

## Final datasheet

### EconoDUAL™3 module with Trench/Fieldstop IGBT4 and emitter controlled HE diode and PressFIT / NTC

#### Features

- Electrical features
  - $V_{CES} = 1200\text{ V}$
  - $I_{C\text{ nom}} = 450\text{ A} / I_{CRM} = 900\text{ A}$
  - Low  $V_{CE,sat}$
  - $T_{vj,op} = 150^{\circ}\text{C}$
- Mechanical features
  - PressFIT contact technology
  - Standard housing



#### Potential applications

- Motor drives
- Servo drives
- UPS systems
- Wind turbines

#### Product validation

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

#### Description

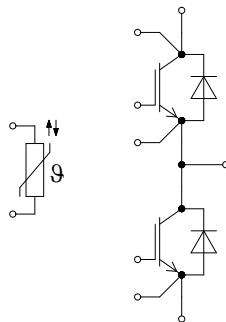


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## 1 Package

**Table 1** Insulation coordination

| Parameter                           | Symbol           | Note or test condition                                   | Values    | Unit |
|-------------------------------------|------------------|----------------------------------------------------------|-----------|------|
| Isolation test voltage              | $V_{ISOL}$       | RMS, $f = 50$ Hz, $t = 1$ min                            | 2.5       | kV   |
| Isolation test voltage NTC          | $V_{ISOL(NTC)}$  | RMS, $f = 50$ Hz, $t = 1$ min                            | 2.5       | kV   |
| Material of module baseplate        |                  |                                                          | Cu        |      |
| Internal isolation                  |                  | basic insulation (class 1, IEC 61140)                    | $Al_2O_3$ |      |
| Creepage distance                   | $d_{Creep\ nom}$ | terminal to baseplate, nom., (PD2, IEC 60664-1, Ed. 3.0) | > 15      | mm   |
| Creepage distance                   | $d_{Creep\ min}$ | terminal to baseplate, min., (PD2, IEC 60664-1, Ed. 3.0) | 14.7      | mm   |
| Creepage distance                   | $d_{Creep\ nom}$ | terminal to terminal, nom., (PD2, IEC 60664-1, Ed. 3.0)  | 12.1      | mm   |
| Creepage distance                   | $d_{Creep\ min}$ | terminal to terminal, min., (PD2, IEC 60664-1, Ed. 3.0)  | 11.5      | mm   |
| Clearance                           | $d_{Clear\ nom}$ | terminal to baseplate, nom.                              | > 12.5    | mm   |
| Clearance                           | $d_{Clear\ min}$ | terminal to baseplate, min.                              | 12.5      | mm   |
| Clearance                           | $d_{Clear\ nom}$ | terminal to terminal, nom.                               | 10.0      | mm   |
| Clearance                           | $d_{Clear\ min}$ | terminal to terminal, min.                               | 9.6       | mm   |
| Comparative tracking index          | $CTI$            |                                                          | > 200     |      |
| Relative thermal index (electrical) | $RTI$            | housing                                                  | 140       | °C   |

**Table 2** Characteristic values

| Parameter                                | Symbol        | Note or test condition                         | Values    |       |      | Unit |
|------------------------------------------|---------------|------------------------------------------------|-----------|-------|------|------|
|                                          |               |                                                | Min.      | Typ.  | Max. |      |
| Thermal resistance, case to heat sink    | $R_{thCH}$    | $\lambda_{grease} = 1$ W/(m·K)                 |           | 0.009 |      | K/W  |
| Stray inductance module                  | $L_{sCE}$     |                                                |           | 20    |      | nH   |
| Module lead resistance, terminals - chip | $R_{CC'+EE'}$ | $T_C = 25$ °C, per switch                      |           | 1.1   |      | mΩ   |
| Storage temperature                      | $T_{stg}$     |                                                | -40       |       | 125  | °C   |
| Mounting torque for module mounting      | $M$           | - Mounting according to valid application note | M5, Screw | 3     | 6    | Nm   |
| Terminal connection torque               | $M$           | - Mounting according to valid application note | M6, Screw | 3     | 6    | Nm   |
| Weight                                   | $G$           |                                                |           | 345   |      | g    |

## 2 IGBT, Inverter

**Table 3** Maximum rated values

| Parameter                         | Symbol    | Note or test condition              |                         | Values   | Unit |
|-----------------------------------|-----------|-------------------------------------|-------------------------|----------|------|
| Collector-emitter voltage         | $V_{CES}$ |                                     | $T_{vj} = 25\text{ °C}$ | 1200     | V    |
| Continuous DC collector current   | $I_{CDC}$ | $T_{vj\text{ max}} = 175\text{ °C}$ | $T_C = 100\text{ °C}$   | 450      | A    |
| Repetitive peak collector current | $I_{CRM}$ | $t_p$ limited by $T_{vj\text{ op}}$ |                         | 900      | A    |
| Gate-emitter peak voltage         | $V_{GES}$ |                                     |                         | $\pm 20$ | V    |

**Table 4** Characteristic values

| Parameter                            | Symbol              | Note or test condition                                                                                       |                          | Values |       |      | Unit          |
|--------------------------------------|---------------------|--------------------------------------------------------------------------------------------------------------|--------------------------|--------|-------|------|---------------|
|                                      |                     |                                                                                                              |                          | Min.   | Typ.  | Max. |               |
| Collector-emitter saturation voltage | $V_{CE\text{ sat}}$ | $I_C = 450\text{ A}$ , $V_{GE} = 15\text{ V}$                                                                | $T_{vj} = 25\text{ °C}$  |        | 1.75  | 2.10 | V             |
|                                      |                     |                                                                                                              | $T_{vj} = 125\text{ °C}$ |        | 2.00  |      |               |
|                                      |                     |                                                                                                              | $T_{vj} = 150\text{ °C}$ |        | 2.05  |      |               |
| Gate threshold voltage               | $V_{GETh}$          | $I_C = 17.1\text{ mA}$ , $V_{CE} = V_{GE}$ , $T_{vj} = 25\text{ °C}$                                         |                          | 5.20   | 5.80  | 6.40 | V             |
| Gate charge                          | $Q_G$               | $V_{GE} = \pm 15\text{ V}$                                                                                   |                          |        | 3.3   |      | $\mu\text{C}$ |
| Internal gate resistor               | $R_{Gint}$          | $T_{vj} = 25\text{ °C}$                                                                                      |                          |        | 1.7   |      | $\Omega$      |
| Input capacitance                    | $C_{ies}$           | $f = 1000\text{ kHz}$ , $T_{vj} = 25\text{ °C}$ , $V_{CE} = 25\text{ V}$ , $V_{GE} = 0\text{ V}$             |                          |        | 28    |      | nF            |
| Reverse transfer capacitance         | $C_{res}$           | $f = 1000\text{ kHz}$ , $T_{vj} = 25\text{ °C}$ , $V_{CE} = 25\text{ V}$ , $V_{GE} = 0\text{ V}$             |                          |        | 1.55  |      | nF            |
| Collector-emitter cut-off current    | $I_{CES}$           | $V_{CE} = 1200\text{ V}$ , $V_{GE} = 0\text{ V}$                                                             | $T_{vj} = 25\text{ °C}$  |        |       | 3    | mA            |
| Gate-emitter leakage current         | $I_{GES}$           | $V_{CE} = 0\text{ V}$ , $V_{GE} = 20\text{ V}$ , $T_{vj} = 25\text{ °C}$                                     |                          |        |       | 400  | nA            |
| Turn-on delay time (inductive load)  | $t_{don}$           | $I_C = 450\text{ A}$ , $V_{CC} = 600\text{ V}$ , $V_{GE} = \pm 15\text{ V}$ , $R_{Gon} = 1.3\text{ }\Omega$  | $T_{vj} = 25\text{ °C}$  |        | 0.190 |      | $\mu\text{s}$ |
|                                      |                     |                                                                                                              | $T_{vj} = 125\text{ °C}$ |        | 0.220 |      |               |
|                                      |                     |                                                                                                              | $T_{vj} = 150\text{ °C}$ |        | 0.220 |      |               |
| Rise time (inductive load)           | $t_r$               | $I_C = 450\text{ A}$ , $V_{CC} = 600\text{ V}$ , $V_{GE} = \pm 15\text{ V}$ , $R_{Gon} = 1.3\text{ }\Omega$  | $T_{vj} = 25\text{ °C}$  |        | 0.060 |      | $\mu\text{s}$ |
|                                      |                     |                                                                                                              | $T_{vj} = 125\text{ °C}$ |        | 0.070 |      |               |
|                                      |                     |                                                                                                              | $T_{vj} = 150\text{ °C}$ |        | 0.070 |      |               |
| Turn-off delay time (inductive load) | $t_{doff}$          | $I_C = 450\text{ A}$ , $V_{CC} = 600\text{ V}$ , $V_{GE} = \pm 15\text{ V}$ , $R_{Goff} = 1.3\text{ }\Omega$ | $T_{vj} = 25\text{ °C}$  |        | 0.490 |      | $\mu\text{s}$ |
|                                      |                     |                                                                                                              | $T_{vj} = 125\text{ °C}$ |        | 0.580 |      |               |
|                                      |                     |                                                                                                              | $T_{vj} = 150\text{ °C}$ |        | 0.620 |      |               |

(table continues...)

**Table 4** (continued) Characteristic values

| Parameter                              | Symbol      | Note or test condition                                                                                                                                                                                           | Values                                                   |        |        | Unit          |
|----------------------------------------|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|--------|--------|---------------|
|                                        |             |                                                                                                                                                                                                                  | Min.                                                     | Typ.   | Max.   |               |
| Fall time (inductive load)             | $t_f$       | $I_C = 450 \text{ A}$ , $V_{CC} = 600 \text{ V}$ ,<br>$V_{GE} = \pm 15 \text{ V}$ , $R_{Goff} = 1.3 \Omega$                                                                                                      | $T_{vj} = 25 \text{ °C}$                                 | 0.080  |        | $\mu\text{s}$ |
|                                        |             |                                                                                                                                                                                                                  | $T_{vj} = 125 \text{ °C}$                                | 0.110  |        |               |
|                                        |             |                                                                                                                                                                                                                  | $T_{vj} = 150 \text{ °C}$                                | 0.120  |        |               |
| Turn-on energy loss per pulse          | $E_{on}$    | $I_C = 450 \text{ A}$ , $V_{CC} = 600 \text{ V}$ ,<br>$L_\sigma = 35 \text{ nH}$ , $V_{GE} = \pm 15 \text{ V}$ ,<br>$R_{Gon} = 1.3 \Omega$ , $di/dt = 7000 \text{ A}/\mu\text{s}$ ( $T_{vj} = 150 \text{ °C}$ )  | $T_{vj} = 25 \text{ °C}$                                 | 15     |        | mJ            |
|                                        |             |                                                                                                                                                                                                                  | $T_{vj} = 125 \text{ °C}$                                | 26     |        |               |
|                                        |             |                                                                                                                                                                                                                  | $T_{vj} = 150 \text{ °C}$                                | 28.5   |        |               |
| Turn-off energy loss per pulse         | $E_{off}$   | $I_C = 450 \text{ A}$ , $V_{CC} = 600 \text{ V}$ ,<br>$L_\sigma = 35 \text{ nH}$ , $V_{GE} = \pm 15 \text{ V}$ ,<br>$R_{Goff} = 1.3 \Omega$ , $dv/dt = 3100 \text{ V}/\mu\text{s}$ ( $T_{vj} = 150 \text{ °C}$ ) | $T_{vj} = 25 \text{ °C}$                                 | 38     |        | mJ            |
|                                        |             |                                                                                                                                                                                                                  | $T_{vj} = 125 \text{ °C}$                                | 55.5   |        |               |
|                                        |             |                                                                                                                                                                                                                  | $T_{vj} = 150 \text{ °C}$                                | 61.5   |        |               |
| SC data                                | $I_{SC}$    | $V_{GE} \leq 15 \text{ V}$ , $V_{CC} = 800 \text{ V}$ ,<br>$V_{CEmax} = V_{CES} - L_{sCE} \cdot di/dt$                                                                                                           | $t_p \leq 10 \mu\text{s}$ ,<br>$T_{vj} = 150 \text{ °C}$ | 1800   |        | A             |
| Thermal resistance, junction to case   | $R_{thJC}$  | per IGBT                                                                                                                                                                                                         |                                                          |        | 0.0660 | K/W           |
| Thermal resistance, case to heat sink  | $R_{thCH}$  | per IGBT, $\lambda_{grease} = 1 \text{ W}/(\text{m} \cdot \text{K})$                                                                                                                                             |                                                          | 0.0300 |        | K/W           |
| Temperature under switching conditions | $T_{vj op}$ |                                                                                                                                                                                                                  | -40                                                      |        | 150    | °C            |

### 3 Diode, Inverter

**Table 5** Maximum rated values

| Parameter                       | Symbol    | Note or test condition                      |                           | Values | Unit                 |
|---------------------------------|-----------|---------------------------------------------|---------------------------|--------|----------------------|
| Repetitive peak reverse voltage | $V_{RRM}$ |                                             | $T_{vj} = 25 \text{ °C}$  | 1200   | V                    |
| Continuous DC forward current   | $I_F$     |                                             |                           | 450    | A                    |
| Repetitive peak forward current | $I_{FRM}$ | $t_p = 1 \text{ ms}$                        |                           | 900    | A                    |
| $I^2t$ - value                  | $I^2t$    | $t_p = 10 \text{ ms}$ , $V_R = 0 \text{ V}$ | $T_{vj} = 125 \text{ °C}$ | 35000  | $\text{A}^2\text{s}$ |
|                                 |           |                                             | $T_{vj} = 150 \text{ °C}$ | 28500  |                      |

**Table 6** Characteristic values

| Parameter                              | Symbol             | Note or test condition                                                                                                                              | Values                    |        |       | Unit          |
|----------------------------------------|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|--------|-------|---------------|
|                                        |                    |                                                                                                                                                     | Min.                      | Typ.   | Max.  |               |
| Forward voltage                        | $V_F$              | $I_F = 450 \text{ A}$ , $V_{GE} = 0 \text{ V}$                                                                                                      | $T_{vj} = 25 \text{ °C}$  | 1.65   | 2.10  | V             |
|                                        |                    |                                                                                                                                                     | $T_{vj} = 125 \text{ °C}$ | 1.65   |       |               |
|                                        |                    |                                                                                                                                                     | $T_{vj} = 150 \text{ °C}$ | 1.65   |       |               |
| Peak reverse recovery current          | $I_{RM}$           | $V_{CC} = 600 \text{ V}$ , $I_F = 450 \text{ A}$ , $V_{GE} = -15 \text{ V}$ , $-di_F/dt = 7000 \text{ A}/\mu\text{s}$ ( $T_{vj} = 150 \text{ °C}$ ) | $T_{vj} = 25 \text{ °C}$  | 450    |       | A             |
|                                        |                    |                                                                                                                                                     | $T_{vj} = 125 \text{ °C}$ | 550    |       |               |
|                                        |                    |                                                                                                                                                     | $T_{vj} = 150 \text{ °C}$ | 575    |       |               |
| Recovered charge                       | $Q_r$              | $V_{CC} = 600 \text{ V}$ , $I_F = 450 \text{ A}$ , $V_{GE} = -15 \text{ V}$ , $-di_F/dt = 7000 \text{ A}/\mu\text{s}$ ( $T_{vj} = 150 \text{ °C}$ ) | $T_{vj} = 25 \text{ °C}$  | 48     |       | $\mu\text{C}$ |
|                                        |                    |                                                                                                                                                     | $T_{vj} = 125 \text{ °C}$ | 92     |       |               |
|                                        |                    |                                                                                                                                                     | $T_{vj} = 150 \text{ °C}$ | 105    |       |               |
| Reverse recovery energy                | $E_{rec}$          | $V_{CC} = 600 \text{ V}$ , $I_F = 450 \text{ A}$ , $V_{GE} = -15 \text{ V}$ , $-di_F/dt = 7000 \text{ A}/\mu\text{s}$ ( $T_{vj} = 150 \text{ °C}$ ) | $T_{vj} = 25 \text{ °C}$  | 26.5   |       | mJ            |
|                                        |                    |                                                                                                                                                     | $T_{vj} = 125 \text{ °C}$ | 48.5   |       |               |
|                                        |                    |                                                                                                                                                     | $T_{vj} = 150 \text{ °C}$ | 55     |       |               |
| Thermal resistance, junction to case   | $R_{thJC}$         | per diode                                                                                                                                           |                           |        | 0.100 | K/W           |
| Thermal resistance, case to heat sink  | $R_{thCH}$         | per diode, $\lambda_{grease} = 1 \text{ W}/(\text{m}\cdot\text{K})$                                                                                 |                           | 0.0450 |       | K/W           |
| Temperature under switching conditions | $T_{vj\text{ op}}$ |                                                                                                                                                     | -40                       |        | 150   | °C            |

## 4 NTC-Thermistor

**Table 7** Characteristic values

| Parameter              | Symbol       | Note or test condition                                        | Values |      |      | Unit       |
|------------------------|--------------|---------------------------------------------------------------|--------|------|------|------------|
|                        |              |                                                               | Min.   | Typ. | Max. |            |
| Rated resistance       | $R_{25}$     | $T_{NTC} = 25 \text{ °C}$                                     |        | 5    |      | k $\Omega$ |
| Deviation of $R_{100}$ | $\Delta R/R$ | $T_{NTC} = 100 \text{ °C}$ , $R_{100} = 493 \text{ }\Omega$   | -5     |      | 5    | %          |
| Power dissipation      | $P_{25}$     | $T_{NTC} = 25 \text{ °C}$                                     |        |      | 20   | mW         |
| B-value                | $B_{25/50}$  | $R_2 = R_{25} \exp[B_{25/50}(1/T_2 - 1/(298,15 \text{ K}))]$  |        | 3375 |      | K          |
| B-value                | $B_{25/80}$  | $R_2 = R_{25} \exp[B_{25/80}(1/T_2 - 1/(298,15 \text{ K}))]$  |        | 3411 |      | K          |
| B-value                | $B_{25/100}$ | $R_2 = R_{25} \exp[B_{25/100}(1/T_2 - 1/(298,15 \text{ K}))]$ |        | 3433 |      | K          |

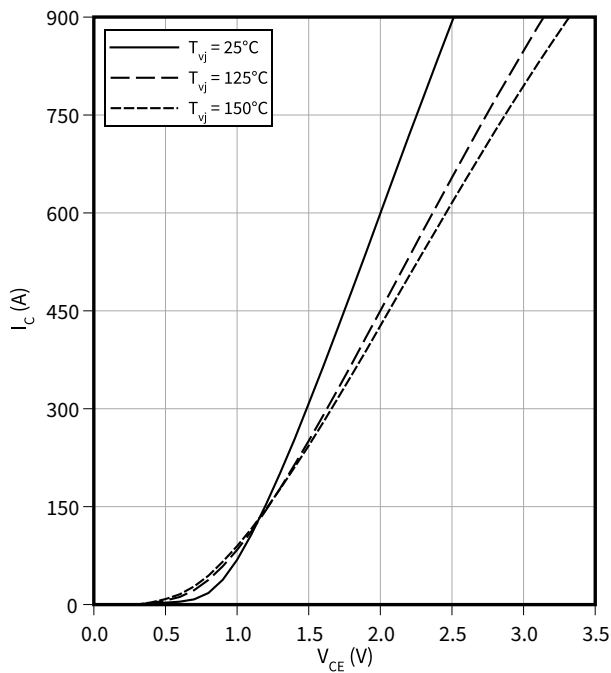
**Note:** For an analytical description of the NTC characteristics please refer to AN2009-10, chapter 4

5 Characteristics diagrams

Output characteristic (typical), IGBT, Inverter

$I_C = f(V_{CE})$

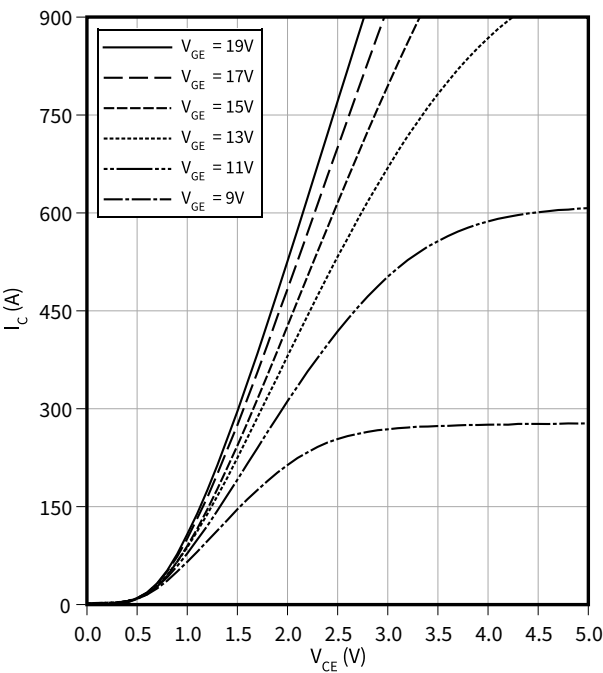
$V_{GE} = 15\text{ V}$



Output characteristic field (typical), IGBT, Inverter

$I_C = f(V_{CE})$

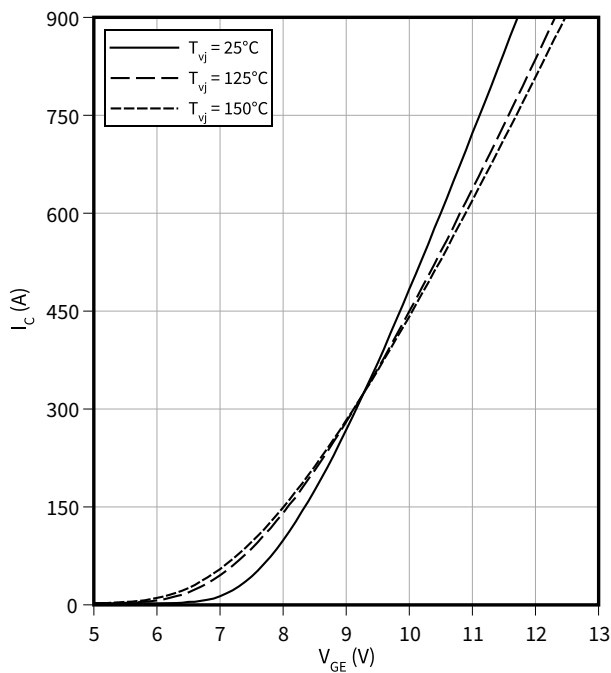
$T_{vj} = 150^\circ\text{C}$



Transfer characteristic (typical), IGBT, Inverter

$I_C = f(V_{GE})$

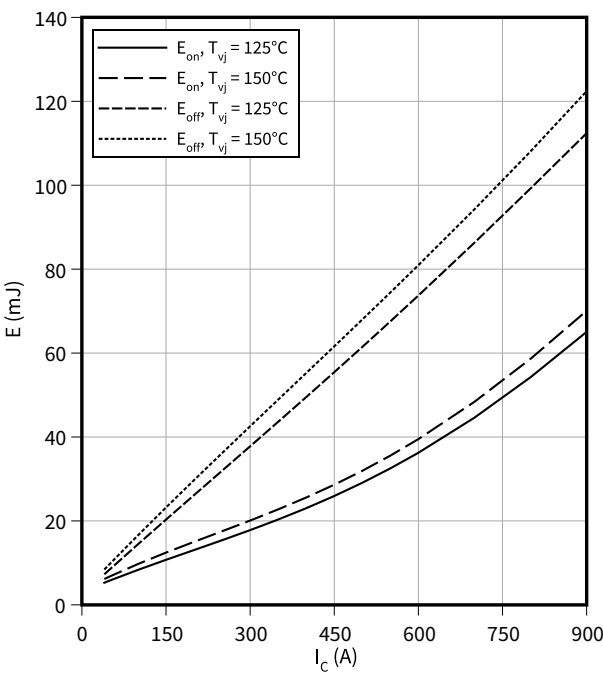
$V_{CE} = 20\text{ V}$



Switching losses (typical), IGBT, Inverter

$E = f(I_C)$

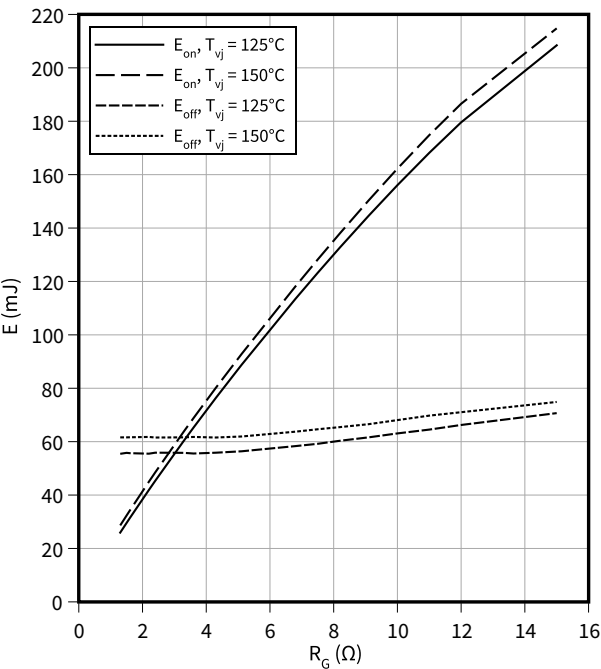
$R_{Gon} = 1.3\ \Omega$ ,  $V_{GE} = -15 / 15\text{ V}$ ,  $V_{CC} = 600\text{ V}$ ,  $R_{Goff} = 1.3\ \Omega$



5 Characteristics diagrams

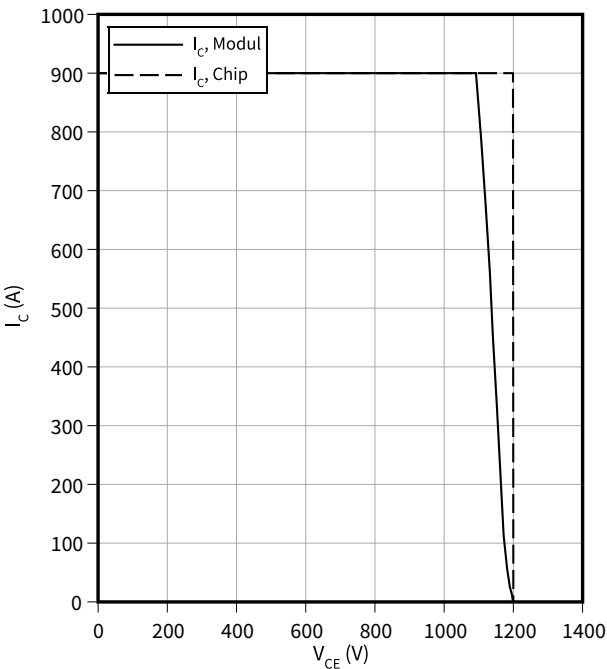
Switching losses (typical), IGBT, Inverter

$E = f(R_G)$   
 $V_{GE} = -15 / 15 \text{ V}, V_{CC} = 600 \text{ V}, I_C = 450 \text{ A}$



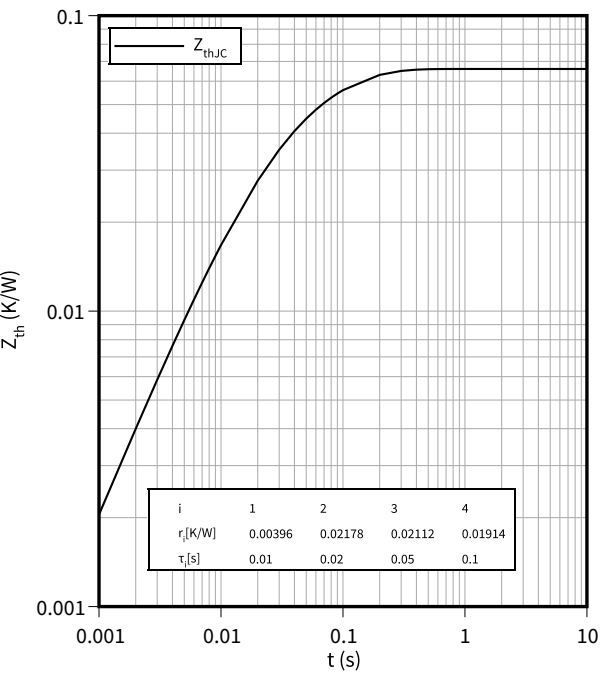
Reverse bias safe operating area (RBSOA), IGBT, Inverter

$I_C = f(V_{CE})$   
 $R_{Goff} = 1.3 \text{ } \Omega, V_{GE} = \pm 15 \text{ V}, T_{vj} = 150 \text{ } ^\circ\text{C}$



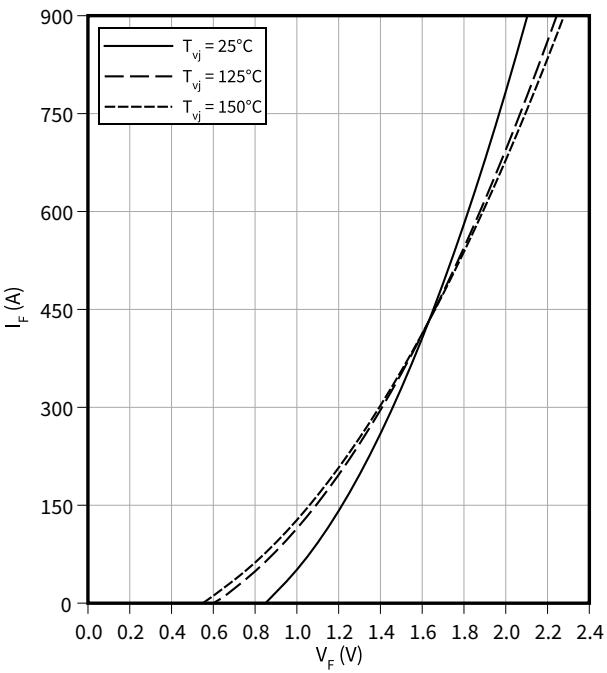
Transient thermal impedance, IGBT, Inverter

$Z_{th} = f(t)$



Forward characteristic (typical), Diode, Inverter

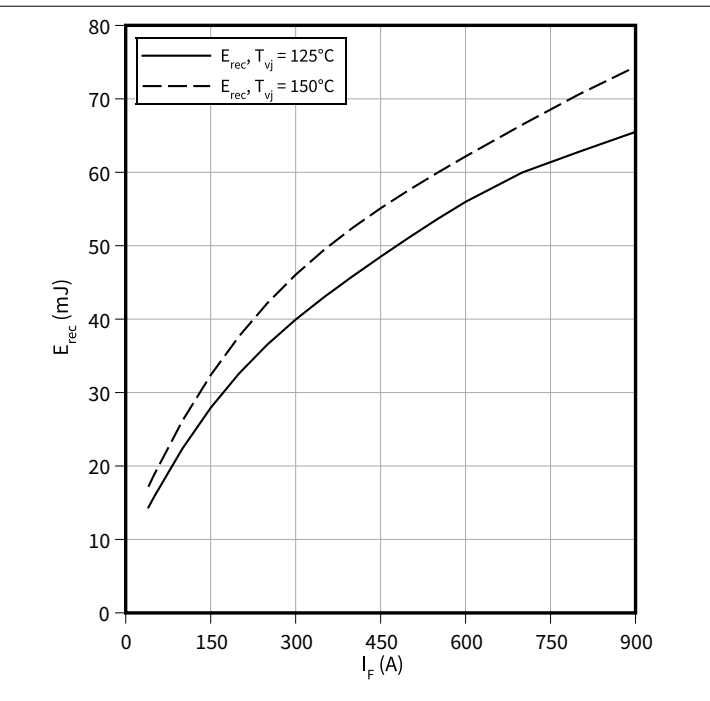
$I_F = f(V_F)$



5 Characteristics diagrams

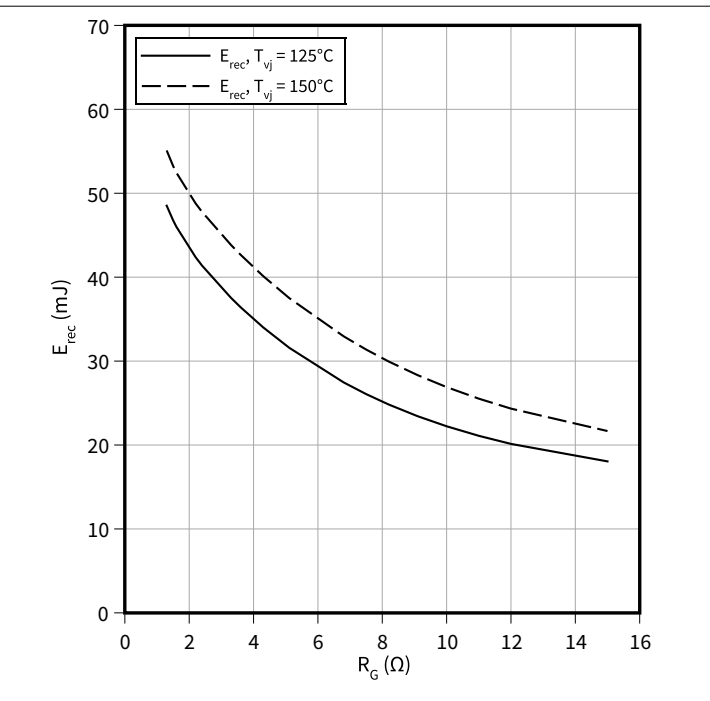
Switching losses (typical), Diode, Inverter

$E_{rec} = f(I_F)$   
 $R_{Gon} = R_{Gon}(IGBT) , V_{CC} = 600 V$



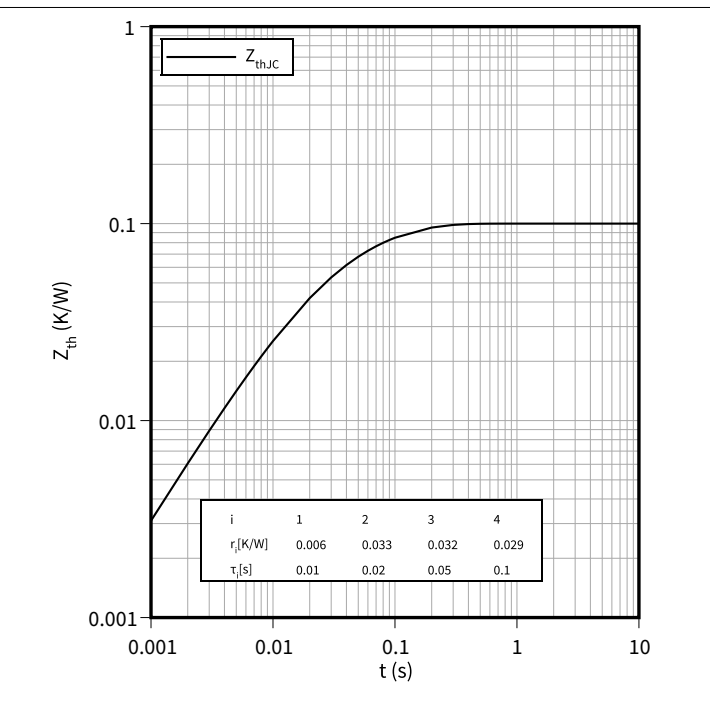
Switching losses (typical), Diode, Inverter

$E_{rec} = f(R_G)$   
 $I_F = 450 A, V_{CC} = 600 V$



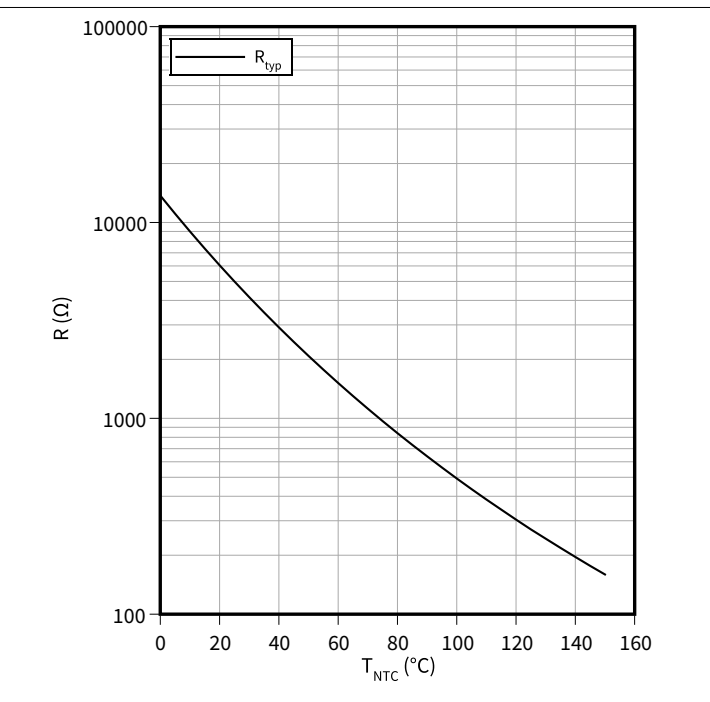
Transient thermal impedance, Diode, Inverter

$Z_{th} = f(t)$



Temperature characteristic (typical), NTC-Thermistor

$R = f(T_{NTC})$



6 Circuit diagram

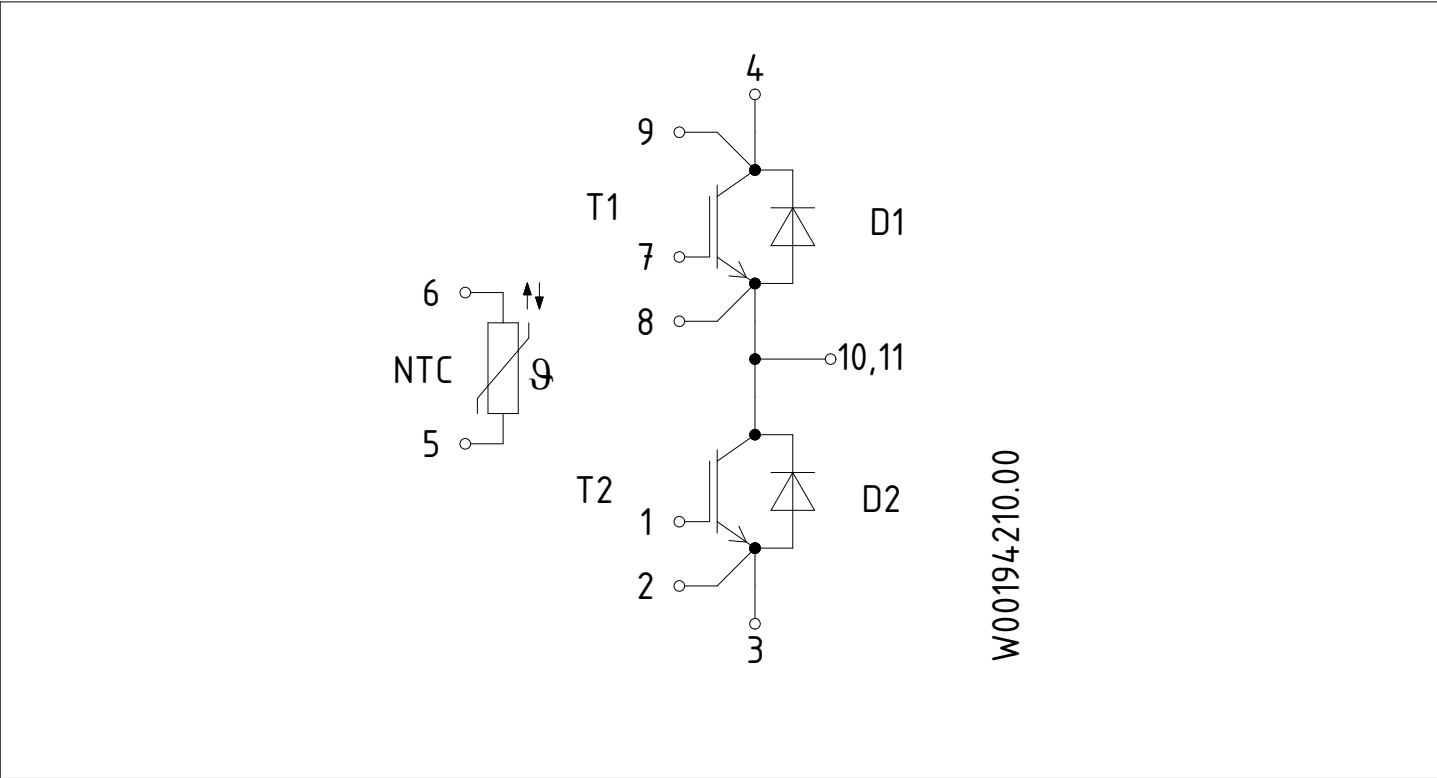


Figure 1

## 7 Package outlines



8 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      | <i>Content</i>                                                                                                | <i>Digit</i>                                                                                                   | <i>Example</i>  |
|                   | 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           |                                                                                                               |                                                                                                                |                 |
|                   | <br>71549142846550549911530 | <br>71549142846550549911530 |                 |

Figure 3

Revision history

Revision history

| Document revision | Date of release | Description of changes                                                                                                                              |
|-------------------|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| V2.0              | 2011-04-26      | Preliminary 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 |
| 1.00              | 2024-03-18      | Final datasheet                                                                                                                                     |

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