# ALPHA & OMEGA SEMICONDUCTOR

# AOT4N60/AOTF4N60
## 600V,4A N-Channel MOSFET

## General Description

The AOT4N60 & AOTF4N60 have been fabricated using an advanced high voltage MOSFET process that is designed to deliver high levels of performance and robustness in popular AC-DC applications.
By providing low $R_{DS(on)}$, $C_{iss}$ and $C_{rss}$ along with guaranteed avalanche capability these parts can be adopted quickly into new and existing offline power supply designs.

For Halogen Free add "L" suffix to part number: AOT4N60L & AOTF4N60L

## Product Summary

| | |
|---|---|
| $V_{DS}$ | 700V@150℃ |
| $I_D$ (at $V_{GS}$=10V) | 4A |
| $R_{DS(ON)}$ (at $V_{GS}$=10V) | < 2.2Ω |

100% UIS Tested
100% $R_g$ Tested

RoHS Compliant



TO-220    **Top View**    TO-220F
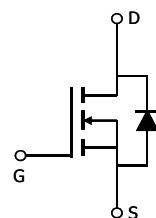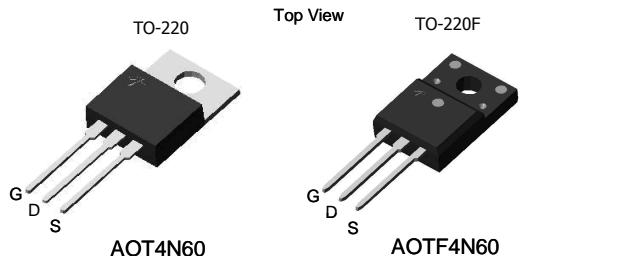
AOT4N60        AOTF4N60

### Absolute Maximum Ratings  $T_A$=25℃ unless otherwise noted

| Parameter | | Symbol | AOT4N60 | AOTF4N60 | Units |
|---|---|---|---|---|---|
| Drain-Source Voltage | | $V_{DS}$ | 600 | | V |
| Gate-Source Voltage | | $V_{GS}$ | ±30 | | V |
| Continuous Drain Current | $T_C$=25℃ | $I_D$ | 4 | 4* | A |
| | $T_C$=100℃ | | 2.7 | 2.7* | |
| Pulsed Drain Current [C] | | $I_{DM}$ | 16 | | |
| Avalanche Current [C] | | $I_{AR}$ | 2.5 | | A |
| Repetitive avalanche energy [C] | | $E_{AR}$ | 94 | | mJ |
| Single plused avalanche energy [G] | | $E_{AS}$ | 188 | | mJ |
| Peak diode recovery dv/dt | | dv/dt | 5 | | V/ns |
| Power Dissipation [B] | $T_C$=25℃ | $P_D$ | 104 | 35 | W |
| | Derate above 25°C | | 0.83 | 0.28 | W/ °C |
| Junction and Storage Temperature Range | | $T_J$, $T_{STG}$ | -55 to 150 | | ℃ |
| Maximum lead temperature for soldering purpose, 1/8" from case for 5 seconds | | $T_L$ | 300 | | ℃ |

### Thermal Characteristics

| Parameter | Symbol | AOT4N60 | AOTF4N60 | Units |
|---|---|---|---|---|
| Maximum Junction-to-Ambient [A,D] | $R_{\theta JA}$ | 65 | 65 | ℃/W |
| Maximum Case-to-sink [A] | $R_{\theta CS}$ | 0.5 | -- | ℃/W |
| Maximum Junction-to-Case | $R_{\theta JC}$ | 1.2 | 3.6 | ℃/W |

* Drain current limited by maximum junction temperature.

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**Electrical Characteristics (T$_J$=25°C unless otherwise noted)**

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| **STATIC PARAMETERS** | | | | | | |
| BV$_{DSS}$ | Drain-Source Breakdown Voltage | I$_D$=250µA, V$_{GS}$=0V, T$_J$=25°C | 600 | | | V |
| | | I$_D$=250µA, V$_{GS}$=0V, T$_J$=150°C | | 700 | | |
| BV$_{DSS}$/ΔTJ | Zero Gate Voltage Drain Current | ID=250µA, VGS=0V | | 0.69 | | V/°C |
| I$_{DSS}$ | Zero Gate Voltage Drain Current | V$_{DS}$=600V, V$_{GS}$=0V | | | 1 | µA |
| | | V$_{DS}$=480V, T$_J$=125°C | | | 10 | |
| I$_{GSS}$ | Gate-Body leakage current | V$_{DS}$=0V, V$_{GS}$=±30V | | | ±100 | nA |
| V$_{GS(th)}$ | Gate Threshold Voltage | V$_{DS}$=5V I$_D$=250µA | 3 | 4 | 4.5 | V |
| R$_{DS(ON)}$ | Static Drain-Source On-Resistance | V$_{GS}$=10V, I$_D$=2A | | 1.9 | 2.2 | Ω |
| g$_{FS}$ | Forward Transconductance | V$_{DS}$=40V, I$_D$=2A | | 7.4 | | S |
| V$_{SD}$ | Diode Forward Voltage | I$_S$=1A,V$_{GS}$=0V | | 0.77 | 1 | V |
| I$_S$ | Maximum Body-Diode Continuous Current | | | | 4 | A |
| I$_{SM}$ | Maximum Body-Diode Pulsed Current | | | | 16 | A |
| **DYNAMIC PARAMETERS** | | | | | | |
| C$_{iss}$ | Input Capacitance | V$_{GS}$=0V, V$_{DS}$=25V, f=1MHz | 400 | 511 | 615 | pF |
| C$_{oss}$ | Output Capacitance | | 40 | 51 | 65 | pF |
| C$_{rss}$ | Reverse Transfer Capacitance | | 3.5 | 4.4 | 5.3 | pF |
| R$_g$ | Gate resistance | V$_{GS}$=0V, V$_{DS}$=0V, f=1MHz | 3.3 | 4.2 | 6.3 | Ω |
| **SWITCHING PARAMETERS** | | | | | | |
| Q$_g$ | Total Gate Charge | V$_{GS}$=10V, V$_{DS}$=480V, I$_D$=4A | | 15 | 18 | nC |
| Q$_{gs}$ | Gate Source Charge | | | 3 | 3.6 | nC |
| Q$_{gd}$ | Gate Drain Charge | | | 7.6 | 9.1 | nC |
| t$_{D(on)}$ | Turn-On DelayTime | V$_{GS}$=10V, V$_{DS}$=300V, I$_D$=4A, R$_G$=25Ω | | 20.2 | 30 | ns |
| t$_r$ | Turn-On Rise Time | | | 28.7 | 42 | ns |
| t$_{D(off)}$ | Turn-Off DelayTime | | | 36 | 51 | ns |
| t$_f$ | Turn-Off Fall Time | | | 27 | 40 | ns |
| t$_{rr}$ | Body Diode Reverse Recovery Time | I$_F$=4A,dI/dt=100A/µs,V$_{DS}$=100V | | 212 | 254 | ns |
| Q$_{rr}$ | Body Diode Reverse Recovery Charge | I$_F$=4A,dI/dt=100A/µs,V$_{DS}$=100V | | 1.6 | 1.9 | µC |

A. The value of R$_{θJA}$ is measured with the device in a still air environment with T$_A$=25°C.
B. The power dissipation P$_D$ is based on T$_{J(MAX)}$=150°C, using junction-to-case thermal resistance, and is more useful in setting the upper dissipation limit for cases where additional heatsinking is used.
C. Repetitive rating, pulse width limited by junction temperature T$_{J(MAX)}$=150°C, Ratings are based on low frequency and duty cycles to keep initial T$_J$ =25°C.
D. The R$_{θJA}$ is the sum of the thermal impedence from junction to case R$_{θJC}$ and case to ambient.
E. The static characteristics in Figures 1 to 6 are obtained using <300 µs pulses, duty cycle 0.5% max.
F. These curves are based on the junction-to-case thermal impedence which is measured with the device mounted to a large heatsink, assuming a maximum junction temperature of T$_{J(MAX)}$=150°C. The SOA curve provides a single pulse rating.
G. L=60mH, I$_{AS}$=2.5A, V$_{DD}$=150V, R$_G$=25Ω, Starting T$_J$=25°C

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**TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS**
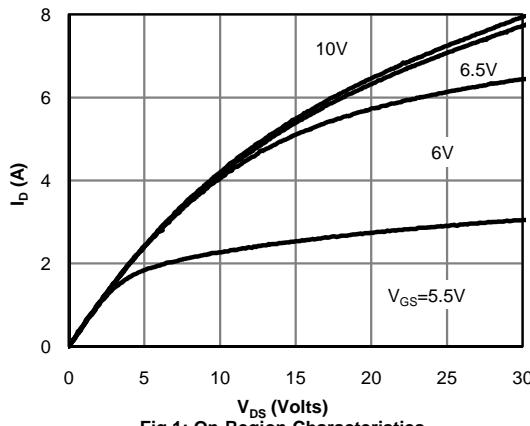

Fig 1: On-Region Characteristics
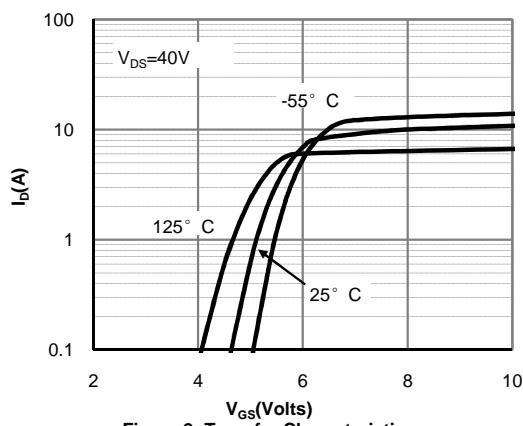

Figure 2: Transfer Characteristics
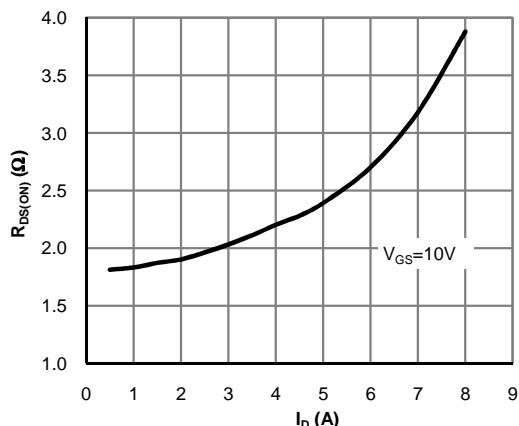

Figure 3: On-Resistance vs. Drain Current and Gate Voltage
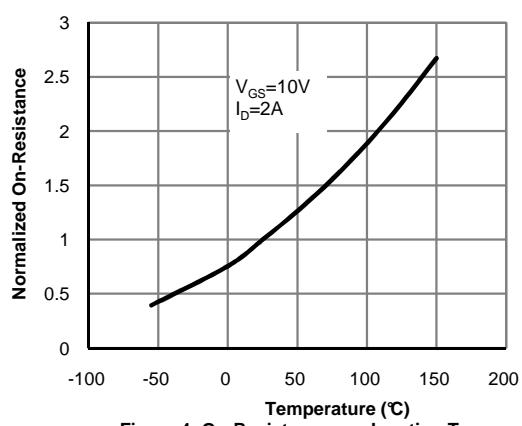

Figure 4: On-Resistance vs. Junction Temperature
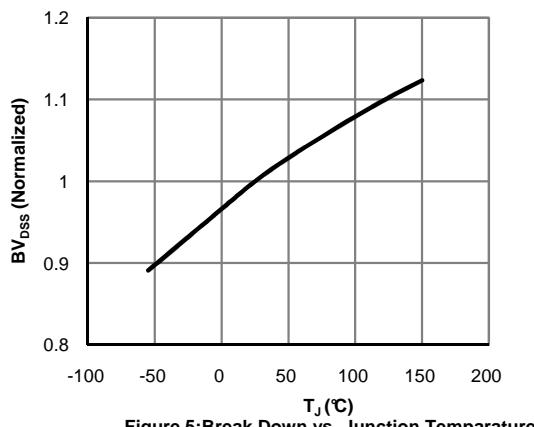

Figure 5:Break Down vs. Junction Temparature
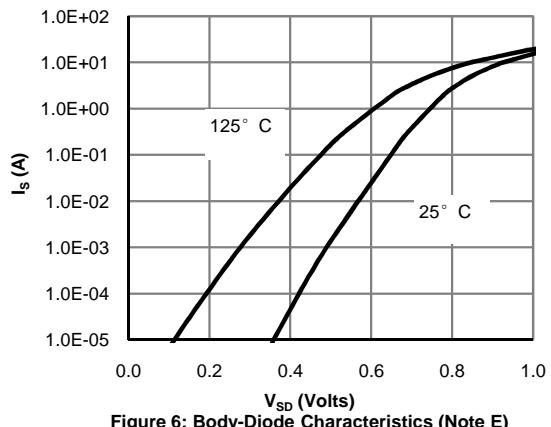

Figure 6: Body-Diode Characteristics (Note E)

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## TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS
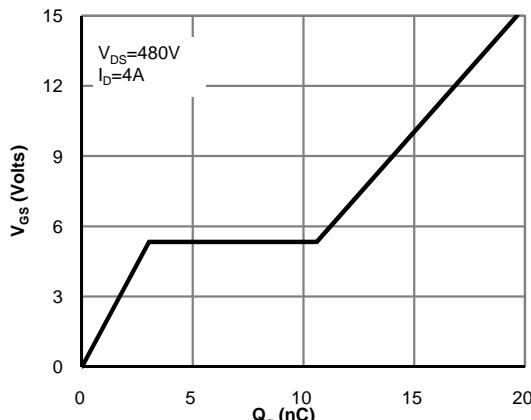


Figure 7: Gate-Charge Characteristics
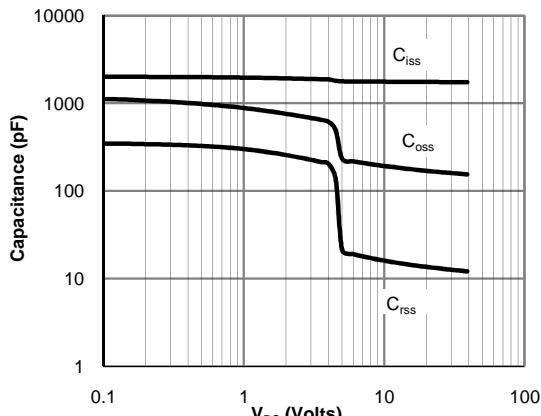


Figure 8: Capacitance Characteristics
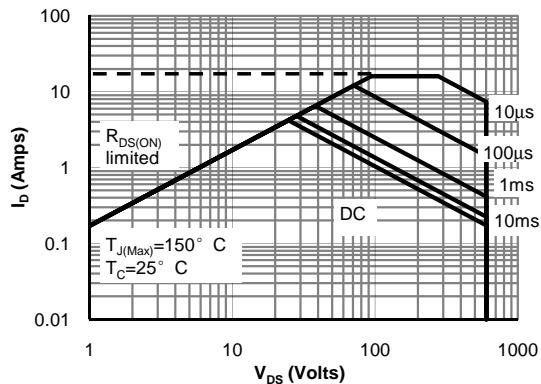


Figure 9: Maximum Forward Biased Safe
Operating Area for AOT4N60 (Note F)
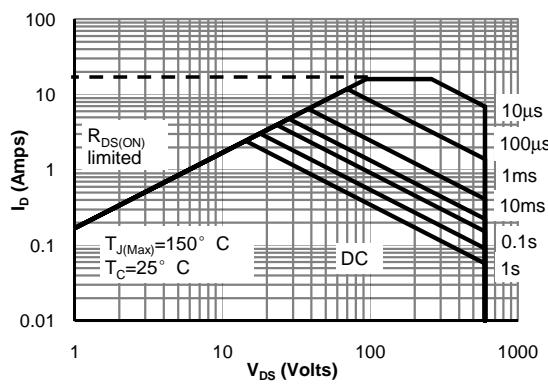


Figure 10: Maximum Forward Biased Safe Operating
Area for AOTF4N60 (Note F)
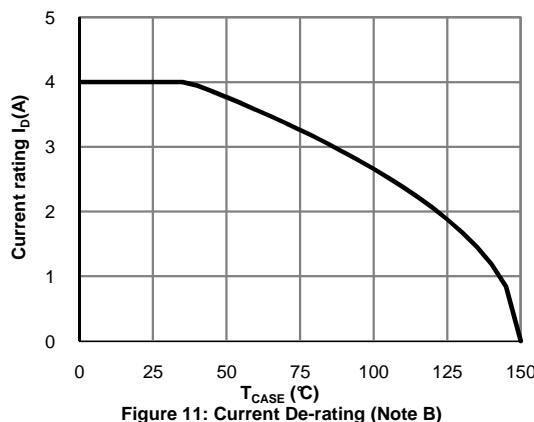


Figure 11: Current De-rating (Note B)

## TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS



D=$T_{on}$/T
$T_{J,PK}=T_C+P_{DM} \cdot Z_{\theta JC} \cdot R_{\theta JC}$
$R_{\theta JC}$=1.2° C/W

In descending order
D=0.5, 0.3, 0.1, 0.05, 0.02, 0.01, single pulse

Single Pulse
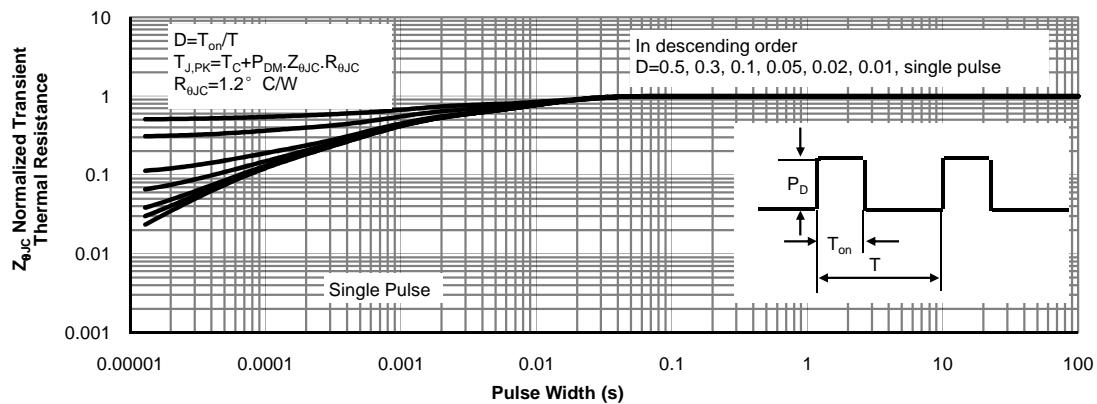
**Figure 12: Normalized Maximum Transient Thermal Impedance for AOT4N60 (Note F)**



D=$T_{on}$/T
$T_{J,PK}=T_C+P_{DM} \cdot Z_{\theta JC} \cdot R_{\theta JC}$
$R_{\theta JC}$=3.6° C/W

In descending order
D=0.5, 0.3, 0.1, 0.05, 0.02, 0.01, single pulse

Single Pulse
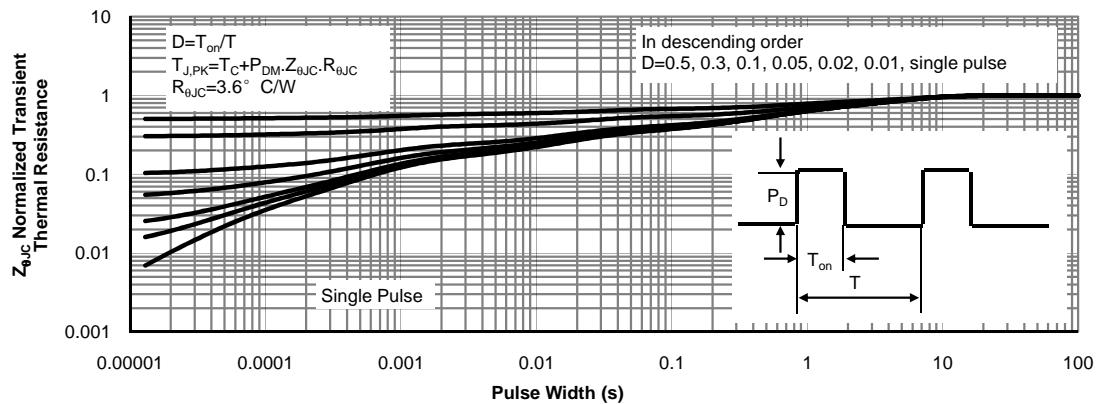
**Figure 13: Normalized Maximum Transient Thermal Impedance for AOTF4N60 (Note F)**

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## Gate Charge Test Circuit & Waveform
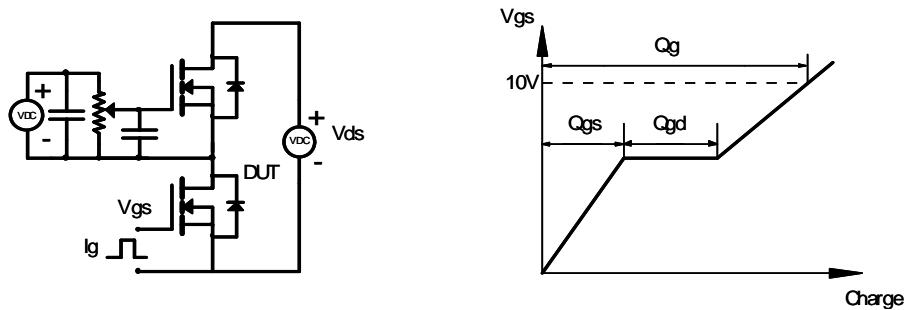


## Resistive Switching Test Circuit & Waveforms
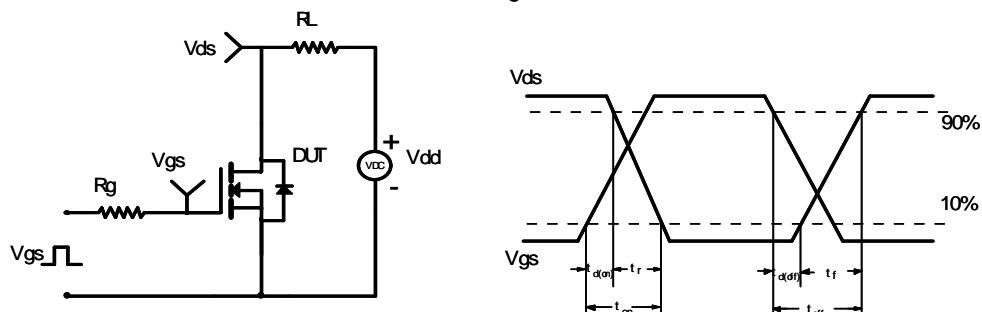


## Unclamped Inductive Switching (UIS) Test Circuit & Waveforms

$$E_{AR} = 1/2 \, LI^2_{AR}$$
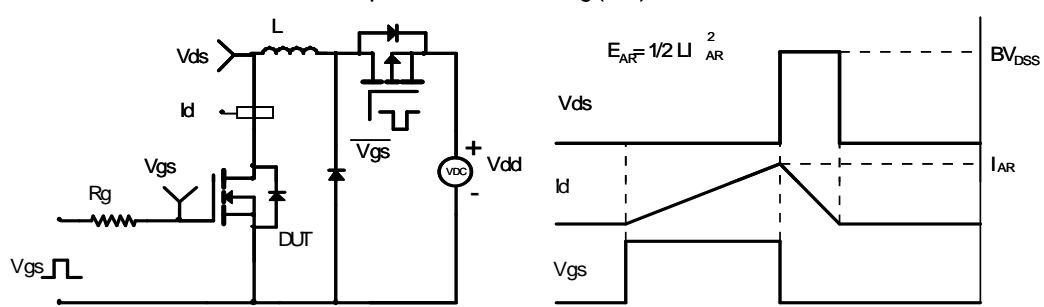


## Diode Recovery Test Circuit & Waveforms

$$Q_{rr} = - \int I \, dt$$