



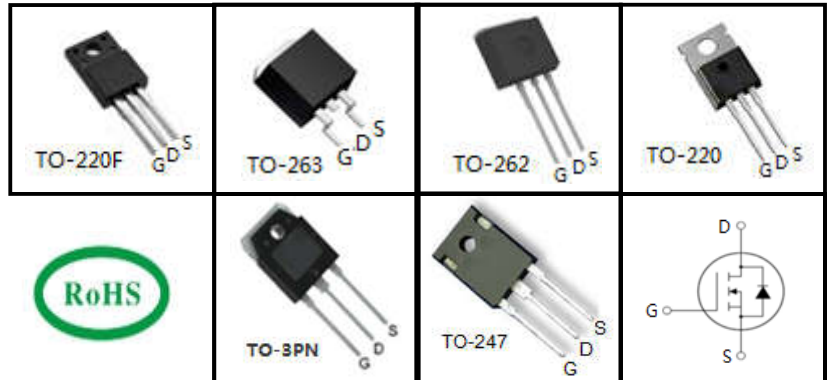
## 650V Super-Junction Power MOSFET

### 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	TPA65R260M	TPB65R260M	TPC65R260M	TPP65R260M	TPV65R260M	TPW65R260M
Package	TO-220F	TO-263	TO-262	TO-220	TO-3PN	TO-247
Marking	65R260M	65R260M	65R260M	65R260M	65R260M	65R260M

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

Parameter	Symbol	Value		Unit
		TO-263, TO-262, TO-220 TO-3PN, TO-247	TO-220F	
Drain-Source Voltage ( $V_{GS} = 0V$ )	$V_{DSS}$	650		V
Continuous Drain Current	$I_D$	$T_C = 25^\circ\text{C}$	15	A
		$T_C = 100^\circ\text{C}$	9	
Pulsed Drain Current (note1)	$I_{DM}$	45		A
Gate-Source Voltage	$V_{GSS}$	$\pm 30$		V
Single Pulse Avalanche Energy (note2)	$E_{AS}$	290		mJ
Avalanche Current (note1)	$I_{AR}$	2.4		A
Repetitive Avalanche Energy (note1)	$E_{AR}$	0.44		mJ
MOSFET dv/dt ruggedness, $V_{DS} = 0 \dots 480V$	dv/dt	50		V/ns
Reverse diode dv/dt, $V_{DS} = 0 \dots 480V$ , $I_{SD} \leq I_D$	dv/dt	15		V/ns
Power Dissipation ( $T_C = 25^\circ\text{C}$ )	$P_D$	105	32	W
Operating Junction and Storage Temperature Range	$T_J, T_{stg}$	-55~+150		$^\circ\text{C}$

### Thermal Resistance

Parameter	Symbol	Value		Unit
		TO-263, TO-262, TO-220 TO-3PN, TO-247	TO-220F	
Thermal Resistance, Junction-to-Case	$R_{thJC}$	1.2	3.9	$^\circ\text{C}/\text{W}$
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.	
<b>Static</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	$I_{GSS}$	$V_{GS} = \pm 30V$	--	--	$\pm 100$	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-Resistance (Note3)	$R_{DS(on)}$	$V_{GS} = 10V, I_D = 7.5A$	--	0.24	0.26	$\Omega$
Forward Transconductance (Note3)	$R_G$	$f = 1.0\text{MHz}$ open drain	--	12.5	--	S
<b>Dynamic</b>						
Input Capacitance	$C_{iss}$	$V_{GS} = 0V,$ $V_{DS} = 100V,$ $f = 1.0\text{MHz}$	--	1202	--	$\mu F$
Output Capacitance	$C_{oss}$		--	43	--	
Reverse Transfer Capacitance	$C_{rss}$		--	5	--	
Total Gate Charge	$Q_g$	$V_{DD} = 520V, I_D = 15A,$ $V_{GS} = 10V$	--	27	--	nC
Gate-Source Charge	$Q_{gs}$		--	5.5	--	
Gate-Drain Charge	$Q_{gd}$		--	10.5	--	
Turn-on Delay Time	$t_{d(on)}$	$V_{DD} = 400V, I_D = 15A,$ $R_G = 25\Omega$	--	25	--	ns
Turn-on Rise Time	$t_r$		--	63	--	
Turn-off Delay Time	$t_{d(off)}$		--	100	--	
Turn-off Fall Time	$t_f$		--	50	--	
<b>Drain-Source Body Diode Characteristics</b>						
Continuous Body Diode Current	$I_S$	$T_C = 25^\circ\text{C}$	--	--	15	A
Pulsed Diode Forward Current	$I_{SM}$		--	--	45	
Body Diode Voltage	$V_{SD}$	$T_J = 25^\circ\text{C}, I_{SD} = 15A, V_{GS} = 0V$	--	0.9	1.2	V
Reverse Recovery Time	$t_{rr}$	$V_R = 400V, I_F = I_S,$ $di_F/dt = 100A/\mu s$	--	410	--	ns
Reverse Recovery Charge	$Q_{rr}$		--	4.1	--	$\mu C$
Peak Reverse Recovery Current	$I_{rm}$		--	20	--	A

**Notes**

1. Repetitive Rating: Pulse Width limited by maximum junction temperature
2.  $I_{AS} = 2.4A, V_{DD} = 50V, R_G = 25\Omega, \text{Starting } T_J = 25^\circ\text{C}$
3. Pulse Test: Pulse Width  $\leq 300\mu s, \text{Duty Cycle } \leq 1\%$



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

Figure 1. Output Characteristics

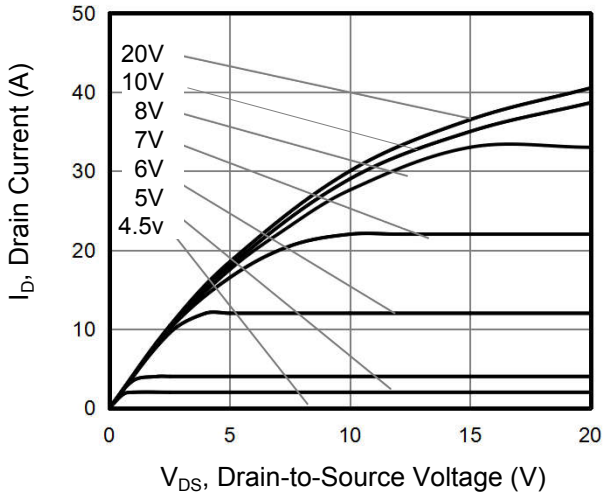


Figure 2. Transfer Characteristics

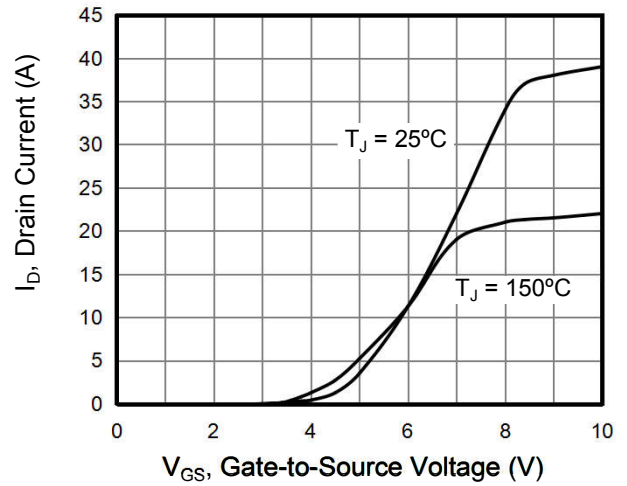


Figure 3. On-Resistance vs. Drain Current

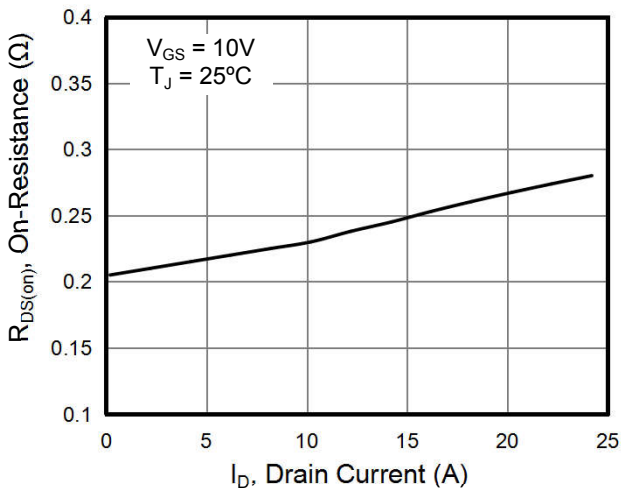


Figure 4. Capacitance

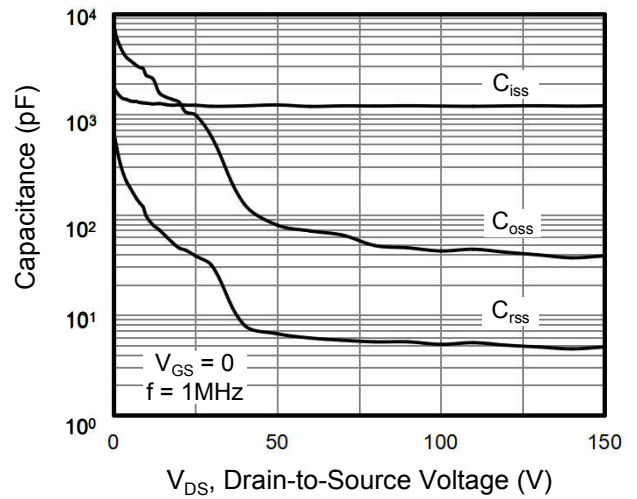


Figure 5. Gate Charge

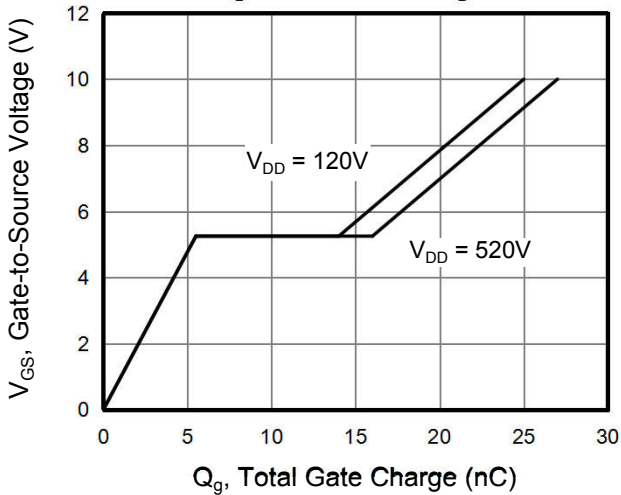
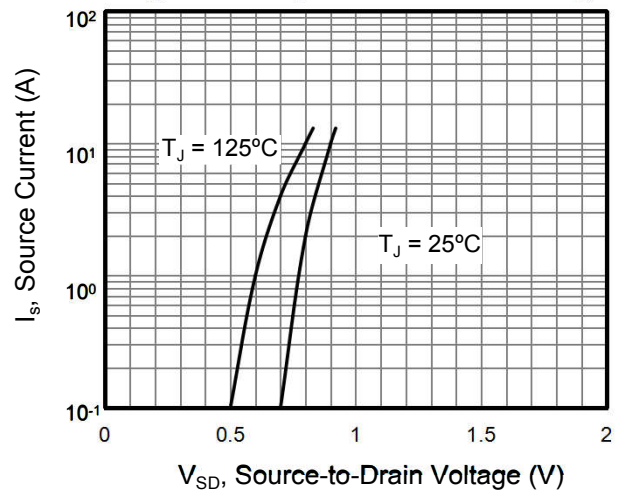


Figure 6. Body Diode Forward Voltage





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

Figure 7. On-Resistance vs. Junction Temperature

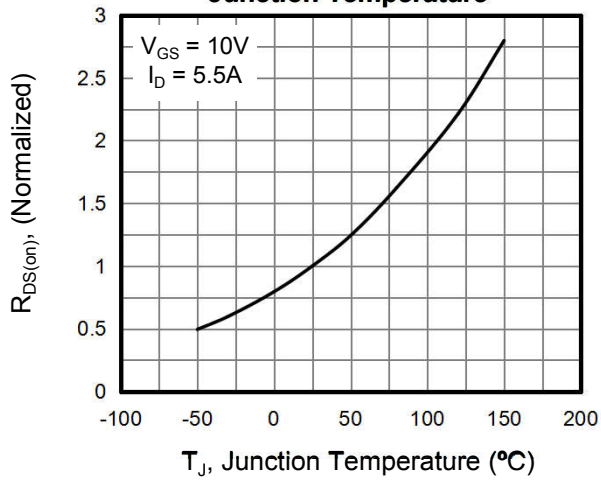


Figure 8. Threshold Voltage vs. Junction Temperature

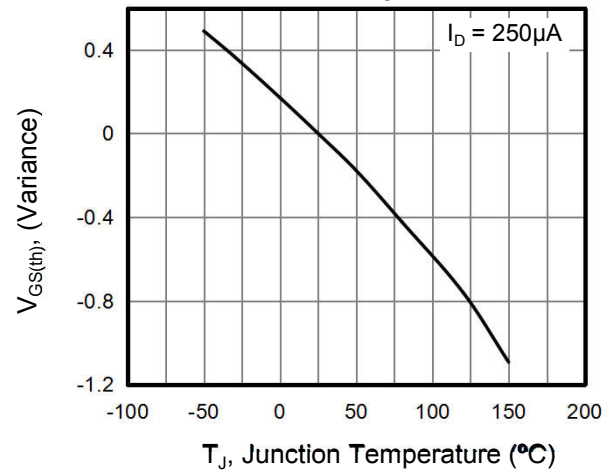
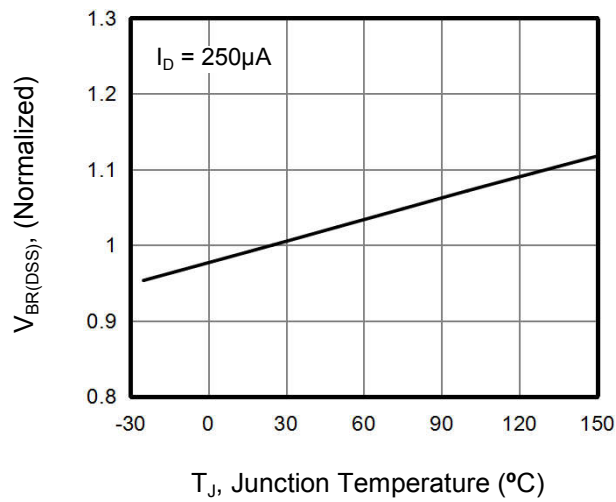


Figure 9. Breakdown voltage vs. Junction Temperature





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

Figure 10 . Transient Thermal Impedance  
TO-263, TO-262, TO-220  
TO-3PN, TO-247

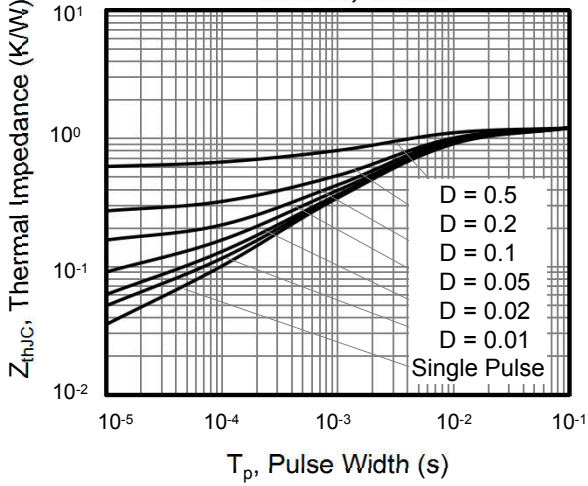


Figure 11. Transient Thermal Impedance  
TO-220F

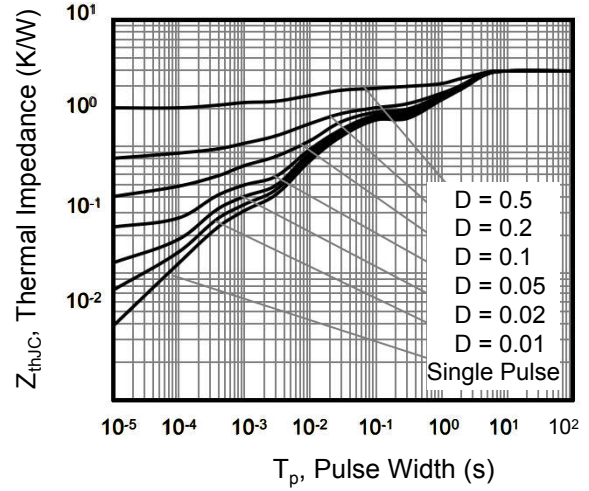


Figure 12. Safe operation area for  
TO-263, TO-262, TO-220  
TO-3PN, TO-247

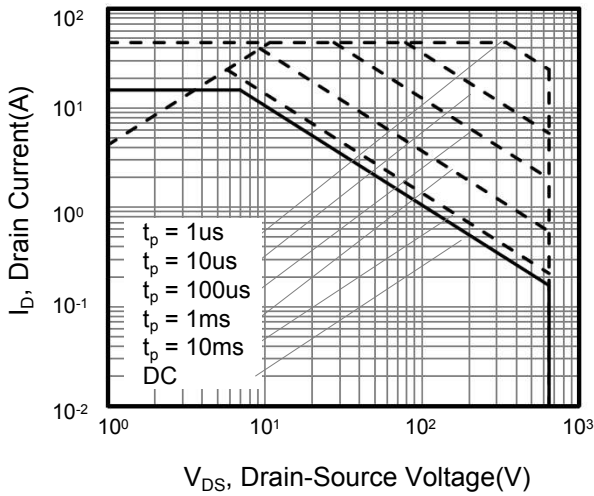


Figure 13. Safe operation area for  
TO-220F

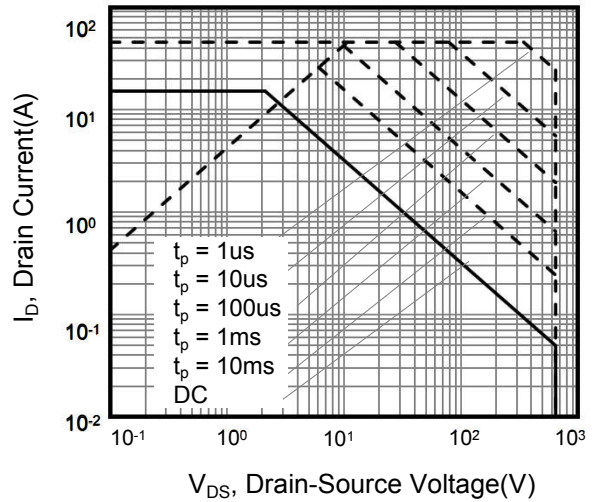




Figure A: Gate Charge Test Circuit and Waveform

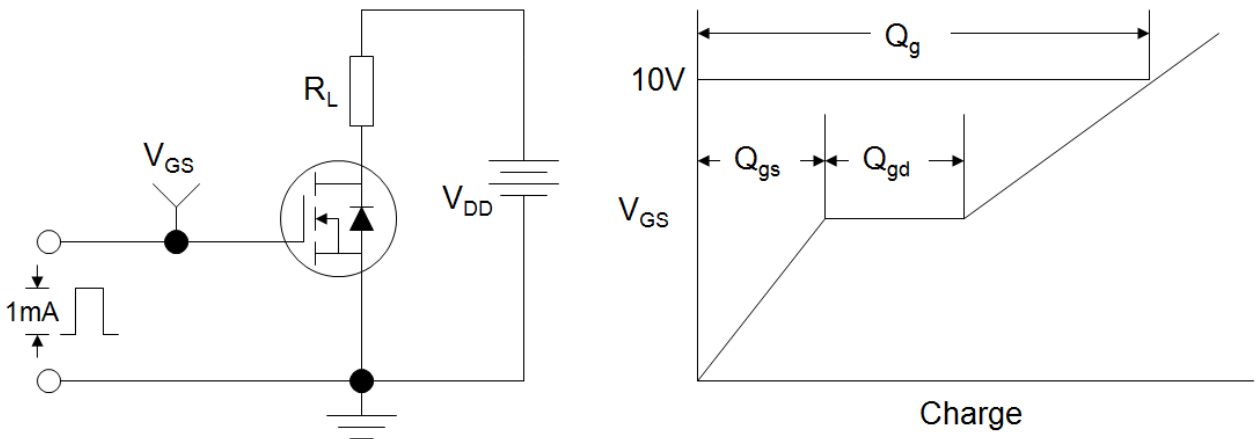


Figure B: Resistive Switching Test Circuit and Waveform

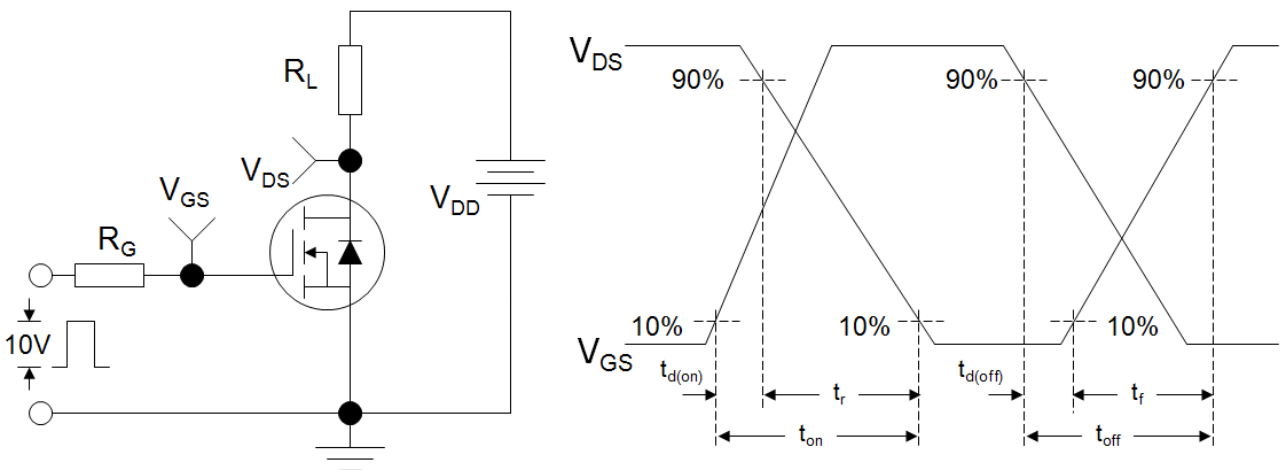
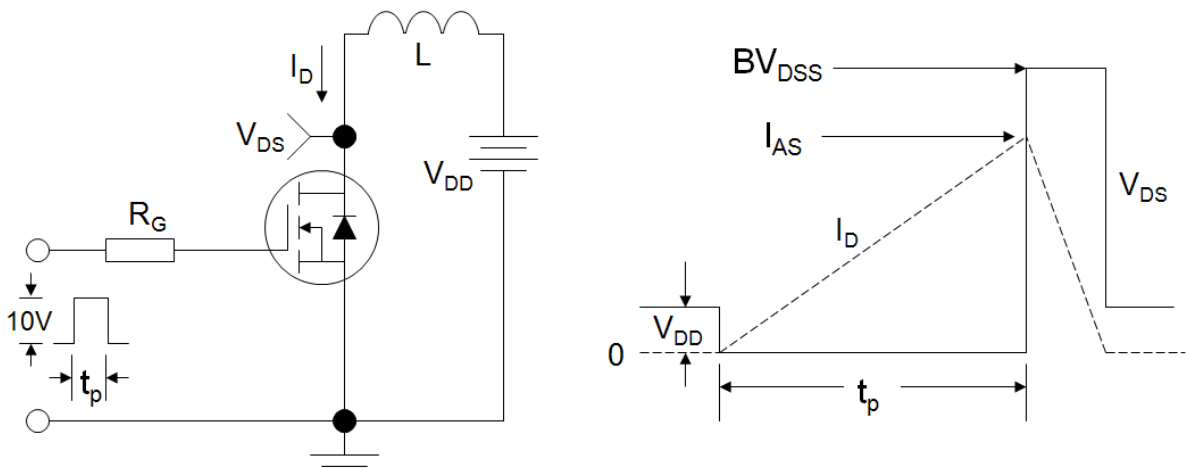
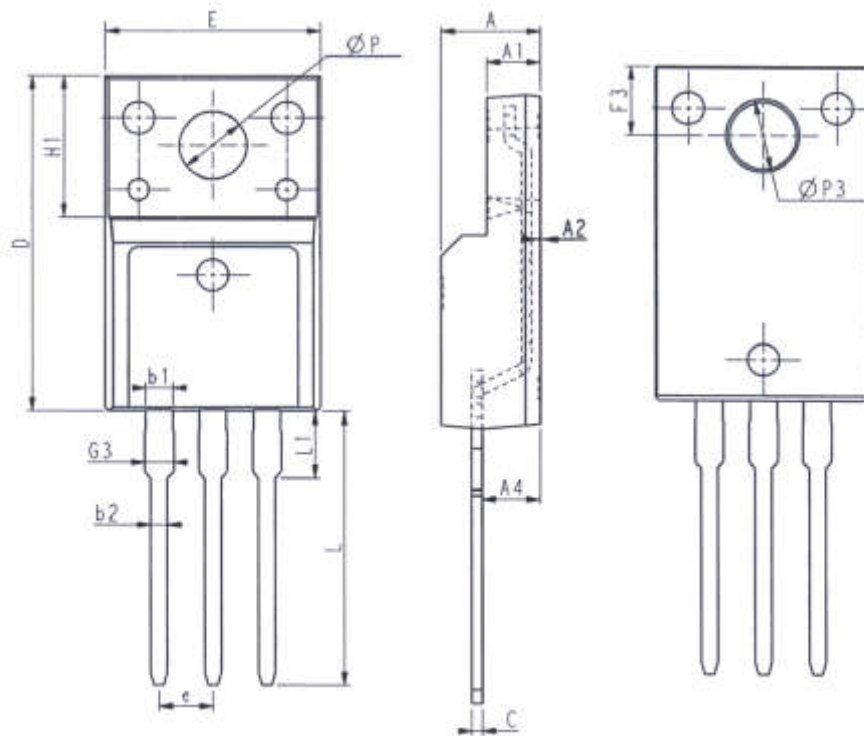


Figure C: Unclamped Inductive Switching Test Circuit and Waveform

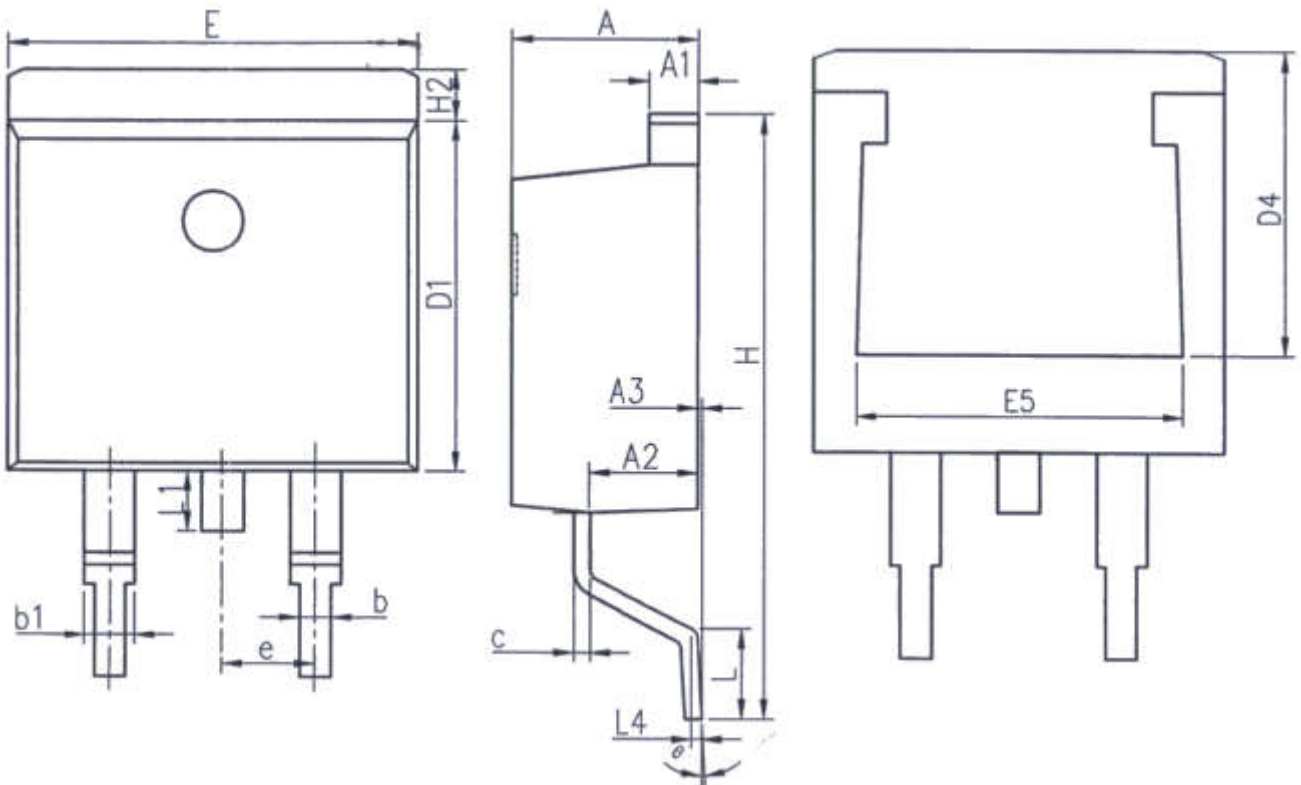


**TO-220F**

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				



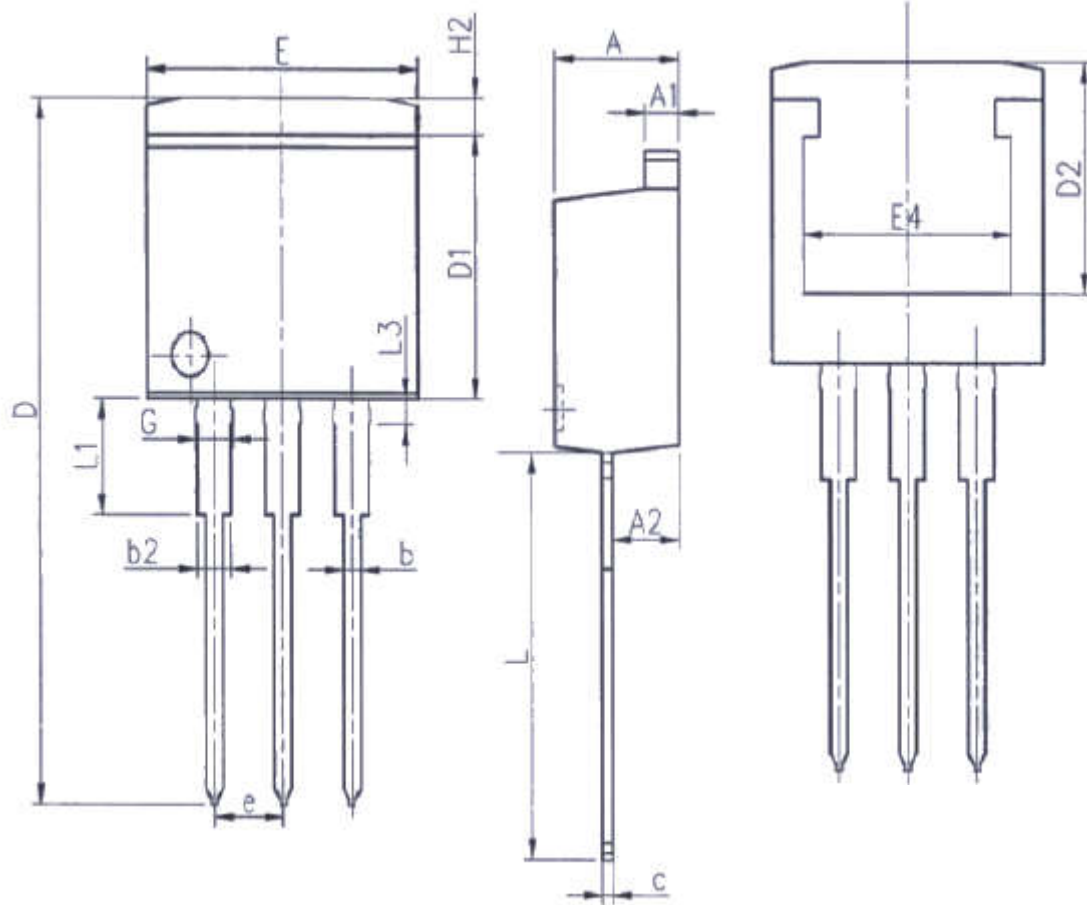
## TO-263



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

Unit: mm		
Symbol	Min.	Max.
E	9.86	10.36
E5	7.06	-
e	2.54BSC	
H	14.70	15.50
H2	1.07	1.47
L	2.00	2.60
L1	1.40	1.70
L4	0.25BSC	
$\theta$	0°	9°



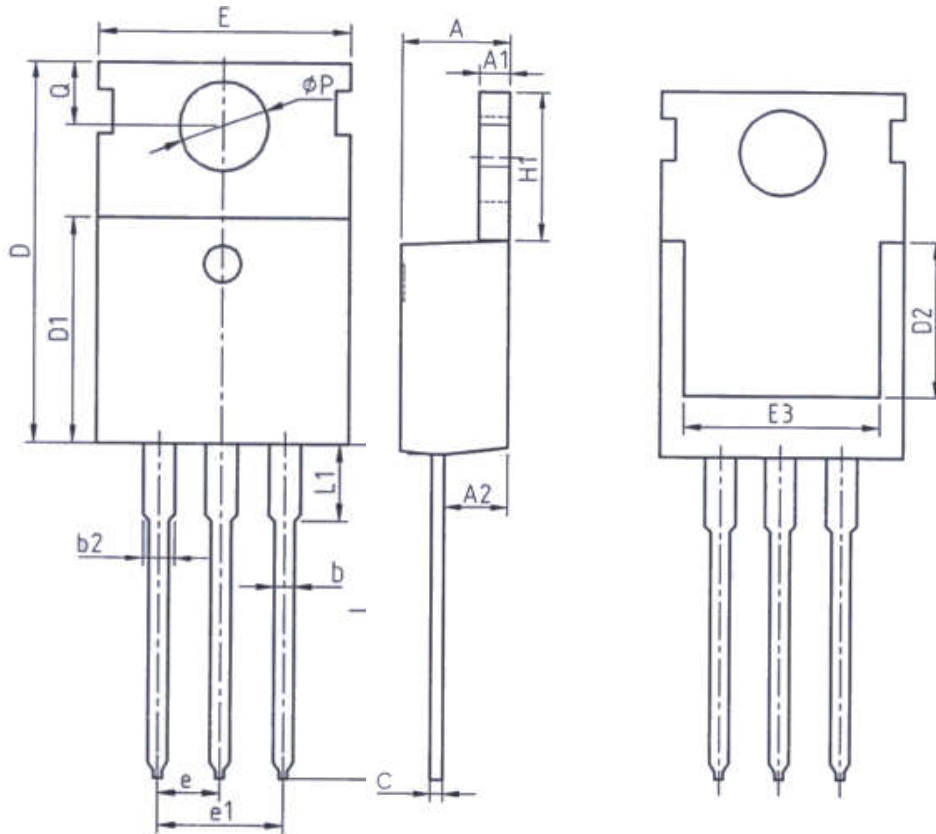
**TO-262**

Unit: mm		
Symbol	Min.	Max.
A	4.37	4.77
A1	1.22	1.42
A2	2.47	2.87
b	0.70	0.97
b2	1.17	1.42
c	0.28	0.53
D	23.20	24.02
D1	8.38	8.90
D2	6.00	-

Unit: mm		
Symbol	Min.	Max.
E	9.90	10.39
E4	7.30	-
e	2.54BSC	
G	1.25	1.50
H2	-	1.31
L	13.34	14.10
L1	3.30	4.06
L3	0.95	1.15

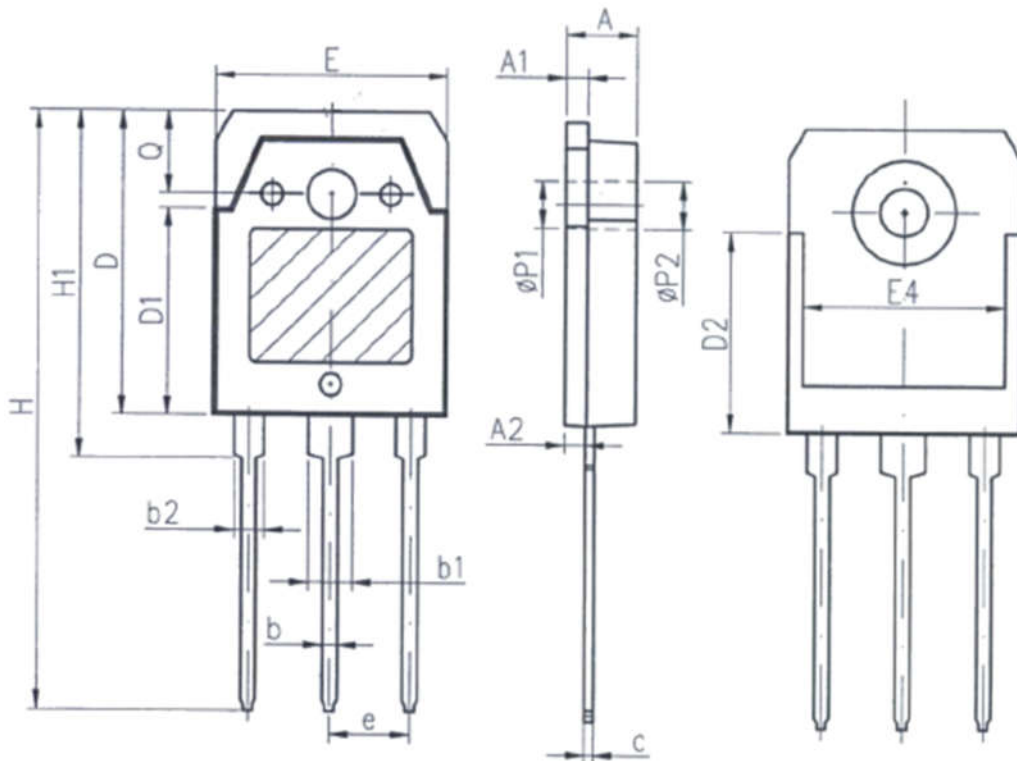


## TO-220



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	-

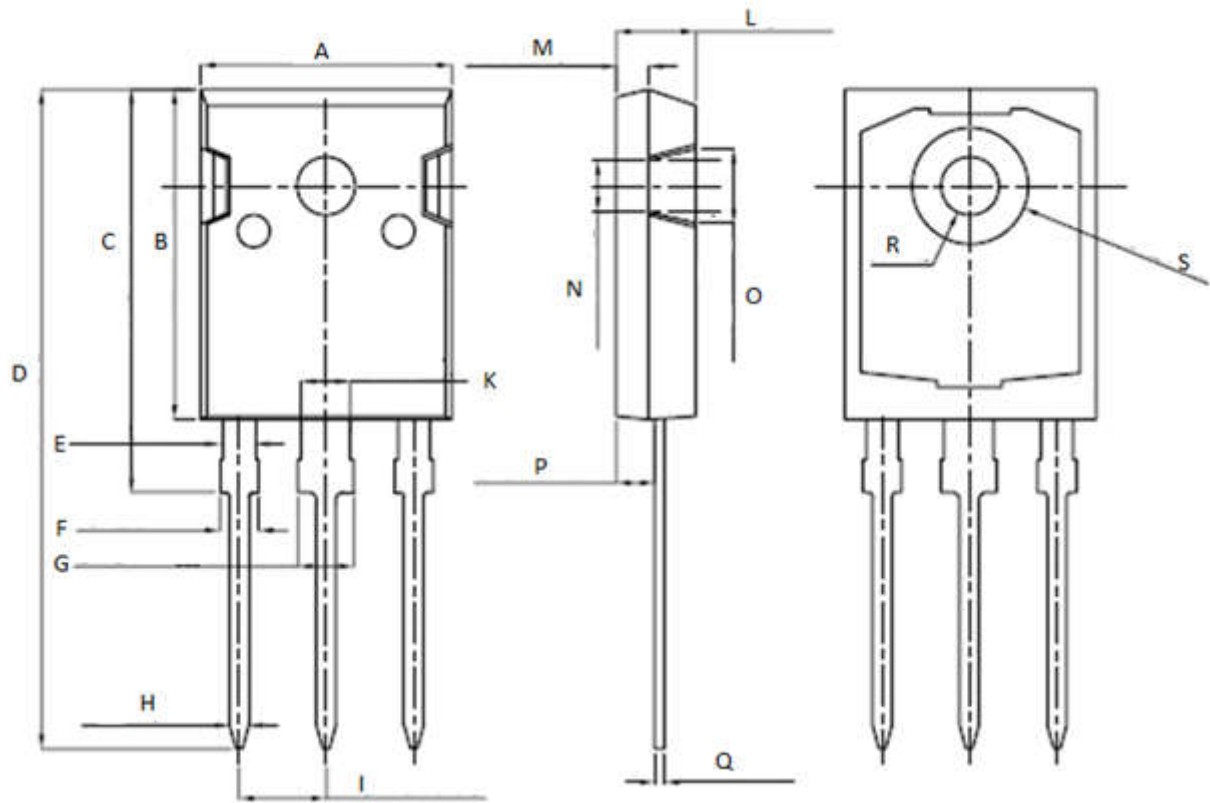
Unit: mm		
Symbol	Min.	Max.
E	9.70	10.30
E3	7.00	-
e	2.54BSC	
e1	5.08BSC	
H1	6.25	6.85
L	12.75	13.80
L1	-	3.40
P	3.40	3.80
Q	2.60	3.00

**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	$\phi 3.5$	$\phi 3.7$
S	$\phi 7.1$	$\phi 7.3$



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