



# NGW30T60M3DF

600 V, 30 A trench field-stop IGBT with full rated silicon diode

Rev. 1 — 3 July 2023

Product data sheet

## 1. General description

The NGW30T60M3DF is a robust Insulated-Gate Bipolar Transistor (IGBT) featuring third-generation technology. It combines carrier stored trench-gate and field-stop (FS) structures. The NGW30T60M3DF is rated to 175 °C with optimized IGBT turn-off losses, and has a short circuit withstand time of 5  $\mu$ s. This hard-switching 600 V, 30 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 30 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  $\mu$ 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

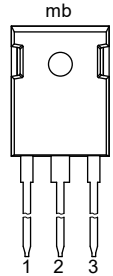
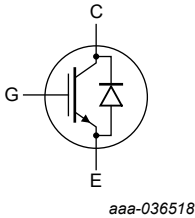
## 4. Quick reference data

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	$V_{GE} = 15\text{ V}; V_{CC} = 400\text{ V}; T_j \leq 150\text{ °C}$	-	5	$\mu$ 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
<a href="#">NGW30T60M3DF</a>	TO-247-3L	Plastic single-ended through-hole package; heatsink mounted; 1 mounting hole; 3-lead TO-247-3L	<a href="#">SOT429-2</a>

## 7. Limiting values

Table 4. Limiting values

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

Symbol	Parameter	Conditions	Min	Max	Unit
<b>IGBT</b>					
$V_{CE}$	collector-emitter voltage	$T_j = 25\text{ °C}$	-	600	V
$I_C$	collector current	$T_{case} = 25\text{ °C}$ [1]	-	75	A
		$T_{case} = 100\text{ °C}$ [1]	-	45	A
$I_{Cpuls}$	peak pulse collector current [2]		-	90	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	$\mu\text{s}$
$V_{GS}$	gate-source voltage		-20	+20	V
$P_{tot}$	total power dissipation	$T_{case} = 25\text{ °C}$	-	285	W
		$T_{case} = 100\text{ °C}$	-	142	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
<b>Diode</b>					
$I_F$	diode forward current	$T_{case} = 25\text{ °C}$ [1]	-	80	A
		$T_{case} = 100\text{ °C}$ [1]	-	58	A
$I_{Fpuls}$	peak pulse diode current [2]	$T_{case} = 25\text{ °C}$		90	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	-	0.45	0.53	K/W
		diode	-	0.71	0.84	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  $T_j = 25\text{ °C}$ , unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Static characteristics</b>						
$V_{(BR)CE}$	collector-emitter breakdown voltage	$V_{GE} = 0\text{ V}; I_C = 0.2\text{ mA}$	600	-	-	V
$V_{CEsat}$	collector-emitter saturation voltage	$V_{GE} = 15\text{ V}; I_C = 30\text{ A}; T_j = 25\text{ °C}$	-	1.4	1.7	V
		$V_{GE} = 15\text{ V}; I_C = 30\text{ A}; T_j = 175\text{ °C}$	-	1.7	-	V
$V_F$	diode forward voltage	$V_{GE} = 0\text{ V}; I_F = 30\text{ A}; T_j = 25\text{ °C}$	-	1.5	2.2	V
		$V_{GE} = 0\text{ V}; I_F = 30\text{ A}; T_j = 175\text{ °C}$	-	1.2	-	V
$V_{GE(th)}$	gate-emitter threshold voltage	$I_C = 0.3\text{ mA}; V_{CE} = V_{GE}; T_j = 25\text{ °C}$	4	5	7	V
$I_{CES}$	zero gate voltage collector current	$V_{CE} = 600\text{ V}; V_{GE} = 0\text{ V}; T_j = 25\text{ °C}$	-	-	400	$\mu\text{A}$
		$V_{CE} = 600\text{ V}; V_{GE} = 0\text{ V}; T_j = 175\text{ °C}$	-	-	10	mA
$I_{GES}$	gate-emitter leakage current	$V_{CE} = 0\text{ V}; V_{GE} = 20\text{ V}$	-	-	200	nA
$g_{fs}$	transconductance	$V_{CE} = 20\text{ V}; I_C = 30\text{ A}; T_j = 25\text{ °C}$	-	18.5	-	S
$r_G$	integrated gate resistor		-	0.9	-	$\Omega$
<b>Dynamic characteristics</b>						
$C_{ies}$	input capacitance	$V_{CE} = 25\text{ V}; V_{GE} = 0\text{ V}; f = 1\text{ MHz}$	-	2040	-	pF
$C_{oes}$	output capacitance		-	136	-	pF
$C_{res}$	reverse transfer capacitance		-	31	-	pF
$Q_G$	gate charge	$V_{CC} = 480\text{ V}; V_{GE} = 15\text{ V}; I_C = 30\text{ A}$	-	130	-	nC
$L_{sCE}$	internal stray inductance	Measured 5 mm from case	-	7.9	-	nH
$I_{C(sc)}$	short circuit collector current	$V_{GE} = 15\text{ V}; V_{CC} = 400\text{ V}; t_{sc} \leq 5\text{ }\mu\text{s}; T_j \leq 150\text{ °C}$	-	130	-	A

## 600 V, 30 A trench field-stop IGBT with full rated silicon diode

Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
<b>IGBT switching characteristics, inductive load</b>							
$t_{d(on)}$	turn-on delay time	$V_{GE} = 15/0\text{ V}; V_{CC} = 400\text{ V};$ $I_C = 30\text{ A}; r_{G(on)} = 10\ \Omega;$ $r_{G(off)} = 10\ \Omega;$ see <a href="#">Fig. 26</a> and <a href="#">Fig. 27</a>	$T_j = 25\text{ }^\circ\text{C}$	-	60	-	ns
			$T_j = 175\text{ }^\circ\text{C}$	-	60	-	ns
$t_r$	rise time		$T_j = 25\text{ }^\circ\text{C}$	-	40	-	ns
			$T_j = 175\text{ }^\circ\text{C}$	-	45	-	ns
$t_{d(off)}$	turn-off delay time		$T_j = 25\text{ }^\circ\text{C}$	-	180	-	ns
			$T_j = 175\text{ }^\circ\text{C}$	-	225	-	ns
$t_f$	fall time		$T_j = 25\text{ }^\circ\text{C}$	-	15	-	ns
			$T_j = 175\text{ }^\circ\text{C}$	-	45	-	ns
$E_{on}$	turn-on switching loss		$T_j = 25\text{ }^\circ\text{C}$	-	0.7	-	mJ
			$T_j = 175\text{ }^\circ\text{C}$	-	0.85	-	mJ
$E_{off}$	turn-off switching loss		$T_j = 25\text{ }^\circ\text{C}$	-	0.4	-	mJ
			$T_j = 175\text{ }^\circ\text{C}$	-	0.75	-	mJ
$E_{ts}$	total switching loss		$T_j = 25\text{ }^\circ\text{C}$	-	1.1	-	mJ
			$T_j = 175\text{ }^\circ\text{C}$	-	1.6	-	mJ
<b>Diode switching characteristics, inductive load</b>							
$t_{rr}$	diode reverse recovery time	$V_R = 400\text{ V}; I_F = 30\text{ A};$ $\Delta I_F/\Delta t = 500\text{ A}/\mu\text{s};$ see <a href="#">Fig. 25</a>	$T_j = 25\text{ }^\circ\text{C}$	-	110	-	ns
			$T_j = 175\text{ }^\circ\text{C}$	-	195	-	ns
$Q_{rr}$	diode reverse recovery charge		$T_j = 25\text{ }^\circ\text{C}$	-	850	-	nC
			$T_j = 175\text{ }^\circ\text{C}$	-	3250	-	nC
$I_{rrm}$	diode peak reverse recovery current		$T_j = 25\text{ }^\circ\text{C}$	-	13	-	A
			$T_j = 175\text{ }^\circ\text{C}$	-	25	-	A
$E_{rr}$	reverse recovery energy		$T_j = 25\text{ }^\circ\text{C}$	-	0.15	-	mJ
			$T_j = 175\text{ }^\circ\text{C}$	-	0.55	-	mJ
$di_{rr}/dt$	diode peak rate of fall of reverse recovery current		$T_j = 25\text{ }^\circ\text{C}$	-	650	-	A/ $\mu\text{s}$
			$T_j = 175\text{ }^\circ\text{C}$	-	760	-	A/ $\mu\text{s}$

9.1. Output characteristics

Table 7. Waveforms and output characteristics

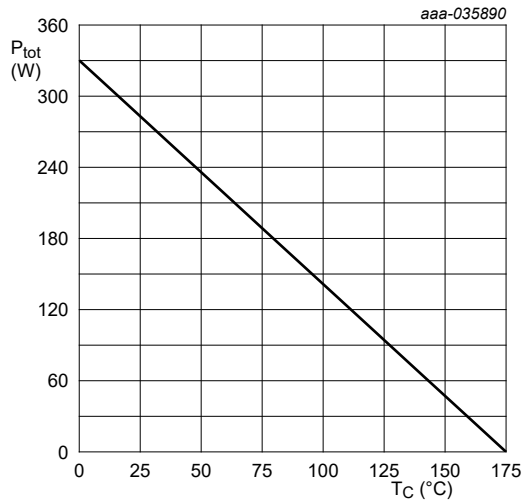


Fig. 1. Power dissipation ( $P_{tot}$ ) as a function of case temperature

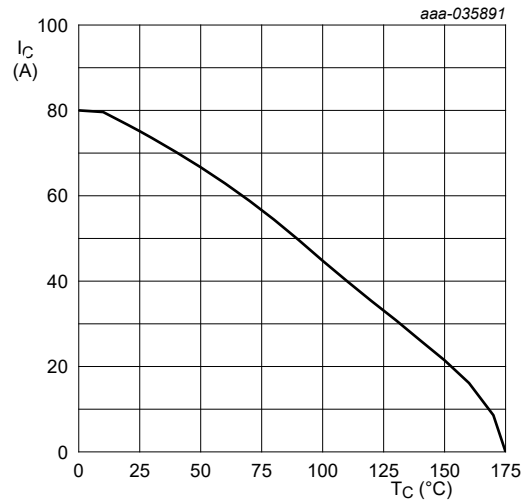
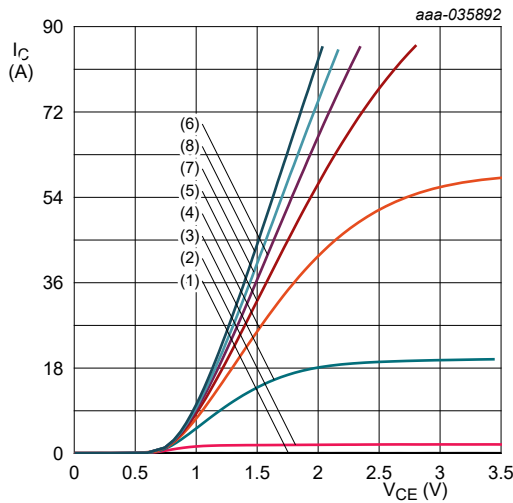
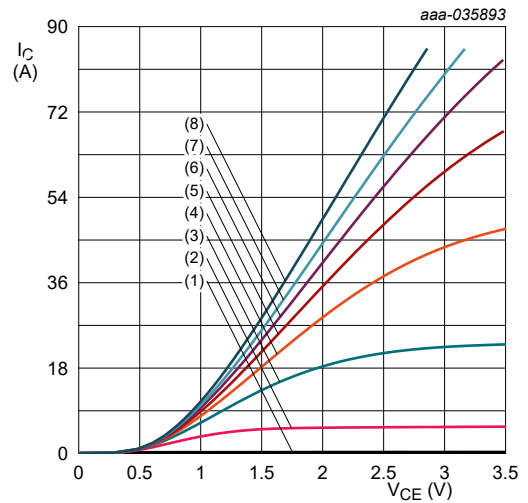


Fig. 2. Collector current ( $I_C$ ) as a function of case temperature



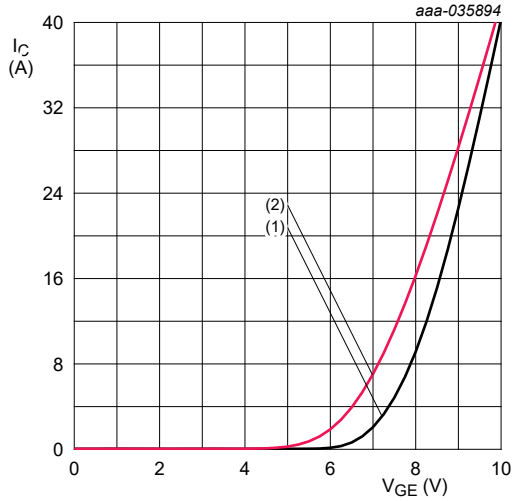
- $T_j = 25\text{ °C}$
- (1)  $V_{GE} = 5\text{ V}$
  - (2)  $V_{GE} = 7\text{ V}$
  - (3)  $V_{GE} = 9\text{ V}$
  - (4)  $V_{GE} = 11\text{ V}$
  - (5)  $V_{GE} = 13\text{ V}$
  - (6)  $V_{GE} = 15\text{ V}$
  - (7)  $V_{GE} = 17\text{ V}$
  - (8)  $V_{GE} = 20\text{ V}$

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



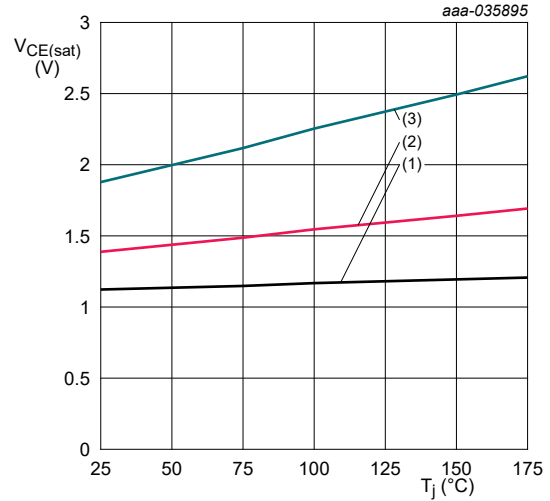
- $T_j = 175\text{ °C}$
- (1)  $V_{GE} = 5\text{ V}$
  - (2)  $V_{GE} = 7\text{ V}$
  - (3)  $V_{GE} = 9\text{ V}$
  - (4)  $V_{GE} = 11\text{ V}$
  - (5)  $V_{GE} = 13\text{ V}$
  - (6)  $V_{GE} = 15\text{ V}$
  - (7)  $V_{GE} = 17\text{ V}$
  - (8)  $V_{GE} = 20\text{ V}$

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



$V_{CE} = 20$  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)  $I_C = 15$  A  
 (2)  $I_C = 30$  A  
 (3)  $I_C = 60$  A

Fig. 6. Collector-emitter saturation voltage as a function of junction temperature; typical values

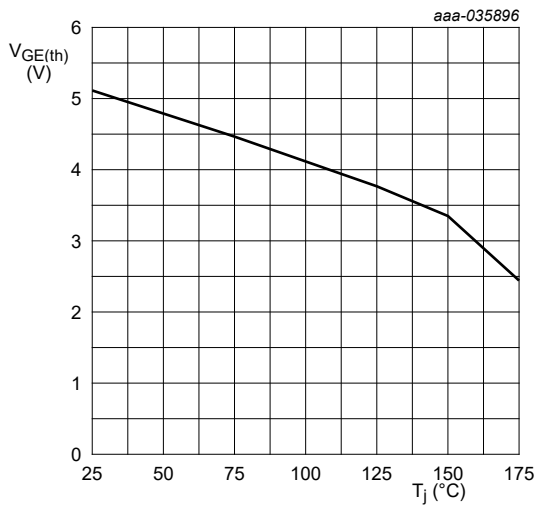
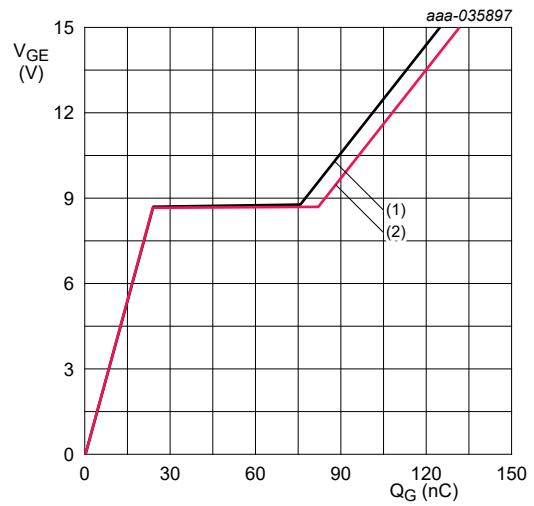
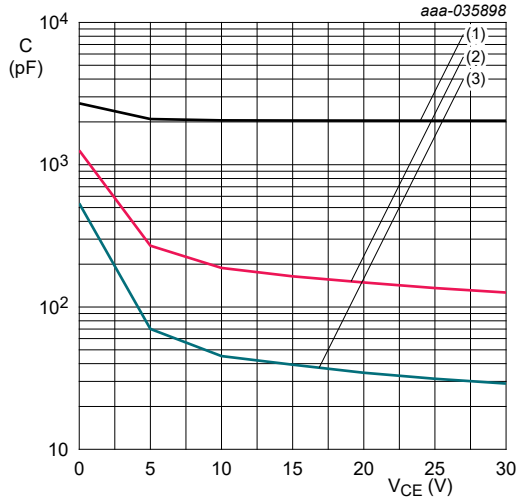


Fig. 7. Gate-emitter threshold voltage as a function of junction temperature



$I_C = 30$  A  
 (1)  $V_{CE} = 120$  V  
 (2)  $V_{CE} = 480$  V

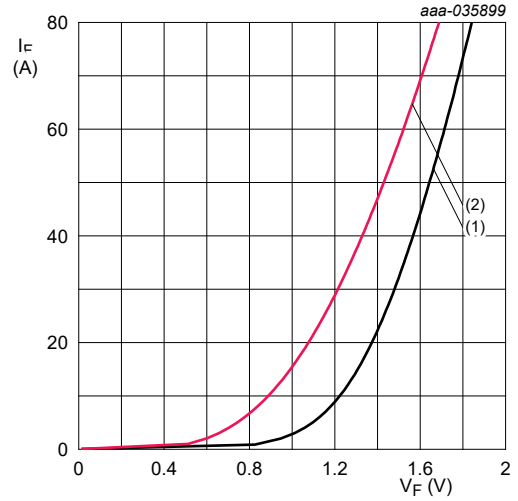
Fig. 8. Gate-emitter voltage as a function of gate charge; typical values



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

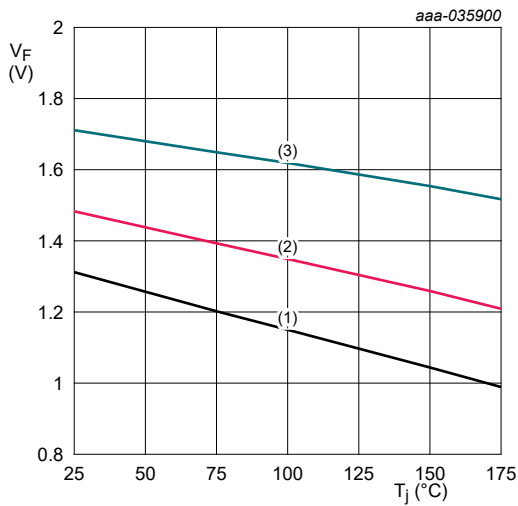
- (1)  $C_{ies}$
- (2)  $C_{oes}$
- (3)  $C_{res}$

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



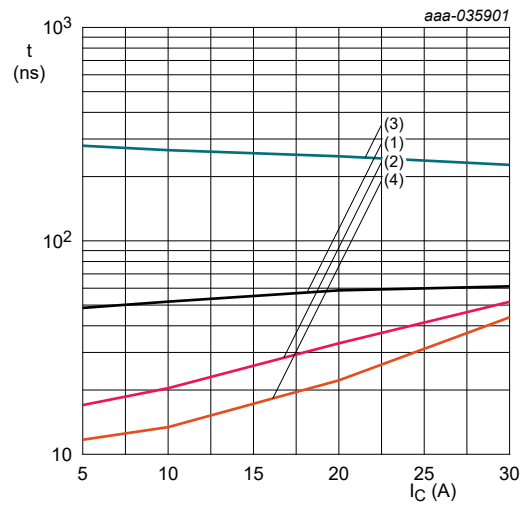
- (1)  $T_{amb} = 25 \text{ °C}$
- (2)  $T_{amb} = 175 \text{ °C}$

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



- (1)  $I_F = 15 \text{ A}$
- (2)  $I_F = 30 \text{ A}$
- (3)  $I_F = 60 \text{ A}$

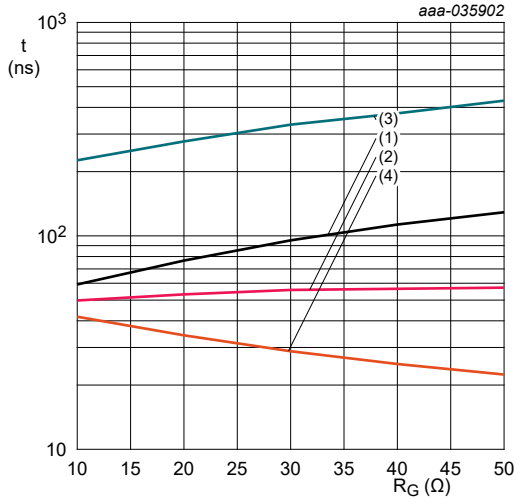
**Fig. 11. Typical diode forward voltage as a function of junction temperature**



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

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

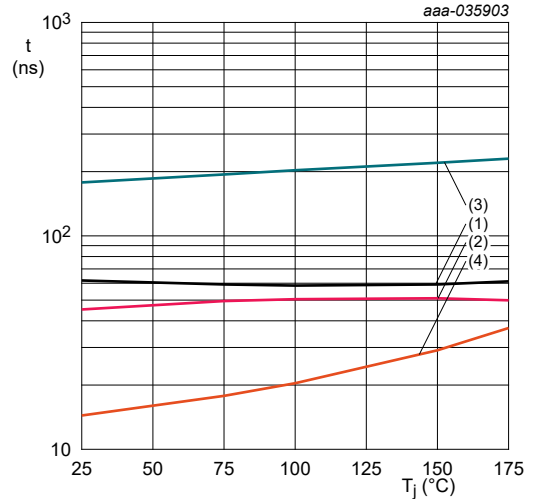
**Fig. 12. Typical switching times as a function of collector current**



$V_{GE} = 15\text{ V to }0\text{ V}; V_{CC} = 400\text{ V}; I_C = 30\text{ A};$   
 $T_j = 175\text{ }^\circ\text{C}$

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

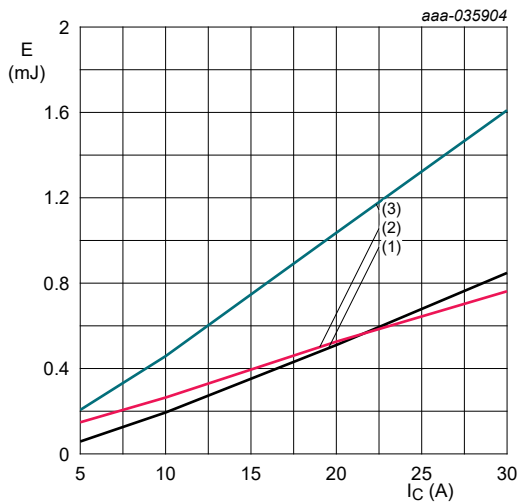
Fig. 13. Typical switching times as a function of gate resistor



$V_{GE} = 15\text{ V to }0\text{ V}; I_C = 30\text{ A}; V_{CC} = 400\text{ V};$   
 $r_{G(on)} = 10\text{ }^\Omega; r_{G(off)} = 10\text{ }^\Omega$

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

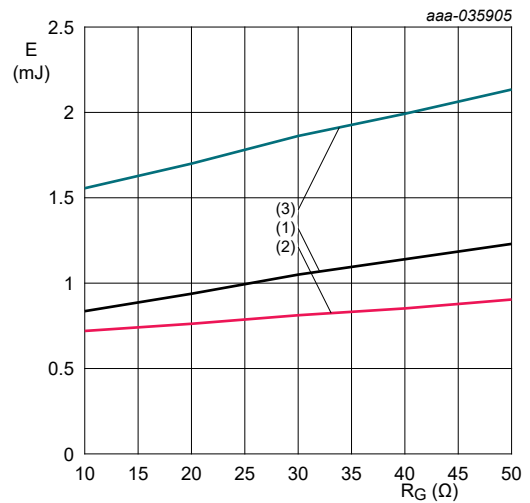
Fig. 14. Typical switching times as a function of junction temperature



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

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

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

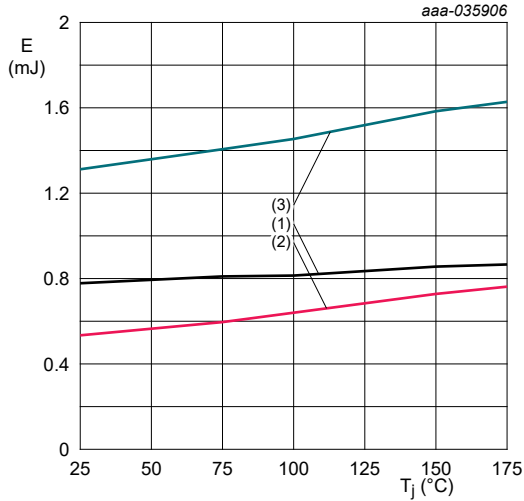


$V_{GE} = 15\text{ V to }0\text{ V}; V_{CC} = 400\text{ V}; I_C = 30\text{ A};$   
 $T_j = 175\text{ }^\circ\text{C}$

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

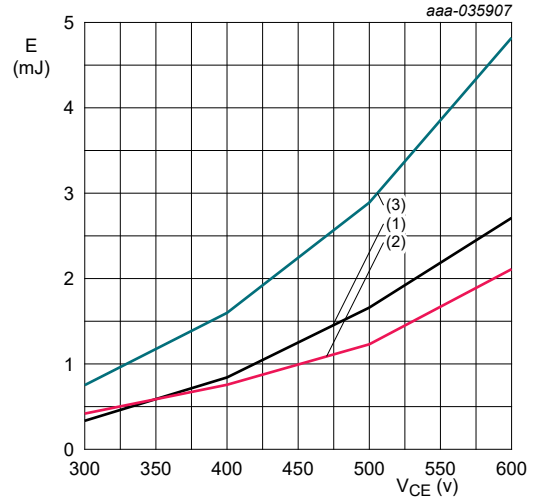
Fig. 16. Typical switching energy losses as a function of gate resistance





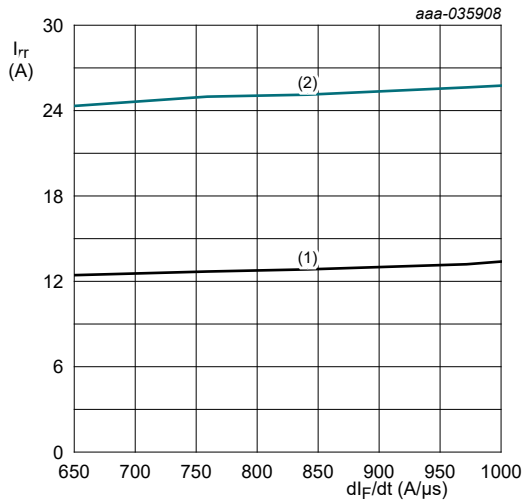
$V_{GE} = 15\text{ V to }0\text{ V}; I_C = 30\text{ A}; V_{CC} = 400\text{ V};$   
 $r_{G(on)} = 10\ \Omega; r_{G(off)} = 10\ \Omega$   
 (1)  $E_{on}$   
 (2)  $E_{off}$   
 (3)  $E_{ts}$

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



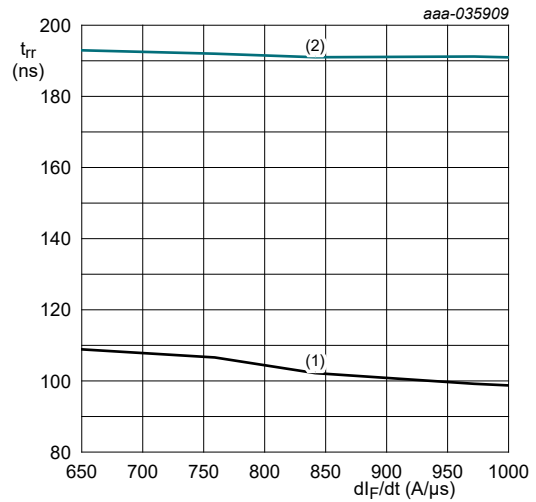
$V_{GE} = 15\text{ V to }0\text{ V}; I_C = 30\text{ A}; r_{G(on)} = 10\ \Omega;$   
 $r_{G(off)} = 10\ \Omega; T_j = 175\text{ }^\circ\text{C}$   
 (1)  $E_{on}$   
 (2)  $E_{off}$   
 (3)  $E_{ts}$

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



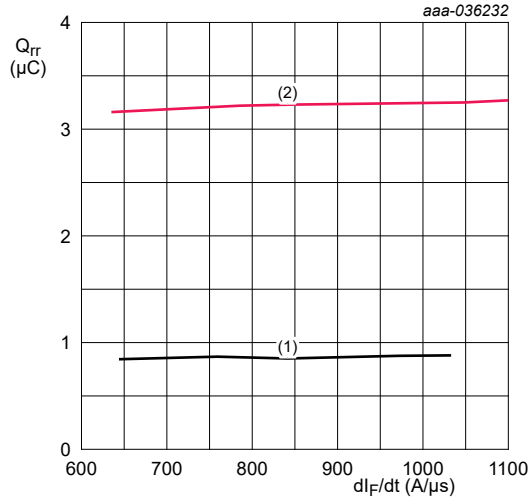
$V_R = 400\text{ V}; I_F = 30\text{ A}$   
 (1)  $T_{amb} = 25\text{ }^\circ\text{C}$   
 (2)  $T_{amb} = 175\text{ }^\circ\text{C}$

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



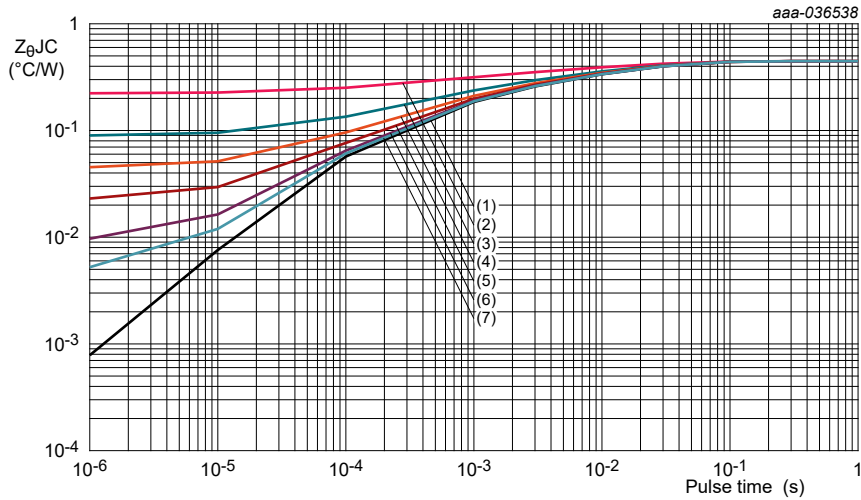
$V_R = 400\text{ V}; I_F = 30\text{ A}$   
 (1)  $T_{amb} = 25\text{ }^\circ\text{C}$   
 (2)  $T_{amb} = 175\text{ }^\circ\text{C}$

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



$V_R = 400 \text{ V}; I_F = 30 \text{ A}$   
 (1)  $T_{amb} = 25 \text{ °C}$   
 (2)  $T_{amb} = 175 \text{ °C}$

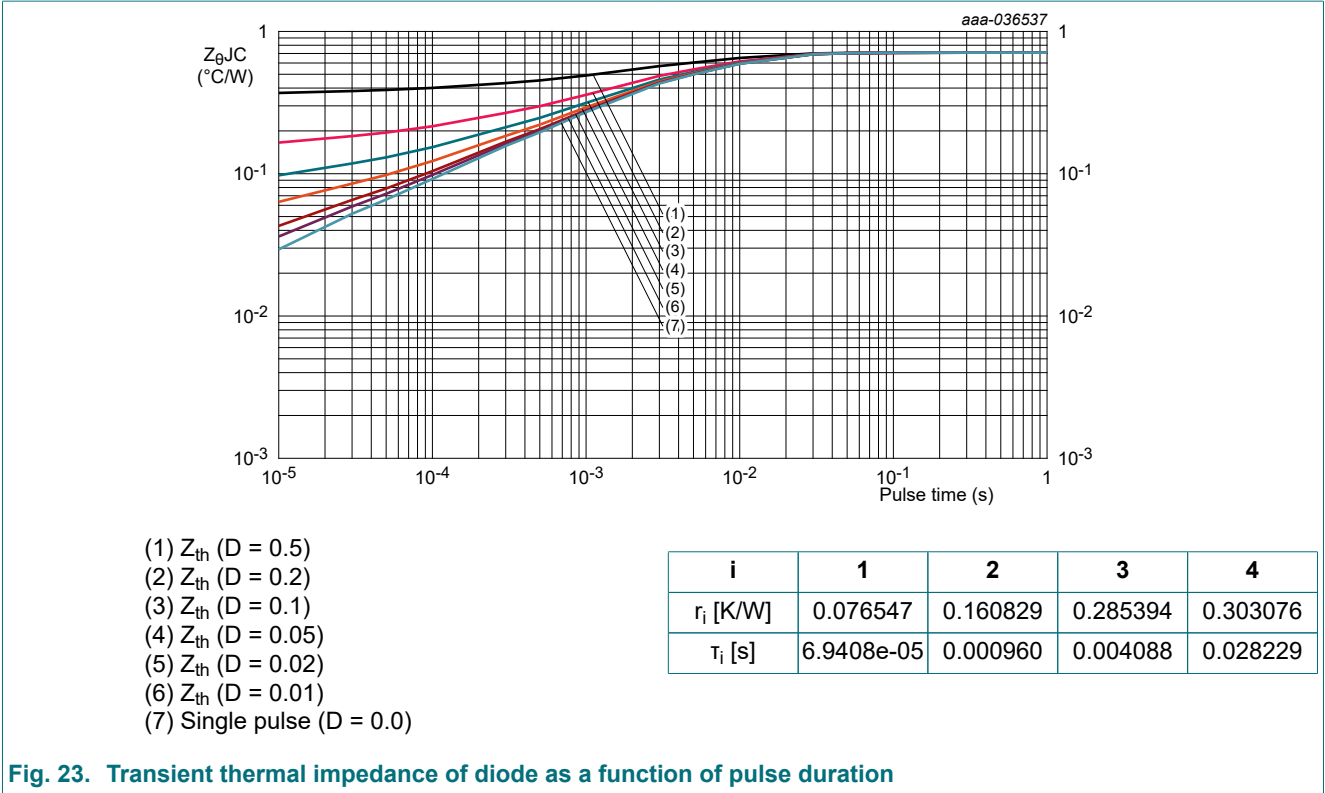
Fig. 21. Typical reverse recovery charge as a function of rate of change of forward current



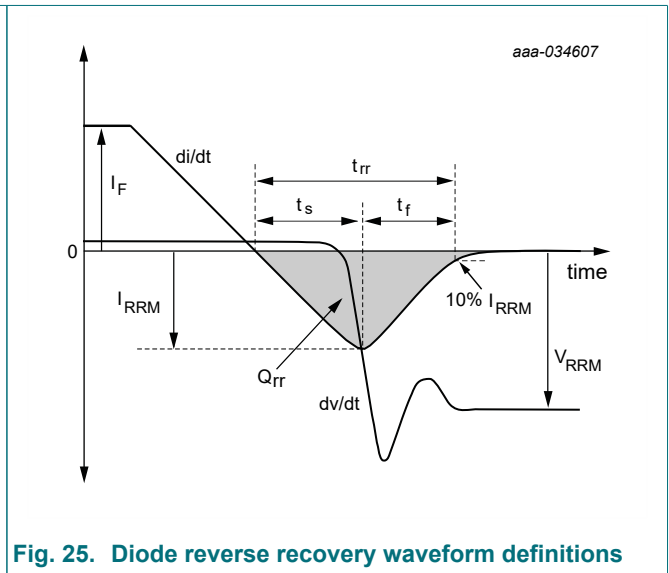
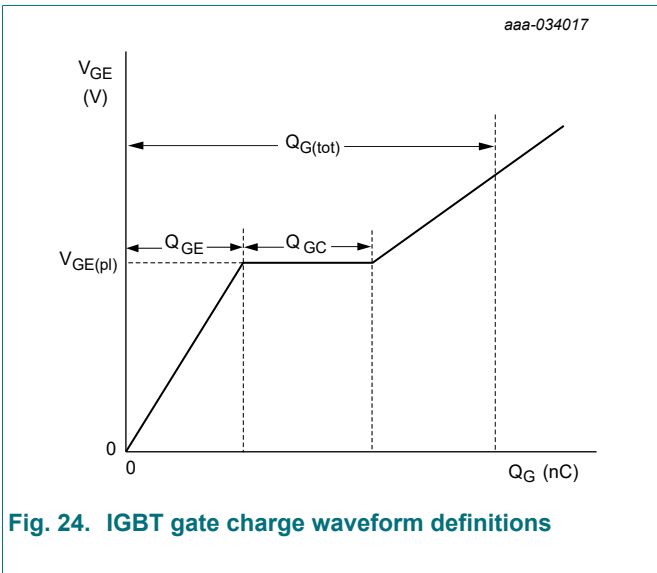
- (1)  $Z_{th} (D = 0.5)$
- (2)  $Z_{th} (D = 0.2)$
- (3)  $Z_{th} (D = 0.1)$
- (4)  $Z_{th} (D = 0.05)$
- (5)  $Z_{th} (D = 0.02)$
- (6)  $Z_{th} (D = 0.01)$
- (7) Single pulse ( $D = 0.0$ )

i	1	2	3	4
$r_i$ [K/W]	0.056786	0.123135	0.144927	0.121162
$T_i$ [s]	0.000113	0.000681	0.005543	0.036756

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



### 9.2. Waveforms



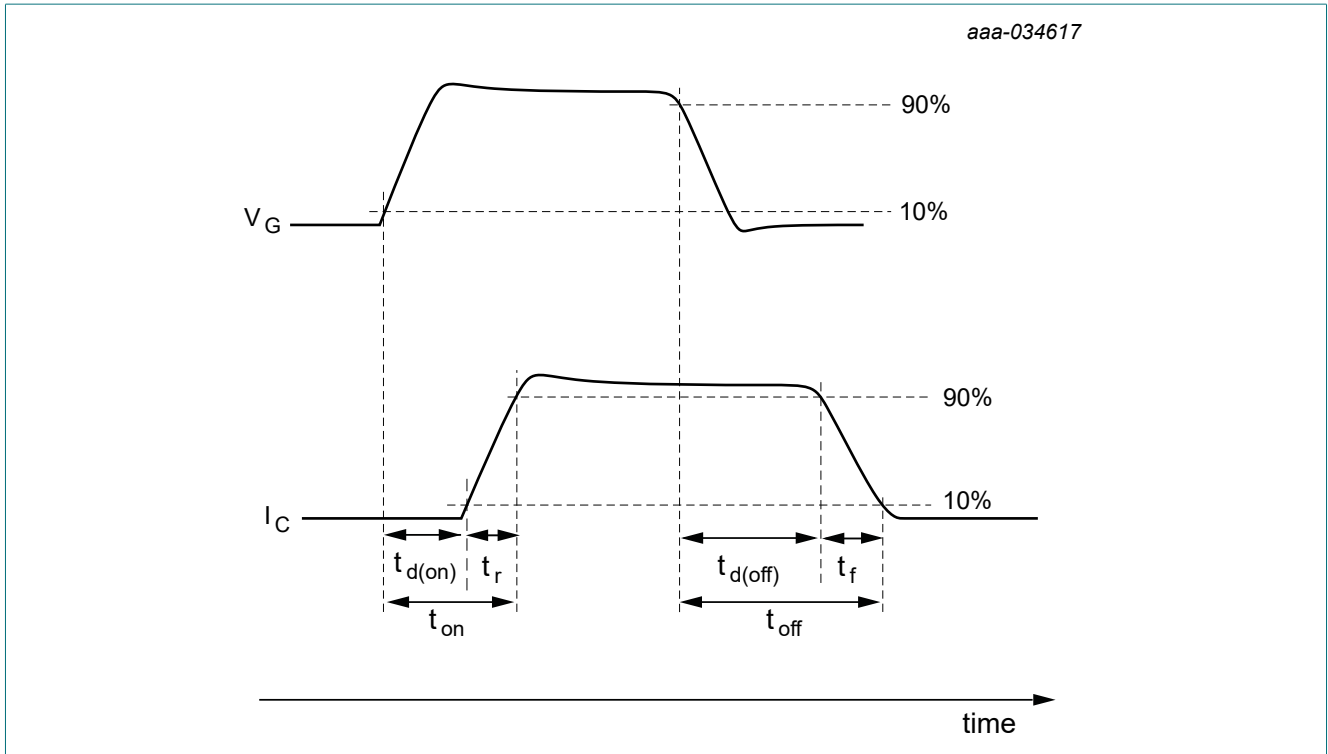


Fig. 26. IGBT switching times definitions

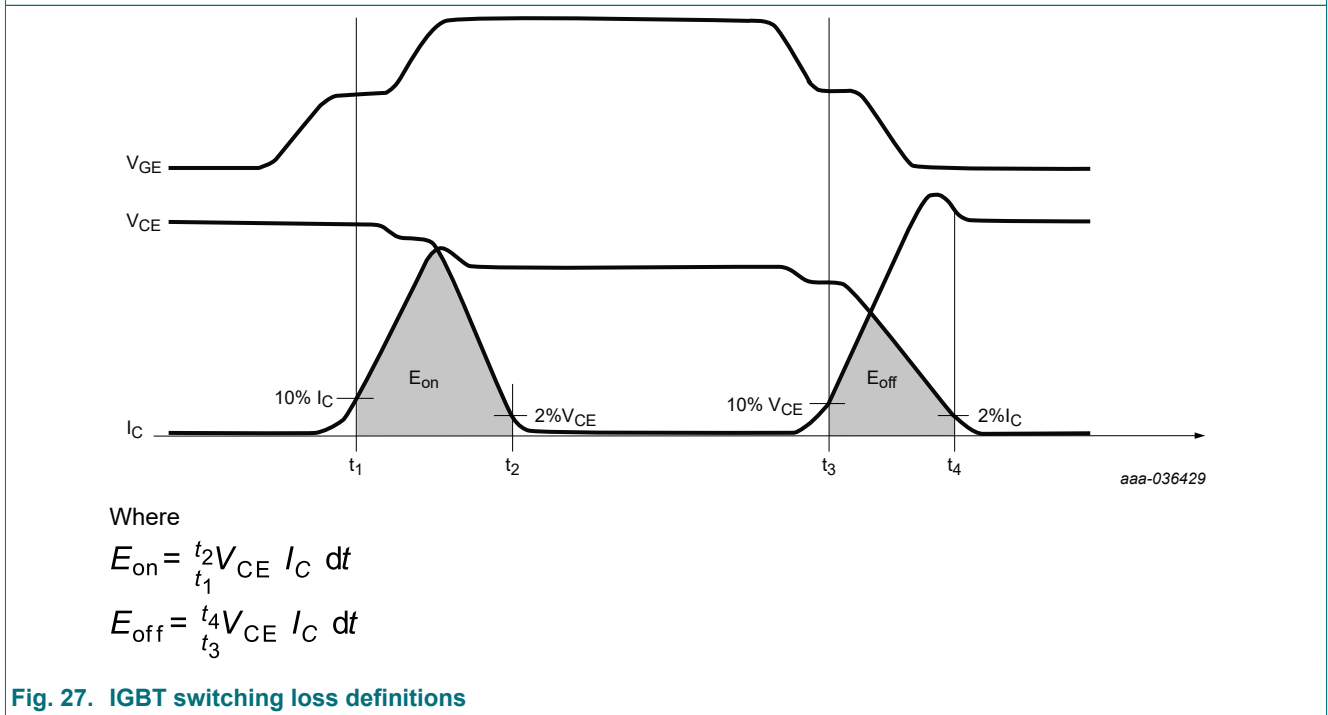


Fig. 27. IGBT switching loss definitions

### 10. Package outline

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

SOT429-2

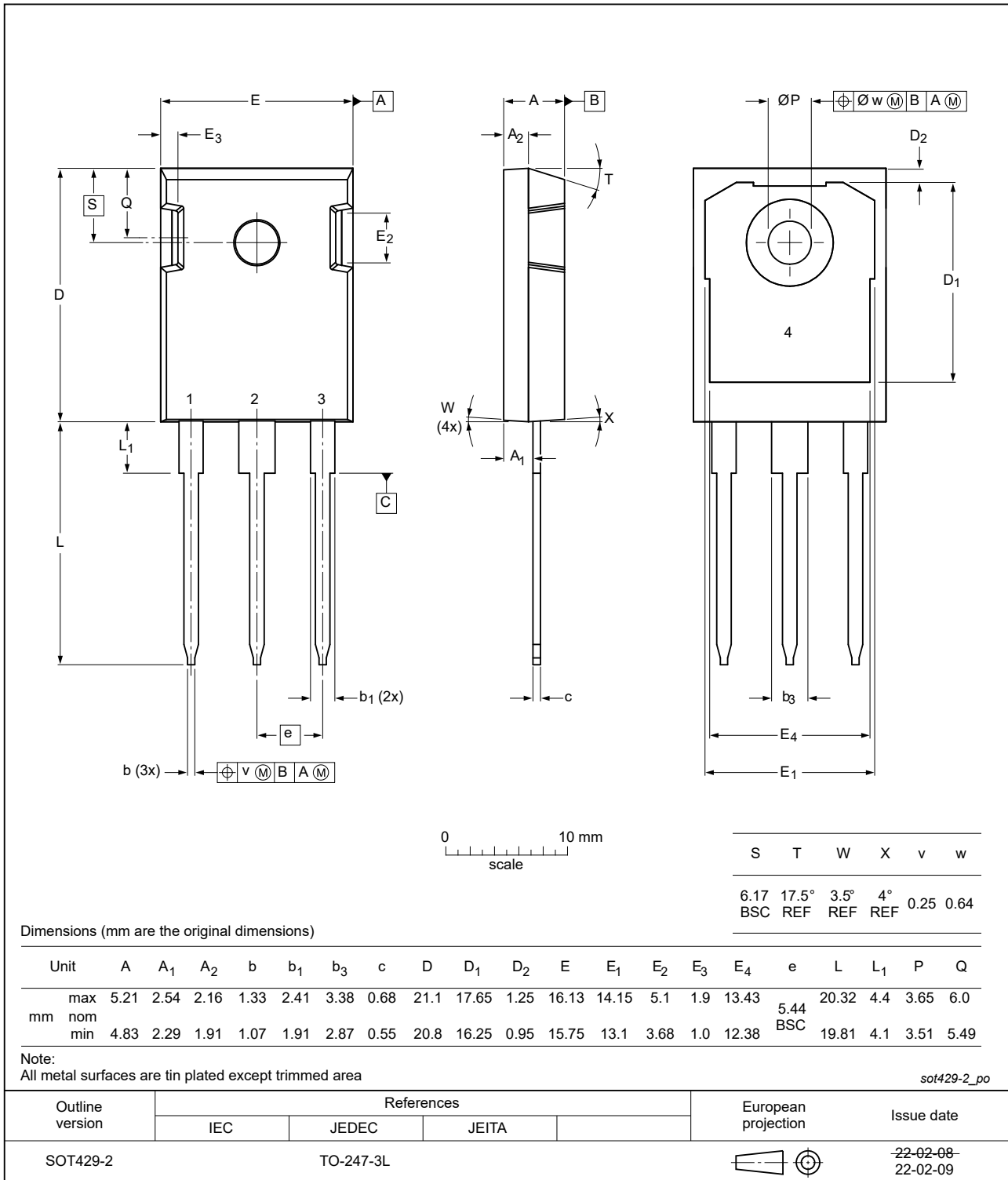


Fig. 28. Package outline TO-247-3L (SOT429-2)

## 11. Revision history

Table 8. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
NGW30T60M3DF v. 1	20230703	Product 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".
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