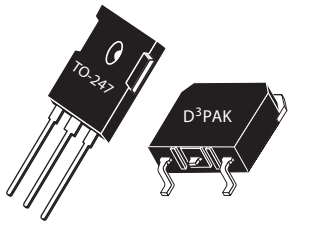
APT23F60B
APT23F60S

600V, 24A, 0.29Ω Max, t_{rr} ≤220ns

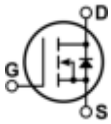
N-Channel FREDFET

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.



APT23F60B **APT23F60S**

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	24	A
	Continuous Drain Current @ T_C = 100°C	14	
I_{DM}	Pulsed Drain Current ①	80	
V_{GS}	Gate-Source Voltage	±30	V
E_{AS}	Single Pulse Avalanche Energy ②	615	mJ
I_{AR}	Avalanche Current, Repetitive or Non-Repetitive	11	A

Thermal and Mechanical Characteristics

Symbol	Characteristic	Min	Typ	Max	Unit
P_D	Total Power Dissipation @ T_C = 25°C			415	W
$R_{\theta JC}$	Junction to Case Thermal Resistance			0.30	°C/W
$R_{\theta CS}$	Case to Sink Thermal Resistance, Flat, Greased Surface		0.11		
T_J,T_{STG}	Operating and Storage Junction Temperature Range	-55		150	°C
T_L	Soldering Temperature for 10 Seconds (1.6mm from case)			300	
W_T	Package Weight		0.22		oz
			6.2		g
Torque	Mounting Torque (TO-264 Package), 4-40 or M3 screw			10	in·lbf
				1.1	N·m

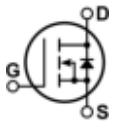
Static Characteristics T_J = 25°C unless otherwise specified APT23F60B_S

Symbol	Parameter	Test Conditions		Min	Typ	Max	Unit
$V_{BR(DSS)}$	Drain-Source Breakdown Voltage	V_{GS} = 0V, I_D = 250µA		600			V
$\Delta V_{BR(DSS)}/\Delta T_J$	Breakdown Voltage Temperature Coefficient	Reference to 25°C, I_D = 250µA			0.57		V/°C
$R_{DS(on)}$	Drain-Source On Resistance③	V_{GS} = 10V, I_D = 11A			0.23	0.29	Ω
$V_{GS(th)}$	Gate-Source Threshold Voltage	V_{GS} = V_{DS}, I_D = 1mA		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} = 600V	T_J = 25°C			250	µA
		V_{GS} = 0V	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 = 11A		22		S
C_{iss}	Input Capacitance	V_{GS} = 0V, V_{DS} = 25V f = 1MHz		4415		pF
C_{rss}	Reverse Transfer Capacitance			45		
C_{oss}	Output Capacitance			405		
$C_{o(cr)}$ ④	Effective Output Capacitance, Charge Related	V_{GS} = 0V, V_{DS} = 0V to 400V		215		
$C_{o(er)}$ ⑤	Effective Output Capacitance, Energy Related			110		
Q_g	Total Gate Charge	V_{GS} = 0 to 10V, I_D = 11A, V_{DS} = 300V		110		nC
Q_{gs}	Gate-Source Charge			24		
Q_{gd}	Gate-Drain Charge			46		
$t_{d(on)}$	Turn-On Delay Time	**Resistive Switching** V_{DD} = 400V, I_D = 11A R_G = 4.7Ω⑥, V_{GG} = 15V		25		ns
t_r	Current Rise Time			29		
$t_{d(off)}$	Turn-Off Delay Time			75		
t_f	Current Fall Time			23		

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) 				24	A
I_{SM}	Pulsed Source Current (Body Diode)①					80	
V_{SD}	Diode Forward Voltage	I_{SD} = 11A, T_J = 25°C, V_{GS} = 0V				1.2	V
t_{rr}	Reverse Recovery Time	I_{SD} = 11A③ di_{SD}/dt = 100A/µs V_{DD} = 100V	T_J = 25°C			220	ns
			T_J = 125°C			400	
Q_{rr}	Reverse Recovery Charge		T_J = 25°C		0.73		µC
			T_J = 125°C		1.79		
I_{rrm}	Reverse Recovery Current		T_J = 25°C		7.3		A
			T_J = 125°C		10.2		
dv/dt	Peak Recovery dv/dt	I_{SD} ≤ 11A, di/dt ≤1000A/µs, V_{DD} = 400V, T_J = 125°C				20	V/ns

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

② Starting at T_J = 25°C, L = 10.17mH, R_G = 25Ω, I_{AS} = 11A.

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: $C_{o(er)}$ = -4.28E-8/V_{DS}^2 + 1.80E-8/V_{DS} + 6.71E-11.

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

Microsemi reserves the right to change, without notice, the specifications and information contained herein.

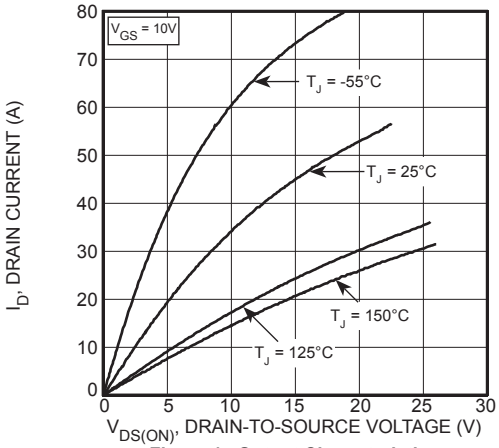


Figure 1, Output Characteristics

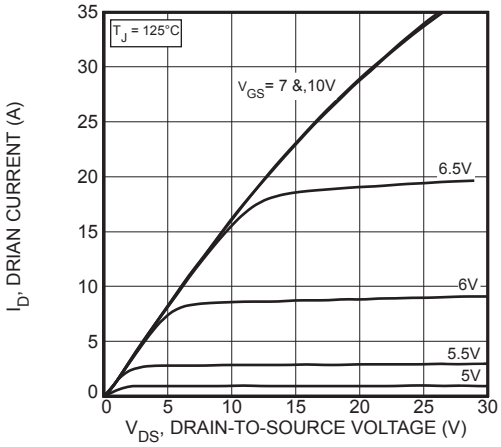


Figure 2, Output Characteristics

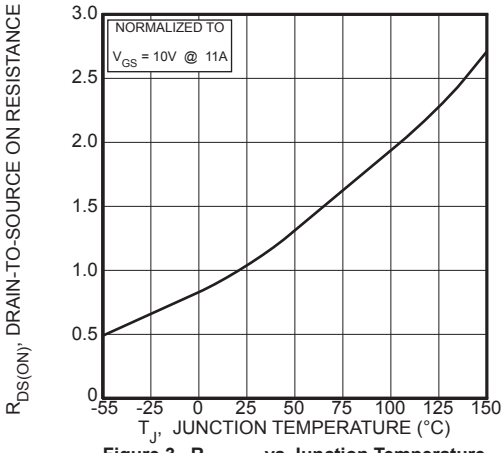


Figure 3, $R_{DS(ON)}$ vs Junction Temperature

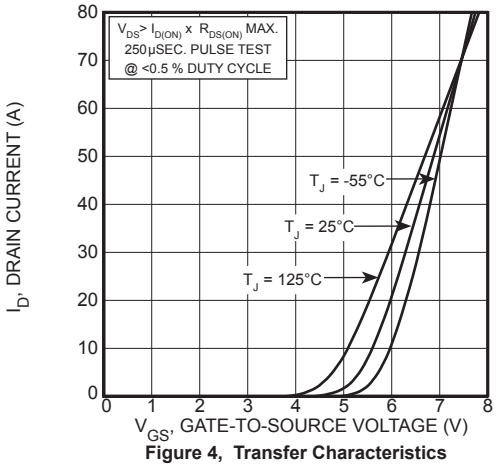


Figure 4, Transfer Characteristics

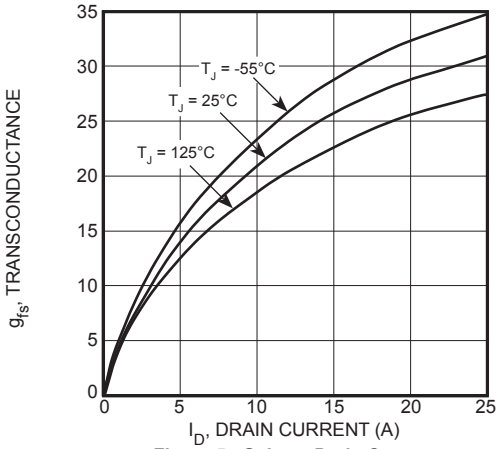


Figure 5, Gain vs Drain Current

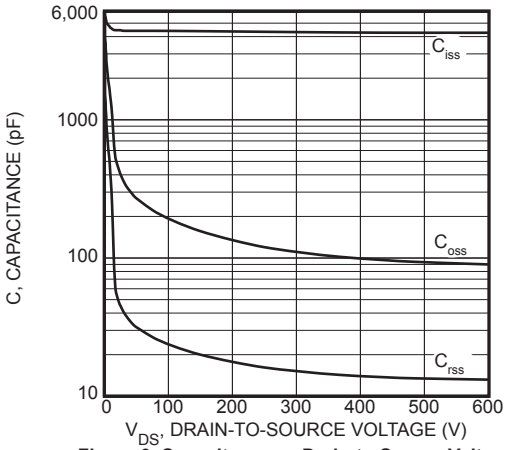


Figure 6, Capacitance vs Drain-to-Source Voltage

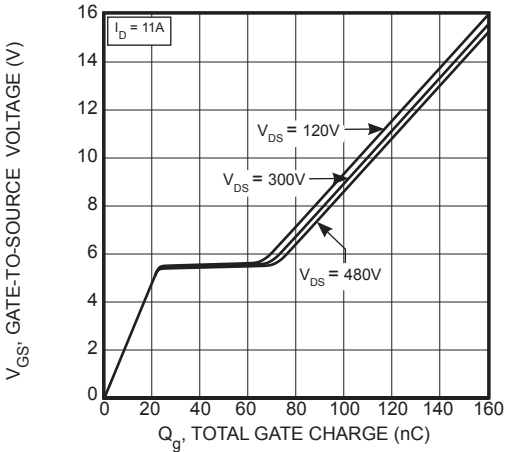


Figure 7, Gate Charge vs Gate-to-Source Voltage

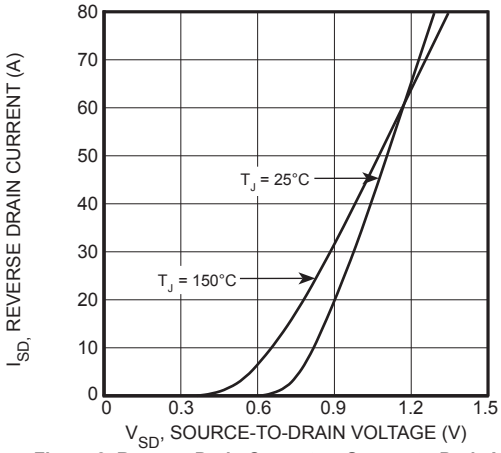


Figure 8, Reverse Drain Current vs Source-to-Drain Voltage

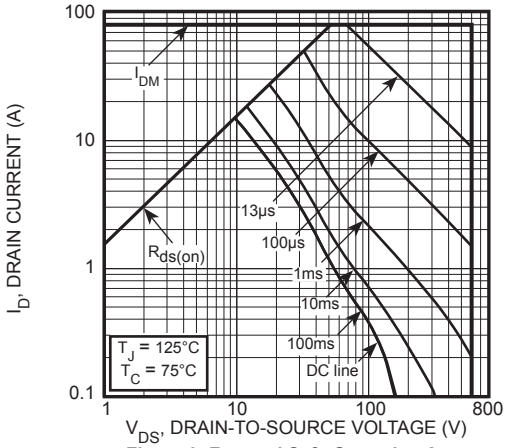


Figure 9, Forward Safe Operating Area

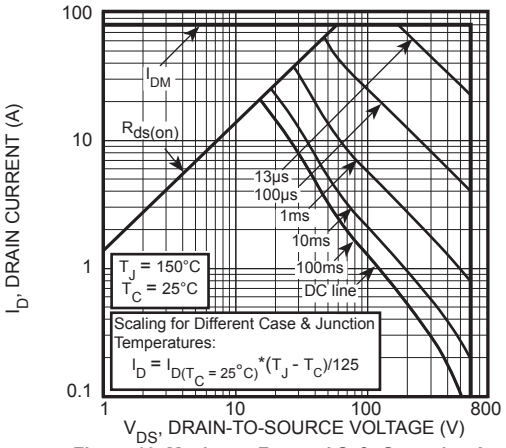


Figure 10, Maximum Forward Safe Operating Area

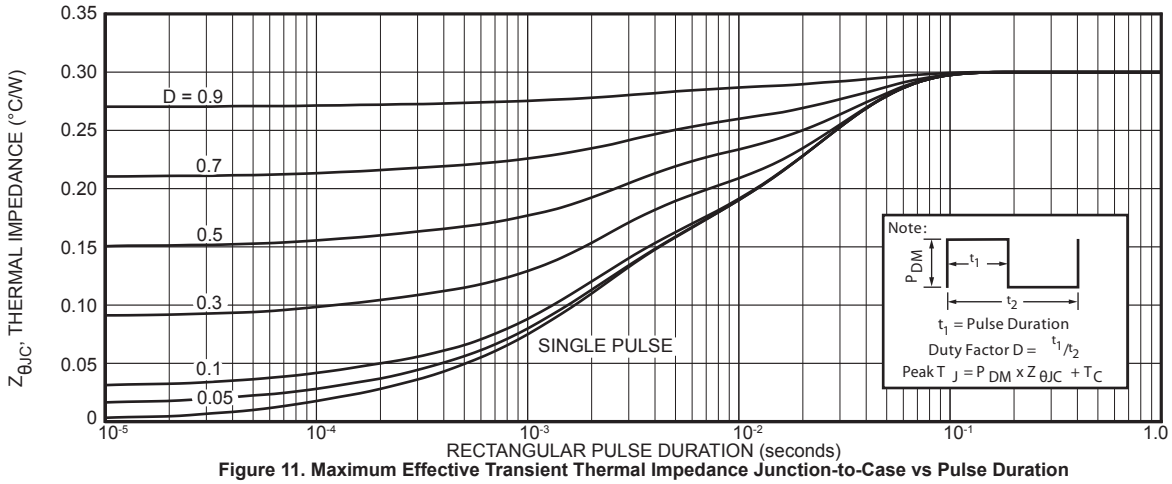
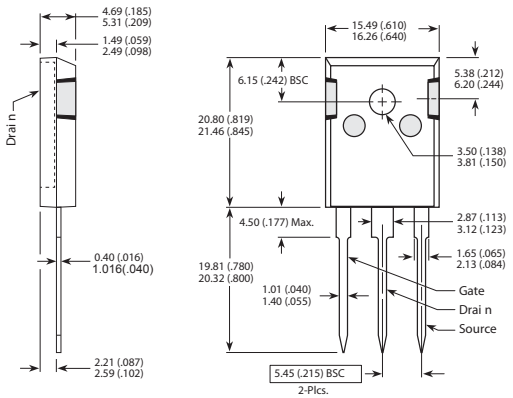


Figure 11. Maximum Effective Transient Thermal Impedance Junction-to-Case vs Pulse Duration

TO-247 (B) Package Outline

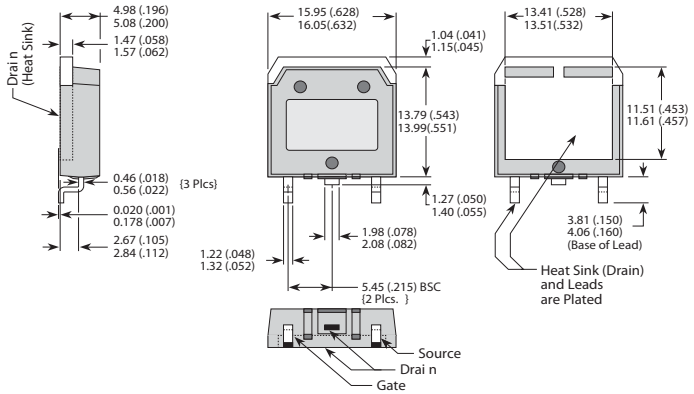
(e1) SAC: Tin, Silver, Copper



Dimensions in Millimeters (Inches)

D^{3}PAK Package Outline

(e3) 100% Sn Plated



Dimensions in Millimeters (Inches)