

FDS5682

N-Channel PowerTrench® MOSFET

60V, 7.5A, 21mΩ

Features

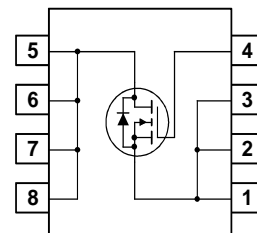
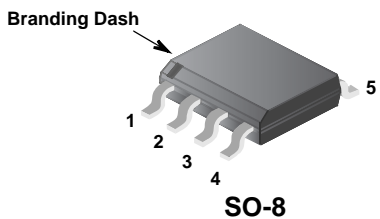
- $r_{DS(ON)} = 21m\Omega$, $V_{GS} = 10V$, $I_D = 7.5A$
- $r_{DS(ON)} = 26.5m\Omega$, $V_{GS} = 4.5V$, $I_D = 6.7A$
- High performance trench technology for extremely low $r_{DS(ON)}$
- Low gate charge
- High power and current handling capability

General Description

This N-Channel MOSFET has been designed specifically to improve the overall efficiency of DC/DC converters using either synchronous or conventional switching PWM controllers. It has been optimized for low gate charge, low $r_{DS(ON)}$ and fast switching speed.

Applications

- DC/DC converters



MOSFET Maximum Ratings $T_A = 25^\circ\text{C}$ unless otherwise noted

| Symbol | Parameter | Ratings | Units |
|----------------|---|------------|----------------------|
| V_{DSS} | Drain to Source Voltage | 60 | V |
| V_{GS} | Gate to Source Voltage | ± 20 | V |
| I_D | Drain Current | | |
| | Continuous ($T_A = 25^\circ\text{C}$, $V_{GS} = 10\text{V}$, $R_{\theta JA} = 50^\circ\text{C/W}$) | 7.5 | A |
| | Continuous ($T_A = 25^\circ\text{C}$, $V_{GS} = 4.5\text{V}$, $R_{\theta JA} = 50^\circ\text{C/W}$) | 6.7 | A |
| | Pulsed | Figure 4 | A |
| E_{AS} | Single Pulse Avalanche Energy (Note 1) | 94 | mJ |
| P_D | Power dissipation | 2.5 | W |
| | Derate above 25°C | 20 | mW/ $^\circ\text{C}$ |
| T_J, T_{STG} | Operating and Storage Temperature | -55 to 150 | $^\circ\text{C}$ |

Thermal Characteristics

| | | | |
|-----------------|--|----|--------------------|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case (Note 2) | 25 | $^\circ\text{C/W}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient at 10 seconds (Note 3) | 50 | $^\circ\text{C/W}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient at 1000 seconds (Note 3) | 85 | $^\circ\text{C/W}$ |

Package Marking and Ordering Information

| Device Marking | Device | Package | Reel Size | Tape Width | Quantity |
|----------------|---------|---------|-----------|------------|------------|
| FDS5682 | FDS5682 | SO-8 | 330mm | 12mm | 2500 units |

Electrical Characteristics $T_A = 25^\circ\text{C}$ unless otherwise noted

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Units |
|--------|-----------|-----------------|-----|-----|-----|-------|
|--------|-----------|-----------------|-----|-----|-----|-------|

Off Characteristics

| | | | | | | |
|------------|-----------------------------------|---|----|---|-----------|---------------|
| B_{VDSS} | Drain to Source Breakdown Voltage | $I_D = 250\mu\text{A}$, $V_{GS} = 0\text{V}$ | 60 | - | - | V |
| I_{DSS} | Zero Gate Voltage Drain Current | $V_{DS} = 50\text{V}$ $V_{GS} = 0\text{V}$ | - | - | 1 | μA |
| | | $T_A = 150^\circ\text{C}$ | - | - | 250 | |
| I_{GSS} | Gate to Source Leakage Current | $V_{GS} = \pm 20\text{V}$ | - | - | ± 100 | nA |

On Characteristics

| | | | | | | |
|--------------|----------------------------------|--|---|-------|--------|----------|
| $V_{GS(TH)}$ | Gate to Source Threshold Voltage | $V_{GS} = V_{DS}$, $I_D = 250\mu\text{A}$ | 1 | - | 2 | V |
| $r_{DS(ON)}$ | Drain to Source On Resistance | $I_D = 7.5\text{A}$, $V_{GS} = 10\text{V}$ | - | 0.017 | 0.021 | Ω |
| | | $I_D = 6.7\text{A}$, $V_{GS} = 4.5\text{V}$ | - | 0.021 | 0.0265 | |
| | | $I_D = 7.5\text{A}$, $V_{GS} = 10\text{V}$, $T_A = 150^\circ\text{C}$ | - | 0.034 | 0.040 | |

Dynamic Characteristics

| | | | | | | | |
|--------------|----------------------------------|---|--|------|-----|----------|----|
| C_{ISS} | Input Capacitance | $V_{DS} = 25\text{V}$, $V_{GS} = 0\text{V}$, $f = 1\text{MHz}$ | - | 1650 | - | pF | |
| C_{OSS} | Output Capacitance | | - | 170 | - | pF | |
| C_{RSS} | Reverse Transfer Capacitance | | - | 65 | - | pF | |
| R_G | Gate Resistance | | - | 3.7 | - | Ω | |
| $Q_{g(TOT)}$ | Total Gate Charge at 10V | $V_{GS} = 0\text{V}$ to 10V | $V_{DD} = 30\text{V}$ $I_D = 7.5\text{A}$ $I_g = 1.0\text{mA}$ | - | 27 | 35 | nC |
| $Q_{g(5)}$ | Total Gate Charge at 5V | $V_{GS} = 0\text{V}$ to 5V | | - | 15 | 20 | nC |
| $Q_{g(TH)}$ | Threshold Gate Charge | $V_{GS} = 0\text{V}$ to 1V | | - | 1.6 | 2.1 | nC |
| Q_{gs} | Gate to Source Gate Charge | | | - | 4.3 | - | nC |
| Q_{gs2} | Gate Charge Threshold to Plateau | | | - | 2.7 | - | nC |
| Q_{gd} | Gate to Drain "Miller" Charge | | - | 4.5 | - | nC | |

Switching Characteristics ($V_{GS} = 10V$)

| | | | | | | |
|--------------|---------------------|---|---|----|-----|----|
| t_{ON} | Turn-On Time | $V_{DD} = 30V, I_D = 7.5A$ $V_{GS} = 10V, R_{GS} = 11\Omega$ | - | - | 33 | ns |
| $t_{d(ON)}$ | Turn-On Delay Time | | - | 9 | - | ns |
| t_r | Rise Time | | - | 13 | - | ns |
| $t_{d(OFF)}$ | Turn-Off Delay Time | | - | 67 | - | ns |
| t_f | Fall Time | | - | 17 | - | ns |
| t_{OFF} | Turn-Off Time | | - | - | 126 | ns |

Drain-Source Diode Characteristics

| | | | | | | |
|----------|-------------------------------|--|---|---|------|----|
| V_{SD} | Source to Drain Diode Voltage | $I_{SD} = 7.5A$ | - | - | 1.25 | V |
| | | $I_{SD} = 2.1A$ | - | - | 1.0 | V |
| t_{rr} | Reverse Recovery Time | $I_{SD} = 7.5A, dI_{SD}/dt=100A/\mu s$ | - | - | 33 | ns |
| Q_{RR} | Reverse Recovered Charge | $I_{SD} = 7.5A, dI_{SD}/dt=100A/\mu s$ | - | - | 29 | nC |

Notes:

- 1: Starting $T_J = 25^\circ C, L = 1mH, I_{AS} = 13.7A, V_{DD} = 60V, V_{GS} = 10V$.
- 2: $R_{\theta JA}$ is the sum of the junction-to-case and case-to-ambient thermal resistance where the case thermal reference is defined as the solder mounting surface of the drain pins. $R_{\theta JC}$ is guaranteed by design while $R_{\theta JA}$ is determined by the user's board design.
- 3: $R_{\theta JA}$ is measured with 1.0 in² copper on FR-4 board.

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

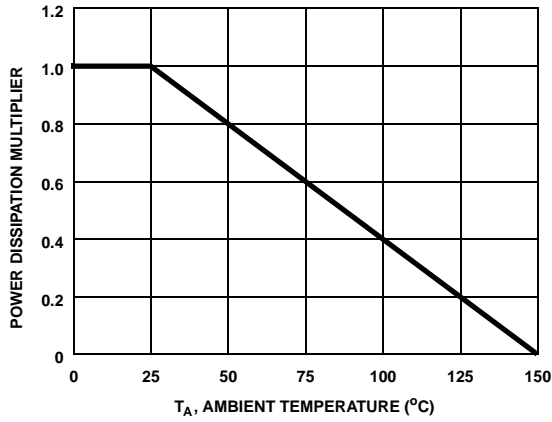


Figure 1. Normalized Power Dissipation vs Ambient Temperature

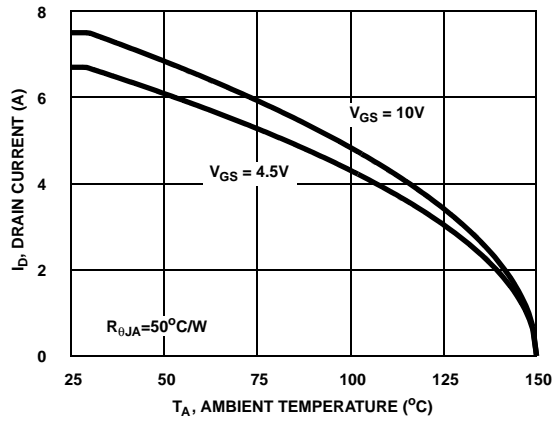


Figure 2. Maximum Continuous Drain Current vs Ambient Temperature

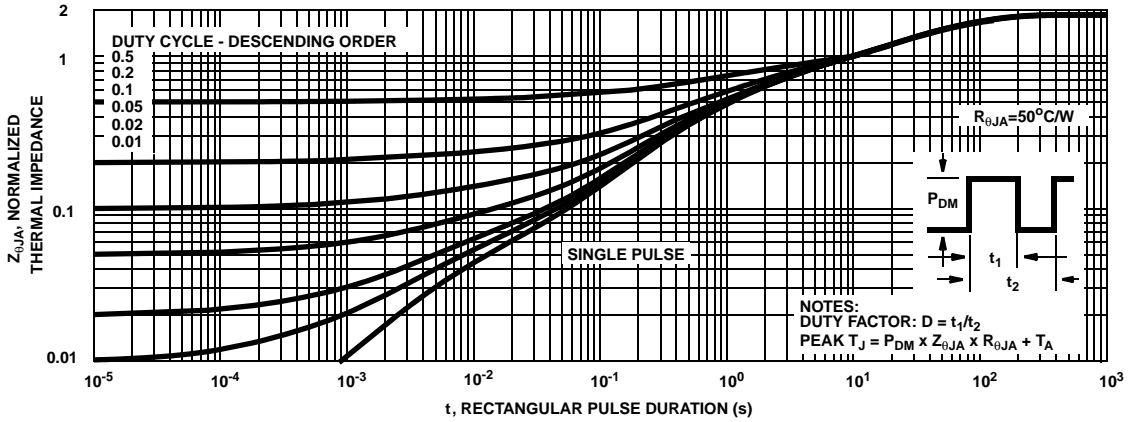


Figure 3. Normalized Maximum Transient Thermal Impedance

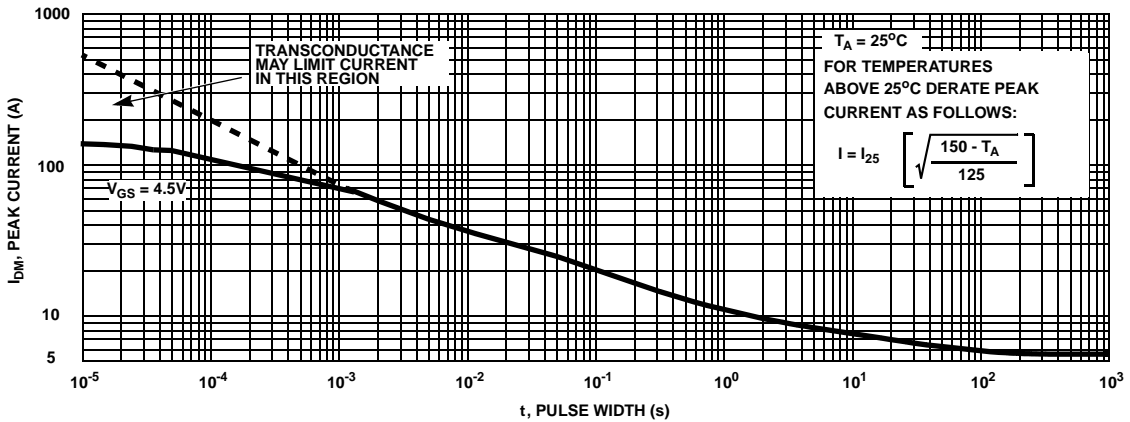
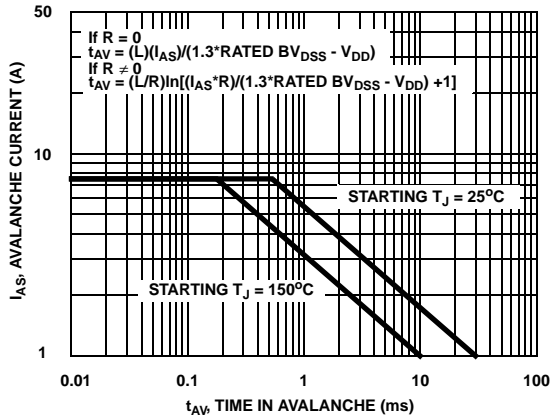


Figure 4. Peak Current Capability

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



NOTE: Refer to Fairchild Application Notes AN7514 and AN7515
Figure 5. Unclamped Inductive Switching Capability

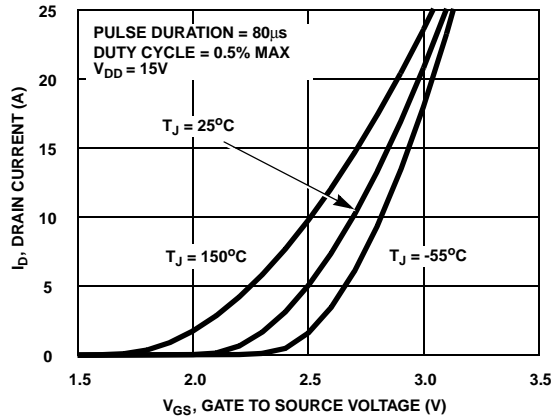


Figure 6. Transfer Characteristics

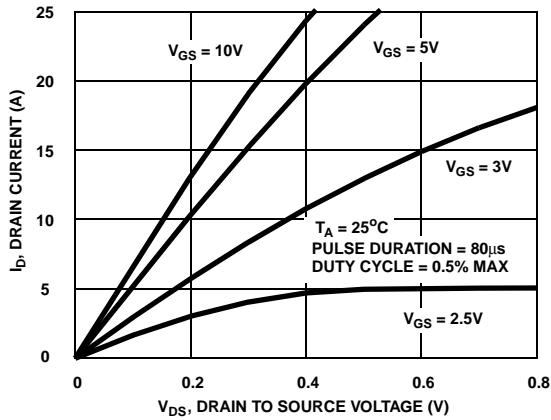


Figure 7. Saturation Characteristics

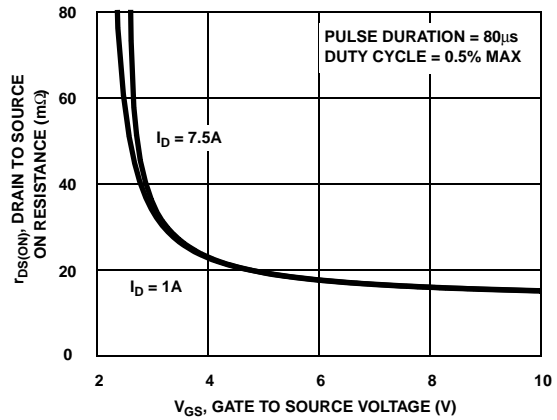


Figure 8. Drain to Source On Resistance vs Gate Voltage and Drain Current

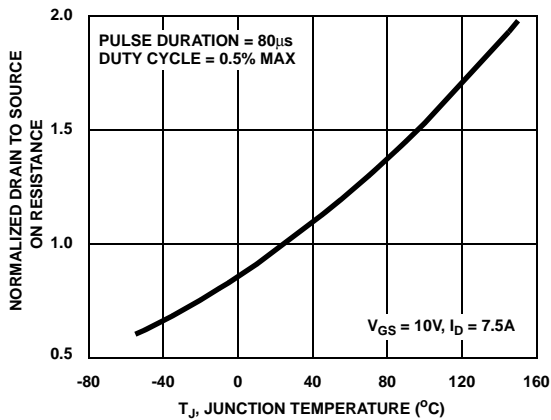


Figure 9. Normalized Drain to Source On Resistance vs Junction Temperature

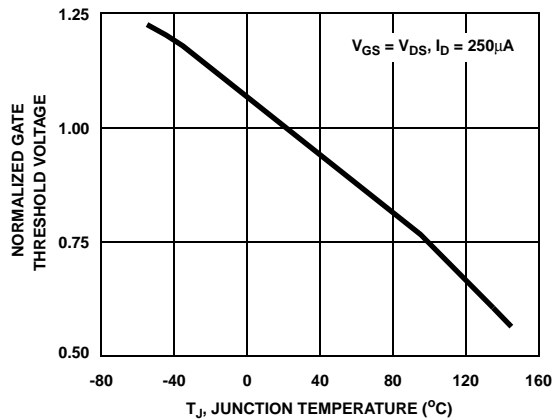


Figure 10. Normalized Gate Threshold Voltage vs Junction Temperature

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

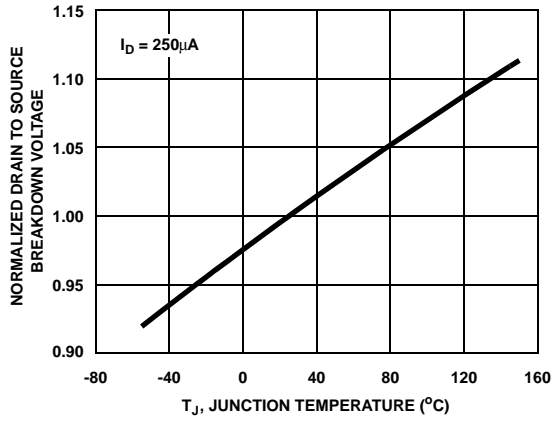


Figure 11. Normalized Drain to Source Breakdown Voltage vs Junction Temperature

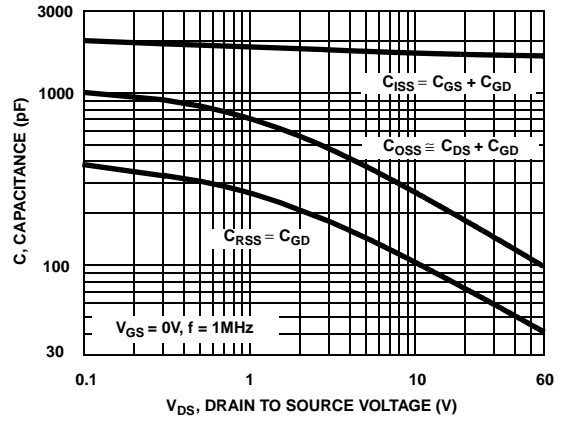


Figure 12. Capacitance vs Drain to Source Voltage

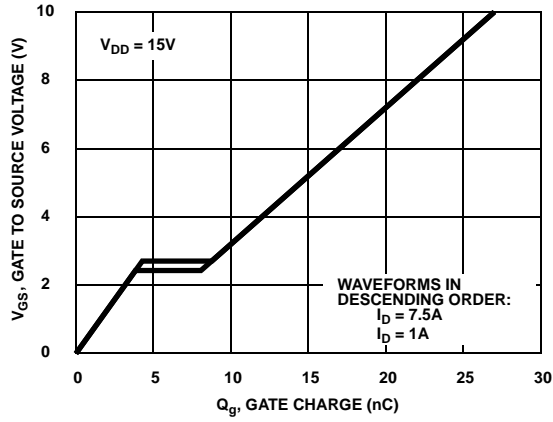


Figure 13. Gate Charge Waveforms for Constant Gate Currents

Test Circuits and Waveforms

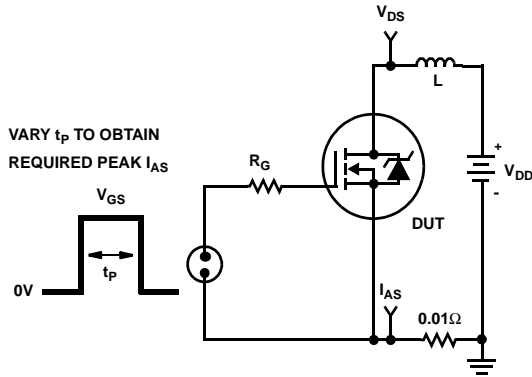


Figure 14. Unclamped Energy Test Circuit

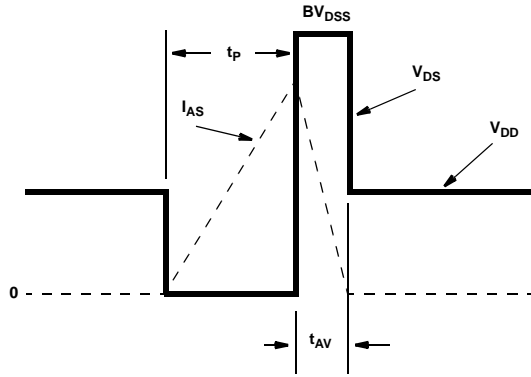


Figure 15. Unclamped Energy Waveforms

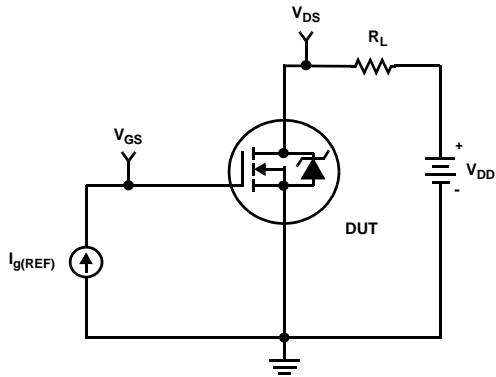


Figure 16. Gate Charge Test Circuit

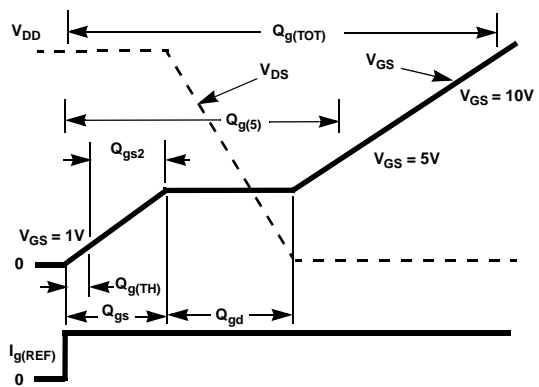


Figure 17. Gate Charge Waveforms

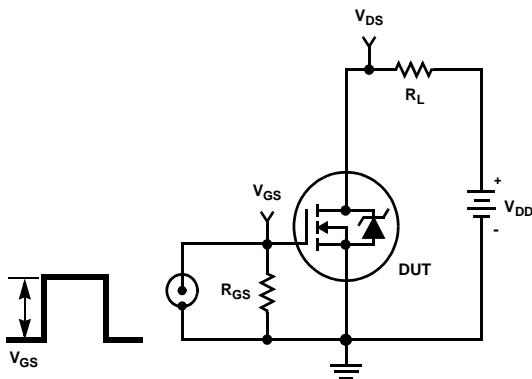


Figure 18. Switching Time Test Circuit

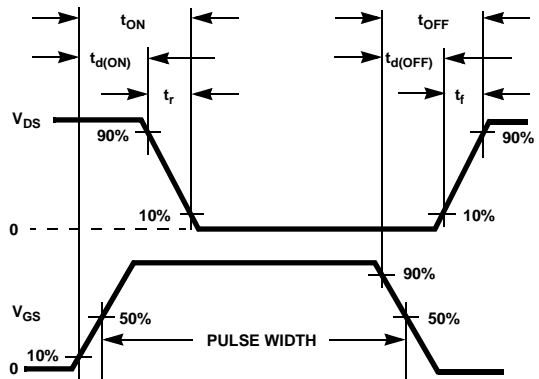


Figure 19. Switching Time Waveforms

Thermal Resistance vs. Mounting Pad Area

The maximum rated junction temperature, T_{JM} , and the thermal resistance of the heat dissipating path determines the maximum allowable device power dissipation, P_{DM} , in an application. Therefore the application's ambient temperature, T_A ($^{\circ}C$), and thermal resistance $R_{\theta JA}$ ($^{\circ}C/W$) must be reviewed to ensure that T_{JM} is never exceeded. Equation 1 mathematically represents the relationship and serves as the basis for establishing the rating of the part.

$$P_{DM} = \frac{(T_{JM} - T_A)}{R_{\theta JA}} \quad (\text{EQ. 1})$$

In using surface mount devices such as the SO8 package, the environment in which it is applied will have a significant influence on the part's current and maximum power dissipation ratings. Precise determination of P_{DM} is complex and influenced by many factors:

1. Mounting pad area onto which the device is attached and whether there is copper on one side or both sides of the board.
2. The number of copper layers and the thickness of the board.
3. The use of external heat sinks.
4. The use of thermal vias.
5. Air flow and board orientation.
6. For non steady state applications, the pulse width, the duty cycle and the transient thermal response of the part, the board and the environment they are in.

Fairchild provides thermal information to assist the designer's preliminary application evaluation. Figure 21 defines the $R_{\theta JA}$ for the device as a function of the top copper (component side) area. This is for a horizontally positioned FR-4 board with 1oz copper after 1000 seconds of steady state power with no air flow. This graph provides the necessary information for calculation of the steady state junction temperature or power dissipation. Pulse applications can be evaluated using the Fairchild device Spice thermal model or manually utilizing the normalized

maximum transient thermal impedance curve.

Thermal resistances corresponding to other copper areas can be obtained from Figure 21 or by calculation using Equation 2. The area, in square inches is the top copper area including the gate and source pads.

$$R_{\theta JA} = 64 + \frac{26}{0.23 + \text{Area}} \quad (\text{EQ. 2})$$

The transient thermal impedance ($Z_{\theta JA}$) is also effected by varied top copper board area. Figure 22 shows the effect of copper pad area on single pulse transient thermal impedance. Each trace represents a copper pad area in square inches corresponding to the descending list in the graph. Spice and SABER thermal models are provided for each of the listed pad areas.

Copper pad area has no perceivable effect on transient thermal impedance for pulse widths less than 100ms. For pulse widths less than 100ms the transient thermal impedance is determined by the die and package. Therefore, C THERM1 through C THERM5 and R THERM1 through R THERM5 remain constant for each of the thermal models. A listing of the model component values is available in Table 1.

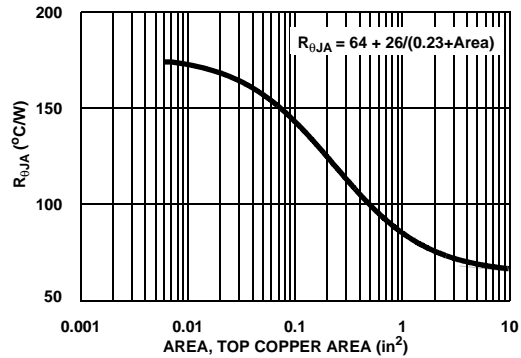


Figure 21. Thermal Resistance vs Mounting Pad Area

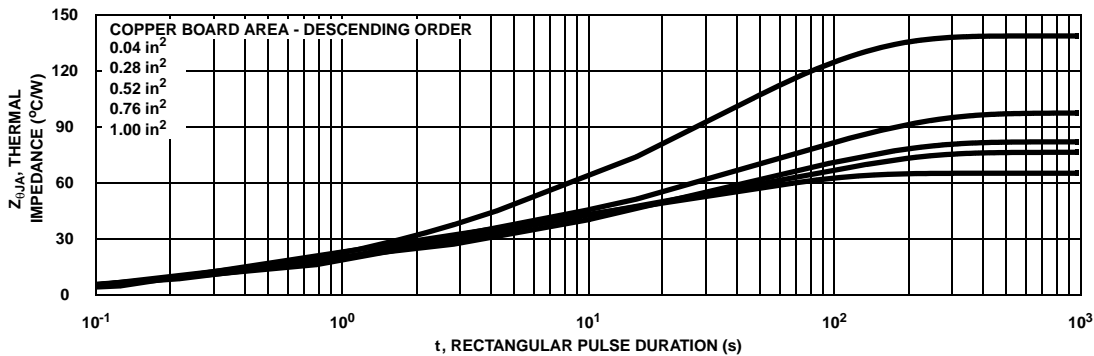


Figure 22. Thermal Impedance vs Mounting Pad Area

PSPICE Electrical Model

.SUBCKT FDS5682 2 1 3 ; rev May 2005
 Ca 12 8 7.7e-10
 Cb 15 14 7.7e-10
 Cin 6 8 16e-10

Dbody 7 5 DbodyMOD
 Dbreak 5 11 DbreakMOD
 Dplcap 10 5 DplcapMOD

Ebreak 11 7 17 18 69.3
 Eds 14 8 5 8 1
 Egs 13 8 6 8 1
 Esg 6 10 6 8 1
 Evthres 6 21 19 8 1
 Evtemp 20 6 18 22 1

It 8 17 1

Lgate 1 9 2.43e-9
 Ldrain 2 5 1.0e-9
 Lsource 3 7 0.22e-9

RLgate 1 9 24.3
 RLdrain 2 5 10
 RLsource 3 7 2.2

Mmed 16 6 8 8 MmedMOD
 Mstro 16 6 8 8 MstroMOD
 Mweak 16 21 8 8 MweakMOD

Rbreak 17 18 RbreakMOD 1
 Rdrain 50 16 RdrainMOD 1e-2
 Rgate 9 20 3.68
 RSLC1 5 51 RSLCMOD 1e-6
 RSLC2 5 50 1e3
 Rsource 8 7 RsourceMOD 2.7e-3
 Rvthres 22 8 RvthresMOD 1
 Rvtemp 18 19 RvtempMOD 1
 S1a 6 12 13 8 S1AMOD
 S1b 13 12 13 8 S1BMOD
 S2a 6 15 14 13 S2AMOD
 S2b 13 15 14 13 S2BMOD

Vbat 22 19 DC 1

ESLC 51 50 VALUE={{(V(5,51)/ABS(V(5,51)))³*(PWR(V(5,51)/(1e-6*60),3.7))}}

.MODEL DbodyMOD D (IS=1.7E-11 N=1.03 RS=8e-3 TRS1=3e-3 TRS2=3e-6
 + CJO=6.82e-10 M=0.6 TT=4e-9 XTI=0.8)

.MODEL DbreakMOD D (RS=1.65 TRS1=1e-3 TRS2=-9e-6)

.MODEL DplcapMOD D (CJO=3.8e-10 IS=1e-30 N=10 M=0.54)

.MODEL MmedMOD NMOS (VTO=1.7 KP=1.08 IS=1e-30 N=10 TOX=1 L=1u W=1u RG=3.68)

.MODEL MstroMOD NMOS (VTO=2.05 KP=50 IS=1e-30 N=10 TOX=1 L=1u W=1u)

.MODEL MweakMOD NMOS (VTO=1.44 KP=0.04 IS=1e-30 N=10 TOX=1 L=1u W=1u RG=36.8 RS=0.1)

.MODEL RbreakMOD RES (TC1=1.0e-3 TC2=-5e-7)

.MODEL RdrainMOD RES (TC1=7.0e-3 TC2=2e-5)

.MODEL RSLCMOD RES (TC1=2.8e-3 TC2=1.9e-5)

.MODEL RsourceMOD RES (TC1=4e-3 TC2=1e-6)

.MODEL RvthresMOD RES (TC1=-2.0e-3 TC2=-7e-6)

.MODEL RvtempMOD RES (TC1=-2.2e-3 TC2=1e-6)

.MODEL S1AMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=-4 VOFF=-1)

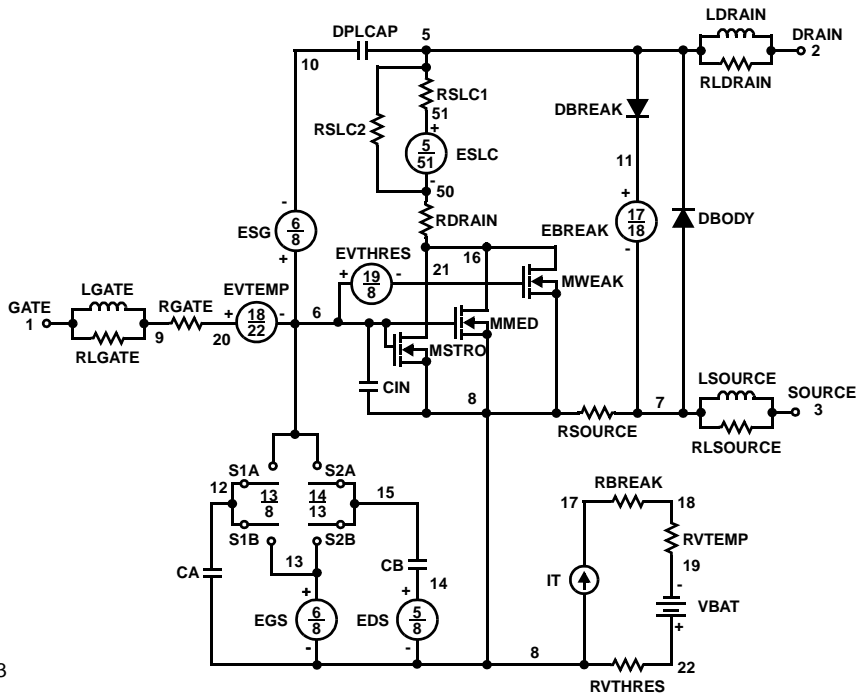
.MODEL S1BMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=-1 VOFF=-4)

.MODEL S2AMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=-0.5 VOFF=0.5)

.MODEL S2BMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=0.5 VOFF=-0.5)

.ENDS

Note: For further discussion of the PSPICE model, consult **A New PSPICE Sub-Circuit for the Power MOSFET Featuring Global Temperature Options**; IEEE Power Electronics Specialist Conference Records, 1991, written by William J. Hepp and C. Frank Wheatley.



SPICE Thermal Model

```

REV May 2005
FDS5682
Copper Area =1.0 in2
CTHERM1 TH 8 2.0e-3
CTHERM2 8 7 5.0e-3
CTHERM3 7 6 1.0e-2
CTHERM4 6 5 4.0e-2
CTHERM5 5 4 9.0e-2
CTHERM6 4 3 2e-1
CTHERM7 3 2 1
CTHERM8 2 TL 3
    
```

```

R THERM1 TH 8 1e-1
R THERM2 8 7 5e-1
R THERM3 7 6 1
R THERM4 6 5 5
R THERM5 5 4 8
R THERM6 4 3 12
R THERM7 3 2 18
R THERM8 2 TL 25
    
```

SABER Thermal Model

```

SABER thermal model FDS5682
Copper Area = 1.0 in2
template thermal_model th tl
thermal_c th, tl
{
ctherm.ctherm1 th 8 =2.0e-3
ctherm.ctherm2 8 7 =5.0e-3
ctherm.ctherm3 7 6 =1.0e-2
ctherm.ctherm4 6 5 =4.0e-2
ctherm.ctherm5 5 4 =9.0e-2
ctherm.ctherm6 4 3 =2e-1
ctherm.ctherm7 3 2 1
ctherm.ctherm8 2 tl 3

rtherm.rtherm1 th 8 =1e-1
rtherm.rtherm2 8 7 =5e-1
rtherm.rtherm3 7 6 =1
rtherm.rtherm4 6 5 =5
rtherm.rtherm5 5 4 =8
rtherm.rtherm6 4 3 =12
rtherm.rtherm7 3 2 =18
rtherm.rtherm8 2 tl =25
}
    
```

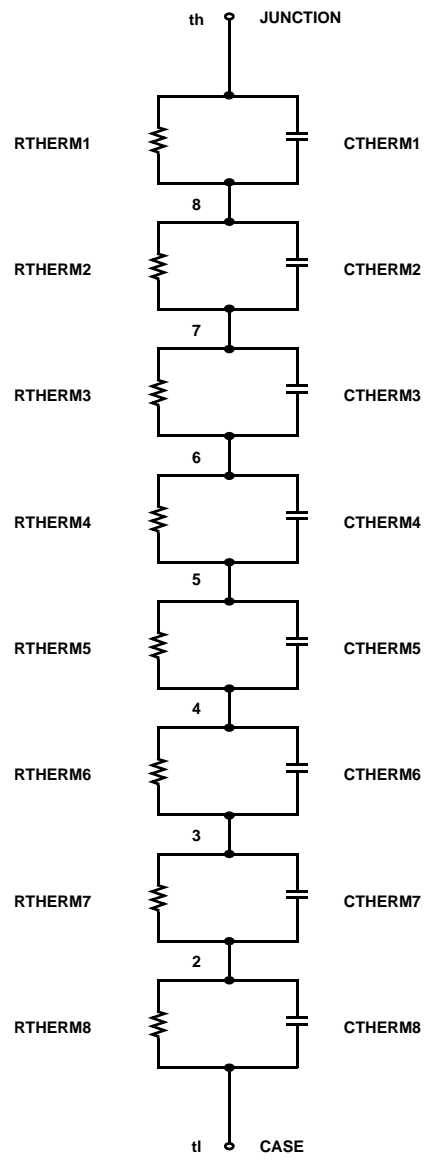



TABLE 1. THERMAL MODELS

| COMPONANT | 0.04 in ² | 0.28 in ² | 0.52 in ² | 0.76 in ² | 1.0 in ² |
|-----------|----------------------|----------------------|----------------------|----------------------|---------------------|
| CTHERM6 | 1.2e-1 | 1.5e-1 | 2.0e-1 | 2.0e-1 | 2.0e-1 |
| CTHERM7 | 0.5 | 1.0 | 1.0 | 1.0 | 1.0 |
| CTHERM8 | 1.3 | 2.8 | 3.0 | 3.0 | 3.0 |
| R THERM6 | 26 | 20 | 15 | 13 | 12 |
| R THERM7 | 39 | 24 | 21 | 19 | 18 |
| R THERM8 | 55 | 38.7 | 31.3 | 29.7 | 25 |



TRADEMARKS

The following includes registered and unregistered trademarks and service marks, owned by Fairchild Semiconductor and/or its global subsidiaries, and is not intended to be an exhaustive list of all such trademarks.

- | | | | |
|---|---|---|---|
| ACEx® | FPS™ | PDP-SPM™ | The Power Franchise® |
| Build it Now™ | F-PFS™ | Power-SPM™ | power the franchise |
| CorePLUS™ | FRFET® | PowerTrench® | TinyBoost™ |
| CorePOWER™ | Global Power Resource SM | Programmable Active Droop™ | TinyBuck™ |
| CROSSVOLT™ | Green FPS™ | QFET® | TinyLogic® |
| CTL™ | Green FPS™ e-Series™ | QS™ | TINYOPTO™ |
| Current Transfer Logic™ | GTO™ | Quiet Series™ | TinyPower™ |
| EcoSPARK® | IntelliMAX™ | RapidConfigure™ | TinyPWM™ |
| EfficientMax™ | ISOPLANAR™ | Saving our world 1mW at a time™ | TinyWire™ |
| EZSWITCH™ * | MegaBuck™ | SmartMax™ | µSerDes™ |
|  | MICROCOUPLER™ | SMART START™ |  |
|  | MicroFET™ | SPM® | UHC® |
| Fairchild® | MicroPak™ | STEALTH™ | Ultra FRFET™ |
| Fairchild Semiconductor® | MillerDrive™ | SuperFET™ | UniFET™ |
| FACT Quiet Series™ | MotionMax™ | SuperSOT™-3 | VCX™ |
| FACT® | Motion-SPM™ | SuperSOT™-6 | VisualMax™ |
| FAST® | OPTOLOGIC® | SuperSOT™-8 | |
| FastvCore™ | OPTOPLANAR® | SuperMOS™ | |
| FlashWriter® * |  |  | |

* EZSWITCH™ and FlashWriter® are trademarks of System General Corporation, used under license by Fairchild Semiconductor.

DISCLAIMER

FAIRCHILD SEMICONDUCTOR RESERVES THE RIGHT TO MAKE CHANGES WITHOUT FURTHER NOTICE TO ANY PRODUCTS HEREIN TO IMPROVE RELIABILITY, FUNCTION, OR DESIGN. FAIRCHILD DOES NOT ASSUME ANY LIABILITY ARISING OUT OF THE APPLICATION OR USE OF ANY PRODUCT OR CIRCUIT DESCRIBED HEREIN; NEITHER DOES IT CONVEY ANY LICENSE UNDER ITS PATENT RIGHTS, NOR THE RIGHTS OF OTHERS. THESE SPECIFICATIONS DO NOT EXPAND THE TERMS OF FAIRCHILD'S WORLDWIDE TERMS AND CONDITIONS, SPECIFICALLY THE WARRANTY THEREIN, WHICH COVERS THESE PRODUCTS.

LIFE SUPPORT POLICY

FAIRCHILD'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF FAIRCHILD SEMICONDUCTOR CORPORATION.

As used herein:

- Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body or (b) support or sustain life, and (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury of the user.
- A critical component in any component of a life support, device, or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

PRODUCT STATUS DEFINITIONS

Definition of Terms

| Datasheet Identification | Product Status | Definition |
|--------------------------|------------------------|--|
| Advance Information | Formative or In Design | This datasheet contains the design specifications for product development. Specifications may change in any manner without notice. |
| Preliminary | First Production | This datasheet contains preliminary data; supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve design. |
| No Identification Needed | Full Production | This datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve the design. |
| Obsolete | Not In Production | This datasheet contains specifications on a product that is discontinued by Fairchild Semiconductor. The datasheet is for reference information only. |