



NGW40T65M3DFP

650 V, 40 A trench field-stop IGBT with full rated silicon diode

Rev. 1.1 — 28 February 2025

Product data sheet

1. General description

The NGW40T65M3DFP is a robust Insulated-Gate Bipolar Transistor (IGBT) featuring third-generation technology. It combines carrier stored trench-gate and field-stop (FS) structures. The NGW40T65M3DFP 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, 40 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 40 A
- Low conduction and switching losses
- Stable and tight parameters for easy parallel operation
- Maximum junction temperature 175 °C
- Fully rated and soft 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

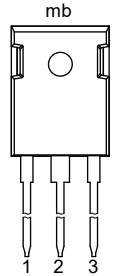
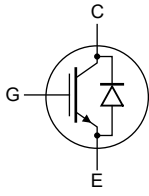
4. Quick reference data

Table 1. Quick reference data

Symbol	Parameter	Conditions	Min	Max	Unit
V_{CES}	collector-emitter voltage	$T_{vj} = 25\text{ °C}$	-	650	V
T_{vj}	operating junction temperature		-40	175	°C
t_{sc}	short circuit withstand time	$V_{GE} = 15\text{ V}$; $V_{CC} = 400\text{ V}$; $T_{vj} \leq 150\text{ °C}$	-	5	µs

5. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	G	gate		 aaa-036518
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
NGW40T65M3DFP	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

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	-	72	A
		T _c = 100 °C	-	48	A
I _{CRM}	repetitive peak collector current	[2]	-	120	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	-	283	W
		T _c = 100 °C	-	142	W
T _{vj}	operating junction temperature		-40	175	°C
T _{stg}	storage temperature		-55	150	°C
T _{solder}	soldering temperature		-	260	°C
Diode					
I _F	diode forward current	[1] T _c = 25 °C	-	80	A
		T _c = 100 °C	-	49	A
I _{FRM}	repetitive peak forward current	[2]	-	120	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.

8. Thermal characteristics

Table 5. 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	-	0.45	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. Electrical characteristics

Table 6. Characteristics

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

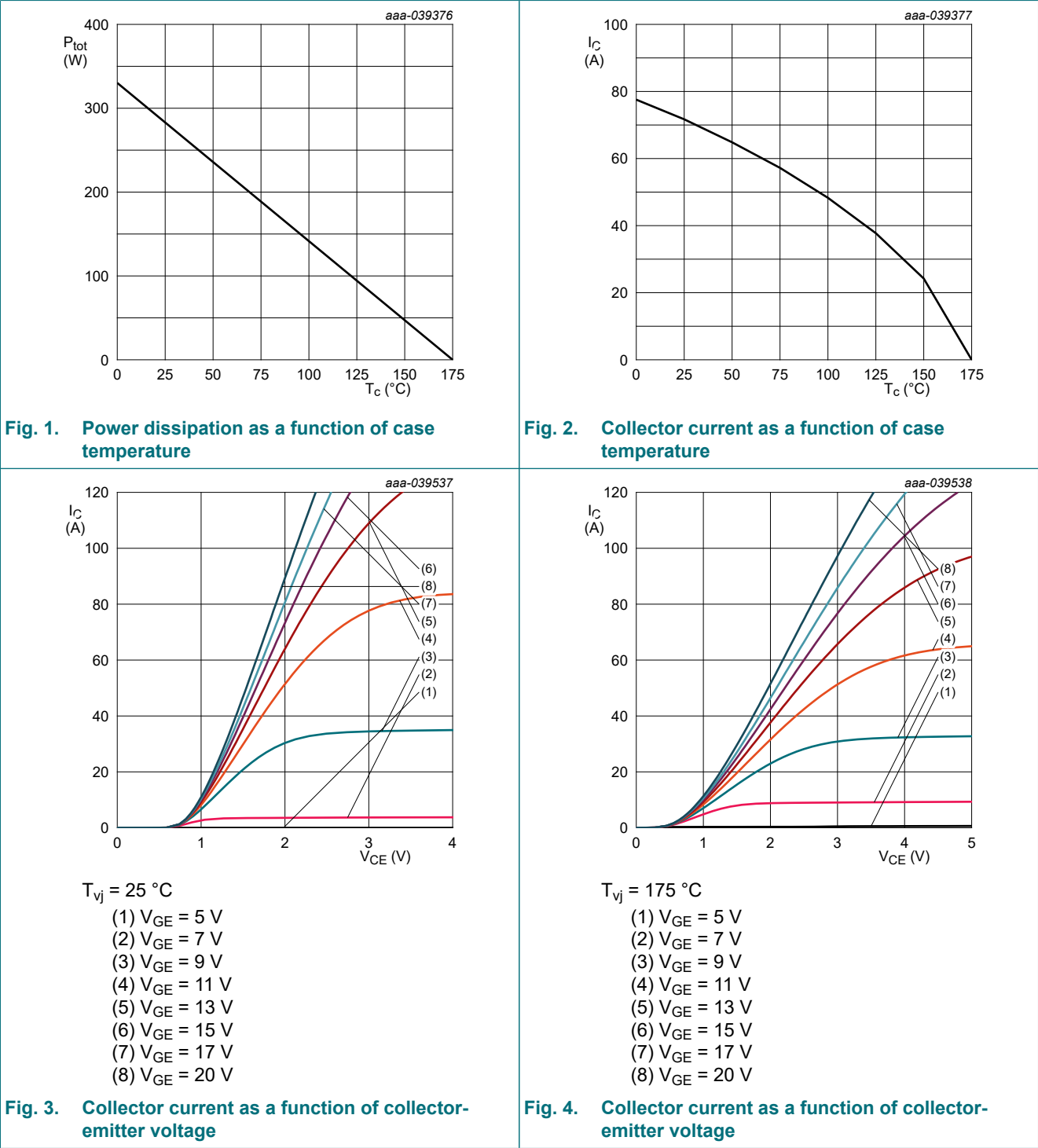
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Static characteristics						
V _{(BR)CES}	collector-emitter breakdown voltage	V _{GE} = 0 V; I _C = 0.2 mA	650	-	-	V
V _{CEsat}	collector-emitter saturation voltage	V _{GE} = 15 V; I _C = 40 A; T _{vj} = 25 °C	-	1.5	1.9	V
		V _{GE} = 15 V; I _C = 40 A; T _{vj} = 175 °C	-	1.9	-	V
V _F	diode forward voltage	V _{GE} = 0 V; I _F = 40 A; T _{vj} = 25 °C	-	1.62	2.1	V
		V _{GE} = 0 V; I _F = 40 A; T _{vj} = 175 °C	-	1.33	-	V
V _{GE(th)}	gate-emitter threshold voltage	I _C = 0.4 mA; V _{CE} = V _{GE} ; T _{vj} = 25 °C	4.3	5	5.7	V
I _{CES}	zero gate voltage collector current	V _{CE} = 650 V; V _{GE} = 0 V; T _{vj} = 25 °C	-	10	-	nA
		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 = 40 A; T _{vj} = 25 °C	-	20	-	S
r _g	internal gate resistor		-	1.3	-	Ω
Dynamic characteristics						
C _{ies}	input capacitance	V _{CE} = 25 V; V _{GE} = 0 V; f = 1 MHz	-	2040	-	pF
C _{oes}	output capacitance		-	136	-	pF
C _{res}	reverse transfer capacitance		-	31	-	pF
Q _G	gate charge	V _{CC} = 520 V; V _{GE} = 15 V; I _C = 40 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 V; V _{CC} = 400 V; t _{sc} ≤ 5 μs; T _{vj} ≤ 150 °C	-	185	-	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 = 40 A; R _{G(on)} = 10 Ω; R _{G(off)} = 10 Ω; see Fig. 27 and Fig. 28	T _{vj} = 25 °C	-	22	ns	
			T _{vj} = 175 °C	-	20	ns	
t _r	rise time		T _{vj} = 25 °C	-	22	ns	
			T _{vj} = 175 °C	-	23	ns	
t _{d(off)}	turn-off delay time		T _{vj} = 25 °C	-	185	ns	
			T _{vj} = 175 °C	-	220	ns	
t _f	fall time		T _{vj} = 25 °C	-	13	ns	
			T _{vj} = 175 °C	-	50	ns	
E _{on}	turn-on switching energy loss		T _{vj} = 25 °C	-	1.05	mJ	
			T _{vj} = 175 °C	-	2.15	mJ	
E _{off}	turn-off switching energy loss		T _{vj} = 25 °C	-	0.52	mJ	
			T _{vj} = 175 °C	-	0.9	mJ	
E _{ts}	total switching energy loss		T _{vj} = 25 °C	-	1.57	mJ	
			T _{vj} = 175 °C	-	3.05	mJ	
Diode switching characteristics, inductive load							
t _{rr}	reverse recovery time		V _R = 400 V; I _F = 40 A; di _F /dt = 1000 A/μs; see Fig. 26	T _{vj} = 25 °C	-	55	ns
		T _{vj} = 175 °C		-	215	ns	
Q _{rr}	reverse recovery charge	T _{vj} = 25 °C		-	700	nC	
		T _{vj} = 175 °C		-	3830	nC	
I _{rrm}	peak reverse recovery current	T _{vj} = 25 °C		-	22	A	
		T _{vj} = 175 °C		-	37	A	
E _{rec}	reverse recovery energy loss	T _{vj} = 25 °C		-	0.12	mJ	
		T _{vj} = 175 °C		-	0.36	mJ	
di _{rrf} /dt	fall rate of reverse recovery current	T _{vj} = 25 °C		-	650	A/μs	
		T _{vj} = 175 °C		-	760	A/μs	

9.1. Characteristic diagrams

Table 7. Waveforms and output characteristics



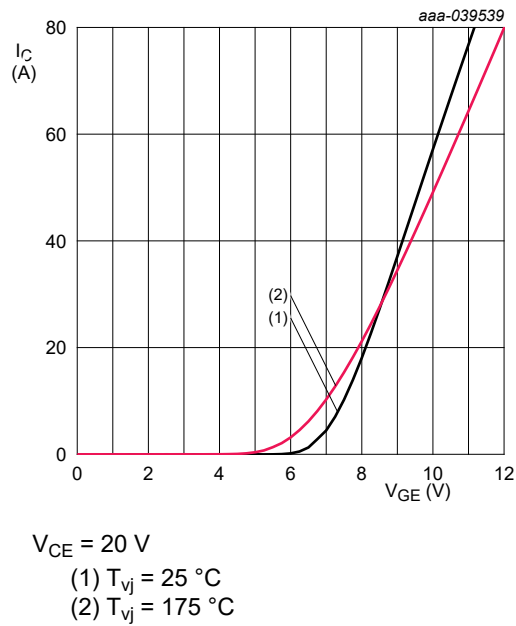


Fig. 5. Collector current as a function of gate-emitter voltage

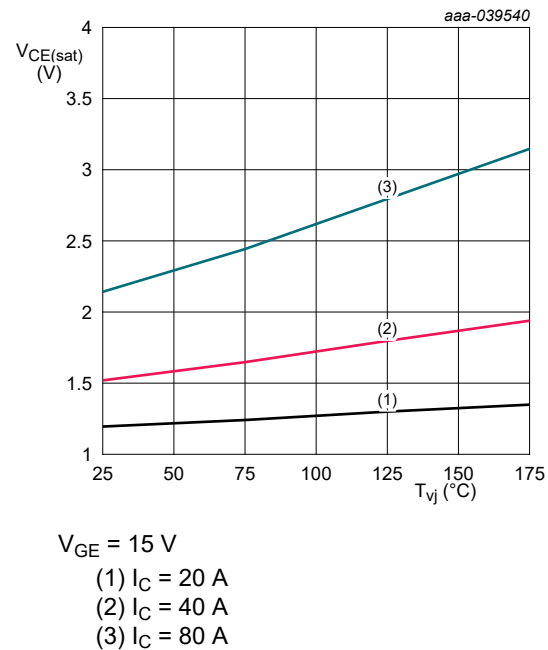


Fig. 6. Collector-emitter saturation voltage as a function of junction temperature

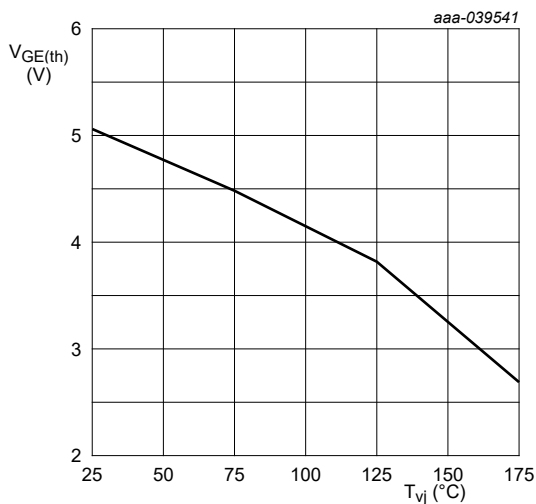


Fig. 7. Gate-emitter threshold voltage as a function of junction temperature

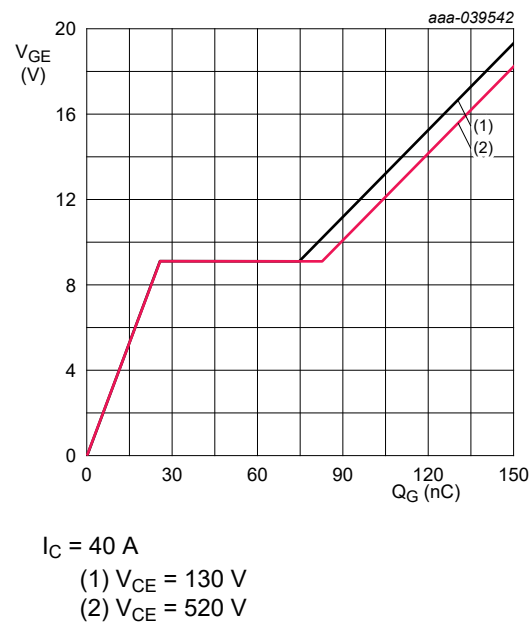


Fig. 8. Gate-emitter voltage as a function of gate charge

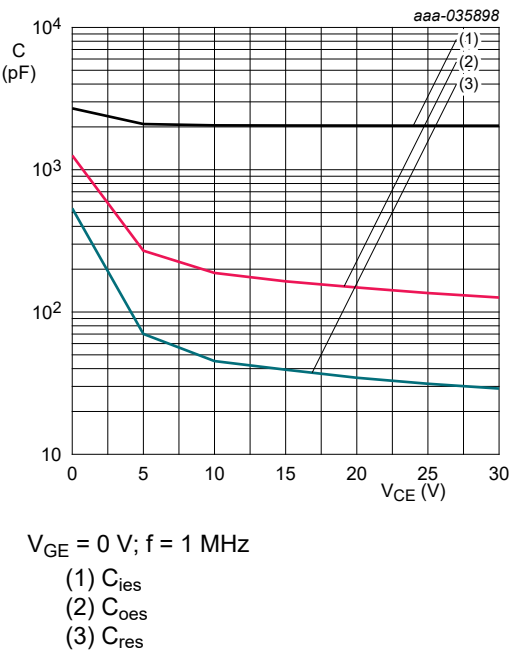


Fig. 9. Typical capacitance as a function of collector-emitter voltage

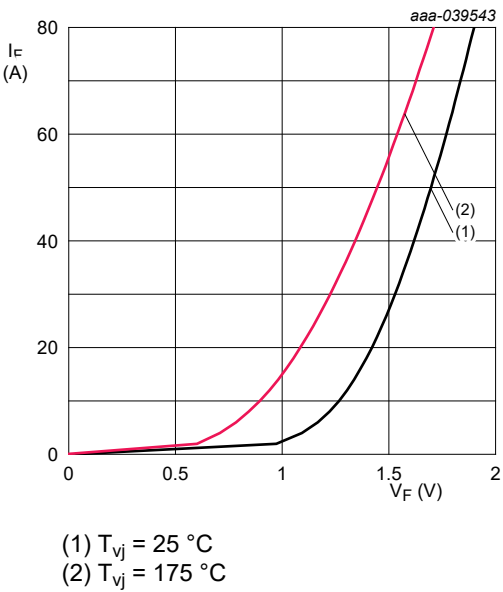


Fig. 10. Typical diode forward current as a function of forward voltage

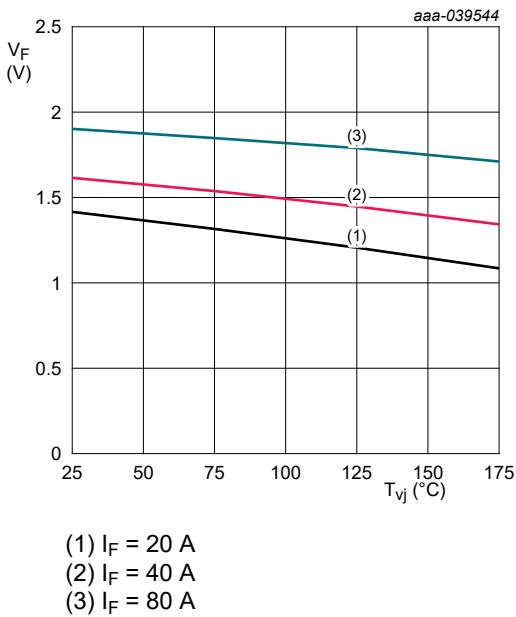


Fig. 11. Typical diode forward voltage as a function of junction temperature

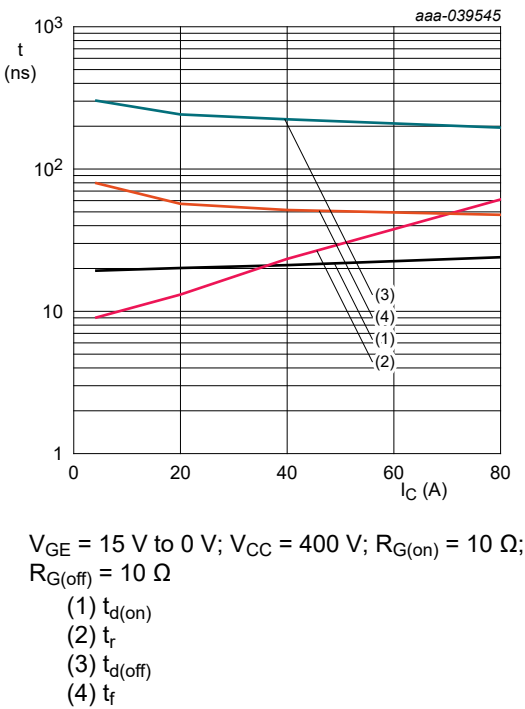
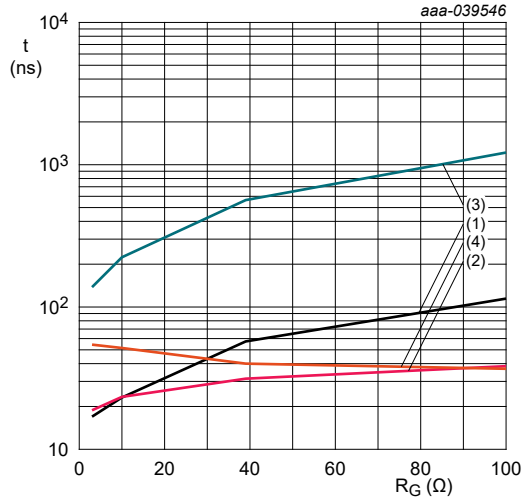


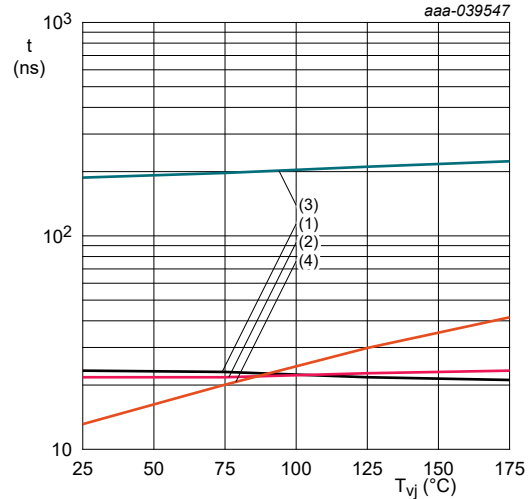
Fig. 12. Typical switching times as a function of collector current



$V_{GE} = 15 \text{ V to } 0 \text{ V}$; $V_{CC} = 400 \text{ V}$; $I_C = 40 \text{ A}$;
 $T_{vj} = 175 \text{ }^\circ\text{C}$

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

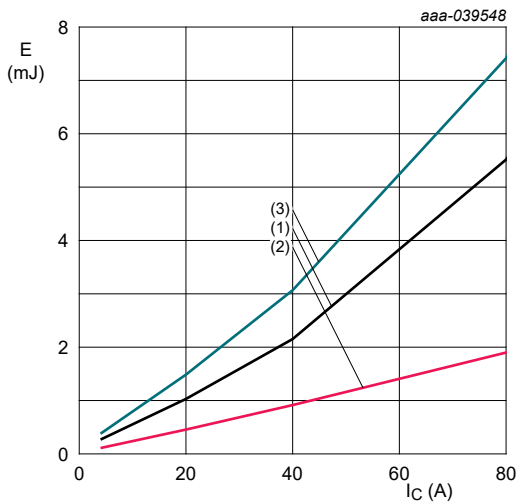
Fig. 13. Typical switching times as a function of gate resistance



$V_{GE} = 15 \text{ V to } 0 \text{ V}$; $I_C = 40 \text{ A}$; $V_{CC} = 400 \text{ V}$;
 $R_{G(on)} = 10 \text{ } \Omega$; $R_{G(off)} = 10 \text{ } \Omega$

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

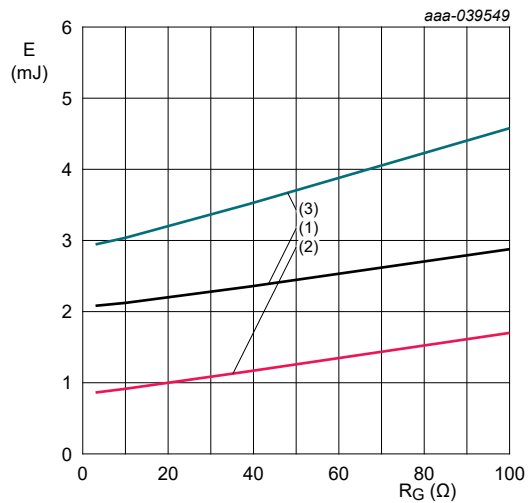
Fig. 14. Typical switching times as a function of junction temperature



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

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

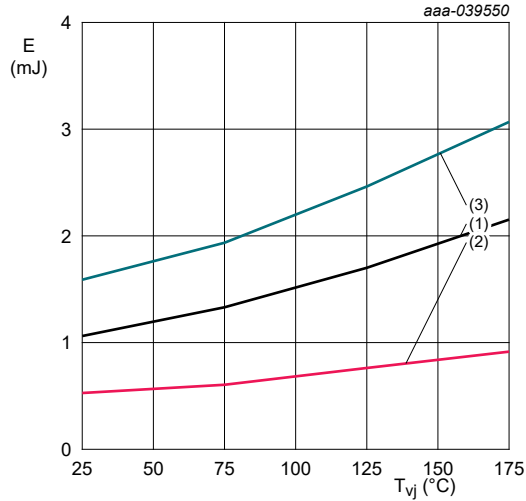
Fig. 15. Typical switching energy losses as a function of collector current



$V_{GE} = 15 \text{ V to } 0 \text{ V}$; $V_{CC} = 400 \text{ V}$; $I_C = 40 \text{ A}$;
 $T_{vj} = 175 \text{ }^\circ\text{C}$

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

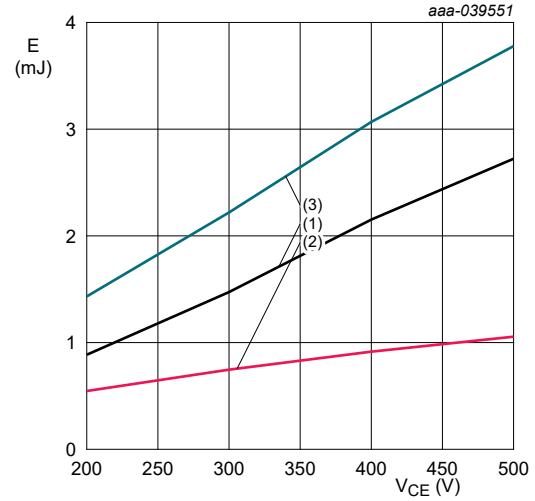
Fig. 16. Typical switching energy losses as a function of gate resistance



$V_{GE} = 15 \text{ V to } 0 \text{ V}$; $I_C = 40 \text{ A}$; $V_{CC} = 400 \text{ V}$;
 $R_{G(on)} = 10 \Omega$; $R_{G(off)} = 10 \Omega$

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

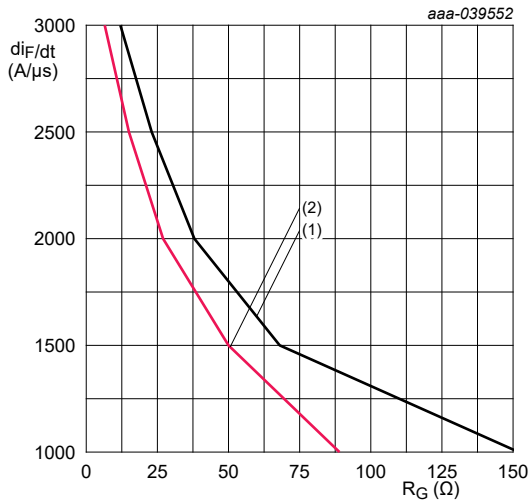
Fig. 17. Typical switching energy losses as a function of junction temperature



$V_{GE} = 15 \text{ V to } 0 \text{ V}$; $I_C = 40 \text{ A}$; $R_{G(on)} = 10 \Omega$;
 $R_{G(off)} = 10 \Omega$; $T_{vj} = 175 \text{ °C}$

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

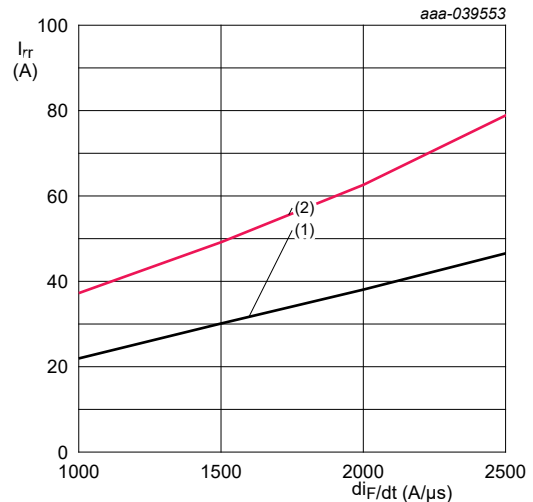
Fig. 18. Typical switching energy losses as a function of collector-emitter voltage



$V_R = 400 \text{ V}$; $I_F = 40 \text{ A}$

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

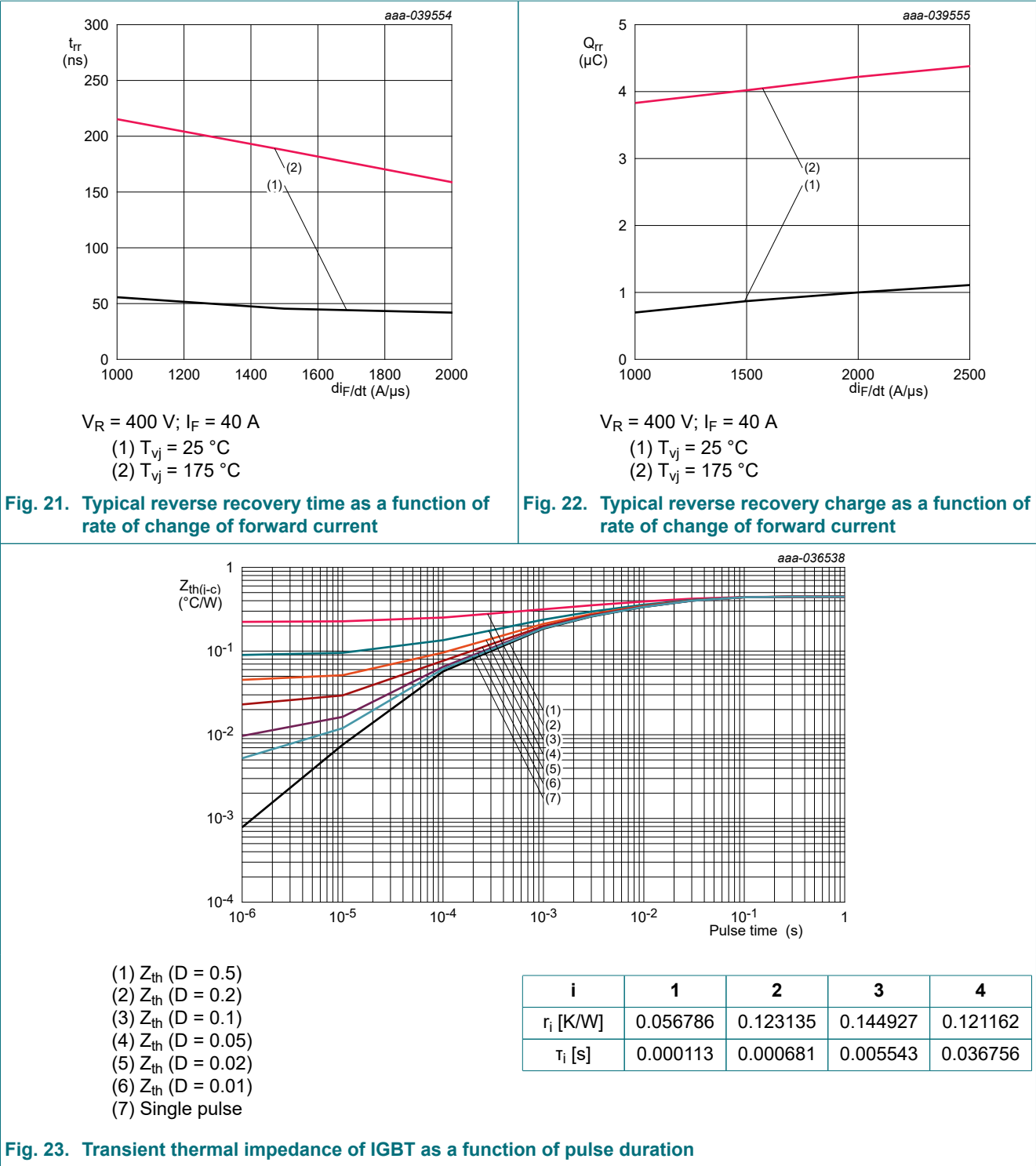
Fig. 19. Typical rate of change of forward current as a function of gate resistance

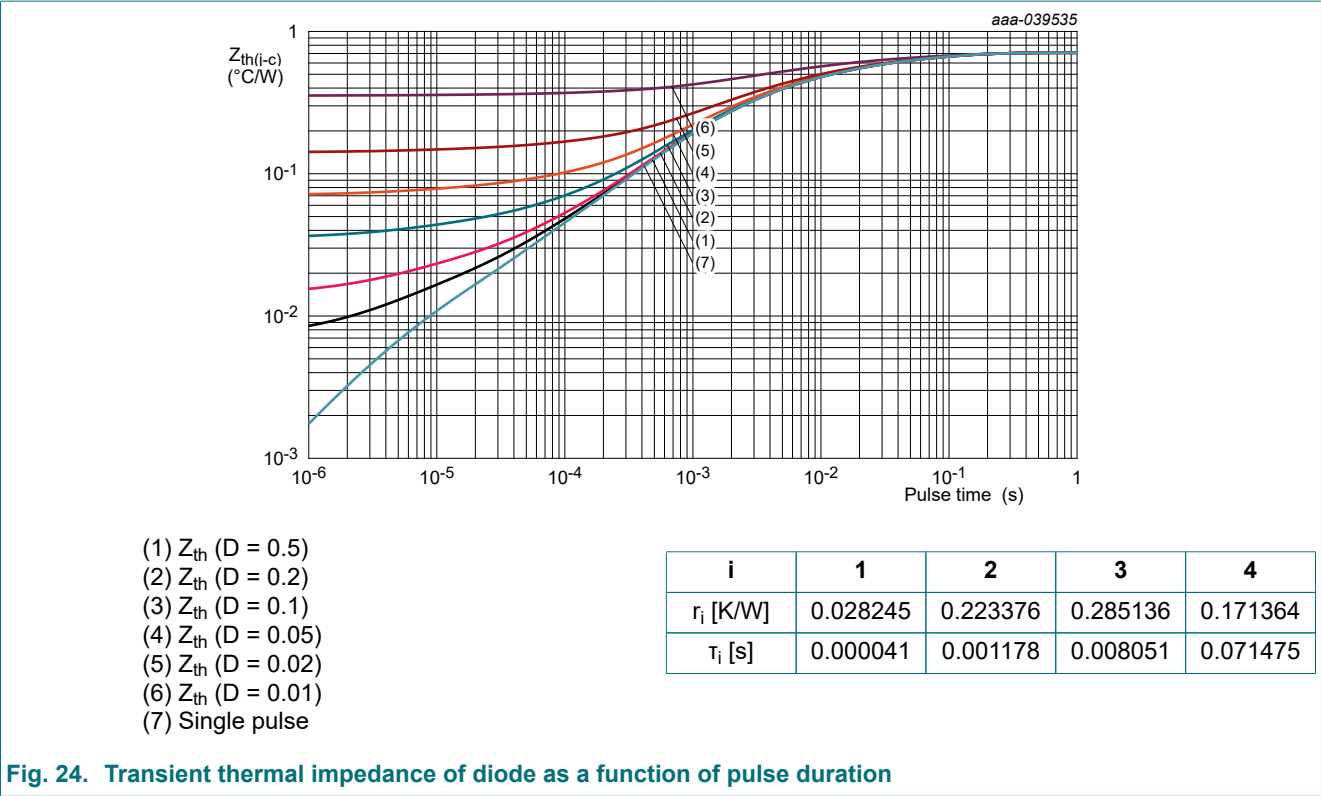


$V_R = 400 \text{ V}$; $I_F = 40 \text{ A}$

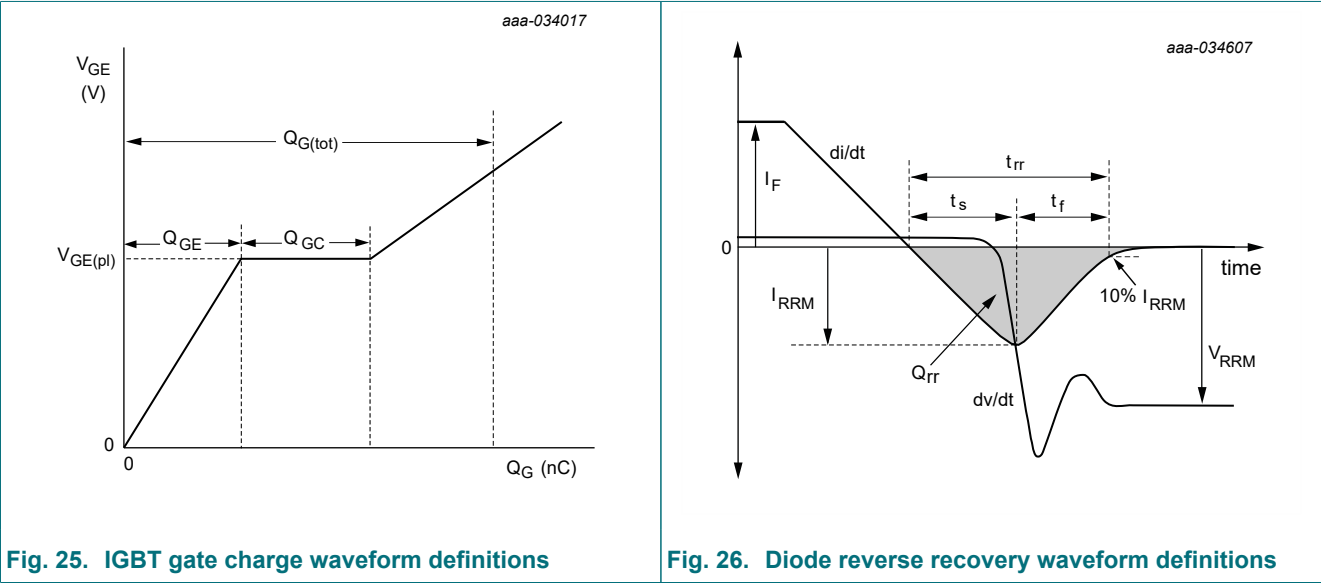
- (1) $T_{vj} = 25 \text{ °C}$
- (2) $T_{vj} = 175 \text{ °C}$

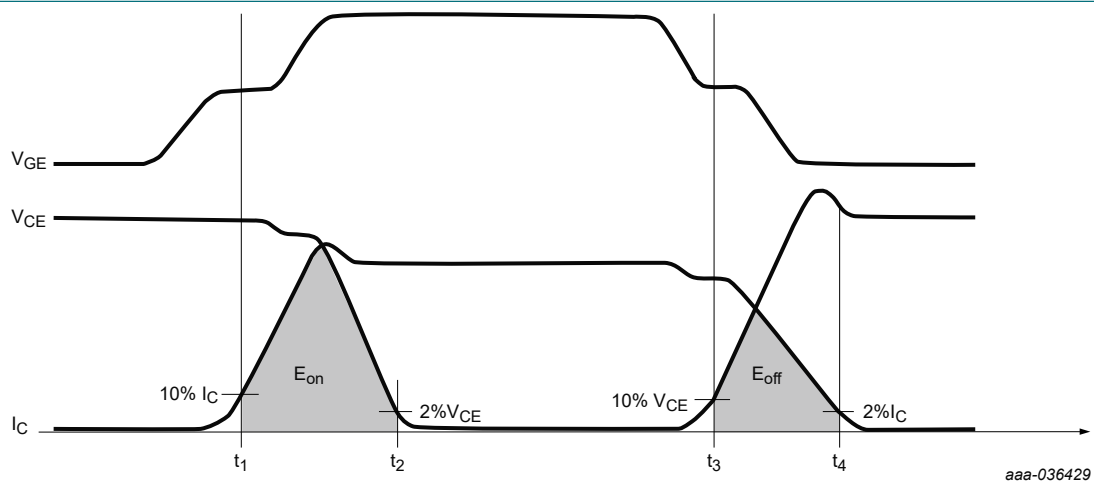
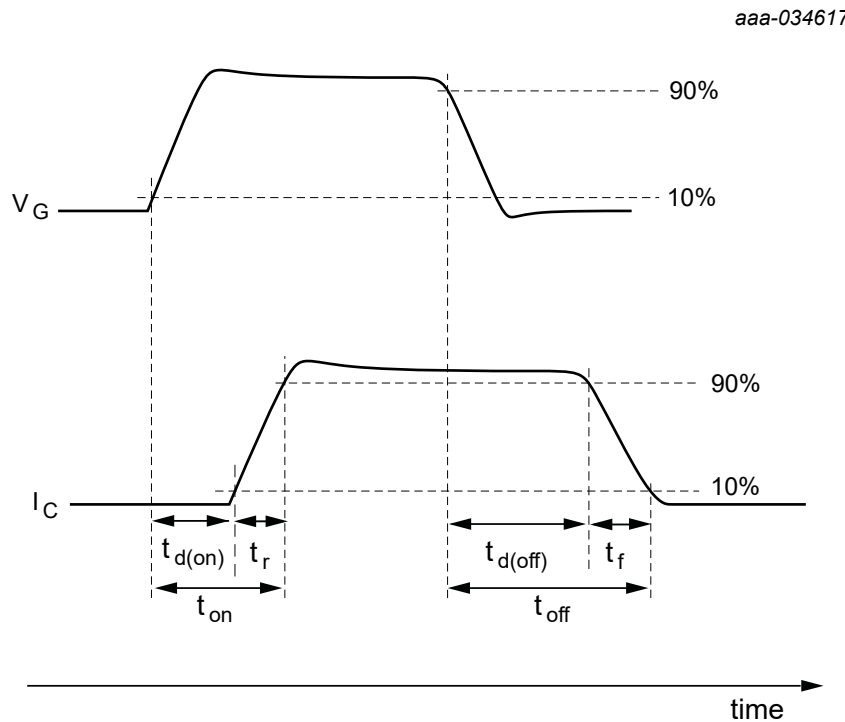
Fig. 20. Typical reverse recovery current as a function of rate of change of forward current





9.2. Waveform definitions





10. Package outline

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

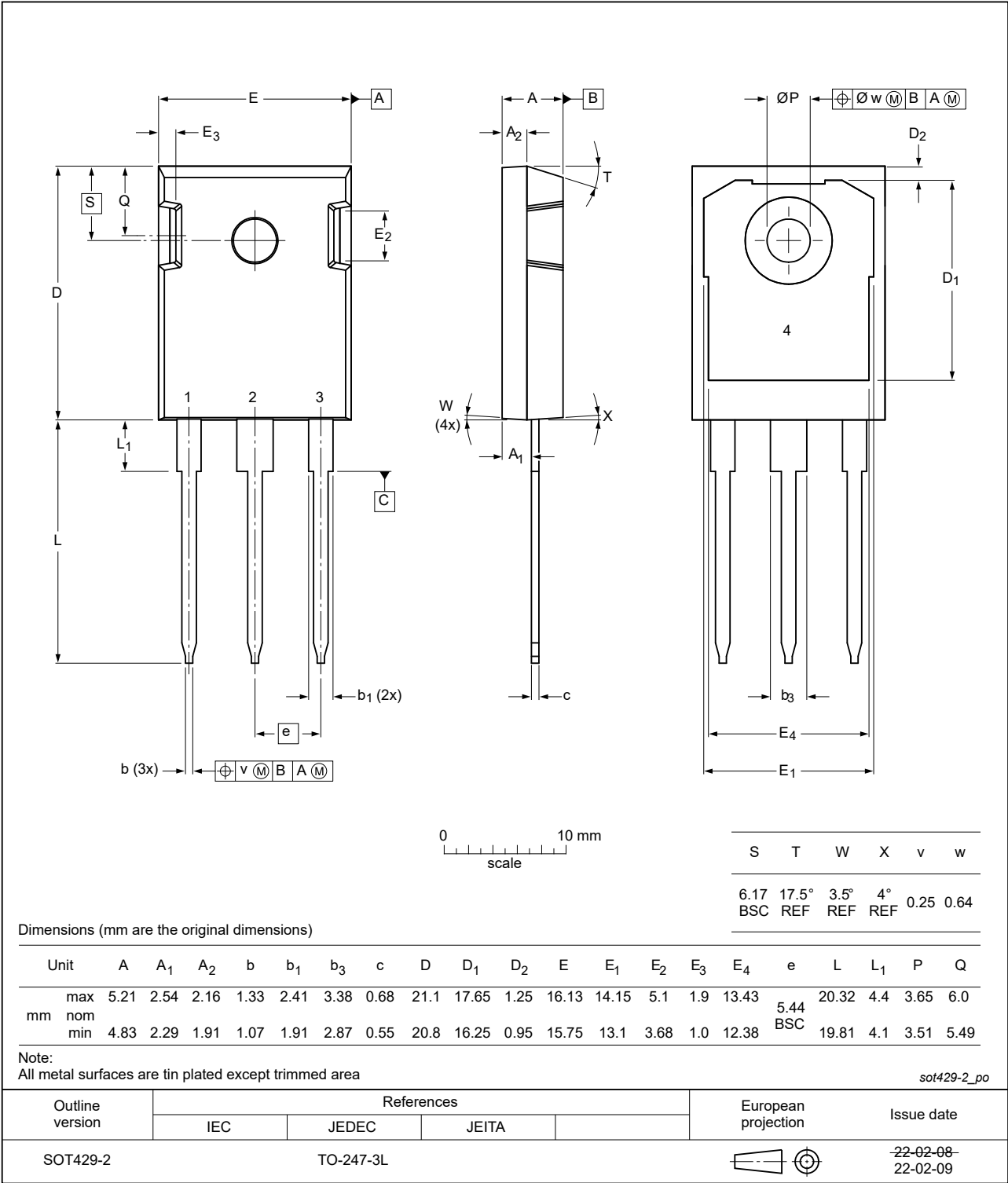


Fig. 29. Package outline TO-247-3L (SOT429-2)

11. Revision history

Table 8. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
NGW40T65M3DFP v. 1.1	20250228	Product data sheet	-	-
Modifications:	• Naming conventions brought into alignment with other data sheets			
NGW40T65M3DFP v. 1	20240628	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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Date of release: 28 February 2025