

## N-Channel Super Junction Power MOSFET II

### General Description

The series of devices use advanced 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.

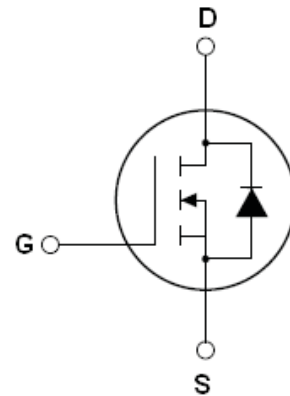
### Features

- New technology for high voltage device
- 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)

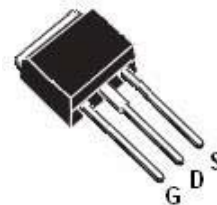
$V_{DS}$	650	V
$R_{DS(ON)}$	900	m $\Omega$
$I_D$	5	A



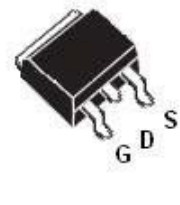
**Schematic diagram**

### Package Marking And Ordering Information

Device	Device Package	Marking
RM5N650IP	TO-251	5N650
RM5N650LD	TO-252	5N650



**TO-251**



**TO-252**

**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 ( $V_{DS}=0V$ )	$V_{GS}$	$\pm 30$	V
Continuous Drain Current at $T_c=25^\circ\text{C}$	$I_{D(DC)}$	5	A
Continuous Drain Current at $T_c=100^\circ\text{C}$	$I_{D(DC)}$	3	A
Pulsed drain current <sup>(Note 1)</sup>	$I_{DM(pluse)}$	15	A
Drain Source voltage slope, $V_{DS} = 480\text{ V}$ , $I_D = 5\text{ A}$ , $T_j = 125^\circ\text{C}$	dv/dt	48	V/ns
Maximum Power Dissipation( $T_c=25^\circ\text{C}$ )	$P_D$	49	W
Derate above $25^\circ\text{C}$		0.39	W/ $^\circ\text{C}$
Single pulse avalanche energy <sup>(Note2)</sup>	$E_{AS}$	135	mJ
Avalanche current <sup>(Note 1)</sup>	$I_{AR}$	2.5	A

Parameter	Symbol	Value	Unit
Repetitive Avalanche energy , $t_{AR}$ limited by $T_{jmax}$ (Note 1)	$E_{AR}$	0.4	mJ
Operating Junction and Storage Temperature Range	$T_J, T_{STG}$	-55...+150	°C

**Table 2. Thermal Characteristic**

Parameter	Symbol	Value	Unit
Thermal Resistance, Junction-to-Case (Maximum)	$R_{thJC}$	2.55	°C/W
Thermal Resistance, Junction-to-Ambient (Maximum)	$R_{thJA}$	75	°C/W

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

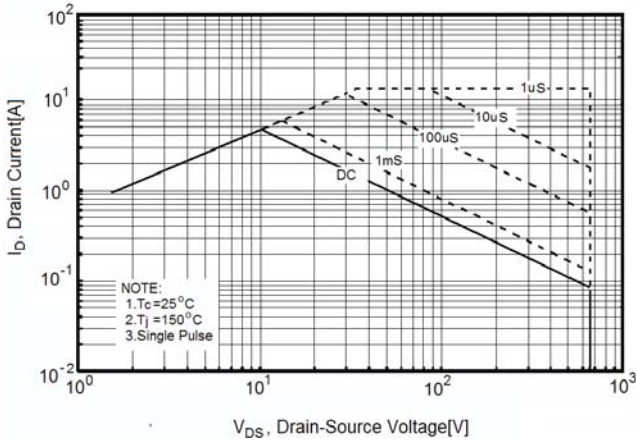
Parameter	Symbol	Condition	Min	Typ	Max	Unit
<b>On/off states</b>						
Drain-Source Breakdown Voltage	$BV_{DSS}$	$V_{GS}=0V, I_D=250\mu A$	650			V
Zero Gate Voltage Drain Current( $T_C=25^\circ C$ )	$I_{DSS}$	$V_{DS}=650V, V_{GS}=0V$			1	$\mu A$
Zero Gate Voltage Drain Current( $T_C=125^\circ C$ )	$I_{DSS}$	$V_{DS}=650V, V_{GS}=0V$			50	$\mu A$
Gate-Body Leakage Current	$I_{GSS}$	$V_{GS}=\pm 30V, V_{DS}=0V$			$\pm 100$	nA
Gate Threshold Voltage	$V_{GS(th)}$	$V_{DS}=V_{GS}, I_D=250\mu A$	2.5	3	3.5	V
Drain-Source On-State Resistance	$R_{DS(ON)}$	$V_{GS}=10V, I_D=2.5A$		780	900	m $\Omega$
<b>Dynamic Characteristics</b>						
Forward Transconductance	$g_{FS}$	$V_{DS} = 20V, I_D = 3A$		4.8		S
Input Capacitance	$C_{ISS}$	$V_{DS}=50V, V_{GS}=0V,$ $F=1.0MHz$		460		pF
Output Capacitance	$C_{OSS}$			45		pF
Reverse Transfer Capacitance	$C_{RSS}$			3.5		pF
Total Gate Charge	$Q_g$	$V_{DS}=480V, I_D=5A,$ $V_{GS}=10V$		10	20	nC
Gate-Source Charge	$Q_{gs}$			1.6		nC
Gate-Drain Charge	$Q_{gd}$			4		nC
Intrinsic gate resistance	$R_G$	$f = 1 MHz$ open drain		2.5		$\Omega$
<b>Switching times</b>						
Turn-on Delay Time	$t_{d(on)}$	$V_{DD}=380V, I_D=3A,$ $R_G=18\Omega, V_{GS}=10V$		6		nS
Turn-on Rise Time	$t_r$			3		nS
Turn-Off Delay Time	$t_{d(off)}$			50	60	nS
Turn-Off Fall Time	$t_f$			9	15	nS
<b>Source- Drain Diode Characteristics</b>						
Source-drain current(Body Diode)	$I_{SD}$	$T_C=25^\circ C$			5	A
Pulsed Source-drain current(Body Diode)	$I_{SDM}$				15	A
Forward on voltage	$V_{SD}$	$T_J=25^\circ C, I_{SD}=5A, V_{GS}=0V$		1	1.3	V
Reverse Recovery Time	$t_{rr}$	$T_J=25^\circ C, I_F=5A, di/dt=100A/\mu s$		250		nS
Reverse Recovery Charge	$Q_{rr}$			2.2		$\mu C$
Peak reverse recovery current	$I_{rrm}$			15		A

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

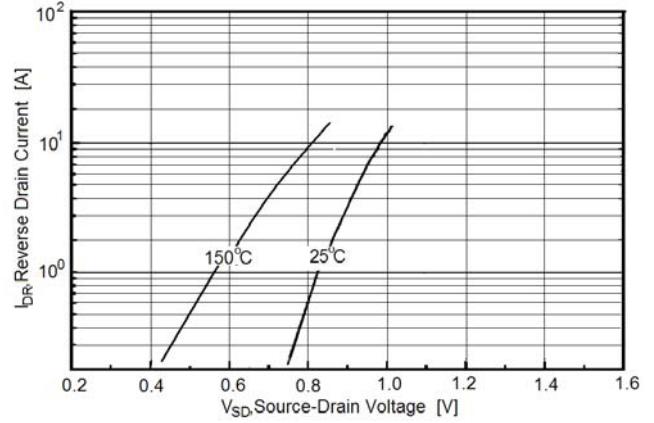
2.  $T_J=25^\circ C, V_{DD}=50V, V_G=10V, R_G=25\Omega$

# RATING AND CHARACTERISTICS CURVES (RM5N650IP/LD)

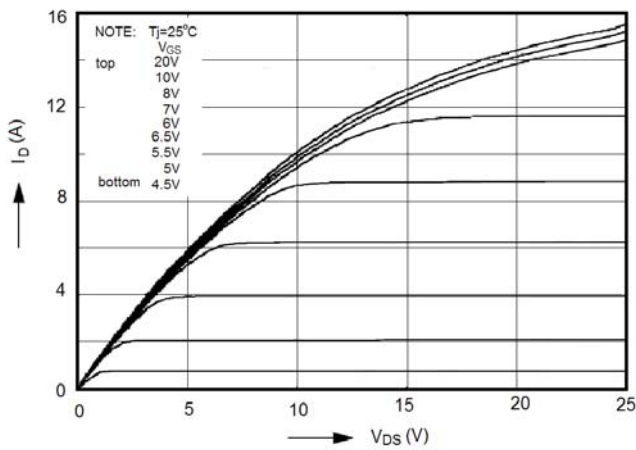
**Figure1. Safe operating area**



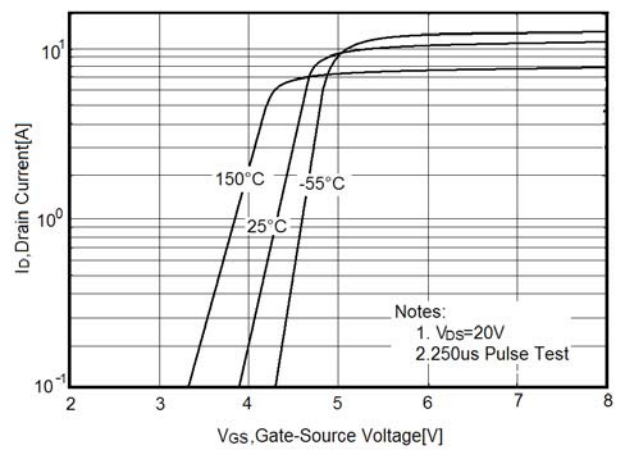
**Figure2. Source-Drain Diode Forward Voltage**



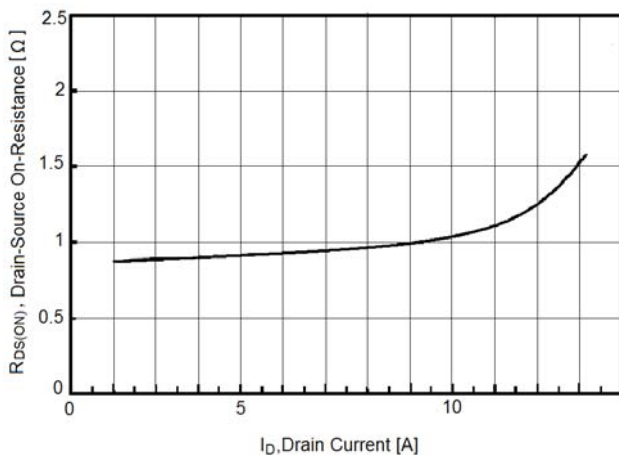
**Figure3. Output characteristics**



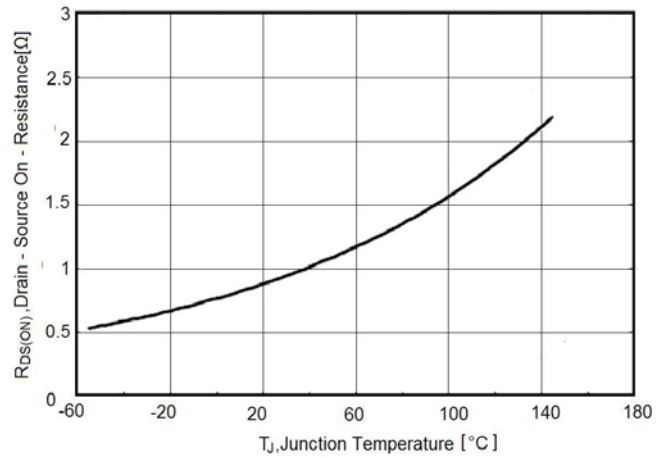
**Figure4. Transfer characteristics**



**Figure5. Static drain-source on resistance**

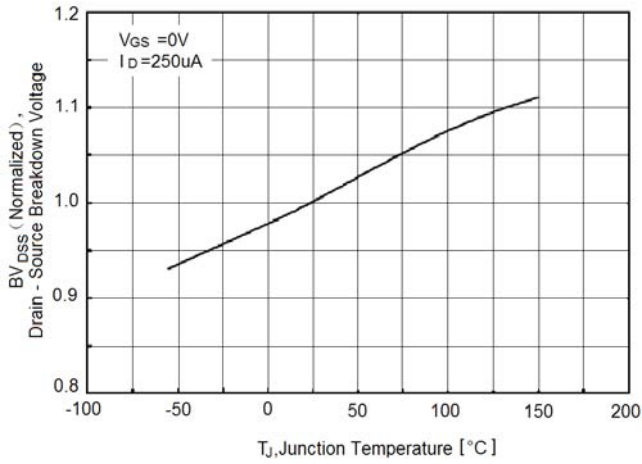


**Figure6.  $R_{DS(ON)}$  vs Junction Temperature**

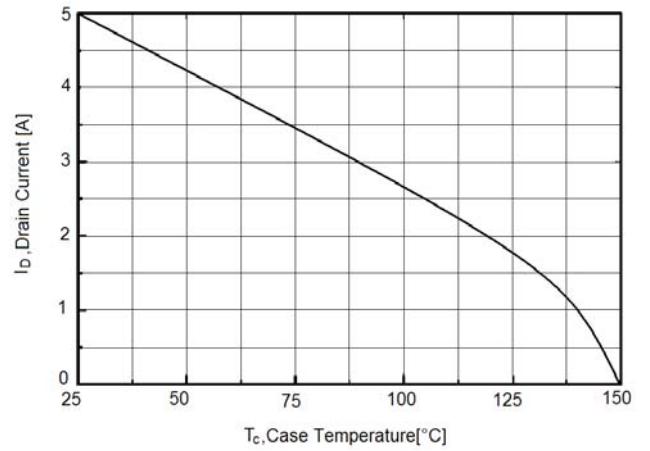


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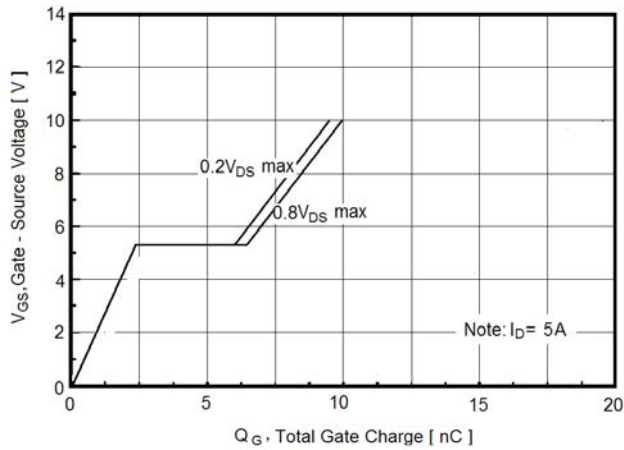
**Figure7.  $BV_{DSS}$  vs Junction Temperature**



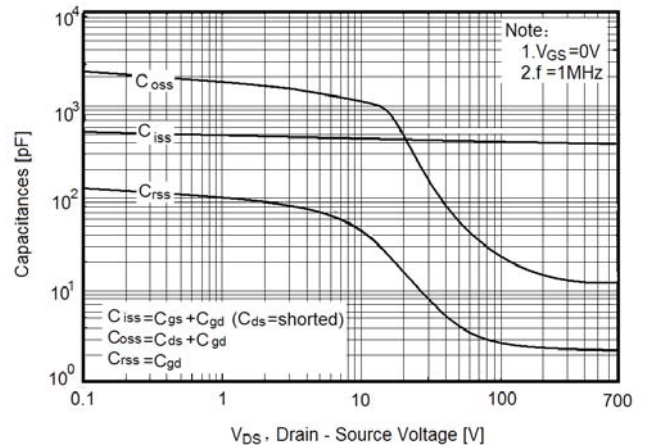
**Figure8. Maximum  $I_D$  vs Junction Temperature**



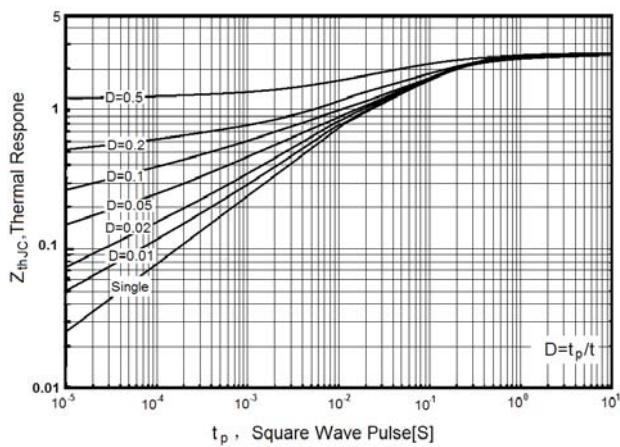
**Figure9. Gate charge waveforms**



**Figure10. Capacitance**

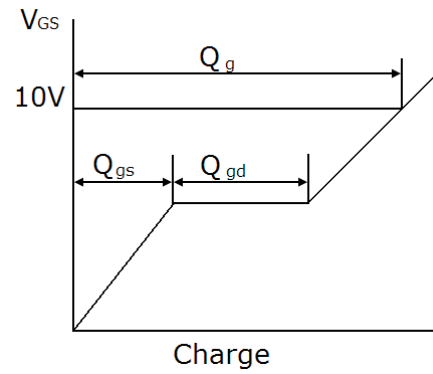
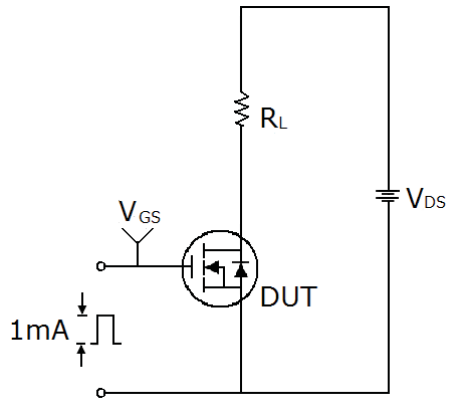


**Figure11. Transient Thermal Impedance**

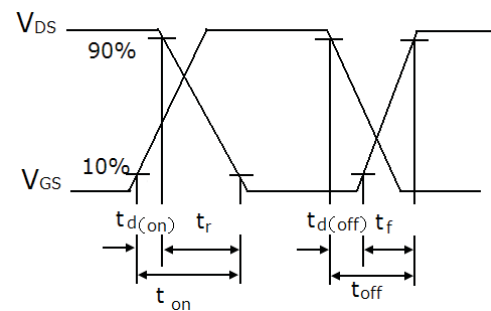
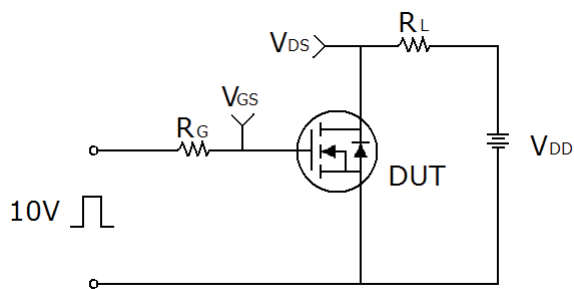


# Test circuit

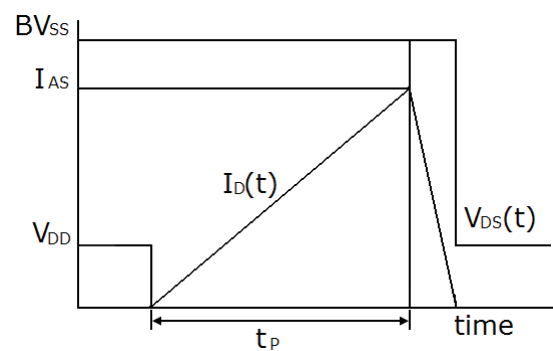
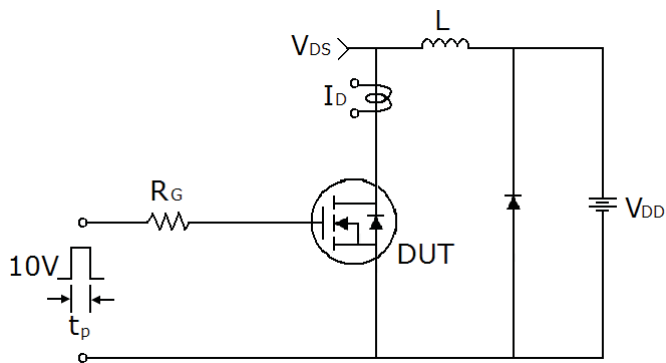
## 1) Gate charge test circuit & Waveform



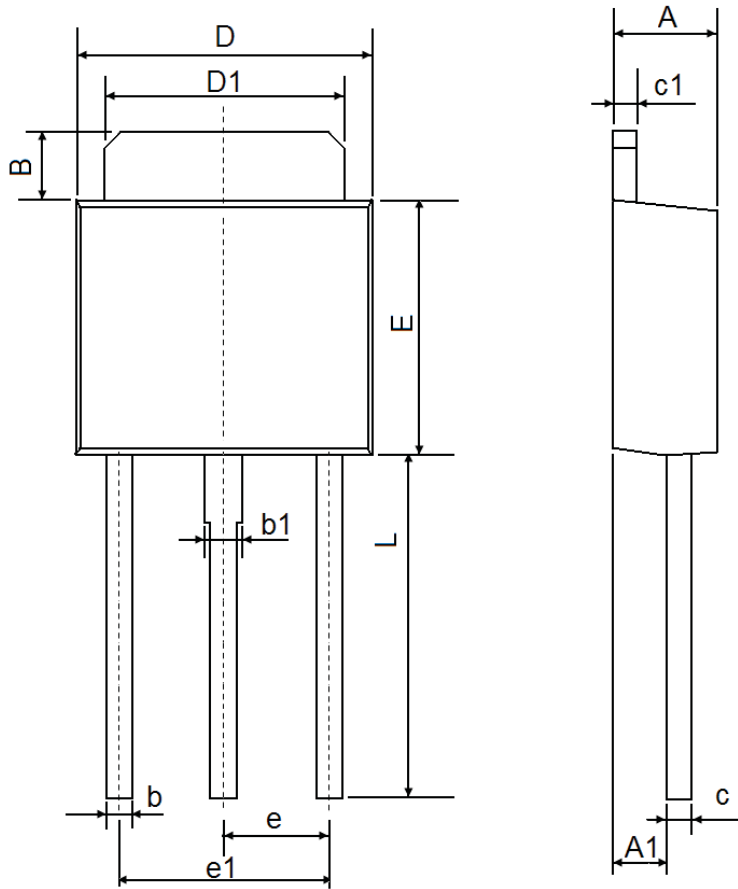
## 2) Switch Time Test Circuit:



## 3) Unclamped Inductive Switching Test Circuit & Waveforms

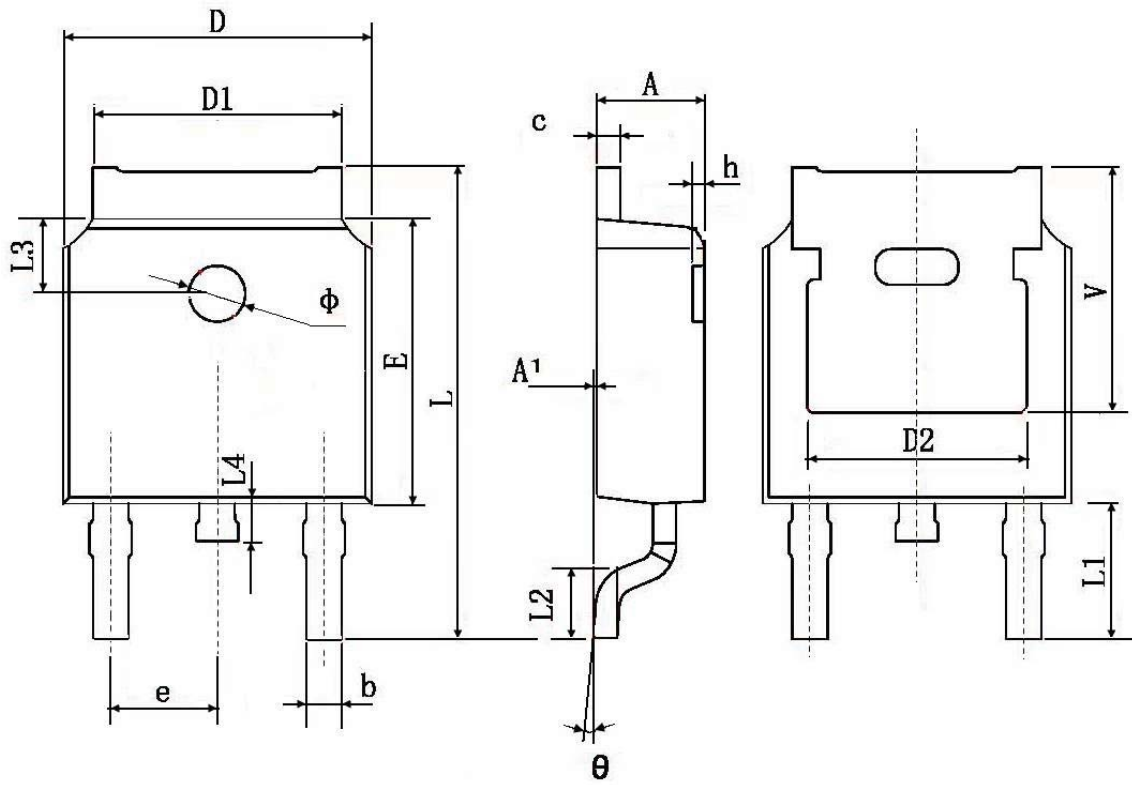


# TO-251 Package Information



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	2.200	2.400	0.087	0.094
A1	1.050	1.350	0.042	0.054
B	1.350	1.650	0.053	0.065
b	0.500	0.700	0.020	0.028
b1	0.700	0.900	0.028	0.035
c	0.430	0.580	0.017	0.023
c1	0.430	0.580	0.017	0.023
D	6.350	6.650	0.250	0.262
D1	5.200	5.400	0.205	0.213
E	5.400	5.700	0.213	0.224
e	2.300 TYP		0.091 TYP	
e1	4.500	4.700	0.177	0.185
L	7.500	7.900	0.295	0.311

# TO-252 Package Information



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	2.200	2.400	0.087	0.094
A1	0.000	0.127	0.000	0.005
b	0.660	0.860	0.026	0.034
c	0.460	0.580	0.018	0.023
D	6.500	6.700	0.256	0.264
D1	5.100	5.460	0.201	0.215
D2	4.830 TYP.		0.190 TYP.	
E	6.000	6.200	0.236	0.244
e	2.186	2.386	0.086	0.094
L	9.800	10.400	0.386	0.409
L1	2.900 TYP.		0.114 TYP.	
L2	1.400	1.700	0.055	0.067
L3	1.600 TYP.		0.063 TYP.	
L4	0.600	1.000	0.024	0.039
phi	1.100	1.300	0.043	0.051
theta	0°	8°	0°	8°
h	0.000	0.300	0.000	0.012
V	5.350 TYP.		0.211 TYP.	