Data Sheet | October 1999 | File Number 4072.3

## 50A, 60V, 0.022 Ohm, Logic Level N-Channel Power MOSFETs

These N-Channel enhancement mode power MOSFETs are manufactured using the latest manufacturing process technology. This process, which uses feature sizes approaching those of LSI 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 TA49164.

## Ordering Information

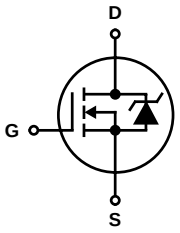
| PART NUMBER | PACKAGE | BRAND |
|---|---|---|
| RFG50N06LE | TO-247 | FG50N06L |
| RFP50N06LE | TO-220AB | FP50N06L |
| RF1S50N06LESM | TO-263AB | F50N06LE |

NOTE: When ordering, use the entire part number. Add the suffix 9A to obtain the TO-263AB variant in tape and reel, i.e. RF1S50N06LESM9A.

## Features

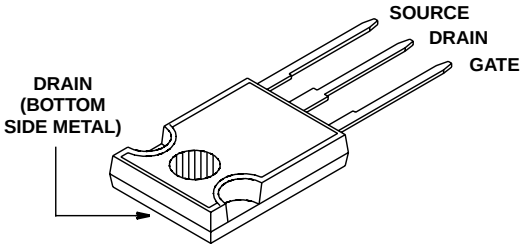
- 50A, 60V
- $r_{DS(ON)} = 0.022\Omega$
- Temperature Compensating PSPICE® Model
- Peak Current vs Pulse Width Curve
- UIS Rating Curve
- 175°C Operating Temperature
- Related Literature
  - TB334 “Guidelines for Soldering Surface Mount Components to PC Boards”

## Symbol

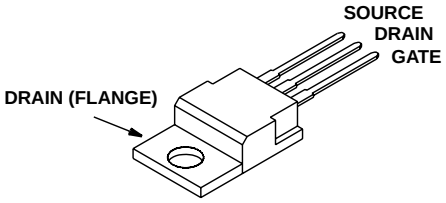



## Packaging

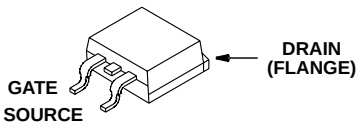
JEDEC STYLE TO-247




JEDEC TO-220AB




JEDEC TO-263AB






CAUTION: These devices are sensitive to electrostatic discharge; follow proper ESD Handling Procedures.
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## Absolute Maximum Ratings $T_C = 25^oC$, Unless Otherwise Specified

| | | RFG50N06LE, RFP50N06LE, RF1S50N06LESM | UNITS |
|---|---|---|---|
| Drain to Source Voltage (Note 1) | $V_{DSS}$ | 60 | V |
| Drain to Gate Voltage ($R_{GS}$ = 20kΩ) (Note 1) | $V_{DGR}$ | 60 | V |
| Gate to Source Voltage | $V_{GS}$ | ±10 | V |
| Continuous Drain Current | $I_D$ | 50 | A |
| Pulsed Drain Current (Note 3) | $I_{DM}$ | Refer to Peak Current Curve | |
| Pulsed Avalanche Rating | $E_{AS}$ | Refer to UIS Curve | |
| Power Dissipation | $P_D$ | 142 | W |
| Derate Above $25^oC$ | | 0.95 | $W/^oC$ |
| 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. $T_J = 25^oC$ to $150^oC$.

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

| PARAMETER | SYMBOL | TEST CONDITIONS | | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Drain to Source Breakdown Voltage | $BV_{DSS}$ | $I_D$ = 250μA, $V_{GS}$ = 0V, Figure 13 | | 60 | - | - | V |
| Gate Threshold Voltage | $V_{GS(TH)}$ | $V_{GS}$ = $V_{DS}$, $I_D$ = 250μA, Figure 12 | | 1 | - | 3 | V |
| Zero Gate Voltage Drain Current | $I_{DSS}$ | $V_{DS}$ = 55V, $V_{GS}$ = 0V | | - | - | 1 | μA |
| | | $V_{DS}$ = 50V, $V_{GS}$ = 0V, $T_C = 150^oC$ | | - | - | 250 | μA |
| Gate to Source Leakage Current | $I_{GSS}$ | $V_{GS}$ = ±10V | | - | - | 10 | μA |
| Drain to Source On Resistance (Note 2) | $r_{DS(ON)}$ | $I_D$ = 50A, $V_{GS}$ = 5V, Figure 11 | | - | - | 0.022 | Ω |
| Turn-On Time | $t_{ON}$ | $V_{DD}$ = 30V, $I_D$ = 50A, $R_L$ = 0.6Ω, $V_{GS}$ = 5V, $R_{GS}$ = 2.5Ω Figures 10, 18, 19 | | - | - | 230 | ns |
| Turn-On Delay Time | $t_{d(ON)}$ | | | - | 20 | - | ns |
| Rise Time | $t_r$ | | | - | 170 | - | ns |
| Turn-Off Delay Time | $t_{d(OFF)}$ | | | - | 48 | - | ns |
| Fall Time | $t_f$ | | | - | 90 | - | ns |
| Turn-Off Time | $t_{OFF}$ | | | - | - | 165 | ns |
| Total Gate Charge | $Q_{g(TOT)}$ | $V_{GS}$ = 0V to 10V | $V_{DD}$ = 48V, $I_D$ = 50A, $R_L$ = 0.96Ω Figures 21, 21 | - | 96 | 120 | nC |
| Gate Charge at 5V | $Q_{g(5)}$ | $V_{GS}$ = 0V to 5V | | - | 57 | 70 | nC |
| Threshold Gate Charge | $Q_{g(TH)}$ | $V_{GS}$ = 0V to 1V | | - | 2.2 | 2.7 | nC |
| Input Capacitance | $C_{ISS}$ | $V_{DS}$ = 25V, $V_{GS}$ = 0V, f = 1MHz Figure 14 | | - | 2100 | - | pF |
| Output Capacitance | $C_{OSS}$ | | | - | 600 | - | pF |
| Reverse Transfer Capacitance | $C_{RSS}$ | | | - | 230 | - | pF |
| Thermal Resistance Junction to Case | $R_{\theta JC}$ | | | - | - | 1.05 | $^oC/W$ |
| Thermal Resistance Junction to Ambient | $R_{\theta JA}$ | TO-247 | | - | - | 30 | $^oC/W$ |
| | | TO-220AB and TO-263AB | | - | - | 80 | $^oC/W$ |

## Source to Drain Diode Specifications

| PARAMETER | SYMBOL | TEST CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| Source to Drain Diode Voltage | $V_{SD}$ | $I_{SD}$ = 45A | - | - | 1.5 | V |
| Diode Reverse Recovery Time | $t_{rr}$ | $I_{SD}$ = 45A, $dI_{SD}/dt$ = 100A/μs | - | - | 125 | ns |

NOTES:

2. Pulse test: pulse width ≤ 80μs, duty cycle ≤ 2%.
3. Repetitive rating: pulse width limited by Max junction temperature. See Transient Thermal Impedance curve (Figure 3).

## Typical Performance Curves Unless Otherwise Specified

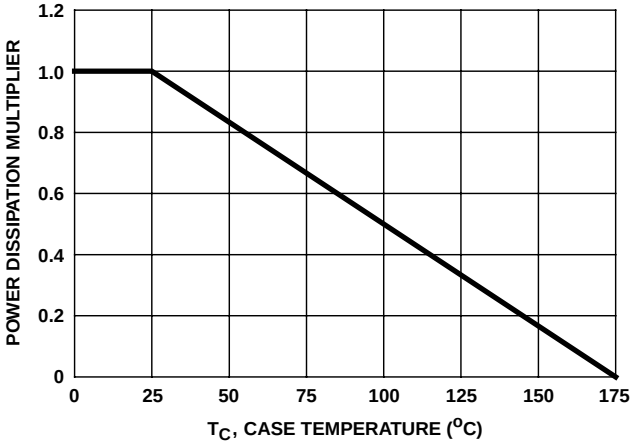



FIGURE 1. NORMALIZED POWER DISSIPATION vs CASE TEMPERATURE

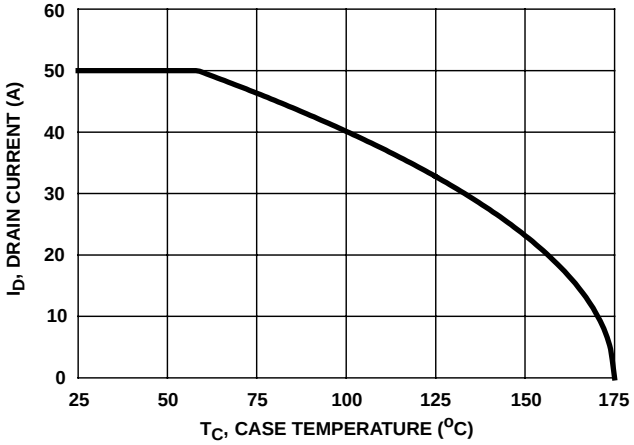



FIGURE 2. MAXIMUM CONTINUOUS DRAIN CURRENT vs CASE TEMPERATURE

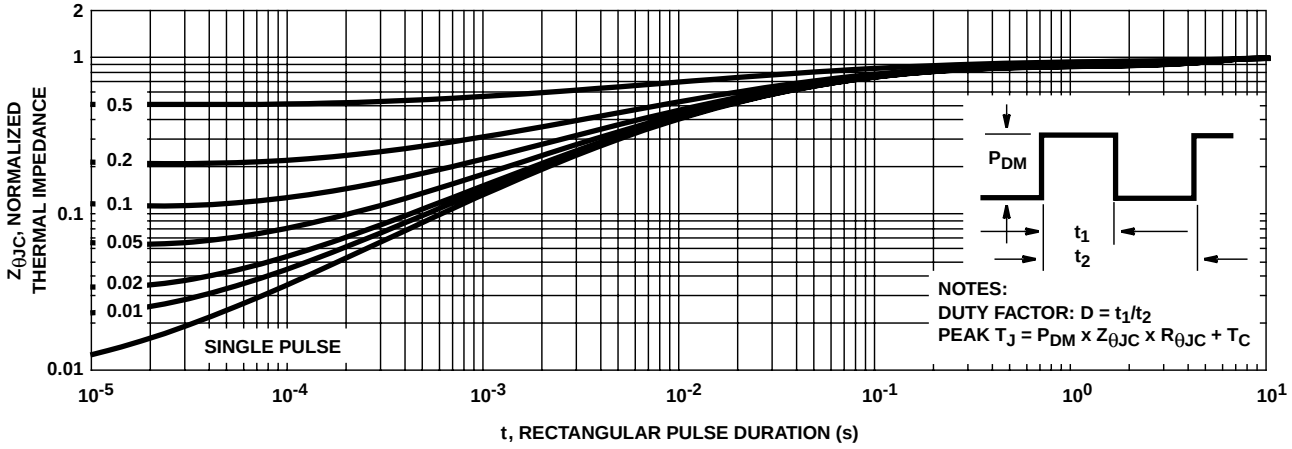



FIGURE 3. NORMALIZED MAXIMUM TRANSIENT THERMAL IMPEDANCE

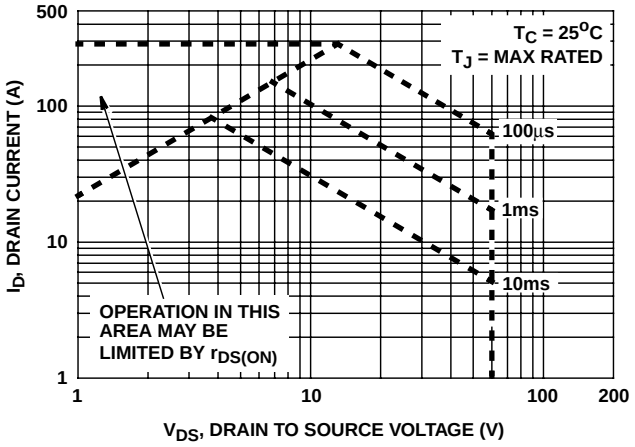



FIGURE 4. FORWARD BIAS SAFE OPERATING AREA

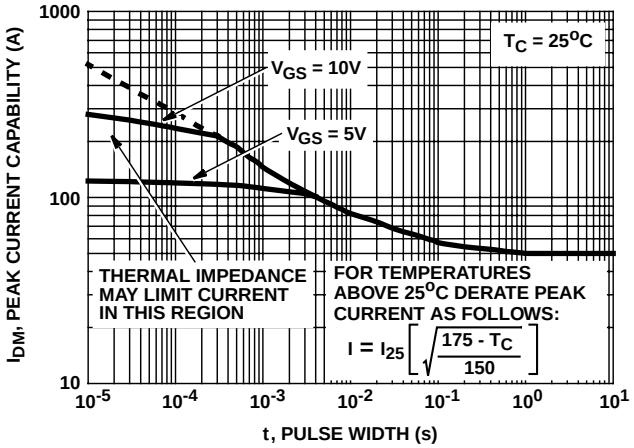
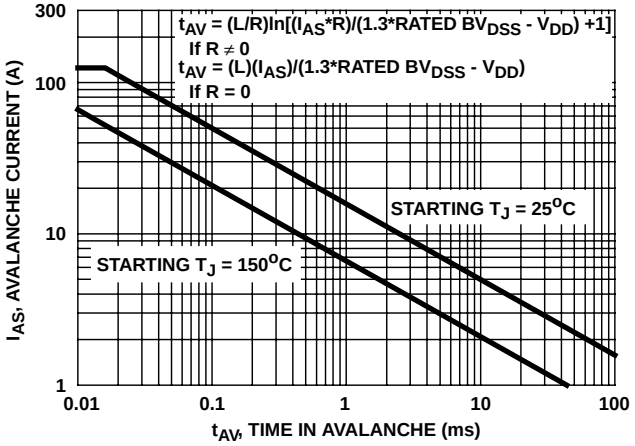



FIGURE 5. PEAK CURRENT CAPABILITY

## Typical Performance Curves Unless Otherwise Specified (Continued)




NOTE: Refer to Intersil Application Notes AN9321 and AN9322

**FIGURE 6. UNCLAMPED INDUCTIVE SWITCHING**

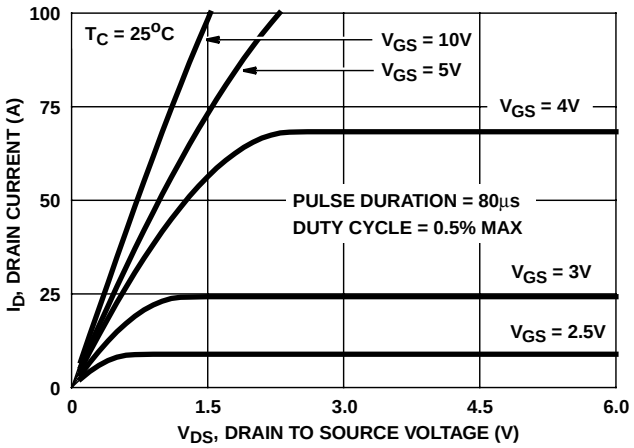



**FIGURE 7. SATURATION CHARACTERISTICS**

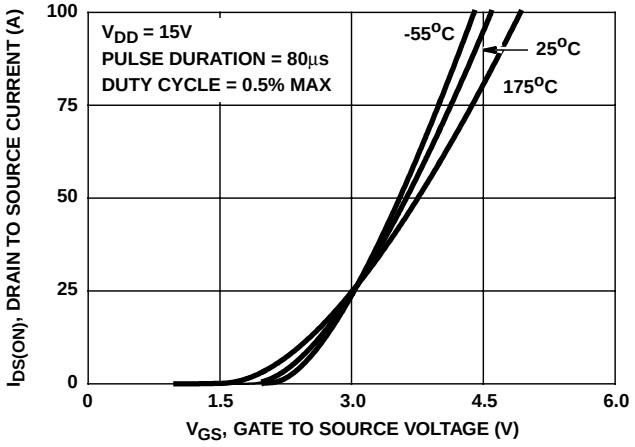



**FIGURE 8. TRANSFER CHARACTERISTICS**

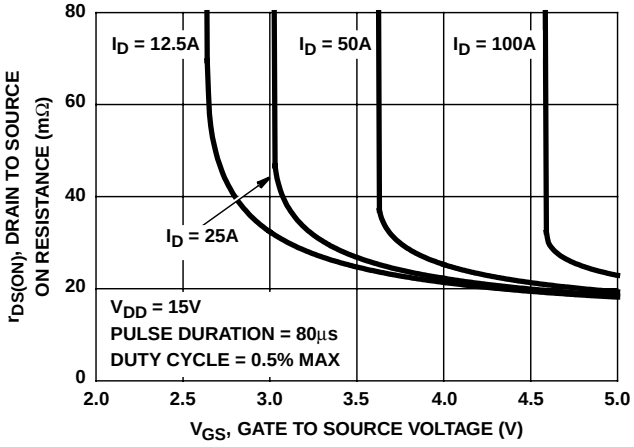



**FIGURE 9. DRAIN TO SOURCE ON RESISTANCE vs GATE VOLTAGE AND DRAIN CURRENT**

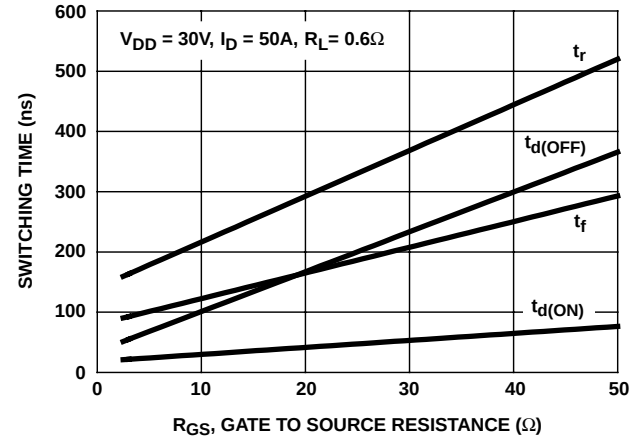



**FIGURE 10. SWITCHING TIME vs GATE RESISTANCE**

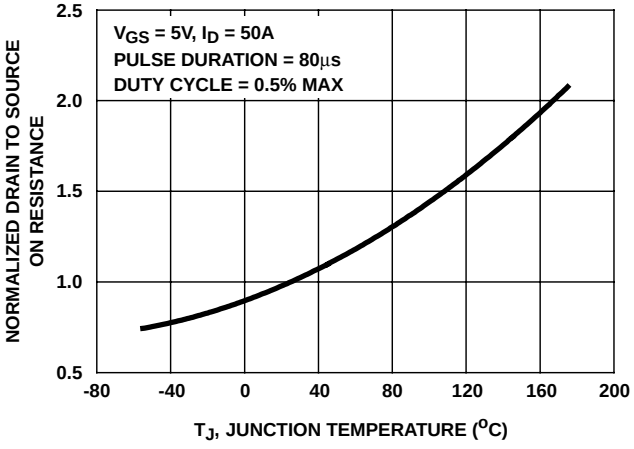



**FIGURE 11. NORMALIZED DRAIN TO SOURCE ON RESISTANCE vs JUNCTION TEMPERATURE**

## Typical Performance Curves Unless Otherwise Specified (Continued)

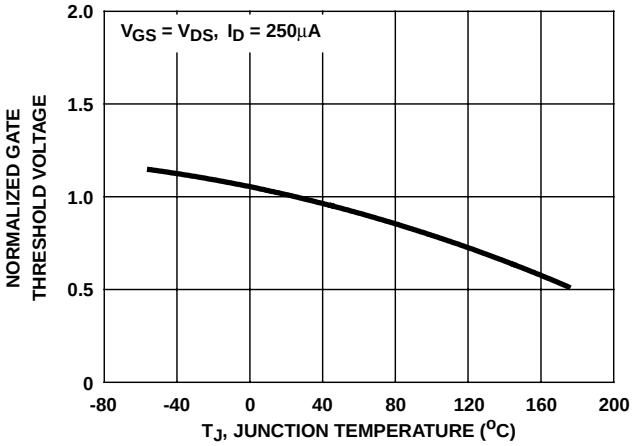



FIGURE 12. NORMALIZED GATE THRESHOLD VOLTAGE vs JUNCTION TEMPERATURE

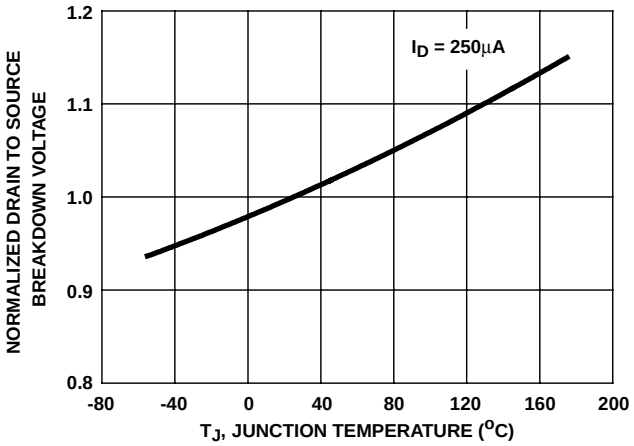



FIGURE 13. NORMALIZED DRAIN TO SOURCE BREAKDOWN VOLTAGE vs JUNCTION TEMPERATURE

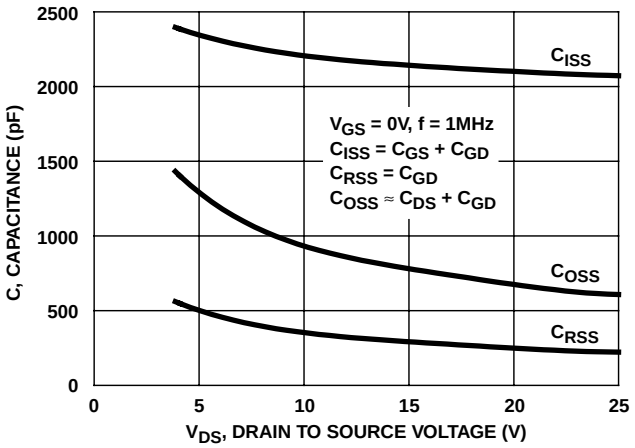
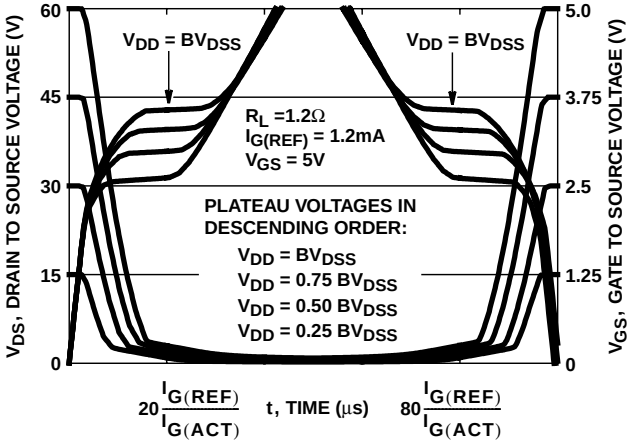



FIGURE 14. CAPACITANCE vs DRAIN TO SOURCE VOLTAGE




NOTE: Refer to Intersil Application Notes AN7254 and AN7260.

FIGURE 15. NORMALIZED SWITCHING WAVEFORMS FOR CONSTANT GATE CURRENT

## Test Circuits and Waveforms

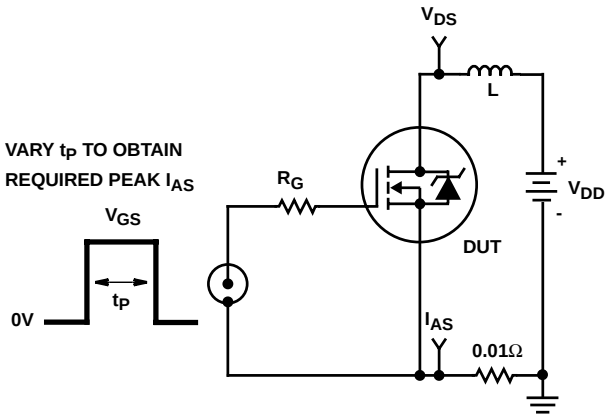



FIGURE 16. UNCLAMPED ENERGY TEST CIRCUIT

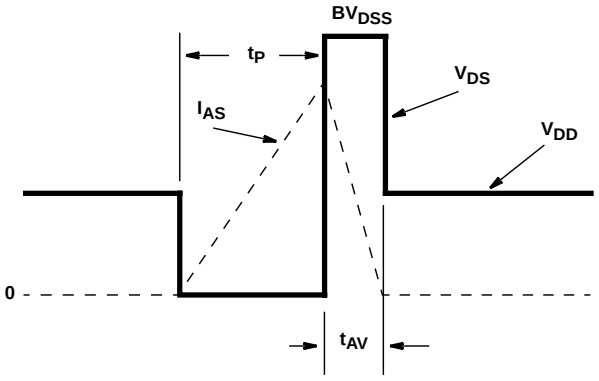



FIGURE 17. UNCLAMPED ENERGY WAVEFORMS

## Test Circuits and Waveforms (Continued)

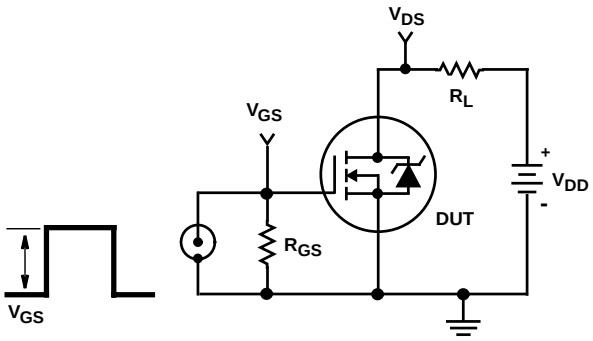



FIGURE 18. SWITCHING TIME TEST CIRCUIT

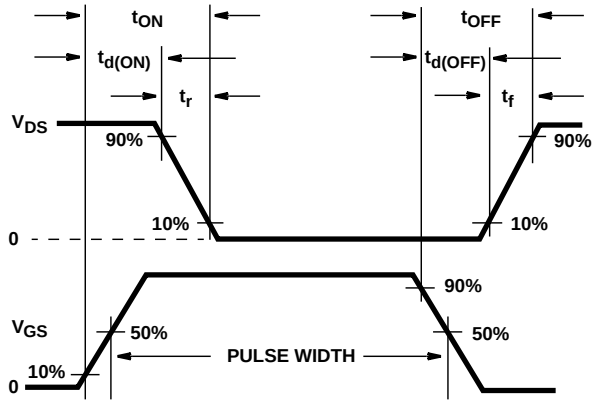



FIGURE 19. RESISTIVE SWITCHING WAVEFORMS

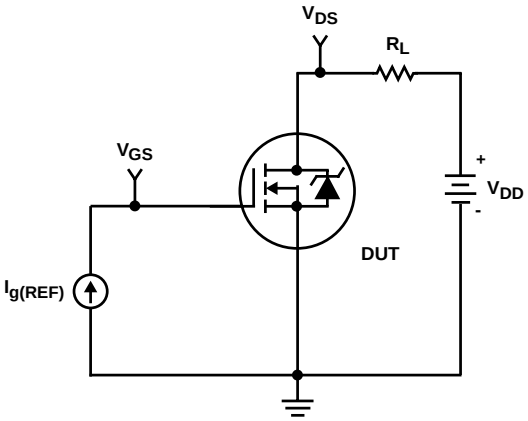



FIGURE 20. GATE CHARGE TEST CIRCUIT

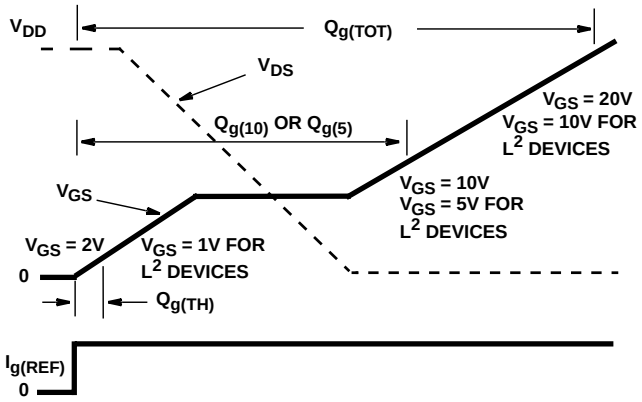



FIGURE 21. GATE CHARGE WAVEFORMS

## PSPICE Electrical Model

```
SUBCKT 50N06LE 2 1 3 ;       rev 8/11/95

CA  12  8 3.73e-9
CB  15  14 3.73e-9
CIN  6  8 2.08e-9


DBODY 7 5 DBODYMOD
DBREAK 5 11  DBREAKMOD
DPLCAP 10 5 DPLCAPMOD


EBREAK 11 7 17  18 66.5
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 4.0e-9
LGATE 1 9 6.0e-9
LSOURCE  3 7 3.0e-9

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 3.75e-3
RGATE  9  20 1.0
RLDRAIN 2 5 40
RLGATE 1 9 60
RLSOURCE 3 7 30
RSLC1 5 51 RSLCMOD 1e-6
RSLC2 5 50 1e3
RSOURCE  8  7  RSOURCEMOD 6.15e-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

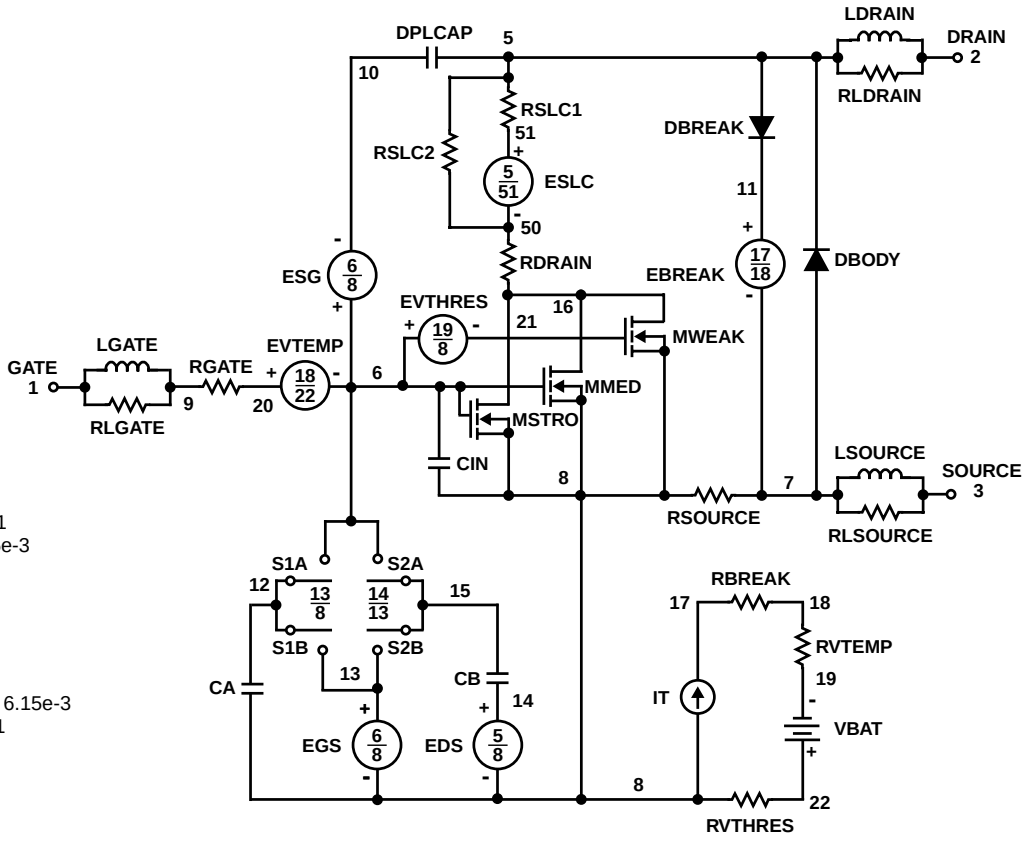
VBAT 22 19  DC  1

ESLC 51 50 VALUE={(V(5,51)/ABS(V(5,51)))*(PWR(V(5,51)/(1e-6*200),4))}

.MODEL DBODYMOD D (IS = 1.70e-12  RS = 3.20e-3  TRS1 = 1.75e-3  TRS2 = 1.75e-6  CJO = 2.55e-9  IKF = 13 XTI = 5.2 TT = 7.00e-8 M = 0.47)
.MODEL DBREAKMOD D (RS = 1.70e-1  IKF = 0.1 TRS1 = 2.00e-3  TRS2 = 8.00e-7)
.MODEL DPLCAPMOD D (CJO = 2.00e-9  IS = 1e-30   VJ = 1.1 M = 0.83 N = 10)
.MODEL MMEDMOD NMOS (VTO = 2.00 KP = 5 IS = 1e-30 N = 10 TOX = 1 L = 1u W = 1u RG = 1.0)
.MODEL MSTROMOD NMOS (VTO = 2.42 KP = 128 IS = 1e-30 N = 10 TOX = 1 L = 1u W = 1u)
.MODEL MWEAKMOD NMOS (VTO = 1.60 KP = 0.01 IS = 1e-30 N = 10 TOX = 1 L = 1u W = 1u RG = 10.0 RS = 0.1)
.MODEL RBREAKMOD RES (TC1 = 1.13e-3  TC2 = 0)
.MODEL RDRAINMOD RES (TC1 = 1.20e-2  TC2 = 6.00e-5)
.MODEL RSLCMOD RES (TC1 = 2.00e-3 TC2 = 1.00e-6)
.MODEL RSOURCEMOD RES (TC1 = 2.00e-3 TC2 =-1.00e-5)
.MODEL RVTHRESMOD RES (TC1 = -2.50e-3 TC2 = -8.50e-6)
.MODEL RVTEMPMOD RES (TC1 = -2.00e-3  TC2 = 5.00e-6)

.MODEL S1AMOD VSWITCH (RON = 1e-5  ROFF = 0.1  VON = -5.3  VOFF= -2.5)
.MODEL S1BMOD VSWITCH (RON = 1e-5  ROFF = 0.1  VON = -2.5  VOFF= -5.3)
.MODEL S2AMOD VSWITCH (RON = 1e-5  ROFF = 0.1  VON = -1.4  VOFF= 0.5)
.MODEL S2BMOD VSWITCH (RON = 1e-5  ROFF = 0.1  VON = 0.5  VOFF= -1.4)

.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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FAX: (886) 2 2715 3029

# OCEAN CHIPS
## Океан Электроники
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Компания «Океан Электроники» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

Наши преимущества:

- Поставка оригинальных импортных электронных компонентов напрямую с производств Америки, Европы и Азии, а так же с крупнейших складов мира;
- Широкая линейка поставок активных и пассивных импортных электронных компонентов (более 30 млн. наименований);
- Поставка сложных, дефицитных, либо снятых с производства позиций;
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- Экспресс доставка в любую точку России;
- Помощь Конструкторского Отдела и консультации квалифицированных инженеров;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Поставка электронных компонентов под контролем ВП;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- При необходимости вся продукция военного и аэрокосмического назначения проходит испытания и сертификацию в лаборатории (по согласованию с заказчиком);
- Поставка специализированных компонентов военного и аэрокосмического уровня качества (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Actel, Aeroflex, Peregrine, VPT, Syfer, Eurofarad, Texas Instruments, MS Kennedy, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

Компания «Океан Электроники» является официальным дистрибьютором и эксклюзивным представителем в России одного из крупнейших производителей разъемов военного и аэрокосмического назначения «**JONHON**», а так же официальным дистрибьютором и эксклюзивным представителем в России производителя высокотехнологичных и надежных решений для передачи СВЧ сигналов «**FORSTAR**».

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Разъемы специального, военного и аэрокосмического назначения:

(Применяются в военной, авиационной, аэрокосмической, морской, железнодорожной, горно- и нефтедобывающей отраслях промышленности)

**«FORSTAR»** (основан в 1998 г.)

ВЧ соединители, коаксиальные кабели, кабельные сборки и микроволновые компоненты:

(Применяются в телекоммуникациях гражданского и специального назначения, в средствах связи, РЛС, а так же военной, авиационной и аэрокосмической отраслях промышленности).

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