



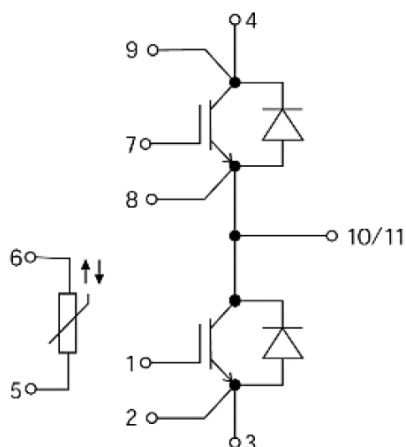
IGBT Modules

V_{CES}	1200V
I_C	450A

Applications

- Motion/servo control
- High frequency switching application
- UPS (Uninterruptible Power Supplies)
- Welding machine

Circuit



Features

- Low $V_{ce(sat)}$ with Trench technology
- Low switching losses especially E_{off}
- $V_{ce(sat)}$ with positive temperature coefficient
- High short circuit capability(10us)
- Including ultra fast & soft recovery anti-parallel FWD
- Low inductance package
- Maximum junction temperature 175°C

● IGBT

Absolute Maximum Ratings

Parameter	Symbol	Conditions	Value	Unit
Collector-Emitter Voltage	V_{CES}	$V_{GE} = 0\text{ V}$, $I_C = 1\text{ mA}$, $T_{vj} = 25\text{ °C}$	1200	V
Continuous Collector Current	I_C	$T_c = 110\text{ °C}$	450	A
Repetitive Peak Collector Current	I_{CRM}	$T_p = 1\text{ ms}$	900	A
Gate-Emitter Voltage	V_{GES}	$T_{vj} = 25\text{ °C}$	± 20	V
Total Power Dissipation	P_{tot}	$T_c = 25\text{ °C}$ $T_{vjmax} = 175\text{ °C}$	2630	W

Characteristic values

Parameter	Symbol	Conditions	Value			Unit
			Min.	Typ.	Max.	
Gate-emitter Threshold Voltage	$V_{GE(th)}$	$V_{GE} = V_{CE}$, $I_C = 22.5 \text{ mA}$, $T_{vj} = 25^\circ\text{C}$	5	6.2	7.5	V
Collector-Emitter Cut-off Current	I_{CES}	$V_{CE} = 1200 \text{ V}$, $V_{GE} = 0 \text{ V}$, $T_{vj} = 25^\circ\text{C}$			1.0	mA
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C = 450 \text{ A}$, $V_{GE} = 15 \text{ V}$, $T_{vj} = 25^\circ\text{C}$		1.6	2	V
		$I_C = 450 \text{ A}$, $V_{GE} = 15 \text{ V}$, $T_{vj} = 125^\circ\text{C}$		1.8		
		$I_C = 450 \text{ A}$, $V_{GE} = 15 \text{ V}$, $T_{vj} = 175^\circ\text{C}$		1.95		
Gate Charge	Q_G			3.5		uC
Internal Gate Resistance	R_{Gint}			1.8		Ω
Input Capacitance	C_{ies}	$V_{CE} = 25 \text{ V}$, $V_{GE} = 0 \text{ V}$, $f = 100 \text{ kHz}$, $T_{vj} = 25^\circ\text{C}$		29		nF
Reverse Transfer Capacitance	C_{res}			1.4		nF
Gate-Emitter leakage current	I_{GES}	$V_{CE} = 0 \text{ V}$, $V_{GE} = \pm 20 \text{ V}$, $T_{vj} = 25^\circ\text{C}$			500	nA
Turn-on Delay Time	$t_{d(on)}$	$I_C = 450 \text{ A}$, $V_{CC} = 600 \text{ V}$, $V_{GE} = \pm 15 \text{ V}$, $R_G = 1 \Omega$, $T_{vj} = 25^\circ\text{C}$		110		ns
Rise Time	t_r			55		ns
Turn-off Delay Time	$t_{d(off)}$	$I_C = 450 \text{ A}$, $V_{CC} = 600 \text{ V}$, $V_{GE} = \pm 15 \text{ V}$, $R_G = 2 \Omega$, $T_{vj} = 25^\circ\text{C}$		520		ns
Fall Time	t_f			190		ns
Energy Dissipation During Turn-on Time	E_{on}	$I_C = 450 \text{ A}$, $V_{CC} = 600 \text{ V}$, $V_{GE} = \pm 15 \text{ V}$, $R_G = 1 \Omega$, $T_{vj} = 25^\circ\text{C}$		30		mJ
Energy Dissipation During Turn-off Time	E_{off}	$I_C = 450 \text{ A}$, $V_{CC} = 600 \text{ V}$, $V_{GE} = \pm 15 \text{ V}$, $R_G = 2 \Omega$, $T_{vj} = 25^\circ\text{C}$		48		mJ
Turn-on Delay Time	$t_{d(on)}$	$I_C = 450 \text{ A}$, $V_{CE} = 600 \text{ V}$, $V_{GE} = \pm 15 \text{ V}$, $R_G = 1 \Omega$, $T_{vj} = 125^\circ\text{C}$		140		ns
Rise Time	t_r			65		ns
Turn-off Delay Time	$t_{d(off)}$	$I_C = 450 \text{ A}$, $V_{CE} = 600 \text{ V}$, $V_{GE} = \pm 15 \text{ V}$, $R_G = 2 \Omega$, $T_{vj} = 125^\circ\text{C}$		620		ns
Fall Time	t_f			300		ns
Energy Dissipation During Turn-on Time	E_{on}	$I_C = 450 \text{ A}$, $V_{CC} = 600 \text{ V}$, $V_{GE} = \pm 15 \text{ V}$, $R_G = 1 \Omega$, $T_{vj} = 125^\circ\text{C}$		54		mJ
Energy Dissipation During Turn-off Time	E_{off}	$I_C = 450 \text{ A}$, $V_{CC} = 600 \text{ V}$, $V_{GE} = \pm 15 \text{ V}$, $R_G = 2 \Omega$, $T_{vj} = 125^\circ\text{C}$		65		mJ
Turn-on Delay Time	$t_{d(on)}$	$I_C = 450 \text{ A}$, $V_{CE} = 600 \text{ V}$, $V_{GE} = \pm 15 \text{ V}$, $R_G = 1 \Omega$, $T_{vj} = 175^\circ\text{C}$		155		ns
Rise Time	t_r			70		ns
Turn-off Delay Time	$t_{d(off)}$	$I_C = 450 \text{ A}$, $V_{CC} = 600 \text{ V}$, $V_{GE} = \pm 15 \text{ V}$, $R_G = 2 \Omega$, $T_{vj} = 175^\circ\text{C}$		670		ns
Fall Time	t_f			360		ns
Energy Dissipation During Turn-on Time	E_{on}	$I_C = 450 \text{ A}$, $V_{CC} = 600 \text{ V}$, $V_{GE} = \pm 15 \text{ V}$, $R_G = 1 \Omega$, $T_{vj} = 175^\circ\text{C}$		71		mJ
Energy Dissipation During Turn-off Time	E_{off}	$I_C = 450 \text{ A}$, $V_{CC} = 600 \text{ V}$, $V_{GE} = \pm 15 \text{ V}$, $R_G = 2 \Omega$, $T_{vj} = 175^\circ\text{C}$		73		mJ
SC Data	I_{sc}	$T_p \leq 10 \text{ us}$, $V_{GE} = 15 \text{ V}$, $T_{vj} = 175^\circ\text{C}$, $V_{cc} = 800 \text{ V}$, $V_{CEM} \leq 1200 \text{ V}$		1350		A

● Diode

Absolute Maximum Ratings

Parameter	Symbol	Conditions	Value	Unit
Repetitive Peak Reverse Voltage	V_{RRM}	$T_{vj} = 25\text{ °C}$	1200	V
Continuous DC Forward Current	I_F		450	A
Repetitive Peak Forward Current	I_{FRM}	$t_p = 1\text{ ms}$	900	A
I^2t -value	I^2t	$V_R = 0\text{ V}$, $t_p = 10\text{ ms}$, $T_j = 150\text{ °C}$	16750	A ² s

Characteristic values

Parameter	Symbol	Conditions	Value			Unit
			Min.	Typ.	Max.	
Forward Voltage	V_F	$I_F = 450\text{ A}$, $T_{vj} = 25\text{ °C}$		1.95	2.5	V
		$I_F = 450\text{ A}$, $T_{vj} = 125\text{ °C}$		2.05		
		$I_F = 450\text{ A}$, $T_{vj} = 175\text{ °C}$		2.05		
Recovered Charge	Q_{rr}	$I_F = 450\text{ A}$ $V_R = 600\text{ V}$		24		uC
Peak Reverse Recovery Current	I_{rr}	$-di_F/dt = 3980\text{ A/us}$ $T_{vj} = 25\text{ °C}$		295		A
Reverse Recovery Energy	E_{rec}			15		mJ
Recovered Charge	Q_{rr}	$I_F = 450\text{ A}$ $V_R = 600\text{ V}$		60		uC
Peak Reverse Recovery Current	I_{rr}	$-di_F/dt = 3980\text{ A/us}$ $T_{vj} = 125\text{ °C}$		350		A
Reverse Recovery Energy	E_{rec}			24		mJ
Recovered Charge	Q_{rr}	$I_F = 450\text{ A}$ $V_R = 600\text{ V}$		85		uC
Peak Reverse Recovery Current	I_{rr}	$-di_F/dt = 3980\text{ A/us}$ $T_{vj} = 175\text{ °C}$		375		A
Reverse Recovery Energy	E_{rec}			32		mJ

● Module Characteristics

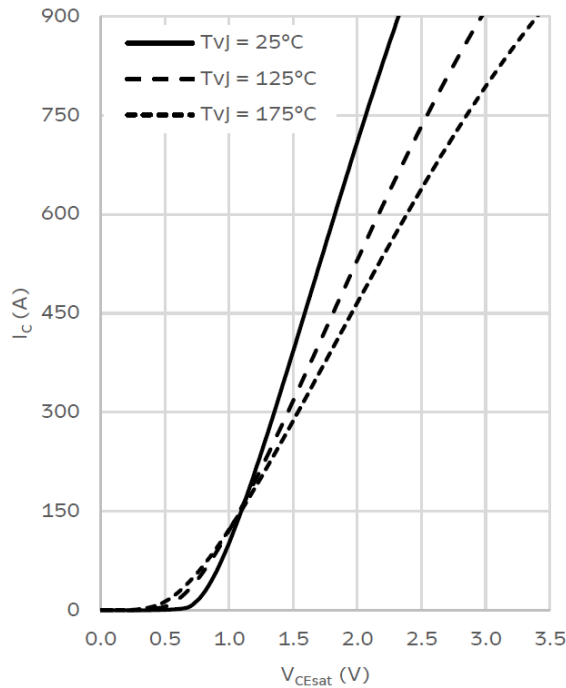
$T_c=25^{\circ}\text{C}$ unless otherwise specified

Parameter	Symbol	Conditions	Value			Unit
			Min.	Typ.	Max.	
Isolation voltage	V_{isol}	$t=1\text{ min, }f=50\text{ Hz}$			3400	V
Maximum Junction Temperature	T_{jmax}				175	$^{\circ}\text{C}$
Operating Junction Temperature	$T_{\text{vj(op)}}$		-40		175	$^{\circ}\text{C}$
Storage Temperature	T_{stg}		-40		125	$^{\circ}\text{C}$
Thermal Resistance Junction-to Case	$R_{\theta\text{JC}}$	per IGBT			0.057	K/W
		per Diode			0.098	
Comparative Tracking Index	CTI		200			
Thermal Resistance Case-to Sink	$R_{\theta\text{CS}}$	Conductive grease applied		0.032		K/W
Module Electrodes Torque	M_t	Recommended(M6)	3		6	N·m
Module-to-Sink Torque	M_s	Recommended(M5)	3		6	N·m
Mass	m			350		g

Characteristics

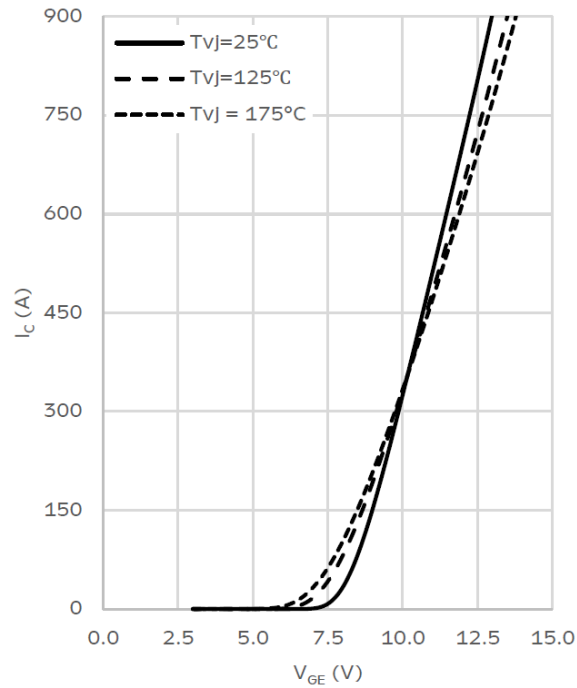
IGBT on-state characteristics (typical)

$I_C = f(V_{CE})$
 $V_{GE} = 15\text{ V}$



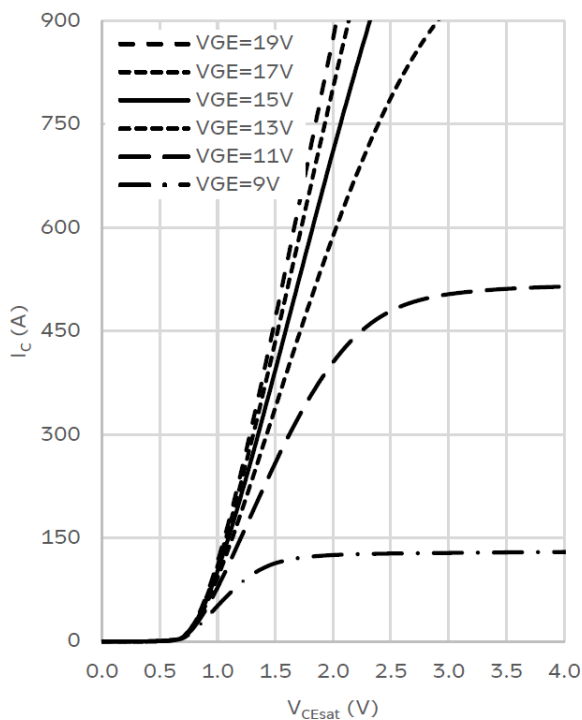
IGBT transfer characteristics (typical)

$I_C = f(V_{GE})$
 $V_{CE} = 20\text{ V}$



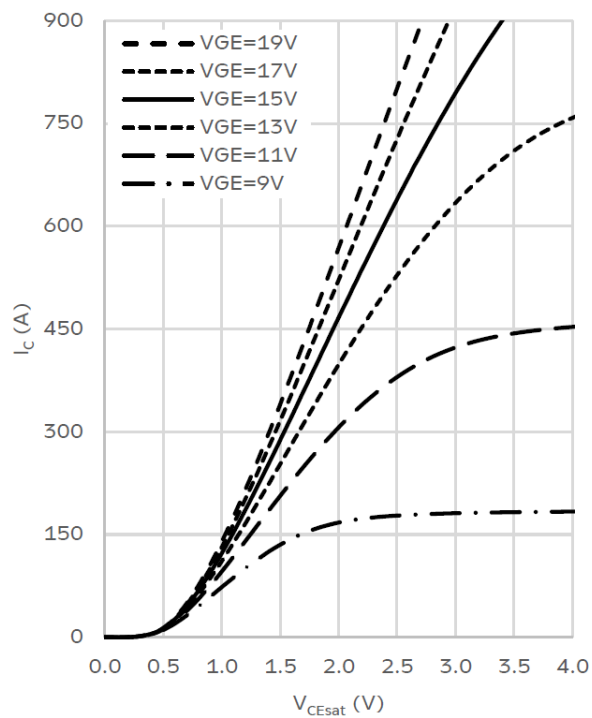
IGBT output characteristics (typical)

$I_C = f(V_{CE})$
 $T_J = 25^\circ\text{C}$



IGBT output characteristics (typical)

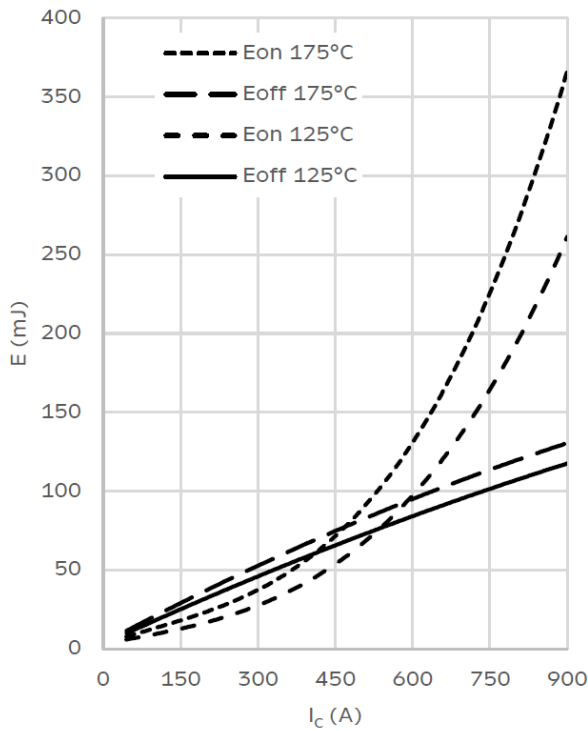
$I_C = f(V_{CE})$
 $T_J = 175^\circ\text{C}$



IGBT switching losses (typical)

$E = f(I_{CE})$

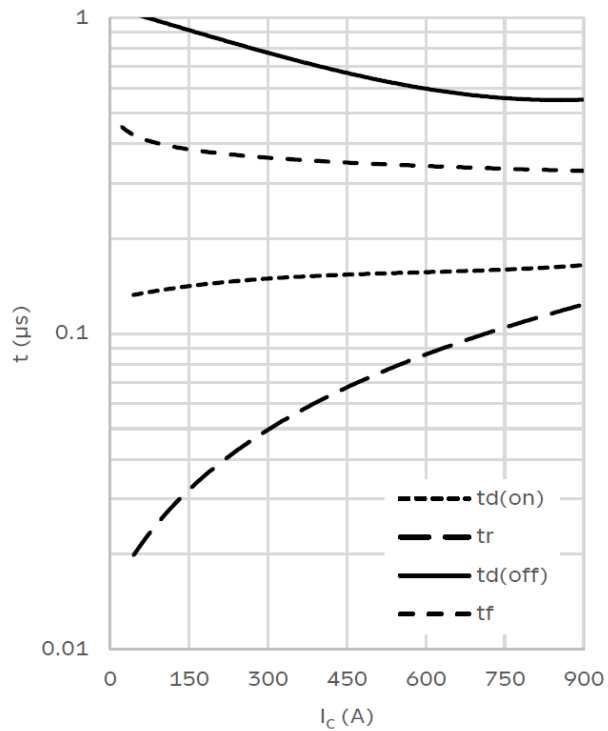
$V_{CE} = 600 \text{ V}$, $R_{Gon} = 1 \Omega$, $R_{Goff} = 2 \Omega$, $V_{GE} = -15/+15 \text{ V}$



IGBT switching times (typical)

$t = f(I_{CE})$, $T_{vj} = 175 \text{ °C}$

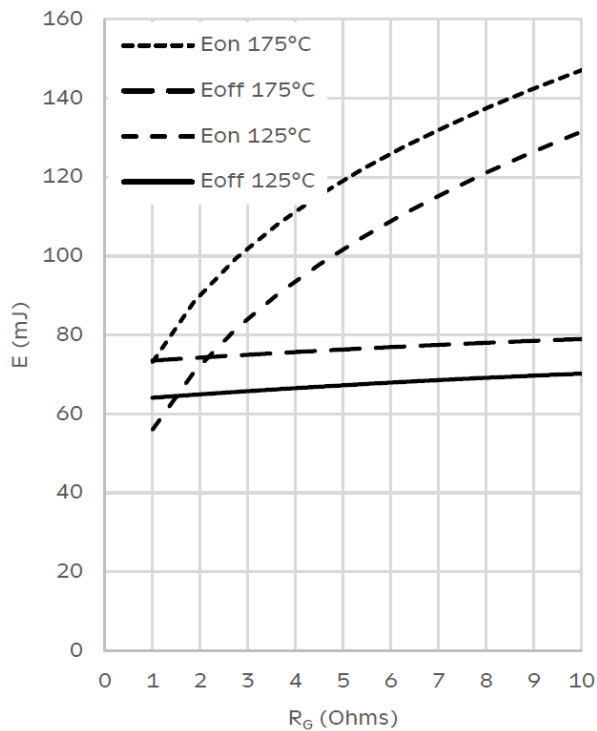
$V_{CE} = 600 \text{ V}$, $R_{Gon} = 1 \Omega$, $R_{Goff} = 2 \Omega$, $V_{GE} = -15/+15 \text{ V}$



IGBT switching losses (typical)

$E = f(R_G)$

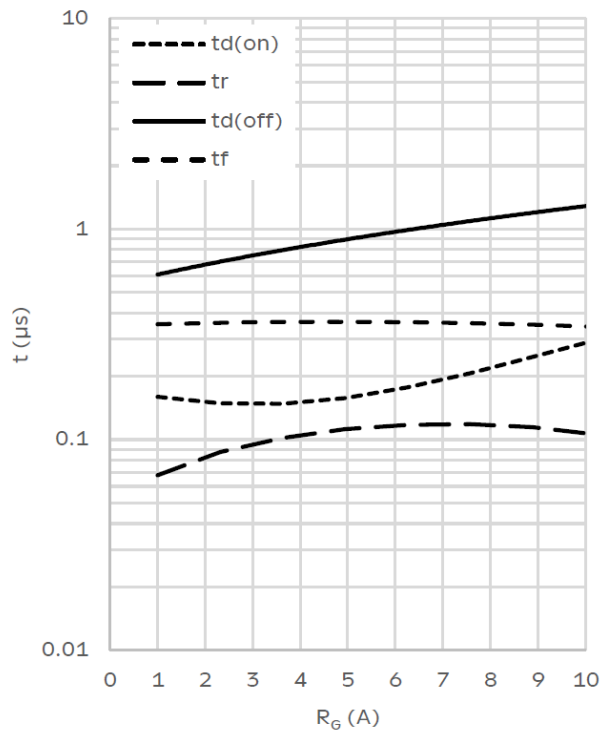
$V_{CE} = 600 \text{ V}$, $I_C = 450 \text{ A}$, $V_{GE} = -15/+15 \text{ V}$



IGBT switching times (typical)

$t = f(R_G)$, $T_{vj} = 175 \text{ °C}$

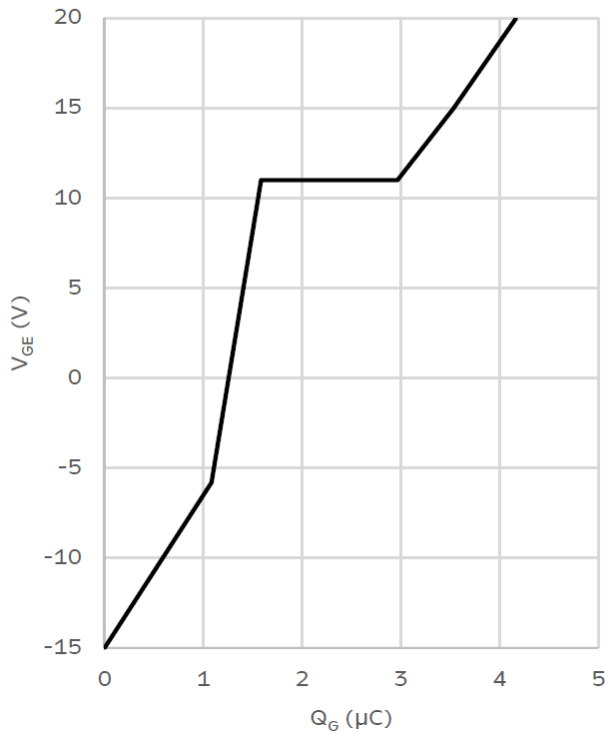
$V_{CE} = 600 \text{ V}$, $I_C = 450 \text{ A}$, $V_{GE} = -15/+15 \text{ V}$



IGBT gate charge (typical)

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

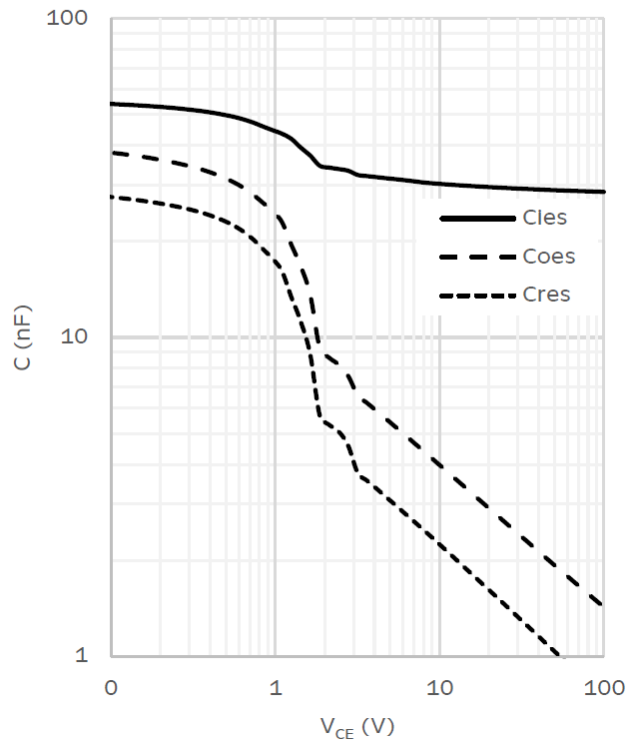
$V_{CE} = 600\text{ V}$, $I_C = 450\text{ A}$



Capacitance characteristics (typical)

$C = f(V_{CE})$, $T_{vj} = 25\text{ }^{\circ}\text{C}$

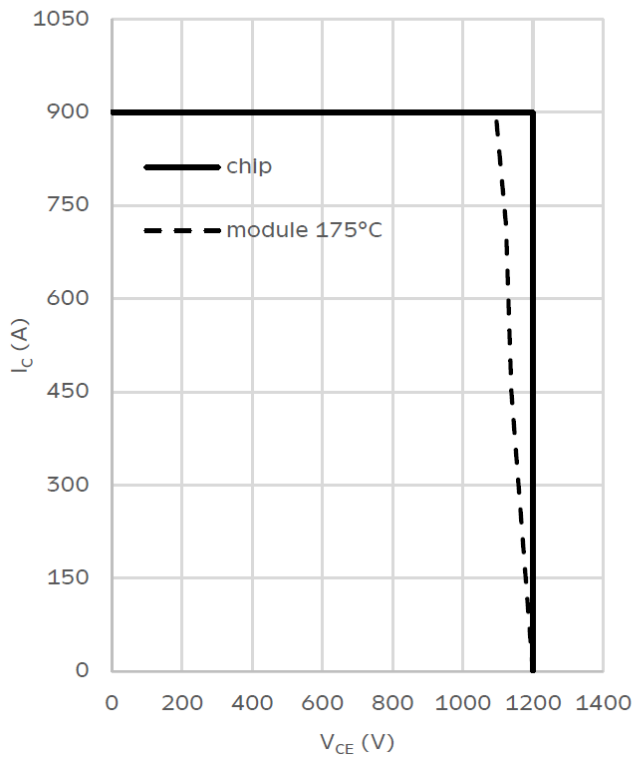
$f = 100\text{ kHz}$, $V_{GE} = 0\text{ V}$



IGBT RBSOA

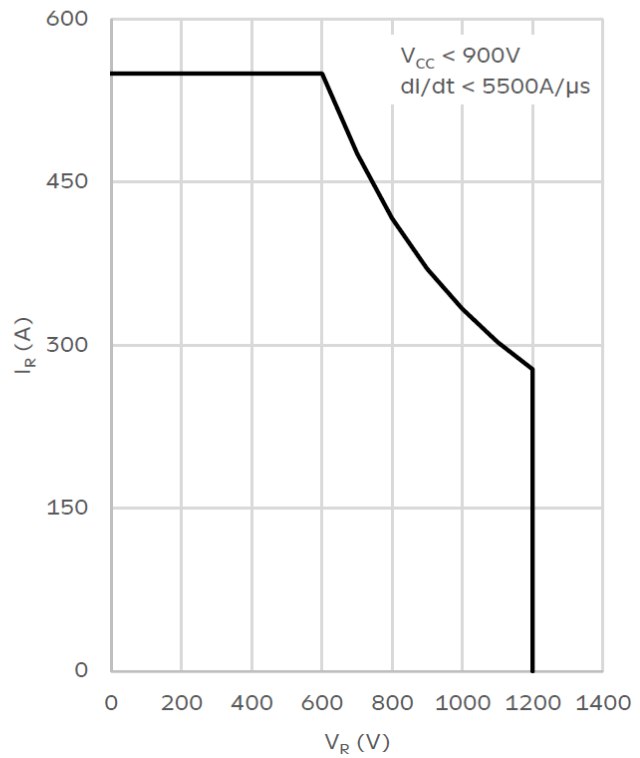
$I_C = f(V_{CEM})$

$R_{Goff} = 2\text{ }\Omega$, $V_{GE} = \pm 15\text{ V}$



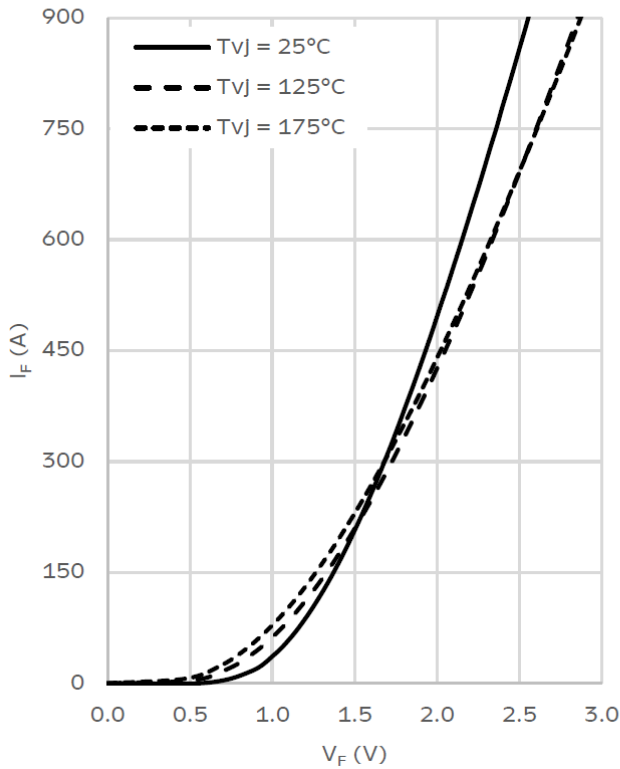
Diode SOA

$T_{vj} \leq 175\text{ }^{\circ}\text{C}$



Diode forward characteristic (typical)

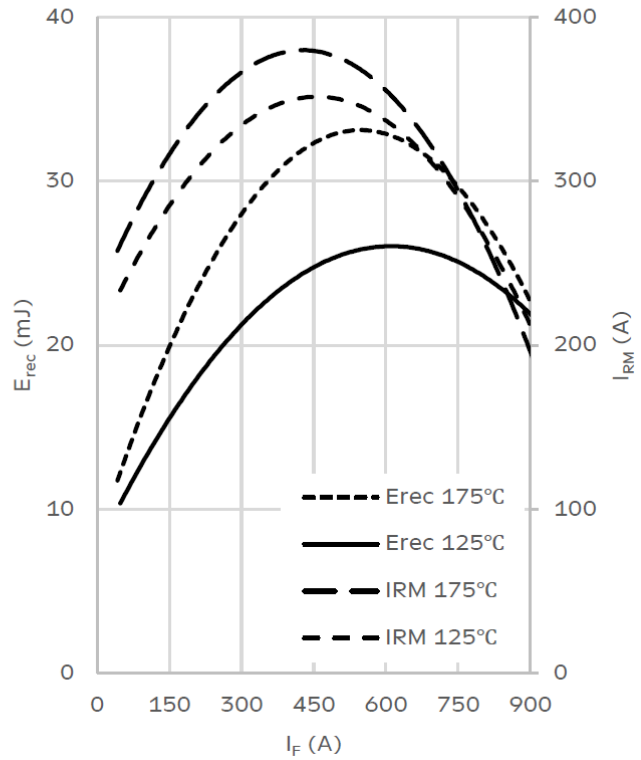
$$I_F = f(V_F)$$



Diode switching characteristics (typical)

$$E_{rec} = f(I_F), I_{RM} = f(I_F)$$

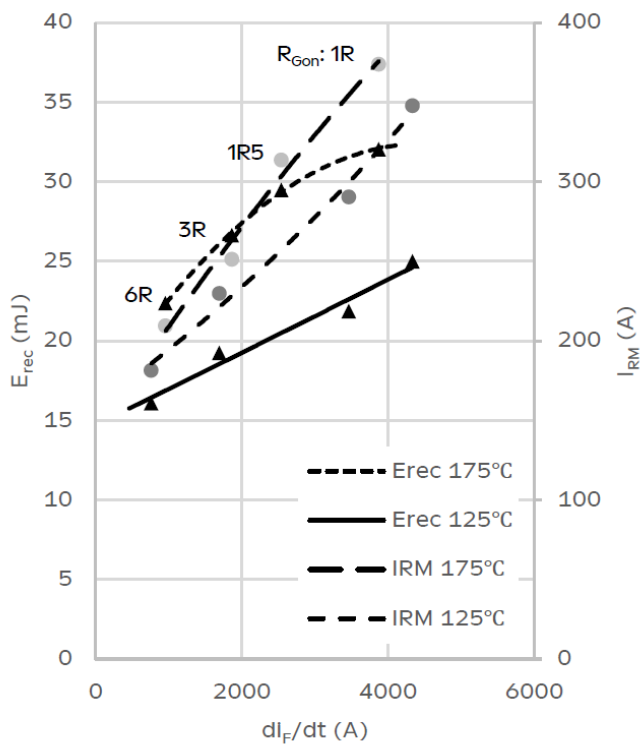
$$V_{DC} = 600 \text{ V}, R_{Gon} = 1 \Omega \text{ (IGBT)}, V_{GE} = -15/+15 \text{ V (IGBT)}$$



Diode switching characteristics (typical)

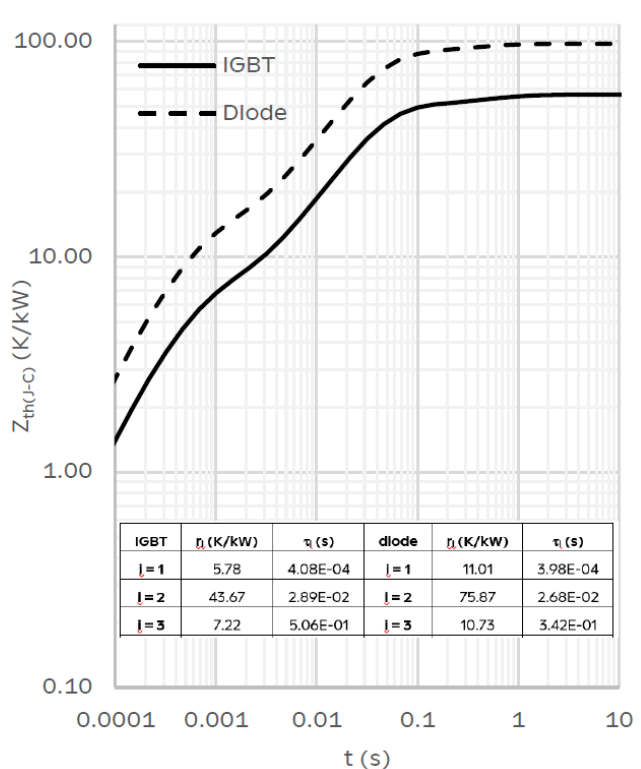
$$E_{rec} = f(dI_F/dt), I_{RM} = f(dI_F/dt)$$

$$V_{DC} = 600 \text{ V}, I_F = 450 \text{ A}, V_{GE} = -15/+15 \text{ V (IGBT)}$$

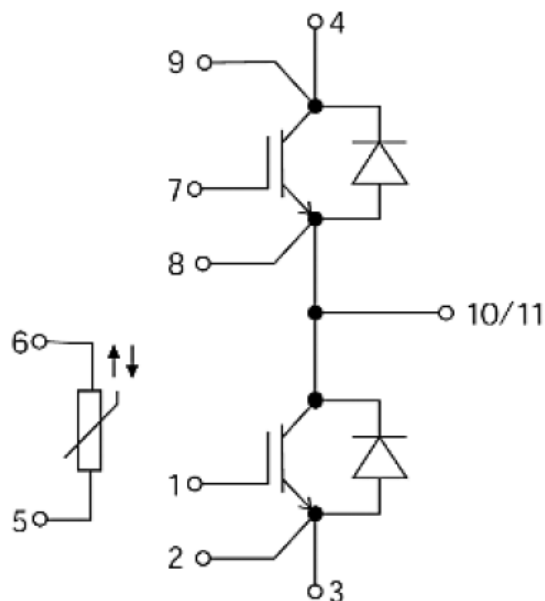


Thermal impedance

$$Z_{th(j-c)} = f(t)$$



● **Circuit Diagram**



● **Package Outline Information**

