

**2.5A, 12V, 0.130 Ohm, Logic Level, Dual P-Channel LittleFET™ Power MOSFET**

This Dual P-Channel power MOSFET is manufactured using an advanced MegaFET process. This process, which uses feature sizes approaching those of LSI integrated circuits, gives optimum utilization of silicon, resulting in outstanding performance. It is designed for use in applications such as switching regulators, switching converters, motor drivers, relay drivers, and low voltage bus switches. This product achieves full rated conduction at a gate bias in the 3V - 5V range, thereby facilitating true on-off power control directly from logic level (5V) integrated circuits.

Formerly developmental type TA49093.

**Ordering Information**

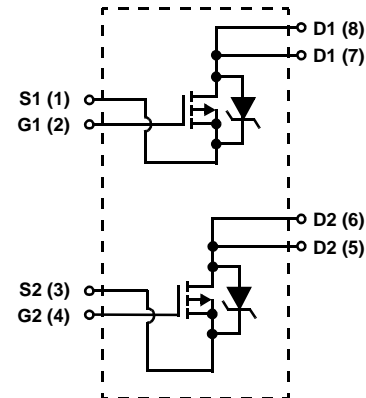
| PART NUMBER | PACKAGE  | BRAND     |
|-------------|----------|-----------|
| RF1K49093   | MS-012AA | RF1K49093 |

NOTE: When ordering, use the entire part number. For ordering in tape and reel, add the suffix 96 to the part number, i.e., RF1K4909396.

**Features**

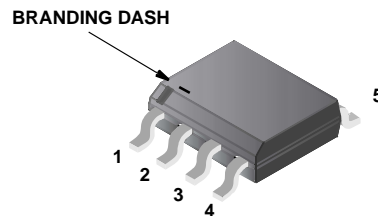
- 2.5A, 12V
- $r_{DS(ON)} = 0.130\Omega$
- Temperature Compensating PSPICE® Model
- On-Resistance vs Gate Drive Voltage Curves
- Peak Current vs Pulse Width Curve
- UIS Rating Curve
- Related Literature
  - TB334 "Guidelines for Soldering Surface Mount Components to PC Boards"

**Symbol**



**Packaging**

JEDEC MS-012AA



# RF1K49093

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

|   | RF1K49093                   | UNITS               |
|---|-----------------------------|---------------------|
| Drain to Source Voltage (Note 1) . . . . .                              | -12                         | V                   |
| Drain to Gate Voltage ( $R_{GS} = 20\text{k}\Omega$ , Note 1) . . . . . | -12                         | V                   |
| Gate to Source Voltage . . . . .  | $\pm 10$                    | V                   |
| Drain Current   |                             |                     |
| Continuous (Pulse width = 5s) . . . . .                                 | 2.5                         | A                   |
| Pulsed (Figure 5) . . . . .   | Refer to Peak Current Curve |                     |
| Pulsed Avalanche Rating (Figure 6) . . . . .                            | Refer to UIS Curve          |                     |
| Power Dissipation   |                             |                     |
| $T_A = 25^\circ\text{C}$ . . . . .                                      | 2                           | W                   |
| Derate Above $25^\circ\text{C}$ . . . . .                               | 0.016                       | W/ $^\circ\text{C}$ |
| Operating and Storage Temperature . . . . .                             | -55 to 150                  | $^\circ\text{C}$    |
| Maximum Temperature for Soldering                                       |                             |                     |
| Leads at 0.063in (1.6mm) from Case for 10s . . . . .                    | 300                         | $^\circ\text{C}$    |
| Package Body for 10s, See Techbrief 334 . . . . .                       | 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  $125^\circ\text{C}$ .

## Electrical Specifications $T_A = 25^\circ\text{C}$ , 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 13)   | -12   | -   | -         | V                         |               |
| Gate Threshold Voltage                 | $V_{GS(TH)}$    | $V_{GS} = V_{DS}$ , $I_D = 250\mu\text{A}$ , (Figure 12)  | -1  | -   | -2        | V                         |               |
| Zero Gate Voltage Drain Current        | $I_{DSS}$       | $V_{DS} = -12\text{V}$ ,<br>$V_{GS} = 0\text{V}$  | $T_A = 25^\circ\text{C}$  | -   | -         | -1                        | $\mu\text{A}$ |
|  |                 |   | $T_A = 150^\circ\text{C}$   | -   | -         | -50                       | $\mu\text{A}$ |
| Gate to Source Leakage Current         | $I_{GSS}$       | $V_{GS} = \pm 10\text{V}$   | -   | -   | $\pm 100$ | nA                        |               |
| Drain to Source On Resistance          | $r_{DS(ON)}$    | $I_D = 2.5\text{A}$ , $V_{GS} = -5\text{V}$ , (Figure 9, 11)  | -   | -   | 0.130     | $\Omega$                  |               |
| Turn-On Time                           | $t_{ON}$        | $V_{DD} = -6\text{V}$ , $I_D \approx 2.5\text{A}$ ,<br>$R_L = 2.40\Omega$ , $V_{GS} = -5\text{V}$ ,<br>$R_{GS} = 25\Omega$<br>(Figure 10) | -   | -   | 115       | ns                        |               |
| Turn-On Delay Time                     | $t_{d(ON)}$     |   | -   | 25  | -         | ns                        |               |
| Rise Time                              | $t_r$           |   | -   | 65  | -         | ns                        |               |
| Turn-Off Delay Time                    | $t_{d(OFF)}$    |   | -   | 40  | -         | ns                        |               |
| Fall Time                              | $t_f$           |   | -   | 45  | -         | ns                        |               |
| Turn-Off Time                          | $t_{OFF}$       |   | -   | -   | 110       | ns                        |               |
| Total Gate Charge                      | $Q_{g(TOT)}$    | $V_{GS} = 0\text{V}$ to $-10\text{V}$   | $V_{DD} = -9.6\text{V}$ ,<br>$I_D = 2.5\text{A}$ ,<br>$R_L = 3.84\Omega$<br>(Figure 15) | 19  | 24        | nC                        |               |
| Gate Charge at -5V                     | $Q_{g(-5)}$     | $V_{GS} = 0\text{V}$ to $-5\text{V}$  |   | 10  | 14        | nC                        |               |
| Threshold Gate Charge                  | $Q_{g(TH)}$     | $V_{GS} = 0\text{V}$ to $-1\text{V}$  |   | 0.8 | 1.1       | nC                        |               |
| Input Capacitance                      | $C_{ISS}$       | $V_{DS} = -10\text{V}$ , $V_{GS} = 0\text{V}$ ,<br>$f = 1\text{MHz}$ (Figure 14)  | -   | 775 | -         | pF                        |               |
| Output Capacitance                     | $C_{OSS}$       |   | -   | 550 | -         | pF                        |               |
| Reverse Transfer Capacitance           | $C_{RSS}$       |   | -   | 150 | -         | pF                        |               |
| Thermal Resistance Junction-to-Ambient | $R_{\theta JA}$ | Pulse width = 1s<br>Device mounted on FR-4 material   | -   | -   | 62.5      | $^\circ\text{C}/\text{W}$ |               |

## Source to Drain Diode Ratings and Specifications

| PARAMETER                     | SYMBOL   | TEST CONDITIONS   | MIN | TYP | MAX   | UNITS |
|-------------------------------|----------|---|-----|-----|-------|-------|
| Source to Drain Diode Voltage | $V_{SD}$ | $I_{SD} = -2.5\text{A}$   | -   | -   | -1.25 | V     |
| Reverse Recovery Time         | $t_{rr}$ | $I_{SD} = -2.5\text{A}$ , $dI_{SD}/dt = -100\text{A}/\mu\text{s}$ | -   | -   | 55    | ns    |

Typical Performance Curves

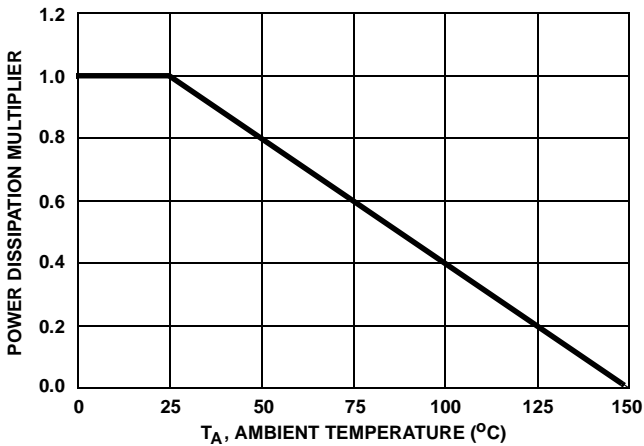


FIGURE 1. NORMALIZED POWER DISSIPATION vs AMBIENT TEMPERATURE

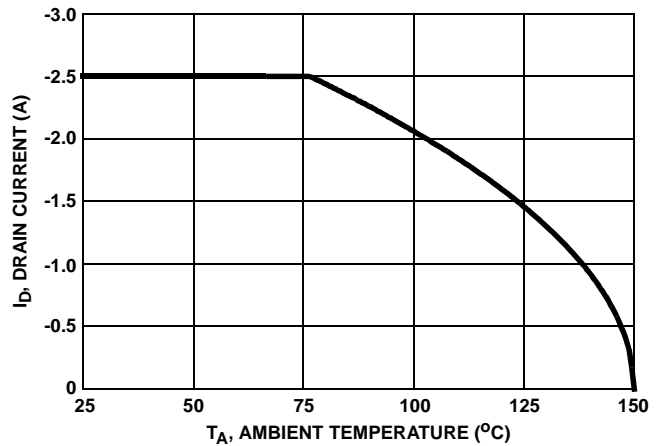


FIGURE 2. MAXIMUM CONTINUOUS DRAIN CURRENT vs AMBIENT TEMPERATURE

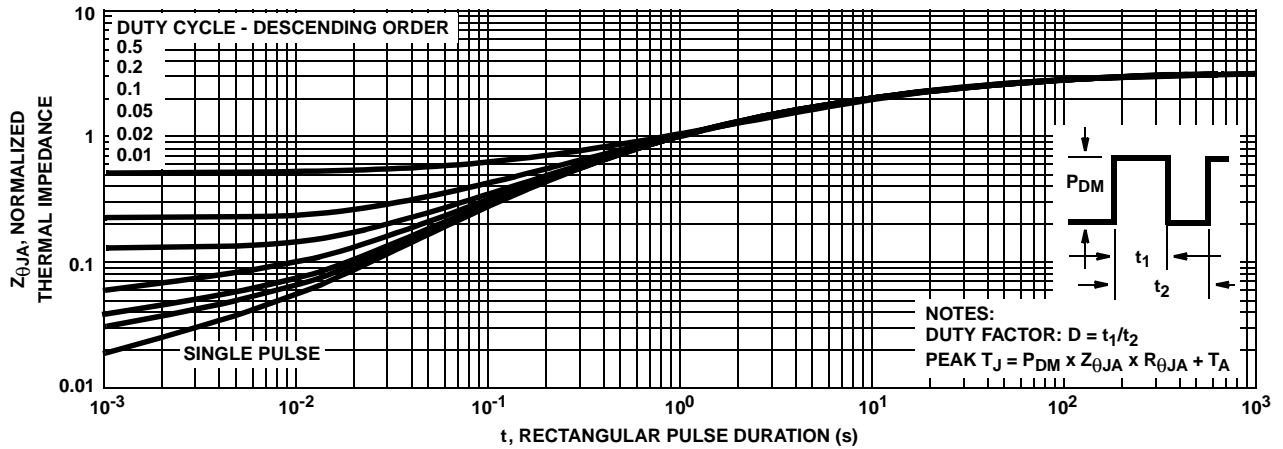


FIGURE 3. NORMALIZED MAXIMUM TRANSIENT THERMAL IMPEDANCE

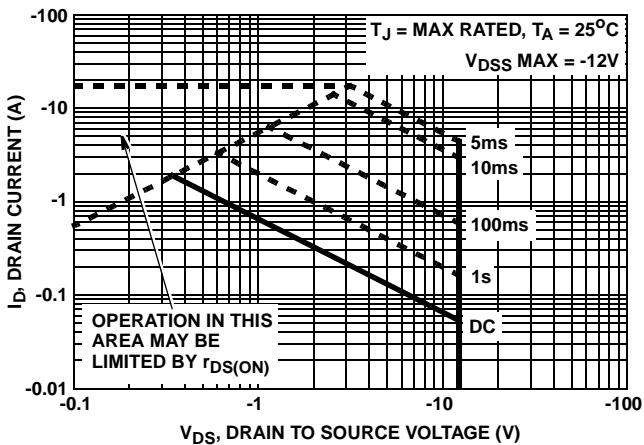


FIGURE 4. FORWARD BIAS SAFE OPERATING AREA

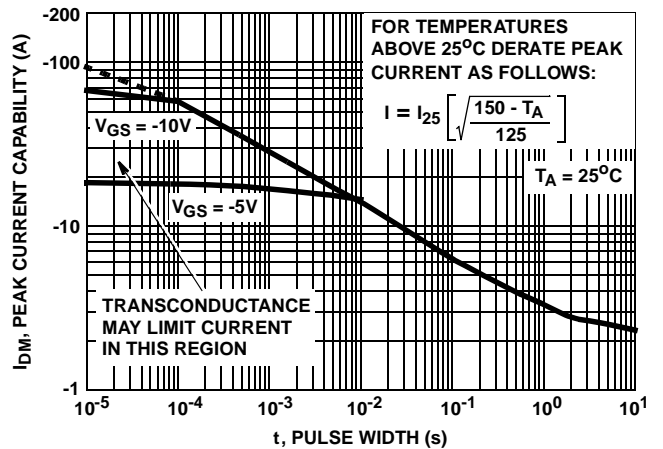
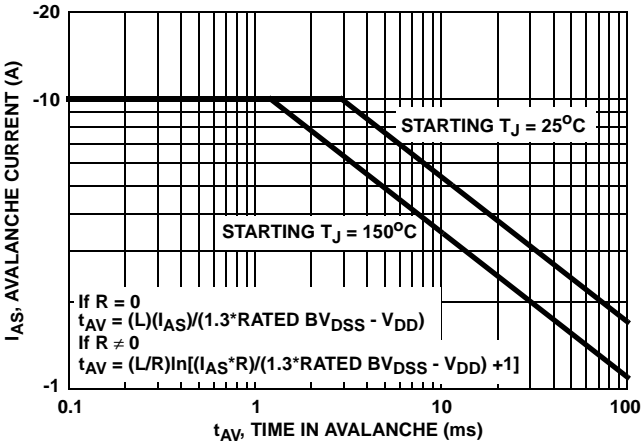
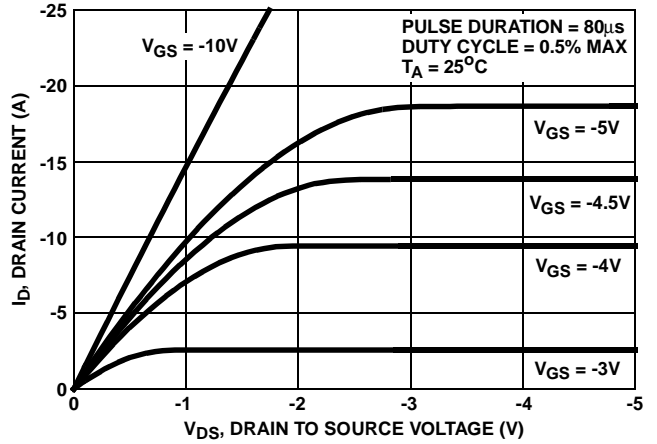


FIGURE 5. PEAK CURRENT CAPABILITY

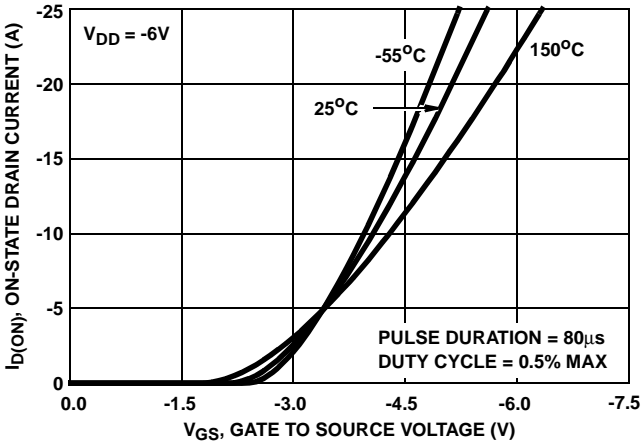
Typical Performance Curves (Continued)



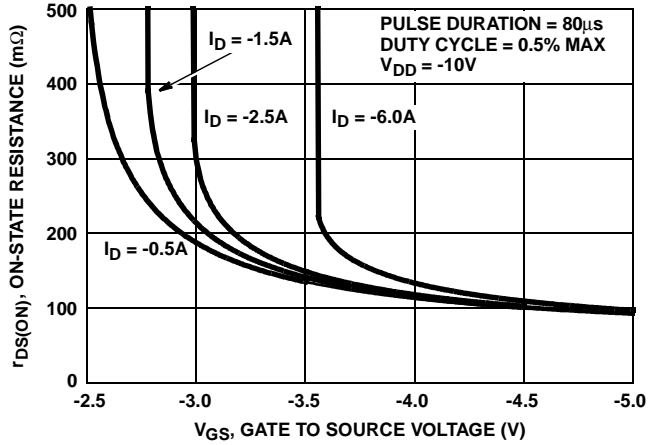
NOTE: Refer to Fairchild Application Notes AN9321 and AN9322.  
**FIGURE 6. UNCLAMPED INDUCTIVE SWITCHING CAPABILITY**



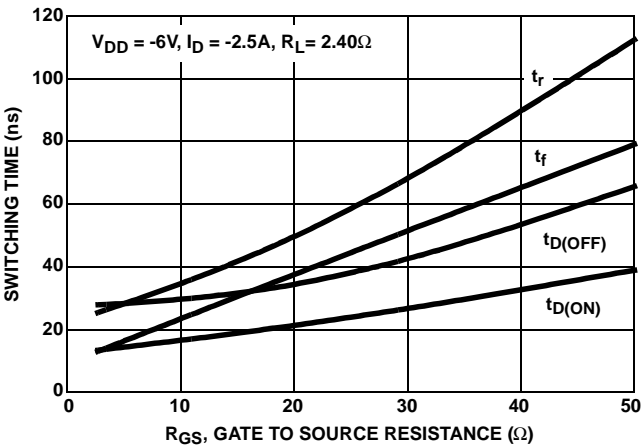
**FIGURE 7. SATURATION CHARACTERISTICS**



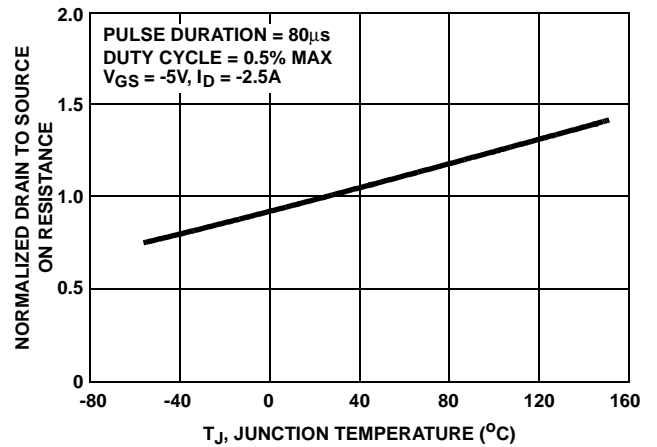
**FIGURE 8. TRANSFER CHARACTERISTICS**



**FIGURE 9. DRAIN TO SOURCE ON RESISTANCE vs GATE VOLTAGE AND DRAIN CURRENT**



**FIGURE 10. SWITCHING TIME AS A FUNCTION OF GATE RESISTANCE**



**FIGURE 11. NORMALIZED DRAIN TO SOURCE ON RESISTANCE vs JUNCTION TEMPERATURE**

Typical Performance Curves (Continued)

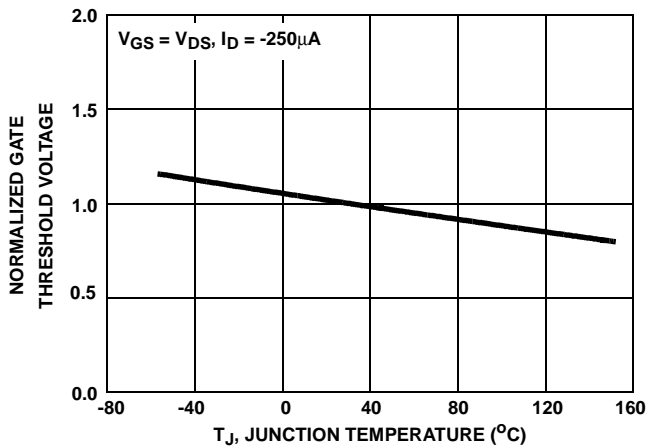


FIGURE 12. NORMALIZED GATE THRESHOLD VOLTAGE vs JUNCTION TEMPERATURE

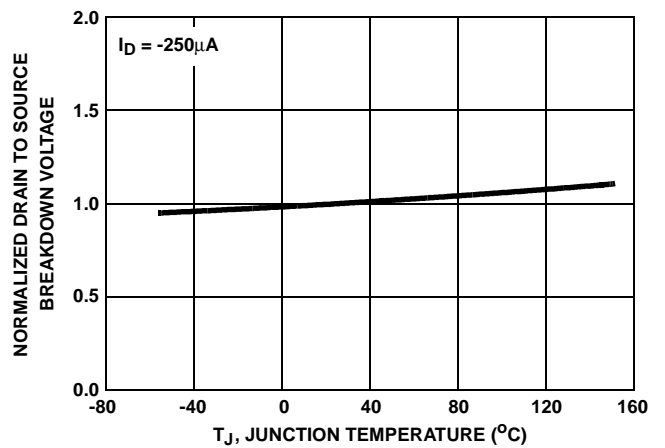


FIGURE 13. NORMALIZED DRAIN TO SOURCE BREAKDOWN VOLTAGE vs JUNCTION TEMPERATURE

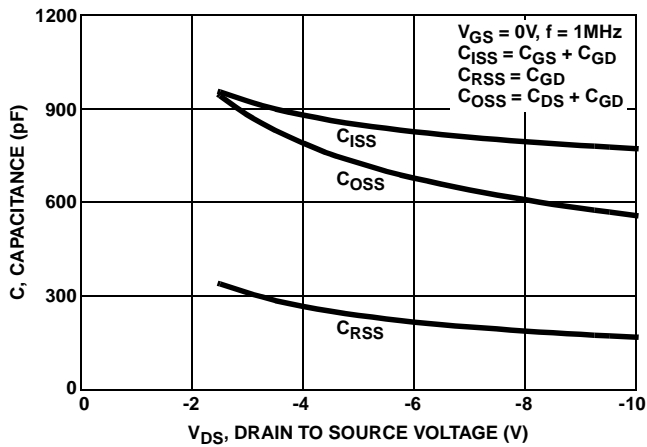
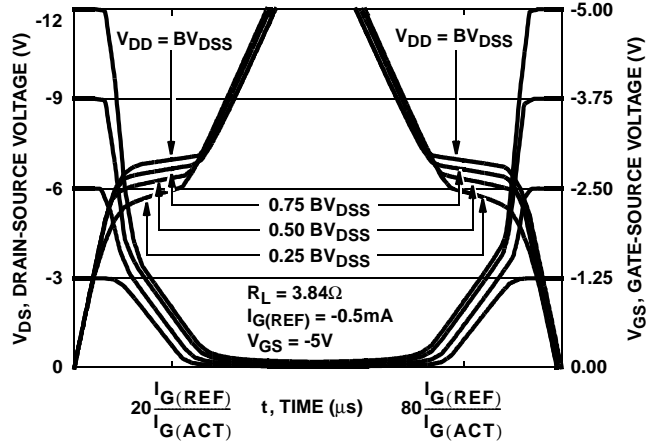


FIGURE 14. CAPACITANCE vs DRAIN TO SOURCE VOLTAGE



NOTE: Refer to Fairchild Application Notes AN7254 and AN7260.

FIGURE 15. NORMALIZED SWITCHING WAVEFORMS FOR CONSTANT GATE CURRENT

Test Circuits and Waveforms

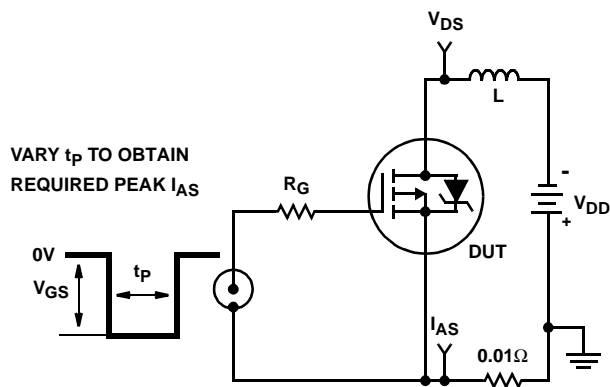


FIGURE 16. UNCLAMPED ENERGY TEST CIRCUIT

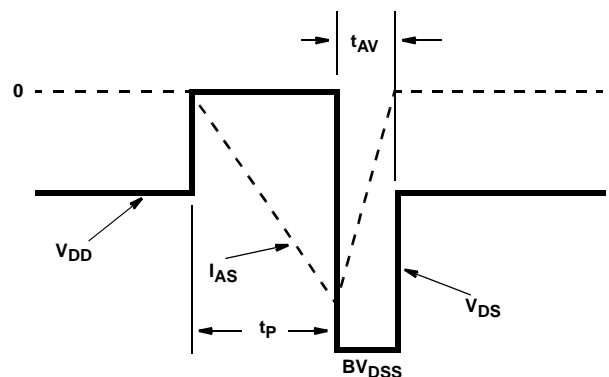


FIGURE 17. UNCLAMPED ENERGY WAVEFORMS

## Test Circuits and Waveforms (Continued)

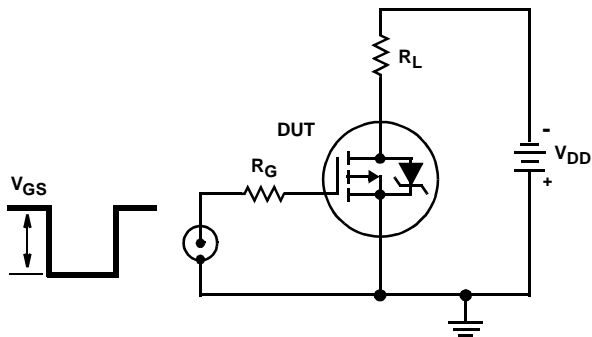


FIGURE 18. SWITCHING TIME TEST CIRCUIT

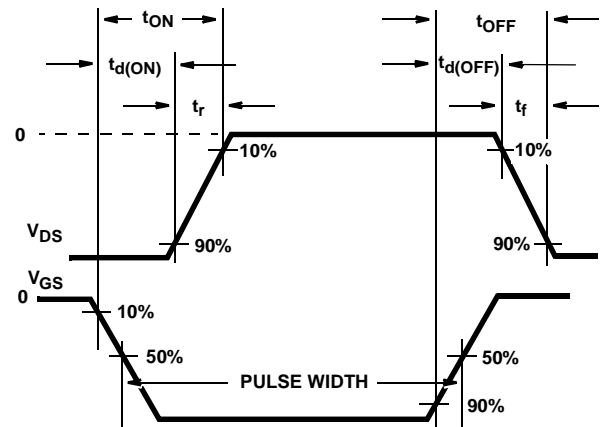


FIGURE 19. RESISTIVE SWITCHING WAVEFORMS

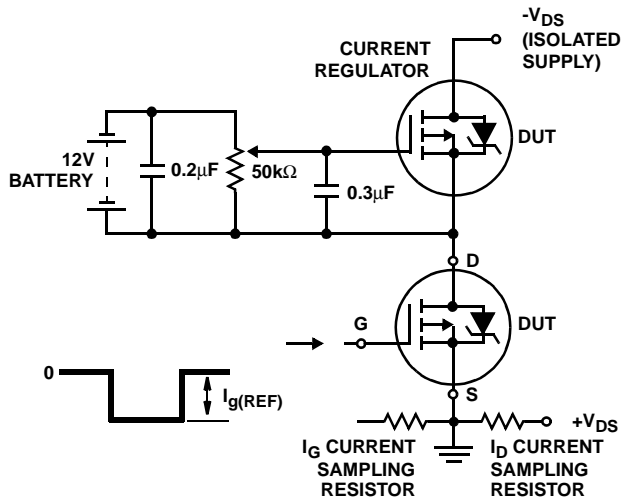


FIGURE 20. GATE CHARGE TEST CIRCUIT

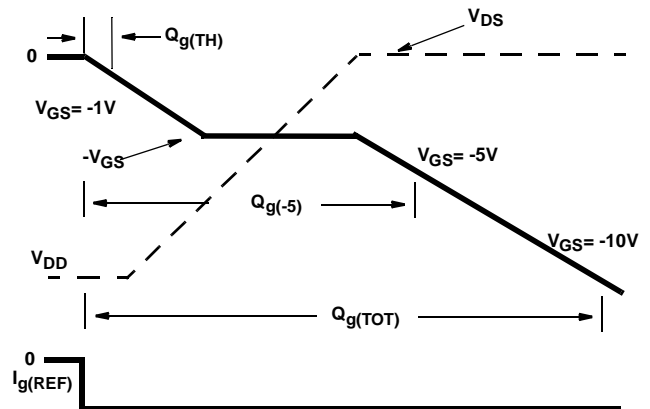


FIGURE 21. GATE CHARGE WAVEFORMS

## Soldering Precautions

The soldering process creates a considerable thermal stress on any semiconductor component. The melting temperature of solder is higher than the maximum rated temperature of the device. The amount of time the device is heated to a high temperature should be minimized to assure device reliability. Therefore, the following precautions should always be observed in order to minimize the thermal stress to which the devices are subjected.

1. Always preheat the device.
2. The delta temperature between the preheat and soldering should always be less than 100°C. Failure to preheat the device can result in excessive thermal stress which can damage the device.
3. The maximum temperature gradient should be less than 5°C per second when changing from preheating to soldering.
4. The peak temperature in the soldering process should be at least 30°C higher than the melting point of the solder chosen.
5. The maximum soldering temperature and time must not exceed 260°C for 10 seconds on the leads and case of the device.
6. After soldering is complete, the device should be allowed to cool naturally for at least three minutes, as forced cooling will increase the temperature gradient and may result in latent failure due to mechanical stress.
7. During cooling, mechanical stress or shock should be avoided.

**PSPICE Electrical Model**

SUBCKT RF1K49093 2 1 3 ;rev 10/24/94

CA 12 8 8.75e-10  
 CB 15 14 8.65e-10  
 CIN 6 8 7.65e-10

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

EBREAK 5 11 17 18 -23.75  
 EDS 14 8 5 8 1  
 EGS 13 8 6 8 1  
 ESG 6 10 8 6 1  
 EVTO 20 6 8 18 1

IT 8 17 1

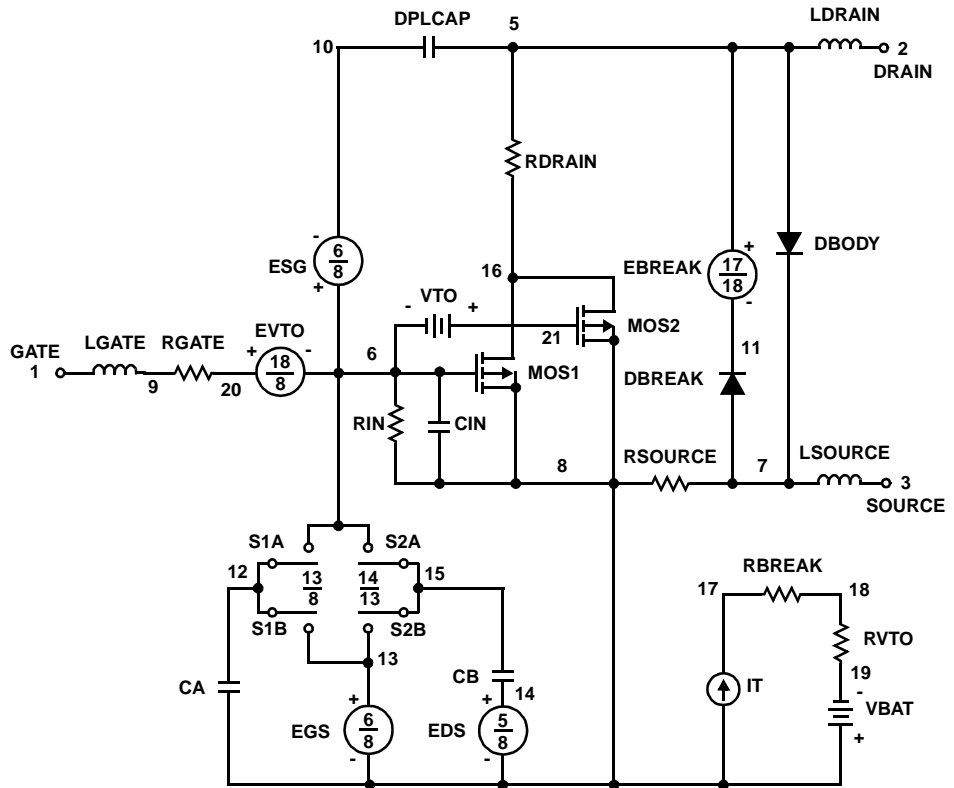
LDRAIN 2 5 1e-9  
 LGATE 1 9 1.233e-9  
 LSOURCE 3 7 0.452e-9

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 7.36e-3  
 RGATE 9 20 6.1  
 RIN 6 8 1e9  
 RSOURCE 8 7 RDSMOD 4.56e-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 -0.558



.MODEL DBDMOD D (IS = 3.0e-13 RS = 4.4e-2 TRS1 = 1.0e-3 TRS2 = -7.37e-6 CJO = 1.27e-9 TT = 2.2e-8)  
 .MODEL DBKMOD D (RS = 7.84e-2 TRS1 = -4.27e-3 TRS2 = 5.77e-5)  
 .MODEL DPLCAPMOD D (CJO = 2.85e-10 IS = 1e-30 N = 10)  
 .MODEL MOSMOD PMOS (VTO = -2.1423 KP = 9.206 IS = 1e-30 N = 10 TOX = 1 L = 1u W = 1u)  
 .MODEL RBKMOD RES (TC1 = 9.61e- 4TC2 = -1.09e-6)  
 .MODEL RDSMOD RES (TC1 = 2.10e-3 TC2 = 6.99e-6)  
 .MODEL RVTOMOD RES (TC1 = -1.82e- 3TC2 = 1.47e-7)  
 .MODEL S1AMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = 5.47 VOFF= 3.47)  
 .MODEL S1BMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = 3.47 VOFF= 5.47)  
 .MODEL S2AMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = 1.05 VOFF= -3.95)  
 .MODEL S2BMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = -3.95 VOFF= 1.05)

.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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| Bottomless <sup>TM</sup>          | FAST <sub>r</sub> <sup>TM</sup>  | OPTOPLANAR <sup>TM</sup>         | STAR*POWER <sup>TM</sup>     |                   |
| CoolFET <sup>TM</sup>             | FRFET <sup>TM</sup>              | PACMAN <sup>TM</sup>             | Stealth <sup>TM</sup>        |                   |
| CROSSVOLT <sup>TM</sup>           | GlobalOptoisolator <sup>TM</sup> | POP <sup>TM</sup>                | SuperSOT <sup>TM</sup> -3    |                   |
| DenseTrench <sup>TM</sup>         | GTO <sup>TM</sup>                | Power247 <sup>TM</sup>           | SuperSOT <sup>TM</sup> -6    |                   |
| DOMET <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>          | QST <sup>TM</sup>                | TinyLogic <sup>TM</sup>      |                   |
| EnSigna <sup>TM</sup>             | MicroFET <sup>TM</sup>           | QT Optoelectronics <sup>TM</sup> | TruTranslation <sup>TM</sup> |                   |
| FACT <sup>TM</sup>                | MicroPak <sup>TM</sup>           | Quiet Series <sup>TM</sup>       | UHC <sup>TM</sup>            |                   |
| FACT Quiet Series <sup>TM</sup>   | MICROWIRE <sup>TM</sup>          | SILENT SWITCHER <sup>®</sup>     | UltraFET <sup>®</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.  |
| Preliminary              | First Production       | This datasheet contains preliminary data, and supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design. |
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