## PrimePACK™3+ B-series module with TRENCHSTOP™IGBT7 and emitter controlled 7 diode and NTC

### Features

- Electrical features
  - $V_{CES}$ = 1200 V
  - $I_{C\ nom}$ = 2400 A / $I_{CRM}$ = 4800 A
  - High current density
  - Low inductive design
  - Low $V_{CE,sat}$
  - $T_{vj,op}$ = 150°C
  - Overload operation up to 175°C
  - TRENCHSTOP™ IGBT7
- Mechanical features
  - High creepage and clearance distances
  - High power density
  - Package with CTI > 400

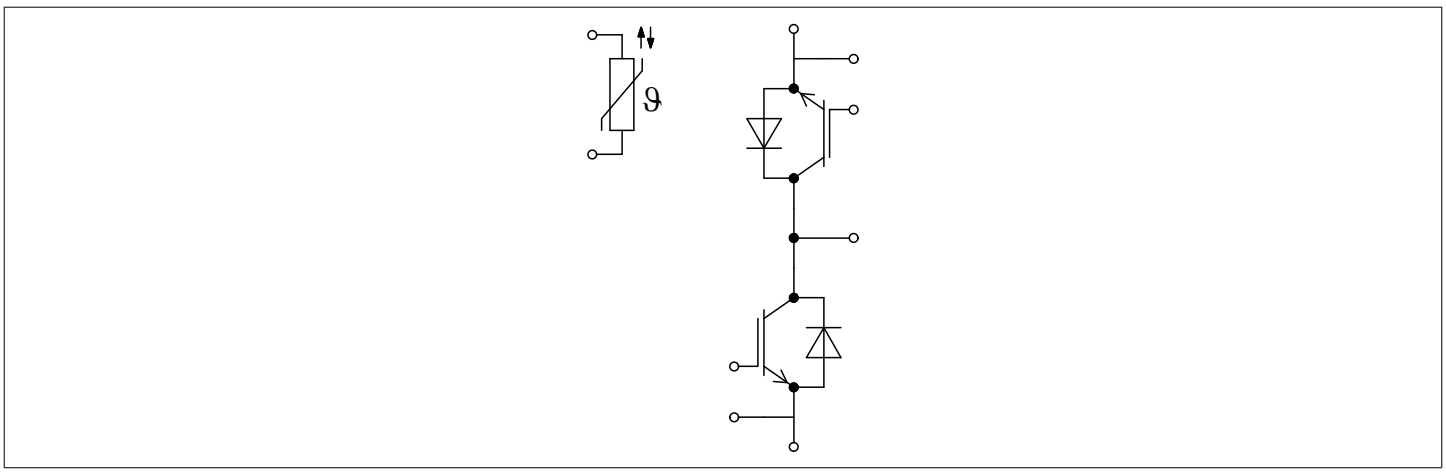
### Potential applications

- Three-level applications
- Solar applications
- Energy storage systems

### 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 | 4.0 | kV |
| Material of module baseplate | | | Cu | |
| Creepage distance | $d_{Creep}$ | terminal to heatsink | 36.0 | mm |
| Creepage distance | $d_{Creep}$ | terminal to terminal | 28.0 | mm |
| Clearance | $d_{Clear}$ | terminal to heatsink | 21.0 | mm |
| Clearance | $d_{Clear}$ | terminal to terminal | 19.0 | mm |
| Comparative tracking index | *CTI* | | >400 | |

**Table 2 Characteristic values**

| Parameter | Symbol | Note or test condition | | Values | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | |
| Stray inductance module | $L_{sCE}$ | | | | 5 | | nH |
| Module lead resistance, terminals - chip | $R_{AA'+CC'}$ | $T_C$=25°C, per switch | | | 0.045 | | mΩ |
| Module lead resistance, terminals - chip | $R_{CC'+EE'}$ | $T_C$=25°C, per switch | | | 0.045 | | mΩ |
| Storage temperature | $T_{stg}$ | | | -40 | | 150 | °C |
| Maximum baseplate operation temperature | $T_{BPmax}$ | | | | | 150 | °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 | M4, Screw | 1.8 | | 2.1 | Nm |
| | | | M8, Screw | 8 | | 10 | |
| Weight | *G* | | | | 1400 | | g |

# 2 IGBT, 3-Level

**Table 3 Maximum rated values**

| Parameter | Symbol | Note or test condition | | Values | Unit |
|---|---|---|---|---|---|
| Collector-emitter voltage | $V_{CES}$ | | $T_{vj}$ = 25 °C | 1200 | V |
| Implemented collector current | $I_{CN}$ | | | 2400 | A |
| Continuous DC collector current | $I_{CDC}$ | $T_{vj\,max}$ = 150 °C | $T_C$ = 70 °C | 2400 | A |

**(table continues...)**

**Table 3 (continued) Maximum rated values**

| Parameter | Symbol | Note or test condition | Values | Unit |
|---|---|---|---|---|
| Repetitive peak collector current | $I_{CRM}$ | $t_p$ limited by $T_{vj\,op}$ | 4800 | 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 | $V_{CE\,sat}$ | $I_C$ = 2400 A, $V_{GE}$ = 15 V | $T_{vj}$ = 25 °C | | 1.27 | 1.79 | V |
| | | | $T_{vj}$ = 125 °C | | 1.37 | 1.82 | |
| | | | $T_{vj}$ = 150 °C | | 1.40 | 1.84 | |
| Gate threshold voltage | $V_{GEth}$ | $I_C$ = 48 mA, $V_{CE}$ = $V_{GE}$, $T_{vj}$ = 25 °C | | 5.15 | 5.80 | 6.45 | V |
| Gate charge | $Q_G$ | $V_{GE}$ = ±15 V, $V_{CE}$ = 600 V | | | 38.1 | | µC |
| Internal gate resistor | $R_{Gint}$ | $T_{vj}$ = 25 °C | | | 0.23 | | Ω |
| Input capacitance | $C_{ies}$ | $f$ = 100 kHz, $T_{vj}$ = 25 °C, $V_{CE}$ = 25 V, $V_{GE}$ = 0 V | | | 325 | | nF |
| Reverse transfer capacitance | $C_{res}$ | $f$ = 100 kHz, $T_{vj}$ = 25 °C, $V_{CE}$ = 25 V, $V_{GE}$ = 0 V | | | 1.92 | | nF |
| Collector-emitter cut-off current | $I_{CES}$ | $V_{CE}$ = 1200 V, $V_{GE}$ = 0 V | $T_{vj}$ = 25 °C | | | 5 | mA |
| Gate-emitter leakage current | $I_{GES}$ | $V_{CE}$ = 0 V, $V_{GE}$ = 20 V, $T_{vj}$ = 25 °C | | | | 400 | nA |
| Turn-on delay time (inductive load) | $t_{don}$ | $I_C$ = 2400 A, $V_{CE}$ = 600 V, $V_{GE}$ = ±15 V, $R_{Gon}$ = 0.4 Ω | $T_{vj}$ = 25 °C | | 0.645 | | µs |
| | | | $T_{vj}$ = 125 °C | | 0.785 | | |
| | | | $T_{vj}$ = 150 °C | | 0.820 | | |
| Rise time (inductive load) | $t_r$ | $I_C$ = 2400 A, $V_{CE}$ = 600 V, $V_{GE}$ = ±15 V, $R_{Gon}$ = 0.4 Ω | $T_{vj}$ = 25 °C | | 0.185 | | µs |
| | | | $T_{vj}$ = 125 °C | | 0.210 | | |
| | | | $T_{vj}$ = 150 °C | | 0.215 | | |
| Turn-off delay time (inductive load) | $t_{doff}$ | $I_C$ = 2400 A, $V_{CE}$ = 600 V, $V_{GE}$ = ±15 V, $R_{Goff}$ = 3.3 Ω | $T_{vj}$ = 25 °C | | 2.800 | | µs |
| | | | $T_{vj}$ = 125 °C | | 2.900 | | |
| | | | $T_{vj}$ = 150 °C | | 3.000 | | |
| Fall time (inductive load) | $t_f$ | $I_C$ = 2400 A, $V_{CE}$ = 600 V, $V_{GE}$ = ±15 V, $R_{Goff}$ = 3.3 Ω | $T_{vj}$ = 25 °C | | 0.205 | | µs |
| | | | $T_{vj}$ = 125 °C | | 0.245 | | |
| | | | $T_{vj}$ = 150 °C | | 0.275 | | |
| Turn-on energy loss per pulse | $E_{on}$ | $I_C$ = 2400 A, $V_{CE}$ = 600 V, $L_\sigma$ = 50 nH, $V_{GE}$ = ±15 V, $R_{Gon}$ = 0.4 Ω, di/dt = 9000 A/µs ($T_{vj}$ = 150 °C) | $T_{vj}$ = 25 °C | | 110 | | mJ |
| | | | $T_{vj}$ = 125 °C | | 205 | | |
| | | | $T_{vj}$ = 150 °C | | 240 | | |

**(table continues...)**

**Table 4 (continued) Characteristic values**

| Parameter | Symbol | Note or test condition | | Values | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | |
| Turn-off energy loss per pulse | $E_{off}$ | $I_C$ = 2400 A, $V_{CE}$ = 600 V, $L_\sigma$ = 50 nH, $V_{GE}$ = ±15 V, $R_{Goff}$ = 3.3 Ω, dv/dt = 1030 V/µs ($T_{vj}$ = 150 °C) | $T_{vj}$ = 25 °C | | 715 | | mJ |
| | | | $T_{vj}$ = 125 °C | | 845 | | |
| | | | $T_{vj}$ = 150 °C | | 890 | | |
| Thermal resistance, junction to case | $R_{thJC}$ | per IGBT | | | | 17.9 | K/kW |
| Thermal resistance, case to heat sink | $R_{thCH}$ | per IGBT, $\lambda_{grease}$= 1 W/(m*K) | | | 12.9 | | K/kW |
| Temperature under switching conditions | $T_{vj\,op}$ | | | -40 | | 150 | °C |

## 3 Diode, 3-Level

**Table 5 Maximum rated values**

| Parameter | Symbol | Note or test condition | | Values | Unit |
|---|---|---|---|---|---|
| Repetitive peak reverse voltage | $V_{RRM}$ | | $T_{vj}$ = 25 °C | 1200 | V |
| Continuous DC forward current | $I_F$ | | | 2400 | A |
| Repetitive peak forward current | $I_{FRM}$ | $t_P$ = 1 ms | | 4800 | A |

**Table 6 Characteristic values**

| Parameter | Symbol | Note or test condition | | Values | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | |
| Forward voltage | $V_F$ | $I_F$ = 2400 A, $V_{GE}$ = 0 V | $T_{vj}$ = 25 °C | | 1.70 | 2.03 | V |
| | | | $T_{vj}$ = 125 °C | | 1.65 | 1.96 | |
| | | | $T_{vj}$ = 150 °C | | 1.60 | 1.94 | |
| Peak reverse recovery current | $I_{RM}$ | $V_R$ = 600 V, $I_F$ = 2400 A, $V_{GE}$ = -15 V, -di$_F$/dt = 6850 A/µs ($T_{vj}$ = 150 °C) | $T_{vj}$ = 25 °C | | 735 | | A |
| | | | $T_{vj}$ = 125 °C | | 885 | | |
| | | | $T_{vj}$ = 150 °C | | 895 | | |
| Recovered charge | $Q_r$ | $V_R$ = 600 V, $I_F$ = 2400 A, $V_{GE}$ = -15 V, -di$_F$/dt = 6850 A/µs ($T_{vj}$ = 150 °C) | $T_{vj}$ = 25 °C | | 210 | | µC |
| | | | $T_{vj}$ = 125 °C | | 410 | | |
| | | | $T_{vj}$ = 150 °C | | 475 | | |
| Reverse recovery energy | $E_{rec}$ | $V_R$ = 600 V, $I_F$ = 2400 A, $V_{GE}$ = -15 V, -di$_F$/dt = 6850 A/µs ($T_{vj}$ = 150 °C) | $T_{vj}$ = 25 °C | | 80 | | mJ |
| | | | $T_{vj}$ = 125 °C | | 150 | | |
| | | | $T_{vj}$ = 150 °C | | 170 | | |

**(table continues...)**

**Table 6 (continued) Characteristic values**

| Parameter | Symbol | Note or test condition | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | |
| Thermal resistance, junction to case | $R_{thJC}$ | per diode | | | 34.1 | K/kW |
| Thermal resistance, case to heat sink | $R_{thCH}$ | per diode, $\lambda_{grease}$= 1 W/(m*K) | | 14.7 | | K/kW |
| Temperature under switching conditions | $T_{vj\ op}$ | | -40 | | 150 | °C |

*Note: Dynamic data for 3-level valid in conjunction with datasheet FF1800R23IE7, version 1.0.*
*$T_{vj\ op}$ up to 175 °C is allowed for operations in overload conditions. For detailed specifications please refer to AN2021-11.*

# 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 °C | | 5 | | kΩ |
| Deviation of $R_{100}$ | $\Delta R/R$ | $T_{NTC}$ = 100 °C, $R_{100}$ = 493 Ω | -5 | | 5 | % |
| Power dissipation | $P_{25}$ | $T_{NTC}$ = 25 °C | | | 20 | mW |
| B-value | $B_{25/50}$ | $R_2 = R_{25} \exp[B_{25/50}(1/T_2-1/(298{,}15\ K))]$ | | 3375 | | K |
| B-value | $B_{25/80}$ | $R_2 = R_{25} \exp[B_{25/80}(1/T_2-1/(298{,}15\ K))]$ | | 3411 | | K |
| B-value | $B_{25/100}$ | $R_2 = R_{25} \exp[B_{25/100}(1/T_2-1/(298{,}15\ K))]$ | | 3433 | | K |

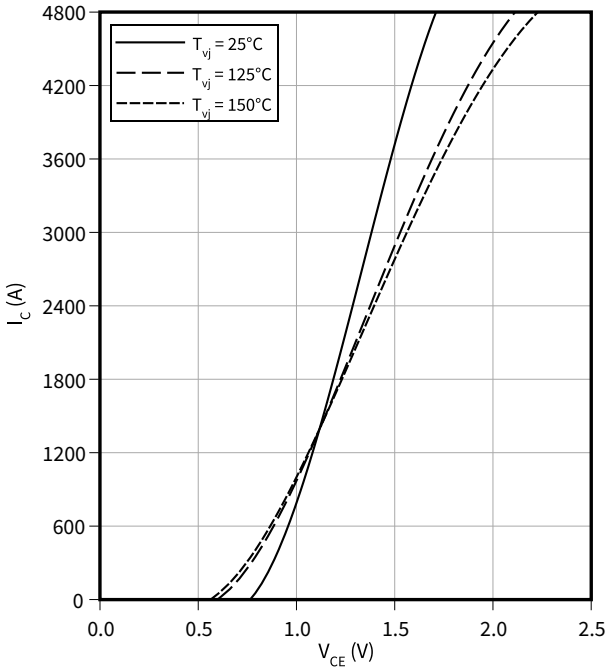
*Note: For detailed specifications please refer to AN2009-10.*

# 5 Characteristics diagrams

**Output characteristic (typical), IGBT, 3-Level**

$I_C = f(V_{CE})$

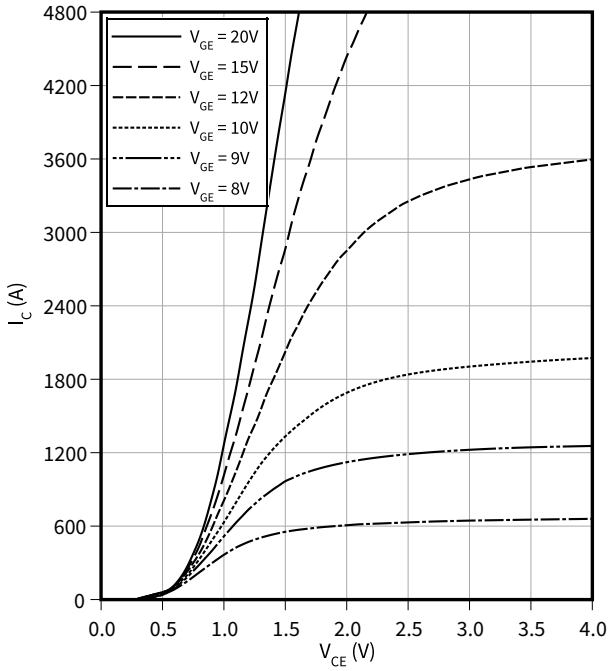
$V_{GE}$ = 15 V




**Output characteristic field (typical), IGBT, 3-Level**

$I_C = f(V_{CE})$

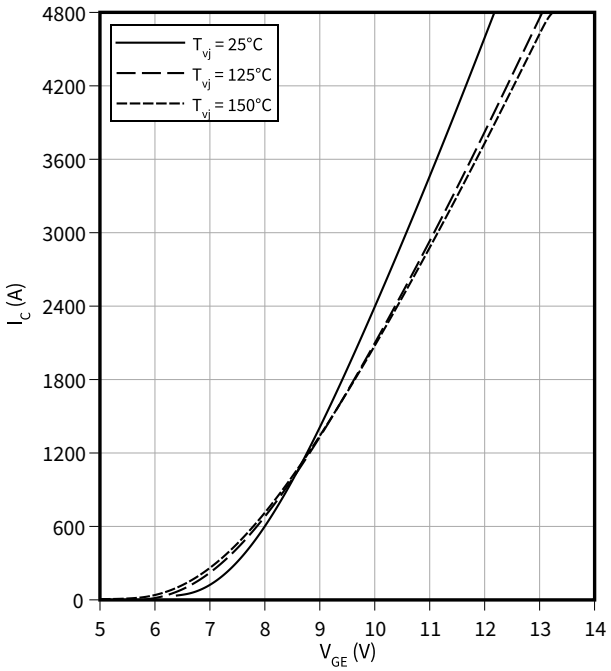
$T_{vj}$ = 150 °C




**Transfer characteristic (typical), IGBT, 3-Level**

$I_C = f(V_{GE})$

$V_{CE}$ = 20 V

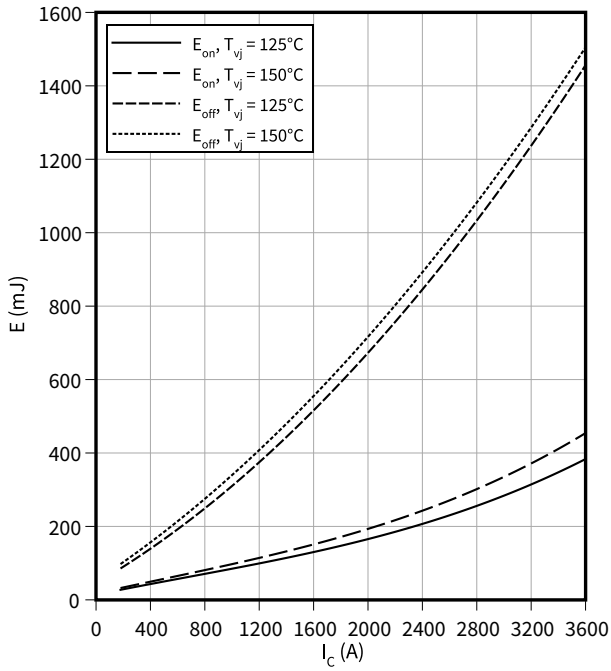



**Switching losses (typical), IGBT, 3-Level**

$E = f(I_C)$

$R_{Goff}$ = 3.3 Ω, $R_{Gon}$ = 0.4 Ω, $V_{CE}$ = 600 V, $V_{GE}$ = ± 15 V

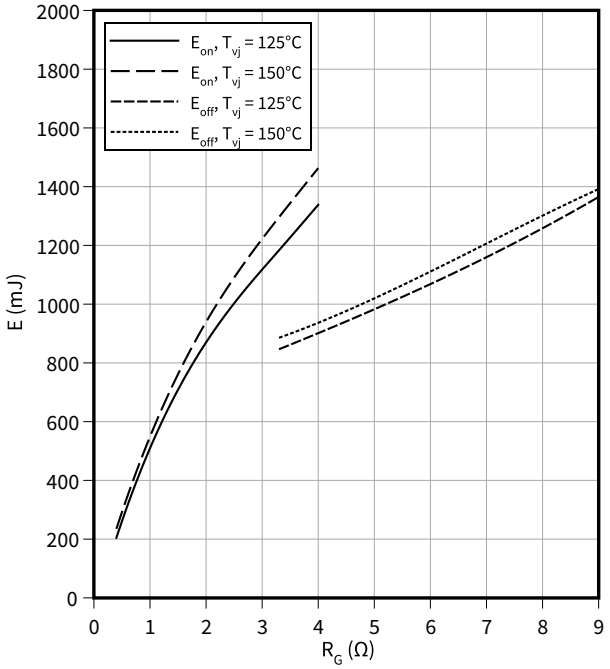
Ic is limited to 3600A by FF1800R23IE7 module.



### Switching losses (typical), IGBT, 3-Level

$E = f(R_G)$

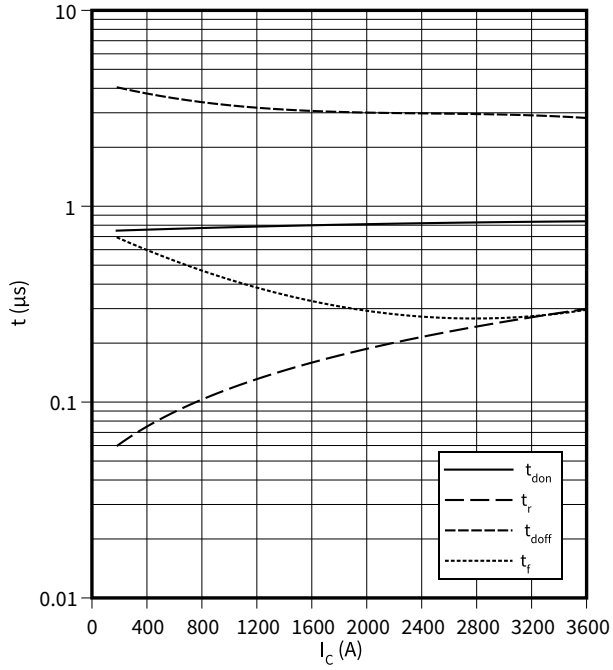
$I_C = 2400\ A$, $V_{CE} = 600\ V$, $V_{GE} = \pm 15\ V$




### Switching times (typical), IGBT, 3-Level

$t = f(I_C)$

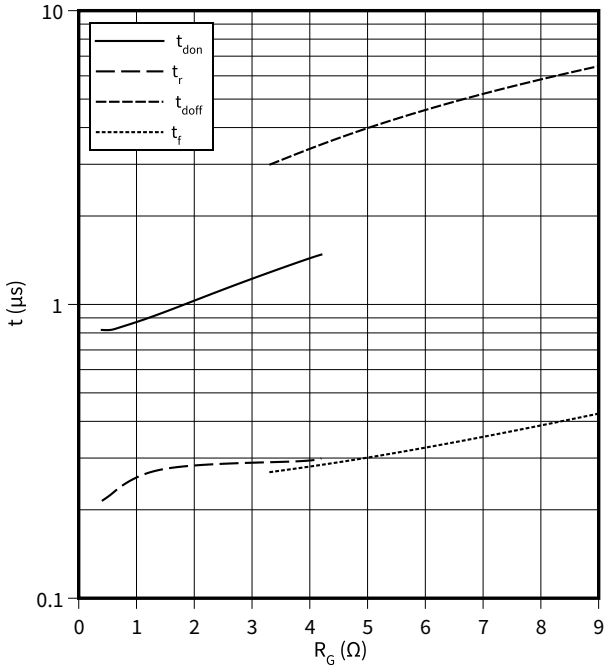
$R_{Goff} = 3.3\ \Omega$, $R_{Gon} = 0.4\ \Omega$, $V_{CE} = 600\ V$, $V_{GE} = \pm 15\ V$, $T_{vj} = 150\ °C$




### Switching times (typical), IGBT, 3-Level

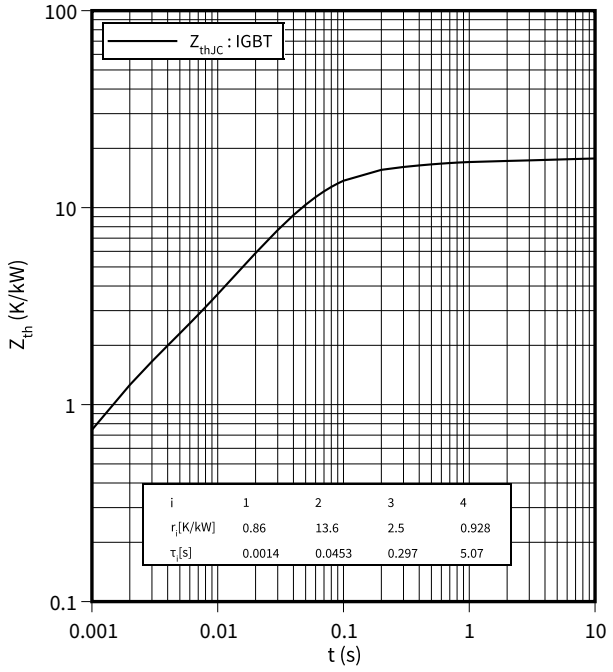
$t = f(R_G)$

$I_C = 2400\ A$, $V_{CE} = 600\ V$, $V_{GE} = \pm 15\ V$, $T_{vj} = 150\ °C$




### Transient thermal impedance , IGBT, 3-Level

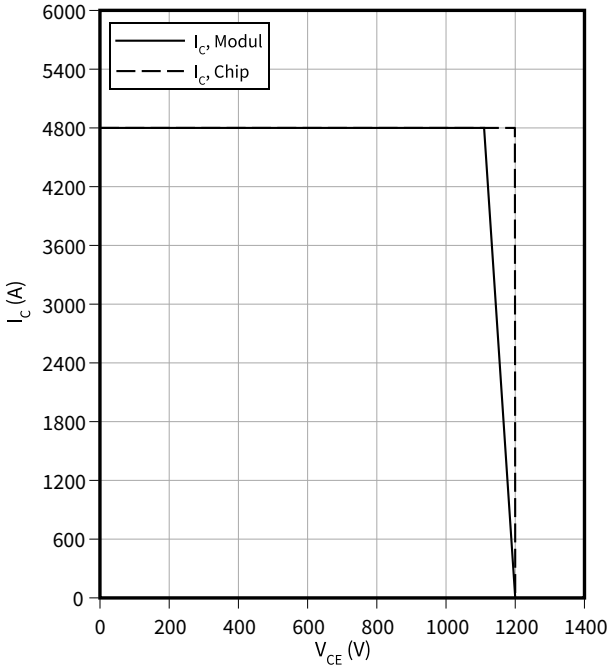
$Z_{th} = f(t)$



### Reverse bias safe operating area (RBSOA), IGBT, 3-Level

$I_C = f(V_{CE})$

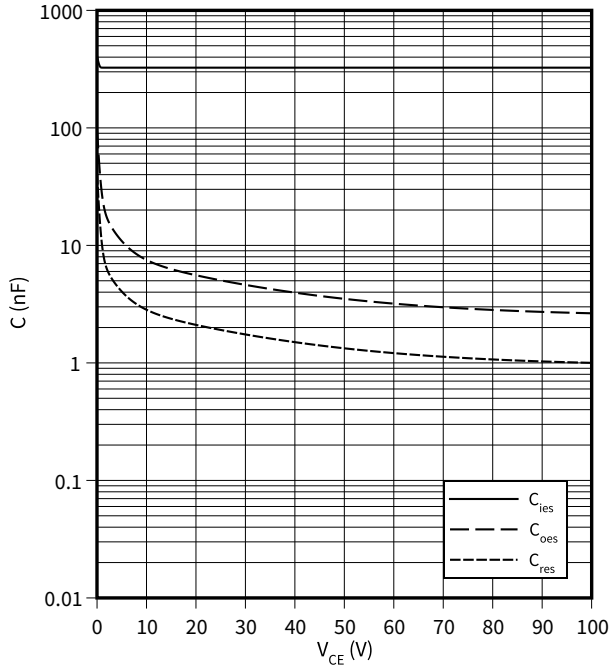
$R_{Goff} = 3.3\ \Omega$, $V_{GE} = 15$ V, $T_{vj} = 150$ °C




### Capacity characteristic (typical), IGBT, 3-Level

$C = f(V_{CE})$

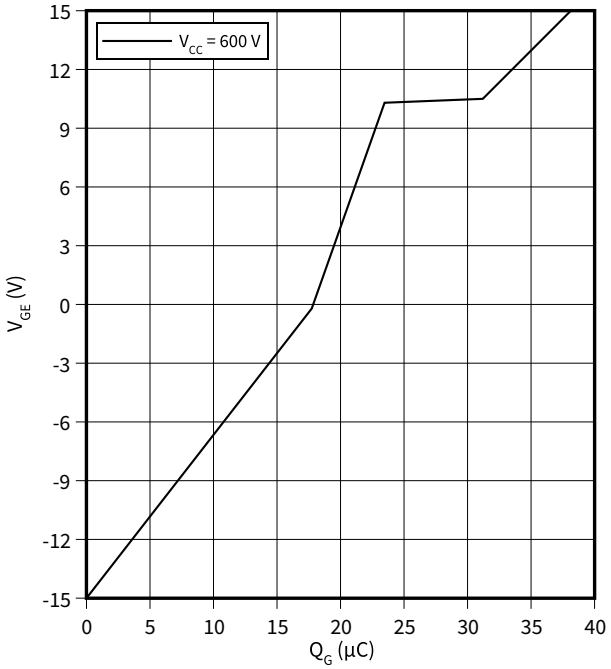
$f = 100$ kHz, $V_{GE} = 0$ V, $T_{vj} = 25$ °C




### Gate charge characteristic (typical), IGBT, 3-Level

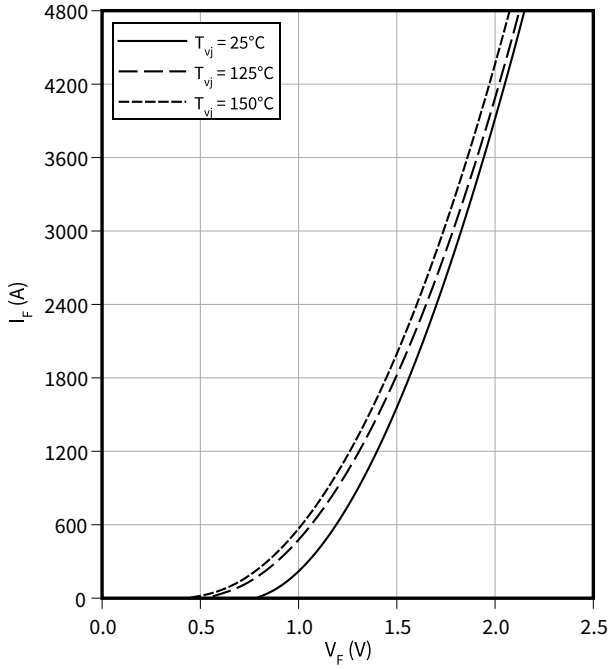
$V_{GE} = f(Q_G)$

$I_C = 2400$ A, $T_{vj} = 25$ °C




### Forward characteristic (typical), Diode, 3-Level

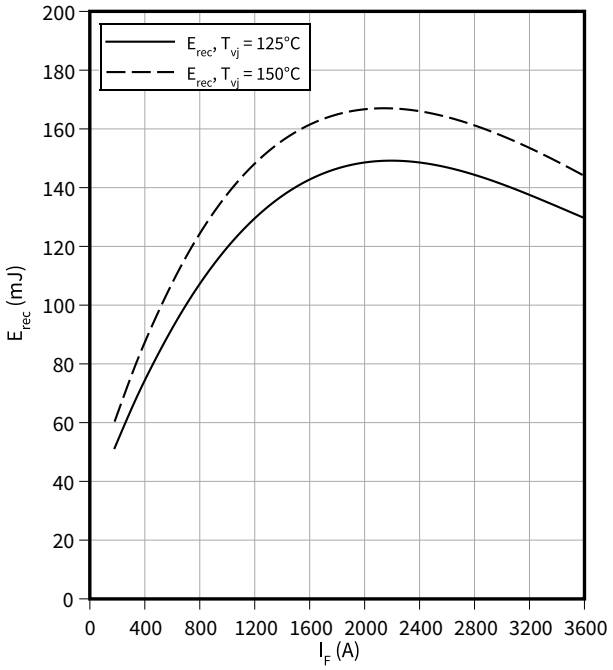
$I_F = f(V_F)$



### Switching losses (typical), Diode, 3-Level

$E_{rec} = f(I_F)$

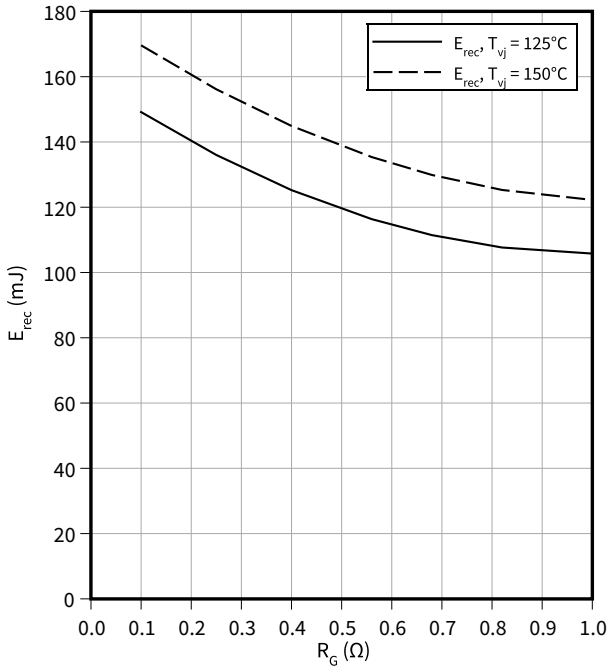
$V_{CE} = 600\ V$, $R_{Gon} = R_{Gon(IGBT)}$




### Switching losses (typical), Diode, 3-Level

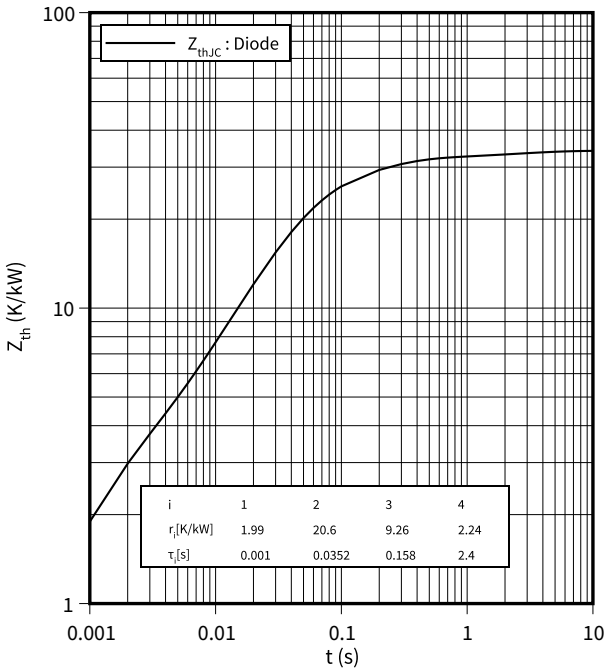
$E_{rec} = f(R_G)$

$V_{CE} = 600\ V$, $I_F = 2400\ A$



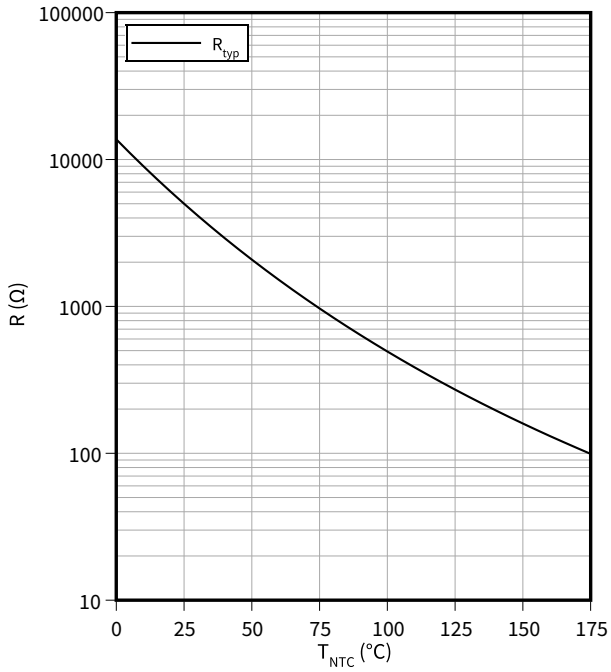

### Transient thermal impedance, Diode, 3-Level

$Z_{th} = f(t)$




### Temperature characteristic (typical), NTC-Thermistor

$R = f(T_{NTC})$



# 6 Circuit diagram

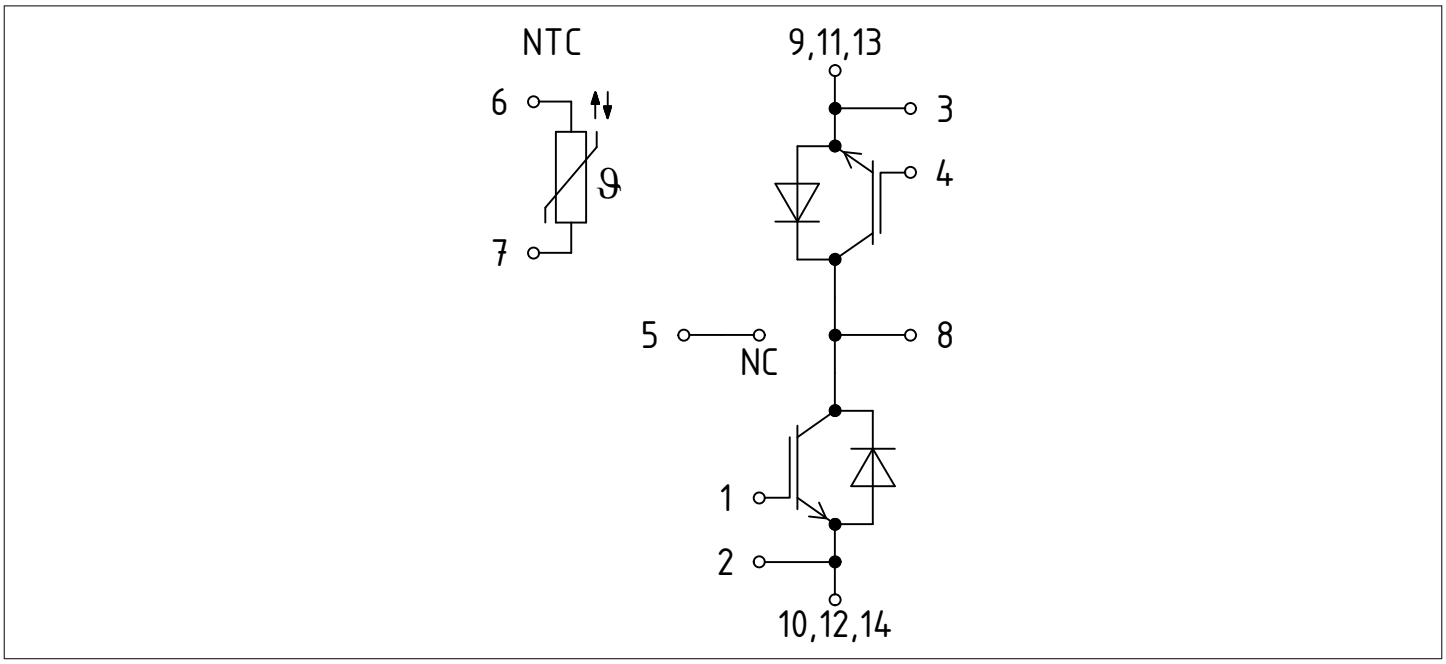



**Figure 1**

# 7 Package outlines

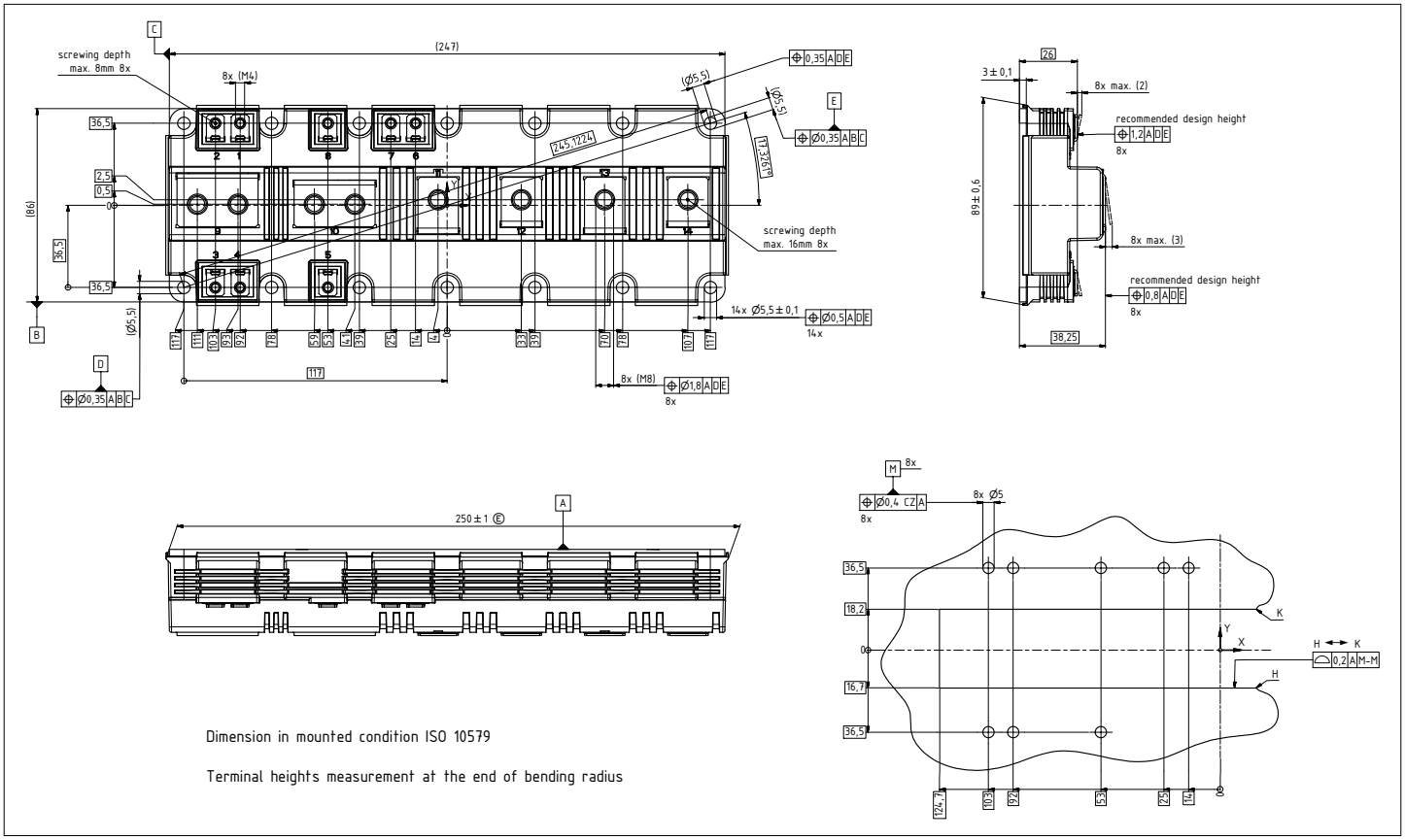



**Figure 2**

# 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 | *Content*<br>Module serial number<br>Module material number<br>Production order number<br>Date code (production year)<br>Date code (production week) | *Digit*<br>1 – 5<br>6 - 11<br>12 - 19<br>20 – 21<br>22 – 23 | *Example*<br>71549<br>142846<br>55054991<br>15<br>30 |
| Example | 7154914284655054991530 | | 7154914284655054991530 |

**Figure 3**

## Revision history

| Document revision | Date of release | Description of changes |
|---|---|---|
| V1.0 | 2019-07-19 | Target datasheet |
| V1.1 | 2020-02-14 | Target 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 | 2020-12-15 | Final datasheet |
| 1.20 | 2022-03-17 | Final datasheet - update to FF1800R23IE7 Rev. 1.0; Extension of diagrams to 4800A (except of dynamic data, which is limited by FF1800R23IE7) |

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