

## N-Channel Power MOSFET (10A, 600Volts)

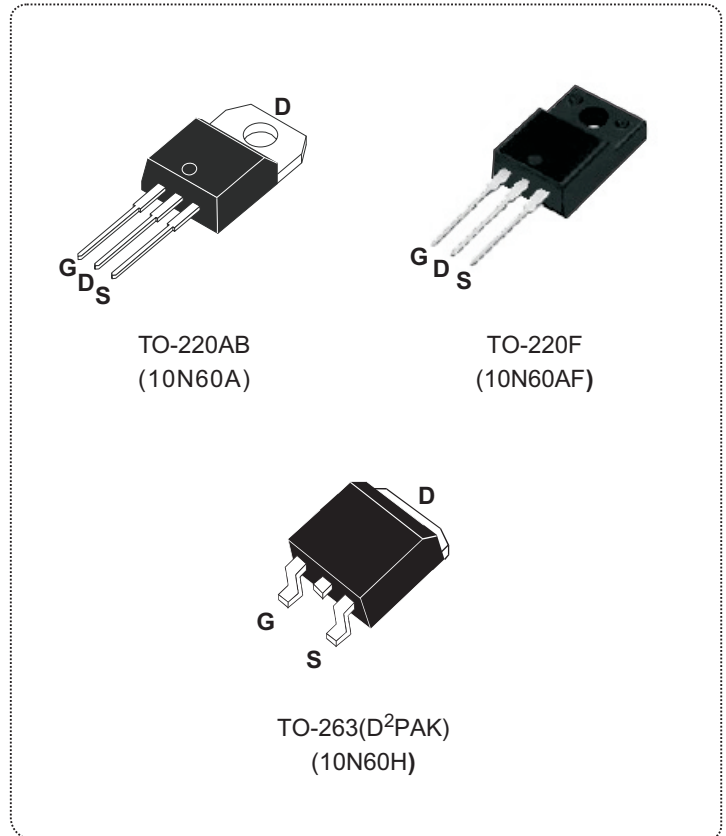
### DESCRIPTION

The Nell **10N60** is a three-terminal silicon device with current conduction capability of 10A, fast switching speed, low on-state resistance, breakdown voltage rating of 600V, and max. threshold voltage of 4 volts.

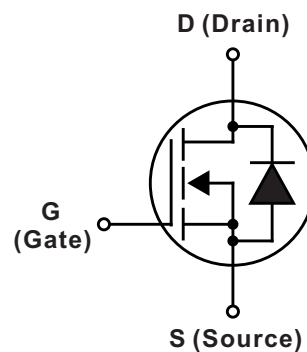
They are designed for use in applications such as switched mode power supplies, DC to DC converters, **PWM** motor controls, bridge circuits and general purpose switching applications.

### FEATURES

- $R_{DS(ON)} = 0.8\Omega @ V_{GS} = 10V$
- Ultra low gate charge(57nC max.)
- Low reverse transfer capacitance ( $C_{RSS} = 18pF$  typical)
- Fast switching capability
- 100% avalanche energy specified
- Improved dv/dt capability
- 150°C operation temperature



PRODUCT SUMMARY	
$I_D$ (A)	10
$V_{DSS}$ (V)	600
$R_{DS(ON)}$ ( $\Omega$ )	0.8 @ $V_{GS} = 10V$
$Q_G$ (nC) max.	57

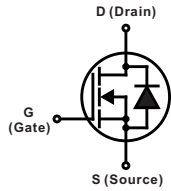


ABSOLUTE MAXIMUM RATINGS (T <sub>C</sub> = 25°C unless otherwise specified)					
SYMBOL	PARAMETER	TEST CONDITIONS		VALUE	UNIT
V <sub>DSS</sub>	Drain to Source voltage	T <sub>J</sub> =25°C to 150°C		600	V
V <sub>DGR</sub>	Drain to Gate voltage	R <sub>GS</sub> =20KΩ		600	
V <sub>GS</sub>	Gate to Source voltage			±30	
I <sub>D</sub>	Continuous Drain Current	T <sub>C</sub> =25°C		10	A
		T <sub>C</sub> =100°C		6.2	
I <sub>DM</sub>	Pulsed Drain current(Note 1)			40	
I <sub>AR</sub>	Avalanche current(Note 1)			10	
E <sub>AR</sub>	Repetitive avalanche energy(Note 1)	I <sub>AR</sub> =10A, R <sub>GS</sub> =50Ω, V <sub>GS</sub> =10V		15.6	
E <sub>AS</sub>	Single pulse avalanche energy (Note 2)	I <sub>AS</sub> =10A, L = 14.2mH		700	
dv/dt	Peak diode recovery dv/dt(Note 3)			4.5	V/ns
P <sub>D</sub>	Total power dissipation	T <sub>C</sub> =25°C	TO-220AB/ TO-263	156	W
			TO-220F	50	
T <sub>J</sub>	Operation junction temperature			-55 to 150	°C
T <sub>STG</sub>	Storage temperature			-55 to 150	
T <sub>L</sub>	Maximum soldering temperature, for 10 seconds	1.6mm from case		300	
	Mounting torque, #6-32 or M3 screw			10 (1.1)	lbf-in (N·m)

Note: 1.Repetitive rating: pulse width limited by junction temperature.  
 2.I<sub>AS</sub> = 10A, V<sub>DD</sub> = 50V, L = 14.2mH, R<sub>GS</sub> = 25Ω, starting T<sub>J</sub>=25°C.  
 3.I<sub>SD</sub> ≤ 10A, di/dt ≤ 200A/μs, V<sub>DD</sub> ≤ V<sub>(BR)DSS</sub>, starting T<sub>J</sub>=25°C.

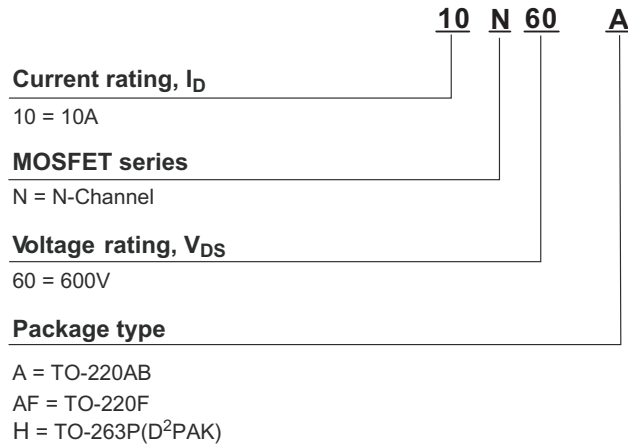
THERMAL RESISTANCE						
SYMBOL	PARAMETER		Min.	Typ.	Max.	UNIT
R <sub>th(j-c)</sub>	Thermal resistance, junction to case	TO-220AB/ TO-263			0.8	°C/W
		TO-220F			2.5	
R <sub>th(j-a)</sub>	Thermal resistance, junction to ambient	TO-220AB/TO-263			62.5	
		TO-220F			62.5	

ELECTRICAL CHARACTERISTICS (T <sub>C</sub> = 25°C unless otherwise specified)						
SYMBOL	PARAMETER	TEST CONDITIONS	Min.	Typ.	Max.	UNIT
V <sub>(BR)DSS</sub>	Drain to source breakdown voltage	I <sub>D</sub> = 250μA, V <sub>GS</sub> = 0V	600			V
ΔV <sub>(BR)DSS</sub> /ΔT <sub>J</sub>	Breakdown voltage temperature coefficient	I <sub>D</sub> = 250μA, V <sub>DS</sub> = V <sub>GS</sub>		0.7		V/°C
I <sub>DSS</sub>	Drain to source leakage current	V <sub>DS</sub> =600V, V <sub>GS</sub> =0V			10	μA
		T <sub>C</sub> = 25°C				
I <sub>GSS</sub>	Gate to source forward leakage current	V <sub>GS</sub> = 30V, V <sub>DS</sub> = 0V			100	nA
	Gate to source reverse leakage current	V <sub>GS</sub> = -30V, V <sub>DS</sub> = 0V			-100	
R <sub>DS(ON)</sub>	Static drain to source on-state resistance	I <sub>D</sub> = 5A, V <sub>GS</sub> = 10V		0.72	0.80	Ω
V <sub>GS(TH)</sub>	Gate threshold voltage	V <sub>GS</sub> =V <sub>DS</sub> , I <sub>D</sub> =250μA	2.0		4.0	V
C <sub>ISS</sub>	Input capacitance	V <sub>DS</sub> = 25V, V <sub>GS</sub> = 0V, f = 1MHz		1570	2040	pF
C <sub>OSS</sub>	Output capacitance			166	215	
C <sub>RSS</sub>	Reverse transfer capacitance			18	24	
t <sub>d(ON)</sub>	Turn-on delay time	V <sub>DD</sub> = 300V, V <sub>GS</sub> = 10V, I <sub>D</sub> = 10A R <sub>GS</sub> = 25Ω (Note 1, 2)		23	55	ns
t <sub>r</sub>	Rise time			69	150	
t <sub>d(OFF)</sub>	Turn-off delay time			144	300	
t <sub>f</sub>	Fall time			77	165	
Q <sub>G</sub>	Total gate charge	V <sub>DD</sub> = 480V, V <sub>GS</sub> = 10V, I <sub>D</sub> = 10A (Note 1, 2)		44	57	nC
Q <sub>GS</sub>	Gate to source charge			6.7		
Q <sub>GD</sub>	Gate to drain charge (Miller charge)			18.5		

SOURCE TO DRAIN DIODE RATINGS AND CHARACTERISTICS (T <sub>C</sub> = 25°C unless otherwise specified)						
SYMBOL	PARAMETER	TEST CONDITIONS	Min.	Typ.	Max.	UNIT
V <sub>SD</sub>	Diode forward voltage	I <sub>SD</sub> = 10A, V <sub>GS</sub> = 0V			1.4	V
I <sub>S</sub> (I <sub>SD</sub> )	Continuous source to drain current	Integral reverse P-N junction diode in the MOSFET			10	A
I <sub>SM</sub>	Pulsed source current				40	
t <sub>rr</sub>	Reverse recovery time	I <sub>SD</sub> = 10A, V <sub>GS</sub> = 0V, dI <sub>F</sub> /dt = 100A/μs		420		ns
Q <sub>rr</sub>	Reverse recovery charge				4.2	μC

Note: 1. Pulse test: Pulse width ≤ 300μs, duty cycle ≤ 2%.  
 2. Essentially independent of operating temperature.

## ORDERING INFORMATION SCHEME



## ■ TEST CIRCUITS AND WAVEFORMS

Fig.1A Peak diode recovery dv/dt test circuit

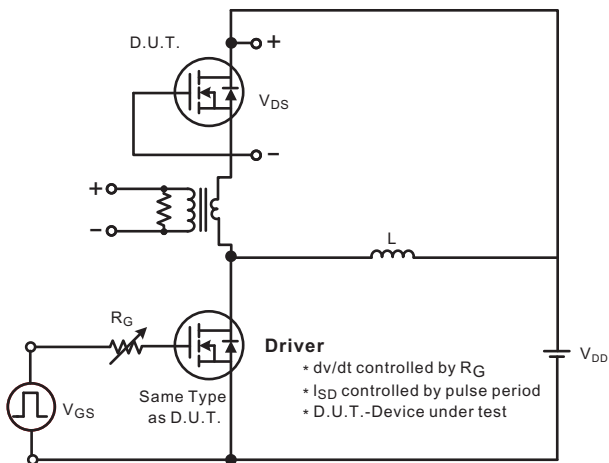
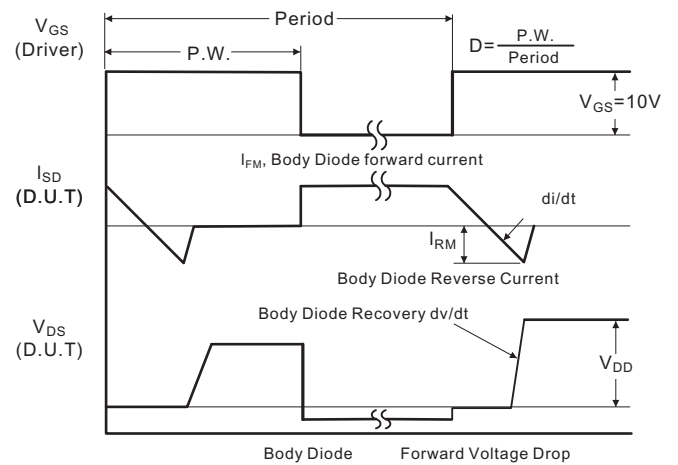


Fig.1B Peak diode recovery dv/dt waveforms



## TEST CIRCUITS AND WAVEFORMS (Cont.)

Fig.2A Switching test circuit

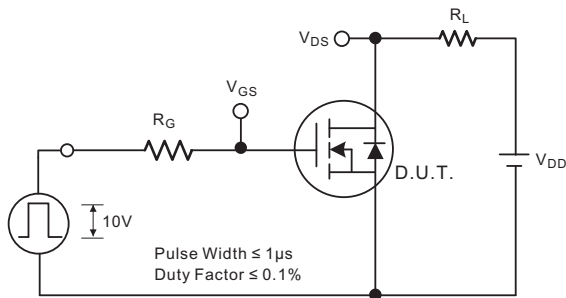


Fig.2B Switching Waveforms

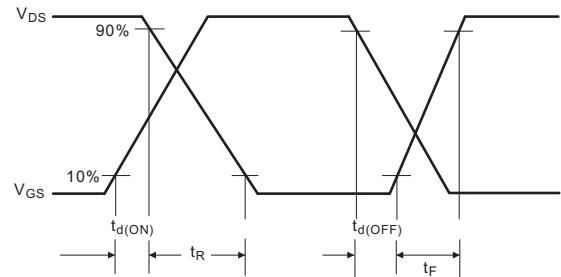


Fig.3A Gate charge test circuit

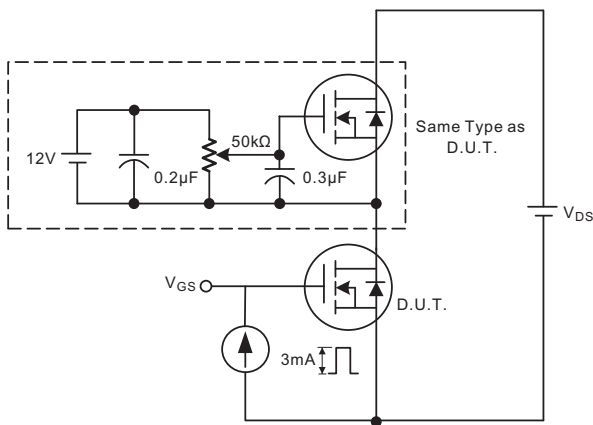


Fig.3B Gate charge waveform

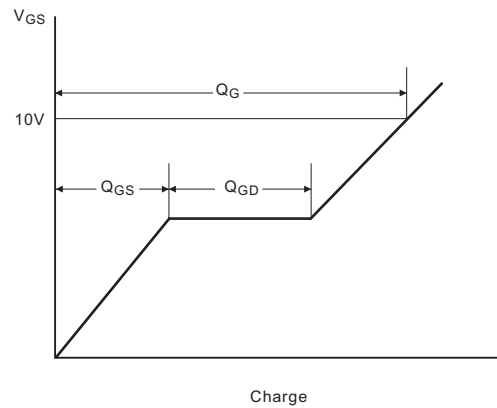


Fig.4A Unclamped Inductive switching test circuit

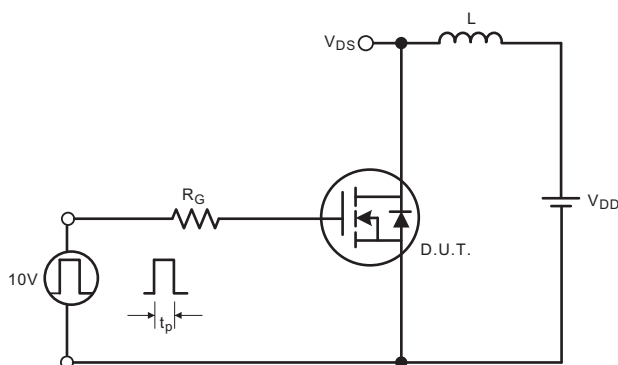
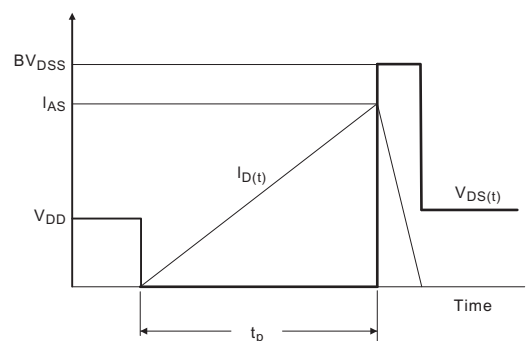
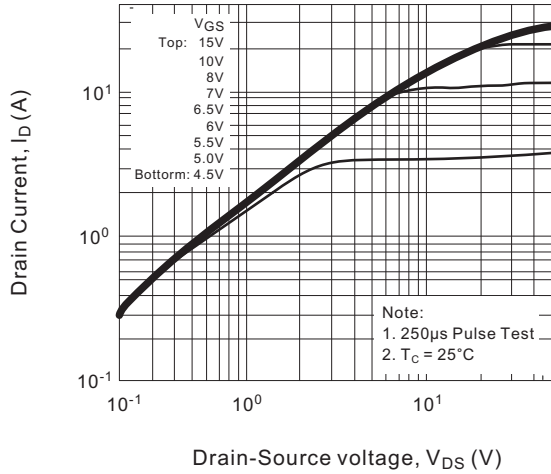


Fig.4B Unclamped Inductive switching waveforms

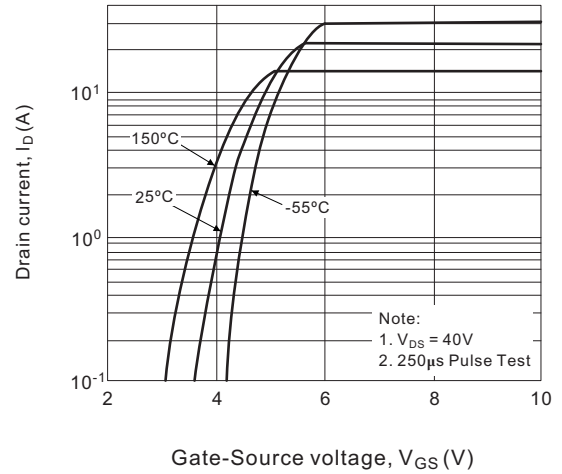


### ■ TYPICAL CHARACTERISTICS

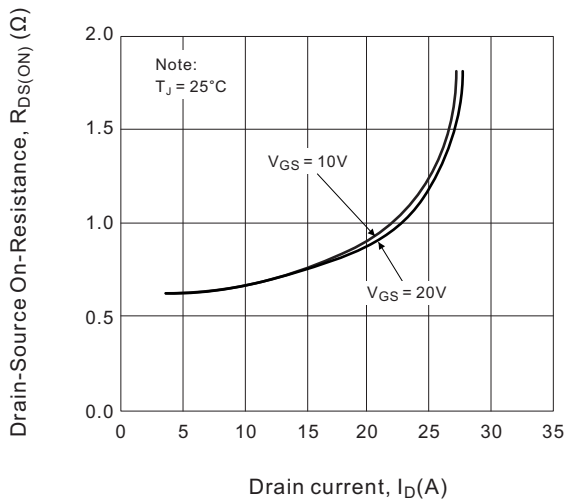
**Fig.1 On-State characteristics**



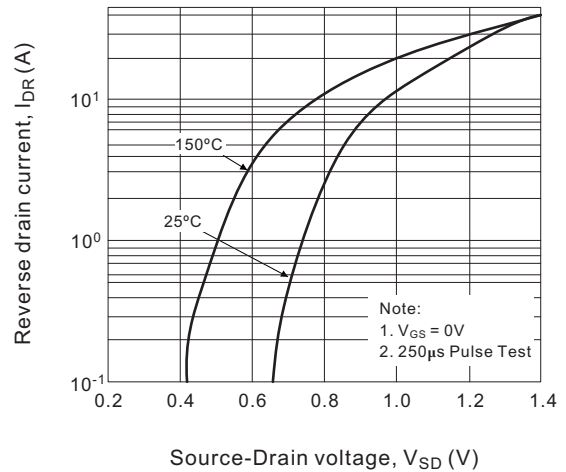
**Fig.2 Transfer characteristics**



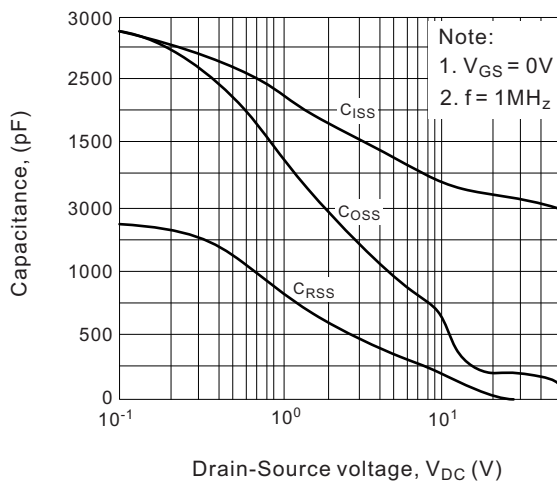
**Fig.3 On-Resistance variation vs. drain current and gate voltage**



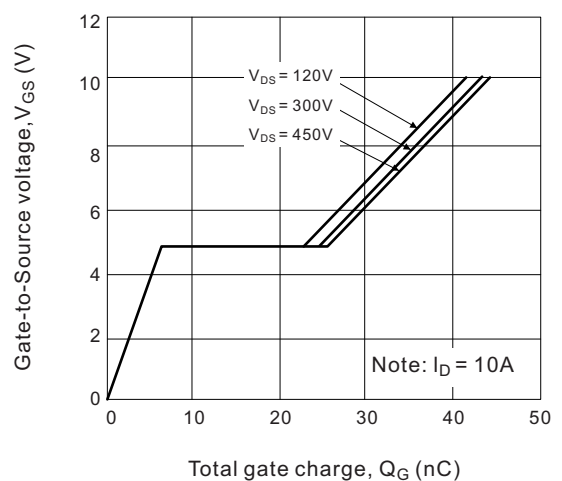
**Fig.4 Body diode forward voltage variation with Source current and Temperature**



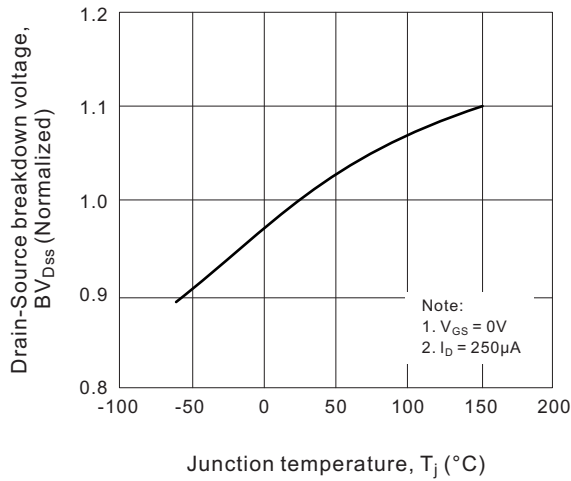
**Fig.5 Capacitance characteristics**



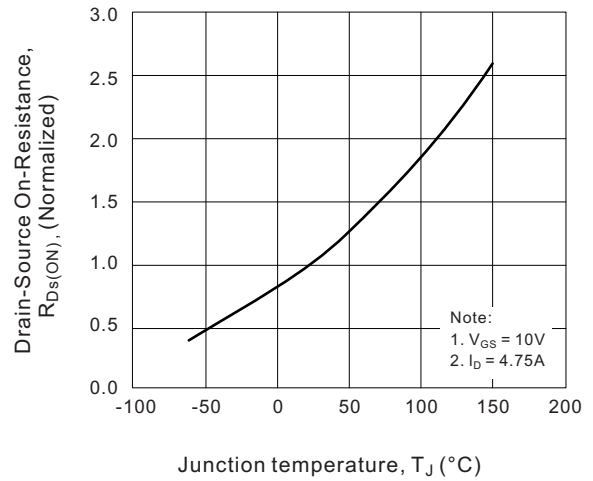
**Fig.6 Gate charge characteristics**



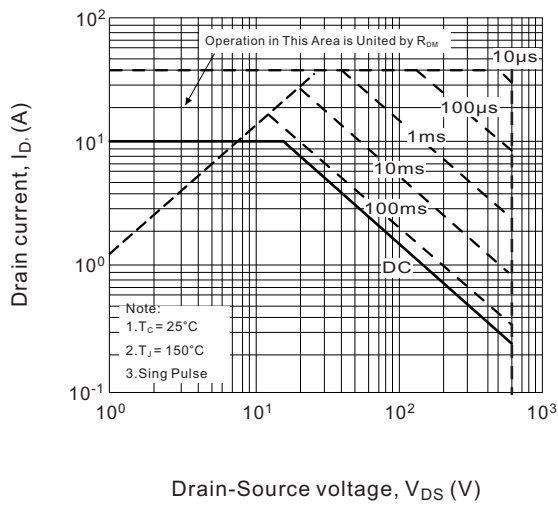
**Fig.7 Breakdown voltage variation vs. Temperature**



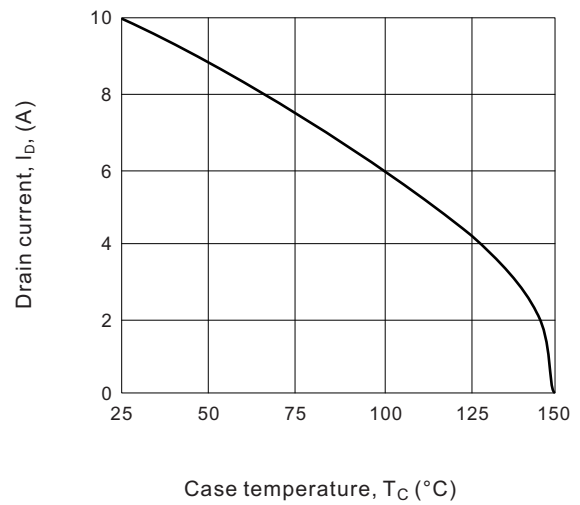
**Fig.8 On-Resistance variation vs. Temperature**



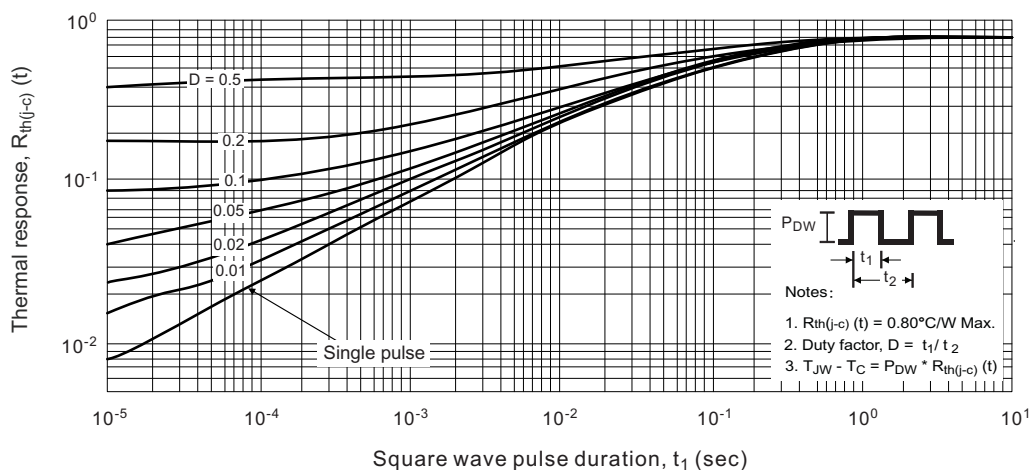
**Fig.9 Maximum safe operating area**



**Fig.10 Maximum drain current vs. Case temperature**

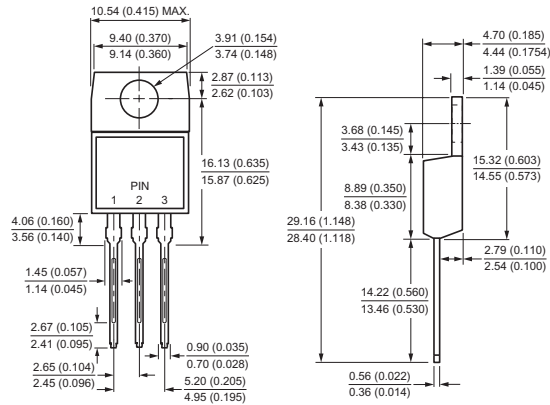


**Fig.11 Transient thermal response curve**

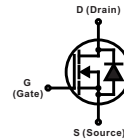


## Case Style

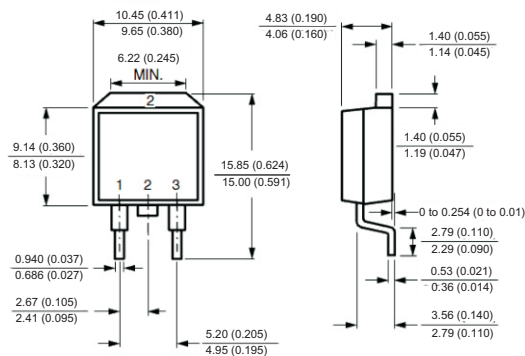
**TO-220AB**



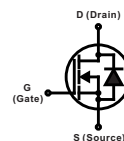
All dimensions in millimeters(inches)



**TO-263(D<sup>2</sup>PAK)**



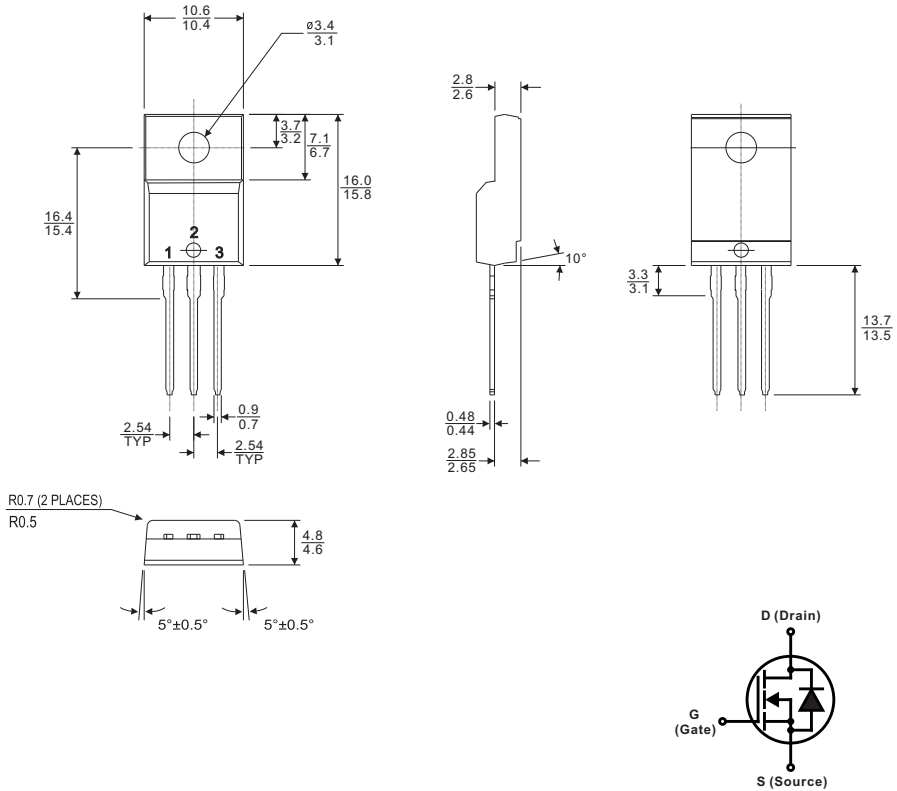
All dimensions in millimeters(inches)





## Case Style

### TO-220F



All dimensions in millimeters