

## Description

The VSM4P04 uses advanced trench technology to provide excellent  $R_{DS(ON)}$  and low gate charge. The complementary MOSFETs may be used to form a level shifted high side switch, and for a host of other applications.

## General Features

### ● N-Channel

$$V_{DS} = 40V, I_D = 6A$$

$$R_{DS(ON)} = 33m\Omega @ V_{GS}=10V(Typ)$$

$$R_{DS(ON)} = 48m\Omega @ V_{GS}=4.5V(Typ)$$

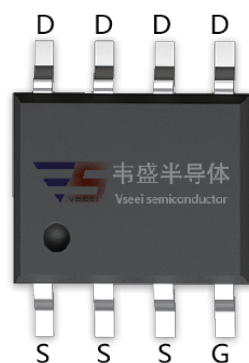
### ● P-Channel

$$V_{DS} = -40V, I_D = -4A$$

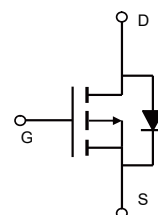
$$R_{DS(ON)} = 69m\Omega @ V_{GS}=-10V(Typ)$$

$$R_{DS(ON)} = 100m\Omega @ V_{GS}=-4.5V(Typ)$$

- High power and current handling capability
- Lead free product is acquired
- Surface mount package



SOP-8



Schematic

## Package Marking and Ordering Information

| Device Marking | Device     | Device Package | Reel Size | Tape width | Quantity   |
|----------------|------------|----------------|-----------|------------|------------|
| VSM4P04        | VSM4P04-S8 | SOP-8          | Ø330mm    | 12mm       | 4000 units |

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

| Parameter                                        |                   | Symbol         | N-Channel  | P-Channel  | Unit        |
|--------------------------------------------------|-------------------|----------------|------------|------------|-------------|
| Drain-Source Voltage                             |                   | $V_{DS}$       | 40         | -40        | V           |
| Gate-Source Voltage                              |                   | $V_{GS}$       | $\pm 20$   | $\pm 20$   | V           |
| Continuous Drain Current                         | $T_A=25^{\circ}C$ | $I_D$          | 6          | -4         | A           |
|                                                  | $T_A=70^{\circ}C$ |                | 4          | -2.8       |             |
| Pulsed Drain Current (Note 1)                    |                   | $I_{DM}$       | 24         | -16        | A           |
| Maximum Power Dissipation                        |                   | $P_D$          | 2.0        | 2.0        | W           |
| Single pulse avalanche energy (Note 5)           |                   | $E_{AS}$       | 20         | 28         | mJ          |
| Operating Junction and Storage Temperature Range |                   | $T_J, T_{STG}$ | -55 To 150 | -55 To 150 | $^{\circ}C$ |

## Thermal Characteristic

|                                                 |                 |      |      |               |
|-------------------------------------------------|-----------------|------|------|---------------|
| Thermal Resistance, Junction-to-Ambient (Note2) | $R_{\theta JA}$ | N-Ch | 62.5 | $^{\circ}C/W$ |
| Thermal Resistance, Junction-to-Ambient (Note2) | $R_{\theta JA}$ | P-Ch | 62.5 | $^{\circ}C/W$ |

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

| Parameter                          | Symbol       | Condition                                                    | Min | Typ  | Max       | Unit       |
|------------------------------------|--------------|--------------------------------------------------------------|-----|------|-----------|------------|
| Off Characteristics                |              |                                                              |     |      |           |            |
| Drain-Source Breakdown Voltage     | $BV_{DSS}$   | $V_{GS}=0V, I_D=250\mu A$                                    | 40  | -    | -         | V          |
| Zero Gate Voltage Drain Current    | $I_{DSS}$    | $V_{DS}=40V, V_{GS}=0V$                                      | -   | -    | 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   | 1.6  | 2.2       | V          |
| Drain-Source On-State Resistance   | $R_{DS(ON)}$ | $V_{GS}=10V, I_D=6A$                                         | -   | 33   | 38        | m $\Omega$ |
|                                    |              | $V_{GS}=4.5V, I_D=3A$                                        | -   | 48   | 63        | m $\Omega$ |
| Forward Transconductance           | $g_{FS}$     | $V_{DS}=5V, I_D=6A$                                          | -   | 8    | -         | S          |
| Dynamic Characteristics (Note4)    |              |                                                              |     |      |           |            |
| Input Capacitance                  | $C_{iss}$    | $V_{DS}=20V, V_{GS}=0V,$<br>$F=1.0MHz$                       | -   | 280  | -         | pF         |
| Output Capacitance                 | $C_{oss}$    |                                                              | -   | 46   | -         | pF         |
| Reverse Transfer Capacitance       | $C_{rss}$    |                                                              | -   | 34   | -         | pF         |
| Switching Characteristics (Note 4) |              |                                                              |     |      |           |            |
| Turn-on Delay Time                 | $t_{d(on)}$  | $V_{DD}=20V, R_L=3.3\Omega$<br>$V_{GS}=10V, R_{GEN}=3\Omega$ | -   | 6    | -         | nS         |
| Turn-on Rise Time                  | $t_r$        |                                                              | -   | 4    | -         | nS         |
| Turn-Off Delay Time                | $t_{d(off)}$ |                                                              | -   | 16   | -         | nS         |
| Turn-Off Fall Time                 | $t_f$        |                                                              | -   | 8    | -         | nS         |
| Total Gate Charge                  | $Q_g$        | $V_{DS}=20V, I_D=6A,$<br>$V_{GS}=10V$                        | -   | 10.2 | -         | nC         |
| Gate-Source Charge                 | $Q_{gs}$     |                                                              | -   | 1.9  | -         | nC         |
| Gate-Drain Charge                  | $Q_{gd}$     |                                                              | -   | 2.1  | -         | nC         |
| Drain-Source Diode Characteristics |              |                                                              |     |      |           |            |
| Diode Forward Voltage (Note 3)     | $V_{SD}$     | $V_{GS}=0V, I_S=6A$                                          | -   | 0.8  | 1.2       | V          |

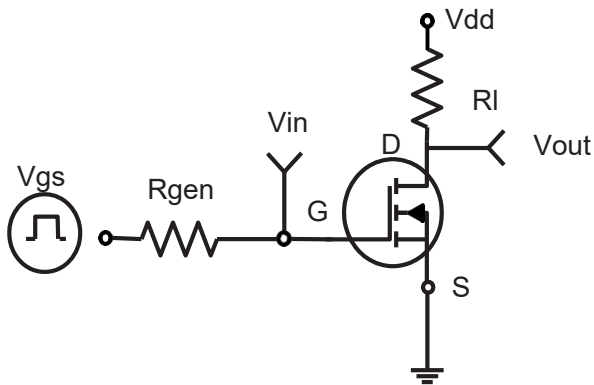
**P-CH Electrical Characteristics (T<sub>A</sub>=25°C unless otherwise noted)**

| 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  | -    | -    | 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 | -1.9 | -2.5 | V    |
| Drain-Source On-State Resistance   | R <sub>DS(ON)</sub> | V <sub>GS</sub> =-10V, I <sub>D</sub> =-4A                                               | -    | 69   | 80   | mΩ   |
|                                    |                     | V <sub>GS</sub> =-4.5V, I <sub>D</sub> =-2A                                              | -    | 100  | 130  | mΩ   |
| Forward Transconductance           | g <sub>FS</sub>     | V <sub>DS</sub> =-5V, I <sub>D</sub> =-4A                                                | -    | 8    | -    | S    |
| Dynamic Characteristics (Note4)    |                     |                                                                                          |      |      |      |      |
| Input Capacitance                  | C <sub>iss</sub>    | V <sub>DS</sub> =-20V, V <sub>GS</sub> =0V,<br>F=1.0MHz                                  | -    | 485  | -    | pF   |
| Output Capacitance                 | C <sub>oss</sub>    |                                                                                          | -    | 97   | -    | pF   |
| Reverse Transfer Capacitance       | C <sub>rss</sub>    |                                                                                          | -    | 70   | -    | pF   |
| Switching Characteristics (Note 4) |                     |                                                                                          |      |      |      |      |
| Turn-on Delay Time                 | t <sub>d(on)</sub>  | V <sub>DD</sub> =-20V, R <sub>L</sub> =5Ω<br>V <sub>GS</sub> =-10V, R <sub>GEN</sub> =3Ω | -    | 9    | -    | nS   |
| Turn-on Rise Time                  | t <sub>r</sub>      |                                                                                          | -    | 8    | -    | nS   |
| Turn-Off Delay Time                | t <sub>d(off)</sub> |                                                                                          | -    | 44   | -    | nS   |
| Turn-Off Fall Time                 | t <sub>f</sub>      |                                                                                          | -    | 41   | -    | nS   |
| Total Gate Charge                  | Q <sub>g</sub>      | V <sub>DS</sub> =-20V, I <sub>D</sub> =-4A<br>V <sub>GS</sub> =-10V                      | -    | 12   | -    | nC   |
| Gate-Source Charge                 | Q <sub>gs</sub>     |                                                                                          | -    | 2.1  | -    | nC   |
| Gate-Drain Charge                  | Q <sub>gd</sub>     |                                                                                          | -    | 2.4  | -    | nC   |
| Drain-Source Diode Characteristics |                     |                                                                                          |      |      |      |      |
| Diode Forward Voltage (Note 3)     | V <sub>SD</sub>     | V <sub>GS</sub> =0V, I <sub>S</sub> =-4A                                                 | -    | -    | -1.2 | V    |

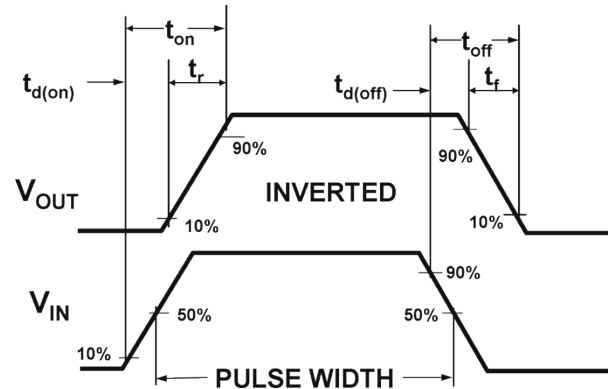
**Notes:**

1. Repetitive Rating: Pulse width limited by maximum junction temperature.
2. Surface Mounted on FR4 Board, t ≤ 10 sec.
3. Pulse Test: Pulse Width ≤ 300μs, Duty Cycle ≤ 2%.
4. Guaranteed by design, not subject to production
5. EAS condition : T<sub>J</sub>=25°C, N: V<sub>DD</sub>=20V, V<sub>G</sub>=10V, L=0.5mH, R<sub>g</sub>=25Ω. P: V<sub>DD</sub>=-20V, V<sub>G</sub>=-10V, L=0.5mH, R<sub>g</sub>=25Ω.

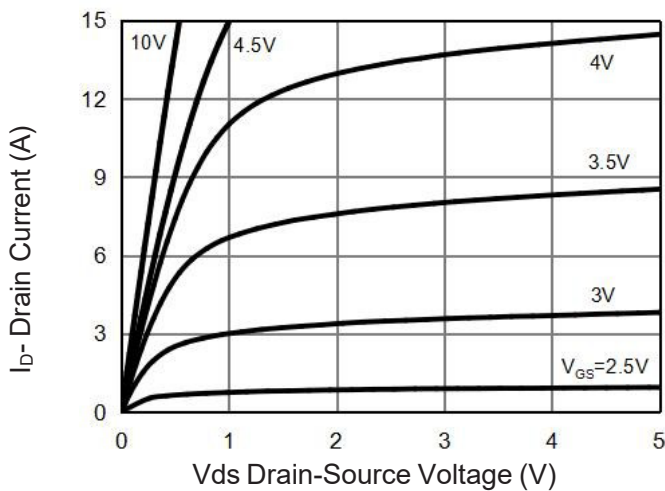
## N- Channel Typical Electrical and Thermal Characteristics (Curves)



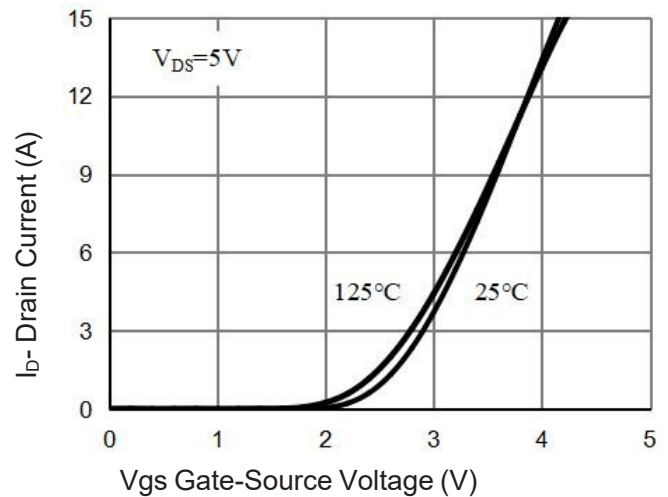
**Figure 1: Switching Test Circuit**



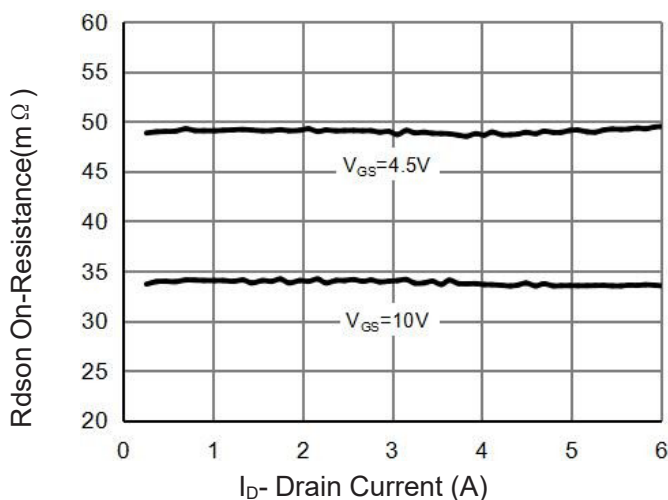
**Figure 2: Switching Waveforms**



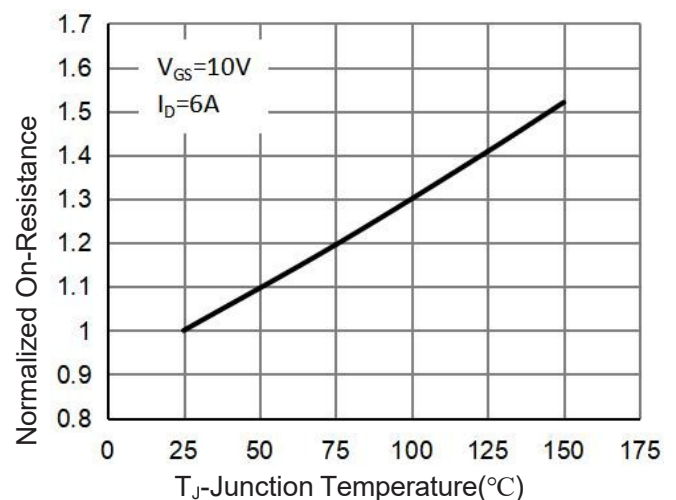
**Figure 3 Output Characteristics**



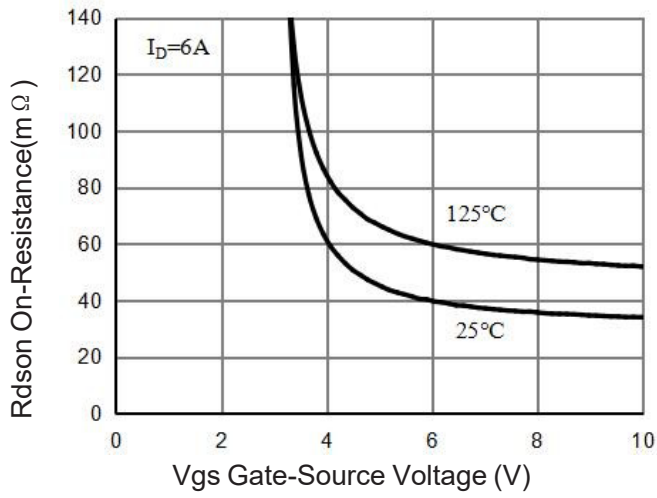
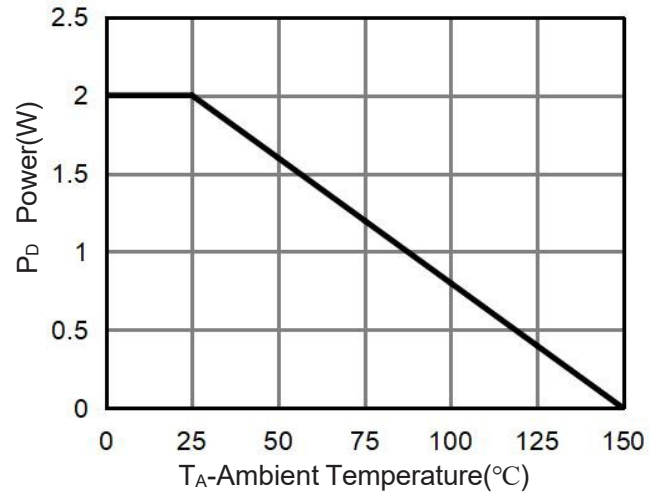
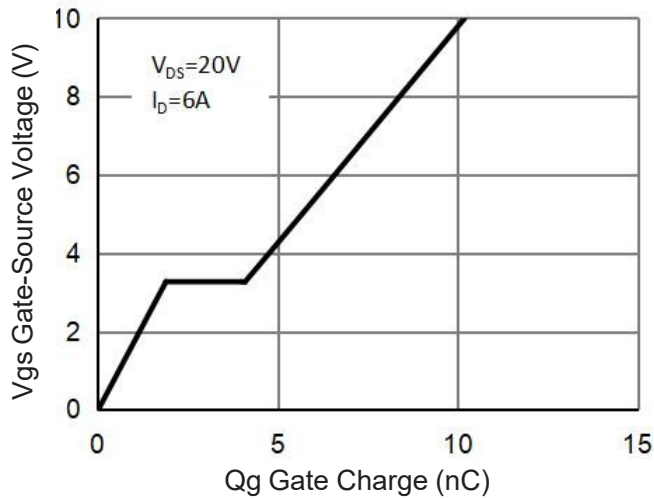
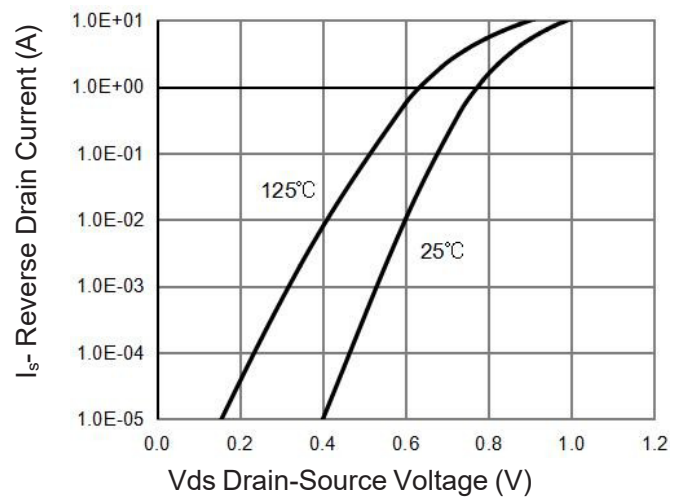
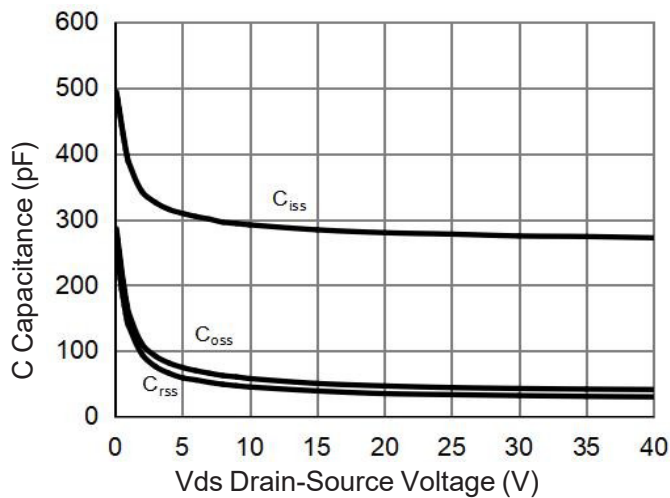
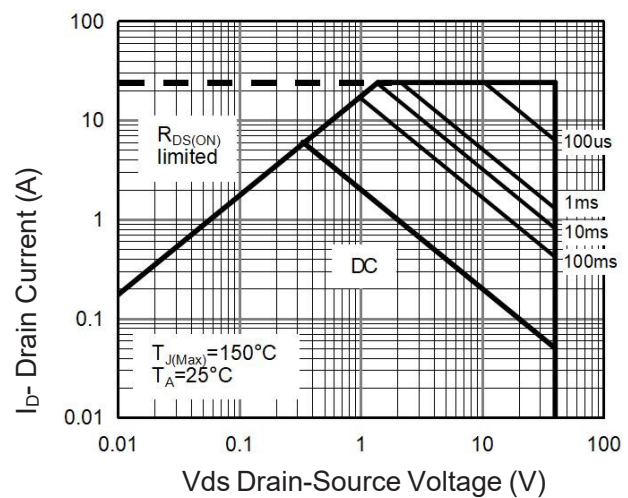
**Figure 4 Transfer Characteristics**

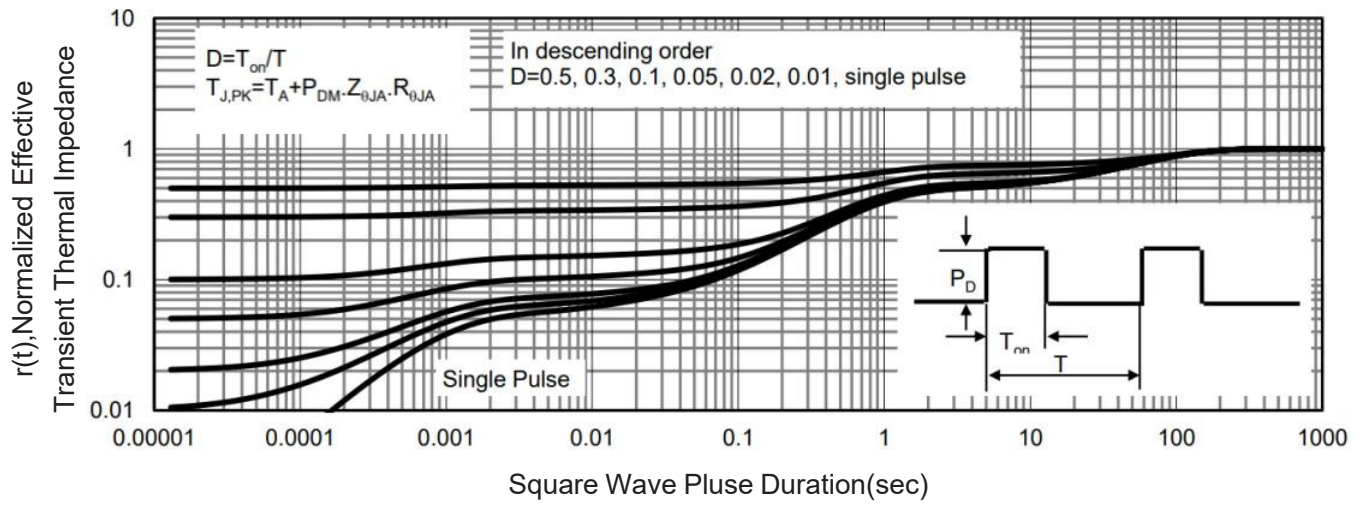


**Figure 5 Drain-Source On-Resistance**

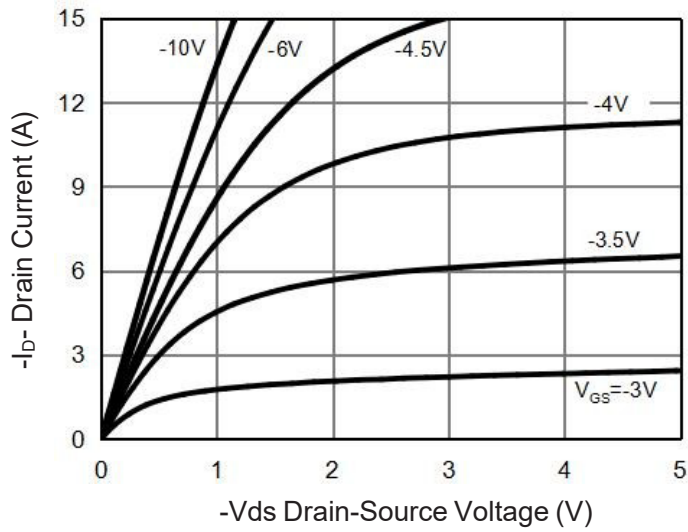
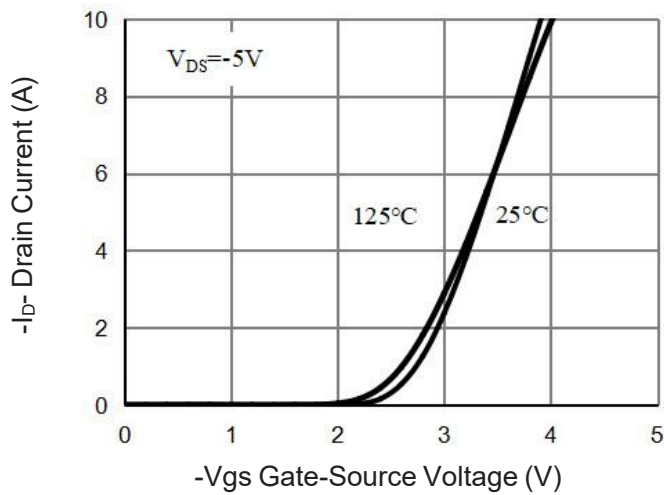
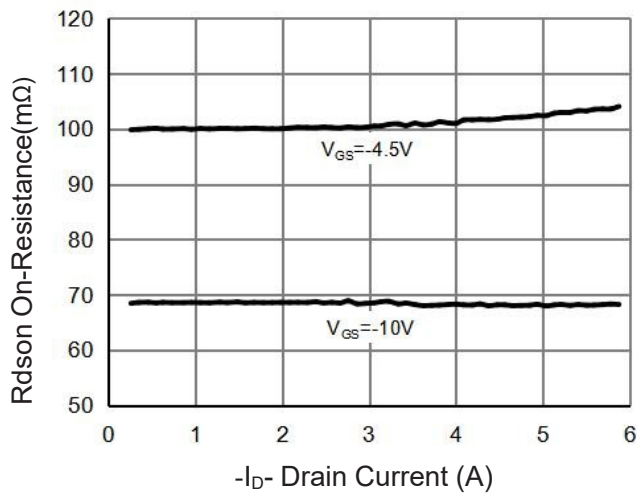
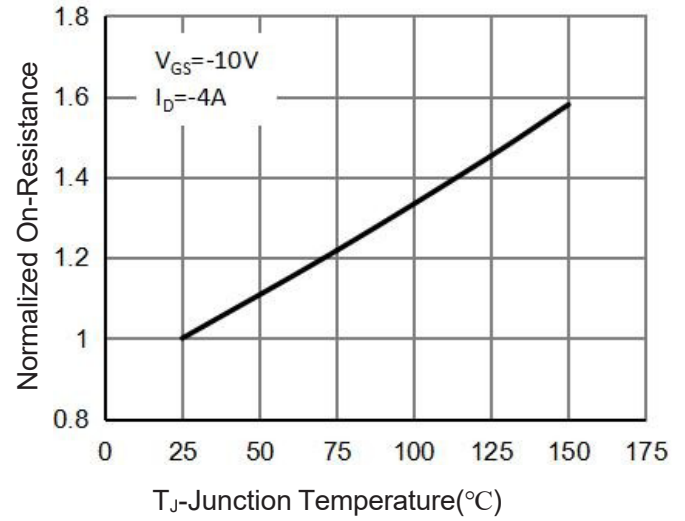
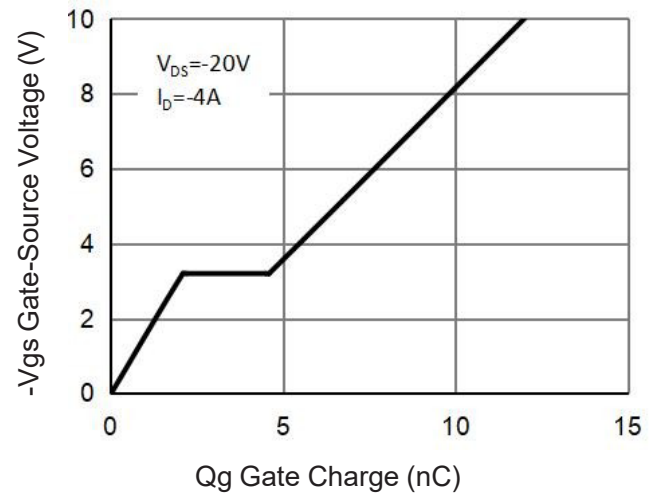
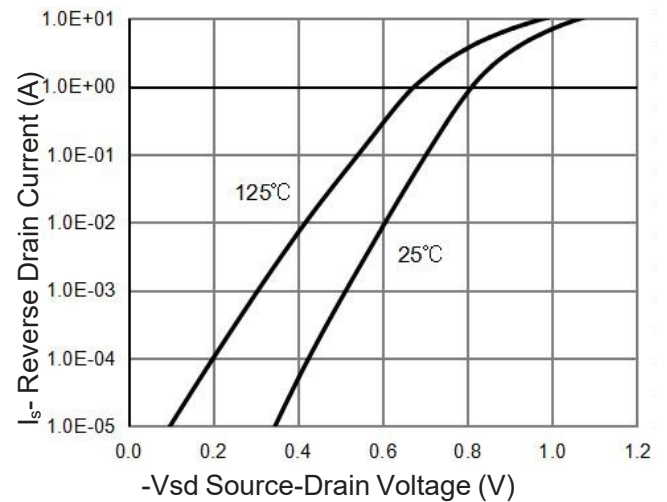


**Figure 6 Drain-Source On-Resistance**


**Figure7 Rdson vs Vgs**

**Figure 8 Power Dissipation**

**Figure 9 Gate Charge**

**Figure 10 Source- Drain Diode Forward**

**Figure 11 Capacitance vs Vds**

**Figure 12 Safe Operation Area**

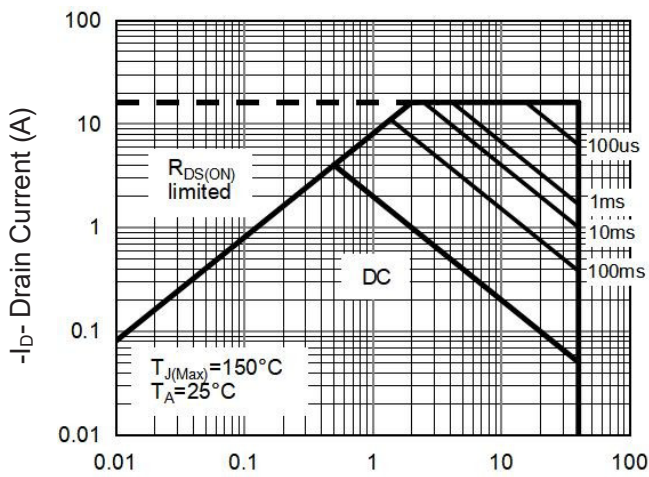


**Figure 13 Normalized Maximum Transient Thermal Impedance**


**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**

C Capacitance (pF)

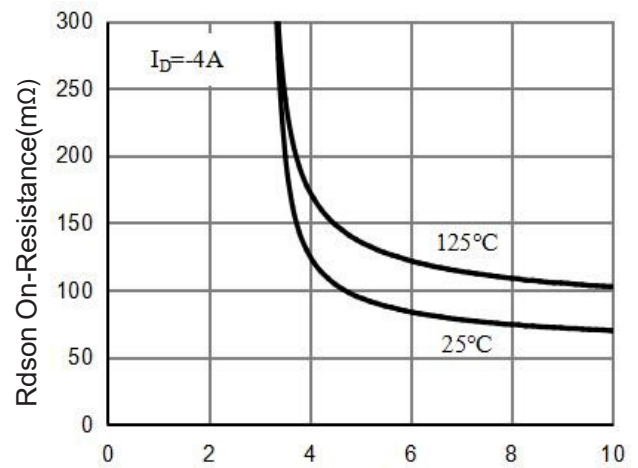
-V<sub>DS</sub> Drain-Source Voltage (V)  
**Figure 7 Capacitance vs V<sub>DS</sub>**



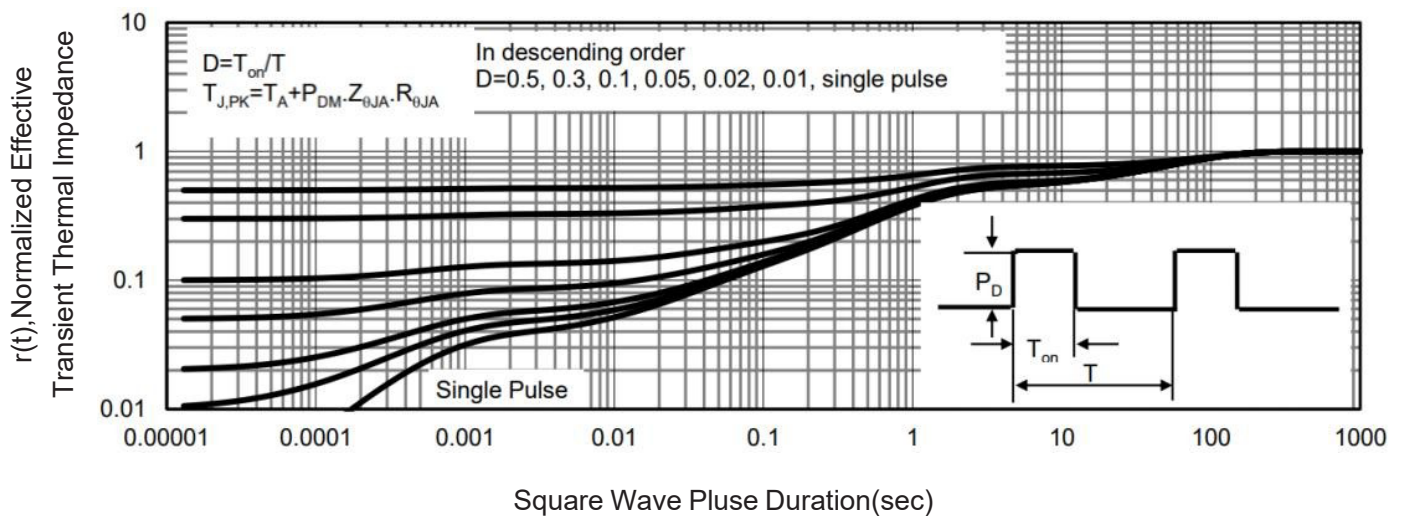
-V<sub>DS</sub> Drain-Source Voltage (V)  
**Figure 8 Safe Operation Area**

P<sub>D</sub> Power (W)

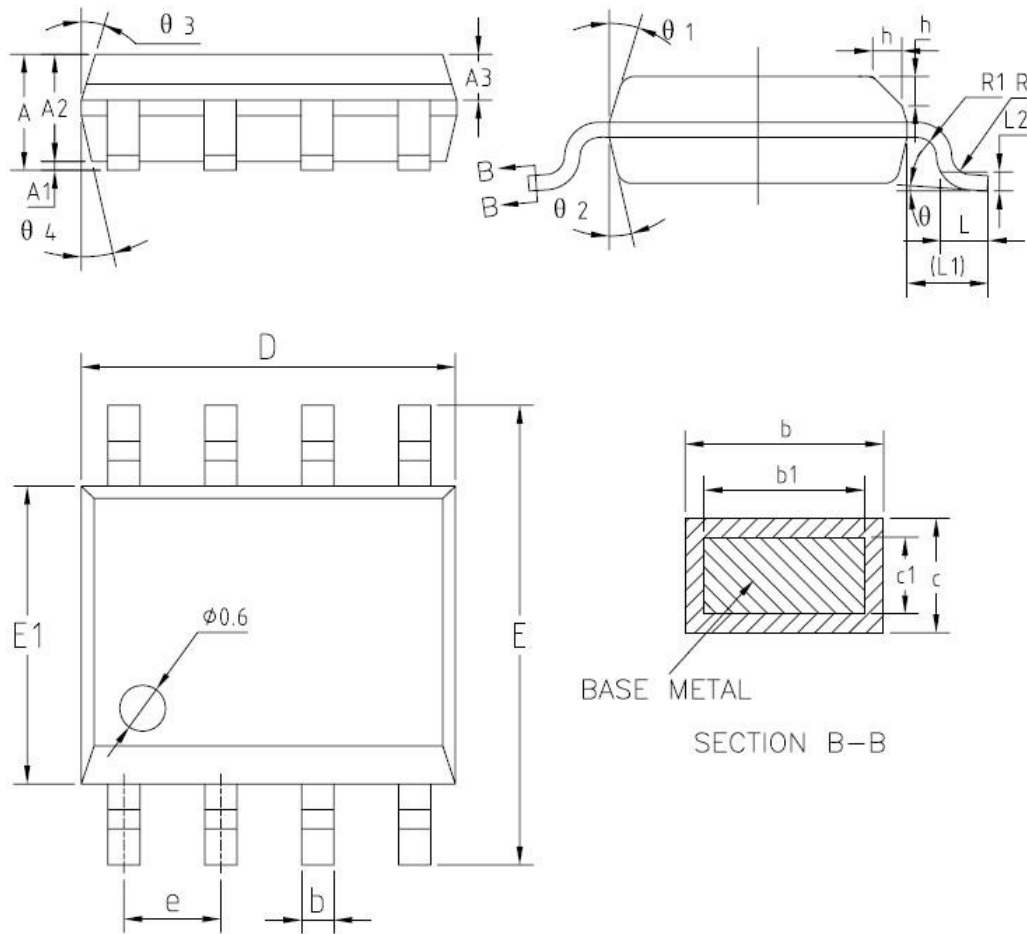
T<sub>A</sub>-Ambient Temperature(°C)  
**Figure 9 Power Dissipation**



-V<sub>GS</sub> Gate-Source Voltage (V)  
**Figure 10 R<sub>DS(on)</sub> vs V<sub>GS</sub>**



**Figure 11 Normalized Maximum Transient Thermal Impedance**



COMMON DIMENSIONS  
(UNITS OF MEASURE=MILLIMETER)

| SYMBOL     | MIN     | NOM  | MAX  |
|------------|---------|------|------|
| A          | 1.35    | 1.55 | 1.75 |
| A1         | 0.10    | 0.15 | 0.25 |
| A2         | 1.25    | 1.40 | 1.65 |
| A3         | 0.50    | 0.60 | 0.70 |
| b          | 0.38    | —    | 0.51 |
| b1         | 0.37    | 0.42 | 0.47 |
| c          | 0.18    | —    | 0.25 |
| c1         | 0.17    | 0.20 | 0.23 |
| D          | 4.80    | 4.90 | 5.00 |
| E          | 5.80    | 6.00 | 6.20 |
| E1         | 3.80    | 3.90 | 4.00 |
| e          | 1.17    | 1.27 | 1.37 |
| L          | 0.45    | 0.60 | 0.80 |
| L1         | 1.04REF |      |      |
| L2         | 0.25BSC |      |      |
| R          | 0.07    | —    | —    |
| R1         | 0.07    | —    | —    |
| h          | 0.30    | 0.40 | 0.50 |
| $\theta$   | 0°      | —    | 8°   |
| $\theta 1$ | 15°     | 17°  | 19°  |
| $\theta 2$ | 11°     | 13°  | 15°  |
| $\theta 3$ | 15°     | 17°  | 19°  |
| $\theta 4$ | 11°     | 13°  | 15°  |