



1200V SiC HPD Power Module

AEPR25B12C1LT

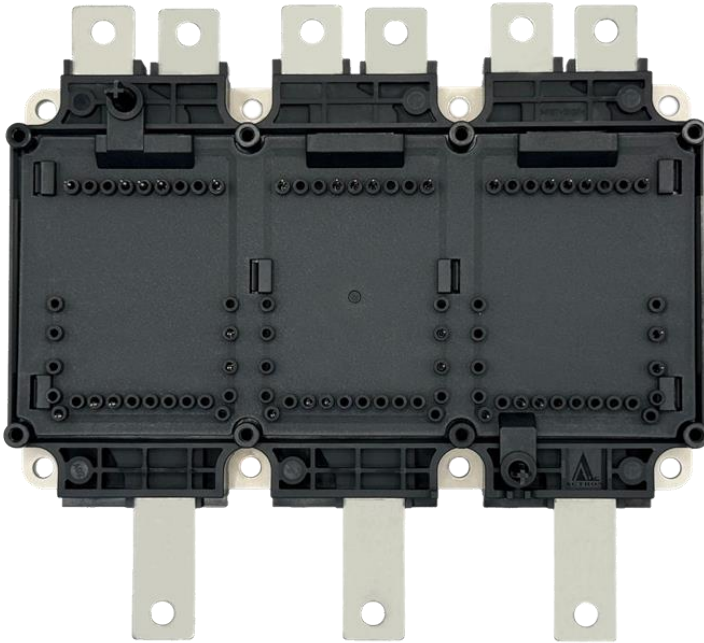
**PRELIMINARY
DATASHEET**

V0.3, 2024/11



ACTRON TECHNOLOGY CORP.

AEPR25B12C1LT SiC HPD Power Module



Applications

- Motor Drives
- All-Terrain Vehicles
- Automotive Applications
- Hybrid Electrical Vehicles (xEV)
- Commercial Agriculture Vehicles

Features

Electrical Features

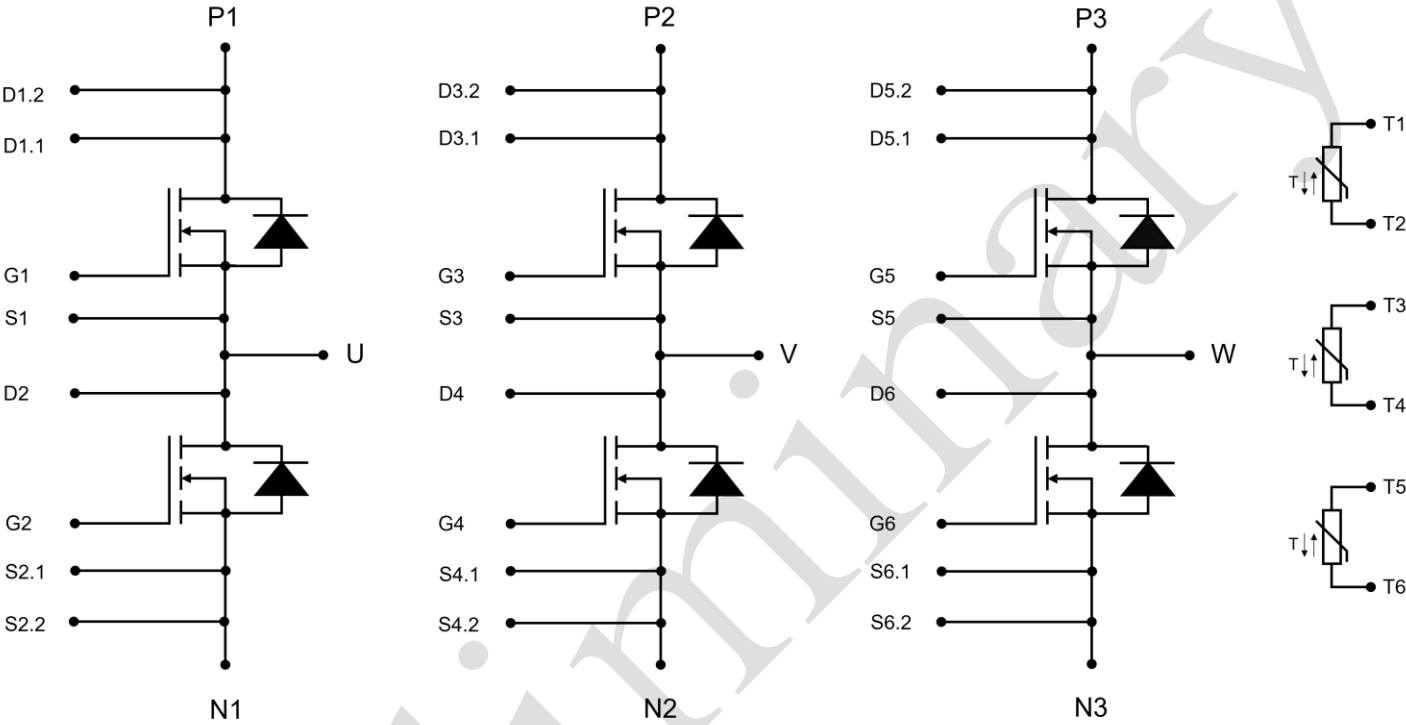
- Low $R_{DS(on)}$
- $T_{j,op} = 150^{\circ}C$
- Blocking Voltage 1200V
- DC Drain Current 400A
- Low Switching Losses
- Low Inductance Design
- SiC MOSFET Technology

Mechanical Features

- Sintered Ag Technology
- Si_3N_4 Ceramic Substrate
- Direct Liquid Cooled Baseplate
- Compact Design
- 4.2kV DC Insulation
- Press-Fit Pin Connection
- UL 94 Module Frame
- NTC Temperature Sensor Included
- Pb-Free and RoHS Compliant
- Guiding Element for PCB and Cooler Assembly



Circuit Diagram





MOSFET

Maximum Rated Values

Parameter	Conditions	Symbol	Values	Unit
Drain-source voltage	$T_j = 25^{\circ}\text{C}$	V_{DSS}	1200	V
Gate-source voltage		V_{GS}	-10/+23	V
	Recommended operating values	V_{GS}	-5/+18	V
DC drain current	$V_{\text{GS}} = 18\text{V}$, $T_F = 60^{\circ}\text{C}$, $T_{j,\text{max}} = 175^{\circ}\text{C}$	$I_{\text{D nom}}$	400	A
Pulsed drain current	t_p limited by $T_{j,\text{max}}$	$I_{\text{D pulse}}$	800	A
Maximum junction temperature		$T_{j,\text{max}}$	175	$^{\circ}\text{C}$

Characteristics Values

Parameter	Conditions	Symbol	Min.	Typ.	Max.	Unit
Drain-source on resistance	$I_{\text{D}} = 400\text{A}$, $V_{\text{GS}} = 18\text{V}$	$R_{\text{DS(on)}}$		2.50	3.40	m Ω
	$I_{\text{D}} = 400\text{A}$, $V_{\text{GS}} = 18\text{V}$			3.85		
	$I_{\text{D}} = 400\text{A}$, $V_{\text{GS}} = 18\text{V}$			4.40		
Gate threshold voltage	$I_{\text{D}} = 210\text{ mA}$, $V_{\text{GS}} = V_{\text{DS}}$	$T_j = 25^{\circ}\text{C}$	$V_{\text{GS,th}}$	1.80	2.50	V
		$T_j = 150^{\circ}\text{C}$		1.90		
		$T_j = 175^{\circ}\text{C}$		1.80		
Drain-source leakage current	$V_{\text{DS}} = 1200\text{V}$, $V_{\text{GS}} = 0\text{V}$	$T_j = 25^{\circ}\text{C}$	I_{DSS}		100	μA
		$T_j = 150^{\circ}\text{C}$			1	mA
		$T_j = 175^{\circ}\text{C}$			5	mA
Gate-source leakage current	$V_{\text{DS}} = 0\text{V}$, $V_{\text{GS}} = 20\text{V}$	$T_j = 25^{\circ}\text{C}$	I_{GSS}		400	nA
Gate charge	$V_{\text{GS}} = -5\text{V} / +18\text{V}$ $V_{\text{DS}} = 600\text{V}$, $I_{\text{D}} = 400\text{A}$	$T_j = 25^{\circ}\text{C}$	Q_{G}		1.9	μC
Input capacitance	$f = 100\text{ kHz}$, $V_{\text{DS}} = 600\text{V}$ $V_{\text{GS}} = 0\text{V}$	$T_j = 25^{\circ}\text{C}$	C_{iss}		45.0	nF
Output capacitance	$f = 100\text{ kHz}$, $V_{\text{DS}} = 600\text{V}$ $V_{\text{GS}} = 0\text{V}$	$T_j = 25^{\circ}\text{C}$	C_{oss}		2.0	nF
Reverse transfer capacitance	$f = 100\text{ kHz}$, $V_{\text{DS}} = 600\text{V}$ $V_{\text{GS}} = 0\text{V}$	$T_j = 25^{\circ}\text{C}$	C_{rss}		0.17	nF



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Parameter	Conditions	Symbol	Min.	Typ.	Max.	Unit
Turn-on delay time inductive load	$I_D = 400A, V_{DS} = 600V$ $V_{GS} = -5V / +18V$ $R_{G,on} = 5.1 \Omega$	$T_j = 25^\circ C$ $T_j = 175^\circ C$ $t_{d(on)}$		110 78		ns
Rise time, inductive load	$I_D = 400A, V_{DS} = 600V$ $V_{GS} = -5V / +18V$ $R_{G,on} = 5.1 \Omega$	$T_j = 25^\circ C$ $T_j = 175^\circ C$ t_r		226 186		ns
Turn-on energy loss per pulse	$I_D = 400A, V_{DS} = 600V$ $L_S = 30 nH$ $V_{GS} = -5V / +18V$ $R_{G,on} = 5.1 \Omega$ $di/dt = 4.1 A/ns (25^\circ C)$ $di/dt = 4.8 A/ns (175^\circ C)$	$T_j = 25^\circ C$ $T_j = 175^\circ C$ E_{on}		18.1 17.9		mJ
Turn-off delay time Inductive load	$I_D = 400A, V_{DS} = 600V$ $V_{GS} = -5V / +18V$ $R_{G,off} = 5.1 \Omega$	$T_j = 25^\circ C$ $T_j = 175^\circ C$ $t_{d(off)}$		535 656		ns
Fall time, inductive load	$I_D = 400A, V_{DS} = 600V$ $V_{GS} = -5V / +18V$ $R_{G,off} = 5.1 \Omega$	$T_j = 25^\circ C$ $T_j = 175^\circ C$ t_f		108 114		ns
Turn-off energy loss per pulse	$I_D = 400A, V_{DS} = 600V$ $L_S = 30 nH$ $V_{GS} = -5V / +18V$ $R_{G,off} = 5.1 \Omega$ $dv/dt = 5.6 V/ns (25^\circ C)$ $dv/dt = 5.3 V/ns (175^\circ C)$	$T_j = 25^\circ C$ $T_j = 175^\circ C$ E_{off}		26.0 28.5		mJ
Short circuit current	$V_{DD} = 800V$ $V_{GS} = -5V / +18V$ $R_{G,on} = 5.1 \Omega$ $R_{G,off} = 5.1 \Omega$ $t_{sc} \leq 3 \mu s$	$T_j = 25^\circ C$ $T_j = 150^\circ C$ I_{sc}		6800 5700		A
Thermal resistance Junction to cooling fluid	Per MOSFET $\Delta V/\Delta t = 10 dm^3/min$ $T_F = 60^\circ C$	$R_{th,JF}$		0.09		K/W
Operated temperature condition		$T_{j,op}$	-40		150	$^\circ C$



Body diode

Maximum Rated Values

Parameter	Conditions	Symbol	Values	Unit
DC body diode forward current	$V_{GS} = -5V, T_j = 175^{\circ}C$	I_{SD}	210	A
Pulsed body diode current	t_p limited by $T_{j, max}$	$I_{SD \text{ pulse}}$	800	A

Characteristics Values

Parameter	Conditions	Symbol	Typ.	Max.	Unit
Forward voltage	$I_{SD} = 400A, V_{GS} = -5V$	$T_j = 25^{\circ}C$	5.20	6.30	V
		$T_j = 150^{\circ}C$	4.45		
		$T_j = 175^{\circ}C$	4.40		
Peak reverse recovery current	$I_{SD} = 400A, V_R = 600V$ $V_{GS} = -5V$	$T_j = 25^{\circ}C$	68		A
		$T_j = 175^{\circ}C$	169		
Recovered charge	$I_{SD} = 400A, V_R = 600V$ $V_{GS} = -5V$	$T_j = 25^{\circ}C$	2.2		μC
		$T_j = 175^{\circ}C$	7.7		
Reverse recovery energy	$I_{SD} = 400A, V_R = 600V$ $V_{GS} = -5V$ $-di/dt = 4.1 A/ns (25^{\circ}C)$ $-di/dt = 4.8 A/ns (175^{\circ}C)$	$T_j = 25^{\circ}C$	0.6		mJ
		$T_j = 175^{\circ}C$	2.3		

NTC-Thermistor

Characteristics Values

Parameter	Conditions	Symbol	Min.	Typ.	Max.	Unit
Rated resistance	$T_c = 25^{\circ}C$	R_{25}		5.0		k Ω
Resistance tolerance	$T_c = 100^{\circ}C$	$\Delta R/R$	-5		5	%
B-value	$R_2 = R_{25} \exp$ $[B_{25/50}(1/T_2 - 1/(298.15 K))]$	$B_{25/50}$		3375		K
B-value	$R_2 = R_{25} \exp$ $[B_{25/80}(1/T_2 - 1/(298.15 K))]$	$B_{25/80}$		3411		K
B-value	$R_2 = R_{25} \exp$ $[B_{25/100}(1/T_2 - 1/(298.15 K))]$	$B_{25/100}$		3433		K



Module

Parameter	Conditions	Symbol	Value	Unit
Isolation test voltage	RMS, $f = 0$ Hz, $t = 1$ sec	V_{ISOL}	4.2	kV
Module baseplate material			Cu + Ni	
Module internal isolation material	Basic isolation (class 1, IEC 61140)		Si_3N_4	
Creepage distance	Terminal to heatsink	$d_{Creep,TH}$	9.0	mm
Creepage distance	Terminal to terminal	$d_{Creep,TT}$	9.0	mm
Clearance distance	Terminal to heatsink	$d_{Clear,TH}$	4.5	mm
Clearance distance	Terminal to terminal	$d_{Clear,TT}$	4.5	mm
Comparative tracking index ¹⁾		CTI	> 200	

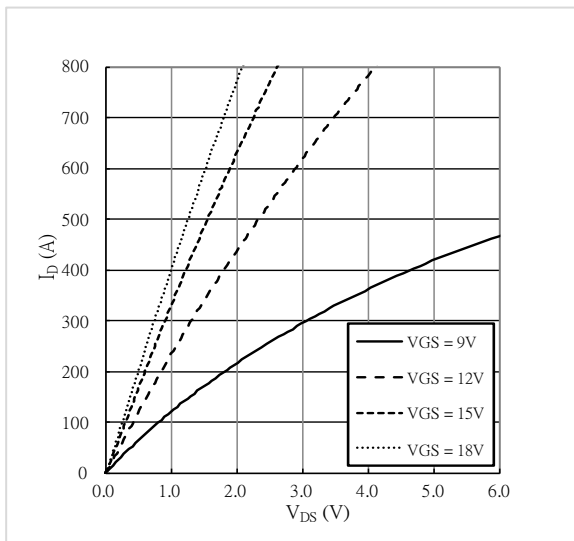
Parameter	Conditions	Symbol	Min.	Typ.	Max.	Unit
Module stray inductance		L_{SDS}		9		nH
Storage temperature		T_{stg}	-40		125	°C
Mounting torque for module mounting	Screw M4 baseplate to heatsink	M	1.80	2.00		Nm
Weight		G		745		g

¹⁾ Extracted by following UL 746A

Characteristics Diagrams

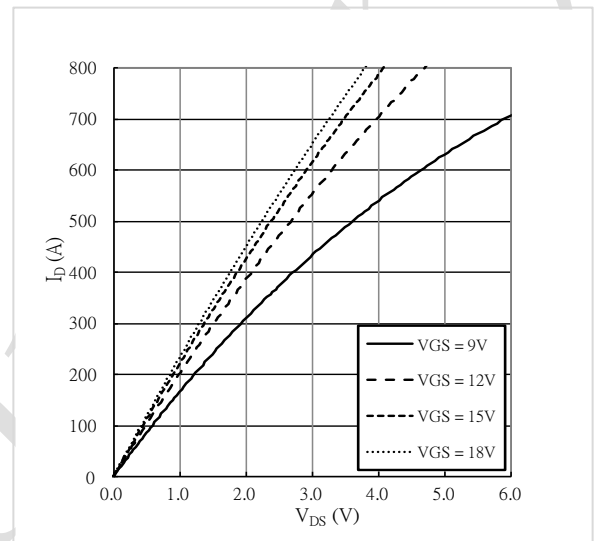
MOSFET, Output characteristics

$T_j = 25^\circ\text{C}$, $I_D = f(V_{DS})$



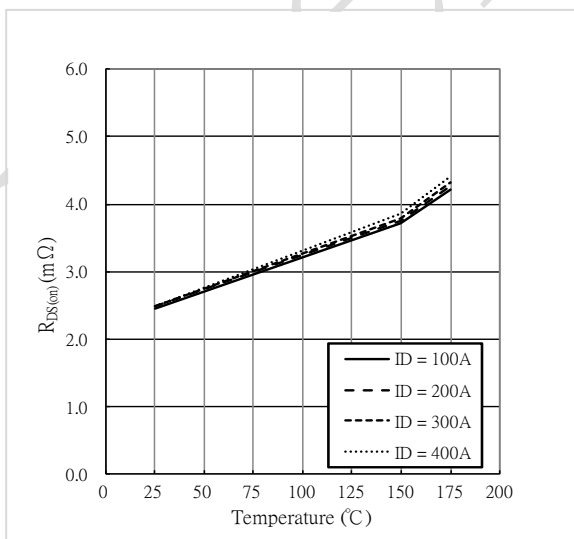
MOSFET, Output characteristics

$T_j = 175^\circ\text{C}$, $I_D = f(V_{DS})$



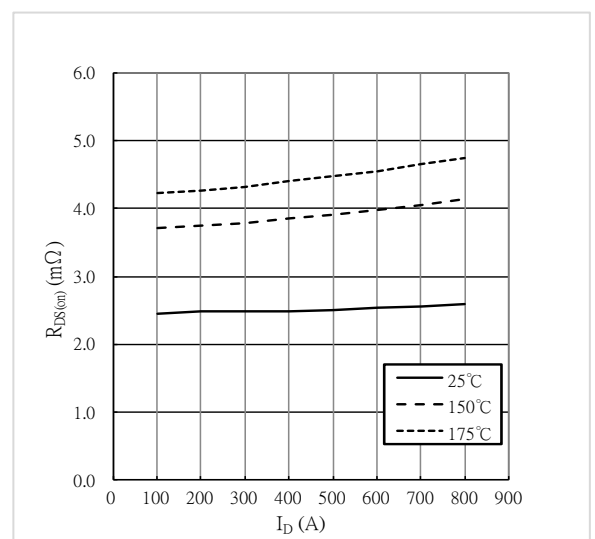
Typical temperature dependence of $R_{DS(on)}$

$V_{GS} = 18\text{V}$, $R_{DS(on)} = f(T_j)$



Typical I_D dependence of $R_{DS(on)}$

$V_{GS} = 18\text{V}$, $R_{DS(on)} = f(I_D)$



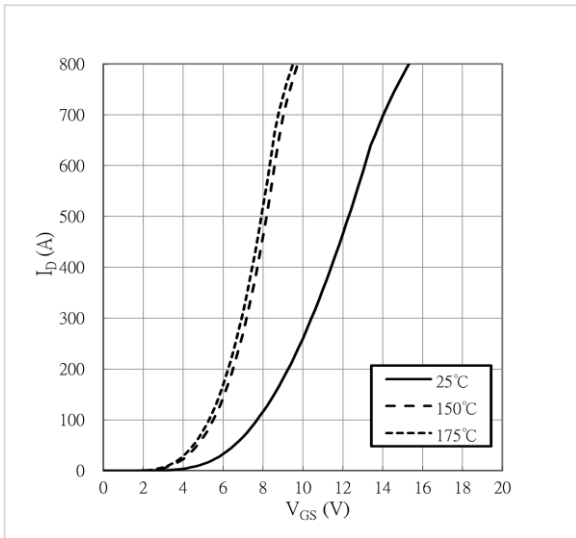


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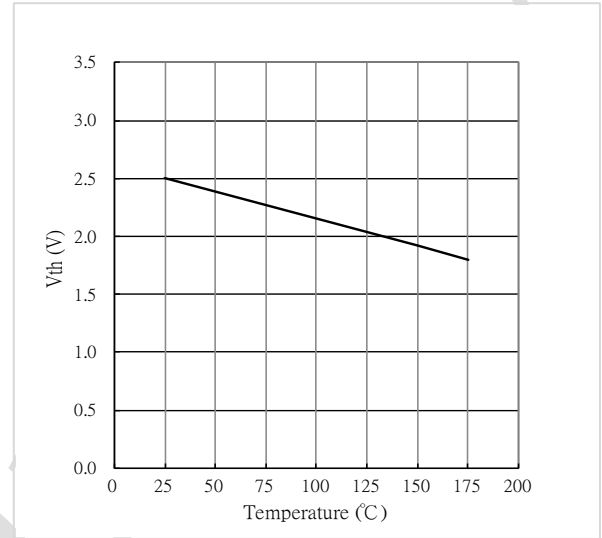
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MOSFET, Transfer characteristics

$$I_D = f(V_{GS})$$

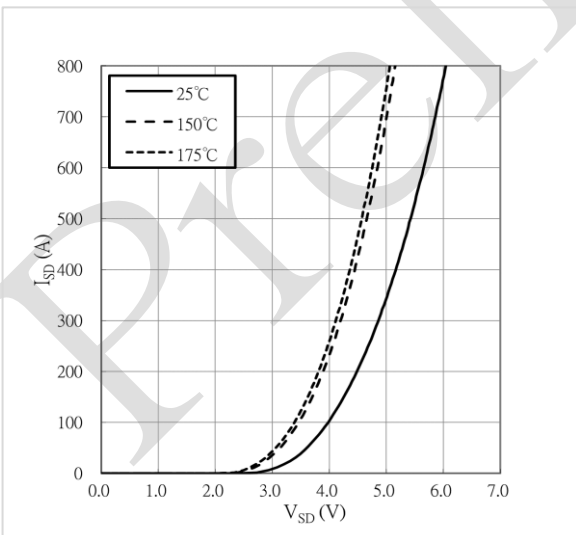


Typical temperature dependence of threshold voltage, $V_{th} = f(T_j)$



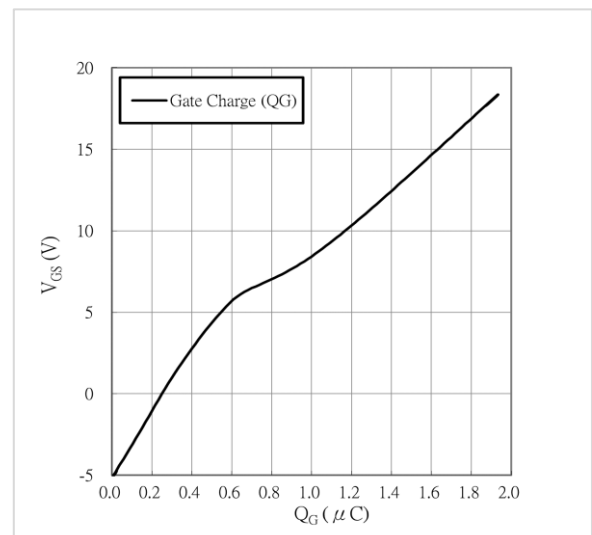
Diode, Forward characteristics

$$V_{GS} = -5V, I_{SD} = f(V_{SD})$$



MOSFET, Total gate charge characteristics

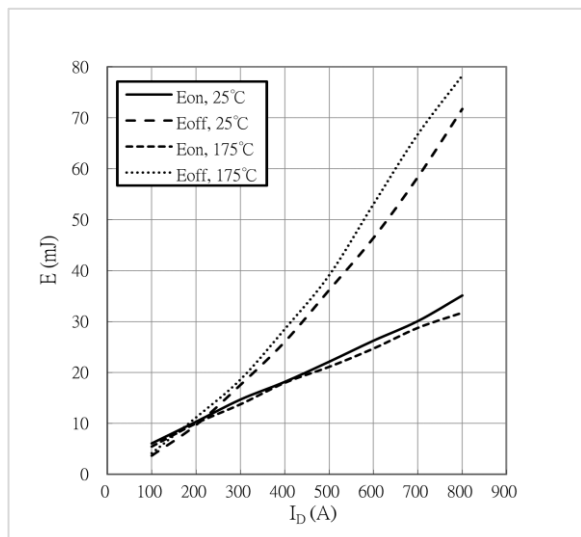
$$V_{DS} = 600V, I_D = 400A, T_j = 25^\circ C, V_{GS} = f(Q_G)$$



MOSFET, Switching losses VS. I_D

$V_{GS} = -5V / +18V$, $R_{G,on} = 5.1\Omega$, $R_{G,off} = 5.1\Omega$

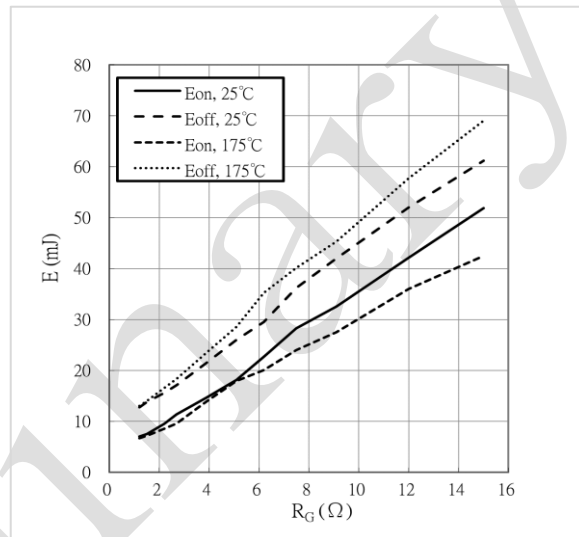
$V_{DS} = 600V$, E_{on} & $E_{off} = f(I_D)$



MOSFET, Switching losses VS. R_G

$V_{GS} = -5V / +18V$, $V_{DS} = 600V$, $I_D = 400A$

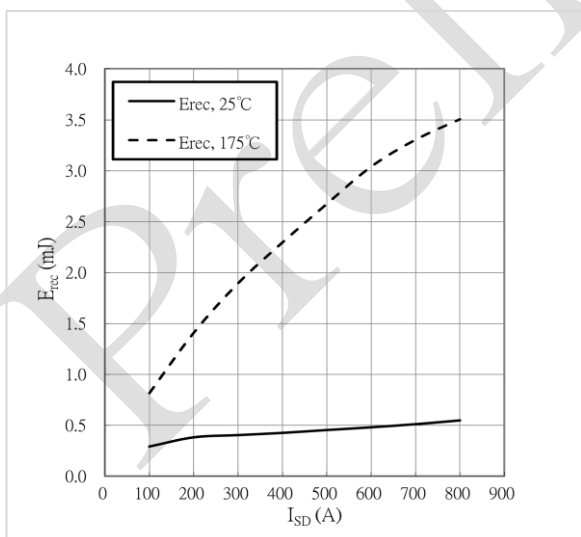
E_{on} & $E_{off} = f(R_G)$



Diode, Switching losses VS. I_{SD}

$V_{GS} = -5V / +18V$, $R_{G,on} = 5.1\Omega$, $R_{G,off} = 5.1\Omega$

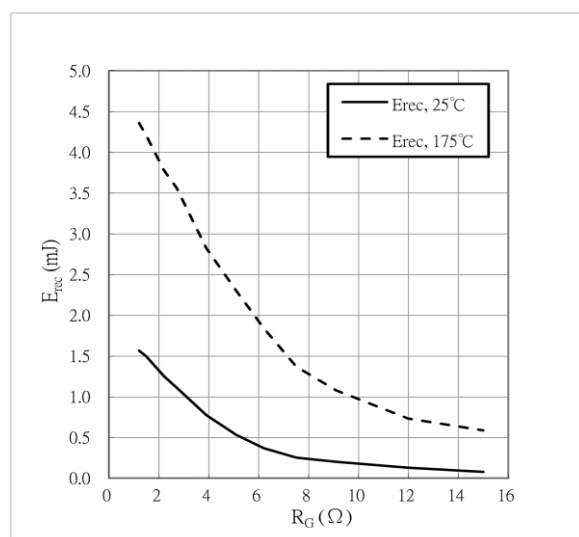
$V_{DS} = 600V$, $E_{rec} = f(I_{SD})$



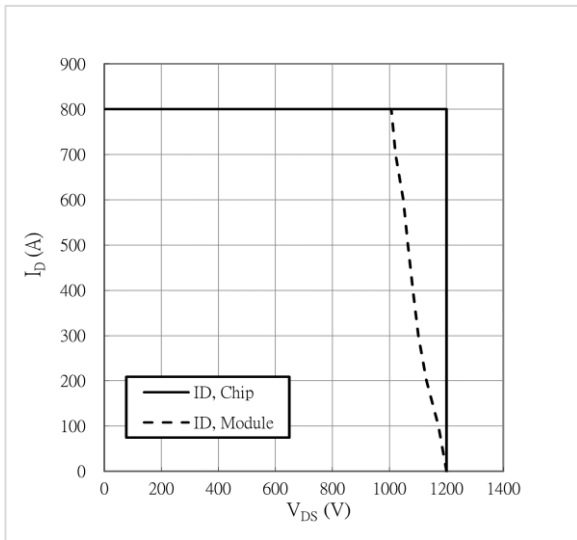
Diode, Switching losses VS. R_G

$V_{GS} = -5V / +18V$, $V_{DS} = 600V$, $I_{SD} = 400A$

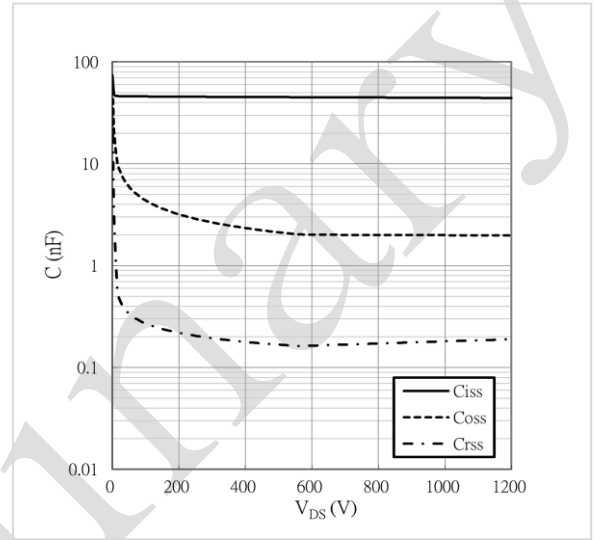
$E_{rec} = f(R_G)$



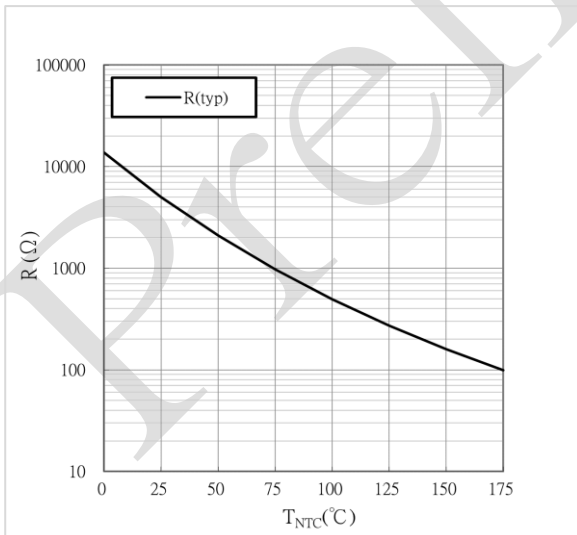
MOSFET, Reverse bias safe operating area
(RBSOA) $V_{GS} = -5V / +18V$, $R_{G,on} = 5.1\Omega$
 $R_{G,off} = 5.1\Omega$, $T_j = 175^\circ C$, $I_D = f(V_{DS})$



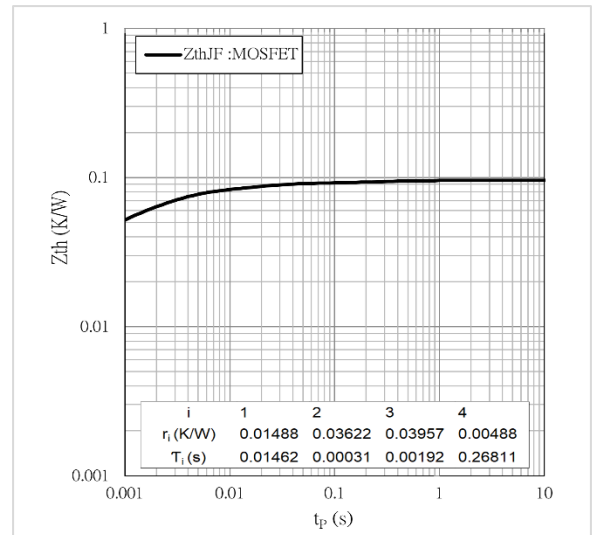
MOSFET, Capacitance characteristics
 $V_{GS} = 0V$, $T_j = 25^\circ C$, $f = 100\text{ kHz}$, $C = f(V_{DS})$



NTC-Thermistor-temperature characteristics
 $R = f(T_{NTC})$

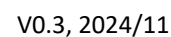


MOSFET, Transient thermal impedance
 $Z_{thJF} = f(t_p)$
 $\Delta V/\Delta t = 10\text{ dm}^3/\text{min}$, $T_F = 60^\circ C$





Package Outlines



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