

P-Channel Enhancement Mode MOSFET

Feature

Pin Description

- -40V/-59A
 $R_{DS(ON)} = 9.7 \text{ m}\Omega(\text{typ.}) @ V_{GS} = -10\text{V}$
 $R_{DS(ON)} = 14.4 \text{ m}\Omega(\text{typ.}) @ V_{GS} = -4.5\text{V}$
- 100% Avalanche Tested
- 100% DVDS
- MSL1 up to 260°C Peak Reflow
- AEC-Q101 Qualified
- 175°C operating temperature
- Reliable and Rugged
- Halogen Free and Green Devices Available
(RoHS Compliant)

Applications

- Switching application
- Li-battery protection
- Motor control

Ordering and Marking Information

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	-59	A
Mounted on Large Heat Sink				
I _{DM}	Pulsed Drain Current *	Tc=25°C	-212	A
I _D	Continuous Drain Current	Tc=25°C	-59	A
		Tc=100°C	-42	A
P _D	Maximum Power Dissipation	Tc=25°C	79	W
		Tc=100°C	40	W
R _{θJC}	Thermal Resistance, Junction-to-Case		1.9	°C/W
R _{θJA}	Thermal Resistance, Junction-to-Ambient **		75	°C/W
E _{AS}	Single Pulsed-Avalanche Energy ***	L=0.3mH	118	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_G= 25Ω, V_{GS} =-10V.

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

Symbol	Parameter	Test Conditions	HYA120P04LQ1			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	-1.1	-1.5	-2.1	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	-	9.7	12	mΩ
		V _{GS} =-4.5V, I _{DS} =-20A		14.4	19	mΩ
Diode Characteristics						
V _{SD}	Diode Forward Voltage	I _{SD} =-20A, V _{GS} =0V	-	-0.87	-1.00	V
t _{rr}	Reverse Recovery Time	I _{SD} =-20A, dI _{SD} /dt=-100A/μs	-	12	-	ns
Q _{rr}	Reverse Recovery Charge		-	6	-	nC

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

Symbol	Parameter	Test Conditions	HYA120P04LQ1			Unit
			Min	Typ.	Max	
Dynamic Characteristics						
R _G	Gate Resistance	V _{GS} =0V, V _{DS} =0V, F=500KHz	-	6.3	-	Ω
C _{iss}	Input Capacitance	V _{GS} =0V, V _{DS} =-25V, Frequency=500KHz	-	1836	-	pF
C _{oss}	Output Capacitance					
C _{rss}	Reverse Transfer Capacitance					
t _{d(ON)}	Turn-on Delay Time	V _{DD} =-20V, R _G =5Ω, I _{DS} =-20A, V _{GS} =-10V	-	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	-	45	-	nC
	Total Gate Charge(V _{GS} =-4.5V)		-	24	-	
Q _{gs}	Gate-Source Charge		-	6	-	
Q _{gd}	Gate-Drain Charge		-	15	-	
V _{plateau}	Gate plateau voltage		-	-3.2	-	V

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

Typical Operating Characteristics

Figure 1: Power Dissipation

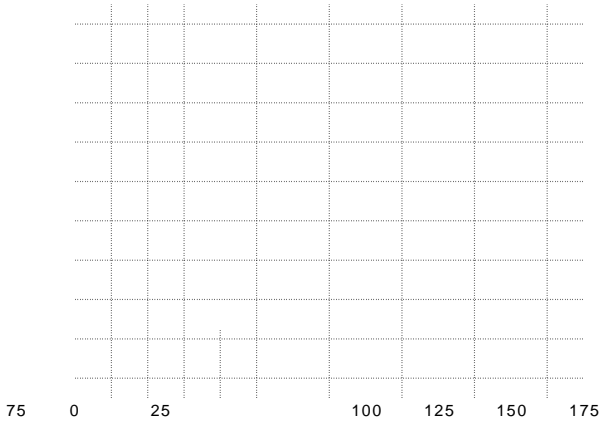


Figure 2: Drain Current

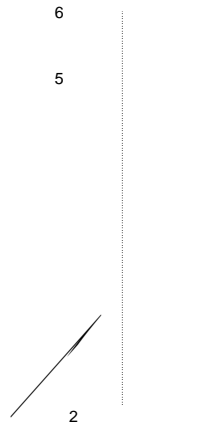


Figure 3: Safe Operation Area

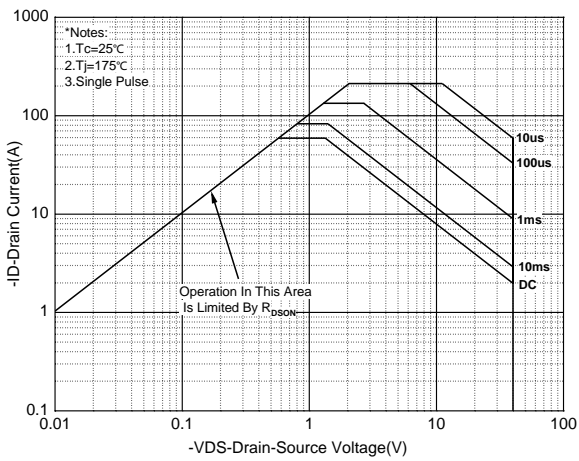


Figure 4: Thermal Transient Impedance



Figure 5: Output Characteristics

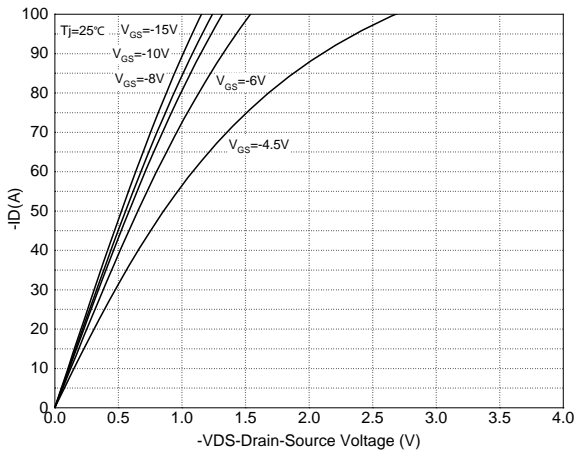


Figure 6: Drain-Source On Resistance



Typical Operating Characteristics(Cont.)

Figure 7: On-Resistance vs. Temperature

Figure 8: Source-Drain Diode Forward

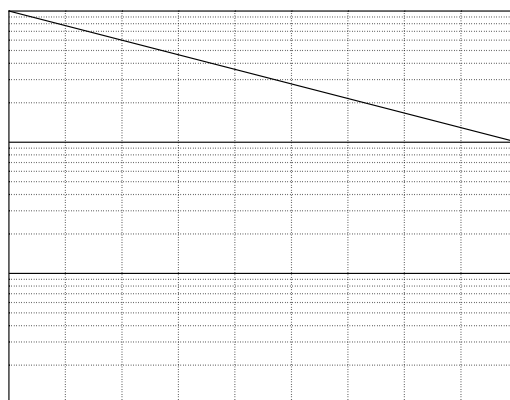
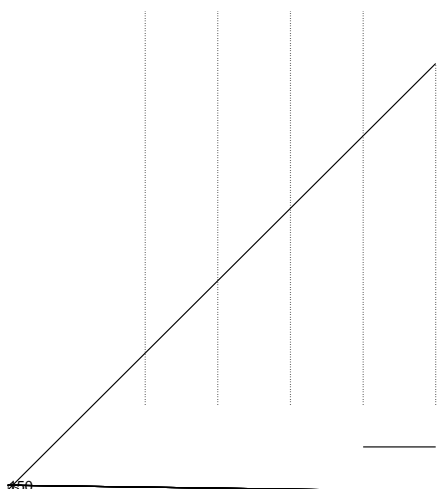


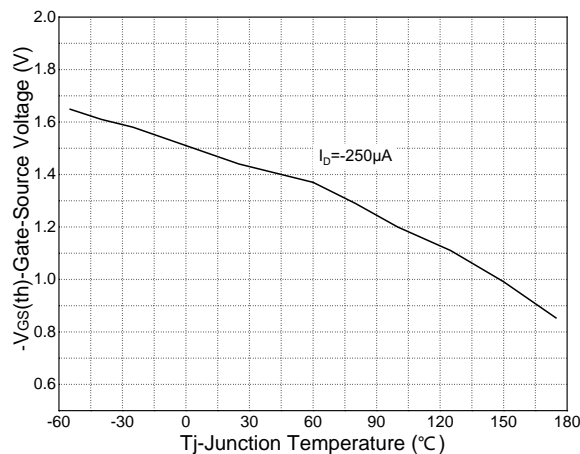
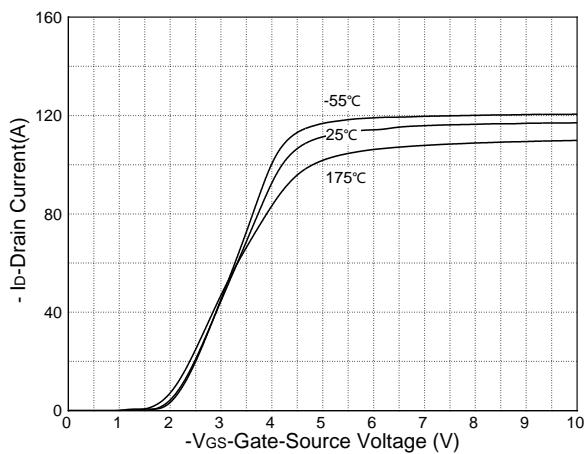
Figure 9: Capacitance Characteristics

Figure 10: Gate Charge Characteristics



Figure 11: Transfer Characteristics

Figure 12: Gate Threshold Voltage



Typical Operating Characteristics(Cont.)

Figure 13: Drain-Source Breakdown

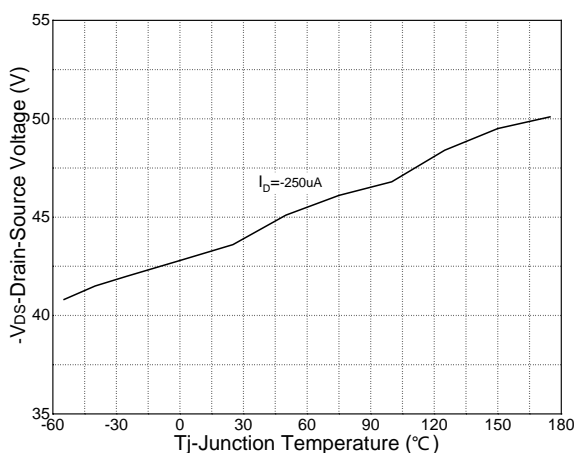


Figure 14: R_{dson} vs. Gate Voltage

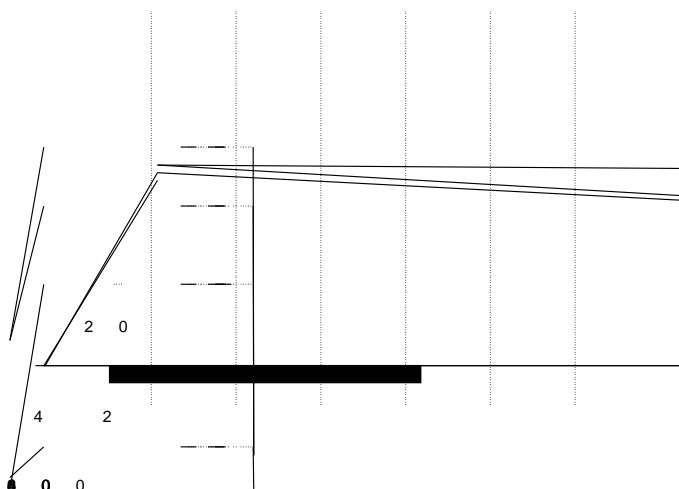
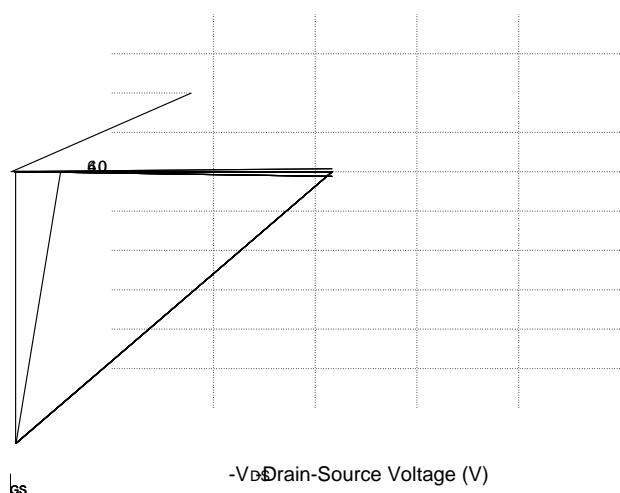
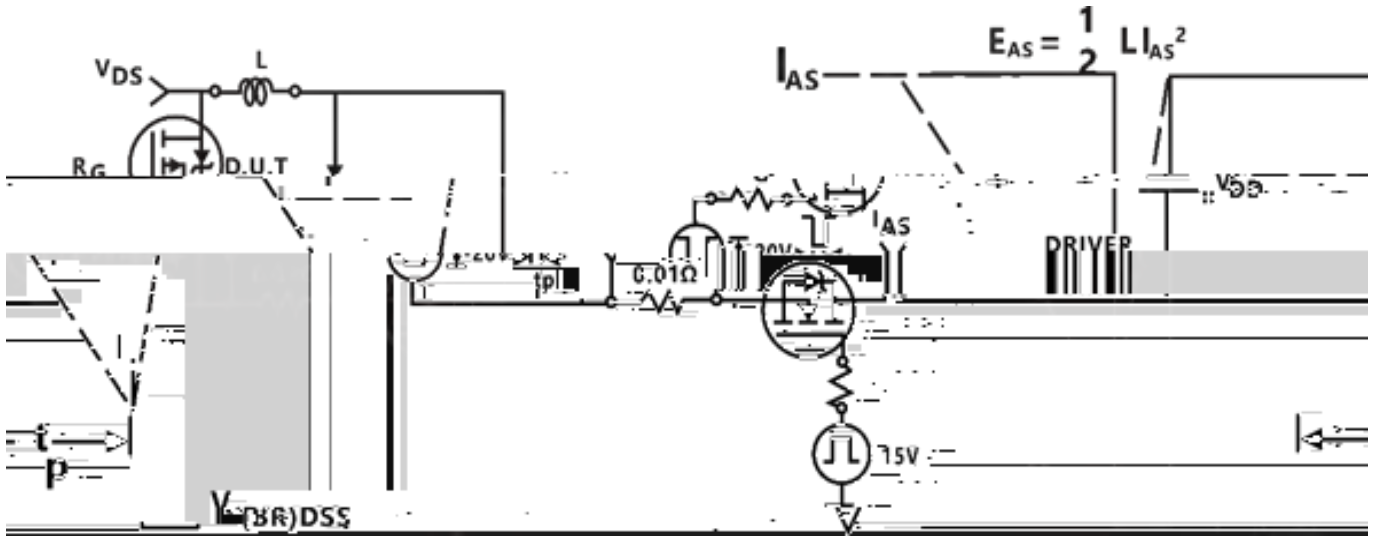


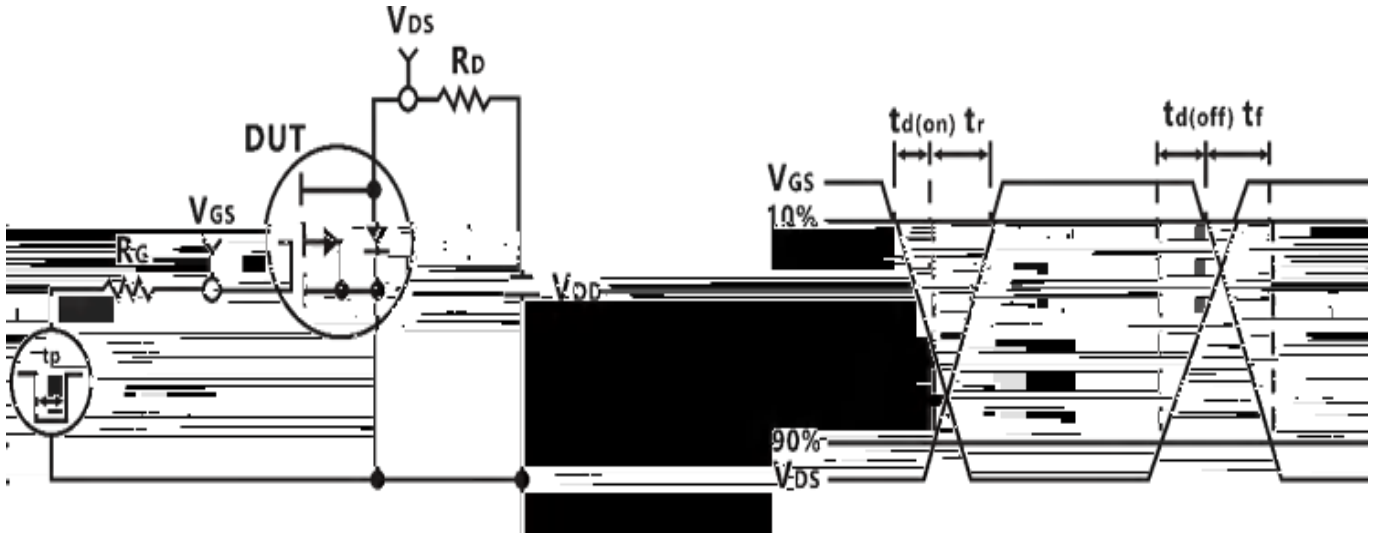
Figure 15: Output Characteristics (125°C)



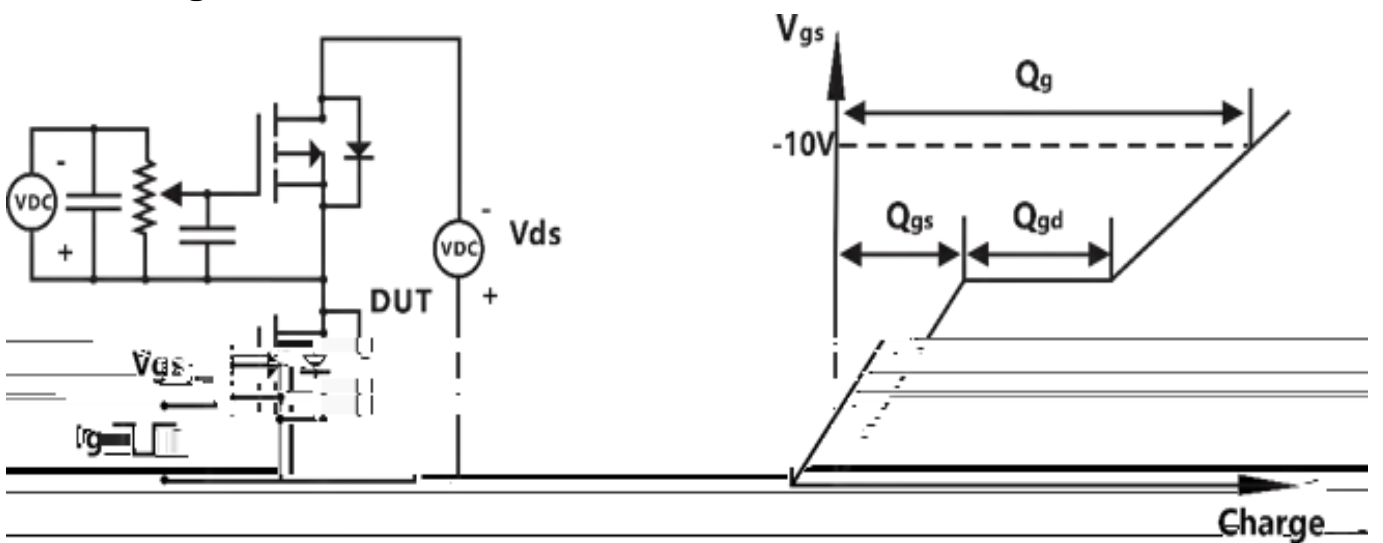
Avalanche Test Circuit



Switching Time Test Circuit



Gate Charge Test Circuit

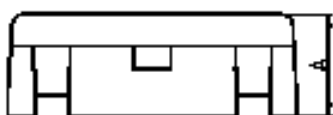
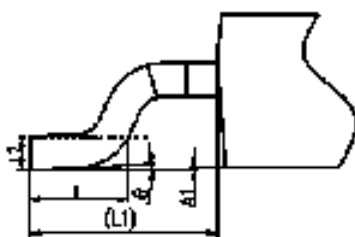
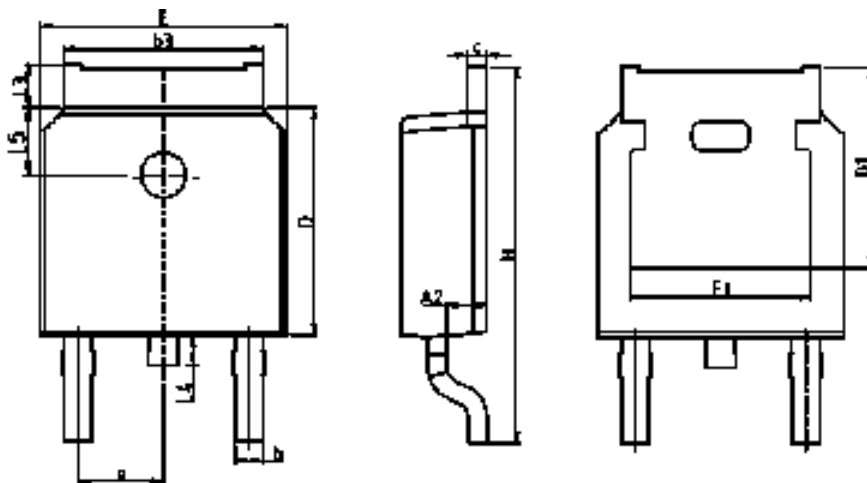


Device Per Unit

Package Type	Unit	Quantity
TO-252-2L	Tube	75
TO-252-2L	Reel	2500
TO-251-3L	Tube	75
TO-251-3S	Tube	75

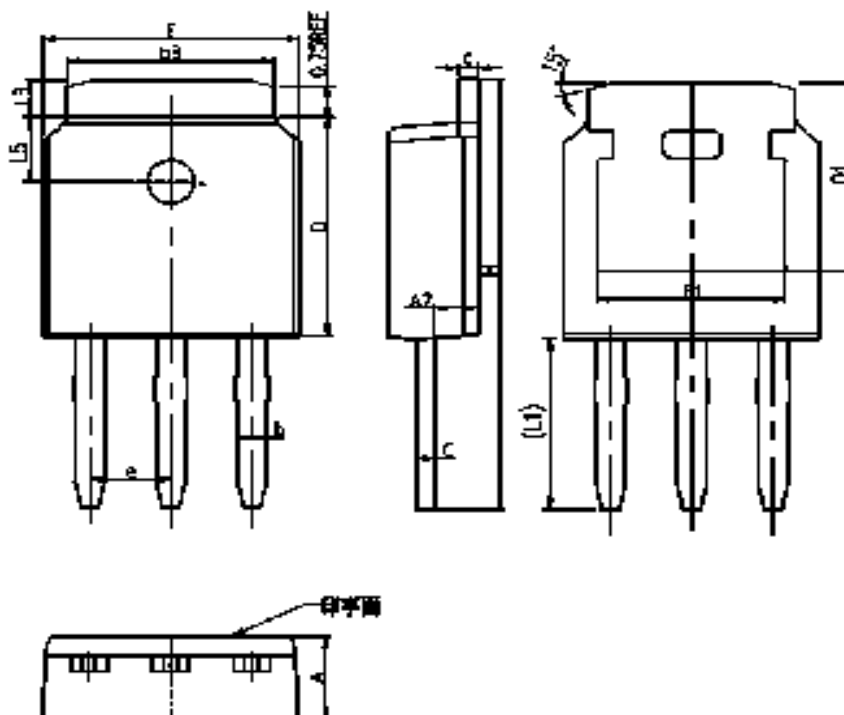
Package Information

TO-252-2L



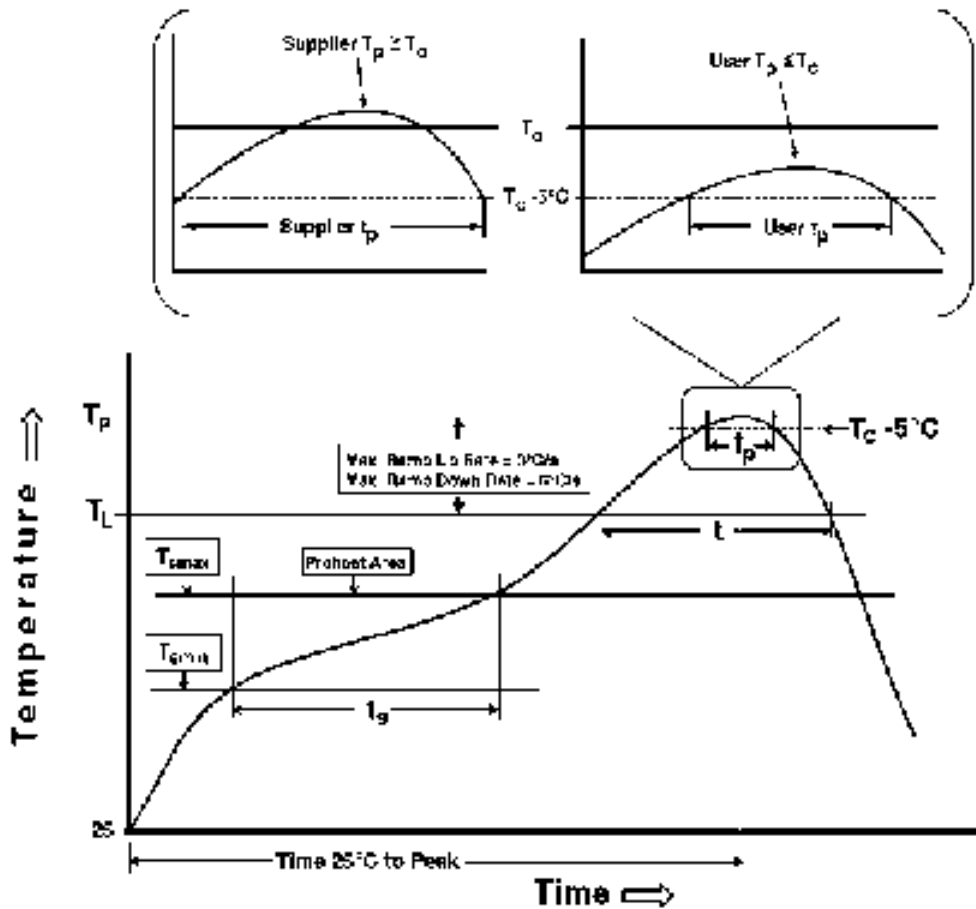
COMMON DIMENSIONS			
SYMBOL	mm		
	MIN	NOM	MAX
A	2.20	2.30	2.40
A1	0.00	-	0.20
A2	0.97	1.07	1.17
b	0.68	0.78	0.90
b3	5.20	5.33	5.50
c	0.43	0.53	0.63
D	5.98	6.10	6.22
D1	5.30REF		
E	6.40	6.60	6.80
E1	4.63	-	-
e	2.286BSC		
H	9.40	10.10	10.50
L	1.38	1.50	1.75
L1	2.90REF		
L2	0.51BSC		
L3	0.88	-	1.28
L4	-	-	1.00
L5	1.65	1.80	1.95
θ	0°	-	8°

TO-251-3S



COMMON DIMENSIONS			
SYMBOL	mm		
	MIN	NOM	MAX
A	2.20	2.30	2.40
A2	0.97	1.07	1.17
b	0.68	0.78	0.90
b3	5.20	5.33	5.50
c	0.43	0.53	0.63
D	5.98	6.10	6.22
D1	5.30REF		
E	6.40	6.60	6.80
E1	4.63	-	-
e	2.286BSC		
H	10.00	11.22	11.44
L1	3.90	4.10	4.30
L3	0.88	1.02	1.28
L5	1.65	1.80	1.95

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
MSL	JESD22-A113	85°C/85%/168Hrs
RSH	JESD22- B106(PTH)	260±5°C, 10±1S
PCT	JESD22-A102	121°C,100%RH, 96hours, 205KPa
TCT	JESD22-A104	1000 Cycles, -55°C~150°C
HTRB	JESD22-A108B	1000 Hrs, 100% BV _{DSS} @ 175°C
HTGB	JESD22-A108B	1000 Hrs, 100%V _{gs} @ 175°C
BHAST	JESD22-A110D	130°C, 85%RH, 230KPA;U=-32V
IOL	MIL-STD-750	Ta=25°C,ΔTj≥100°C, Ton/Toff 3.5min , 8600cycles

Customer Service

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