Microsemi
POWER PRODUCTS GROUP

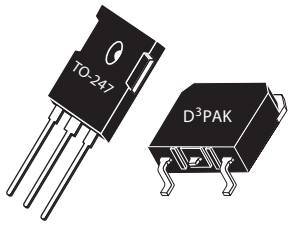
Power MOS 8 Cooler!

# APT15F60B
# APT15F60S

**600V, 16A, 0.43Ω Max, Trr ≤ 190nS**

## 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.




**APT15F60B** **APT15F60S**

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 | 16 | A |
| | Continuous Drain Current @ $T_C$ = 100°C | 10 | |
| $I_{DM}$ | Pulsed Drain Current ① | 54 | |
| $V_{GS}$ | Gate-Source Voltage | ±30 | V |
| $E_{AS}$ | Single Pulse Avalanche Energy ② | 405 | mJ |
| $I_{AR}$ | Avalanche Current, Repetitive or Non-Repetitive | 7 | A |

### Thermal and Mechanical Characteristics

| Symbol | Characteristic | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| $P_D$ | Total Power Dissipation @ $T_C$ = 25°C | | | 290 | W |
| $R_{\theta JC}$ | Junction to Case Thermal Resistance | | | 0.43 | °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 |
| $T_L$ | Soldering Temperature for 10 Seconds (1.6mm from case) | | | 300 | |
| $W_T$ | Package Weight | | 0.22 | | oz |
| | | | 6.2 | | g |
| Torque | Mounting Torque ( TO-247 Package), 6-32 or M3 screw | | | 10 | in·lbf |
| | | | | 1.1 | N·m |

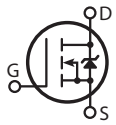
## Static Characteristics $T_J$ = 25°C unless otherwise specified APT15F60B_S

| 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, $I_D$ = 7A | | | 0.34 | 0.43 | Ω |
| $V_{GS(th)}$ | Gate-Source Threshold Voltage | $V_{GS}$ = $V_{DS}$, $I_D$ = .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 | $V_{DS}$ = 400V | $T_J$ = 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, $I_D$ = 7A | | 14 | | S |
| $C_{iss}$ | Input Capacitance | $V_{GS}$ = 0V, $V_{DS}$ = 25V f = 1MHz | | 2882 | | pF |
| $C_{rss}$ | Reverse Transfer Capacitance | | | 29 | | |
| $C_{oss}$ | Output Capacitance | | | 264 | | |
| $C_{o(cr)}$ ④ | Effective Output Capacitance, Charge Related | $V_{GS}$ = 0V, $V_{DS}$ = 0V to 400V | | 141 | | |
| $C_{o(er)}$ ⑤ | Effective Output Capacitance, Energy Related | | | 73 | | |
| $Q_g$ | Total Gate Charge | $V_{GS}$ = 0 to 10V, $I_D$ = 7A, $V_{DS}$ = 300V | | 72 | | nC |
| $Q_{gs}$ | Gate-Source Charge | | | 15 | | |
| $Q_{gd}$ | Gate-Drain Charge | | | 30 | | |
| $t_{d(on)}$ | Turn-On Delay Time | **Resistive Switching** $V_{DD}$ = 400V, $I_D$ = 7A $R_G$ = 10Ω⑥, $V_{GG}$ = 15V | | 16 | | ns |
| $t_r$ | Current Rise Time | | | 19 | | |
| $t_{d(off)}$ | Turn-Off Delay Time | | | 49 | | |
| $t_f$ | Current Fall Time | | | 15 | | |

## 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)   | | | | 15 | A |
| $I_{SM}$ | Pulsed Source Current (Body Diode)① | | | | | 54 | |
| $V_{SD}$ | Diode Forward Voltage | $I_{SD}$ = 7A, $T_J$ = 25°C, $V_{GS}$ = 0V | | | | 1.0 | V |
| $t_{rr}$ | Reverse Recovery Time | $I_{SD}$ = 7A③ $di_{SD}/dt$ = 100A/µs $V_{DD}$ = 100V | $T_J$ = 25°C | | 167 | 190 | ns |
| | | | $T_J$ = 125°C | | 295 | 354 | |
| $Q_{rr}$ | Reverse Recovery Charge | | $T_J$ = 25°C | | 0.59 | | µC |
| | | | $T_J$ = 125°C | | 1.40 | | |
| $I_{rrm}$ | Reverse Recovery Current | | $T_J$ = 25°C | | 6.2 | | A |
| | | | $T_J$ = 125°C | | 8.5 | | |
| dv/dt | Peak Recovery dv/dt | $I_{SD}$ ≤ 7A, 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 = 16.4mH, $R_G$ = 25Ω, $I_{AS}$ = 7A.

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: $C_{o(er)}$ = -3.43E-8/$V_{DS}$^2 + 1.44E-8/$V_{DS}$ + 5.38E-11.

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

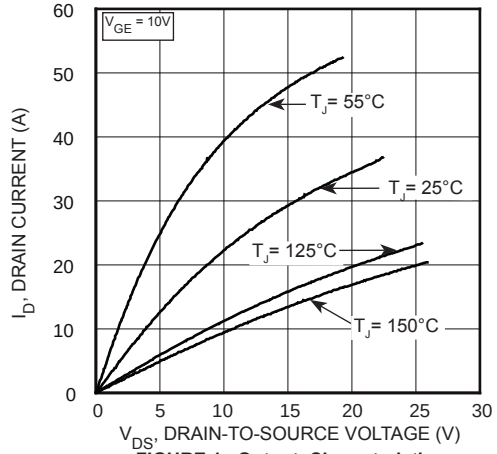



**FIGURE 1, Output Characteristics**

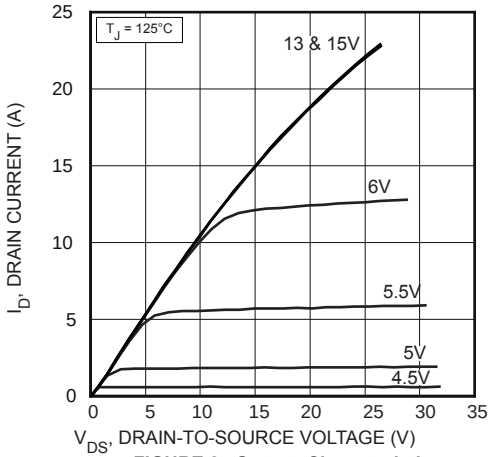



**FIGURE 2, Output Characteristics**

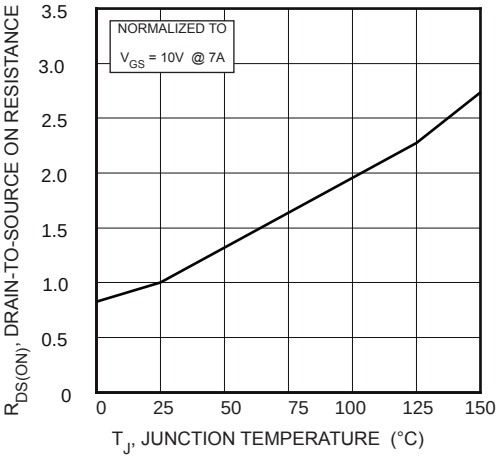



**FIGURE 3, $R_{DS(ON)}$ vs Junction Temperature**

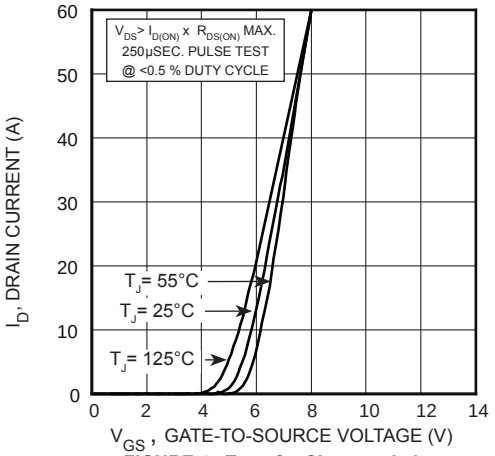



**FIGURE 4, Transfer Characteristics**

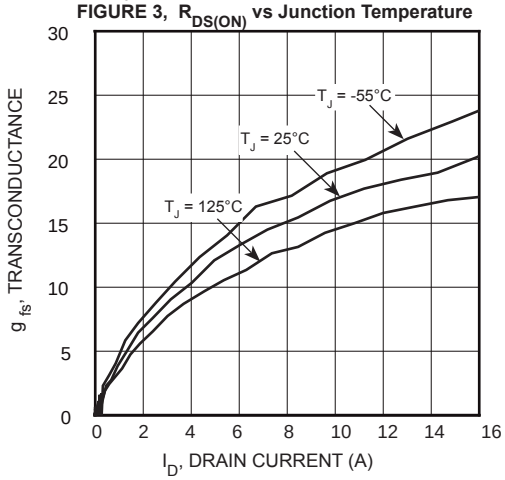



**FIGURE 5, Gain vs Drain Current**

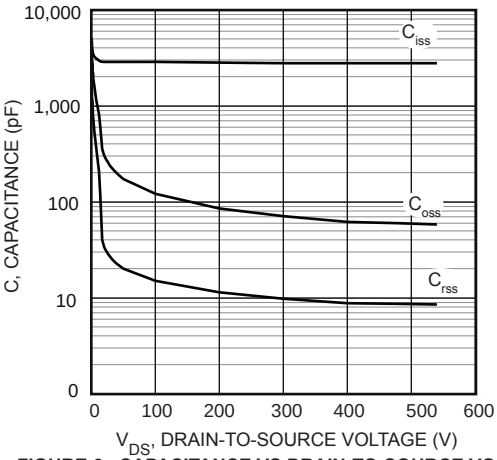



**FIGURE 6, CAPACITANCE VS DRAIN-TO-SOURCE VOLTAGE**

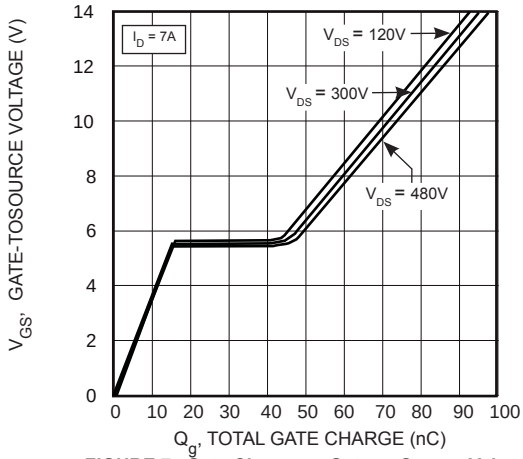



**FIGURE 7, Gate Charge vs Gate-to-Source Voltage**

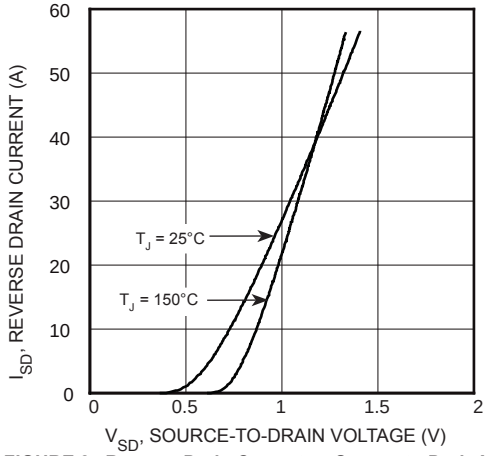



**FIGURE 8, Reverse Drain Current vs Source-to-Drain Voltage**

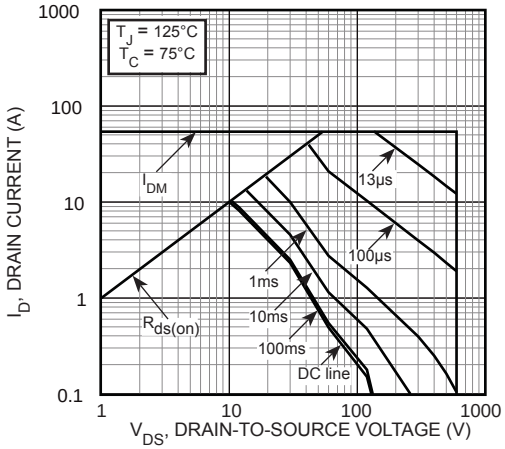



**Figure 9, Forward Safe Operating Area**

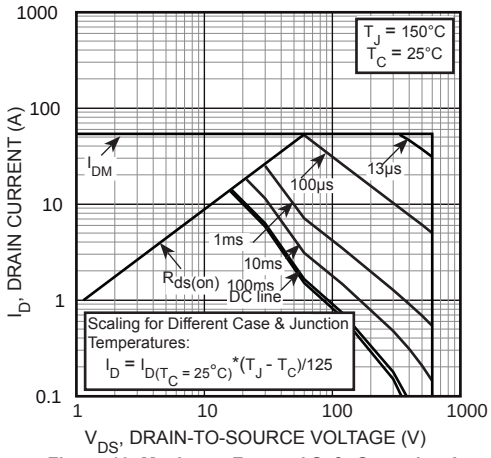



**Figure 10, Maximum Forward Safe Operating Area**

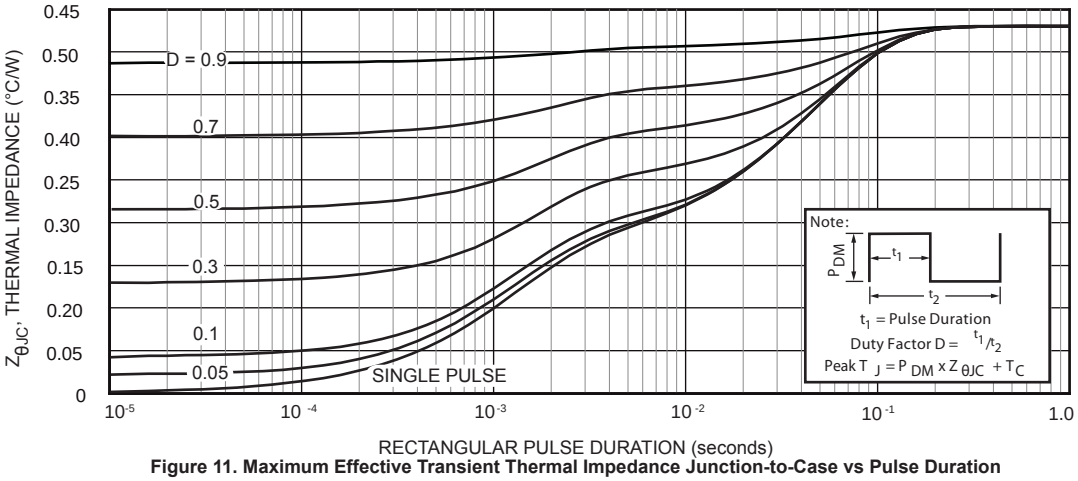
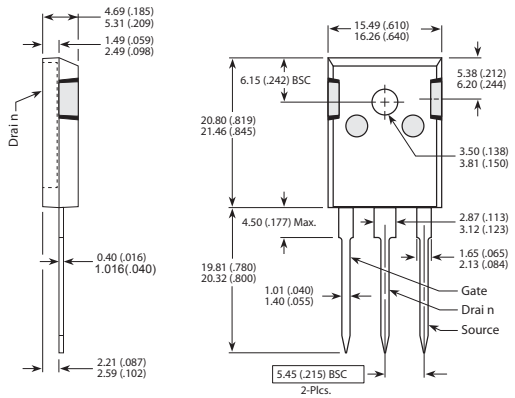



**Figure 11. Maximum Effective Transient Thermal Impedance Junction-to-Case vs Pulse Duration**

## TO-247 (B) Package Outline

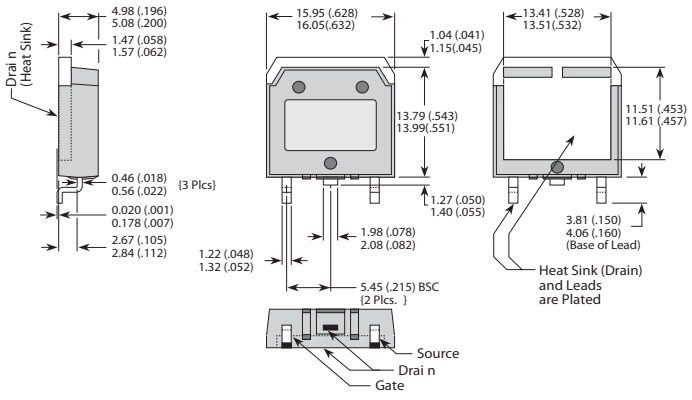
e1 SAC: Tin, Silver, Copper




**Dimensions in Millimeters (Inches)**

## D$^3$PAK Package Outline

e3 100% Sn Plated




**Dimensions in Millimeters (Inches)**