

## Description:

This N+P Channel MOSFET uses advanced trench technology and

design to provide excellent  $R_{DS(on)}$  with low gate charge.

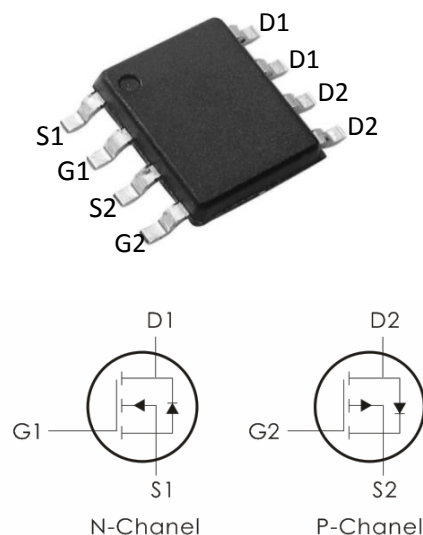
It can be used in a wide variety of applications.

## Features:

N-Channel:  $V_{DS}=60V, I_D=4.5A, R_{DS(on)}<40m\Omega @V_{GS}=10V$

P-Channel:  $V_{DS}=-60V, I_D=-4.1A, R_{DS(on)}<90m\Omega @V_{GS}=-10V$

- 1) High Power and current handling capability.
- 2) Lead free product is acquired.
- 3) Surface Mount Package.



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

| Symbol         | Parameter                                        | N-Channel   | P-Channel   | Units       |
|----------------|--------------------------------------------------|-------------|-------------|-------------|
| $V_{DS}$       | Drain-Source Voltage                             | 60          | -60         | V           |
| $V_{GS}$       | Gate-Source Voltage                              | $\pm 20$    | $\pm 20$    | V           |
| $I_D$          | Drain Current-Continuous @ $T_A=25^{\circ}C^1$   | 4.5         | -4.1        | A           |
|                | Drain Current-Continuous @ $T_A=70^{\circ}C^1$   | 3.5         | -3.2        |             |
| $I_{DM}$       | Pulsed Drain Current- <sup>2</sup>               | 18          | -14         |             |
| EAS            | Single Pulse Avalanche Energy <sup>3</sup>       | 22          | 29.7        | mJ          |
| $I_{AS}$       | Avalanche Current                                | 21          | 24.2        | A           |
| $P_D$          | Power Dissipation <sup>4</sup>                   | 1.5         | 1.5         | W           |
| $T_J, T_{STG}$ | Operating and Storage Junction Temperature Range | -55 to +150 | -55 to +150 | $^{\circ}C$ |

## Thermal Characteristics:

| Symbol          | Parameter                                            | N-Channel Max | P-Channel Max | Units         |
|-----------------|------------------------------------------------------|---------------|---------------|---------------|
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient <sup>1</sup> | 85            | 85            | $^{\circ}C/W$ |
| $R_{\theta JC}$ | Thermal Resistance, Junction Case <sup>1</sup>       | 25            | 25            |               |

| Part NO.   | Marking    | Package |
|------------|------------|---------|
| FDS4559-NL | FDS4559-NL | SOP-8   |

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

| Symbol                             | Parameter                                       | Conditions                                                                                   | Min | Typ  | Max   | Units |
|------------------------------------|-------------------------------------------------|----------------------------------------------------------------------------------------------|-----|------|-------|-------|
| ON/Off Characteristics             |                                                 |                                                                                              |     |      |       |       |
| BV <sub>DSS</sub>                  | Drain-Source Breakdown Voltage                  | V <sub>GS</sub> =0V, I <sub>D</sub> =250 μ A                                                 | 60  | ---  | ---   | V     |
| I <sub>DSS</sub>                   | Zero Gate Voltage Drain Current                 | V <sub>GS</sub> =0V, V <sub>DS</sub> =48V                                                    | --- | ---  | 1     | μ A   |
| I <sub>GSS</sub>                   | Gate-Source Leakage Current                     | V <sub>GS</sub> =± 20V, V <sub>DS</sub> =0A                                                  | --- | ---  | ± 100 | nA    |
| On Characteristics                 |                                                 |                                                                                              |     |      |       |       |
| V <sub>GS(th)</sub>                | GATE-Source Threshold Voltage                   | V <sub>GS</sub> =V <sub>DS</sub> , I <sub>D</sub> =250 μ A                                   | 1   | ---  | 2.5   | V     |
| R <sub>DS(ON)</sub>                | Drain-Source On Resistance <sup>2</sup>         | V <sub>GS</sub> =10V, I <sub>D</sub> =4A                                                     | --- | ---  | 40    | m Ω   |
|                                    |                                                 | V <sub>GS</sub> =4.5V, I <sub>D</sub> =3A                                                    | --- | ---  | 50    |       |
| G <sub>FS</sub>                    | Forward Transconductance                        | V <sub>DS</sub> =5V, I <sub>D</sub> =4A                                                      | --- | 28.3 | ---   | S     |
| R <sub>g</sub>                     | Gate Resistance                                 | V <sub>DS</sub> =0V , V <sub>GS</sub> =0V, f=1MHz                                            | --- | 2.5  | ---   | Ω     |
| Dynamic Characteristics            |                                                 |                                                                                              |     |      |       |       |
| C <sub>iss</sub>                   | Input Capacitance                               | V <sub>DS</sub> =15V, V <sub>GS</sub> =0V, f=1MHz                                            | --- | 1027 | ---   | pF    |
| C <sub>oss</sub>                   | Output Capacitance                              |                                                                                              | --- | 65   | ---   |       |
| C <sub>rss</sub>                   | Reverse Transfer Capacitance                    |                                                                                              | --- | 46   | ---   |       |
| Switching Characteristics          |                                                 |                                                                                              |     |      |       |       |
| t <sub>d(on)</sub>                 | Turn-On Delay Time                              | V <sub>DD</sub> =30V, I <sub>D</sub> =4A<br><br>V <sub>GS</sub> =10V , R <sub>G</sub> =3.3 Ω | --- | 3    | ---   | ns    |
| t <sub>r</sub>                     | Rise Time                                       |                                                                                              | --- | 34   | ---   | ns    |
| t <sub>d(off)</sub>                | Turn-Off Delay Time                             |                                                                                              | --- | 23   | ---   | ns    |
| t <sub>f</sub>                     | Fall Time                                       |                                                                                              | --- | 6    | ---   | ns    |
| Q <sub>g</sub>                     | Total Gate Charge ( 4.5V )                      | V <sub>GS</sub> =10V, V <sub>DS</sub> =48V,<br><br>I <sub>D</sub> =4A                        | --- | 19   | ---   | nC    |
| Q <sub>gs</sub>                    | Gate-Source Charge                              |                                                                                              | --- | 2.6  | ---   | nC    |
| Q <sub>gd</sub>                    | Gate-Drain “Miller” Charge                      |                                                                                              | --- | 4.1  | ---   | nC    |
| Drain-Source Diode Characteristics |                                                 |                                                                                              |     |      |       |       |
| V <sub>SD</sub>                    | Source-Drain Diode Forward Voltage <sup>2</sup> | V <sub>GS</sub> =0V, I <sub>S</sub> =1A , T <sub>J</sub> =25℃                                | --- | ---  | 1.2   | V     |

|          |                                          |                             |     |      |     |    |
|----------|------------------------------------------|-----------------------------|-----|------|-----|----|
| $I_S$    | Continuous Source Current <sup>1,5</sup> | $V_G=V_D=0V$                | --- | ---  | 4.5 | A  |
| $I_{SM}$ | Pulsed Source Current <sup>2,5</sup>     |                             | --- | ---  | 18  |    |
| $t_{rr}$ | Reverse Recovery Time                    | $I_F=4A, di/dt=100A/\mu s,$ | --- | 12.1 | --- | nS |
| $Q_{rr}$ | Reverse Recovery Charge                  | $T_J=25^\circ C$            | --- | 6.7  | --- | nC |

### Notes:

- 1.The data tested by surface mounted on a 1 inch<sup>2</sup> FR-4 board with 2OZ copper.
- 2.The data tested by pulsed , pulse width  $\leq 300\mu s$  , duty cycle  $\leq 2\%$
- 3.The EAS data shows Max. rating . The test condition is  $V_{DD}=25V, V_{GS}=10V, L=0.1mH, I_{AS}=21A$
- 4.The power dissipation is limited by 150 $^\circ C$  junction temperature
- 5.The data is theoretically the same as  $I_D$  and  $I_{DM}$  , in real applications , should be limited by total power dissipation.

### Typical Characteristics: ( $T_C=25^\circ C$ unless otherwise noted)

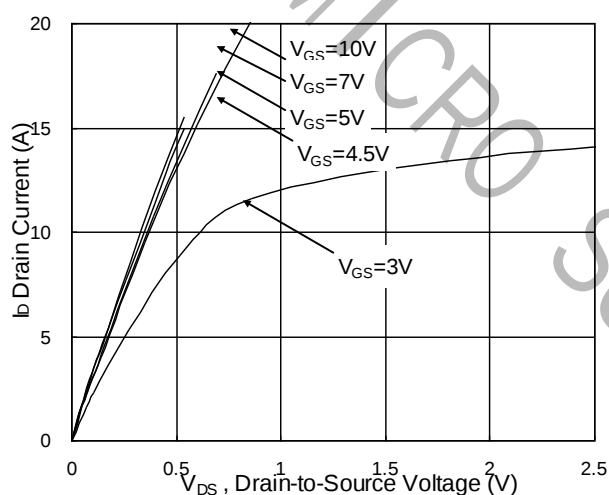


Fig.1 Typical Output Characteristics

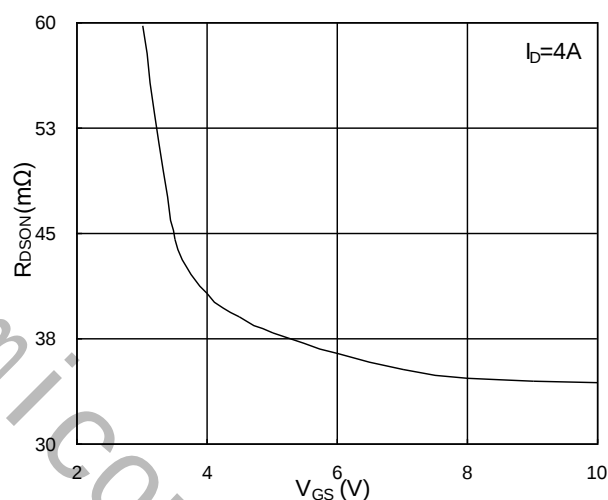


Fig.2 On-Resistance vs. Gate-Source

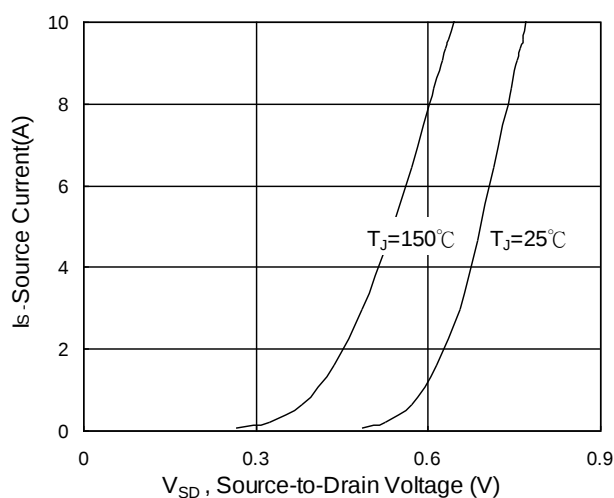


Fig.3 Forward Characteristics Of Reverse

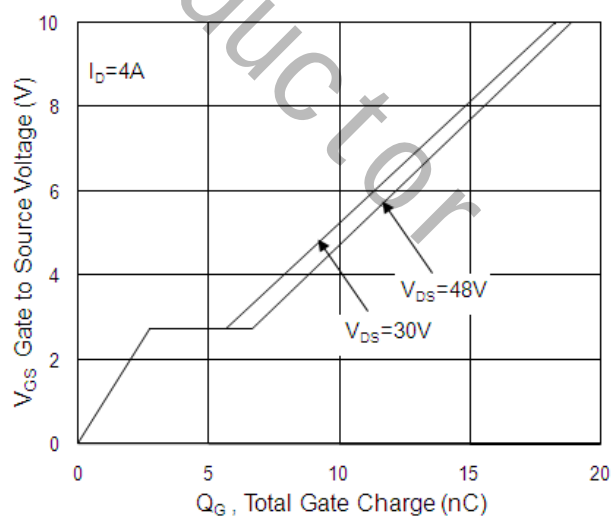


Fig.4 Gate-Charge Characteristics

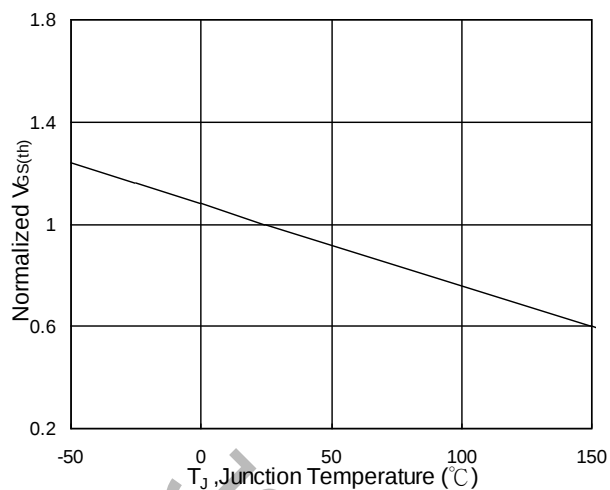
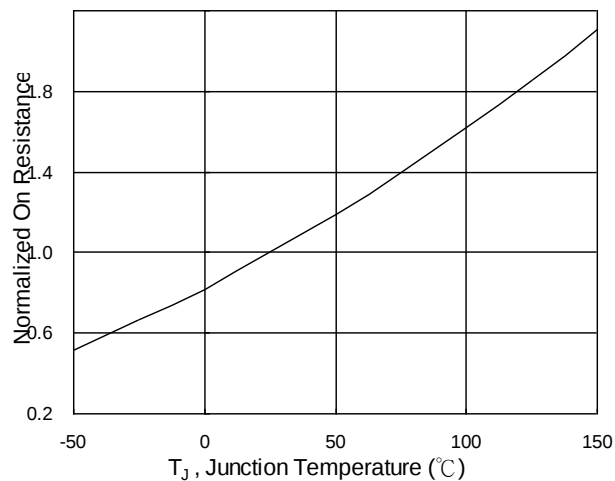
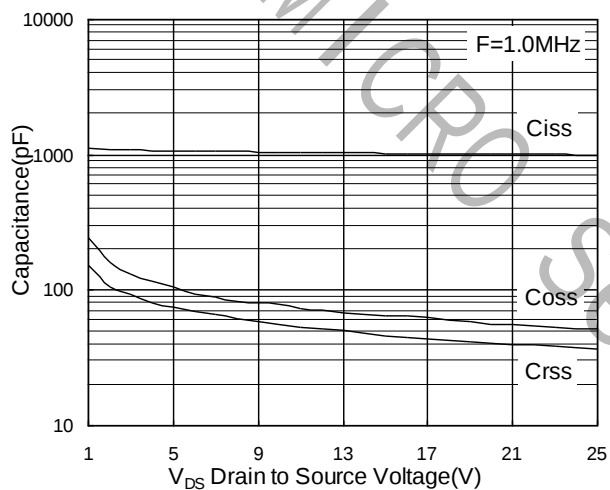

 Fig.5 Normalized  $V_{GS(th)}$  vs.  $T_J$ 

 Fig.6 Normalized  $R_{DS(on)}$  vs.  $T_J$ 


Fig.7 Capacitance

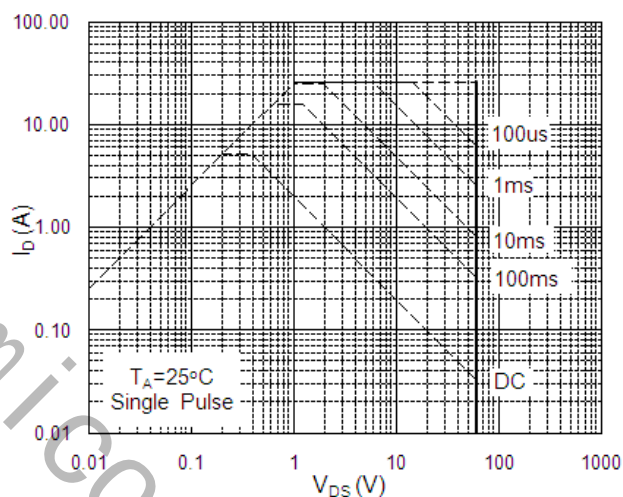


Fig.8 Safe Operating Area

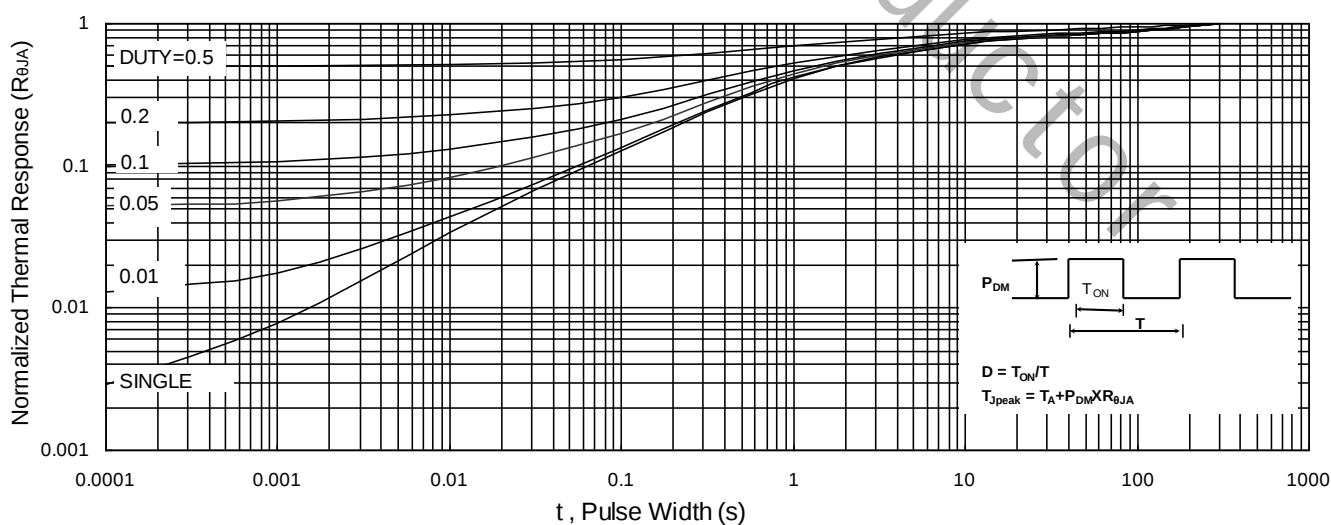
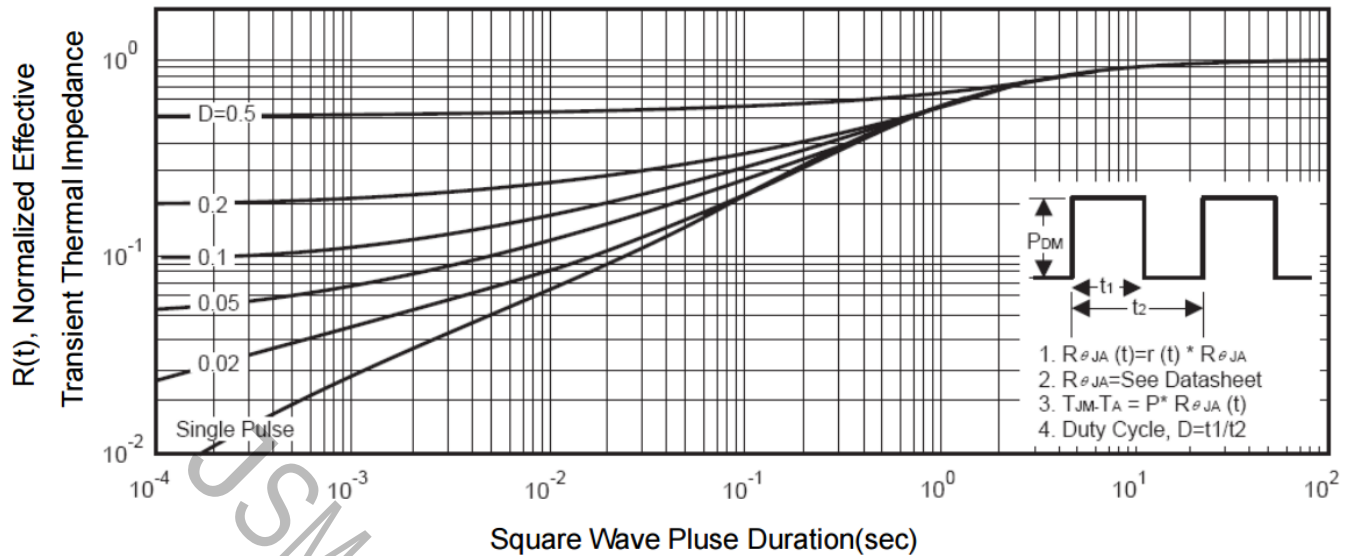


Fig.9 Normalized Maximum Transient Thermal Impedance



### P-Channel Electrical Characteristics: ( $T_C=25^{\circ}\text{C}$ unless otherwise noted)

| Symbol                          | Parameter                               | Conditions                                                 | Min  | Typ | Max  | Units |
|---------------------------------|-----------------------------------------|------------------------------------------------------------|------|-----|------|-------|
| ON/Off States                   |                                         |                                                            |      |     |      |       |
| BV <sub>DSS</sub>               | Drain-Source Breakdown Voltage          | V <sub>GS</sub> =0V, I <sub>D</sub> =-250 μA               | -60  | --- | ---  | V     |
| I <sub>DSS</sub>                | Zero Gate Voltage Drain Current         | V <sub>GS</sub> =0V, V <sub>DS</sub> =-48V                 | ---  | --- | 1    | μA    |
| I <sub>GSS</sub>                | Gate-Source Leakage Current             | V <sub>GS</sub> =±20V, V <sub>DS</sub> =0A                 | ---  | --- | ±100 | nA    |
| On Characteristics <sup>3</sup> |                                         |                                                            |      |     |      |       |
| V <sub>GS(th)</sub>             | GATE-Source Threshold Voltage           | V <sub>GS</sub> =V <sub>DS</sub> , I <sub>D</sub> =-250 μA | -1.2 | --- | -2.5 | V     |
| R <sub>DS(on)</sub>             | Drain-Source On Resistance <sup>2</sup> | V <sub>GS</sub> =-10V, I <sub>D</sub> =-3A                 | ---  | --- | 90   | m Ω   |
|                                 |                                         | V <sub>GS</sub> =-4.5V, I <sub>D</sub> =-2A                | ---  | --- | 125  |       |
| G <sub>FS</sub>                 | Forward Transconductance                | V <sub>DS</sub> =-5V, I <sub>D</sub> =-3A                  | ---  | 8.7 | ---  | S     |
| R <sub>g</sub>                  | Gate Resistance                         | V <sub>DS</sub> = 0 V , V <sub>GS</sub> =0V, f=1MHz        | ---  | 15  | ---  | Ω     |
| Dynamic Characteristics         |                                         |                                                            |      |     |      |       |
| C <sub>iss</sub>                | Input Capacitance                       | V <sub>DS</sub> =-15V, V <sub>GS</sub> =0V, f=1MHz         | ---  | 900 | ---  | pF    |
| C <sub>oss</sub>                | Output Capacitance                      |                                                            | ---  | 65  | ---  |       |
| C <sub>rss</sub>                | Reverse Transfer Capacitance            |                                                            | ---  | 47  | ---  |       |
| Switching Characteristics       |                                         |                                                            |      |     |      |       |
| t <sub>d(on)</sub>              | Turn-On Delay Time                      | V <sub>DD</sub> =-15V, V <sub>GS</sub> =-10V,              | ---  | 8.8 | ---  | ns    |

|                                    |                                                 |                                           |     |      |      |    |
|------------------------------------|-------------------------------------------------|-------------------------------------------|-----|------|------|----|
| $t_r$                              | Rise Time                                       | $R_{GEN}=3.3\ \Omega ,I_D=-1A$            | --- | 19.6 | ---  | ns |
| $t_{d(off)}$                       | Turn-Off Delay Time                             |                                           | --- | 47.2 | ---  | ns |
| $t_f$                              | Fall Time                                       |                                           | --- | 9.6  | ---  | ns |
| $Q_g$                              | Total Gate Charge （-4.5V）                       | $V_{GS}=-4.5V, V_{DS}=-48V,$<br>$I_D=-3A$ | --- | 10   | ---  | nC |
| $Q_{gs}$                           | Gate-Source Charge                              |                                           | --- | 1.9  | ---  | nC |
| $Q_{gd}$                           | Gate-Drain “Miller” Charge                      |                                           | --- | 6.5  | ---  | nC |
| Drain-Source Diode Characteristics |                                                 |                                           |     |      |      |    |
| $V_{SD}$                           | Source-Drain Diode Forward Voltage <sup>3</sup> | $V_{GS}=0V,I_S=-6.5A$                     | --- | ---  | -1.2 | V  |
| $I_S$                              | Continuous Source Current <sup>1,5</sup>        | $V_G=V_D=0V,$                             | --- | ---  | -4.1 | A  |
| $I_{SM}$                           | Diode Forward Voltage <sup>2</sup>              |                                           | --- | ---  | -14  |    |

### Notes:

1. The data tested by surface mounted on a 1 inch<sup>2</sup> FR-4 board with 2OZ copper.
2. The data tested by pulsed, pulse width  $\leq 300\mu s$ , duty cycle  $\leq 2\%$
3. The EAS data shows Max. rating. The test condition is  $V_{DD}=-25V, V_{GS}=-10V, L=0.1mH, I_{AS}=-24.4A$
4. The power dissipation is limited by 150°C junction temperature
5. The data is theoretically the same as  $I_D$  and  $I_{DM}$ , in real applications, should be limited by total power dissipation.

### Typical Characteristics: ( $T_C=25^\circ C$ unless otherwise noted)

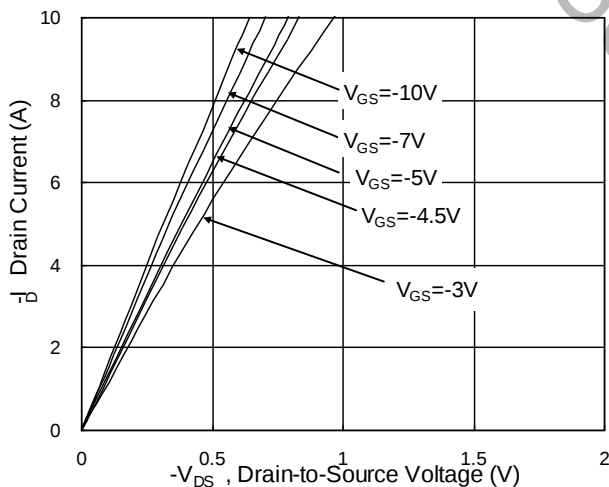


Fig.1 Typical Output Characteristics

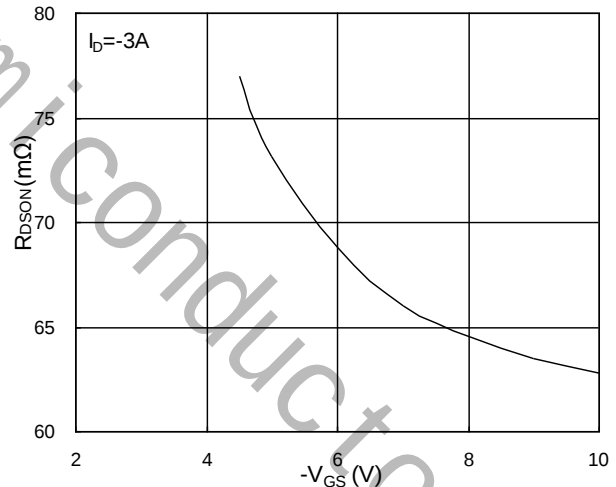


Fig.2 On-Resistance v.s Gate-Source

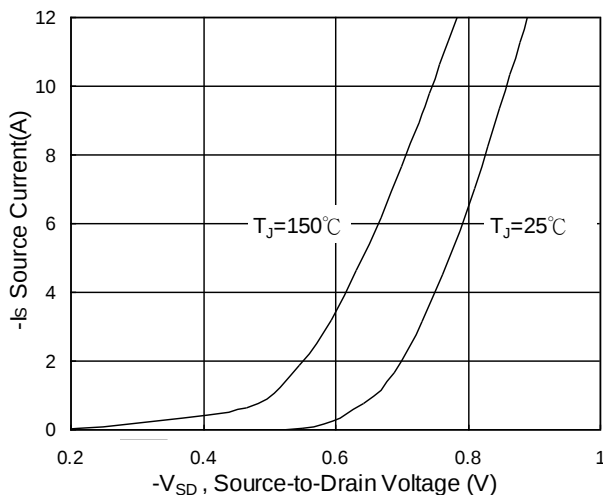


Fig.3 Forward Characteristics of Reverse

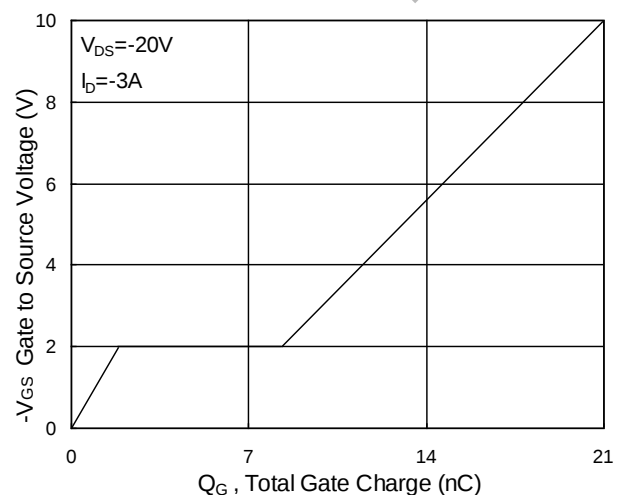
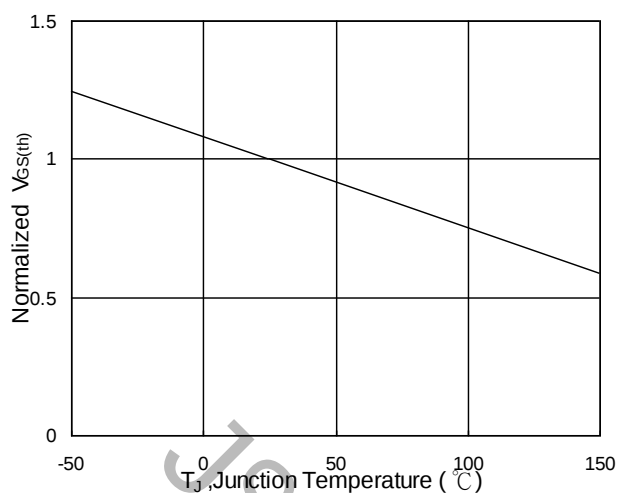
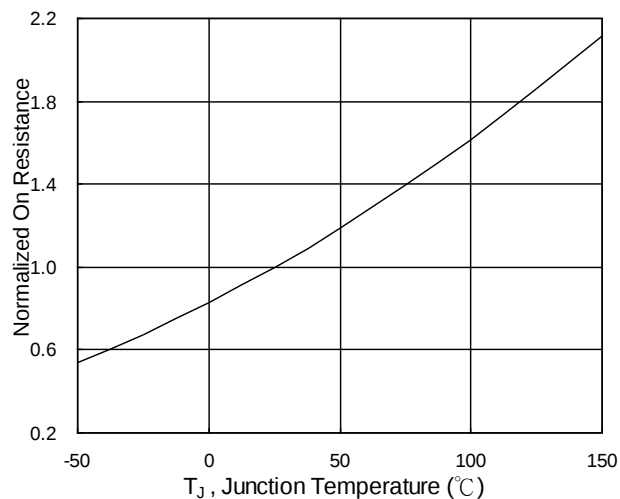
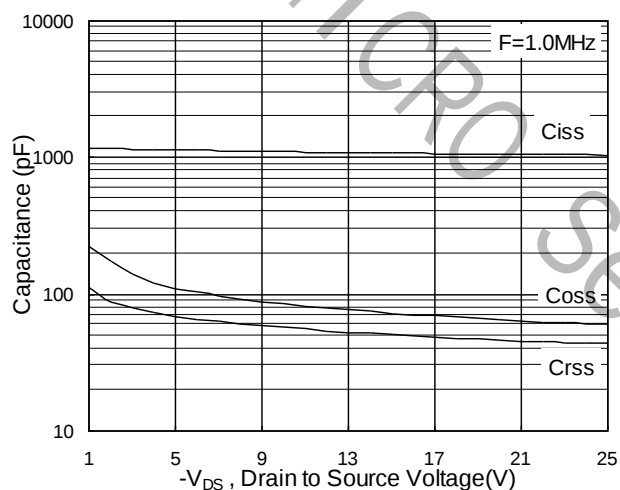
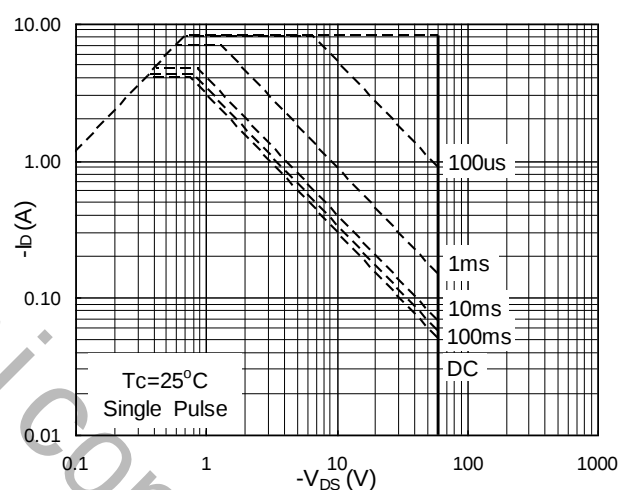
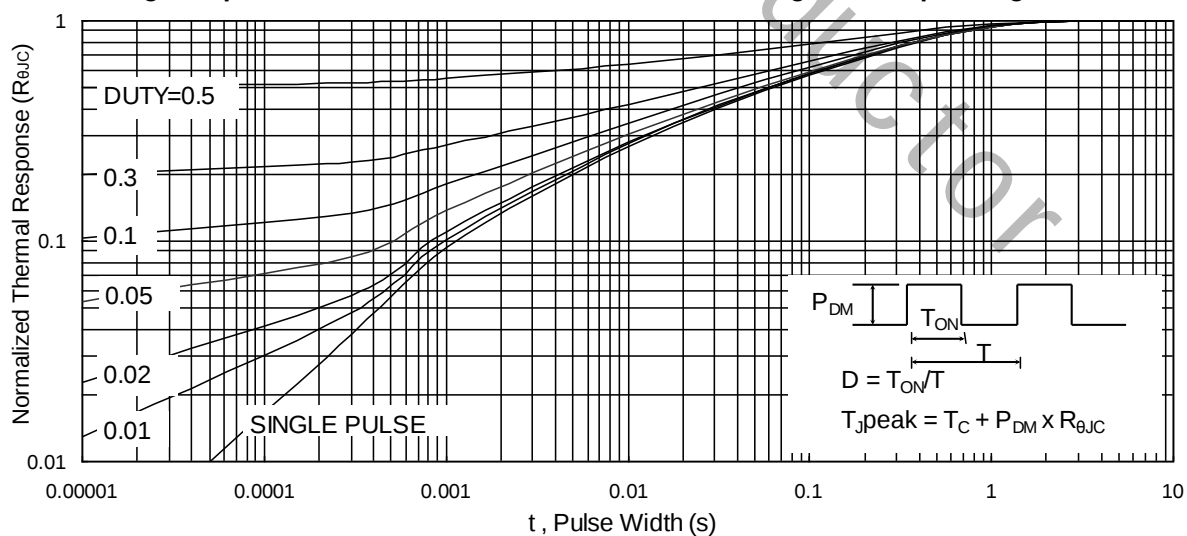


Fig.4 Gate-Charge Characteristics


**Fig.5 Normalized  $V_{GS(th)}$  vs.  $T_J$** 

**Fig.6 Normalized  $R_{DS(on)}$  vs.  $T_J$** 

**Fig.7 Capacitance**

**Fig.8 Safe Operating Area**

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