

# NGW50T65M3DFP

## 650 V, 50 A trench field-stop IGBT with full rated silicon diode

Rev. 2 — 11 November 2025 Product data sheet

## 1. General description

The NGW50T65M3DFP is a robust Insulated-Gate Bipolar Transistor (IGBT) featuring third-generation technology. It combines carrier stored trench-gate and field-stop (FS) structures. The NGW50T65M3DFP is rated to 175 °C with optimized IGBT turn-off losses, and has a short circuit withstand time of 5 µs. This hard-switching 650 V, 50 A IGBT is optimized for high-voltage, high-frequency industrial power inverter applications and servo motor drive applications.

## 2. Features

- Device current is rated at 50 A
- Low conduction and switching losses
- Stable and tight parameters for easy parallel operation
- Maximum junction temperature 175 °C
- Fully rated and fast reverse recovery diode
- 5 µs short circuit withstand time
- HV-H3TRB qualified

## 3. Applications

- Motor drives for industrial and consumer appliances
  - Servo motors operating between 5-20 kW (up to 20 kHz) for robotics, elevators, operating grippers, in-line manufacturing, etc.
- Power inverters, such as
  - Uninterruptible Power Supply (UPS) inverter
  - EV charging converter
- Induction heating
- Welding

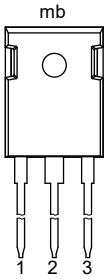
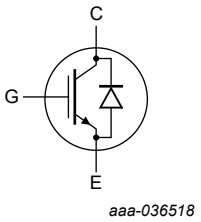
## 4. Quick reference data

**Table 1. Quick reference data**

| Symbol | Parameter | Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| $V_{CES}$ | collector-emitter voltage | $T_{vj}$ = 25 °C | - | 650 | V |
| $T_{vj}$ | operating junction temperature | | -40 | 175 | °C |
| $t_{sc}$ | short circuit withstand time | $V_{GE}$ = 15 V; $V_{CC}$ = 400 V; $T_{vj} \leq$ 150 °C | - | 5.0 | µs |

# 5. Pinning information

**Table 2. Pinning information**

| Pin | Symbol | Description | Simplified outline | Graphic symbol |
|---|---|---|---|---|
| 1 | G | gate |  |  |
| 2 | C | collector | | |
| 3 | E | emitter | | |
| mb | C | mounting base; connected to collector | | |

# 6. Ordering information

**Table 3. Ordering information**

| Type number | Package | | |
|---|---|---|---|
| | Name | Description | Version |
| NGW50T65M3DFP | TO-247-3 | Plastic single-ended through-hole package; heatsink mounted; 1 mounting hole; 3-lead TO-247-3 | SOT429-5 |

# 7. Marking

**Table 4. Marking codes**

| Type number | Marking code |
|---|---|
| NGW50T65M3DFP | W50T65M3DFP |

# 8. Limiting values

**Table 5. Limiting values**

| Symbol | Parameter | Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| **IGBT** | | | | | |
| $V_{CES}$ | collector-emitter voltage | $T_{vj}$ = 25 °C | - | 650 | V |
| $I_C$ | collector current [1] | $T_c$ = 25 °C | - | 80 | A |
| | | $T_c$ = 100 °C | - | 64 | A |
| $I_{CRM}$ | repetitive peak collector current [2] | | - | 150 | A |
| $t_{sc}$ | short circuit withstand time [3] | $V_{GE}$ = 15 V; $V_{CC}$ = 400 V; $T_{vj}$ ≤150 °C | - | 5.0 | µs |
| $V_{GE}$ | gate-emitter voltage | | -20 | 20 | V |
| $P_{tot}$ | total power dissipation | $T_c$ = 25 °C | - | 368 | W |
| | | $T_c$ = 100 °C | - | 184 | W |
| $T_{vj}$ | operating junction temperature | | -40 | 175 | °C |
| $T_{stg}$ | storage temperature | | -55 | 150 | °C |
| $T_{solder}$ | soldering temperature | | - | 260 | °C |



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| Symbol | Parameter | Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| **Diode** | | | | | |
| $I_F$ | diode forward current [1] | $T_c$ = 25 °C | - | 80 | A |
| | | $T_c$ = 100 °C | - | 71 | A |
| $I_{FRM}$ | repetitive peak forward current [2] | | - | 150 | A |

[1] Value is limited by bondwire and $T_{vj(max)}$.
[2] Time duration is limited by $T_{vj(max)}$.
[3] Short circuit cycles ≤ 1000, time between tests ≥ 1 s.

# 9. Thermal characteristics

**Table 6. Thermal characteristics**

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| M | mounting torque, M3 screw | | - | 0.6 | - | Nm |
| $R_{th(j-c)}$ | thermal resistance from junction to case | IGBT | - | 0.34 | 0.41 | K/W |
| | | diode | - | 0.48 | 0.58 | K/W |
| $R_{th(j-a)}$ | thermal resistance from junction to ambient | in free air | - | - | 40 | K/W |

# 10. Electrical characteristics

**Table 7. Characteristics**

*All values at $T_{vj}$ = 25 °C, unless otherwise specified.*

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **Static characteristics** | | | | | | |
| $V_{(BR)CES}$ | collector-emitter breakdown voltage | $V_{GE}$ = 0 V; $I_C$ = 0.2 mA | 650 | - | - | V |
| $V_{CEsat}$ | collector-emitter saturation voltage | $V_{GE}$ = 15 V; $I_C$ = 50 A; $T_{vj}$ = 25 °C | - | 1.46 | 1.9 | V |
| | | $V_{GE}$ = 15 V; $I_C$ = 50 A; $T_{vj}$ = 175 °C | - | 1.88 | - | V |
| $V_F$ | diode forward voltage | $V_{GE}$ = 0 V; $I_F$ = 50 A; $T_{vj}$ = 25 °C | - | 1.48 | 2.0 | V |
| | | $V_{GE}$ = 0 V; $I_F$ = 50 A; $T_{vj}$ = 175 °C | - | 1.22 | - | V |
| $V_{GE(th)}$ | gate-emitter threshold voltage | $I_C$ = 0.5 mA; $V_{CE}$ = $V_{GE}$; $T_{vj}$ = 25 °C | 4.3 | 5.0 | 5.7 | V |
| $I_{CES}$ | zero gate voltage collector current | $V_{CE}$ = 650 V; $V_{GE}$ = 0 V; $T_{vj}$ = 25 °C | - | - | 30 | µA |
| | | $V_{CE}$ = 650 V; $V_{GE}$ = 0 V; $T_{vj}$ = 175 °C | - | 0.5 | - | mA |
| $I_{GES}$ | gate-emitter leakage current | $V_{CE}$ = 0 V; $V_{GE}$ = 20 V | - | - | 100 | nA |
| $g_{fs}$ | transconductance | $V_{CE}$ = 20 V; $I_C$ = 50 A; $T_{vj}$ = 25 °C | - | 26.5 | - | S |
| $r_g$ | internal gate resistor | | - | 1.2 | - | Ω |
| **Dynamic characteristics** | | | | | | |
| $C_{ies}$ | input capacitance | $V_{CE}$ = 25 V; $V_{GE}$ = 0 V; f = 1 MHz | - | 4149 | - | pF |
| $C_{oes}$ | output capacitance | | - | 181 | - | pF |
| $C_{res}$ | reverse transfer capacitance | | - | 34 | - | pF |
| $Q_G$ | gate charge | $V_{CC}$ = 520 V; $I_C$ = 50 A; $V_{GE}$ = 15 V | - | 166 | - | nC |
| $L_{sCE}$ | internal stray inductance | measured 5 mm from case | - | 7.9 | - | nH |
| $I_{C(sc)}$ | short circuit collector current | $V_{GE}$ = 15 V; $V_{CC}$ = 400 V; $t_{sc}$ ≤ 5 µs; $T_{vj}$ ≤ 150 °C | - | 272 | - | A |


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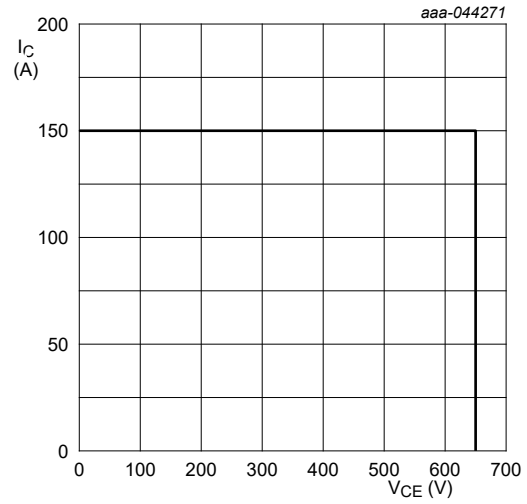
| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| **IGBT switching characteristics, inductive load** | | | | | | | |
| $t_{d(on)}$ | turn-on delay time | $V_{GE}$ = 15/0 V; $V_{CC}$ = 400 V; $I_C$ = 50 A; $R_{G(on)}$ = 10 Ω; $R_{G(off)}$ = 10 Ω; see Fig. 27. | $T_{vj}$ = 25 °C | - | 29 | - | ns |
| | | | $T_{vj}$ = 175 °C | - | 28 | - | ns |
| $t_r$ | rise time | | $T_{vj}$ = 25 °C | - | 25 | - | ns |
| | | | $T_{vj}$ = 175 °C | - | 27 | - | ns |
| $t_{d(off)}$ | turn-off delay time | | $T_{vj}$ = 25 °C | - | 223 | - | ns |
| | | | $T_{vj}$ = 175 °C | - | 264 | - | ns |
| $t_f$ | fall time | | $T_{vj}$ = 25 °C | - | 14 | - | ns |
| | | | $T_{vj}$ = 175 °C | - | 64 | - | ns |
| $E_{on}$ | turn-on switching energy loss | | $T_{vj}$ = 25 °C | - | 1.52 | - | mJ |
| | | | $T_{vj}$ = 175 °C | - | 3.31 | - | mJ |
| $E_{off}$ | turn-off switching energy loss | | $T_{vj}$ = 25 °C | - | 0.77 | - | mJ |
| | | | $T_{vj}$ = 175 °C | - | 1.29 | - | mJ |
| $E_{ts}$ | total switching energy loss | | $T_{vj}$ = 25 °C | - | 2.29 | - | mJ |
| | | | $T_{vj}$ = 175 °C | - | 4.60 | - | mJ |
| **Diode switching characteristics, inductive load** | | | | | | | |
| $t_{rr}$ | reverse recovery time | $V_R$ = 400 V; $I_F$ = 50 A; $di_F/dt$ = 500 A/µs; see Fig. 26. | $T_{vj}$ = 25 °C | - | 94 | - | ns |
| | | | $T_{vj}$ = 175 °C | - | 194 | - | ns |
| $Q_{rr}$ | reverse recovery charge | | $T_{vj}$ = 25 °C | - | 861 | - | nC |
| | | | $T_{vj}$ = 175 °C | - | 4059 | - | nC |
| $I_{rrm}$ | peak reverse recovery current | | $T_{vj}$ = 25 °C | - | 20 | - | A |
| | | | $T_{vj}$ = 175 °C | - | 39 | - | A |
| $E_{rec}$ | reverse recovery energy loss | | $T_{vj}$ = 25 °C | - | 0.06 | - | mJ |
| | | | $T_{vj}$ = 175 °C | - | 0.41 | - | mJ |
| $di_{rrf}/dt$ | fall rate of reverse recovery current | | $T_{vj}$ = 25 °C | - | 556 | - | A/µs |
| | | | $T_{vj}$ = 175 °C | - | 366 | - | A/µs |


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## 10.1. Characteristic diagrams

**Table 8. Waveforms and output characteristics**




- $V_{GE}$ = 15 V
- $T_{vj} \leq 175$ °C

**Fig. 1. Reverse bias safe operating area**

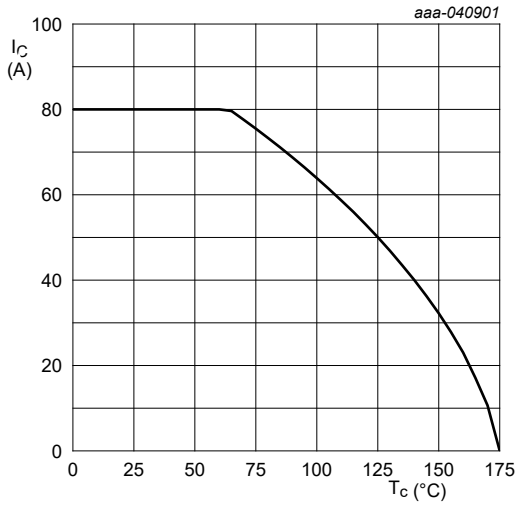
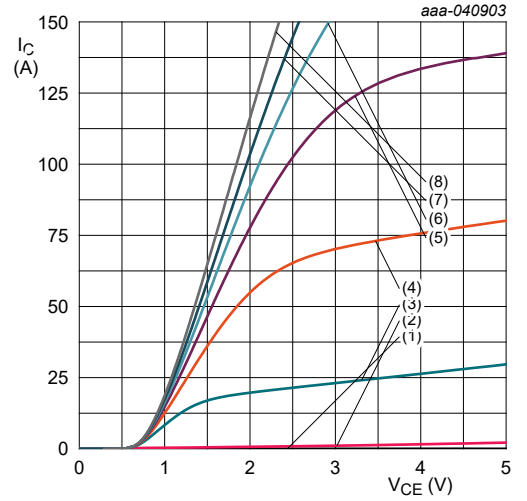


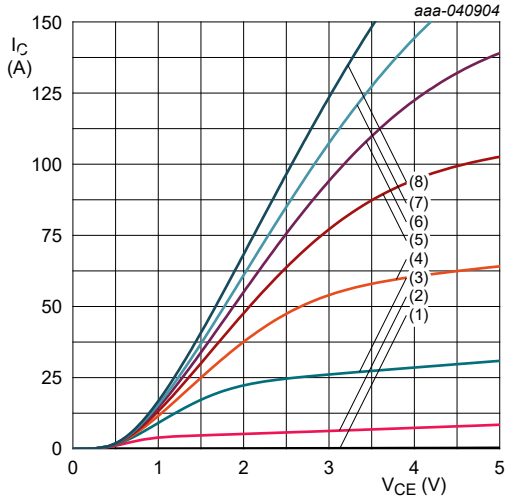

**Fig. 2. Collector current as a function of case temperature**




$T_{vj}$ = 25 °C

(1) $V_{GE}$ = 5 V
(2) $V_{GE}$ = 7 V
(3) $V_{GE}$ = 9 V
(4) $V_{GE}$ = 11 V
(5) $V_{GE}$ = 13 V
(6) $V_{GE}$ = 15 V
(7) $V_{GE}$ = 17 V
(8) $V_{GE}$ = 20 V

**Fig. 3. Collector current as a function of collector-emitter voltage**




$T_{vj}$ = 175 °C

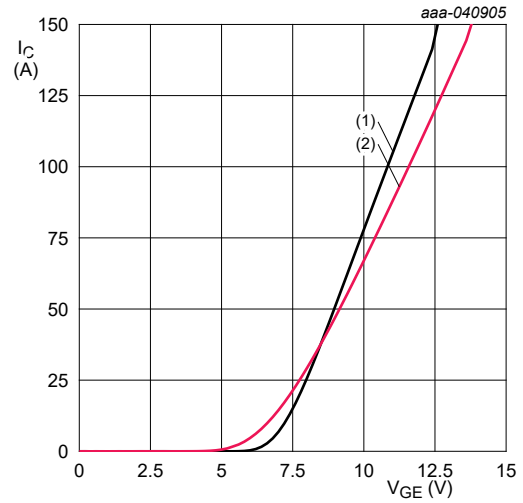
(1) $V_{GE}$ = 5 V
(2) $V_{GE}$ = 7 V
(3) $V_{GE}$ = 9 V
(4) $V_{GE}$ = 11 V
(5) $V_{GE}$ = 13 V
(6) $V_{GE}$ = 15 V
(7) $V_{GE}$ = 17 V
(8) $V_{GE}$ = 20 V

**Fig. 4. Collector current as a function of collector-emitter voltage**



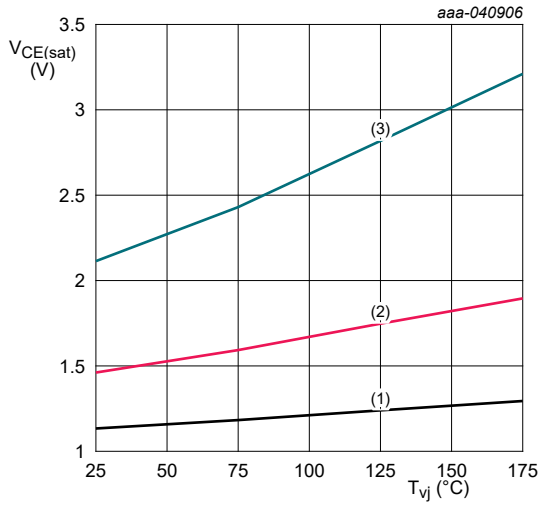
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$V_{CE}$ = 20 V
(1) $T_{vj}$ = 25 °C
(2) $T_{vj}$ = 175 °C

**Fig. 5. Collector current as a function of gate-emitter voltage**




$V_{GE}$ = 15 V
(1) $I_C$ = 25 A
(2) $I_C$ = 50 A
(3) $I_C$ = 100 A

**Fig. 6. Collector-emitter saturation voltage as a function of junction temperature**

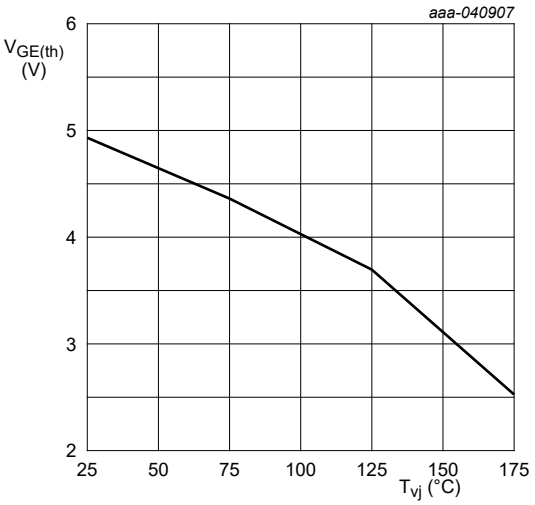
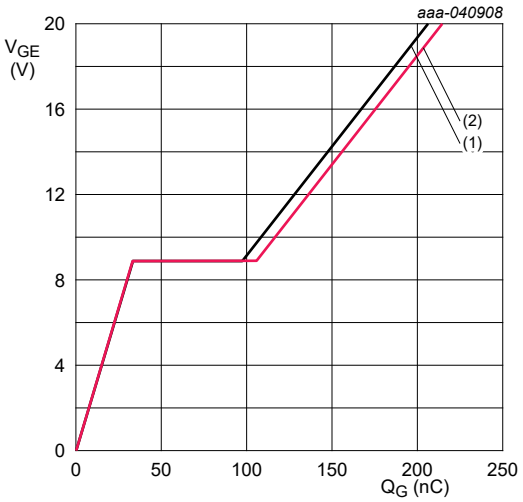



**Fig. 7. Gate-emitter threshold voltage as a function of junction temperature**



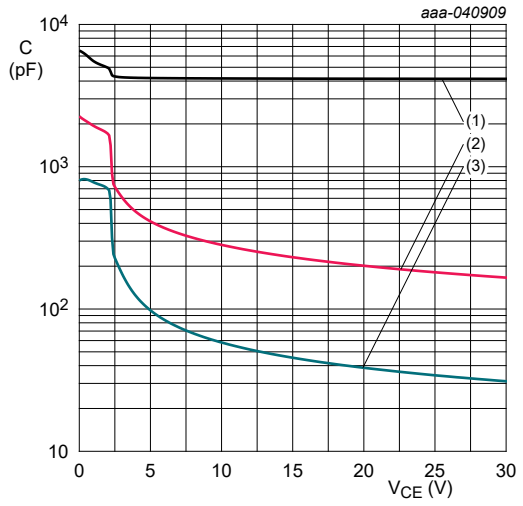

$I_C$ = 50 A
(1) $V_{CE}$ = 130 V
(2) $V_{CE}$ = 520 V

**Fig. 8. Gate-emitter voltage as a function of gate charge**



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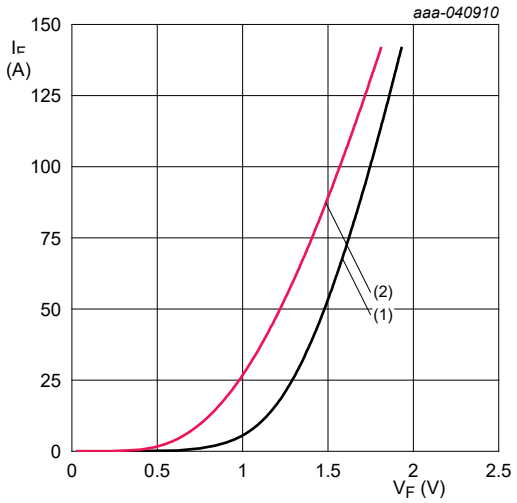
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$V_{GE}$ = 0 V; f = 1 MHz

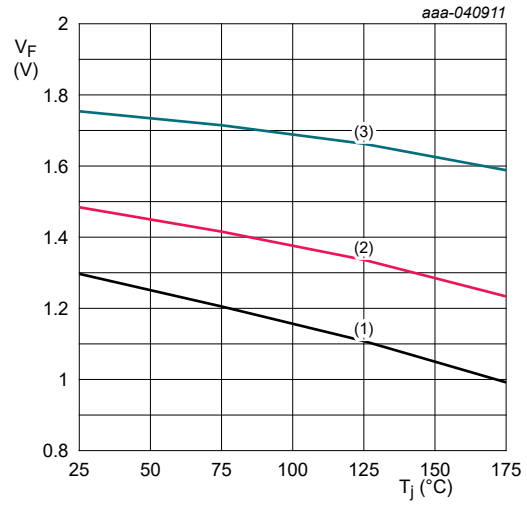
(1) $C_{ies}$
(2) $C_{oes}$
(3) $C_{res}$

**Fig. 9. Typical capacitance as a function of collector-emitter voltage**



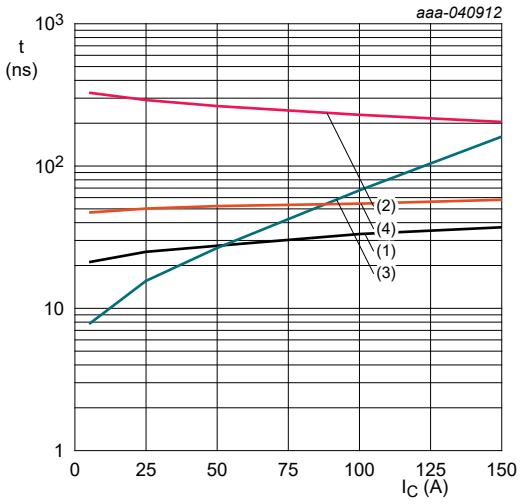

(1) $T_{vj}$ = 25 °C
(2) $T_{vj}$ = 175 °C

**Fig. 10. Typical diode forward current as a function of forward voltage**




(1) $I_F$ = 25 A
(2) $I_F$ = 50 A
(3) $I_F$ = 100 A

**Fig. 11. Typical diode forward voltage as a function of junction temperature**




$V_{GE}$ = 15 V to 0 V; $V_{CC}$ = 400 V; $R_{G(on)}$ = 10 Ω; $R_{G(off)}$ = 10 Ω; $T_{vj}$ = 175 °C

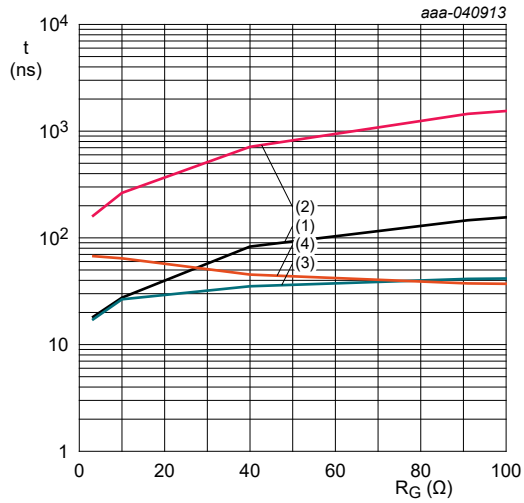
(1) $t_{d(on)}$
(2) $t_{d(off)}$
(3) $t_r$
(4) $t_f$

**Fig. 12. Typical switching times as a function of collector current**



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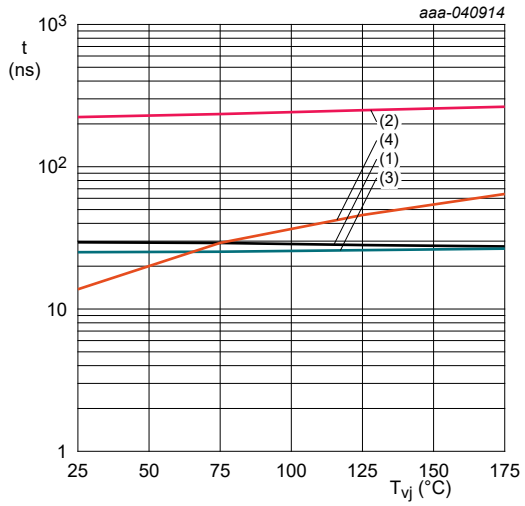
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$V_{GE}$ = 15 V to 0 V; $V_{CC}$ = 400 V; $I_C$ = 50 A; $T_{vj}$ = 175 °C

(1) $t_{d(on)}$
(2) $t_{d(off)}$
(3) $t_r$
(4) $t_f$

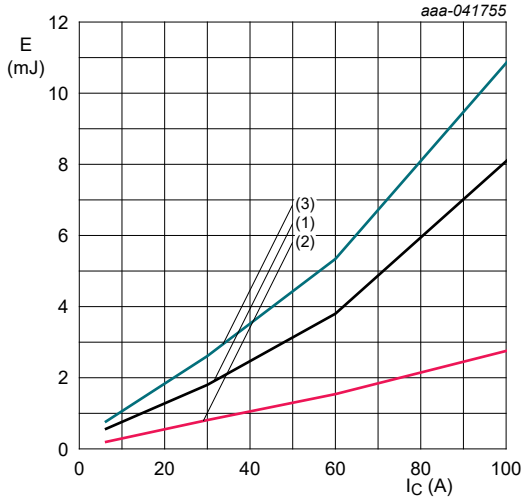
**Fig. 13. Typical switching times as a function of gate resistance**




$V_{GE}$ = 15 V to 0 V; $V_{CC}$ = 400 V; $I_C$ = 50 A; $R_{G(on)}$ = 10 Ω; $R_{G(off)}$ = 10 Ω

(1) $t_{d(on)}$
(2) $t_{d(off)}$
(3) $t_r$
(4) $t_f$

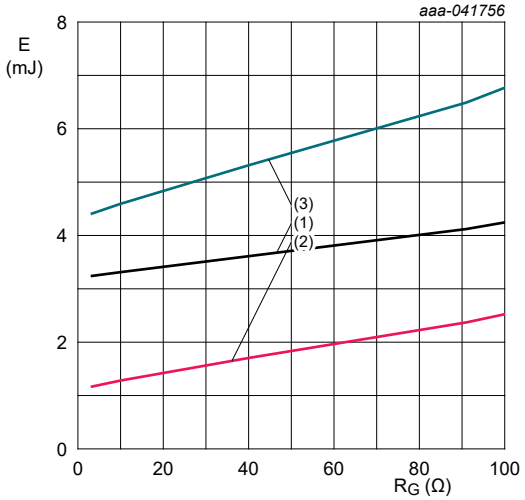
**Fig. 14. Typical switching times as a function of junction temperature**




$V_{GE}$ = 15 V to 0 V; $V_{CC}$ = 400 V; $R_{G(on)}$ = 10 Ω; $R_{G(off)}$ = 10 Ω; $T_{vj}$ = 175 °C

(1) $E_{on}$
(2) $E_{off}$
(3) $E_{ts}$

**Fig. 15. Typical switching energy losses as a function of collector current**

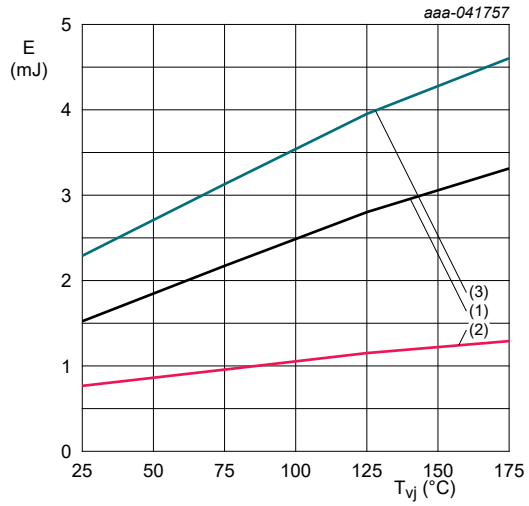



$V_{GE}$ = 15 V to 0 V; $V_{CC}$ = 400 V; $I_C$ = 50 A; $T_{vj}$ = 175 °C

(1) $E_{on}$
(2) $E_{off}$
(3) $E_{ts}$

**Fig. 16. Typical switching energy losses as a function of gate resistance**

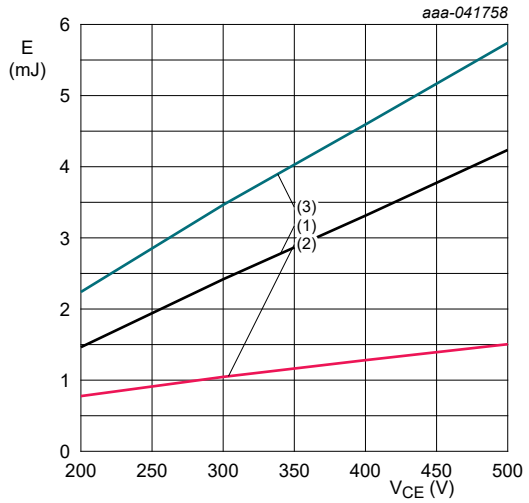

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$V_{GE}$ = 15 V to 0 V; $V_{CC}$ = 400 V; $I_C$ = 50 A; $R_{G(on)}$ = 10 Ω; $R_{G(off)}$ = 10 Ω

(1) $E_{on}$
(2) $E_{off}$
(3) $E_{ts}$

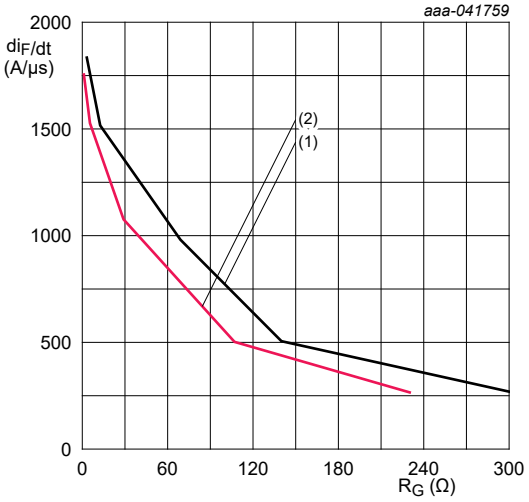
**Fig. 17. Typical switching energy losses as a function of junction temperature**




$V_{GE}$ = 15 V to 0 V; $I_C$ = 50 A; $R_{G(on)}$ = 10 Ω; $R_{G(off)}$ = 10 Ω; $T_{vj}$ = 175 °C

(1) $E_{on}$
(2) $E_{off}$
(3) $E_{ts}$

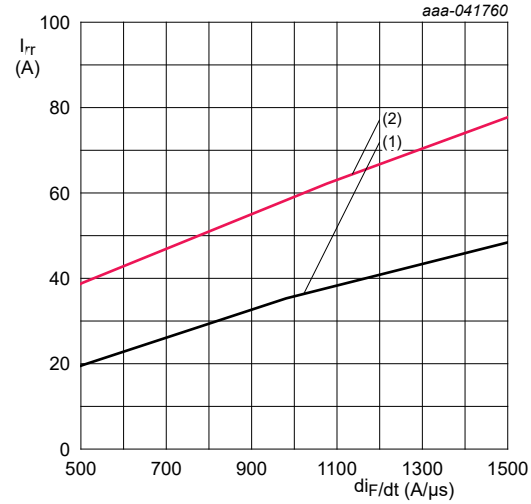
**Fig. 18. Typical switching energy losses as a function of collector-emitter voltage**




$V_R$ = 400 V; $I_F$ = 50 A

(1) $T_{vj}$ = 25 °C
(2) $T_{vj}$ = 175 °C

**Fig. 19. Typical rate of change of forward current as a function of gate resistance**




$V_R$ = 400 V; $I_F$ = 50 A

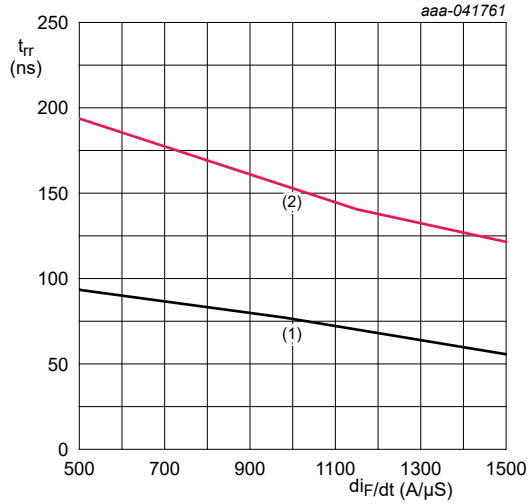
(1) $T_{vj}$ = 25 °C
(2) $T_{vj}$ = 175 °C

**Fig. 20. Typical reverse recovery current as a function of rate of change of forward current**



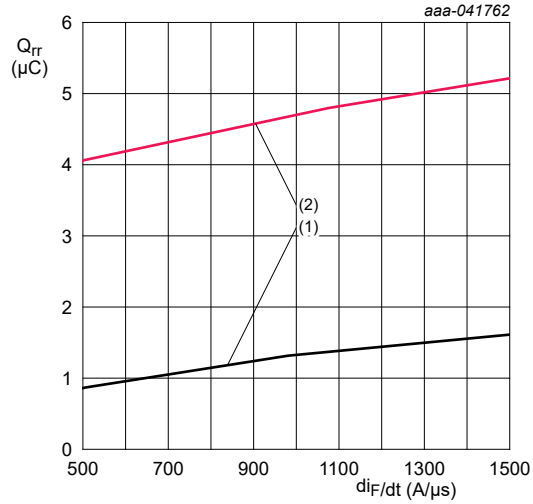
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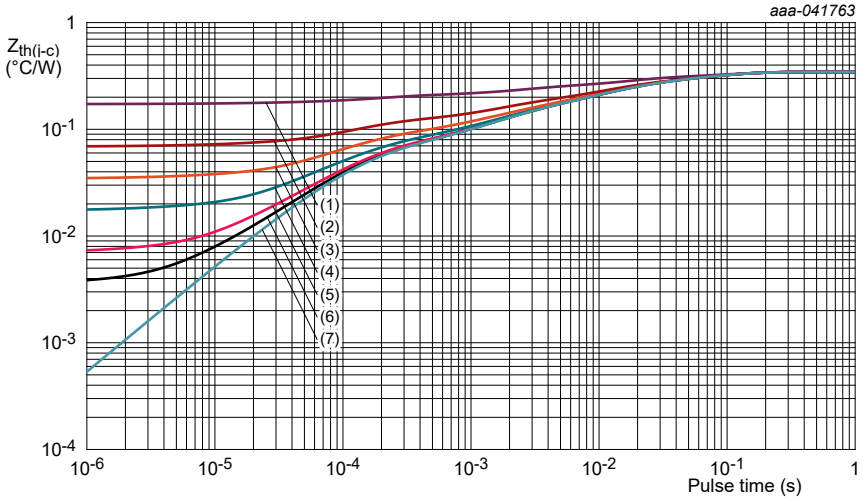

$V_R$ = 400 V; $I_F$ = 50 A
(1) $T_{vj}$ = 25 °C
(2) $T_{vj}$ = 175 °C

**Fig. 21. Typical reverse recovery time as a function of rate of change of forward current**




$V_R$ = 400 V; $I_F$ = 50 A
(1) $T_{vj}$ = 25 °C
(2) $T_{vj}$ = 175 °C

**Fig. 22. Typical reverse recovery charge as a function of rate of change of forward current**



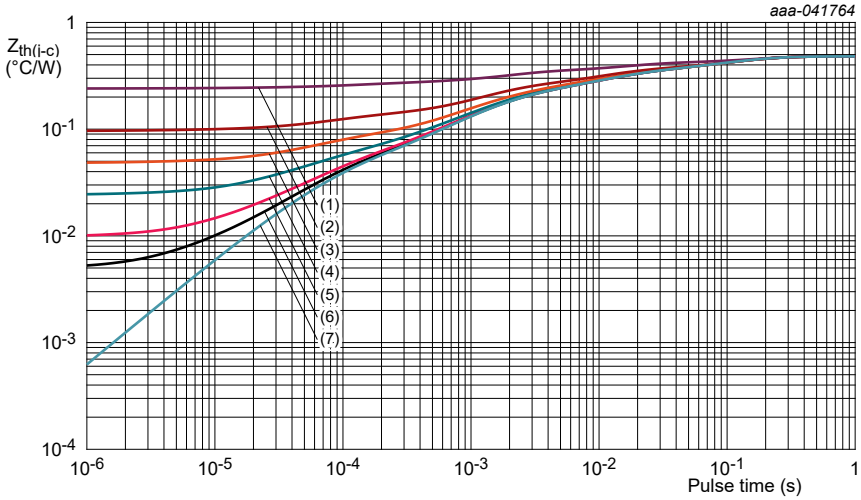

(1) $Z_{th}$ (D = 0.5)
(2) $Z_{th}$ (D = 0.2)
(3) $Z_{th}$ (D = 0.1)
(4) $Z_{th}$ (D = 0.05)
(5) $Z_{th}$ (D = 0.02)
(6) $Z_{th}$ (D = 0.01)
(7) Single pulse

| **i** | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| $r_i$ [K/W] | 0.054561 | 0.069549 | 0.120610 | 0.099952 |
| $\tau_i$ [s] | 0.000114 | 0.001523 | 0.010841 | 0.065724 |

**Fig. 23. Transient thermal impedance of IGBT as a function of pulse duration**


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(1) $Z_{th}$ (D = 0.5)
(2) $Z_{th}$ (D = 0.2)
(3) $Z_{th}$ (D = 0.1)
(4) $Z_{th}$ (D = 0.05)
(5) $Z_{th}$ (D = 0.02)
(6) $Z_{th}$ (D = 0.01)
(7) Single pulse

| i | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| $r_i$ [K/W] | 0.033250 | 0.147084 | 0.140747 | 0.159467 |
| $\tau_i$ [s] | 0.000068 | 0.001202 | 0.009743 | 0.102842 |

**Fig. 24. Transient thermal impedance of diode as a function of pulse duration**

## 10.2. Waveform definitions

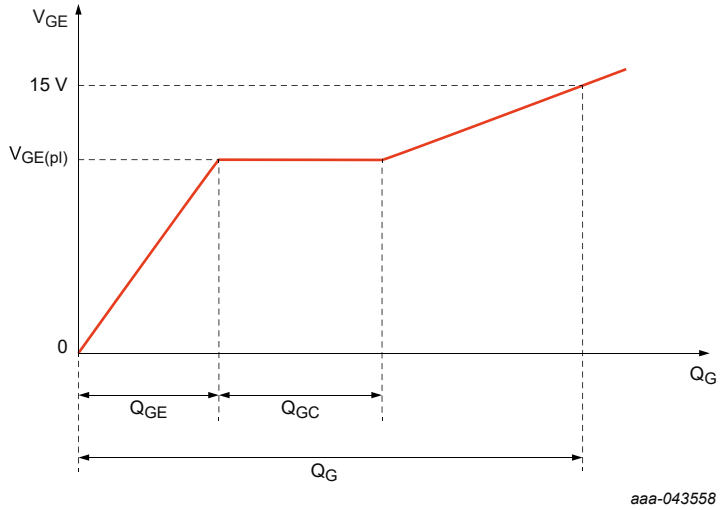



**Fig. 25. IGBT gate charge waveform definitions**


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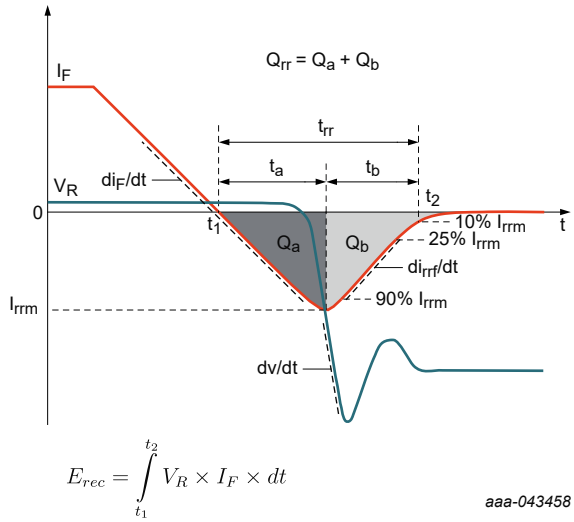



**Fig. 26. Diode reverse recovery waveform definitions**

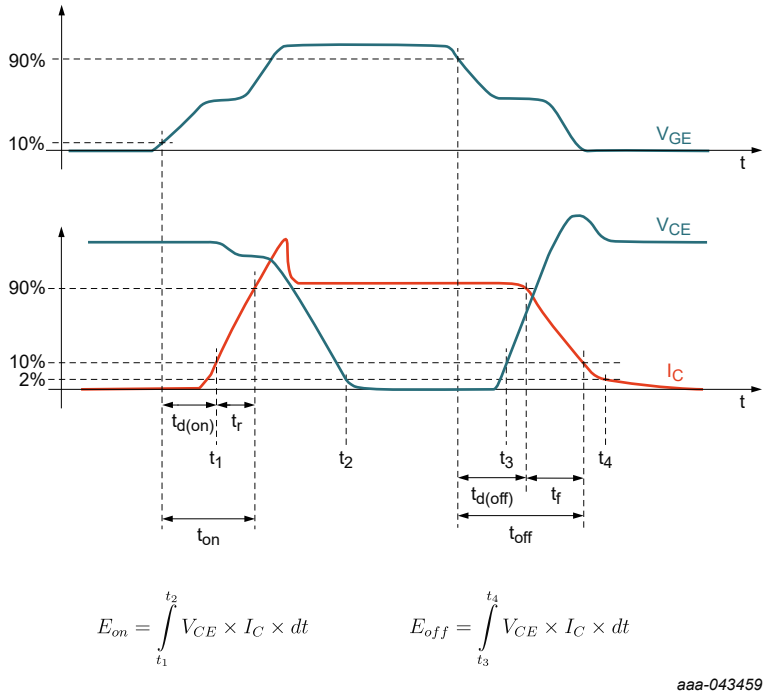
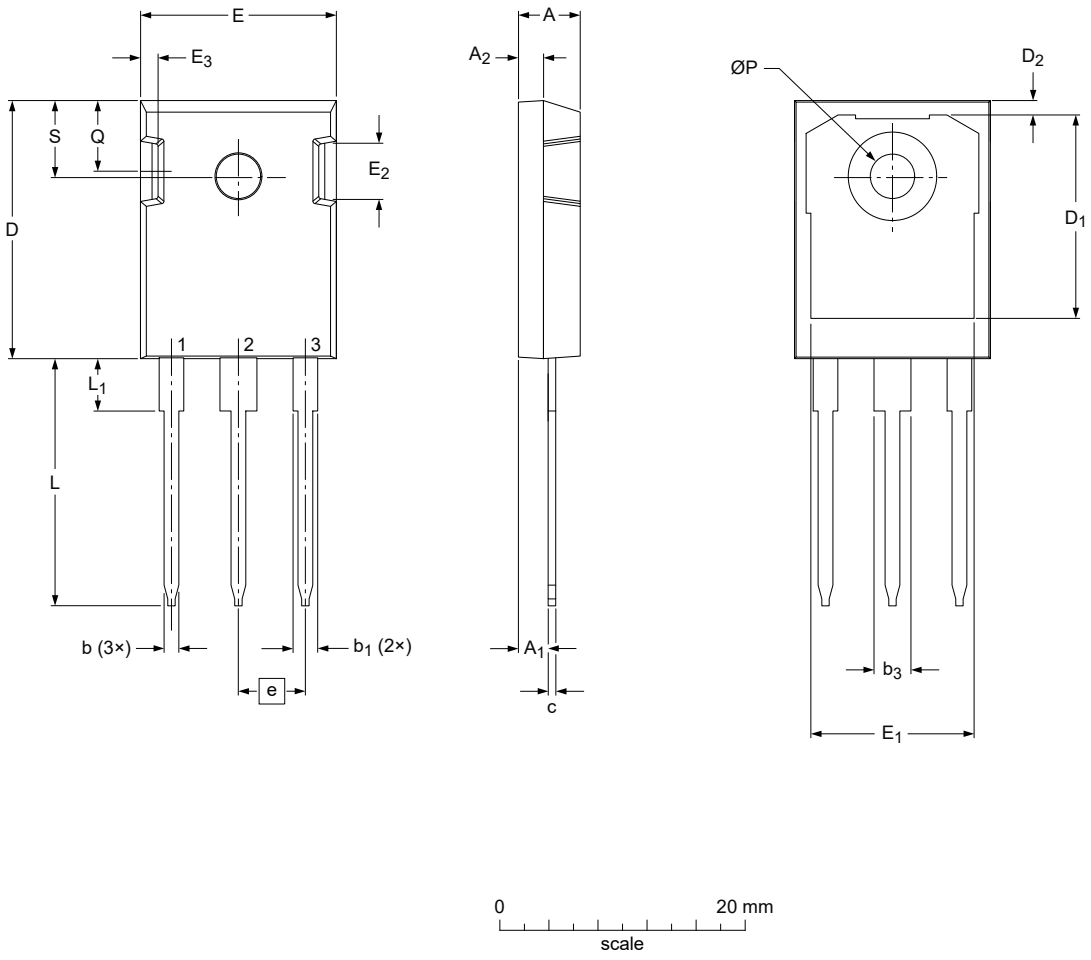



**Fig. 27. IGBT switching times and energy loss definitions**


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## 11. Package outline

**Plastic single-ended through-hole package; heatsink mounted; 1 mounting hole; 3-lead TO-247-3** **SOT429-5**




Dimensions (mm are the original dimensions)

| Unit[1] | | A | $A_1$ | $A_2$ | b | $b_1$ | $b_3$ | c | D | $D_1$ | $D_2$ | E | $E_1$ | $E_2$ | $E_3$ | e | L | $L_1$ | øP | Q | S |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | max | 5.21 | 2.54 | 2.16 | 1.33 | 2.41 | 3.38 | 0.68 | 21.10 | 17.65 | 1.35 | 16.13 | 13.50 | 5.10 | 2.60 | 5.44 BSC | 20.32 | 4.40 | 3.70 | 6.00 | 6.30 |
| | nom | | | | | | | | | | | | | | | | | | | | |
| | min | 4.83 | 2.29 | 1.90 | 1.07 | 1.91 | 2.87 | 0.55 | 20.80 | 16.25 | 0.95 | 15.70 | 12.38 | 3.68 | 1.00 | | 19.80 | 3.95 | 3.50 | 5.49 | 6.04 |

Note
All metal surfaces are tin plated except trimmed area.

*sot429-5_po*

| Outline version | References | | | | European projection | Issue date |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | JEITA | | | |
| SOT429-5 | | | | | | 25-07-23 |

**Fig. 28. Package outline TO-247-3 (SOT429-5)**



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# 12. Revision history

**Table 9. Revision history**

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|---|---|---|---|---|
| NGW50T65M3DFP v. 2 | 20251111 | Product data sheet | - | NGW50T65M3DFP v. 1.1 |
| Modifications | • Updated the 3D package on the first page.<br>• Added new section Section 7.<br>• Replaced "Power dissipation as a function of case temperature" chart with "Reverse bias safe operating area" in Section 10.1.<br>• Updated the value of $I_{CES}$ in Section 10.<br>• Updated the package information in Section 6.<br>• Updated the waveform definitions in Section 10.2.<br>• Updated the package outline in Section 11. | | | |
| NGW50T65M3DFP v. 1.1 | 20250307 | Product data sheet | - | NGW50T65M3DFP v. 1 |
| Modifications | • Naming conventions brought into alignment with other data sheets | | | |
| NGW50T65M3DFP v. 1 | 20250117 | Product data sheet | - | - |



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| Document status [1][2] | Product status [3] | Definition |
|---|---|---|
| Objective [short] data sheet | Development | This document contains data from the objective specification for product development. |
| Preliminary [short] data sheet | Qualification | This document contains data from the preliminary specification. |
| Product [short] data sheet | Production | This document contains the product specification. |

[1] Please consult the most recently issued document before initiating or completing a design.
[2] The term 'short data sheet' is explained in section "Definitions".
[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the internet at https://www.nexperia.com.

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