

**19A, 55V, 0.070 Ohm, N-Channel UltraFET  
Power MOSFETs**


These N-Channel power MOSFETs are manufactured using the innovative UltraFET® process. This advanced process technology

achieves the lowest possible on-resistance per silicon area, resulting in outstanding performance. This device is capable of withstanding high energy in the avalanche mode and the diode exhibits very low reverse recovery time and stored charge. It was designed for use in applications where power efficiency is important, such as switching regulators, switching converters, motor drivers, relay drivers, low-voltage bus switches, and power management in portable and battery-operated products.

Formerly developmental type TA75309.

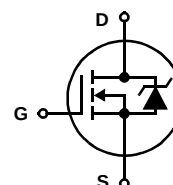
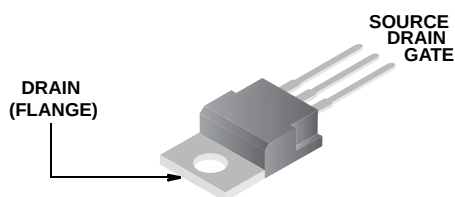
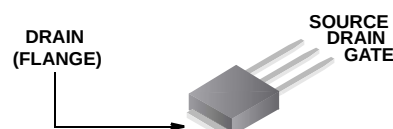
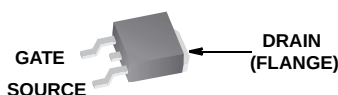
**Ordering Information**

| PART NUMBER  | PACKAGE  | BRAND  |
|--------------|----------|--------|
| HUFA75309P3  | TO-220AB | 75309P |
| HUFA75309D3  | TO-251AA | 75309D |
| HUFA75309D3S | TO-252AA | 75309D |

NOTE: When ordering, use the entire part number. Add the suffix T to obtain the TO-252AA variant in tape and reel, e.g., HUFA75309D3ST.

**Features**

- 19A, 55V
- Simulation Models
  - Temperature Compensated PSPICE® and SABER™ Models
  - SPICE and SABER Thermal Impedance Models Available on the WEB at: [www.fairchildsemi.com](http://www.fairchildsemi.com)
- Peak Current vs Pulse Width Curve
- UIS Rating Curve
- Related Literature
  - TB334, "Guidelines for Soldering Surface Mount Components to PC Boards"

**Symbol**

**Packaging**
**JEDEC STYLE TO-220AB**

**JEDEC TO-251AA**

**JEDEC TO-252AA**


This product has been designed to meet the extreme test conditions and environment demanded by the automotive industry. For a copy of the requirements, see AEC Q101 at: <http://www.aecouncil.com/>

Reliability data can be found at: <http://www.fairchildsemi.com/products/discrete/reliability/index.html>.

All Fairchild semiconductor products are manufactured, assembled and tested under ISO9000 and QS9000 quality systems certification.

# HUFA75309P3, HUFA75309D3, HUFA75309D3S

## Absolute Maximum Ratings $T_C = 25^{\circ}\text{C}$ , Unless Otherwise Specified

|                                                                          | HUFA75309P3, HUFA75309D3,<br>HUFA75309D3S | UNITS                       |
|--------------------------------------------------------------------------|-------------------------------------------|-----------------------------|
| Drain to Source Voltage (Note 1) . . . . .                               | $V_{DSS}$ 55                              | V                           |
| Drain to Gate Voltage ( $R_{GS} = 20\text{k}\Omega$ ) (Note 1) . . . . . | $V_{DGR}$ 55                              | V                           |
| Gate to Source Voltage . . . . .                                         | $V_{GS}$ $\pm 20$                         | V                           |
| Drain Current                                                            |                                           |                             |
| Continuous (Figure 2). . . . .                                           | $I_D$ 19                                  | A                           |
| Pulsed Drain Current . . . . .                                           | $I_{DM}$ Figure 4                         |                             |
| Pulsed Avalanche Rating . . . . .                                        | $E_{AS}$ Figures 6, 14, 15                |                             |
| Power Dissipation . . . . .                                              | $P_D$ 55                                  | W                           |
| Derate Above $25^{\circ}\text{C}$ . . . . .                              | 0.37                                      | $\text{W}/^{\circ}\text{C}$ |
| Operating and Storage Temperature . . . . .                              | $T_J, T_{STG}$ -55 to 175                 | $^{\circ}\text{C}$          |
| Maximum Temperature for Soldering                                        |                                           |                             |
| Leads at 0.063in (1.6mm) from Case for 10s. . . . .                      | $T_L$ 300                                 | $^{\circ}\text{C}$          |
| Package Body for 10s, See Techbrief 334 . . . . .                        | $T_{pkg}$ 260                             | $^{\circ}\text{C}$          |

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

### NOTE:

1.  $T_J = 25^{\circ}\text{C}$  to  $150^{\circ}\text{C}$ .

## Electrical Specifications $T_C = 25^{\circ}\text{C}$ , Unless Otherwise Specified

| PARAMETER                                        | SYMBOL              | TEST CONDITIONS                                                                                                         | MIN                                                                                                                    | TYP   | MAX   | UNITS |    |
|--------------------------------------------------|---------------------|-------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|-------|-------|-------|----|
| OFF STATE SPECIFICATIONS                         |                     |                                                                                                                         |                                                                                                                        |       |       |       |    |
| Drain to Source Breakdown Voltage                | BV <sub>DSS</sub>   | I <sub>D</sub> = 250μA, V <sub>GS</sub> = 0V (Figure 11)                                                                | 55                                                                                                                     | -     | -     | V     |    |
| Zero Gate Voltage Drain Current                  | I <sub>DSS</sub>    | V <sub>DS</sub> = 50V, V <sub>GS</sub> = 0V                                                                             | -                                                                                                                      | -     | 1     | μA    |    |
|                                                  |                     | V <sub>DS</sub> = 45V, V <sub>GS</sub> = 0V, T <sub>C</sub> = 150°C                                                     | -                                                                                                                      | -     | 250   | μA    |    |
| Gate to Source Leakage Current                   | I <sub>GSS</sub>    | V <sub>GS</sub> = ±20V                                                                                                  | -                                                                                                                      | -     | ±100  | nA    |    |
| ON STATE SPECIFICATIONS                          |                     |                                                                                                                         |                                                                                                                        |       |       |       |    |
| Gate to Source Threshold Voltage                 | V <sub>GS(TH)</sub> | V <sub>GS</sub> = V <sub>DS</sub> , I <sub>D</sub> = 250μA (Figure 10)                                                  | 2                                                                                                                      | -     | 4     | V     |    |
| Drain to Source On Resistance                    | r <sub>DS(ON)</sub> | I <sub>D</sub> = 19A, V <sub>GS</sub> = 10V (Figure 9)                                                                  | -                                                                                                                      | 0.060 | 0.070 | Ω     |    |
| THERMAL SPECIFICATIONS                           |                     |                                                                                                                         |                                                                                                                        |       |       |       |    |
| Thermal Resistance Junction to Case              | R <sub>θJC</sub>    | (Figure 3)                                                                                                              | -                                                                                                                      | -     | 2.7   | °C/W  |    |
| Thermal Resistance Junction to Ambient           | R <sub>θJA</sub>    | TO-220                                                                                                                  | -                                                                                                                      | -     | 62    | °C/W  |    |
|                                                  |                     | TO-251, TO-252                                                                                                          | -                                                                                                                      | -     | 100   | °C/W  |    |
| SWITCHING SPECIFICATIONS (V <sub>GS</sub> = 10V) |                     |                                                                                                                         |                                                                                                                        |       |       |       |    |
| Turn-On Time                                     | t <sub>ON</sub>     | V <sub>DD</sub> = 30V, I <sub>D</sub> ≡ 19A,<br>R <sub>L</sub> = 1.58Ω, V <sub>GS</sub> = 10V,<br>R <sub>GS</sub> = 27Ω | -                                                                                                                      | -     | 70    | ns    |    |
| Turn-On Delay Time                               | t <sub>d(ON)</sub>  |                                                                                                                         | -                                                                                                                      | 7     | -     | ns    |    |
| Rise Time                                        | t <sub>r</sub>      |                                                                                                                         | -                                                                                                                      | 39    | -     | ns    |    |
| Turn-Off Delay Time                              | t <sub>d(OFF)</sub> |                                                                                                                         | -                                                                                                                      | 24    | -     | ns    |    |
| Fall Time                                        | t <sub>f</sub>      |                                                                                                                         | -                                                                                                                      | 30    | -     | ns    |    |
| Turn-Off Time                                    | t <sub>OFF</sub>    |                                                                                                                         | -                                                                                                                      | -     | 80    | ns    |    |
| GATE CHARGE SPECIFICATIONS                       |                     |                                                                                                                         |                                                                                                                        |       |       |       |    |
| Total Gate Charge                                | Q <sub>g(TOT)</sub> | V <sub>GS</sub> = 0V to 20V                                                                                             | V <sub>DD</sub> = 30V,<br>I <sub>D</sub> ≡ 19A,<br>R <sub>L</sub> = 1.58Ω<br>I <sub>g(REF)</sub> = 1.0mA<br>(Figure13) | -     | 20    | 24    | nC |
| Gate Charge at 10V                               | Q <sub>g(10)</sub>  | V <sub>GS</sub> = 0V to 10V                                                                                             |                                                                                                                        | -     | 11    | 13.5  | nC |
| Threshold Gate Charge                            | Q <sub>g(TH)</sub>  | V <sub>GS</sub> = 0V to 2V                                                                                              |                                                                                                                        | -     | 0.68  | 0.85  | nC |
| Gate to Source Gate Charge                       | Q <sub>gs</sub>     |                                                                                                                         |                                                                                                                        | -     | 1.8   | -     | nC |
| Reverse Transfer Capacitance                     | Q <sub>gd</sub>     |                                                                                                                         |                                                                                                                        | -     | 5     | -     | nC |

**HUFA75309P3, HUFA75309D3, HUFA75309D3S**

**Electrical Specifications**     $T_C = 25^{\circ}\text{C}$ , Unless Otherwise Specified

| PARAMETER                         | SYMBOL    | TEST CONDITIONS                                                                    | MIN | TYP | MAX | UNITS |
|-----------------------------------|-----------|------------------------------------------------------------------------------------|-----|-----|-----|-------|
| <b>CAPACITANCE SPECIFICATIONS</b> |           |                                                                                    |     |     |     |       |
| Input Capacitance                 | $C_{ISS}$ | $V_{DS} = 25\text{V}$ , $V_{GS} = 0\text{V}$ ,<br>$f = 1\text{MHz}$<br>(Figure 12) | -   | 350 | -   | pF    |
| Output Capacitance                | $C_{OSS}$ |                                                                                    | -   | 150 | -   | pF    |
| Reverse Transfer Capacitance      | $C_{RSS}$ |                                                                                    | -   | 39  | -   | pF    |

**Source to Drain Diode Specifications**

| PARAMETER                     | SYMBOL   | TEST CONDITIONS                                                | MIN | TYP | MAX  | UNITS |
|-------------------------------|----------|----------------------------------------------------------------|-----|-----|------|-------|
| Source to Drain Diode Voltage | $V_{SD}$ | $I_{SD} = 19\text{A}$                                          | -   | -   | 1.25 | V     |
| Reverse Recovery Time         | $t_{rr}$ | $I_{SD} = 19\text{A}$ , $dI_{SD}/dt = 100\text{A}/\mu\text{s}$ | -   | -   | 50   | ns    |
| Reverse Recovered Charge      | $Q_{RR}$ | $I_{SD} = 19\text{A}$ , $dI_{SD}/dt = 100\text{A}/\mu\text{s}$ | -   | -   | 70   | nC    |

**Typical Performance Curves**

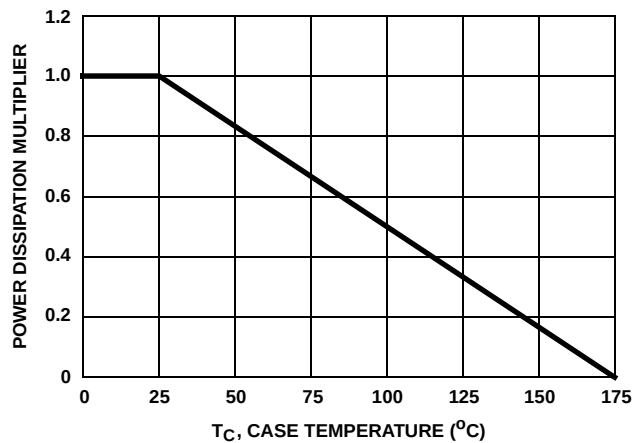


FIGURE 1. NORMALIZED POWER DISSIPATION vs CASE TEMPERATURE

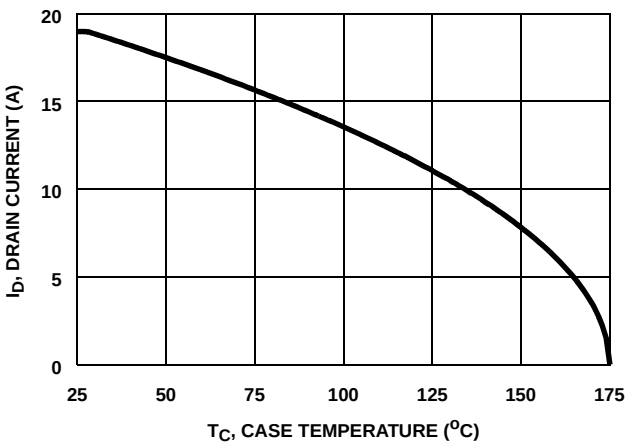


FIGURE 2. MAXIMUM CONTINUOUS DRAIN CURRENT vs CASE TEMPERATURE

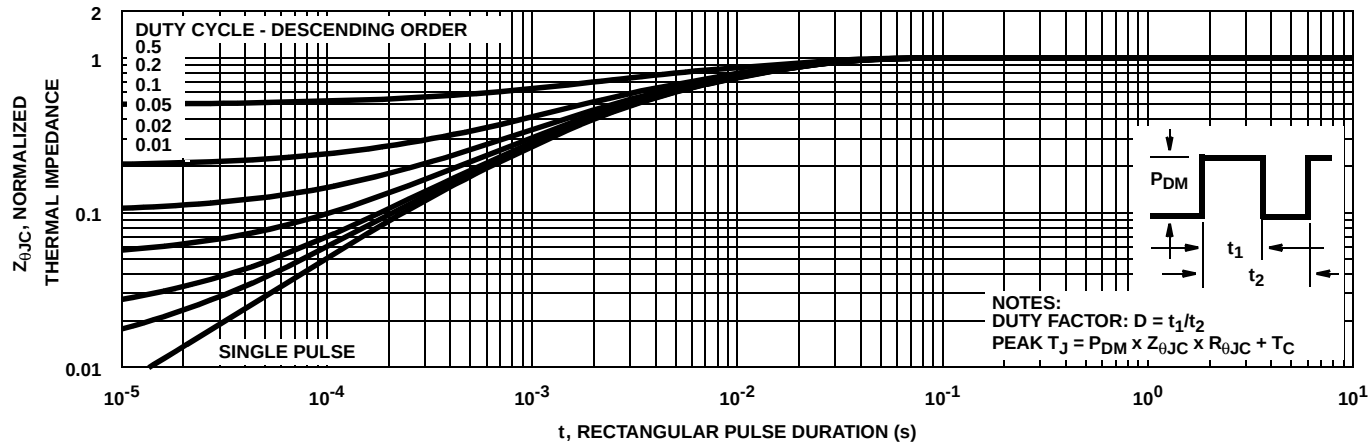


FIGURE 3. NORMALIZED MAXIMUM TRANSIENT THERMAL IMPEDANCE

Typical Performance Curves (Continued)

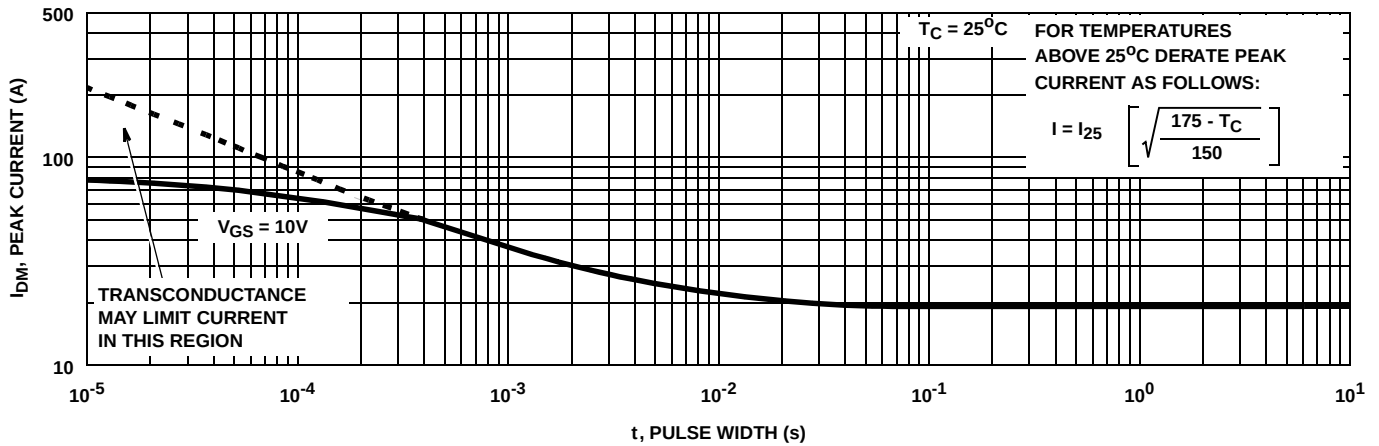


FIGURE 4. PEAK CURRENT CAPABILITY

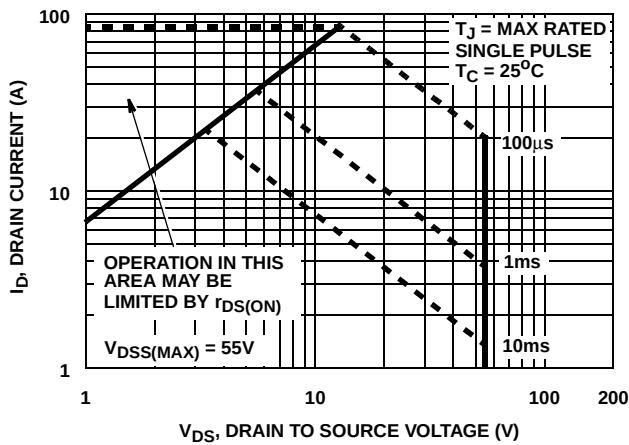
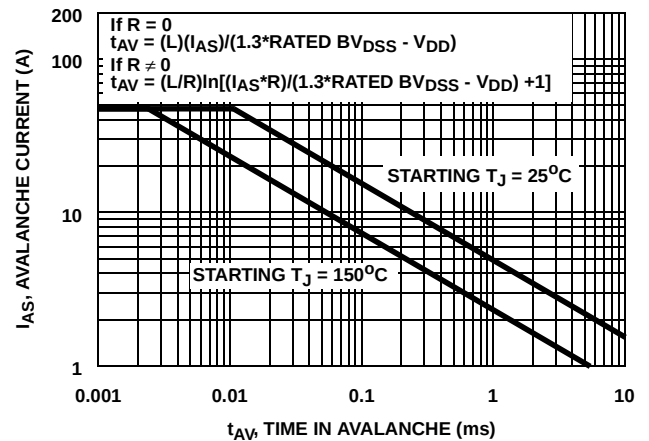


FIGURE 5. FORWARD BIAS SAFE OPERATING AREA



NOTE: Refer to Fairchild Application Notes AN9321 and AN9322.

FIGURE 6. UNCLAMPED INDUCTIVE SWITCHING CAPABILITY

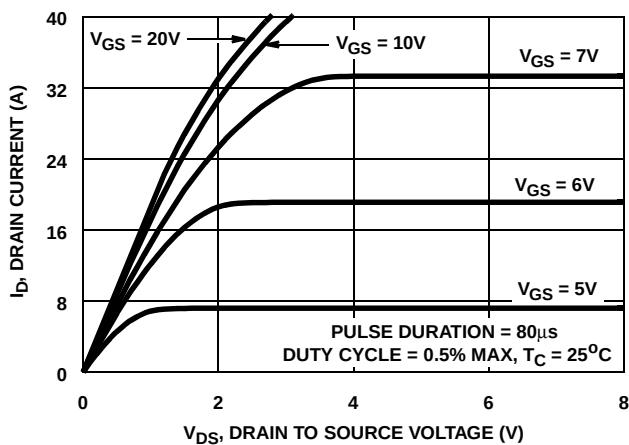


FIGURE 7. SATURATION CHARACTERISTICS

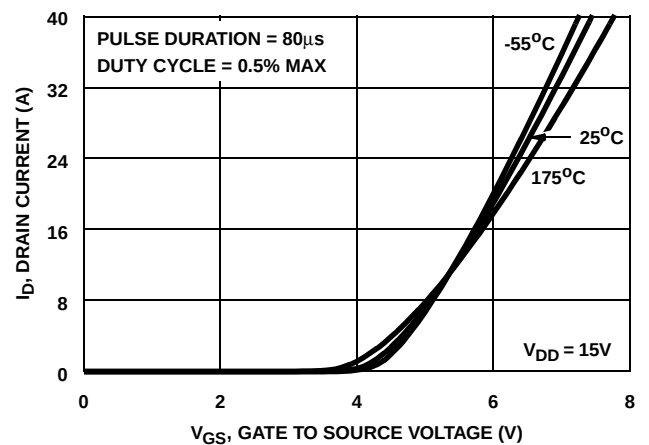


FIGURE 8. TRANSFER CHARACTERISTICS

Typical Performance Curves (Continued)

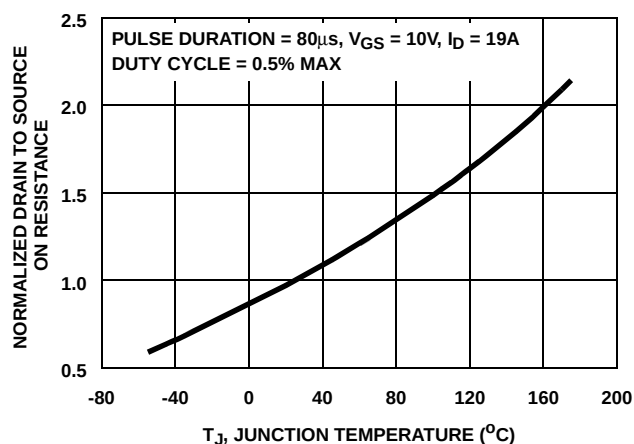


FIGURE 9. NORMALIZED DRAIN TO SOURCE ON RESISTANCE vs JUNCTION TEMPERATURE

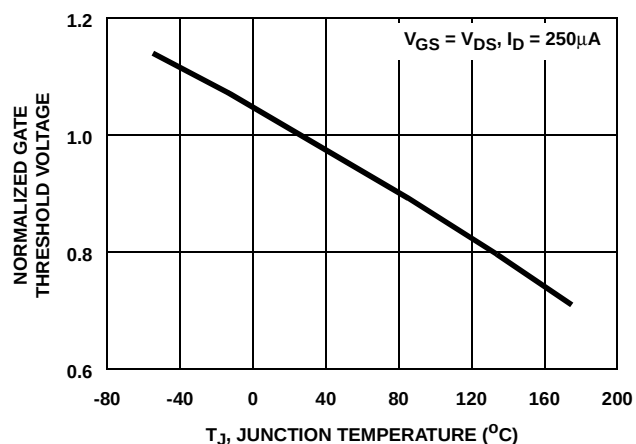


FIGURE 10. NORMALIZED GATE THRESHOLD VOLTAGE vs JUNCTION TEMPERATURE

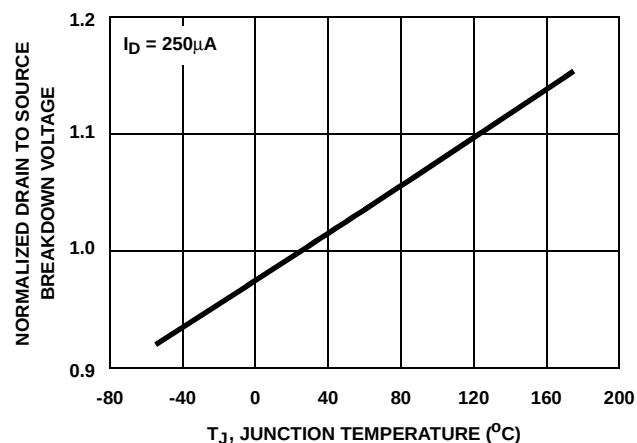


FIGURE 11. NORMALIZED DRAIN TO SOURCE BREAKDOWN VOLTAGE vs JUNCTION TEMPERATURE

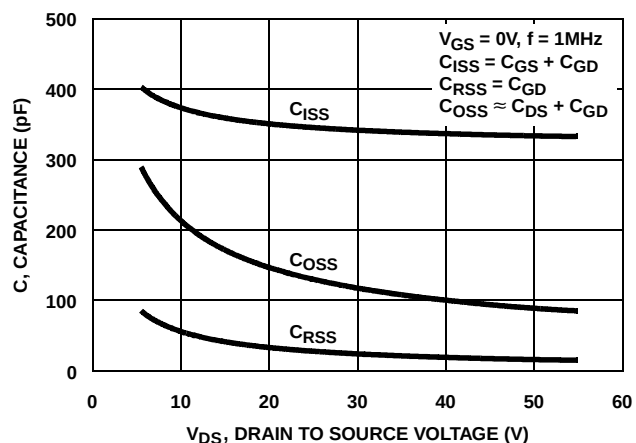
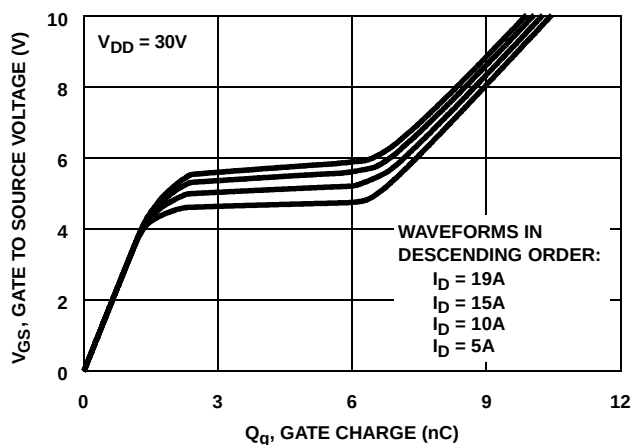


FIGURE 12. CAPACITANCE vs DRAIN TO SOURCE VOLTAGE



NOTE: Refer to Fairchild Application Notes AN7254 and AN7260.

FIGURE 13. GATE CHARGE WAVEFORMS FOR CONSTANT GATE CURRENT

## Test Circuits and Waveforms

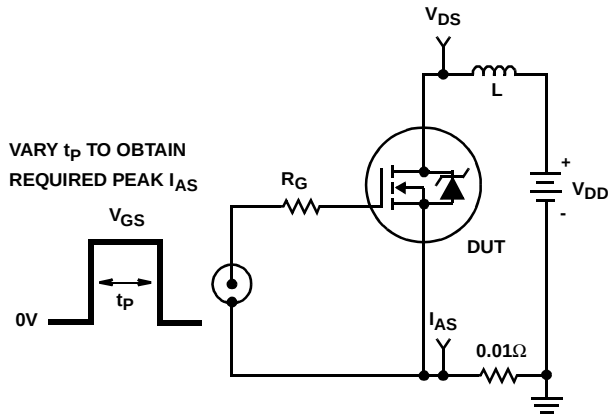


FIGURE 14. UNCLAMPED ENERGY TEST CIRCUIT

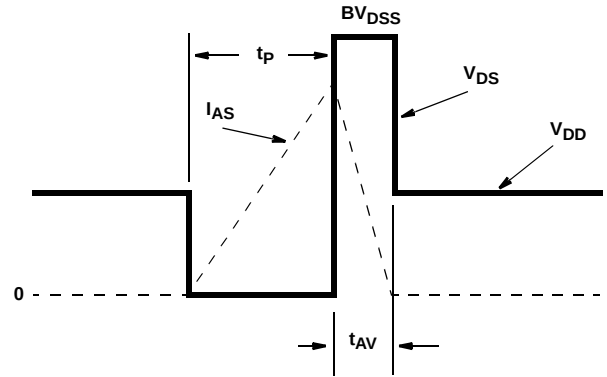


FIGURE 15. UNCLAMPED ENERGY WAVEFORMS

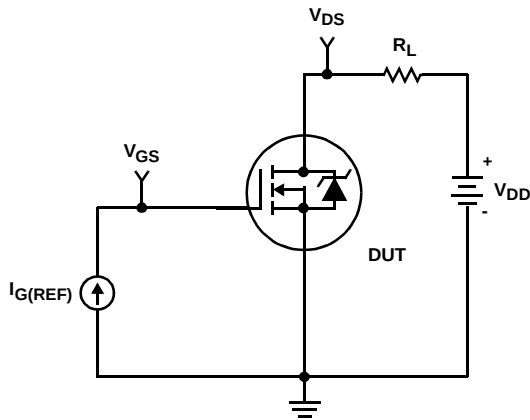


FIGURE 16. GATE CHARGE TEST CIRCUIT

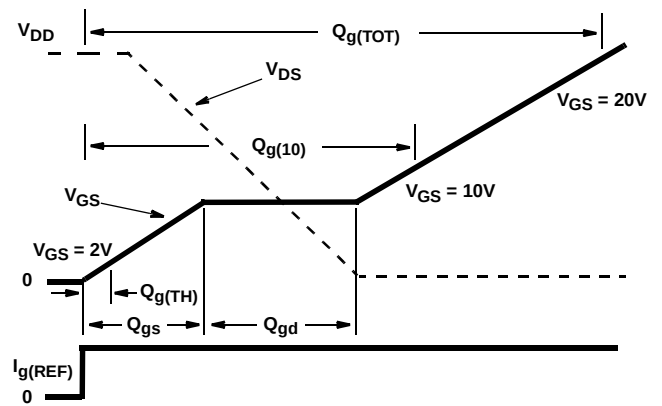


FIGURE 17. GATE CHARGE WAVEFORM

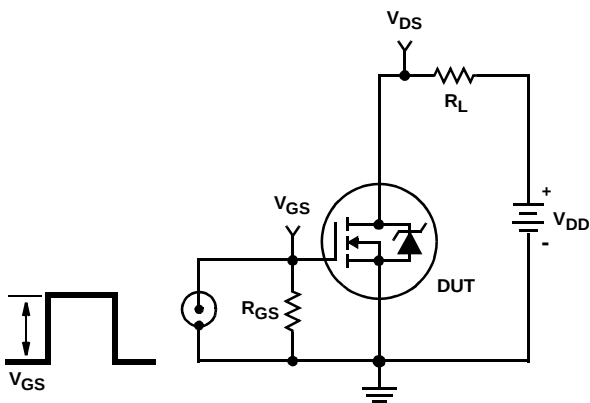


FIGURE 18. SWITCHING TIME TEST CIRCUIT

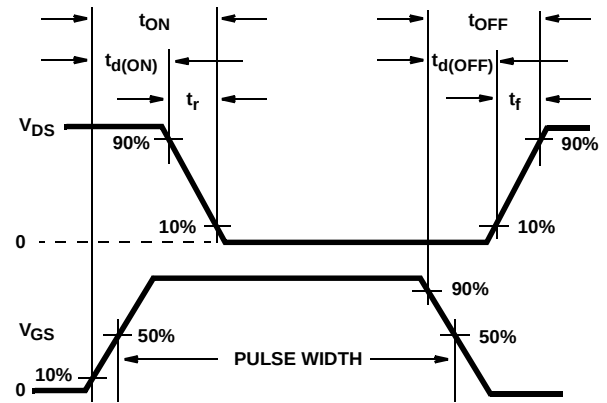


FIGURE 19. RESISTIVE SWITCHING WAVEFORMS

# PSPICE Electrical Model

.SUBCKT HUFA75309 2 1 3 ; rev 30June97

CA 12 8 3.85e-10  
CB 15 14 4.15e-10  
CIN 6 8 3.17e-10

DBODY 7 5 DBODYMOD  
DBREAK 5 11 DBREAKMOD  
DPLCAP 10 5 DPLCAPMOD

EBREAK 11 7 17 18 59.22  
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

LDRAIN 2 5 1e-9  
LGATE 1 9 2.24e-9  
LSOURCE 3 7 2.09e-9

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 9.1e-3  
RGATE 9 20 1.27  
RLDRAIN 2 5 10  
RLGATE 1 9 22.4  
RLSOURCE 3 7 20.9  
RSLC1 5 51 RSLCMOD 1e-6  
RSLC2 5 50 1e3  
RSOURCE 8 7 RSOURCEMOD 4.0e-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

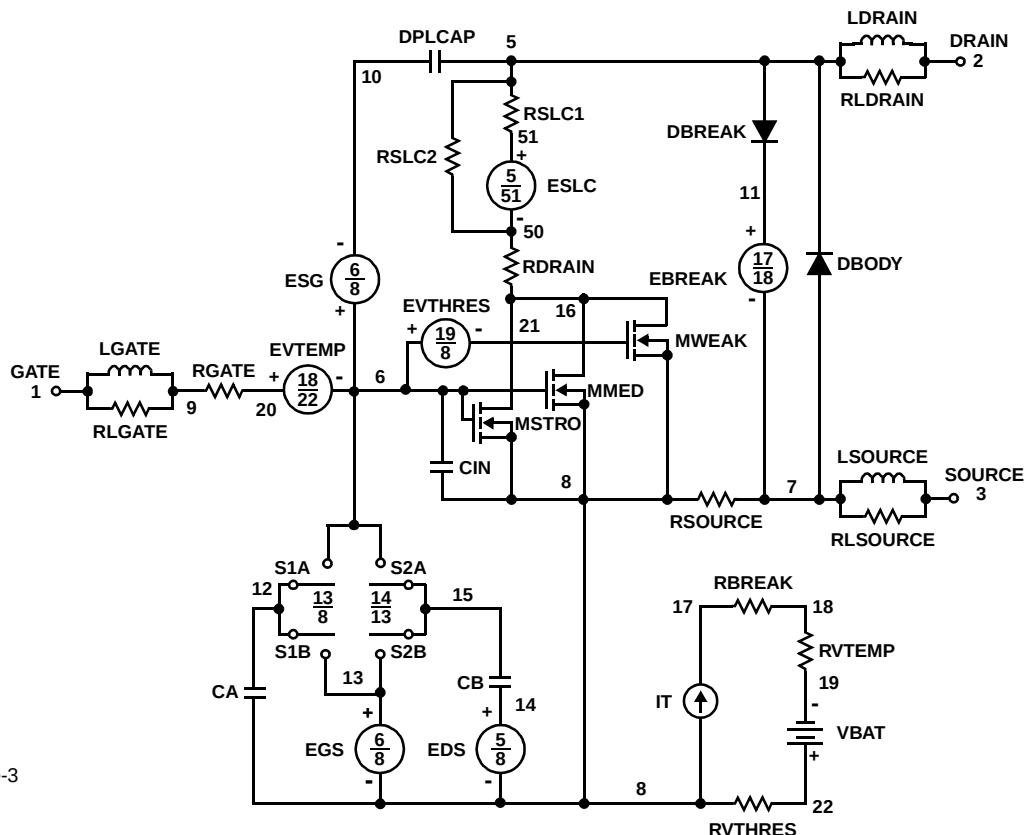
ESLC 51 50 VALUE={(V(5,51)/ABS(V(5,51)))\*(PWR(V(5,51)/(1e-6\*43),4.5))}

.MODEL DBODYMOD D (IS = 3.0e-13 RS = 1.04e-2 TRS1 = 1.89e-3 TRS2 = 0 CJO = 5.25e-10 TT = 3.09e-8 M = 0.5)  
.MODEL DBREAKMOD D (RS = 2.66e-1 TRS1 = 1.31e-4 TRS2 = 1.34e-5)  
.MODEL DPLCAPMOD D (CJO = 3.8e-10 IS = 1e-30 ON = 10 M = 0.79)  
.MODEL MMEDMOD NMOS (VTO = 3.45 KP = 2 IS = 1e-30 N = 10 TOX = 1 L = 1u W = 1u RG = 1.27)  
.MODEL MSTROMOD NMOS (VTO = 3.95 KP = 19 IS = 1e-30 N = 10 TOX = 1 L = 1u W = 1u)  
.MODEL MWEAKMOD NMOS (VTO = 3.05KP = 0.05 IS = 1e-30 N = 10 TOX = 1 L = 1u W = 1u RG = 12.7 RS = 0.1)  
.MODEL RBREAKMOD RES (TC1 = 1.05e-3 TC2 = 1.21e-7)  
.MODEL RDRAINMOD RES (TC1 = 3.1e-2 TC2 = 3.7e-5)  
.MODEL RSLCMOD RES (TC1 = 2.71e-3 TC2 = 1.07e-5)  
.MODEL RSOURCEMOD RES (TC1 = 0 TC2 = 0)  
.MODEL RVTHRESMOD RES (TC = -3.31e-3 TC2 = -4.31e-6)  
.MODEL RVTEMPMOD RES (TC1 = -1.62e-3 TC2 = 1.29e-6)

.MODEL S1AMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = -6.0 VOFF = -3.0)  
.MODEL S1BMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = -3.0 VOFF = -6.0)  
.MODEL S2AMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = 1.9 VOFF = 4.9)  
.MODEL S2BMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = 4.9 VOFF = 1.9)

.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 February 1999

HUFA75309

CTHERM1 th 6 8e-4  
 CHERM2 6 5 1e-3  
 CHERM3 5 4 2e-3  
 CHERM4 4 3 2.8e-3  
 CHERM5 3 2 5.5e-3  
 CHERM6 2 tl 1.6e-2

RHERM1 th 6 1e-3  
 RHERM2 6 5 7e-3  
 RHERM3 5 4 9e-2  
 RHERM4 4 3 4e-1  
 RHERM5 3 2 6e-1  
 RHERM6 2 tl 9.5e-1

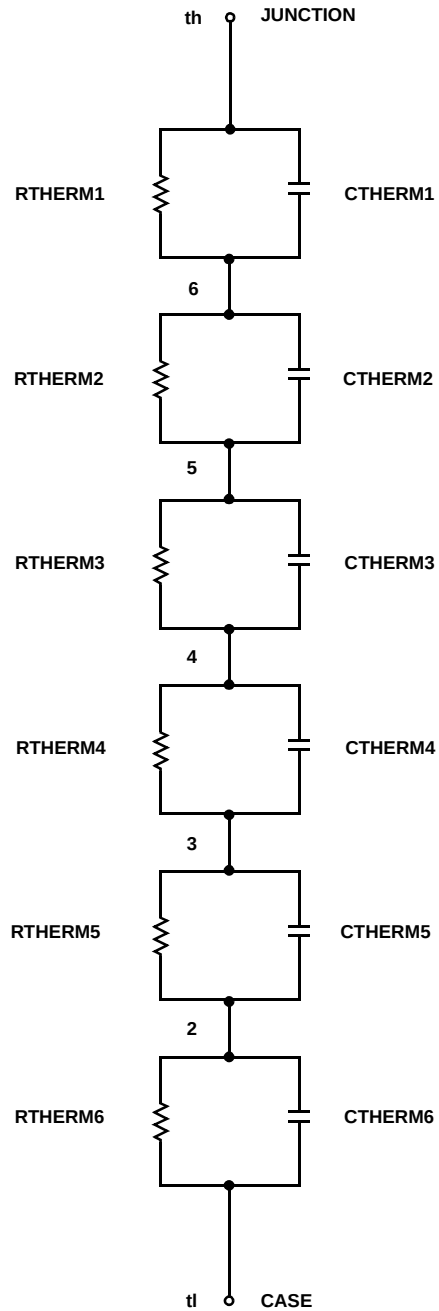
## SABER Thermal Model

SABER thermal model HUFA75309

template thermal\_model th tl  
 thermal\_c th, tl

```
{
    ctherm.therm1 th 6 = 8e-4
    ctherm.therm2 6 5 = 1e-3
    ctherm.therm3 5 4 = 2e-3
    ctherm.therm4 4 3 = 2.8e-3
    ctherm.therm5 3 2 = 5.5e-3
    ctherm.therm6 2 tl = 1.6e-2
```

```
rtherm.rtherm1 th 6 = 1e-3
rtherm.rtherm2 6 5 = 7e-3
rtherm.rtherm3 5 4 = 9e-2
rtherm.rtherm4 4 3 = 4e-1
rtherm.rtherm5 3 2 = 6e-1
rtherm.rtherm6 2 tl = 9.5e-1
}
```



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|                                   |                                  |                                  |                              |                   |
|-----------------------------------|----------------------------------|----------------------------------|------------------------------|-------------------|
| ACE <sup>Ex</sup> <sup>TM</sup>   | FAST <sup>®</sup>                | OPTOLOGIC <sup>TM</sup>          | SMART START <sup>TM</sup>    | VCX <sup>TM</sup> |
| Bottomless <sup>TM</sup>          | FAST <sup>r</sup> <sup>TM</sup>  | OPTOPLANAR <sup>TM</sup>         | STAR*POWER <sup>TM</sup>     |                   |
| CoolFET <sup>TM</sup>             | FRFET <sup>TM</sup>              | PACMAN <sup>TM</sup>             | Stealth <sup>TM</sup>        |                   |
| CROSSVOLT <sup>TM</sup>           | GlobalOptoisolator <sup>TM</sup> | POP <sup>TM</sup>                | SuperSOT <sup>TM</sup> -3    |                   |
| DenseTrench <sup>TM</sup>         | GTO <sup>TM</sup>                | Power247 <sup>TM</sup>           | SuperSOT <sup>TM</sup> -6    |                   |
| DOME <sup>TM</sup>                | HiSeC <sup>TM</sup>              | PowerTrench <sup>®</sup>         | SuperSOT <sup>TM</sup> -8    |                   |
| EcoSPARK <sup>TM</sup>            | ISOPLANAR <sup>TM</sup>          | QFET <sup>TM</sup>               | SyncFET <sup>TM</sup>        |                   |
| E <sup>2</sup> CMOS <sup>TM</sup> | LittleFET <sup>TM</sup>          | QS <sup>TM</sup>                 | TinyLogic <sup>TM</sup>      |                   |
| EnSigna <sup>TM</sup>             | MicroFET <sup>TM</sup>           | QT Optoelectronics <sup>TM</sup> | TruTranslation <sup>TM</sup> |                   |
| FACT <sup>TM</sup>                | MicroPak <sup>TM</sup>           | Quiet Series <sup>TM</sup>       | UHC <sup>TM</sup>            |                   |
| FACT Quiet Series <sup>TM</sup>   | MICROWIRE <sup>TM</sup>          | SILENT SWITCHER <sup>®</sup>     | UltraFET <sup>®</sup>        |                   |

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2. A critical component is 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.                                                                                    |
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