

## Description

The VSM24N20 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

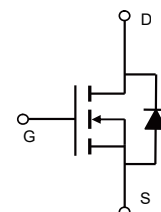
- $V_{DS}=200V, I_D=24A$   
 $R_{DS(ON)} < 80m\Omega @ V_{GS}=10V$  (Typ:62m $\Omega$ )
- High density cell design for ultra low  $R_{dson}$
- Fully characterized avalanche voltage and current
- Good stability and uniformity with high  $E_{AS}$
- Excellent package for good heat dissipation
- Special process technology for high ESD capability

## Application

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



TO-220F



Schematic

## Package Marking and Ordering Information

| Device Marking | Device      | Device Package | Reel Size | Tape width | Quantity |
|----------------|-------------|----------------|-----------|------------|----------|
| VSM24N20       | VSM24N20-TF | TO-220F        | -         | -          | -        |

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

| Parameter                                        | Symbol              | Limit      | Unit        |
|--------------------------------------------------|---------------------|------------|-------------|
| Drain-Source Voltage                             | $V_{DS}$            | 200        | V           |
| Gate-Source Voltage                              | $V_{GS}$            | $\pm 20$   | V           |
| Drain Current-Continuous                         | $I_D$               | 24         | A           |
| Drain Current-Continuous( $T_C=100^{\circ}C$ )   | $I_D(100^{\circ}C)$ | 16.5       | A           |
| Pulsed Drain Current                             | $I_{DM}$            | 100        | A           |
| Maximum Power Dissipation                        | $P_D$               | 45         | W           |
| Single pulse avalanche energy (Note 5)           | $E_{AS}$            | 250        | mJ          |
| Operating Junction and Storage Temperature Range | $T_J, T_{STG}$      | -55 To 175 | $^{\circ}C$ |

## Thermal Characteristic

|                                                             |                 |      |               |
|-------------------------------------------------------------|-----------------|------|---------------|
| Thermal Resistance, Junction-to-Ambient <sup>(Note 2)</sup> | $R_{\theta JA}$ | 3.33 | $^{\circ}C/W$ |
|-------------------------------------------------------------|-----------------|------|---------------|

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

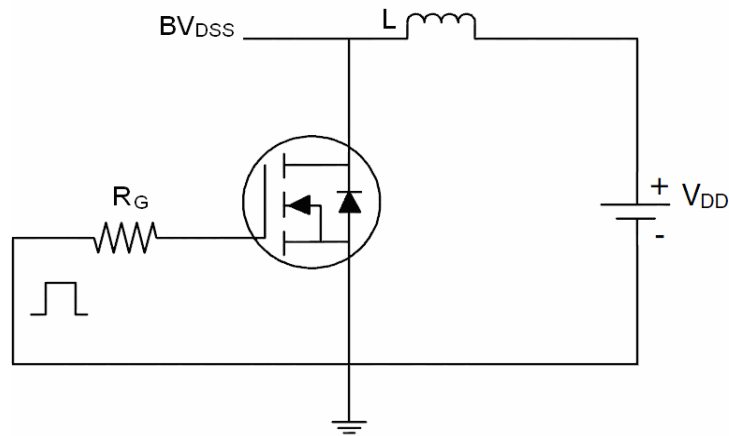
| Parameter                          | Symbol       | Condition                                                 | Min | Typ  | Max       | Unit       |
|------------------------------------|--------------|-----------------------------------------------------------|-----|------|-----------|------------|
| Off Characteristics                |              |                                                           |     |      |           |            |
| Drain-Source Breakdown Voltage     | $BV_{DSS}$   | $V_{GS}=0V, I_D=250\mu A$                                 | 200 | 220  | -         | V          |
| Zero Gate Voltage Drain Current    | $I_{DSS}$    | $V_{DS}=200V, V_{GS}=0V$                                  | -   | -    | 1         | $\mu A$    |
| Gate-Body Leakage Current          | $I_{GSS}$    | $V_{GS}=\pm 20V, V_{DS}=0V$                               | -   | -    | $\pm 100$ | nA         |
| On Characteristics (Note 3)        |              |                                                           |     |      |           |            |
| Gate Threshold Voltage             | $V_{GS(th)}$ | $V_{DS}=V_{GS}, I_D=250\mu A$                             | 1.0 | 1.5  | 2.5       | V          |
| Drain-Source On-State Resistance   | $R_{DS(ON)}$ | $V_{GS}=10V, I_D=15A$                                     | -   | 62   | 80        | m $\Omega$ |
| Forward Transconductance           | $g_{FS}$     | $V_{DS}=10V, I_D=15A$                                     | 30  | -    | -         | S          |
| Dynamic Characteristics (Note4)    |              |                                                           |     |      |           |            |
| Input Capacitance                  | $C_{iss}$    | $V_{DS}=25V, V_{GS}=0V,$<br>$F=1.0MHz$                    |     | 4200 |           | PF         |
| Output Capacitance                 | $C_{oss}$    |                                                           |     | 163  |           | PF         |
| Reverse Transfer Capacitance       | $C_{rss}$    |                                                           |     | 75   |           | PF         |
| Switching Characteristics (Note 4) |              |                                                           |     |      |           |            |
| Turn-on Delay Time                 | $t_{d(on)}$  | $V_{DD}=100V, I_D=15A$<br>$V_{GS}=10V, R_{GEN}=2.5\Omega$ | -   | 10   | -         | nS         |
| Turn-on Rise Time                  | $t_r$        |                                                           | -   | 18   | -         | nS         |
| Turn-Off Delay Time                | $t_{d(off)}$ |                                                           | -   | 22   | -         | nS         |
| Turn-Off Fall Time                 | $t_f$        |                                                           | -   | 5    | -         | nS         |
| Total Gate Charge                  | $Q_g$        | $V_{DS}=100V, I_D=15A,$<br>$V_{GS}=10V$                   |     | 60   |           | nC         |
| Gate-Source Charge                 | $Q_{gs}$     |                                                           |     | 19   |           | nC         |
| Gate-Drain Charge                  | $Q_{gd}$     |                                                           |     | 17   |           | nC         |
| Drain-Source Diode Characteristics |              |                                                           |     |      |           |            |
| Diode Forward Voltage (Note 3)     | $V_{SD}$     | $V_{GS}=0V, I_S=15A$                                      | -   | -    | 1.2       | V          |
| Diode Forward Current (Note 2)     | $I_S$        | -                                                         | -   | -    | 24        | A          |
| Reverse Recovery Time              | $t_{rr}$     | $T_J = 25^{\circ}C, I_F = 15A$                            | -   | 90   | -         | nS         |
| Reverse Recovery Charge            | $Q_{rr}$     | $di/dt = 100A/\mu s^{(Note3)}$                            | -   | 300  | -         | nC         |

**Notes:**

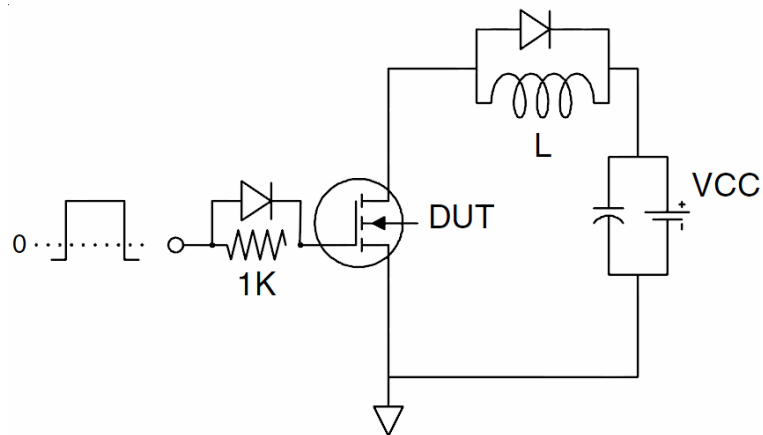
1. Repetitive Rating: Pulse width limited by maximum junction temperature.
2. Surface Mounted on FR4 Board,  $t \leq 10$  sec.
3. Pulse Test: Pulse Width  $\leq 300\mu s$ , Duty Cycle  $\leq 2\%$ .
4. Guaranteed by design, not subject to production
5. EAS condition:  $T_J=25^{\circ}\text{C}, V_{DD}=50V, V_G=10V, L=0.5mH, R_g=25\Omega$

## Test Circuit

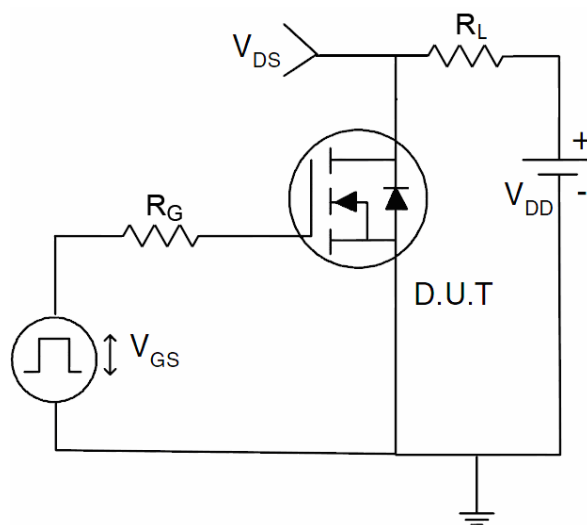
### 1) $E_{AS}$ Test Circuits



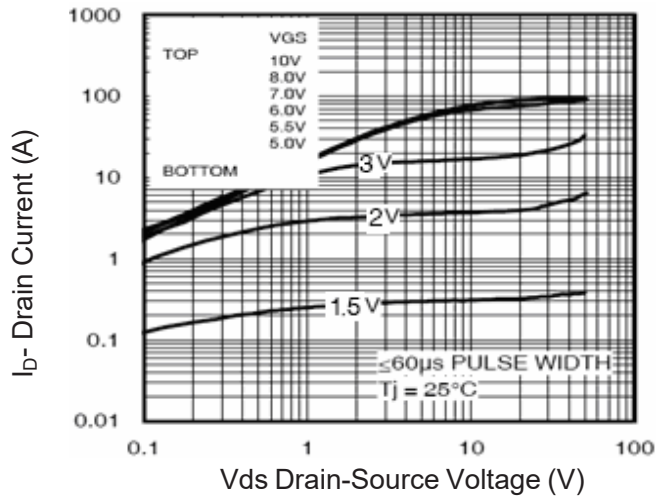
### 2) Gate Charge Test Circuit



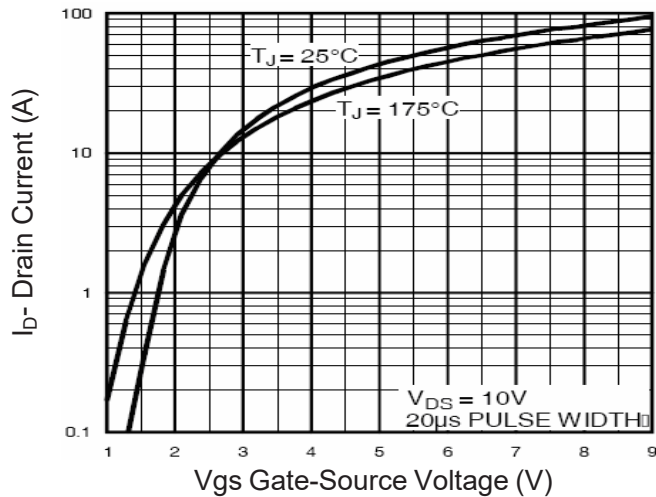
### 3) Switch Time Test Circuit



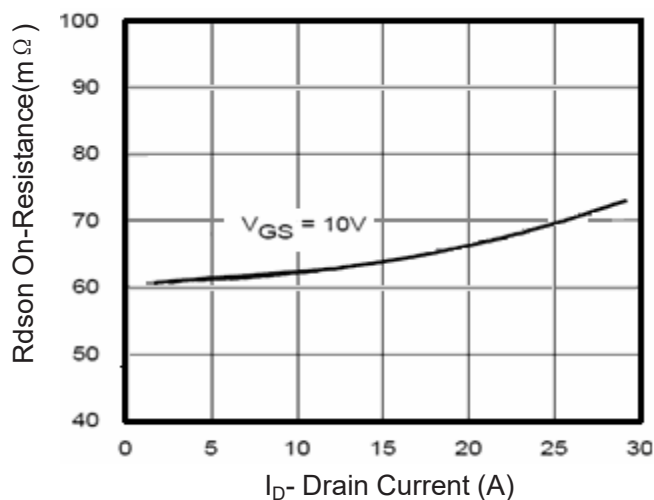
## Typical Electrical and Thermal Characteristics (Curves)



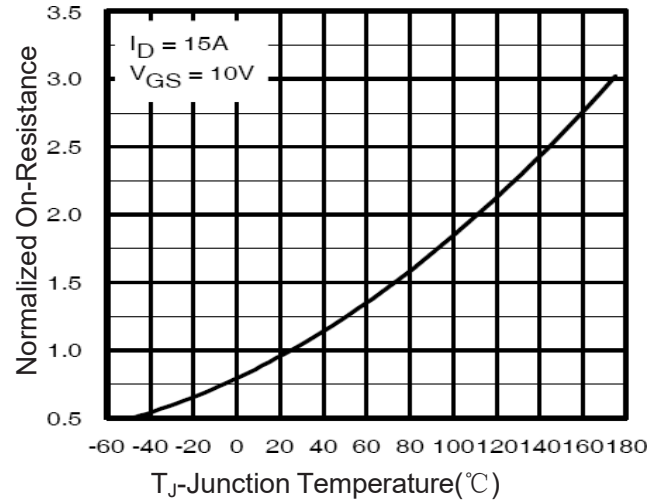
**Figure 1 Output Characteristics**



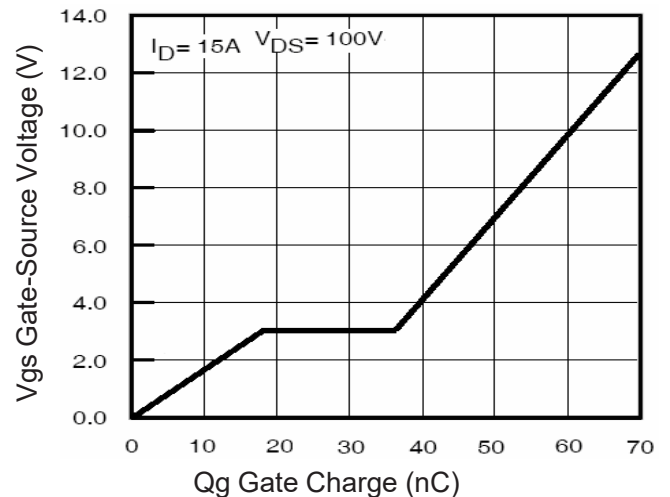
**Figure 2 Transfer Characteristics**



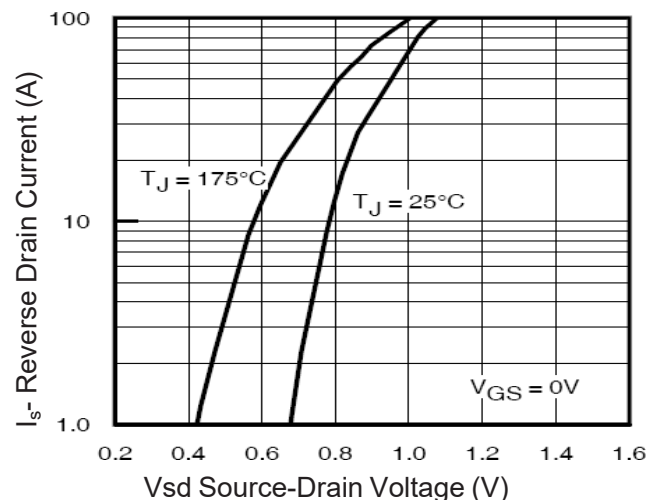
**Figure 3 Rdson- Drain Current**



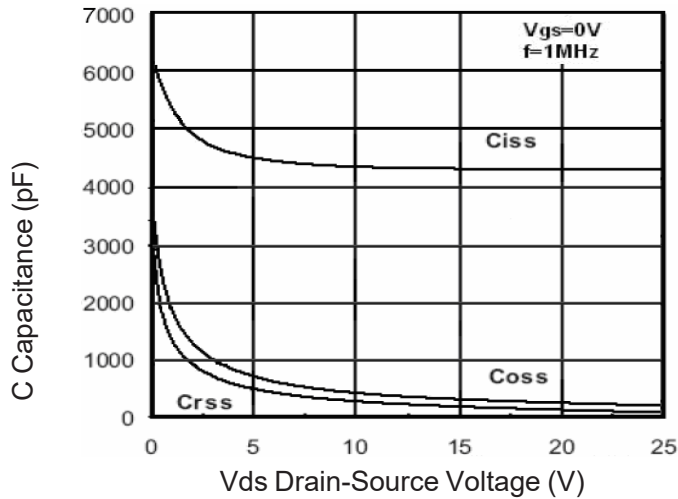
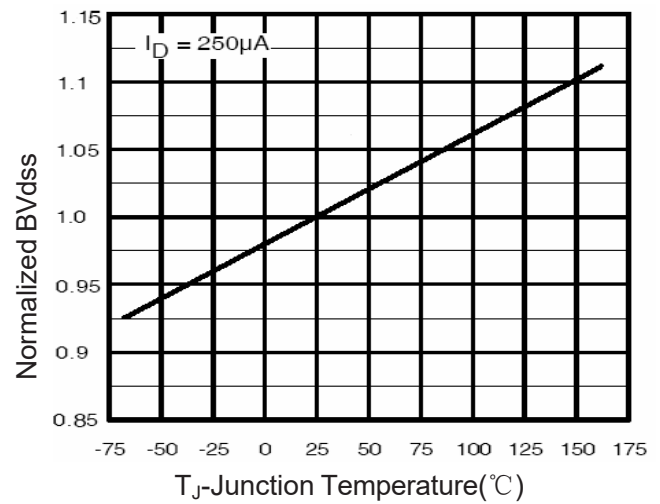
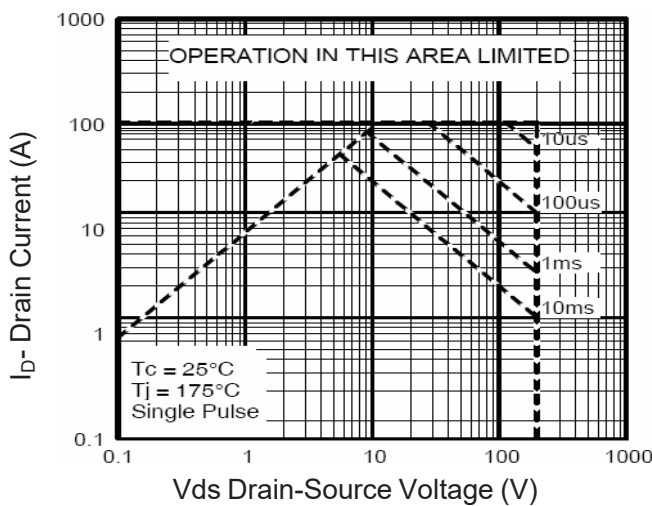
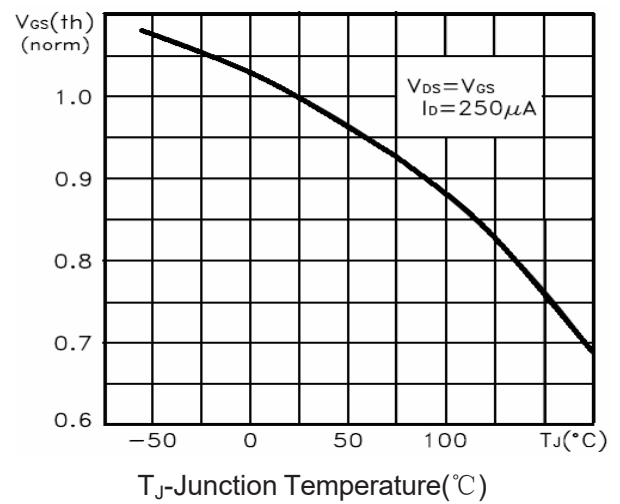
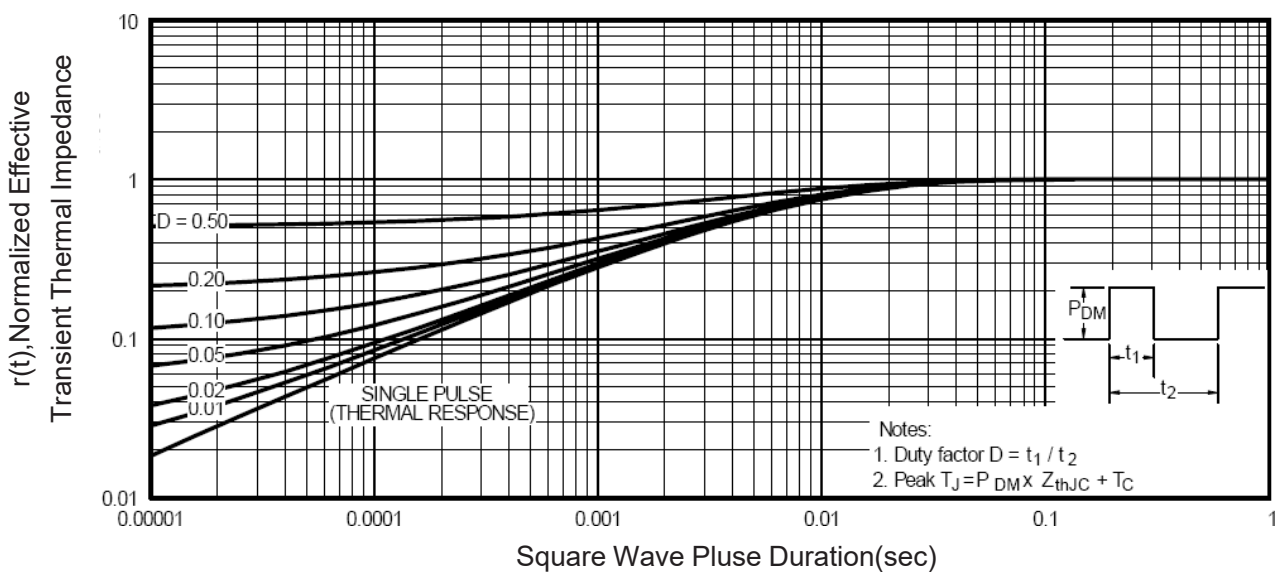
**Figure 4 Rdson-Junction Temperature**



**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**