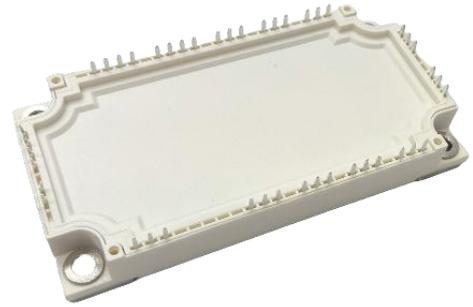# 1. Product Features

1.1 Electrical features

- V_{CES}=650V
- $I_{C\,nom}$=200A / I_{CRM}=400A
- Low switching losses
- Low inductance
- Fast switching and short tail current
- Integrated NTC temperature sensor
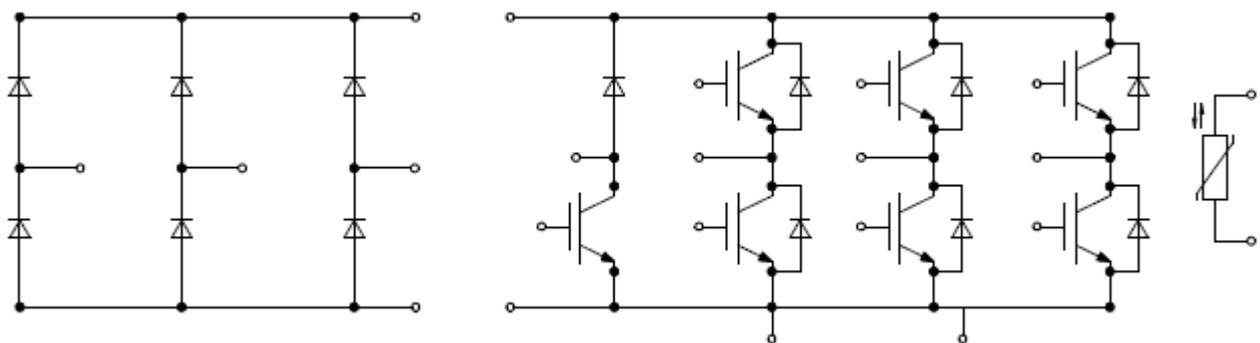- High power and thermal cycling capability

1.2 Mechanical features

- Al_2O_3 substrate with low thermal resistance
- Copper base plate

2. Typical Applications

- Switching mode power supply
- Drive inverters with brake system
- Uninterruptible power supply
- AC and DC servo drive amplifier

3. Description

3 Phase Bridge+Brake+Rectifier

4. IGBT, Inverter

4.1 Maximum Rated Values

Parameter	Note or test condition	Symbol	Values	Unit
Collector-emitter voltage 集电极—发射极间电压	T_{vj} = 25°C	V_{CES}	650	V
Continuous DC collector current 连续集电极电流	T_C = 80°C, T_{vj} max = 150°C	$I_{C\ nom}$	200	A
Repetitive peak collector current 集电极峰值电流	t_P = 1 ms	I_{CRM}	400	A
Total power dissipation 总功率损耗	T_C = 25°C, $T_{vj\ max}$ = 175°C	P_{tot}	635	W
Gate-emitter peak voltage 栅极－发射极峰值电压		V_{GES}	+/- 20	V

4.2 Characteristic value

Parameter	Note or test condition		Symbol	Values			Unit
				Min.	Typ.	Max.	
Collector-emitter saturation voltage 集电极－发射极饱和电压	I_C = 200 A, V_{GE} = 15 V	T_{vj} = 25°C	$V_{CE,sat}$		1.37		V
		T_{vj} = 125°C			1.48		V
		T_{vj} = 150°C			1.51		V
Gate threshold voltage 栅极阈值电压	I_C = 3.2mA, V_{CE} = V_{GE}, T_{vj} = 25°C		$V_{GE,th}$	5.0	5.8	6.5	V
Gate charge 栅极电荷	V_{GE} = -15 V ... +15 V		Q_G		1.51		μC
Internal gate resistor 内部栅极电阻	T_{vj} = 25°C		R_{Gint}		2.90		Ω
Input capacitance 输入电容	f=1MHz, T_{vj}=25°C, V_{CE}=25V, V_{GE}=0V		C_{ies}		32.4		nF
Reverse transfer capacitance 反向传输电容	f=1MHz, T_{vj}=25°C, V_{CE}=25V, V_{GE}=0V		C_{res}		0.14		nF
Collector-emitter cut-off current 集电极-发射极截止电流	V_{CE} = 650 V, V_{GE} = 0 V, T_{vj} = 25°C		I_{CES}			1	mA
Gate-emitter leakage current 栅极-发射极漏电流	V_{CE} = 0 V, V_{GE} = 20 V, T_{vj} = 25°C		I_{GES}			100	nA
Turn-on delay time, inductive load 开通延迟时间	I_C = 200A, V_{CE} = 300V V_{GE} = +15/-15V $R_{G,on}$ = 1.5Ω	T_{vj} = 25°C	$t_{d,on}$		0.09		us
		T_{vj} = 125°C			0.10		us
		T_{vj} = 150°C			0.11		us
Rise time, inductive load 上升时间	I_C = 200A, V_{CE} = 300V V_{GE} = +15/-15V $R_{G,on}$ = 1.5Ω	T_{vj} = 25°C	t_r		0.05		us
		T_{vj} = 125°C			0.05		us
		T_{vj} = 150°C			0.05		us

(table continues...) 待续

Parameter	Note or test condition		Symbol	Values			Unit
				Min.	Typ.	Max.	
Turn-off delay time, inductive load 关断延迟时间	$I_C = 200A$, $V_{CE} = 300V$	$T_{vj} = 25°C$	$t_{d,off}$		0.16		us
	$V_{GE} = +15/-15V$	$T_{vj} = 125°C$			0.19		us
	$R_{G,off} = 1.5Ω$	$T_{vj} = 150°C$			0.20		us
Fall time, inductive load 下降时间	$I_C = 200A$, $V_{CE} = 300V$	$T_{vj} = 25°C$	t_f		0.11		us
	$V_{GE} = +15/-15V$	$T_{vj} = 125°C$			0.22		us
	$R_{G,off} = 1.5Ω$	$T_{vj} = 150°C$			0.26		us
Turn-on energy loss per pulse 开通损耗能量	$I_C = 200A$, $V_{CE} = 300V$, L_s=30nH	$T_{vj} = 25°C$	E_{on}		2.09		mJ
	$V_{GE} = +15/-15V$, di/dt =2970A/μs	$T_{vj} = 125°C$			2.12		mJ
	$R_{G,on} = 1.5Ω$ ($T_{vj} = 150°C$)	$T_{vj} = 150°C$			2.14		mJ
Turn-off energy loss per pulse 关断损耗能量	$I_C = 200A$, $V_{CE} = 300V$, L_s=30nH	$T_{vj} = 25°C$	E_{off}		4.15		mJ
	$V_{GE} = +15/-15V$, dv/dt =2860V/μs	$T_{vj} = 125°C$			7.05		mJ
	$R_{G,off} = 1.5Ω$ ($T_{vj} = 150°C$)	$T_{vj} = 150°C$			7.80		mJ
SC data 短路数据	$V_{GE} ≤15V$, V_{CC} =300 V, $t_P ≤ 8$ μs, $T_{vj} = 150°C$, $C_{GE} = 0.0uF$, $V_{CEmax} = V_{CES} - L_{sCE} · di/dt$		I_{SC}		2026		A
Thermal resistance, junction to case 结一散热器热阻	Per IGBT		$R_{th,JC}$			0.23	K/W

5. Diode, Inverter

5.1 Maximum Rated Values

Parameter	Note or test condition	Symbol	Values	Unit
Repetitive peak reverse voltage 反向重复峰值电压	$T_{vj} = 25°C$	V_{RRM}	650	V
Continuous DC forward current 连续正向直流电流		I_F	200	A
Repetitive peak forward current 正向重复峰值电流	$t_P = 1$ ms	I_{FRM}	400	A

5.2 Characteristic value

Parameter	Note or test condition		Symbol	Values			Unit
				Min.	Typ.	Max.	
Forward voltage 正向电压	$I_F = 200$ A, $V_{GE} = 0$ V	$T_{vj} = 25°C$	V_F		1.22		V
		$T_{vj} = 125°C$			1.19		V
		$T_{vj} = 150°C$			1.17		V

(table continues...) 待续

Parameter	Note or test condition		Symbol	Values			Unit
				Min.	Typ.	Max.	
Peak reverse recovery current 反向恢复峰值电流	I_F = 200A, V_R = 300V	T_{vj} = 25°C	I_{RM}		172		A
	V_{GE} = -15V , - di_F/dt = 2260 A/μs	T_{vj} = 125°C			186		A
	$R_{G,off}$ = 1.5Ω (T_{vj} = 150°C)	T_{vj} = 150°C			190		A
Recovered charge 恢复电荷	I_F = 200A, V_R = 300V	T_{vj} = 25°C	Q_r		16.6		μC
	V_{GE} = -15V , - di_F/dt = 2260 A/μs	T_{vj} = 125°C			23.3		μC
	$R_{G,off}$ = 1.5Ω (T_{vj} = 150°C)	T_{vj} = 150°C			25.9		μC
Reverse recovery energy 反向恢复损耗（每脉冲）	I_F = 200A, V_R = 300V	T_{vj} = 25°C	E_{rec}		1.07		mJ
	V_{GE} = -15V , - di_F/dt = 2260 A/μs	T_{vj} = 125°C			2.56		mJ
	$R_{G,off}$ = 1.5Ω (T_{vj} = 150°C)	T_{vj} = 150°C			2.99		mJ
Thermal resistance, junction to case 结—散热器热阻	Per diode		$R_{th,JC}$			0.38	K/W

6. Diode, Rectifier

6.1 Maximum Rated Values

Parameter	Note or test condition	Symbol	Values	Unit
Repetitive peak reverse voltage 反向重复峰值电压	T_{vj} = 25°C	V_{RRM}	1600	V
Average Rectified Output current 整流器输出均方根电流	V_F = 1.2, T_{vj}= 150°C	I_F	200	A
Surge forward current 正向浪涌电流	t_p = 10 ms, Tvj = 150°C	I_{FSM}	1344	A
I^2t - value I^2t-值	t_p = 10 ms, Tvj = 150°C	I^2t	9031	A^2s

6.2 Characteristic value

Parameter	Note or test condition	Symbol	Values			Unit
			Min.	Typ.	Max.	
Forward voltage 正向电压	T_{vj} = 150°C, I_F = 200 A	V_F		1.0		V
Reverse current 反向电流	T_{vj} = 150°C, V_R = 1600 V	I_R		1		mA
Thermal resistance, junction to case 结—散热器热阻	Per diode	R_{thJC}			0.22	K/W

7. IGBT, Brake-Chopper

7.1 Maximum Rated Values

Parameter	Note or test condition	Symbol	Values	Unit
Collector-emitter voltage 集电极—发射极间电压	T_{vj} = 25°C	V_{CES}	650	V
Continuous DC collector current 连续集电极电流	T_C = 74°C, T_{vj} max = 150°C	$I_{C\,nom}$	150	A
Repetitive peak collector current 集电极峰值电流	t_P = 1 ms	I_{CRM}	300	A
Total power dissipation 总功率损耗	T_C = 25°C, $T_{vj\,max}$ = 175°C	P_{tot}	440	W
Gate-emitter peak voltage 栅极—发射极峰值电压		V_{GES}	+/- 20	V

7.2 Characteristic value

Parameter	Note or test condition		Symbol	Values			Unit
				Min.	Typ.	Max.	
Collector-emitter saturation voltage 集电极—发射极饱和电压	I_C = 150 A, V_{GE} = 15 V	T_{vj} = 25°C	$V_{CE,sat}$		1.36		V
		T_{vj} = 125°C			1.46		V
		T_{vj} = 150°C			1.49		V
Gate threshold voltage 栅极阈值电压	I_C = 1.5mA, V_{CE} = V_{GE}, T_{vj} = 25°C		$V_{GE,th}$	5.0	5.7	6.5	V
Gate charge 栅极电荷	V_{GE} = -15 V … +15 V		Q_G		1.51		μC
Internal gate resistor 内部栅极电阻	T_{vj} = 25°C		R_{Gint}		2.90		Ω
Input capacitance 输入电容	f=1MHz, T_{vj}=25°C, V_{CE}=25V, V_{GE}=0V		C_{ies}		32.3		nF
Reverse transfer capacitance 反向传输电容	f=1MHz, T_{vj}=25°C, V_{CE}=25V, V_{GE}=0V		C_{res}		0.14		nF
Collector-emitter cut-off current 集电极-发射极截止电流	V_{CE} = 650 V, V_{GE} = 0 V, T_{vj} = 25°C		I_{CES}			1	mA
Gate-emitter leakage current 栅极-发射极漏电流	V_{CE} = 0 V, V_{GE} = 20 V, T_{vj} = 25°C		I_{GES}			100	nA
Turn-on delay time, inductive load 开通延迟时间	I_C = 150A, V_{CE} = 300V	T_{vj} = 25°C	$t_{d,on}$		0.15		us
	V_{GE} = +15/-15V	T_{vj} = 125°C			0.16		us
	$R_{G,on}$ = 3.3Ω	T_{vj} = 150°C			0.17		us

(table continues...) 待续

Technical datasheet

Parameter	Note or test condition		Symbol	Values			Unit
				Min.	Typ.	Max.	
Rise time, inductive load 上升时间	I_C = 150A, V_{CE} = 300V	T_{vj} = 25°C	t_r		0.03		us
	V_{GE} = +15/-15V	T_{vj} = 125°C			0.03		us
	$R_{G,on}$ = 3.3Ω	T_{vj} = 150°C			0.04		us
Turn-off delay time, inductive load 关断延迟时间	I_C = 150A, V_{CE} = 300V	T_{vj} = 25°C	$t_{d,off}$		0.12		us
	V_{GE} = +15/-15V	T_{vj} = 125°C			0.14		us
	$R_{G,off}$ = 3.3Ω	T_{vj} = 150°C			0.14		us
Fall time, inductive load 下降时间	I_C = 150A, V_{CE} = 300V	T_{vj} = 25°C	t_f		0.18		us
	V_{GE} = +15/-15V	T_{vj} = 125°C			0.26		us
	$R_{G,off}$ = 3.3Ω	T_{vj} = 150°C			0.28		us
Turn-on energy loss per pulse 开通损耗能量	I_C = 150A, V_{CE} = 300V, L_S=30nH	T_{vj} = 25°C	E_{on}		4.30		mJ
	V_{GE} = +15/-15V, di/dt =3290A/μs	T_{vj} = 125°C			7.08		mJ
	$R_{G,on}$ = 3.3Ω (T_{vj} = 150°C)	T_{vj} = 150°C			8.17		mJ
Turn-off energy loss per pulse 关断损耗能量	I_C = 150A, V_{CE} = 300V, L_S=30nH	T_{vj} = 25°C	E_{off}		4.56		mJ
	V_{GE} = +15/-15V, dv/dt =4500A/μs	T_{vj} = 125°C			6.07		mJ
	$R_{G,off}$ = 3.3Ω (T_{vj} = 150°C)	T_{vj} = 150°C			6.36		mJ
SC data 短路数据	V_{GE} ≤15V, V_{CC} =300 V, t_P ≤ 8 μs, T_{vj} = 150°C , C_{GE} = 0.0uF , V_{CEmax} = V_{CES} - L_{sCE} · di/dt		I_{SC}		1380		A
Thermal resistance, junction to case 结－散热器热阻	Per IGBT		$R_{th,JC}$			0.34	K/W

8. Diode, Brake-Chopper

8.1 Maximum Rated Values

Parameter	Note or test condition	Symbol	Values	Unit
Repetitive peak reverse voltage 反向重复峰值电压	$T_{vj} = 25°C$	V_{RRM}	650	V
Continuous DC forward current 连续正向直流电流		I_F	150	A
Repetitive peak forward current 正向重复峰值电流	$t_P = 1$ ms	I_{FRM}	300	A

8.2 Characteristic value

Parameter	Note or test condition		Symbol	Values			Unit
				Min.	Typ.	Max.	
Forward voltage 正向电压	$I_F = 150$ A, $V_{GE} = 0$ V	$T_{vj} = 25°C$	V_F		1.63		V
		$T_{vj} = 125°C$			1.38		V
		$T_{vj} = 150°C$			1.32		V
Peak reverse recovery current 反向恢复峰值电流	$I_F = 150A$, $V_R = 300V$	$T_{vj} = 25°C$	I_{RM}		36.8		A
	$V_{GE} = -15V$, $- di_F/dt = 750$ A/µs	$T_{vj} = 125°C$			53.5		A
	$R_{G,off} = 3.3Ω$ $(T_{vj} = 150°C)$	$T_{vj} = 150°C$			54.4		A
Recovered charge 恢复电荷	$I_F = 150A$, $V_R = 300V$	$T_{vj} = 25°C$	Q_r		2.79		µC
	$V_{GE} = -15V$, $- di_F/dt = 750$ A/µs	$T_{vj} = 125°C$			5.57		µC
	$R_{G,off} = 3.3Ω$ $(T_{vj} = 150°C)$	$T_{vj} = 150°C$			6.54		µC
Reverse recovery energy 反向恢复损耗（每脉冲）	$I_F = 150A$, $V_R = 300V$	$T_{vj} = 25°C$	E_{rec}		0.21		mJ
	$V_{GE} = -15V$, $- di_F/dt = 750$ A/µs	$T_{vj} = 125°C$			0.36		mJ
	$R_{G,off} = 3.3Ω$ $(T_{vj} = 150°C)$	$T_{vj} = 150°C$			0.47		mJ
Thermal resistance, junction to case 结—散热器热阻	Per diode		$R_{th,JC}$			0.65	K/W

9. NTC-Thermistor

9.1 Characteristic value

Parameter	Note or test condition	Symbol	Values			Unit
			Min.	Typ.	Max.	
Rated resistance 额定电阻值	Tc = 25°C	R_{25}		5.00		KΩ
Power dissipation 耗散功耗	Tc = 25°C	P_{25}			20	mW
B-value B-Z 值	$R_2=R_{25}exp[B_{25/50}(1/T_2-1/(298, 15K))]$	B_{25}/B_{50}		3375		
B-value B-Z 值	$R_2=R_{25}exp[B_{25/50}(1/T_2-1/(298, 15K))]$	B_{25}/B_{75}		3408		
B-value B-Z 值	$R_2=R_{25}exp[B_{25/50}(1/T_2-1/(298, 15K))]$	B_{25}/B_{100}		3435		

10. Module

10.1 Characteristic value

Parameter	Note or test condition	Symbol	Values			Unit
			Min.	Typ.	Max.	
Isolation Voltage 隔离电压	RMS, f=50HZ,1min	V_{ISOL}			2500	V
Stray inductance module 杂散电感		L_{sCE}		25		nH
Operation Junction Temperature 结温		T_{jop}	-40		150	˚C
Storage Temperature Range 存储温度范围		T_{stg}	-40		125	˚C
Mounting Torque 安装扭矩	Screw M5	M	3		6	N.m
Weight of Module 重量		G		300		g

11. Characteristics diagrams

Output characteristic IGBT, Inverter (typical)
$I_C = f(V_{CE})$
$V_{GE} = 15V$

Output characteristic IGBT, Inverter (typical)
$I_C = f(V_{CE})$
$T_{vj} = 150°C$

Transfer characteristic IGBT, Inverter (typical)
$I_C = f(V_{GE})$
$V_{CE} = 20V$

Switching losses IGBT, Inverter (typical)
$E_{on} = f(I_C)$, $E_{off} = f(I_C)$
$R_{Goff} = 1.5\ \Omega$, $R_{Gon} = 1.5\ \Omega$, $V_{CE} = 300\ V$, $V_{GE} = \pm 15\ V$
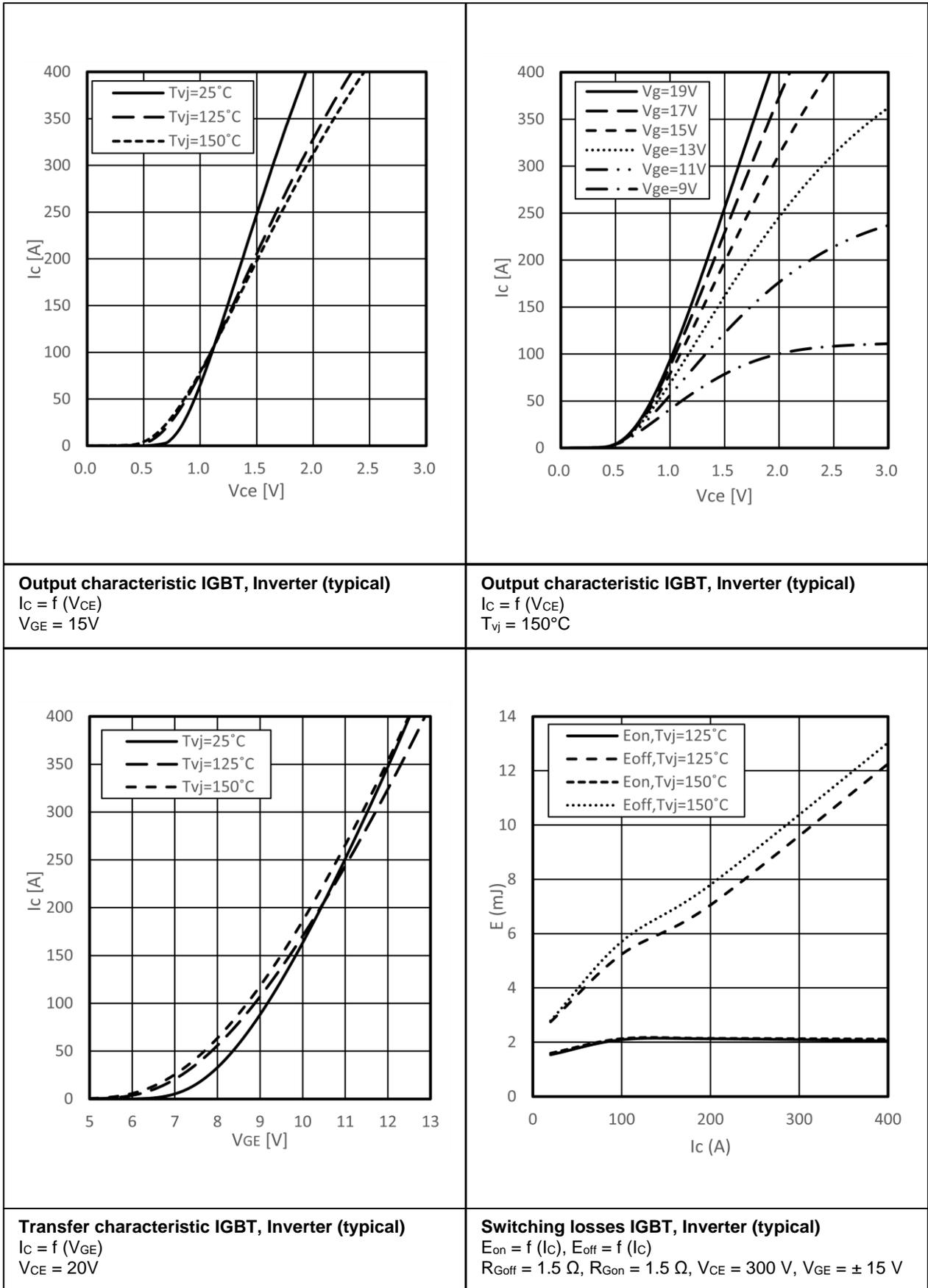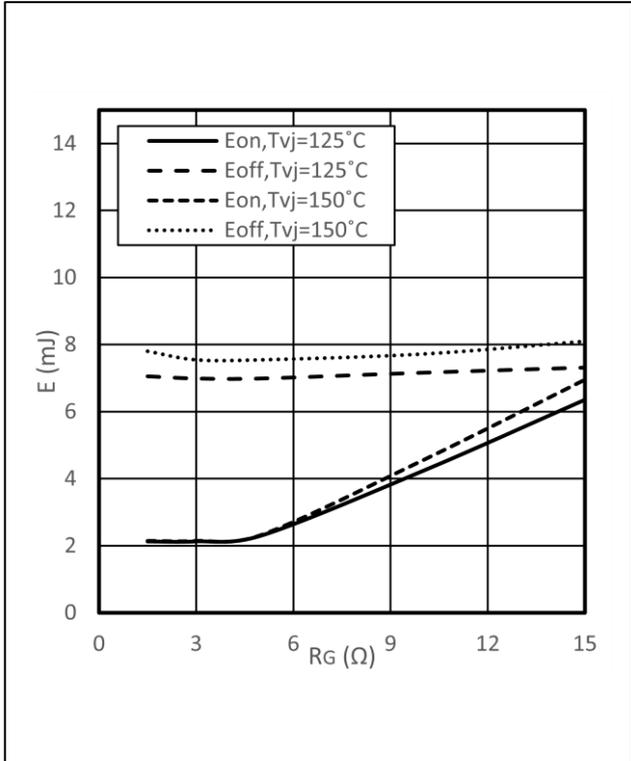
Switching losses IGBT, Inverter (typical)
$E_{on} = f(R_G)$, $E_{off} = f(R_G)$
$I_C = 200$ A, $V_{CE} = 300$ V, $V_{GE} = \pm 15$ V
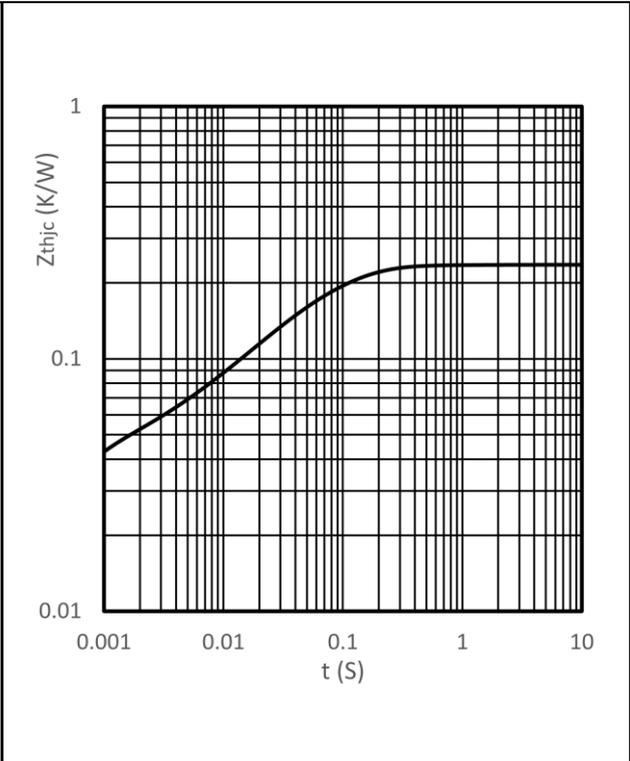
Transient thermal impedance IGBT, Inverter
$Z_{thJC} = f(t)$
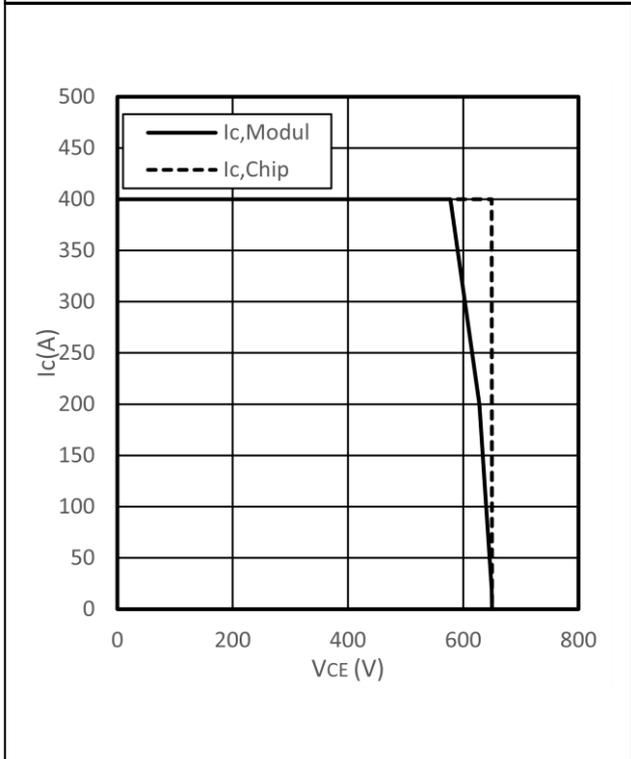
Reverse bias safe operating area IGBT, Inverter (RBSOA)
$I_C = f(V_{CE})$
$V_{GE} = 15$ V, $R_{Goff} = 1.5$ Ω, $T_{vj} = 150°C$
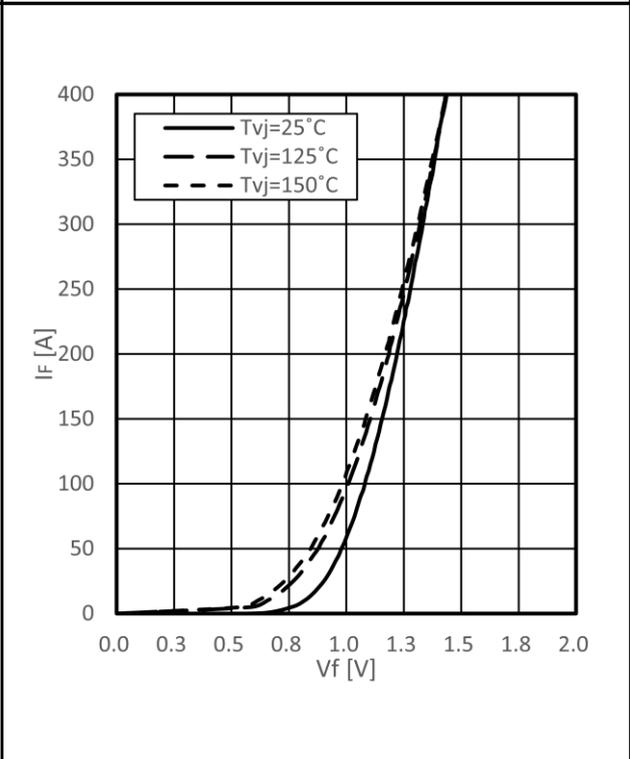
Forward characteristic of Diode, Inverter (typical)
$I_F = f(V_F)$
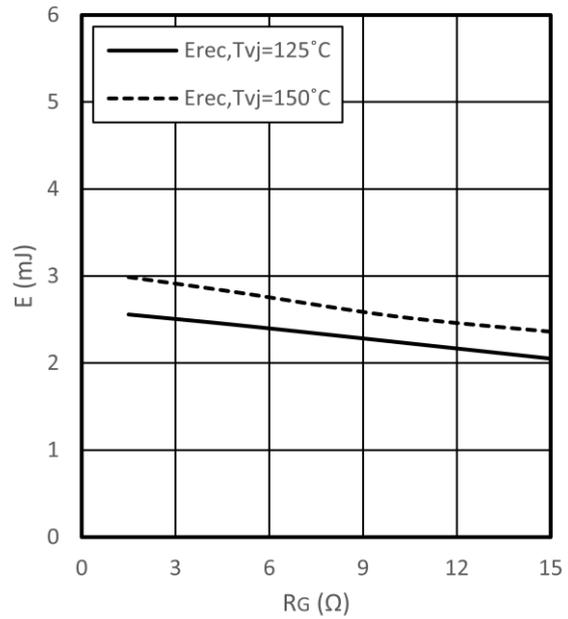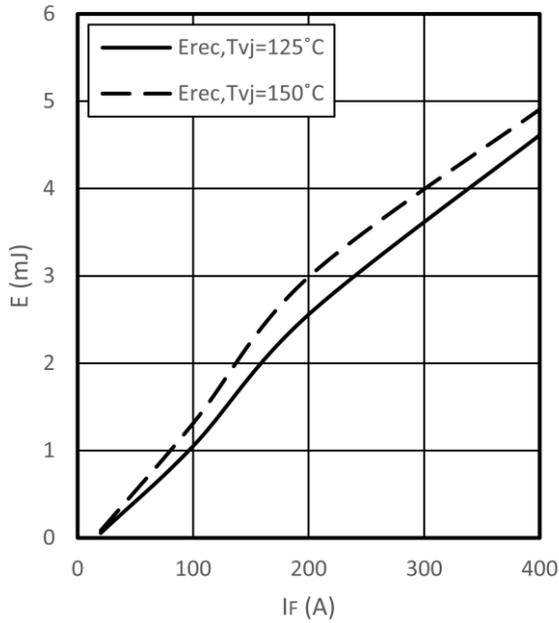
Switching losses Diode, Inverter (typical)
$E_{rec} = f (I_F)$
$R_{Gon} = 1.5\ \Omega$, $V_{CE} = 300\ V$

Switching losses Diode, Inverter (typical)
$E_{rec} = f (R_G)$
$I_F = 200\ A$, $V_{CE} = 300\ V$
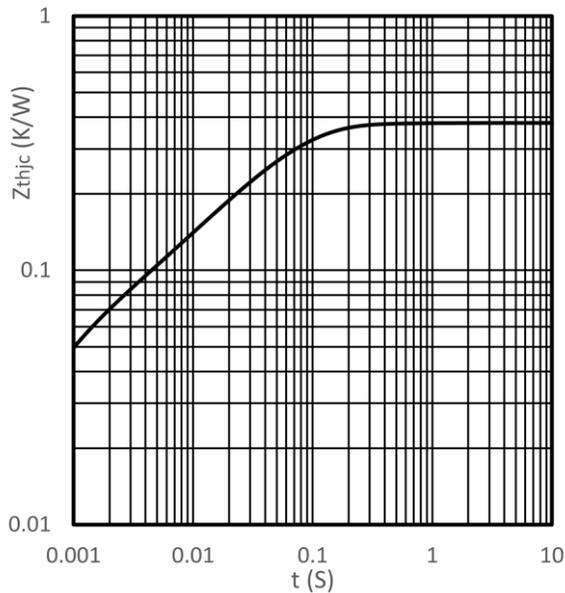
Transient thermal impedance Diode, Inverter
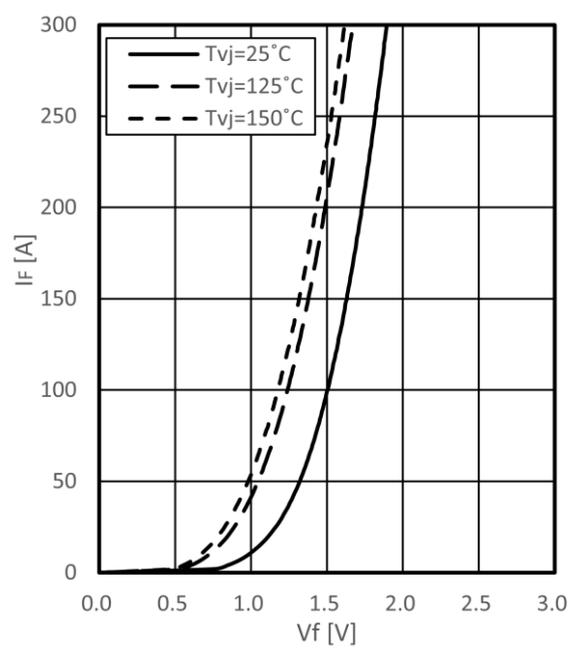$Z_{thJC} = f (t)$
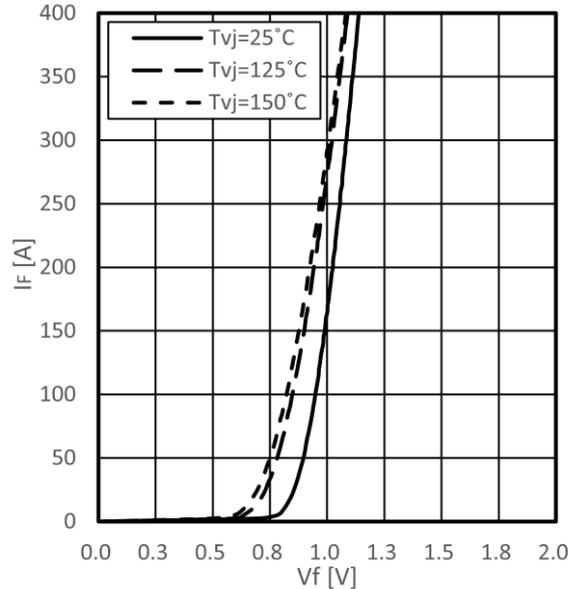
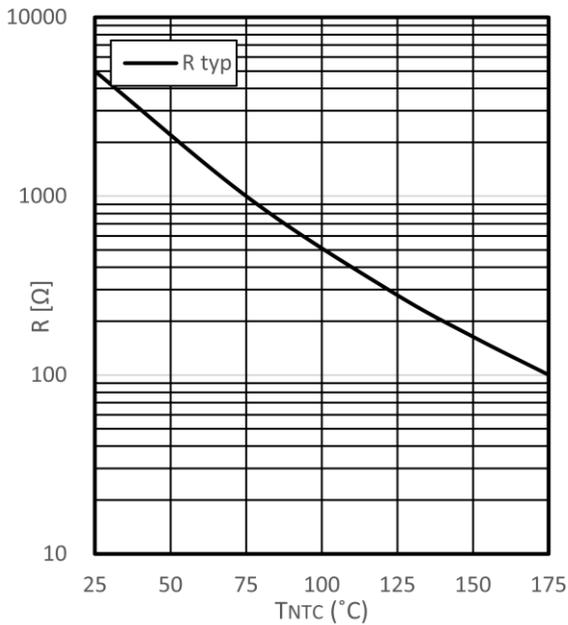**Forward characteristic of Diode, Rectifier (typical)**
$I_F = f (V_F)$
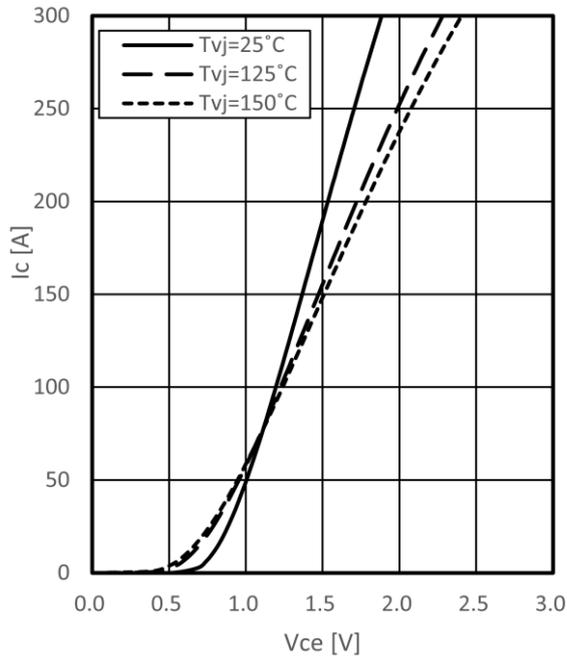
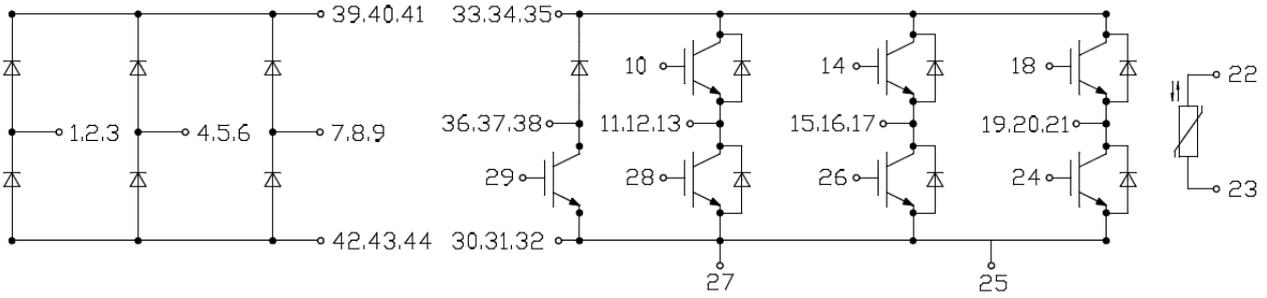**Output characteristic IGBT, Brake-Chopper(typical)**
$I_C = f (V_{CE})$
$V_{GE} = 15V$

Forward characteristic of Diode, Brake-Chopper (typical)
$I_F = f (V_F)$

NTC-Thermistor-temperature characteristic (typical)
$R = f (T_{NTC})$

12. Circuit Diagram

13. Package Outlines