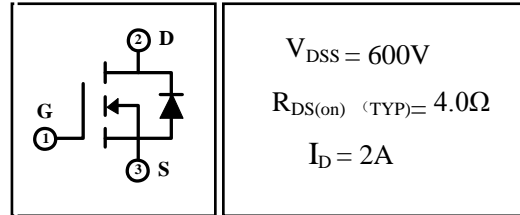


## 2A 600V N-channel Enhancement Mode Power MOSFET

### 1 Description

These N-channel Enhanced VDMOSFETs, is obtained by the self-aligned planar technology which reduce the conduction loss, improve switching performance and enhance the avalanche energy. Which accords with the RoHS standard.



### 2 Features

- Fast Switching
- Low ON Resistance( $R_{ds(on)} \leq 4.5\Omega$ )
- Low Gate Charge(Typical Data:8nC)
- Low Reverse Transfer Capacitances(Typical:3.8pF)
- 100% Single Pulse Avalanche Energy Test
- 100%  $\Delta V_{DS}$  Test

### 3 Applications

- Used in Various Power Switching Circuit for System Miniaturization and Higher Efficiency.
- Power Switch Circuit of Electron Ballast and Adaptor.



### 4 Electrical Characteristics

#### 4.1 Absolute Maximum Rating (Tc=25°C, unless otherwise noted)

| Parameter   | Symbol                                    | Value     | Units      |   |
|---|---|-----------|------------|---|
| Maximum Drain-Source DC Voltage                   | $V_{DS}$                                  | 600       | V          |   |
| Maximum Gate-Drain Voltage                        | $V_{GS}$                                  | $\pm 30$  | V          |   |
| Drain Current(continuous)                         | $I_D (T=25^\circ C)$<br>$(T=100^\circ C)$ | 2         | A          |   |
|   |   | 1.26      | A          |   |
| Drain Current(Pulsed) <sup>(Note 1)</sup>         | $I_{DM}$                                  | 8         | A          |   |
| Single Pulse Avalanche Energy <sup>(Note 5)</sup> | $E_{AS}$                                  | 64        | mJ         |   |
| Avalanche Energy Repetitive <sup>(Note 1)</sup>   | $E_{AR}$                                  | 6.4       | mJ         |   |
| Avalanche Current <sup>(Note 1)</sup>             | $I_{AR}$                                  | 3.6       | A          |   |
| Peak Diode Recovery $dv/dt$ <sup>(Note 6)</sup>   | $dv/dt$                                   | 5         | V/ns       |   |
| Total Dissipation                                 | $T_a=25^\circ C$                          | $P_{tot}$ | 2          | W |
|   | $T_C=25^\circ C$                          | $P_{tot}$ | 35         | W |
| Junction Temperature                              | $T_j$                                     | 150       | $^\circ C$ |   |
| Storage Temperature                               | $T_{stg}$                                 | -55~150   | $^\circ C$ |   |
| Maximum Temperature for soldering                 | $T_L$                                     | 300       | $^\circ C$ |   |

**4.2 Thermal Characteristics**

| Parameter                                | Symbol     | Value | Unit |
|--|------------|-------|------|
| Thermal Resistance Junction to Case-sink | $R_{thJC}$ | 3.57  | °C/W |
| Thermal Resistance Junction to Ambient   | $R_{thJA}$ | 62.5  | °C/W |

**4.3 Electrical Characteristics (T<sub>c</sub>=25°C, unless otherwise noted)**

| Parameter   | Symbol       | Test Condition                                  | Value |     |      | Units    |
|---|--------------|---|-------|-----|------|----------|
|   |              |   | Min   | Typ | Max  |          |
| <b>Off Characteristics</b>                          |              |   |       |     |      |          |
| Drain-source Breakdown Voltage                      | $BV_{DSS}$   | $I_D=250\mu A, V_{GS}=0V$                       | 600   | --  | --   | V        |
| Drain-to-Source Leakage Current                     | $I_{DSS}$    | $V_{DS}=600V, V_{GS}=0V, T_C=25^\circ C$        | --    | --  | 1    | $\mu A$  |
|   |              | $V_{DS}=480V, V_{GS}=0V, T_C=125^\circ C$       | --    | --  | 100  | $\mu A$  |
| Gate-to-Source Forward Leakage                      | $I_{GSSF}$   | $V_{GS}=+30V$                                   | --    | --  | 100  | nA       |
| Gate-to-Source Reverse Leakage                      | $I_{GSSR}$   | $V_{GS}=-30V$                                   | --    | --  | -100 | nA       |
| <b>On Characteristics</b> <sup>(Note 3)</sup>       |              |   |       |     |      |          |
| Gate Threshold Voltage                              | $V_{GS(th)}$ | $V_{DS}=V_{GS}, I_D=250\mu A$                   | 2     | --  | 4    | V        |
| Drain-source on Resistance                          | $R_{DS(on)}$ | $V_{GS}=10V, I_D=1A$                            | --    | 4   | 4.5  | $\Omega$ |
| <b>Dynamic Characteristics</b> <sup>(Note 4)</sup>  |              |   |       |     |      |          |
| Forward Transfer Conductance                        | $g_{fs}$     | $V_{DS}=15V, I_D=1A$                            | 2     | --  | --   | S        |
| Input Capacitance                                   | $C_{iss}$    | $V_{GS}=0V, V_{DS}=25V, f=1.0MHz$               | --    | 280 | --   | pF       |
| Output Capacitance                                  | $C_{oss}$    |   | --    | 30  | --   |          |
| Reverse Transfer Capacitance                        | $C_{rss}$    |   | --    | 3.8 | --   |          |
| <b>Switching Characteristics</b> <sup>(note4)</sup> |              |   |       |     |      |          |
| Turn-on Delay Time                                  | $t_{d(on)}$  | $I_D=2A, V_{DD}=300V, V_{GS}=10V, R_G=18\Omega$ | --    | 7.8 | --   | nS       |
| Turn-on Rise Time                                   | $t_r$        |   | --    | 5.5 | --   | nS       |
| Turn-off Delay Time                                 | $t_{d(off)}$ |   | --    | 33  | --   | nS       |
| Turn-off Fall Time                                  | $t_f$        |   | --    | 16  | --   | nS       |
| Total Gate Charge                                   | $Q_g$        | $I_D=2A, V_{DD}=480V, V_{GS}=10V$               | --    | 8.5 | --   | nC       |
| Gate-to-Source Charge                               | $Q_{gs}$     |   | --    | 1.5 | --   |          |
| Gate-to-Drain("Miller") Charge                      | $Q_{gd}$     |   | --    | 4   | --   |          |
| <b>Drain-Source Diode Characteristics</b>           |              |   |       |     |      |          |
| Diode Forward Voltage <sup>(N<br/>ote 3)</sup>      | $V_{FSD}$    | $V_{GS}=0V, I_S=2A$                             | --    | --  | 1.5  | V        |

|   |           |   |    |     |    |    |
|---|-----------|---|----|-----|----|----|
| Diode Forward Current <sup>(Note 2)</sup> | $I_S$     |   | -- | --  | 2  | A  |
| Reverse Recovery Time                     | $t_{rr}$  | $T_J=25^\circ\text{C}, I_F=2\text{A},$<br>$dI_F/dt=100\text{A}/\mu\text{S}, V_{GS}=0\text{V}$ | -- | 80  | -- | nS |
| Reverse Recovery Charge                   | $Q_{rr}$  |   | -- | 180 | -- | nC |
| Reverse Recovery Current                  | $I_{RRM}$ |   | -- | 4.5 | -- | A  |

**Notes:**

- 1: Repetitive rating, pulse width limited by maximum junction temperature.
- 2: Surface mounted on FR4 Board,  $t \leq 10\text{sec}$ .
- 3: Pulse width  $\leq 300\mu\text{s}$ , duty cycle  $\leq 2\%$ .
- 4: Guaranteed by design, not subject to production.
5.  $L=10\text{mH}, I_D=3.58\text{A}, V_{DD}=50\text{V}, V_{GATE}=600\text{V}, \text{Start } T_J=25^\circ\text{C}$ .
6.  $I_{SD}=2\text{A}, di/dt \leq 100\text{A}/\mu\text{s}, V_{DD} \leq BV_{DSS}, \text{Start } T_J=25^\circ\text{C}$ .

**5 Typical characteristics diagrams**

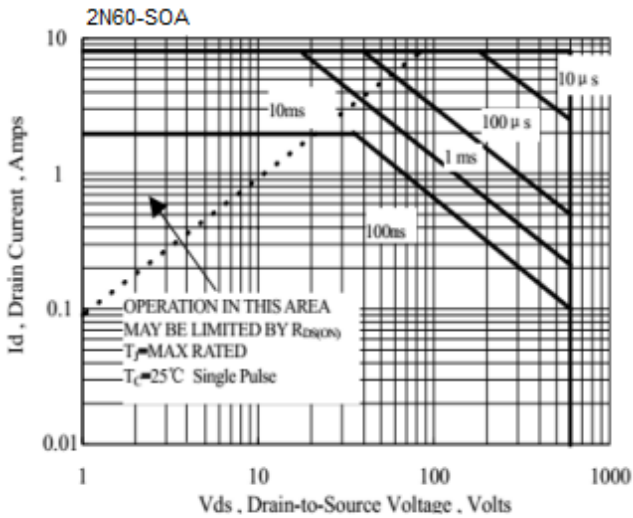


Figure 1 Maximum Forward Bias Safe Operating Area

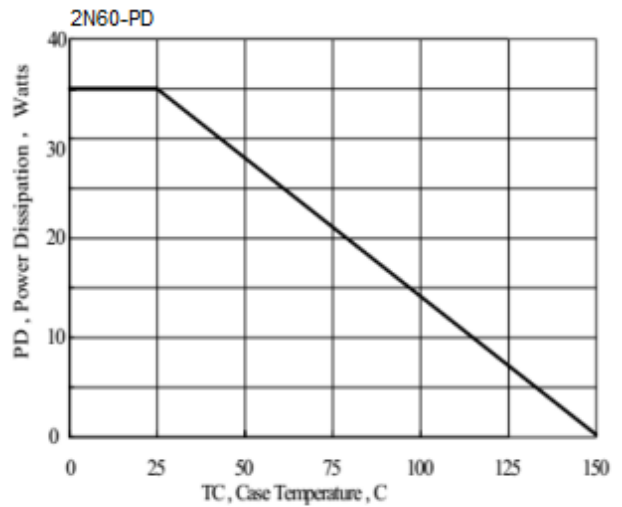


Figure 2 Maximum Power Dissipation vs Case Temperature

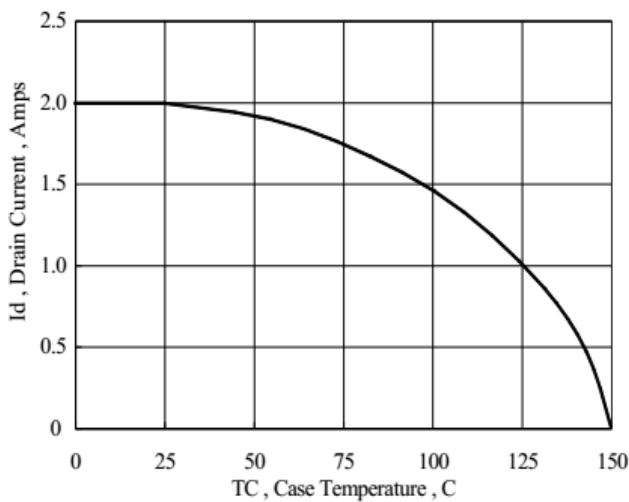


Figure 3 Maximum Continuous Drain Current vs Case Temperature

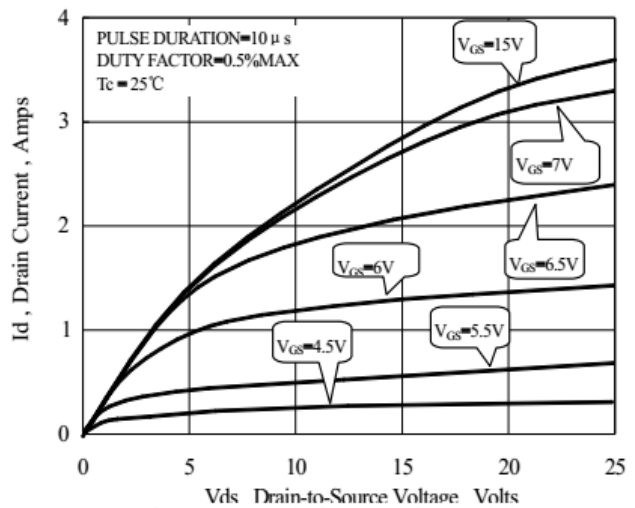


Figure 4 Typical Output Characteristics

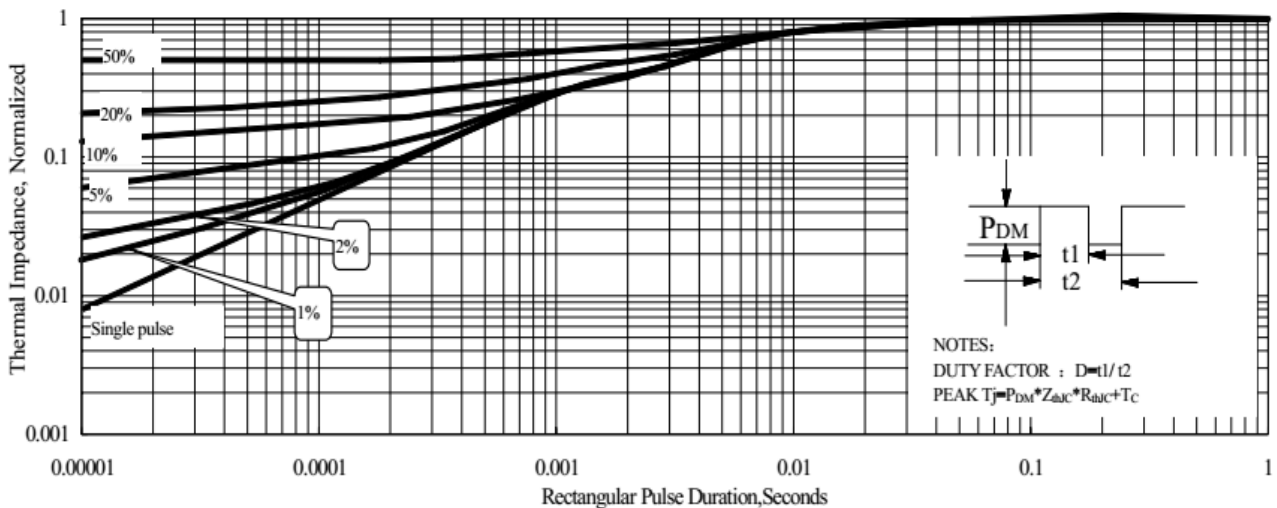


Figure 5 Maximum Effective Thermal Impedance, Junction to Case

**5 Typical characteristics diagrams(continues)**

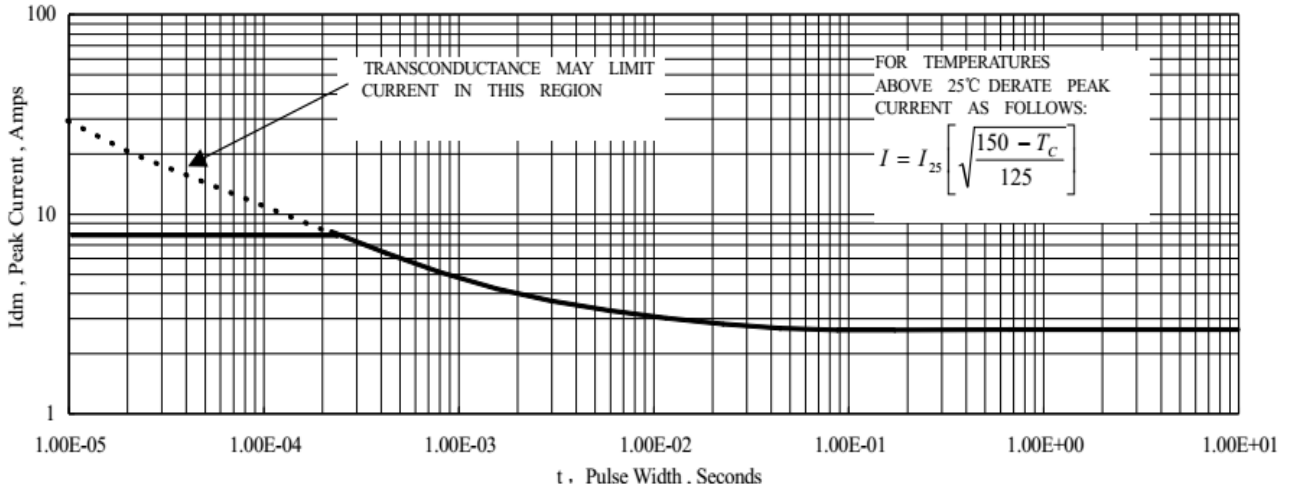


Figure 6 Maximum Peak Current Capability

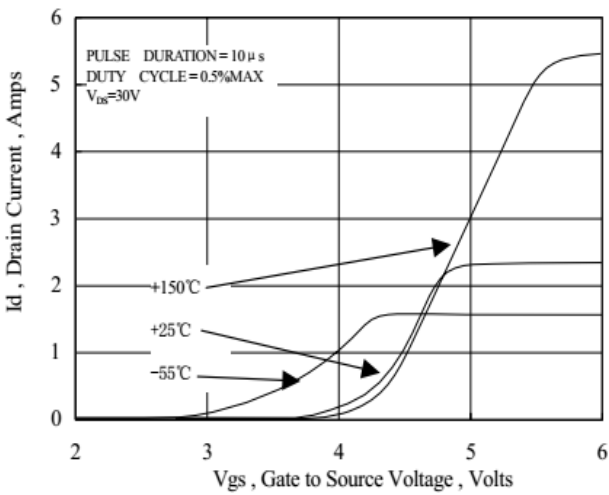


Figure 7 Typical Transfer Characteristics

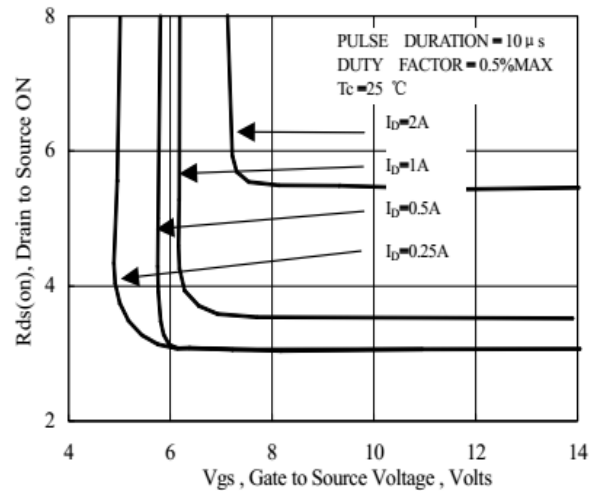


Figure 8 Typical Drain to Source ON Resistance vs Gate Voltage and Drain Current

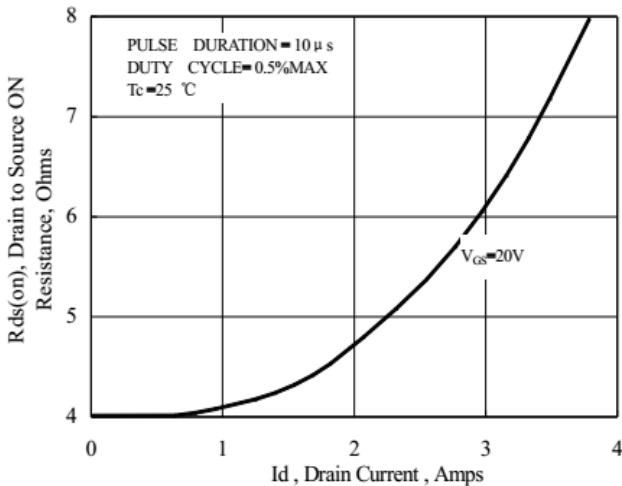


Figure 9 Typical Drain to Source ON Resistance vs Drain Current

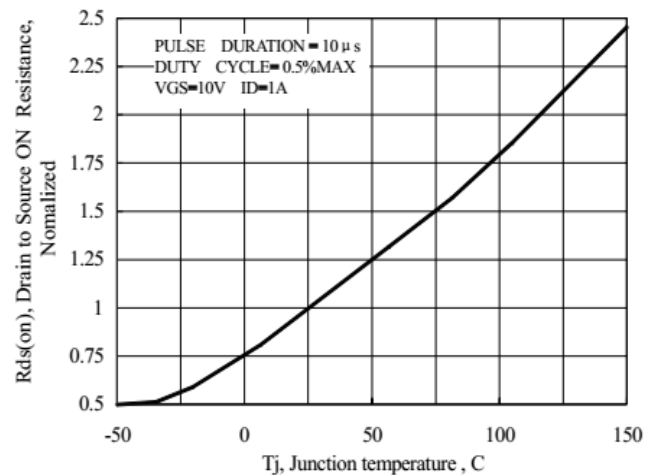


Figure 10 Typical Drain to Source on Resistance vs Junction Temperature

**5 Typical characteristics diagrams(continues)**

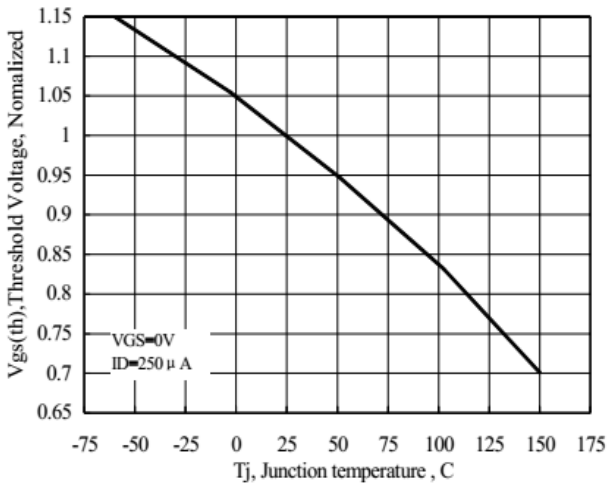


Figure 11 Typical Theshold Voltage vs Junction Temperature

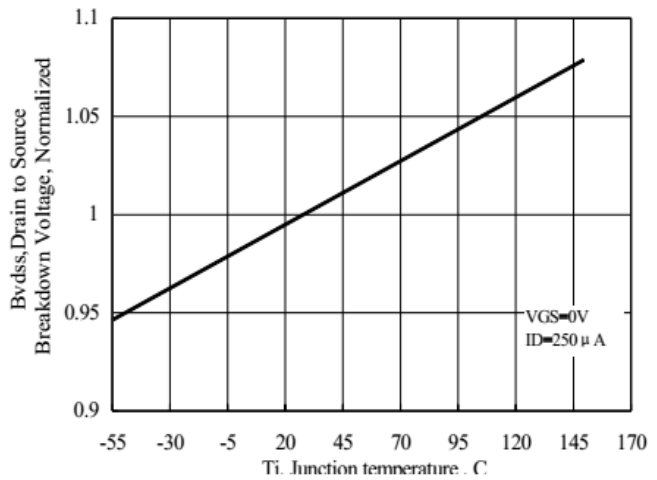


Figure 12 Typical Breakdown Voltage vs Junction Temperature

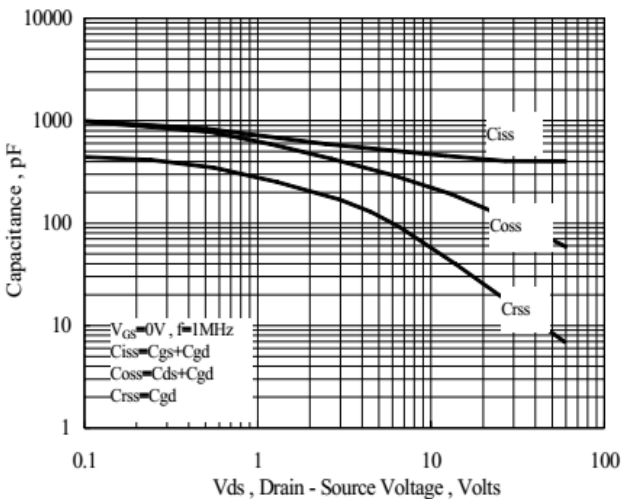


Figure 13 Typical Capacitance vs Drain to Source Voltage

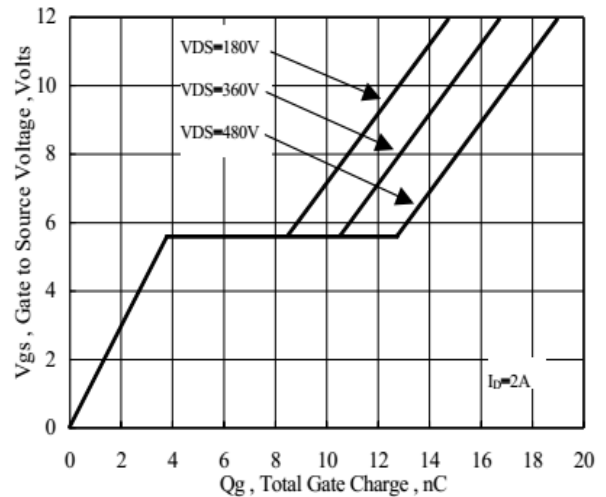


Figure 14 Typical Gate Charge vs Gate to Source Voltage

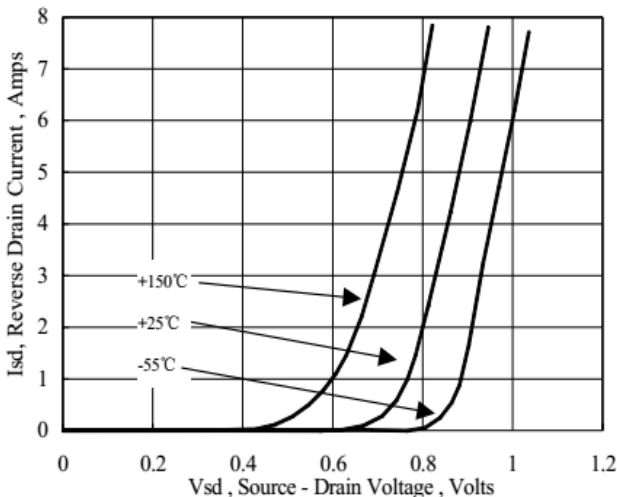


Figure 15 Typical Body Diode Transfer Characteristics

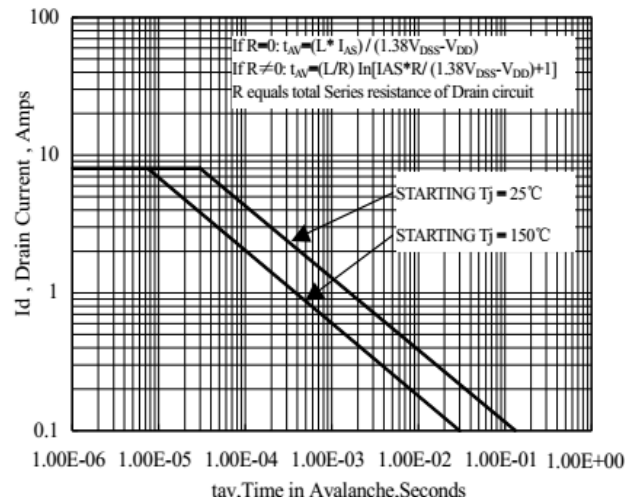


Figure 16 Unclamped Inductive Switching Capability

5 Typical characteristics diagrams(continues)

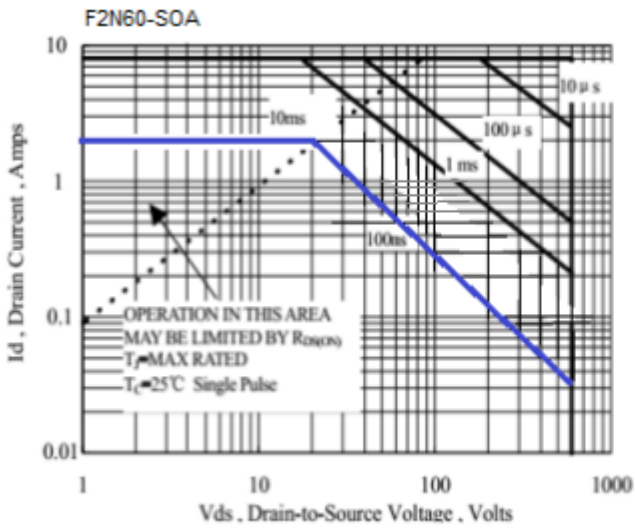


Figure 17 Maximum Forward Bias Safe Operating Area

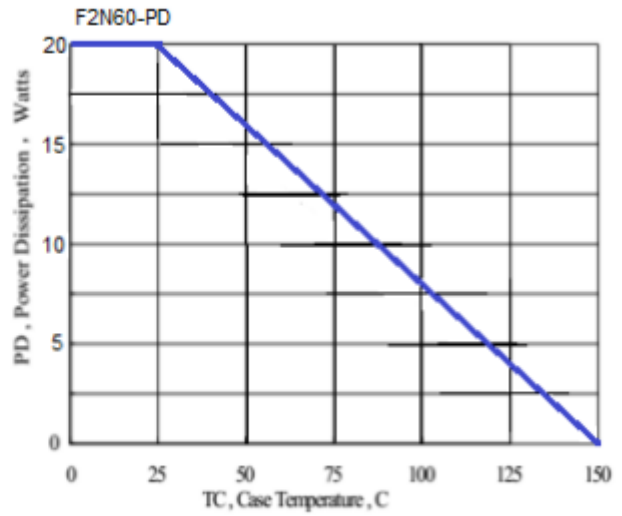
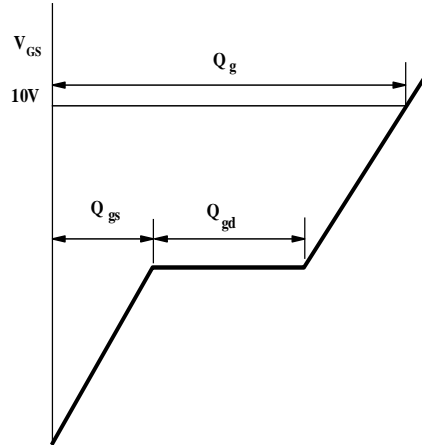
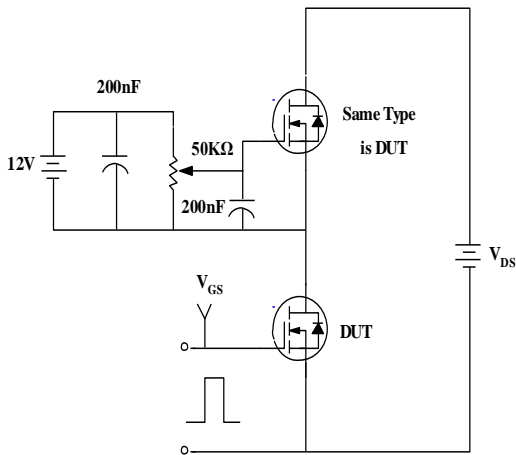
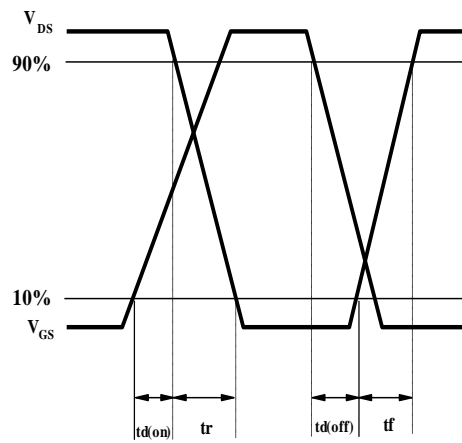
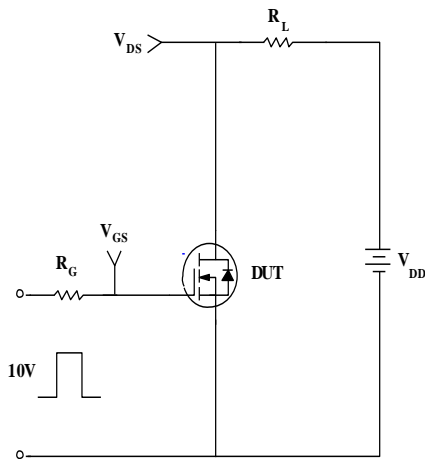


Figure 18 Maximum Power Dissipation vs Case Temperature

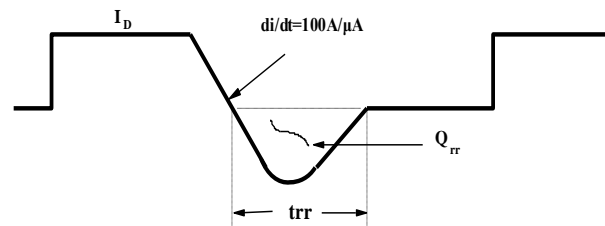
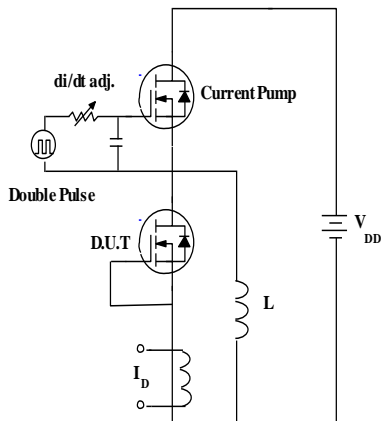
**6 Typical Test Circuit and Waveform**



**1) Gate Charge Test Circuit & Waveform**



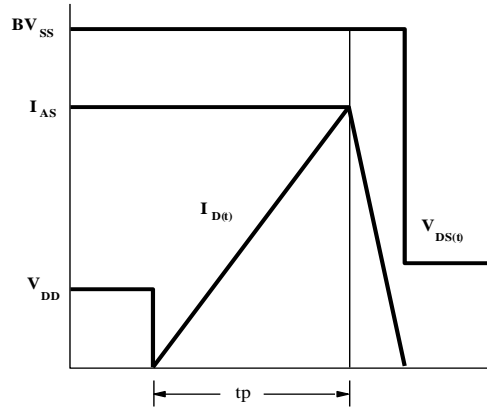
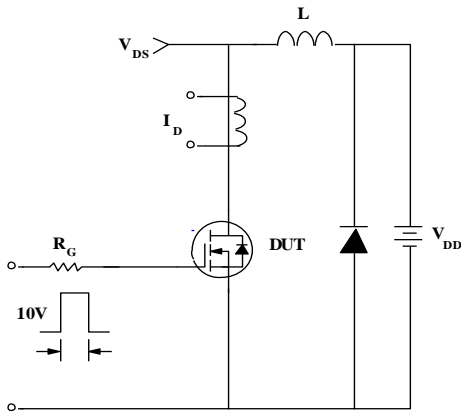
**2) Resistive Switching Test Circuit & Waveforms**



**3) Diode Reverse Recovery Test Circuit & Waveform**



**6 Typical Test Circuit and Waveform(continues)**



**4) Unclamped Inductive Switching Test Circuit & Waveforms**

**7 Product Names Rules**

**F X X N E X X**

**Packaging Code**  
 220F: F    220: Nothing  
 251: B    252: D  
 262: I    263: E  
 3PN: P    247: W

**Rated Voltage Code**  
 With 2 Digital, For Example:  
 60 on behalf of 600V,  
 06 on behalf of 60v

**Rated Current Code**  
 With 1-2 Digital,  
 For Example:  
 4 on behalf of 4A,  
 10 on behalf of 10A,  
 08 on behalf of 0.8A

**Special Function Code**  
 E on behalf of build-in ESD  
 Nothing on behalf of not ESD

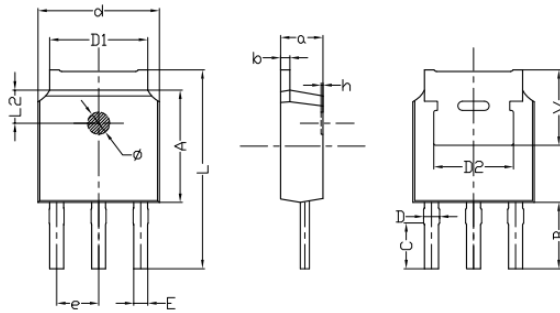
**Channel Polarity Code**  
 N on behalf of N channel  
 P on behalf of P channel

**8 Product Specifications and Packaging Models**

| Product Model | Package Type | Mark Name | RoHS    | Package     | Quantity |
|---------------|--------------|-----------|---------|-------------|----------|
| 2N60          | TO-220C      | 2N60      | Pb-free | Tube        | 1000/box |
| F2N60         | TO-220F      | F2N60     | Pb-free | Tube        | 1000/box |
| B2N60         | TO-251       | B2N60     | Pb-free | Tube        | 1000/box |
| D2N60         | TO-252       | D2N60     | Pb-free | Tape & Reel | 3000/box |
| I2N60         | TO-262       | I2N60     | Pb-free | Tube        | 1000/box |
| E2N60         | TO-263       | E2N60     | Pb-free | Tape & Reel | 800/box  |

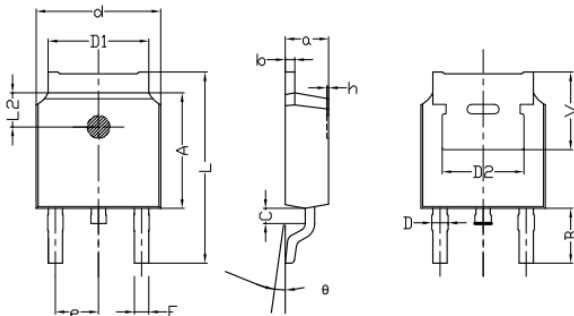
**9 Dimensions**

TO-251B PACKAGE OUTLINE DIMENSIONS



| Symbol | Dimensions In Millimeters |       | Dimensions In Inches |        |
|--------|---------------------------|-------|----------------------|--------|
|        | min.                      | max.  | min.                 | max.   |
| a      | 2.20                      | 2.40  | 0.087                | 0.0946 |
| b      | 0.46                      | 0.58  | 0.018                | 0.023  |
| c      | 2.45                      | 2.65  | 0.097                | 0.104  |
| D      | 0.80                      | 0.90  | 0.032                | 0.035  |
| d      | 6.30                      | 6.70  | 0.248                | 0.264  |
| D1     | 5.00                      | 5.50  | 0.197                | 0.217  |
| D2     | TYP 4.83                  |       | TYP 0.190            |        |
| A      | 5.80                      | 6.20  | 0.228                | 0.244  |
| e      | 2.19                      | 2.39  | 0.086                | 0.094  |
| L      | 10.40                     | 11.00 | 0.4098               | 0.4334 |
| B      | 3.50                      | 3.70  | 0.1379               | 0.1458 |
| L2     | 1.5                       | 1.8   | 0.059                | 0.071  |
| φ      | 1.10                      | 1.30  | 0.0433               | 0.0512 |
| h      | 0.00                      | 0.30  | 0.000                | 0.012  |
| V      | 5.25                      | 5.85  | 0.207                | 0.230  |
| E      | 0.60                      | 0.80  | 0.0236               | 0.0315 |

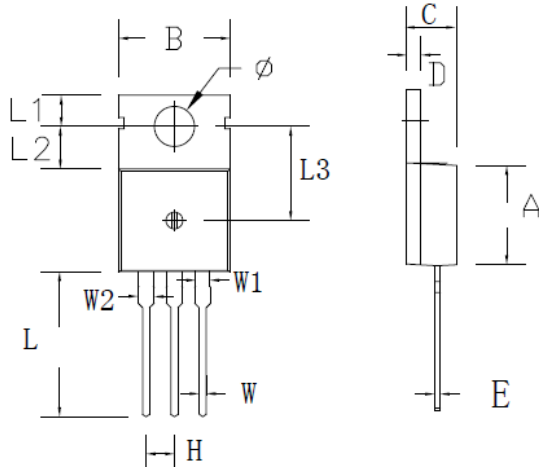
TO-252B PACKAGE OUTLINE DIMENSIONS



| Symbol | Dimensions In Millimeters |       | Dimensions In Inches |       |
|--------|---------------------------|-------|----------------------|-------|
|        | min.                      | max.  | min.                 | max.  |
| a      | 2.20                      | 2.40  | 0.087                | 0.095 |
| b      | 0.46                      | 0.58  | 0.018                | 0.023 |
| c      | 0.70                      | 0.90  | 0.028                | 0.035 |
| D      | 0.80                      | 1.00  | 0.032                | 0.039 |
| d      | 6.30                      | 6.70  | 0.248                | 0.264 |
| D1     | 5.00                      | 5.50  | 0.197                | 0.217 |
| D2     | TYP 4.83                  |       | TYP 0.190            |       |
| A      | 5.80                      | 6.20  | 0.228                | 0.244 |
| e      | 2.19                      | 2.39  | 0.086                | 0.094 |
| L      | 9.40                      | 10.40 | 0.370                | 0.409 |
| B      | 2.6                       | 3.2   | 0.102                | 0.126 |
| L2     | 1.5                       | 1.8   | 0.059                | 0.071 |
| θ      | 0                         | 8     | 0                    | 8     |
| h      | 0                         | 0.3   | 0                    | 0.012 |
| V      | 5.25                      | 5.85  | 0.207                | 0.230 |

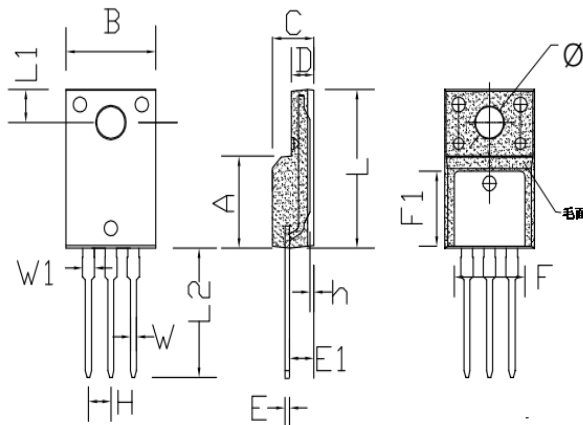
**9 Dimensions(continues)**

TO-220C PACKAGE OUTLINE DIMENSIONS



| Symbol | Dimensions In Millimeters |       | Dimensions In Inches |       |
|--------|---------------------------|-------|----------------------|-------|
|        | min.                      | max.  | min.                 | max.  |
| A      | 8.80                      | 9.30  | 0.346                | 0.366 |
| B      | 9.70                      | 10.30 | 0.382                | 0.406 |
| C      | 4.25                      | 4.75  | 0.167                | 0.187 |
| D      | 1.20                      | 1.45  | 0.047                | 0.057 |
| E      | 0.40                      | 0.60  | 0.016                | 0.024 |
| H      | 2.54 TYP                  |       | 0.100 TYP            |       |
| W      | 0.60                      | 0.95  | 0.024                | 0.037 |
| W1     | 1.05                      | 1.45  | 0.041                | 0.057 |
| W2     | 1.20                      | 1.60  | 0.047                | 0.063 |
| L      | 12.60                     | 13.40 | 0.496                | 0.528 |
| L1     | 2.45                      | 2.95  | 0.096                | 0.116 |
| L2     | 3.45                      | 3.95  | 0.136                | 0.156 |
| L3     | 8.15                      | 8.65  | 0.321                | 0.341 |
| φ      | 3.50                      | 3.90  | 0.138                | 0.154 |

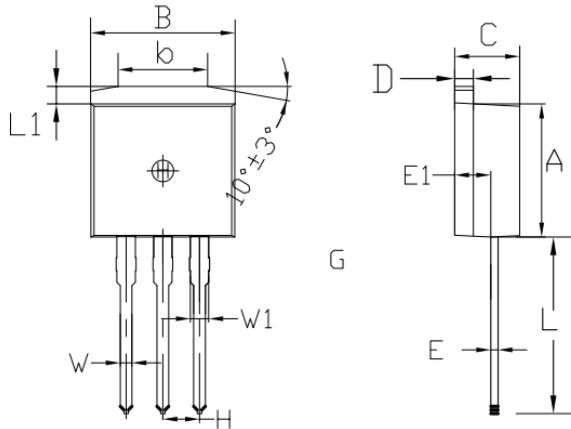
TO-220F PACKAGE OUTLINE DIMENSIONS



| Symbol | Dimensions In Millimeters |       | Dimensions In Inches |       |
|--------|---------------------------|-------|----------------------|-------|
|        | min.                      | max.  | min.                 | max.  |
| A      | 8.80                      | 9.30  | 0.346                | 0.366 |
| B      | 10.00                     | 10.50 | 0.394                | 0.413 |
| C      | 4.30                      | 4.90  | 0.169                | 0.193 |
| D      | 2.30                      | 2.70  | 0.091                | 0.106 |
| L      | 15.55                     | 16.15 | 0.612                | 0.636 |
| h      | 0.40                      | 0.60  | 0.016                | 0.024 |
| L1     | 3.15                      | 3.55  | 0.124                | 0.140 |
| L2     | 12.65                     | 13.35 | 0.498                | 0.526 |
| W      | 0.70                      | 0.90  | 0.028                | 0.035 |
| W1     | 1.15                      | 1.55  | 0.045                | 0.061 |
| H      | 2.54 TYP                  |       | 0.100 TYP            |       |
| E      | 0.48                      | 0.53  | 0.019                | 0.021 |
| φ      | 2.90                      | 3.40  | 0.114                | 0.134 |
| E1     | 2.40                      | 2.90  | 0.094                | 0.114 |
| F      | 7.75                      | 8.25  | 0.305                | 0.325 |
| F1     | 7.35                      | 7.85  | 0.289                | 0.309 |

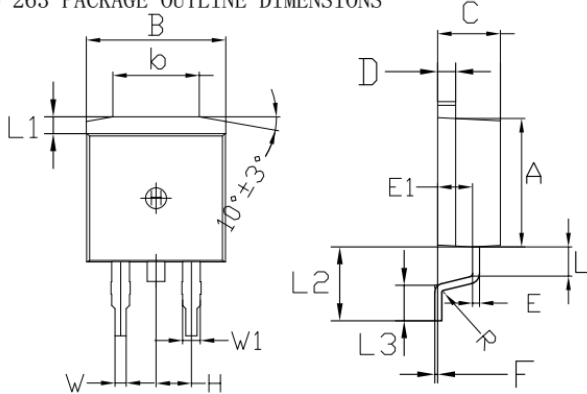
**9 Dimensions(continues)**

TO-262 PACKAGE OUTLINE DIMENSIONS



| Symbol | Dimensions In Millimeters |       | Dimensions In Inches |        |
|--------|---------------------------|-------|----------------------|--------|
|        | min.                      | max.  | min.                 | max.   |
| A      | 8.80                      | 9.30  | 0.346                | 0.366  |
| B      | 9.70                      | 10.30 | 0.382                | 0.406  |
| C      | 4.25                      | 4.75  | 0.167                | 0.187  |
| D      | 1.20                      | 1.45  | 0.047                | 0.057  |
| E      | 0.40                      | 0.60  | 0.016                | 0.024  |
| L      | 12.25                     | 13.75 | 0.482                | 0.541  |
| L1     | 1.15                      | 1.45  | 0.045                | 0.057  |
| E1     | 2.4                       | 2.6   | 0.0945               | 0.1024 |
| W      | 0.80                      | 0.82  | 0.0315               | 0.034  |
| W1     | 1.20                      | 1.30  | 0.047                | 0.051  |
| H      | 2.54 TYP                  |       | 0.200 TYP            |        |
| b      | 5.50                      | 6.50  | 0.216                | 0.256  |

TO-263 PACKAGE OUTLINE DIMENSIONS



| Symbol | Dimensions In Millimeters |       | Dimensions In Inches |        |
|--------|---------------------------|-------|----------------------|--------|
|        | min.                      | max.  | min.                 | max.   |
| A      | 8.80                      | 9.30  | 0.346                | 0.366  |
| B      | 9.70                      | 10.30 | 0.382                | 0.406  |
| C      | 4.25                      | 4.75  | 0.167                | 0.187  |
| D      | 1.20                      | 1.45  | 0.047                | 0.057  |
| E      | 0.40                      | 0.60  | 0.016                | 0.024  |
| L      | 1.90                      | 2.30  | 0.075                | 0.091  |
| L1     | 1.15                      | 1.45  | 0.045                | 0.057  |
| R      | 0.24                      | 0.26  | 0.0095               | 0.0102 |
| W      | 0.80                      | 0.82  | 0.0315               | 0.0323 |
| W1     | 1.20                      | 1.30  | 0.047                | 0.051  |
| H      | 2.54 TYP                  |       | 0.200 TYP            |        |
| b      | 5.50                      | 6.50  | 0.216                | 0.256  |
| E1     | 2.4                       | 2.6   | 0.0946               | 0.1024 |
| L2     | 5.20                      | 5.80  | 0.205                | 0.228  |
| L3     | 2.20                      | 3.20  | 0.087                | 0.126  |
| F      | 0.03                      | 0.23  | 0.0012               | 0.0091 |

## 10 Attentions

- ROUM Semiconductor Technology CO.,LTD. reserves the right to change the specification without prior notice! The customer should obtain the latest version of the information before making the order and verify that the information is complete and up to date.
- It is the responsibility of the purchaser for any failure or failure of any semiconductor product under certain conditions. It is the responsibility of the purchaser to comply with safety standards and to take safety measures in the system design and machine manufacturing of Roma products in order to avoid potential risk of failure. Injury or property damage.
- Product promotion is endless, our company will be dedicated to provide customers with better products.

## 11 Appendix

Revision history:

| Date       | REV. | Description | Page |
|------------|------|-------------|------|
| 2017.04.10 | 1.0  | Original    |      |