## N-Channel FREDFET

Power MOS 8™ is a high speed, high voltage N-channel switch-mode power MOSFET. This 'FREDFET' version has a drain-source (body) diode that has been optimized for high reliability in ZVS phase shifted bridge and other circuits through reduced t_{rr}, soft recovery, and high recovery dv/dt capability. Low gate charge, high gain, and a greatly reduced ratio of C_{rss}/C_{iss} result in excellent noise immunity and low switching loss. The intrinsic gate resistance and capacitance of the poly-silicon gate structure help control di/dt during switching, resulting in low EMI and reliable paralleling, even when switching at very high frequency.

SOT-227

IS OTO P ®

"UL Recognized" file # E145592
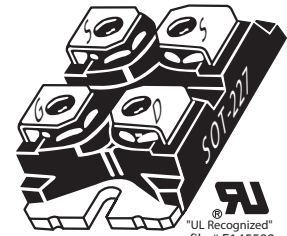
APT19F100J

Single die FREDFET
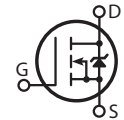
FEATURES

- **Fast switching with low EMI**
- **Low t_{rr} for high reliability**
- **Ultra low C_{rss} for improved noise immunity**
- **Low gate charge**
- **Avalanche energy rated**
- **RoHS compliant**

TYPICAL APPLICATIONS

- **ZVS phase shifted and other full bridge**
- **Half bridge**
- **PFC and other boost converter**
- **Buck converter**
- **Single and two switch forward**
- **Flyback**

Absolute Maximum Ratings

Symbol	Parameter	Ratings	Unit
I_D	Continuous Drain Current @ T_C = 25°C	20	A
	Continuous Drain Current @ T_C = 100°C	13	
I_{DM}	Pulsed Drain Current ①	120	
V_{GS}	Gate-Source Voltage	±30	V
E_{AS}	Single Pulse Avalanche Energy ②	1875	mJ
I_{AR}	Avalanche Current, Repetitive or Non-Repetitive	16	A

Thermal and Mechanical Characteristics

Symbol	Characteristic	Min	Typ	Max	Unit
P_D	Total Power Dissipation @ T_C = 25°C			460	W
$R_{\theta JC}$	Junction to Case Thermal Resistance			0.27	°C/W
$R_{\theta CS}$	Case to Sink Thermal Resistance, Flat, Greased Surface		0.15		
T_J, T_{STG}	Operating and Storage Junction Temperature Range	-55		150	°C
$V_{Isolation}$	RMS Voltage (50-60hHz Sinusoidal Waveform from Terminals to Mounting Base for 1 Min.)	2500			V
W_T	Package Weight		1.03		oz
			29.2		g
Torque	Terminals and Mounting Screws.			10	in·lbf
				1.1	N·m

Static Characteristics T_J = 25°C unless otherwise specified

Symbol	Parameter	Test Conditions		Min	Typ	Max	Unit
$V_{BR(DSS)}$	Drain-Source Breakdown Voltage	V_{GS} = 0V, I_D = 250µA		1000			V
$\Delta V_{BR(DSS)}/\Delta T_J$	Breakdown Voltage Temperature Coefficient	Reference to 25°C, I_D = 250µA			1.15		V/°C
$R_{DS(on)}$	Drain-Source On Resistance③	V_{GS} = 10V, I_D = 16A			0.39	0.44	Ω
$V_{GS(th)}$	Gate-Source Threshold Voltage	V_{GS} = V_{DS}, I_D = 2.5mA		2.5	4	5	V
$\Delta V_{GS(th)}/\Delta T_J$	Threshold Voltage Temperature Coefficient				-10		mV/°C
I_{DSS}	Zero Gate Voltage Drain Current	V_{DS} = 1000V V_{GS} = 0V	T_J = 25°C			250	µA
			T_J = 125°C			1000	
I_{GSS}	Gate-Source Leakage Current	V_{GS} = ±30V				±100	nA

Dynamic Characteristics T_J = 25°C unless otherwise specified

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
g_{fs}	Forward Transconductance	V_{DS} = 50V, I_D = 16A		34		S
C_{iss}	Input Capacitance	V_{GS} = 0V, V_{DS} = 25V f = 1MHz		8500		pF
C_{rss}	Reverse Transfer Capacitance			115		
C_{oss}	Output Capacitance			715		
$C_{o(cr)}$ ④	Effective Output Capacitance, Charge Related	V_{GS} = 0V, V_{DS} = 0V to 667V		290		
$C_{o(er)}$ ⑤	Effective Output Capacitance, Energy Related			150		
Q_g	Total Gate Charge	V_{GS} = 0 to 10V, I_D = 16A, V_{DS} = 500V		260		nC
Q_{gs}	Gate-Source Charge			46		
Q_{gd}	Gate-Drain Charge			125		
$t_{d(on)}$	Turn-On Delay Time	**Resistive Switching** V_{DD} = 667V, I_D = 16A R_G = 2.2Ω⑥, V_{GG} = 15V		36		ns
t_r	Current Rise Time			37		
$t_{d(off)}$	Turn-Off Delay Time			140		
t_f	Current Fall Time			35		

Source-Drain Diode Characteristics

Symbol	Parameter	Test Conditions			Min	Typ	Max	Unit
I_S	Continuous Source Current (Body Diode)	MOSFET symbol showing the integral reverse p-n junction diode (body diode)					20	A
I_{SM}	Pulsed Source Current (Body Diode)①						120	
V_{SD}	Diode Forward Voltage	I_{SD} = 16A, T_J = 25°C, V_{GS} = 0V					1.1	V
t_{rr}	Reverse Recovery Time	I_{SD} = 16A③ V_{DD} = 100V di_{SD}/dt = 100A/µs	T_J = 25°C				290	ns
			T_J = 125°C				600	
Q_{rr}	Reverse Recovery Charge		T_J = 25°C			1.3		µC
			T_J = 125°C			3.5		
I_{rrm}	Reverse Recovery Current		T_J = 25°C			10.6		A
			T_J = 125°C			14.2		
dv/dt	Peak Recovery dv/dt	I_{SD} ≤ 16A, di/dt ≤1000A/µs, V_{DD} = 667V, T_J = 125°C					25	V/ns

① Repetitive Rating: Pulse width and case temperature limited by maximum junction temperature.

② Starting at T_J = 25°C, L = 14.65mH, R_G = 2.2Ω, I_{AS} = 16A.

③ Pulse test: Pulse Width < 380µs, duty cycle < 2%.

④ $C_{o(cr)}$ is defined as a fixed capacitance with the same stored charge as C_{OSS} with V_{DS} = 67% of $V_{(BR)DSS}$.

⑤ $C_{o(er)}$ is defined as a fixed capacitance with the same stored energy as C_{OSS} with V_{DS} = 67% of $V_{(BR)DSS}$. To calculate $C_{o(er)}$ for any value of V_{DS} less than $V_{(BR)DSS}$, use this equation: $C_{o(er)}$ = -2.47E-7/V_{DS}^2 + 4.36E-8/V_{DS} + 8.44E-11.

⑥ R_G is external gate resistance, not including internal gate resistance or gate driver impedance. (MIC4452)

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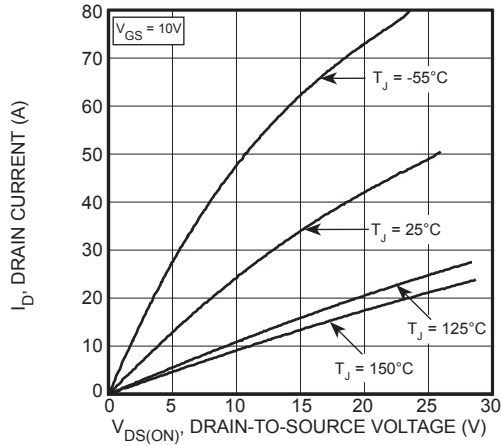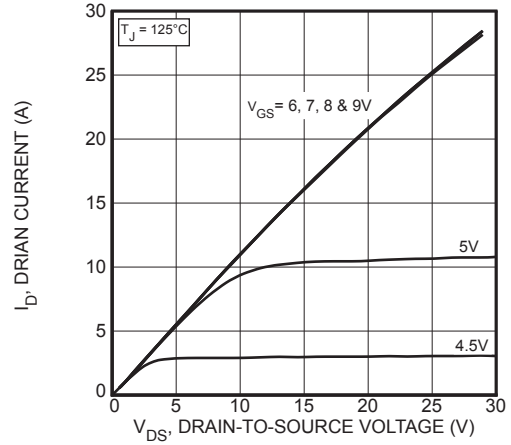
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Figure 1, Output Characteristics

$V_{GS} = 10V$

$T_J = -55°C$
$T_J = 25°C$
$T_J = 125°C$
$T_J = 150°C$

I_D, DRAIN CURRENT (A)
$V_{DS(ON)}$, DRAIN-TO-SOURCE VOLTAGE (V)

Figure 2, Output Characteristics

$T_J = 125°C$

$V_{GS} = 6, 7, 8 \& 9V$
5V
4.5V

I_D, DRIAN CURRENT (A)
V_{DS}, DRAIN-TO-SOURCE VOLTAGE (V)
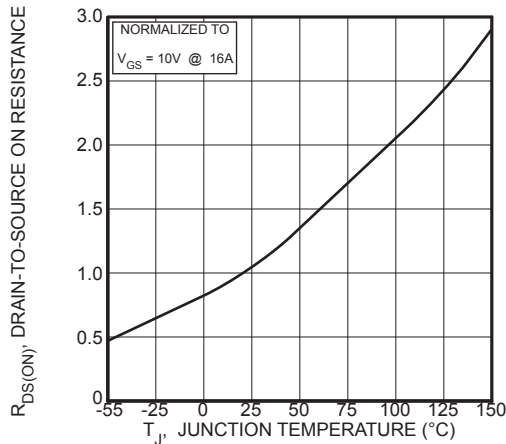
Figure 3, $R_{DS(ON)}$ vs Junction Temperature

NORMALIZED TO
$V_{GS} = 10V$ @ 16A

$R_{DS(ON)}$, DRAIN-TO-SOURCE ON RESISTANCE
T_J, JUNCTION TEMPERATURE (°C)
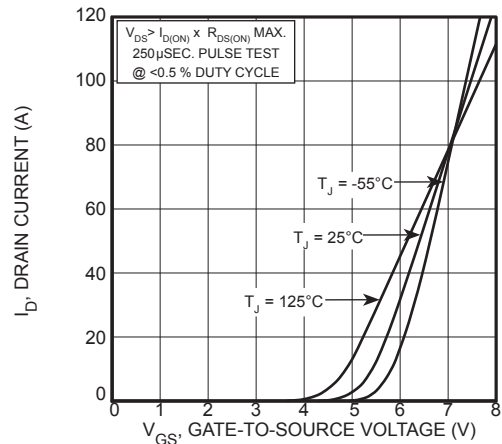
Figure 4, Transfer Characteristics

$V_{DS} > I_{D(ON)}$ x $R_{DS(ON)}$ MAX.
250µSEC. PULSE TEST
@ <0.5 % DUTY CYCLE

$T_J = -55°C$
$T_J = 25°C$
$T_J = 125°C$

I_D, DRAIN CURRENT (A)
V_{GS}, GATE-TO-SOURCE VOLTAGE (V)
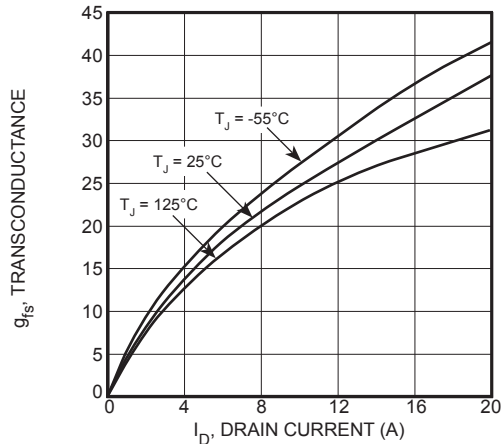
Figure 5, Gain vs Drain Current

$T_J = -55°C$
$T_J = 25°C$
$T_J = 125°C$

g_{fs}, TRANSCONDUCTANCE
I_D, DRAIN CURRENT (A)
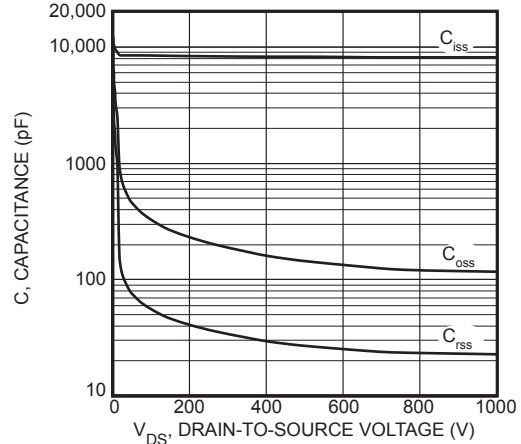
Figure 6, Capacitance vs Drain-to-Source Voltage

C_{iss}
C_{oss}
C_{rss}

C, CAPACITANCE (pF)
V_{DS}, DRAIN-TO-SOURCE VOLTAGE (V)
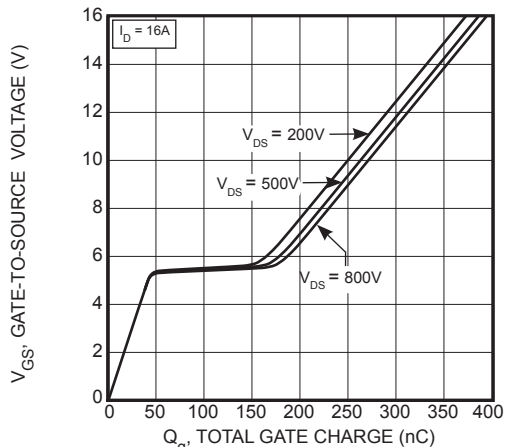
Figure 7, Gate Charge vs Gate-to-Source Voltage

$I_D = 16A$

$V_{DS} = 200V$
$V_{DS} = 500V$
$V_{DS} = 800V$

V_{GS}, GATE-TO-SOURCE VOLTAGE (V)
Q_g, TOTAL GATE CHARGE (nC)
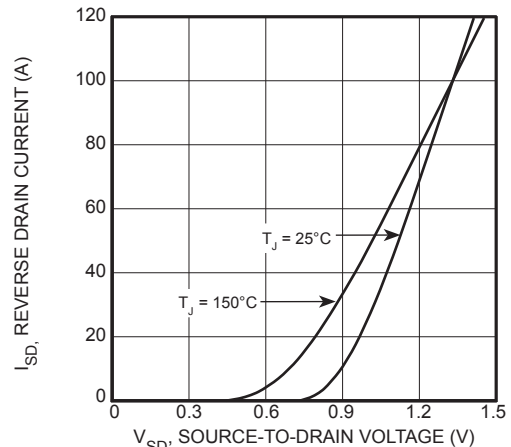
Figure 8, Reverse Drain Current vs Source-to-Drain Voltage

$T_J = 25°C$
$T_J = 150°C$

I_{SD}, REVERSE DRAIN CURRENT (A)
V_{SD}, SOURCE-TO-DRAIN VOLTAGE (V)

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I_D, DRAIN CURRENT (A)

I_{DM}

13µs
100µs
1ms
$R_{ds(on)}$
10ms
100ms
DC line

T_J = 125°C
T_C = 75°C

V_{DS}, DRAIN-TO-SOURCE VOLTAGE (V)
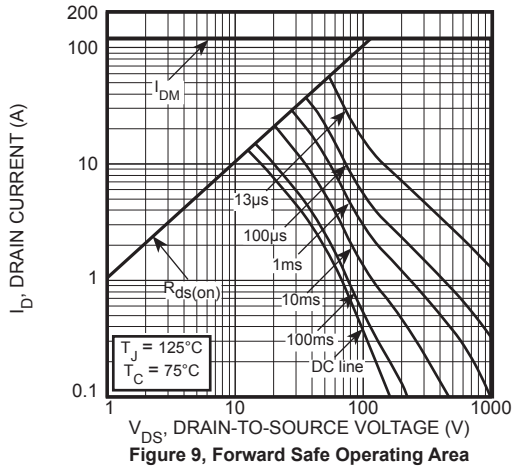
Figure 9, Forward Safe Operating Area

I_D, DRAIN CURRENT (A)

I_{DM}

$R_{ds(on)}$
13µs
100µs
1ms
10ms
100ms
DC line

T_J = 150°C
T_C = 25°C

Scaling for Different Case & Junction Temperatures:

$I_D = I_{D(T_C = 25°C)} * (T_J - T_C)/125$

V_{DS}, DRAIN-TO-SOURCE VOLTAGE (V)
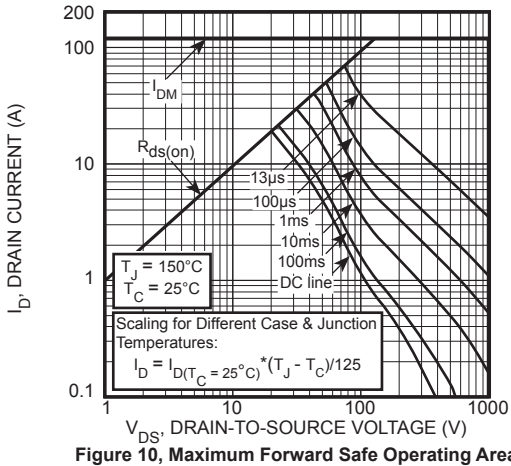
Figure 10, Maximum Forward Safe Operating Area

$Z_{\theta JC}$, THERMAL IMPEDANCE (°C/W)

D = 0.9
0.7
0.5
0.3
0.1
0.05

SINGLE PULSE

Note:

P_{DM}
t_1
t_2

t_1 = Pulse Duration
Duty Factor D = t_1/t_2
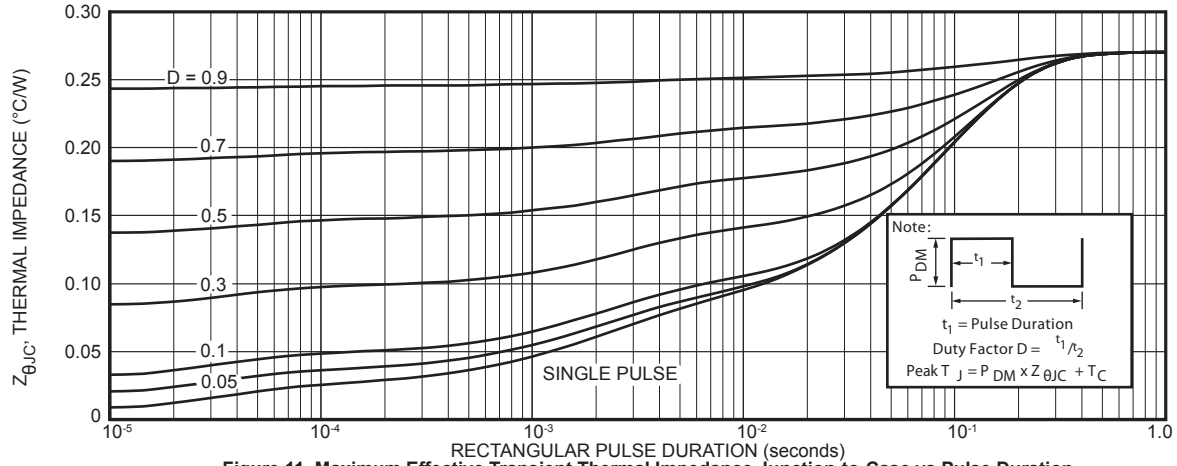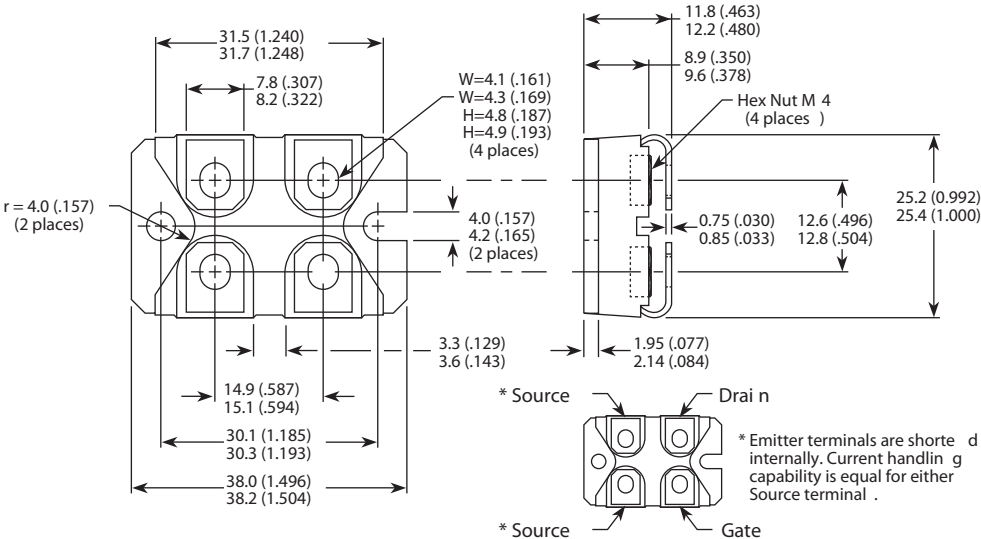Peak $T_J = P_{DM} \times Z_{\theta JC} + T_C$

RECTANGULAR PULSE DURATION (seconds)

Figure 11. Maximum Effective Transient Thermal Impedance Junction-to-Case vs Pulse Duration

SOT-227 (ISOTOP®) Package Outline

31.5 (1.240)
31.7 (1.248)

7.8 (.307)
8.2 (.322)

W=4.1 (.161)
W=4.3 (.169)
H=4.8 (.187)
H=4.9 (.193)
(4 places)

11.8 (.463)
12.2 (.480)

8.9 (.350)
9.6 (.378)

Hex Nut M 4
(4 places)

r = 4.0 (.157)
(2 places)

4.0 (.157)
4.2 (.165)
(2 places)

0.75 (.030)
0.85 (.033)

12.6 (.496)
12.8 (.504)

25.2 (0.992)
25.4 (1.000)

3.3 (.129)
3.6 (.143)

1.95 (.077)
2.14 (.084)

14.9 (.587)
15.1 (.594)

30.1 (1.185)
30.3 (1.193)

38.0 (1.496)
38.2 (1.504)

* Source

Drai n

* Emitter terminals are shorte d
internally. Current handlin g
capability is equal for either
Source terminal .

* Source

Gate

Dimensions in Millimeters and (Inches)

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