

2.5A, 60V, 0.130 Ohm, ESD Rated, Dual N-Channel LittleFET™ Power MOSFET

The RF1K49221 Dual N-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 device can be operated directly from integrated circuits.

The RF1K49221 incorporates ESD protection and is designed to withstand 2kV (Human Body Model) of ESD.

Formerly developmental type TA49221.

Ordering Information

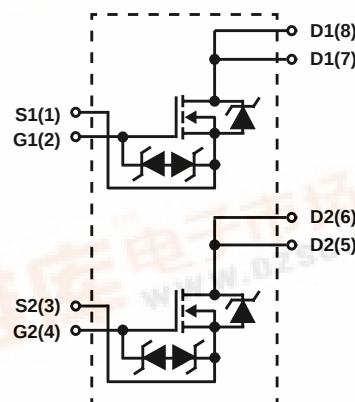
PART NUMBER	PACKAGE	BRAND
RF1K49221	MS-012AA	RF1K49221

NOTE: When ordering, use the entire part number. For ordering in tape and reel, add the suffix 96 to the part number, i.e. RF1K4922196.

Features

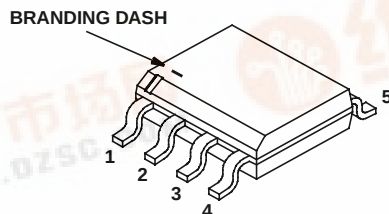
- 2.5A, 60V
- $r_{DS(ON)} = 0.130\Omega$
- 2kV ESD Protected
- Temperature Compensating PSPICE® Model
- Thermal Impedance PSPICE Model
- Peak Current vs Pulse Width Curve
- UIS Rating Curve
- Related Literature
 - TB334 "Guidelines for Soldering Surface Mount Components to PC Boards"

Symbol



Packaging

JEDEC MS-012AA



RF1K49221

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

	RF1K49221	UNITS
Drain to Source Voltage	60	V
Drain to Gate Voltage ($R_{GS} = 20\text{k}\Omega$)	60	V
Gate to Source Voltage	± 20	V
Drain Current		
Continuous (Pulse Width = 5s)	2.5	A
Pulsed	Refer to Peak Current Curve	
Pulsed Avalanche Rating	Refer to UIS Curve	
Power Dissipation	2	W
Derate Above 25°C	0.016	W/ $^{\circ}\text{C}$
Electrostatic Discharge Rating MIL-STD-883, Category B(2)	2	kV
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°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 12)	60	-	-	V
Gate to Source Threshold Voltage	$V_{GS(TH)}$	$V_{GS} = V_{DS}$, $I_D = 250\mu\text{A}$, (Figure 11)	1	-	3	V
Zero Gate Voltage Drain Current	I_{DSS}	$V_{DS} = 60\text{V}$, $V_{GS} = 0\text{V}$				
		$T_A = 25^{\circ}\text{C}$	-	-	1	μA
		$T_A = 150^{\circ}\text{C}$	-	-	50	μA
Gate to Source Leakage Current	I_{GSS}	$V_{GS} = \pm 20\text{V}$, $T_A = 25^{\circ}\text{C}$	-	-	10	μA
		$V_{GS} = \pm 10\text{V}$, $T_A = 85^{\circ}\text{C}$	-	-	25	μA
Drain to Source On Resistance	$r_{DS(ON)}$	$I_D = 2.5\text{A}$, (Figures 9, 10)				
		$V_{GS} = 10\text{V}$	-	-	0.130	Ω
		$V_{GS} = 4.5\text{V}$	-	-	0.350	Ω
Turn-On Time	t_{ON}	$V_{DD} = 30\text{V}$, $I_D \cong 2.5\text{A}$, $R_L = 12\Omega$, $V_{GS} = 10\text{V}$, $R_{GS} = 25\Omega$, (Figure 14)	-	-	50	ns
Turn-On Delay Time	$t_{d(ON)}$		-	10	-	ns
Rise Time	t_r		-	25	-	ns
Turn-Off Delay Time	$t_{d(OFF)}$		-	68	-	ns
Fall Time	t_f		-	32	-	ns
Turn-Off Time	t_{OFF}		-	-	150	ns
Total Gate Charge	$Q_{g(TOT)}$	$V_{GS} = 0\text{V}$ to 20V	-	24	29	nC
Gate Charge at 10V	$Q_{g(10)}$	$V_{GS} = 0\text{V}$ to 10V	-	13	16	nC
Threshold Gate Charge	$Q_{g(TH)}$	$V_{GS} = 0\text{V}$ to 2V	-	0.8	1.0	nC
Input Capacitance	C_{ISS}	$V_{DS} = 25\text{V}$, $V_{GS} = 0\text{V}$, $f = 1\text{MHz}$	-	365	-	pF
Output Capacitance	C_{OSS}	(Figure 13)	-	140	-	pF
Reverse Transfer Capacitance	C_{RSS}		-	40	-	pF
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	Pulse Width = 1s Device mounted on FR-4 material	-	-	62.5	$^{\circ}\text{C/W}$

Source to Drain Diode 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}	$I_{SD} = 2.5\text{A}$, $dI_{SD}/dt = 100\text{A}/\mu\text{s}$	-	-	58	ns

Typical Performance Curves

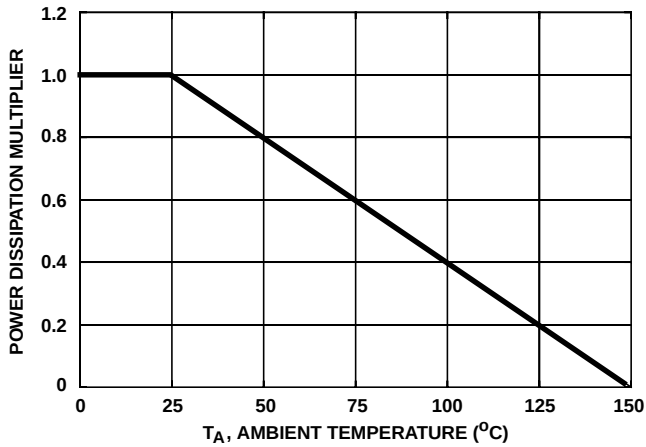


FIGURE 1. NORMALIZED POWER DISSIPATION vs AMBIENT TEMPERATURE

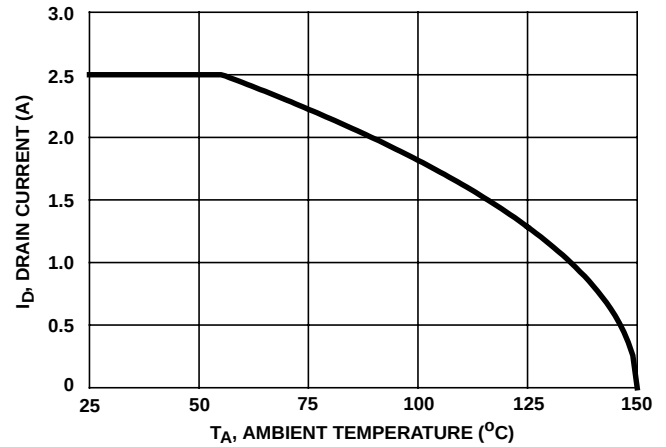


FIGURE 2. MAXIMUM CONTINUOUS DRAIN CURRENT vs AMBIENT TEMPERATURE

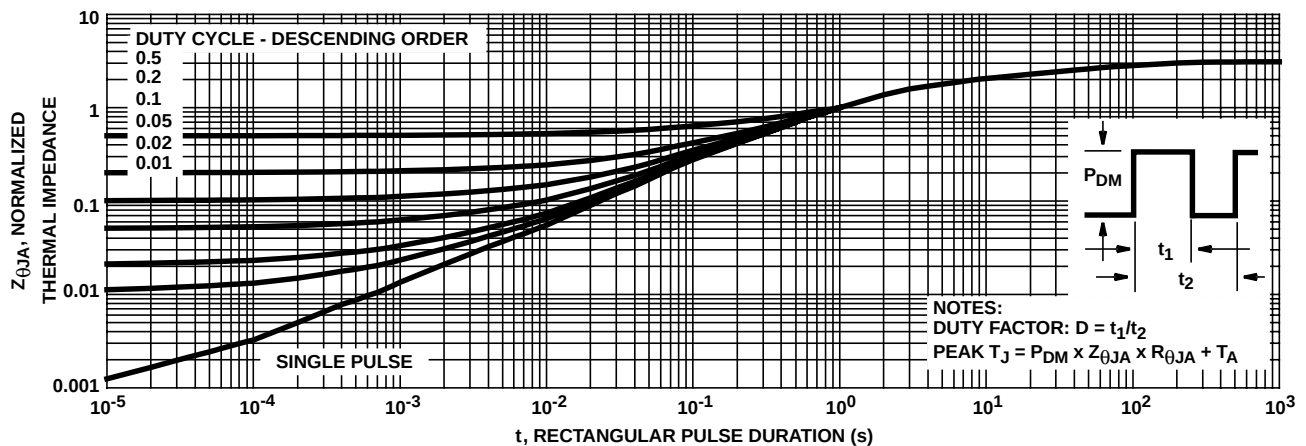


FIGURE 3. NORMALIZED MAXIMUM TRANSIENT THERMAL IMPEDANCE

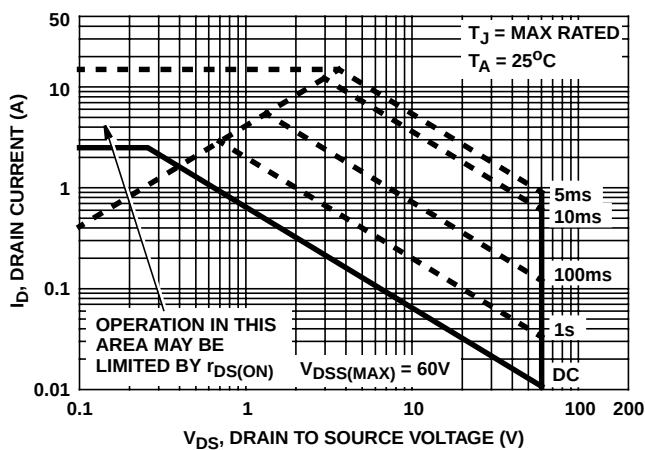


FIGURE 4. FORWARD BIAS SAFE OPERATING AREA

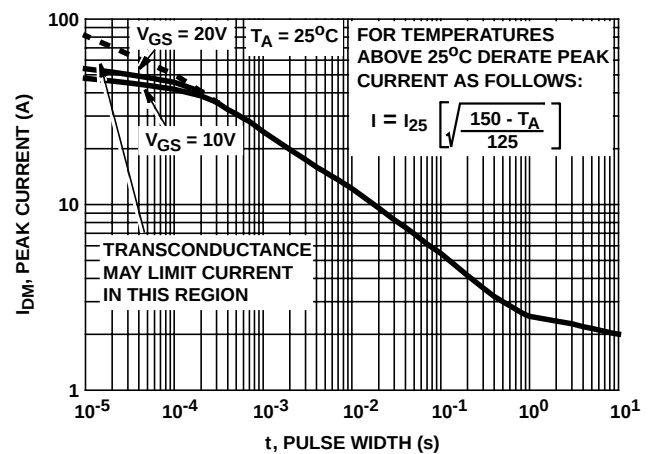
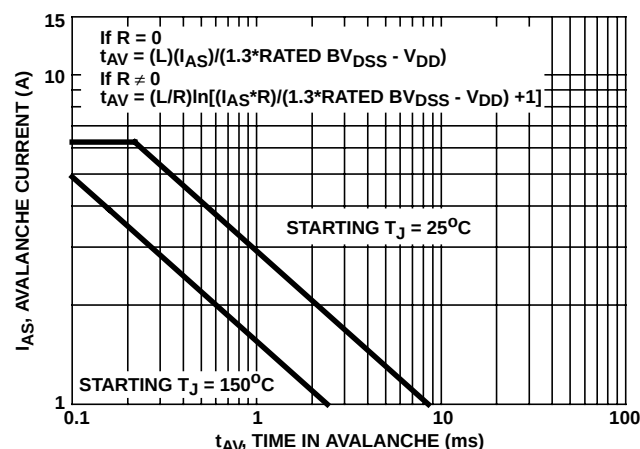


FIGURE 5. PEAK CURRENT CAPABILITY

Typical Performance Curves (Continued)



NOTE: Refer to Intersil Application Notes AN9321 and AN9322.

FIGURE 6. UNCLAMPED INDUCTIVE SWITCHING CAPABILITY

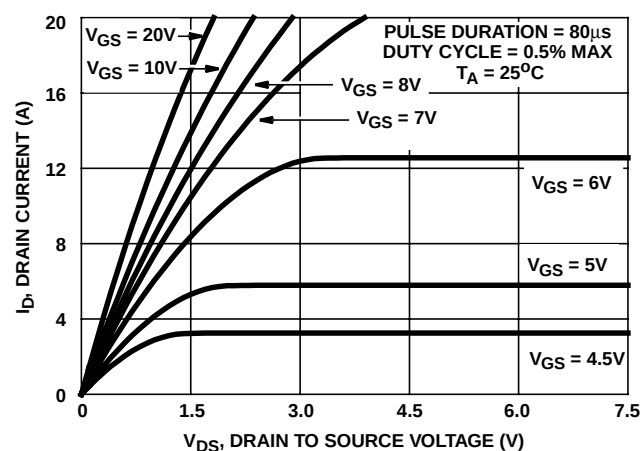


FIGURE 7. SATURATION CHARACTERISTICS

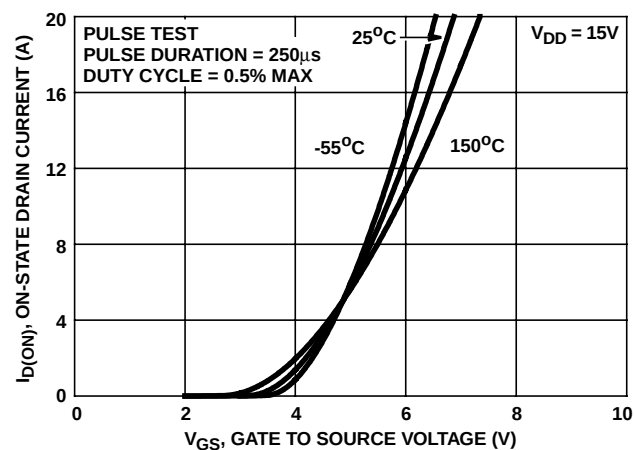


FIGURE 8. TRANSFER CHARACTERISTICS

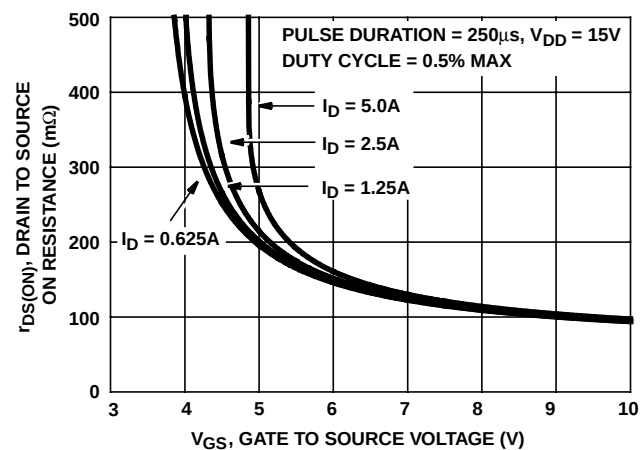


FIGURE 9. DRAIN TO SOURCE ON RESISTANCE vs GATE VOLTAGE AND DRAIN CURRENT

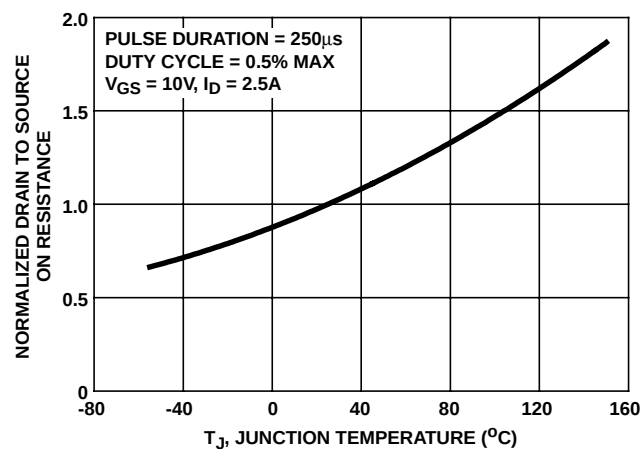


FIGURE 10. NORMALIZED DRAIN TO SOURCE ON RESISTANCE vs JUNCTION TEMPERATURE

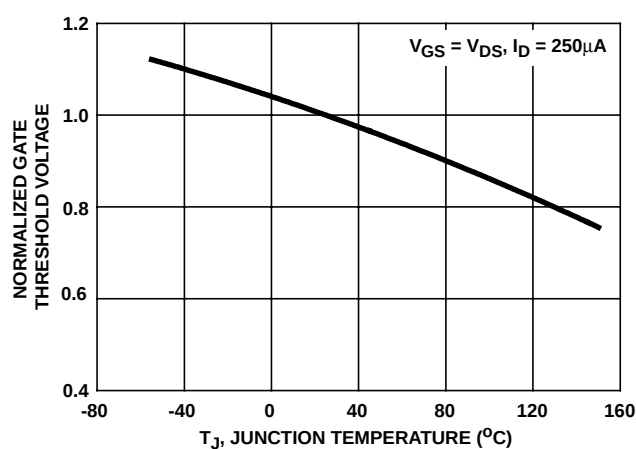


FIGURE 11. NORMALIZED GATE THRESHOLD VOLTAGE vs JUNCTION TEMPERATURE

Typical Performance Curves (Continued)

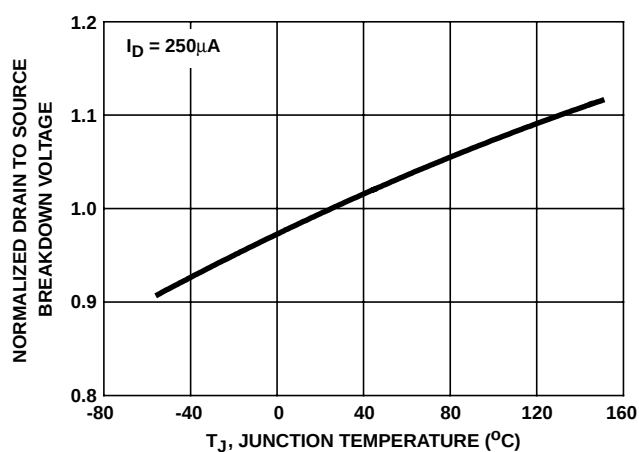


FIGURE 12. NORMALIZED DRAIN TO SOURCE BREAKDOWN VOLTAGE vs JUNCTION TEMPERATURE

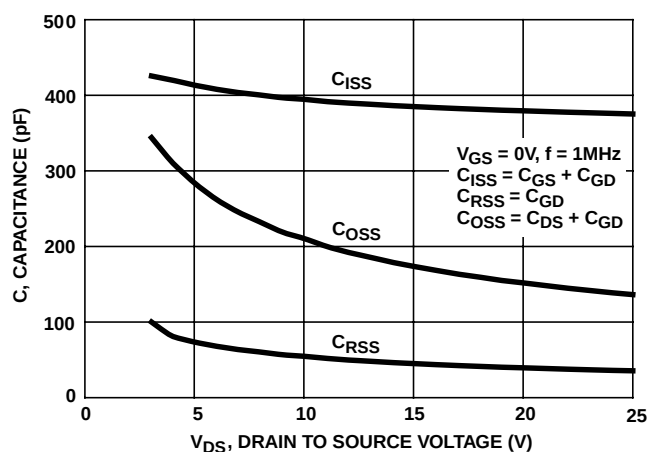
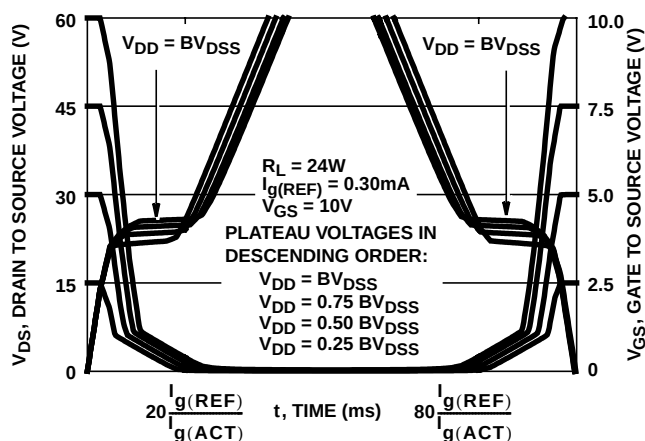


FIGURE 13. CAPACITANCE vs DRAIN TO SOURCE VOLTAGE



NOTE: Refer to Intersil Application Notes AN7254 and AN7260.

FIGURE 14. NORMALIZED SWITCHING WAVEFORMS FOR CONSTANT GATE CURRENT

Test Circuits and Waveforms

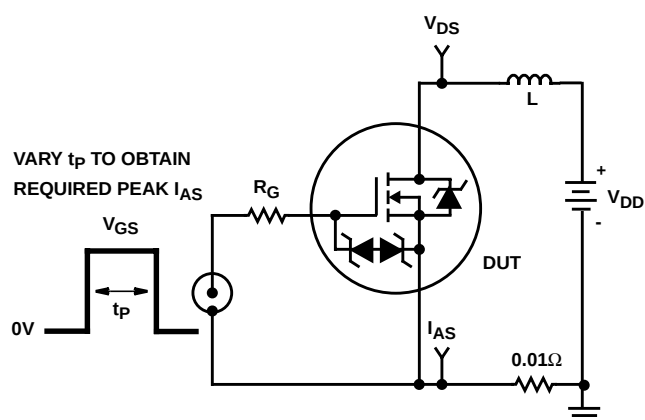


FIGURE 15. UNCLAMPED ENERGY TEST CIRCUIT

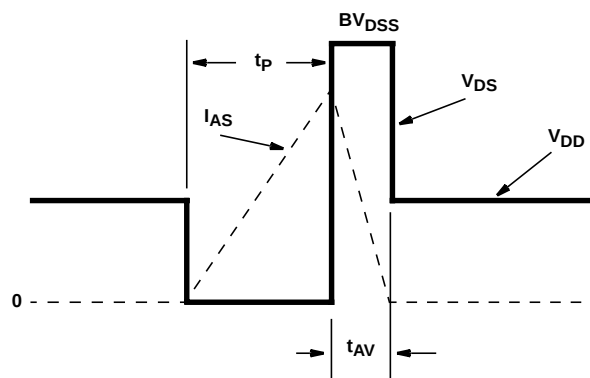


FIGURE 16. UNCLAMPED ENERGY WAVEFORMS

Test Circuits and Waveforms (Continued)

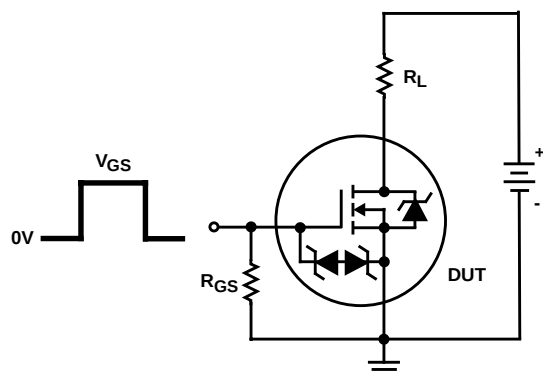


FIGURE 17. SWITCHING TIME TEST CIRCUIT

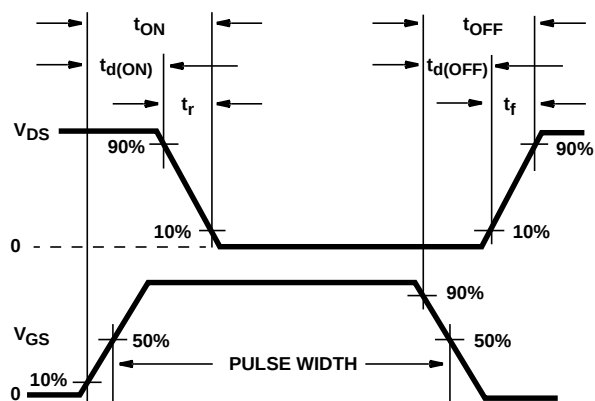


FIGURE 18. RESISTIVE SWITCHING WAVEFORMS

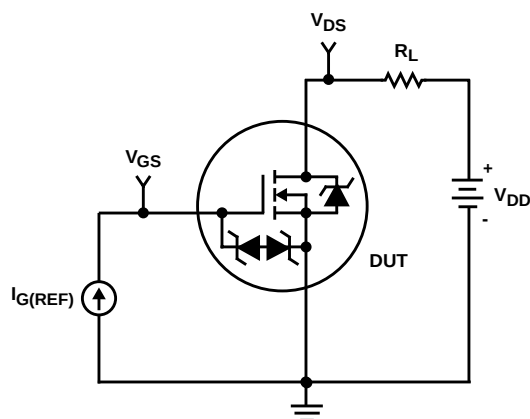


FIGURE 19. GATE CHARGE TEST CIRCUIT

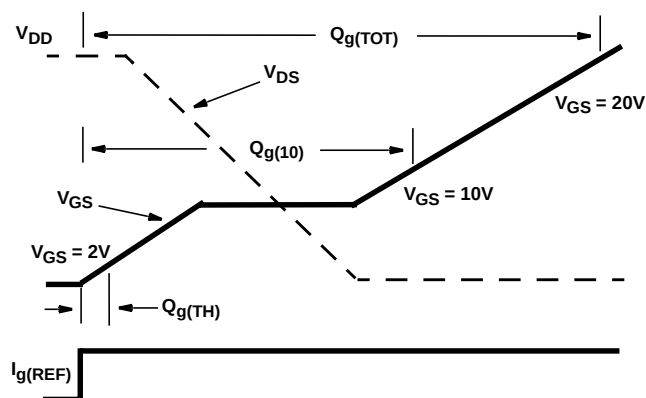


FIGURE 20. GATE CHARGE WAVEFORMS

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 RF1K49221 2 1 3: rev 4/8/97

CA	12	8	5.60e-10
CB	15	14	5.30e-10
CIN	6	8	3.40e-10

```
DBODY 7 5 DBODYMOD
DBREAK 5 11 DBREAKMOD
DESD1 91 9 DESD1MOD
DESD2 91 7 DESD2MOD
DPLCAP 10 5 DPLCAPMOD
```

```
EBREAK 11 7 17 18 67.29
EDS 14 8 5 8 1
EGS 13 8 6 8 1
ESG 6 10 6 8 1
EVTHRES 6 21 19 8 1
EVTEMP 20 6 18 22 1
```

IT 8 17 1

```
LDRAIN 2 5 1e-9
LGATE 1 9 1.12e-9
LSOURCE 3 7 4.50e-10
```

MMED 16 6 8 8 MMEDMOD
MSTRO 16 6 8 8 MSTROMOD
MWEAK 16 21 8 8 MWEAKMOD

```
RBREAK 17 18 RBREAKMOD 1
RDRAIN 50 16 RDRAINMOD 28.58e-3
RGATE 9 20 15.34
RSLC1 5 51 RSLCMOD 1e-6
RSLC2 5 50 1e3
RLDRAIN 2 5 10
RLGATE 1 9 11.2
RLSOURCE 3 7 4.5
RSOURCE 8 7 RSOURCEMOD 28.85e-3
RVTHRES 22 8 RVTHRESMOD 1
RVTEMP 18 19 RVTEMPMOD 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

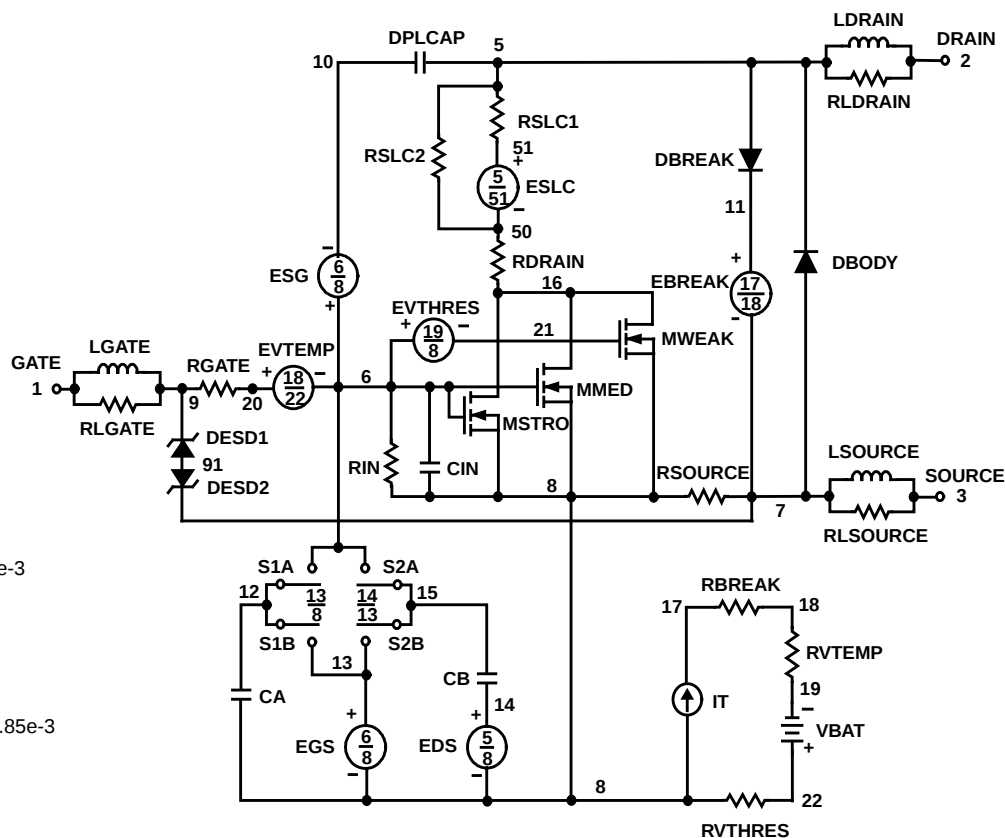
VBAT 22 19 DC 1

ESLC 51 50 VALUE={ (V(5,51)/ABS(V(5,51))) * (PWR(V(5,51)/(1e-6*30),2.5)) }

```
.MODEL DBODYMOD D (IS = 1.95e-13 RS = 2.58e-2 TRS1 = 2.00e-3 TRS2 = -4.39e-7 CJO = 5.15e-10 TT = 5.23e-8 M=0.5)
.MODEL DBREAKMOD D (RS = 6.24e-1 TRS1 = -3.03e-4 TRS2 = 4.27e-6
.MODEL DESD1MOD D (BV=32.3 TBV1=0 TBV2=0 RS=0 TRS1=0 TRS2=0
.MODEL DESD2MOD D (BV=32.5 TBV1=0 TBV2=0 RS=25 TRS1=5.18e-4 TRS2=-1.52e-6)
.MODEL DPLCAPMOD D (CJO = 1.80e-10 IS = 1e-30 N = 10 M=0.5)
.MODEL MMEDMOD NMOS (VTO=2.755 KP=0.21 IS=1e-30 N=10 TOX=1 L=1u W=1u RG=15.34)
.MODEL MSTROMOD NMOS (VTO=3.165 KP=3.75 IS=1e-30 N=10 TOX=1 L=1u W=1u)
.MODEL MWEAKMOD NMOS (VTO=2.520 KP=0.040 IS=1e-30 N=10 TOX=1 L=1u W=1u RG=153.4 RS=0.1)
.MODEL RBREAKMOD RES (TC1 = 1.10e-3 TC2 = -1.09e-6)
.MODEL RDRAINMOD RES (TC1 = 1.15e-2 TC2 = 4.09e-5
.MODEL RSLCMOD RES (TC1=3.03e-3 TC2=4.52e-6)
.MODEL RSOURCEMOD RES (TC1=0 TC2=0)
.MODEL RVTHRESMOD RES (TC=-7.20e-4 TC2=-7.11e-6)
.MODEL RVTEMPMOD RES (TC1 = -3.01e-3 TC2 = 1.81e-6)
```

```
.MODEL S1AMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = -7.80 VOFF= -4.80)
.MODEL S1BMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = -4.80 VOFF= -7.80)
.MODEL S2AMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = 1.10 VOFF= 4.10)
.MODEL S2BMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = 4.10 VOFF= 1.10)
```

.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, written by William J. Hepp and C. Frank Wheatley.

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