

## FDP8870\_F085

### N-Channel PowerTrench® MOSFET

#### 30V, 156A, 4.1mΩ

#### General Description

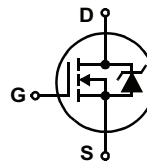
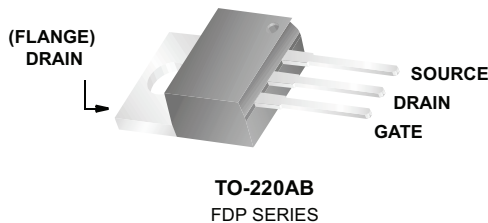
This N-Channel MOSFET has been designed specifically to improve the overall efficiency of DC/DC converters using either synchronous or conventional switching PWM controllers. It has been optimized for low gate charge, low  $r_{DS(ON)}$  and fast switching speed.

#### Features

- $r_{DS(ON)} = 4.1m\Omega$   $V_{GS} = 10V$ ,  $I_D = 35A$
- $r_{DS(ON)} = 4.6m\Omega$   $V_{GS} = 4.5V$ ,  $I_D = 35A$
- High performance trench technology for extremely low  $r_{DS(ON)}$
- Low gate charge
- High power and current handling capability
- Qualified to AEC Q101
- RoHS Compliant

#### Applications

- DC/DC converters



#### MOSFET Maximum Ratings $T_C = 25^\circ\text{C}$ unless otherwise noted

Symbol	Parameter	Ratings	Units
$V_{DSS}$	Drain to Source Voltage	30	V
$V_{GS}$	Gate to Source Voltage	$\pm 20$	V
$I_D$	Drain Current		
	Continuous ( $T_C = 25^\circ\text{C}$ , $V_{GS} = 10V$ ) (Note 1)	156	A
	Continuous ( $T_C = 25^\circ\text{C}$ , $V_{GS} = 4.5V$ ) (Note 1)	147	A
	Continuous ( $T_{amb} = 25^\circ\text{C}$ , $V_{GS} = 10V$ , with $R_{\theta JA} = 62^\circ\text{C/W}$ )	19	A
	Pulsed	Figure 4	A
$E_{AS}$	Single Pulse Avalanche Energy (Note 2)	300	mJ
$P_D$	Power dissipation	160	W
	Derate above $25^\circ\text{C}$	1.07	W/ $^\circ\text{C}$
$T_J, T_{STG}$	Operating and Storage Temperature	-55 to 175	$^\circ\text{C}$

#### Thermal Characteristics

$R_{\theta JC}$	Thermal Resistance Junction to Case TO-220	0.94	$^\circ\text{C/W}$
$R_{\theta JA}$	Thermal Resistance Junction to Ambient TO-220 ( Note 3)	62	$^\circ\text{C/W}$

#### Package Marking and Ordering Information

Device Marking	Device	Package	Reel Size	Tape Width	Quantity
FDP8870	FDP8870_F085	TO-220AB	Tube	N/A	50 units

**Electrical Characteristics**  $T_C = 25^\circ\text{C}$  unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
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**Off Characteristics**

$B_{VDSS}$	Drain to Source Breakdown Voltage	$I_D = 250\mu\text{A}, V_{GS} = 0\text{V}$	30	-	-	V
$I_{DSS}$	Zero Gate Voltage Drain Current	$V_{DS} = 24\text{V}$ $V_{GS} = 0\text{V}$	-	-	1	$\mu\text{A}$
		$T_C = 150^\circ\text{C}$	-	-	250	
$I_{GSS}$	Gate to Source Leakage Current	$V_{GS} = \pm 20\text{V}$	-	-	$\pm 100$	nA

**On Characteristics**

$V_{GS(TH)}$	Gate to Source Threshold Voltage	$V_{GS} = V_{DS}, I_D = 250\mu\text{A}$	1.2	-	2.5	V
$r_{DS(ON)}$	Drain to Source On Resistance	$I_D = 35\text{A}, V_{GS} = 10\text{V}$	-	0.0034	0.0041	$\Omega$
		$I_D = 35\text{A}, V_{GS} = 4.5\text{V}$	-	0.0040	0.0046	
		$I_D = 35\text{A}, V_{GS} = 10\text{V}, T_J = 175^\circ\text{C}$	-	0.0051	0.0065	

**Dynamic Characteristics**

$C_{ISS}$	Input Capacitance	$V_{DS} = 15\text{V}, V_{GS} = 0\text{V}, f = 1\text{MHz}$	-	5200	-	pF	
$C_{OSS}$	Output Capacitance		-	970	-	pF	
$C_{RSS}$	Reverse Transfer Capacitance		-	570	-	pF	
$R_G$	Gate Resistance	$V_{GS} = 0.5\text{V}, f = 1\text{MHz}$	-	2.1	-	$\Omega$	
$Q_{g(TOT)}$	Total Gate Charge at 10V	$V_{GS} = 0\text{V to } 10\text{V}$	$V_{DD} = 15\text{V}$ $I_D = 35\text{A}$ $I_g = 1.0\text{mA}$	-	106	132	nC
$Q_{g(5)}$	Total Gate Charge at 5V	$V_{GS} = 0\text{V to } 5\text{V}$		-	56	69	nC
$Q_{g(TH)}$	Threshold Gate Charge	$V_{GS} = 0\text{V to } 1\text{V}$		-	5.0	6.5	nC
$Q_{gs}$	Gate to Source Gate Charge			-	15	-	nC
$Q_{gs2}$	Gate Charge Threshold to Plateau			-	10	-	nC
$Q_{gd}$	Gate to Drain "Miller" Charge			-	23	-	nC

**Switching Characteristics** ( $V_{GS} = 10\text{V}$ )

$t_{ON}$	Turn-On Time	$V_{DD} = 15\text{V}, I_D = 35\text{A}$ $V_{GS} = 4.5\text{V}, R_{GS} = 3.3\Omega$	-	-	168	ns
$t_{d(ON)}$	Turn-On Delay Time		-	11	-	ns
$t_r$	Rise Time		-	105	-	ns
$t_{d(OFF)}$	Turn-Off Delay Time		-	70	-	ns
$t_f$	Fall Time		-	46	-	ns
$t_{OFF}$	Turn-Off Time		-	-	173	ns

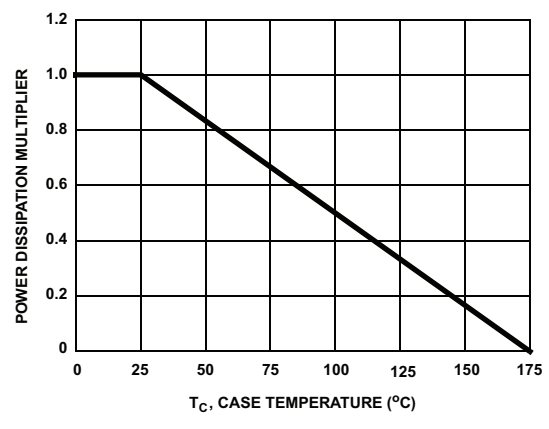
**Drain-Source Diode Characteristics**

$V_{SD}$	Source to Drain Diode Voltage	$I_{SD} = 35\text{A}$	-	-	1.25	V
		$I_{SD} = 15\text{A}$	-	-	1.0	V
$t_{rr}$	Reverse Recovery Time	$I_{SD} = 35\text{A}, dI_{SD}/dt = 100\text{A}/\mu\text{s}$	-	-	37	ns
$Q_{RR}$	Reverse Recovered Charge	$I_{SD} = 35\text{A}, dI_{SD}/dt = 100\text{A}/\mu\text{s}$	-	-	21	nC

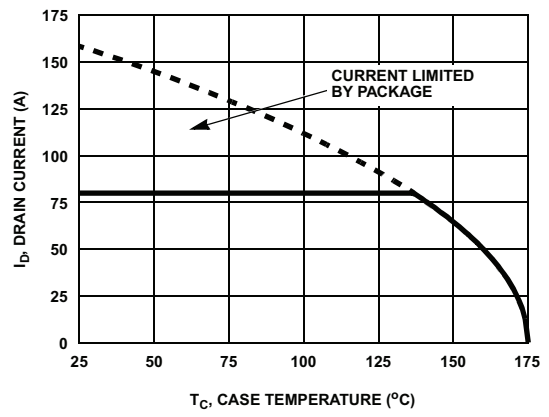
**Notes:**

- 1: Package current limitation is 80A.
- 2: Starting  $T_J = 25^\circ\text{C}$ ,  $L = 0.15\text{mH}$ ,  $I_{AS} = 64\text{A}$ ,  $V_{DD} = 27\text{V}$ ,  $V_{GS} = 10\text{V}$ .
- 3: Pulse width = 100s.

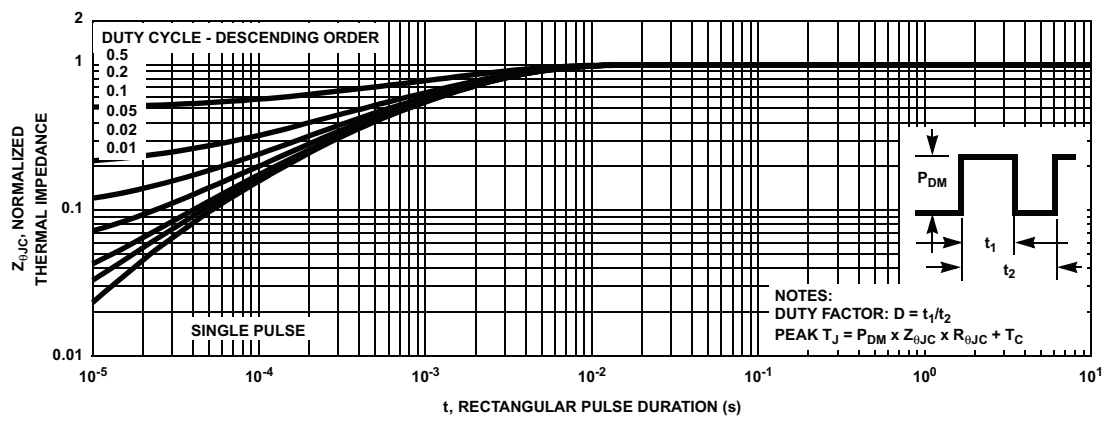
**Typical Characteristics**  $T_C = 25^\circ\text{C}$  unless otherwise noted



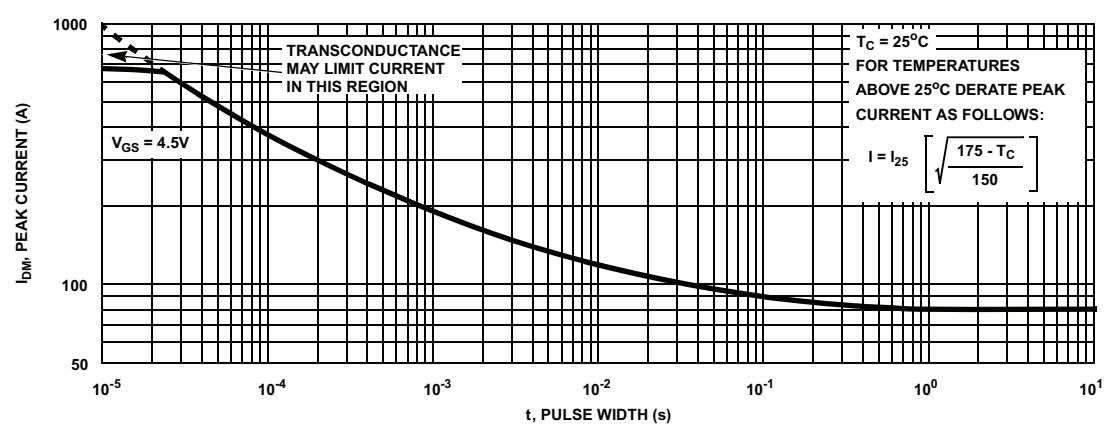
**Figure 1. Normalized Power Dissipation vs Case Temperature**



**Figure 2. Maximum Continuous Drain Current vs Case Temperature**

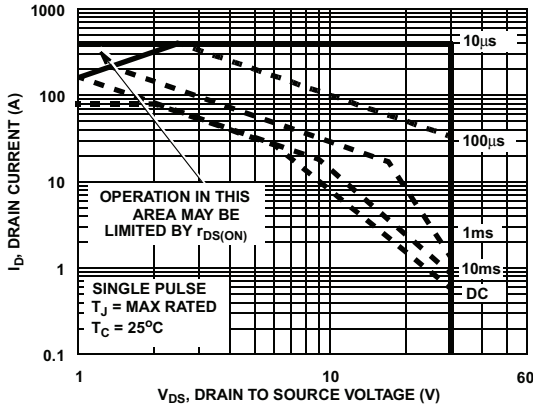


**Figure 3. Normalized Maximum Transient Thermal Impedance**

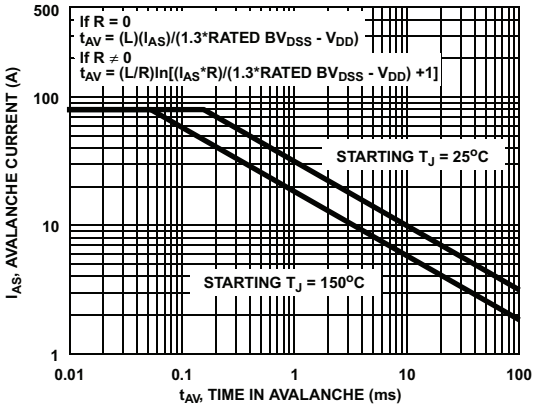


**Figure 4. Peak Current Capability**

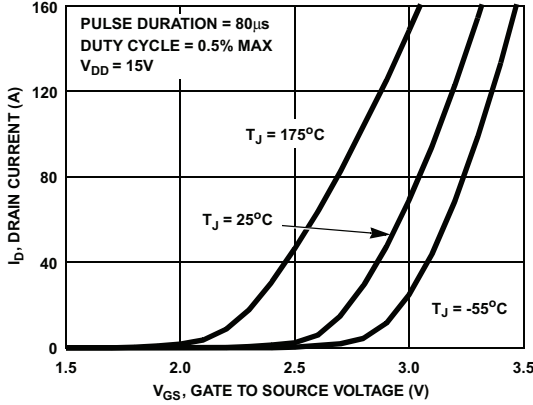
**Typical Characteristics**  $T_C = 25^\circ\text{C}$  unless otherwise noted



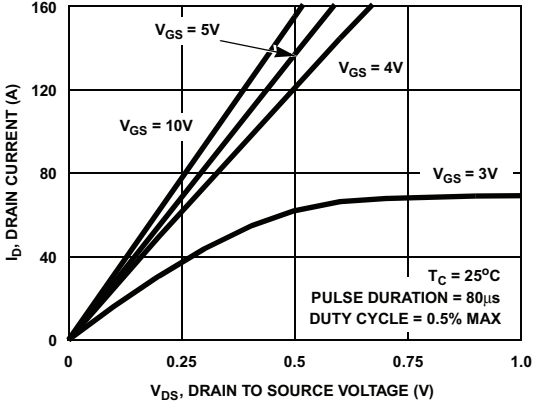
**Figure 5. Forward Bias Safe Operating Area**



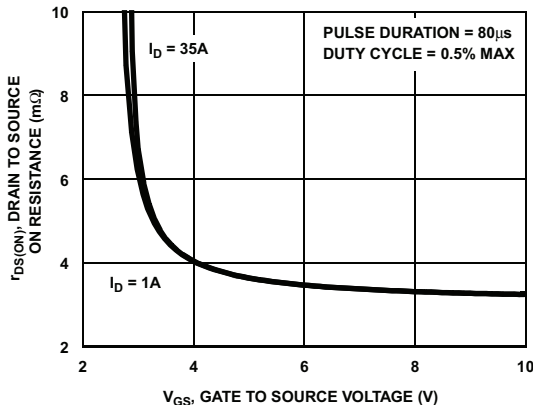
NOTE: Refer to Fairchild Application Notes AN7514 and AN7515  
**Figure 6. Unclamped Inductive Switching Capability**



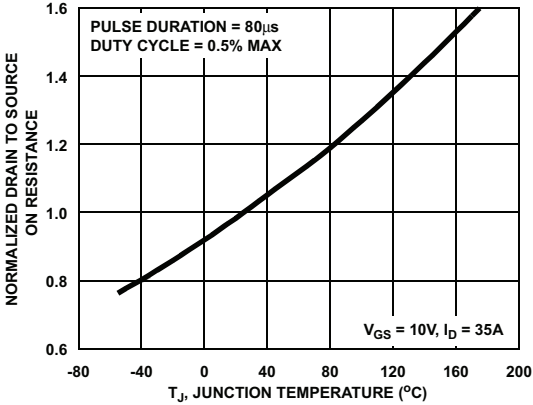
**Figure 7. Transfer Characteristics**



**Figure 8. Saturation Characteristics**

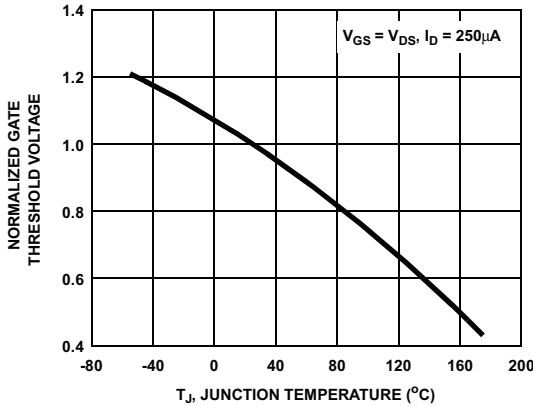


**Figure 9. Drain to Source On Resistance vs Gate Voltage and Drain Current**

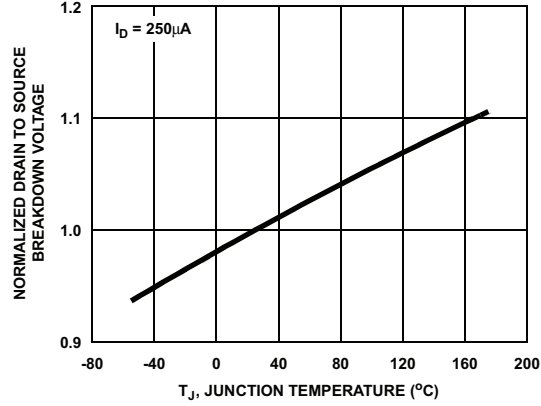


**Figure 10. Normalized Drain to Source On Resistance vs Junction Temperature**

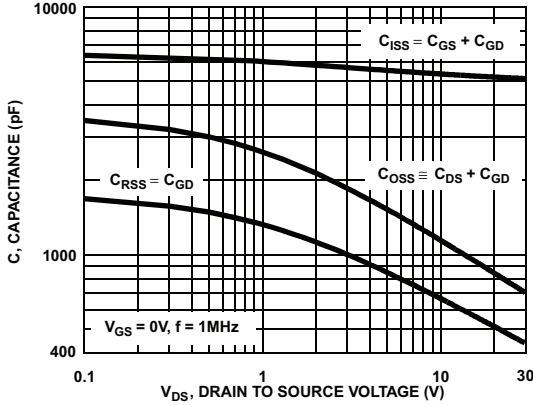
**Typical Characteristics**  $T_C = 25^\circ\text{C}$  unless otherwise noted



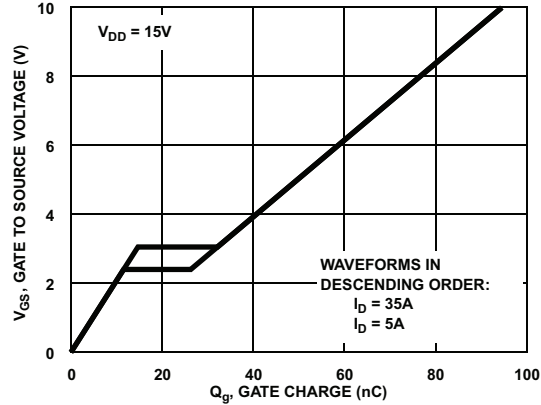
**Figure 11. Normalized Gate Threshold Voltage vs Junction Temperature**



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

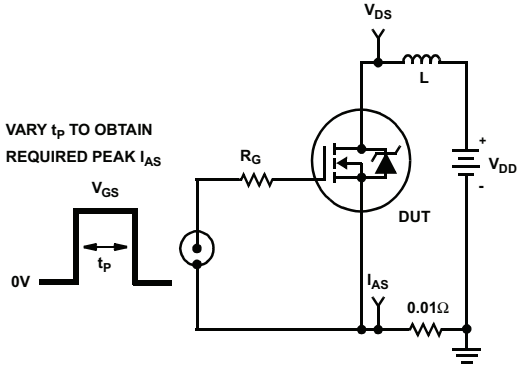


**Figure 13. Capacitance vs Drain to Source Voltage**

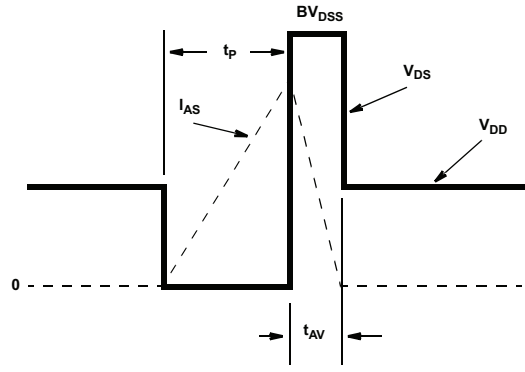


**Figure 14. Gate Charge Waveforms for Constant Gate Current**

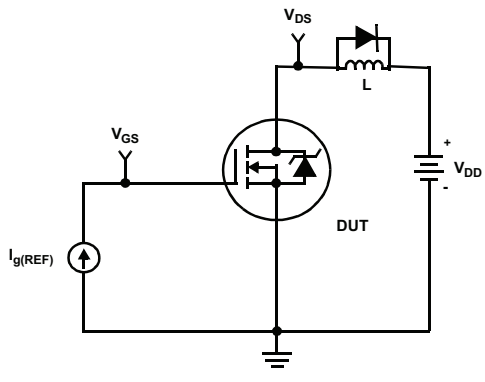
**Test Circuits and Waveforms**



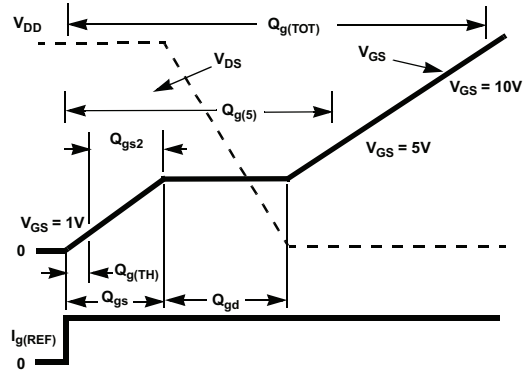
**Figure 15. Unclamped Energy Test Circuit**



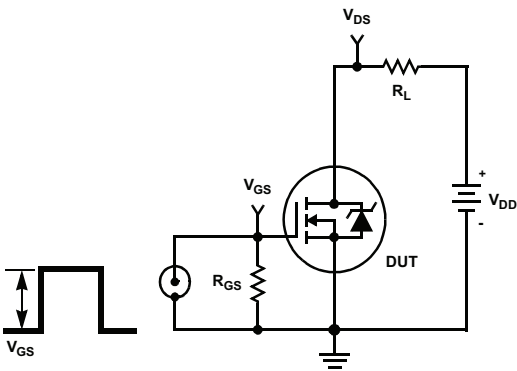
**Figure 16. Unclamped Energy Waveforms**



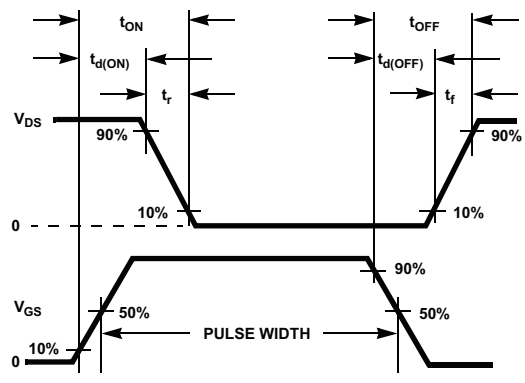
**Figure 17. Gate Charge Test Circuit**



**Figure 18. Gate Charge Waveforms**



**Figure 19. Switching Time Test Circuit**



**Figure 20. Switching Time Waveforms**

### PSPICE Electrical Model

.SUBCKT FDP8870 2 1 3 ; rev December 2003  
 Ca 12 8 4.5e-9  
 Cb 15 14 4.5e-9  
 Cin 6 8 4.7e-9

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

Ebreak 11 7 17 18 33.45  
 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 3.6e-9  
 Ldrain 2 5 1.0e-9  
 Lsource 3 7 3.3e-9

RLgate 1 9 36  
 RLdrain 2 5 10  
 RLsource 3 7 33

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 2.15e-3  
 Rgate 9 20 2.1  
 RSLC1 5 51 RSLCMOD 1e-6  
 RSLC2 5 50 1e3  
 Rsource 8 7 RsourceMOD 9e-4  
 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),10))}

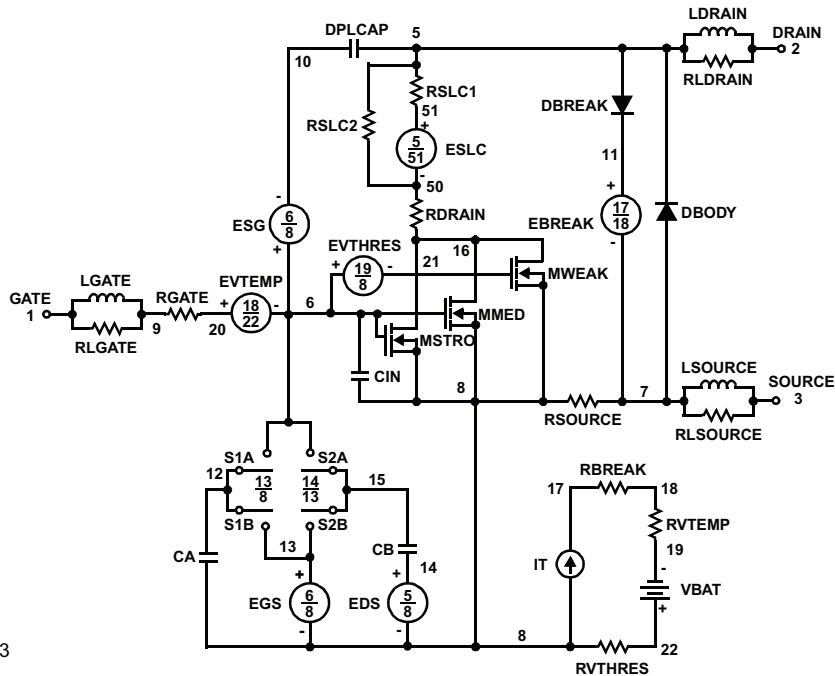
.MODEL DbodyMOD D (IS=7.5E-12 IKF=17 N=1.01 RS=2.1e-3 TRS1=2e-3 TRS2=2e-7  
 + CJO=1.9e-9 M=0.57 TT=9e-11 XTI=2.6)  
 .MODEL DbreakMOD D (RS=8e-2 TRS1=1e-3 TRS2=-8.9e-6)  
 .MODEL DplcapMOD D (CJO=1.75e-9 IS=1e-30 N=10 M=0.4)

.MODEL MmedMOD NMOS (VTO=2.1 KP=30 IS=1e-30 N=10 TOX=1 L=1u W=1u RG=2.1 T\_ABS=25)  
 .MODEL MstroMOD NMOS (VTO=2.51 KP=650 IS=1e-30 N=10 TOX=1 L=1u W=1u T\_ABS=25)  
 .MODEL MweakMOD NMOS (VTO=1.67 KP=0.1 IS=1e-30 N=10 TOX=1 L=1u W=1u RG=21 RS=0.1 T\_ABS=25)

.MODEL RbreakMOD RES (TC1=8.3e-4 TC2=-9e-7)  
 .MODEL RdrainMOD RES (TC1=2.3e-3 TC2=5e-6)  
 .MODEL RSLCMOD RES (TC1=1e-4 TC2=1e-6)  
 .MODEL RsourceMOD RES (TC1=8e-3 TC2=1e-6)  
 .MODEL RvthresMOD RES (TC1=-2.3e-3 TC2=-9e-6)  
 .MODEL RvtempMOD RES (TC1=-3e-3 TC2=2e-7)

.MODEL S1AMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=-4 VOFF=-2)  
 .MODEL S1BMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=-2 VOFF=-4)  
 .MODEL S2AMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=-1 VOFF=-0.5)  
 .MODEL S2BMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=-0.5 VOFF=-1)  
 .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 December 2003

template FDP8870 n2,n1,n3 =m\_temp

electrical n2,n1,n3

number m\_temp=25

{

var i iscl

dp..model dbodymod = (isl=7.5e-12,ikf=17,nl=1.01,rs=2.1e-3,trs1=2e-3,trs2=2e-7,cjo=1.9e-9,m=0.57,tt=9e-11,xti=2.6)

dp..model dbreakmod = (rs=8e-2,trs1=1e-3,trs2=-8.9e-6)

dp..model dplcapmod = (cjo=1.75e-9,isl=10e-30,nl=10,m=0.4)

m..model mmedmod = (type=\_n,vto=2.1,kp=30, is=1e-30, tox=1)

m..model mstrongmod = (type=\_n,vto=2.51,kp=650, is=1e-30, tox=1)

m..model mweakmod = (type=\_n,vto=1.67,kp=0.1, is=1e-30, tox=1,rs=0.1)

sw\_vcsp..model s1amod = (ron=1e-5,roff=0.1,von=-4,voff=-2)

sw\_vcsp..model s1bmod = (ron=1e-5,roff=0.1,von=-2,voff=-4)

sw\_vcsp..model s2amod = (ron=1e-5,roff=0.1,von=-1,voff=-0.5)

sw\_vcsp..model s2bmod = (ron=1e-5,roff=0.1,von=-0.5,voff=-1)

c.ca n12 n8 = 4.5e-9

c.cb n15 n14 = 4.5e-9

c.cin n6 n8 = 4.7e-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 = 33.45

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 = 3.6e-9

l.ldrain n2 n5 = 1.0e-9

l.lsource n3 n7 = 3.3e-9

res.rlgate n1 n9 = 36

res.rldrain n2 n5 = 10

res.rlsource n3 n7 = 33

m.mmed n16 n6 n8 n8 = model=mmedmod, l=1u, w=1u, temp=m\_temp

m.mstrong n16 n6 n8 n8 = model=mstrongmod, l=1u, w=1u, temp=m\_temp

m.mweak n16 n21 n8 n8 = model=mweakmod, l=1u, w=1u, temp=m\_temp

res.rbreak n17 n18 = 1, tc1=8.3e-4,tc2=-9e-7

res.rdrain n50 n16 = 2.15e-3, tc1=2.3e-3,tc2=5e-6

res.rgate n9 n20 = 2.1

res.rslc1 n5 n51 = 1e-6, tc1=1e-4,tc2=1e-6

res.rslc2 n5 n50 = 1e3

res.rsource n8 n7 = 9e-4, tc1=8e-3,tc2=1e-6

res.rvthres n22 n8 = 1, tc1=-2.3e-3,tc2=-9e-6

res.rvtemp n18 n19 = 1, tc1=-3e-3,tc2=2e-7

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

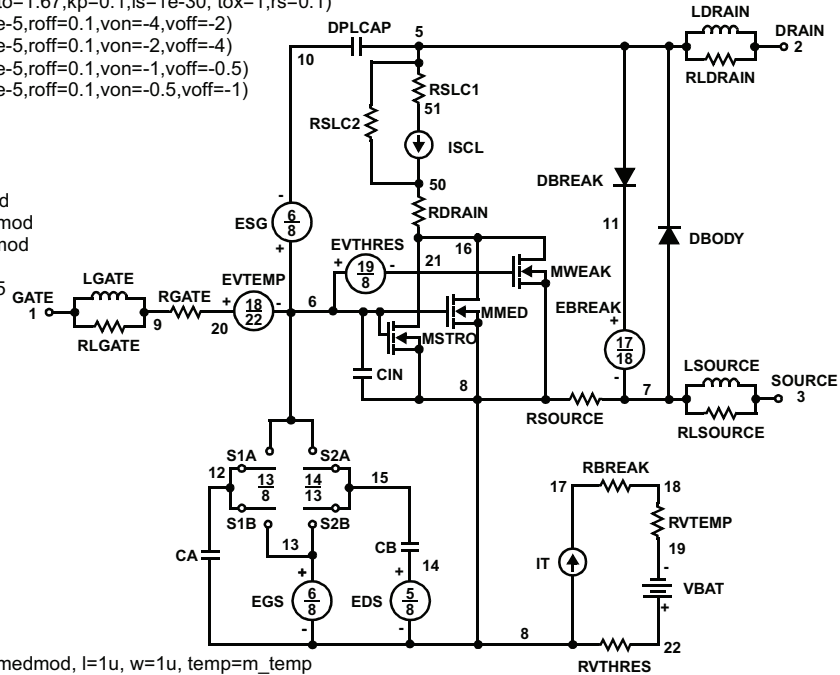
equations {

i (n51->n50) +=iscl

iscl: v(n51,n50) = ((v(n5,n51)/(1e-9+abs(v(n5,n51))))\*((abs(v(n5,n51))\*1e6/500)\*\* 10))

}

}





**PSPICE Thermal Model**

REV 23 December 2003

FDP8870T

CTHERM1 TH 6 1e-3  
 CTHERM2 6 5 2e-3  
 CTHERM3 5 4 3e-3  
 CTHERM4 4 3 9e-3  
 CTHERM5 3 2 1e-2  
 CTHERM6 2 TL 2e-2

RTHERM1 TH 6 3e-2  
 RTHERM2 6 5 8e-2  
 RTHERM3 5 4 1.1e-1  
 RTHERM4 4 3 1.6e-1  
 RTHERM5 3 2 1.72e-1  
 RTHERM6 2 TL 2e-1

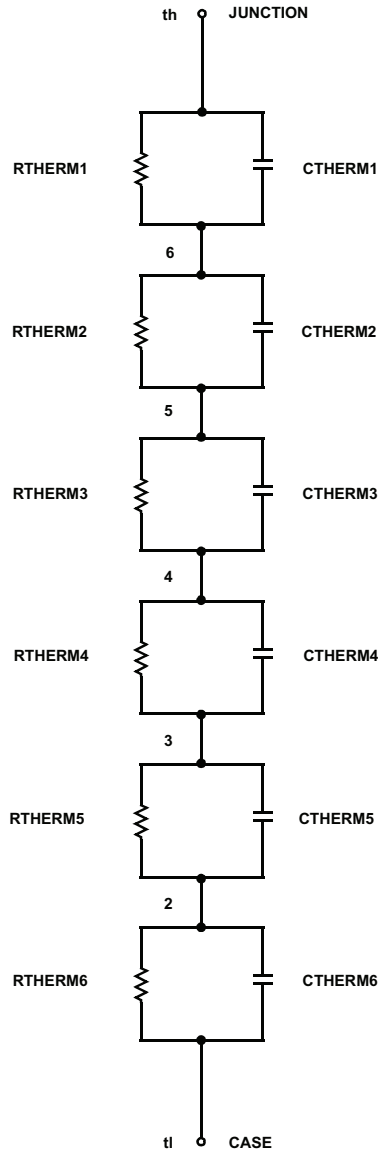
**SABER Thermal Model**

SABER thermal model FDP8870T

template thermal\_model th tl  
 thermal\_c th, tl

```
{
    ctherm.ctherm1 th 6 =1e-3
    ctherm.ctherm2 6 5 =2e-3
    ctherm.ctherm3 5 4 =3e-3
    ctherm.ctherm4 4 3 =9e-3
    ctherm.ctherm5 3 2 =1e-2
    ctherm.ctherm6 2 tl =2e-2
```

```
rtherm.rtherm1 th 6 =3e-2
rtherm.rtherm2 6 5 =8e-2
rtherm.rtherm3 5 4 =1.1e-1
rtherm.rtherm4 4 3 =1.6e-1
rtherm.rtherm5 3 2 =1.72e-1
rtherm.rtherm6 2 tl =2e-1
}
```





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Auto-SPM™	FRFET®	PowerTrench®	
Build it Now™	Global Power Resource <sup>SM</sup>	PowerXS™	
CorePLUS™	Green FPS™	Programmable Active Droop™	
CorePOWER™	Green FPS™ e-Series™	QFET®	
CROSSVOLT™	Gmax™	QS™	
CTL™	GTO™	Quiet Series™	
Current Transfer Logic™	IntelliMAX™	RapidConfigure™	
DEUXPEED®	ISOPLANAR™	™	
Dual Cool™	MegaBuck™	Saving our world, 1mW/W/kW at a time™	
EcoSPARK®	MICROCOUPLER™	SignalWise™	
EfficientMax™	MicroFET™	SmartMax™	
ESBC™	MicroPak™	SMART START™	
™	MicroPak2™	SPM®	
Fairchild®	MillerDrive™	STEALTH™	
Fairchild Semiconductor®	MotionMax™	SuperFET™	
FACT Quiet Series™	Motion-SPM™	SuperSOT™-3	
FACT®	OptoHit™	SuperSOT™-6	
FAST®	OPTOLOGIC®	SuperSOT™-8	
FastvCore™	OPTOPLANAR®	SupreMOS™	
FETBench™	™	SyncFET™	
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