

P-Channel Enhancement Mode MOSFET

Feature

Pin Description

- -40V/-90A
 $R_{DS(ON)} = 5.9\ m\ (typ.)\ @V_{GS} = -10V$
 $R_{DS(ON)} = 9.2\ m\ (typ.)\ @V_{GS} = -4.5V$
- 100% Avalanche Tested
- 100% DVDS
- Reliable and Rugged
- Halogen Free and Green Devices Available
 (RoHS Compliant)

G D S
 G D S

Applications

- Switching application
- Li-battery protection
- DC-DC
- Motor control

Ordering and Marking Information

	P	B	Package Code	
	HYG060P04	HYG060P04	P: TO-220FB-3L	B:TO-263-2L
	XYMXXXXXX	XYMXXXXXX	Date Code	
			XYMXXXXXX	

Absolute Maximum Ratings

Symbol	Parameter	Rating	Unit	
Common Ratings (Tc=25°C Unless Otherwise Noted)				
V _{DSS}	Drain-Source Voltage	-40	V	
V _{GSS}	Gate-Source Voltage	±20	V	
T _J	Junction Temperature Range	-55 to 175	°C	
T _{STG}	Storage Temperature Range		°C	
I _S	Source Current-Continuous(Body Diode)	Tc=25°C	-90	A
Mounted on Large Heat Sink				
I _{DM}	Pulsed Drain Current *	Tc=25°C	-324	A
I _D	Continuous Drain Current	Tc=25°C	-90	A
		Tc=100°C	-63	A
P _D	Maximum Power Dissipation	Tc=25°C	125	W
		Tc=100°C	62	W
R _{JC}	Thermal Resistance, Junction-to-Case		1.2	°C/W
R _{JA}	Thermal Resistance, Junction-to-Ambient **		62.5	°C/W
E _{AS}	Single Pulsed-Avalanche Energy ***	L=0.3mH	320	mJ

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

** Surface mounted on 1in2 FR-4 board.

*** Limited by T_{Jmax}, starting T_J=25°C, L = 0.3mH, R_c= 25 , V_{GS} =-10V.

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

Symbol	Parameter	Test Conditions	HYG060P04LQ2			Unit
			Min	Typ.	Max	
Static Characteristics						
BV _{DSS}	Drain-Source Breakdown Voltage	V _{GS} =0V, I _{DS} =-250μA	-40	-	-	V
I _{DSS}	Drain-to-Source Leakage Current	V _{DS} =-40V, V _{GS} =0V	-	-	-1	μA
		T _J =125°C	-	-	-50	μA
V _{GS(th)}	Gate Threshold Voltage	V _{DS} =V _{GS} , I _{DS} =-250μA	-1		-2	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} =-20A	-	5.9	7.5	m
		V _{GS} =-4.5V, I _{DS} =-20A		9.2	12	m
Diode Characteristics						
V _{SD}	Diode Forward Voltage	I _{SD} =-20A, V _{GS} =0V	-	-0.84	-1.3	V
t _{rr}	Reverse Recovery Time	I _{SD} =-20A, dI _{SD} /dt=100A/μs	-	21.3	-	ns
Q _{rr}	Reverse Recovery Charge		-	14.8	-	nC

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

Symbol	Parameter	Test Conditions	HYG060P04LQ2			Unit
			Min	Typ.	Max	
Dynamic Characteristics						
R _G	Gate Resistance	V _{GS} =0V, V _{DS} =0V, F=500KHz	-	4.8	-	
C _{iss}	Input Capacitance	V _{GS} =0V, V _{DS} =-25V, Frequency=500KHz	-	3506	-	pF
C _{oss}	Output Capacitance					
C _{rss}	Reverse Transfer Capacitance					
t _{d(ON)}	Turn-on Delay Time	V _{DD} =-20V, R _G =4 Ω, I _{DS} =-20A, V _{GS} =-10V	-	8.9	-	ns
T _r	Turn-on Rise Time					
t _{d(OFF)}	Turn-off Delay Time					
T _f	Turn-off Fall Time					
Gate Charge Characteristics						
Q _g	Total Gate Charge(V _{GS} =-10V)	V _{DS} =-32V, I _{DS} =-20A	-	86.8	-	nC
	Total Gate Charge(V _{GS} =-4.5V)		-	46.4	-	
Q _{gs}	Gate-Source Charge		-	12.5	-	
Q _{gd}	Gate-Drain Charge		-	24.8	-	
V _{plateau}	Gate plateau voltage		-	-3.2	-	V

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

Typical Operating Characteristics

Figure 1: Power Dissipation

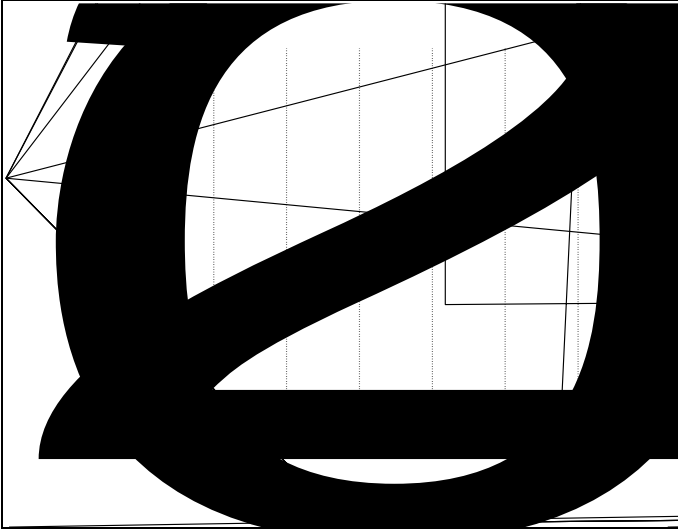


Figure 2: Drain Current

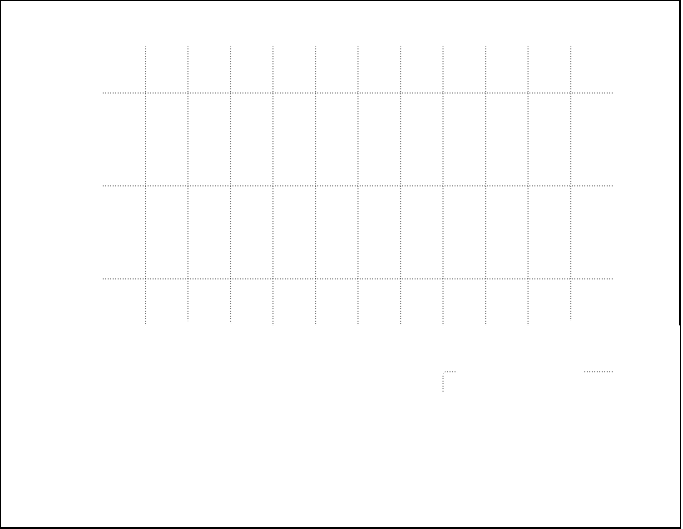


Figure 3: Safe Operation Area

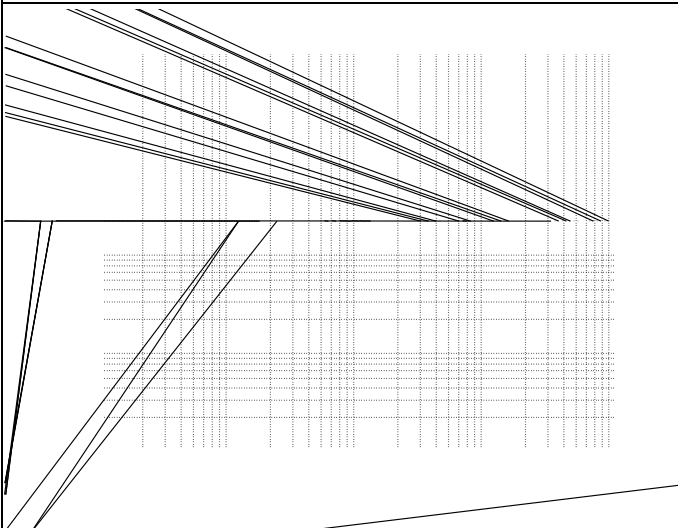


Figure 4: Thermal Transient Impedance

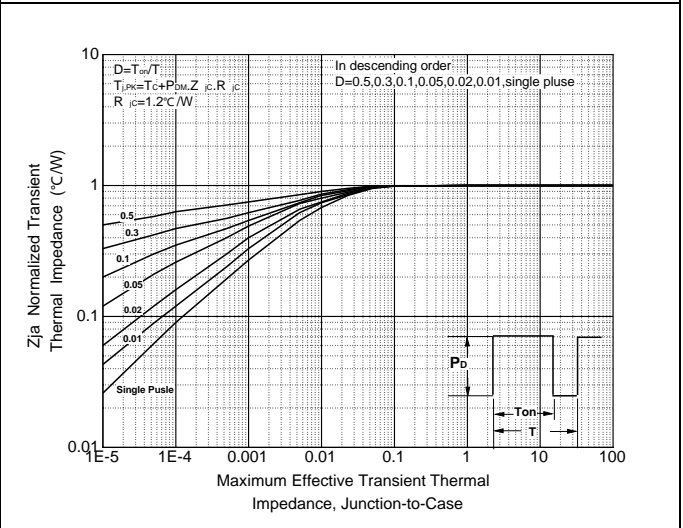


Figure 5: Output Characteristics

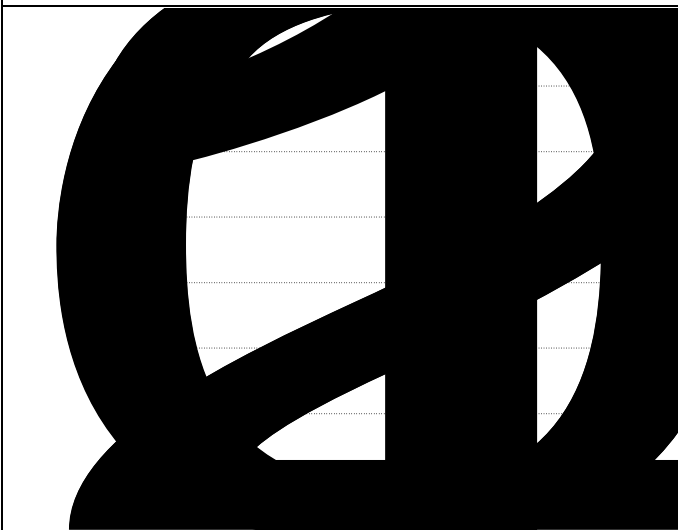
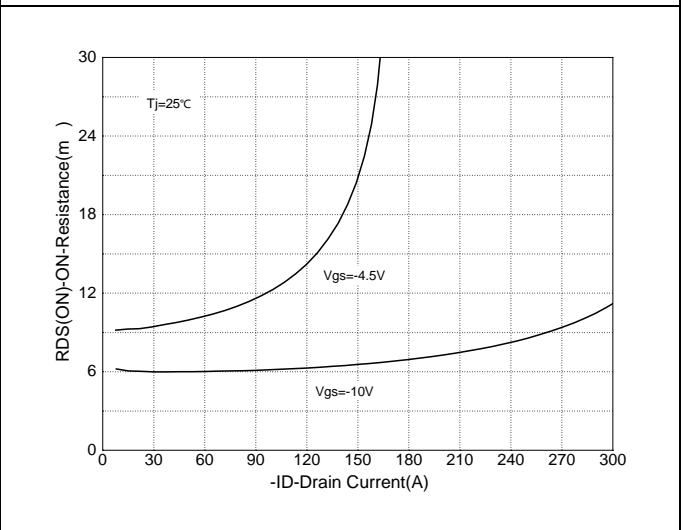


Figure 6: Drain-Source On Resistance



Typical Operating Characteristics(Cont.)

Figure 7: On-Resistance vs. Temperature

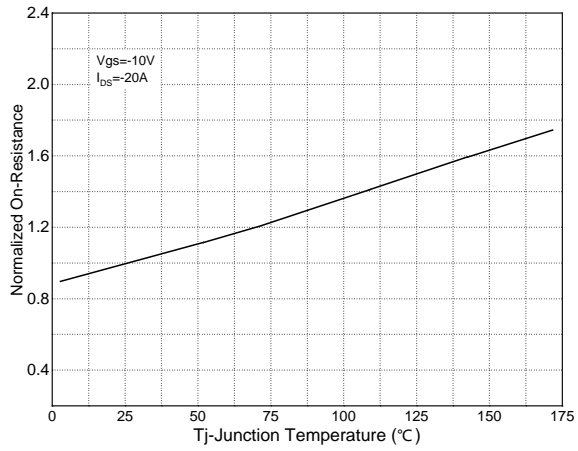


Figure 8: Source-Drain Diode Forward



Figure 9: Capacitance Characteristics

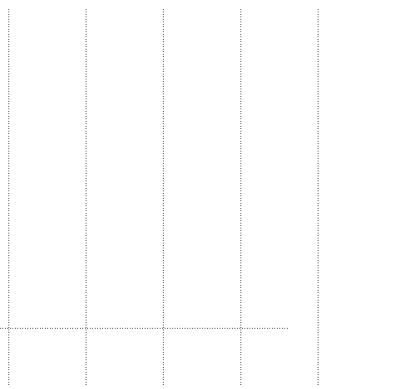
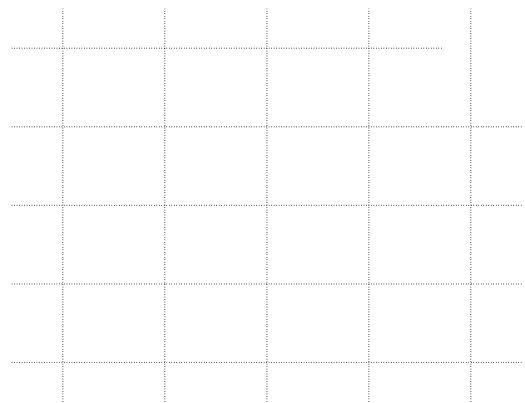
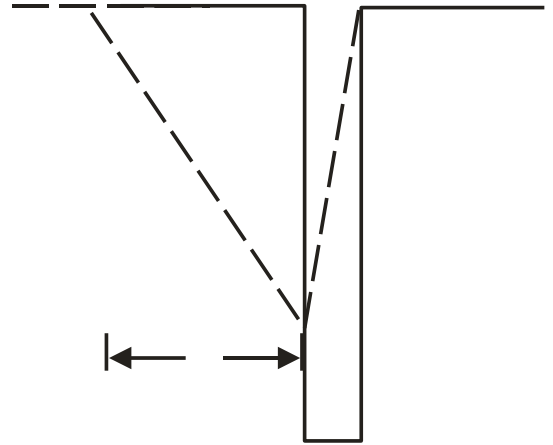
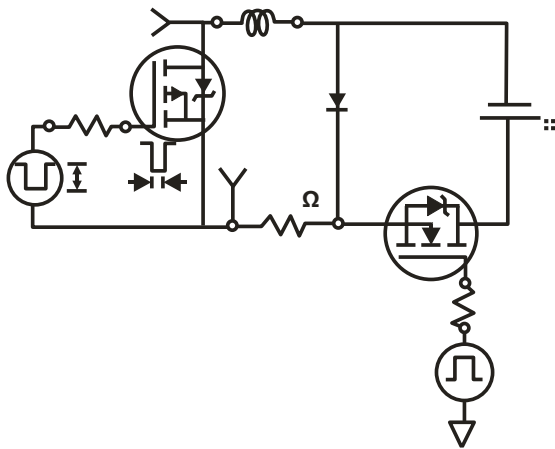


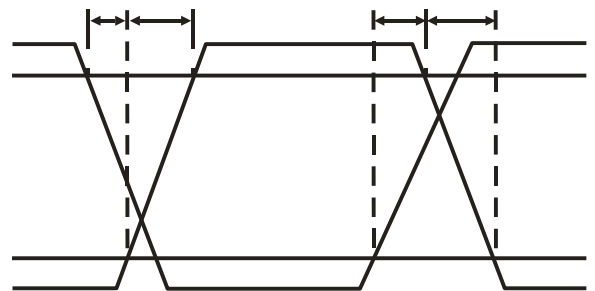
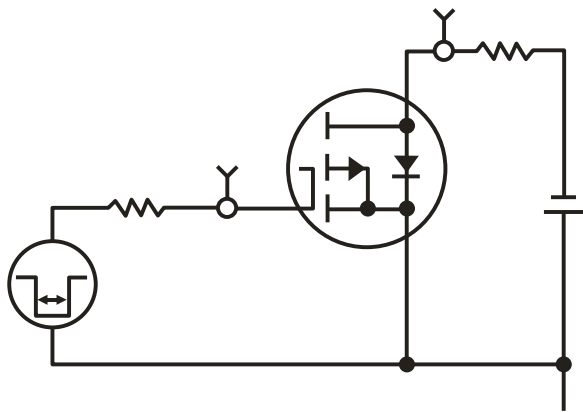
Figure 10: Gate Charge Characteristics



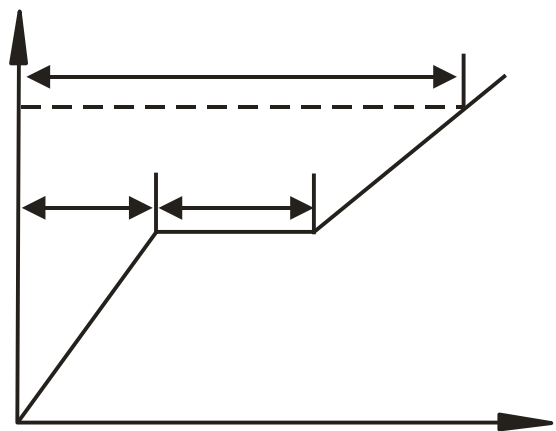
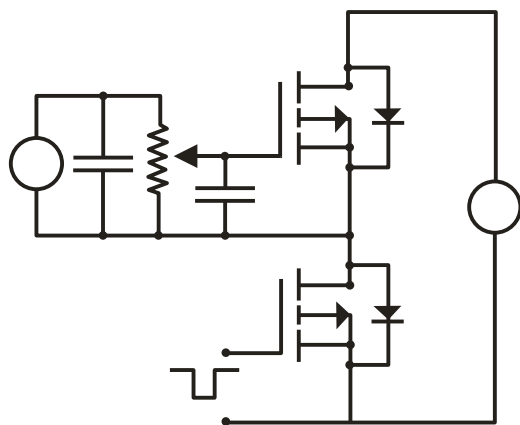
Avalanche Test Circuit



Switching Time Test Circuit



Gate Charge Test Circuit



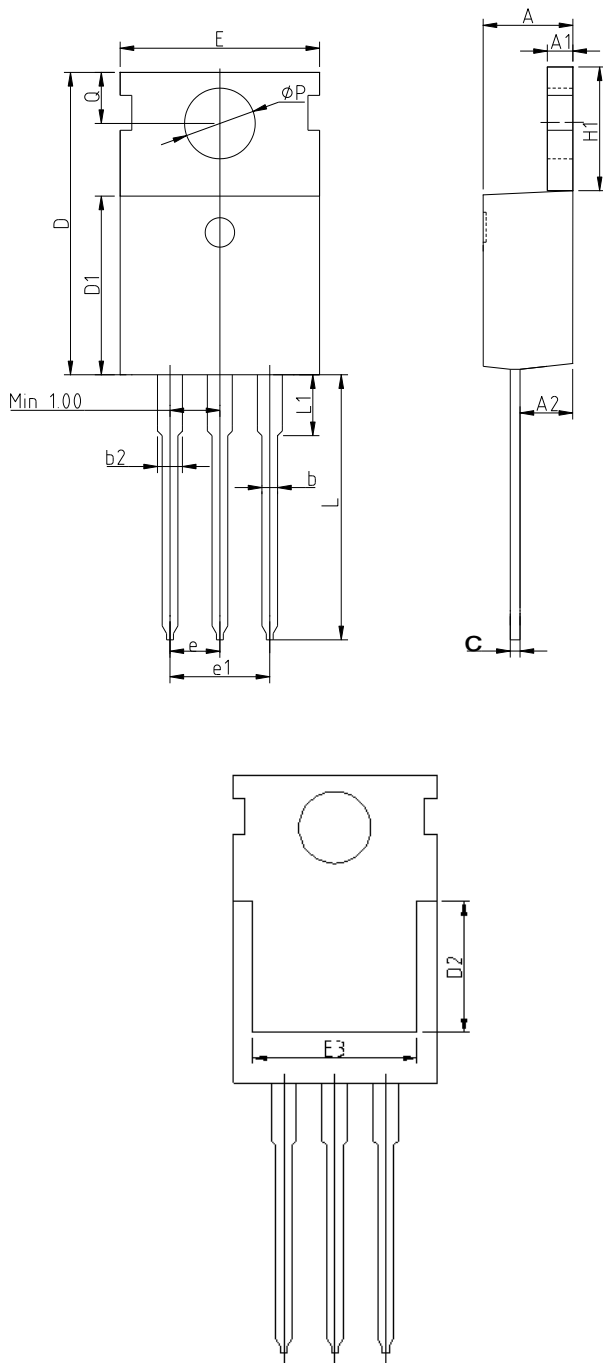
Device Per Unit

Package Type	Unit	Quantity
TO-220FB-3L	Tube	50
TO-263-2L	Reel	800

Package Information

TO-220FB-3L

(unit:mm)

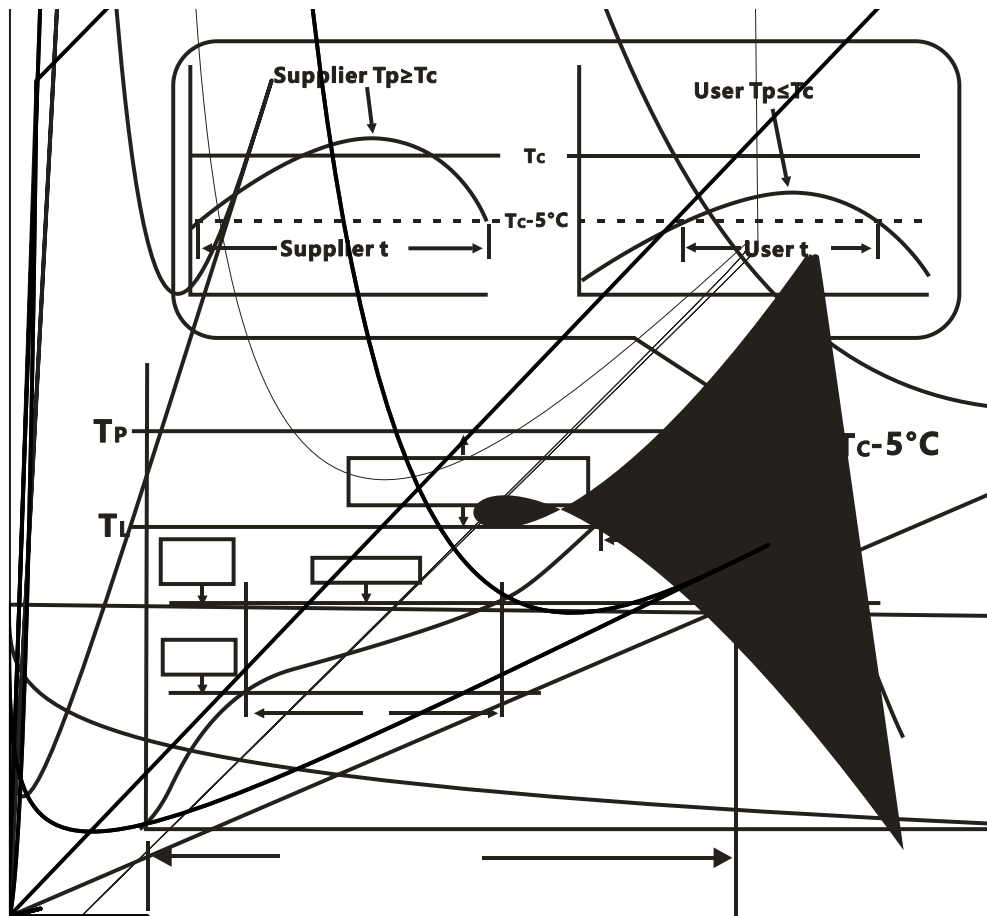


COMMON DIMENSIONS			
SYMBOL	mm		
	MIN	NOM	MAX
A	4.37	4.57	4.77
A1	1.25	1.30	1.40
A2	2.20	2.40	2.60
b	0.70	0.80	0.95
b2	1.17	1.27	1.47
c	0.45	0.50	0.60
D	15.10	15.60	16.10
D1	8.80	9.10	9.40
D2	5.50	6.30	7.10
E	9.70	10.00	10.30
E3	7.00	7.80	8.60
e	2.54 BSC		
e1	5.08 BSC		
H1	6.25	6.50	6.85
L	12.75	13.50	13.80
L1	-	3.10	3.40
P	3.40	3.60	3.80
Q	2.60	2.80	3.00

TO-263-2L

COMMON DIMENSIONS			
SYMBOL	mm		
	MIN	NOM	MIN
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	0.70	0.81	0.96
b1	1.17	1.27	1.47
c	0.30	0.38	0.53
D1	8.50	8.70	8.90
D4	6.60	-	-
E	9.86	10.16	10.36
E5	7.06	-	-
e	2.54 BSC		
H	14.70	15.10	15.50
H2	1.07	1.27	1.47
L	2.00	2.30	2.60
L1	1.40	1.55	1.70
L4	0.25 BSC		
	0°	5°	9°

Classification Profile



Classification Reflow Profiles

Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Preheat & Soak		
Temperature min (T_{smin})	100 °C	150 °C
Temperature max (T_{smax})	150 °C	200 °C
Time (T_{smin} to T_{smax}) (t_s)	60-120 seconds	60-120 seconds
Average ramp-up rate (T_{smax} to T_p)	3 °C/second max.	3°C/second max.
Liquidous temperature (T_l)	183 °C	217 °C
Time at liquidous (t_l)	60-150 seconds	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 (Tc)

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 (Tc)

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	168/500 Hrs, Bias @ 150°C
HTGB	JESD-22, A108	168 /500 Hrs, V _{gs} 100% @