

AP4688S

N+P Channel Power MOSFET

● **Features**

N-Channel

$V_{DS} = 60V$,

$I_D = 8.0 A$

$R_{DS(ON)} @ V_{GS} = 10V$, TYP $32m\Omega$

$R_{DS(ON)} @ V_{GS} = 4.5V$, TYP $39m\Omega$

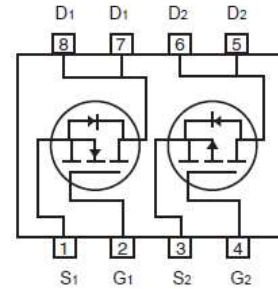
P-Channel

$V_{DS} = -60V$,

$I_D = -6.0A$

$R_{DS(ON)} @ V_{GS} = 10V$, TYP $52m\Omega$

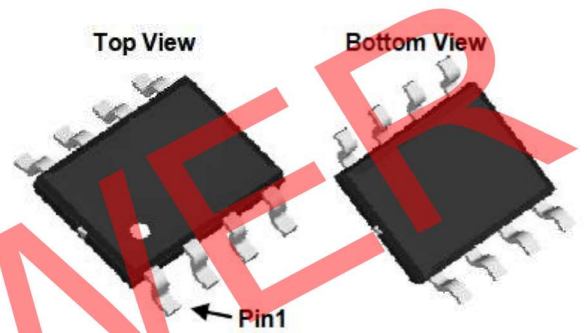
$R_{DS(ON)} @ V_{GS} = 4.5V$, TYP $65m\Omega$



● **General Description**

Motor Control

Synchronous Rectification



● **Absolute Maximum Ratings @ $T_A=25^\circ C$ unless otherwise noted**

| Parameter | Symbol | N-Channel | P-Channel | Unit | |
|--|---------------|------------------|-----------|------------|---|
| Drain-Source Voltage | V_{DSS} | 60 | -60 | V | |
| Gate-Source Voltage | V_{GSS} | ± 20 | ± 20 | V | |
| Drain Current (Continuous) *AC | I_D | $T_A=25^\circ C$ | 8.0 | -6.0 | A |
| | | $T_A=70^\circ C$ | 6.5 | -4.5 | |
| Drain Current (Pulse) *B | I_{DM} | 15 | -12 | A | |
| Power Dissipation | P_D | 3 | | W | |
| Operating Temperature/ Storage Temperature | T_J/T_{STG} | -55~150 | | $^\circ C$ | |

● **Thermal Resistance Ratings**

| Parameter | Symbol | Maximum | Unit |
|-----------------------------|------------|---------|--------------|
| Maximum Junction-to-Ambient | R_{thJA} | 62.5 | $^\circ C/W$ |

AP4688S
N+P Channel Power MOSFET
N-Channel Electrical Characteristics @ $T_A=25^\circ\text{C}$ unless otherwise noted

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|----------------------------------|---------------|--|-----|-----|-----------|------------|
| Static | | | | | | |
| Drain-Source Breakdown Voltage | $V_{(BR)DSS}$ | $V_{GS} = 0V, I_D = 250\mu A$ | 60 | -- | -- | V |
| Zero Gate Voltage Drain Current | I_{DSS} | $V_{DS} = 48V, V_{GS} = 0V$ | -- | -- | 1 | μA |
| Gate Threshold Voltage | $V_{GS(TH)}$ | $V_{GS} = V_{DS}, I_{BS} = 250\mu A$ | 1 | 1.6 | 3 | V |
| Gate Leakage Current | I_{GSS} | $V_{GS} = \pm 20V, V_{DS} = 0V$ | -- | -- | ± 100 | nA |
| Drain-Source On-state Resistance | $R_{DS(on)}$ | $V_{GS} = 10V, I_D = 4.5A$ | -- | 32 | 50 | m Ω |
| | $R_{DS(on)}$ | $V_{GS} = 4.5V, I_D = 3.5A$ | -- | 39 | 60 | m Ω |
| Forward Transconductance | g_{FS} | $V_{DS} = 10V, I_D = 4A$ | 2 | -- | -- | S |
| Diode Forward Voltage | V_{SD} | $I_{SD} = 2A, V_{GS} = 0V$ | -- | -- | 1.2 | V |
| Diode Forward Current | I_S | $T_C = 25^\circ\text{C}$ | -- | -- | 4.5 | A |
| Switching | | | | | | |
| Total Gate Charge | Q_g | $V_{GS} = 10V, V_{DS} = 30V, I_D = 4.5A$ | -- | 13 | -- | nC |
| Gate-Source Charge | Q_{gs} | | -- | 1.7 | -- | nC |
| Gate-Drain Charge | Q_{gd} | | -- | 2.6 | -- | nC |
| Turn-on Delay Time | $t_{d(on)}$ | $V_{DD} = 30V, V_{GS} = 10V, I_D = 1A,$ $R_{GEN} = 6\Omega$ | -- | 11 | -- | ns |
| Turn-on Rise Time | t_r | | -- | 3 | -- | ns |
| Turn-off Delay Time | $t_{d(off)}$ | | -- | 30 | -- | ns |
| Turn-Off Fall Time | t_f | | -- | 3 | -- | ns |
| Dynamic | | | | | | |
| Input Capacitance | C_{iss} | $V_{DS} = 25V, V_{GS} = 0V, f = 1.0\text{MHz}$ | -- | 670 | -- | pF |
| Output Capacitance | C_{oss} | | -- | 80 | -- | pF |
| Reverse Transfer Capacitance | C_{rss} | | -- | 45 | -- | pF |

A: The value of $R_{\theta JA}$ is measured with the device mounted on 1in² FR-4 board with 2oz. Copper, in a still air environment with $T_A=25^\circ\text{C}$. The value in any given application depends on the user's specific board design.

B: Repetitive rating, pulse width limited by junction temperature.

C: The current rating is based on the $t \leq 10s$ junction to ambient thermal resistance rating.

AP4688S
N+P Channel Power MOSFET
P-Channel Electrical Characteristics @ $T_A=25^{\circ}\text{C}$ unless otherwise noted

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|----------------------------------|---------------|--|-----|------|-----------|------------|
| Static | | | | | | |
| Drain-Source Breakdown Voltage | $V_{(BR)DSS}$ | $V_{GS} = 0V, I_D = -250\mu A$ | -60 | -- | -- | V |
| Zero Gate Voltage Drain Current | I_{DSS} | $V_{DS} = -48V, V_{GS} = 0V$ | -- | -- | -1 | μA |
| Gate Threshold Voltage | $V_{GS(TH)}$ | $V_{GS} = V_{DS}, I_{DS} = -250\mu A$ | -1 | -1.6 | -3 | V |
| Gate Leakage Current | I_{GSS} | $V_{GS} = \pm 20V, V_{DS} = 0V$ | -- | -- | ± 100 | nA |
| Drain-Source On-state Resistance | $R_{DS(on)}$ | $V_{GS} = -10V, I_D = -4.5A$ | -- | 52 | 65 | m Ω |
| | $R_{DS(on)}$ | $V_{GS} = -4.5V, I_D = -3.8A$ | -- | 65 | 75 | m Ω |
| Forward Transconductance | g_{FS} | $V_{DS} = -10V, I_D = -3.1A$ | 2 | -- | -- | S |
| Diode Forward Voltage | V_{SD} | $I_{SD} = -1A, V_{GS} = 0V$ | -- | -- | -1.2 | V |
| Diode Forward Current | I_S | $T_C = 25^{\circ}\text{C}$ | -- | -- | -3.5 | A |
| Switching | | | | | | |
| Total Gate Charge | Q_g | $V_{GS} = -10V, V_{DS} = -30V, I_D = -3.5A$ | -- | 11 | -- | nC |
| Gate-Source Charge | Q_{gs} | | -- | 2.4 | -- | nC |
| Gate-Drain Charge | Q_{gd} | | -- | 1.6 | -- | nC |
| Turn-on Delay Time | $t_{d(on)}$ | $V_{DD} = -30V, V_{GS} = -10V, I_D = -1A, R_{GEN} = 6\Omega$ | -- | 12 | -- | ns |
| Turn-on Rise Time | t_r | | -- | 4 | -- | ns |
| Turn-off Delay Time | $t_{d(off)}$ | | -- | 38 | -- | ns |
| Turn-Off Fall Time | t_f | | -- | 12 | -- | ns |
| Dynamic | | | | | | |
| Input Capacitance | C_{iss} | $V_{DS} = -30V, V_{GS} = 0V, f = 1.0\text{MHz}$ | -- | 885 | -- | pF |
| Output Capacitance | C_{oss} | | -- | 85 | -- | pF |
| Reverse Transfer Capacitance | C_{rss} | | -- | 80 | -- | pF |

A: The value of $R_{\theta JA}$ is measured with the device mounted on 1in² FR-4 board with 2oz. Copper, in a still air environment with $T_A=25^{\circ}\text{C}$. The value in any given application depends on the user's specific board design.

B: Repetitive rating, pulse width limited by junction temperature.

C: The current rating is based on the $t_s \leq 10s$ junction to ambient thermal resistance rating.

AP4688S

N+P Channel Power MOSFET

Typical Performance Characteristics (($T_A = 25\text{ }^\circ\text{C}$, unless otherwise noted))

N-Channel

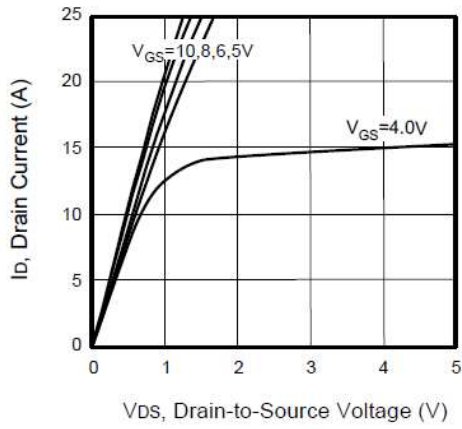


Figure 1. Output Characteristics

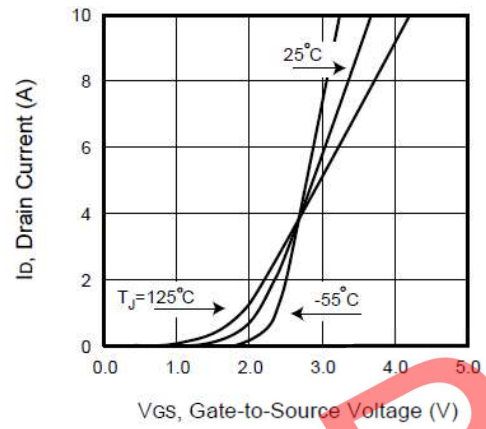


Figure 2. Transfer Characteristics

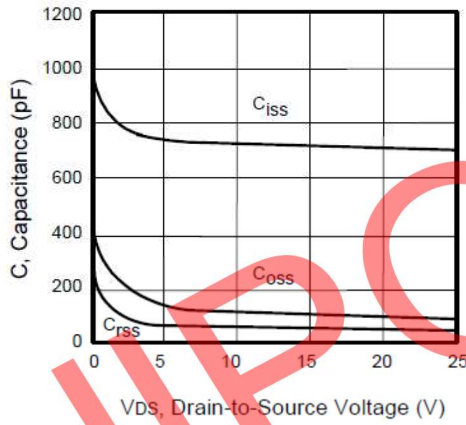


Figure 3. Capacitance

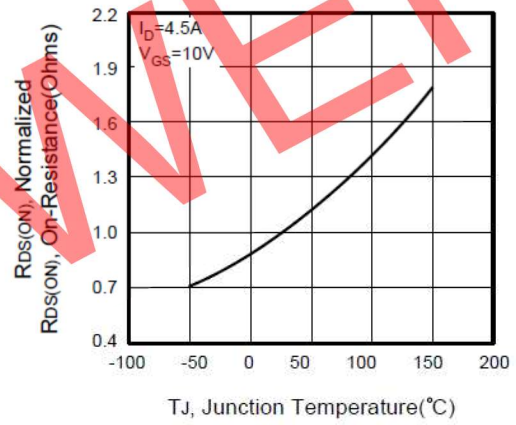


Figure 4. On-Resistance Variation with Temperature

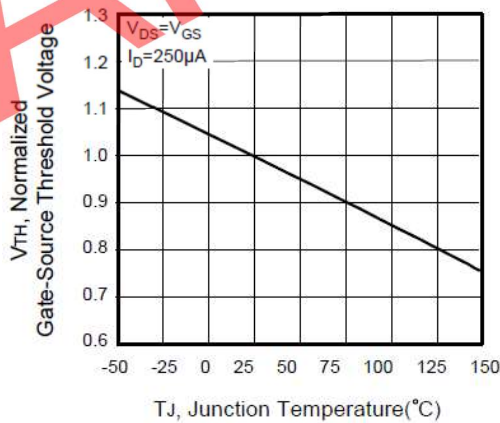


Figure 5. Gate Threshold Variation with Temperature

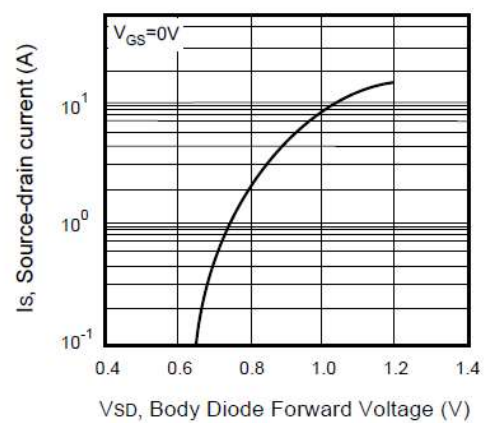


Figure 6. Body Diode Forward Voltage Variation with Source Current

AP4688S

N+P Channel Power MOSFET

P-Channel

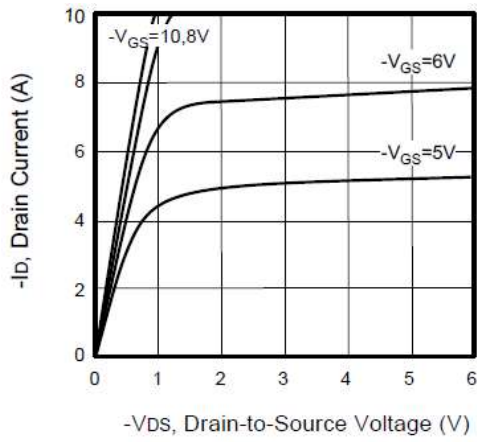


Figure 1. Output Characteristics

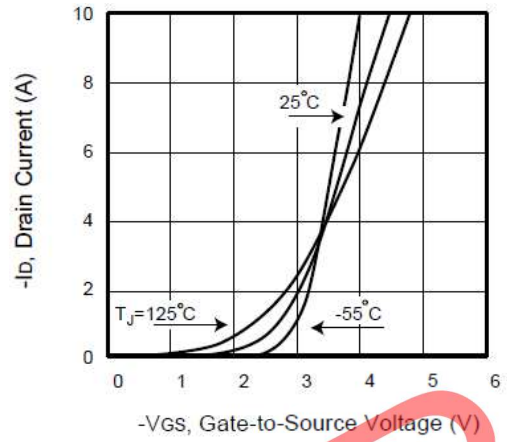


Figure 2. Transfer Characteristics

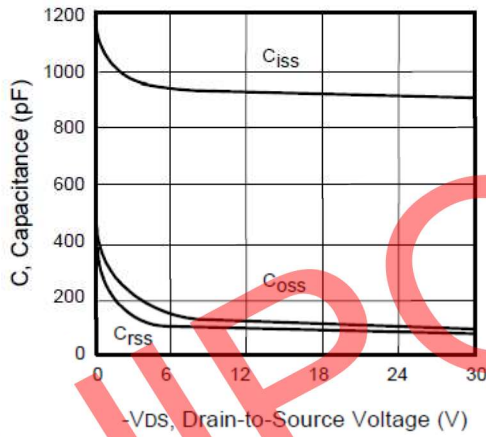


Figure 3. Capacitance

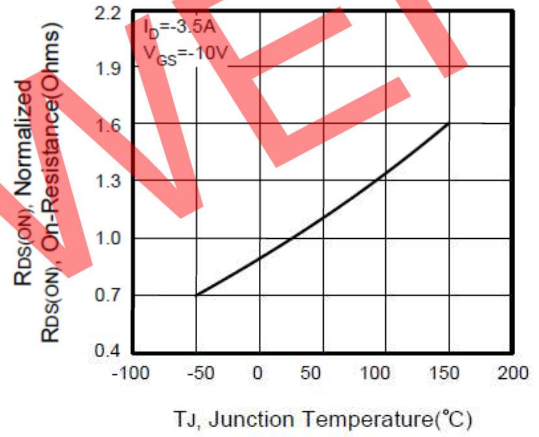


Figure 4. On-Resistance Variation with Temperature

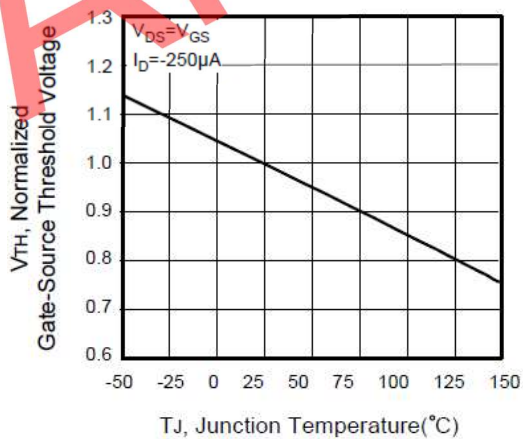


Figure 5. Gate Threshold Variation with Temperature

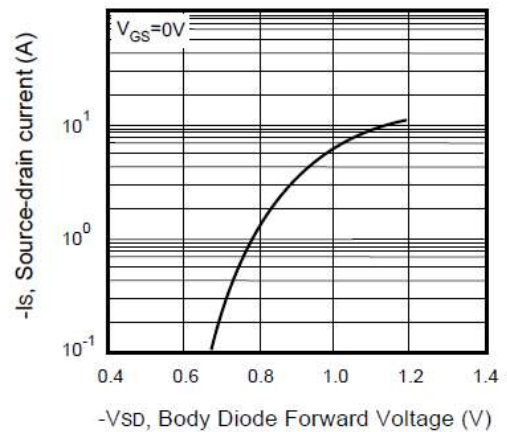


Figure 6. Body Diode Forward Voltage Variation with Source Current

AP4688S

N+P Channel Power MOSFET

N-Channel

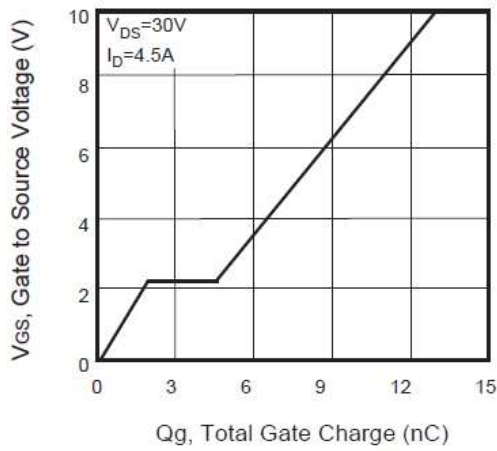


Figure 13. Gate Charge

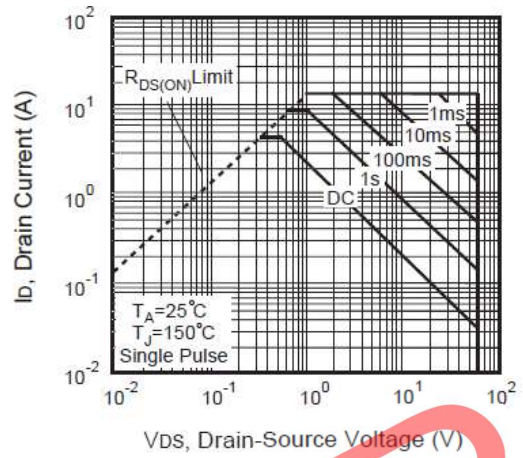


Figure 14. Maximum Safe Operating Area

P-Channel

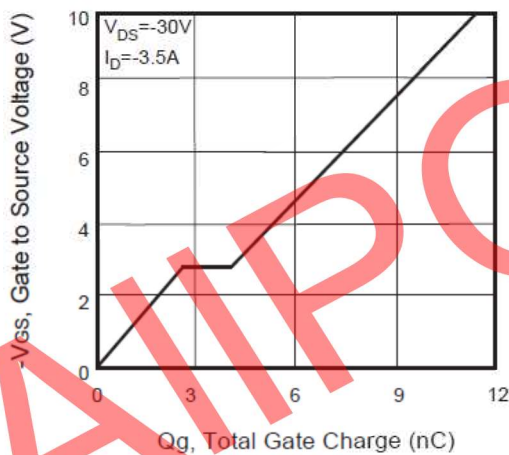


Figure 15. Gate Charge

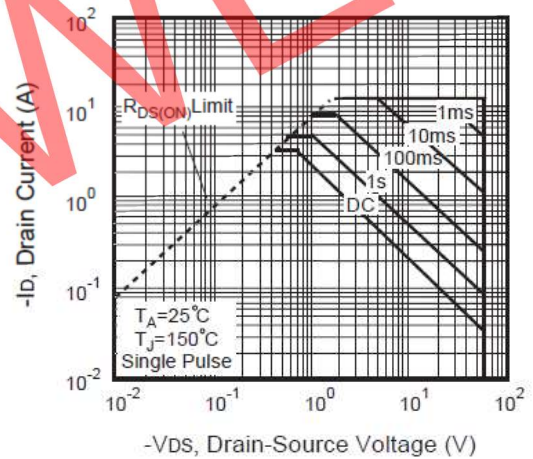


Figure 16. Maximum Safe Operating Area

AP4688S

N+P Channel Power MOSFET

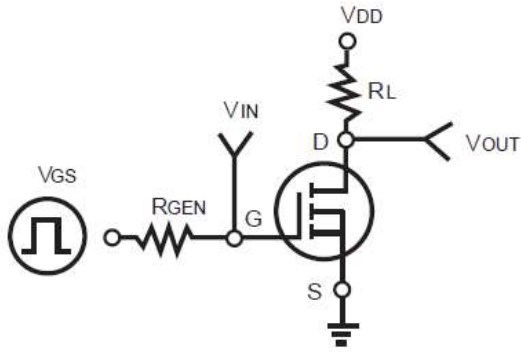


Figure 17. Switching Test Circuit

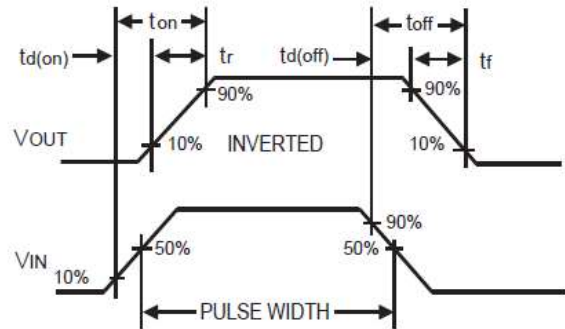


Figure 18. Switching Waveforms

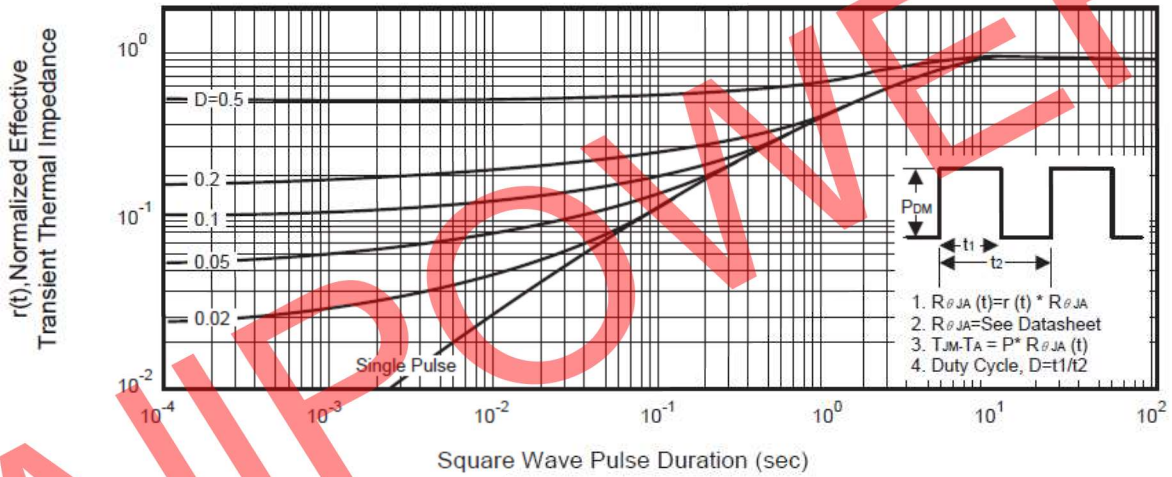
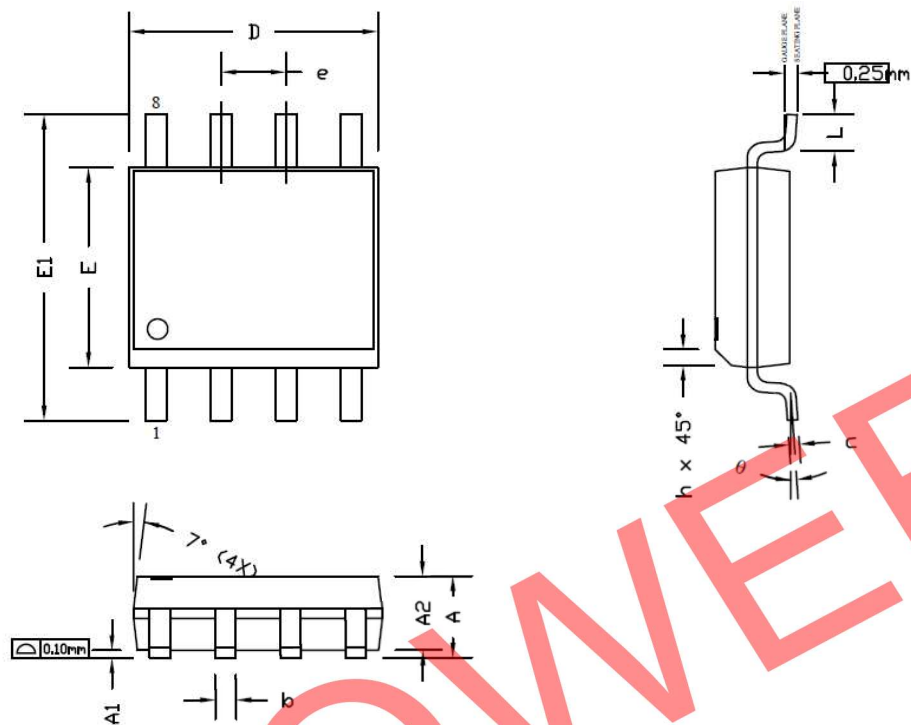


Figure 19. Normalized Thermal Transient Impedance Curve

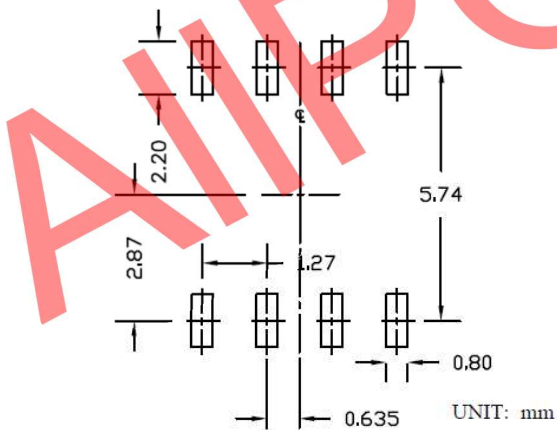
AP4688S

N+P Channel Power MOSFET

Package Information



RECOMMENDED LAND PATTERN



| SYMBOLS | DIMENSIONS IN MILLIMETERS | | | DIMENSIONS IN INCHES | | |
|---------|---------------------------|------|------|----------------------|-------|-------|
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | 1.35 | 1.65 | 1.75 | 0.053 | 0.065 | 0.069 |
| A1 | 0.10 | 0.15 | 0.25 | 0.004 | 0.006 | 0.010 |
| A2 | 1.25 | 1.50 | 1.65 | 0.049 | 0.059 | 0.065 |
| b | 0.31 | 0.41 | 0.51 | 0.012 | 0.016 | 0.020 |
| c | 0.17 | 0.20 | 0.25 | 0.007 | 0.008 | 0.010 |
| D | 4.80 | 4.90 | 5.00 | 0.189 | 0.193 | 0.197 |
| E | 3.80 | 3.90 | 4.00 | 0.150 | 0.154 | 0.157 |
| e | 1.27 BSC | | | 0.050 BSC | | |
| E1 | 5.80 | 6.00 | 6.20 | 0.228 | 0.236 | 0.244 |
| h | 0.25 | 0.30 | 0.50 | 0.010 | 0.012 | 0.020 |
| L | 0.40 | 0.69 | 1.27 | 0.016 | 0.027 | 0.050 |
| θ | 0° | 4° | 8° | 0° | 4° | 8° |

NOTE

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. DIMENSIONS ARE INCLUSIVE OF PLATING.
3. PACKAGE BODY SIZES EXCLUDE MOLD FLASH AND GATE BURRS.
MOLD FLASH AT THE NON-LEAD SIDES SHOULD BE LESS THAN 6 MILS EACH.
4. DIMENSION L IS MEASURED IN GAUGE PLANE.
5. CONTROLLING DIMENSION IS MILLIMETER.
CONVERTED INCH DIMENSIONS ARE NOT NECESSARILY EXACT.