

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

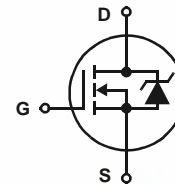
| PART NUMBER | PACKAGE | BRAND |
|--------------|----------|--------|
| HUFA75309P3 | TO-220AB | 75309P |
| HUFA75309D3 | TO-251AA | 75309D |
| HUFA75309D3S | TO-252AA | 75309D |

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.

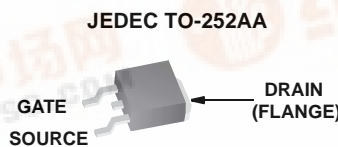
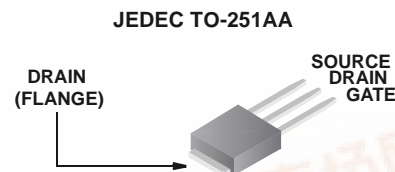
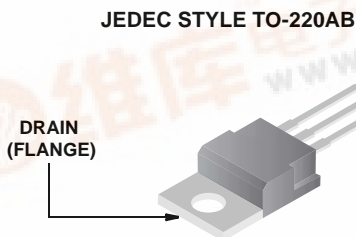
Features

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

Symbol



Packaging



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, HUFA75309D3S | UNITS |
|---|---|---------------------|
| Drain to Source Voltage (Note 1) | V_{DSS} 55 | V |
| Drain to Gate Voltage ($R_{GS} = 20k\Omega$) (Note 1) | V_{DGR} 55 | V |
| Gate to Source Voltage | V_{GS} ± 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°C | 0.37 | 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:

- $T_J = 25^\circ\text{C}$ to 150°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_{DSS} | $I_D = 250\mu\text{A}, V_{GS} = 0\text{V}$ (Figure 11) | 55 | - | - | V | |
| Zero Gate Voltage Drain Current | I_{DSS} | $V_{DS} = 50\text{V}, V_{GS} = 0\text{V}$ | - | - | 1 | μA | |
| | | $V_{DS} = 45\text{V}, V_{GS} = 0\text{V}, T_C = 150^\circ\text{C}$ | - | - | 250 | μA | |
| Gate to Source Leakage Current | I_{GSS} | $V_{GS} = \pm 20\text{V}$ | - | - | ± 100 | nA | |
| ON STATE SPECIFICATIONS | | | | | | | |
| Gate to Source Threshold Voltage | $V_{GS(TH)}$ | $V_{GS} = V_{DS}, I_D = 250\mu\text{A}$ (Figure 10) | 2 | - | 4 | V | |
| Drain to Source On Resistance | $r_{DS(ON)}$ | $I_D = 19\text{A}, V_{GS} = 10\text{V}$ (Figure 9) | - | 0.060 | 0.070 | Ω | |
| THERMAL SPECIFICATIONS | | | | | | | |
| Thermal Resistance Junction to Case | $R_{\theta JC}$ | (Figure 3) | - | - | 2.7 | $^\circ\text{C}/\text{W}$ | |
| Thermal Resistance Junction to Ambient | $R_{\theta JA}$ | TO-220 | - | - | 62 | $^\circ\text{C}/\text{W}$ | |
| | | TO-251, TO-252 | - | - | 100 | $^\circ\text{C}/\text{W}$ | |
| SWITCHING SPECIFICATIONS ($V_{GS} = 10\text{V}$) | | | | | | | |
| Turn-On Time | t_{ON} | $V_{DD} = 30\text{V}, I_D \cong 19\text{A},$ $R_L = 1.58\Omega, V_{GS} = 10\text{V},$ $R_{GS} = 27\Omega$ | - | - | 70 | ns | |
| Turn-On Delay Time | $t_{d(ON)}$ | | - | 7 | - | ns | |
| Rise Time | t_r | | - | 39 | - | ns | |
| Turn-Off Delay Time | $t_{d(OFF)}$ | | - | 24 | - | ns | |
| Fall Time | t_f | | - | 30 | - | ns | |
| Turn-Off Time | t_{OFF} | | - | - | 80 | ns | |
| GATE CHARGE SPECIFICATIONS | | | | | | | |
| Total Gate Charge | $Q_{g(TOT)}$ | $V_{GS} = 0\text{V}$ to 20V | $V_{DD} = 30\text{V},$ $I_D \cong 19\text{A},$ $R_L = 1.58\Omega$ $I_{g(REF)} = 1.0\text{mA}$ (Figure 13) | - | 20 | 24 | nC |
| Gate Charge at 10V | $Q_{g(10)}$ | $V_{GS} = 0\text{V}$ to 10V | | - | 11 | 13.5 | nC |
| Threshold Gate Charge | $Q_{g(TH)}$ | $V_{GS} = 0\text{V}$ to 2V | | - | 0.68 | 0.85 | nC |
| Gate to Source Gate Charge | Q_{gs} | | | - | 1.8 | - | nC |
| Reverse Transfer Capacitance | Q_{gd} | | | - | 5 | - | nC |

HUFA75309P3, HUFA75309D3, HUFA75309D3S

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

| PARAMETER | SYMBOL | TEST CONDITIONS | MIN | TYP | MAX | UNITS |
|-----------------------------------|-----------|--|-----|-----|-----|-------|
| CAPACITANCE SPECIFICATIONS | | | | | | |
| Input Capacitance | C_{ISS} | $V_{DS} = 25\text{V}, V_{GS} = 0\text{V},$ $f = 1\text{MHz}$ (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

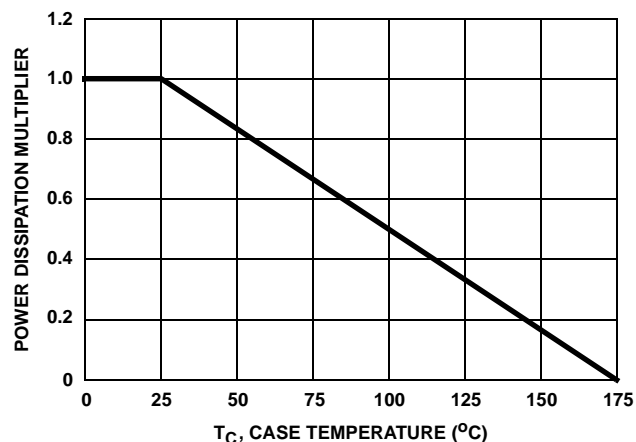


FIGURE 1. NORMALIZED POWER DISSIPATION vs CASE TEMPERATURE

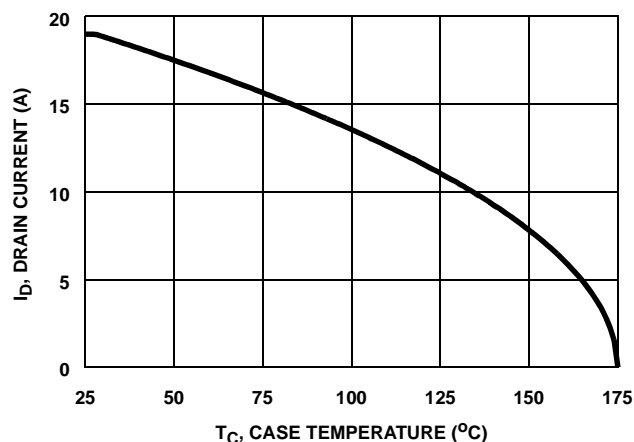


FIGURE 2. MAXIMUM CONTINUOUS DRAIN CURRENT vs CASE TEMPERATURE

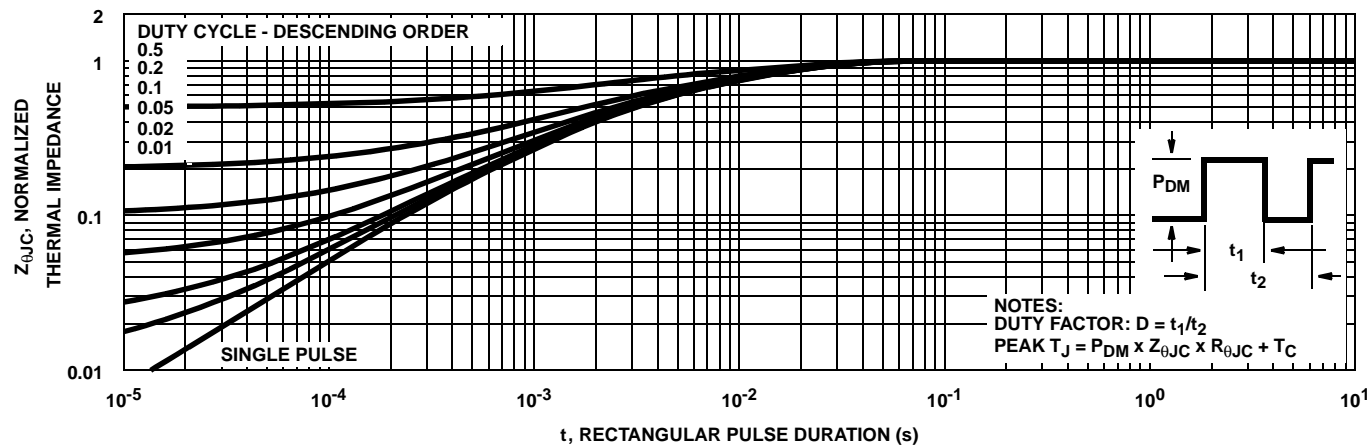


FIGURE 3. NORMALIZED MAXIMUM TRANSIENT THERMAL IMPEDANCE

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Typical Performance Curves (Continued)

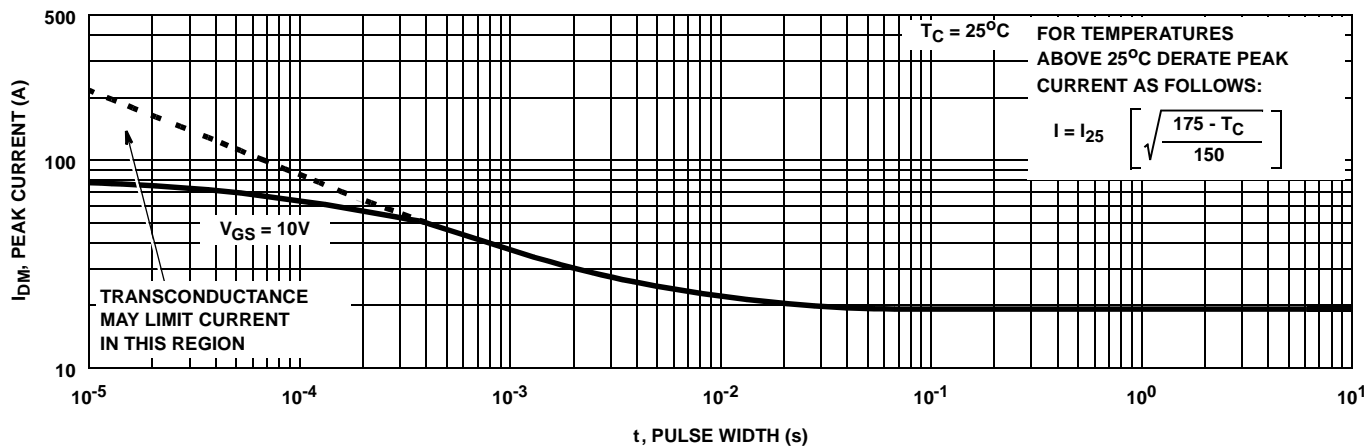


FIGURE 4. PEAK CURRENT CAPABILITY

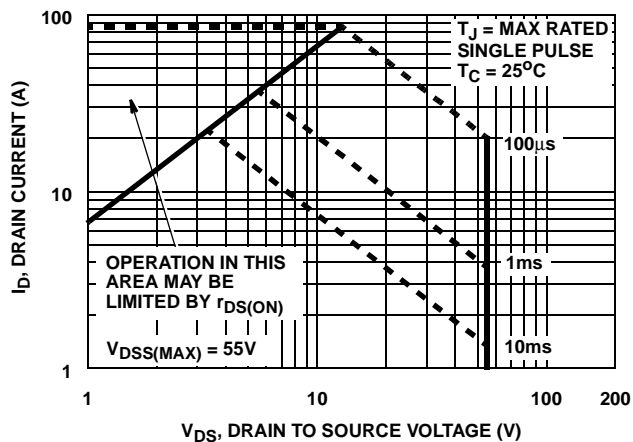
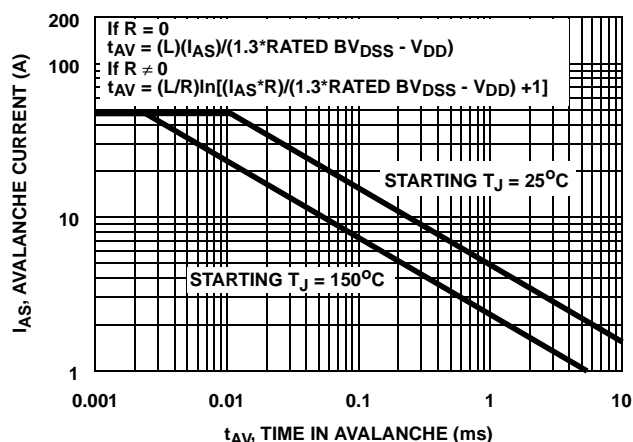


FIGURE 5. FORWARD BIAS SAFE OPERATING AREA



NOTE: Refer to Fairchild Application Notes AN9321 and AN9322.

FIGURE 6. UNCLAMPED INDUCTIVE SWITCHING CAPABILITY

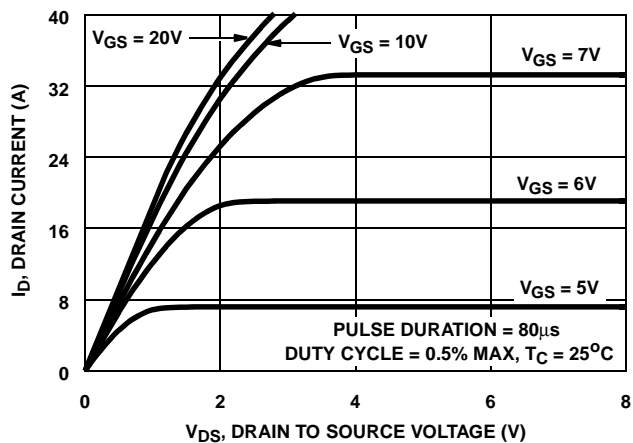


FIGURE 7. SATURATION CHARACTERISTICS

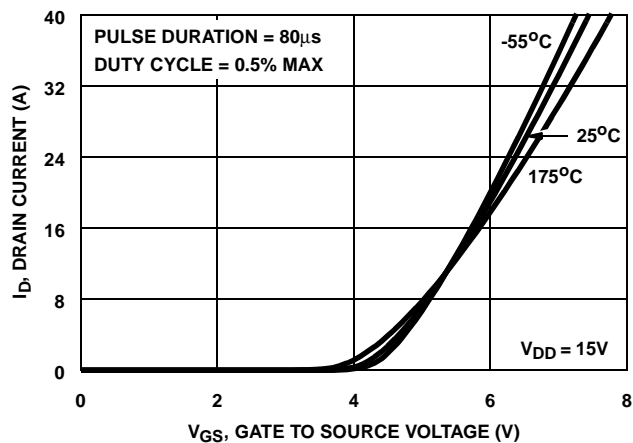


FIGURE 8. TRANSFER CHARACTERISTICS

HUFA75309P3, HUFA75309D3, HUFA75309D3S

Typical Performance Curves (Continued)

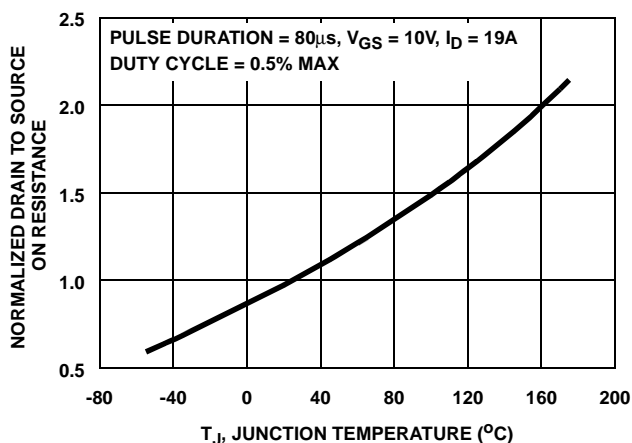


FIGURE 9. NORMALIZED DRAIN TO SOURCE ON RESISTANCE vs JUNCTION TEMPERATURE

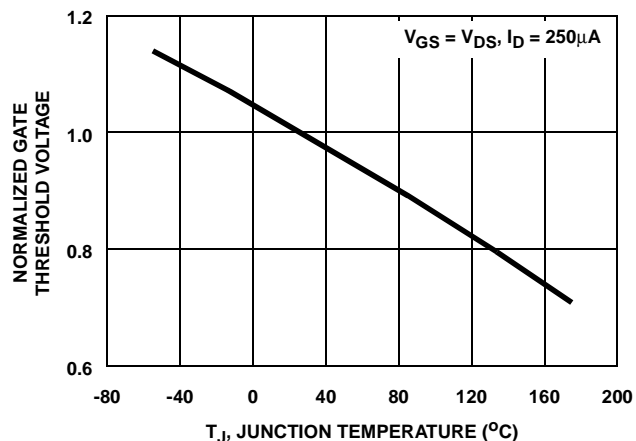


FIGURE 10. NORMALIZED GATE THRESHOLD VOLTAGE vs JUNCTION TEMPERATURE

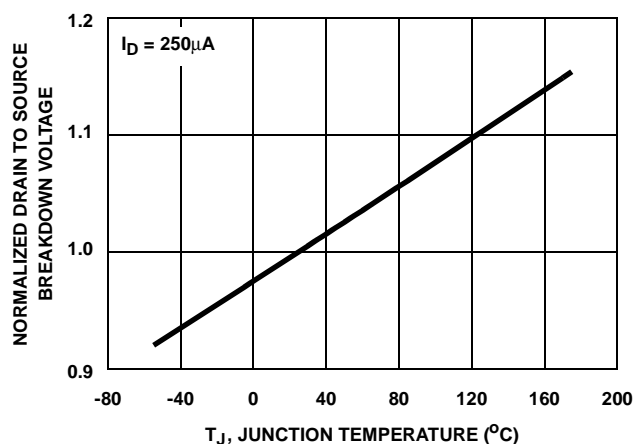


FIGURE 11. NORMALIZED DRAIN TO SOURCE BREAKDOWN VOLTAGE vs JUNCTION TEMPERATURE

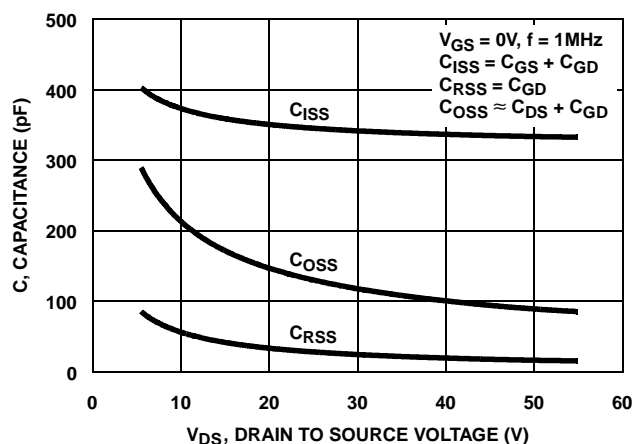
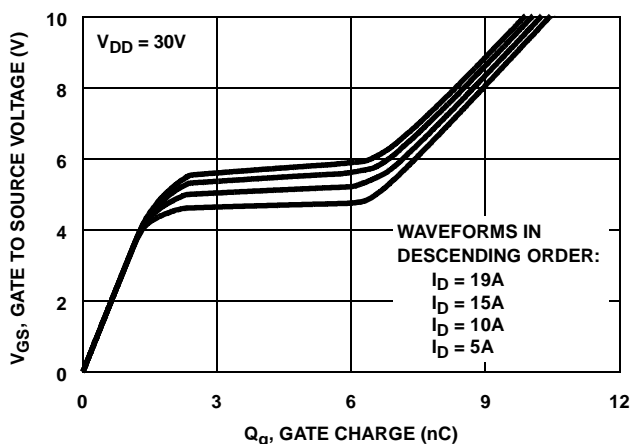


FIGURE 12. CAPACITANCE vs DRAIN TO SOURCE VOLTAGE



NOTE: Refer to Fairchild Application Notes AN7254 and AN7260.

FIGURE 13. GATE CHARGE WAVEFORMS FOR CONSTANT GATE CURRENT

Test Circuits and Waveforms

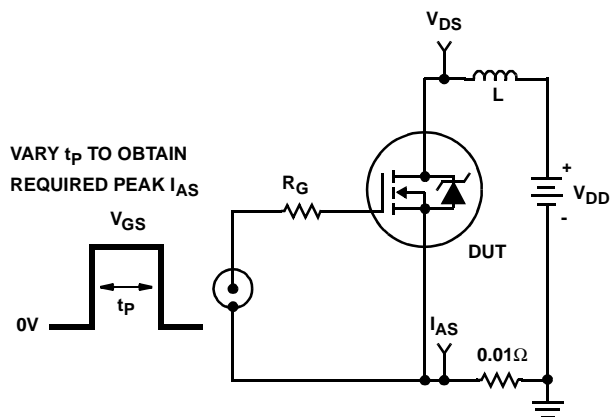


FIGURE 14. UNCLAMPED ENERGY TEST CIRCUIT

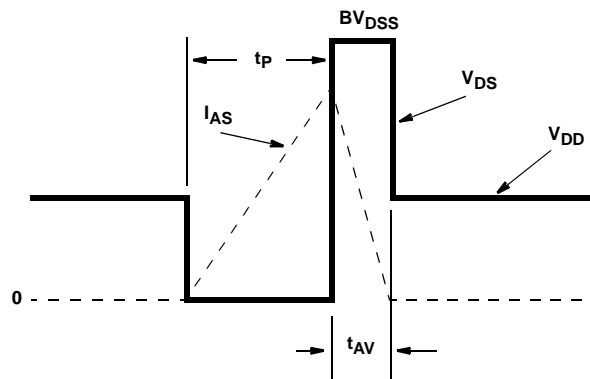


FIGURE 15. UNCLAMPED ENERGY WAVEFORMS

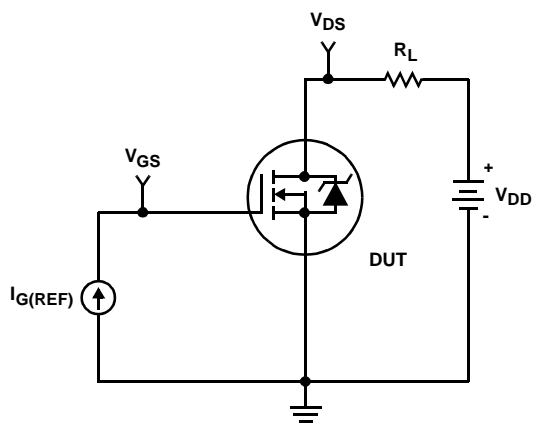


FIGURE 16. GATE CHARGE TEST CIRCUIT

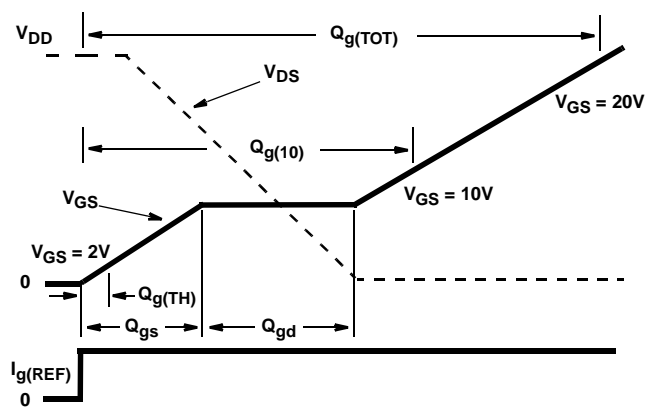


FIGURE 17. GATE CHARGE WAVEFORM

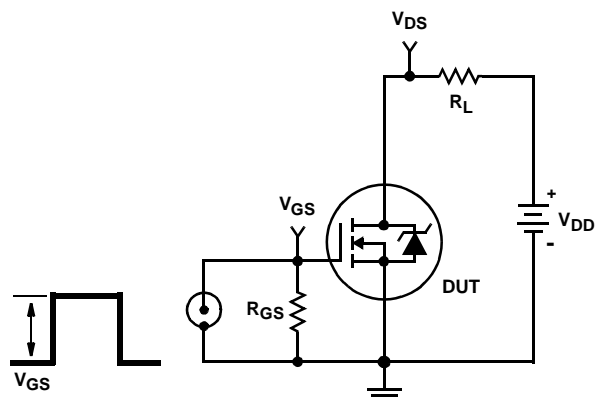


FIGURE 18. SWITCHING TIME TEST CIRCUIT

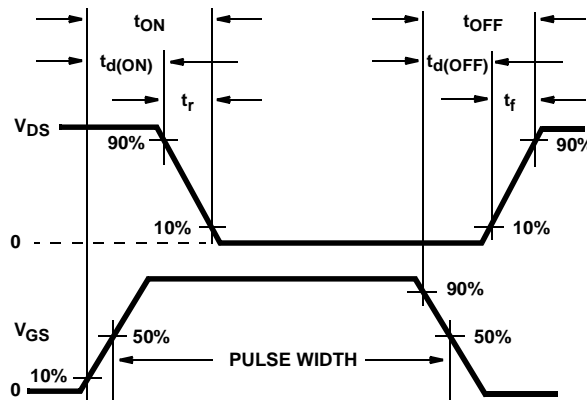


FIGURE 19. RESISTIVE SWITCHING WAVEFORMS

HUFA75309P3, HUFA75309D3, HUFA75309D3S

SABER Electrical Model

REV February 1999

template HUFA75309 n2, n1, n3
electrical n2, n1, n3

```
{
var i iscl
d..model dbodymod = (is = 3.0e-13, cjo = 5.25e-10, tt = 3.09e-8, m = 0.5)
d..model dbreakmod = ()
d..model dplcapmod = (cjo = 3.8e-10, is = 1e-30, n = 10, m = 0.79)
m..model mmedmod = (type=_n, vto = 3.45, kp = 2, is = 1e-30, tox = 1)
m..model mstrongmod = (type=_n, vto = 3.95, kp = 19, is = 1e-30, tox = 1)
m..model mweakmod = (type=_n, vto = 3.05, kp = 0.05, is = 1e-30, tox = 1)
sw_vcsp..model s1amod = (ron = 1e-5, roff = 0.1, von = -6.0, voff = -3.0)
sw_vcsp..model s1bmod = (ron = 1e-5, roff = 0.1, von = -3.0, voff = -6.0)
sw_vcsp..model s2amod = (ron = 1e-5, roff = 0.1, von = 1.9, voff = 4.9)
sw_vcsp..model s2bmod = (ron = 1e-5, roff = 0.1, von = 4.9, voff = 1.9)

```

```
c.ca n12 n8 = 3.85e-10
c.cb n15 n14 = 4.15e-10
c.cin n6 n8 = 3.17e-10

```

```
d.dbody n7 n71 = model=dbodymod
d.dbreak n72 n11 = model=dbreakmod
d.dplcap n10 n5 = model=dplcapmod

```

```
i.it n8 n17 = 1

```

```
l.ldrain n2 n5 = 1e-9
l.lgate n1 n9 = 2.24e-9
l.lsource n3 n7 = 2.09e-9

```

```
m.mmed n16 n6 n8 n8 = model=mmedmod, l = 1u, w = 1u
m.mstrong n16 n6 n8 n8 = model=mstrongmod, l = 1u, w = 1u
m.mweak n16 n21 n8 n8 = model=mweakmod, l = 1u, w = 1u

```

```
res.rbreak n17 n18 = 1, tc1 = 1.05e-3, tc2 = -1.21e-7
res.rbody n71 n5 = 1.04e-2, tc1 = 1.89e-3, tc2 = 0
res.rdbreak n72 n5 = 2.66e-1, tc1 = 1.31e-4, tc2 = 1.34e-5
res.rdrain n50 n16 = 9.1e-3, tc1 = 3.1e-2, tc2 = 3.7e-5
res.rgate n9 n20 = 1
res.rldrain n2 n5 = 10
res.rlgate n1 n9 = 22.4
res.rlsource n3 n7 = 20.9
res.rslc1 n5 n51 = 1e-6, tc1 = 2.71e-3, tc2 = 1.07e-5
res.rslc2 n5 n50 = 1e3
res.rsource n8 n7 = 4.0e-2, tc1 = 0, tc2 = 0
res.rvtemp n18 n19 = 1, tc1 = -1.62e-3, tc2 = 1.29e-6
res.rvthres n22 n8 = 1, tc1 = -3.31e-3, tc2 = -4.31e-6

```

```
spe.ebreak n11 n7 n17 n18 = 59.22
spe.eds n14 n8 n5 n8 = 1
spe.egs n13 n8 n6 n8 = 1
spe.esg n6 n10 n6 n8 = 1
spe.evtemp n20 n6 n18 n22 = 1
spe.evthres n6 n21 n19 n8 = 1

```

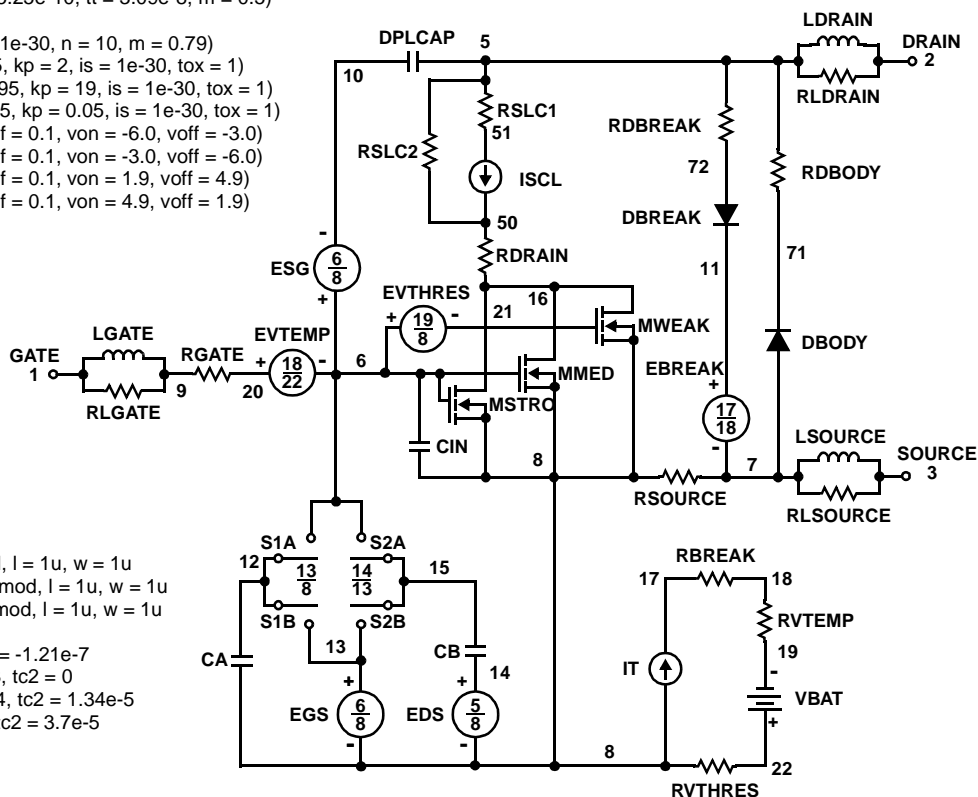
```
sw_vcsp.s1a n6 n12 n13 n8 = model=s1amod
sw_vcsp.s1b n13 n12 n13 n8 = model=s1bmod
sw_vcsp.s2a n6 n15 n14 n13 = model=s2amod
sw_vcsp.s2b n13 n15 n14 n13 = model=s2bmod

```

```
v.vbat n22 n19 = dc = 1

```

```
equations {
i (n51->n50) + = iscl
iscl: v(n51,n50) = (((v(n5,n51))/(1e-9+abs(v(n5,n51))))*((abs(v(n5,n51))*1e6/43)** 4.5))
}
}
```



HUFA75309P3, HUFA75309D3, HUFA75309D3S

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

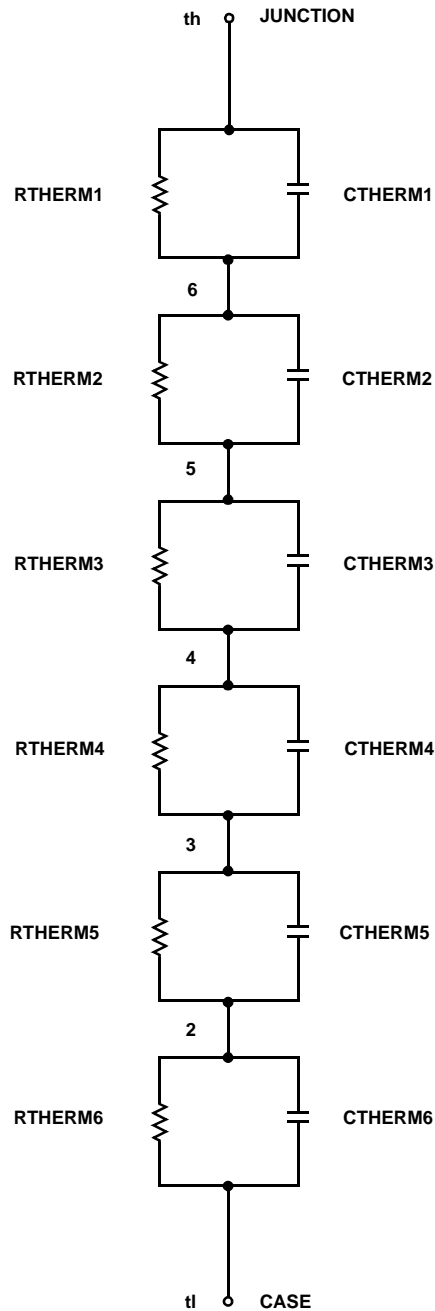
SABER Thermal Model

SABER thermal model HUFA75309

template thermal_model th tl
 thermal_c th, tl

```
{
ctherm.ctherm1 th 6 = 8e-4
ctherm.ctherm2 6 5 = 1e-3
ctherm.ctherm3 5 4 = 2e-3
ctherm.ctherm4 4 3 = 2.8e-3
ctherm.ctherm5 3 2 = 5.5e-3
ctherm.ctherm6 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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| Bottomless TM | FAST ^r TM | OPTOPLANAR TM | STAR*POWER TM | |
| CoolFET TM | FRFET TM | PACMAN TM | Stealth TM | |
| CROSSVOLT TM | GlobalOptoisolator TM | POP TM | SuperSOT TM -3 | |
| DenseTrench TM | GTO TM | Power247 TM | SuperSOT TM -6 | |
| DOME TM | HiSeC TM | PowerTrench [®] | SuperSOT TM -8 | |
| EcoSPARK TM | ISOPLANAR TM | QFET TM | SyncFET TM | |
| E ² CMOS TM | LittleFET TM | QS TM | TinyLogic TM | |
| EnSigna TM | MicroFET TM | QT Optoelectronics TM | TruTranslation TM | |
| FACT TM | MicroPak TM | Quiet Series TM | UHC TM | |
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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. |
| Preliminary | First Production | This datasheet contains preliminary data, and supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design. |
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