Data Sheet | January 2002

# 5.6A, 100V, 0.600 Ohm, P-Channel Power MOSFETs

These advanced power MOSFETs are designed, tested, and guaranteed to withstand a specific level of energy in the avalanche breakdown mode of operation. They are P-Channel enhancement mode silicon gate power field effect transistors designed for applications such as switching regulators, switching convertors, motor drivers, relay drivers, and drivers for high power bipolar switching transistors requiring high speed and low gate-drive power. They can be operated directly from integrated circuits.

Formerly developmental type TA17501.

## Ordering Information

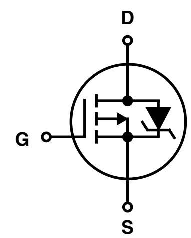
| PART NUMBER | PACKAGE | BRAND |
|---|---|---|
| IRFR9120 | TO-252AA | IF9120 |
| IRFU9120 | TO-251AA | IF9120 |

NOTE: When ordering use the entire part number. Add the suffix 9A to obtain the TO-252AA variant in tape and reel, e.g., IRFR91209A.

## Features

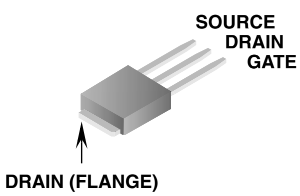
- 5.6A, 100V
- $r_{DS(ON)} = 0.600\Omega$
- Temperature Compensating PSPICE™ Model
- Peak Current vs Pulse Width Curve
- UIS Rating Curve
- Related Literature
  - TB334 “Guidelines for Soldering Surface Mount Components to PC Boards”

## Symbol

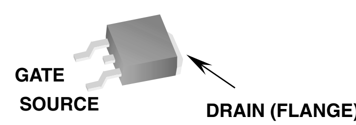



## Packaging

JEDEC TO-251AA




JEDEC TO-252AA



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

| | | IRFR9120, IRFU9120 | UNITS |
|---|---|---|---|
| Drain to Source Voltage (Note 1) | $V_{DSS}$ | -100 | V |
| Drain to Gate Voltage ($R_{GS} = 20k\Omega$) (Note 1) | $V_{DGR}$ | -100 | V |
| Gate to Source Voltage | $V_{GS}$ | ±20 | V |
| Continuous Drain Current | $I_D$ | 5.6 | A |
| Pulsed Drain Current (Note 3) | $I_{DM}$ | Refer to Peak Current Curve | |
| Single Pulse Avalanche Rating | $E_{AS}$ | Refer to UIS Curve | |
| Power Dissipation | $P_D$ | 42 | W |
| Linear Derating Factor | | 0.33 | $W/^oC$ |
| Operating and Storage Temperature | $T_J, T_{STG}$ | -55 to 150 | $^oC$ |
| 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. $T_J = 25^oC$ to $125^oC$.

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

| PARAMETER | SYMBOL | TEST CONDITIONS | | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Drain to Source Breakdown Voltage | $BV_{DSS}$ | $I_D = 250\mu A$, $V_{GS} = 0V$ | | -100 | - | - | V |
| Gate to 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 $BV_{DSS}$, $V_{GS} = 0V$ | | - | - | -25 | µA |
| | | $V_{DS}$ = 0.8 x Rated $BV_{DSS}$, $V_{GS} = 0V$, $T_C = 150^oC$ | | - | - | -250 | µA |
| Gate to Source Leakage Current | $I_{GSS}$ | $V_{GS} = \pm 20V$ | | - | - | ±100 | nA |
| Drain to Source on Resistance (Note 2) | $r_{DS(ON)}$ | $I_D = 3.4A$, $V_{GS} = -10V$, (Figure 9) | | - | - | 0.600 | Ω |
| Turn-On Time | $t_{ON}$ | $V_{DD} = -50V$, $I_D = 6.8A$, $R_L = 7.1\Omega$, $V_{GS} = -10V$, $R_{GS} = 18\Omega$ (Figures 13, 16, 17) | | - | - | 60 | ns |
| Turn-On Delay Time | $t_{d(ON)}$ | | | - | 9.6 | - | ns |
| Rise Time | $t_r$ | | | - | 29 | - | ns |
| Turn-Off Delay Time | $t_{d(OFF)}$ | | | - | 21 | - | ns |
| Fall Time | $t_f$ | | | - | 25 | - | ns |
| Turn-Off Time | $t_{OFF}$ | | | - | - | 60 | ns |
| Total Gate Charge | $Q_g$ | $V_{GS} = 0V$ to $-10V$ | $V_{DD} = -80V$, $I_D = 5.6A$, $R_L = 14.3\Omega$, $I_{G(REF)} = 1.0mA$ | - | - | 18 | nC |
| Gate to Drain Charge | $Q_{gd}$ | | | - | - | 9 | nC |
| Gate to Source Charge | $Q_{gs}$ | | | - | - | 3 | nC |
| Input Capacitance | $C_{ISS}$ | $V_{DS} = -25V$, $V_{GS} = 0V$, f = 1MHz | | - | 485 | - | pF |
| Output Capacitance | $C_{OSS}$ | | | - | 170 | - | pF |
| Reverse Transfer Capacitance | $C_{RSS}$ | | | - | 45 | - | pF |
| Thermal Resistance Junction to Case | $R_{\theta JC}$ | | | - | - | 3.00 | $^oC/W$ |
| Thermal Resistance Junction to Ambient | $R_{\theta JA}$ | | | - | - | 100 | $^oC/W$ |

## Source to Drain Diode Ratings and Specifications

| PARAMETER | SYMBOL | TEST CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| Source to Drain Diode Voltage (Note 2) | $V_{SD}$ | $I_{SD} = -5.6A$ | - | - | -6.3 | V |
| Reverse Recovery Time | $t_{rr}$ | $I_{SD} = -6.8A$, $dI_{SD}/dt = -100A/\mu s$ | - | 130 | 150 | ns |
| Reverse Recovery Charge | $Q_{RR}$ | | - | 0.70 | 1.4 | µC |

NOTES:

2. Pulse test: pulse width ≤ 300µs, duty cycle ≤ 2%.
3. Repetitive rating: pulse width limited by maximum junction temperature. See Transient Thermal Impedance curve (Figure 3)

## Typical Performance Curves Unless Otherwise Specified

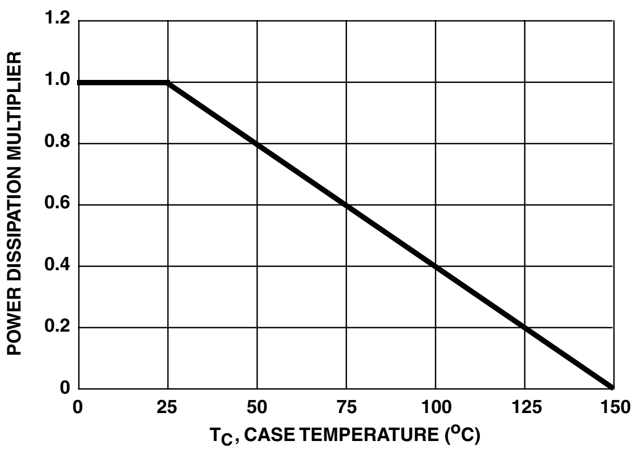



FIGURE 1. NORMALIZED POWER DISSIPATION vs CASE TEMPERATURE

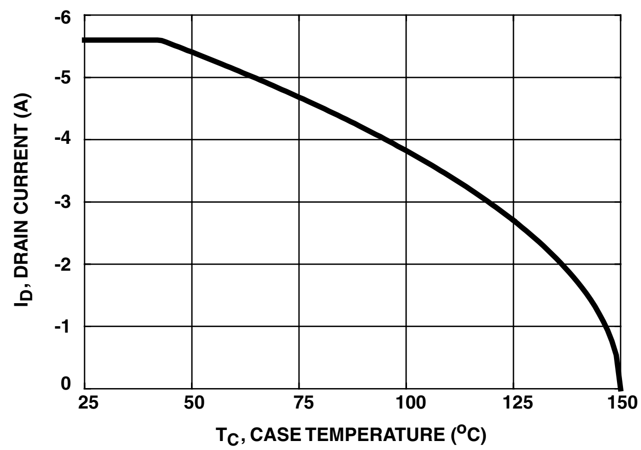



FIGURE 2. MAXIMUM CONTINUOUS DRAIN CURRENT vs CASE TEMPERATURE

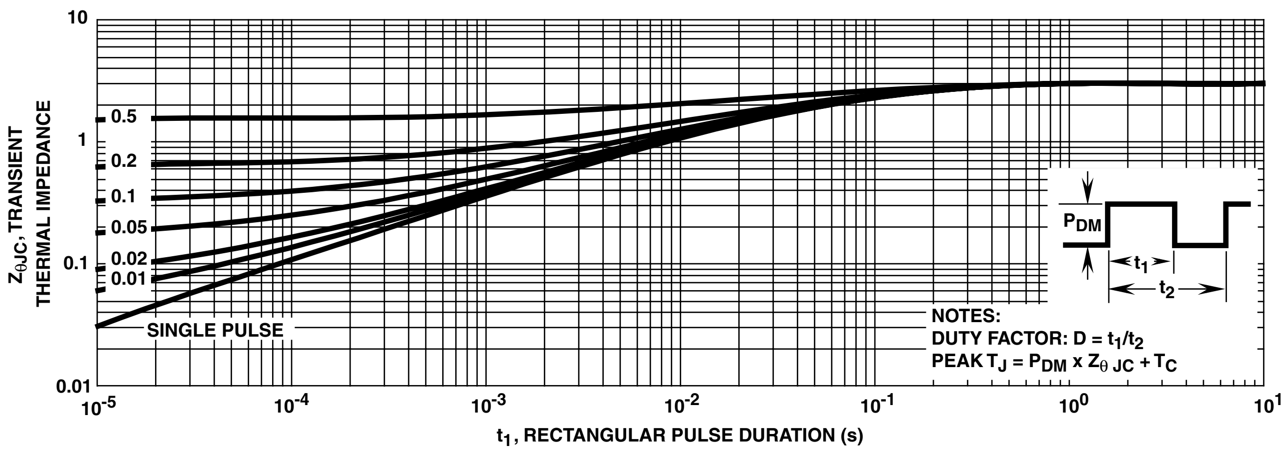



FIGURE 3. MAXIMUM TRANSIENT THERMAL IMPEDANCE

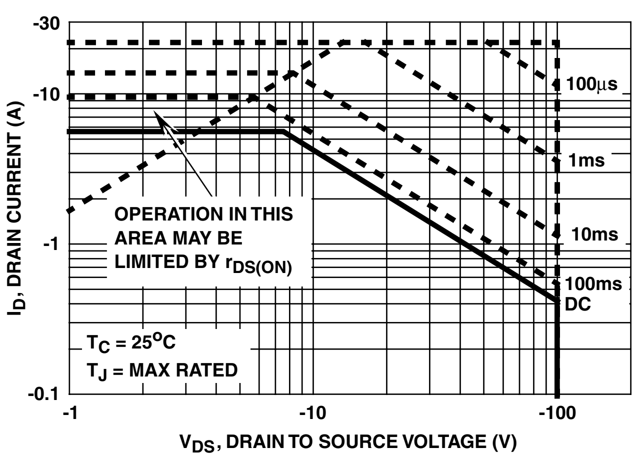



FIGURE 4. FORWARD BIAS SAFE OPERATING AREA

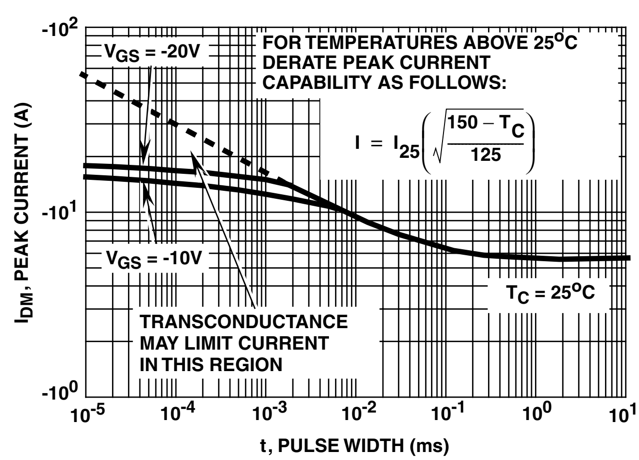



FIGURE 5. PEAK CURRENT CAPABILITY

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

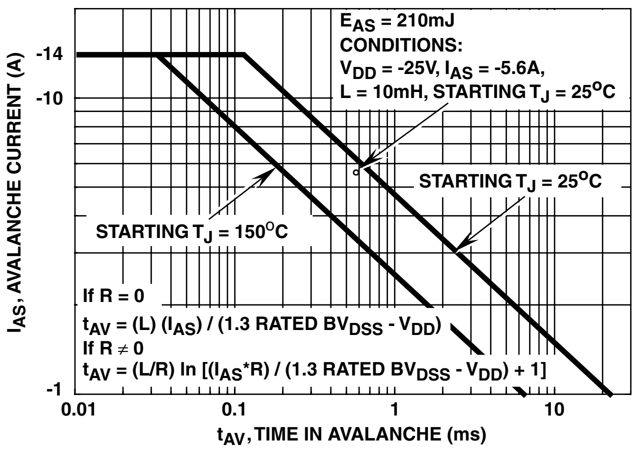



**FIGURE 6. UNCLAMPED INDUCTIVE SWITCHING**

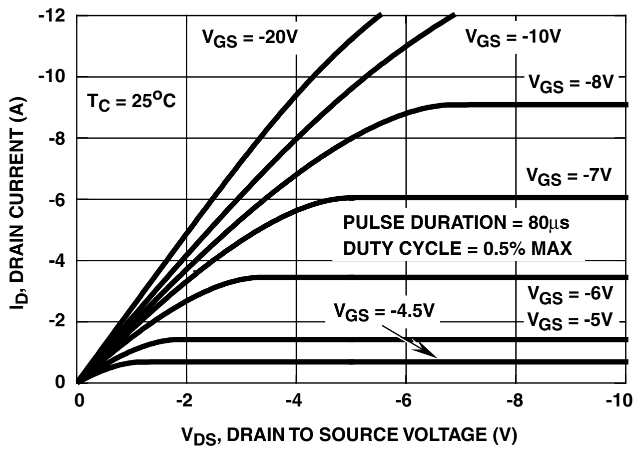



**FIGURE 7. SATURATION CHARACTERISTICS**

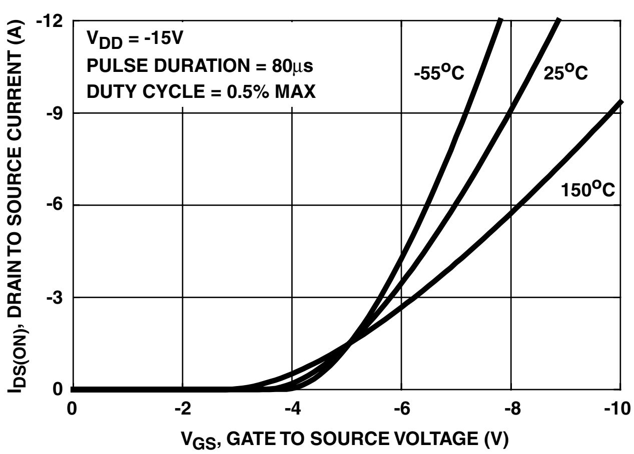



**FIGURE 8. TRANSFER CHARACTERISTICS**

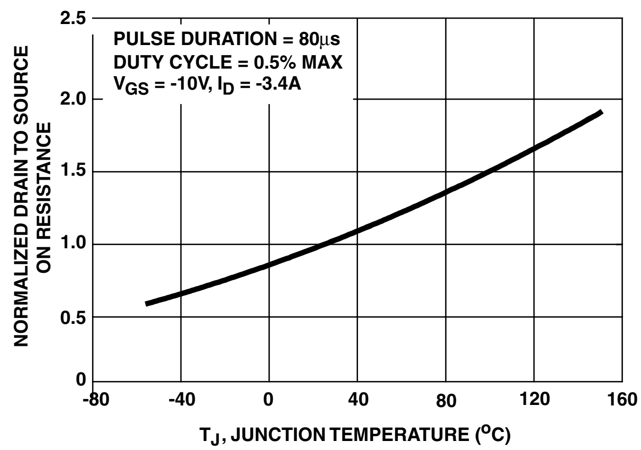



**FIGURE 9. NORMALIZED DRAIN TO SOURCE ON RESISTANCE vs JUNCTION TEMPERATURE**

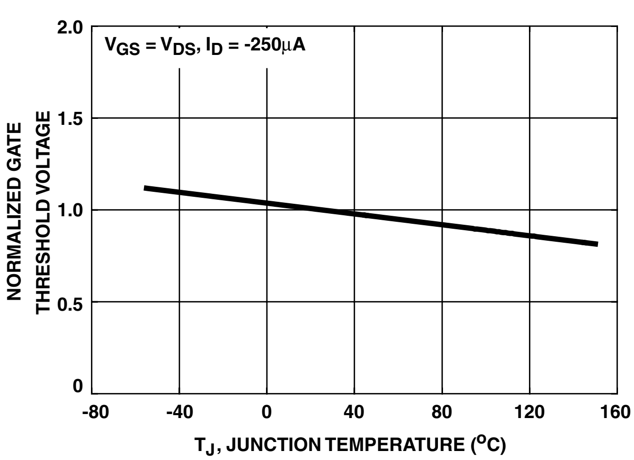



**FIGURE 10. NORMALIZED GATE THRESHOLD VOLTAGE vs TEMPERATURE**

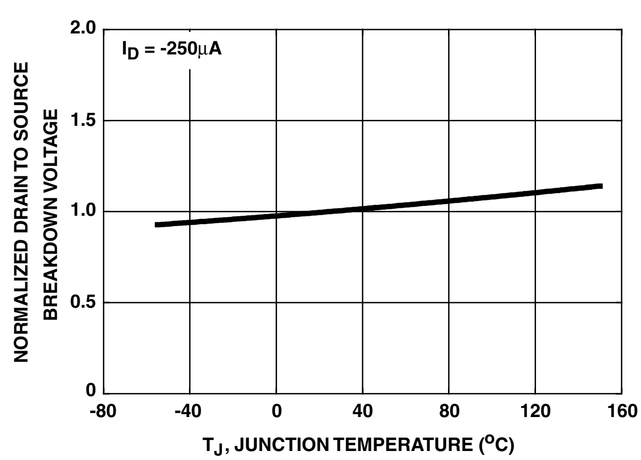



**FIGURE 11. NORMALIZED DRAIN TO SOURCE BREAKDOWN VOLTAGE vs JUNCTION TEMPERATURE**

## Typical Performance Curves Unless Otherwise Specified (Continued)

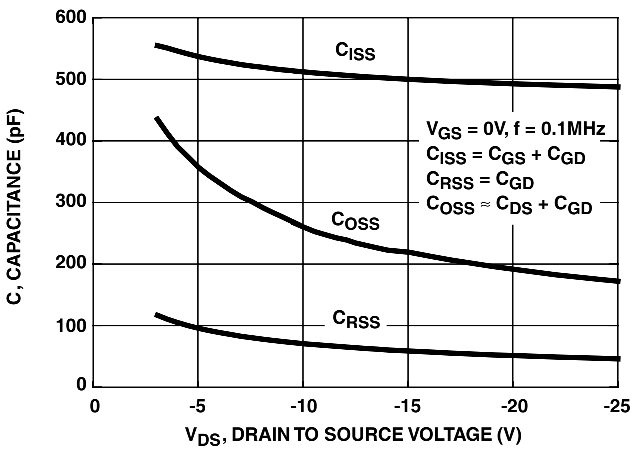
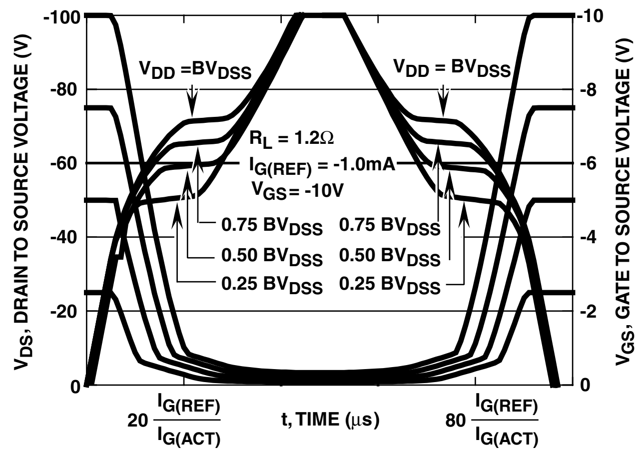



FIGURE 12. CAPACITANCE vs DRAIN TO SOURCE VOLTAGE




NOTE: Refer to Fairchild Application Notes AN7254 and AN7260.

FIGURE 13. NORMALIZED SWITCHING WAVEFORMS FOR CONSTANT GATE CURRENT

## Test Circuits and Waveforms

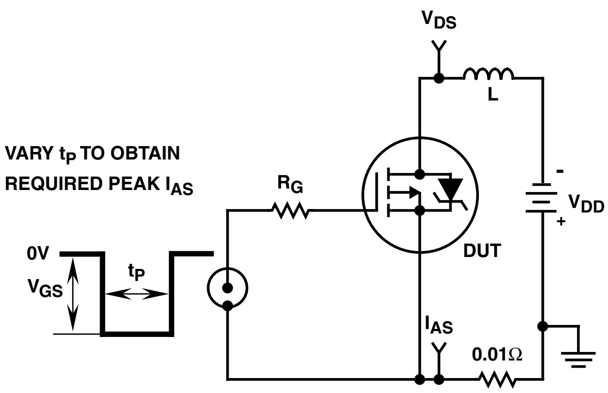



FIGURE 14. UNCLAMPED ENERGY TEST CIRCUIT

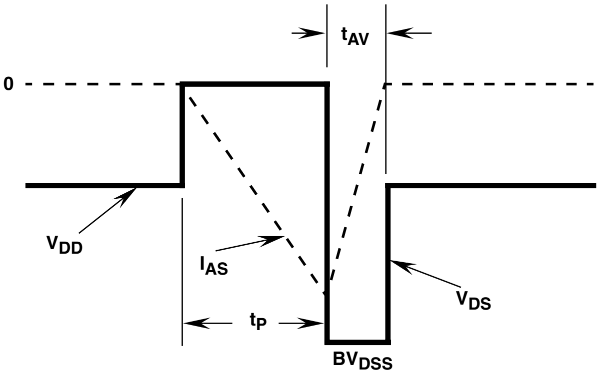



FIGURE 15. UNCLAMPED ENERGY WAVEFORMS

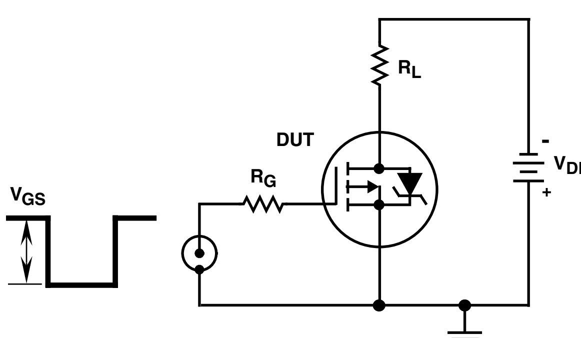



FIGURE 16. RESISTIVE SWITCHING TEST CIRCUIT

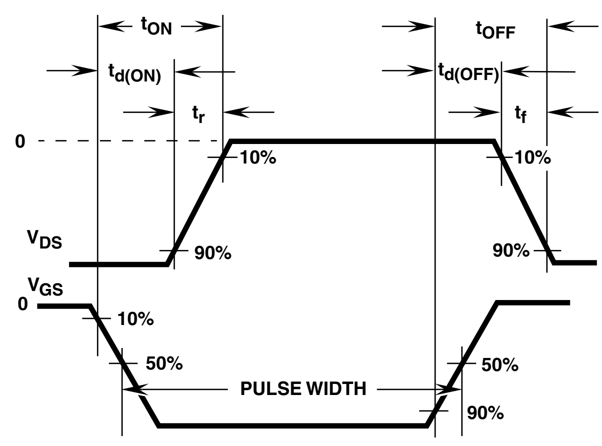
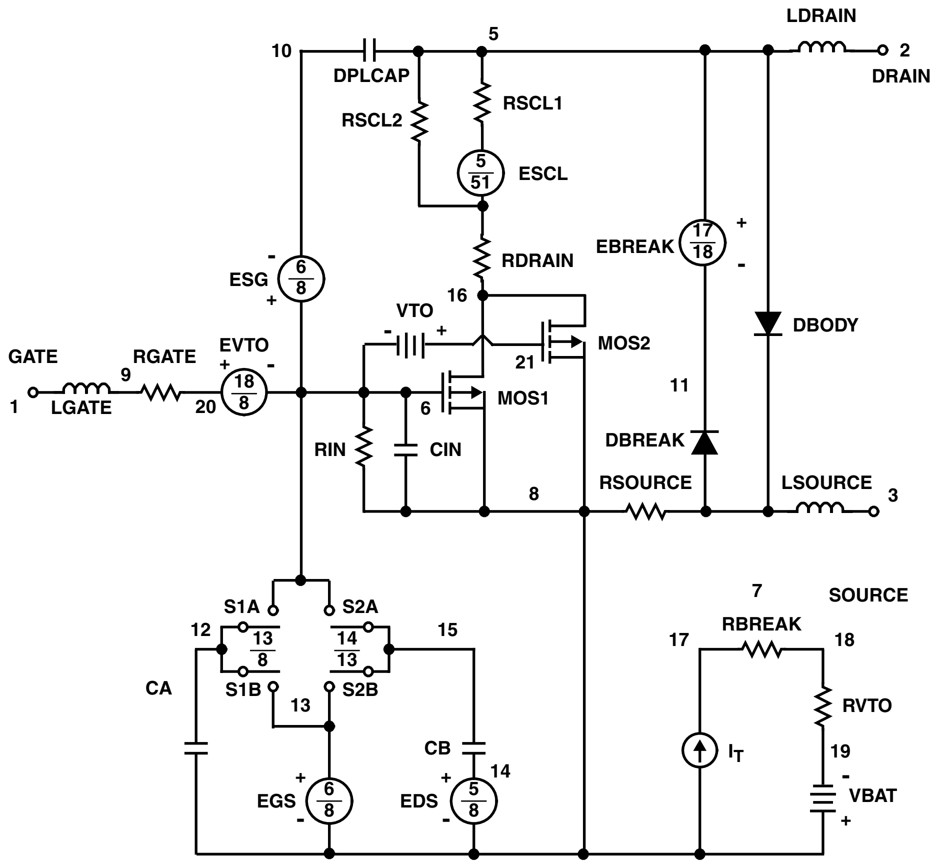



FIGURE 17. RESISTIVE SWITCHING WAVEFORMS

## PSPICE Electrical Model

```
.SUBCKT IRFU9120   2  1  3          REV 9/16/94

CA 12 8 618.9e-12
CB 15 14 633.9e-12
CIN 6 8 441.1e-12

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

EBREAK 5 11 17 18  -127.38
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 2.609e-9
LSOURCE 3 7 2.609e-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 245.6e-3
RGATE 9 20 2.69
RIN 6 8 1e9
RSCL1  5  51  RSCLMOD  1e-6
RSCL2  5  50  1e3
RSOURCE 8 7 RDSMOD 123.96e-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 -0.77
```




```
ESCL  51  50  VALUE={(V(5,51)/ABS(V(5,51)))*(PWR(V(5,51)*1e6/13.2,6))}

.MODEL DBDMOD D (IS=5.1e-14 RS=9.4e-2 TRS1=-2.2e-3 TRS2=-5.2e-6 CJO=6.43e-10 TT=9.7e-8)
.MODEL DBKMOD D (RS=1.45 TRS1=3.84e-4 TRS2=-9.83e-6)
.MODEL DPLCAPMOD D (CJO=235e-12 IS=1e-30 N=10)
.MODEL MOSMOD PMOS (VTO=-3.49 KP=1.58 IS=1e-30 N=10 TOX=1 L=1u W=1u)
.MODEL RBKMOD RES (TC1=1.01e-3 TC2=1.05e-6)
.MODEL RDSMOD RES (TC1=6.23e-3 TC2=1.23e-5)
.MODEL RSCLMOD  RES (TC1=2.05e-3  TC2=-0.35e-5)
.MODEL RVTOMOD RES (TC1=-3.46e-3 TC2=3.33e-7)
.MODEL S1AMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=6.3 VOFF=4.3)
.MODEL S1BMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=4.3 VOFF=6.3)
.MODEL S2AMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=1.0 VOFF=-4.0)
.MODEL S2BMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=-4.0 VOFF=1.0)

.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.

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| DenseTrench™ | GTO™ | Power247™ | SuperSOT™-6 | |
| DOME™ | HiSeC™ | PowerTrench® | SuperSOT™-8 | |
| EcoSPARK™ | ISOPLANAR™ | QFET™ | SyncFET™ | |
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| EnSigna™ | MicroFET™ | QT Optoelectronics™ | TruTranslation™ | |
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