

## 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

	D	U	V
HYA120P04	HYA120P04	HYA120P04	
XYMXXXXXX	XYMXXXXXX	XYMXXXXXX	

**Absolute Maximum Ratings**

Symbol	Parameter	Rating	Unit	
<b>Common Ratings (Tc=25°C Unless Otherwise Noted)</b>				
V <sub>DSS</sub>	Drain-Source Voltage	-40	V	
V <sub>GSS</sub>	Gate-Source Voltage	±20	V	
T <sub>J</sub>	Junction Temperature Range	-55 to 175	°C	
T <sub>STG</sub>	Storage Temperature Range		°C	
I <sub>S</sub>	Source Current-Continuous(Body Diode)	Tc=25°C	-59	A
<b>Mounted on Large Heat Sink</b>				
I <sub>DM</sub>	Pulsed Drain Current *	Tc=25°C	-212	A
I <sub>D</sub>	Continuous Drain Current	Tc=25°C	-59	A
		Tc=100°C	-42	A
P <sub>D</sub>	Maximum Power Dissipation	Tc=25°C	79	W
		Tc=100°C	40	W
R <sub>θJC</sub>	Thermal Resistance, Junction-to-Case		1.9	°C/W
R <sub>θJA</sub>	Thermal Resistance, Junction-to-Ambient **		75	°C/W
E <sub>AS</sub>	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<sub>Jmax</sub> , starting T<sub>J</sub>=25°C, L = 0.3mH, R<sub>G</sub>= 25Ω, V<sub>GS</sub> =-10V.

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

Symbol	Parameter	Test Conditions	HYA120P04LQ1			Unit
			Min	Typ.	Max	
<b>Static Characteristics</b>						
BV <sub>DSS</sub>	Drain-Source Breakdown Voltage	V <sub>GS</sub> =0V, I <sub>DS</sub> =-250μA	-40	-	-	V
I <sub>DSS</sub>	Drain-to-Source Leakage Current	V <sub>DS</sub> =-40V, V <sub>GS</sub> =0V	-	-	-1	μA
		T <sub>J</sub> =125°C	-	-	-50	μA
V <sub>GS(th)</sub>	Gate Threshold Voltage	V <sub>DS</sub> =V <sub>GS</sub> , I <sub>DS</sub> =-250μA	-1.1	-1.5	-2.1	V
I <sub>GSS</sub>	Gate-Source Leakage Current	V <sub>GS</sub> = ± 20V, V <sub>DS</sub> =0V	-	-	±100	nA
R <sub>DS(ON)</sub>	Drain-Source On-State Resistance	V <sub>GS</sub> =-10V, I <sub>DS</sub> =-20A	-	9.7	12	mΩ
		V <sub>GS</sub> =-4.5V, I <sub>DS</sub> =-20A		14.4	19	mΩ
<b>Diode Characteristics</b>						
V <sub>SD</sub>	Diode Forward Voltage	I <sub>SD</sub> =-20A, V <sub>GS</sub> =0V	-	-0.87	-1.00	V
t <sub>rr</sub>	Reverse Recovery Time	I <sub>SD</sub> =-20A, dI <sub>SD</sub> /dt=-100A/μs	-	12	-	ns
Q <sub>rr</sub>	Reverse Recovery Charge		-	6	-	nC

## Electrical Characteristics (Cont.) (T<sub>c</sub> =25°C Unless Otherwise Noted)

Symbol	Parameter	Test Conditions	HYA120P04LQ1			Unit
			Min	Typ.	Max	
<b>Dynamic Characteristics</b>						
R <sub>G</sub>	Gate Resistance	V <sub>GS</sub> =0V, V <sub>DS</sub> =0V, F=500KHz	-	6.3	-	Ω
C <sub>iss</sub>	Input Capacitance	V <sub>GS</sub> =0V, V <sub>DS</sub> =-25V, Frequency=500KHz	-	1836	-	pF
C <sub>oss</sub>	Output Capacitance					
C <sub>rss</sub>	Reverse Transfer Capacitance					
t <sub>d(ON)</sub>	Turn-on Delay Time	V <sub>DD</sub> =-20V, R <sub>G</sub> =5Ω, I <sub>DS</sub> =-20A, V <sub>GS</sub> =-10V	-	9	-	ns
T <sub>r</sub>	Turn-on Rise Time					
t <sub>d(OFF)</sub>	Turn-off Delay Time					
T <sub>f</sub>	Turn-off Fall Time					
<b>Gate Charge Characteristics</b>						
Q <sub>g</sub>	Total Gate Charge(V <sub>GS</sub> =-10V)	V <sub>DS</sub> =-32V, I <sub>DS</sub> =-20A	-	45	-	nC
	Total Gate Charge(V <sub>GS</sub> =-4.5V)		-	24	-	
Q <sub>gs</sub>	Gate-Source Charge		-	6	-	
Q <sub>gd</sub>	Gate-Drain Charge		-	15	-	
V <sub>plateau</sub>	Gate plateau voltage		-	-3.2	-	V

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

Typical Operating Characteristics

Figure 1: Power Dissipation

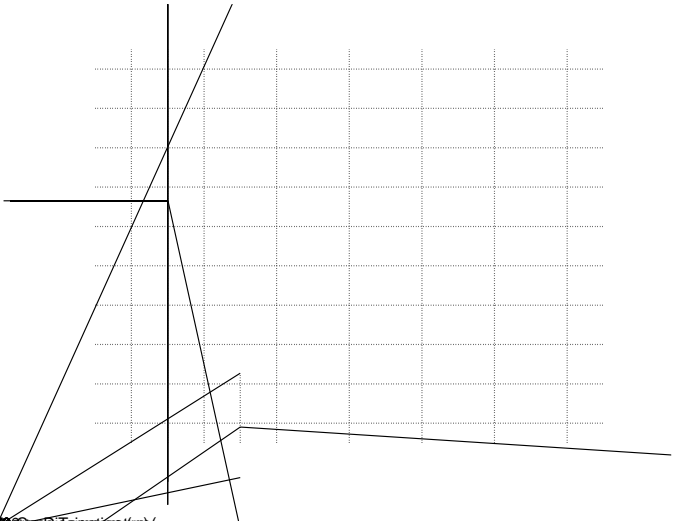


Figure 2: Drain Current



Figure 3: Safe Operation Area

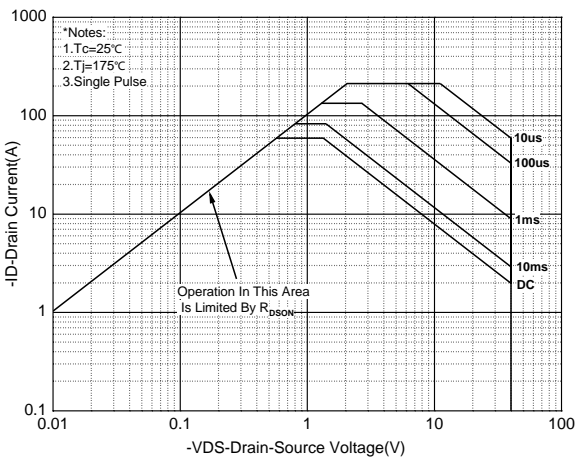


Figure 4: Thermal Transient Impedance



Figure 5: Output Characteristics

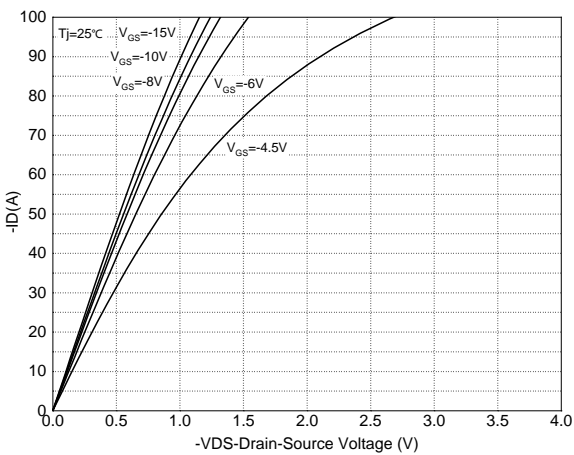
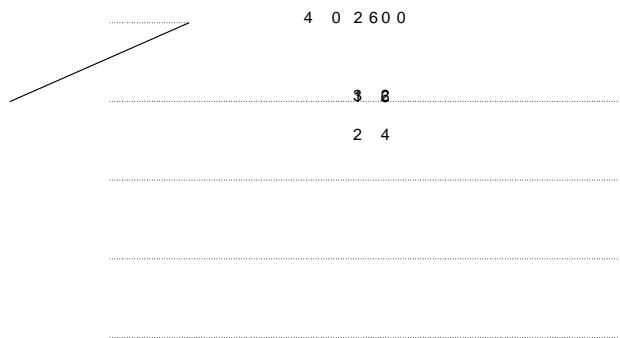


Figure 6: Drain-Source On Resistance



Typical Operating Characteristics(Cont.)

Figure 7: On-Resistance vs. Temperature

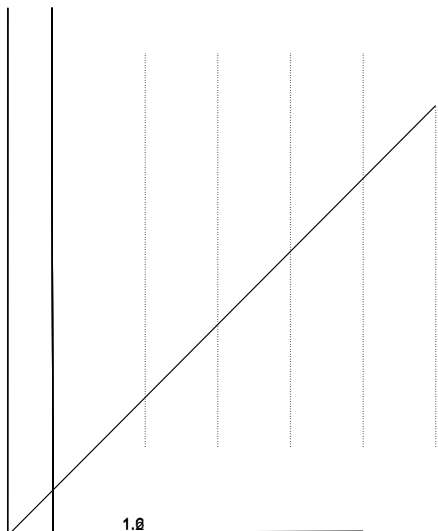


Figure 9: Capacitance Characteristics



Figure 11: Transfer Characteristics

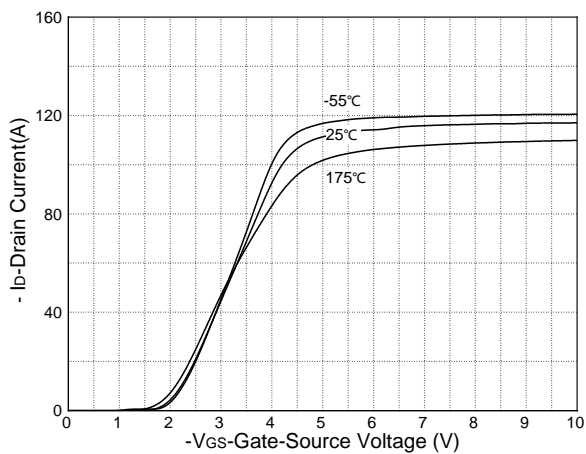


Figure 8: Source-Drain Diode Forward

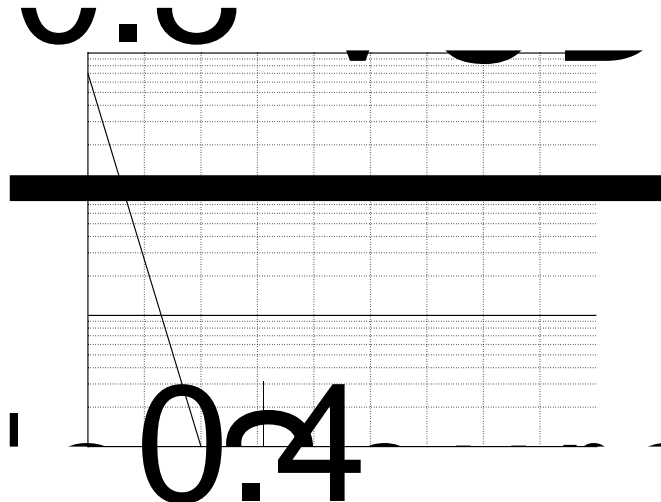
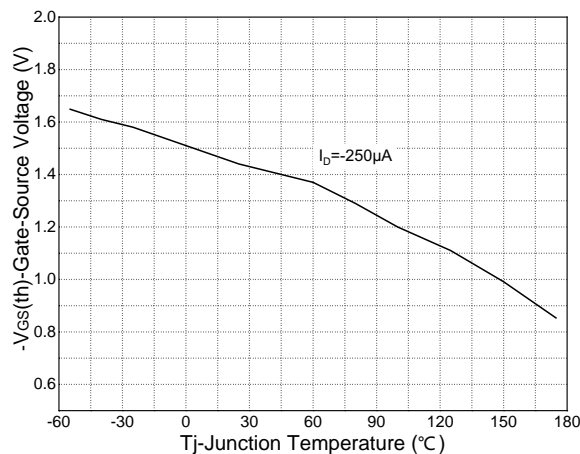


Figure 10: Gate Charge Characteristics



Figure 12: Gate Threshold Voltage



Typical Operating Characteristics(Cont.)

Figure 13: Drain-Source Breakdown

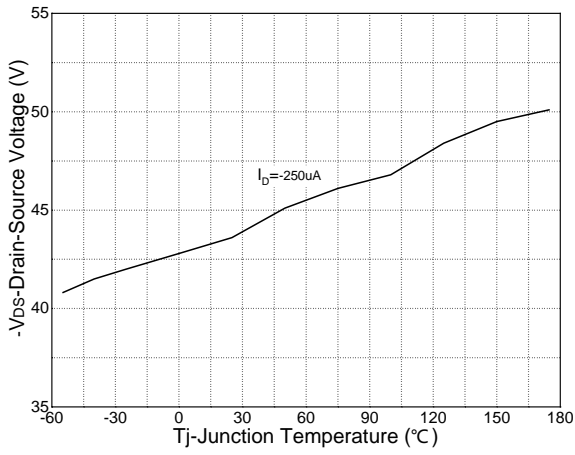


Figure 14: R<sub>dson</sub> vs. Gate Voltage

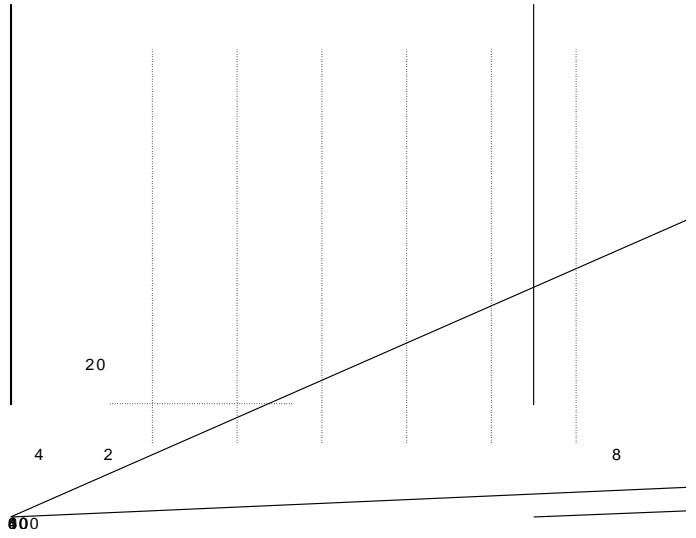
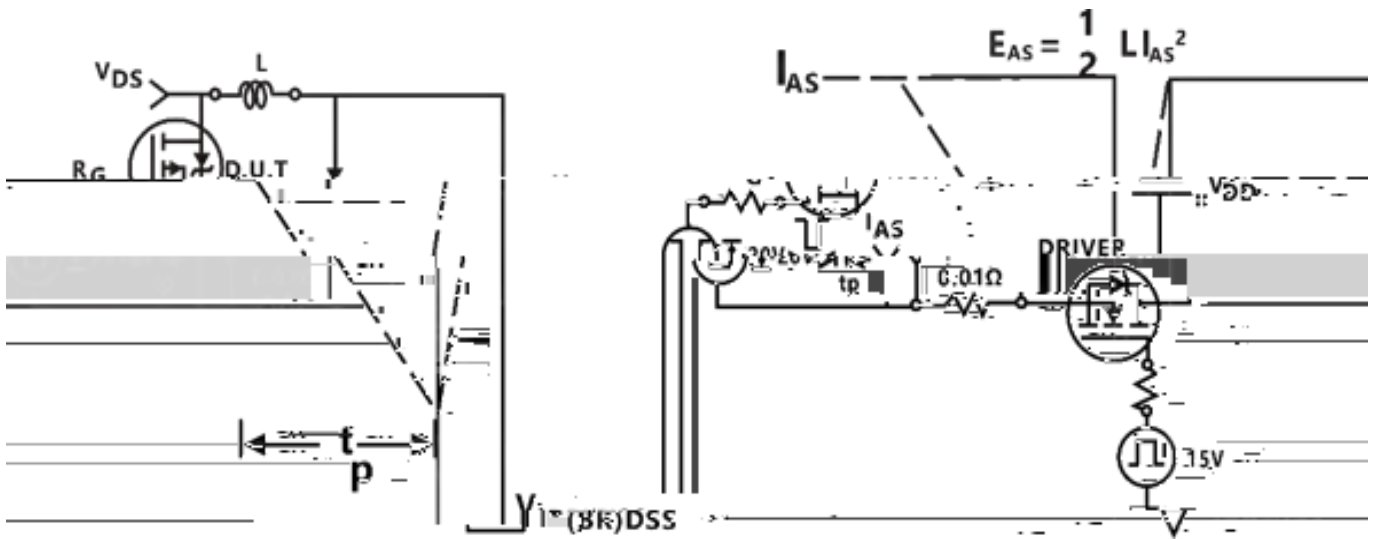


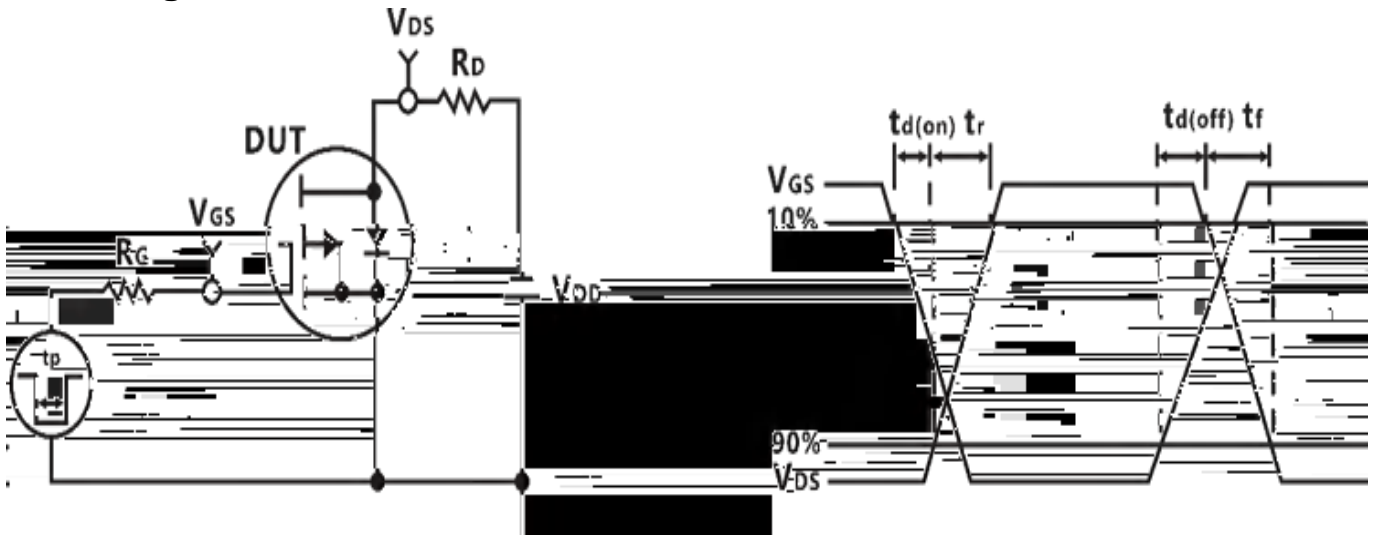
Figure 15: Output Characteristics (125°C)



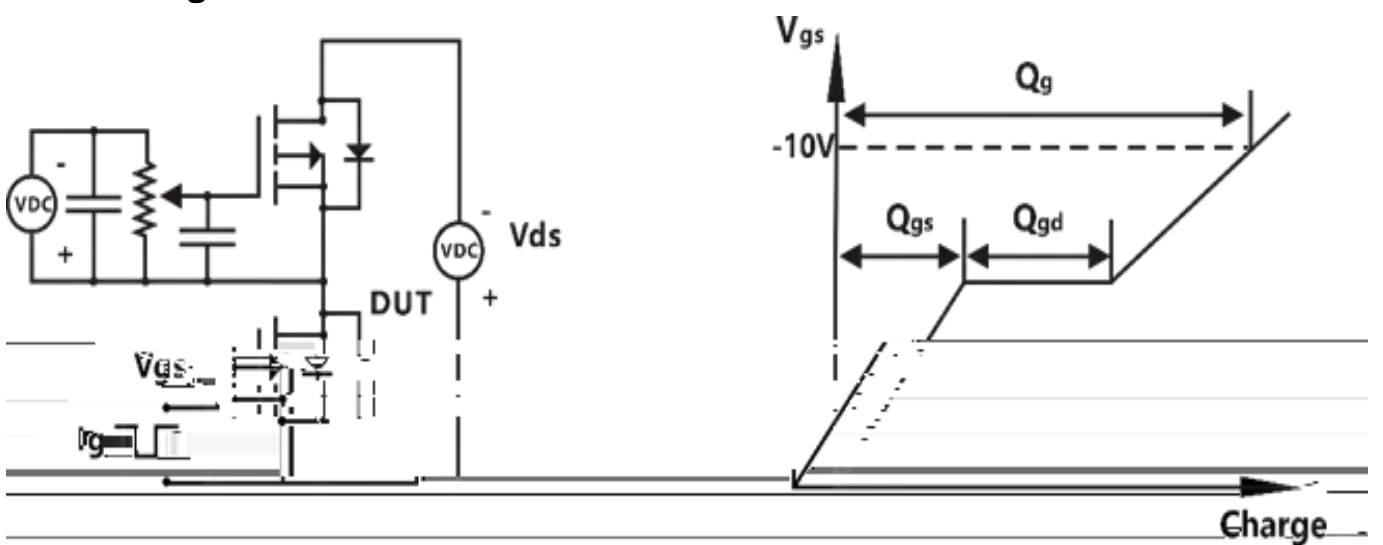
**Avalanche Test Circuit**



**Switching Time Test Circuit**



**Gate Charge Test Circuit**

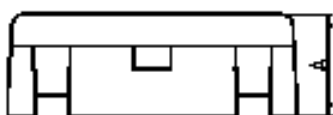
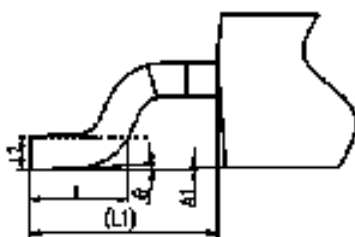
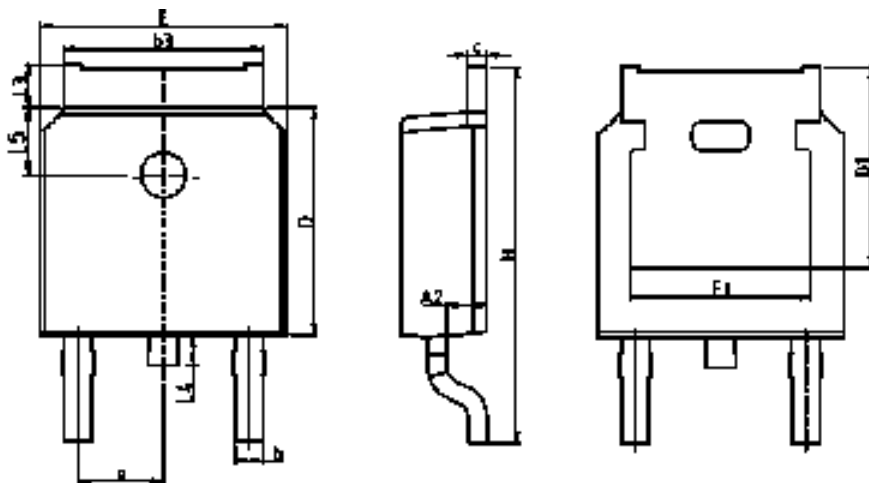


## Device Per Unit

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

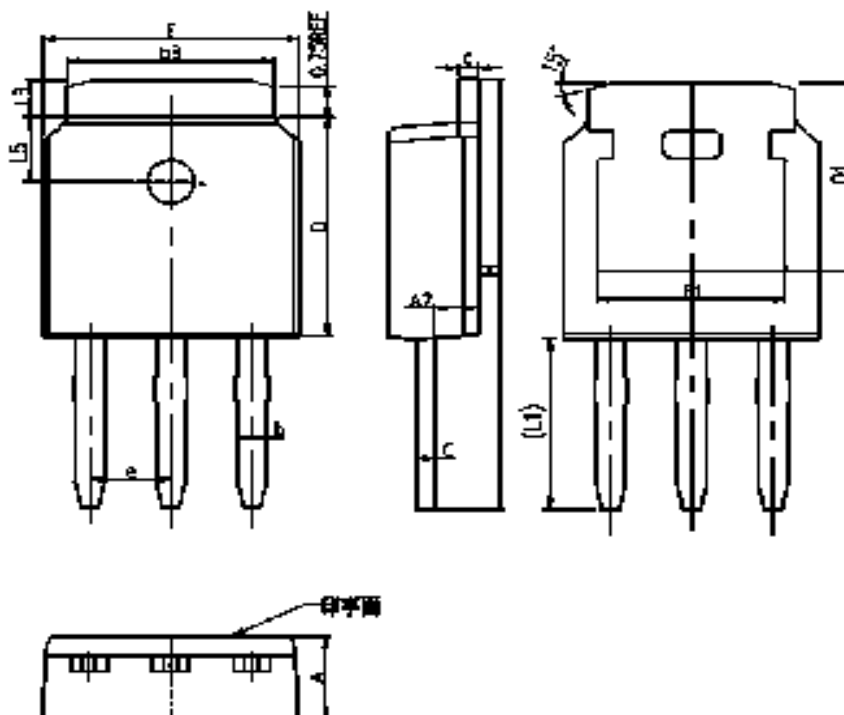


COMMON DIMENSIONS			
SYMBOL	mm		
	MIN	NOM	MAX
A	2.20	2.30	2.40
A1	0.00	-	0.20
A2	0.97	1.07	1.17
b	0.68	0.78	0.90
b3	5.20	5.33	5.50
c	0.43	0.53	0.63
D	5.98	6.10	6.22
D1	5.30REF		
E	6.40	6.60	6.80
E1	4.63	-	-
e	2.286BSC		
H	9.40	10.10	10.50
L	1.38	1.50	1.75
L1	2.90REF		
L2	0.51BSC		
L3	0.88	-	1.28
L4	-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



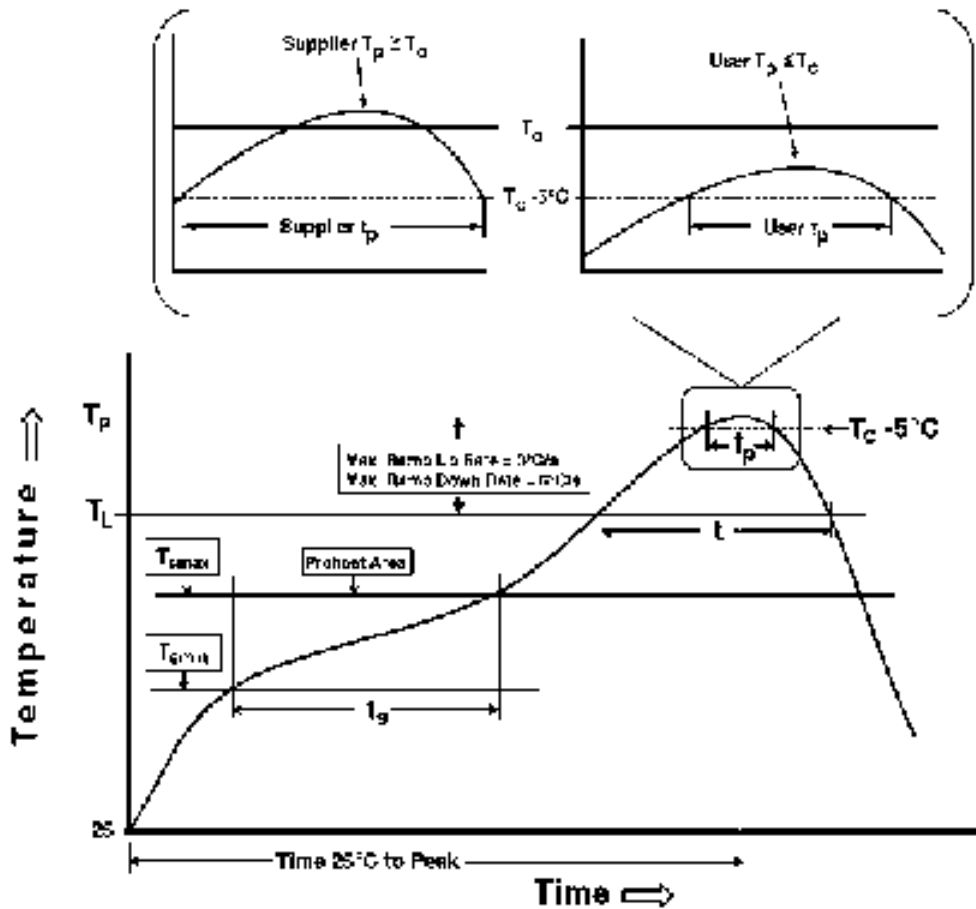


TO-251-3S



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
<b>Preheat &amp; Soak</b>		
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 <sup>3</sup> <350	Volume mm <sup>3</sup> ≥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 <sup>3</sup> <350	Volume mm <sup>3</sup> 350-2000	Volume mm <sup>3</sup> ≥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 <sub>DSS</sub> @ 175°C
HTGB	JESD22-A108B	1000 Hrs, 100%V <sub>gs</sub> @ 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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