

## 60A, 30V, Avalanche Rated, P-Channel Enhancement-Mode Power MOSFETs

December 1995

### Features

- 60A, 30V
- $r_{DS(ON)} = 0.027\Omega$
- Temperature Compensating PSPICE Model
- Peak Current vs Pulse Width Curve
- UIS Rating Curve
- +175°C Operating Temperature

### Description

The RFG60P03, RFP60P03, RF1S60P03 and RF1S60P03SM P-Channel power MOSFETs are manufactured using the MegaFET process. This process, which uses feature sizes approaching those of LSI integrated circuits gives optimum utilization of silicon, resulting in outstanding performance. They were designed for use in applications such as switching regulators, switching converters, motor drivers and relay drivers. These transistors can be operated directly from integrated circuits.

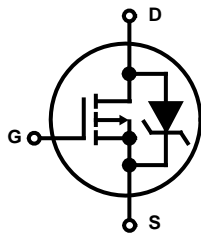
#### PACKAGE AVAILABILITY

PART NUMBER	PACKAGE	BRAND
RFG60P03	TO-247	RFG60P03
RFP60P03	TO-220AB	RFP60P03
RF1S60P03	TO-262AA	F1S60P03
RF1S60P03SM	TO-263AB	F1S60P03

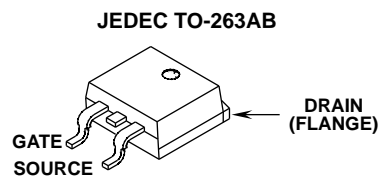
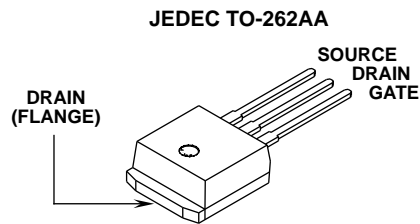
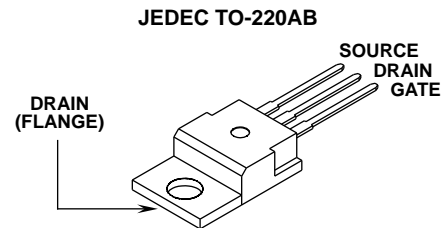
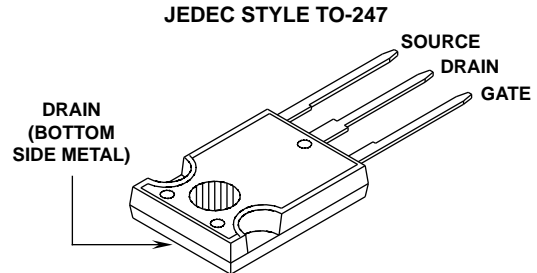
NOTE: When ordering use the entire part number.

Formerly developmental type TA49045.

### Symbol



### Packages



### Absolute Maximum Ratings $T_C = +25^\circ\text{C}$

		RFG60P03, RFP60P03, RF1S60P03, RF1S60P03SM	UNITS
Drain Source Voltage	$V_{DSS}$	-30	V
Drain Gate Voltage	$V_{DGR}$	-30	V
Gate Source Voltage	$V_{GS}$	$\pm 20$	V
Drain Current			
RMS Continuous	$I_D$	60	A
Pulsed Drain Current	$I_{DM}$	Refer to Peak Current Curve	
Single Pulse Avalanche Rating	$E_{AS}$	Refer to UIS Curve	
Power Dissipation			
$T_C = +25^\circ\text{C}$	$P_D$	176	W
Derate above +25°C	$P_T$	1.17	W/°C
Operating and Storage Temperature	$T_J, T_{STG}$	-55 to +175	°C

CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper ESD handling procedures.

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## Specifications RFG60P03, RFP60P03, RF1S60P03, RF1S60P03SM

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

PARAMETERS	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS	
Drain-Source Breakdown Voltage	$BV_{DSS}$	$I_D = 250\mu\text{A}$ , $V_{GS} = 0\text{V}$	-30	-	-	V	
Gate Threshold Voltage	$V_{GS(TH)}$	$V_{GS} = V_{DS}$ , $I_D = 250\mu\text{A}$	-2	-	-4	V	
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{DS} = -30\text{V}$ , $V_{GS} = 0\text{V}$	$T_C = +25^\circ\text{C}$	-	-	-1	$\mu\text{A}$
			$T_C = +150^\circ\text{C}$	-	-	-50	$\mu\text{A}$
Gate-Source Leakage Current	$I_{GSS}$	$V_{GS} = \pm 20\text{V}$	-	-	100	nA	
On Resistance	$r_{DS(ON)}$	$I_D = 60\text{A}$ , $V_{GS} = -10\text{V}$	-	-	0.027	$\Omega$	
Turn-On Time	$t_{ON}$	$V_{DD} = -15\text{V}$ , $I_D = 60\text{A}$ $R_L = 0.25\Omega$ , $V_{GS} = -10\text{V}$ $R_{GS} = 2.5\Omega$	-	-	140	ns	
Turn-On Delay Time	$t_{D(ON)}$		-	20	-	ns	
Rise Time	$t_R$		-	75	-	ns	
Turn-Off Delay Time	$t_{D(OFF)}$		-	35	-	ns	
Fall Time	$t_F$		-	40	-	ns	
Turn-Off Time	$t_{OFF}$		-	-	115	ns	
Total Gate Charge	$Q_{G(TOT)}$		$V_{GS} = 0$ to $-20\text{V}$	$V_{DD} = -24\text{V}$ , $I_D = 60\text{A}$ , $R_L = 0.4\Omega$	-	190	230
Gate Charge at 10V	$Q_{G(-10)}$	$V_{GS} = 0$ to $-10\text{V}$	-		100	120	nC
Threshold Gate Charge	$Q_{G(TH)}$	$V_{GS} = 0$ to $-2\text{V}$	-		7.5	9	nC
Input Capacitance	$C_{ISS}$	$V_{DS} = -25\text{V}$ , $V_{GS} = 0\text{V}$ $f = 1\text{MHz}$	-	3000	-	pF	
Output Capacitance	$C_{OSS}$		-	1500	-	pF	
Reverse Transfer Capacitance	$C_{RSS}$		-	525	-	pF	
Thermal Resistance, Junction to Case	$R_{\theta JC}$		-	-	0.85	$^\circ\text{C/W}$	
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	-	-	80	$^\circ\text{C/W}$		

### Source-Drain Diode Ratings and Specifications

PARAMETERS	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Forward Voltage	$V_{SD}$	$I_{SD} = -60\text{A}$	-	-	-1.75	V
Reverse Recovery Time	$t_{RR}$	$I_{SD} = -60\text{A}$ , $dI_{SD}/dt = -100\text{A}/\mu\text{s}$	-	-	200	ns

Typical Performance Curves

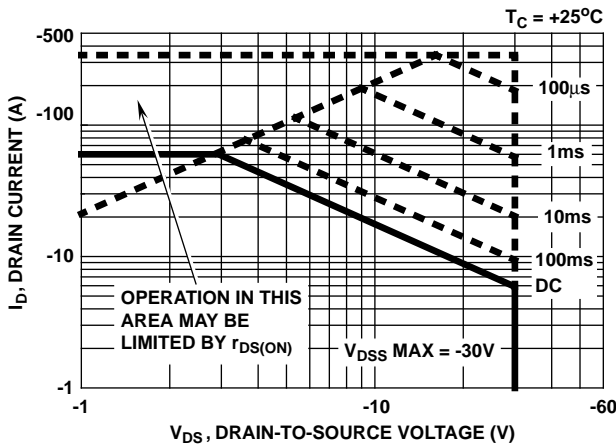


FIGURE 1. SAFE OPERATING AREA CURVE

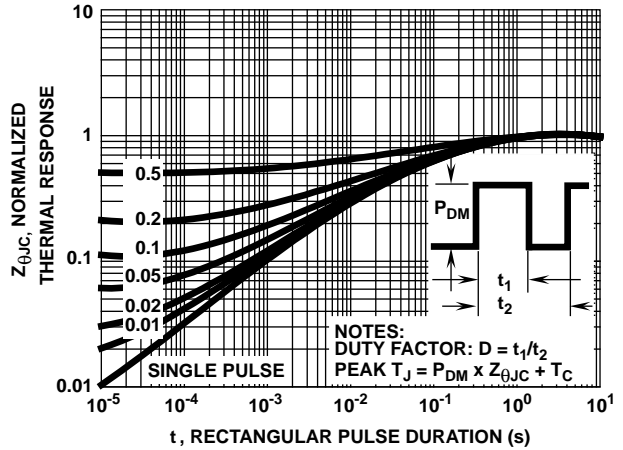


FIGURE 2. NORMALIZED MAXIMUM TRANSIENT THERMAL IMPEDANCE

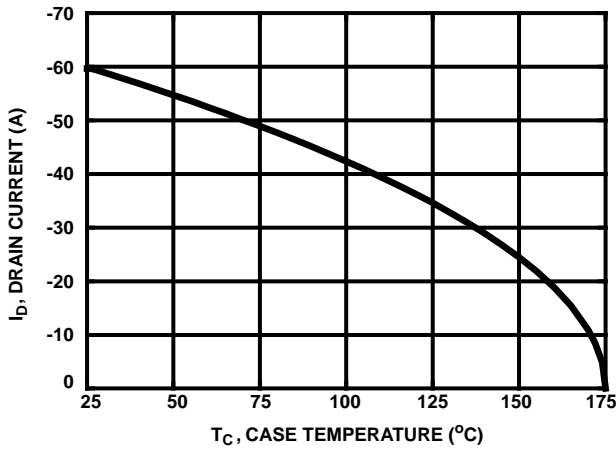


FIGURE 3. MAXIMUM CONTINUOUS DRAIN CURRENT vs TEMPERATURE

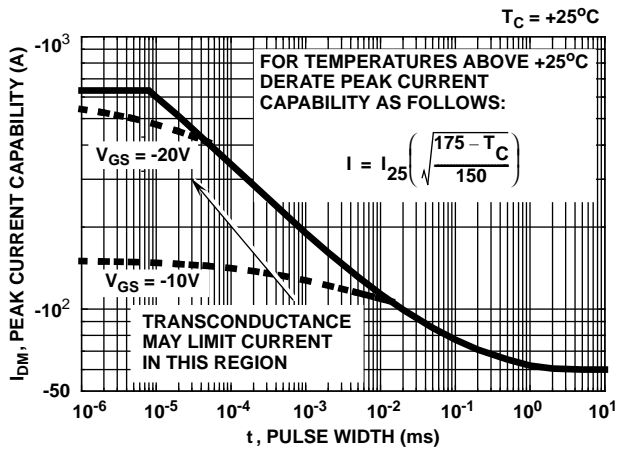


FIGURE 4. PEAK CURRENT CAPABILITY

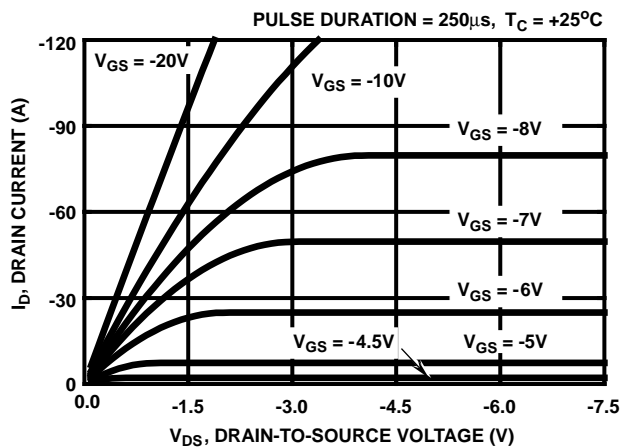


FIGURE 5. TYPICAL SATURATION CHARACTERISTICS

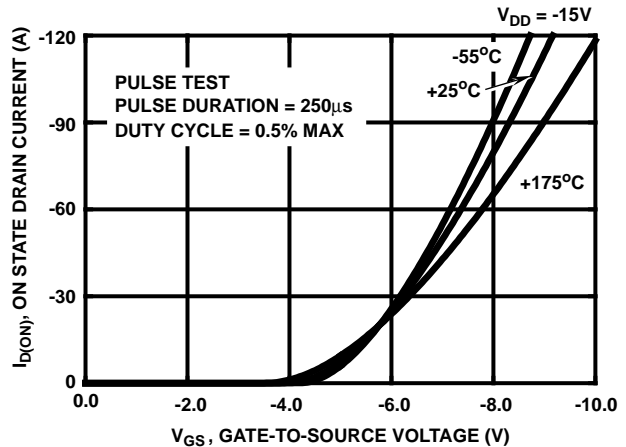


FIGURE 6. TYPICAL TRANSFER CHARACTERISTICS

Typical Performance Curves (Continued)

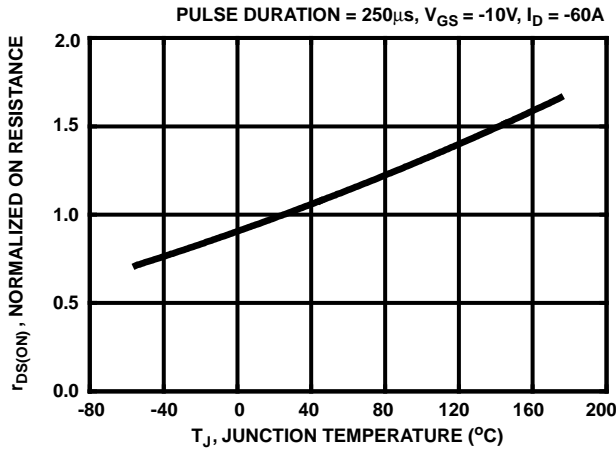


FIGURE 7. NORMALIZED  $r_{DS(ON)}$  vs JUNCTION TEMPERATURE

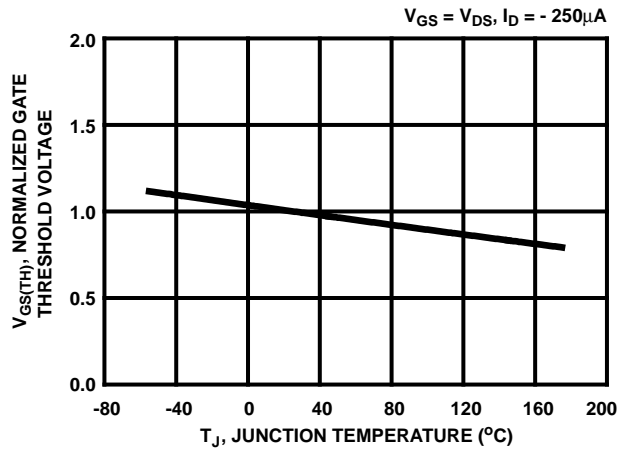


FIGURE 8. NORMALIZED GATE THRESHOLD VOLTAGE vs TEMPERATURE

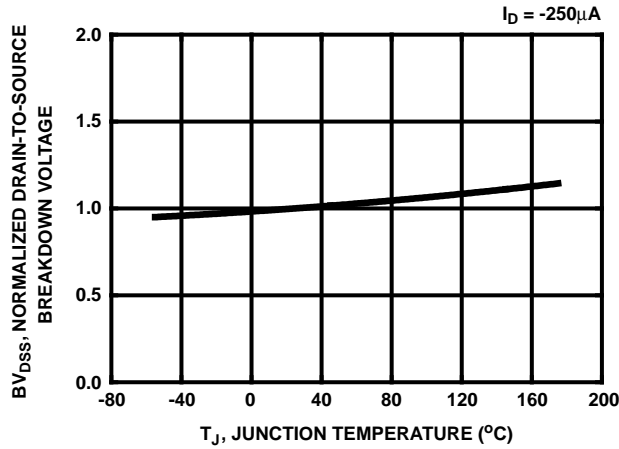


FIGURE 9. NORMALIZED DRAIN SOURCE BREAKDOWN VOLTAGE vs TEMPERATURE

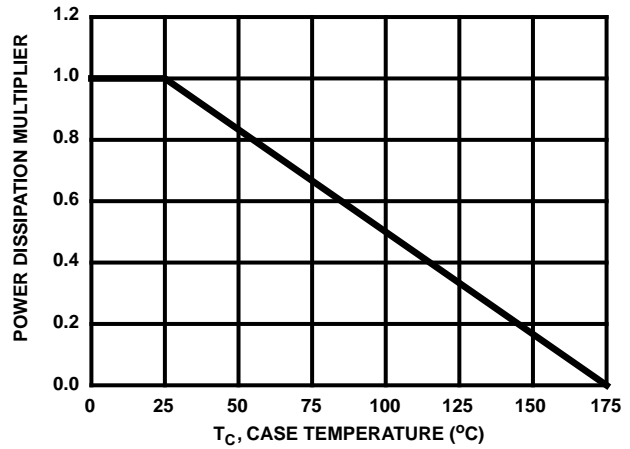


FIGURE 10. NORMALIZED SWITCHING WAVEFORMS

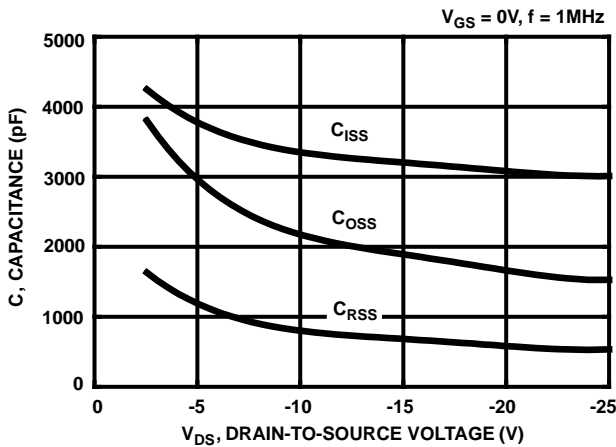


FIGURE 11. TYPICAL CAPACITANCE vs VOLTAGE

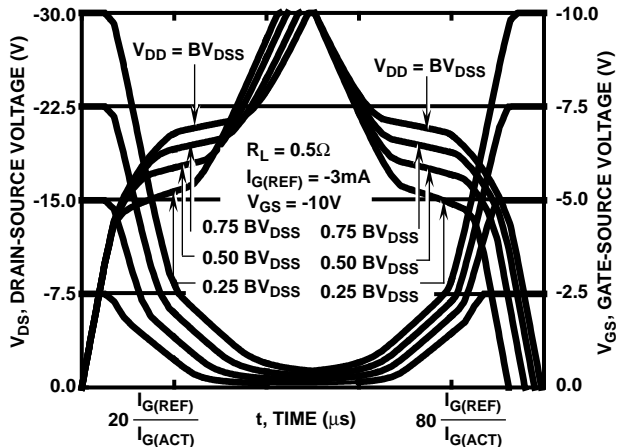


FIGURE 12. NORMALIZED SWITCHING WAVEFORMS FOR CONSTANT GATE CURRENT. REFER TO APPLICATION NOTE AN7254 AND AN7260

Typical Performance Curves (Continued)

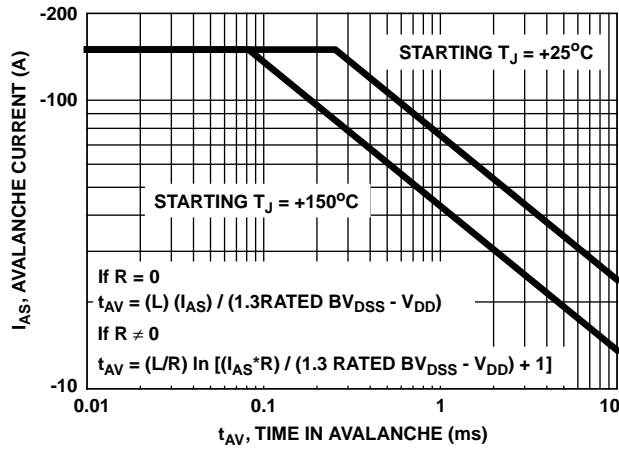


FIGURE 13. UNCLAMPED INDUCTIVE SWITCHING

Test Circuits and Waveforms

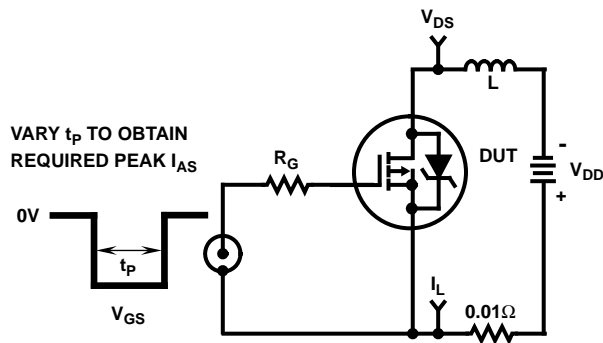


FIGURE 14. UNCLAMPED ENERGY TEST CIRCUIT

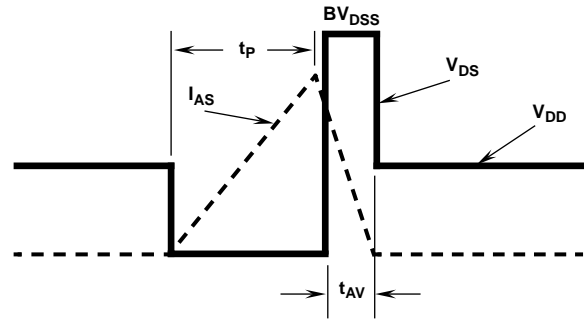


FIGURE 15. UNCLAMPED ENERGY WAVEFORMS

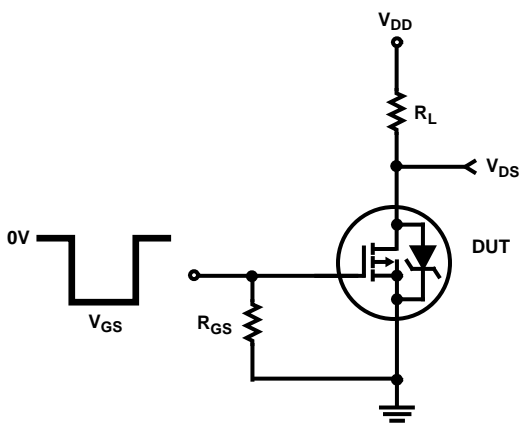


FIGURE 16. RESISTIVE SWITCHING TEST CIRCUIT

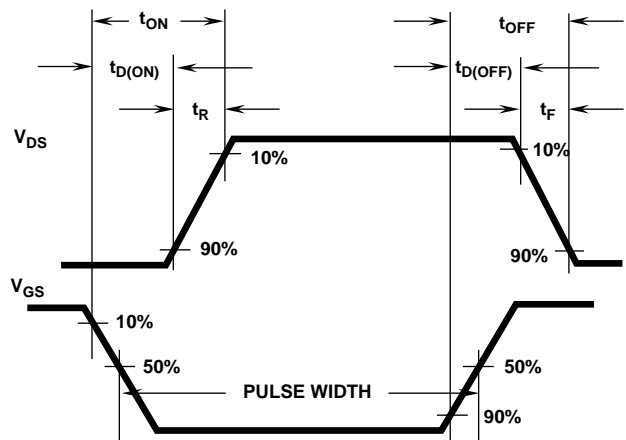


FIGURE 17. RESISTIVE SWITCHING WAVEFORMS

## RFG60P03, RFP60P03, RF1S60P03, RF1S60P03SM

### Temperature Compensated PSPICE Model for the RFG60P03, RFP60P03, RF1S60P03, RF1S60P03SM

.SUBCKT RFP60P03 2 1 3

REV 6/21/94

CA 12 8 5.01e-9  
CB 15 14 3.9e-9  
CIN 6 8 3.09e-9

DBODY 5 7 DBDMOD  
DBREAK 7 11 DBKMOD  
DPLCAP 10 6 DPLCAPMOD

EBREAK 5 11 17 18 -36.59  
EDS 14 8 5 8 1  
EGS 13 8 6 8 1  
ESG 5 10 8 6 1  
EVTO 20 6 8 18 1

IT 8 17 1

LDRAIN 2 5 1e-9  
LGATE 1 9 4.92e-9  
LSOURCE 3 7 2.36e-9

MOS1 16 6 8 8 MOSMOD M=0.99  
MOS2 16 21 8 8 MOSMOD M=0.01

RBREAK 17 18 RBKMOD 1  
RDRAIN 5 16 RDSMOD 1e-4  
RGATE 9 20 3.25  
RIN 6 8 1e9  
RSOURCE 8 7 RDSMOD 11.28e-3  
RVTO 18 19 RVTOMOD 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 8 19 DC 1  
VTO 21 6 -0.92

.MODEL DBDMOD D (IS=4.21e-13 RS=1e-2 TRS1=-2.69e-4 TRS2=-1.33e-6 CJO=5.05e-9 TT=5.33e-8)  
.MODEL DBKMOD D (RS=3.80e-2 TRS1=-4.76e-4 TRS2=-4.17e-12)  
.MODEL DPLCAPMOD D (CJO=4.05e-9 IS=1e-30 N=10)  
.MODEL MOSMOD PMOS (VTO=-3.98 KP=16.27 IS=1e-30 N=10 TOX=1 L=1u W=1u)  
.MODEL RBKMOD RES (TC1=8.05e-4 TC2=1.48e-6)  
.MODEL RDSMOD RES (TC1=2.80e-3 TC2=2.62e-6)  
.MODEL RVTOMOD RES (TC1=-3.34e-3 TC2=1.46e-6)  
.MODEL S1AMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=7.5 VOFF=4.5)  
.MODEL S1BMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=4.5 VOFF=7.5)  
.MODEL S2AMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=1.43 VOFF=-3.57)  
.MODEL S2BMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=-3.57 VOFF=1.43)

.ENDS

NOTE: For further discussion of the PSPICE model consult **A New PSPICE Sub-circuit for the Power MOSFET Featuring Global Temperature Options**; authors, William J. Hepp and C. Frank Wheatley.

