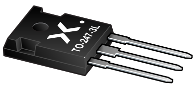


NGW40T65H3DFP

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

Rev. 1 — 17 January 2025 | Product data sheet

1. General description

The NGW40T65H3DFP is a robust Insulated-Gate Bipolar Transistor (IGBT) featuring third-generation technology. It combines carrier stored trench-gate and field-stop (FS) structures. The NGW40T65H3DFP is rated to 175 °C with optimized IGBT turn-off losses. This hard-switching 650 V, 40 A IGBT is optimized for high-voltage, high-frequency industrial power inverter 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 fast reverse recovery diode
- HV-H3TRB qualified

3. Applications

- Power inverters such as
  - Uninterruptible Power Supply (UPS) inverter
  - EV charging converter
- Power Factor Correction (PFC)
- Induction heating
- Welding

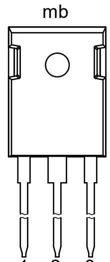
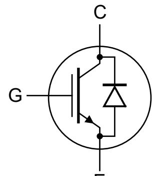
4. Quick reference data

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

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
NGW40T65H3DFP	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	-	47	A
I_{CRM}	repetitive peak collector current [2]		-	160	A
V_{GE}	gate-emitter voltage		-20	20	V
P_{tot}	total power dissipation	T_c = 25 °C	-	275	W
		T_c = 100 °C	-	138	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	-	50	A
I_{FRM}	repetitive peak forward current [2]		-	160	A

[1] Value is limited by bondwire and $T_{vj(max)}$.
[2] Time duration is limited by $T_{vj(max)}$.

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	-	0.46	0.54	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	-	1.70	2.0	V
		V_{GE} = 15 V; I_C = 40 A; T_{vj} = 175 °C	-	2.23	-	V
V_F	diode forward voltage	V_{GE} = 0 V; I_F = 40 A; T_{vj} = 25 °C	-	1.53	2.0	V
		V_{GE} = 0 V; I_F = 40 A; T_{vj} = 175 °C	-	1.27	-	V
$V_{GE(th)}$	gate-emitter threshold voltage	I_C = 0.4 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	-	8	-	nA
		V_{CE} = 650 V; V_{GE} = 0 V; T_{vj} = 175 °C	-	0.4	-	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	-	23.2	-	S
r_g	internal gate resistor		-	2.1	-	Ω
Dynamic characteristics						
C_{ies}	input capacitance	V_{CE} = 25 V; V_{GE} = 0 V; f = 1 MHz	-	1757	-	pF
C_{oes}	output capacitance		-	129	-	pF
C_{res}	reverse transfer capacitance		-	13	-	pF
Q_G	gate charge	V_{CC} = 520 V; V_{GE} = 15 V; I_C = 40 A	-	62	-	nC
L_{sCE}	internal stray inductance	measured 5 mm from case	-	7.9	-	nH

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	-	17	-	ns
			T_{vj} = 175 °C	-	16	-	ns
t_r	rise time		T_{vj} = 25 °C	-	30	-	ns
			T_{vj} = 175 °C	-	30	-	ns
$t_{d(off)}$	turn-off delay time		T_{vj} = 25 °C	-	72	-	ns
			T_{vj} = 175 °C	-	96	-	ns
t_f	fall time		T_{vj} = 25 °C	-	31	-	ns
			T_{vj} = 175 °C	-	56	-	ns
E_{on}	turn-on switching energy loss		T_{vj} = 25 °C	-	1.16	-	mJ
			T_{vj} = 175 °C	-	2.31	-	mJ
E_{off}	turn-off switching energy loss		T_{vj} = 25 °C	-	0.34	-	mJ
			T_{vj} = 175 °C	-	0.62	-	mJ
E_{ts}	total switching energy loss		T_{vj} = 25 °C	-	1.51	-	mJ
			T_{vj} = 175 °C	-	2.94	-	mJ
Diode switching characteristics, inductive load							
t_{rr}	reverse recovery time	V_R = 400 V; I_F = 40 A; di_F/dt = 500 A/µs; see Fig. 26	T_{vj} = 25 °C	-	130	-	ns
			T_{vj} = 175 °C	-	251	-	ns
Q_{rr}	reverse recovery charge		T_{vj} = 25 °C	-	907	-	nC
			T_{vj} = 175 °C	-	3825	-	nC
I_{rrm}	peak reverse recovery current		T_{vj} = 25 °C	-	15	-	A
			T_{vj} = 175 °C	-	30	-	A
E_{rec}	reverse recovery energy loss		T_{vj} = 25 °C	-	0.12	-	mJ
			T_{vj} = 175 °C	-	0.62	-	mJ
di_{rrf}/dt	fall rate of reverse recovery current		T_{vj} = 25 °C	-	134	-	A/µs
			T_{vj} = 175 °C	-	167	-	A/µs

9.1. Characteristic diagrams

Table 7. Waveforms and output characteristics

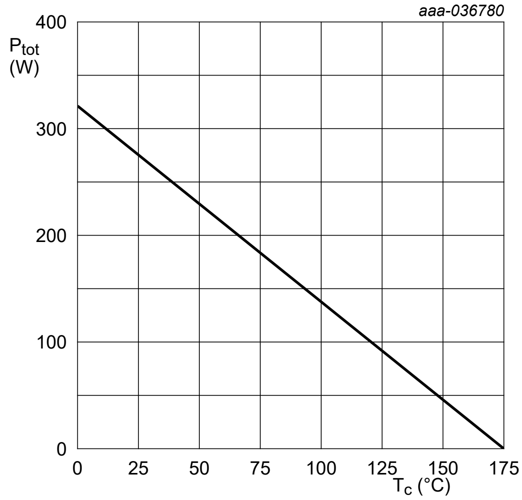


Fig. 1. **Power dissipation as a function of case temperature**

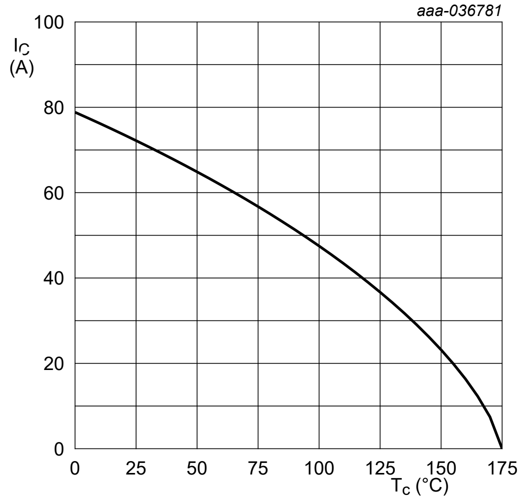
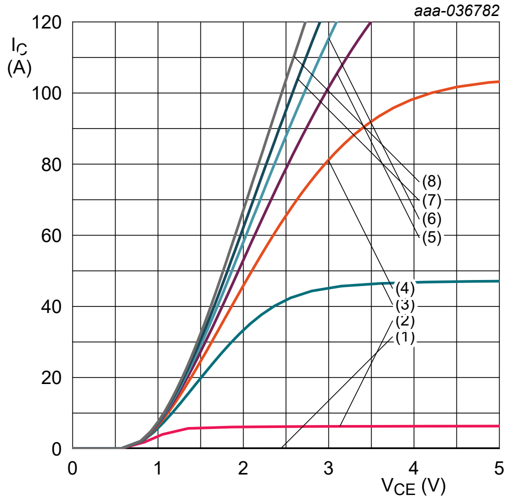


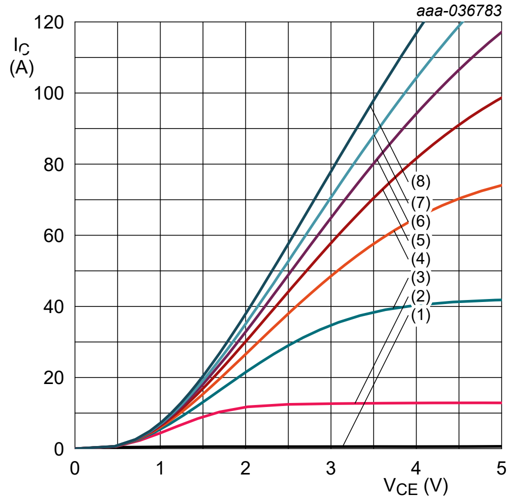
Fig. 2. **Collector current as a function of case temperature**



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

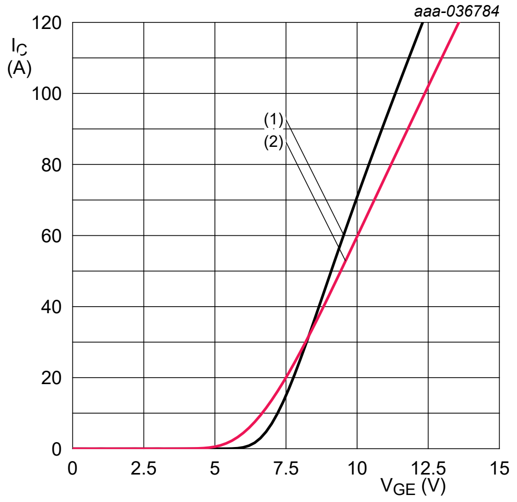
Fig. 3. **Collector current as a function of collector-emitter voltage**



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**

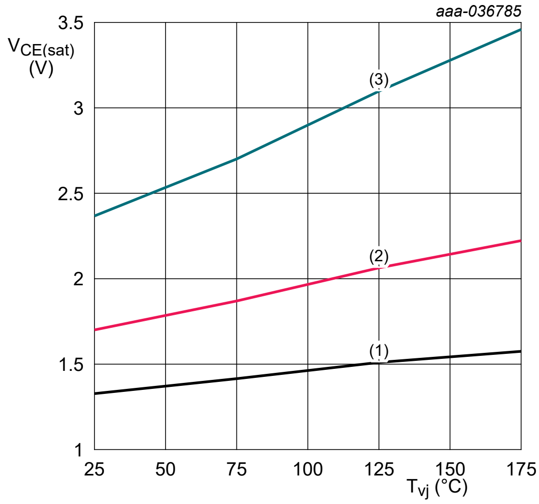


V_{CE} = 20 V

(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 = 20 A

(2) I_C = 40 A

(3) I_C = 80 A

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

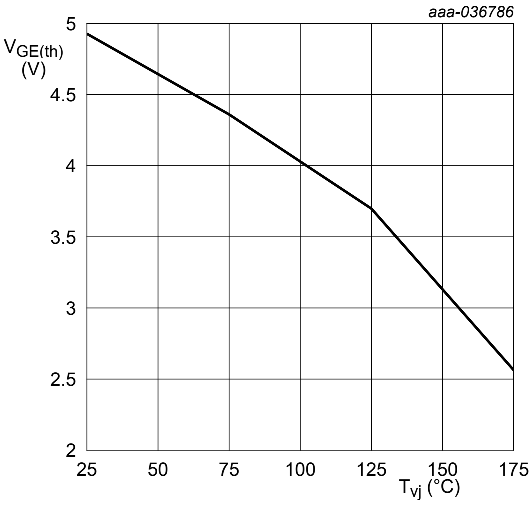
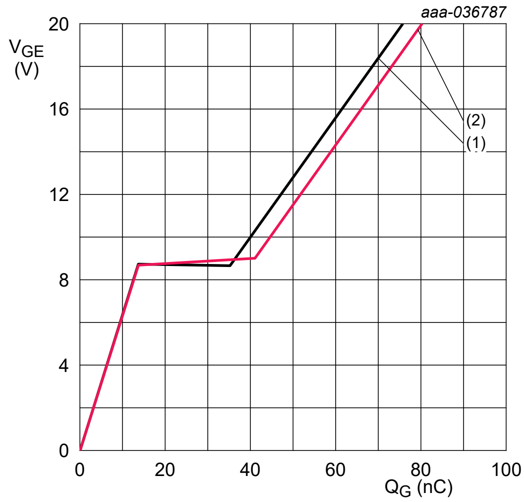


Fig. 7. Gate-emitter threshold voltage as a function of junction temperature

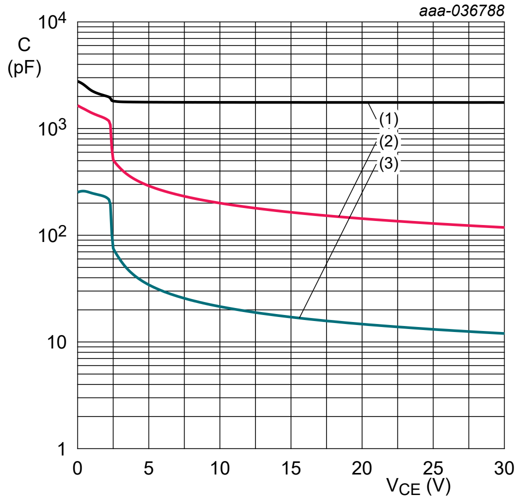


I_C = 40 A

(1) V_{CE} = 130 V

(2) V_{CE} = 520 V

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



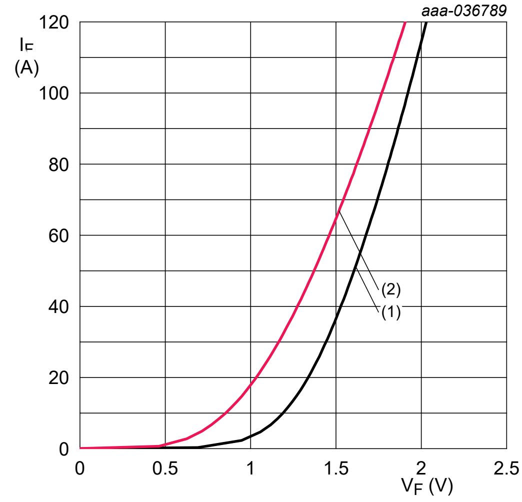
V_{GE} = 0 V; f = 1 MHz

(1) C_{ies}

(2) C_{oes}

(3) C_{res}

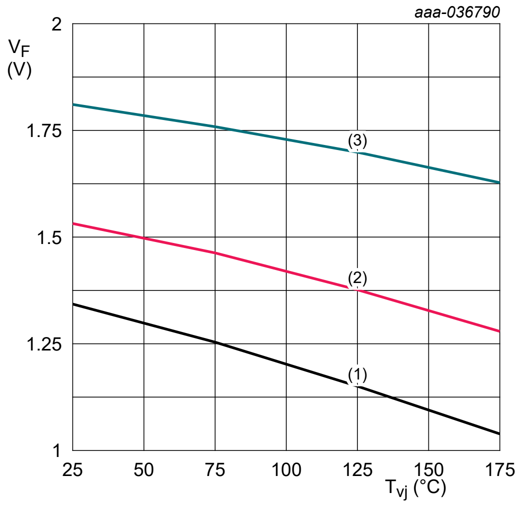
Fig. 9. Typical capacitance as a function of collector-emitter voltage



(1) T_{vj} = 25 °C

(2) T_{vj} = 175 °C

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

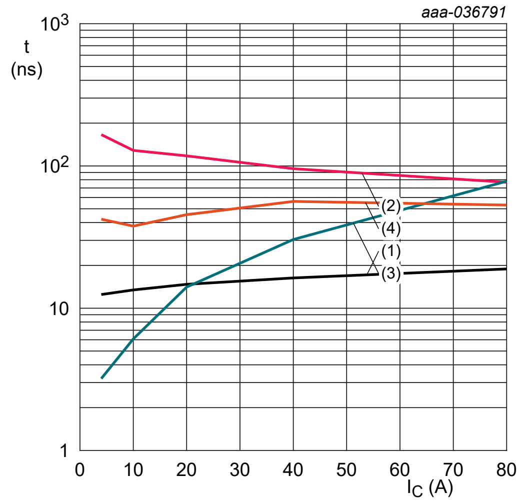


(1) I_F = 20 A

(2) I_F = 40 A

(3) I_F = 80 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

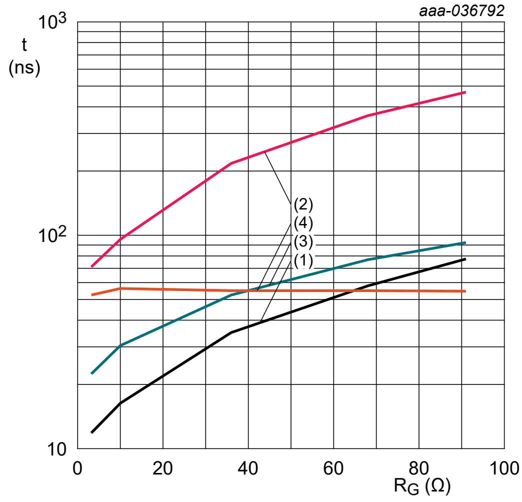
(1) $t_{d(on)}$

(2) $t_{d(off)}$

(3) t_r

(4) t_f

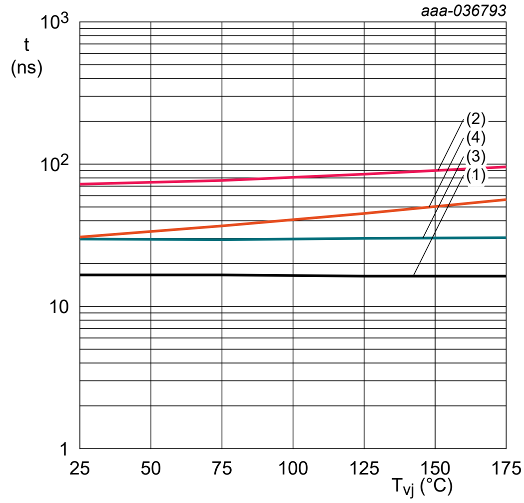
Fig. 12. Typical switching times as a function of collector current



V_{GE} = 15 V to 0 V; V_{CC} = 400 V; I_C = 40 A;
T_{vj} = 175 °C

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

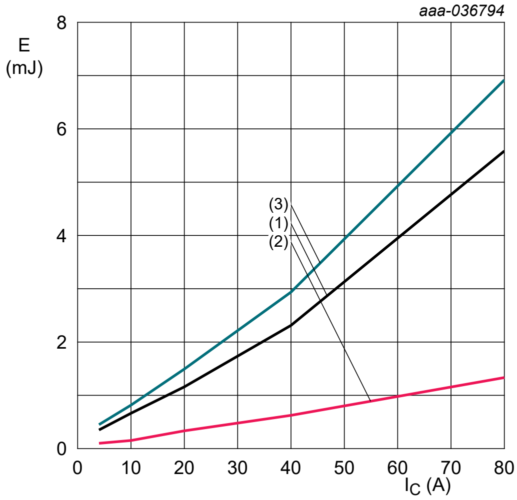
Fig. 13. Typical switching times as a function of gate resistance



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

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

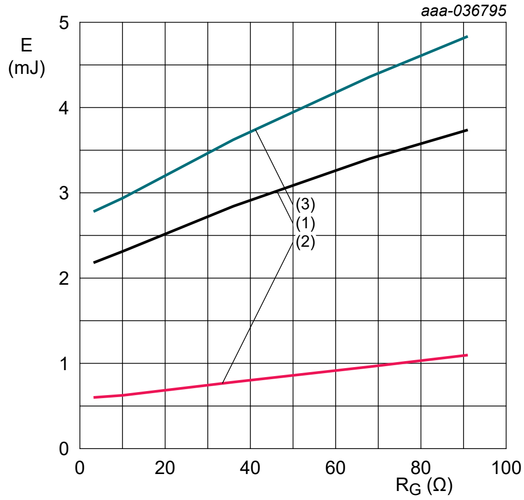
Fig. 14. Typical switching times as a function of junction temperature



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}

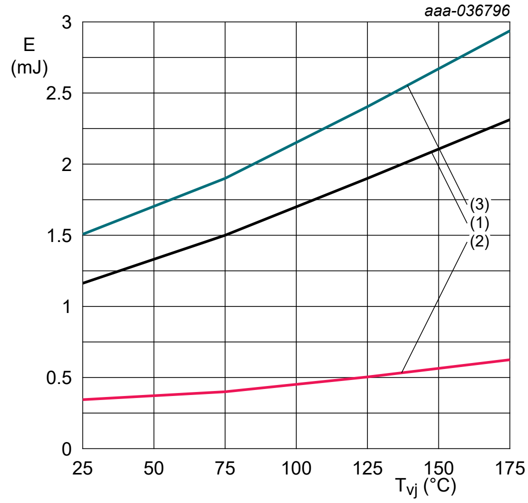
Fig. 15. Typical switching energy losses as a function of collector current



V_{GE} = 15 V to 0 V; V_{CC} = 400 V; I_C = 40 A;
T_{vj} = 175 °C

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

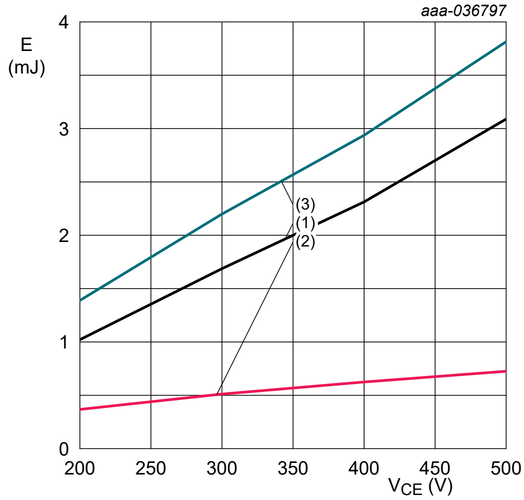
Fig. 16. Typical switching energy losses as a function of gate resistance



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

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

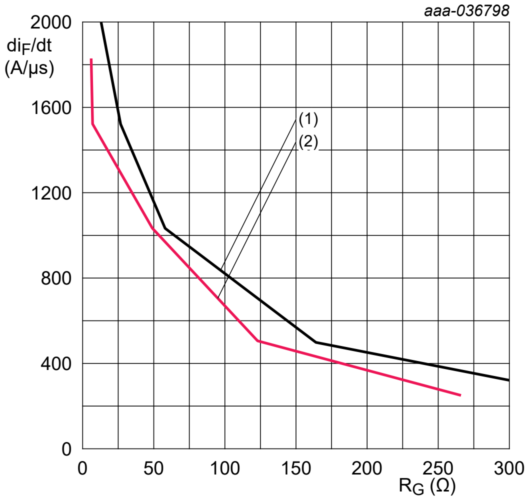
Fig. 17. Typical switching energy losses as a function of junction temperature



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

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

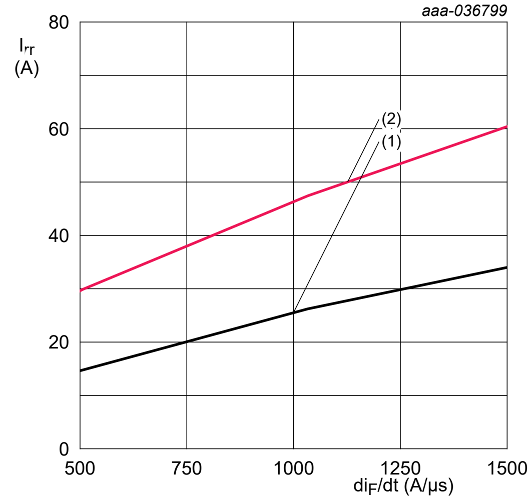
Fig. 18. Typical switching energy losses as a function of collector-emitter voltage



V_R = 400 V; I_F = 40 A

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

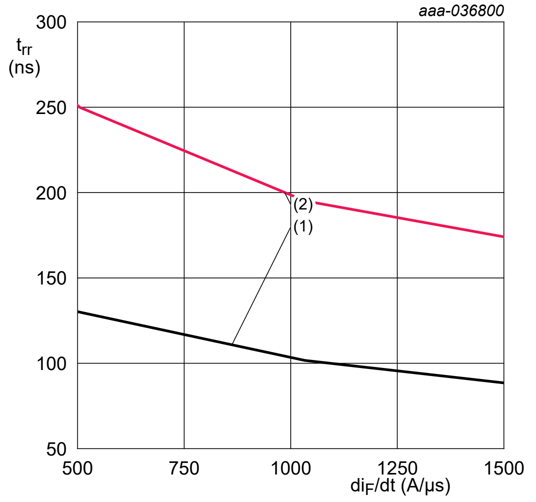
Fig. 19. Typical rate of change of forward current as a function of change of gate resistance



V_R = 400 V; I_F = 40 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

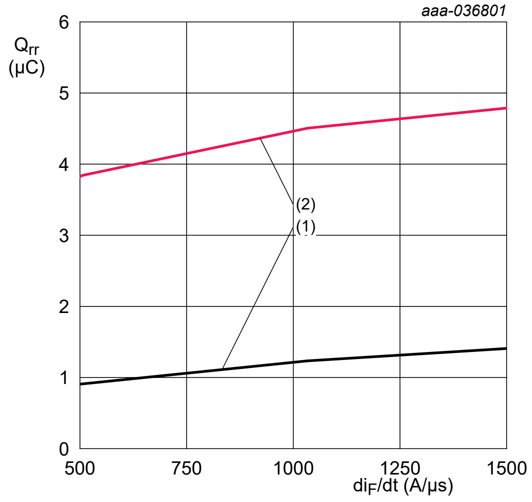


V_R = 400 V; I_F = 40 A

(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

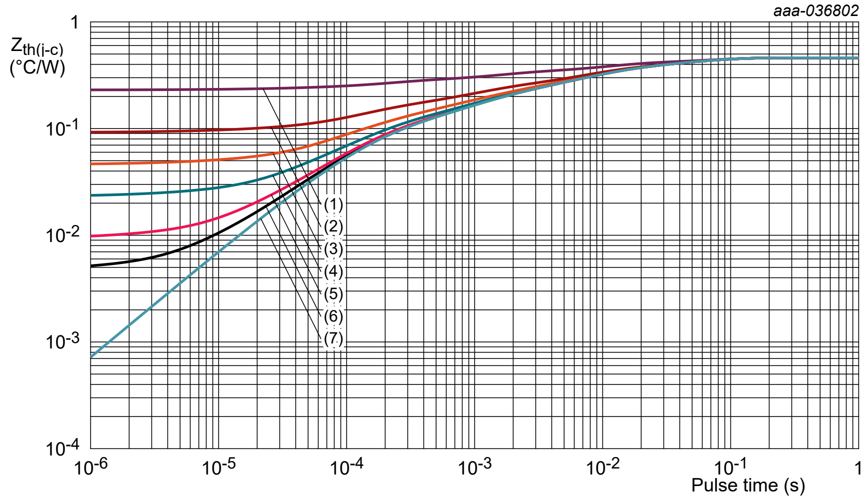


V_R = 400 V; I_F = 40 A

(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)

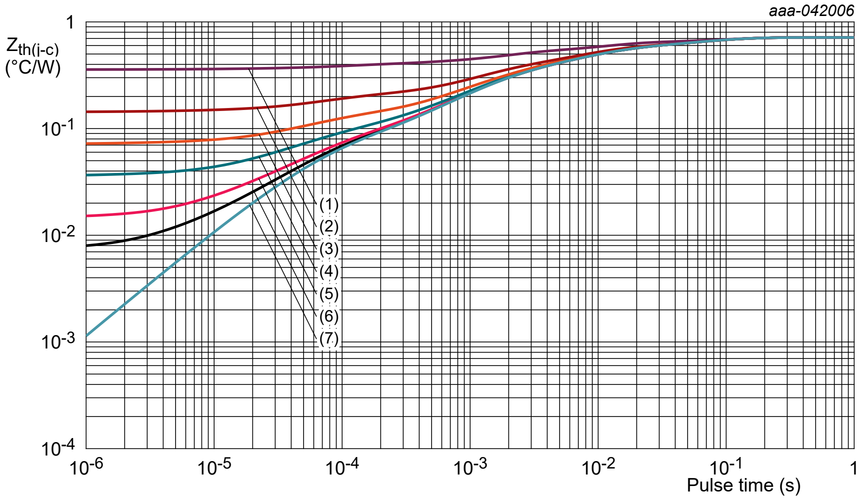
(5) Z_{th} (D = 0.02)

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

(7) Single pulse (D = 0.0)

i	1	2	3	4
r_i [K/W]	0.074202	0.102016	0.159376	0.124789
τ_i [s]	0.000127	0.000929	0.006905	0.043256

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 (D = 0.0)

i	1	2	3	4
r_i [K/W]	0.053591	0.212437	0.267846	0.180394
τ_i [s]	0.000058	0.001161	0.007083	0.060605

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

9.2. Waveform definitions

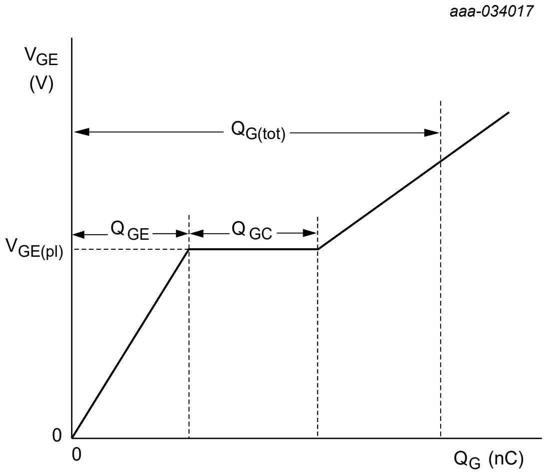


Fig. 25. IGBT gate charge waveform definitions

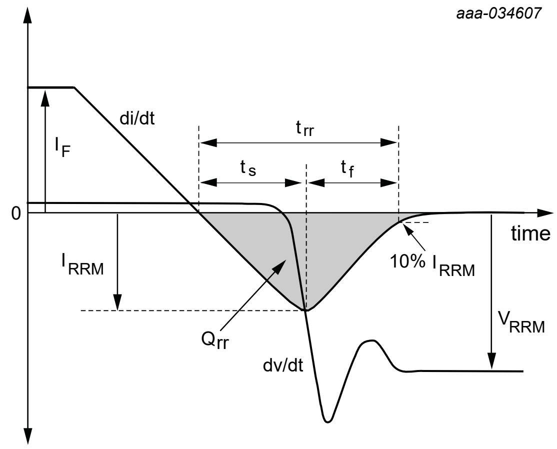


Fig. 26. Diode reverse recovery waveform definitions

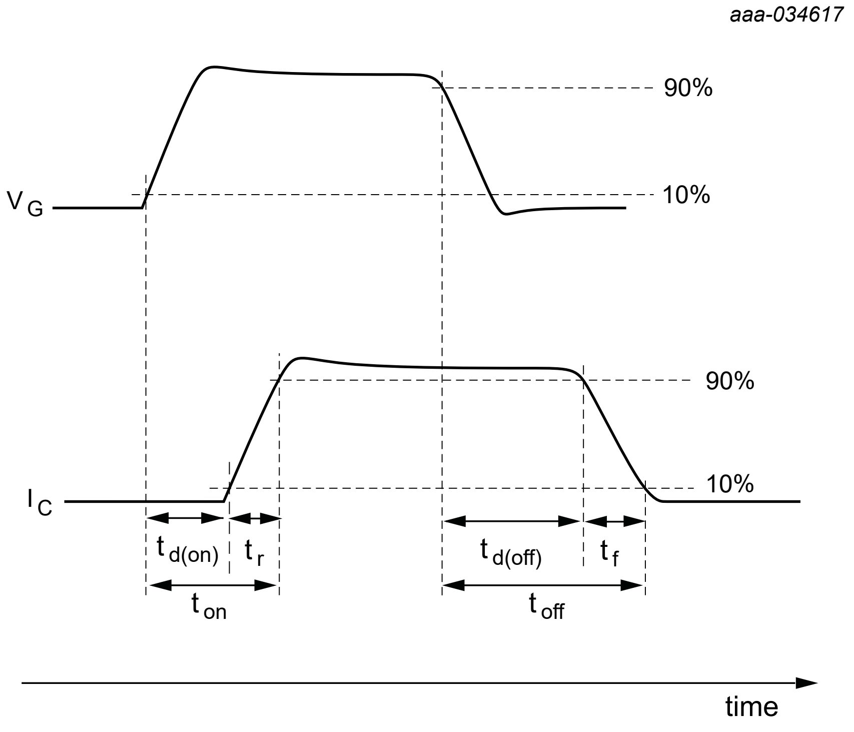
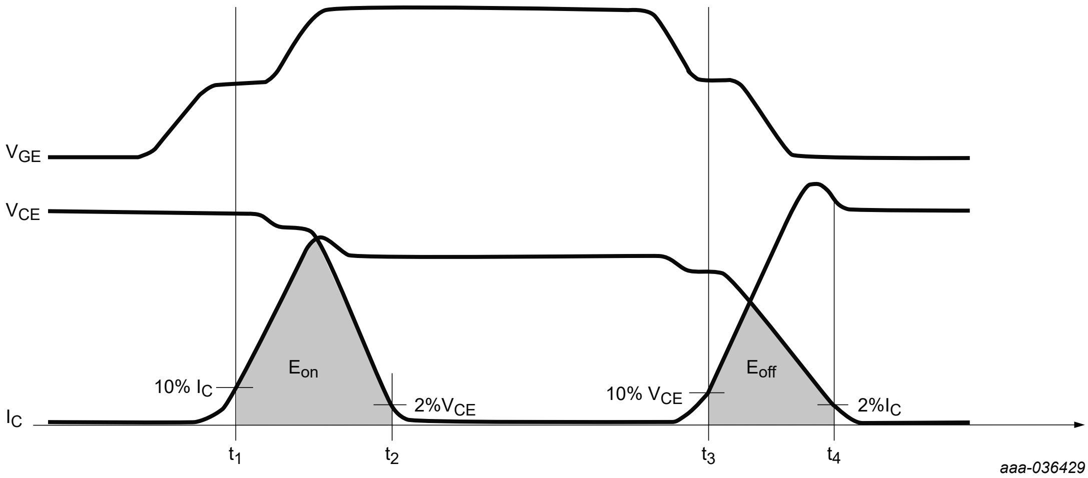


Fig. 27. IGBT switching times definitions



Where

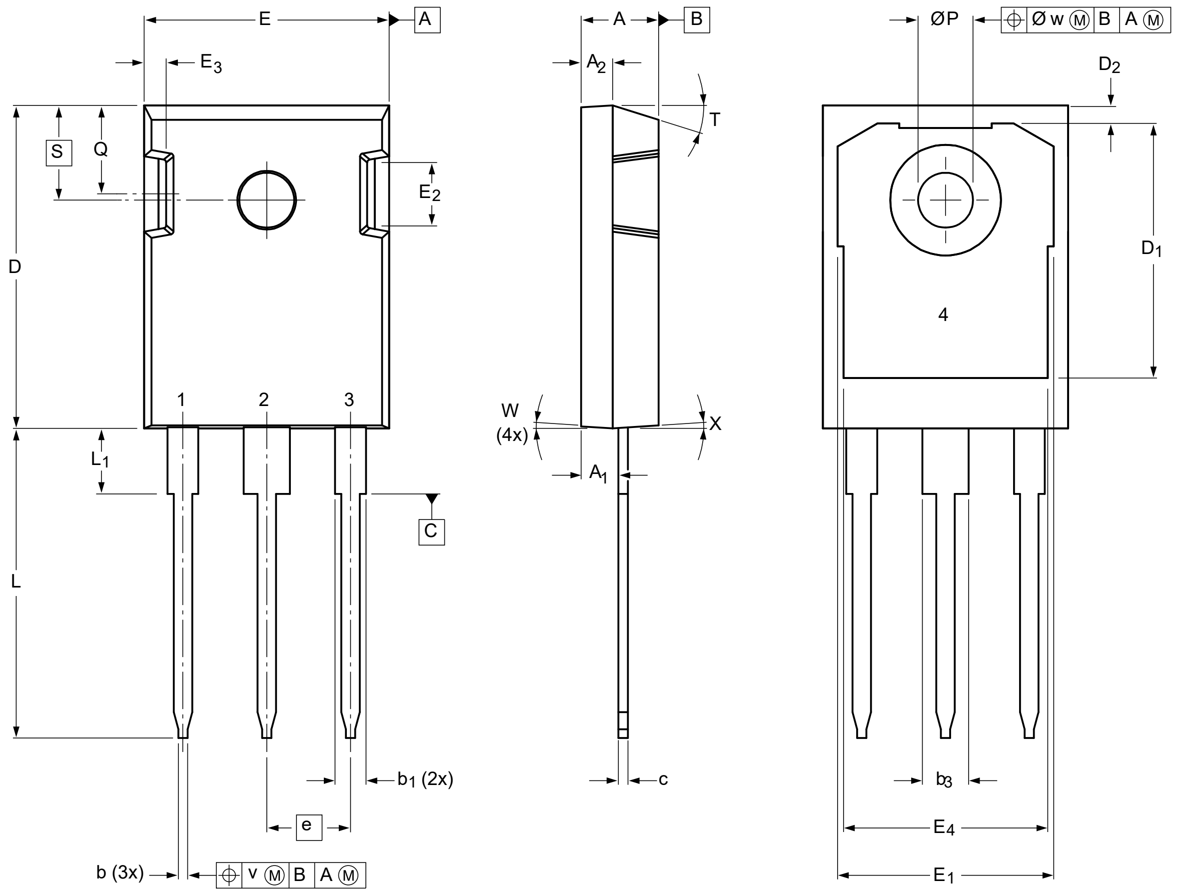
$$E_{on} = \int_{t_1}^{t_2} V_{CE} \; I_C \; dt$$

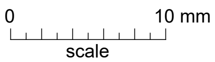
$$E_{off} = \int_{t_3}^{t_4} V_{CE} \; I_C \; dt$$

Fig. 28. IGBT switching energy loss definitions

10. Package outline

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





S	T	W	X	v	w
6.17 BSC	17.5° REF	3.5° REF	4° REF	0.25	0.64

Dimensions (mm are the original dimensions)

Unit		A	A_1	A_2	b	b_1	b_3	c	D	D_1	D_2	E	E_1	E_2	E_3	E_4	e	L	L_1	P	Q
	max	5.21	2.54	2.16	1.33	2.41	3.38	0.68	21.1	17.65	1.25	16.13	14.15	5.1	1.9	13.43		20.32	4.4	3.65	6.0
mm	nom																5.44 BSC				
	min	4.83	2.29	1.91	1.07	1.91	2.87	0.55	20.8	16.25	0.95	15.75	13.1	3.68	1.0	12.38		19.81	4.1	3.51	5.49

Note:
All metal surfaces are tin plated except trimmed area

sot429-2_po

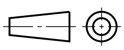
Outline version	References				European projection	Issue date
	IEC	JEDEC	JEITA			
SOT429-2		TO-247-3L				~~22-02-08~~ 22-02-09

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
NGW40T65H3DFP v. 1	20250117	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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