## Description

The Power MOSFET is fabricated using the advanced planar VDMOS technology. The resulting device has low conduction resistance, superior switching performance and high avalanche energy.

## Features

- Low $R_{DS(on)}$
- Low gate charge (typ. $Q_g$ = 14.5 nC)
- 100% UIS tested
- RoHS compliant

## Applications

- Power factor correction.
- Switched mode power supplies.
- LED driver.

## Product Summary

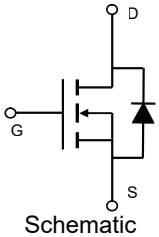
| | |
|---|---|
| $V_{DSS}$ | 650V |
| $I_D$ | 5A |
| $R_{DS(on),max}$ | 2.1Ω |
| $Q_{g,typ}$ | 14.5 nC |


TO-251


TO-252


TO-220F


TO-220C



Schematic

## Absolute Maximum Ratings

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| Drain-Source Voltage | $V_{DSS}$ | 650 | V |
| Continuous drain current ( $T_C$ = 25°C ) | $I_D$ | 5 | A |
| ( $T_C$ = 100°C ) | | 3.1 | A |
| Pulsed drain current [1] | $I_{DM}$ | 20 | A |
| Gate-Source voltage | $V_{GSS}$ | ±30 | V |
| Avalanche energy, single pulse [2] | $E_{AS}$ | 245 | mJ |
| Peak diode recovery dv/dt [3] | dv/dt | 5 | V/ns |
| Power Dissipation C TO-220F( $T_C$ = 25°C ) | $P_D$ | 30 | W |
| Derate above 25°C | | 0.24 | W/°C |
| Power Dissipation C TO-220\TO-251\TO-252( $T_C$ = 25°C ) | | 75 | W |
| Derate above 25°C | | 0.6 | W/°C |
| Operating junction and storage temperature range | $T_J$, $T_{STG}$ | -55 to +150 | °C |
| Continuous diode forward current | $I_S$ | 5 | A |
| Diode pulse current | $I_{S,pulse}$ | 20 | A |

## Thermal Characteristics

| Parameter | Symbol | Value | | Unit |
|---|---|---|---|---|
| | | C TO-220F | C TO-220\TO-251\TO-252 | |
| Thermal resistance, Junction-to-case | $R_{\theta JC}$ | 4.17 | 1.67 | °C/W |
| Thermal resistance, Junction-to-ambient | $R_{\theta JA}$ | 62.5 | 110 | °C/W |

## Package Marking and Ordering Information

| Device | Device Package | Marking | Units/Tube | Units/Reel |
|---|---|---|---|---|
| VSM5N65-T1 | TO-251 | VSM5N65-T1 | 50 | |
| VSM5N65-T2 | TO-252 | VSM5N65-T2 | 50 | |
| VSM5N65-TF | TO-220F | VSM5N65-TF | | 2500 |
| VSM5N65-TC | TO-220C | VSM5N65-TC | 72 | |

## Electrical Characteristics

$T_c$ = 25°C unless otherwise noted

| Parameter | Symbol | Test Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **Static characteristics** | | | | | | |
| Drain-source breakdown voltage | $BV_{DSS}$ | $V_{GS}$=0 V, $I_D$=0.25 mA | 650 | - | - | V |
| Gate threshold voltage | $V_{GS(th)}$ | $V_{DS}$=$V_{GS}$, $I_D$=0.25 mA | 2 | - | 4 | V |
| Drain cut-off current | $I_{DSS}$ | $V_{DS}$=650 V, $V_{GS}$=0 V,<br>$T_j$ = 25°C<br>$T_j$ = 125°C | <br>-<br>- | <br>- | <br>1<br>100 | <br>μA |
| Gate leakage current, Forward | $I_{GSSF}$ | $V_{GS}$=30 V, $V_{DS}$=0 V | - | - | 100 | nA |
| Gate leakage current, Reverse | $I_{GSSR}$ | $V_{GS}$=-30 V, $V_{DS}$=0 V | - | - | -100 | nA |
| Drain-source on-state resistance | $R_{DS(on)}$ | $V_{GS}$=10 V, $I_D$=2.5 A | - | 1.8 | 2.1 | Ω |
| **Dynamic characteristics** | | | | | | |
| Input capacitance | $C_{iss}$ | $V_{DS}$ = 25 V, $V_{GS}$ = 0 V, | - | 730 | - | |
| Output capacitance | $C_{oss}$ | f = 1 MHz | - | 60 | - | pF |
| Reverse transfer capacitance | $C_{rss}$ | | - | 3.5 | - | |
| Turn-on delay time | $t_{d(on)}$ | $V_{DD}$ = 325 V, $I_D$ = 5 A | - | 12.2 | - | |
| Rise time | $t_r$ | $R_G$ = 10 Ω, $V_{GS}$=15 V | - | 35 | - | ns |
| Turn-off delay time | $t_{d(off)}$ | | - | 35 | - | |
| Fall time | $t_f$ | | - | 14.8 | - | |
| **Gate charge characteristics** | | | | | | |
| Gate to source charge | $Q_{gs}$ | $V_{DD}$=520 V, $I_D$=5 A, | - | 4.3 | - | |
| Gate to drain charge | $Q_{gd}$ | $V_{GS}$=0 to 10 V | - | 5.3 | - | nC |
| Gate charge total | $Q_g$ | | - | 14.5 | - | |
| Gate plateau voltage | $V_{plateau}$ | | - | 5 | - | V |
| **Reverse diode characteristics** | | | | | | |
| Diode forward voltage | $V_{SD}$ | $V_{GS}$=0 V, $I_F$=5 A | - | - | 1.3 | V |
| Reverse recovery time | $t_{rr}$ | $V_R$=520 V, $I_F$=5 A, | - | 340 | - | ns |
| Reverse recovery charge | $Q_{rr}$ | $dI_F/dt$=100 A/μs | - | 2.09 | - | μC |
| Peak reverse recovery current | $I_{rrm}$ | | - | 12.3 | - | A |

Notes:

1. Pulse width limited by maximum junction temperature.
2. L=10mH, $I_{AS}$ = 7A, Starting $T_j$= 25°C.
3. $I_{SD}$ = 5A, di/dt≤100A/us, $V_{DD}$≤$BV_{DS}$, Starting $T_j$= 25°C.

## Electrical Characteristics Diagrams

Figure 1. Typical Output Characteristics

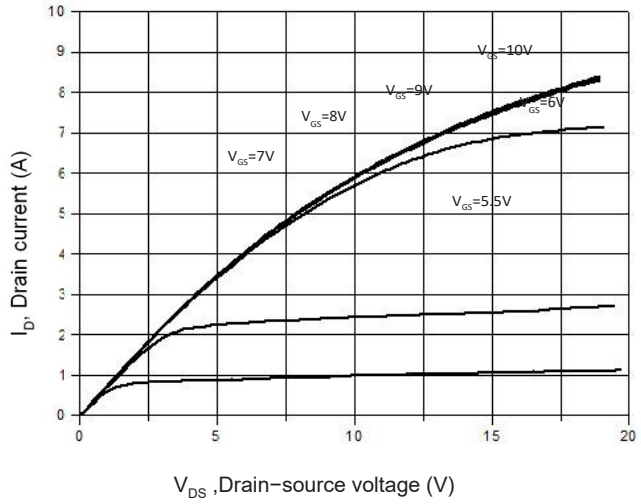



Figure 2. Transfer Characteristics

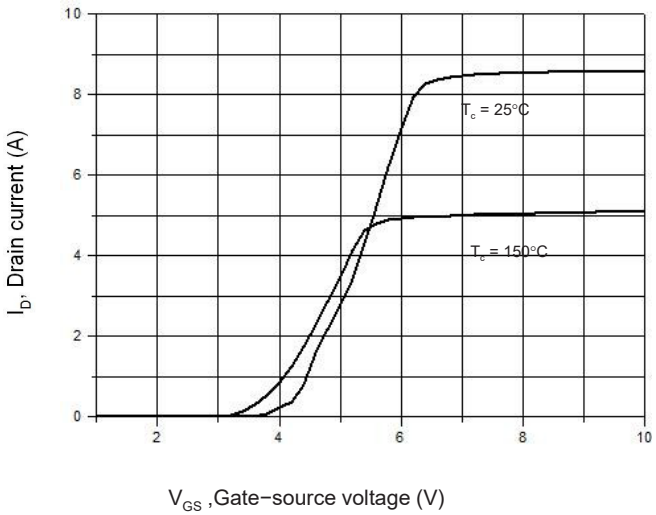



Figure 3. On-Resistance Variation vs. Drain Current

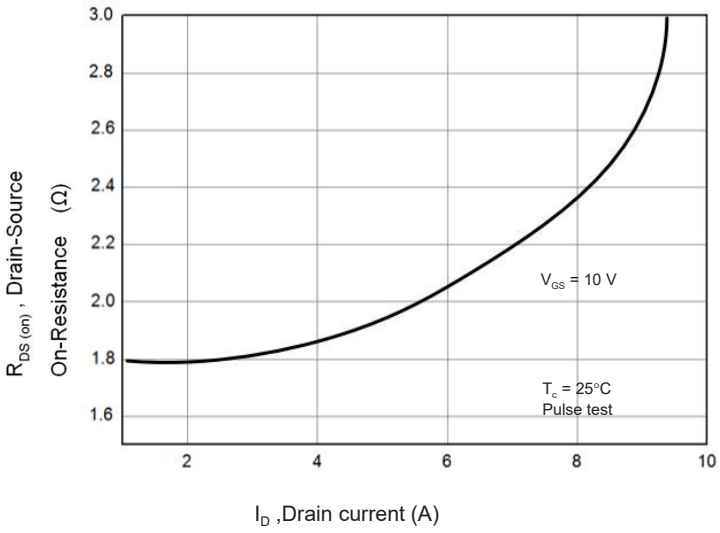



Figure 4. Threshold Voltage vs. Temperature

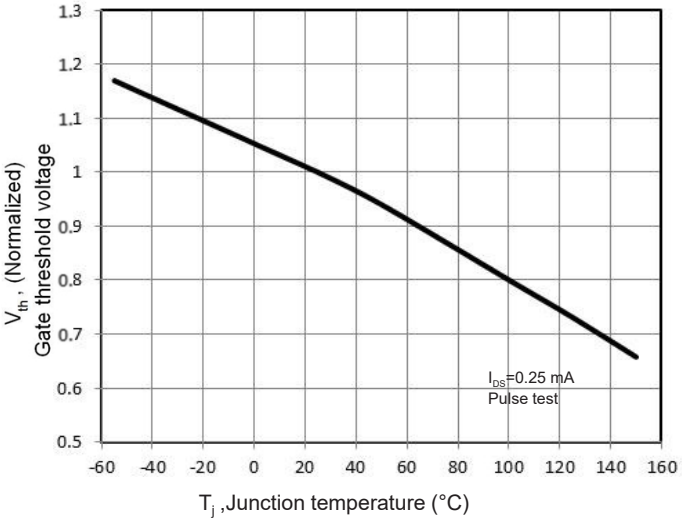



Figure 5. Breakdown Voltage vs. Temperature

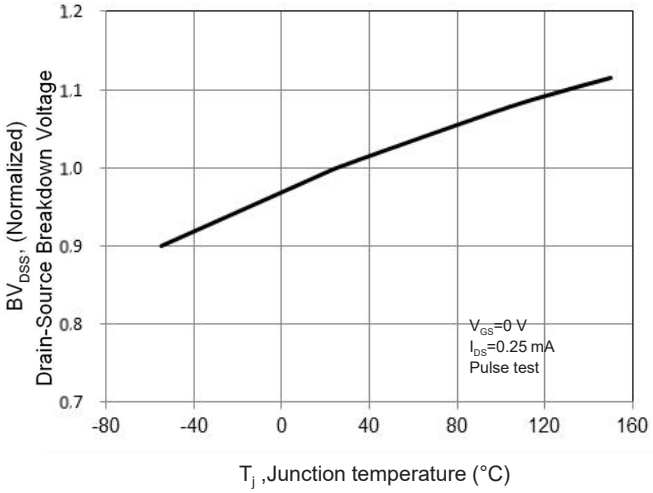



Figure 6. On-Resistance vs. Temperature

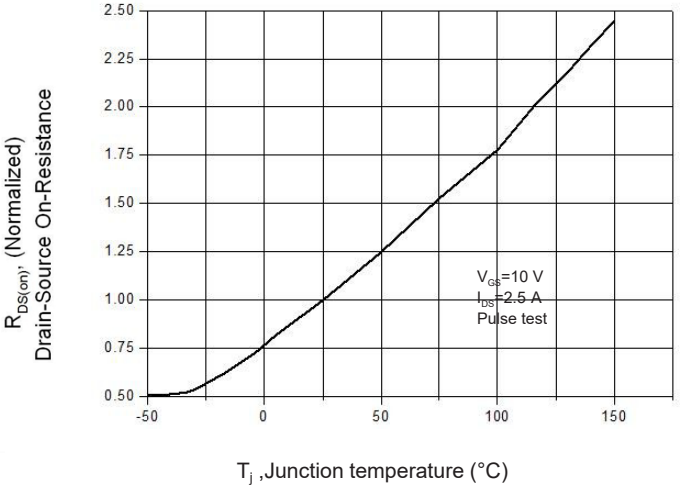


Figure 7. Capacitance Characteristics

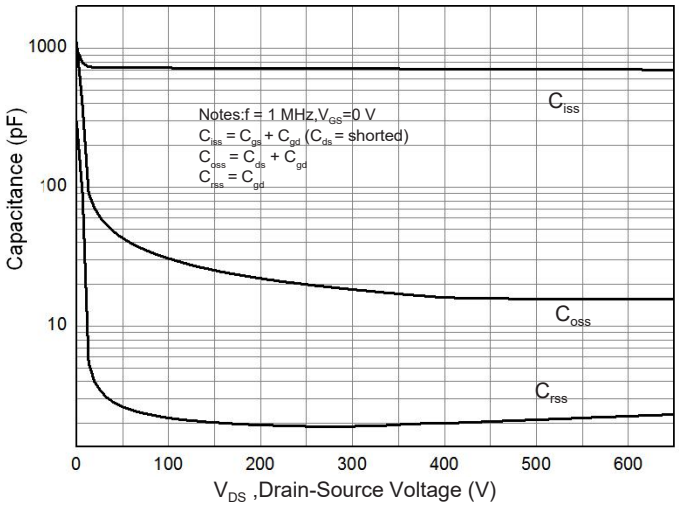



Figure 8. Gate Charge Characteristics

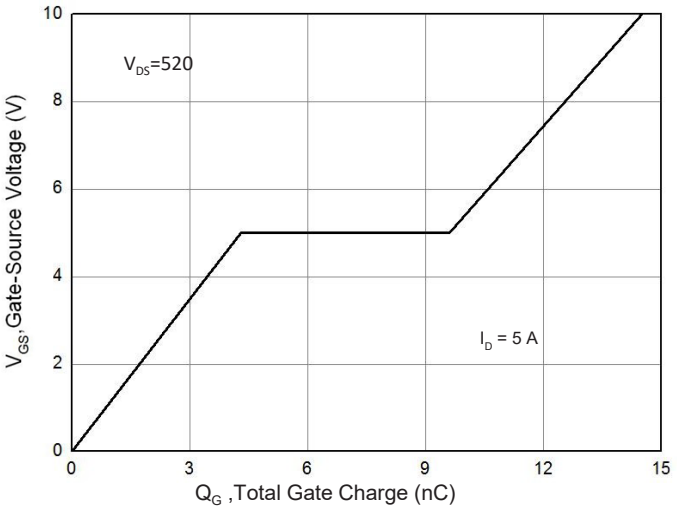



Figure 9. Maximum Safe Operating Area

C C TO-220F

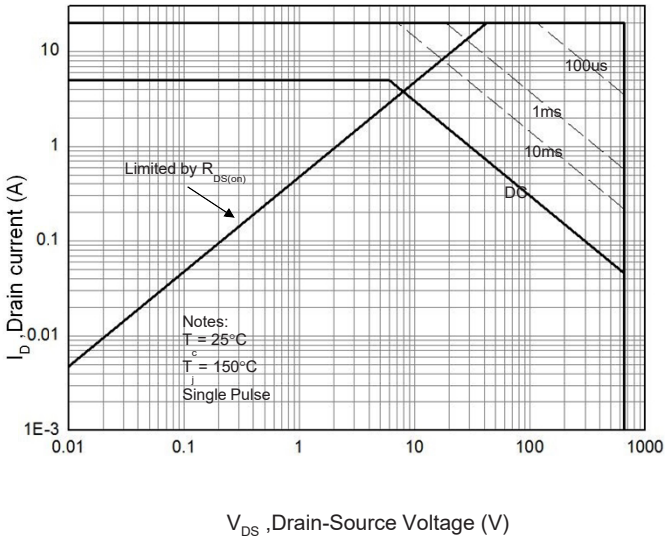



Figure 10. Maximum Safe Operating Area

C C TO-220/TO-251/TO-252

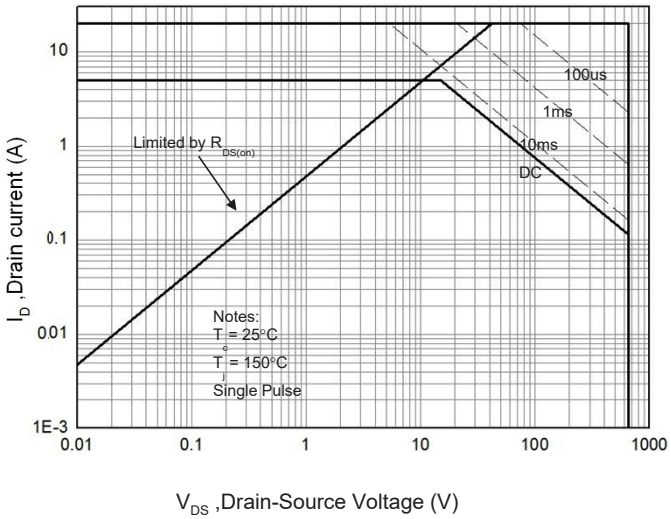



Figure 11. Power Dissipation vs. Temperature

C C TO-220F

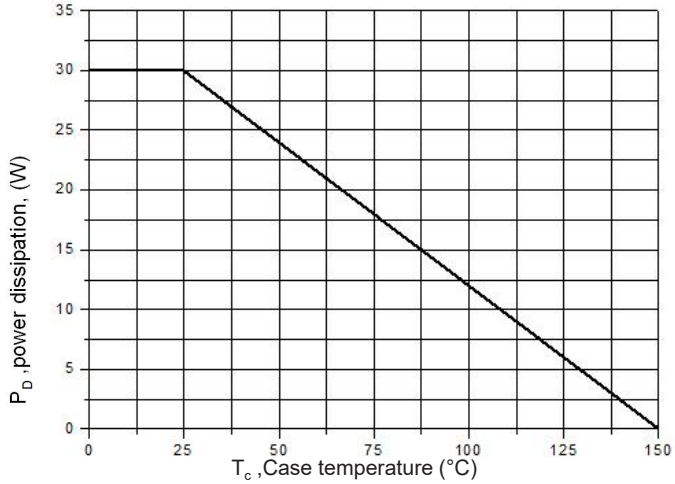



Figure 12. Power Dissipation vs. Temperature

C C TO-220/TO-251/TO-252

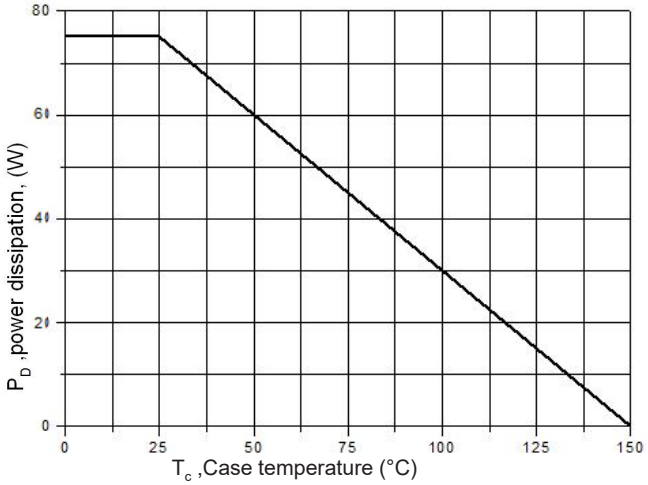


Figure 13. Continuous Drain Current vs. Temperature

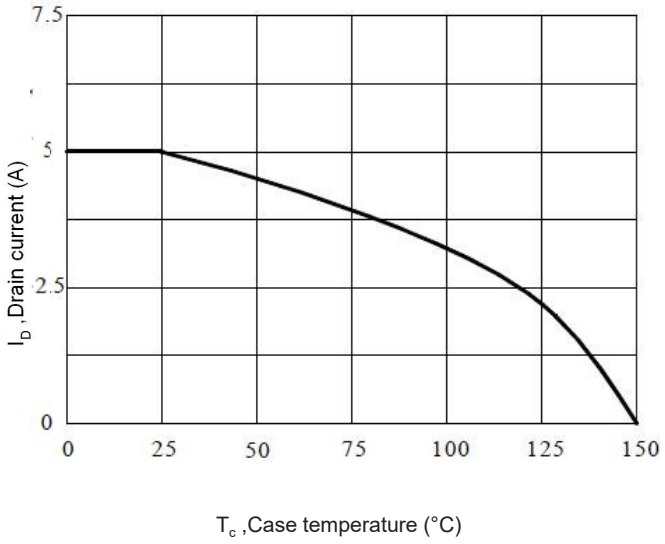



Figure 14. Body Diode Transfer Characteristics

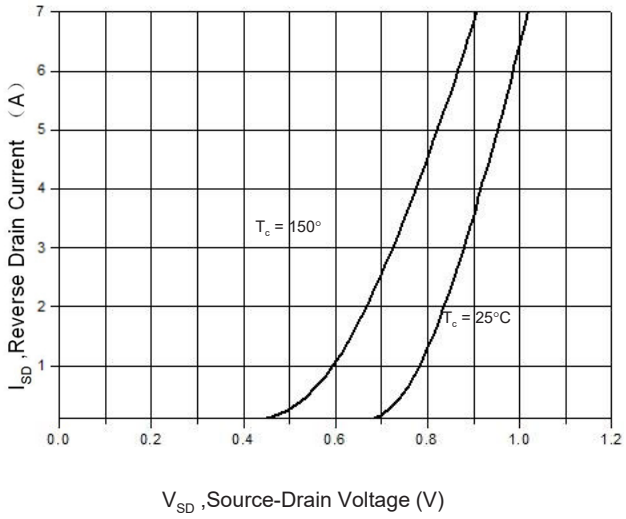



Figure 15 Transient Thermal Impedance, Junction to Case，C TO-220F

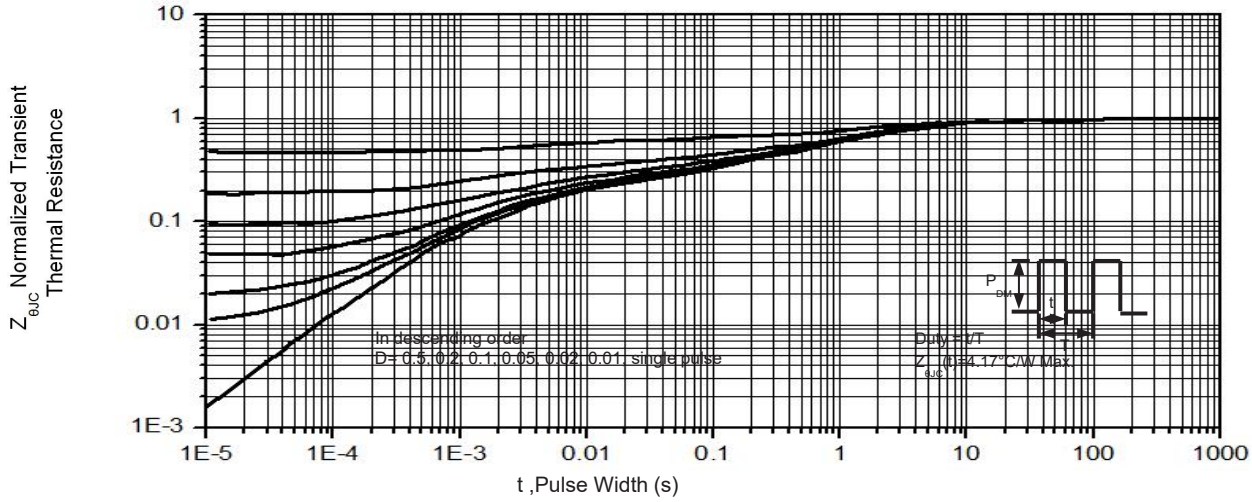
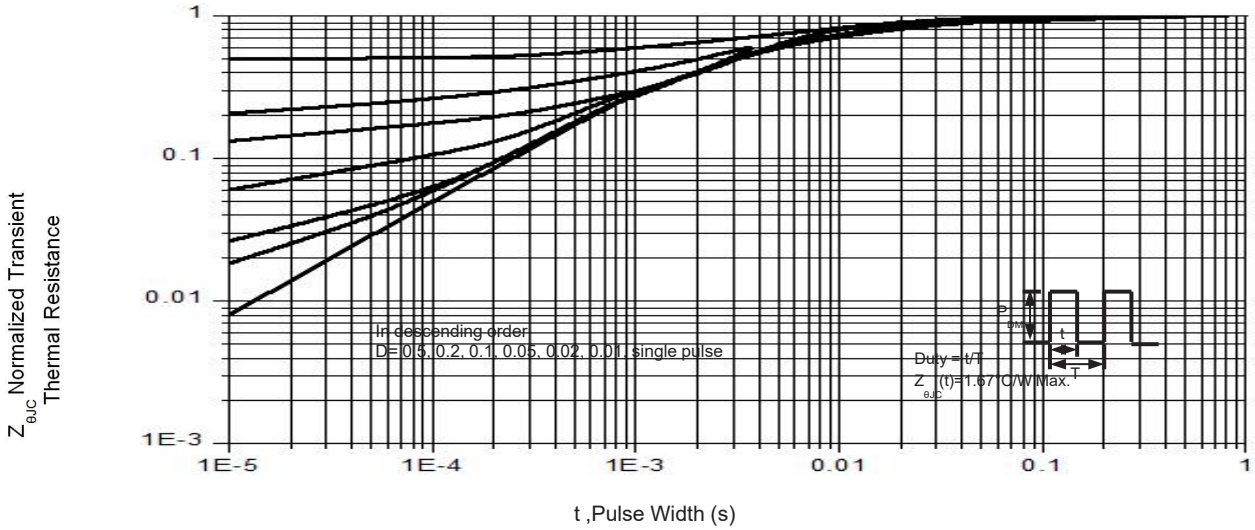
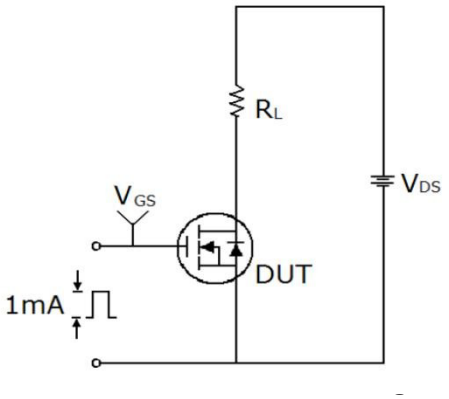
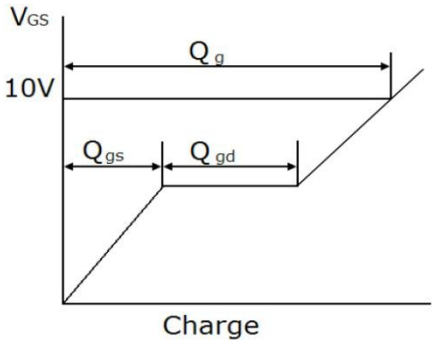


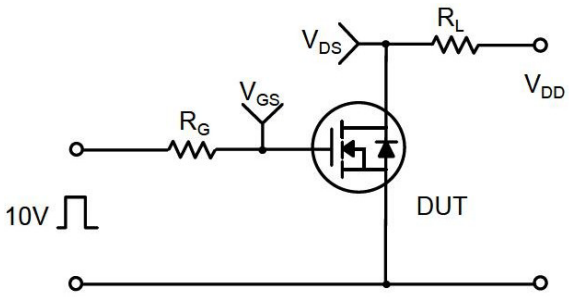

Figure 16. Transient Thermal Impedance, Junction to Case，C TO-220/TO-251/TO-252

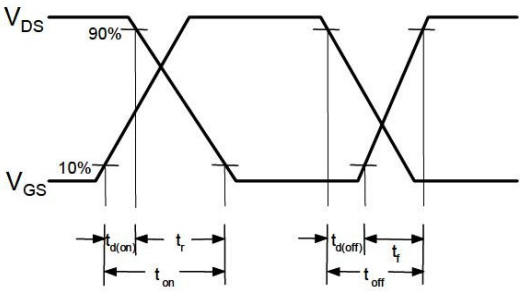


## Gate Charge Test Circuit & Waveform




## Unclamped Inductive Switching Test Circuit & Waveforms