



600V Super-Junction Power MOSFET

FEATURES

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

APPLICATIONS

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



Device Marking and Package Information				
Device	TPA60R160M	TPP60R160M	TPV60R160M	TPW60R160M
Package	TO-220F	TO-220	TO-3PN	TO-247
Marking	60R160M	60R160M	60R160M	60R160M

Absolute Maximum Ratings $T_C = 25^\circ\text{C}$, unless otherwise noted						
Parameter	Symbol	Value				Unit
		TO-220	TO-3PN	TO-247	TO-220F	
Drain-Source Voltage ($V_{GS} = 0V$)	V_{DSS}	600				V
Continuous Drain Current	I_D	$T_C = 25^\circ\text{C}$				A
		$T_C = 100^\circ\text{C}$				
Pulsed Drain Current (note1)	I_{DM}	60				A
Gate-Source Voltage	V_{GSS}	± 30				V
Single Pulse Avalanche Energy (note2)	E_{AS}	418				mJ
Avalanche Current (note1)	I_{AR}	3.4				A
Repetitive Avalanche Energy (note1)	E_{AR}	0.63				mJ
MOSFET dv/dt ruggedness, $V_{DS} = 0 \dots 480V$	dv/dt	50				
Reverse diode dv/dt, $V_{DS} = 0 \dots 480V, I_{SD} \leq I_D$	dv/dt	15				
Power Dissipation ($T_C = 25^\circ\text{C}$)	P_D	151			34	W
Operating Junction and Storage Temperature Range	T_J, T_{stg}	-55~+150				$^\circ\text{C}$

Thermal Resistance						
Parameter	Symbol	Value				Unit
		TO-220	TO-3PN	TO-247	TO-220F	
Thermal Resistance, Junction-to-Case	R_{thJC}	0.83			3.7	$^\circ\text{C/W}$
Thermal Resistance, Junction-to-Ambient	R_{thJA}	62			80	



Specifications $T_J = 25^\circ\text{C}$, unless otherwise noted						
Parameter	Symbol	Test Conditions	Value			Unit
			Min.	Typ.	Max.	
Static						
Drain-Source Breakdown Voltage	$V_{(BR)DSS}$	$V_{GS} = 0V, I_D = 250\mu A$	600	--	--	V
Zero Gate Voltage Drain Current	I_{DSS}	$V_{DS} = 600V, V_{GS} = 0V, T_J = 25^\circ\text{C}$	--	--	1	μA
		$V_{DS} = 600V, V_{GS} = 0V, T_J = 150^\circ\text{C}$	--	--	100	
Gate-Source Leakage	I_{GSS}	$V_{GS} = \pm 30V$	--	--	± 100	nA
Gate-Source Threshold Voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}, I_D = 250\mu A$	2.5	--	4.0	V
Drain-Source On-Resistance (Note3)	$R_{DS(on)}$	$V_{GS} = 10V, I_D = 10A$	--	0.14	0.16	Ω
Gate resistance	R_G	$f = 1.0\text{MHz}$ open drain	--	12	--	Ω
Dynamic						
Input Capacitance	C_{iss}	$V_{GS} = 0V,$ $V_{DS} = 100V,$ $f = 1.0\text{MHz}$	--	1726	--	μF
Output Capacitance	C_{oss}		--	71	--	
Reverse Transfer Capacitance	C_{rss}		--	5	--	
Total Gate Charge	Q_g	$V_{DD} = 480V, I_D = 20A,$ $V_{GS} = 10V$	--	38	--	nC
Gate-Source Charge	Q_{gs}		--	8	--	
Gate-Drain Charge	Q_{gd}		--	14.5	--	
Turn-on Delay Time	$t_{d(on)}$	$V_{DD} = 400V, I_D = 20A,$ $R_G = 25\Omega$	--	31	--	ns
Turn-on Rise Time	t_r		--	69	--	
Turn-off Delay Time	$t_{d(off)}$		--	124	--	
Turn-off Fall Time	t_f		--	48	--	
Drain-Source Body Diode Characteristics						
Continuous Body Diode Current	I_S	$T_C = 25^\circ\text{C}$	--	--	20	A
Pulsed Diode Forward Current	I_{SM}		--	--	60	
Body Diode Voltage	V_{SD}	$T_J = 25^\circ\text{C}, I_{SD} = 20A, V_{GS} = 0V$	--	0.9	1.2	V
Reverse Recovery Time	t_{rr}	$V_R = 400V, I_F = I_S,$ $di_F/dt = 100A/\mu s$	--	460	--	ns
Reverse Recovery Charge	Q_{rr}		--	5.5	--	μC
Peak Reverse Recovery Current	I_{rm}		--	24	--	A

Notes

1. Repetitive Rating: Pulse Width limited by maximum junction temperature
2. $I_{AS} = 3.4A, V_{DD} = 50V, R_G = 25\Omega$, Starting $T_J = 25^\circ\text{C}$
3. Pulse Test: Pulse Width $\leq 300\mu s$, Duty Cycle $\leq 1\%$



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

Figure 1. Output Characteristics

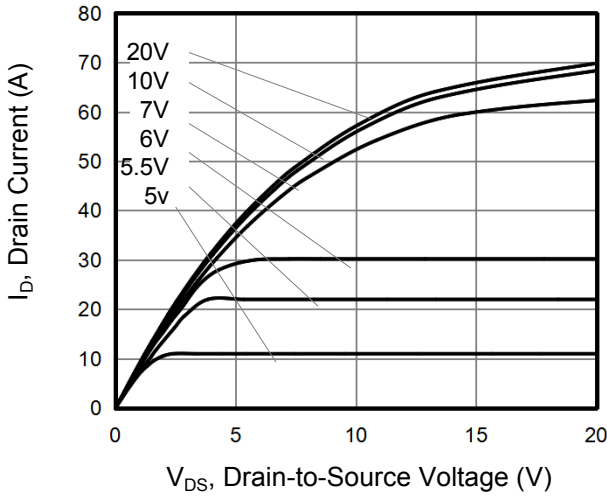


Figure 2. Transfer Characteristics

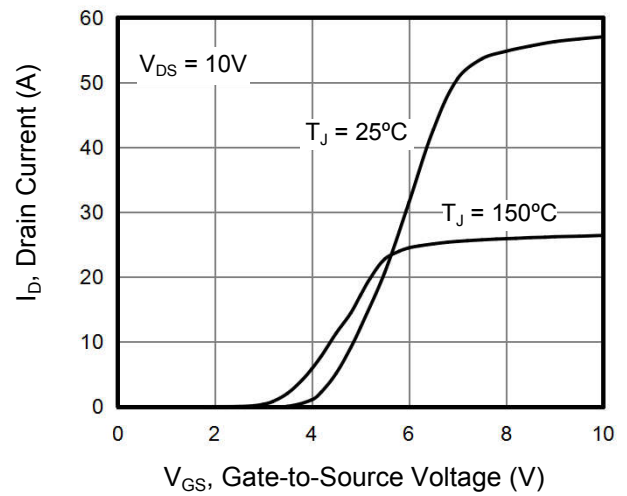


Figure 3. On-Resistance vs. Drain Current

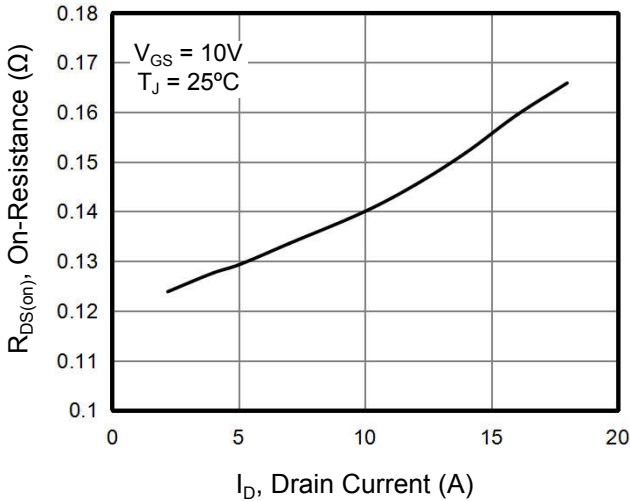


Figure 4. Capacitance

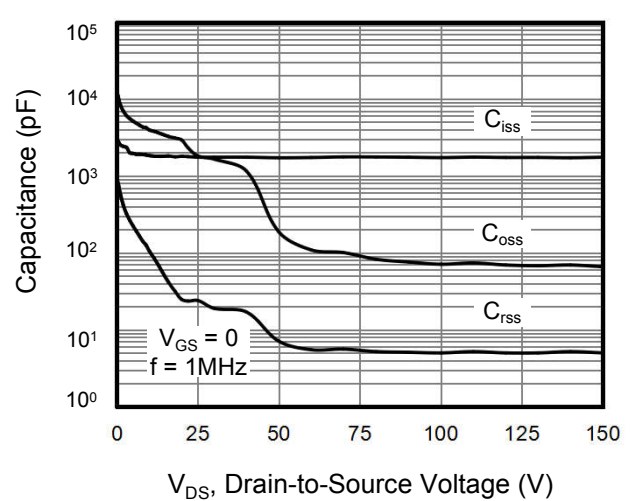


Figure 5. Gate Charge

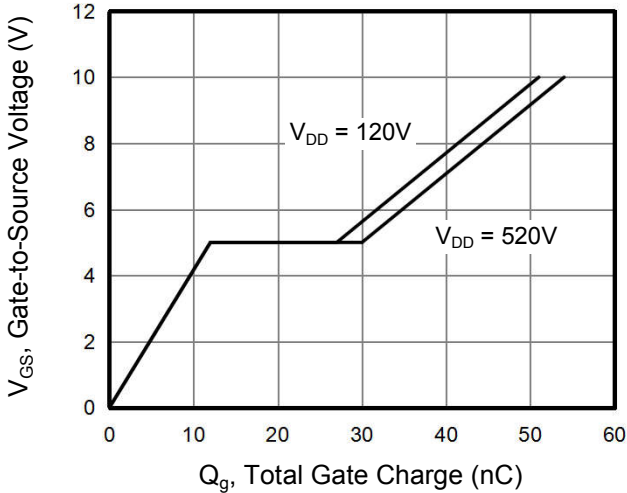
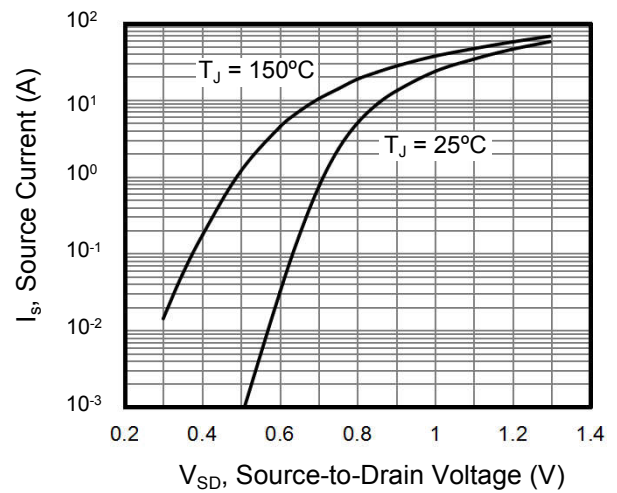


Figure 6. Body Diode Forward Voltage





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

Figure 7. On-Resistance vs. Junction Temperature

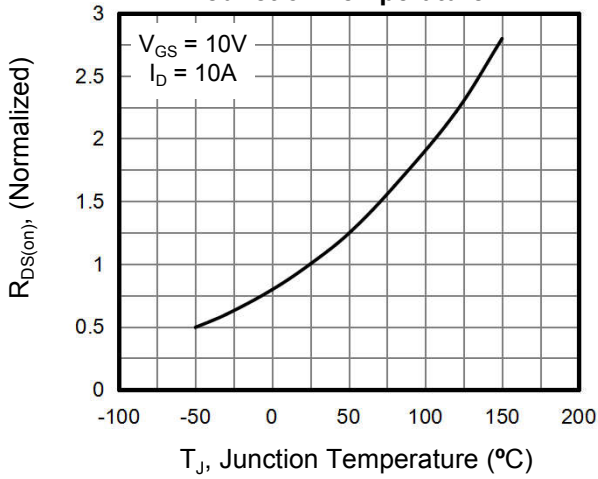


Figure 8. Threshold Voltage vs. Junction Temperature

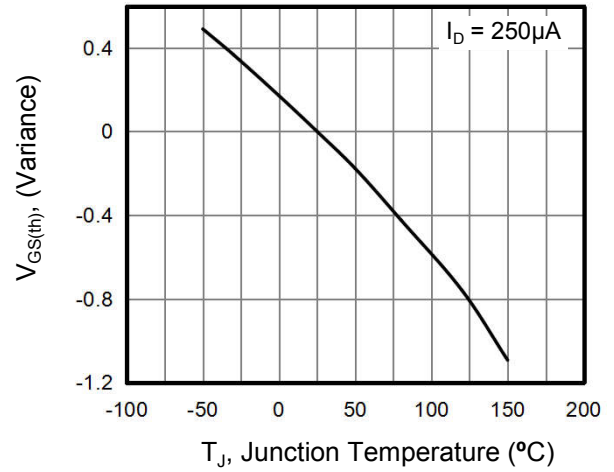


Figure 9. Transient Thermal Impedance TO-220/TO-3PN/TO-247

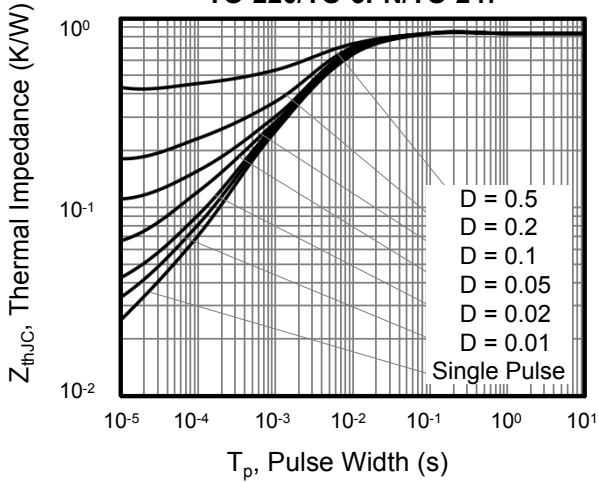


Figure 10. Transient Thermal Impedance TO-220F

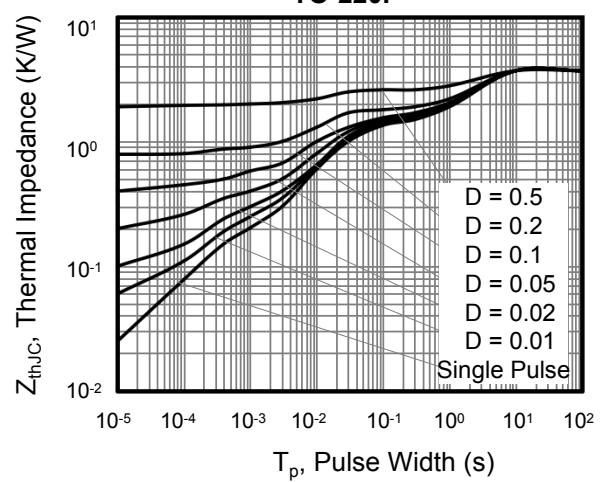


Figure 12. Safe operation area for TO-220/TO-3PN/TO-247

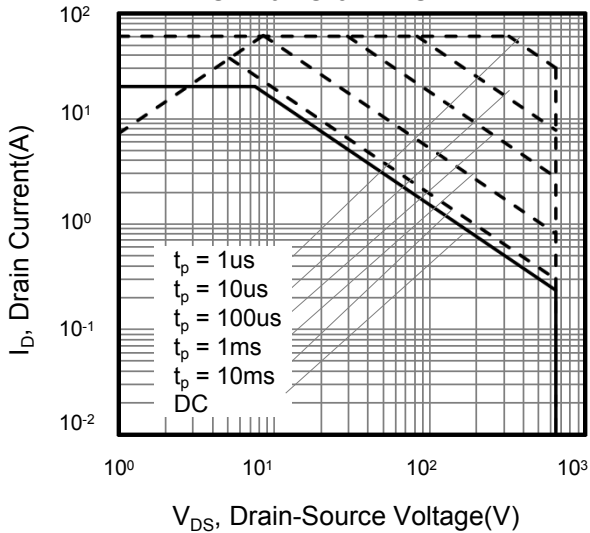


Figure 13. Safe operation area for TO-220F

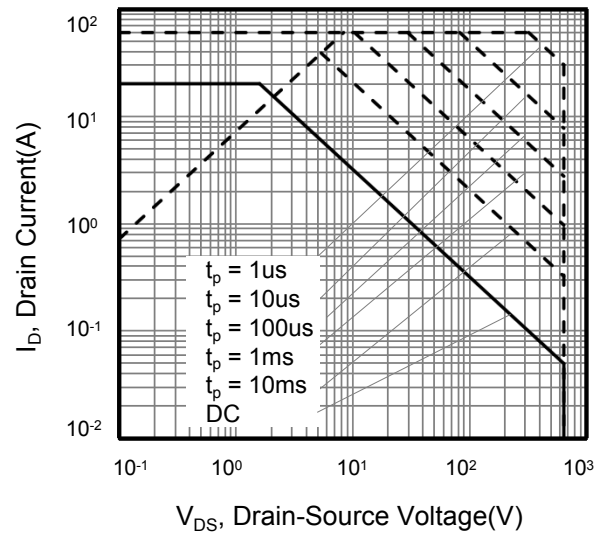




Figure A: Gate Charge Test Circuit and Waveform



Figure B: Resistive Switching Test Circuit and Waveform

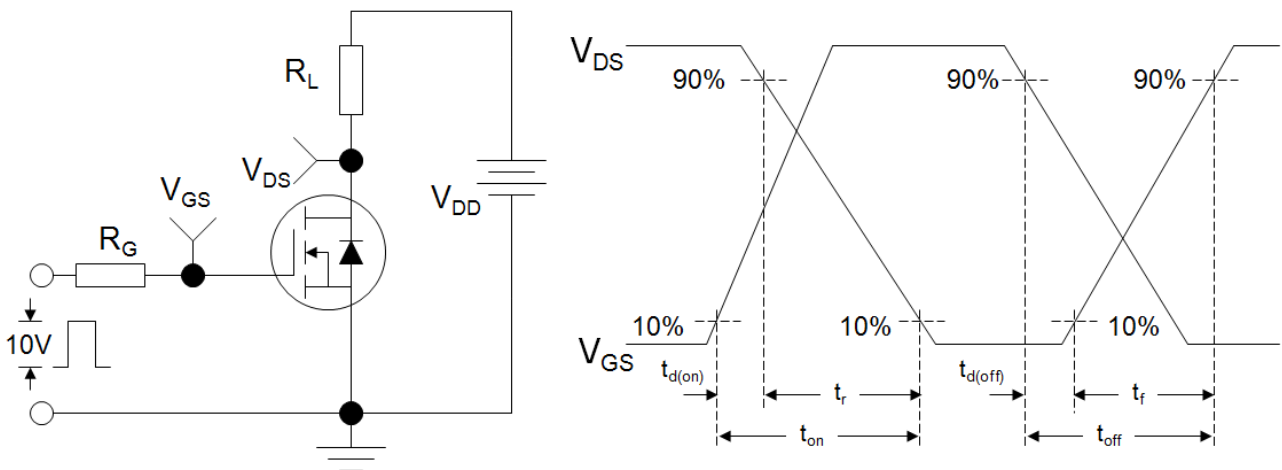
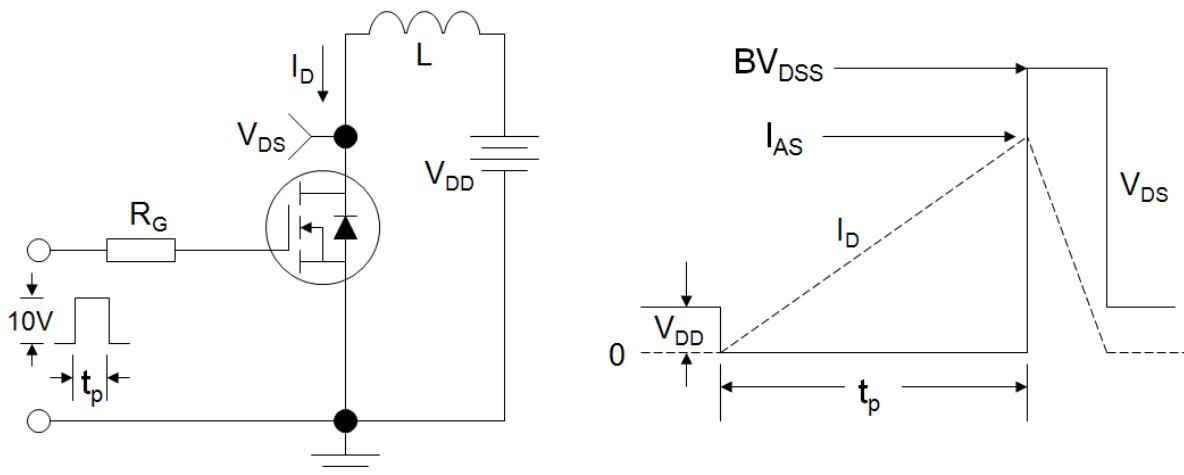
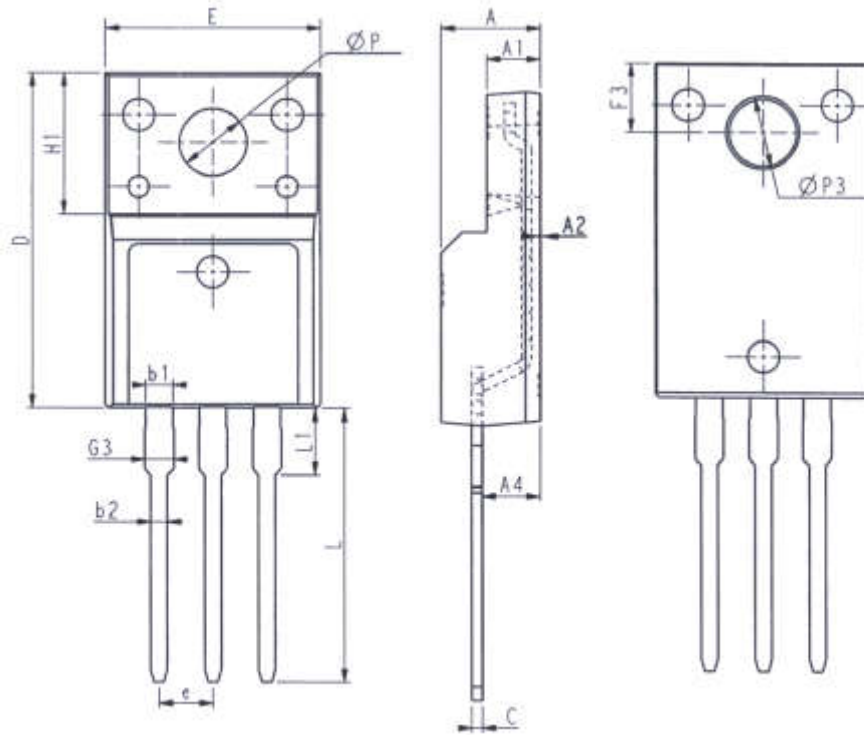


Figure C: Unclamped Inductive Switching Test Circuit and Waveform





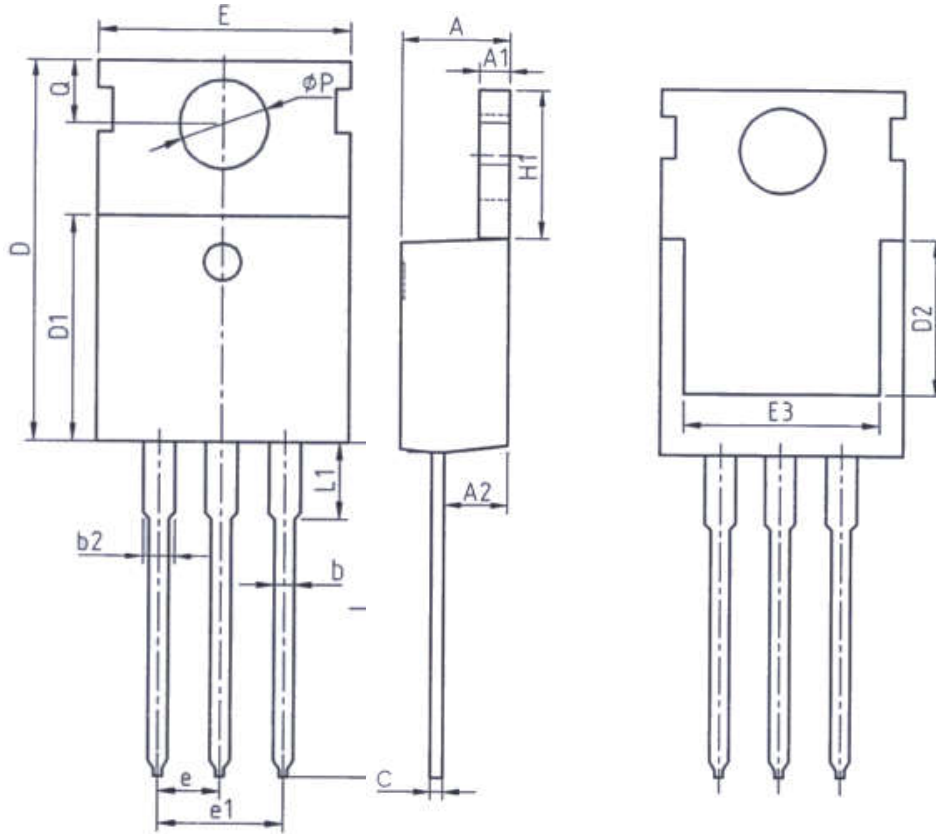
TO-220F



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-220

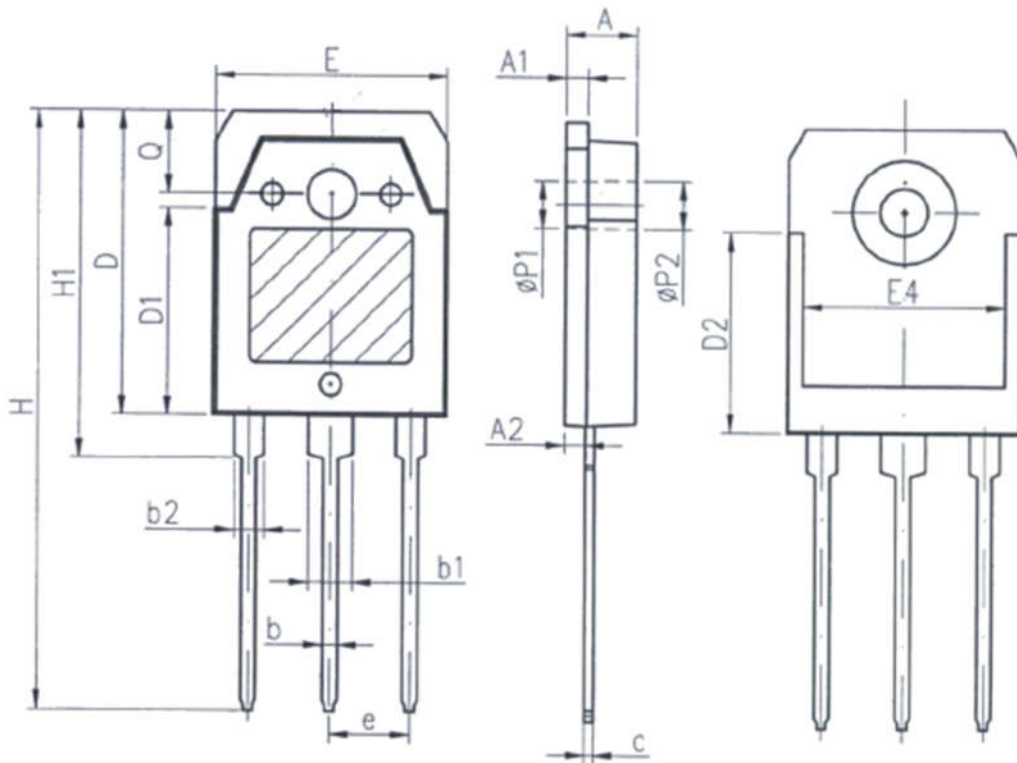


Unit: mm		
Symbol	Min.	Max.
A	4.37	4.77
A1	1.25	1.45
A2	2.20	2.60
b	0.70	0.95
b2	1.17	1.47
c	0.40	0.65
D	15.10	16.10
D1	8.80	9.40
D2	5.50	-

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



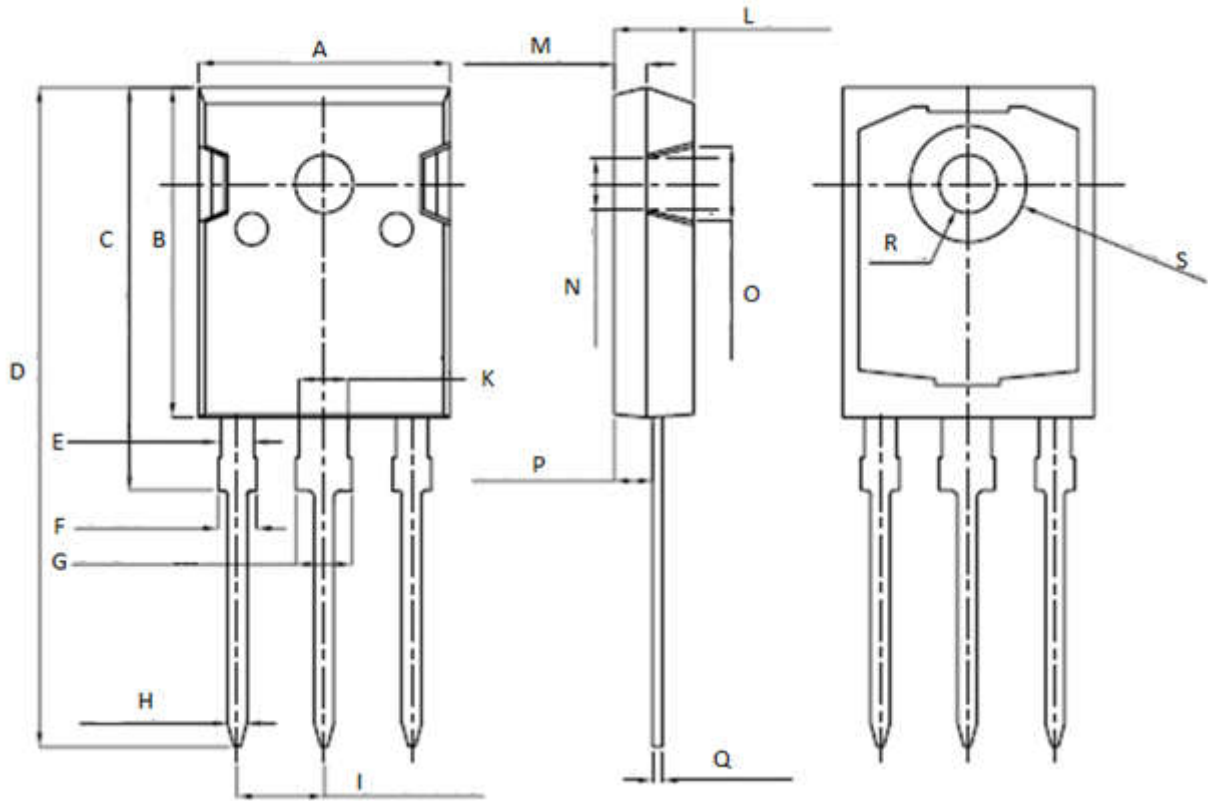
TO-3PN



Unit:mm		
Symbol	Min.	Max.
A	4.6	5
A1	1.4	1.65
A2	1.18	1.58
b	0.8	1.2
b1	2.8	3.2
b2	1.8	2.2
c	0.5	0.75
D	19.6	20.2
D1	13.55	14.25
D2	12.9REF	
E	15.35	15.85
E4	12.6	-
e	5.45TYP	
H	40.1	40.9
H1	23.15	23.65
P1	3.2REF	
P2	3.5REF	



TO-247



Unit: mm		
Symbol	Min.	Max.
A	15.95	16.25
B	20.85	21.25
C	20.95	21.35
D	40.5	40.9
E	1.9	2.1
F	2.1	2.25
G	3.1	3.25
H	1.1	1.3
I	5.40	5.50

Unit: mm		
Symbol	Min.	Max.
K	2.90	3.10
L	4.90	5.30
M	1.90	2.10
N	4.50	4.70
O	5.40	5.60
P	2.29	2.49
Q	0.51	0.71
R	φ 3.5	φ 3.7
S	φ 7.1	φ 7.3



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