

## 20A, 30V, 0.025 Ohm, N-Channel Power MOSFETs

The RFD20N03 and RFD20N03SM 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 TA49235.

### Ordering Information

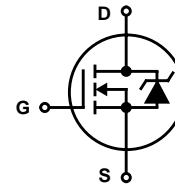
PART NUMBER	PACKAGE	BRAND
RFD20N03	TO-251AA	F20N03
RFD20N03SM	TO-252AA	F20N03

NOTE: When ordering, use the entire part number. Add the suffix 9A to obtain the TO-252AA variant in tape and reel, e.g., RFD20N03SM9A.

### Features

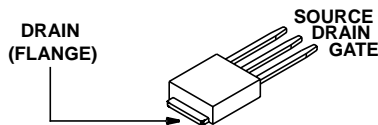
- 20A, 30V
- $r_{DS(ON)} = 0.025\Omega$
- Temperature Compensating PSPICE® Model
- Thermal Impedance SPICE Model
- Peak Current vs Pulse Width Curve
- UIS Rating Curve
- 175°C Operating Temperature
- Related Literature
  - TB334 "Guidelines for Soldering Surface Mount Components to PC Boards"

### Symbol

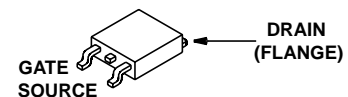


### Packaging

JEDEC TO-251AA



JEDEC TO-252AA



## RFD20N03, RFD20N03SM

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

		UNITS
Drain to Source Voltage (Note 1) . . . . .	$V_{DSS}$	30 V
Drain to Gate Voltage ( $R_{GS} = 20k\Omega$ ) (Note 1) . . . . .	$V_{DGR}$	30 V
Gate to Source Voltage . . . . .	$V_{GS}$	$\pm 20$ V
Drain Current		
Continuous (Figure 2) . . . . .	$I_D$	20 A
Pulsed Drain Current . . . . .	$I_{DM}$	Figure 5
Pulsed Avalanche Rating . . . . .	$E_{AS}$	Figure 6
Power Dissipation (Figure 4) . . . . .	$P_D$	90 W
Derate Above $25^\circ\text{C}$ (Figure 1) . . . . .		0.60 $W/^\circ\text{C}$
Operating and Storage Temperature . . . . .	$T_J, T_{STG}$	-55 to 175 $^\circ\text{C}$
Maximum Temperature for Soldering		
Leads at 0.063in (1.6mm) from Case for 10s . . . . .	$T_L$	300 $^\circ\text{C}$
Package Body for 10s, See Techbrief 334 . . . . .	$T_{pkg}$	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:**

- $T_J = 25^\circ\text{C}$  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)	30	-	-	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	$I_{DSS}$	$V_{DS} = 30\text{V}, V_{GS} = 0\text{V}$	-	-	1	$\mu\text{A}$
		$V_{DS} = 30\text{V}, V_{GS} = 0\text{V}, T_C = 150^\circ\text{C}$	-	-	50	$\mu\text{A}$
Gate to Source Leakage Current	$I_{GSS}$	$V_{GS} = \pm 20\text{V}$	-	-	100	nA
Drain to Source On Resistance	$r_{DS(ON)}$	$I_D = 20\text{A}, V_{GS} = 10\text{V}$ (Figure 9)	-	0.022	0.025	$\Omega$
Turn-On Time	$t_{ON}$	$V_{DD} = 15\text{V}, I_D \equiv 20\text{A}, R_L = 0.75\Omega, V_{GS} = 10\text{V}, R_{GS} = 9.1\Omega$	-	-	60	ns
Turn-On Delay Time	$t_{d(ON)}$		-	10	-	ns
Rise Time	$t_r$		-	30	-	ns
Turn-Off Delay Time	$t_{d(OFF)}$		-	12	-	ns
Fall Time	$t_f$		-	32	-	ns
Turn-Off Time	$t_{OFF}$		-	-	66	ns
Total Gate Charge	$Q_g(TOT)$	$V_{GS} = 0\text{V}$ to $20\text{V}$	-	60	75	nC
Gate Charge at 10V	$Q_g(10)$	$V_{GS} = 0\text{V}$ to $10\text{V}$				
Threshold Gate Charge	$Q_g(TH)$	$V_{GS} = 0\text{V}$ to $2\text{V}$				
Input Capacitance	$C_{ISS}$	$V_{DS} = 25\text{V}, V_{GS} = 0\text{V}, f = 1\text{MHz}$ (Figure 12)	-	1150	-	pF
Output Capacitance	$C_{OSS}$		-	550	-	pF
Reverse Transfer Capacitance	$C_{RSS}$		-	110	-	pF
Thermal Resistance Junction to Case	$R_{\theta JC}$	(Figure 3)	-	-	1.66	$^\circ\text{C/W}$
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	TO-251, TO-252	-	-	100	$^\circ\text{C/W}$

### Source to Drain Diode Specifications

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Source to Drain Diode Voltage	$V_{SD}$	$I_{SD} = 20\text{A}$	-	-	1.25	V
Reverse Recovery Time	$t_{rr}$	$I_{SD} = 20\text{A}, dI_{SD}/dt = 100\text{A}/\mu\text{s}$	-	-	70	ns
Reverse Recovered Charge	$Q_{RR}$	$I_{SD} = 20\text{A}, dI_{SD}/dt = 100\text{A}/\mu\text{s}$	-	-	145	nC

Typical Performance Curves

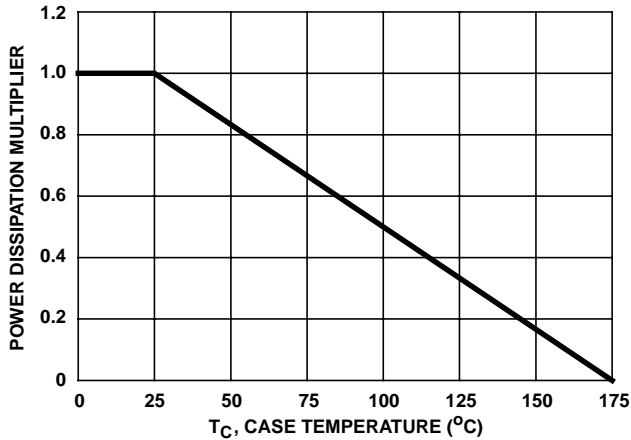


FIGURE 1. NORMALIZED POWER DISSIPATION vs CASE TEMPERATURE

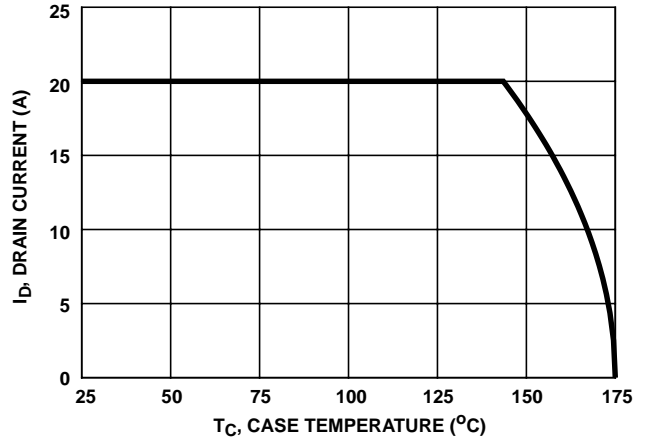


FIGURE 2. MAXIMUM CONTINUOUS DRAIN CURRENT vs CASE TEMPERATURE

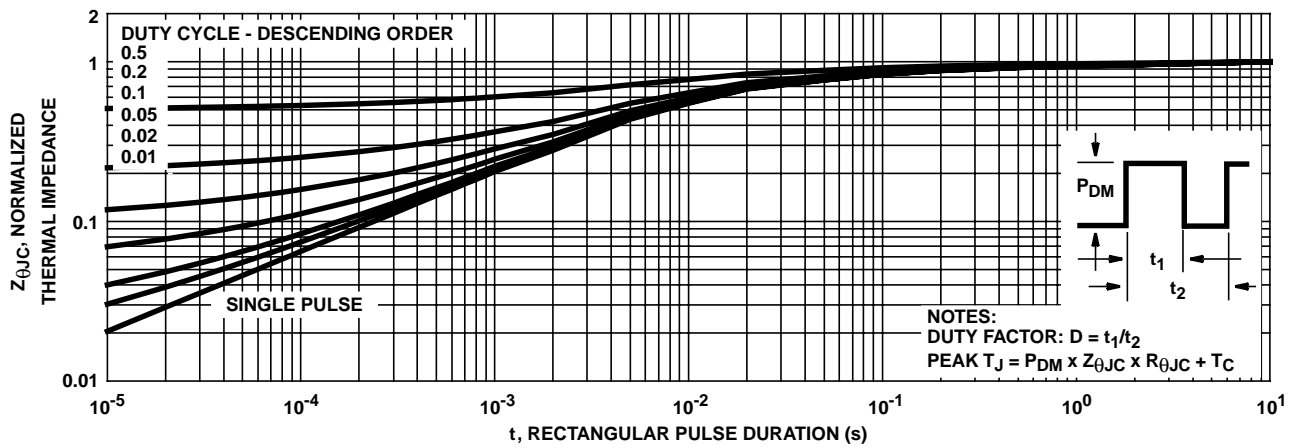


FIGURE 3. NORMALIZED MAXIMUM TRANSIENT THERMAL IMPEDANCE

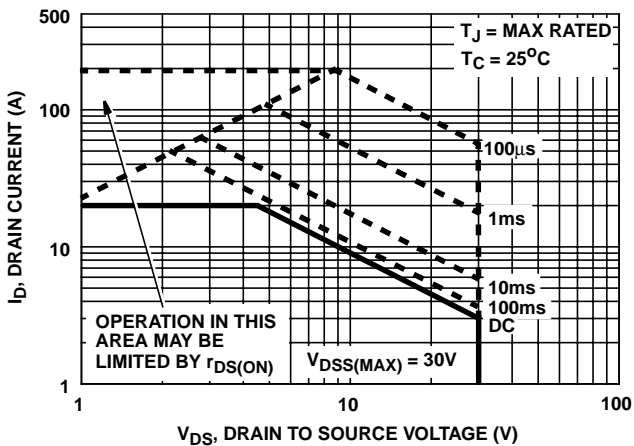


FIGURE 4. FORWARD BIAS SAFE OPERATING AREA

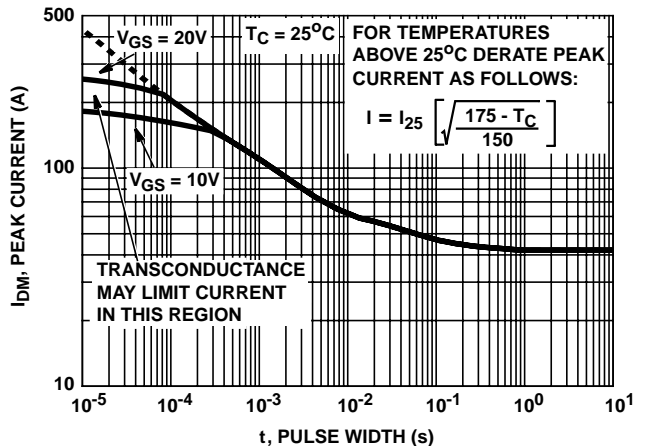
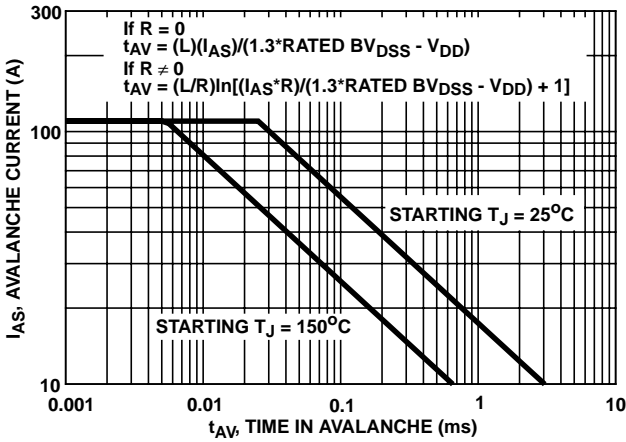


FIGURE 5. PEAK CURRENT CAPABILITY

Typical Performance Curves (Continued)



NOTE: Refer to Intersil Application Notes AN9321 and AN9322.

FIGURE 6. UNCLAMPED INDUCTIVE SWITCHING CAPABILITY

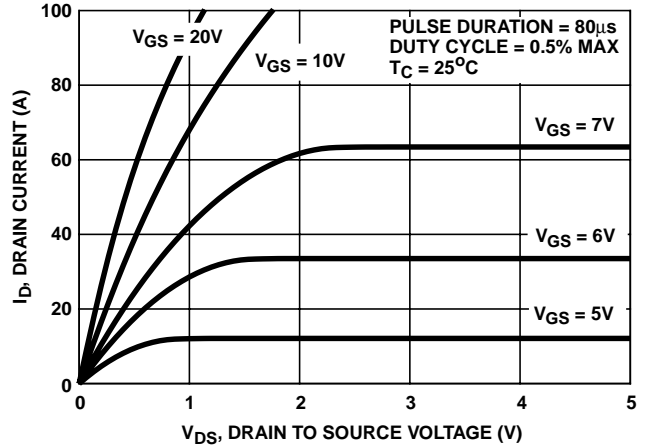


FIGURE 7. SATURATION CHARACTERISTICS

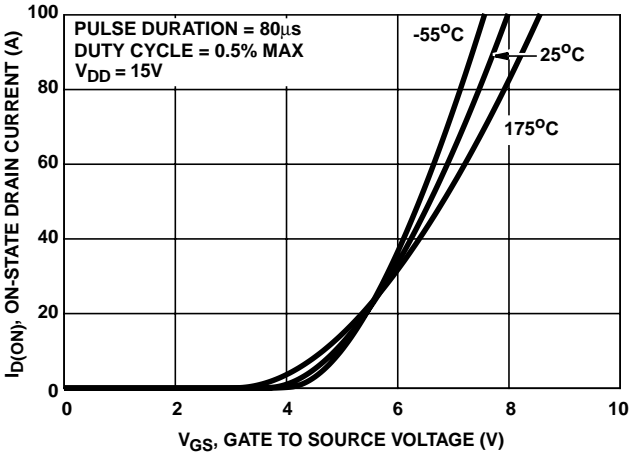


FIGURE 8. TRANSFER CHARACTERISTICS

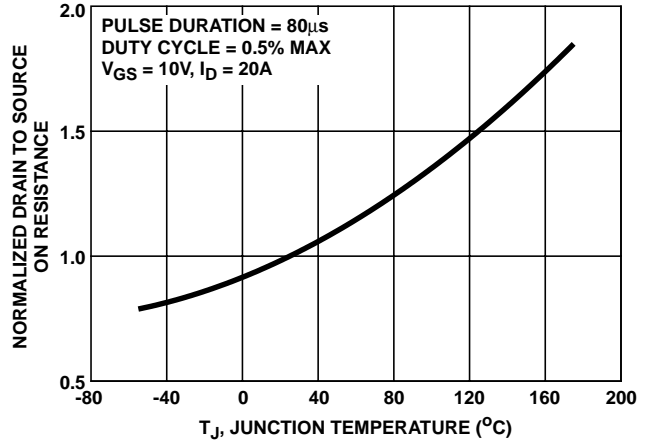


FIGURE 9. NORMALIZED DRAIN TO SOURCE ON RESISTANCE vs JUNCTION TEMPERATURE

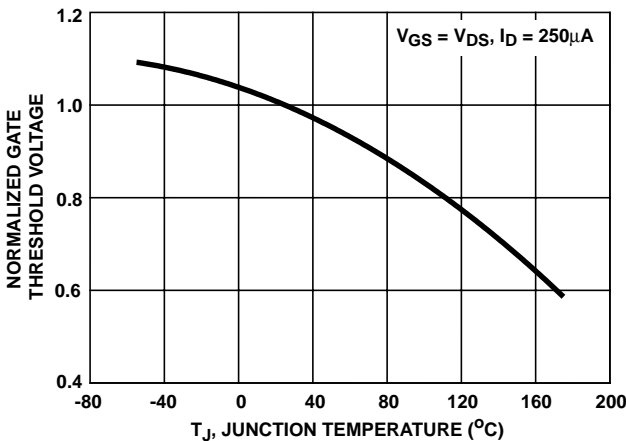


FIGURE 10. NORMALIZED GATE THRESHOLD VOLTAGE vs JUNCTION TEMPERATURE

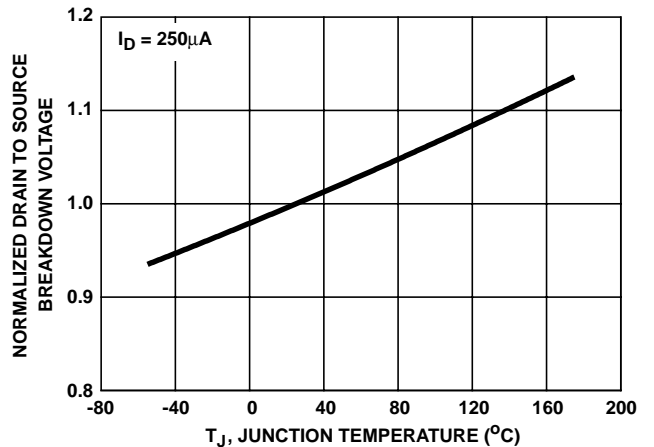


FIGURE 11. NORMALIZED DRAIN TO SOURCE BREAKDOWN VOLTAGE vs JUNCTION TEMPERATURE

Typical Performance Curves (Continued)

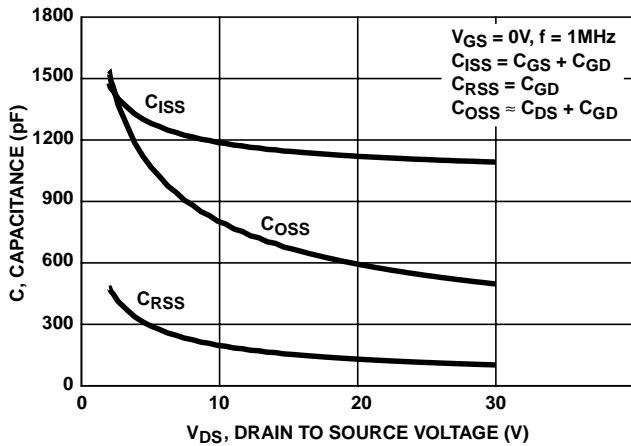


FIGURE 12. CAPACITANCE vs DRAIN TO SOURCE VOLTAGE

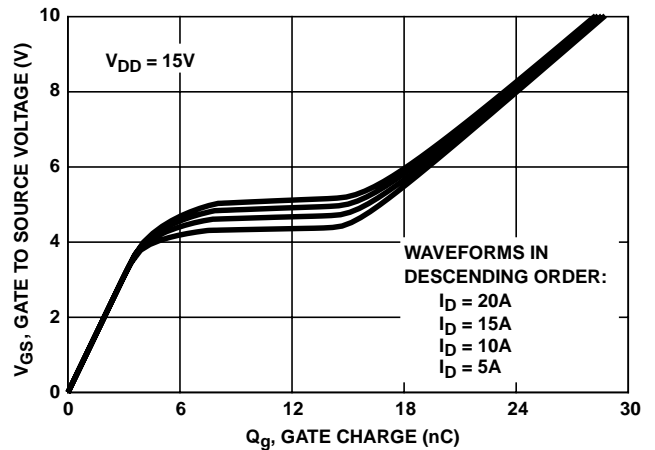


FIGURE 13. GATE CHARGE WAVEFORMS FOR CONSTANT GATE CURRENT

Test Circuits and Waveforms

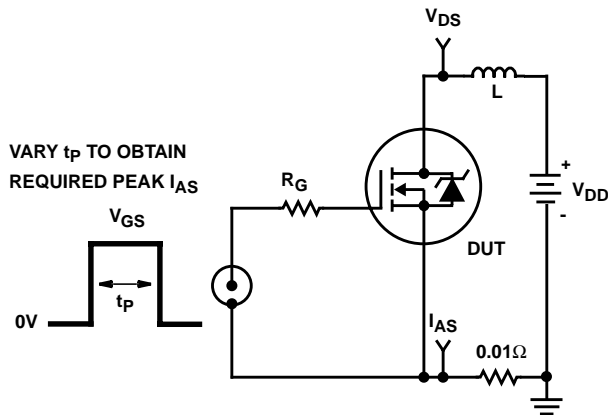


FIGURE 14. UNCLAMPED ENERGY TEST CIRCUIT

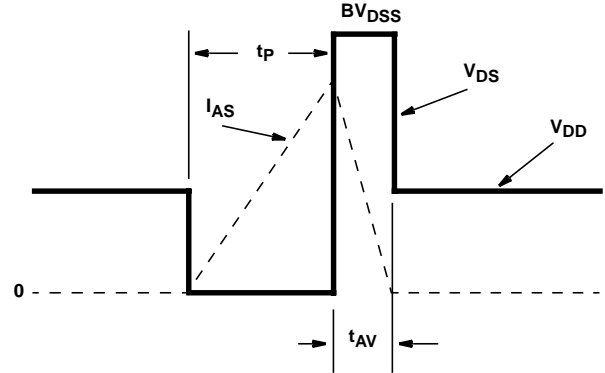


FIGURE 15. UNCLAMPED ENERGY WAVEFORMS

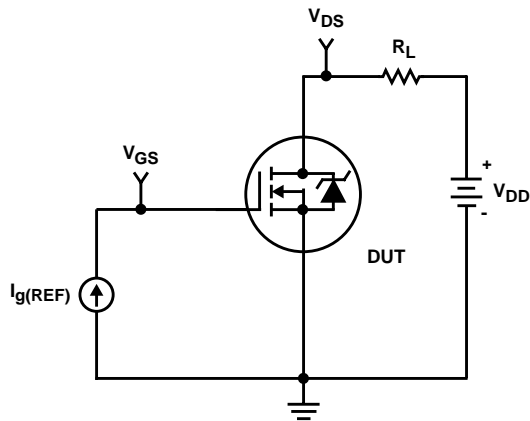


FIGURE 16. GATE CHARGE TEST CIRCUIT

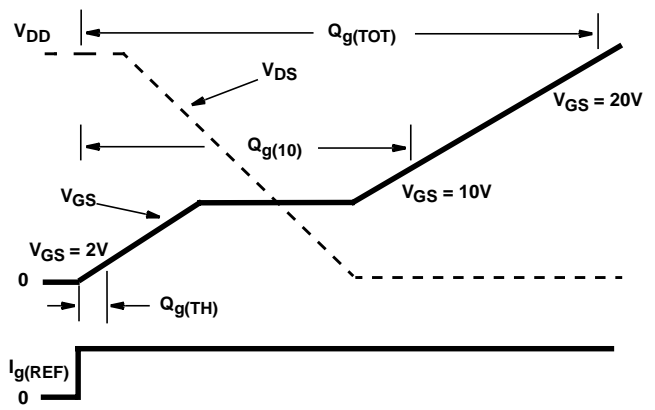


FIGURE 17. GATE CHARGE WAVEFORM

Test Circuits and Waveforms (Continued)

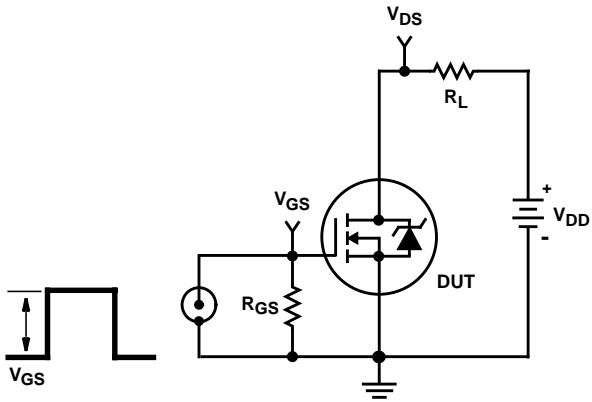


FIGURE 18. SWITCHING TIME TEST CIRCUIT

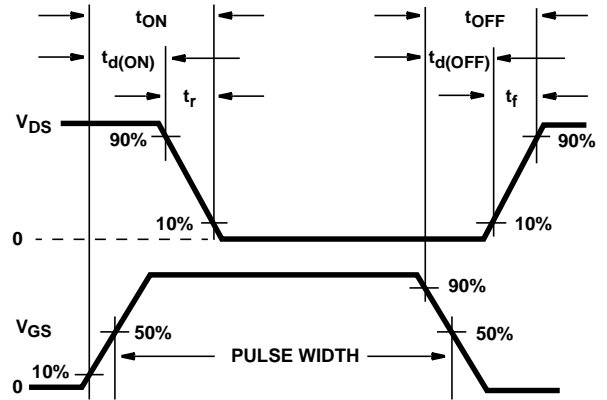


FIGURE 19. RESISTIVE SWITCHING WAVEFORMS

**PSPICE Electrical Model**

SUBCKT RFD20N03, RFD20N03SM 2 1 3 ; rev 28 Jul 97

CA 12 8 1.3e-9  
 CB 15 14 1.3e-9  
 CIN 6 8 9.9e-10

DBODY 7 5 DBODYMOD  
 DBREAK 5 11 DBREAKMOD  
 DPLCAP 10 5 DPLCAPMOD

EBREAK 11 7 17 18 33.15  
 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

LDRAIN 2 5 1.00e-9  
 LGATE 1 9 3.57e-9  
 LSOURCE 3 7 4.25e-9

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 5e-4  
 RGATE 9 20 1.24  
 RLDRAIN 2 5 10  
 RLGATE 1 9 28.6  
 RLSOURCE 3 7 26.9  
 RSLC1 5 51 RSLCMOD 1e-6  
 RSLC2 5 50 1e3  
 RSOURCE 8 7 RSOURCEMOD 6.2e-3  
 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

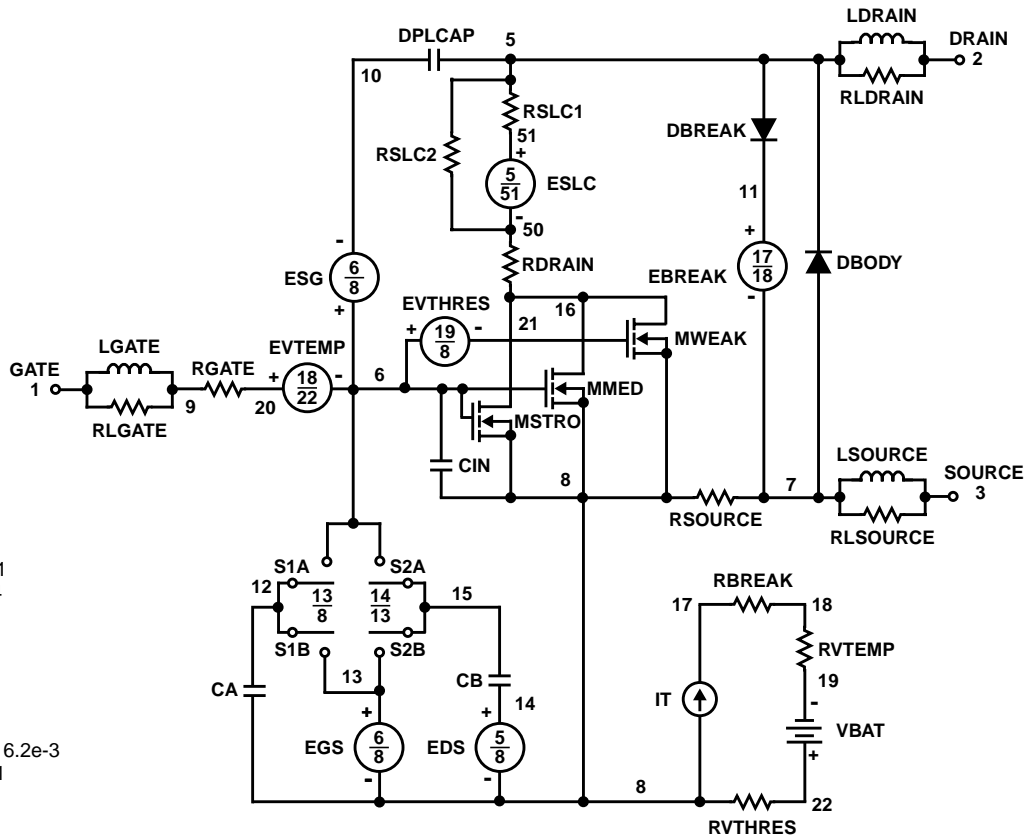
VBAT 22 19 DC 1

ESLC 51 50 VALUE={(V(5,51)/ABS(V(5,51)))\*(PWR(V(5,51)/(1e-6\*120),3))}

```
.MODEL DBODYMOD D (IS = 9e-13 RS = 6.4e-3 IKF=7.4 TIKF=0.005 N=1.02 TRS1 = 3.5e-3 TRS2 = -1e-5 CJO = 1.78e-9 TT = 4.0e-8 M = 0.4053)
.MODEL DBREAKMOD D (RS = 0.1 N=3.5 IKF=-1e-3 TRS1 = -1e-3 TRS2 = 1e-6)
.MODEL DPLCAPMOD D (CJO = 1.3e-9 IS = 1e-30 N = 10 M = 0.62)
.MODEL MMEDMOD NMOS (VTO = 3.17 KP = 1.3 IS = 1e-30 N = 10 TOX = 1 L = 1u W = 1u RG = 1.24)
.MODEL MSTROMOD NMOS (VTO = 3.68 KP = 13 IS = 1e-30 N = 10 TOX = 1 L = 1u W = 1u)
.MODEL MWEAKMOD NMOS (VTO = 2.68 KP = 0.009 IS = 1e-30 N = 10 TOX = 1 L = 1u W = 1u RG = 12.4 RS = 0.1)
.MODEL RBREAKMOD RES (TC1 = 8e-4 TC2 = 4.5e-7)
.MODEL RDRAINMOD RES (TC1 = 3.5e-2 TC2 = 4.5e-4)
.MODEL RSLCMOD RES (TC1 = 1e-3 TC2 = 1e-6)
.MODEL RSOURCEMOD RES (TC1 = 0 TC2 = 0)
.MODEL RVTHRESMOD RES (TC = -1.2e-3 TC2 = -2e-5)
.MODEL RVTEMPMOD RES (TC1 = -3.5e-3 TC2 = 1e-7)

.MODEL S1AMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = -8.60 VOFF= -2.50)
.MODEL S1BMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = -2.50 VOFF= -8.60)
.MODEL S2AMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = 0.00 VOFF= 0.30)
.MODEL S2BMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = 0.30 VOFF= 0.00)

.ENDS
```



.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.

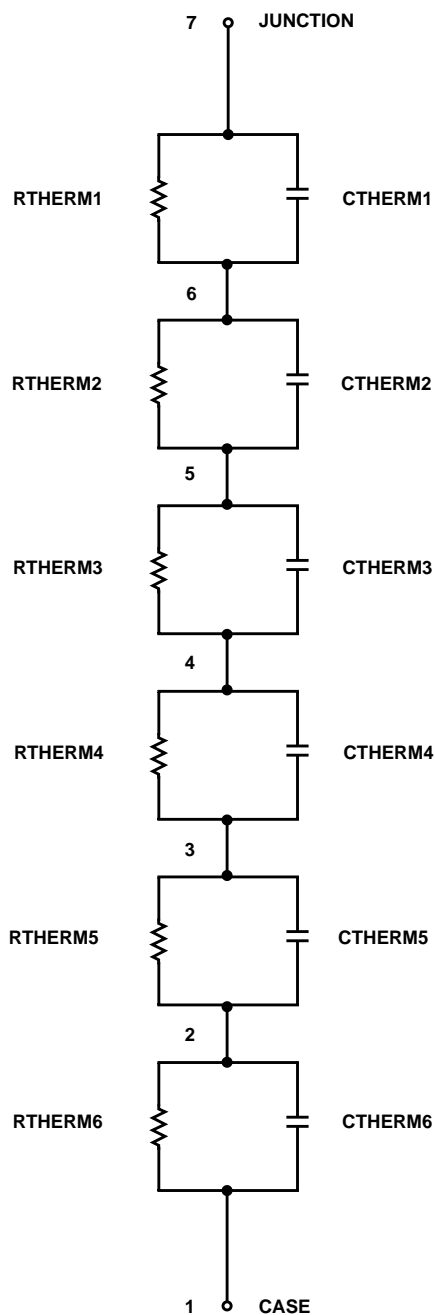
**SPICE Thermal Model**

REV 28 July 97

RFD20N03, RFD20N03SM

CTHERM1 7 6 9.9e-7  
 CHERM2 6 5 1.5e-3  
 CHERM3 5 4 2.2e-3  
 CHERM4 4 3 5.7e-3  
 CHERM5 3 2 7.5e-2  
 CHERM6 2 1 5.4e-1

RATHERM1 7 6 8e-3  
 RATHERM2 6 5 2.3e-2  
 RATHERM3 5 4 9.0e-2  
 RATHERM4 4 3 6.9e-1  
 RATHERM5 3 2 6.1e-1  
 RATHERM6 2 1 8.0e-2



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