

### General Description

These N-channel enhanced mode power mosfets Used advanced trench technology design, provided excellent  $R_{DS(on)}$  and low gate charge. Which accords with the RoHS standard.

### Features

- Fast switching
- Low on-resistance
- Low gate charge and low reverse transfer capacitances
- 100% avalanche tested

### Mechanical Data

- Case:TO-220,ITO-220,TO-263,TO-262 Package

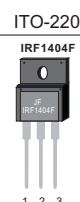
### Application

- Switching applications

### Ordering Information

Part No.	Package Type	Package	Quality(box)
IRF1404	TO-220	Tube	1000
IRF1404F	ITO-220	Tube	1000
IRF1404D	TO-263	Tape & Reel	800
IRF1404E	TO-262	Tube	1000

Product Summary			
$V_{DS}$	$R_{DS(on)}$ (m $\Omega$ ) Typ	$I_D$ (A)	$Q_g$ (Typ)
40V	1.9@ 10V	200	155nc



### Block Diagram

Pin Definition:

1. Gate
2. Drain
3. Source

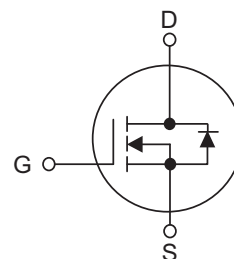


Table1 Absolute Maximum Ratings ( $T_C=25^\circ\text{C}$ , unless otherwise specified)

Parameter	Symbol	TO-220/TO-262/TO-263	ITO-220	Unit
Drain-Source Voltage	$V_{DS}$	40		V
Gate-Source Voltage	$V_{GS}$	$\pm 20$		V
Continuous Drain Current	$I_D$	200		A
		135		
Pulsed Drain Current (Note 1)	$I_{DM}$	750		A
Single Pulse Avalanche Energy(Note 2)	$E_{AS}$	121		mJ
Avalanche Current(Note 1)	$I_{AS}$	90		A
Power Dissipation $T_C=25^\circ\text{C}$	$P_D$	215	85	W
Operating Junction and Storage Temperature	$T_J/T_{STG}$	$-55 \sim +175$		C

Table 2. Thermal Characteristics

Parameter	Symbol	TO-220/TO-262/TO-263	ITO-220	Unit
Thermal resistance Junction to Ambient	$R_{\theta JA}$	75	75	C/W
Thermal resistance Junction to Case	$R_{\theta JC}$	0.7	1.76	C/W

Table 3. Electrical Characteristics ( $T_J=25^\circ\text{C}$ , unless otherwise specified)

Parameter		Symbol	Test Conditions	Min	Typ	Max	Unit
Off Characteristics							
Drain-Source Breakdown Voltage		BV <sub>DSS</sub>	V <sub>GS</sub> =0V,I <sub>D</sub> =250μA	40	50		V
Drain-Source Leakage Current		I <sub>DSS</sub>	V <sub>DS</sub> =40V,V <sub>GS</sub> =0V			10	μA
Gate- Source Leakage Current	Forward	I <sub>GSS</sub>	V <sub>GS</sub> =20V,V <sub>DS</sub> =0V			100	nA
	Reverse		V <sub>GS</sub> =-20V,V <sub>DS</sub> =0V			-100	nA
On Characteristics(Note 4)							
Gate Threshold Voltage		V <sub>GS(TH)</sub>	V <sub>DS</sub> =V <sub>GS</sub> ,I <sub>D</sub> =250μA	2.0		4.0	V
Static Drain-Source On-State Resistance		R <sub>DS(ON)</sub>	V <sub>GS</sub> =10V,I <sub>D</sub> =40A		1.9	4	mΩ
Dynamic Characteristics(Note 5)							
Input Capacitance		C <sub>ISS</sub>	V <sub>DS</sub> =25V,V <sub>GS</sub> =0V,f=1MHz		5700		pF
Output Capacitance		C <sub>OSS</sub>			1450		pF
Reverse Transfer Capacitance		C <sub>RSS</sub>			590		pF
Switching Characteristics (Note 5)							
Turn-On Delay Time		t <sub>d (on)</sub>	V <sub>DD</sub> =30V,I <sub>D</sub> =60A, V <sub>GS</sub> =10V,R <sub>G</sub> =6Ω		35		ns
Turn-On Rise Time		t <sub>R</sub>			20		ns
Turn-Off Delay Time		t <sub>d (off)</sub>			45		ns
Turn-Off Fall Time		t <sub>f</sub>			62		ns
Total Gate Charge		Q <sub>G</sub>	V <sub>DD</sub> =32V,I <sub>D</sub> =60A, V <sub>GS</sub> =10V		155		nC
Gate-Source Charge		Q <sub>GS</sub>			30		nC
Gate-Drain Charge		Q <sub>GD</sub>			60		nC
Drain-Source Diode Characteristics and Maximum Ratings							
Drain-Source Diode Forward Voltage		V <sub>SD</sub>	V <sub>GS</sub> =0V, I <sub>S</sub> =60A			1.3	V
Maximum Continuous Drain-Source Diode Forward Current		I <sub>S</sub>				200	A
Reverse Recovery Time		t <sub>rr</sub>	V <sub>GS</sub> =0V, I <sub>F</sub> =60A dI <sub>F</sub> /dt=100A/μs (Note 1)		36		ns
Reverse Recovery Charge		Q <sub>RR</sub>			60		nC

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

2  $L=0.5\text{mH}, I_D=90A, V_{DD}=50V, V_{GATE}=40V$ , Starting  $T_J=25^\circ\text{C}$

4 Pulse Test: Pulse width  $\leq 300\mu s$ , Duty cycle  $\leq 2\%$

5 Guaranteed by design,not subject to production

## Typical Characteristics Diagrams

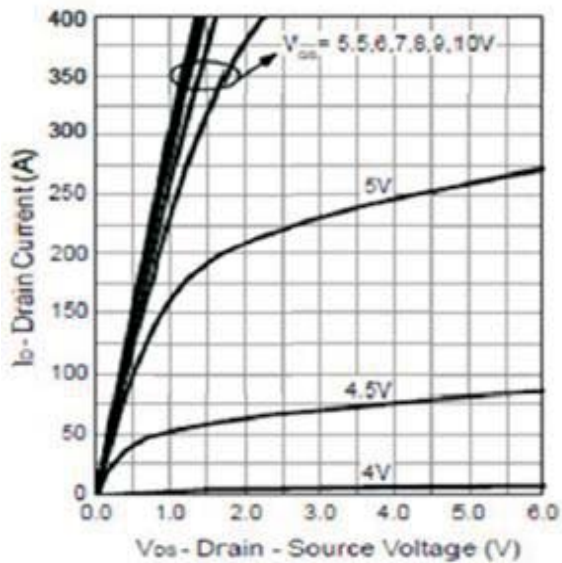


Figure 1 Output Characteristics

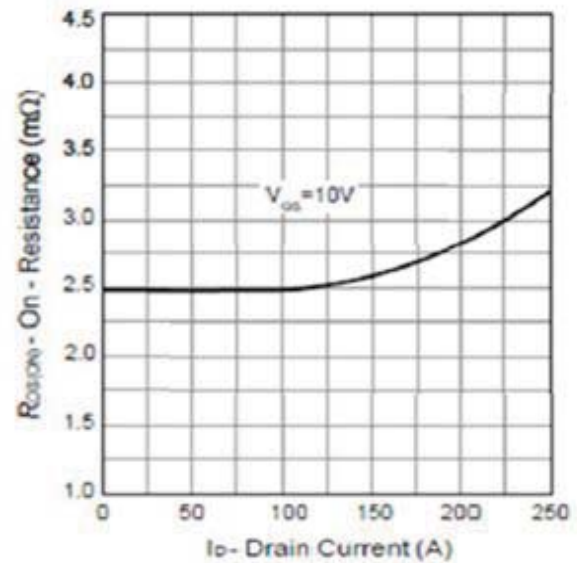


Figure 2 Drain-Source On Resistance

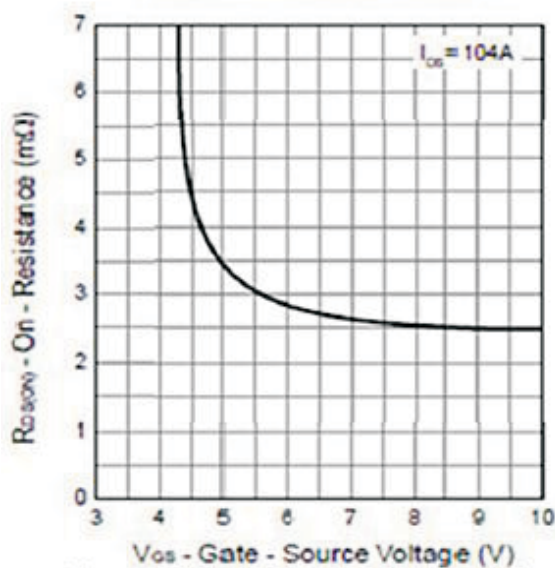


Figure 3 Gate-Source On Resistance

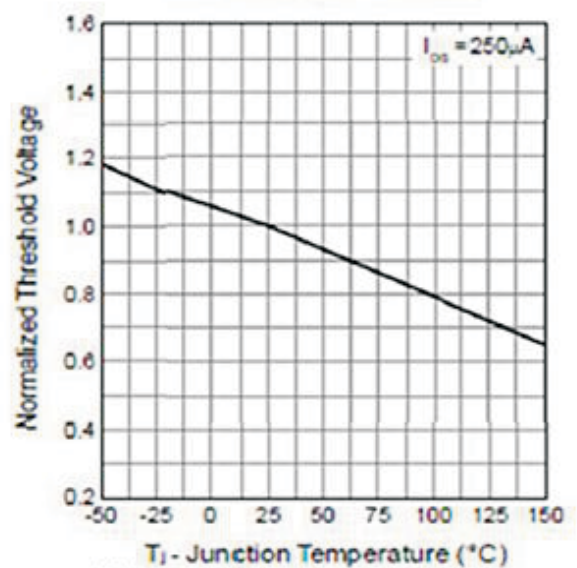


Figure 4 Gate Threshold Voltage

## Typical Characteristics Diagrams

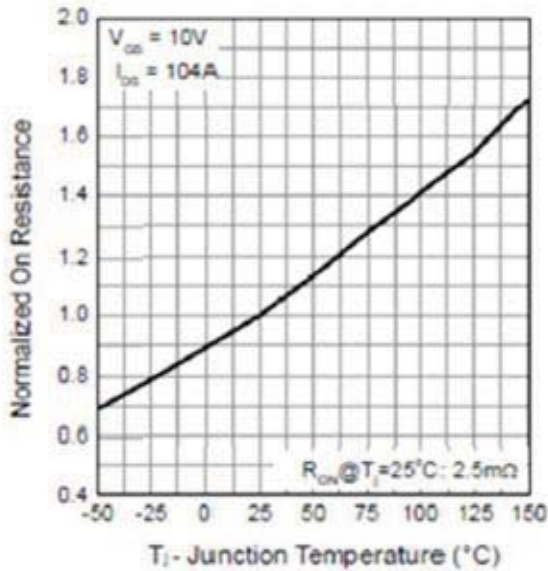


Figure 5 Drain-Source On Resistance

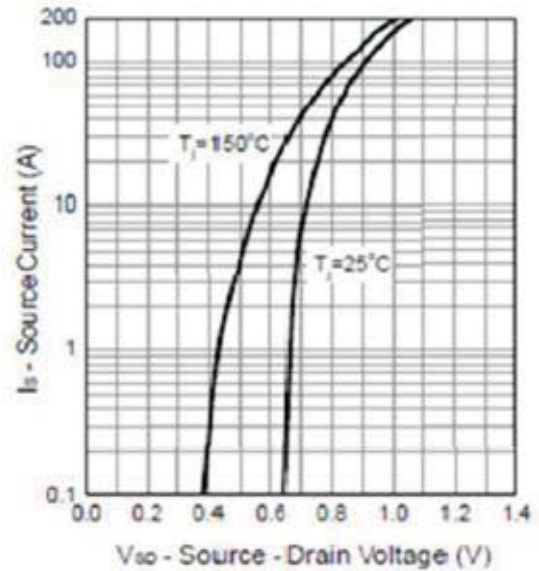


Figure 6 Source-Drain Diode Forward

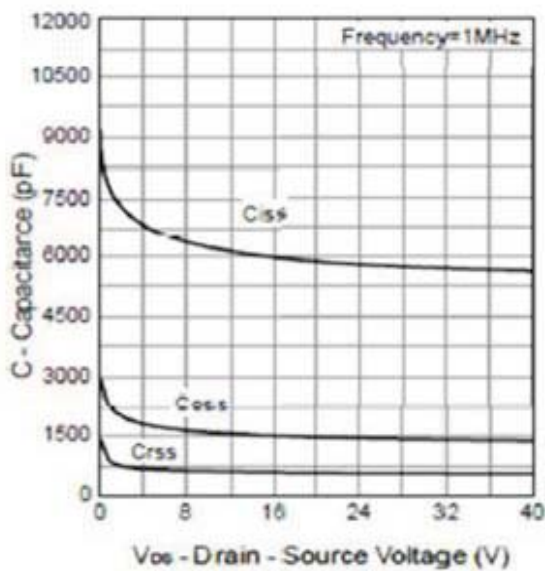


Figure 7 Capacitance

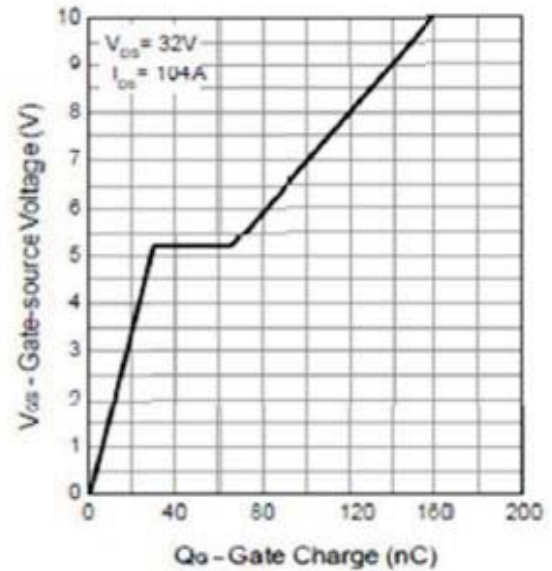


Figure 8 Gate Charge

## Typical Characteristics Diagrams

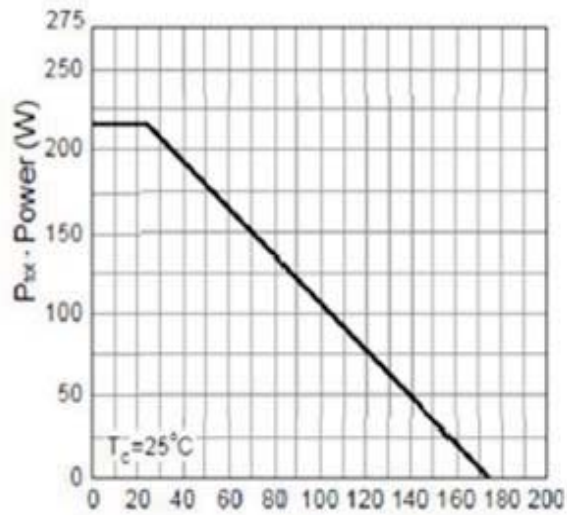


Figure 9 Power Dissipation

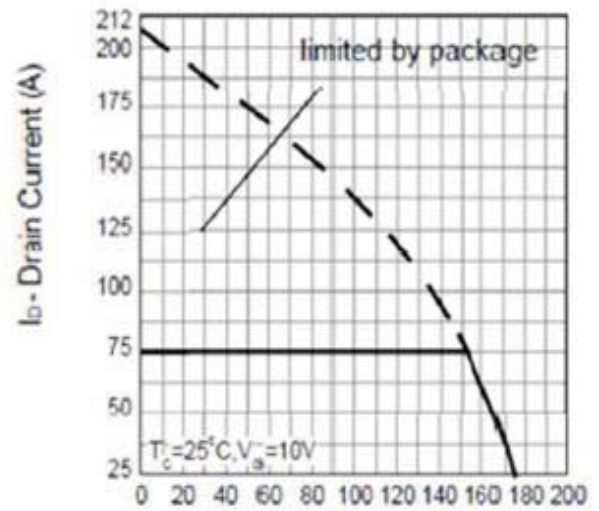


Figure 10 Drain Current

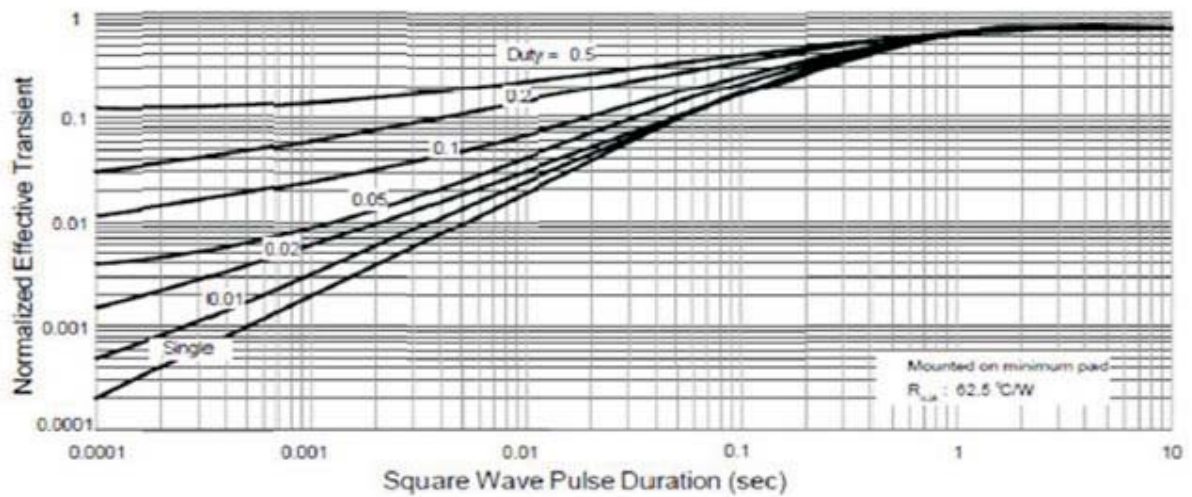
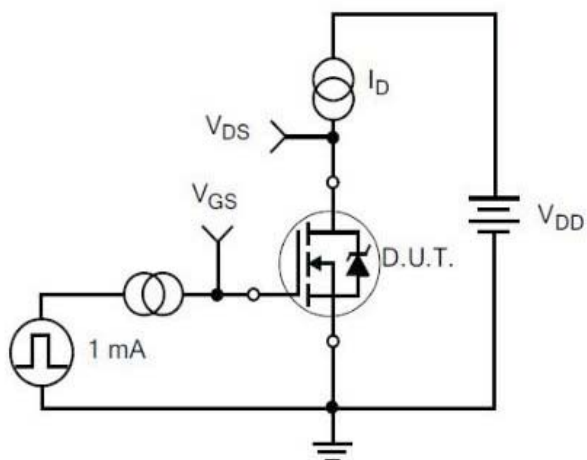


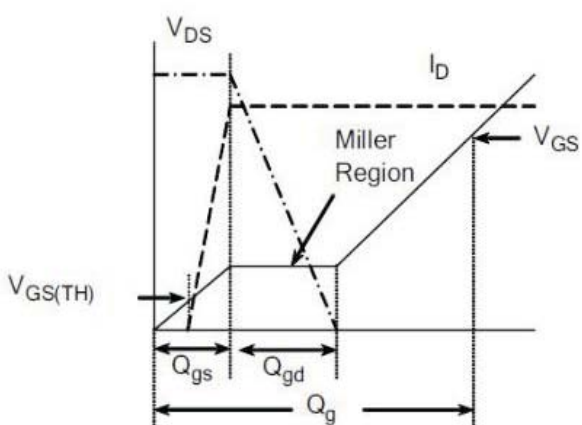
Figure 11 Thermal Transient Impedance



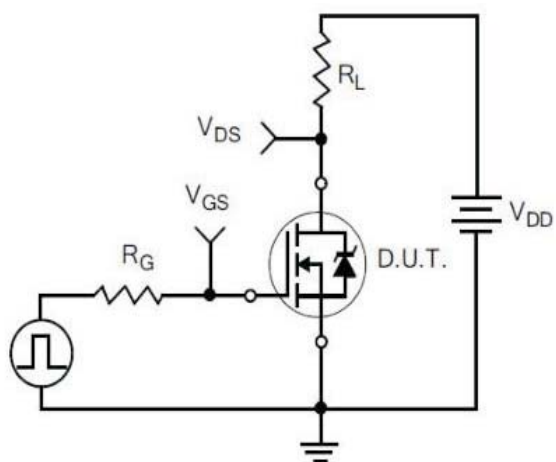
## Typical Test Circuit



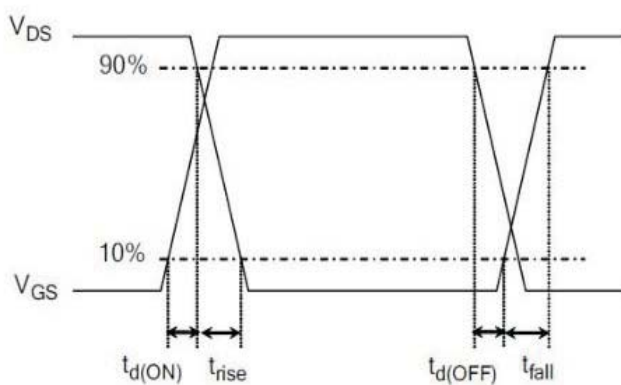
1) Gate Charge Test Circuit



2) Gate Charge Waveform

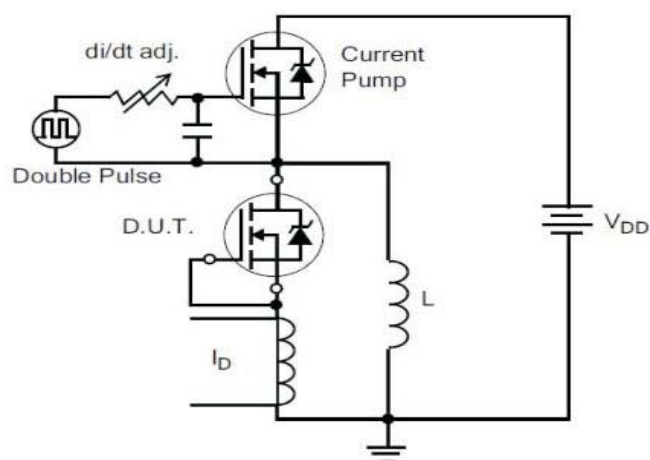


3) Resistive Switching Test Circuit

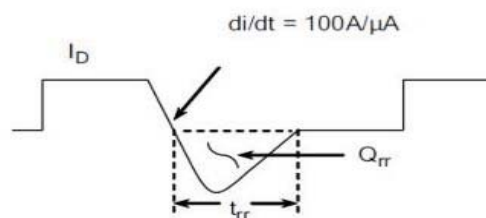


4) Resistive Switching Waveforms

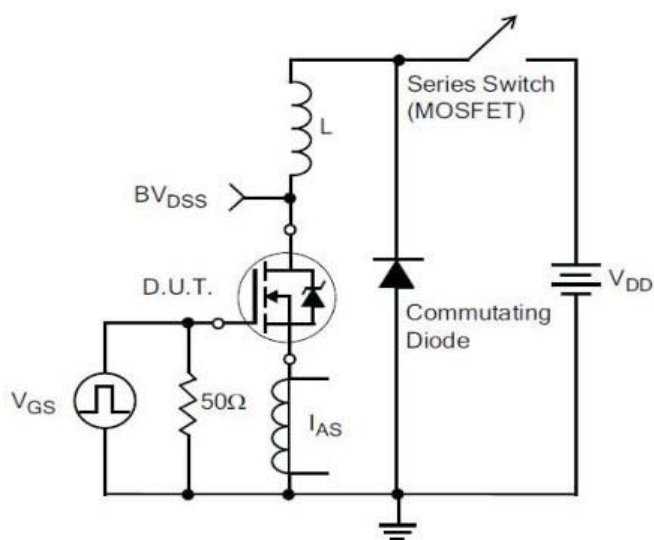
## Typical Test Circuit



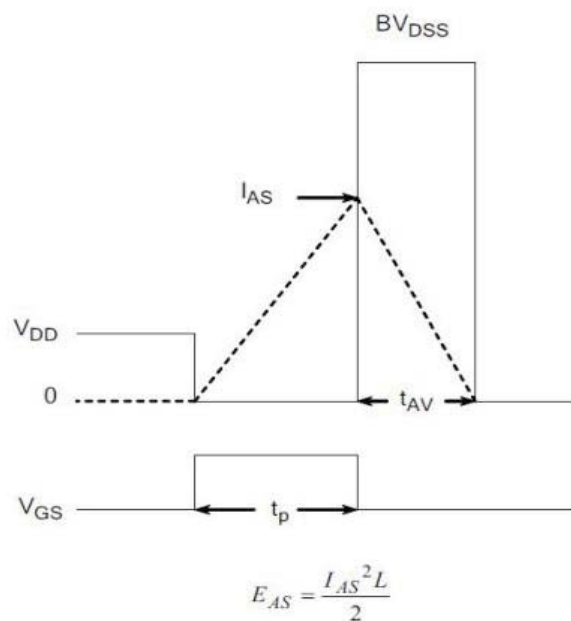
5) Diode Reverse Recovery Test Circuit



6) Diode Reverse Recovery Waveform

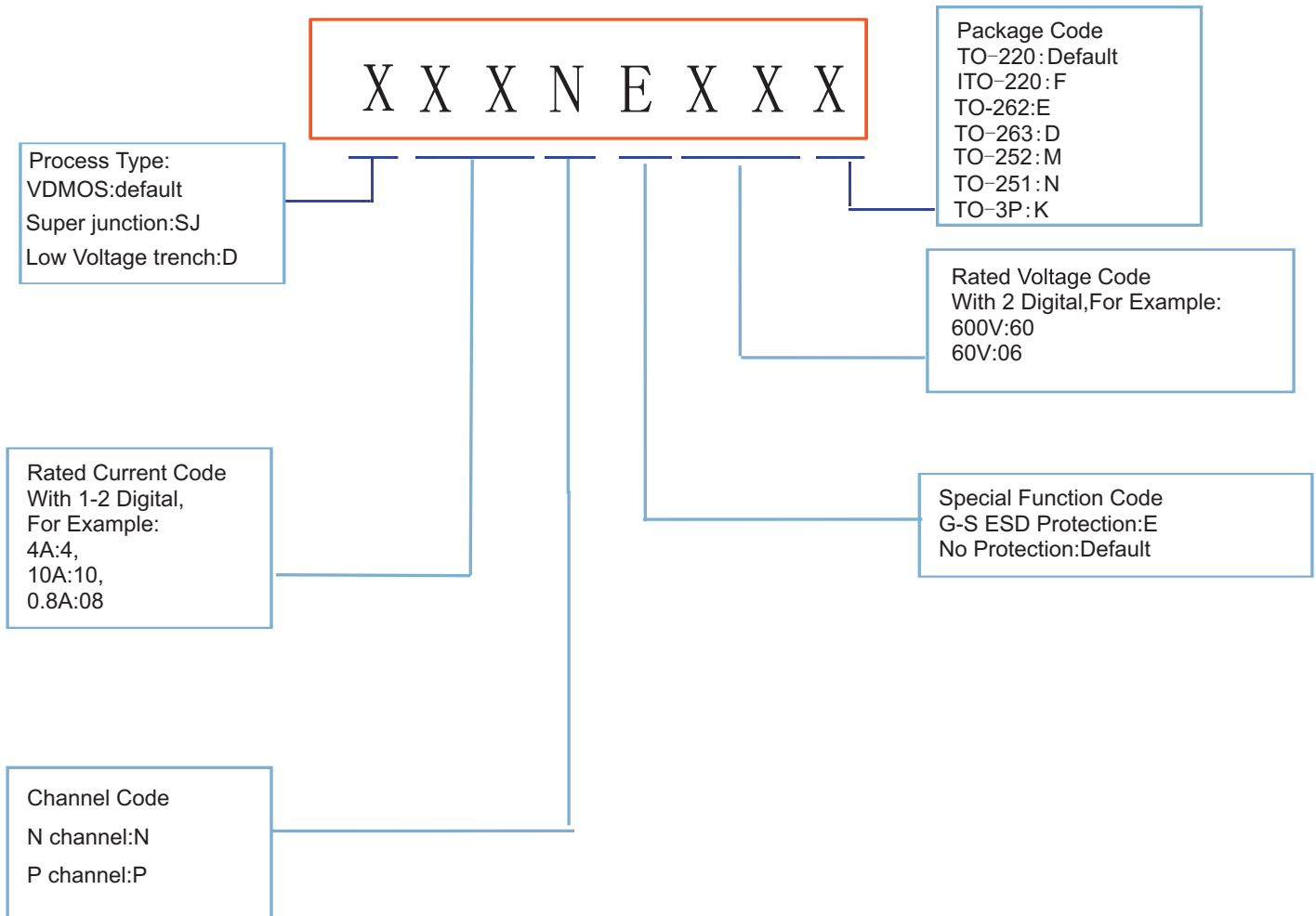


7) . Unclamped Inductive Switching Test Circuit



8) Unclamped Inductive Switching Waveforms

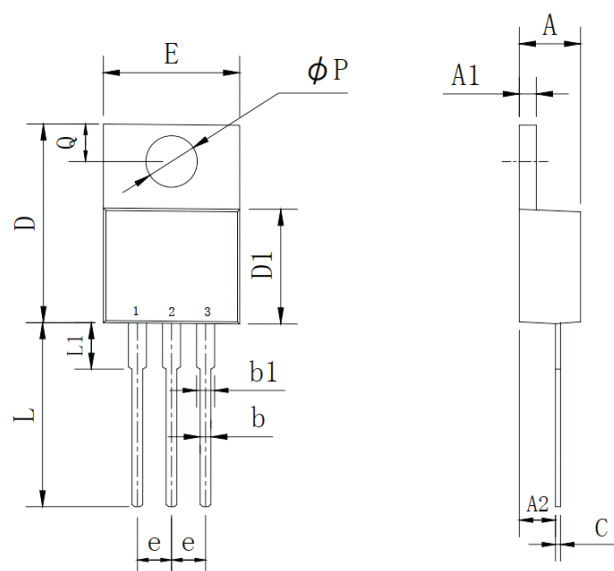
## Product Names Rules





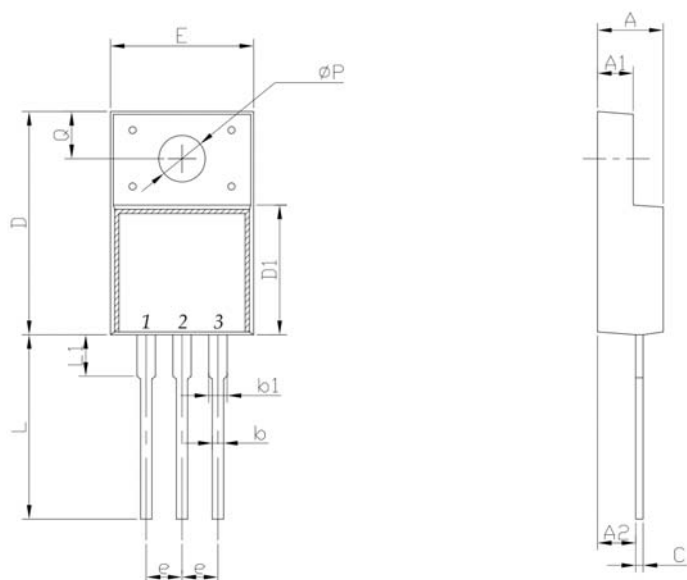
## Dimensions

### TO-220 PACKAGE OUTLINE DIMENSIONS



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	4.25	4.87	0.167	0.192
A1	1.07	1.47	0.042	0.058
A2	2.03	2.92	0.080	0.115
b	0.51	1.11	0.020	0.044
b1	0.97	1.6	0.038	0.063
C	0.3	0.7	0.012	0.028
D	14.6	15.9	0.575	0.626
D1	8.04	9.3	0.317	0.366
E	9.57	10.57	0.377	0.416
e	2.34	2.74	0.092	0.108
L	12.58	14.3	0.495	0.563
L1	2.8	4.2	0.110	0.165
P	3.4	4.14	0.134	0.163
Q	2.45	3	0.096	0.118

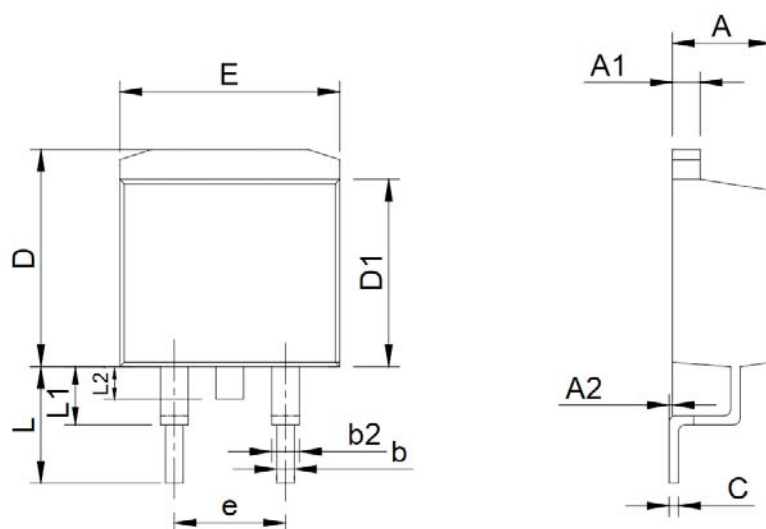
### ITO-220 PACKAGE OUTLINE DIMENSIONS



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	4.24	4.9	0.167	0.193
A1	2.3	2.92	0.091	0.115
A2	2.61	2.81	0.103	0.111
b	0.3	1	0.012	0.039
b1	0.9	1.55	0.035	0.061
C	0.3	0.7	0.012	0.028
D	14.5	16.36	0.571	0.644
D1	8.8	9.41	0.346	0.370
E	9.5	10.5	0.374	0.413
e	2.3	2.75	0.091	0.108
L	12.6	14	0.496	0.551
L1	2.45	4.3	0.096	0.169
P	2.9	3.8	0.114	0.150
Q	2.5	3.55	0.098	0.140

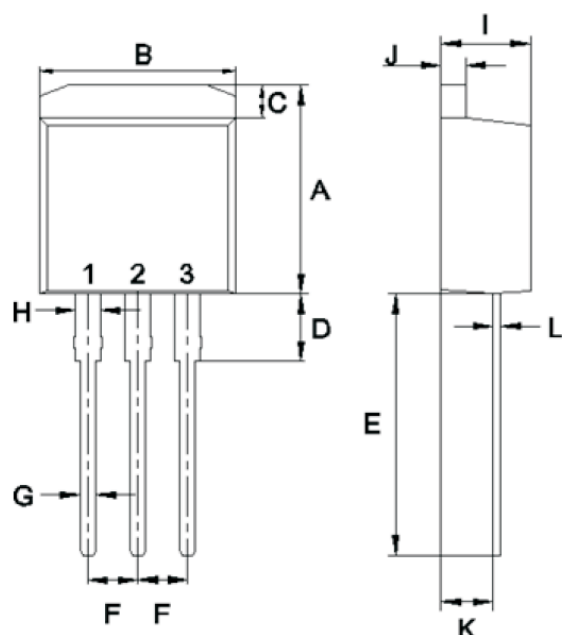
## Dimensions

### TO-263 PACKAGE OUTLINE DIMENSIONS



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	4.25	4.87	0.167	0.192
A1	1.07	1.47	0.042	0.058
A2	0	0.25	0.000	0.010
b	0.61	1.01	0.024	0.040
b1	1.2	1.34	0.047	0.053
C	0.3	0.6	0.012	0.024
D	9.48	10.84	0.373	0.427
D1	8.49	9.3	0.334	0.366
E	9.7	10.31	0.382	0.406
e	4.88	5.28	0.192	0.208
L	4.46	5.85	0.176	0.230
L1	1.33	2.33	0.052	0.092
L2	0	2.2	0.000	0.087

### TO-262 PACKAGE OUTLINE DIMENSIONS



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	10.14	11.14	0.399	0.439
B	9.57	10.57	0.377	0.416
C	1.15	1.84	0.045	0.072
D	2.95	3.95	0.116	0.156
E	12.25	13.75	0.482	0.541
F	2.34	2.74	0.092	0.108
G	0.51	1.11	0.020	0.044
H	0.97	1.57	0.038	0.062
I	4.25	4.87	0.167	0.192
J	1.07	1.47	0.042	0.058
K	2.03	2.92	0.080	0.115
L	0.3	0.6	0.012	0.024

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