

**60A, 50V, 0.030 Ohm, ESD Rated,  
P-Channel Power MOSFET**

This is a P-Channel power MOSFET 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. It was designed for use in applications such as switching regulators, switching converters, motor drivers, and relay drivers. This type can be operated directly from integrated circuits.

Formerly developmental type TA09835.

**Ordering Information**

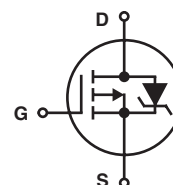
| PART NUMBER | PACKAGE | BRAND     |
|-------------|---------|-----------|
| RFG60P05E   | TO-247  | RFG60P05E |

NOTE: When ordering, use the entire part number.

**Features**

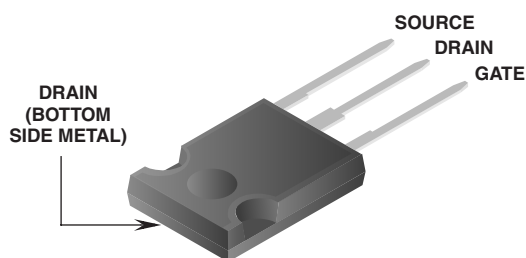
- 60A, 50V
- $r_{DS(ON)} = 0.030\Omega$
- Temperature Compensating PSPICE® Model
- 2kV ESD Rated
- Peak Current vs Pulse Width Curve
- UIS Rating Curve
- 175°C Operating Temperature
- Related Literature
  - TB334 "Guidelines for Soldering Surface Mount Components to PC Boards"

**Symbol**



**Packaging**

**JEDEC STYLE TO-247**



# RFG60P05E

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

|                                                                   | RFG60P05E                            | UNITS               |
|-------------------------------------------------------------------|--------------------------------------|---------------------|
| Drain to Source Breakdown Voltage (Note 1) . . . . .              | $V_{DS}$ -50                         | V                   |
| Drain to Gate Voltage ( $R_{GS} = 20k\Omega$ ) (Note 1) . . . . . | $V_{DGR}$ -50                        | V                   |
| Gate to Source Voltage . . . . .                                  | $V_{GS}$ $\pm 20$                    | V                   |
| Continuous Drain Current . . . . .                                | $I_D$ 60                             | A                   |
| Pulsed Drain Current (Note 3) (Figure 5) . . . . .                | $I_{DM}$ Refer to Peak Current Curve |                     |
| Power Dissipation . . . . .                                       | $P_D$ 215                            | W                   |
| Derate above $25^\circ\text{C}$ . . . . .                         | 1.43                                 | W/ $^\circ\text{C}$ |
| Single Pulse Avalanche Rating (Figure 6) . . . . .                | $E_{AS}$ Refer to UIS Curve          | W/ $^\circ\text{C}$ |
| Electrostatic Discharge Rating. . . . .                           | $E_{SD}$ 2                           | kV                  |
| MIL-STD-883, Category B(2)                                        |                                      |                     |
| 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 <sub>DSS</sub>   | I <sub>D</sub> = 250μA, V <sub>GS</sub> = 0V                                                                                           |                                                                                                       | -50 | -    | -     | V     |
| Gate Threshold Voltage                  | V <sub>GS(TH)</sub> | V <sub>GS</sub> = V <sub>DS</sub> , I <sub>D</sub> = 250μA                                                                             |                                                                                                       | -2  | -    | -4    | V     |
| Zero Gate Voltage Drain Current         | I <sub>DSS</sub>    | V <sub>DS</sub> = -50V, V <sub>GS</sub> = 0V                                                                                           |                                                                                                       | -   | -    | -1    | μA    |
|                                         |                     | V <sub>DS</sub> = 0.8 x Rated BV <sub>DSS</sub> , T <sub>C</sub> = 150°C                                                               |                                                                                                       | -   | -    | -25   | μA    |
| Gate to Source Leakage Current          | I <sub>GSS</sub>    | V <sub>GS</sub> = ±20V                                                                                                                 |                                                                                                       | -   | -    | ±100  | nA    |
| Drain to Source On Resistance (Note 2)  | r <sub>DS(ON)</sub> | I <sub>D</sub> = 60A, V <sub>GS</sub> = -10V (Figure 9)                                                                                |                                                                                                       | -   | -    | 0.030 | Ω     |
| Turn-On Time                            | t <sub>(ON)</sub>   | V <sub>DD</sub> = -25V, I <sub>D</sub> = 30A, R <sub>L</sub> = 0.83Ω,<br>V <sub>GS</sub> = -10V, R <sub>GS</sub> = 2.5Ω<br>(Figure 13) |                                                                                                       | -   | -    | 125   | ns    |
| Turn-On Delay Time                      | t <sub>d(ON)</sub>  |                                                                                                                                        |                                                                                                       | -   | 20   | -     | ns    |
| Rise Time                               | t <sub>r</sub>      |                                                                                                                                        |                                                                                                       | -   | 60   | -     | ns    |
| Turn-Off Delay Time                     | t <sub>d(OFF)</sub> |                                                                                                                                        |                                                                                                       | -   | 65   | -     | ns    |
| Fall Time                               | t <sub>F</sub>      |                                                                                                                                        |                                                                                                       | -   | 20   | -     | ns    |
| Turn-Off Time                           | t <sub>(OFF)</sub>  |                                                                                                                                        |                                                                                                       | -   | -    | 125   | ns    |
| Total Gate Charge                       | Q <sub>g(TOT)</sub> | V <sub>GS</sub> = 0V to -20V                                                                                                           | V <sub>DD</sub> = -40V, I <sub>D</sub> = 60A,<br>R <sub>L</sub> = 0.67Ω<br>I <sub>g(REF)</sub> = -4mA | -   | -    | 450   | nC    |
| Gate Charge at 10V                      | Q <sub>g(-10)</sub> | V <sub>GS</sub> = 0V to -10V                                                                                                           |                                                                                                       | -   | -    | 225   | nC    |
| Threshold Gate Charge                   | Q <sub>g(TH)</sub>  | V <sub>GS</sub> = 0V to -2V                                                                                                            |                                                                                                       | -   | -    | 15    | nC    |
| Input Capacitance                       | C <sub>ISS</sub>    | V <sub>DS</sub> = -25V, V <sub>GS</sub> = 0V, f = 1MHz<br>(Figure 12)                                                                  |                                                                                                       | -   | 7200 | -     | pF    |
| Output Capacitance                      | C <sub>OSS</sub>    |                                                                                                                                        |                                                                                                       | -   | 1700 | -     | pF    |
| Reverse Transfer Capacitance            | C <sub>RSS</sub>    |                                                                                                                                        |                                                                                                       | -   | 325  | -     | pF    |
| Thermal Resistance, Junction to Case    | R <sub>θJC</sub>    |                                                                                                                                        |                                                                                                       | -   | -    | 0.70  | °C/W  |
| Thermal Resistance, Junction to Ambient | R <sub>θJA</sub>    |                                                                                                                                        |                                                                                                       | -   | -    | 30    | °C/W  |

## Source to Drain Diode Specifications

| PARAMETER                              | SYMBOL   | TEST CONDITIONS                                                 | MIN | TYP | MAX   | UNITS |
|----------------------------------------|----------|-----------------------------------------------------------------|-----|-----|-------|-------|
| Source to Drain Diode Voltage (Note 2) | $V_{SD}$ | $I_{SD} = -60\text{A}$                                          | -   | -   | -1.75 | V     |
| Diode Reverse Recovery Time            | $t_{RR}$ | $I_{SD} = -60\text{A}$ , $dI_{SD}/dt = 100\text{A}/\mu\text{s}$ | -   | -   | 200   | ns    |

### NOTE:

2. Pulse test: pulse width  $\leq 300\mu\text{s}$  maximum, duty cycle  $\leq 2\%$ .
3. Repetitive rating: pulse width limited by maximum junction temperature. See Transient Thermal Impedance curve (Figure 3).

# Typical Performance Curves Unless Otherwise Specified

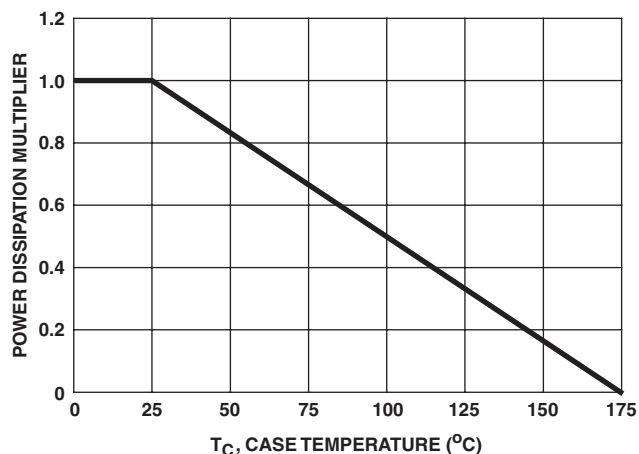


FIGURE 1. NORMALIZED POWER DISSIPATION vs CASE TEMPERATURE

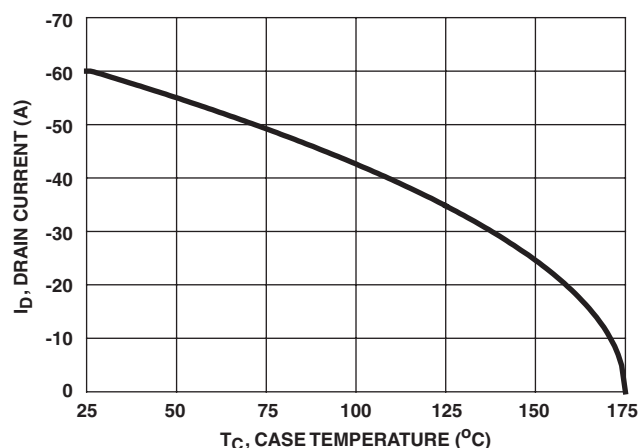


FIGURE 2. MAXIMUM CONTINUOUS DRAIN CURRENT vs CASE TEMPERATURE

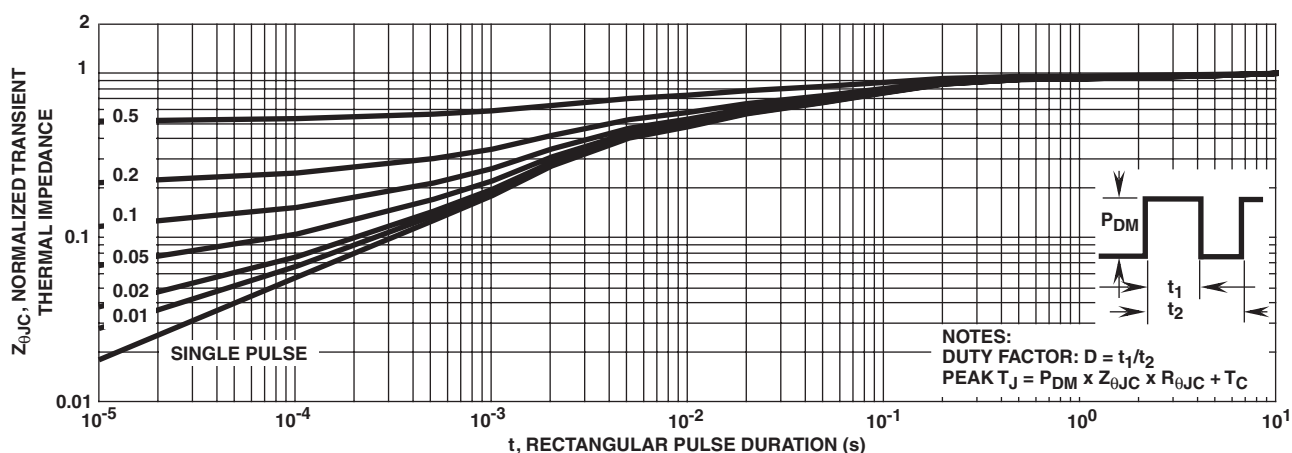


FIGURE 3. NORMALIZED MAXIMUM TRANSIENT THERMAL IMPEDANCE

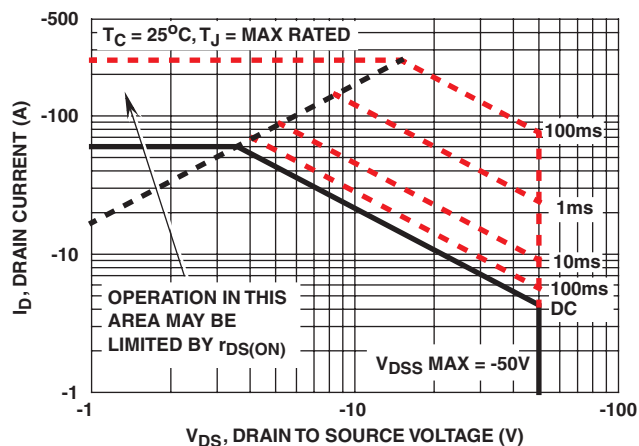


FIGURE 4. FORWARD BIAS SAFE OPERATING AREA

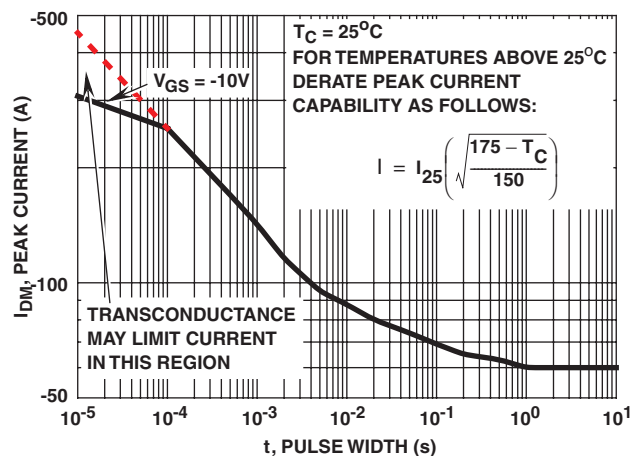
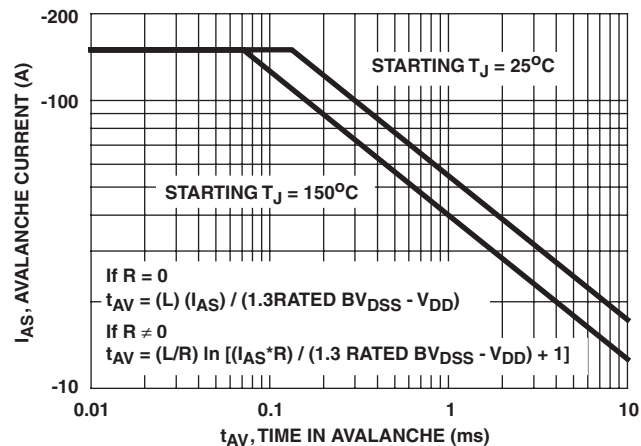
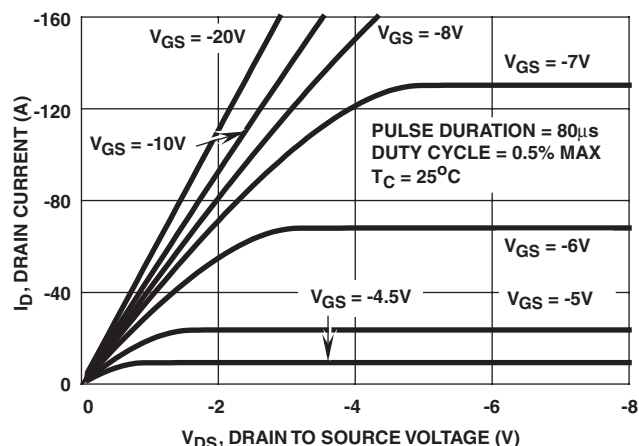


FIGURE 5. PEAK CURRENT CAPABILITY

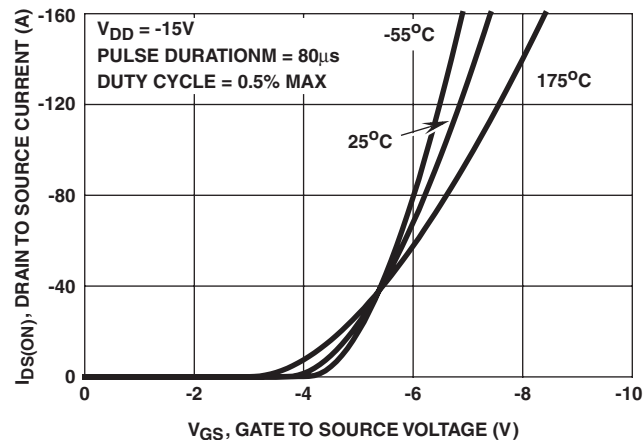
**Typical Performance Curves** Unless Otherwise Specified (Continued)



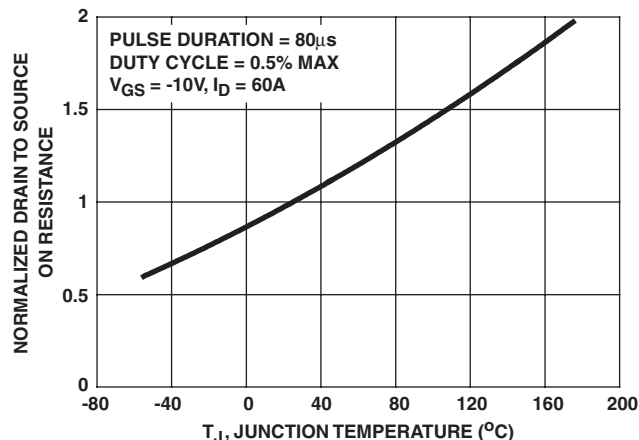
NOTE: Refer to Fairchild Application Notes AN9321 and AN9322.  
**FIGURE 6. UNCLAMPED INDUCTIVE SWITCHING CAPABILITY**



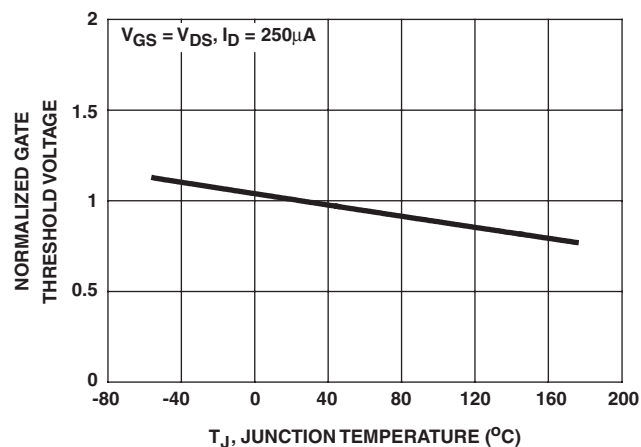
**FIGURE 7. SATURATION CHARACTERISTICS**



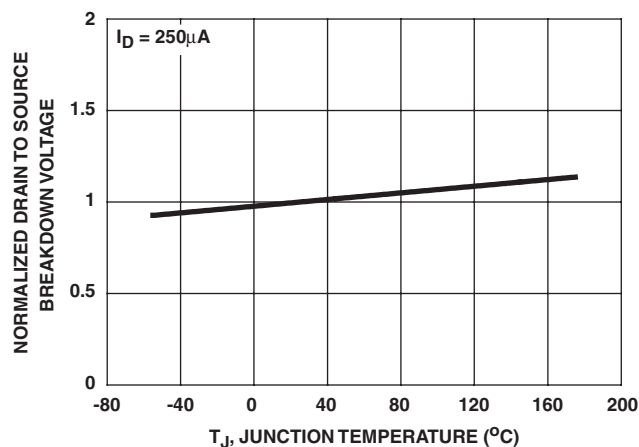
**FIGURE 8. TRANSFER CHARACTERISTICS**



**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 Unless Otherwise Specified (Continued)

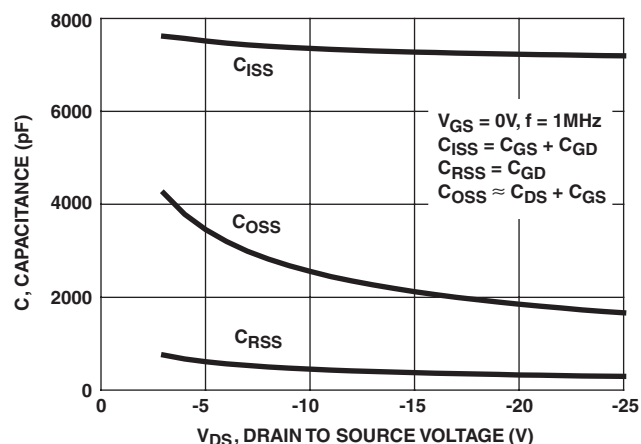
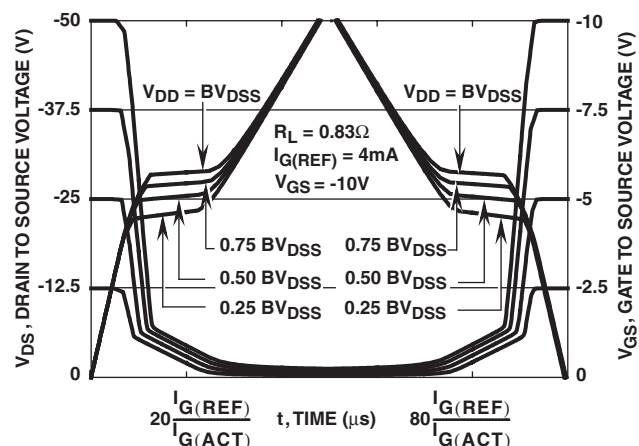


FIGURE 12. CAPACITANCE vs DRAIN TO SOURCE VOLTAGE



NOTE: Refer to Fairchild Application Notes AN7254 and AN7260.

FIGURE 13. NORMALIZED SWITCHING WAVEFORMS FOR CONSTANT GATE CURRENT

## Test Circuits and Waveforms

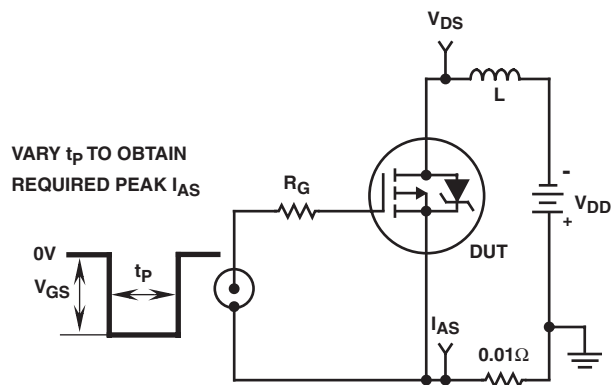


FIGURE 14. UNCLAMPED ENERGY TEST CIRCUIT

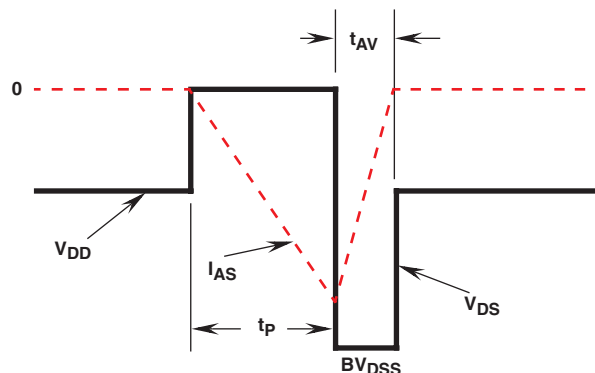


FIGURE 15. UNCLAMPED ENERGY WAVEFORMS

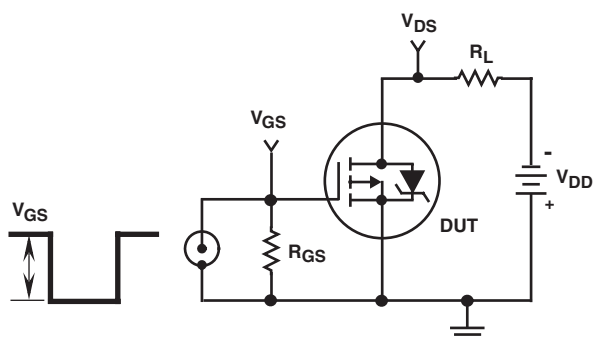


FIGURE 16. SWITCHING TIME TEST CIRCUIT

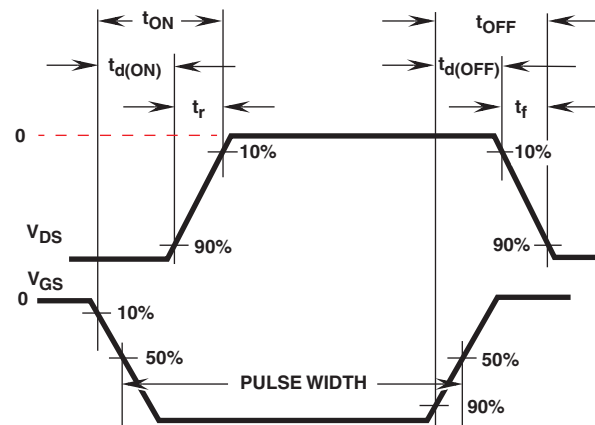


FIGURE 17. RESISTIVE SWITCHING WAVEFORMS

Test Circuits and Waveforms (Continued)

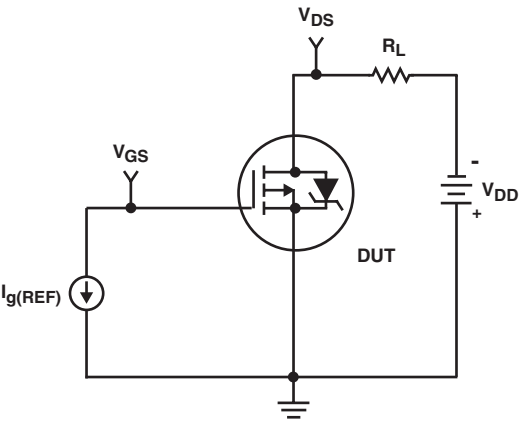


FIGURE 18. GATE CHARGE TEST CIRCUIT

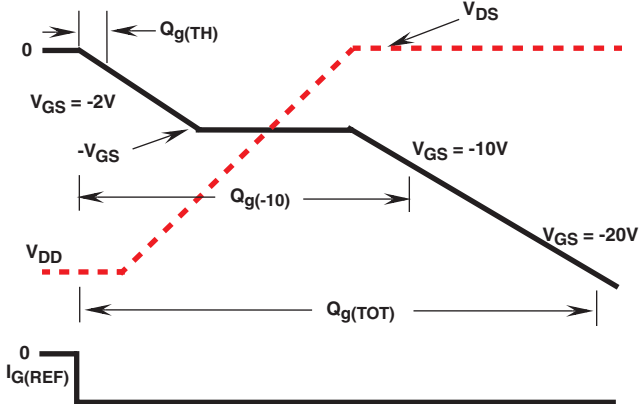


FIGURE 19. GATE CHARGE WAVEFORMS

## PSPICE Electrical Model

.SUBCKT RFG60P05E 2 1 3;

REV 9/20/94

CA 12 8 1.01e-8  
CB 15 14 1.05e-8  
CIN 6 8 6.9e-9

DBODY 5 7 DBDMOD  
DBREAK 7 11 DBKMOD  
DPLCAP 10 6 DPLCAPMOD

EBREAK 5 11 17 18 -76.35  
EDS 14 8 5 8 1  
EGS 13 8 6 8 1  
ESG 5 10 8 6 1  
EVTO 20 6 8 18 1

IT 8 17 1

LDRAIN 2 5 1e-9  
LGATE 1 9 7.9e-9  
LSOURCE 3 7 4.18e-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 5 16 RDSMOD 12.83e-3  
RGATE 9 20 1.5  
RIN 6 8 1e9  
RSOURCE 8 7 RDSMOD 3.25e-3  
RVTO 18 19 RVTOMOD 1

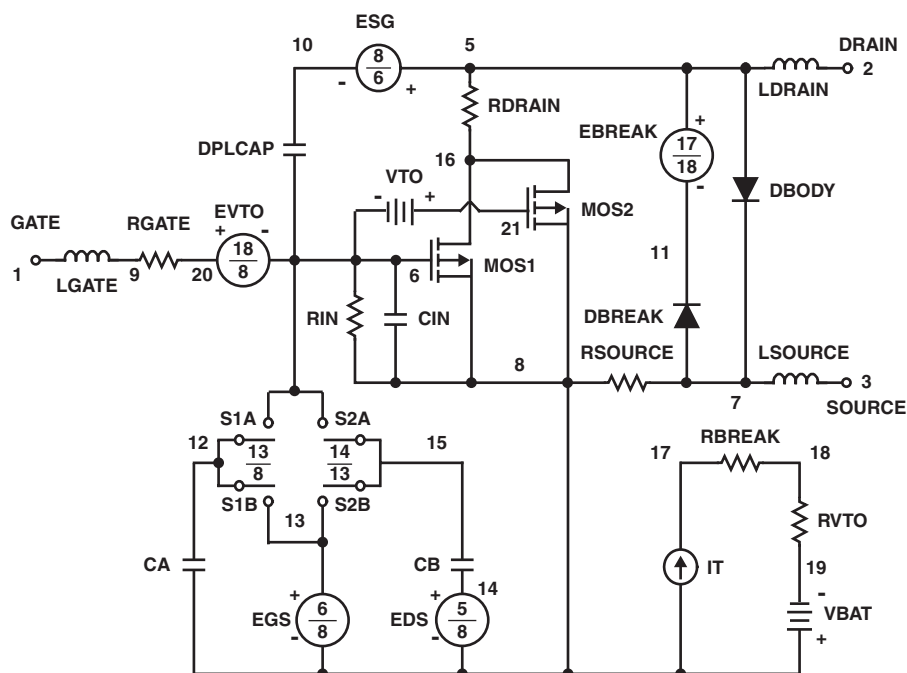
S1A 6 12 13 8 S1AMOD  
S1B 13 12 13 8 S1BMOD  
S2A 6 15 14 13 S2AMOD  
S2B 13 15 14 13 S2BMOD

VBAT 8 19 DC 1  
VTO 21 6 -0.83

.MODEL DBDMOD D (IS = 1.24e-12 RS = 4.72e-3 TRS1 = 1.43e-3 TRS2 = -4.91e-7 CJO = 6.98e-9 TT = 1.5e-7)  
.MODEL DBKMOD D (RS = 1.11e-1 TRS1 = 1.34e-3 TRS2 = 4.46e-12)  
.MODEL DPLCAPMOD D (CJO = 15e-10 IS = 1e-30 N = 10)  
.MODEL MOSMOD PMOS (VTO = -3.71 KP = 31.5 IS = 1e-30 N = 10 TOX = 1 L = 1u W = 1u)  
.MODEL RBKMOD RES (TC1 = 9.42e-4 TC2 = 0)  
.MODEL RDSMOD RES (TC1 = 5.85e-3 TC2 = 7.69e-6)  
.MODEL RVTOMOD RES (TC1 = -3.39e-3 TC2 = 1.07e-6)  
.MODEL S1AMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = 4.6 VOFF = 2.6)  
.MODEL S1BMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = 2.6 VOFF = 4.6)  
.MODEL S2AMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = 1.16 VOFF = -3.84)  
.MODEL S2BMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = -3.84 VOFF = 1.16)

.ENDS

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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| DenseTrench <sup>TM</sup>         | GTO <sup>TM</sup>                | Power247 <sup>TM</sup>           | SuperSOT <sup>TM</sup> -6    |                   |
| DOME <sup>TM</sup>                | HiSeC <sup>TM</sup>              | PowerTrench <sup>®</sup>         | SuperSOT <sup>TM</sup> -8    |                   |
| EcoSPARK <sup>TM</sup>            | ISOPLANAR <sup>TM</sup>          | QFET <sup>TM</sup>               | SyncFET <sup>TM</sup>        |                   |
| E <sup>2</sup> CMOS <sup>TM</sup> | LittleFET <sup>TM</sup>          | QS <sup>TM</sup>                 | TinyLogic <sup>TM</sup>      |                   |
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## PRODUCT STATUS DEFINITIONS

### Definition of Terms

| Datasheet Identification | Product Status         | Definition                                                                                                                                                                                                            |
|--------------------------|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Advance Information      | Formative or In Design | This datasheet contains the design specifications for product development. Specifications may change in any manner without notice.                                                                                    |
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