

# RFD16N02L, RFD16N02LSM

16A, 20V, 0.022 Ohm, N-Channel,  
Logic Level, Power MOSFET

May 1997

## Features

- 16A, 20V
- $r_{DS(ON)} = 0.022\Omega$
- *Temperature Compensating* PSPICE Model
- Can be Driven Directly from CMOS, NMOS, and TTL Circuits
- Peak Current vs Pulse Width Curve
- UIS Rating Curve
- 175°C Operating Temperature

## Ordering Information

PART NUMBER	PACKAGE	BRAND
RFD16N02L	TO-251AA	16N02L
RFD16N02LSM	TO-252AA	16N02L

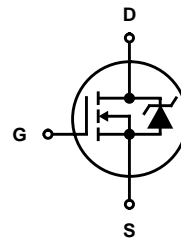
NOTE: When ordering, use the entire part number. Add the suffix 9A, to obtain the TO-252AA variant in tape and reel, e.g. RFD16N02LSM9A.

Formerly developmental type TA49243.

## Description

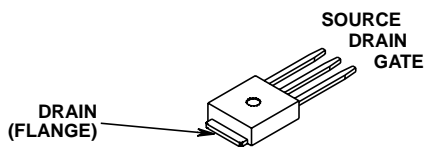
The RFD16N02L and RFD16N02LSM are N-Channel power MOSFETs manufactured using the MegaFET process. This process, which uses feature sizes approaching those of LSI circuits, gives optimum utilization of silicon, resulting in outstanding performance. They were designed for use in applications such as switching regulators, switching converters, motor drivers and relay drivers. This performance is accomplished through a special gate oxide design which provides full rated conductance at gate bias in the 3V to 5V range, thereby facilitating true on-off power control directly from logic level (5V) integrated circuits.

## Symbol

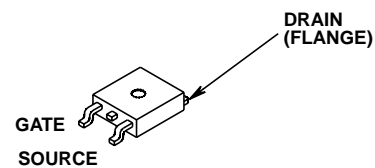


## Packaging

JEDEC TO-251AA



JEDEC TO-252AA



## RFD16N02L, RFD16N02LSM

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

	RFD16N02L, RFD16N02LSM	UNITS
Drain to Source Voltage . . . . .	20	V
Drain to Gate Voltage . . . . .	20	V
Gate to Source Voltage . . . . .	$\pm 10$	V
Drain Current		
RMS Continuous . . . . .	16	A
Pulsed Drain Current . . . . .	Refer to Peak Current Curve	
Pulsed Avalanche Rating . . . . .	Refer to UIS Curve	
Power Dissipation . . . . .	90	W
Derate Above $25^\circ\text{C}$ . . . . .	0.606	$\text{W}/^\circ\text{C}$
Operating and Storage Temperature . . . . .	-55 to 175	$^\circ\text{C}$
Soldering Temperature of Leads for 10s . . . . .	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.*

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

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS	
Drain to Source Breakdown Voltage	$BV_{DSS}$	$I_D = 250\mu\text{A}$ , $V_{GS} = 0\text{V}$	20	-	-	V	
Gate to Source Threshold Voltage	$V_{GS(TH)}$	$V_{GS} = V_{DS}$ , $I_D = 250\mu\text{A}$	1	-	2	V	
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{DS} = 20\text{V}$ , $V_{GS} = 0\text{V}$	$T_C = 25^\circ\text{C}$	-	-	1	$\mu\text{A}$
			$T_C = 150^\circ\text{C}$	-	-	50	$\mu\text{A}$
Gate to Source Leakage Current	$I_{GSS}$	$V_{GS} = \pm 10\text{V}$	-	-	$\pm 100$	nA	
Drain to Source On Resistance	$r_{DS(ON)}$	$I_D = 16\text{A}$ , $V_{GS} = 5\text{V}$	-	-	0.022	$\Omega$	
Turn-On Time	$t_{ON}$	$V_{DD} = 15\text{V}$ , $I_D \cong 16\text{A}$ , $R_L = 0.93\Omega$ , $V_{GS} = 5\text{V}$ , $R_{GS} = 5\Omega$	-	-	120	ns	
Turn-On Delay Time	$t_{d(ON)}$		-	15	-	ns	
Rise Time	$t_r$		-	95	-	ns	
Turn-Off Delay Time	$t_{d(OFF)}$		-	25	-	ns	
Fall Time	$t_f$		-	27	-	ns	
Turn-Off Time	$t_{OFF}$		-	-	80	ns	
Total Gate Charge	$Q_{g(TOT)}$	$V_{GS} = 0\text{V}$ to $10\text{V}$	-	50	60	nC	
Gate Charge at 5V	$Q_{g(5)}$	$V_{GS} = 0\text{V}$ to $5\text{V}$					
Threshold Gate Charge	$Q_{g(TH)}$	$V_{GS} = 0\text{V}$ to $1\text{V}$					
Input Capacitance	$C_{ISS}$	$V_{DS} = 20\text{V}$ , $V_{GS} = 0\text{V}$ , $f = 1\text{MHz}$	-	1300	-	pF	
Output Capacitance	$C_{OSS}$		-	724	-	pF	
Reverse Transfer Capacitance	$C_{RSS}$		-	250	-	pF	
Thermal Resistance Junction to Case	$R_{\theta JC}$		-	-	1.65	$^\circ\text{C}/\text{W}$	
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	TO-251 and TO-252	-	-	100	$^\circ\text{C}/\text{W}$	

### Source to Drain Diode Specifications

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Source to Drain Diode Voltage	$V_{SD}$	$I_{SD} = 16\text{A}$	-	-	1.5	V
Reverse Recovery Time	$t_{rr}$	$I_{SD} = 16\text{A}$ , $dI_{SD}/dt = 100\text{A}/\mu\text{s}$	-	-	80	ns

Typical Performance Curves

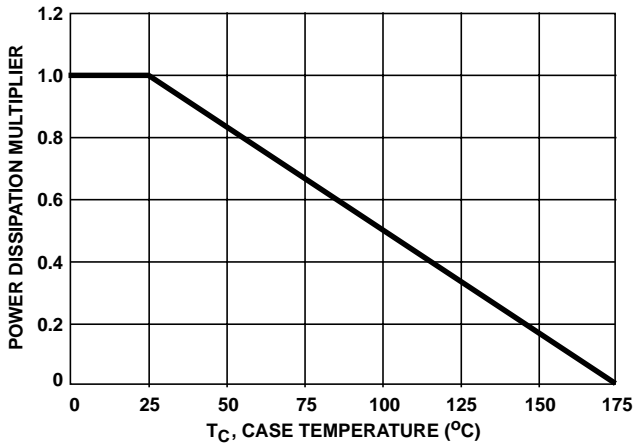


FIGURE 1. NORMALIZED POWER DISSIPATION vs TEMPERATURE DERATING

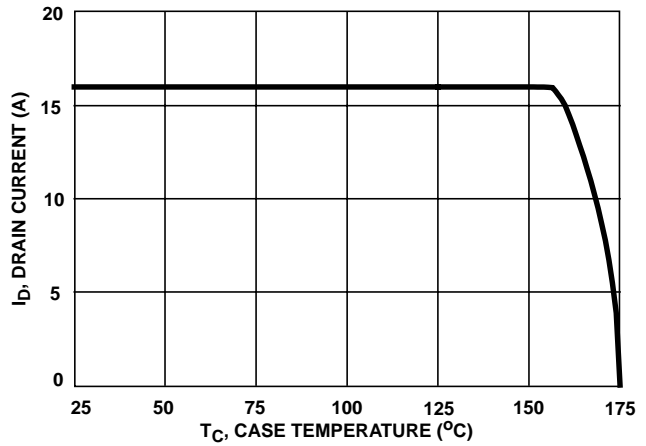


FIGURE 2. MAXIMUM CONTINUOUS DRAIN CURRENT vs CASE TEMPERATURE

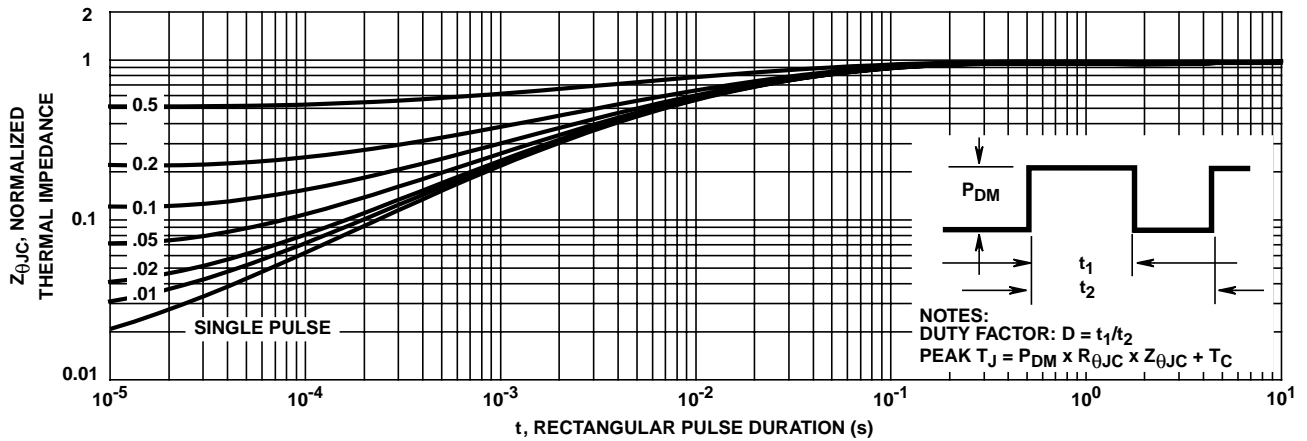


FIGURE 3. NORMALIZED MAXIMUM TRANSIENT THERMAL IMPEDANCE

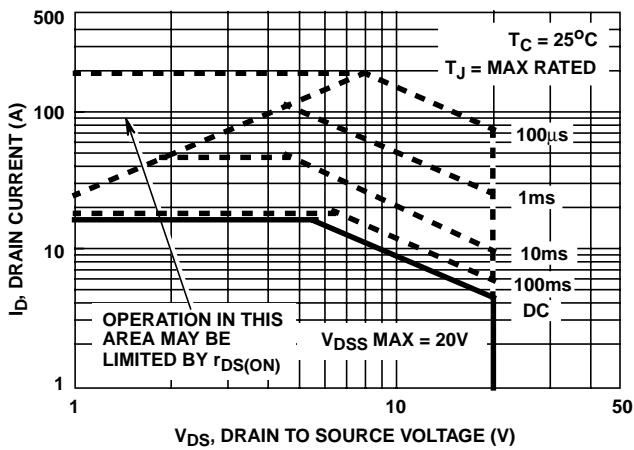


FIGURE 4. FORWARD BIAS SAFE OPERATING AREA

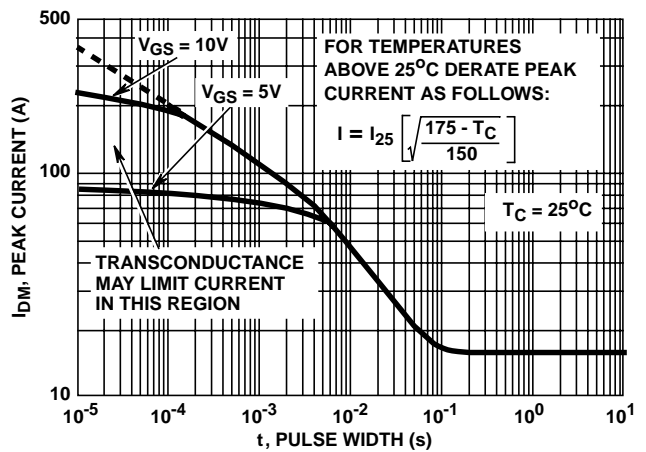
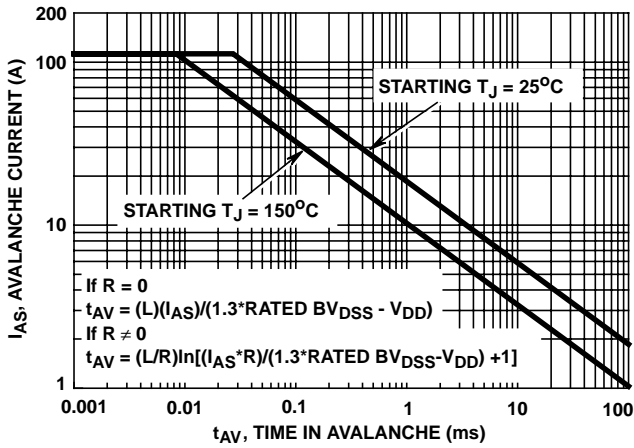


FIGURE 5. PEAK CURRENT CAPABILITY

Typical Performance Curves (Continued)



NOTE: Refer to Intersil Application Notes AN9321 and AN9322.

FIGURE 6. UNCLAMPED INDUCTIVE SWITCHING

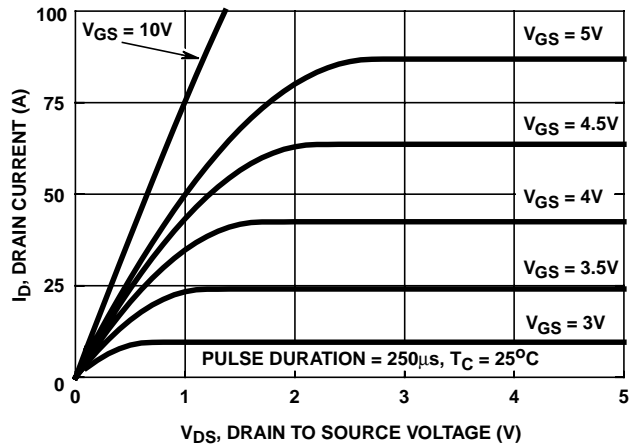


FIGURE 7. SATURATION CHARACTERISTICS

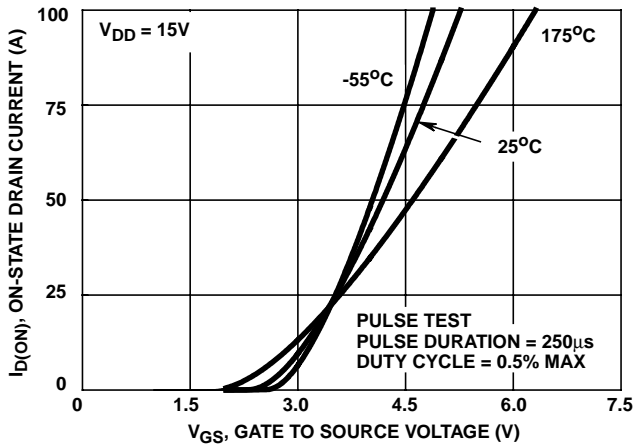


FIGURE 8. TRANSFER CHARACTERISTICS

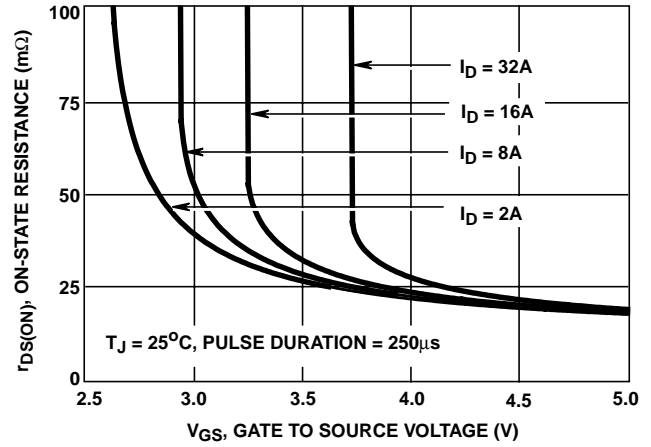


FIGURE 9. DRAIN TO SOURCE ON RESISTANCE vs GATE VOLTAGE AND DRAIN CURRENT

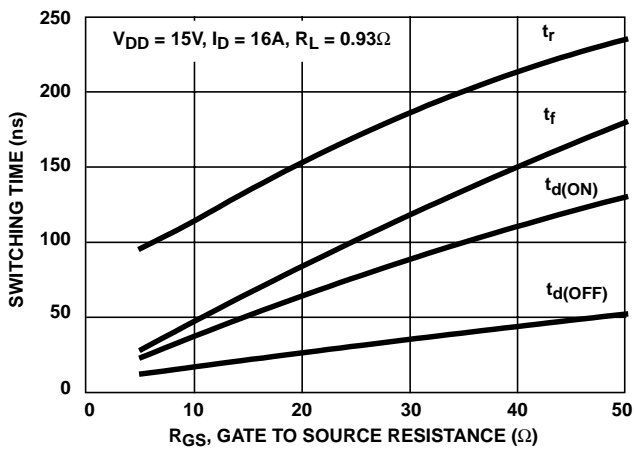


FIGURE 10. SWITCHING TIME AS A FUNCTION OF GATE RESISTANCE

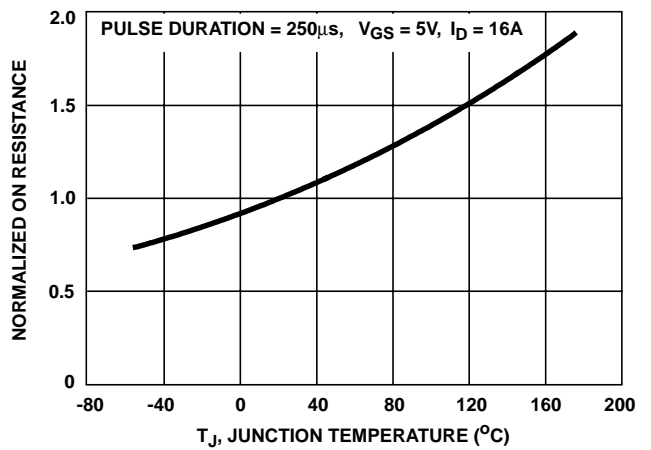


FIGURE 11. NORMALIZED DRAIN TO SOURCE ON RESISTANCE vs JUNCTION TEMPERATURE

Typical Performance Curves (Continued)

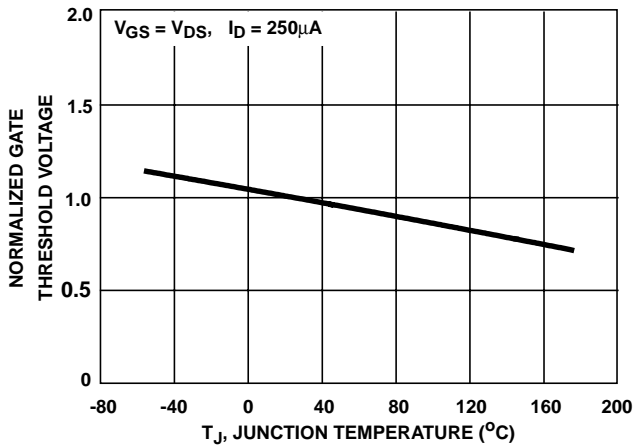


FIGURE 12. NORMALIZED GATE THRESHOLD VOLTAGE vs JUNCTION TEMPERATURE

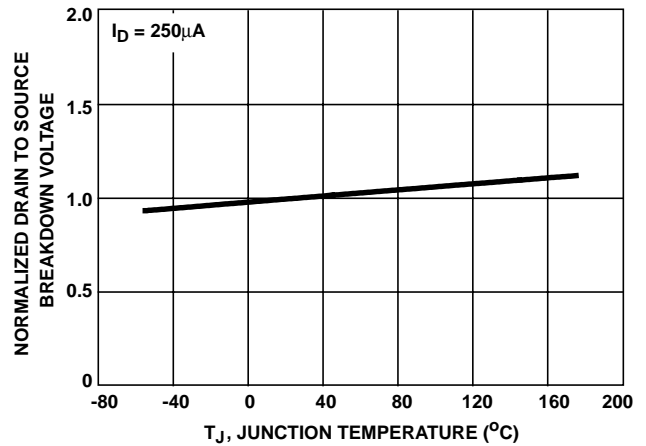


FIGURE 13. NORMALIZED DRAIN TO SOURCE BREAKDOWN VOLTAGE vs JUNCTION TEMPERATURE

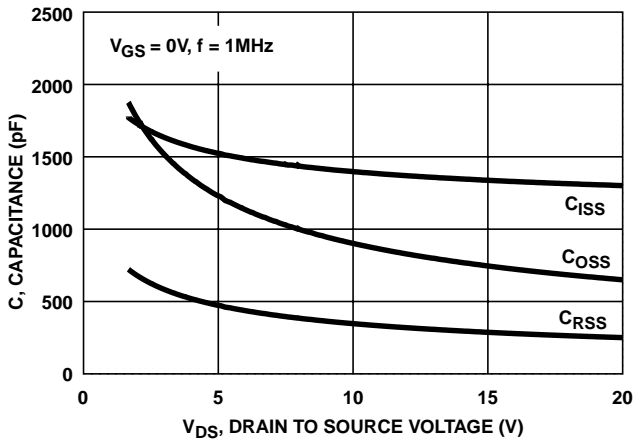
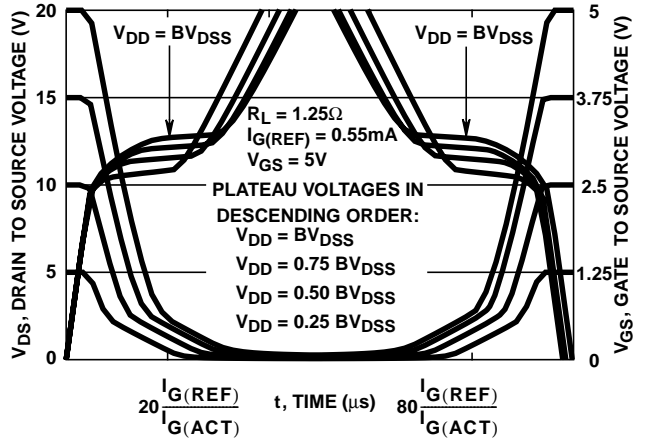


FIGURE 14. CAPACITANCE vs DRAIN TO SOURCE VOLTAGE



NOTE: Refer to Application Notes AN7254 and AN7260.

FIGURE 15. NORMALIZED SWITCHING WAVEFORMS FOR CONSTANT GATE CURRENT

Test Circuits and Waveforms

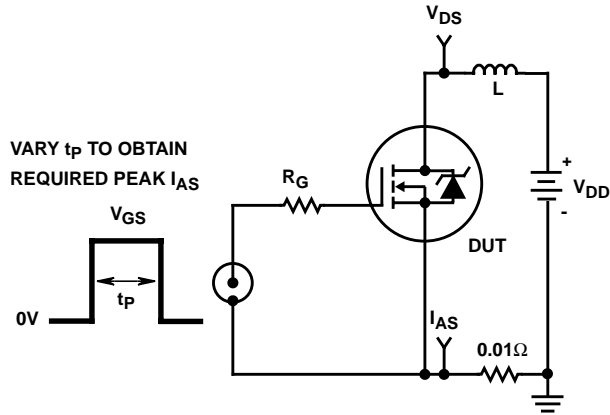


FIGURE 16. UNCLAMPED ENERGY TEST CIRCUIT

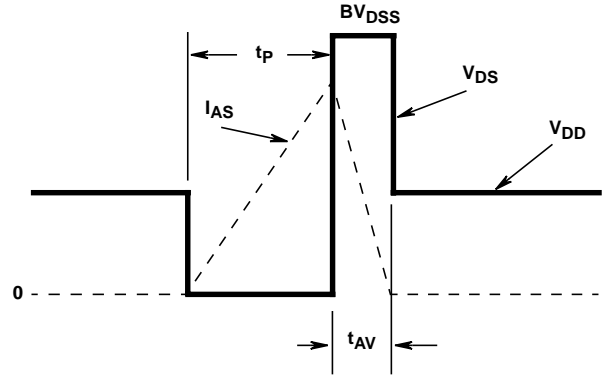


FIGURE 17. UNCLAMPED ENERGY WAVEFORMS

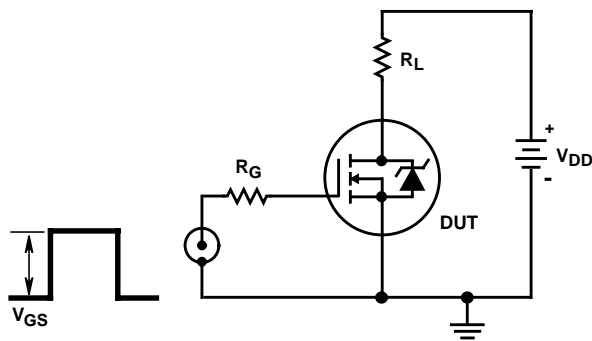


FIGURE 18. SWITCHING TIME TEST CIRCUIT

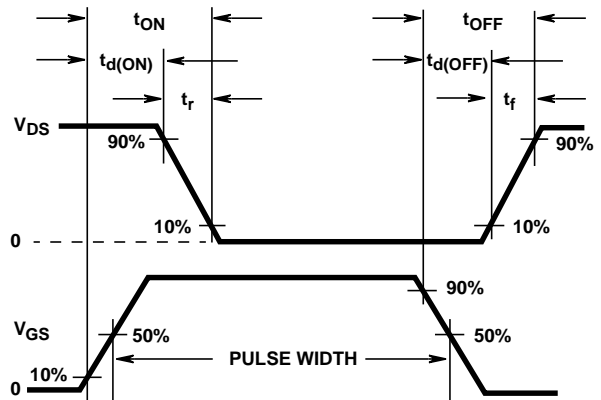


FIGURE 19. RESISTIVE SWITCHING WAVEFORMS

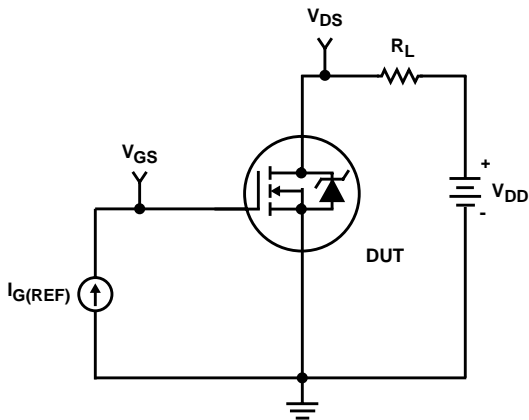


FIGURE 20. GATE CHARGE TEST CIRCUIT

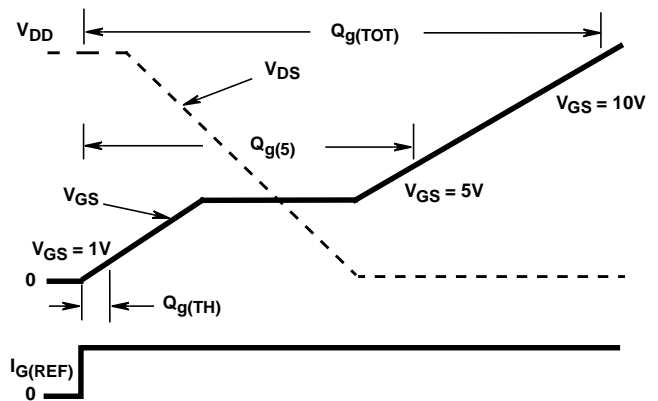


FIGURE 21. GATE CHARGE WAVEFORMS

## RFD16N02L, RFD16N02LSM

### Temperature Compensated PSPICE Model for the RFD16N02L, RFD16N02LSM

```
.SUBCKT RFD16N02L 2 1 3; rev 12/12/94
CA 12 8 2.55e-9
CB 15 14 2.64e-9
CIN 6 8 1.05e-9
```

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

```
EBREAK 11 7 17 18 33.3
```

```
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 3.4e-9
LSOURCE 3 7 3.4e-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 0.14e-3
RGATE 9 20 0.89
RIN 6 8 1e9
RSCL1 5 51 RSCLMOD 1e-6
RSCL2 5 50 1e3
RSOURCE 8 7 RDSMOD 10.31e-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 0.583
```

```
ESCL 51 50 VALUE = {(V(5,51)/ABS(V(5,51)))*(PWR(V(5,51)*1e6/176,6))}
```

```
.MODEL DBDMOD D (IS = 3.61e-13 RS = 5.06e-3 TRS1 = 3.05e-3 TRS2 = 7.57e-6 CJO = 2.0e-9 TT = 2.18e-8)
```

```
.MODEL DBKMOD D (RS = 1.66e-1 TRS1 = -2.97e-3 TRS2 = 7.57e-6)
```

```
.MODEL DPLCAPMOD D (CJO = 1.25e-9 IS = 1e-30 N = 10)
```

```
.MODEL MOSMOD NMOS (VTO = 2.313 KP = 53.82 IS = 1e-30 N = 10 TOX = 1 L = 1u W = 1u)
```

```
.MODEL RBKMOD RES (TC1 = 8.95e-4 TC2 = -1e-7)
```

```
.MODEL RDSMOD RES (TC1 = 3.92e-3 TC2 = 1.29e-5)
```

```
.MODEL RSCLMOD RES (TC1 = 2.03e-3 TC2 = 0.45e-5)
```

```
.MODEL RVTOMOD RES (TC1 = -2.27e-3 TC2 = -5.75e-7)
```

```
.MODEL S1AMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = -4.82 VOFF = -2.82)
```

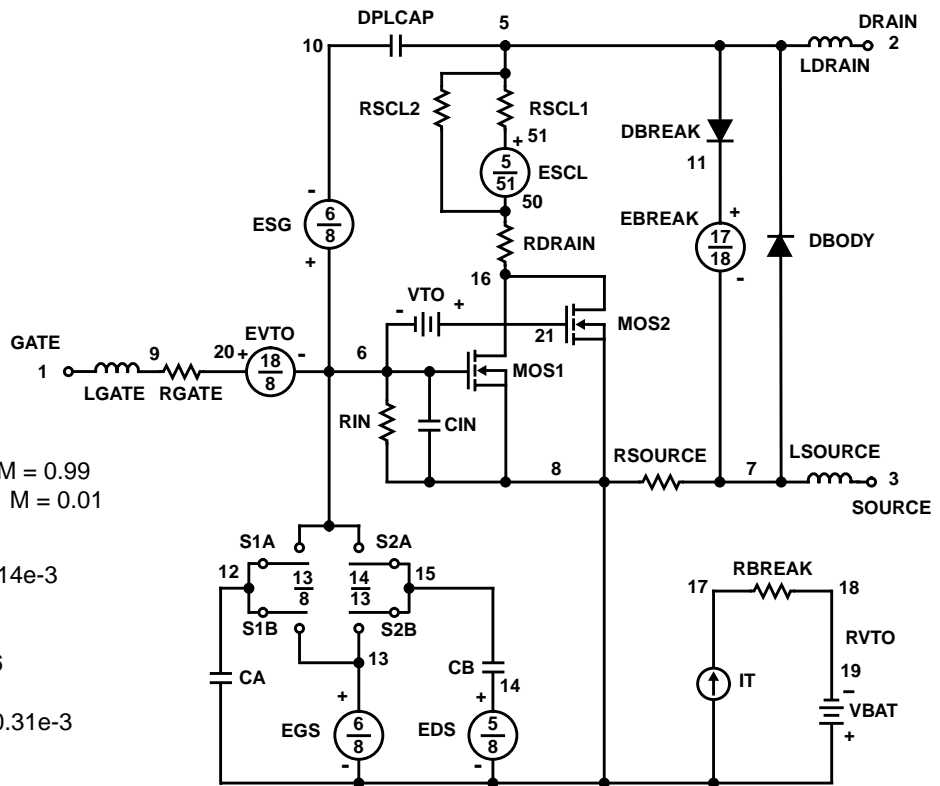
```
.MODEL S1BMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = -2.82 VOFF = -4.82)
```

```
.MODEL S2AMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = -2.67 VOFF = 2.33)
```

```
.MODEL S2BMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = 2.33 VOFF = -2.67)
```

```
.ENDS
```

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



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