

STARPOWER

SEMICONDUCTOR

IGBT

GD400MLX65B3ST

650V/400A 3-level 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 3-level-applications.

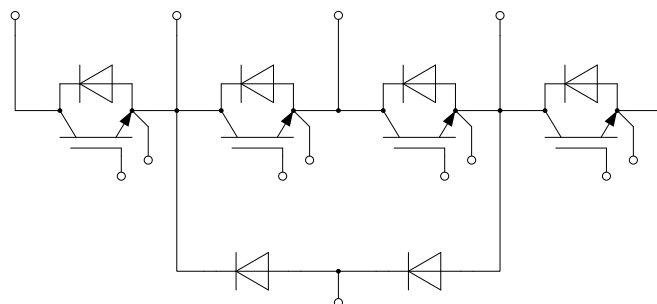
Features

- Low $V_{CE(sat)}$ trench IGBT technology
- 6 μ 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

- Solar power
- UPS
- 3-level-applications

Equivalent Circuit Schematic



Absolute Maximum Ratings $T_C=25^{\circ}\text{C}$ unless otherwise noted**T1-T4 IGBT**

Symbol	Description	Value	Unit
V_{CES}	Collector-Emitter Voltage	650	V
V_{GES}	Gate-Emitter Voltage	± 20	V
I_C	Collector Current @ $T_C=25^{\circ}\text{C}$	484	A
	@ $T_C=60^{\circ}\text{C}$	400	A
I_{CM}	Pulsed Collector Current $t_p=1\text{ms}$	800	A
P_D	Maximum Power Dissipation @ $T_j=175^{\circ}\text{C}$	1136	W

D1-D4 Diode

Symbol	Description	Value	Unit
V_{RRM}	Repetitive Peak Reverse Voltage	650	V
I_F	Diode Continuous Forward Current	300	A
I_{FM}	Diode Maximum Forward Current $t_p=1\text{ms}$	600	A

D5,D6 Diode

Symbol	Description	Value	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	Value	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

T1-T4 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	1.80	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		Ω
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		μC
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=300\text{V}, I_C=400\text{A}, R_G=2.0\Omega, V_{GE}=\pm 15\text{V}, T_j=25^{\circ}\text{C}$		134		ns
t_r	Rise Time			64		ns
$t_{d(off)}$	Turn-Off Delay Time			286		ns
t_f	Fall Time			60		ns
E_{on}	Turn-On Switching Loss			0.86		mJ
E_{off}	Turn-Off Switching Loss			9.77		mJ
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=300\text{V}, I_C=400\text{A}, R_G=2.0\Omega, V_{GE}=\pm 15\text{V}, T_j=125^{\circ}\text{C}$		148		ns
t_r	Rise Time			68		ns
$t_{d(off)}$	Turn-Off Delay Time			307		ns
t_f	Fall Time			75		ns
E_{on}	Turn-On Switching Loss			1.63		mJ
E_{off}	Turn-Off Switching Loss			11.8		mJ
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=300\text{V}, I_C=400\text{A}, R_G=2.0\Omega, V_{GE}=\pm 15\text{V}, T_j=150^{\circ}\text{C}$		160		ns
t_r	Rise Time			71		ns
$t_{d(off)}$	Turn-Off Delay Time			312		ns
t_f	Fall Time			84		ns
E_{on}	Turn-On Switching Loss			2.08		mJ
E_{off}	Turn-Off Switching Loss			12.3		mJ
I_{SC}	SC Data	$t_P \leq 6\mu\text{s}, V_{GE}=15\text{V}, T_j=150^{\circ}\text{C}, V_{CC}=360\text{V}, V_{CEM} \leq 650\text{V}$		2000		A

D1-D4 Diode Characteristics $T_C=25^{\circ}\text{C}$ unless otherwise noted

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_F	Diode Forward Voltage	$I_F=300\text{A}, V_{GE}=0\text{V}, T_j=25^{\circ}\text{C}$		1.55	2.00	V
		$I_F=300\text{A}, V_{GE}=0\text{V}, T_j=125^{\circ}\text{C}$		1.50		
		$I_F=300\text{A}, V_{GE}=0\text{V}, T_j=150^{\circ}\text{C}$		1.45		
Q_r	Recovered Charge	$V_R=300\text{V}, I_F=300\text{A},$ $-di/dt=5230\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=25^{\circ}\text{C}$		6.64		μC
I_{RM}	Peak Reverse Recovery Current			192		A
E_{rec}	Reverse Recovery Energy			2.52		mJ
Q_r	Recovered Charge	$V_R=300\text{V}, I_F=300\text{A},$ $-di/dt=5200\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=125^{\circ}\text{C}$		11.9		μC
I_{RM}	Peak Reverse Recovery Current			240		A
E_{rec}	Reverse Recovery Energy			4.76		mJ
Q_r	Recovered Charge	$V_R=300\text{V}, I_F=300\text{A},$ $-di/dt=5190\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=150^{\circ}\text{C}$		14.5		μC
I_{RM}	Peak Reverse Recovery Current			256		A
E_{rec}	Reverse Recovery Energy			5.37		mJ

D5,D6 Diode Characteristics $T_C=25^{\circ}\text{C}$ unless otherwise noted

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_F	Diode Forward Voltage	$I_F=400\text{A}, V_{GE}=0\text{V}, T_j=25^{\circ}\text{C}$		1.65	2.10	V
		$I_F=400\text{A}, V_{GE}=0\text{V}, T_j=125^{\circ}\text{C}$		1.65		
		$I_F=400\text{A}, V_{GE}=0\text{V}, T_j=150^{\circ}\text{C}$		1.65		
Q_r	Recovered Charge	$V_R=400\text{V}, I_F=400\text{A},$ $-di/dt=4700\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=25^{\circ}\text{C}$		10.5		μC
I_{RM}	Peak Reverse Recovery Current			216		A
E_{rec}	Reverse Recovery Energy			3.52		mJ
Q_r	Recovered Charge	$V_R=400\text{V}, I_F=400\text{A},$ $-di/dt=4300\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=150^{\circ}\text{C}$		21		μC
I_{RM}	Peak Reverse Recovery Current			276		A
E_{rec}	Reverse Recovery Energy			7.80		mJ
Q_r	Recovered Charge	$V_R=400\text{V}, I_F=400\text{A},$ $-di/dt=4200\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=175^{\circ}\text{C}$		23.6		μC
I_{RM}	Peak Reverse Recovery Current			288		A
E_{rec}	Reverse Recovery Energy			8.84		mJ

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

Symbol	Parameter	Min.	Typ.	Max.	Unit
R_{thJC}	Junction-to-Case (per T1-T4 IGBT)			0.132	K/W
	Junction-to-Case (per D1-D4 Diode)			0.273	
	Junction-to-Case (per D5,D6 Diode)			0.228	
R_{thCH}	Case-to-Heatsink (per T1-T4 IGBT)		0.071		K/W
	Case-to-Heatsink (per D1-D4 Diode)		0.147		
	Case-to-Heatsink (per D5,D6 Diode)		0.122		
	Case-to-Heatsink (per Module)		0.010		
M	Terminal Connection Torque, Screw M5	2.5		5.0	N.m
	Mounting Torque, Screw M6	3.0		5.0	
G	Weight of Module		340		g

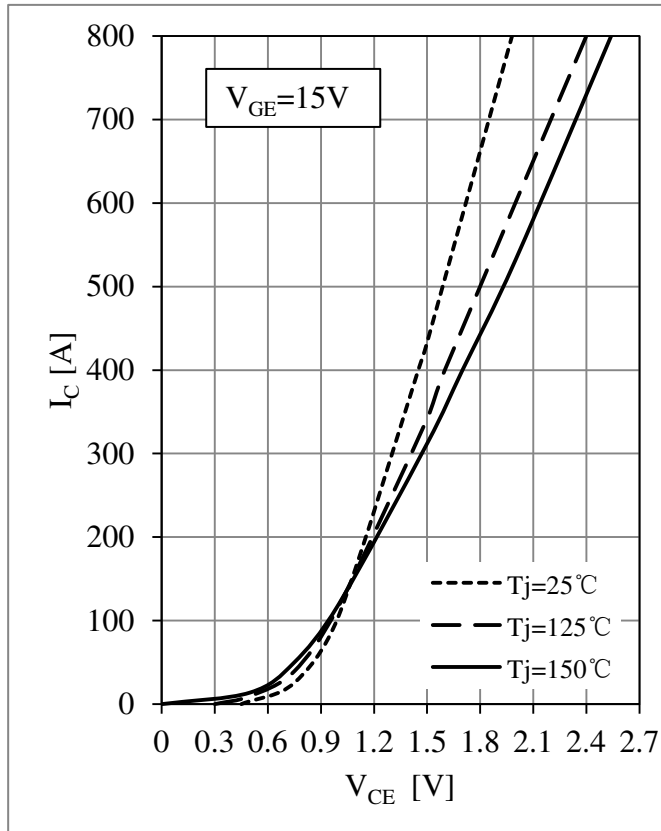


Fig 1. T1-T4 IGBT Output Characteristics

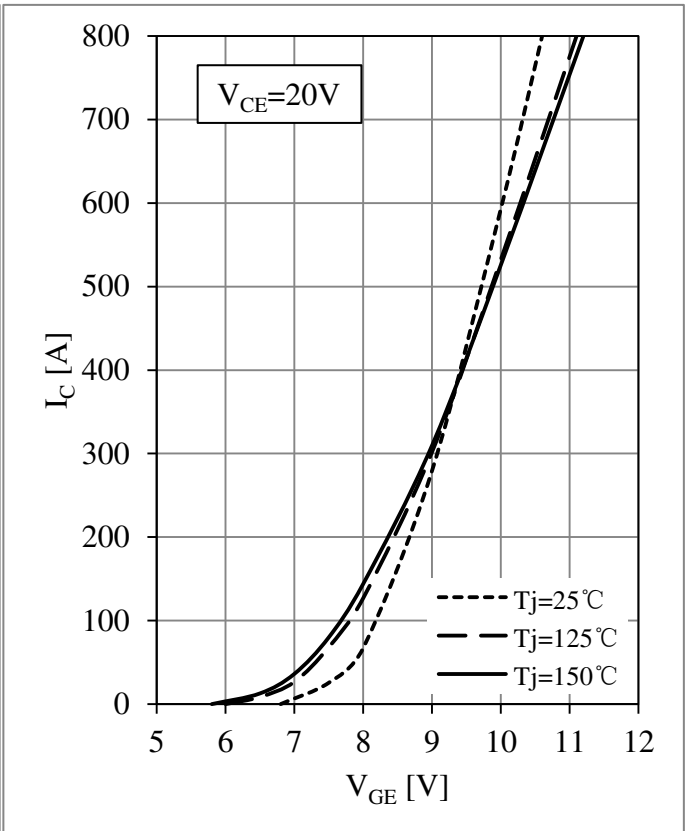
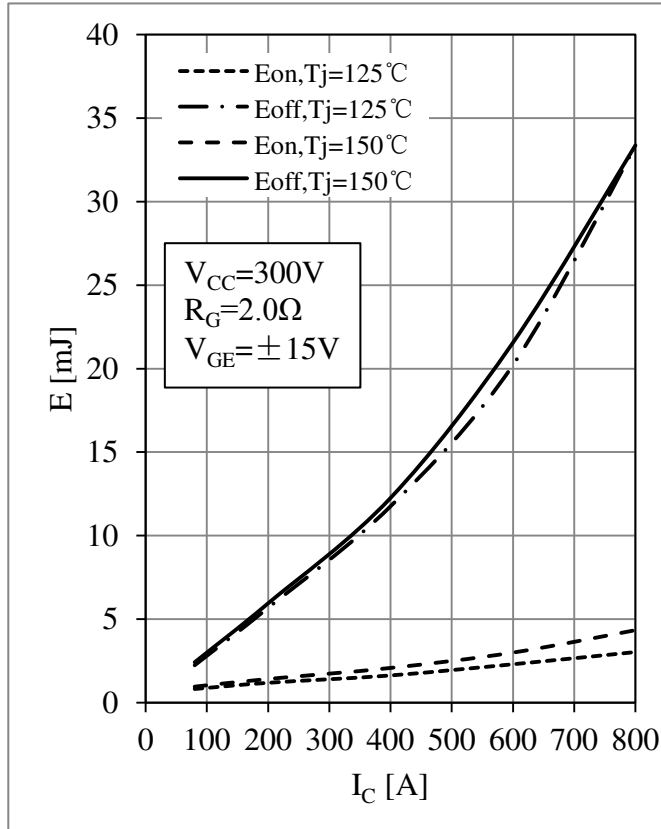
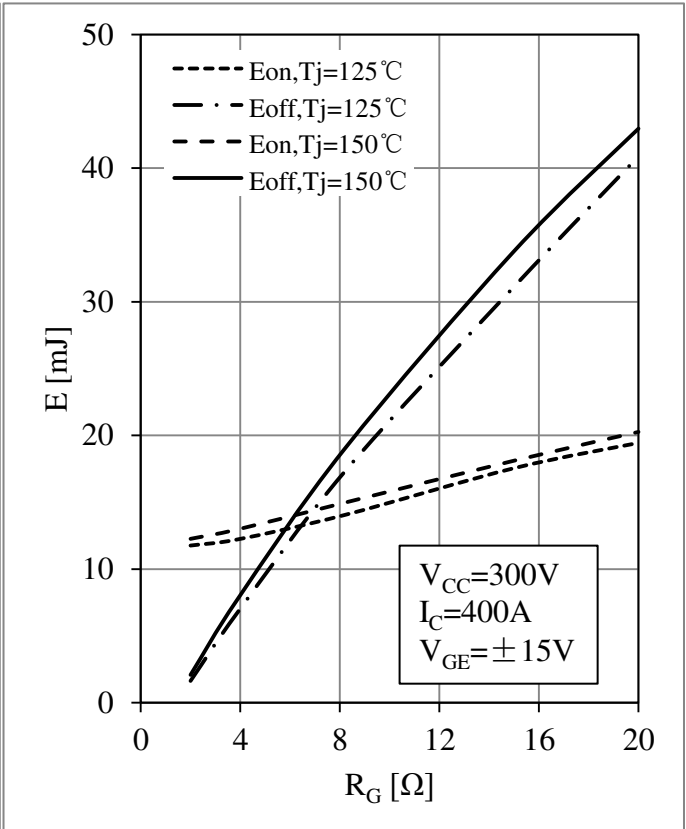


Fig 2. T1-T4 IGBT Transfer Characteristics

Fig 3. T1-T4 IGBT Switching Loss vs. I_C Fig 4. T1-T4 IGBT Switching Loss vs. R_G

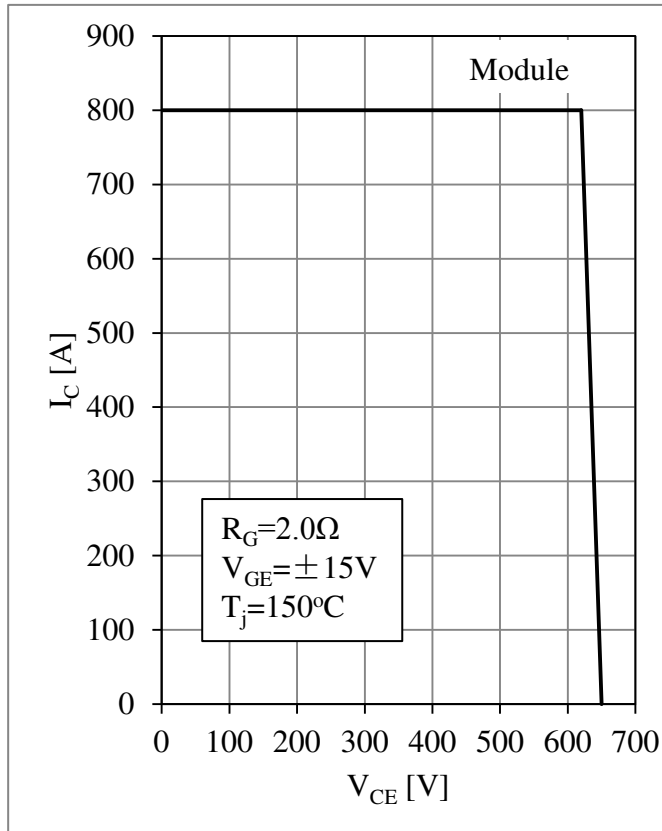


Fig 5. T1-T4 RBSOA

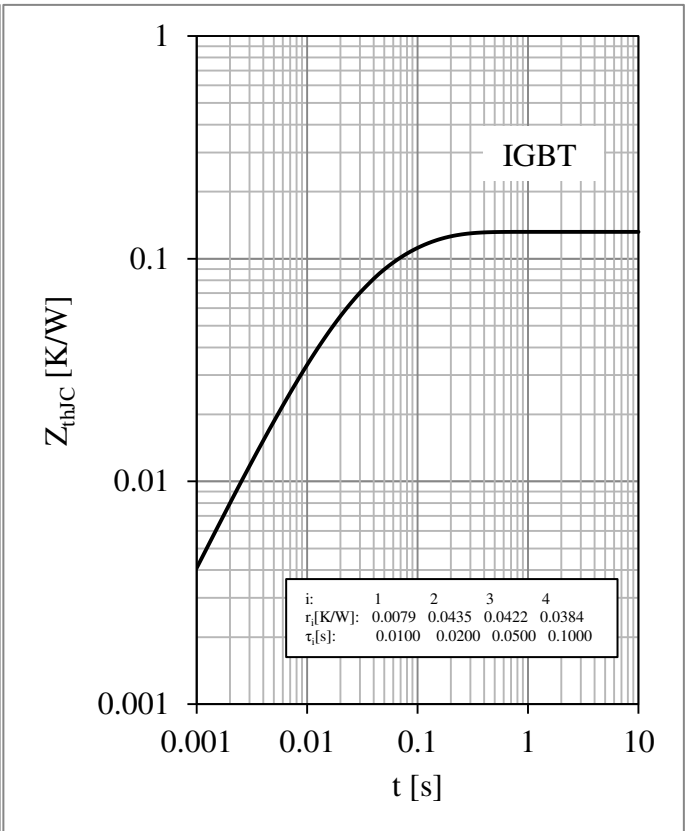


Fig 6. T1-T4 IGBT Transient Thermal Impedance

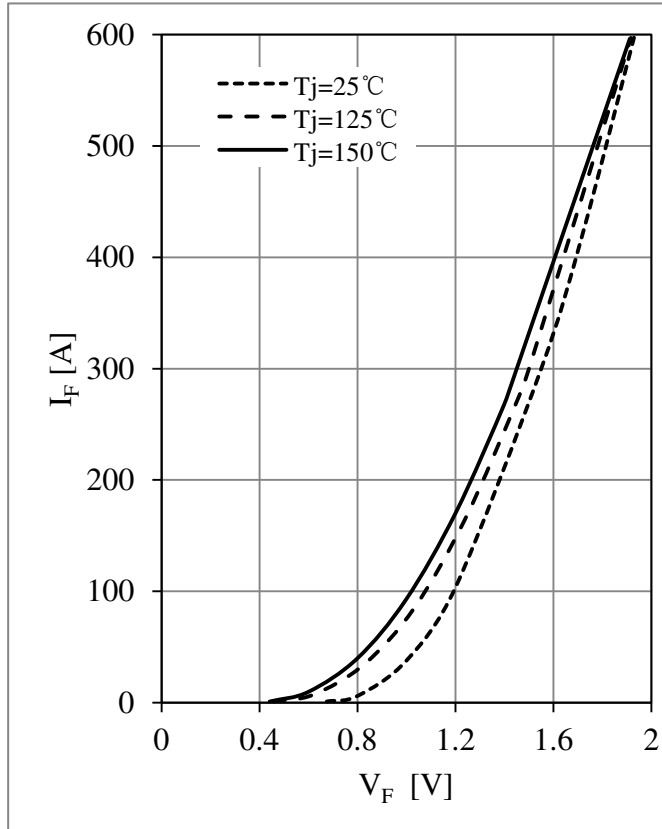
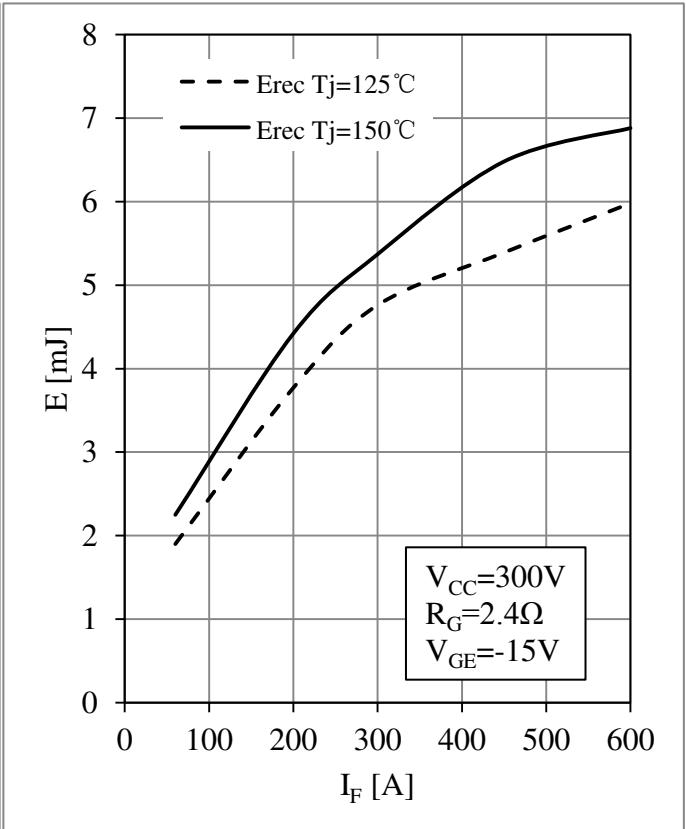


Fig 7. D1-D4 Diode Forward Characteristics

Fig 8. D1-D4 Diode Switching Loss vs. I_F

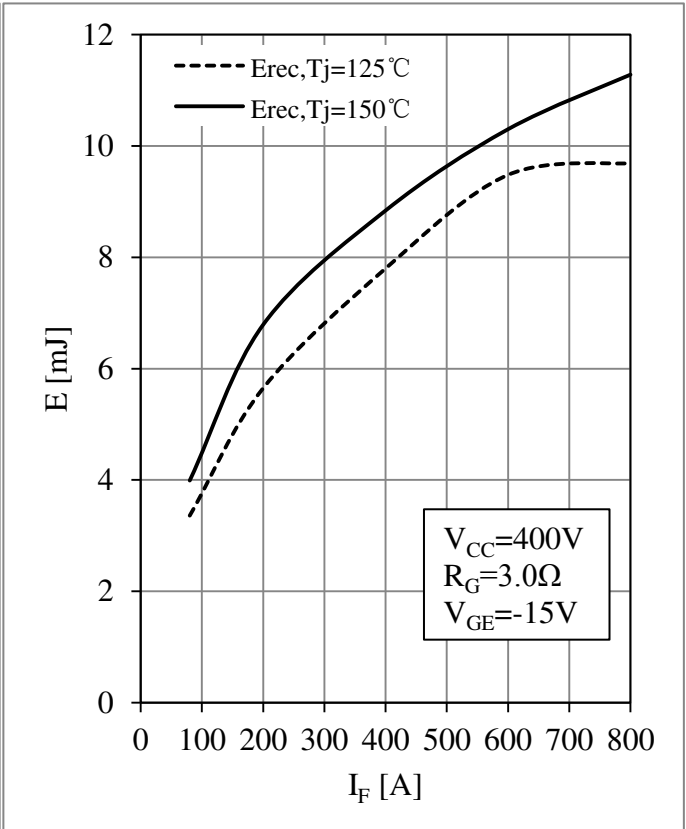
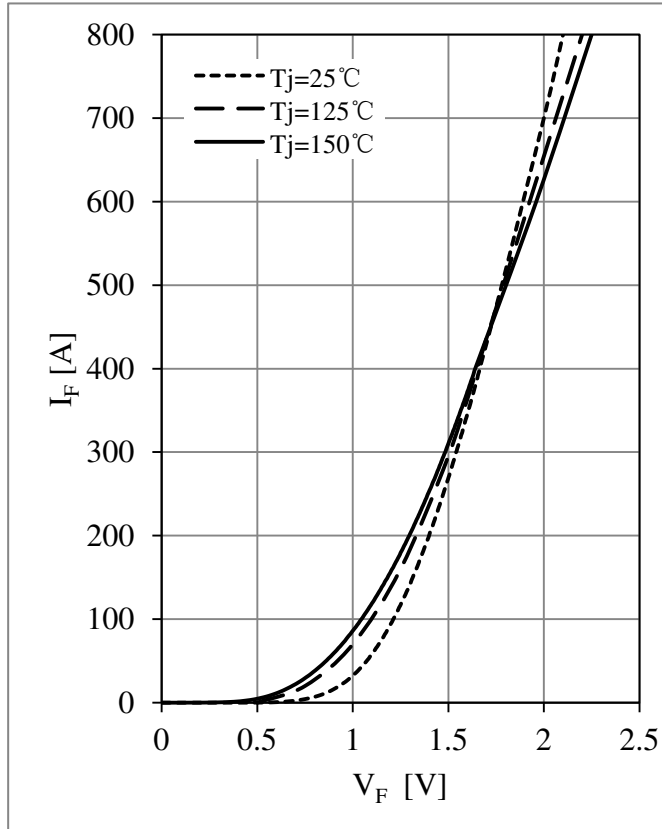
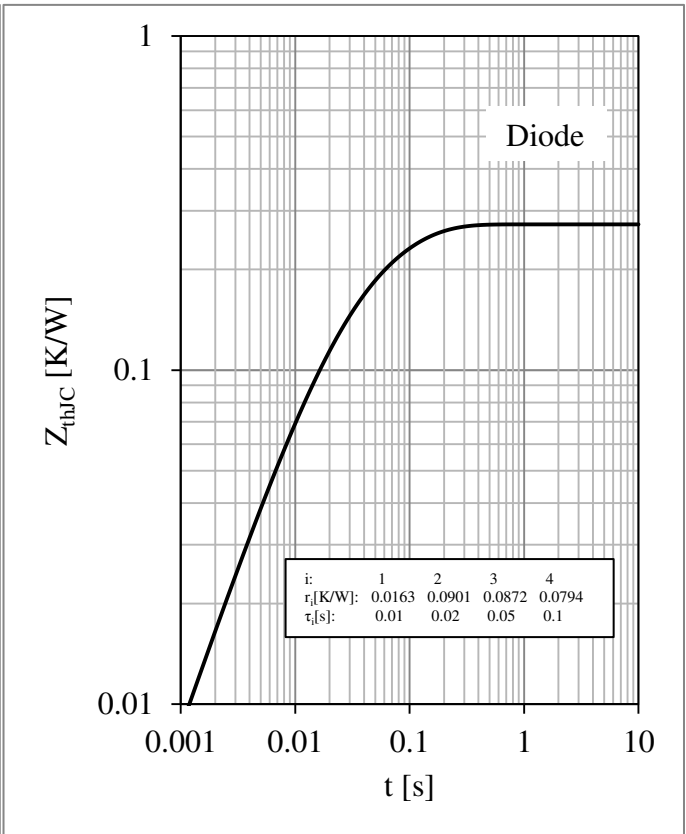
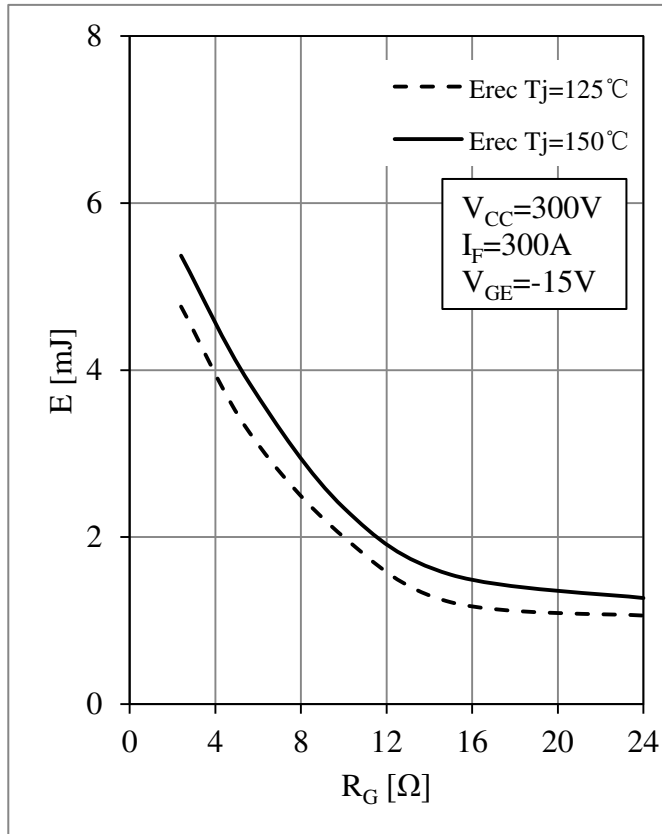
Fig 9. D1-D4 Diode Switching Loss vs. R_G

Fig 10. D1-D4 Diode Transient Thermal Impedance

Fig 11. D5,D6 Diode Forward Characteristics

Fig 12. D5,D6 Diode Switching Loss vs. I_F

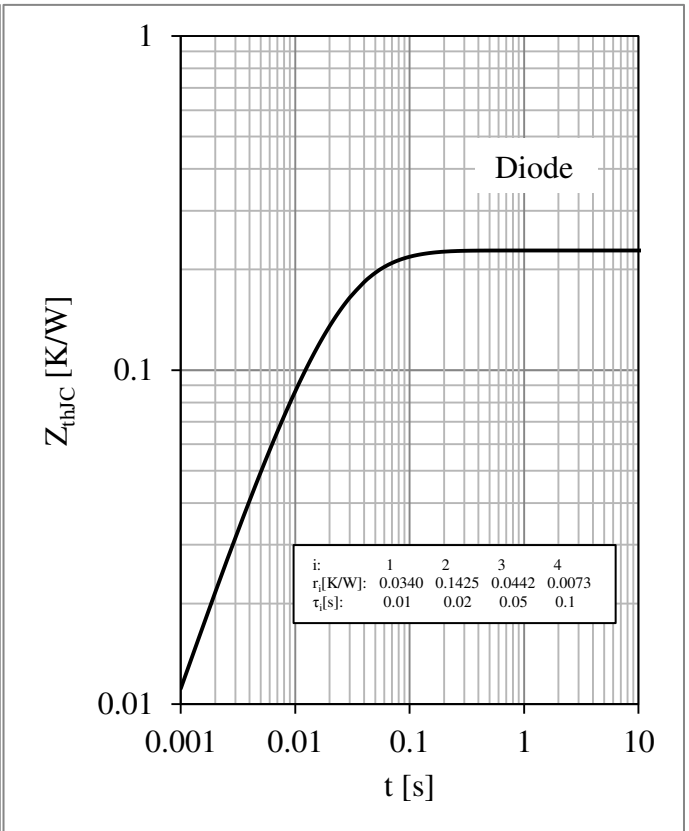
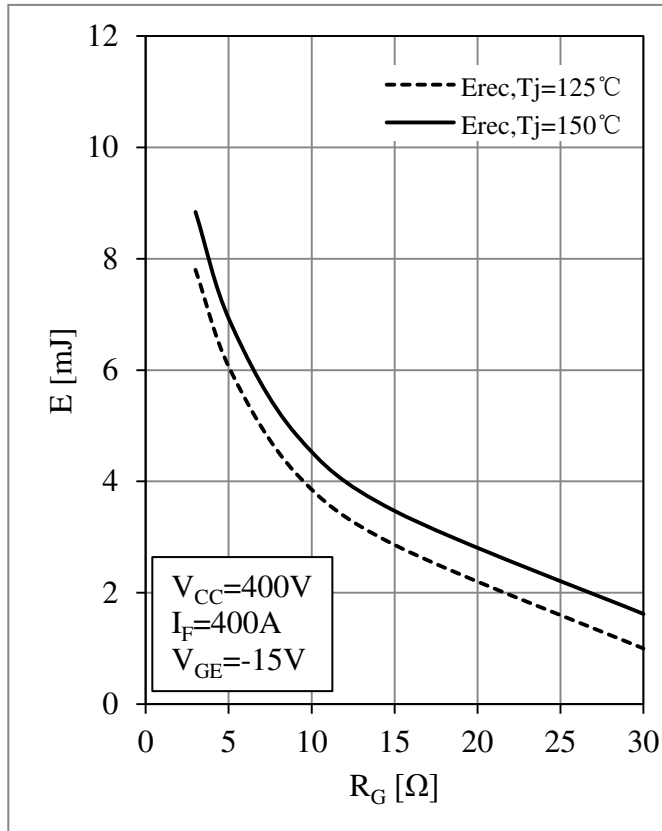
Fig 13. D5,D6 Diode Switching Loss vs. R_G

Fig 14. D5,D6 Diode Transient Thermal Impedance

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