## 15A, 50V, 0.150 Ohm, P-Channel Power MOSFETs

These are P-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.

Formerly developmental type TA09833.

## Ordering Information

| PART NUMBER | PACKAGE | BRAND |
|---|---|---|
| RFD15P05 | TO-251AA | D15P05 |
| RFD15P05SM | TO-252AA | D15P05 |
| RFP15P05 | TO-220AB | RFP15P05 |

NOTE: When ordering, use the entire part number. Add the suffix 9A to obtain the TO-252AA variant in the tape and reel, i.e., RFD15P05SM9A.
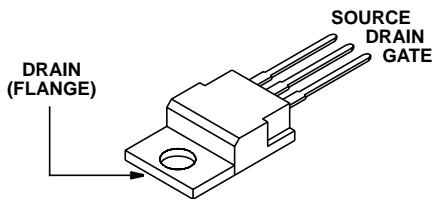
## Features

- 15A, 50V

- $r_{DS(ON)} = 0.150\Omega$

- 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"
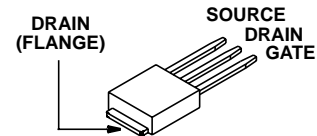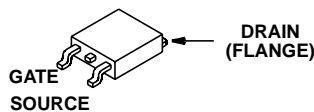
## Symbol
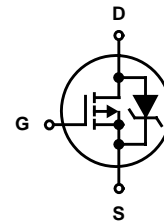


## Packaging

**JEDEC TO-220AB**



**JEDEC TO-251AA**



**JEDEC TO-252AA**

## RFD15P05, RFD15P05SM, RFP15P05

### Absolute Maximum Ratings $T_C = 25^oC$, Unless Otherwise Specified

| | RFD15P05, RFD15P05SM, RFP15P05 | UNITS |
|---|---|---|
| Drain Source Voltage (Note 1) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . $V_{DSS}$ | -50 | V |
| Drain Gate Voltage ($R_G$ = 20K$\Omega$) (Note 1) . . . . . . . . . . . . . . . . . . . . . . . . . . $V_{DGR}$ | -50 | V |
| Gate Source Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . $V_{GS}$ | $\pm20$ | V |
| Drain Current Continuous . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . $I_D$ | -15 | A |
|   Pulsed (Note 3) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . $I_{DM}$ | Refer to Peak Current Curve | |
| Single Pulse Avalanche Rating . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . $E_{AS}$ | Refer to UIS Curve | |
| Power Dissipation . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . $P_D$ | 80 | W |
|   Derate above 25$^o$C. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 0.533 | W/$^o$C |
| Operating and Storage Temperature . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . $T_J$, $T_{STG}$ | -55 to 175 | $^oC$ |
| Maximum Temperature for Soldering | | |
|   Leads at 0.063in (1.6mm) from Case for 10s. . . . . . . . . . . . . . . . . . . . . . . . . . $T_L$ | 300 | $^oC$ |
|   Package Body for 10s, See Techbrief 334 . . . . . . . . . . . . . . . . . . . . . . . . . . $T_{pkg}$ | 260 | $^oC$ |

*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$^o$C to 150$^o$C.

### Electrical Specifications $T_C = 25^oC$, Unless Otherwise Specified

| PARAMETER | SYMBOL | TEST CONDITIONS | | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Drain to Source Breakdown Voltage | $BV_{DSS}$ | $I_D$ = 250$\mu$A, $V_{GS}$ = 0V (Figure 11) | | -50 | - | - | V |
| Gate Threshold Voltage | $V_{GS(TH)}$ | $V_{GS}$ = $V_{DS}$, $I_D$ = 250$\mu$A | | -2.0 | - | -4.0 | V |
| Zero Gate Voltage Drain Current | $I_{DSS}$ | $V_{DS}$ = Rated $BV_{DSS}$ | | - | - | -1 | $\mu$A |
| | | $V_{DS}$ = 0.8 x Rated $BV_{DSS}$, $T_C$ = 150$^o$C | | - | - | 25 | $\mu$A |
| Gate to Source Leakage Current | $I_{GSS}$ | $V_{GS}$ = $\pm20$V | | - | - | $\pm100$ | nA |
| Drain to Source On Resistance | $r_{DS(ON)}$ | $I_D$ = 15A, $V_{GS}$ = -10V (Figure 9) | | - | - | 0.150 | $\Omega$ |
| Turn-On Time | $t_{ON}$ | $V_{DD}$ = -25V, $I_D \approx$ 7.5A, $R_G$ = 12.5$\Omega$, $R_L$ = 3.3$\Omega$, $V_{GS}$ = -10V (Figures 16, 17) | | - | - | 60 | ns |
| Turn-On Delay Time | $t_{D(ON)}$ | | | - | 16 | - | ns |
| Rise Time | $t_R$ | | | - | 30 | - | ns |
| Turn-Off Delay Time | $t_{D(OFF)}$ | | | - | 50 | - | ns |
| Fall Time | $t_F$ | | | - | 20 | - | ns |
| Turn-Off Time | $t_{OFF}$ | | | - | - | 100 | ns |
| Total Gate Charge | $Q_{G(TOT)}$ | $V_{GS}$ = 0V to -20V | $V_{DD}$ = -40V, $I_D$ = 15A, $R_L$ = 2.67$\Omega$, $I_{G(REF)}$ = -0.65mA (Figures 18, 19) | - | - | 150 | nC |
| Gate Charge at -10V | $Q_{G(-10)}$ | $V_{GS}$ = 0V to -10V | | - | - | 75 | nC |
| Threshold Gate Charge | $Q_{G(TH)}$ | $V_{GS}$ = 0V to -2V | | - | - | 3.5 | nC |
| Input Capacitance | $C_{ISS}$ | $V_{DS}$ = -25V, $V_{GS}$ = 0V f = 1MHz (Figure 12) | | - | 1150 | - | pF |
| Output Capacitance | $C_{OSS}$ | | | - | 300 | - | pF |
| Reverse Transfer Capacitance | $C_{RSS}$ | | | - | 56 | - | pF |
| Thermal Resistance Junction to Case | $R_{\theta JC}$ | TO-220AB, TO-251AA, TO-252AA | | - | - | 1.875 | $^oC$/W |
| Thermal Resistance Junction to Ambient | $R_{\theta JA}$ | TO-251AA, TO-252AA | | - | - | 100 | $^oC$/W |
| | | TO-220AB | | - | - | 62.5 | $^oC$/W |

### Source to Drain Diode Specifications

| PARAMETER | SYMBOL | TEST CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| Source to Drain Diode Voltage | $V_{SD}$ | $I_{SD}$ = -15A | - | - | -1.5 | V |
| Reverse Recovery Time | $t_{RR}$ | $I_{SD}$ = -15A, d$I_{SD}$/dt = -100A/$\mu$s | - | - | 125 | ns |

NOTES:

2. Pulse test: pulse duration $\leq$ 300ms, duty cycle $\leq$ 2%.

3. Repetitive rating: pulse width limited by maximum junction temperature. See Transient Thermal Impedance curve (Figure 3).
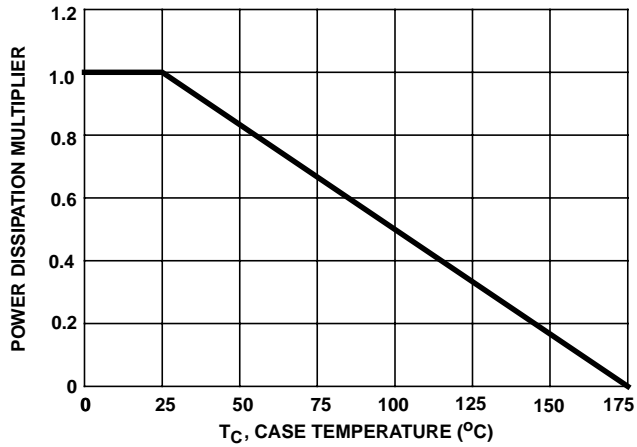
intersil

## Typical Performance Curves
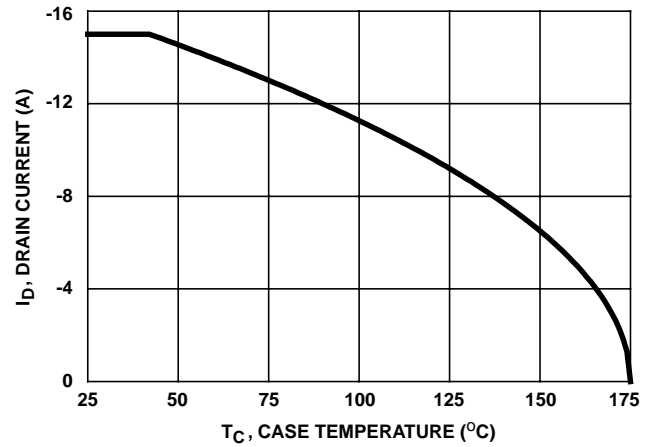


FIGURE 1. NORMALIZED POWER DISSIPATION vs CASE
TEMPERATURE



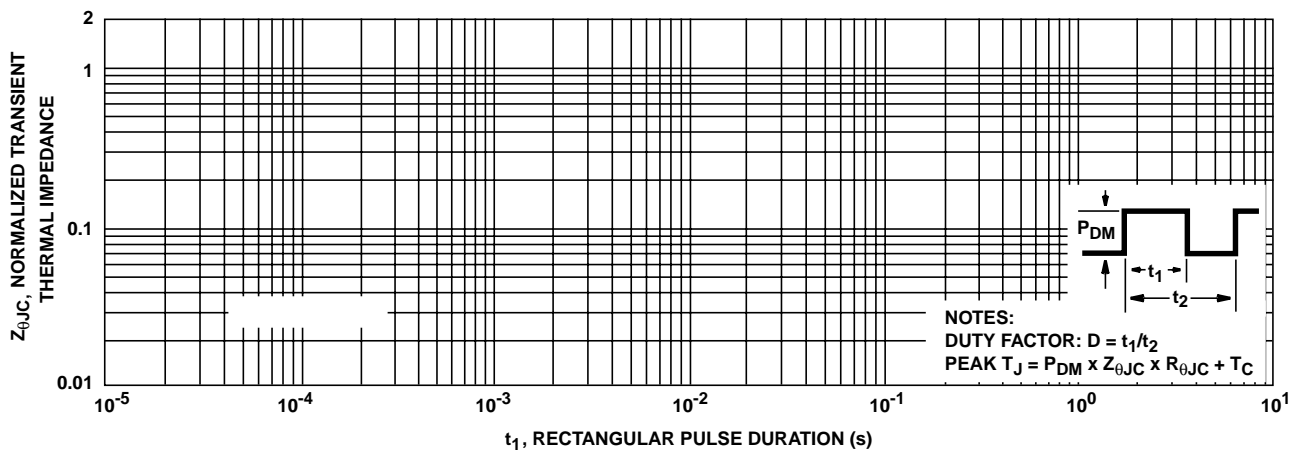FIGURE 2. MAXIMUM CONTINUOUS DRAIN CURRENT vs
CASE TEMPERATURE



NOTES:
DUTY FACTOR: $D = t_1/t_2$
PEAK $T_J = P_{DM} \times Z_{\theta JC} \times R_{\theta JC} + T_C$

FIGURE 3. NORMALIZED MAXIMUM TRANSIENT THERMAL IMPEDANCE

FIGURE 4. FORWARD BIAS SAFE OPERATING AREA

FIGURE 5. PEAK CURRENT CAPABILITY
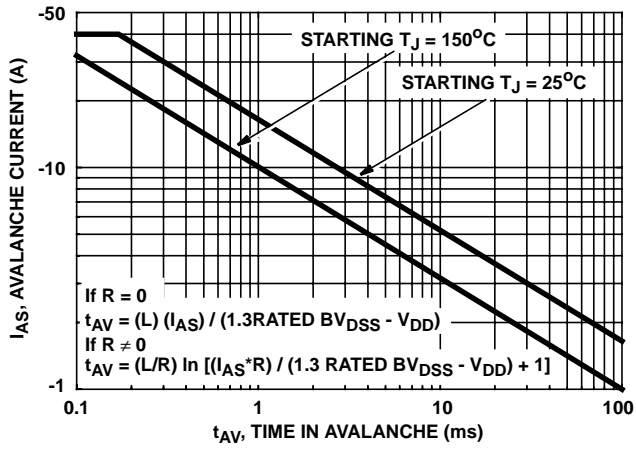
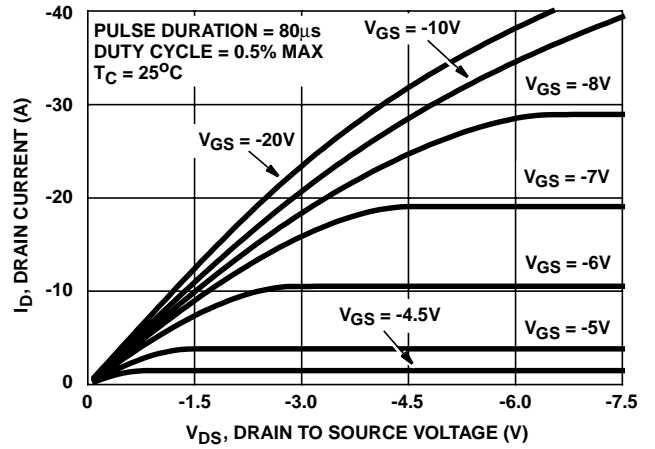## *Typical Performance Curves* (Continued)



**FIGURE 6. UNCLAMPED INDUCTIVE SWITCHING CAPABILITY**

Graph annotations:
STARTING $T_J$ = 150°C
STARTING $T_J$ = 25°C

If R = 0
$t_{AV}$ = (L) ($I_{AS}$) / (1.3 RATED BV$_{DSS}$ - V$_{DD}$)
If R ≠ 0
$t_{AV}$ = (L/R) ln [($I_{AS}$*R) / (1.3 RATED BV$_{DSS}$ - V$_{DD}$) + 1]

Y-axis: $I_{AS}$, AVALANCHE CURRENT (A)
X-axis: $t_{AV}$, TIME IN AVALANCHE (ms)



**FIGURE 7. SATURATION CHARACTERISTICS**

PULSE DURATION = 80µs
DUTY CYCLE = 0.5% MAX
$T_C$ = 25°C

$V_{GS}$ = -10V
$V_{GS}$ = -8V
$V_{GS}$ = -20V
$V_{GS}$ = -7V
$V_{GS}$ = -6V
$V_{GS}$ = -4.5V
$V_{GS}$ = -5V

Y-axis: $I_D$, DRAIN CURRENT (A)
X-axis: $V_{DS}$, DRAIN TO SOURCE VOLTAGE (V)
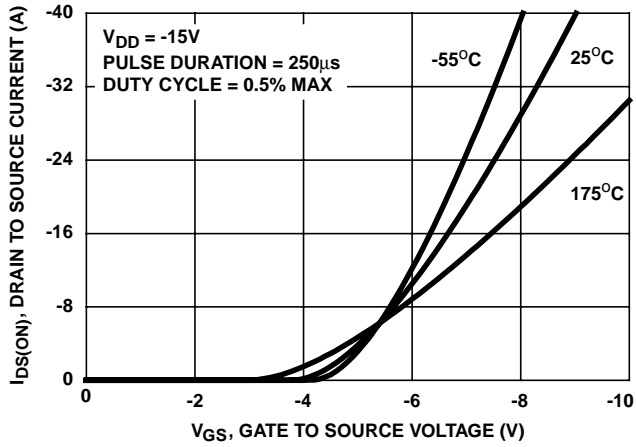


**FIGURE 8. TRANSFER CHARACTERISTICS**

$V_{DD}$ = -15V
PULSE DURATION = 250µs
DUTY CYCLE = 0.5% MAX
-55°C   25°C   175°C

Y-axis: $I_{DS(ON)}$, DRAIN TO SOURCE CURRENT (A)
X-axis: $V_{GS}$, GATE TO SOURCE VOLTAGE (V)
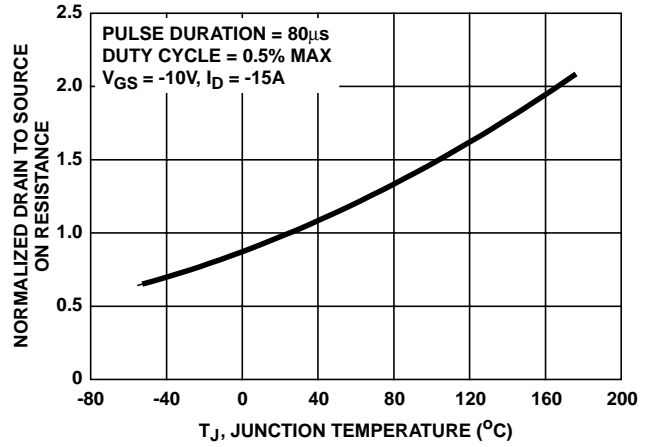


**FIGURE 9. NORMALIZED DRAIN TO SOURCE ON RESISTANCE vs JUNCTION TEMPERATURE**

PULSE DURATION = 80µs
DUTY CYCLE = 0.5% MAX
$V_{GS}$ = -10V, $I_D$ = -15A

Y-axis: NORMALIZED DRAIN TO SOURCE ON RESISTANCE
X-axis: $T_J$, JUNCTION TEMPERATURE (°C)
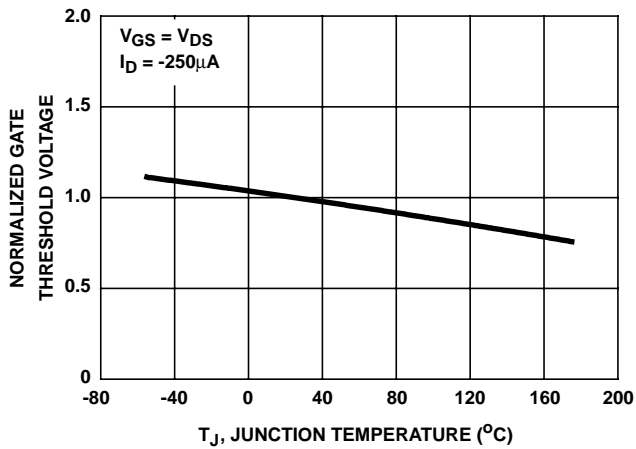


**FIGURE 10. NORMALIZED GATE THRESHOLD VOLTAGE vs JUNCTION TEMPERATURE**

$V_{GS}$ = $V_{DS}$
$I_D$ = -250µA

Y-axis: NORMALIZED GATE THRESHOLD VOLTAGE
X-axis: $T_J$, JUNCTION TEMPERATURE (°C)
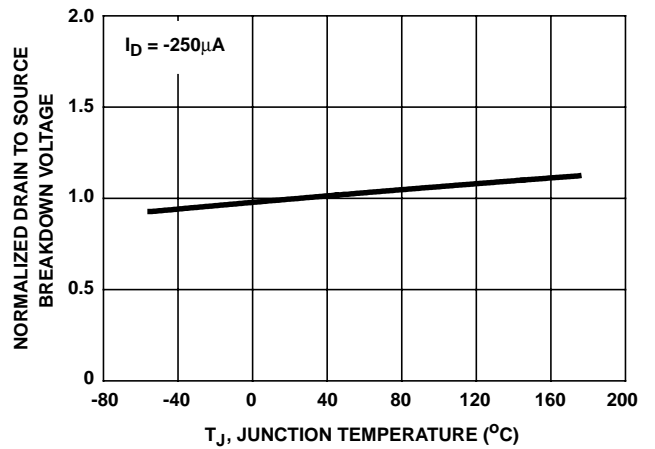


**FIGURE 11. NORMALIZED DRAIN TO SOURCE BREAKDOWN VOLTAGE vs JUNCTION TEMPERATURE**

$I_D$ = -250µA

Y-axis: NORMALIZED DRAIN TO SOURCE BREAKDOWN VOLTAGE
X-axis: $T_J$, JUNCTION TEMPERATURE (°C)

## *Typical Performance Curves* (Continued)
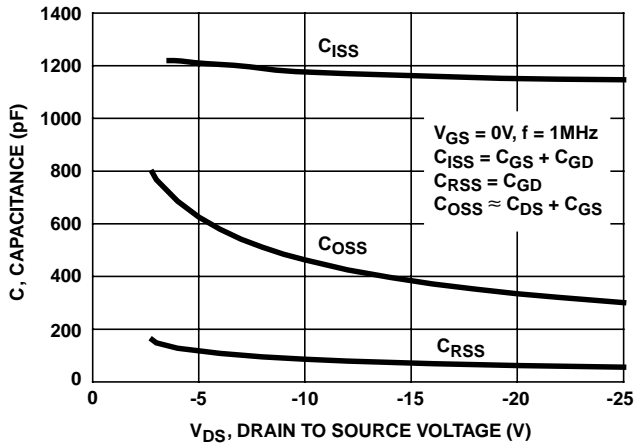


**FIGURE 12. CAPACITANCE vs DRAIN TO SOURCE VOLTAGE**
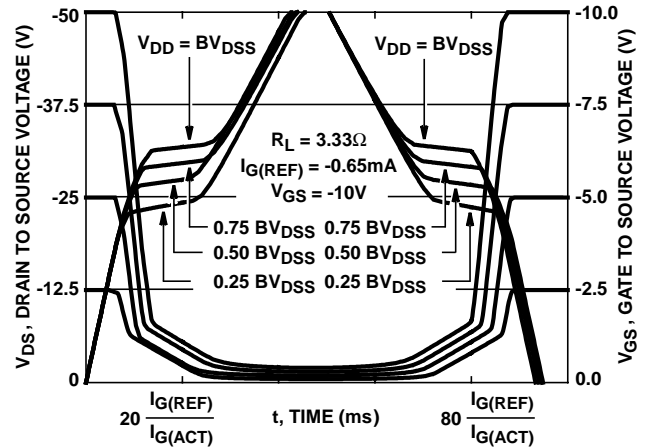


NOTE: Refer to Intersil Application Notes AN7254 and AN7260

**FIGURE 13. NORMALIZED SWITCHING WAVEFORMS FOR CONSTANT GATE CURRENT**
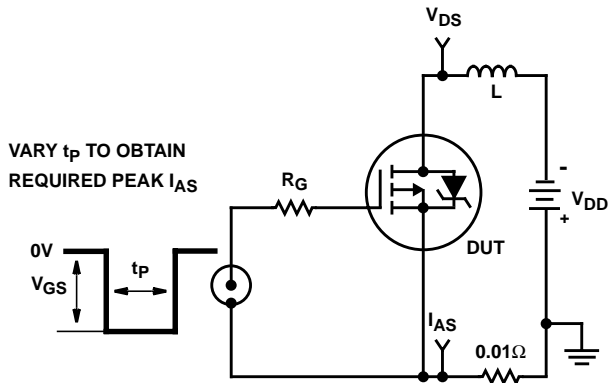
## *Test Circuits and Waveforms*
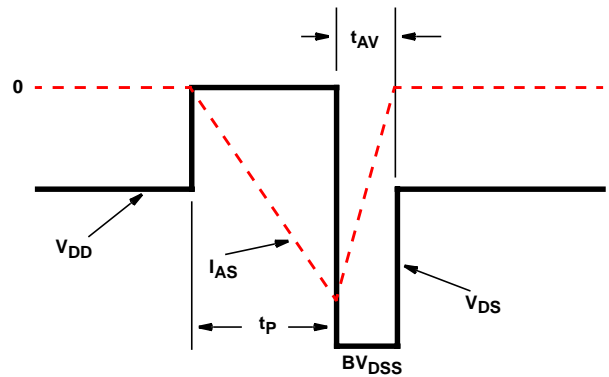


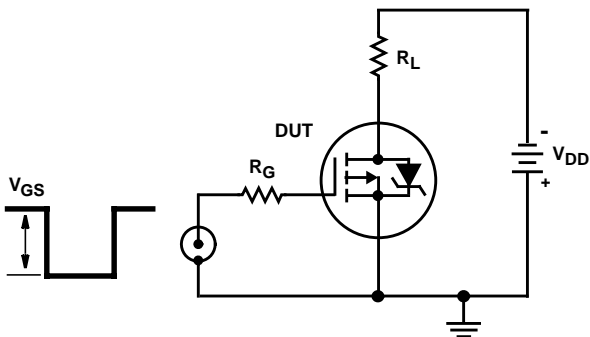**FIGURE 14. UNCLAMPED ENERGY TEST CIRCUIT**



**FIGURE 15. UNCLAMPED ENERGY WAVEFORMS**
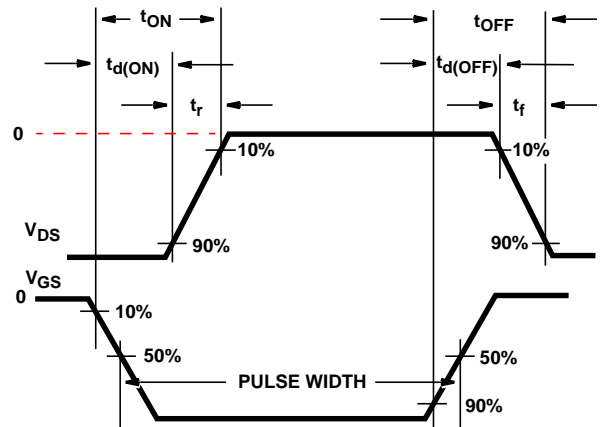


**FIGURE 16. SWITCHING TIME TEST CIRCUIT**



**FIGURE 17. RESISTIVE SWITCHING WAVEFORMS**

## Test Circuits and Waveforms (Continued)
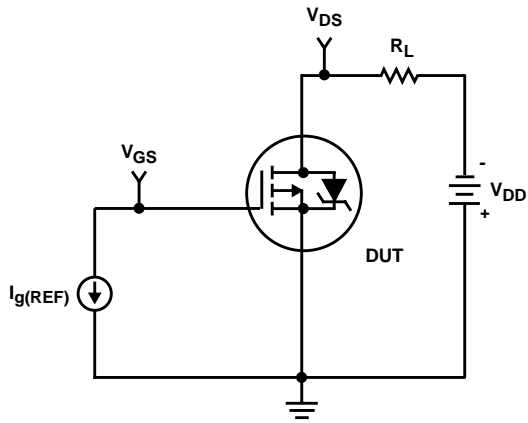


FIGURE 18. GATE CHARGE TEST CIRCUIT
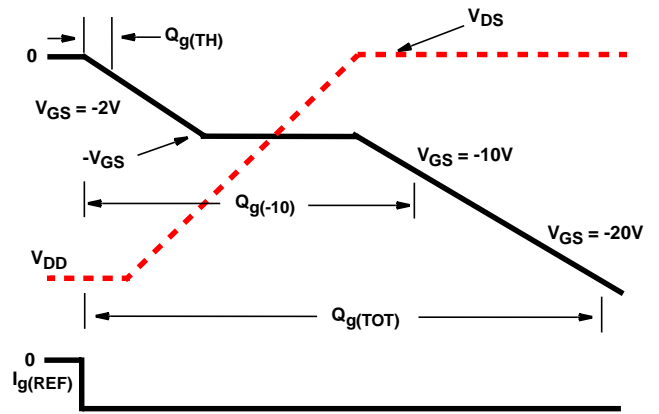


FIGURE 19. GATE CHARGE WAVEFORMS

*intersil*

## PSPICE Electrical Model

.SUBCKT RFP15P05  2  1  3        REV 9/06/94

CA 12 8 1.6e-9
CB 15 14 1.47e-9
CIN 6 8 1.09e-9

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

EBREAK 5 11 17 18 -73.0
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 6.73e-9
LSOURCE 3 7 6.69e-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 63.6e-3
RGATE 9 20 7.37
RIN 6 8 1e9
RSCL1 5 51 RSCLMOD 1e-6
RSCL2 5 50 1e3
RSOURCE 8 7 RDSMOD 46.5e-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 -0.65

ESCL 51 50 VALUE = {(V(5,51)/ABS(V(5,51)))*(PWR(V(5,51)*1e6/35,4))}

.MODEL DBDMOD D (IS = 1.27e-13 RS = 1.62e-2 TRS1 = 1.35e-3 TRS2 = -4.33e-6 CJO = 1.25e-9 TT = 7.97e-8)
.MODEL DBKMOD D (RS = 2.54e-1 TRS1 = 4.54e-3 TRS2 = -1.12e-5)
.MODEL DPLCAPMOD D (CJO = 285e-12 IS = 1e-30 N = 10)
.MODEL MOSMOD PMOS (VTO = -3.78 KP = 6.97 IS = 1e-30 N = 10 TOX = 1 L = 1u W = 1u)
.MODEL RBKMOD RES (TC1 = 9.15e-4 TC2 = -4.0e-7)
.MODEL RDSMOD RES (TC1 = 5.47e-3 TC2 = 1.37e-5)
.MODEL RSCLMOD RES (TC1 = 1.9e-3 TC2 = -7.5e-6)
.MODEL RVTOMOD RES (TC1 = -3.71e-3 TC2 = -2.41e-6)
.MODEL S1AMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = 3.65 VOFF = 1.65)
.MODEL S1BMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = 1.65 VOFF = 3.65)
.MODEL S2AMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = 0.60 VOFF = -4.40)
.MODEL S2BMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = -4.40 VOFF = 0.60)

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

## *Sales Office Headquarters*