

# STARPOWER

SEMICONDUCTOR

**IGBT**

## GD100MLX65L3S

**650V/100A 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-application.

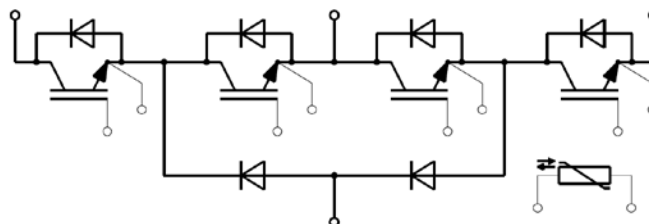
### Features

- 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 copper baseplate 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 @ $T_C=25^{\circ}\text{C}$	160	A
	@ $T_C=100^{\circ}\text{C}$	100	A
$I_{CM}$	Pulsed Collector Current $t_p=1\text{ms}$	200	A
$P_D$	Maximum Power Dissipation @ $T_j=175^{\circ}\text{C}$	451	W

**D1-D4 Diode**

Symbol	Description	Value	Unit
$V_{RRM}$	Repetitive Peak Reverse Voltage	650	V
$I_F$	Diode Continuous Forward Current	100	A
$I_{FM}$	Diode Maximum Forward Current $t_p=1\text{ms}$	200	A

**D5,D6 Diode**

Symbol	Description	Value	Unit
$V_{RRM}$	Repetitive Peak Reverse Voltage	650	V
$I_F$	Diode Continuous Forward Current	100	A
$I_{FM}$	Diode Maximum Forward Current $t_p=1\text{ms}$	200	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	$I_C=100\text{A}, V_{GE}=15\text{V}, T_j=25^\circ\text{C}$		1.45	1.90	V
		$I_C=100\text{A}, V_{GE}=15\text{V}, T_j=125^\circ\text{C}$		1.60		
		$I_C=100\text{A}, V_{GE}=15\text{V}, T_j=150^\circ\text{C}$		1.70		
$V_{GE(th)}$	Gate-Emitter Threshold Voltage	$I_C=1.60\text{mA}, V_{CE}=V_{GE}, T_j=25^\circ\text{C}$	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			2.0		$\Omega$
$C_{ies}$	Input Capacitance	$V_{CE}=25\text{V}, f=1\text{MHz}, V_{GE}=0\text{V}$		11.6		nF
$C_{res}$	Reverse Transfer Capacitance				0.23	
$Q_G$	Gate Charge	$V_{GE}=-15\dots+15\text{V}$		0.69		$\mu\text{C}$
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=300\text{V}, I_C=100\text{A}, R_G=3.3\Omega, V_{GE}=\pm 15\text{V}, T_j=25^\circ\text{C}$		40		ns
$t_r$	Rise Time			20		ns
$t_{d(off)}$	Turn-Off Delay Time			192		ns
$t_f$	Fall Time			40		ns
$E_{on}$	Turn-On Switching Loss			0.44		mJ
$E_{off}$	Turn-Off Switching Loss			2.00		mJ
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=300\text{V}, I_C=100\text{A}, R_G=3.3\Omega, V_{GE}=\pm 15\text{V}, T_j=125^\circ\text{C}$		48		ns
$t_r$	Rise Time			24		ns
$t_{d(off)}$	Turn-Off Delay Time			208		ns
$t_f$	Fall Time			52		ns
$E_{on}$	Turn-On Switching Loss			0.68		mJ
$E_{off}$	Turn-Off Switching Loss			2.68		mJ
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=300\text{V}, I_C=100\text{A}, R_G=3.3\Omega, V_{GE}=\pm 15\text{V}, T_j=150^\circ\text{C}$		52		ns
$t_r$	Rise Time			24		ns
$t_{d(off)}$	Turn-Off Delay Time			216		ns
$t_f$	Fall Time			60		ns
$E_{on}$	Turn-On Switching Loss			0.78		mJ
$E_{off}$	Turn-Off Switching Loss			2.80		mJ
$I_{SC}$	SC Data	$t_p \leq 6\mu\text{s}, V_{GE}=15\text{V}, T_j=150^\circ\text{C}, V_{CC}=360\text{V}, V_{CEM} \leq 650\text{V}$		500		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	$I_F=100\text{A}, V_{GE}=0\text{V}, T_j=25^\circ\text{C}$		1.55	2.00	V
		$I_F=100\text{A}, V_{GE}=0\text{V}, T_j=125^\circ\text{C}$		1.50		
		$I_F=100\text{A}, V_{GE}=0\text{V}, T_j=150^\circ\text{C}$		1.45		
$Q_r$	Recovered Charge	$V_R=300\text{V}, I_F=100\text{A},$ $-di/dt=3520\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=25^\circ\text{C}$		4.6		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			99		A
$E_{rec}$	Reverse Recovery Energy			1.32		mJ
$Q_r$	Recovered Charge	$V_R=300\text{V}, I_F=100\text{A},$ $-di/dt=3520\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=125^\circ\text{C}$		8.6		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			121		A
$E_{rec}$	Reverse Recovery Energy			2.37		mJ
$Q_r$	Recovered Charge	$V_R=300\text{V}, I_F=100\text{A},$ $-di/dt=3520\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=150^\circ\text{C}$		9.9		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			127		A
$E_{rec}$	Reverse Recovery Energy			2.64		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	$I_F=100\text{A}, V_{GE}=0\text{V}, T_j=25^\circ\text{C}$		1.55	2.00	V
		$I_F=100\text{A}, V_{GE}=0\text{V}, T_j=125^\circ\text{C}$		1.50		
		$I_F=100\text{A}, V_{GE}=0\text{V}, T_j=150^\circ\text{C}$		1.45		
$Q_r$	Recovered Charge	$V_R=300\text{V}, I_F=100\text{A},$ $-di/dt=3520\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=25^\circ\text{C}$		4.6		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			99		A
$E_{rec}$	Reverse Recovery Energy			1.32		mJ
$Q_r$	Recovered Charge	$V_R=300\text{V}, I_F=100\text{A},$ $-di/dt=3520\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=125^\circ\text{C}$		8.6		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			121		A
$E_{rec}$	Reverse Recovery Energy			2.37		mJ
$Q_r$	Recovered Charge	$V_R=300\text{V}, I_F=100\text{A},$ $-di/dt=3520\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=150^\circ\text{C}$		9.9		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			127		A
$E_{rec}$	Reverse Recovery Energy			2.64		mJ

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

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$R_{25}$	Rated Resistance			5.0		$\text{k}\Omega$
$\Delta R/R$	Deviation of $R_{100}$	$T_C=100^{\circ}\text{C}, R_{100}=493.3\Omega$	-5		5	%
$P_{25}$	Power Dissipation				20.0	mW
$B_{25/50}$	B-value	$R_2=R_{25}\exp[B_{25/50}(1/T_2-1/(298.15\text{K}))]$		3375		K
$B_{25/80}$	B-value	$R_2=R_{25}\exp[B_{25/80}(1/T_2-1/(298.15\text{K}))]$		3411		K
$B_{25/100}$	B-value	$R_2=R_{25}\exp[B_{25/100}(1/T_2-1/(298.15\text{K}))]$		3433		K

**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		2.00		$\text{m}\Omega$
$R_{thJC}$	Junction-to-Case (per T1-T4 IGBT)		0.302	0.332	K/W
	Junction-to-Case (per D1-D4 Diode)		0.538	0.592	
	Junction-to-Case (per D5,D6 Diode)		0.425	0.468	
$R_{thCH}$	Case-to-Sink (per T1-T4 IGBT)		0.283		K/W
	Case-to-Sink (per D1-D4 Diode)		0.506		
	Case-to-Sink (per D5,D6 Diode)		0.400		
	Case-to-Sink (per Module)		0.037		
F	Mounting Force Per Clamp	40		80	K/W
G	Weight of Module		39		g

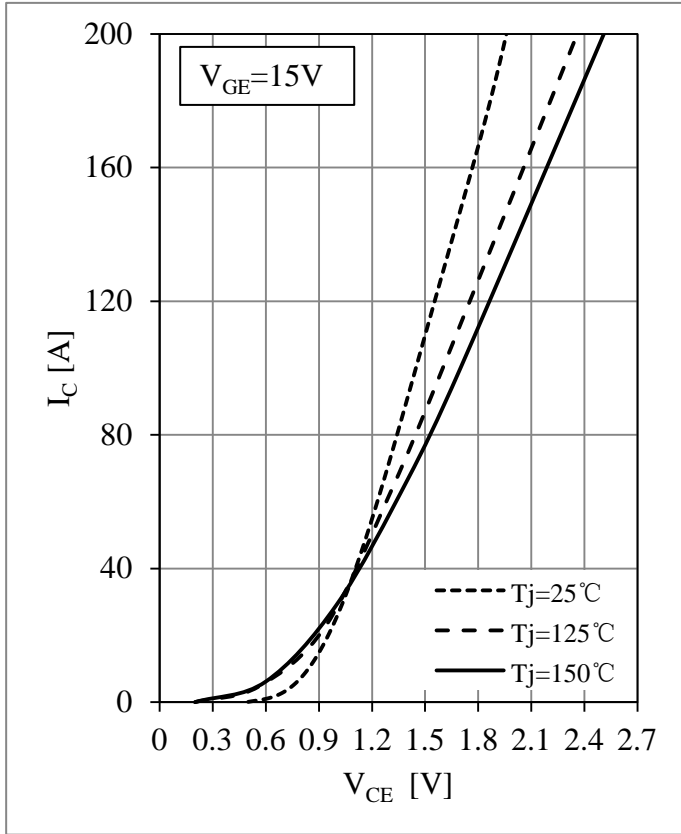


Fig 1. T1-T4 IGBT Output Characteristics

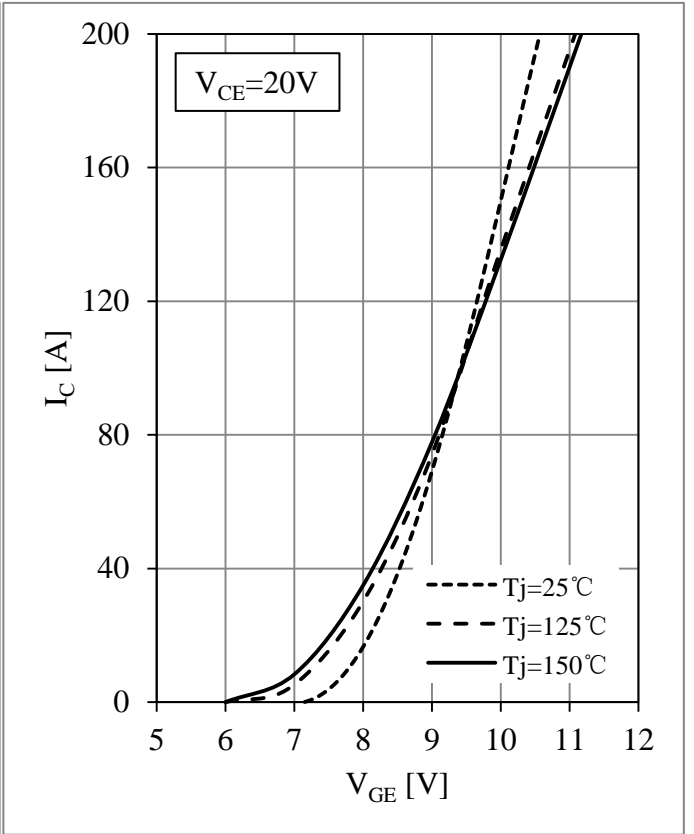


Fig 2. T1-T4 IGBT Transfer Characteristics

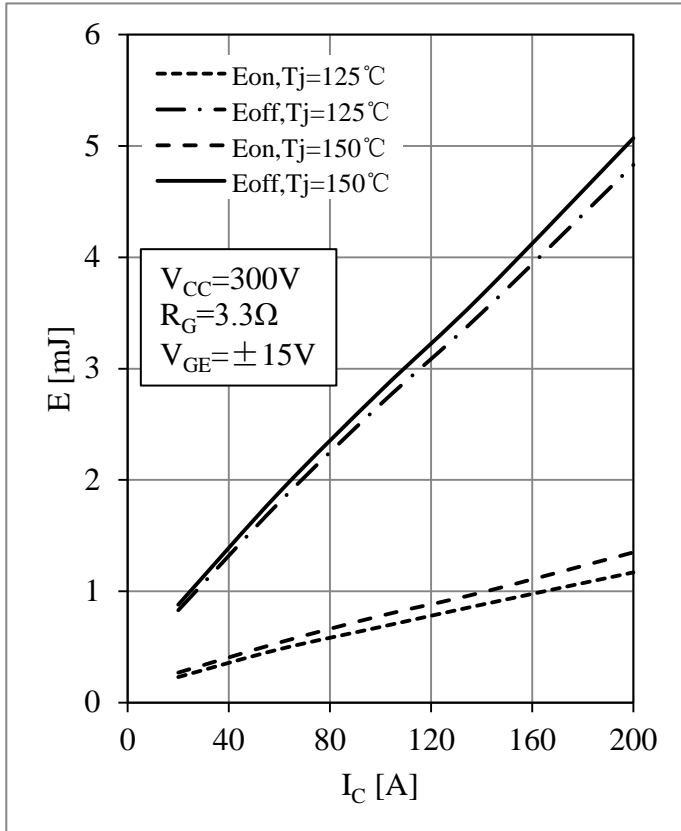


Fig 3. T1-T4 IGBT Switching Loss vs.  $I_C$

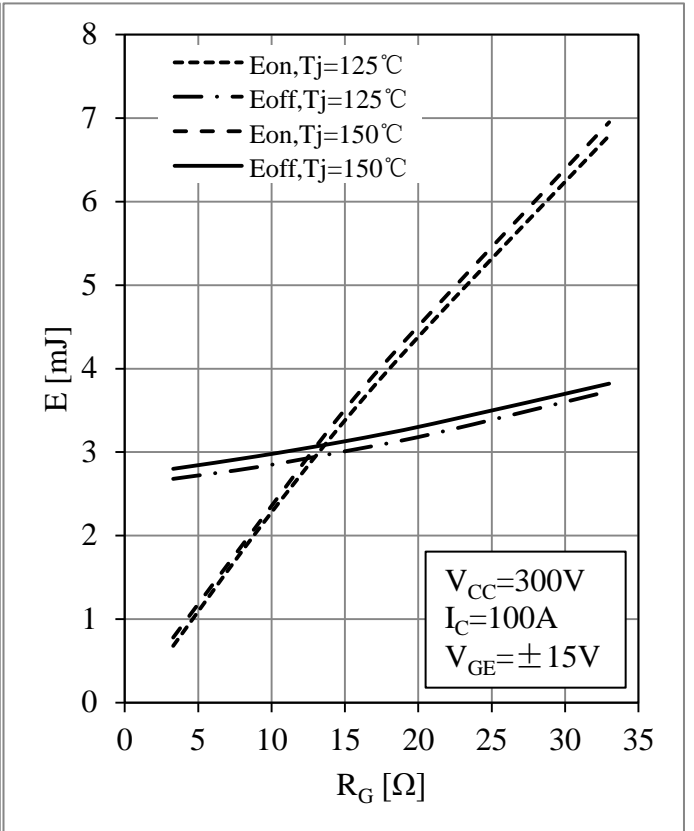


Fig 4. T1-T4 IGBT Switching Loss vs.  $R_G$

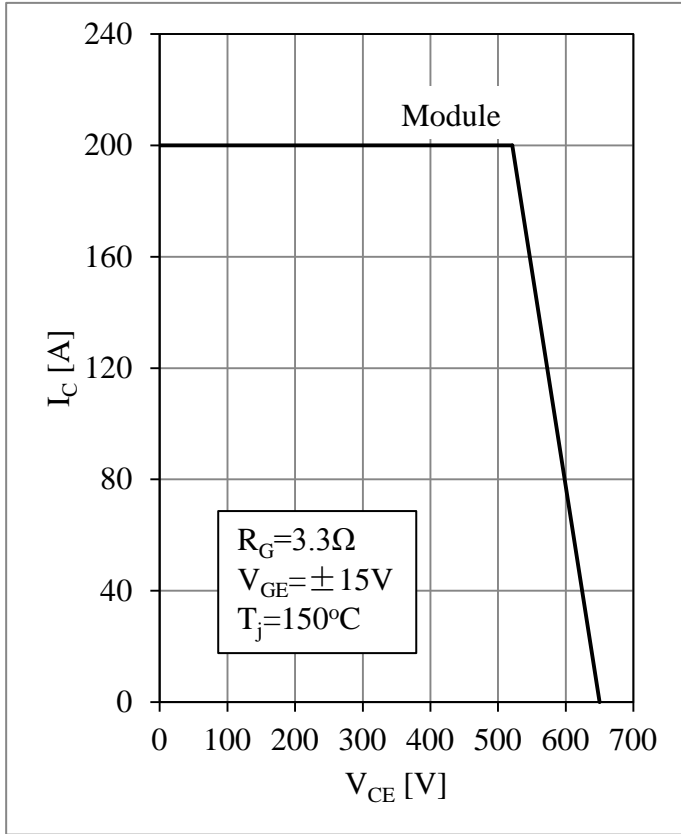


Fig 5. T1-T4 RBSOA

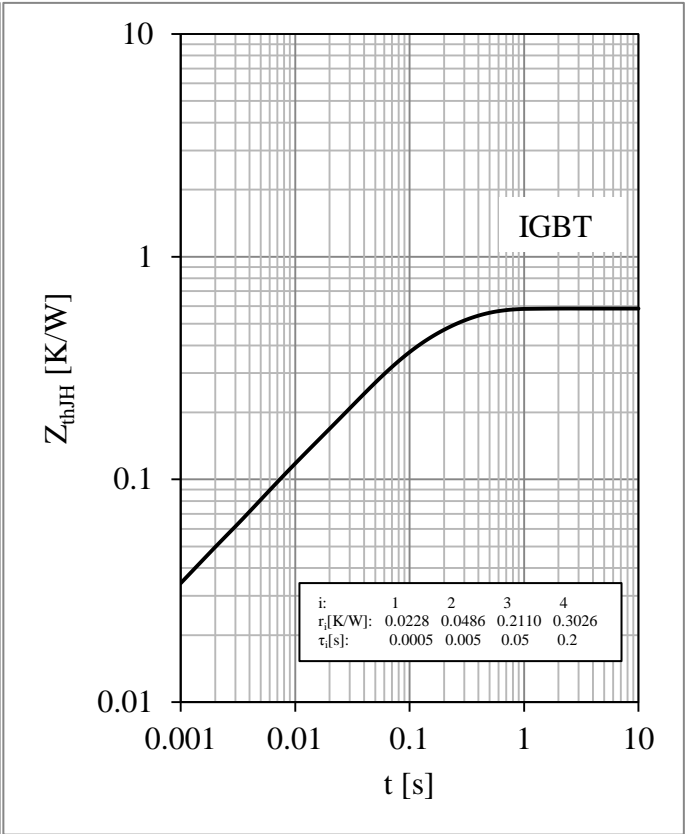


Fig 6. T1-T4 IGBT Transient Thermal Impedance

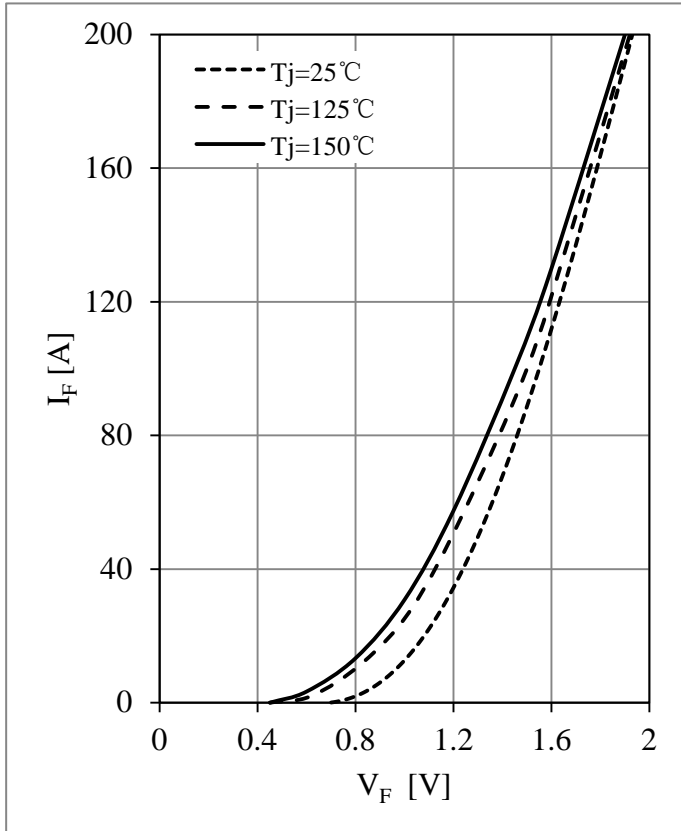


Fig 7. D1-D4 Diode Forward Characteristics

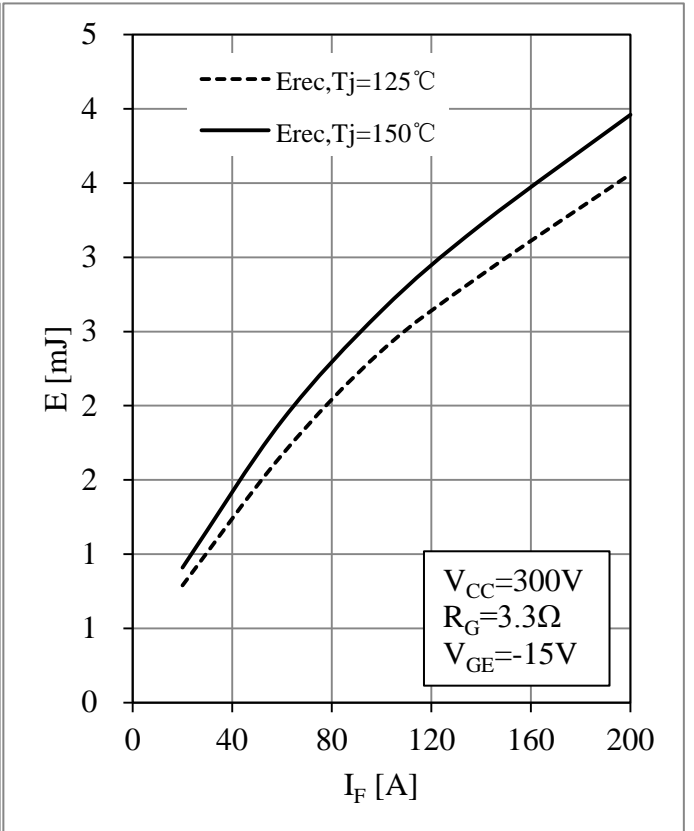


Fig 8. D1-D4 Diode Switching Loss vs.  $I_F$

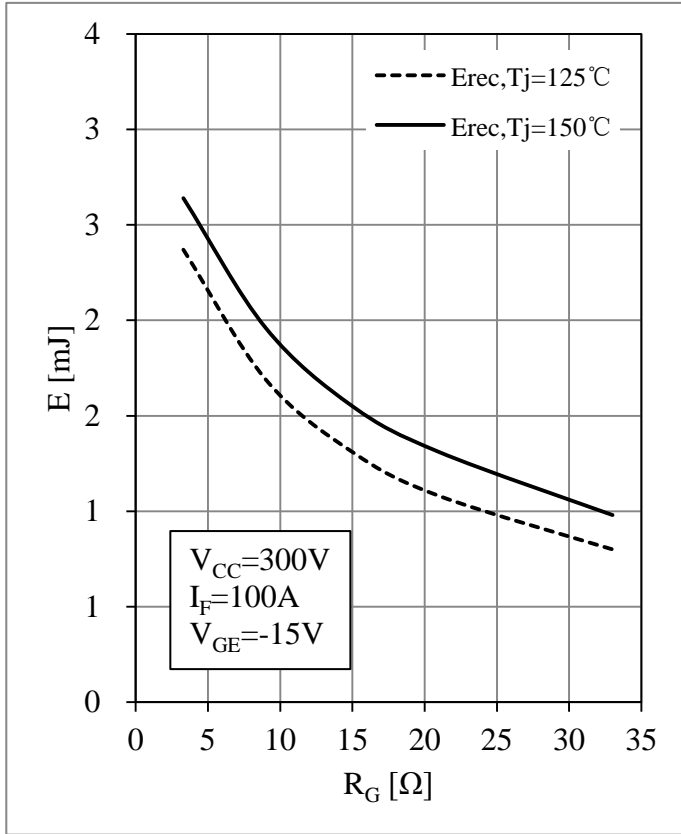


Fig 9. D1-D4 Diode Switching Loss vs.  $R_G$

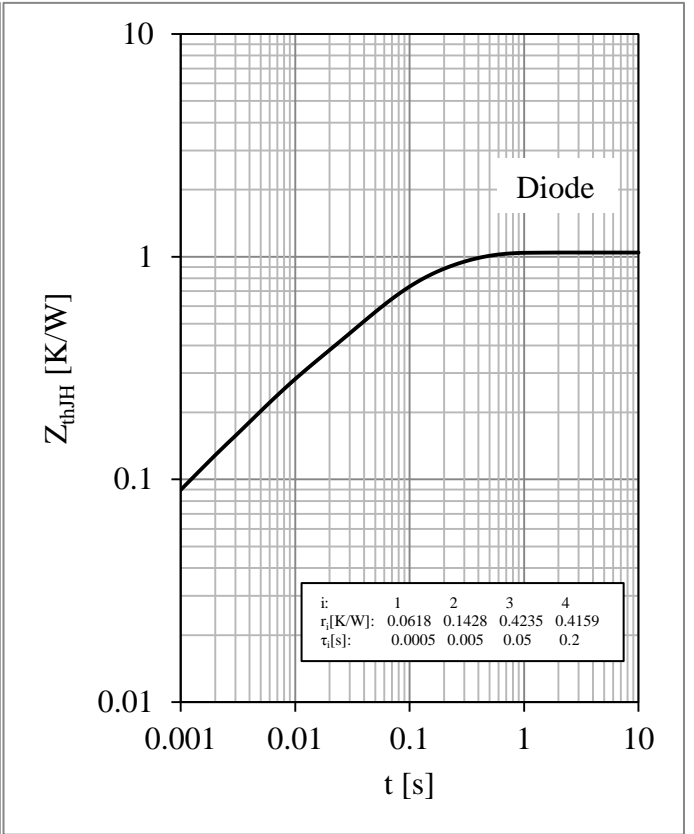


Fig 10. D1-D4 Diode Transient Thermal Impedance

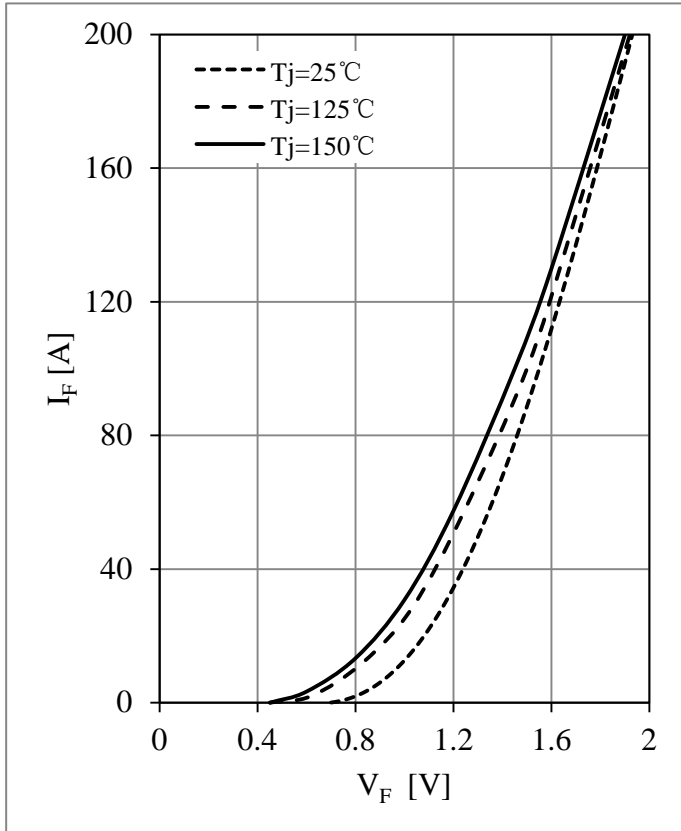


Fig 11. D5,D6 Diode Forward Characteristics

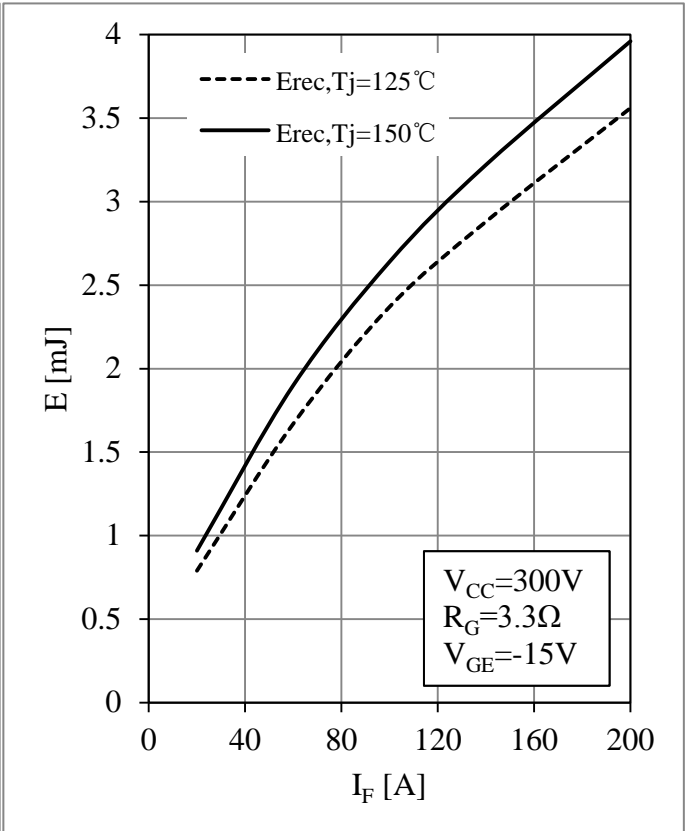


Fig 12. D5,D6 Diode Switching Loss vs.  $I_F$



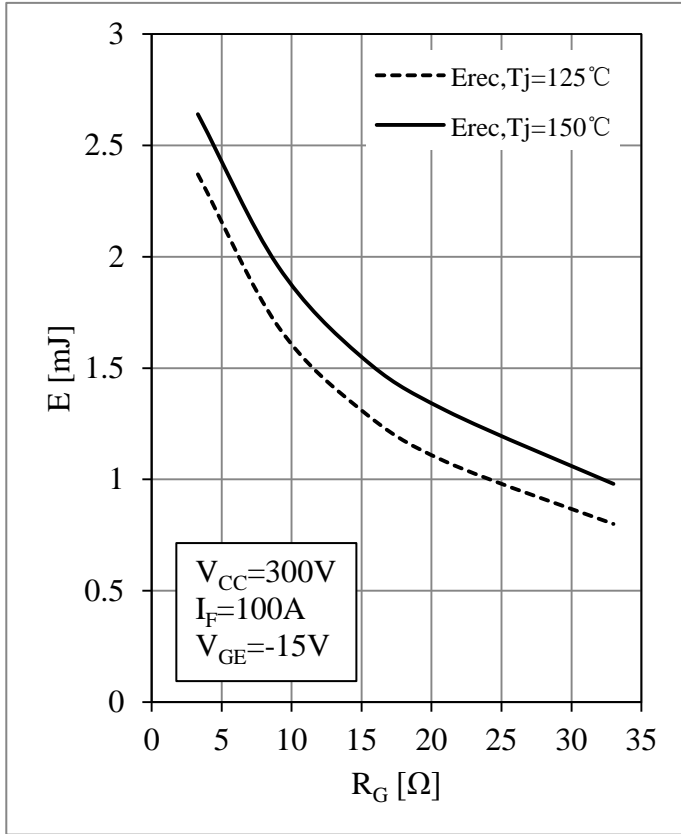


Fig 13. D5,D6 Diode Switching Loss vs.  $R_G$

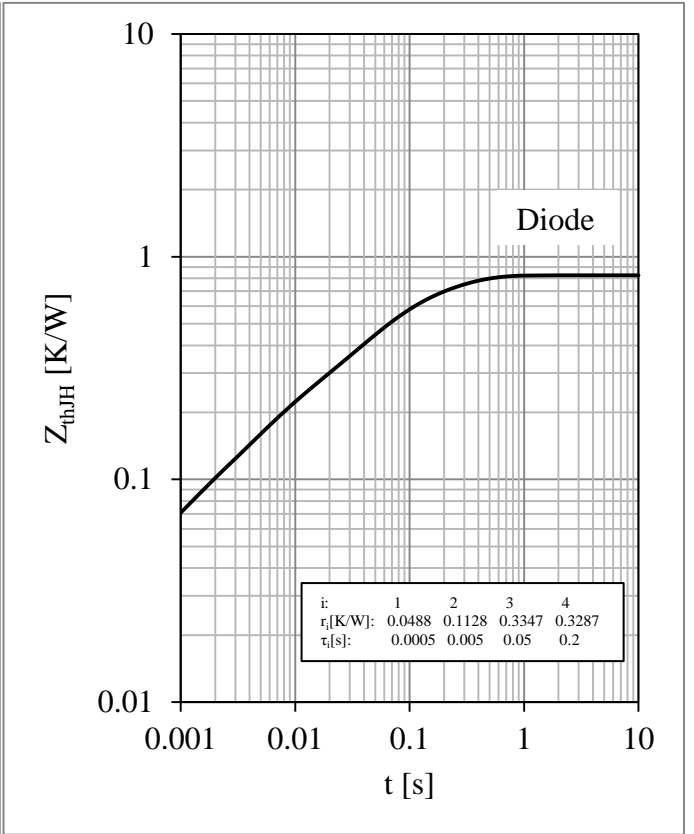


Fig 14. D5,D6 Diode Transient Thermal Impedance

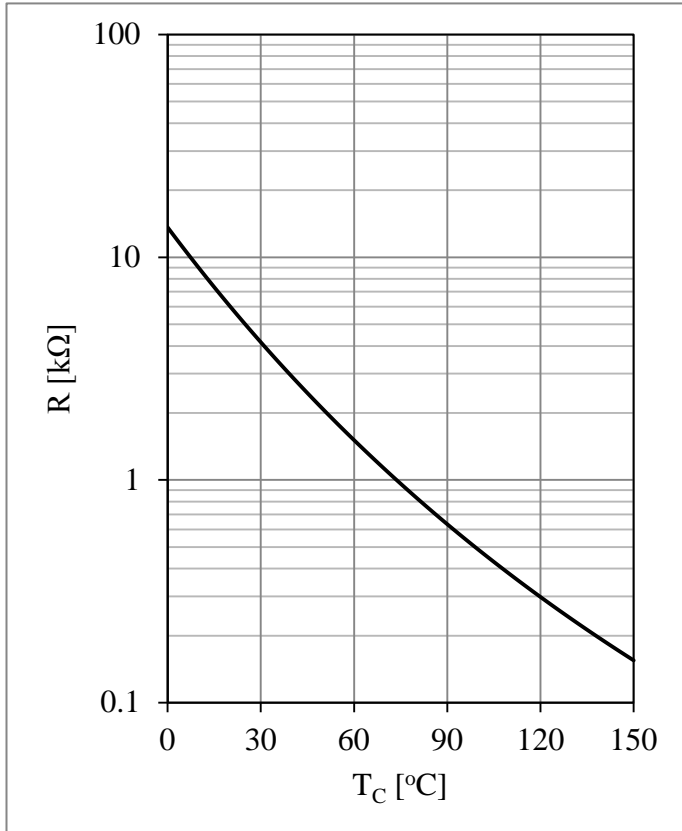
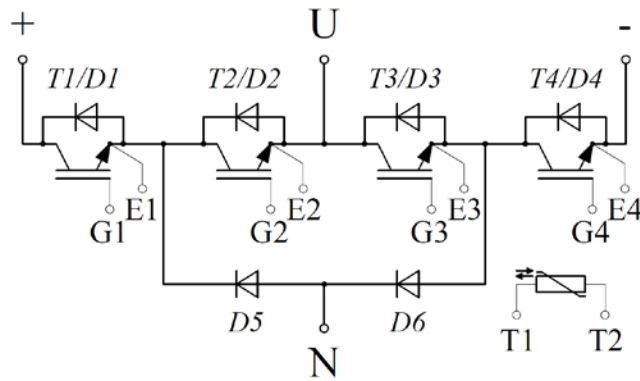


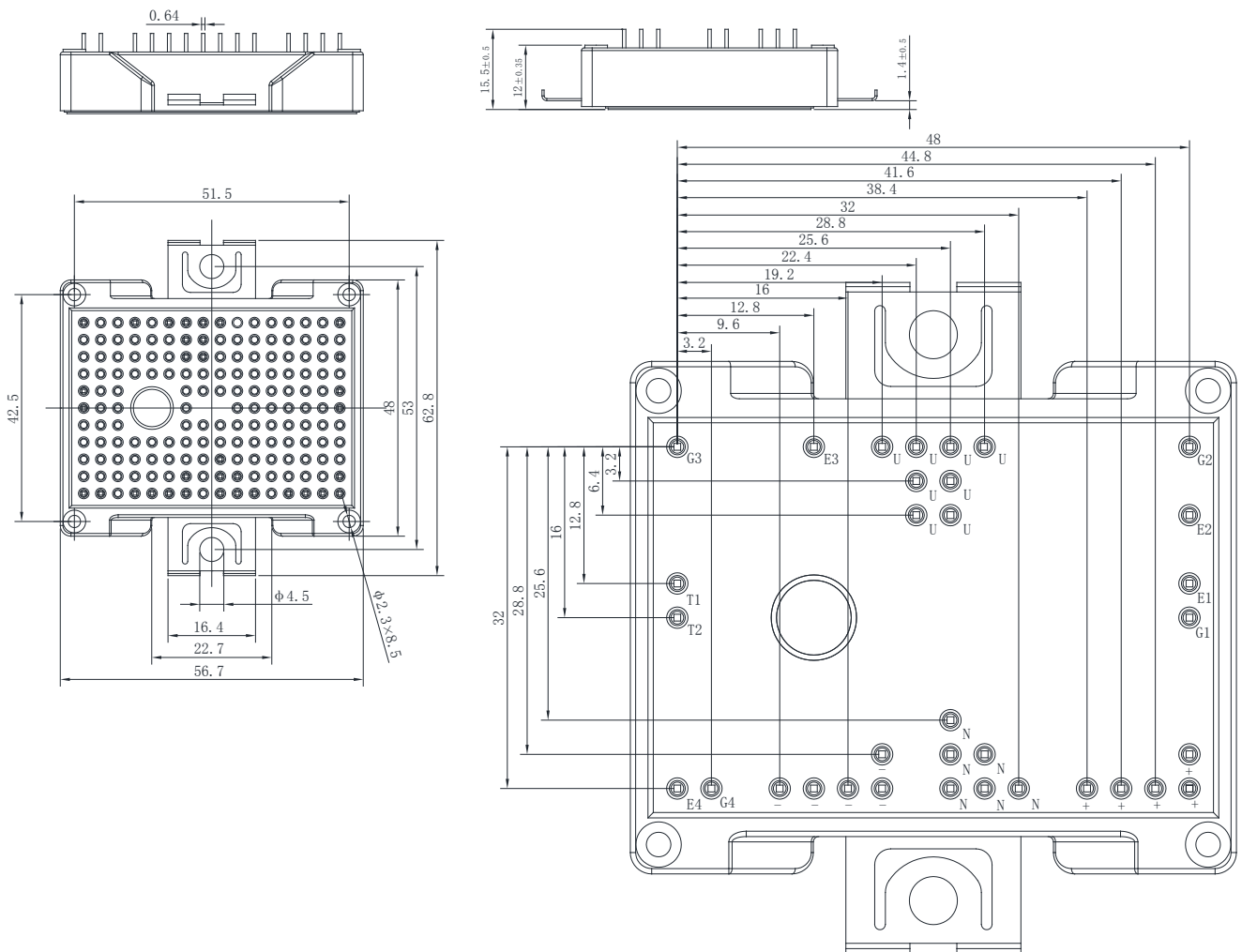
Fig 15. NTC Temperature Characteristic

**Circuit Schematic**



**Package Dimensions**

Dimensions in Millimeters



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