# <u>MOSFET</u> – Power, N-Channel, UltraFET

55 V, 75 A, 7 mΩ

## HUF75345G3, HUF75345P3, HUF75345S3S

## Description

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.

## Features

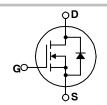
- 75 A, 55 V
- Simulation Models
  - Temperature Compensated PSPICE<sup>™</sup> and SABER<sup>®</sup> Models
     Thermal Impedance SPICE and SABER Models
  - Infimal Impedance SPICE and SABER M
- Peak Current vs Pulse Width Curve
- UIS Rating Curve
- These Devices are Pb-Free

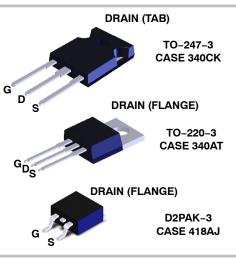


## **ON Semiconductor®**

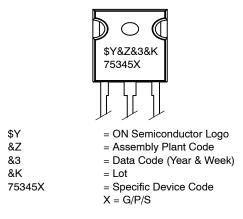
## www.onsemi.com

V <sub>DSS</sub>	R <sub>DS(ON)</sub> MAX	I <sub>D</sub> MAX
55 V	$7 \text{ m}\Omega$	75 A





## MARKING DIAGRAM



### **ORDERING INFORMATION**

See detailed ordering and shipping information on page 2 of this data sheet.

## PACKAGE MARKING AND ORDERING INFORMATION

Part Number	Package	Brand
HUF75345G3	TO-247-3	75345G
HUF75345P3	TO-220-3	75345P
HUF75345S3ST	D2PAK-3	75345S

## MOSFET MAXIMUM RATINGS (T<sub>C</sub> = 25°C, Unless otherwise noted)

Symbol	Parameter		Value	Unit
V <sub>DSS</sub>	Drain to Source Voltage (Note 1)		55	V
V <sub>DGR</sub>	Drain to Gate Voltage ( $R_{GS}$ = 20 k $\Omega$ ) (Note 1)		55	V
$V_{GS}$	Gate to Source Voltage		±20	V
I <sub>D</sub>	Drain Current	– Continuous (Figure 2)	75	А
I <sub>DM</sub>	Drain Current	– Pulsed	Figure 4	
E <sub>AS</sub>	Pulsed Avalanche Rating		Figure 6	
PD	Power Dissipation	(T <sub>C</sub> = 25°C)	325	W
		– Derate Above 25°C	2.17	W/°C
TJ, T <sub>STG</sub>	Operating and Storage Temperature		-55 to +175	°C
ΤL	Maximum Temperature for Soldering Leads at 0.063 in (1.6 mm) from Case for 10 s		300	°C
T <sub>pkg</sub>	Maximum Temperature for Soldering Leads Package Body for 10 s		260	°C

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected. 1.  $T_J = 25^{\circ}C$  to  $150^{\circ}C$ 

Symbol	Parameter	Test Conditions	Min.	Тур.	Max.	Unit
OFF STATE CH	IARACTERISTICS					
BV <sub>DSS</sub>	Drain to Source Breakdown Voltage	$I_D$ = 250 $\mu$ A, V <sub>GS</sub> = 0 V (Figure 11)	55			V
I <sub>DSS</sub>	Zero Gate Voltage Drain Current	$V_{DS} = 50 \text{ V}, \text{ V}_{GS} = 0 \text{ V}$			1	μA
		$V_{DS}$ = 45 V, $V_{GS}$ = 0 V, $T_{C}$ = 150°C			250	1
I <sub>GSS</sub>	Gate to Source Leakage Current	$V_{GS} = \pm 20 \text{ V}$			±100	nA
N STATE CH	ARACTERISTICS					
V <sub>GS(TH)</sub>	Gate to Source Threshold Voltage	$V_{GS}$ = $V_{DS}$ , $I_D$ = 250 $\mu$ A (Figure 10)	2		4.0	V
R <sub>DS(ON)</sub>	Drain to Source On Resistance	I <sub>D</sub> = 75 A, V <sub>GS</sub> = 10 V (Figure 9)		0.006	0.007	Ω
HERMAL CH	ARACTERISTICS					
$R_{\thetaJC}$	Thermal Resistance Junction to Case	(Figure 3)			0.46	°C/W
$R_{\thetaJA}$	Thermal Resistance Junction to Ambient	TO-247			30	°C/W
	Thermal Resistance Junction to Ambient	TO-220, D2PAK			62	°C/W
	HARACTERISTICS (V <sub>GS</sub> = 10 V)			•	1	
t <sub>ON</sub>	Turn-On Time	$V_{DD} = 30 \text{ V}, \text{ I}_{D} = 75 \text{ A},$			195	ns
t <sub>d(ON)</sub>	Turn-On Delay Time	$R_{L}^{2} = 0.4 \Omega, V_{GS} = 10 V, R_{GS} = 2.5 \Omega$		14		ns
t <sub>r</sub>	Rise Time			118		ns
t <sub>d(OFF)</sub>	Turn-Off Delay Time			42		ns
t <sub>f</sub>	Fall Time			26		ns
t <sub>OFF</sub>	Turn-Off Time				98	ns
ATE CHARGI	E CHARACTERISTICS					
Q <sub>g(tot)</sub>	Total Gate Charge	$\begin{array}{l} V_{GS} = 0 \text{ V to } 20 \text{ V}, \\ V_{DD} = 30 \text{ V}, \text{ I}_{D} = 75 \text{ A}, \text{ R}_{L} = 0.4 \Omega, \\ \text{I}_{g(\text{REF})} = 1.0 \text{ mA (Figure 13)} \end{array}$		220	275	nC
Q <sub>g(10)</sub>	Gate Charge at 10 V	$\begin{array}{l} V_{GS} = 0 \; V \; to \; 10 \; V, \\ V_{DD} = 30 \; V, \; I_{D} = 75 \; A, \; R_{L} = 0.4 \; \Omega, \\ I_{g(REF)} = 1.0 \; \text{mA} \; (Figure \; 13) \end{array}$		125	165	nC
Q <sub>g(th)</sub>	Threshold Gate Charge	$\begin{array}{l} V_{GS} = 0 \; V \; to \; 2 \; V, \\ V_{DD} = \; 30 \; V, \; I_{D} = \; 75 \; A, \; R_{L} = \; 0.4 \; \Omega, \\ I_{g(REF)} = \; 1.0 \; \text{mA} \; (\text{Figure 13}) \end{array}$		6.8	10	nC
Q <sub>gs</sub>	Gate to Source Gate Charge	$V_{DD} = 30 \text{ V}, \text{ I}_D = 75 \text{ A}, \text{ R}_L = 0.4 \Omega,$		14		nC
Q <sub>gd</sub>	Gate to Drain "Miller" Charge	I <sub>g(REF)</sub> = 1.0 mA (Figure 13)		58		nC
APACITANCE	E CHARACTERISTICS			-	-	-
C <sub>iss</sub>	Input Capacitance	V <sub>DS</sub> = 25 V, V <sub>GS</sub> = 0 V, f = 1 Mhz		4000		pF
C <sub>oss</sub>	Output Capacitance	(Figure 12)		1450		pF
C <sub>rss</sub>	Reverse Transfer Capacitance			450		pF
OURCE TO D	RAIN DIODE CHARACTERISTICS			•	-	
V <sub>SD</sub>	Source to Drain Diode Voltage	I <sub>SD</sub> = 75 A			1.25	V
t <sub>rr</sub>	Reverse Recovery Time	I <sub>SD</sub> = 75 A, dl <sub>SD</sub> /dt = 100 A/μs			55	ns

## ELECTRICAL CHARACTERISTICS (T<sub>C</sub> = 25°C unless otherwise noted)

 $\mathsf{Q}_{\mathsf{R}\mathsf{R}}$ 

Reverse Recovered Charge

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

 $I_{SD}$  = 75 A, dI<sub>SD</sub>/dt = 100 A/µs

nC

80

## **TYPICAL PERFORMANCE CURVES**

 $T_C = 25^{\circ}C$  unless otherwise noted

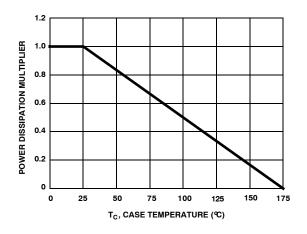


Figure 1. Normalized Power Dissipation vs. Case Temperature

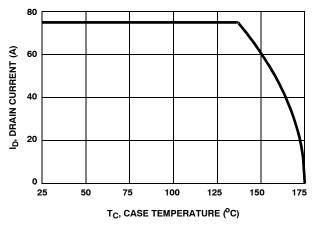


Figure 2. Maximum Continuous Drain Current vs Case Temperature

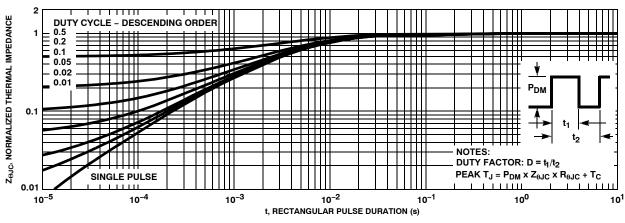
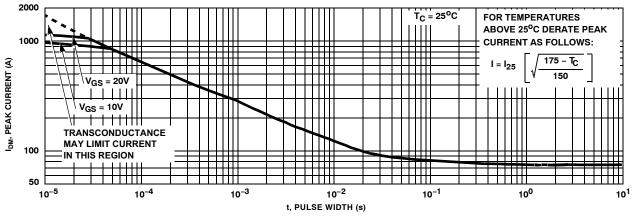


Figure 3. Normalized Maximum Transient Thermal Impedance





## TYPICAL CHARACTERISTICS (Continued)

 $T_C = 25^{\circ}C$  unless otherwise noted

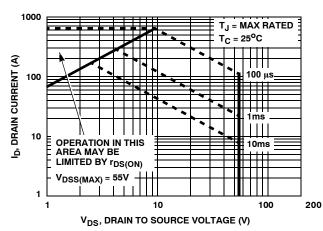


Figure 5. Forward Bias Safe Operating Area

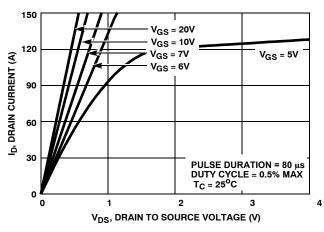


Figure 7. Saturation Characteristics

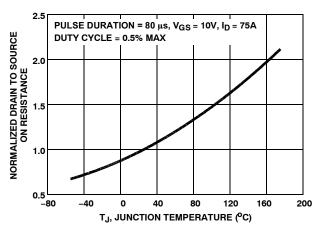


Figure 9. Normalized Drain to Source On Resistance vs Junction Temperature

NOTE: Refer to ON Semiconductor Application Notes AN-7514 and AN-7515

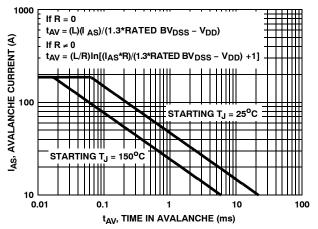


Figure 6. Unclamped Inductive Switching Capability

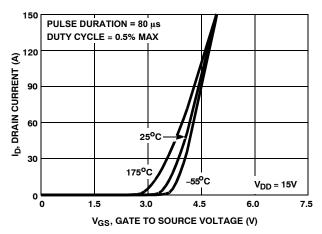
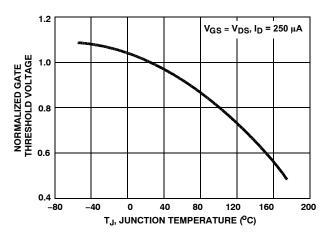


Figure 8. Transfer Characteristics





## TYPICAL CHARACTERISTICS (Continued)

 $T_C$  = 25°C unless otherwise noted

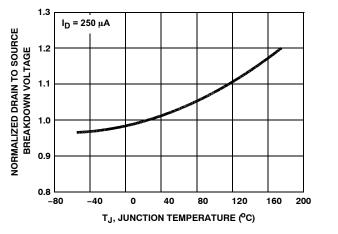


Figure 11. Normalized Drain to Source Breakdown vs. Junction Temperature

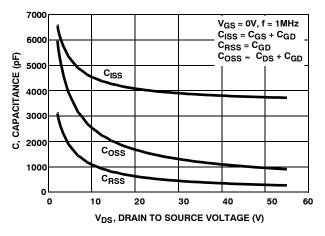
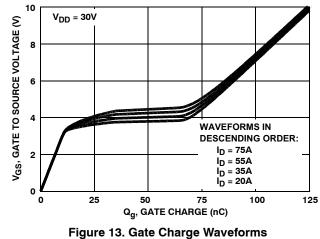


Figure 12. Capacitance vs. Drain to Source Voltage



for Constant Gate Currents

## **TEST CIRCUITS WAVEFORMS**

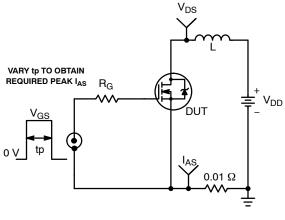


Figure 14. Unclamped Energy Test Circuit

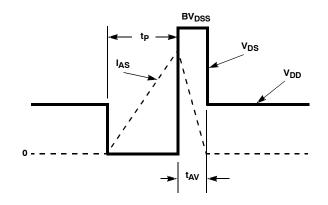


Figure 15. Unclamped Energy Waveforms

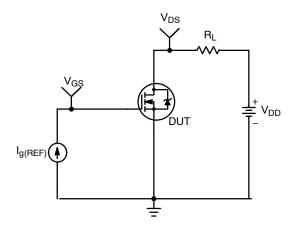


Figure 16. Gate Charge Test Circuit

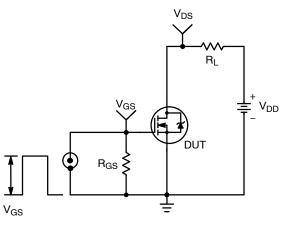


Figure 18. Switching Time Test Circuit

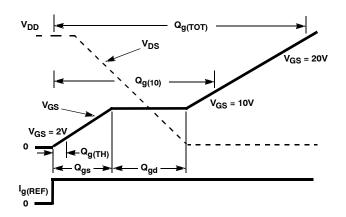
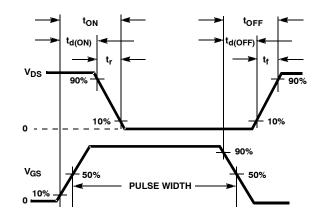
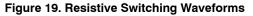


Figure 17. Gate Charge Waveforms





## **PSPICE Electrical Model**

.SUBCKT HUF75345 2 1 3 ; rev 3 Feb 99

CA 12 8 5.55e-9 CB 15 14 5.55e-9 CIN 6 8 3.45e-9

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

EBREAK 11 7 17 18 56.7 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 2.6e-9 LSOURCE 3 7 1.1e-9 KGATE LSOURCE LGATE 0.0085

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 1e-4 RGATE 9 20 0.36 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 3.15e-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\*500),3.5))}

.MODEL DBODYMOD D (IS = 6e-12 RS = 1.4e-3 IKF = 20 XTI = 5 TRS1 = 2.75e-3 TRS2 = 5.0e-6 CJO = 5.5e-9 TT = 5.9e-8 M = 0.5 VJ = 0.75) .MODEL DBREAKMOD D (RS = 2.8e-2 IKF = 30 TRS1 = -4.0e-3 TRS2 = 1.0e-6) .MODEL DPLCAPMOD D (CJO = 6.75e-9 IS = 1e-30 M = 0.88 VJ = 1.45 FC = 0.5) .MODEL MMEDMOD NMOS (VTO = 2.93 KP = 13.75 IS = 1e-30 N = 10 TOX = 1 L = 1u W = 1u RG = 0.36) .MODEL MSTROMOD NMOS (VTO = 3.23 KP = 96 IS = 1e-30 N = 10 TOX = 1 L = 1u W = 1u Lambda = 0.06) .MODEL MWEAKMOD NMOS (VTO = 2.35 KP = 0.02 IS = 1e-30 N = 10 TOX = 1 L = 1u W = 1u RG = 3.6) .MODEL RBREAKMOD RES (TC1 = 8.0e-4 TC2 = 4.0e-6) .MODEL RDRAINMOD RES (TC1 = 1.5e-1 TC2 = 6.5e-4)

.MODEL RSLCMOD RES (TC1 = 1.0e-4 TC2 = 1.05e-6) .MODEL RSOURCEMOD RES (TC1 = 1.0e-3 TC2 = 0) .MODEL RVTHRESMOD RES (TC1 = -1.5e-3 TC2 = -2.6e-5) .MODEL RVTEMPMOD RES (TC1 = -2.75e-3 TC2 = 1.45e-6) .MODEL S1AMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = -9.00 VOFF = -4.00) .MODEL S1BMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = -4.00 VOFF = -9.00) .MODEL S2AMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = 0.00 VOFF = 0.50)

.MODEL S2BMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = 0.50 VOFF= 0.00)

## .ENDS

NOTE: For further discussion of the PSPICE model, consult <u>A New PSPICE Sub-Circuit for the Power MOSFET</u> <u>Featuring Global Temperature Options</u>; IEEE Power Electronics Specialist Conference Records, 1991, written by William J. Hepp and C. Frank Wheatley.

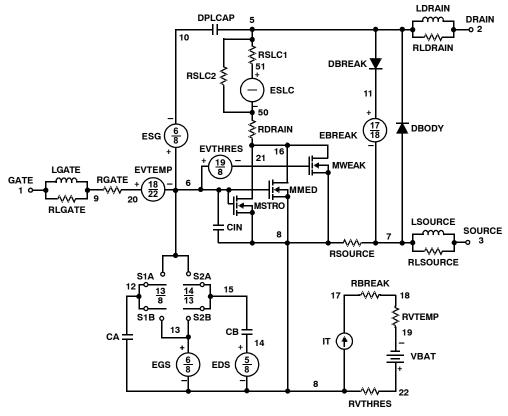


Figure 20. PSPICE Electrical Model

## **SABER Electrical Model**

**REV 3 February 1999** template huf75345 n2, n1, n3 electrical n2, n1, n3 { var i iscl d..model dbodymod = (is = 6e-12, xti = 5, cjo = 5.5e-9, tt = 5.9e-8, m=0.5, vj=0.75) d..model dbreakmod = () d..model dplcapmod = (cjo = 6.75e-9, is = 1e-30, m = 0.88, vj = 1.45, fc=0.5) m..model mmedmod = (type= n, vto = 2.93, kp = 13.75, is = 1e-30, tox = 1) m..model mstrongmod = (type= n, vto = 3.23, kp = 96, is=1e-30,tox=1, lambda = 0.06) m..model mweakmod = (type= n, vto = 2.35, kp = 0.02, is = 1e-30, tox = 1) sw vcsp..model s1amod = (ron = 1e-5, roff = 0.1, von = -9, voff = -4) sw vcsp..model s1bmod = (ron = 1e-5, roff = 0.1, von = -4, voff = -9) sw vcsp..model s2amod = (ron = 1e-5, roff = 0.1, von = 0, voff = 0.5) sw vcsp..model s2bmod = (ron = 1e-5, roff = 0.1, von = 0.5, voff = 0) c.ca n12 n8 = 5.55e - 9c.cb n15 n14 = 5.55e-9c.cin n6 n8 = 3.45e-9d.dbody n7 n71 = model=dbodymod d.dbreak n72 n11 = model=dbreakmod d.dplcap n10 n5 = model=dplcapmodi.it n8 n17 = 11.1 drain n2 n5 = 1e-91.1gate n1 n9 = 2.6e-91.1source n3 n7 = 1.1e-9k.k1 i(l.lgate) i(l.lsource) = l(l.lgate), l(l.lsource), 0.0085 m.mmed n16 n6 n8 n8 = model=mmedmod, l = 1u, w = 1um.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 = 8e-4, tc2 = 4e-6res.rdbody n71 n5 = 1.4e-3, tc1 = 2.75e-3, tc2 = 5e-6res.rdbreak n72 n5 = 2.8e-2, tc1 = -4e-3, tc2 = 1e-6res.rdrain n50 n16 = 1e-4, tc1 = 1.5e-1, tc2 = 6.5e-4 res.rgate n9 n20 = 0.36res.rldrain n2 n5 = 10res.rlgate n1 n9 = 26res.rlsource n3 n7 = 11res.rslc1 n5 n51 = 1e-6, tc1 = 1e-4, tc2 = 1.05e-6 res.rslc2 n5 n50 = 1e3res.rsource n8 n7 = 3.15e-3, tc1 = 1e-3, tc2 = 0res.rvtemp n18 n19 = 1, tc1 = -2.75e-3, tc2 = 1.45e-6res.rvthres n22 n8 = 1, tc1 = -1.5e-3, tc2 = -2.6e-5spe.ebreak n11 n7 n17 n18 = 56.7 spe.eds n14 n8 n5 n8 = 1spe.egs n13 n8 n6 n8 = 1 spe.esg n6 n10 n6 n8 = 1spe.evtemp n20 n6 n18 n22 = 1spe.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)*1e6/500))** 3.5))
  }
}
```

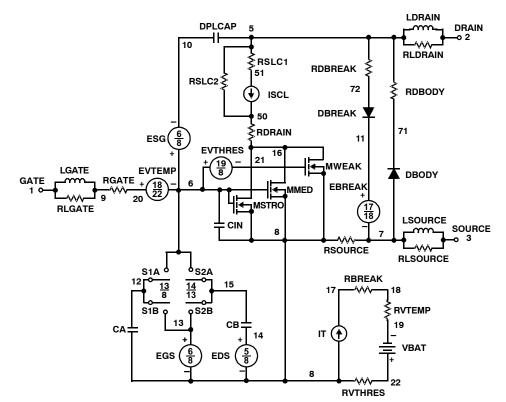


Figure 21. SABER Electrical Model

## SPICE Thermal Model

REV 5 February 1999

## HUF75345

CTHERM1 th 6 6.3e-3 CTHERM2 6 5 1.5e-2 CTHERM3 5 4 2.0e-2 CTHERM4 4 3 3.0e-2 CTHERM5 3 2 8.0e-2 CTHERM6 2 tl 1.5e-1

RTHERM1 th 6 5.0e-3 RTHERM2 6 5 1.8e-2 RTHERM3 5 4 5.0e-2 RTHERM4 4 3 8.5e-2 RTHERM5 3 2 1.0e-1 RTHERM6 2 tl 1.1e-1

## **SABER Thermal Model**

SABER thermal model HUF75345

template thermal\_model th tl thermal\_c th, tl { ctherm.ctherm1 th 6 = 6.3e-3ctherm.ctherm2 6 5 = 1.5e-2ctherm.ctherm3 5 4 = 2.0e-2ctherm.ctherm4 4 3 = 3.0e-2ctherm.ctherm5 3 2 = 8.0e-2ctherm.ctherm62tl = 1.5e-1rtherm.rtherm1 th 6 = 5.0e-3rtherm.rtherm265 = 1.8e-2rtherm.rtherm354 = 5.0e-2rtherm.rtherm4 4 3 = 8.5e-2rtherm.rtherm5 3 2 = 1.0e - 1rtherm.rtherm62tl = 1.1e-1}

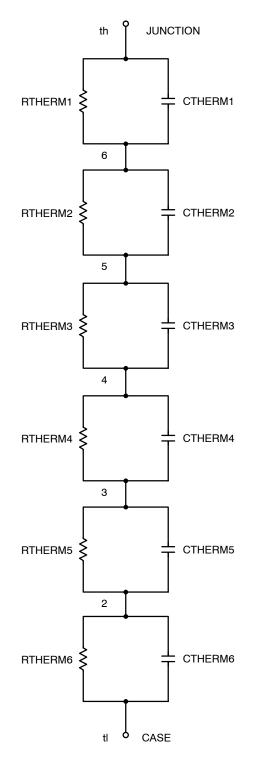
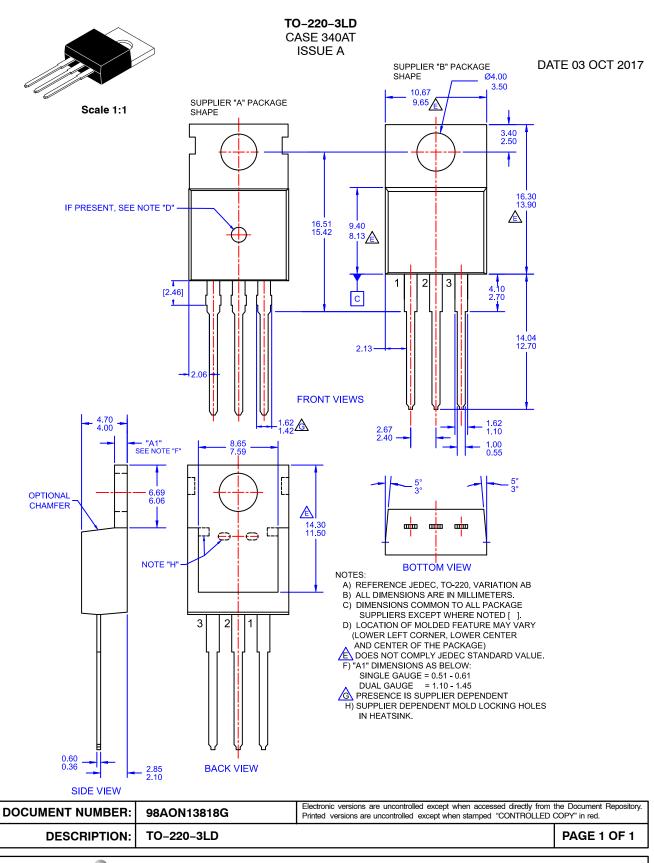


Figure 22. Thermal Model

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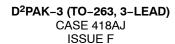




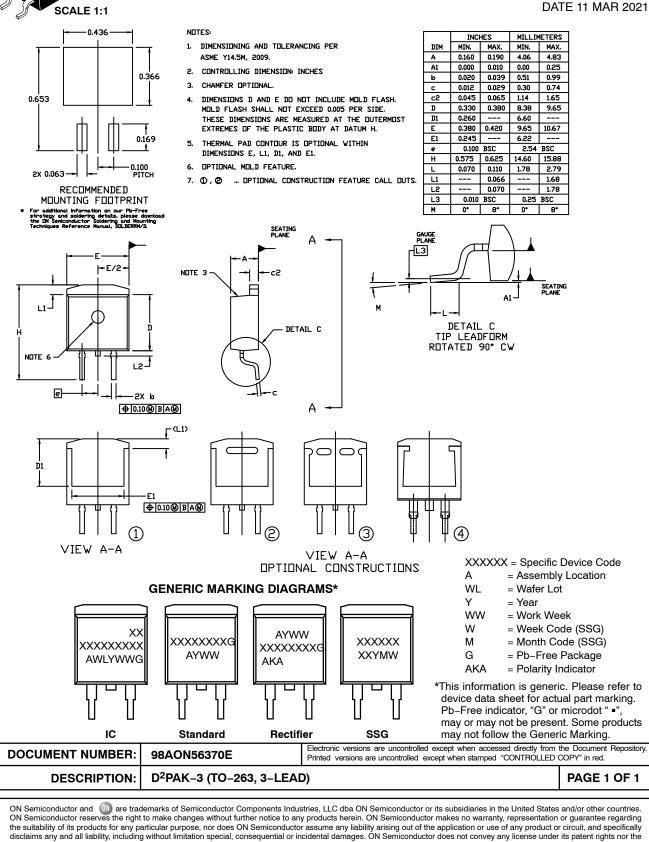
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## **MECHANICAL CASE OUTLINE** PACKAGE DIMENSIONS









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