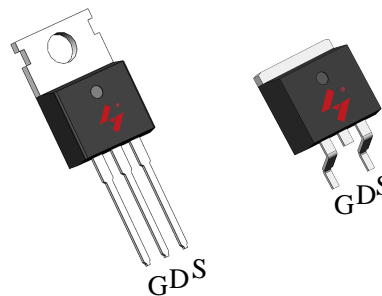


N-Channel Enhancement Mode MOSFET

Features

- 40V/208A
 $R_{DS(ON)} = 2.5\text{ m}\Omega$ (typ.) @ $V_{GS} = 10\text{V}$
- 100% avalanche tested
- Reliable and Rugged
- Lead Free and Green Devices Available (RoHS Compliant)

Pin Description

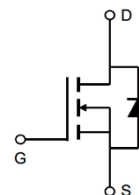


TO-220FB-3L

TO-263-2L


Applications

- Switching application
- Power Management for DC/DC



N-Channel MOSFET

Ordering and Marking Information

 <p> P B HY4004 HY4004 YYXXXJWW G YYXXXJWW G </p>	<p> Package Code P : TO-220FB-3L B: TO-263-2L </p> <p> Date Code Assembly Material YYXXX WW G : Lead Free Device </p>
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Note: HUAYI lead-free products contain molding compounds/die attach materials and 100% matte tin plate Termination finish; which are fully compliant with RoHS. HUAYI lead-free products meet or exceed the lead-free requirements 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 product and/or to this document at any time without notice.

Absolute Maximum Ratings

Symbol	Parameter	Rating	Unit	
Common Ratings ($T_C=25^{\circ}\text{C}$ Unless Otherwise Noted)				
V_{DSS}	Drain-Source Voltage	40	V	
V_{GSS}	Gate-Source Voltage	± 20		
T_J	Maximum Junction Temperature	175	$^{\circ}\text{C}$	
T_{STG}	Storage Temperature Range	-55 to 175	$^{\circ}\text{C}$	
I_S	Diode Continuous Forward Current	$T_C=25^{\circ}\text{C}$	208	A
Mounted on Large Heat Sink				
I_{DM}	Pulsed Drain Current *	$T_C=25^{\circ}\text{C}$	750**	A
I_D	Continuous Drain Current	$T_C=25^{\circ}\text{C}$	208	A
		$T_C=100^{\circ}\text{C}$	138	
P_D	Maximum Power Dissipation	$T_C=25^{\circ}\text{C}$	217	W
		$T_C=100^{\circ}\text{C}$	108	
$R_{\theta JC}$	Thermal Resistance-Junction to Case		0.69	$^{\circ}\text{C/W}$
$R_{\theta JA}$	Thermal Resistance-Junction to Ambient		62.5	
Avalanche Ratings				
E_{AS}	Avalanche Energy, Single Pulsed	$L=0.5\text{mH}$	1.4***	J

Note : * Repetitive rating ; pulse width limited by junction temperature

** Drain current is limited by junction temperature

*** $V_D=32\text{V}$

Electrical Characteristics ($T_C = 25^{\circ}\text{C}$ Unless Otherwise Noted)

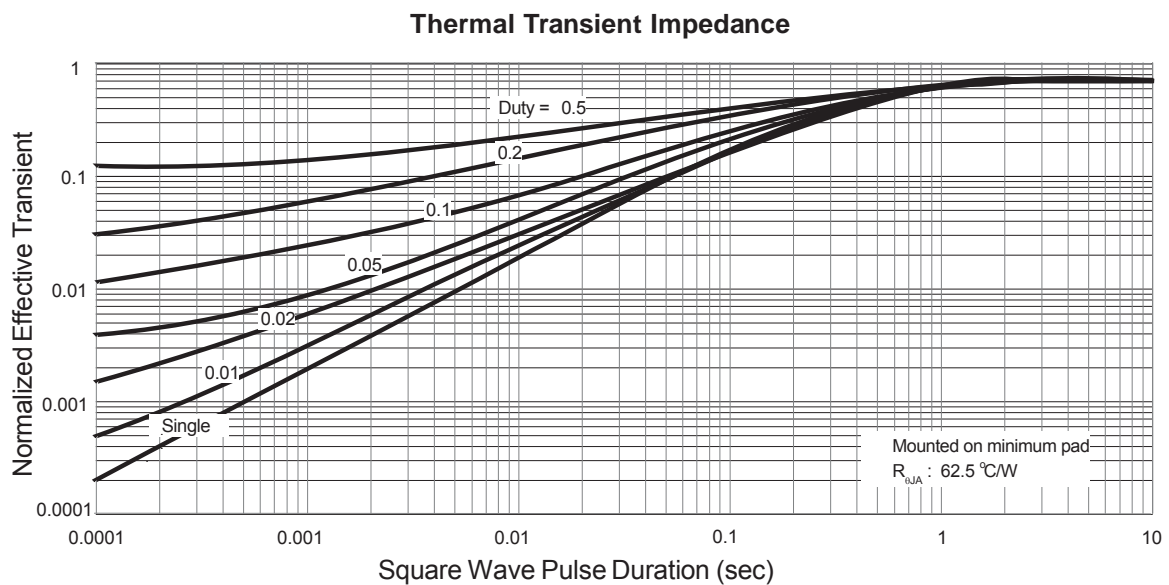
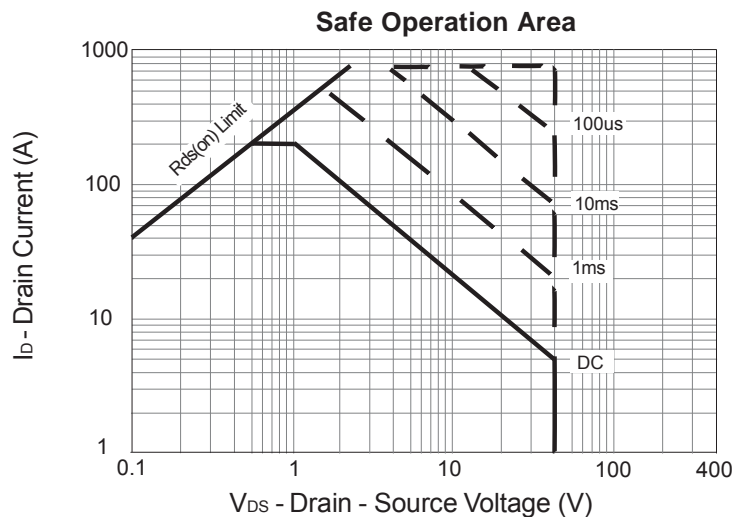
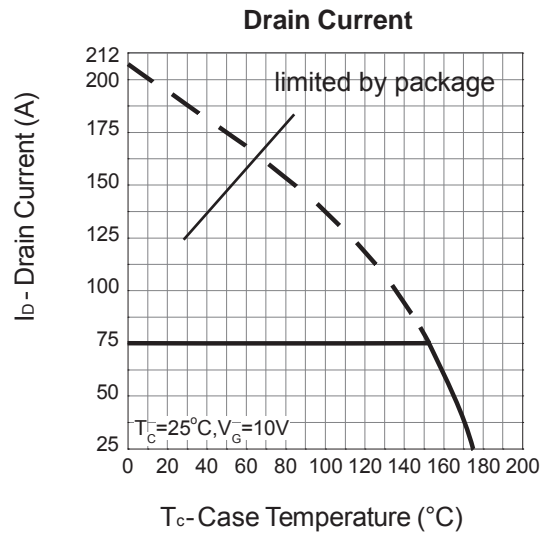
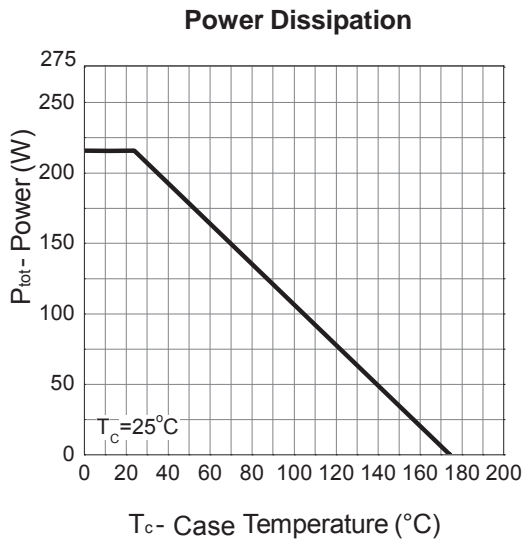
Symbol	Parameter	Test Conditions	HY4004			Unit
			Min.	Typ.	Max.	
Static Characteristics						
BV_{DSS}	Drain-Source Breakdown Voltage	$V_{GS}=0\text{V}, I_{DS}=250\mu\text{A}$	40	-	-	V
I_{DSS}	Zero Gate Voltage Drain Current	$V_{DS}=40\text{V}, V_{GS}=0\text{V}$ $T_J=85^{\circ}\text{C}$	-	-	1	μA
			-	-	10	
$V_{GS(th)}$	Gate Threshold Voltage	$V_{DS}=V_{GS}, I_{DS}=250\mu\text{A}$	2.0	3.0	4.0	V
I_{GSS}	Gate Leakage Current	$V_{GS}=\pm 20\text{V}, V_{DS}=0\text{V}$	-	-	± 100	nA
$R_{DS(ON)^*}$	Drain-Source On-state Resistance	$V_{GS}=10\text{V}, I_{DS}=104\text{A}$	-	2.5	3.2	$\text{m}\Omega$
Diode Characteristics						
V_{SD}^*	Diode Forward Voltage	$I_{SD}=104\text{A}, V_{GS}=0\text{V}$	-	0.8	1.2	V
t_{rr}	Reverse Recovery Time	$I_{SD}=104\text{A},$ $di_{SD}/dt=100\text{A}/\mu\text{s}$	-	37	-	ns
Q_{rr}	Reverse Recovery Charge		-	60	-	nC

Electrical Characteristics (Cont.) ($T_C = 25^\circ\text{C}$ Unless Otherwise Noted)

Symbol	Parameter	Test Conditions	HY4004			Unit
			Min.	Typ.	Max.	
Dynamic Characteristics						
R_G	Gate Resistance	$V_{GS}=0V, V_{DS}=0V, F=1\text{MHz}$	-	1.0	-	Ω
C_{iss}	Input Capacitance	$V_{GS}=0V,$ $V_{DS}=25V,$ Frequency=1.0MHz	-	5712	-	pF
C_{oss}	Output Capacitance		-	1465	-	
C_{rss}	Reverse Transfer Capacitance		-	596	-	
$t_{d(ON)}$	Turn-on Delay Time	$V_{DD}=20V, R_G=6\Omega,$ $I_{DS}=104A, V_{GS}=10V,$	-	35	-	ns
T_r	Turn-on Rise Time		-	20	-	
$t_{d(OFF)}$	Turn-off Delay Time		-	45	-	
T_f	Turn-off Fall Time		-	62	-	
Gate Charge Characteristics						
Q_g	Total Gate Charge	$V_{DS}=32V, V_{GS}=10V,$ $I_{DS}=104A$	-	158	-	nC
Q_{gs}	Gate-Source Charge		-	30	-	
Q_{gd}	Gate-Drain Charge		-	66	-	

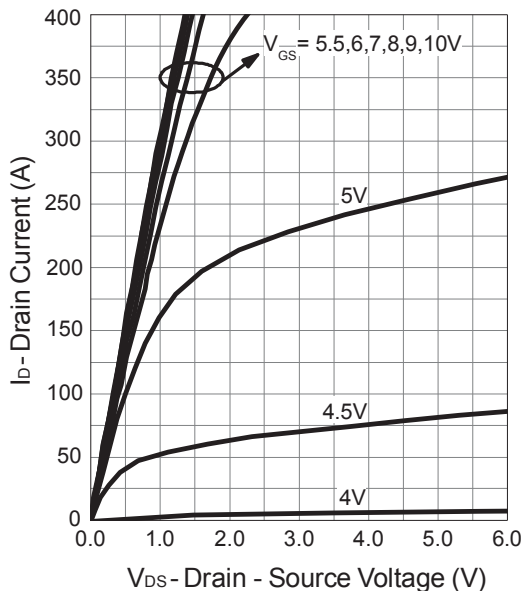
Note * : Pulse test ; pulse width $\leq 300\mu\text{s}$, duty cycle $\leq 2\%$.

Typical Operating Characteristics

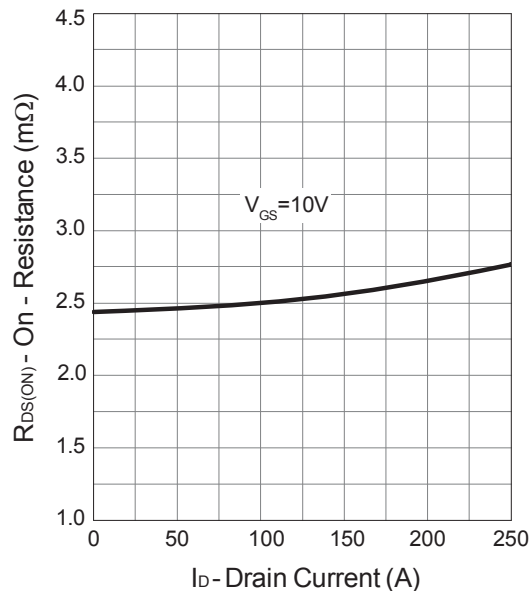


Typical Operating Characteristics (Cont.)

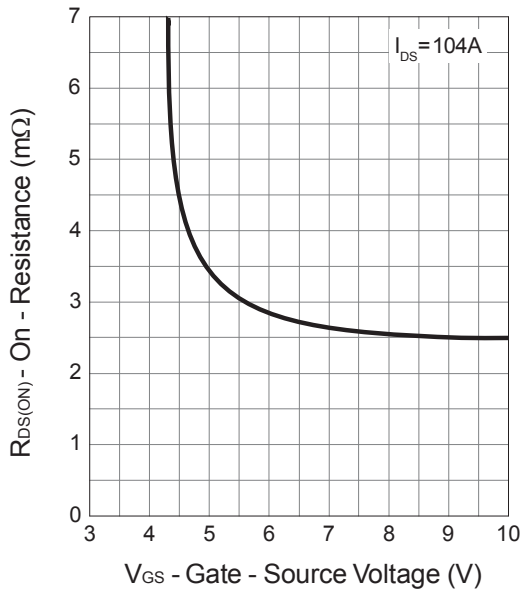
Output Characteristics



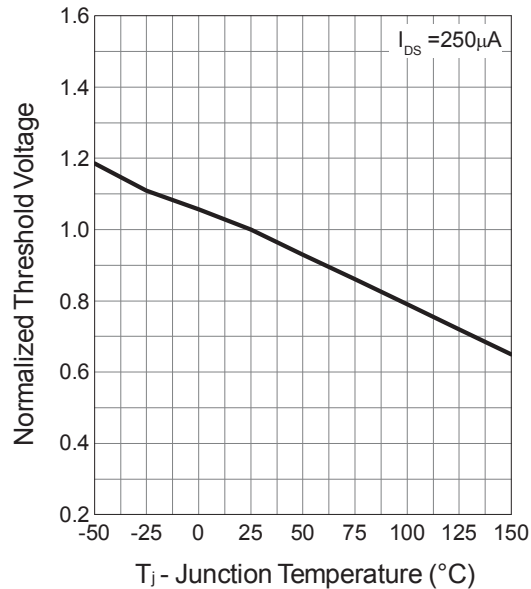
Drain-Source On Resistance



Gate-Source On Resistance

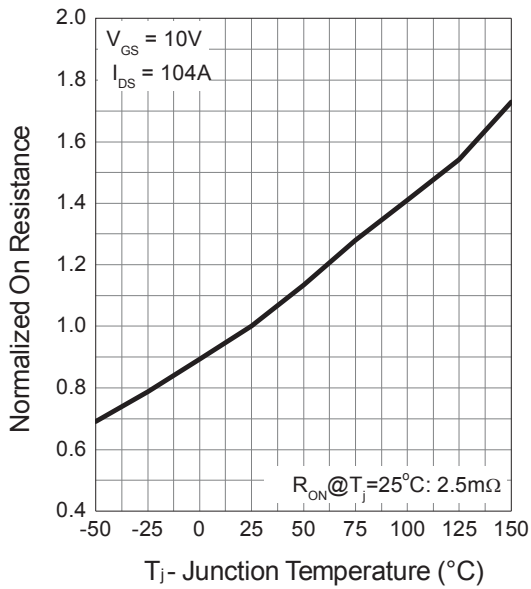


Gate Threshold Voltage

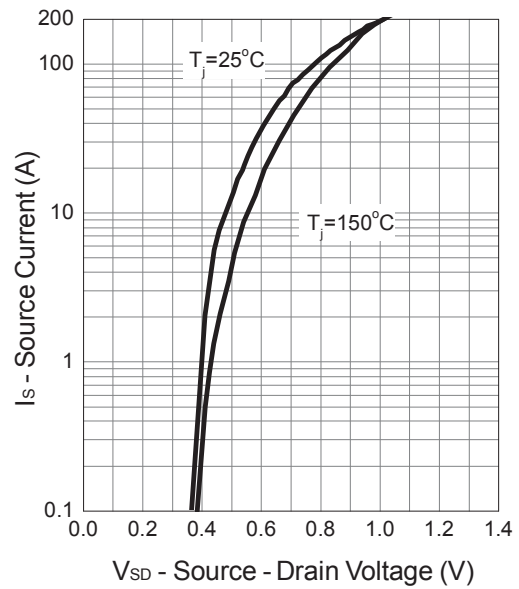


Typical Operating Characteristics (Cont.)

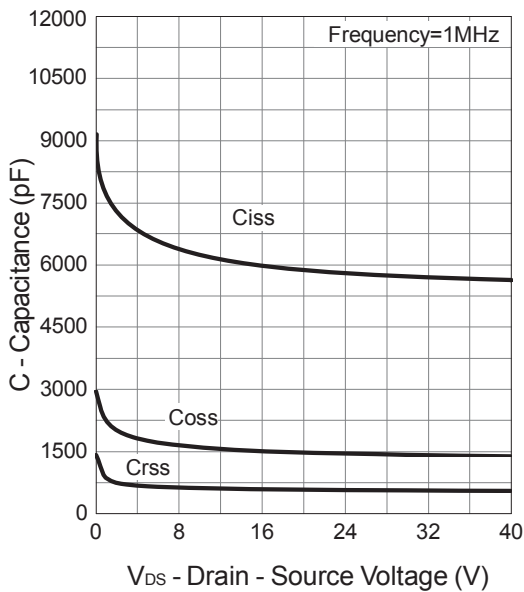
Drain-Source On Resistance



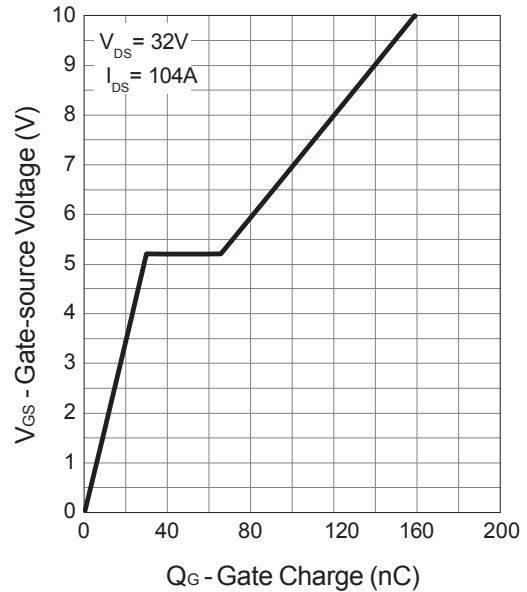
Source-Drain Diode Forward



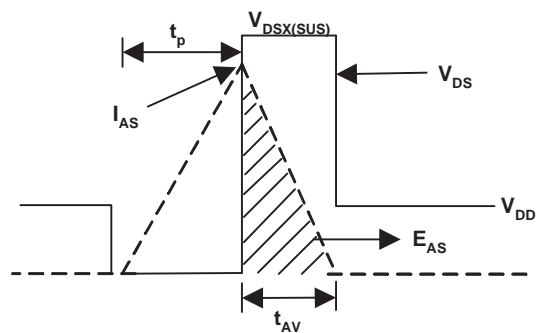
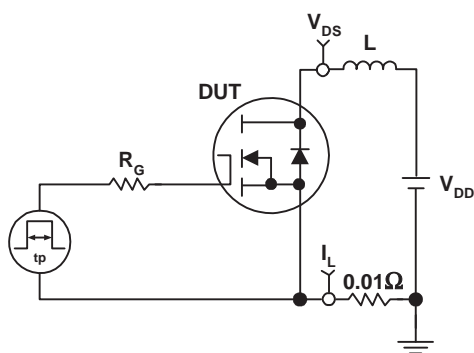
Capacitance



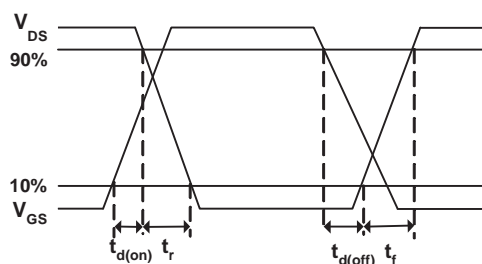
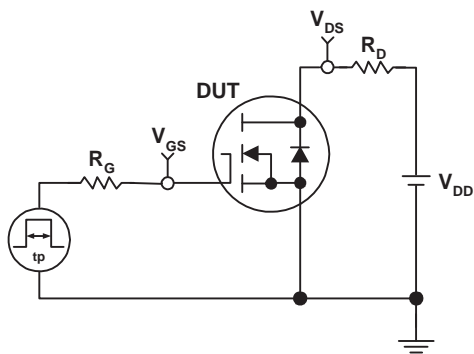
Gate Charge



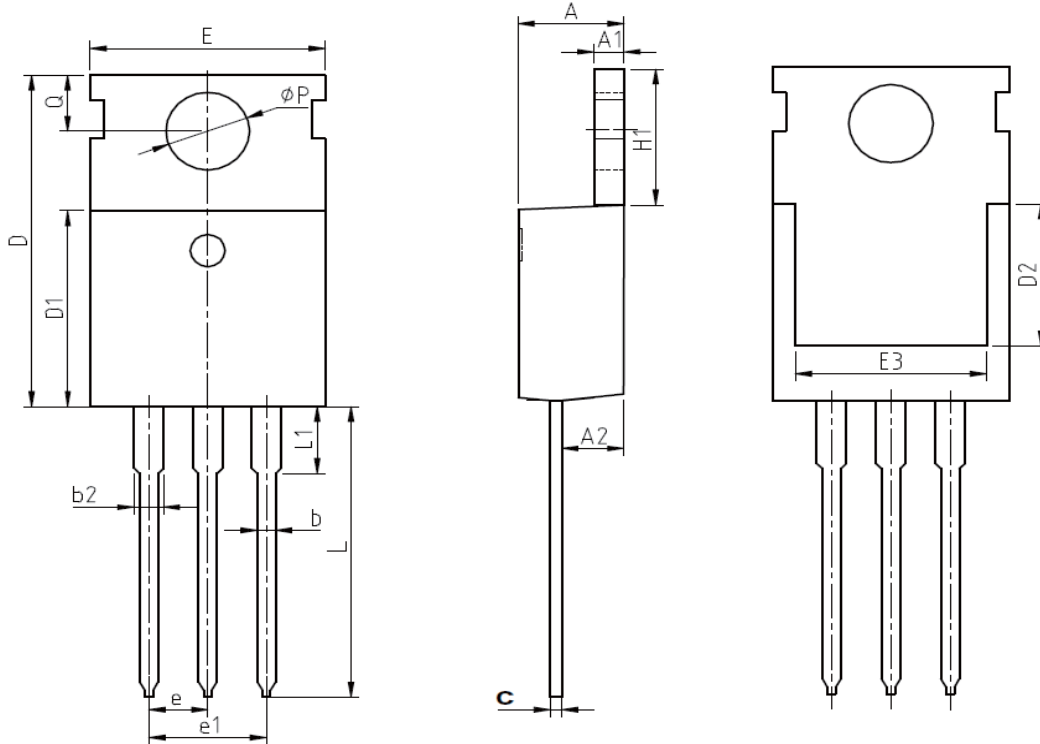
Avalanche Test Circuit



Avalanche Test Circuit



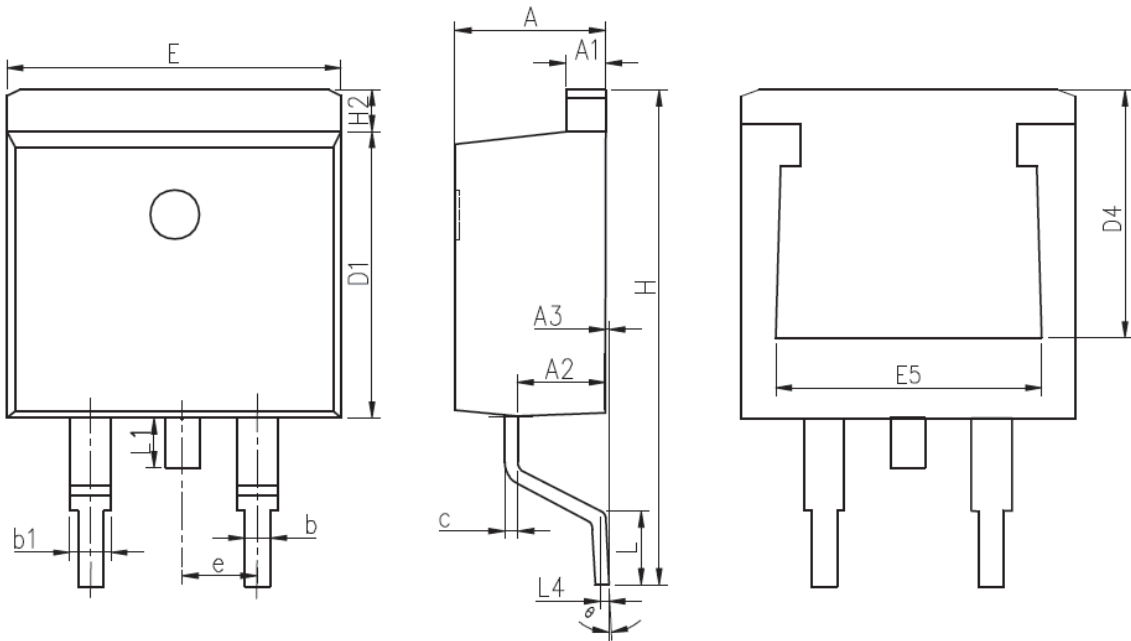
Package Information
TO-220FB-3L



COMMON DIMENSIONS

SYMBOL	mm		
	MIN	N	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



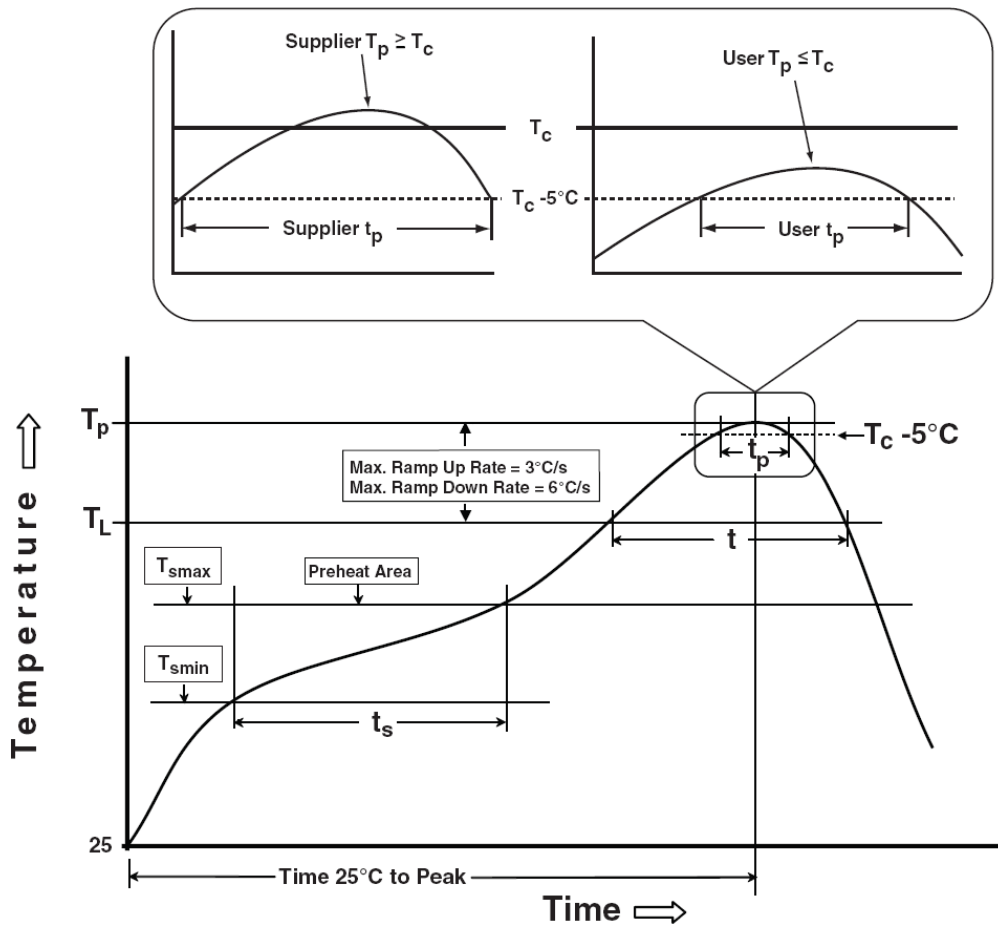
COMMON DIMENSIONS

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°

Devices Per Unit

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

Classification Profile



Classification Reflow Profiles

Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Preheat & Soak Temperature min (T_{smin}) Temperature max (T_{smax}) Time (T_{smin} to T_{smax}) (t_s)	100 °C 150 °C 60-120 seconds	150 °C 200 °C 60-120 seconds
Average ramp-up rate (T_{smax} to T_p)	3 °C/second max.	3°C/second max.
Liquidous temperature (T_L) Time at liquidous (t_L)	183 °C 60-150 seconds	217 °C 60-150 seconds
Peak package body Temperature (T_p)*	See Classification Temp in table 1	See Classification Temp in 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. ** 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 (T_c)

Package Thickness	Volume mm ³ <350	Volume mm ³ ≥350
<2.5 mm	235 °C	220 °C
≥2.5 mm	220 °C	220 °C

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

Package Thickness	Volume mm ³ <350	Volume mm ³ 350-2000	Volume mm ³ >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

Customer Service

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