



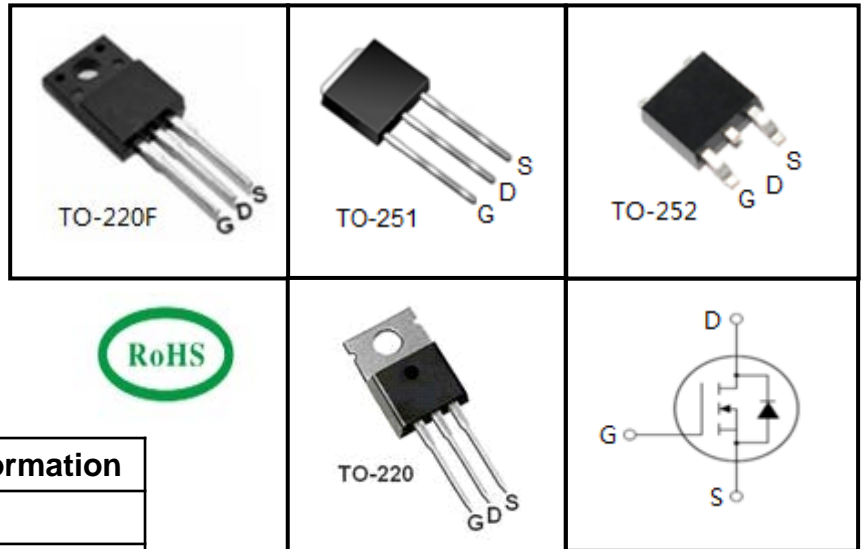
## 650V N-Channel MOSFET

### FEATURES

- Fast switching
- 100% avalanche tested
- Improved dv/dt capability

### APPLICATIONS

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



### Device Marking and Package Information

Device	Package	Marking
TMA4N65M	TO-220F	A4N65M
TMD4N65M	TO-252	D4N65M
TMP4N65M	TO-220	P4N65M
TMU4N65M	TO-251	U4N65M

### Absolute Maximum Ratings $T_C = 25^\circ\text{C}$ , unless otherwise noted

Parameter	Symbol	Value				Unit
		TO-220F	TO-220	TO-251	TO-252	
Drain-Source Voltage ( $V_{GS} = 0V$ )	$V_{DSS}$	650				V
Continuous Drain Current	$I_D$	3.5				A
Pulsed Drain Current (note1)	$I_{DM}$	14				A
Gate-Source Voltage	$V_{GSS}$	$\pm 30$				V
Single Pulse Avalanche Energy (note2)	$E_{AS}$	120				mJ
Avalanche Current (note1)	$I_{AR}$	3.5				A
Repetitive Avalanche Energy (note1)	$E_{AR}$	14				mJ
Power Dissipation ( $T_C = 25^\circ\text{C}$ )	$P_D$	31	72			W
Operating Junction and Storage Temperature Range	$T_J, T_{stg}$	-55~+150				$^\circ\text{C}$

### Thermal Resistance

Parameter	Symbol	Value				Unit
		TO-220F	TO-220	TO-251	TO-252	
Thermal Resistance, Junction-to-Case	$R_{thJC}$	4.0	1.74			$^\circ\text{C/W}$
Thermal Resistance, Junction-to-Ambient	$R_{thJA}$	62.5	60			



Specifications $T_J = 25^\circ\text{C}$ , unless otherwise noted						
Parameter	Symbol	Test Conditions	Value			Unit
			Min.	Typ.	Max.	
<b>Static</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	$\mu\text{A}$
Gate-Source Leakage	$I_{GSS}$	$V_{GS} = \pm 30V$	--	--	$\pm 100$	nA
Gate-Source Threshold Voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}, I_D = 250\mu\text{A}$	3.0	--	4.0	V
Drain-Source On-Resistance (Note3)	$R_{DS(on)}$	$V_{GS} = 10V, I_D = 1.75A$	--	2.35	2.8	$\Omega$
<b>Dynamic</b>						
Input Capacitance	$C_{iss}$	$V_{GS} = 0V,$ $V_{DS} = 25V,$ $f = 1.0\text{MHz}$	--	512	--	pF
Output Capacitance	$C_{oss}$		--	61	--	
Reverse Transfer Capacitance	$C_{rss}$		--	10	--	
Total Gate Charge	$Q_g$	$V_{DD} = 520V, I_D = 3.5A,$ $V_{GS} = 10V$	--	13.5	--	nC
Gate-Source Charge	$Q_{gs}$		--	2	--	
Gate-Drain Charge	$Q_{gd}$		--	6	--	
Turn-on Delay Time	$t_{d(on)}$	$V_{DD} = 325V, I_D = 3.5A,$ $R_G = 25\Omega$	--	11	--	ns
Turn-on Rise Time	$t_r$		--	24	--	
Turn-off Delay Time	$t_{d(off)}$		--	45	--	
Turn-off Fall Time	$t_f$		--	50	--	
<b>Drain-Source Body Diode Characteristics</b>						
Continuous Body Diode Current	$I_S$	$T_C = 25^\circ\text{C}$	--	--	3.5	A
Pulsed Diode Forward Current	$I_{SM}$		--	--	14	
Body Diode Voltage	$V_{SD}$	$T_J = 25^\circ\text{C}, I_{SD} = 3.5A, V_{GS} = 0V$	--	--	1.4	V
Reverse Recovery Time	$t_{rr}$	$V_{GS} = 0V, I_S = 3.5A,$ $di_F/dt = 100A/\mu\text{s}$	--	220	--	ns
Reverse Recovery Charge	$Q_{rr}$		--	3.1	--	$\mu\text{C}$

**Notes**

1. Repetitive Rating: Pulse width limited by maximum junction temperature
2.  $I_{AS} = 3.5A, V_{DD} = 50V, R_G = 25\Omega$ , 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 ( $T_J = 25^\circ\text{C}$ )

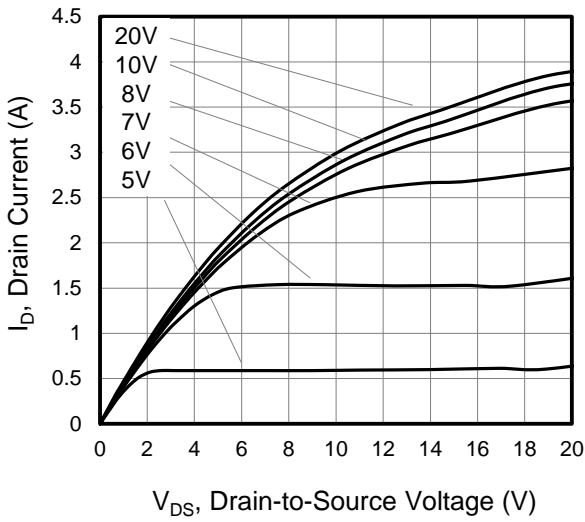


Figure 2. Body Diode Forward Voltage

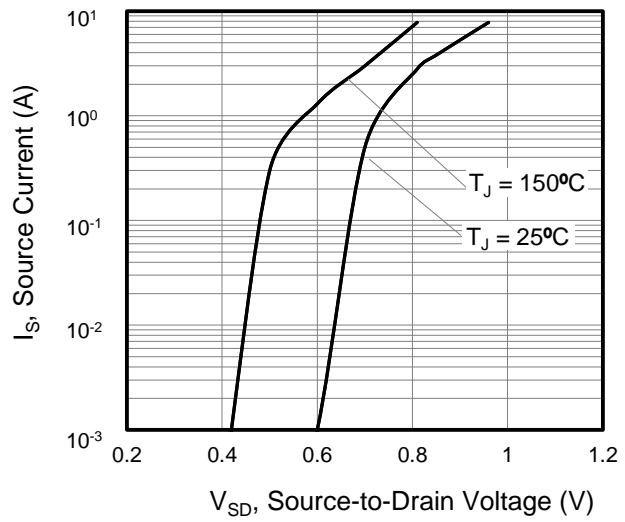


Figure 3. Drain Current vs. Temperature

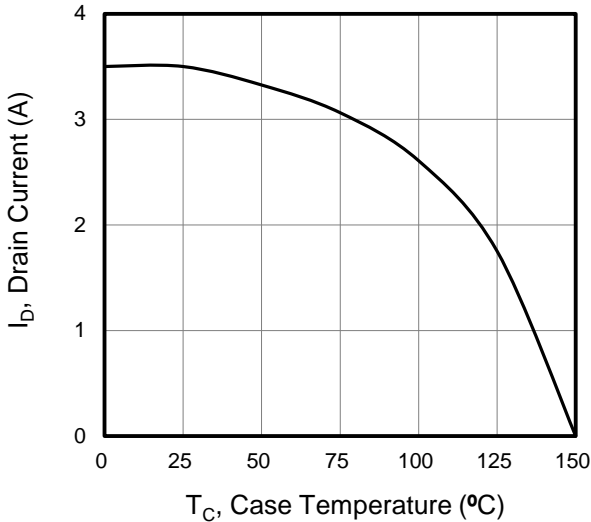


Figure 4.  $BV_{DSS}$  Variation vs. Temperature

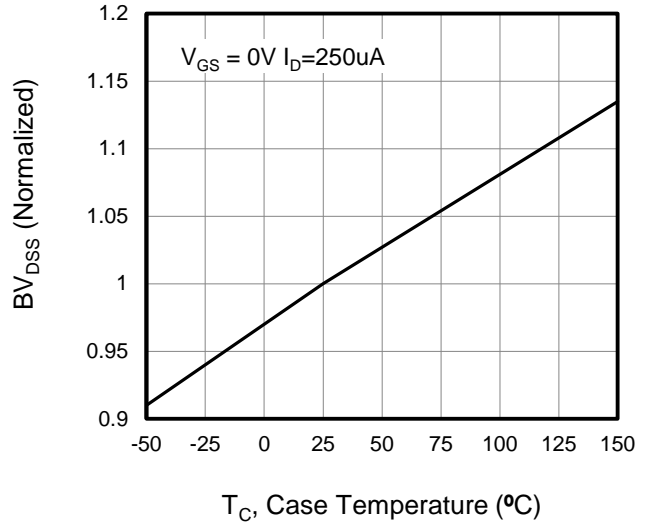


Figure 5. Transfer Characteristics

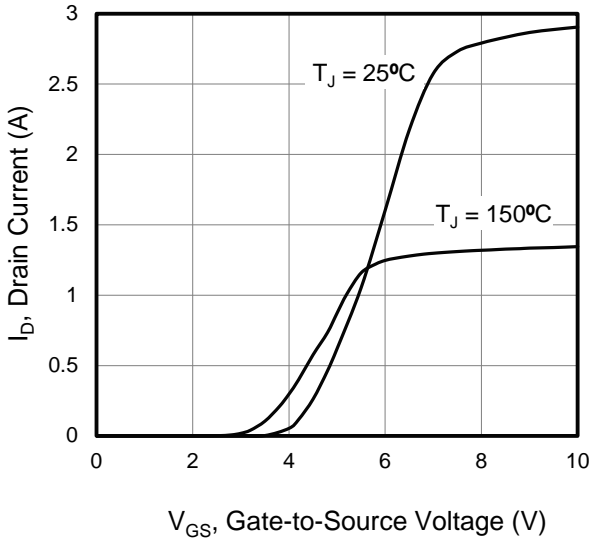
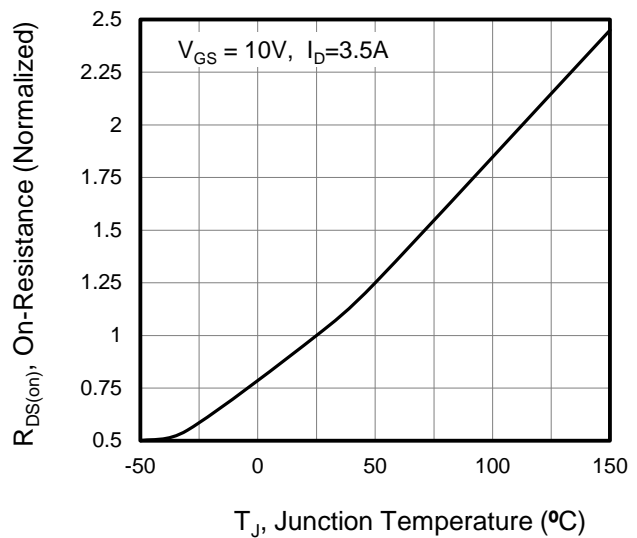


Figure 6. On-Resistance vs. Temperature





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

Figure 7. Capacitance

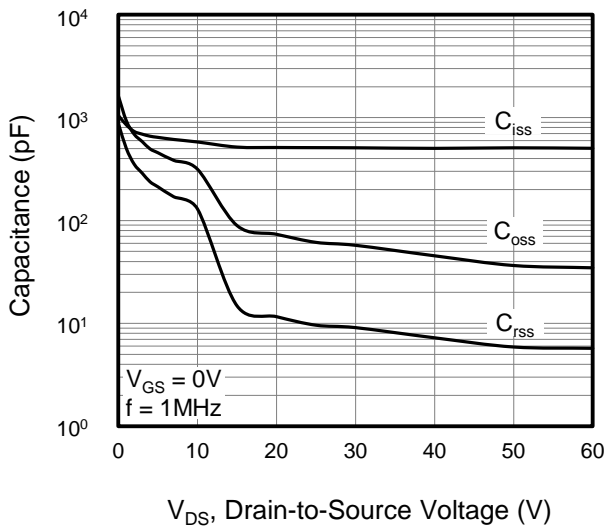


Figure 8. Gate Charge

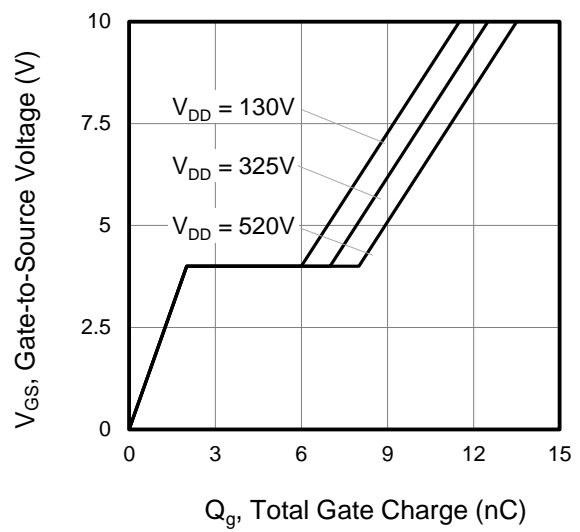


Figure 9. Transient Thermal Impedance TO-220F

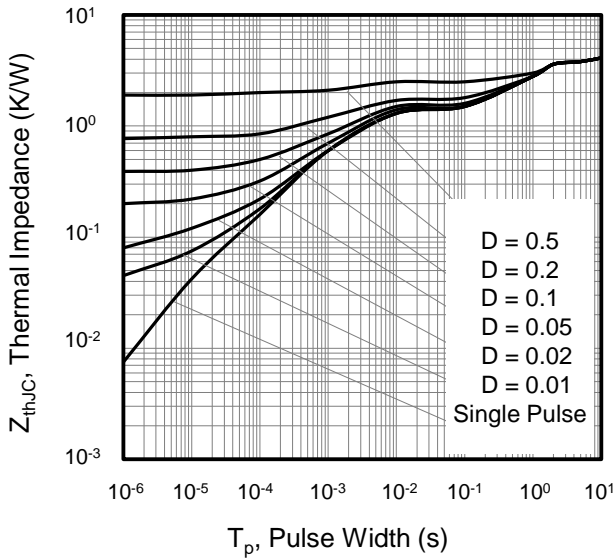


Figure 10. Transient Thermal Impedance TO-220, TO-251, TO-252

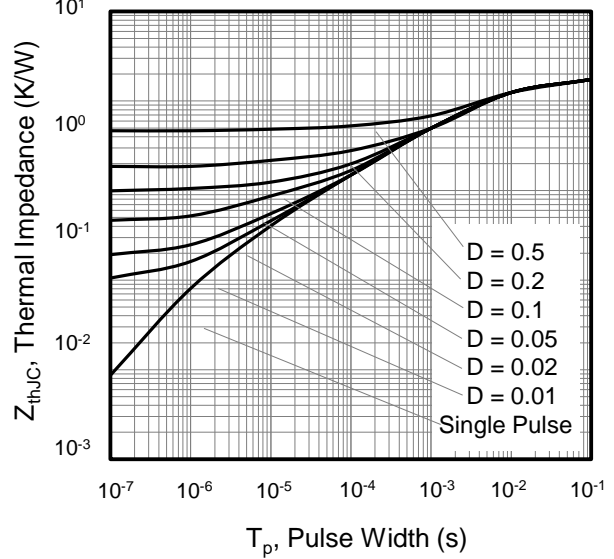




Figure A: Gate Charge Test Circuit and Waveform

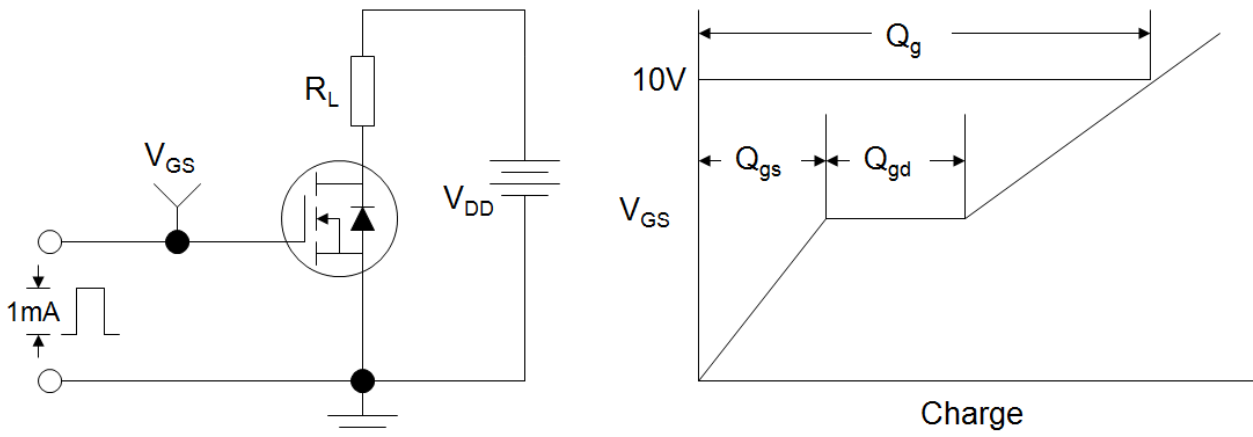
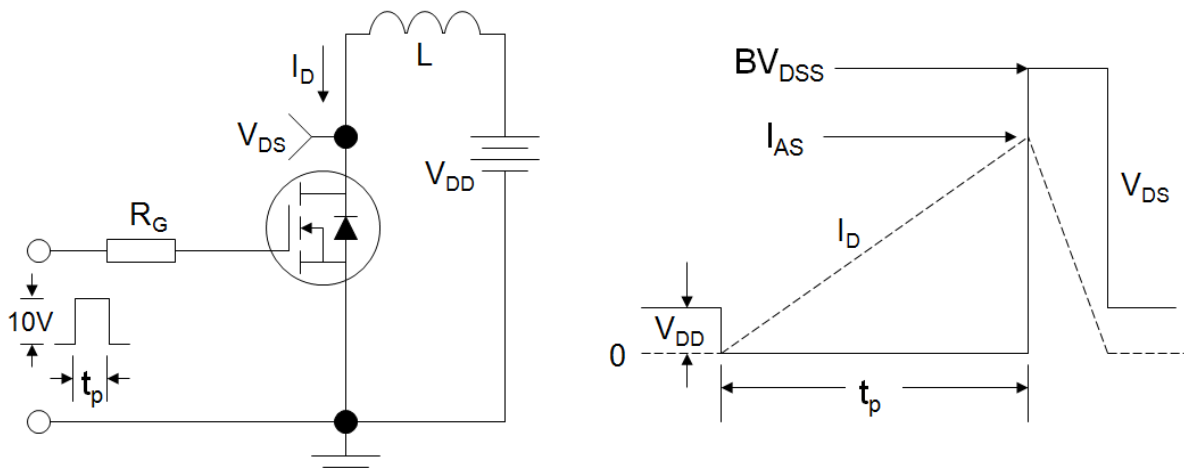


Figure B: Resistive Switching Test Circuit and Waveform

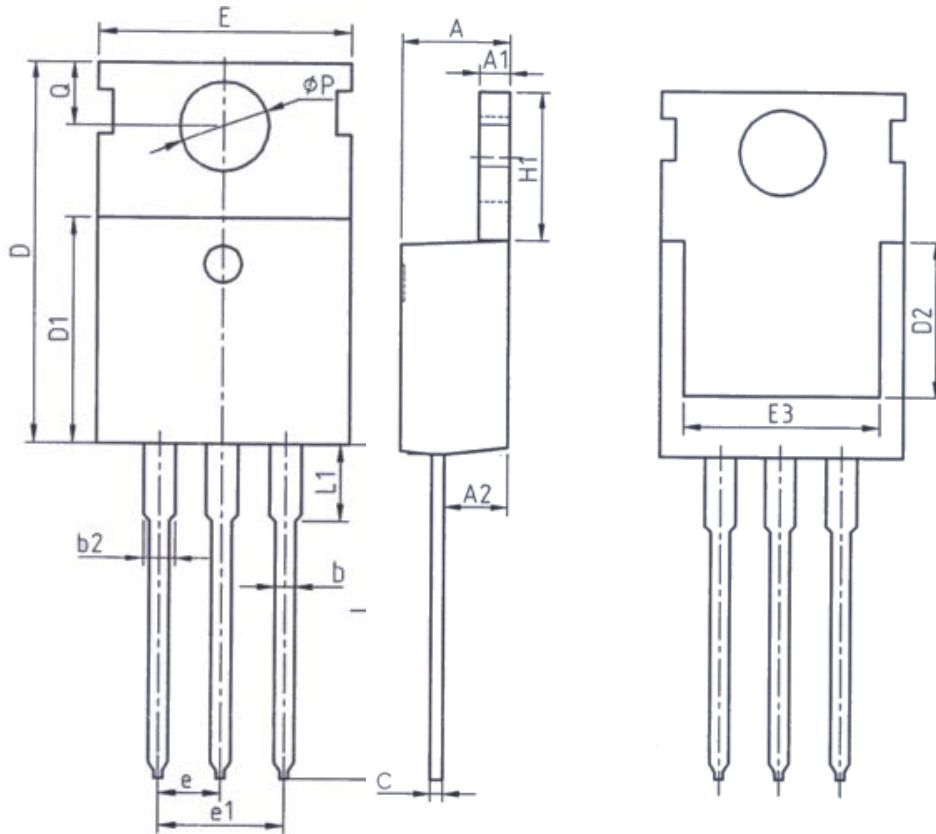


Figure C: Unclamped Inductive Switching Test Circuit and Waveform





## TO-220

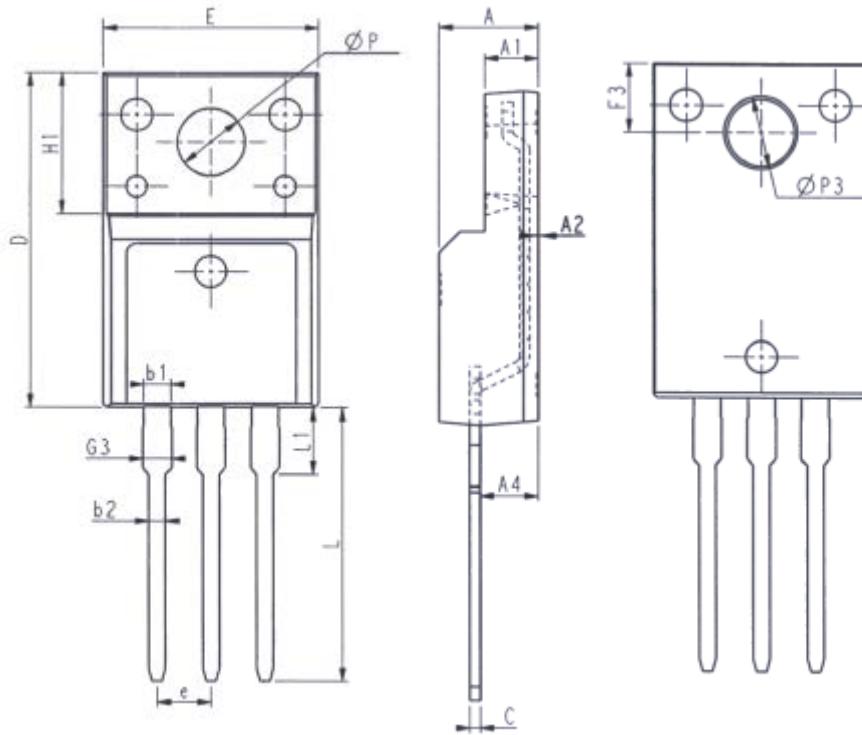


Unit: mm		
Symbol	Min.	Max.
A	4.37	4.77
A1	1.25	1.45
A2	2.20	2.60
b	0.70	0.95
b2	1.17	1.47
c	0.40	0.65
D	15.10	16.10
D1	8.80	9.40
D2	5.50	-

Unit: mm		
Symbol	Min.	Max.
E	9.70	10.30
E3	7.00	-
e	2.54BSC	
e1	5.08BSC	
H1	6.25	6.85
L	12.75	13.80
L1	-	3.40
P	3.40	3.80
Q	2.60	3.00



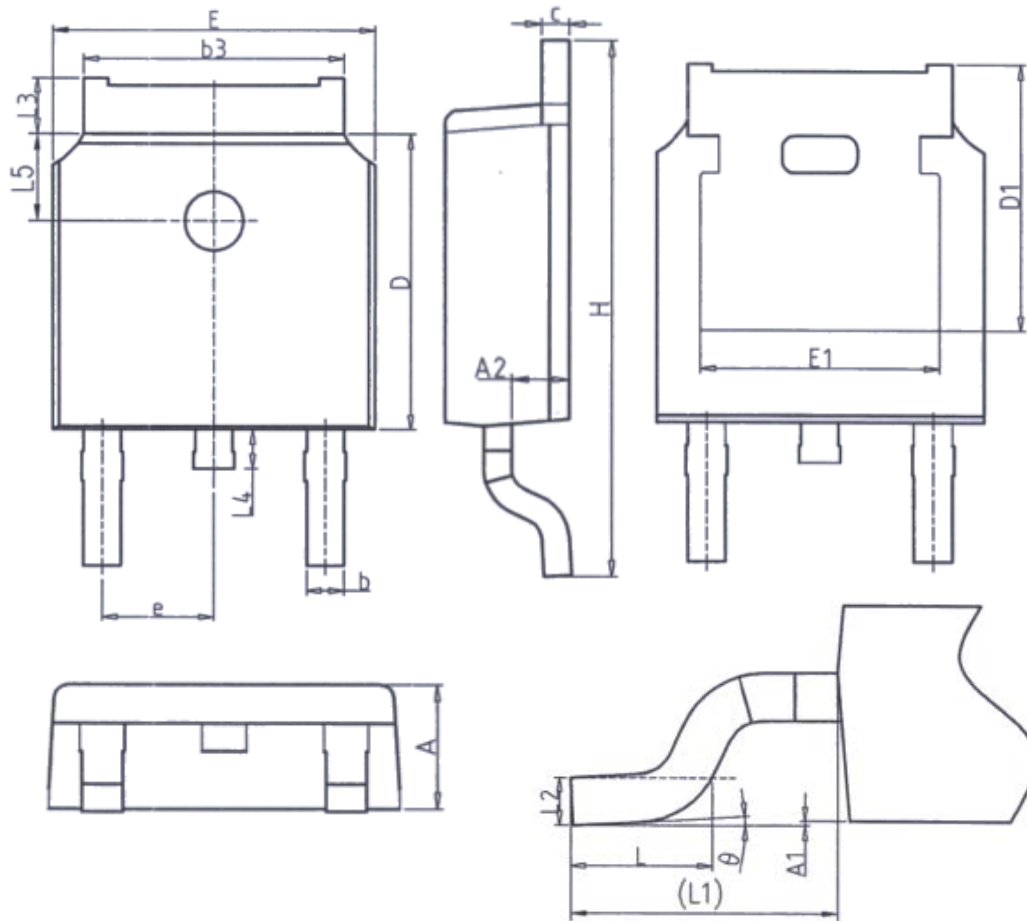
## TO-220F



Unit: mm			Unit: mm		
Symbol	Min.	Max.	Symbol	Min.	Max.
E	9.96	10.36	L	12.68	13.28
A	4.50	4.90	L1	2.93	3.13
A1	2.34	2.74	P	3.03	3.38
A2	0.30	0.60	P3	3.15	3.65
A4	2.56	2.96	F3	3.15	3.45
c	0.40	0.65	G3	1.25	1.55
D	15.57	16.17	b1	1.18	1.43
H1	6.70REF		b2	0.70	0.95
e	2.54BSC				



### TO-252



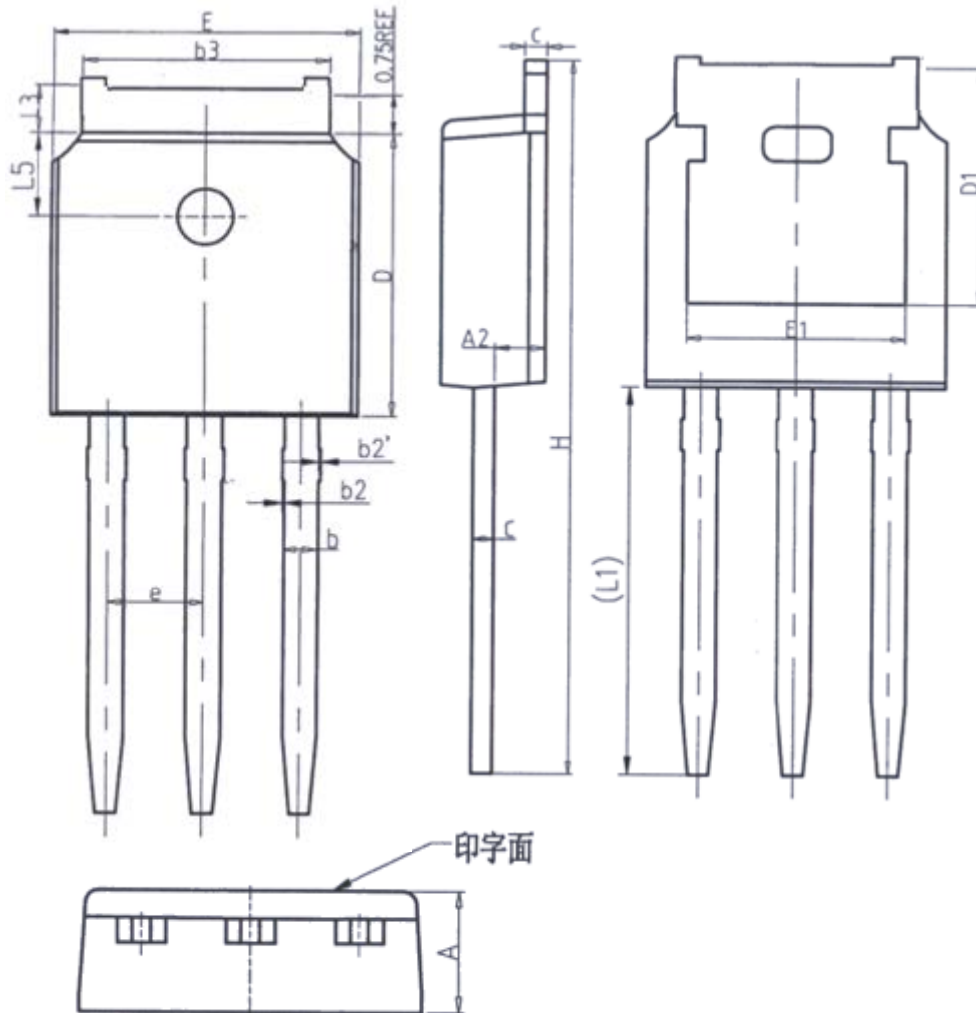
Unit: mm		
Symbol	Min.	Max.
A	2.20	2.40
A1	0.00	0.20
A2	0.97	1.17
b	0.68	0.90
b3	5.20	5.50
c	0.43	0.63
D	5.98	6.22
D1	5.30REF	
E	6.40	6.80
E1	4.63	-

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





### TO-251



Unit: mm		
Symbol	Min.	Max.
A	2.20	2.40
A2	0.97	1.17
b	0.68	0.90
b2	0.00	0.10
b2'	0.00	0.10
b3	5.20	5.50
c	0.43	0.63
D	5.98	6.22

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



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