★ 100% EAS Guaranteed
★ Green Device Available
★ Super Low Gate Charge
★ Excellent CdV/dt effect decline
★ Advanced high cell density Trench technology

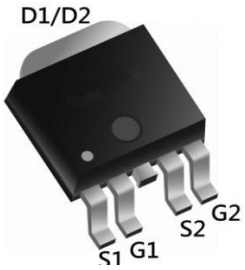
## Product Summary

| BVDSS | RDSON | ID |
|---|---|---|
| 40V | 17mΩ | 25A |
| -40V | 32mΩ | -25A |

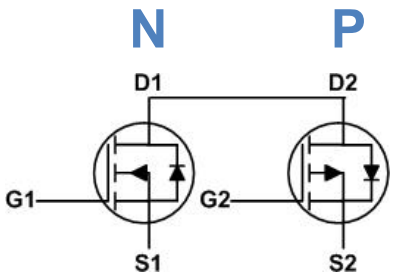
## Description

The ZX 4012 is the high performance complementary N-ch and P-ch MOSFETs with high cell density, which provide excellent RDSON and gate charge for most of the synchronous buck converter applications.
The ZX 4012 meet the RoHS and Green Product requirement 100% EAS guaranteed with full function reliability approved.

## TO252-4L Pin Configuration




pin assignment




Schematic diagram

## Package Marking and Ordering Information

| Product | Package | Marking | Packing | Min Unit Quantity |
|---|---|---|---|---|
| ZX 4012 | TO252-4L | * | 2500PCS/Reel | 2500PCS |

## Absolute Maximum Ratings

| Symbol | Parameter | Rating | | Units |
|---|---|---|---|---|
| | | N-Ch | P-Ch | |
| $V_{DS}$ | Drain-Source Voltage | 40 | -40 | V |
| $V_{GS}$ | Gate-Source Voltage | ±20 | ±20 | V |
| $I_D$@$T_C$=25℃ | Continuous Drain Current, $V_{GS}$ @ 10V[1] | 25 | -25 | A |
| $I_D$@$T_C$=100℃ | Continuous Drain Current, $V_{GS}$ @ 10V[1] | 18 | -16 | A |
| $I_{DM}$ | Pulsed Drain Current[2] | 46 | -40 | A |
| EAS | Single Pulse Avalanche Energy[3] | 28 | 66 | mJ |
| $I_{AS}$ | Avalanche Current | 17.8 | -27.2 | A |
| $P_D$@$T_C$=25℃ | Total Power Dissipation[4] | 25 | 31.3 | W |
| $T_{STG}$ | Storage Temperature Range | -55 to 150 | -55 to 150 | ℃ |
| $T_J$ | Operating Junction Temperature Range | -55 to 150 | -55 to 150 | ℃ |

## Thermal Data

| Symbol | Parameter | Typ. | Max. | Unit |
|---|---|---|---|---|
| $R_{\theta JA}$ | Thermal Resistance Junction-Ambient [1] | --- | 62 | ℃/W |
| $R_{\theta JC}$ | Thermal Resistance Junction-Case[1] | --- | 5 | ℃/W |

## N-Channel Electrical Characteristics ($T_J$=25℃ unless otherwise specified)

| Symbol | Parameter | Test Condition | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| **Off Characteristic** | | | | | | |
| $V_{(BR)DSS}$ | Drain-Source Breakdown Voltage | $V_{GS}$=0V, $I_D$=250μA | 40 | - | - | V |
| $I_{DSS}$ | Zero Gate Voltage Drain Current | $V_{DS}$=40V, $V_{GS}$=0V | - | - | 1.0 | μA |
| $I_{GSS}$ | Gate to Body Leakage Current | $V_{DS}$=0V, $V_{GS}$=±20V | - | - | ±100 | nA |
| **On Characteristics** | | | | | | |
| $V_{GS(th)}$ | Gate Threshold Voltage | $V_{DS}$=$V_{GS}$, $I_D$=250μA | 1.0 | 1.5 | 2.5 | V |
| $R_{DS(on)}$ | Static Drain-Source on-Resistance note3 | $V_{GS}$=10V, $I_D$=8A | - | 17 | 22 | mΩ |
| | | $V_{GS}$=4.5V, $I_D$=5A | - | 25 | 35 | mΩ |
| **Dynamic Characteristics** | | | | | | |
| $C_{iss}$ | Input Capacitance | $V_{DS}$=20V, $V_{GS}$=0V, f=1.0MHz | - | 633 | - | pF |
| $C_{oss}$ | Output Capacitance | | - | 67 | - | pF |
| $C_{rss}$ | Reverse Transfer Capacitance | | - | 58 | - | pF |
| $Q_g$ | Total Gate Charge | $V_{DS}$=20V, $I_D$=8A, $V_{GS}$=10V | - | 12 | - | nC |
| $Q_{gs}$ | Gate-Source Charge | | - | 3.2 | - | nC |
| $Q_{gd}$ | Gate-Drain(“Miller”) Charge | | - | 3.1 | - | nC |
| **Switching Characteristics** | | | | | | |
| $t_{d(on)}$ | Turn-on Delay Time | $V_{DD}$= 20V, $R_L$ =2.5Ω $V_{GS}$=10V,$R_{REN}$ =3Ω | - | 4 | - | ns |
| $t_r$ | Turn-on Rise Time | | - | 3 | - | ns |
| $t_{d(off)}$ | Turn-off Delay Time | | - | 15 | - | ns |
| $t_f$ | Turn-off Fall Time | | - | 2 | - | ns |
| **Drain-Source Diode Characteristics and Maximum Ratings** | | | | | | |
| $I_S$ | Maximum Continuous Drain to Source Diode Forward Current | | - | - | 20 | A |
| $I_{SM}$ | Maximum Pulsed Drain to Source Diode Forward Current | | - | - | 32 | A |
| $V_{SD}$ | Drain to Source Diode Forward Voltage | $V_{GS}$=0V, $I_S$= 8A | - | - | 1.2 | V |

Notes:1. Repetitive Rating: Pulse Width Limited by Maximum Junction Temperature

2. EAS condition : $T_J$=25℃,$V_{DD}$=20V,$V_G$=10V,L=0.5mH,Rg=25Ω,$I_{AS}$=7.2A

$T_J$=25℃,$V_{DD}$=-20V,$V_G$= -10V,L=0.5mH,Rg=25Ω,$I_{AS}$=-8.4A

3. Pulse Test: Pulse Width≤300μs, Duty Cycle≤2%

## P-Channel Electrical Characteristics ($T_J$=25 ℃, unless otherwise noted)

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $BV_{DSS}$ | Drain-Source Breakdown Voltage | $V_{GS}$=0V , $I_D$=-250uA | -40 | --- | --- | V |
| $\triangle BV_{DSS}/\triangle T_J$ | $BV_{DSS}$ Temperature Coefficient | Reference to 25℃ , $I_D$=-1mA | --- | -0.012 | --- | V/℃ |
| $R_{DS(ON)}$ | Static Drain-Source On-Resistance[2] | $V_{GS}$=-10V , $I_D$=-8A | --- | 32 | 45 | mΩ |
| | | $V_{GS}$=-4.5V , $I_D$=-4A | --- | 47 | 70 | |
| $V_{GS(th)}$ | Gate Threshold Voltage | $V_{GS}$=$V_{DS}$ , $I_D$ =-250uA | -1.0 | -1.6 | -2.5 | V |
| $\triangle V_{GS(th)}$ | $V_{GS(th)}$ Temperature Coefficient | | --- | 4.32 | --- | mV/℃ |
| $I_{DSS}$ | Drain-Source Leakage Current | $V_{DS}$=-32V , $V_{GS}$=0V , $T_J$=25℃ | --- | --- | 1 | uA |
| | | $V_{DS}$=-32V , $V_{GS}$=0V , $T_J$=55℃ | --- | --- | 5 | |
| $I_{GSS}$ | Gate-Source Leakage Current | $V_{GS}$=±20V , $V_{DS}$=0V | --- | --- | ±100 | nA |
| gfs | Forward Transconductance | $V_{DS}$=-5V , $I_D$=-8A | --- | 12.6 | --- | S |
| $R_g$ | Gate Resistance | $V_{DS}$=0V , $V_{GS}$=0V , f=1MHz | --- | 13 | 16 | Ω |
| $Q_g$ | Total Gate Charge (-4.5V) | $V_{DS}$=-20V , $V_{GS}$=-4.5V , $I_D$=-12A | --- | 9 | --- | 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=1MHz | --- | 1004 | --- | pF |
| $C_{oss}$ | Output Capacitance | | --- | 108 | --- | |
| $C_{rss}$ | Reverse Transfer Capacitance | | --- | 80 | --- | |

## Diode Characteristics

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $I_S$ | Continuous Source Current[1,5] | $V_G$=$V_D$=0V , Force Current | --- | --- | -20 | A |
| $I_{SM}$ | Pulsed Source Current[2,5] | | --- | --- | -40 | A |
| $V_{SD}$ | Diode Forward Voltage[2] | $V_{GS}$=0V , $I_S$=-1A , $T_J$=25℃ | --- | --- | -1 | 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 ≦ 300us , duty cycle ≦ 2%
3. The EAS data shows Max. rating . The test condition is $V_{DD}$=-25V,$V_{GS}$=-10V,L=0.1mH,$I_{AS}$=-27.2A
4. The power dissipation is limited by 150℃ 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 Performance Characteristics-N

**Figure1:** Output Characteristics

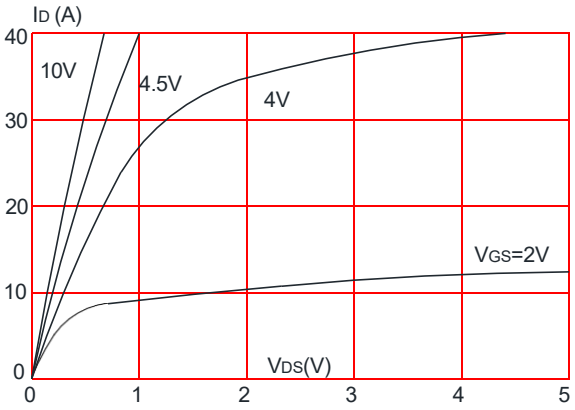



**Figure 2:** Typical Transfer Characteristics

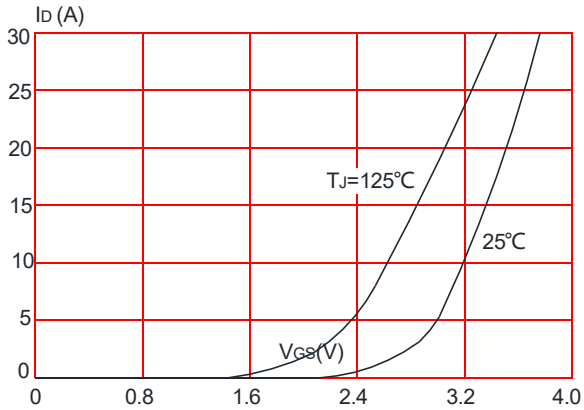



**Figure 3:**On-resistance vs. Drain Current

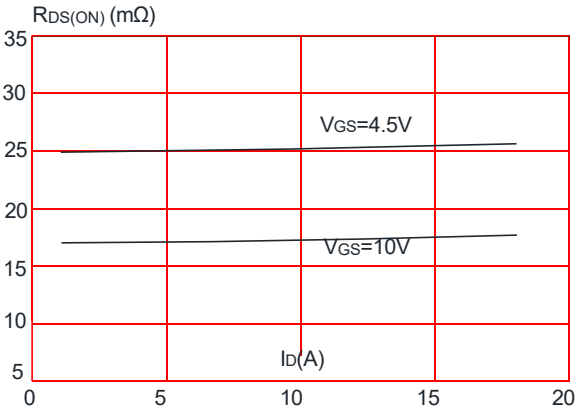



**Figure 4**: Body Diode Characteristics

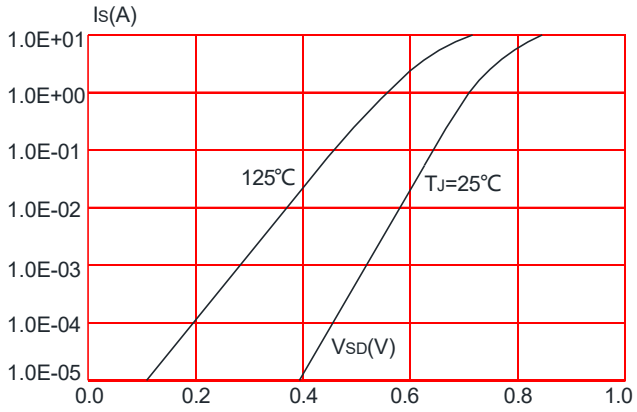



**Figure 5:** Gate Charge Characteristics

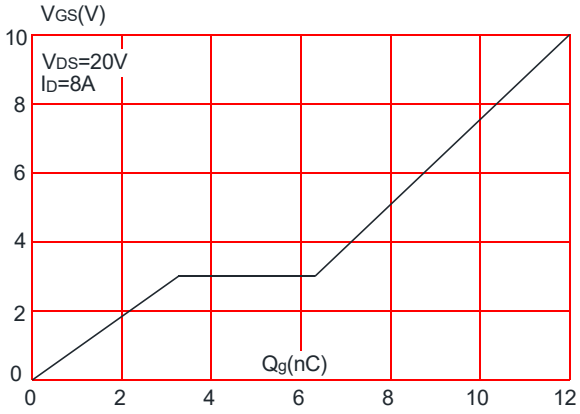



**Figure 6:** Capacitance Characteristics

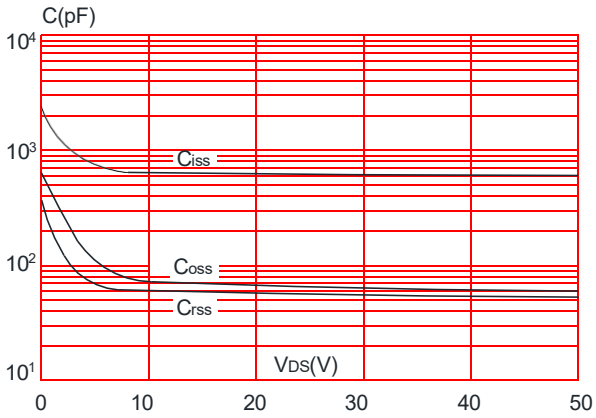


**Figure 7:** Normalized Breakdown Voltage vs. Junction Temperature

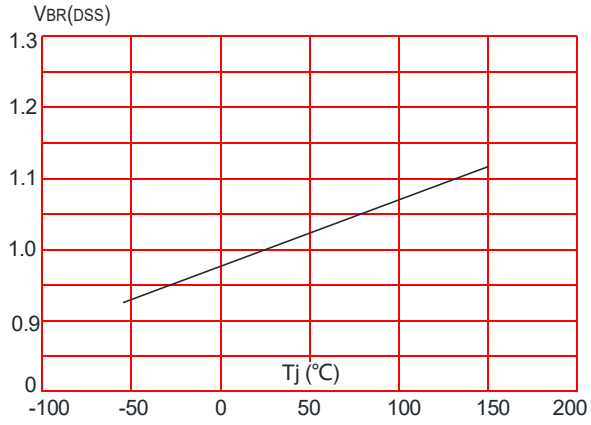



**Figure 8:** Normalized on Resistance vs. Junction Temperature

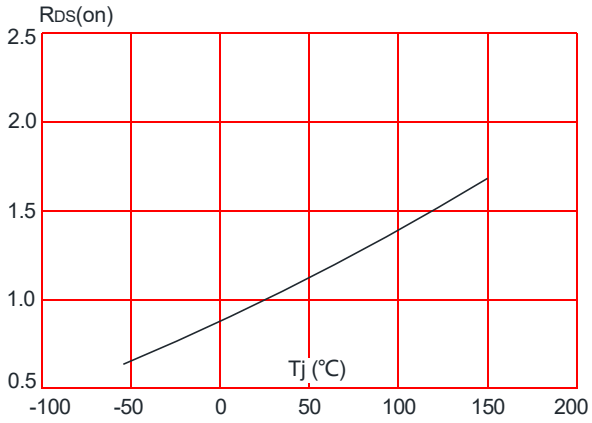



**Figure 9:** Maximum Safe Operating Area

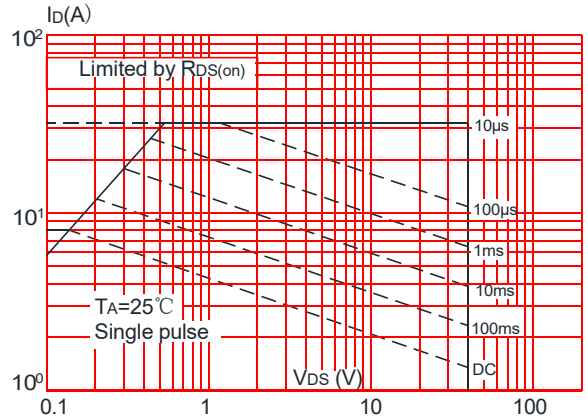



**Figure 10:** Maximum Continuous Drain Current vs. Ambient Temperature

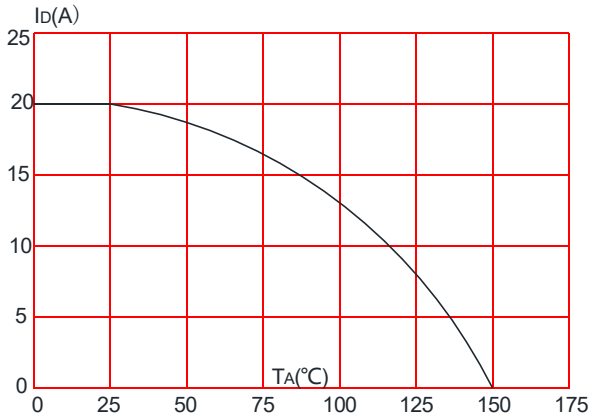
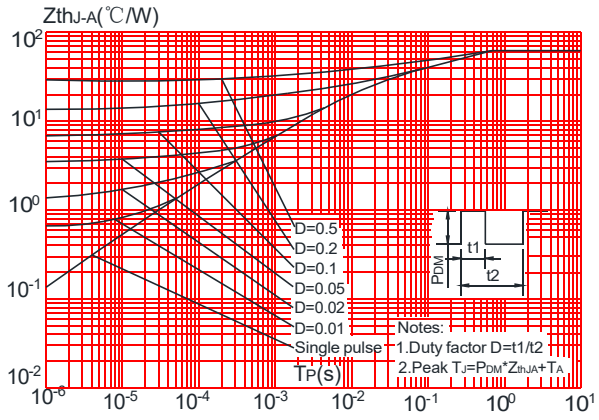



**Figure.11:** Maximum Effective Transient Thermal Impedance, Junction-to-Ambient



## P-Channel Typical Characteristics

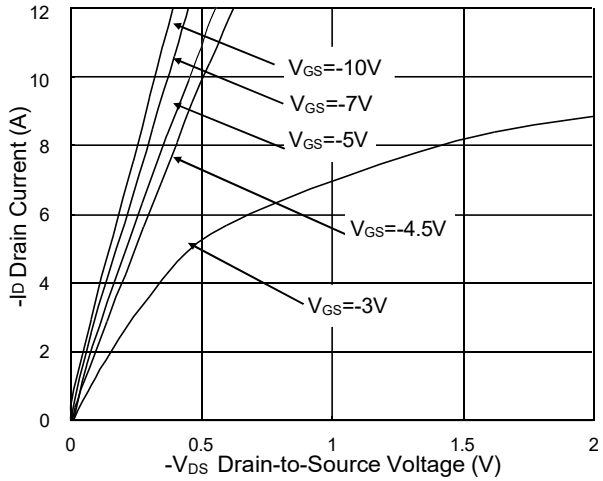



Fig.1 Typical Output Characteristics

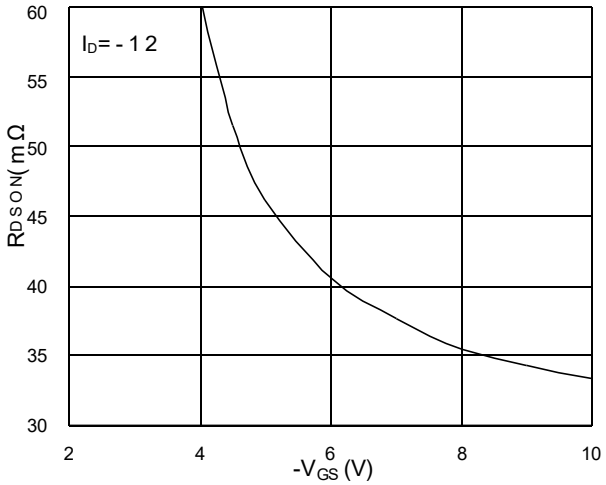



Fig.2 On-Resistance v.s Gate-Source

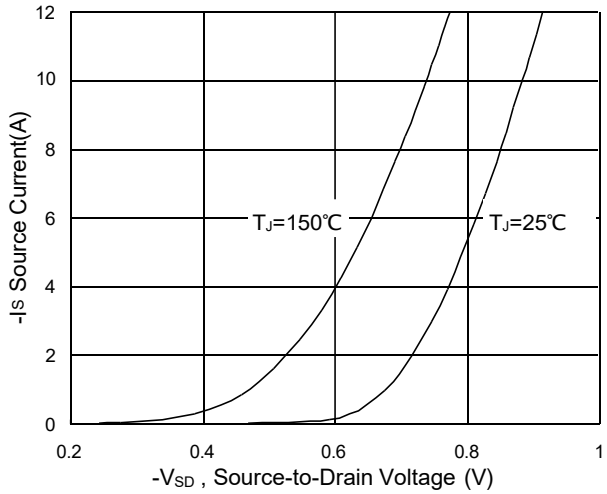



Fig.3 Forward Characteristics of Reverse

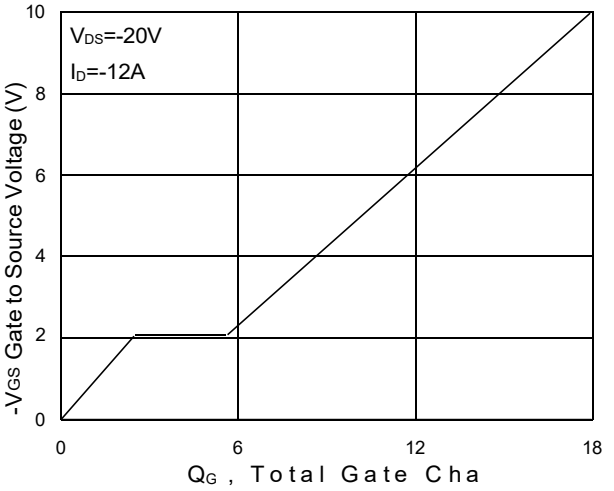



Fig.4 Gate-Charge Characteristics

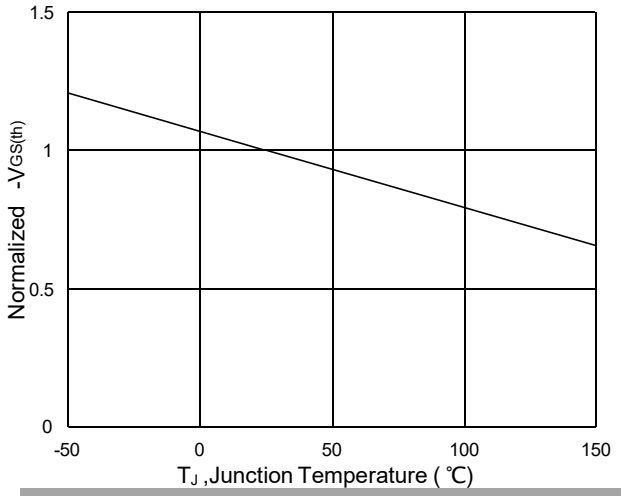



Fig.5 Normalized $V_{GS(th)}$ v.s $T_J$

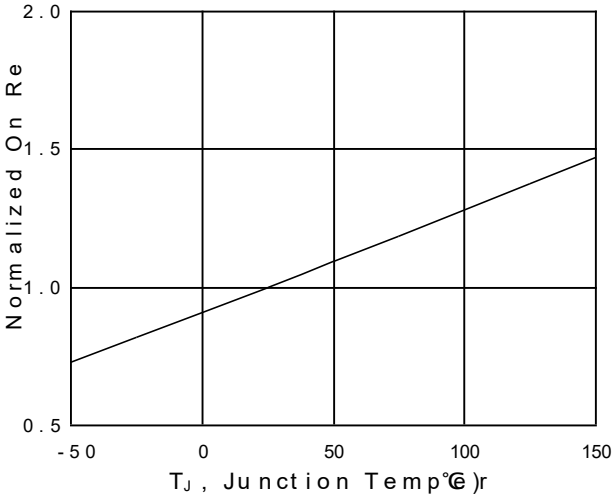



Fig.6 Normalized $R_{DSON}$ v.s $T_J$

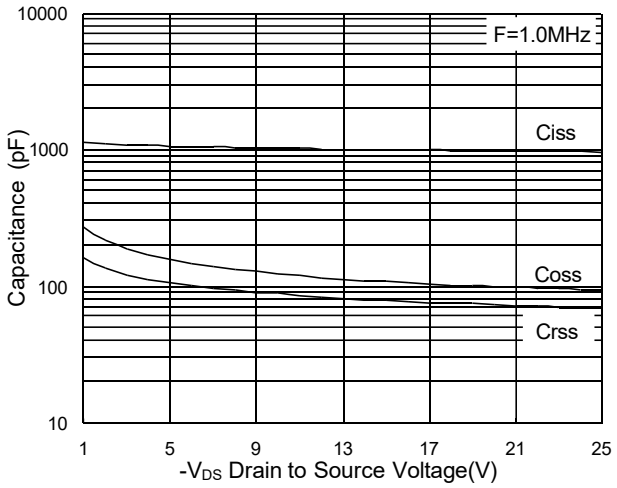



**Fig.7 Capacitance**

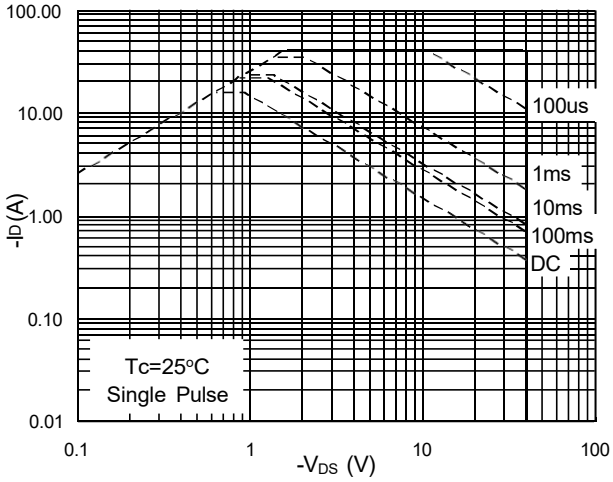



**Fig.8 Safe Operating Area**

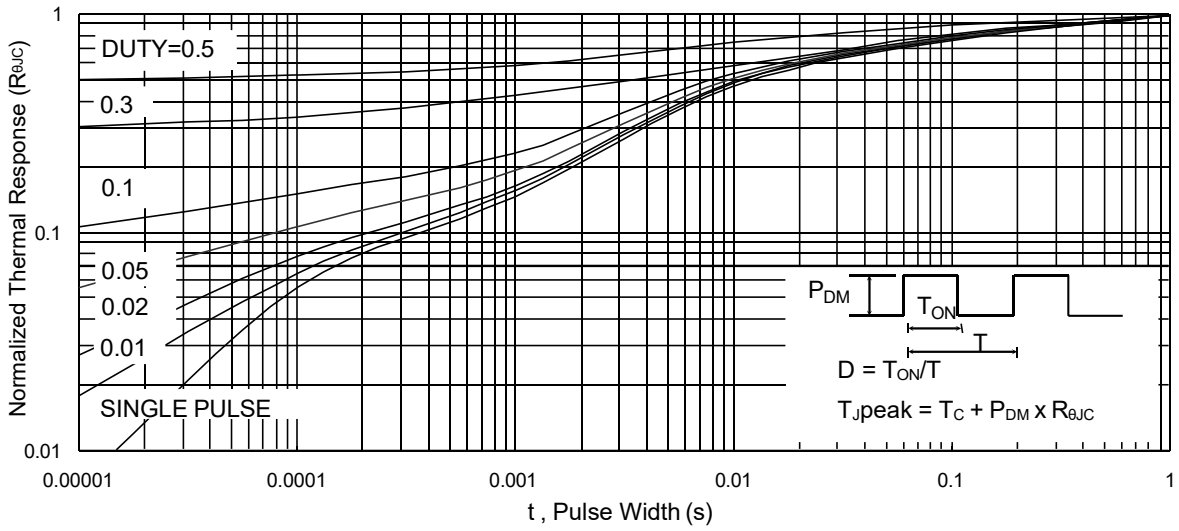



**Fig.9 Normalized Maximum Transient Thermal Impedance**

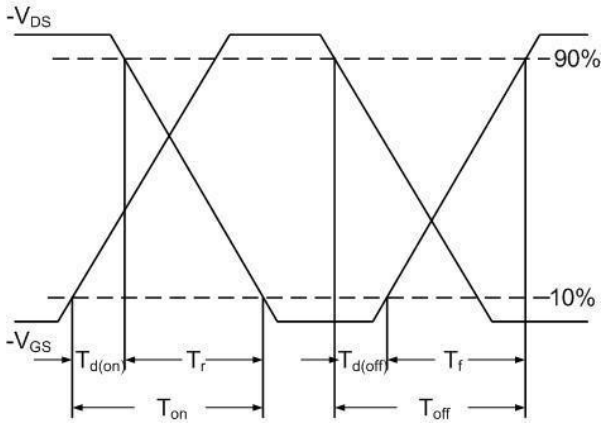



**Fig.10 Switching Time Waveform**

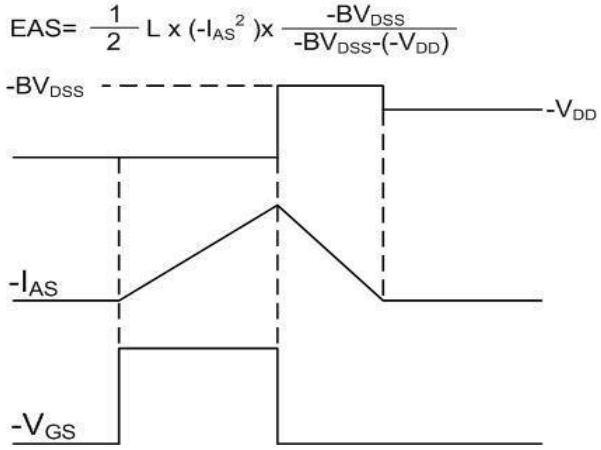
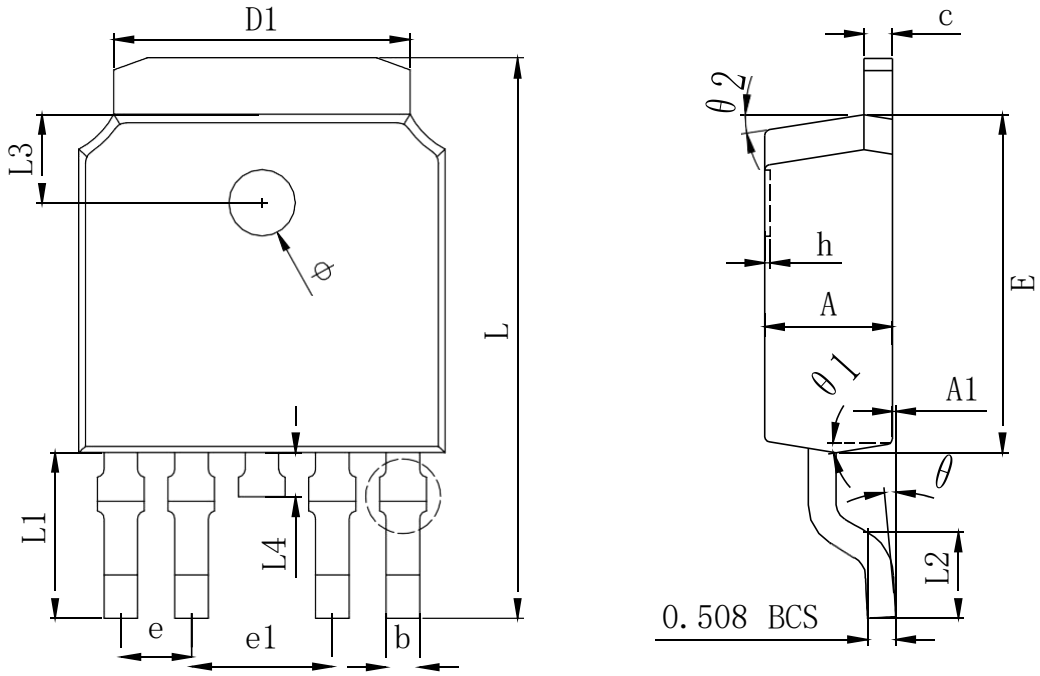
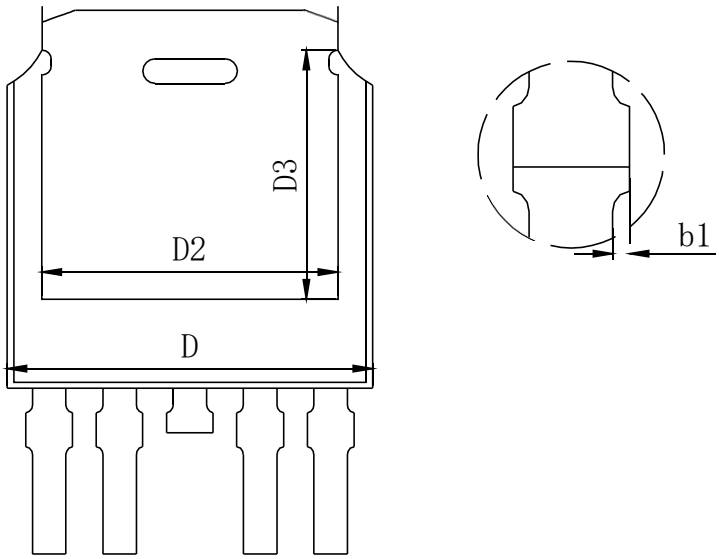



**Fig.11 Unclamped Inductive Waveform**

## Mechanical Dimensions for TO-252-4L




| SYMBOL | MILLIMETER | | |
|---|---|---|---|
| | MIN | Typ. | MAX |
| A | 2.200 | 2.300 | 2.400 |
| A1 | 0.000 | | 0.127 |
| b | 0.550 | 0.600 | 0.650 |
| b1 | 0.000 | | 0.120 |
| c(↕ 靡 ) | 0.460 | 0.520 | 0.580 |
| D | 6.500 | 6.600 | 6.700 |
| D1 | 5.334 REF | | |
| D2 | 5.346 REF | | |
| D3 | 4.490 REF | | |
| E | 6.000 | 6.100 | 6.200 |
| e | 1.270 TYP | | |
| e1 | 2.540 TYP | | |
| h | 0.000 | 0.100 | 0.200 |
| L | 9.900 | 10.100 | 10.300 |
| L1 | 2.988 REF | | |
| L2 | 1.400 | 1.550 | 1.700 |
| L3 | 1.600 REF | | |
| L4 | 0.700 | 0.800 | 0.900 |
| 8 | 1.100 | 1.200 | 1.300 |
| θ | 0° | | 8° |
| θ1 | 9°TYP | | |
| θ2 | 9°TYP | | |