

## 1200V Silicon Carbide Power MOSFET

### Features

- Revolutionary semiconductor material Silicon Carbide
- High blocking voltage with low on-resistance
- High-speed switching with very low switching losses
- High-speed and high robust intrinsic body diode
- Optimized package with separate driver source pin

### Product Summary

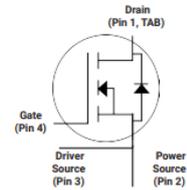
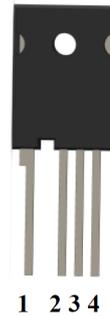


BVDSS	RDSON	ID
1200V	75mΩ	39A

### Applications

- Motor Drives
- EV battery chargers
- Solar energy system
- UPS
- Industrial motor control

### TO247-4L Pin Configuration



### Maximum Ratings For MOSFET ( $T_{VJ} = 25^{\circ}\text{C}$ unless otherwise specified)

Symbol	Parameter	Value	Unit	Testing Conditions
$V_{DSS}$	Drain-Source Voltage	1200	V	
$I_D$	Continuous DC Drain Current for $R_{th(j-c,typ.)}$ , Limited by $T_{VJ(max)}$	39	A	$T_C = 25^{\circ}\text{C}$
		28		$T_C = 100^{\circ}\text{C}$
$I_{DM}$	Peak Drain Current, tp Limited by $T_{VJ(max)}$	72	A	$T_C = 25^{\circ}\text{C}$
$V_{GS, max}$	Gate-Source Max Voltage	-10/22	V	
$V_{GS, op}$	Gate-Source Operate Voltage	-5/18	V	
$E_{AS}$	Single Pulse Avalanche Energy	122	mJ	$L=0.5\text{ mH}$ , $I_{AS}=23\text{ A}$ , $V_{DD}=50\text{ V}$ , $V_{GS}=18\text{ V}$
$P_{tot}$	Power Dissipation for $R_{th(j-c,typ.)}$	193	W	$T_C = 25^{\circ}\text{C}$

### Package Values

Symbol	Parameter	Min.	Typ.	Max.	Unit	Testing Conditions
$R_{th(j-c)}$	MOSFET/Body Diode Junction-Case Thermal Resistance		0.77	0.93	K/W	
$T_{VJ}$ , $T_{STG}$	Operating Junction and Storage Temperature	-55		175	$^{\circ}\text{C}$	
$T_{SOLD}$	Soldering Temperature, Wave Soldering only Allowed at Leads 1.6mm from Case for 10s		260		$^{\circ}\text{C}$	
M	M3 screw, Maximum of mounting processes: 3			1	Nm	

**MOSFET Characteristics** ( $T_{VJ} = 25^{\circ}\text{C}$  unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit	Testing Conditions
$V_{(BR)DSS}$	Drain-Source Breakdown Voltage	1200			V	$I_D = 100 \mu\text{A}$
$V_{GS(th)}$	Gate Threshold Voltage		3.0		V	$V_{DS} = V_{GS}, I_D = 4.5 \text{ mA}$ $T_{VJ} = 25^{\circ}\text{C}$
			2.0			$T_{VJ} = 175^{\circ}\text{C}$
$I_{DSS}$	Drain-Source Leakage Current		0.1	20	$\mu\text{A}$	$V_{GS} = 0 \text{ V}, V_{DS} = 1200 \text{ V}$ $T_{VJ} = 25^{\circ}\text{C}$
			1			
$I_{GSS}$	Gate-Source Leakage Current			250	nA	$V_{GS} = 22 \text{ V}, V_{DS} = 0 \text{ V}$ $T_{VJ} = 25^{\circ}\text{C}$
$I_{SGS}$	Source-Gate Leakage Current			250	nA	$V_{GS} = -10 \text{ V}, V_{DS} = 0 \text{ V}$ $T_{VJ} = 25^{\circ}\text{C}$
$R_{DS(on)}$	Drain-Source On-State Resistance		58		m $\Omega$	$V_{GS} = 18 \text{ V}, I_D = 15 \text{ A}$ $T_{VJ} = 25^{\circ}\text{C}$
			104			
$g_{fs}$	Transconductance		9.5		S	$V_{DS} = 10 \text{ V}, I_D = 15 \text{ A}$
$R_{G(int)}$	Internal Gate Resistance		5.2		$\Omega$	$f = 1\text{MHz}, V_{AC} = 25 \text{ mV}$
$C_{iss}$	Input Capacitance		1110		pF	$V_{GS} = 0 \text{ V}, V_{DS} = 800 \text{ V}, f = 1\text{MHz}$
$C_{oss}$	Output Capacitance		55		pF	
$C_{rss}$	Reverse Transfer Capacitance		4		pF	
$Q_{GS}$	Gate to Source Charge		17.5		nC	
$Q_{GD}$	Gate to Drain Charge		6.2		nC	$V_{GS} = -5 \text{ V} / +18 \text{ V}, V_{DD} = 800 \text{ V}, I_D = 15 \text{ A}$
$Q_G$	Total Gate Charge		54		nC	

**Dynamic MOSFET Characteristics** ( $T_{VJ} = 25^{\circ}\text{C}$  unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit	Testing Conditions
$t_{d(on)}$	Turn-On Delay Time		7.2		ns	$V_{GS} = -5 \text{ V} / +18 \text{ V},$ $L = 200\mu\text{H}$ $V_{DD} = 800 \text{ V}, I_D = 15 \text{ A},$ $R_{G(on)} = 2.2 \Omega, R_{G(off)} = 2.2 \Omega$
			6.5			
$t_r$	Rise Time		9.0		ns	$T_{VJ} = 175^{\circ}\text{C}$
			9.2			$T_{VJ} = 25^{\circ}\text{C}$
$t_{d(off)}$	Turn-Off Delay Time		17.9		ns	$T_{VJ} = 175^{\circ}\text{C}$
			20.2			$T_{VJ} = 25^{\circ}\text{C}$
$t_f$	Fall Time		9.9		ns	$T_{VJ} = 175^{\circ}\text{C}$
			10.5			$T_{VJ} = 25^{\circ}\text{C}$
$E_{on}$	Turn-On Switching Loss		170.9		$\mu\text{J}$	$T_{VJ} = 175^{\circ}\text{C}$
			167.6			$T_{VJ} = 25^{\circ}\text{C}$
$E_{off}$	Turn-Off Switching Loss		2.5		$\mu\text{J}$	$T_{VJ} = 175^{\circ}\text{C}$
			2.9			$T_{VJ} = 25^{\circ}\text{C}$
$E_{tot}$	Total Switching Energy		173.4		$\mu\text{J}$	$T_{VJ} = 175^{\circ}\text{C}$
			170.5			$T_{VJ} = 25^{\circ}\text{C}$

Note:  $E_{on}/E_{off}$  result is with body diode.

**Maximum Ratings For Body Diode** ( $T_{VJ} = 25^{\circ}\text{C}$  unless otherwise specified)

Symbol	Parameter	Value	Unit	Testing Conditions
$V_{DSS}$	Drain-Source Voltage	1200	V	
$I_S$	Continuous DC Source Current, Limited by $T_{VJ(max)}$	31	A	$T_C = 25^{\circ}\text{C}$
		17	A	$T_C = 100^{\circ}\text{C}$
$I_{SM}$	Peak Reverse Drain Current, tp Limited by $T_{VJ(max)}$	72	A	$T_C = 25^{\circ}\text{C}$

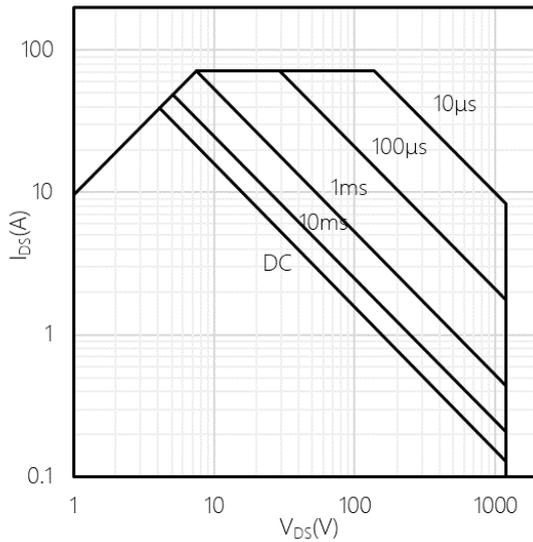
**Body Diode Characteristics** ( $T_{VJ} = 25^{\circ}\text{C}$  unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit	Testing Conditions	
$V_{SD}$	Body Diode Forward Voltage		4.2		V	$V_{GS} = -5\text{ V}, I_{SD} = 7.5\text{ A}$	$T_{VJ} = 25^{\circ}\text{C}$
			3.7				$T_{VJ} = 175^{\circ}\text{C}$
$I_{rrm}$	Peak Reverse Recovery Current		15		A	$V_{DS} = 800\text{ V}, V_{GS} = -5\text{ V},$ $I_{SD} = 15\text{ A}, di/dt = 2\text{ kA}/\mu\text{s}$	$T_{VJ} = 25^{\circ}\text{C}$
			23				$T_{VJ} = 175^{\circ}\text{C}$
$Q_{rr}$	Reverse Recovery Charge		198		nC		$T_{VJ} = 25^{\circ}\text{C}$
			437				$T_{VJ} = 175^{\circ}\text{C}$
$t_{rr}$	Reverse Recovery Time		28		ns		$T_{VJ} = 25^{\circ}\text{C}$
			36				$T_{VJ} = 175^{\circ}\text{C}$
$E_{rr}$	Reverse Recovery Energy		43		$\mu\text{J}$	$T_{VJ} = 25^{\circ}\text{C}$	
			104			$T_{VJ} = 175^{\circ}\text{C}$	

Typical Performances

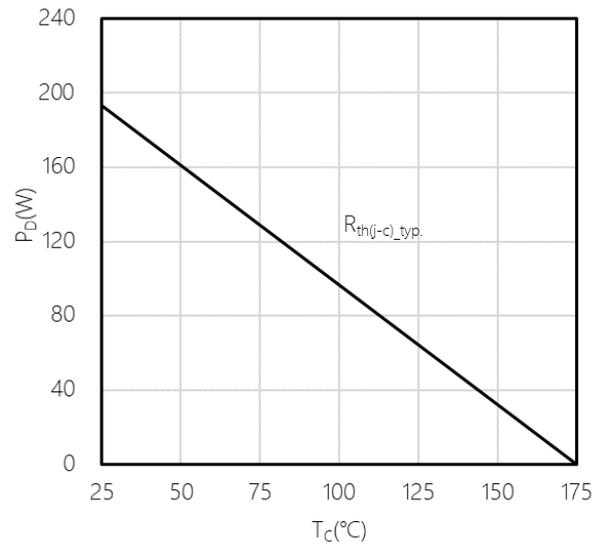
Safe operating area (SOA)

$R_{th(j-c)} = 0.93 \text{ }^\circ\text{C/W}$ , Single Pulse,  $T_{vj} = 25^\circ\text{C}$



Power dissipation as a function of case temperature limited by bond wire

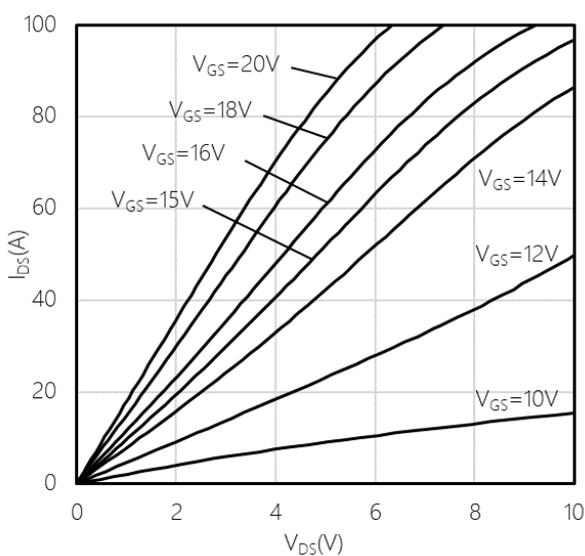
$P_D = f(T_C)$



Typical output characteristic,  $V_{GS}$  as parameter

$I_{DS} = f(V_{DS})$

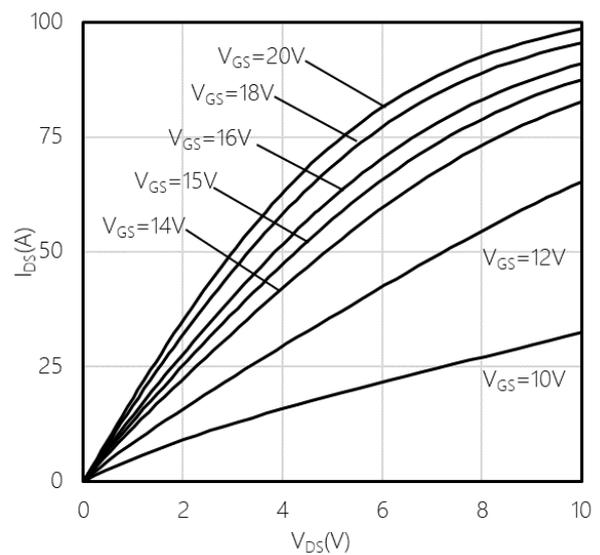
$T_{vj} = -55 \text{ }^\circ\text{C}$



Typical output characteristic,  $V_{GS}$  as parameter

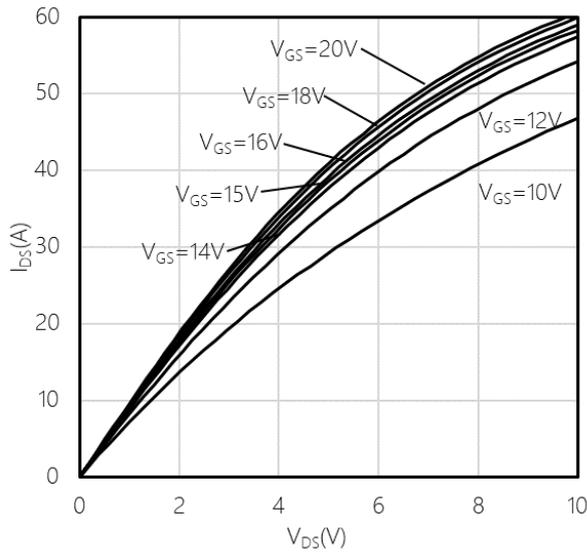
$I_{DS} = f(V_{DS})$

$T_{vj} = 25 \text{ }^\circ\text{C}$



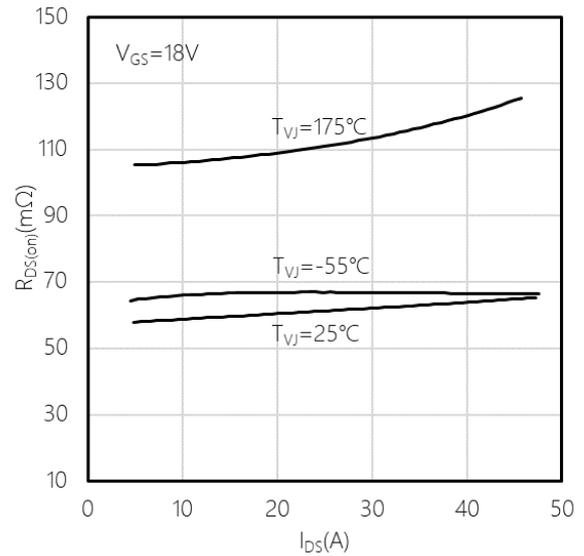
**Typical output characteristic,  $V_{GS}$  as parameter**

$I_{DS} = f(V_{DS})$   
 $T_{VJ} = 175^{\circ}\text{C}$



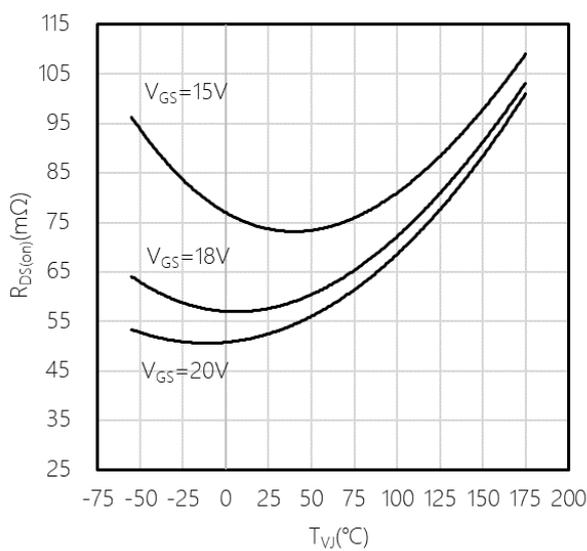
**Typical on-state resistance as a function of drain current**

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



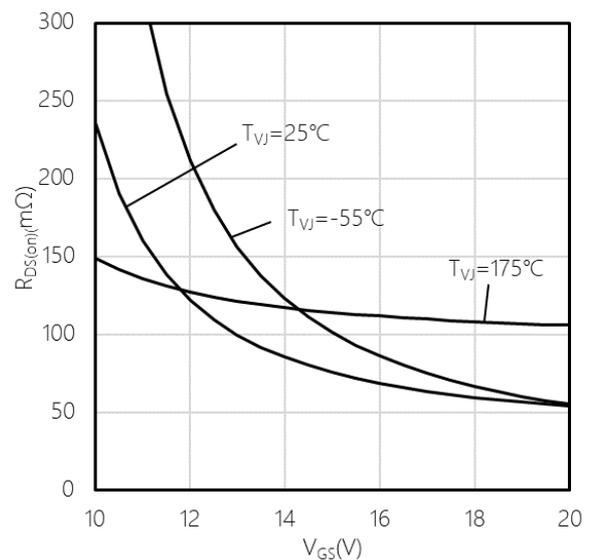
**Typical on-state resistance as a function of temperature**

$R_{DS(on)} = f(T_{VJ}), I_{DS} = 15\text{A}$



**Typical on-state resistance as a function of  $V_{GS}$**

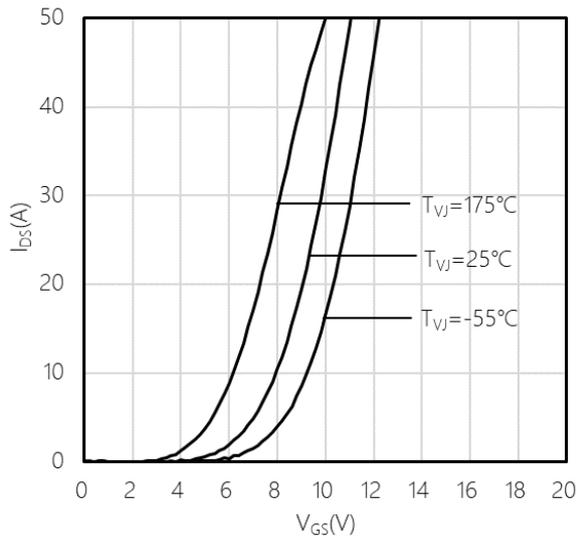
$R_{DS(on)} = f(V_{GS})$   
 $I_{DS} = 15\text{A}$



**Typical transfer characteristic**

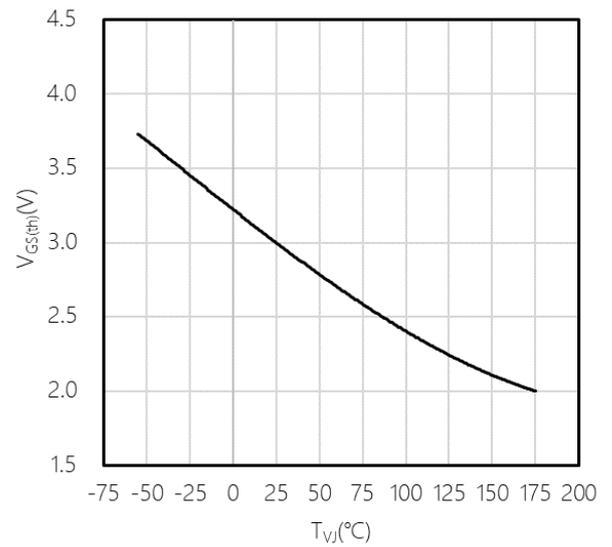
$I_{DS} = f(V_{GS})$

$V_{DS} = 20\text{ V}$



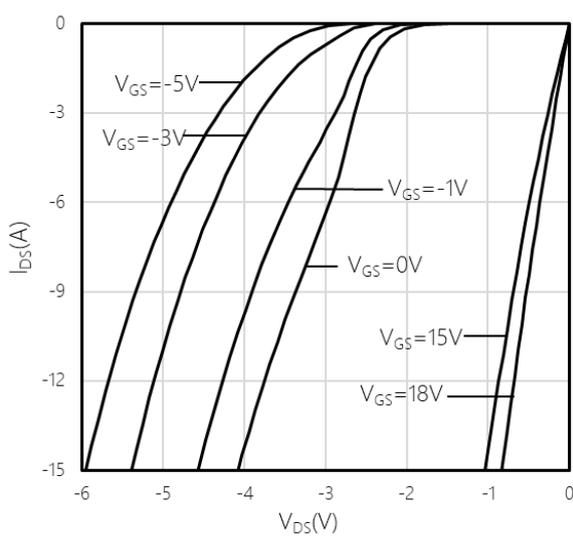
**Typical gate-source threshold voltage as a function of junction temperature**

$V_{GS(th)} = f(T_{VJ}), I_{DS} = 4.5\text{ mA}$



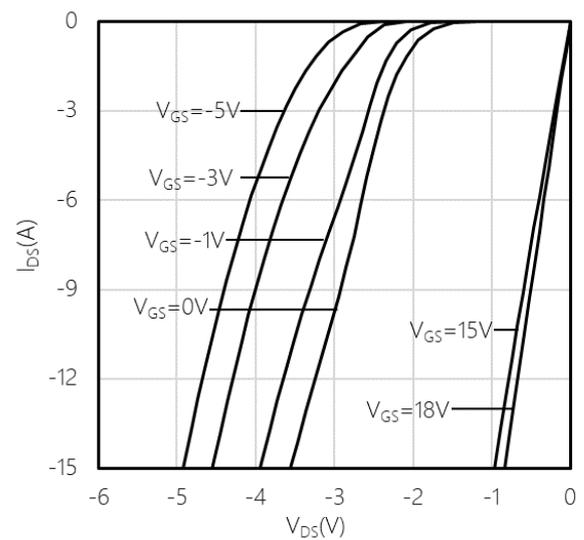
**Typical reverse drain current as function of reverse drain voltage,  $V_{GS}$  as parameter**

$I_{DS} = f(V_{DS}), T_{VJ} = -55^\circ\text{C}$



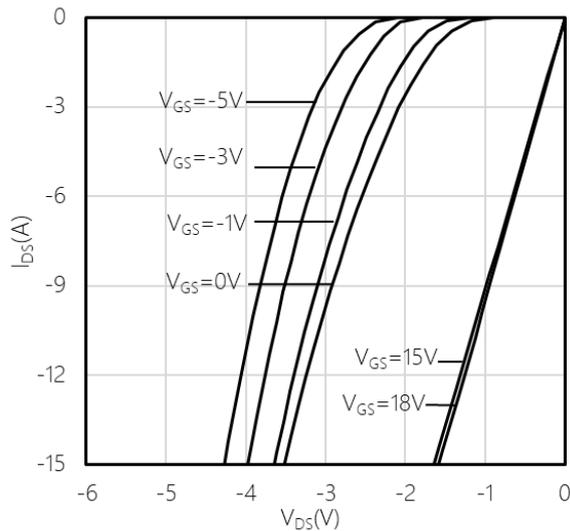
**Typical reverse drain current as function of reverse drain voltage,  $V_{GS}$  as parameter**

$I_{DS} = f(V_{DS}), T_{VJ} = 25^\circ\text{C}$



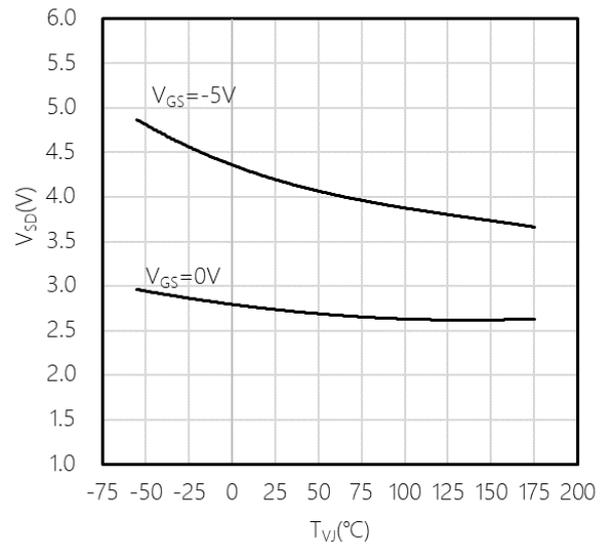
**Typical reverse drain current as function of reverse drain voltage,  $V_{GS}$  as parameter**

$I_{DS} = f(V_{DS}), T_{VJ} = 175\text{ }^{\circ}\text{C}$



**Typical reverse drain voltage as function of junction temperature**

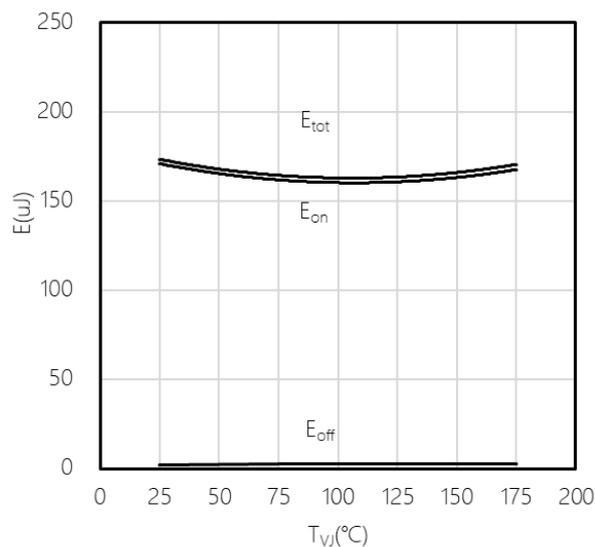
$V_{SD} = f(T_{VJ}), I_{SD} = 7.5\text{ A}$



**Typical switching energy as a function of junction temperature, 2nd device own body diode:  $V_{GS} = -5\text{ V}$**

$E = f(T_{VJ})$

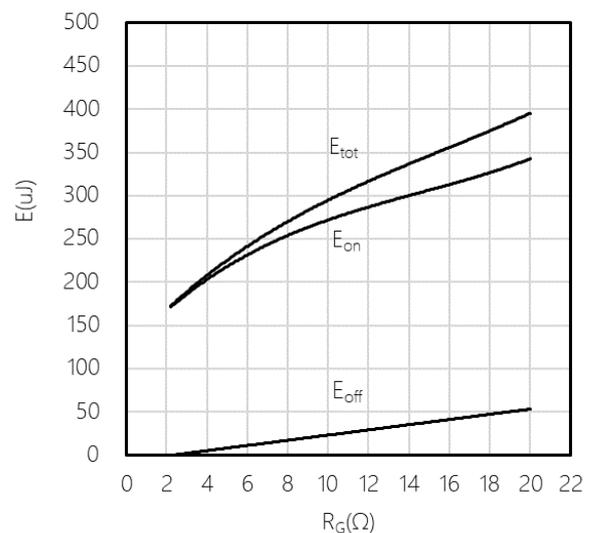
$V_{DS} = 800\text{ V}, R_{G(ext)} = 2.2\text{ }\Omega, V_{GS} = -5\text{ V} / +18\text{ V}, I_{DS} = 15\text{ A}$



**Typical switching energy losses as a function of gate resistance, 2nd device own body diode:  $V_{GS} = -5\text{ V}$**

$E = f(R_{G(ext)})$

$V_{GS} = -5/18\text{ V}, I_{DS} = 15\text{ A}, T_{VJ} = 25\text{ }^{\circ}\text{C}, V_{DS} = 800\text{ V}$

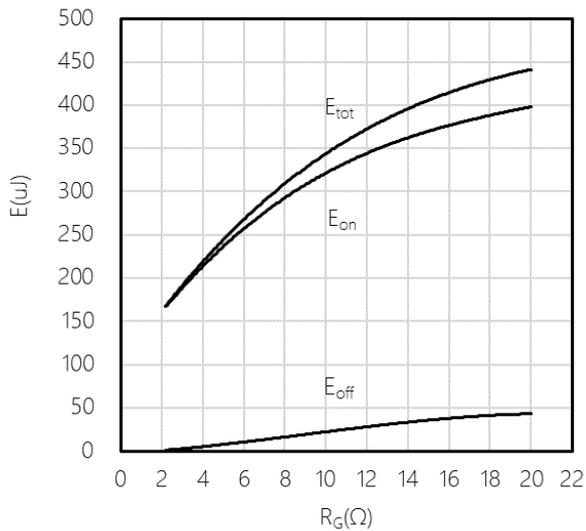


1200V Silicon Carbide Power MOSFET

Typical switching energy losses as a function of gate resistance, 2nd device own body diode:  $V_{GS} = -5\text{ V}$

$E = f(R_{G(ext)})$

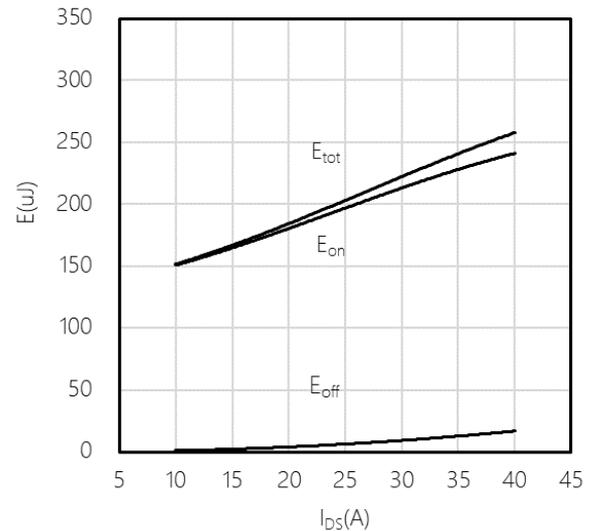
$V_{GS} = -5/18\text{ V}$ ,  $I_{DS} = 15\text{ A}$ ,  $T_{VJ} = 175\text{ }^\circ\text{C}$ ,  $V_{DS} = 800\text{ V}$



Typical switching energy losses as a function of  $I_{DS}$ , 2nd device own body diode:  $V_{GS} = -5\text{ V}$

$E = f(I_{DS})$

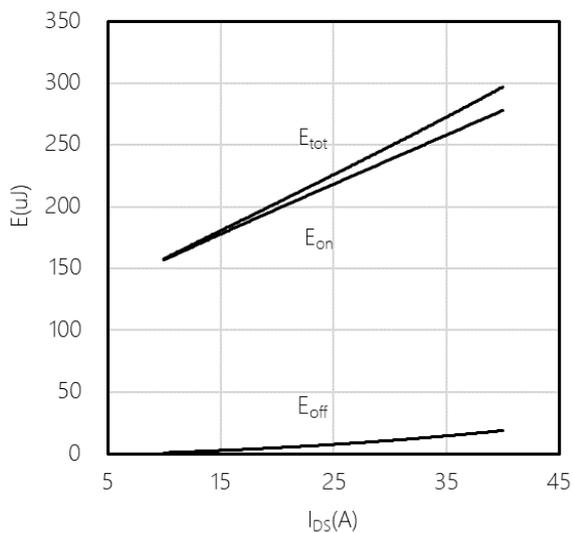
$V_{GS} = -5/18\text{ V}$ ,  $R_{G(ext)} = 2.2\text{ } \Omega$ ,  $T_{VJ} = 25\text{ }^\circ\text{C}$ ,  $V_{DS} = 800\text{ V}$



Typical switching energy losses as a function of  $I_{DS}$ , 2nd device own body diode:  $V_{GS} = -5\text{ V}$

$E = f(I_{DS})$

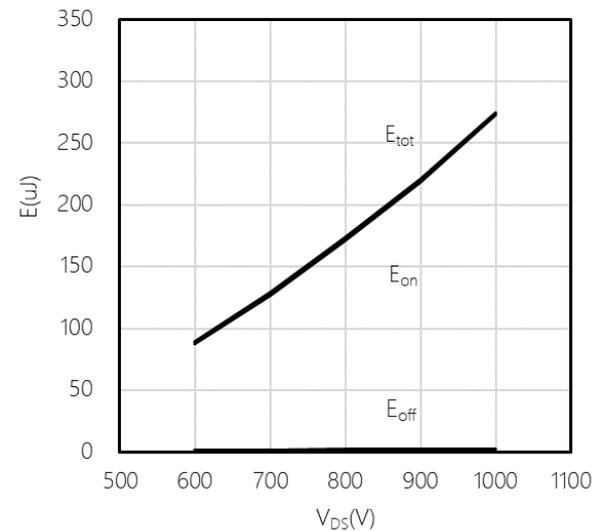
$V_{GS} = -5/18\text{ V}$ ,  $R_{G(ext)} = 2.2\text{ } \Omega$ ,  $T_{VJ} = 175\text{ }^\circ\text{C}$ ,  $V_{DS} = 800\text{ V}$



Typical switching energy losses as a function of  $V_{DS}$ , 2nd device own body diode:  $V_{GS} = -5\text{ V}$

$E = f(V_{DS})$

$V_{GS} = -5/18\text{ V}$ ,  $R_{G(ext)} = 2.2\text{ } \Omega$ ,  $T_{VJ} = 25\text{ }^\circ\text{C}$ ,  $I_{DS} = 15\text{ A}$



1200V Silicon Carbide Power MOSFET

Typical switching energy losses as a function of  $V_{DS}$ ,

2nd device own body diode:  $V_{GS} = -5\text{ V}$

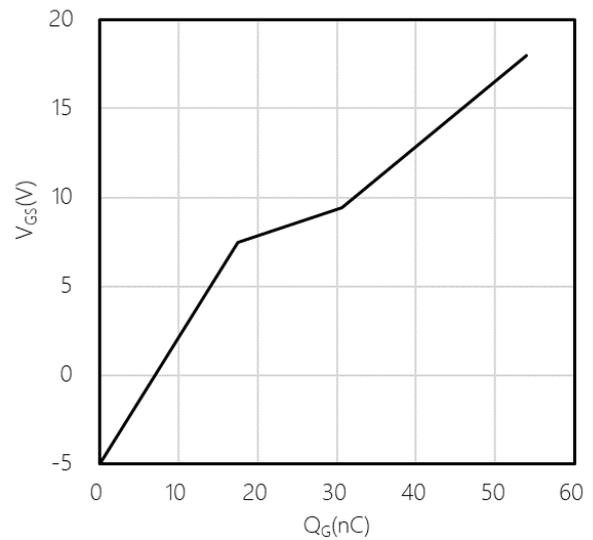
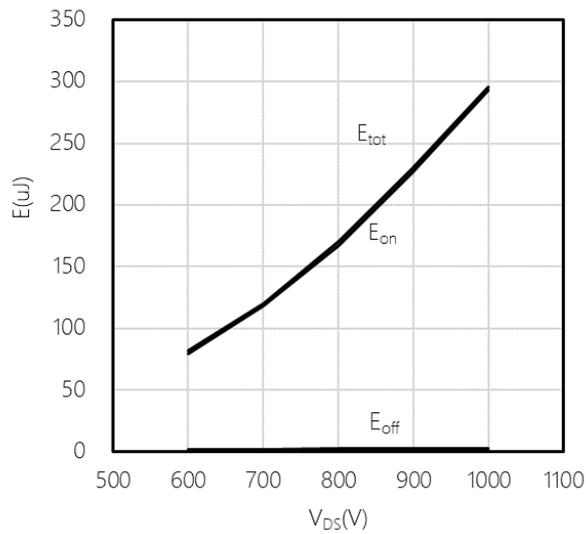
$E = f(V_{DS})$

$V_{GS} = -5/18\text{ V}$ ,  $R_{G(ext)} = 2.2\ \Omega$ ,  $T_{VJ} = 175\text{ }^\circ\text{C}$ ,  $I_{DS} = 15\text{ A}$

Typical gate charge

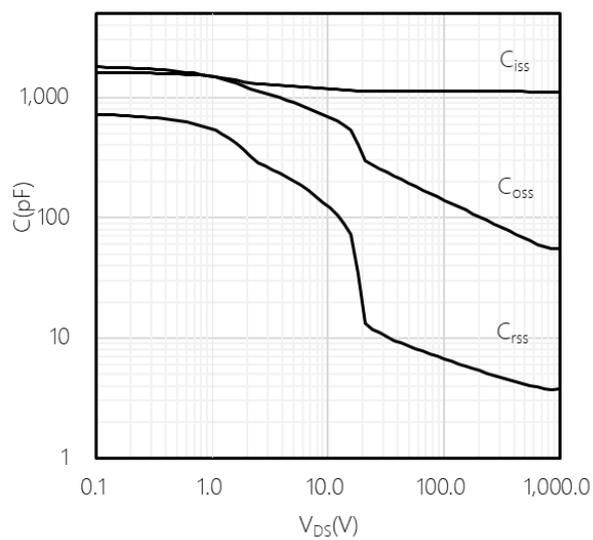
$V_{GS} = f(Q_G)$ ,  $I_{DS} = 15\text{ A}$ ,  $V_{DS} = 800\text{ V}$

turn-on pulse



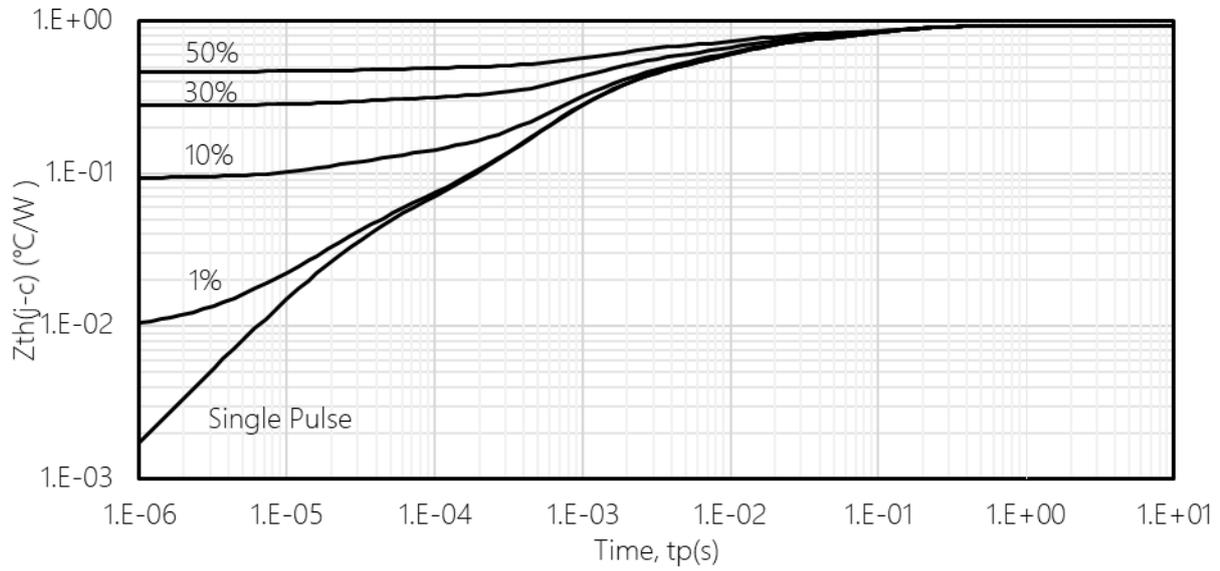
Typical capacitance as a function of drain-source voltage

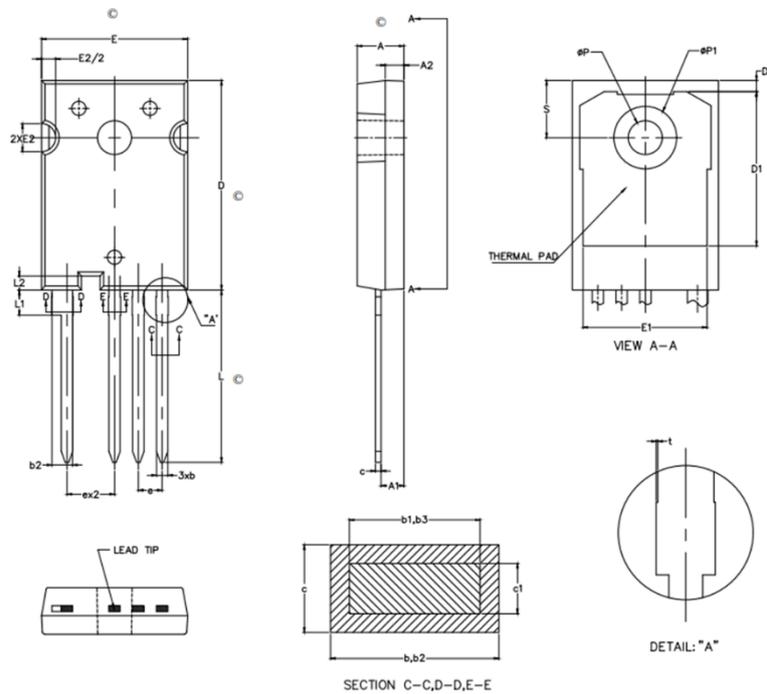
$C = f(V_{DS})$ ,  $V_{GS} = 0\text{ V}$ ,  $f = 1\text{ MHz}$



**Transient thermal resistance (MOSFET)**

$(Z_{th(j-c,max)} = f(t_p), \text{Parameter } D = t_p/T$



**Package Dimensions**


Symbols	Dimensions			
	Mm		Inch	
	MIN.	MAX.	MIN.	MAX.
A	4.90	5.10	0.193	0.201
A1	2.31	2.51	0.091	0.099
A2	1.90	2.10	0.075	0.083
b	1.16	1.26	0.046	0.050
b1	1.15	1.22	0.045	0.048
b2	2.16	2.26	0.085	0.089
b3	2.15	2.22	0.085	0.087
c	0.59	0.66	0.023	0.026
c1	0.58	0.62	0.023	0.024
D	22.40	22.60	0.882	0.890
D1	16.15	16.75	0.640	0.663
D2	1.22	1.53	0.041	0.053
E	15.75	15.90	0.620	0.626
E1	13.26	—	0.552	—
E2	2.90	3.10	0.114	0.122
e	2.54BSC		0.1BSC	
L	18.30	18.60	0.720	0.732
L1	—	2.80	—	0.110
L2	—	1.50	—	0.059
φP	3.50	3.70	0.138	0.146
φP1	—	7.40	—	0.291
S	6.22	6.42	0.238	0.246
t	0.00	0.15	0.000	0.006