NGB30T65M3DFP

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

Rev. 1 — 14 April 2025 Product data sheet

1. General description

The NGB30T65M3DFP is a robust Insulated-Gate Bipolar Transistor (IGBT) featuring third-generation technology. It combines carrier stored trench-gate and field-stop (FS) structures. The NGB30T65M3DFP 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, 30 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 30 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

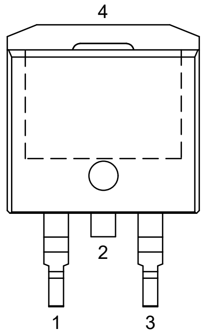
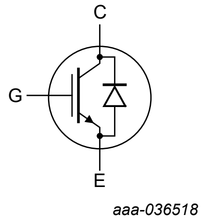
4. Quick reference data

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

5. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	G	gate		
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
NGB30T65M3DFP	D2PAK	Plastic single-ended surface-mounted package; 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	-	56	A
		T_c = 100 °C	-	38	A
I_{CRM}	repetitive peak collector current [2]		-	90	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	-	199	W
		T_c = 100 °C	-	99	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	-	49	A
		T_c = 100 °C	-	30	A
I_{FRM}	repetitive peak forward current [2]		-	90	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	-	0.64	0.75	K/W
		diode	-	1.26	1.49	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 = 30 A; T_{vj} = 25 °C	-	1.52	1.8	V
		V_{GE} = 15 V; I_C = 30 A; T_{vj} = 175 °C	-	1.95	-	V
V_F	diode forward voltage	V_{GE} = 0 V; I_F = 30 A; T_{vj} = 25 °C	-	1.70	2.0	V
		V_{GE} = 0 V; I_F = 30 A; T_{vj} = 175 °C	-	1.45	-	V
$V_{GE(th)}$	gate-emitter threshold voltage	I_C = 0.3 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	-	4	-	nA
		V_{CE} = 650 V; V_{GE} = 0 V; T_{vj} = 175 °C	-	0.3	-	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 = 30 A; T_{vj} = 25 °C	-	14.4	-	S
r_g	internal gate resistor		-	1.9	-	Ω
Dynamic characteristics						
C_{ies}	input capacitance	V_{CE} = 25 V; V_{GE} = 0 V; f = 1 MHz	-	2191	-	pF
C_{oes}	output capacitance		-	77	-	pF
C_{res}	reverse transfer capacitance		-	22	-	pF
Q_G	gate charge	V_{CC} = 520 V; I_C = 30 A; V_{GE} = 15 V	-	81	-	nC
L_{sCE}	internal stray inductance		-	5.4	-	nH
$I_{C(sc)}$	short circuit collector current	V_{GE} = 15 V; V_{CC} = 400 V; t_{sc} ≤ 5 µs; T_{vj} ≤ 150 °C	-	148	-	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 = 30 A; $R_{G(on)}$ = 10 Ω; $R_{G(off)}$ = 10 Ω; see Fig. 27 and Fig. 28	T_{vj} = 25 °C	-	19	-	ns
			T_{vj} = 175 °C	-	18	-	ns
t_r	rise time		T_{vj} = 25 °C	-	19	-	ns
			T_{vj} = 175 °C	-	20	-	ns
$t_{d(off)}$	turn-off delay time		T_{vj} = 25 °C	-	139	-	ns
			T_{vj} = 175 °C	-	179	-	ns
t_f	fall time		T_{vj} = 25 °C	-	38	-	ns
			T_{vj} = 175 °C	-	74	-	ns
E_{on}	turn-on switching energy loss		T_{vj} = 25 °C	-	0.78	-	mJ
			T_{vj} = 175 °C	-	1.52	-	mJ
E_{off}	turn-off switching energy loss		T_{vj} = 25 °C	-	0.42	-	mJ
			T_{vj} = 175 °C	-	0.75	-	mJ
E_{ts}	total switching energy loss		T_{vj} = 25 °C	-	1.21	-	mJ
			T_{vj} = 175 °C	-	2.27	-	mJ
Diode switching characteristics, inductive load							
t_{rr}	reverse recovery time	V_R = 400 V; I_F = 30 A; di_F/dt = 500 A/µs; see Fig. 26	T_{vj} = 25 °C	-	115	-	ns
			T_{vj} = 175 °C	-	226	-	ns
Q_{rr}	reverse recovery charge		T_{vj} = 25 °C	-	617	-	nC
			T_{vj} = 175 °C	-	2401	-	nC
I_{rrm}	peak reverse recovery current		T_{vj} = 25 °C	-	16	-	A
			T_{vj} = 175 °C	-	27	-	A
E_{rec}	reverse recovery energy loss		T_{vj} = 25 °C	-	0.06	-	mJ
			T_{vj} = 175 °C	-	0.34	-	mJ
di_{rrf}/dt	fall rate of reverse recovery current		T_{vj} = 25 °C	-	366	-	A/µs
			T_{vj} = 175 °C	-	216	-	A/µs

9.1. Characteristic diagrams

Table 7. Waveforms and output characteristics

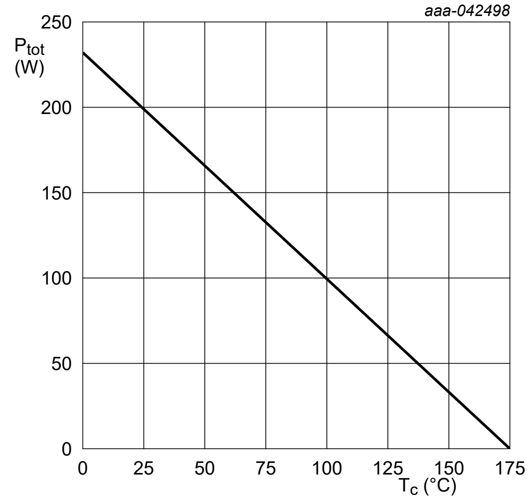


Fig. 1. **Power dissipation as a function of case temperature**

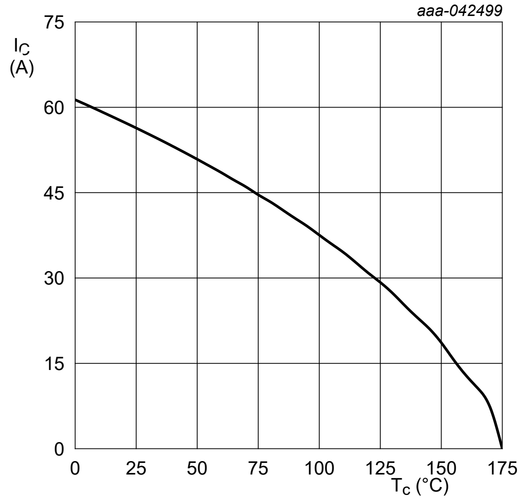
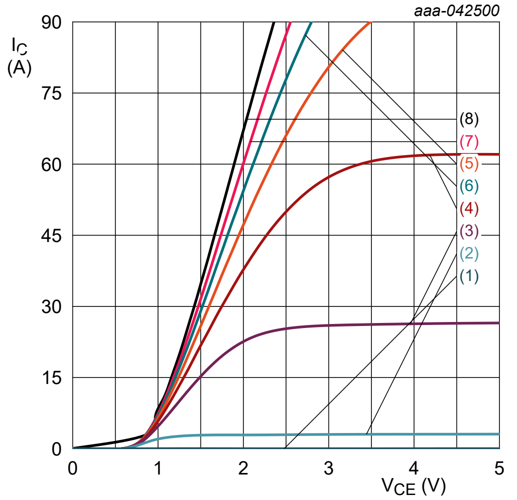
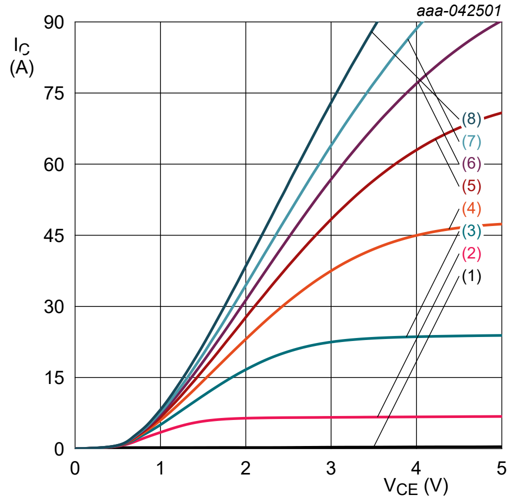


Fig. 2. **Collector current as a function of case temperature**



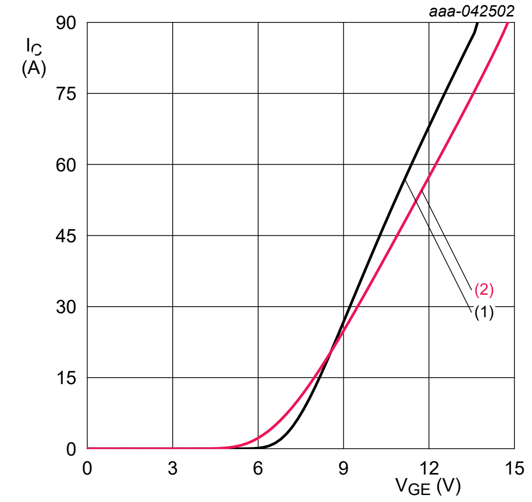
T_{vj} = 25 °C
(1) V_{GE} = 5 V
(2) V_{GE} = 7 V
(3) V_{GE} = 9 V
(4) V_{GE} = 11 V
(5) V_{GE} = 13 V
(6) V_{GE} = 15 V
(7) V_{GE} = 17 V
(8) V_{GE} = 20 V

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**

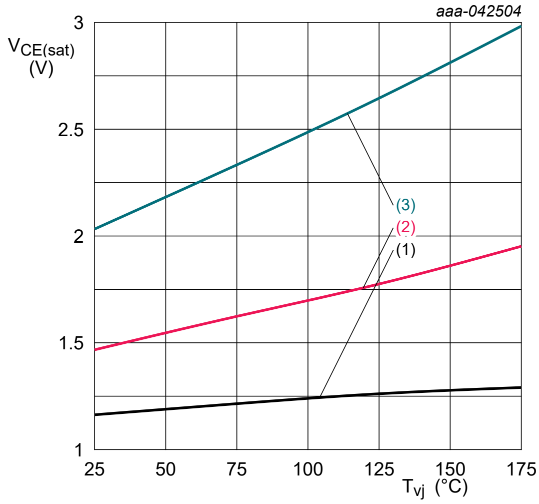


V_{CE} = 20 V

(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 = 15 A

(2) I_C = 30 A

(3) I_C = 60 A

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

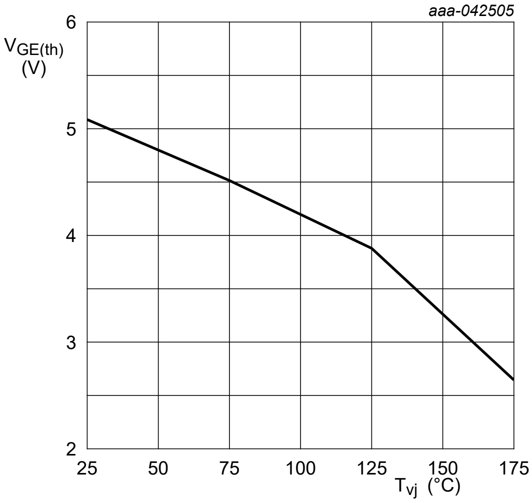
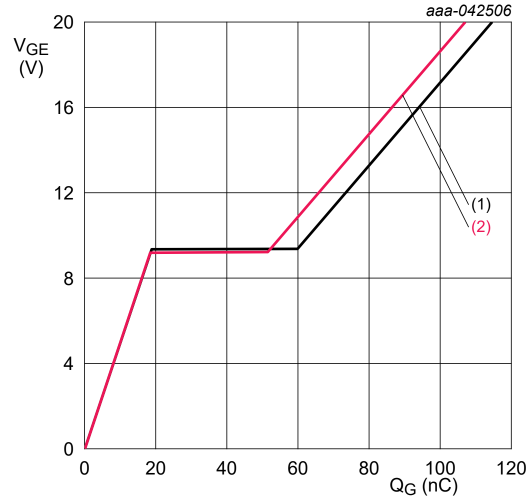


Fig. 7. Gate-emitter threshold voltage as a function of junction temperature

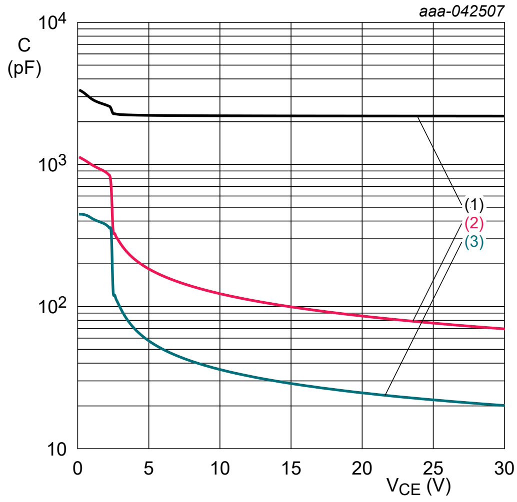


I_C = 30 A

(1) V_{CE} = 130 V

(2) V_{CE} = 520 V

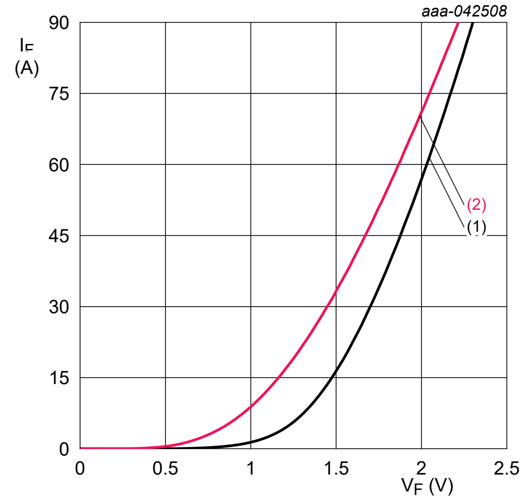
Fig. 8. Gate-emitter voltage as a function of gate charge



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

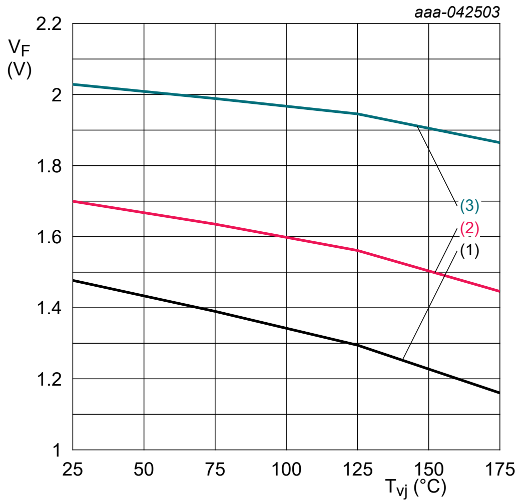
(1) C_{ies}
(2) C_{oes}
(3) C_{res}

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



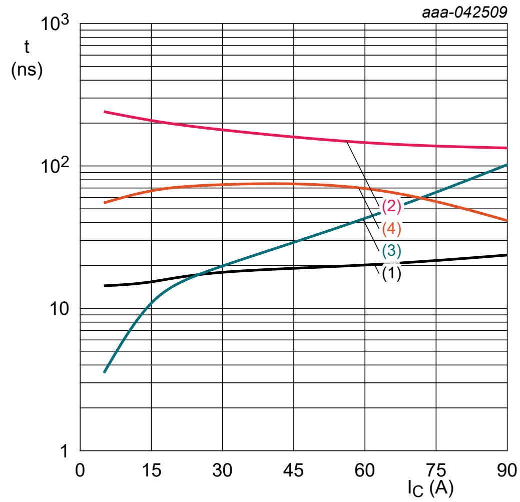
(1) T_{vj} = 25 °C
(2) T_{vj} = 175 °C

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



(1) I_F = 15 A
(2) I_F = 30 A
(3) I_F = 60 A

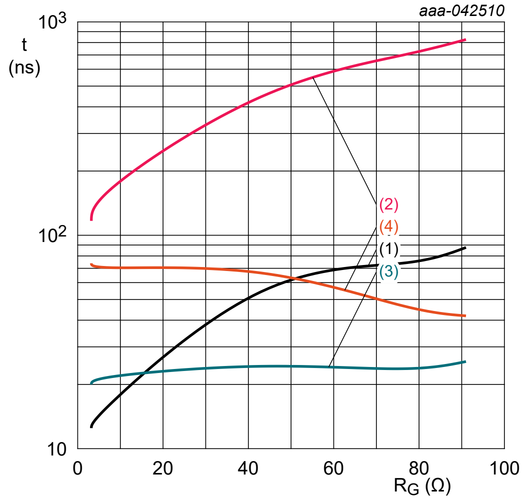
Fig. 11. Typical diode forward voltage as a function of junction temperature



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

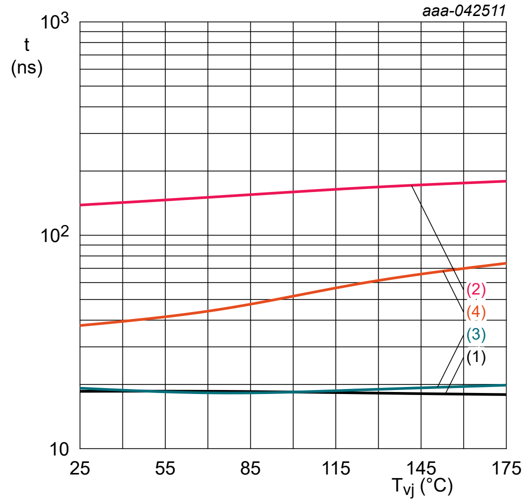
Fig. 12. Typical switching times as a function of collector current



V_{GE} = 15 V to 0 V; V_{CC} = 400 V; I_C = 30 A;
T_{vj} = 175 °C

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

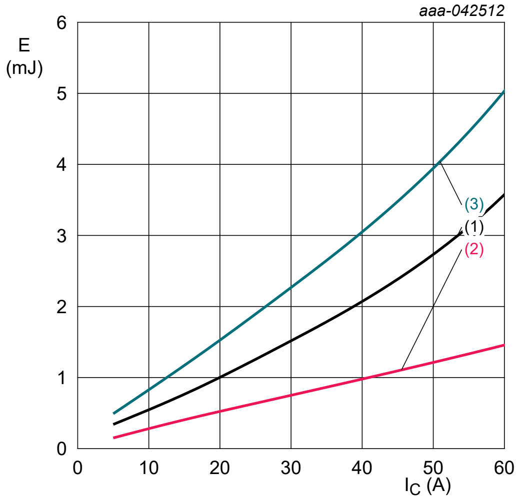
Fig. 13. Typical switching times as a function of gate resistance



V_{GE} = 15 V to 0 V; V_{CC} = 400 V; I_C = 30 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

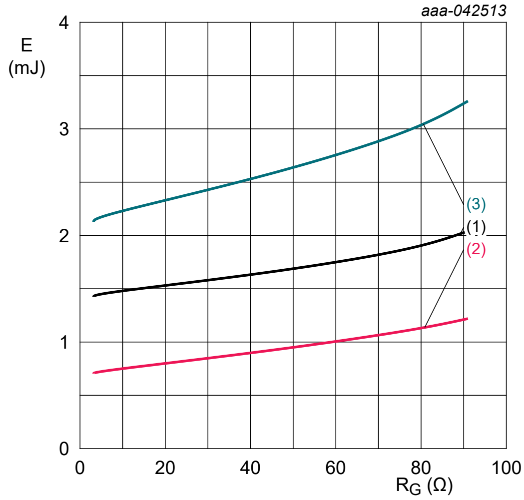
Fig. 14. Typical switching times as a function of junction temperature



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}

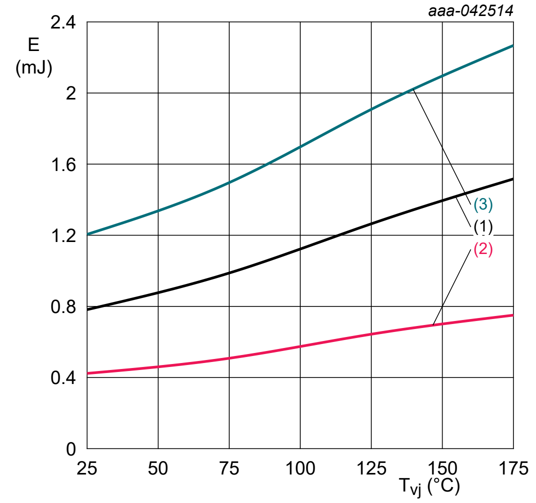
Fig. 15. Typical switching energy losses as a function of collector current



V_{GE} = 15 V to 0 V; V_{CC} = 400 V; I_C = 30 A;
T_{vj} = 175 °C

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

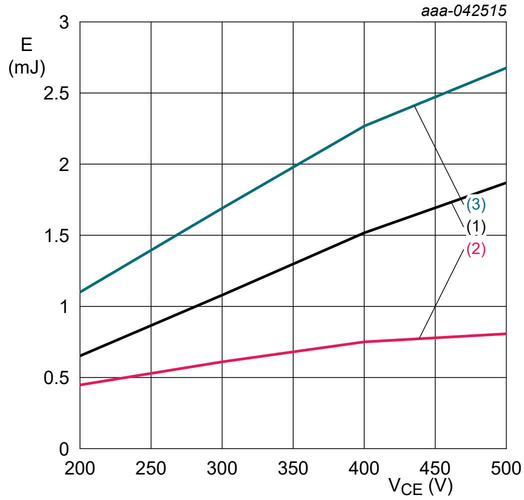
Fig. 16. Typical switching energy losses as a function of gate resistance



V_{GE} = 15 V to 0 V; V_{CC} = 400 V; I_C = 30 A;
$R_{G(on)}$ = 10 Ω; $R_{G(off)}$ = 10 Ω

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

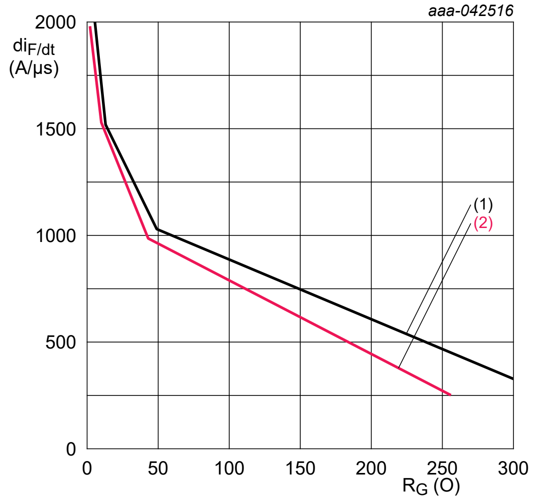
Fig. 17. Typical switching energy losses as a function of junction temperature



V_{GE} = 15 V to 0 V; I_C = 30 A; $R_{G(on)}$ = 10 Ω;
$R_{G(off)}$ = 10 Ω; T_{vj} = 175 °C

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

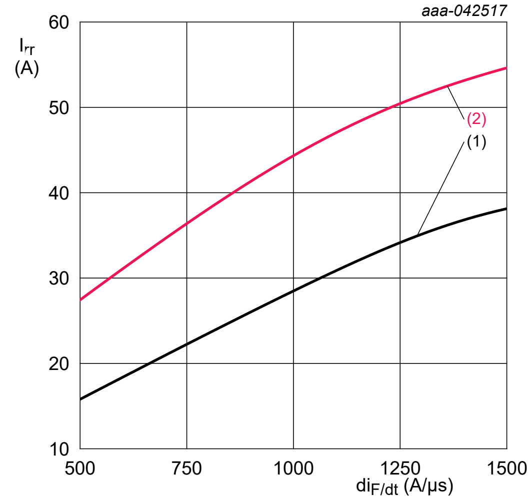
Fig. 18. Typical switching energy losses as a function of collector-emitter voltage



V_R = 400 V; I_F = 30 A

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

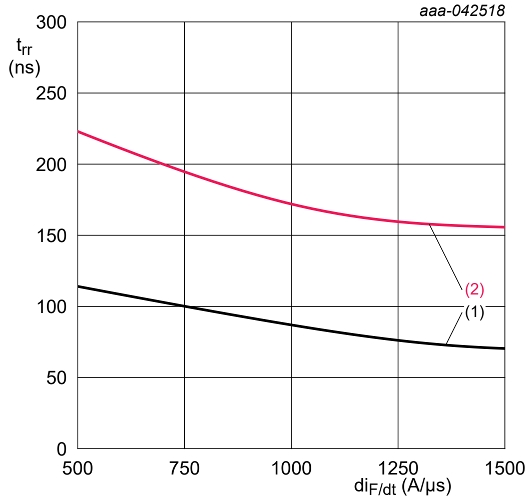
Fig. 19. Typical rate of change of forward current as a function of gate resistance



V_R = 400 V; I_F = 30 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

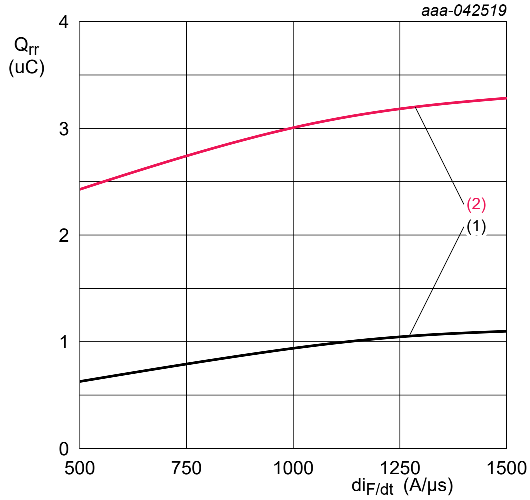


V_R = 400 V; I_F = 30 A

(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

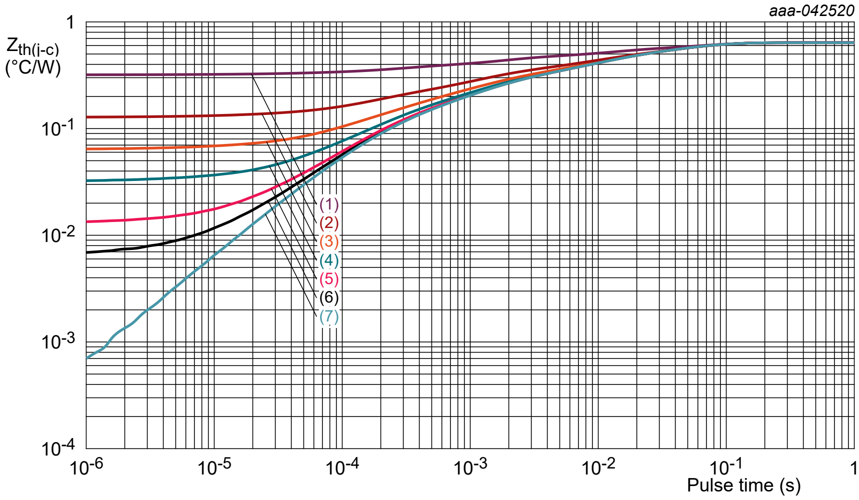


V_R = 400 V; I_F = 30 A

(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)

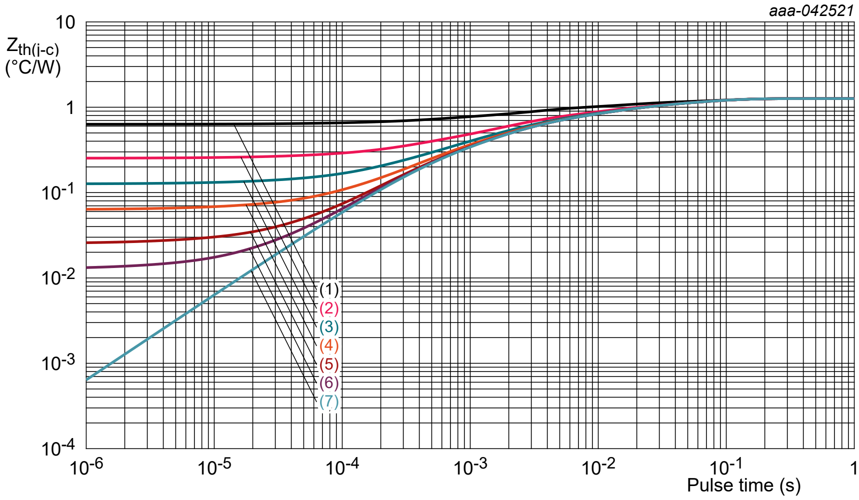
(5) Z_{th} (D = 0.02)

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

(7) Single pulse

i	1	2	3	4
r_i [K/W]	0.082175	0.162867	0.168367	0.224989
τ_i [s]	0.000169	0.001091	0.007988	0.041820

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]	0.137907	0.424177	0.356198	0.345517
τ_i [s]	0.000369	0.001898	0.010251	0.054882

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

9.2. Waveform definitions

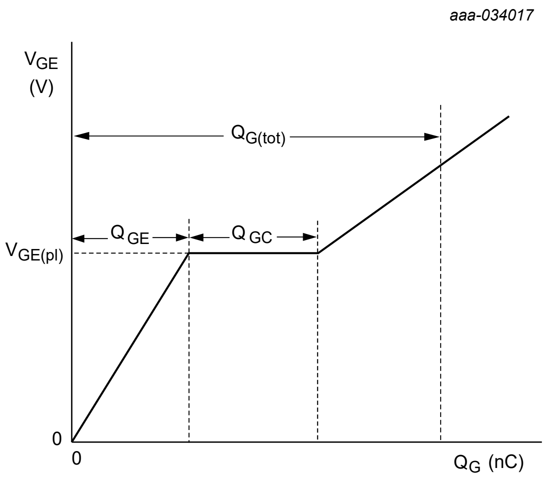


Fig. 25. IGBT gate charge waveform definitions

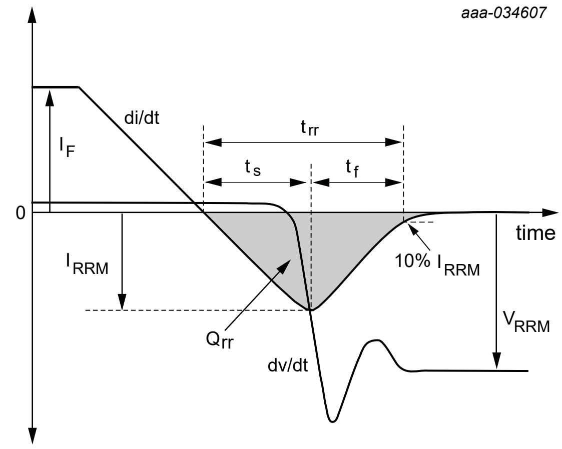


Fig. 26. Diode reverse recovery waveform definitions

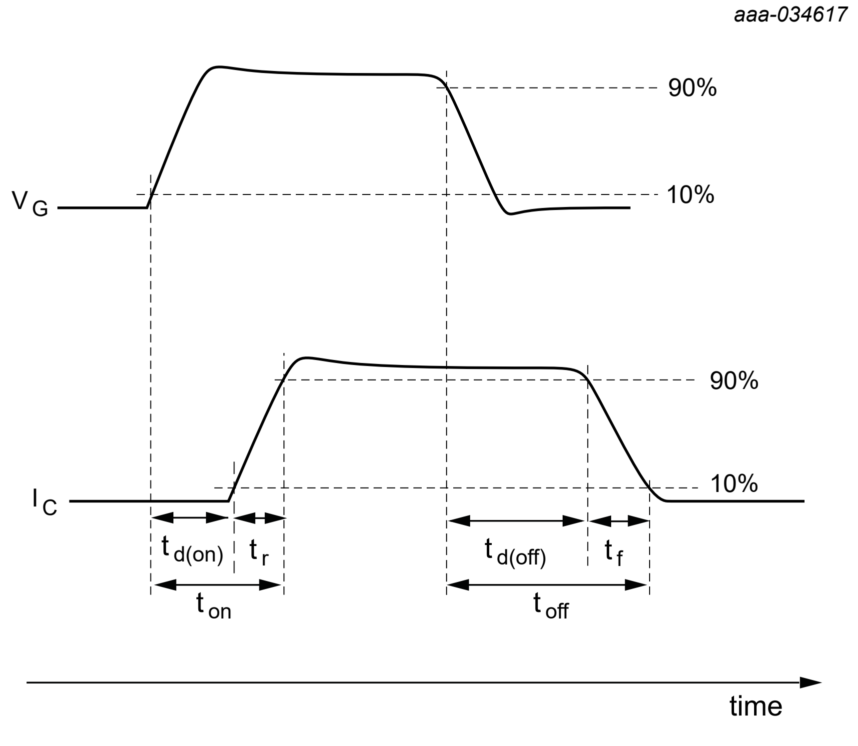
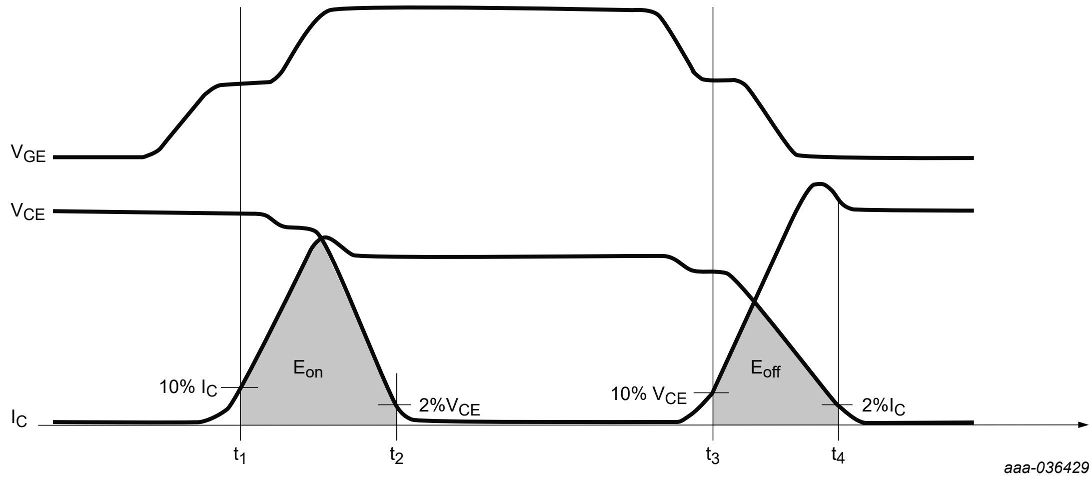


Fig. 27. IGBT switching times definitions



Where

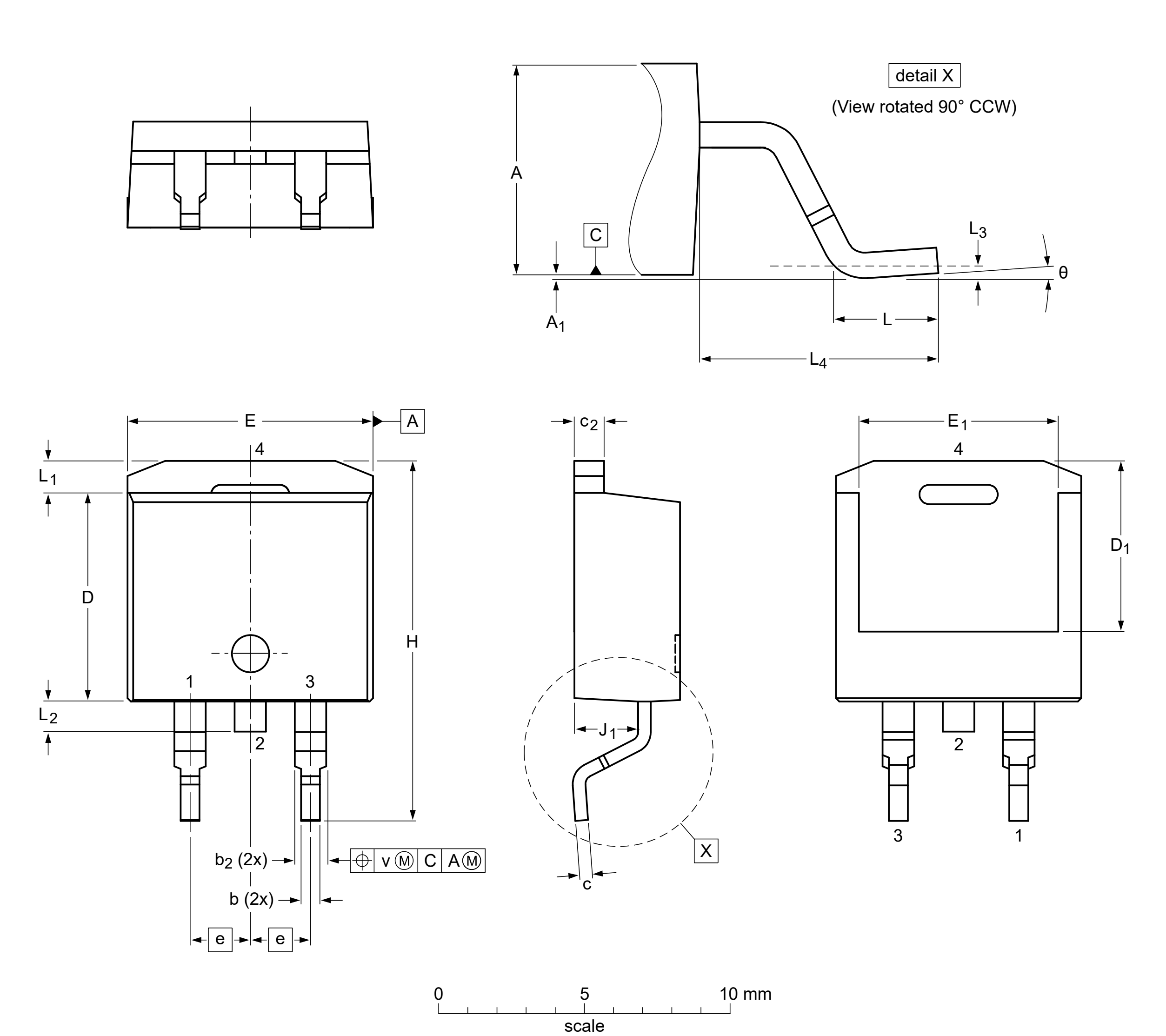
$$E_{\mathrm{on}} = \int_{t_1}^{t_2} V_{\mathrm{CE}} \times I_C \times \mathrm{d}t$$

$$E_{\mathrm{off}} = \int_{t_3}^{t_4} V_{\mathrm{CE}} \times I_C \times \mathrm{d}t$$

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	A1	b	b2	c	c2	D	D1	E	E1	e	H	L	L1	L2	L3	L4	J1	θ	V
mm	max	4.56	0.25	0.90	1.37	0.69	1.34	9.00	7.50	10.55	8.70		15.60	2.50	1.65	1.78		5.28	2.96	8°	
	nom											2.54 BSC					0.25 TYP				0.25
	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
NGB30T65M3DFP v. 1	20250414	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: 14 April 2025