

N-Channel Super Junction Power MOSFET III

General Description

The series of devices use advanced trench gate super junction technology and design to provide excellent $R_{DS(ON)}$ with low gate charge. This super junction MOSFET fits the industry's AC-DC SMPS requirements for PFC, AC/DC power conversion, and industrial power applications.

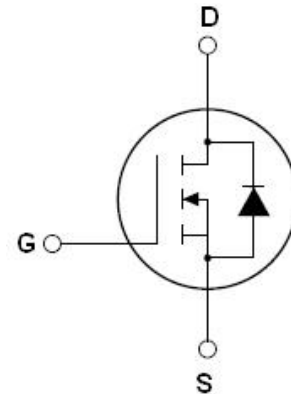
Features

- Optimized body diode reverse recovery performance
- Low on-resistance and low conduction losses
- Small package
- Ultra Low Gate Charge cause lower driving requirements
- 100% Avalanche Tested
- ROHS compliant

Application

- Power factor correction (PFC)
- Switched mode power supplies(SMPS)
- Uninterruptible Power Supply (UPS)
- LLC Half-bridge

V_{DS}	650	V
$R_{DS(ON)TYP}$	89	m Ω
I_D	38	A

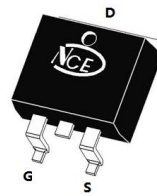


Schematic diagram

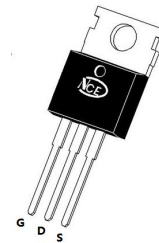
✧ Intrinsic fast-recovery body diode

Package Marking And Ordering Information

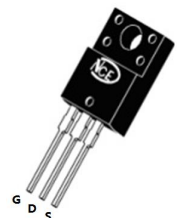
Device	Device Package	Marking
NCE65TF099D	TO-263	NCE65TF099D
NCE65TF099	TO-220	NCE65TF099
NCE65TF099F	TO-220F	NCE65TF099F



TO-263



TO-220



TO-220F

Table 1. Absolute Maximum Ratings ($T_c=25^\circ\text{C}$)

Parameter	Symbol	NCE65TF099D NCE65TF099	NCE65TF099F	Unit
Drain-Source Voltage ($V_{GS}=0V$)	V_{DS}	650		V
Gate-Source Voltage ($V_{DS}=0V$) AC ($f>1$ Hz)	V_{GS}	± 40		V
Continuous Drain Current at $T_c=25^\circ\text{C}$	$I_{D(DC)}$	38	38*	A
Continuous Drain Current at $T_c=100^\circ\text{C}$	$I_{D(DC)}$	24	24*	A
Pulsed drain current (Note 1)	$I_{DM(pluse)}$	152	152*	A
Maximum Power Dissipation($T_c=25^\circ\text{C}$) Derate above 25°C	P_D	322	36	W
		2.58	0.29	
Single pulse avalanche energy (Note 2)	E_{AS}	841		mJ
Avalanche current(Note 1)	I_{AR}	7		A
Repetitive Avalanche energy , t_{AR} limited by T_{jmax} (Note 1)	E_{AR}	3.9		mJ



NCE65TF099D, NCE65TF099, NCE65TF099F

Parameter	Symbol	NCE65TF099D NCE65TF099	NCE65TF099F	Unit
Drain Source voltage slope, $V_{DS} \leq 480V$,	dv/dt	50		V/ns
Reverse diode dv/dt, $V_{DS} \leq 480V, I_{SD} < I_D$	dv/dt	50		V/ns
Operating Junction and Storage Temperature Range	T_J, T_{STG}	-55...+150		°C

* limited by maximum junction temperature

Table 2. Thermal Characteristic

Parameter	Symbol	NCE65TF099D NCE65TF099	NCE65TF099F	Unit
Thermal Resistance, Junction-to-Case (Maximum)	R_{thJC}	0.39	3.47	°C /W
Thermal Resistance, Junction-to-Ambient (Maximum)	R_{thJA}	62	80	°C /W

Table 3. Electrical Characteristics (TA=25°C unless otherwise noted)

Parameter	Symbol	Condition	Min	Typ	Max	Unit
On/off states						
Drain-Source Breakdown Voltage	BV_{DSS}	$V_{GS}=0V, I_D=500\mu A$	650			V
Zero Gate Voltage Drain Current($T_c=25^\circ C$)	I_{DSS}	$V_{DS}=650V, V_{GS}=0V$			3	μA
Zero Gate Voltage Drain Current($T_c=125^\circ C$)	I_{DSS}	$V_{DS}=650V, V_{GS}=0V$			300	μA
Gate-Body Leakage Current	I_{GSS}	$V_{GS}=\pm 20V, V_{DS}=0V$			± 100	nA
Gate Threshold Voltage	$V_{GS(th)}$	$V_{DS}=V_{GS}, I_D=250\mu A$	2.6	3.5	4.3	V
Drain-Source On-State Resistance	$R_{DS(on)}$	$V_{GS}=10V, I_D=19A$		89	109	m Ω
Dynamic Characteristics						
Input Capacitance	C_{iss}	$V_{DS}=50V, V_{GS}=0V,$ $F=1.0MHz$		2800	3200	pF
Output Capacitance	C_{oss}			150		pF
Reverse Transfer Capacitance	C_{rss}			1.5		pF
Total Gate Charge	Q_g	$V_{DS}=480V, I_D=38A,$ $V_{GS}=10V$		45	55	nC
Gate-Source Charge	Q_{gs}			15		nC
Gate-Drain Charge	Q_{gd}			11.5		nC
Intrinsic gate resistance	R_G	$f = 1 MHz, open drain$		2.5		Ω
Switching times						
Turn-on Delay Time	$t_{d(on)}$	$V_{DD}=380V, I_D=19A,$ $R_G=1.7\Omega, V_{GS}=10V$		16		nS
Turn-on Rise Time	t_r			13		nS
Turn-Off Delay Time	$t_{d(off)}$			71		nS
Turn-Off Fall Time	t_f			13		nS
Source- Drain Diode Characteristics						
Source-drain current(Body Diode)	I_{SD}	$T_c=25^\circ C$			38	A
Pulsed Source-drain current(Body Diode)	I_{SDM}				152	A
Forward On Voltage	V_{SD}	$T_J=25^\circ C, I_{SD}=28A, V_{GS}=0V$		0.9	1.2	V
Reverse Recovery Time	t_{rr}	$T_J=25^\circ C, I_F=19A, di/dt=100A/\mu s$		180		nS
Reverse Recovery Charge	Q_{rr}			1.6		μC
Peak Reverse Recovery Current	I_{rrm}			18		A

Notes 1.Repetitive Rating: Pulse width limited by maximum junction temperature

2. $T_J=25^\circ C, V_{DD}=50V, V_G=10V, R_G=25\Omega$

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS (curves)

Figure1. Safe operating area

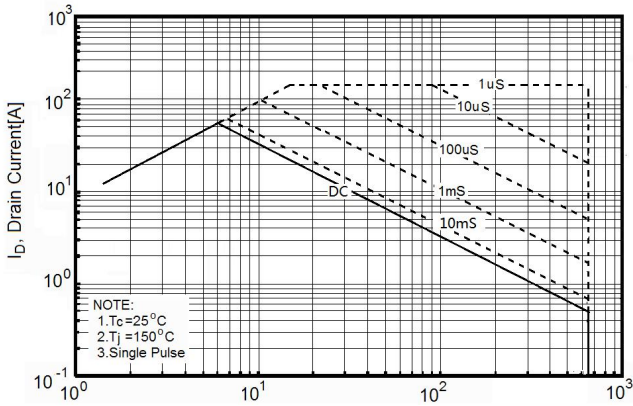


Figure2. Safe operating area for TO-220F

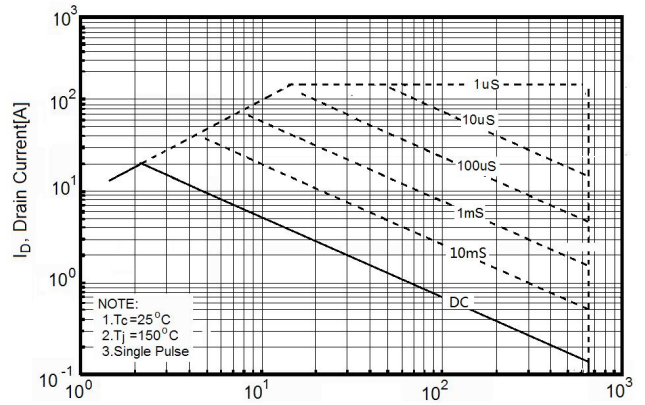


Figure3. Source-Drain Diode Forward Voltage

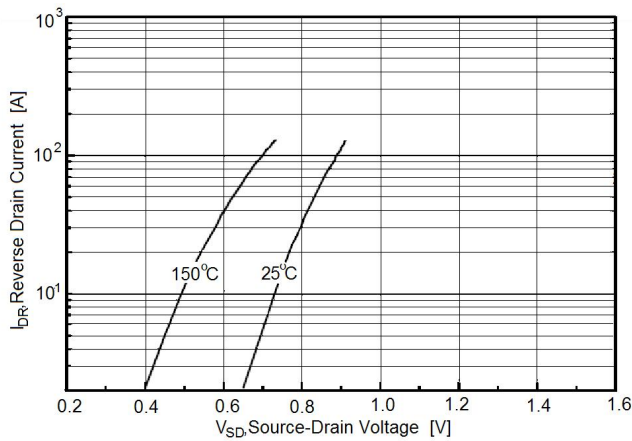


Figure4. Output characteristics

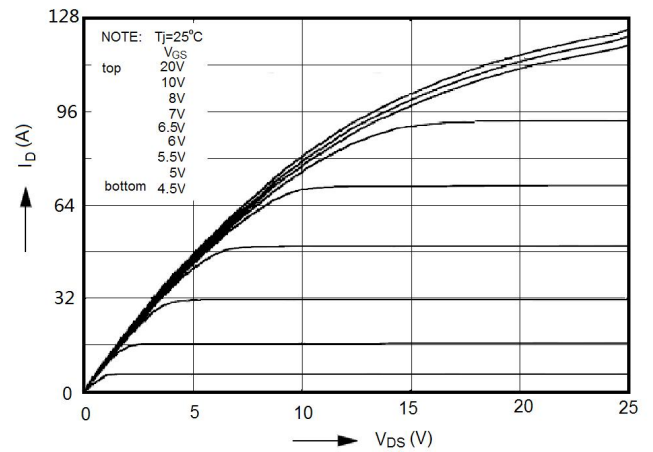


Figure5. Transfer characteristics

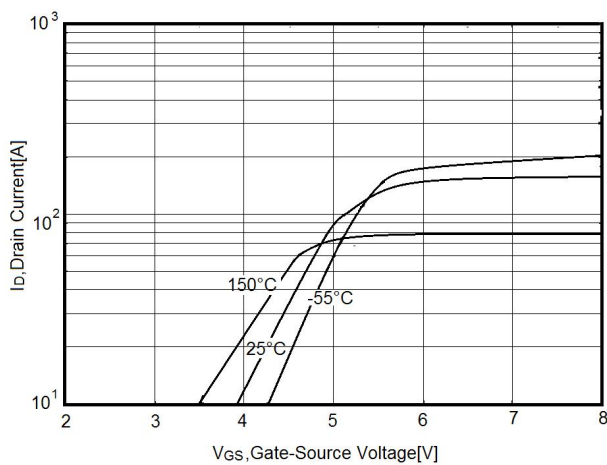


Figure6. Static drain-source on resistance

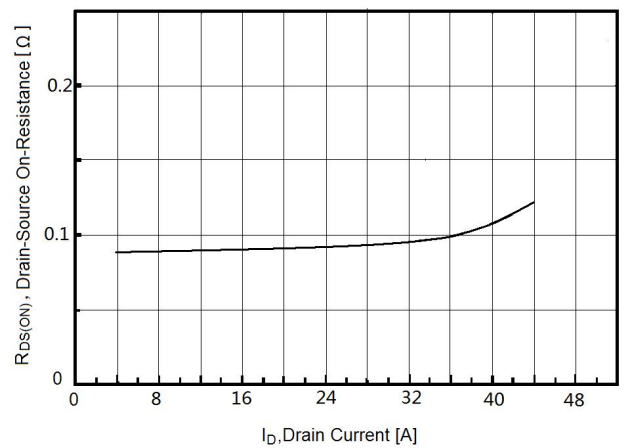


Figure7. $R_{DS(ON)}$ vs Junction Temperature

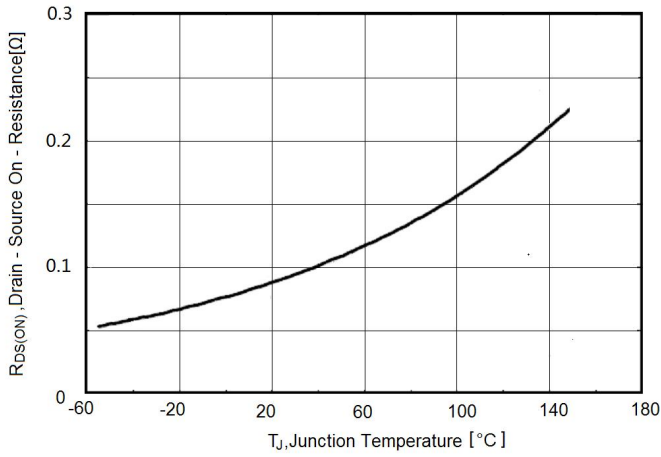


Figure8. BV_{DSS} vs Junction Temperature

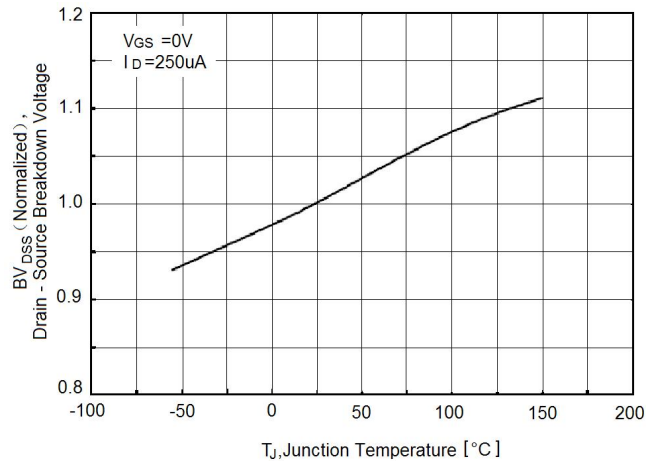


Figure9. Maximum I_D vs Junction Temperature

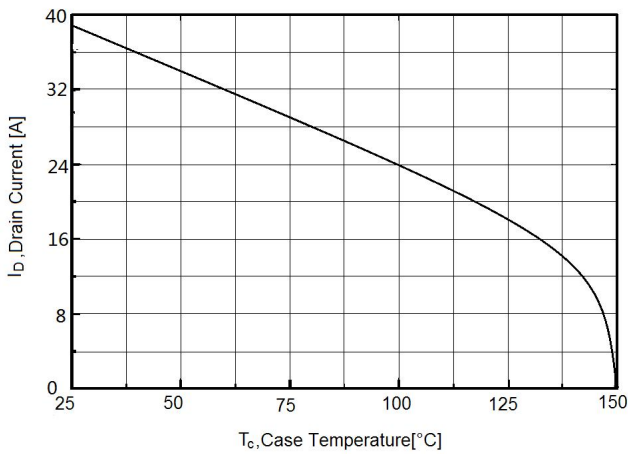


Figure10. Gate charge waveforms

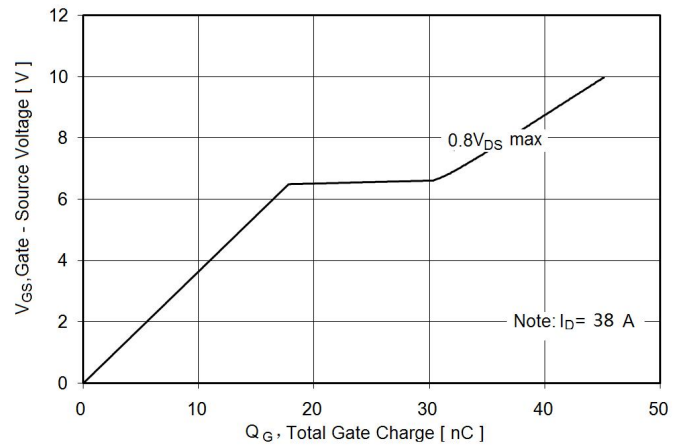
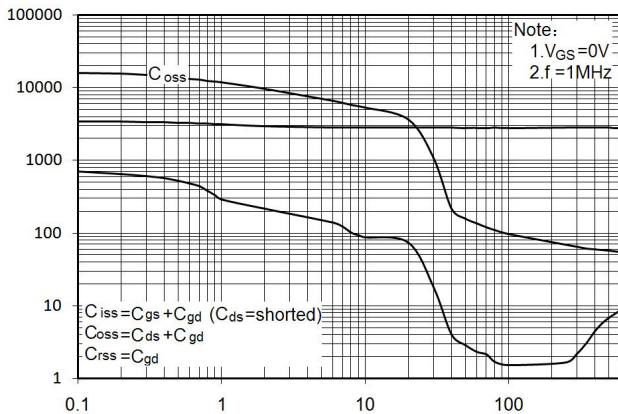
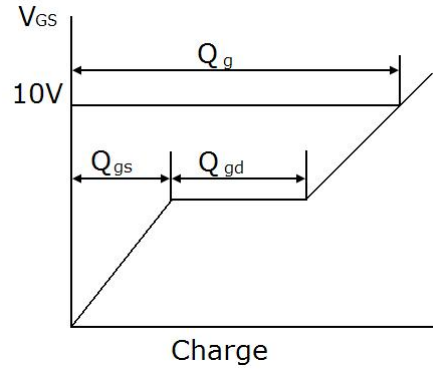
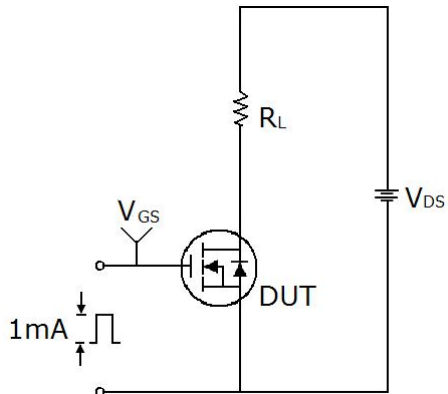


Figure11. Capacitance

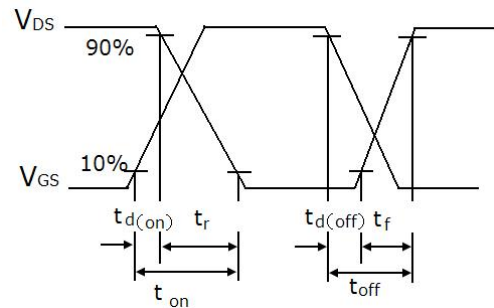
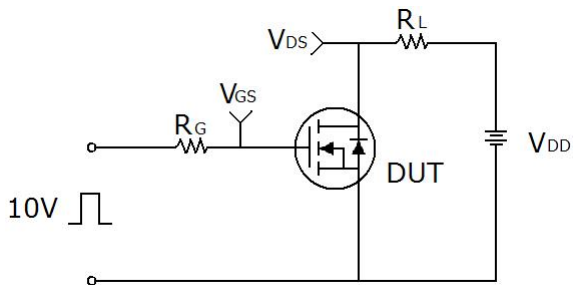


Test circuit

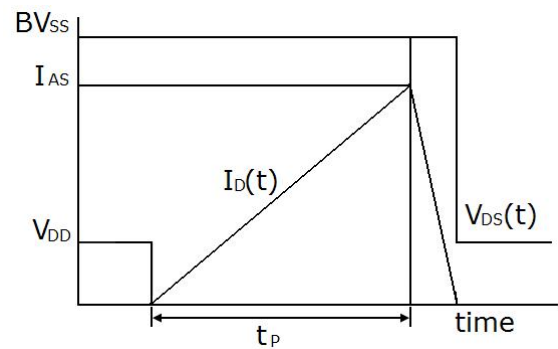
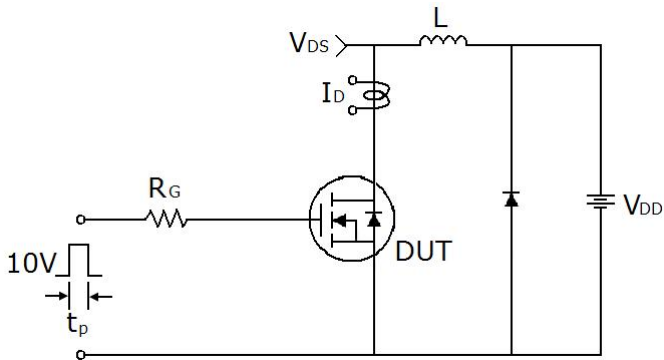
1) Gate charge test circuit & Waveform



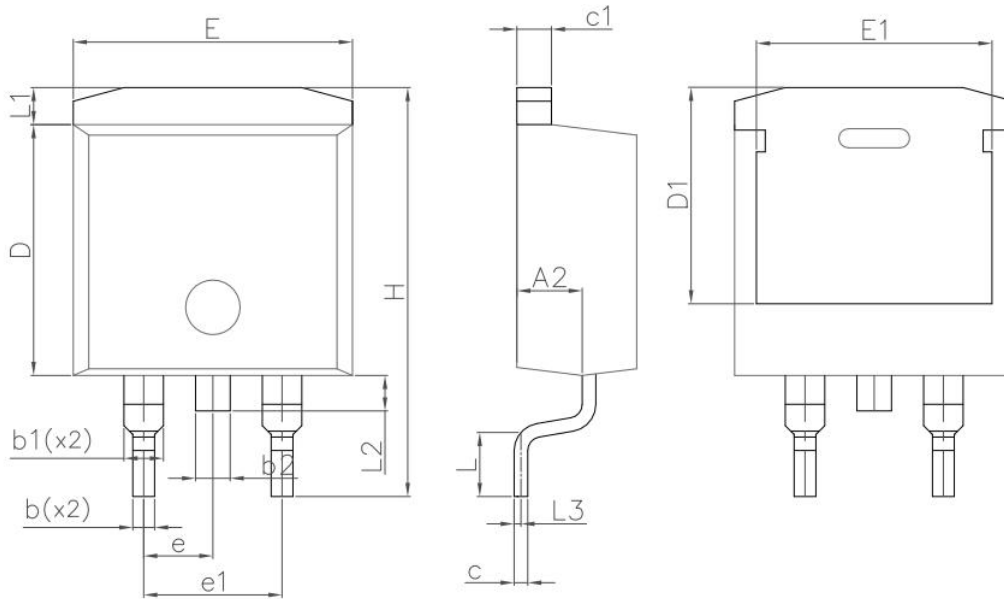
2) Switch Time Test Circuit:



3) Unclamped Inductive Switching Test Circuit & Waveforms

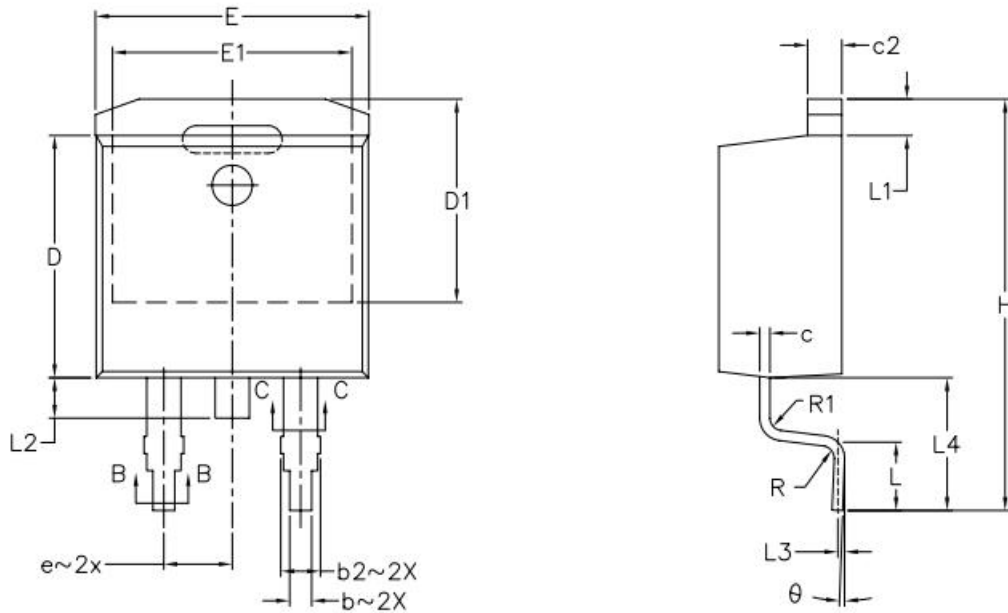


TO-263-2L-E Package Information



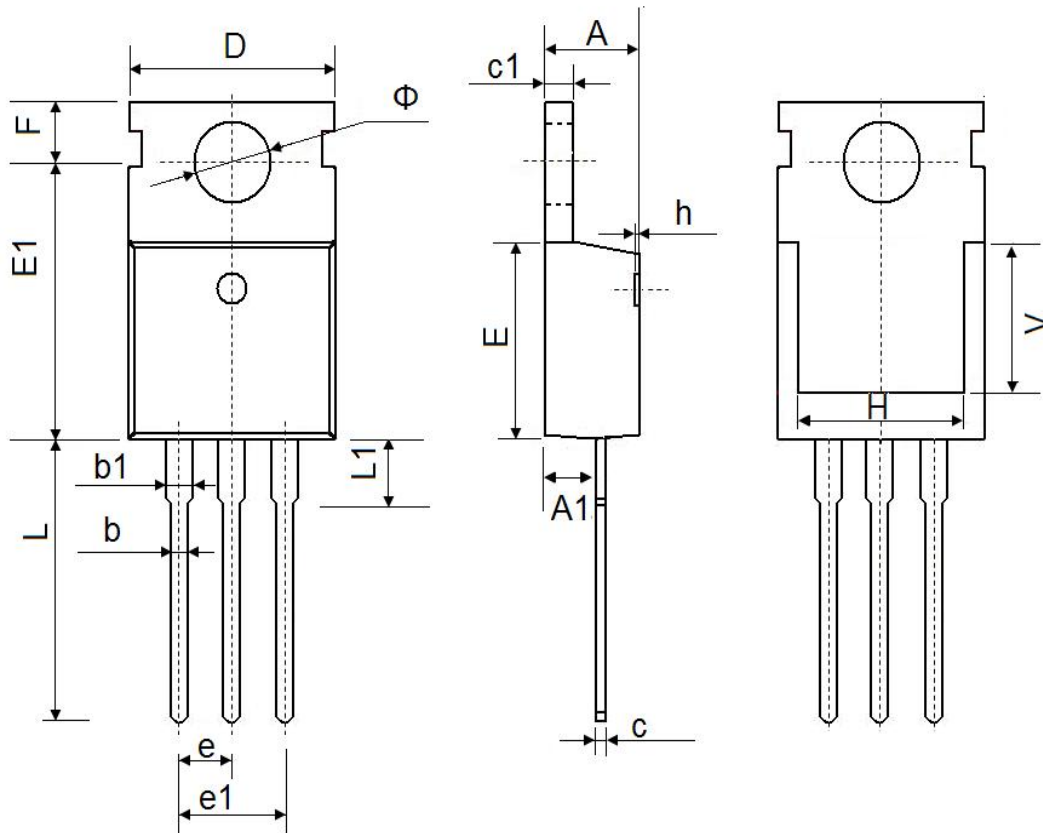
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	4.20	4.60	0.165	0.181
A2	2.20	2.60	0.087	0.102
b	0.70	0.90	0.028	0.035
b1	1.20	1.75	0.047	0.069
b2	1.17	1.37	0.046	0.054
c	0.40	0.60	0.016	0.024
c1	1.15	1.40	0.045	0.055
D	9.10	9.30	0.358	0.366
D1	7.63	8.23	0.300	0.324
E	10.05	10.45	0.396	0.411
E1	8.35	8.95	0.329	0.352
e	2.54BSC		0.100BSC	
e1	5.08BSC		0.200BSC	
H	14.61	15.88	0.575	0.625
L	1.78	2.79	0.070	0.110
L1	1.36REF		0.054REF	
L2	1.30REF		0.051REF	

TO-263-2L-J Package Information



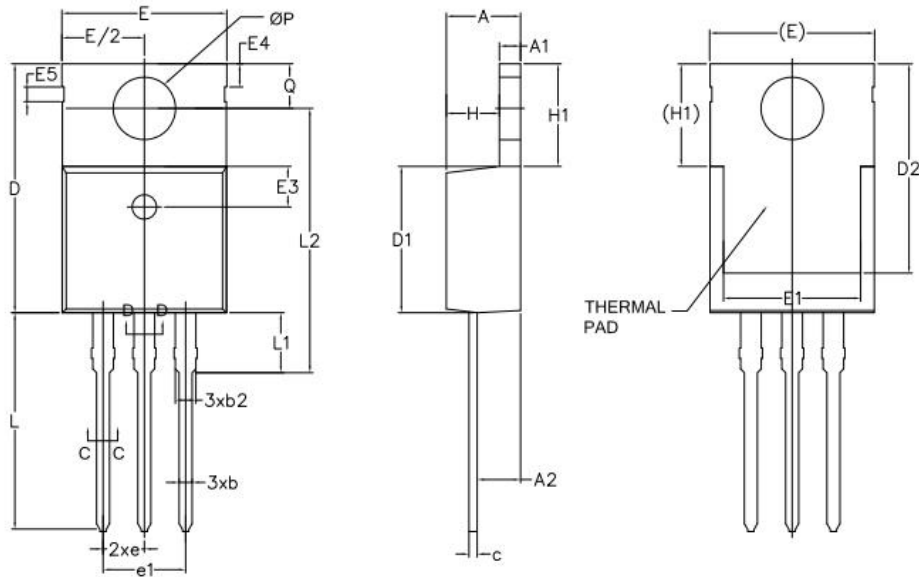
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	4.06	4.83	0.160	0.190
A1	0.00	0.25	0.000	0.010
b	0.51	0.99	0.020	0.039
b1	0.51	0.89	0.020	0.035
b2	1.14	1.78	0.045	0.070
b3	1.14	1.73	0.045	0.068
c	0.38	0.74	0.015	0.029
c1	0.38	0.58	0.015	0.023
c2	1.14	1.65	0.045	0.065
D	8.38	9.65	0.330	0.380
D1	6.86		0.270	
E	9.65	10.00	0.380	0.394
E1	6.22		0.245	
e	2.54BSC		0.100BSC	
H	14.61	15.88	0.575	0.625
L	1.78	2.79	0.070	0.110
L1		1.68		0.066
L2		1.78		0.070
L3	0.25BSC		0.101BSC	
L4	4.78	5.28	0.188	0.208

TO-220-3L-E Package Information



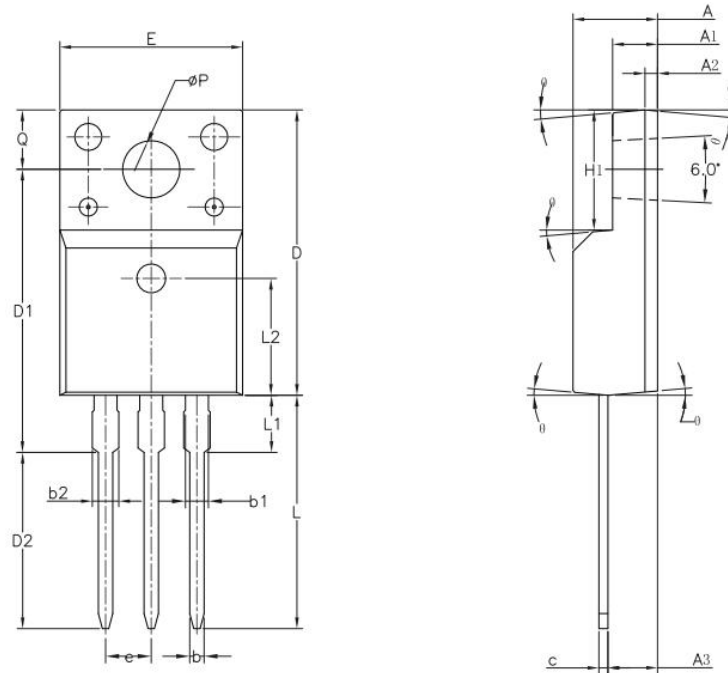
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	4.20	4.60	0.165	0.181
A1	2.25	2.55	0.089	0.100
b	0.70	0.90	0.028	0.035
b1	1.17	1.37	0.046	0.054
c	0.33	0.65	0.013	0.026
c1	1.20	1.40	0.047	0.055
D	8.95	9.75	0.352	0.384
E	9.74	10.04	0.352	0.384
E1	9.91	10.25	0.390	0.404
e	2.54BSC		0.100BSC	
e1	5.08BSC		0.200BSC	
H	15.45	15.85	0.608	0.624
L	12.90	13.40	0.508	0.528
L1	2.85	3.25	0.112	0.128
φ	3.40	3.80	0.134	0.150

TO-220-3L-J Package Information



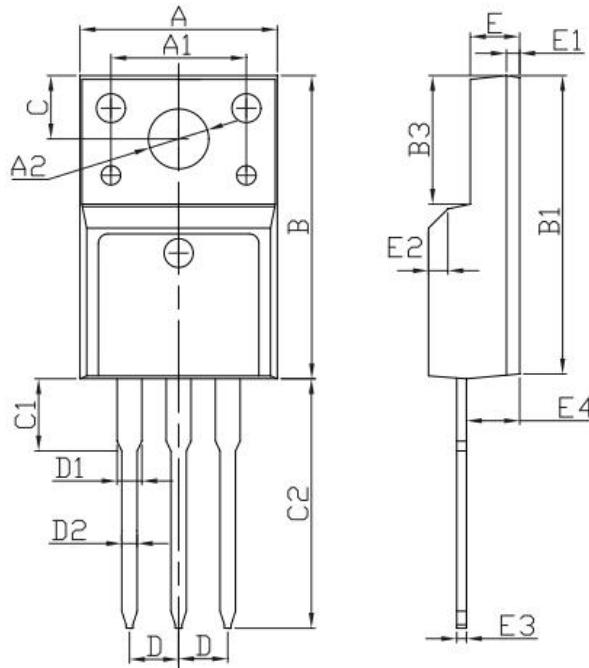
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	4.47	4.67	0.176	0.184
A1	1.20	1.40	0.047	0.055
A2	2.35	2.90	0.093	0.114
b	0.71	0.91	0.028	0.036
b1	0.71	0.86	0.028	0.034
b2	1.22	1.36	0.048	0.054
c	0.47	0.60	0.019	0.024
c1	0.47	0.55	0.019	0.022
D	14.70	15.80	0.579	0.622
D1	8.90	9.47	0.350	0.373
D2	11.75	13.60	0.463	0.535
E	9.70	10.37	0.382	0.408
E1	7.00	8.89	0.276	0.350
E2	9.80	10.20	0.386	0.402
E3	2.40	2.60	0.094	0.102
E4	1.27	1.57	0.050	0.062
e	2.54BSC		0.100BSC	
e1	5.08BSC		0.200BSC	
H	3.00	3.40	0.118	0.134
L	12.90	14.80	0.508	0.583
L1	2.54	3.84	0.100	0.151
L2	12.13	16.50	0.478	0.650
ΦP	3.60	3.90	0.142	0.154
Q	4.60	4.90	0.181	0.193

TO-220F-3L-P Package Information



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	4.50	4.83	0.177	0.190
A1	2.34	2.74	0.092	0.108
A2	0.70 REF		0.028 REF	
A3	2.56	2.93	0.101	0.115
b	0.70	0.90	0.028	0.035
b1	1.18	1.38	0.046	0.054
b2	--	1.47	--	0.058
c	0.45	0.60	0.018	0.024
D	15.67	16.07	0.616	0.631
D1	15.55	15.95	0.611	0.627
D2	9.60	10.00	0.377	0.393
E	9.96	10.36	0.391	0.407
e	2.54 BSC		0.100 BSC	
H1	6.48	6.88	0.255	0.270
L	12.68	13.28	0.498	0.522
L1	--	3.50	--	0.138
L2	6.50 REF		0.255 REF	
$\varnothing P$	3.08	3.28	0.121	0.129
Q	3.20	3.40	0.126	0.134
$\theta 1$	1.0°	5.0°	1.00°	5.00°

TO-220F-3L-L Package Information



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	9.86	10.46	0.387	0.411
A1	6.80	7.20	0.267	0.283
A2	2.92	3.32	0.115	0.130
A3	9.40	10.00	0.369	0.393
B	15.40	16.40	0.605	0.644
B1	15.10	16.10	0.593	0.633
B2	4.40	5.00	0.173	0.196
B3	6.40	7.00	0.251	0.275
C	3.05	3.55	0.120	0.139
C1	2.95	3.55	0.116	0.139
C2	28.20	29.20	1.108	1.147
D	2.54 BSC		0.100 BSC	
D1	--	1.47	--	0.058
D2	0.60	1.00	0.024	0.039
E	2.30	2.80	0.090	0.110
E1	0.45	0.95	0.018	0.037
E2	45.0°		45.00°	
E3	0.30	0.70	0.012	0.028
E4	2.45	3.05	0.096	0.120



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