



# 650V Super-junction Power MOSFET

## Description

### 650V Super-junction Power MOSFET

Super-junction power MOSFET is a revolutionary technology for high voltage power MOSFETs, designed according to the SJ principle. The Multi-EPI SJ MOSFET provide an extremely low switching, communication and conduction losses device with highest robustness make especially resonant switching applications more reliable, more efficient, lighter and cooler, designed by Wuxi Unigroup Microelectronics Company.

## Features

- Very low FOM  $R_{DS(on)} \times Q_g$
- 100% avalanche tested
- Easy to use/drive
- RoHS compliant

## Applications

- Switch Mode Power Supply (SMPS)
- Uninterruptible Power Supply (UPS)
- Power Factor Correction (PFC)
- Charger

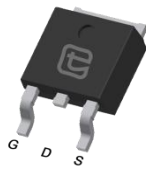
TO-220F



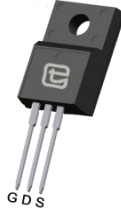
TO-263



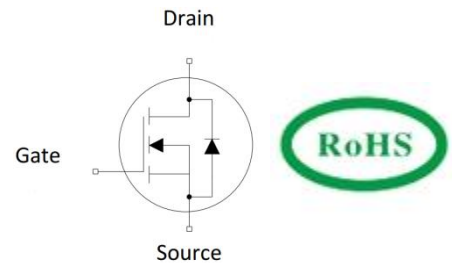
TO-252



TO-220FP-NL



TO-251



## Device Marking and Package Information

Device	Package	Marking
TPA65R600M	TO-220F	65R600M
TPB65R600M	TO-263	65R600M
TPD65R600M	TO-252	65R600M
TPR65R600M	TO-220FP-NL	65R600M
TPU65R600M	TO-251	65R600M

## Key Performance Parameters

Parameter	Value	Unit
$V_{DS} @ T_{j,max}$	700	V
$R_{DS(on),max}$	0.6	$\Omega$
$Q_{g,typ}$	13	nC
$I_D$	7	A
$I_{D,pulse}$	21	A
$E_{OSS} @ 400V$	1.59	$\mu J$
Body Diode $di_f/dt$	500	A/ $\mu s$



Absolute Maximum Ratings $T_C = 25^\circ\text{C}$ , unless otherwise noted				
Parameter		Symbol	Value	Unit
Continuous Drain Current	$T_C = 25^\circ\text{C}$	$I_D$	7	A
	$T_C = 100^\circ\text{C}$		4.2	
Pulsed Drain Current	(note1)	$I_{D,pulse}$	21	A
Gate-Source Voltage		$V_{GSS}$	$\pm 30$	V
Single Pulse Avalanche Energy	(note2)	$E_{AS}$	142	mJ
Repetitive Avalanche Energy	(note2)	$E_{AR}$	0.21	mJ
Avalanche Current		$I_{AR}$	1.3	A
MOSFET dv/dt Ruggedness, $V_{DS} = 0 \dots 480\text{V}$		dv/dt	50	V/ns
Power Dissipation For TO-220F, TO-220FP-NL		$P_D$	28	W
Power Dissipation For TO-263, TO-252, TO-251			63	
Continuous Diode Forward Current		$I_S$	6	A
Diode Pulsed Current	(note1)	$I_{S,pulse}$	21	
Reverse Diode dv/dt	(note3)	dv/dt	15	V/ns
Maximum Diode Commutation Speed	(note3)	$di_f/dt$	500	A/ $\mu\text{s}$
Operating Junction and Storage Temperature Range		$T_J, T_{stg}$	$-55 \sim +150$	$^\circ\text{C}$

Thermal Resistance For TO-220F, TO-220FP-NL			
Parameter	Symbol	Value	Unit
Thermal Resistance, Junction-to-Case	$R_{thJC}$	4.5	$^\circ\text{C}/\text{W}$
Thermal Resistance, Junction-to-Ambient	$R_{thJA}$	62	

Thermal Resistance For TO-263, TO-252, TO-251			
Parameter	Symbol	Value	Unit
Thermal Resistance, Junction-to-Case	$R_{thJC}$	2.0	$^\circ\text{C}/\text{W}$
Thermal Resistance, Junction-to-Ambient	$R_{thJA}$	62	



Electrical Characteristics $T_J = 25^\circ\text{C}$ , unless otherwise noted						
Parameter	Symbol	Test Conditions	Value			Unit
			Min.	Typ.	Max.	
<b>Static Characteristics</b>						
Drain-Source Breakdown Voltage	$V_{(BR)DSS}$	$V_{GS} = 0V, I_D = 250\mu A$	650	--	--	V
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{DS} = 650V, V_{GS} = 0V, T_J = 25^\circ\text{C}$	--	--	1	$\mu A$
		$V_{DS} = 650V, V_{GS} = 0V, T_J = 150^\circ\text{C}$	--	--	100	
Gate-Source Leakage Current	$I_{GSS}$	$V_{GS} = \pm 30V$	--	--	$\pm 100$	nA
Gate-Source Threshold Voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}, I_D = 250\mu A$	2.5	--	4.5	V
Drain-Source On-State-Resistance	$R_{DS(on)}$	$V_{GS} = 10V, I_D = 3.5A$	--	0.53	0.6	$\Omega$
Gate Resistance	$R_G$	$f = 1.0\text{MHz}$ open drain	--	7	--	$\Omega$
<b>Dynamic Characteristics</b>						
Input Capacitance	$C_{iss}$	$V_{GS} = 0V,$ $V_{DS} = 100V,$ $f = 1.0\text{MHz}$	--	509	--	$\mu F$
Output Capacitance	$C_{oss}$		--	23	--	
Reverse Transfer Capacitance	$C_{rss}$		--	1.5	--	
Total Gate Charge	$Q_g$	$V_{DD} = 520V, I_D = 7A,$ $V_{GS} = 10V$	--	13	--	nC
Gate-Source Charge	$Q_{gs}$		--	2.8	--	
Gate-Drain Charge	$Q_{gd}$		--	5.6	--	
Turn-on Delay Time	$t_{d(on)}$	$V_{DD} = 400V, I_D = 7A,$ $R_G = 25\Omega$	--	55	--	ns
Turn-on Rise Time	$t_r$		--	61	--	
Turn-off Delay Time	$t_{d(off)}$		--	117	--	
Turn-off Fall Time	$t_f$		--	42	--	
<b>Drain-Source Body Diode Characteristics</b>						
Body Diode Forward Voltage	$V_{SD}$	$T_J = 25^\circ\text{C}, I_{SD} = 3.5A, V_{GS} = 0V$	--	0.9	1.2	V
Reverse Recovery Time	$t_{rr}$	$V_R = 400V, I_F = 7A,$ $di_F/dt = 100A/\mu s$	--	321	--	ns
Reverse Recovery Charge	$Q_{rr}$		--	3.4	--	$\mu C$
Peak Reverse Recovery Current	$I_{rrm}$		--	21.2	--	A

**Notes**

1. Repetitive Rating: Pulse width limited by maximum junction temperature
2.  $I_{AS} = 2.4A, V_{DD} = 50V, R_G = 25\Omega$ , Starting  $T_J = 25^\circ\text{C}$
3. Identical low side and high side switch with identical  $R_G$



Typical Characteristics  $T_J = 25^\circ\text{C}$ , unless otherwise noted

Figure 1. Output Characteristics

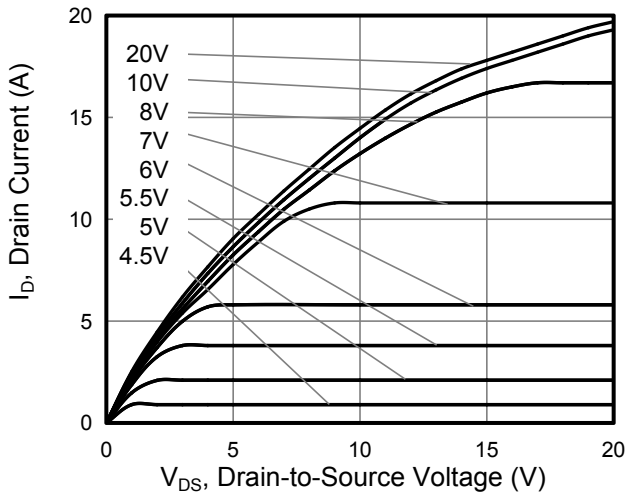


Figure 2. Transfer Characteristics

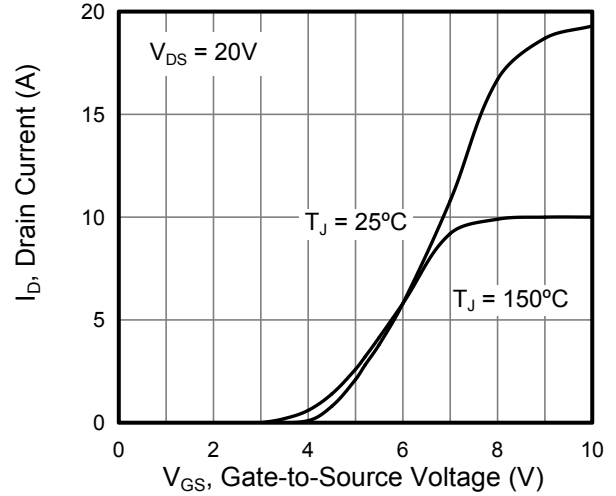


Figure 3. On-Resistance vs. Drain Current

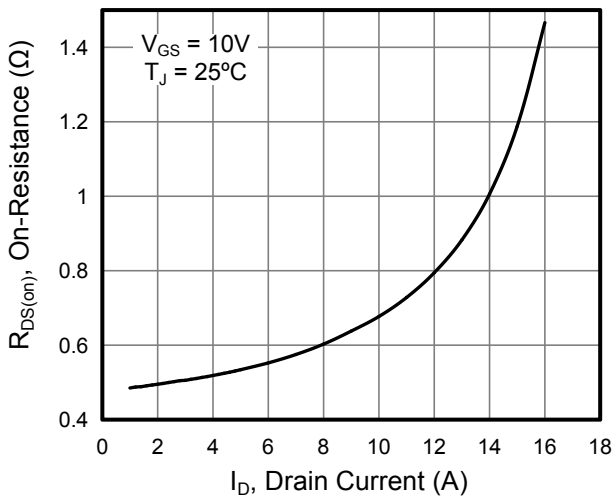


Figure 4. Capacitance

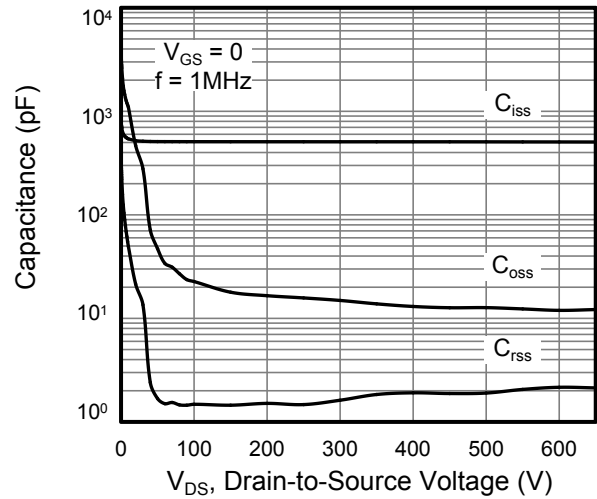


Figure 5. Gate Charge

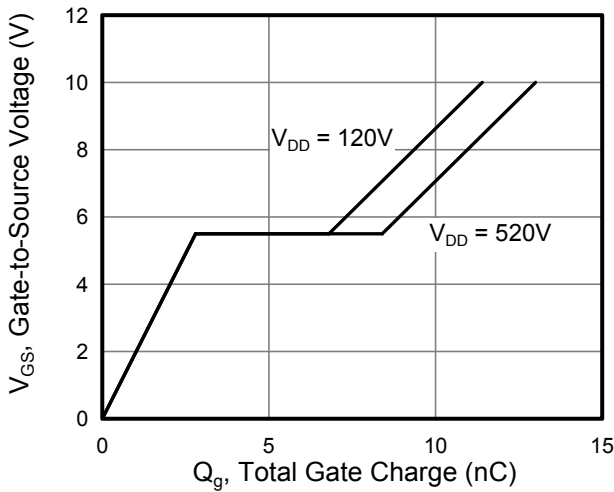
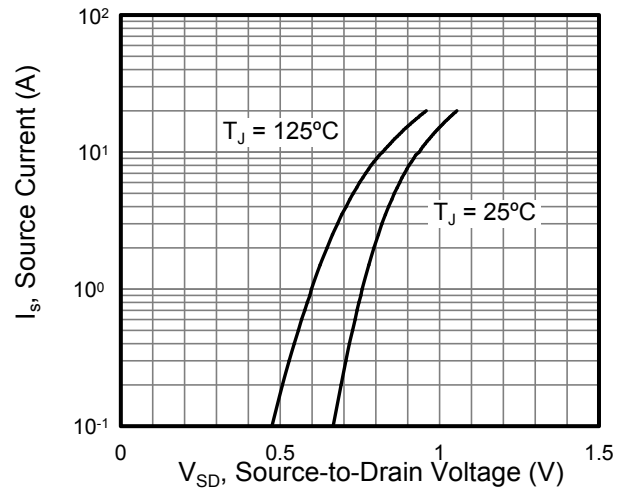


Figure 6. Body Diode Forward Voltage





Typical Characteristics  $T_J = 25^\circ\text{C}$ , unless otherwise noted

Figure 7. On-Resistance vs. Temperature

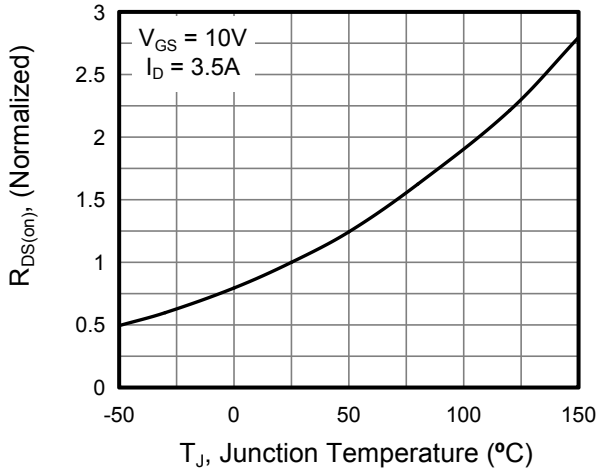


Figure 8. Breakdown voltage vs. Junction Temperature

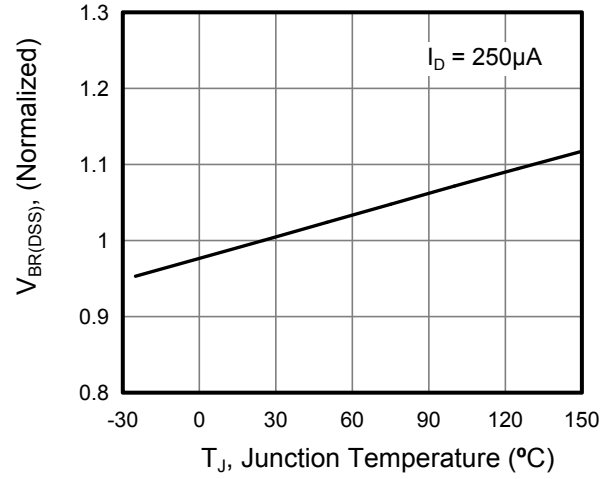


Figure 9. Transient Thermal Impedance For TO-263/TO-252/TO-251

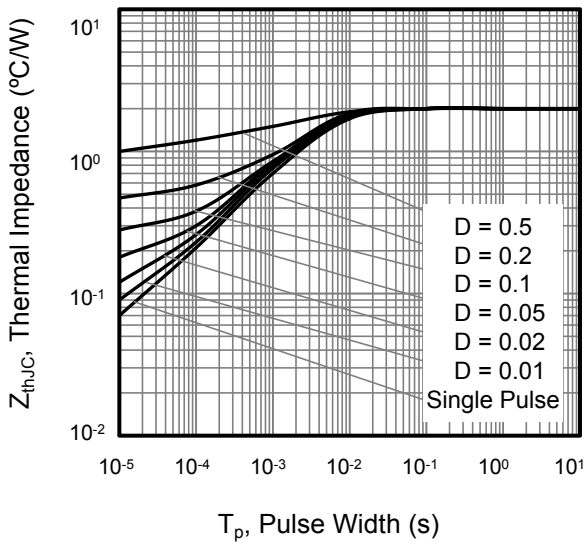


Figure 10. Transient Thermal Impedance For TO-220F/TO-220FP-NL

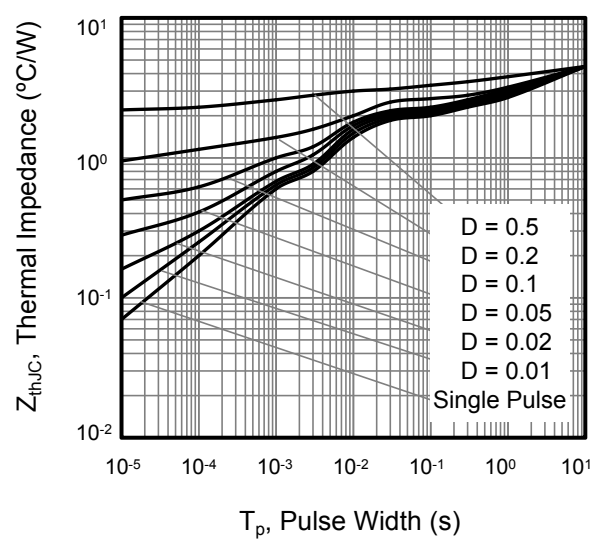


Figure 11. Safe Operation Area For TO-263/TO-252/TO-251

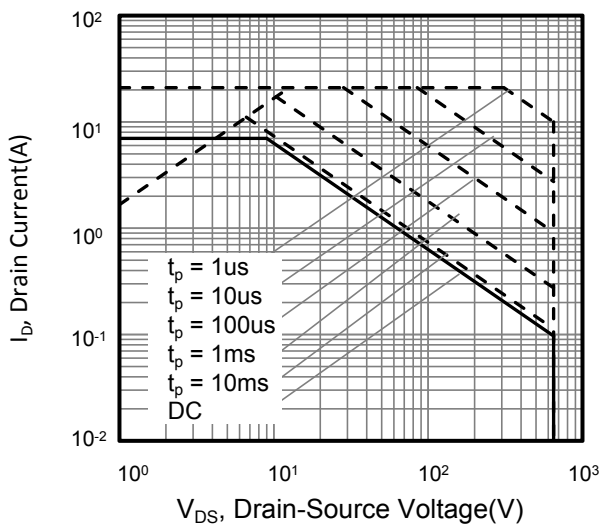
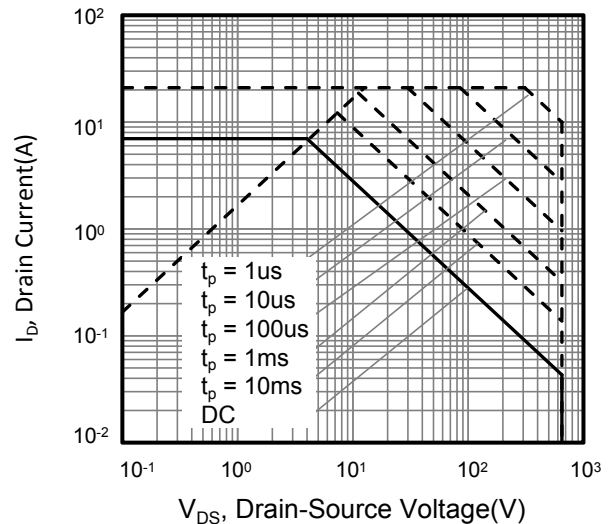


Figure 12. Safe Operation Area For TO-220F/TO-220FP-NL





Typical Characteristics  $T_J = 25^\circ\text{C}$ , unless otherwise noted

Figure 13. Typ. Coss Stored Energy

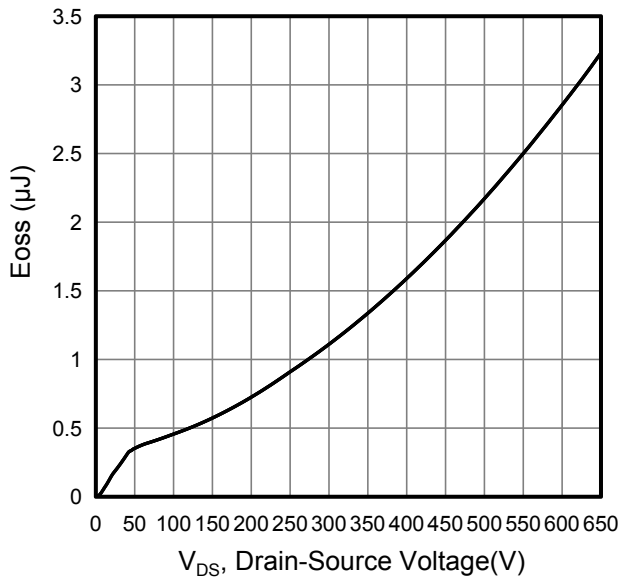




Figure A: Gate Charge Test Circuit and Waveform

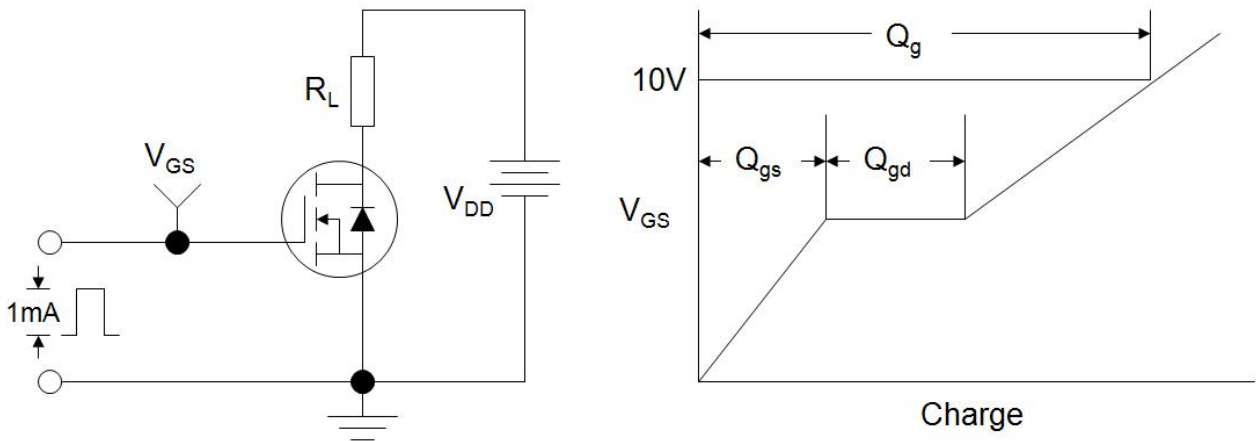


Figure B: Resistive Switching Test Circuit and Waveform

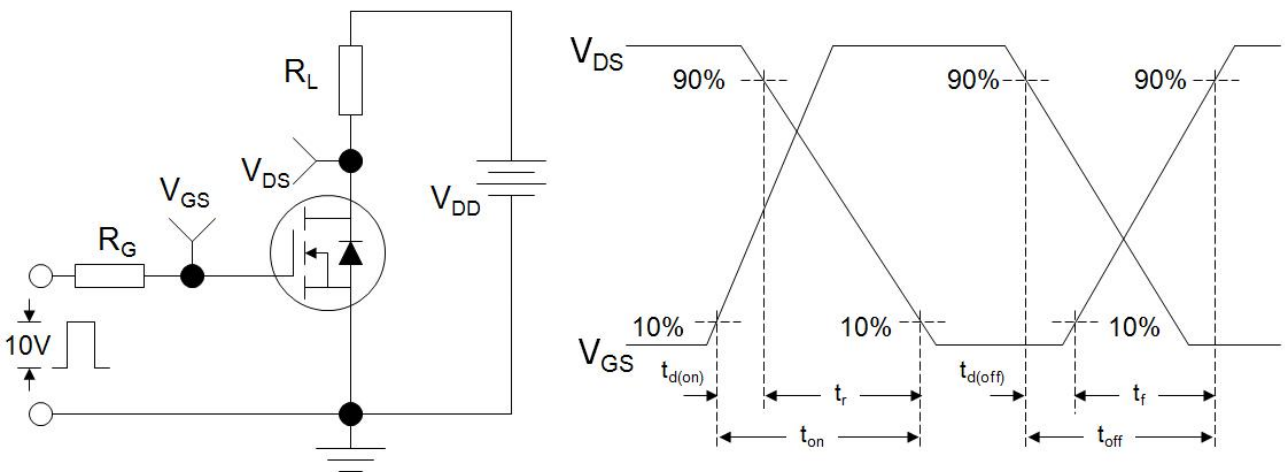
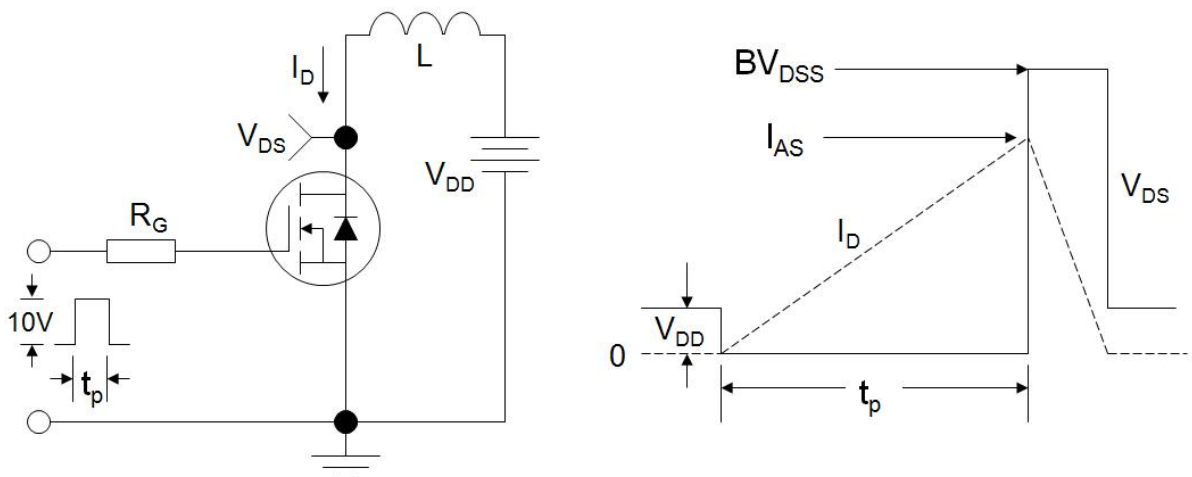
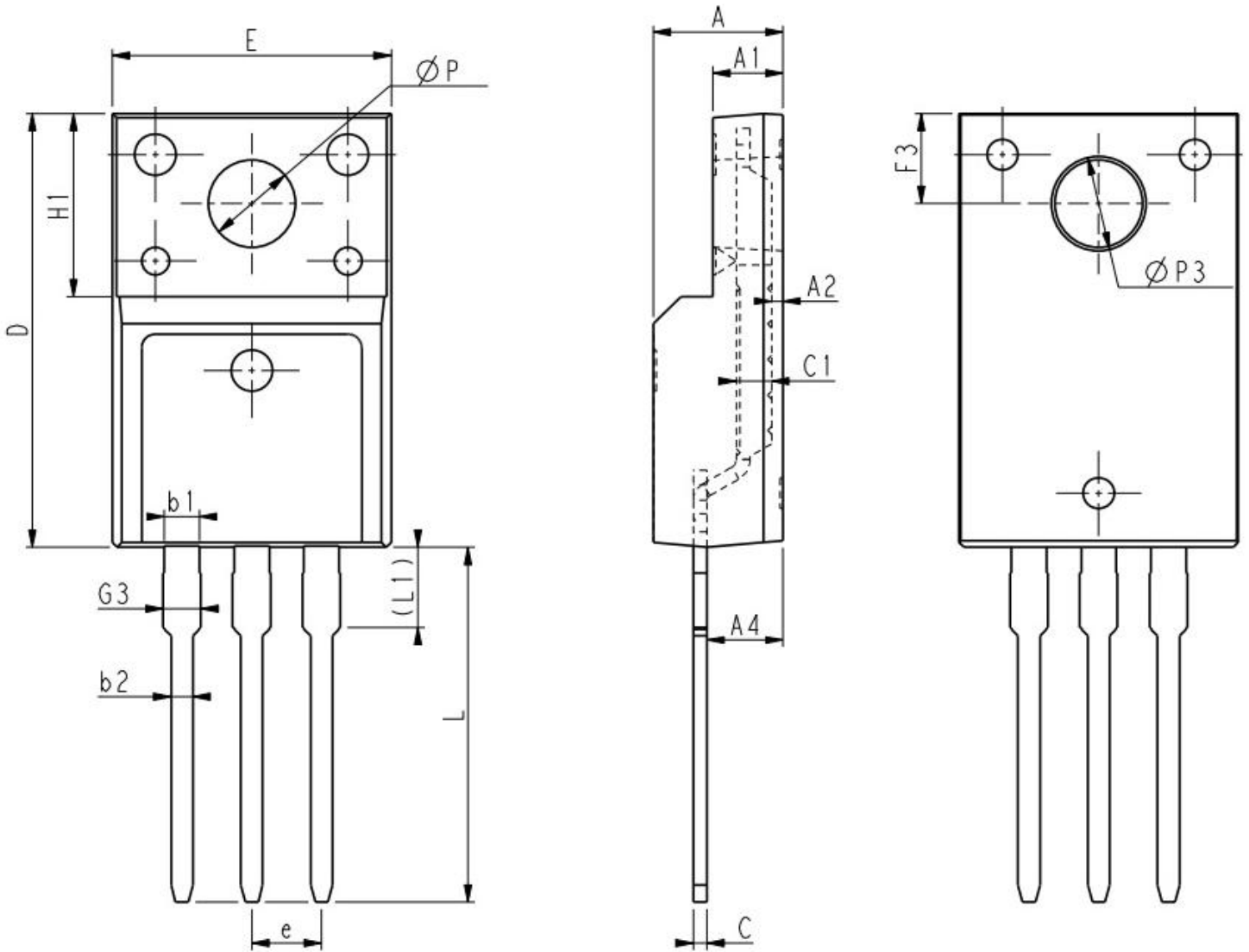


Figure C: Unclamped Inductive Switching Test Circuit and Waveform





**TO-220F (封装厂 H)**



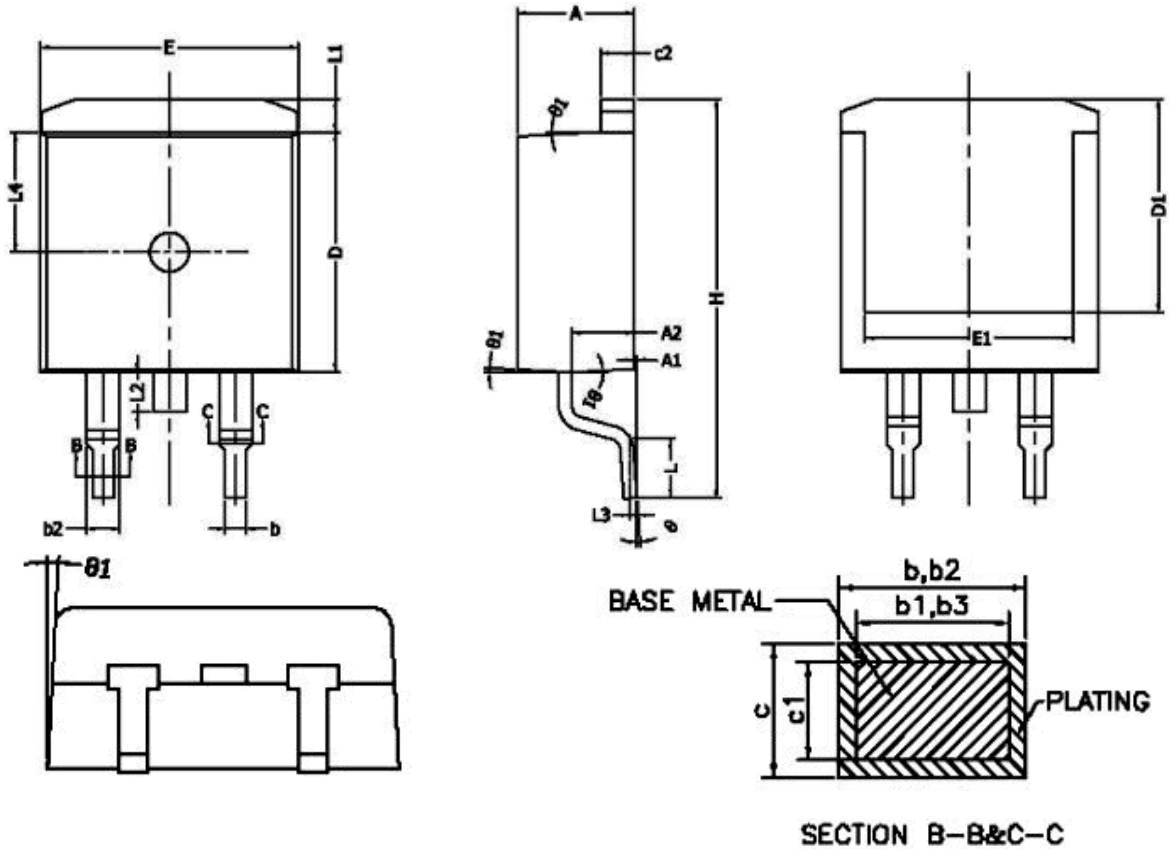
Unit:mm			
Symbol	Min.	Nom	Max.
E	9.96	10.16	10.36
A	4.50	4.70	4.90
A1	2.34	2.54	2.74
A2	0.30	0.45	0.60
A4	2.56	2.76	2.96
c	0.40	0.50	0.65
c1	1.20	1.30	1.35
D	15.57	15.87	16.17
H1	6.70REF		

Unit:mm			
Symbol	Min.	Nom	Max.
e	2.54BSC		
L	12.68	12.98	13.28
L1	2.93	3.03	3.13
$\Phi P$	3.03	3.18	3.38
$\Phi P3$	3.15	3.45	3.65
F3	3.15	3.30	3.45
G3	1.25	1.35	1.55
b1	1.18	1.28	1.43
b2	0.70	0.80	0.95





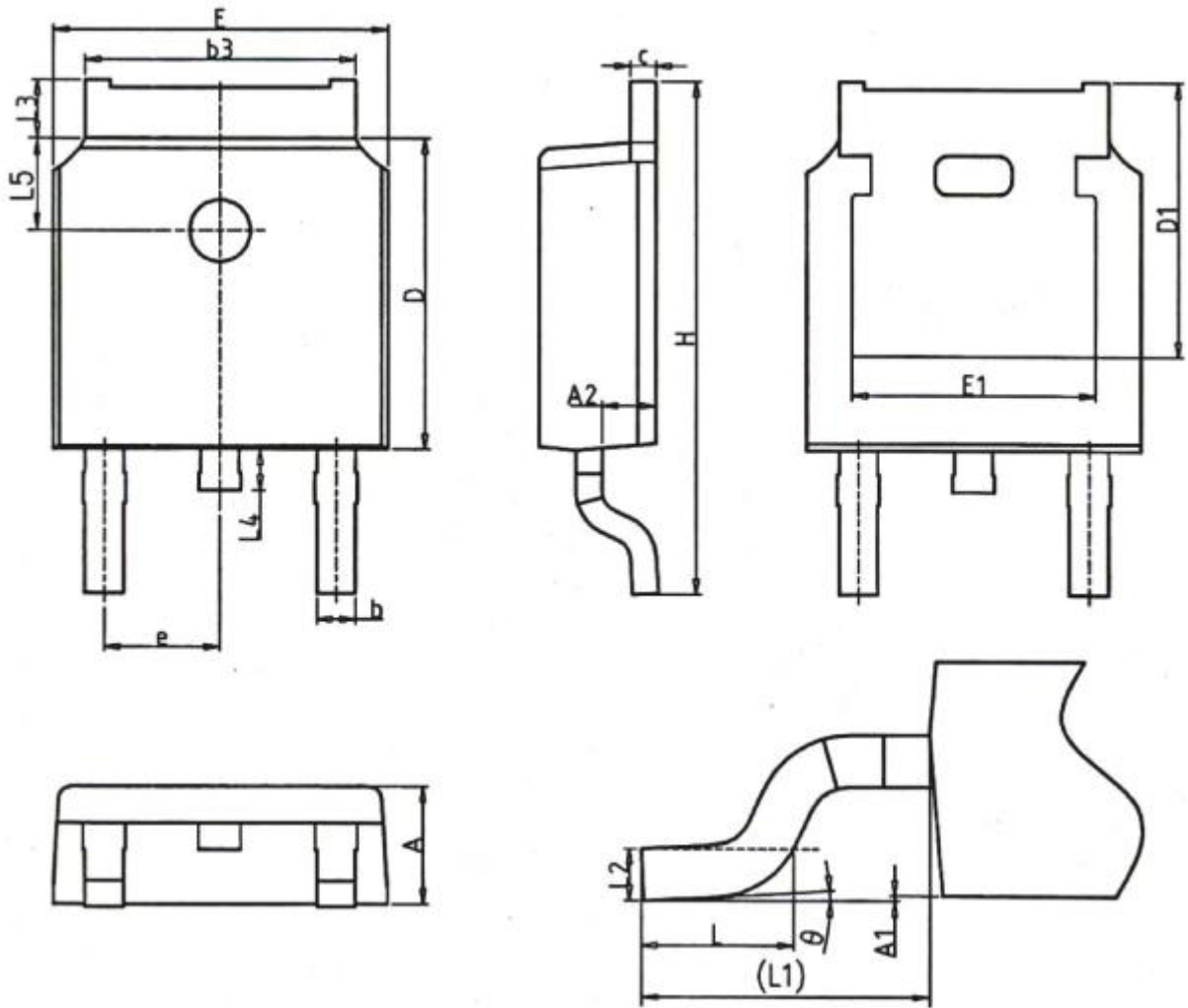
### TO-263 (封装厂 I)



SYMBOL	MIN	NOM	MAX
A	4.40	4.50	4.60
A1	0	0.10	0.25
A2	2.20	2.40	2.60
b	0.76	--	0.89
b1	0.75	0.80	0.85
b2	1.23	--	1.37
b3	1.22	1.27	1.32
c	0.47	--	0.60
c1	0.46	0.51	0.56
c2	1.25	1.30	1.35
D	9.10	9.20	9.30
D1	8.00	--	--
E	9.80	9.90	10.00
E1	7.80	--	--
e	2.54 BSC		
H	14.90	15.30	15.70
L	2.00	2.30	2.60
L1	1.17	1.27	1.40
L2	--	--	1.75
L3	0.25BSC		
L4	4.60 REF		
theta	0°	--	8°
theta1	1°	3°	5°



TO-252 (封装厂 H)

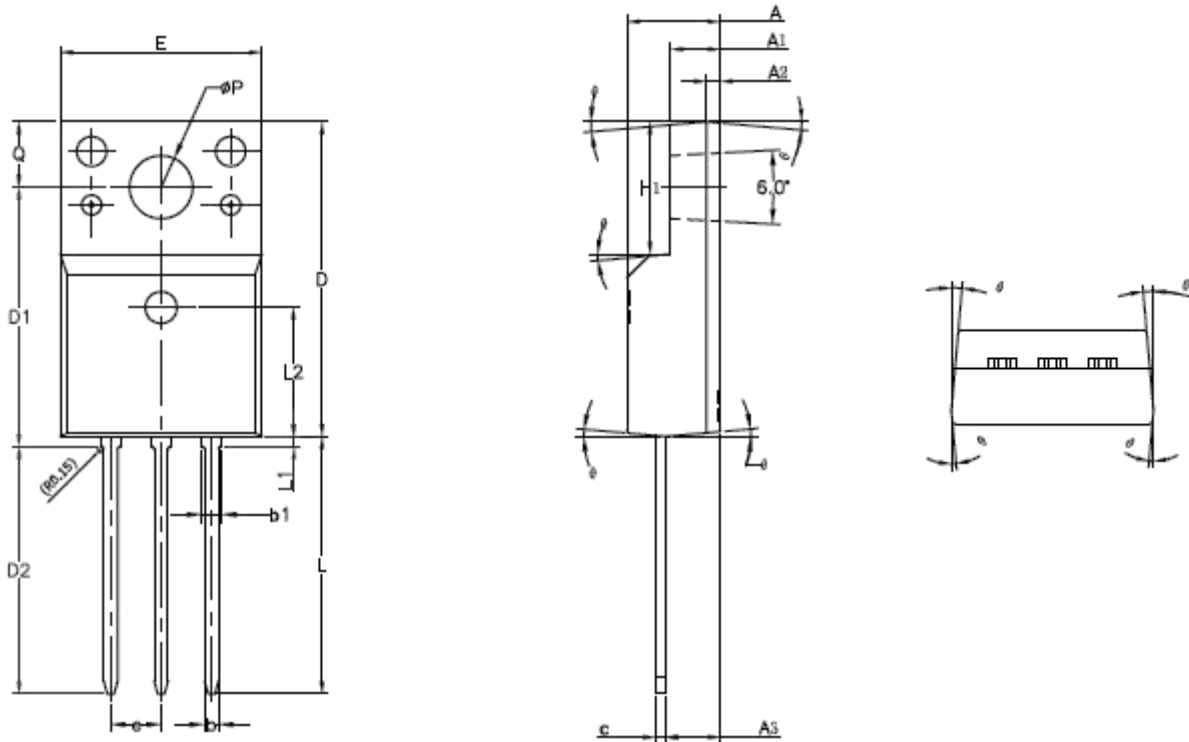


Unit:mm			
Symbol	Min.	Nom	Max.
A	2.20	2.30	2.40
A1	0.00	-	0.20
A2	0.97	1.07	1.17
b	0.68	0.78	0.90
b3	5.20	5.33	5.50
c	0.43	0.53	0.63
D	5.98	6.10	6.22
D1	5.30 REF		
E	6.40	6.60	6.80
E1	4.63	-	-

Unit:mm			
Symbol	Min.	Nom	Max.
e	2.286 BSC		
H	9.40	10.10	10.50
L	1.38	1.50	1.75
L1	2.90 REF		
L2	0.51 BSC		
L3	0.88	-	1.28
L4	-	-	1.00
L5	1.65	1.80	1.95
θ	0°	-	8°



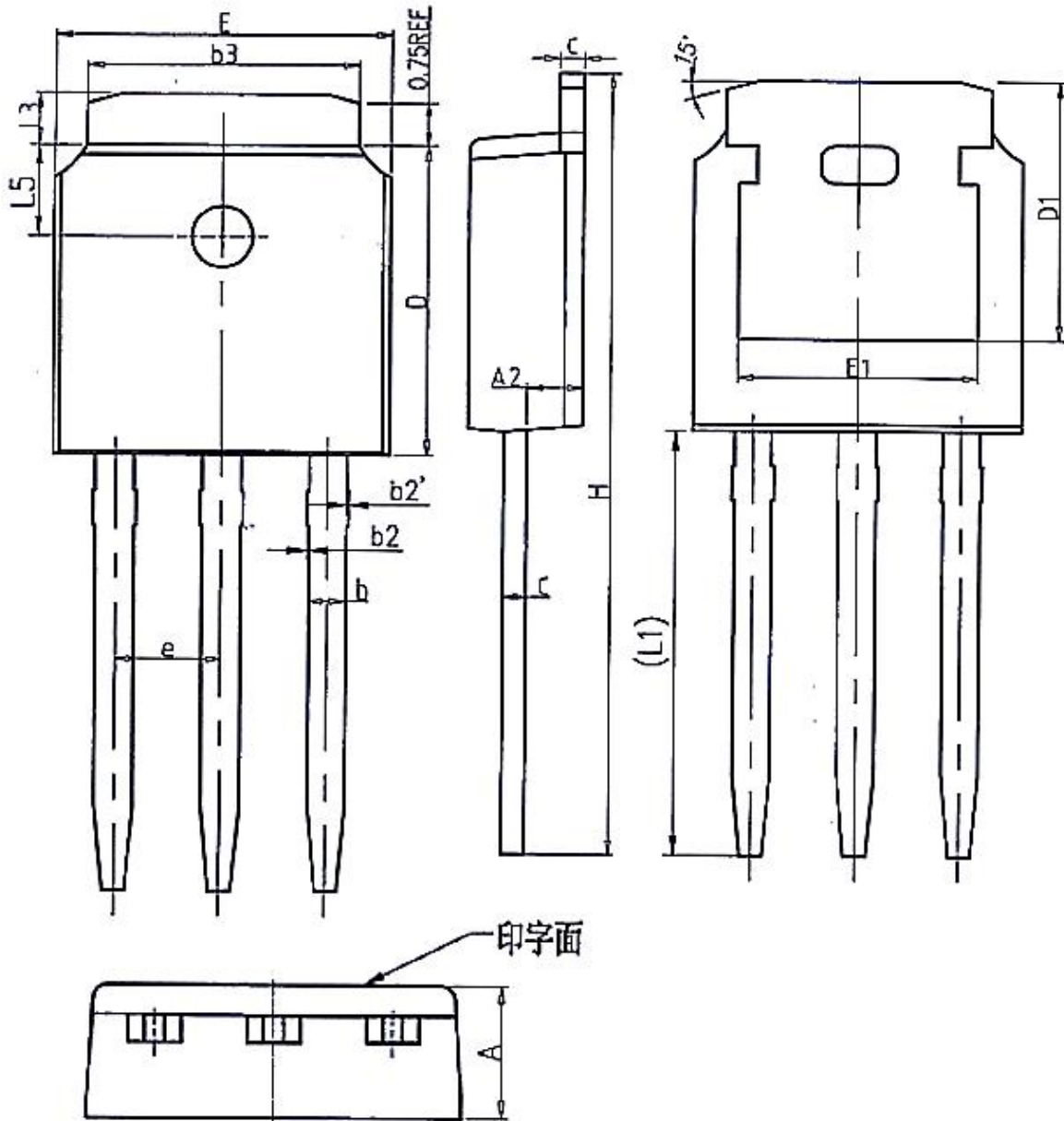
## TO-220FP-NL (封装厂 I)



SYMBOL	MIN	NOM	MAX
A	4.50	4.70	4.83
A1	2.34	2.54	2.74
A2	0.70 REF		
A3	2.56	2.76	2.93
b	0.60	-	0.80
b1	0.90	-	1.10
c	0.45	0.50	0.60
D	15.67	15.87	16.07
D1	12.87	13.07	13.27
D2	12.28	12.48	12.68
E	9.96	10.16	10.36
e	2.54BSC		
H1	6.48	6.68	6.88
L	12.68	12.98	13.28
L1	-	-	0.85
L2	6.50REF		
phi P	3.08	3.18	3.28
Q	3.20	-	3.40
theta 1	1°	3°	5°



TO-251 (封装厂 H)



Unit:mm			
Symbol	Min.	Nom	Max.
A	2.20	2.30	2.40
A2	0.97	1.07	1.17
b	0.68	0.78	0.90
b2	0.00	0.04	0.10
b2'	0.00	0.04	0.10
b3	5.20	5.33	5.50
c	0.43	0.53	0.63
D	5.98	6.10	6.22

Unit:mm			
Symbol	Min.	Nom	Max.
D1	5.30 REF		
E	6.40	6.60	6.80
E1	4.63	-	-
e	2.286 BSC		
H	16.22	16.52	16.82
L1	9.15	9.40	9.65
L3	0.88	1.02	1.28
L5	1.65	1.80	1.95



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