



NGW50T60M3DF

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

Rev. 1.0 — 3 July 2023

Preliminary data sheet

1. General description

The NGW50T60M3DF is a robust Insulated-Gate Bipolar Transistor (IGBT) featuring third-generation technology. It combines carrier stored trench-gate and field-stop (FS) structures. The NGW50T60M3DF is rated to 175 °C with optimized IGBT turn-off losses, and has a short circuit withstand time of 5 μ s. This hard-switching 600 V, 50 A IGBT is optimized for high-voltage, low-frequency industrial power inverter and servo motor drive applications.

2. Features and benefits

- Collector current (I_C) rated at 50 A
- Low conduction and switching losses
- Stable and tight parameters for easy parallel operation
- Maximum junction temperature of 175 °C
- Fully rated as a soft fast reverse recovery diode
- 5 μ s short circuit withstand time
- RoHS compliant, lead-free plating

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
 - Uninterruptible Power Supply (UPS) inverter
 - Photovoltaic (PV) strings
 - EV charging
- Induction heating
- Welding

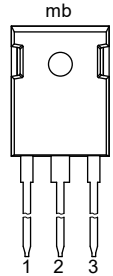
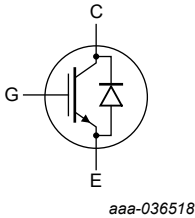
4. Quick reference data

Table 1. Quick reference data

Symbol	Parameter	Conditions	Min	Max	Unit
V_{CE}	collector-emitter voltage	$T_j = 25\text{ °C}$	-	600	V
T_j	operating junction temperature		-40	+175	°C
t_{sc}	short circuit withstand time	$V_{GE} = 15\text{ V}; V_{CC} = 400\text{ V};$ $T_j \leq 175\text{ °C}$	-	5	μ s

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
NGW50T60M3DF	TO-247-3L	Plastic single-ended through-hole package; heatsink mounted; 1 mounting hole; 3-lead TO-247-3L	SOT429-2

7. Limiting values

Table 4. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit
IGBT					
V_{CE}	collector-emitter voltage	$T_j = 25\text{ °C}$	-	600	V
I_C	collector current	$T_{case} = 25\text{ °C}$ [1]	-	80	A
		$T_{case} = 100\text{ °C}$ [1]	-	77	A
I_{Cpuls}	peak pulse collector current [2]		-	150	A
t_{sc}	short circuit withstand time	$V_{GE} = 15\text{ V}; V_{CC} = 400\text{ V};$ $T_j \leq 150\text{ °C}$	-	5.0	μS
V_{GE}	gate-emitter voltage		-20	+20	V
P_{tot}	total power dissipation	$T_{case} = 25\text{ °C}$	-	357	W
		$T_{case} = 100\text{ °C}$	-	179	W
T_j	operating junction temperature		-40	+175	$^{\circ}\text{C}$
T_{stg}	storage temperature		-55	+150	$^{\circ}\text{C}$
T_{solder}	soldering temperature		-	260	$^{\circ}\text{C}$
M	mounting torque, M3 screw		-	0.6	Nm

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

Symbol	Parameter	Conditions	Min	Max	Unit
Diode					
I _F	diode forward current	T _{case} = 25 °C [1]	-	80	A
		T _{case} = 100 °C [1]	-	65	A
I _{Fpuls}	peak pulse diode current [2]	T _{case} = 25 °C		150	A

[1] Value limited by bondwire and T_{j(max)}.

[2] t_p limited by T_{j(max)}.

8. Thermal characteristics

Table 5. Thermal characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
R _{th(j-c)}	thermal resistance from junction to case	IGBT	-	0.29	0.35	K/W
		diode	-	0.48	0.57	K/W
R _{th(j-a)}	thermal resistance from junction to ambient	in free air	-	-	40	K/W

9. Characteristics

Table 6. Characteristics

All values at T_j = 25 °C, unless otherwise specified.

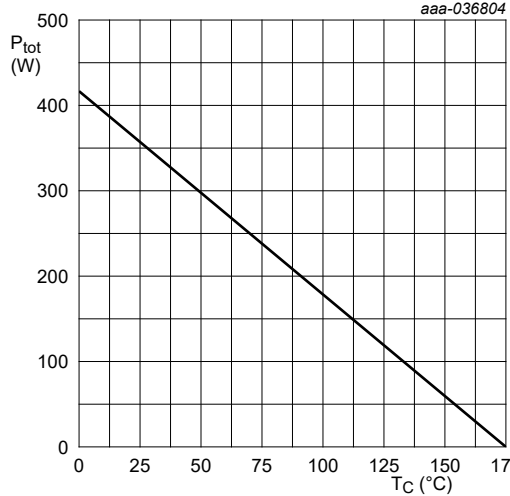
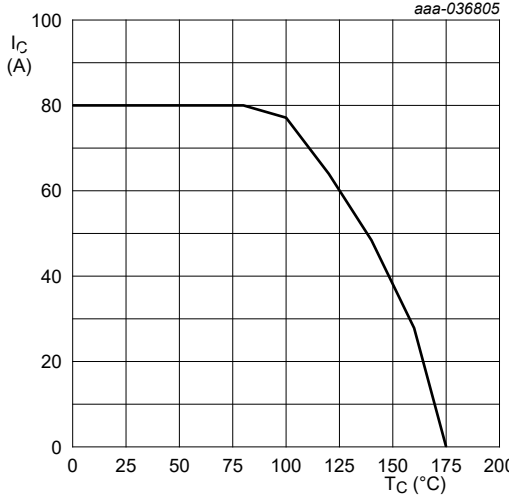
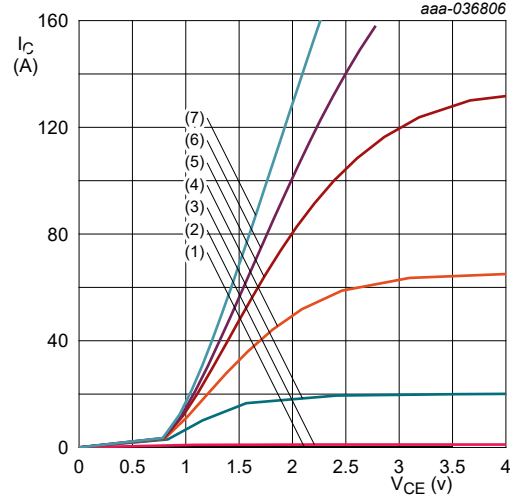
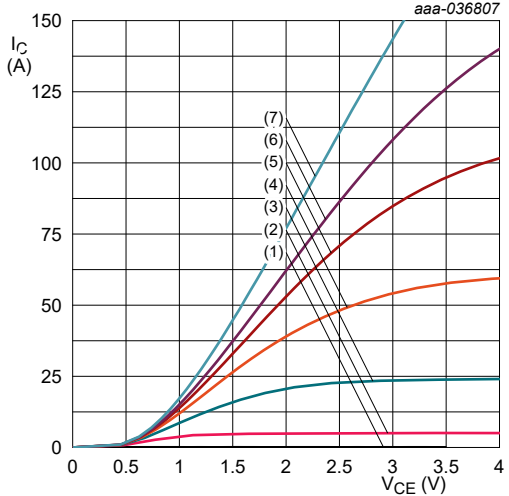
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Static characteristics						
V _{(BR)CE}	collector-emitter breakdown voltage	V _{GE} = 0 V; I _C = 0.2 mA	600	-	-	V
V _{CEsat}	collector-emitter saturation voltage	V _{GE} = 15 V; I _C = 50 A; T _j = 25 °C	-	1.4	1.8	V
		V _{GE} = 15 V; I _C = 50 A; T _j = 175 °C	-	1.8	-	V
V _F	diode forward voltage	V _{GE} = 0 V; I _F = 50 A; T _j = 25 °C	-	1.5	2	V
		V _{GE} = 0 V; I _F = 50 A; T _j = 175 °C	-	1.3	-	V
V _{GE(th)}	gate-emitter threshold voltage	I _C = 0.5 mA; V _{CE} = V _{GE} ; T _j = 25 °C	4	5.4	7	V
I _{CES}	zero gate voltage collector current	V _{CE} = 600 V; V _{GE} = 0 V; T _j = 25 °C	-	-	400	μA
		V _{CE} = 600 V; V _{GE} = 0 V; T _j = 175 °C	-	-	10	mA
I _{GES}	gate-emitter leakage current	V _{CE} = 0 V; V _{GE} = 20 V	-	-	200	nA
g _{fs}	transconductance	V _{CE} = 20 V; I _C = 50 A; T _j = 25 °C	-	22.6	-	S
r _G	integrated gate resistor		-	0.8	-	Ω
Dynamic characteristics						
C _{ies}	input capacitance	V _{CE} = 25 V; V _{GE} = 0 V; f = 1 MHz	-	5527	-	pF
C _{oes}	output capacitance		-	212	-	pF
C _{res}	reverse transfer capacitance		-	44	-	pF
Q _G	gate charge	V _{CC} = 480 V; V _{GE} = 15 V; I _C = 50 A	-	213	-	nC
L _{sCE}	internal stray conductance	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 _j ≤ 150 °C	-	190	-	A

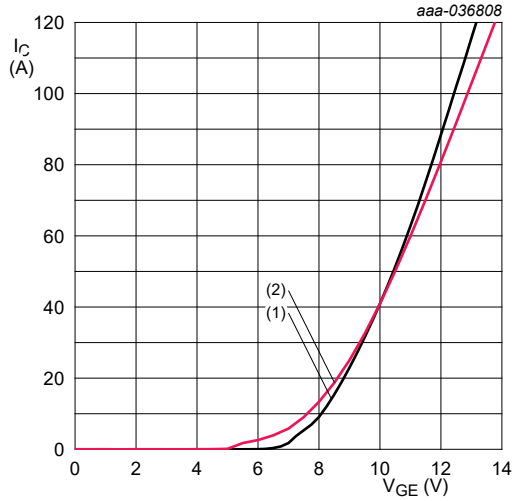
600 V, 50 A trench field-stop IGBT with full rated silicon diode

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
IGBT switching characteristics, inductive load						
$t_{d(on)}$	turn-on delay time	$V_{GE} = 15/0 \text{ V};$ $V_{CC} = 400 \text{ V}; I_C = 50 \text{ A};$ $r_{G(on)} = 10 \text{ } \Omega; r_{G(off)} = 10 \text{ } \Omega;$ see Fig. 26 and Fig. 27	$T_j = 25 \text{ } ^\circ\text{C}$	-	58	- ns
			$T_j = 175 \text{ } ^\circ\text{C}$	-	55	- ns
t_r	rise time		$T_j = 25 \text{ } ^\circ\text{C}$	-	41	- ns
			$T_j = 175 \text{ } ^\circ\text{C}$	-	42	- ns
$t_{d(off)}$	turn-off delay time		$T_j = 25 \text{ } ^\circ\text{C}$	-	243	- ns
			$T_j = 175 \text{ } ^\circ\text{C}$	-	299	- ns
t_f	fall time		$T_j = 25 \text{ } ^\circ\text{C}$	-	19	- ns
			$T_j = 175 \text{ } ^\circ\text{C}$	-	58	- ns
E_{on}	turn-on switching loss		$T_j = 25 \text{ } ^\circ\text{C}$	-	1.7	- mJ
			$T_j = 175 \text{ } ^\circ\text{C}$	-	1.85	- mJ
E_{off}	turn-off switching loss		$T_j = 25 \text{ } ^\circ\text{C}$	-	0.84	- mJ
			$T_j = 175 \text{ } ^\circ\text{C}$	-	1.33	- mJ
E_{ts}	total switching loss		$T_j = 25 \text{ } ^\circ\text{C}$	-	2.54	- mJ
			$T_j = 175 \text{ } ^\circ\text{C}$	-	3.18	- mJ
Diode switching characteristics, inductive load						
t_{rr}	diode reverse recovery time	$V_R = 400 \text{ V}; I_F = 50 \text{ A};$ $\Delta I_F/\Delta t = 500 \text{ A}/\mu\text{s};$ see Fig. 25	$T_j = 25 \text{ } ^\circ\text{C}$	-	180	- ns
			$T_j = 175 \text{ } ^\circ\text{C}$	-	630	- ns
Q_{rr}	diode reverse recovery charge		$T_j = 25 \text{ } ^\circ\text{C}$	-	520	- nC
			$T_j = 175 \text{ } ^\circ\text{C}$	-	4180	- nC
I_{rrm}	diode peak reverse recovery current		$T_j = 25 \text{ } ^\circ\text{C}$	-	9	- A
			$T_j = 175 \text{ } ^\circ\text{C}$	-	18	- A
E_{rr}	reverse recovery energy		$T_j = 25 \text{ } ^\circ\text{C}$	-	0.01	- mJ
			$T_j = 175 \text{ } ^\circ\text{C}$	-	0.14	- mJ
di_{rr}/dt	diode peak rate or fall of reverse recovery current		$T_j = 25 \text{ } ^\circ\text{C}$	-	270	- A/ μs
			$T_j = 175 \text{ } ^\circ\text{C}$	-	200	- A/ μs

9.1. Waveforms and output characteristics

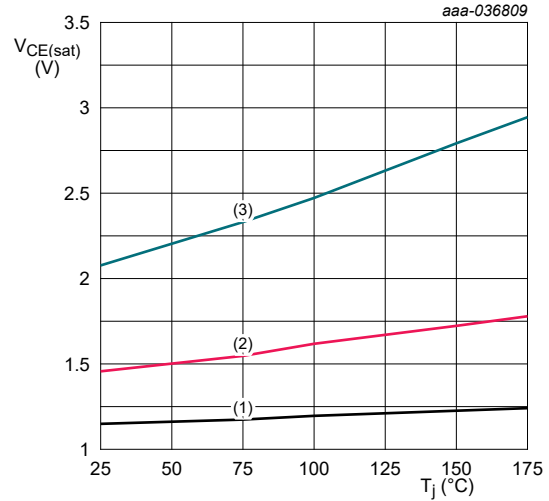
Table 7. Waveforms and output characteristics

 <p>aaa-036804</p>	 <p>aaa-036805</p>
<p>Fig. 1. Power dissipation (P_{tot}) as a function of case temperature</p>	<p>Fig. 2. Collector current (I_C) as a function of case temperature</p>
 <p>aaa-036806</p> <p>$T_j = 25\text{ °C}$</p> <ul style="list-style-type: none"> (1) $V_{GE} = 5\text{ V}$ (2) $V_{GE} = 7\text{ V}$ (3) $V_{GE} = 9\text{ V}$ (4) $V_{GE} = 11\text{ V}$ (5) $V_{GE} = 13\text{ V}$ (6) $V_{GE} = 15\text{ V}$ (7) $V_{GE} = 20\text{ V}$ 	 <p>aaa-036807</p> <p>$T_j = 175\text{ °C}$</p> <ul style="list-style-type: none"> (1) $V_{GE} = 5\text{ V}$ (2) $V_{GE} = 7\text{ V}$ (3) $V_{GE} = 9\text{ V}$ (4) $V_{GE} = 11\text{ V}$ (5) $V_{GE} = 13\text{ V}$ (6) $V_{GE} = 15\text{ V}$ (7) $V_{GE} = 20\text{ V}$
<p>Fig. 3. Collector current as a function of collector-emitter voltage</p>	<p>Fig. 4. Collector current as a function of collector-emitter voltage</p>



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

Fig. 5. Collector current as a function of gate-emitter voltage; typical values



$V_{GE} = 15$ 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; typical values

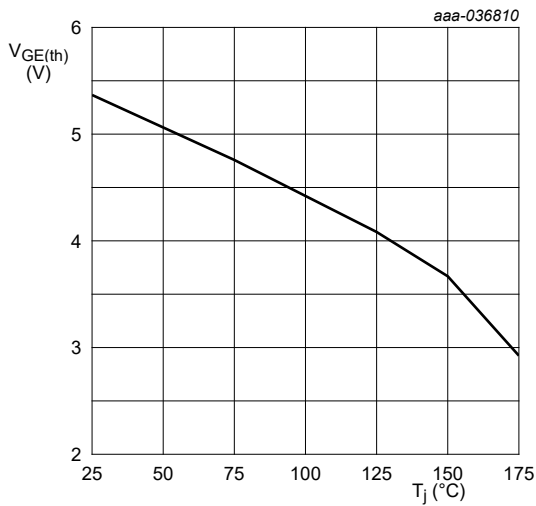
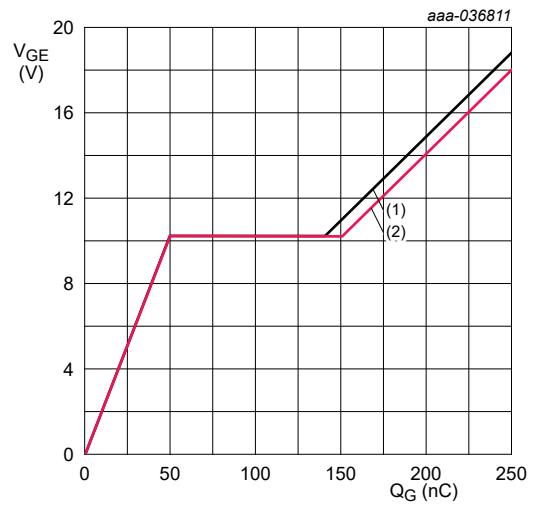
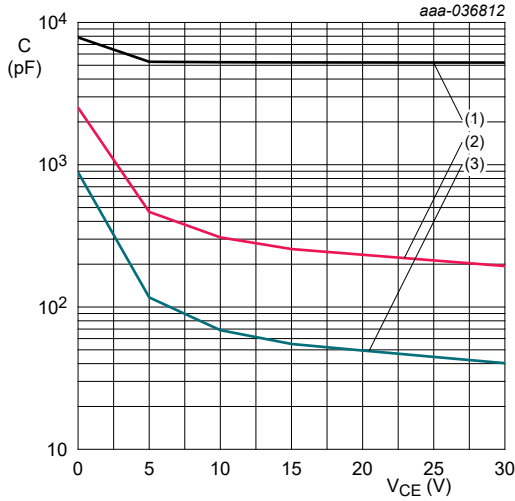


Fig. 7. Gate-emitter threshold voltage as a function of junction temperature



$I_C = 50$ A
 (1) $V_{CE} = 120$ V
 (2) $V_{CE} = 480$ V

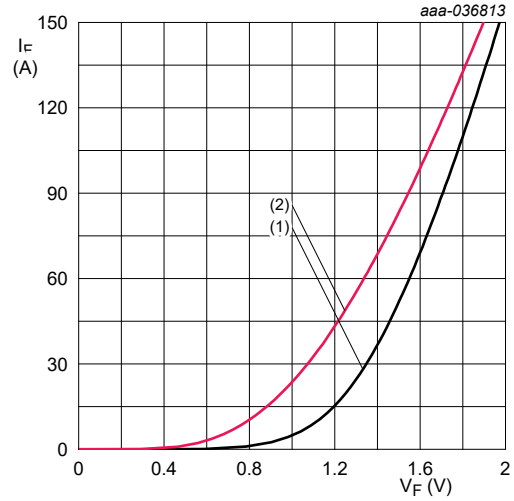
Fig. 8. Gate-emitter voltage as a function of gate charge; typical values



$V_{GE} = 0 \text{ V}$, $f = 1 \text{ MHz}$

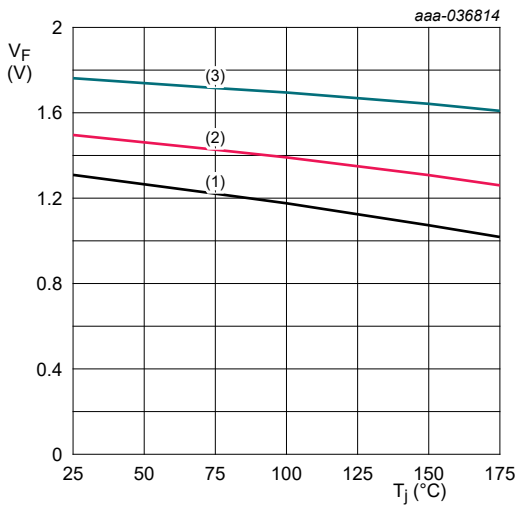
- (1) C_{ies}
- (2) C_{oes}
- (3) C_{res}

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



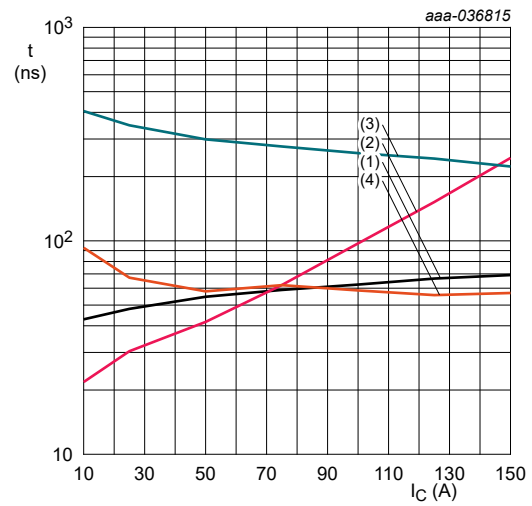
- (1) $T_{amb} = 25 \text{ °C}$
- (2) $T_{amb} = 175 \text{ °C}$

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



- (1) $I_F = 25 \text{ A}$
- (2) $I_F = 50 \text{ A}$
- (3) $I_F = 100 \text{ A}$

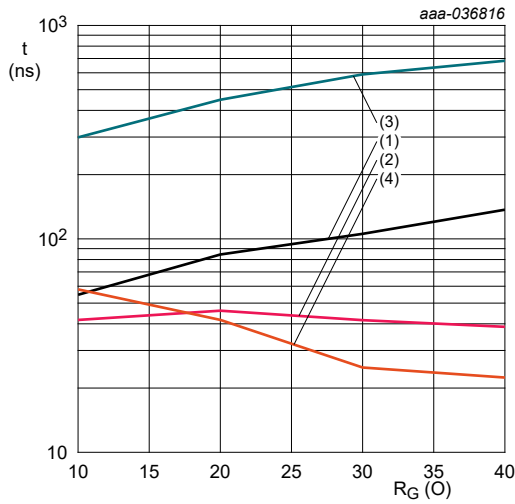
Fig. 11. Typical diode forward voltage as a function of junction temperature



$V_{GE} = 15 \text{ V to } 0 \text{ V}$; $V_{CC} = 400 \text{ V}$; $r_{G(on)} = 10 \text{ } \Omega$;
 $r_{G(off)} = 10 \text{ } \Omega$

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

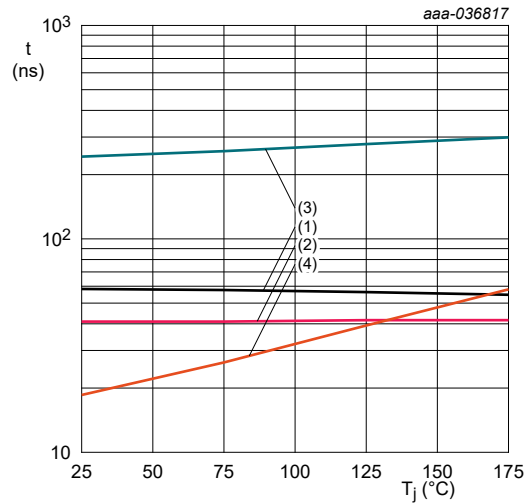
Fig. 12. Typical switching times as a function of collector current



$V_{GE} = 15\text{ V to }0\text{ V}; V_{CC} = 400\text{ V}; I_C = 50\text{ A}; T_j = 175\text{ }^\circ\text{C}$

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

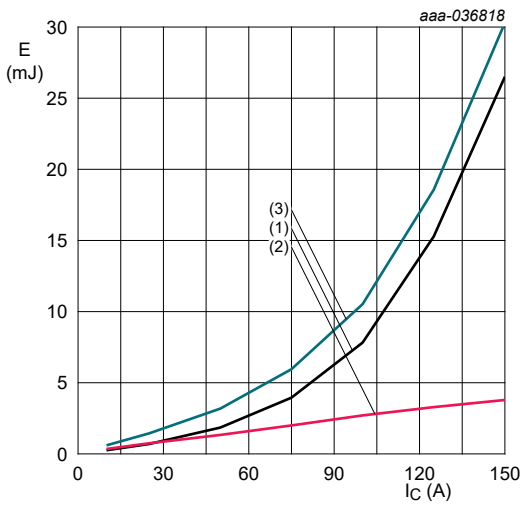
Fig. 13. Typical switching times as a function of gate resistor



$V_{GE} = 15\text{ V to }0\text{ V}; I_C = 50\text{ A}; V_{CC} = 400\text{ V}; r_{G(on)} = 10\text{ }^\Omega; r_{G(off)} = 10\text{ }^\Omega$

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

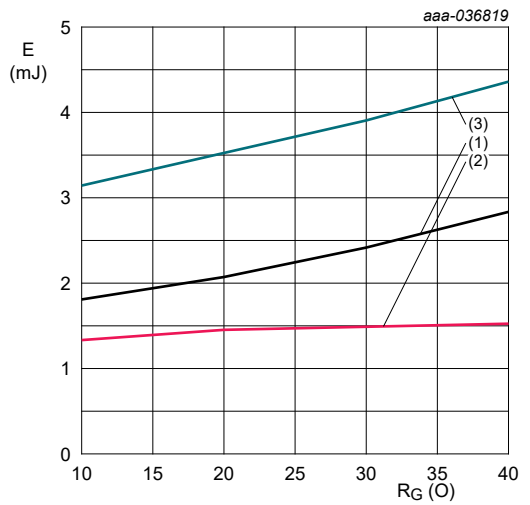
Fig. 14. Typical switching times as a function of junction temperature



$V_{GE} = 15\text{ V to }0\text{ V}; V_{CC} = 400\text{ V}; r_{G(on)} = 10\text{ }^\Omega; r_{G(off)} = 10\text{ }^\Omega; T_j = 175\text{ }^\circ\text{C}$

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

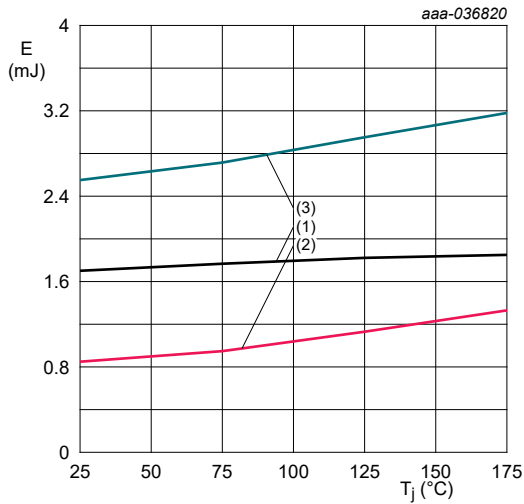
Fig. 15. Typical switching energy losses as a function of collector current



$V_{GE} = 15\text{ V to }0\text{ V}; V_{CC} = 400\text{ V}; I_C = 50\text{ A}; T_j = 175\text{ }^\circ\text{C}$

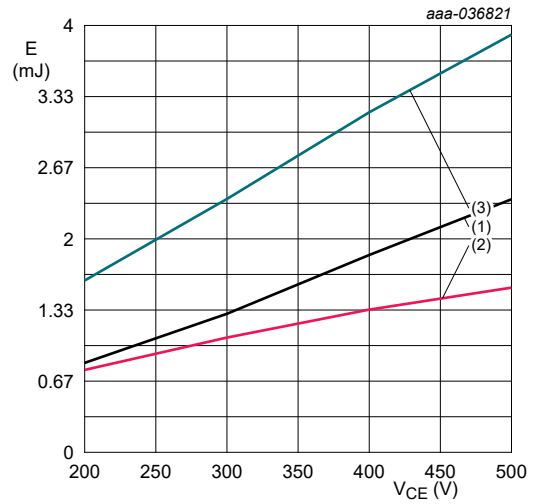
- (1) E_{on}
- (2) E_{off}
- (3) E_{ts}

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



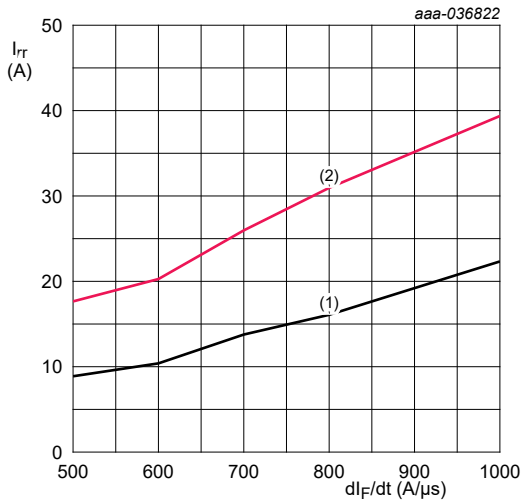
$V_{GE} = 15 \text{ V to } 0 \text{ V}; I_C = 50 \text{ A}; V_{CC} = 400 \text{ V};$
 $r_{G(on)} = 10 \text{ } \Omega; r_{G(off)} = 10 \text{ } \Omega$
 (1) E_{on}
 (2) E_{off}
 (3) E_{ts}

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



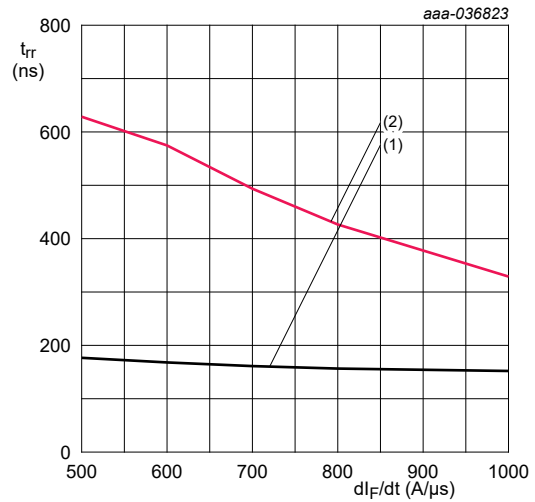
$V_{GE} = 15 \text{ V to } 0 \text{ V}; I_C = 50 \text{ A}; r_{G(on)} = 10 \text{ } \Omega;$
 $r_{G(off)} = 10 \text{ } \Omega; T_j = 175 \text{ } ^\circ\text{C}$
 (1) E_{on}
 (2) E_{off}
 (3) E_{ts}

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



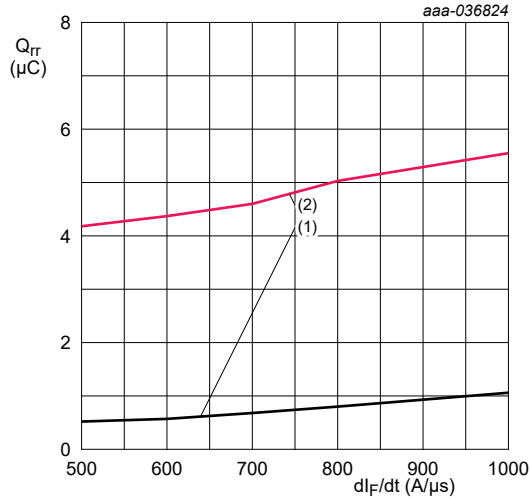
$V_R = 400 \text{ V}; I_F = 50 \text{ A}$
 (1) $T_{amb} = 25 \text{ } ^\circ\text{C}$
 (2) $T_{amb} = 175 \text{ } ^\circ\text{C}$

Fig. 19. Typical reverse recovery current as a function of change of forward current



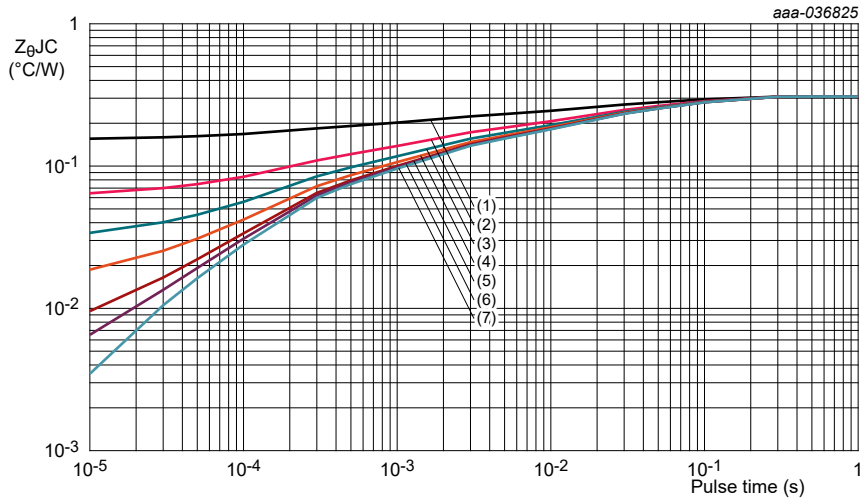
$V_R = 400 \text{ V}; I_F = 50 \text{ A}$
 (1) $T_{amb} = 25 \text{ } ^\circ\text{C}$
 (2) $T_{amb} = 175 \text{ } ^\circ\text{C}$

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



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

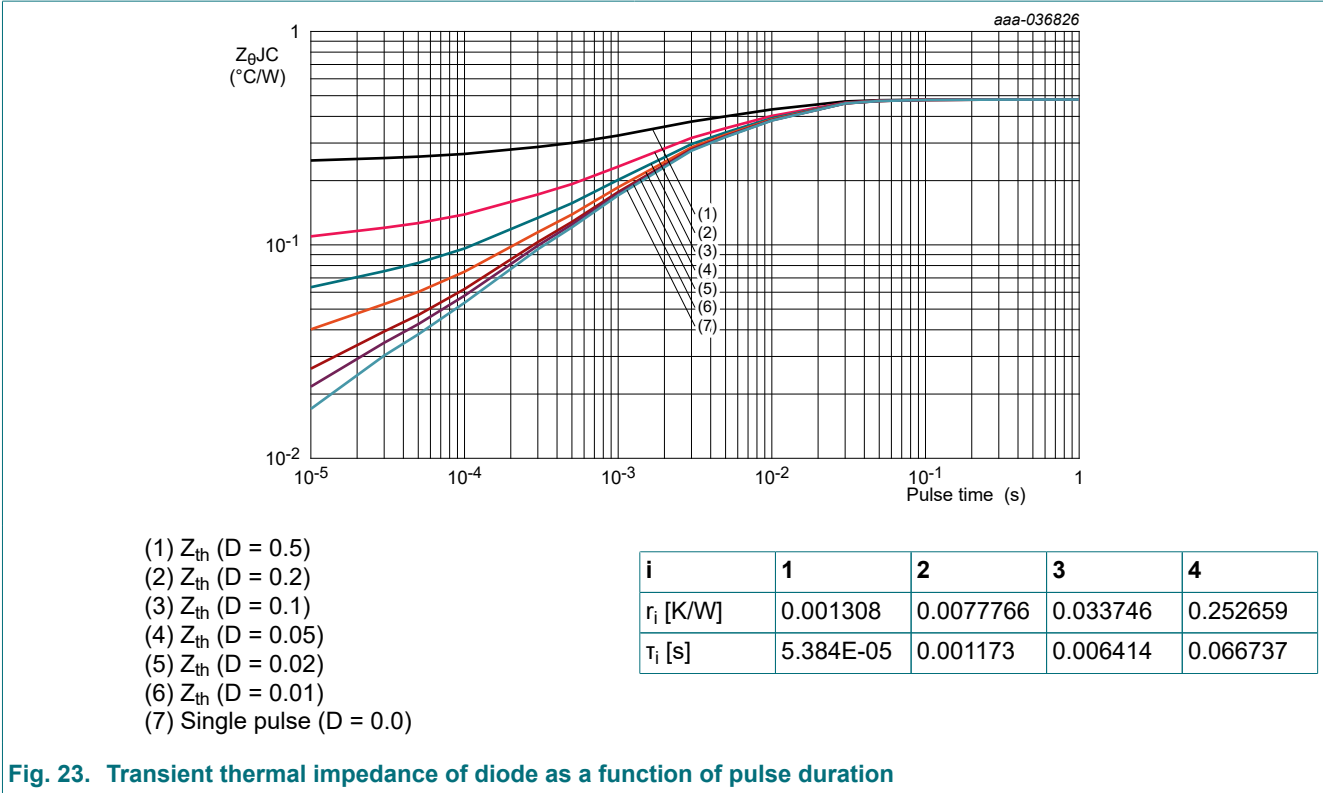
Fig. 21. Typical reverse recovery charge as a function of rate of change of forward current



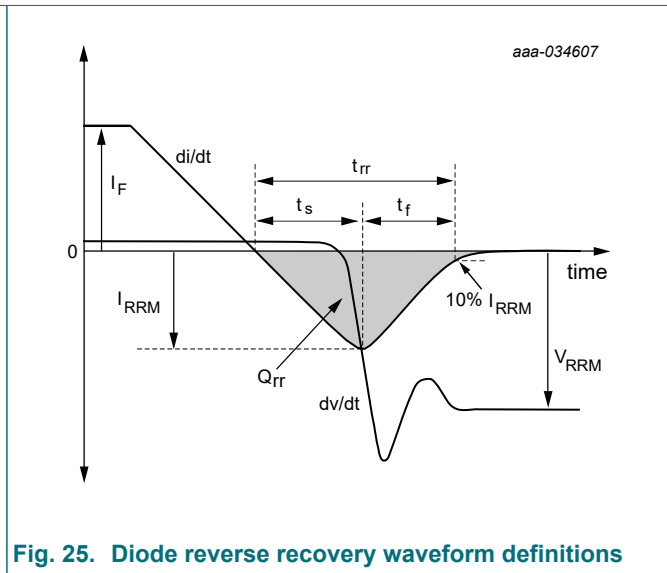
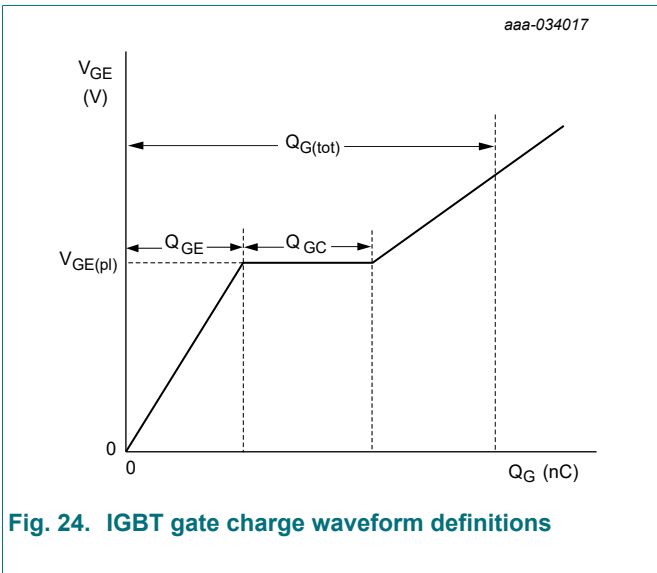
- (1) $Z_{th} (D = 0.5)$
- (2) $Z_{th} (D = 0.2)$
- (3) $Z_{th} (D = 0.1)$
- (4) $Z_{th} (D = 0.05)$
- (5) $Z_{th} (D = 0.02)$
- (6) $Z_{th} (D = 0.01)$
- (7) Single pulse ($D = 0.0$)

i	1	2	3	4
r_i [K/W]	0.046192	0.071159	0.078864	0.111922
T_i [s]	0.000162	0.001166	0.010189	0.071390

Fig. 22. Transient thermal impedance of IGBT as a function of pulse duration



9.2. Waveforms



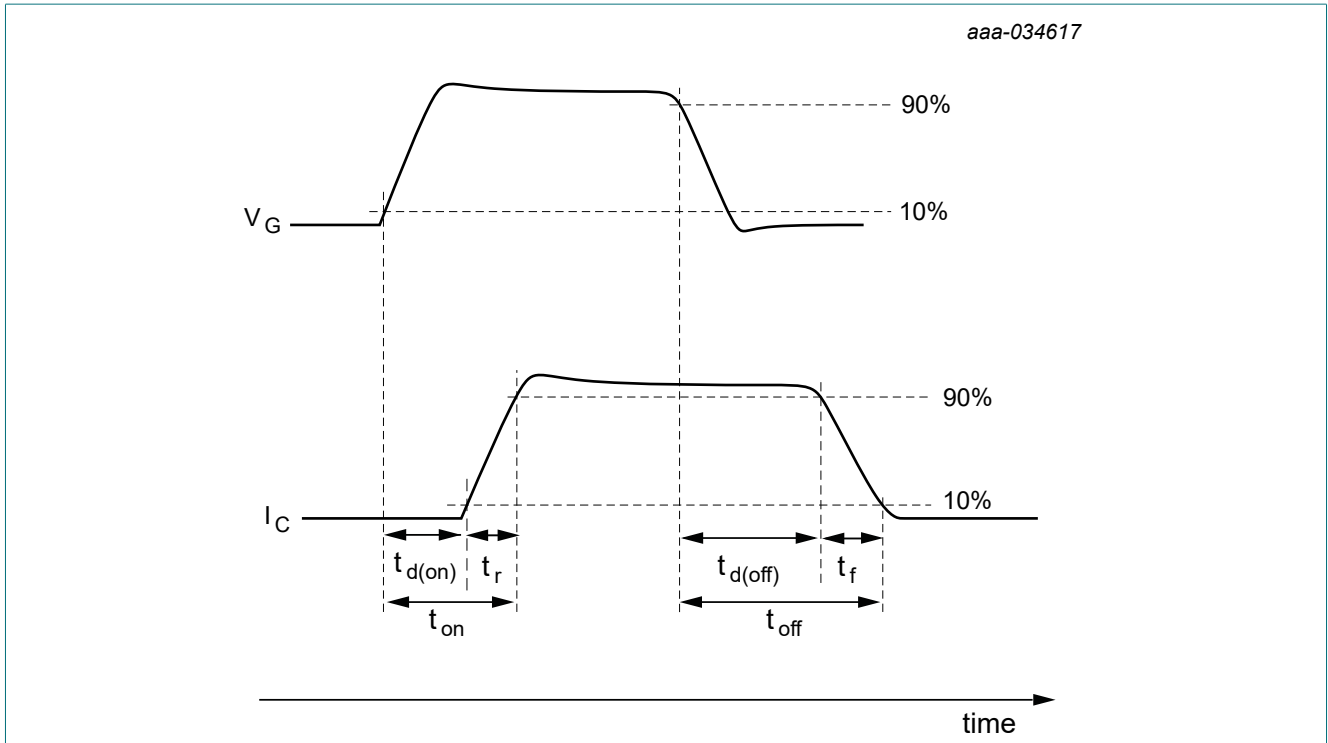
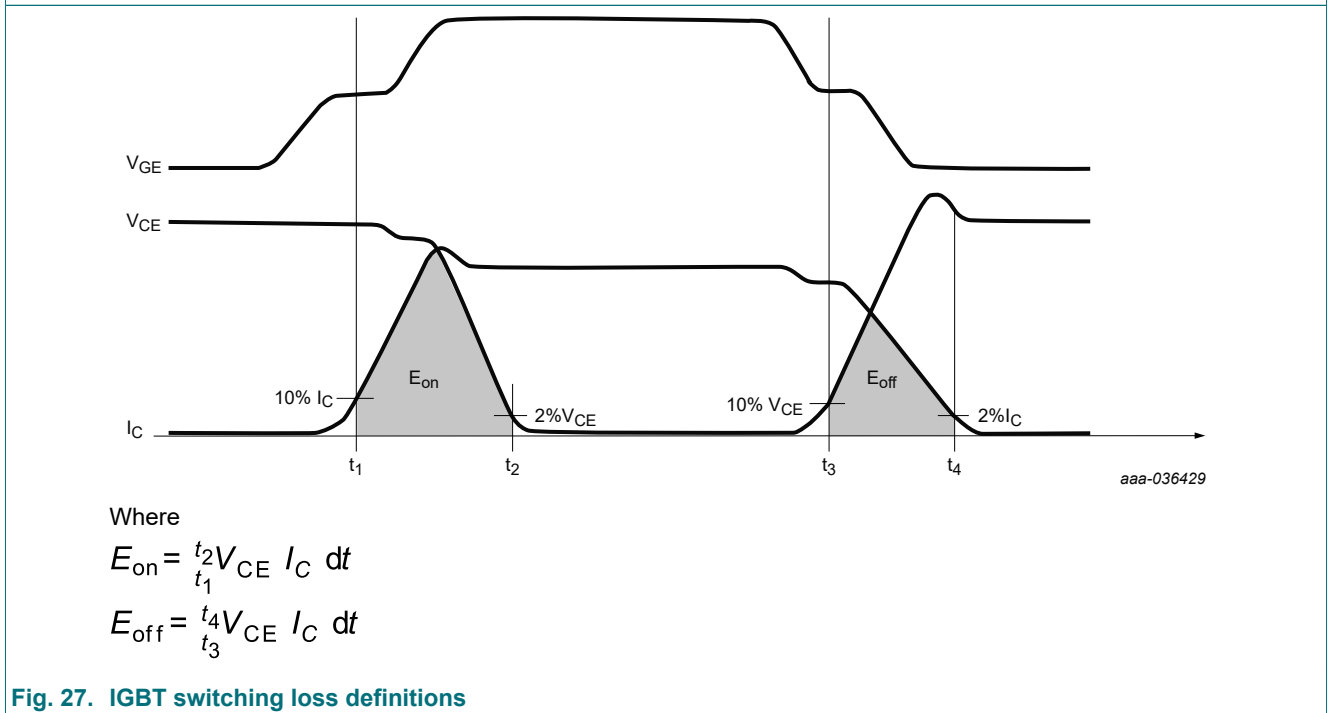


Fig. 26. IGBT switching times definitions



Where

$$E_{on} = \int_{t_1}^{t_2} V_{CE} I_C dt$$

$$E_{off} = \int_{t_3}^{t_4} V_{CE} I_C dt$$

Fig. 27. IGBT switching loss definitions

10. Package outline

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

SOT429-2

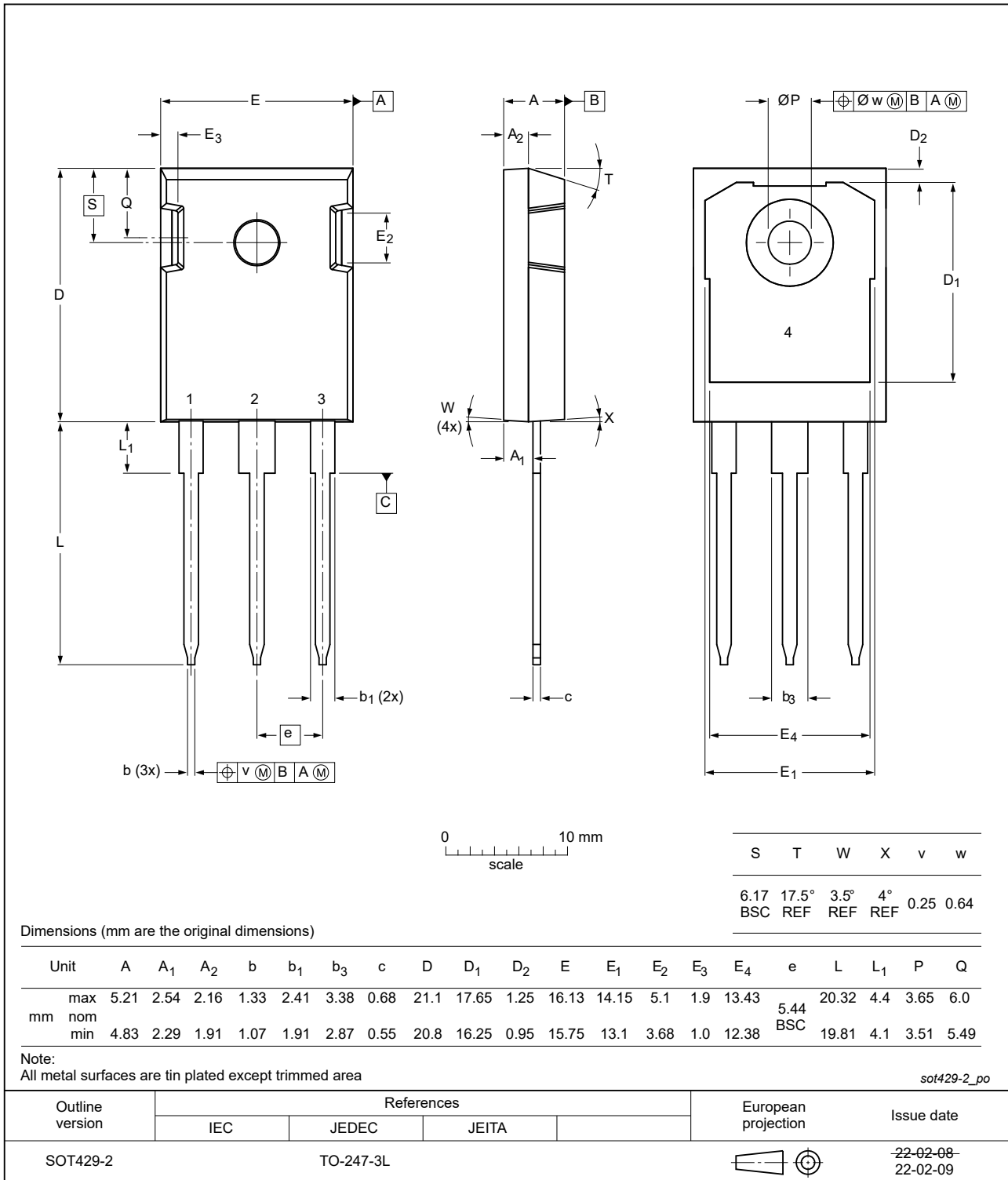


Fig. 28. Package outline TO-247-3L (SOT429-2)

11. Revision history

Table 8. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
NGW50T60M3DF v. 1.0	20230703	Preliminary data sheet	-	-

12. Legal information

Data sheet status

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>.

Definitions

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Date of release: 3 July 2023
