

## N-Channel Super Junction Power MOSFET IV

### 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.

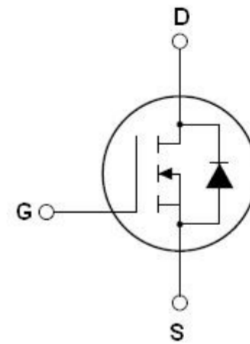
### Features

- 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

$V_{DS\ min@T_{jmax}}$	710	V
$R_{DS(ON)TYP}$	460	mΩ
$I_D$	8	A
$Q_g$	12.8	nC



Schematic diagram

### Package Marking And Ordering Information

Device	Device Package	Marking
NCE65N520F	TO-220F-3L	NCE65N520F



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

Parameter	Symbol	Value	Unit
Drain-Source Voltage ( $V_{GS}=0V$ )	$V_{DS}$	650	V
Gate-Source Voltage ( $V_{DS}=0V$ ) AC ( $f>1\text{ Hz}$ )	$V_{GS}$	$\pm 30$	V
Gate-Source Voltage ( $V_{DS}=0V$ ) DC	$V_{GS}$	$\pm 20$	V
Continuous Drain Current at $T_c=25^\circ\text{C}$	$I_{D(DC)}$	8	A
Continuous Drain Current at $T_c=100^\circ\text{C}$	$I_{D(DC)}$	5.6	A
Pulsed drain current (Note 1)	$I_{DM(pluse)}$	24	A
Maximum Power Dissipation( $T_c=25^\circ\text{C}$ )	$P_D$	31.6	W
Derate above $25^\circ\text{C}$		0.21	W/ $^\circ\text{C}$
Avalanche current(Note 2)	$I_{AS}$	2.5	A
Drain Source voltage slope, $V_{DS} \leq 480\text{ V}$ ,	$dv/dt$	50	V/ns
Reverse diode $dv/dt$ , $V_{DS} \leq 480\text{ V}, I_{SD} < I_D$	$dv/dt$	15	V/ns
Operating Junction and Storage Temperature Range	$T_J, T_{STG}$	-55...+175	$^\circ\text{C}$

\* limited by maximum junction temperature

**Table 2. Thermal Characteristic**

Parameter	Symbol	Value	Unit
Thermal Resistance, Junction-to-Case (Maximum)	$R_{thJC}$	4.74	$^{\circ}\text{C}/\text{W}$
Thermal Resistance, Junction-to-Ambient (Maximum)	$R_{thJA}$	62	$^{\circ}\text{C}/\text{W}$

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

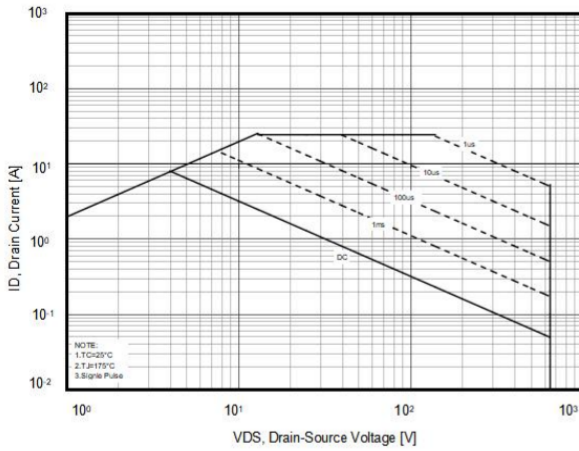
Parameter	Symbol	Condition	Min	Typ	Max	Unit
<b>On/off states</b>						
Drain-Source Breakdown Voltage	$BV_{DSS}$	$V_{GS}=0V, I_D=250\mu A$	650			V
Zero Gate Voltage Drain Current(Tc=25°C)	$I_{DSS}$	$V_{DS}=650V, V_{GS}=0V$			1	$\mu A$
Zero Gate Voltage Drain Current(Tc=125°C)	$I_{DSS}$	$V_{DS}=650V, V_{GS}=0V$			100	$\mu A$
Gate-Body Leakage Current	$I_{GSS}$	$V_{GS}=\pm 20V, V_{DS}=0V$			$\pm 200$	nA
Gate Threshold Voltage	$V_{GS(th)}$	$V_{DS}=V_{GS}, I_D=250\mu A$	3	3.5	4	V
Drain-Source On-State Resistance	$R_{DS(on)}$	$V_{GS}=10V, I_D=4A$		460	530	m $\Omega$
<b>Dynamic Characteristics</b>						
Input Capacitance	$C_{iss}$	$V_{DS}=50V, V_{GS}=0V,$ $F=1.0\text{MHz}$		532		pF
Output Capacitance	$C_{oss}$			21		pF
Reverse Transfer Capacitance	$C_{rss}$			3.5		pF
Total Gate Charge	$Q_g$	$V_{DS}=480V, I_D=4A,$ $V_{GS}=10V$		12.8		nC
Gate-Source Charge	$Q_{gs}$			1.9		nC
Gate-Drain Charge	$Q_{gd}$			6		nC
Gate plateau voltage	$V_{gp}$			4.9		V
Intrinsic gate resistance	$R_G$	$f = 1 \text{ MHz open drain}$		35		$\Omega$
<b>Switching times</b>						
Turn-on Delay Time	$t_{d(on)}$	$V_{DD}=480V, I_D=4A,$ $R_G=1.7\Omega, V_{GS}=10V$		9		nS
Turn-on Rise Time	$t_r$			6		nS
Turn-Off Delay Time	$t_{d(off)}$			52		nS
Turn-Off Fall Time	$t_f$			7		nS
<b>Source- Drain Diode Characteristics</b>						
Source-drain current(Body Diode)	$I_{SD}$	$T_C=25^{\circ}\text{C}$			8	A
Pulsed Source-drain current(Body Diode)	$I_{SDM}$				24	A
Forward On Voltage	$V_{SD}$	$T_j=25^{\circ}\text{C}, I_{SD}=8A, V_{GS}=0V$		0.9	1.2	V
Reverse Recovery Time	$t_{rr}$	$T_j=25^{\circ}\text{C}, I_F=4A,$ $di/dt=100A/\mu s$		190		nS
Reverse Recovery Charge	$Q_{rr}$			1.34		$\mu\text{C}$
Peak Reverse Recovery Current	$I_{rm}$			14		A

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

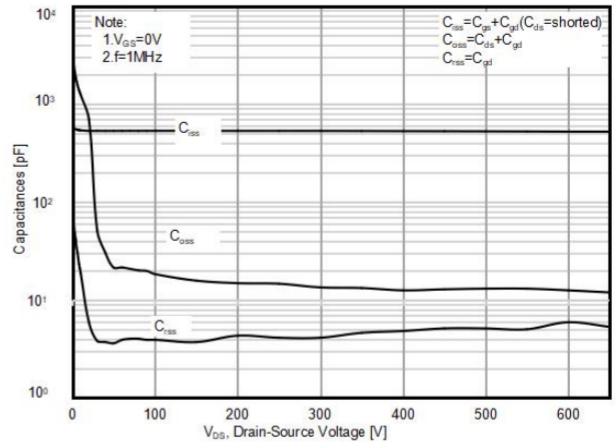
2.  $T_j=25^{\circ}\text{C}, V_{DD}=50V, V_G=10V, R_G=25\Omega$

## TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS (curves)

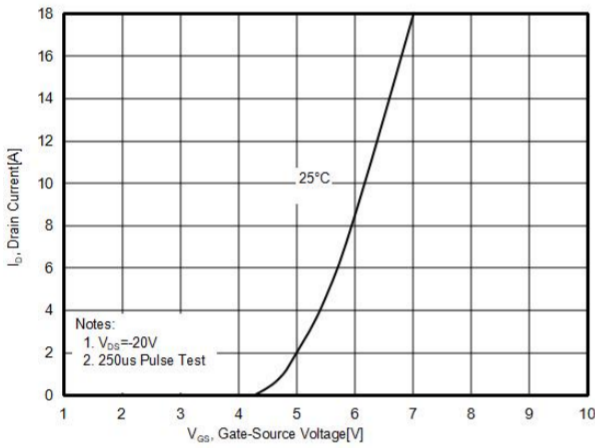
**Figure1. Safe operating area**



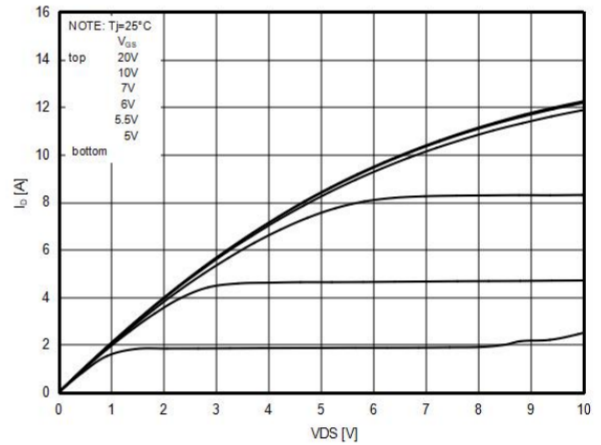
**Figure2. Capacitance**



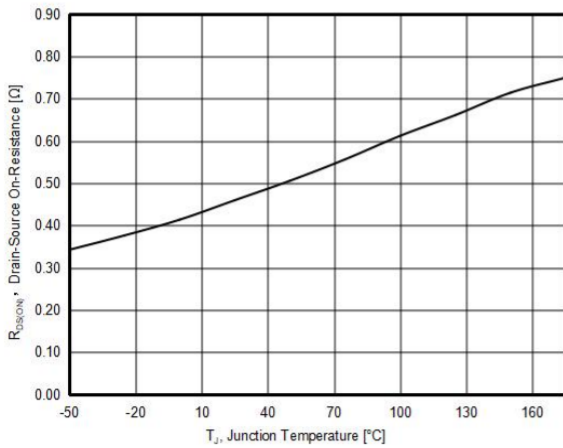
**Figure3. Transfer characteristics**



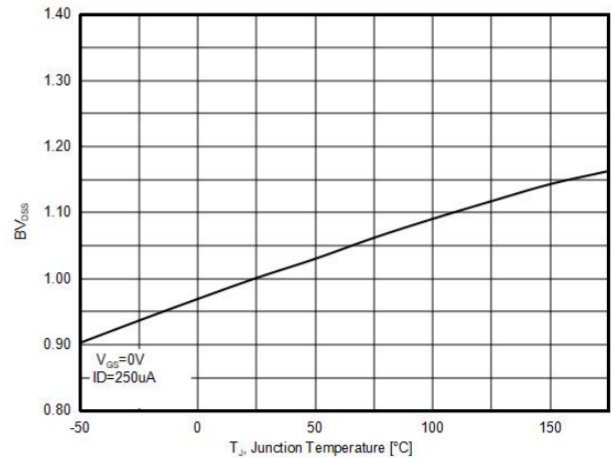
**Figure4. Output characteristics**



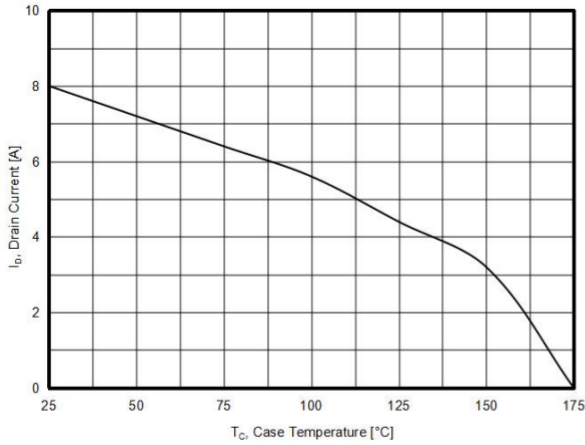
**Figure5. RDS(ON) vs Junction Temperature**



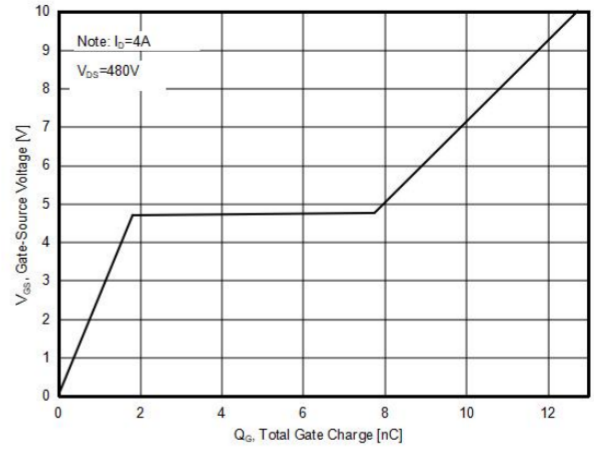
**Figure6. BVDS vs Junction Temperature**



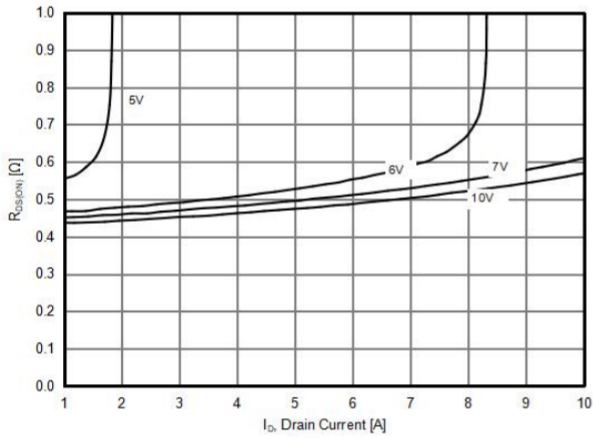
**Figure7. Maximum  $I_D$  vs Junction Temperature**



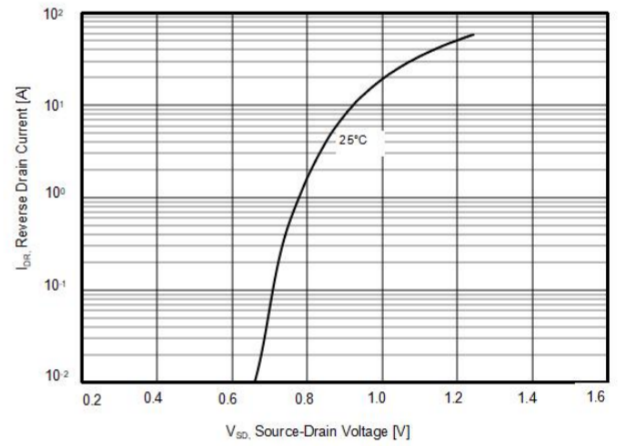
**Figure8. Gate charge waveforms**



**Figure9. Static drain-source on resistance**

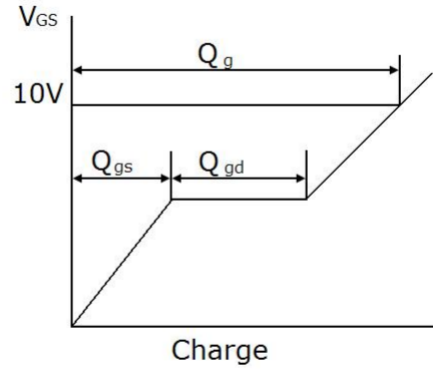
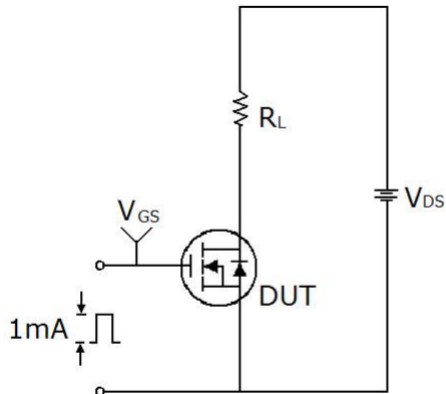


**Figure10. Source-Drain Diode Forward Voltage**

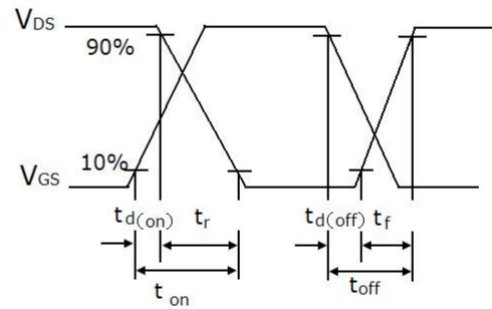
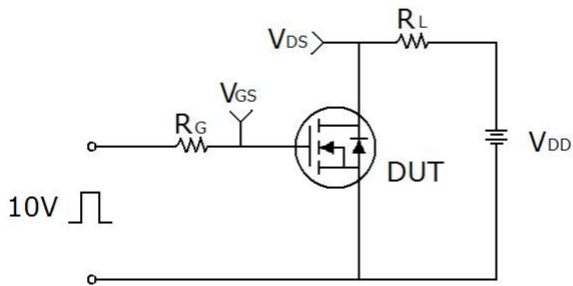


## Test circuit

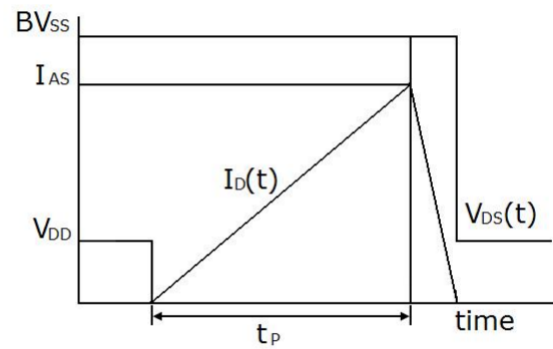
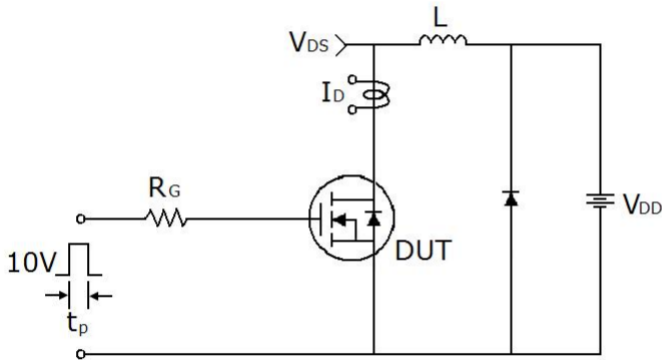
### 1) Gate charge test circuit & Waveform



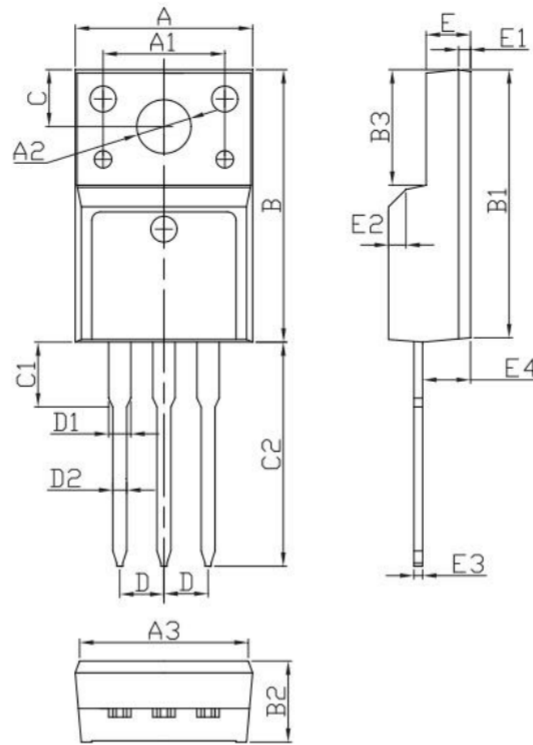
### 2) Switch Time Test Circuit:



### 3) Unclamped Inductive Switching Test Circuit & Waveforms

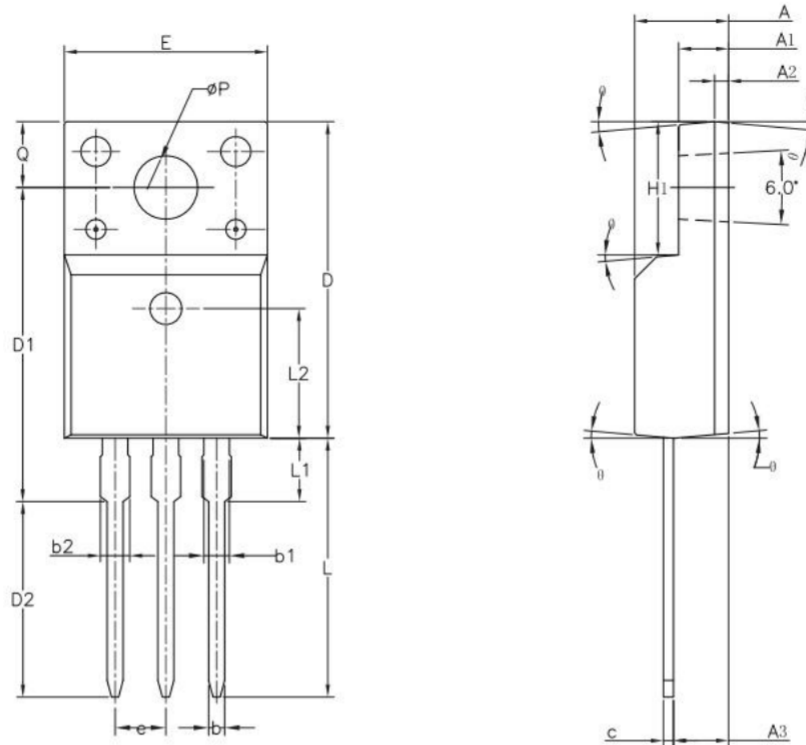


## TO-220F-3L-L Package Information



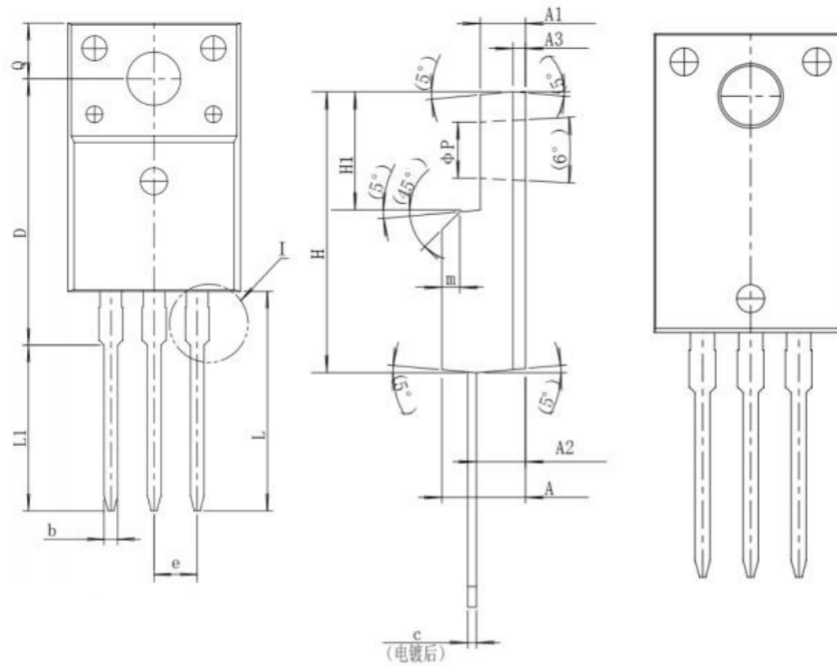
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	9.96	10.36	0.391	0.407
A1	6.85	7.15	0.269	0.281
A2	2.97	3.27	0.117	0.128
A3	9.50	9.90	0.373	0.389
B	15.70	16.10	0.617	0.633
B1	15.40	15.80	0.605	0.621
B2	4.50	4.90	0.177	0.193
B3	6.50	6.90	0.255	0.271
C	3.10	3.50	0.122	0.138
C1	3.05	3.45	0.120	0.136
C2	12.80	13.20	0.503	0.519
D	2.54 BSC		0.100 BSC	
D1	1.13	1.43	0.044	0.056
D2	0.65	0.95	0.026	0.037
E	2.35	2.75	0.092	0.108
E1	0.55	0.85	0.022	0.033
E2	45.0°		45.00°	
E3	0.35	0.65	0.014	0.026
E4	2.55	2.95	0.100	0.116

# TO-220F-3L-P Package Information



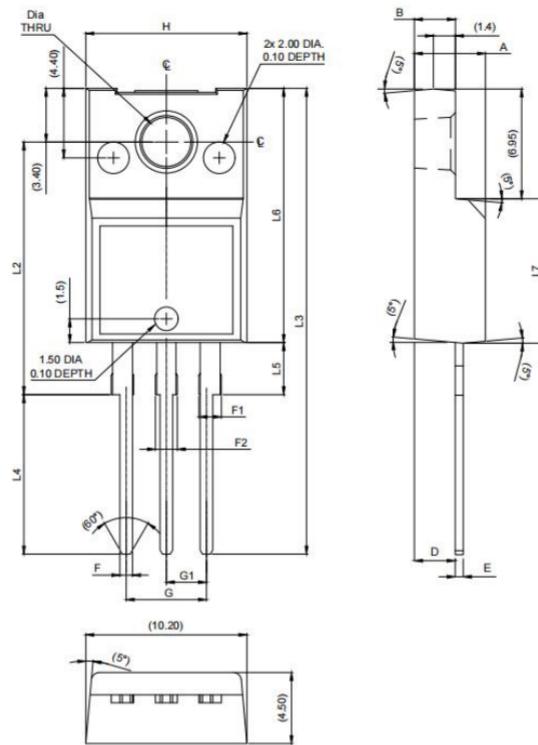
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	4.50	4.83	0.177	0.190
A1	2.34	2.74	0.092	0.108
A2	0.70 REF		0.028 REF	
A3	2.56	2.93	0.101	0.115
b	0.70	0.90	0.028	0.035
b1	1.18	1.38	0.046	0.054
b2	--	1.47	--	0.058
c	0.45	0.60	0.018	0.024
D	15.67	16.07	0.616	0.631
D1	15.55	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	
$\phi P$	3.08	3.28	0.121	0.129
Q	3.20	3.40	0.126	0.134

## TO-220F-3L-M Package Information



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	4.60	4.80	0.181	0.189
A1	2.44	2.64	0.096	0.104
A2	2.65	2.85	0.104	0.112
A3	0.70 REF		0.028 REF	
b	0.70	0.90	0.028	0.035
b2	1.18	1.39	0.046	0.055
b1	1.28	1.47	--	0.058
c	0.45	0.60	0.018	0.024
D	15.64	15.85	0.614	0.623
E	10.06	10.26	0.395	0.403
e	2.54 BSC		0.100 BSC	
H	15.77	15.97	0.620	0.627
H1	6.58	6.78	0.259	0.266
L	12.68	13.28	0.498	0.522
L1	9.60	10.00	0.377	0.393
$\phi P$	3.08	3.28	0.121	0.129
Q	3.20	3.40	0.126	0.134

## TO-220F-3L-B Package Information



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	4.40	4.60	0.173	0.181
B	2.50	2.70	0.098	0.106
D	2.50	2.75	0.098	0.108
E	0.45	0.70	0.018	0.028
F	0.75	1.00	0.029	0.039
F1	1.15	1.50	0.045	0.059
F2	1.15	1.50	0.045	0.059
G	4.95	5.20	0.19	0.20
G1	2.40	2.70	0.09	0.11
H	10.00	10.40	0.39	0.41
L2	16.00		0.63	
L3	28.60	30.60	1.12	1.20
L4	9.80	10.60	0.39	0.42
L5	2.90	3.60	0.11	0.14
L6	15.90	16.40	0.62	0.64
L7	9.00	9.30	0.35	0.37
Dia	3.00	3.20	0.12	0.13

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