

# STARPOWER

SEMICONDUCTOR

**IGBT**

## GD50MLX65F1S

**650V/50A 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-application.

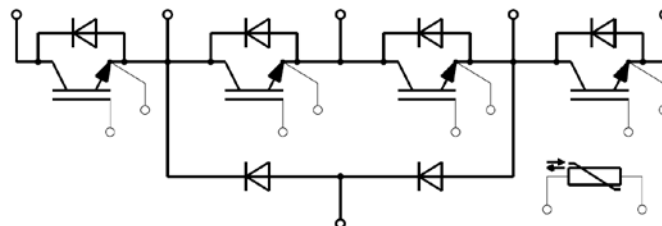
### Features

- 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
- Fast & soft reverse recovery anti-parallel FWD
- Isolated heatsink using DBC technology

### Typical Applications

- Solar power
- UPS
- 3-level-application

### 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	$\pm 20$	V
$I_C$	Collector Current @ $T_C=25^{\circ}\text{C}$	74	A
	@ $T_C=85^{\circ}\text{C}$	50	
$I_{CM}$	Pulsed Collector Current $t_p=1\text{ms}$	100	A
$P_D$	Maximum Power Dissipation @ $T_j=175^{\circ}\text{C}$	197	W

**D1-D4 Diode**

Symbol	Description	Value	Unit
$V_{RRM}$	Repetitive Peak Reverse Voltage	650	V
$I_F$	Diode Continuous Forward Current	50	A
$I_{FM}$	Diode Maximum Forward Current $t_p=1\text{ms}$	100	A

**D5,D6 Diode**

Symbol	Description	Value	Unit
$V_{RRM}$	Repetitive Peak Reverse Voltage	650	V
$I_F$	Diode Continuous Forward Current	60	A
$I_{FM}$	Diode Maximum Forward Current $t_p=1\text{ms}$	120	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, $f=50\text{Hz}$ , $t=1\text{min}$	4000	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	$I_C=50\text{A}, V_{GE}=15\text{V}, T_j=25^\circ\text{C}$		1.45	1.90	V	
		$I_C=50\text{A}, V_{GE}=15\text{V}, T_j=125^\circ\text{C}$		1.60			
		$I_C=50\text{A}, V_{GE}=15\text{V}, T_j=150^\circ\text{C}$		1.70			
$V_{GE(th)}$	Gate-Emitter Threshold Voltage	$I_C=0.80\text{mA}, V_{CE}=V_{GE}, T_j=25^\circ\text{C}$	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			0		$\Omega$	
$C_{ies}$	Input Capacitance	$V_{CE}=25\text{V}, f=1\text{MHz}, V_{GE}=0\text{V}$		5.80		nF	
$C_{res}$	Reverse Transfer Capacitance				0.11		nF
$Q_G$	Gate Charge	$V_{GE}=-15\dots+15\text{V}$		0.35		$\mu\text{C}$	
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=300\text{V}, I_C=50\text{A}, R_G=6.8\Omega, V_{GE}=\pm 15\text{V}, T_j=25^\circ\text{C}$		18		ns	
$t_r$	Rise Time			15		ns	
$t_{d(off)}$	Turn-Off Delay Time			136		ns	
$t_f$	Fall Time			24		ns	
$E_{on}$	Turn-On Switching Loss			0.32		mJ	
$E_{off}$	Turn-Off Switching Loss			0.96		mJ	
$t_{d(on)}$	Turn-On Delay Time		$V_{CC}=300\text{V}, I_C=50\text{A}, R_G=6.8\Omega, V_{GE}=\pm 15\text{V}, T_j=125^\circ\text{C}$		18		ns
$t_r$	Rise Time				18		ns
$t_{d(off)}$	Turn-Off Delay Time			152		ns	
$t_f$	Fall Time			32		ns	
$E_{on}$	Turn-On Switching Loss			0.46		mJ	
$E_{off}$	Turn-Off Switching Loss			1.28		mJ	
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=300\text{V}, I_C=50\text{A}, R_G=6.8\Omega, V_{GE}=\pm 15\text{V}, T_j=150^\circ\text{C}$			18		ns
$t_r$	Rise Time				18		ns
$t_{d(off)}$	Turn-Off Delay Time			160		ns	
$t_f$	Fall Time			40		ns	
$E_{on}$	Turn-On Switching Loss			0.51		mJ	
$E_{off}$	Turn-Off Switching Loss			1.36		mJ	
$I_{SC}$	SC Data		$t_p \leq 6\mu\text{s}, V_{GE}=15\text{V}, T_j=150^\circ\text{C}, V_{CC}=300\text{V}, V_{CEM} \leq 600\text{V}$		250		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	$I_F=50\text{A}, V_{GE}=0\text{V}, T_j=25^\circ\text{C}$		1.55	2.05	V
		$I_F=50\text{A}, V_{GE}=0\text{V}, T_j=125^\circ\text{C}$		1.50		
		$I_F=50\text{A}, V_{GE}=0\text{V}, T_j=150^\circ\text{C}$		1.45		
$Q_r$	Recovered Charge	$V_R=300\text{V}, I_F=50\text{A},$ $-di/dt=2420\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=25^\circ\text{C}$		2.2		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			55		A
$E_{rec}$	Reverse Recovery Energy			0.55		mJ
$Q_r$	Recovered Charge	$V_R=300\text{V}, I_F=50\text{A},$ $-di/dt=2420\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=125^\circ\text{C}$		4.3		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			66		A
$E_{rec}$	Reverse Recovery Energy			1.10		mJ
$Q_r$	Recovered Charge	$V_R=300\text{V}, I_F=50\text{A},$ $-di/dt=2420\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=150^\circ\text{C}$		4.8		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			72		A
$E_{rec}$	Reverse Recovery Energy			1.27		mJ

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

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Units
$V_F$	Diode Forward Voltage	$I_C=60\text{A}, V_{GE}=0\text{V}, T_j=25^\circ\text{C}$		1.60	2.05	V
		$I_C=60\text{A}, V_{GE}=0\text{V}, T_j=125^\circ\text{C}$		1.55		
		$I_C=60\text{A}, V_{GE}=0\text{V}, T_j=150^\circ\text{C}$		1.50		
$Q_r$	Recovered Charge	$V_R=300\text{V}, I_F=60\text{A},$ $-di/dt=4200\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=25^\circ\text{C}$		2.6		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			88		A
$E_{rec}$	Reverse Recovery Energy			0.7		mJ
$Q_r$	Recovered Charge	$V_R=300\text{V}, I_F=60\text{A},$ $-di/dt=4200\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=125^\circ\text{C}$		4.6		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			96		A
$E_{rec}$	Reverse Recovery Energy			1.1		mJ
$Q_r$	Recovered Charge	$V_R=300\text{V}, I_F=60\text{A},$ $-di/dt=4200\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=150^\circ\text{C}$		5.4		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			98		A
$E_{rec}$	Reverse Recovery Energy			1.3		mJ

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

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$R_{25}$	Rated Resistance			22.0		$\text{k}\Omega$
$\Delta R/R$	Deviation of $R_{100}$	$T_C=100^{\circ}\text{C}, R_{100}=1486.1\Omega$	-5		5	%
$P_{25}$	Power Dissipation				200	mW
$B_{25/50}$	B-value	$R_2=R_{25}\exp[B_{25/50}(1/T_2-1/(298.15\text{K}))]$		4000		K

**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)		0.691	0.760	K/W
	Junction-to-Case (per D1-D4 Diode)		1.175	1.293	
	Junction-to-Case (per D5,D6 Diode)		0.995	1.094	
$R_{thCH}$	Case-to-Heatsink (per T1-T4 IGBT)		0.271		K/W
	Case-to-Heatsink (per D1-D4 Diode)		0.461		
	Case-to-Heatsink (per D5,D6 Diode)		0.390		
	Case-to-Heatsink (per Module)		0.035		
M	Mounting Torque, Screw M4	2.0		2.2	N.m
G	Weight of Module		26		g

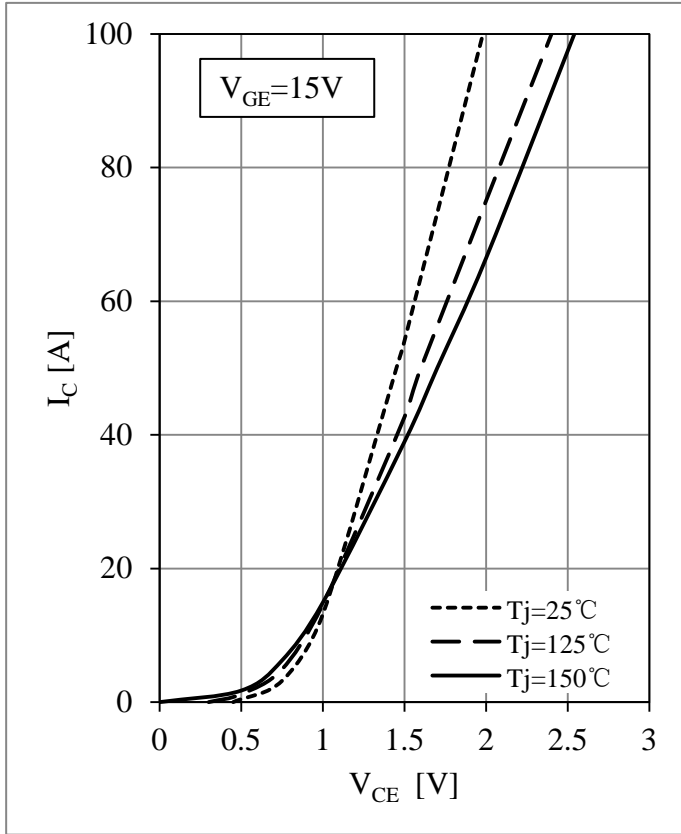


Fig 1. T1-T4 IGBT Output Characteristics

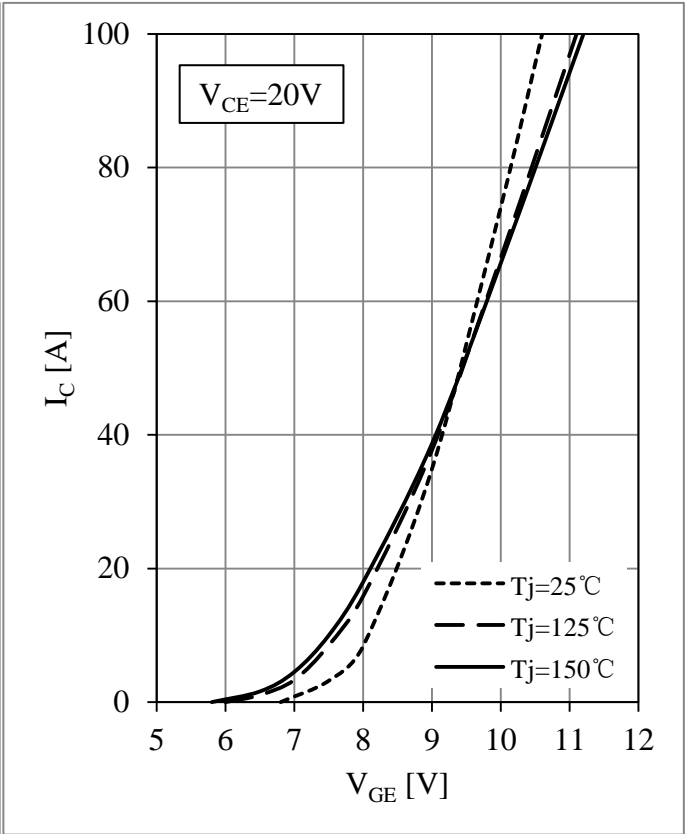


Fig 2. T1-T4 IGBT Transfer Characteristics

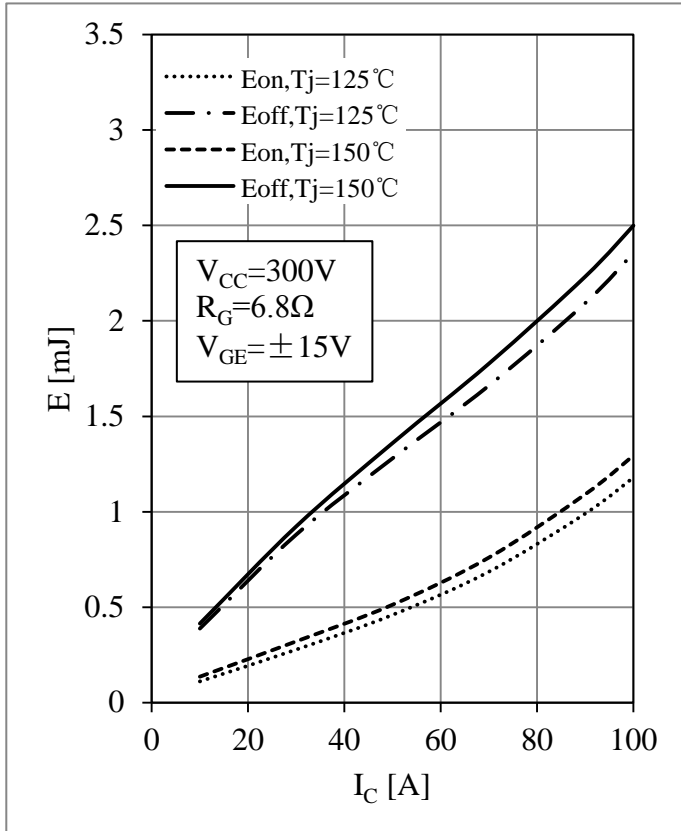


Fig 3. T1-T4 IGBT Switching Loss vs.  $I_C$

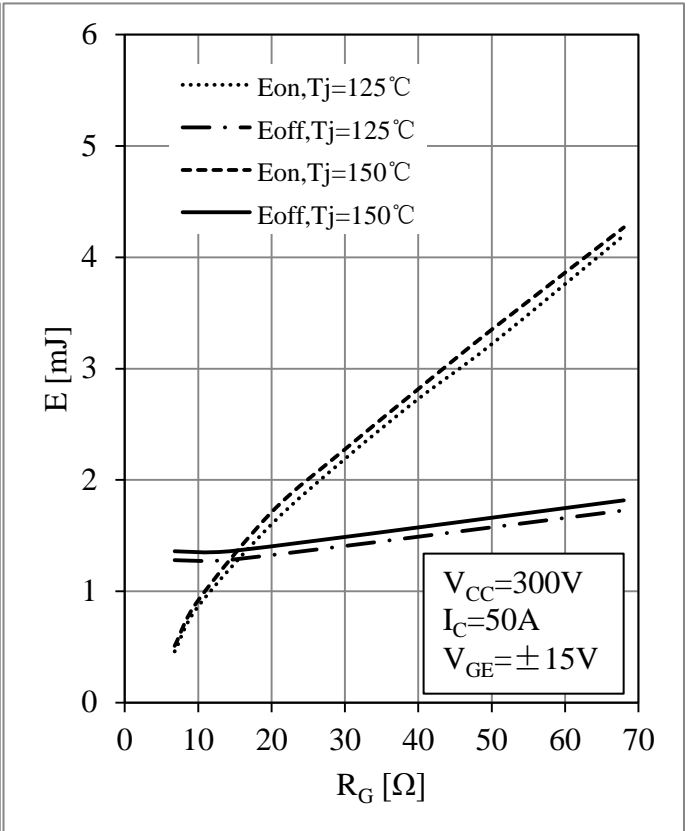


Fig 4. T1-T4 IGBT Switching Loss vs.  $R_G$

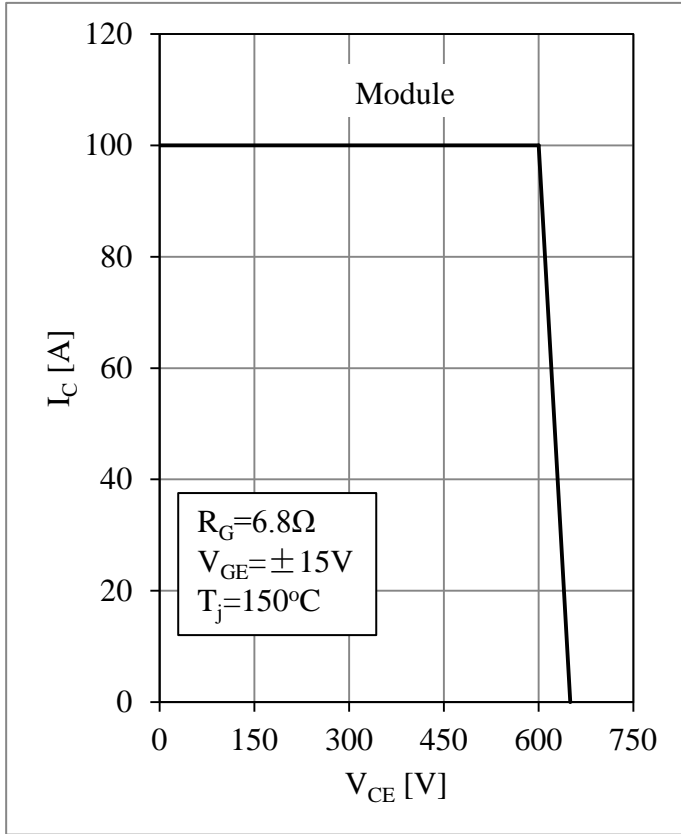


Fig 5. T1-T4 RBSOA

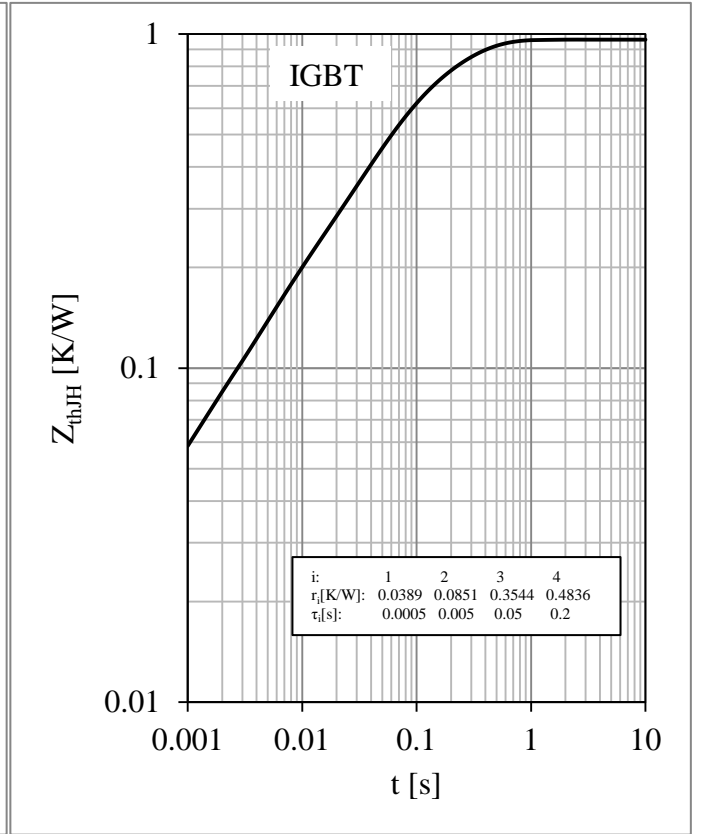


Fig 6. T1-T4 IGBT Transient Thermal Impedance

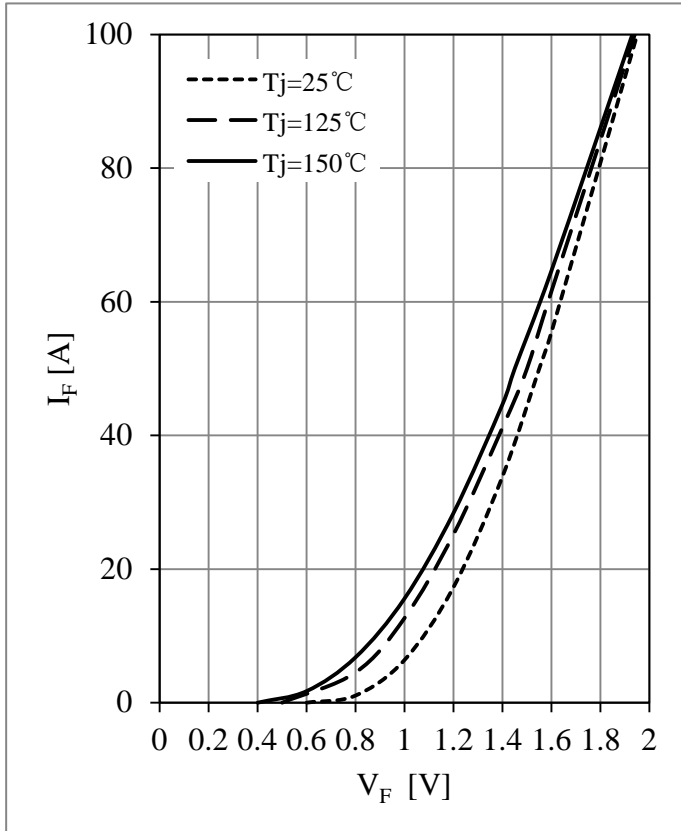


Fig 7. D1-D4 Diode Forward Characteristics

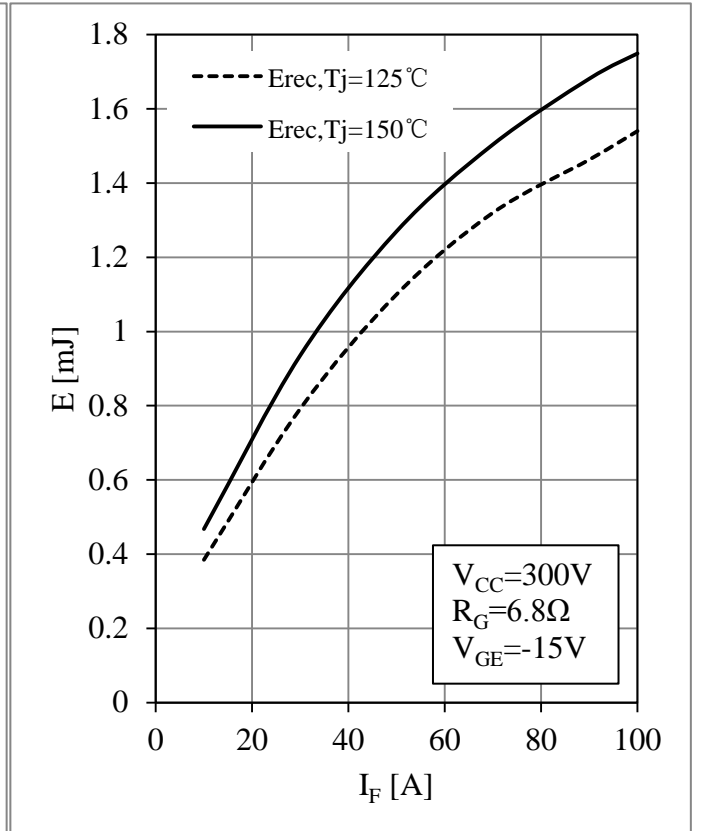


Fig 8. D1-D4 Diode Switching Loss vs.  $I_F$

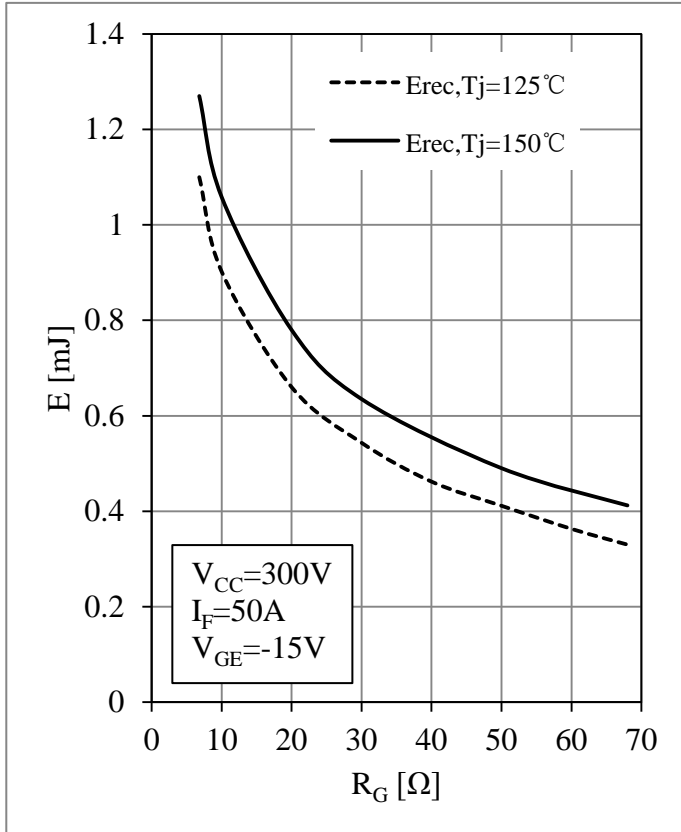


Fig 9. D1-D4 Diode Switching Loss vs.  $R_G$

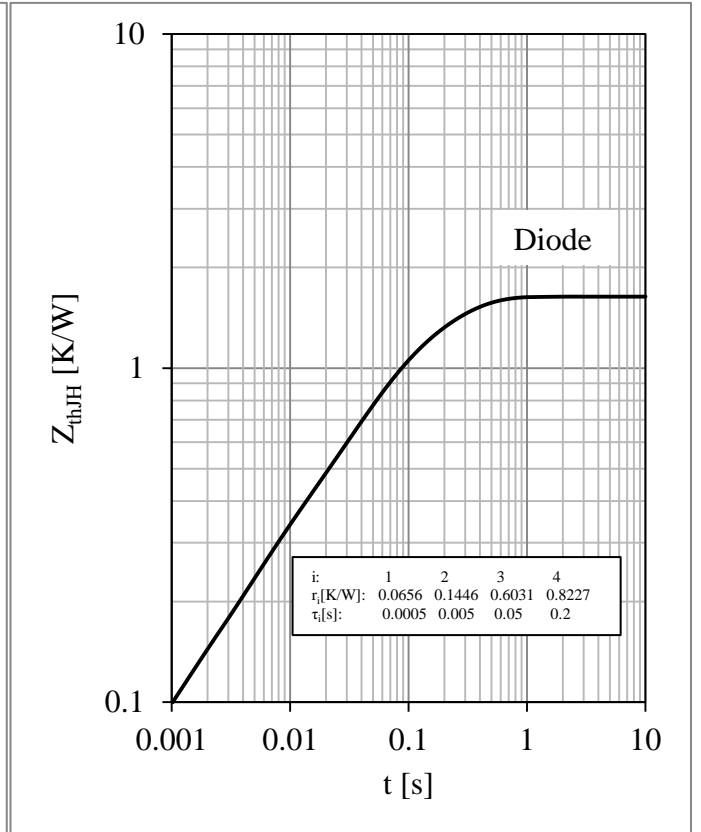


Fig 10. D1-D4 Diode Transient Thermal Impedance

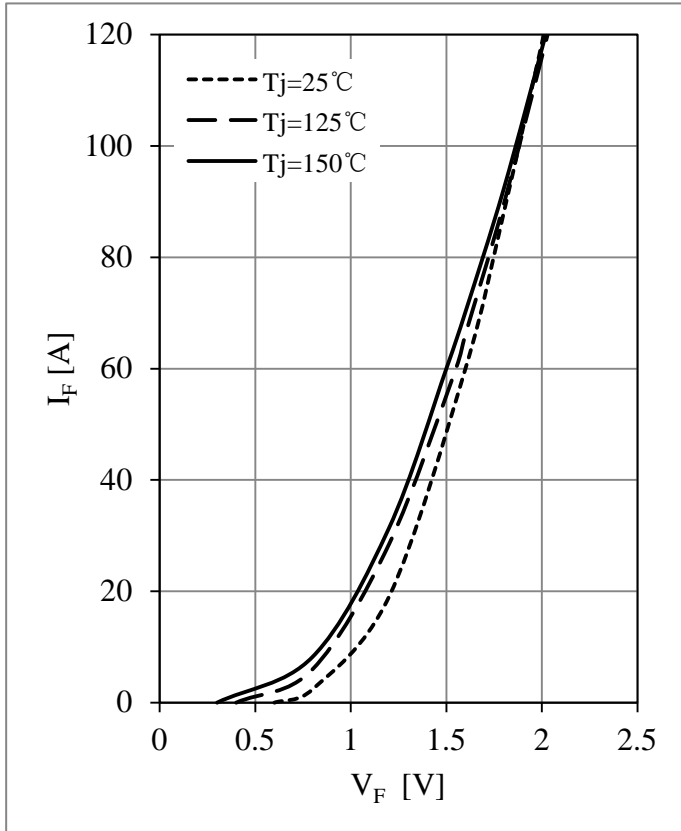


Fig 11. D5,D6 Diode Forward Characteristics

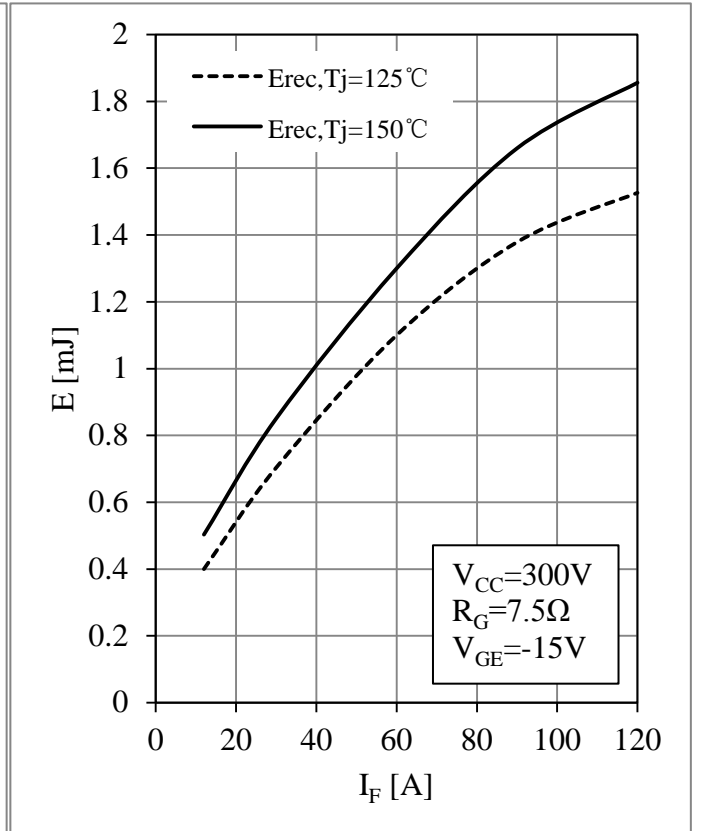


Fig 12. D5,D6 Diode Switching Loss vs.  $I_F$



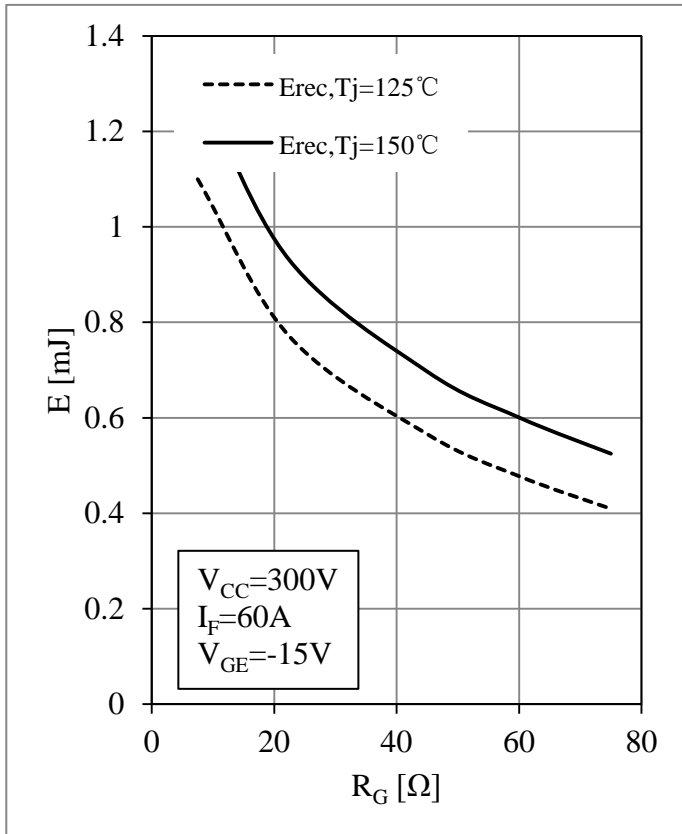


Fig 13. D5,D6 Diode Switching Loss vs.  $R_G$

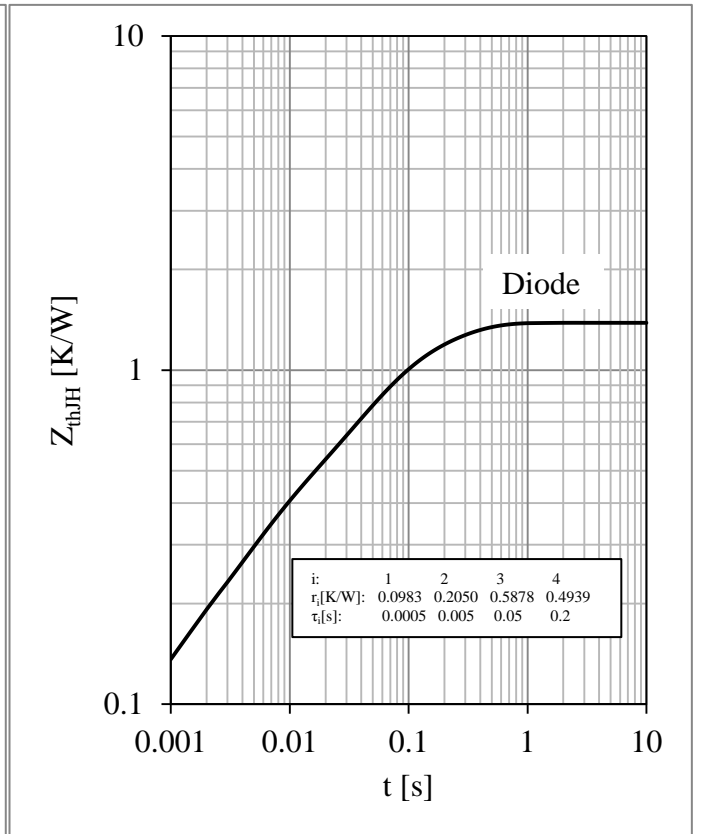


Fig 14. D5,D6 Diode Transient Thermal Impedance

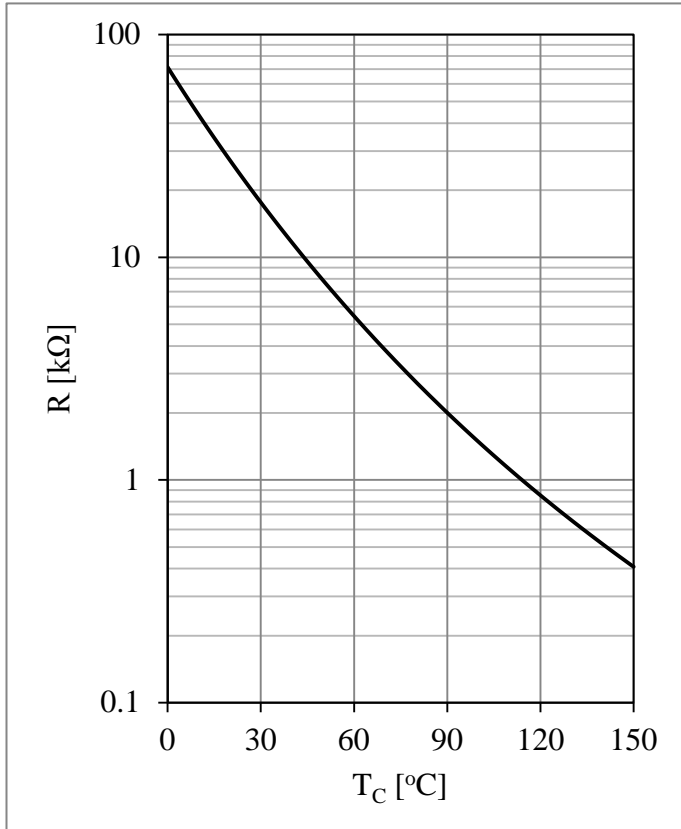
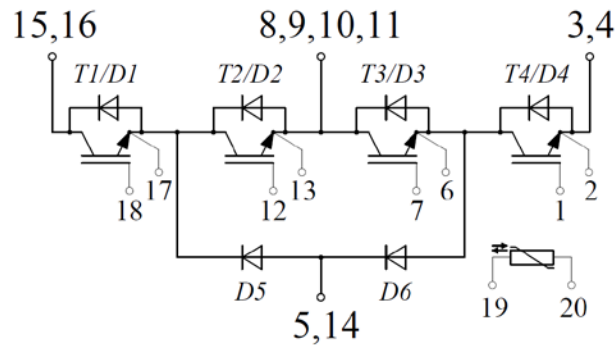


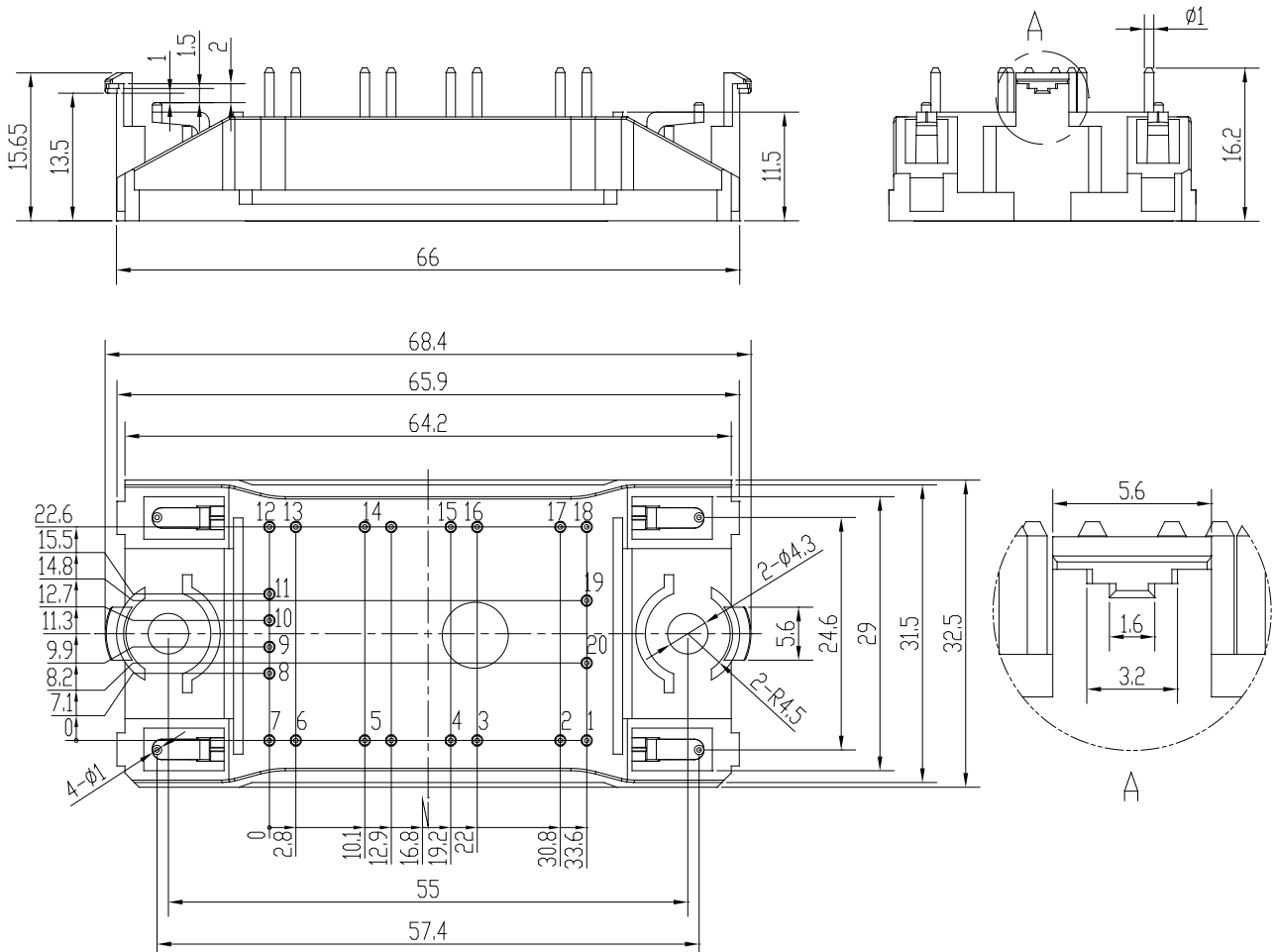
Fig 15. NTC Temperature Characteristic

**Circuit Schematic**



**Package Dimensions**

Dimensions in Millimeters



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