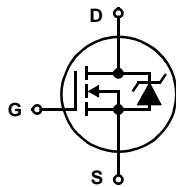


20A, 20V, 0.022 Ohm, N-Channel, Logic Level Power MOSFETs

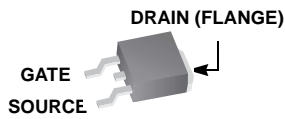
The HUF76013 is an application-specific MOSFET optimized for switching when used as the upper switch in synchronous buck applications. The low gate charge and low input capacitance results in lower driver and lower switching losses thereby increasing the overall system efficiency.

Symbol

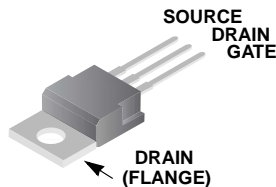


Packaging

HUF76013D3S
JEDEC TO-252AA



HUF76013P3
JEDEC TO-220AB



Features

- 20A, 20V
 - $r_{DS(ON)} = 0.022\Omega$, $V_{GS} = 10V$
 - $r_{DS(ON)} = 0.030\Omega$, $V_{GS} = 5V$
- PWM Optimized for Synchronous Buck Applications
- Fast Switching
- Low Gate Charge
 - Q_g Total 14nC (Typ)
- Low Capacitance
 - C_{ISS} 624pF (Typ)
 - C_{RSS} 71pF (Typ)

Ordering Information

PART NUMBER	PACKAGE	BRAND
HUF76013P3	TO-220AB	76013P
HUF76013D3S	TO-252AA	76013D

NOTE: When ordering, use the entire part number. Add the suffix T to obtain the HUF76013D3S in tape and reel, e.g., HUF76013D3ST.

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

SYMBOL	PARAMETER	HUF76013P3, HUF76013D3S	UNITS
V_{DSS}	Drain to Source Voltage (Note 1)	20	V
V_{DGR}	Drain to Gate Voltage ($R_{GS} = 20k\Omega$) (Note 1)	20	V
V_{GS}	Gate to Source Voltage	± 16	V
I_D	Drain Current		
I_D	Continuous ($T_C = 25^\circ C$, $V_{GS} = 10V$) (Figure 2)	20	A
I_D	Continuous ($T_C = 100^\circ C$, $V_{GS} = 5V$)	20	A
I_{DM}	Pulsed Drain Current	Figure 4	A
P_D	Power Dissipation	50	W
	Derate Above $25^\circ C$	0.4	W/ $^\circ C$
T_J, T_{STG}	Operating and Storage Temperature	-55 to 150	$^\circ C$
T_L	Maximum Temperature for Soldering		$^\circ C$
T_{pkg}	Leads at 0.063in (1.6mm) from Case for 10s	300	$^\circ C$
	Package Body for 10s, See Techbrief TB334	260	$^\circ C$
THERMAL SPECIFICATIONS			
$R_{\theta JC}$	Thermal Resistance Junction to Case, TO-220, TO-252	2.5	$^\circ C/W$
$R_{\theta JA}$	Thermal Resistance Junction to Ambient TO-220	62	$^\circ C/W$
	Thermal Resistance Junction to Ambient TO-252	100	$^\circ C/W$

NOTE:

1. $T_J = 25^\circ C$ to $125^\circ C$.

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.

HUF76013P3, HUF76013D3S

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

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS	
OFF STATE SPECIFICATIONS							
Drain to Source Breakdown Voltage	BV_{DSS}	$I_D = 250\mu\text{A}$, $V_{GS} = 0\text{V}$ (Figure 11)	20	-	-	V	
Zero Gate Voltage Drain Current	I_{DSS}	$V_{DS} = 20\text{V}$, $V_{GS} = 0\text{V}$	-	-	1	μA	
		$V_{DS} = 20\text{V}$, $V_{GS} = 0\text{V}$, $T_C = 150^\circ\text{C}$	-	-	250	μA	
Gate to Source Leakage Current	I_{GSS}	$V_{GS} = \pm 16\text{V}$	-	-	± 100	nA	
ON STATE SPECIFICATIONS							
Gate to Source Threshold Voltage	$V_{GS(TH)}$	$V_{GS} = V_{DS}$, $I_D = 250\mu\text{A}$ (Figure 10)	1	-	3	V	
Drain to Source ON Resistance	$r_{DS(ON)}$	$I_D = 20\text{A}$, $V_{GS} = 10\text{V}$ (Figures 8, 9)	-	0.018	0.022	Ω	
		$I_D = 20\text{A}$, $V_{GS} = 5\text{V}$ (Figure 8)	-	0.025	0.030	Ω	
SWITCHING SPECIFICATIONS ($V_{GS} = 5\text{V}$)							
Turn-On Time	t_{ON}	$V_{DD} = 10\text{V}$, $I_D = 20\text{A}$ $V_{GS} = 5\text{V}$, $R_{GS} = 19\Omega$ (Figures 14, 18, 19)	-	-	197	ns	
Turn-On Delay Time	$t_{d(ON)}$		-	11	-	ns	
Rise Time	t_r		-	120	-	ns	
Turn-Off Delay Time	$t_{d(OFF)}$		-	19	-	ns	
Fall Time	t_f		-	30	-	ns	
Turn-Off Time	t_{OFF}		-	-	72	ns	
SWITCHING SPECIFICATIONS ($V_{GS} = 10\text{V}$)							
Turn-On Time	t_{ON}	$V_{DD} = 10\text{V}$, $I_D = 20\text{A}$ $V_{GS} = 10\text{V}$, $R_{GS} = 19\Omega$ (Figures 15, 18, 19)	-	-	151	ns	
Turn-On Delay Time	$t_{d(ON)}$		-	7	-	ns	
Rise Time	t_r		-	93	-	ns	
Turn-Off Delay Time	$t_{d(OFF)}$		-	37	-	ns	
Fall Time	t_f		-	29	-	ns	
Turn-Off Time	t_{OFF}		-	-	100	ns	
GATE CHARGE SPECIFICATIONS							
Total Gate Charge at 10V	$Q_{g(TOT)}$	$V_{GS} = 0\text{V}$ to 10V	$V_{DD} = 10\text{V}$, $I_D = 20\text{A}$, $I_{g(REF)} = 1.0\text{mA}$ (Figures 13, 16, 17)	-	14.4	17	nC
Total Gate Charge at 5V	$Q_{g(TOT)}$	$V_{GS} = 0\text{V}$ to 5V		-	7.8	9	nC
Threshold Gate Charge	$Q_{g(TH)}$	$V_{GS} = 0\text{V}$ to 1V		-	0.9	1	nC
Gate to Source Gate Charge	Q_{gs}			-	3.5	-	nC
Gate to Drain "Miller" Charge	Q_{gd}			-	3.2	-	nC
CAPACITANCE SPECIFICATIONS							
Input Capacitance	C_{ISS}	$V_{DS} = 20\text{V}$, $V_{GS} = 0\text{V}$, $f = 1\text{MHz}$ (Figure 12)	-	624	-	pF	
Output Capacitance	C_{OSS}		-	444	-	pF	
Reverse Transfer Capacitance	C_{RSS}		-	71	-	pF	

Source to Drain Diode Specifications

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Source to Drain Diode Voltage	V_{SD}	$I_{SD} = 20\text{A}$	-	-	1.25	V
		$I_{SD} = 10\text{A}$	-	-	1.0	V
Reverse Recovery Time	t_{rr}	$I_{SD} = 20\text{A}$, $dI_{SD}/dt = 100\text{A}/\mu\text{s}$	-	-	55	ns
Reverse Recovered Charge	Q_{RR}	$I_{SD} = 20\text{A}$, $dI_{SD}/dt = 100\text{A}/\mu\text{s}$	-	-	82	nC

Typical Performance Curves

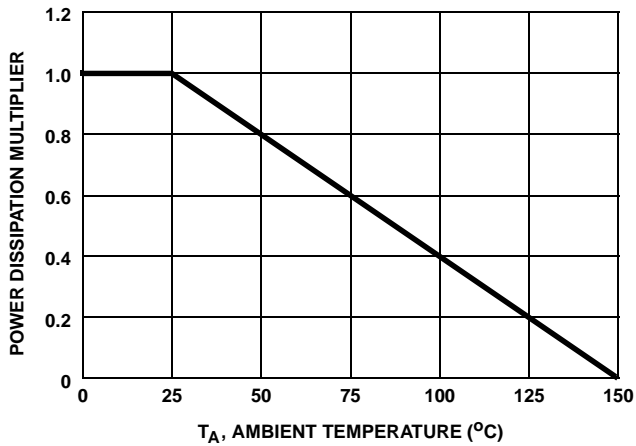


FIGURE 1. NORMALIZED POWER DISSIPATION vs CASE TEMPERATURE

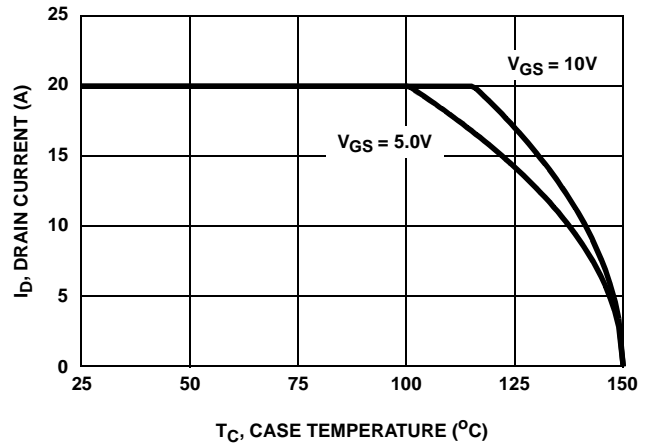


FIGURE 2. MAXIMUM CONTINUOUS DRAIN CURRENT vs CASE TEMPERATURE

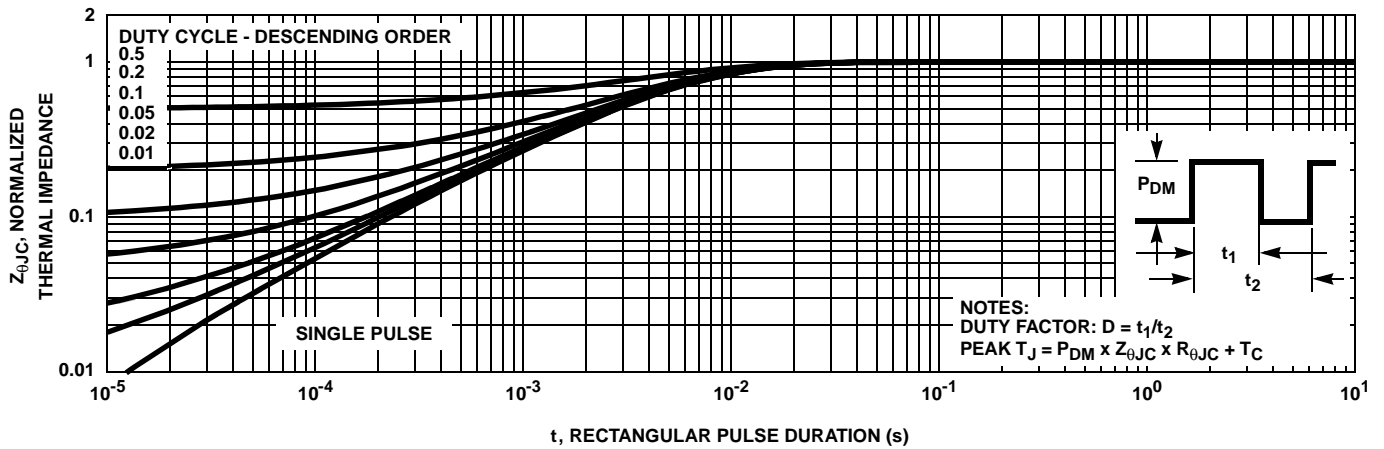


FIGURE 3. NORMALIZED MAXIMUM TRANSIENT THERMAL IMPEDANCE

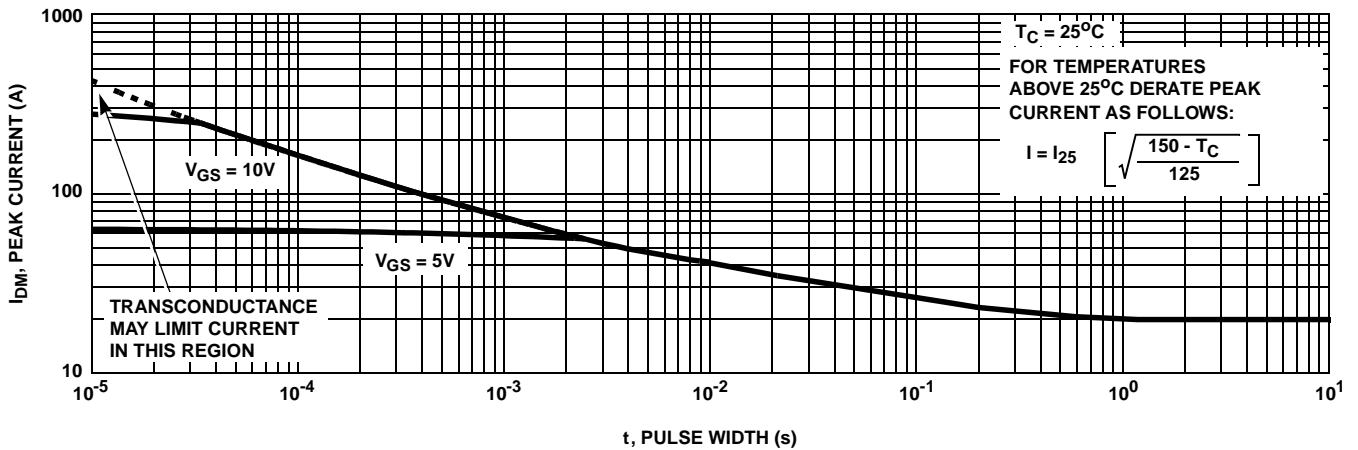


FIGURE 4. PEAK CURRENT CAPABILITY

Typical Performance Curves (Continued)

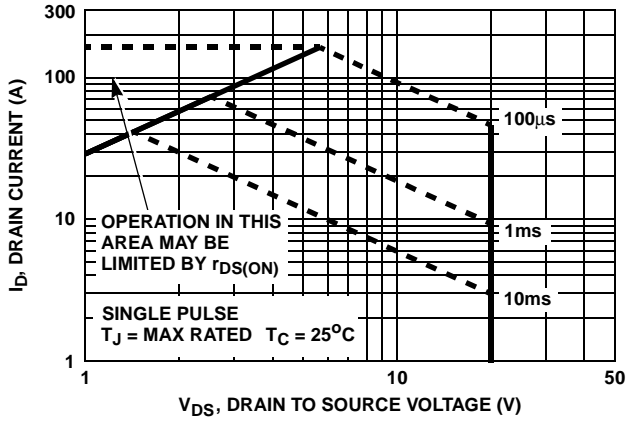


FIGURE 5. FORWARD BIAS SAFE OPERATING AREA

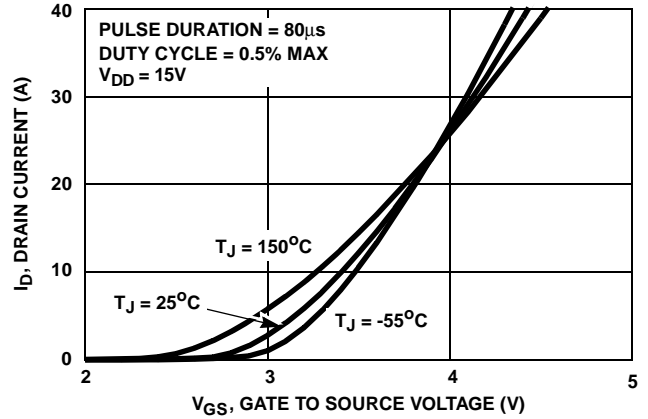


FIGURE 6. TRANSFER CHARACTERISTICS

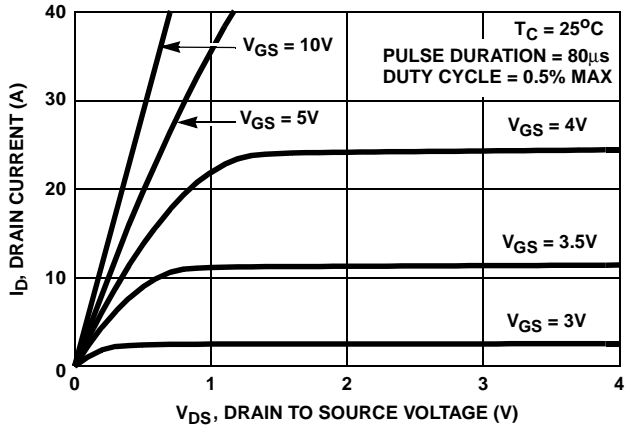


FIGURE 7. SATURATION CHARACTERISTICS

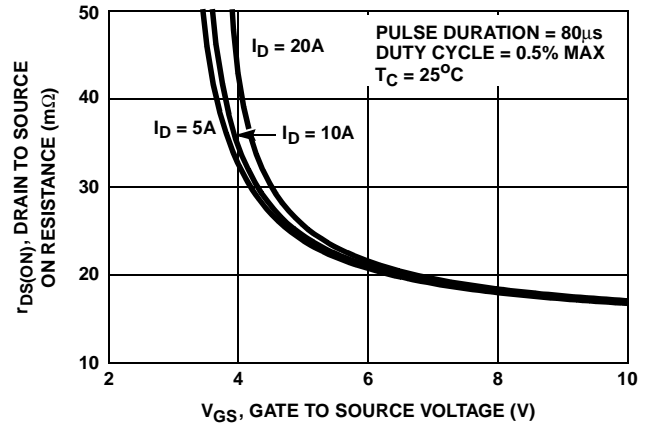


FIGURE 8. DRAIN TO SOURCE ON RESISTANCE vs GATE VOLTAGE AND DRAIN CURRENT

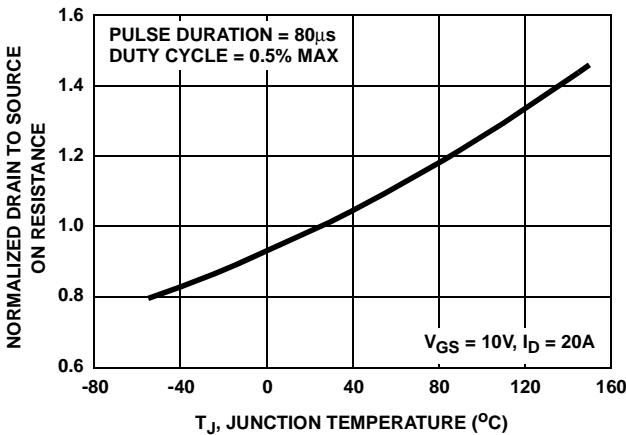


FIGURE 9. NORMALIZED DRAIN TO SOURCE ON RESISTANCE vs JUNCTION TEMPERATURE

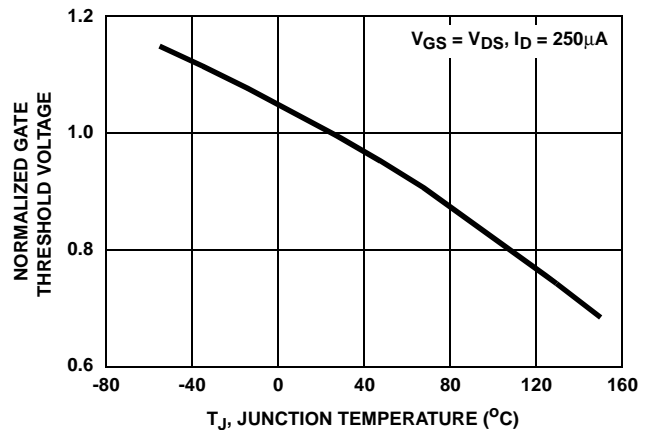


FIGURE 10. NORMALIZED GATE THRESHOLD VOLTAGE vs JUNCTION TEMPERATURE

Typical Performance Curves (Continued)

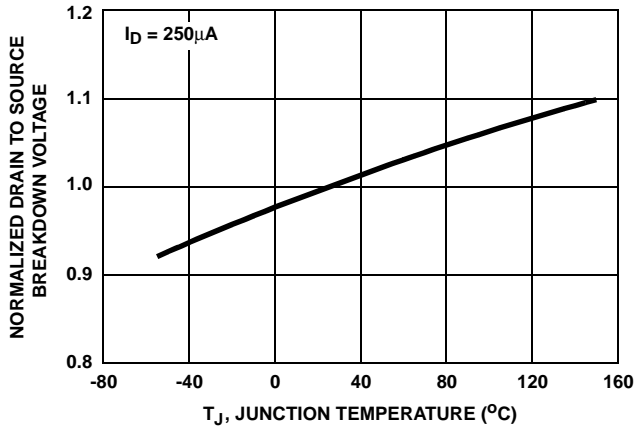


FIGURE 11. NORMALIZED DRAIN TO SOURCE BREAKDOWN VOLTAGE vs JUNCTION TEMPERATURE

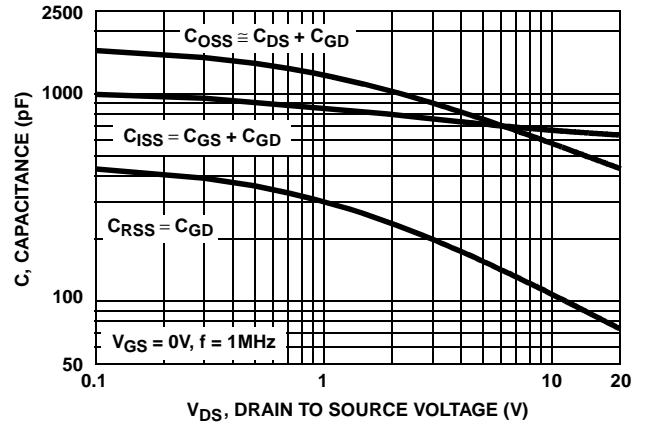
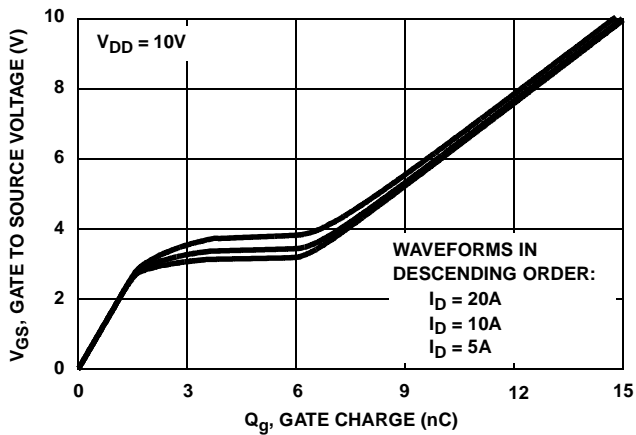


FIGURE 12. CAPACITANCE vs DRAIN TO SOURCE VOLTAGE



NOTE: Refer to Fairchild Application Notes AN7254 and AN7260.

FIGURE 13. GATE CHARGE WAVEFORMS FOR CONSTANT GATE CURRENT

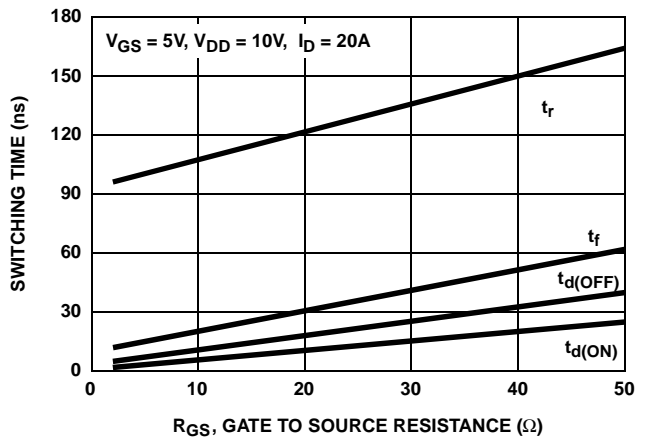


FIGURE 14. SWITCHING TIME vs GATE RESISTANCE

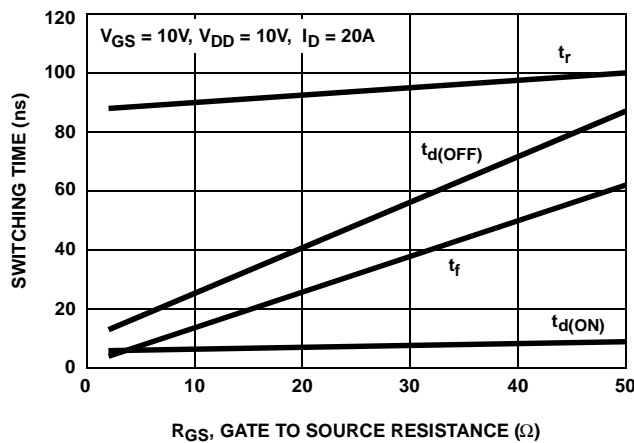


FIGURE 15. SWITCHING TIME vs GATE RESISTANCE

Test Circuits and Waveforms

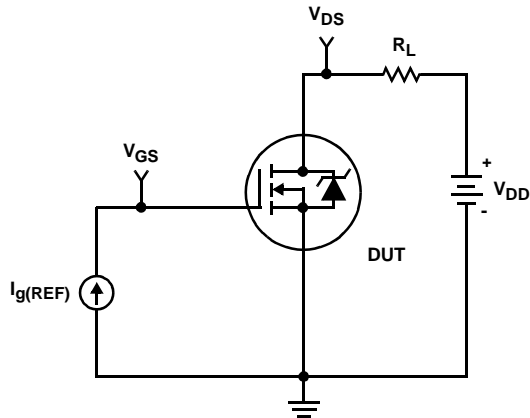


FIGURE 16. GATE CHARGE TEST CIRCUIT

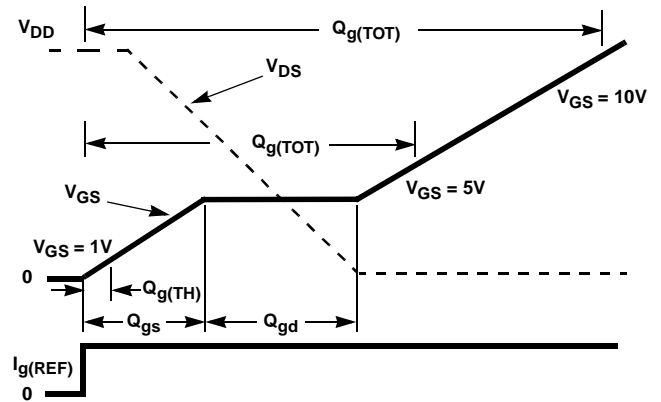


FIGURE 17. GATE CHARGE WAVEFORMS

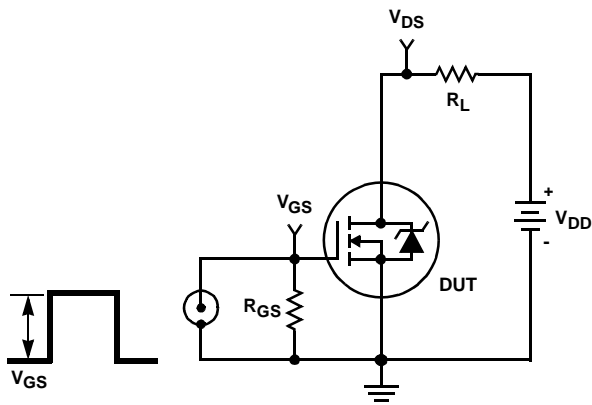


FIGURE 18. SWITCHING TIME TEST CIRCUIT

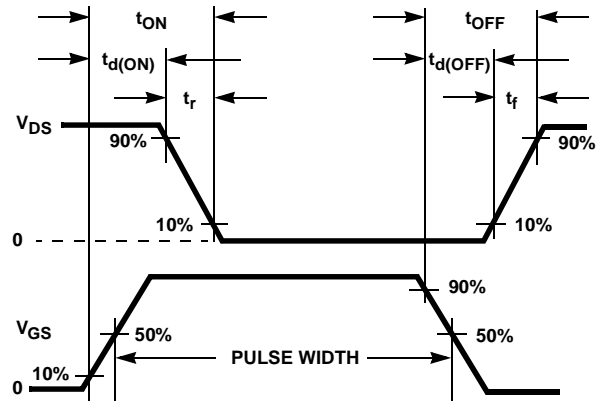


FIGURE 19. SWITCHING TIME WAVEFORM

HUF76013P3, HUF76013D3S

PSpICE Electrical Model

.SUBCKT HUF76013P3 2 1 3 ; rev 23March 2000

CA 12 8 6.5e-10
 CB 15 14 7.0e-10
 CIN 6 8 5.6e-10

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

EBREAK 11 7 17 18 26
 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 1.00e-9
 LGATE 1 9 4.9e-9
 LSOURCE 3 7 4.9e-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 1e-3
 RGATE 9 20 3.0
 RLDRAIN 2 5 10
 RLGATE 1 9 49
 RLSOURCE 3 7 49
 RSLC1 5 51 RSLCMOD 1e-6
 RSLC2 5 50 1e3
 RSOURCE 8 7 RSOURCEMOD 12.5e-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

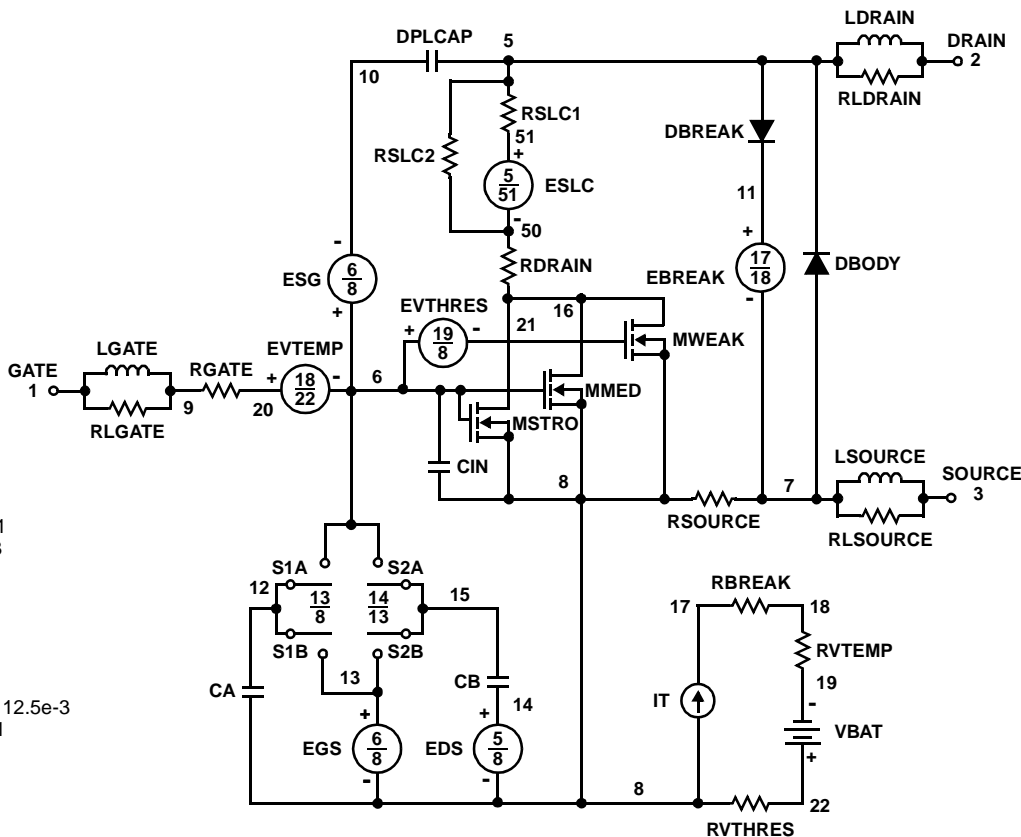
ESLC 51 50 VALUE={(V(5,51)/ABS(V(5,51)))*(PWR(V(5,51))/(1e-6*175),2.5))}

.MODEL DBODYMOD D (IS = 5.4e-13 RS = 1.15e-2 TRS1 = 7.0e-5 TRS2 = -1.0e-6 CJO = 12.3e-10 TT = 2.93e-8 M = 0.40)
 .MODEL DBREAKMOD D (RS = 3.50e-1 TRS1 = 1e-3 TRS2 = -6.5e-6)
 .MODEL DPLCAPMOD D (CJO = 4.6e-1 OIS = 1e-3 ON = 10 M = 0.6)
 .MODEL MMEDMOD NMOS (VTO = 2.2 KP = 2.0 IS = 1e-30 N = 10 TOX = 1 L = 1u W = 1u RG = 3.0)
 .MODEL MSTROMOD NMOS (VTO = 2.66 KP = 40 IS = 1e-30 N = 10 TOX = 1 L = 1u W = 1u LAMBDA=.01)
 .MODEL MWEAKMOD NMOS (VTO = 1.90 KP = 0.03 IS = 1e-30 N = 10 TOX = 1 L = 1u W = 1u RG = 30 RS = 0.1)
 .MODEL RBREAKMOD RES (TC1 = 1.0e-3 TC2 = -1.0e-6)
 .MODEL RDRAINMOD RES (TC1 = 2.1e-2 TC2 = 6.5e-5)
 .MODEL RSLCMOD RES (TC1 = 3.5e-3 TC2 = 2e-6)
 .MODEL RSOURCEMOD RES (TC1 = 1e-3 TC2 = 1e-6)
 .MODEL RVTHRESMOD RES (TC1 = -1.9e-3 TC2 = -6.0e-6)
 .MODEL RVTEMPMOD RES (TC1 = -1.8e-3 TC2 = 0)

.MODEL S1AMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = -4.5 VOFF = -1.5)
 .MODEL S1BMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = -1.5 VOFF = -4.5)
 .MODEL S2AMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = -0.5 VOFF = 0)
 .MODEL S2BMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = 0 VOFF = -0.5)

.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.



SPICE Thermal Model

REV 23 March 2000

HUF76013T

CTHERM1 th 6 1.0e-3
 CTHERM2 6 5 2.80e-3
 CTHERM3 5 4 3.00e-3
 CTHERM4 4 3 3.40e-3
 CTHERM5 3 2 6.40e-3
 CTHERM6 2 tl 9.50e-2

RTHERM1 th 6 1.85e-2
 RTHERM2 6 5 4.61e-2
 RTHERM3 5 4 1.30e-1
 RTHERM4 4 3 7.29e-1
 RTHERM5 3 2 1.10
 RTHERM6 2 tl 1.46e-1

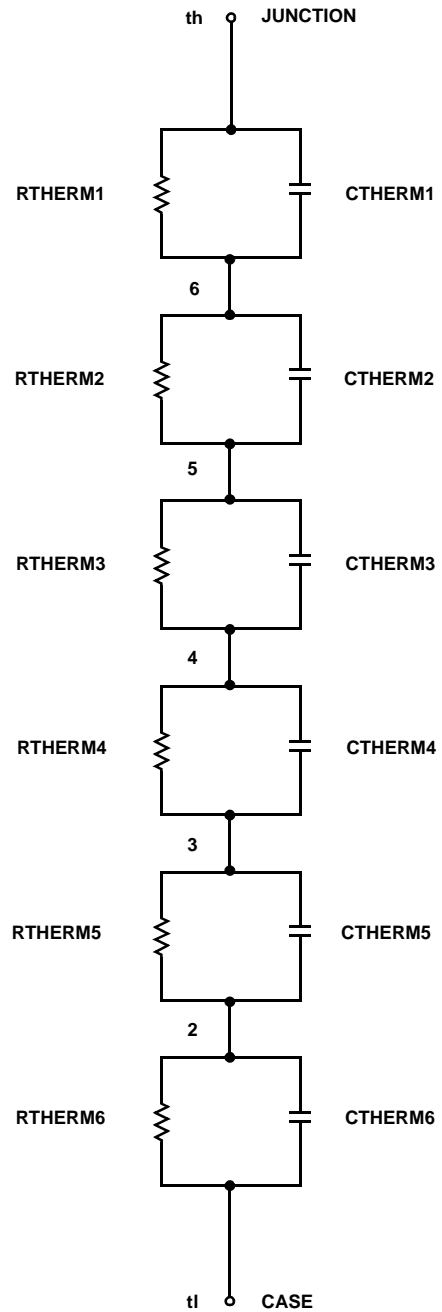
SABER Thermal Model

SABER thermal model HUF76013T

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thermal_c th, tl
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    ctherm.ctherm1 th 6 = 1.0e-3
    ctherm.ctherm2 6 5 = 2.80e-3
    ctherm.ctherm3 5 4 = 3.00e-3
    ctherm.ctherm4 4 3 = 3.40e-3
    ctherm.ctherm5 3 2 = 6.40e-3
    ctherm.ctherm6 2 tl = 9.50e-2

    rtherm.rtherm1 th 6 = 1.85e-2
    rtherm.rtherm2 6 5 = 4.61e-2
    rtherm.rtherm3 5 4 = 1.30e-1
    rtherm.rtherm4 4 3 = 7.29e-1
    rtherm.rtherm5 3 2 = 1.10
    rtherm.rtherm6 2 tl = 1.46e-1
}
    
```



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CROSSVOLT TM	GlobalOptoisolator TM	POP TM	SuperSOT TM -3	
DenseTrench TM	GTO TM	Power247 TM	SuperSOT TM -6	
DOMET TM	HiSeC TM	PowerTrench [®]	SuperSOT TM -8	
EcoSPARK TM	ISOPLANAR TM	QFET TM	SyncFET TM	
E ² CMOS TM	LittleFET TM	QST TM	TinyLogic TM	
EnSigna TM	MicroFET TM	QT Optoelectronics TM	TruTranslation TM	
FACT TM	MicroPak TM	Quiet Series TM	UHC TM	
FACT Quiet Series TM	MICROWIRE TM	SILENT SWITCHER [®]	UltraFET [®]	

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2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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