

FQP45N03L

N-Channel Logic Level PWM Optimized Power MOSFET

General Description

This device employs a new advanced MOSFET technology and features low gate charge while maintaining low on-resistance.

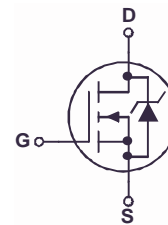
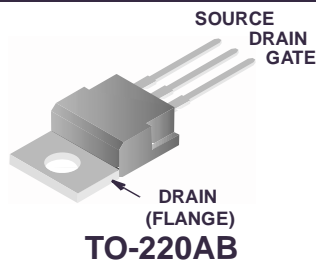
Optimized for switching applications, this device improves the overall efficiency of DC/DC converters and allows operation to higher switching frequencies.

Applications

- DC/DC converters

Features

- Fast switching
- $r_{DS(ON)} = 0.014\Omega$ (Typ), $V_{GS} = 10V$
- $r_{DS(ON)} = 0.020\Omega$ (Typ), $V_{GS} = 5V$
- Q_g (Typ) = 13nC, $V_{GS} = 5V$
- Q_{gd} (Typ) = 4.5nC
- C_{ISS} (Typ) = 1450pF



MOSFET Maximum Ratings $T_C = 25^\circ\text{C}$ unless otherwise noted

| Symbol | Parameter | Ratings | Units |
|----------------|---|------------|---------------------|
| V_{DSS} | Drain to Source Voltage | 30 | V |
| V_{GS} | Gate to Source Voltage | ± 16 | V |
| I_D | Drain Current | | |
| | Continuous ($T_C = 25^\circ\text{C}$, $V_{GS} = 10V$) | 41 | A |
| | Continuous ($T_C = 100^\circ\text{C}$, $V_{GS} = 4.5V$) | 22 | A |
| | Continuous ($T_C = 25^\circ\text{C}$, $V_{GS} = 10V$, $R_{\theta JA} = 43^\circ\text{C/W}$) | 8.1 | A |
| | Pulsed | Figure 4 | A |
| P_D | Power dissipation | 53 | W |
| | Derate above 25°C | 0.43 | W/ $^\circ\text{C}$ |
| T_J, T_{STG} | Operating and Storage Temperature | -55 to 150 | $^\circ\text{C}$ |

Thermal Characteristics

| | | | |
|-----------------|---|------|--------------------|
| $R_{\theta JC}$ | Thermal Resistance Junction to Case TO-220 | 2.31 | $^\circ\text{C/W}$ |
| $R_{\theta JA}$ | Thermal Resistance Junction to Ambient TO-220 | 62 | $^\circ\text{C/W}$ |

Package Marking and Ordering Information

| Device Marking | Device | Package | Reel Size | Tape Width | Quantity |
|----------------|-----------|----------|-----------|------------|----------|
| FQP45N03L | FQP45N03L | TO-220AB | Tube | N/A | 50 |

Electrical Characteristics $T_C = 25^\circ\text{C}$ unless otherwise noted

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Units |
|--------|-----------|-----------------|-----|-----|-----|-------|
|--------|-----------|-----------------|-----|-----|-----|-------|

Off Characteristics

| | | | | | | |
|------------|-----------------------------------|--|----|---|-----------|---------------|
| B_{VDSS} | Drain to Source Breakdown Voltage | $I_D = 250\mu\text{A}, V_{GS} = 0\text{V}$ | 30 | - | - | V |
| I_{DSS} | Zero Gate Voltage Drain Current | $V_{DS} = 25\text{V}$ $V_{GS} = 0\text{V}$ $T_C = 150^\circ\text{C}$ | - | - | 1 | μA |
| I_{GSS} | Gate to Source Leakage Current | $V_{GS} = \pm 16\text{V}$ | - | - | ± 100 | nA |

On Characteristics

| | | | | | | |
|--------------|----------------------------------|---|---|----------------|----------------|----------|
| $V_{GS(TH)}$ | Gate to Source Threshold Voltage | $V_{GS} = V_{DS}, I_D = 250\mu\text{A}$ | 1 | - | 3 | V |
| $r_{DS(ON)}$ | Drain to Source On Resistance | $I_D = 41\text{A}, V_{GS} = 10\text{V}$ $I_D = 22\text{A}, V_{GS} = 4.5\text{V}$ | - | 0.014 0.020 | 0.018 0.025 | Ω |

Dynamic Characteristics

| | | | | | | |
|--------------|-------------------------------|---|---|------|-----|----|
| C_{ISS} | Input Capacitance | $V_{DS} = 15\text{V}, V_{GS} = 0\text{V},$ $f = 1\text{MHz}$ | - | 1450 | - | pF |
| C_{OSS} | Output Capacitance | | - | 300 | - | pF |
| C_{RSS} | Reverse Transfer Capacitance | | - | 120 | - | pF |
| $Q_{g(TOT)}$ | Total Gate Charge at 10V | $V_{GS} = 0\text{V to } 10\text{V}$ | | 25 | 38 | nC |
| $Q_{g(5)}$ | Total Gate Charge at 5V | $V_{GS} = 0\text{V to } 5\text{V}$ | | 13 | 20 | nC |
| $Q_{g(TH)}$ | Threshold Gate Charge | $V_{GS} = 0\text{V to } 1\text{V}$ | | 1.5 | 2.3 | nC |
| Q_{gs} | Gate to Source Gate Charge | $V_{DD} = 15\text{V}$ $I_D = 22\text{A}$ $I_g = 1.0\text{mA}$ | | 4.3 | - | nC |
| Q_{gd} | Gate to Drain "Miller" Charge | | | 4.5 | - | nC |

Switching Characteristics ($V_{GS} = 4.5\text{V}$)

| | | | | | | |
|--------------|---------------------|--|---|----|-----|----|
| t_{ON} | Turn-On Time | $V_{DD} = 15\text{V}, I_D = 11\text{A}$ $V_{GS} = 5\text{V}, R_{GS} = 11\Omega$ | - | - | 115 | ns |
| $t_{d(ON)}$ | Turn-On Delay Time | | - | 15 | - | ns |
| t_r | Rise Time | | - | 60 | - | ns |
| $t_{d(OFF)}$ | Turn-Off Delay Time | | - | 25 | - | ns |
| t_f | Fall Time | | - | 30 | - | ns |
| t_{OFF} | Turn-Off Time | | - | - | 83 | ns |

Switching Characteristics ($V_{GS} = 10\text{V}$)

| | | | | | | |
|--------------|---------------------|---|---|----|-----|----|
| t_{ON} | Turn-On Time | $V_{DD} = 15\text{V}, I_D = 11\text{A}$ $V_{GS} = 10\text{V}, R_{GS} = 11\Omega$ | - | - | 57 | ns |
| $t_{d(ON)}$ | Turn-On Delay Time | | - | 8 | - | ns |
| t_r | Rise Time | | - | 30 | - | ns |
| $t_{d(OFF)}$ | Turn-Off Delay Time | | - | 45 | - | ns |
| t_f | Fall Time | | - | 30 | - | ns |
| t_{OFF} | Turn-Off Time | | - | - | 115 | ns |

Unclamped Inductive Switching

| | | | | | | |
|----------|----------------|---------------------------------------|-----|---|---|---------------|
| t_{AV} | Avalanche Time | $I_D = 2.9\text{A}, L = 3.0\text{mH}$ | 195 | - | - | μs |
|----------|----------------|---------------------------------------|-----|---|---|---------------|

Drain-Source Diode Characteristics

| | | | | | | |
|----------|-------------------------------|---|---|---|------|----|
| V_{SD} | Source to Drain Diode Voltage | $I_{SD} = 22\text{A}$ | - | - | 1.25 | V |
| | | $I_{SD} = 20\text{A}$ | - | - | 1.0 | V |
| t_{rr} | Reverse Recovery Time | $I_{SD} = 22\text{A}, dI_{SD}/dt = 100\text{A}/\mu\text{s}$ | - | - | 65 | ns |
| Q_{RR} | Reverse Recovered Charge | $I_{SD} = 22\text{A}, dI_{SD}/dt = 100\text{A}/\mu\text{s}$ | - | - | 100 | nC |

Typical Characteristic $T_C = 25^\circ\text{C}$ unless otherwise noted

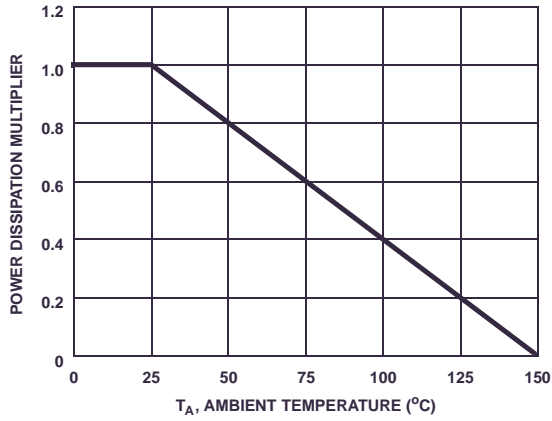


Figure 1. Normalized Power Dissipation vs Ambient Temperature

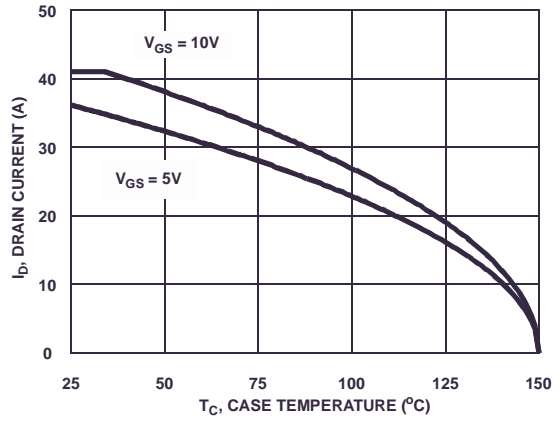


Figure 2. Maximum Continuous Drain Current vs Case Temperature

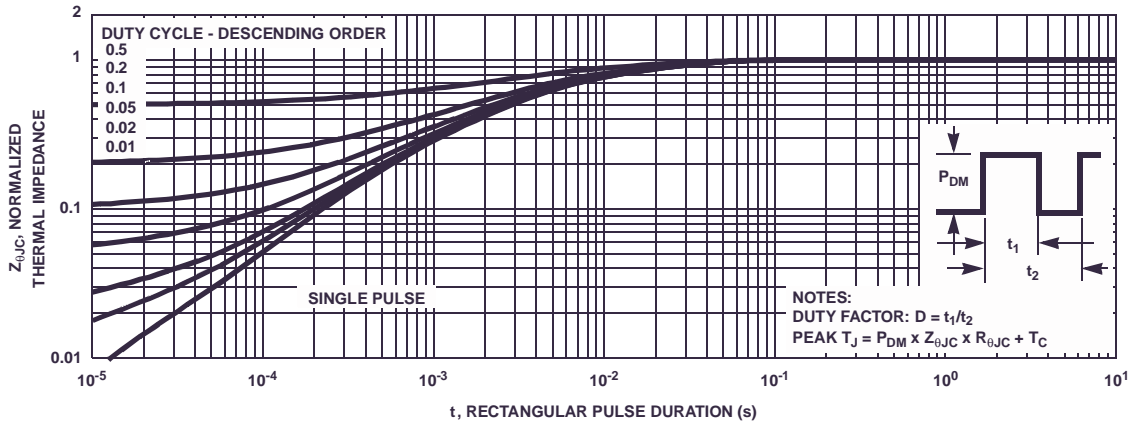


Figure 3. Normalized Maximum Transient Thermal Impedance

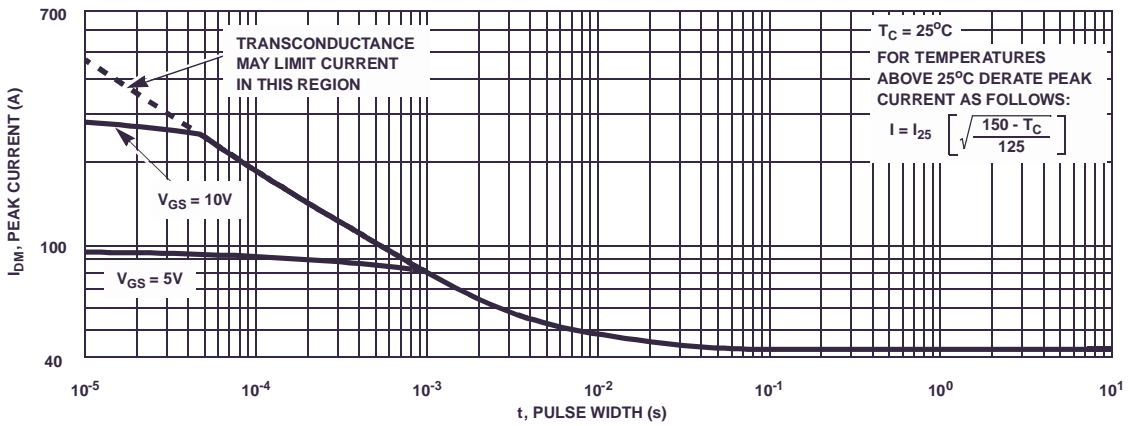


Figure 4. Peak Current Capability

Typical Characteristic $T_C = 25^\circ\text{C}$ unless otherwise noted (Continued)

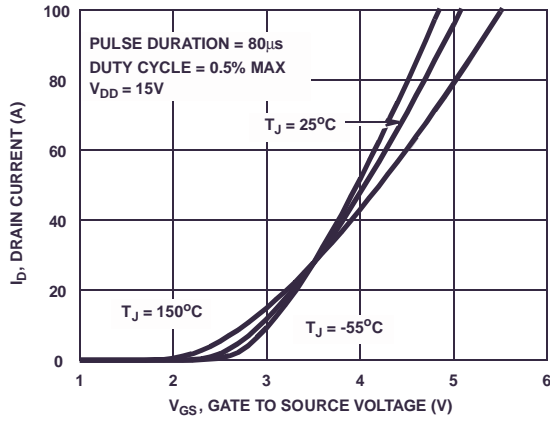


Figure 5. Transfer Characteristics

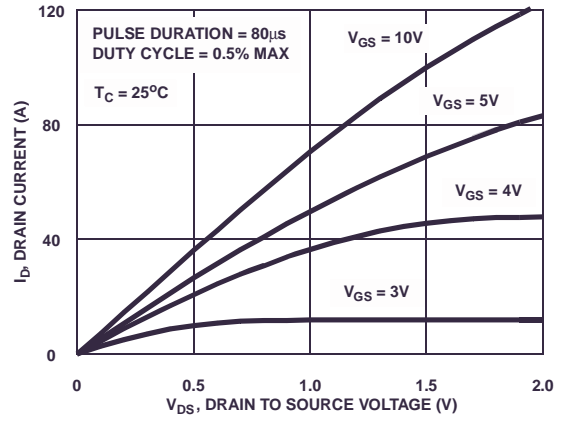


Figure 6. Saturation Characteristics

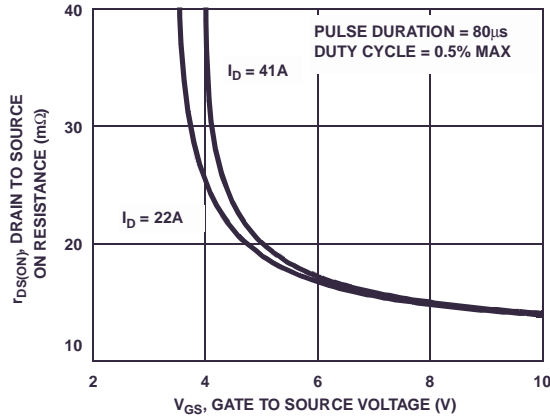


Figure 7. Drain to Source On Resistance vs Gate Voltage and Drain Current

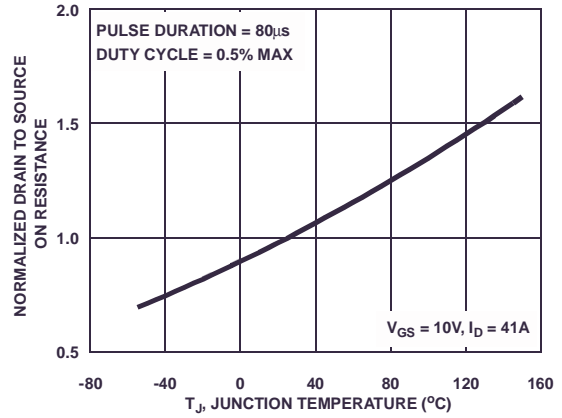


Figure 8. Normalized Drain to Source On Resistance vs Junction Temperature

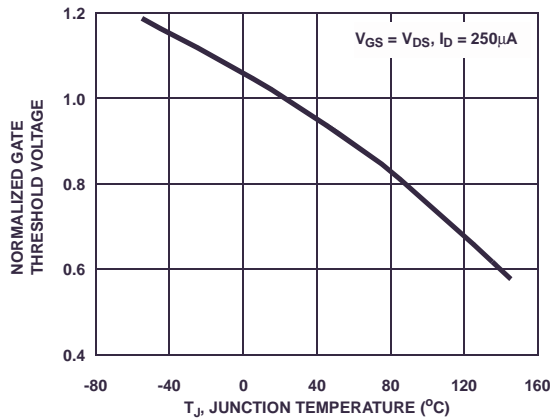


Figure 9. Normalized Gate Threshold Voltage vs Junction Temperature

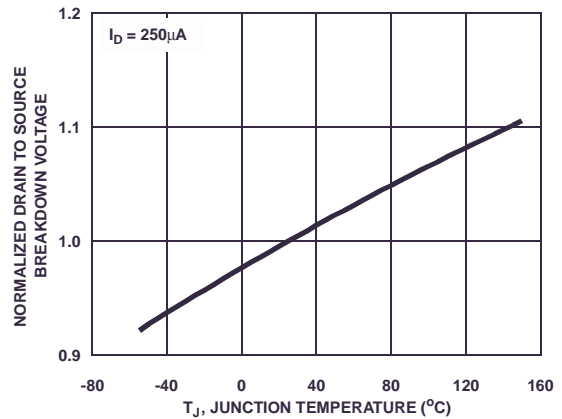


Figure 10. Normalized Drain to Source Breakdown Voltage vs Junction Temperature

Typical Characteristic $T_C = 25^\circ\text{C}$ unless otherwise noted (Continued)

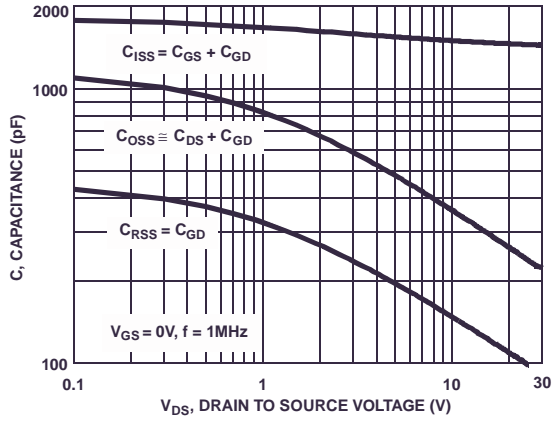


Figure 11. Capacitance vs Drain to Source Voltage

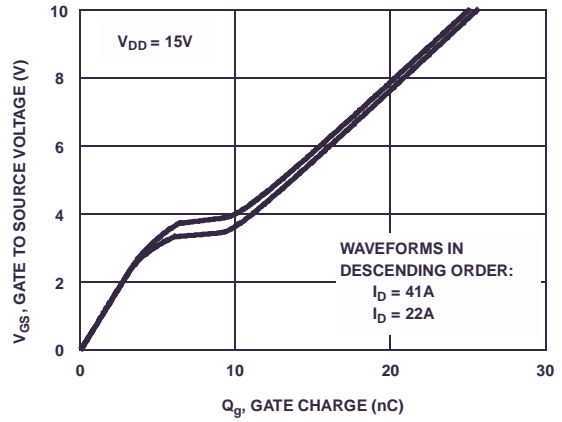


Figure 12. Gate Charge Waveforms for Constant Gate Currents

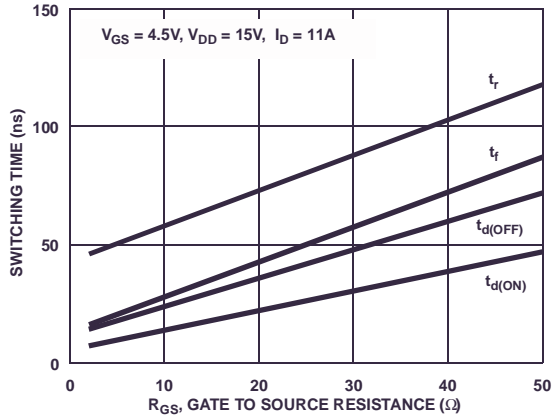


Figure 13. Switching Time vs Gate Resistance

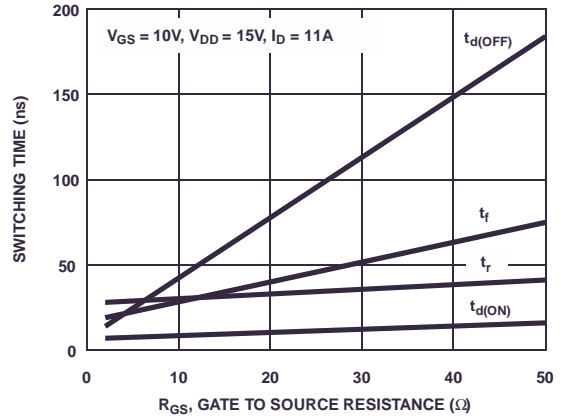


Figure 14. Switching Time vs Gate Resistance

Test Circuits and Waveforms

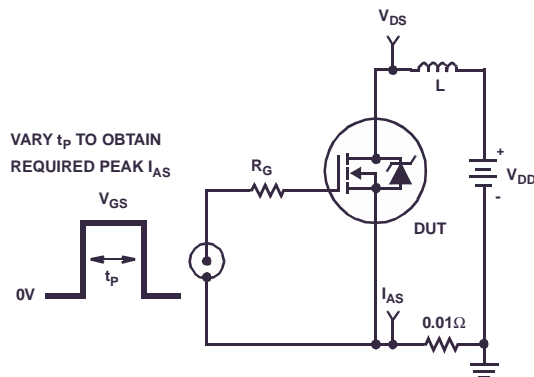


Figure 15. Unclamped Energy Test Circuit

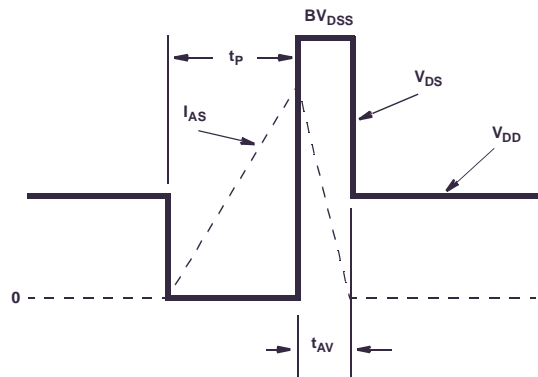


Figure 16. Unclamped Energy Waveforms

Test Circuits and Waveforms (Continued)

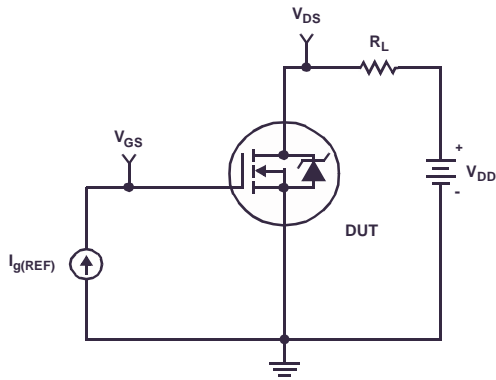


Figure 17. Gate Charge Test Circuit

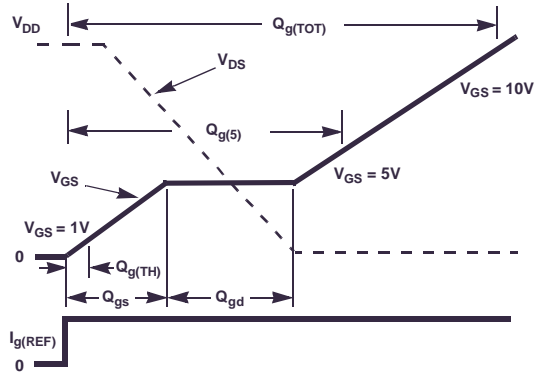


Figure 18. Gate Charge Waveforms

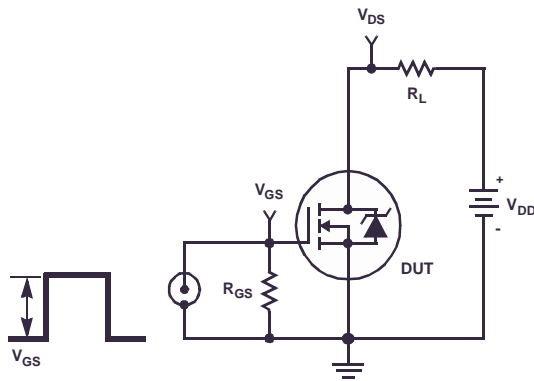


Figure 19. Switching Time Test Circuit

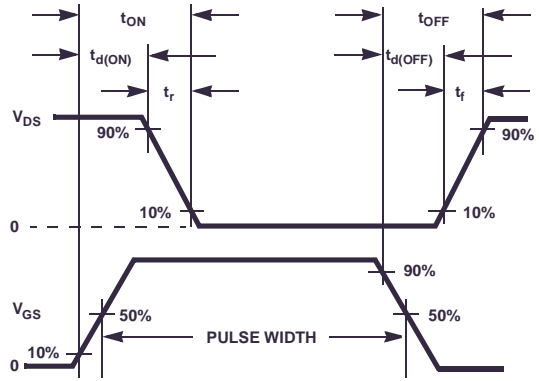


Figure 20. Switching Time Waveforms

PSPICE Electrical Model

.SUBCKT FQP45N03L 2 1 3 ; rev October 2002

CA 12 8 8e-10
 CB 15 14 1e-9
 CIN 6 8 1.35e-9

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

EBREAK 11 7 17 18 31.8
 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 6.24e-9
 LSOURCE 3 7 3.15e-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 2e-3
 RGATE 9 20 1.9
 RLDRAIN 2 5 10
 RLGATE 1 9 62.4
 RLSOURCE 3 7 31.5
 RSLC1 5 51 RSLCMOD 1e-6
 RSLC2 5 50 1e3
 RSOURCE 8 7 RSOURCEMOD 9.5e-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*160),5)}

.MODEL DBODYMOD D (IS = 1.1e-11 N=1.075 RS = 8.9e-3 TRS1 = 9e-4 TRS2 = 1e-6 XTI=2.2 CJO = 7e-10 TT = 8e-11 M = 0.49)

.MODEL DBREAKMOD D (RS = 1.1 TRS1 = 1e-3 TRS2 = -8.9e-6)

.MODEL DPLCAPMOD D (CJO = 4.5e-10 IS = 1e-30 N = 10 M = 0.46)

.MODEL MMEDMOD NMOS (VTO = 1.9 KP = 6 IS=1e-30 N = 10 TOX = 1 L = 1u W = 1u RG = 1.9)

.MODEL MSTROMOD NMOS (VTO = 2.29 KP = 50 IS = 1e-30 N = 10 TOX = 1 L = 1u W = 1u)

.MODEL MWEAKMOD NMOS (VTO = 1.54 KP = 0.05 IS = 1e-30 N = 10 TOX = 1 L = 1u W = 1u RG = 19 RS = 0.1)

.MODEL RBREAKMOD RES (TC1 = 1e-3 TC2 = -7e-7)

.MODEL RDRAINMOD RES (TC1 = 1.9e-2 TC2 = 3e-5)

.MODEL RSLCMOD RES (TC1 = 1e-3 TC2 = 1e-6)

.MODEL RSOURCEMOD RES (TC1 = 1e-3 TC2 = 1e-6)

.MODEL RVTHRESMOD RES (TC1 = -2.1e-3 TC2 = -1e-5)

.MODEL RVTEMPMOD RES (TC1 = -1.8e-3 TC2 = 1e-6)

.MODEL S1AMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = -4.0 VOFF = -0.8)

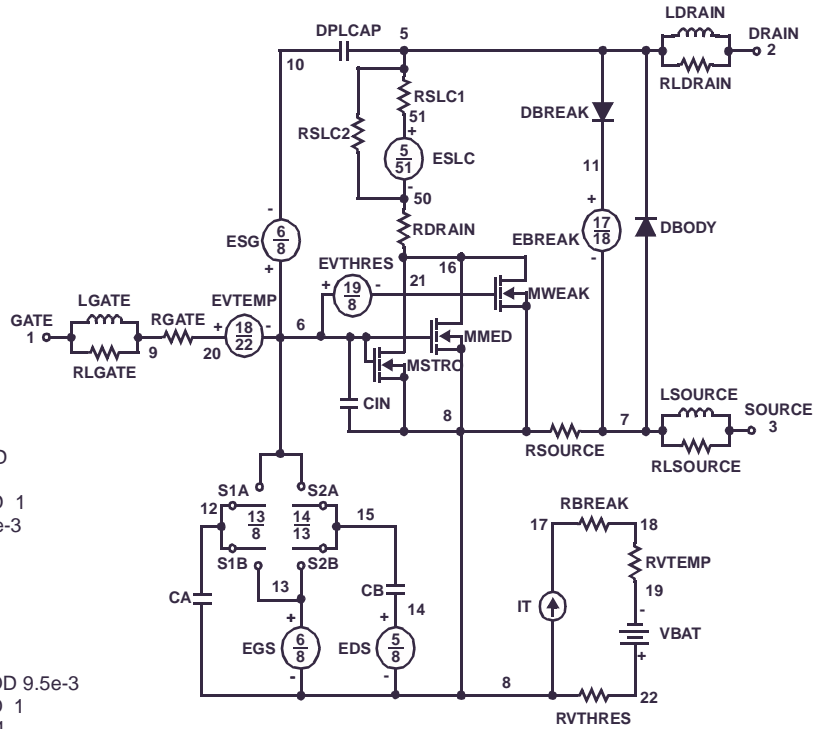
.MODEL S1BMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = -0.8 VOFF = -4.0)

.MODEL S2AMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = -0.3 VOFF = 0.2)

.MODEL S2BMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = 0.2 VOFF = -0.3)

.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.



SPICE Thermal Model

REV 23 October 2002

FQP45N03L_Thermal

```

CTHERM1 th 6 1.0e-3
CTHERM2 6 5 1.5e-3
CTHERM3 5 4 1.9e-3
CTHERM4 4 3 3e-3
CTHERM5 3 2 5e-3
CTHERM6 2 tl 2.5e-2
    
```

```

R THERM1 th 6 2.5e-3
R THERM2 6 5 3.5e-3
R THERM3 5 4 5.2e-2
R THERM4 4 3 5e-1
R THERM5 3 2 5.7e-1
R THERM6 2 tl 6.9e-1
    
```

SABER Thermal Model

SABER thermal model FQP45N03L_Thermal

```

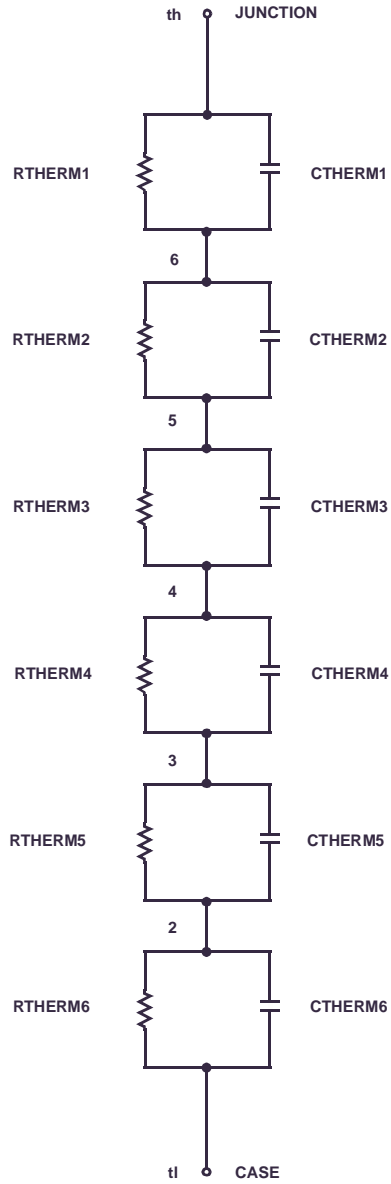
template thermal_model th tl
thermal_c th, tl
    
```

```

{
ctherm.ctherm1 th 6 = 1.0e-3
ctherm.ctherm2 6 5 = 1.5e-3
ctherm.ctherm3 5 4 = 1.9e-3
ctherm.ctherm4 4 3 = 3e-3
ctherm.ctherm5 3 2 = 5e-3
ctherm.ctherm6 2 tl = 2.5e-2
    
```

```

rtherm.rtherm1 th 6 = 2.5e-3
rtherm.rtherm2 6 5 = 3.5e-3
rtherm.rtherm3 5 4 = 5.2e-2
rtherm.rtherm4 4 3 = 5e-1
rtherm.rtherm5 3 2 = 5.7e-1
rtherm.rtherm6 2 tl = 6.9e-1
}
    
```



TRADEMARKS

The following are registered and unregistered trademarks Fairchild Semiconductor owns or is authorized to use and is not intended to be an exhaustive list of all such trademarks.

| | | | | |
|--------------------------------------|---------------------|--------------------|---------------------|-----------------|
| ACEx™ | FACT™ | ImpliedDisconnect™ | PACMAN™ | SPM™ |
| ActiveArray™ | FACT Quiet Series™ | ISOPLANAR™ | POP™ | Stealth™ |
| Bottomless™ | FAST® | LittleFET™ | Power247™ | SuperSOT™-3 |
| CoolFET™ | FASTr™ | MicroFET™ | PowerTrench® | SuperSOT™-6 |
| CROSSVOLT™ | FRFET™ | MicroPak™ | QFET™ | SuperSOT™-8 |
| DOME™ | GlobalOptoisolator™ | MICROWIRE™ | QS™ | SyncFET™ |
| EcoSPARK™ | GTO™ | MSX™ | QT Optoelectronics™ | TinyLogic™ |
| E ² CMOS™ | HiSeC™ | MSXPro™ | Quiet Series™ | TruTranslation™ |
| EnSigna™ | I ² C™ | OCX™ | RapidConfigure™ | UHC™ |
| Across the board. Around the world.™ | | OCXPro™ | RapidConnect™ | UltraFET® |
| The Power Franchise™ | | OPTOLOGIC® | SILENT SWITCHER® | VCX™ |
| Programmable Active Droop™ | | OPTOPLANAR™ | SMART START™ | |

DISCLAIMER

FAIRCHILD SEMICONDUCTOR RESERVES THE RIGHT TO MAKE CHANGES WITHOUT FURTHER NOTICE TO ANY PRODUCTS HEREIN TO IMPROVE RELIABILITY, FUNCTION OR DESIGN. FAIRCHILD DOES NOT ASSUME ANY LIABILITY ARISING OUT OF THE APPLICATION OR USE OF ANY PRODUCT OR CIRCUIT DESCRIBED HEREIN; NEITHER DOES IT CONVEY ANY LICENSE UNDER ITS PATENT RIGHTS, NOR THE RIGHTS OF OTHERS.

LIFE SUPPORT POLICY

FAIRCHILD'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF FAIRCHILD SEMICONDUCTOR CORPORATION.

As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, or (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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. |
| No Identification Needed | Full Production | This datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design. |
| Obsolete | Not In Production | This datasheet contains specifications on a product that has been discontinued by Fairchild semiconductor. The datasheet is printed for reference information only. |