

### 30A, 60V, ESD Rated, 0.047 Ohm, Logic Level N-Channel Power MOSFETs

These are N-Channel power MOSFETs 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.

These transistors incorporate ESD protection and are designed to withstand 2kV (Human Body Model) of ESD.

Formerly developmental type TA49027.

### Ordering Information

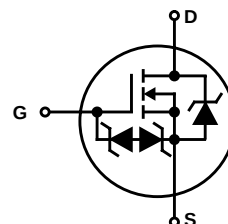
| PART NUMBER   | PACKAGE  | BRAND    |
|---------------|----------|----------|
| RFP30N06LE    | TO-220AB | F30N06LE |
| RF1S30N06LESM | TO-263AB | 1S30N06L |

NOTE: When ordering use the entire part number. Add suffix, 9A, to obtain the TO-263 variant in tape and reel i.e. RF1S30N06LESM9A.

### Features

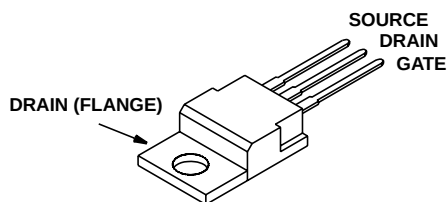
- 30A, 60V
- $r_{DS(ON)} = 0.047\Omega$
- 2kV ESD Protected
- Temperature Compensating PSPICE™ Model
- Peak Current vs Pulse Width Curve
- UIS Rating Curve
- Related Literature
  - TB334 "Guidelines for Soldering Surface Mount Components to PC Boards"

### Symbol

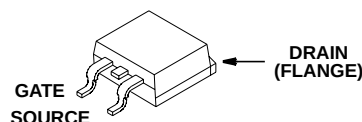


### Packaging

JEDEC TO-220AB



JEDEC TO-263AB



# RFP30N06LE, RF1S30N06LESM

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

|                                                                          | RFP30N06LE, RF1S30N06LESM            | UNITS                 |
|--------------------------------------------------------------------------|--------------------------------------|-----------------------|
| Drain to Source Voltage (Note 1) . . . . .                               | $V_{DS}$ 60                          | V                     |
| Drain to Gate Voltage ( $R_{GS} = 20\text{k}\Omega$ ) (Note 1) . . . . . | $V_{DGR}$ 60                         | V                     |
| Gate to Source Voltage . . . . .                                         | $V_{GS}$ +10, -8                     | V                     |
| Continuous Drain Current . . . . .                                       | $I_D$ 30                             | A                     |
| Pulsed Drain Current (Note 3) . . . . .                                  | $I_{DM}$ Refer to Peak Current Curve |                       |
| Pulsed Avalanche Rating . . . . .                                        | $E_{AS}$ Refer to UIS Curve          |                       |
| Power Dissipation . . . . .                                              | $P_D$ 96                             | W                     |
| Derate Above $25^{\circ}\text{C}$ . . . . .                              | 0.645                                | W/ $^{\circ}\text{C}$ |
| Electrostatic Discharge Rating, MIL-STD-883, Category B(2). . . . .      | ESD 2                                | kV                    |
| 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:

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 Threshold Voltage              | $V_{GS(TH)}$    | $V_{GS} = V_{DS}$ , $I_D = 250\mu\text{A}$ , Figure 10                                                                                | 1                   | -                   | 2                     | V                    |
| Zero Gate Voltage Drain Current        | $I_{DSS}$       | $V_{DS} = \text{Rated } BV_{DSS}$ , $V_{GS} = 0$                                                                                      | -                   | -                   | 25                    | $\mu\text{A}$        |
|                                        |                 | $V_{DS} = 0.8 \times \text{Rated } BV_{DSS}$ , $V_{GS} = 0$ , $T_C = 150^{\circ}\text{C}$                                             | -                   | -                   | 250                   | $\mu\text{A}$        |
| Gate to Source Leakage Current         | $I_{GSS}$       | $V_{GS} = +10, -8\text{V}$                                                                                                            | -                   | -                   | $\pm 10$              | $\mu\text{A}$        |
| Drain to Source On Resistance (Note 2) | $r_{DS(ON)}$    | $I_D = 30\text{A}$ , $V_{GS} = 5\text{V}$ , Figure 9                                                                                  | -                   | -                   | 0.047                 | $\Omega$             |
| Turn-On Time                           | $t_{ON}$        | $V_{DD} = 30\text{V}$ , $I_D = 30\text{A}$ , $R_L = 1\Omega$ , $V_{GS} = 5\text{V}$ ,<br>$R_{GS} = 2.5\Omega$ ,<br>Figures 13, 16, 17 | -                   | -                   | 140                   | ns                   |
| Turn-On Delay Time                     | $t_{d(ON)}$     |                                                                                                                                       | -                   | 11                  | -                     | ns                   |
| Rise Time                              | $t_r$           |                                                                                                                                       | -                   | 88                  | -                     | ns                   |
| Turn-Off Delay Time                    | $t_{d(OFF)}$    |                                                                                                                                       | -                   | 30                  | -                     | ns                   |
| Fall Time                              | $t_f$           |                                                                                                                                       | -                   | 40                  | -                     | ns                   |
| Turn-Off Time                          | $t_{OFF}$       |                                                                                                                                       | -                   | -                   | 100                   | ns                   |
| Total Gate Charge                      | $Q_{g(TOT)}$    | $V_{GS} = 0\text{V}$ to $10\text{V}$                                                                                                  | -<br>51<br>62<br>nC | -<br>28<br>34<br>nC | -<br>1.8<br>2.6<br>nC | pF                   |
| 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                      | $C_{ISS}$       | $V_{DS} = 25\text{V}$ , $V_{GS} = 0\text{V}$ ,<br>$f = 1\text{MHz}$<br>Figure 12                                                      | -                   | 1350                | -                     | pF                   |
| Output Capacitance                     | $C_{OSS}$       |                                                                                                                                       | -                   | 290                 | -                     | pF                   |
| Reverse Transfer Capacitance           | $C_{RSS}$       |                                                                                                                                       | -                   | 85                  | -                     | pF                   |
| Thermal Resistance Junction to Case    | $R_{\theta JC}$ |                                                                                                                                       | -                   | -                   | 1.55                  | $^{\circ}\text{C/W}$ |
| Thermal Resistance Junction to Ambient | $R_{\theta JA}$ |                                                                                                                                       | -                   | -                   | 80                    | $^{\circ}\text{C/W}$ |

## Source to Drain Diode Specifications

| PARAMETER                              | SYMBOL   | TEST CONDITIONS                                                | MIN | TYP | MAX | UNITS |
|----------------------------------------|----------|----------------------------------------------------------------|-----|-----|-----|-------|
| Source to Drain Diode Voltage (Note 2) | $V_{SD}$ | $I_{SD} = 30\text{A}$                                          | -   | -   | 1.5 | V     |
| Diode Reverse Recovery Time            | $t_{rr}$ | $I_{SD} = 30\text{A}$ , $dI_{SD}/dt = 100\text{A}/\mu\text{s}$ | -   | -   | 125 | ns    |

### NOTES:

2. Pulse Test: Pulse Width  $\leq 300\text{ms}$ , Duty Cycle  $\leq 2\%$ .
3. Repetitive Rating: Pulse Width limited by max junction temperature. See Transient Thermal Impedance Curve (Figure 3) and Peak Current Capability Curve (Figure 5).

# Typical Performance Curves Unless Otherwise Specified

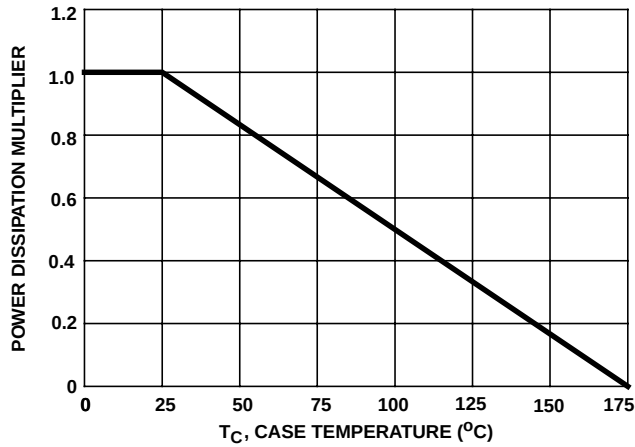


FIGURE 1. NORMALIZED POWER DISSIPATION vs CASE TEMPERATURE

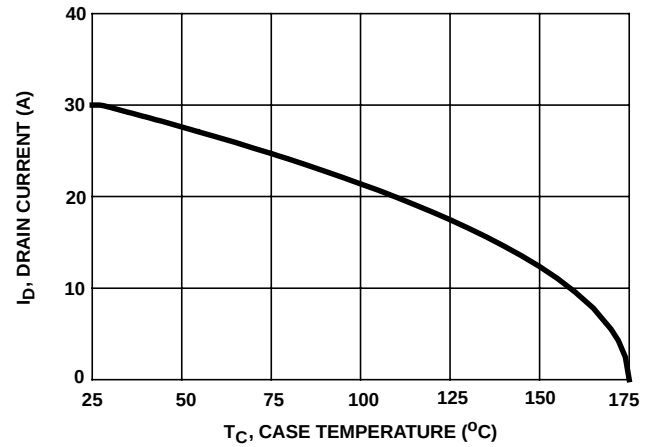


FIGURE 2. MAXIMUM CONTINUOUS DRAIN CURRENT vs CASE TEMPERATURE

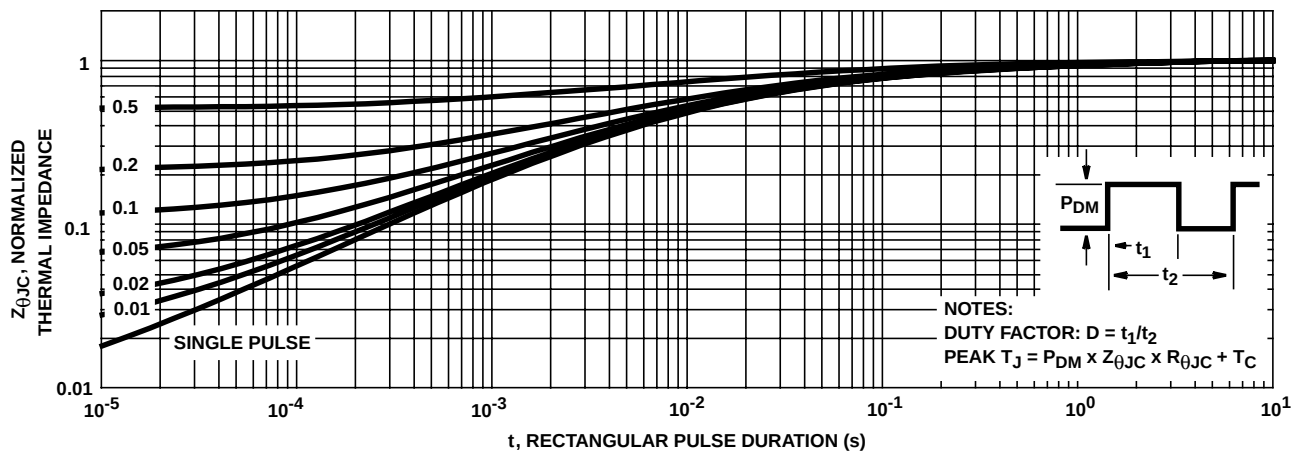


FIGURE 3. NORMALIZED MAXIMUM TRANSIENT THERMAL IMPEDANCE

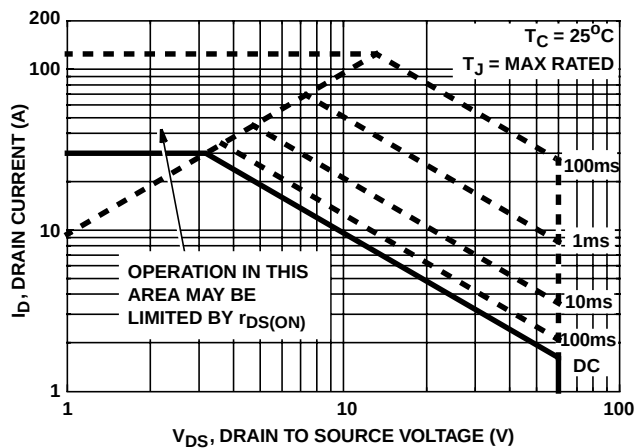


FIGURE 4. FORWARD BIAS SAFE OPERATING AREA

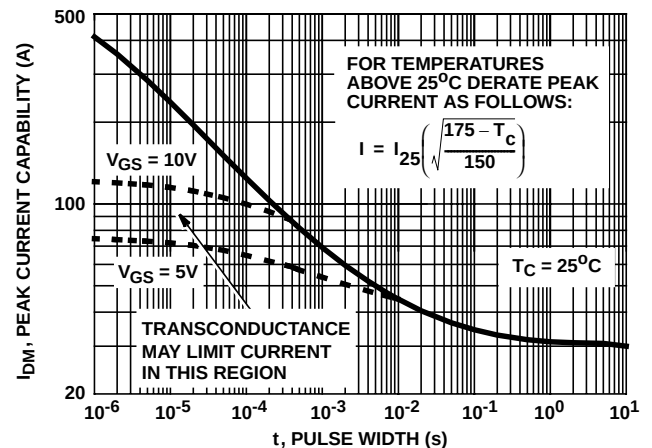
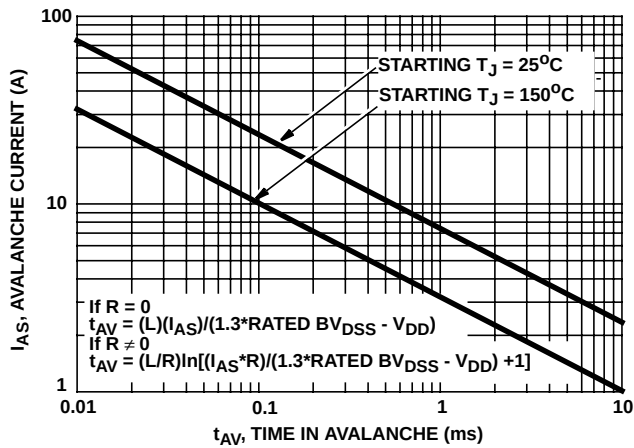


FIGURE 5. PEAK CURRENT CAPABILITY

# Typical Performance Curves Unless Otherwise Specified (Continued)



NOTE: Refer to Intersil Application Notes AN9321 and AN9322.

FIGURE 6. UNCLAMPED INDUCTIVE SWITCHING

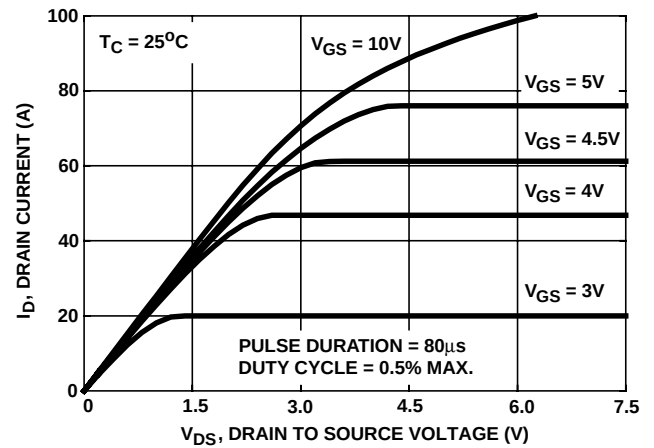


FIGURE 7. SATURATION CHARACTERISTICS

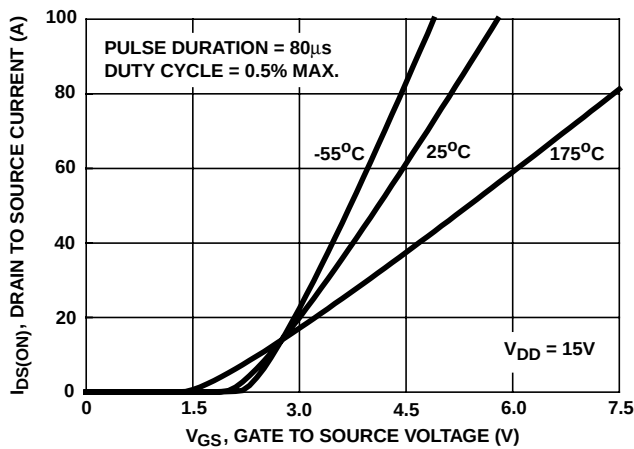


FIGURE 8. TRANSFER CHARACTERISTICS

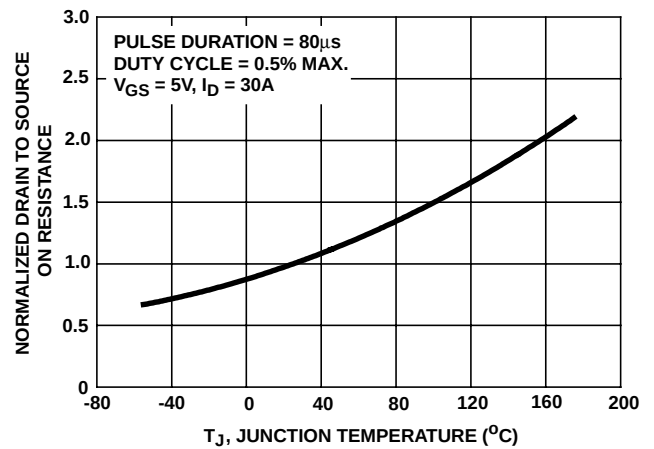


FIGURE 9. NORMALIZED DRAIN TO SOURCE ON RESISTANCE vs JUNCTION TEMPERATURE

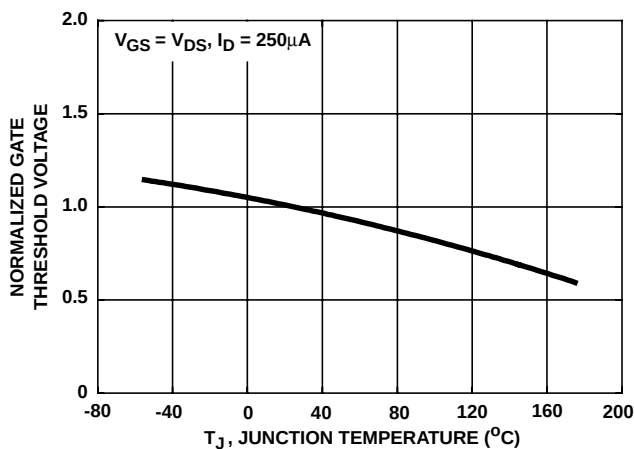


FIGURE 10. NORMALIZED GATE THRESHOLD VOLTAGE vs JUNCTION TEMPERATURE

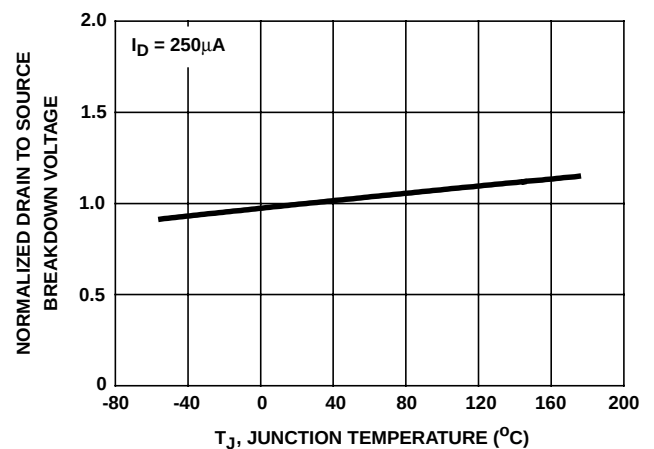


FIGURE 11. NORMALIZED DRAIN TO SOURCE BREAKDOWN VOLTAGE vs JUNCTION TEMPERATURE

# Typical Performance Curves Unless Otherwise Specified (Continued)

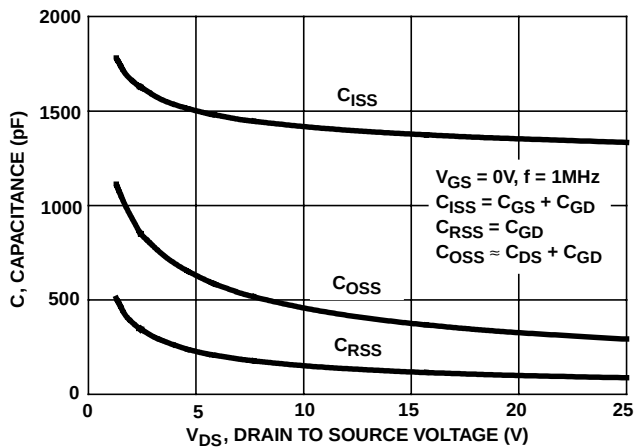
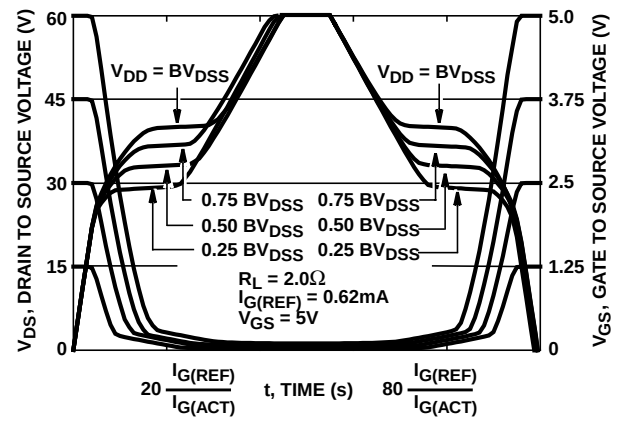


FIGURE 12. CAPACITANCE vs DRAIN TO SOURCE VOLTAGE



NOTE: Refer to Intersil Application Notes AN7254 and AN7260.

FIGURE 13. NORMALIZED SWITCHING WAVEFORMS FOR CONSTANT GATE CURRENT

## Test Circuits and Waveforms

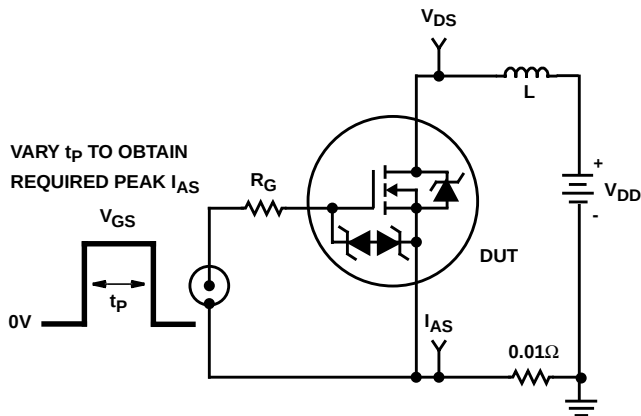


FIGURE 14. UNCLAMPED ENERGY TEST CIRCUIT

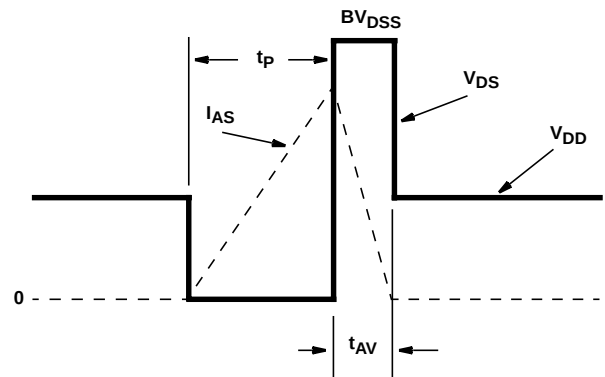


FIGURE 15. UNCLAMPED ENERGY WAVEFORMS

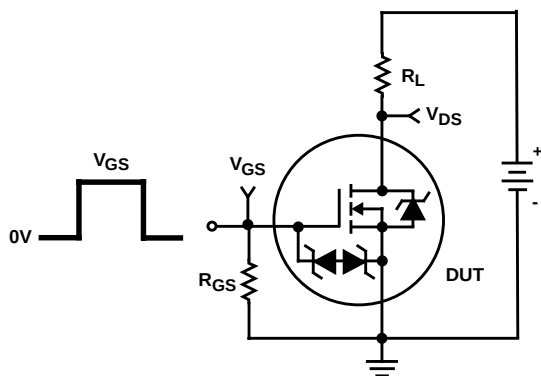


FIGURE 16. SWITCHING TIME TEST CIRCUIT

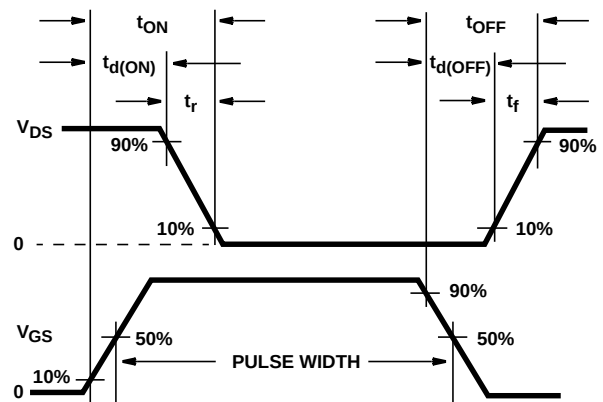


FIGURE 17. RESISTIVE SWITCHING WAVEFORMS

**Test Circuits and Waveforms** (Continued)

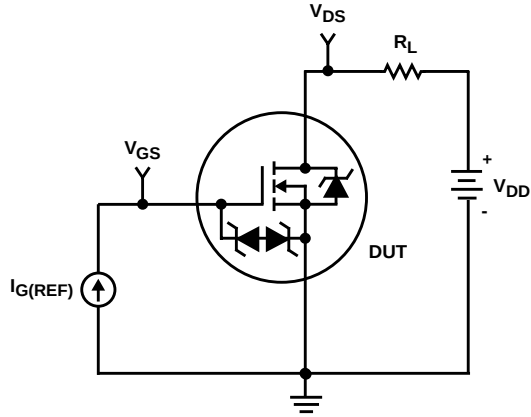


FIGURE 18. GATE CHARGE TEST CIRCUIT

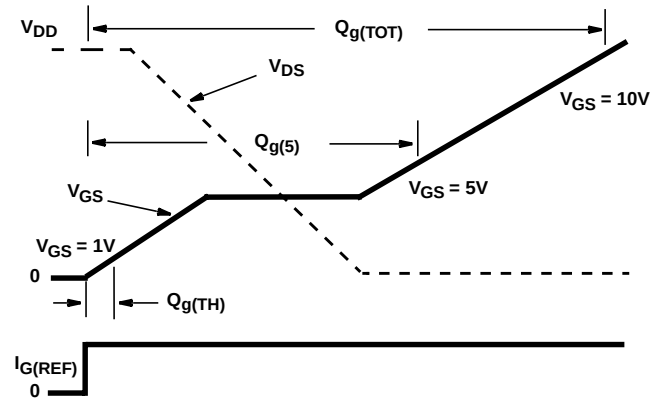


FIGURE 19. GATE CHARGE WAVEFORMS

**PSpice Electrical Model**

SUBCKT RFP30N06LE 2 1 3; rev 6/2/93

CA 12 8 1 3.34e-9

CB 15 14 3.44e-9

CIN 6 8 0 1.343e-9

DBODY 7 5 DBDMOD

DBREAK 5 11 DBKMOD

DESD1 91 9 DESD1MOD

DESD2 91 7 DESD2MOD

DPLCAP 10 5 DPLCAPMOD

EBREAK 11 7 17 18 75.39

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 7.22e-9

LSOURCE 3 7 6.31e-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 11.86e-3

RGATE 9 20 2.52

RIN 6 8 1e9

RSCL1 5 51 RSLVCMOD 1e-6

RSCL2 5 50 1e3

RSOURCE 8 7 RDSMOD 26.6e-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 0.5

ESCL 51 50 VALUE = {(V(5,51)/ABS(V(5,51)))\*(PWR(V(5,51)\*1e6/89,7))}

.MODEL DBDMOD D (IS = 3.80e-13 RS = 1.12e-2 TRS1 = 1.61e-3 TRS2 = 6.08e-6 CJO = 1.05e-9 TT = 3.84e-8)

.MODEL DBKMOD D (RS = 1.82e-1 TRS1 = 7.50e-3 TRS2 = -4.0e-5)

.MODEL DESD1MOD D (BV = 13.54 TBV1 = 0 TBV2 = 0 RS = 45.5 TRS1 = 0 TRS2 = 0)

.MODEL DESD2MOD D (BV = 11.46 TBV1 = -7.576e-4 TBV2 = -3.0e-6 RS = 0 TRS1 = 0 TRS2 = 0)

.MODEL DPLCAPMOD D (CJO = 0.591e-9 IS = 1e-30 N = 10)

.MODEL MOSMOD NMOS (VTO = 1.94 KP = 139.2 IS = 1e-30 N = 10 TOX = 1 L = 1u W = 1u)

.MODEL RBKMOD RES (TC1 = 1.07e-3 TC2 = -3.03e-7)

.MODEL RDSMOD RES (TC1 = 5.38e-3 TC2 = 1.64e-5)

.MODEL RSLVCMOD RES (TC1 = 1.75e-3 TC2 = 3.90e-6)

.MODEL RVTOMOD RES (TC1 = -2.15e-3 TC2 = -5.43e-6)

.MODEL S1AMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = -4.05 VOFF = -1.5)

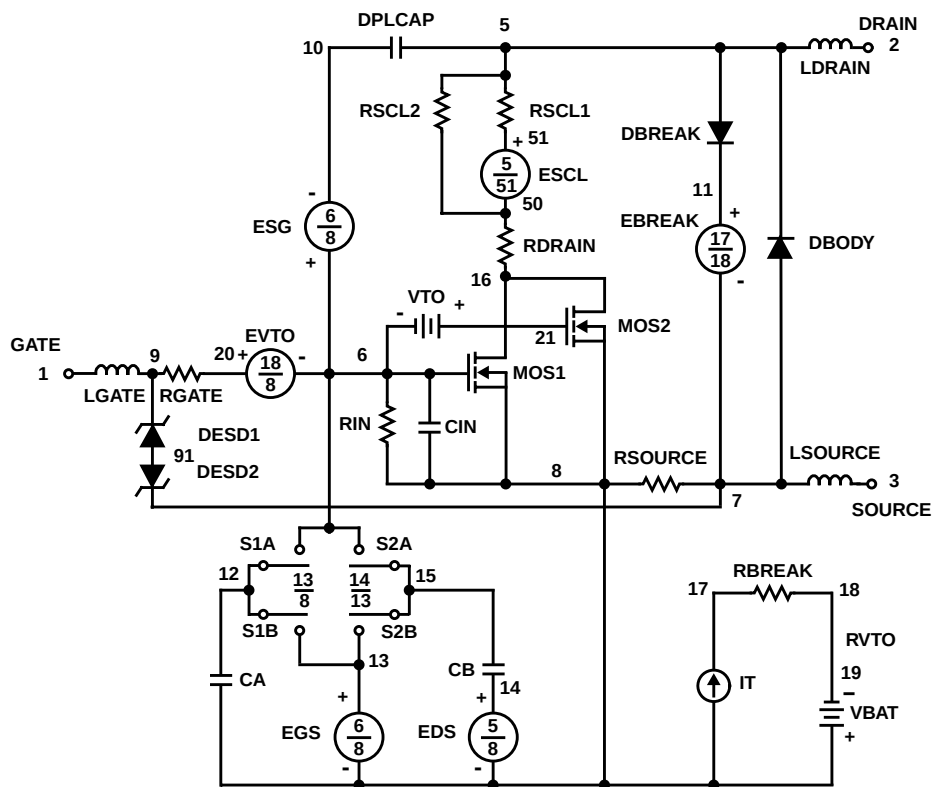
.MODEL S1BMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = -1.5 VOFF = -4.05)

.MODEL S2AMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = -2.2 VOFF = 2.8)

.MODEL S2BMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = 2.8 VOFF = -2.2)

.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.



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