STARPOWER

SEMICONDUCTOR **IGBT**

GD450MLS65F6S

650V/450A 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.

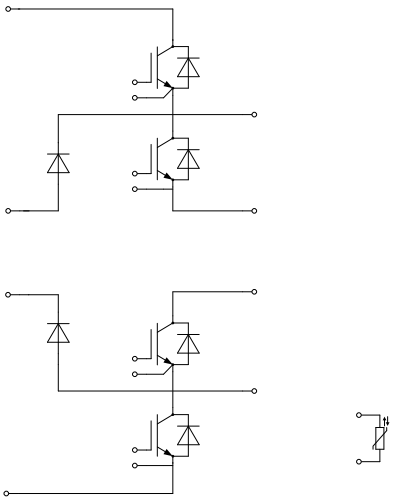
Features

- Low $V_{CE(sat)}$ Trench IGBT technology
- $V_{CE(sat)}$ 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
- 3-level-application

Equivalent Circuit Schematic



Absolute Maximum Ratings T_C=25°C unless otherwise noted

Q1/Q4 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=80°C	305	A
I_{CM}	Pulsed Collector Current t_p=1ms	900	A
P_D	Maximum Power Dissipation @ T_j=175°C	955	W

Q2/Q3 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=80°C	270	A
I_{CM}	Pulsed Collector Current t_p=1ms	750	A
P_D	Maximum Power Dissipation @ T_j=175°C	842	W

D1-D4 Diode

Symbol	Description	Value	Unit
V_{RRM}	Repetitive Peak Reverse Voltage	650	V
I_F	Diode Continuous Forward Current@ T_C=80°C	130	A
I_{FM}	Diode Maximum Forward Current t_p=1ms	500	A

D5,D6 Diode

Symbol	Description	Value	Unit
V_{RRM}	Repetitive Peak Reverse Voltage	650	V
I_F	Diode Continuous Forward Current@ T_C=80°C	305	A
I_{FM}	Diode Maximum Forward Current t_p=1ms	1000	A

Module

Symbol	Description	Value	Unit
T_{jmax}	Maximum Junction Temperature	175	°C
T_{jop}	Operating Junction Temperature	-40 to +150	°C
T_{STG}	Storage Temperature Range	-40 to +125	°C
V_{ISO}	Isolation Voltage RMS,f=50Hz,t=1min	3200	V

Q1/Q4 IGBT Characteristics T_C=25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$V_{CE(sat)}$	Collector to Emitter Saturation Voltage	I_C=450A,V_{GE}=15V, T_j=25°C		1.45	1.90	V
		I_C=450A,V_{GE}=15V, T_j=125°C		1.60		
		I_C=450A,V_{GE}=15V, T_j=150°C		1.65		
$V_{GE(th)}$	Gate-Emitter Threshold Voltage	I_C=7.20mA,V_{CE}=V_{GE}, T_j=25°C	4.4	5.0	5.6	V
I_{CES}	Collector Cut-Off Current	V_{CE}=V_{CES},V_{GE}=0V, T_j=25°C			1.0	mA
I_{GES}	Gate-Emitter Leakage Current	V_{GE}=V_{GES},V_{CE}=0V, T_j=25°C			400	nA
R_{Gint}	Internal Gate Resistance			0.8		Ω
C_{ies}	Input Capacitance	V_{CE}=25V,f=100kHz, V_{GE}=0V		30.3		nF
C_{oes}	Onput Capacitance			1.33		nF
C_{res}	Reverse Transfer Capacitance			0.49		nF
Q_G	Gate Charge	V_{GE}=-15…+15V		2.77		μC
$t_{d(on)}$	Turn-On Delay Time	V_{CC}=400V,I_C=100A, R_G=4.7Ω, V_{GE}=-5V/+15V, T_j=25°C		90		ns
t_r	Rise Time			50		ns
$t_{d(off)}$	Turn-Off Delay Time			768		ns
t_f	Fall Time			36		ns
E_{on}	Turn-On Switching Loss			3.70		mJ
E_{off}	Turn-Off Switching Loss			0.57		mJ
$t_{d(on)}$	Turn-On Delay Time	V_{CC}=400V,I_C=100A, R_G=4.7Ω, V_{GE}=-5V/+15V, T_j=125°C		94		ns
t_r	Rise Time			60		ns
$t_{d(off)}$	Turn-Off Delay Time			829		ns
t_f	Fall Time			37		ns
E_{on}	Turn-On Switching Loss			4.87		mJ
E_{off}	Turn-Off Switching Loss			0.72		mJ
$t_{d(on)}$	Turn-On Delay Time	V_{CC}=400V,I_C=100A, R_G=4.7Ω, V_{GE}=-5V/+15V, T_j=150°C		97		ns
t_r	Rise Time			61		ns
$t_{d(off)}$	Turn-Off Delay Time			841		ns
t_f	Fall Time			41		ns
E_{on}	Turn-On Switching Loss			5.20		mJ
E_{off}	Turn-Off Switching Loss			0.80		mJ

Q2/Q3 IGBT Characteristics T_C=25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$V_{CE(sat)}$	Collector to Emitter Saturation Voltage	I_C=375A,V_{GE}=15V, T_j=25°C		1.45	1.90	V
		I_C=375A,V_{GE}=15V, T_j=125°C		1.60		
		I_C=375A,V_{GE}=15V, T_j=150°C		1.65		
$V_{GE(th)}$	Gate-Emitter Threshold Voltage	I_C=6.00mA,V_{CE}=V_{GE}, T_j=25°C	4.4	5.0	5.6	V
I_{CES}	Collector Cut-Off Current	V_{CE}=V_{CES},V_{GE}=0V, T_j=25°C			1.0	mA
I_{GES}	Gate-Emitter Leakage Current	V_{GE}=V_{GES},V_{CE}=0V, T_j=25°C			400	nA
R_{Gint}	Internal Gate Resistance			1.0		Ω
C_{ies}	Input Capacitance	V_{CE}=25V,f=100kHz, V_{GE}=0V		25.2		nF
C_{oes}	Onput Capacitance			1.11		nF
C_{res}	Reverse Transfer Capacitance			0.41		nF
Q_G	Gate Charge	V_{GE}=-15…+15V		2.31		μC
$t_{d(on)}$	Turn-On Delay Time	V_{CC}=400V,I_C=100A, R_G=4.7Ω, V_{GE}=-5V/+15V, T_j=25°C		90		ns
t_r	Rise Time			45		ns
$t_{d(off)}$	Turn-Off Delay Time			664		ns
t_f	Fall Time			23		ns
E_{on}	Turn-On Switching Loss			2.63		mJ
E_{off}	Turn-Off Switching Loss			0.62		mJ
$t_{d(on)}$	Turn-On Delay Time	V_{CC}=400V,I_C=100A, R_G=4.7Ω, V_{GE}=-5V/+15V, T_j=125°C		90		ns
t_r	Rise Time			52		ns
$t_{d(off)}$	Turn-Off Delay Time			726		ns
t_f	Fall Time			20		ns
E_{on}	Turn-On Switching Loss			3.11		mJ
E_{off}	Turn-Off Switching Loss			0.79		mJ
$t_{d(on)}$	Turn-On Delay Time	V_{CC}=400V,I_C=100A, R_G=4.7Ω, V_{GE}=-5V/+15V, T_j=150°C		90		ns
t_r	Rise Time			54		ns
$t_{d(off)}$	Turn-Off Delay Time			736		ns
t_f	Fall Time			22		ns
E_{on}	Turn-On Switching Loss			3.17		mJ
E_{off}	Turn-Off Switching Loss			0.82		mJ

D1-D4 Diode Characteristics T_C=25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_F	Diode Forward Voltage	I_F=200A,V_{GE}=0V,T_j=25°C		1.60	2.05	V
		I_F=200A,V_{GE}=0V,T_j=125°C		1.65		
		I_F=200A,V_{GE}=0V,T_j=150°C		1.65		
Q_r	Recovered Charge	V_R=400V,I_F=100A, -di/dt=3100A/μs,V_{GE}=-5V T_j=25°C		2.63		μC
I_{RM}	Peak Reverse Recovery Current			80		A
E_{rec}	Reverse Recovery Energy			0.46		mJ
Q_r	Recovered Charge	V_R=400V,I_F=100A, -di/dt=3200A/μs,V_{GE}=-5V T_j=125°C		4.71		μC
I_{RM}	Peak Reverse Recovery Current			102		A
E_{rec}	Reverse Recovery Energy			1.19		mJ
Q_r	Recovered Charge	V_R=400V,I_F=100A, -di/dt=3200A/μs,V_{GE}=-5V T_j=150°C		5.53		μC
I_{RM}	Peak Reverse Recovery Current			108		A
E_{rec}	Reverse Recovery Energy			1.42		mJ

D5,D6 Diode Characteristics T_C=25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_F	Diode Forward Voltage	I_F=500A,V_{GE}=0V,T_j=25°C		1.60	2.05	V
		I_F=500A,V_{GE}=0V,T_j=125°C		1.65		
		I_F=500A,V_{GE}=0V,T_j=150°C		1.65		
Q_r	Recovered Charge	V_R=400V,I_F=100A, -di/dt=3220A/μs,V_{GE}=-5V T_j=25°C		3.68		μC
I_{RM}	Peak Reverse Recovery Current			100		A
E_{rec}	Reverse Recovery Energy			0.62		mJ
Q_r	Recovered Charge	V_R=400V,I_F=100A, -di/dt=3350A/μs,V_{GE}=-5V T_j=125°C		8.00		μC
I_{RM}	Peak Reverse Recovery Current			142		A
E_{rec}	Reverse Recovery Energy			1.59		mJ
Q_r	Recovered Charge	V_R=400V,I_F=100A, -di/dt=3360A/μs,V_{GE}=-5V T_j=150°C		9.57		μC
I_{RM}	Peak Reverse Recovery Current			152		A
E_{rec}	Reverse Recovery Energy			1.83		mJ

NTC Characteristics T_C=25°C unless otherwise noted

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

Module Characteristics T_C=25°C unless otherwise noted

Symbol	Parameter	Min.	Typ.	Max.	Unit
R_{thJC}	Junction-to-Case (per Q1/Q4 IGBT) Junction-to-Case (per Q2/Q3 IGBT) Junction-to-Case (per D1-D4 Diode) Junction-to-Case (per D5,D6 Diode)			0.157 0.178 0.378 0.165	K/W
R_{thCH}	Case-to-Heatsink (per Q1/Q4 IGBT) Case-to-Heatsink (per Q2/Q3 IGBT) Case-to-Heatsink (per D1-D4 Diode) Case-to-Heatsink (per D5,D6 Diode)		0.066 0.086 0.186 0.087		K/W
M	Mounting Torque, Screw:M5	3.0		5.0	N.m
G	Weight of Module		250		g

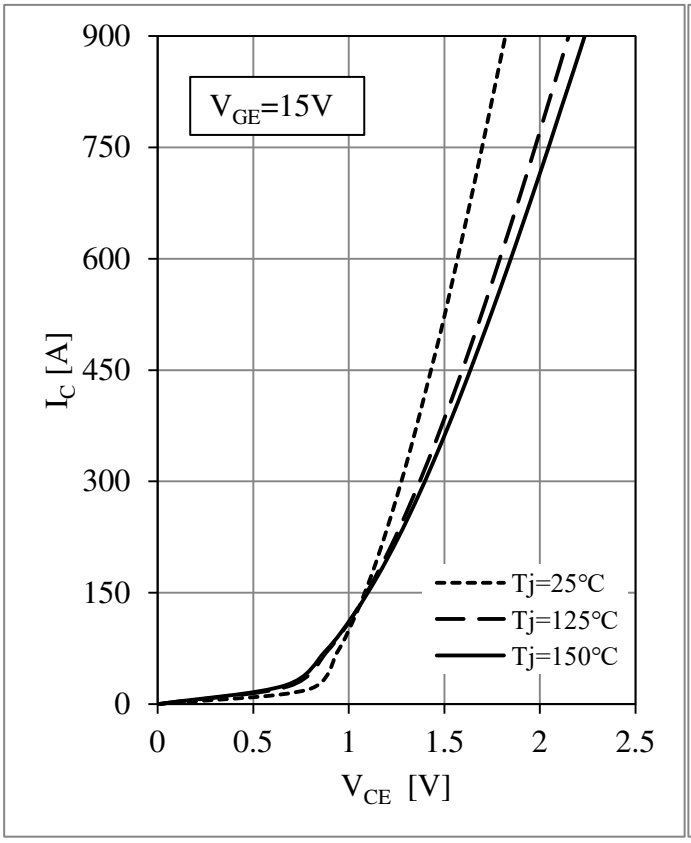


Fig 1. Q1/Q4 IGBT Output Characteristics

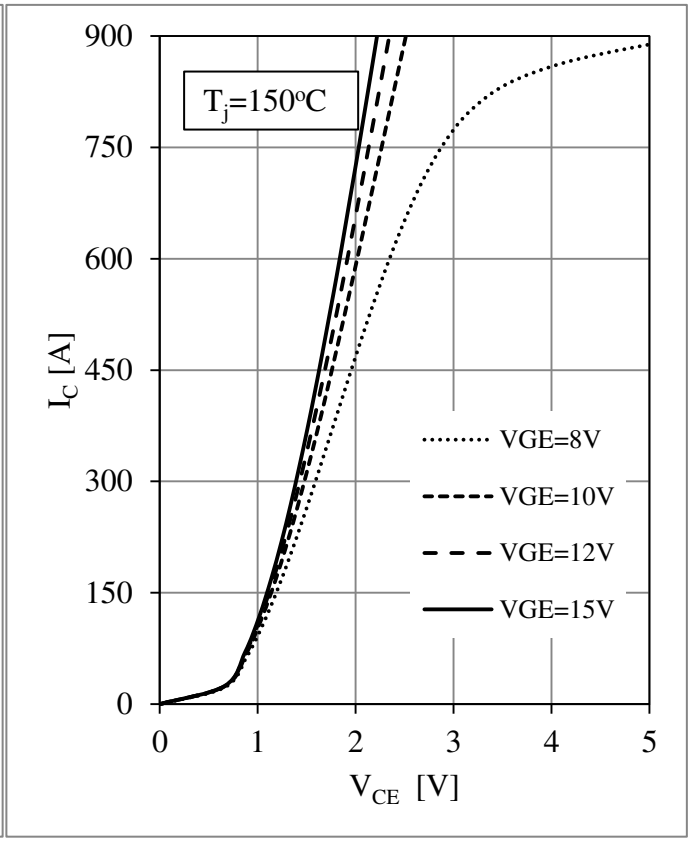


Fig 2. Q1/Q4 IGBT Output Characteristics

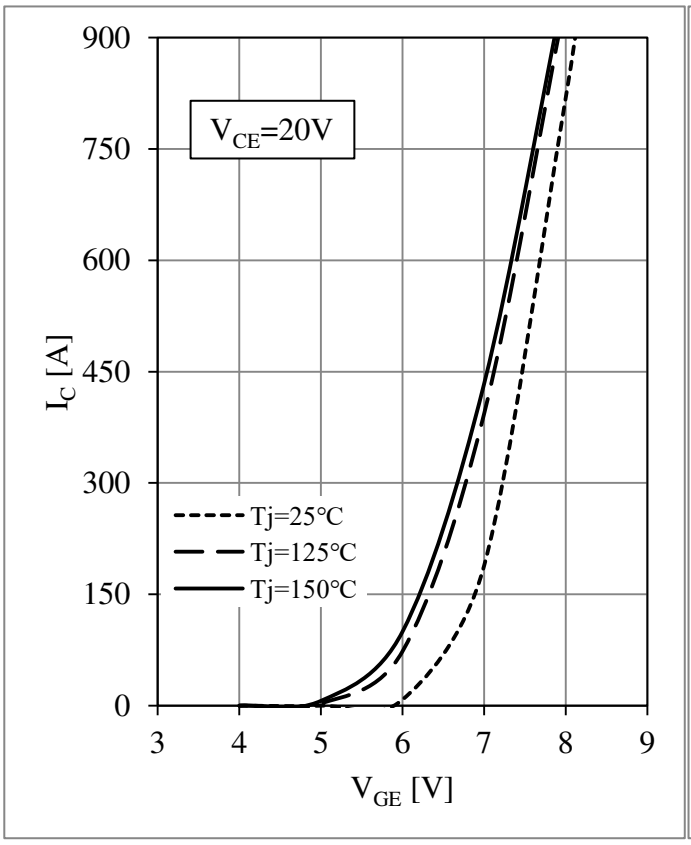


Fig 3. Q1/Q4 IGBT Transfer Characteristics

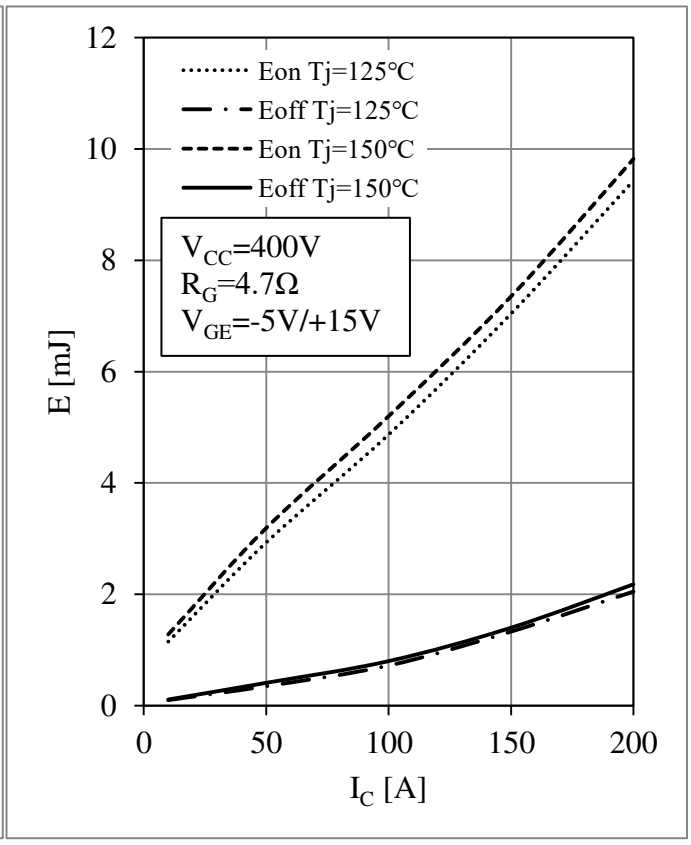


Fig 4. Q1/Q4 IGBT Switching Loss vs. I_C

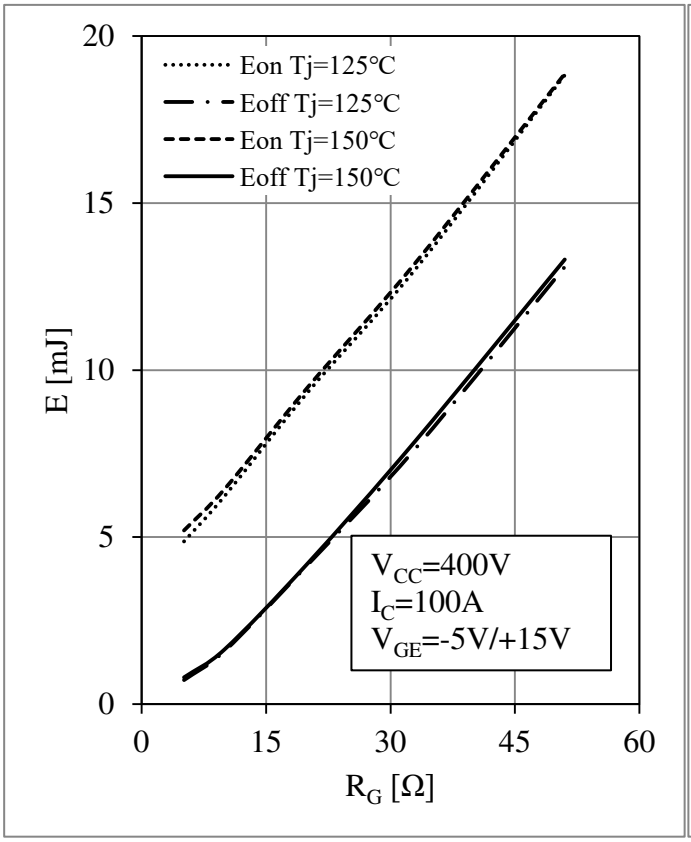


Fig 5.Q1/Q4 IGBT Switching Loss vs. RG

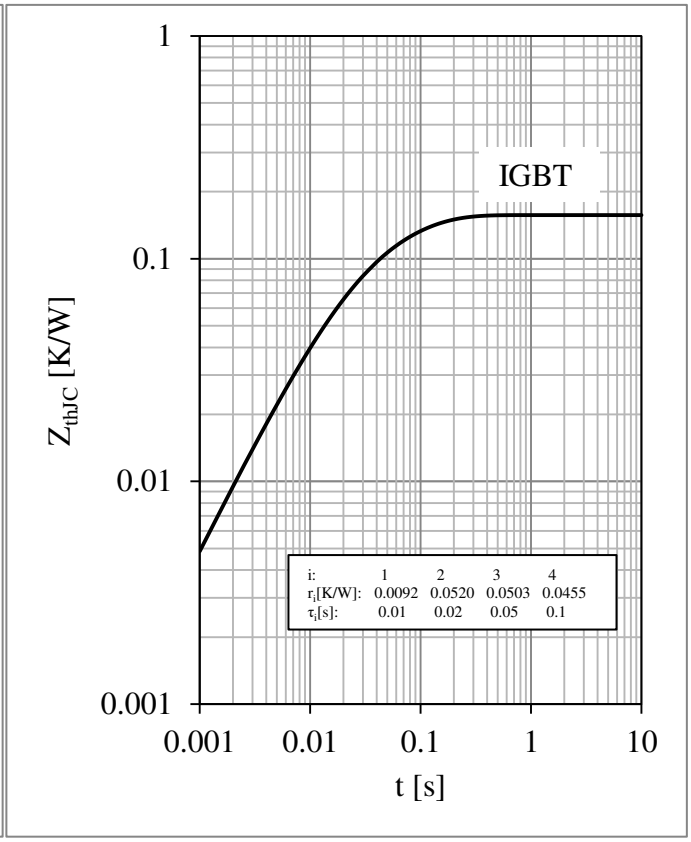


Fig 6. Q1/Q4 IGBT Transient Thermal Impedance

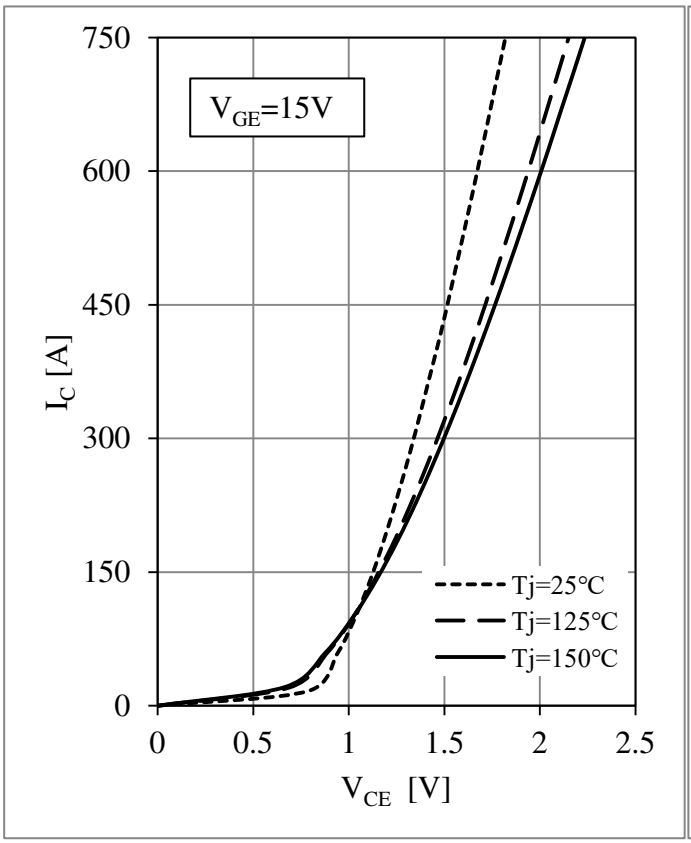


Fig 7. Q2/Q3 IGBT Output Characteristics

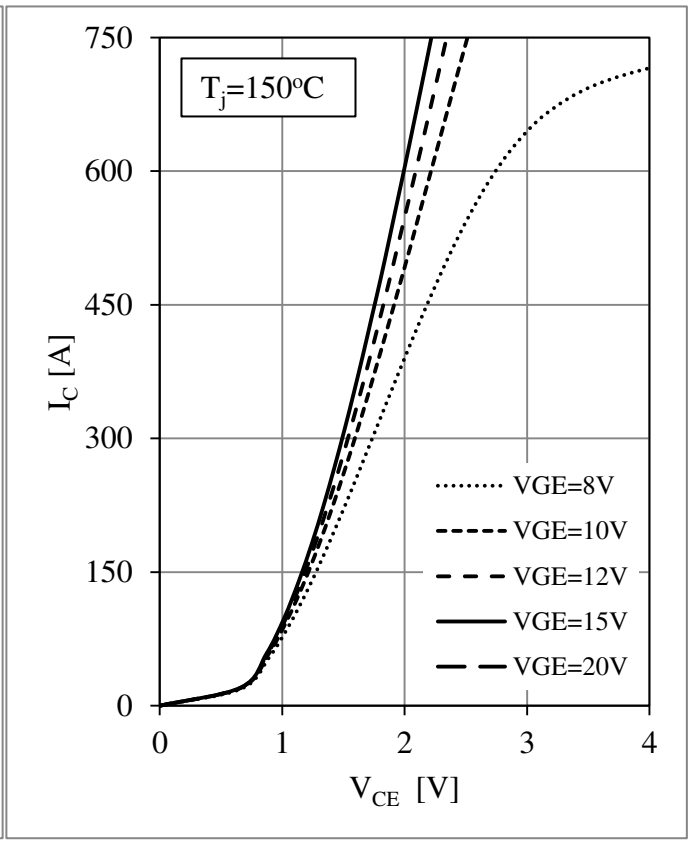


Fig 8. Q2/Q3 IGBT Output Characteristics

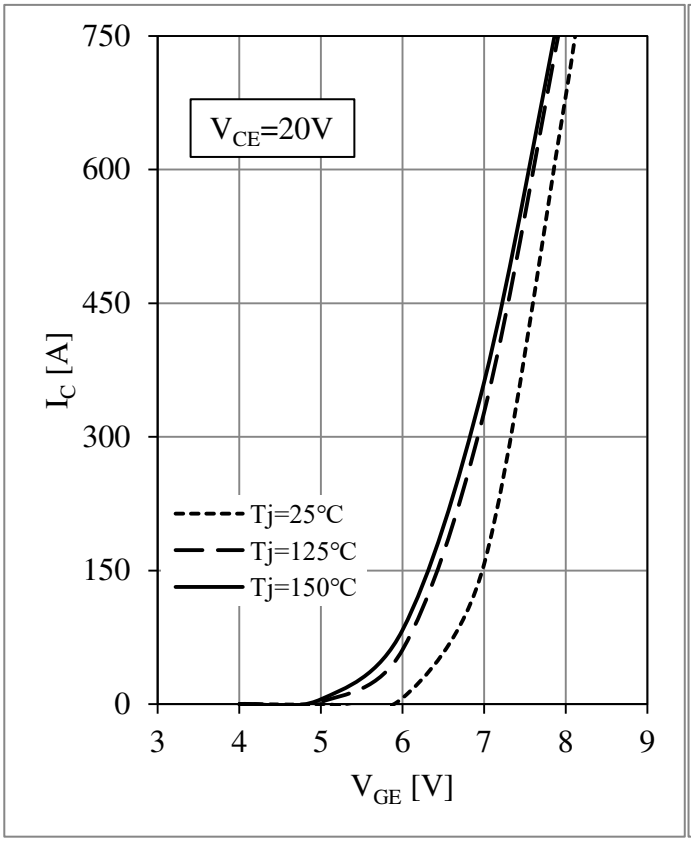


Fig 9. Q2/Q3 IGBT Transfer Characteristics

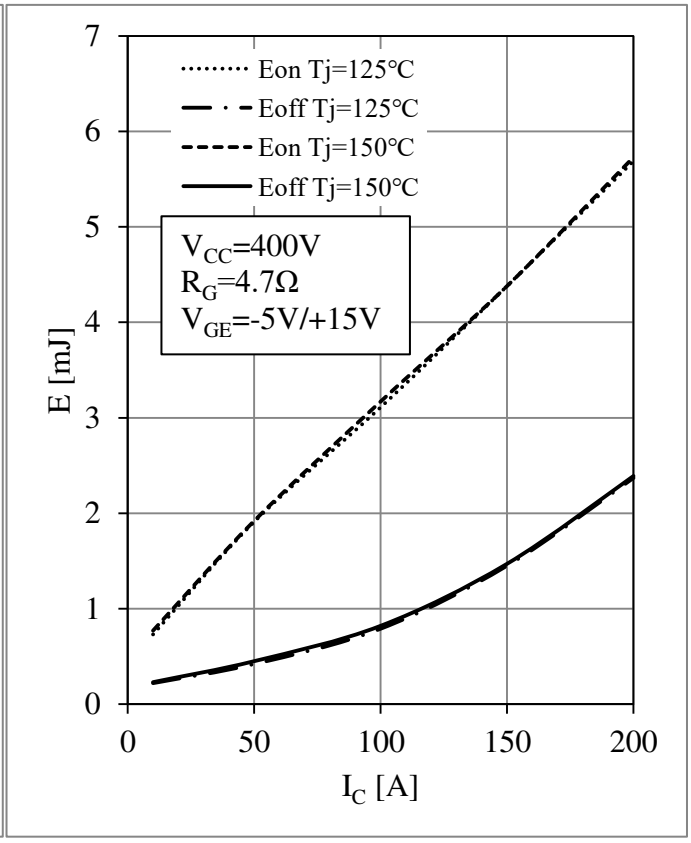


Fig 10. Q2/Q3 IGBT Switching Loss vs. I_C

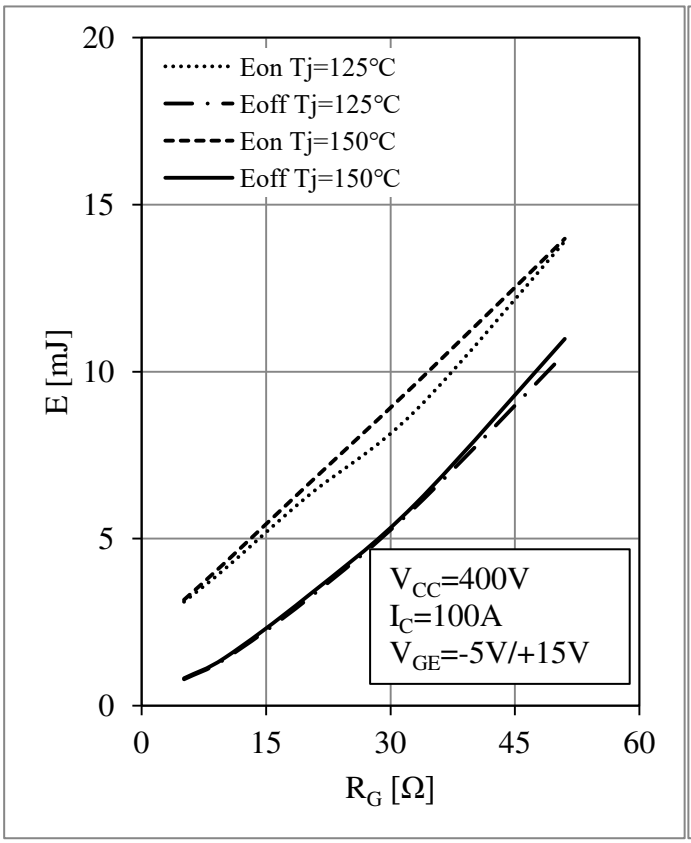


Fig 11.Q2/Q3 IGBT Switching Loss vs. RG

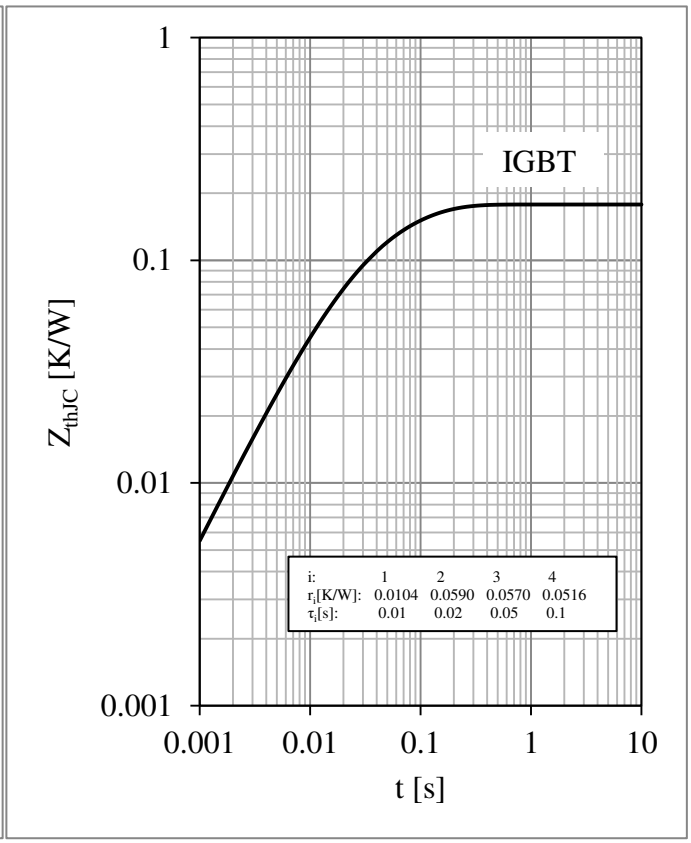


Fig 12. Q2/Q3 IGBT Transient Thermal Impedance

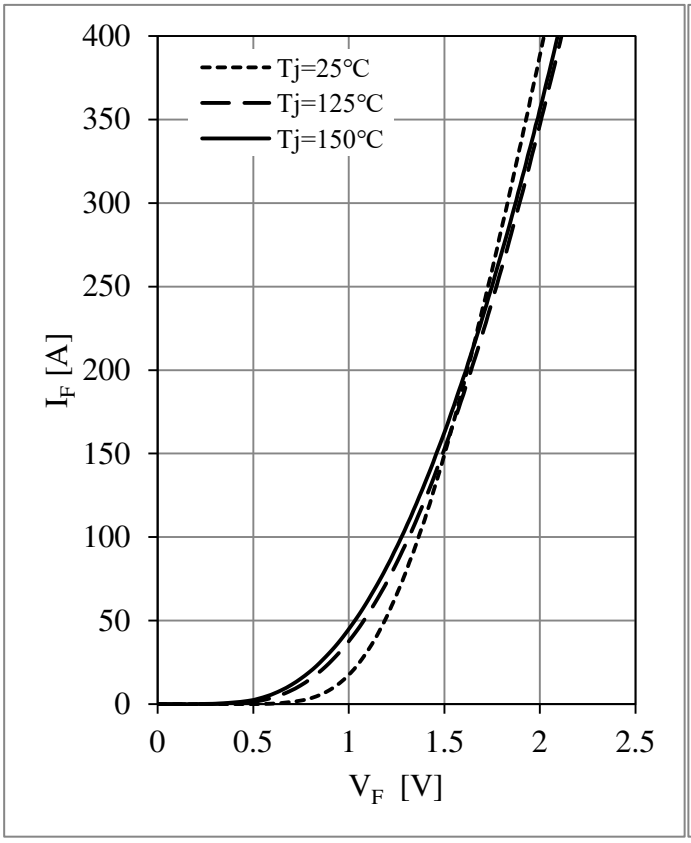


Fig 13. D1-D4 Diode Forward Characteristics

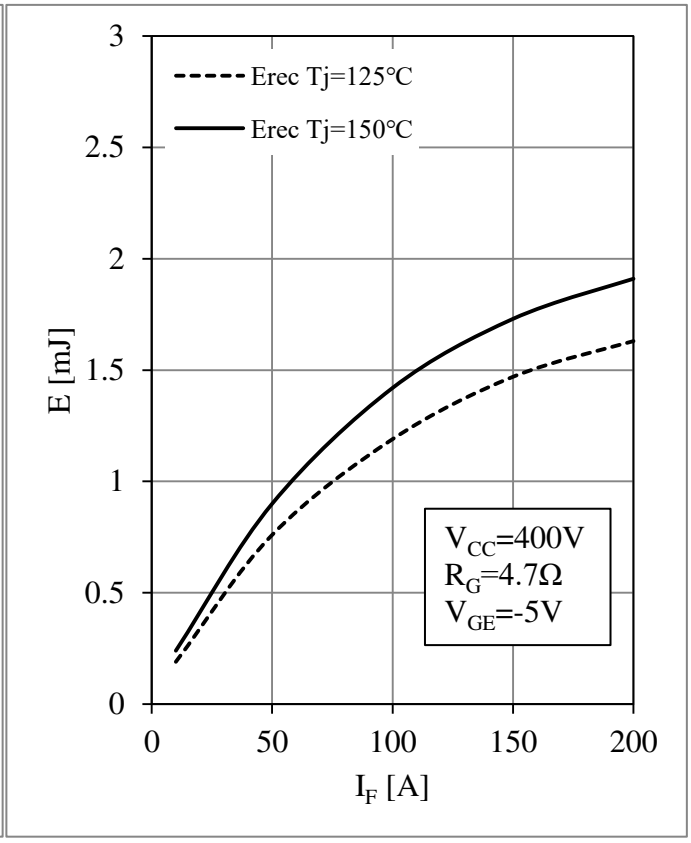


Fig 14. D1-D4 Diode Switching Loss vs. I_F

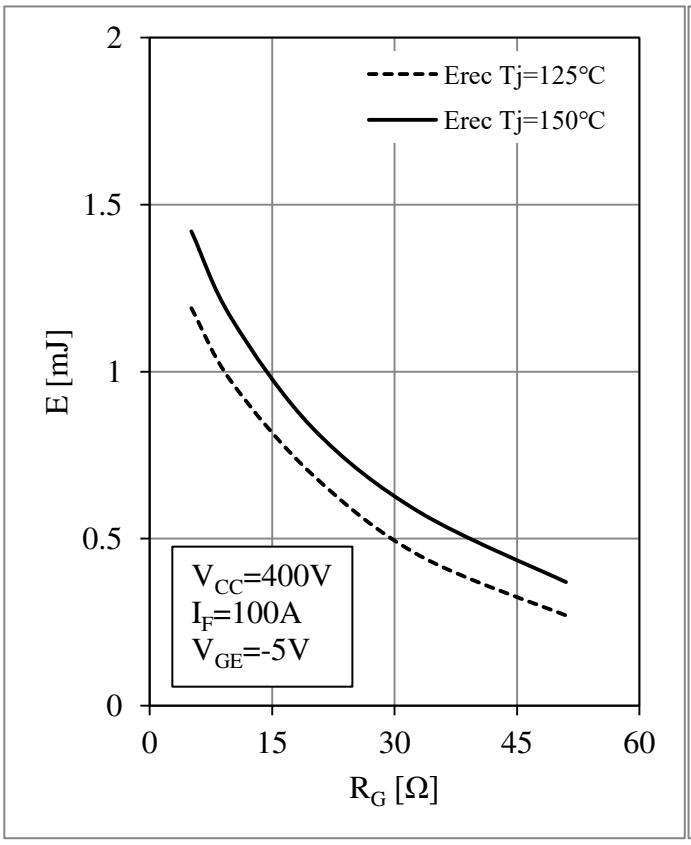


Fig 15. D1-D4 Diode Switching Loss vs. R_G

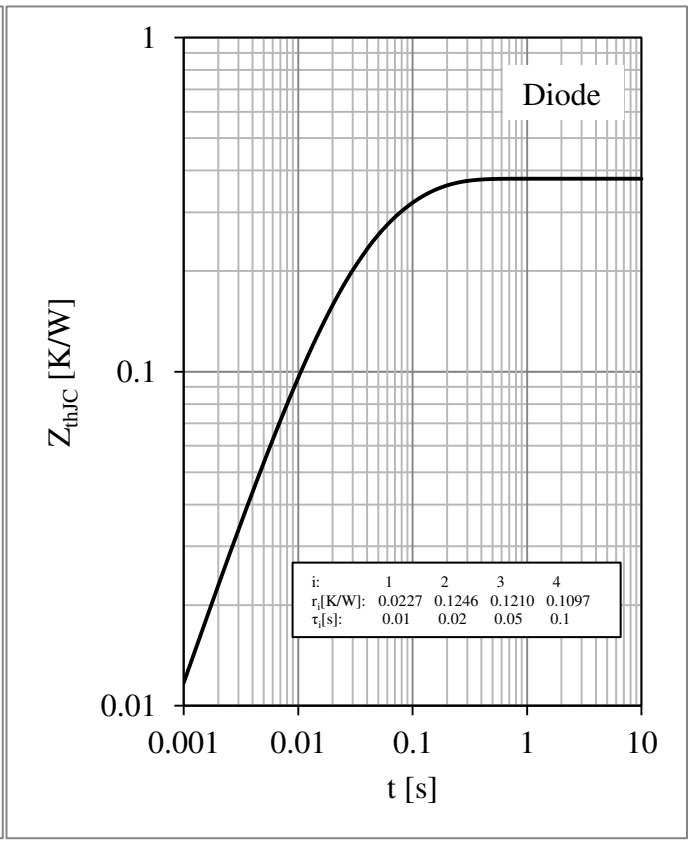


Fig 16. D1-D4 Diode Transient Thermal Impedance

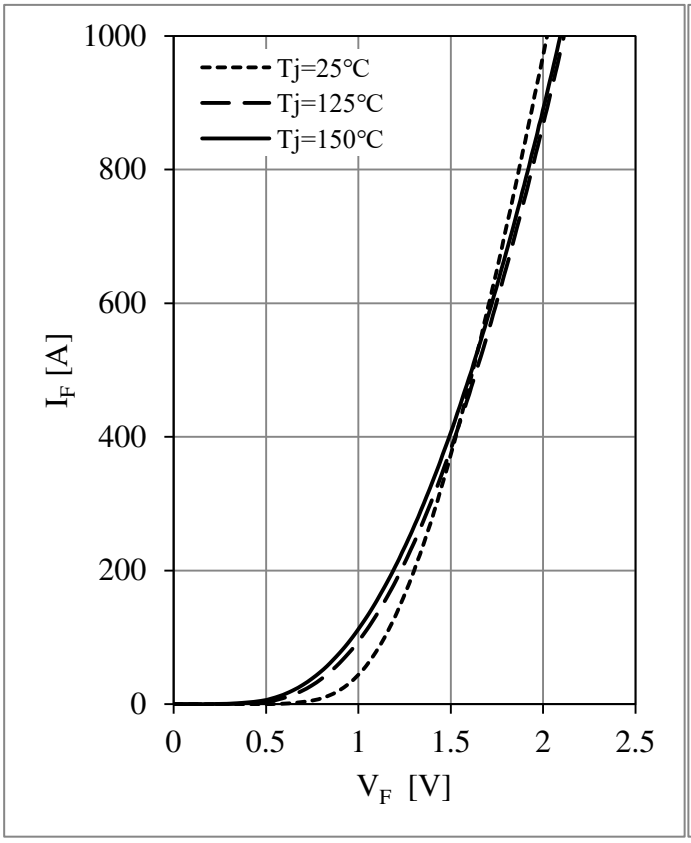


Fig 17. D5/D6 Diode Forward Characteristics

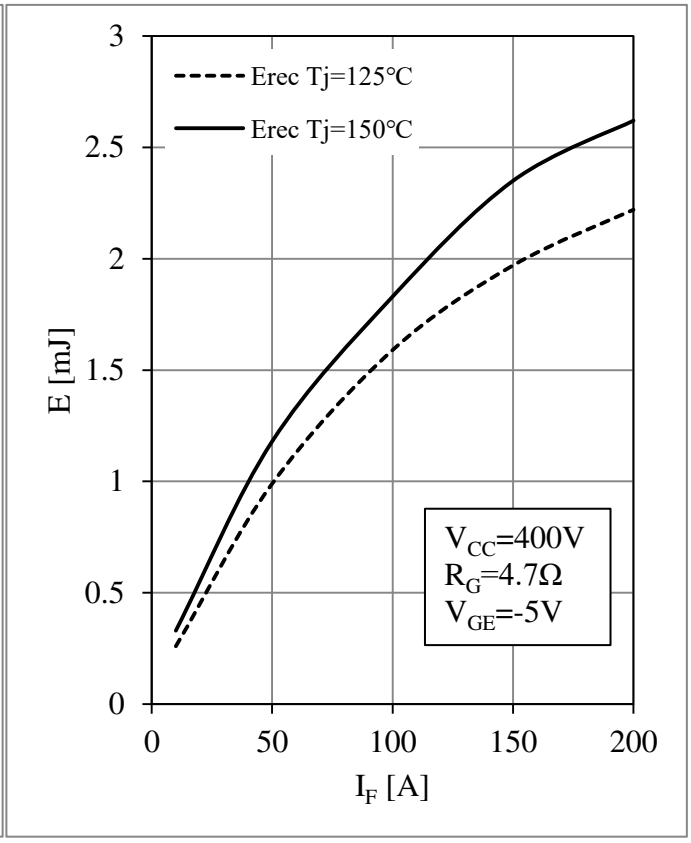


Fig 18. D5/D6 Diode Switching Loss vs. I_F

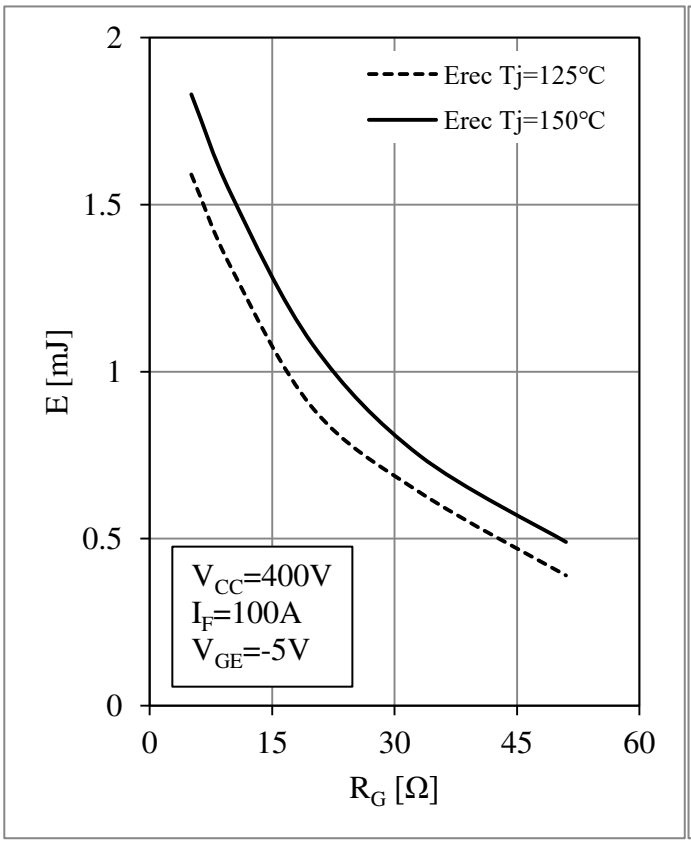


Fig 19. D5/D6 Diode Switching Loss vs. R_G

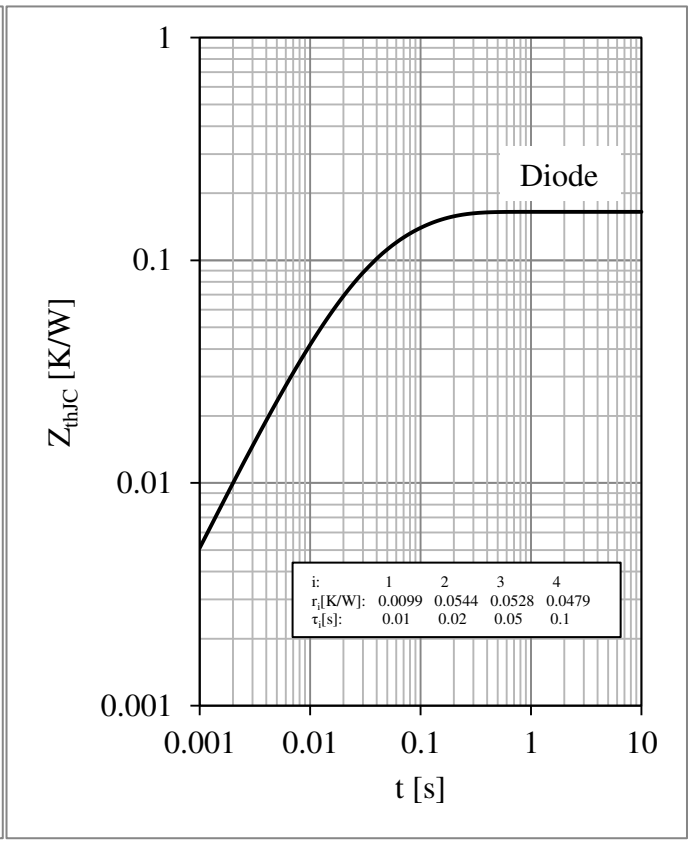


Fig 20. D5/D6 Diode Transient Thermal Impedance

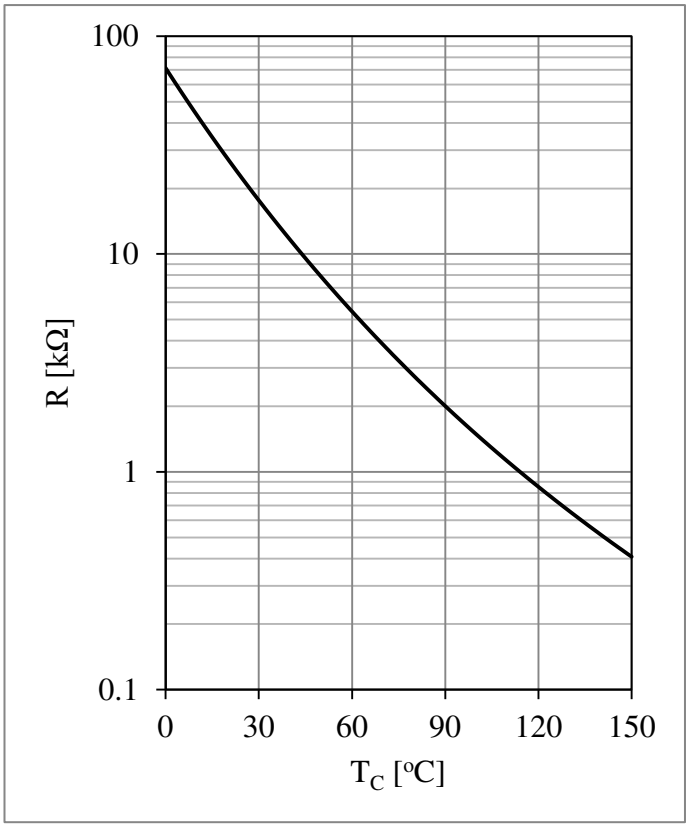
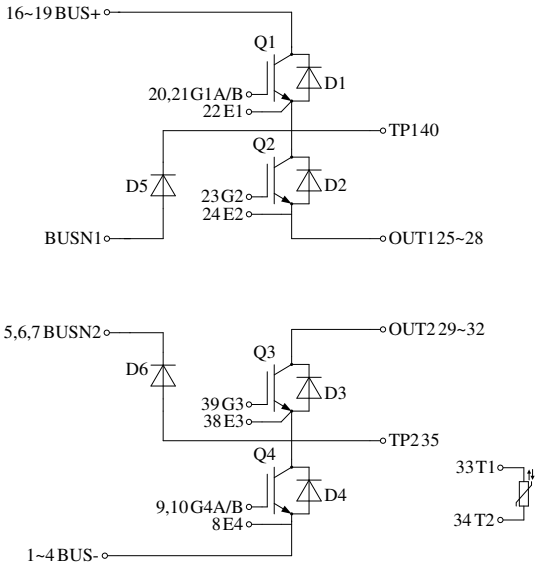


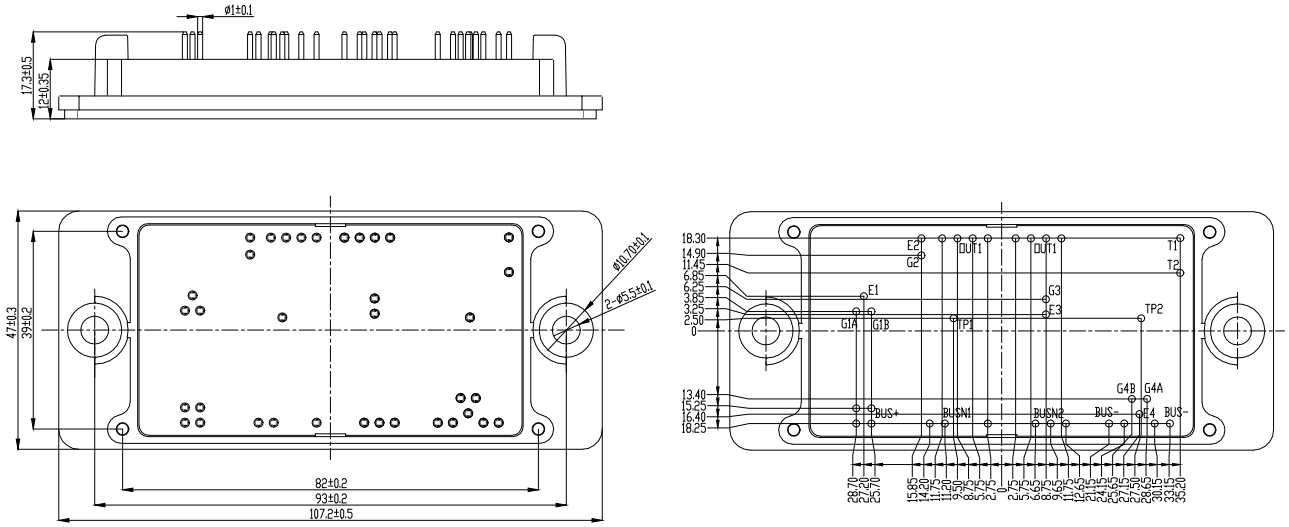
Fig 21. NTC Temperature Characteristic

Circuit Schematic



Package Dimensions

Dimensions in Millimeters



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