

# STARPOWER

SEMICONDUCTOR

**IGBT**

## GD400CLX65C2S

**650V/400A chopper in one-package**

### General Description

STARPOWER IGBT Power Module provides ultra low conduction loss as well as short circuit ruggedness. They are designed for the applications such as inductive heating.

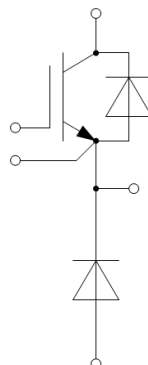
### Features

- Low  $V_{CE(sat)}$  Trench IGBT technology
- 6 $\mu$ s short circuit capability
- $V_{CE(sat)}$  with positive temperature coefficient
- Maximum junction temperature 175°C
- Low inductance case
- Fast & soft reverse recovery anti-parallel FWD
- Isolated copper baseplate using DBC technology

### Typical Applications

- Switching mode power supply
- Inductive heating
- Electronic welder

### Equivalent Circuit Schematic



**Absolute Maximum Ratings**  $T_C=25^{\circ}\text{C}$  unless otherwise noted**IGBT**

Symbol	Description	Values	Unit
$V_{CES}$	Collector-Emitter Voltage	650	V
$V_{GES}$	Gate-Emitter Voltage	$\pm 20$	V
$I_C$	Collector Current @ $T_C=25^{\circ}\text{C}$	509	A
	@ $T_C=65^{\circ}\text{C}$	400	
$I_{CM}$	Pulsed Collector Current $t_p=1\text{ms}$	800	A
$P_D$	Maximum Power Dissipation @ $T_j=175^{\circ}\text{C}$	1260	W

**Diode**

Symbol	Description	Values	Unit
$V_{RRM}$	Repetitive Peak Reverse Voltage	650	V
$I_F$	Diode Continuous Forward Current	400	A
$I_{FM}$	Diode Maximum Forward Current $t_p=1\text{ms}$	800	A

**Module**

Symbol	Description	Values	Unit
$T_{jmax}$	Maximum Junction Temperature	175	$^{\circ}\text{C}$
$T_{jop}$	Operating Junction Temperature	-40 to +150	$^{\circ}\text{C}$
$T_{STG}$	Storage Temperature Range	-40 to +125	$^{\circ}\text{C}$
$V_{ISO}$	Isolation Voltage RMS, $f=50\text{Hz}$ , $t=1\text{min}$	2500	V

**IGBT Characteristics**  $T_c=25^\circ\text{C}$  unless otherwise noted

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$V_{CE(sat)}$	Collector to Emitter Saturation Voltage	$I_C=400\text{A}, V_{GE}=15\text{V}, T_j=25^\circ\text{C}$		1.45	1.90	V
		$I_C=400\text{A}, V_{GE}=15\text{V}, T_j=125^\circ\text{C}$		1.60		
		$I_C=400\text{A}, V_{GE}=15\text{V}, T_j=150^\circ\text{C}$		1.70		
$V_{GE(th)}$	Gate-Emitter Threshold Voltage	$I_C=6.40\text{mA}, V_{CE}=V_{GE}, T_j=25^\circ\text{C}$	5.1	5.8	6.5	V
$I_{CES}$	Collector Cut-Off Current	$V_{CE}=V_{CES}, V_{GE}=0\text{V}, T_j=25^\circ\text{C}$			1.0	mA
$I_{GES}$	Gate-Emitter Leakage Current	$V_{GE}=V_{GES}, V_{CE}=0\text{V}, T_j=25^\circ\text{C}$			400	nA
$R_{Gint}$	Internal Gate Resistance			1.0		$\Omega$
$C_{ies}$	Input Capacitance	$V_{CE}=25\text{V}, f=1\text{MHz}, V_{GE}=0\text{V}$		46.4		nF
$C_{res}$	Reverse Transfer Capacitance			0.91		nF
$Q_G$	Gate Charge	$V_{GE}=-15\dots+15\text{V}$		2.77		$\mu\text{C}$
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=300\text{V}, I_C=400\text{A}, R_G=1.8\Omega, V_{GE}=\pm 15\text{V}, T_j=25^\circ\text{C}$		80		ns
$t_r$	Rise Time			64		ns
$t_{d(off)}$	Turn-Off Delay Time			368		ns
$t_f$	Fall Time			40		ns
$E_{on}$	Turn-On Switching Loss			2.3		mJ
$E_{off}$	Turn-Off Switching Loss			10.4		mJ
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=300\text{V}, I_C=400\text{A}, R_G=1.8\Omega, V_{GE}=\pm 15\text{V}, T_j=125^\circ\text{C}$		88		ns
$t_r$	Rise Time			64		ns
$t_{d(off)}$	Turn-Off Delay Time			400		ns
$t_f$	Fall Time			56		ns
$E_{on}$	Turn-On Switching Loss			3.4		mJ
$E_{off}$	Turn-Off Switching Loss			12.8		mJ
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=300\text{V}, I_C=400\text{A}, R_G=1.8\Omega, V_{GE}=\pm 15\text{V}, T_j=150^\circ\text{C}$		96		ns
$t_r$	Rise Time			64		ns
$t_{d(off)}$	Turn-Off Delay Time			400		ns
$t_f$	Fall Time			64		ns
$E_{on}$	Turn-On Switching Loss			3.6		mJ
$E_{off}$	Turn-Off Switching Loss			13.6		mJ
$I_{SC}$	SC Data	$t_p \leq 10\mu\text{s}, V_{GE}=15\text{V}, T_j=150^\circ\text{C}, V_{CC}=360\text{V}, V_{CEM} \leq 650\text{V}$		2000		A

**Diode Characteristics**  $T_C=25^\circ\text{C}$  unless otherwise noted

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Units
$V_F$	Diode Forward Voltage	$I_F=400\text{A}, V_{GE}=0\text{V}, T_j=25^\circ\text{C}$		1.55	2.00	V
		$I_F=400\text{A}, V_{GE}=0\text{V}, T_j=125^\circ\text{C}$		1.50		
		$I_F=400\text{A}, V_{GE}=0\text{V}, T_j=150^\circ\text{C}$		1.45		
$Q_r$	Recovered Charge	$V_R=300\text{V}, I_F=400\text{A},$ $-di/dt=6050\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=25^\circ\text{C}$		19.8		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			231		A
$E_{rec}$	Reverse Recovery Energy			3.96		mJ
$Q_r$	Recovered Charge	$V_R=300\text{V}, I_F=400\text{A},$ $-di/dt=6050\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=125^\circ\text{C}$		33.0		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			308		A
$E_{rec}$	Reverse Recovery Energy			7.98		mJ
$Q_r$	Recovered Charge	$V_R=300\text{V}, I_F=400\text{A},$ $-di/dt=6050\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=150^\circ\text{C}$		37.4		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			330		A
$E_{rec}$	Reverse Recovery Energy			9.13		mJ

**Module Characteristics**  $T_C=25^\circ\text{C}$  unless otherwise noted

Symbol	Parameter	Min.	Typ.	Max.	Unit
$L_{CE}$	Stray Inductance		15		nH
$R_{CC'+EE'}$	Module Lead Resistance, Terminal to Chip		0.25		m $\Omega$
$R_{thJC}$	Junction-to-Case (per IGBT)			0.119	K/W
	Junction-to-Case (per Diode)			0.218	
$R_{thCH}$	Case-to-Heatsink (per IGBT)		0.021		K/W
	Case-to-Heatsink (per Diode)		0.038		
	Case-to-Heatsink (per Module)		0.010		
M	Terminal Connection Torque, Screw M6	2.5		5.0	N.m
	Mounting Torque, Screw M6	3.0		5.0	
G	Weight of Module		300		g

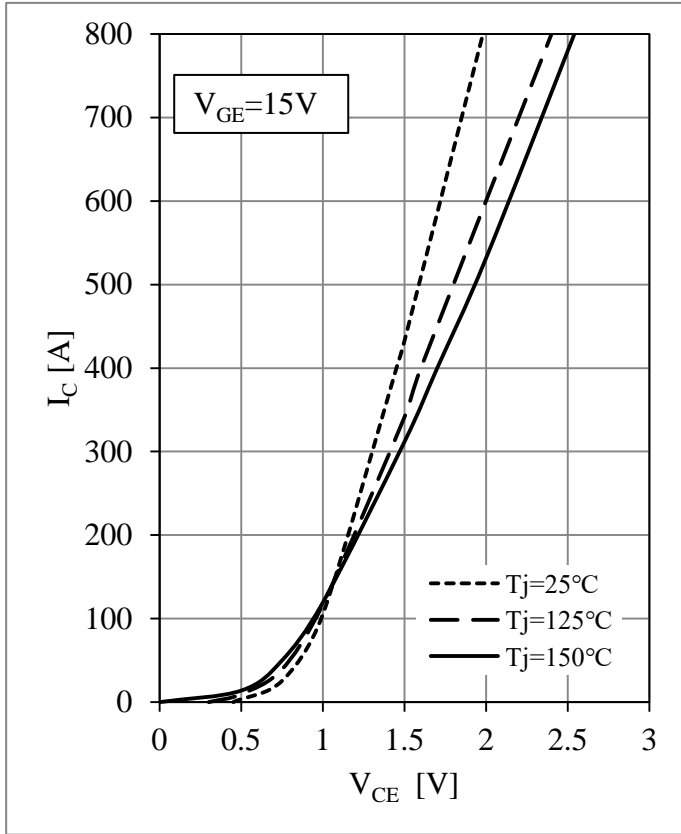


Fig 1. IGBT Output Characteristics

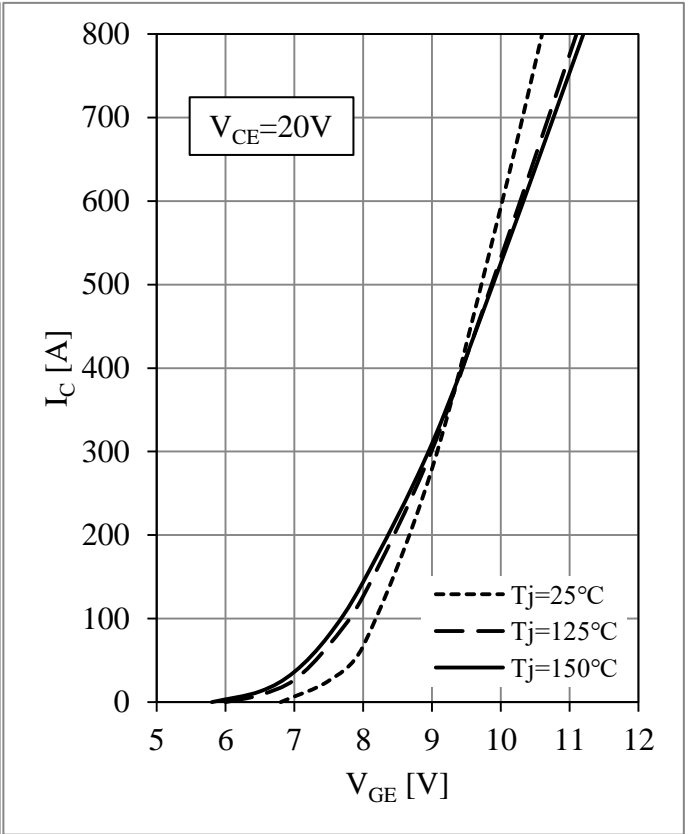


Fig 2. IGBT Transfer Characteristics

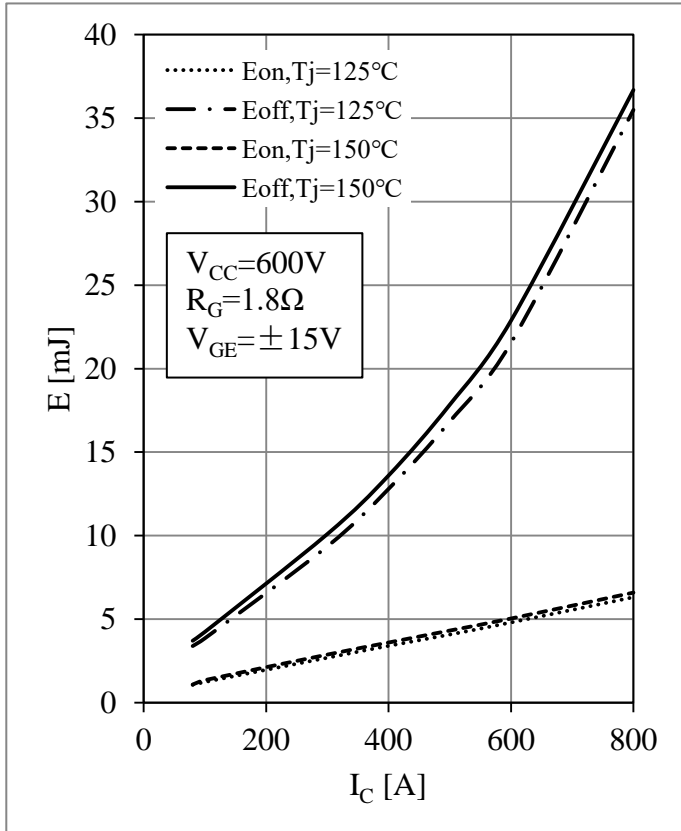


Fig 3. IGBT Switching Loss vs.  $I_C$

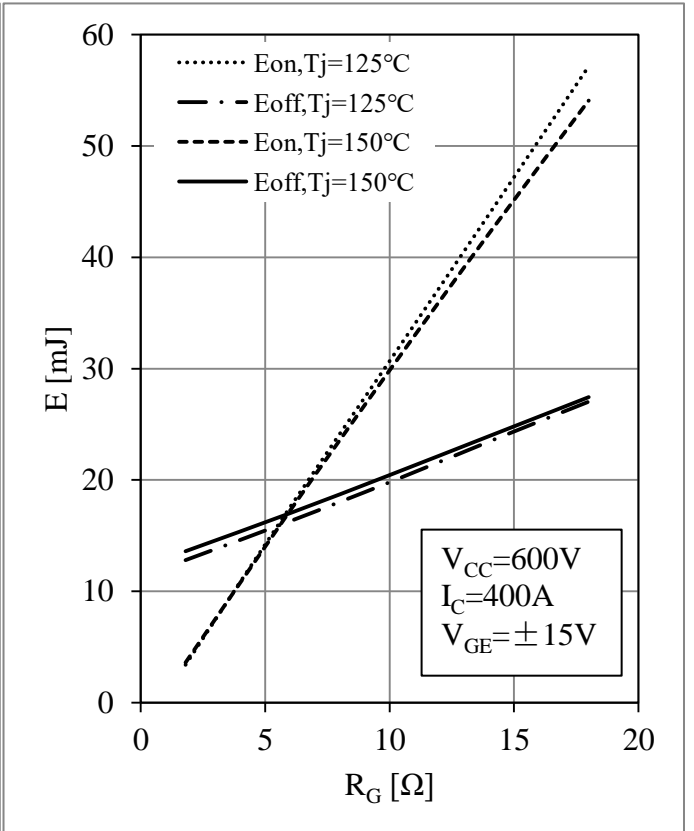


Fig 4. IGBT Switching Loss vs.  $R_G$

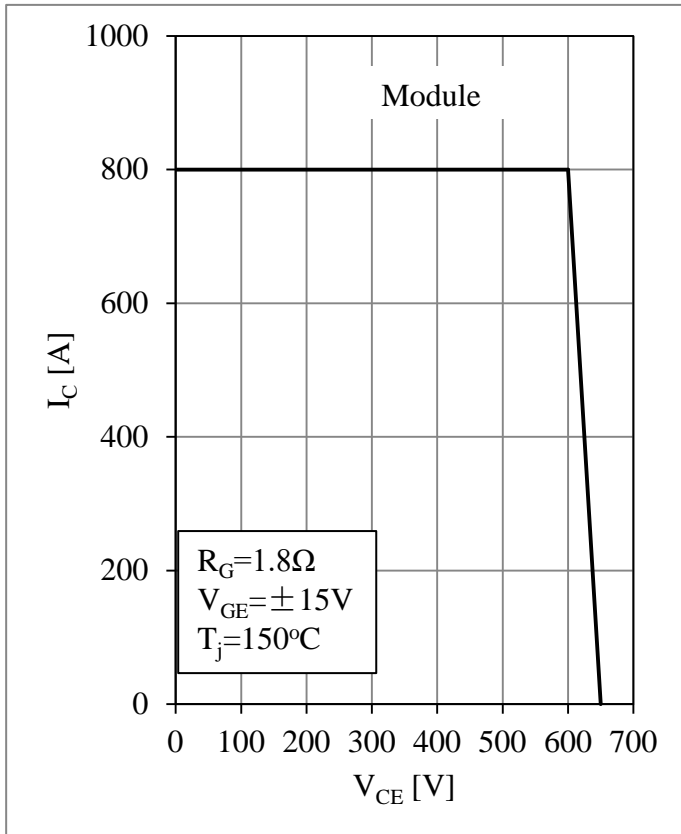


Fig 5. RBSOA

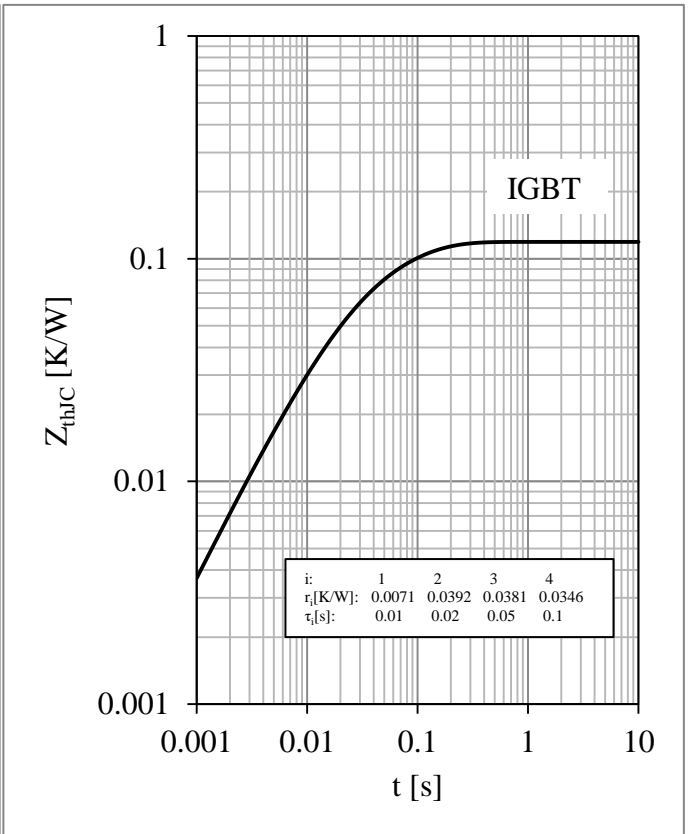


Fig 6. IGBT Transient Thermal Impedance

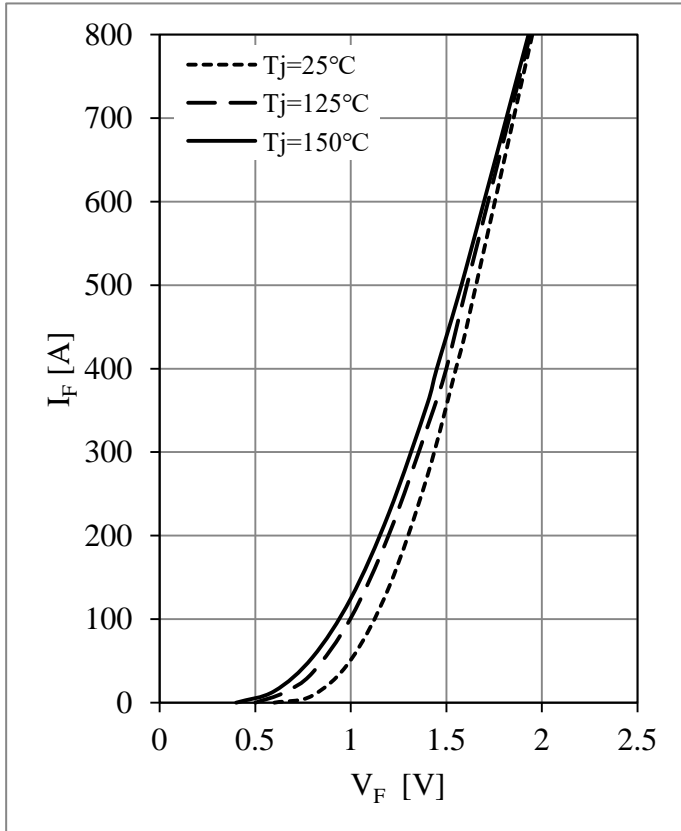


Fig 7. Diode Forward Characteristics

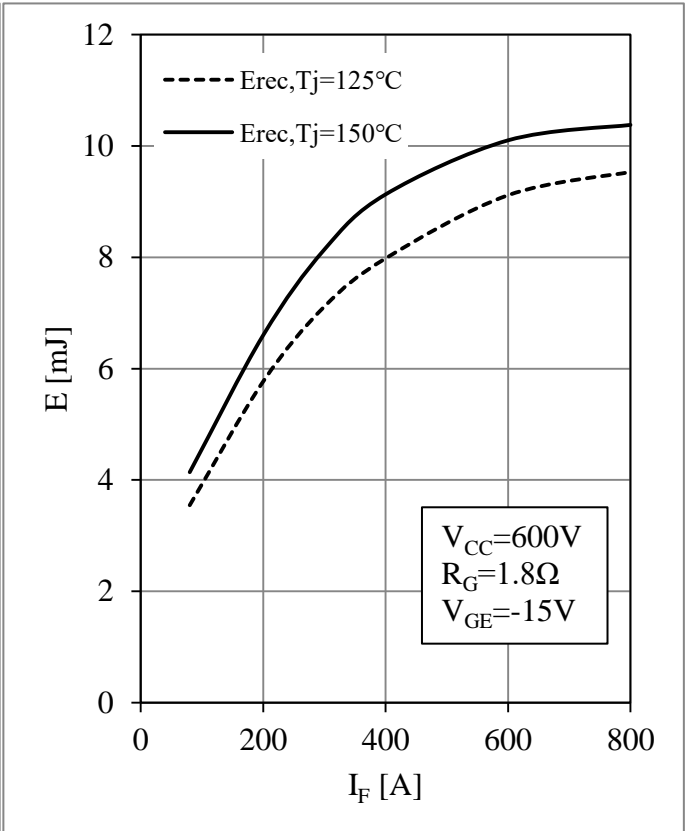


Fig 8. Diode Switching Loss vs.  $I_F$

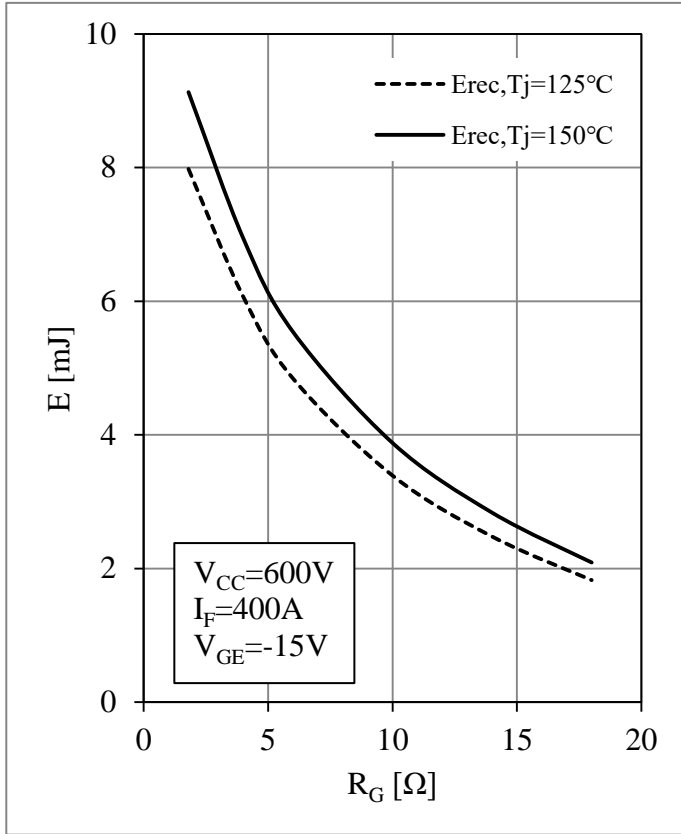


Fig 9. Diode Switching Loss vs.  $R_G$

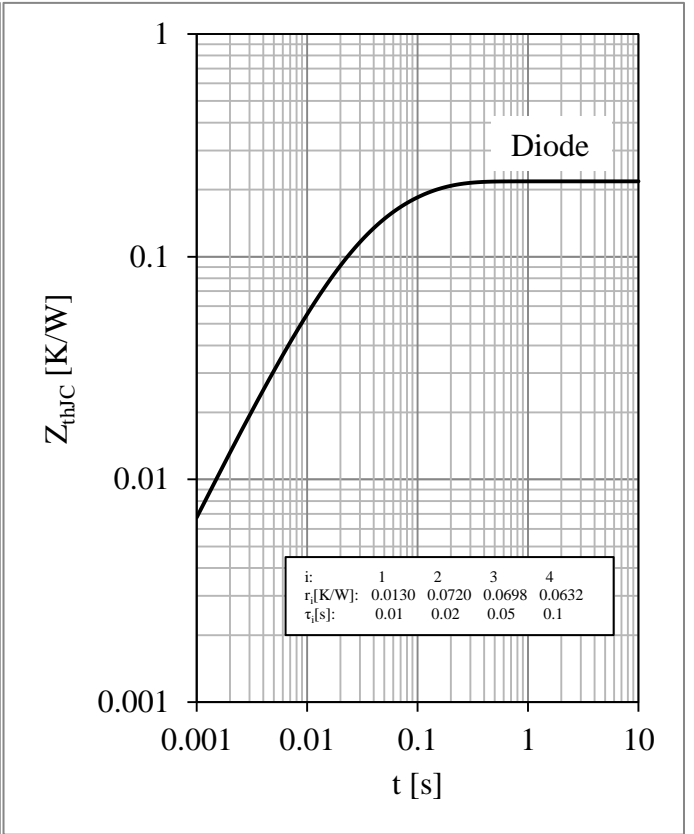


Fig 10. Diode Transient Thermal Impedance





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