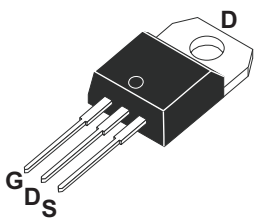
N-Channel Power MOSFET
13A, 600Volts

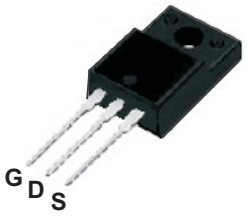
DESCRIPTION

The Nell **13N60** is a three-terminal silicon device with current conduction capability of 13A, 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.



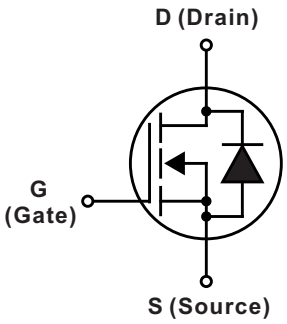
TO-220AB
(13N60A)



TO-220F
(13N60AF)

FEATURES

- $R_{DS(ON)}$ = 0.26Ω @ V_{GS} = 10V
- Ultra low gate charge(40nC max.)
- Low reverse transfer capacitance (C_{RSS} = 3pF typical)
- Fast switching capability
- 100% avalanche energy specified
- Improved dv/dt capability
- 150°C operation temperature



PRODUCT SUMMARY	
I_D (A)	13
V_{DSS} (V)	600
$R_{DS(ON)}$ (Ω)	0.26 @ V_{GS} = 10V
Q_G(nC) max.	40

ABSOLUTE MAXIMUM RATINGS (T_C = 25°C unless otherwise specified)

SYMBOL	PARAMETER	TEST CONDITIONS		VALUE	UNIT
V_{DSS}	Drain to Source voltage	T_J=25°C to 150°C		600	V
V_{DGR}	Drain to Gate voltage	R_{GS}=20KΩ		600	
V_{GS}	Gate to Source voltage			±30	
I_D	Continuous Drain Current	T_C=25°C		13	A
		T_C=100°C		8.2	
I_{DM}	Pulsed Drain current(Note 1)			39	
I_{AR}	Avalanche current(Note 1)			4.3	
E_{AR}	Repetitive avalanche energy(Note 1)	I_{AR}=4.3A,R_{GS}=50Ω, V_{GS}=10V		1.2	mJ
E_{AS}	Single pulse avalanche energy (Note 2)	I_{AS}=4.3A		235	
dv/dt	MOSFET dv/dt ruggedness			100	V /ns
	Peak diode recovery dv/dt (Note 3)			20	
P_D	Total power dissipation (Derate above 25°C)	T_C=25°C	TO-220AB	116(0.93)	W(W/°C)
			TO-220F	34(0.27)	
T_J	Operation junction temperature			-55 to 150	
T_{STG}	Storage temperature			-55 to 150	°C
T_L	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)

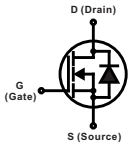
Note: 1.Repetitive rating: pulse width limited by junction temperature..
2.I_{AS}=4.3A, V_{DD}=50V, R_{GS}=25Ω, starting T_J = 25 °C.
3.I_{SD} ≤ 13A, di/dt ≤ 200A/μs, V_{DD} ≤ $V_{(BR)DSS}$, starting T_J = 25°C.

THERMAL RESISTANCE

SYMBOL	PARAMETER		Min.	Typ.	Max.	UNIT
$R_{th(j-c)}$	Thermal resistance, junction to case	TO-220AB			1.07	°C/W
		TO-220F			3.7	
$R_{th(j-a)}$	Thermal resistance, junction to ambient	TO-220AB			62.5	°C/W
		TO-220F			62.5	

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise specified)

SYMBOL	PARAMETER	TEST CONDITIONS		Min.	Typ.	Max.	UNIT
◎ OFF CHARACTERISTICS							
$V_{(BR)DSS}$	Drain to source breakdown voltage	I_D = 1mA, V_{GS} = 0V		600			V
$\Delta V_{(BR)DSS}/\Delta T_J$	Breakdown voltage temperature coefficient	I_D = 1mA, V_{DS} = V_{GS}			0.73		V/°C
I_{DSS}	Drain to source leakage current	V_{DS}=600V, V_{GS}=0V	T_C = 25°C			10	μA
		V_{DS}=480V, V_{GS}=0V	T_C=125°C			100	
I_{GSS}	Gate to source forward leakage current	V_{GS} = 30V, V_{DS} = 0V				100	nA
	Gate to source reverse leakage current	V_{GS} = -30V, V_{DS} = 0V				-100	
◎ ON CHARACTERISTICS							
$R_{DS(ON)}$	Static drain to source on-state resistance	V_{GS} = 10V, I_D = 6.5A			0.24	0.26	Ω
$V_{GS(TH)}$	Gate threshold voltage	V_{GS}=V_{DS}, I_D=250μA		2		4	V
gfs	Forward transconductance	V_{DS}=40V, I_D=6.5A			16.3		S
◎ DYNAMIC CHARACTERISTICS							
C_{ISS}	Input capacitance	V_{DS} = 100V, V_{GS} = 0V, f =1MHz			1325	1765	pF
C_{OSS}	Output capacitance				50	65	
C_{RSS}	Reverse transfer capacitance				3	5	
C_{OSS}	Output capacitance	V_{DS} = 380V, V_{GS} = 0V, f =1MHz			30		
C_{OSS} eff	Effective output capacitance	V_{DS} = 0 to 480V, V_{GS} = 0V			145		
Q_G	Total gate charge	V_{DD} = 380V, V_{GS} = 10V I_D = 6.5A, (Note1,2)			30.5	40	nC
Q_{GS}	Gate to source charge				6.0		
Q_{GD}	Gate to drain charge (Miller charge)				9.5		
ESR	Equivalent series resistance (G-S)	Drain open			2.8		Ω
◎ SWITCHING CHARACTERISTICS							
$t_{d(ON)}$	Turn-on delay time	V_{DD} = 380V, V_{GS} = 10V I_D = 6.5A, R_G=4.7Ω (Note1,2)			14.5	39	ns
t_r	Rise time				10.5	31.5	
$t_{d(OFF)}$	Turn-off delay time				45	100	
t_f	Fall time				10	30	

SOURCE TO DRAIN DIODE RATINGS AND CHARACTERISTICS (T_C = 25°C unless otherwise specified)						
SYMBOL	PARAMETER	TEST CONDITIONS	Min.	Typ.	Max.	UNIT
V_{SD}	Diode forward voltage	I_{SD} = 6.5A, V_{GS} = 0V			1.2	V
$I_S(I_{SD})$	Continuous source to drain current	Integral reverse P-N junction diode in the MOSFET 			13	A
I_{SM}	Pulsed source current				39	
t_{rr}	Reverse recovery time	I_{SD} = 6.5A, V_{GS} = 0V, dI_F/dt = 100A/μs		280		ns
Q_{rr}	Reverse recovery charge			3.5		μC

Note: 1. Pulse test: Pulse width ≤ 300μs, duty cycle ≤ 2%.

2. Essentially independent of operating temperature.

ORDERING INFORMATION SCHEME

13 N 60 A

Current rating, I_D

13 = 13A

MOSFET series

N = N-Channel

Voltage rating, V_{DS}

60 = 600V

Package type

A = TO-220AB

AF = TO-220F

■ TEST CIRCUITS AND WAVEFORMS

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

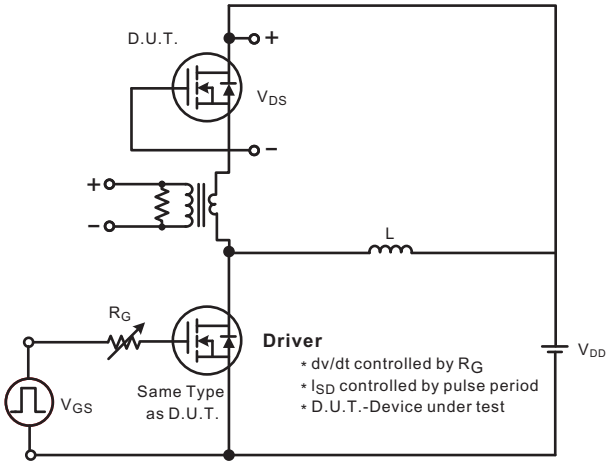
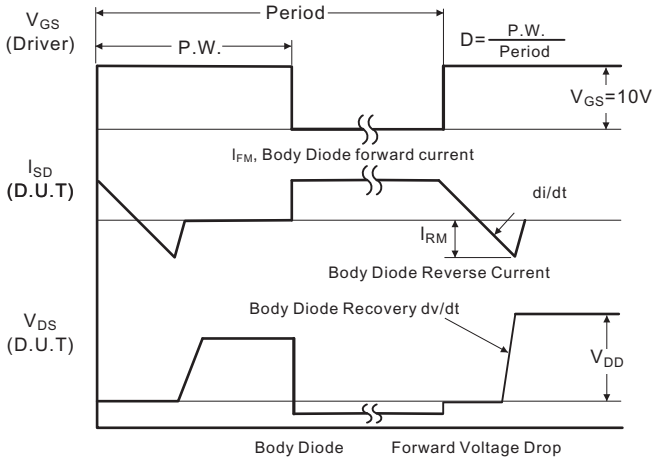


Fig.1B Peak diode recovery dv/dt waverforms



■ TEST CIRCUITS AND WAVEFORMS(Cont.)

Fig.2A Switching test circuit

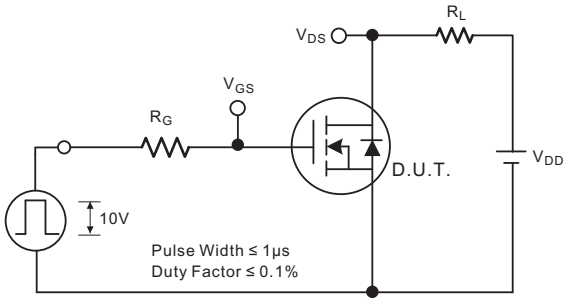


Fig.2B Switching Waveforms

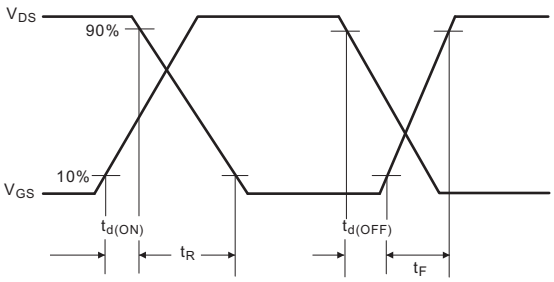


Fig.3A Gate charge test circuit

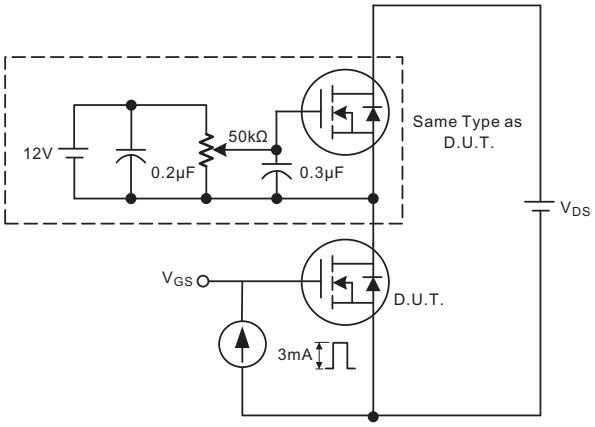


Fig.3B Gate charge waveform

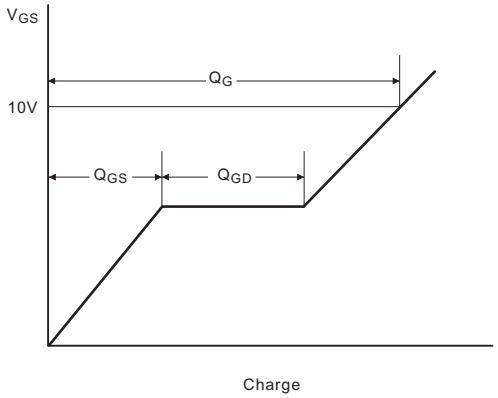


Fig.4A Unclamped Inductive switching test circuit

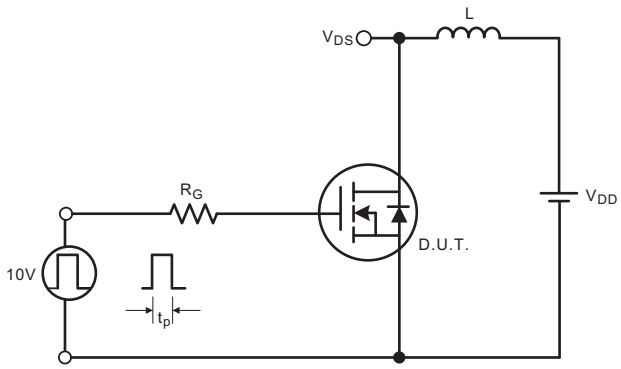
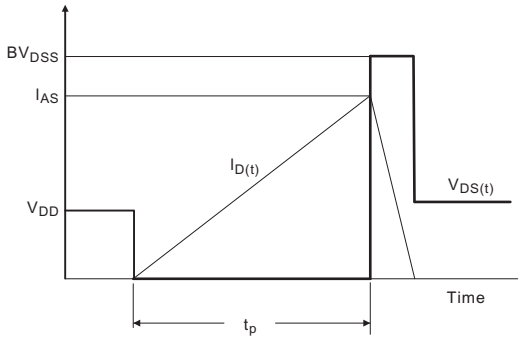


Fig.4B Unclamped Inductive switching waveforms



■ TYPICAL CHARACTERISTICS

Fig.1 On-State characteristics

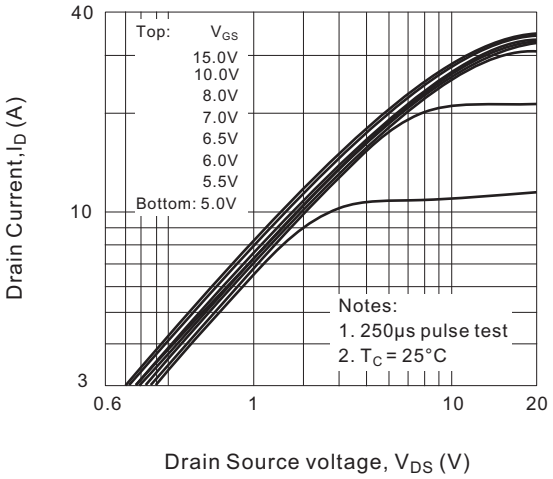


Fig.2 Transfer characteristics

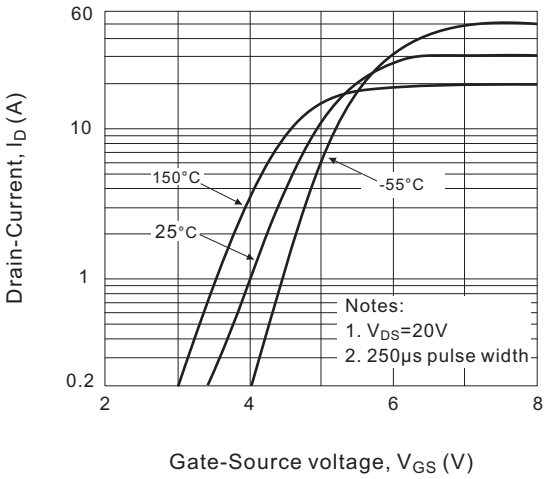


Fig.3 On-Resistance variation vs. Drain current and Gate voltage

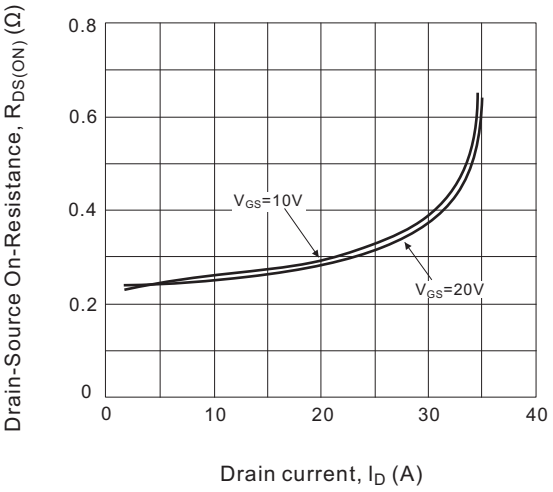


Fig.4 Body diode forward voltage variation vs Source current and Temperature

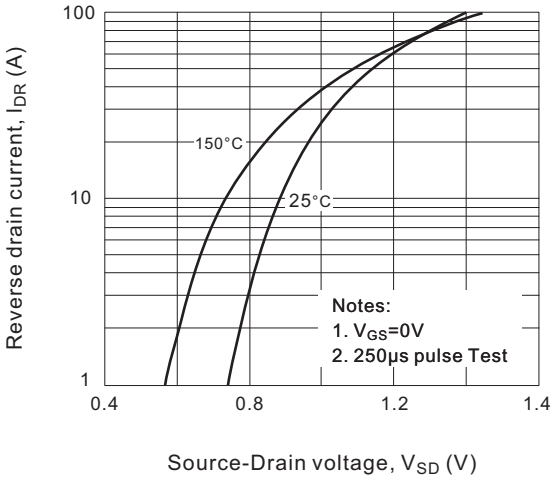


Fig.5 Capacitance characteristics

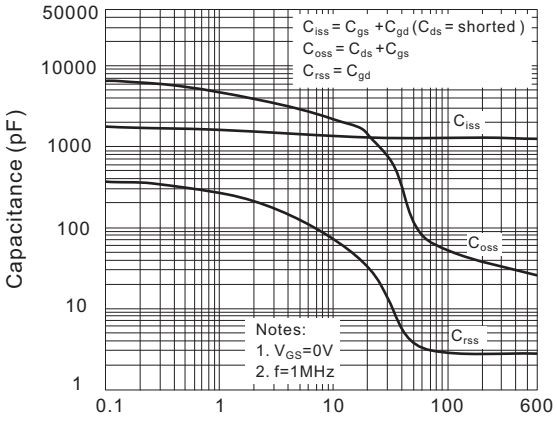


Fig.6 Gate charge characteristics

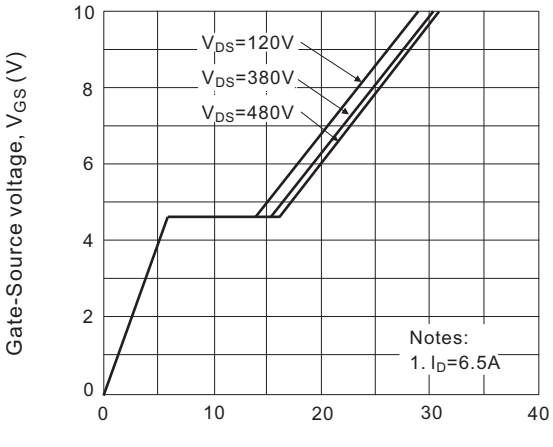


Fig.7a Maximum safe operating area for 13N60A

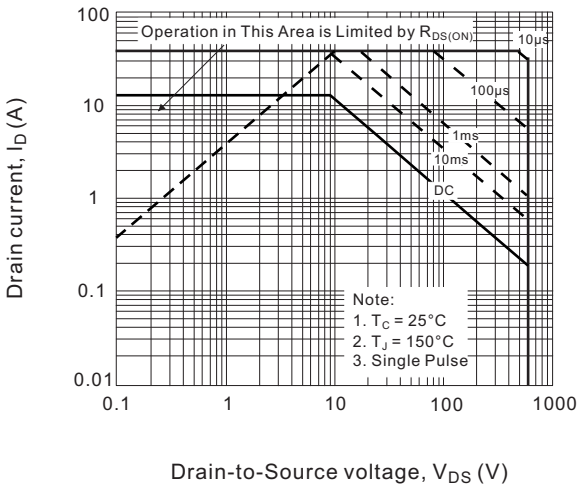


Fig.7b Maximum safe operating area for 13N60AF

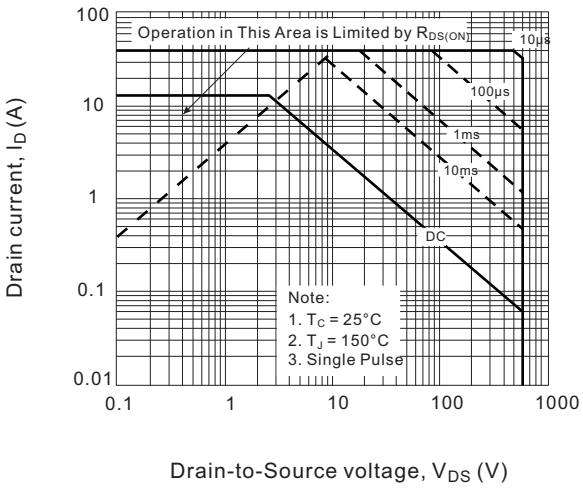


Fig.8a Transient thermal response curve for 13N60A

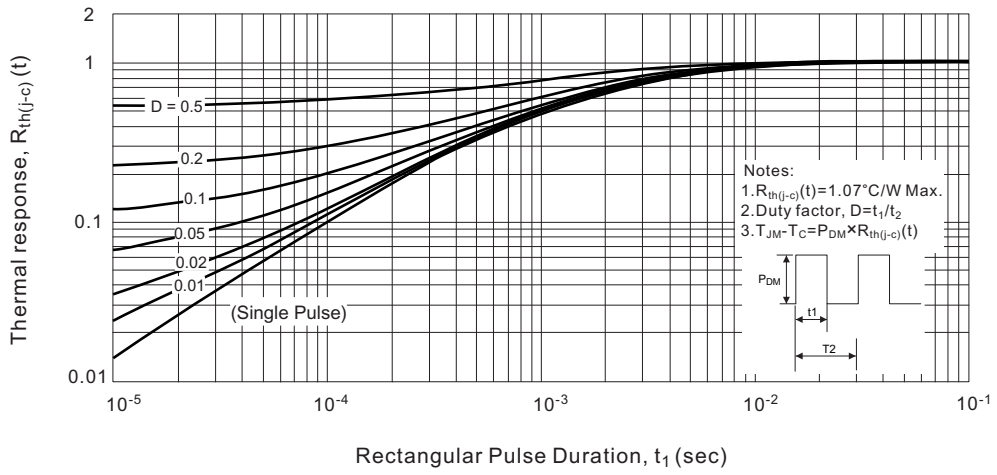


Fig.8b Transient thermal response curve for 13N60AF

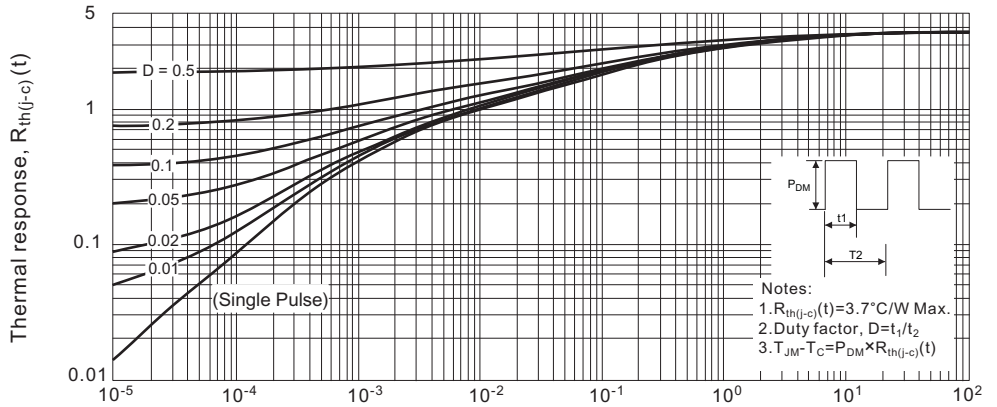


Fig.9 Breakdown voltage variation vs. temperature

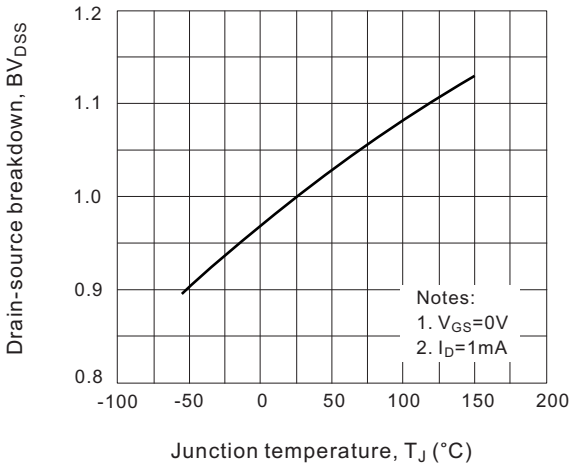


Fig.10 On-resistance variation vs. temperature

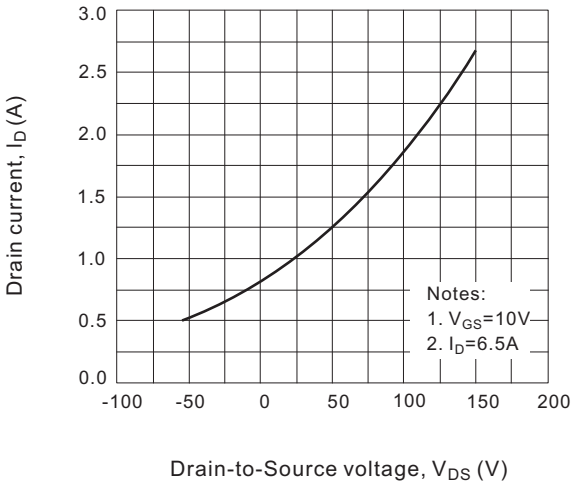
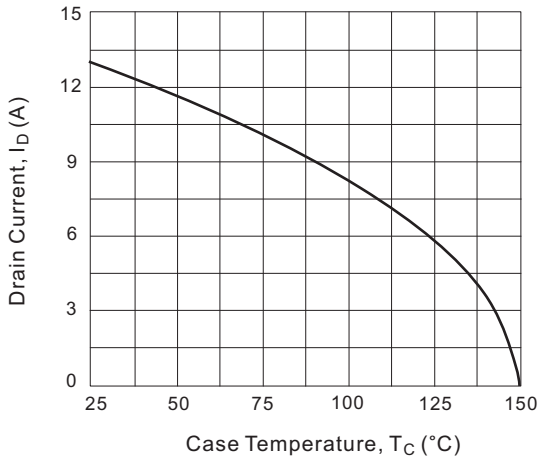
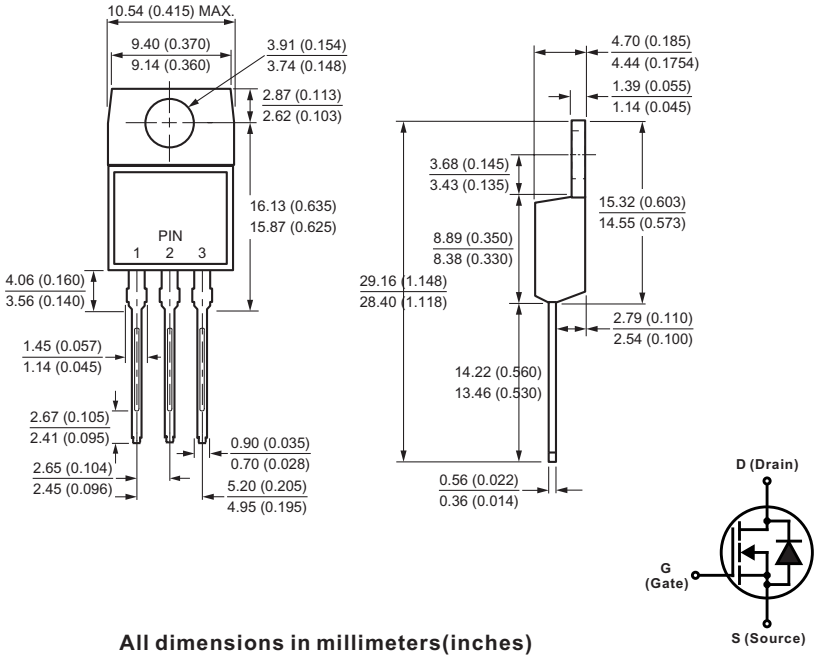


Fig.11 Maximum drain current vs.case temperature

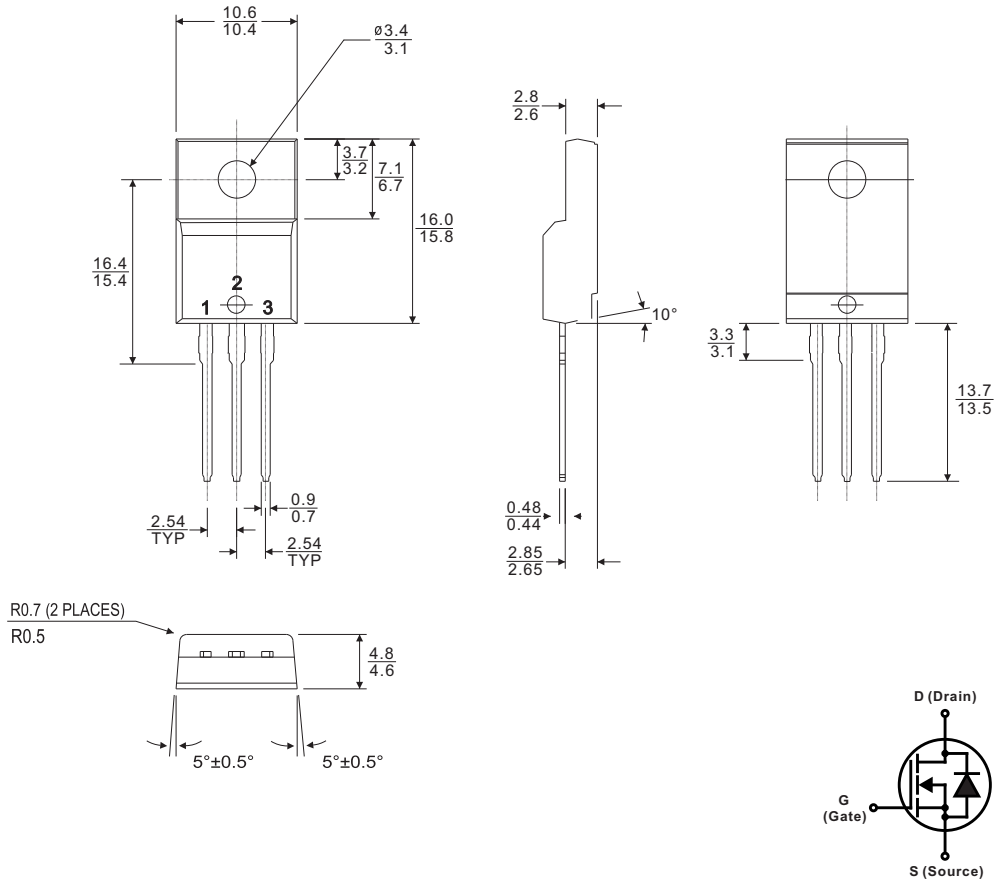


TO-220AB



All dimensions in millimeters(inches)

TO-220F



All dimensions in millimeters