

December 1995

### Features

- 70A, 60V
- $r_{DS(on)} = 0.014\Omega$
- *Temperature Compensated* PSpice Model
- Peak Current vs Pulse Width Curve
- UIS Rating Curve (Single Pulse)
- +175°C Operating Temperature

### Description

The RFG70N06, RFP70N06, RF1S70N06 and RF1S70N06SM 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. These transistors can be operated directly from integrated circuits.

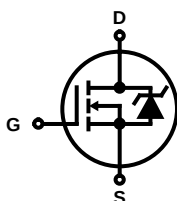
#### PACKAGE AVAILABILITY

| PART NUMBER | PACKAGE  | BRAND    |
|-------------|----------|----------|
| RFG70N06    | TO-247   | RFG70N06 |
| RFP70N06    | TO-220AB | RFP70N06 |
| RF1S70N06   | TO-262AA | F1S70N06 |
| RF1S70N06SM | TO-263AB | F1S70N06 |

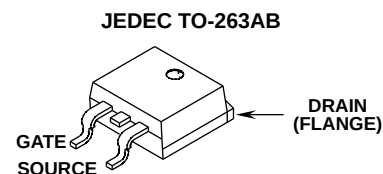
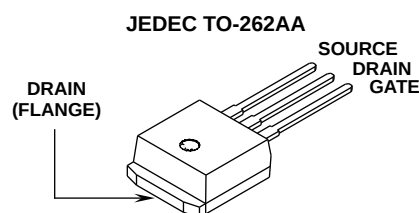
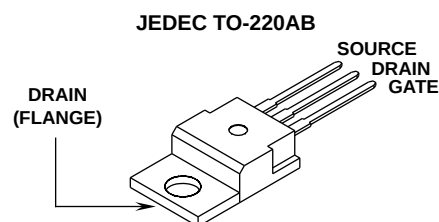
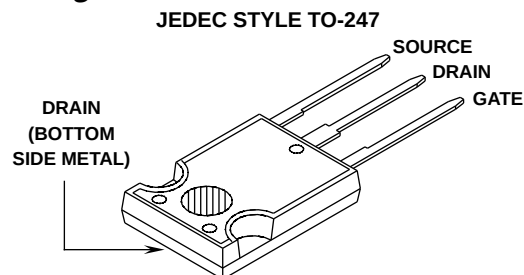
NOTE: When ordering use the entire part number. Add the suffix, 9A, to obtain the TO-263AB variant in tape and reel, e.g. RF1S70N06SM9A.

Formerly developmental type TA49007.

### Symbol



### Packages



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

|                                   | RFG70N06, RFP70N06<br>RF1S70N06, RF1S70N06SM | UNITS |
|-----------------------------------|----------------------------------------------|-------|
| Drain Source Voltage              | 60                                           | V     |
| Drain Gate Voltage                | 60                                           | V     |
| Gate Source Voltage               | $\pm 20$                                     | V     |
| Drain Current                     |                                              |       |
| RMS Continuous                    | 70                                           | A     |
| Pulsed Drain Current              | Refer to Peak Current Curve                  |       |
| Single Pulse Avalanche Rating     | Refer to UIS Curve                           |       |
| Power Dissipation                 |                                              |       |
| $T_C = +25^\circ\text{C}$         | 150                                          | W     |
| Derate above $+25^\circ\text{C}$  | 1.0                                          | W/°C  |
| Operating and Storage Temperature | -55 to +175                                  | °C    |

## Specifications RFG70N06, RFP70N06, RF1S70N06, RF1S70N06SM

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

| PARAMETER                              | SYMBOL          | TEST CONDITIONS                                                                        |                       | MIN                           | TYP                                         | MAX   | UNITS         |
|----------------------------------------|-----------------|----------------------------------------------------------------------------------------|-----------------------|-------------------------------|---------------------------------------------|-------|---------------|
| Drain-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        | $I_{DSS}$       | $V_{DS} = 60V, V_{GS} = 0V$                                                            | $T_C = +25^{\circ}C$  | -                             | -                                           | 1     | $\mu A$       |
|                                        |                 |                                                                                        | $T_C = +150^{\circ}C$ | -                             | -                                           | 50    | $\mu A$       |
| Gate-Source Leakage Current            | $I_{GSS}$       | $V_{GS} = \pm 20V$                                                                     |                       | -                             | -                                           | 100   | nA            |
| On Resistance                          | $r_{DS(ON)}$    | $I_D = 70A, V_{GS} = 10V$                                                              |                       | -                             | -                                           | 0.014 | $\Omega$      |
| Turn-On Time                           | $t_{ON}$        | $V_{DD} = 30V, I_D = 70A$<br>$R_L = 0.43\Omega, V_{GS} = +10V$<br>$R_{GS} = 2.5\Omega$ |                       | -                             | -                                           | 125   | ns            |
| Turn-On Delay Time                     | $t_{D(ON)}$     |                                                                                        |                       | -                             | 12                                          | -     | ns            |
| Rise Time                              | $t_R$           |                                                                                        |                       | -                             | 50                                          | -     | ns            |
| Turn-Off Delay Time                    | $t_{D(OFF)}$    |                                                                                        |                       | -                             | 40                                          | -     | ns            |
| Fall Time                              | $t_F$           |                                                                                        |                       | -                             | 15                                          | -     | ns            |
| Turn-Off Time                          | $t_{OFF}$       |                                                                                        |                       | -                             | -                                           | 125   | ns            |
| Total Gate Charge                      | $Q_{G(TOT)}$    |                                                                                        |                       | $V_{GS} = 0V \text{ to } 20V$ | $V_{DD} = 48V, I_D = 70A, R_L = 0.68\Omega$ | -     | 185           |
| Gate Charge at 10V                     | $Q_{G(10)}$     | $V_{GS} = 0V \text{ to } 10V$                                                          | -                     | 100                           |                                             | 115   | nC            |
| Threshold Gate Charge                  | $Q_{G(TH)}$     | $V_{GS} = 0V \text{ to } 2V$                                                           | -                     | 5.5                           |                                             | 6.5   | nC            |
| Input Capacitance                      | $C_{ISS}$       | $V_{DS} = 25V, V_{GS} = 0V$<br>$f = 1MHz$                                              |                       | -                             | 3000                                        | -     | pF            |
| Output Capacitance                     | $C_{OSS}$       |                                                                                        |                       | -                             | 900                                         | -     | pF            |
| Reverse Transfer Capacitance           | $C_{RSS}$       |                                                                                        |                       | -                             | 300                                         | -     | pF            |
| Thermal Resistance Junction to Case    | $R_{\theta JC}$ |                                                                                        |                       | -                             | -                                           | 1.0   | $^{\circ}C/W$ |
| Thermal Resistance Junction to Ambient | $R_{\theta JA}$ |                                                                                        |                       | -                             | -                                           | 80    | $^{\circ}C/W$ |

### Source-Drain Diode Specifications

| PARAMETER             | SYMBOL   | TEST CONDITIONS                                                | MIN | TYP | MAX | UNITS |
|-----------------------|----------|----------------------------------------------------------------|-----|-----|-----|-------|
| Forward Voltage       | $V_{SD}$ | $I_{SD} = 70\text{A}$                                          | -   | -   | 1.5 | V     |
| Reverse Recovery Time | $t_{RR}$ | $I_{SD} = 70\text{A}$ , $dI_{SD}/dt = 100\text{A}/\mu\text{s}$ | -   | -   | 125 | ns    |

## Typical Performance Curves

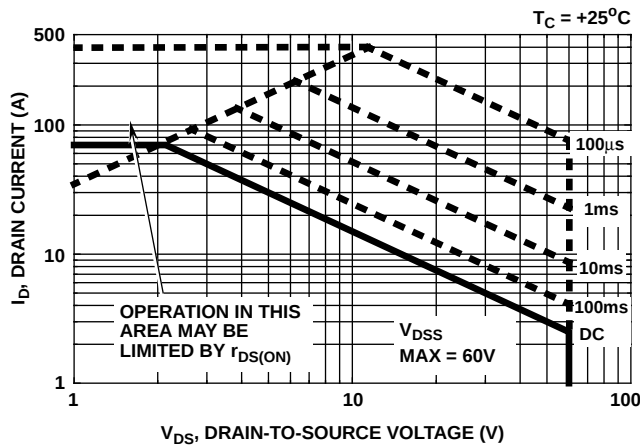


FIGURE 1. SAFE OPERATING AREA CURVE

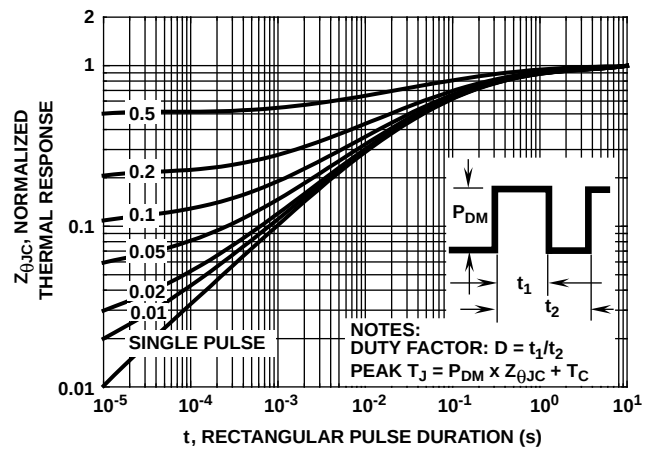


FIGURE 2. NORMALIZED MAXIMUM TRANSIENT THERMAL IMPEDANCE

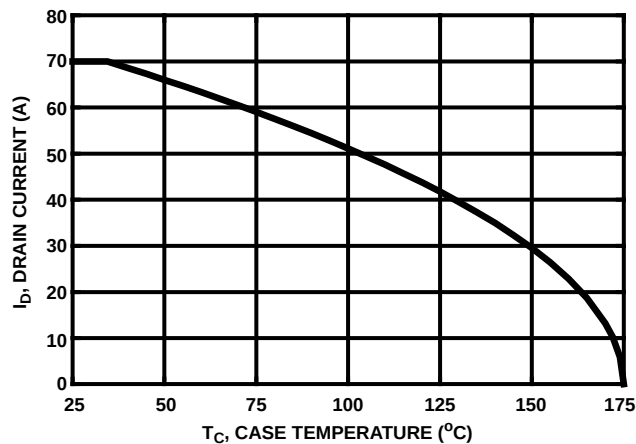


FIGURE 3. MAXIMUM CONTINUOUS DRAIN CURRENT vs TEMPERATURE

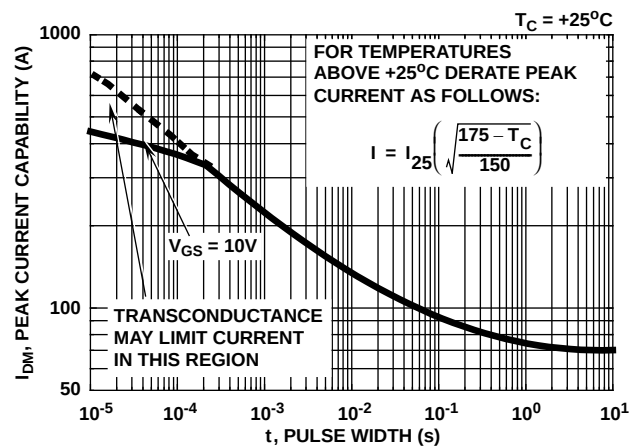


FIGURE 4. PEAK CURRENT CAPABILITY

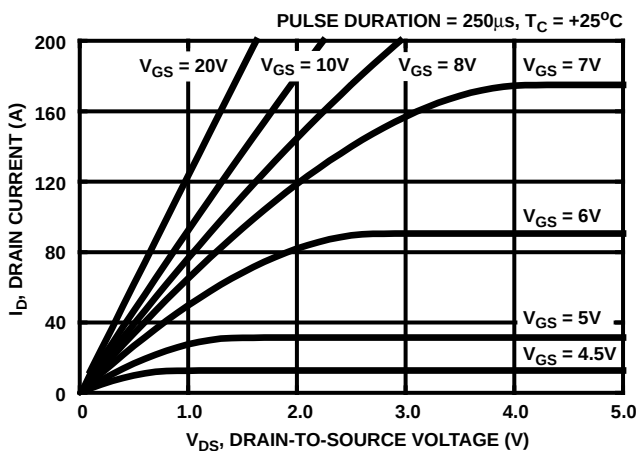


FIGURE 5. TYPICAL SATURATION CHARACTERISTICS

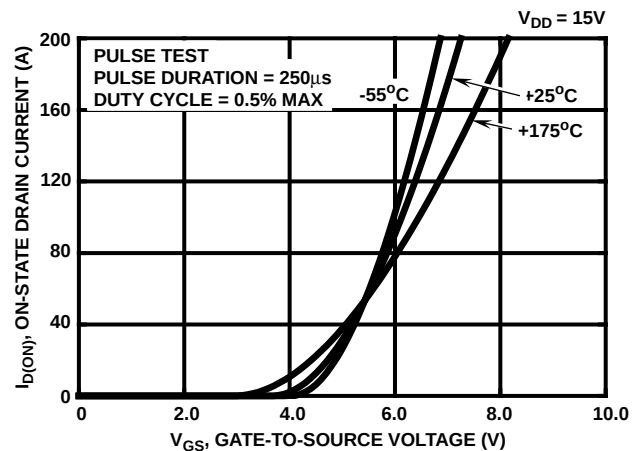


FIGURE 6. TYPICAL TRANSFER CHARACTERISTICS

# Typical Performance Curves (Continued)

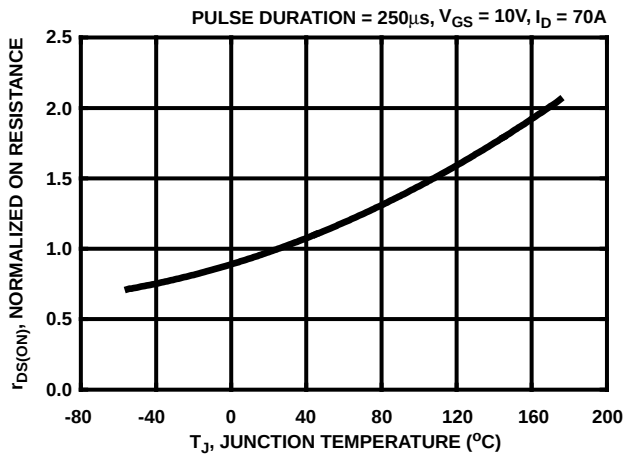


FIGURE 7. NORMALIZED  $r_{DS(ON)}$  vs JUNCTION TEMPERATURE

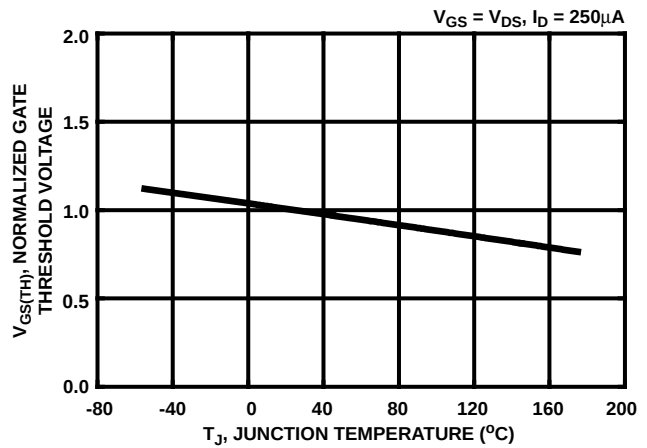


FIGURE 8. NORMALIZED GATE THRESHOLD VOLTAGE vs JUNCTION TEMPERATURE

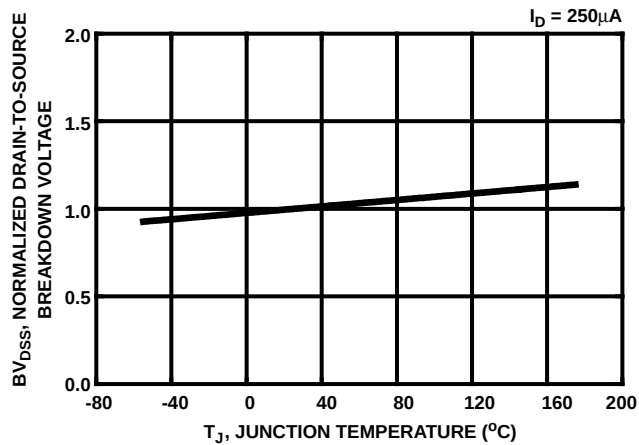


FIGURE 9. NORMALIZED DRAIN-SOURCE BREAKDOWN VOLTAGE vs JUNCTION TEMPERATURE

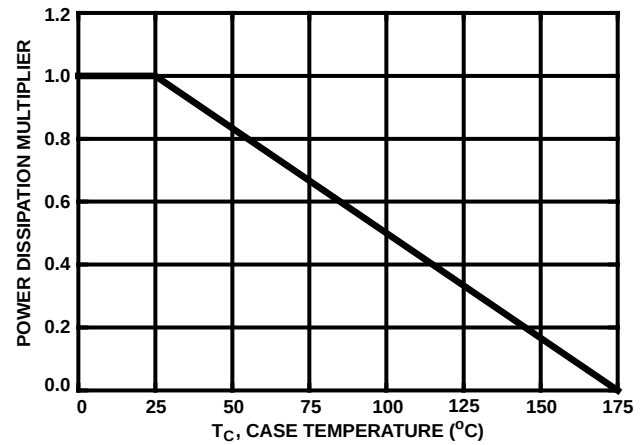


FIGURE 10. NORMALIZED POWER DISSIPATION vs TEMPERATURE DERATING CURVE

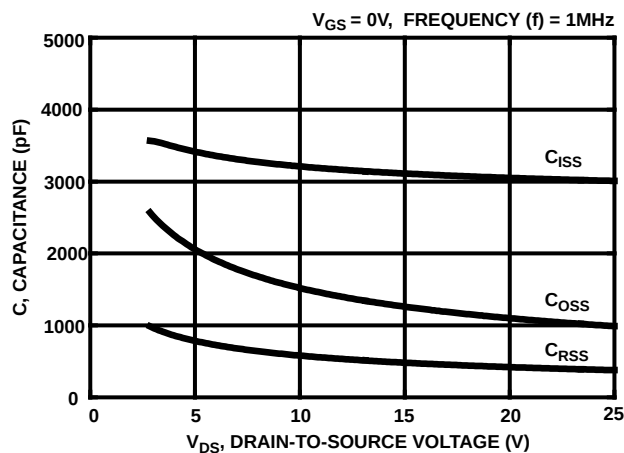


FIGURE 11. TYPICAL CAPACITANCE vs VOLTAGE

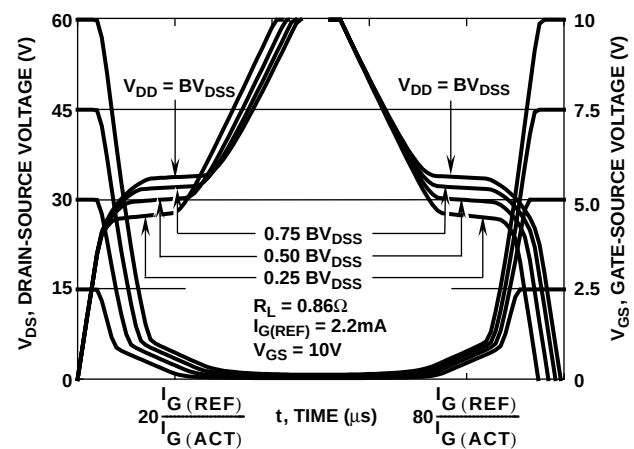


FIGURE 12. NORMALIZED SWITCHING WAVEFORMS FOR CONSTANT GATE CURRENT. REFER TO HARRIS APPLICATION NOTES AN7254 AND AN7260

# Typical Performance Curves (Continued)

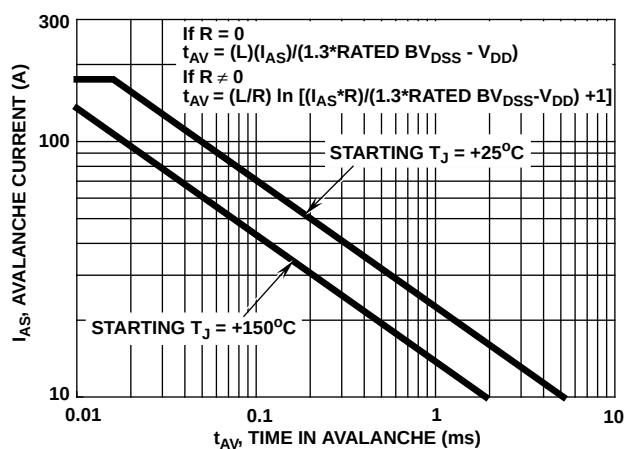


FIGURE 13. UNCLAMPED INDUCTIVE SWITCHING

REFER TO HARRIS APPLICATION NOTES AN9321 AND AN9322

## Test Circuits and Waveforms

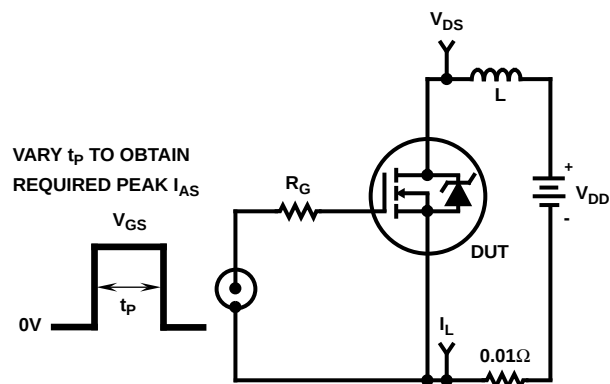


FIGURE 14. UNCLAMPED ENERGY TEST CIRCUIT

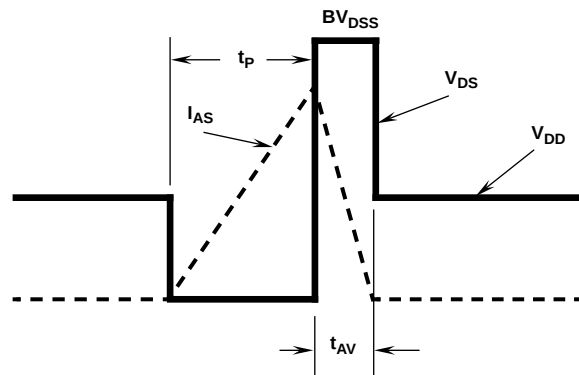


FIGURE 15. UNCLAMPED ENERGY WAVEFORMS

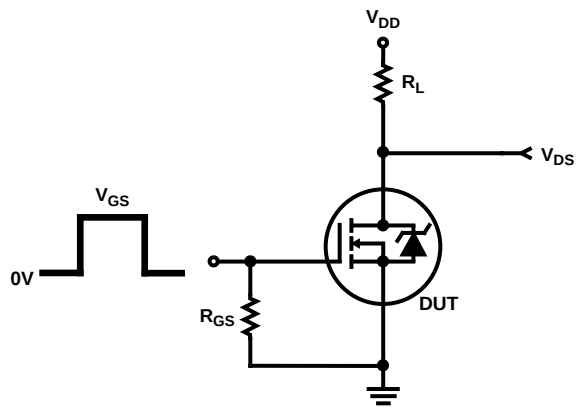


FIGURE 16. RESISTIVE SWITCHING TEST CIRCUIT

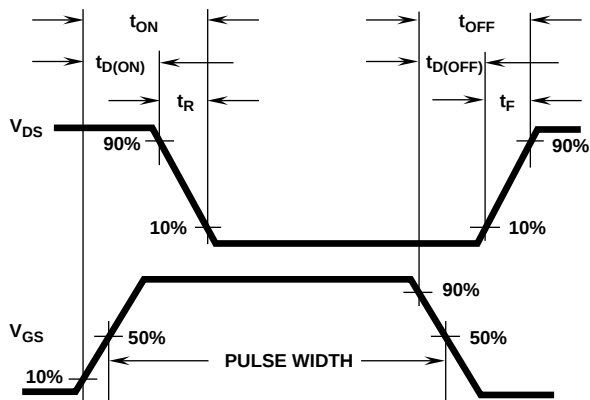


FIGURE 17. RESISTIVE SWITCHING WAVEFORMS

**Temperature Compensated PSPICE Model for the  
RF70N06, RFP70N06, RF1S70N06, RF1S70N06SM**

.SUBCKT RF70N06 2 1 3; rev 3/20/92

CA 12 8 5.56e-9  
CB 15 14 5.30e-9  
CIN 6 8 2.63e-9

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

EBREAK 11 7 17 18 65.18  
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 3.10e-9  
LSOURCE 3 7 1.82e-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 4.66e-3  
RLDRAIN 2 5 10  
RGATE 9 20 1.21  
RLGATE 1 9 31  
RIN 6 8 1e9  
RSOURCE 8 7 RDSMOD 3.92e-3  
RLSOURCE 3 7 18.2  
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 0.605

.MODEL DBDMOD D (IS = 7.91e-12 RS = 3.87e-3 TRS1 = 2.71e-3 TRS2 = 2.50e-7 CJO = 4.84e-9 TT = 4.51e-8)  
.MODEL DBKMOD D (RS = 3.9e-2 TRS1 = 1.05e-4 TRS2 = 3.11e-5)  
.MODEL DPLCAPMOD D (CJO = 4.8e-9 IS = 1e-30 N = 10)  
.MODEL MOSMOD NMOS (VTO = 3.46 KP = 47 IS = 1e-30 N = 10 TOX = 1 L = 1u W = 1u)  
.MODEL RBKMOD RES (TC1 = 8.46e-4 TC2 = -8.48e-7)  
.MODEL RDSMOD RES (TC1 = 2.23e-3 TC2 = 6.56e-6)  
.MODEL RVTOMOD RES (TC1 = -3.29e-3 TC2 = 3.49e-7)  
.MODEL S1AMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = -8.35 VOFF = -6.35)  
.MODEL S1BMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = -6.35 VOFF = -8.35)  
.MODEL S2AMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = -2.0 VOFF = 3.0)  
.MODEL S2BMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = 3.0 VOFF = -2.0)

.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.

