

XHP™3 module with Trench/Fieldstop IGBT3 and emitter controlled 3 diode

Features

- Electrical features
 - $V_{CES} = 3300\text{ V}$
 - $I_{C\text{nom}} = 450\text{ A} / I_{CRM} = 900\text{ A}$
 - Low switching losses
 - High DC stability
 - High short-circuit capability
 - Low $V_{CE,sat}$
 - $T_{vj,op} = 150^{\circ}\text{C}$
 - Unbeatable robustness
 - $V_{CE,sat}$ with positive temperature coefficient
- Mechanical features
 - ALSiC base plate for increased thermal cycling capability
 - Isolated base plate
 - Package with CTI > 600



Potential applications

- Medium-voltage converters
- Motor drives
- Traction drives
- UPS systems
- Wind turbines

Product validation

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

Description

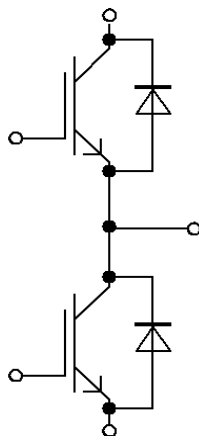


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1 Package

Table 1 Insulation coordination

| Parameter | Symbol | Note or test condition | Values | Unit |
|--------------------------------------|-------------|--|--------|------|
| Isolation test voltage | V_{ISOL} | RMS, $f = 50 \text{ Hz}$, $t = 10 \text{ s}$ | 6.0 | kV |
| Partial discharge extinction voltage | V_{isol} | RMS, $f = 50 \text{ Hz}$, $Q_{PD} \leq 10 \text{ pC}$ | 2.6 | kV |
| Material of module baseplate | | | AlSiC | |
| Creepage distance | d_{Creep} | terminal to heatsink | 53.0 | mm |
| Creepage distance | d_{Creep} | terminal to terminal | 53.0 | mm |
| Clearance | d_{Clear} | terminal to heatsink | 26.0 | 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} | | | 25 | | nH | |
| Module lead resistance, terminals - chip | $R_{AA'+CC'}$ | $T_C = 25^\circ\text{C}$, per switch | | 0.31 | | mΩ | |
| Module lead resistance, terminals - chip | $R_{CC'+EE'}$ | $T_C = 25^\circ\text{C}$, per switch | | 0.41 | | mΩ | |
| Storage temperature | T_{stg} | | -40 | | 150 | °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 | M3, Screw | 0.9 | | 1.1 | Nm |
| | | | M8, Screw | 8 | | 10 | |
| Weight | G | | | 700 | | g | |

2 IGBT, Inverter

Table 3 Maximum rated values

| Parameter | Symbol | Note or test condition | Values | Unit | |
|-----------------------------------|-----------|--|------------------------------|------|---|
| Collector-emitter voltage | V_{CES} | | $T_{vj} = -40^\circ\text{C}$ | 3300 | V |
| | | | $T_{vj} = 150^\circ\text{C}$ | 3300 | |
| Continuous DC collector current | I_{CDC} | $T_{vj \text{ max}} = 150^\circ\text{C}$ | $T_C = 100^\circ\text{C}$ | 450 | A |
| Repetitive peak collector current | I_{CRM} | $t_p = 1 \text{ ms}$ | | 900 | A |

(table continues...)

Table 3 (continued) Maximum rated values

| Parameter | Symbol | Note or test condition | Values | Unit |
|---------------------------|-----------|------------------------|--------|------|
| 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 | $V_{CE\ sat}$ | $I_C = 450\ A, V_{GE} = 15\ V$ | $T_{vj} = 25\ ^\circ C$ | 2.50 | 2.75 | V |
| | | | $T_{vj} = 125\ ^\circ C$ | 2.90 | | |
| | | | $T_{vj} = 150\ ^\circ C$ | 3.00 | 3.30 | |
| Gate threshold voltage | V_{GEth} | $I_C = 12\ mA, V_{CE} = V_{GE}, T_{vj} = 25\ ^\circ C$ | 5.20 | 5.80 | 6.40 | V |
| Gate charge | Q_G | $V_{GE} = \pm 15\ V, V_{CE} = 1800\ V$ | | 12.5 | | μC |
| Internal gate resistor | R_{Gint} | $T_{vj} = 25\ ^\circ C$ | | 1.3 | | Ω |
| Input capacitance | C_{ies} | $f = 1000\ kHz, T_{vj} = 25\ ^\circ C, V_{CE} = 25\ V, V_{GE} = 0\ V$ | | 84 | | nF |
| Reverse transfer capacitance | C_{res} | $f = 1000\ kHz, T_{vj} = 25\ ^\circ C, V_{CE} = 25\ V, V_{GE} = 0\ V$ | | 2 | | nF |
| Collector-emitter cut-off current | I_{CES} | $V_{CE} = 3300\ V, V_{GE} = 0\ V$ | | | 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} | $I_C = 450\ A, V_{CE} = 1800\ V, V_{GE} = \pm 15\ V, R_{Gon} = 0.7\ \Omega$ | $T_{vj} = 25\ ^\circ C$ | 0.530 | | μs |
| | | | $T_{vj} = 125\ ^\circ C$ | 0.570 | | |
| | | | $T_{vj} = 150\ ^\circ C$ | 0.580 | | |
| Rise time (inductive load) | t_r | $I_C = 450\ A, V_{CE} = 1800\ V, V_{GE} = \pm 15\ V, R_{Gon} = 0.7\ \Omega$ | $T_{vj} = 25\ ^\circ C$ | 0.100 | | μs |
| | | | $T_{vj} = 125\ ^\circ C$ | 0.130 | | |
| | | | $T_{vj} = 150\ ^\circ C$ | 0.130 | | |
| Turn-off delay time (inductive load) | t_{doff} | $I_C = 450\ A, V_{CE} = 1800\ V, V_{GE} = \pm 15\ V, R_{Goff} = 3.3\ \Omega$ | $T_{vj} = 25\ ^\circ C$ | 1.710 | | μs |
| | | | $T_{vj} = 125\ ^\circ C$ | 1.860 | | |
| | | | $T_{vj} = 150\ ^\circ C$ | 1.920 | | |
| Fall time (inductive load) | t_f | $I_C = 450\ A, V_{CE} = 1800\ V, V_{GE} = \pm 15\ V, R_{Goff} = 3.3\ \Omega$ | $T_{vj} = 25\ ^\circ C$ | 0.130 | | μs |
| | | | $T_{vj} = 125\ ^\circ C$ | 0.240 | | |
| | | | $T_{vj} = 150\ ^\circ C$ | 0.270 | | |
| Turn-on time (resistive load) | t_{on_R} | $I_C = 500\ A, V_{CE} = 2000\ V, V_{GE} = \pm 15\ V, R_{Gon} = 0.7\ \Omega$ | $T_{vj} = 25\ ^\circ C$ | 1.15 | | μs |
| Turn-on energy loss per pulse | E_{on} | $I_C = 450\ A, V_{CE} = 1800\ V, L_\sigma = 85\ nH, V_{GE} = \pm 15\ V, R_{Gon} = 0.7\ \Omega, di/dt = 3650\ A/\mu s (T_{vj} = 150\ ^\circ C)$ | $T_{vj} = 25\ ^\circ C$ | 500 | | mJ |
| | | | $T_{vj} = 125\ ^\circ C$ | 765 | | |
| | | | $T_{vj} = 150\ ^\circ C$ | 845 | | |

(table continues...)

Table 4 (continued) Characteristic values

| Parameter | Symbol | Note or test condition | Values | | | Unit |
|--|-------------------|--|--|------|------|------------------|
| | | | Min. | Typ. | Max. | |
| Turn-off energy loss per pulse | E_{off} | $I_C = 450\text{ A}$, $V_{CE} = 1800\text{ V}$, $L_\sigma = 85\text{ nH}$, $V_{GE} = \pm 15\text{ V}$, $R_{Goff} = 3.3\ \Omega$, $dv/dt = 2850\text{ V}/\mu\text{s}$ ($T_{vj} = 150\text{ }^\circ\text{C}$) | $T_{vj} = 25\text{ }^\circ\text{C}$ | 415 | | mJ |
| | | | $T_{vj} = 125\text{ }^\circ\text{C}$ | 610 | | |
| | | | $T_{vj} = 150\text{ }^\circ\text{C}$ | 670 | | |
| SC data | I_{SC} | $V_{GE} \leq 15\text{ V}$, $V_{CC} = 2500\text{ V}$, $V_{CEmax} = V_{CES} - L_{sCE} \cdot di/dt$ | $t_p \leq 10\ \mu\text{s}$, $T_{vj} \leq 150\text{ }^\circ\text{C}$ | 1800 | | A |
| Thermal resistance, junction to case | R_{thJC} | per IGBT | | | 28.4 | K/kW |
| Thermal resistance, case to heat sink | R_{thCH} | per IGBT, $\lambda_{grease} = 1\text{ W}/(\text{m}^2\text{K})$ | | 17.4 | | K/kW |
| Temperature under switching conditions | $T_{vj\text{op}}$ | | -40 | | 150 | $^\circ\text{C}$ |

3 Diode, Inverter

Table 5 Maximum rated values

| Parameter | Symbol | Note or test condition | Values | Unit | |
|---------------------------------|-------------|---|--------------------------------------|---------------|-------------------|
| Repetitive peak reverse voltage | V_{RRM} | | $T_{vj} = -40\text{ }^\circ\text{C}$ | 3300 | V |
| | | | $T_{vj} = 150\text{ }^\circ\text{C}$ | 3300 | |
| Continuous DC forward current | I_F | | 450 | A | |
| Repetitive peak forward current | I_{FRM} | $t_p = 1\text{ ms}$ | 900 | A | |
| I^2t - value | I^2t | $t_p = 10\text{ ms}$, $V_R = 0\text{ V}$ | $T_{vj} = 125\text{ }^\circ\text{C}$ | 82.9 | kA ² s |
| | | | $T_{vj} = 150\text{ }^\circ\text{C}$ | 68 | |
| Maximum power dissipation | P_{RQM} | $T_{vj} = 150\text{ }^\circ\text{C}$ | 1000 | 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 | $I_F = 450\text{ A}$, $V_{GE} = 0\text{ V}$ | $T_{vj} = 25\text{ }^\circ\text{C}$ | 3.10 | 3.50 | V |
| | | | $T_{vj} = 125\text{ }^\circ\text{C}$ | 2.75 | | |
| | | | $T_{vj} = 150\text{ }^\circ\text{C}$ | 2.65 | 2.95 | |

(table continues...)

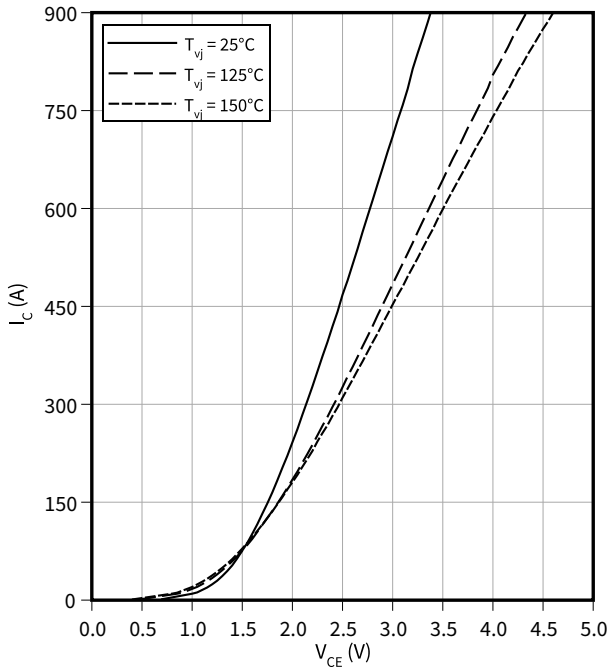
Table 6 (continued) Characteristic values

| Parameter | Symbol | Note or test condition | Values | | | Unit |
|--|--------------------|---|--------------------------|------|------|---------------|
| | | | Min. | Typ. | Max. | |
| Peak reverse recovery current | I_{RM} | $V_R = 1800\text{ V}$, $I_F = 450\text{ A}$, $V_{GE} = -15\text{ V}$, $-di_F/dt = 3650\text{ A}/\mu\text{s}$ ($T_{vj} = 150\text{ °C}$) | $T_{vj} = 25\text{ °C}$ | 680 | | A |
| | | | $T_{vj} = 125\text{ °C}$ | 680 | | |
| | | | $T_{vj} = 150\text{ °C}$ | 680 | | |
| Recovered charge | Q_r | $V_R = 1800\text{ V}$, $I_F = 450\text{ A}$, $V_{GE} = -15\text{ V}$, $-di_F/dt = 3650\text{ A}/\mu\text{s}$ ($T_{vj} = 150\text{ °C}$) | $T_{vj} = 25\text{ °C}$ | 230 | | μC |
| | | | $T_{vj} = 125\text{ °C}$ | 445 | | |
| | | | $T_{vj} = 150\text{ °C}$ | 525 | | |
| Reverse recovery energy | E_{rec} | $V_R = 1800\text{ V}$, $I_F = 450\text{ A}$, $V_{GE} = -15\text{ V}$, $-di_F/dt = 3650\text{ A}/\mu\text{s}$ ($T_{vj} = 150\text{ °C}$) | $T_{vj} = 25\text{ °C}$ | 220 | | mJ |
| | | | $T_{vj} = 125\text{ °C}$ | 490 | | |
| | | | $T_{vj} = 150\text{ °C}$ | 595 | | |
| Thermal resistance, junction to case | R_{thJC} | per diode | | | 45.5 | K/kW |
| Thermal resistance, case to heat sink | R_{thCH} | per diode, $\lambda_{grease} = 1\text{ W}/(\text{m}^*\text{K})$ | | 19.3 | | K/kW |
| Temperature under switching conditions | $T_{vj\text{ op}}$ | | -40 | | 150 | °C |

4 Characteristics diagrams

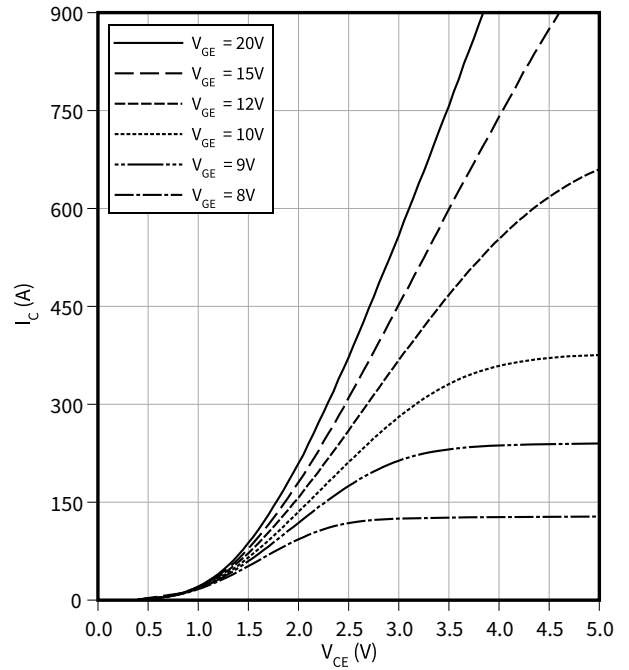
output characteristic (typical), IGBT, Inverter

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



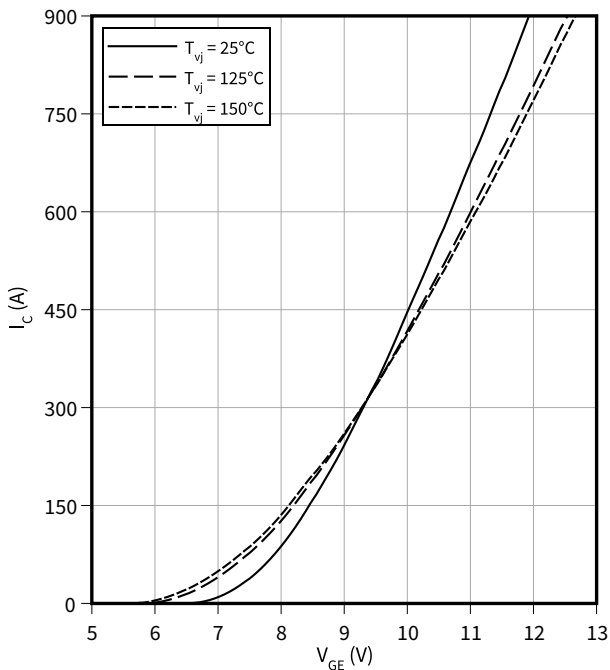
output characteristic (typical), IGBT, Inverter

$I_C = f(V_{CE})$
 $T_{vj} = 150\text{ °C}$



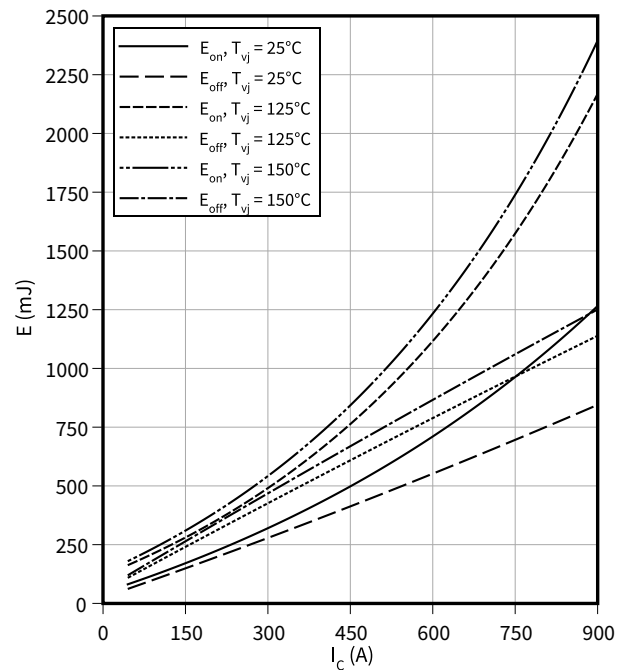
transfer characteristic (typical), IGBT, Inverter

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



switching losses (typical), IGBT, Inverter

$E = f(I_C)$
 $R_{Goff} = 3.3\ \Omega$, $R_{Gon} = 0.7\ \Omega$, $V_{CE} = 1800\text{ V}$, $V_{GE} = \pm 15\text{ V}$

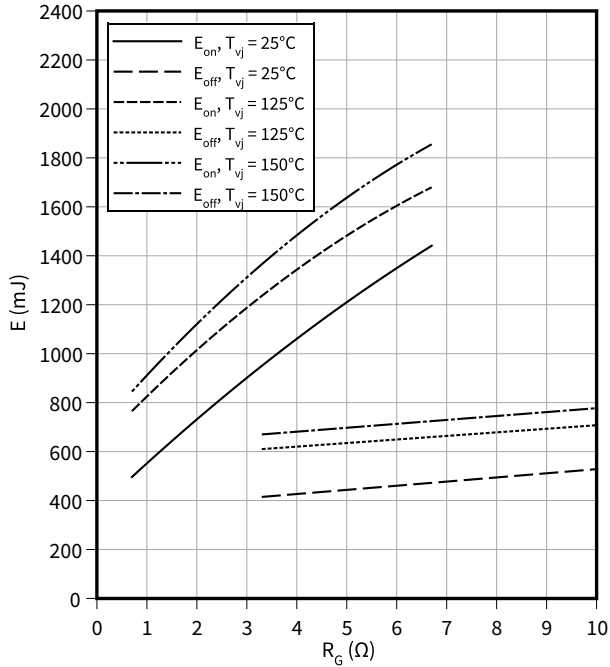


4 Characteristics diagrams

switching losses (typical), IGBT, Inverter

$E = f(R_G)$

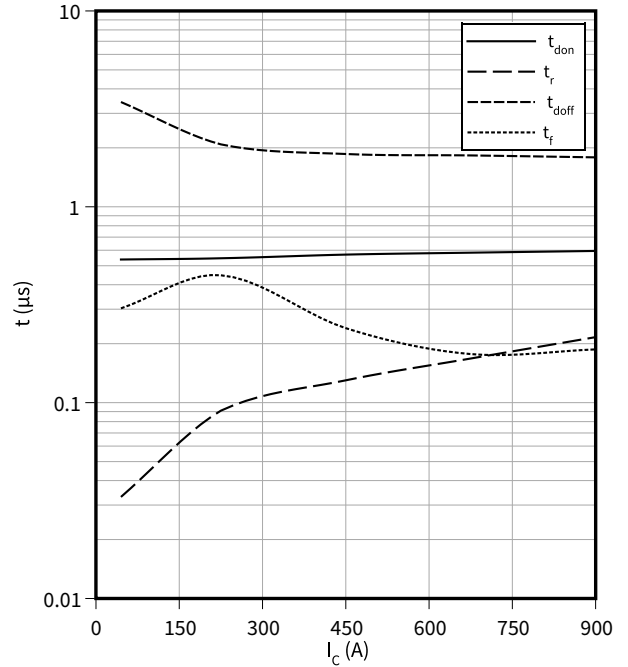
$I_C = 450 \text{ A}, V_{CE} = 1800 \text{ V}, V_{GE} = \pm 15 \text{ V}$



switching times (typical), IGBT, Inverter

$t = f(I_C)$

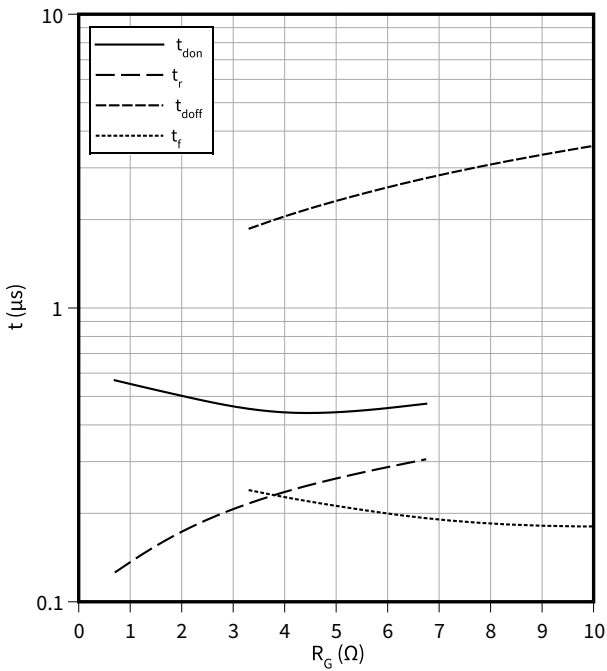
$R_{Goff} = 3.3 \Omega, R_{Gon} = 0.7 \Omega, V_{CE} = 1800 \text{ V}, V_{GE} = \pm 15 \text{ V}, T_{vj} = 150^\circ\text{C}$



switching times (typical), IGBT, Inverter

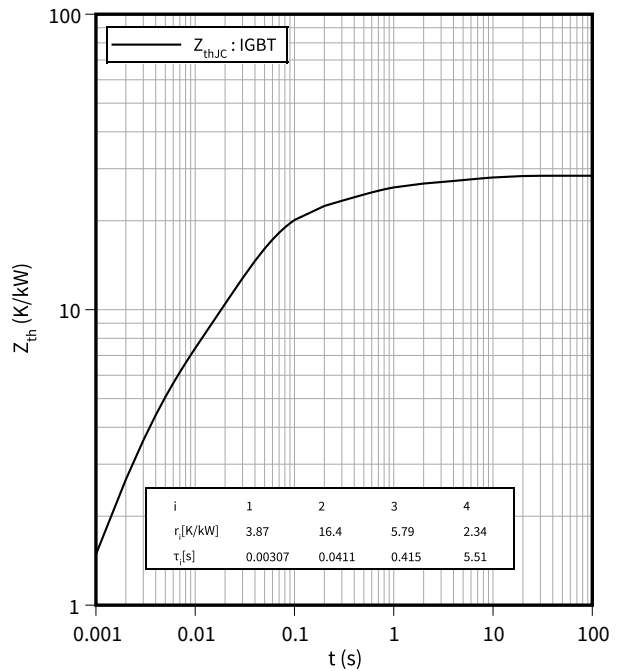
$t = f(R_G)$

$I_C = 450 \text{ A}, V_{CE} = 1800 \text{ V}, V_{GE} = \pm 15 \text{ V}, T_{vj} = 150^\circ\text{C}$



transient thermal impedance, IGBT, Inverter

$Z_{th} = f(t)$

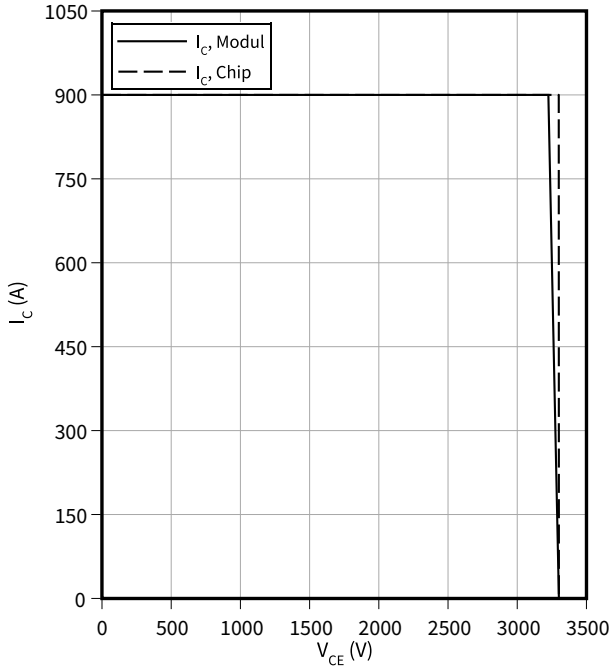


4 Characteristics diagrams

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

$I_C = f(V_{CE})$

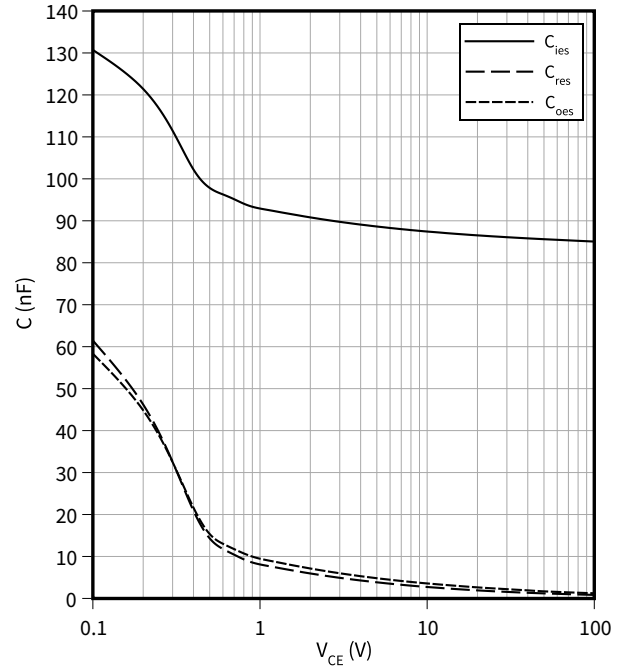
$R_{Goff} = 3.3 \Omega, V_{GE} = \pm 15 V, T_{vj} = 150 \text{ }^\circ\text{C}$



capacity characteristic (typical), IGBT, Inverter

$C = f(V_{CE})$

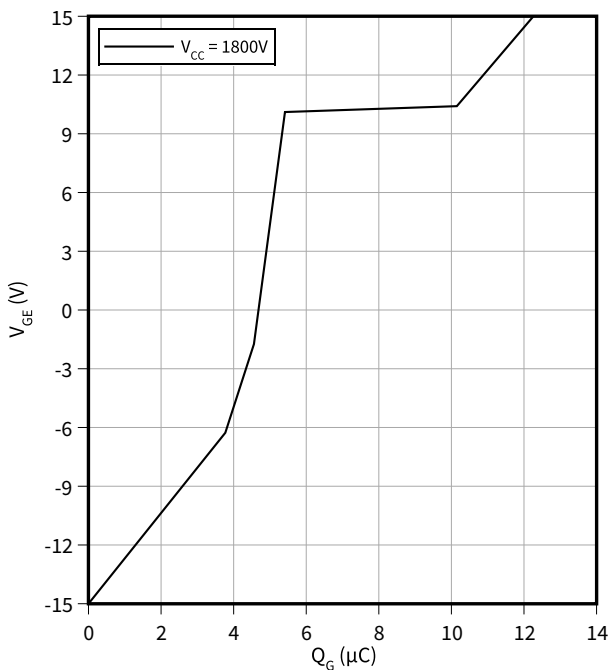
$f = 1000 \text{ kHz}, V_{GE} = 0 V, T_{vj} = 25 \text{ }^\circ\text{C}$



gate charge characteristic (typical), IGBT, Inverter

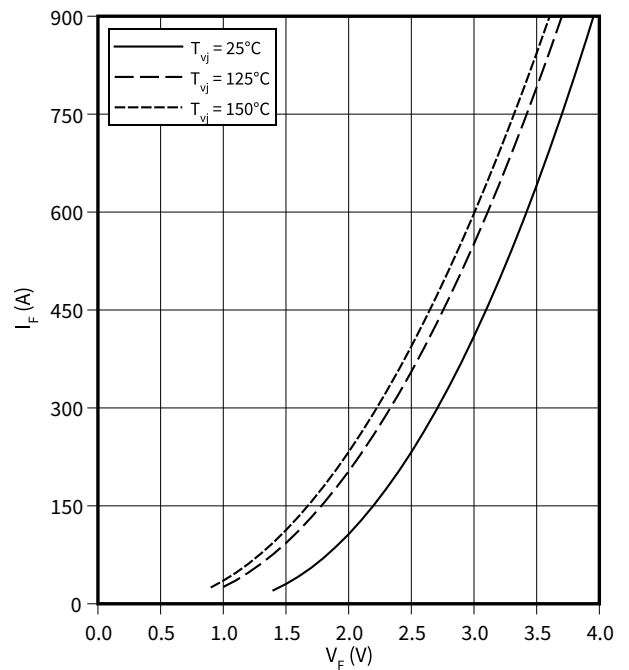
$V_{GE} = f(Q_G)$

$I_C = 450 A, T_{vj} = 25 \text{ }^\circ\text{C}$



forward characteristic of (typical), Diode, Inverter

$I_F = f(V_F)$

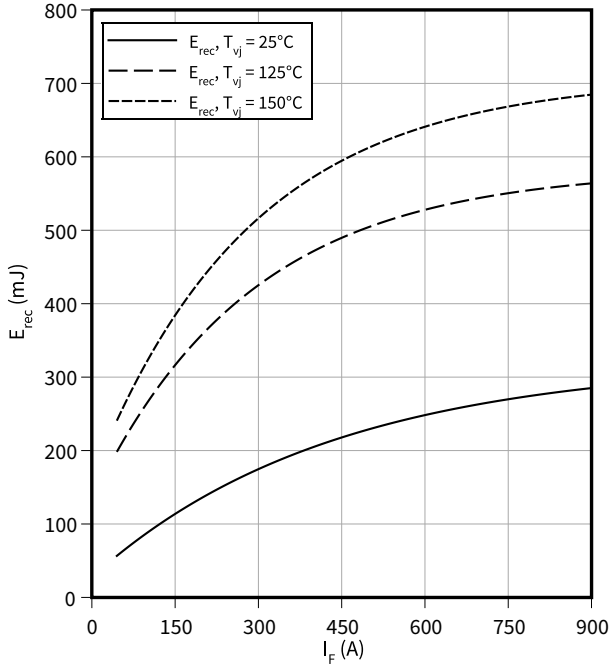


4 Characteristics diagrams

switching losses (typical), Diode, Inverter

$E_{rec} = f(I_F)$

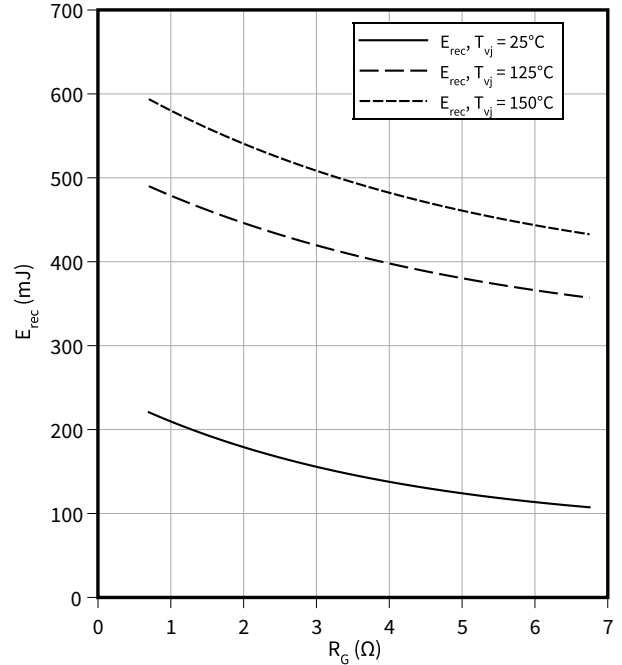
$V_{CE} = 1800\text{ V}, R_{Gon} = R_{Gon}(IGBT)$



switching losses (typical), Diode, Inverter

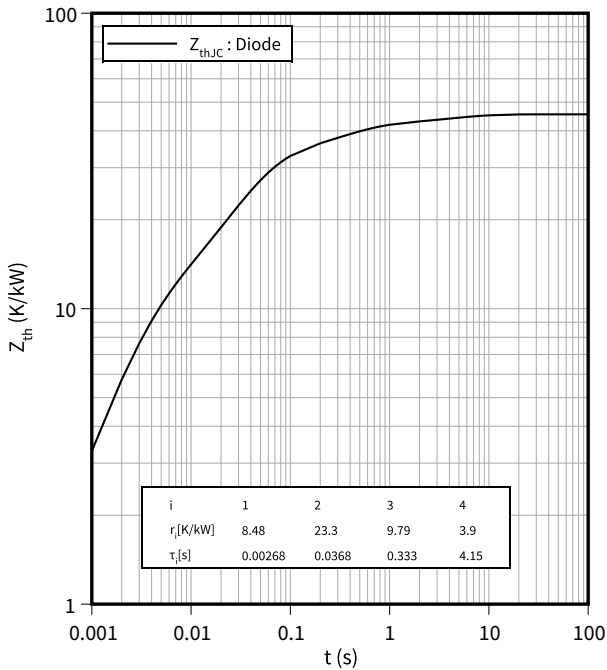
$E_{rec} = f(R_G)$

$V_{CE} = 1800\text{ V}, I_F = 450\text{ A}$



transient thermal impedance , Diode, Inverter

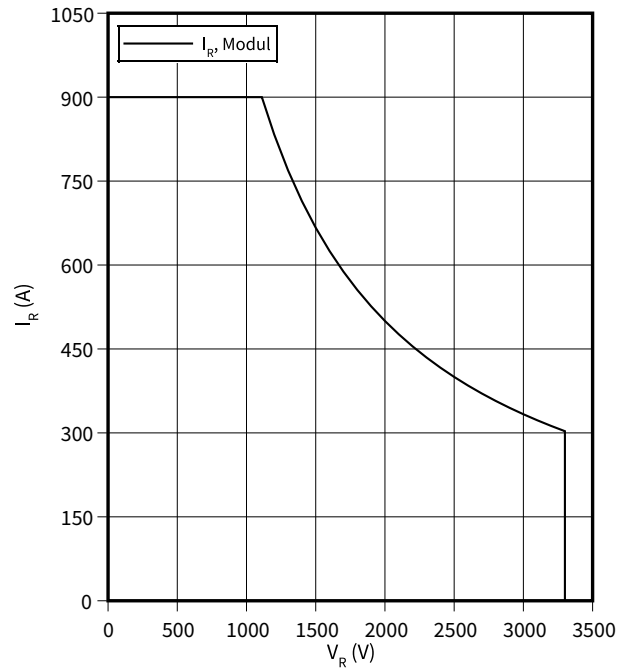
$Z_{th} = f(t)$



safe operation area (SOA), Diode, Inverter

$I_R = f(V_R)$

$T_{vj} = 150\text{ °C}$



5 Circuit diagram

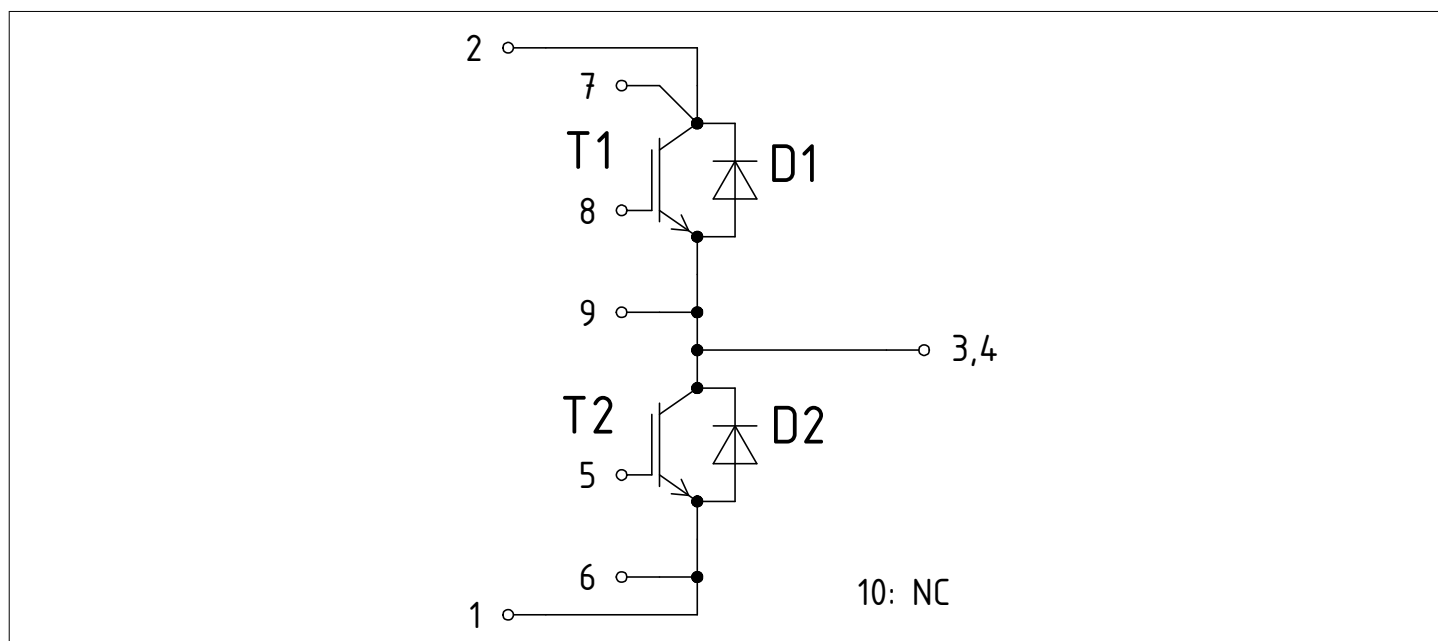


Figure 1

6 Package outlines

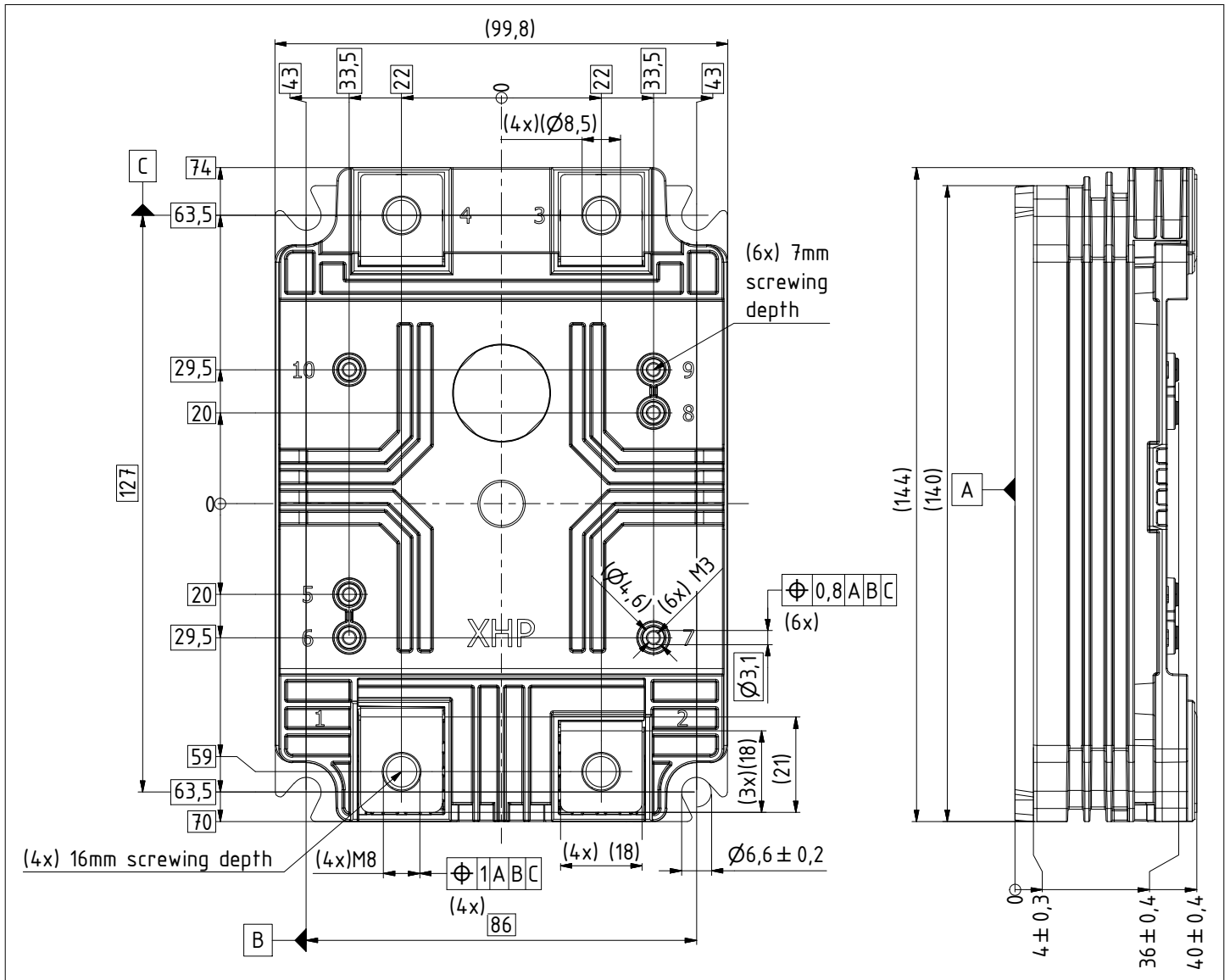


Figure 2

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 | 2013-12-05 | Target datasheet |
| V1.1 | 2014-08-25 | Target datasheet |
| V1.2 | 2015-01-22 | Target datasheet |
| V1.3 | 2015-10-16 | Target datasheet |
| V1.4 | 2015-10-16 | Target datasheet |
| V2.0 | 2016-05-18 | Preliminary datasheet |
| V2.1 | 2016-09-02 | Preliminary datasheet |
| V2.2 | 2016-12-23 | Preliminary datasheet |
| V2.3 | 2018-02-14 | Preliminary datasheet |
| V3.0 | 2018-12-12 | Final datasheet |
| V3.1 | 2018-12-13 | Final datasheet |
| V3.2 | 2020-01-27 | 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 | 2021-11-04 | Final datasheet |