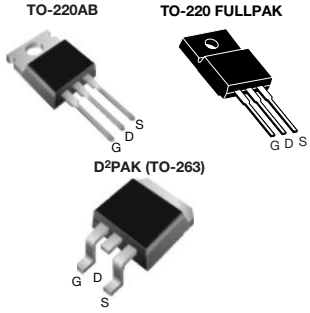
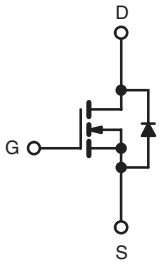
# Power MOSFET

| PRODUCT SUMMARY | | |
|---|---|---|
| $V_{DS}$ (V) at $T_J$ max. | 560 V | |
| $R_{DS(on)}$ (Ω) | $V_{GS}$ = 10 V | 0.38 |
| $Q_g$ (Max.) (nC) | 68 | |
| $Q_{gs}$ (nC) | 17.6 | |
| $Q_{gd}$ (nC) | 21.8 | |
| Configuration | Single | |




N-Channel MOSFET

## FEATURES

- Low Figure-of-Merit $R_{on}$ x $Q_g$
- 100 % Avalanche Tested
- Gate Charge Improved
- $T_{rr}/Q_{rr}$ Improved
- Compliant to RoHS Directive 2002/95/EC

Available
RoHS* COMPLIANT

| ORDERING INFORMATION | | | |
|---|---|---|---|
| Package | TO-220AB | D²PAK (TO-263) | TO-220 FULLPAK |
| Lead (Pb)-free | SiHP16N50C-E3 | SiHB16N50C-E3 | SiHF16N50C-E3 |

**ABSOLUTE MAXIMUM RATINGS** $T_C$ = 25 °C, unless otherwise noted

| PARAMETER | | | SYMBOL | LIMIT TO220-AB D²PAK (TO-263) | LIMIT TO-220 FULLPAK | UNIT |
|---|---|---|---|---|---|---|
| Drain-Source Voltage | | | $V_{DS}$ | 500 | | V |
| Gate-Source Voltage | | | $V_{GS}$ | ± 30 | | |
| Continuous Drain Current ($T_J$ = 150 °C)[a] | $V_{GS}$ at 10 V | $T_C$ = 25 °C | $I_D$ | 16 | | A |
| | | $T_C$ = 100 °C | | 10 | | |
| Pulsed Drain Current[c] | | | $I_{DM}$ | 40 | | |
| Linear Derating Factor | | | | 2 | | W/°C |
| Single Pulse Avalanche Energy[b] | | | $E_{AS}$ | 320 | | mJ |
| Maximum Power Dissipation | | | $P_D$ | 250 | 38 | W |
| Operating Junction and Storage Temperature Range | | | $T_J$, $T_{stg}$ | - 55 to + 150 | | °C |
| Soldering Recommendations (Peak Temperature)[d] | for 10 s | | | 300 | | |

**Notes**

a. Limited by maximum junction temperature.
b. $V_{DD}$ = 50 V, starting $T_J$ = 25 °C, L = 2.5 mH, $R_g$ = 25 Ω, $I_{AS}$ = 16 A.
c. Repetitive rating; pulse width limited by maximum junction temperature.
d. 1.6 mm from case.

* Pb containing terminations are not RoHS compliant, exemptions may apply

| THERMAL RESISTANCE RATINGS | | | | |
|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TO220-AB D²PAK (TO-263)** | **TO-220 FULLPAK** | **UNIT** |
| Maximum Junction-to-Ambient | $R_{thJA}$ | 62 | 65 | °C/W |
| Maximum Junction-to-Case (Drain) | $R_{thJC}$ | 0.5 | 3.3 | |
| Junction-to-Ambient (PCB mount)[a] | $R_{thJA}$ | 40 | - | |

**Note**

a. When mounted on 1" square PCB (FR-4 or G-10 material).

| SPECIFICATIONS $T_J$ = 25 °C, unless otherwise noted | | | | | | |
|---|---|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS** | **MIN.** | **TYP.** | **MAX.** | **UNIT** |
| **Static** | | | | | | |
| Drain-Source Breakdown Voltage | $V_{DS}$ | $V_{GS}$ = 0 V, $I_D$ = 250 µA | 500 | - | - | V |
| $V_{DS}$ Temperature Coefficient | $\Delta V_{DS}/T_J$ | Reference to 25 °C, $I_D$ = 1 mA | - | 0.6 | - | V/°C |
| Gate-Source Threshold Voltage (N) | $V_{GS(th)}$ | $V_{DS}$ = $V_{GS}$, $I_D$ = 250 µA | 3.0 | - | 5.0 | V |
| Gate-Source Leakage | $I_{GSS}$ | $V_{GS}$ = ± 30 V | - | - | ± 100 | nA |
| Zero Gate Voltage Drain Current | $I_{DSS}$ | $V_{DS}$ = 500 V, $V_{GS}$ = 0 V | - | - | 50 | µA |
| | | $V_{DS}$ = 400 V, $V_{GS}$ = 0 V, $T_J$ = 125 °C | - | - | 250 | |
| Drain-Source On-State Resistance | $R_{DS(on)}$ | $V_{GS}$ = 10 V; $I_D$ = 8 A | - | 0.31 | 0.38 | Ω |
| Forward Transconductance[a] | $g_{fs}$ | $V_{DS}$ = 50 V, $I_D$ = 3 A | - | 3 | - | S |
| **Dynamic** | | | | | | |
| Input Capacitance | $C_{iss}$ | $V_{GS}$ = 0 V, $V_{DS}$ = 25 V, f = 1.0 MHz | - | 1900 | - | pF |
| Output Capacitance | $C_{oss}$ | | - | 230 | - | |
| Reverse Transfer Capacitance | $C_{rss}$ | | - | 24 | - | |
| Total Gate Charge | $Q_g$ | $V_{GS}$ = 10 V; $I_D$ = 16 A, $V_{DS}$ = 400 V | - | 45 | 68 | nC |
| Gate-Source Charge | $Q_{gs}$ | | - | 18 | - | |
| Gate-Drain Charge | $Q_{gd}$ | | - | 22 | - | |
| Turn-On Delay Time | $t_{d(on)}$ | $V_{DD}$ = 250 V, $I_D$ = 16 A, $R_g$ = 9.1 Ω, $V_{GS}$ = 10 V | - | 27 | - | ns |
| Rise Time | $t_r$ | | - | 156 | - | |
| Turn-Off Delay Time | $t_{d(off)}$ | | - | 29 | - | |
| Fall Time | $t_f$ | | - | 31 | - | |
| Gate Input Resistance | $R_g$ | f = 1 MHz, open drain | - | 1.6 | - | Ω |
| **Drain-Source Body Diode Characteristics** | | | | | | |
| Continuous Source-Drain Diode Current | $I_S$ | MOSFET symbol showing the integral reverse p - n junction diode  | - | - | 16 | A |
| Pulsed Diode Forward Current | $I_{SM}$ | | - | - | 30 | |
| Body Diode Voltage | $V_{SD}$ | $T_J$ = 25 °C, $I_S$ = 10 A, $V_{GS}$ = 0 V | - | - | 1.8 | V |
| Body Diode Reverse Recovery Time | $t_{rr}$ | $T_J$ = 25 °C, $I_F$ = $I_S$, dI/dt = 100 A/µs, $V_R$ = 20 V | - | 555 | - | ns |
| Body Diode Reverse Recovery Charge | $Q_{rr}$ | | - | 5.5 | - | µC |
| Body Diode Reverse Recovery Current | $I_{RRM}$ | | - | 18 | - | A |

**Note**

- The information shown here is a preliminary product proposal, not a commercial product data sheet. Vishay Siliconix is not committed to produce this or any similar product. This information should not be used for design purposes, nor construed as an offer to furnish or sell such products.

**TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted

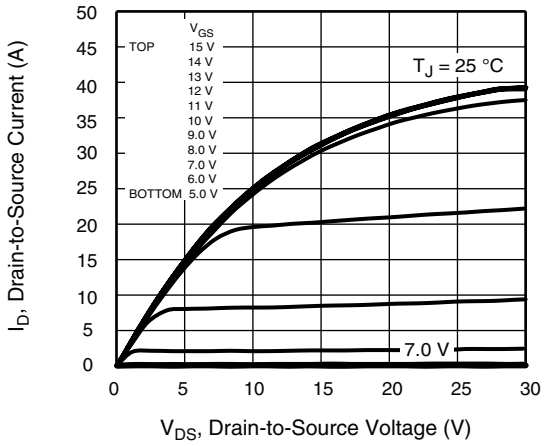



**Fig. 1 - Typical Output Characteristics (TO-220)**

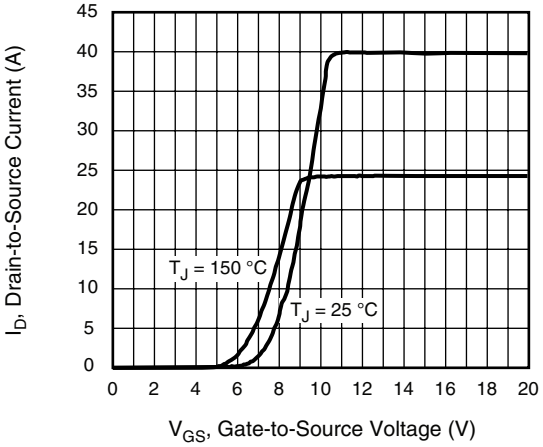



**Fig. 3 - Typical Transfer Characteristics**

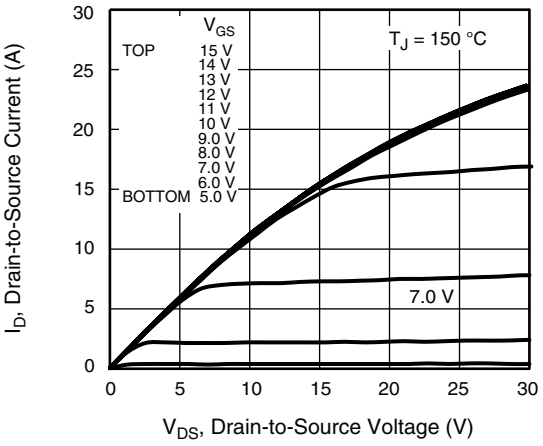



**Fig. 2 - Typical Output Characteristics (TO-220)**

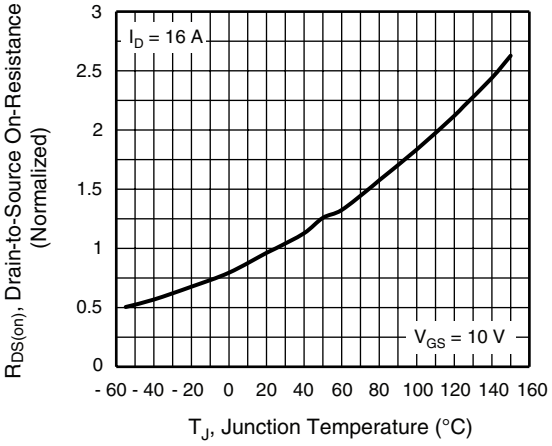



**Fig. 4 - Normalized On-Resistance vs. Temperature**

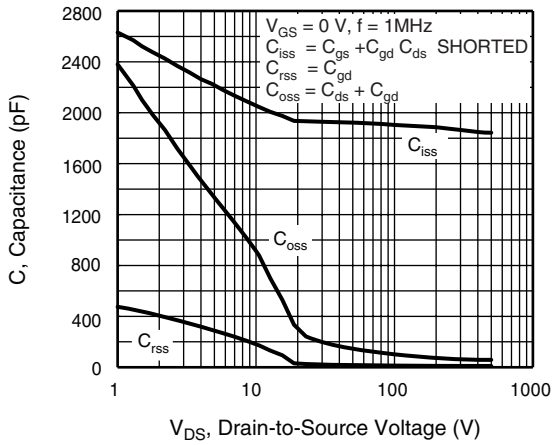



**Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage**

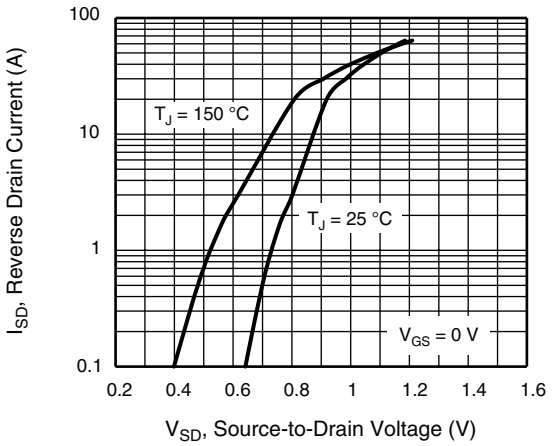



**Fig. 7 - Typical Source-Drain Diode Forward Voltage**

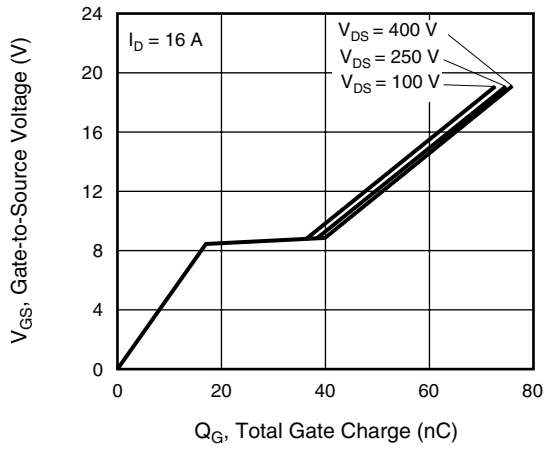



**Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage**

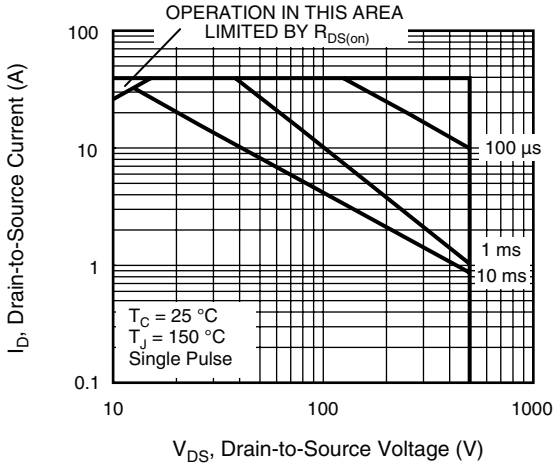



**Fig. 8 - Maximum Safe Operating Area (TO-220AB, $D^2PAK$)**

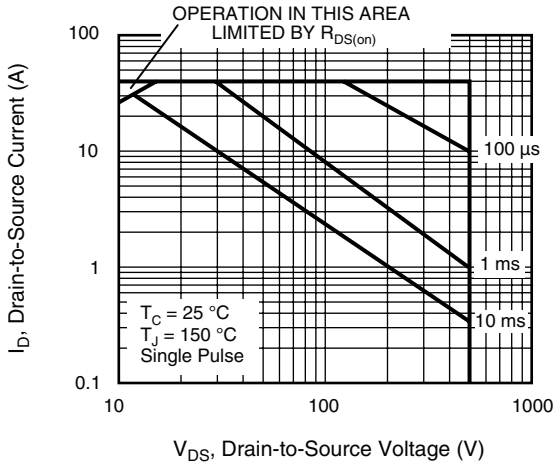



**Fig. 9 - Maximum Safe Operating Area (TO-220 FULLPAK)**

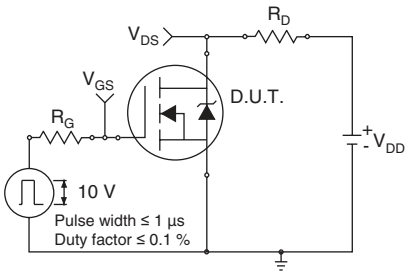



**Fig. 10a - Switching Time Test Circuit**

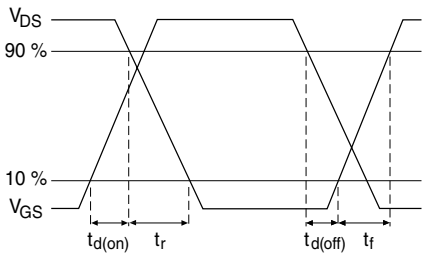



**Fig. 10b - Switching Time Waveforms**

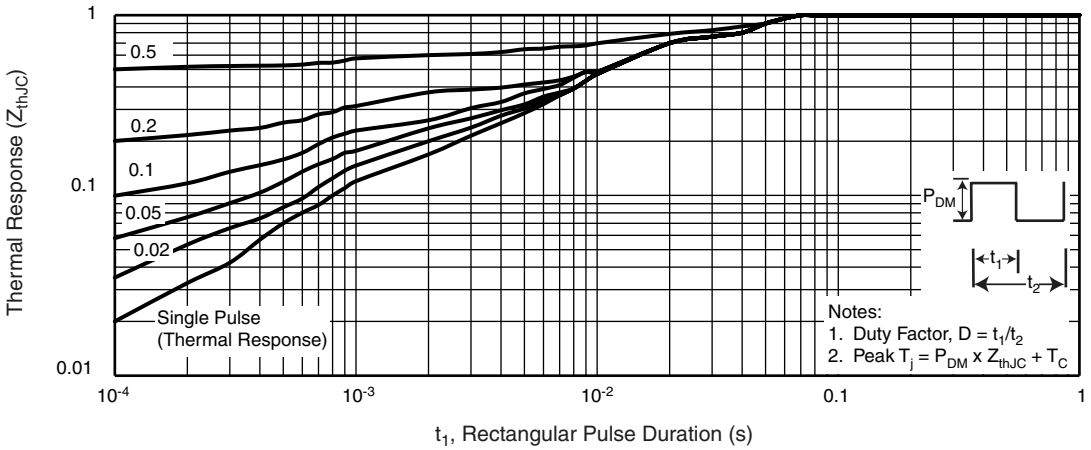



**Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case (TO-220AB, $D^2PAK$)**

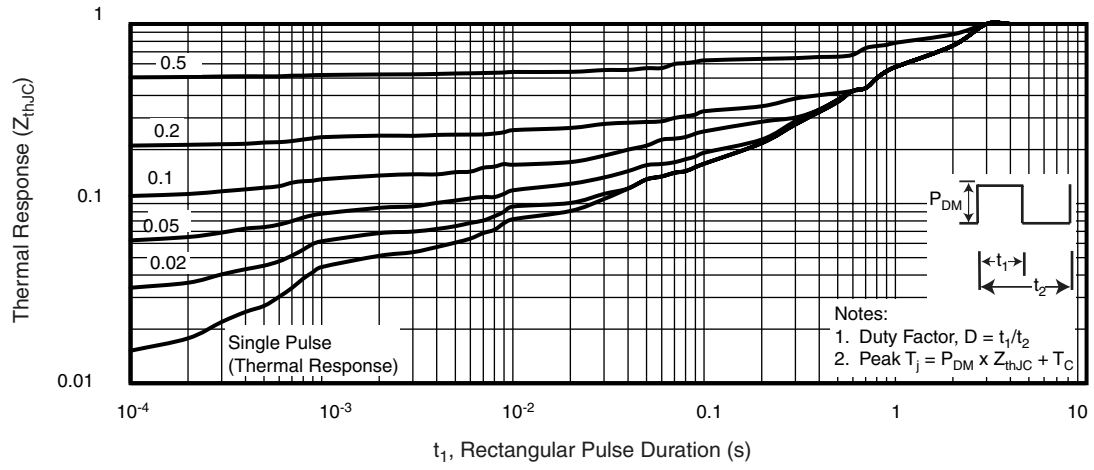



**Fig. 12 - Maximum Effective Transient Thermal Impedance, Junction-to-Case (TO-220 FULLPAK)**

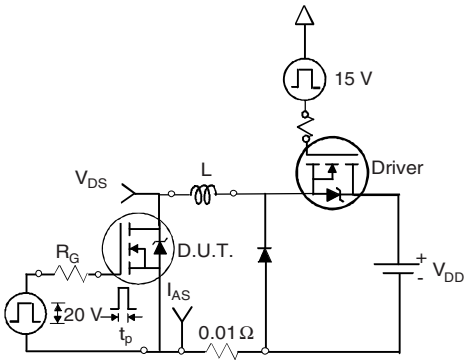



**Fig. 13a - Unclamped Inductive Test Circuit**

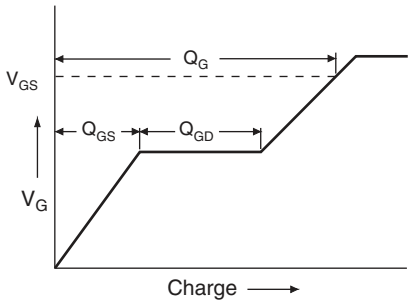



**Fig. 14a - Basic Gate Charge Waveform**

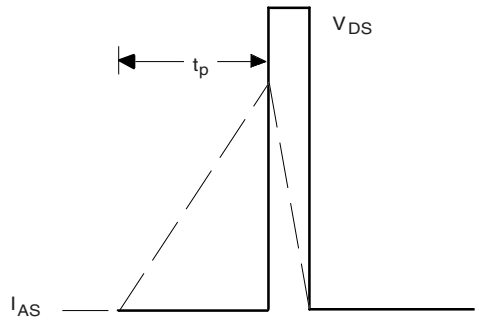



**Fig. 13b - Unclamped Inductive Waveforms**

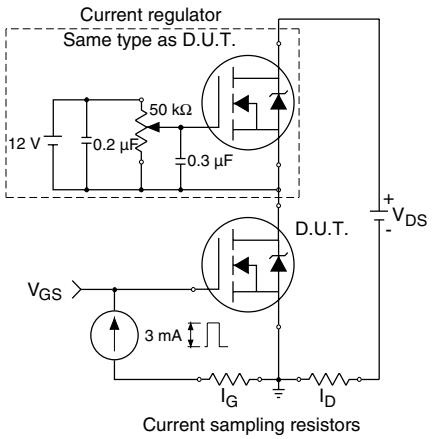
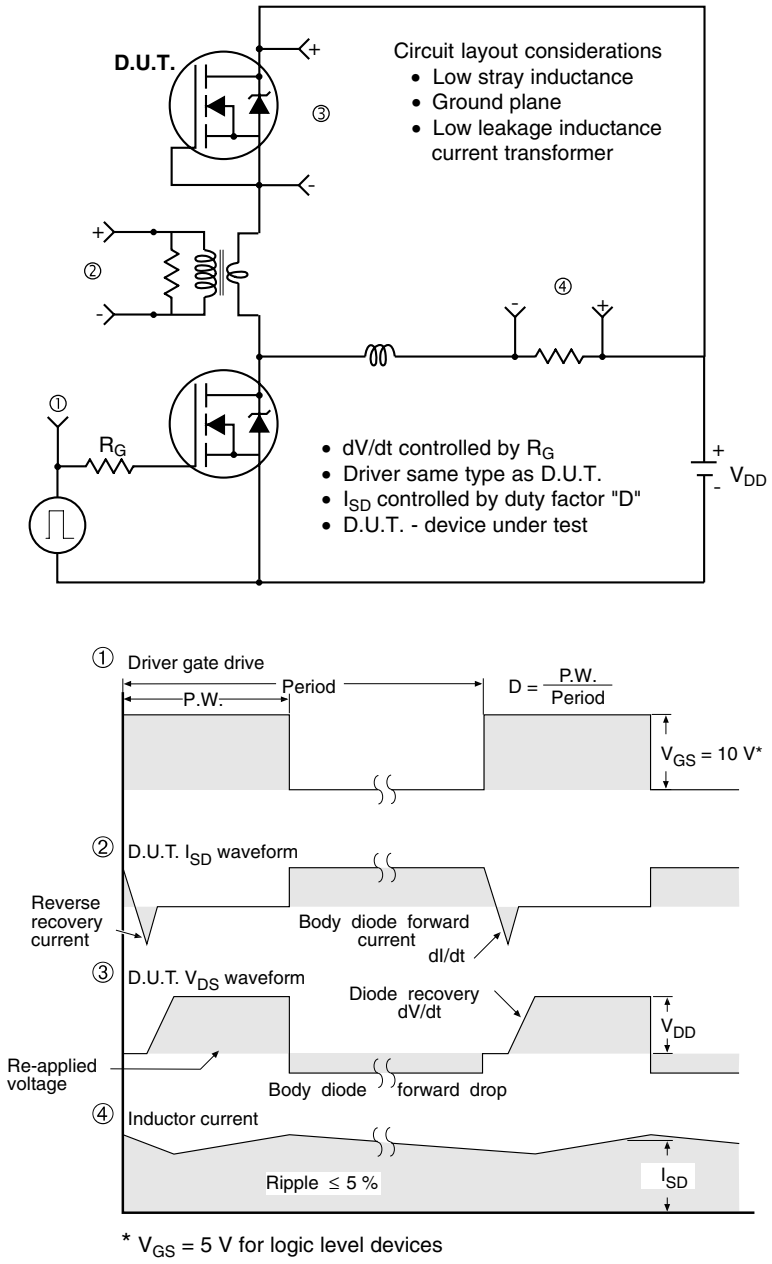



**Fig. 14b - Gate Charge Test Circuit**

## Peak Diode Recovery dV/dt Test Circuit




* $V_{GS}$ = 5 V for logic level devices

**Fig. 15 - For N-Channel**

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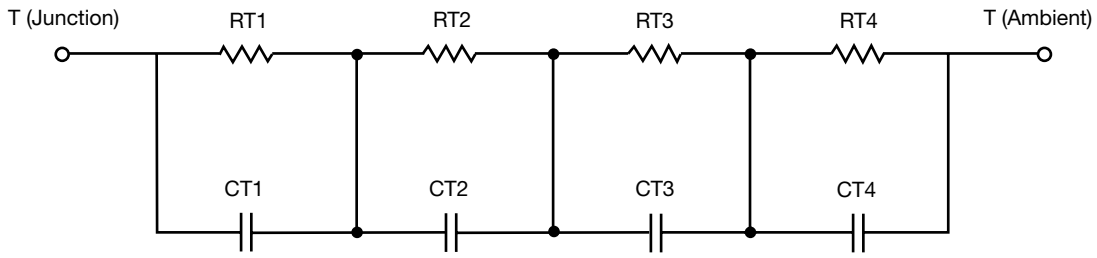
# R-C Thermal Model Parameters

## DESCRIPTION

The parametric values in the R-C thermal model have been derived using curve-fitting techniques. R-C values for the electrical circuit in the Foster/tank and Cauer/filter configurations are included. When implemented in P-SPICE, these values have matching characteristic curves to the single-pulse transient thermal impedance curves for the MOSFET.

These RC values can be used in the P-SPICE simulation to evaluate the thermal behavior of the MOSFET junction temperature under a defined power profile. These techniques are described in application note AN609, “Thermal Simulation of Power MOSFETs on the P-SPICE Platform”.

## R-C THERMAL MODEL FOR TANK CONFIGURATION



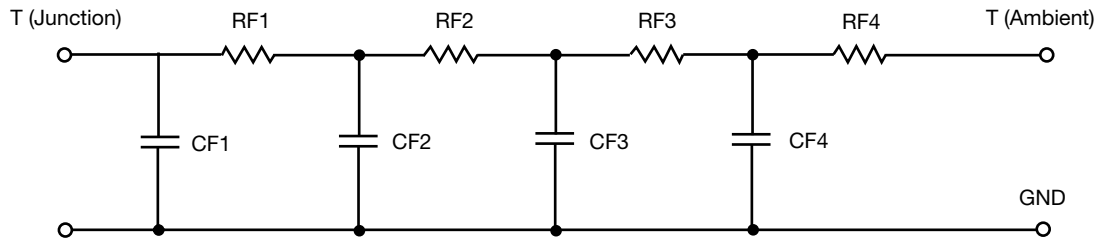

| R-C VALUES FOR TANK CONFIGURATION | | | |
|---|---|---|---|
| THERMAL RESISTANCE (°C/W) | | | |
| **Junction to** | **Ambient** | **SiHP-SiHB Case** | **SiHF Case** |
| RT1 | N/A | 32.3517 m | 167.5117 m |
| RT2 | N/A | 188.0759 m | 1.2673 |
| RT3 | N/A | 201.3236 m | 1.7202 |
| RT4 | N/A | 78.2488 m | 144.9883 m |
| THERMAL CAPACITANCE (Joules/°C) | | | |
| **Junction to** | **Ambient** | **SiHP-SiHB Case** | **SiHF Case** |
| CT1 | N/A | 12.1244 m | 82.7807 m |
| CT2 | N/A | 135.8367 m | 1.0857 |
| CT3 | N/A | 59.5808 m | 731.5658 m |
| CT4 | N/A | 336.9463 m | 3.3959 m |

**Note:**

1. N/A indicates not applicable
2. Package Names: SiHP..TO220AB, SiHB..D2PAK(TO263), SiHF..TO220 FullPAK

*This document is intended as a SPICE modeling guideline and does not constitute a commercial product datasheet. Designers should refer to the appropriate datasheet of the same number for guaranteed specification limits.*

## R-C THERMAL MODEL FOR FILTER CONFIGURATION

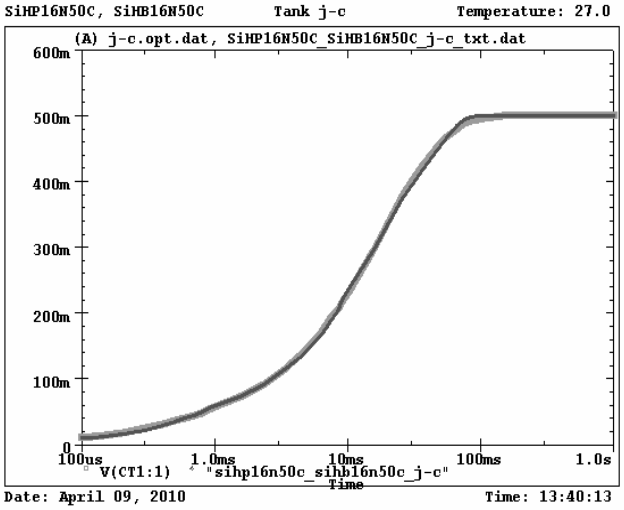


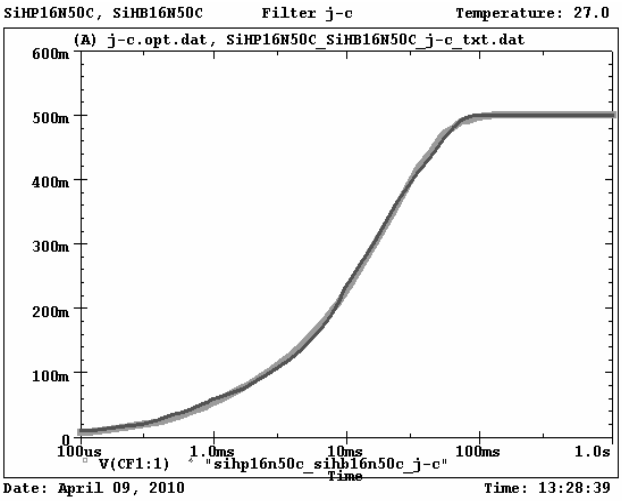

| R-C VALUES FOR FILTER CONFIGURATION | | | |
|---|---|---|---|
| THERMAL RESISTANCE (°C/W) | | | |
| **Junction to** | **Ambient** | **SiHP-SiHB Case** | **SiHF Case** |
| RF1 | N/A | 104.6594 m | 51.2178 m |
| RF2 | N/A | 312.0074 m | 134.7475 m |
| RF3 | N/A | 5.4260 m | 206.4347 m |
| RF4 | N/A | 77.9072 m | 2.9076 |
| THERMAL CAPACITANCE (Joules/°C) | | | |
| **Junction to** | **Ambient** | **SiHP-SiHB Case** | **SiHF Case** |
| CF1 | N/A | 13.9178 m | 137.1847 u |
| CF2 | N/A | 32.5839 m | 10.6770 m |
| CF3 | N/A | 50.0700 m | 73.0024 m |
| CF4 | N/A | 20.0146 m | 364.3531 m |

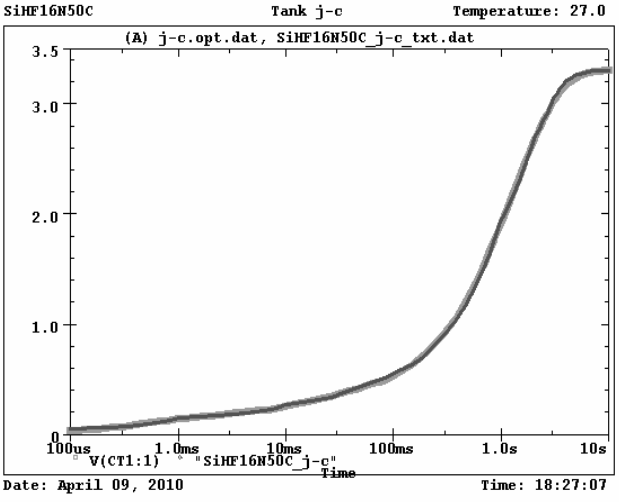
**Note:**

1. N/A indicates not applicable

2. Package Names: SiHP..TO220AB, SiHB..D2PAK(TO263), SiHF..TO220 FullPAK


SiHP16N50C, SiHB16N50C Tank j-c Temperature: 27.0
(A) j-c.opt.dat, SiHP16N50C_SiHB16N50C_j-c_txt.dat
600m
500m
400m
300m
200m
100m
0
100us 1.0ms 10ms 100ms 1.0s
V(CT1:1) "sihp16n50c_sihb16n50c_j-c"
Time
Date: April 09, 2010 Time: 13:40:13


SiHP16N50C, SiHB16N50C Filter j-c Temperature: 27.0
(A) j-c.opt.dat, SiHP16N50C_SiHB16N50C_j-c_txt.dat
600m
500m
400m
300m
200m
100m
0
100us 1.0ms 10ms 100ms 1.0s
V(CF1:1) "sihp16n50c_sihb16n50c_j-c"
Time
Date: April 09, 2010 Time: 13:28:39


SiHF16N50C Tank j-c Temperature: 27.0
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3.5
3.0
2.0
1.0
0
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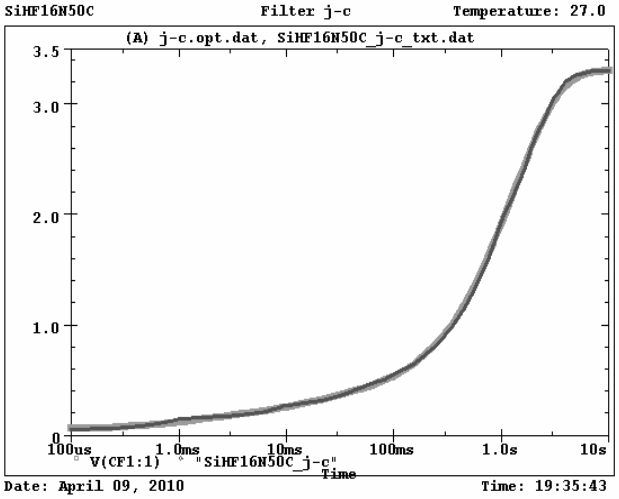
Time
Date: April 09, 2010 Time: 18:27:07


SiHF16N50C Filter j-c Temperature: 27.0
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3.5
3.0
2.0
1.0
0
100us 1.0ms 10ms 100ms 1.0s 10s
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Time
Date: April 09, 2010 Time: 19:35:43