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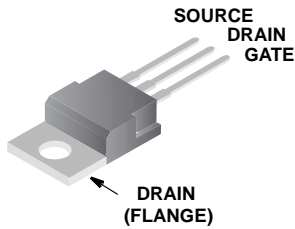## N-Channel UltraFET Power MOSFET
## 100 V, 75 A, 14 mΩ

### Packaging

**JEDEC TO-220AB**

SOURCE
DRAIN
GATE

DRAIN
(FLANGE)

**HUF75645P3**

**JEDEC TO-263AB**

DRAIN
(FLANGE)

GATE

SOURCE
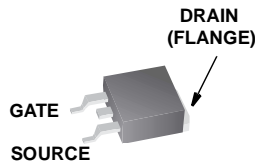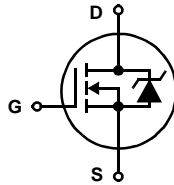
**HUF75645S3ST**

### Symbol

D

G

S

### Features

• Ultra Low On-Resistance
  - $r_{DS(ON)} = 0.014\Omega$, $V_{GS} = 10V$

• Simulation Models
  - Temperature Compensated PSPICE® and SABER™ Electrical Models
  - Spice and Saber Thermal Impedance Models
  - www.onsemi.com

• Peak Current vs Pulse Width Curve

• UIS Rating Curve

### Ordering Information

| PART NUMBER | PACKAGE | BRAND |
|---|---|---|
| HUF75645P3 | TO-220AB | 75645P |
| HUF75645S3ST | TO-263AB | 75645S |

## Absolute Maximum Ratings     $T_C = 25^oC$, Unless Otherwise Specified

| | HUF75645P3, HUF75645S3ST | UNITS |
|---|---|---|
| Drain to Source Voltage (Note 1) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . $V_{DSS}$ | 100 | V |
| Drain to Gate Voltage ($R_{GS} = 20k\Omega$) (Note 1) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . $V_{DGR}$ | 100 | V |
| Gate to Source Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . $V_{GS}$ | ±20 | V |
| Drain Current | | |
| Continuous ($T_C= 25^oC$, $V_{GS} = 10V$) (Figure 2) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . $I_D$ | 75 | A |
| Continuous ($T_C= 100^oC$, $V_{GS} = 10V$) (Figure 2) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . $I_D$ | 65 | A |
| Pulsed Drain Current . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . $I_{DM}$ | Figure 4 | |
| Pulsed Avalanche Rating . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . UIS | Figures 6, 14, 15 | |
| Power Dissipation . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . $P_D$ | 310 | W |
| Derate Above 25$^oC$ . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 2.07 | W/$^oC$ |
| Operating and Storage Temperature . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . $T_J, T_{STG}$ | -55 to 175 | $^oC$ |
| Maximum Temperature for Soldering | | |
| Leads at 0.063in (1.6mm) from Case for 10s. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . $T_L$ | 300 | $^oC$ |
| Package Body for 10s, See Techbrief TB334. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . $T_{pkg}$ | 260 | $^oC$ |

NOTES:

1. $T_J = 25^oC$ to 150$^oC$.

*CAUTION: Stresses above those listed in "Absol24ute 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.*

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

| PARAMETER | SYMBOL | TEST CONDITIONS | | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|---|
| **OFF STATE SPECIFICATIONS** | | | | | | | |
| Drain to Source Breakdown Voltage | $BV_{DSS}$ | $I_D = 250\mu A$, $V_{GS} = 0V$ (Figure 11) | | 100 | - | - | V |
| Zero Gate Voltage Drain Current | $I_{DSS}$ | $V_{DS} = 95V$, $V_{GS} = 0V$ | | - | - | 1 | μA |
| | | $V_{DS} = 90V$, $V_{GS} = 0V$, $T_C = 150^{\circ}C$ | | - | - | 250 | μA |
| Gate to Source Leakage Current | $I_{GSS}$ | $V_{GS} = \pm20V$ | | - | - | ±100 | nA |
| **ON STATE SPECIFICATIONS** | | | | | | | |
| Gate to Source Threshold Voltage | $V_{GS(TH)}$ | $V_{GS} = V_{DS}$, $I_D = 250\mu A$ (Figure 10) | | 2 | - | 4 | V |
| Drain to Source On Resistance | $r_{DS(ON)}$ | $I_D = 75A$, $V_{GS} = 10V$ (Figure 9) | | - | 0.0115 | 0.014 | Ω |
| **THERMAL SPECIFICATIONS** | | | | | | | |
| Thermal Resistance Junction to Case | $R_{\theta JC}$ | TO-220 and TO-263 | | - | - | 0.48 | $^{\circ}C/W$ |
| Thermal Resistance Junction to Ambient | $R_{\theta JA}$ | | | - | - | 62 | $^{\circ}C/W$ |
| **SWITCHING SPECIFICATIONS** ($V_{GS} = 10V$) | | | | | | | |
| Turn-On Time | $t_{ON}$ | $V_{DD} = 50V$, $I_D = 75A$ $V_{GS} = 10V$, $R_{GS} = 2.5\Omega$ (Figures 18, 19) | | - | - | 197 | ns |
| Turn-On Delay Time | $t_{d(ON)}$ | | | - | 14 | - | ns |
| Rise Time | $t_r$ | | | - | 117 | - | ns |
| Turn-Off Delay Time | $t_{d(OFF)}$ | | | - | 41 | - | ns |
| Fall Time | $t_f$ | | | - | 97 | - | ns |
| Turn-Off Time | $t_{OFF}$ | | | - | - | 207 | ns |
| **GATE CHARGE SPECIFICATIONS** | | | | | | | |
| Total Gate Charge | $Q_{g(TOT)}$ | $V_{GS} = 0V$ to $20V$ | $V_{DD} = 50V$, $I_D = 75A$, $I_{g(REF)} = 1.0mA$ (Figures 13, 16, 17) | - | 198 | 238 | nC |
| Gate Charge at 10V | $Q_{g(10)}$ | $V_{GS} = 0V$ to $10V$ | | - | 106 | 127 | nC |
| Threshold Gate Charge | $Q_{g(TH)}$ | $V_{GS} = 0V$ to $2V$ | | - | 6.8 | 8.2 | nC |
| Gate to Source Gate Charge | $Q_{gs}$ | | | - | 14 | - | nC |
| Gate to Drain "Miller" Charge | $Q_{gd}$ | | | - | 41 | - | nC |
| **CAPACITANCE SPECIFICATIONS** | | | | | | | |
| Input Capacitance | $C_{ISS}$ | $V_{DS} = 25V$, $V_{GS} = 0V$, f = 1MHz (Figure 12) | | - | 3790 | - | pF |
| Output Capacitance | $C_{OSS}$ | | | - | 810 | - | pF |
| Reverse Transfer Capacitance | $C_{RSS}$ | | | - | 230 | - | pF |

## Source to Drain Diode Specifications

| PARAMETER | SYMBOL | TEST CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| Source to Drain Diode Voltage | $V_{SD}$ | $I_{SD} = 75A$ | - | - | 1.25 | V |
| | | $I_{SD} = 35A$ | - | - | 1.00 | V |
| Reverse Recovery Time | $t_{rr}$ | $I_{SD} = 75A$, $dI_{SD}/dt = 100A/\mu s$ | - | - | 145 | ns |
| Reverse Recovered Charge | $Q_{RR}$ | $I_{SD} = 75A$, $dI_{SD}/dt = 100A/\mu s$ | - | - | 360 | nC |

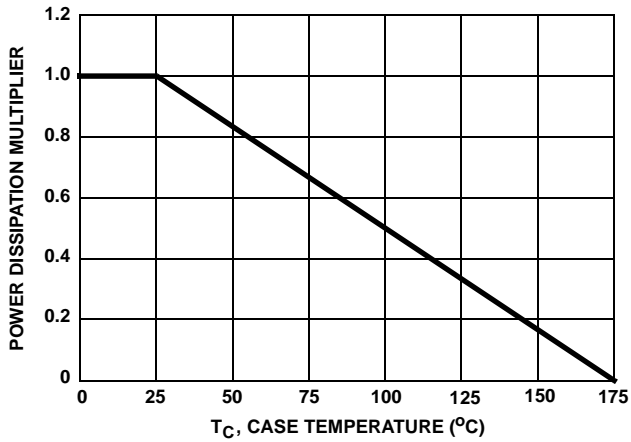## *Typical Performance Curves*



FIGURE 1. NORMALIZED POWER DISSIPATION vs CASE
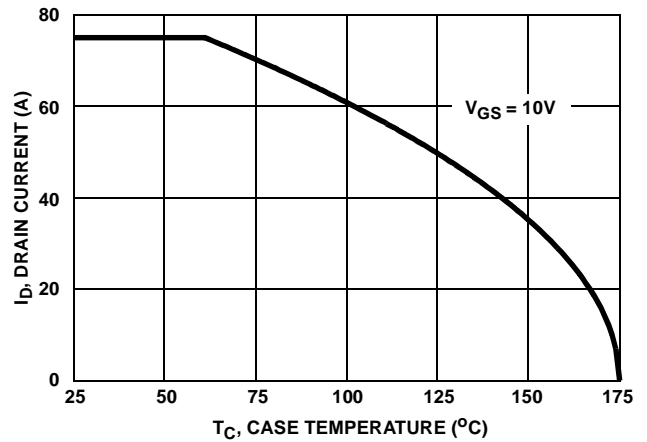TEMPERATURE



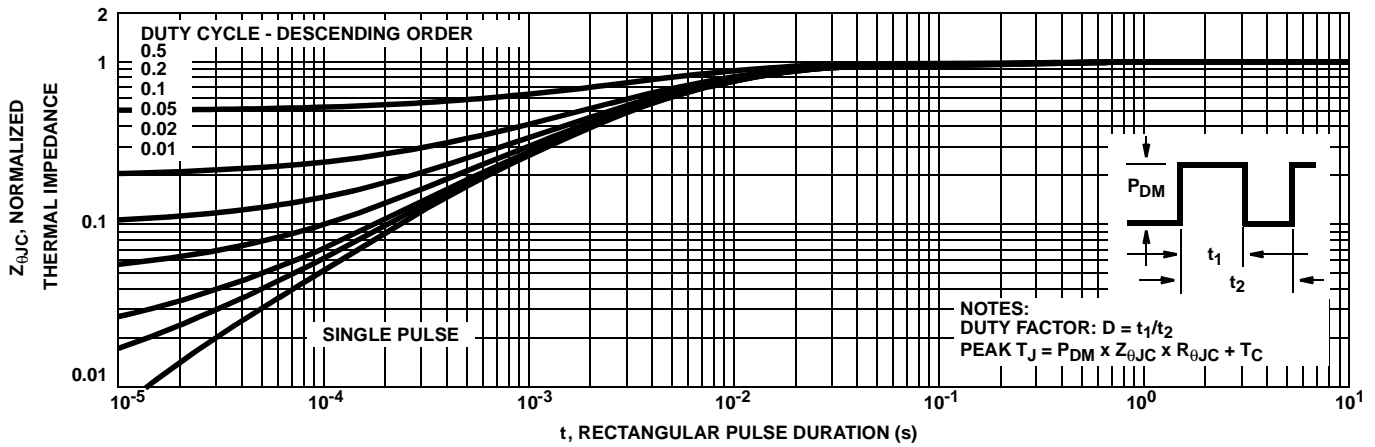FIGURE 2. MAXIMUM CONTINUOUS DRAIN CURRENT vs
CASE TEMPERATURE



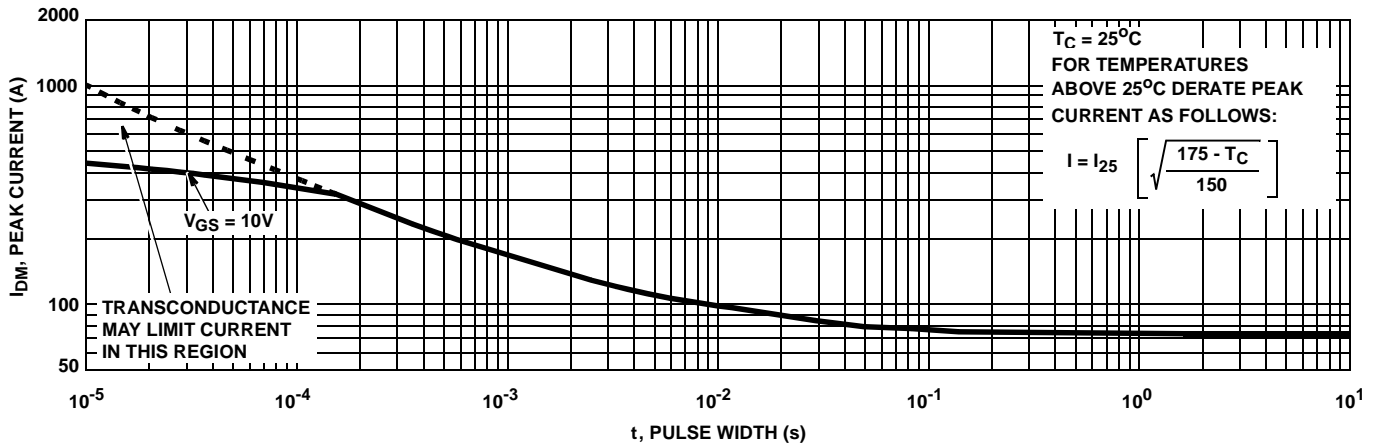FIGURE 3. NORMALIZED MAXIMUM TRANSIENT THERMAL IMPEDANCE



FIGURE 4. PEAK CURRENT CAPABILITY
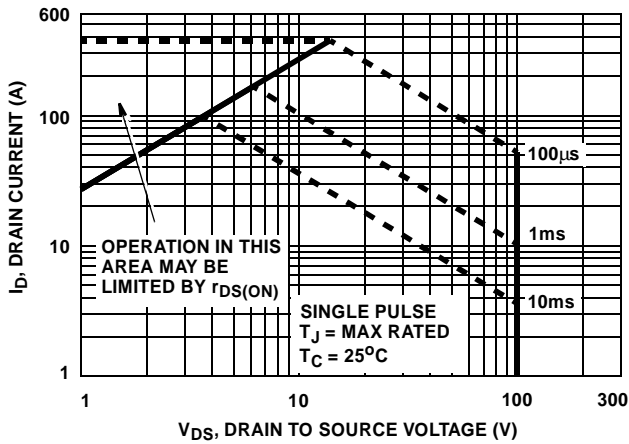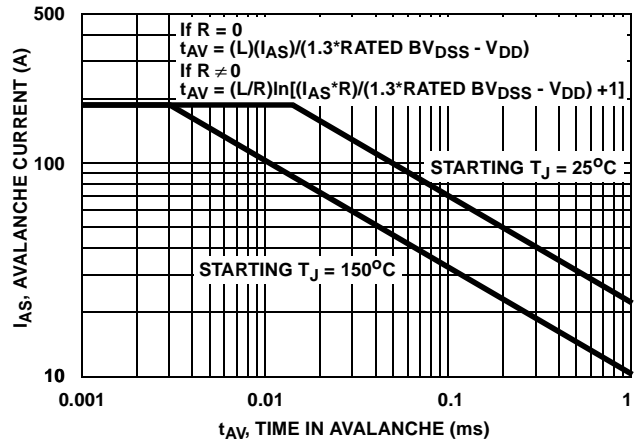
## *Typical Performance Curves* (Continued)

**FIGURE 5. FORWARD BIAS SAFE OPERATING AREA**

NOTE: Refer to ON Semiconductor Application Notes AN9321 and AN9322.
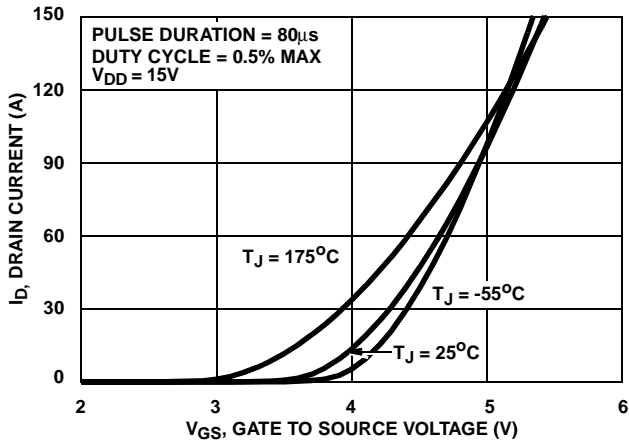
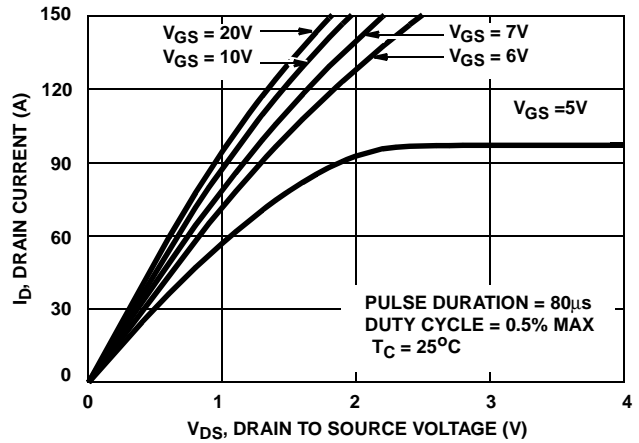**FIGURE 6. UNCLAMPED INDUCTIVE SWITCHING CAPABILITY**

**FIGURE 7. TRANSFER CHARACTERISTICS**

**FIGURE 8. SATURATION CHARACTERISTICS**
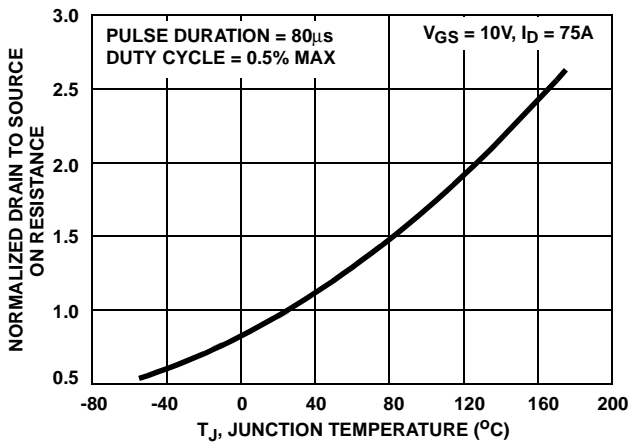
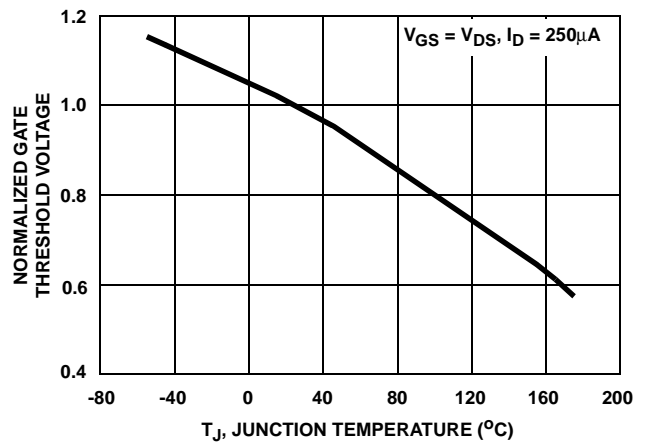**FIGURE 9. NORMALIZED DRAIN TO SOURCE ON RESISTANCE vs JUNCTION TEMPERATURE**

**FIGURE 10. NORMALIZED GATE THRESHOLD VOLTAGE vs JUNCTION TEMPERATURE**
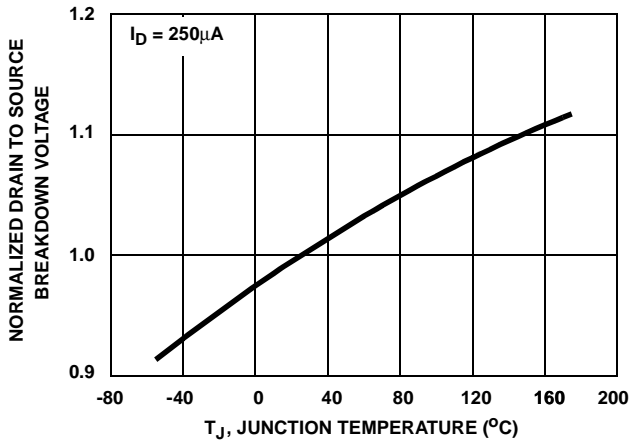
## *Typical Performance Curves* (Continued)



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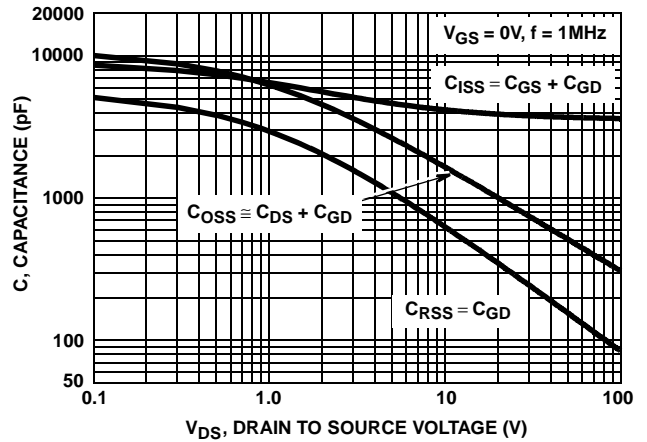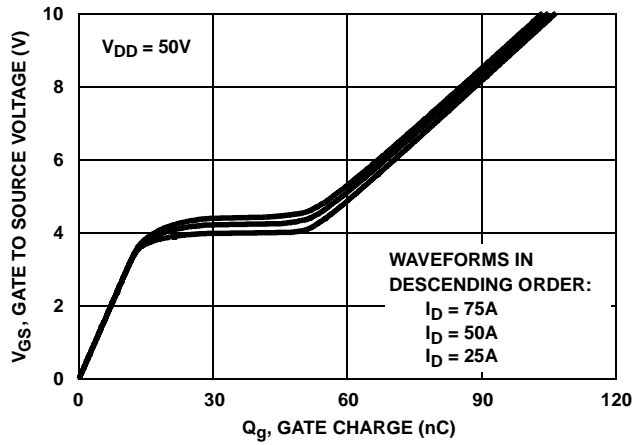VOLTAGE vs JUNCTION TEMPERATURE



FIGURE 12. CAPACITANCE vs DRAIN TO SOURCE VOLTAGE



NOTE: Refer to ON Semiconductor Application Notes AN7254 and AN7260.

FIGURE 13. GATE CHARGE WAVEFORMS FOR CONSTANT GATE CURRENT
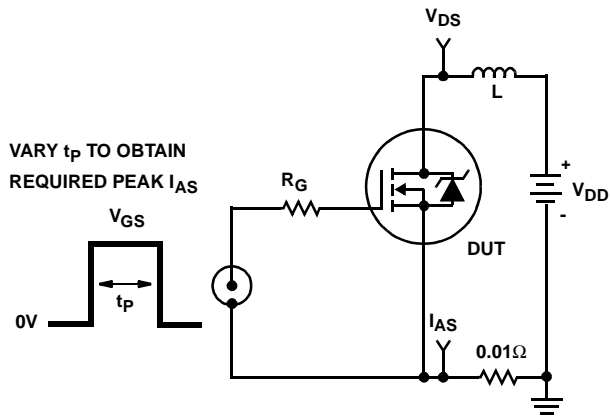
## *Test Circuits and Waveforms*



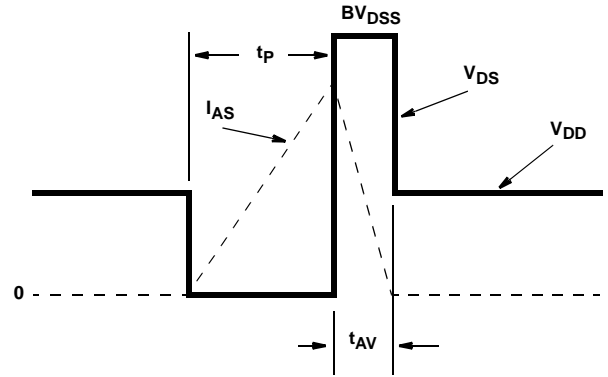**FIGURE 14. UNCLAMPED ENERGY TEST CIRCUIT**
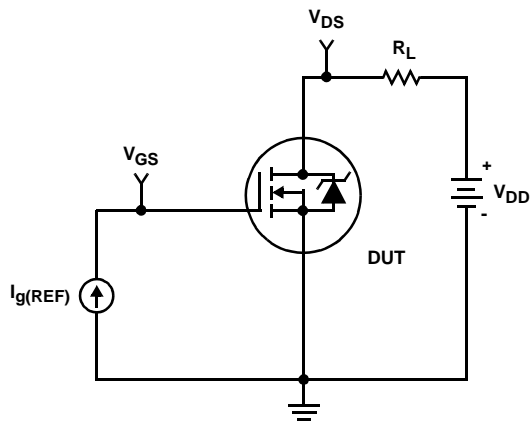


**FIGURE 15. UNCLAMPED ENERGY WAVEFORMS**



**FIGURE 16. GATE CHARGE TEST CIRCUIT**



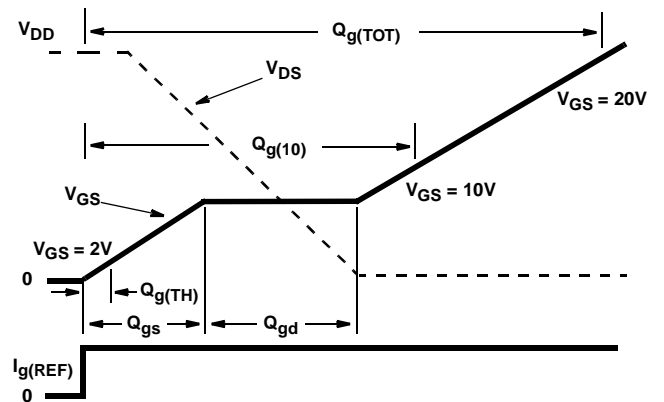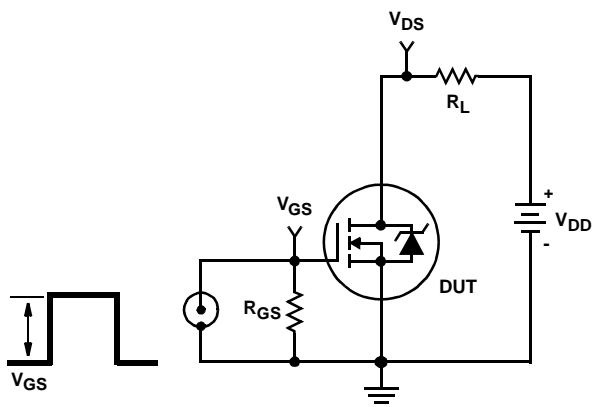**FIGURE 17. GATE CHARGE WAVEFORMS**



**FIGURE 18. SWITCHING TIME TEST CIRCUIT**



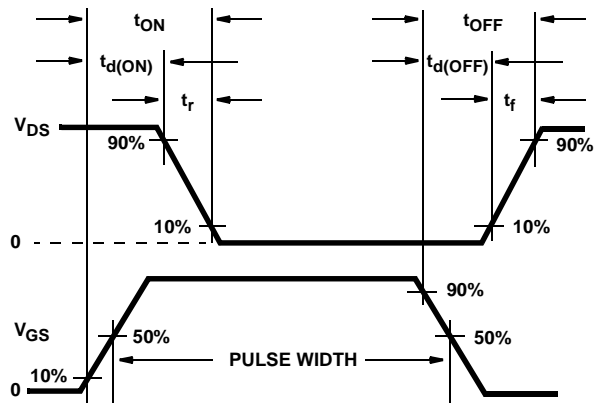**FIGURE 19. SWITCHING TIME WAVEFORM**

## PSPICE Electrical Model

.SUBCKT HUF75645 2 1 3 ;      rev 21 May 1999


CA  12 8 5.31e-9
CB  15 14 5.31e-9
CIN  6 8 3.56e-9


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


EBREAK 11 7 17  18 115.5
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 1.0e-9
LGATE  1 9 5.1e-9
LSOURCE  3  7 4.4e-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 7.80e-3
RGATE  9  20 0.83
RLDRAIN 2 5 10
RLGATE 1 9 26
RLSOURCE 3 7 11
RSLC1 5 51 RSLCMOD 1e-6
RSLC2 5 50 1e3
RSOURCE  8  7 RSOURCEMOD 1.65e-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*205),3.5))}

.MODEL DBODYMOD D (IS = 3.00e-12 IKF = 19  RS = 1.78e-3  XTI = 5 TRS1 = 2.25e-3  TRS2 = 1.00e-5  CJO = 5.32e-9  TT = 7.4e-8 M = 0.68)
.MODEL DBREAKMOD D (RS = 2.15e- 1IKF = 1 TRS1 = 8e- 4TRS2 = 3e-6)
.MODEL DPLCAPMOD D (CJO = 5.55e- 9IS = 1e-3  0M = 0.98)
.MODEL MMEDMOD NMOS (VTO = 3.13 KP = 10 IS = 1e-30 N = 10 TOX = 1 L = 1u W = 1u RG = 0.83)
.MODEL MSTROMOD NMOS (VTO = 3.51 KP = 93 IS = 1e-30 N = 10 TOX = 1 L = 1u W = 1u)
.MODEL MWEAKMOD NMOS (VTO = 2.65 KP = 0.11 IS = 1e-30 N = 10 TOX = 1 L = 1u W = 1u RG = 8.33 )
.MODEL RBREAKMOD RES (TC1 = 9.9e- 4TC2 = -1.3e-6)
.MODEL RDRAINMOD RES (TC1 = 9.40e-3  TC2 = 2.93e-5)
.MODEL RSLCMOD RES (TC1 = 2.63e-3 TC2 = 1.05e-6)
.MODEL RSOURCEMOD RES (TC1 = 1e-3 TC2 = 1e-6)
.MODEL RVTHRESMOD RES (TC1 = -2.57e-3 TC2 = -7.05e-6)
.MODEL RVTEMPMOD RES (TC1 = -2.87e- 3TC2 = -2.21e-6)


.MODEL S1AMOD VSWITCH (RON = 1e-5  ROFF = 0.1  VON = -6.2  VOFF= -2.4)
.MODEL S1BMOD VSWITCH (RON = 1e-5  ROFF = 0.1  VON = -2.4  VOFF= -6.2)
.MODEL S2AMOD VSWITCH (RON = 1e-5  ROFF = 0.1  VON = -1.8  VOFF= 0.5)
.MODEL S2BMOD VSWITCH (RON = 1e-5  ROFF = 0.1  VON = 0.5  VOFF= -1.8)

.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.
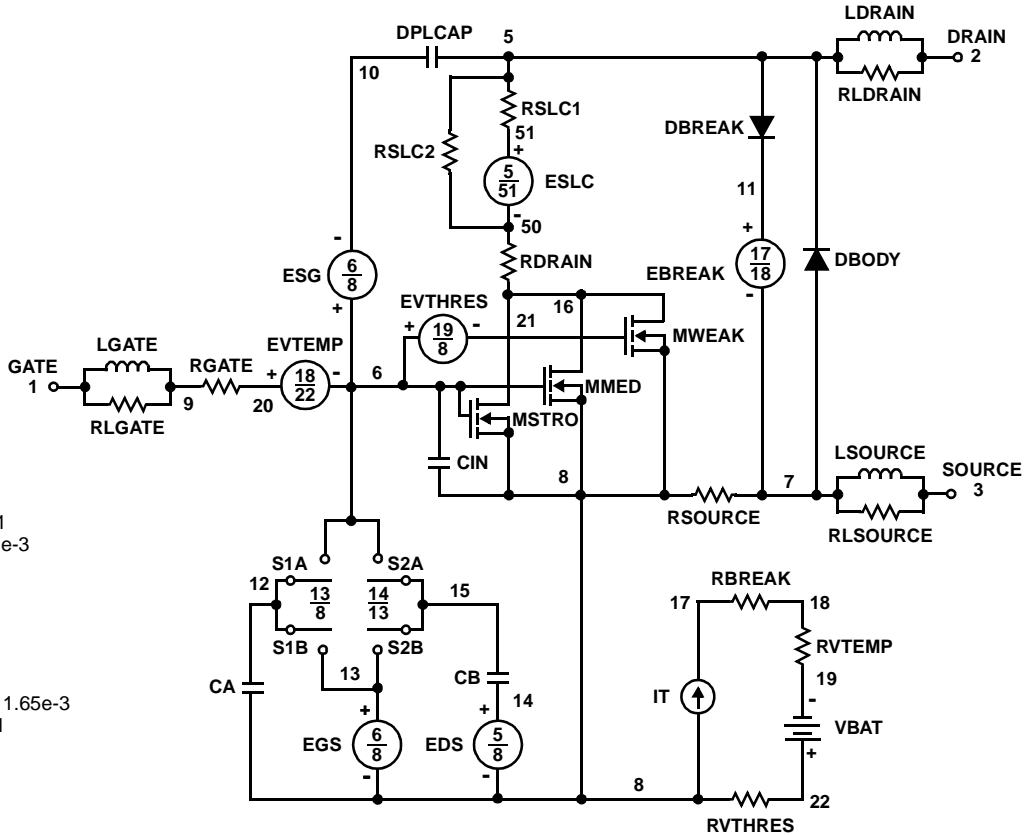
## SABER Electrical Model

REV 21 May 1999

```
template ta75645 n2,n1,n3
electrical n2,n1,n3
{
var i iscl
d..model dbodymod =  (is = 3.00e-12, cjo = 5.32e-9, tt = 7.4e-8, xti = 5, m = 0.68)
d..model dbreakmod = ()
d..model dplcapmod =  (cjo = 5.55e-9, is = 1e-30, vj=1.0, m = 0.8)
m..model mmedmod = (type=_n, vto = 3.13, kp = 10, is = 1e-30, tox = 1)
m..model mstrongmod = (type=_n, vto = 3.51, kp = 93, is = 1e-30, tox = 1)
m..model mweakmod = (type=_n, vto = 2.65, kp = 0.11, is = 1e-30, tox = 1)
sw_vcsp..model s1amod =  (ron = 1e-5, roff = 0.1, von = -6.2, voff = -2.4)
sw_vcsp..model s1bmod =  (ron =1e-5, roff = 0.1, von = -2.4, voff = -6.2)
sw_vcsp..model s2amod =  (ron = 1e-5, roff = 0.1, von = -1.8, voff = 0.5)
sw_vcsp..model s2bmod =  (ron = 1e-5, roff = 0.1, von = 0.5, voff = -1.8)

c.ca n12 n8 = 5.31e-9
c.cb n15 n14 = 5.31e-9
c.cin n6 n8 = 3.56e-9

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 = 5.1e-9
l.lsource n3 n7 = 4.4e-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 = 9.9e-4, tc2 = -1.3e-6
res.rdbody n71 n5 = 1.78e-3, tc1 = 2.25e-3, tc2 = 1.e-5
res.rdbreak n72 n5 = 2.15e-1, tc1 = 8e-4, tc2 = 3e-6
res.rdrain n50 n16 = 7.8e-3, tc1 = 9.4e-3, tc2 = 2.93e-5
res.rgate n9 n20 = 0.83
res.rldrain n2 n5 = 10
res.rlgate n1 n9 = 26
res.rlsource n3 n7 = 11
res.rslc1 n5 n51  = 1e-6, tc1 = 2.63e-3, tc2 = 1.05e-6
res.rslc2 n5 n50 = 1e3
res.rsource n8 n7 = 1.65e-3, tc1 = 1e-3, tc2 = 1e-6
res.rvtemp n18 n19 = 1, tc1 = -2.87e-3, tc2 = -2.21e-6
res.rvthres n22 n8 = 1, tc1 = -2.57e-3, tc2 = -7.05e-6

spe.ebreak n11 n7 n17 n18 = 115.5
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)*1e6/205))** 3.5))
}
}
```
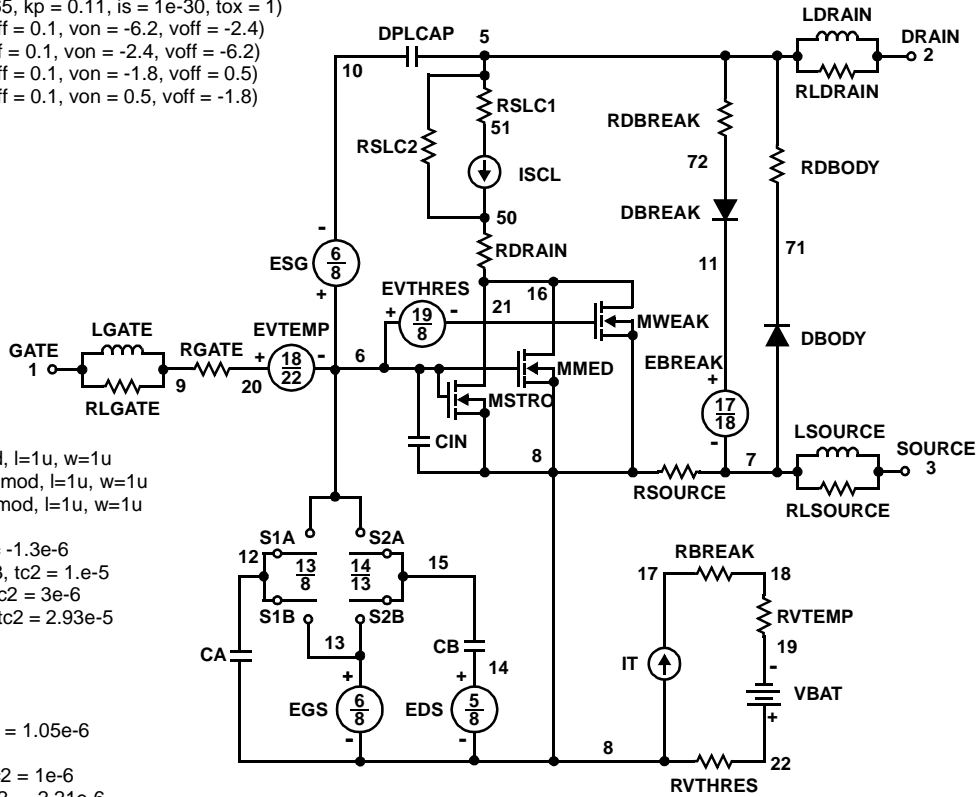
## SPICE Thermal Model

REV 28 July 1999

HUF75645T

CTHERM1 th 6 8.80e-3
CTHERM2 6 5 2.50e-2
CTHERM3 5 4 2.70e-2
CTHERM4 4 3 3.70e-2
CTHERM5 3 2 4.40e-2
CTHERM6 2 tl 3.40e-1

RTHERM1 th 6 1.20e-2
RTHERM2 6 5 3.00e-2
RTHERM3 5 4 4.30e-2
RTHERM4 4 3 8.80e-2
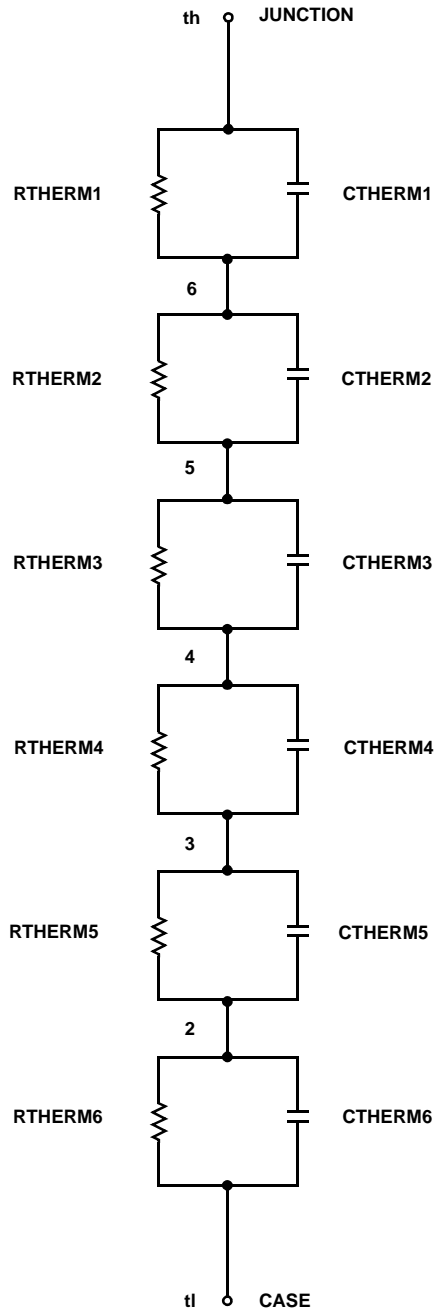RTHERM5 3 2 9.90e-2
RTHERM6 2 tl 1.10e-1

## SABER Thermal Model

SABER thermal model HUF75645T

```
template thermal_model th tl
thermal_c th, tl
{
ctherm.ctherm1 th 6 = 8.80e-3
ctherm.ctherm2 6 5 = 2.50e-2
ctherm.ctherm3 5 4 = 2.70e-2
ctherm.ctherm4 4 3 = 3.70e-2
ctherm.ctherm5 3 2 = 4.40e-2
ctherm.ctherm6 2 tl = 3.40e-1

rtherm.rtherm1 th 6 = 1.20e-2
rtherm.rtherm2 6 5 = 3.00e-2
rtherm.rtherm3 5 4 = 4.30e-2
rtherm.rtherm4 4 3 = 8.80e-2
rtherm.rtherm5 3 2 = 9.90e-2
rtherm.rtherm6 2 tl = 1.10e-1
}
```

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