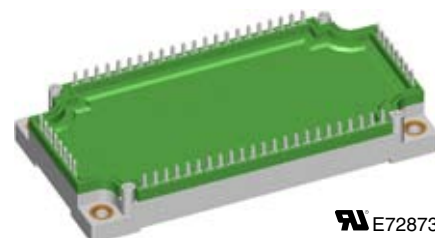
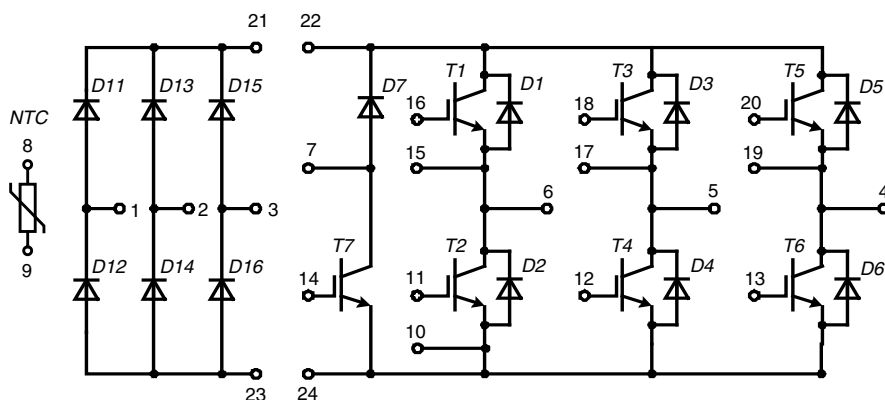


Converter - Brake - Inverter Module (CBI3) with Trench IGBT technology



Three Phase Rectifier	Brake Chopper	Three Phase Inverter
$V_{RRM} = 2200 \text{ V}$	$V_{CES} = 1700 \text{ V}$	$V_{CES} = 1700 \text{ V}$
$I_{FAVM} = 60 \text{ A}$	$I_{C25} = 48 \text{ A}$	$I_{C25} = 74 \text{ A}$
$I_{FSM} = 550 \text{ A}$	$V_{CE(sat)} = 2.1 \text{ V}$	$V_{CE(sat)} = 2.0 \text{ V}$

Input Rectifier Bridge D11 - D16			
Symbol	Conditions	Maximum Ratings	
V_{RRM}		2200	V
I_{FAV}	$T_C = 80^\circ\text{C}$; sine 180°	40	A
I_{DAVM}	$T_C = 80^\circ\text{C}$; rectangular; $d = 1/3$; bridge	130	A
I_{FSM}	$T_C = 25^\circ\text{C}$; $t = 10 \text{ ms}$; sine 50 Hz	550	A
P_{tot}	$T_C = 25^\circ\text{C}$	110	W

Symbol	Conditions	Characteristic Values			
		$(T_{VJ} = 25^\circ\text{C}, \text{ unless otherwise specified})$			
		min.	typ.	max.	
V_F	$I_F = 50 \text{ A}$; $T_{VJ} = 25^\circ\text{C}$ $T_{VJ} = 125^\circ\text{C}$		1.25 1.25	1.5	V V
I_R	$V_R = V_{RRM}$; $T_{VJ} = 25^\circ\text{C}$ $T_{VJ} = 125^\circ\text{C}$		0.8	0.05	mA mA
R_{thJC}	(per diode)			1.1	K/W

Application: AC motor drives with

- Input from single or three phase grid
- Three phase synchronous or asynchronous motor
- Electric braking operation

Features

- High level of integration - only one power semiconductor module required for the whole drive
- IGBT technology with low saturation voltage, low switching losses and tail current, high RBSOA and short circuit ruggedness
- Epitaxial free wheeling diodes with Hyperfast and soft reverse recovery
- Industry standard package with insulated copper base plate and soldering pins for PCB mounting
- Temperature sense included

Output Inverter T1 - T6

Symbol	Conditions	Maximum Ratings	
V_{CES}	$T_{VJ} = 25^{\circ}\text{C}$ to 150°C	1700	V
V_{GES}	Continuous	± 20	V
I_{C25}	$T_C = 25^{\circ}\text{C}$	74	A
I_{C80}	$T_C = 80^{\circ}\text{C}$	53	A
I_{CM}	$T_C = 80^{\circ}\text{C}$; $t_p = 1 \text{ ms}$	100	A
P_{tot}	$T_C = 25^{\circ}\text{C}$	290	W

Symbol Conditions Characteristic Values

($T_{VJ} = 25^{\circ}\text{C}$, unless otherwise specified)

			min.	typ.	max.	
$V_{CE(sat)}$	$I_C = 50 \text{ A}$; $V_{GE} = 15 \text{ V}$	$T_{VJ} = 25^{\circ}\text{C}$ $T_{VJ} = 125^{\circ}\text{C}$		2.0 2.4	2.4	V V
$V_{GE(th)}$	$I_C = 2 \text{ mA}$; $V_{GE} = V_{CE}$		5		6.5	V
I_{CES}	$V_{CE} = V_{CES}$; $V_{GE} = 0 \text{ V}$	$T_{VJ} = 25^{\circ}\text{C}$ $T_{VJ} = 125^{\circ}\text{C}$		1.0	0.4	mA mA
I_{GES}	$V_{CE} = 0 \text{ V}$; $V_{GE} = \pm 20 \text{ V}$				400	nA
C_{ies}	$V_{CE} = 25 \text{ V}$; $V_{GE} = 0 \text{ V}$; $f = 1 \text{ MHz}$			4.4		nF
Q_{Gon}	$V_{CE} = 900 \text{ V}$; $V_{GE} = 15 \text{ V}$; $I_C = 75 \text{ A}$			600		nC
$t_{d(on)}$ t_r $t_{d(off)}$ t_f E_{on} E_{off}	Inductive load, $T_{VJ} = 125^{\circ}\text{C}$ $V_{CE} = 900 \text{ V}$; $I_C = 50 \text{ A}$ $V_{GE} = \pm 15 \text{ V}$; $R_G = 8 \Omega$			250 50 500 480 11 12		ns ns ns ns mJ mJ
RBSOA		$I_C = I_{CM}$; $V_{GE} = 15 \text{ V}$ $R_G = 27 \Omega$; $T_{VJ} = 125^{\circ}\text{C}$	$V_{CEK} \leq V_{CES} - L_S di/dt$			V
t_{SC} (SCSOA)		$V_{CE} = 1000 \text{ V}$; $V_{GE} = \pm 15 \text{ V}$; $R_G = 27 \Omega$ $t_p \leq 10 \mu\text{s}$; non-repetitive; $T_{VJ} = 125^{\circ}\text{C}$		10		μs
R_{thJC}					0.43	K/W

Output Inverter D1 - D6

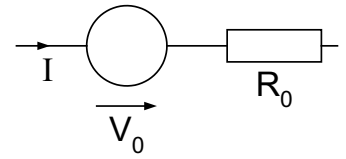
Symbol	Conditions	Maximum Ratings	
I_{F25}	$T_C = 25^{\circ}\text{C}$	56	A
I_{F80}	$T_C = 80^{\circ}\text{C}$	39	A

Symbol Conditions Characteristic Values

			min.	typ.	max.	
V_F	$I_F = 50 \text{ A}$; $T_{VJ} = 25^{\circ}\text{C}$ $T_{VJ} = 125^{\circ}\text{C}$			2.0 2.0	2.4	V V
I_{RM} Q_{rr} t_{rr} E_{rec}	$I_F = 50 \text{ A}$; $di_F/dt = -1200 \text{ A}/\mu\text{s}$; $T_{VJ} = 125^{\circ}\text{C}$; $V_R = 900 \text{ V}$; $V_{GE} = 0 \text{ V}$			80 20 650 9		A μC ns mJ
R_{thJC}		(per diode)			0.65	K/W

Equivalent Circuits for Simulation

Conduction



IGBT (typ. at $V_{GE} = 15 \text{ V}$; $T_J = 125^{\circ}\text{C}$)

T1-T6

$$V_0 = 1.0 \text{ V}; R_0 = 25 \text{ m}\Omega$$

T7

$$V_0 = 1.0 \text{ V}; R_0 = 28 \text{ m}\Omega$$

Diode (typ. at $T_J = 125^{\circ}\text{C}$)

D1-D6

$$V_0 = 1.35 \text{ V}; R_0 = 15 \text{ m}\Omega$$

D7

$$V_0 = 1.65 \text{ V}; R_0 = 37 \text{ m}\Omega$$

D11-D16

$$V_0 = 0.83 \text{ V}; R_0 = 4.1 \text{ m}\Omega$$

Brake Chopper T7

Symbol	Conditions	Maximum Ratings	
V_{CES}	$T_{VJ} = 25^{\circ}\text{C}$ to 150°C	1700	V
V_{GES}	Continuous	± 20	V
I_{C25}	$T_C = 25^{\circ}\text{C}$	48	A
I_{C80}	$T_C = 80^{\circ}\text{C}$	34	A
I_{CM}	$T_C = 80^{\circ}\text{C}; t_p = 1 \text{ ms}$	60	A
P_{tot}	$T_C = 25^{\circ}\text{C}$	200	W

Symbol	Conditions	Characteristic Values			
(T _{VJ} = 25°C, unless otherwise specified)					
		min.	typ.	max.	

$V_{CE(sat)}$	$I_C = 30 \text{ A}; V_{GE} = 15 \text{ V}$	$T_{VJ} = 25^{\circ}\text{C}$ $T_{VJ} = 125^{\circ}\text{C}$		1.9 2.1	2.2	V V
$V_{GE(th)}$	$I_C = 2 \text{ mA}; V_{GE} = V_{CE}$		5		6.5	V
I_{CES}	$V_{CE} = V_{CES}; V_{GE} = 0 \text{ V}$	$T_{VJ} = 25^{\circ}\text{C}$ $T_{VJ} = 125^{\circ}\text{C}$		0.6	0.3	mA mA
I_{GES}	$V_{CE} = 0 \text{ V}; V_{GE} = \pm 20 \text{ V}$				400	nA
C_{iss}	$V_{CE} = 25 \text{ V}; V_{GE} = 0 \text{ V}; f = 1 \text{ MHz}$			4.4		nF
Q_{Gon}	$V_{CE} = 900 \text{ V}; V_{GE} = 15 \text{ V}; I_C = 30 \text{ A}$			600		nC
$t_{d(on)}$ t_r $t_{d(off)}$ t_f E_{off} E_{on}	Inductive load, $T_{VJ} = 125^{\circ}\text{C}$ $V_{CE} = 900 \text{ V}; I_C = 30 \text{ A}$ $V_{GE} = \pm 15 \text{ V}; R_G = 27 \Omega$			165 40 700 400 7 6		ns ns ns ns mJ mJ
RBSOA		$I_C = I_{CM}; V_{GE} = 15 \text{ V}$ $R_G = 27 \Omega; T_{VJ} = 125^{\circ}\text{C}$	$V_{CEK} \leq V_{CES} - L_S di/dt$			V
t_{SC} (SCSOA)		$V_{CE} = 900 \text{ V}; V_{GE} = \pm 15 \text{ V}; R_G = 45 \Omega$ $t_p \leq 10 \mu\text{s}; \text{non-repetitive}; T_{VJ} = 125^{\circ}\text{C}$		10		μs
R_{thJC}					0.62	K/W

Brake Chopper D7

Symbol	Conditions	Maximum Ratings	
V_{RRM}	$T_{VJ} = 25^{\circ}\text{C}$ to 150°C	1700	V
I_{F25}	$T_C = 25^{\circ}\text{C}$	30	A
I_{F80}	$T_C = 80^{\circ}\text{C}$	21	A

Symbol	Conditions	Characteristic Values			
		min.	typ.	max.	

V_F	$I_F = 30 \text{ A};$	$T_{VJ} = 25^{\circ}\text{C}$ $T_{VJ} = 125^{\circ}\text{C}$		2.5 2.6	3.3	V V
I_R	$V_R = V_{RRM};$	$T_{VJ} = 25^{\circ}\text{C}$ $T_{VJ} = 125^{\circ}\text{C}$		0.2	0.05	mA mA
I_{RM} t_{rr}	$I_F = 30 \text{ A}; di_F/dt = -800 \text{ A}/\mu\text{s}; T_{VJ} = 125^{\circ}\text{C}$ $V_R = 900 \text{ V}$			35 700		A ns
R_{thJC}		(per diode)			0.9	K/W

Temperature Sensor NTC

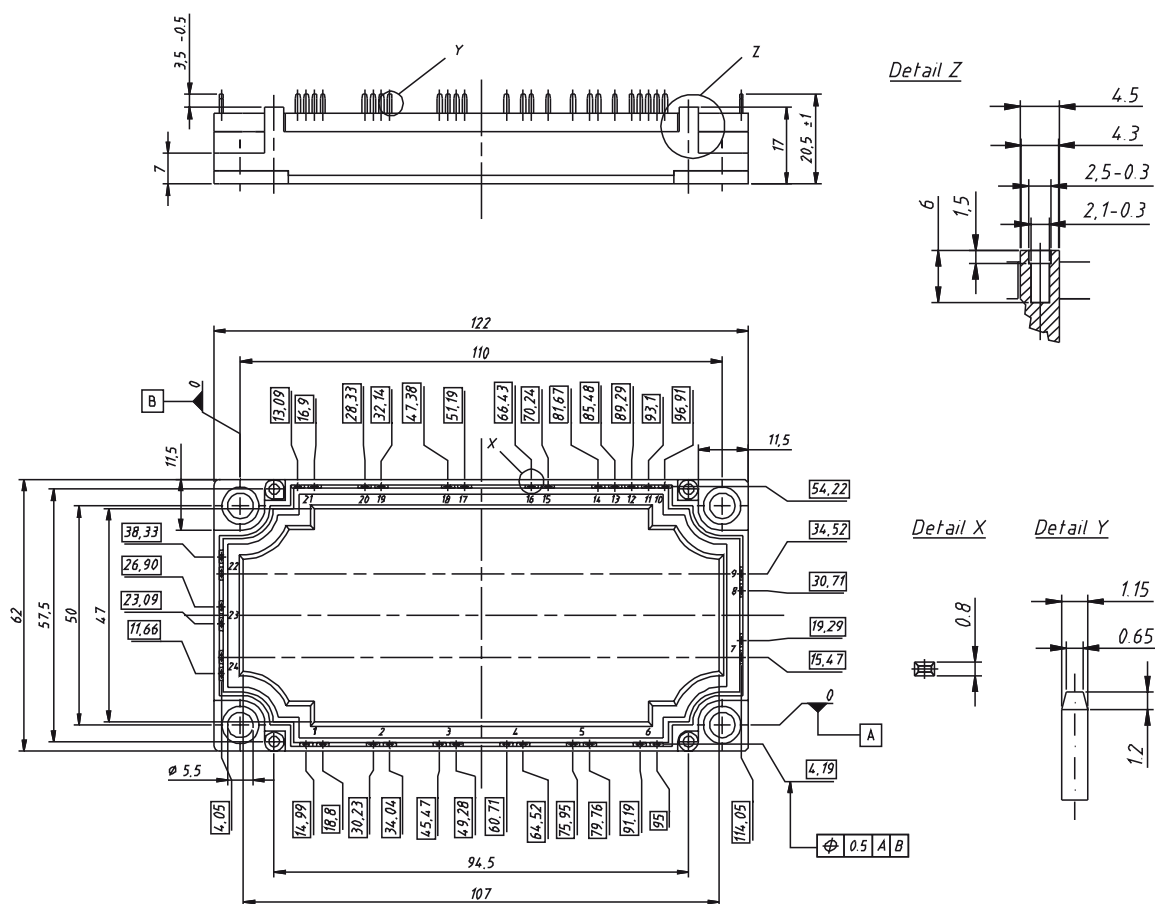
Symbol	Conditions	Characteristic Values			
		min.	typ.	max.	
R₂₅ B_{25/50}	T = 25°C	4.75	5.0 3375	5.25	kΩ K

Module

Symbol	Conditions	Maximum Ratings	
T_{VJ}	operating	-40...+125	°C
T_{JM}		+150	°C
T_{stg}		-40...+125	°C
V_{ISO}	$I_{ISOL} \leq 1 \text{ mA}$; 50/60 Hz; 1 min.	3400	V~
M_d	Mounting torque (M5)	3 - 6	Nm

Symbol	Conditions	Characteristic Values			
		min.	typ.	max.	
R_{therm-chip}	Resistance terminal to chip		7		mΩ
d_S	Creepage distance on surface	12.7			mm
d_A	Strike distance in air	9.6			mm
R_{thCH}	with heatsink compound		0.02		K/W
Weight			300		g

Dimensions in mm (1 mm = 0.0394")



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Input Rectifier Bridge D11 - D16

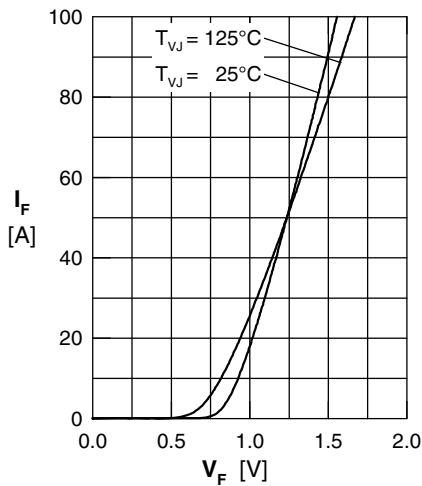


Fig. 1 Typ. forward current vs. voltage drop per diode

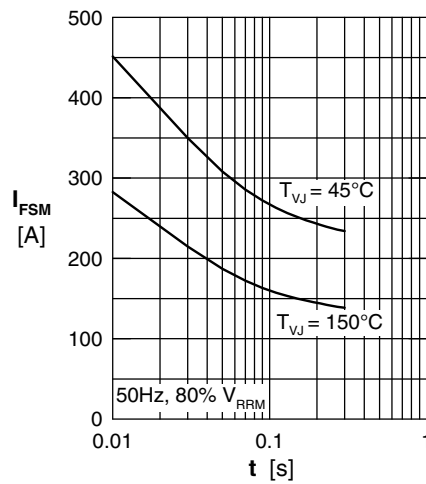


Fig. 2 Surge overload current

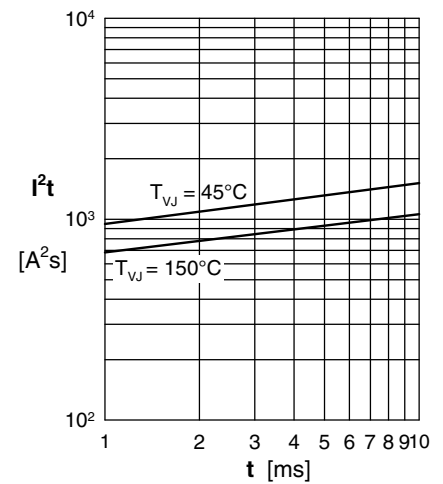


Fig. 3 I^2t versus time per diode

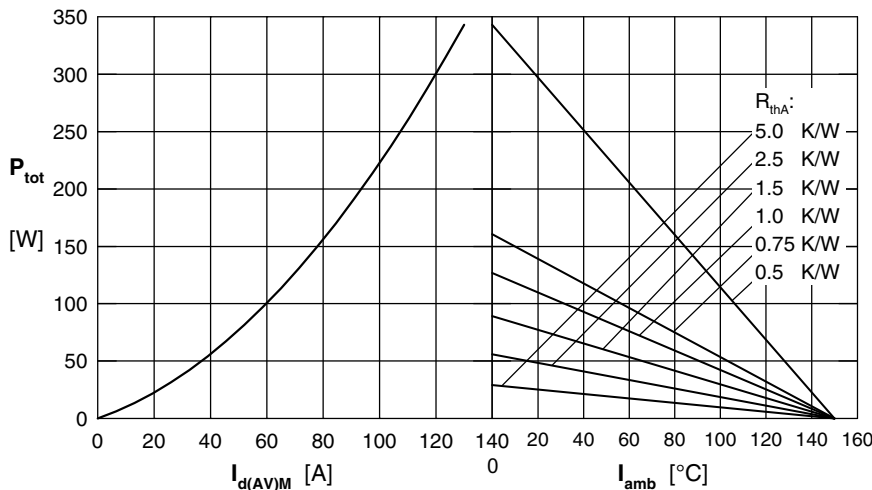


Fig. 4 Power dissipation versus direct output current & ambient temperature, sin 180°

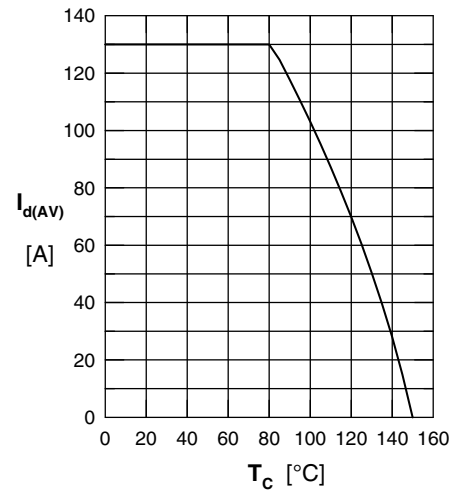


Fig. 5 Max. forward current vs. case temperature

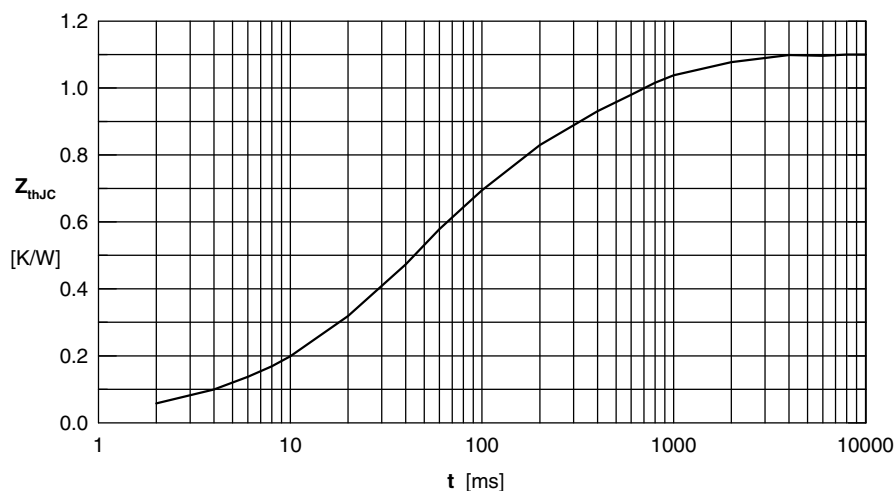
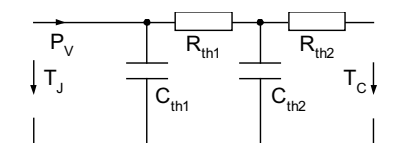


Fig. 6 Transient thermal impedance junction to case



	R_i	τ_i
1	0.06	0.0085
2	0.024	0.001
3	0.586	0.045
4	0.114	0.85
5	0.317	0.35

Output Inverter T1 - T6 / D1 - D6

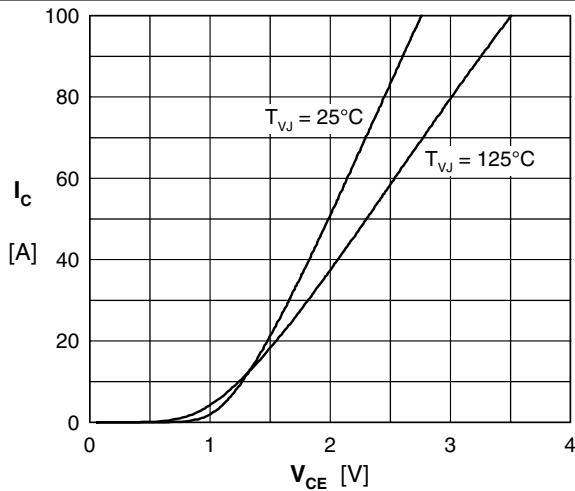


Fig. 7 Typical output characteristic

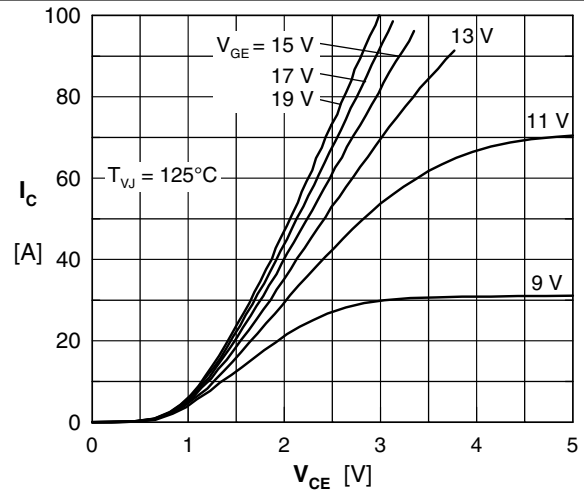


Fig. 8 Typical output characteristic

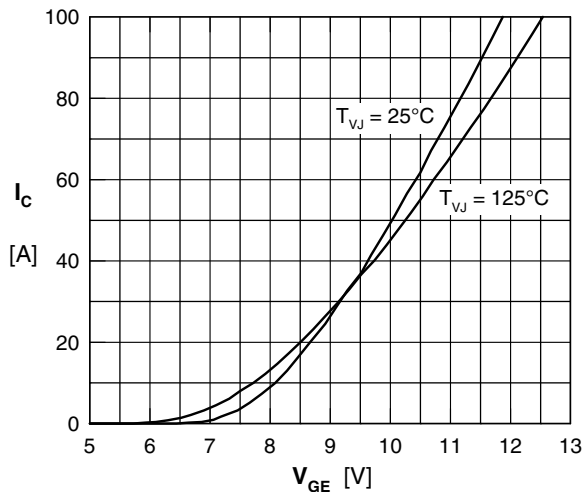


Fig. 9 Typical transfer characteristic

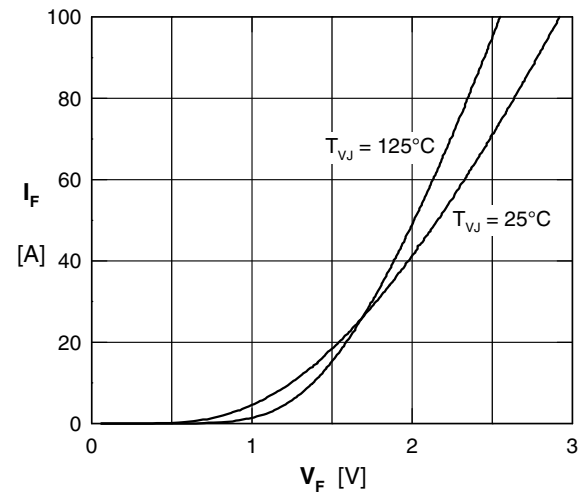


Fig. 10 Typical forward characteristic of free wheeling diode

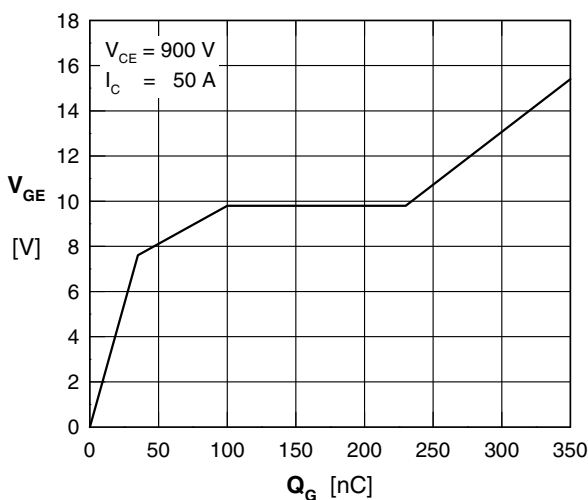


Fig. 11 Typical turn on gate charge

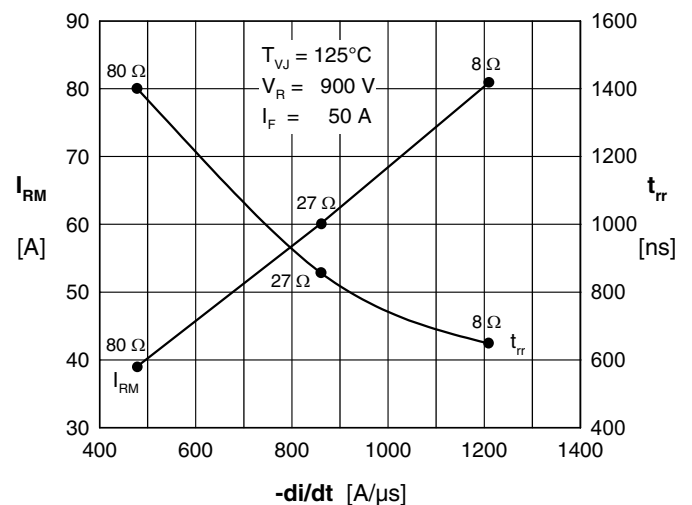


Fig. 12 Typ. turn-off characteristics of free wheeling diode

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Output Inverter T1 - T6 / D1 - D6

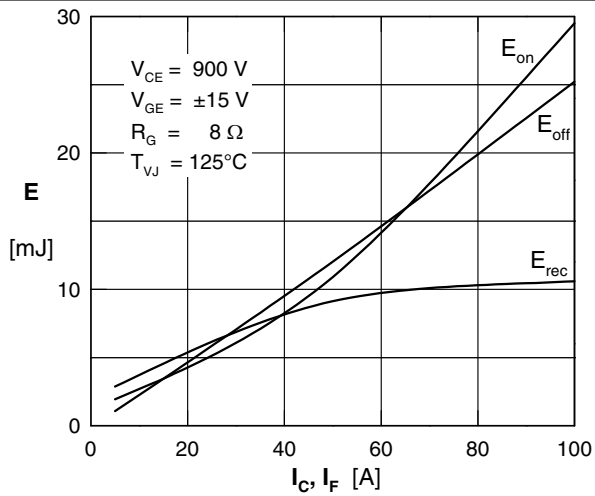


Fig. 13 Typ. turn on energy & switching times versus collector current

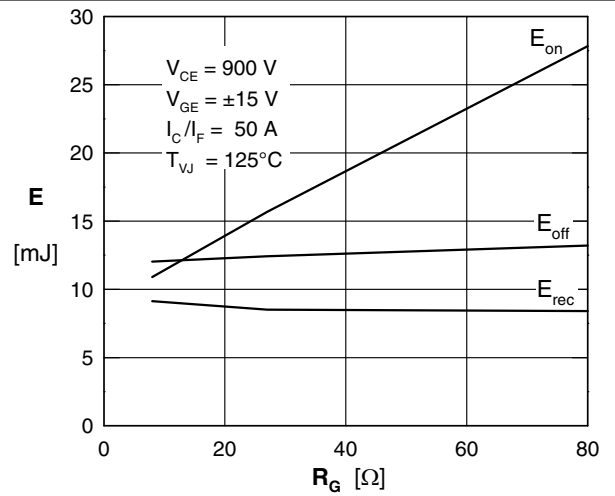


Fig. 14 Typ. turn off energy and switching times versus collector current

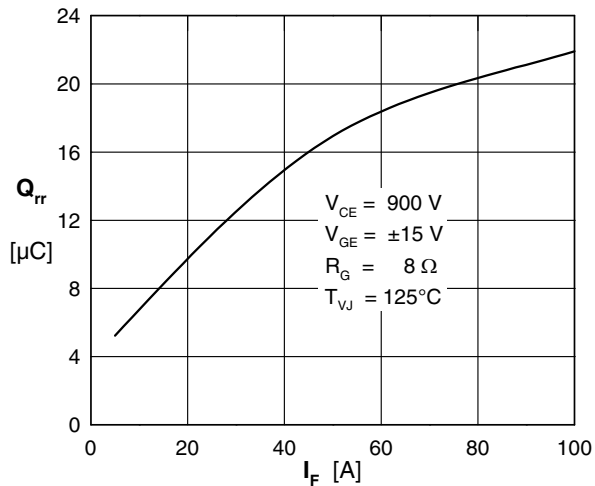


Fig. 15 Typical turn-off characteristics of free wheeling diode

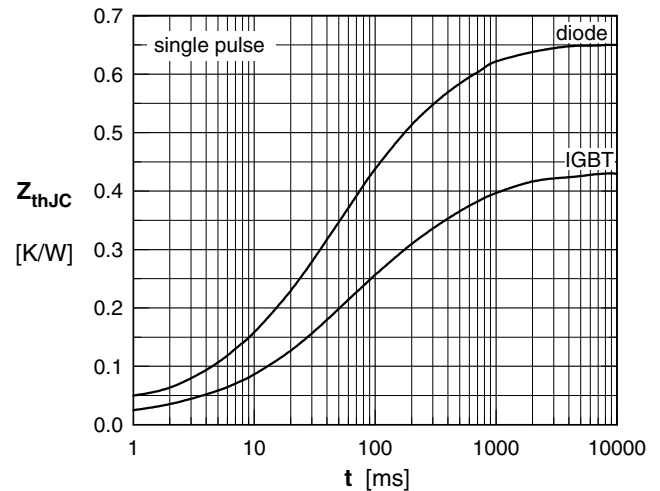


Fig. 16 Transient thermal impedance junction to case

Temperature Sensor NTC

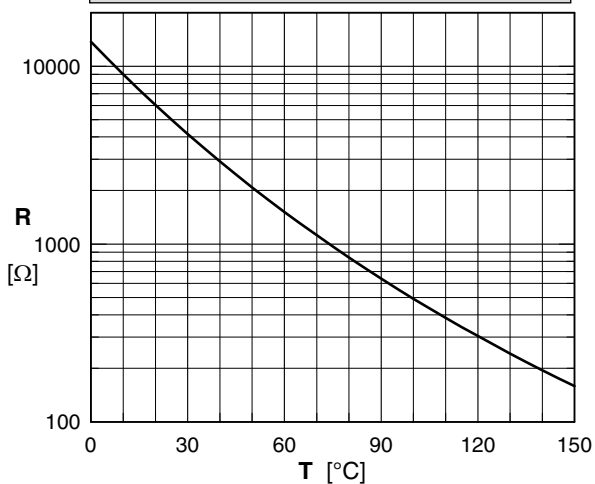
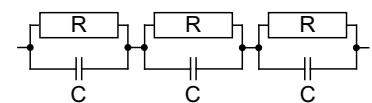


Fig. 17 Typ. NTC resistance vs. temperature

	IGBT		Diode	
	R_i	τ_i	R_i	τ_i
1	0.0326	0.0014	0.1941	0.0206
2	0.1311	0.0258	0.0542	0.0016
3	0.1492	0.1099	0.2549	0.0930
4	0.1169	0.6361	0.1461	0.5958



Brake Chopper T7 / D7

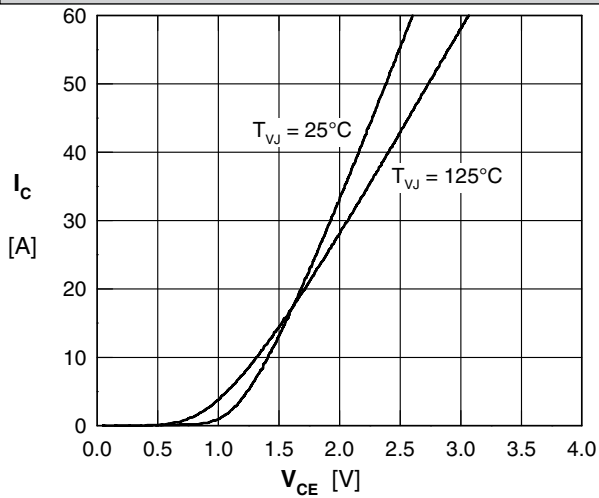


Fig. 18 Typical output characteristic

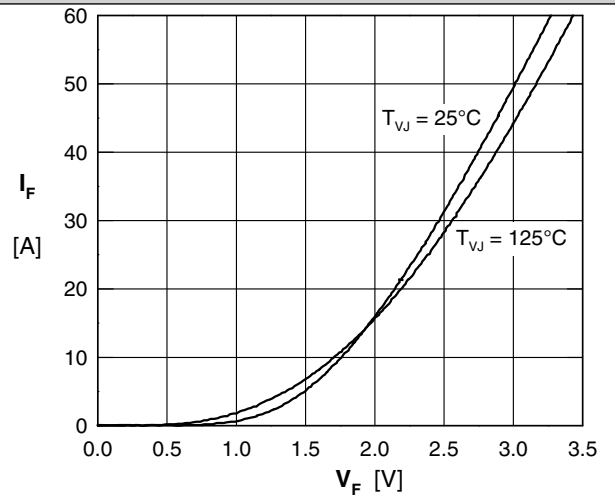


Fig. 19 Typ. forward characteristics of brake diode

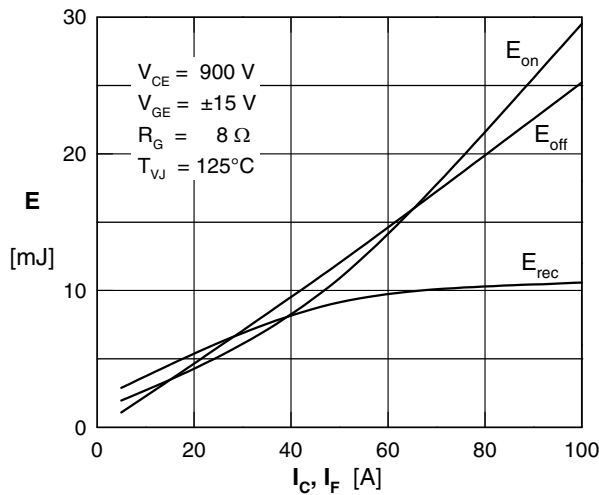


Fig. 20 Typ. turn on energy & switching times versus collector current

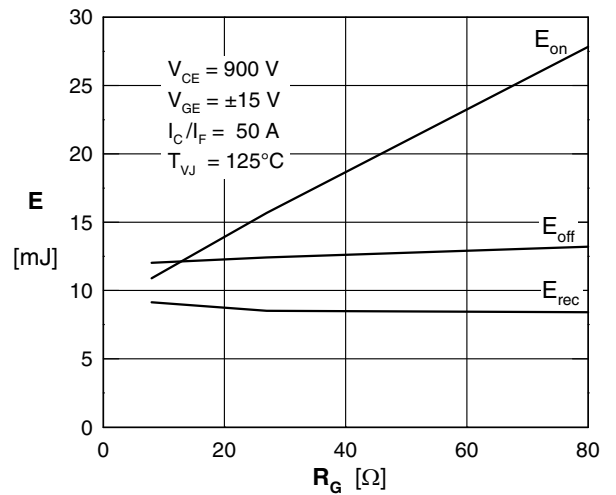


Fig. 21 Typ. turn off energy and switching times versus collector current

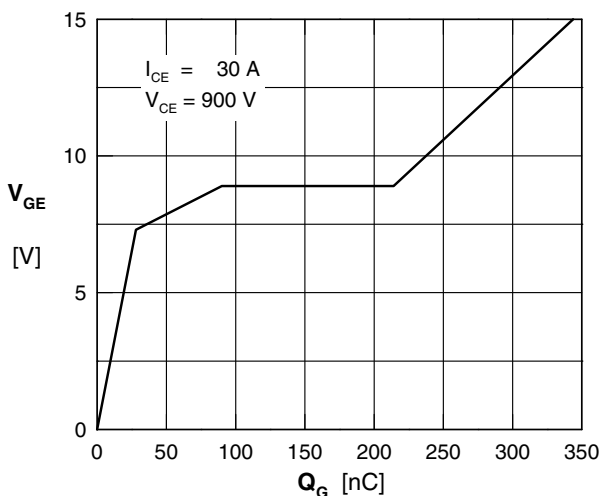


Fig. 22 Typ. turn on gate charge

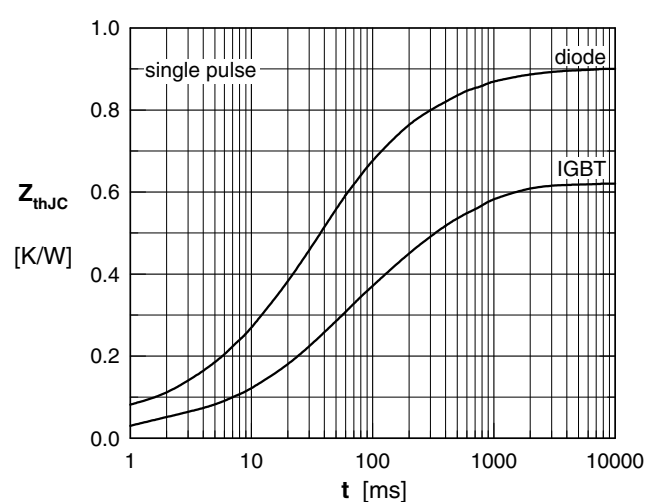


Fig. 23 Transient thermal impedance junction to case

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