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Data Sheet October 2013

#### N-Channel UltraFET Power MOSFET 55 V, 20 A, 36 mΩ

These N-Channel power MOSFETs are manufactured using the innovative UltraFET process. This advanced process technology achieves the lowest possible onresistance 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 batteryoperated products.

Formerly developmental type TA75321.

#### **Features**

- 20A, 55V
- Simulation Models
  - Temperature Compensating PSPICE® and SABER™
  - 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"

#### **Packaging**

#### JEDEC TO-252AA



#### Symbol



Product reliability information can be found at http://www.fairchildsemi.com/products/discrete/reliability/index.html For severe environments, see our Automotive HUFA series.

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

#### HUF75321D3ST

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

		UNITS
Drain to Source Voltage (Note 1)	55	V
Drain to Gate Voltage ( $R_{GS} = 20k\Omega$ ) (Note 1) $V_{DGR}$	55	V
Gate to Source Voltage	±20	V
Drain Current		
Continuous (Figure 2)I <sub>D</sub>	20	Α
Pulsed Drain Current	Figure 4	
Pulsed Avalanche Rating E <sub>AS</sub>	Figures 6, 14, 15	
Power Dissipation P <sub>D</sub>	93	W
Derate Above 25 <sup>o</sup> C	0.625	W/oC
Operating and Storage Temperature	-55 to 175	°С
Maximum Temperature for Soldering		
Leads at 0.063in (1.6mm) from Case for 10sT <sub>I</sub>	300	οС
Package Body for 10s, See Techbrief 334	260	°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.  $T_J = 25^{\circ}C$  to  $150^{\circ}C$ .

### **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 <sub>DSS</sub>	$I_D = 250 \mu A$ , $V_{GS} = 0V$ (Figure 11)		55	-	-	V
Zero Gate Voltage Drain Current	I <sub>DSS</sub>	V <sub>DS</sub> = 50V, V <sub>GS</sub> =	0V	\ -	-	1	μΑ
		V <sub>DS</sub> = 45V, V <sub>GS</sub> =	$0V, T_C = 150^{\circ}C$	-	-	250	μΑ
Gate to Source Leakage Current	I <sub>GSS</sub>	V <sub>GS</sub> = ±20V		-	-	±100	nA
ON STATE SPECIFICATIONS	*			<u> </u>			
Gate to Source Threshold Voltage	V <sub>GS(TH)</sub>	$V_{GS} = V_{DS}$ , $I_D = 28$	50μA (Figure 10)	2	-	4	V
Drain to Source On Resistance	r <sub>DS(ON)</sub>	I <sub>D</sub> = 20A, V <sub>GS</sub> = 10V (Figure 9)		-	0.030	0.036	Ω
THERMAL SPECIFICATIONS					•		
Thermal Resistance Junction to Case	$R_{ heta JC}$	(Figure 3)		-	-	1.6	oC/M
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	TO-252		/ -	-	100	oC/M
SWITCHING SPECIFICATIONS (V <sub>GS</sub> = 10	V)				•		
Turn-On Time	tON	$V_{DD} = 30V, I_{D} \approx 20A,$ $R_{L} = 1.5\Omega, V_{GS} = 10V,$ $R_{GS} = 25\Omega$		-	-	100	ns
Turn-On Delay Time	t <sub>d</sub> (ON)			-	11	-	ns
Rise Time	t <sub>r</sub>			-	55	-	ns
Turn-Off Delay Time	t <sub>d</sub> (OFF)			-	47	-	ns
Fall Time	t <sub>f</sub>			-	66	-	ns
Turn-Off Time	tOFF			-	-	170	ns
GATE CHARGE SPECIFICATIONS							
Total Gate Charge	Q <sub>g(TOT)</sub>	V <sub>GS</sub> = 0V to 20V	$V_{DD} = 30V,$ $I_{D} \cong 20A,$ $R_{L} = 1.5\Omega$ $I_{g(REF)} = 1.0mA$	-	36	44	nC
Gate Charge at 10V	Q <sub>g(10)</sub>	V <sub>GS</sub> = 0V to 10V		-	21	26	nC
Threshold Gate Charge	Q <sub>g(TH)</sub>	V <sub>GS</sub> = 0V to 2V		-	1.3	1.6	nC
Gate to Source Gate Charge	Q <sub>gs</sub>		(Figure 13)	-	3	-	nC
Reverse Transfer Capacitance	Q <sub>gd</sub>				9	-	nC

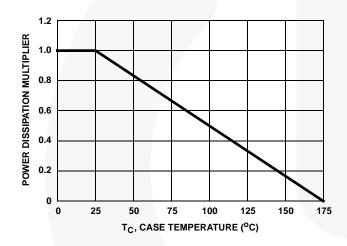
#### **Electrical Specifications** $T_C = 25^{\circ}C$ , Unless Otherwise Specified

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS
CAPACITANCE SPECIFICATIONS						
Input Capacitance	C <sub>ISS</sub>			680	-	pF
Output Capacitance	C <sub>OSS</sub>	f = 1MHz (Figure 12)	-	270		pF
Reverse Transfer Capacitance	C <sub>RSS</sub>		-	60	-	pF

#### **Source to Drain Diode Specifications**

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Source to Drain Diode Voltage	V <sub>SD</sub>	I <sub>SD</sub> = 20A	-	-	1.25	V
Reverse Recovery Time	t <sub>rr</sub>	$I_{SD} = 20A$ , $dI_{SD}/dt = 100A/\mu s$	-	-	59	ns
Reverse Recovered Charge	Q <sub>RR</sub>	$I_{SD} = 20A$ , $dI_{SD}/dt = 100A/\mu s$	-	-	82	nC

### **Typical Performance Curves**



25 20 15 15 0 25 50 75 100 125 150 175 T<sub>C</sub>, CASE TEMPERATURE (°C)

FIGURE 1. NORMALIZED POWER DISSIPATION vs CASE TEMPERATURE

FIGURE 2. MAXIMUM CONTINUOUS DRAIN CURRENT vs CASE TEMPERATURE

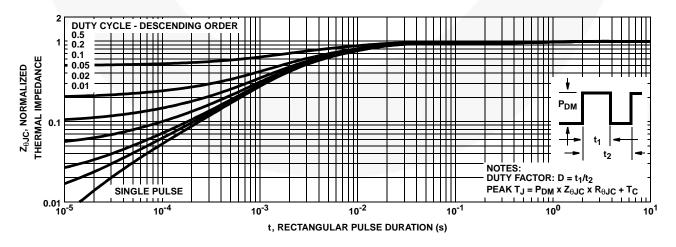


FIGURE 3. NORMALIZED MAXIMUM TRANSIENT THERMAL IMPEDANCE

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#### Typical Performance Curves (Continued)

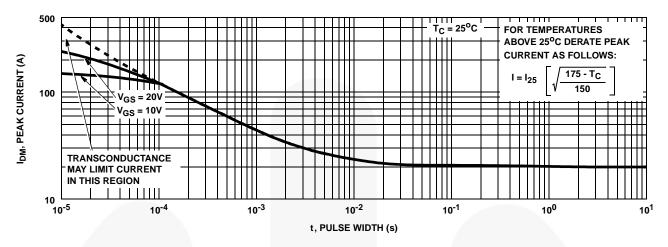


FIGURE 4. PEAK CURRENT CAPABILITY

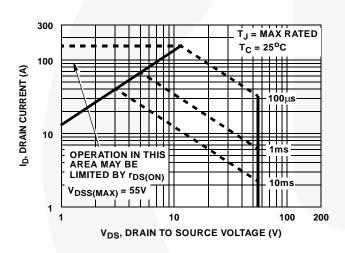
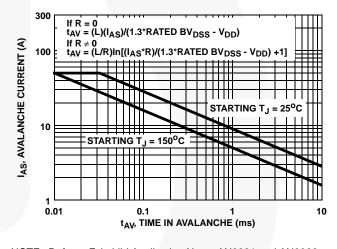


FIGURE 5. FORWARD BIAS SAFE OPERATING AREA



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

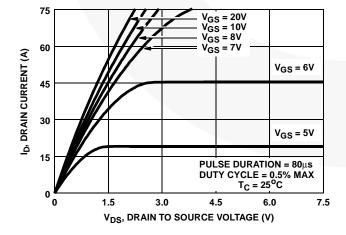


FIGURE 7. SATURATION CHARACTERISTICS

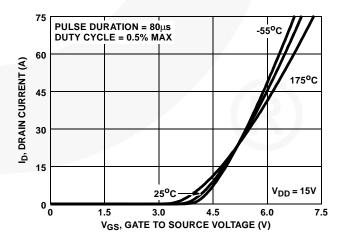


FIGURE 8. TRANSFER CHARACTERISTICS

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1.2

#### Typical Performance Curves (Continued)

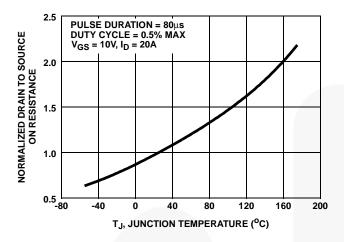
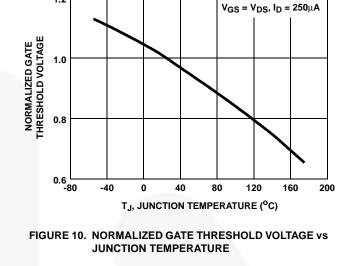


FIGURE 9. NORMALIZED DRAIN TO SOURCE ON RESISTANCE vs JUNCTION TEMPERATURE



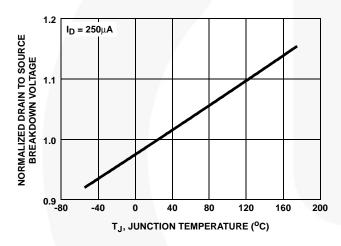


FIGURE 11. NORMALIZED DRAIN TO SOURCE BREAKDOWN VOLTAGE vs JUNCTION TEMPERATURE

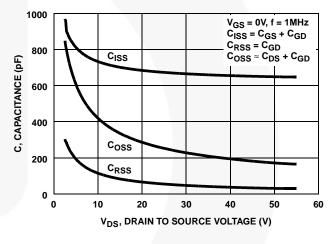
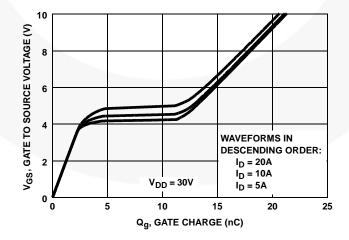


FIGURE 12. CAPACITANCE vs DRAIN TO SOURCE VOLTAGE



NOTE: Refer to Fairchild Application Notes AN7254 and AN7260.

FIGURE 13. GATE CHARGE WAVEFORMS FOR CONSTANT GATE CURRENT

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#### Test Circuits and Waveforms

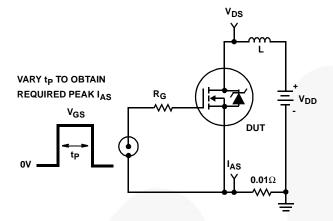


FIGURE 14. UNCLAMPED ENERGY TEST CIRCUIT

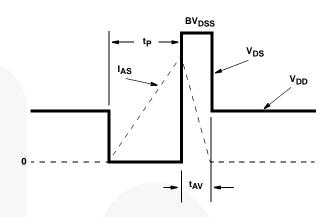


FIGURE 15. UNCLAMPED ENERGY WAVEFORMS

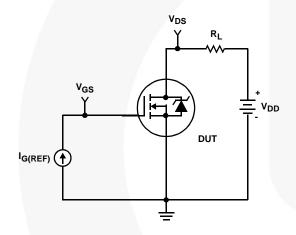


FIGURE 16. GATE CHARGE TEST CIRCUIT

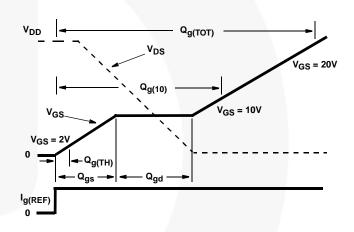


FIGURE 17. GATE CHARGE WAVEFORM

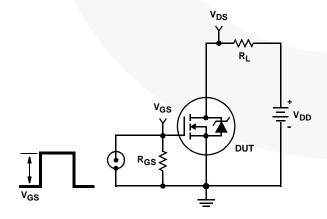


FIGURE 18. SWITCHING TIME TEST CIRCUIT

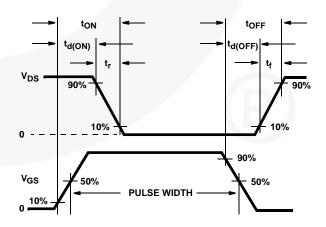


FIGURE 19. RESISTIVE SWITCHING WAVEFORMS

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#### PSPICE Electrical Model

.SUBCKT HUF75321D 2 1 3 : rev 4/29/98 CA 12 8 9.96e-10 CB 15 14 9.83e-10 LDRAIN CIN 6 8 6.18e-10 **DPLCAP** DRAIN 5 **-**02 10 **RLDRAIN DBODY 7 5 DBODYMOD** ≶RSLC1 DBREAK 5 11 DBREAKMOD DBREAK T **DPLCAP 10 5 DPLCAPMOD** RSLC2 **ESLC** 11 EBREAK 11 7 17 18 59.54 . 50 EDS 14 8 5 8 1 EGS 13 8 6 8 1 DBODY **≻**RDRAIN 8 **EBREAK ESG** ESG 6 10 6 8 1 **EVTHRES** EVTHRES 6 21 19 8 1 16 21 1<u>9</u> 8 EVTEMP 20 6 18 22 1 **MWEAK EVTEMP LGATE RGATE** GATE **←**MMED IT 8 17 1 20 i<del>√</del>\_MSTRO **RLGATE** LDRAIN 2 5 1e-9 LSOURCE LGATE 1 9 3.57e-9 CIN SOURCE 8 LSOURCE 3 7 4.25e-9 **RSOURCE** MMED 16 6 8 8 MMEDMOD RLSOURCE MSTRO 16 6 8 8 MSTROMOD S1A MWEAK 16 21 8 8 MWEAKMOD **RBREAK** 13 8 15 14 17 18 <del>13</del> RBREAK 17 18 RBREAKMOD 1 RDRAIN 50 16 RDRAINMOD 5.50e-3 S1B **RVTEMP** RGATE 9 20 2.25 CB 19 RLDRAIN 2 5 10 CA IT 14 **RLGATE 1 9 35.7** VRAT **RLSOURCE 3 7 42.5** 8 <u>5</u> **EGS EDS** RSLC1 5 51 RSLCMOD 1e-6 RSLC2 5 50 1e3 R RSOURCE 8 7 RSOURCEMOD 16.30e-3 RVTHRES 22 8 RVTHRESMOD 1 **RVTHRES 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- 1TRS1 = 3.62e- 3TRS2 = 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- 3TC2 = 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- 3TC2 = 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 S2AMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = 3.00 VOFF= 0.00)

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.

.ENDS

#### SABER Electrical Model

```
REV April 1998
template huf75321d 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 = ()
                                                                                                                               LDRAIN
                                                                                 DPLCAP
d..model dplcapmod = (cjo = 9e-10, is = 1e-30, n = 10, m = 0.85)
                                                                                                                                          DRAIN
m..model mmedmod = (type=_n, vto = 3.25, kp = 1.75, is = 1e-30, tox = 1)
                                                                             10
m..model mstrongmod = (type=_n, vto = 3.65, kp = 32, is = 1e-30, tox = 1)
                                                                                                                               RLDRAIN
m..model mweakmod = (type=_n, vto = 2.91, kp = 0.07, is = 1e-30, tox = 1)
                                                                                             ≻RSLC1
                                                                                                          RDBREAK
sw_vcsp..model s1amod = (ron = 1e-5, roff = 0.1, von = -7.85, voff = -4.85)
                                                                               RSLC<sub>2</sub>
sw_vcsp..model s1bmod = (ron = 1e-5, roff = 0.1, von = -4.85, voff = -7.85)
                                                                                                                   72
                                                                                                                               RDBODY
sw_vcsp..model s2amod = (ron = 1e-5, roff = 0.1, von = 0, voff = 3.0)
                                                                                            Ŧ
                                                                                                ISCL
sw_vcsp..model s2bmod = (ron = 1e-5, roff = 0.1, von = 3.0, voff = 0)
                                                                                                           DBREAK
                                                                                              50
c.ca n12 n8 = 9.96e-10
                                                                                              RDRAIN
c.cb n15 n14 = 9.83e-10
                                                                     ESG
                                                                                                                    11
c.cin n6 n8 = 6.18e-10
                                                                                 EVTHRES
                                                                                              21
                                                                                                             MWEAK
                                                                    EVTEMP
                                                  I GATE
d.dbody n7 n71 = model=dbodymod
                                                                                                                               DBODY
                                                           RGATE
                                         GATE
d.dbreak n72 n11 = model=dbreakmod
                                                                      18
22
                                                                                                              EBREAK
d.dplcap n10 n5 = model=dplcapmod
                                                                  20
                                                                                            -MSTRO
                                                 RLGATE
i.it n8 n17 = 1
                                                                                                                              LSOURCE
                                                                                        CIN
                                                                                                                                          SOURCE
                                                                                                  8
I.ldrain n2 n5 = 1e-9
I.lgate n1 n9 =3.57e-9
                                                                                                             RSOURCE
                                                                                                                              RLSOURCE
I.Isource n3 n7 = 4.25e-9
                                                                                                                  RBREAK
m.mmed n16 n6 n8 n8 = model=mmedmod, I = 1u, w = 1u
                                                                                                                            18
m.mstrong n16 n6 n8 n8 = model=mstrongmod, I = 1u, w = 1u
m.mweak n16 n21 n8 n8 = model=mweakmod, I = 1u, w = 1u
                                                                                                                             RVTEMP
                                                                               o S2B
                                                                    S<sub>1</sub>B
                                                                                       CB
res.rbreak n17 n18 = 1, tc1 = 1.05e-3, tc2 = 1.21e-7
                                                                                                                             19
                                                              CA
                                                                                                            IT
res.rdbody 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
                                                                                                                               VBAT
                                                                       FGS
                                                                                           <u>5</u>
                                                                                    FDS
res.rdrain n50 n16 = 5.5e-3, tc1 = 2.4e-2, tc2 = 1.02e-6
res.rgate n9 n20 = 2.25
                                                                                                          8
res.rldrain n2 n5 = 10
res.rlgate n1 n9 = 35.7
                                                                                                                 RVTHRES
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))
```

#### SPICE Thermal Model

REV 24 February 1999

HUF75321D

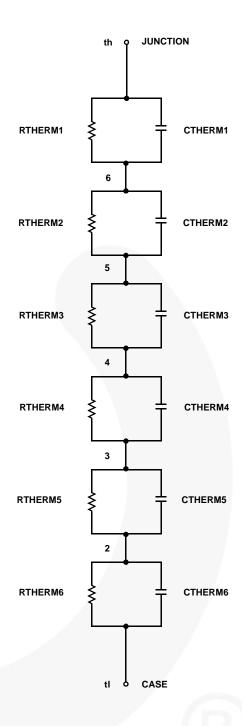
CTHERM1 th 6 2.7e-3 CTHERM2 6 5 3.7e-3 CTHERM3 5 4 1.2e-2 CTHERM4 4 3 3.8e-3 CTHERM5 3 2 1.4e-2 CTHERM6 2 tl 10.55 RTHERM1 th 6 1.10e-2 RTHERM2 6 5 2.72e-2 RTHERM3 5 4 7.67e-2 RTHERM4 4 3 4.30e-1 RTHERM5 3 2 6.49e-1

RTHERM6 2 tl 8.61e-2

#### SABER Thermal Model

SABER thermal model HUF75321D

```
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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GreenBridge™ Green FPŠ™ Green FPS™ e-Series™

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