

**2N7002K**



**N-Channel Enhancement Mode Trench Power MOSFET**

**Voltage:** 60 Volts

**Current:** 0.34 Amperes

**Package:** SOT-23

**Features**

- NH'S Advanced Trench Technology
- Low Rds(on) For Low On-State Loss
- High EAS For High Reliability
- Excellent Qg\*Rds(on) Product(FOM)

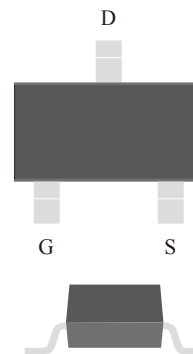
**Typical Applications**

- DC-DC Converter
- Battery Management System(BMS)
- Printed Circuit Board For Control Circuit
- Uninterruptible Power Supplies(UPS)

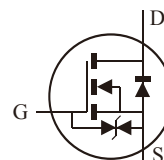
**Product Summary**

|                  |      |   |
|------------------|------|---|
| VDS Min.@Tj      | 60   | V |
| ID Min.@Ta       | 0.34 | A |
| RDS(ON)(TYP)@10V | 2.20 | Ω |

**Diagram:**



**Polarity:**



**\*100% UIS TESTED**

**\*100% ΔVDS TESTED**

**Absolute Maximum Ratings (Ta=25℃ Unless Otherwise Specified)**

| Parameter                             | Test Conditions | Symbol          | Ratings | Unit |
|---------------------------------------|-----------------|-----------------|---------|------|
| Drain-Source Voltage                  |                 | V <sub>DS</sub> | 60      | V    |
| Gate-Source Voltage                   |                 | V <sub>GS</sub> | ±20     | V    |
| Continuous Drain Current (Note 1)     | Ta= 25 ℃        | I <sub>D</sub>  | 0.34    | A    |
|                                       | Ta= 100 ℃       |                 | 0.22    |      |
| Drain Current-Pulse (Note 1)          | Tj< 150 ℃       | I <sub>DM</sub> | 1.35    | A    |
| Maximum Power Dissipation Power       | Ta= 25 ℃        | P <sub>D</sub>  | 300     | mW   |
| Dissipation Derating Factor Above 25℃ | Ta= 100 ℃       |                 | 120     |      |
| Derating Factor                       |                 | D <sub>F</sub>  | 2.40    | mW/℃ |

**Thermal Characteristics (Ta=25℃ Unless Otherwise Specified)**

| Parameter                                                   | Test Conditions                      | Symbol           | Typ.       | Unit |
|-------------------------------------------------------------|--------------------------------------|------------------|------------|------|
| Junction Temperature                                        |                                      | T <sub>J</sub>   | -55 to 150 | ℃    |
| Storage Temperature Range                                   |                                      | T <sub>STD</sub> | -55 to 150 | ℃    |
| Thermal Resistance Junction To Ambient<br>With Steady-State | Still Air Environment<br>With Ta=25℃ | R <sub>θJA</sub> | 357.0      | ℃/W  |

Notes: 1.Pulse Width Limited By Max. Junction Temperature. (See Fig. 13).

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**Electrical Characteristics (Ta=25°C Unless Otherwise Specified )**

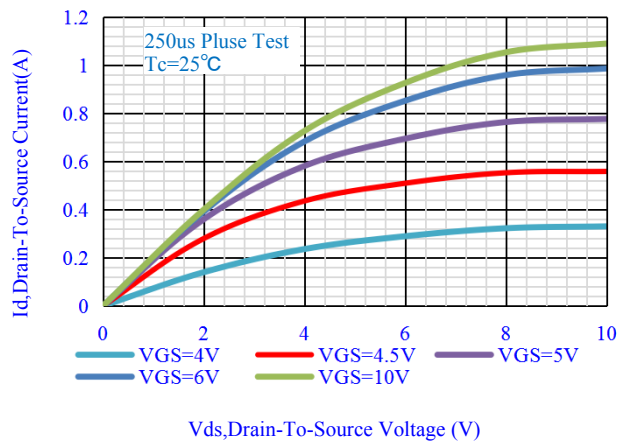
| Parameter                                                                                   | Test Conditions       | Symbol                              | Min. | Typ. | Max. | Unit |
|---------------------------------------------------------------------------------------------|-----------------------|-------------------------------------|------|------|------|------|
| Static Off Characteristics                                                                  |                       |                                     |      |      |      |      |
| Drain-Source Breakdown Voltage                                                              | VGS=0V,ID=250uA       | BV <sub>DSS</sub>                   | 60   | --   | --   | V    |
| Bvdss Temperature Coefficient                                                               | ID=250uA,Reference25℃ | ΔBV <sub>DSS</sub> /ΔT <sub>J</sub> | --   | 0.07 | --   | V/℃  |
| Drain-Source Leakage Current                                                                | VDS= 60 V,VGS=0V      | I <sub>DSS</sub>                    | --   | --   | 1    | uA   |
| Gate-Body Leakage Current                                                                   | VGS= ±20 V,VDS=0V     | I <sub>GSS</sub>                    | --   | --   | ±100 | nA   |
| Static On Characteristics                                                                   |                       |                                     |      |      |      |      |
| Gate Threshold Voltage                                                                      | VGS= VDS ID=250uA     | V <sub>GS(TH)</sub>                 | 1.0  | 1.7  | 2.5  | V    |
| Drain-Source On Resistance                                                                  | ID= 0.2 A,VGS= 10.0 V | R <sub>DS(ON)</sub>                 | --   | 2.2  | 4.0  | Ω    |
|                                                                                             | ID= 0.2 A,VGS= 4.5 V  |                                     | --   | 2.9  | 6.0  |      |
| Dynamic Characteristics                                                                     |                       |                                     |      |      |      |      |
| Input Capacitance                                                                           | VDS= 30 V             | C <sub>iss</sub>                    | --   | 40.0 | --   | pF   |
| Output Capacitance                                                                          | VGS= 0 V              | C <sub>oss</sub>                    | --   | 30.0 | --   | pF   |
| Reverse Transfer Capacitance                                                                | F= 1 MHZ              | C <sub>rss</sub>                    | --   | 10.0 | --   | pF   |
| Switching Paramters (Test Circuit & Waveform See Fig.14)                                    |                       |                                     |      |      |      |      |
| Turn-On Delay Time                                                                          | VDS= 30 V             | t <sub>d(on)</sub>                  | --   | 10.0 | --   | ns   |
| Turn-On Rise Time                                                                           | VGS= 10.0 V           | t <sub>r</sub>                      | --   | 8.0  | --   | ns   |
| Turn-Off Delay Time                                                                         | RG= 10.0 Ω            | t <sub>d(off)</sub>                 | --   | 15.0 | --   | ns   |
| Turn-Off Rise Time                                                                          |                       | t <sub>f</sub>                      | --   | 20.0 | --   | ns   |
| Gate Charge Paramters (Test Circuit & Waveform See Fig.15)                                  |                       |                                     |      |      |      |      |
| Total Gate Charge                                                                           | VDS= 30 V             | Q <sub>g</sub>                      | --   | 1.6  | --   | nC   |
| Gate-Source Charge                                                                          | VGS= 10.0 V           | Q <sub>gs</sub>                     | --   | 0.8  | --   | nC   |
| Gate-Drain Charge                                                                           | ID= 0.2 A             | Q <sub>gd</sub>                     | --   | 0.5  | --   | nC   |
| Drain-Source Diode Characteristics And Maximum Ratings (Test Circuit & Waveform See Fig.17) |                       |                                     |      |      |      |      |
| Max. Diode Forward Cuurent                                                                  |                       | I <sub>S</sub>                      | --   | --   | 0.3  | A    |
| Max. Pulsed Forward Cuurent                                                                 |                       | I <sub>SM</sub>                     | --   | --   | 1.3  | A    |
| Diode Forward Voltage                                                                       | ID= 0.2 A,VGS=0V      | V <sub>SD</sub>                     | --   | 0.8  | 1.4  | V    |

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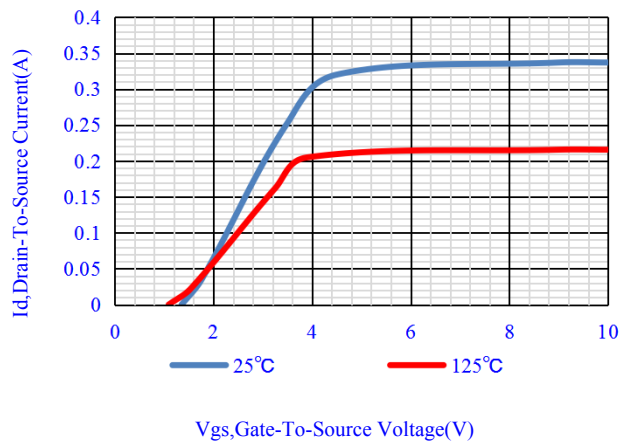
**N-Channel Enhancement Mode Trench Power MOSFET**



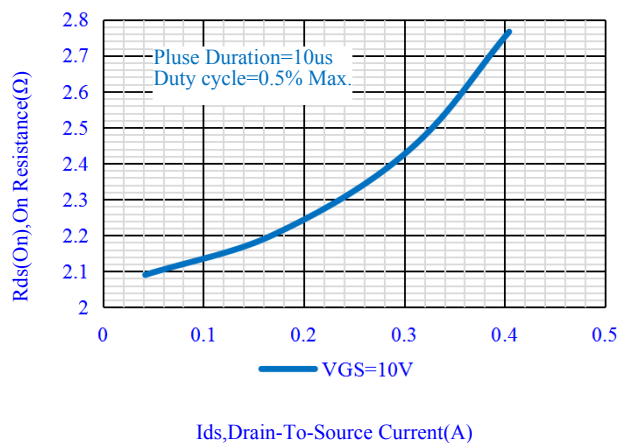
**Typical Characteristics Curves**



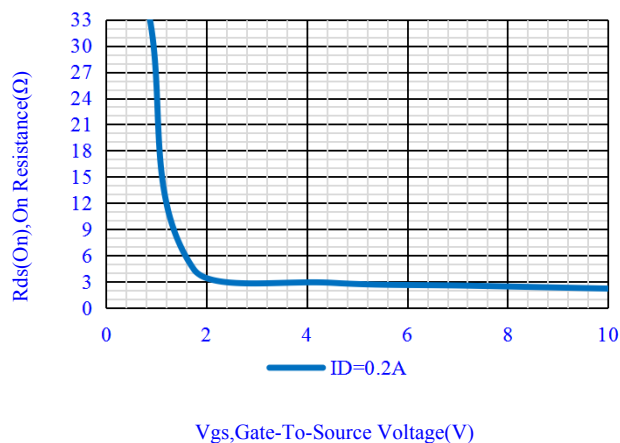
**Fig.1-Output Characteristics**



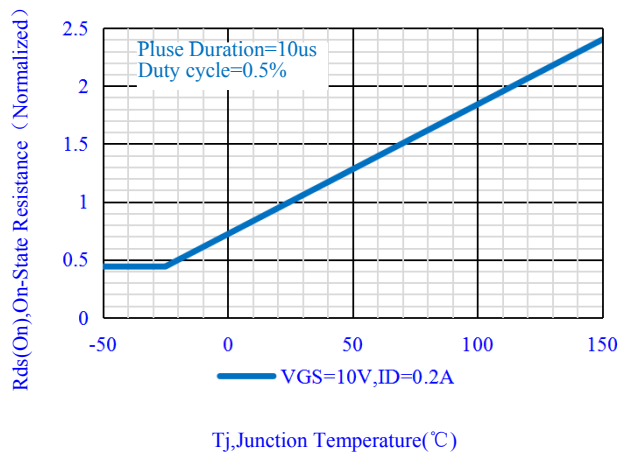
**Fig.2-Transfer Characteristics**



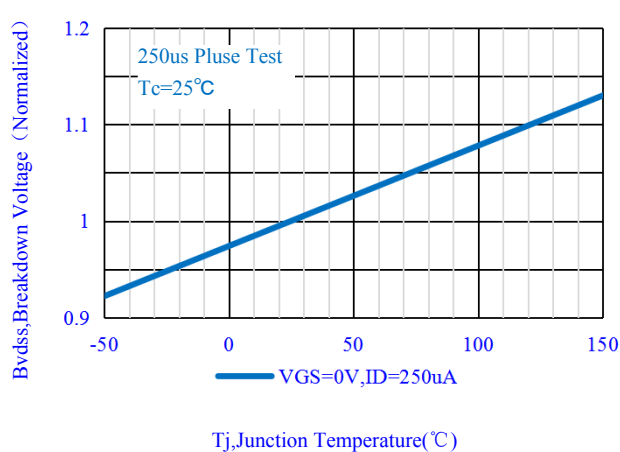
**Fig.3-On Resistance Vs. Drain Current**



**Fig.4-On Resistance Vs. Gate Source Voltage**



**Fig.5-On Resistance Vs. Junction Temperature**



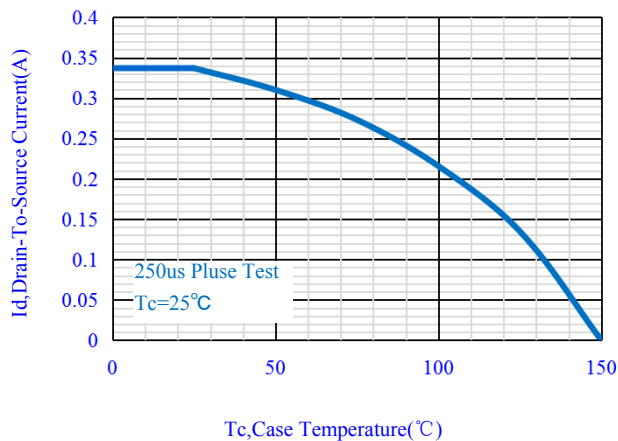
**Fig.6-Breakdown Voltage Vs. Junction Temperature**

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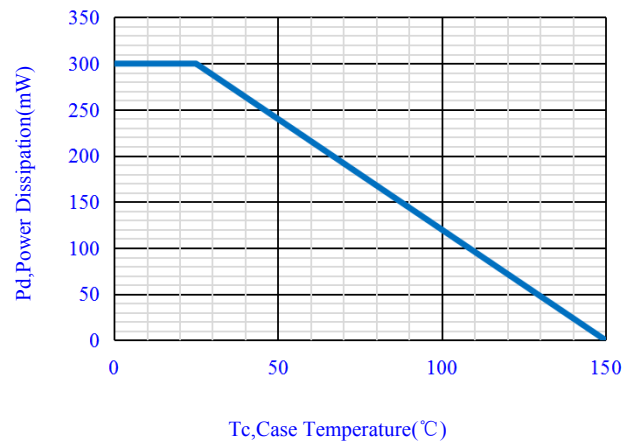
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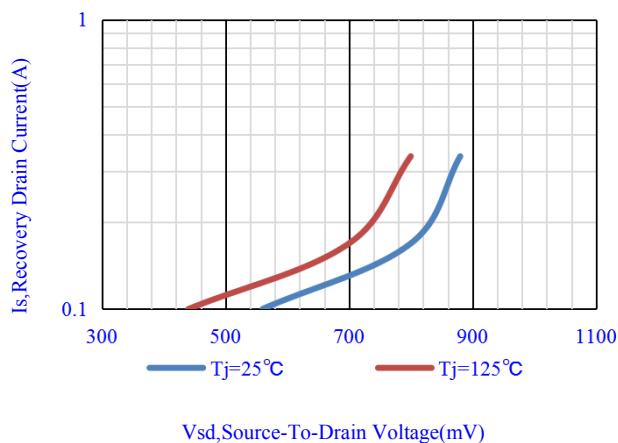
**Typical Characteristics Curves**



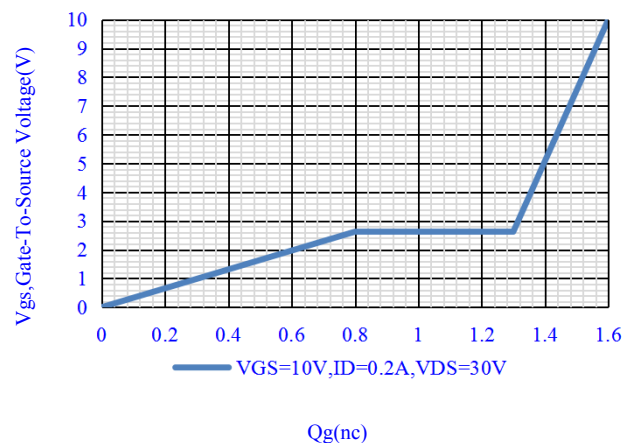
**Fig.7-Maximum Continuous Drain Current Vs. Case Temperature**



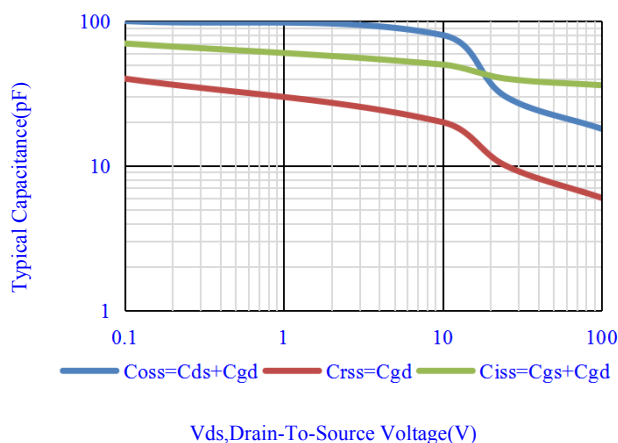
**Fig.8-Maximum Power Dissipation Vs. Case Temperature**



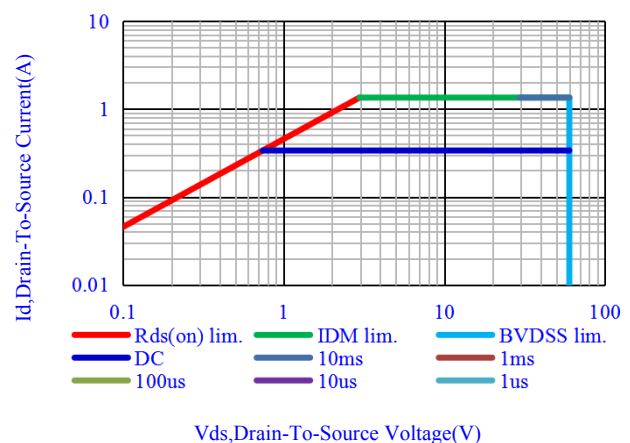
**Fig.9-Source-To-Drain Diode Forward Voltage**



**Fig.10-Gate Charge Waveform**



**Fig.11-Typical Capacitance Vs. Drain-To-Source Voltage**



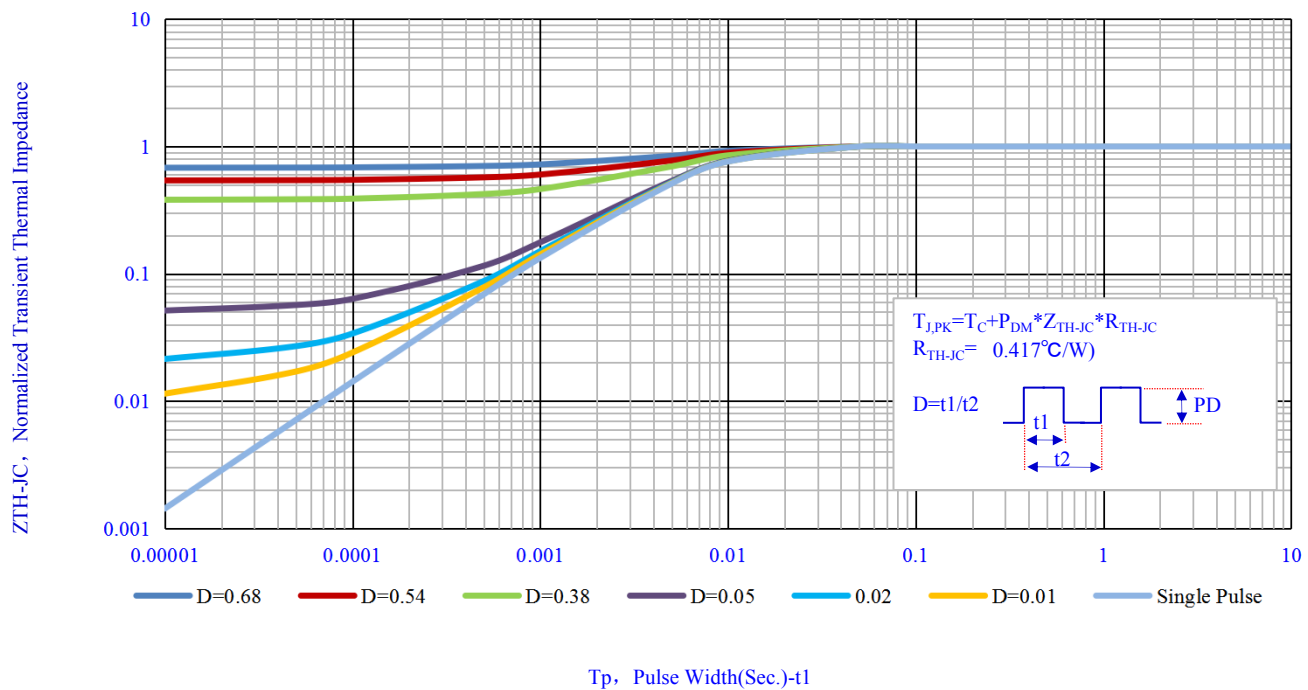
**Fig.12-Maximum Safe Operating Area(SOA)**

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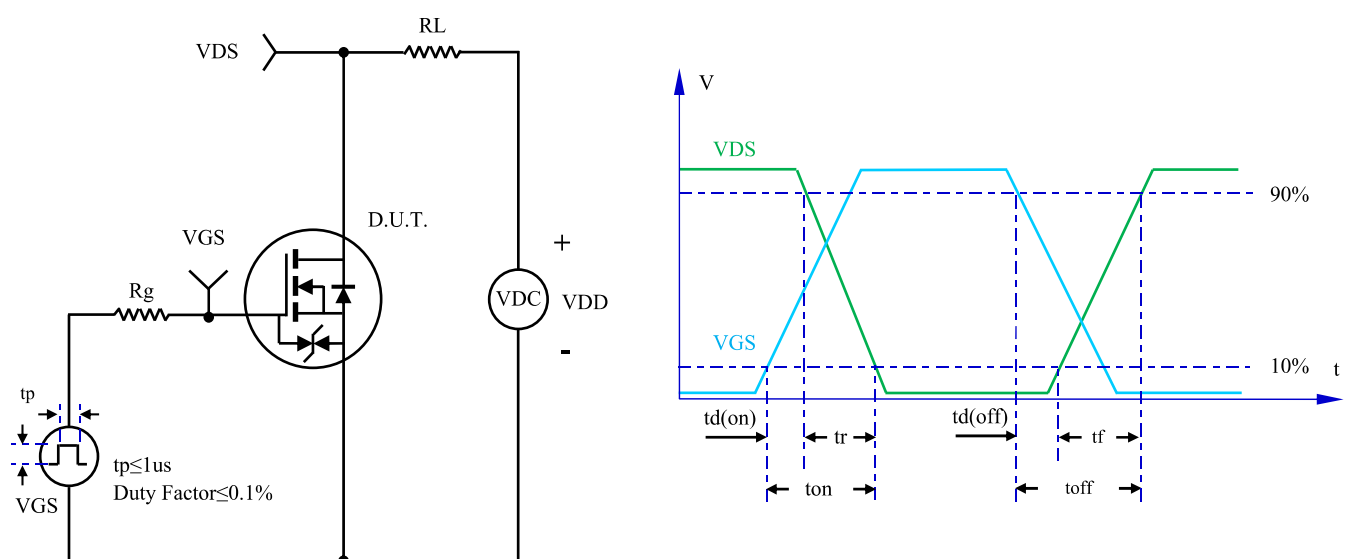


**Typical Characteristics Curves**



**Fig.13- Normalized Maximum Transient Thermal Impedance Vs.Pulse Width**

**Test Circuit & Waveform**



**Fig.14- Resistive Switching Test Circuit & Waveform**

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Test Circuit & Waveform

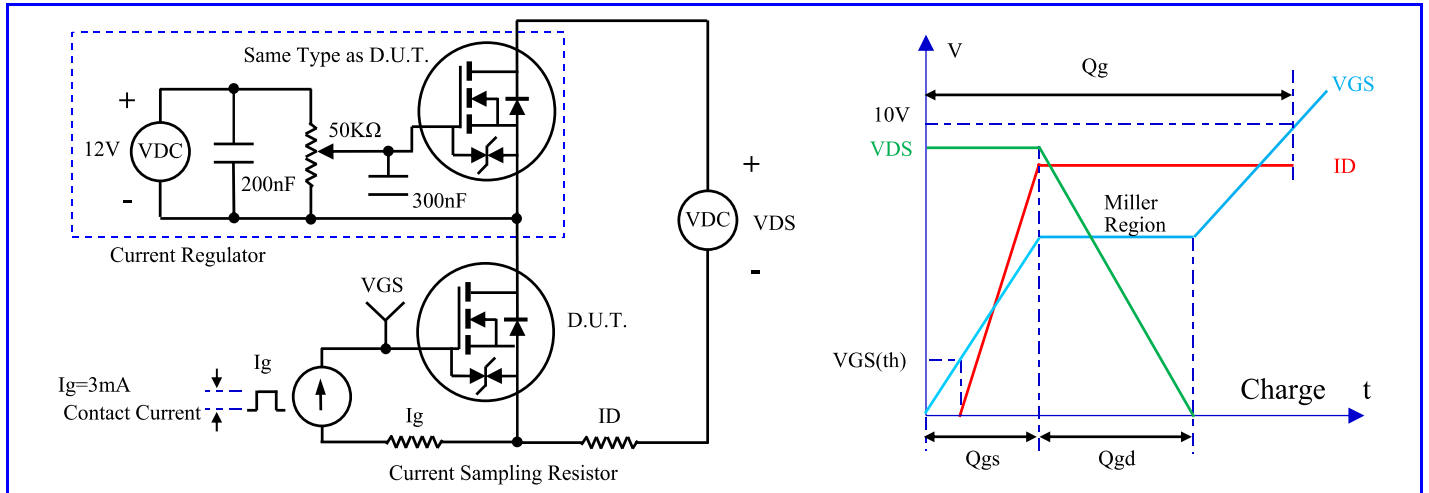


Fig.15- Gate Charge Test Circuit & Waveform

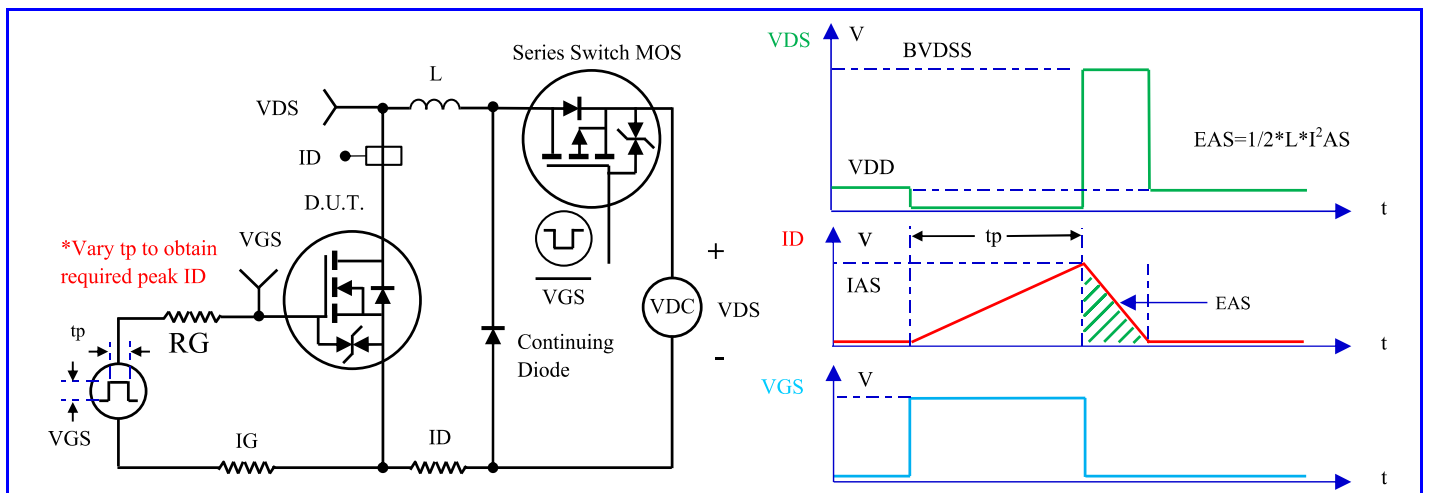


Fig.16- Unclamped Inductive Switching (UIS) Test Circuit & Waveform

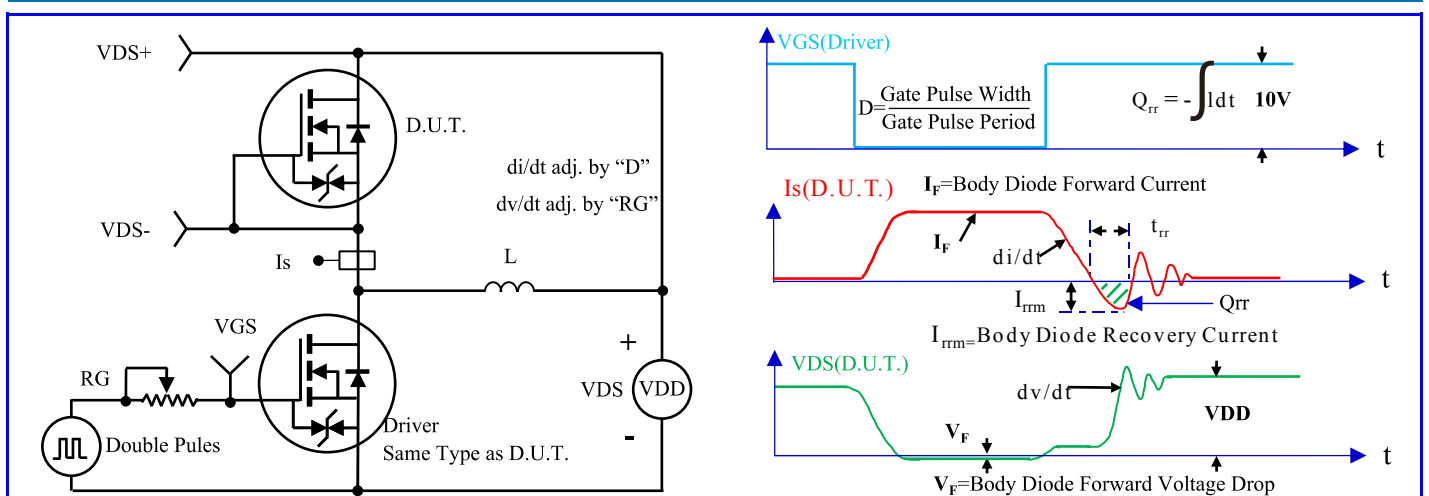


Fig.17- Diode Recovery Test Circuit & Waveform

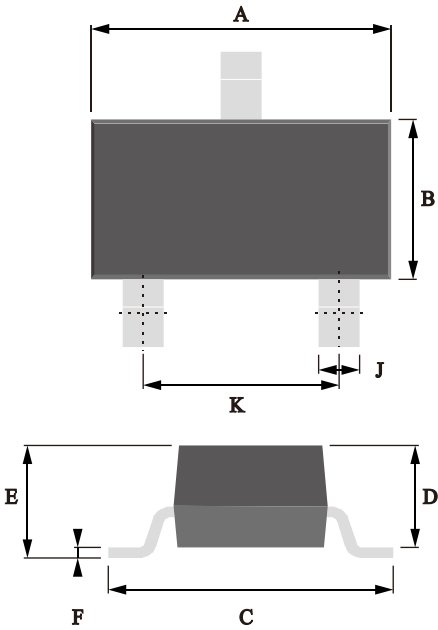
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OUTLINE DRAWINGS

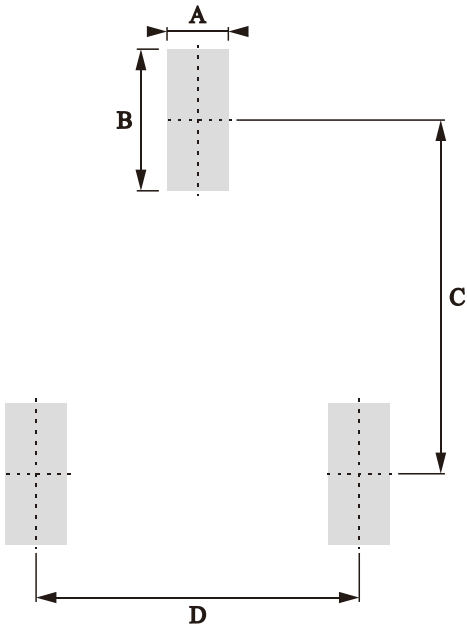
SOT-23



| OUTLINE DIMENSIONS |            |      |      |        |      |        |
|--------------------|------------|------|------|--------|------|--------|
| Dim.               | Milimeters |      |      | Inches |      |        |
|                    | Min.       | Typ. | Max. | Min.   | Typ. | Max.   |
| A                  | 2.80       | -    | 3.20 | 0.1102 | -    | 0.1260 |
| B                  | 1.15       | -    | 1.45 | 0.0453 | -    | 0.0571 |
| C                  | 2.25       | -    | 2.65 | 0.0886 | -    | 0.1043 |
| D                  | 0.85       | -    | 1.15 | 0.0335 | -    | 0.0453 |
| E                  | 0.90       | -    | 1.20 | 0.0354 | -    | 0.0472 |
| F                  | 0.08       | -    | 0.18 | 0.0031 | -    | 0.0071 |
| J                  | 0.30       | -    | 0.50 | 0.0118 | -    | 0.0197 |
| K                  | 1.70       | -    | 2.10 | 0.0669 | -    | 0.0827 |

RECOMMEDND LAYOUT DRAWINGS

SOT-23



| OUTLINE DIMENSIONS |            |      |      |        |        |      |
|--------------------|------------|------|------|--------|--------|------|
| Dim.               | Milimeters |      |      | Inches |        |      |
|                    | Min.       | Typ. | Max. | Min.   | Typ.   | Max. |
| A                  | -          | 0.60 | -    | -      | 0.0000 | -    |
| B                  | -          | 0.80 | -    | -      | 0.0315 | -    |
| C                  | -          | 2.00 | -    | -      | 0.0787 | -    |
| D                  | -          | 1.90 | -    | -      | 0.0748 | -    |

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MARKING INFORMATION



MARKING INSTRUCTIONS

72K=Make

PACKING INFORMATION

| Package Type | Package Code | Product Weight<br>Approx(g/Pcs) | Package Method | Quantity<br>(Pcs/Min. Pack.) | Quantity<br>(Pcs/Inner Box) | Quantity<br>(Pcs/Carton) |
|--------------|--------------|---------------------------------|----------------|------------------------------|-----------------------------|--------------------------|
| SOT-23       | P1           | 0.008                           | 7" Reel        | 3000                         | 45000                       | 180000                   |
| SOT-23       | P2           | 0.008                           | 7" Reel        | 5000                         | 45000                       | 180000                   |

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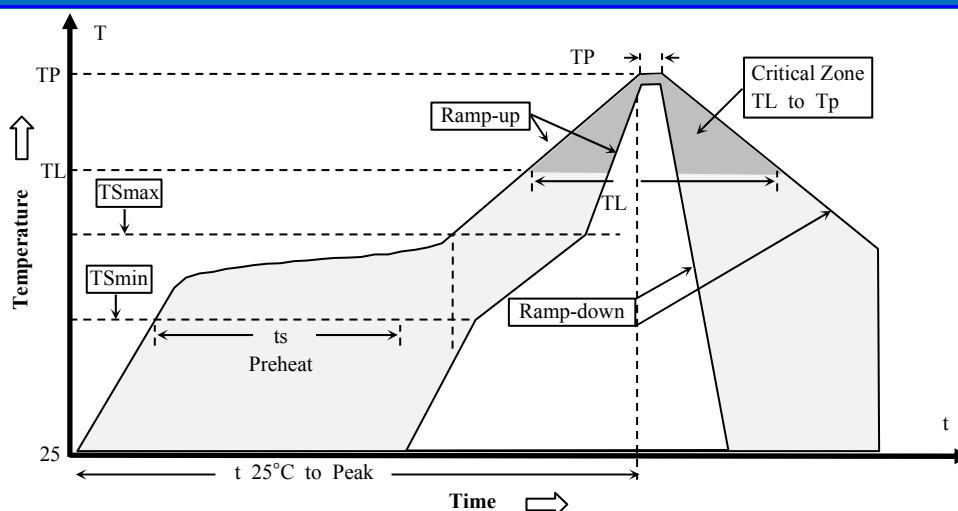
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**Recommended wave soldering condition**

| Product         | Peak Temperature | Soldering Time  |
|-----------------|------------------|-----------------|
| Pb-free devices | 260 +0/-5 °C     | 5 +1/-1 seconds |

**Recommended temperature profile for IR reflow**



| Profile feature                                                                                                                            | Sn-Pb eutectic Assembly          | Pb-free Assembly                 |
|--------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|----------------------------------|
| Average ramp-up rate<br>(T <sub>smax</sub> to T <sub>p</sub> )                                                                             | 3°C/second max.                  | 3°C/second max.                  |
| Preheat<br>-Temperature Min(T <sub>S</sub> min)<br>-Temperature Max(T <sub>S</sub> max)<br>-Time(t <sub>s</sub> min to t <sub>s</sub> max) | 100°C<br>150°C<br>60-120 seconds | 150°C<br>200°C<br>60-180 seconds |
| Time maintained above:<br>-Temperature (T <sub>L</sub> )<br>- Time (t <sub>L</sub> )                                                       | 183°C<br>60-150 seconds          | 217°C<br>60-150 seconds          |
| Peak Temperature(T <sub>P</sub> )                                                                                                          | 240 +0/-5 °C                     | 260 +0/-5 °C                     |
| Time within 5°C of actual peak<br>temperature(tp)                                                                                          | 10-30 seconds                    | 20-40 seconds                    |
| Ramp down rate                                                                                                                             | 6°C/second max.                  | 6°C/second max.                  |
| Time 25 °C to peak temperature                                                                                                             | 6 minutes max.                   | 8 minutes max.                   |

Note : All temperatures refer to topside of the package, measured on the package body surface.

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