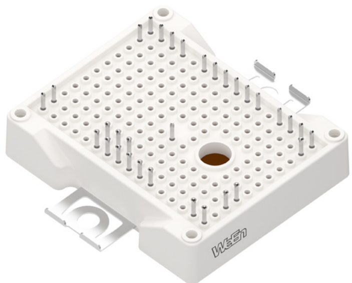
WMG50T12B2S

Module

Rev.01 - 13 January 2025 | Product data sheet

1. General description



WMG50T12B2S is a T-type NPC (Neutral Point Clamped) three-level module consisting of two 50A, 1200V half-bridge IGBTs with inverse diodes, two 50A, 650V neutral point IGBTs with inverse diodes and an NTC thermistor. The integrated field stop trench IGBTs and FRDs provide lower conduction losses and switching losses, enabling designers to achieve high efficiency and superior reliability.

2. Features and benefits

- T-NPC topology
- Low switching losses
- Low Vcesat
- Compact design
- Solder pin
- Integrated NTC temperature sensor
- Al_2O_3 substrate with low thermal resistance

3. Applications

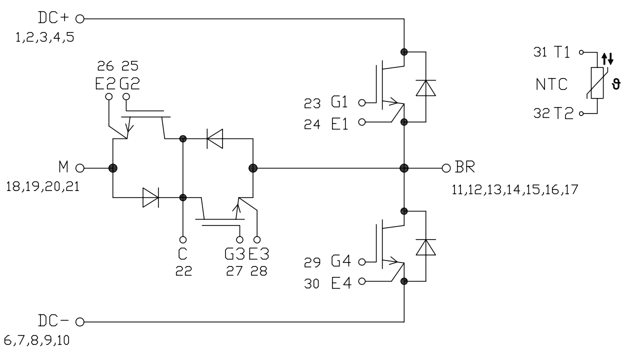
- Three-level applications
- Solar
- Motor Drives
- UPS

4. Ordering information

Table 1. Ordering information

Type number	Package Name	Orderable part number	Packing method	Small packing quantity	Package version	Package issue date
WMG50T12B2S	WeEnPACK-B2	WMG50T12B2ST	Tray	12	WeEnPACK-B2PTL-E	31-Mar-2024

5. Circuit diagram



6. Limiting values

Table 2. Limiting values

Symbol	Parameter	Test Condition	Value	Unit
IGBT, T1/T4				
V_{CE}	Collector-emitter voltage		1200	V
V_{GE}	Gate-emitter voltage		±20	V
I_{CN}	Implemented collector current		100	A
I_C	Continous collector current	T_C = 95 °C, limited by T_{jmax}	50	A
I_{Cpulse}	Pulsed collector current	tp limited by T_{jmax}	150	A
P_{tot}	Total power dissipation	T_C = 95 °C	160	W
t_{sc}	Short circuit withstand time	V_{GE} = 15 V; V_{CC} = 600 V; T_j = 150 °C	10	μs
T_{jmax}	Maximum junction temperature		175	°C
IGBT, T2/T3				
V_{CE}	Collector-emitter voltage		650	V
V_{GE}	Gate-emitter voltage		±20	V
I_{CN}	Implemented collector current		100	A
I_C	Continous collector current	T_C = 95 °C, limited by T_{jmax}	50	A
I_{Cpulse}	Pulsed collector current	tp limited by T_{jmax}	150	A
P_{tot}	Total power dissipation	T_C = 95 °C	123	W
t_{sc}	Short circuit withstand time	V_{GE} = 15 V; V_{CC} = 400 V; T_j = 150 °C	5	μs
T_{jmax}	Maximum junction temperature		175	°C
Diode, D1/D4				
V_{RRM}	Diode repetitive peak reverse voltage		1200	V
I_{FN}	Diode Implemented collector current		100	A
I_F	Diode Continous collector current	T_C = 95 °C, limited by T_{jmax}	50	A
I_{FRM}	Diode repetitive reak forward current	tp limited by T_{jmax}	150	A
P_{tot}	Total power dissipation	T_C = 95 °C	53	W
T_{jmax}	Maximum junction temperature		175	°C
Diode, D2/D3				
V_{RRM}	Diode repetitive peak reverse voltage		650	V
I_{FN}	Diode Implemented collector current		100	A
I_F	Diode Continous collector current	T_C = 95 °C, limited by T_{jmax}	50	A
I_{FRM}	Diode repetitive reak forward current	tp limited by T_{jmax}	150	A
P_{tot}	Total power dissipation	T_C = 95 °C	73	W
T_{jmax}	Maximum junction temperature		175	°C

7. Module package thermal & insulation properties

Table 3. Thermal & Insulation properties

Symbol	Parameter	Test Condition	Value	Unit
V_{ISOL}	RMS isolation voltage	T_j = 25 °C, all terminals shorted, f = 50 Hz, t = 1 min	2500	V
d_{Creep}	Creepage distance	terminal to heatsink	11.5	mm
d_{Clear}	Clearance	terminal to heatsink	10	mm
CTI	Comperative tracking index		> 200	
T_{stg}	Storage temperature		-40 to 125	°C

8. Electrical characteristics

Table 4. Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Half-bridge IGBT characteristics, T1/T4						
V_{CEsat}	Collector-emitter saturation voltage	V_{GE} = 15 V; I_C = 50 A; T_j = 25 °C	-	1.85	-	V
		V_{GE} = 15 V; I_C = 50 A; T_j = 150 °C	-	2.4	-	V
$V_{GE(th)}$	Gate-emitter threhold voltage	I_C = 0.5 mA; V_{CE} = V_{GE}; T_j = 25 °C	4.2	5.3	6.4	V
I_{CES}	Zero gate voltage collector current	V_{CE} = 1200 V; V_{GE} = 0 V; T_j = 25 °C	-	-	1	mA
I_{GES}	Gate leakage current	V_{GE} = 20 V; V_{CE} = 0 V; T_j = 25 °C	-	-	250	nA
Q_G	Gate charge	V_{CC} = 400 V; I_C = 50 A; V_{GE} = ±15 V	-	373	-	nC
C_{ies}	Input capacitance	V_{CE} = 25 V; V_{GE} = 0V; f = 1 MHz; T_j = 25 °C	-	6824	-	pF
C_{oes}	Output capacitance		-	235	-	pF
C_{res}	Reverse transfer capacitance		-	40	-	pF
$t_{d(on)}$	Turn-on delay time	T_j = 25 °C V_{CC} = 400 V; I_C = 50 A; V_{GE} = ±15 V; R_g = 10 Ω	-	45	-	nS
t_r	Rise time		-	36	-	nS
$t_{d(off)}$	Turn-off delay time		-	141	-	nS
t_f	Fall time		-	149	-	nS
E_{on}	Turn-on energy		-	2.1	-	mJ
E_{off}	Turn-off energy		-	1.35	-	mJ
$t_{d(on)}$	Turn-on delay time	T_j =150 °C V_{CC} = 400 V; I_C = 50 A; V_{GE} = ±15 V; R_g = 10 Ω	-	43	-	nS
t_r	Rise time		-	42	-	nS
$t_{d(off)}$	Turn-off delay time		-	155	-	nS
t_f	Fall time		-	201	-	nS
E_{on}	Turn-on energy		-	3.4	-	mJ
E_{off}	Turn-off energy		-	1.7	-	mJ
R_{thJC}	Thermal resistance, junction to case		-	0.5	-	K/W
T_{jop}	Operation temperature		-40		150	°C
Neutral point Diode characteristics, D2/D3						
V_F	Diode forward voltage	I_F = 50 A; T_j = 25 °C	-	1.7	-	V
		I_F = 50 A; T_j = 150 °C	-	1.5	-	V
Q_{rr}	Reverse recovery charge	T_j = 25 °C V_R = 400 V; I_F = 50 A; di/dt = 1000 A/μs;	-	1544	-	nC
I_{rrm}	Peak reverse recovery current		-	29	-	A
E_{rr}	Reverse recovery energy		-	0.35	-	mJ
Q_{rr}	Reverse recovery charge	T_j = 150 °C V_R = 400 V; I_F = 50 A; di/dt = 1000 A/μs;	-	3618	-	nC
I_{rrm}	Peak reverse recovery current		-	36	-	A
E_{rr}	Reverse recovery energy		-	1.1	-	mJ
R_{thJC}	Thermal resistance, junction to case		-	1.1	-	K/W
T_{jop}	Operation temperature		-40		150	°C

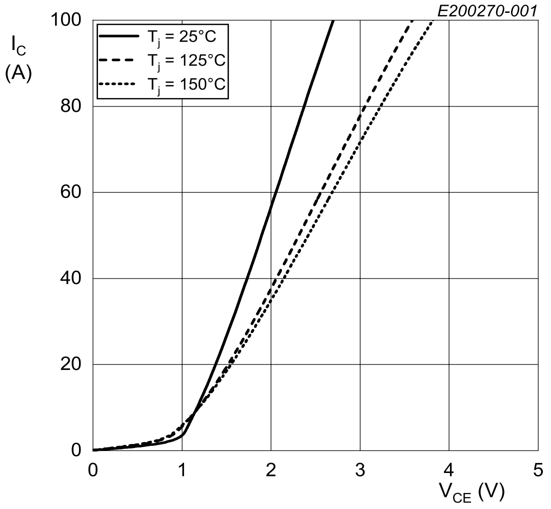
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Neutral point IGBT characteristics, T2/T3						
V_{CEsat}	Collector-emitter saturation voltage	V_{GE} = 15 V; I_C = 50 A; T_j = 25 °C	-	1.6	-	V
		V_{GE} = 15 V; I_C = 50 A; T_j = 150 °C	-	2.0	-	V
$V_{GE(th)}$	Gate-emitter threhold voltage	I_C = 0.5 mA; V_{CE} = V_{GE}; T_j = 25 °C	4.3	5.4	6.5	V
I_{CES}	Zero gate voltage collector current	V_{CE} = 650 V; V_{GE} = 0 V; T_j = 25 °C	-	-	1	mA
I_{GES}	Gate leakage current	V_{GE} = 20 V; V_{CE} = 0 V; T_j = 25 °C	-	-	250	nA
Q_G	Gate charge	V_{CC} = 400 V; I_C = 50 A; V_{GE} = ±15 V	-	203	-	nC
C_{ies}	Input capacitance	V_{CE} = 25 V; V_{GE} = 0V; f = 1 MHz; T_j = 25 °C	-	2968	-	pF
C_{oes}	Output capacitance		-	265	-	pF
C_{res}	Reverse transfer capacitance		-	55	-	pF
$t_{d(on)}$	Turn-on delay time	T_j = 25 °C V_{CC} = 400 V; I_C = 50 A; V_{GE} = ±15 V; R_g = 10 Ω	-	26	-	nS
t_r	Rise time		-	29	-	nS
$t_{d(off)}$	Turn-off delay time		-	115	-	nS
t_f	Fall time		-	45	-	nS
E_{on}	Turn-on energy		-	1.5	-	mJ
E_{off}	Turn-off energy		-	0.8	-	mJ
$t_{d(on)}$	Turn-on delay time	T_j =150 °C V_{CC} = 400 V; I_C = 50 A; V_{GE} = ±15 V; R_g = 10 Ω	-	28	-	nS
t_r	Rise time		-	33	-	nS
$t_{d(off)}$	Turn-off delay time		-	131	-	nS
t_f	Fall time		-	57	-	nS
E_{on}	Turn-on energy		-	2.1	-	mJ
E_{off}	Turn-off energy		-	1.15	-	mJ
R_{thJC}	Thermal resistance, junction to case		-	0.65	-	K/W
T_{jop}	Operation temperature		-40		150	°C
Half-bridge Diode characteristics, D1/D4						
V_F	Diode forward voltage	I_F = 50 A; T_j = 25 °C	-	2.5	-	V
		I_F = 50 A; T_j = 150 °C	-	2.35	-	V
Q_{rr}	Reverse recovery charge	T_j = 25 °C V_R = 400 V; I_F = 50 A; di/dt = 1300 A/μs;	-	1508	-	nC
I_{rrm}	Peak reverse recovery current		-	35	-	A
E_{rr}	Reverse recovery energy		-	0.45	-	mJ
Q_{rr}	Reverse recovery charge	T_j = 150 °C V_R = 400 V; I_F = 50 A; di/dt = 1300 A/μs;	-	3087	-	nC
I_{rrm}	Peak reverse recovery current		-	21	-	A
E_{rr}	Reverse recovery energy		-	0.9	-	mJ
R_{thJC}	Thermal resistance, junction to case		-	1.5	-	K/W
T_{jop}	Operation temperature		-40		150	°C

9. NTC - thermistor

Table 5. NTC - Thermistor

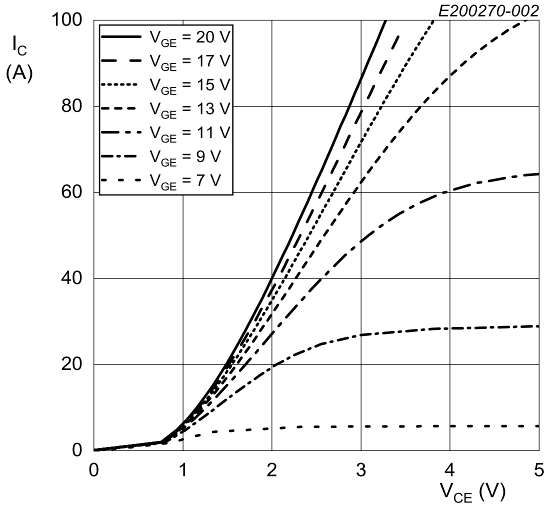
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
R_{25}	Rated resistance	T_c = 25 °C	-	5000	-	Ω
R_{100}		T_c = 100 °C	465±5%			Ω
$B_{25/50}$	B-value	$B_2=R_{25}\ \exp[B_{25/50}(1/T_2\text{-}1(298.15K))]$	3380±5%			K

Typical Characteristics - IGBT T1/T2/T3/T4 and Diode D1/D2/D3/D4



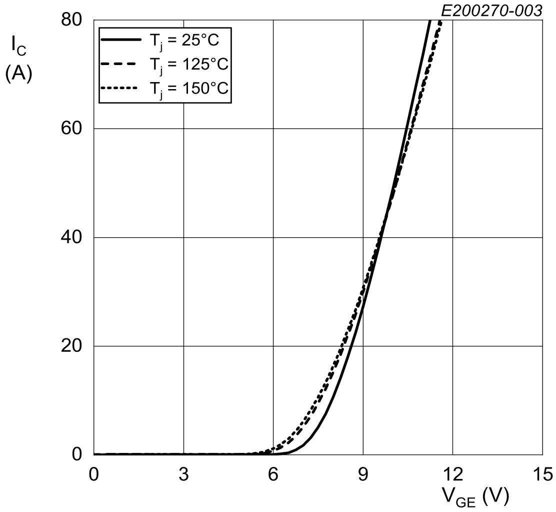
V_{GE} = 15V

Fig. 1. IGBT typical output characteristics, T1/T4



T_j = 150 °C

Fig. 2. IGBT typical output characteristics, T1/T4



V_{CE} = 20 V

Fig. 3. IGBT typical transfer characteristics, T1/T4

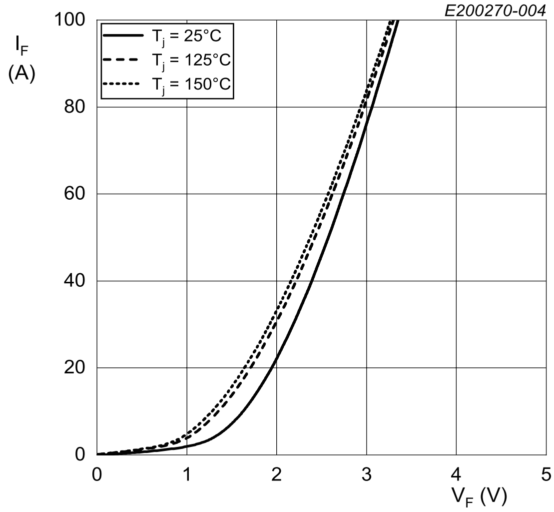


Fig. 4. Diode typical forward characteristics, D1/ D4

Typical Characteristics - IGBT T1/T2/T3/T4 and Diode D1/D2/D3/D4

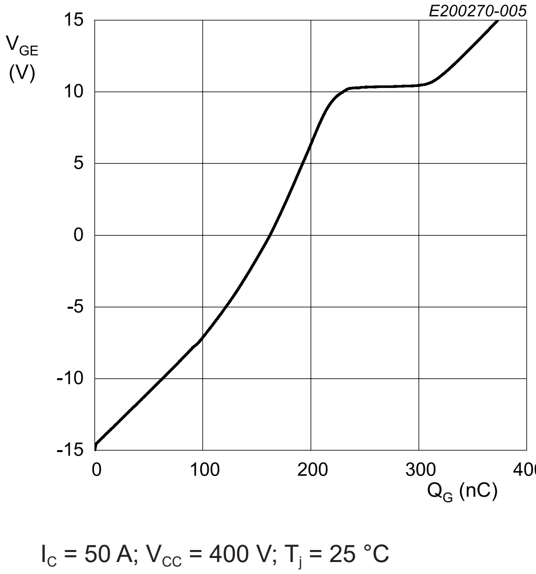


Fig. 5. Typical gate charge, T1/T4

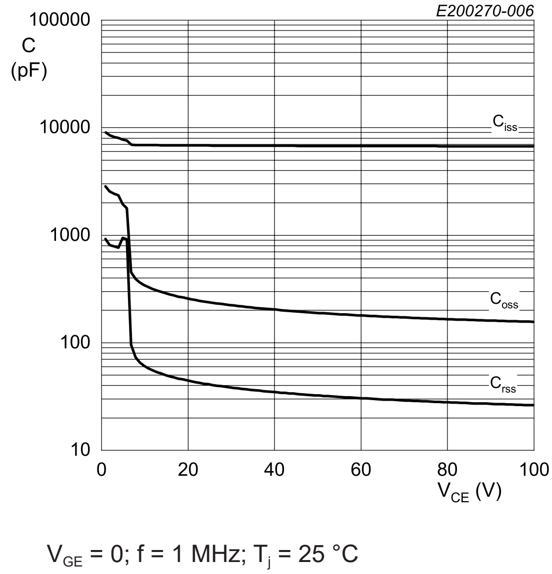


Fig. 6. Typical capacitance as a function of collector emitter voltage, T1/T4

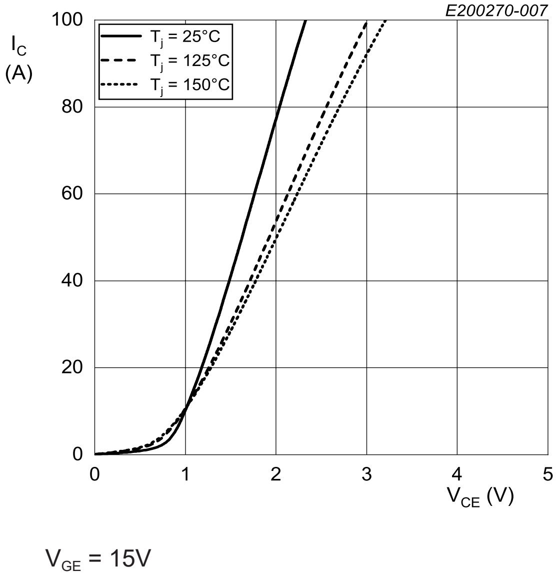


Fig. 7. IGBT typical output characteristics, T2/T3

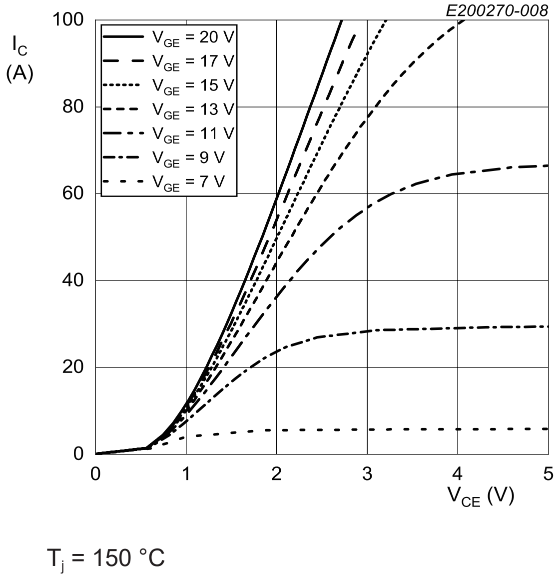
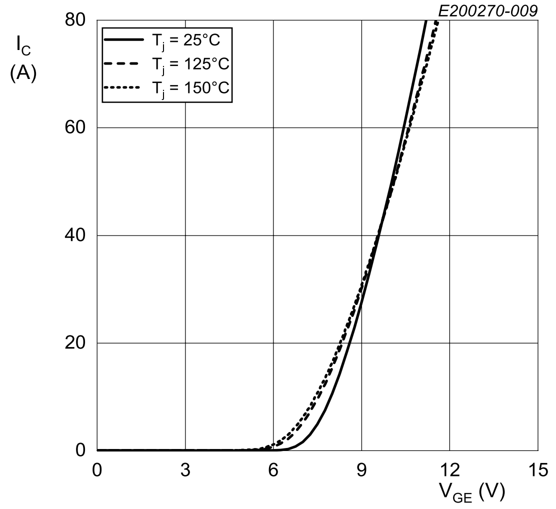


Fig. 8. IGBT typical output characteristics, T2/T3

Typical Characteristics - IGBT T1/T2/T3/T4 and Diode D1/D2/D3/D4



V_{CE} = 20 V

Fig. 9. IGBT typical transfer characteristics, T2/T3

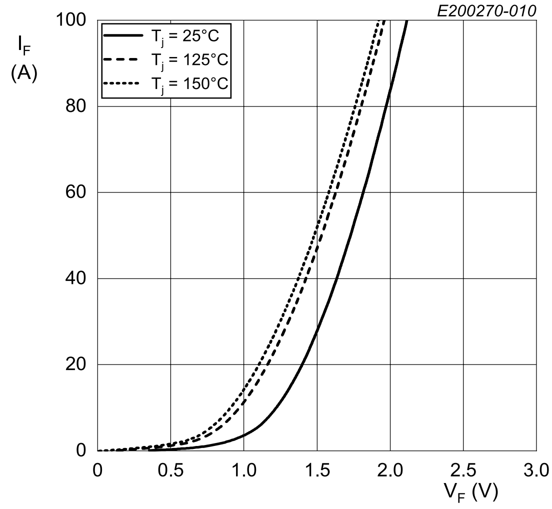
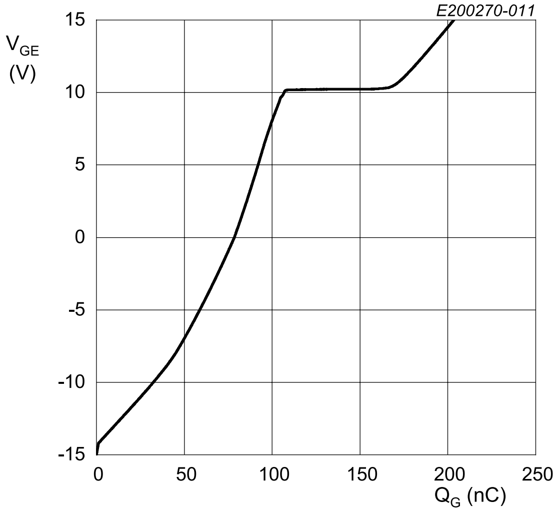
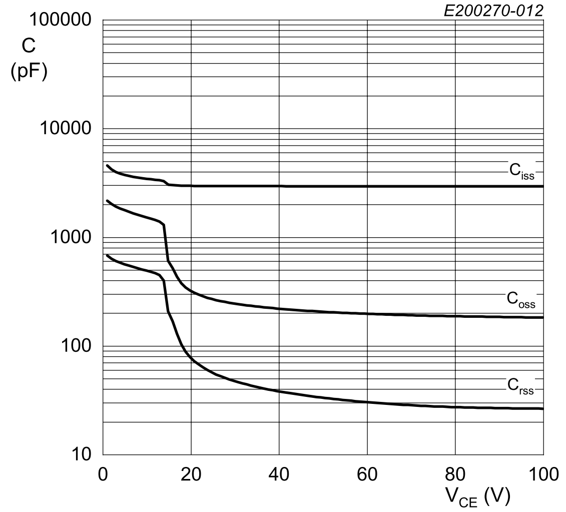


Fig. 10. Diode typical forward characteristics, D2/D3



I_C = 50 A; V_{CC} = 400 V; T_j = 25 °C

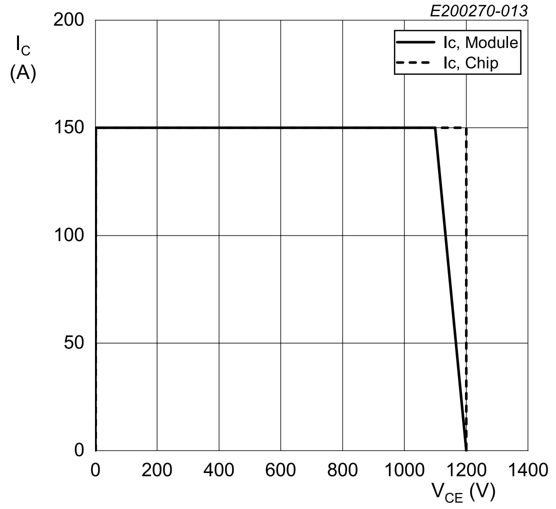
Fig. 11. Typical gate charge, T2/T3



V_{GE} = 0; f = 1 MHz; T_j = 25 °C

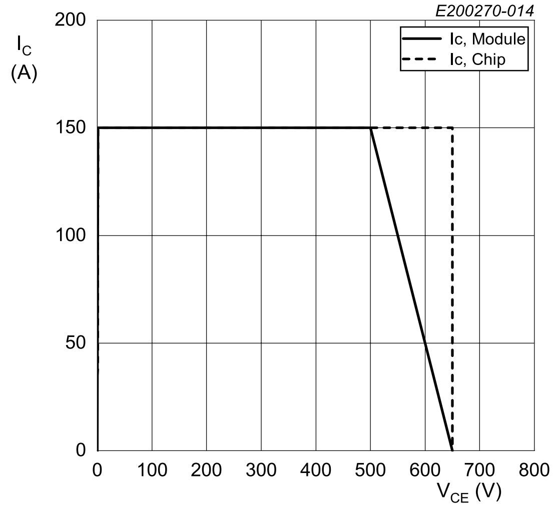
Fig. 12. Typical capacitance as a function of collector emitter voltage, T2/T3

Typical Characteristics - IGBT T1/T2/T3/T4 and Diode D1/D2/D3/D4



R_g = 10 Ω; V_{GE} = ±15V; T_j = 150 °C

Fig. 13. Reverse bias safe operating area, T1/T4



R_g = 10 Ω; V_{GE} = ±15V; T_j = 150 °C

Fig. 14. Reverse bias safe operating area, T2/T3

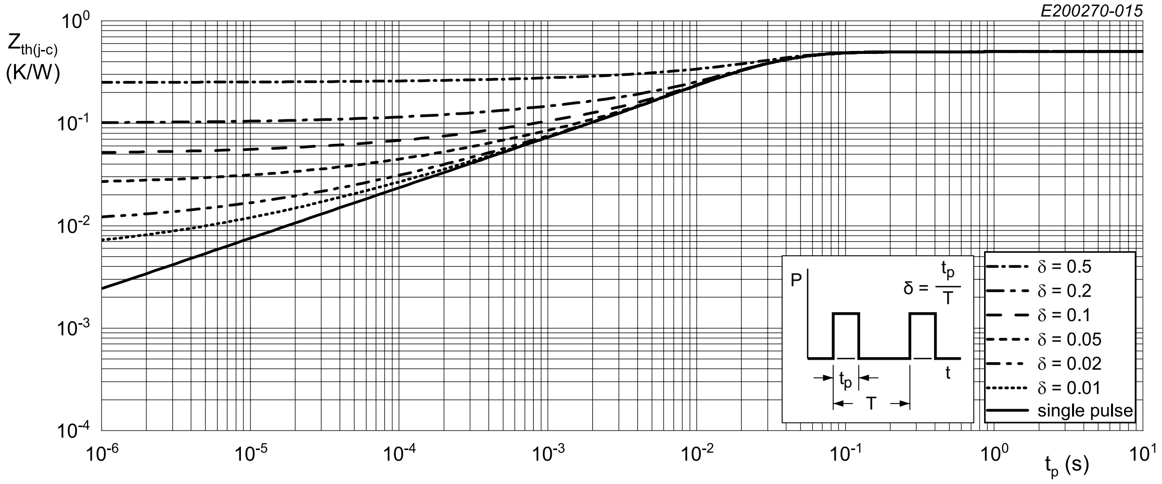


Fig. 15. Typical Transient thermal impedance IGBT, T1/T4

Typical Characteristics - IGBT T1/T2/T3/T4 and Diode D1/D2/D3/D4

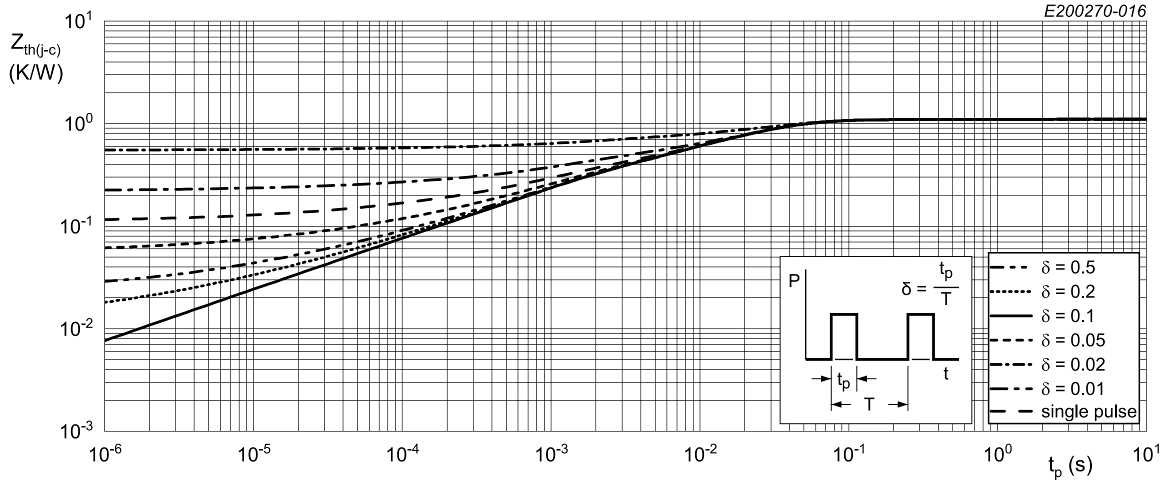


Fig. 16. Typical Transient thermal impedance Diode, D1/D4

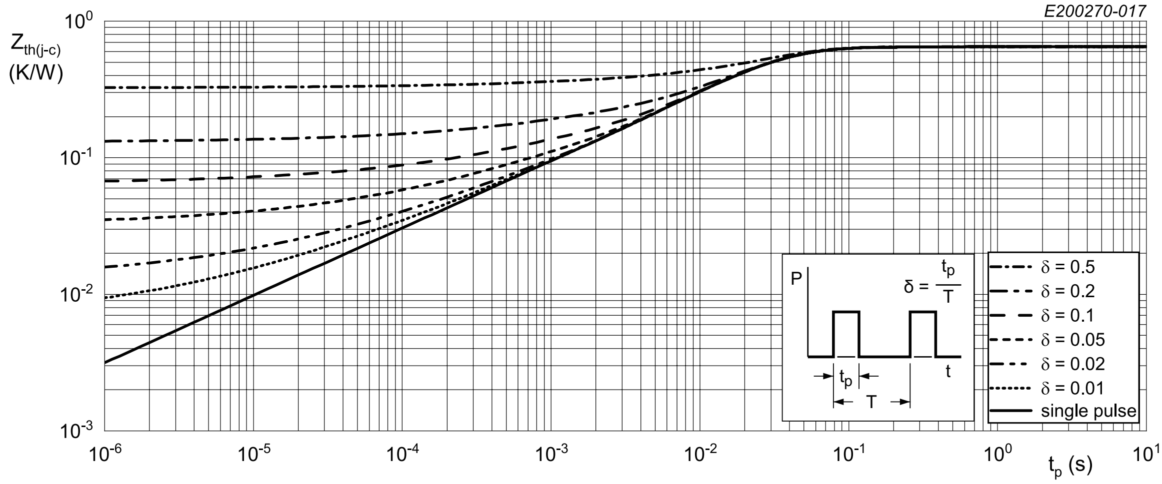


Fig. 17. Typical Transient thermal impedance IGBT, T2/T3

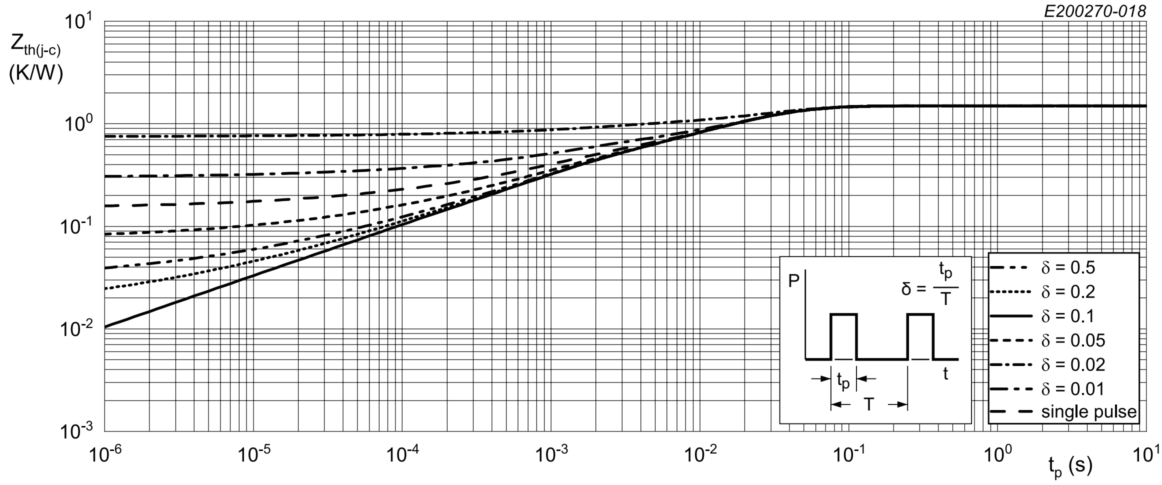
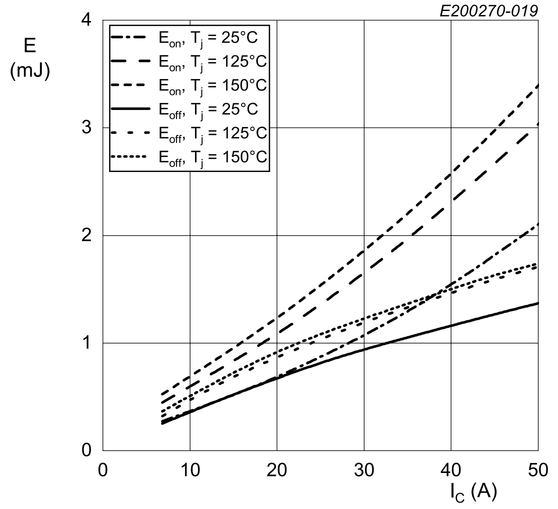


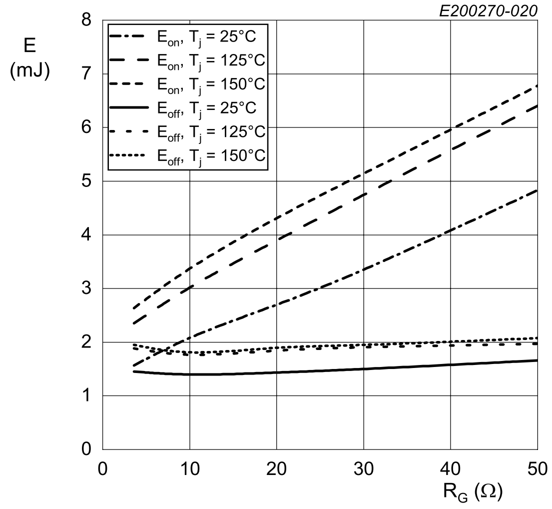
Fig. 18. Typical Transient thermal impedance Diode, D2/D3

Typical Characteristics - IGBT T1/T4 Comutates Diode D2/D3



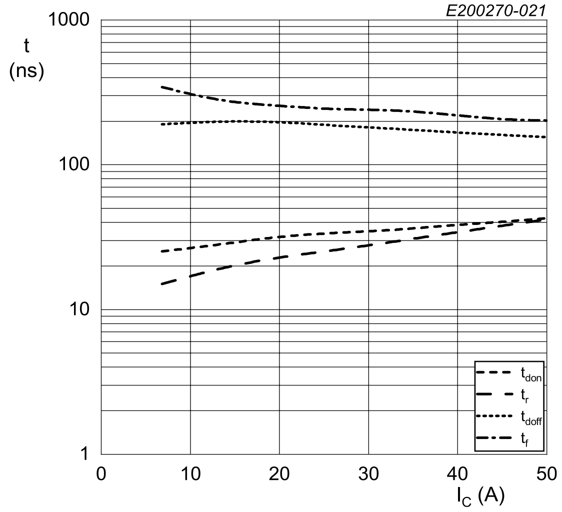
R_g = 10 Ω; V_{GE} = ±15V;
V_{CE} = 400 V; inductive load

Fig. 19. Typical switching energy loss as a function of collector current, T1/T4



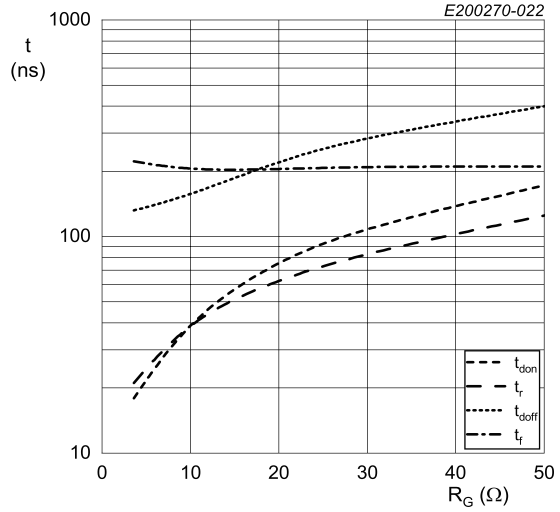
I_C = 50 A; V_{GE} = ±15V;
V_{CE} = 400 V; inductive load

Fig. 20. Typical switching energy loss as a function of gate resistance, T1/T4



R_g = 10 Ω; V_{GE} = ±15V; T_j = 150 °C;
V_{CE} = 400 V; inductive load

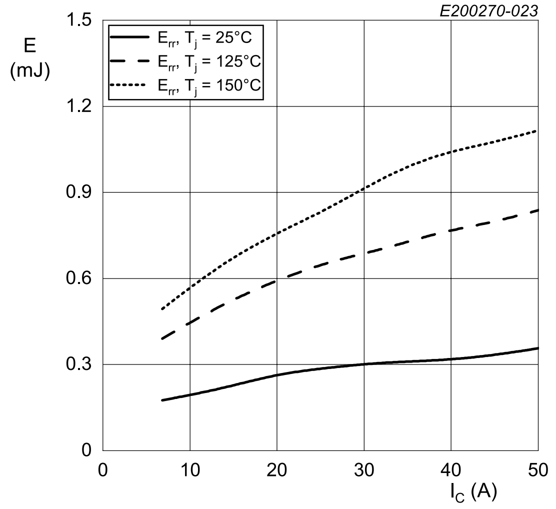
Fig. 21. Typical switching times as a function of collector current, T1/T4



I_C = 50 A; V_{GE} = ±15V; T_j = 150 °C;
V_{CE} = 400 V; inductive load

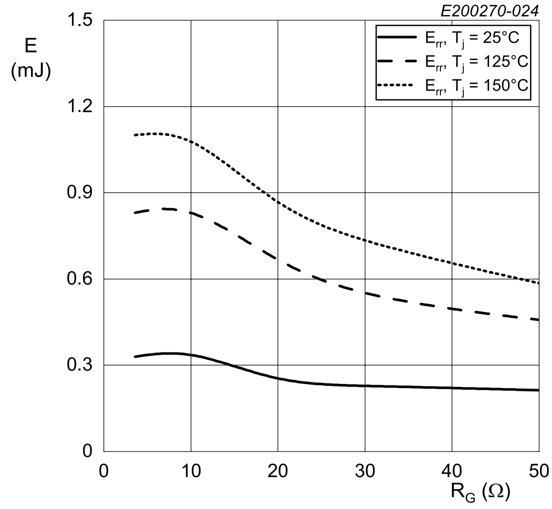
Fig. 22. Typical switching times as a function of gate resistance, T1/T4

Typical Characteristics - IGBT T1/T4 Comutates Diode D2/D3



R_g = 10 Ω; V_{CE} = 400 V;
inductive load

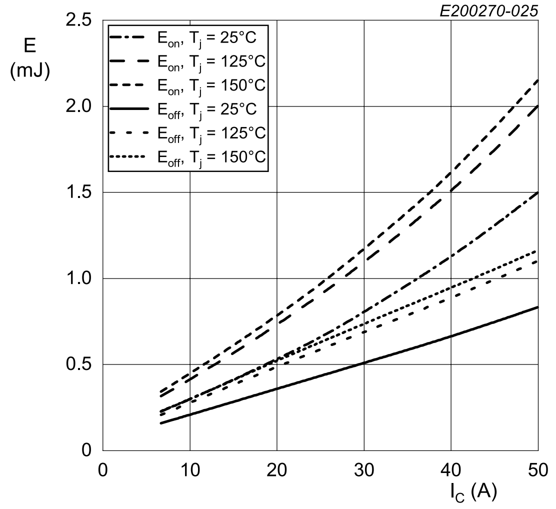
Fig. 23. Typical reverse recovered energy loss as a function of collector current, D2/D3



I_F = 50 A; V_{CE} = 400 V;
inductive load

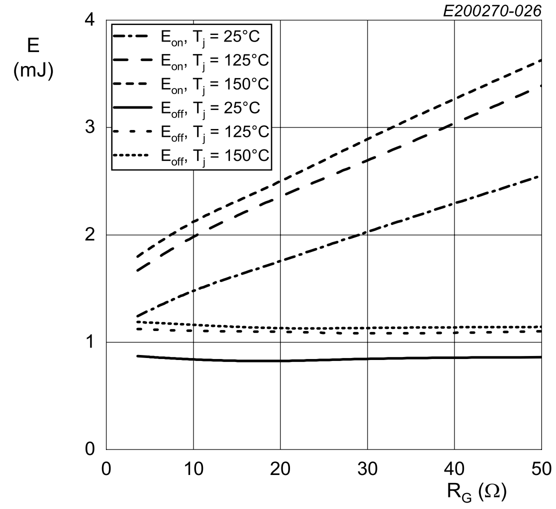
Fig. 24. Typical reverse recovered energy loss as a function of gate resistance, D2/D3

Typical Characteristics - IGBT T2/T3 Comutates Diode D1/D4



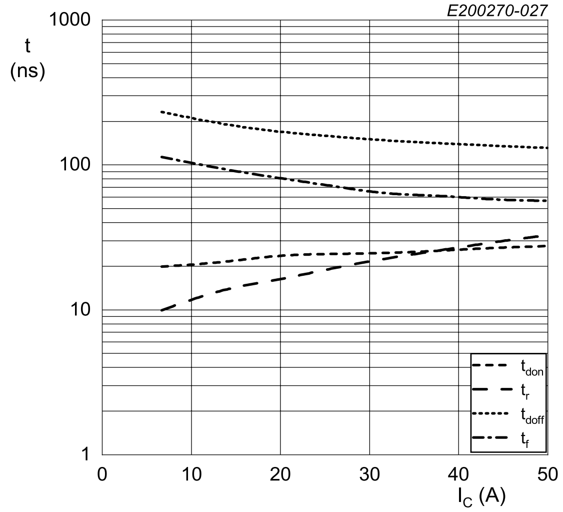
R_g = 10 Ω; V_{GE} = ±15V;
V_{CE} = 400 V; inductive load

Fig. 25. Typical switching energy loss as a function of collector current, T2/T3



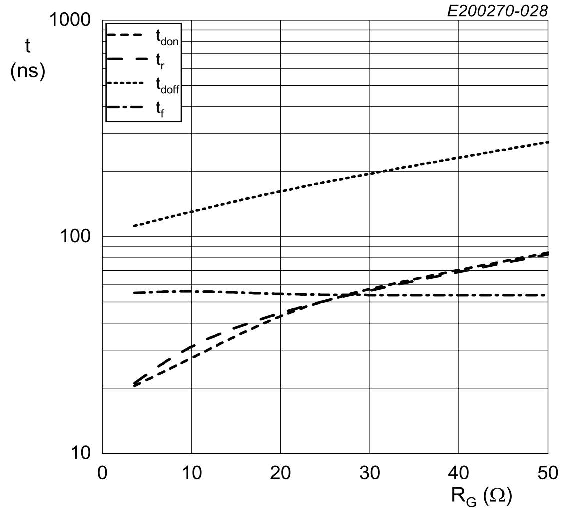
I_C = 50 A; V_{GE} = ±15V;
V_{CE} = 400 V; inductive load

Fig. 26. Typical switching energy loss as a function of gate resistance, T2/T3



R_g = 10 Ω; V_{GE} = ±15V; T_j = 150 °C;
V_{CE} = 400 V; inductive load

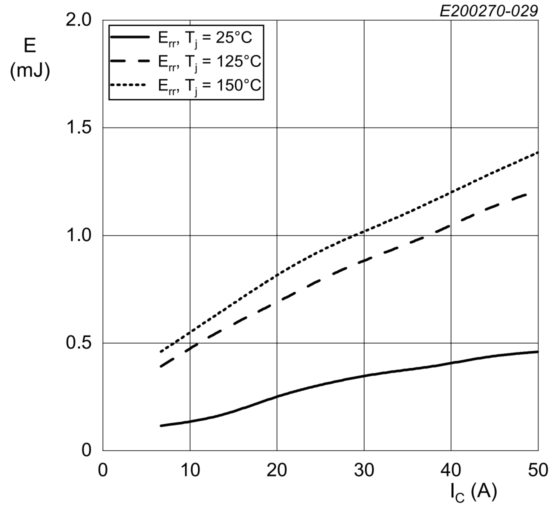
Fig. 27. Typical switching times as a function of collector current, T2/T3



I_C = 50 A; V_{GE} = ±15V; T_j = 150 °C;
V_{CE} = 400 V; inductive load

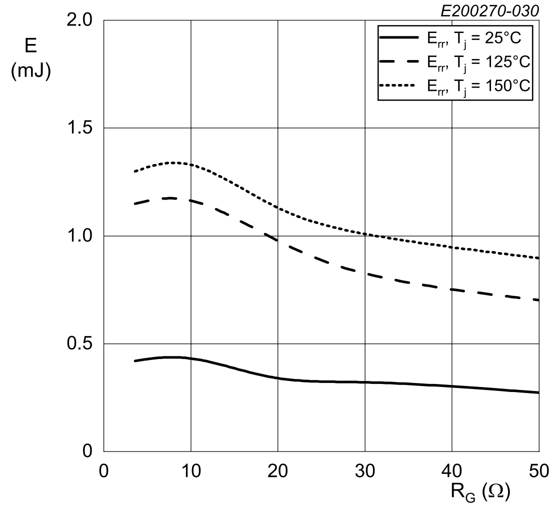
Fig. 28. Typical switching times as a function of gate resistance, T2/T3

Typical Characteristics - IGBT T2/T3 Comutates Diode D1/D4



R_g = 10 Ω; V_{CE} = 400 V;
inductive load

Fig. 29. Typical reverse recovered energy loss as a function of collector current, D1/D4



I_F = 50 A; V_{CE} = 400 V;
inductive load

Fig. 30. Typical reverse recovered energy loss as a function of gate resistance, D1/D4

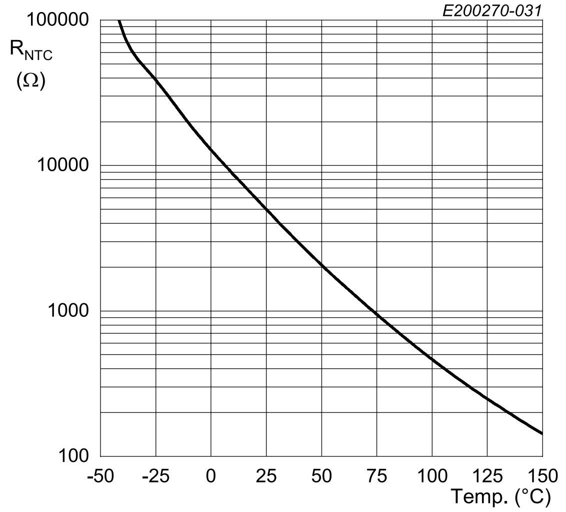
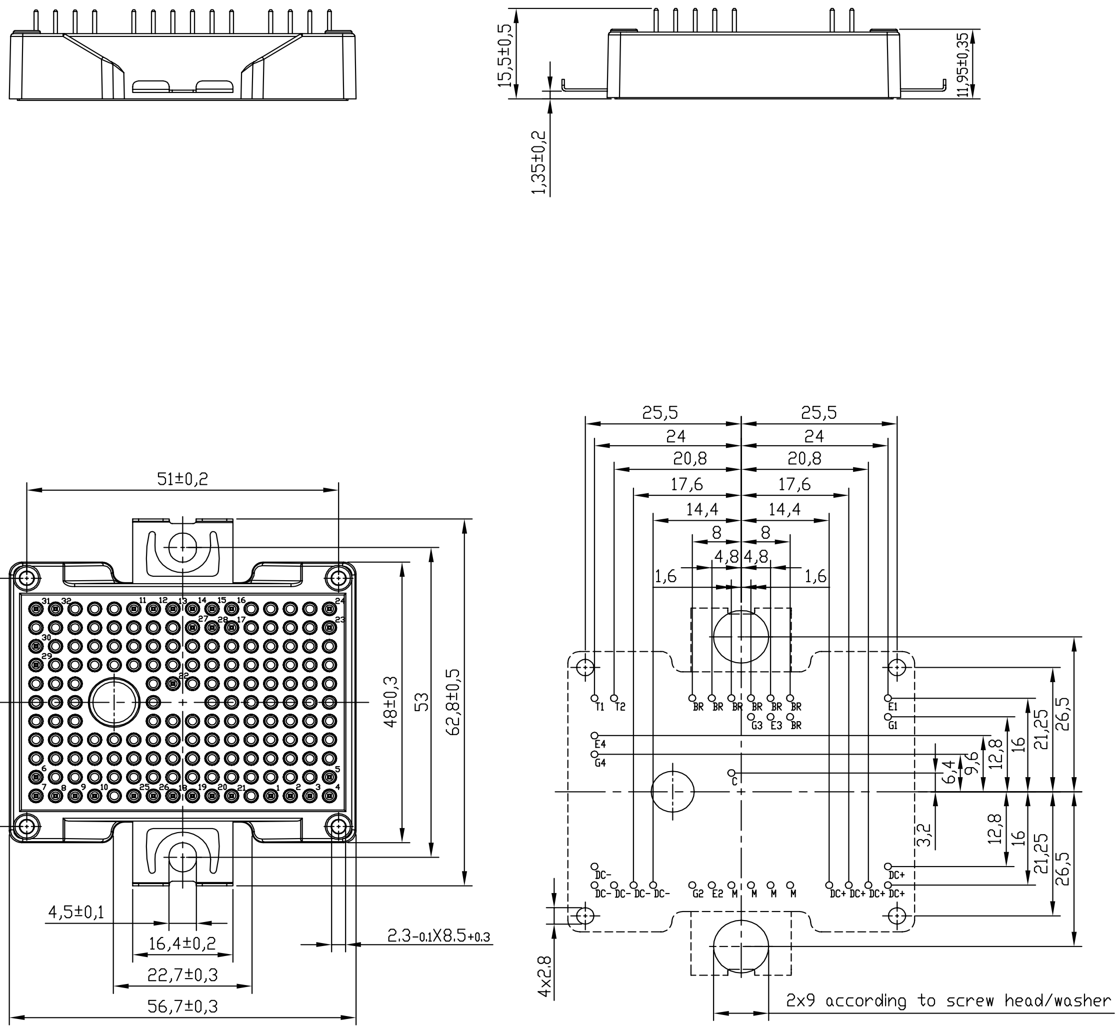


Fig. 31. Typical NTC characteristic as a function of temperature

10. Package outline

Package Outline | Dimensions in mm



11. 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.

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[2] The term 'short data sheet' is explained in section "Definitions".
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