

October 1997

### Features

- 50A, 60V
- $r_{DS(ON)} = 0.022\Omega$
- *Temperature Compensating PSPICE Model*
- *Peak Current vs Pulse Width Curve*
- *UIS Rating Curve*
- 175°C Operating Temperature
- **Related Literature**
  - TB334, "Guidelines for Soldering Surface Mount Components to PC Boards"

### Ordering Information

PART NUMBER	PACKAGE	BRAND
RFG50N06	TO-247	RFG50N06
RFP50N06	TO-220AB	RFP50N06
RF1S50N06	TO-262AA	F1S50N06
RF1S50N06SM	TO-263AB	F1S50N06

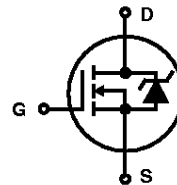
NOTE: When ordering, use the entire part number. Add the suffix, 9A, to obtain the TO-263AB variant in tape and reel, i.e. RF1S50N06SM9A.

### Description

These N-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.

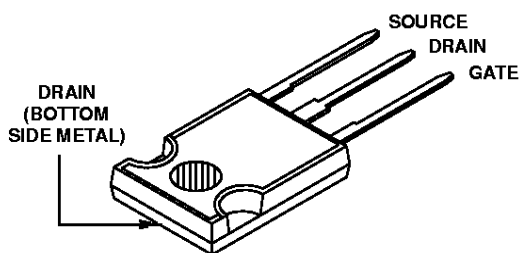
Formerly developmental type TA49018.

### Symbol

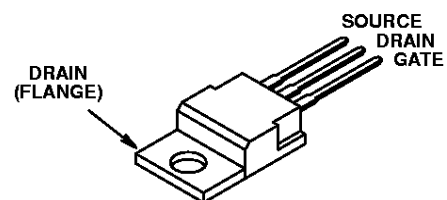


### Packaging

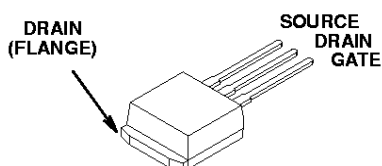
JEDEC STYLE TO-247



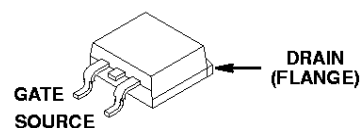
JEDEC TO-220AB



JEDEC TO-262AA



JEDEC TO-263AB



## RFG50N06, RFP50N06, RF1S50N06, RF1S50N06SM

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

	RFG50N06, RFP50N06 RF1S50N06, RF1S50N06SM	UNITS
Drain to Source Voltage (Note 1) . . . . .	60	V
Drain to Gate Voltage ( $R_{GS} = 20\text{k}\Omega$ ) (Note 1) . . . . .	60	V
Gate to Source Voltage . . . . .	$\pm 20$	V
Continuous Drain Current (Figure 2) . . . . .	50	A
Pulsed Drain Current . . . . .	(Figure 5)	
Pulsed Avalanche Rating . . . . .	(Figure 6, 14, 15)	
Power Dissipation . . . . .	131	W
Linear Derating Factor . . . . .	0.877	W/ $^\circ\text{C}$
Operating and Storage Temperature . . . . .	-55 to 175	$^\circ\text{C}$
Maximum Temperature for Soldering		
Leads at 0.063in (1.6mm) from Case for 10s . . . . .	300	$^\circ\text{C}$
Package Body for 10s, see Techbrief 334 . . . . .	260	$^\circ\text{C}$

**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.

**NOTE:**

1.  $T_J = 25^\circ\text{C}$  to  $150^\circ\text{C}$ .

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

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS	
Drain to Source Breakdown Voltage	$BV_{DSS}$	$I_D = 250\mu\text{A}$ , $V_{GS} = 0\text{V}$ (Figure 11)	60	-	-	V	
Gate to Source Threshold Voltage	$V_{GS(TH)}$	$V_{GS} = V_{DS}$ , $I_D = 250\mu\text{A}$ (Figure 10)	2	-	4	V	
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{DS} = 60\text{V}$ , $V_{GS} = 0\text{V}$	$T_C = 25^\circ\text{C}$	-	1	$\mu\text{A}$	
			$T_C = 150^\circ\text{C}$	-	50	$\mu\text{A}$	
Gate to Source Leakage Current	$I_{GSS}$	$V_{GS} = \pm 20\text{V}$	-	-	$\pm 100$	nA	
Drain to Source On Resistance	$r_{DS(ON)}$	$I_D = 50\text{A}$ , $V_{GS} = 10\text{V}$ (Figures 9)	-	-	0.022	$\Omega$	
Turn-On Time	$t_{ON}$	$V_{DD} = 30\text{V}$ , $I_D = 50\text{A}$ $R_L = 0.6\Omega$ , $V_{GS} = 10\text{V}$ $R_{GS} = 3.6\Omega$ (Figures 16, 17)	-	-	95	ns	
Turn-On Delay Time	$t_{d(ON)}$		-	12	-	ns	
Rise Time	$t_r$		-	55	-	ns	
Turn-Off Delay Time	$t_{d(OFF)}$		-	37	-	ns	
Fall Time	$t_f$		-	13	-	ns	
Turn-Off Time	$t_{OFF}$		-	-	75	ns	
Total Gate Charge	$Q_g(TOT)$	$V_{GS} = 0$ to $20\text{V}$	$V_{DD} = 48\text{V}$ , $I_D = 50\text{A}$ , $R_L = 0.96\Omega$ (Figures 13, 18, 19)	-	125	150	nC
Gate Charge at 10V	$Q_g(10)$	$V_{GS} = 0$ to $10\text{V}$		-	67	80	nC
Threshold Gate Charge	$Q_g(TH)$	$V_{GS} = 0$ to $2\text{V}$		-	3.7	4.5	nC
Input Capacitance	$C_{ISS}$	$V_{DS} = 25\text{V}$ , $V_{GS} = 0\text{V}$ $f = 1\text{MHz}$ (Figure 12)	-	2020	-	pF	
Output Capacitance	$C_{OSS}$		-	600	-	pF	
Reverse Transfer Capacitance	$C_{RSS}$		-	200	-	pF	
Thermal Resistance Junction to Case	$R_{\theta JC}$	(Figure 3)	-	-	1.14	$^\circ\text{C/W}$	
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	TO-247	-	-	30	$^\circ\text{C/W}$	
		TO-220, TO-262, TO-263	-	-	62	$^\circ\text{C/W}$	

### Source to Drain Diode Specifications

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Source to Drain Diode Voltage	$V_{SD}$	$I_{SD} = 50\text{A}$	-	-	1.5	V
Reverse Recovery Time	$t_{rr}$	$I_{SD} = 50\text{A}$ , $dI_{SD}/dt = 100\text{A}/\mu\text{s}$	-	-	125	ns

Typical Performance Curves Unless Otherwise Specified

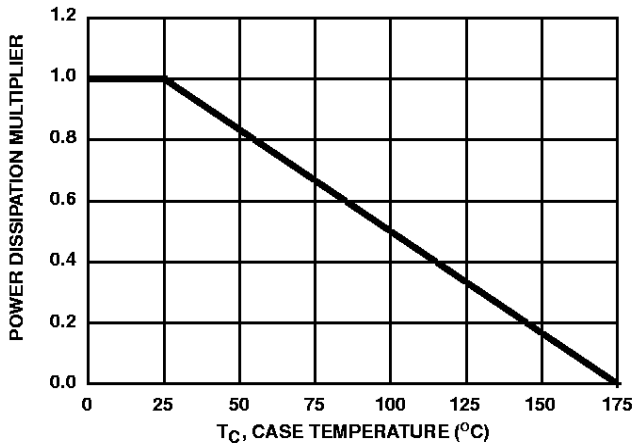


FIGURE 1. NORMALIZED POWER DISSIPATION vs CASE TEMPERATURE

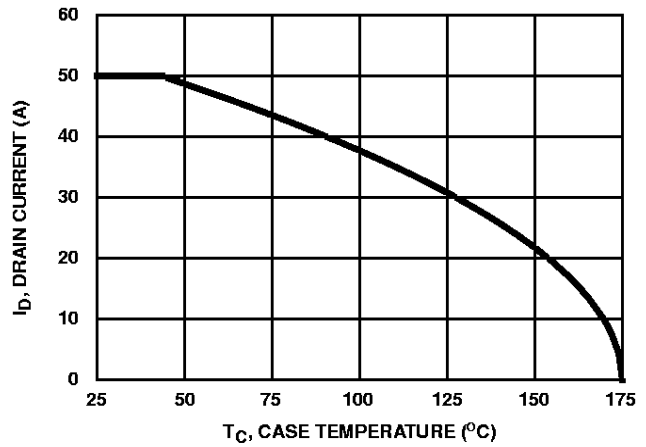


FIGURE 2. MAXIMUM CONTINUOUS DRAIN CURRENT vs CASE TEMPERATURE

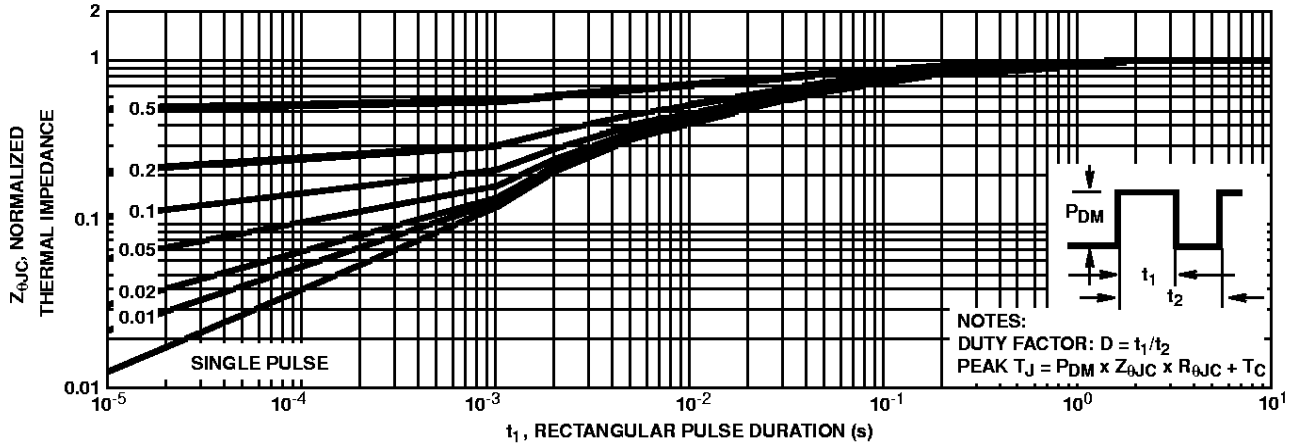


FIGURE 3. NORMALIZED MAXIMUM TRANSIENT THERMAL IMPEDANCE

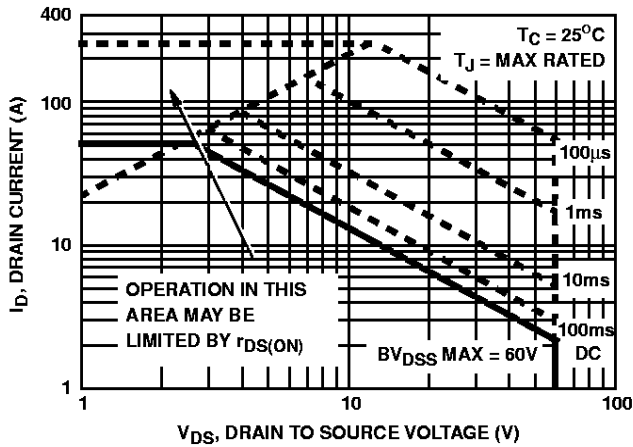


FIGURE 4. FORWARD BIAS SAFE OPERATING AREA

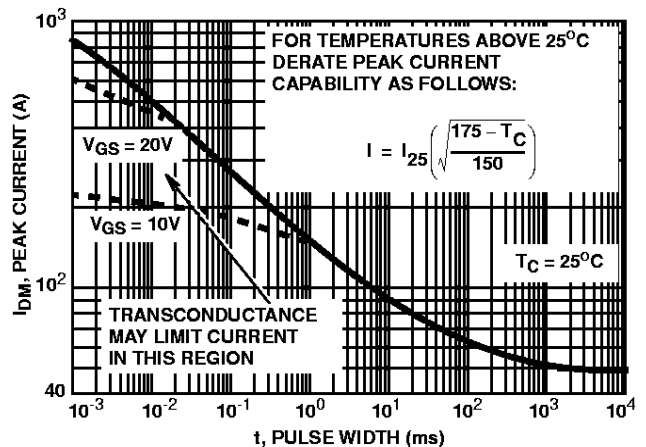
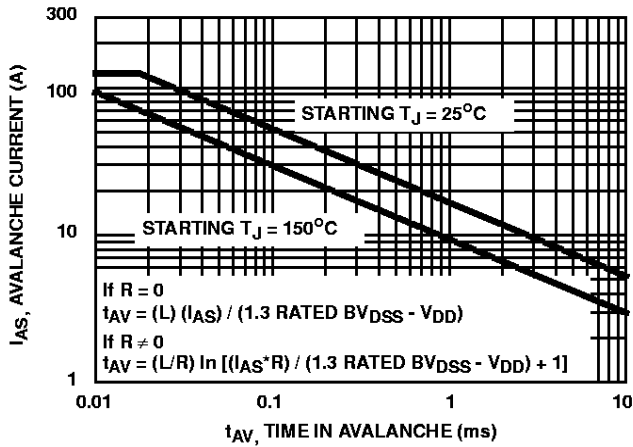


FIGURE 5. PEAK CURRENT CAPABILITY

Typical Performance Curves Unless Otherwise Specified (Continued)



NOTE: Refer to Harris Application Notes 9321 and 9322.

FIGURE 6. UNCLAMPED INDUCTIVE SWITCHING CAPABILITY

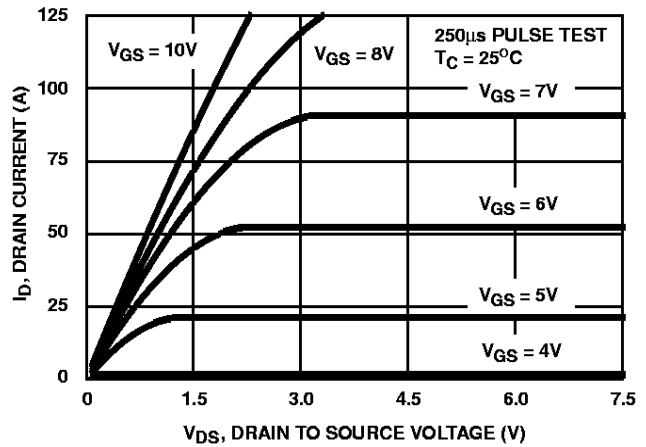


FIGURE 7. SATURATION CHARACTERISTICS

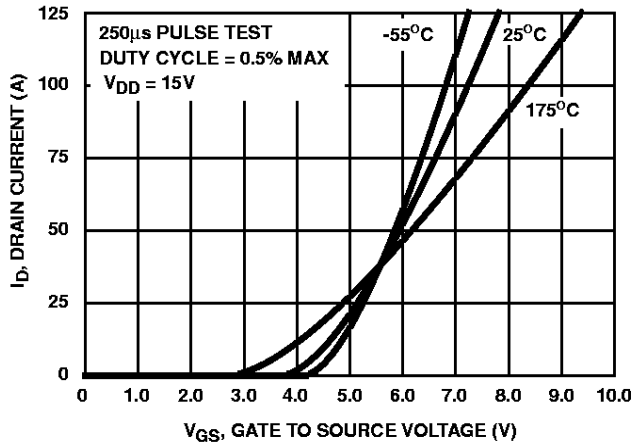


FIGURE 8. TRANSFER CHARACTERISTICS

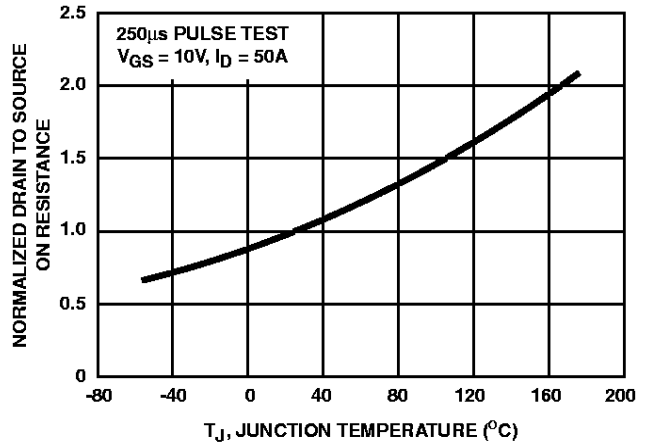


FIGURE 9. NORMALIZED DRAIN TO SOURCE ON RESISTANCE vs JUNCTION TEMPERATURE

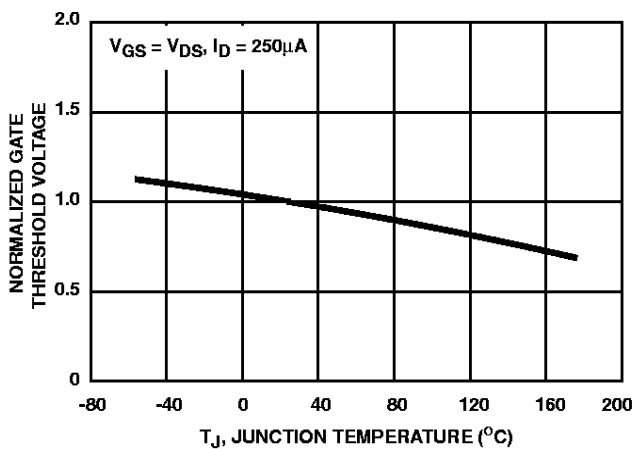


FIGURE 10. NORMALIZED GATE THRESHOLD VOLTAGE vs JUNCTION TEMPERATURE

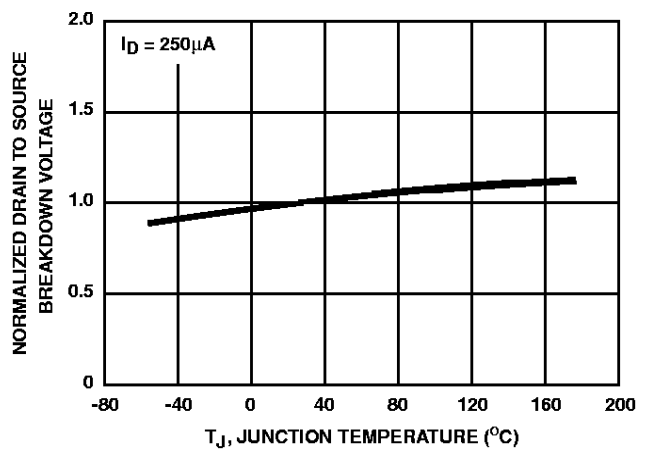


FIGURE 11. NORMALIZED DRAIN TO SOURCE BREAKDOWN VOLTAGE vs JUNCTION TEMPERATURE

**Typical Performance Curves** Unless Otherwise Specified (Continued)

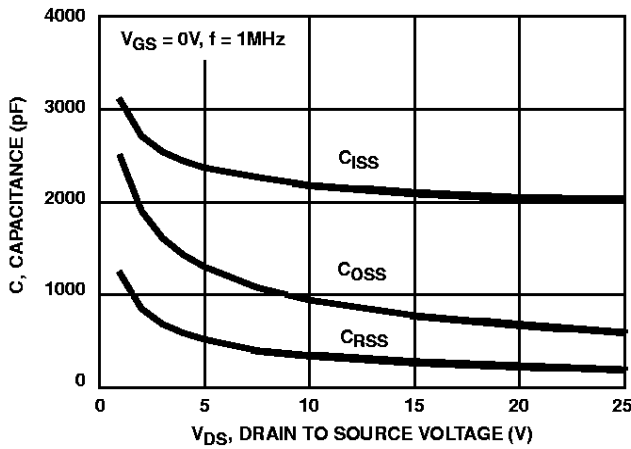
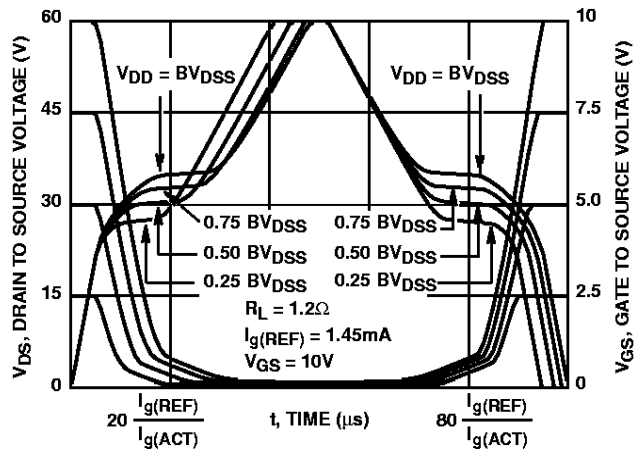


FIGURE 12. CAPACITANCE vs DRAIN TO SOURCE VOLTAGE



NOTE: Refer to Harris Application Notes 7254 and 7260.  
FIGURE 13. NORMALIZED SWITCHING WAVEFORMS FOR CONSTANT GATE CURRENT

**Test Circuits and Waveforms**

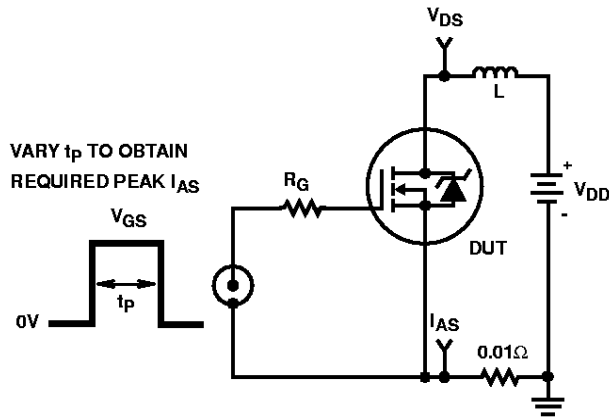


FIGURE 14. UNCLAMPED ENERGY TEST CIRCUIT

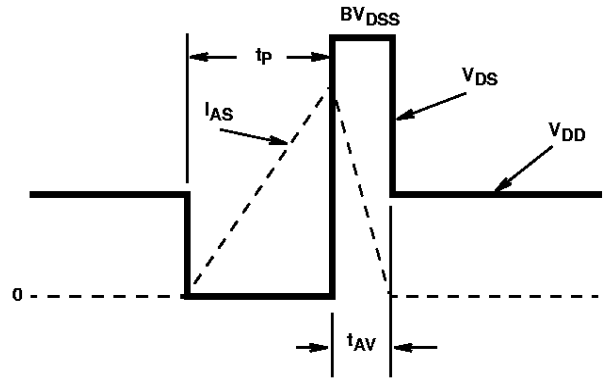


FIGURE 15. UNCLAMPED ENERGY WAVEFORMS

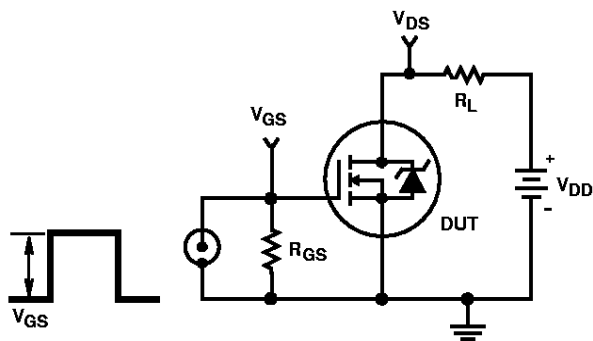


FIGURE 16. SWITCHING TIME TEST CIRCUIT

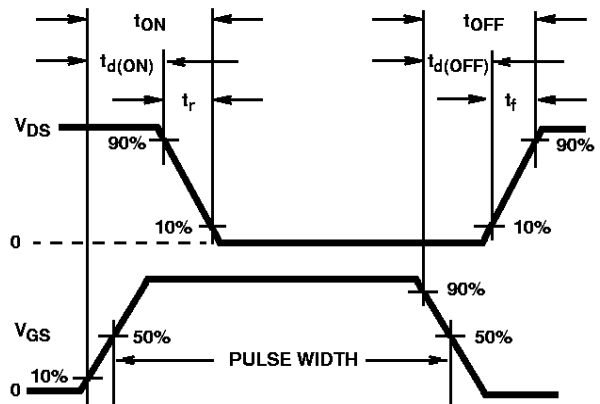


FIGURE 17. SWITCHING WAVEFORMS

Test Circuits and Waveforms (Continued)

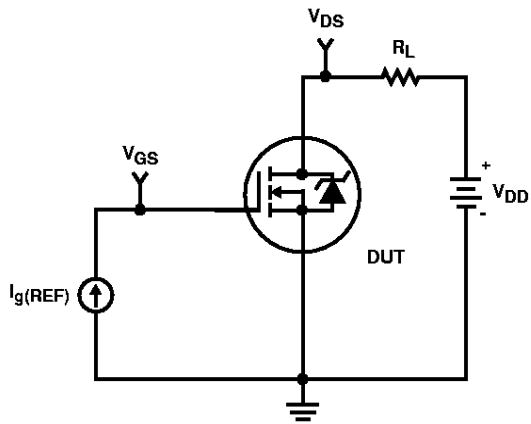


FIGURE 18. GATE CHARGE TEST CIRCUIT

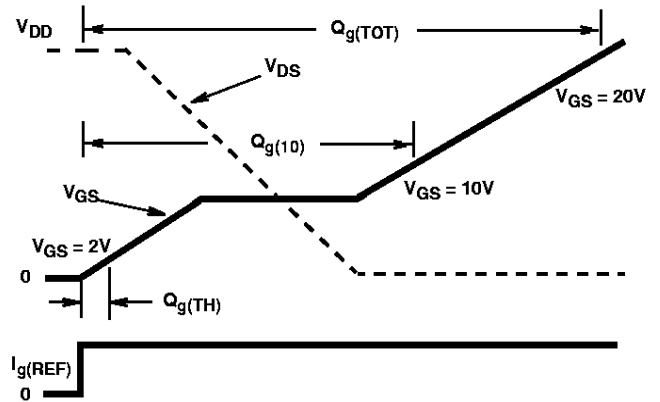


FIGURE 19. GATE CHARGE WAVEFORMS

# RFG50N06, RFP50N06, RF1S50N06, RF1S50N06SM

## PSPICE Electrical Model

.SUBCKT RFP50N06 2 1 3

REV 2/22/93

\*NOM TEMP = 25°C

CA 12 8 3.68e-9  
 CB 15 14 3.625e-9  
 CIN 6 8 1.98e-9

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

EBREAK 11 7 17 18 64.59  
 EDS 14 8 5 8 1  
 EGS 13 8 6 8 1  
 ESG 6 10 6 8 1  
 EVTO 20 6 18 8 1

IT 8 17 1

LDRAIN 2 5 1e-9  
 LGATE 1 9 5.65e-9  
 LSOURCE 3 7 4.13e-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 0.690  
 RIN 6 8 1e9  
 RSOURCE 8 7 RDSMOD 12e-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 0.678

.MODEL DBDMOD D (IS=9.85e-13 RS=4.91e-3 TRS1=2.07e-3 TRS2=2.51e-7 CJO=2.05e-9 TT=4.33e-8)  
 .MODEL DBKMOD D (RS=1.98e-1 TRS1=2.35E-4 TRS2=-3.83e-6)  
 .MODEL DPLCAPMOD D (CJO=1.42e-9 IS=1e-30 N=10)  
 .MODEL MOSMOD NMOS (VTO=3.65 KP=35 IS=1e-30 N=10 TOX=1 L=1u W=1u)  
 .MODEL RBKMOD RES (TC1=1.23e-3 TC2=-2.34e-7)  
 .MODEL RDSMOD RES (TC1=5.01e-3 TC2=1.49e-5)  
 .MODEL RVTOMOD RES (TC1=-5.03e-3 TC2=-5.16e-6)  
 .MODEL S1AMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=-6.75 VOFF=-2.5)  
 .MODEL S1BMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=-2.5 VOFF=-6.75)  
 .MODEL S2AMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=-2.7 VOFF=2.3)  
 .MODEL S2BMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=2.3 VOFF=-2.7)

.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.

