![Microsemi logo] **Microsemi**
POWER PRODUCTS GROUP

APTSM120AM55CT1AG

> *Phase leg*
> *SiC MOSFET Power Module*

V_{DSS} = 1200V
R_{DSon} = 50mΩ max @ Tj = 25°C
I_D = 74A @ Tc = 25°C
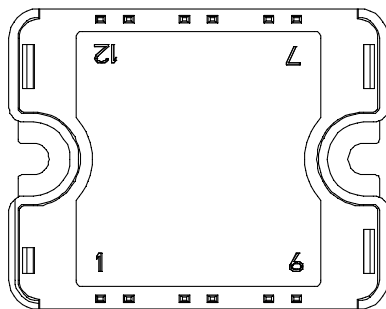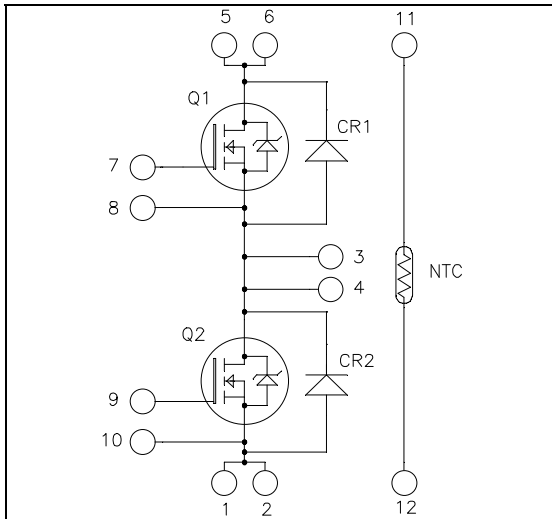
Pins 1/2 ; 3/4 ; 5/6 must be shorted together

Application
- Welding converters
- Switched Mode Power Supplies
- Uninterruptible Power Supplies
- Motor control

Features
- *SiC Power MOSFET*
  - Low $R_{DS(on)}$
  - High temperature performance

- *SiC Schottky Diode*
  - Zero reverse recovery
  - Zero forward recovery
  - Temperature Independent switching behavior
  - Positive temperature coefficient on VF

- Very low stray inductance
- Internal thermistor for temperature monitoring
- Kelvin source for easy drive
- AlN substrate for improved thermal performance

Benefits
- Outstanding performance at high frequency operation
- Direct mounting to heatsink (isolated package)
- Low junction to case thermal resistance
- Solderable terminals both for power and signal for easy PCB mounting
- Low profile
- RoHS Compliant

All ratings @ T_j = 25°C unless otherwise specified

Absolute maximum ratings (Per SiC MOSFET)

Symbol	Parameter		Max ratings	Unit
V_{DSS}	Drain - Source Voltage		1200	V
I_D	Continuous Drain Current	T_c = 25°C	74	A
		T_c = 80°C	59	
I_{DM}	Pulsed Drain current		140	
V_{GS}	Gate - Source Voltage		-10/+25	V
R_{DSon}	Drain - Source ON Resistance		50	mΩ
P_D	Power Dissipation	T_c = 25°C	470	W

⚠ **CAUTION:** These Devices are sensitive to Electrostatic Discharge. Proper Handling Procedures Should Be Followed.
See application note APT0502 on www.microsemi.com

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Electrical Characteristics (Per SiC MOSFET)

Symbol	Characteristic	Test Conditions		Min	Typ	Max	Unit
I_{DSS}	Zero Gate Voltage Drain Current	V_{GS} = 0V ; V_{DS} = 1200V			20	200	μA
$R_{DS(on)}$	Drain – Source on Resistance	V_{GS} = 20V I_D = 40A	T_j = 25°C		40	50	mΩ
			T_j = 175°C		70		
$V_{GS(th)}$	Gate Threshold Voltage	$V_{GS} = V_{DS}$, I_D = 2mA		1.7	3		V
I_{GSS}	Gate – Source Leakage Current	V_{GS} = 20 V, V_{DS} = 0V				200	nA

Dynamic Characteristics (Per SiC MOSFET)

Symbol	Characteristic	Test Conditions		Min	Typ	Max	Unit
C_{iss}	Input Capacitance	V_{GS} = 0V V_{DS} = 1000V f = 1MHz			5120		pF
C_{oss}	Output Capacitance				240		
C_{rss}	Reverse Transfer Capacitance				40		
Q_g	Total gate Charge	V_{GS}= -5/20V V_{Bus} = 600V I_D = 40A			272		nC
Q_{gs}	Gate – Source Charge				80		
Q_{gd}	Gate – Drain Charge				80		
$T_{d(on)}$	Turn-on Delay Time	V_{GS} = -5/+20V V_{Bus} = 800V I_D = 40A R_{Gext} = 2.5Ω			10		ns
T_r	Rise Time				10		
$T_{d(off)}$	Turn-off Delay Time				45		
T_f	Fall Time				30		
E_{on}	Turn on Energy	Inductive Switching V_{GS} = -5/+20V V_{Bus} = 600V I_D = 40A R_{Gext} = 2.5Ω	T_j = 150°C		0.9		mJ
E_{off}	Turn off Energy		T_j = 150°C		0.5		mJ
R_{Gint}	Internal gate resistance				1.65		Ω
R_{thJC}	Junction to Case Thermal Resistance					0.32	°C/W

Body diode ratings and characteristics (Per SiC MOSFET)

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
V_{SD}	Diode Forward Voltage	V_{GS} = 0V, I_{SD} = 40A		3.9		V
t_{rr}	Reverse Recovery Time	I_{SD} = 40A ; V_{GS} = -2V V_R = 800V ; di_F/dt = 200A/μs		140		ns
Q_{rr}	Reverse Recovery Charge			230		nC
I_{rr}	Reverse Recovery Current			4		A

SiC diode characteristics (Per SiC diode)

Symbol	Characteristic	Test Conditions		Min	Typ	Max	Unit
V_{RRM}	Peak Repetitive Reverse Voltage					1200	V
I_{RM}	Reverse Leakage Current	V_R=1200V	$T_j = 25°C$		20	400	μA
			$T_j = 175°C$		1000		
I_F	DC Forward Current		Tc = 125°C		20		A
V_F	Diode Forward Voltage	$I_F = 20A$	$T_j = 25°C$		1.5	1.8	V
			$T_j = 175°C$		2.3		
Q_C	Total Capacitive Charge	$I_F = 20A$, $V_R = 600V$ di/dt = 1000A/μs			240		nC
C	Total Capacitance	f = 1MHz, $V_R = 200V$			230		pF
		f = 1MHz, $V_R = 400V$			170		
R_{thJC}	Junction to Case Thermal Resistance					0.55	°C/W

Temperature sensor NTC (see application note APT0406 on www.microsemi.com).

| Symbol	Characteristic		Min	Typ	Max	Unit
R_{25}	Resistance @ 25°C			50		kΩ
$\Delta R_{25}/R_{25}$				5		%
$B_{25/85}$	T_{25} = 298.15 K			3952		K
$\Delta B/B$		T_C=100°C		4		%

$$R_T = \frac{R_{25}}{\exp\left[B_{25/85}\left(\frac{1}{T_{25}} - \frac{1}{T}\right)\right]}$$

T: Thermistor temperature
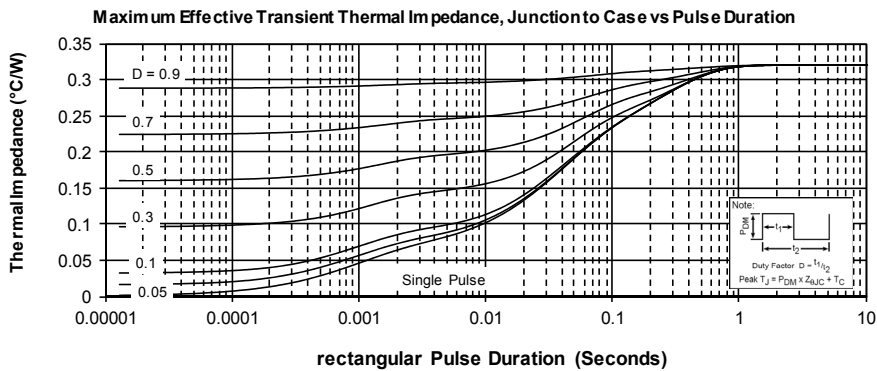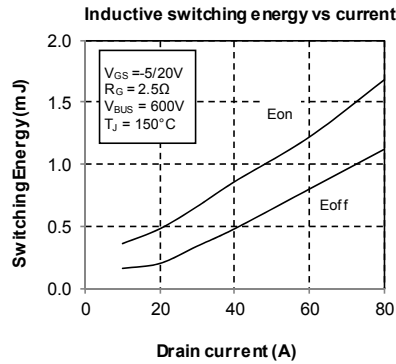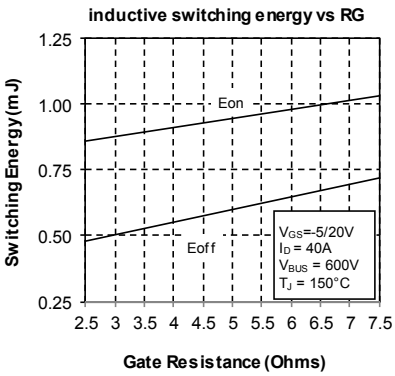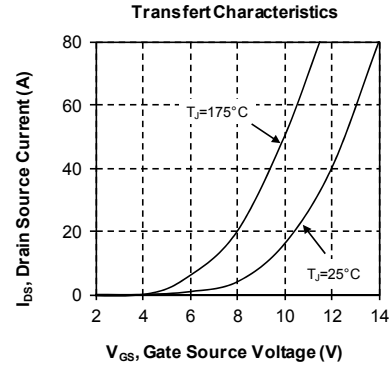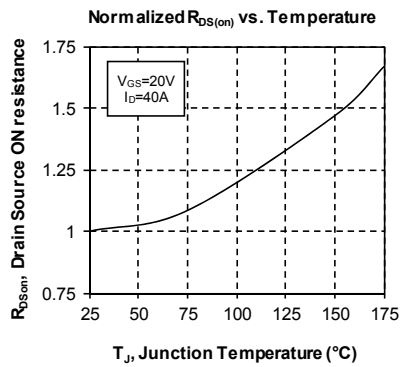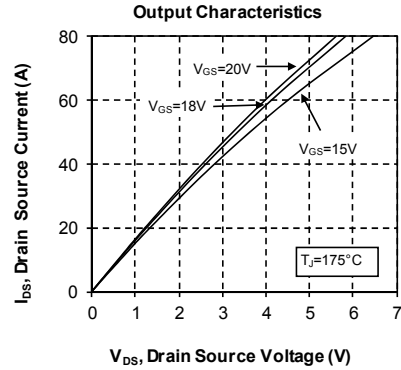R_T: Thermistor value at T

Package characteristics

Symbol	Characteristic			Min	Max	Unit
V_{ISOL}	RMS Isolation Voltage, any terminal to case t =1 min, 50/60Hz			4000		V
T_J	Operating junction temperature range			-40	175	°C
T_{JOP}	Recommended junction temperature under switching conditions			-40	$T_J$max -25	
T_{STG}	Storage Temperature Range			-40	125	
T_C	Operating Case Temperature			-40	125	
Torque	Mounting torque	To heatsink	M4	2	3	N.m
Wt	Package Weight				80	g

Package outline (dimensions in mm)
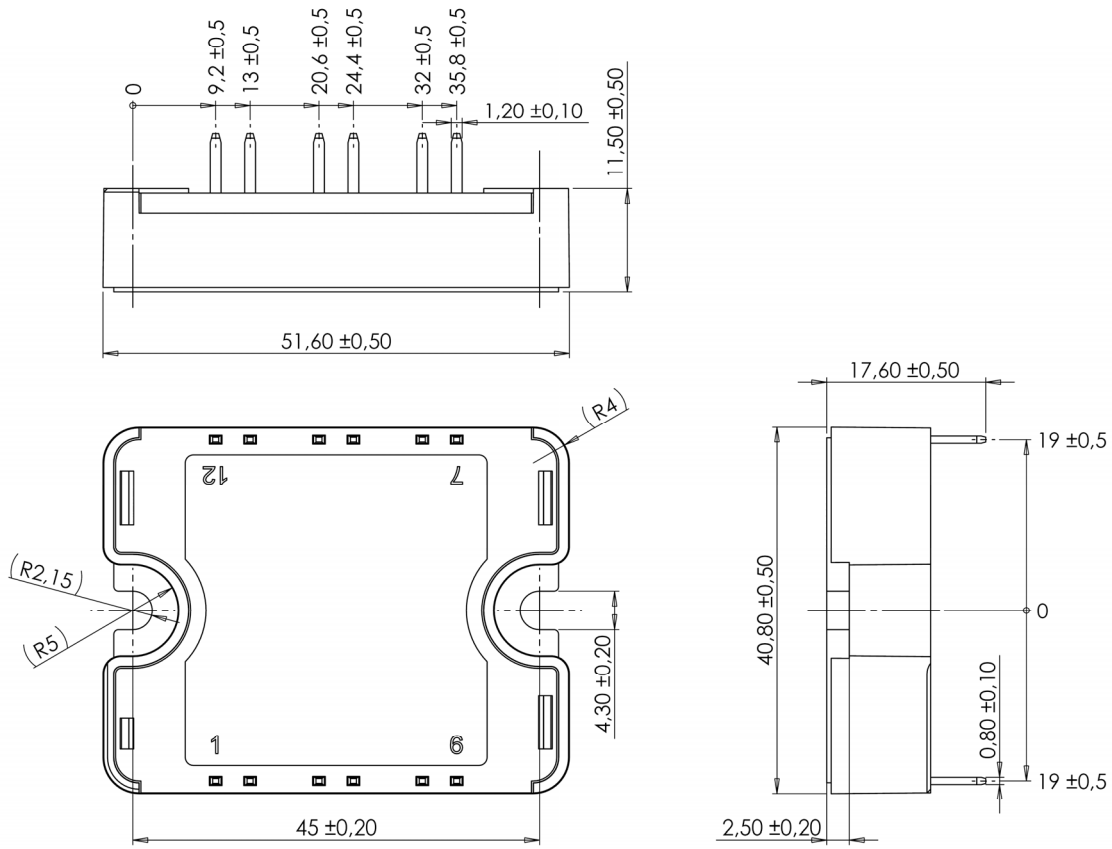
See application note 1904 - Mounting Instructions for SP1 Power Modules on www.microsemi.com

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Typical SiC MOSFET Performance Curve

Output Characteristics

$V_{GS}=20V$
$V_{GS}=18V$
$V_{GS}=15V$
$T_J=25°C$

I_{DS}, Drain Source Current (A)
V_{DS}, Drain Source Voltage (V)

Output Characteristics

$V_{GS}=20V$
$V_{GS}=18V$
$V_{GS}=15V$
$T_J=175°C$

I_{DS}, Drain Source Current (A)
V_{DS}, Drain Source Voltage (V)

Normalized $R_{DS(on)}$ vs. Temperature

$V_{GS}=20V$
$I_D=40A$

R_{DSon}, Drain Source ON resistance
T_J, Junction Temperature (°C)

Transfer Characteristics

$T_J=175°C$
$T_J=25°C$

I_{DS}, Drain Source Current (A)
V_{GS}, Gate Source Voltage (V)

inductive switching energy vs RG

Eon
Eoff

$V_{GS}=-5/20V$
$I_D = 40A$
$V_{BUS} = 600V$
$T_J = 150°C$

Switching Energy (mJ)
Gate Resistance (Ohms)

Inductive switching energy vs current

$V_{GS} =-5/20V$
$R_G = 2.5\Omega$
$V_{BUS} = 600V$
$T_J = 150°C$

Eon
Eoff

Switching Energy (mJ)
Drain current (A)

Maximum Effective Transient Thermal Impedance, Junction to Case vs Pulse Duration

D = 0.9
0.7
0.5
0.3
0.1
0.05

Single Pulse

Note:
P_{DM}
t_1
t_2
Duty Factor D = t_1/t_2
Peak $T_J = P_{DM}$ x $Z_{\theta JC}$ + T_C

Thermal Impedance (°C/W)
rectangular Pulse Duration (Seconds)

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Capacitance vs Drain Source Voltage

C, Capacitance (nF)

Ciss

Coss

Crss

V_{DS}, Drain Source Voltage (V)
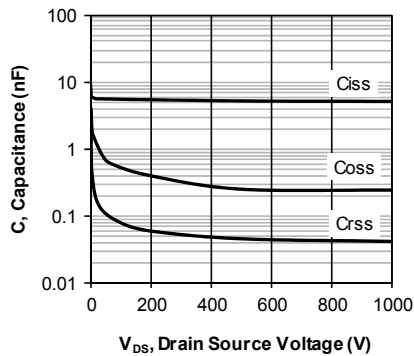
Gate Charge vs Gate Source Voltage
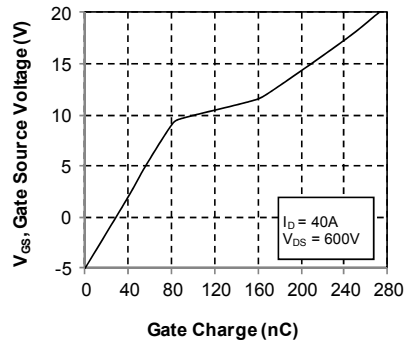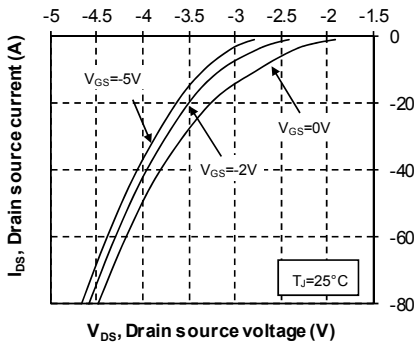
V_{GS}, Gate Source Voltage (V)

I_D = 40A
V_{DS} = 600V

Gate Charge (nC)

Body diode Characteristics

I_{DS}, Drain source current (A)

V_{GS}=-5V
V_{GS}=-2V
V_{GS}=0V

T_J=25°C

V_{DS}, Drain source voltage (V)

3rd quadrant Characteristics

I_{DS}, Drain source current (A)

V_{GS}=0V
V_{GS}=5V
V_{GS}=15V
V_{GS}=18V
V_{GS}=20V

T_J=25°C

V_{DS}, Drain source voltage (V)

Body diode Characteristics

I_{DS}, Drain source current (A)

V_{GS}=-5V
V_{GS}=-2V
V_{GS}=0V

T_J=175°C

V_{DS}, Drain source voltage (V)

3rd quadrant Characteristics

I_{DS}, Drain source current (A)

V_{GS}=0V
V_{GS}=5V
V_{GS}=15V
V_{GS}=18V
V_{GS}=20V

T_J=175°C

V_{DS}, Drain source voltage (V)
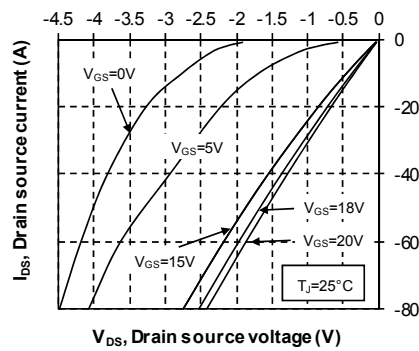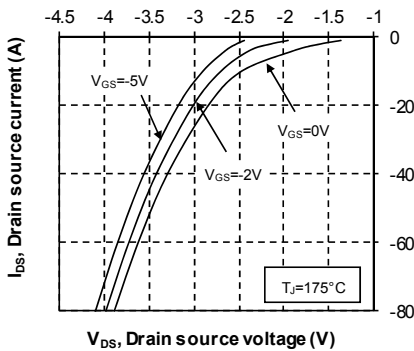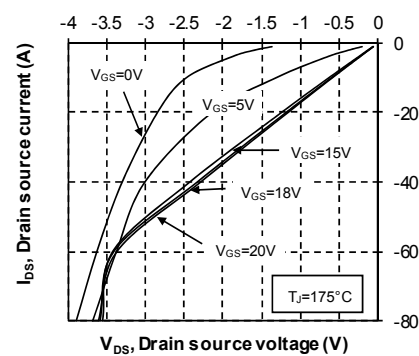
Operating Frequency vs Drain Current

Frequency (kHz)

V_{BUS}=600V
D=50%
R_G=2.5Ω
T_J=150°C
T_C=75°C

ZVS
ZCS
Hard switching

I_D, Drain Current (A)
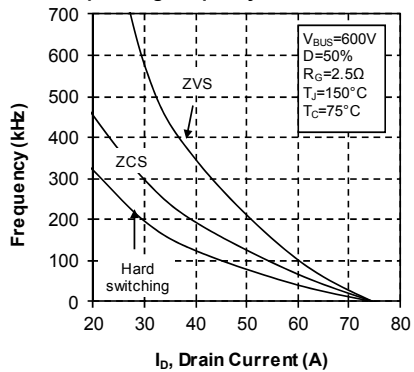
Typical SiC diode Performance Curve

Maximum Effective Transient Thermal Impedance, Junction to Case vs Pulse Duration

Forward Characteristics

Reverse Characteristics

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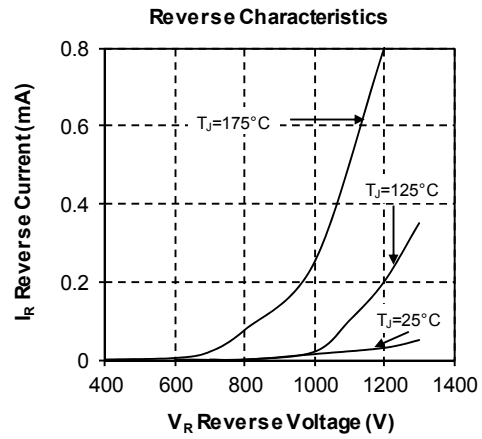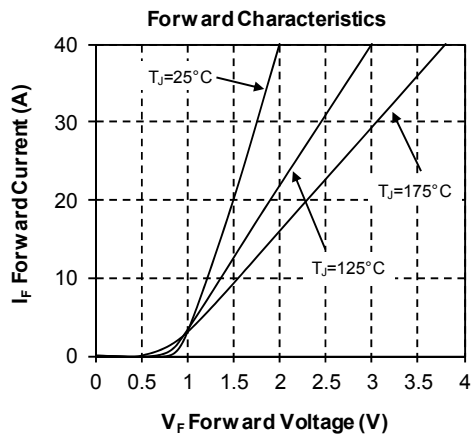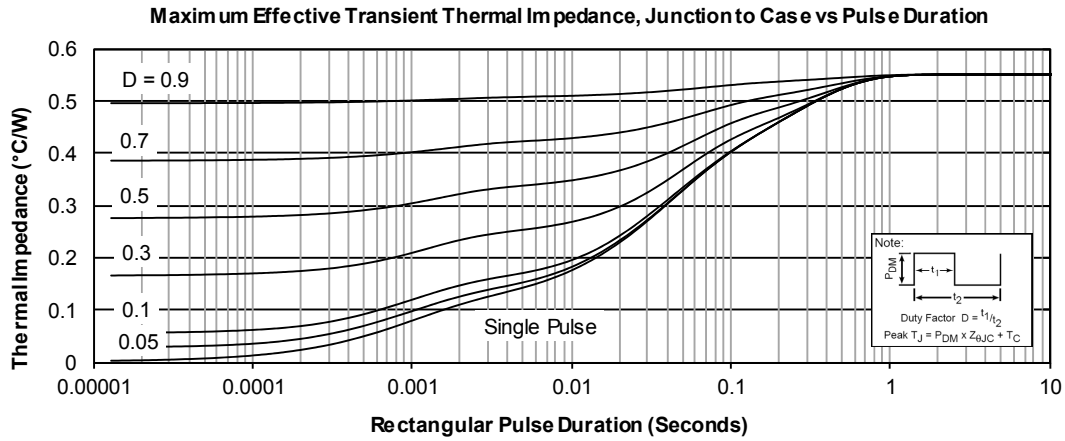
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