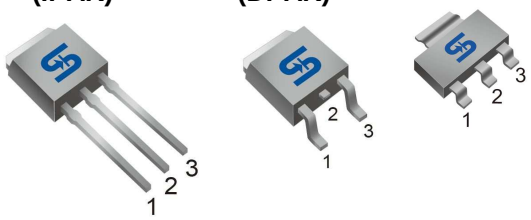
TAIWAN SEMICONDUCTOR

RoHS COMPLIANCE

# TSM1NB60

600V N-Channel Power MOSFET

**TO-251 (IPAK)** **TO-252 (DPAK)** **SOT-223**



**Pin Definition:**
1. Gate
2. Drain
3. Source

**PRODUCT SUMMARY**

| $V_{DS}$ (V) | $R_{DS(on)}$(Ω) | $I_D$ (A) |
|---|---|---|
| 600 | 10 @ $V_{GS}$ =10V | 0.5 |

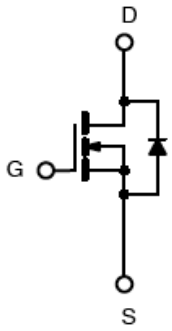
## General Description

The TSM1NB60 N-Channel Power MOSFET is produced by new advance planar process. This advanced technology has been especially tailored to minimize on-state resistance, provide superior switching performance, and withstand high energy pulse in the avalanche and commutation mode.

## Features

- Low $R_{DS(ON)}$ 8Ω (Typ.)
- Low gate charge typical @ 6.1nC (Typ.)
- Low Crss typical @ 4.2pF (Typ.)

## Block Diagram




N-Channel MOSFET

## Ordering Information

| Part No. | Package | Packing |
|---|---|---|
| TSM1NB60CH C5G | TO-251 | 75pcs / Tube |
| TSM1NB60CP ROG | TO-252 | 2.5Kpcs / 13” Reel |
| TSM1NB60CW RPG | SOT-223 | 2.5Kpcs / 13” Reel |

**Note:** “G” denotes for Halogen Free

## Absolute Maximum Rating (Ta = 25°C unless otherwise noted)

| Parameter | | Symbol | Limit | | | Unit |
|---|---|---|---|---|---|---|
| | | | IPAK | DPAK | SOT-223 | |
| Drain-Source Voltage | | $V_{DS}$ | 600 | | | V |
| Gate-Source Voltage | | $V_{GS}$ | ±30 | | | V |
| Continuous Drain Current | Tc = 25ºC | $I_D$ | 1 | | | A |
| | Tc = 100ºC | | 0.7 | | | A |
| Pulsed Drain Current * | | $I_{DM}$ | 4 | | | A |
| Single Pulse Avalanche Energy (Note 2) | | $E_{AS}$ | 5 | | | mJ |
| Peak Diode Recovery dv/dt (Note 3) | | dv/dt | 4.5 | | | V/ns |
| Total Power Dissipation @ $T_C$ = 25°C | | $P_{TOT}$ | 39 | 39 | 2.1 | W |
| Operating Junction Temperature | | $T_J$ | 150 | | | ºC |
| Storage Temperature Range | | $T_{STG}$ | -55 to +150 | | | °C |

**Note:** Limited by maximum junction temperature

## Thermal Performance

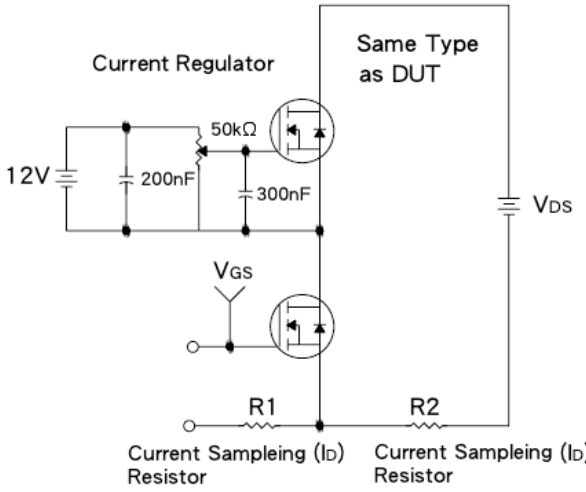
| Parameter | Symbol | Limit | | | Unit |
|---|---|---|---|---|---|
| | | IPAK | DPAK | SOT-223 | |
| Thermal Resistance - Junction to Case | $R\Theta_{JC}$ | 2.87 | 2.87 | -- | °C/W |
| Thermal Resistance - Junction to Ambient | $R\Theta_{JA}$ | 110 | 110 | 60 | °C/W |

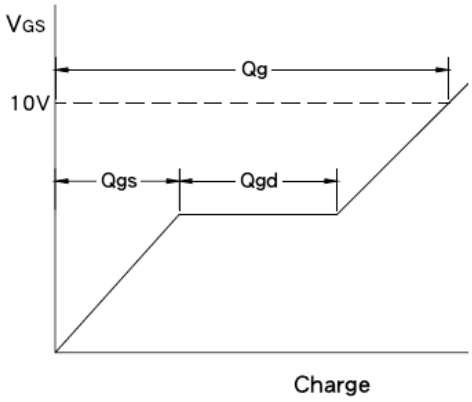
## Electrical Specifications (Ta = 25°C unless otherwise noted)

| Parameter | Conditions | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **Static** | | | | | | |
| Drain-Source Breakdown Voltage | $V_{GS}$ = 0V, $I_D$ = 250uA | $BV_{DSS}$ | 600 | -- | -- | V |
| Drain-Source On-State Resistance | $V_{GS}$ = 10V, $I_D$ = 0.5A | $R_{DS(ON)}$ | -- | 8 | 10 | Ω |
| Gate Threshold Voltage | $V_{DS}$ = $V_{GS}$, $I_D$ = 250uA | $V_{GS(TH)}$ | 2.5 | 3.5 | 4.5 | V |
| Zero Gate Voltage Drain Current | $V_{DS}$ = 600V, $V_{GS}$ = 0V | $I_{DSS}$ | -- | -- | 10 | uA |
| Gate Body Leakage | $V_{GS}$ = ±30V, $V_{DS}$ = 0V | $I_{GSS}$ | -- | -- | ±100 | nA |
| Forward Transfer Conductance | $V_{DS}$ = 10V, $I_D$ = 0.5A | $g_{fs}$ | -- | 0.8 | -- | S |
| **Dynamic** | | | | | | |
| Total Gate Charge | $V_{DS}$ = 480V, $I_D$ = 1A, $V_{GS}$ = 10V (Note 4,5) | $Q_g$ | -- | 6.1 | -- | nC |
| Gate-Source Charge | | $Q_{gs}$ | -- | 1.4 | -- | |
| Gate-Drain Charge | | $Q_{gd}$ | -- | 3.3 | -- | |
| Input Capacitance | $V_{DS}$ = 25V, $V_{GS}$ = 0V, f = 1.0MHz | $C_{iss}$ | -- | 138 | -- | pF |
| Output Capacitance | | $C_{oss}$ | -- | 17.1 | -- | |
| Reverse Transfer Capacitance | | $C_{rss}$ | -- | 4.2 | -- | |
| **Switching** | | | | | | |
| Turn-On Delay Time | $V_{GS}$ = 10V, $I_D$ = 1A, $V_{DD}$ = 300V, $R_G$ =25Ω (Note 4,5) | $t_{d(on)}$ | -- | 7.7 | -- | nS |
| Turn-On Rise Time | | $t_r$ | -- | 6.8 | -- | |
| Turn-Off Delay Time | | $t_{d(off)}$ | -- | 15.3 | -- | |
| Turn-Off Fall Time | | $t_f$ | -- | 14.9 | -- | |
| **Source-Drain Diode Ratings and Characteristic** | | | | | | |
| Source Current | Integral reverse diode in the MOSFET | $I_S$ | -- | -- | 1 | A |
| Source Current (Pulse) | | $I_{SM}$ | -- | -- | 4 | A |
| Diode Forward Voltage | $I_S$ = 1A, $V_{GS}$ = 0V | $V_{SD}$ | -- | 0.9 | 1.4 | V |

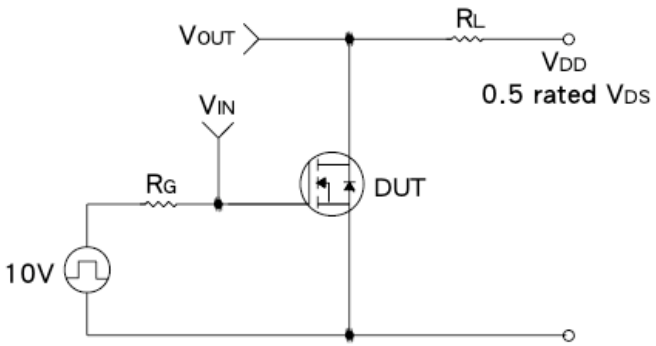
**Note 1:** Repetitive Rating: Pulse Width Limited by Maximum Junction Temperature
**Note 2:** $V_{DD}$ = 50V, $I_{AS}$=1A, L=10mH, $R_G$ =25Ω, Starting $T_J$=25ºC
**Note 3:** $I_{SD}$≤1A, di/dt≤200A/uS, $V_{DD}$≤$BV_{DSS}$, Starting $T_J$=25ºC
**Note 4:** Pulse test: pulse width ≤300uS, duty cycle ≤2%
**Note 5:** Essentially Independent of Operating Temperature

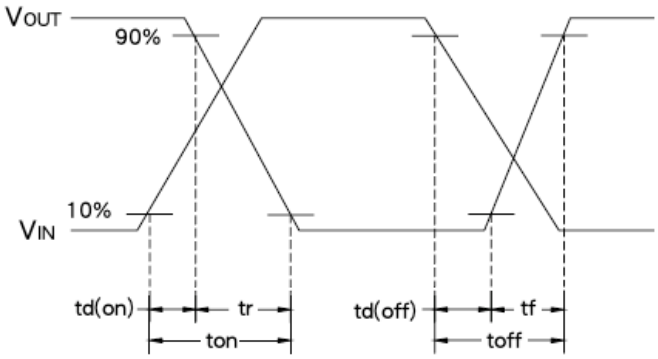
## Gate Charge Test Circuit & Waveform



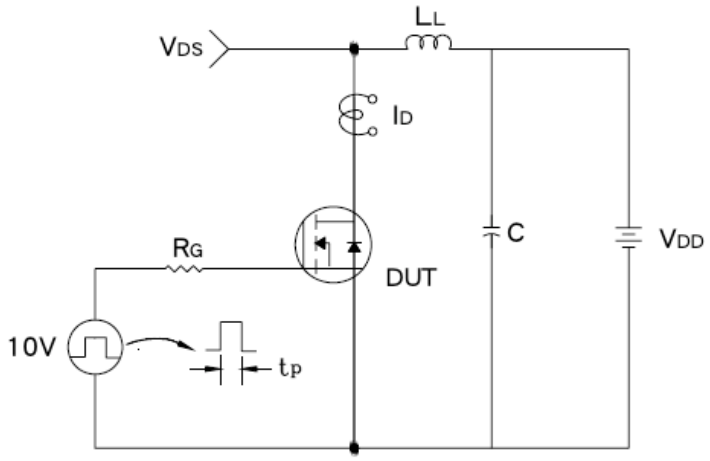



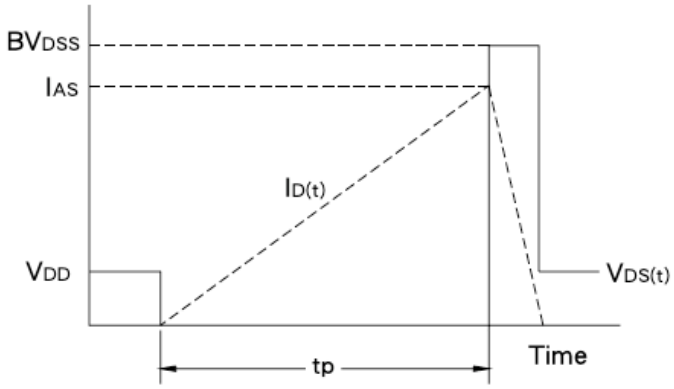

## Resistive Switching Test Circuit & Waveform



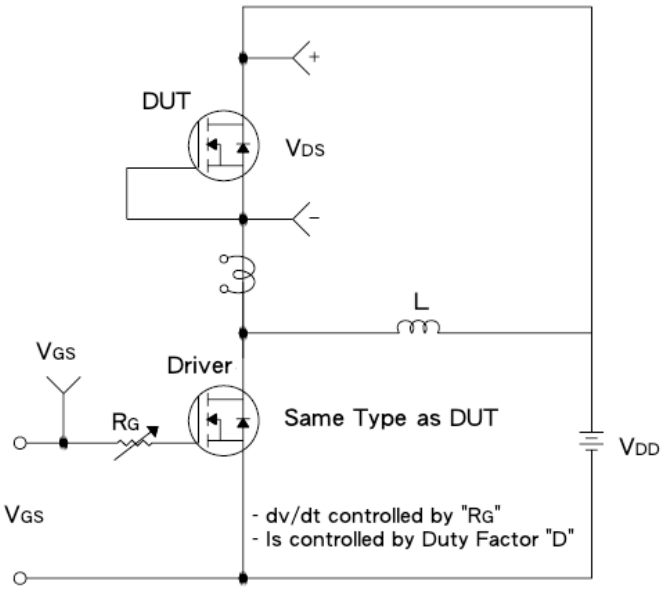



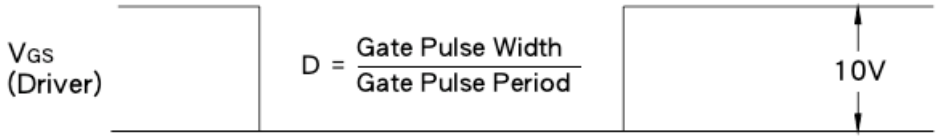

## $E_{AS}$ Test Circuit & Waveform

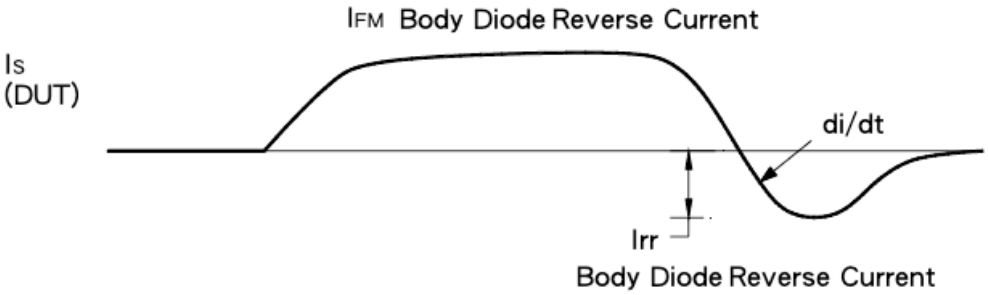


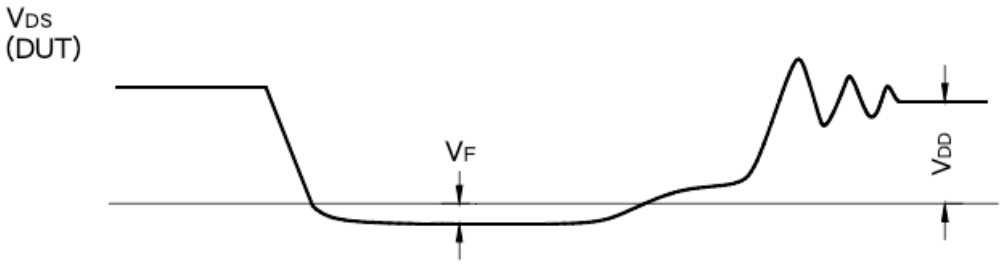



## Diode Reverse Recovery Time Test Circuit & Waveform

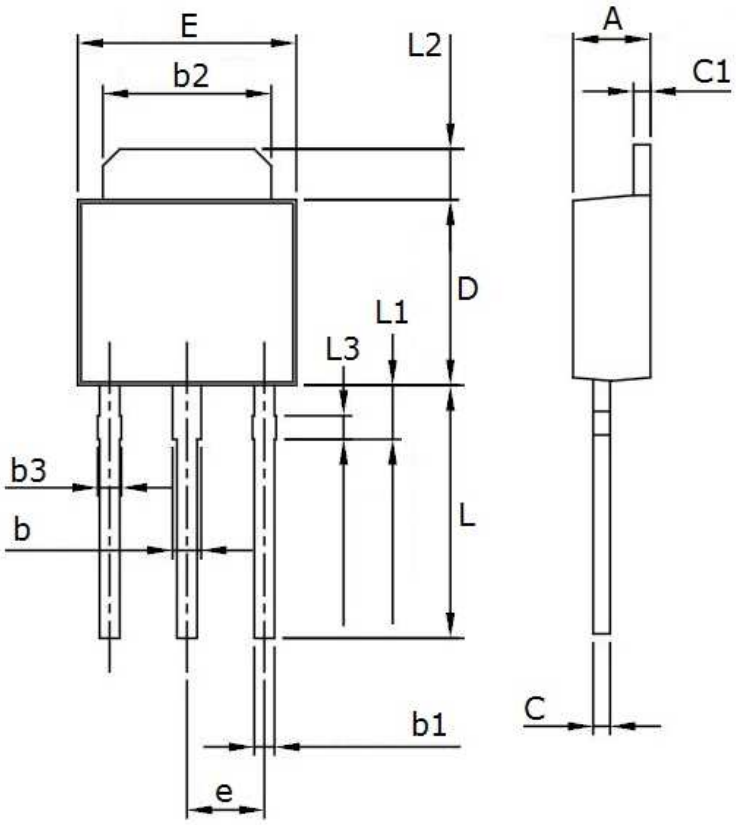


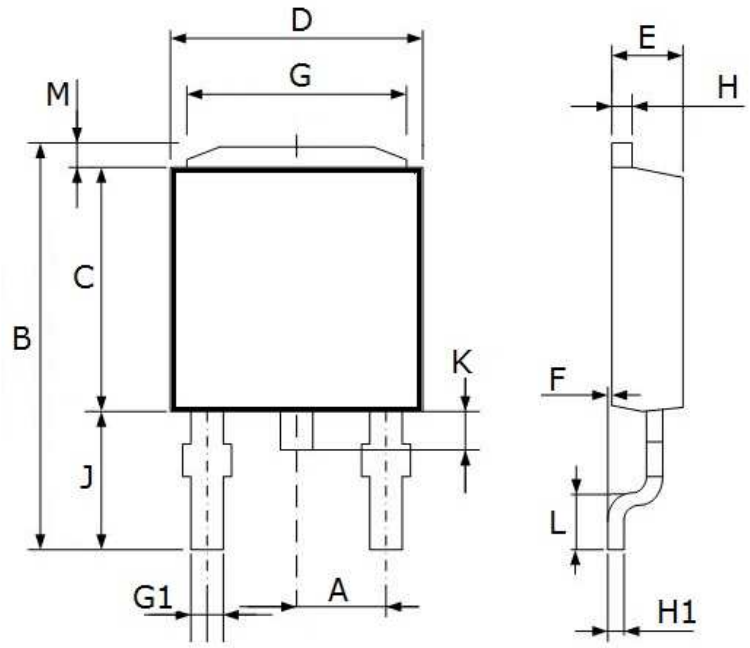



## TO-251 Mechanical Drawing



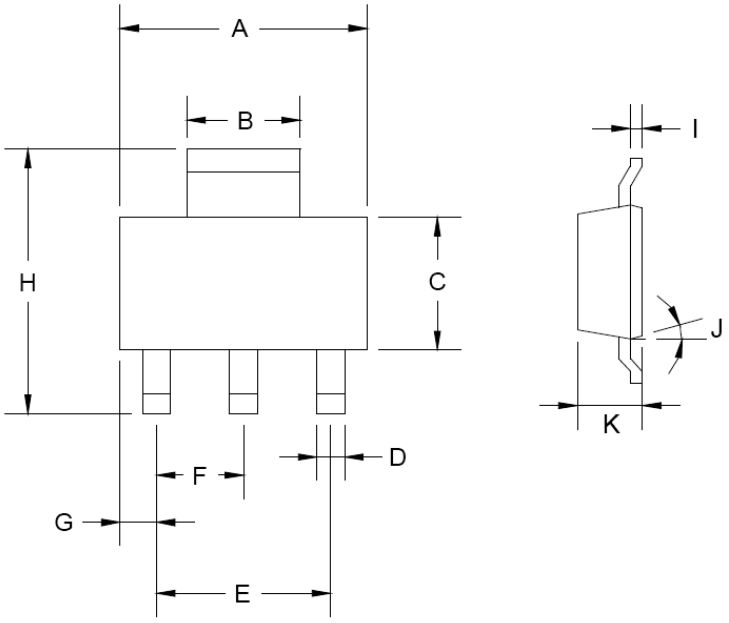

| TO-251 DIMENSION | | | | |
|---|---|---|---|---|
| DIM | MILLIMETERS | | INCHES | |
| | MIN | MAX | MIN | MAX |
| A | 2.10 | 2.50 | 0.083 | 0.098 |
| b | 0.65 | 1.05 | 0.026 | 0.041 |
| b1 | 0.58 | 0.62 | 0.023 | 0.024 |
| b2 | 4.80 | 5.20 | 0.189 | 0.205 |
| b3 | 0.68 | 0.72 | 0.027 | 0.028 |
| C | 0.35 | 0.65 | 0.014 | 0.026 |
| C1 | 0.40 | 0.60 | 0.016 | 0.024 |
| D | 5.30 | 5.70 | 0.209 | 0.224 |
| E | 6.30 | 6.70 | 0.248 | 0.264 |
| e | 2.30 BSC | | 0.09 BSC | |
| L | 7.00 | 8.00 | 0.276 | 0.315 |
| L1 | 1.40 | 1.80 | 0.055 | 0.071 |
| L2 | 1.30 | 1.70 | 0.051 | 0.067 |
| L3 | 0.50 | 0.90 | 0.020 | 0.035 |

## TO-252 Mechanical Drawing




| TO-252 DIMENSION | | | | |
|---|---|---|---|---|
| DIM | MILLIMETERS | | INCHES | |
| | MIN | MAX | MIN | MAX |
| A | 2.30 BSC | | 0.090 BSC | |
| B | 10.20 | 10.80 | 0.402 | 0.425 |
| C | 5.30 | 5.70 | 0.209 | 0.224 |
| D | 6.30 | 6.70 | 0.248 | 0.264 |
| E | 2.10 | 2.50 | 0.083 | 0.098 |
| F | 0.00 | 0.20 | 0.000 | 0.008 |
| G | 4.80 | 5.20 | 0.189 | 0.205 |
| G1 | 0.40 | 0.80 | 0.016 | 0.031 |
| H | 0.40 | 0.60 | 0.016 | 0.024 |
| H1 | 0.35 | 0.65 | 0.014 | 0.026 |
| J | 3.35 | 3.65 | 0.132 | 0.144 |
| K | 0.50 | 1.10 | 0.020 | 0.043 |
| L | 0.90 | 1.50 | 0.035 | 0.059 |
| M | 1.30 | 1.70 | 0.051 | 0.067 |

## SOT-223 Mechanical Drawing




| SOT-223 DIMENSION | | | | |
|---|---|---|---|---|
| DIM | MILLIMETERS | | INCHES | |
| | MIN | MAX | MIN | MAX |
| A | 6.350 | 6.850 | 0.250 | 0.270 |
| B | 2.900 | 3.100 | 0.114 | 0.122 |
| C | 3.450 | 3.750 | 0.136 | 0.148 |
| D | 0.595 | 0.635 | 0.023 | 0.025 |
| E | 4.550 | 4.650 | 0.179 | 0.183 |
| F | 2.250 | 2.350 | 0.088 | 0.093 |
| G | 0.835 | 1.035 | 0.032 | 0.041 |
| H | 6.700 | 7.300 | 0.263 | 0.287 |
| I | 0.250 | 0.355 | 0.010 | 0.014 |
| J | 10° | 16° | 10° | 16° |
| K | 1.550 | 1.800 | 0.061 | 0.071 |

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