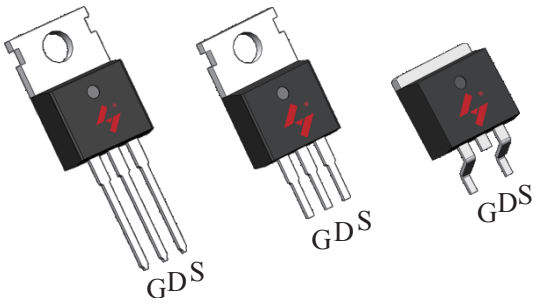
N-Channel Enhancement Mode MOSFET

## Feature

- 45V/150A
  $R_{DS(ON)}$= 2.9mΩ (typ.) @$V_{GS}$ = 10V
  $R_{DS(ON)}$= 3.4mΩ (typ.) @$V_{GS}$ = 4.5V
- 100% Avalanche Tested
- Reliable and Rugged
- Lead Free and Green Devices Available
  (RoHS Compliant)

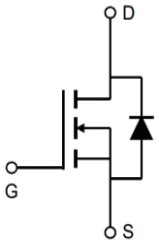
## Pin Description




TO-220FB-3L TO-220FB-3S TO-263-2L

## Applications

- Switching Application
- Power Management for DC/DC




N-Channel MOSFET

## Ordering and Marking Information

| P | B | M |
|---|---|---|
| HY3404 | HY3404 | HY3404 |
| AYMXXXXXX | AYMXXXXXX | AYMXXXXXX |

Package Code
P:TO-220FB-3L B:TO-263-2L M:TO-220FB-3S

Date Code
AYMXXXXXX

Note: HUAYI lead-free products contain molding compounds/die attach materials and 100% matte tin plateTermi-Nation finish; which are fully compliant with RoHS. HUAYI lead-free products meet or exceed the lead-Free require-ments of IPC/JEDEC J-STD-020 for MSL classification at lead-free peak reflow temperature. HUAYI defines “Green” to mean lead-free (RoHS compliant) and halogen free (Br or Cl does not exceed 900ppm by weight in homogeneous material and total of Br and Cl does not exceed 1500ppm by weight).

HUAYI reserves the right to make changes, corrections, enhancements, modifications, and improvements to this pr-oduct and/or to this document at any time without notice..

## Absolute Maximum Ratings

| Symbol | Parameter | | Rating | Unit |
|---|---|---|---|---|
| **Common Ratings** (Tc=25°C Unless Otherwise Noted) | | | | |
| $V_{DSS}$ | Drain-Source Voltage | | 45 | V |
| $V_{GSS}$ | Gate-Source Voltage | | ±20 | V |
| $T_J$ | Maximum Junction Temperature | | -55 to 175 | °C |
| $T_{STG}$ | Storage Temperature Range | | -55 to 175 | °C |
| $I_S$ | Source Current-Continuous(Body Diode) | Tc=25°C | 150 | A |
| **Mounted on Large Heat Sink** | | | | |
| $I_{DM}$ | Pulsed Drain Current * | Tc=25°C | 530 | A |
| $I_D$ | Continuous Drain Current | Tc=25°C | 150 | A |
| | | Tc=100°C | 102 | A |
| $P_D$ | Maximum Power Dissipation | Tc=25°C | 187.5 | W |
| | | Tc=100°C | 93.7 | W |
| $R_{\theta JC}$ | Thermal Resistance, Junction-to-Case** | | 0.8 | °C/W |
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient | | 62.5 | °C/W |
| $E_{AS}$ | SinglePulsed-Avalanche Energy *** | L=0.3mH | 411 | mJ |

Note: * Repetitive rating; pulse width limited by max.junction temperature.
** Drain current is limited by junction temperature
*** Limited by $T_J$max , starting $T_J$=25°C, L = 0.3mH, VD= 32V, $V_{GS}$ =10V.

## Electrical Characteristics(Tc =25°C Unless Otherwise Noted)

| Symbol | Parameter | Test Conditions | HY3404 | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min | Typ. | Max | |
| **Static Characteristics** | | | | | | |
| $BV_{DSS}$ | Drain-Source Breakdown Voltage | $V_{GS}$=0V,$I_{DS}$=250μA | 45 | - | - | V |
| $I_{DSS}$ | Drain-to-Source Leakage Current | $V_{DS}$=45V,$V_{GS}$=0V | - | - | 1 | μA |
| | | $T_J$=125°C | - | - | 100 | μA |
| $V_{GS(th)}$ | Gate Threshold Voltage | $V_{DS}$=$V_{GS}$, $I_{DS}$=250μA | 1.0 | 1.7 | 3.0 | V |
| $I_{GSS}$ | Gate-Source Leakage Current | $V_{GS}$=±20V,$V_{DS}$=0V | - | - | ±100 | nA |
| $R_{DS(ON)}$* | Drain-Source On-State Resistance | $V_{GS}$=10V,$I_{DS}$=40A | - | 2.9 | 3.6 | mΩ |
| $R_{DS(ON)}$* | Drain-Source On-State Resistance | $V_{GS}$=4.5V,$I_{DS}$=40A | - | 3.4 | 4.3 | mΩ |
| **Diode Characteristics** | | | | | | |
| $V_{SD}$* | Diode Forward Voltage | $I_{SD}$=40A,$V_{GS}$=0V | - | 0.84 | 1.0 | V |
| $t_{rr}$ | Reverse Recovery Time | $I_{SD}$=20A,dI$_{SD}$/dt=100A/μs | - | 21 | - | ns |
| $Q_{rr}$ | Reverse Recovery Charge | | - | 14 | - | nC |

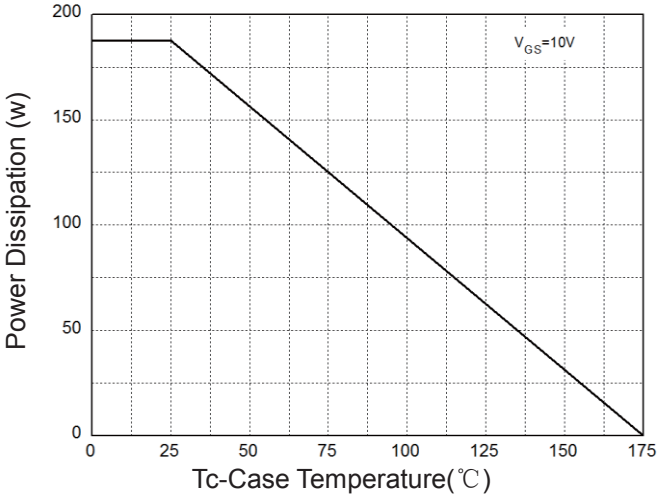
## Electrical Characteristics (Cont.) (Tc =25°C Unless Otherwise Noted)

| Symbol | Parameter | Test Conditions | HY3404 | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min | Typ. | Max | |
| **Dynamic Characteristics** | | | | | | |
| $R_G$ | Gate Resistance | $V_{GS}$=0V,$V_{DS}$=0V, Frequency=1.0MHz | - | 1.0 | - | Ω |
| $C_{iss}$ | Input Capacitance | $V_{GS}$=0V, $V_{DS}$=25V, Frequency=1.0MHz | - | 5129 | - | pF |
| $C_{oss}$ | Output Capacitance | | - | 440 | - | |
| $C_{rss}$ | Reverse Transfer Capacitance | | - | 230 | - | |
| $t_{d(ON)}$ | Turn-on Delay Time | $V_{DD}$=25V,$R_G$=2.5Ω, $I_{DS}$=40A,$V_{GS}$=10V | - | 14 | - | ns |
| $T_r$ | Turn-on Rise Time | | - | 71 | - | |
| $t_{d(OFF)}$ | Turn-off Delay Time | | - | 64 | - | |
| $T_f$ | Turn-off Fall Time | | - | 105 | - | |
| **Gate Charge Characteristics** | | | | | | |
| $Q_g$ | Total Gate Charge（VGS=10V） | $V_{DS}$ =32V, $I_D$=40A | - | 102 | - | nC |
| $Q_g$ | Total Gate Charge（VGS=4.5V） | | | 48 | | |
| $Q_{gs}$ | Gate-Source Charge | | - | 13 | - | |
| $Q_{gd}$ | Gate-Drain Charge | | - | 23 | - | |

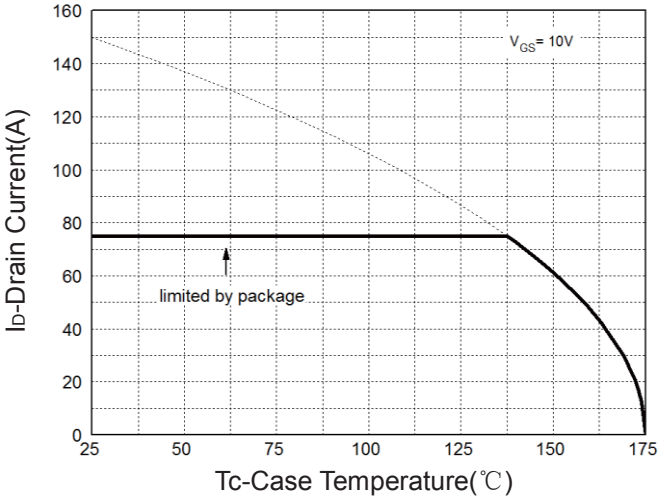
Note: *Pulse test，pulse width ≤ 300us，duty cycle ≤ 2%

## Typical Operating Characteristics

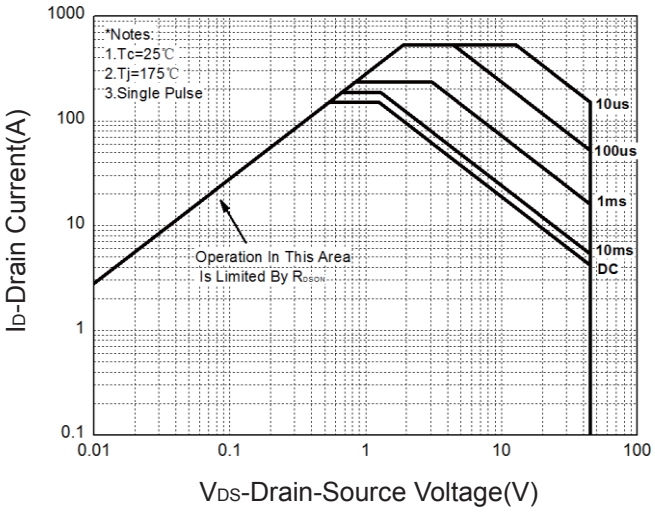
### Figure 1: Power Dissipation



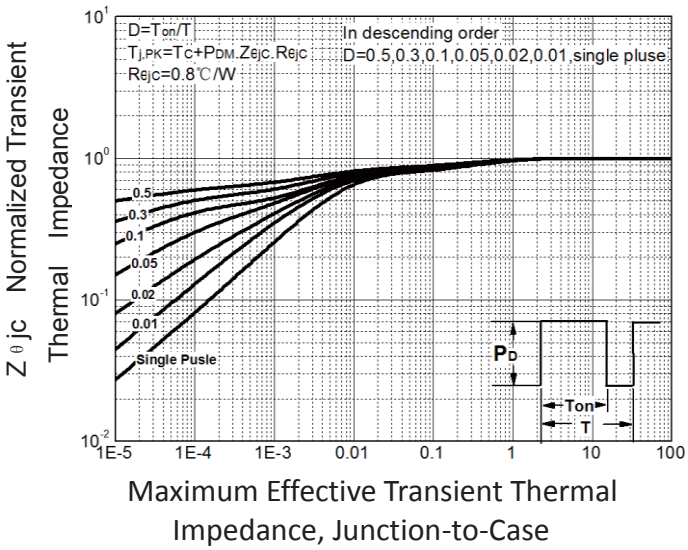

### Figure 2: Drain Current




### Figure 3: Safe Operation Area

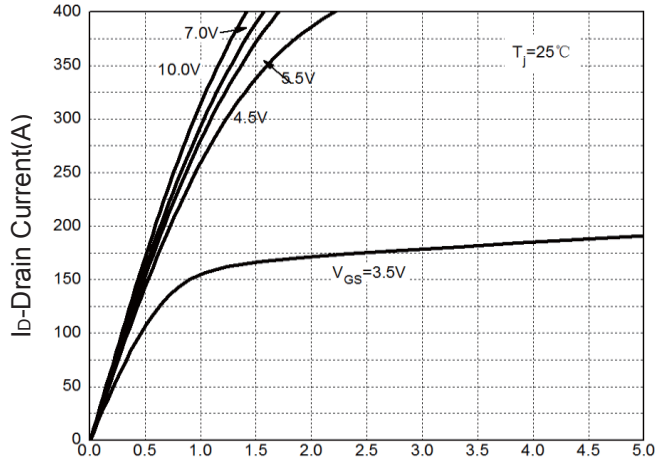



### Figure 4: Thermal Transient Impedance

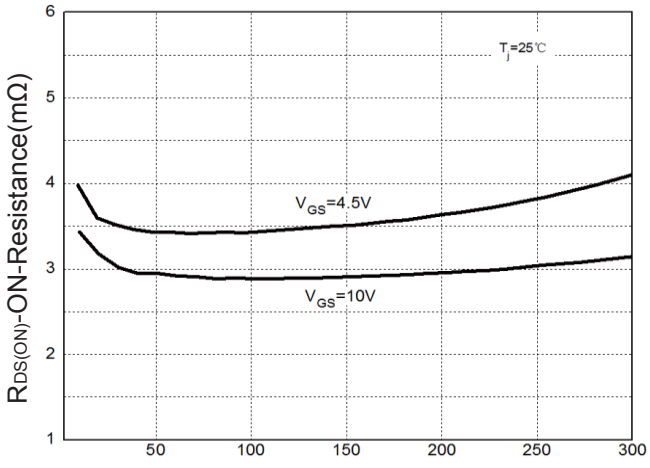



Maximum Effective Transient Thermal Impedance, Junction-to-Case

### Figure 5: Output Characteristics

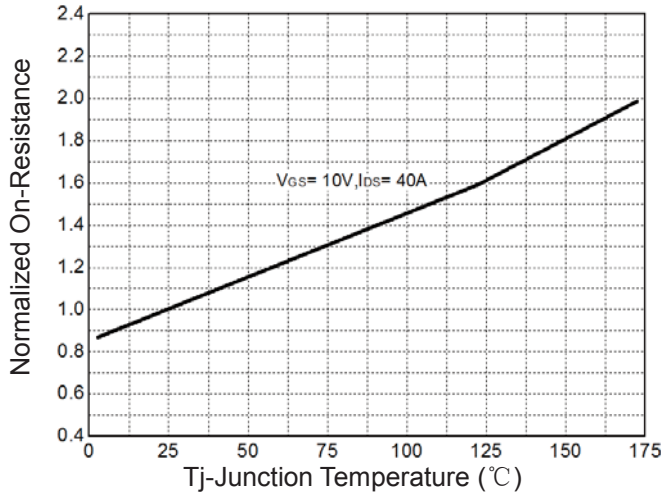



### Figure 6: Drain-Source On Resistance

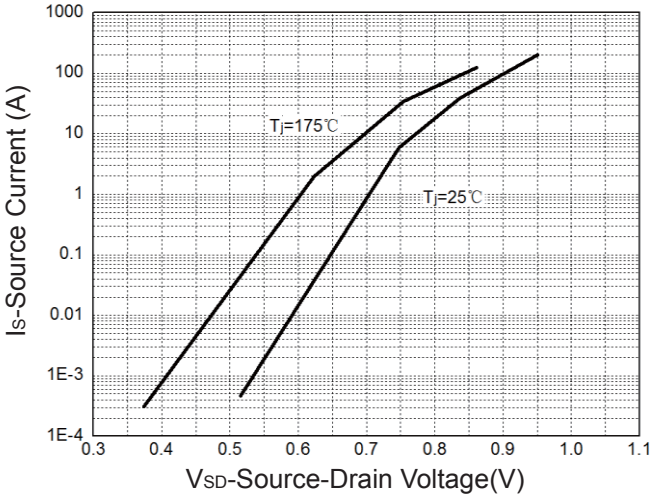


## Typical Operating Characteristics(Cont.)

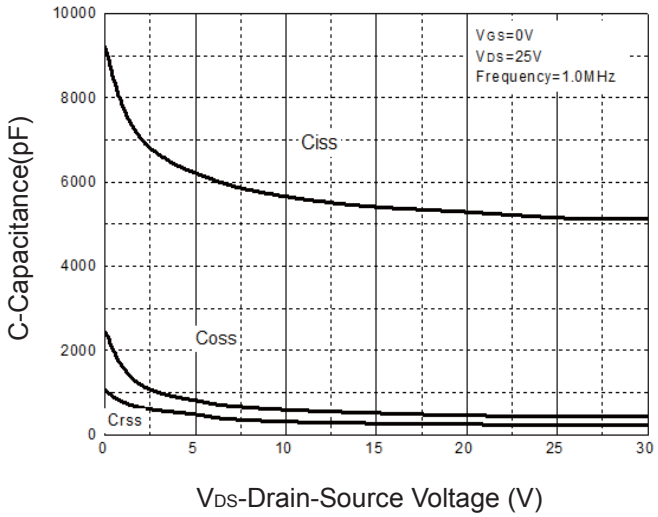
### Figure 7: On-Resistance vs. Temperature



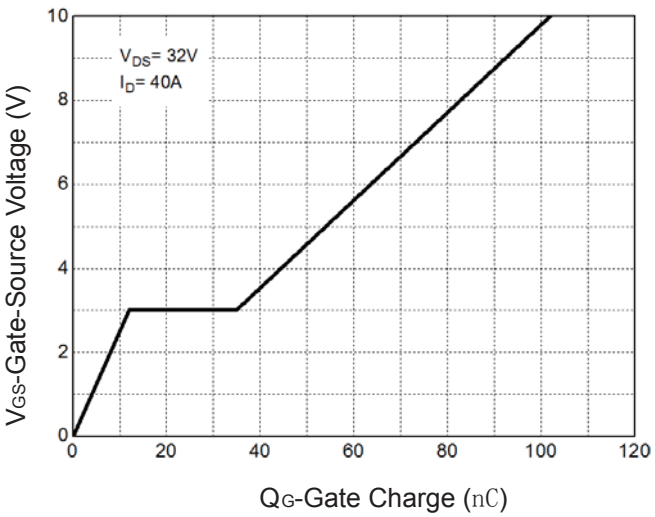

### Figure 8: Source-Drain Diode Forward



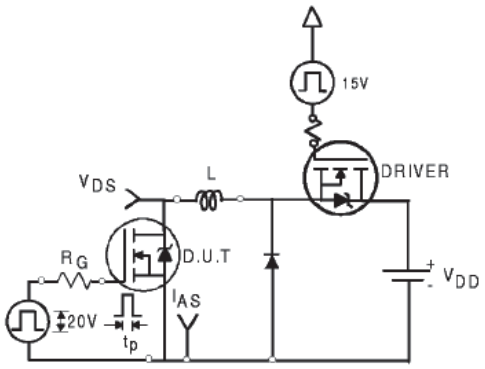

### Figure 9: Capacitance Characteristics

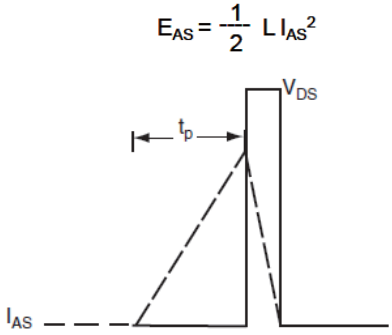



### Figure 10: Gate Charge Characteristics

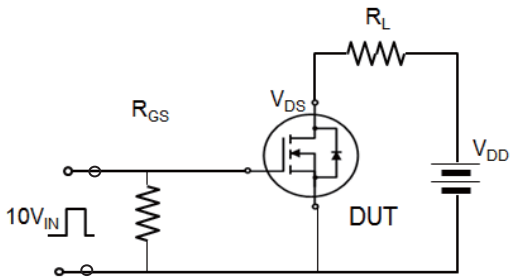


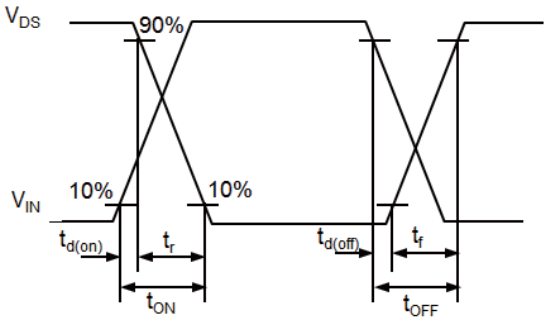
## Avalanche Test Circuit



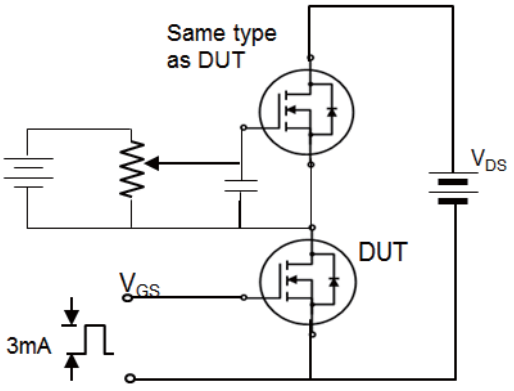



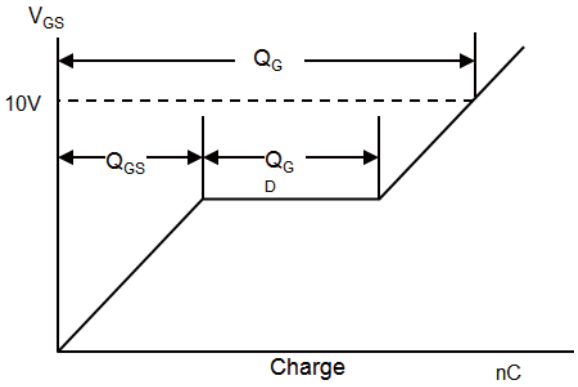

## Switching Time Test Circuit




## Gate Charge Test Circuit



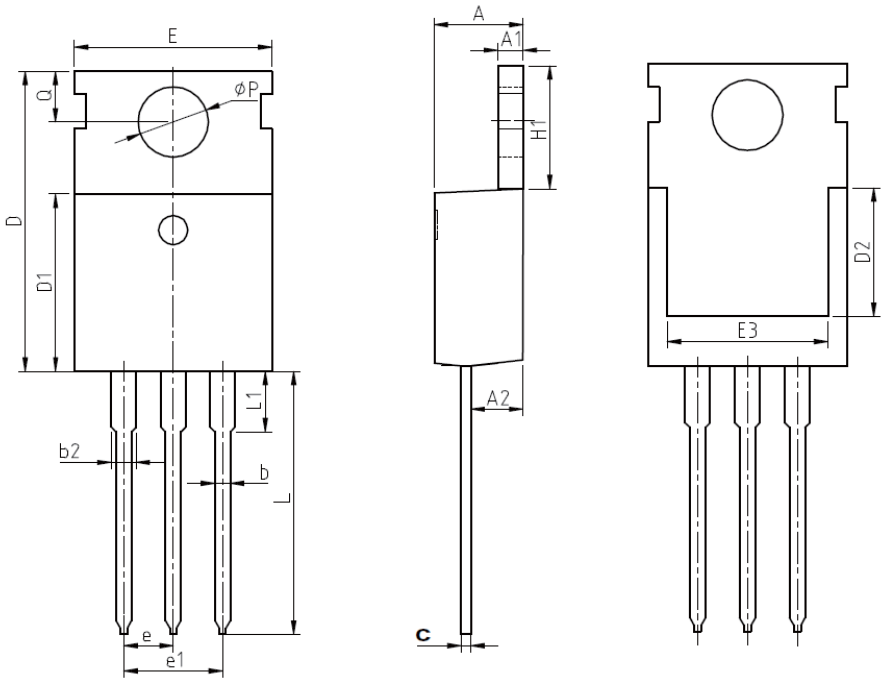



## Device Per Unit

| Package Type | Unit | Quantity |
|---|---|---|
| TO-220FB-3L | Tube | 50 |
| TO-263-2L | Tube | 50 |
| TO-220FB-3S | Tube | 50 |

## Package Information

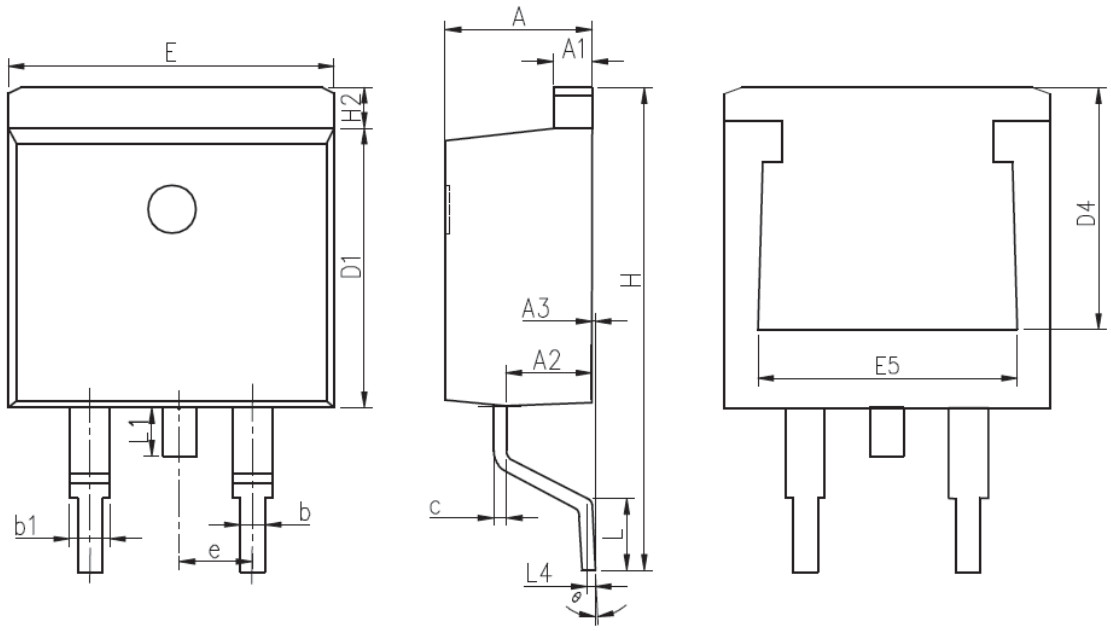
**TO-220FB-3L**




COMMON DIMENSIONS

| SYMBOL | mm | | |
|---|---|---|---|
| | MIN | NOM | MAX |
| A | 4.37 | 4.57 | 4.77 |
| A1 | 1.25 | 1.30 | 1.45 |
| A2 | 2.20 | 2.40 | 2.60 |
| b | 0.70 | 0.80 | 0.95 |
| b2 | 1.17 | 1.27 | 1.47 |
| c | 0.40 | 0.50 | 0.65 |
| D | 15.10 | 15.60 | 16.10 |
| D1 | 8.80 | 9.10 | 9.40 |
| D2 | 5.50 | - | - |
| E | 9.70 | 10.00 | 10.30 |
| E3 | 7.00 | - | - |
| e | 2.54 BSC | | |
| e1 | 5.08 BSC | | |
| H1 | 6.25 | 6.50 | 6.85 |
| L | 12.75 | 13.50 | 13.80 |
| L1 | - | 3.10 | 3.40 |
| ΦP | 3.40 | 3.60 | 3.80 |
| Q | 2.60 | 2.80 | 3.00 |

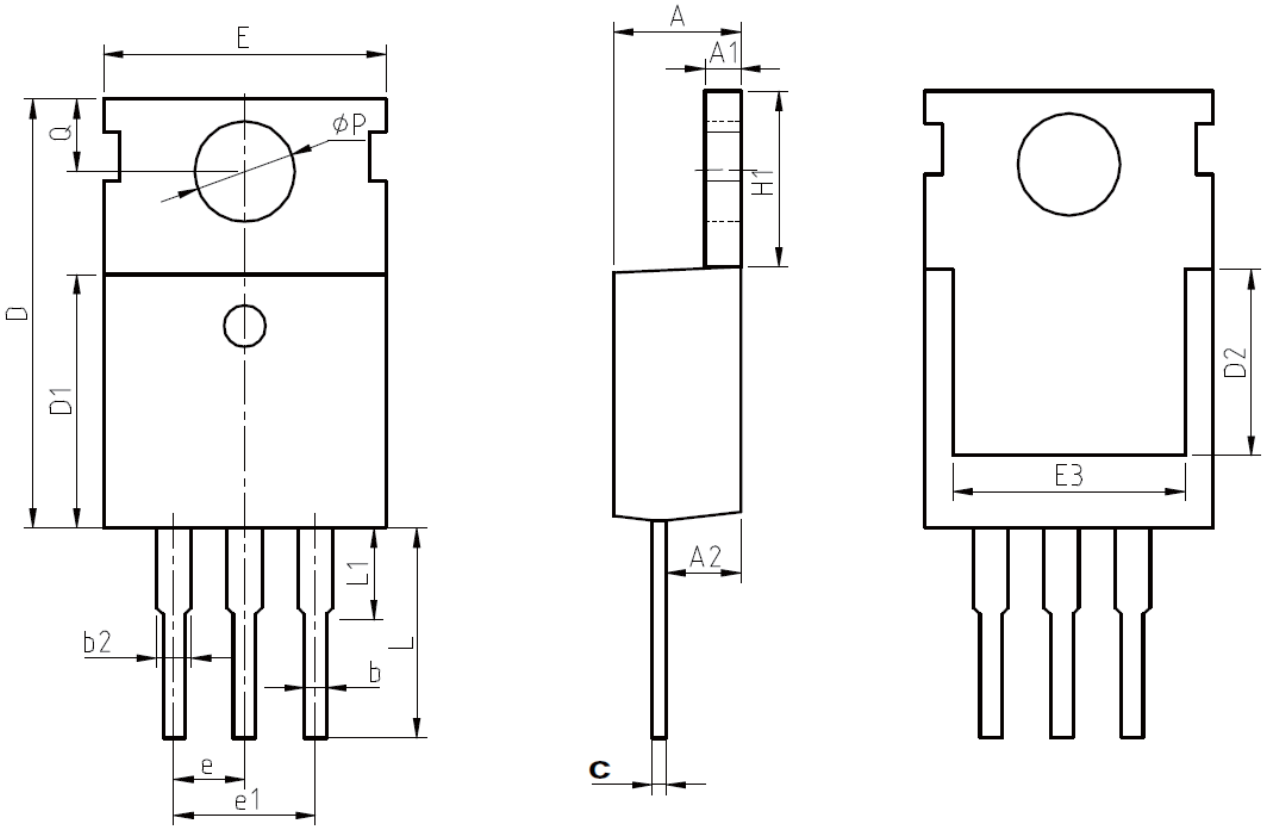
**TO-263-2L**




COMMON DIMENSIONS

| SYMBOL | mm | | |
|---|---|---|---|
| | MIN | NOM | MAX |
| A | 4.37 | 4.57 | 4.77 |
| A1 | 1.22 | 1.27 | 1.42 |
| A2 | 2.49 | 2.69 | 2.89 |
| A3 | 0 | 0.13 | 0.25 |
| b | 0.7 | 0.81 | 0.96 |
| b1 | 1.17 | 1.27 | 1.47 |
| c | 0.3 | 0.38 | 0.53 |
| D1 | 8.5 | 8.7 | 8.9 |
| D4 | 6.6 | - | - |
| E | 9.86 | 10.16 | 10.36 |
| E5 | 7.06 | - | - |
| e | 2.54 BSC | | |
| H | 14.7 | 15.1 | 15.5 |
| H2 | 1.07 | 1.27 | 1.47 |
| L | 2 | 2.3 | 2.6 |
| L1 | 1.4 | 1.55 | 1.7 |
| L4 | 0.25 BSC | | |
| θ | 0° | 5° | 9° |

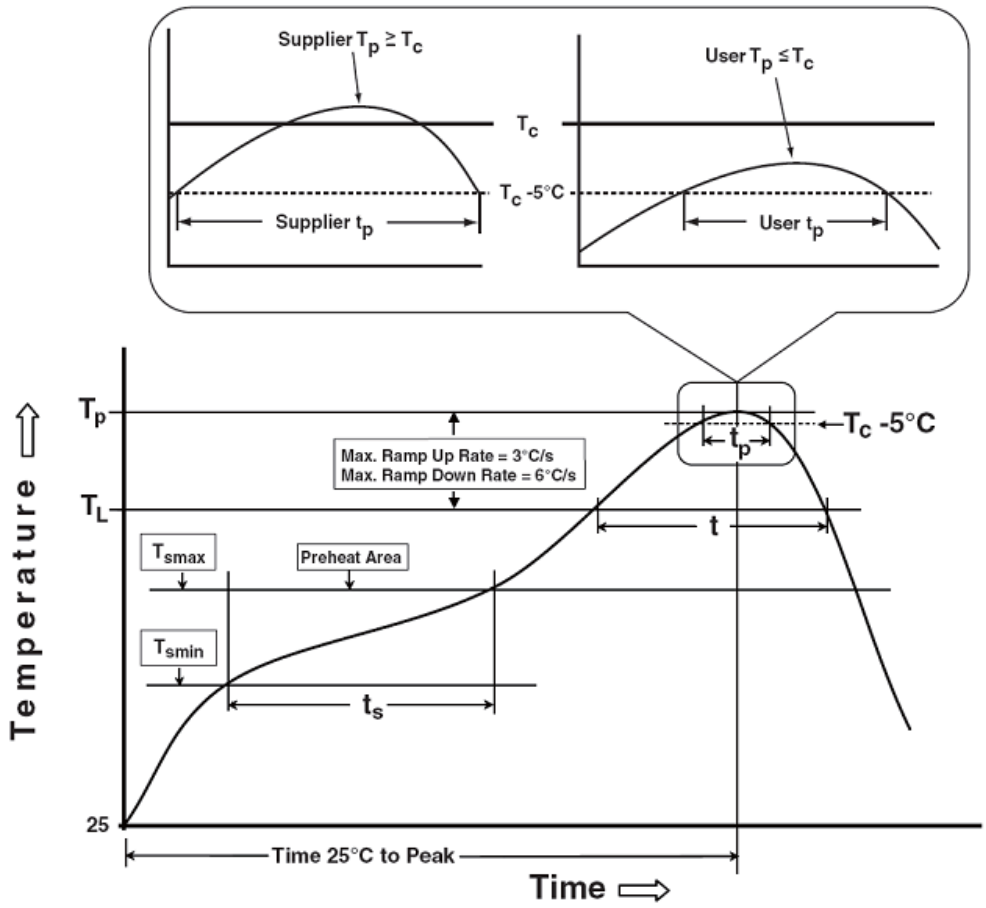
**TO-220FB-3S**




COMMON DIMENSIONS

| SYMBOL | mm | | |
|---|---|---|---|
| | MIN | NOM | MAX |
| A | 4.37 | 4.57 | 4.77 |
| A1 | 1.25 | 1.30 | 1.45 |
| A2 | 2.20 | 2.40 | 2.60 |
| b | 0.70 | 0.80 | 0.95 |
| b2 | 1.17 | 1.27 | 1.47 |
| c | 0.40 | 0.50 | 0.65 |
| D | 15.10 | 15.60 | 16.10 |
| D1 | 8.10 | 9.10 | 9.40 |
| D2 | 5.50 | - | - |
| E | 9.70 | 10.00 | 10.30 |
| E3 | 7.00 | - | - |
| e | 2.54 BSC | | |
| e1 | 5.08 BSC | | |
| H1 | 6.25 | 6.50 | 6.85 |
| L | 6.80 | 7.00 | 7.20 |
| L1 | - | 3.10 | 3.40 |
| ΦP | 3.40 | 3.60 | 3.80 |
| Q | 2.60 | 2.80 | 3.00 |

## Classification Profile




## Classification Reflow Profiles

| Profile Feature | Sn-Pb Eutectic Assembly | Pb-Free Assembly |
|---|---|---|
| **Preheat & Soak**<br>Temperature min ($T_{smin}$)<br>Temperature max ($T_{smax}$)<br>Time (Tsmin to Tsmax) ($t_s$) | <br>100 °C<br>150 °C<br>60-120 seconds | <br>150 °C<br>200 °C<br>60-120 seconds |
| Average ramp-up rate ($T_{smax}$to $T_P$) | 3 °C/second max. | 3°C/second max. |
| Liquidous temperature ($T_L$)<br>Time at liquidous ($t_L$) | 183 °C<br>60-150 seconds | 217 °C<br>60-150 seconds |
| Peak package body Temperature ($T_p$)* | See Classification Temp in table 1 | SeeClassification Tempin table 2 |
| Time ($t_P$)** within 5°C of the specified classification temperature ($T_c$) | 20** seconds | 30** seconds |
| Average ramp-down rate ($T_p$to $T_{smax}$) | 6 °C/second max. | 6 °C/second max. |
| Time 25°C to peak temperature | 6 minutes max. | 8 minutes max. |
| *Tolerance for peak profile Temperature ($T_p$) is defined as a supplier minimum and a user maximum.<br>** Tolerance for time at peak profile temperature ($t_p$) is defined as a supplier minimum and a user maximum. | | |

Table 1.SnPb Eutectic Process – Classification Temperatures (Tc)

| Package Thickness | Volume mm³ <350 | Volume mm³ ⩾350 |
|---|---|---|
| ＜2.5 mm | 235 °C | 220 °C |
| ≥2.5 mm | 220 °C | 220 °C |

Table 2.Pb-free Process – Classification Temperatures (Tc)

| Package Thickness | Volume mm³ <350 | Volume mm³ 350-2000 | Volume mm³ ⩾2000 |
|---|---|---|---|
| <1.6 mm | 260 °C | 260 °C | 260 °C |
| 1.6 mm – 2.5 mm | 260 °C | 250 °C | 245 °C |
| ⩾2.5 mm | 250 °C | 245 °C | 245 °C |

## Reliability Test Program

| Test item | Method | Description |
|---|---|---|
| SOLDERABILITY | JESD-22, B102 | 5 Sec, 245°C |
| HTRB | JESD-22, A108 | 168 Hrs /500 Hrs /1000 Hrs, Bias @ 150°C |
| PCT | JESD-22, A102 | 96 Hrs, 100%RH, 2atm, 121°C |
| TCT | JESD-22, A104 | 500 Cycles, -55°C~150°C |

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