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Data Sheet October 2013

N-Channel UltraFET Power MOSFET 55 V, 60 A, 19 $m\Omega$

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 TA75332.

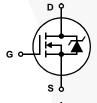
Ordering Information

PART NUMBER	PACKAGE	BRAND
HUF75332P3	TO-220AB	75332P

Features

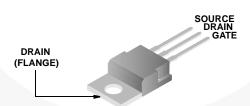
- 60A, 55V
- · Simulation Models
 - Temperature Compensated PSPICE® and SABER™ Models
 - SPICE and SABER Thermal Impedance Models Available on the WEB at: www.fairchildsemi.com
- · Peak Current vs Pulse Width Curve
- UIS Rating Curve
- · Related Literature
 - TB334, "Guidelines for Soldering Surface Mount Components to PC Boards"

Symbol



Packaging

JEDEC TO-220AB



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.

HUF75332P3

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

		UNITS
Drain to Source Voltage (Note 1)VDSS	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)	60	Α
Pulsed Drain Current	Figure 4	
Pulsed Avalanche Rating E _{AS}	Figure 6	
Power Dissipation	145	W
Derate Above 25°C	0.97	W/oC
Operating and Storage Temperature	-55 to 175	οС
Maximum Temperature for Soldering		
Leads at 0.063in (1.6mm) from Case for 10sT _I	300	οС
Package Body for 10s, See Techbrief 334	260	oC

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 _{DSS}	$I_D = 250 \mu A, V_{GS} =$	0V (Figure 11)	55	-	-	V
Zero Gate Voltage Drain Current	I _{DSS}	V _{DS} = 50V, V _{GS} =	0V	\ -	-	1	μΑ
		V _{DS} = 45V, V _{GS} =	$0V, T_C = 150^{\circ}C$	-	-	250	μΑ
Gate to Source Leakage Current	I _{GSS}	$V_{GS} = \pm 20V$		-	-	±100	nA
ON STATE SPECIFICATIONS	_ II				1		
Gate to Source Threshold Voltage	V _{GS(TH)}	$V_{GS} = V_{DS}$, $I_D = 2$	50μA (Figure 10)	2	-	4	V
Drain to Source On Resistance	r _{DS(ON)}	$I_D = 60A, V_{GS} = 10$	OV (Figure 9)	-	0.016	0.019	Ω
THERMAL SPECIFICATIONS						l	
Thermal Resistance Junction to Case	$R_{\theta JC}$	(Figure 3)		/-	-	1.03	oC/W
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	TO-220		-	-	62	oC/W
SWITCHING SPECIFICATIONS (V _{GS} = 10 Turn-On Time	V) t _{ON}	$V_{DD} = 30V$, $I_D \cong 60A$,		-	_	130	ns
, 55	1	Vpp = 30V lp ≈ 6	na .		_	130	ns
Turn-On Delay Time	t _d (ON)	$R_{L} = 0.50\Omega, V_{GS} = 10V,$ $R_{GS} = 6.8\Omega$		-	9	-	ns
Rise Time	t _r	63		-	90	-	ns
Turn-Off Delay Time	t _{d(OFF)}			-	50	-	
Fall Time	t _f						ns
	٩			-	45	-	ns
Turn-Off Time	tOFF	+		-	45	- 125	
Turn-Off Time GATE CHARGE SPECIFICATIONS				-	45 -		ns
		V _{GS} = 0V to 20V	V _{DD} = 30V,	-	70		ns
GATE CHARGE SPECIFICATIONS	toff	$V_{GS} = 0V \text{ to } 20V$ $V_{GS} = 0V \text{ to } 10V$	I _D ≅ 60A,		- (125	ns ns
GATE CHARGE SPECIFICATIONS Total Gate Charge	t _{OFF}				70	125	ns ns
GATE CHARGE SPECIFICATIONS Total Gate Charge Gate Charge at 10V	t_{OFF} $Q_{g(TOT)}$ $Q_{g(10)}$	V _{GS} = 0V to 10V	$I_D \cong 60A$, $R_L = 0.50\Omega$	-	70 40	125 85 50	ns ns nC

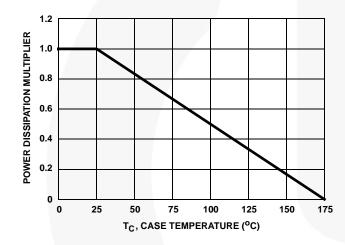
$\textbf{Electrical Specifications} \hspace{0.3cm} \textbf{T}_{C} = 25^{o} \text{C, Unless Otherwise Specified}$

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS
CAPACITANCE SPECIFICATIONS						
Input Capacitance	C _{ISS}	$V_{DS} = 25V, V_{GS} = 0V,$	-	1300	-	pF
Output Capacitance	C _{OSS}	f = 1MHz (Figure 12)	-	480	-	pF
Reverse Transfer Capacitance	C _{RSS}	,	-	115	1	pF

Source to Drain Diode Specifications

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Source to Drain Diode Voltage	V_{SD}	I _{SD} = 60A	-	-	1.25	V
Reverse Recovery Time	t _{rr}	$I_{SD} = 60A$, $dI_{SD}/dt = 100A/\mu s$	-	-	75	ns
Reverse Recovered Charge	Q_{RR}	$I_{SD} = 60A$, $dI_{SD}/dt = 100A/\mu s$	-	-	140	nC

Typical Performance Curves



80 60 CASE TEMPERATURE (°C)

FIGURE 1. NORMALIZED POWER DISSIPATION vs CASE TEMPERATURE

FIGURE 2. MAXIMUM CONTINUOUS DRAIN CURRENT vs CASE TEMPERATURE

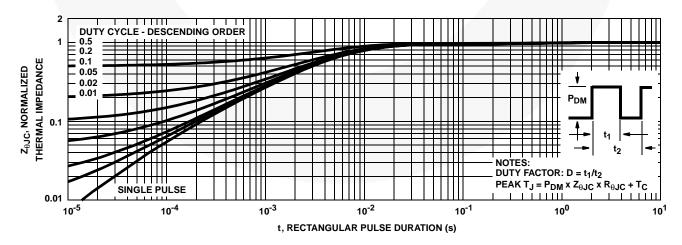


FIGURE 3. NORMALIZED MAXIMUM TRANSIENT THERMAL IMPEDANCE

Typical Performance Curves (Continued)

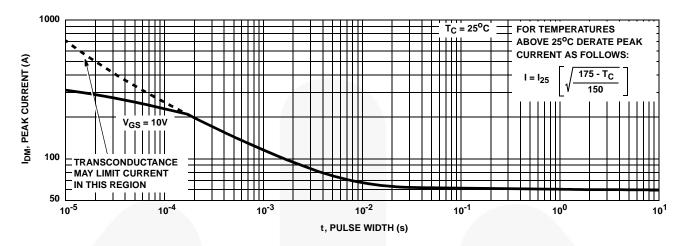


FIGURE 4. PEAK CURRENT CAPABILITY

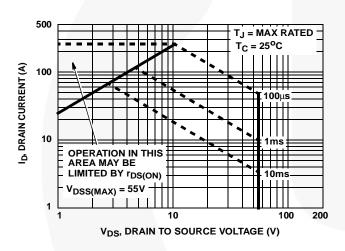


FIGURE 5. FORWARD BIAS SAFE OPERATING AREA

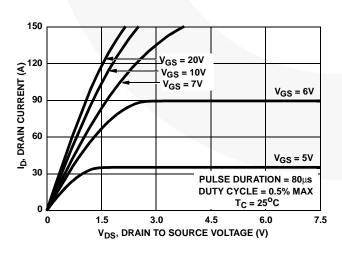
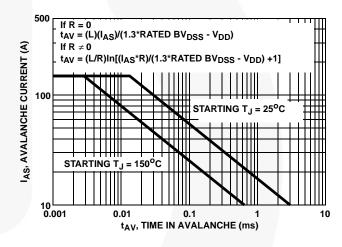


FIGURE 7. SATURATION CHARACTERISTICS



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

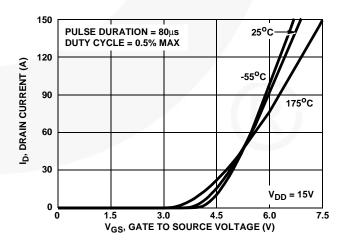


FIGURE 8. TRANSFER CHARACTERISTICS

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Typical Performance Curves (Continued)

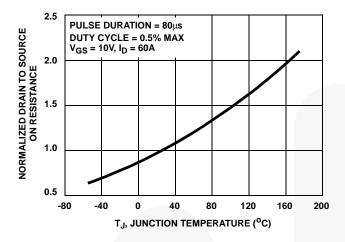


FIGURE 9. NORMALIZED DRAIN TO SOURCE ON RESISTANCE vs JUNCTION TEMPERATURE

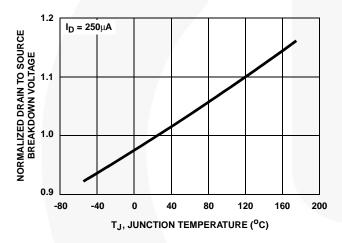


FIGURE 11. NORMALIZED DRAIN TO SOURCE BREAKDOWN VOLTAGE vs JUNCTION TEMPERATURE

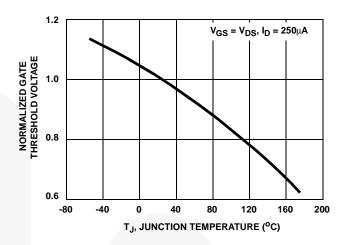


FIGURE 10. NORMALIZED GATE THRESHOLD VOLTAGE vs JUNCTION TEMPERATURE

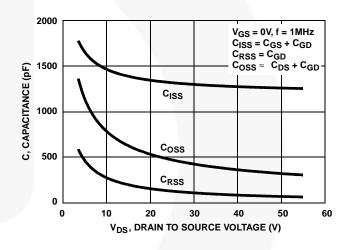
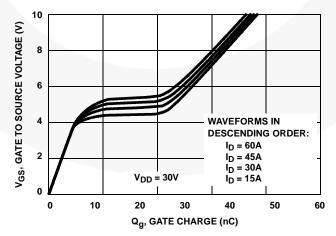


FIGURE 12. CAPACITANCE vs DRAIN TO SOURCE VOLTAGE



NOTE: Refer to Fairchild Application Notes AN7254 and AN7260.

FIGURE 13. GATE CHARGE WAVEFORMS FOR CONSTANT GATE CURRENT

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Test Circuits and Waveforms

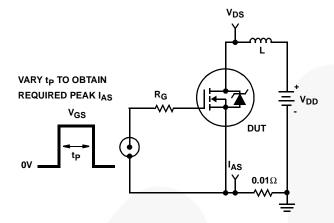


FIGURE 14. UNCLAMPED ENERGY TEST CIRCUIT

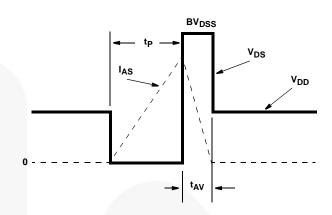


FIGURE 15. UNCLAMPED ENERGY WAVEFORMS

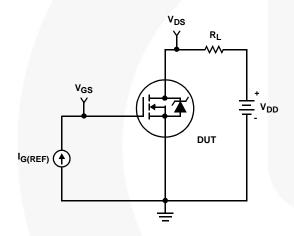


FIGURE 16. GATE CHARGE TEST CIRCUIT

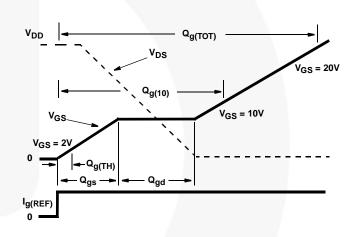


FIGURE 17. GATE CHARGE WAVEFORM

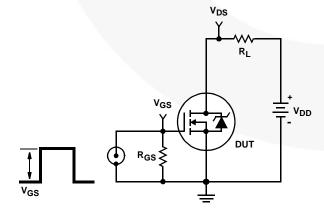


FIGURE 18. SWITCHING TIME TEST CIRCUIT

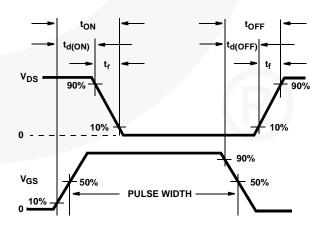


FIGURE 19. RESISTIVE SWITCHING WAVEFORMS

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PSPICE Electrical Model

```
.SUBCKT HUF75332 2 1 3;
                                rev 17 February 1999
CA 12 8 1.8e-9
CB 15 14 1.73e-9
                                                                                                               LDRAIN
                                                                     DPLCAP
CIN 6 8 1.19e-9
                                                                                                                         DRAIN
                                                                                                                          0 2
                                                                                                               RLDRAIN
DBODY 7 5 DBODYMOD
                                                                                 RSLC1
DBREAK 5 11 DBREAKMOD
                                                                                              DBREAK \
                                                                                51
DPLCAP 10 5 DPLCAPMOD
                                                                   RSLC2
                                                                                   ESLC
                                                                                                     11
EBREAK 11 7 17 18 58.85
                                                                                 50
EDS 14 8 5 8 1
                                                                                                      17
18
                                                                                                             DBODY
EGS 13 8 6 8 1
                                                                                ₹RDRAIN
                                                                8
                                                                                             EBREAK
                                                          ESG
ESG 6 10 6 8 1
                                                                     EVTHRES
EVTHRES 6 21 19 8 1
                                                                                21
EVTEMP 20 6 18 22 1
                                                                        19
8
                                                                                               MWEAK
                                         LGATE
                                                         EVTEMP
                                                 RGATE
                                GATE
                                                                                      MMED
                                                                                   •
IT 8 17 1
                                                 9
                                                       20
                                        RLGATE
LDRAIN 2 5 1e-9
                                                                                                              LSOURCE
LGATE 1 9 1e-9
                                                                           CIN
                                                                                                                         SOURCE
                                                                                    8
LSOURCE 3 7 1e-9
                                                                                                                           3
K1 LSOURCE LGATE 0.0085
                                                                                               RSOURCE
                                                                                                              RLSOURCE
MMED 16 6 8 8 MMEDMOD
                                                          S<sub>1</sub>A
                                                                    S2A
MSTRO 16 6 8 8 MSTROMOD
                                                                                                   RBREAK
                                                             <u>13</u>
8
                                                                  14
13
                                                                          15
MWEAK 16 21 8 8 MWEAKMOD
                                                                                               17
RBREAK 17 18 RBREAKMOD 1
                                                                    S2B
                                                                                                           ≷RVTEMP
                                                         S1B
RDRAIN 50 16 RDRAINMOD 4.5e-3
                                                                           CB
                                                                                                             19
                                                   CA
RGATE 9 20 1.3
                                                                                             IT (↑
RLDRAIN 2510
                                                                                                               VBAT
RLGATE 1 9 10
                                                            EGS
                                                                       EDS
                                                                              8
RLSOURCE 3 7 10
RSLC1 5 51 RSLCMOD 1e-6
                                                                                            8
RSLC2 5 50 1e3
RSOURCE 8 7 RSOURCEMOD 5.95e-3
                                                                                                  RVTHRES
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*180),4.6))}
.MODEL DBODYMOD D (IS = 1.3e-12 RS = 3.0e-3 IKF = 20 XTI = 6 TRS1 = 2.7e-3 TRS2 = 7.0e-7 CJO = 1.7e-9 TT = 4.0e-8 M = 0.45 vj = 0.75)
.MODEL DBREAKMOD D (RS = 1.71e-2 IKF = 1.0e-5 TRS1 = -4.0e-4 TRS2 = -1.55e-5)
.MODEL DPLCAPMOD D (CJO = 1.8e-9 IS = 1e-30 N = 1 M = 0.9 vj = 1.45)
.MODEL MMEDMOD NMOS (VTO = 3.183 KP = 2 IS = 1e-30 N = 10 TOX = 1 L = 1u W = 1u RG = 1.3)
.MODEL MSTROMOD NMOS (VTO = 3.66 KP = 51.5 IS = 1e-30 N = 10 TOX = 1 L = 1u W = 1u)
MODEL MWEAKMOD NMOS (VTO = 2.703 KP = 0.008 IS = 1e-30 N = 10 TOX = 1 L = 1u W = 1u RG = 13)
.MODEL RBREAKMOD RES (TC1 = 1.05e-3 TC2 = 4.5e-7)
.MODEL RDRAINMOD RES (TC1 = 1.16e-2 TC2 = 1.7e-5)
.MODEL RSLCMOD RES (TC1 = 3.96e-3 TC2 = 2.7e-6)
.MODEL RSOURCEMOD RES (TC1 = 1e-3 TC2 = 1e-5)
.MODEL RVTHRESMOD RES (TC1 = -2.8e-3 TC2 = -1.0e-5)
.MODEL RVTEMPMOD RES (TC1 = -2.75e-3 TC2 = 5.0e-7)
.MODEL S1AMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = -8 VOFF= -3)
.MODEL S1BMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = -3 VOFF= -8)
.MODEL S2AMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = 0 VOFF= 0.5)
.MODEL S2BMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = 0.5 VOFF= 0)
.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 17 February 1999
template huf75332 n2, n1, n3
electrical n2, n1, n3
var i iscl
d..model dbodymod = (is = 1.3e-12, xti = 6, cjo = 1.7e-9, tt = 4.0e-8, m = 0.45, vj = 0.75)
d..model dbreakmod = ()
                                                                                                                                LDRAIN
d..model dplcapmod = (cjo = 1.8e-9, is = 1e-30, m = 0.9, vj = 1.45)
                                                                                  DPI CAP
                                                                                                                                           DRAIN
m..model mmedmod = (type=_n, vto = 3.183, kp = 2, is = 1e-30, tox = 1)
                                                                              10
m..model mstrongmod = (type=_n, vto = 3.66, kp = 51.5, is = 1e-30, tox = 1)
                                                                                                                               RLDRAIN
m..model mweakmod = (type=_n, vto = 2.703, kp = 8.0e-3, is = 1e-30, tox = 1)
                                                                                             ≻RSLC1
                                                                                                          RDBREAK
sw_vcsp..model s1amod = (ron = 1e-5, roff = 0.1, von = -8, voff = -3)
                                                                                              51
                                                                               RSLC2 €
sw_vcsp..model s1bmod = (ron = 1e-5, roff = 0.1, von = -3, voff = -8)
                                                                                                                   72
                                                                                                                                RDBODY
sw_vcsp..model s2amod = (ron = 1e-5, roff = 0.1, von = 0, voff = 0.5)
                                                                                            Ŧ
                                                                                                ISCL
sw_vcsp..model s2bmod = (ron = 1e-5, roff = 0.1, von = 0.5, voff = 0)
                                                                                                            DBREAK
                                                                                              50
c.ca n12 n8 = 1.8e-9
                                                                                             RDRAIN
c.cb n15 n14 = 1.73e-9
                                                                      ESG
                                                                                  EVTHRES
c.cin n6 n8 = 1.19e-9
                                                                                              21
                                                                                     19
8
                                                                                                              MWEAK
                                                                    EVTEMP
                                                  IGATE
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
                                                                                        Ч<mark>⊸</mark>мѕтко
                                                  RLGATE
i.it n8 n17 = 1
                                                                                                                               LSOURCE
                                                                                        CIN
                                                                                                                                          SOURCE
                                                                                                  8
I.ldrain n2 n5 = 1.0e-9
1.1gate n1 n9 = 1.0e-9
                                                                                                              RSOURCE
                                                                                                                              RLSOURCE
I.Isource n3 n7 = 1.0e-9
k.kl i (l.lgate) i (l.lsource) = I (l.lgate), I (l.lsource), 0.0085
                                                                                                                  RBREAK
                                                                                                                     ₩
                                                                                                                             18
m.mmed n16 n6 n8 n8 = model=mmedmod, I = 1u, w = 1u
m.mstrong n16 n6 n8 n8 = model=mstrongmod, I = 1u, w = 1u
                                                                                                                             RVTEMP
                                                                               o S2B
                                                                    S<sub>1</sub>B
m.mweak n16 n21 n8 n8 = model=mweakmod, I = 1u, w = 1u
                                                                                       CB
                                                                                                                             19
                                                              CA
                                                                                                            IT
res.rbreak n17 n18 = 1, tc1 = 1.05e-3, tc2 = 4.5e-7
res.rdbody n71 n5 = 3.0e-3, tc1 = 2.7e-3, tc2 = 7.0e-7
                                                                                                                               VBAT
                                                                        FGS
                                                                                     FDS
res.rdbreak n72 n5 = 1.71e-2, tc1 = -4.0e-4, tc2 = -1.55e-5
res.rdrain n50 n16 = 4.5e-3, tc1 = 1.16e-2, tc2 = 1.7e-5
                                                                                                          8
res.rgate n9 n20 = 1.3
res.rldrain n2 n5 = 10
                                                                                                                 RVTHRES
res.rlgate n1 n9 = 10
res.rlsource n3 n7 = 10
res.rslc1 n5 n51 = 1e-6, tc1 = 3.96e-3, tc2 = 2.7e-6
res.rslc2 n5 n50 = 1e3
res.rsource n8 n7 = 5.95e-3, tc1 = 1e-3, tc2 = 1e-5
res.rvtemp n18 n19 = 1, tc1 = -2.75e-3, tc2 = 5.0e-7
res.rvthres n22 n8 = 1, tc1 = -2.8e-3, tc2 = -1.0e-5
spe.ebreak n11 n7 n17 n18 = 58.85
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)*1e6/180))** 4.6))
```

SPICE Thermal Model

REV 11February 1999

HUF75332

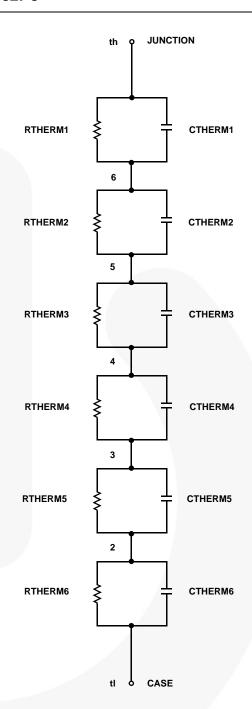
CTHERM1 th 6 4.00e-3
CTHERM2 6 5 7.00e-3
CTHERM3 5 4 7.50e-3
CTHERM4 4 3 8.00e-3
CTHERM5 3 2 1.85e-2
CTHERM6 2 tl 12.55

RTHERM1 th 6 7.09e-3
RTHERM2 6 5 1.77e-2
RTHERM3 5 4 4.97e-2
RTHERM4 4 3 2.79e-1
RTHERM5 3 2 4.21e-1
RTHERM6 2 tl 5.58e-2

SABER Thermal Model

SABER thermal model HUF75332

template thermal_model th tl thermal_c th, tl { ctherm.ctherm1 th 6=4.00e-3 ctherm.ctherm2 6.5=7.00e-3 ctherm.ctherm3 5.4=7.50e-3 ctherm.ctherm4 4.3=8.00e-3 ctherm.ctherm5 3.2=1.85e-2 ctherm.ctherm6 $2.11e\text{-}11e\text{$





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