

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

TMOS Version

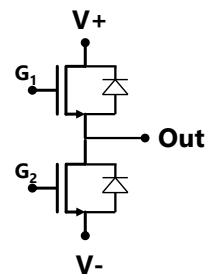
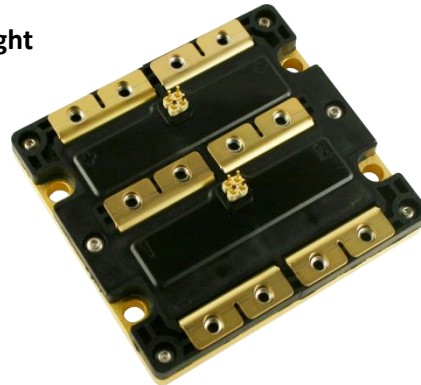
FEATURES

- 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
- Ultra-fast switching (<30 ns), low inductance
- High system efficiency
- Flux-free, void-free packaging
- Low profile, small form factor, extremely lightweight
- High reliability

600 V / 1000 A / 1.4 m Ω

APPLICATIONS

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



DESCRIPTION

The APE HT-2201 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 ($T_c = 25\text{ }^\circ\text{C}$ unless otherwise specified)

Symbol	Parameter	Condition(s)	Value	Units
V_{DSS}	Drain-source voltage		600	V
V_{GSS}	Gate-source voltage		-5 to 20	V
I_D	Continuous drain current	$T_c = 25\text{ }^\circ\text{C}$	1000	A
		$T_c = 100\text{ }^\circ\text{C}$	TBD	
		$T_c = 225\text{ }^\circ\text{C}$	TBD	
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 ¹		225	$^\circ\text{C}$
$T_{j(min)}$	Minimum operating junction temperature		- 50	$^\circ\text{C}$
$T_{j(max)}$	Maximum operating junction temperature		225	
T_{stg}	Storage temperature		- 50 to 225	$^\circ\text{C}$
V_{isol}	Insulation test voltage	AC, 1 min.	TBD	V
		AC, 1 s.	TBD	

Power Module 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	$V_{GS} = -2\text{ V}$, $I_D = 1\text{ mA}$	600	-	-	V
$V_{GS(th)}$	Gate-source threshold voltage	$V_{DS} = 10\text{ V}$, $I_D = 1\text{ mA}$	1.0	-	3.0	V
		$V_{DS} = V_{GS}$, $I_D = 1\text{ mA}$, $T_j = 200\text{ }^\circ\text{C}$	TBD	-	TBD	
I_{DSS}	Drain-source leakage current	$V_{GS} = -2\text{ V}$, $V_{DS} = 600\text{ V}$	-	-	200	μA
		$V_{GS} = 2\text{ V}$, $V_{DS} = 600\text{ V}$, $T_j = 200\text{ }^\circ\text{C}$	-	-	TBD	
I_{GSS}	Gate-source leakage current	$V_{GS} = 20\text{ V}$, $V_{DS} = 0\text{ V}$	-	-	40	μA
$R_{DS(on)}$	Drain-source turn-on resistance	$V_{GS} = 20\text{ V}$, $I_D = 1000\text{ A}$	-	1.4	1.6	m Ω
		$V_{GS} = 20\text{ V}$, $I_D = 1000\text{ A}$, $T_j = 150\text{ }^\circ\text{C}$	-	TBD	TBD	
C_{iss}	Input capacitance	$V_{GS} = 0\text{ V}$	-	TBD	-	pF
C_{oss}	Output capacitance	$V_{DS} = 600\text{ V}$	-	TBD	-	
C_{rss}	Reverse transfer capacitance	$f = 1\text{ MHz}$	-	TBD	-	
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 200\text{ V}$, $V_{GS} = -4\text{ to }20\text{ V}$ $I_D = 500\text{ A}$ $R_{G(ext)} = 1.0\text{ }\Omega$, $R_L = 43\text{ }\mu\text{H}$	-	TBD	-	ns
t_{rv}	Rise time		-	45	-	
$t_{d(off)}$	Turn-off delay time		-	TBD	-	
t_{fv}	Fall time		-	35	-	

¹The packaging materials have been qualified at this temperature.

Power Module 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	$V_{DD} = 400\text{ V}$, $V_{GS} = -4\text{ to }20\text{ V}$ $I_D = 1000\text{ A}$ $R_{G(ext)} = xx\ \Omega$, $R_L = xx\ \Omega$	TBD	-	-	nC
Q_{gd}	Gate to drain charge		TBD	-	-	
Q_g	Gate charge total		TBD	-	-	

Power Module 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	$I_F = 50\text{ A}$	-	3.4	-	V
		$I_F = 300\text{ A}$, $T_j = 25\text{ }^\circ\text{C}$	-	5.3	-	
I_R	Reverse current	$V_R = 600\text{ V}$	-	TBD	-	μA
		$V_R = 600\text{ V}$, $T_j = 150\text{ }^\circ\text{C}$	-	TBD	-	
Q_C	Capacitive charge	$V_R = 600\text{ V}$, $I_F = 450\text{ A}$, $di/dt = 22900\text{ A}/\mu\text{s}$	-	TBD	-	nC

Power Module Thermal Characteristics² ($T_j = 25\text{ }^\circ\text{C}$ 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 ($T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified)

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

TYPICAL PERFORMANCE CURVES

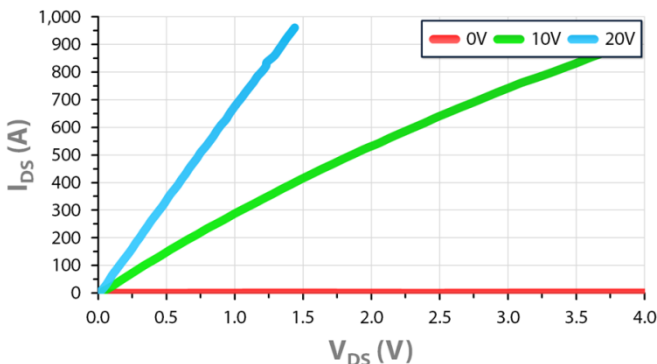
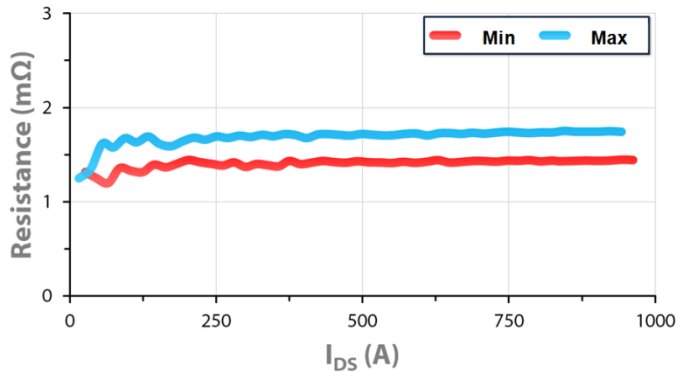
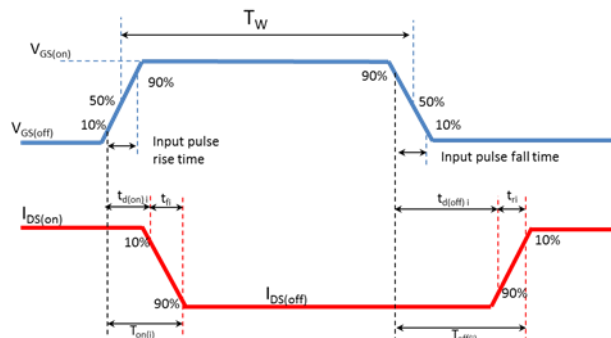
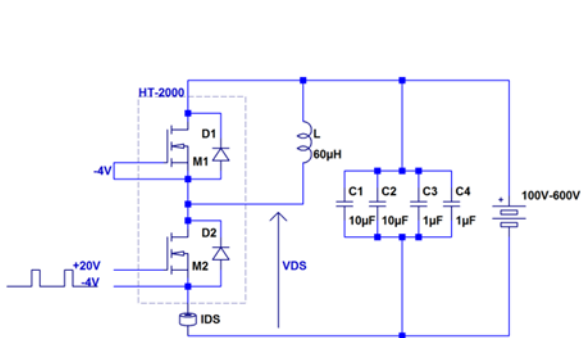
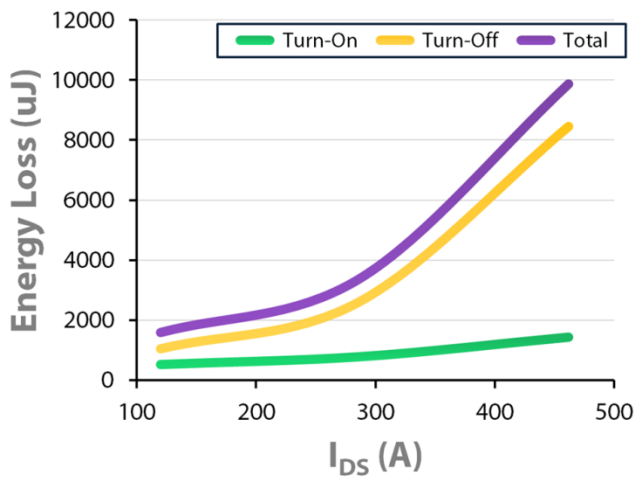


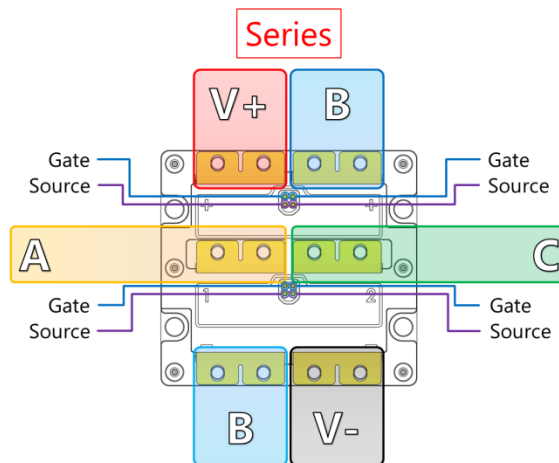
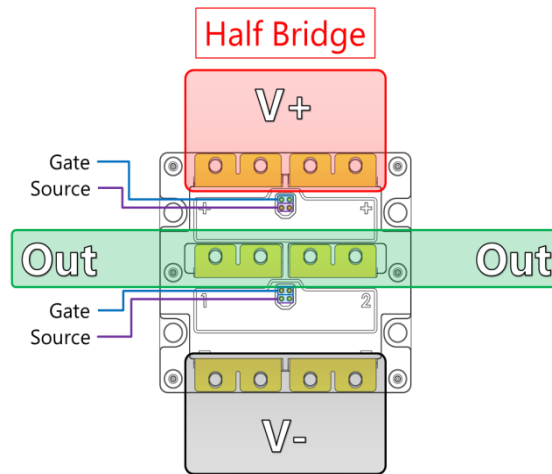
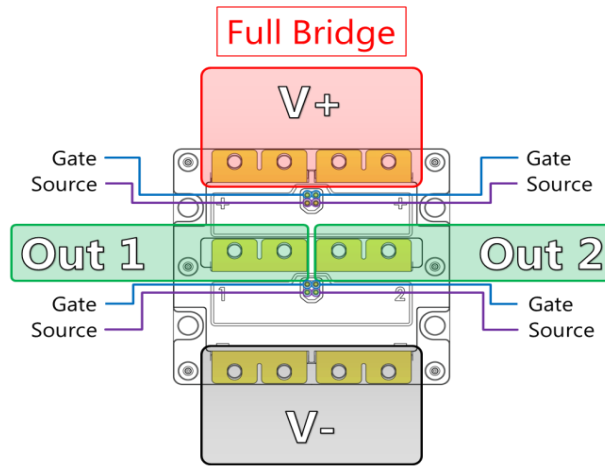
Fig. 1 - Die Junction @ 25 °C

² FET thermal resistance junction-case is calculated measured with a 105 °C coldplate and full power distributed through the FETs. The thermal properties typically improve at lower temperatures.



Typical Normalized On Resistance

 Normalized to an on resistance value of 1.4 mΩ ($I_D = 1000 \text{ A}$, $T_j = 25 \text{ }^\circ\text{C}$)

Typical Switching Losses

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



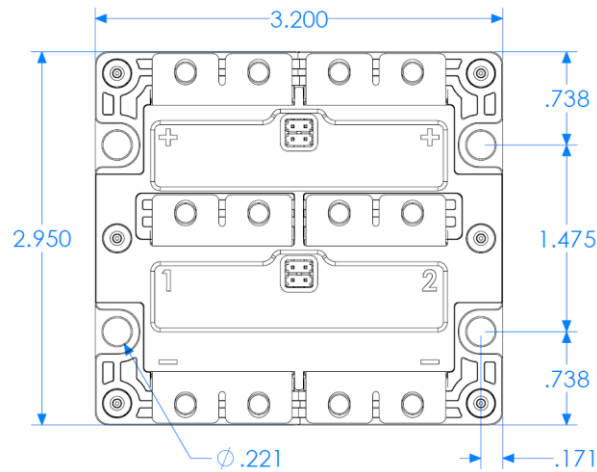
MOUNTING DIMENSIONS

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



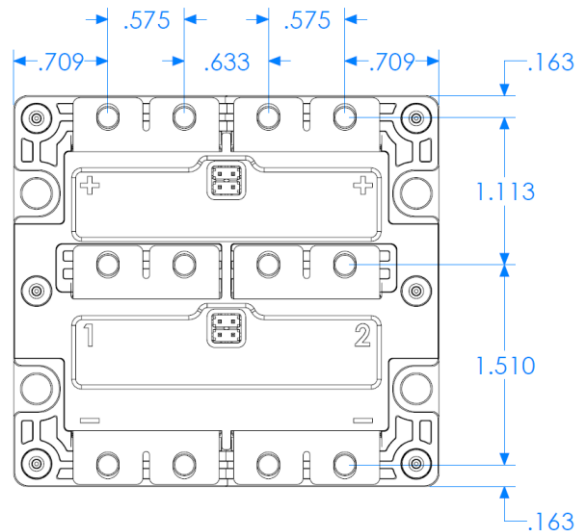
POWER CONTACT DIMENSIONS

All dimensions are listed in inches

#6-32 bolts required for the power contacts

A torque of 40 in-lb is recommended

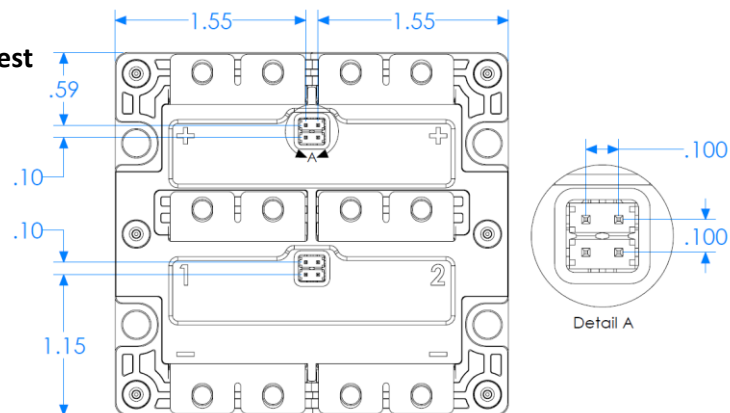
CAD models are available upon request



GATE DRIVE CONNECTIONS

All dimensions are listed in inches

CAD models are available upon request





PRELIMINARY

APE HT-2103

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