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Stocking Distributor

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[Fairchild Semiconductor](#)
[HUFA75321D3](#)

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sales@integrated-circuit.com

20A, 55V, 0.036 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 TA75321.

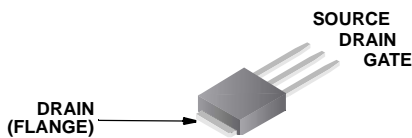
Ordering Information

| PART NUMBER | PACKAGE | BRAND |
|--------------|----------|--------|
| HUFA75321D3 | TO-251AA | 75321D |
| HUFA75321D3S | TO-252AA | 75321D |

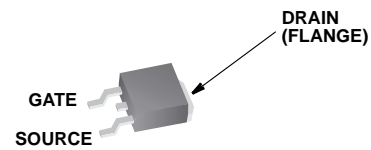
NOTE: When ordering, use the entire part number. Add the suffix T to obtain the TO-251AA variant in tape and reel, e.g., HUFA75321D3ST.

Packaging

JEDEC TO-251AA



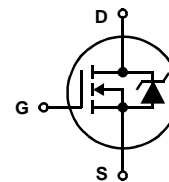
JEDEC TO-252AA



Features

- 20A, 55V
- Simulation Models
 - Temperature Compensating PSPICE® and SABER™ Models
 - Thermal Impedance SPICE and SABER 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



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.

HUFA75321D3, HUFA75321D3S

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

| | | | 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 | 20 | A |
| Pulsed Drain Current | I_{DM} | Figure 4 | |
| Pulsed Avalanche Rating | E_{AS} | Figures 6, 14, 15 | |
| Power Dissipation | P_D | 93 | W |
| Derate Above 25°C | | 0.625 | $\text{W}/^{\circ}\text{C}$ |
| 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:

- $T_J = 25^{\circ}\text{C}$ 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 | $r_{DS(ON)}$ | $I_D = 20\text{A}, V_{GS} = 10\text{V}$ (Figure 9) | - | 0.030 | 0.036 | Ω | |
| THERMAL SPECIFICATIONS | | | | | | | |
| Thermal Resistance Junction to Case | $R_{\theta JC}$ | (Figure 3) | - | - | 1.6 | $^{\circ}\text{C}/\text{W}$ | |
| Thermal Resistance Junction to Ambient | $R_{\theta JA}$ | TO-251, TO-252 | - | - | 100 | $^{\circ}\text{C}/\text{W}$ | |
| SWITCHING SPECIFICATIONS ($V_{GS} = 10\text{V}$) | | | | | | | |
| Turn-On Time | t_{ON} | $V_{DD} = 30\text{V}, I_D \cong 20\text{A}, R_L = 1.5\Omega, V_{GS} = 10\text{V}, R_{GS} = 25\Omega$ | - | - | 100 | ns | |
| Turn-On Delay Time | $t_{d(ON)}$ | | - | 11 | - | ns | |
| Rise Time | t_r | | - | 55 | - | ns | |
| Turn-Off Delay Time | $t_{d(OFF)}$ | | - | 47 | - | ns | |
| Fall Time | t_f | | - | 66 | - | ns | |
| Turn-Off Time | t_{OFF} | | - | - | 170 | ns | |
| GATE CHARGE SPECIFICATIONS | | | | | | | |
| Total Gate Charge | $Q_{g(TOT)}$ | $V_{GS} = 0\text{V}$ to 20V | $V_{DD} = 30\text{V}, I_D \cong 20\text{A}, R_L = 1.5\Omega, I_g(\text{REF}) = 1.0\text{mA}$ (Figure 13) | - | 36 | 44 | nC |
| Gate Charge at 10V | $Q_{g(10)}$ | $V_{GS} = 0\text{V}$ to 10V | | - | 21 | 26 | nC |
| Threshold Gate Charge | $Q_{g(TH)}$ | $V_{GS} = 0\text{V}$ to 2V | | - | 1.3 | 1.6 | nC |
| Gate to Source Gate Charge | Q_{gs} | | | - | 3 | - | nC |
| Reverse Transfer Capacitance | Q_{gd} | | | - | 9 | - | nC |

HUFA75321D3, HUFA75321D3S

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) | - | 680 | - | pF |
| Output Capacitance | C_{OSS} | | - | 270 | - | pF |
| Reverse Transfer Capacitance | C_{RSS} | | - | 60 | - | pF |

Source to Drain Diode Specifications

| PARAMETER | SYMBOL | TEST CONDITIONS | MIN | TYP | MAX | UNITS |
|-------------------------------|----------|--|-----|-----|------|-------|
| Source to Drain Diode Voltage | V_{SD} | $I_{SD} = 20\text{A}$ | - | - | 1.25 | V |
| Reverse Recovery Time | t_{rr} | $I_{SD} = 20\text{A}$, $dI_{SD}/dt = 100\text{A}/\mu\text{s}$ | - | - | 59 | ns |
| Reverse Recovered Charge | Q_{RR} | $I_{SD} = 20\text{A}$, $dI_{SD}/dt = 100\text{A}/\mu\text{s}$ | - | - | 82 | nC |

Typical Performance Curves

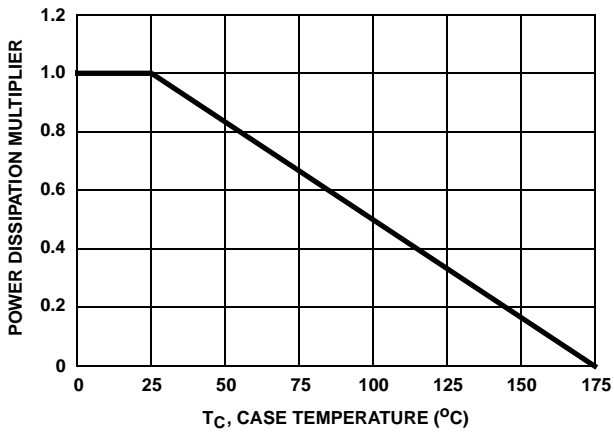


FIGURE 1. NORMALIZED POWER DISSIPATION vs CASE TEMPERATURE

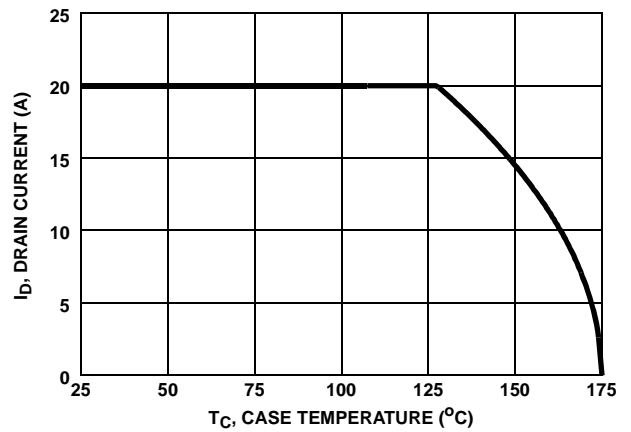


FIGURE 2. MAXIMUM CONTINUOUS DRAIN CURRENT vs CASE TEMPERATURE

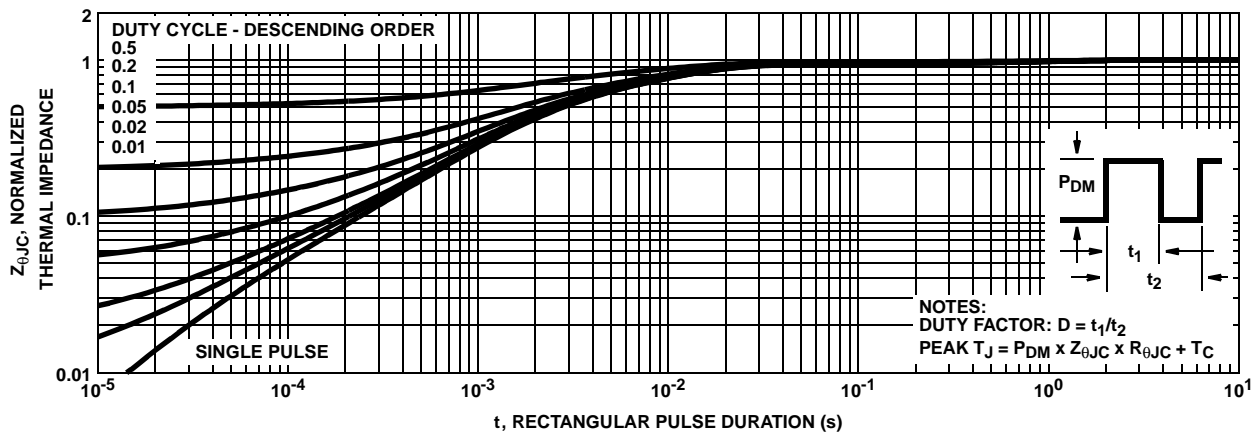


FIGURE 3. NORMALIZED MAXIMUM TRANSIENT THERMAL IMPEDANCE

HUFA75321D3, HUFA75321D3S

Typical Performance Curves (Continued)

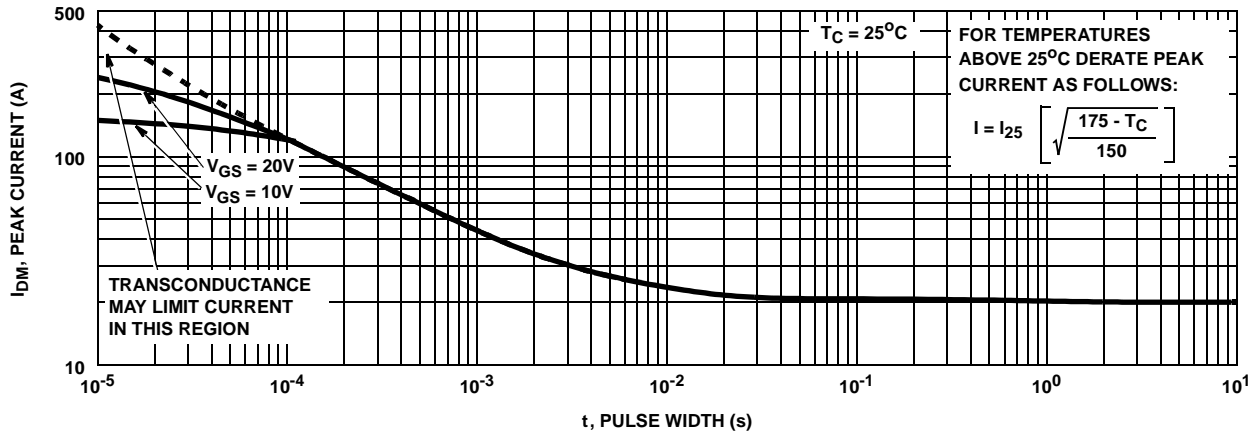


FIGURE 4. PEAK CURRENT CAPABILITY

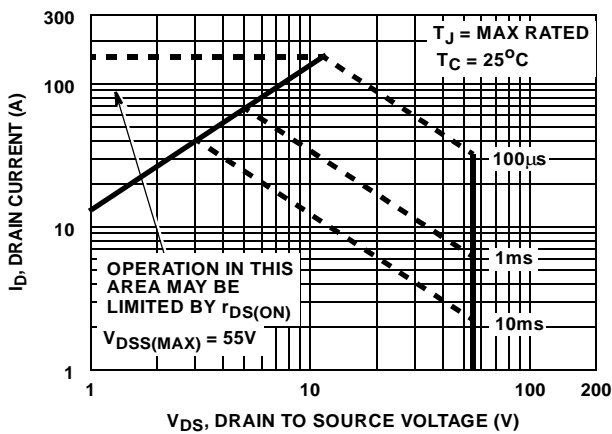
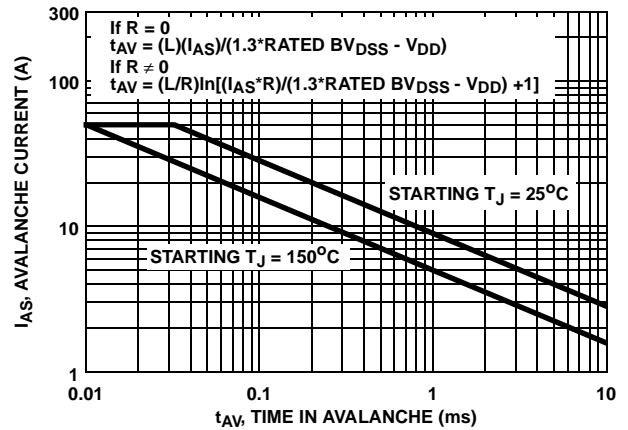


FIGURE 5. FORWARD BIAS SAFE OPERATING AREA



NOTE: Refer to Fairchild Application Notes AN9321 and AN9322.

FIGURE 6. UNCLAMPED INDUCTIVE SWITCHING CAPABILITY

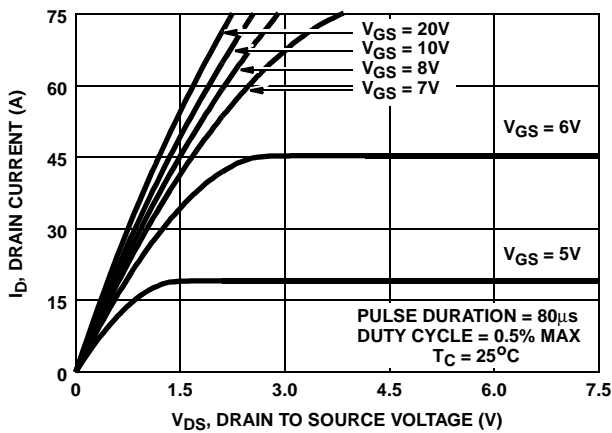


FIGURE 7. SATURATION CHARACTERISTICS

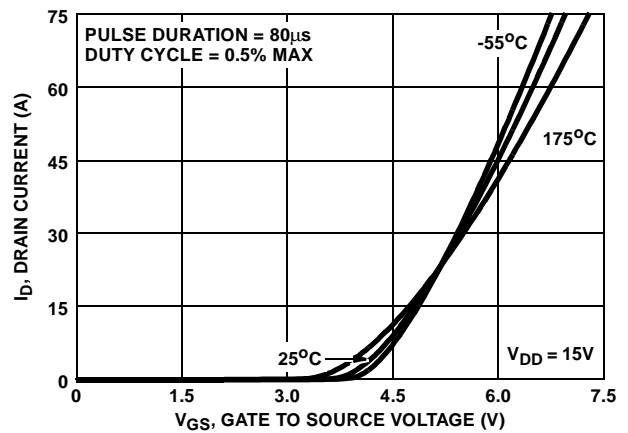


FIGURE 8. TRANSFER CHARACTERISTICS

HUFA75321D3, HUFA75321D3S

Typical Performance Curves (Continued)

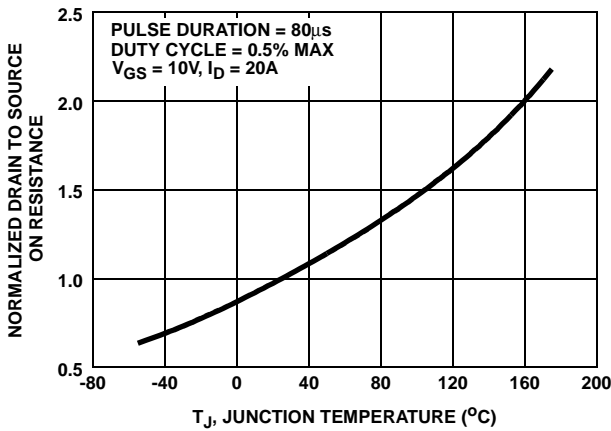


FIGURE 9. NORMALIZED DRAIN TO SOURCE ON RESISTANCE vs JUNCTION TEMPERATURE

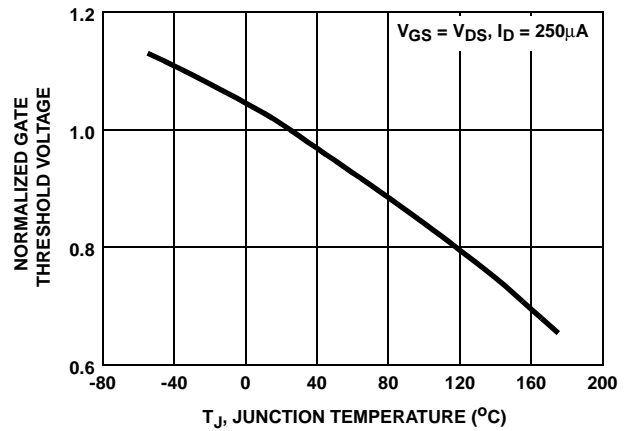


FIGURE 10. NORMALIZED GATE THRESHOLD VOLTAGE vs JUNCTION TEMPERATURE

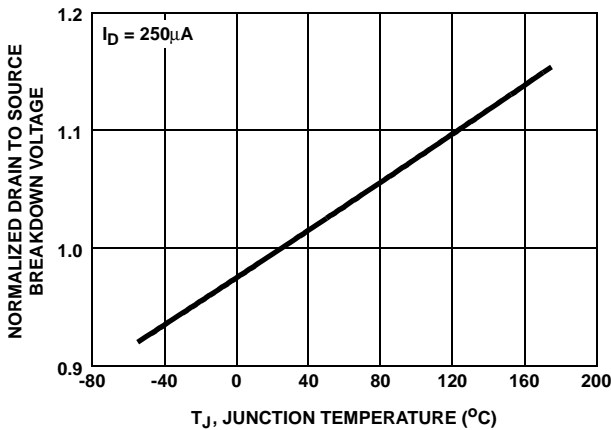


FIGURE 11. NORMALIZED DRAIN TO SOURCE BREAKDOWN VOLTAGE vs JUNCTION TEMPERATURE

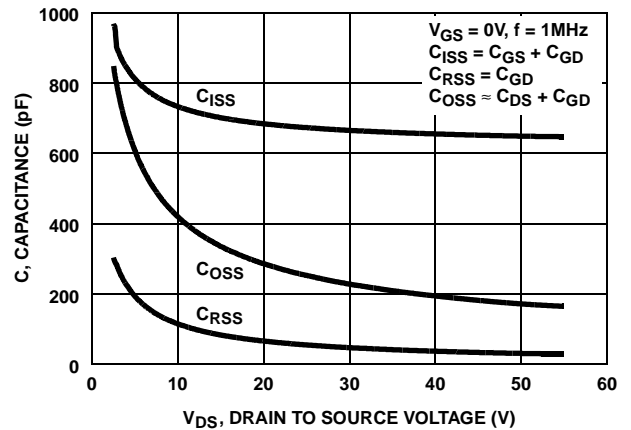
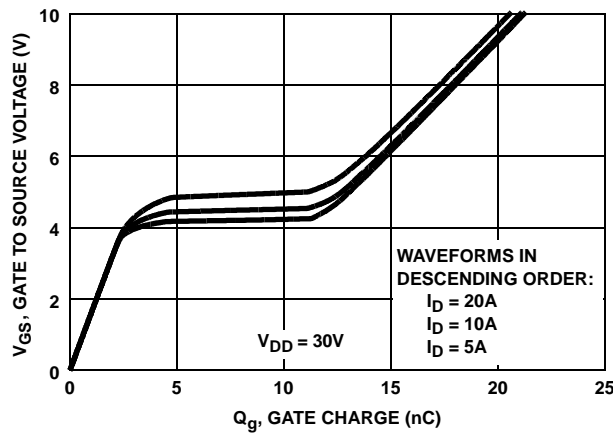


FIGURE 12. CAPACITANCE vs DRAIN TO SOURCE VOLTAGE



NOTE: Refer to Fairchild Application Notes AN7254 and AN7260.
FIGURE 13. GATE CHARGE WAVEFORMS FOR CONSTANT GATE CURRENT

HUFA75321D3, HUFA75321D3S

Test Circuits and Waveforms

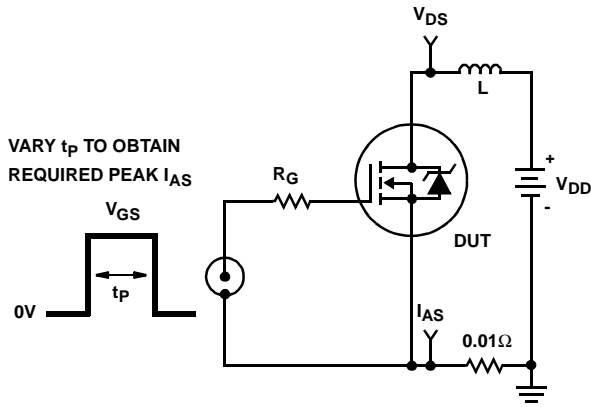


FIGURE 14. UNCLAMPED ENERGY TEST CIRCUIT

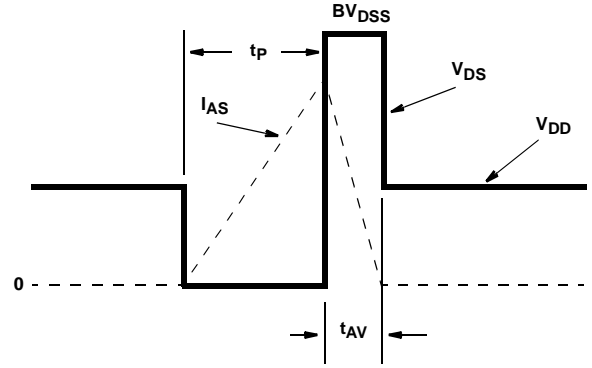


FIGURE 15. UNCLAMPED ENERGY WAVEFORMS

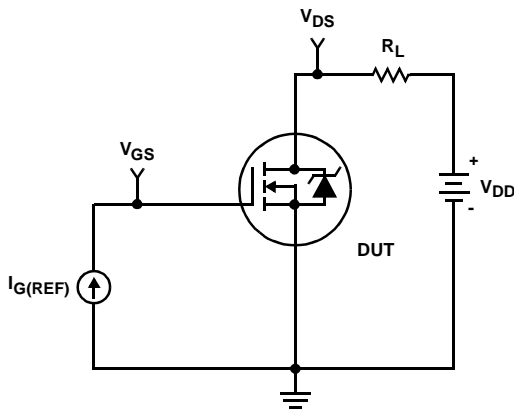


FIGURE 16. GATE CHARGE TEST CIRCUIT

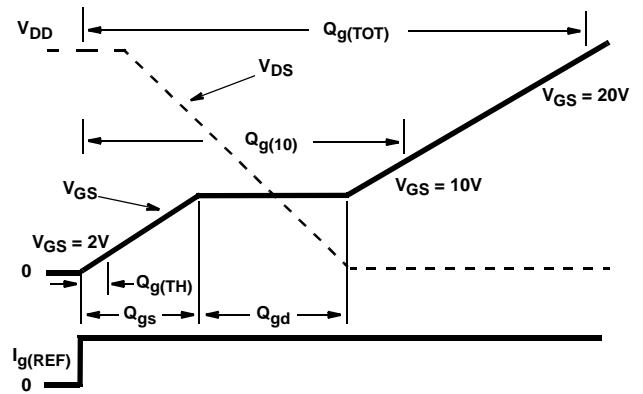


FIGURE 17. GATE CHARGE WAVEFORM

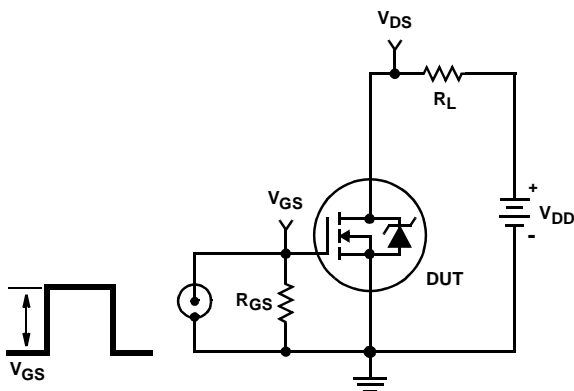


FIGURE 18. SWITCHING TIME TEST CIRCUIT

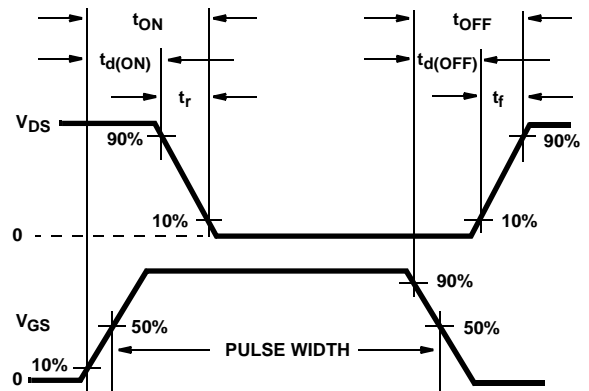


FIGURE 19. RESISTIVE SWITCHING WAVEFORMS

HUFA75321D3, HUFA75321D3S

PSPICE Electrical Model

.SUBCKT HUFA75321D 2 1 3 ; rev 4/29/98

CA 12 8 9.96e-10
 CB 15 14 9.83e-10
 CIN 6 8 6.18e-10

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

EBREAK 11 7 17 18 59.54
 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 3.57e-9
 LSOURCE 3 7 4.25e-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 5.50e-3
 RGATE 9 20 2.25
 RLDRAIN 2 5 10
 RLGATE 1 9 35.7
 RLSOURCE 3 7 42.5
 RSLC1 5 51 RSLCMOD 1e-6
 RSLC2 5 50 1e3
 RSOURCE 8 7 RSOURCEMOD 16.30e-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

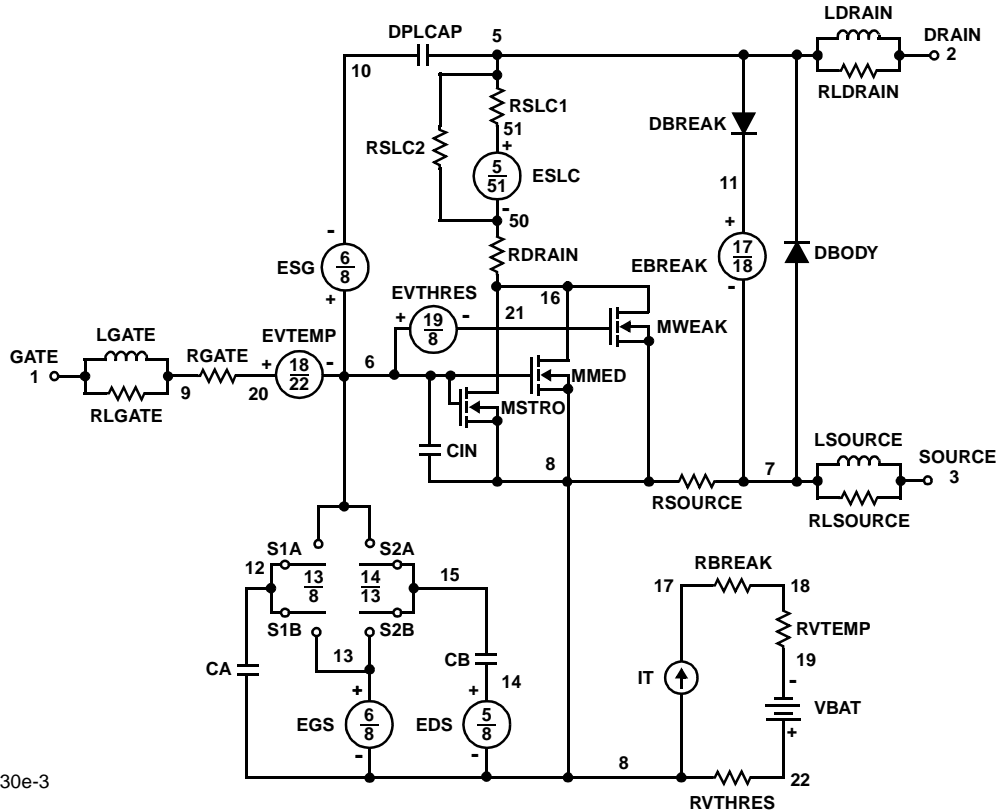
ESLC 51 50 VALUE={{(V(5,51)/ABS(V(5,51)))*(PWR(V(5,51))/(1e-6*101),2.5))}}

.MODEL DBODYMOD D (IS = 7.47e-13 RS = 6.45e-3 TRS1 = 2.01e-3 TRS2 = 1.21e-6 CJO = 1.02e-9 TT = 3.21e-8 M = 0.50)
 .MODEL DBREAKMOD D (RS = 2.01e-1 TRS1 = 3.62e-3 TRS2 = 6.01e-7)
 .MODEL DPLCAPMOD D (CJO = 9.0e-1 0IS = 1e-3 0N = 10 M = 0.85)
 .MODEL MMEDMOD NMOS (VTO = 3.25 KP = 1.75 IS = 1e-30 N = 10 TOX = 1 L = 1u W = 1u RG = 2.25)
 .MODEL MSTROMOD NMOS (VTO = 3.65 KP = 32.00 IS = 1e-30 N = 10 TOX = 1 L = 1u W = 1u)
 .MODEL MWEAKMOD NMOS (VTO = 2.91 KP = 0.07 IS = 1e-30 N = 10 TOX = 1 L = 1u W = 1u RG = 22.5 RS = 0.1)
 .MODEL RBREAKMOD RES (TC1 = 1.05e-3 TC2 = 1.21e-7)
 .MODEL RDRAINMOD RES (TC1 = 2.40e-2 TC2 = 1.02e-6)
 .MODEL RSLCMOD RES (TC1 = 2.07e-4 TC2 = 4.67e-5)
 .MODEL RSOURCEMOD RES (TC1 = 0 TC2 = 0)
 .MODEL RVTHRESMOD RES (TC = -3.01e-3 TC2 = -8.85e-6)
 .MODEL RVTEMPMOD RES (TC1 = -1.96e-3 TC2 = 1.39e-6)

.MODEL S1AMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = -7.85 VOFF = -4.85)
 .MODEL S1BMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = -4.85 VOFF = -7.85)
 .MODEL S2AMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = 0.00 VOFF = 3.00)
 .MODEL S2BMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = 3.00 VOFF = 0.00)

.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.



HUFA75321D3, HUFA75321D3S

SABER Electrical Model

REV April 1998

template HUFA75321d n2, n1, n3
 electrical n2, n1, n3

```
{
var i iscl
d..model dbodymod = (is = 7.47e-13, cjo = 1.02e-9, tt = 3.21e-8, m = 0.5)
d..model dbreakmod = ()
d..model dplcapmod = (cjo = 9e-10, is = 1e-30, n = 10, m = 0.85)
m..model mmedmod = (type=_n, vto = 3.25, kp = 1.75, is = 1e-30, tox = 1)
m..model mstrongmod = (type=_n, vto = 3.65, kp = 32, is = 1e-30, tox = 1)
m..model mweakmod = (type=_n, vto = 2.91, kp = 0.07, is = 1e-30, tox = 1)
sw_vcsp..model s1amod = (ron = 1e-5, roff = 0.1, von = -7.85, voff = -4.85)
sw_vcsp..model s1bmod = (ron = 1e-5, roff = 0.1, von = -4.85, voff = -7.85)
sw_vcsp..model s2amod = (ron = 1e-5, roff = 0.1, von = 0, voff = 3.0)
sw_vcsp..model s2bmod = (ron = 1e-5, roff = 0.1, von = 3.0, voff = 0)
```

```
c.ca n12 n8 = 9.96e-10
c.cb n15 n14 = 9.83e-10
c.cin n6 n8 = 6.18e-10
```

```
d.body n7 n71 = model=dbodymod
d.break n72 n11 = model=dbreakmod
d.dplcap n10 n5 = model=dplcapmod
```

```
i.it n8 n17 = 1
```

```
l.l drain n2 n5 = 1e-9
l.l gate n1 n9 = 3.57e-9
l.l source n3 n7 = 4.25e-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
```

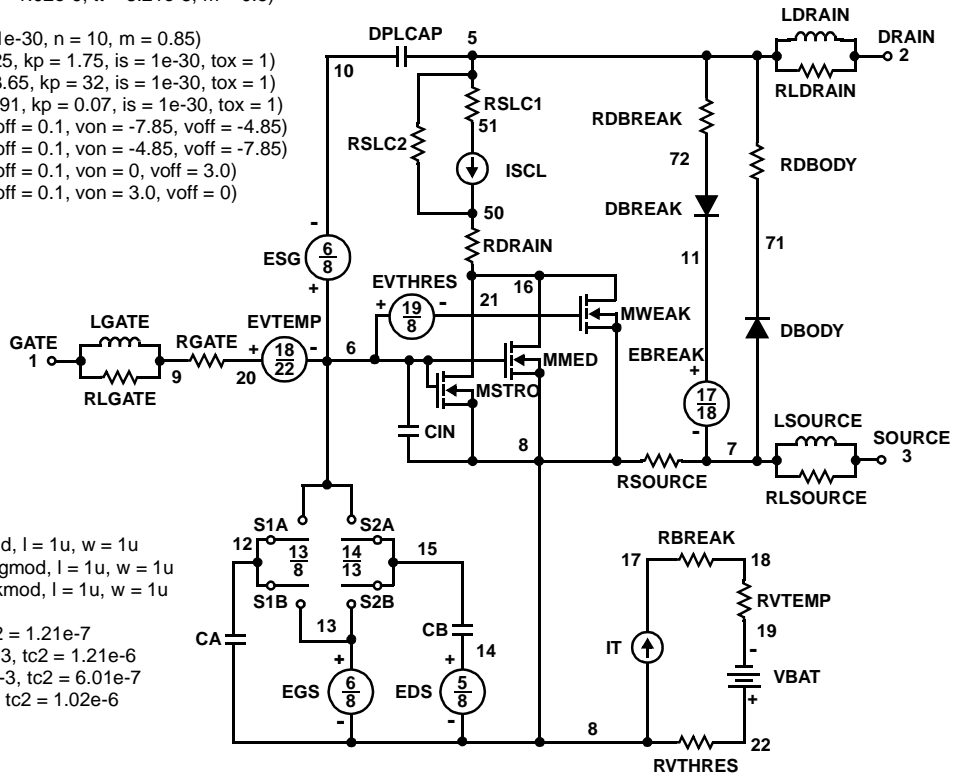
```
res.rbreak n17 n18 = 1, tc1 = 1.05e-3, tc2 = 1.21e-7
res.rbody n71 n5 = 6.45e-3, tc1 = 2.01e-3, tc2 = 1.21e-6
res.rdbreak n72 n5 = 2.01e-1, tc1 = 3.62e-3, tc2 = 6.01e-7
res.rdrain n50 n16 = 5.5e-3, tc1 = 2.4e-2, tc2 = 1.02e-6
res.rgate n9 n20 = 2.25
res.rldrain n2 n5 = 10
res.rlgate n1 n9 = 35.7
res.rlsource n3 n7 = 42.5
res.rslc1 n5 n51 = 1e-6, tc1 = 2.07e-4, tc2 = 4.67e-5
res.rslc2 n5 n50 = 1e3
res.rsource n8 n7 = 16.3e-3, tc1 = 0, tc2 = 0
res.rvtemp n18 n19 = 1, tc1 = -1.96e-3, tc2 = 1.39e-6
res.rvthres n22 n8 = 1, tc1 = -3.01e-3, tc2 = -8.85e-6
```

```
spe.ebreak n11 n7 n17 n18 = 59.54
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)*1e6/101))** 2.5)
}
}
```



HUFA75321D3, HUFA75321D3S

SPICE Thermal Model

REV 24 February 1999

HUFA75321D

CTHERM1 th 6 2.7e-3
 CTHERM2 6 5 3.7e-3
 CTHERM3 5 4 1.2e-2
 CTHERM4 4 3 3.8e-3
 CTHERM5 3 2 1.4e-2
 CTHERM6 2 tl 10.55

RTHERM1 th 6 1.10e-2
 RTHERM2 6 5 2.72e-2
 RTHERM3 5 4 7.67e-2
 RTHERM4 4 3 4.30e-1
 RTHERM5 3 2 6.49e-1
 RTHERM6 2 tl 8.61e-2

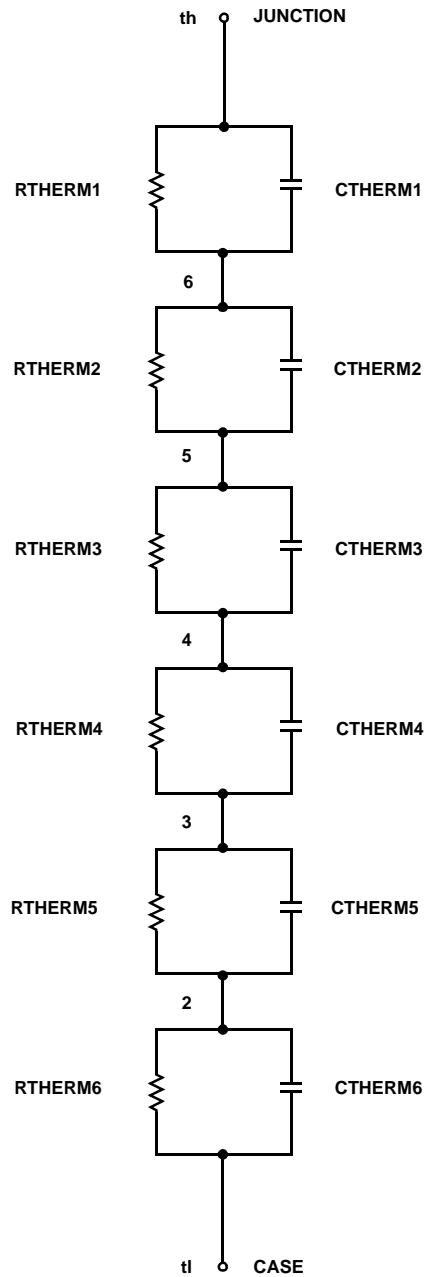
SABER Thermal Model

SABER thermal model HUFA75321D

template thermal_model th tl
 thermal_c th, tl

```
{
    ctherm.ctherm1 th 6 = 2.7e-3
    ctherm.ctherm2 6 5 = 3.7e-3
    ctherm.ctherm3 5 4 = 1.2e-2
    ctherm.ctherm4 4 3 = 3.8-3
    ctherm.ctherm5 3 2 = 1.4e-2
    ctherm.ctherm6 2 tl = 10.55
```

```
rtherm.rtherm1 th 6 = 1.10e-3
rtherm.rtherm2 6 5 = 2.72e-2
rtherm.rtherm3 5 4 = 7.67e-2
rtherm.rtherm4 4 3 = 4.30e-1
rtherm.rtherm5 3 2 = 6.49e-1
rtherm.rtherm6 2 tl = 8.61e-2
}
```



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| | | | | |
|---|----------------------------------|----------------------------------|------------------------------|-------------------|
| ACE ^x TM | FAST [®] | OPTOLOGIC TM | SMART START TM | VCX TM |
| 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 C ^{MOS} TM | LittleFET TM | QST TM | TinyLogic TM | |
| EnSigna TM | MicroFET TM | QT Optoelectronics TM | TruTranslation TM | |
| FACT TM | MicroPak TM | Quiet Series TM | UHC TM | |
| FACT Quiet Series TM | MICROWIRE TM | SILENT SWITCHER [®] | UltraFET [®] | |

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PRODUCT STATUS DEFINITIONS

Definition of Terms

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