

# High-Temperature Silicon Carbide (SiC) Half-Bridge Power Module

## N-Channel MOSFET Version

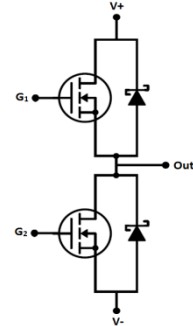
**1200 V / 225 A / 13.5 mΩ**

### FEATURES

- High temperature:  $T_{c(max)} = 225\text{ °C}$   
 $T_{J(max)} = 225\text{ °C}$
- AS9100:Rev. C-certified manufacturing, traceable throughout value chain
- Ultra-fast switching (<30 ns), low inductance
- Enables high system efficiency
- Low profile, small form factor

### APPLICATIONS

- High-efficiency converters / inverters
- Motor drives
- Aerospace: Military & Commercial
- Smart grid/grid-tie distributed generation
- Industrial and automotive traction drives



### DESCRIPTION

The APE HT-2102-A Silicon Carbide (SiC) half-bridge power module was designed specifically to address the growing demand for higher power densities, higher temperatures, and higher switching frequencies.

### COMPANION PARTS

Maximum performance may be obtained through use of the companion high-temperature gate driver, part number APE MTGD2-2011, designed especially for driving the Silicon Carbide module.

### Power Module Absolute Maximum Ratings ( $T_c = 25\text{ °C}$ unless otherwise specified)

Symbol	Parameter	Condition(s)	Value	Units
$V_{DSS}$	Drain-source voltage		1200	V
$V_{GSS}$	Gate-source voltage		-5 to 20	V
$I_D$	Continuous drain current	$T_c = 25\text{ °C}$	225	A
		$T_c = 100\text{ °C}$	175	
		$T_c = 200\text{ °C}$	80	
$I_{DM}$	Peak pulsed drain current	Pulse width $\leq 10\text{ }\mu\text{s}$ , duty cycle $\leq 2\%$	TBD	A
$P_D$	Maximum power dissipated		1600	W
$T_{C(max)}$	Maximum case temperature <sup>1</sup>		225	°C
$T_{J(min)}$	Minimum operating junction temperature		- 50	°C
$T_{J(max)}$	Maximum operating junction temperature		225	
$T_{stg}$	Storage temperature		- 50 to 225	°C
$V_{isol}$	Insulation test voltage	AC, 1 min.	TBD	V
		AC, 1 s.	TBD	

<sup>1</sup>The packaging materials have been qualified at this temperature.

Switch Position Electrical Characteristics ( $T_c = 25\text{ }^\circ\text{C}$ 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	$V_{DS} = V_{GS}, I_D = 1\text{ mA}$	-	2.1	-	V
		$V_{DS} = V_{GS}, I_D = 1\text{ mA}, T_j = 205\text{ }^\circ\text{C}$	-	1.1	-	
$I_{DSS}$	Drain-source leakage current	$V_{GS} = -5\text{ V}, V_{DS} = 1200\text{ V}$	-	-	200	$\mu\text{A}$
		$V_{GS} = -5\text{ V}, V_{DS} = 1200\text{ V}, T_j = 205\text{ }^\circ\text{C}$	-	-	2000	
$I_{GSS}$	Gate-source leakage current	$V_{GS} = 20\text{ V}, V_{DS} = 0\text{ V}$	-	-	250	nA
$R_{DS(on)}$	Drain-source turn-on resistance	$V_{GS} = 20\text{ V}, I_D = 75\text{ A}$	-	13.5	-	m $\Omega$
		$V_{GS} = 20\text{ V}, I_D = 75\text{ A}, T_j = 225\text{ }^\circ\text{C}$	-	26.6	-	
$C_{iss}$	Input capacitance	$V_{GS} = 0\text{ V}$	-	11,490	-	pF
$C_{oss}$	Output capacitance	$V_{DS} = 800\text{ V}$	-	720	-	
$C_{rss}$	Reverse transfer capacitance	$f = 1\text{ MHz}$	-	78	-	
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 600\text{ V}, V_{GS} = -4\text{ to }20\text{ V}$ $I_D = 120\text{ A}$ $R_{G(ext)} = 0\text{ }\Omega, R_L = 60\text{ }\Omega$	-	36	-	ns
$t_{rv}$	Rise time		-	20	-	
$t_{d(off)}$	Turn-off delay time		-	68	-	
$t_{fv}$	Fall time		-	25	-	

Switch Position Gate Charge Electrical Characteristics ( $T_c = 25\text{ }^\circ\text{C}$ unless otherwise specified)						
Symbols	Parameter	Condition(s)	Values			Units
			Min.	Typical	Max.	
$Q_{gs}$	Gate to source charge	$V_{DD} = 800\text{ V}, V_{GS} = -4\text{ to }20\text{ V}$ $I_D = 120\text{ A}$	-	143	-	nC
$Q_{gd}$	Gate to drain charge		-	260	-	
$Q_g$	Gate charge total		-	545	-	

Diode Position Electrical Characteristics ( $T_c = 25\text{ }^\circ\text{C}$ unless otherwise specified)						
Symbols	Parameter	Condition(s)	Values			Units
			Min.	Typical	Max.	
$V_{FM}$	Forward voltage	$I_F = 60\text{ A}$	-	1.65	-	V
		$I_F = 60\text{ A}, T_j = 200\text{ }^\circ\text{C}$	-	2.5	-	
$I_R$	Reverse current	$V_R = 1200\text{ V}$	-	TBD	-	$\mu\text{A}$
		$V_R = 1200\text{ V}, T_j = 200\text{ }^\circ\text{C}$	-	TBD	-	
$Q_C$	Capacitive charge	$V_R = 1200\text{ V}, I_F = 120\text{ A}, di/dt = 7500\text{ A}/\mu\text{s}$	-	780	-	nC

Thermal Characteristics ( $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified)						
Symbols	Parameter	Condition(s)	Values			Units
			Min.	Typical	Max.	
$R_{\theta(j-c)}$	FET thermal resistance junction-case			0.125		$^\circ\text{C}/\text{W}$

**Power Module Mechanical Characteristics**

Symbols	Parameter	Condition(s)	Values			Units
			Min.	Typical	Max.	
w	Weight			140		g
M <sub>s</sub>	Lead frame mounting torque	6-32 steel screw for lead frame, 10-32 steel screw for baseplate		40		in·lb

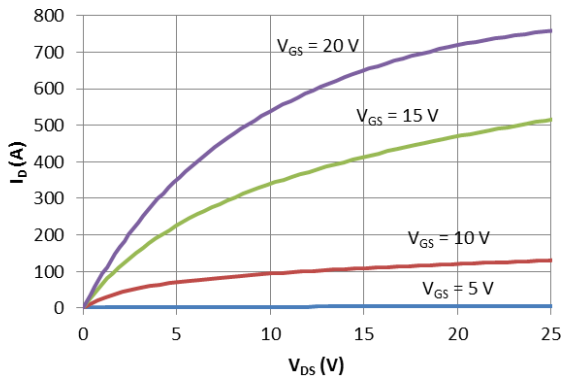
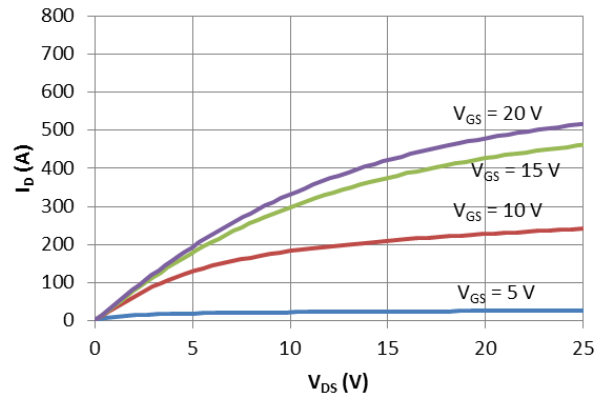
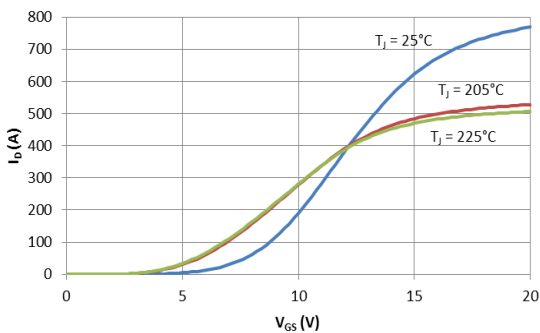
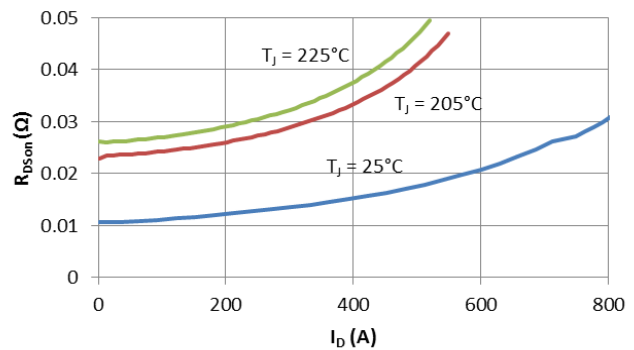
**TYPICAL PERFORMANCE CURVES**

 Fig. 1 - Typical Output Characteristics,  $T_j = 25^\circ\text{C}$ 

 Fig. 2 - Typical Output Characteristics,  $T_j = 205^\circ\text{C}$ 


Fig. 3 - Transconductance


 Fig. 4 - Typical On Resistance,  $V_{GS} = 20\text{ V}$ 

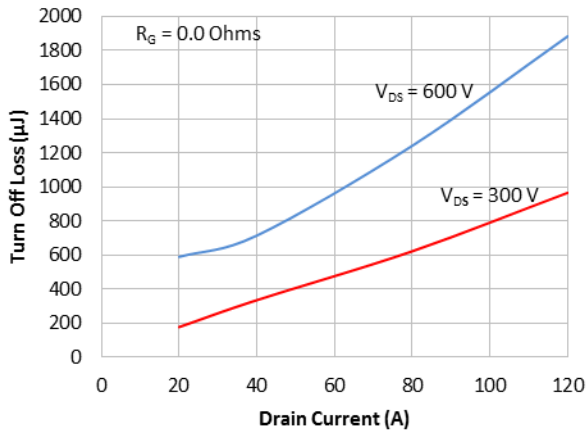



Fig. 5 – Turn off loss versus drain current

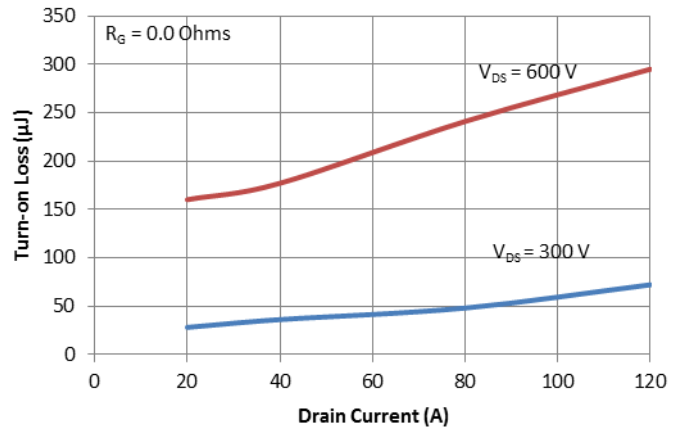


Fig. 6 – Turn on loss versus drain current

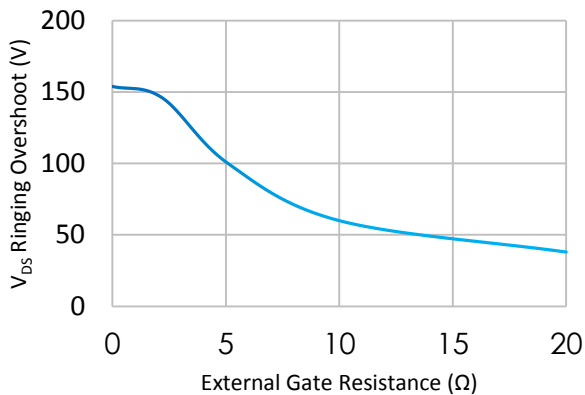


Fig. 7 – Ringing voltage overshoot versus external gate resistance

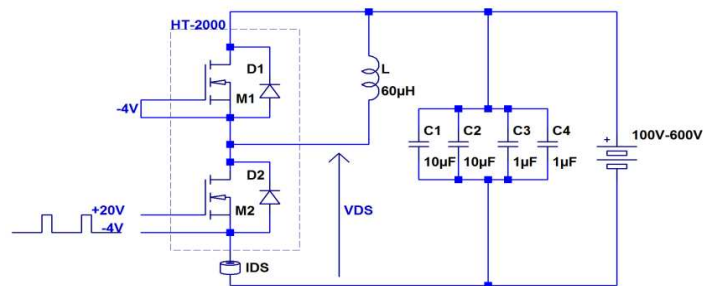
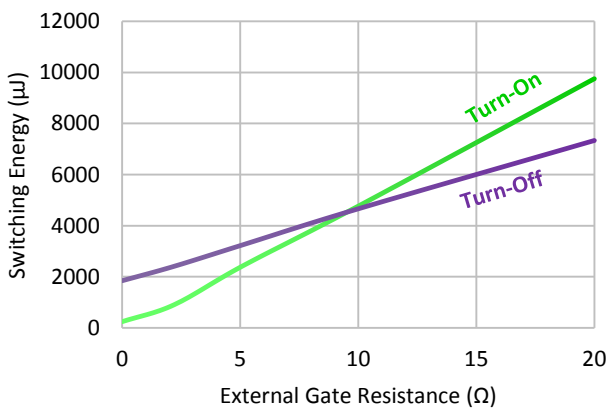

 Fig. 8 – Energy values obtained using companion gate driver ( $T_{amb} = 25\text{ }^{\circ}\text{C}$ ).


Fig. 9 – Switching energy versus external gate resistance

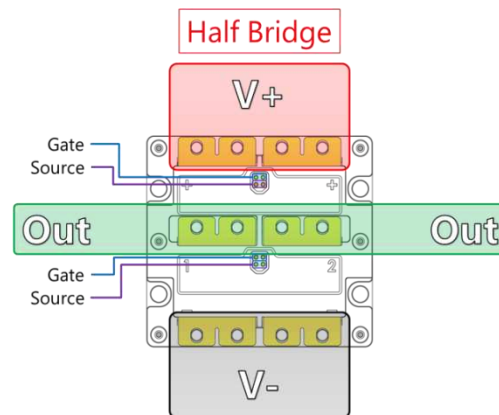


Fig 10 – Half Bridge Connection

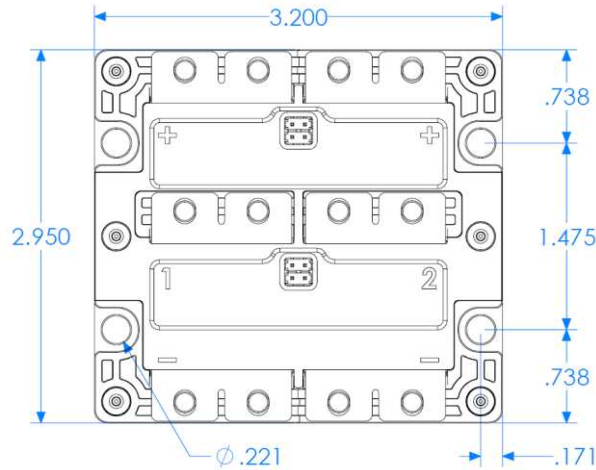
**MOUNTING DIMENSIONS**

All dimensions are listed in inches

#10-32 bolts are recommended for mounting

A torque of 40 in·lb is recommended

CAD models are available upon request

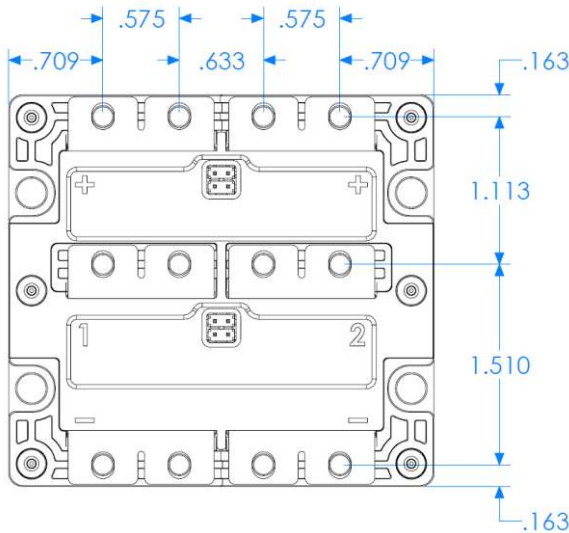

**POWER CONTACT DIMENSIONS**

All dimensions are listed in inches

#6-32 bolts required for the power contacts

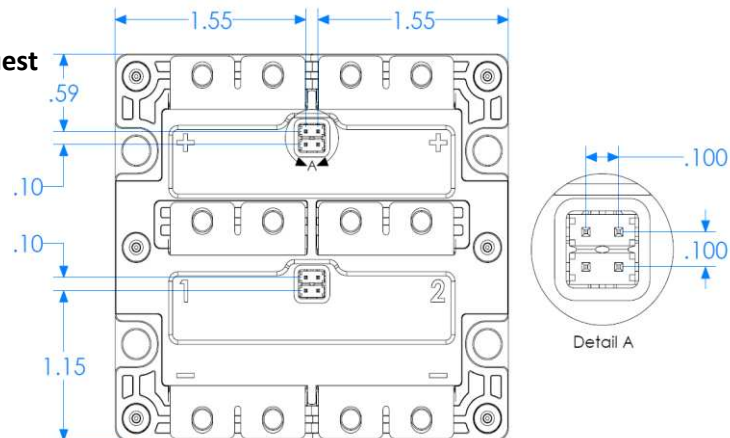
A torque of 40 in·lb is recommended

CAD models are available upon request


**GATE DRIVE CONNECTIONS**

All dimensions are listed in inches

CAD models are available upon request





**PRELIMINARY**

**APE HT-2102-A**

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