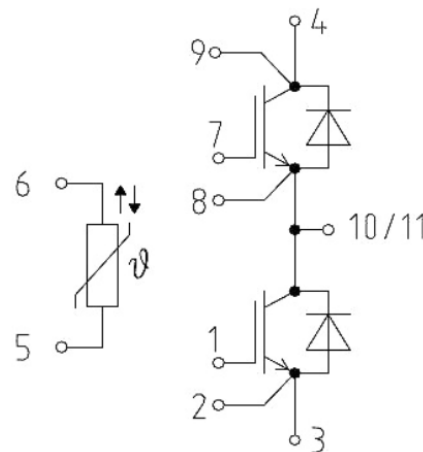


C5 series package: 1200V 450A IGBT module

Datasheet



Equivalent
Circuit Schematic

Features:

- Trenchgate Gen.7 IGBT technology
- $V_{CE(sat)}$ with positive temperature coefficient
- High RBSOA capability
- Low static losses: $V_{CE(sat)} = 1,5V@25^{\circ}C$
- Low dynamic losses

Options:

- Pre-applied TIM (option +M01)
- Adoption for parallel connection (V_f selection)

Typical Applications:

- Motor Drives
- Solar Applications
- UPS Systems
- Energy Stores

**IGBT, Inverter / IGBT
Maximum Rated Values**

Collector-emitter Voltage	$T_{vj} = 25^{\circ}\text{C}$	V_{CES}	1200	V
Continuous DC Collector Current		I_{Cnom}	450	A
	$T_C = 100^{\circ}\text{C}, T_{vj\ max} \leq 175^{\circ}\text{C}$	I_C	540	A
Repetitive Peak Collector Current	$t_p\ T_{vj\ op}$	I_{CRM}	900	A
Total Power Dissipation	$T_C = 25^{\circ}\text{C}, T_{vj\ max} = 175^{\circ}\text{C}$	P_{tot}	2344	W
Gate-emitter Peak Voltage		V_{GES}	± 20	V

Characteristic Values

			min.	typ.	max.	
Collector-emitter Saturation Voltage ¹⁾	$I_C = 450\text{A}, V_{GE} = 15\text{V}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	V_{CESat}	1.40	1.51 1.71 1.79	1.70	V
Gate Threshold Voltage	$V_{CE} = V_{GE}, I_C = 24\text{mA}, T_{vj} = 25^{\circ}\text{C}$	V_{GEth}	5.0	6.0	7.0	V
Gate Charge	$V_{GE} = -10\text{V}/15\text{V}, V_{CE} = 600\text{V}$	Q_G	—	4.1	—	μC
Internal Gate Resistor	$T_{vj} = 25^{\circ}\text{C}$	R_{Gint}	—	1.05	—	Ω
Input Capacitance	$f = 100\text{kHz}, T_{vj} = 25^{\circ}\text{C}, V_{CE} = 25\text{V}, V_{GE} = 0\text{V}$	C_{ies}	—	106	—	nF
Output Capacitance	$f = 100\text{kHz}, T_{vj} = 25^{\circ}\text{C}, V_{CE} = 25\text{V}, V_{GE} = 0\text{V}$	C_{oes}	—	1.96	—	nF
Reverse Transfer Capacitance	$f = 100\text{kHz}, T_{vj} = 25^{\circ}\text{C}, V_{CE} = 25\text{V}, V_{GE} = 0\text{V}$	C_{res}	—	0.28	—	nF
Collector-emitter Cutoff Current	$V_{CE} = 1200\text{V}, V_{GE} = 0\text{V}, T_{vj} = 25^{\circ}\text{C}$	I_{CES}	—	—	100	μA
Gate-emitter Leakage Current	$V_{CE} = 0\text{V}, V_{GE} = 20\text{V}, T_{vj} = 25^{\circ}\text{C}$	I_{GES}	—	—	500	nA
Turn-on Delay Time, Inductive Load	$I_C = 450\text{A}, V_{CE} = 600\text{V}$ $V_{GE} = -8\text{V}/15\text{V}$ $R_{GON} = 1.0\Omega$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	t_{don}	—	206 212 216 240	—	ns
Rise Time, Inductive Load	$I_C = 450\text{A}, V_{CE} = 600\text{V}$ $V_{GE} = -8\text{V}/15\text{V}$ $R_{GON} = 1.0\Omega$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	t_r	—	62 74 77 98	—	ns
Turn-off Delay Time, Inductive Load	$I_C = 450\text{A}, V_{CE} = 600\text{V}$ $V_{GE} = -8\text{V}/15\text{V}$ $R_{GON} = 1.0\Omega$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	t_{doff}	—	389 434 440 495	—	ns
Fall Time, Inductive Load	$I_C = 450\text{A}, V_{CE} = 600\text{V}$ $V_{GE} = -8\text{V}/15\text{V}$ $R_{Goff} = 1\Omega$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	t_f	—	123 191 203 210	—	ns
Turn-on Energy Loss per Pulse	$I_C = 450\text{A}, V_{CE} = 600\text{V}, L_{\sigma} = 30\text{nH}$ $V_{GE} = -8\text{V}/15\text{V}, R_{GON} = 1.0\Omega$ $di/dt = 4200\text{A}/\mu\text{s} (T_{vj} = 175^{\circ}\text{C})$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	E_{on}	—	27.1 38.1 46.4 51.2	—	mJ
Turn-off energy Loss per Pulse	$I_C = 450\text{A}, V_{CE} = 600\text{V}, L_{\sigma} = 30\text{nH}$ $V_{GE} = -8\text{V}/15\text{V}, R_{GON} = 1.0\Omega$ $du/dt = 6300\text{V}/\mu\text{s} (T_{vj} = 175^{\circ}\text{C})$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	E_{off}	—	33.4 46.4 50.4 56.9	—	mJ

SC Data	V _{GE} = -8V/15V V _{CC} = 600V t _p ≤ 10μs, T _{vj} = 25°C t _p ≤ 10μs, T _{vj} = 150°C t _p ≤ 10μs, T _{vj} = 175°C	I _{sc}	—	2700 2100 2000	—	A
Thermal Resistance, Junction to Case	Per IGBT / IGBT	R _{thJC}	—	0.064	—	K/W
Thermal Resistance, Case to Heatsink	Per IGBT / IGBT λ _{grease} = 1W/(m·K)	R _{thCH}	—	0.019	—	K/W
Temperature under Switching Conditions		T _{vj op}	-40		175	°C

Diode, Inverter Maximum Rated Values

Repetitive Peak Reverse Voltage	T _{vj} = 25°C	V _{RRM}	1200	V
Continuous DC Forward Current		I _{Fnom}	450	A
Repetitive Peak Forward Current	t _p T _{vj op}	I _{FRM}	900	A

Characteristic Values

			min.	typ.	max.	
Forward Voltage ¹⁾	I _F = 450A, V _{GE} = 0V T _{vj} = 25°C T _{vj} = 150°C T _{vj} = 175°C	V _F	1.50	2.01 1.94 1.84	2.40	V
Peak Reverse Recovery Current	I _F = 450A, V _R = 600V -di _F /dt = 5600A/μs (T _{vj} = 175°C) V _{GE} = -8V T _{vj} = 25°C T _{vj} = 125°C T _{vj} = 150°C T _{vj} = 175°C	I _{RM}	—	302 358 374 390	—	A
Recovery Charge	I _F = 450A, V _R = 600V -di _F /dt = 5600A/μs (T _{vj} = 175°C) V _{GE} = -8V T _{vj} = 25°C T _{vj} = 125°C T _{vj} = 150°C T _{vj} = 175°C	Q _R	—	21.3 42.1 50.0 56.0	—	μC
Reverse Recovery Energy	I _F = 450A, V _R = 600V -di _F /dt = 5600A/μs (T _{vj} = 175°C) V _{GE} = -8V T _{vj} = 25°C T _{vj} = 125°C T _{vj} = 150°C T _{vj} = 175°C	E _{rec}	—	11.3 22.5 27.7 33.0	—	mJ
Thermal Resistance, Junction to Case	Per FRD / FRD	R _{thJC}	—	0.092	—	K/W
Thermal Resistance, Case to Heatsink	Per FRD / FRD λ _{grease} = 1W/(m·K)	R _{thHC}	—	0.021	—	K/W
Temperature under Switching Conditions ²⁾		T _{vj op}	-40	—	175	°C

NTC-Thermistor / NTC

Maximum Rated Values

			min.	typ.	max.	
Rated Resistance	TNTC = 25°C	R25	—	5	—	KΩ
Deviation of R100 R100	TNTC = 100°C, R100 = 465Ω	ΔR/R	-7.3	—	7.3	%
Power Dissipation	TNTC = 25°C	P25	—	—	10	mW
B-Value B	$R_2 = R_{25} \exp[B_{25/50}(1/T_2 - 1/(298.15K))]$	B25/50	—	3380	—	K
	$R_2 = R_{25} \exp[B_{25/80}(1/T_2 - 1/(298.15K))]$	B25/80	—	3470	—	K
	$R_2 = R_{25} \exp[B_{25/100}(1/T_2 - 1/(298.15K))]$	B25/100	—	3520	—	K

Module

Isolation Test Voltage	RMS, f=50Hz	V _{ISOL}	3.0	kV
Isolation Test Voltage of NTC NTC	RMS, f=50Hz	V _{ISOL} (NTC)	3.0	kV
Material of Module Baseplate			Cu	
Internal Isolation			ZTA	
Creepage Distance	Terminal to heatsink, min Terminal to terminal, min		14.7 15.1	mm
Clearance	Terminal to heatsink, min Terminal to terminal, min		9.6 12.5	mm
Comparative Tracking Index		CTI	>200	

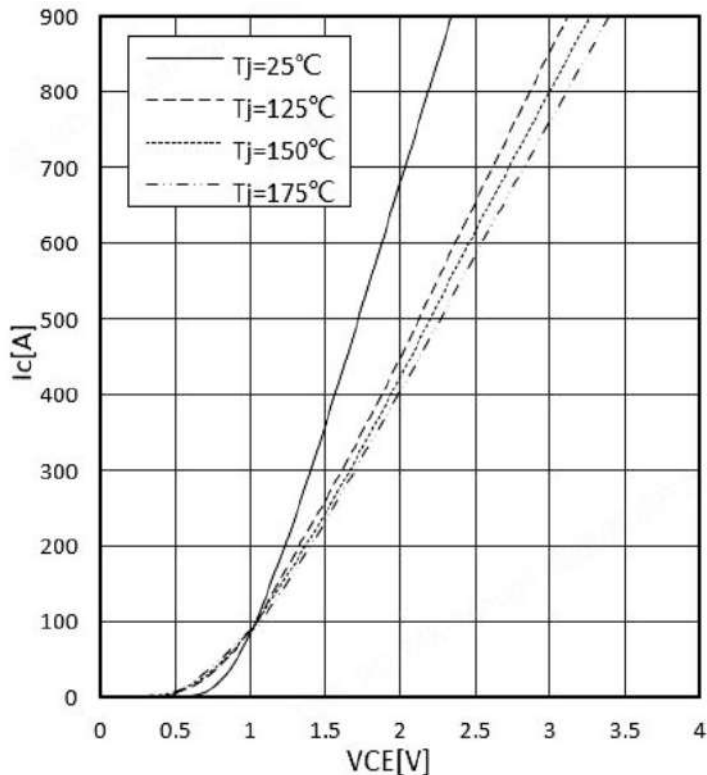
			min.	typ.	max.	
Stray Inductance Module		L _{sCE}	—	20	—	nH
Module Lead Resistance, Terminals-Chip	T _C = 25°C, Per Switch	R _{CC'+EE'}	—	0.8	—	mΩ
Storage Temperature		T _{stg}	-40	—	125	°C
Mounting Torque for Module Mounting	Screw M5 / M5	M	4.0	—	6.0	Nm
Mounting Torque for Terminal Mounting	Screw M5 / M5	M	4.0	—	6.0	Nm
Weight		G	—	345	—	g

1) Terminal impedance is not included.

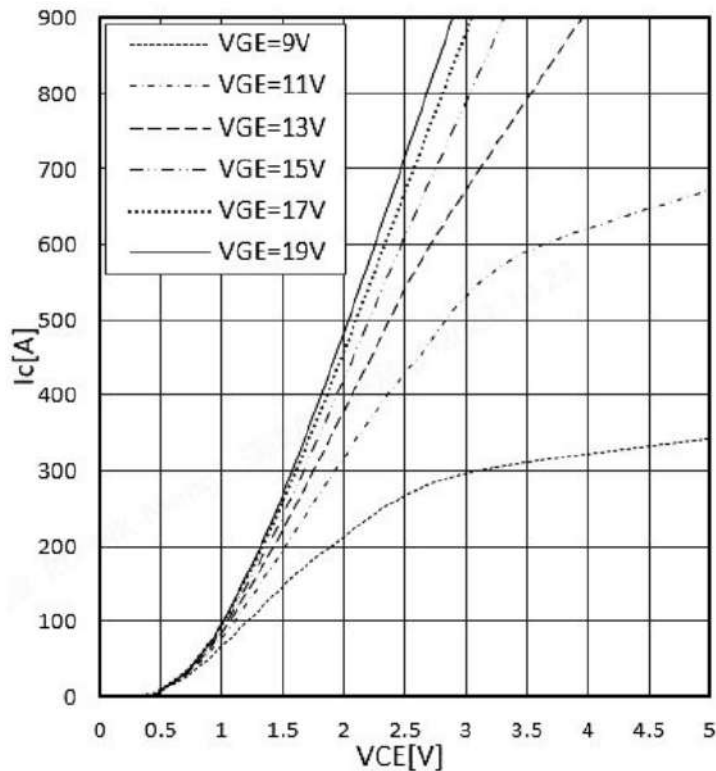
2) T_{vj op} > 150°C is allowed for operation at overload conditions.
T_{vj op} > 150°C.

Circuit Diagram

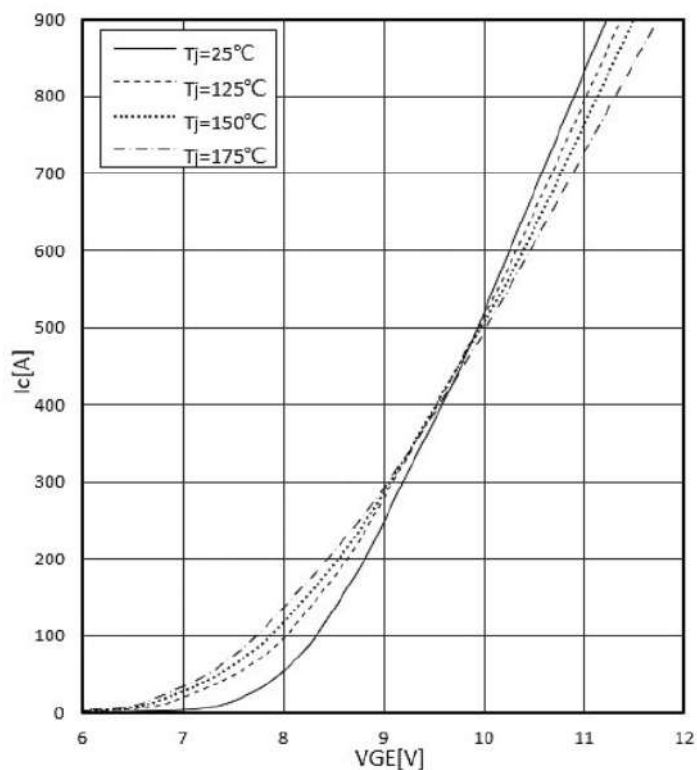
Output characteristic IGBT, Inverter (typical), IGBT
 $I_c = f(V_{CE})$, $V_{GE} = 15V$



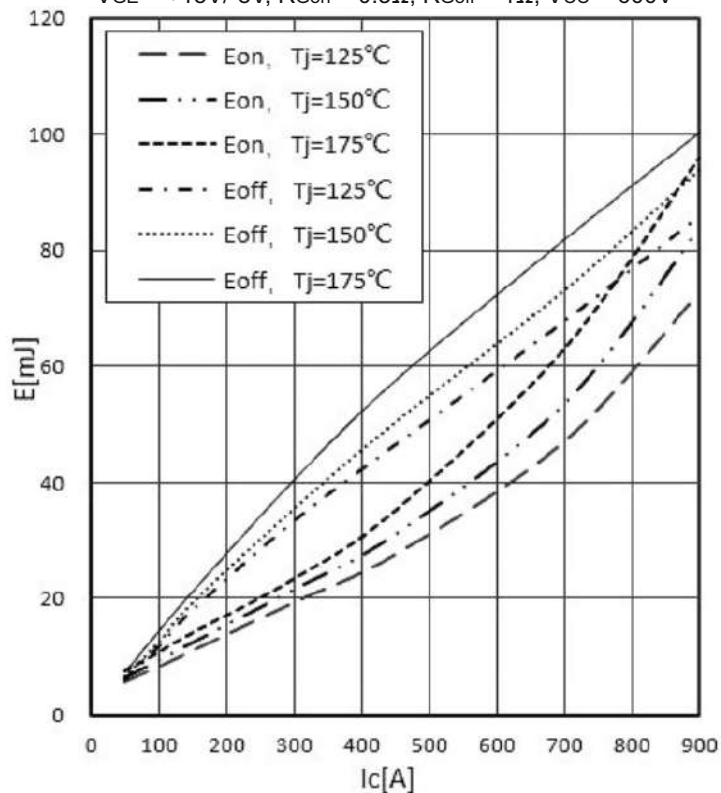
Output characteristic IGBT, Inverter (typical), IGBT
 $I_c = f(V_{CE})$, $T_{vj} = 175^{\circ}C$



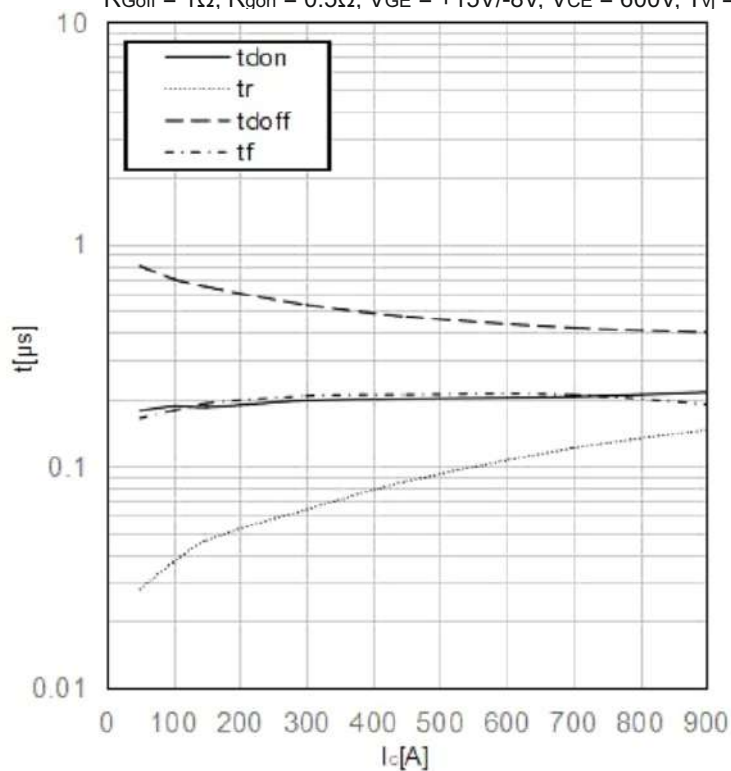
Transfer characteristic IGBT, Inverter (typical), IGBT
 $I_c = f(V_{GE})$, $V_{CE} = 20V$



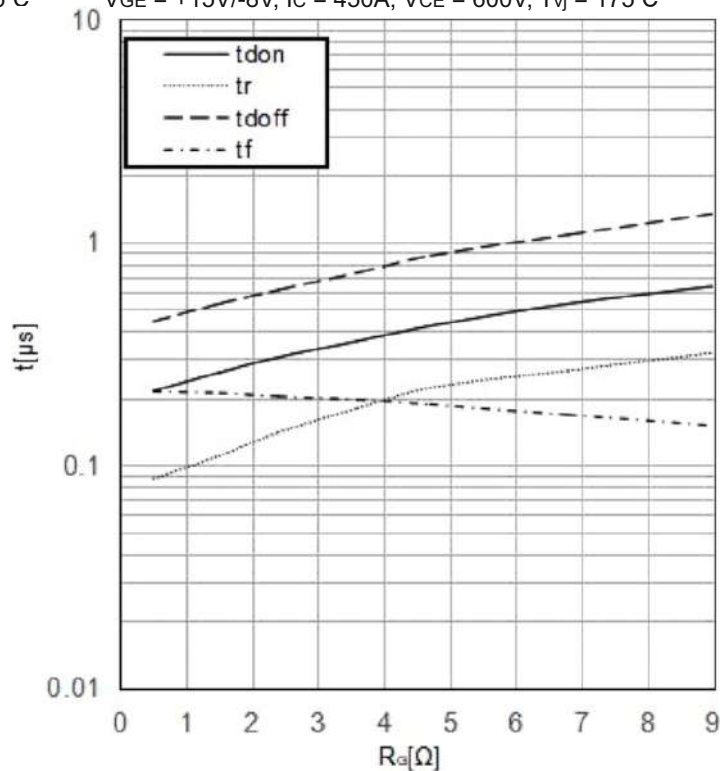
Switching losses IGBT, Inverter (Typical), IGBT
 $E_{on} = f(I_c)$, $E_{off} = f(I_c)$
 $V_{GE} = +15V/-8V$, $R_{Gon} = 0.5\Omega$, $R_{Goff} = 1\Omega$, $V_{CC} = 600V$



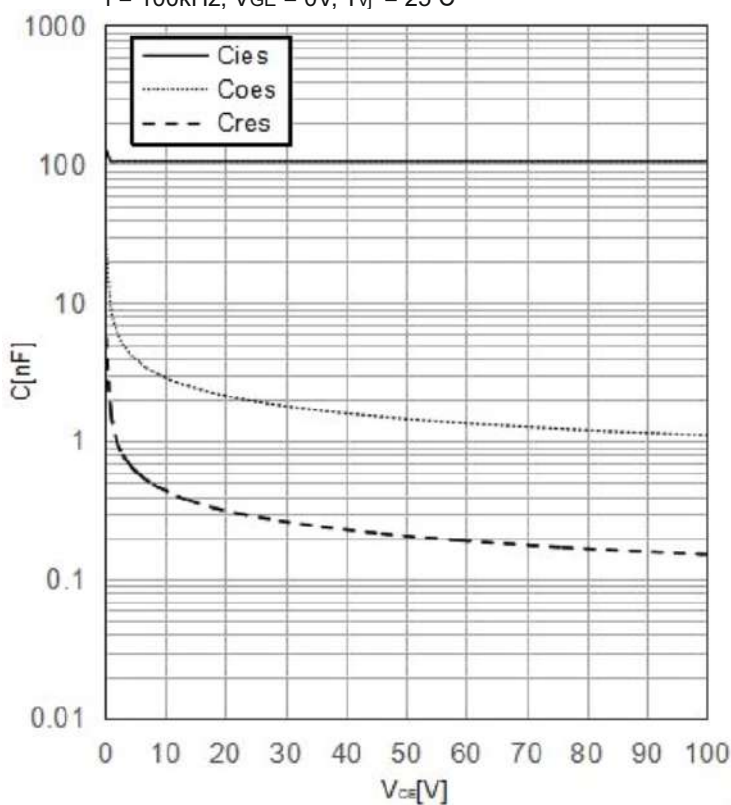
Switching time IGBT, Inverter (typical), IGBT

 $t = f(I_C)$
 $R_{Goff} = 1\Omega, R_{Gon} = 0.5\Omega, V_{GE} = +15V/-8V, V_{CE} = 600V, T_{vj} = 175^\circ C$


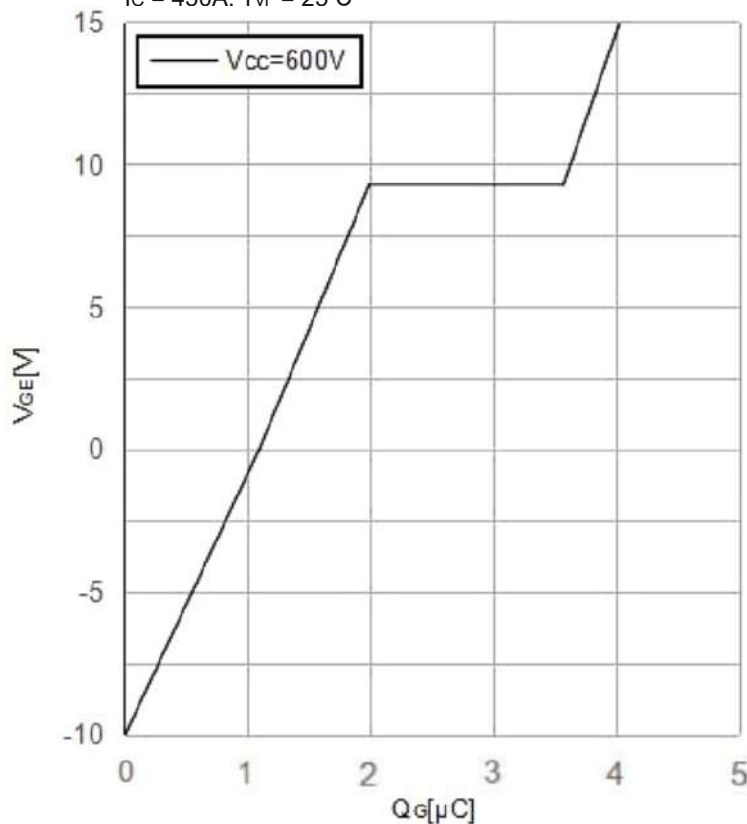
Switching time IGBT, Inverter (typical), IGBT

 $t = f(R_G)$
 $V_{GE} = +15V/-8V, I_C = 450A, V_{CE} = 600V, T_{vj} = 175^\circ C$


Capacitance characteristic IGBT, Inverter, IGBT

 $C = f(V_{CE})$
 $f = 100kHz, V_{GE} = 0V, T_{vj} = 25^\circ C$


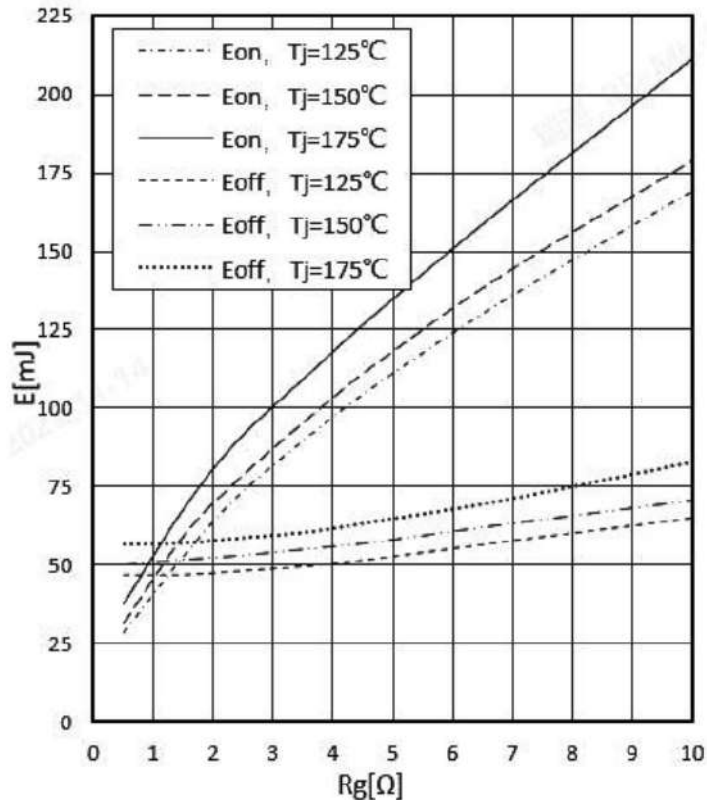
Gate Charge characteristic IGBT, Inverter, IGBT

 $V_{GE} = f(Q_G)$
 $I_C = 450A, T_{vj} = 25^\circ C$


Switching losses IGBT, Inverter (Typical), IGBT

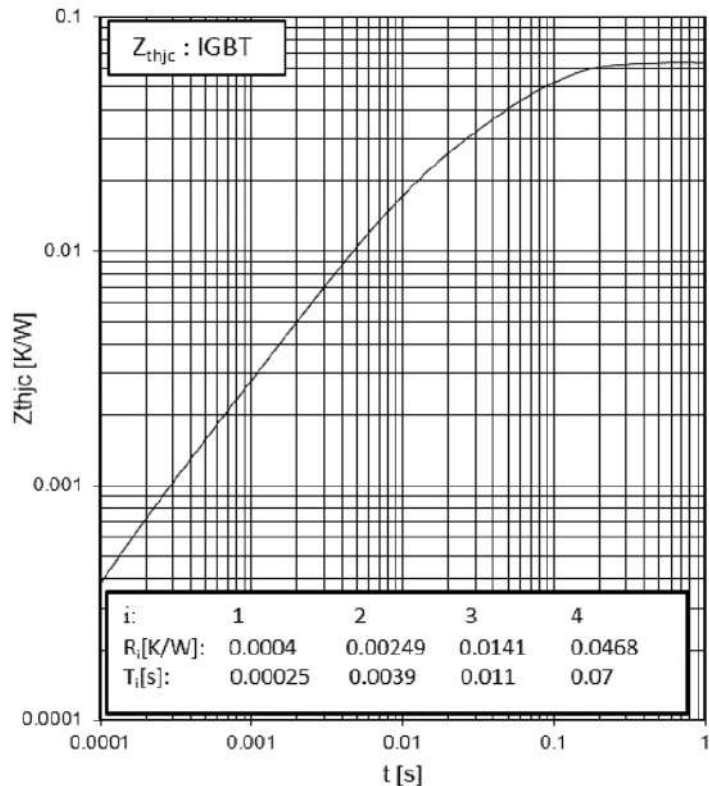
$$E_{on} = f(R_g)1\Omega, E_{off} = f(R_g),$$

$$V_{GE} = +15V/-8V, I_C = 450A, V_{CE} = 600V$$



Transient thermal impedance IGBT, Inerter, IGBT

$$E_{thJC} = f(t)$$

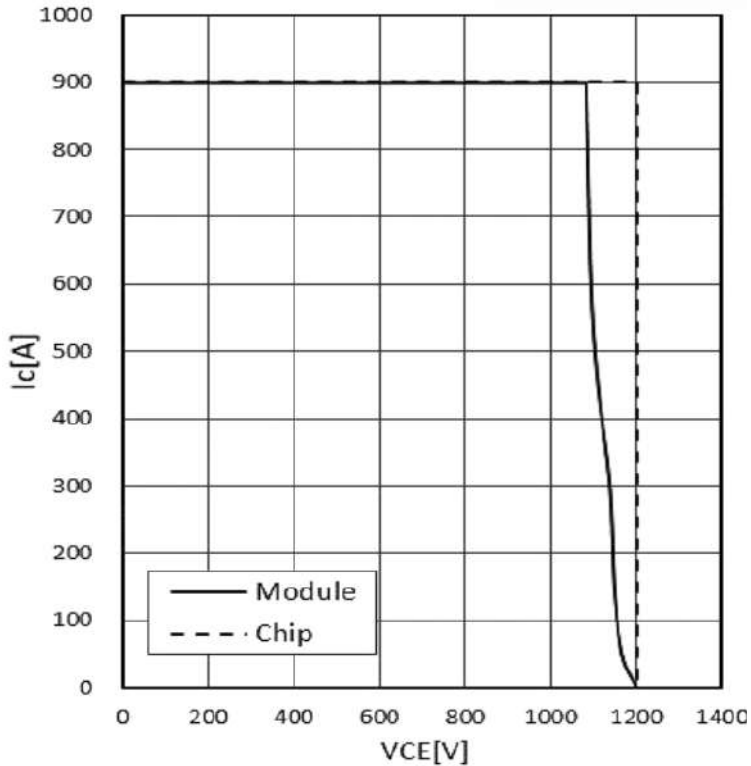


Reverse bias safe operating area IGBT, Inverter (RBSOA)

IGBT (RBSOA)

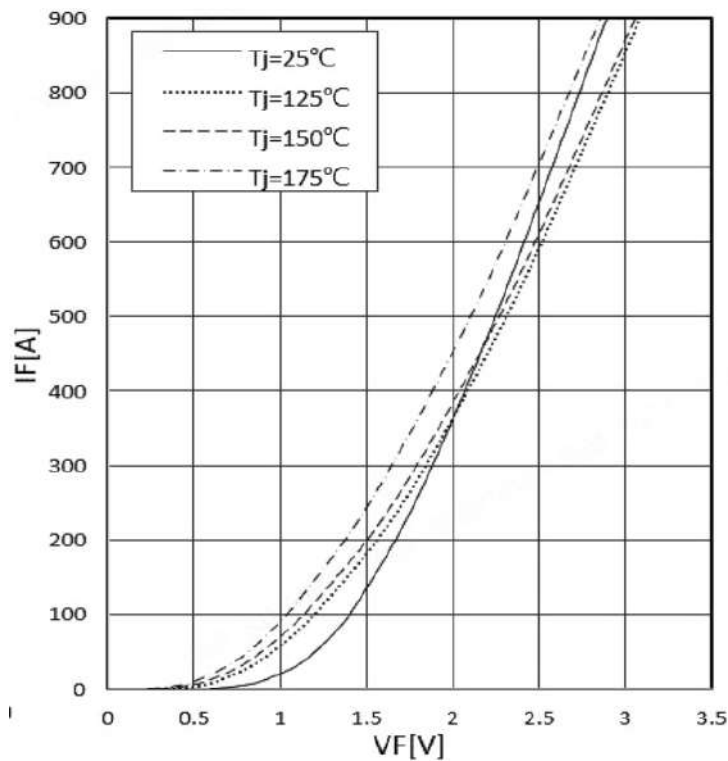
$$I_C = f(V_{CE})$$

$$V_{GE} = +15V/-8V, R_{aoff} = 1\Omega, T_{vi} = 175^\circ C$$



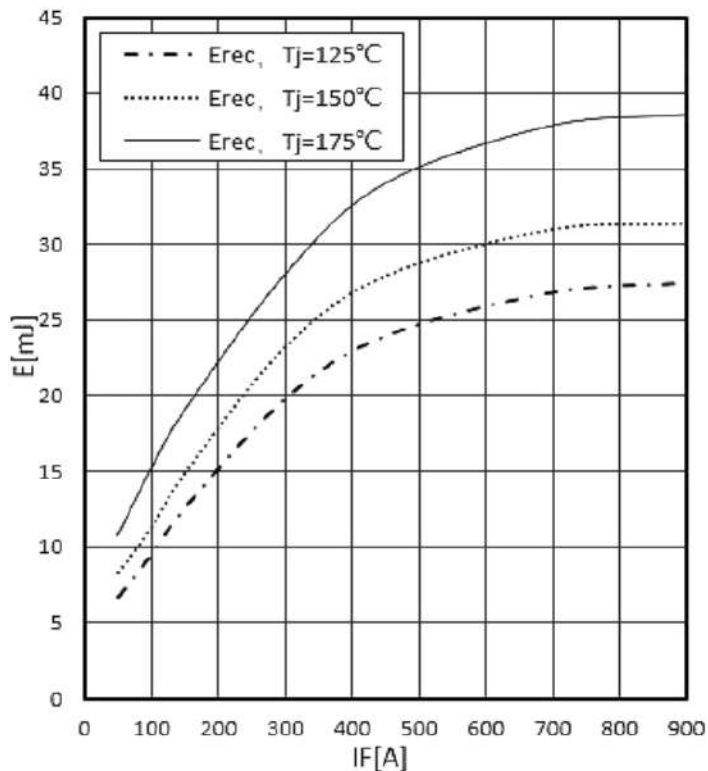
Forward characteristic of Diode, Inverter (typical)

$$I_F = f(V_F)$$



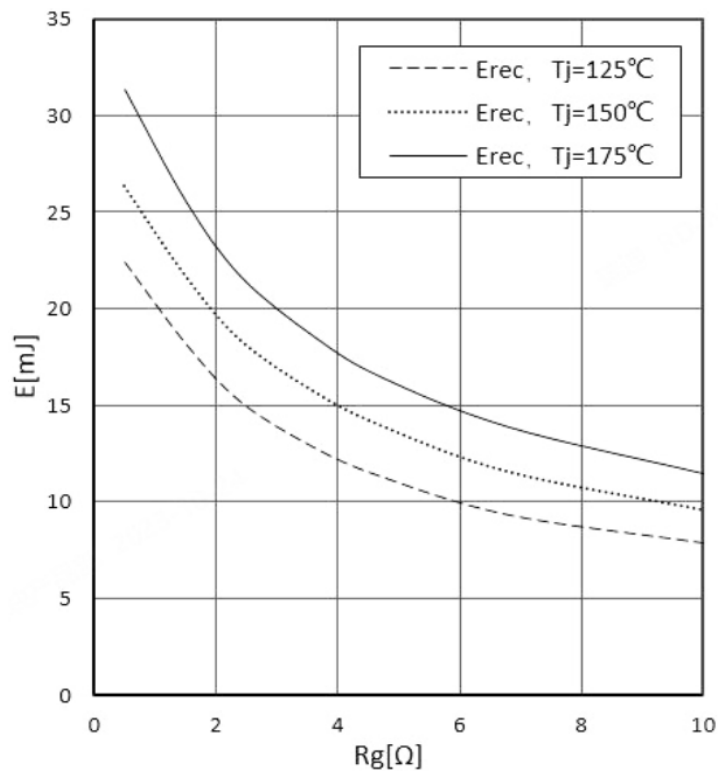
Switching losses Diode, Inverter (typical)

$$E_{rec} = f(I_F), R_{gon} = 0.5\Omega, V_{CE} = 600V$$



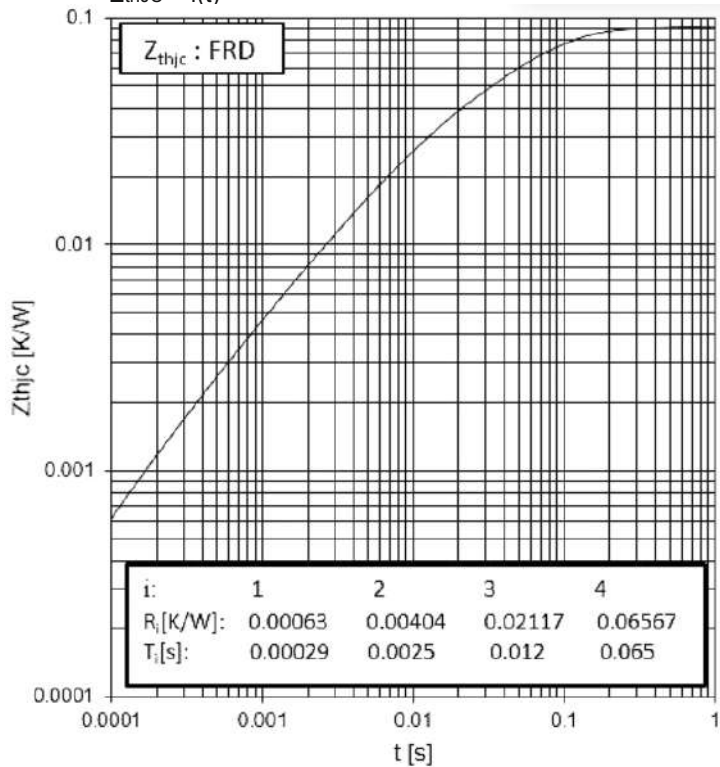
Switching losses Diode, Inverter (typical)

$$E_{rec} = f(R_g), I_F = 450A, V_{CE} = 600V$$



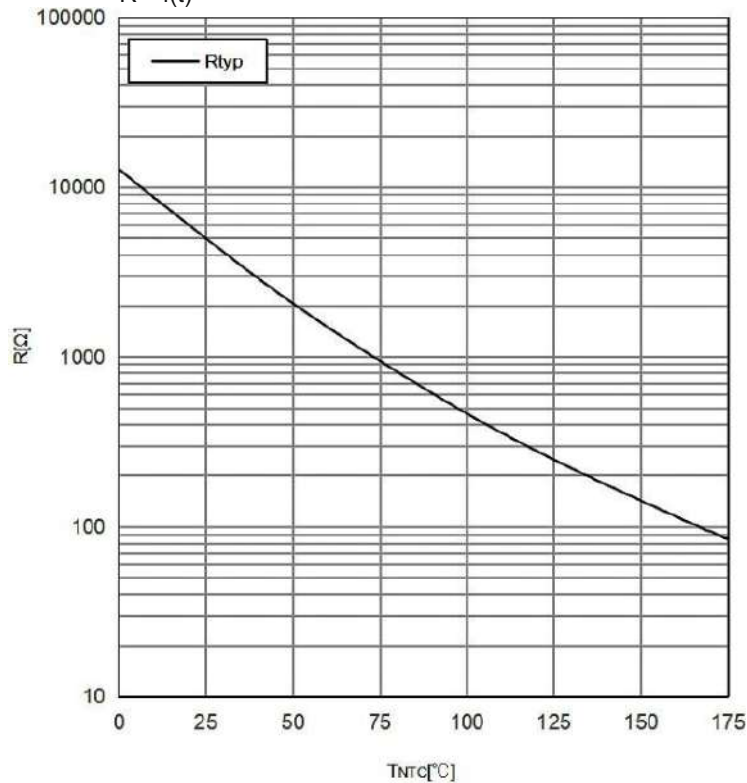
Transient thermal impedance IGBT, Inerter, IGBT

$$E_{thJC} = f(t)$$



NTC-Thermistor-temperature characteristic (typical)

$$R = f(t)$$



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