# 650V Enhancement mode GaN HEMT

**GNP2050TD-Z**

EcoGaN

## Features

- 650V E-mode GaN HEMT
- 50mΩ Resistance
- 6.4nC Gate Charge

## Package Information

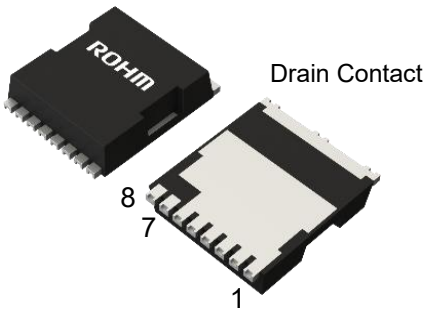
W (Typ) × D (Typ) × H (Max)

11.68 mm × 9.9 mm × 2.4 mm

TOLL-8N

## Application

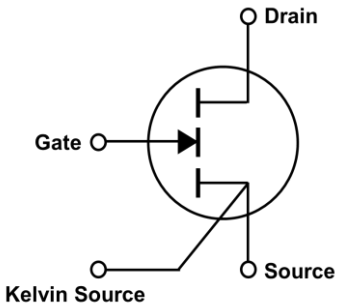
- High Switching Frequency Converter
- High Density Converter




## Key Performance Parameters

| Symbol | Values | Unit |
|---|---|---|
| $V_{DS,max}$ | 650 | V |
| $I_D$ | 31.5 | A |
| $I_{D,pulse}$ | 62.9 | A |
| $R_{DS(on),typ}$ | 50 | mΩ |
| $Q_g$ | 6.4 | nC |
| $Q_{oss}$ @400V | 60 | nC |
| $Q_{rr}$ | 0 | nC |

| | |
|---|---|
| Gate | 8 |
| Kelvin Source | 7 |
| Drain | Drain Contact |
| Source | 1,2,3,4,5,6 |




## Ordering Information

| Ordering Code | Package | Ordering Unit (pcs) | Marking |
|---|---|---|---|
| GNP2050TD-ZTR | TOLL-8N | 2,000 | GNP2050 |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## Maximum Ratings

| Parameter | Symbol | Ratings | Unit | Conditions |
|---|---|---|---|---|
| Drain to Source Voltage Continuous | $V_{DSS}$ | 650 | V | - |
| Transient Drain to Source Voltage *1 | $V_{DS(transient)}$ | 800 | V | - |
| Gate to Source Voltage | $V_{GSS}$ | -10 to +6.5 | V | - |
| Transient Gate to Source Voltage *2 | $V_{GS(transient)}$ | 8.5 | V | - |
| Continuous Drain Current *3 | $I_D$ | 31.5 | A | $T_c$ = 25°C |
| | | 14.1 | | $T_c$ = 125°C |
| Pulse Drain Current *3*4 | $I_{D,pulse}$ | 62.9 | A | $T_c$ = 25°C |
| | | 28.1 | | $T_c$ = 125°C |
| Power Dissipation | $P_{tot}$ | 159 | W | $T_c$ = 25°C |
| Operation Temperature | $T_j$ | -55 to 150 | °C | - |
| Range of Storage Temperature | $T_{stg}$ | -55 to 150 | °C | - |

*1 $t_{pulse}$=1μs, <10 hrs of total time.

*2 $t_{pulse}$<20ns, <0.5 hr of total time.

*3 Limited and calculated by maximum temperature allowed..

*4 $V_{GS}$=6V,Duty=0.1, $t_{pulse}$=1μs.

Please note especially when using driver source
that VGSS_surge must be in the range of absolute maximum rating.

## Thermal Resistance

| Parameter | Symbol | Values | | | Unit | Conditions |
|---|---|---|---|---|---|---|
| | | Min | Typ | Max | | |
| Thermal Resistance, Junction to Ambient | $R_{thJA}$ | - | - | 34.2 | °C/W | Device on JEDEC Standard Board for Thermal Resistance |
| Thermal Resistance, Junction to Case | $R_{thJC}$ | - | 0.56 | 0.78 | °C/W | - |
| Reflow Soldering Temperature | $T_{solder}$ | - | - | 260 | °C | MSL 3 |


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## Static Characteristics ($T_j$ = 25°C)

| Parameter | Symbol | Values | | | Unit | Conditions |
|---|---|---|---|---|---|---|
| | | Min | Typ | Max | | |
| Gate Threshold Voltage | $V_{GS(th)}$ | 1.0 | 1.5 | 2.5 | V | $V_{DS}$ = 30mV, $I_D$ = 23mA |
| Drain to Source Breakdown Voltage | $V_{(BR)DSS}$ | 650 | - | - | V | $V_{GS}$ = 0V, $T_j$ = 25°C |
| Zero Gate Voltage Drain Current | $I_{DSS}$ | - | 0.35 | 35 | μA | $V_{GS}$ = 0V<br>$V_{DS}$ = 650V<br>$T_j$ = 25°C |
| | | - | 12 | - | | $V_{GS}$ = 0V<br>$V_{DS}$ = 650V<br>$T_j$ = 150°C |
| Gate to Source Leakage Current | $I_{GSS+}$ | - | 0.2 | 3.0 | mA | $V_{GS}$ = 6.5V, $V_{DS}$ = 0V |
| Static Drain to Source On State Resistance | $R_{DS(on)}$ | - | 52 | 73 | mΩ | $V_{GS}$ = 5.0V<br>$I_D$ = 12A<br>$T_j$ = 25°C |
| | | - | 120 | - | | $V_{GS}$ = 5.0V<br>$I_D$ = 12A<br>$T_j$ = 150°C |
| | | - | 50 | 70 | | $V_{GS}$ = 6.0V<br>$I_D$ = 12A<br>$T_j$ = 25°C |
| | | - | 115 | - | | $V_{GS}$ = 6.0V<br>$I_D$ = 12A<br>$T_j$ = 150°C |
| Gate Input Resistance | $R_G$ | - | 1.7 | - | Ω | f = 100MHz, open drain |


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## Dynamic Characteristics ($T_j$ = 25°C)

| Parameter | Symbol | Values | | | Unit | Conditions |
|---|---|---|---|---|---|---|
| | | Min | Typ | Max | | |
| Input Capacitance | $C_{iss}$ | - | 222 | - | pF | $V_{GS}$ = 0V |
| Output Capacitance | $C_{oss}$ | - | 65 | - | | $V_{DS}$ = 400V |
| Reverse Transfer Capacitance | $C_{rss}$ | - | 0.8 | - | | f = 1MHz |
| Effective Output Capacitance, Energy Related | $C_{o(er)}$ | - | 98 | - | pF | $V_{GS}$ = 0V, $V_{DS}$ = 0V to 400V |
| Effective Output Capacitance, Time Related | $C_{o(tr)}$ | - | 150 | - | | $V_{GS}$ = 0V, $V_{DS}$ = 0V to 400V |
| Output Charge | $Q_{oss}$ | - | 60 | - | nC | $V_{GS}$ = 0V, $V_{DS}$ = 0V to 400V |
| Turn - On Delay Time | $t_{d(on)}$ | - | 9.0 | - | ns | $V_{DS}$ = 400V |
| Rise Time | $t_r$ | - | 5.9 | - | | $I_D$ = 8A |
| Turn - Off Delay Time | $t_{d(off)}$ | - | 19.5 | - | | $V_{GS}$ = 6V/0V |
| Fall Time | $t_f$ | - | 14.5 | - | | $R_{on}$ = 10Ω $R_{off}$ = 10Ω |
| Total Gate Charge | $Q_g$ | - | 6.4 | - | nC | $V_{DS}$ = 400V |
| Gate to Source Charge | $Q_{gs}$ | - | 0.5 | - | | $I_D$ = 8A |
| Gate to Drain Charge | $Q_{gd}$ | | 0.7 | | | $V_{GS}$ = 6V/0V |
| Gate Plateau Voltage | $V_{plat}$ | - | 2.0 | - | V | |

## Reverse Conduction Electrical Characteristics ($T_j$ = 25°C)

| Parameter | Symbol | Values | | | Unit | Conditions |
|---|---|---|---|---|---|---|
| | | Min | Typ | Max | | |
| Source to Drain Reverse Voltage | $V_{SD}$ | - | 2.5 | - | V | $V_{GS}$ = 0V, $I_{SD}$ = 12A |
| Reverse Recovery Time | $t_{rr}$ | - | 0 | - | ns | |
| Reverse Recovery Charge | $Q_{rr}$ | - | 0 | - | nC | |
| Peak Reverse Recovery Current | $I_{rrm}$ | - | 0 | - | A | |


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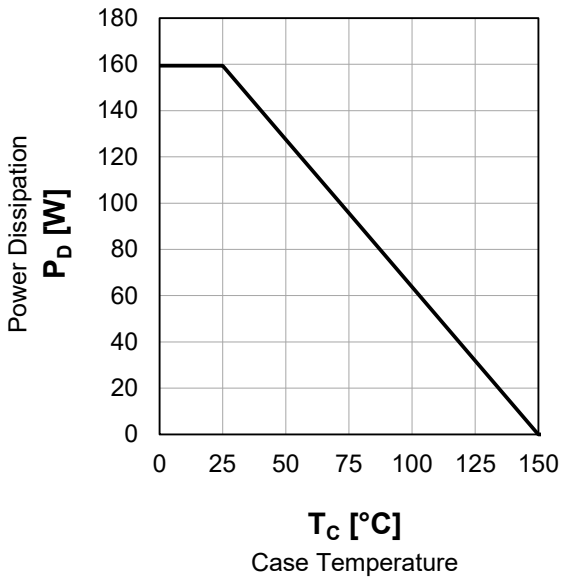
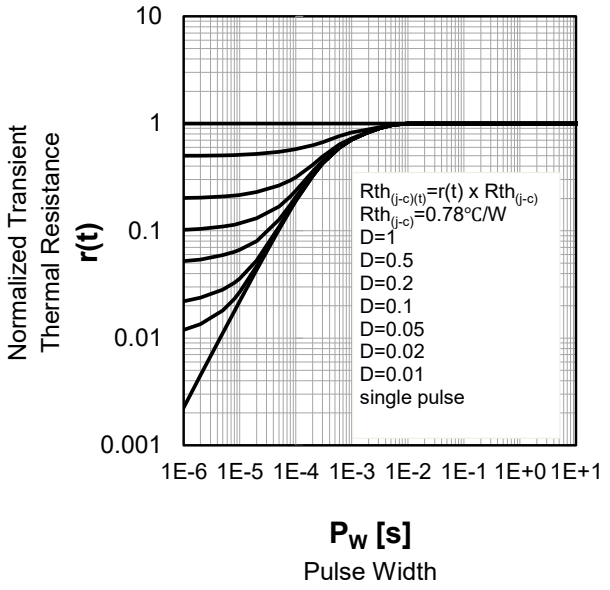
## Electrical Characteristic Curves

Fig.1 Power Dissipation Derating Curve



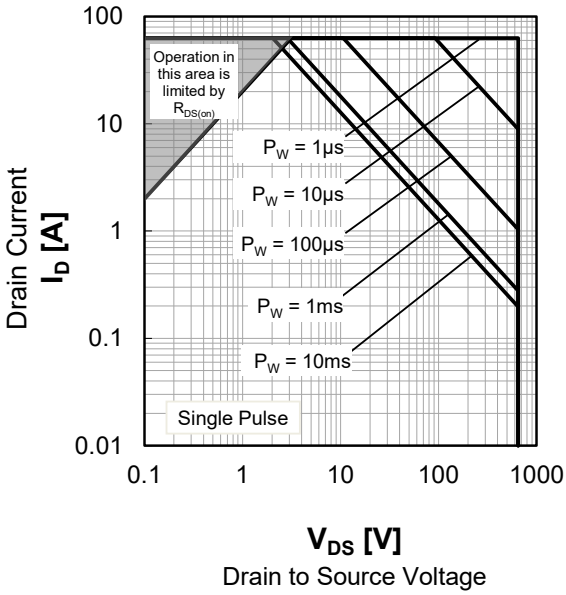

$P_D = f(T_c)$

Fig.2 Normalized Transient Thermal Resistance vs. Pulse Width



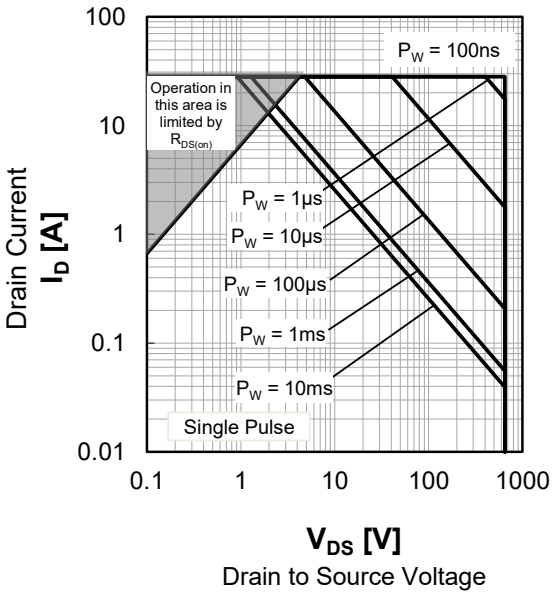

r(t) = f($P_W$, D); $T_C$ = 25°C

Fig.3 Max. Safe Operating Area




$I_D = f(V_{DS}, P_W)$; $T_C$ = 25°C

Fig.4 Max. Safe Operating Area




$I_D = f(V_{DS}, P_W)$; $T_C$ = 125°C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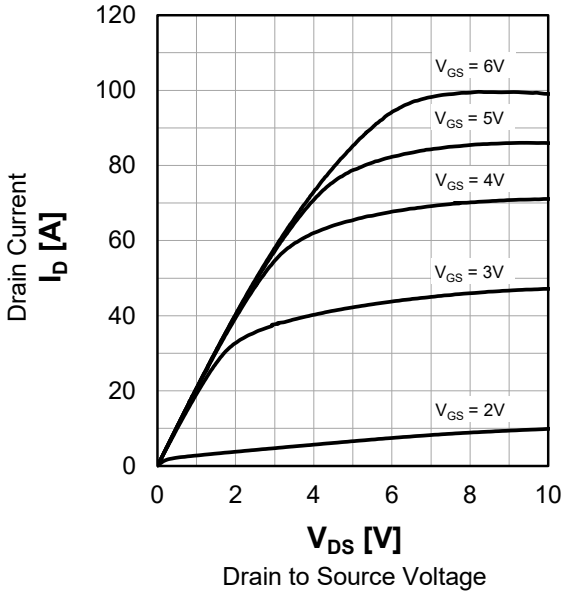
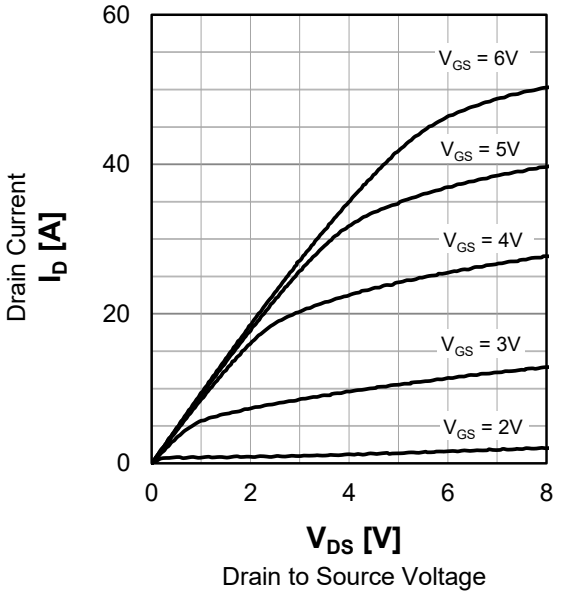
## Electrical Characteristic Curves

Fig.5 Typ. Output Characteristics



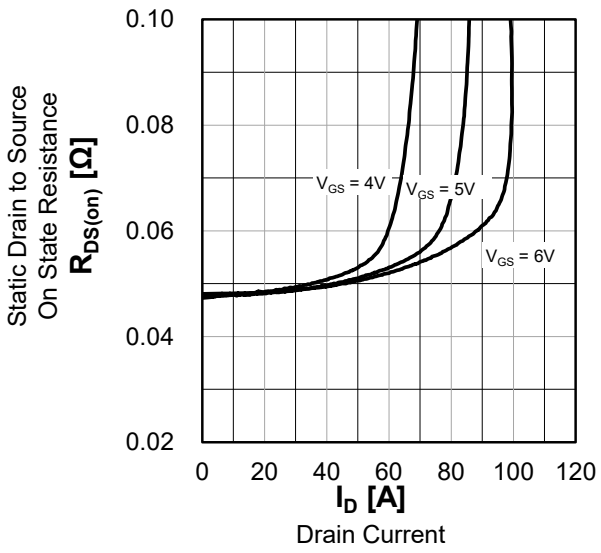

$I_D = f(V_{DS}, V_{GS})$; $T_j = 25°C$

Fig.6 Typ. Output Characteristics



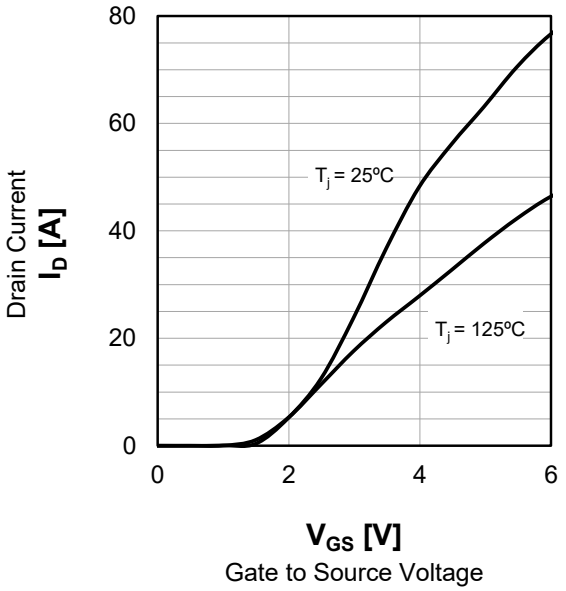

$I_D = f(V_{DS}, V_{GS})$; $T_j = 125°C$

Fig.7 Static Drain to Source On State Resistance vs. Drain to Source Current




$R_{DS(on)} = f(I_D, V_{GS})$; $T_j = 25°C$

Fig.8 Typ. Transfer Characteristics




$I_D = f(V_{GS}, T_j)$; $V_{DS}$ = 10 V; $T_j$ = 25°C, 125°C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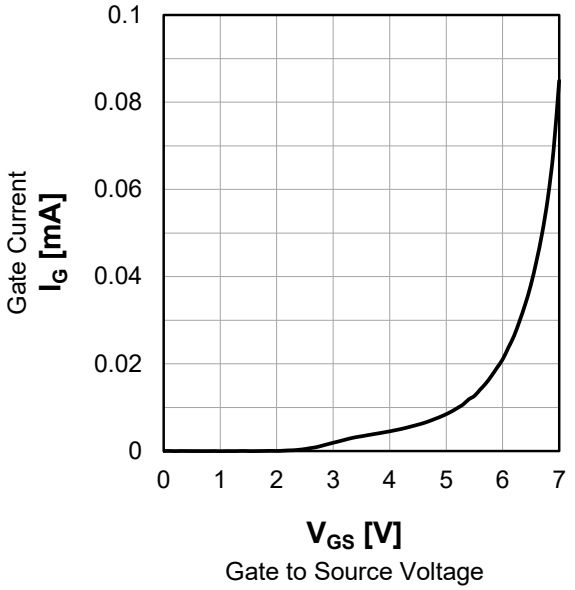
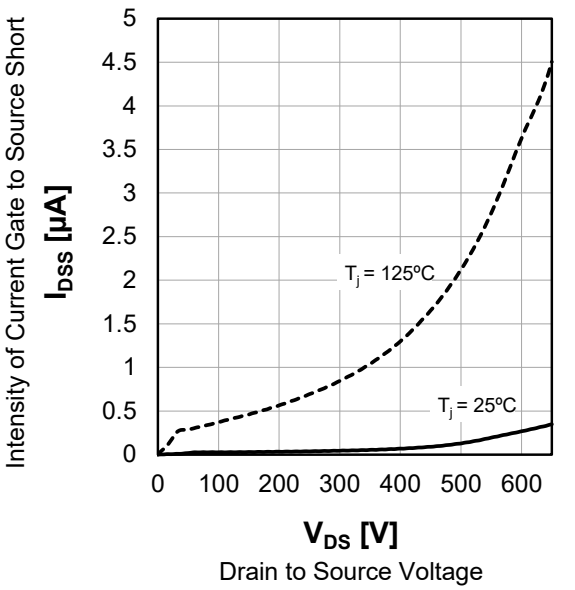
## Electrical Characteristic Curves

Fig.9 Gate to Source Leakage Characteristics



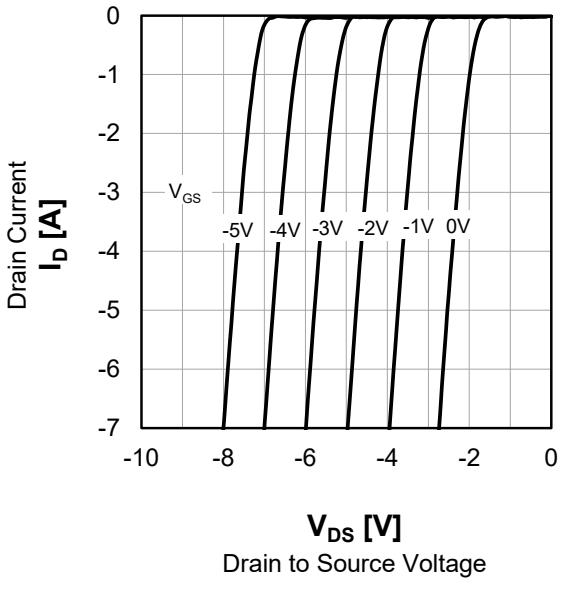

$I_G = f(V_{GS})$; $T_j$ = 25°C

Fig.10 Drain to Source Leakage Characteristics



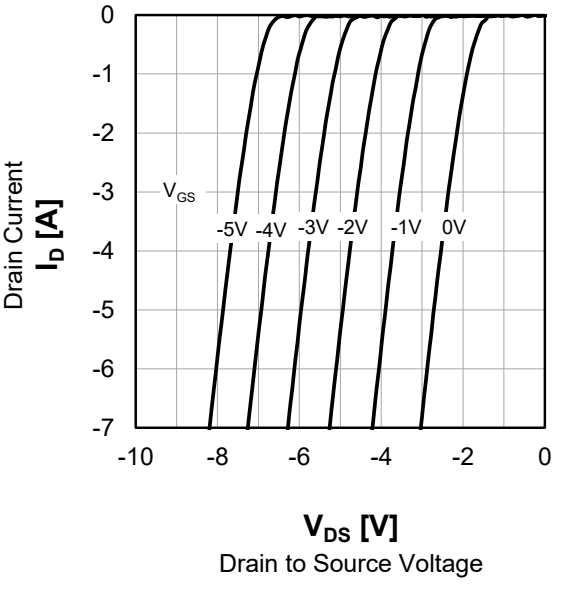

$I_{DSS} = f(V_{DS}, T_j)$; $V_{GS}$ = 0 V; $T_j$ = 25°C, 125°C

Fig.11 Channel Reverse Characteristics




$I_D = f(V_{DS}, V_{GS})$; $T_j$ = 25°C

Fig.12 Channel Reverse Characteristics




$I_D = f(V_{DS}, V_{GS})$; $T_j$ = 125°C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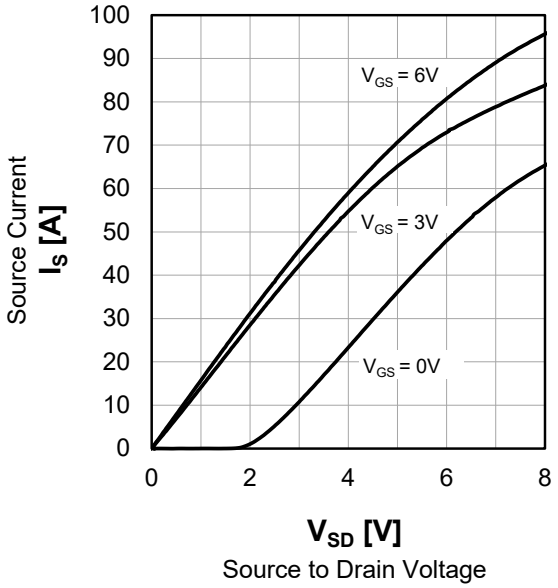
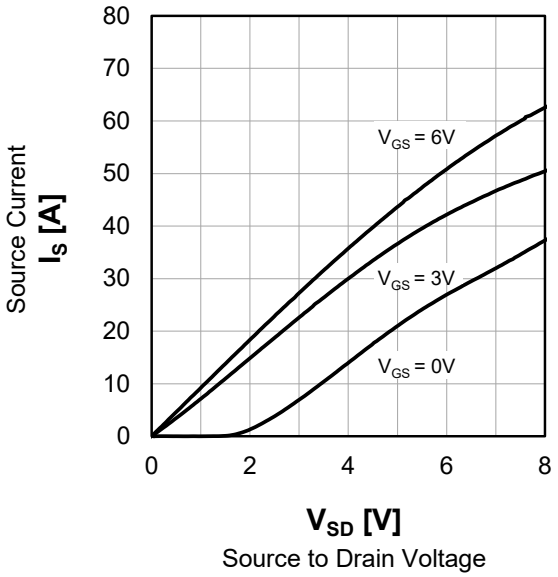
## Electrical Characteristic Curves

Fig.13 Channel Reverse Characteristics



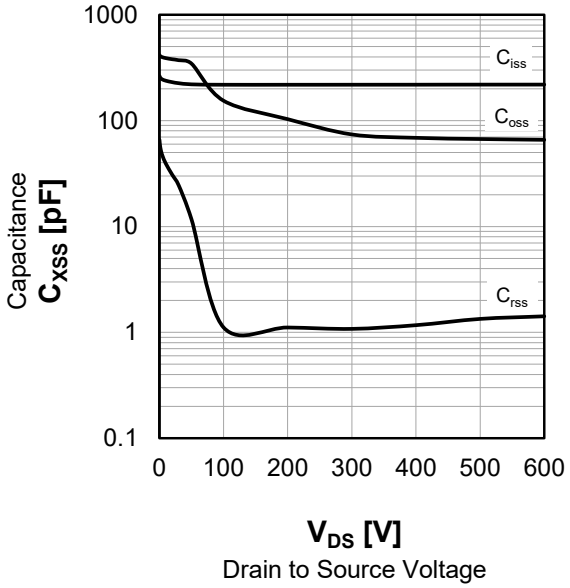

$I_S = f(V_{SD}, V_{GS})$; $T_j$ = 25°C

Fig.14 Channel Reverse Characteristics



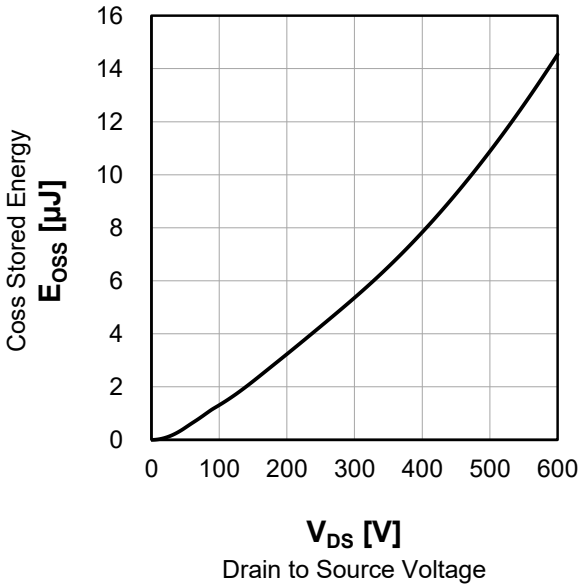

$I_S = f(V_{SD}, V_{GS})$; $T_j$ = 125°C

Fig.15 Typ. Capacitance




$C_{XSS} = f(V_{DS})$; $V_{GS}$ = 0V; f = 1MHz; $T_j$ = 25°C

Fig.16 Typ. Coss Stored Energy




$E_{oss} = f(V_{DS})$; $T_j$ = 25°C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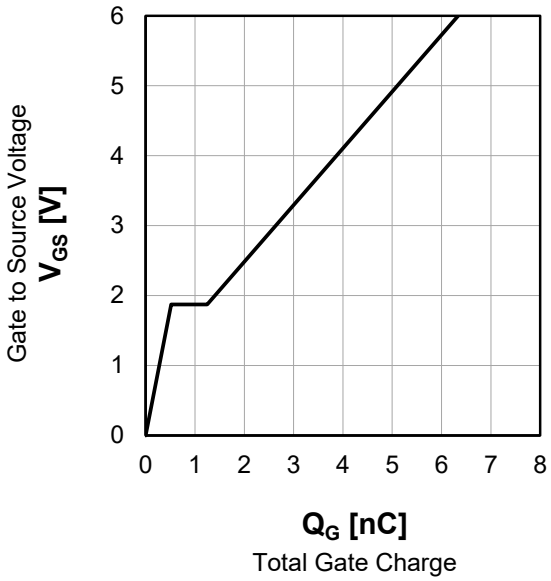
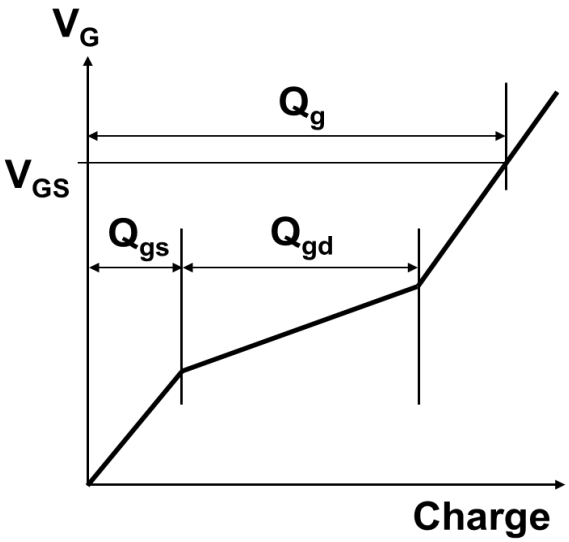
## Electrical Characteristic Curves

| Fig.17 Typ. Gate Charge | ※ Gate Charge Waveform |
|---|---|
|  |  |
| $V_{GS}$ = f($Q_g$); $V_{DCLINK}$ = 400V; $I_D$ = 8A | |



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## Measurement Circuits and Waveforms

Fig.18 Gate Charge Measurement Circuit

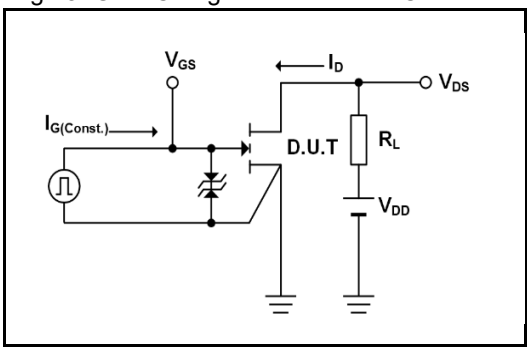



Fig.19 Switching Characteristics Measurement Circuit

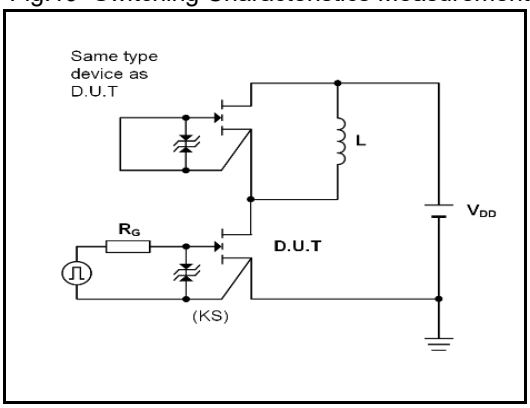



Fig.20 Waveforms for Switching Time

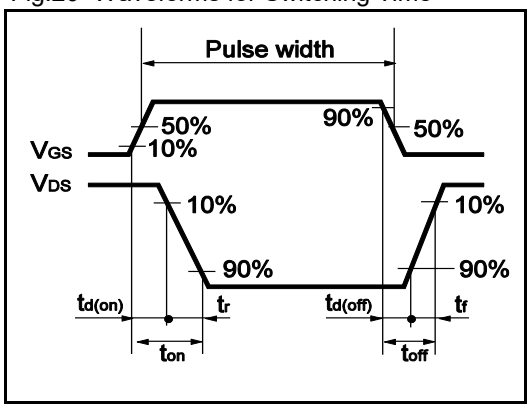
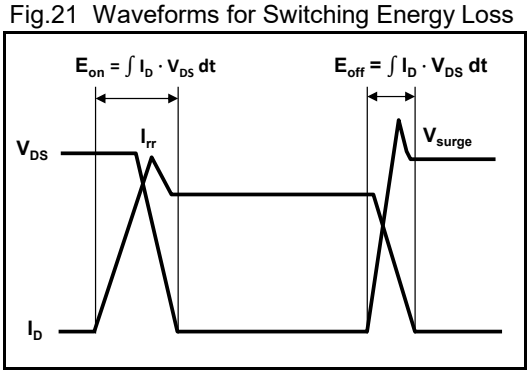



Fig.21 Waveforms for Switching Energy Loss





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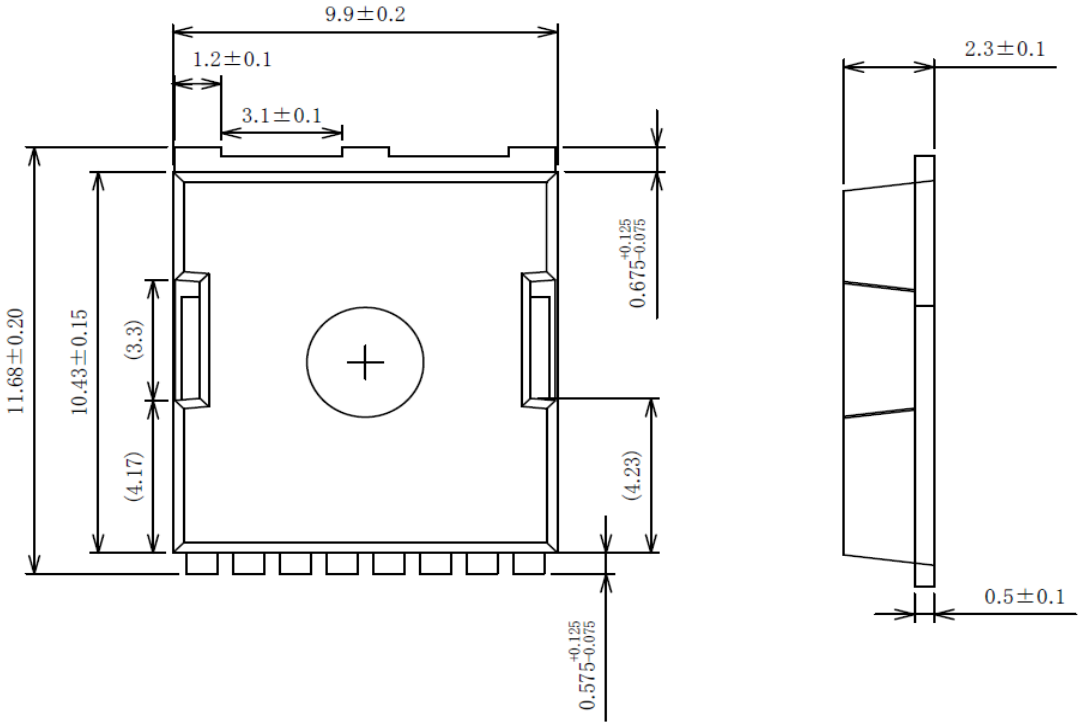
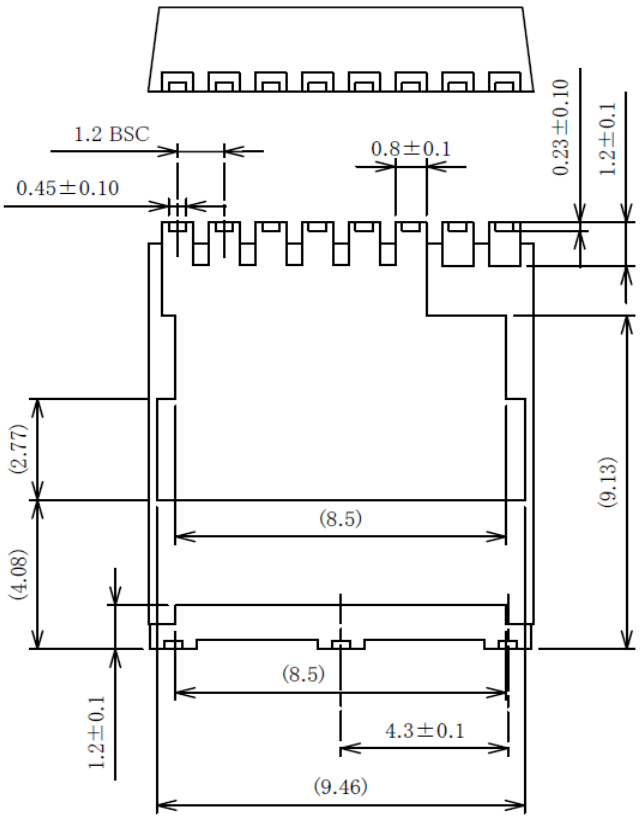
## Physical Dimension

(mm)




(mm)





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## Revision History

| Date | Revision | Changes |
|---|---|---|
| 9.October.2025 | 001 | New Release |


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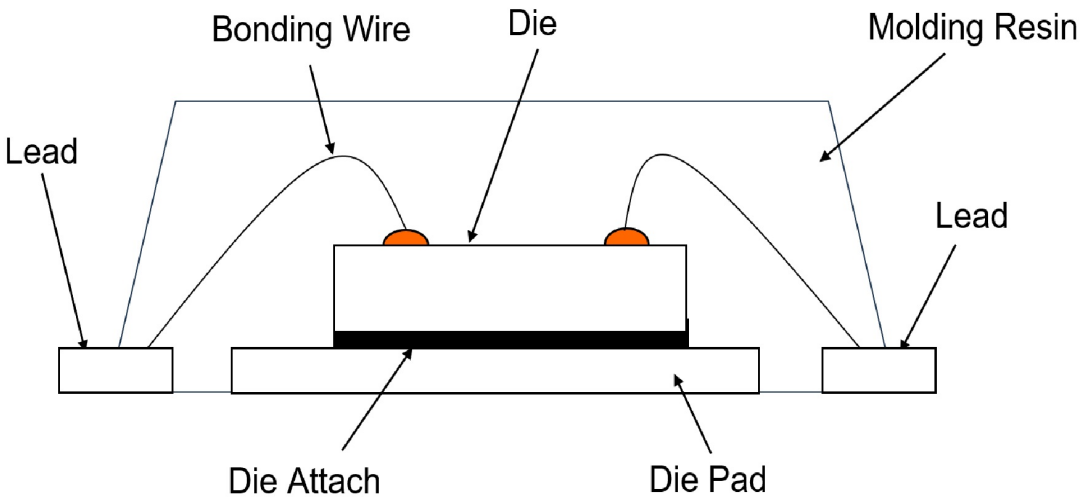
# Package Information : TOLL-8N

## 1. Package Information

| | |
|---|---|
| Package Name | TOLL-8N |
| Type | TO |
| Pin Count | 8 |
| Package Weight [g] | 0.74 |
| Lead Finish | Pure Tin |
| MSL | Level3 |

## 2. Package Structure





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## 3. Packing Specification

### 3.1 Packing form, Quantity, PIN1 Orientation

| | | |
|---|---|---|
| Packing Form | | Tape&Reel |
| Packing Quantity | [pcs] | 2000 |
| PIN 1 Orientation | | TR |

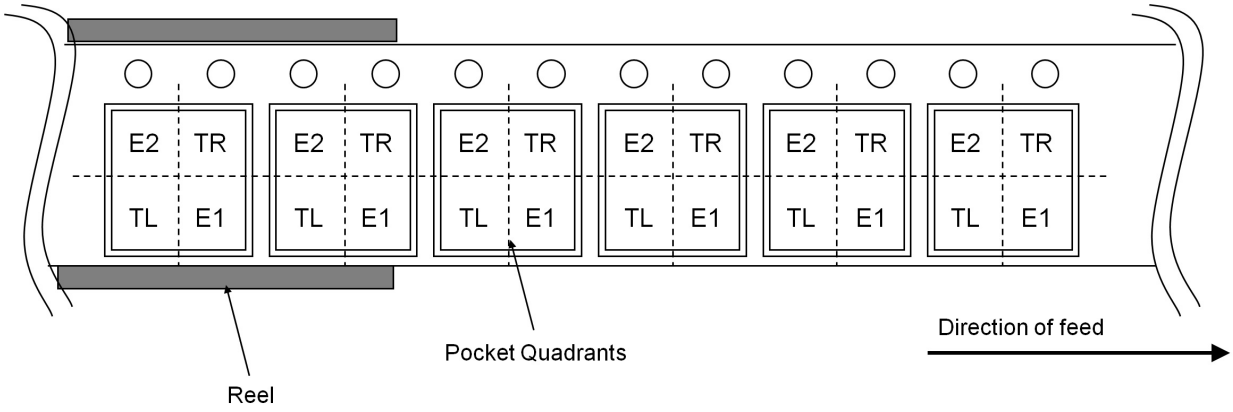


Fig.1 Quadrant Assignments for PIN 1 Orientation in Tape

E2 : PIN1 is placed to the top left corner. TR : PIN1 is placed to the top right corner.

TL : PIN1 is placed to the lower left. E1 : PIN1 is placed to the lower right.

### 3.2 Use material

| Item | Material |
|---|---|
| Embossed carrier tape | PS |
| Cover tape | PET+PE |
| Reel | PS |
| Desiccant | Clay |
| Envelope | Aluminum-laminated |
| Air cap | PE |
| Unit box | Cardboard |
| Shipping box | Cardboard |

### 3.3 Leader specification

No component pockets are 420 mm or more.

### 3.4 Trailer specification

No component pockets are 180 mm or more. Tape is free from reel.

### 3.5 Peelback strength

Cover tape peelback strength is 0.2 N to 0.7 N.

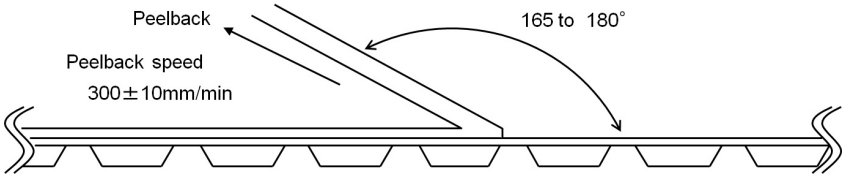


Fig. 2 Test method

### 3.6 Missing Ics

(1) No consecutive dropouts.

(2) A maximun 0.1 % of specified number of products in each packing may be missing.


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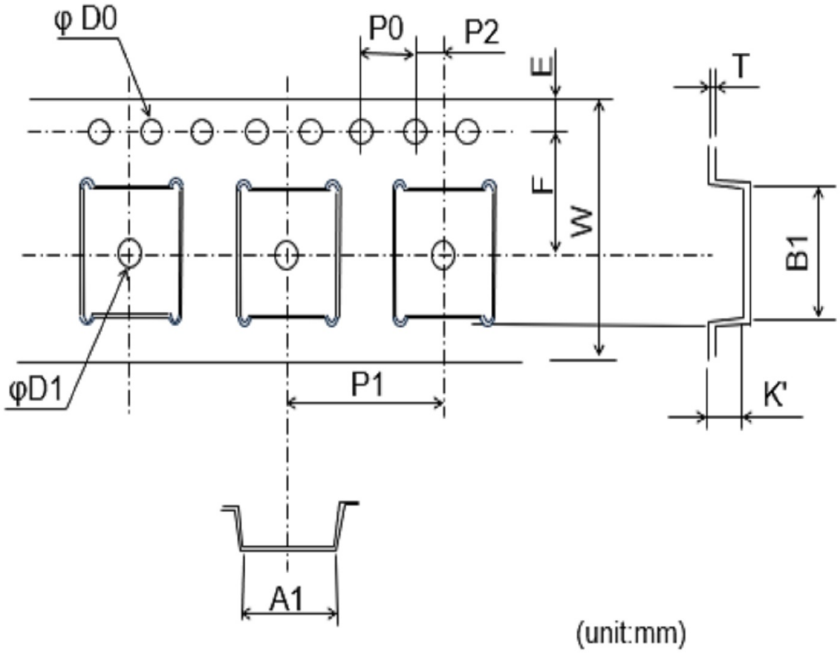
3.7 Tape and Reel Specification

3.7.1 Tape Dimension




(unit:mm)

| | Tape Dimension | Tape Tolerance |
|---|---|---|
| A1 | 10.30 | ±0.1 |
| B1 | 12.10 | ±0.1 |
| D0 | φ1.5 | +0.1/-0 |
| D1 | φ1.5 | +0.1/-0 |
| E | 1.75 | ±0.1 |
| F | 11.50 | ±0.1 |
| K' | 2.70 | ±0.1 |
| P0 | 4.00 | ±0.1 |
| P1 | 12.0 | ±0.1 |
| P2 | 2.00 | ±0.1 |
| T | 0.30 | ±0.1 |
| W | 24.0 | ±0.3 |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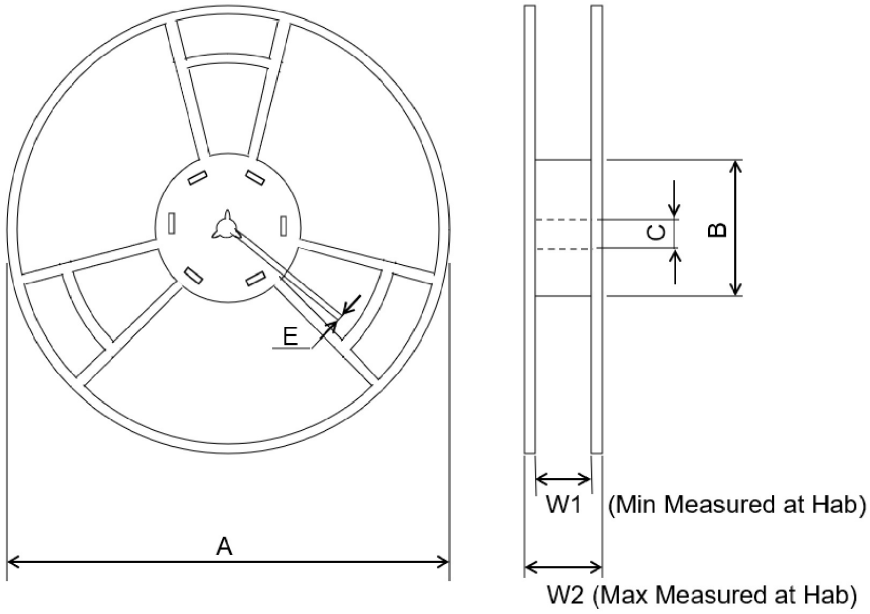
3.7.2 Reel Dimension




(unit:mm)

| | Reel Dimension | Reel Tolerance |
|---|---|---|
| A | 330 | ±2.0 |
| B | 100 | ±1.0 |
| C | 13.2 | ±0.3 |
| D | | |
| E | 2 | ±0.3 |
| W1 | 24.4 | |
| W2 | 31.4 | |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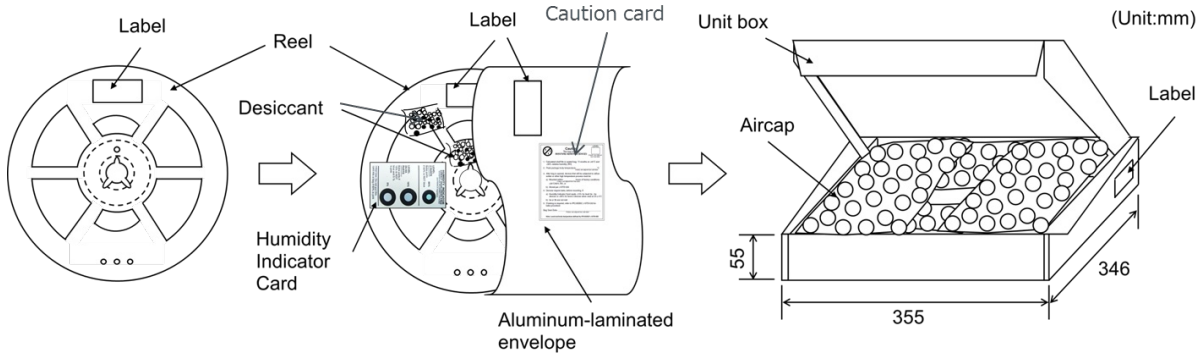
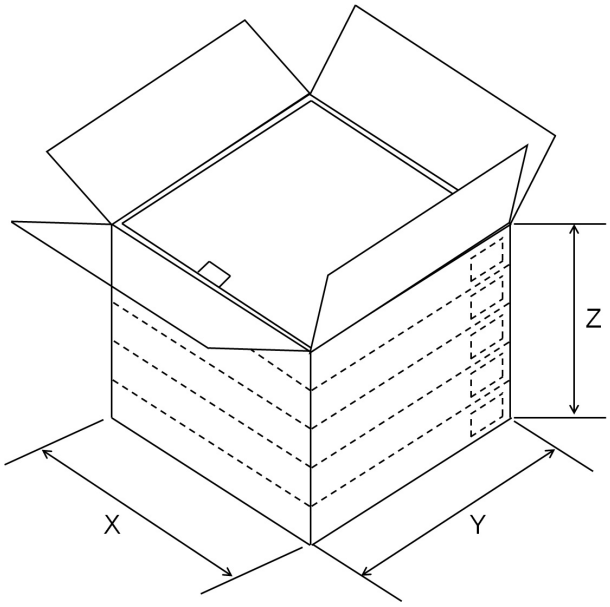
### 3.8 Packing Method

1 reel(s) or less per unit box




### 3.9 Packing Style

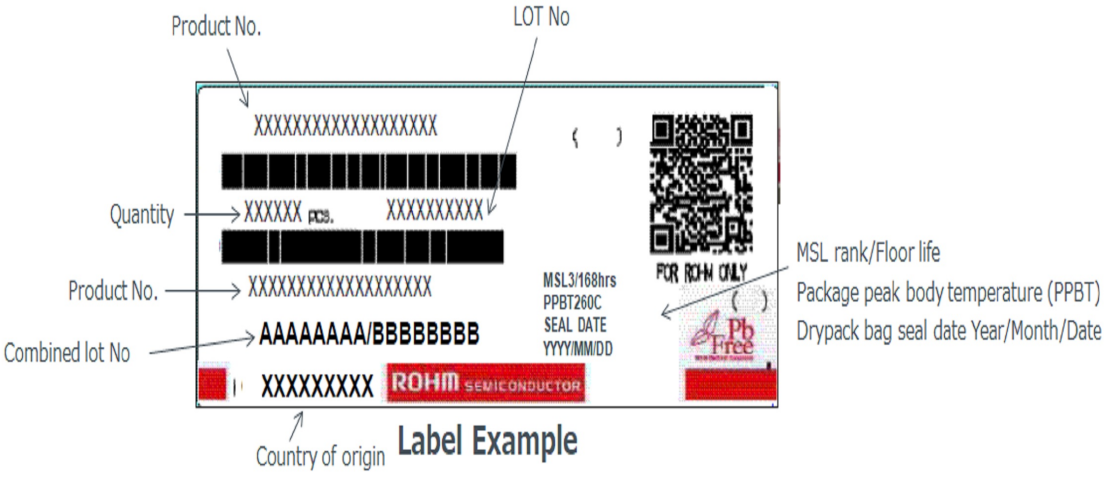
5 unit boxes or less per shipping box




(unit:mm)

| Shipping Box Dimension | |
|---|---|
| X | 372 |
| Y | 368 |
| Z | 305 |

### 3.10 Label Specification





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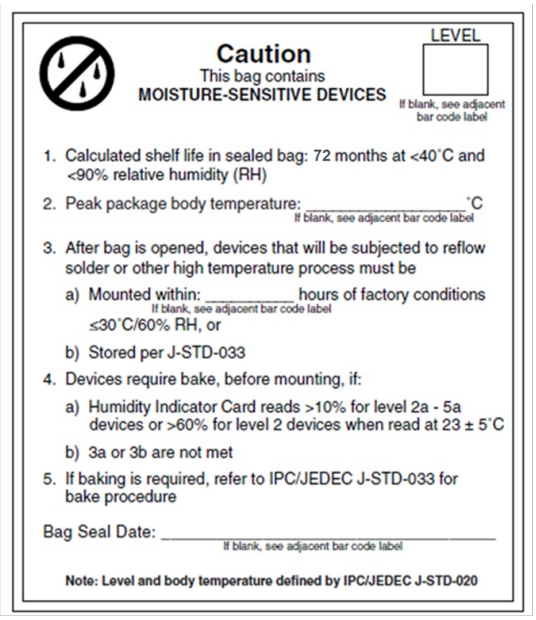
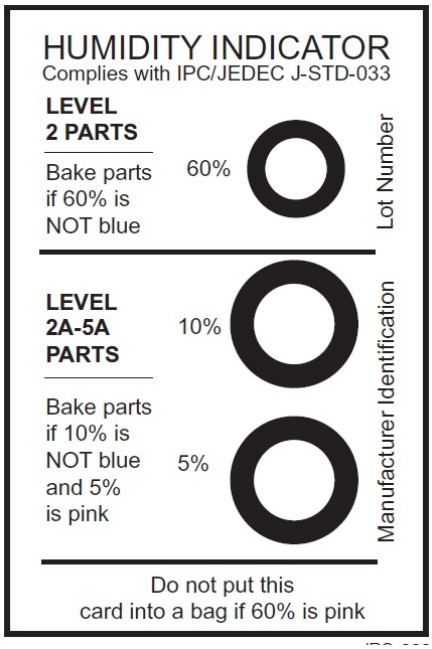
3.11 Caution card specification




Remark ) Standard item 1. calculated shelf life in caution card is not applied for MSL1 product.

3.12 Indicator card specification





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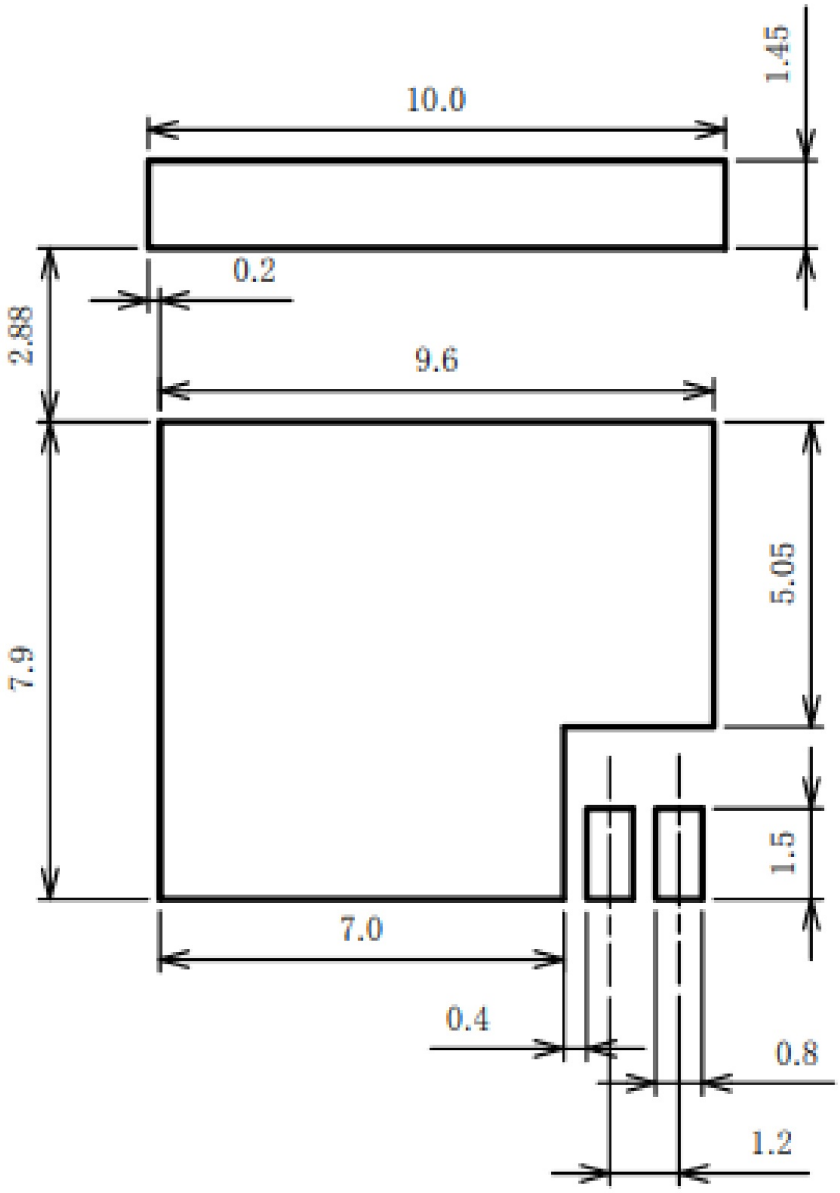
4. Footprint dimensions




(unit:mm)

In actual design, please optimize in accordance with the situation of your board design and soldering condition.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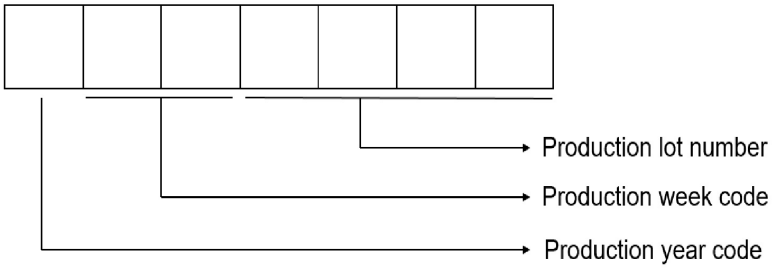
## 5. Marking Specification




## 6. Storage conditions

### 6.1 Storage environment

Recommended storage conditions

| | Min. | Max. | Unit |
|---|---|---|---|
| Temperature | 5 | 30 | °C |
| Humidity | - | 70 | % RH |

### 6.2 Storage period (Start to count since delivery date)

| | Min. | Max. | Unit |
|---|---|---|---|
| Storage period | - | 1 | year |

### 6.3 Specified storage period until soldering

| | Min. | Max. | Unit |
|---|---|---|---|
| Acceptable time | - | 168 | h |

The above value is a time from opening the moisture-proof packaging until the soldering. Cases where it is necessary to perform the drying process is the following.

Case 1 : in excess of the above-mentioned "Acceptable time"

Case 2 : it has passed more than 6 years not open

Recommended the dry process conditions

| | Temperature [°C] | Time [h] |
|---|---|---|
| Reel*(Note1)* | 60 | 48 |
| Other Heat-proof container | | |

*(Note1) When carrying out the dry process in a "Reel" state, the peelback strength will change. Please refer to the following values:*

| | Min. | Max. | Unit |
|---|---|---|---|
| Peelback strength | 0.2 | 0.9 | N |

The drying process is the impact on the solderability because the oxidation of the terminal portion will occur. Therefore, specify the maximum times of the dry processing as follows:

Recommended execution count of the dry process

| | | Unit |
|---|---|---|
| Reel | 1 | times |
| Other Heat-proof container | | times |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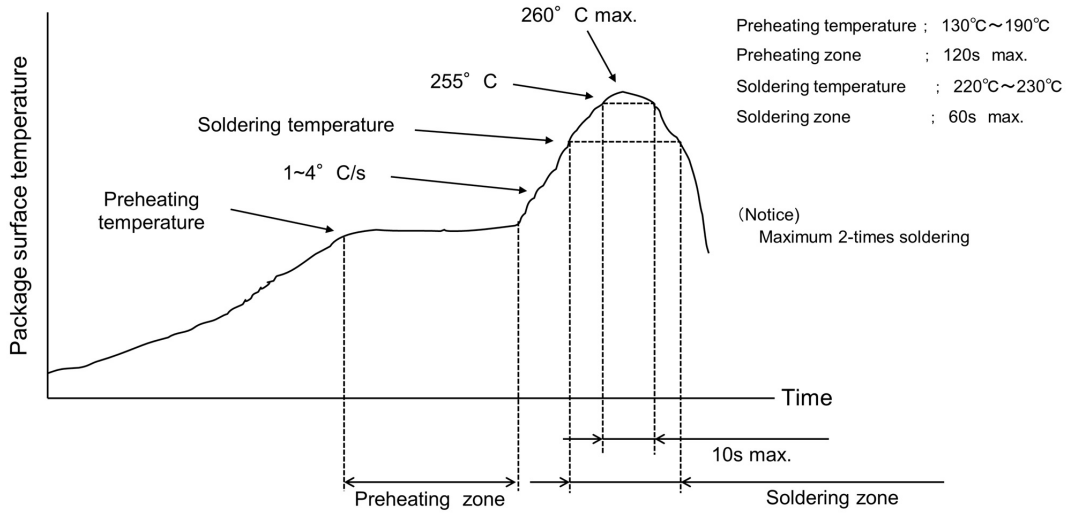
## 7. Soldering conditions

### 7.1 Recommended temperature profile for reflow




### 7.2 Recommended condition for wave soldering

| | | | |
|---|---|---|---|
| Preheating temperature | : | 120 °C to 150 | °C |
| Preheating time | : | 60 s MAX | |
| Soldering temperature | : | 260 °C ± 3 | °C |
| Soldering time | : | 12 s MAX | |

Notes for wave soldering
(1)Soldering time is provided for total soldering time in case of dual wave soldering.
(2) Do not use other soldering methods with wave soldering.
(3) Recommend to clean the board to eliminate flux, solder waste,
and other impurities for reliability, after soldering.
(4) Optimize soldering condition to prevent solder bridging.
(5) The heatsink may not be connected using wave soldering methods.

### 7.3 Recommended condition for solder iron

| | | | |
|---|---|---|---|
| Solder iron temperature | : | 380 °C or less | |
| Mounting time | : | 4 s or less | |

Notes for solder iron
(1)The heatsink may not be connected using solder iron.
(2)Solder mounting time is the time per 1 lead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1. Our Products are designed and manufactured for application in ordinary electronic equipment (such as AV equipment, OA equipment, telecommunication equipment, home electronic appliances, amusement equipment, etc.). If you intend to use our Products in devices requiring extremely high reliability (such as medical equipment (Note 1), transport equipment, traffic equipment, aircraft/spacecraft, nuclear power controllers, fuel controllers, car equipment including car accessories, safety devices, etc.) and whose malfunction or failure may cause loss of human life, bodily injury or serious damage to property ("Specific Applications"), please consult with the ROHM sales representative in advance. Unless otherwise agreed in writing by ROHM in advance, ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of any ROHM's Products for Specific Applications.

(Note1) Medical Equipment Classification of the Specific Applications

| JAPAN | USA | EU | CHINA |
|---|---|---|---|
| CLASSⅢ | CLASSⅢ | CLASSⅡb | CLASSⅢ |
| CLASSⅣ | | CLASSⅢ | |

2. ROHM designs and manufactures its Products subject to strict quality control system. However, semiconductor products can fail or malfunction at a certain rate. Please be sure to implement, at your own responsibilities, adequate safety measures including but not limited to fail-safe design against the physical injury, damage to any property, which a failure or malfunction of our Products may cause. The following are examples of safety measures:
   [a] Installation of protection circuits or other protective devices to improve system safety
   [b] Installation of redundant circuits to reduce the impact of single or multiple circuit failure

3. Our Products are designed and manufactured for use under standard conditions and not under any special or extraordinary environments or conditions, as exemplified below. Accordingly, ROHM shall not be in any way responsible or liable for any damages, expenses or losses arising from the use of any ROHM's Products under any special or extraordinary environments or conditions. If you intend to use our Products under any special or extraordinary environments or conditions (as exemplified below), your independent verification and confirmation of product performance, reliability, etc, prior to use, must be necessary:
   [a] Use of our Products in any types of liquid, including water, oils, chemicals, and organic solvents
   [b] Use of our Products outdoors or in places where the Products are exposed to direct sunlight or dust
   [c] Use of our Products in places where the Products are exposed to sea wind or corrosive gases, including $Cl_2$, $H_2S$, $NH_3$, $SO_2$, and $NO_2$
   [d] Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves
   [e] Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
   [f] Sealing or coating our Products with resin or other coating materials
   [g] Use of our Products without cleaning residue of flux (Exclude cases where no-clean type fluxes is used. However, recommend sufficiently about the residue.) ; or Washing our Products by using water or water-soluble cleaning agents for cleaning residue after soldering
   [h] Use of the Products in places subject to dew condensation

4. The Products are not subject to radiation-proof design.

5. Please verify and confirm characteristics of the final or mounted products in using the Products.

6. In particular, if a transient load (a large amount of load applied in a short period of time, such as pulse, is applied, confirmation of performance characteristics after on-board mounting is strongly recommended. Avoid applying power exceeding normal rated power; exceeding the power rating under steady-state loading condition may negatively affect product performance and reliability.

7. De-rate Power Dissipation depending on ambient temperature. When used in sealed area, confirm that it is the use in the range that does not exceed the maximum junction temperature.

8. Confirm that operation temperature is within the specified range described in the product specification.

9. ROHM shall not be in any way responsible or liable for failure induced under deviant condition from what is defined in this document.

## Precaution for Mounting / Circuit board design

1. When a highly active halogenous (chlorine, bromine, etc.) flux is used, the residue of flux may negatively affect product performance and reliability.

2. In principle, the reflow soldering method must be used on a surface-mount products, the flow soldering method must be used on a through hole mount products. If the flow soldering method is preferred on a surface-mount products, please consult with the ROHM representative in advance.

For details, please refer to ROHM Mounting specification


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### Precautions Regarding Application Examples and External Circuits

1. If change is made to the constant of an external circuit, please allow a sufficient margin considering variations of the characteristics of the Products and external components, including transient characteristics, as well as static characteristics.

2. You agree that application notes, reference designs, and associated data and information contained in this document are presented only as guidance for Products use. Therefore, in case you use such information, you are solely responsible for it and you must exercise your own independent verification and judgment in the use of such information contained in this document. ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of such information.

### Precaution for Electrostatic

This Product is electrostatic sensitive product, which may be damaged due to electrostatic discharge. Please take proper caution in your manufacturing process and storage so that voltage exceeding the Products maximum rating will not be applied to Products. Please take special care under dry condition (e.g. Grounding of human body / equipment / solder iron, isolation from charged objects, setting of Ionizer, friction prevention and temperature / humidity control).

### Precaution for Storage / Transportation

1. Product performance and soldered connections may deteriorate if the Products are stored in the places where:
   [a] the Products are exposed to sea winds or corrosive gases, including $Cl_2$, $H_2S$, $NH_3$, $SO_2$, and $NO_2$
   [b] the temperature or humidity exceeds those recommended by ROHM
   [c] the Products are exposed to direct sunshine or condensation
   [d] the Products are exposed to high Electrostatic

2. Even under ROHM recommended storage condition, solderability of products out of recommended storage time period may be degraded. It is strongly recommended to confirm solderability before using Products of which storage time is exceeding the recommended storage time period.

3. Store / transport cartons in the correct direction, which is indicated on a carton with a symbol. Otherwise bent leads may occur due to excessive stress applied when dropping of a carton.

4. Use Products within the specified time after opening a humidity barrier bag. Baking is required before using Products of which storage time is exceeding the recommended storage time period.

### Precaution for Product Label

A two-dimensional barcode printed on ROHM Products label is for ROHM's internal use only.

### Precaution for Disposition

When disposing Products please dispose them properly using an authorized industry waste company.

### Precaution for Foreign Exchange and Foreign Trade act

Since concerned goods might be fallen under listed items of export control prescribed by Foreign exchange and Foreign trade act, please consult with ROHM in case of export.

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