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Data Sheet October 2013

#### N-Channel UltraFET Power MOSFET 100 V, 56 A, 25 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.

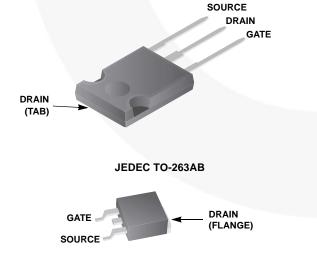
Formerly developmental type TA75639.

#### Ordering Information

DADT NUMBER	DE NUMBER DAGMAGE BRAND					
PART NUMBER	PACKAGE	BRAND				
HUF75639G3	TO-247	75639G				
HUF75639P3	TO-220AB	75639P				
HUF75639S3ST	TO-263AB	75639S				
HUF75639S3	TO-262AA	75639S				

#### **Packaging**

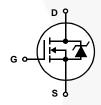
#### **JEDEC STYLE TO-247**



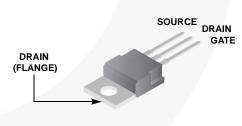
#### **Features**

- 56A, 100V
- Simulation Models
  - Temperature Compensated PSPICE® and SABER™ **Electrical Models**
  - Spice and Saber Thermal Impedance Models
  - www.fairchildsemi.com
- · Peak Current vs Pulse Width Curve
- UIS Rating Curve
- · Related Literature
  - TB334, "Guidelines for Soldering Surface Mount Components to PC Boards"

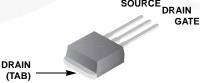
#### Symbol



#### JEDEC TO-220AB



# SOURCE



TO-262AA

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.

#### HUF75639G3, HUF75639P3, HUF75639S3S, HUF75639S3

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

		UNITS
Drain to Source Voltage (Note 1)	100	V
Drain to Gate Voltage ( $R_{GS} = 20k\Omega$ ) (Note 1)	100	V
Gate to Source Voltage	±20	V
Drain Current		
Continuous (Figure 2)	56	Α
Pulsed Drain Current	Figure 4	
Pulsed Avalanche Rating E <sub>AS</sub>	Figures 6, 14, 15	
Power Dissipation	200	W
Derate Above 25 <sup>o</sup> C	1.35	W/oC
Operating and Storage Temperature	-55 to 175	оС
Maximum Temperature for Soldering		
Leads at 0.063in (1.6mm) from Case for 10sT <sub>L</sub>	300	оС
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	*				*		<b>!</b>
Drain to Source Breakdown Voltage	BV <sub>DSS</sub>	$I_D = 250 \mu A, V_{GS} =$	0V (Figure 11)	100	-	-	V
Zero Gate Voltage Drain Current	I <sub>DSS</sub>	V <sub>DS</sub> = 95V, V <sub>GS</sub> =	0V	-	-	1	μΑ
		V <sub>DS</sub> = 90V, 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	1						
Gate to Source Threshold Voltage	V <sub>GS(TH)</sub>	$V_{GS} = V_{DS}$ , $I_D = 2$	50μA (Figure 10)	2	-	4	V
Drain to Source On Resistance	r <sub>DS(ON)</sub>	I <sub>D</sub> = 56A, V <sub>GS</sub> = 10	OV (Figure 9)	-	0.021	0.025	Ω
THERMAL SPECIFICATIONS	- 1						
Thermal Resistance Junction to Case	$R_{ heta JC}$	(Figure 3)		-	-	0.74	oC/W
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	TO-247		-	-	30	oC/W
		TO-220, TO-263, T	O-262	-	-	62	oC/W
SWITCHING SPECIFICATIONS (VGS = 10	)V)					7	
Turn-On Time	ton	$V_{DD} = 50V, I_{D} \cong 56A,$ $R_{L} = 0.89\Omega, V_{GS} = 10V,$ $R_{GS} = 5.1\Omega$		-	-	110	ns
Turn-On Delay Time	t <sub>d</sub> (ON)			-	15	-	ns
Rise Time	t <sub>r</sub>			-	60	-	ns
Turn-Off Delay Time	t <sub>d</sub> (OFF)			-	20	/h-s	ns
Fall Time	t <sub>f</sub>			-	25	-	ns
Turn-Off Time	toff			-	-	70	ns
GATE CHARGE SPECIFICATIONS				<b>-</b>			I.
Total Gate Charge	Q <sub>g(TOT)</sub>	V <sub>GS</sub> = 0V to 20V	$V_{DD} = 50V,$ $I_{D} \cong 56A,$ $R_{I} = 0.89\Omega$	-	110	130	nC
Gate Charge at 10V	Q <sub>g(10)</sub>	V <sub>GS</sub> = 0V to 10V		-	57	75	nC
Threshold Gate Charge	Q <sub>g(TH)</sub>	V <sub>GS</sub> = 0V to 2V	$I_{g(REF)} = 1.0 \text{mA}$	-	3.7	4.5	nC
Gate to Source Gate Charge	Q <sub>gs</sub>		(Figure 13)	-	9.8	-	nC
Gate to Drain "Miller" Charge	Q <sub>gd</sub>			-	24	-	nC

#### HUF75639G3, HUF75639P3, HUF75639S3S, HUF75639S3

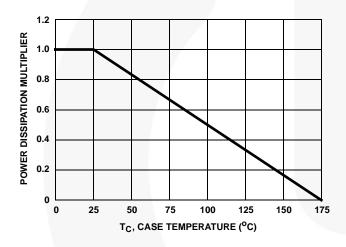
#### **Electrical Specifications** $T_C = 25^{\circ}C$ , Unless Otherwise Specified

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS
CAPACITANCE SPECIFICATIONS						
Input Capacitance	C <sub>ISS</sub>	$V_{DS} = 25V, V_{GS} = 0V,$	-	2000	-	pF
Output Capacitance	C <sub>OSS</sub>	f = 1MHz (Figure 12)	-	500	-	pF
Reverse Transfer Capacitance	C <sub>RSS</sub>		-	65	-	pF

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

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Source to Drain Diode Voltage	$V_{SD}$	I <sub>SD</sub> = 56A	-	-	1.25	V
Reverse Recovery Time	t <sub>rr</sub>	$I_{SD} = 56A$ , $dI_{SD}/dt = 100A/\mu s$	-	-	110	ns
Reverse Recovered Charge	Q <sub>RR</sub>	$I_{SD} = 56A$ , $dI_{SD}/dt = 100A/\mu s$	-	-	320	nC

#### **Typical Performance Curves**



60 (V) 10 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

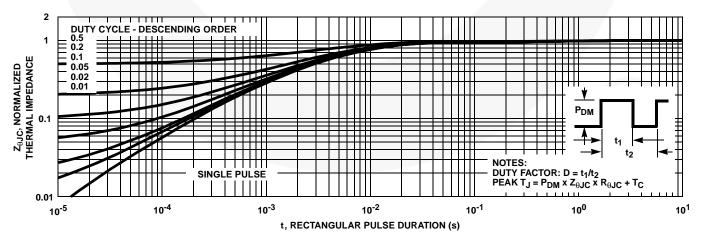


FIGURE 3. NORMALIZED MAXIMUM TRANSIENT THERMAL IMPEDANCE

#### Typical Performance Curves (Continued)

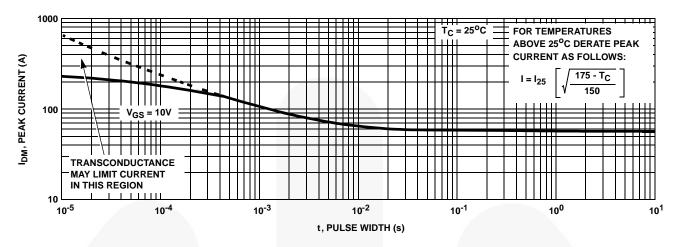


FIGURE 4. PEAK CURRENT CAPABILITY

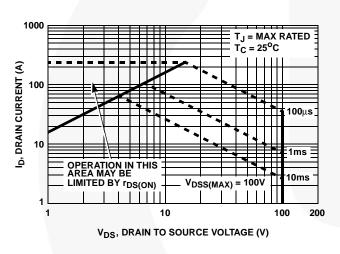


FIGURE 5. FORWARD BIAS SAFE OPERATING AREA

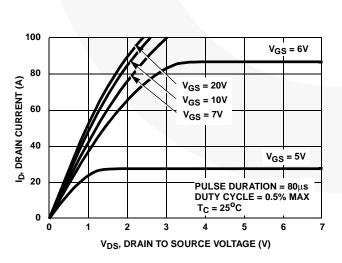
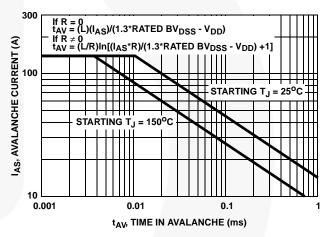


FIGURE 7. SATURATION CHARACTERISTICS



NOTE: Refer to Fairchild Application Notes AN9321 and AN9322.

FIGURE 6. UNCLAMPED INDUCTIVE SWITCHING CAPABILITY

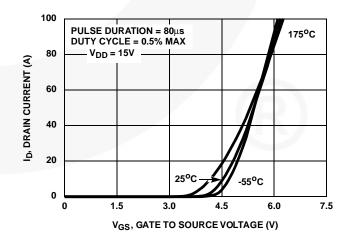


FIGURE 8. TRANSFER CHARACTERISTICS

#### Typical Performance Curves (Continued)

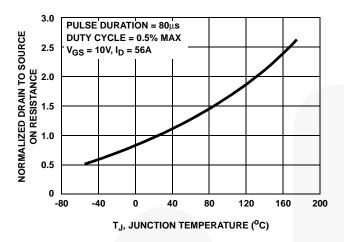


FIGURE 9. NORMALIZED DRAIN TO SOURCE ON RESISTANCE vs JUNCTION TEMPERATURE

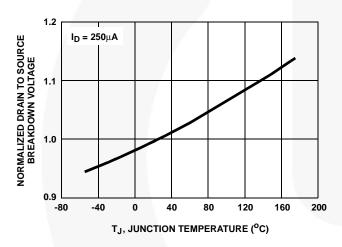


FIGURE 11. NORMALIZED DRAIN TO SOURCE BREAKDOWN VOLTAGE vs JUNCTION TEMPERATURE

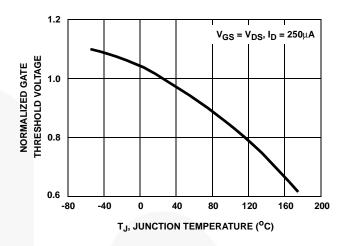


FIGURE 10. NORMALIZED GATE THRESHOLD VOLTAGE vs JUNCTION TEMPERATURE

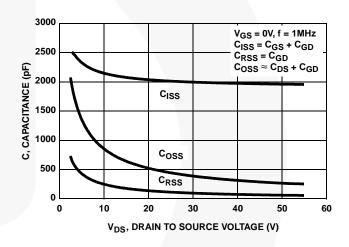
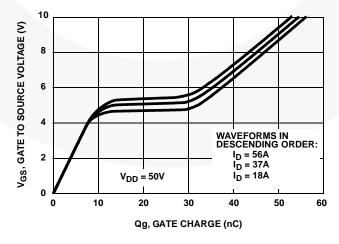


FIGURE 12. CAPACITANCE vs DRAIN TO SOURCE VOLTAGE



NOTE: Refer to Fairchild Application Notes AN7254 and AN7260.

FIGURE 13. GATE CHARGE WAVEFORMS FOR CONSTANT GATE CURRENT

#### **Test Circuits and Waveforms**

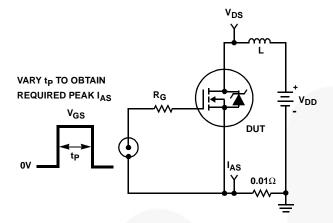


FIGURE 14. UNCLAMPED ENERGY TEST CIRCUIT

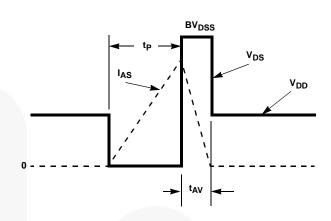


FIGURE 15. UNCLAMPED ENERGY WAVEFORMS

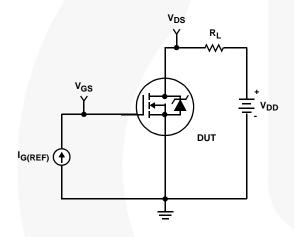


FIGURE 16. GATE CHARGE TEST CIRCUIT

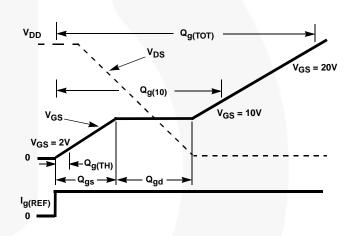


FIGURE 17. GATE CHARGE WAVEFORM

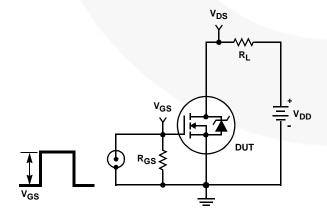


FIGURE 18. SWITCHING TIME TEST CIRCUIT

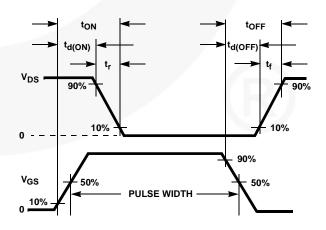


FIGURE 19. RESISTIVE SWITCHING WAVEFORMS

#### **PSPICE Electrical Model**

SUBCKT HUF75639 2 1 3 : rev Oct. 98 CA 12 8 2.8e-9 CB 15 14 2.65e-9 CIN 6 8 1.9e-9 LDRAIN **DPLCAP** DRAIN DBODY 7 5 DBODYMOD DBREAK 5 11 DBREAKMOD 10 DPLCAP 10 5 DPLCAPMOD RLDRAIN RSLC1 DBREAK \ EBREAK 11 7 17 18 110 51 RSLC2 EDS 14 8 5 8 1 EGS 13 8 6 8 1 **ESLC** 11 ESG 6 10 6 8 1 EVTHRES 6 21 19 8 1 50 EVTEMP 20 6 18 22 1 17 18 **RDRAIN** ▲ DBODY **EBREAK ESG** IT 8 17 1 **EVTHRES** 16 21 19 8 **MWEAK** I DRAIN 2 5 2e-9 I GATE EVTEMP LGATE 1 9 1e-9 **RGATE** GATE LSOURCE 3 7 0.47e-9 MMFD 22 9 20 MSTRO **RLGATE 1 9 10** RLGATE RLDRAIN 2 5 20 **LSOURCE** CIN SOURCE **RLSOURCE 3 7 4.69** 8 3 MMED 16 6 8 8 MMEDMOD **RSOURCE** RLSOURCE MSTRO 16 6 8 8 MSTROMOD S2A MWEAK 16 21 8 8 MWEAKMOD S1A **RBREAK** 12 ┌ 13 8 15 17 18 RBREAK 17 18 RBREAKMOD 1 13 RDRAIN 50 16 RDRAINMOD 1.3e-2 S2B S<sub>1</sub>B RVTEMP RGATE 9 20 0.7 RSLC1 5 51 RSLCMOD 1e-6 13 CB 19 CA IT RSLC2 5 50 1e3 14 RSOURCE 8 7 RSOURCEMOD 4.5e-3 **VBAT** RVTHRES 22 8 RVTHRESMOD 1 8 **EGS EDS RVTEMP 18 19 RVTEMPMOD 1** 8 S1A 6 12 13 8 S1AMOD **RVTHRES** 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 =  $\{(V(5,51)/ABS(V(5,51)))^*(PWR(V(5,51)/(1e-6*115),4))\}$ .MODEL DBODYMOD D (IS = 1.4e-12 RS = 3.3e-3 XTI = 4.7 TRS1 = 2e-3 TRS2 = 0.1e-5 CJO = 3.3e-9 TT = 6.1e-8 M = 0.7) .MODEL DBREAKMOD D (RS = 3.5e- 1TRS1 = 1e- 3TRS2 = 1e-6) .MODEL DPLCAPMOD D (CJO = 2.2e- 9IS = 1e-3 0N = 10 M = 0.95 vj = 1.0) .MODEL MMEDMOD NMOS (VTO = 3.5 KP = 4.8 IS = 1e-30 N = 10 TOX = 1 L = 1u W = 1u Rg = 0.7) .MODEL MSTROMOD NMOS (VTO = 3.97 KP = 56.5 IS = 1e-30 N = 10 TOX = 1 L = 1u W = 1u) .MODEL MWEAKMOD NMOS (VTO =3.11 KP = 0.085 IS = 1e-30 N = 10 TOX = 1 L = 1u W = 1u RG = 7 RS = 0.1) .MODEL RBREAKMOD RES (TC1 = 0.8e- 3TC2 = 1e-6) .MODEL RDRAINMOD RES (TC1 = 1e-2 TC2 = 1.75e-5) .MODEL RSLCMOD RES (TC1 = 2.8e-3 TC2 = 14e-6) .MODEL RSOURCEMOD RES (TC1 = 0 TC2 = 0) .MODEL RVTHRESMOD RES (TC = -2.0e-3 TC2 = -1.75e-5) .MODEL RVTEMPMOD RES (TC1 = -2.75e- 3TC2 = 0.05e-9) .MODEL S1AMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = -6.0 VOFF = -3.5) .MODEL S1BMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = -3.5 VOFF = -6.0) .MODEL S2AMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = -2.5 VOFF = 4.95) .MODEL S2AMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = 4.95 VOFF = -2.5) .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

nom temp=25 deg c 100v Ultrafet

```
REV Oct. 98
template huf75639 n2,n1,n3
electrical n2,n1,n3
                                                                                                                             LDRAIN
var i iscl
                                                                             DPLCAP
                                                                                                                                       DRAIN
d..model dbodymod = (is=1.4e-12, xti=4.7, cjo=33e-10,tt=6.1e-8, m=0.7)
                                                                         10
d..model dbreakmod = ()
d..model dplcapmod = (cjo=22e-10,is=1e-30,n=10,m=0.95, vj=1.0)
                                                                                                                            RLDRAIN
                                                                                          RSLC1
m..model mmedmod = (type=_n,vto=3.5,kp=4.8,is=1e-30, tox=1)
                                                                                                       RDBREAK
                                                                                          51
m..model mstrongmod = (type=_n, vto=3.97, kp=56.5, is=1e-30, tox=1)
                                                                           RSLC<sub>2</sub>
m..model mweakmod = (type=_n,vto=3.11,kp=0.085,is=1e-30, tox=1)
                                                                                                                72
                                                                                                                            RDBODY
                                                                                             ISCL
sw_vcsp..model s1amod = (ron=1e-5,roff=0.1,von=-6.0,voff=-3.5)
sw_vcsp..model s1bmod = (ron=1e-5,roff=0.1,von=-3.5,voff=-6.0)
                                                                                                         DBREAK
                                                                                          50
sw vcsp..model s2amod = (ron=1e-5,roff=0.1,von=-2.5,voff=4.95)
sw_vcsp..model s2bmod = (ron=1e-5,roff=0.1,von=4.95,voff=-2.5)
                                                                                         RDRAIN
                                                                       8
                                                                 ESG
                                                                                                                 11
c.ca n12 n8 = 28.5e-10
                                                                              EVTHRES
                                                                                              16
c.cb n15 n14 = 26.5e-10
                                                                                          21
                                                                                                          MWEAK
c.cin n6 n8 = 19e-10
                                             LGATE
                                                               EVTEMP
                                                                                                                            DRODY
                                    GATE
                                                       RGATE
                                                                                                           EBREAK
                                                                                                 MMED
d.dbody n7 n71 = model=dbodymod
                                                                  22
                                                              20
d.dbreak n72 n11 = model=dbreakmod
                                                                                         MSTRO
                                             RLGATE
d.dplcap n10 n5 = model=dplcapmod
                                                                                                                            LSOURCE
                                                                                    CIN
                                                                                                                                       SOURCE
                                                                                               8
i.it n8 n17 = 1
                                                                                                          RSOURCE
I.ldrain n2 n5 = 2.0e-9
                                                                                                                           RLSOURCE
I.lgate n1 n9 = 1e-9
I.Isource n3 n7 = 4.69e-10
                                                                                                               RBREAK
                                                                                   15
                                                                          14
13
m.mmed n16 n6 n8 n8 = model=mmedmod, l=1u, w=1u
m.mstrong n16 n6 n8 n8 = model=mstrongmod, l=1u, w=1u
                                                                S1B
                                                                           o SŽB
                                                                                                                          RVTEMP
m.mweak n16 n21 n8 n8 = model=mweakmod, l=1u, w=1u
                                                                                   СВ
                                                                                                                          19
                                                         CA
                                                                                                        IT
res.rbreak n17 n18 = 1, tc1=0.8e-3,tc2=-1e-6
res.rdbody n71 n5 = 3.3e-3, tc1=2.0e-3, tc2=0.1e-5
                                                                                                                           VBAT
                                                                   EGS
                                                                                EDS
res.rdbreak n72 n5 = 3.5e-1, tc1=1e-3, tc2=1e-6
res.rdrain n50 n16 = 13e-3, tc1=1e-2,tc2=1.75e-5
                                                                                                       8
res.rgate n9 n20 = 0.7
res.rldrain n2 n5 = 20
                                                                                                              RVTHRES
res.rlgate n1 n9 = 10
res.rlsource n3 n7 = 4.69
res.rslc1 n5 n51 = 1e-6, tc1=2.8e-3,tc2=14e-6
res.rslc2 n5 n50 = 1e3
res.rsource n8 n7 = 4.5e-3, tc1=0,tc2=0
res.rvtemp n18 n19 = 1, tc1=-2.75e-3,tc2=0.05e-9
res.rvthres n22 n8 = 1, tc1=-2e-3, tc2=-1.75e-5
spe.ebreak n11 n7 n17 n18 = 110
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)*1e6/115))** 4))
```

#### Spice Thermal Model

**REV APRIL 1998** 

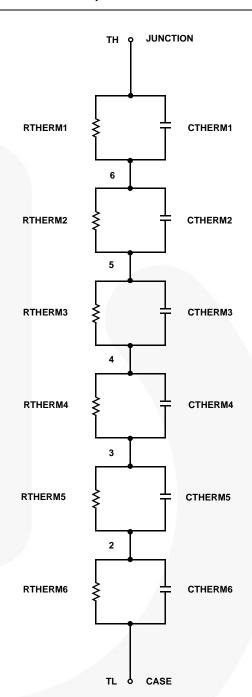
HUF75639

CTHERM1 TH 6 2.8e-3 CTHERM2 6 5 4.6e-3 CTHERM3 5 4 5.5e-3 CTHERM4 4 3 9.2e-3 CTHERM5 3 2 1.7e-2 CTHERM6 2 TL 4.3e-2 RTHERM1 TH 6 5.0e-4 RTHERM2 6 5 1.5e-3 RTHERM3 5 4 2.0e-2 RTHERM4 4 3 9.0e-2 RTHERM5 3 2 1.9e-1 RTHERM6 2 TL 2.9e-1

#### Saber Thermal Model

Saber thermal model HUF75639

template thermal\_model th tl thermal\_c th, tl { ctherm.ctherm1 th 6=2.8e-3 ctherm.ctherm2 6.5=4.6e-3 ctherm.ctherm3 5.4=5.5e-3 ctherm.ctherm4 4.3=9.2e-3 ctherm.ctherm5 3.2=1.7e-2 ctherm.ctherm6 2.1=4.3e-2 rtherm.rtherm1 th 6=5.0e-4 rtherm.rtherm2 6.5=1.5e-3 rtherm.rtherm3 5.4=2.0e-2 rtherm.rtherm4 4.3=9.0e-2 rtherm.rtherm5 3.2=1.9e-1 rtherm.rtherm6 2.1=2.9e-1





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