HARRIS Semiconductor

RFD16N06, RFD16N06SM

16A, 60V, 0.047 Ohm, N-Channel Power MOSFET

September 1998

Features

- 16A, 60V
- $r_{DS(ON)} = 0.047\Omega$
- *Temperature Compensating* PSPICE Model
- Peak Current vs Pulse Width Curve
- UIS Rating Curve
- 175^oC Operating Temperature
- Related Literature
  - TB334 "Guidelines for Soldering Surface Mount Components to PC Boards"

Ordering Information

PART NUMBER	PACKAGE	BRAND
RFD16N06	TO-251AA	F16N06
RFD16N06SM	TO-252AA	F16N06

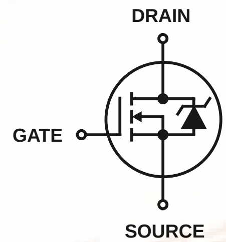
NOTE: When ordering, use the entire part number. Add suffix 9A to obtain the TO-252AA variant in tape and reel, i.e., RFD16N06SM9A.

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.

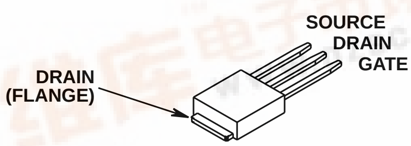
Formerly developmental type TA09771.

Symbol

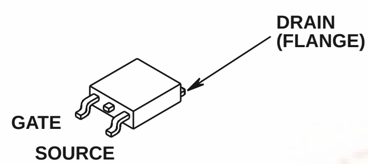


Packaging

JEDEC TO-251AA



JEDEC TO-252AA



Absolute Maximum Ratings $T_C = 25^oC$

	RFD16N06, RFD16N06SM	UNITS
Drain to Source Voltage (Note 1) . . . . . V_{DSS}	60	V
Drain to Gate Voltage ($R_{GS} = 20k\Omega$) (Note 1) . . . . . V_{DGR}	60	V
Continuous Drain Current . . . . . I_D	16	A
Pulsed Drain Current (Note 3) . . . . . I_{DM}	Refer to Peak Current Curve	
Gate to Source Voltage . . . . . V_{GS}	±20	V
Pulsed Avalanche Rating . . . . . E_{AS}	Refer to UIS Curve	
Power Dissipation . . . . . P_D	72	W
Linear Derating Factor	0.48	$W/^oC$
Operating and Storage Temperature . . . . . T_J, T_{STG}	-55 to 175	^oC
Maximum Temperature for Soldering		
Leads at 0.063in (1.6mm) from Case for 10s . . . . . T_L	300	^oC
Package Body for 10s, See Techbrief 334 . . . . . T_{pkg}	260	^oC

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. $T_J = 25^oC$ to 150^oC.

Electrical Specifications $T_C = 25^oC$, Unless Otherwise Specified

PARAMETER	SYMBOL	TEST CONDITIONS		MIN	TYP	MAX	UNITS
Drain to Source Breakdown Voltage	BV_{DSS}	$I_D = 250\mu A$, $V_{GS} = 0V$		60	-	-	V
Gate Threshold Voltage	$V_{GS(TH)}$	$V_{GS} = V_{DS}$, $I_D = 250\mu A$		2	-	4	V
Zero Gate Voltage Drain Current	I_{DSS}	V_{DS} = Rated BV_{DSS}, $V_{GS} = 0V$		-	-	1	µA
		V_{DS} = 0.8 x Rated BV_{DSS}, $T_C = 150^oC$		-	-	25	µA
Gate to Source Leakage Current	I_{GSS}	$V_{GS} = \pm 20V$		-	-	±100	nA
Drain to Source On Resistance (Note 2)	$r_{DS(ON)}$	$I_D = 16A$, $V_{GS} = 10V$ (Figure 9)		-	-	0.047	Ω
Turn-On Time	t_{ON}	$V_{DD} = 30V$, $I_D \approx 8A$, $R_L = 3.75\Omega$, $V_{GS} = 10V$, $R_G = 25\Omega$ (Figures 13, 16, 17)		-	-	65	ns
Turn-On Delay Time	$t_{d(ON)}$			-	14	-	ns
Rise Time	t_r			-	30	-	ns
Turn-Off Delay Time	$t_{d(OFF)}$			-	55	-	ns
Fall Time	t_f			-	30	-	ns
Turn-Off Time	t_{OFF}			-	-	125	ns
Total Gate Charge	$Q_{g(TOT)}$	V_{GS} = 0V to 20V	$V_{DD} = 48V$, $I_D = 16A$, $R_L = 3\Omega$, $I_{G(REF)} = 0.8mA$ (Figures 18, 19)	-	-	80	nC
Gate Charge at 10V	$Q_{g(10)}$	V_{GS} = 0V to 10V		-	-	45	nC
Threshold Gate Charge	$Q_{g(TH)}$	V_{GS} = 0V to 2V		-	-	2.2	nC
Input Capacitance	C_{ISS}	$V_{DS} = 25V$, $V_{GS} = 0V$, f = 1MHz		-	900	-	pF
Output Capacitance	C_{OSS}			-	325	-	pF
Reverse Transfer Capacitance	C_{RSS}			-	100	-	pF
Thermal Resistance Junction to Case	$R_{\theta JC}$			-	-	2.083	$^oC/W$
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	TO-251 and TO-252		-	-	100	$^oC/W$

Source to Drain Diode Specifications

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Source to Drain Diode Voltage	V_{SD}	$I_{SD} = 16A$	-	-	1.5	V
Diode Reverse Recovery Time	t_{rr}	$I_{SD} = 16A$, $dI_{SD}/dt = 100A/\mu s$	-	-	125	ns

NOTES:

2. Pulse test: pulse width ≤ 300ms, duty cycle ≤ 2%.
3. Repetitive rating: pulse width limited by maximum junction temperature. See Transient Thermal Impedance curve (Figure 3).

Typical Performance Curves

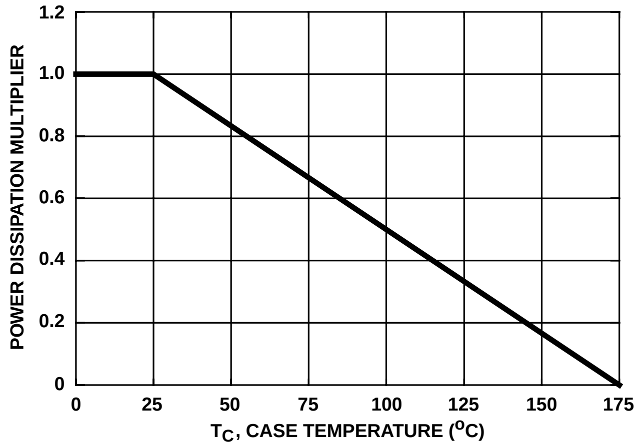


FIGURE 1. NORMALIZED POWER DISSIPATION vs CASE TEMPERATURE

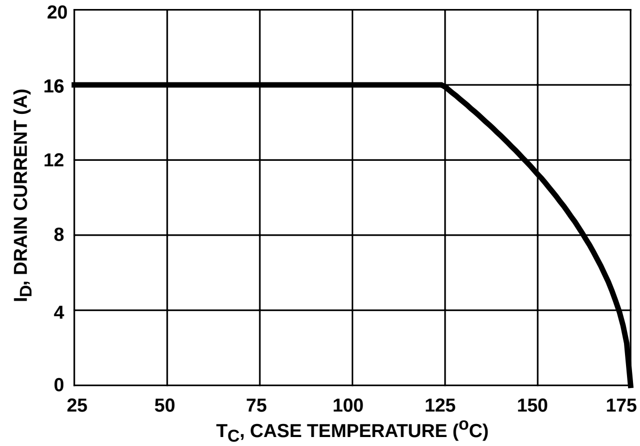


FIGURE 2. MAXIMUM CONTINUOUS DRAIN CURRENT vs CASE TEMPERATURE

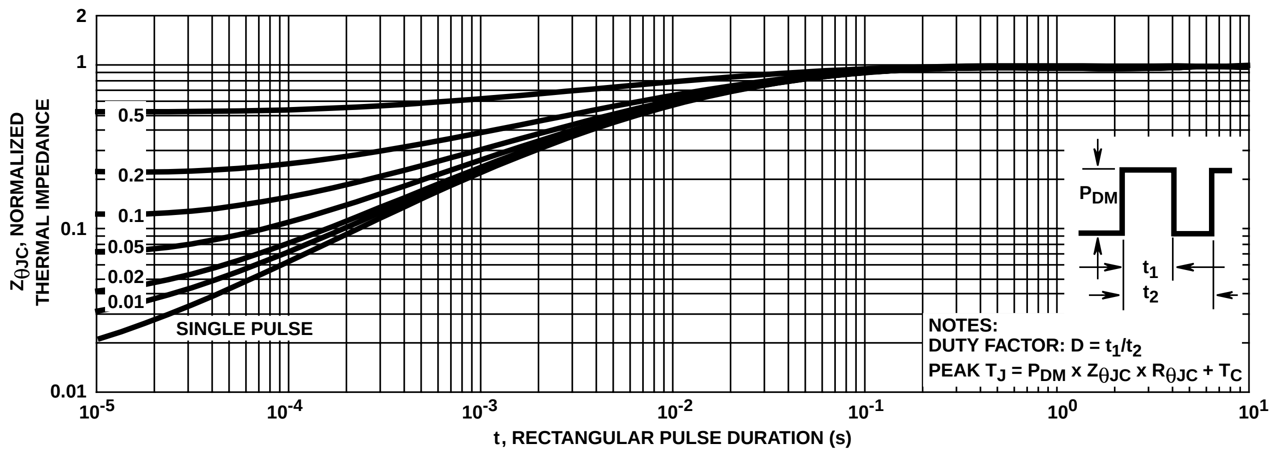


FIGURE 3. NORMALIZED MAXIMUM TRANSIENT THERMAL IMPEDANCE

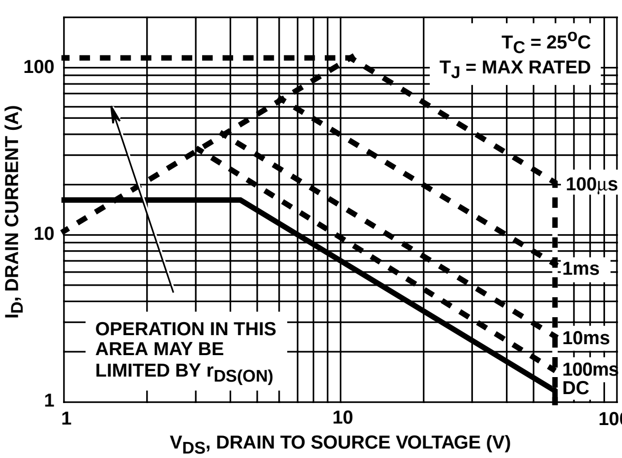


FIGURE 4. FORWARD BIAS SAFE OPERATING AREA

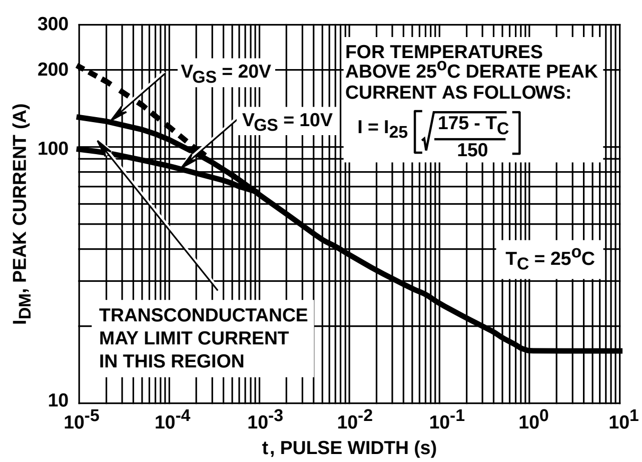
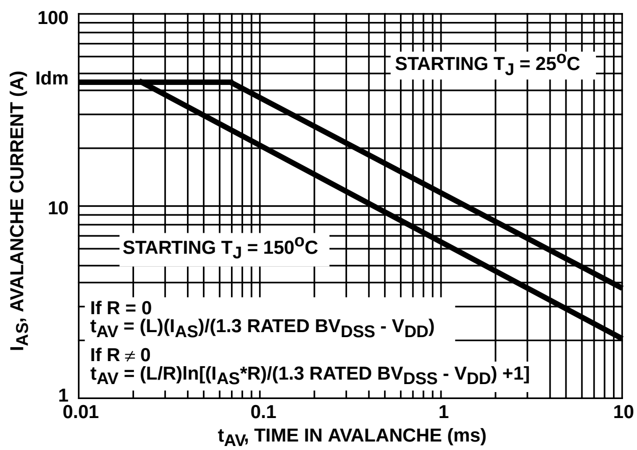


FIGURE 5. PEAK CURRENT CAPABILITY

Typical Performance Curves (Continued)



NOTE: Refer to Harris Application Notes AN9321 and AN9322.

FIGURE 6. UNCLAMPED INDUCTIVE SWITCHING CAPABILITY

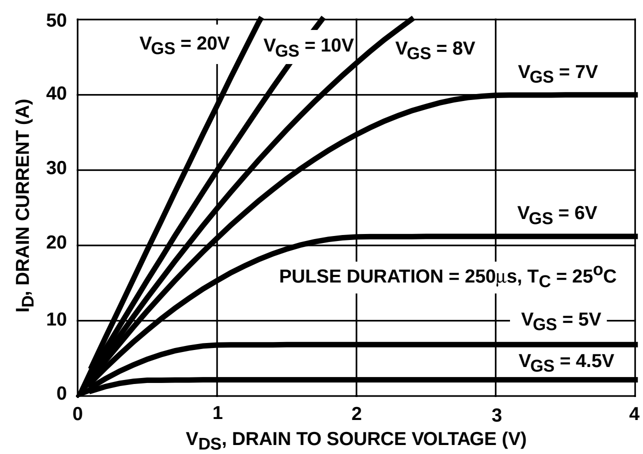


FIGURE 7. SATURATION CHARACTERISTICS

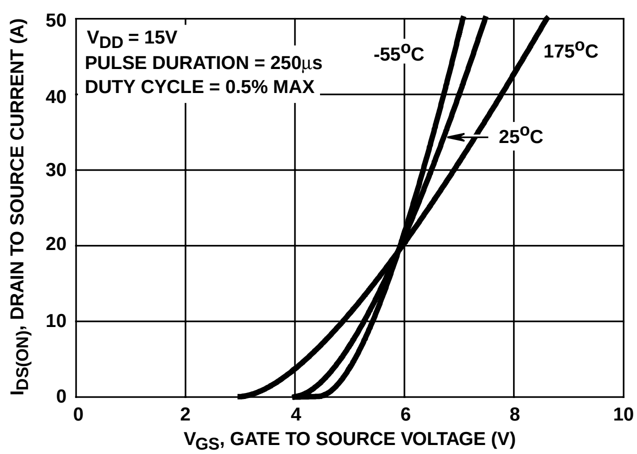


FIGURE 8. TRANSFER CHARACTERISTICS

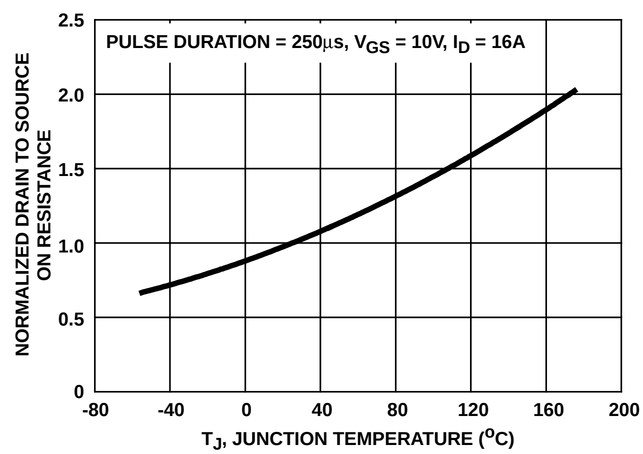


FIGURE 9. NORMALIZED DRAIN TO SOURCE ON RESISTANCE vs JUNCTION TEMPERATURE

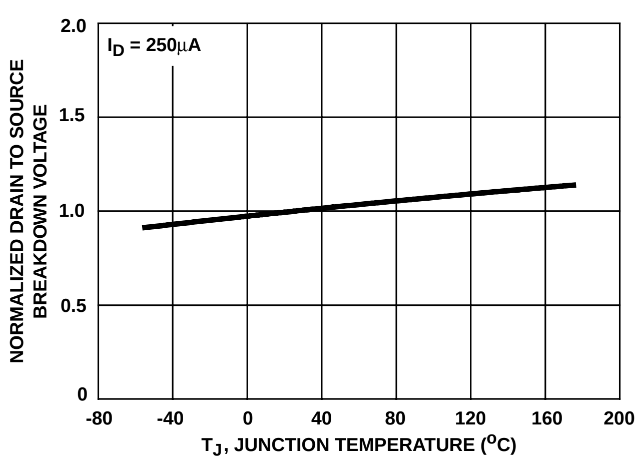


FIGURE 10. NORMALIZED DRAIN TO SOURCE BREAKDOWN VOLTAGE vs JUNCTION TEMPERATURE

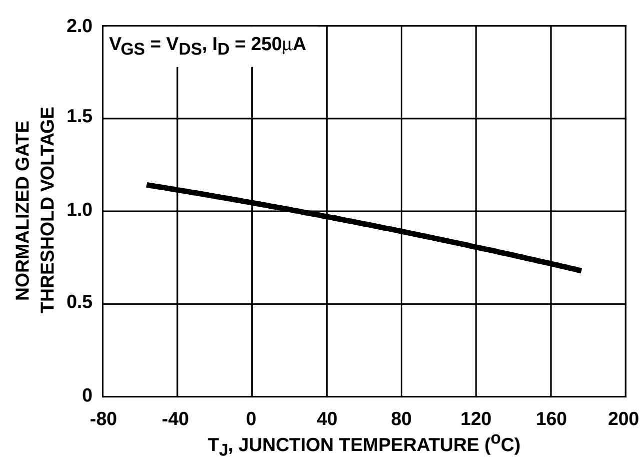


FIGURE 11. NORMALIZED GATE THRESHOLD VOLTAGE vs JUNCTION TEMPERATURE

Typical Performance Curves (Continued)

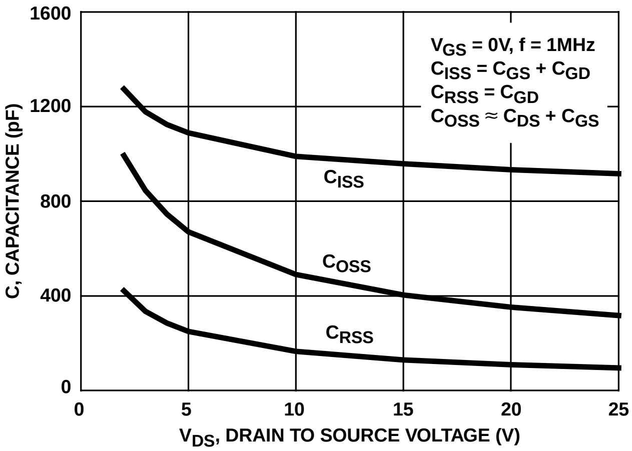
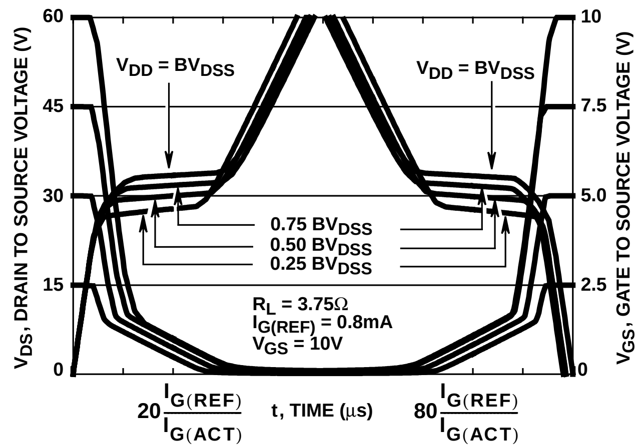


FIGURE 12. CAPACITANCE vs DRAIN TO SOURCE VOLTAGE



NOTE: Refer to Harris Application Notes AN7254 and AN7260.

FIGURE 13. NORMALIZED SWITCHING WAVEFORMS FOR CONSTANT GATE CURRENT

Test Circuits and Waveforms

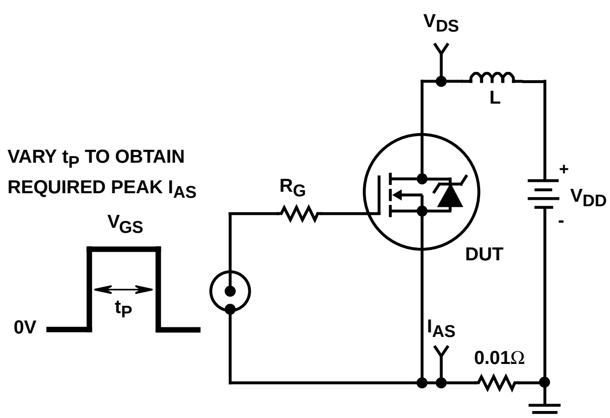


FIGURE 14. UNCLAMPED ENERGY TEST CIRCUIT

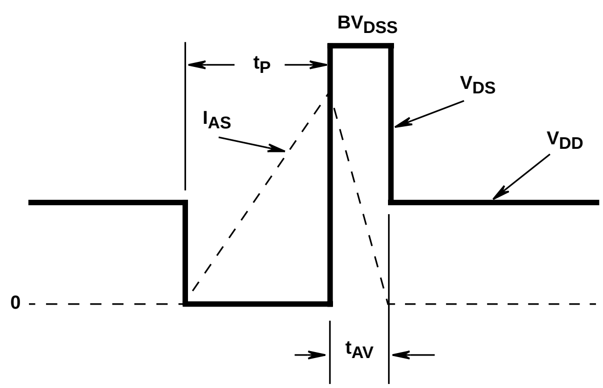


FIGURE 15. UNCLAMPED ENERGY WAVEFORMS

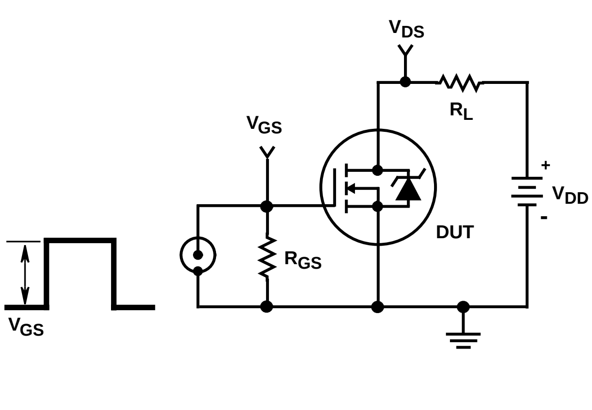


FIGURE 16. SWITCHING TIME TEST CIRCUIT

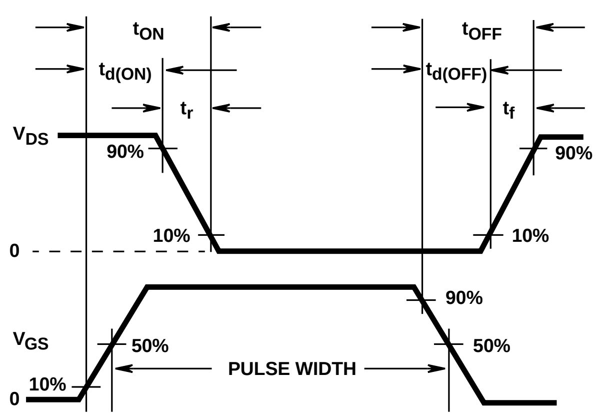


FIGURE 17. RESISTIVE SWITCHING WAVEFORMS

Test Circuits and Waveforms (Continued)

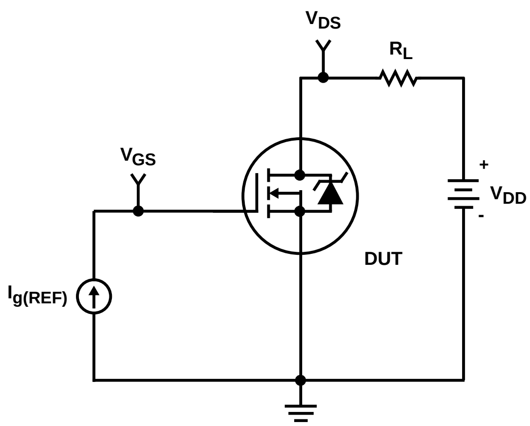


FIGURE 18. GATE CHARGE TEST CIRCUIT

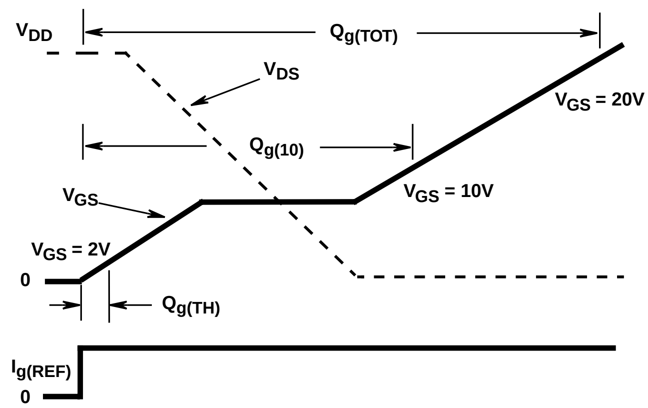


FIGURE 19. GATE CHARGE WAVEFORM

PSPICE Electrical Model

```
.SUBCKT    RFD16N06  2 1 3 ;       rev 10/31/94
CA  12  8  1.788e-10
CB  15  14  1.875e-10
CIN  6  8  8.33e-10

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

EBREAK  11  7  17  18  64.89
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  4.56e-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  50  16  RDSMOD  0.4e-3
RGATE  9  20  3.0
RIN  6  8  1e9
RSCL1  5  51  RSCLMOD 1e-6
RSCL2  5  50  1e3
RSOURCE  8  7  RDSMOD  21.5e-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   0.82

ESCL  51 50  VALUE = {(V(5,51)/ABS(V(5,51)))*(PWR(V(5,51)*1e6/94,7))}

.MODEL DBDMOD D (IS = 2.5e-13  RS = 7.1e-3  TRS1 = 3.04e-3  TRS2 = -10e-6  CJO = 1.12e-9  TT = 5.6e-8)
.MODEL DBKMOD D (RS = 2.51e-1  TRS1 = -6.57e-4  TRS2 = 1.66e-6)
.MODEL DPLCAPMOD D (CJO = 6.1e-10  IS = 1e-30  N = 10)
.MODEL MOSMOD NMOS (VTO = 3.96  KP = 16.68  IS = 1e-30  N = 10  TOX = 1  L = 1u  W = 1u)
.MODEL RBKMOD RES (TC1 = 1.07e-3  TC2 = -7.19e-7)
.MODEL RDSMOD RES (TC1 = 5.45e-3  TC2 = 1.66e-5)
.MODEL RSCLMOD RES (TC1 = 1.25e-3  TC2 = 17e-6)
.MODEL RVTOMOD RES (TC1 = -5.15e-3  TC2 = -4.83e-6)
.MODEL S1AMOD VSWITCH (RON = 1e-5  ROFF = 0.1  VON = -5.25  VOFF= -3.25)
.MODEL S1BMOD VSWITCH (RON = 1e-5  ROFF = 0.1  VON = -3.25  VOFF= -5.25)
.MODEL S2AMOD VSWITCH (RON = 1e-5  ROFF = 0.1  VON = 0.56  VOFF= 5.56)
.MODEL S2BMOD VSWITCH (RON = 1e-5  ROFF = 0.1  VON = 5.56  VOFF= 0.56)

.ENDS
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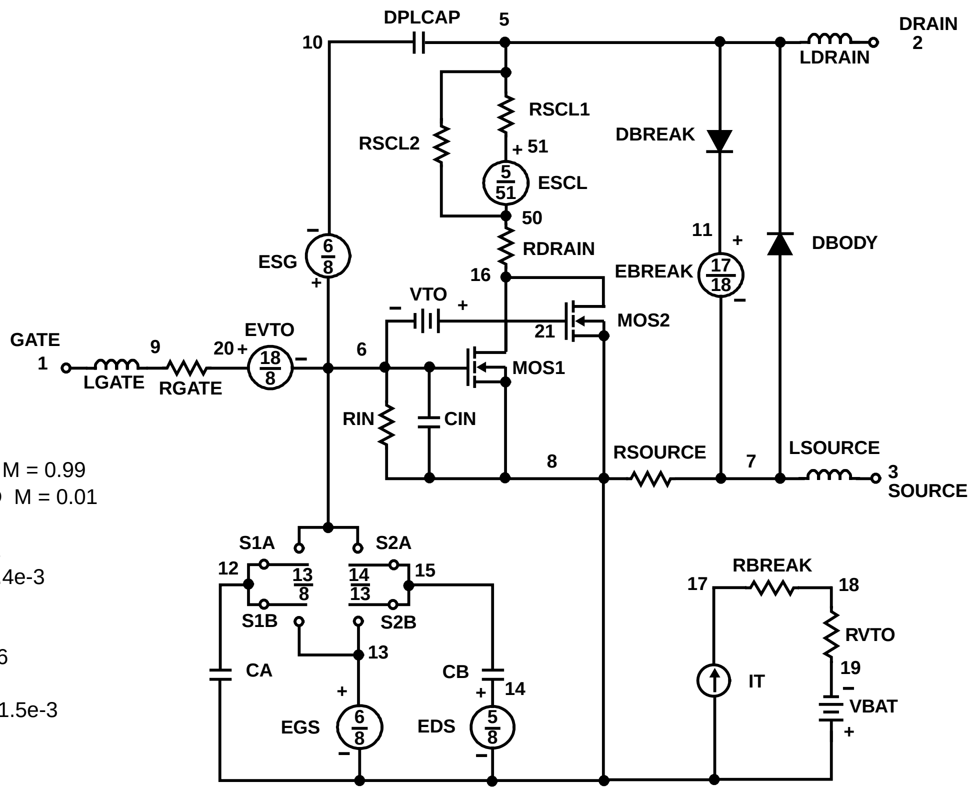

NOTE: For further discussion of the PSPICE model, consult **A New PSPICE Sub-Circuit for the Power MOSFET Featuring Global Temperature Options**; authored by William J. Hepp and C. Frank Wheatley.