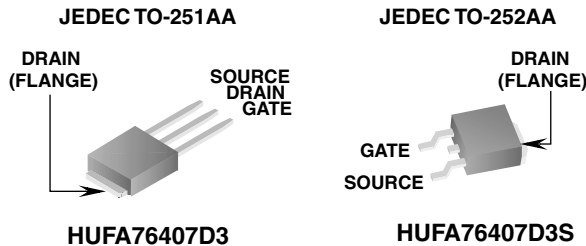
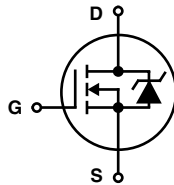


11A, 60V, 0.107 Ohm, N-Channel, Logic Level UltraFET® Power MOSFETs

Packaging



Symbol



Features

- Ultra Low On-Resistance
 - $r_{DS(ON)} = 0.092\Omega$, $V_{GS} = 10V$
 - $r_{DS(ON)} = 0.107\Omega$, $V_{GS} = 5V$
- 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
- Switching Time vs R_{GS} Curves

Ordering Information

PART NUMBER	PACKAGE	BRAND
HUFA76407D3	TO-251AA	76407D
HUFA76407D3S	TO-252AA	76407D

NOTE: When ordering, use the entire part number. Add the suffix T to obtain the TO-252AA variant in tape and reel, e.g., HUFA76407D3ST.

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

Drain to Source Voltage (Note 1)	V_{DSS}
Drain to Gate Voltage ($R_{GS} = 20k\Omega$) (Note 1)	V_{DGR}
Gate to Source Voltage	V_{GS}
Drain Current	
Continuous ($T_C = 25^\circ\text{C}$, $V_{GS} = 5V$)	I_D
Continuous ($T_C = 25^\circ\text{C}$, $V_{GS} = 10V$) (Figure 2)	I_D
Continuous ($T_C = 135^\circ\text{C}$, $V_{GS} = 5V$)	I_D
Continuous ($T_C = 135^\circ\text{C}$, $V_{GS} = 4.5V$) (Figure 2)	I_D
Pulsed Drain Current	I_{DM}
Pulsed Avalanche Rating	UIS
Power Dissipation	P_D
Derate Above 25°C	
Operating and Storage Temperature	T_J, T_{STG}
Maximum Temperature for Soldering	
Leads at 0.063in (1.6mm) from Case for 10s.	T_L
Package Body for 10s, See Techbrief TB334	T_{pkg}

NOTE:

1. $T_J = 25^\circ\text{C}$ to 150°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.

This product has been designed to meet the extreme test conditions and environment demanded by the automotive industry. For a copy of the requirements, see AEC Q101 at: <http://www.aecouncil.com/>

HUFA76407D3, HUFA76407D3S	UNITS
60	V
60	V
± 16	V
11	A
12	A
6	A
6	A
Figure 4	
Figures 6, 14, 15	
38	W
0.25	W/ $^\circ\text{C}$
-55 to 175	$^\circ\text{C}$
300	$^\circ\text{C}$
260	$^\circ\text{C}$

HUFA76407D3, HUFA76407D3S

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 = 250μA, V _{GS} = 0V (Figure 12)	60	-	-	V	
		I _D = 250μA, V _{GS} = 0V , T _C = -40°C (Figure 12)	55	-	-	V	
Zero Gate Voltage Drain Current	I _{DSS}	V _{DS} = 55V, V _{GS} = 0V	-	-	1	μA	
		V _{DS} = 50V, V _{GS} = 0V, T _C = 150°C	-	-	250	μA	
Gate to Source Leakage Current	I _{GSS}	V _{GS} = ±16V	-	-	±100	nA	
ON STATE SPECIFICATIONS							
Gate to Source Threshold Voltage	V _{GS(TH)}	V _{GS} = V _{DS} , I _D = 250μA (Figure 11)	1	-	3	V	
Drain to Source On Resistance	r _{DS(ON)}	I _D = 13A, V _{GS} = 10V (Figures 9, 10)	-	0.077	0.092	Ω	
		I _D = 8A, V _{GS} = 5V (Figure 9)	-	0.095	0.107	Ω	
		I _D = 8A, V _{GS} = 4.5V (Figure 9)	-	0.107	0.117	Ω	
THERMAL SPECIFICATIONS							
Thermal Resistance Junction to Case	R _{θJC}	TO-251, TO-252	-	-	3.94	°C/W	
Thermal Resistance Junction to Ambient	R _{θJA}		-	-	100	°C/W	
SWITCHING SPECIFICATIONS (V _{GS} = 4.5V)							
Turn-On Time	t _{ON}	V _{DD} = 30V, I _D = 8A V _{GS} = 4.5V, R _{GS} = 32Ω (Figures 15, 21, 22)	-	-	170	ns	
Turn-On Delay Time	t _{d(ON)}		-	8	-	ns	
Rise Time	t _r		-	105	-	ns	
Turn-Off Delay Time	t _{d(OFF)}		-	22	-	ns	
Fall Time	t _f		-	39	-	ns	
Turn-Off Time	t _{OFF}		-	-	92	ns	
SWITCHING SPECIFICATIONS (V _{GS} = 10V)							
Turn-On Time	t _{ON}	V _{DD} = 30V, I _D = 13A V _{GS} = 10V, R _{GS} = 32Ω (Figures 16, 21, 22)	-	-	56	ns	
Turn-On Delay Time	t _{d(ON)}		-	5	-	ns	
Rise Time	t _r		-	32	-	ns	
Turn-Off Delay Time	t _{d(OFF)}		-	43	-	ns	
Fall Time	t _f		-	45	-	ns	
Turn-Off Time	t _{OFF}		-	-	132	ns	
GATE CHARGE SPECIFICATIONS							
Total Gate Charge	Q _{g(TOT)}	V _{GS} = 0V to 10V	V _{DD} = 30V, I _D = 8A, I _{g(REF)} = 1.0mA (Figures 14, 19, 20)	-	9.4	11.3	nC
Gate Charge at 5V	Q _{g(5)}	V _{GS} = 0V to 5V		-	5.2	6.2	nC
Threshold Gate Charge	Q _{g(TH)}	V _{GS} = 0V to 1V		-	0.36	0.43	nC
Gate to Source Gate Charge	Q _{gs}			-	1.2	-	nC
Reverse Transfer Capacitance	Q _{gd}			-	2.5	-	nC
CAPACITANCE SPECIFICATIONS							
Input Capacitance	C _{ISS}	V _{DS} = 25V, V _{GS} = 0V, f = 1MHz (Figure 13)	-	350	-	pF	
Output Capacitance	C _{OSS}		-	105	-	pF	
Reverse Transfer Capacitance	C _{RSS}		-	23	-	pF	

Source to Drain Diode Specifications

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Source to Drain Diode Voltage	V_{SD}	$I_{SD} = 8\text{A}$	-	-	1.25	V
		$I_{SD} = 3\text{A}$	-	-	1.0	V
Reverse Recovery Time	t_{rr}	$I_{SD} = 8\text{A}$, $dI_{SD}/dt = 100\text{A}/\mu\text{s}$	-	-	66	ns
Reverse Recovered Charge	Q_{RR}	$I_{SD} = 8\text{A}$, $dI_{SD}/dt = 100\text{A}/\mu\text{s}$	-	-	159	nC

Typical Performance Curves

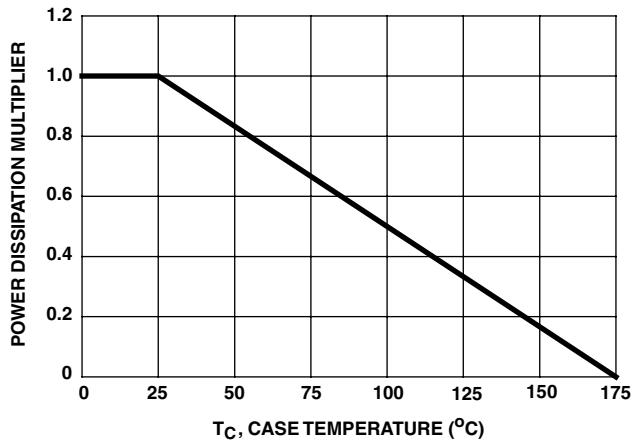


FIGURE 1. NORMALIZED POWER DISSIPATION vs CASE TEMPERATURE

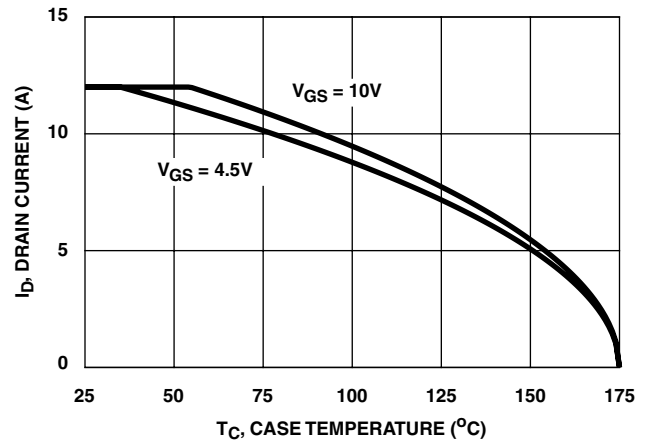


FIGURE 2. MAXIMUM CONTINUOUS DRAIN CURRENT vs CASE TEMPERATURE

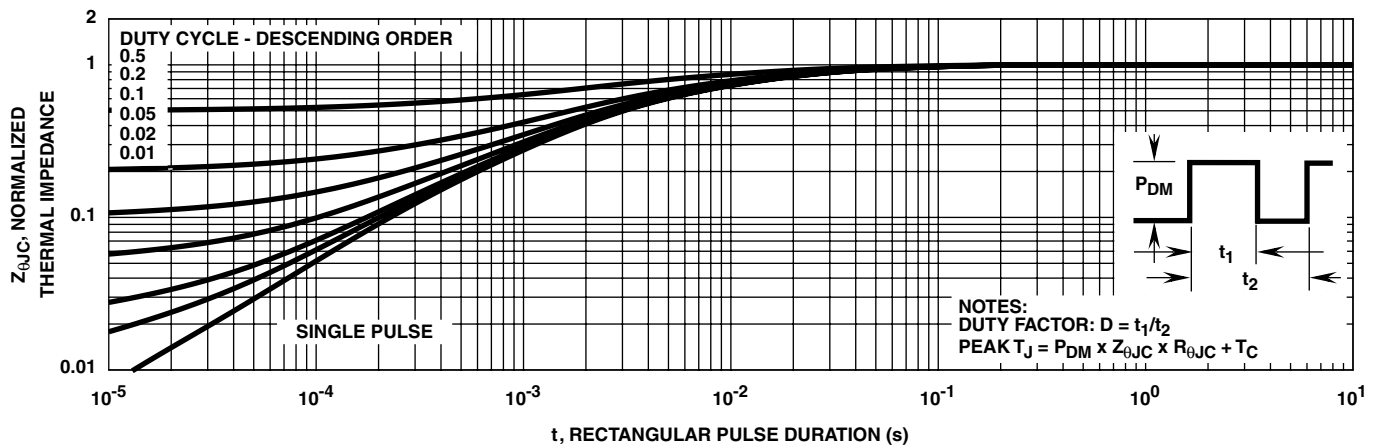


FIGURE 3. NORMALIZED MAXIMUM TRANSIENT THERMAL IMPEDANCE

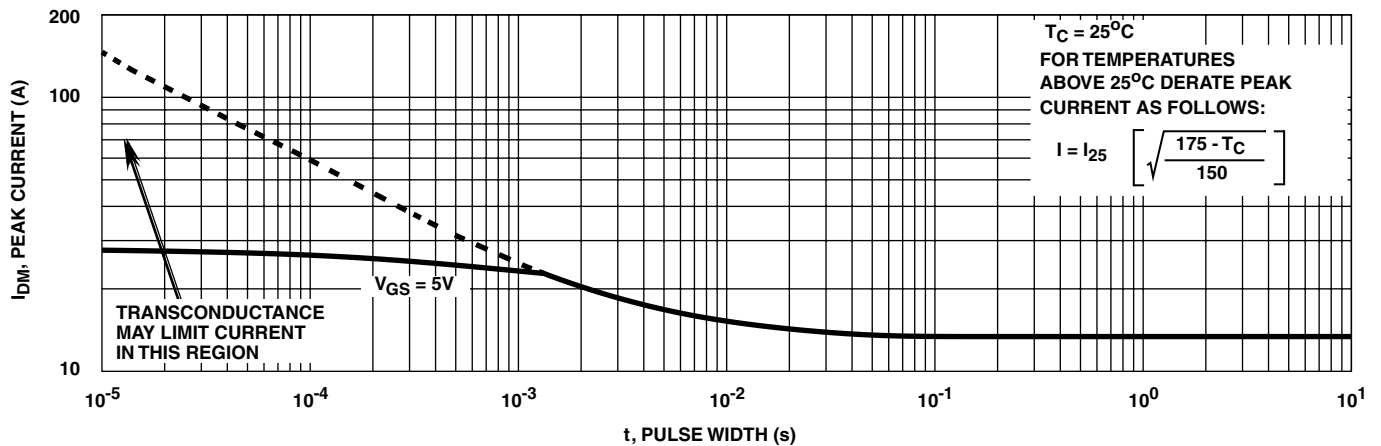


FIGURE 4. PEAK CURRENT CAPABILITY

Typical Performance Curves (Continued)

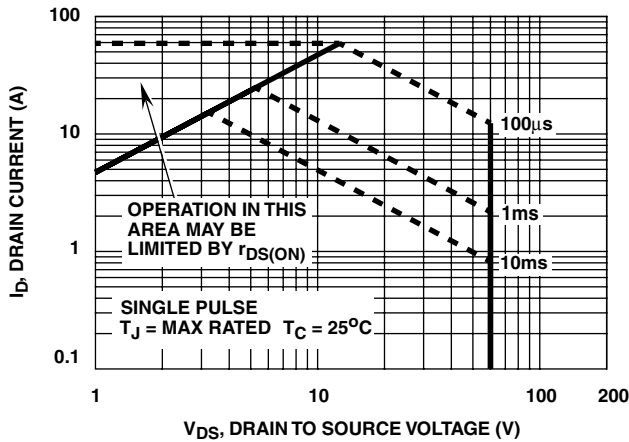


FIGURE 5. FORWARD BIAS SAFE OPERATING AREA

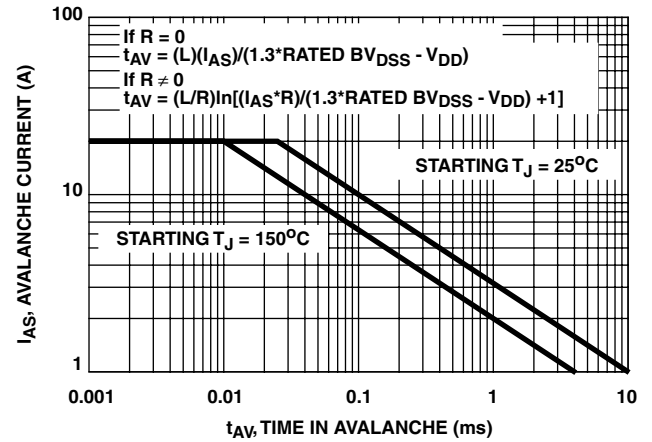


FIGURE 6. UNCLAMPED INDUCTIVE SWITCHING CAPABILITY

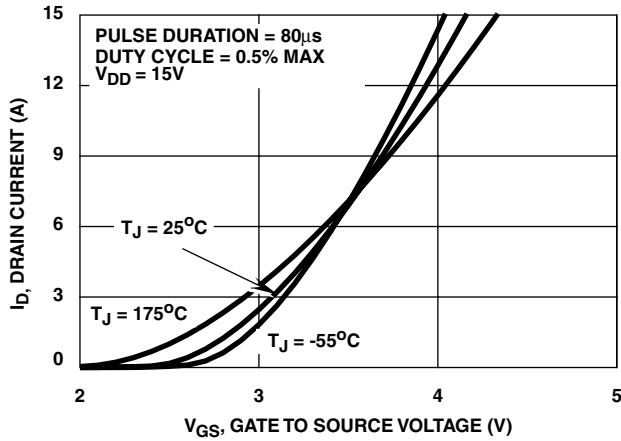


FIGURE 7. TRANSFER CHARACTERISTICS

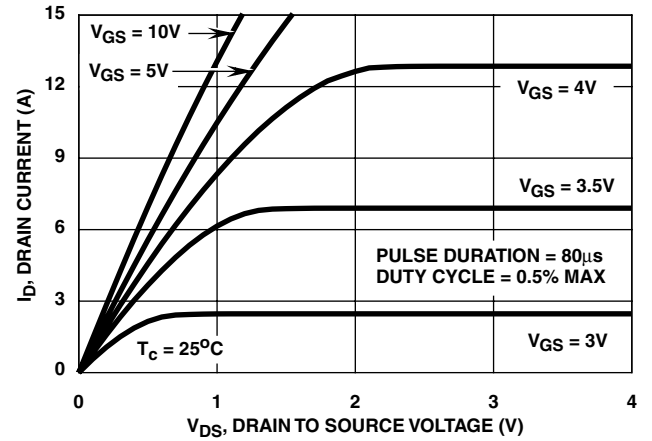


FIGURE 8. SATURATION CHARACTERISTICS

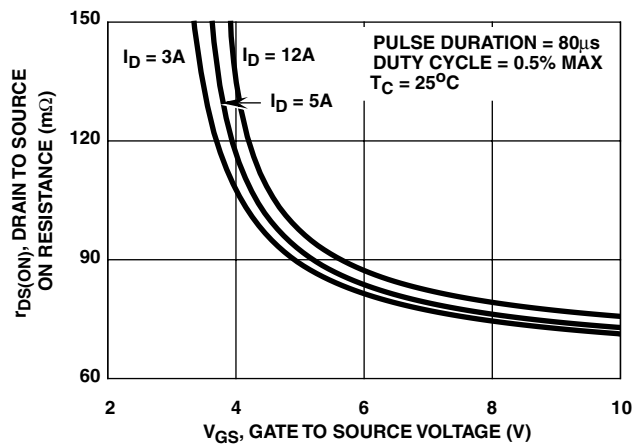


FIGURE 9. DRAIN TO SOURCE ON RESISTANCE vs. GATE VOLTAGE AND DRAIN CURRENT

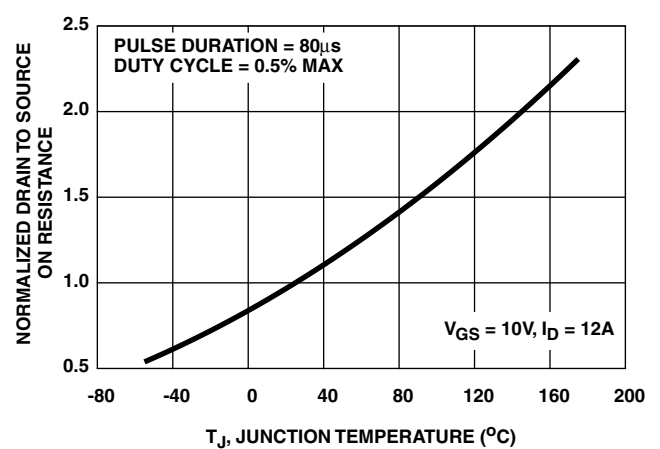


FIGURE 10. NORMALIZED DRAIN TO SOURCE ON RESISTANCE vs. JUNCTION TEMPERATURE

Typical Performance Curves (Continued)

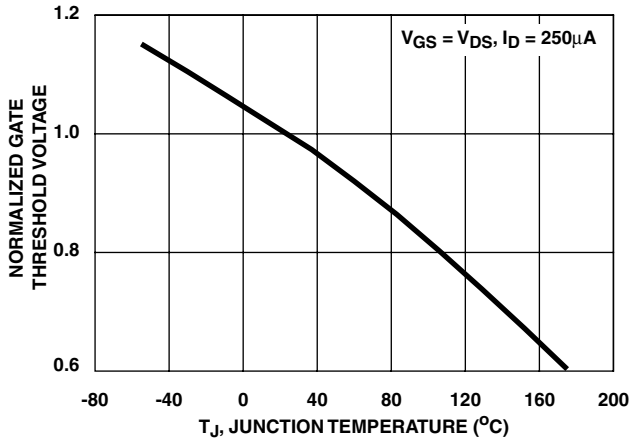


FIGURE 11. NORMALIZED GATE THRESHOLD VOLTAGE vs JUNCTION TEMPERATURE

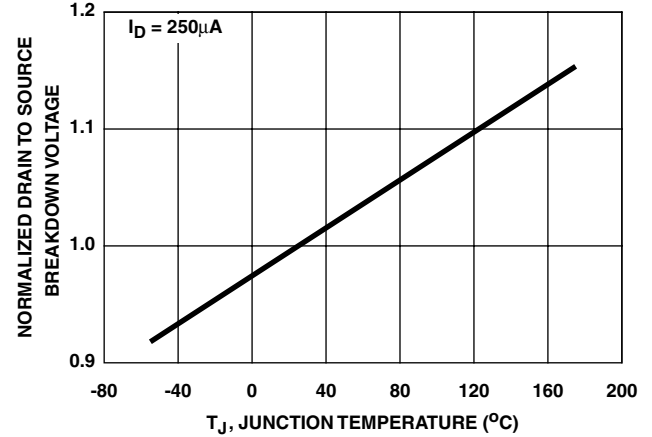


FIGURE 12. NORMALIZED DRAIN TO SOURCE BREAKDOWN VOLTAGE vs JUNCTION TEMPERATURE

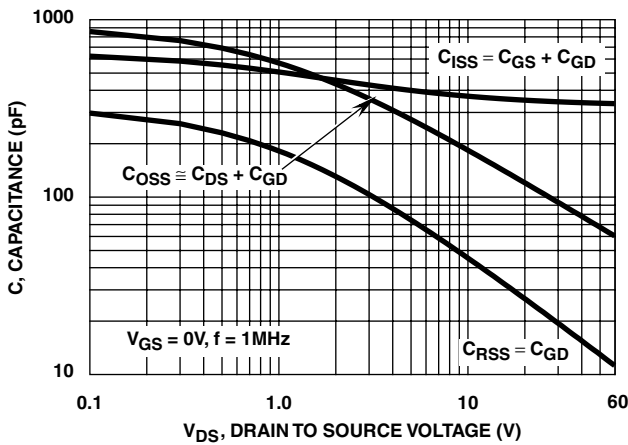
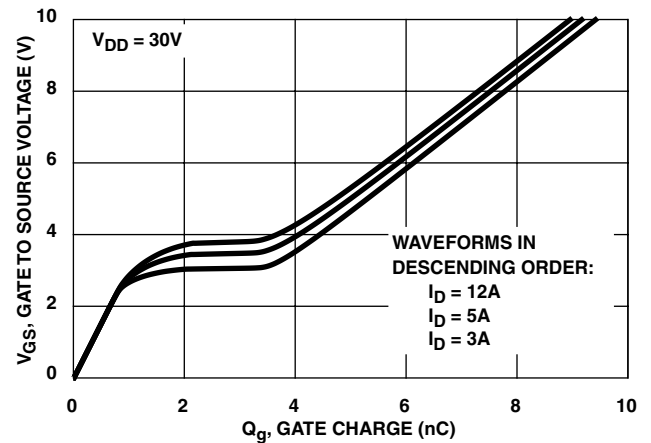


FIGURE 13. CAPACITANCE vs DRAIN TO SOURCE VOLTAGE



NOTE: Refer to Fairchild Application Notes AN7254 and AN7260.

FIGURE 14. GATE CHARGE WAVEFORMS FOR CONSTANT GATE CURRENT

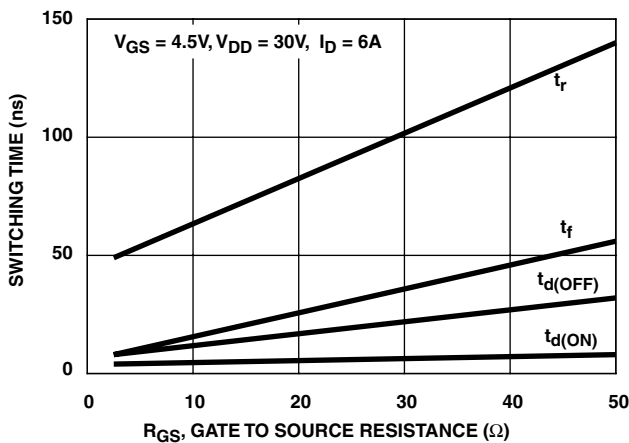


FIGURE 15. SWITCHING TIME vs GATE RESISTANCE

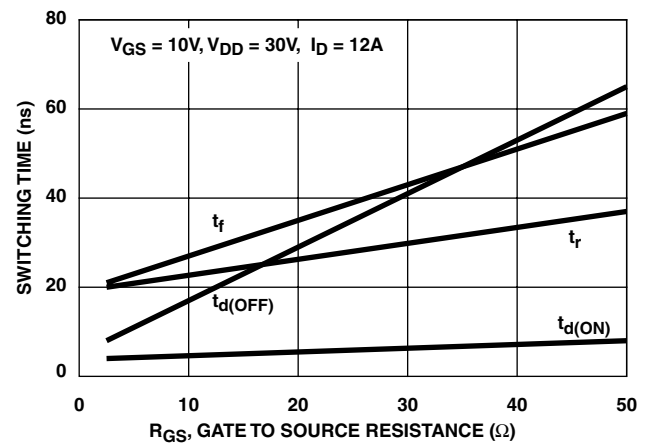


FIGURE 16. SWITCHING TIME vs GATE RESISTANCE

Test Circuits and Waveforms

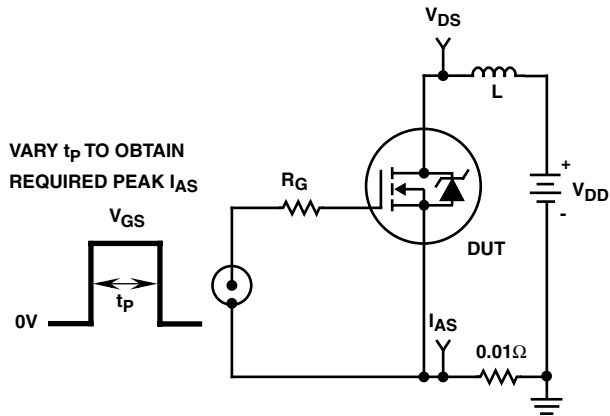


FIGURE 17. UNCLAMPED ENERGY TEST CIRCUIT

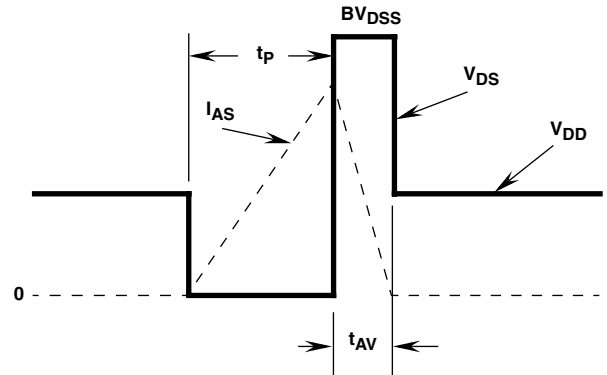


FIGURE 18. UNCLAMPED ENERGY WAVEFORMS

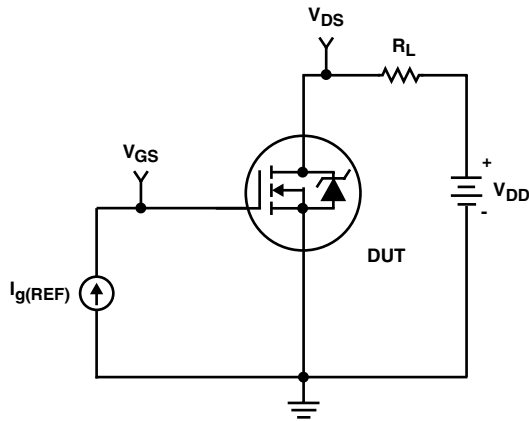


FIGURE 19. GATE CHARGE TEST CIRCUIT

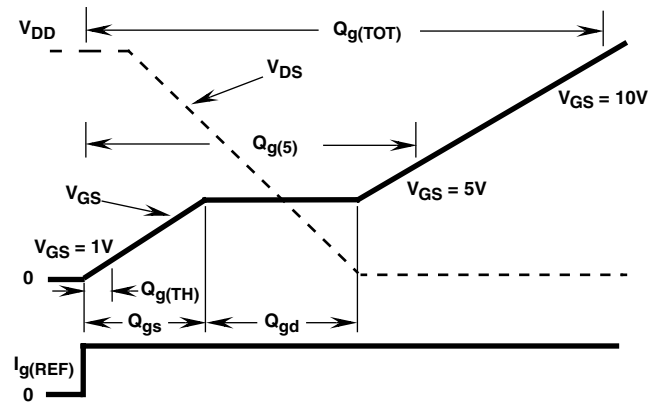


FIGURE 20. GATE CHARGE WAVEFORMS

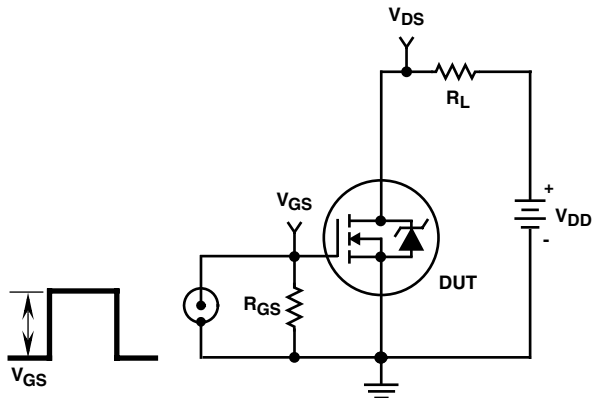


FIGURE 21. SWITCHING TIME TEST CIRCUIT

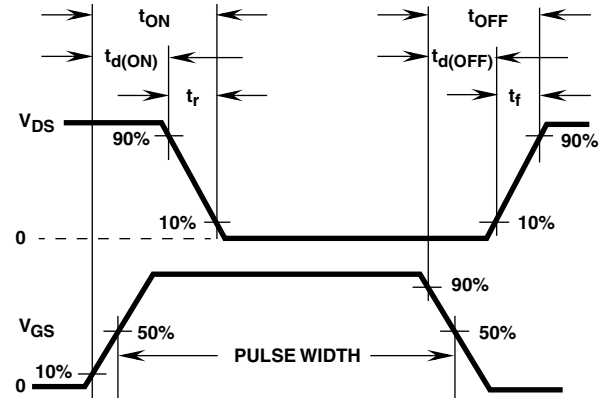


FIGURE 22. SWITCHING TIME WAVEFORM

PSICE Electrical Model

.SUBCKT HUFA76407 2 1 3 ; rev 28June 1999

CA 12 8 3.9e-9
CB 15 14 4.9e-9
CIN 6 8 3.25e-10

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

EBREAK 11 7 17 18 67.8
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 1.0e-9
LGATE 1 9 5.42e-9
LSOURCE 3 7 2.57e-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 3.7e-2
RGATE 9 20 3.37
RLDRAIN 2 5 10
RLGATE 1 9 54.2
RLSOURCE 3 7 25.7
RSLC1 5 51 RSLCMOD 1e-6
RSLC2 5 50 1e3
RSOURCE 8 7 RSOURCEMOD 2.50e-2
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

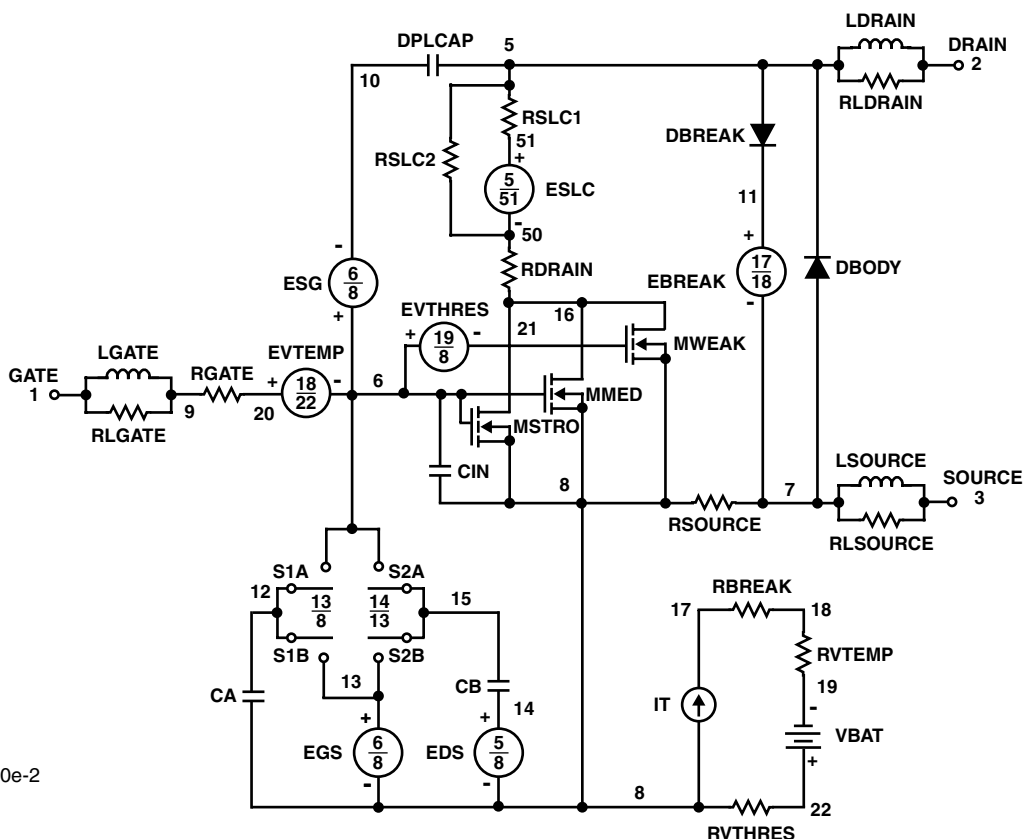
ESLC 51 50 VALUE={ (V(5,51)/ABS(V(5,51))) * (PWR(V(5,51)/(1e-6*30),3)) }

.MODEL DBODYMOD D (IS = 1.75e-13 RS = 1.75e-2 TRS1 = 1e-4 TRS2 = 5e-6 CJO = 5.9e-10 TT = 5.45e-8 N = 1.03 M = 0.6)
.MODEL DBREAKMOD D (RS = 6.50e-1 TRS1 = 1.25e-4 TRS2 = 1.34e-6)
.MODEL DPLCAPMOD D (CJO = 3.21e-10 IS = 1e-30 N = 10 M = 0.81)
.MODEL MMEDMOD NMOS (VTO = 2.02 KP = .83 IS = 1e-30 N = 10 TOX = 1 L = 1u W = 1u RG = 3.37)
.MODEL MSTROMOD NMOS (VTO = 2.39 KP = 14 IS = 1e-30 N = 10 TOX = 1 L = 1u W = 1u)
.MODEL MWEAKMOD NMOS (VTO = 1.78 KP = 0.02 IS = 1e-30 N = 10 TOX = 1 L = 1u W = 1u RG = 33.7 RS = 0.1)
.MODEL RBREAKMOD RES (TC1 = 1.06e-3 TC2 = 0)
.MODEL RDRAINMOD RES (TC1 = 1.23e-2 TC2 = 2.58e-5)
.MODEL RSLCMOD RES (TC1 = 0 TC2 = 0)
.MODEL RSOURCEMOD RES (TC1 = 1e-3 TC2 = 0)
.MODEL RVTHRESMOD RES (TC1 = -2.19e-3 TC2 = -4.97e-6)
.MODEL RVTEMPMOD RES (TC1 = -1.6e-3 TC2 = 1e-7)

.MODEL S1AMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = -4 VOFF = -2.5)
.MODEL S1BMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = -2.5 VOFF = -4)
.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 PSICE model, consult **A New PSICE 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 28June 1999

HUFA76407T

CTHERM1 th 6 4.5e-4
 CTHERM2 6 5 2.5e-3
 CTHERM3 5 4 1.9e-3
 CTHERM4 4 3 2.6e-3
 CTHERM5 3 2 5.5e-3
 CTHERM6 2 tl 1.8e-2

RTHERM1 th 6 3.1e-2
 RTHERM2 6 5 15.1e-2
 RTHERM3 5 4 4.2e-1
 RTHERM4 4 3 8.4e-1
 RTHERM5 3 2 8.7e-1
 RTHERM6 2 tl 1.5

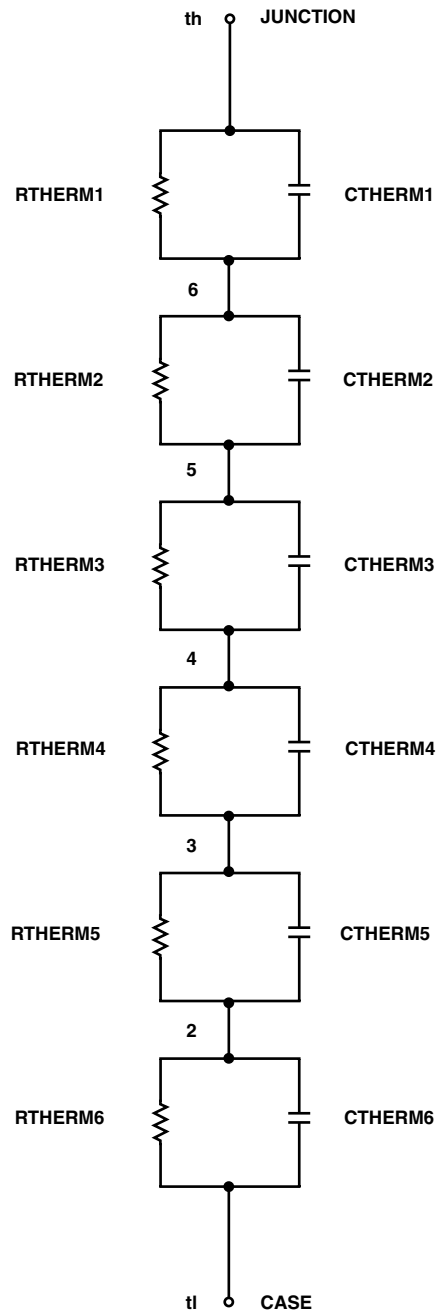
SABER Thermal Model

SABER thermal model HUFA76407T

template thermal_model th tl
 thermal_c th, tl

```
{
    ctherm.ctherm1 th 6 = 4.5e-4
    ctherm.ctherm2 6 5 = 2.5e-3
    ctherm.ctherm3 5 4 = 1.9e-3
    ctherm.ctherm4 4 3 = 2.6e-3
    ctherm.ctherm5 3 2 = 5.5e-3
    ctherm.ctherm6 2 tl = 1.8e-2
```

```
    rtherm.rtherm1 th 6 = 3.1e-2
    rtherm.rtherm2 6 5 = 15.1e-2
    rtherm.rtherm3 5 4 = 4.2e-1
    rtherm.rtherm4 4 3 = 8.4e-1
    rtherm.rtherm5 3 2 = 8.7e-1
    rtherm.rtherm6 2 tl = 1.5
}
```



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DenseTrench [™]	GTO [™]	Power247 [™]	SuperSOT [™] -6	
DOME [™]	HiSeC [™]	PowerTrench [®]	SuperSOT [™] -8	
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EnSigna [™]	MicroFET [™]	QT Optoelectronics [™]	TruTranslation [™]	
FACT [™]	MicroPak [™]	Quiet Series [™]	UHC [™]	
FACT Quiet Series [™]	MICROWIRE [™]	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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Preliminary	First Production	This datasheet contains preliminary data, and supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design.
No Identification Needed	Full Production	This datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design.
Obsolete	Not In Production	This datasheet contains specifications on a product that has been discontinued by Fairchild semiconductor. The datasheet is printed for reference information only.

Rev. H4