

## High Temperature Silicon Carbide Power MOSFET N-Channel Enhancement Mode

### FEATURES

- High temperature:  $T_{C(max)} = 225\text{ }^{\circ}\text{C}$ ,  $T_{J(max)} = 225\text{ }^{\circ}\text{C}$
- AS9100:Rev. C-certified manufacturing, traceable throughout value chain
- < 20 ns switching, enables high system efficiency
- Hermetic seal; flux-free packaging; high reliability
- Backside isolation

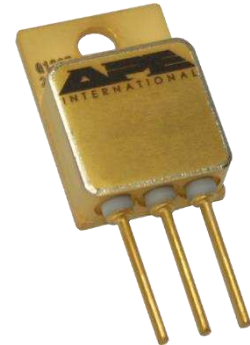
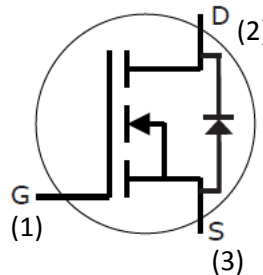
### HIGH TEMPERATURE APPLICATIONS

- Downhole tools
- High efficiency DC/DC converters & motor drives
- Aerospace: Military & Commercial
- Smart grid/grid-tie distributed generation

### COMPANION PARTS

- Silicon Carbide Schottky Diodes, APE HT-0112, APE HT-0122
- Low-Temperature Single-Channel Gate Driver, APE ITGD1-0021
- Mil-Temperature Dual-Channel Gate Driver, APE MTGD2-2011
- High-Temperature Dual-Channel Gate Driver, APE HTGD2-0031

**1200 V / 45 A / 80 mΩ**



TO-254 Package      1 2 3  
                                 G D S

### Absolute Maximum Ratings<sup>1</sup> ( $T_J = 25\text{ }^{\circ}\text{C}$ unless otherwise specified)

Symbol	Parameter	Condition(s)	Value	Units
$V_{DSS}$	Drain-source voltage		1200	V
$V_{GS}$	Gate-source voltage		-6 to 22	V
$I_D$	Continuous drain current <sup>2</sup>	$V_{GS} = 20\text{ V}$ , $T_C = 25\text{ }^{\circ}\text{C}$	45	A
		$V_{GS} = 20\text{ V}$ , $T_C = 100\text{ }^{\circ}\text{C}$	36	
		$V_{GS} = 20\text{ V}$ , $T_C = 200\text{ }^{\circ}\text{C}$	16	
$I_{DM}$	Peak pulsed drain current <sup>1</sup>	Pulse width $t_p$ limited by $T_{J(max)}$ ; $T_J = 25\text{ }^{\circ}\text{C}$ , $t_p = 1\text{ ms}$	TBD	A
$E_{AS}$	Single-pulse avalanche energy		TBD	J
$E_{AR}$	Repetitive avalanche energy		TBD	J
$I_{AR}$	Repetitive avalanche current		TBD	A
$P_{tot}$	Power dissipation <sup>1</sup>	$T_C = 25\text{ }^{\circ}\text{C}$	200 <sup>2</sup>	W
		$T_C = 100\text{ }^{\circ}\text{C}$	125 <sup>2</sup>	
		$T_C = 200\text{ }^{\circ}\text{C}$	25 <sup>2</sup>	
$T_J$	Operating junction temperature		-50 to 225 <sup>3</sup>	$^{\circ}\text{C}$
$T_{stg}$	Storage temperature		-50 to 225 <sup>3</sup>	$^{\circ}\text{C}$
$V_{isol}$	Insulation test voltage	AC, 1 min.	TBD	V
		AC, 1 s.	TBD	V

<sup>1</sup> Obtained from Rohm Co., Ltd. S2301 TCST Rev. 0 datasheet

<sup>2</sup> Assumes a thermal resistance junction to case of  $\leq 1.0\text{ }^{\circ}\text{C/W}$

<sup>3</sup> Data obtained through APEI experimentation and/or calculation

SiC MOSFET Electrical Characteristics <sup>1</sup> ( $T_J = 25\text{ }^\circ\text{C}$ unless otherwise specified)						
Symbols	Parameter	Condition(s)	Values			Units
			Min.	Typical	Max.	
$V_{(BR)DSS}$	Drain-source breakdown voltage	$V_{GS} = 0\text{ V}, I_D = 1\text{ mA}$	1200	-	-	V
$V_{GS(th)}$	Gate-source threshold voltage <sup>4</sup>	$V_{DS} = V_{GS}, I_D = 4.4\text{ mA}$	1.6	-	4.0	V
		$T_J = 225\text{ }^\circ\text{C}$	-	TBD	-	
$I_{DSS}$	Zero gate voltage drain current	$V_{DS} = 1200\text{ V}, V_{GS} = 0\text{ V}$	-	-	10	$\mu\text{A}$
$I_{GSS}$	Gate-source leakage current	$V_{GS} = 22\text{ V}, V_{DS} = 0\text{ V}$	-	-	100	nA
$R_{DS(on)}$	Drain-source on-resistance	$V_{GS} = 18\text{ V}, I_D = 10\text{ A}$	-	80	111	m $\Omega$
		$T_J = 225\text{ }^\circ\text{C}$	-	TBD	-	
$g_{fs}$	Transconductance	$V_{DS} = 10\text{ V}, I_D = 10\text{ A}$	-	3.7	-	S
		$T_J = 225\text{ }^\circ\text{C}$	-	TBD	-	
$C_{iss}$	Input capacitance	$V_{GS} = 0\text{ V}$	-	2080	-	pF
$C_{oss}$	Output capacitance	$V_{DS} = 800\text{ V}$	-	77	-	pF
$C_{rss}$	Reverse transfer capacitance	$f = 1\text{ MHz}$	-	16	-	pF
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 400\text{ V}, V_{GS} = 18\text{ V}$ $I_D = 10\text{ A}$ $R_{G(ext)} = 0\text{ }\Omega, R_L = 40\text{ }\Omega$	-	35	-	ns
$t_{rv}$	Rise time		-	36	-	ns
$t_{d(off)}$	Turn-off delay time		-	76	-	ns
$t_{fv}$	Fall time		-	22	-	ns
$E_{on}$	Turn-On switching loss		-	TBD	-	$\mu\text{J}$
			-	TBD	-	
$E_{off}$	Turn-Off switching loss		-	TBD	-	$\mu\text{J}$
			-	TBD	-	

SiC Inverse Body Diode Electrical Characteristics <sup>1,5</sup> ( $T_J = 25\text{ }^\circ\text{C}$ unless otherwise specified)						
Symbols	Parameter	Condition(s)	Values			Units
			Min.	Typical	Max.	
$V_{SD}$	Diode forward voltage	$V_{GS} = -3\text{ V}, I_F = 10\text{ A}$	-	4.5	-	V
$t_{rr}$	Reverse recovery time	$V_{GS} = 0\text{ V}, I_F = 10\text{ A}$ $V_R = 800\text{ V}$ $di_F/dt = 400\text{ }\mu\text{A}/\mu\text{s}$	-	TBD	-	ns
$Q_{rr}$	Reverse recovery charge		-	120	-	nC
$I_{rrm}$	Peak reverse recovery current		-	TBD	-	A

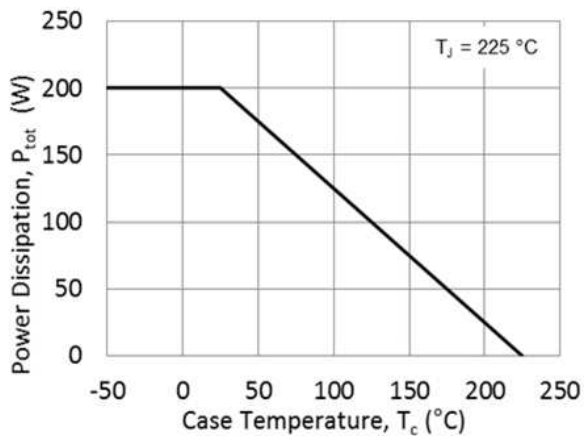
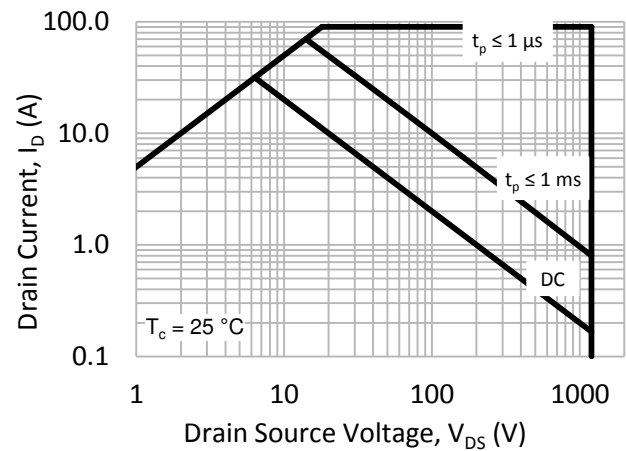
<sup>4</sup> The recommended on-state VGS is +20 V and the recommended off-state VGS is between 0 V and -5 V

<sup>5</sup> APEI recognizes the end user's ultimate responsibility for determining the appropriateness of use and effectiveness of the SiC inverse body diode for freewheeling capability in their specific application. Increased performance may be achieved by using other APEI products found in the Companion Parts section of this datasheet.

SiC MOSFET Gate Charge Electrical Characteristics <sup>1</sup> ( $T_J = 25\text{ }^\circ\text{C}$ unless otherwise specified)						
Symbols	Parameter	Condition(s)	Values			Units
			Min.	Typical	Max.	
$Q_{gs}$	Gate to source charge	$V_{DD} = 400\text{ V}$ , $V_{GS} = 18\text{ V}$	-	27	-	nC
$Q_{gd}$	Gate to drain charge	$I_D = 10\text{ A}$	-	31	-	nC
$Q_g$	Gate charge total	$R_L = 40\ \Omega$	-	106	-	nC

Thermal Characteristics ( $T_J = 25\text{ }^\circ\text{C}$ unless otherwise specified)						
Symbols	Parameter	Condition(s)	Values			Units
			Min.	Typical	Max.	
$R_{\theta(j-c)}$	Thermal resistance junction-case	Calculated at $200\text{ }^\circ\text{C}$	-	TBD	1.0	$^\circ\text{C/W}$

Mechanical Characteristics ( $T_J = 25\text{ }^\circ\text{C}$ unless otherwise specified)						
Symbols	Parameter	Condition(s)	Values			Units
			Min.	Typical	Max.	
w	Weight		-	9.0	-	g
$M_s$	Mounting torque	6-32 steel screw, Al heat sink	-	0.78	1.04	N-m

**TYPICAL PERFORMANCE CURVES**

 Fig. 1 - Maximum power dissipation  $P_{tot}$  versus case temperature  $T_c$ 

 Fig. 2 - Maximum safe operating area (SOA)  $I_D = f(V_{DS})$

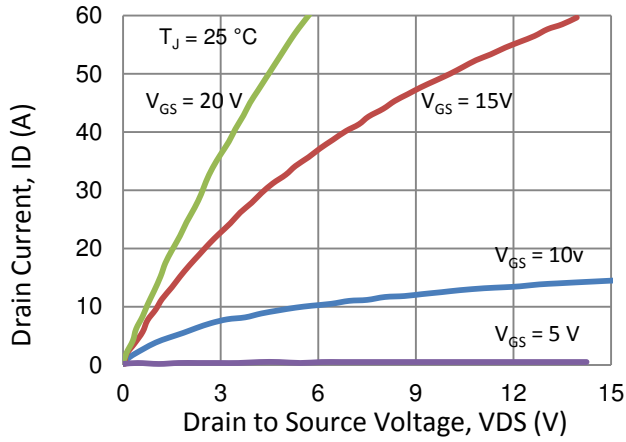
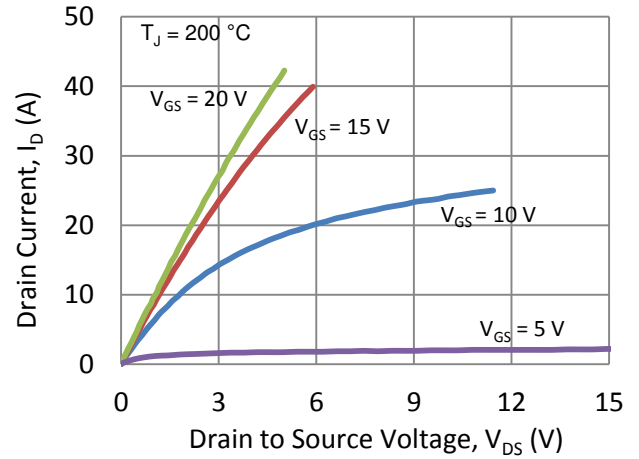
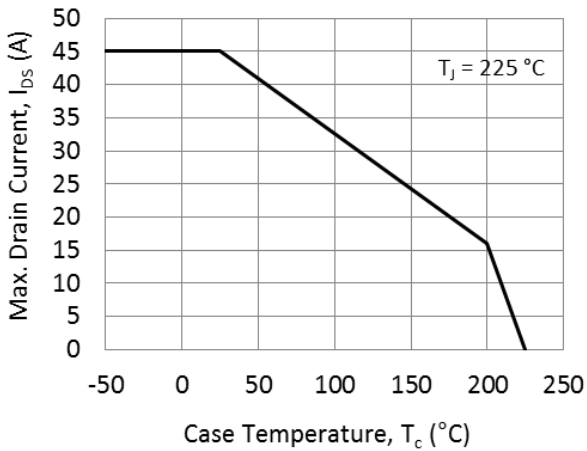

 Fig. 3 Forward output characteristic  $ID = f(V_{DS})$ , 25 °C

 Fig. 4 - Forward output characteristic  $ID = f(V_{DS})$ , 200 °C


Fig. 5 - Drain current derating versus case temperature TC

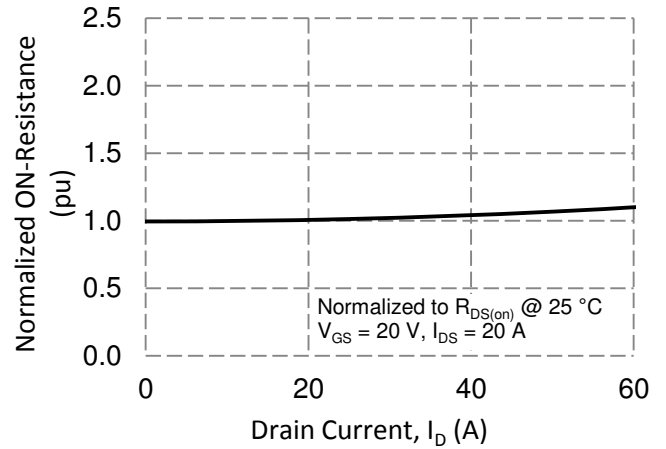


Fig. 6 - ON-resistance versus drain current and gate-source voltage

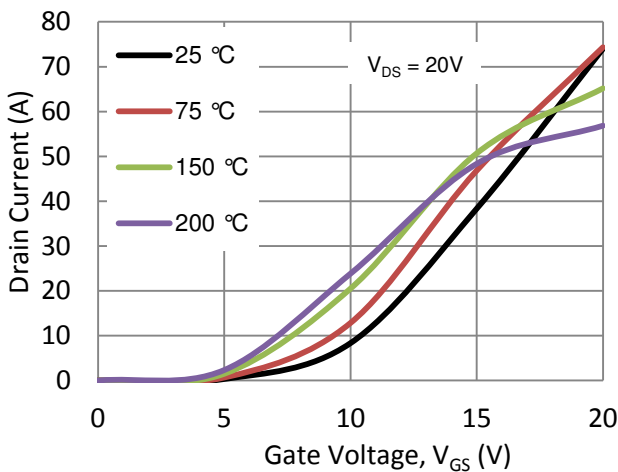
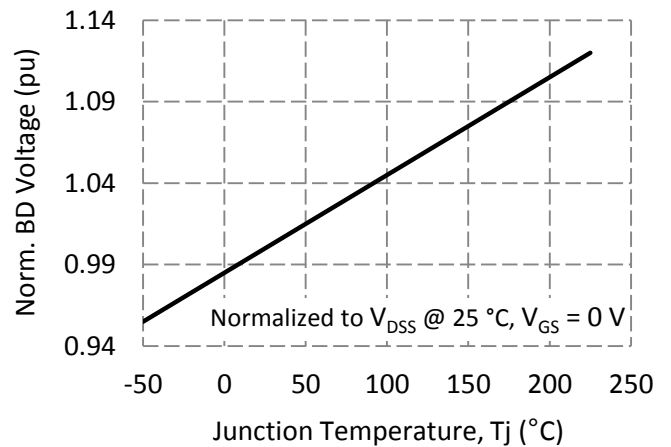


Fig. 7 - Transconductance versus temperature


 Fig. 8 - Drain-source breakdown voltage versus junction temperature  $T_j$

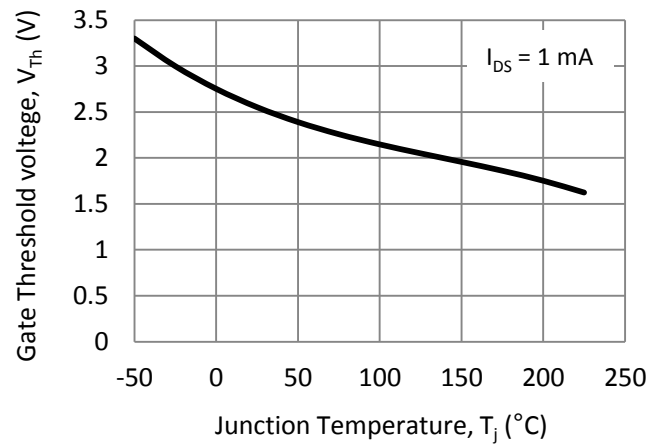
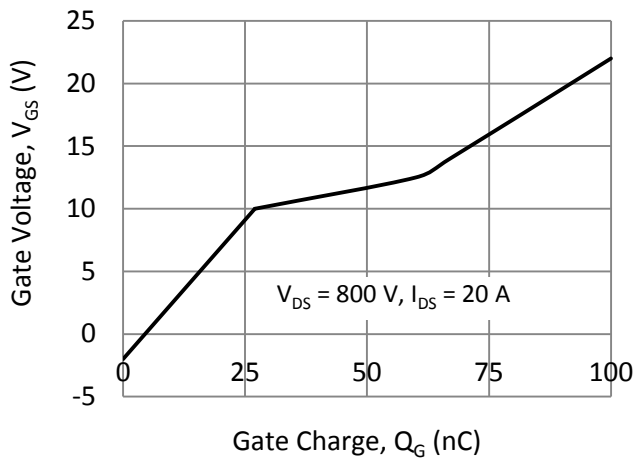
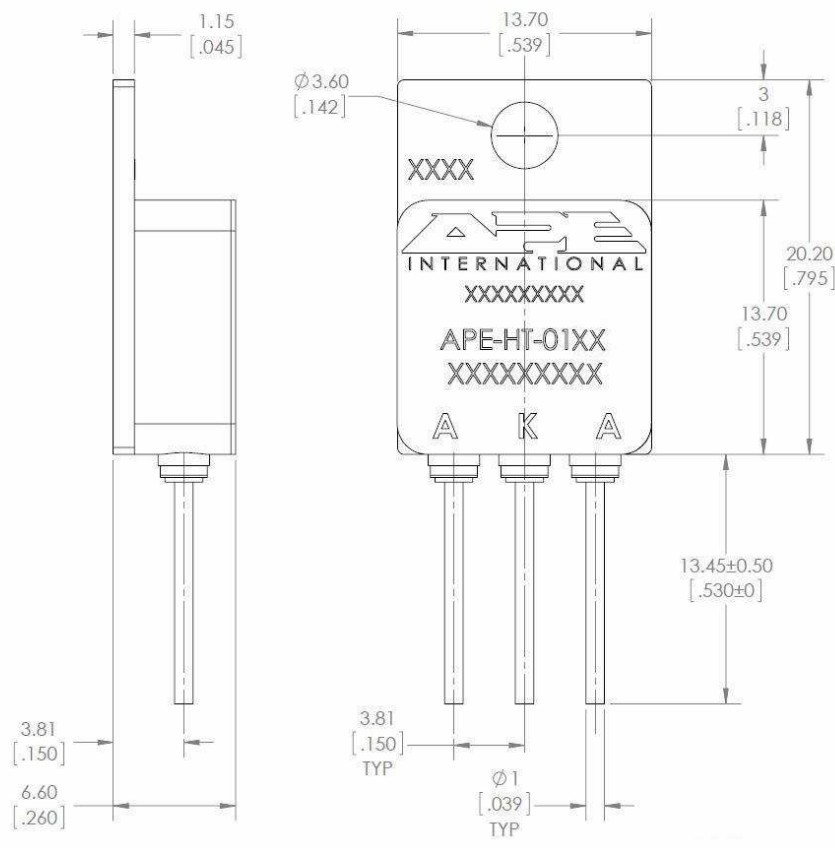


Fig. 9 - Gate charge characteristic  $V_{GS} = f(Q_G)$

Fig. 10 - Gate-source threshold voltage versus junction temperature  $T_j$

### PACKAGE DIMENSIONS

All dimensions shown are in inches [millimeters]





**PRELIMINARY**

**APE HT-0111-A**

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