

## Features

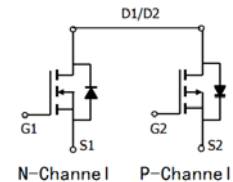
- N+P Channel
- Enhancement mode
- Very low on-resistance
- Fast Switching
- Pb-free lead plating; RoHS compliant



## TO-252-4L



| Part ID     | Package Type | Marking  | Tape and reel information |
|-------------|--------------|----------|---------------------------|
| VSD030C04MC | TO-252-4L    | 030C04MC | 2500pcs/Reel              |



## Absolute Maximum Ratings

| Symbol                                                       | Parameter                            |                       | Rating          |                 | Unit |
|--------------------------------------------------------------|--------------------------------------|-----------------------|-----------------|-----------------|------|
|                                                              |                                      |                       | NMOS            | PMOS            |      |
| Common Ratings (T <sub>c</sub> =25°C Unless Otherwise Noted) |                                      |                       |                 |                 |      |
| V <sub>GS</sub>                                              | Gate-Source Voltage                  |                       | ±20             | ±20             | V    |
| V <sub>(BR)DSS</sub>                                         | Drain-Source Breakdown Voltage       |                       | 40              | -40             | V    |
| T <sub>J</sub>                                               | Maximum Junction Temperature①        |                       | 150             |                 | °C   |
| T <sub>STG</sub>                                             | Storage Temperature Range            |                       | -50 to 150      |                 | °C   |
| I <sub>S</sub>                                               | Diode Continuous Forward Current     | T <sub>C</sub> =25°C  | 31              | -22             | A    |
| Mounted on Large Heat Sink                                   |                                      |                       |                 |                 |      |
| I <sub>DM</sub>                                              | Pulse Drain Current Tested②          | T <sub>C</sub> =25°C  | 124             | -88             | A    |
| I <sub>D</sub>                                               | Continuous Drain Current             | T <sub>C</sub> =25°C  | 31              | -22             | A    |
|                                                              |                                      | T <sub>C</sub> =100°C | 20              | -14             |      |
| P <sub>D</sub>                                               | Power dissipation for Dual Operation | T <sub>C</sub> =25°C  | 35              | 31              | W    |
| R <sub>θJC</sub>                                             | Thermal Resistance-Junction to Case  |                       | 3.5             | 4               | °C/W |
| R <sub>θJA</sub>                                             | Thermal Resistance Junction-Ambient  |                       | 100             | 100             | °C/W |
| Drain-Source Avalanche Ratings                               |                                      |                       |                 |                 |      |
| EAS                                                          | Avalanche Energy, Single Pulsed      |                       | 16 <sup>③</sup> | 25 <sup>④</sup> | mJ   |

## N-Channel Electrical Characteristics

| Symbol                                                                               | Parameter                                               | Condition                                                                                     | Min | Typ  | Max  | Unit |
|--------------------------------------------------------------------------------------|---------------------------------------------------------|-----------------------------------------------------------------------------------------------|-----|------|------|------|
| Static Electrical Characteristics @ T <sub>J</sub> = 25°C (unless otherwise stated)  |                                                         |                                                                                               |     |      |      |      |
| V <sub>(BR)DSS</sub>                                                                 | Drain-Source Breakdown Voltage                          | V <sub>GS</sub> =0V I <sub>D</sub> =250μA                                                     | 40  | --   | --   | V    |
| I <sub>DSS</sub>                                                                     | Zero Gate Voltage Drain Current( T <sub>C</sub> =25°C)  | V <sub>DS</sub> =40V,V <sub>GS</sub> =0V                                                      | --  | --   | 1    | μA   |
|                                                                                      | Zero Gate Voltage Drain Current( T <sub>C</sub> =125°C) | V <sub>DS</sub> =40V,V <sub>GS</sub> =0V                                                      | --  | --   | 100  | μA   |
| I <sub>GSS</sub>                                                                     | Gate-Body Leakage Current                               | V <sub>GS</sub> =±20V,V <sub>DS</sub> =0V                                                     | --  | --   | ±100 | nA   |
| V <sub>GS(TH)</sub>                                                                  | Gate Threshold Voltage                                  | V <sub>DS</sub> =V <sub>GS</sub> ,I <sub>D</sub> =250μA                                       | 1.8 | 2.3  | 3.2  | V    |
| R <sub>DS(ON)</sub>                                                                  | Drain-Source On-State Resistance②                       | V <sub>GS</sub> =10V, I <sub>D</sub> =12A                                                     | --  | 18   | 25   | mΩ   |
|                                                                                      |                                                         | V <sub>GS</sub> =4.5V, I <sub>D</sub> =8A                                                     | --  | 24   | 30   | mΩ   |
| Dynamic Electrical Characteristics @ T <sub>J</sub> = 25°C (unless otherwise stated) |                                                         |                                                                                               |     |      |      |      |
| C <sub>iss</sub>                                                                     | Input Capacitance                                       | V <sub>DS</sub> =20V,V <sub>GS</sub> =0V,<br>f=1MHz                                           | --  | 840  | --   | pF   |
| C <sub>oss</sub>                                                                     | Output Capacitance                                      |                                                                                               | --  | 90   | --   | pF   |
| C <sub>rss</sub>                                                                     | Reverse Transfer Capacitance                            |                                                                                               | --  | 75   | --   | pF   |
| R <sub>g</sub>                                                                       | Gate Resistance                                         | f=1MHz                                                                                        | --  | 1.7  | --   | Ω    |
| Q <sub>g</sub>                                                                       | Total Gate Charge                                       | V <sub>DS</sub> =20V,I <sub>D</sub> =4A,<br>V <sub>GS</sub> =10V                              | --  | 12   | --   | nC   |
| Q <sub>gs</sub>                                                                      | Gate Source Charge                                      |                                                                                               | --  | 2.3  | --   | nC   |
| Q <sub>gd</sub>                                                                      | Gate Drain Charge                                       |                                                                                               | --  | 3.9  | --   | nC   |
| Switching Characteristics                                                            |                                                         |                                                                                               |     |      |      |      |
| t <sub>d(on)</sub>                                                                   | Turn on Delay Time                                      | V <sub>DD</sub> =20V,<br>I <sub>D</sub> =4A,<br>R <sub>G</sub> =3.3Ω,<br>V <sub>GS</sub> =10V | --  | 7    | --   | nS   |
| t <sub>r</sub>                                                                       | Turn on Rise Time                                       |                                                                                               | --  | 12   | --   | nS   |
| t <sub>d(off)</sub>                                                                  | Turn Off Delay Time                                     |                                                                                               | -   | 21   | --   | nS   |
| t <sub>f</sub>                                                                       | Turn Off Fall Time                                      |                                                                                               | --  | 9    | --   | nS   |
| Source Drain Diode Characteristics                                                   |                                                         |                                                                                               |     |      |      |      |
| V <sub>SD</sub>                                                                      | Forward on voltage                                      | I <sub>SD</sub> =12A,V <sub>GS</sub> =0V                                                      | --  | 0.82 | 1.2  | V    |
| t <sub>rr</sub>                                                                      | Reverse Recovery Time                                   | T <sub>J</sub> =25°C ,I <sub>sd</sub> =4A,<br>V <sub>GS</sub> =0V                             | --  | 33   | --   | nS   |
| Q <sub>rr</sub>                                                                      | Reverse Recovery Charge                                 | di/dt=-100A/μs                                                                                | --  | 20   | --   | nC   |

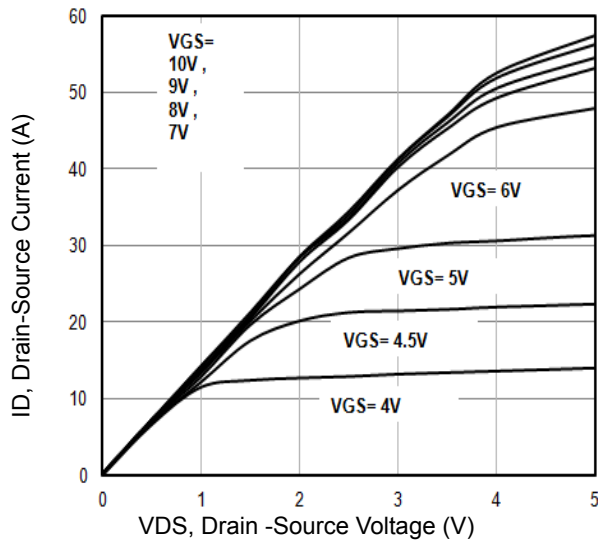
## P-Channel Electrical Characteristics

| Symbol                                                                               | Parameter                                              | Condition                                                                                        | Min  | Typ   | Max  | Unit |
|--------------------------------------------------------------------------------------|--------------------------------------------------------|--------------------------------------------------------------------------------------------------|------|-------|------|------|
| Static Electrical Characteristics @ T <sub>J</sub> = 25°C (unless otherwise stated)  |                                                        |                                                                                                  |      |       |      |      |
| V <sub>(BR)DSS</sub>                                                                 | Drain-Source Breakdown Voltage                         | V <sub>GS</sub> =0V I <sub>D</sub> =-250μA                                                       | -40  | --    | --   | V    |
| I <sub>DSS</sub>                                                                     | Zero Gate Voltage Drain Current(T <sub>C</sub> =25°C)  | V <sub>DS</sub> =-40V,V <sub>GS</sub> =0V                                                        | --   | --    | -1   | μA   |
|                                                                                      | Zero Gate Voltage Drain Current(T <sub>C</sub> =125°C) | V <sub>DS</sub> =-40V,V <sub>GS</sub> =0V                                                        | --   | --    | -100 | μA   |
| I <sub>GSS</sub>                                                                     | Gate-Body Leakage Current                              | V <sub>GS</sub> =±20V,V <sub>DS</sub> =0V                                                        | --   | --    | ±100 | nA   |
| V <sub>GS(TH)</sub>                                                                  | Gate Threshold Voltage                                 | V <sub>DS</sub> =V <sub>GS</sub> ,I <sub>D</sub> =-250μA                                         | -1.0 | -1.7  | -2.5 | V    |
| R <sub>DS(ON)</sub>                                                                  | Drain-Source On-State Resistance②                      | V <sub>GS</sub> =-10V, I <sub>D</sub> =-12A                                                      | --   | 32    | 40   | mΩ   |
|                                                                                      |                                                        | V <sub>GS</sub> =-4.5V, I <sub>D</sub> =-8A                                                      | --   | 38    | 45   | mΩ   |
| Dynamic Electrical Characteristics @ T <sub>J</sub> = 25°C (unless otherwise stated) |                                                        |                                                                                                  |      |       |      |      |
| C <sub>iss</sub>                                                                     | Input Capacitance                                      | V <sub>DS</sub> =-20V,V <sub>GS</sub> =0V,<br>f=1MHz                                             | --   | 1520  | --   | pF   |
| C <sub>oss</sub>                                                                     | Output Capacitance                                     |                                                                                                  | --   | 155   | --   | pF   |
| C <sub>rss</sub>                                                                     | Reverse Transfer Capacitance                           |                                                                                                  | --   | 110   | --   | pF   |
| R <sub>g</sub>                                                                       | Gate Resistance                                        | f=1MHz                                                                                           | --   | 24    | --   | Ω    |
| Q <sub>g</sub>                                                                       | Total Gate Charge                                      | V <sub>DS</sub> =-20V,I <sub>D</sub> =-3A,<br>V <sub>GS</sub> =-10V                              | --   | 29    | --   | nC   |
| Q <sub>gs</sub>                                                                      | Gate Source Charge                                     |                                                                                                  | --   | 5     | --   | nC   |
| Q <sub>gd</sub>                                                                      | Gate Drain Charge                                      |                                                                                                  | --   | 11    | --   | nC   |
| Switching Characteristics                                                            |                                                        |                                                                                                  |      |       |      |      |
| t <sub>d(on)</sub>                                                                   | Turn on Delay Time                                     | V <sub>DD</sub> =-20V,<br>I <sub>D</sub> =-3A,<br>R <sub>G</sub> =3.3Ω,<br>V <sub>GS</sub> =-10V | --   | 13    | --   | ns   |
| t <sub>r</sub>                                                                       | Turn on Rise Time                                      |                                                                                                  | --   | 38    | --   | ns   |
| t <sub>d(off)</sub>                                                                  | Turn Off Delay Time                                    |                                                                                                  | -    | 67    | --   | ns   |
| t <sub>f</sub>                                                                       | Turn Off Fall Time                                     |                                                                                                  | --   | 21    | --   | ns   |
| Source Drain Diode Characteristics                                                   |                                                        |                                                                                                  |      |       |      |      |
| V <sub>SD</sub>                                                                      | Forward on voltage                                     | I <sub>SD</sub> =-12A,V <sub>GS</sub> =0V                                                        | --   | -0.83 | -1.2 | V    |
| t <sub>rr</sub>                                                                      | Reverse Recovery Time                                  | T <sub>J</sub> =25°C,I <sub>sd</sub> =-3A,<br>V <sub>GS</sub> =0V                                | --   | 49    | --   | nS   |
| Q <sub>rr</sub>                                                                      | Reverse Recovery Charge                                | di/dt=-100A/μs                                                                                   | --   | 35    | --   | nC   |

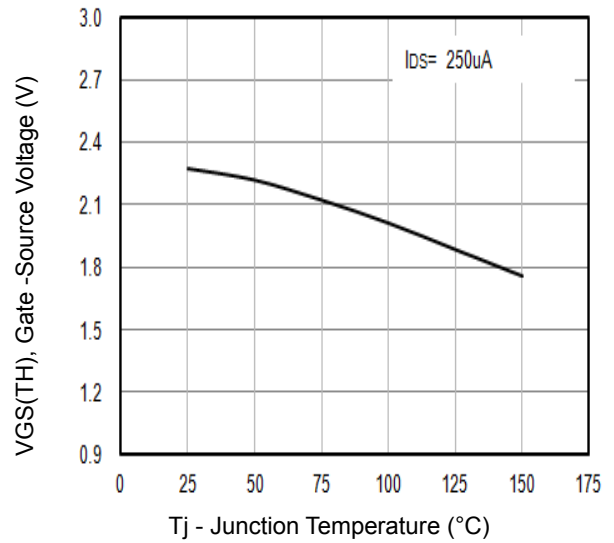
### Notes:

- ① Repetitive rating; pulse width limited by max. junction temperature.
- ② Pulse width ≤ 300μs; duty cycles ≤ 2%.
- ③ Limited by T<sub>Jmax</sub>, starting T<sub>J</sub> = 25°C, L = 0.5mH, R<sub>G</sub> = 25Ω, I<sub>AS</sub> = 8A, V<sub>GS</sub> = 10V. Part not recommended for use above this value
- ④ Limited by T<sub>Jmax</sub>, starting T<sub>J</sub> = 25°C, L = 0.5mH, R<sub>G</sub> = 25Ω, I<sub>AS</sub> = -10A, V<sub>GS</sub> = -10V. Part not recommended for use above this value

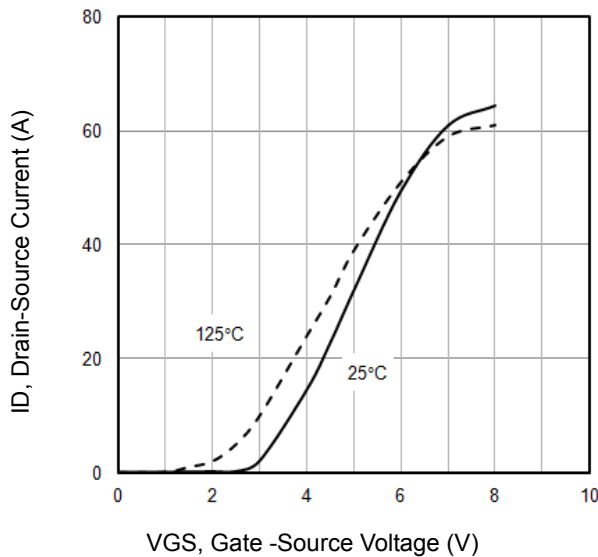
## N-Channel Typical Characteristics



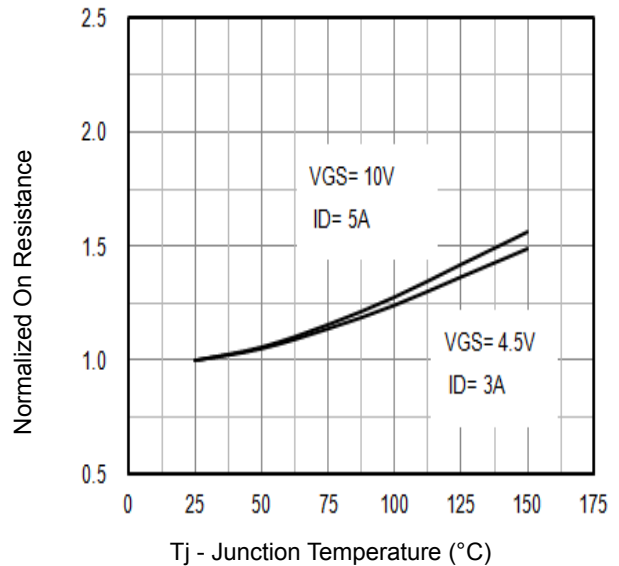
**Fig1.** Typical Output Characteristics



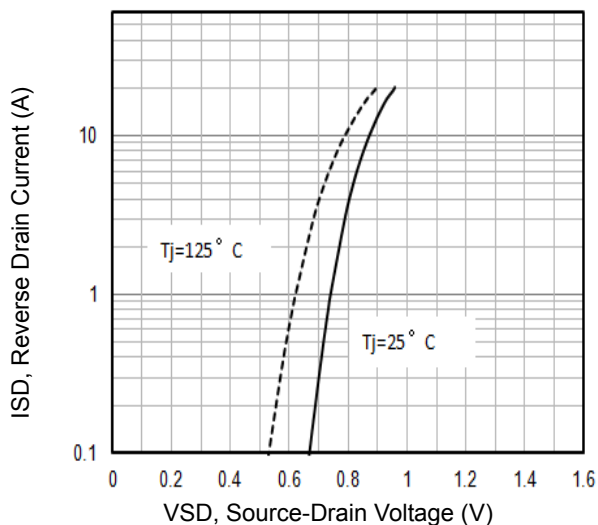
**Fig2.**  $V_{GS(TH)}$  Gate-Source Voltage Vs.  $T_j$



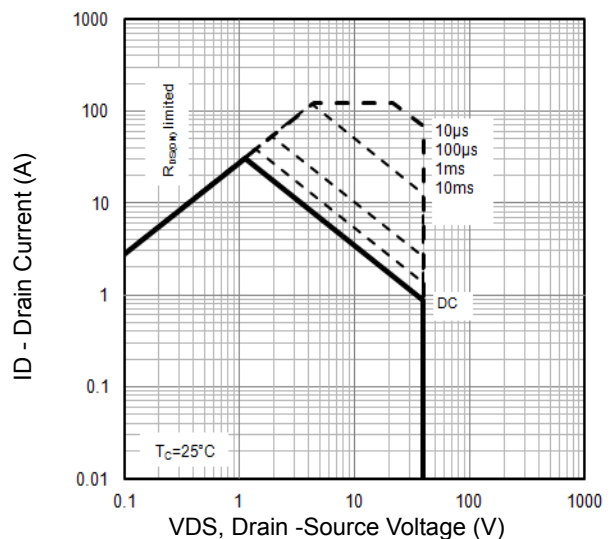
**Fig3.** Typical Transfer Characteristics



**Fig4.** Normalized On-Resistance Vs.  $T_j$

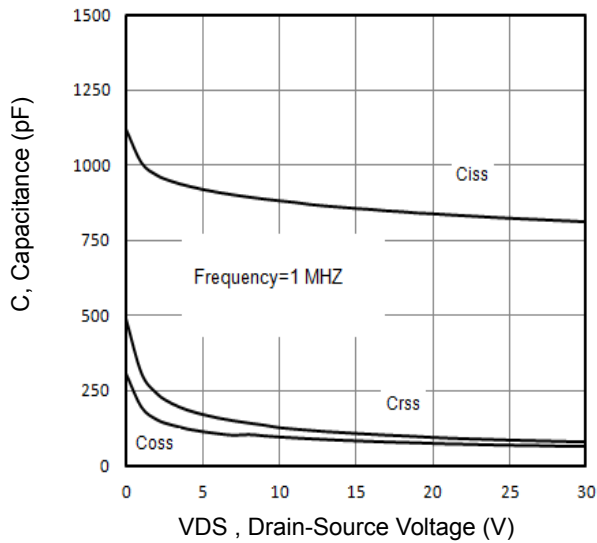


**Fig5.** Typical Source-Drain Diode Forward Voltage

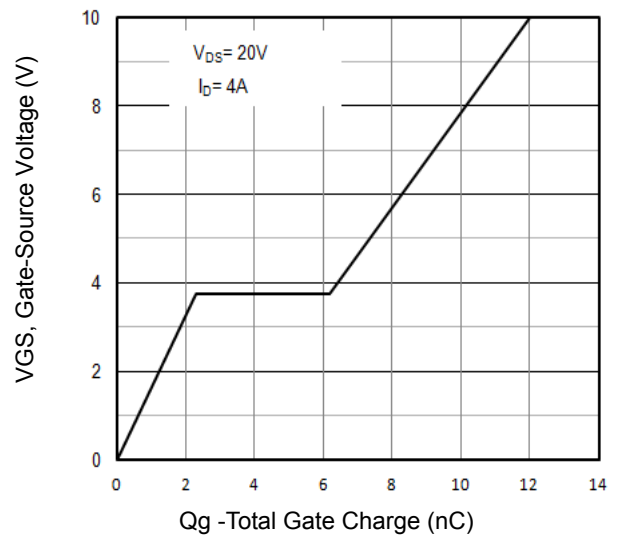


**Fig6.** Maximum Safe Operating Area

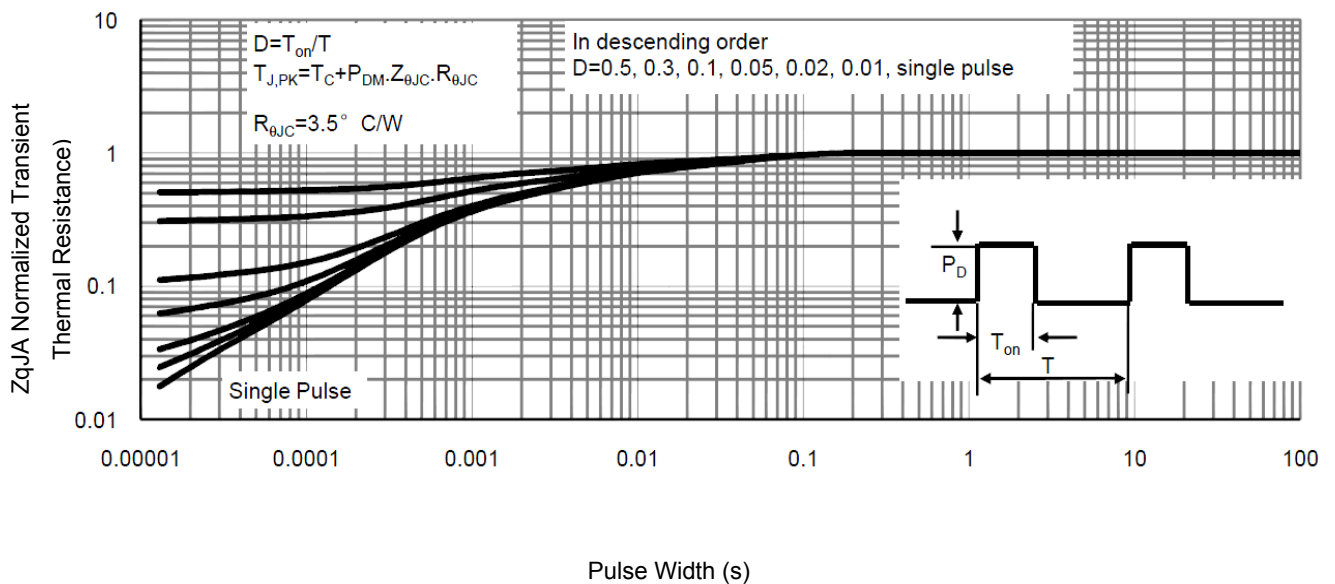
## N-Channel Typical Characteristics



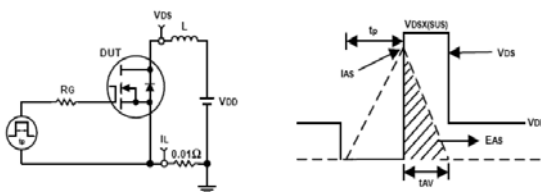
**Fig7.** Typical Capacitance Vs. Drain-Source Voltage



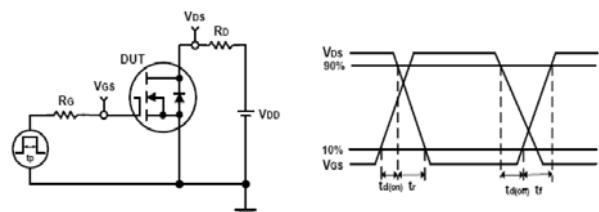
**Fig8.** Typical Gate Charge Vs. Gate-Source Voltage



**Fig 9** .Normalized Maximum Transient Thermal Impedance

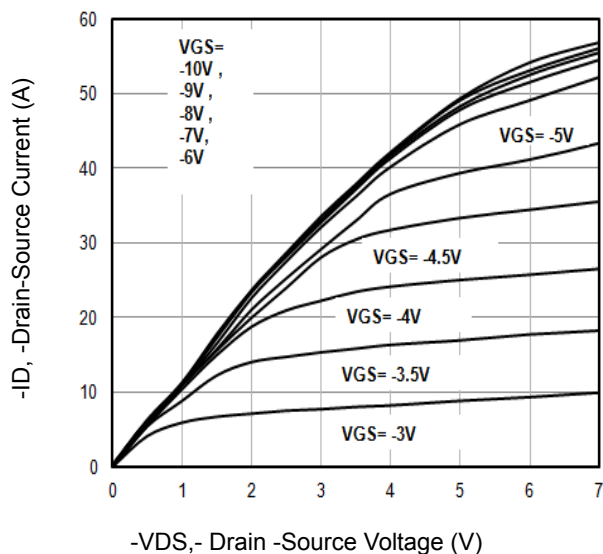


**Fig10.** Unclamped Inductive Test Circuit and waveforms

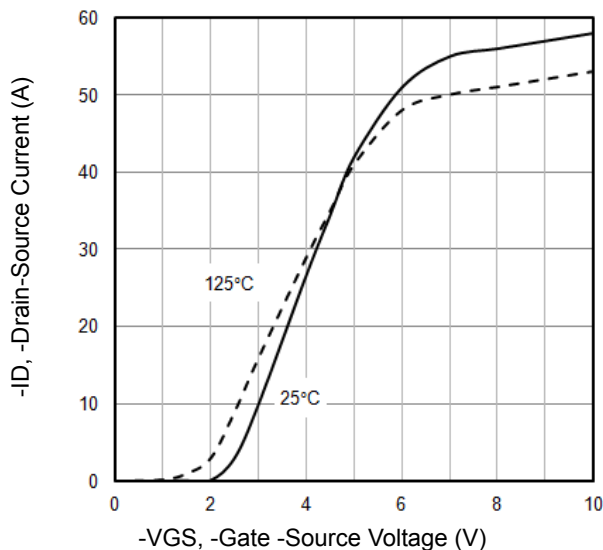


**Fig11.** Switching Time Test Circuit and waveforms

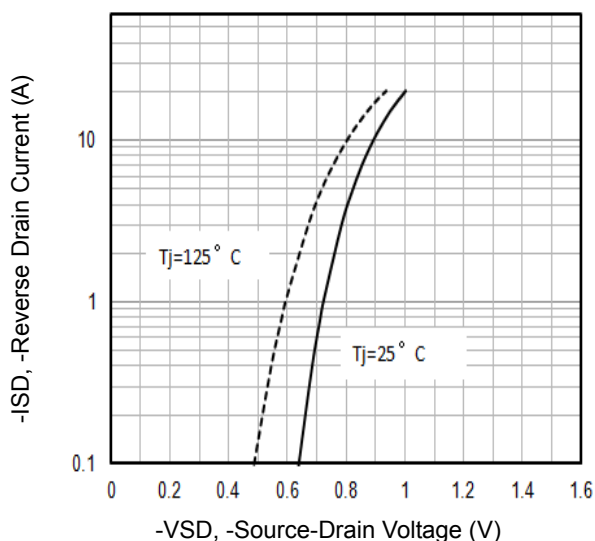
## P-Channel Typical Characteristics



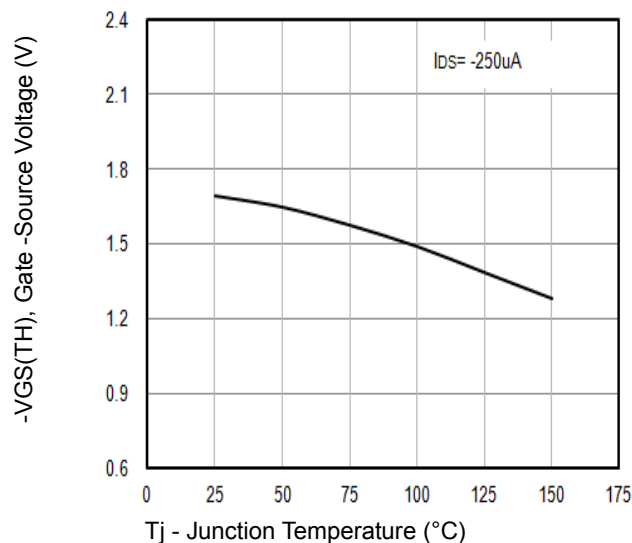
**Fig1.** Typical Output Characteristics



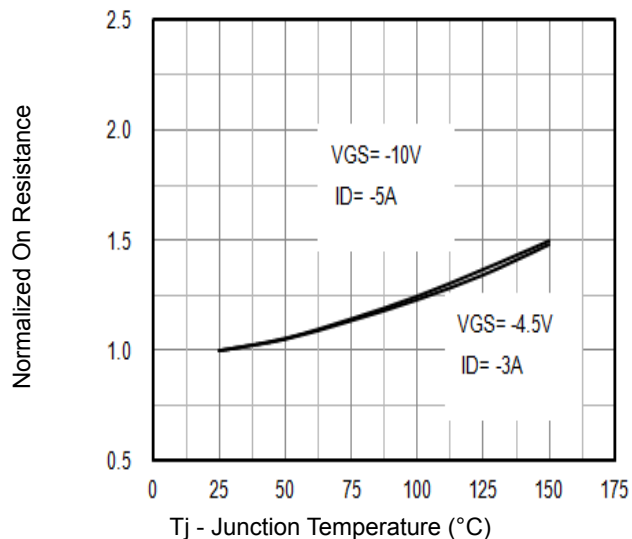
**Fig3.** Typical Transfer Characteristics



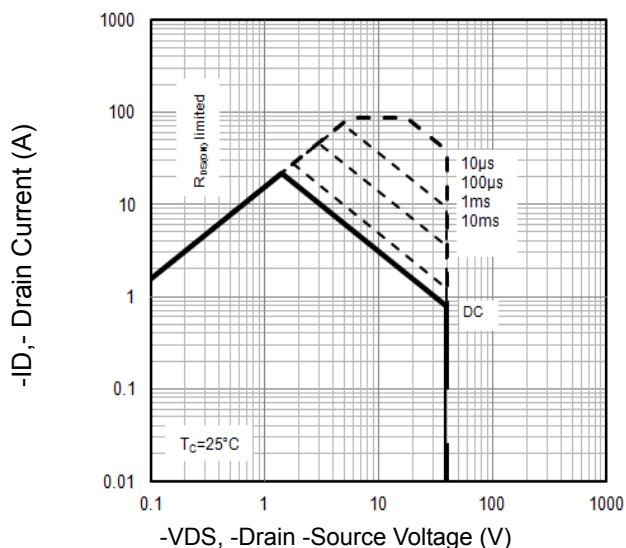
**Fig5.** Typical Source-Drain Diode Forward Voltage



**Fig2.**  $V_{GS(TH)}$  Gate -Source Voltage Vs.  $T_j$

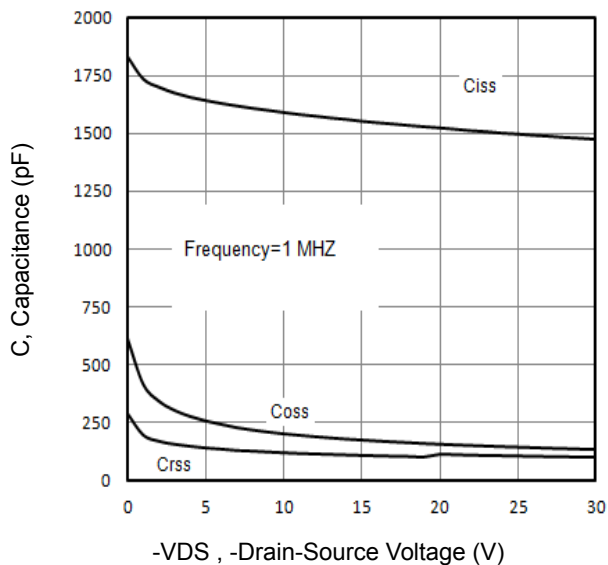


**Fig4.** Normalized On-Resistance Vs.  $T_j$

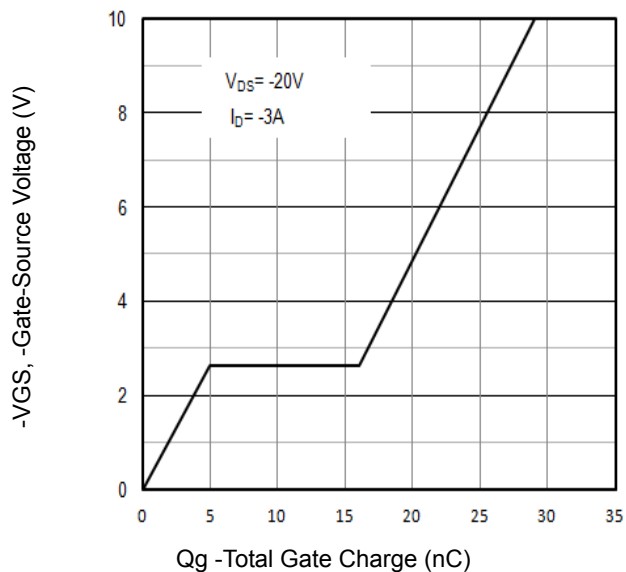


**Fig6.** Maximum Safe Operating Area

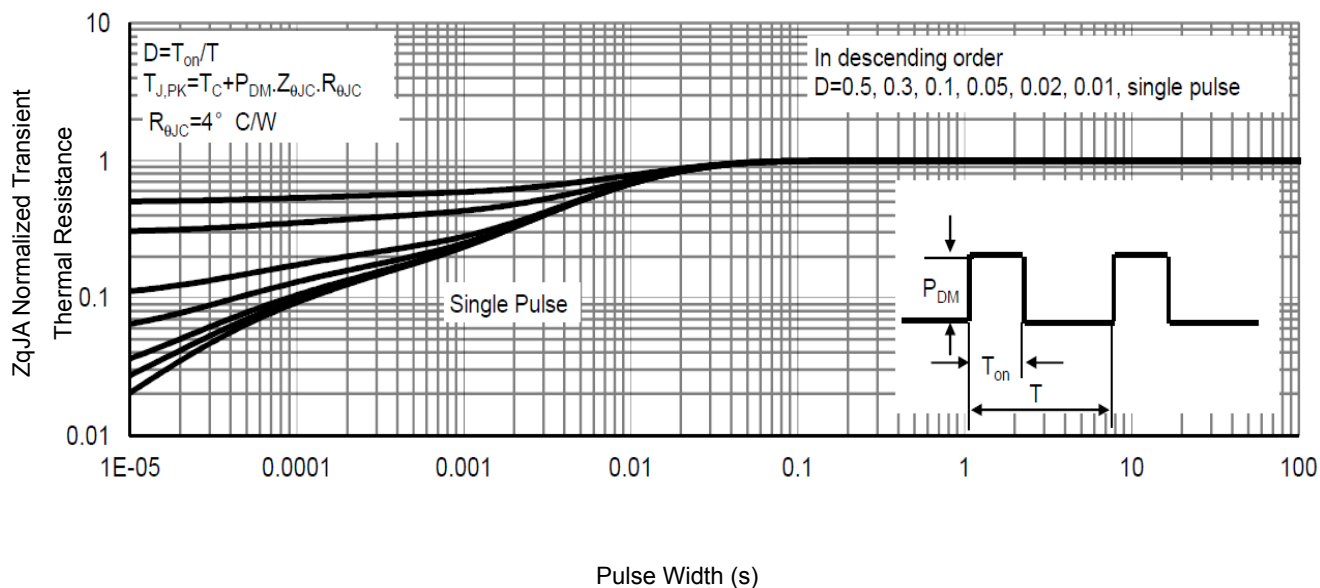
## P-Channel Typical Characteristics



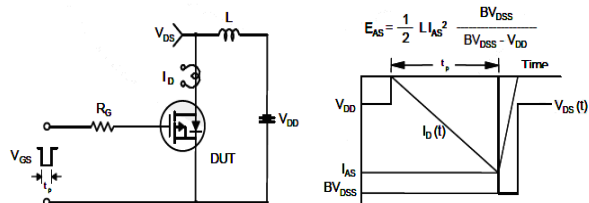
**Fig7.** Typical Capacitance Vs. Drain-Source Voltage



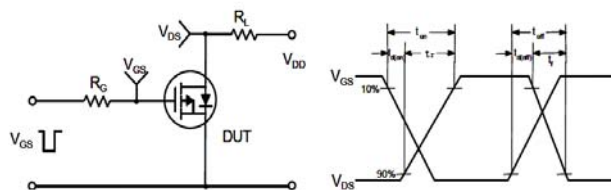
**Fig8.** Typical Gate Charge Vs. Gate-Source Voltage



**Fig9.** Normalized Maximum Transient Thermal Impedance

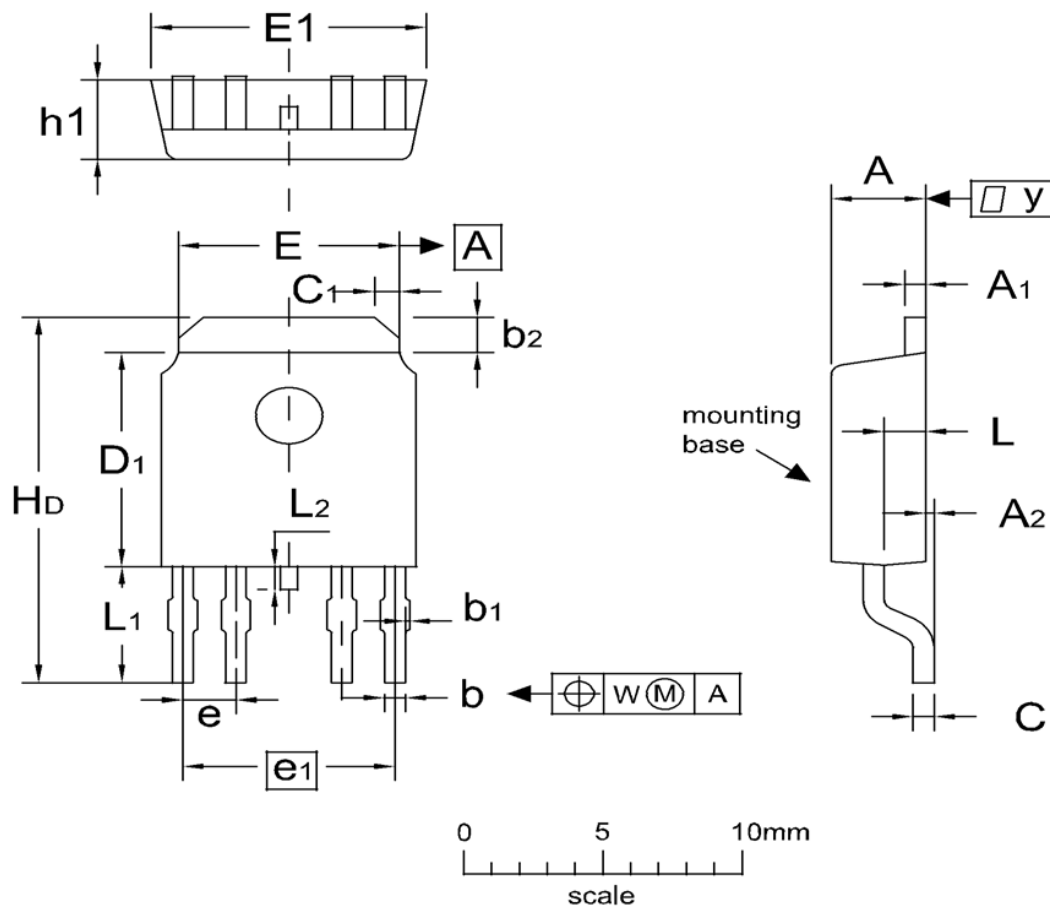


**Fig10.** Unclamped Inductive Test Circuit and Waveforms



**Fig11.** Switching Time Test Circuit and waveforms

## TO-252-4L Package Outline Data



**DIMENSIONS** ( unit : mm )

| Symbol         | Min | Typ  | Max | Symbol         | Min  | Typ  | Max  |
|----------------|-----|------|-----|----------------|------|------|------|
| A              | 2.1 | 2.3  | 2.5 | A <sub>1</sub> | 0.4  | 0.5  | 0.6  |
| A2             | --  | --   | 0.3 | b              | 0.4  | 0.5  | 0.6  |
| b <sub>1</sub> | --  | --   | 0.1 | b <sub>2</sub> | 0.8  | 1.0  | 1.2  |
| C              | 0.4 | 0.5  | 0.6 | C <sub>1</sub> | 0.4  | 0.6  | 0.8  |
| D <sub>1</sub> | 5.7 | 6.1  | 6.5 | E              | 5.0  | 5.3  | 5.6  |
| E <sub>1</sub> | 6.3 | 6.6  | 6.9 | e              | --   | 1.27 | --   |
| e <sub>1</sub> | --  | 5.08 | --  | H <sub>D</sub> | 9.6  | 10.0 | 10.4 |
| h <sub>1</sub> | 2.1 | 2.3  | 2.5 | L              | 0.80 | 1.0  | 1.2  |
| L <sub>1</sub> | 2.6 | 2.9  | 3.2 | L <sub>2</sub> | 0.35 | 0.65 | 0.95 |

## Customer Service

**Sales and Service:**

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