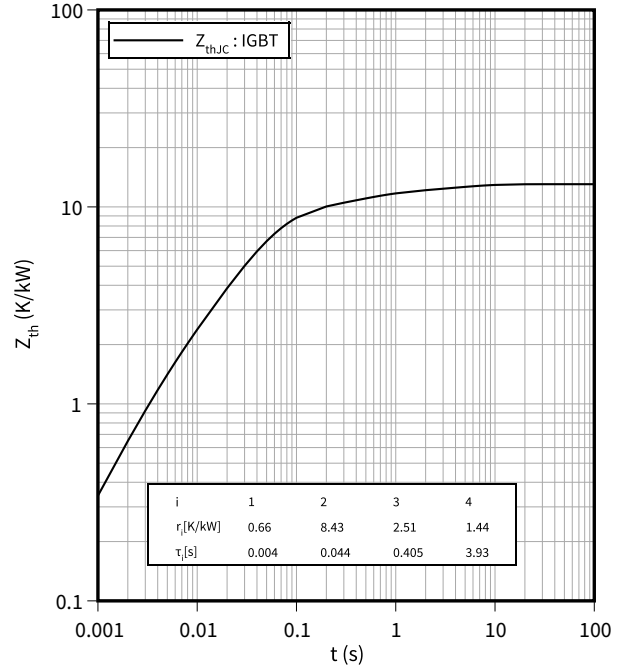
$E = f(R_G)$

$I_C = 500 \text{ A}$, $V_{CE} = 3600 \text{ V}$, $V_{GE} = \pm 15 \text{ V}$



transient thermal impedance , IGBT, Inverter

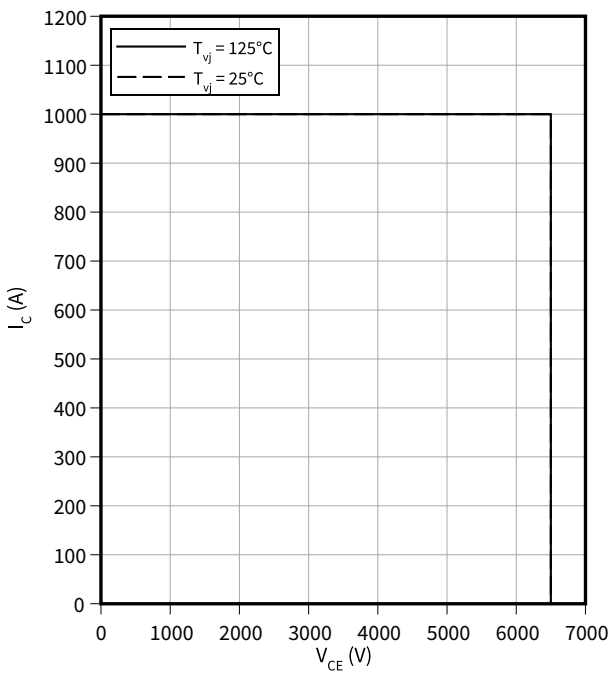
$Z_{th} = f(t)$



reverse bias safe operating area (RBSOA), IGBT, Inverter

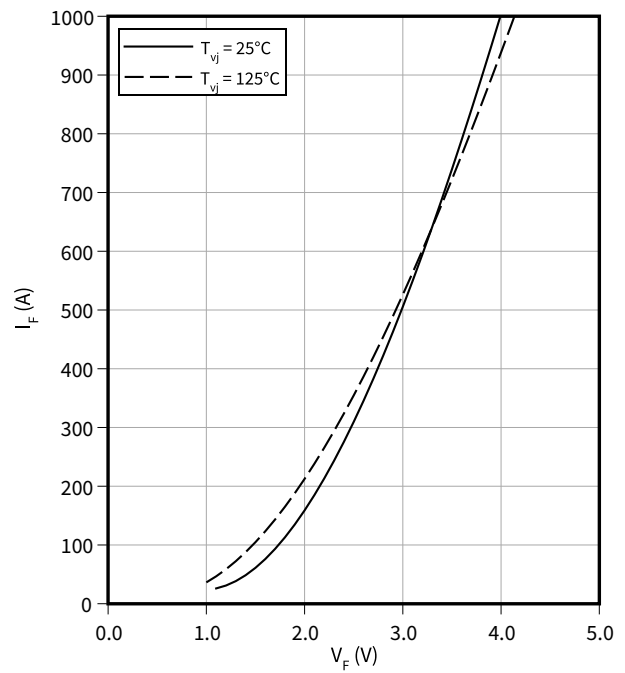
$I_C = f(V_{CE})$

$R_{Goff} = 10 \Omega$, $V_{GE} = \pm 15 \text{ V}$, $T_{vj} = 125 \text{ °C}$



forward characteristic of (typical), Diode, Inverter

$I_F = f(V_F)$

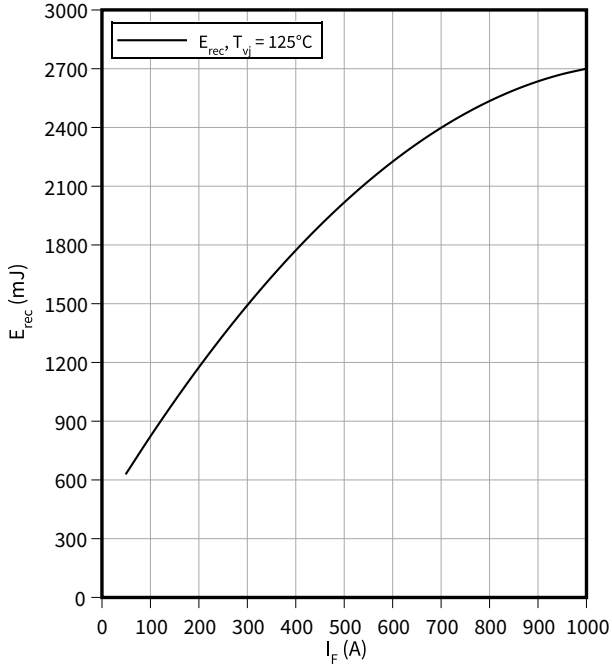


4 Characteristics diagrams

switching losses (typical), Diode, Inverter

$E_{rec} = f(I_F)$

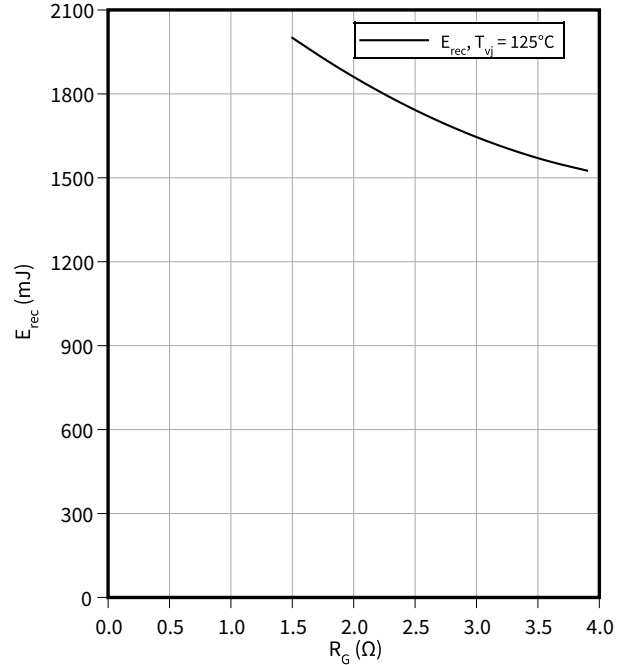
$V_{CE} = 3600\text{ V}$, $R_{Gon} = R_{Gon}(IGBT)$



switching losses (typical), Diode, Inverter

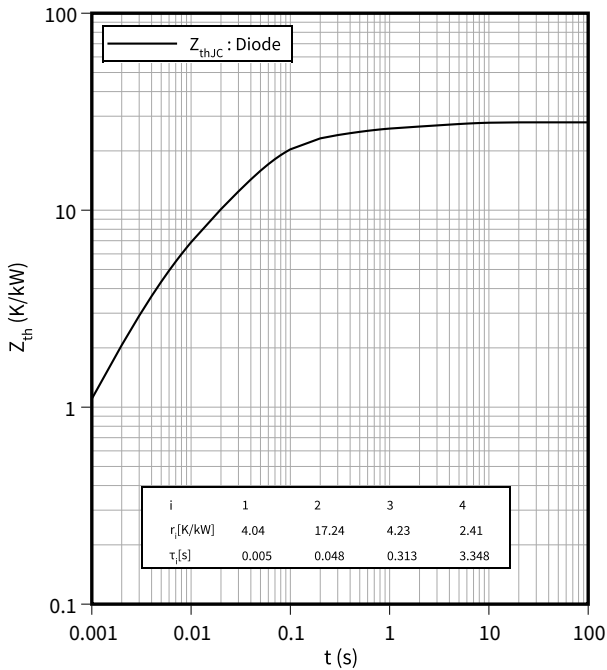
$E_{rec} = f(R_G)$

$V_{CE} = 3600\text{ V}$, $I_F = 500\text{ A}$



transient thermal impedance, Diode, Inverter

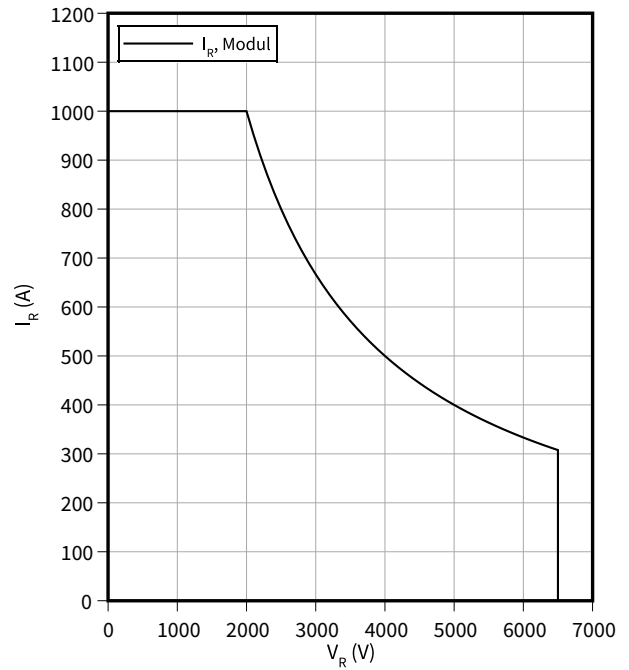
$Z_{th} = f(t)$



safe operation area (SOA), Diode, Inverter

$I_R = f(V_R)$

$T_{vj} = 125\text{ °C}$



5 Circuit diagram

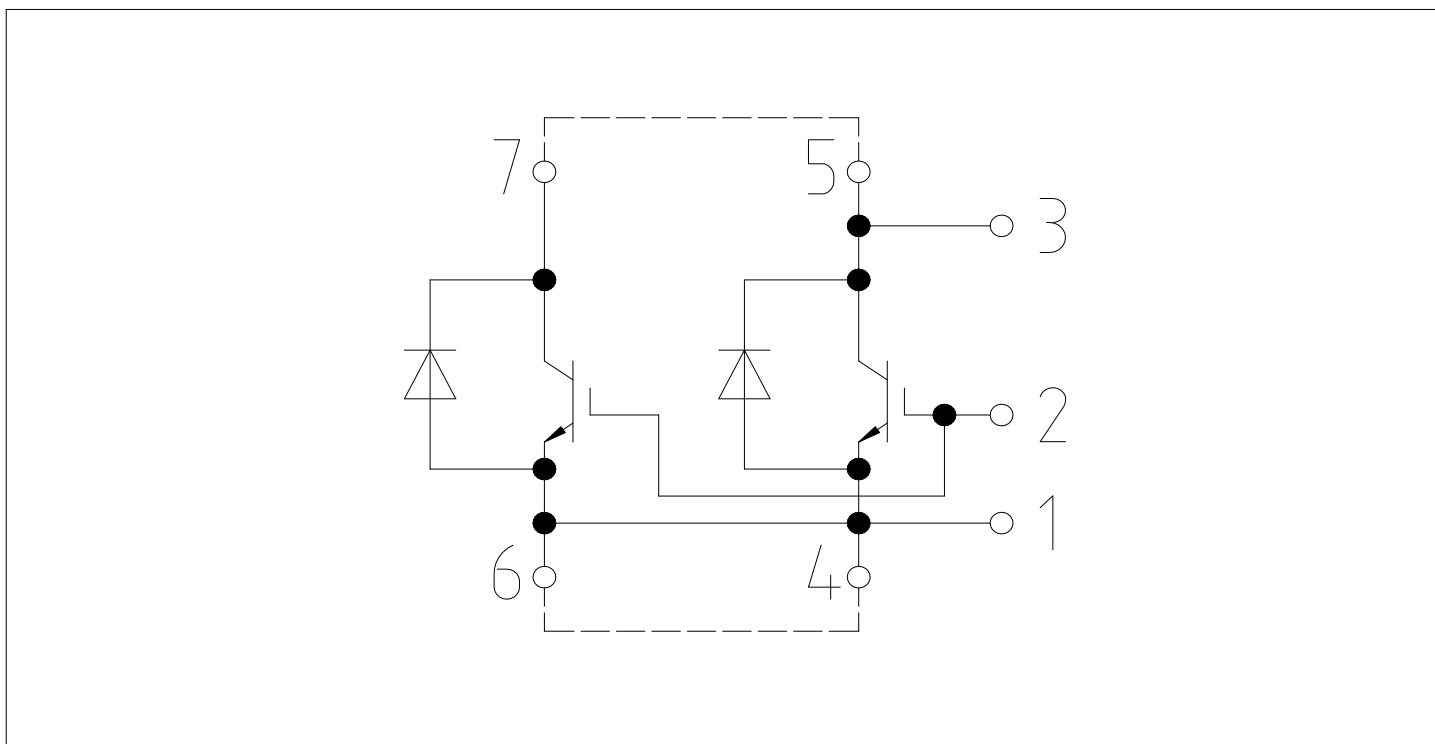


Figure 1

6 Package outlines

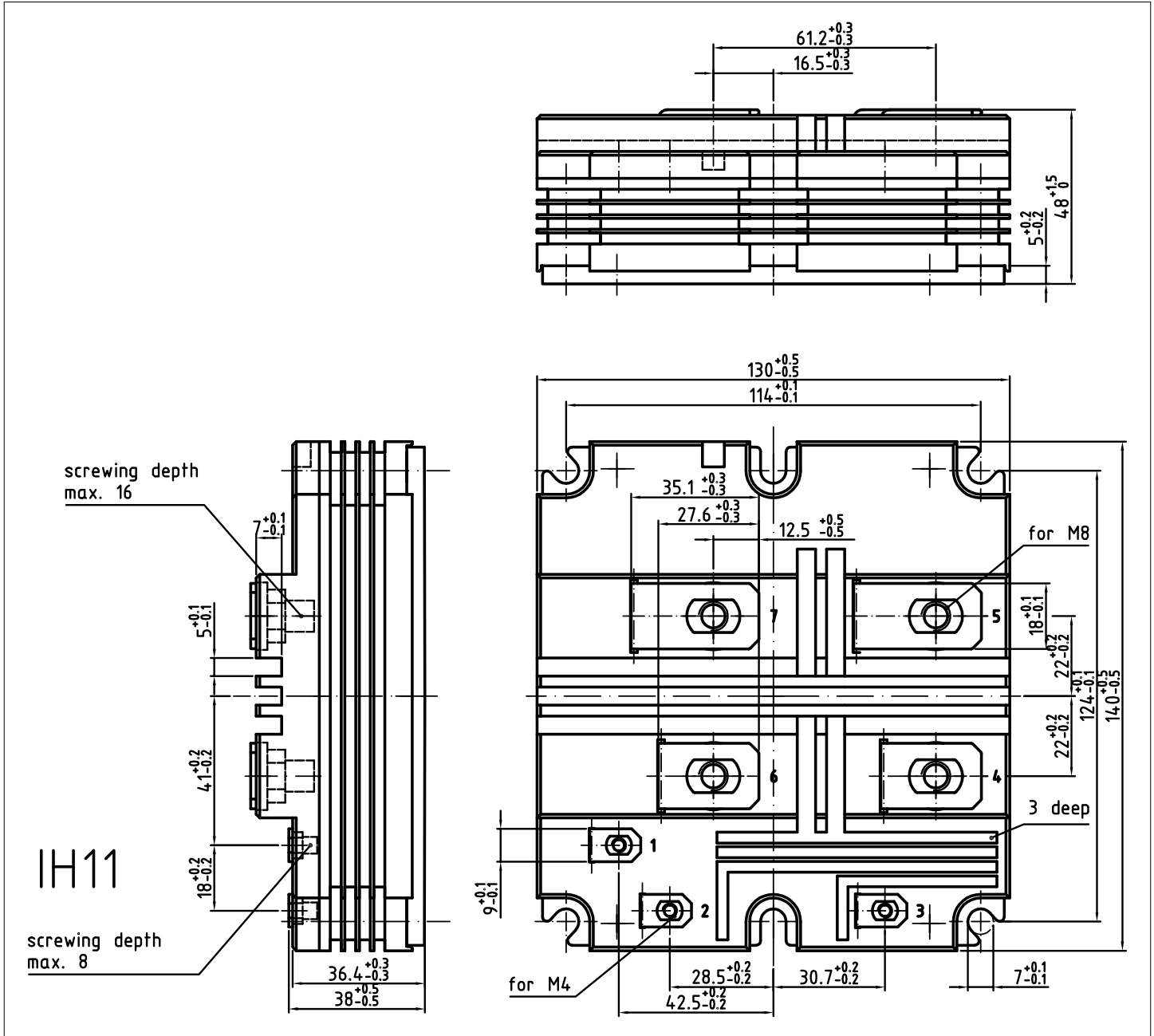


Figure 2

7 Module label code



| Module label code | | | |
|-------------------|--|-----------------|---|
| Code format | Data Matrix | Barcode Code128 | |
| Encoding | ASCII text | Code Set A | |
| Symbol size | 16x16 | 23 digits | |
| Standard | IEC24720 and IEC16022 | IEC8859-1 | |
| Code content | Content | Digit | Example |
| | Module serial number | 1 - 5 | 71549 |
| | Module material number | 6 - 11 | 142846 |
| | Production order number | 12 - 19 | 55054991 |
| | Date code (production year) | 20 - 21 | 15 |
| | Date code (production week) | 22 - 23 | 30 |
| Example |  | |  |
| | 71549142846550549911530 | | 71549142846550549911530 |

Figure 3

Revision history

| Document revision | Date of release | Description of changes |
|-------------------|-----------------|---|
| V1.0 | 2009-04-06 | Target datasheet |
| V2.0 | 2010-12-13 | Preliminary datasheet |
| V2.1 | 2012-06-25 | Preliminary datasheet |
| V2.2 | 2012-08-22 | Preliminary datasheet |
| V3.0 | 2014-06-16 | Final datasheet |
| V3.1 | 2018-01-15 | Final datasheet |
| V3.2 | 2019-09-06 | Final datasheet |
| V3.3 | 2020-05-06 | Final datasheet |
| n/a | 2020-09-01 | Datasheet migrated to a new system with a new layout and new revision number schema: target or preliminary datasheet = 0.xy; final datasheet = 1.xy |
| 1.10 | 2021-10-25 | Final datasheet |

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