



## 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 deep trench SJ MOSFET provide an extremely low switching, commutation 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



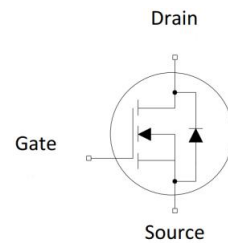
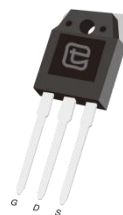
TO-220



TO-220FP-NL



TO-3PN



### Device Marking and Package Information

Device	Package	Marking
TPA65R160C	TO-220F	65R160C
TPB65R160C	TO-263	65R160C
TPP65R160C	TO-220	65R160C
TPR65R160C	TO-220FP-NL	65R160C
TPV65R160C	TO-3PN	65R160C

### Key Performance Parameters

Parameter	Value	Unit
$V_{DS} @ T_{j,max}$	700	V
$R_{DS(on),max}$	0.16	$\Omega$
$Q_{g,typ}$	46	nC
$I_D$	20	A
$I_{D,pulse}$	60	A



<b>Absolute Maximum Ratings</b> $T_C = 25^\circ\text{C}$ , unless otherwise noted				
Parameter		Symbol	Values	Unit
Continuous Drain Current	$T_C = 25^\circ\text{C}$	$I_D$	20	A
Pulsed Drain Current	(note1)	$I_{D,pulse}$	60	A
Gate-Source Voltage		$V_{GSS}$	$\pm 30\text{V}$	V
Single Pulse Avalanche Energy	(note2)	$E_{AS}$	480	mJ
Repetitive Avalanche Energy	(note2)	$E_{AR}$	0.75	mJ
Avalanche Current		$I_{AR}$	4	A
Power Dissipation For TO-220F, TO-220FP-NL		$P_D$	34	W
Power Dissipation For TO-263, TO-220, TO-3PN			151	
Continuous Diode Forward Current		$I_S$	20	A
Diode Pulsed Current	(note1)	$I_{S,pulse}$	60	
Operating Junction and Storage Temperature Range		$T_J, T_{stg}$	$-55\sim+150$	$^\circ\text{C}$

<b>Thermal Resistance For TO-220F, TO-220FP-NL</b>			
Parameter	Symbol	Value	Unit
Thermal Resistance, Junction-to-Case	$R_{thJC}$	3.7	$^\circ\text{C}/\text{W}$
Thermal Resistance, Junction-to-Ambient	$R_{thJA}$	80	

<b>Thermal Resistance For TO-263, TO-220, TO-3PN</b>			
Parameter	Symbol	Value	Unit
Thermal Resistance, Junction-to-Case	$R_{thJC}$	0.83	$^\circ\text{C}/\text{W}$
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	$V_{(BR)DSS}$	$V_{GS} = 0V, I_D = 250\mu\text{A}$	650	--	--	V
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{DS} = 650V, V_{GS} = 0V, T_J = 25^\circ\text{C}$	--	--	1	$\mu\text{A}$
		$V_{DS} = 650V, V_{GS} = 0V, T_J = 150^\circ\text{C}$	--	--	100	
Gate-Source Leakage Current	$I_{GSS}$	$V_{GS} = \pm 30V$	--	--	$\pm 100$	nA
Gate-Source Threshold Voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}, I_D = 250\mu\text{A}$	2.5	--	4.0	V
Drain-Source On-State-Resistance	$R_{DS(on)}$	$V_{GS} = 10V, I_D = 10A$	--	0.14	0.16	$\Omega$
Forward Transconductance (Note3)	$g_{fs}$	$V_{DS} = 10V, I_D = 10A$	--	18.8	--	S
<b>Dynamic Characteristics</b>						
Input Capacitance	$C_{iss}$	$V_{GS} = 0V,$ $V_{DS} = 50V,$ $f = 1.0\text{MHz}$	--	2328	--	$\text{pF}$
Output Capacitance	$C_{oss}$		--	116	--	
Reverse Transfer Capacitance	$C_{rss}$		--	7	--	
Total Gate Charge	$Q_g$	$V_{DD} = 520V, I_D = 20A,$ $V_{GS} = 10V$	--	46	--	$\text{nC}$
Gate-Source Charge	$Q_{gs}$		--	11	--	
Gate-Drain Charge	$Q_{gd}$		--	13	--	
Turn-on Delay Time	$t_{d(on)}$	$V_{DD} = 400V, I_D = 20A,$ $R_G = 25\Omega$	--	43	--	$\text{ns}$
Turn-on Rise Time	$t_r$		--	14	--	
Turn-off Delay Time	$t_{d(off)}$		--	150	--	
Turn-off Fall Time	$t_f$		--	7	--	
<b>Drain-Source Body Diode Characteristics</b>						
Body Diode Forward Voltage	$V_{SD}$	$T_J = 25^\circ\text{C}, I_{SD} = 20A, V_{GS} = 0V$	--	0.95	1.2	V
Reverse Recovery Time	$t_{rr}$	$V_R = 520V, I_F = I_S,$ $di_F/dt = 100A/\mu\text{s}$	--	460	--	ns
Reverse Recovery Charge	$Q_{rr}$		--	8.2	--	$\mu\text{C}$
Peak Reverse Recovery Current	$I_{rrm}$		--	35	--	A

**Notes**

1. Repetitive Rating: Pulse Width limited by maximum junction temperature
2.  $I_{AS} = 4A, V_{DD} = 50V, R_G = 25\Omega$ , Starting  $T_J = 25^\circ\text{C}$
3. Pulse Test: Pulse Width  $\leq 300\mu\text{s}$ , Duty Cycle  $\leq 1\%$



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

Figure 1. Output Characteristics

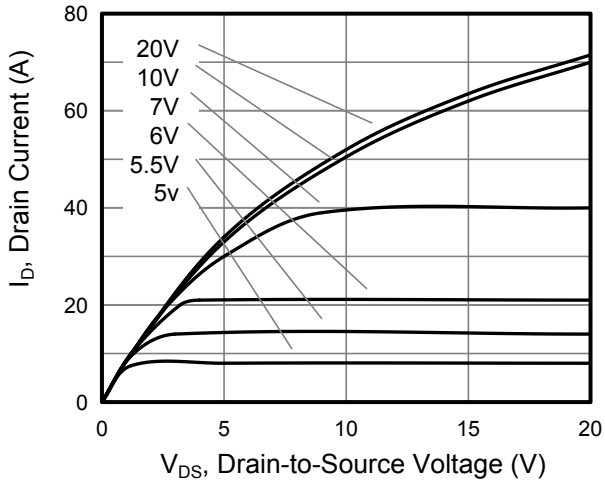


Figure 2. Transfer Characteristics

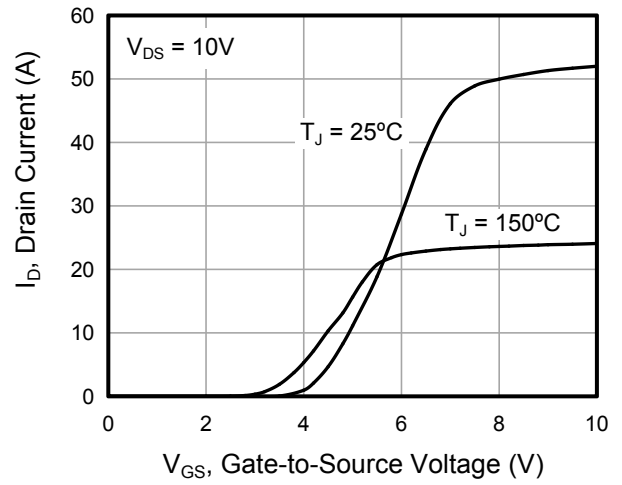


Figure 3. On-Resistance vs. Drain Current

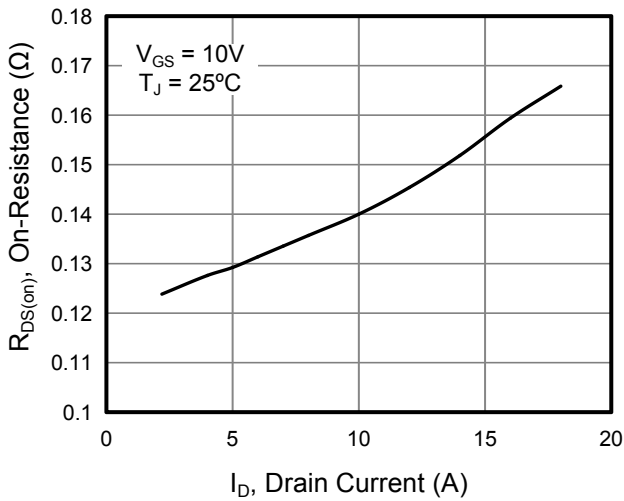


Figure 4. Capacitance

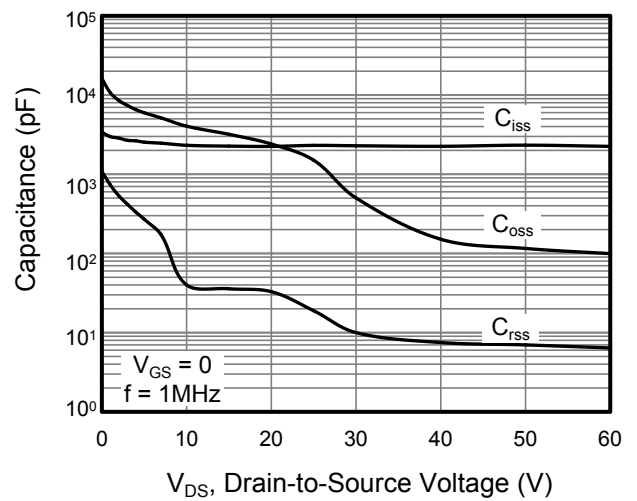


Figure 5. Gate Charge

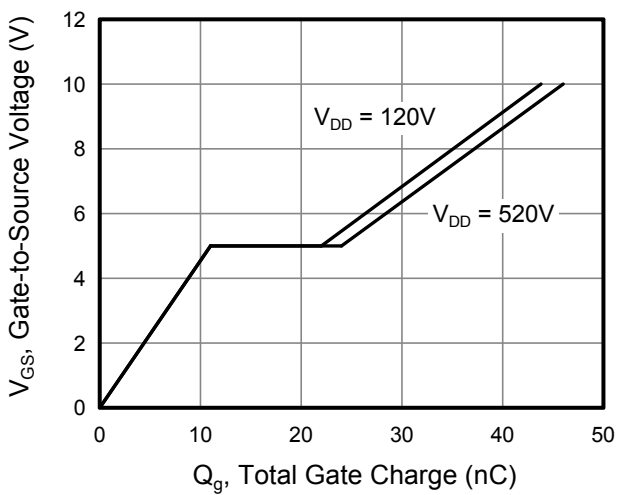
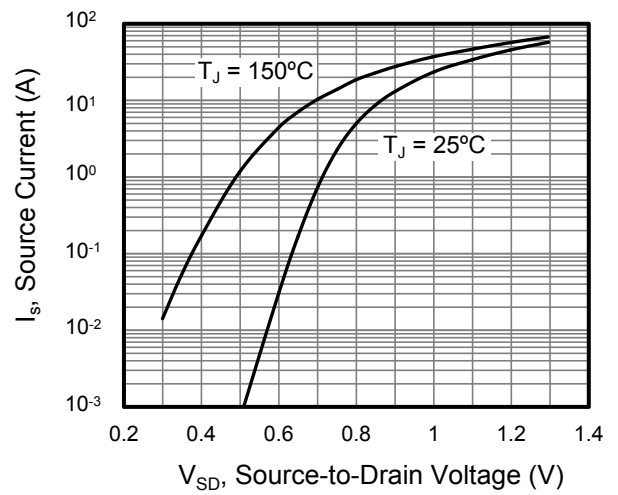


Figure 6. Body Diode Forward Voltage





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

Figure 7. On-Resistance vs. Junction Temperature

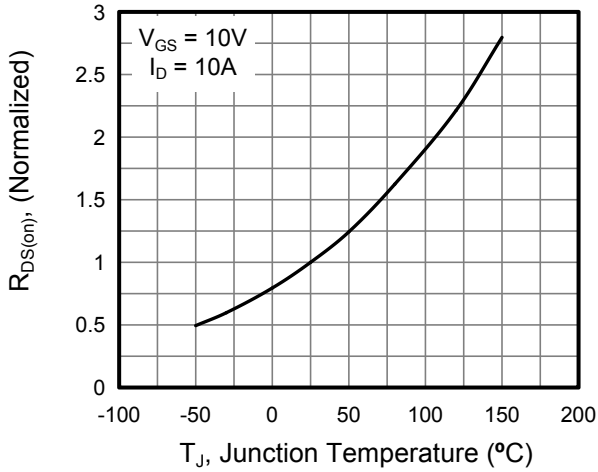


Figure 8. Threshold Voltage vs. Junction Temperature

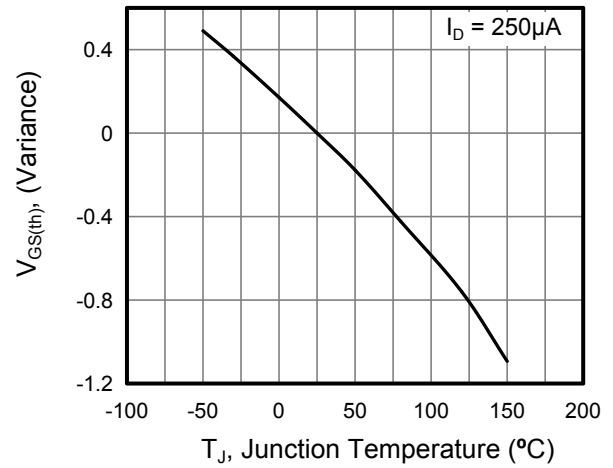


Figure 9. Transient Thermal Impedance For TO-263/TO-220/TO-3PN

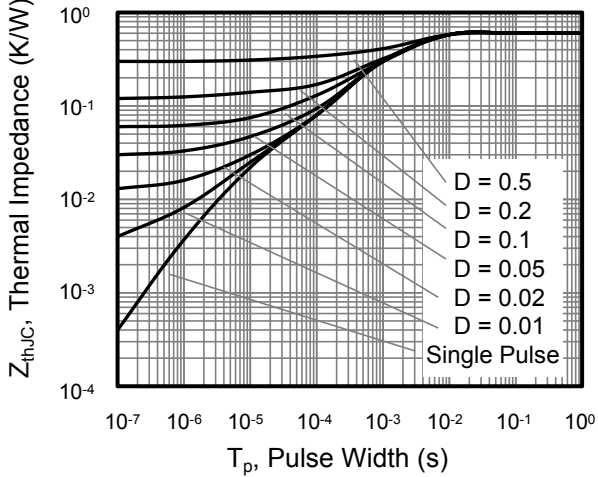


Figure 10. Transient Thermal Impedance For TO-220F/TO-220FP-NL

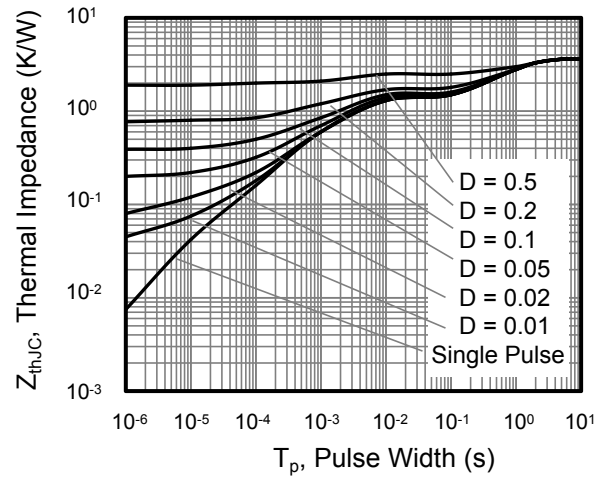




Figure A: Gate Charge Test Circuit and Waveform

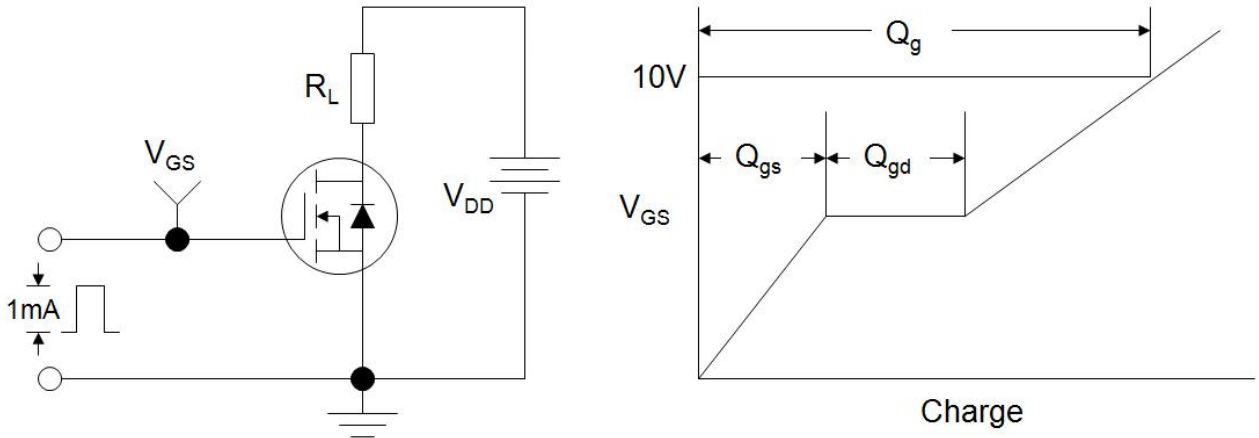


Figure B: Resistive Switching Test Circuit and Waveform

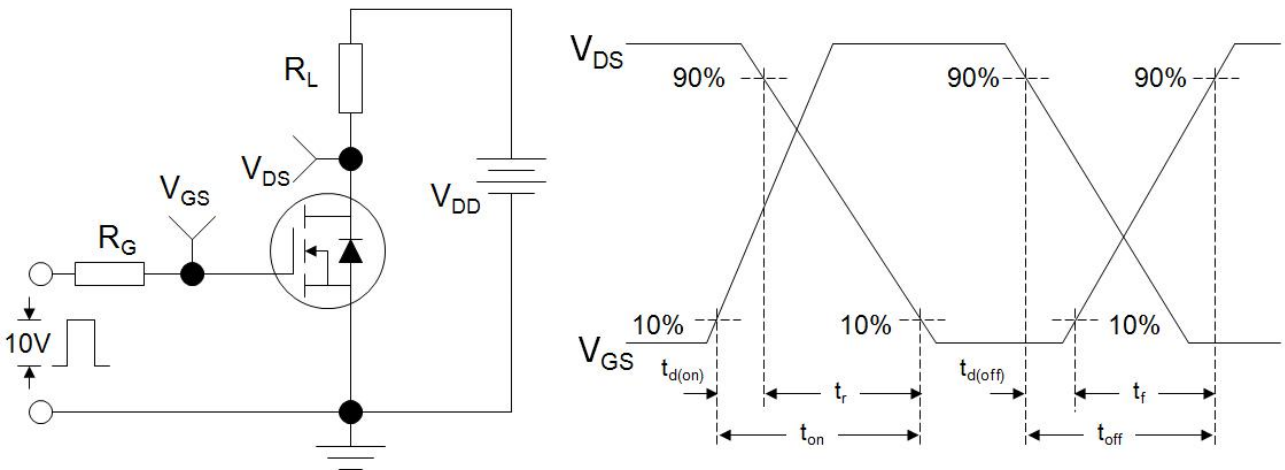
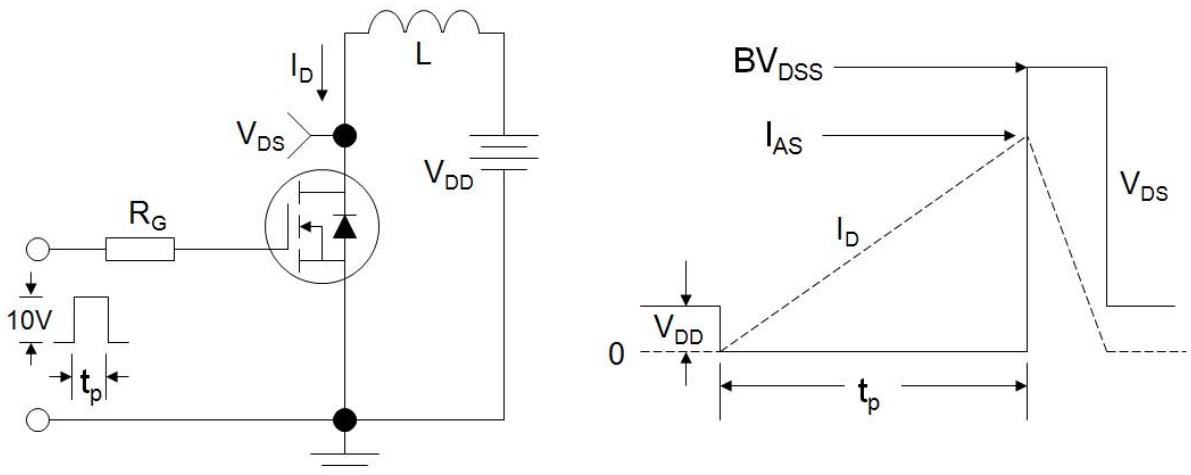
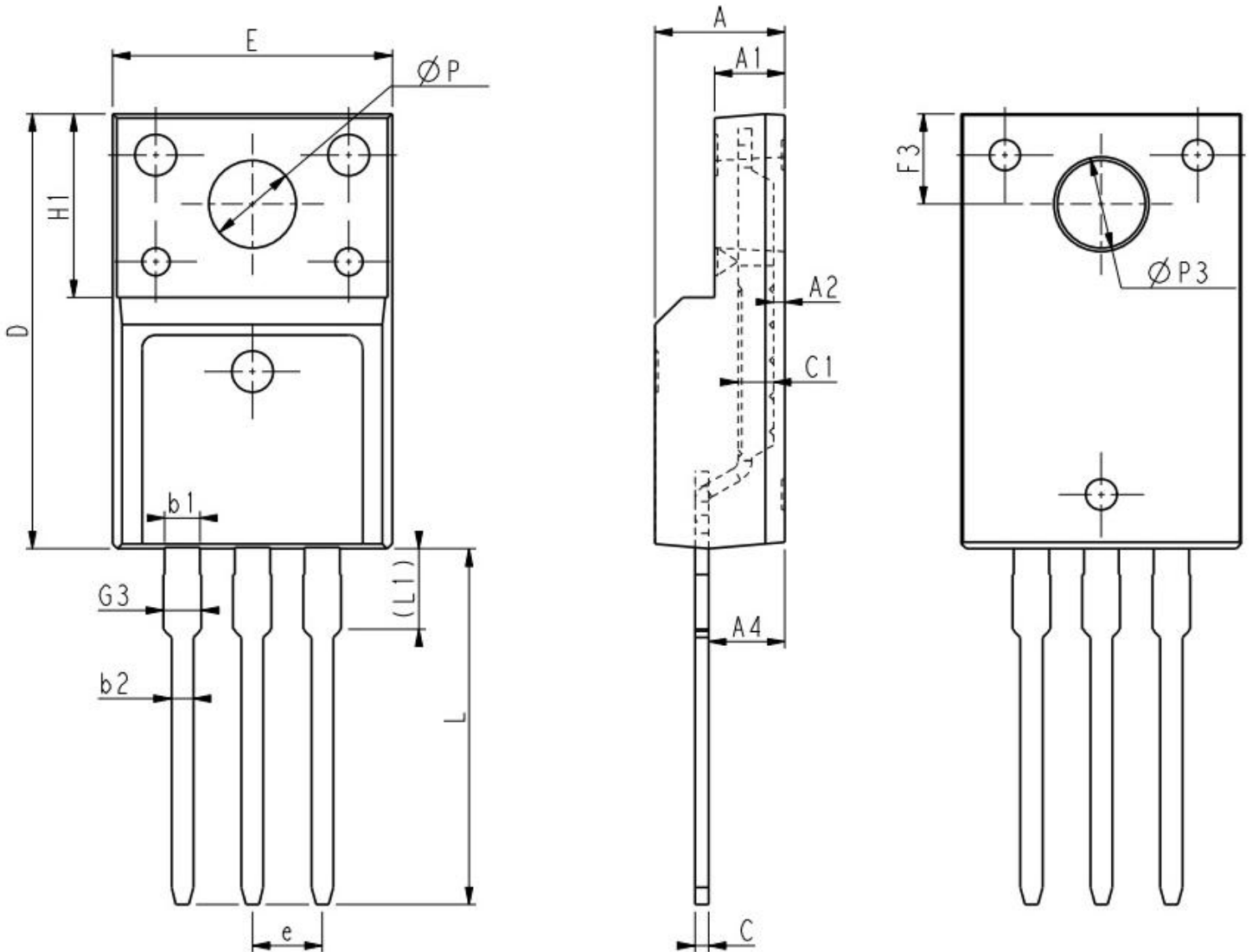


Figure C: Unclamped Inductive Switching Test Circuit and Waveform





TO-220F (封装厂 H)

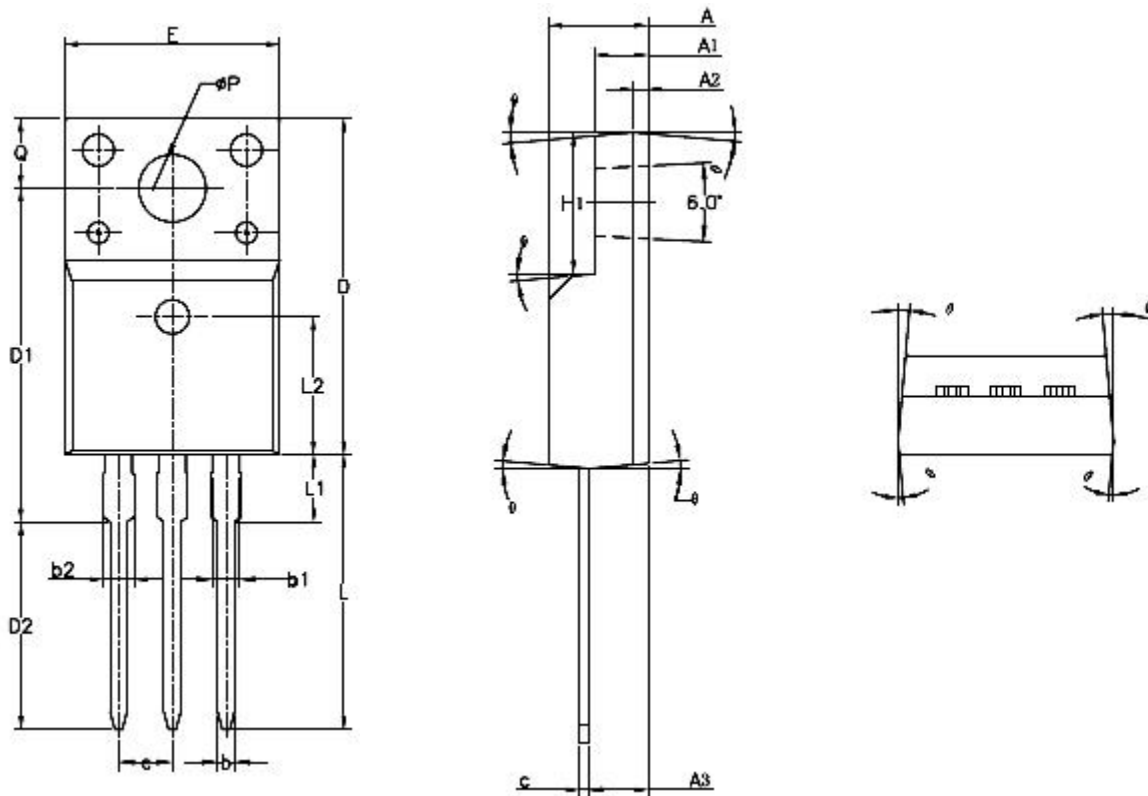


Unit:mm			
Symbol	Min.	Nom	Max.
E	9.96	10.16	10.36
A	4.50	4.70	4.90
A1	2.34	2.54	2.74
A2	0.30	0.45	0.60
A4	2.56	2.76	2.96
c	0.40	0.50	0.65
c1	1.20	1.30	1.35
D	15.57	15.87	16.17
H1	6.70REF		

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-220F (封装厂 I)

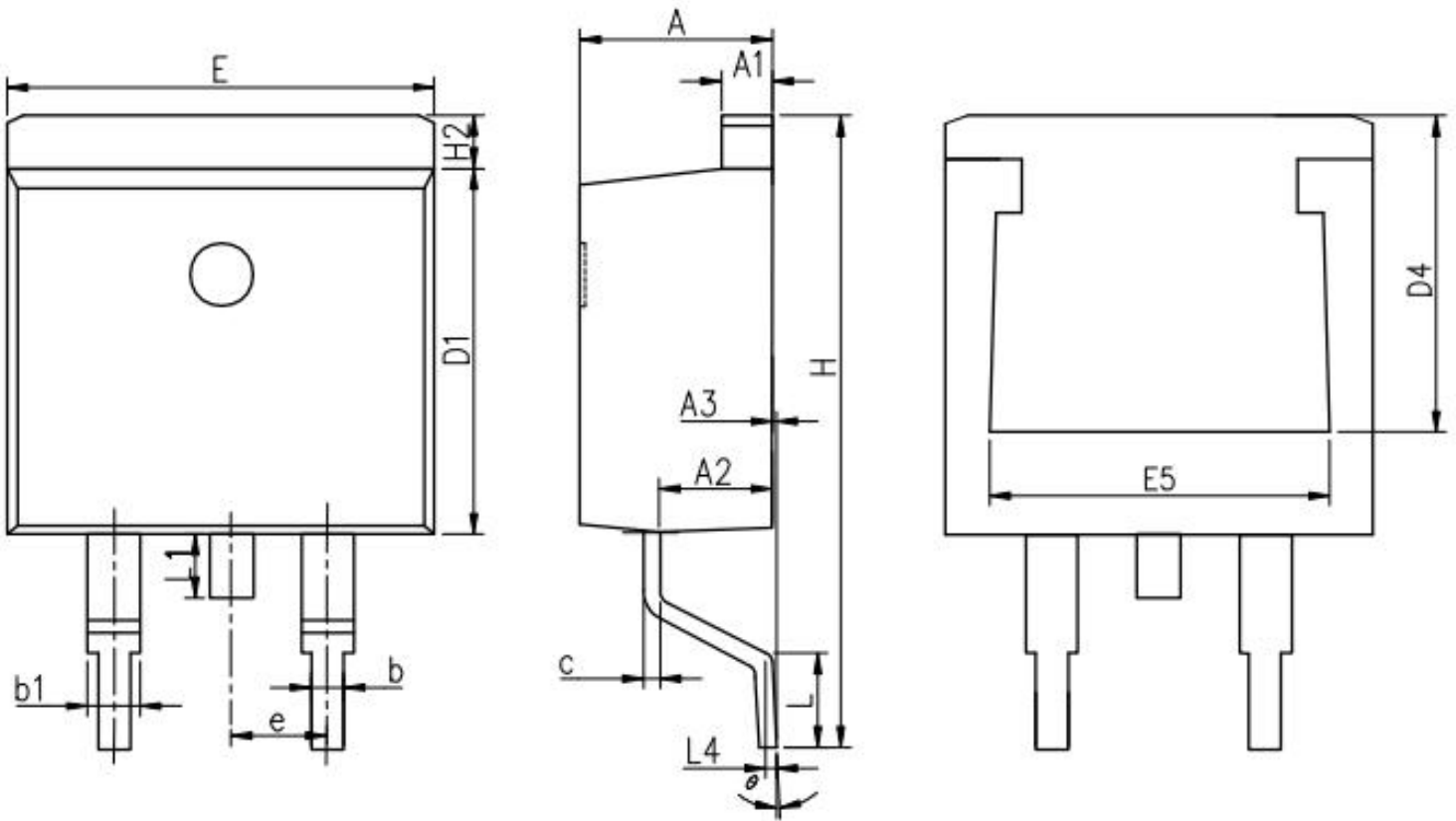


SYMBOL	MIN	NOM	MAX
A	4.50	4.70	4.83
A1	2.34	2.54	2.74
A2	0.70 REF		
A3	2.56	2.76	2.93
b	0.70	—	0.90
b1	1.18	—	1.38
b2	—	—	1.47
c	0.45	0.50	0.60
D	15.67	15.87	16.07
D1	15.55	15.75	15.95
D2	9.60	9.80	10.0
E	9.96	10.16	10.36
e	2.54BSC		
H1	6.48	6.68	6.88
L	12.68	12.98	13.28
L1	—	—	3.50
L2	6.50REF		
$\phi P$	3.08	3.18	3.28
Q	3.20	—	3.40
$\theta 1$	1°	3°	5°





### TO-263 (封装厂 H)

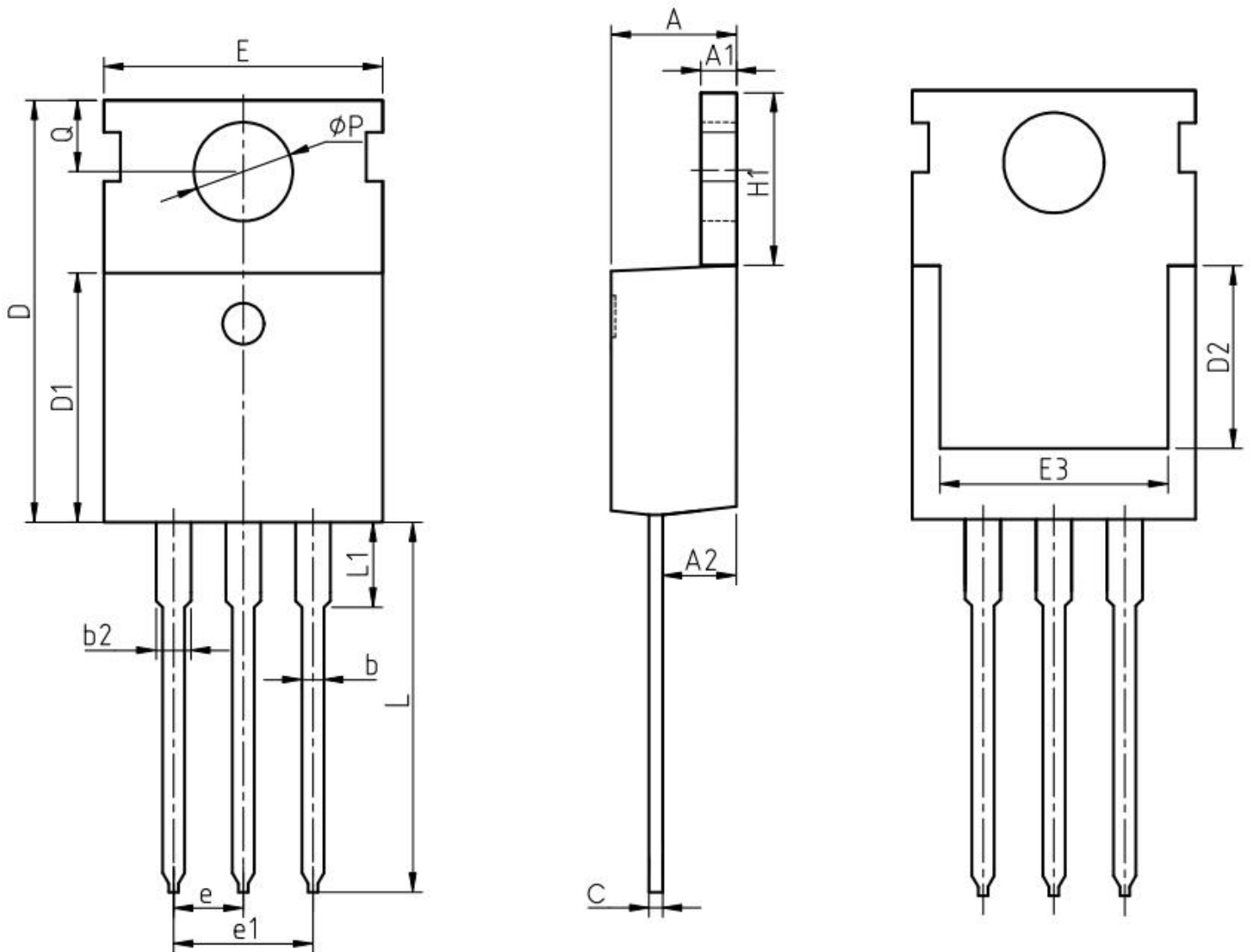


Unit:mm			
Symbol	Min.	Nom	Max.
A	4.37	4.57	4.77
A1	1.22	1.27	1.42
A2	2.49	2.69	2.89
A3	0.00	0.13	0.25
b	0.70	0.81	0.96
b1	1.17	1.27	1.47
c	0.30	0.38	0.53
D1	8.50	8.70	8.90
D4	6.60	-	-

Unit:mm			
Symbol	Min.	Nom	Max.
E	9.86	10.16	10.36
E5	7.06	-	-
e	2.54BSC		
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	0.25BSC		
theta	0°	5°	9°



TO-220 (封装厂 H)

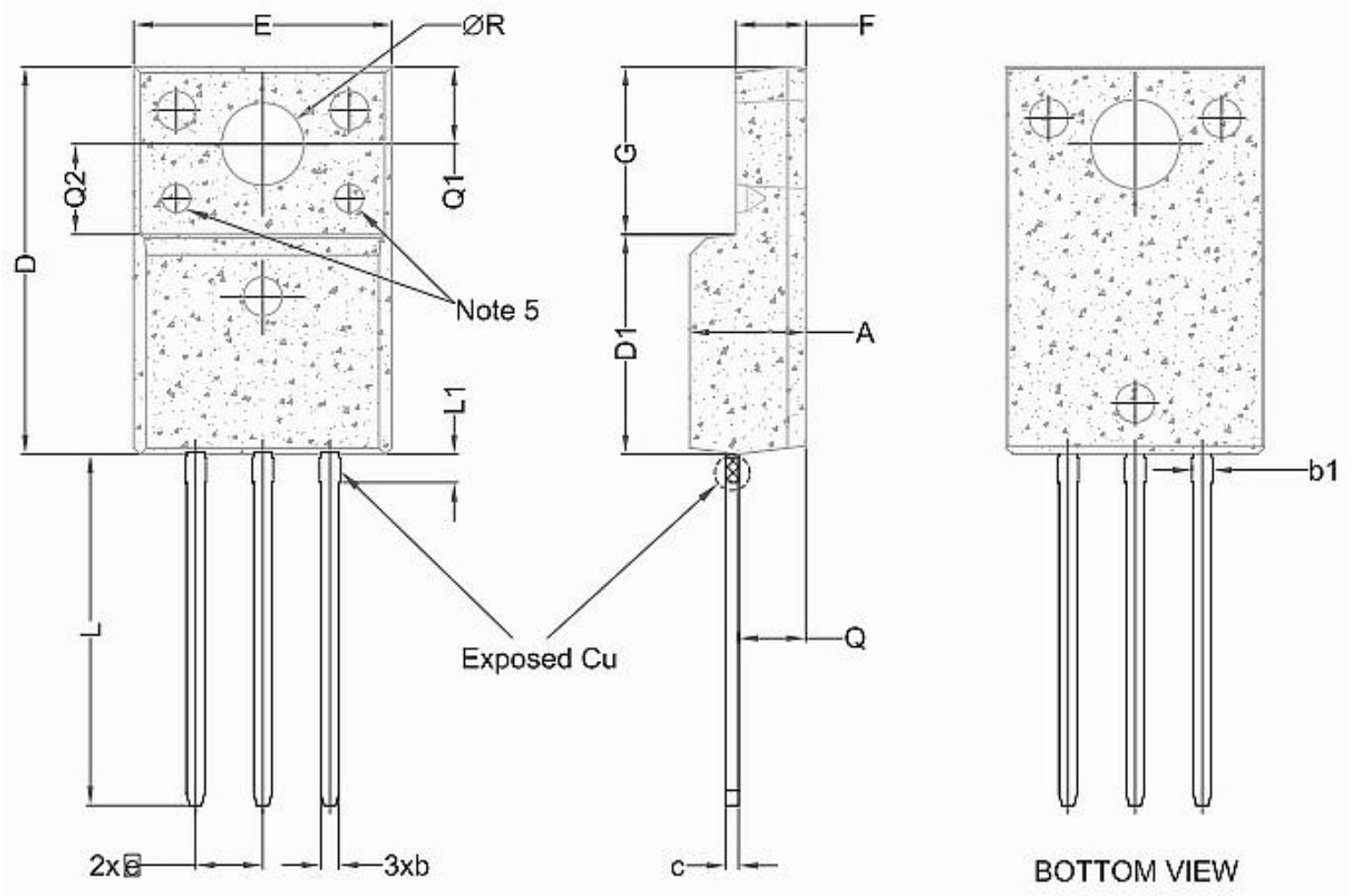


Unit:mm			
Symbol	Min.	Nom	Max.
A	4.37	4.57	4.70
A1	1.25	1.30	1.40
A2	2.20	2.40	2.60
b	0.70	0.80	0.95
b2	1.17	1.27	1.47
c	0.45	0.50	0.60
D	15.10	15.60	16.10
D1	8.80	9.10	9.40
D2	5.50	-	-

Unit:mm			
Symbol	Min.	Nom	Max.
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
$\phi P$	3.40	3.60	3.80
Q	2.60	2.80	3.00



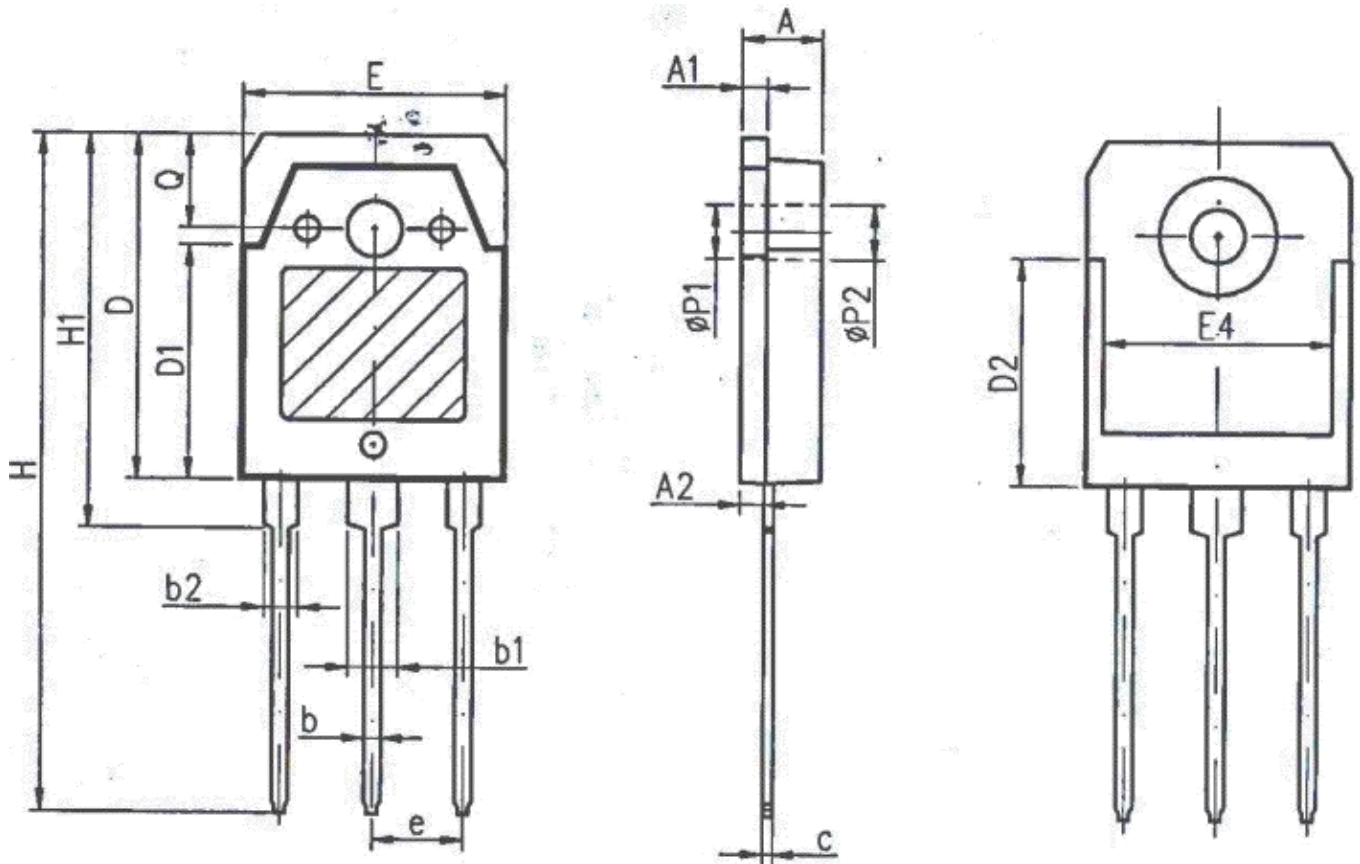
### TO-220FP-NL (封装厂 M)



Unit:mm				Unit:mm			
Symbol	Min.	Nom	Max.	Symbol	Min.	Nom	Max.
A	4.30	4.50	4.70	F	2.50	2.70	2.90
b	0.60	0.70	0.80	G	6.30	6.50	6.70
b1	0.60	0.80	0.90	L	13.40	13.60	13.80
c	0.45	0.50	0.60	L1	1.00	1.10	1.20
D	14.70	15.00	15.30	Q	2.50	2.60	2.70
D1	8.50 REF			Q1	2.90	3.00	3.10
e	2.60BSC			Q2	3.50 REF		
E	9.70	10.00	10.30	ΦR	3.00	3.20	3.40



### TO-3PN (封装厂 H)



SYMBOL	mm		
	MIN	NOM	MAX
A	4.60	4.80	5.00
A1	1.40	1.50	1.65
A2	1.18	1.38	1.58
b	0.80	1.00	1.20
b1	2.80	3.00	3.20
b2	1.80	2.00	2.20
c	0.50	0.60	0.75
D	19.60	19.90	20.20
D1	13.55	13.90	14.25
D2	12.90 REF		
E	15.35	15.60	15.85
E4	12.60	-	-
e	5.45 TYP		
H	40.10	40.50	40.90
H1	23.15	23.40	23.65
$\phi P1$	3.20 REF		
$\phi P2$	3.50 REF		



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