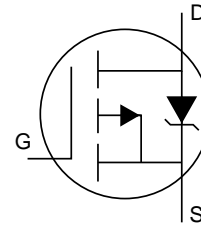


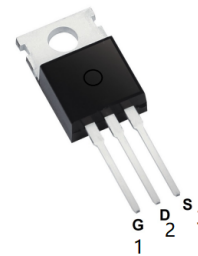
Description

The TO-220 package is universally preferred for all commercial-industrial applications at power dissipation levels to approximately 50 watts. The low thermal resistance and low package cost of the TO-220 contribute to its wide acceptance throughout the industry.



Features

- $V_{DS} (V) = -55V$
- $I_D = -12A (V_{GS} = -10V)$
- $R_{DS(ON)} < 170m\Omega (V_{GS} = -10V)$



Absolute Maximum Ratings

	Parameter	Max.	Units
$I_D @ T_C = 25^\circ C$	Continuous Drain Current, $V_{GS} @ -10V$	-12	A
$I_D @ T_C = 100^\circ C$	Continuous Drain Current, $V_{GS} @ -10V$	-8.5	
I_{DM}	Pulsed Drain Current ①	-48	
$P_D @ T_C = 25^\circ C$	Power Dissipation	45	W
	Linear Derating Factor	0.30	W/°C
V_{GS}	Gate-to-Source Voltage	± 20	V
E_{AS}	Single Pulse Avalanche Energy②	96	mJ
I_{AR}	Avalanche Current①	-7.2	A
E_{AR}	Repetitive Avalanche Energy①	4.5	mJ
dv/dt	Peak Diode Recovery dv/dt ③	-5.0	V/ns
T_J	Operating Junction and	-55 to + 175	°C
T_{STG}	Storage Temperature Range		
	Soldering Temperature, for 10 seconds		
	Mounting torque, 6-32 or M3 screw	10 lbf•in (1.1N•m)	

Thermal Resistance

	Parameter	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case		3.3	°C/W
$R_{\theta CS}$	Case-to-Sink, Flat, Greased Surface	0.50		
$R_{\theta JA}$	Junction-to-Ambient		62	

	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)DSS}$	Drain-to-Source Breakdown Voltage	-55			V	$V_{GS} = 0V, I_D = -250\mu A$
$\Delta V_{(BR)DSS}/\Delta T_J$	Breakdown Voltage Temp. Coefficient		-0.05		V/°C	Reference to 25°C, $I_D = -1mA$
$R_{DS(on)}$	Static Drain-to-Source On-Resistance			175	mΩ	$V_{GS} = -10V, I_D = -7.2A$ ④
$V_{GS(th)}$	Gate Threshold Voltage	-2.0		-4.0	V	$V_{DS} = V_{GS}, I_D = -250\mu A$
g_{fs}	Forward Transconductance	2.5			S	$V_{DS} = -25V, I_D = -7.2A$
I_{DSS}	Drain-to-Source Leakage Current			-25	μA	$V_{DS} = -55V, V_{GS} = 0V$
				-250		$V_{DS} = -44V, V_{GS} = 0V, T_J = 150°C$
I_{GSS}	Gate-to-Source Forward Leakage			100	nA	$V_{GS} = 20V$
	Gate-to-Source Reverse Leakage			-100		$V_{GS} = -20V$
Q_g	Total Gate Charge			19	nC	$I_D = -7.2A$
Q_{gs}	Gate-to-Source Charge			5.1		$V_{DS} = -44V$
Q_{gd}	Gate-to-Drain ("Miller") Charge			10		$V_{GS} = -10V$, See Fig. 6 and 13 ④
$t_{d(on)}$	Turn-On Delay Time		13		ns	$V_{DD} = -28V$ $I_D = -7.2A$ $R_G = 24\Omega$ $R_D = 3.7\Omega$, See Fig. 10 ④
t_r	Rise Time		55			
$t_{d(off)}$	Turn-Off Delay Time		23			
t_f	Fall Time		37			
L_D	Internal Drain Inductance		4.5		nH	Between lead, 6mm (0.25in.) from package and center of die contact
L_S	Internal Source Inductance		7.5			
C_{iss}	Input Capacitance		350		pF	$V_{GS} = 0V$ $V_{DS} = -25V$ $f = 1.0MHz$, See Fig. 5
C_{oss}	Output Capacitance		170			
C_{riss}	Reverse Transfer Capacitance		92			

Source-Drain Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Conditions
I_S	Continuous Source Current (Body Diode)			-12	A	MOSFET symbol showing the integral reverse p-n junction diode.
I_{SM}	Pulsed Source Current (Body Diode) ①			-48		
V_{SD}	Diode Forward Voltage			-1.6	V	$T_J = 25°C, I_S = -7.2A, V_{GS} = 0V$ ④
t_{rr}	Reverse Recovery Time		47	71	ns	$T_J = 25°C, I_F = -7.2A$
Q_{rr}	Reverse Recovery Charge		84	130	μC	$di/dt = -100A/\mu s$ ④
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S+L_D)				

Notes:

- ① Repetitive rating; pulse width limited by max. junction temperature. (See fig. 11)
- ② Starting $T_J = 25°C, L = 3.7mH$
 $R_G = 25\Omega, I_{AS} = -7.2A$. (See Figure 12)
- ③ $I_{SD} \leq -7.2A, di/dt \leq -280A/\mu s, V_{DD} \leq V_{(BR)DSS}$
 $T_J \leq 175°C$
- ④ Pulse width $\leq 300\mu s$; duty cycle $\leq 2\%$.

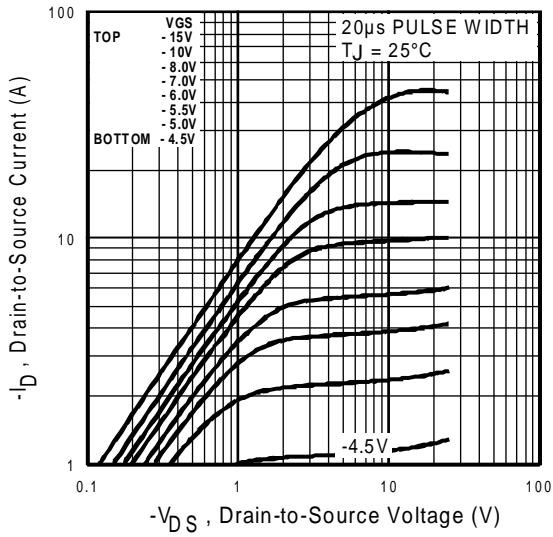


Fig 1. Typical Output Characteristics,

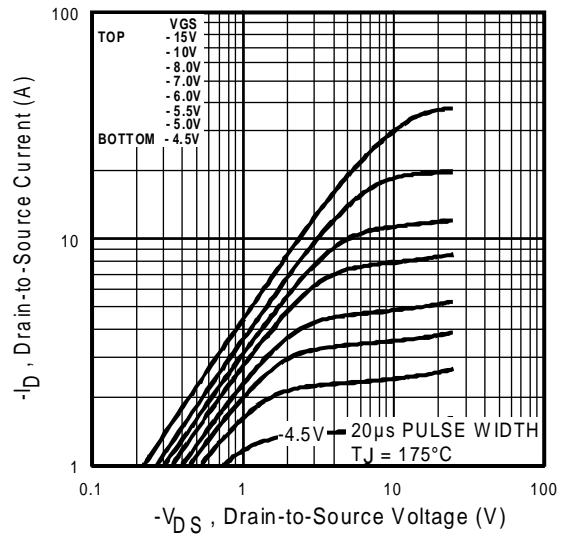


Fig 2. Typical Output Characteristics,

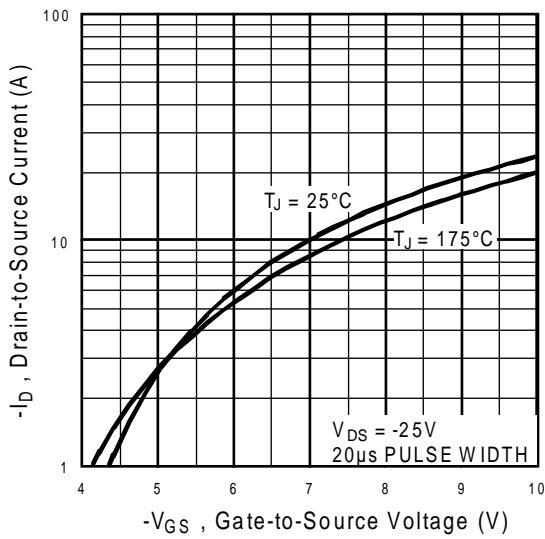


Fig 3. Typical Transfer Characteristics

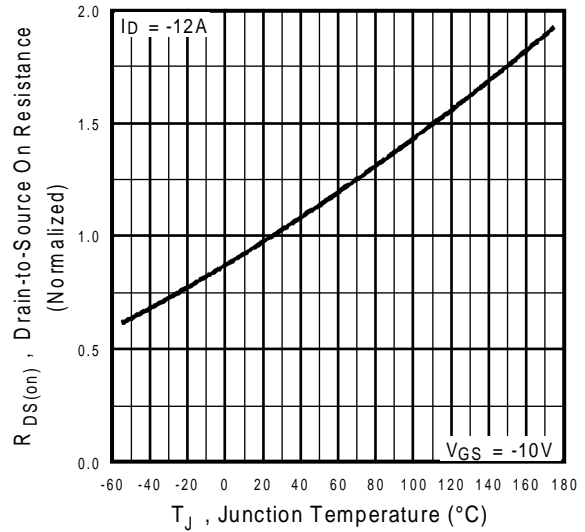


Fig 4. Normalized On-Resistance Vs. Temperature

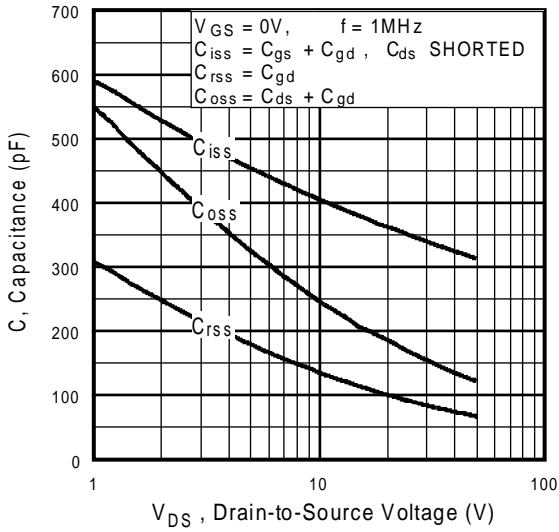


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

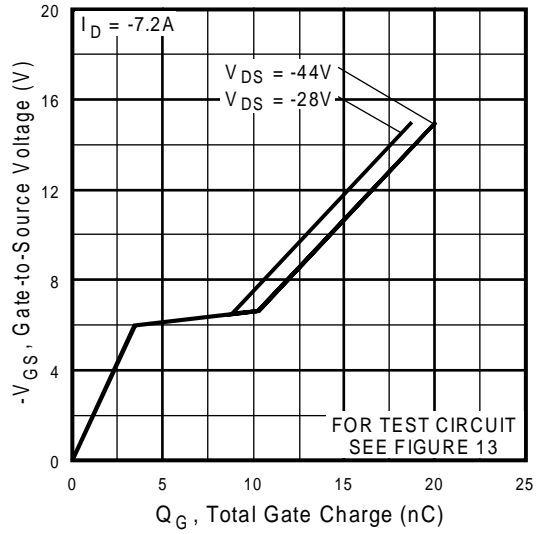


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

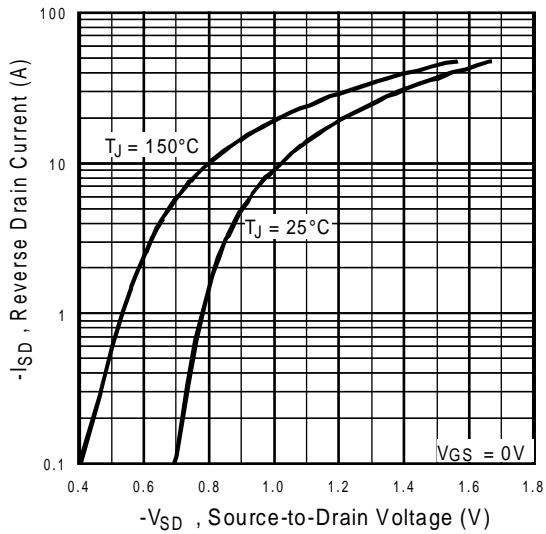


Fig 7. Typical Source-Drain Diode Forward Voltage

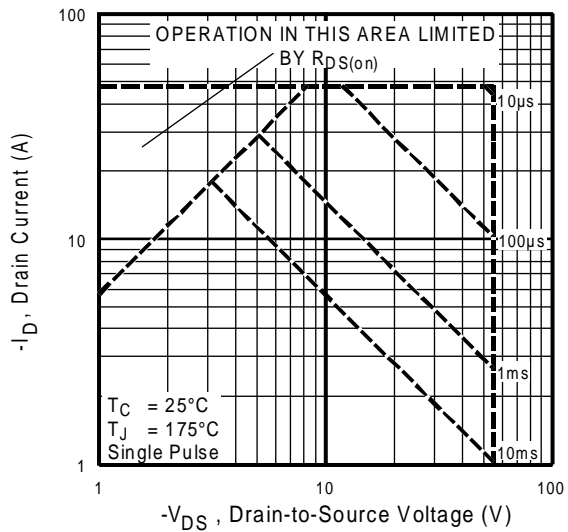


Fig 8. Maximum Safe Operating Area

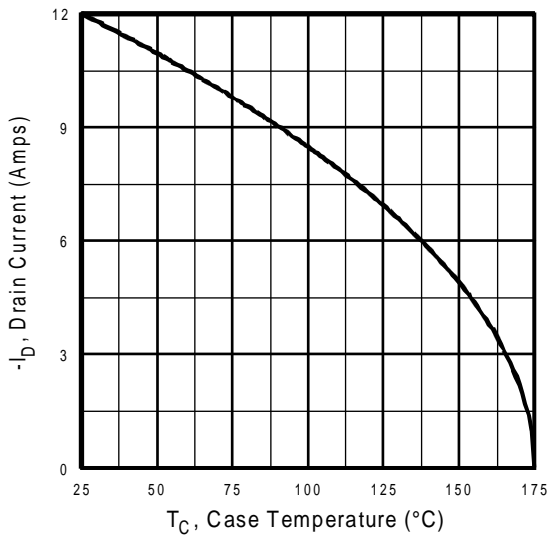


Fig 9. Maximum Drain Current Vs. Case Temperature

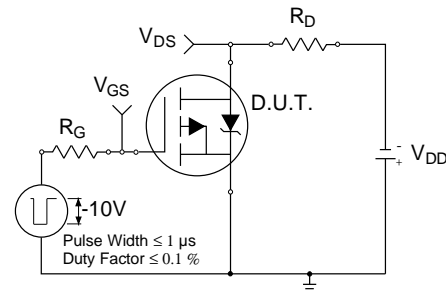


Fig 10a. Switching Time Test Circuit

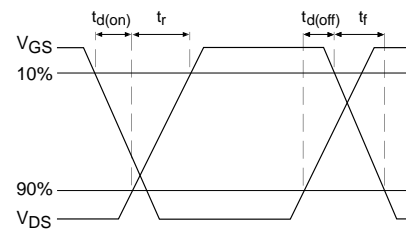


Fig 10b. Switching Time Waveforms

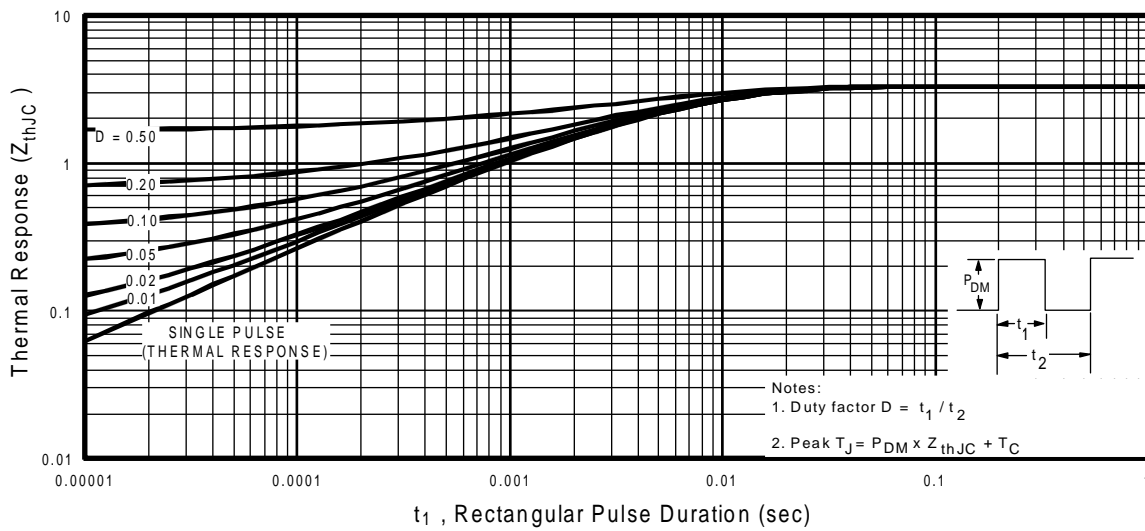


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

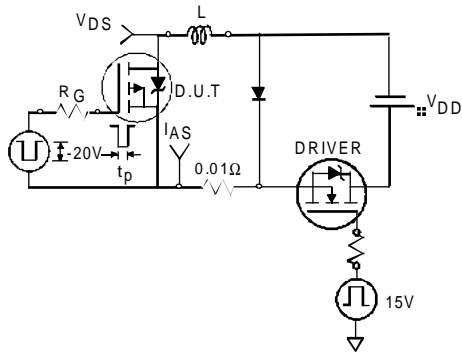


Fig 12a. Unclamped Inductive Test Circuit

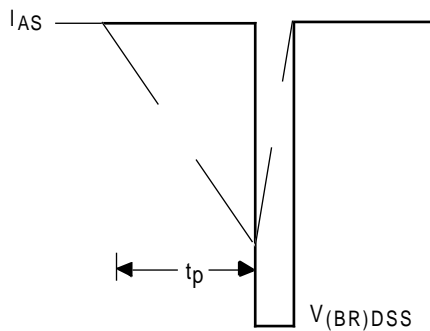


Fig 12b. Unclamped Inductive Waveforms

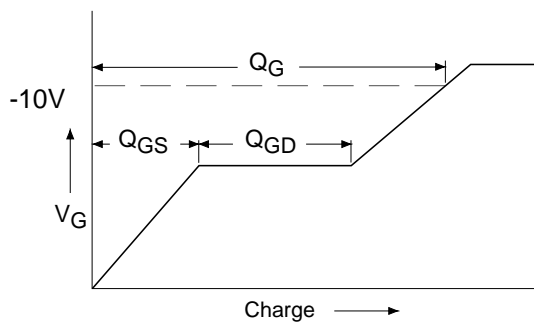


Fig 13a. Basic Gate Charge Waveform

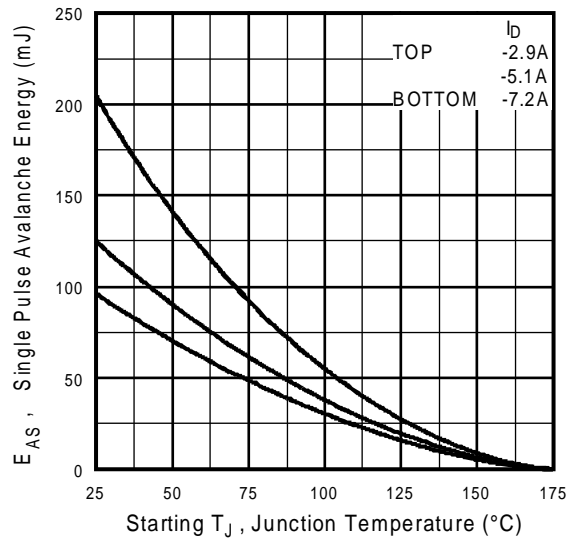


Fig 12c. Maximum Avalanche Energy Vs. Drain Current

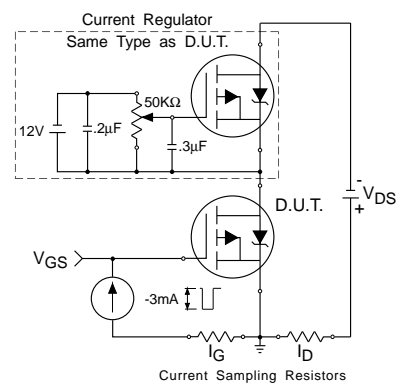
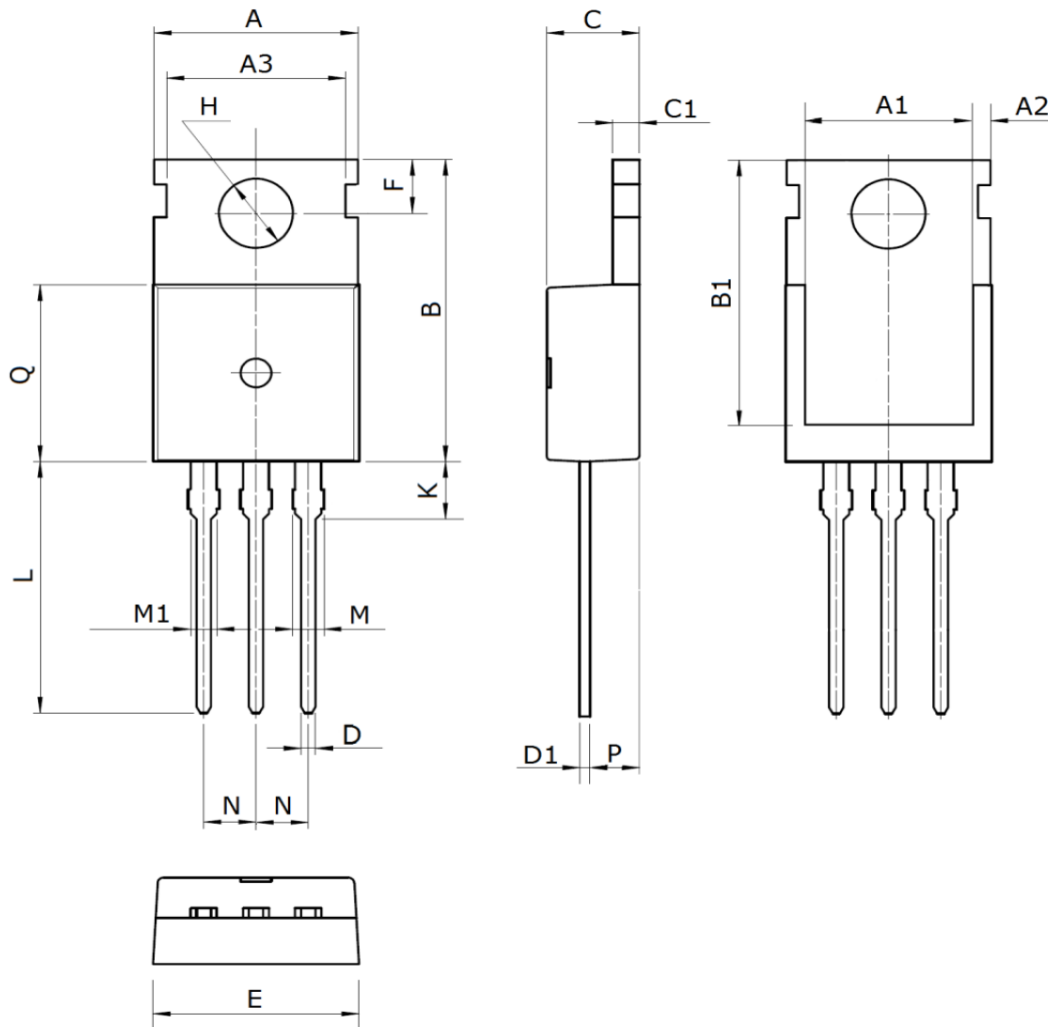


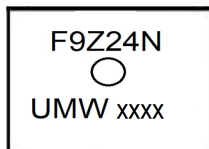
Fig 13b. Gate Charge Test Circuit

Package Mechanical Data TO-220



Symbol	Dimensions (mm)	Symbol	Dimensions (mm)	Symbol	Dimensions (mm)
A	10.0±0.3	C1	1.3±0.2	L	13.2±0.4
A1	8.0±0.2	D	0.8±0.2	M	1.38±0.1
A2	0.94±0.1	D1	0.5±0.1	M1	1.28±0.1
A3	8.7±0.1	E	10.0±0.3	N	2.54(typ)
B	15.6±0.4	F	2.8±0.1	P	2.4±0.3
B1	13.2±0.2	H	3.6±0.1	Q	9.15±0.25
C	4.5±0.2	K	3.1±0.2		

Marking



Ordering information

Order code	Package	Baseqty	Deliverymode
UMW IRF9Z24N	TO-220	1000	Tube and box