

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

N-Channel DMOS Version

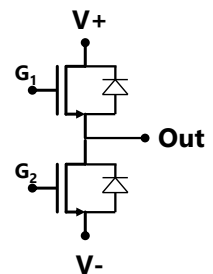
1200 V / 160 A / 20 mΩ

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
- High system efficiency
- Flux-free, void-free packaging
- Package retains hermeticity to 400 °C
- High reliability

APPLICATIONS

- High-efficiency converters / inverters
- Motor drives
- Aerospace: Military & Commercial
- Military



DESCRIPTION

The APE XT-1201 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. It features a flexible layout, allowing for rapid configuration as either a half or a full bridge and straightforward paralleling between modules.

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	$T_c = 25\text{ °C}$	160	A
		$T_c = 100\text{ °C}$	TBD	
		$T_c = 225\text{ °C}$	TBD	
I_{DM}	Peak pulsed drain current	Pulse width $\leq 10\ \mu\text{s}$, duty cycle $\leq 2\%$	TBD	A
P_D	Maximum power dissipated		TBD	W
$T_{c(max)}$	Maximum case temperature ¹		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	

¹Device limited.

Power Module Switch Position Electrical Characteristics (T _c = 25 °C unless otherwise specified)						
Symbols	Parameter	Condition(s)	Values			Units
			Min.	Typical	Max.	
V _{(BR)DSS}	Drain-source breakdown voltage	V _{GS} = 0 V, I _D = 1 mA	1200	-	-	V
V _{GS(th)}	Gate-source threshold voltage	V _{DS} = V _{GS} , I _D = 1 mA	2.0	2.1	4.0	V
		V _{DS} = V _{GS} , I _D = 1 mA, T _j = 205 °C	1.0	1.1	3.0	
I _{DSS}	Drain-source leakage current	V _{GS} = - 2 V, V _{DS} = 1200 V	-	-	133	μA
		V _{GS} = 2 V, V _{DS} = 1200 V, T _j = 205 °C	-	-	1333	
I _{GSS}	Gate-source leakage current	V _{GS} = 20 V, V _{DS} = 0 V	-	-	167	nA
R _{DS(on)}	Drain-source turn-on resistance	V _{GS} = 20 V, I _D = 75 A	-	20.3	22	mΩ
		V _{GS} = 20 V, I _D = 75 A, T _j = 205 °C	-	29.3	34	
C _{iss}	Input capacitance	V _{GS} = 0 V	-	3833	-	pF
C _{oss}	Output capacitance	V _{DS} = 800 V	-	400	-	
C _{rss}	Reverse transfer capacitance	f = 1 MHz	-	27	-	
t _{d(on)}	Turn-on delay time	V _{DD} = 600 V, V _{GS} = - 4 to 20 V I _D = 60 A R _{G(ext)} = 0 Ω, R _L = 60 Ω	-	36	-	ns
t _{rv}	Rise time		-	14	-	
t _{d(off)}	Turn-off delay time		-	68	-	
t _{fv}	Fall time		-	34	-	

Power Module Switch Position Gate Charge Electrical Characteristics (T _c = 25 °C unless otherwise specified)						
Symbols	Parameter	Condition(s)	Values			Units
			Min.	Typical	Max.	
Q _{gs}	Gate to source charge	V _{DD} = 800 V, V _{GS} = - 4 to 20 V I _D = 75 A R _{G(ext)} = xx Ω, R _L = xx Ω	48	-	-	nC
Q _{gd}	Gate to drain charge		87	-	-	
Q _g	Gate charge total		187	-	-	

Power Module Diode Position Electrical Characteristics (T _c = 25 °C unless otherwise specified)						
Symbols	Parameter	Condition(s)	Values			Units
			Min.	Typical	Max.	
V _{FM}	Forward voltage	I _F = 60 A	-	TBD	TBD	V
		I _F = 60 A, T _j = 200 °C	-	TBD	TBD	
I _R	Reverse current	V _R = 1200 V	-	-	-	μA
		V _R = 1200 V, T _j = 200 °C	-	-	-	
Q _C	Capacitive charge	V _R = 1200 V, I _F = 120 A, di/dt = 7500 A/μs	-	TBD	-	nC

Power Module Thermal Characteristics ² (T _j = 25 °C unless otherwise specified)						
Symbols	Parameter	Condition(s)	Values			Units
			Min.	Typical	Max.	
R _{θ(j-c)}	FET thermal resistance junction-case			TBD		°C/W

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.

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			130		g

SiC MOSFET Electrical Characteristics³ ($T_c = 25\text{ }^\circ\text{C}$ 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	$V_{DS} = V_{GS}, I_D = 4.4\text{ mA}$	1.7	-	3.7	V
I_{DSS}	Zero gate voltage drain current	$V_{DS} = 1200\text{ V}, V_{GS} = 0\text{ V}$	-	-	10	μA
I_{GSS}	Gate-source leakage current	$V_{GS} = 22\text{ V}, V_{DS} = 0\text{ V}$	-	-	100	nA
		$V_{GS} = -6\text{ V}, V_{DS} = 0\text{ V}$	-	-	-100	
$R_{DS(on)}$	Drain-source turn-on resistance	$V_{GS} = 18\text{ V}, I_D = 10\text{ A}$	-	90	120	m Ω
		$V_{GS} = 18\text{ V}, I_D = 10\text{ A}, T_c = 150\text{ }^\circ\text{C}$	-	130	170	
g_{fs}	Transconductance	$V_{DS} = 10\text{ V}, I_D = 10\text{ A}$	-	4	-	S
C_{iss}	Input capacitance	$V_{GS} = 0\text{ V}$ $V_{DS} = 25\text{ V}$ $f = 1\text{ MHz}$	-	2200	-	pF
C_{oss}	Output capacitance		-	381	-	pF
C_{rss}	Reverse transfer capacitance		-	46	-	pF
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 300\text{ V}, V_{GS} = 18\text{ V}$ $I_D = 10\text{ A}$ $R_{G(ext)} = 0\text{ }\Omega, R_L = 30\text{ }\Omega$	-	29	-	ns
t_{rv}	Rise time		-	31	-	ns
$t_{d(off)}$	Turn-off delay time		-	75	-	ns
t_{fv}	Fall time		-	19	-	ns
E_{on}	Turn-On switching loss		-	-	-	μJ
E_{off}	Turn-Off switching loss		-	-	-	μJ
R_G	Internal gate resistance	-	-	-	Ω	

SiC MOSFET Inverse Body Diode Electrical Characteristics⁴ ($T_c = 25\text{ }^\circ\text{C}$ 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	$V_{GS} = 0\text{ V}, I_F = 10\text{ A}$ $V_R = 800\text{ V}$ $di_F/dt = 400\text{ A}/\mu\text{s}$	-	TBD	-	ns
Q_{rr}	Reverse recovery charge		-	120	-	nC
I_{rrm}	Peak reverse recovery current		-	TBD	-	A

³ Obtained from Cree Inc. CPMF-1200-S080B Rev. A datasheet

SiC MOSFET Gate Charge Electrical Characteristics ⁴ ($T_c = 25\text{ }^\circ\text{C}$ unless otherwise specified)						
Symbols	Parameter	Condition(s)	Values			Units
			Min.	Typical	Max.	
Q_{gs}	Gate to source charge	$V_{DD} = 600\text{ V}$, $V_{GS} = 18\text{ V}$ $I_D = 10\text{ A}$ $R_{G(ext)} = 10\ \Omega$, $R_L = 60\ \Omega$	-	30	-	nC
Q_{gd}	Gate to drain charge		-	30	-	
Q_g	Gate charge total		-	98	-	

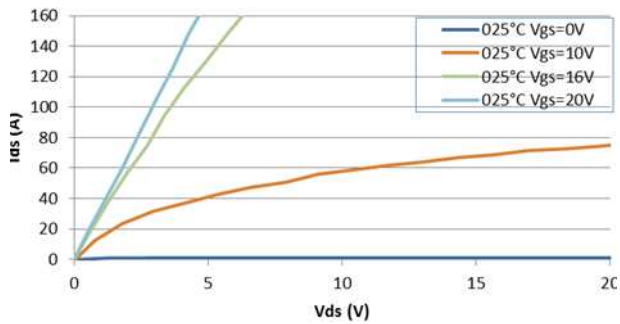
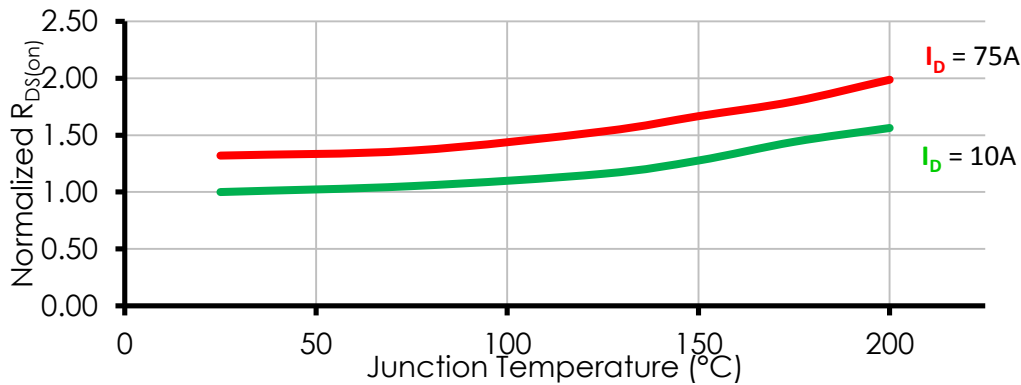
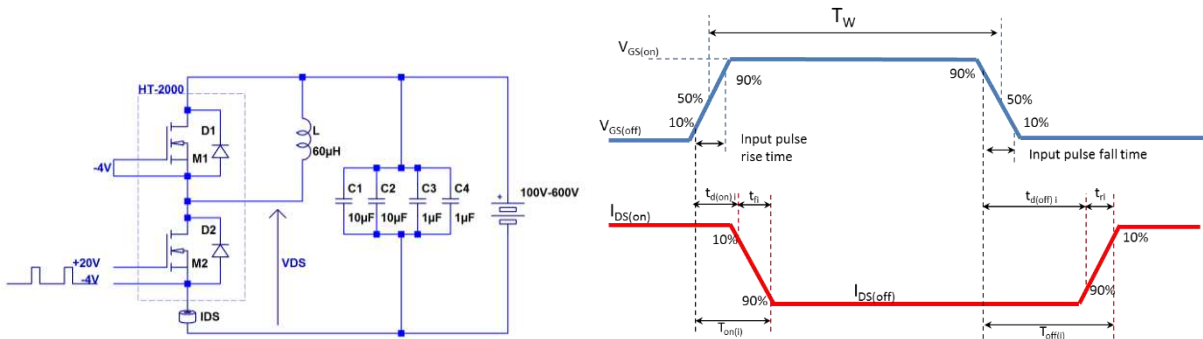
TYPICAL PERFORMANCE CURVES


Fig 1 On-state curve at Die Junction 25°C

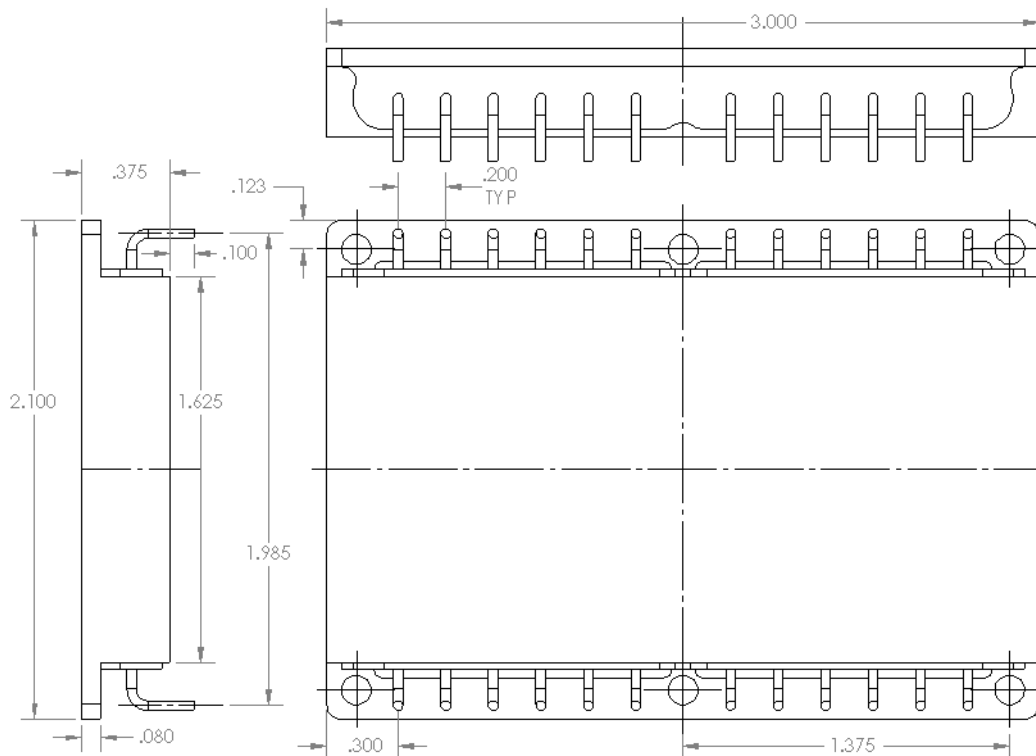

 Fig 2. Normalized to an on resistance value of 20.25 mΩ ($I_D = 10\text{ A}$, $T_j = 25\text{ }^\circ\text{C}$)

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

CAD models are available at www.apei.net

PART NUMBER	PACKAGE	MARKING
APE XT-1101	Custom	



PRELIMINARY

APE XT-1201

COMPANION PARTS

Standard-Temperature Gate Driver, APE-xxxx

High-Temperature Gate Driver, APE-xxxx

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PRELIMINARY

APE XT-1201

ORDERING INSTRUCTIONS

An order for one or more parts can be initiated by issuing a purchase order to APEI, Inc. Please e-mail or fax your purchase order to sales@apei.net or +1.866.515.6604, respectively.

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