

## N-Channel Enhancement Mode Power MOSFET

### Description

SMIRF4N65 is an N-channel enhancement mode power MOS field effect transistor. The improved planar stripe cell and the improved guard ring terminal have been especially tailored to minimize on-state resistance, provide superior switching performance, and withstand high energy pulse in the avalanche and commutation mode.

These devices are widely used in AC-DC power suppliers, DC/DC converters and H-bridge PWM motor drivers.

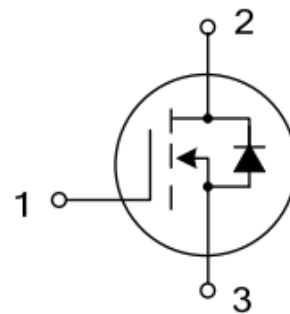
### General Features

- 4A, 650V,  $R_{DS(on)}$ (typ.)= 2.3ohm@ $V_{GS}=10V$
- Low Gate charge
- Low  $C_{rss}$
- Fast Switching
- Improved dv/dt Capability

### Application

- Power switching application
- Hard switched and high frequency circuits
- Uninterruptible power supply

$I_D$	4A
$V_{DSS}$	650V
$R_{dson (max)}$	2.8Ω( $V_{GS}=10V, I_D=2A$ )
$Q_g$	13.7nC



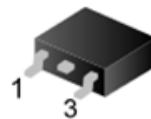
1.Gate 2.Drain 3.Source



TO-220



TO-220F



TO-252



TO-251

**Order Information**

Order Information	Marking ID	Package	Packing Type Supplied As
SMIRF4N65TBRL	IRF4N65	TO251-3L	2400 Units on Box
SMIRF4N65T9RL	IRF4N65	TO252-2L	3000 Units on Reel
SMIRF4N65T2TL	IRF4N65	TO220F-3L	1000 units on Box, 5000 units on Carton
SMIRF4N65T1TL	IRF4N65	TO220-3L	1000 units on Box, 5000 units on Carton

**Absolute Maximum Ratings Ta=25 °C unless otherwise noted**

Parameter	Symbol	Value	Unit
Drain-source Voltage	$V_{DS}$	650	V
Gate-source Voltage	$V_{GS}$	$\pm 30$	V
Continuous Drain Current(Ta=25°C)	$I_D$	4	A
Drain Current-Pulsed	$I_{DM}$	16	A
Total Dissipation (Ta=25°C)	TO251	55	W
	TO252	50	
	TO220	30	
	TO220F	30	
Junction Temperature	$T_J$	150	°C
Storage Temperature	$T_{STG}$	-65 to 150	°C
Single Pulse Avalanche Energy	$E_{AS}$	130	mJ
ESD HBM(Human Body Mode)		$\geq 2000$	V
ESD MM(Machine Mode)		$\geq 200$	V

**Electrical Characteristics Ta = 25°C**

PARAMETER	Symbol	Test Condition	MIN	TYP	MAX	UNIT
Drain-source Breakdown Voltage	$BV_{DSS}$	$V_{GS}=0V, I_D=250\mu A$	650			V
Gate Threshold Voltage	$V_{GS(TH)}$	$V_{GS}=V_{DS}, I_D=250\mu A$	2.0		4.0	V
Drain-source Leakage Current	$I_{DSS}$	$V_{DS}=650V, V_{GS}=0V$			25	$\mu A$
Drain-Source Diode Forward Voltage	$V_{SD}$	$V_{GS}=0V, I_S=4A$			1.4	V
Gate-body Leakage Current ( $V_{DS} = 0$ )	$I_{GSS}$	$V_{GS}=\pm 30V$			$\pm 100$	nA
Static Drain-source On Resistance	$R_{DS(ON)}$	$V_{GS}=10V, I_D=2A$		2.3	2.8	$\Omega$

## Thermal Characteristics Ta=25°C

PARAMETER		Symbol	TYP	MAX	UNIT
Maximum Junction-to-case (note1)	TO251,TO252	R <sub>QJC</sub>		2.5	°C/W
	TO220F,TO220			3	
Maximum Junction-to-Ambient	TO251,TO252	R <sub>QJA</sub>		63	°C/W
	TO220F,TO220			80	

**Note1:** Surface Mounted on FR4 Board, t ≤ 10 sec

## Dynamic Characteristics Ta = 25 °C

PARAMETER	Symbol	Test Condition	MIN	TYP	MAX	UNIT
Input Capacitance	C <sub>iss</sub>	V <sub>DS</sub> =25V, V <sub>GS</sub> =0V, f=1.0MHZ		610		pF
output Capacitance	C <sub>oss</sub>			62	85	pF
Reverse Transfer Capacitance	C <sub>rss</sub>			7	10	pF

## Switching Characteristics Ta=25 °C

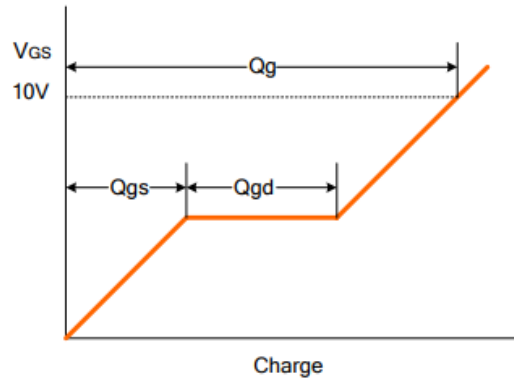
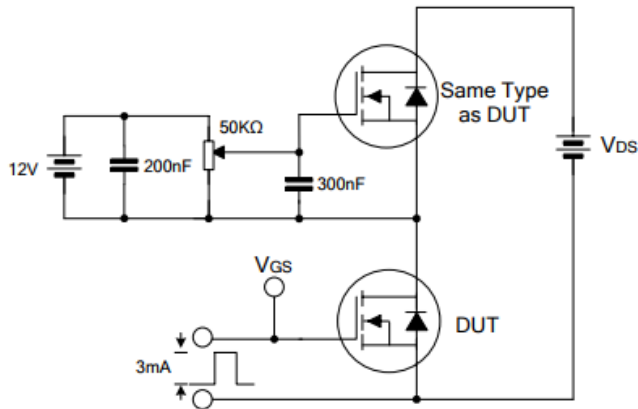
PARAMETER	Symbol	Test Condition	MIN	TYP	MAX	UNIT
Turn-On Delay Time	T <sub>d(on)</sub>	V <sub>DS</sub> =300V, I <sub>D</sub> =4A, R <sub>G</sub> =25Ω		20	40	nS
Turn-On Rise Time	T <sub>r</sub>			30	70	nS
Turn-Off Delay Time	T <sub>d(off)</sub>			25	100	nS
Turn-Off Rise Time	T <sub>f</sub>			35	85	nS
Total Gate Charge	Q <sub>g</sub>	V <sub>DS</sub> =160V, I <sub>D</sub> =4A, V <sub>GS</sub> =10V		13.7		nC
Gate-Source Charge	Q <sub>gs</sub>			2.9		nC
Gate-Drain Charge	Q <sub>gd</sub>			4.6		nC

## Drain-Source Diode Maximum Ratings and Characteristics Ta=25 °C

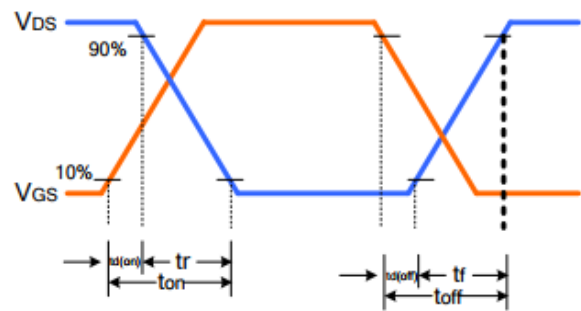
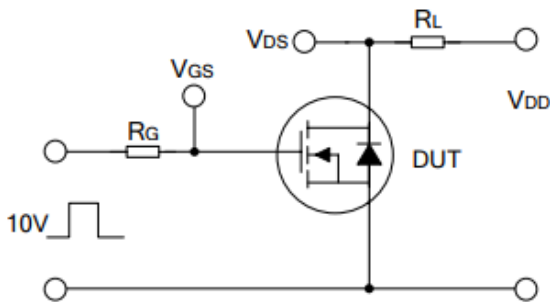
PARAMETER	Symbol	Test Condition	MIN	TYP	MAX	UNIT
Max. Diode Forward Current	I <sub>s</sub>	Integral Reverse P-N Junction Diode in the MOSFET			4	A
Pulsed Source Current	I <sub>sm</sub>				16	
Diode Forward Voltage	V <sub>SD</sub>	V <sub>GS</sub> =0V, I <sub>s</sub> =4A			1.4	V
Reverse Recovery Time	T <sub>rr</sub>	V <sub>GS</sub> =0V, I <sub>s</sub> =4A, dI <sub>F</sub> /dt=100A/μs		390		nS
Reverse Recovery Charge	Q <sub>rr</sub>				1.5	

## Test Circuit

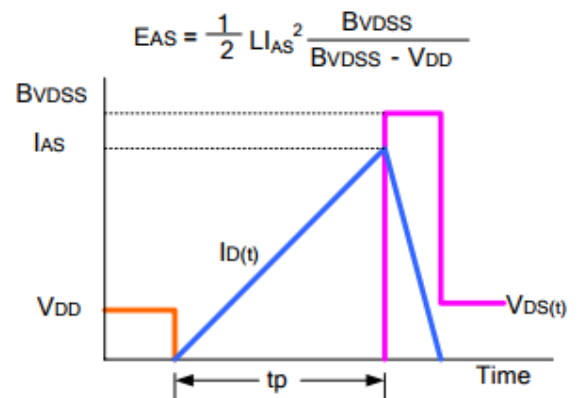
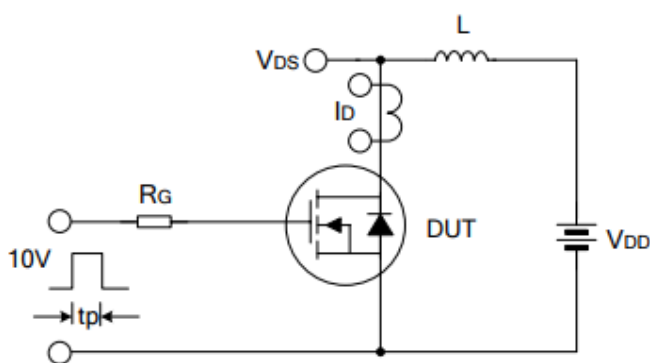
### Gate Charge Test Circuit & Waveform



### Resistive Switching Test Circuit & Waveform



### Unclamped Inductive Switching Test Circuit & Waveform



## Typical Electrical And Thermal Characteristics

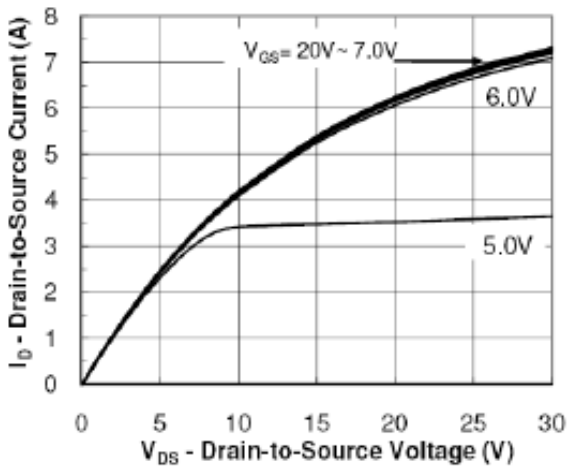


Figure 1: Output Characteristics

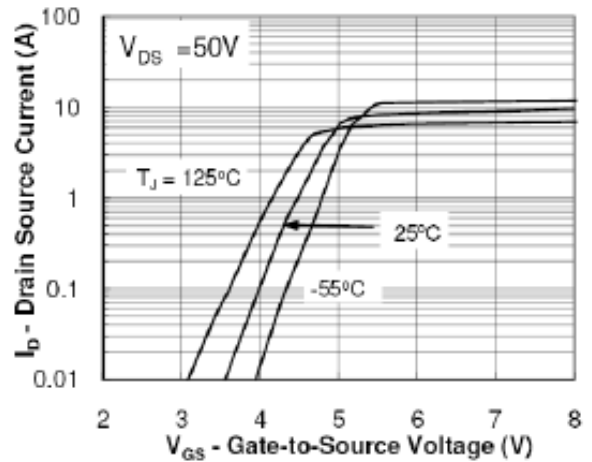


Figure 2: Transfer Characteristics

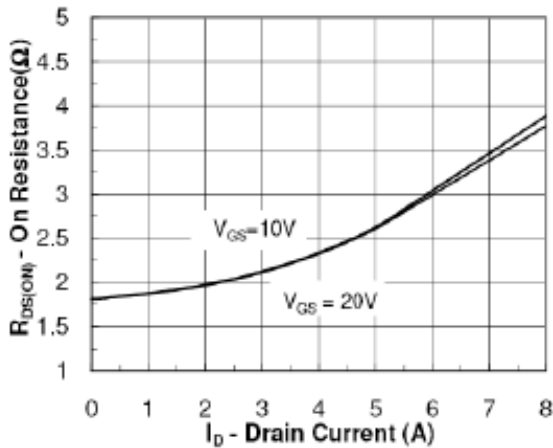


Figure 3: On Resistance Vs Drain Current

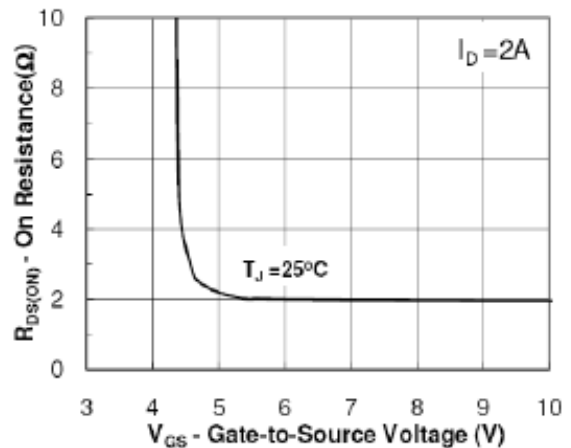


Figure 4: On Resistance Vs Gate Source Voltage

Source Voltage

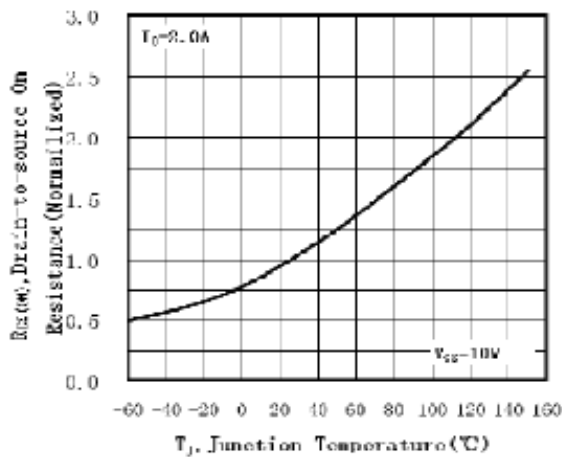


Figure 5: On Resistance Vs Junction Temperature

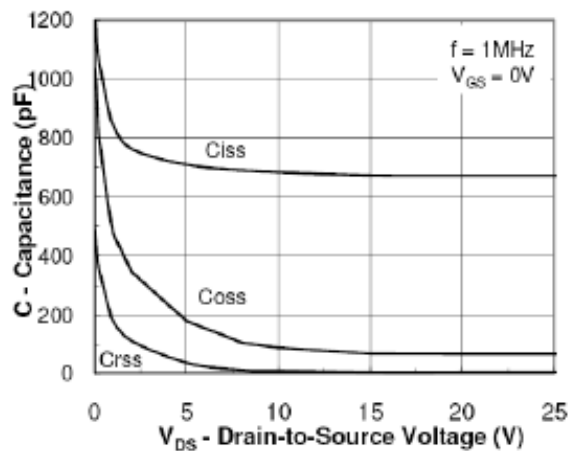


Figure 6: Capacitance Characteristics

Characteristics

## Characteristics Curve

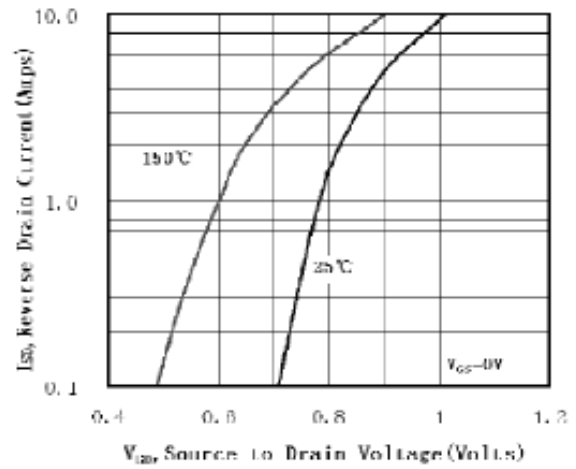
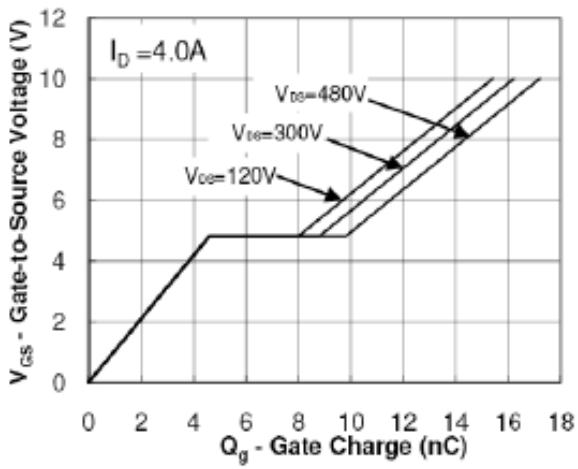


Figure7: Gate Charge Waveform  
Forward Voltage

Figure8: Source-Drain Diode

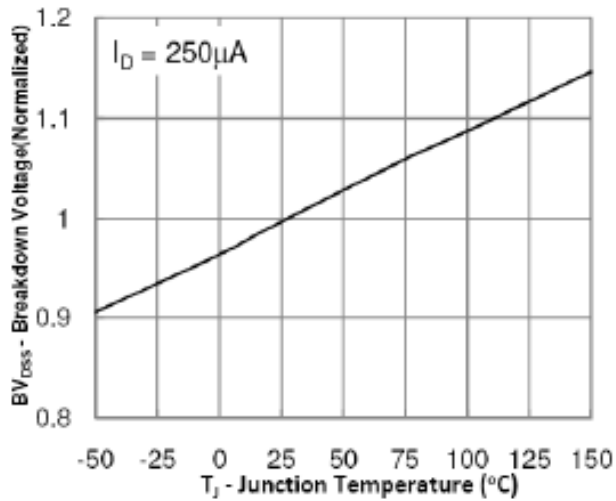
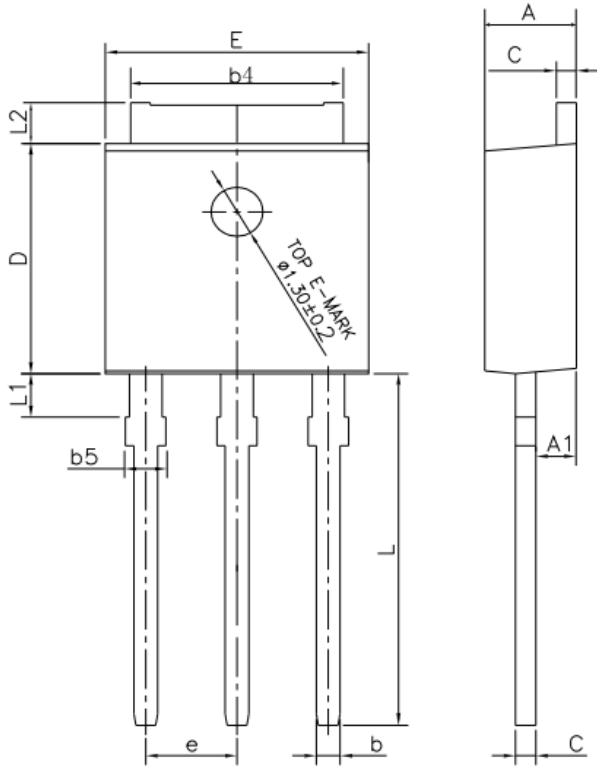


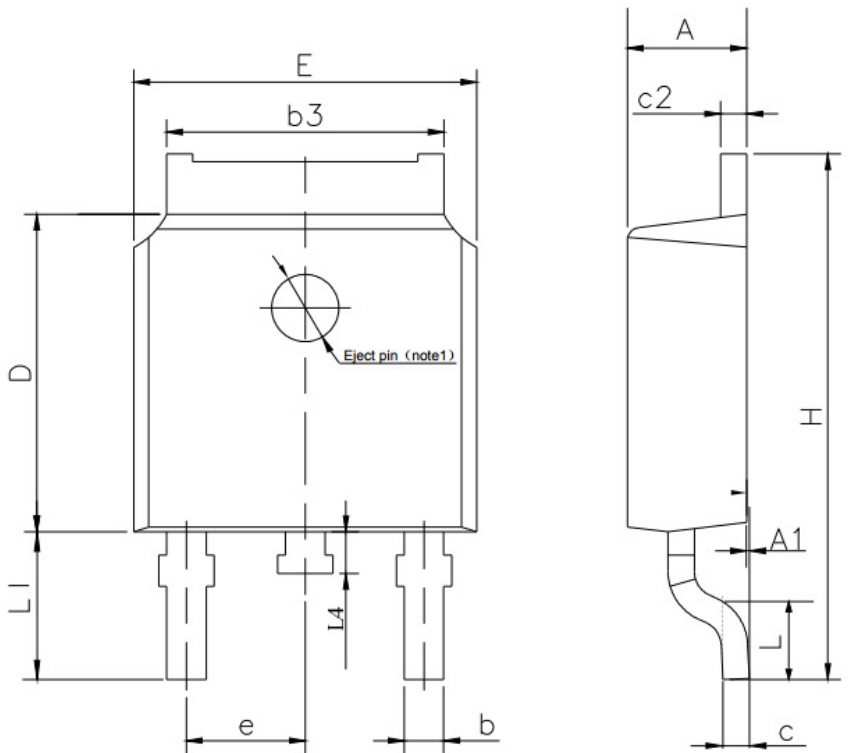
Figure9: Breakdown Voltage Vs Junction Temperature

## Outline Information (TO251-3L)



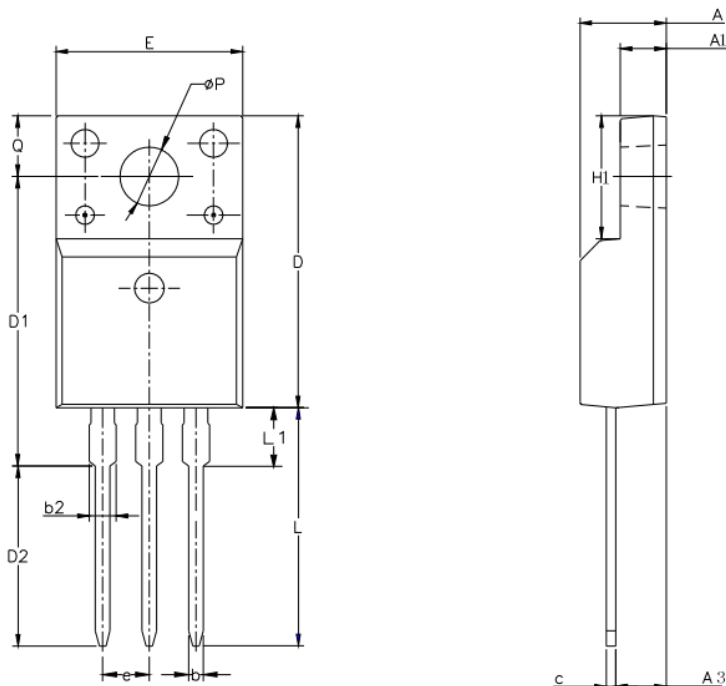
SYMBOL	MIN	NOM	MAX
A	2.18	2.30	2.39
A1	0.89	1.00	1.14
b	0.56	---	0.89
b4	4.95	5.33	5.46
b5	---	---	1.05
c	0.46	---	0.61
D	5.97	6.10	6.27
E	6.35	6.60	6.73
e	2.29 BCS		
L	8.89	9.30	9.65
L1	0.95	---	1.50
L2	0.89	---	1.27

## Outline Information (TO252-2L)



SYMBOL	MIN	NOM	MAX
A	2.10	2.30	2.50
A1	0	---	0.127
b	0.66	0.76	0.89
b3	5.10	5.33	5.46
c	0.45	---	0.65
c2	0.45	---	0.65
D	5.80	6.10	6.40
E	6.30	6.60	6.90
e	2.30TYP		
H	9.60	10.10	10.60
L	1.40	1.50	1.70
L1	2.90REF		
L4	0.60	0.80	1.00

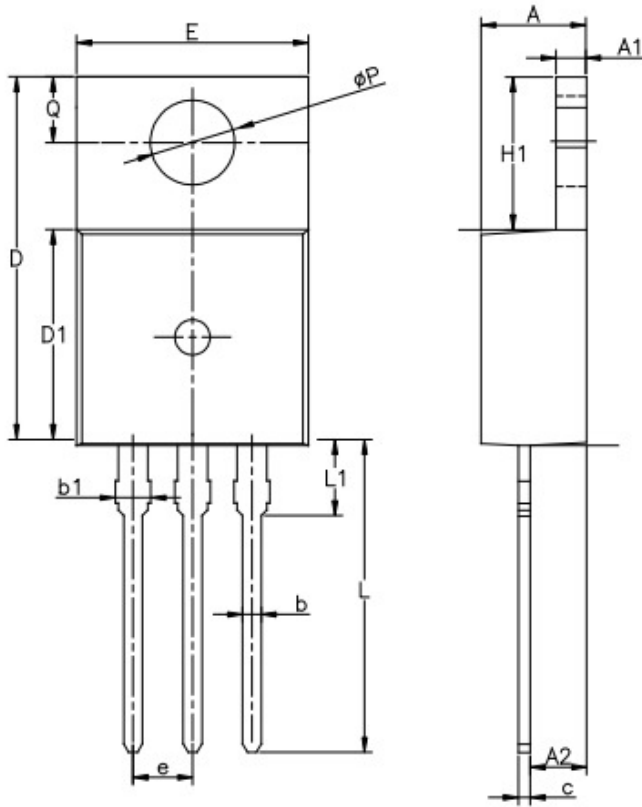
## Outline Information (TO220F-3L)



SYMBOL	MIN	NOM	MAX
A	4.42	4.70	5.02
A1	2.30	2.54	2.80
A3	2.50	2.76	3.10
b	0.70	0.80	0.90
b2	—	—	1.47
c	0.35	0.50	0.65
D	15.25	15.87	16.25
D1	15.30	15.75	16.30
D2	9.30	9.80	10.30
E	9.73	10.16	10.36
e	2.54BCS		
H1	6.40	6.68	7.00
L	12.48	12.98	13.48
L1	/	/	3.50
$\phi P$	3.00	3.18	3.40
Q	3.05	3.30	3.55

## Outline Information (TO220-3L)





SYMBOL	MIN	NOM	MAX
A	4.30	4.50	4.70
A1	1.00	1.30	1.50
A2	1.80	2.40	2.80
b	0.60	0.80	1.00
b1	1.00	—	1.60
c	0.30	—	0.70
D	15.10	15.70	16.10
D1	8.10	9.20	10.00
E	9.60	9.90	10.40
e	2.54BSC		
H1	6.10	6.50	7.00
L	12.60	13.08	13.60
L1	—	—	3.95
$\Phi P$	3.40	3.70	3.90
Q	2.60	—	3.20