

## Description

The VSM120N04 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

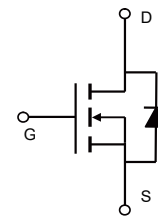
- $V_{DS} = 40V, I_D = 120A$   
 $R_{DS(ON)} < 3.95m\Omega @ V_{GS} = 10V$   
 $R_{DS(ON)} < 7m\Omega @ V_{GS} = 4.5V$
- High density cell design for ultra low  $R_{dson}$
- Fully characterized avalanche voltage and current
- Good stability and uniformity with high  $E_{AS}$
- Excellent package for good heat dissipation
- Special process technology for high ESD capability

## Application

- Load switching
- Hard switched and high frequency circuits
- Uninterruptible power supply



TO-252



Schematic

## Package Marking and Ordering Information

| Device Marking | Device       | Device Package | Reel Size | Tape width | Quantity |
|----------------|--------------|----------------|-----------|------------|----------|
| VSM120N04      | VSM120N04-T2 | TO-252         | -         | -          | -        |

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

| Parameter                                        | Symbol             | Limit      | Unit          |
|--------------------------------------------------|--------------------|------------|---------------|
| Drain-Source Voltage                             | $V_{DS}$           | 40         | V             |
| Gate-Source Voltage                              | $V_{GS}$           | $\pm 20$   | V             |
| Drain Current-Continuous                         | $I_D$              | 120        | A             |
| Drain Current-Continuous( $T_c = 100^\circ C$ )  | $I_D(100^\circ C)$ | 85         | A             |
| Pulsed Drain Current                             | $I_{DM}$           | 330        | A             |
| Maximum Power Dissipation                        | $P_D$              | 120        | W             |
| Derating factor                                  |                    | 0.8        | W/ $^\circ C$ |
| Single pulse avalanche energy (Note 5)           | $E_{AS}$           | 1080       | 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>    | $R_{\theta JC}$ | 1.25 | $^{\circ}\text{C/W}$ |
| Thermal Resistance, Junction-to-Ambient <sup>(Note 2)</sup> | $R_{\theta JA}$ | 55   | $^{\circ}\text{C/W}$ |

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

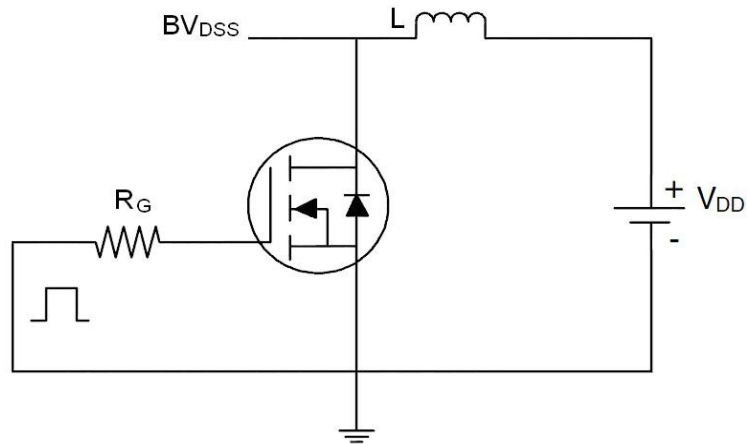
| Parameter                          | Symbol              | Condition                                                                                                | Min | Typ  | Max  | Unit |
|------------------------------------|---------------------|----------------------------------------------------------------------------------------------------------|-----|------|------|------|
| Off Characteristics                |                     |                                                                                                          |     |      |      |      |
| Drain-Source Breakdown Voltage     | BV <sub>DSS</sub>   | V <sub>GS</sub> =0V I <sub>D</sub> =250μA                                                                | 40  | 45   | -    | V    |
| Zero Gate Voltage Drain Current    | I <sub>DSS</sub>    | V <sub>DS</sub> =40V, 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 (Note 3)        |                     |                                                                                                          |     |      |      |      |
| Gate Threshold Voltage             | V <sub>GS(th)</sub> | V <sub>DS</sub> =V <sub>GS</sub> , I <sub>D</sub> =250μA                                                 | 1.2 | 1.8  | 2.5  | V    |
| Drain-Source On-State Resistance   | R <sub>DS(ON)</sub> | V <sub>GS</sub> =10V, I <sub>D</sub> =20A                                                                | -   | 3.1  | 3.95 | mΩ   |
|                                    |                     | V <sub>GS</sub> =4.5V, I <sub>D</sub> =10A                                                               | -   | 5.8  | 7.0  |      |
| Forward Transconductance           | g <sub>FS</sub>     | V <sub>DS</sub> =10V, I <sub>D</sub> =20A                                                                | 26  | -    | -    | S    |
| Dynamic Characteristics (Note4)    |                     |                                                                                                          |     |      |      |      |
| Input Capacitance                  | C <sub>iss</sub>    | V <sub>DS</sub> =20V, V <sub>GS</sub> =0V,<br>F=1.0MHz                                                   | -   | 5400 | -    | PF   |
| Output Capacitance                 | C <sub>OSS</sub>    |                                                                                                          | -   | 970  | -    | PF   |
| Reverse Transfer Capacitance       | C <sub>rSS</sub>    |                                                                                                          | -   | 380  | -    | PF   |
| Switching Characteristics (Note 4) |                     |                                                                                                          |     |      |      |      |
| Turn-on Delay Time                 | t <sub>d(on)</sub>  | V <sub>DD</sub> =20V, I <sub>D</sub> =2A, R <sub>L</sub> =1Ω<br>V <sub>GS</sub> =10V, R <sub>G</sub> =3Ω | -   | 15   | -    | nS   |
| Turn-on Rise Time                  | t <sub>r</sub>      |                                                                                                          | -   | 18   | -    | nS   |
| Turn-Off Delay Time                | t <sub>d(off)</sub> |                                                                                                          | -   | 52   | -    | nS   |
| Turn-Off Fall Time                 | t <sub>f</sub>      |                                                                                                          | -   | 23   | -    | nS   |
| Total Gate Charge                  | Q <sub>g</sub>      | V <sub>DS</sub> =20V, I <sub>D</sub> =20A,<br>V <sub>GS</sub> =10V                                       | -   | 75   |      | nC   |
| Gate-Source Charge                 | Q <sub>gs</sub>     |                                                                                                          | -   | 10.5 |      | nC   |
| Gate-Drain Charge                  | Q <sub>gd</sub>     |                                                                                                          | -   | 17   |      | nC   |
| Drain-Source Diode Characteristics |                     |                                                                                                          |     |      |      |      |
| Diode Forward Voltage (Note 3)     | V <sub>SD</sub>     | V <sub>GS</sub> =0V, I <sub>S</sub> =40A                                                                 | -   |      | 1.2  | V    |
| Diode Forward Current (Note 2)     | I <sub>S</sub>      |                                                                                                          | -   | -    | 120  | A    |
| Reverse Recovery Time              | t <sub>rr</sub>     | T <sub>J</sub> = 25°C, IF = 40A<br>di/dt = 100A/μs(Note3)                                                | -   | 42   | -    | nS   |
| Reverse Recovery Charge            | Q <sub>rr</sub>     |                                                                                                          | -   | 45   | -    | nC   |
| Forward Turn-On Time               | t <sub>on</sub>     | Intrinsic turn-on time is negligible (turn-on is dominated by LS+LD)                                     |     |      |      |      |

## Notes:

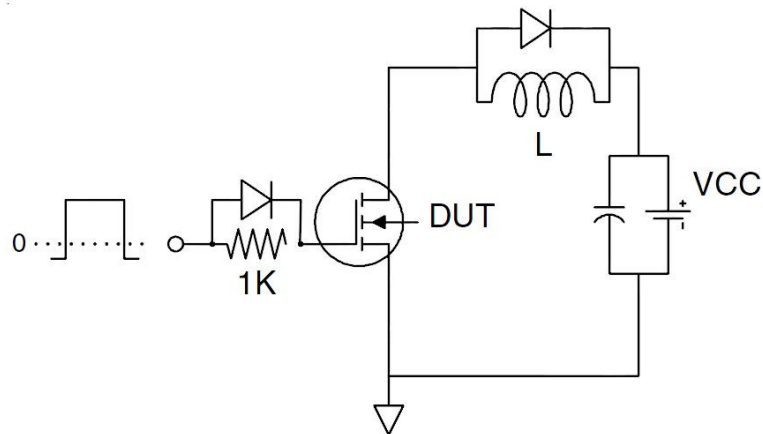
1. Repetitive Rating: Pulse width limited by maximum junction temperature.
2. Surface Mounted on FR4 Board,  $t \leq 10$  sec. The value of  $R_{\theta JA}$  is measured with the device mounted on 1in2 FR-4 board with 2oz. Copper, in a still air environment with  $T_A = 25^{\circ}\text{C}$ . The Power dissipation PDSM is based on  $R_{\theta JA}$  and the maximum allowed junction temperature of  $150^{\circ}\text{C}$ . The value in any given application depends on the user's specific board design, and the maximum temperature of  $175^{\circ}\text{C}$  may be used if the PCB allows it.
3. Pulse Test: Pulse Width  $\leq 300\mu s$ , Duty Cycle  $\leq 2\%$ .
4. Guaranteed by design, not subject to production
5.  $E_{AS}$  condition :  $T_J=25^{\circ}\text{C}, V_{DD}=20V, V_G=10V, L=1mH, R_g=25\Omega$ .

## Test circuit

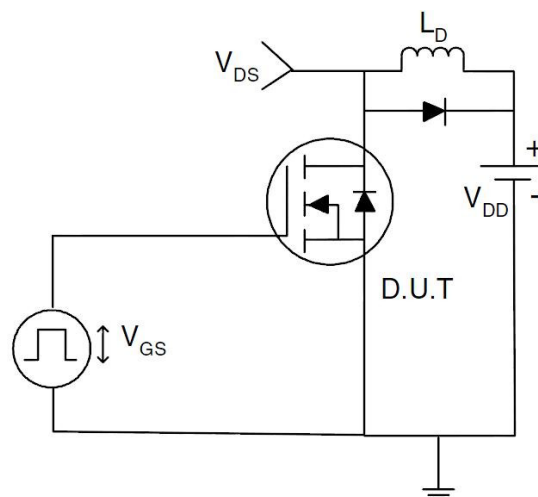
### 1) $E_{AS}$ Test Circuit



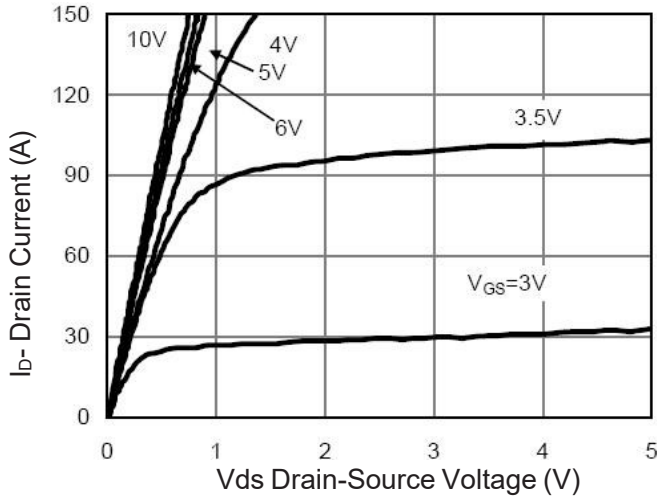
### 2) Gate Charge Test Circuit



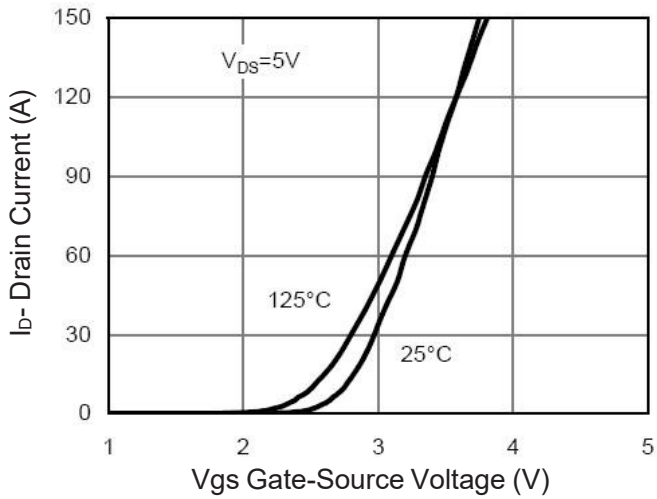
### 3) Switch Time Test Circuit



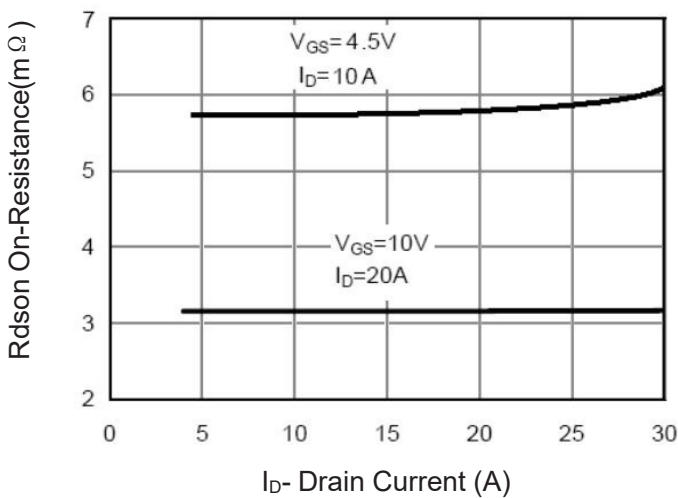
## Typical Electrical and Thermal Characteristics (Curves)



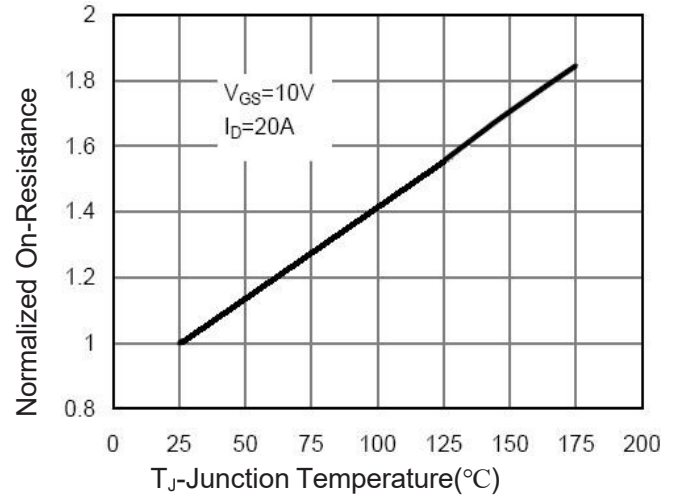
**Figure 1 Output Characteristics**



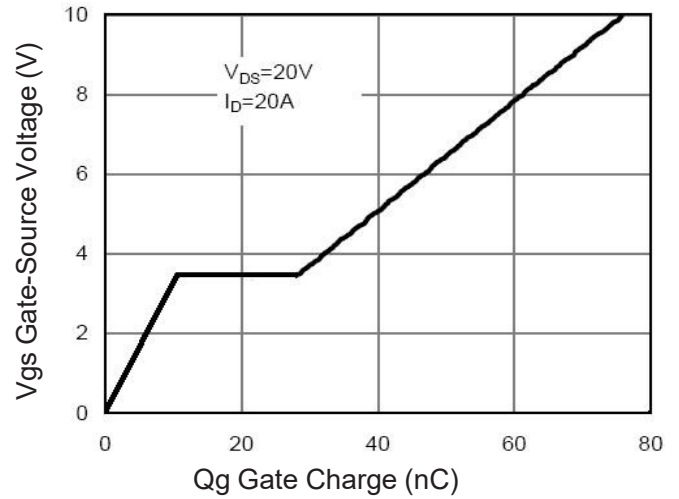
**Figure 2 Transfer Characteristics**



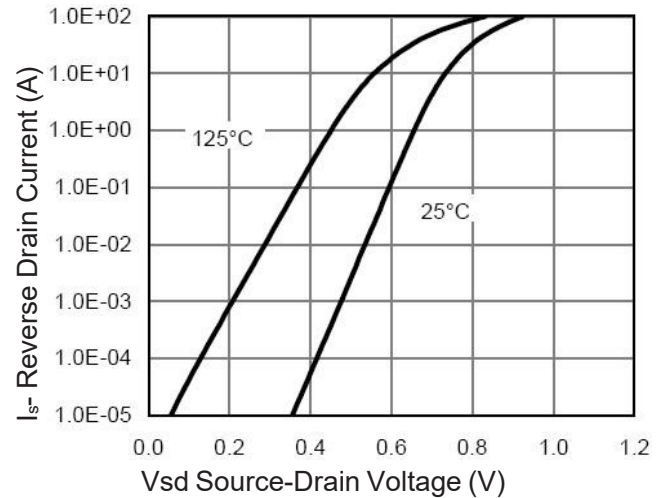
**Figure 3 Rdson- Drain Current**



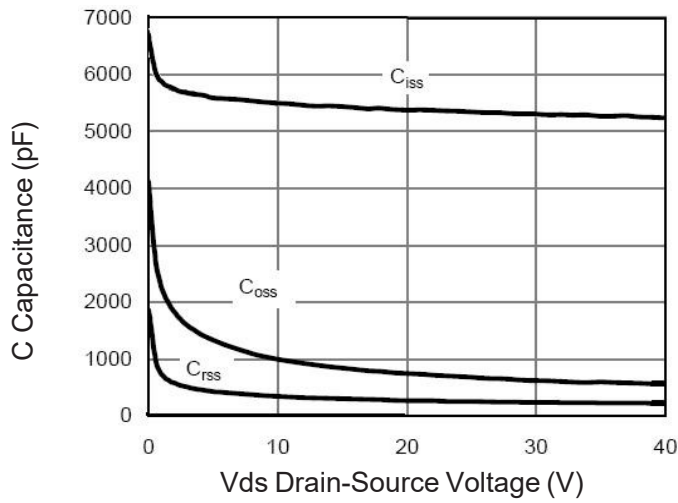
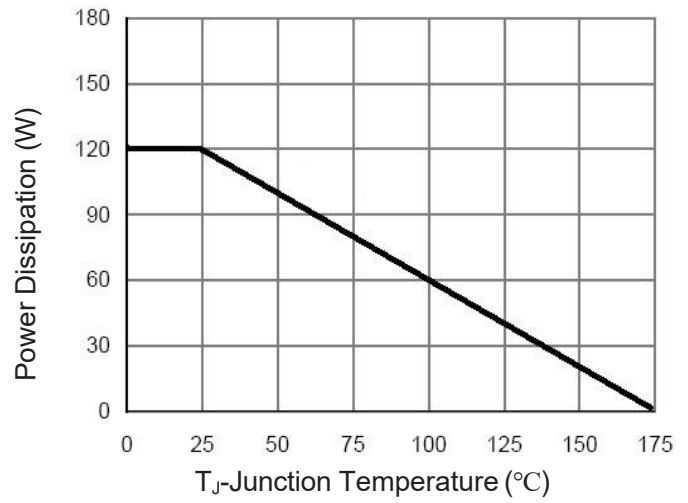
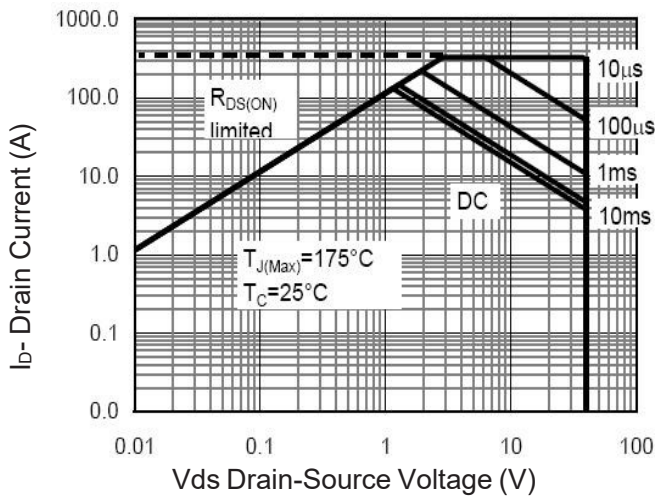
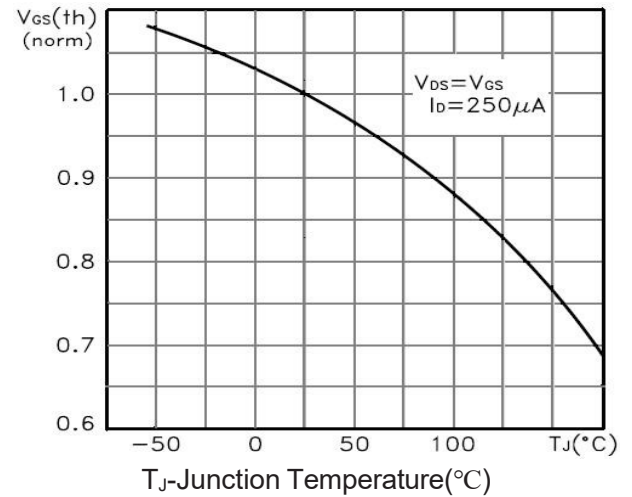
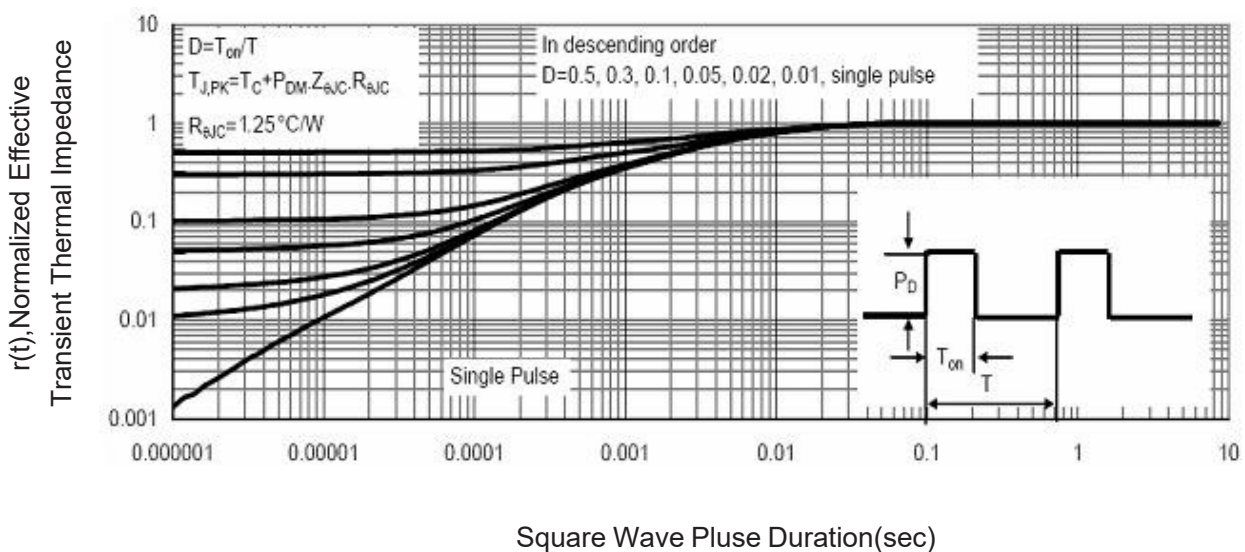
**Figure 4 Rdson-Junction Temperature**



**Figure 5 Gate Charge**



**Figure 6 Source- Drain Diode Forward**


**Figure 7 Capacitance vs Vds**

**Figure 9 Power De-rating**

**Figure 8 Safe Operation Area**

**Figure 10  $V_{GS(\text{th})}$  vs Junction Temperature**

**Figure 11 Normalized Maximum Transient Thermal Impedance**