

## Description

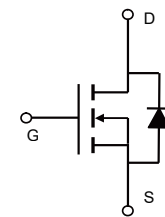
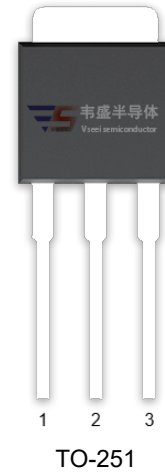
The VSM20N06 uses advanced trench technology and design to provide excellent  $R_{DS(ON)}$  with low gate charge. It can be used in a wide variety of applications.

## General Features

- $V_{DS} = 60V, I_D = 20A$   
 $R_{DS(ON)} < 25m\Omega @ V_{GS} = 10V$   
 $R_{DS(ON)} < 31m\Omega @ V_{GS} = 4.5V$
- High density cell design for ultra low  $R_{DS(ON)}$
- Fully characterized avalanche voltage and current
- Good stability and uniformity with high  $E_{AS}$
- Excellent package for good heat dissipation
- Special process technology for high ESD capability

## Application

- Power switching application
- Hard switched and high frequency circuits
- Uninterruptible power supply



Schematic

## Package Marking and Ordering Information

| Device Marking | Device      | Device Package | Reel Size | Tape width | Quantity |
|----------------|-------------|----------------|-----------|------------|----------|
| VSM20N06       | VSM20N06-T1 | TO-251         | -         | -          | -        |

## Absolute Maximum Ratings ( $T_C = 25^\circ C$ unless otherwise noted)

| Parameter                                        | Symbol             | Limit      | Unit          |
|--------------------------------------------------|--------------------|------------|---------------|
| Drain-Source Voltage                             | $V_{DS}$           | 60         | V             |
| Gate-Source Voltage                              | $V_{GS}$           | $\pm 20$   | V             |
| Drain Current-Continuous                         | $I_D$              | 20         | A             |
| Drain Current-Continuous( $T_C = 100^\circ C$ )  | $I_D(100^\circ C)$ | 14         | A             |
| Pulsed Drain Current                             | $I_{DM}$           | 60         | A             |
| Maximum Power Dissipation                        | $P_D$              | 45         | W             |
| Derating factor                                  |                    | 0.3        | W/ $^\circ C$ |
| Single pulse avalanche energy (Note 5)           | $E_{AS}$           | 72         | mJ            |
| Operating Junction and Storage Temperature Range | $T_J, T_{STG}$     | -55 To 175 | $^\circ C$    |

## Thermal Characteristic

|                                                          |                 |     |                      |
|----------------------------------------------------------|-----------------|-----|----------------------|
| Thermal Resistance, Junction-to-Case <sup>(Note 2)</sup> | $R_{\theta JC}$ | 3.3 | $^{\circ}\text{C/W}$ |
|----------------------------------------------------------|-----------------|-----|----------------------|

## Electrical Characteristics ( $T_c=25^{\circ}\text{C}$ unless otherwise noted)

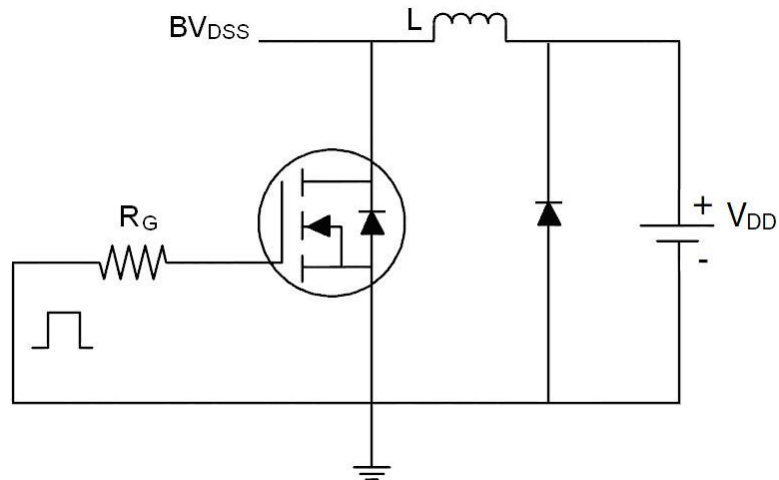
| Parameter                                         | Symbol              | Condition                                                                                                  | Min | Typ   | Max  | Unit |
|---------------------------------------------------|---------------------|------------------------------------------------------------------------------------------------------------|-----|-------|------|------|
| Off Characteristics                               |                     |                                                                                                            |     |       |      |      |
| Drain-Source Breakdown Voltage                    | BV <sub>DSS</sub>   | V <sub>GS</sub> =0V I <sub>D</sub> =250μA                                                                  | 60  | -     | -    | V    |
| Zero Gate Voltage Drain Current                   | I <sub>DSS</sub>    | V <sub>DS</sub> =60V, V <sub>GS</sub> =0V                                                                  | -   | -     | 1    | μA   |
| Gate-Body Leakage Current                         | I <sub>GSS</sub>    | V <sub>GS</sub> =±20V, V <sub>DS</sub> =0V                                                                 | -   | -     | ±100 | nA   |
| On Characteristics <small>(Note 3)</small>        |                     |                                                                                                            |     |       |      |      |
| Gate Threshold Voltage                            | V <sub>GS(th)</sub> | V <sub>DS</sub> =V <sub>GS</sub> , I <sub>D</sub> =250μA                                                   | 1.2 | 1.6   | 2.5  | V    |
| Drain-Source On-State Resistance                  | R <sub>DS(ON)</sub> | V <sub>GS</sub> =10V, I <sub>D</sub> =20A                                                                  | -   | 21    | 25   | mΩ   |
|                                                   |                     | V <sub>GS</sub> =4.5V, I <sub>D</sub> =20A                                                                 |     | 25.5  | 31   |      |
| Forward Transconductance                          | g <sub>FS</sub>     | V <sub>DS</sub> =5V, I <sub>D</sub> =5A                                                                    | 11  | -     | -    | S    |
| Dynamic Characteristics <small>(Note4)</small>    |                     |                                                                                                            |     |       |      |      |
| Input Capacitance                                 | C <sub>iss</sub>    | V <sub>DS</sub> =30V, V <sub>GS</sub> =0V,<br>F=1.0MHz                                                     | -   | 973.2 | -    | PF   |
| Output Capacitance                                | C <sub>Oss</sub>    |                                                                                                            | -   | 61.2  | -    | PF   |
| Reverse Transfer Capacitance                      | C <sub>rss</sub>    |                                                                                                            | -   | 58.8  | -    | PF   |
| Switching Characteristics <small>(Note 4)</small> |                     |                                                                                                            |     |       |      |      |
| Turn-on Delay Time                                | t <sub>d(on)</sub>  | V <sub>DD</sub> =30V, I <sub>D</sub> =2A, R <sub>L</sub> =6.7Ω<br>V <sub>GS</sub> =10V, R <sub>G</sub> =3Ω | -   | 5     | -    | nS   |
| Turn-on Rise Time                                 | t <sub>r</sub>      |                                                                                                            | -   | 2.6   | -    | nS   |
| Turn-Off Delay Time                               | t <sub>d(off)</sub> |                                                                                                            | -   | 16.1  | -    | nS   |
| Turn-Off Fall Time                                | t <sub>f</sub>      |                                                                                                            | -   | 2.3   | -    | nS   |
| Total Gate Charge                                 | Q <sub>g</sub>      | V <sub>DS</sub> =30V, I <sub>D</sub> =4.5A,<br>V <sub>GS</sub> =10V                                        | -   | 25    |      | nC   |
| Gate-Source Charge                                | Q <sub>gs</sub>     |                                                                                                            | -   | 4.5   |      | nC   |
| Gate-Drain Charge                                 | Q <sub>gd</sub>     |                                                                                                            | -   | 6.5   |      | nC   |
| Drain-Source Diode Characteristics                |                     |                                                                                                            |     |       |      |      |
| Diode Forward Voltage <small>(Note 3)</small>     | V <sub>SD</sub>     | V <sub>GS</sub> =0V, I <sub>S</sub> =20A                                                                   | -   |       | 1.2  | V    |
| Diode Forward Current <small>(Note 2)</small>     | I <sub>S</sub>      |                                                                                                            | -   | -     | 20   | A    |
| Reverse Recovery Time                             | t <sub>rr</sub>     | T <sub>J</sub> = 25°C, I <sub>F</sub> =20A<br>di/dt = 100A/μs <sup>(Note3)</sup>                           | -   | 29    | -    | nS   |
| Reverse Recovery Charge                           | Q <sub>rr</sub>     |                                                                                                            | -   | 49    | -    | nC   |
| Forward Turn-On Time                              | t <sub>on</sub>     | Intrinsic turn-on time is negligible (turn-on is dominated by LS+LD)                                       |     |       |      |      |

## Notes:

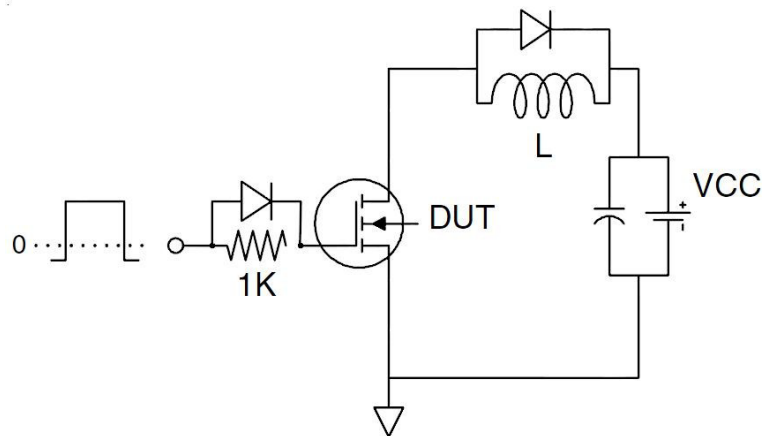
1. Repetitive Rating: Pulse width limited by maximum junction temperature.
2. Surface Mounted on FR4 Board,  $t \leq 10$  sec.
3. Pulse Test: Pulse Width  $\leq 300\mu s$ , Duty Cycle  $\leq 2\%$ .
4. Guaranteed by design, not subject to production
5. EAS condition:  $T_J=25^{\circ}\text{C}, V_{DD}=30V, V_G=10V, L=0.5mH, R_g=25\Omega$

## Test Circuit

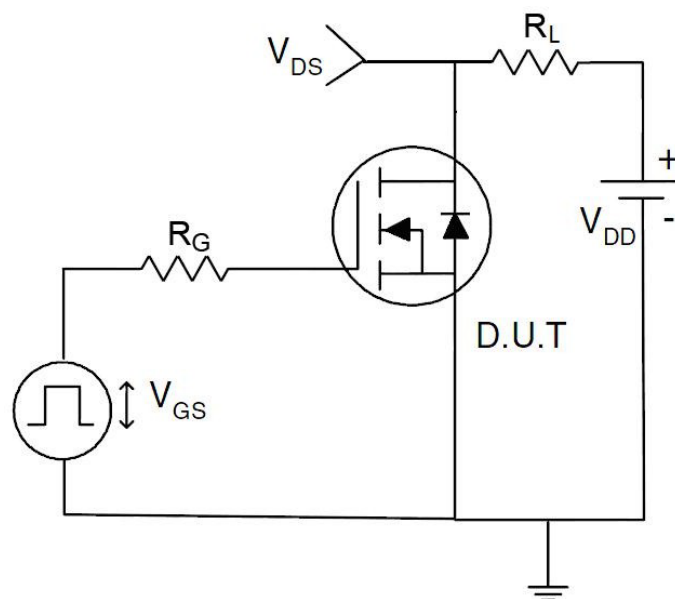
### 1) $E_{AS}$ test Circuit



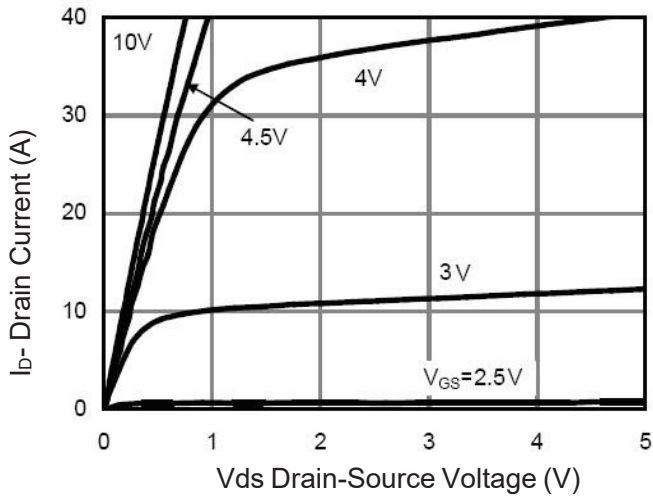
### 2) Gate charge test Circuit



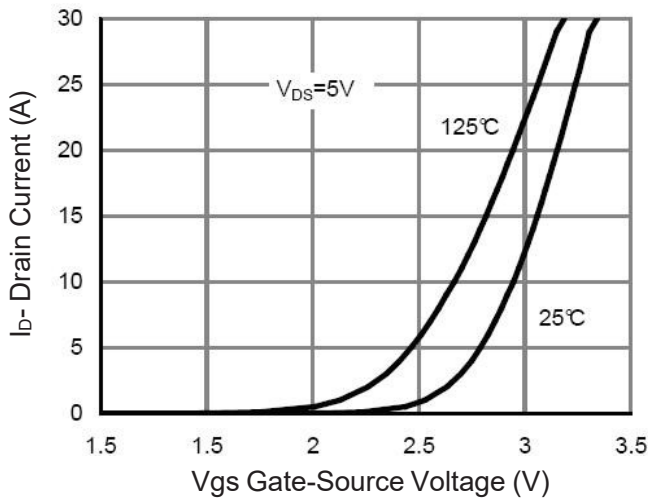
### 3) Switch Time Test Circuit



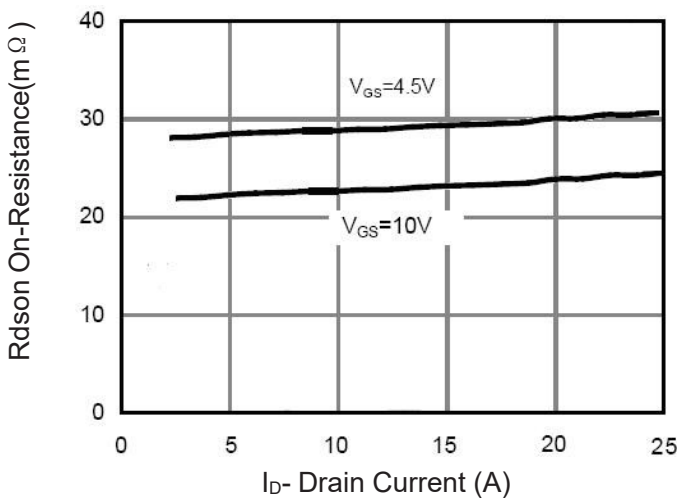
## Typical Electrical and Thermal Characteristics (Curves)



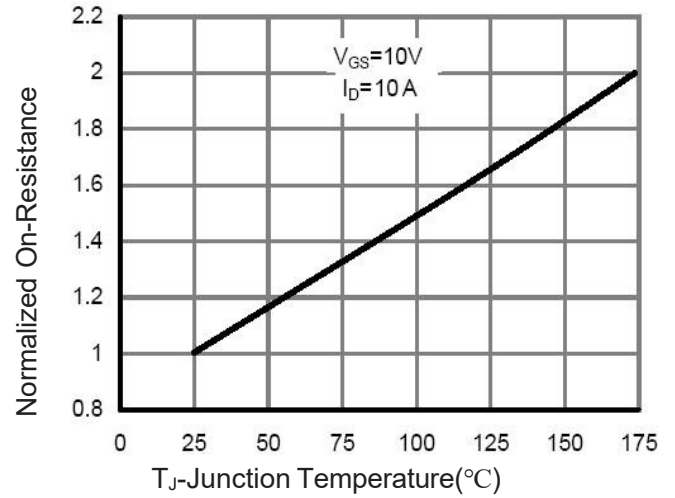
**Figure 1 Output Characteristics**



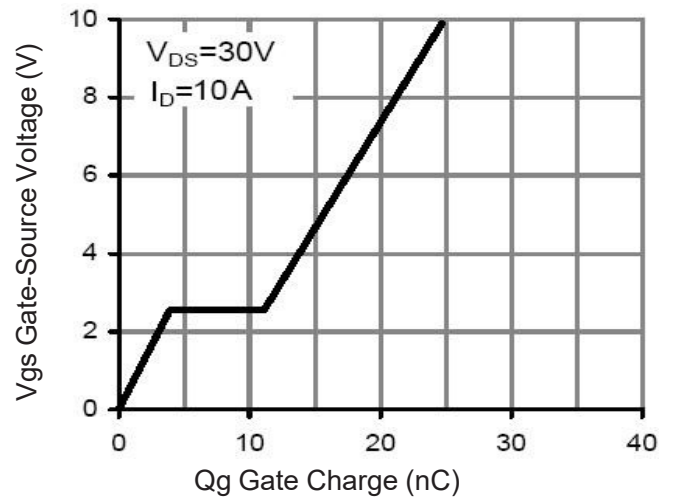
**Figure 2 Transfer Characteristics**



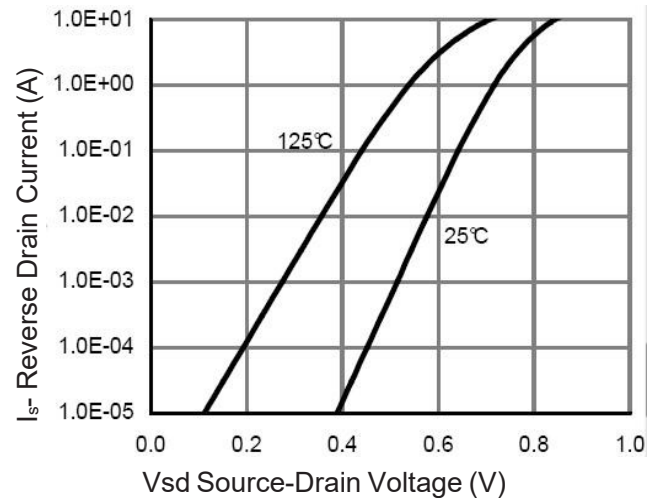
**Figure 3 Rdson- Drain Current**



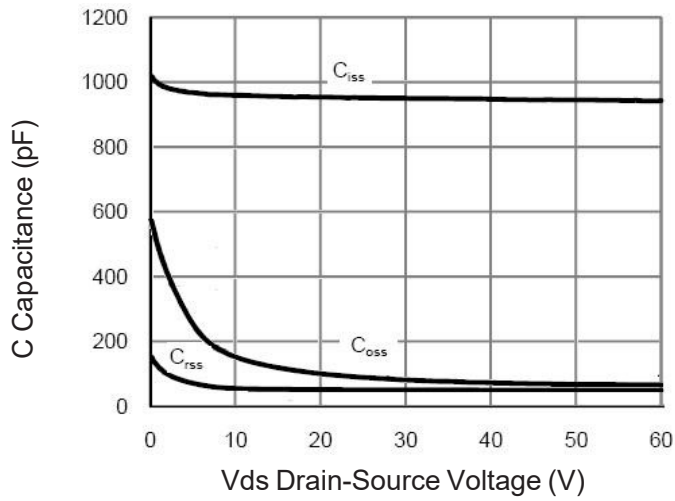
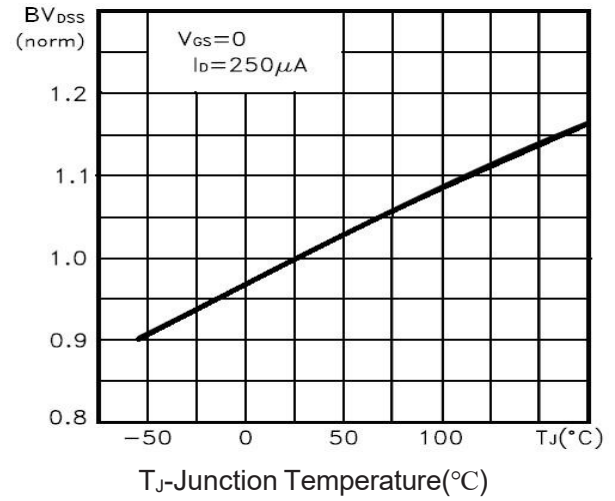
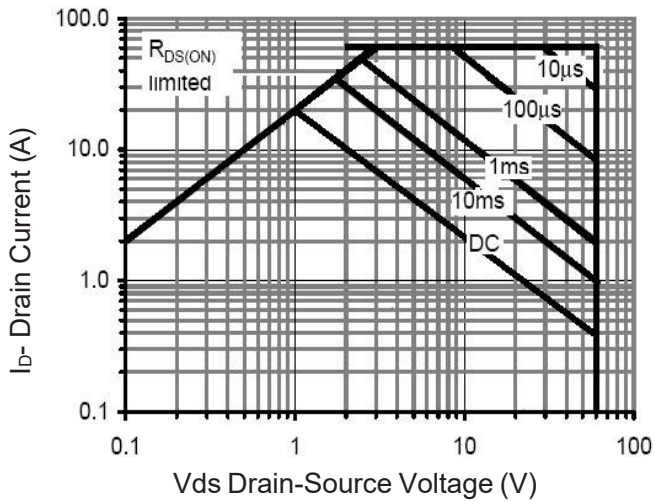
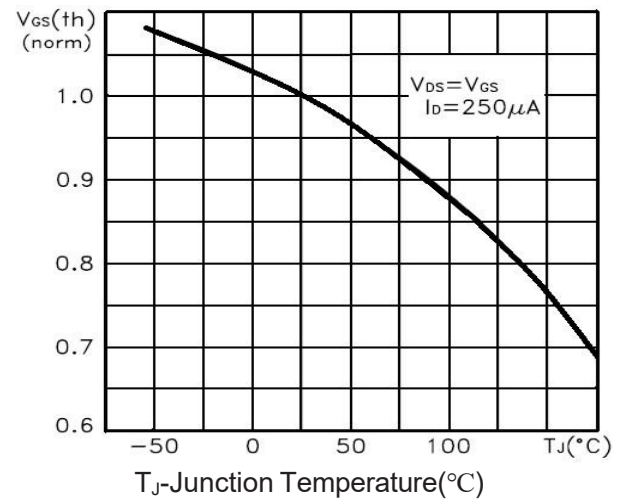
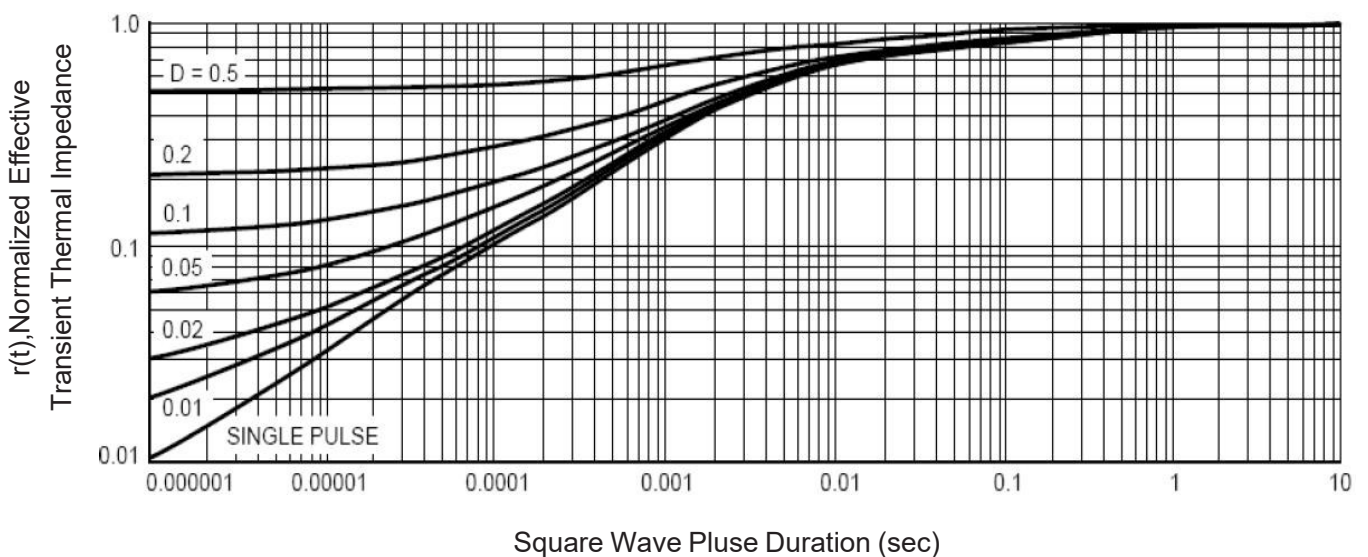
**Figure 4 Rdson-Junction Temperature**



**Figure 5 Gate Charge**



**Figure 6 Source- Drain Diode Forward**


**Figure 7 Capacitance vs Vds**

**Figure 9 BV<sub>DSS</sub> vs Junction Temperature**

**Figure 8 Safe Operation Area**

**Figure 10 V<sub>GS(th)</sub> vs Junction Temperature**

**Figure 11 Normalized Maximum Transient Thermal Impedance**