

Surface Mount N-Channel Power MOSFET

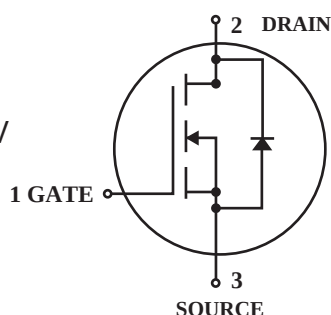
(Pb) Lead(Pb)-Free

Description:

This advanced technology has 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 well suited for high efficiency switched mode power supplies, active power factor correction, electronic lamp ballasts based on half bridge topology.

Features:

- * 2.0A, 600V, $R_{DS(ON)} = 5.0 \text{ Ohms} @ V_{GS} = 10V$
- * Low gate charge
- * Low C_{rss}
- * Fast switching
- * Improved dv/dt capability

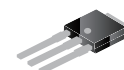


DRAIN CURRENT

2 AMPERES

DRAIN SOURCE VOLTAGE

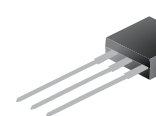
600 VOLTAGE



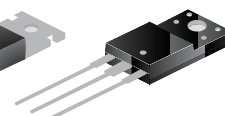
D-PAK3/(TO-251)



D-PAK/(TO-252)



TO-220



TO-220F

Maximum Ratings ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	600	V
Gate-Source Voltage	V_{GS}	30	
Avalanche Current - (Note 1)	I_{AR}	2.0	A
Continuous Drain Current	I_D	2.0	
Pulsed Drain Current, T_P Limited by T_{JMAX} - (Note 1)	I_{DM}	8.0	
Avalanche Energy, Single Pulsed (Note 2)	E_{AS}	140	mJ
Avalanche Energy, Repetitive, Limited by T_{JMAX}	E_{AR}	4.5	mJ
Peak Diode Recovery dv/dt (Note 3)	dv/dt	4.5	V/ns
Total Power Dissipation 2N60P($T_C = 25^\circ\text{C}$) 2N60F($T_C = 25^\circ\text{C}$) 2N60I/D($T_C = 25^\circ\text{C}$) 2N60P(Derate above 25°C) 2N60F(Derate above 25°C) 2N60I/D(Derate above 25°C)	P_D	44 23 34 0.35 0.18 0.27	W
Maximum lead temperature for soldering purposes, 1/8" from case for 5 seconds	T_L	300	$^\circ\text{C}$
Operating Junction and Storage Temperature Range	T_J, T_{stg}	-55~+150	$^\circ\text{C}$

* Drain current limited by maximum junction temperature.

Electrical Characteristics ($T_A = 25^\circ\text{C}$ Unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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Static

Drain-Source Breakdown Voltage @ $V_{GS}=0, I_D=250\mu\text{A}$	BV_{DSS}	600	-	-	V
Gate Threshold Voltage @ $V_{DS}=V_{GS}, I_D=250\mu\text{A}$	$V_{GS(Th)}$	2.0	-	4.0	
Gate-Source Leakage current Forward@ $V_{GS}=30\text{V}, V_{DS}=0\text{V}$ ReVerse@ $V_{GS}=-30\text{V}, V_{DS}=0\text{V}$	I_{GSS}	- -	- -	100 -100	nA
Drain-Source Leakage Current($T_j=25^\circ\text{C}$) @ $V_{DS}=600\text{V}, V_{GS}=0$ Drain-Source Leakage Current($T_j=125^\circ\text{C}$) @ $V_{DS}=480\text{V}, V_{GS}=0$	I_{DSS}	- -	- -	10 100	μA
Drain-Source On-State Resistance @ $V_{GS}=10\text{V}, I_D=1.0\text{A}$	$R_{DS(on)}$	-	4.0	5.0	Ω
Forward Transconductance @ $V_{DS}=50\text{V}, I_D=1.0\text{A}$ (Note 4)	g_{fs}	-	2.25	-	S
Breakdown Voltage Temperature Coefficient $I_D=250\mu\text{A}$, Referenced to 25°C	$\Delta BV_{DSS} / \Delta T_j$	-	0.4	-	$\text{V}/^\circ\text{C}$

Dynamic

Input Capacitance @ $V_{GS}=0\text{V}, V_{DS}=25\text{V}, f=1.0\text{MHz}$	C_{iss}	-	320	380	pF
Output Capacitance @ $V_{GS}=0\text{V}, V_{DS}=25\text{V}, f=1.0\text{MHz}$	C_{oss}	-	30	45	
Reverse Transfer Capacitance @ $V_{GS}=0\text{V}, V_{DS}=25\text{V}, f=1.0\text{MHz}$	C_{rss}	-	3	5.6	

Switching

Turn-on Delay Time $V_{DD}=300\text{V}, I_D=2.0\text{A}, R_G=25\Omega$ (Note 4, 5)	$t_{d(on)}$	-	13	30	ns
Turn-on Rise Time $V_{DD}=300\text{V}, I_D=2.0\text{A}, R_G=25\Omega$ (Note 4, 5)	t_r	-	12	60	
Turn-off Delay Time $V_{DD}=300\text{V}, I_D=2.0\text{A}, R_G=25\Omega$ (Note 4, 5)	$t_{d(off)}$	-	73	100	
Turn-off Fall Time $V_{DD}=300\text{V}, I_D=2.0\text{A}, R_G=25\Omega$ (Note 4, 5)	t_f	-	14.3	70	
Total Gate Charge $V_{DS}=480\text{V}, I_D=7.5\text{A}, V_{GS}=10\text{V}$ (Note 4, 5)	Q_g	-	9.3	13	nC
Gate-Source Charge $V_{DS}=480\text{V}, I_D=7.5\text{A}, V_{GS}=10\text{V}$ (Note 4, 5)	Q_{gs}	-	2.0	-	
Gate-Drain Change $V_{DS}=480\text{V}, I_D=7.5\text{A}, V_{GS}=10\text{V}$ (Note 4, 5)	Q_{gd}	-	3.3	-	

Electrical Characteristics ($T_A = 25^\circ\text{C}$ Unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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Source-Drain Diode Characteristics

Drain-Source Diode Forward Voltage @ $V_{GS}=0V, I_S=7.5A$	V_{SD}	-	-	1.4	V
Maximum Continuous Drain-Source Diode Forward Current	I_S	-	-	2.0	A
Maximum Pulsed Drain-Source Diode Forward Current	I_{SM}	-	-	8.0	A
Reverse Recovery Time@ $V_{GS}=0V, I_S=7.5A, dI_F/dt=100A/\mu s$ (Note 4)	T_{rr}	-	230	-	ns
Reverse Recovery Charge @ $V_{GS}=0V, I_S=7.5A, dI_F/dt=100A/\mu s$ (Note 4)	Q_{rr}	-	1.0	-	μC

Thermal Data

Characteristic	Symbol	Value	Unit
Junction-to-Ambient 2N60P 2N60F 2N60I 2N60D	R_{JA}	62.5 120 112 112	$^\circ\text{C/W}$
Junction-to-Case 2N60P 2N60F 2N60I 2N60D	R_{JC}	2.26 5.56 3.7 3.7	$^\circ\text{C/W}$

Note: 1. Repetitive Rating : Pulse width limited by maximum junction temperature
 2. $L = 30mH, I_{AS} = 2.58A, V_{DD} = 123V, R_G = 25\Omega$, Starting $T_J = 25^\circ\text{C}$
 3. $I_{SD} \leq 2.4A, di/dt \leq 200A/\mu s, V_{DD} \leq BV_{DSS}$, Starting $T_J = 25^\circ\text{C}$
 4. Pulse Test: Pulse width $\leq 300\mu s$, Duty cycle $\leq 2\%$
 5. Essentially independent of operating temperature

Ordering Information

Order Number	Package	Pin Assignment			Packing
		1	2	3	
2N60P	TO-220	G	D	S	Tube
2N60F	TO-220F	G	D	S	Tube
2N60I	D-PAK3/TO-251	G	D	S	Tube
2N60D	D-PAK/TO-252	G	D	S	Tube

Test Circuits And Waveforms

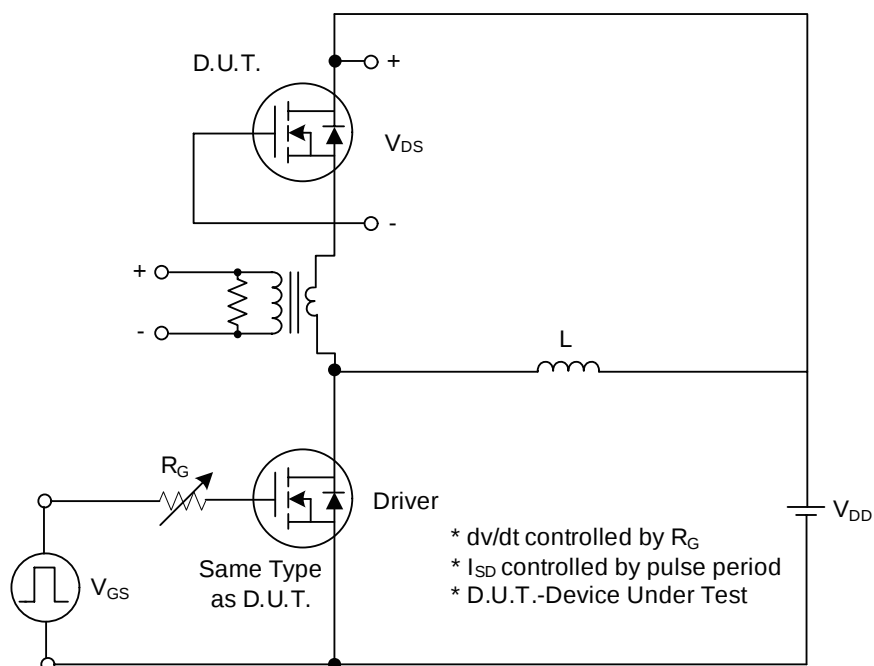


Fig. 1A Peak Diode Recovery dv/dt Test Circuit

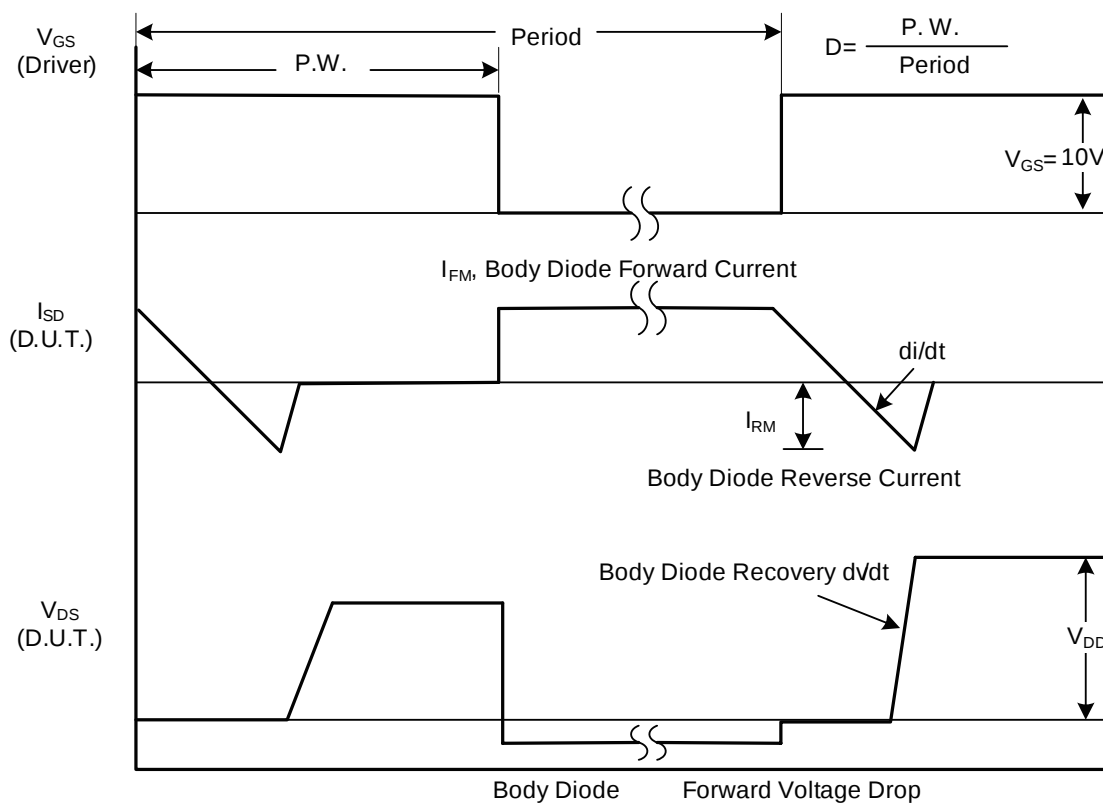


Fig. 1B Peak Diode Recovery dv/dt Waveforms

Test Circuits And Waveforms(cont.)

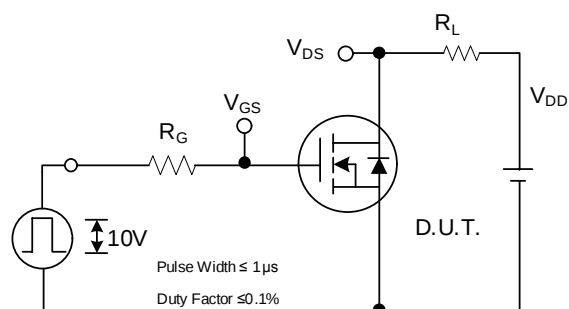


Fig. 2A Switching Test Circuit

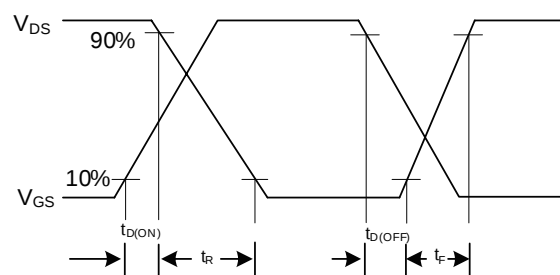


Fig. 2B Switching Waveforms

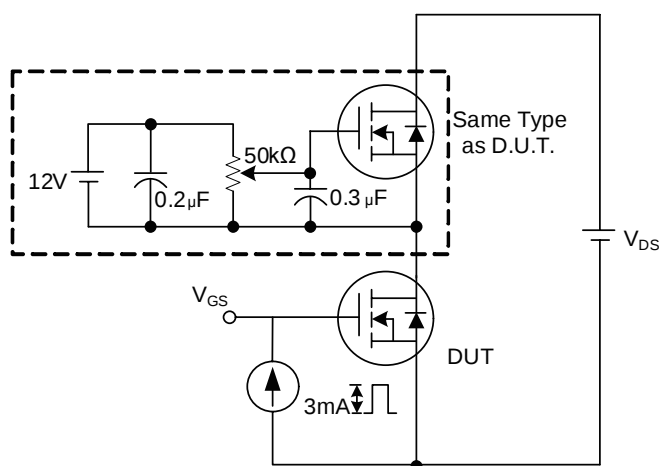


Fig. 3A Gate Charge Test Circuit

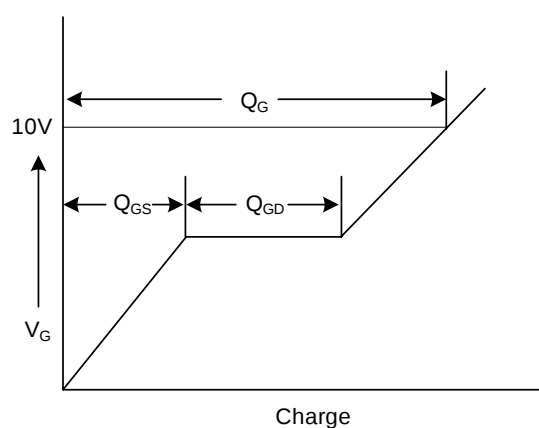


Fig. 3B Gate Charge Waveform

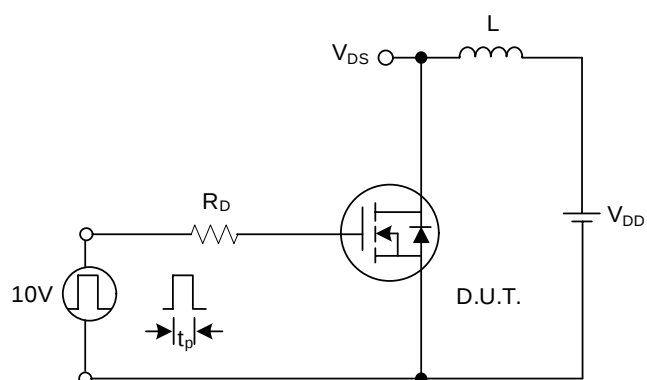


Fig. 4A Unclamped Inductive Switching Test Circuit

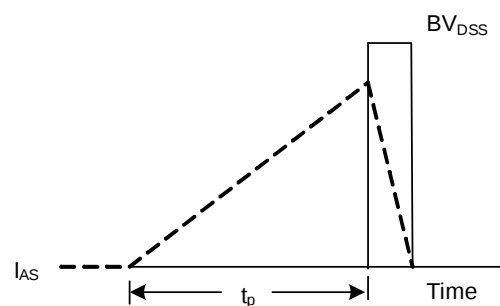
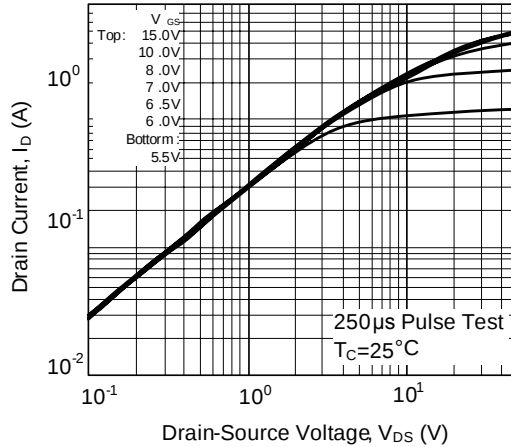


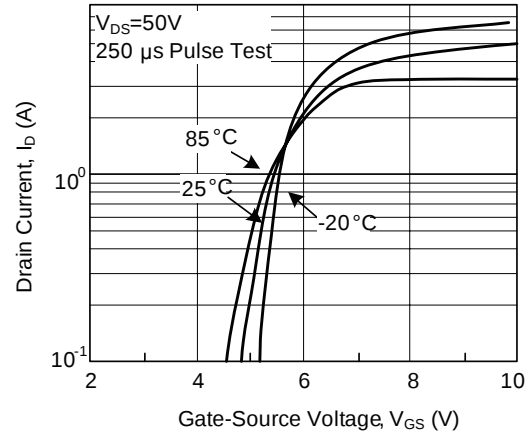
Fig. 4B Unclamped Inductive Switching Waveforms

Typical Characteristics

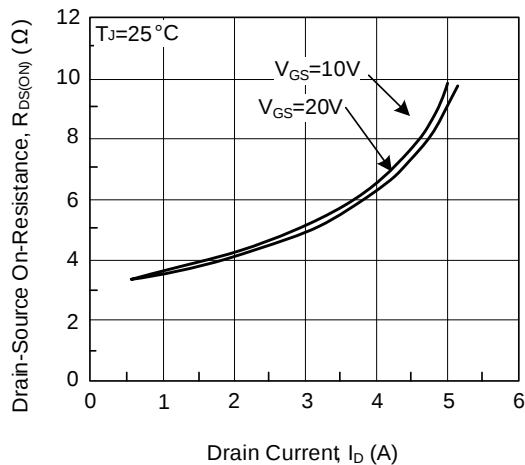
On-Region Characteristics



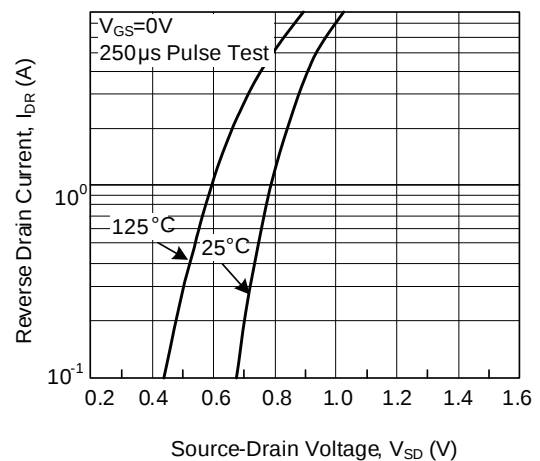
Transfer Characteristics



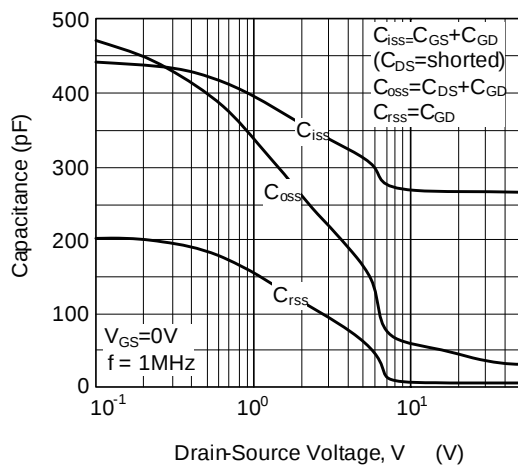
On-Resistance Variation vs Drain Current and Gate Voltage



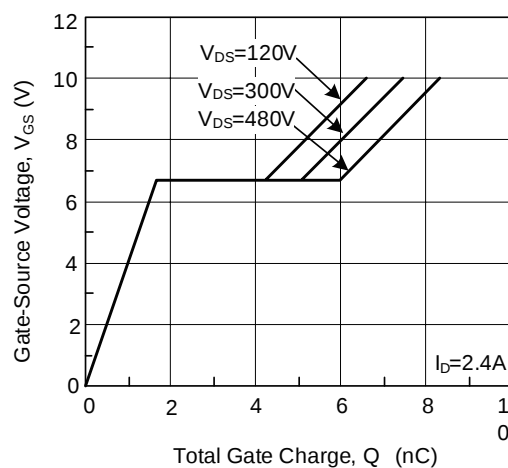
Body Diode Forward Voltage Variations vs. Source Current and Temperature



Capacitance vs. Drain-Source Voltage

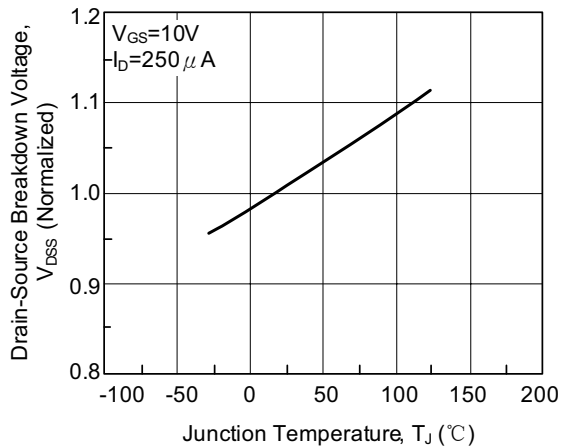


Gate Charge vs. Gate Charge Voltage

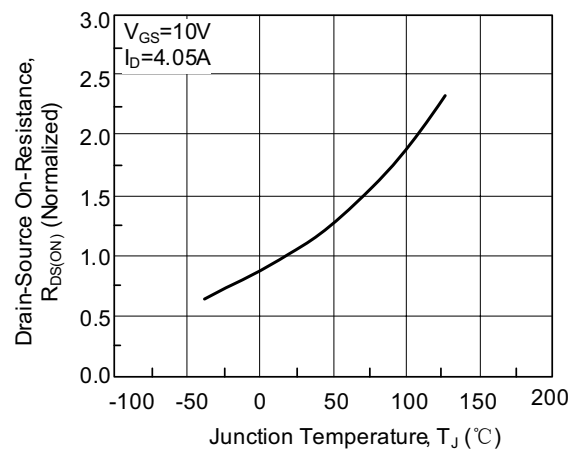


Typical Characteristics

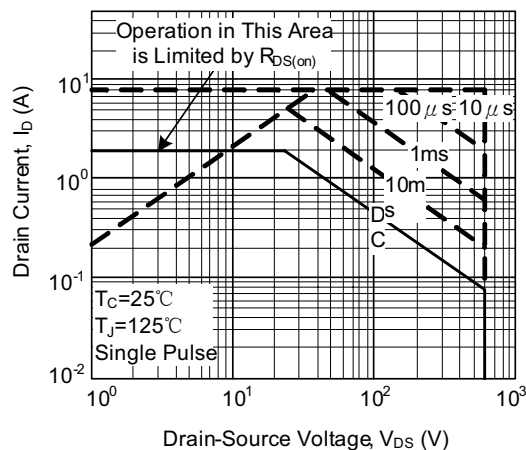
Breakdown Voltage vs Temperature



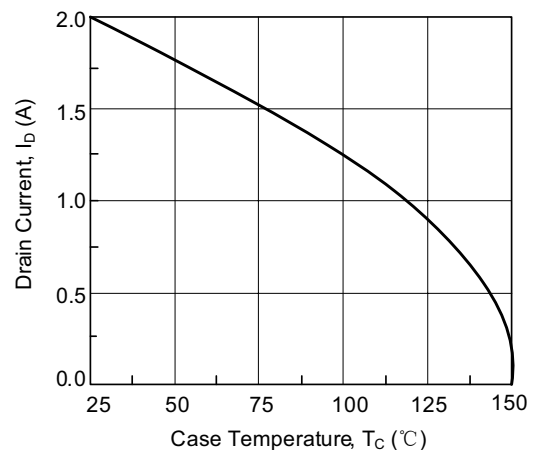
On-Resistance vs. Temperature



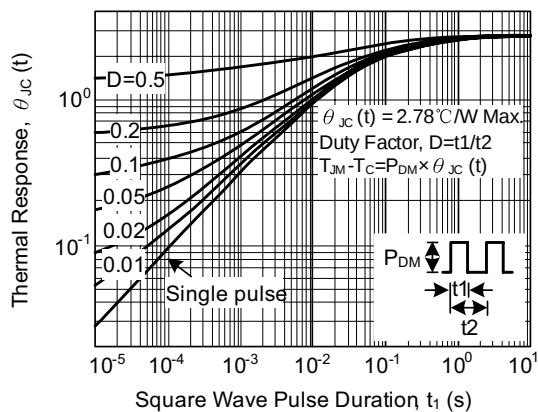
Max. Safe Operating Area



Max. Drain Current vs. Case Temperature

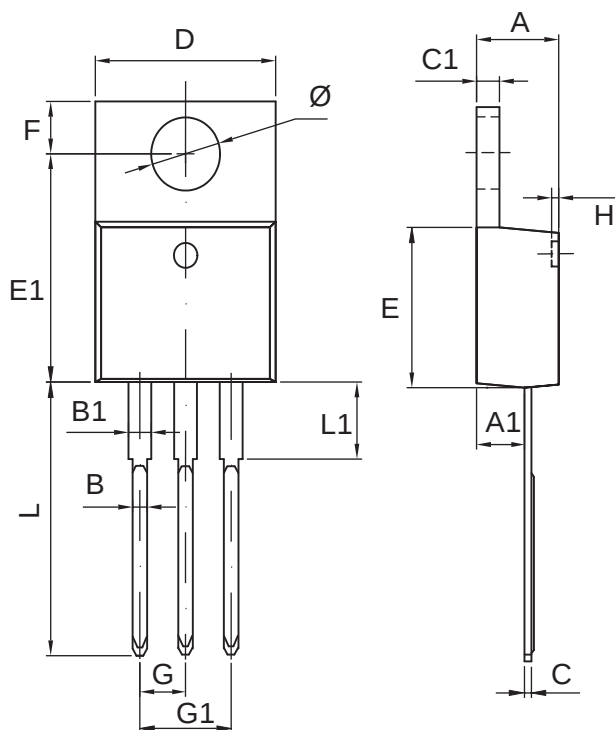


Thermal Response



TO-220 Outline Dimensions

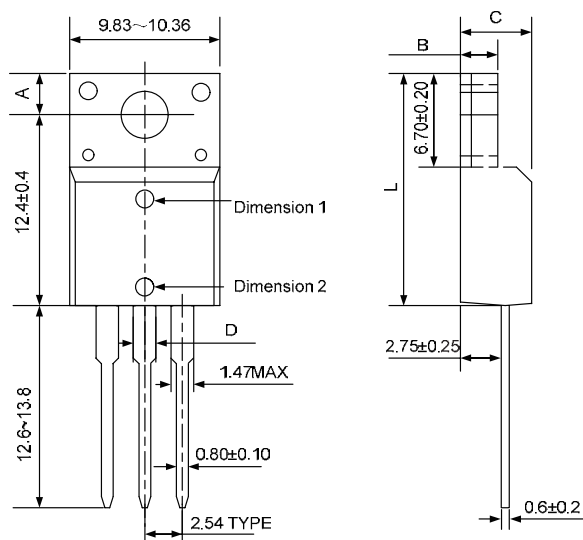
Unit:mm



TO-220		
Dim	Min	Max
A	4.47	4.67
A1	2.52	2.82
B	0.71	0.91
B1	1.17	1.37
C	0.31	0.53
C1	1.17	1.37
D	10.01	10.31
E	8.50	8.90
E1	12.06	12.446
G	2.54 TYP	
G1	4.98	5.18
F	2.59	2.89
H	0.00	0.30
L	13.4	13.8
L1	3.56	3.96
Φ	3.73	3.93

TO-220F Outline Dimensions

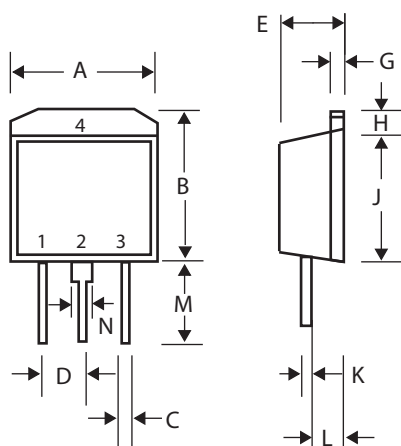
Unit:mm



TO-220F		
Symbol	Dimension 1	Dimension 2
A	3.3±0.15	2.70±0.75
B	2.55±0.20	3.0±0.20
C	4.72±0.2	4.5±0.20
D	1.47MAX	1.75MAX
L	15.75±0.30	15±0.30

TO-251 Outline Dimensions

unit:mm

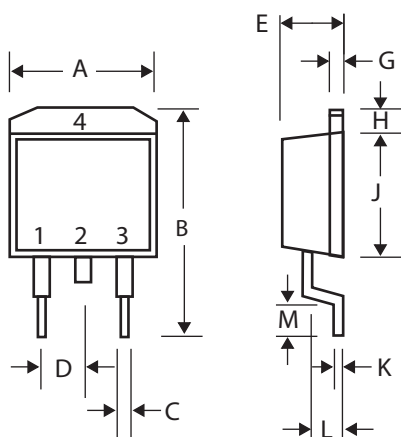


TO-251		
Dim	Min	Max
A	6.40	6.80
B	6.80	7.20
C	0.50	0.80
D	-	2.30
E	2.20	2.50
G	0.45	0.55
H	1.00	1.60
J	5.40	5.80
K	0.45	0.69
L	0.90	1.50
M	6.50	-
N	-	0.90

1. Emitter
2. Base
3. Collector

TO-252 Outline Dimensions

unit:mm



TO-252		
Dim	Min	Max
A	6.40	6.80
B	9.00	10.00
C	0.50	0.80
D	-	2.30
E	2.20	2.50
G	0.45	0.55
H	1.00	1.60
J	5.40	5.80
K	0.30	0.64
L	0.70	1.70
M	0.90	1.50