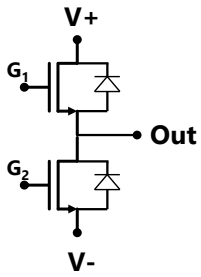
High-Temperature Silicon Carbide (SiC) Half-Bridge Power Module

N-Channel DMOS Version

1200 V / 160 A / 20 mΩ

FEATURES

- **High temperature: $T_{c(max)}$ = 225 °C**
  $T_{j(max)}$ = 225 °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 parallelling between modules.

Power Module Absolute Maximum Ratings (T_c = 25 °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 °C	160	A
		T_c = 100 °C	TBD	
		T_c = 225 °C	TBD	
I_{DM}	Peak pulsed drain current	Pulse width ≤ 10 µs, duty cycle ≤ 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	

[1]Device 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 V_{DS} = 800 V f = 1 MHz	-	3833	-	pF
C_{oss}	Output capacitance		-	400	-	
C_{rss}	Reverse transfer capacitance		-	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.**	
$R_{\theta(j-c)}$	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 °C unless otherwise specified)						
Symbols	Parameter	Condition(s)	Values			Units
			Min.	Typical	Max.	
w	Weight			130		g

SiC MOSFET Electrical Characteristics[3] (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 = 4.4 mA	1.7	-	3.7	V
I_{DSS}	Zero gate voltage drain current	V_{DS} = 1200 V, V_{GS} = 0 V	-	-	10	µA
I_{GSS}	Gate-source leakage current	V_{GS} = 22 V, V_{DS} = 0 V	-	-	100	nA
		V_{GS} = -6 V, V_{DS} = 0 V	-	-	-100	
$R_{DS(on)}$	Drain-source turn-on resistance	V_{GS} = 18 V, I_D = 10 A	-	90	120	mΩ
		V_{GS} = 18 V, I_D = 10 A, T_c = 150 °C	-	130	170	
g_{fs}	Transconductance	V_{DS} = 10 V, I_D = 10 A	-	4	-	S
C_{iss}	Input capacitance	V_{GS} = 0 V V_{DS} = 25 V f = 1 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 V, V_{GS} = 18 V I_D = 10 A $R_{G(ext)}$ = 0 Ω, R_L = 30 Ω	-	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 Characteristics[4] (T_c = 25 °C unless otherwise specified)						
Symbols	Parameter	Condition(s)	Values			Units
			Min.	Typical	Max.	
V_{SD}	Diode forward voltage	V_{GS} = -3 V, I_F = 10 A	-	4.5	-	V
t_{rr}	Reverse recovery time	V_{GS} = 0 V, I_F = 10 A	-	TBD	-	ns
Q_{rr}	Reverse recovery charge	V_R = 800 V	-	120	-	nC
I_{rrm}	Peak reverse recovery current	di_F/dt = 400 A/µs	-	TBD	-	A

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

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

TYPICAL PERFORMANCE CURVES

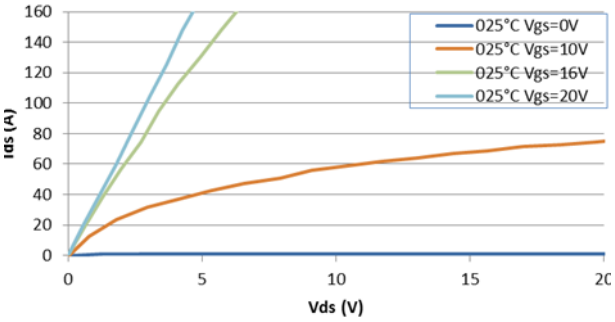


Fig 1 On-state curve at Die Junction 25°C

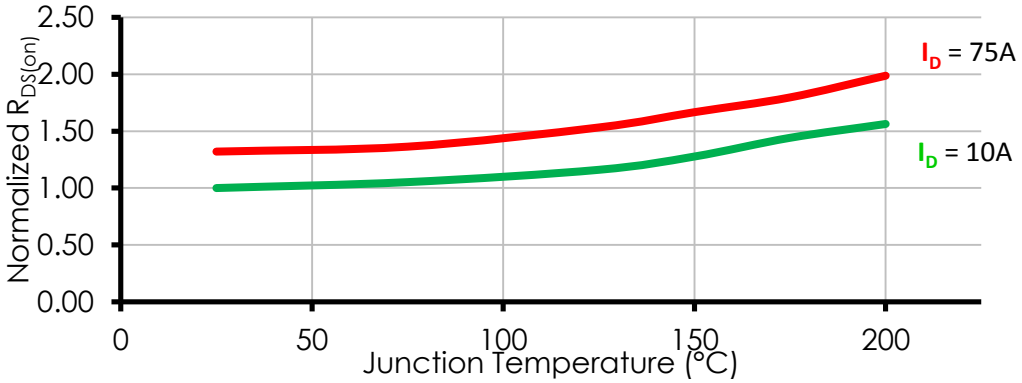
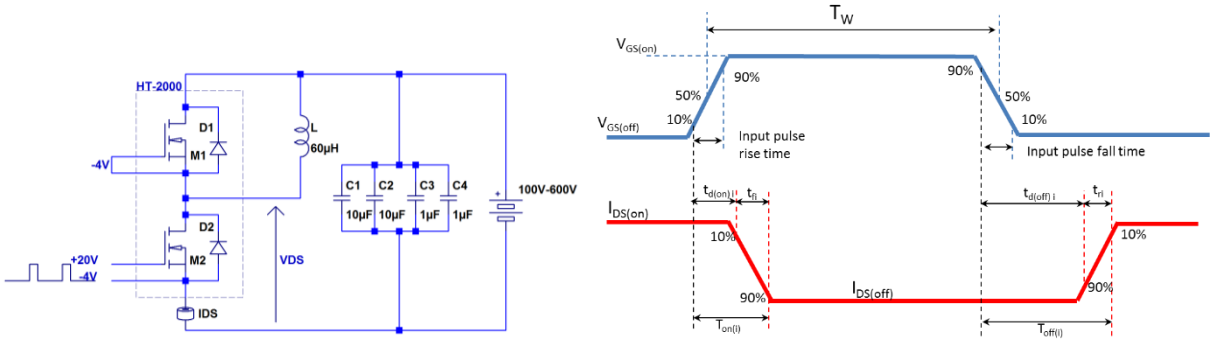


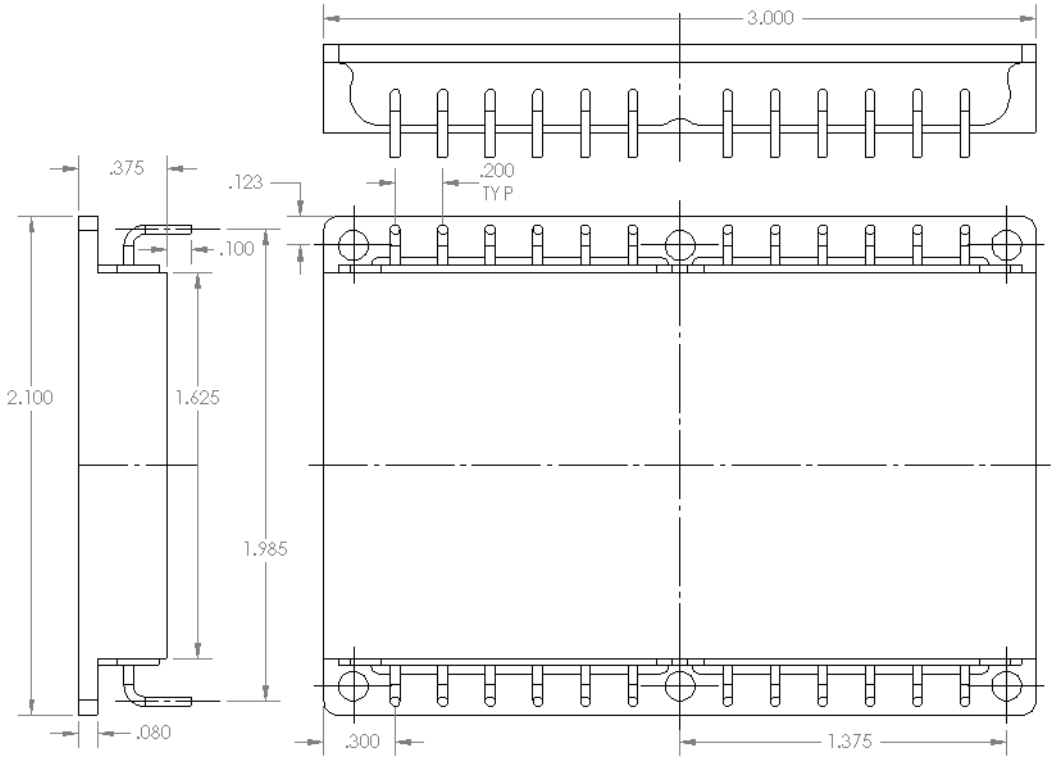
Fig 2. Normalized to an on resistance value of 20.25 mΩ (I_D = 10 A, T_j =25 °C)

Typical Switching Losses



Energy values obtained using companion gate driver (T_{amb} = 25 °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	

COMPANION PARTS

Standard-Temperature Gate Driver, APE-xxxx
High-Temperature Gate Driver, APE-xxxx

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