

# STARPOWER

SEMICONDUCTOR

**SiC MOSFET**

## MD13HTC75P6HE

**750V/1.25mΩ 6 in one-package**

### General Description

STARPOWER MOSFET Power Module provides very low  $R_{DS(on)}$  as well as optimized intrinsic diode. It's designed for the applications such as hybrid and electric vehicle.

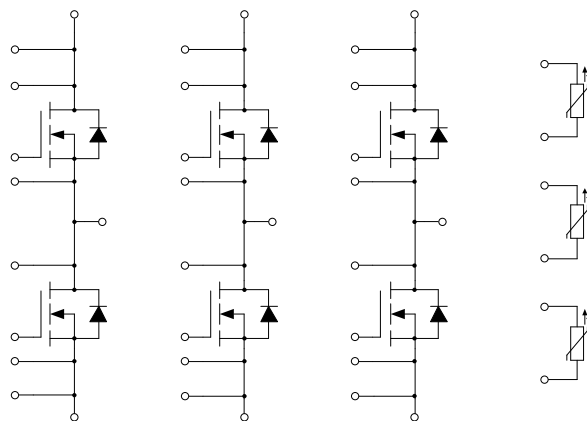
### Features

- SiC power MOSFET
- Low  $R_{DS(on)}$
- Optimized intrinsic reverse diode
- Low inductance case avoid oscillations
- Isolated copper pinfin baseplate using  $Si_3N_4$  AMB technology

### Typical Applications

- Automotive application
- Hybrid and electric vehicle
- Inverter for motor drive

### Equivalent Circuit Schematic



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

Symbol	Description	Value	Unit
$V_{DSS}$	Drain-Source Voltage	750	V
$V_{GSSmax}$	Gate-Source Voltage	-8/+19	V
$V_{GSSop}$	Gate-Source Voltage	-4/+15	V
$I_D$	Drain Current @ $T_F=75^{\circ}\text{C}$	680	A
$I_{DM}$	Pulsed Drain Current, $t_p$ limited by $T_{jmax}$	1320	A
$P_D$	Maximum Power Dissipation @ $T_F=75^{\circ}\text{C}$ $T_j=175^{\circ}\text{C}$	990	W

**Body Diode**

Symbol	Description	Value	Unit
$I_S$	Source Current @ $T_F=75^{\circ}\text{C}$	219	A

**Module**

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

**MOSFET Characteristics**  $T_F=25^\circ\text{C}$  unless otherwise noted

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$R_{DS(on)}$	Static Drain-Source On-Resistance	$I_D=660\text{A}, V_{GS}=15\text{V}, T_j=25^\circ\text{C}$		1.25		m $\Omega$
		$I_D=660\text{A}, V_{GS}=15\text{V}, T_j=150^\circ\text{C}$		1.50		
		$I_D=660\text{A}, V_{GS}=15\text{V}, T_j=175^\circ\text{C}$		1.70		
$V_{GS(th)}$	Gate-Source Threshold Voltage	$I_D=180\text{mA}, V_{DS}=V_{GS}, T_j=25^\circ\text{C}$	1.8	2.4	3.6	V
$I_{DSS}$	Drain-Source Leakage Current	$V_{DS}=V_{DSS}, V_{GS}=0\text{V}, T_j=25^\circ\text{C}$			500	$\mu\text{A}$
$I_{GSS}$	Gate-Source Leakage Current	$V_{GS}=15\text{V}, V_{DS}=0\text{V}, T_j=25^\circ\text{C}$			800	nA
$R_{Gint}$	Internal Gate Resistance			0.40		$\Omega$
$C_{iss}$	Input Capacitance	$V_{GS}=0\text{V}, V_{DS}=470\text{V}, f=100\text{kHz}$		57.5		nF
$C_{oss}$	Output Capacitance			3.71		nF
$C_{rss}$	Reverse Transfer Capacitance			0.31		nF
$Q_g$	Total Gate Charge	$I_D=660\text{A}, V_{DS}=470\text{V}, V_{GS}=-4/+15\text{V}$		1.19		$\mu\text{C}$
$t_{d(on)}$	Turn-On Delay Time	$V_{DS}=470\text{V}, I_D=660\text{A}, R_{Gon}=1.5\Omega, R_{Goff}=4.7\Omega, L_S=25\text{nH}, V_{GS}=-4/+15\text{V}, T_j=25^\circ\text{C}$		92		ns
$t_r$	Rise Time			64		ns
$t_{d(off)}$	Turn-Off Delay Time			628		ns
$t_f$	Fall Time			89		ns
$E_{on}$	Turn-On Switching Loss	$T_j=25^\circ\text{C}$		5.56		mJ
$E_{off}$	Turn-Off Switching Loss			41.6		mJ
$t_{d(on)}$	Turn-On Delay Time	$V_{DS}=470\text{V}, I_D=660\text{A}, R_{Gon}=1.5\Omega, R_{Goff}=4.7\Omega, L_S=25\text{nH}, V_{GS}=-4/+15\text{V}, T_j=150^\circ\text{C}$		85		ns
$t_r$	Rise Time			59		ns
$t_{d(off)}$	Turn-Off Delay Time			688		ns
$t_f$	Fall Time			98		ns
$E_{on}$	Turn-On Switching Loss	$T_j=150^\circ\text{C}$		4.49		mJ
$E_{off}$	Turn-Off Switching Loss			41.9		mJ
$t_{d(on)}$	Turn-On Delay Time	$V_{DS}=470\text{V}, I_D=660\text{A}, R_{Gon}=1.5\Omega, R_{Goff}=4.7\Omega, L_S=25\text{nH}, V_{GS}=-4/+15\text{V}, T_j=175^\circ\text{C}$		84		ns
$t_r$	Rise Time			58		ns
$t_{d(off)}$	Turn-Off Delay Time			720		ns
$t_f$	Fall Time			104		ns
$E_{on}$	Turn-On Switching Loss	$T_j=175^\circ\text{C}$		4.40		mJ
$E_{off}$	Turn-Off Switching Loss			42.1		mJ

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

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$V_{SD}$	Diode Forward Voltage	$I_S=660\text{A}, V_{GS}=-4\text{V}, T_j=25^{\circ}\text{C}$		5.40		V
		$I_S=660\text{A}, V_{GS}=-4\text{V}, T_j=150^{\circ}\text{C}$		4.90		
		$I_S=660\text{A}, V_{GS}=-4\text{V}, T_j=175^{\circ}\text{C}$		4.85		
$Q_r$	Diode Reverse Recovery Charge	$V_R=470\text{V}, I_S=660\text{A}, -di/dt=11690\text{A}/\mu\text{s}, L_S=25\text{nH}, V_{GS}=-4\text{V}, T_j=25^{\circ}\text{C}$		4.50		$\mu\text{C}$
$I_{rrm}$	Peak Reverse Recovery Current			172		A
$E_{rec}$	Reverse Recovery Energy			2.57		mJ
$Q_r$	Diode Reverse Recovery Charge	$V_R=470\text{V}, I_S=660\text{A}, -di/dt=12560\text{A}/\mu\text{s}, L_S=25\text{nH}, V_{GS}=-4\text{V}, T_j=150^{\circ}\text{C}$		6.75		$\mu\text{C}$
$I_{rrm}$	Peak Reverse Recovery Current			238		A
$E_{rec}$	Reverse Recovery Energy			3.84		mJ
$Q_r$	Diode Reverse Recovery Charge	$V_R=470\text{V}, I_S=660\text{A}, -di/dt=12700\text{A}/\mu\text{s}, L_S=25\text{nH}, V_{GS}=-4\text{V}, T_j=175^{\circ}\text{C}$		6.99		$\mu\text{C}$
$I_{rrm}$	Peak Reverse Recovery Current			244		A
$E_{rec}$	Reverse Recovery Energy			4.20		mJ

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

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$R_{25}$	Rated Resistance			5.0		k $\Omega$
$\Delta R/R$	Deviation of $R_{100}$	$T_j=100^{\circ}\text{C}, R_{100}=493.3\Omega$	-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**  $T_F=25^{\circ}\text{C}$  unless otherwise noted

Symbol	Parameter	Min.	Typ.	Max.	Unit
$L_{CE}$	Stray Inductance		8		nH
$\Delta p$	$\Delta V/\Delta t=10.0\text{dm}^3/\text{min}, T_F=75^{\circ}\text{C}$		64		mbar
$p$	Maximum Pressure In Cooling Circuit			2.5	bar
$R_{thJF}$	Junction-to-Cooling Fluid (per MOSFET) $\Delta V/\Delta t=10.0\text{dm}^3/\text{min}, T_F=75^{\circ}\text{C}$			0.101	K/W
$M$	Terminal Connection Torque, Screw M5 Mounting Torque, Screw M4	3.6 1.8		4.4 2.2	N.m
$G$	Weight of Module		750		g

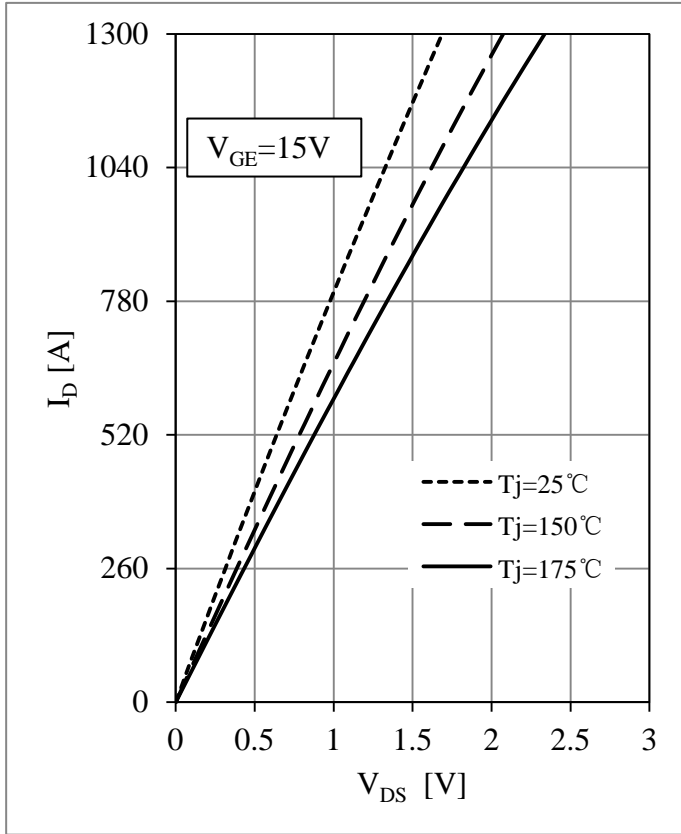


Fig 1. MOSFET Output Characteristics

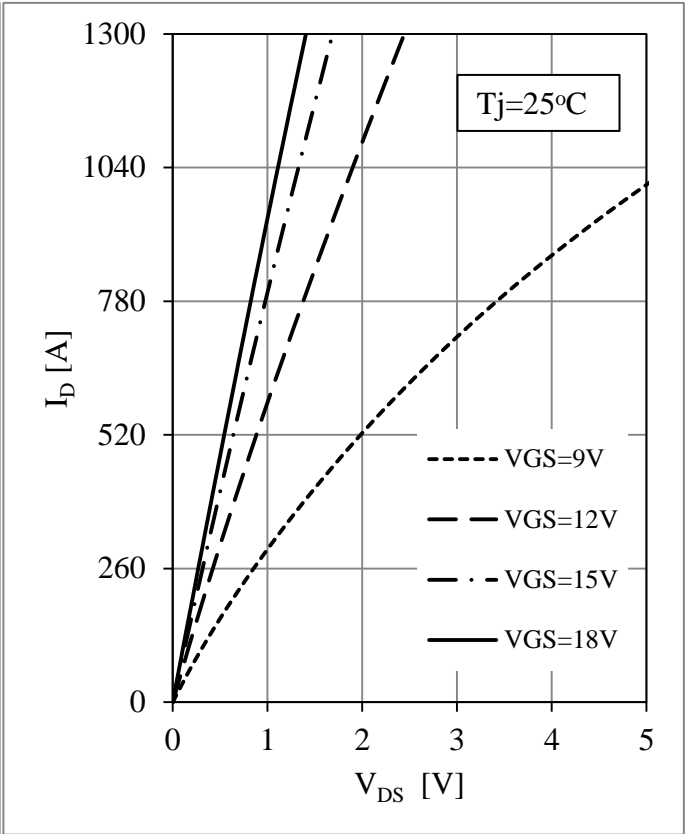


Fig 2. MOSFET Output Characteristics

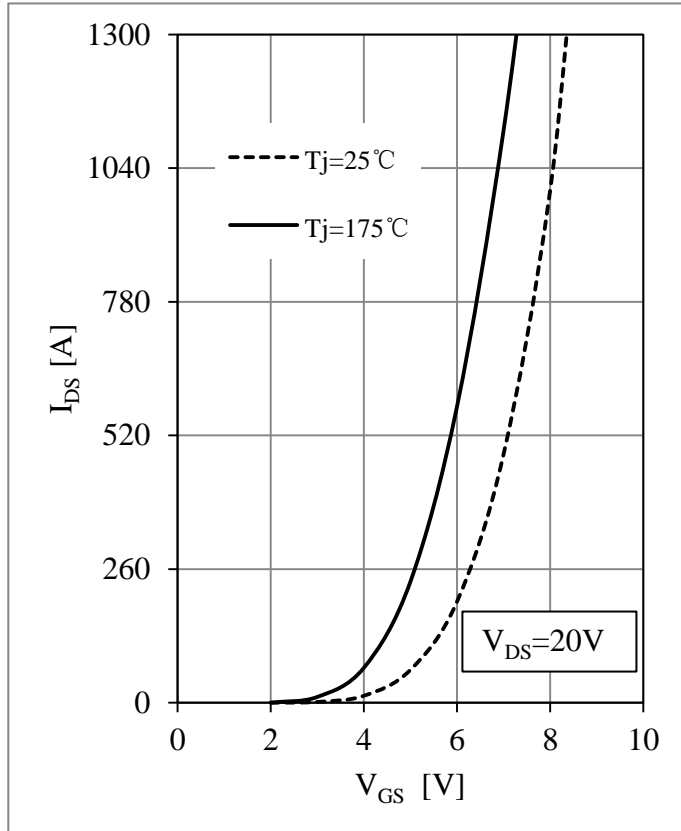


Fig 3. MOSFET Transfer Characteristics

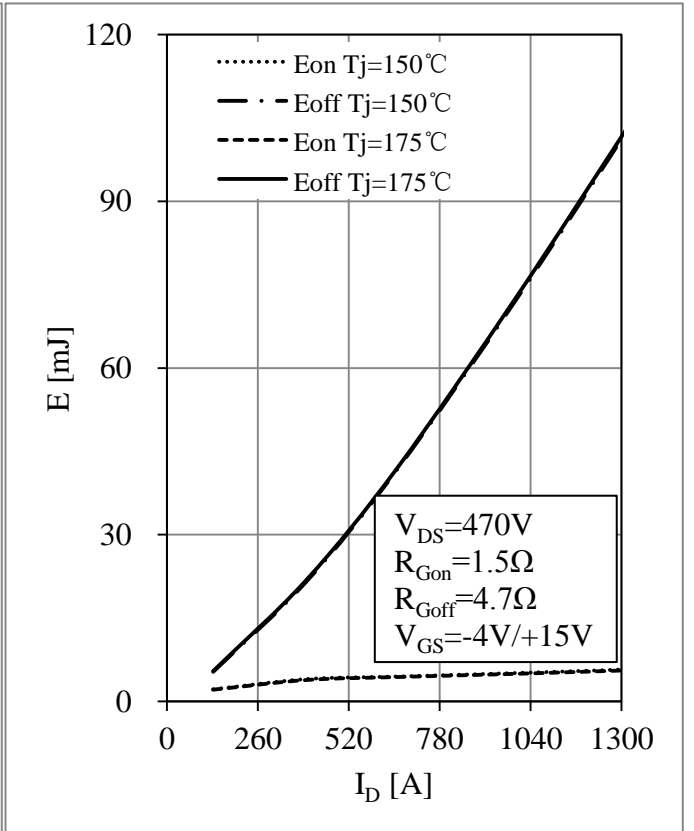


Fig 4. MOSFET Switching Loss vs.  $I_{DS}$

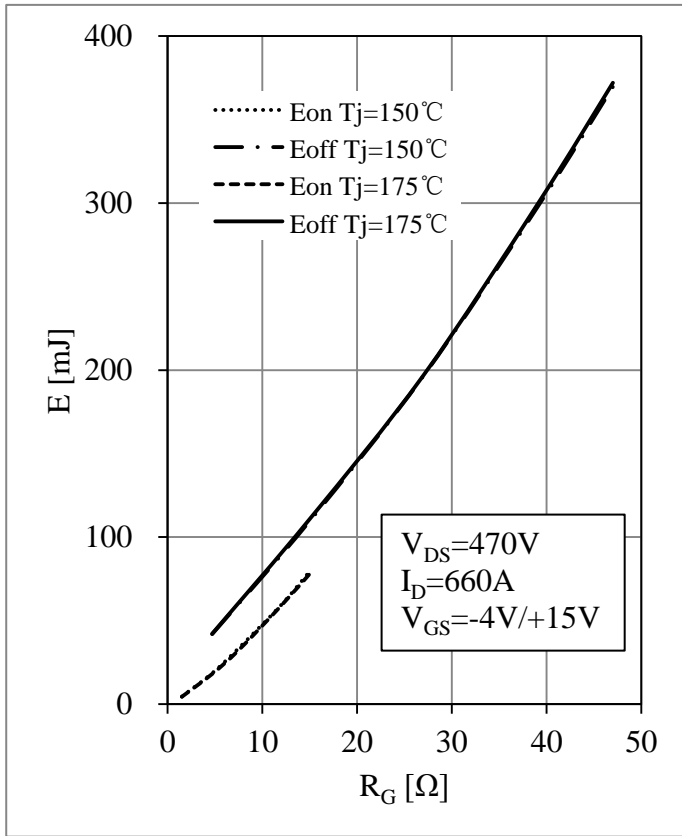


Fig 5. MOSFET Switching Loss vs.  $R_G$

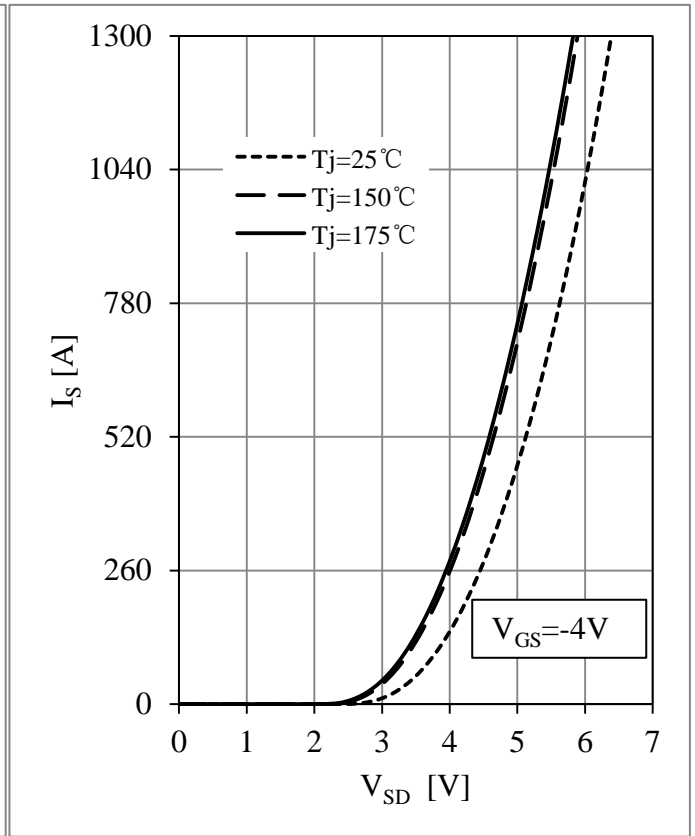


Fig 6. Body Diode Characteristics

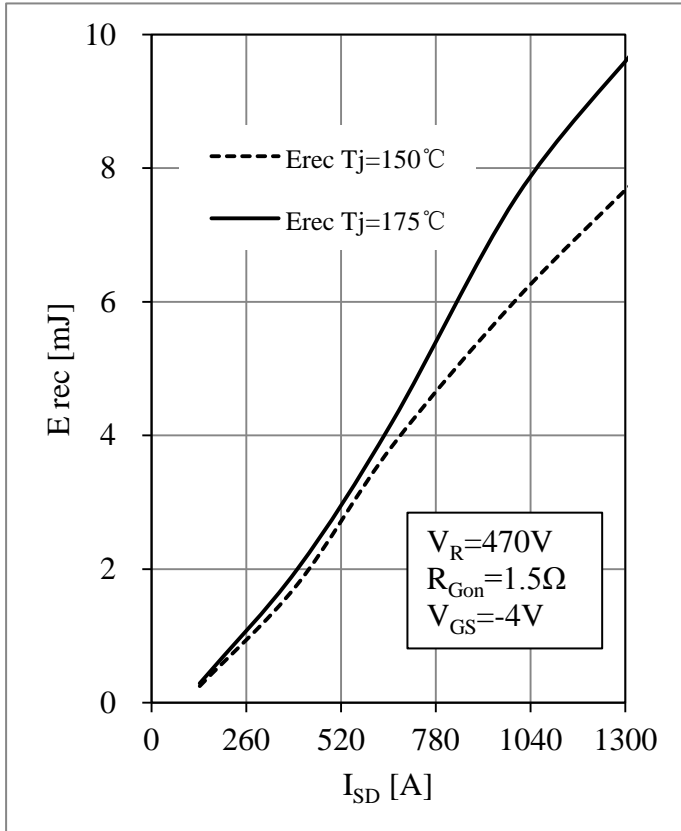


Fig 7. Body Diode Switching Loss vs.  $I_S$

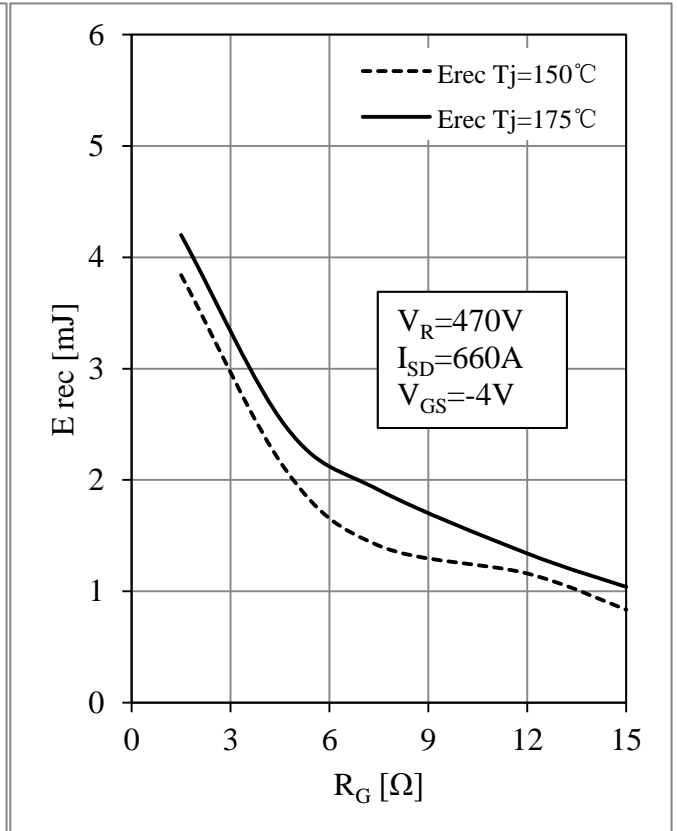


Fig 8. Body Diode Switching Loss vs.  $R_G$

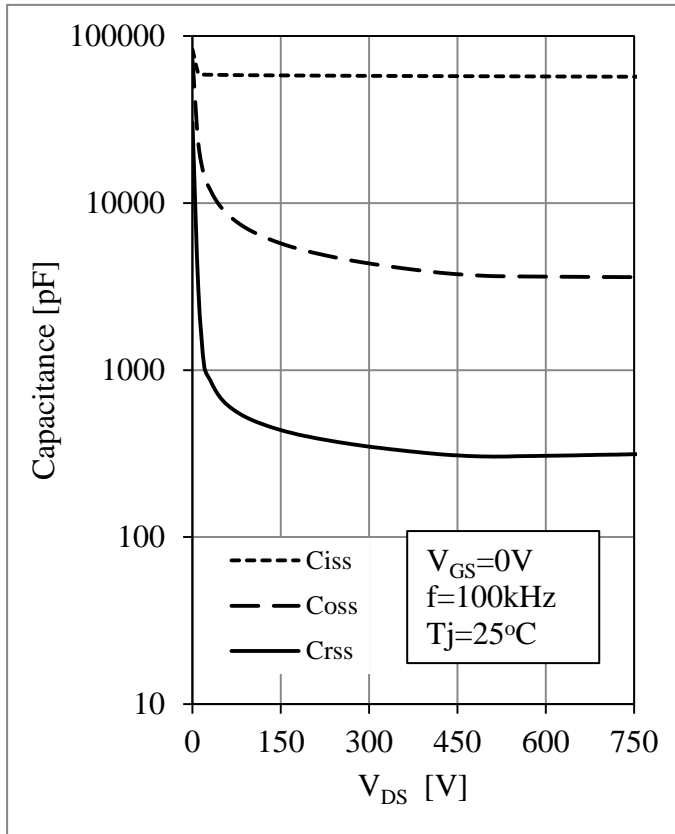


Fig 9. Capacitance vs.  $V_{DS}$

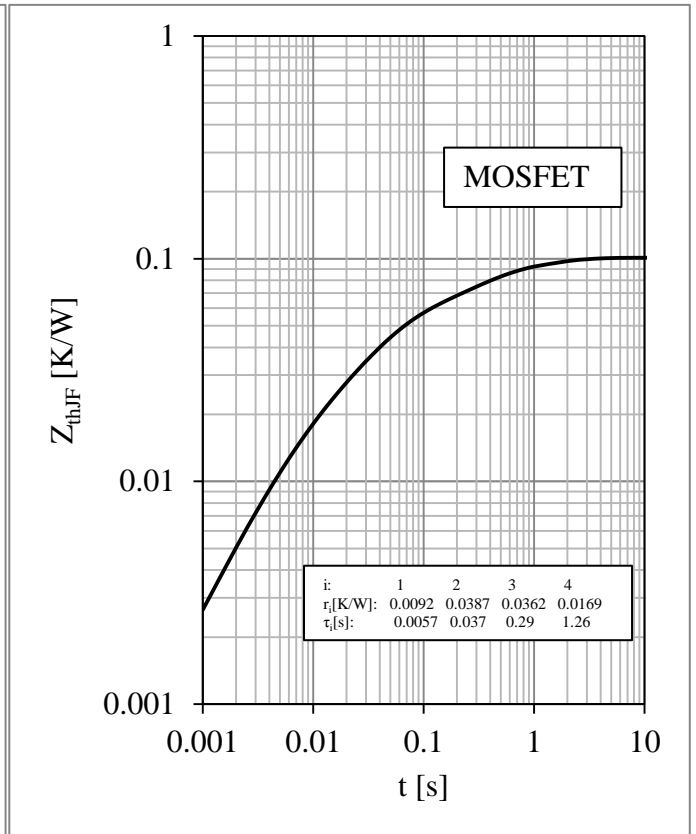


Fig 10. MOSFET Transient Thermal Impedance

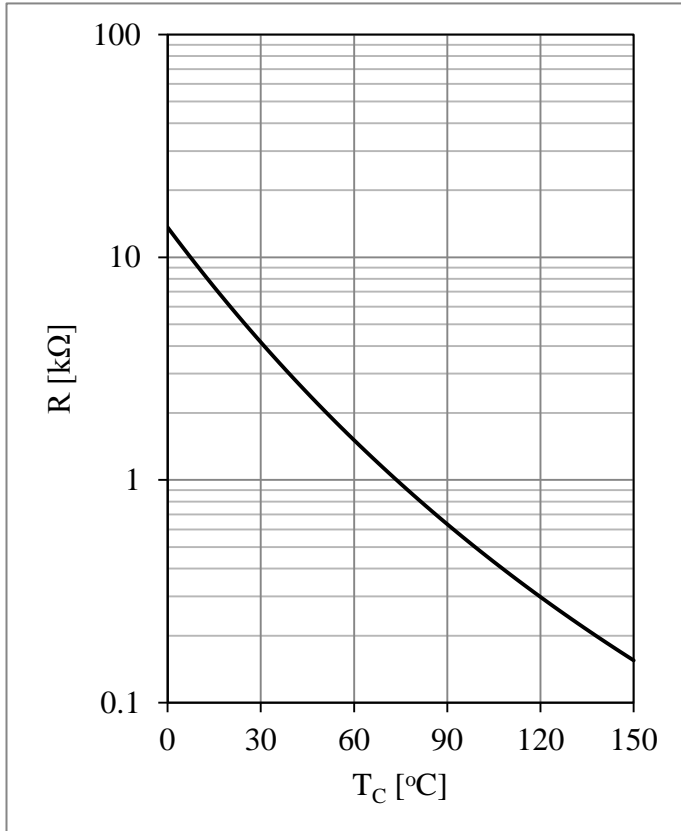
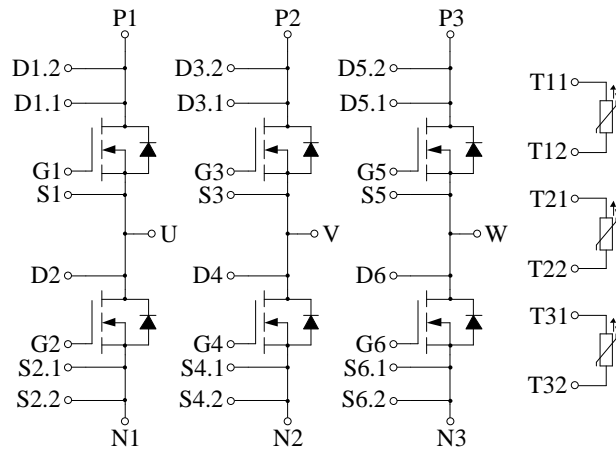


Fig 11. NTC Temperature Characteristic

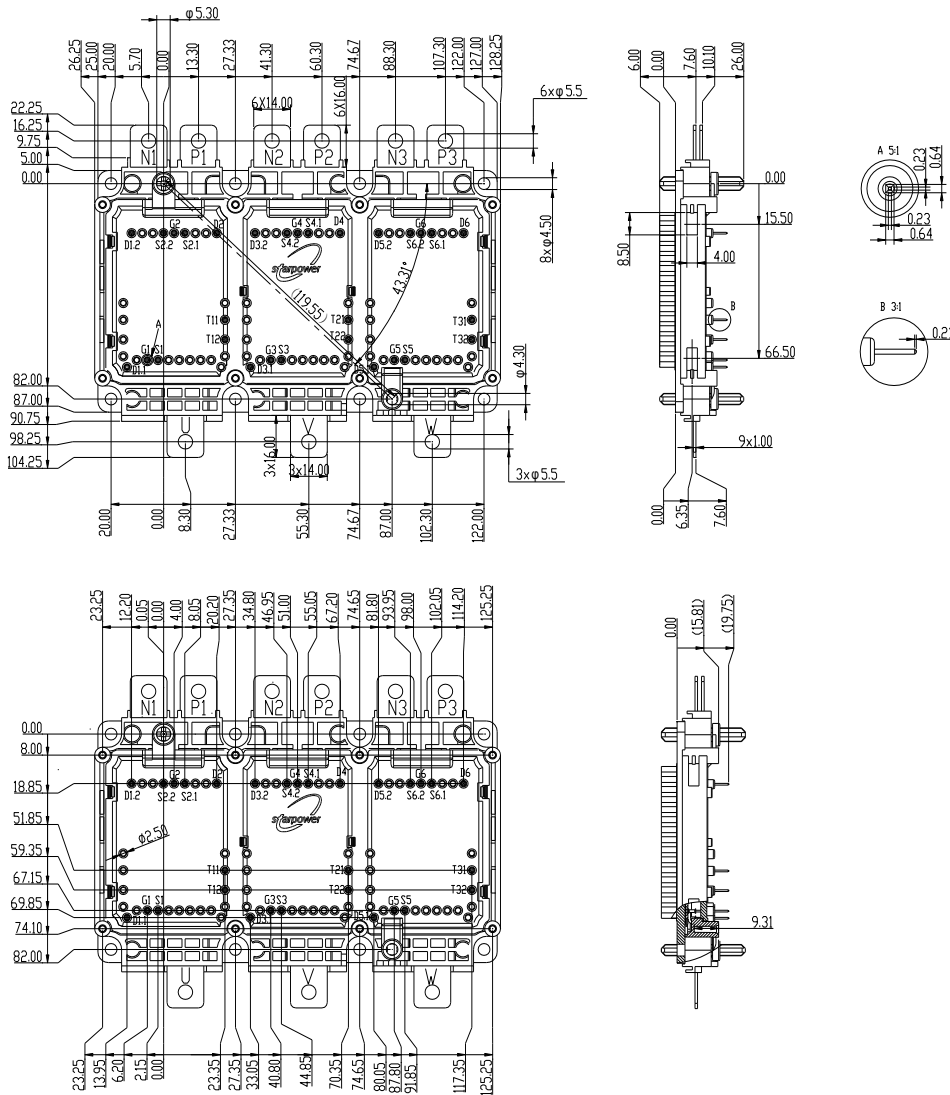


Circuit Schematic



Package Dimensions

Dimensions in Millimeters



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