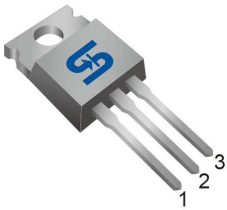
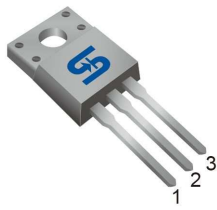
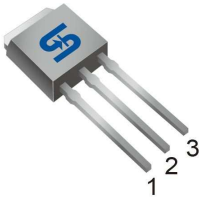
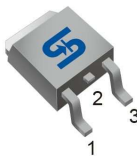


**TO-220**

**ITO-220**

**Pin Definition:**

1. Gate
2. Drain
3. Source

**Key Parameter Performance**

| Parameter          | Value | Unit     |
|--------------------|-------|----------|
| $V_{DS}$           | 650   | V        |
| $R_{DS(on)}$ (max) | 3.37  | $\Omega$ |
| $Q_g$              | 13.46 | nC       |

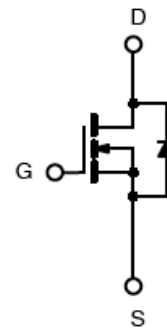
**TO-251  
(IPAK)**

**TO-252  
(DPAK)**

**Application**

- Power Supply.
- Lighting

**Ordering Information**

| Part No.       | Package | Packing            |
|----------------|---------|--------------------|
| TSM4NB65CZ C0G | TO-220  | 50pcs / Tube       |
| TSM4NB65CI C0G | ITO-220 | 50pcs / Tube       |
| TSM4NB65CH C5G | TO-251  | 75pcs / Tube       |
| TSM4NB65CP ROG | TO-252  | 2.5kpcs / 13" Reel |

**Note:** "G" denotes for Halogen- and Antimony-free as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds

**Block Diagram**

**N-Channel MOSFET**
**Absolute Maximum Ratings** ( $T_C = 25^\circ\text{C}$  unless otherwise noted)

| Parameter                                          | Symbol    | Limit       |         |        | Unit             |
|----------------------------------------------------|-----------|-------------|---------|--------|------------------|
|                                                    |           | IPAK/DPAK   | ITO-220 | TO-220 |                  |
| Drain-Source Voltage                               | $V_{DS}$  | 650         |         |        | V                |
| Gate-Source Voltage                                | $V_{GS}$  | $\pm 30$    |         |        | V                |
| Continuous Drain Current <sup>(Note 1)</sup>       | $I_D$     | 4           |         |        | A                |
|                                                    |           | 2.4         |         |        | A                |
| Pulsed Drain Current <sup>(Note 2)</sup>           | $I_{DM}$  | 16          |         |        | A                |
| Single Pulse Avalanche Energy <sup>(Note 3)</sup>  | $E_{AS}$  | 31.2        |         |        | mJ               |
| Total Power Dissipation @ $T_C = 25^\circ\text{C}$ | $P_{TOT}$ | 50          | 25      | 70     | W                |
| Operating Junction Temperature                     | $T_J$     | -55 to +150 |         |        | $^\circ\text{C}$ |
| Storage Temperature Range                          | $T_{STG}$ | -55 to +150 |         |        | $^\circ\text{C}$ |

### Thermal Performance

| Parameter                                | Symbol          | Limit     |         |        | Unit                 |
|------------------------------------------|-----------------|-----------|---------|--------|----------------------|
|                                          |                 | IPAK/DPAK | ITO-220 | TO-220 |                      |
| Thermal Resistance - Junction to Case    | $R_{\theta JC}$ | 2.5       | 5       | 1.78   | $^{\circ}\text{C/W}$ |
| Thermal Resistance - Junction to Ambient | $R_{\theta JA}$ | 83        | 62.5    | 62.5   | $^{\circ}\text{C/W}$ |

### Electrical Specifications ( $T_A=25^{\circ}\text{C}$ unless otherwise noted)

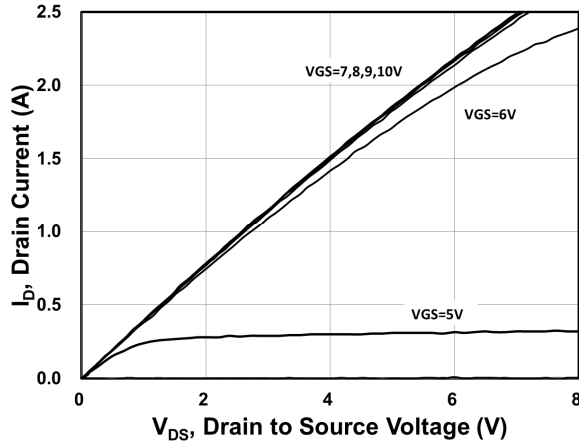
| Parameter                                              | Conditions                                                   | Symbol       | Min | Typ   | Max       | Unit     |
|--------------------------------------------------------|--------------------------------------------------------------|--------------|-----|-------|-----------|----------|
| Static (Note 4)                                        |                                                              |              |     |       |           |          |
| Drain-Source Breakdown Voltage                         | $V_{GS} = 0V, I_D = 250\mu A$                                | $BV_{DSS}$   | 650 | --    | --        | V        |
| Drain-Source On-State Resistance                       | $V_{GS} = 10V, I_D = 2A$                                     | $R_{DS(ON)}$ | --  | 2.7   | 3.37      | $\Omega$ |
| Gate Threshold Voltage                                 | $V_{DS} = V_{GS}, I_D = 250\mu A$                            | $V_{GS(TH)}$ | 2.5 | 3.6   | 4.5       | V        |
| Zero Gate Voltage Drain Current                        | $V_{DS} = 650V, V_{GS} = 0V$                                 | $I_{DSS}$    | --  | --    | 1         | $\mu A$  |
| Gate Body Leakage                                      | $V_{GS} = \pm 30V, V_{DS} = 0V$                              | $I_{GSS}$    | --  | --    | $\pm 100$ | nA       |
| Forward Transfer Conductance                           | $V_{DS} = 40V, I_D = 2A$                                     | $g_{fs}$     | --  | 2.6   | --        | S        |
| Dynamic (Note 5)                                       |                                                              |              |     |       |           |          |
| Total Gate Charge                                      | $V_{DS} = 480V, I_D = 4A,$<br>$V_{GS} = 10V$                 | $Q_g$        | --  | 13.46 | --        | nC       |
| Gate-Source Charge                                     |                                                              | $Q_{gs}$     | --  | 2.98  | --        |          |
| Gate-Drain Charge                                      |                                                              | $Q_{gd}$     | --  | 6.66  | --        |          |
| Input Capacitance                                      | $V_{DS} = 25V, V_{GS} = 0V,$<br>$f = 1.0MHz$                 | $C_{iss}$    | --  | 549   | --        | pF       |
| Output Capacitance                                     |                                                              | $C_{oss}$    | --  | 75    | --        |          |
| Reverse Transfer Capacitance                           |                                                              | $C_{rss}$    | --  | 18    | --        |          |
| Switching (Note 6)                                     |                                                              |              |     |       |           |          |
| Turn-On Delay Time                                     | $V_{GS} = 10V, I_D = 4A,$<br>$V_{DD} = 300V, R_G = 25\Omega$ | $t_{d(on)}$  | --  | 11    | --        | ns       |
| Turn-On Rise Time                                      |                                                              | $t_r$        | --  | 20    | --        |          |
| Turn-Off Delay Time                                    |                                                              | $t_{d(off)}$ | --  | 30    | --        |          |
| Turn-Off Fall Time                                     |                                                              | $t_f$        | --  | 19    | --        |          |
| Source-Drain Diode Ratings and Characteristic (Note 4) |                                                              |              |     |       |           |          |
| Source Current                                         | Integral reverse diode in the MOSFET                         | $I_S$        | --  | --    | 4         | A        |
| Source Current (Pulse)                                 |                                                              | $I_{SM}$     | --  | --    | 16        | A        |
| Diode Forward Voltage                                  | $I_S = 4A, V_{GS} = 0V$                                      | $V_{SD}$     | --  | --    | 1.13      | V        |

#### Notes:

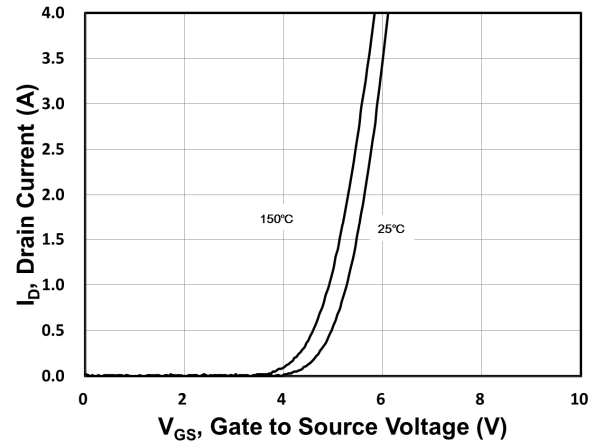
- Current limited by package
- Pulse width limited by the maximum junction temperature
- $L = 10\text{mH}, I_{AS} = 2.4\text{A}, V_{DD} = 50\text{V}, R_G = 25\Omega$ , Starting  $T_J = 25^{\circ}\text{C}$
- Pulse test:  $PW \leq 300\mu\text{s}$ , duty cycle  $\leq 2\%$
- For DESIGN AID ONLY, not subject to production testing.
- Switching time is essentially independent of operating temperature.

### Electrical Characteristics Curves

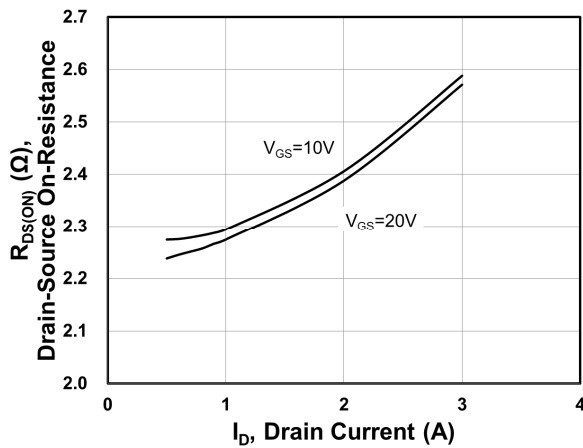
**Output Characteristics**



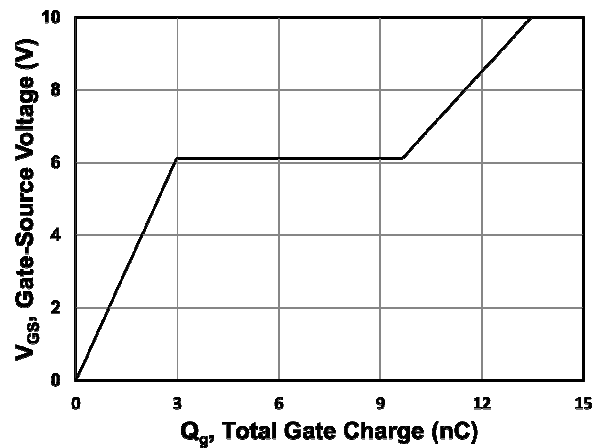
**Transfer Characteristics**



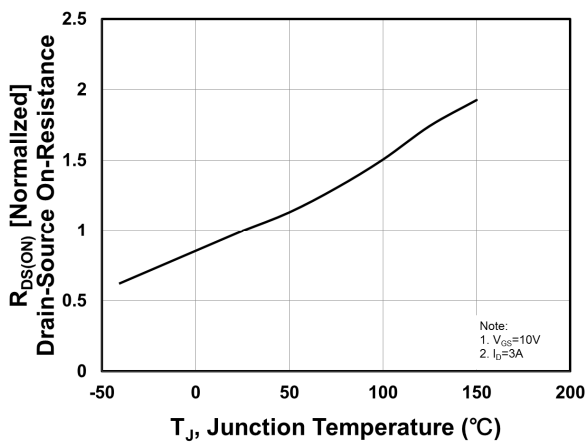
**On-Resistance vs. Drain Current**



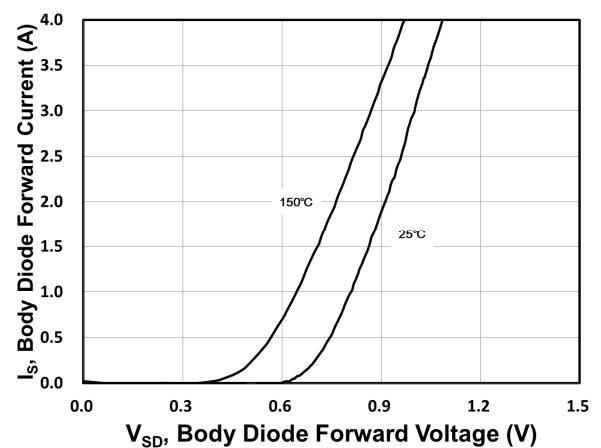
**Gate-Source Voltage vs. Gate Charge**



**On-Resistance vs. Junction Temperature**

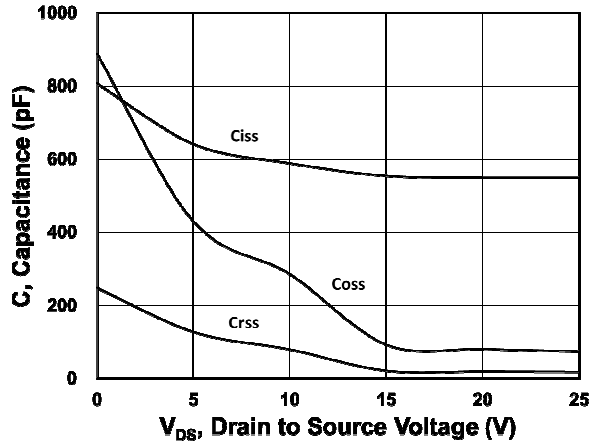


**Source-Drain Diode Forward Current vs. Voltage**

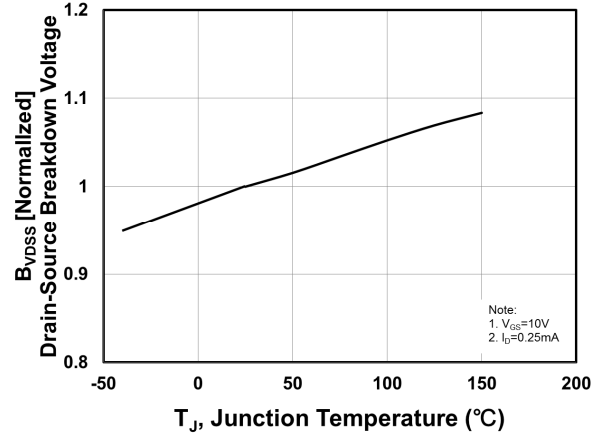


### Electrical Characteristics Curves

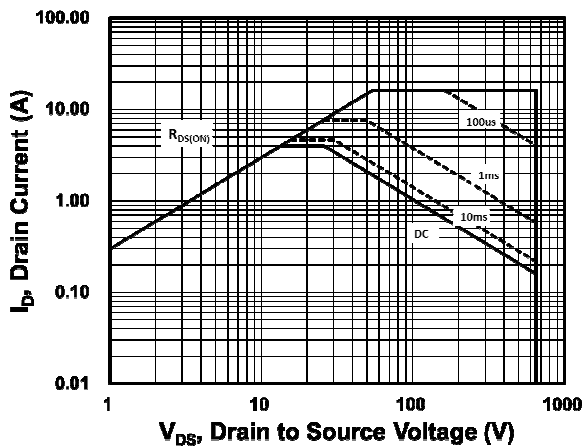
Capacitance vs. Drain-Source Voltage



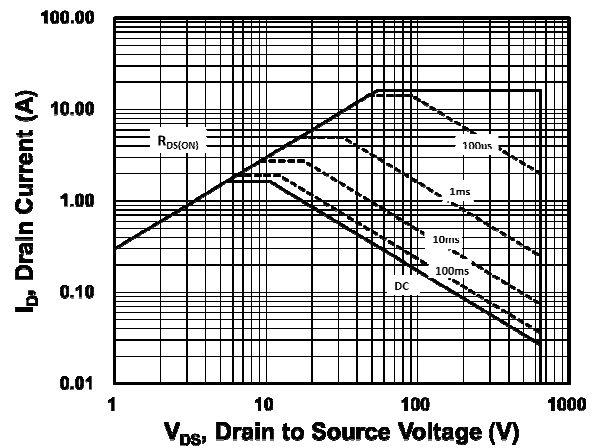
$BV_{DSS}$  vs. Junction Temperature



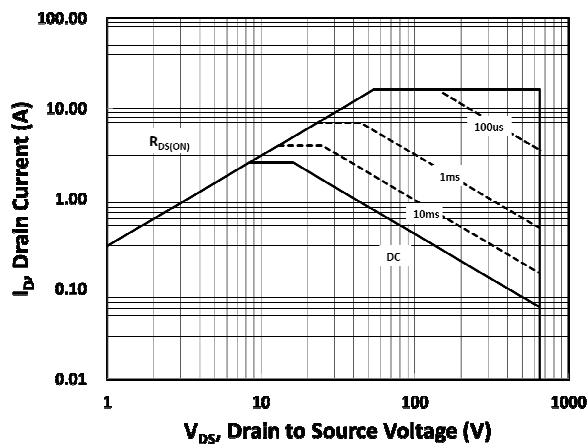
Maximum Safe Operating Area (TO-220)



Maximum Safe Operating Area (ITO-220)

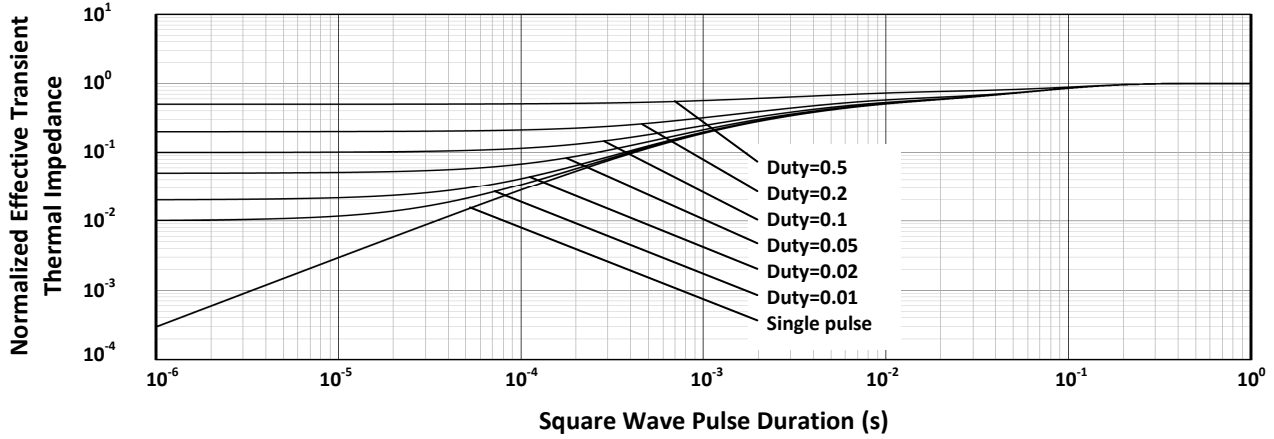


Maximum Safe Operating Area (DPAK/IPAK)

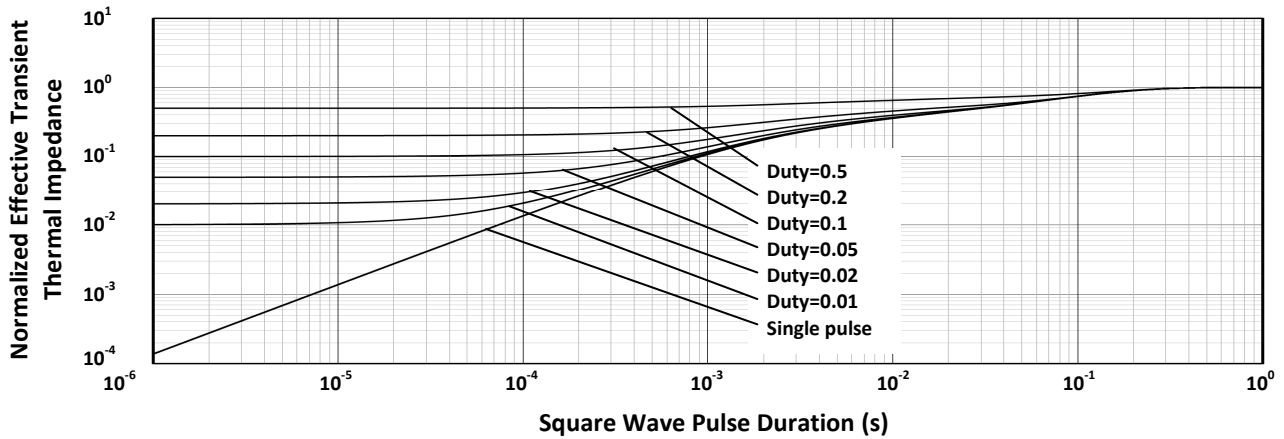


### Electrical Characteristics Curves

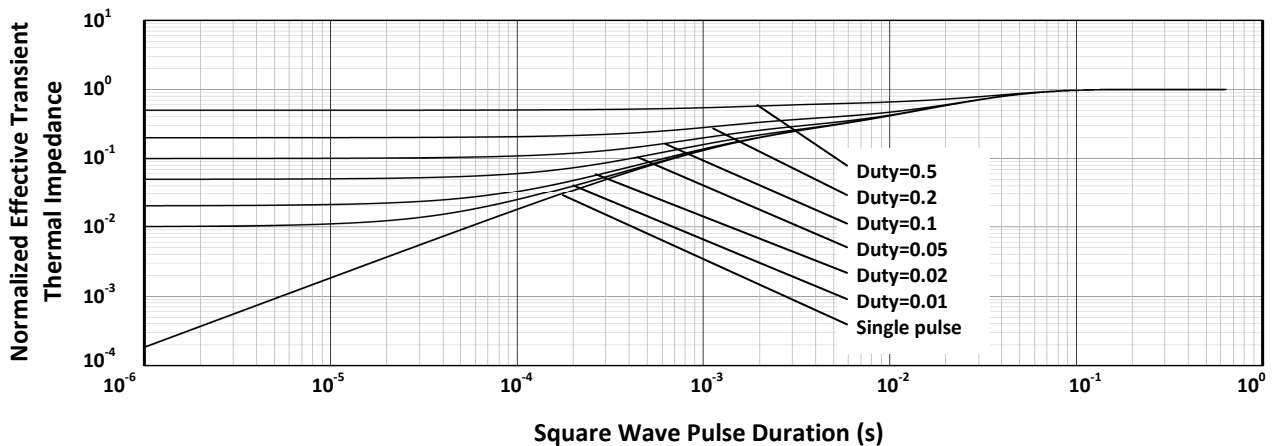
**Normalized Thermal Transient Impedance, Junction-to-Case (TO-220)**



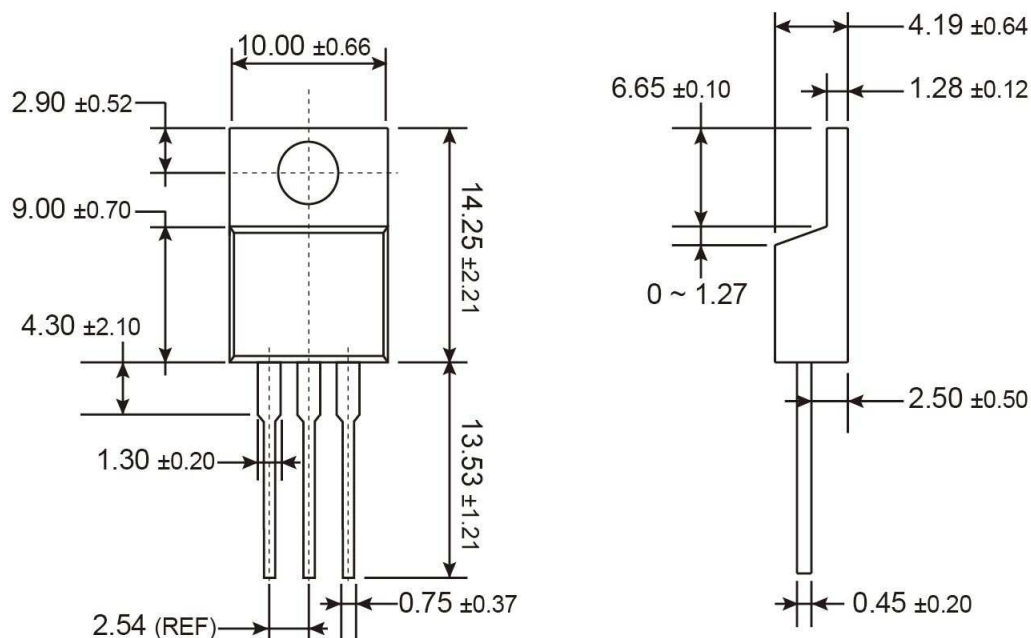
**Normalized Thermal Transient Impedance, Junction-to-Case (ITO-220)**



**Normalized Thermal Transient Impedance, Junction-to-Case (DPAK/IPAK)**

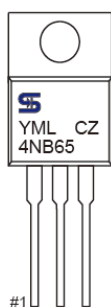


### TO-220 Mechanical Drawing



Unit: Millimeters

### Marking Diagram



**Y** = Year Code

**M** = Month Code for Halogen Free Product

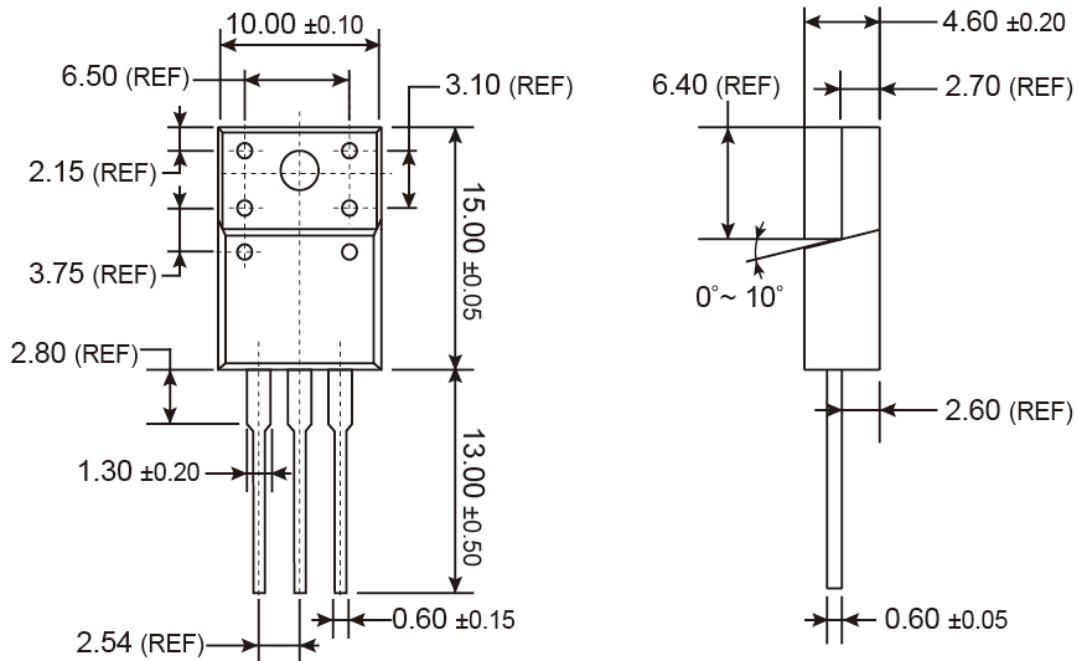
**O** =Jan **P** =Feb **Q** =Mar **R** =Apr

**S** =May **T** =Jun **U** =Jul **V** =Aug

**W** =Sep **X** =Oct **Y** =Nov **Z** =Dec

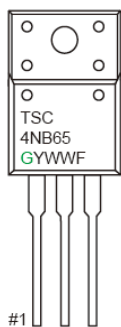
**L** = Lot Code

### ITO-220 Mechanical Drawing



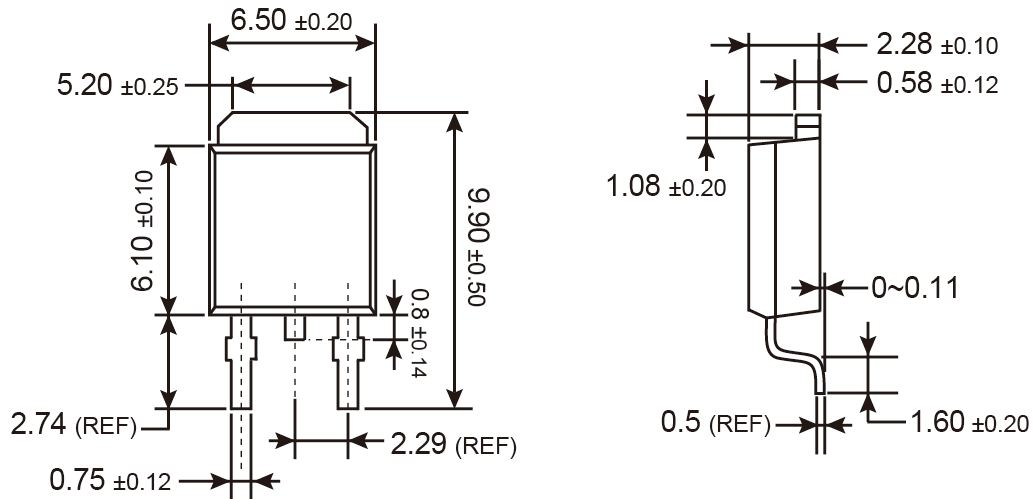
Unit: Millimeters

### Marking Diagram



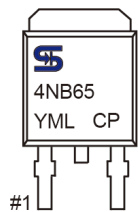
- G** = Halogen Free
- Y** = Year Code
- WW** = Week Code (01~52)
- F** = Factory Code

### TO-252 (DPAK) Mechanical Drawing



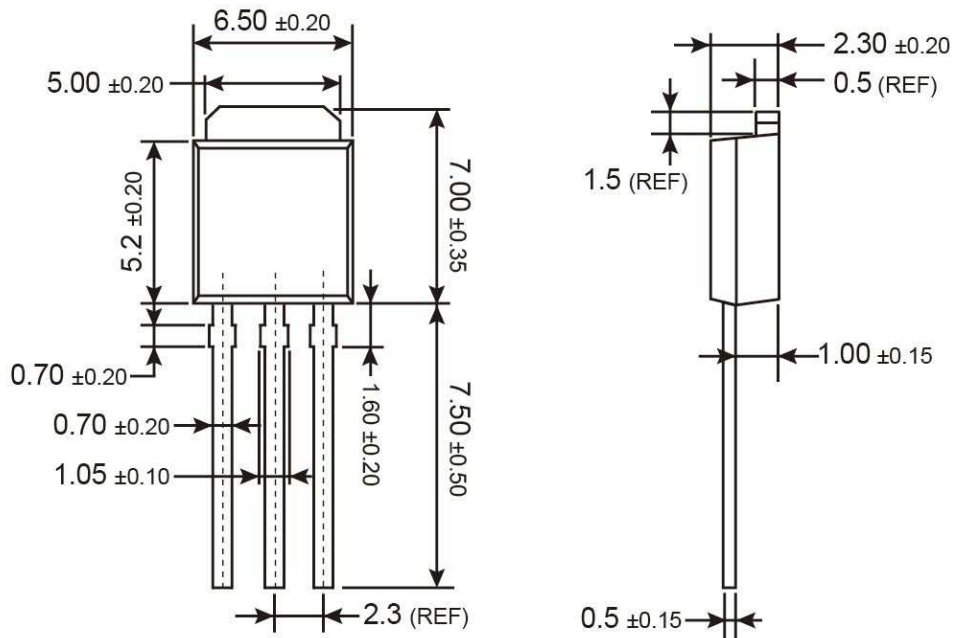
Unit: Millimeters

### Marking Diagram



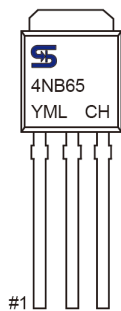
Y = Year Code  
M = Month Code for Halogen Free Product  
O =Jan P =Feb Q =Mar R =Apr  
S =May T =Jun U =Jul V =Aug  
W =Sep X =Oct Y =Nov Z =Dec  
L = Lot Code

### TO-251 (IPAK) Mechanical Drawing



Unit: Millimeters

### Marking Diagram



Y = Year Code  
M = Month Code for Halogen Free Product  
O =Jan P =Feb Q =Mar R =Apr  
S =May T =Jun U =Jul V =Aug  
W =Sep X =Oct Y =Nov Z =Dec  
L = Lot Code

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### Офис по работе с юридическими лицами:

105318, г.Москва, ул.Щербаковская д.3, офис 1107, 1118, ДЦ «Щербаковский»

Телефон: +7 495 668-12-70 (многоканальный)

Факс: +7 495 668-12-70 (доб.304)

E-mail: [info@moschip.ru](mailto:info@moschip.ru)

Skype отдела продаж:

moschip.ru

moschip.ru\_4

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