## General Description

The WSD4048DN56 is the highest performance trench N-Ch and P-Channel MOSFET with extreme high cell density, which provide excellent $R_{DS(ON)}$ and gate charge for most of the synchronous buck converter applications.

The WSD4048DN56 meet the RoHS and Green Product requirement 100% $E_{AS}$ guaranteed with full function reliability approved.

## Features

- Advanced high cell density Trench technology
- Super Low Gate Charge
- Excellent CdV/dt effect decline
- 100% $E_{AS}$ Guaranteed
- Green Device Available

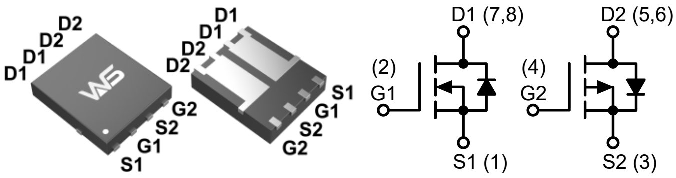
## Product Summery

| $BV_{DSS}$ | $R_{DS(ON)}$ | $I_D$ |
|---|---|---|
| 40V | 14mΩ | 34A |
| -40V | 32mΩ | -24A |

## Applications

- High Frequency Point-of-Load Synchronous Buck Converter for MB/NB/UMPC/VGA
- Networking DC-DC Power System
- CCFL Back-light Inverter

## DFN5X6-8L Pin Configuration




## Absolute Maximum Ratings

| Symbol | Parameter | Rating | | Units |
|---|---|---|---|---|
| | | N-Channel | P-Channel | |
| $V_{DS}$ | Drain-Source Voltage | 40 | -40 | V |
| $V_{GS}$ | Gate-Source Voltage | ±20 | ±20 | V |
| $I_D@T_C=25°C$ | Continuous Drain Current, $V_{GS}$ @ 10V [1] | 34 | -24 | A |
| $I_D@T_C=70°C$ | Continuous Drain Current, $V_{GS}$ @ 10V [1] | 22 | -18 | A |
| $I_{DM}$ | Pulse Drain Current [2] | 46 | -40 | A |
| $E_{AS}$ | Single Pulse Avalanche Energy [3] | 28 | 66 | mJ |
| $I_{AS}$ | Avalanche Current | 17.8 | -27.2 | A |
| $P_D@T_C=25°C$ | Total Power Dissipation [4] | 25 | 31.3 | W |
| $T_{STG}$ | Storage Temperature Range | -55 to 150 | -55 to 150 | °C |
| $T_J$ | Operating Junction Temperature Range | -55 to 150 | -55 to 150 | °C |

## Thermal Data

| Symbol | Parameter | Rating | Units |
|---|---|---|---|
| $R_{\theta JA}$ | Thermal Resistance Junction-Ambient [1] | 62 | °C/W |
| $R_{\theta JC}$ | Thermal Resistance Junction-Case [1] | 5.0 | °C/W |

## N-Channel Electrical Characteristics ($T_J$=25°C, Unless Otherwise Noted)

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| $BV_{DSS}$ | Drain-Source Breakdown Voltage | $V_{GS}$=0V , $I_D$=250μA | 40 | --- | --- | V |
| $\Delta BV_{DSS}/\Delta T_J$ | $BV_{DSS}$ Temperature Coefficient | Reference to 25°C, $I_D$=1mA | --- | 0.034 | --- | V/°C |
| $R_{DS(ON)}$ | Static Drain-Source On-Resistance [2] | $V_{GS}$=10V , $I_D$=10A | --- | 14 | 21 | mΩ |
| | | $V_{GS}$=4.5V , $I_D$=5A | --- | 18 | 25 | |
| $V_{GS(th)}$ | Gate Threshold Voltage | $V_{GS}=V_{DS}$ , $I_D$=250μA | 1.5 | 2.0 | 2.5 | V |
| $\Delta V_{GS(th)}$ | $V_{GS(th)}$ Temperature Coefficient | | --- | -4.56 | --- | mV/°C |
| $I_{DSS}$ | Drain-Source Leakage Current | $V_{DS}$=32V , $V_{GS}$=0V , $T_J$=25°C | --- | --- | 1.0 | μA |
| | | $V_{DS}$=32V , $V_{GS}$=0V , $T_J$=55°C | --- | --- | 5.0 | |
| $I_{GSS}$ | Gate-Source Leakage Current | $V_{GS}$=±20V , $V_{DS}$=0V | --- | --- | ±100 | nA |
| $g_{fs}$ | Forward Transconductance | $V_{DS}$=5V , $I_D$=10A | --- | 15 | --- | S |
| $R_g$ | Gate Resistance | $V_{DS}$=0V , $V_{GS}$=0V , $f$=1.0MHz | --- | 2.5 | 5.2 | Ω |
| $Q_g$ | Total Gate Charge (4.5V) | $V_{DS}$=20V , $V_{GS}$=4.5V , $I_D$=12A | --- | 9.5 | --- | nC |
| $Q_{gs}$ | Gate-Source Charge | | --- | 1.25 | --- | |
| $Q_{gd}$ | Gate-Drain Charge | | --- | 2.5 | --- | |
| $T_{d(on)}$ | Turn-On Delay Time | $V_{DD}$=20V , $V_{GS}$=10V , $R_G$=3.3Ω , $I_D$=1A | --- | 8.9 | --- | ns |
| $T_r$ | Rise Time | | --- | 2.2 | --- | |
| $T_{d(off)}$ | Turn-Off Delay Time | | --- | 41 | --- | |
| $T_f$ | Fall Time | | --- | 2.7 | --- | |
| $C_{iss}$ | Input Capacitance | $V_{DS}$=15V , $V_{GS}$=0V , $f$=1.0MHz | --- | 810 | --- | pF |
| $C_{oss}$ | Output Capacitance | | --- | 90 | --- | |
| $C_{rss}$ | Reverse Transfer Capacitance | | --- | 60 | --- | |

## Diode Characteristics

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| $I_S$ | Continuous Source Current [1,6] | $V_G=V_D$=0V , Force Current | --- | --- | 23 | A |
| $I_{SM}$ | Pulsed Source Current [2,6] | | --- | --- | 46 | |
| $V_{SD}$ | Diode Forward Voltage [2] | $V_{GS}$=0V , $I_S$=1A , $T_J$=25°C | --- | --- | 1.2 | V |

Note:

1. The data tested by surface mounted on a 1 $inch^2$ FR-4 board with 2OZ copper.
2. The data tested by pulsed, pulse width ≤ 300μs , duty cycle ≤ 2%.
3. The $E_{AS}$ data shows Max. rating.
4. The power dissipation is limited by 150°C junction temperature.
5. The Min. value is 100% $E_{AS}$ tested guarantee.
6. The data is theoretically the same as $I_D$ and $I_{DM}$ , in real applications , should be limited by total power dissipation.

## **P-Channel Electrical Characteristics** ($T_J$=25°C, Unless Otherwise Noted)

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| $BV_{DSS}$ | Drain-Source Breakdown Voltage | $V_{GS}$=0V , $I_D$=-250μA | -40 | --- | --- | V |
| $\Delta BV_{DSS}/\Delta T_J$ | $BV_{DSS}$ Temperature Coefficient | Reference to 25°C, $I_D$=-1mA | --- | -0.012 | --- | V/°C |
| $R_{DS(ON)}$ | Static Drain-Source On-Resistance [2] | $V_{GS}$=-10V , $I_D$=-10A | --- | 32 | 38 | mΩ |
| | | $V_{GS}$=-4.5V , $I_D$=-4A | --- | 46 | 62 | |
| $V_{GS(th)}$ | Gate Threshold Voltage | $V_{GS}$=$V_{DS}$ , $I_D$=-250μA | -1.5 | -2.0 | -2.5 | V |
| $\Delta V_{GS(th)}$ | $V_{GS(th)}$ Temperature Coefficient | | --- | 4.32 | --- | mV/°C |
| $I_{DSS}$ | Drain-Source Leakage Current | $V_{DS}$=-32V , $V_{GS}$=0V , $T_J$=25°C | --- | --- | -1.0 | μA |
| | | $V_{DS}$=-32V , $V_{GS}$=0V , $T_J$=55°C | --- | --- | -5.0 | |
| $I_{GSS}$ | Gate-Source Leakage Current | $V_{GS}$=±20V , $V_{DS}$=0V | --- | --- | ±100 | nA |
| $g_{fs}$ | Forward Transconductance | $V_{DS}$=-5V , $I_D$=-8A | --- | 12.6 | --- | S |
| $R_g$ | Gate Resistance | $V_{DS}$=0V , $V_{GS}$=0V , $f$=1.0MHz | --- | 13 | 16 | Ω |
| $Q_g$ | Total Gate Charge (-4.5V) | $V_{DS}$=-20V , $V_{GS}$=-4.5V , $I_D$=-12A | --- | 9.0 | --- | nC |
| $Q_{gs}$ | Gate-Source Charge | | --- | 2.54 | --- | |
| $Q_{gd}$ | Gate-Drain Charge | | --- | 3.1 | --- | |
| $T_{d(on)}$ | Turn-On Delay Time | $V_{DD}$=-15V , $V_{GS}$=-10V , $R_G$=3.3Ω , $I_D$=-1A | --- | 19.2 | --- | ns |
| $T_r$ | Rise Time | | --- | 12.8 | --- | |
| $T_{d(off)}$ | Turn-Off Delay Time | | --- | 48.6 | --- | |
| $T_f$ | Fall Time | | --- | 4.6 | --- | |
| $C_{iss}$ | Input Capacitance | $V_{DS}$=-15V , $V_{GS}$=0V , $f$=1.0MHz | --- | 1904 | --- | pF |
| $C_{oss}$ | Output Capacitance | | --- | 108 | --- | |
| $C_{rss}$ | Reverse Transfer Capacitance | | --- | 80 | --- | |

## Diode Characteristics

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| $I_S$ | Continuous Source Current [1,6] | $V_G$=$V_D$=0V , Force Current | --- | --- | -20 | A |
| $I_{SM}$ | Pulsed Source Current [2,6] | | --- | --- | -40 | |
| $V_{SD}$ | Diode Forward Voltage [2] | $V_{GS}$=0V , $I_S$=-1A , $T_J$=25°C | --- | --- | -1.0 | V |

Note:

1. The data tested by surface mounted on a 1 inch$^2$ FR-4 board with 2OZ copper.
2. The data tested by pulsed, pulse width ≤ 300μs , duty cycle ≤ 2%.
3. The $E_{AS}$ data shows Max. rating.
4. The power dissipation is limited by 150°C junction temperature.
5. The Min. value is 100% $E_{AS}$ tested guarantee.
6. The data is theoretically the same as $I_D$ and $I_{DM}$ , in real applications , should be limited by total power dissipation.

## N-Channel Typical Characteristics

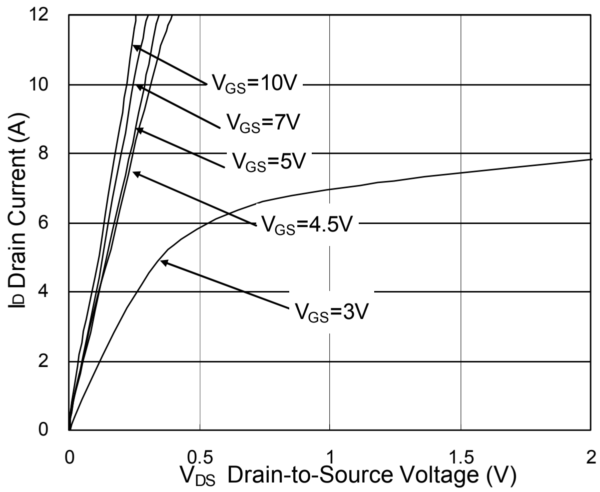



**Fig.1 Typical Output Characteristics**

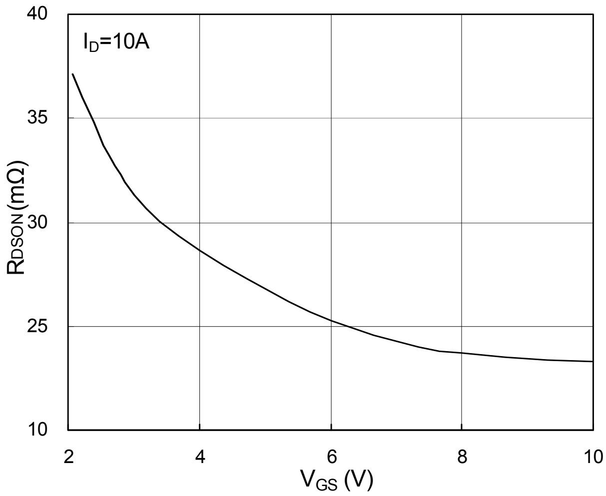



**Fig.2 On-Resistance vs. G-S Voltage**

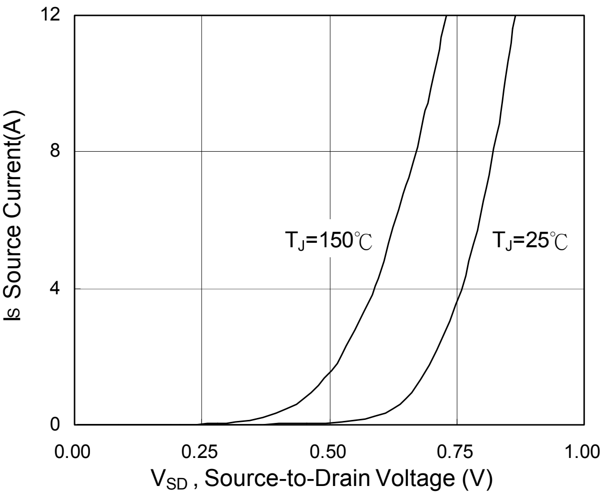



**Fig.3 Forward Characteristics of Reverse**

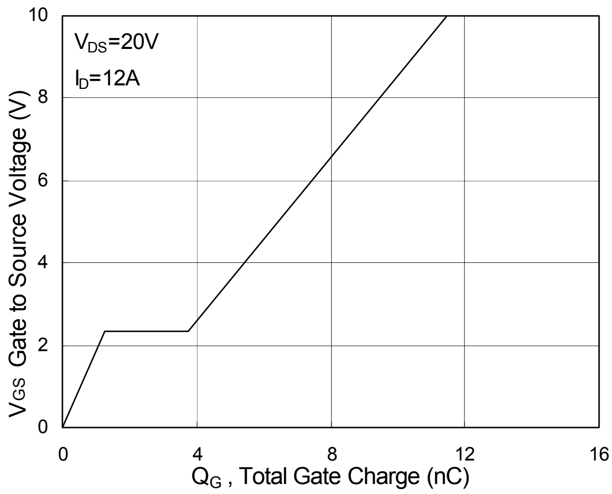



**Fig.4 Gate-Charge Characteristics**

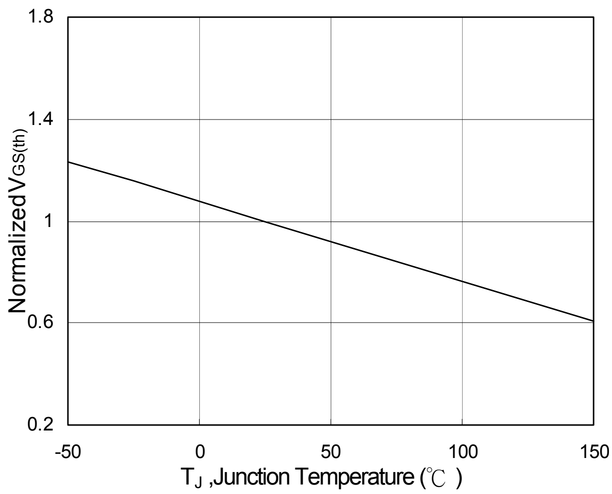



**Fig.5 Normalized $V_{GS(th)}$ vs. $T_J$**

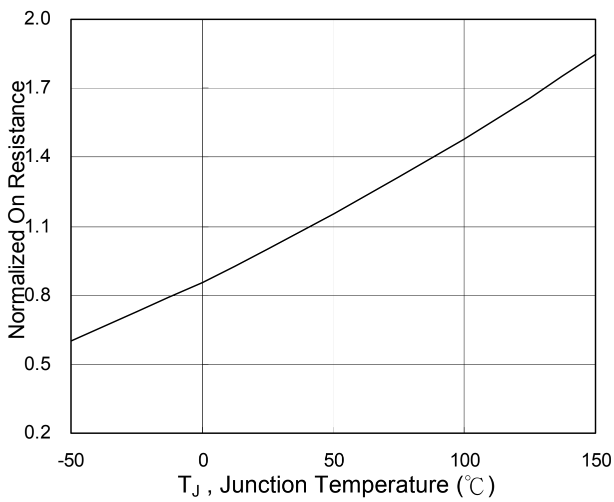



**Fig.6 Normalized $R_{DSON}$ vs. $T_J$**

## N-Channel Typical Characteristics (Cont.)

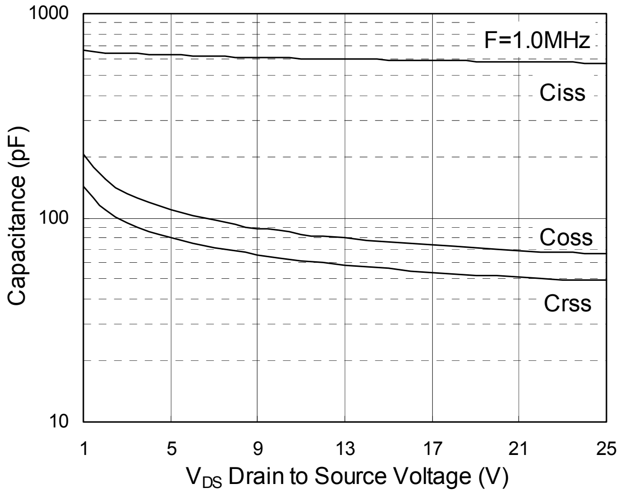



**Fig.7 Capacitance**

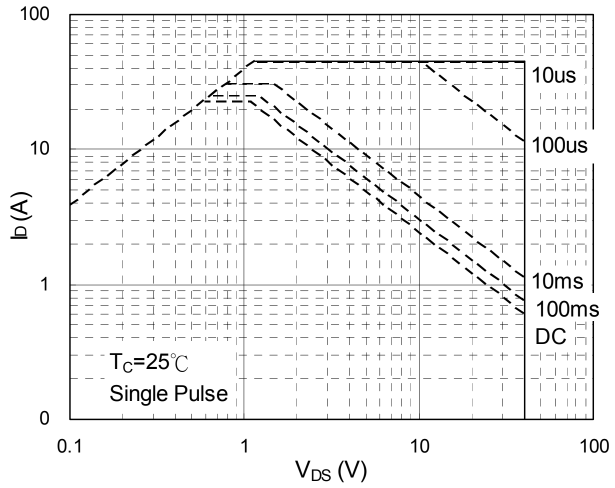



**Fig.8 Safe Operating Area**

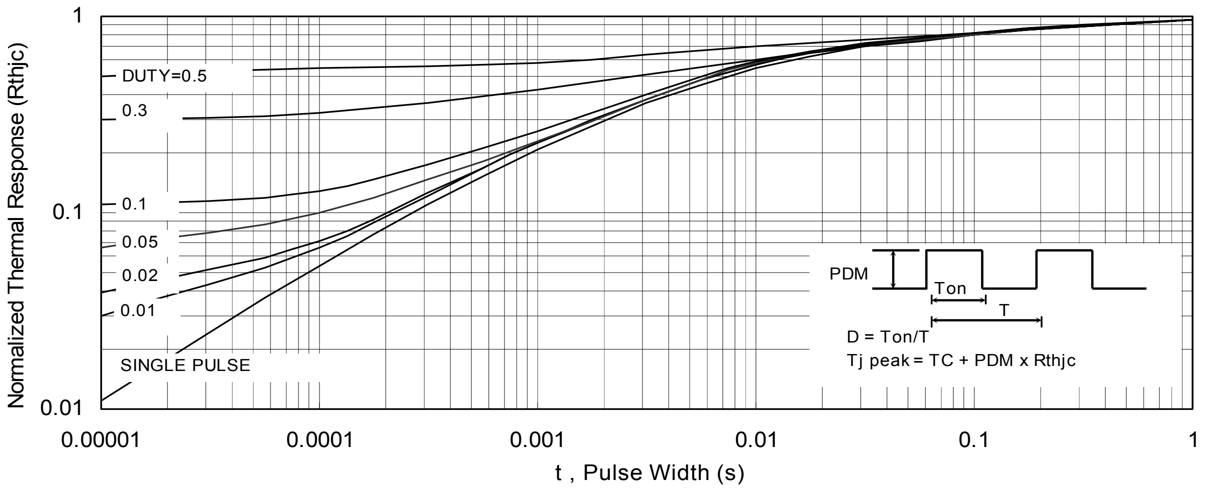
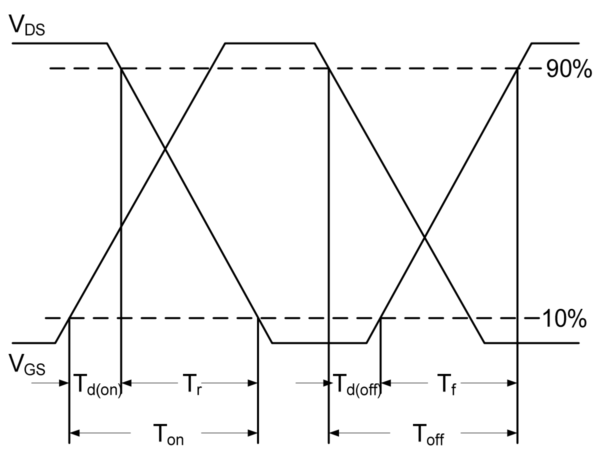



**Fig.9 Normalized Maximum Transient Thermal Impedance**




$$EAS = \frac{1}{2} L \times I_{AS}^2 \times \frac{BV_{DSS}}{BV_{DSS} - V_{DD}}$$

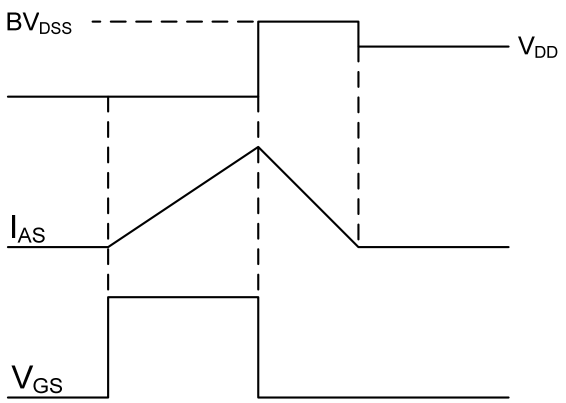



**Fig.10 Switching Time Waveform**

**Fig.11 Unclamped Inductive Switching Wave**

## P-Channel Typical Characteristics

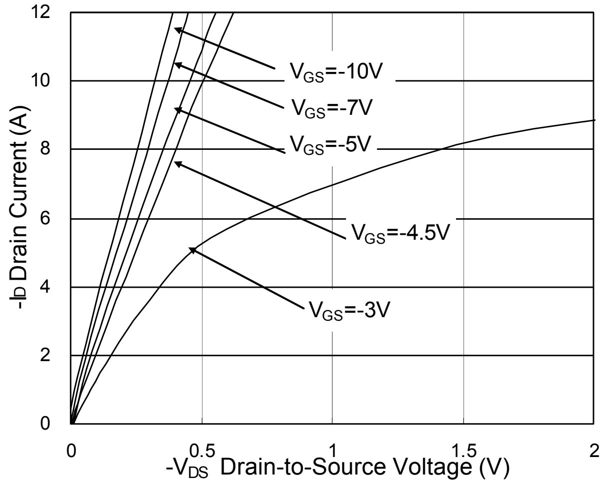



**Fig.1 Typical Output Characteristics**

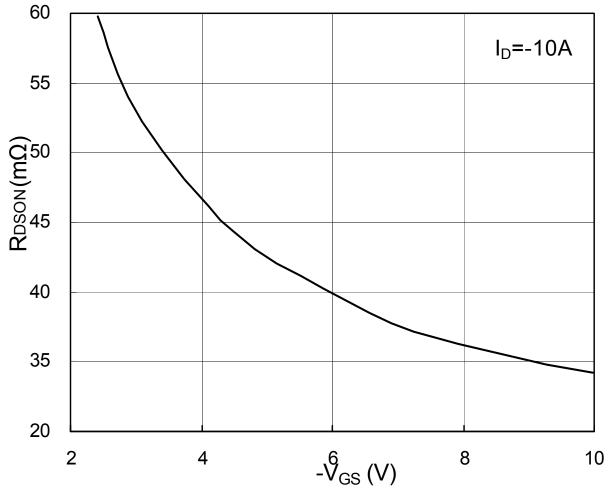



**Fig.2 On-Resistance v.s Gate-Source**

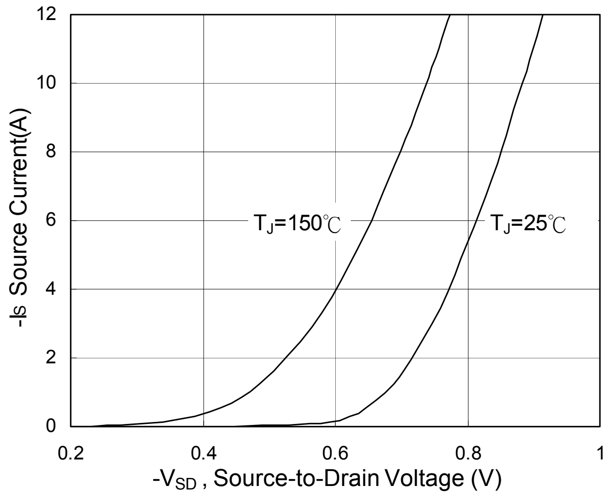



**Fig.3 Forward Characteristics of Reverse**

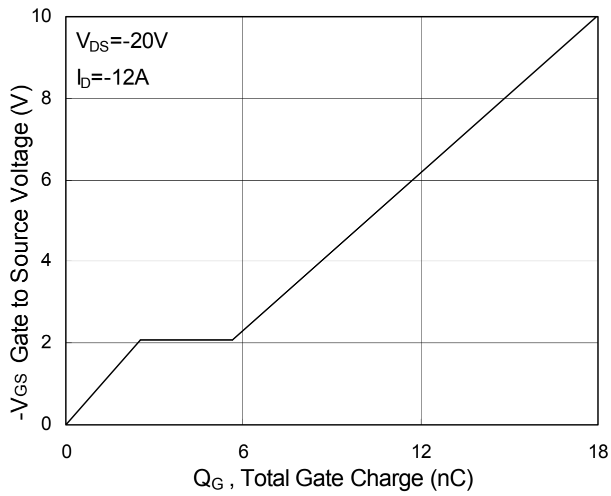



**Fig.4 Gate-Charge Characteristics**

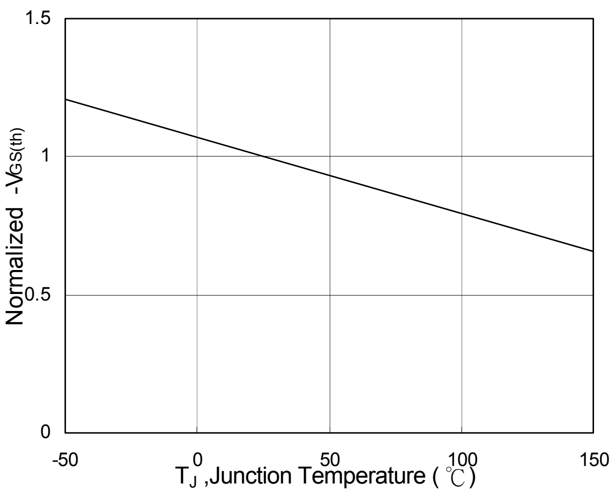



**Fig.5 Normalized $V_{GS(th)}$ v.s $T_J$**

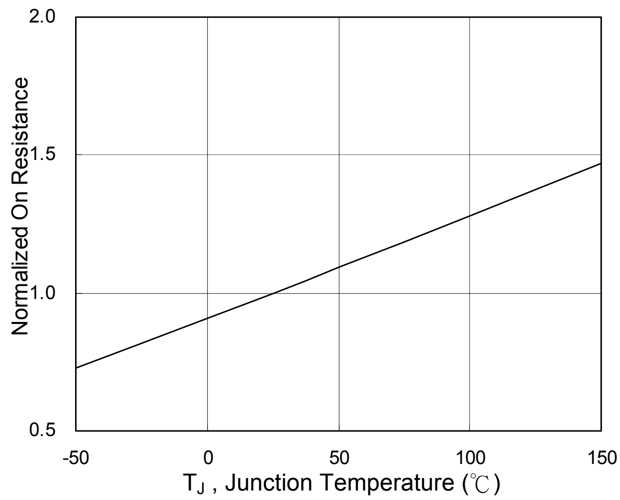



**Fig.6 Normalized $R_{DSON}$ v.s $T_J$**

## P-Channel Typical Characteristics (Cont.)

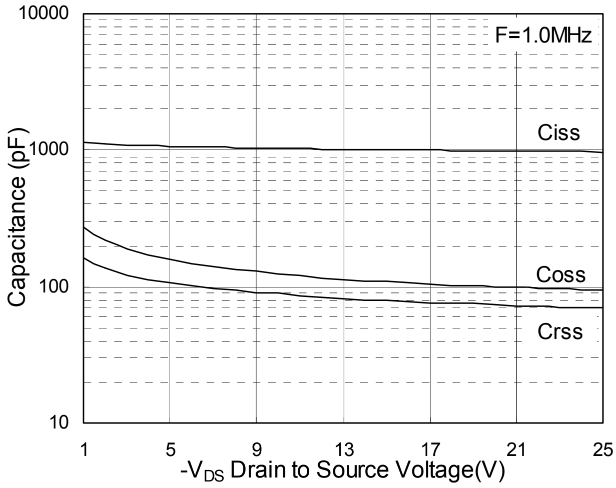



Fig.7 Capacitance

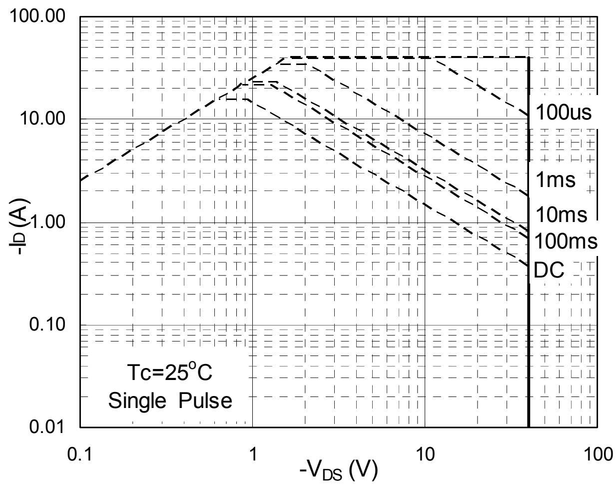



Fig.8 Safe Operating Area

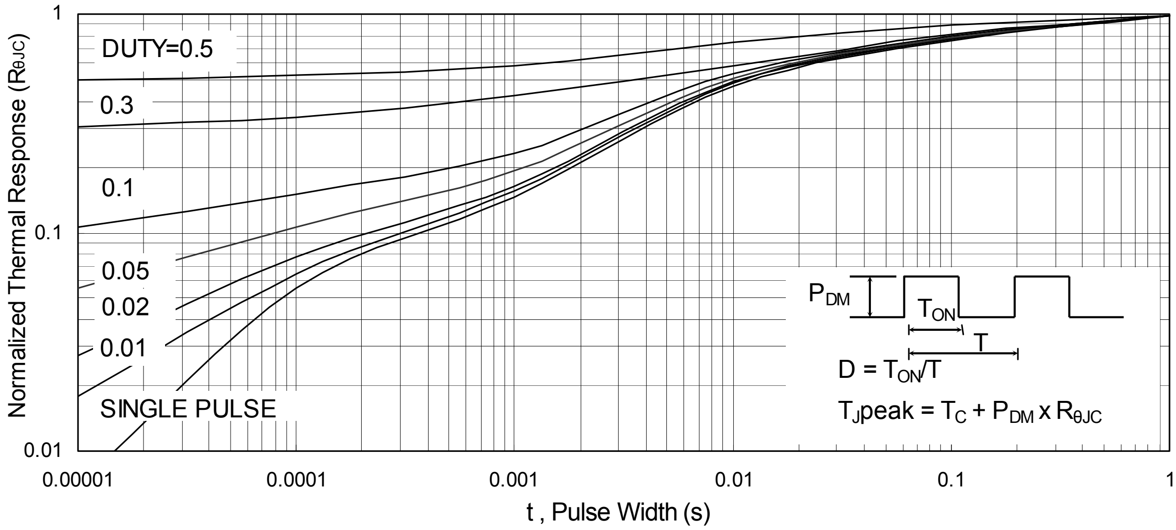



Fig.9 Normalized Maximum Transient Thermal Impedance

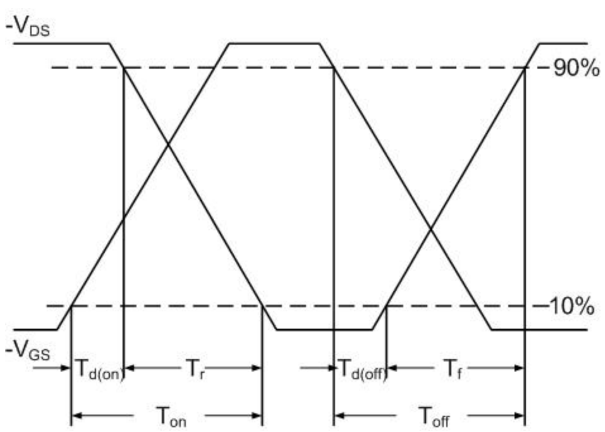



Fig.10 Switching Time Waveform

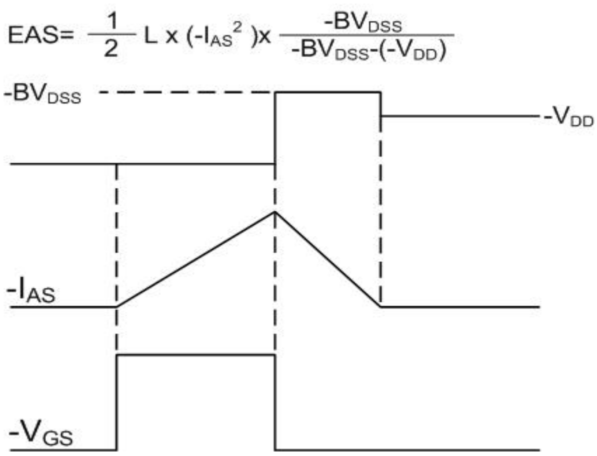
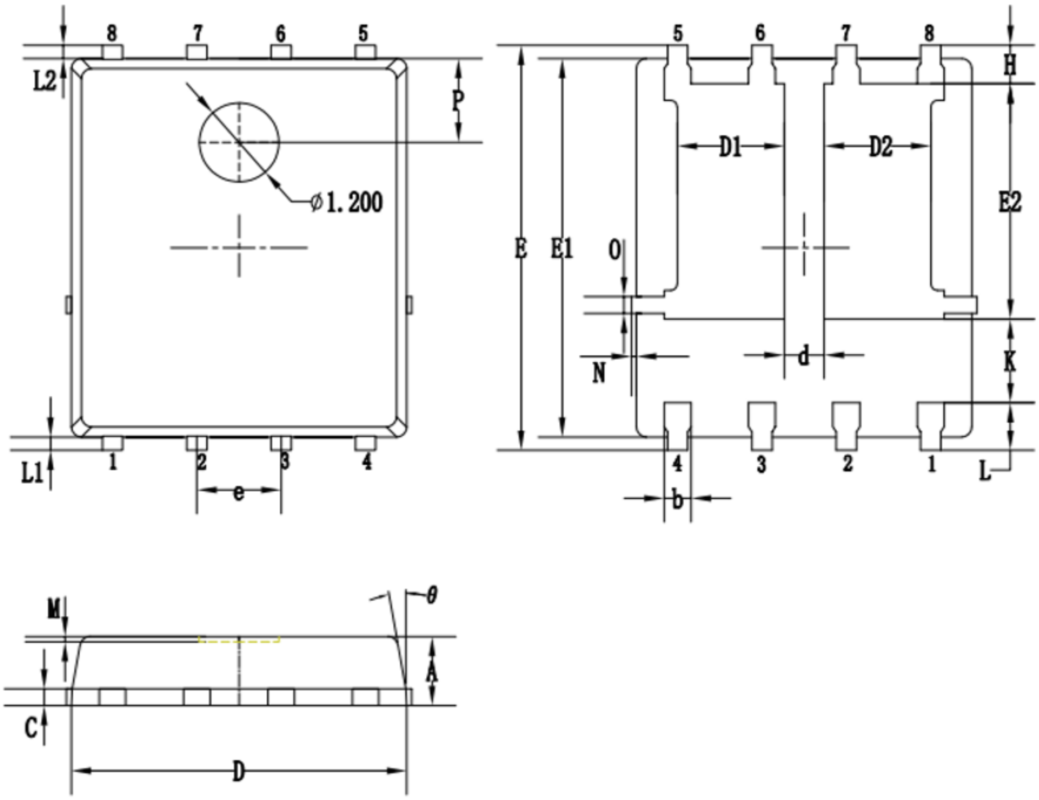



Fig.11 Unclamped Inductive Waveform

## Packaging information




| SYMBOLS | MILLIMETERS | | |
|---|---|---|---|
| | MIN. | NOM. | MAX. |
| A | 0.90 | 1.05 | 1.20 |
| b | 0.35 | 0.40 | 0.50 |
| C | 0.20 | 0.25 | 0.35 |
| D | 4.90 | 5.05 | 5.20 |
| D1/D2 | 1.51 | 1.61 | 1.71 |
| d | 0.50 | 0.60 | 0.70 |
| E | 6.00 | 6.15 | 6.30 |
| E1 | 5.60 | 5.75 | 5.90 |
| E2 | 3.47 | 3.57 | 3.67 |
| e | 1.27 BSC. | | |
| H | 0.48 | 0.58 | 0.68 |
| K | 1.17 | 1.27 | 1.37 |
| L | 0.64 | 0.74 | 0.84 |
| L1/L2 | 0.20 REF. | | |
| θ | 8° | 10° | 12° |
| M | 0.08 REF. | | |
| N | 0 | - | 0.15 |
| O | 0.25 REF. | | |
| P | 1.28 REF. | | |

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