NGB15T65M3DFP

650 V, 15 A trench field-stop IGBT with full rated silicon diode

Rev. 1 — 6 June 2025 — Product data sheet

1. General description

NGB15T65M3DFP is a robust Insulated-Gate Bipolar Transistor (IGBT) featuring third-generation technology. It combines carrier stored trench-gate and field-stop (FS) structures. NGB15T65M3DFP 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, 15 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 15 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

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 converter applications, such as uninterruptible power supply (UPS)
- Induction heating
- Welding

4. Quick reference data

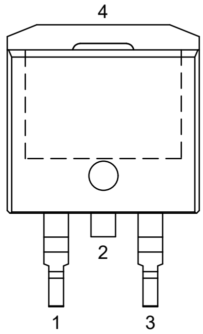
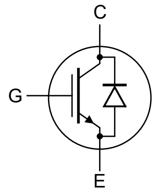
Table 1. Quick reference data

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} ≤ 150 °C	-	5.0	µs

nexperia

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		
4	C	mounting base; connected to collector		

6. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
NGB15T65M3DFP	D2PAK	Plastic single-ended surface-mounted package (D2PAK); 3 terminals (one lead cropped)	SOT404B-1

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	-	33	A
		T_c = 100 °C	-	23	A
I_{CRM}	repetitive peak collector current [2]		-	45	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	-	127	W
		T_c = 100 °C	-	64	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	-	33	A
		T_c = 100 °C	-	21	A
I_{FRM}	repetitive peak forward current [2]		-	45	A

[1] Value is limited by internal bonding wire 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
$R_{th(j-c)}$	thermal resistance from junction to case	IGBT	-	1.00	1.18	K/W
		diode	-	1.71	2.02	K/W
$R_{th(j-a)}$	thermal resistance from junction to ambient	minimum footprint on PCB	-	-	65	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 = 15 A; T_{vj} = 25 °C	-	1.53	1.7	V
		V_{GE} = 15 V; I_C = 15 A; T_{vj} = 175 °C	-	1.94	-	V
V_F	diode forward voltage	V_{GE} = 0 V; I_F = 15 A; T_{vj} = 25 °C	-	1.57	1.9	V
		V_{GE} = 0 V; I_F = 15 A; T_{vj} = 175 °C	-	1.29	-	V
$V_{GE(th)}$	gate-emitter threshold voltage	I_C = 0.15 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	-	3	-	nA
		V_{CE} = 650 V; V_{GE} = 0 V; T_{vj} = 175 °C	-	0.2	-	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 = 15 A; T_{vj} = 25 °C	-	7.0	-	S
r_g	internal gate resistor		-	2.9	-	Ω
Dynamic characteristics						
C_{ies}	input capacitance	V_{CE} = 25 V; V_{GE} = 0 V; f = 1 MHz	-	1136	-	pF
C_{oes}	output capacitance		-	42	-	pF
C_{res}	reverse transfer capacitance		-	12	-	pF
Q_G	gate charge	V_{CC} = 520 V; I_C = 15 A; V_{GE} = 15 V	-	45	-	nC
L_{sCE}	internal stray inductance		-	6.2	-	nH
$I_{C(sc)}$	short circuit collector current	V_{GE} = 15 V; V_{CC} = 400 V; t_{sc} ≤ 5 µs; T_{vj} ≤ 150 °C	-	77	-	A

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 = 15 A; $R_{G(on)}$ = 10 Ω; $R_{G(off)}$ = 10 Ω; see Fig. 27 and Fig. 28	T_{vj} = 25 °C	-	12	-	ns
			T_{vj} = 175 °C	-	11	-	ns
t_r	rise time		T_{vj} = 25 °C	-	8	-	ns
			T_{vj} = 175 °C	-	12	-	ns
$t_{d(off)}$	turn-off delay time		T_{vj} = 25 °C	-	88	-	ns
			T_{vj} = 175 °C	-	133	-	ns
t_f	fall time		T_{vj} = 25 °C	-	46	-	ns
			T_{vj} = 175 °C	-	70	-	ns
E_{on}	turn-on switching energy loss		T_{vj} = 25 °C	-	0.33	-	mJ
			T_{vj} = 175 °C	-	0.72	-	mJ
E_{off}	turn-off switching energy loss		T_{vj} = 25 °C	-	0.19	-	mJ
			T_{vj} = 175 °C	-	0.33	-	mJ
E_{ts}	total switching energy loss		T_{vj} = 25 °C	-	0.52	-	mJ
			T_{vj} = 175 °C	-	1.06	-	mJ
Diode switching characteristics, inductive load							
t_{rr}	reverse recovery time	V_R = 400 V; I_F = 15 A; di_F/dt = 500 A/µs; see Fig. 26	T_{vj} = 25 °C	-	88	-	ns
			T_{vj} = 175 °C	-	173	-	ns
Q_{rr}	reverse recovery charge		T_{vj} = 25 °C	-	459	-	nC
			T_{vj} = 175 °C	-	1604	-	nC
I_{rrm}	peak reverse recovery current		T_{vj} = 25 °C	-	14	-	A
			T_{vj} = 175 °C	-	22	-	A
E_{rec}	reverse recovery energy loss		T_{vj} = 25 °C	-	0.06	-	mJ
			T_{vj} = 175 °C	-	0.27	-	mJ
di_{rrf}/dt	fall rate of reverse recovery current		T_{vj} = 25 °C	-	276	-	A/µs
			T_{vj} = 175 °C	-	239	-	A/µs

9.1. Characteristic diagrams

Table 7. Waveforms and output characteristics

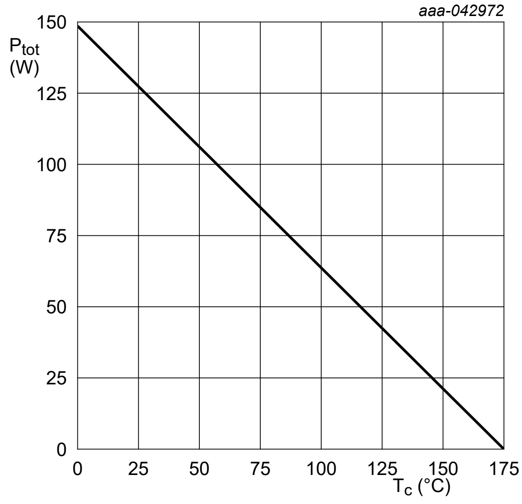


Fig. 1. Power dissipation as a function of case temperature

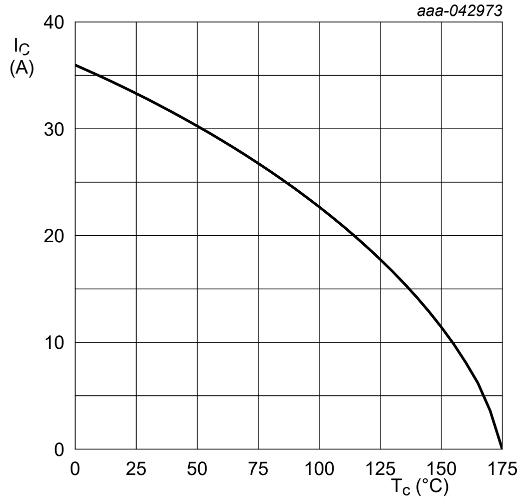
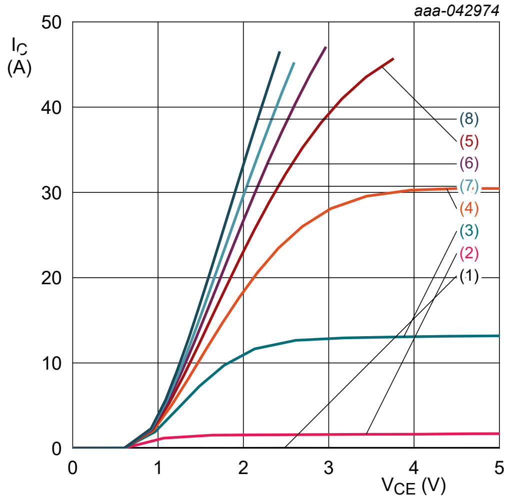


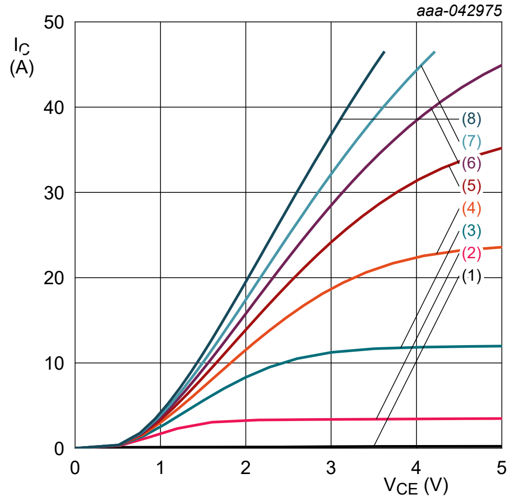
Fig. 2. Collector current as a function of case temperature



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

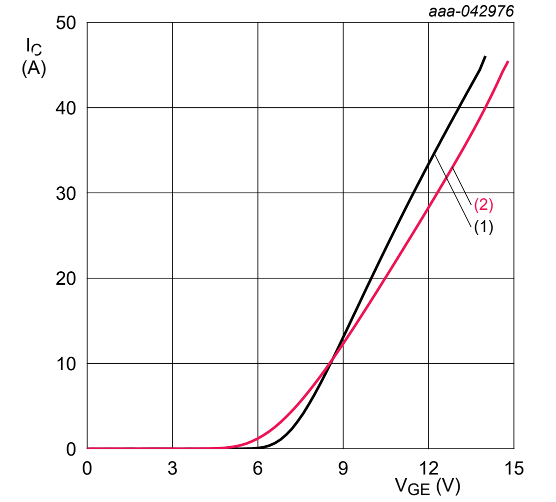
Fig. 3. Collector current as a function of collector-emitter voltage



T_{vj} = 175 °C

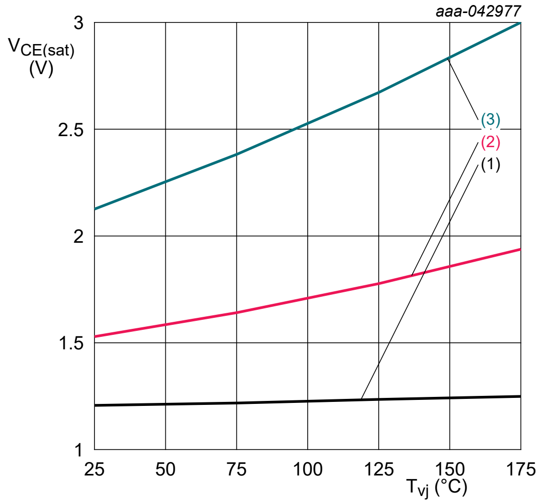
(1) V_{GE} = 5 V
(2) V_{GE} = 7 V
(3) V_{GE} = 9 V
(4) V_{GE} = 11 V
(5) V_{GE} = 13 V
(6) V_{GE} = 15 V
(7) V_{GE} = 17 V
(8) V_{GE} = 20 V

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



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 = 7.5 A
(2) I_C = 15 A
(3) I_C = 30 A

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

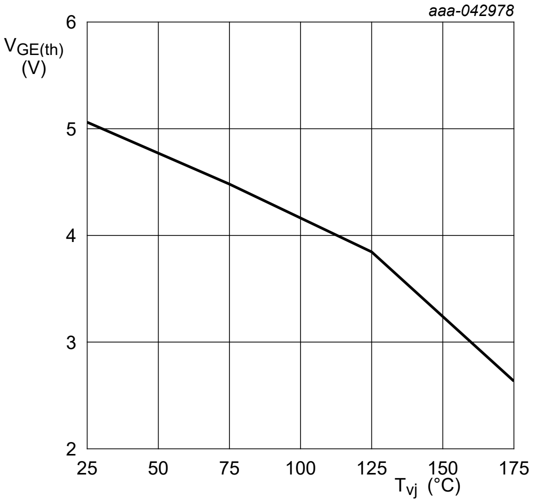
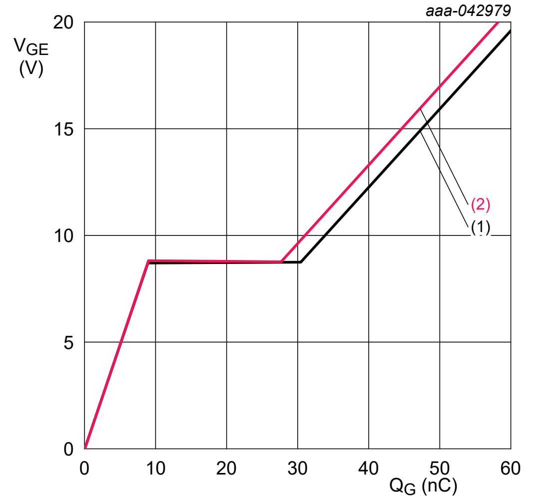
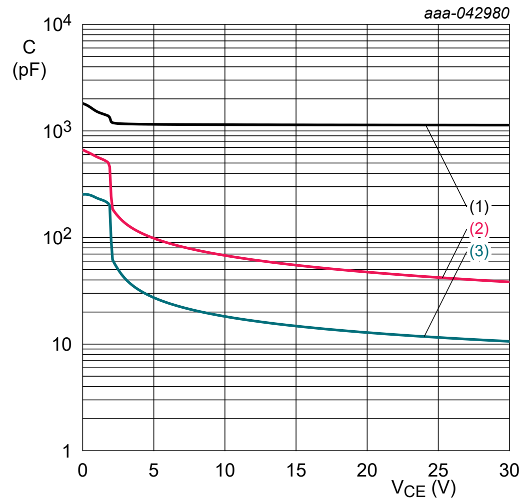


Fig. 7. Gate-emitter threshold voltage as a function of junction temperature



I_C = 15 A
(1) V_{CE} = 130 V
(2) V_{CE} = 520 V

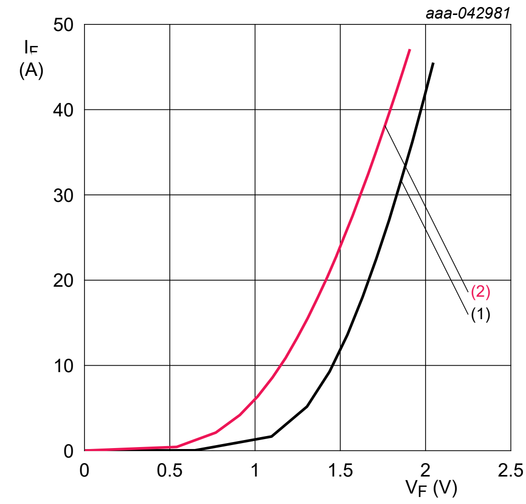
Fig. 8. Gate-emitter voltage as a function of gate charge



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

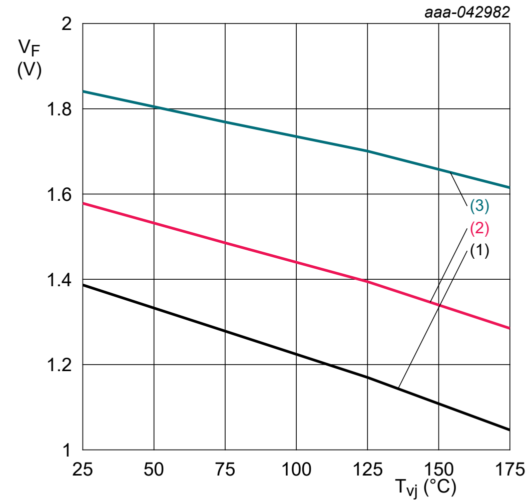
(1) C_{ies}
(2) C_{oes}
(3) C_{res}

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



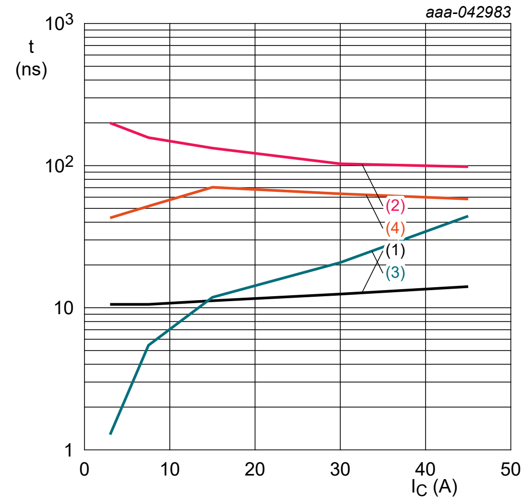
(1) T_{vj} = 25 °C
(2) T_{vj} = 175 °C

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



(1) I_F = 7.5 A
(2) I_F = 15 A
(3) I_F = 30 A

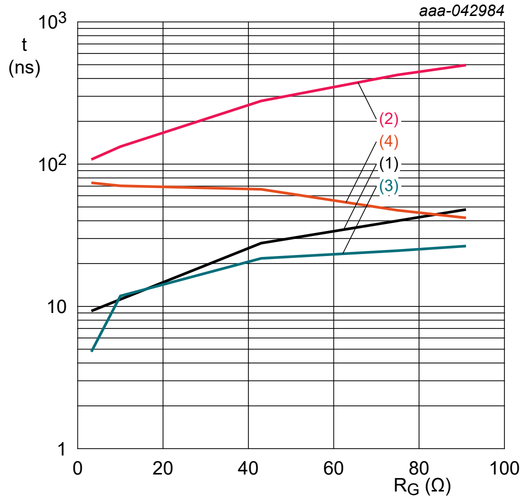
Fig. 11. Typical diode forward voltage as a function of junction temperature



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

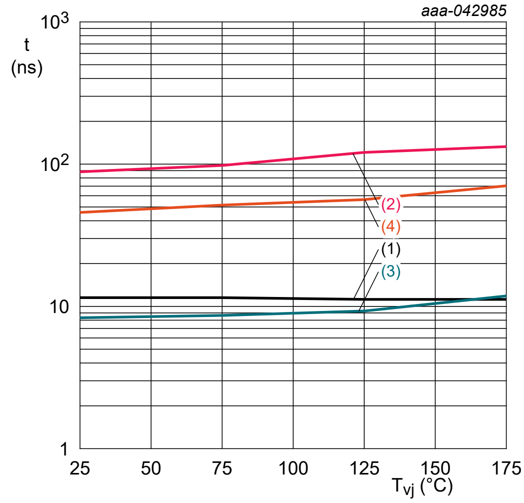
Fig. 12. Typical switching times as a function of collector current



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

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

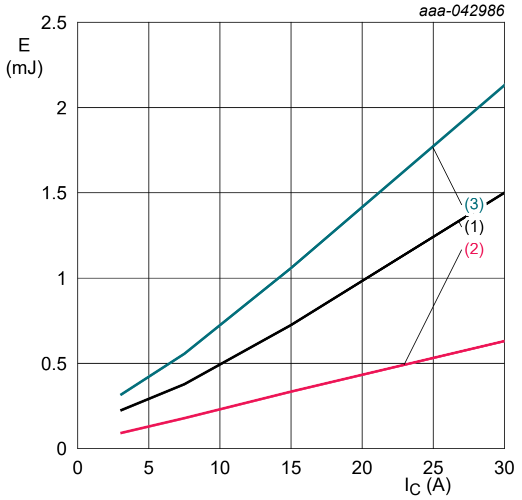
Fig. 13. Typical switching times as a function of gate resistance



V_{GE} = 15 V to 0 V; V_{CC} = 400 V; I_C = 15 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

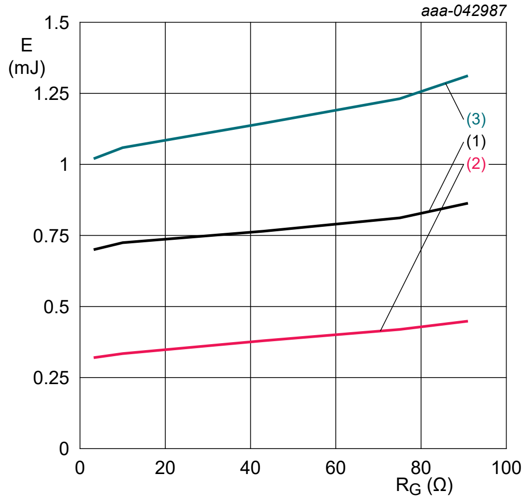
Fig. 14. Typical switching times as a function of junction temperature



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}

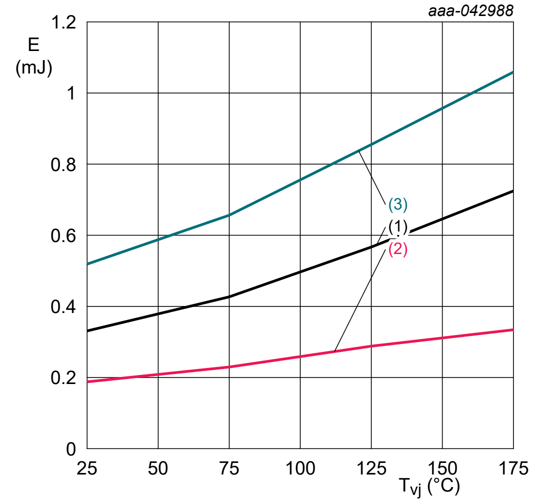
Fig. 15. Typical switching energy losses as a function of collector current



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

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

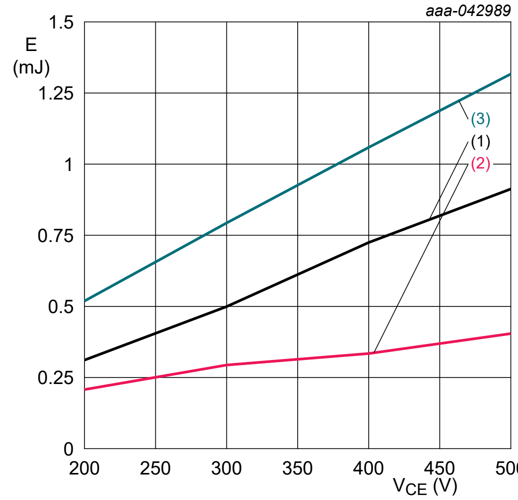
Fig. 16. Typical switching energy losses as a function of gate resistance



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

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

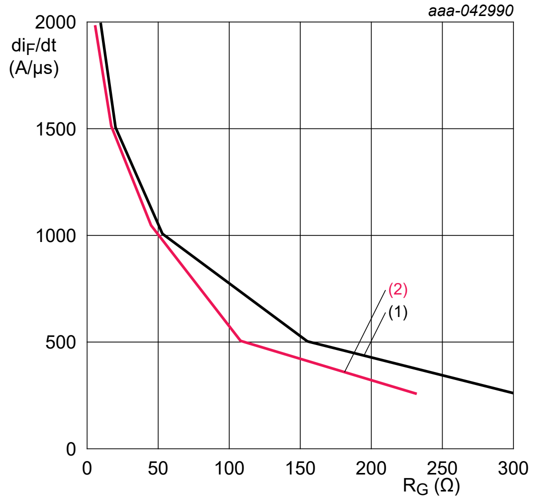
Fig. 17. Typical switching energy losses as a function of junction temperature



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

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

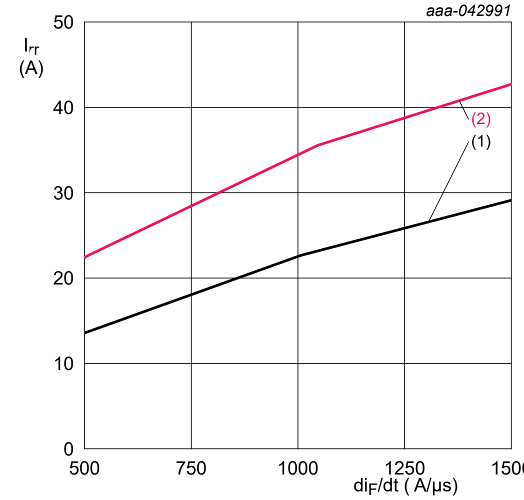
Fig. 18. Typical switching energy losses as a function of collector-emitter voltage



V_R = 400 V; I_F = 15 A

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

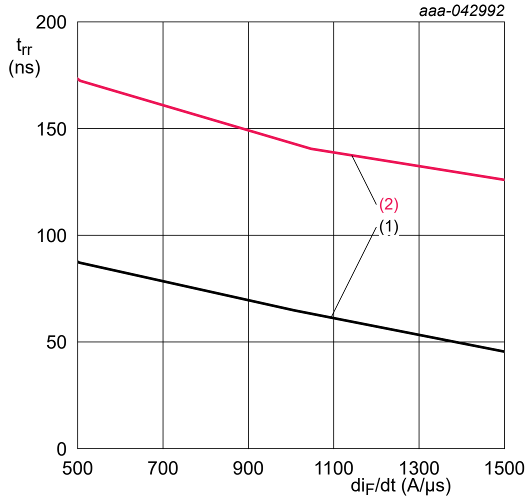
Fig. 19. Typical rate of change of forward current as a function of gate resistance



V_R = 400 V; I_F = 15 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

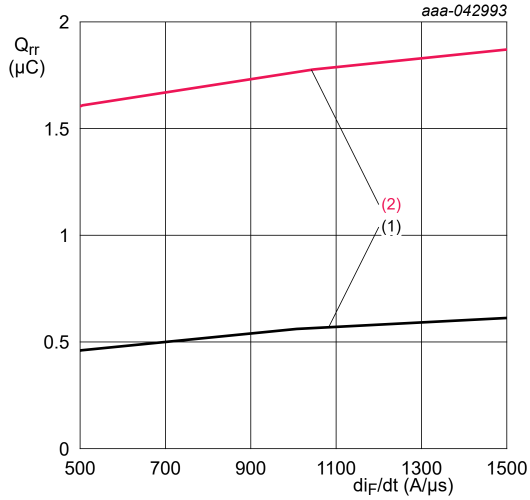


V_R = 400 V; I_F = 15 A

(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

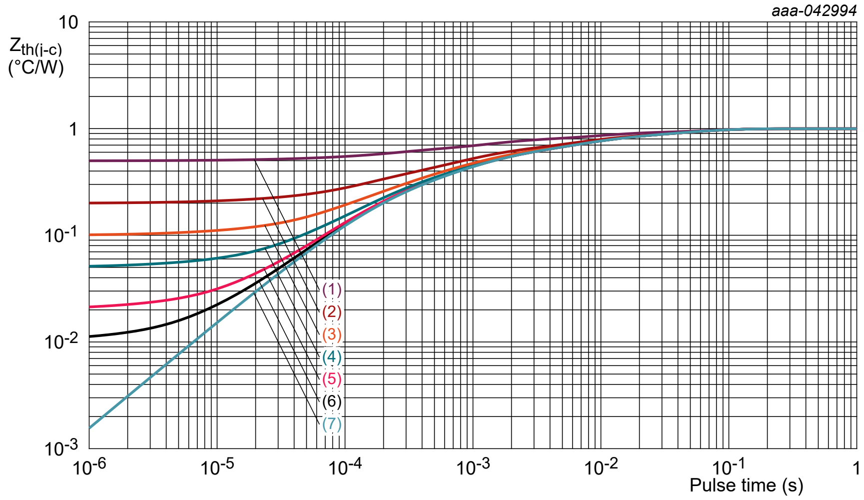


V_R = 400 V; I_F = 15 A

(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)

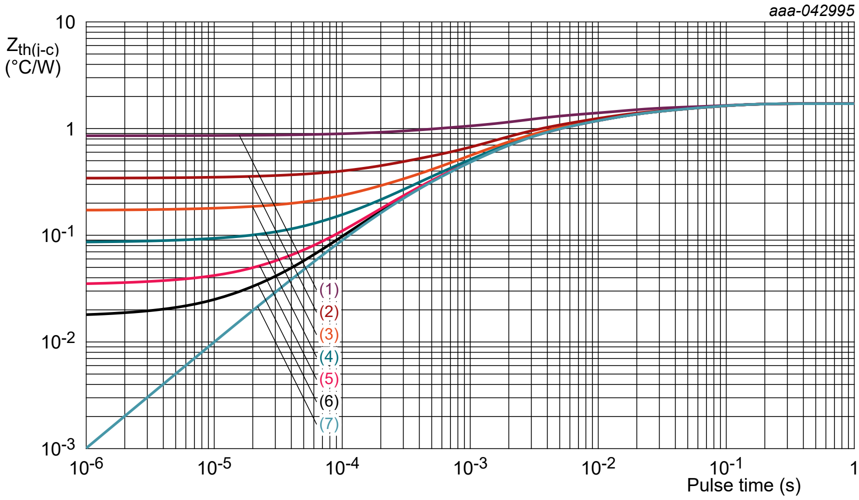
(5) Z_{th} (D = 0.02)

(6) Z_{th} (D = 0.01)

(7) Single pulse

i	1	2	3	4
r_i [K/W]	0.158251	0.321659	0.289049	0.227833
τ_i [s]	0.000144	0.000797	0.005748	0.042139

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



(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]	0.136493	0.604922	0.563380	0.407679
τ_i [s]	0.000243	0.001598	0.008716	0.059975

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

9.2. Waveform definitions

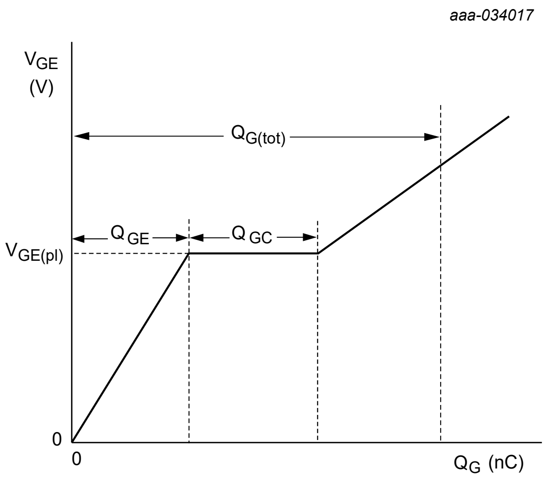


Fig. 25. IGBT gate charge waveform definitions

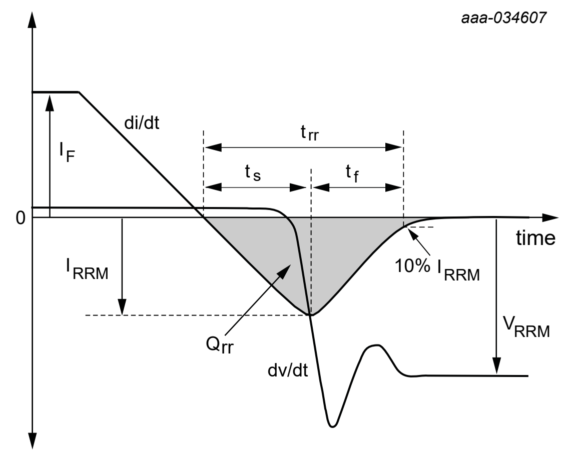


Fig. 26. Diode reverse recovery waveform definitions

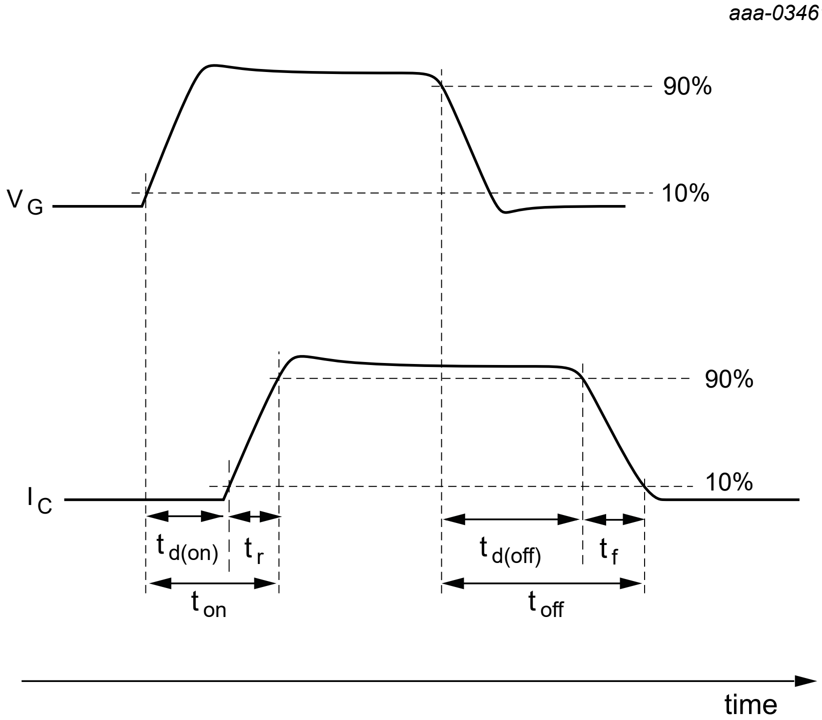
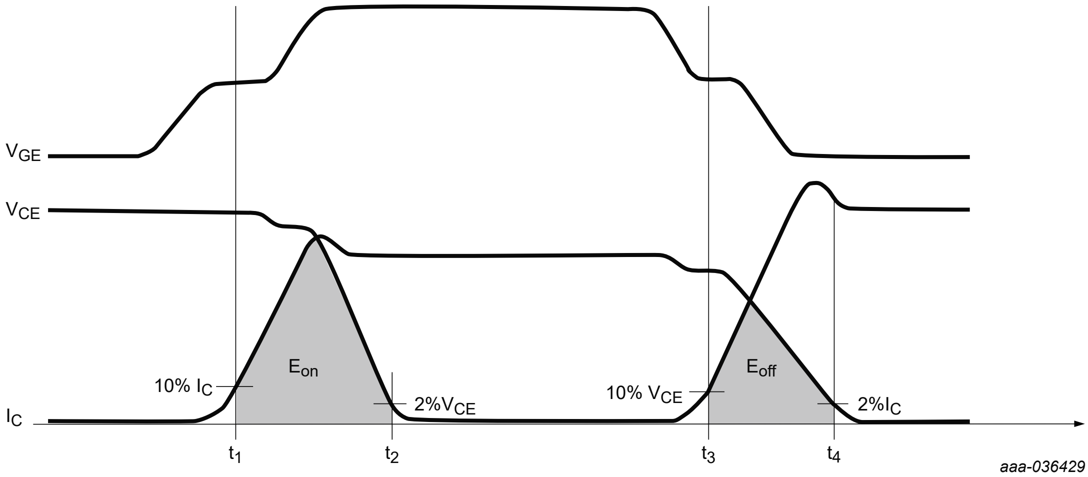


Fig. 27. IGBT switching times definitions



Where

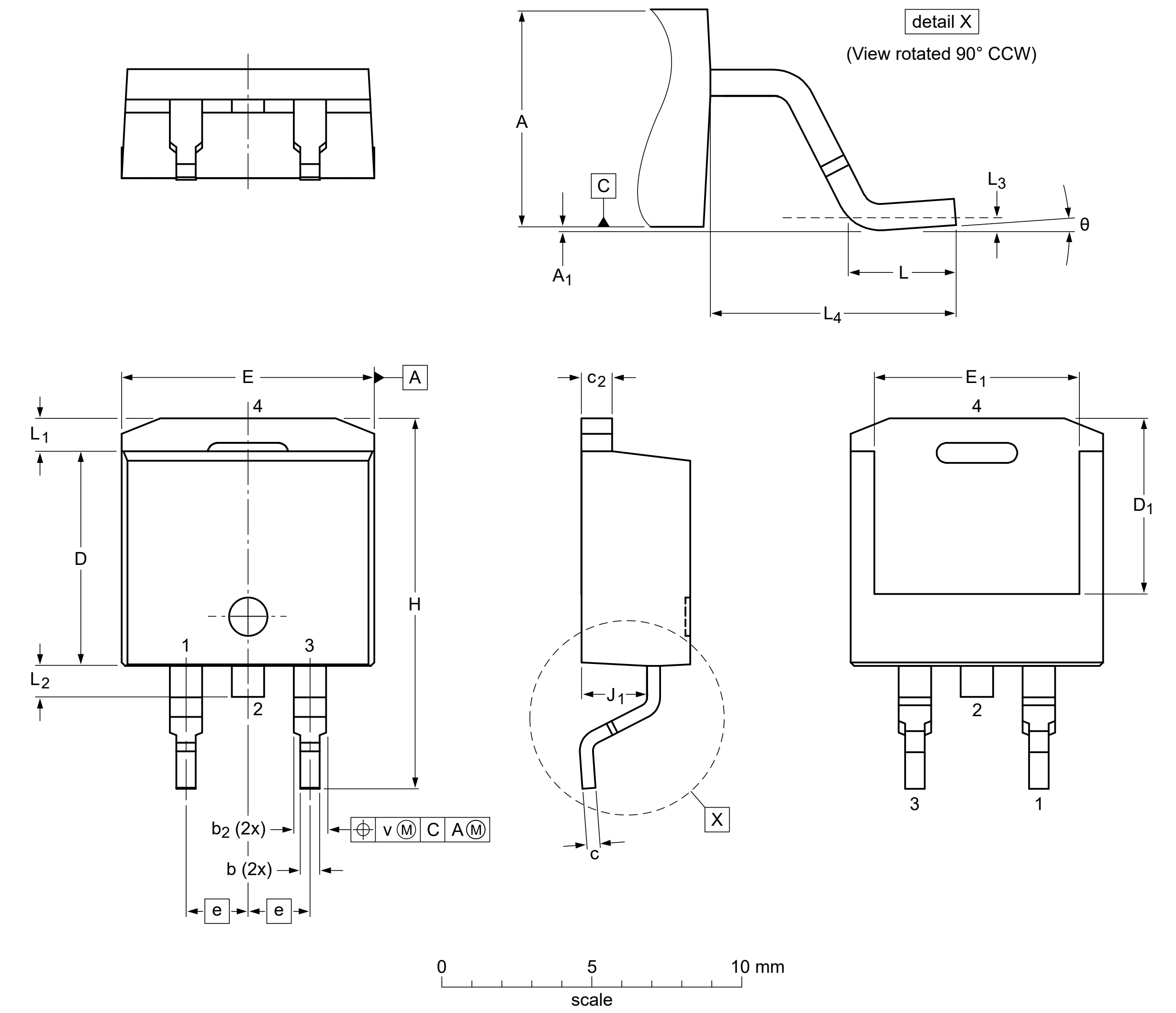
$$E_{on} = \int_{t_1}^{t_2} V_{CE} \, I_C \, dt$$

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

Fig. 28. IGBT switching energy loss definitions

10. Package outline

Plastic single-ended surface-mounted package (D2PAK); 3 leads (one lead cropped) **SOT404B-1**



Dimensions (mm are the original dimensions)

Unit		A	A_1	b	b_2	c	c_2	D	D_1	E	E_1	e	H	L	L_1	L_2	L_3	L_4	J_1	θ	V
mm	max	4.56	0.25	0.90	1.37	0.69	1.34	9.00	7.50	10.55	8.70	2.54 BSC	15.60	2.50	1.65	1.78	0.25 TYP	5.28	2.96	8°	0.25
	nom																				
	min	4.36	0.00	0.70	1.17	0.38	1.19	8.60	6.90	10.15	8.10		15.00	1.90				4.78	2.56	0°	

Note
1. Heat sink side flash is max. 0.8 mm.
2. Radius on terminal is optional.

sot404b-1_po

Outline version	References				European projection	Issue date
	IEC	JEDEC	JEITA			
SOT404B-1		TO-263AB				22-04-29

Fig. 29. Package outline D2PAK (SOT404B-1)

11. Revision history

Table 8. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
NGB15T65M3DFP v. 1	June 6, 2025	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".
[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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