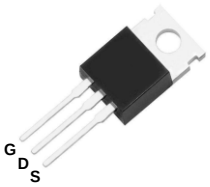
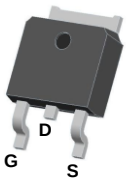
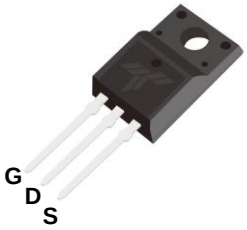
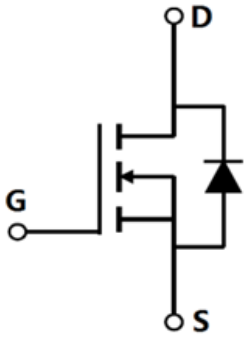
CSP090N06S2, CSI090N06S2
CSD090N06S2, CSA090N06S2

N-channel 60V, 7.5mΩ typ.,
SGT MOSFET S2 in TO-220, TO-251, TO-252 and TO-220F

Datasheet - production data

1. Descriptions

TO-220	TO-251
	
TO-252	**TO-220F**
	
Schematic Diagram	
	

Key Performance Parameters

Parameters	Value	Unit
BV_{DSS}	60	V
$R_{DS(on),max}$	9	mΩ
P_D	75	W
I_D	60	A

Features

- High Speed Power Switching,Logic level
- Enhanced Body diode dv/dt capability
- Ehanced Avalanche Ruggedness
- 100% UIS Tested, 100% Rg Tested
- Lead Free, Halogen Free

Applications

- DC/DC Converter
- Motor Drivers
- Ideal for high-frequency switching and synchronous rectification

Type/Ordering Code	Package	Marking	Related Links
CSP090N06S2	TO-220	090N06S2	see Appendix A
CSI090N06S2	TO-251		
CSD090N06S2	TO-252		
CSA090N06S2	TO-220F		

Contents

2. Maximum Ratings

at T_j = 25°C, unless otherwise specified

Absolute Maximum Ratings

Symbol	Parameter	Values			Unit	Test Condition
		Min.	Typ.	Max.		
V_{DS}	Drain-source voltage	-	-	60	V	V_{GS}=0V, I_D=250μA
V_{GS}	Gate source voltage	-20	-	20	V	static; AC (f>1 Hz)
I_D	Continuous drain current	- -	- -	60 43	A	T_C=25°C T_C=100°C
$I_{D,pulse}$	Pulsed drain current	-	-	240	A	T_C=25°C
P_D	Power dissipation (Non FullPAK) TO-220, TO-251, TO-252	-	-	75	W	T_C=25°C
P_D	Power dissipation (FullPAK) TO-220F	-	-	24	W	T_C=25°C
E_{AS}	Avalanche energy, single pulse[1)]	-	-	180	mJ	I_D=6A; V_{DD} =50V
T_j, T_{stg}	Operating and storage temperature	-55	-	175	°C	-

3. Thermal Characteristics

Thermal Characteristics (Non FullPAK) TO-220, TO-251, TO-252

Symbol	Parameter	Values			Unit	Test Condition
		Min.	Typ.	Max.		
R_{thJC}	Thermal resistance, junction - case	-	-	2	°C/W	T_C = 25°C
R_{thJA}	Thermal resistance, junction - ambient	-	-	75	°C/W	T_C = 25°C

Thermal Characteristics (FullPAK) TO-220F

Symbol	Parameter	Values			Unit	Test Condition
		Min.	Typ.	Max.		
R_{thJC}	Thermal resistance, junction - case	-	-	6.25	°C/W	T_C = 25°C
R_{thJA}	Thermal resistance, junction - ambient[2)]	-	-	75	°C/W	T_C = 25°C

4. Electrical Characteristics

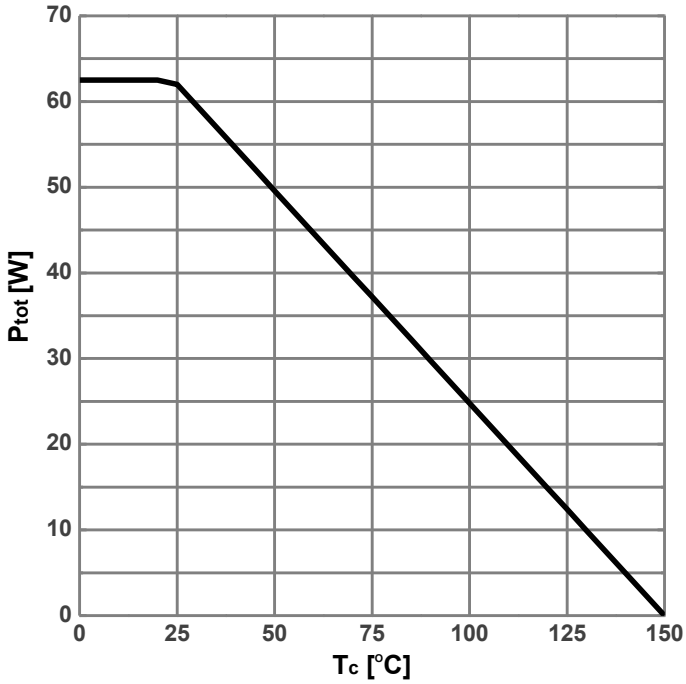
at T_j = 25°C, unless otherwise specified

Symbol	Parameter	Values			Unit	Test Condition
		Min.	Typ.	Max.		
Off Characteristics						
$V_{(BR)DSS}$	Drain-source breakdown voltage	60	-	-	V	V_{GS}=0V, I_D=250μA
I_{DSS}	Zero gate voltage drain current	-	-	1	μA	V_{DS}=60V, V_{GS}=0V
I_{GSS}	Gate-source leakage current	-	-	±100	nA	V_{GS}=±20V, V_{DS}=0V
On Characteristics[3)]						
$V_{(GS)th}$	Gate threshold voltage	1.0	1.8	2.5	V	V_{DS}=V_{GS}, I_D=250μA
$R_{DS(on)}$	Drain-source on-state resistance	-	7.5 10	9 14	mΩ	V_{GS}=10V, I_D=20A V_{GS}=4.5V, I_D=10A
R_G	Gate resistance	-	2.6	-	Ω	V_{DD}=0V,V_{GS}=0V,F=1MHz
g_{fs}	Transconductance		80		S	V_{DS}=5V, I_D=20A
Dynamic Characteristics						
C_{iss}	Input capacitance	-	1480	-	pF	V_{GS}=0V, V_{DS}=30V, F=1MHz
C_{oss}	Output capacitance	-	290	-	pF	
C_{rss}	Reverse transfer capacitance	-	4.1	-	pF	
Switching Characteristics[4)]						
$t_{d(on)}$	Turn-on delay time	-	11	-	ns	V_{DD}=30V, V_{GS}=10V, I_D=14.5A,R_G=3Ω
t_r	Turn-on rise time	-	5	-	ns	
$t_{d(off)}$	Turn-off delay time	-	56	-	ns	
t_f	Turn-off fall time	-	12	-	ns	
Q_g	Gate charge total	-	23	-	nC	V_{DD}=30V, I_D=14.5A, V_{GS}=10V
Q_{gs}	Gate to source charge	-	4.8	-	nC	
Q_{gd}	Gate to drain charge	-	2.4	-	nC	
Reverse Diode Characteristics						
V_{SD}	Diode forward voltage[3)]	-	0.9	1.2	V	V_{GS}=0V, I_F=20A
I_S	Diode forward current[2)]	-	-	60	A	
t_{rr}	Reverse recovery time	-	32	-	ns	V_{GS}=0V, I_F=14.5A, di_F/dt=100A/μs[3)]
Q_{rr}	Reverse recovery charge	-	46	-	μC	

1) V_{DD}=50V, L=10mH, R_G=25Ω, Starting T_j=25°C.
2) Surface Mounted on FR4 Board, t ≤ 10 sec.
3) Test: Pulse Width ≤ 300μs, Duty Cycle ≤ 2%.
4) Guaranteed by design, not subject to production
5) Repetitive Rating: Pulse width limited by maximum junction temperature.

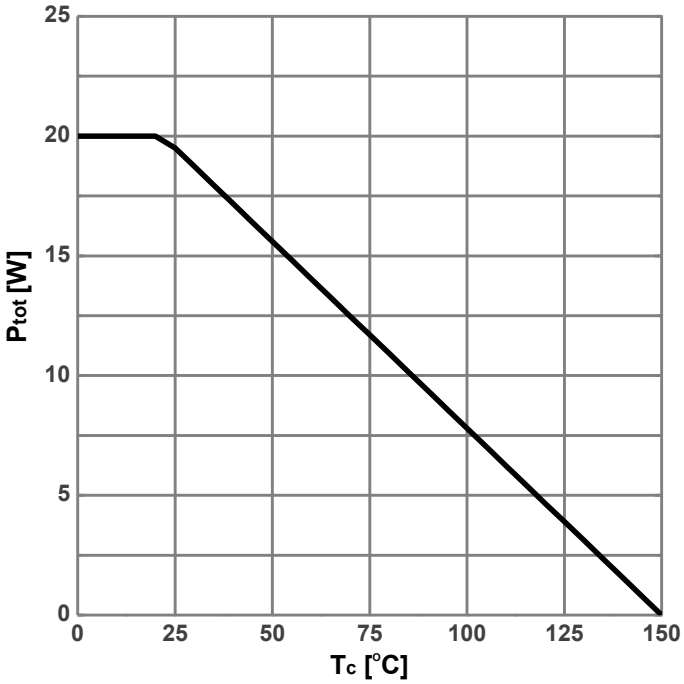
5. Electrical Characteristics Diagrams

Diagram 1: Power dissipation (Non FullPAK)



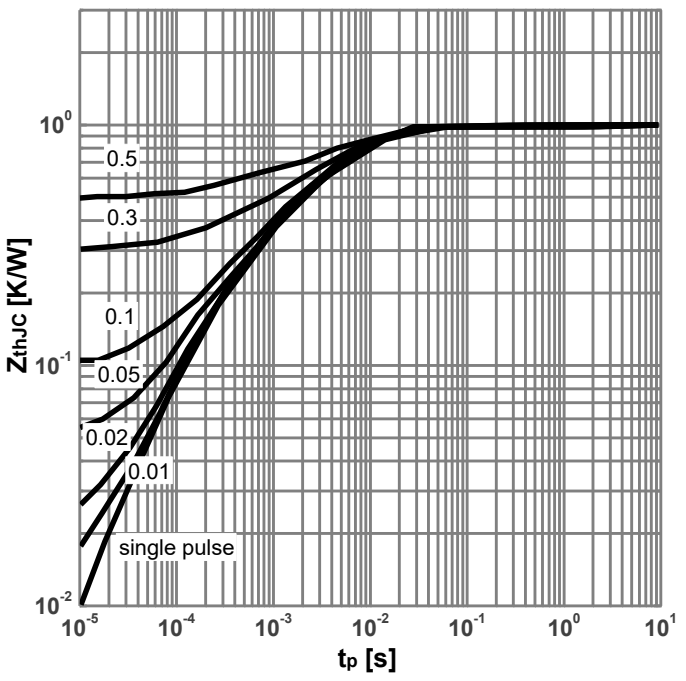
$P_{tot}=f(T_C)$

Diagram 2: Power dissipation (FullPAK)



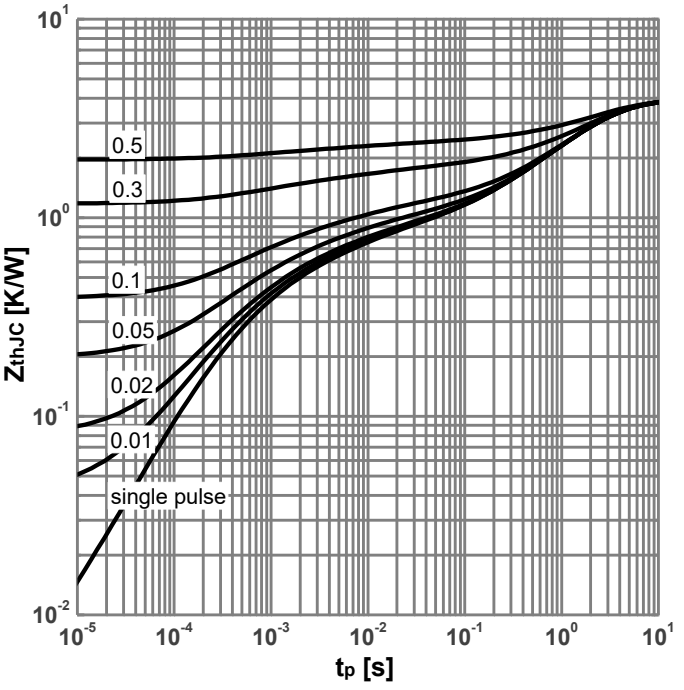
$P_{tot}=f(T_C)$

Diagram 3: Max. transient thermal impedance (Non FullPAK)



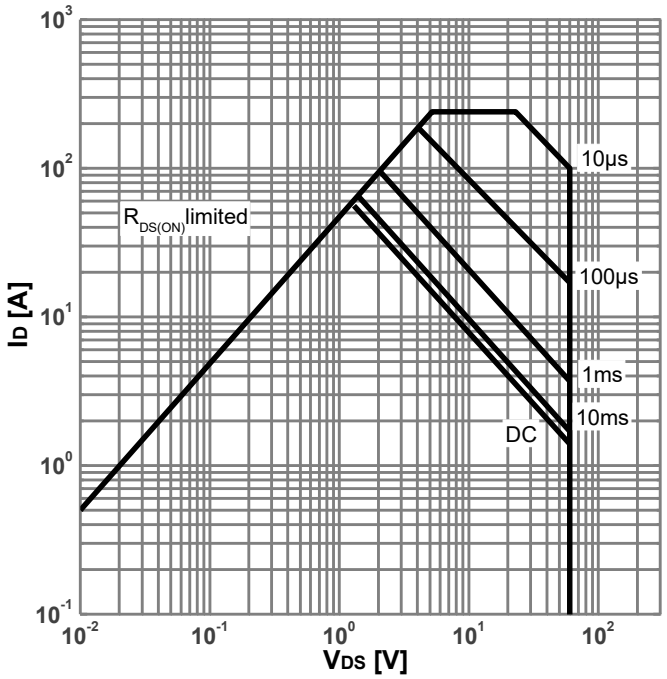
$Z_{thJC}=f(t_p)$; parameter: D= t_p/T

Diagram 4: Max. transient thermal impedance (FullPAK)



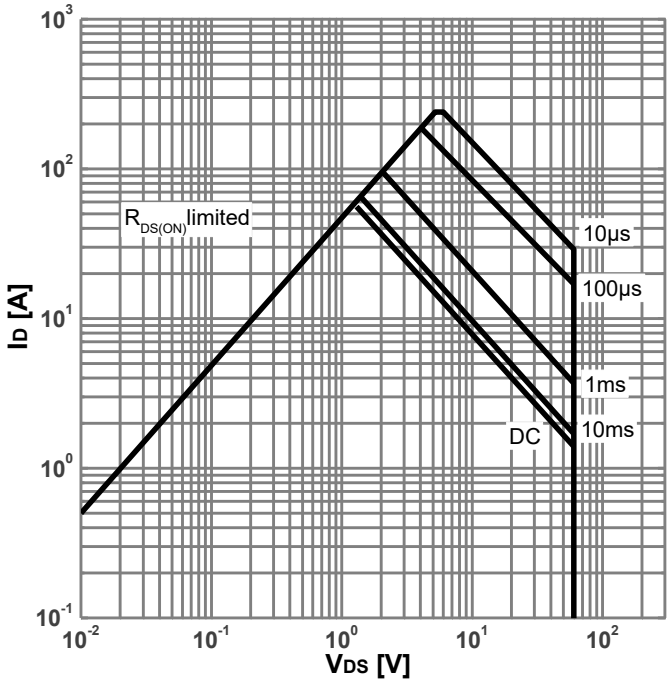
$Z_{thJC}=f(t_p)$; parameter: D= t_p/T

Diagram 5: Safe operating area (Non FullPAK)



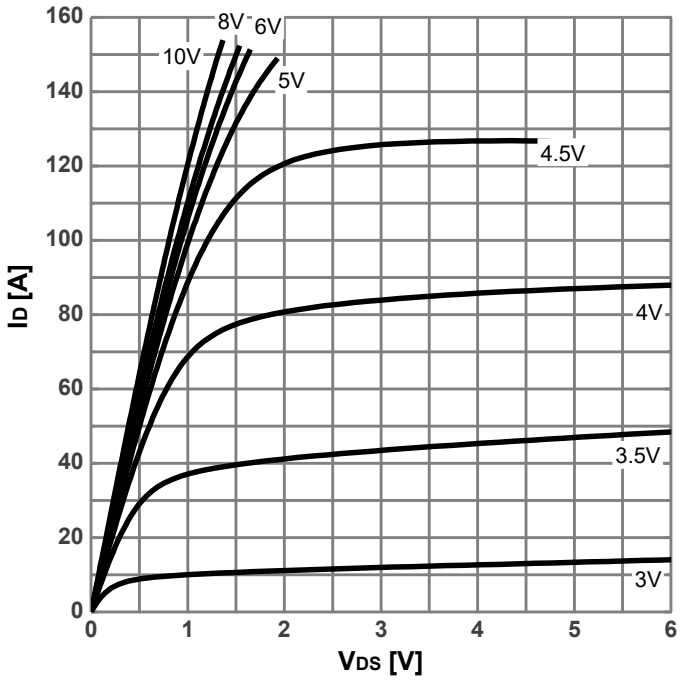
I_D=f(V_{DS}); Tj=25°C; D=0; parameter: t_p

Diagram 6: Safe operating area (FullPAK)



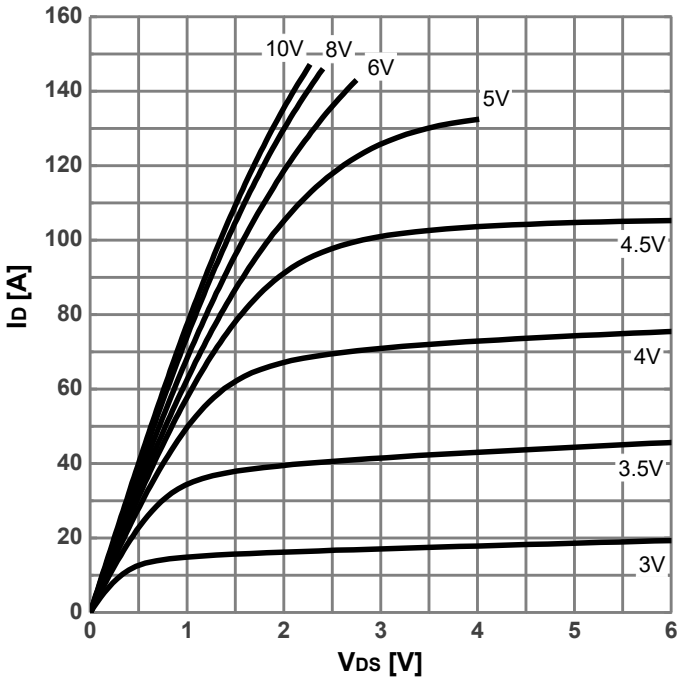
I_D=f(V_{DS}); Tj=25°C; D=0; parameter: t_p

Diagram 7: Typ. output characteristics



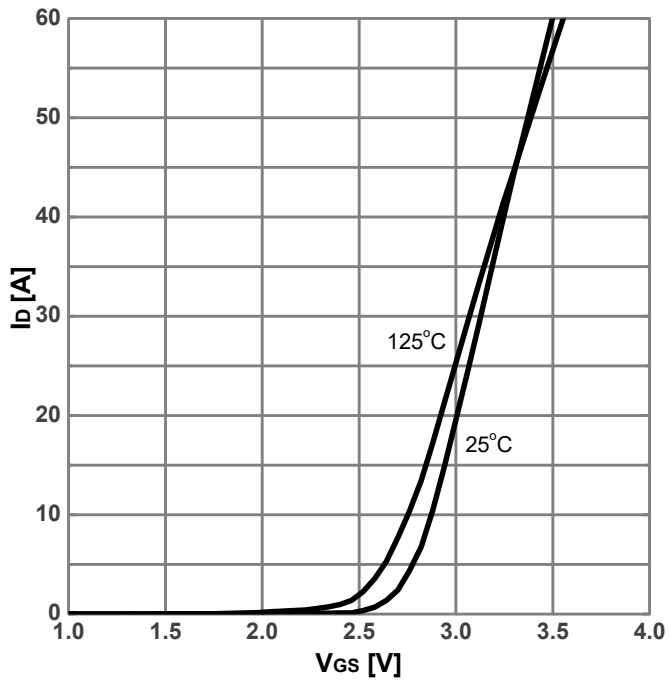
I_D=f(V_{DS}); Tj=25°C; parameter: V_{GS}

Diagram 8: Typ. output characteristics



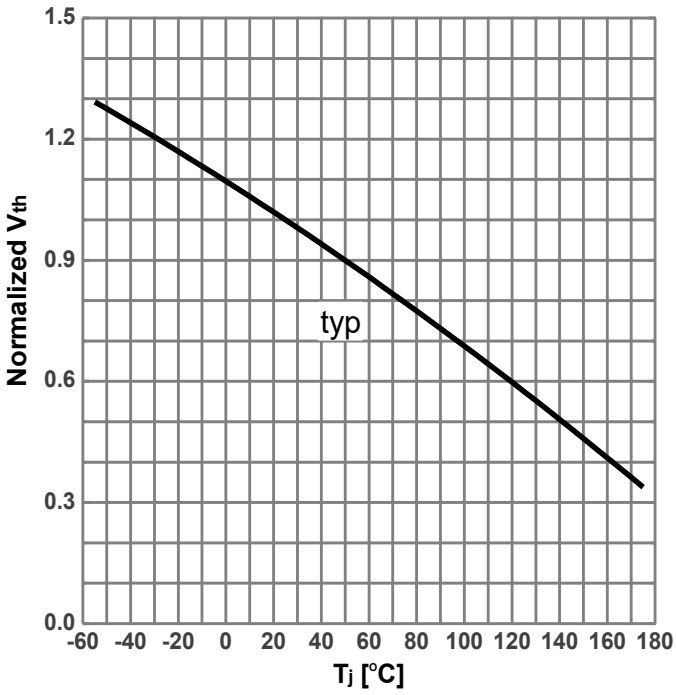
I_D=f(V_{DS}); Tj=125°C; parameter: V_{GS}

Diagram 9: Typ. transfer characteristics



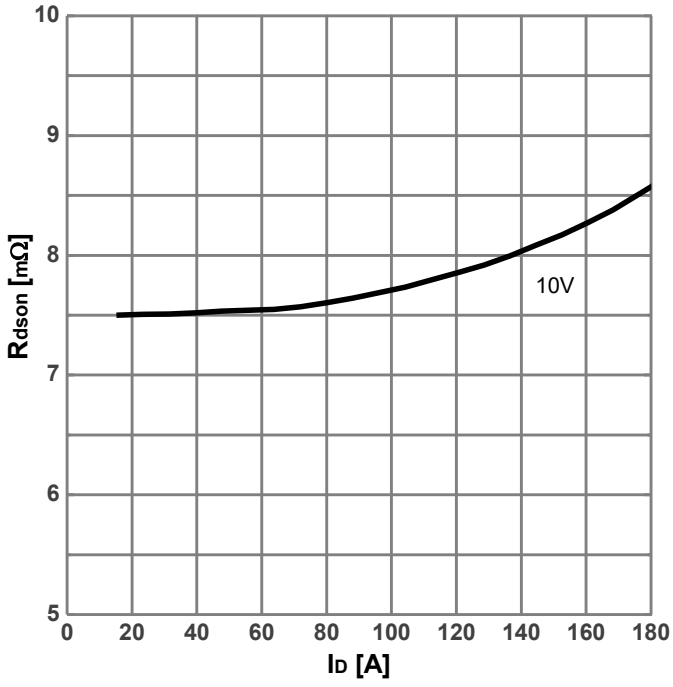
I_D=f(V_{GS}); V_{DS}=15V; parameter: T_j

Diagram 10: Gate threshold voltage vs. Junction temperature



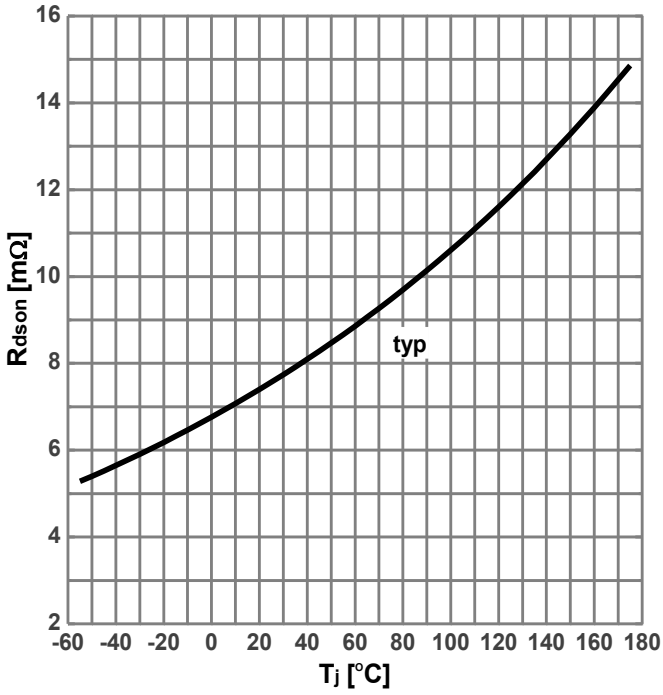
V_{th}=f(T_j); I_D=250μA

Diagram 11: On-state resistance vs. Drain current



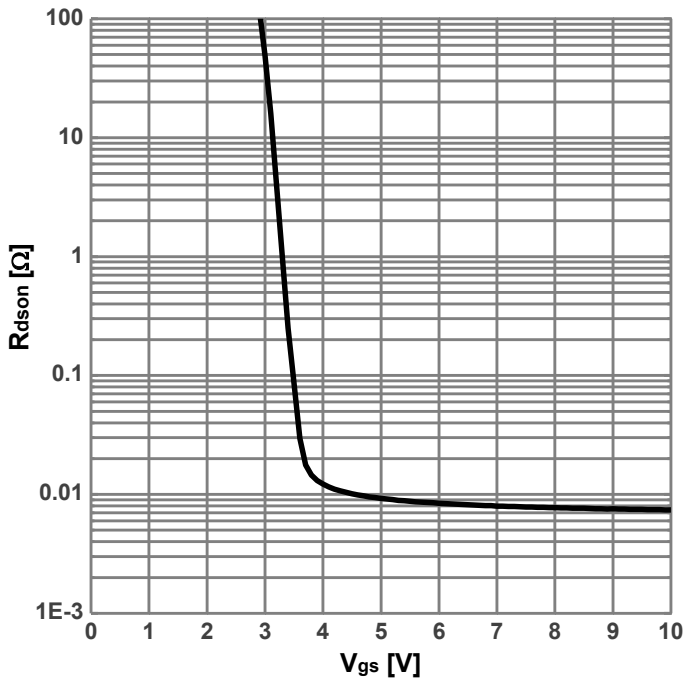
R_{DS}(on)=f(I_D); Tj=25°C; parameter: V_{GS}

Diagram 12: On-state resistance vs. Junction temperature



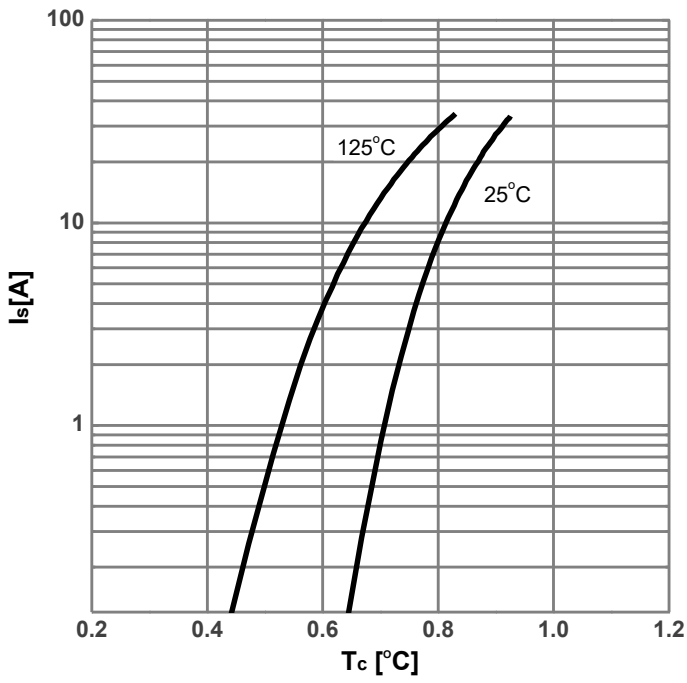
R_{DS}(on)=f(T_j); I_D=20A; V_{GS}=10V

Diagram 13: On-state resistance vs. Vgs characteristics



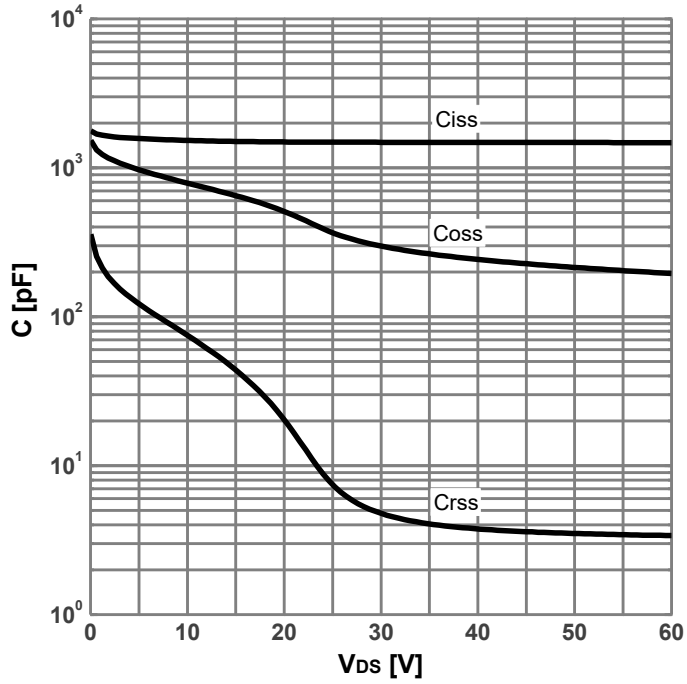
R_{DS}(on)=f(V_{gs}); Tj=25°C; I_D=20A

Diagram 14: Forward characteristics of reverse diode



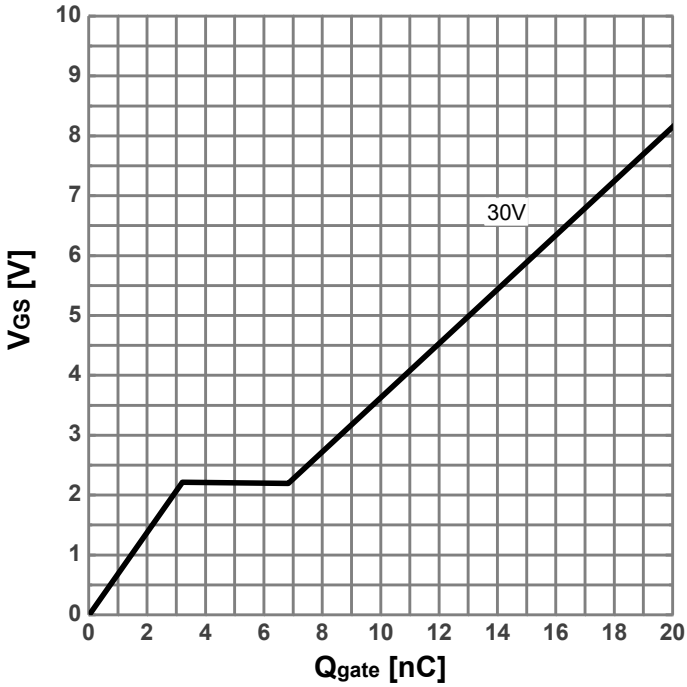
I_F=f(V_{SD}); parameter: T_j

Diagram 15: Typ. capacitances



C=f(V_{DS}); V_{GS}=0V; f=1MHz

Diagram 16: Typ. gate charge



V_{GS}=f(Q_{gate}); I_D=14.5A pulsed; V_{DS}=30V

6. Test Circuits

Table 7. Diode Characteristics

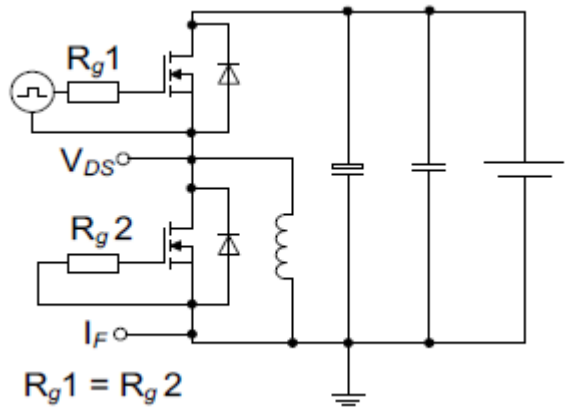
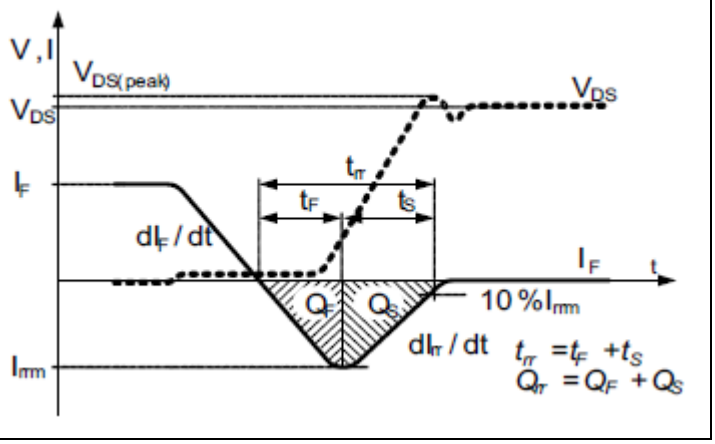
Test circuit for diode characteristics	Diode recovery waveform
	

Table 8. Switching Times

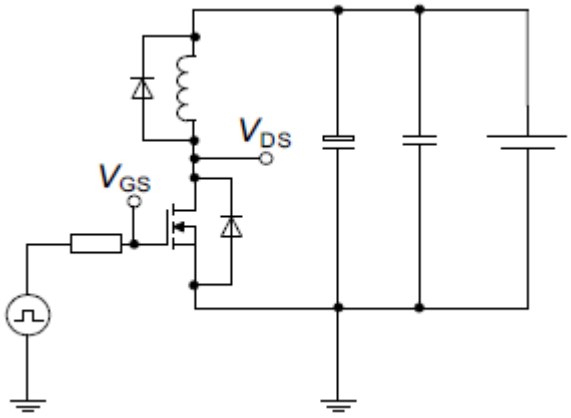
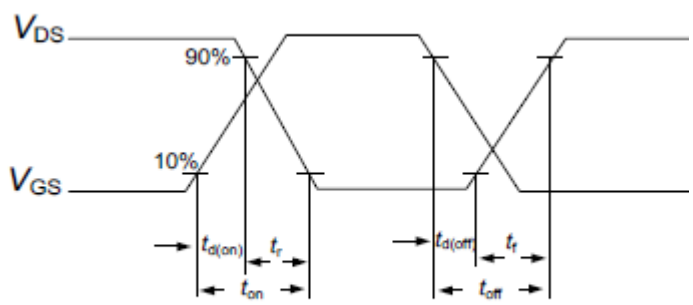
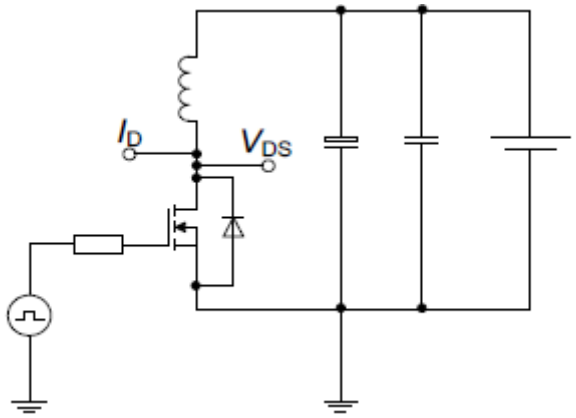
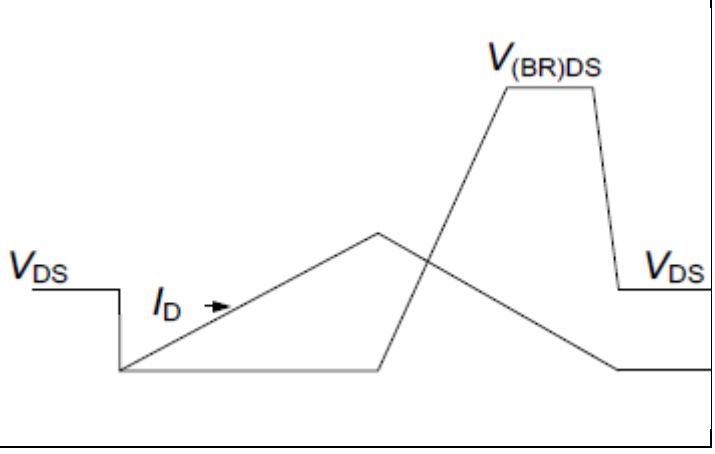
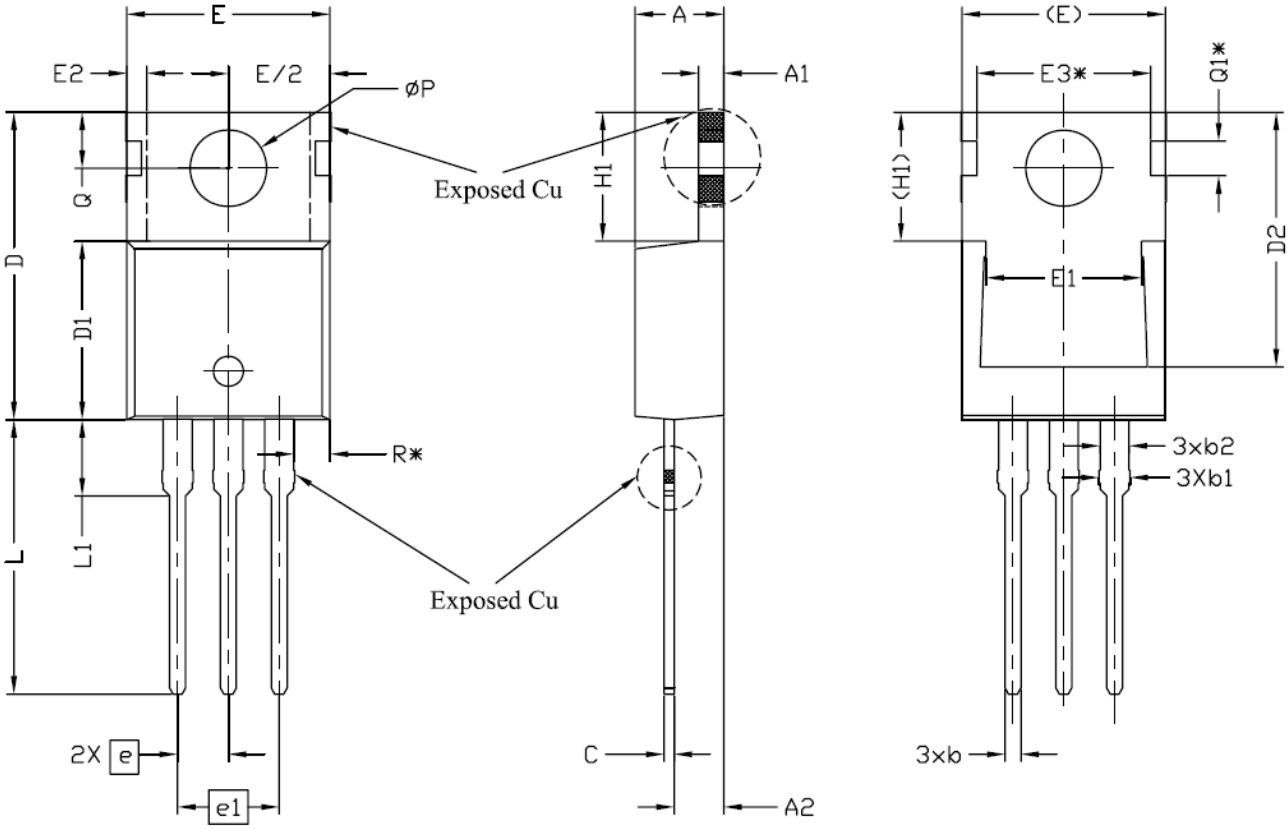
Switching times test circuit for inductive load	Switching times waveform
	

Table 9. Unclamped Inductive Load

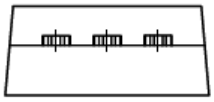
Unclamped inductive load test circuit	Unclamped inductive waveform
	

7. Package Outlines

Figure 1 Outline TO-220 Dimensions in mm

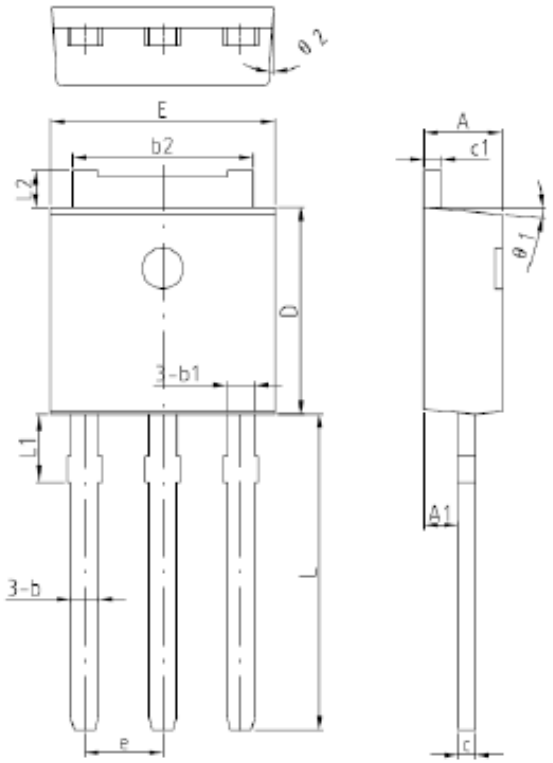


SYMBOL	DIMENSIONS			NOTES
	MIN.	NOM.	MAX.	
A	4.24	4.44	4.64	
A1	1.15	1.27	1.40	
A2	2.30	2.48	2.70	
b	0.70	0.80	0.90	
b1	1.20	1.55	1.75	
b2	1.20	1.45	1.70	
c	0.40	0.50	0.60	
D	14.70	15.37	16.00	4
D1	8.82	8.92	9.02	
D2	12.43	12.73	12.83	5
E	9.96	10.16	10.36	4,5
E1	6.86	7.77	8.89	5
E2	-	-	0.76	6
E3*	8.70REF.			
e	2.54BSC			
e1	5.08BSC			
H1	6.30	6.45	6.60	5,6
L	13.47	13.72	13.97	
L1	3.60	3.80	4.00	
ØP	3.75	3.84	3.93	
Q	2.60	2.80	3.00	
Q1*	1.73REF.			
R*	1.82REF.			



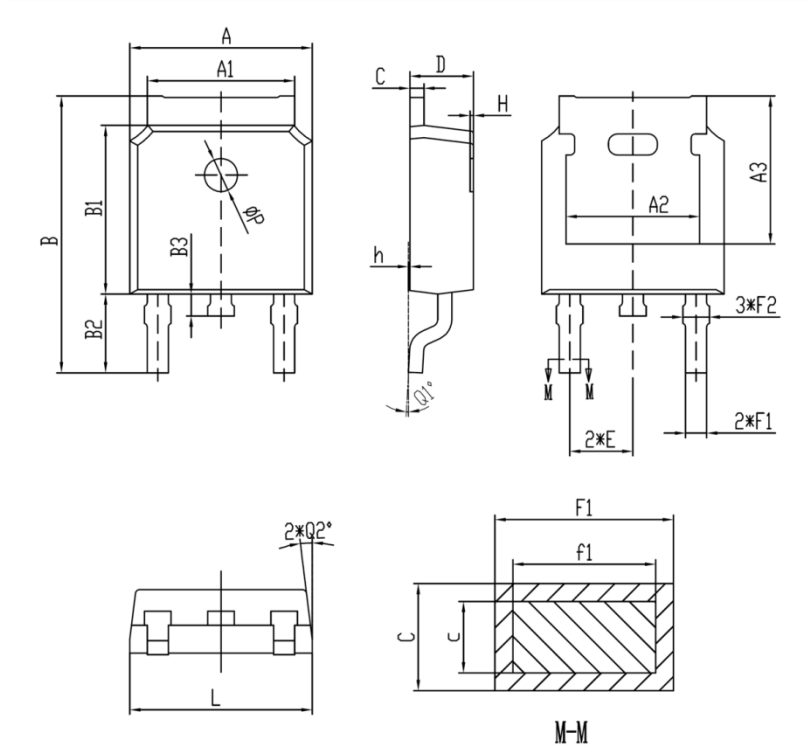
Note:
1. Package Reference: JEDEC TO220, Variation AB.
2. All Dimensions Are In mm.
3. Slot Required, Notch May Be Rounded
4. Dimension D & E Do Not Include Mold Flash. Mold Flash Shall Not Exceed 0.127mm Pre Side. These Dimensions Are Measured At The Outermost Extreme Of The Plastic Body.
5. Thermal Pad Contour Optional Within Dimensions E, H1, D2 & E1.
6. Dimension E2 & H1 Define A Zone Where Stamping And Singulation Irregularities Are Allowed.
7. "*" is reference .

Figure 2 Outline TO-251 Dimensions in mm



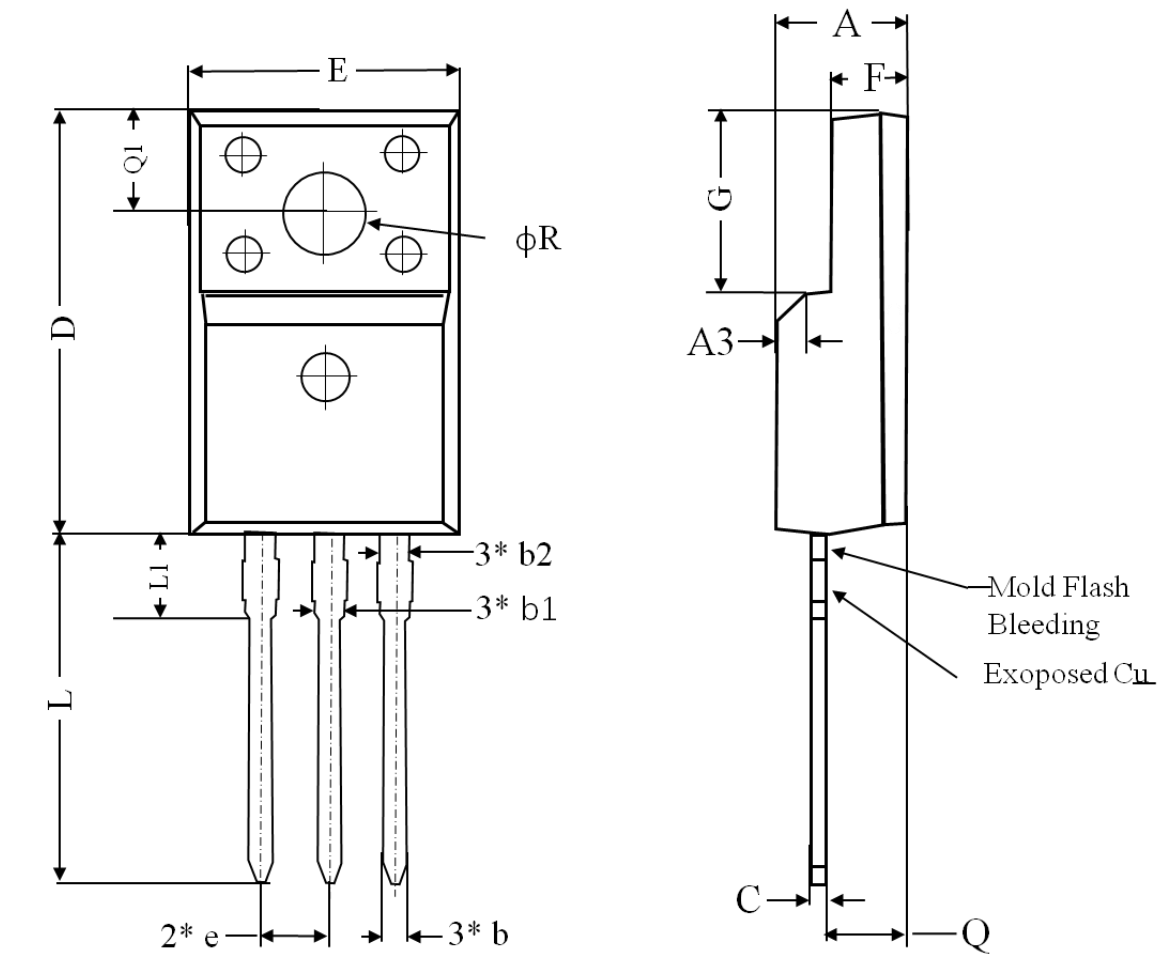
Symbol	Dimensions(mm)		
	Min.	Typ.	Max.
A	2.20	2.30	2.40
A1	0.90	1.01	1.17
b	0.50	-	0.91
b1	-	0.81	-
b2	5.13	5.33	5.46
c	0.46	0.50	0.60
c1	0.46	0.50	0.60
D	5.95	6.10	6.25
E	6.45	6.60	6.75
e		2.286(BSC)	
L	9.00	9.30	9.60
L1	-	2.00	-
L2	0.90	-	1.25
θ1	-	5°	-
θ2	-	3°	-

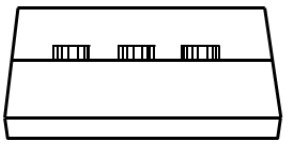
Figure 3 Outline TO-252 Dimensions in mm



SYMBOL	MIN	NOM	MAX
A	6.50	6.60	6.70
A1	5.16	5.31	5.46
A2		4.83 REF	
A3		5.30 REF	
B	9.77	9.97	10.17
B1	6.00	6.10	6.20
B2	2.60	2.80	3.00
B3	0.70	0.80	0.90
C	0.41	—	0.61
c	0.40	0.50	0.60
D	2.20	2.30	2.40
E	2.186	2.286	2.386
F1	0.67	—	0.87
f1	0.66	0.76	0.86
F2	0.76	0.86	0.96
H	0.00	—	0.30
h	0.00	—	0.15
L	6.50	6.60	6.70
øP	1.10	1.20	1.30
Q1°	0°	—	8°
Q2°	6°	7°	8°

Figure 4 Outline TO-220 FullPAK Dimensions in mm





Note:

1. All Dimension Are In mm.
2. Package Body Sizes Exclude Mold Flash And Burrs Mold Flash Should Be less Than 6 Mil.

SYMBOL	DIMENSIONS		
	Min.	Nom.	Max.
A	4.60	4.70	4.80
b	0.70	0.80	0.91
b1	1.20	1.30	1.47
b2	1.10	1.20	1.30
C	0.45	0.50	0.63
D	15.80	15.87	15.97
e		2.54	
E	10.00	10.10	10.30
F	2.44	2.54	2.64
G	6.50	6.70	6.90
L	12.90	13.10	13.30
L1	3.13	3.23	3.33
Q	2.65	2.75	2.85
Q1	3.20	3.30	3.40
Φr	3.08	3.18	3.28

8. Appendix

CoolSemi Webpage: www.coolsemi.com.