FAIRCHILD
SEMICONDUCTOR®

February 2005

FDP8880 / FDB8880
N-Channel PowerTrench® MOSFET
30V, 54A, 11.6mΩ

Features

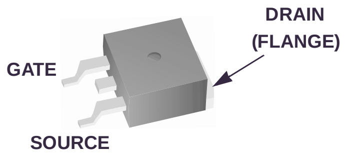
- $r_{DS(ON)}$ = 14.5mΩ, V_{GS} = 4.5V, I_D = 40A
- $r_{DS(ON)}$ = 11.6mΩ, V_{GS} = 10V, I_D = 40A
- High performance trench technology for extremely low $r_{DS(ON)}$
- Low gate charge
- High power and current handling capability

Applications

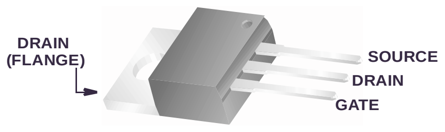
- DC/DC converters

General Description

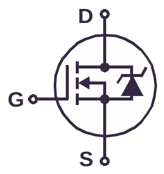
This N-Channel MOSFET has been designed specifically to improve the overall efficiency of DC/DC converters using either synchronous or conventional switching PWM controllers. It has been optimized for low gate charge, low $r_{DS(ON)}$ and fast switching speed.



TO-263AB
FDB SERIES



TO-220AB
FDP SERIES



MOSFET Maximum Ratings T_C = 25°C unless otherwise noted

Symbol	Parameter	Ratings	Units
V_{DSS}	Drain to Source Voltage	30	V
V_{GS}	Gate to Source Voltage	±20	V
I_D	Drain Current Continuous ($T_C = 25^oC$, V_{GS} = 10V)	54	A
	Continuous ($T_C = 25^oC$, V_{GS} = 4.5V)	48	A
	Continuous ($T_{amb} = 25^oC$, V_{GS} = 10V, with $R_{\theta JA} = 43^oC/W$)	11	A
	Pulsed	Figure 4	A
E_{AS}	Single Pulse Avalanche Energy (Note 1)	31	mJ
P_D	Power dissipation	55	W
	Derate above 25^oC	0.37	$W/^oC$
T_J, T_{STG}	Operating and Storage Temperature	-55 to 175	^oC

Thermal Characteristics

$R_{\theta JC}$	Thermal Resistance Junction to Case TO-220,TO-263	2.73	$^oC/W$
$R_{\theta JA}$	Thermal Resistance Junction to Ambient TO-220,TO-262 (Note 2)	62	$^oC/W$
$R_{\theta JA}$	Thermal Resistance Junction to Ambient TO-263, $1in^2$ copper pad area	43	$^oC/W$

Package Marking and Ordering Information

Device Marking	Device	Package	Reel Size	Tape Width	Quantity
FDP8880	FDP8880	TO-220AB	Tube	N/A	50 units
FDB8880	FDB8880	TO-263AB	330mm	24mm	800 units
FDP8880	FDP8880_NL (Note 3)	TO-220AB	Tube	N/A	50 units
FDB8880	FDB8880_NL (Note 3)	TO-263AB	330mm	24mm	800 units

Electrical Characteristics T_C = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions		Min	Typ	Max	Units
Off Characteristics							
B_{VDSS}	Drain to Source Breakdown Voltage	I_D = 250μA, V_{GS} = 0V		30	-	-	V
I_{DSS}	Zero Gate Voltage Drain Current	V_{DS} = 24V		-	-	1	μA
		V_{GS} = 0V	$T_C = 150^oC$	-	-	250	
I_{GSS}	Gate to Source Leakage Current	V_{GS} = ±20V		-	-	±100	nA
On Characteristics							
$V_{GS(TH)}$	Gate to Source Threshold Voltage	$V_{GS} = V_{DS}$, I_D = 250μA		1.2	-	2.5	V
$r_{DS(ON)}$	Drain to Source On Resistance	I_D = 40A, V_{GS} = 10V		-	0.0095	0.0116	Ω
		I_D = 40A, V_{GS} = 4.5V		-	0.012	0.0145	
		I_D = 40A, V_{GS} = 10V, $T_J = 175^oC$		-	0.015	0.019	

Dynamic Characteristics

C_{ISS}	Input Capacitance	V_{DS} = 15V, V_{GS} = 0V, f = 1MHz		-	1240	-	pF
C_{OSS}	Output Capacitance			-	255	-	pF
C_{RSS}	Reverse Transfer Capacitance			-	147	-	pF
R_G	Gate Resistance	V_{GS} = 0.5V, f = 1MHz		-	2.7	-	Ω
$Q_{g(TOT)}$	Total Gate Charge at 10V	V_{GS} = 0V to 10V	V_{DD} = 15V I_D = 40A I_g = 1.0mA	-	22	29	nC
$Q_{g(5)}$	Total Gate Charge at 5V	V_{GS} = 0V to 5V		-	12	16	nC
$Q_{g(TH)}$	Threshold Gate Charge	V_{GS} = 0V to 1V		-	1.6	2.1	nC
Q_{gs}	Gate to Source Gate Charge			-	3.2	-	nC
Q_{gs2}	Gate Charge Threshold to Plateau			-	2.0	-	nC
Q_{gd}	Gate to Drain “Miller” Charge			-	4.8	-	nC

Switching Characteristics (V_{GS} = 10V)

t_{ON}	Turn-On Time	V_{DD} = 15V, I_D = 40A V_{GS} = 10V, R_{GS} = 13.6Ω	-	-	171	ns
$t_{d(ON)}$	Turn-On Delay Time		-	8	-	ns
t_r	Rise Time		-	107	-	ns
$t_{d(OFF)}$	Turn-Off Delay Time		-	47	-	ns
t_f	Fall Time		-	51	-	ns
t_{OFF}	Turn-Off Time		-	-	147	ns

Drain-Source Diode Characteristics

V_{SD}	Source to Drain Diode Voltage	I_{SD} = 40A	-	-	1.25	V
		I_{SD} = 3.5A	-	-	1.0	V
t_{rr}	Reverse Recovery Time	I_{SD} = 40A, dI_{SD}/dt = 100A/µs	-	-	27	ns
Q_{RR}	Reverse Recovered Charge	I_{SD} = 40A, dI_{SD}/dt = 100A/µs	-	-	18	nC

Notes:

1: Starting T_J = 25°C, L = 34uH, I_{AS} = 43A,Vdd = 27V, Vgs = 10V.

2: Pulse width = 100s.

3: FDP8880_NL / FDB8880_NL is lead free product.
FDP8880_NL / FDB8880_NL marking will appear on the reel label.

Typical Characteristics $T_C = 25°C$ unless otherwise noted

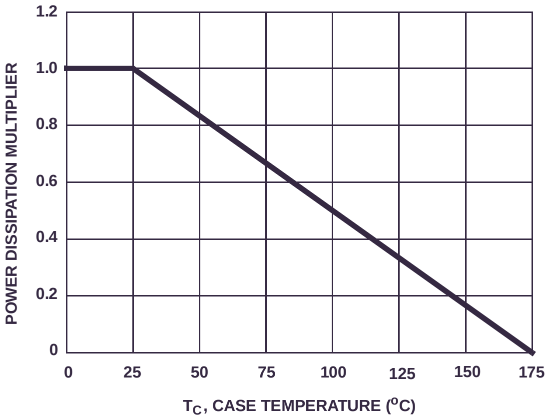


Figure 1. Normalized Power Dissipation vs Case Temperature

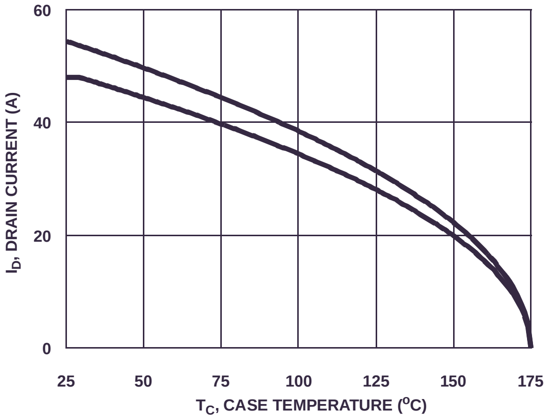


Figure 2. Maximum Continuous Drain Current vs Case Temperature

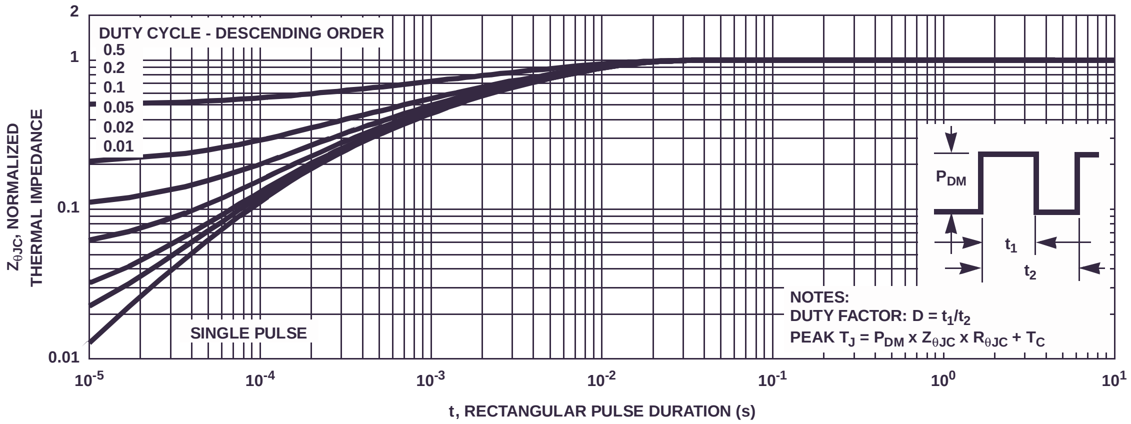


Figure 3. Normalized Maximum Transient Thermal Impedance

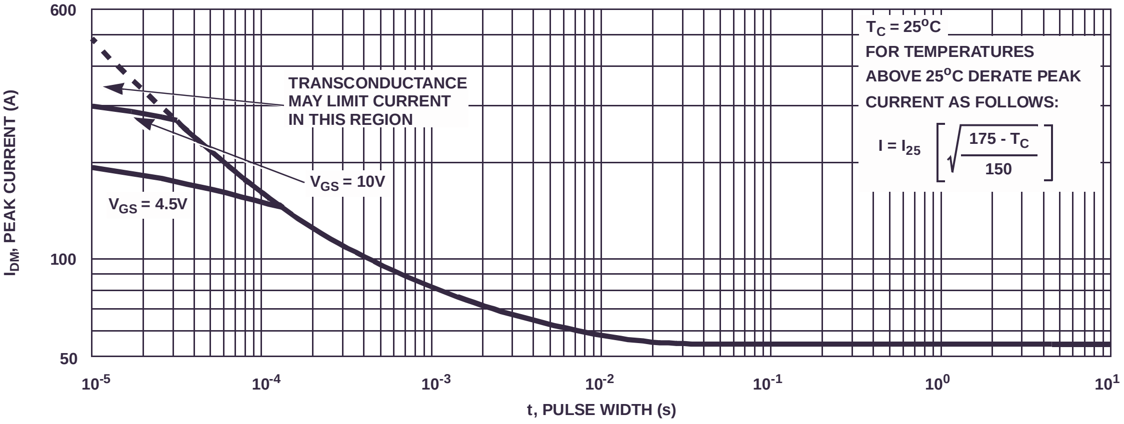


Figure 4. Peak Current Capability

Typical Characteristics T_C = 25°C unless otherwise noted

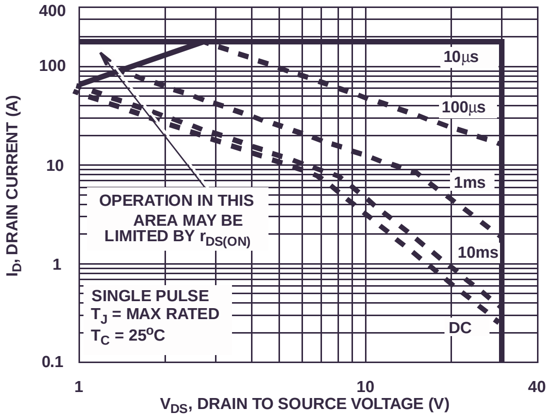
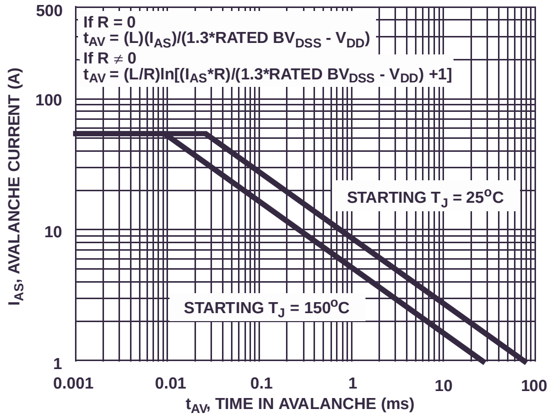


Figure 5. Forward Bias Safe Operating Area



NOTE: Refer to Fairchild Application Notes AN7514 and AN7515

Figure 6. Unclamped Inductive Switching Capability

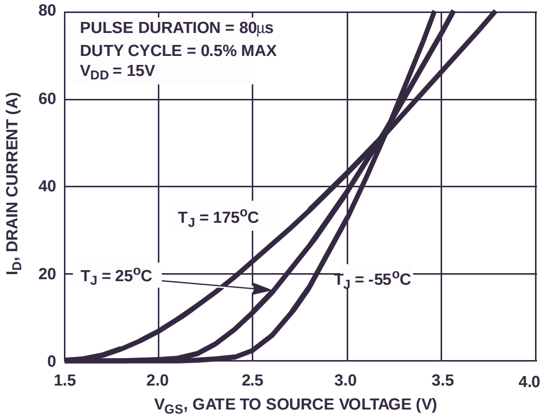


Figure 7. Transfer Characteristics

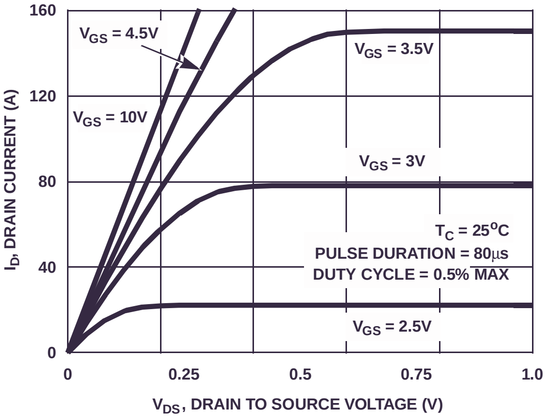


Figure 8. Saturation Characteristics

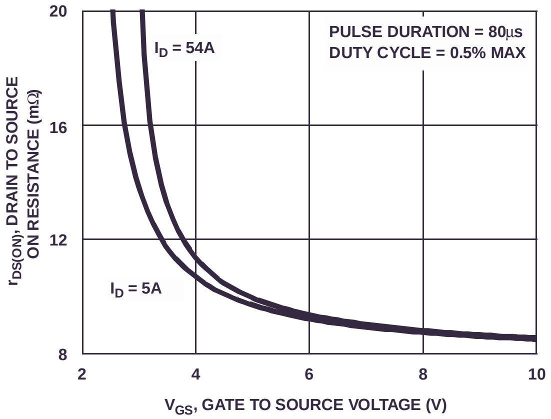


Figure 9. Drain to Source On Resistance vs Gate Voltage and Drain Current

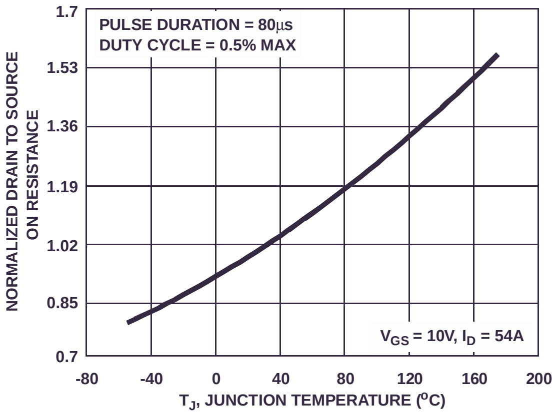


Figure 10. Normalized Drain to Source On Resistance vs Junction Temperature

Typical Characteristics T_C = 25°C unless otherwise noted

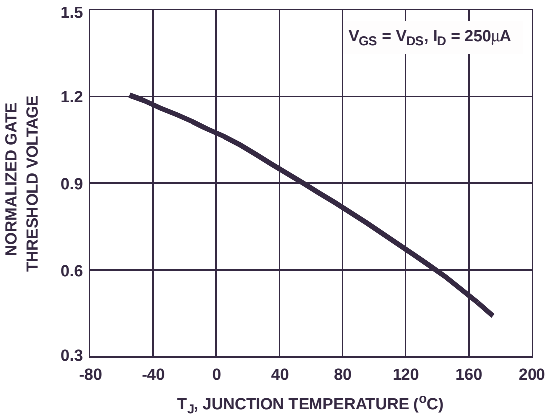


Figure 11. Normalized Gate Threshold Voltage vs Junction Temperature

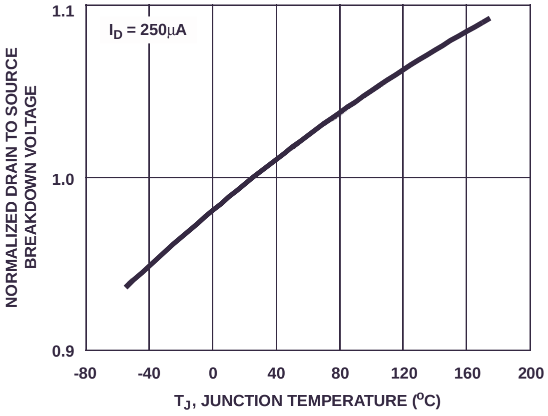


Figure 12. Normalized Drain to Source Breakdown Voltage vs Junction Temperature

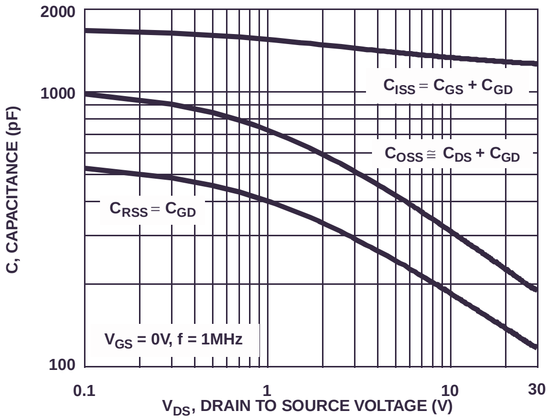


Figure 13. Capacitance vs Drain to Source Voltage

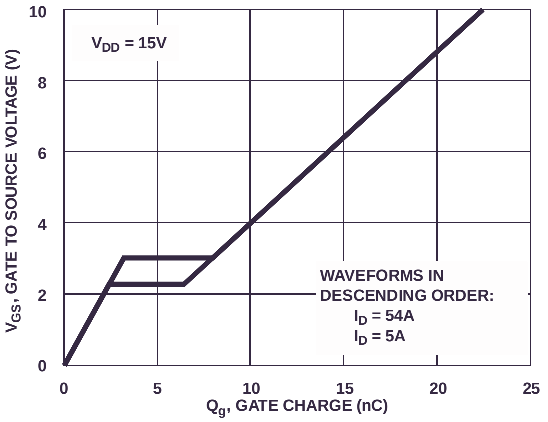


Figure 14. Gate Charge Waveforms for Constant Gate Current

Test Circuits and Waveforms

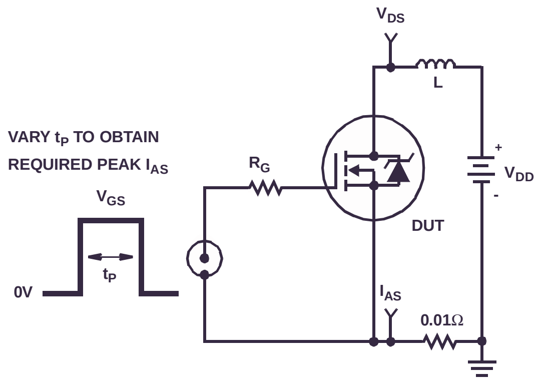


Figure 15. Unclamped Energy Test Circuit

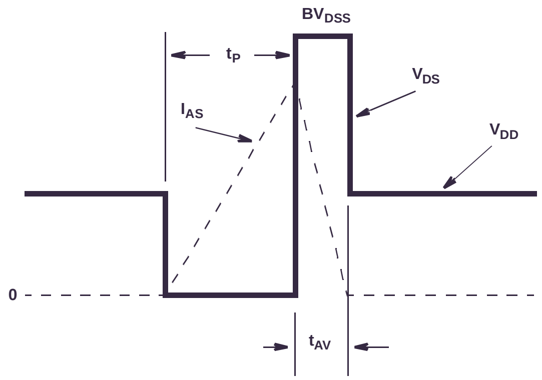


Figure 16. Unclamped Energy Waveforms

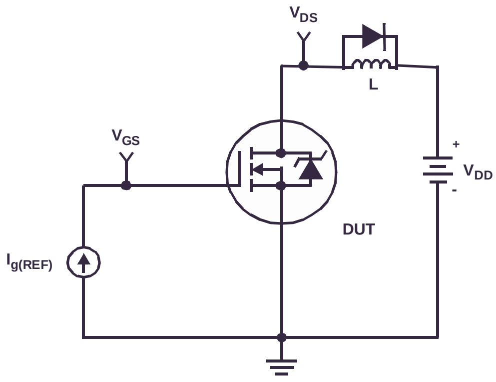


Figure 17. Gate Charge Test Circuit

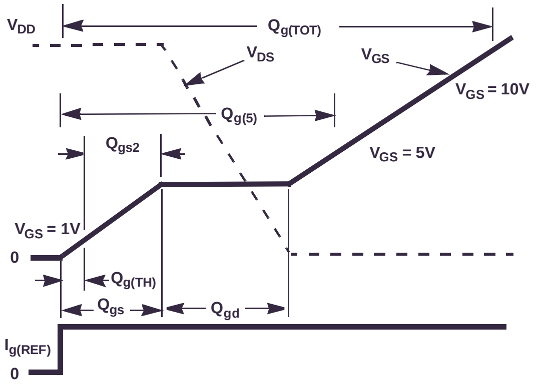


Figure 18. Gate Charge Waveforms

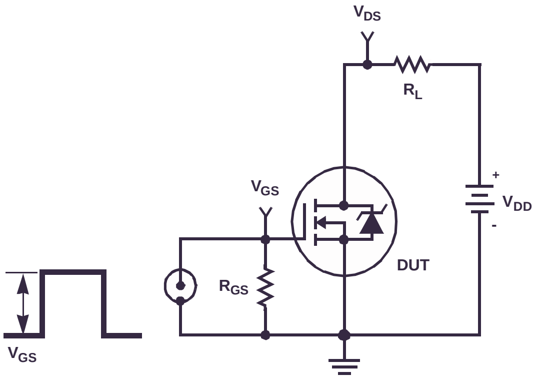


Figure 19. Switching Time Test Circuit

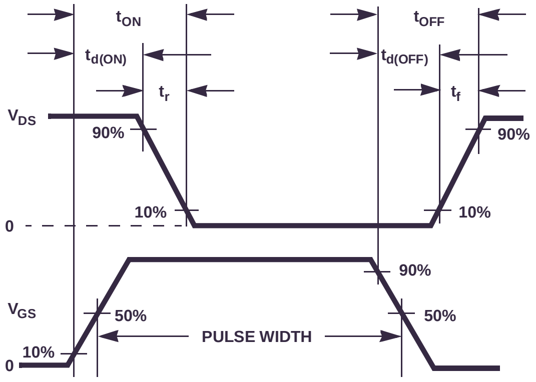


Figure 20. Switching Time Waveforms

PSPICE Electrical Model

```
.SUBCKT FDP8880  2 1 3 ; rev October 2004
Ca 12 8 9.5e-10
Cb 15 14 9.5e-10
Cin 6 8 1.15e-9

Dbody 7 5 DbodyMOD
Dbreak 5 11 DbreakMOD
Dplcap 10 5 DplcapMOD

Ebreak 11 7 17 18 32.88
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

Lgate 1 9 5.3e-9
Ldrain 2 5 1.0e-9
Lsource 3 7 1.7e-9

RLgate 1 9 53
RLdrain 2 5 10
RLsource 3 7 17

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 1.0e-3
Rgate 9 20 2.2
RSLC1 5 51 RSLCMOD 1e-6
RSLC2 5 50 1e3
Rsource 8 7 RsourceMOD 6.8e-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

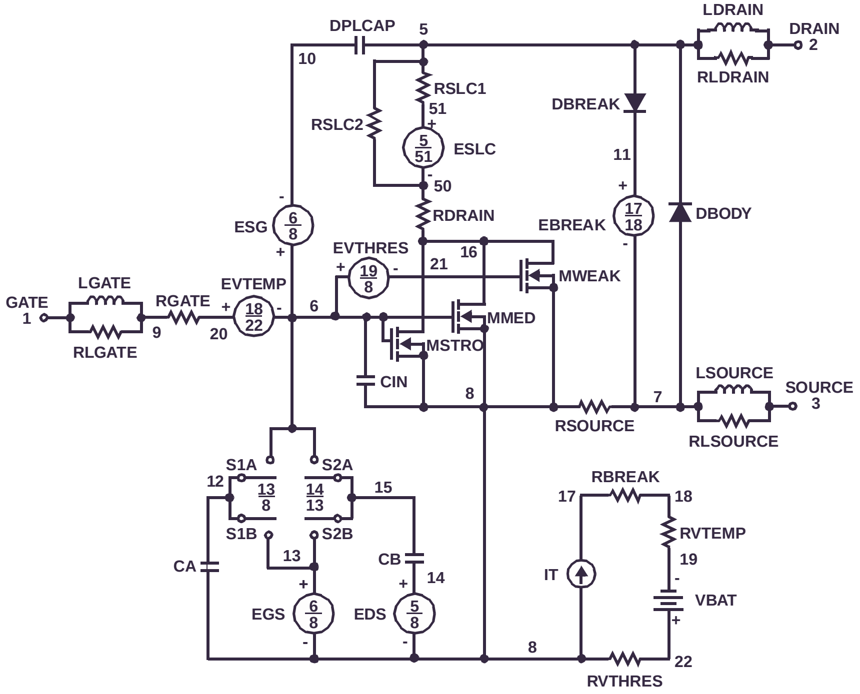
ESLC 51 50  VALUE={(V(5,51)/ABS(V(5,51)))*(PWR(V(5,51)/(1e-6*170),5))}

.MODEL DbodyMOD D (IS=3E-12 IKF=10 N=1.01 RS=5e-3 TRS1=8e-4 TRS2=2e-7
+ CJO=4.8e-10 M=0.55 TT=1e-11 XTI=2)
.MODEL DbreakMOD D (RS=0.2 TRS1=1e-3 TRS2=-8.8e-6)
.MODEL DplcapMOD D (CJO=5.5e-10 IS=1e-30 N=10 M=0.45)

.MODEL MstroMOD NMOS (VTO=2.10 KP=170 IS=1e-30 N=10 TOX=1 L=1u W=1u)
.MODEL MmedMOD NMOS (VTO=1.75 KP=10 IS=1e-30 N=10 TOX=1 L=1u W=1u RG=2.2)
.MODEL MweakMOD NMOS (VTO=1.39 KP=0.05 IS=1e-30 N=10 TOX=1 L=1u W=1u RG=22 RS=0.1)

.MODEL RbreakMOD RES (TC1=8.0e-4 TC2=-8e-7)
.MODEL RdrainMOD RES (TC1=-12e-3 TC2=.35e-4)
.MODEL RSLCMOD RES (TC1=9e-4 TC2=1e-6)
.MODEL RsourceMOD RES (TC1=5e-3 TC2=1e-6)
.MODEL RvtempMOD RES (TC1=-2.78e-3 TC2=1.5e-6)
.MODEL RvthresMOD RES (TC1=-1e-3 TC2=-8.2e-6)

 MODEL S1AMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=-4 VOFF=-3.5)
.MODEL S1BMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=-3.5 VOFF=-4)
.MODEL S2AMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=-1.3 VOFF=-0.8)
.MODEL S2BMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=-0.8 VOFF=-1.3)
.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 October 2004
template FDP8880 n2,n1,n3
electrical n2,n1,n3
{
var i iscl
dp..model dbodymod =  (isl=3e-12,ikf=10,nl=1.01,rs=5e-3,trs1=8e-4,trs2=2e-7,cjo=4.8e-10,m=0.55,tt=1e-11,xti=2)
dp..model dbreakmod = (rs=0.2,trs1=1e-3,trs2=-8.8e-6)
dp..model dplcapmod =  (cjo=5.5e-10,isl=10e-30,nl=10,m=0.45)
m..model mstrongmod = (type=_n,vto=2.10,kp=170,is=1e-30, tox=1)
m..model mmedmod = (type=_n,vto=1.75,kp=10,is=1e-30, tox=1)
m..model mweakmod = (type=_n,vto=1.39,kp=0.05,is=1e-30, tox=1,rs=0.1)
sw_vcsp..model s1amod =  (ron=1e-5,roff=0.1,von=-4,voff=-3.5)
sw_vcsp..model s1bmod =  (ron=1e-5,roff=0.1,von=-3.5,voff=-4)
sw_vcsp..model s2amod =  (ron=1e-5,roff=0.1,von=-1.3,voff=-0.8)
sw_vcsp..model s2bmod =  (ron=1e-5,roff=0.1,von=-0.8,voff=-1.3)
c.ca n12 n8 = 9.5e-10
c.cb n15 n14 = 9.5e-10
c.cin n6 n8 = 1.15e-9

dp.dbody n7 n5 = model=dbodymod
dp.dbreak n5 n11 = model=dbreakmod
dp.dplcap n10 n5 = model=dplcapmod

spe.ebreak n11 n7 n17 n18 = 32.88
spe.eds n14 n8 n5 n8 = 1
spe.egs n13 n8 n6 n8 = 1
spe.esg n6 n10 n6 n8 = 1
spe.evthres n6 n21 n19 n8 = 1
spe.evtemp n20 n6 n18 n22 = 1

i.it n8 n17 = 1

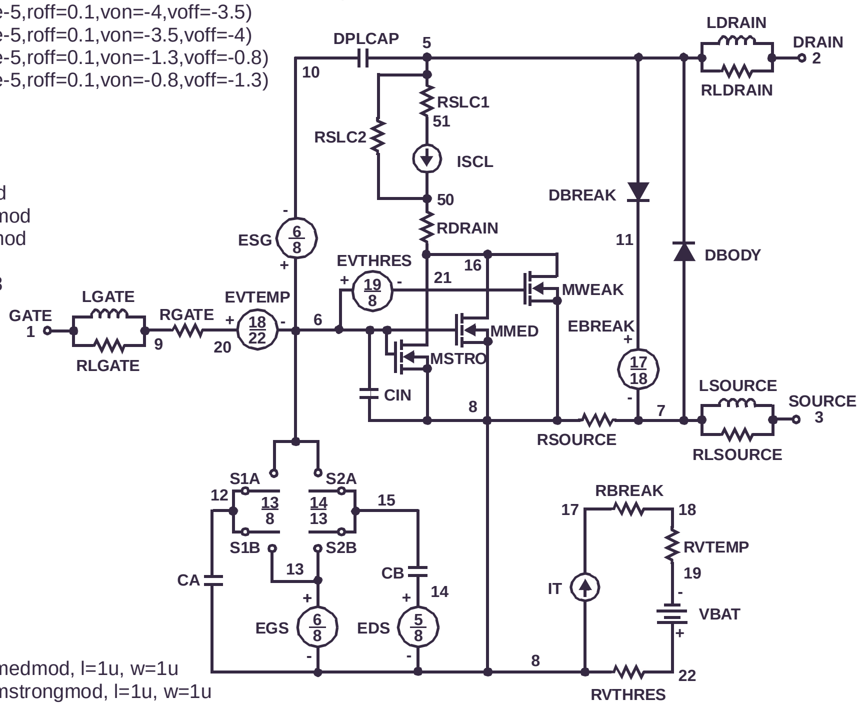
l.lgate n1 n9 = 5.3e-9
l.ldrain n2 n5 = 1.0e-9
l.lsource n3 n7 = 1.7e-9

res.rlgate n1 n9 = 53
res.rldrain n2 n5 = 10
res.rlsource n3 n7 = 17

m.mmed n16 n6 n8 n8 = model=mmedmod, l=1u, w=1u
m.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=8.0e-4,tc2=-8e-7
res.rdrain n50 n16  = 1.0e-3, tc1=-12e-3,tc2=.35e-4
res.rgate n9 n20 = 2.2
res.rslc1 n5 n51  = 1e-6, tc1=9e-4,tc2=1e-6
res.rslc2 n5 n50 = 1e3
res.rsource n8 n7  = 6.8e-3, tc1=5e-3,tc2=1e-6
res.rvthres n22 n8  = 1, tc1=-1e-3,tc2=-8.2e-6
res.rvtemp n18 n19  = 1, tc1=-2.78e-3,tc2=1.5e-6
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)*1e6/170))** 5))}
}
```



PSPICE Thermal Model

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REV 23 December 2003

FDP8880T

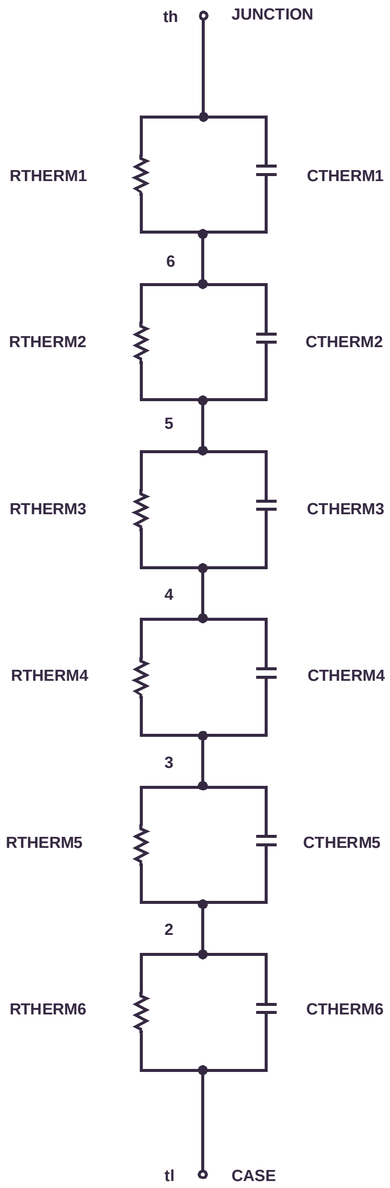
CTHERM1 TH 6 8e-4
CTHERM2 6 5 1e-3
CTHERM3 5 4 2.5e-3
CTHERM4 4 3 2.6e-3
CTHERM5 3 2 8e-3
CTHERM6 2 TL 1.5e-2

RTHERM1 TH 6 1.44e-1
RTHERM2 6 5 1.9e-1
RTHERM3 5 4 3.0e-1
RTHERM4 4 3 4.0e-1
RTHERM5 3 2 5.7e-1
RTHERM6 2 TL 5.8e-1
```

SABER Thermal Model

```
SABER thermal model FDP8880T
template thermal_model th tl
thermal_c th, tl
{
ctherm.ctherm1 th 6 =8e-4
ctherm.ctherm2 6 5 =1e-3
ctherm.ctherm3 5 4 =2.5e-3
ctherm.ctherm4 4 3 =2.6e-3
ctherm.ctherm5 3 2 =8e-3
ctherm.ctherm6 2 tl =1.5e-2

rtherm.rtherm1 th 6 =1.44e-1
rtherm.rtherm2 6 5 =1.9e-1
rtherm.rtherm3 5 4 =3.0e-1
rtherm.rtherm4 4 3 =4.0e-1
rtherm.rtherm5 3 2 =5.7e-1
rtherm.rtherm6 2 tl =5.8e-1
}
```



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FACT™
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FAST®
FASTr™
FPS™
FRFET™
GlobalOptoisolator™
GTO™
HiSeC™
I^{2}C™
i-Lo™

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ImpliedDisconnect™
IntelliMAX™
ISOPLANAR™
LittleFET™
MICROCOUPLER™
MicroFET™
MicroPak™
MICROWIRE™
MSX™
MSXPro™
OCX™
OCXPro™
OPTOLOGIC®
OPTOPLANAR™
PACMAN™
POP™
Power247™
PowerEdge™
PowerSaver™
PowerTrench®
QFET®
QS™
QT Optoelectronics™
Quiet Series™
RapidConfigure™
RapidConnect™
µSerDes™
SILENT SWITCHER®
SMART START™
SPM™
Stealth™
SuperFET™
SuperSOT™-3
SuperSOT™-6
SuperSOT™-8
SyncFET™
TinyLogic®
TINYOPTO™
TruTranslation™
UHC™
UltraFET®
UniFET™
VCX™

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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.

PRODUCT STATUS DEFINITIONS

Definition of Terms

Datasheet Identification	Product Status	Definition
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