

## Power MOSFET

**TO-220 FULLPAK**


P-Channel MOSFET

### FEATURES

- Advanced process technology
- Dynamic dV/dt rating
- 150 °C operating temperature
- Fast switching
- P-channel
- Fully avalanche rated
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)


**RoHS**  
COMPLIANT

### PRODUCT SUMMARY

$V_{DS}$ (V)	-250	
$R_{DS(on)}$ ( $\Omega$ )	$V_{GS} = -10$ V	1.0
$Q_g$ (Max.) (nC)	38	
$Q_{gs}$ (nC)	8.0	
$Q_{gd}$ (nC)	18	
Configuration	Single	

### DESCRIPTION

Third generation power MOSFETs from Vishay provide the designer with the best combination of fast switching, ruggedized device design, low on-resistance and cost-effectiveness.

The TO-220 FULLPAK eliminates the need for additional insulating hardware in commercial-industrial applications. The moulding compound used provides a high isolation capability and a low thermal resistance between the tab and external heatsink. This isolation is equivalent to using a 100 micron mica barrier with standard TO-220 product. The FULLPAK is mounted to a heatsink using a single clip or by a single screw fixing.

### ORDERING INFORMATION

Package	TO-220 FULLPAK
Lead (Pb)-free	IRFI9634GPbF

### ABSOLUTE MAXIMUM RATINGS $T_C = 25$ °C, unless otherwise noted

PARAMETER	SYMBOL	LIMIT	UNIT	
Drain-source voltage	$V_{DS}$	-250	V	
Gate-source voltage	$V_{GS}$	$\pm 20$		
Continuous drain current	$V_{GS}$ at -10 V	$T_C = 25$ °C	A	
		$T_C = 100$ °C		
Pulsed drain current <sup>a</sup>	$I_{DM}$	-16		
Linear derating factor		0.28	W/°C	
Single pulse avalanche energy <sup>b</sup>	$E_{AS}$	520	mJ	
Repetitive avalanche current <sup>a</sup>	$I_{AR}$	-4.1	A	
Repetitive avalanche energy <sup>a</sup>	$E_{AR}$	3.5	mJ	
Maximum power dissipation	$T_C = 25$ °C	$P_D$	35	W
Peak diode recovery dV/dt <sup>c</sup>		dV/dt	-5.0	V/ns
Operating junction and storage temperature range	$T_J, T_{stg}$	-55 to +150	°C	
Soldering recommendations (peak temperature) <sup>d</sup>	For 10 s	300		
Mounting torque	6-32 or M3 screw		10	lbf · in
			1.1	N · m

#### Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)
- Starting  $T_J = 25$  °C,  $L = 62$  mH,  $R_G = 25$   $\Omega$ ,  $I_{AS} = -4.1$  A (see fig. 12)
- $I_{SD} \leq -4.1$  A,  $dI/dt \leq -640$  A/ $\mu$ s,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 150$  °C
- 1.6 mm from case

THERMAL RESISTANCE RATINGS				
PARAMETER	SYMBOL	TYP.	MAX.	UNIT
Maximum junction-to-ambient	$R_{thJA}$	-	65	°C/W
Maximum junction-to-case (drain)	$R_{thJC}$	-	3.6	

SPECIFICATIONS $T_J = 25\text{ }^\circ\text{C}$ , unless otherwise noted							
PARAMETER	SYMBOL	TEST CONDITIONS		MIN.	TYP.	MAX.	UNIT
<b>Static</b>							
Drain-source breakdown voltage	$V_{DS}$	$V_{GS} = 0\text{ V}$ , $I_D = 250\text{ }\mu\text{A}$		-250	-	-	V
$V_{DS}$ temperature coefficient	$\Delta V_{DS}/T_J$	Reference to $25\text{ }^\circ\text{C}$ , $I_D = 1\text{ mA}$		-	-0.27	-	V/°C
Gate-source threshold voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$		-2.0	-	-4.0	V
Gate-source leakage	$I_{GSS}$	$V_{GS} = \pm 20\text{ V}$		-	-	$\pm 100$	nA
Zero gate voltage drain current	$I_{DSS}$	$V_{DS} = -250\text{ V}$ , $V_{GS} = 0\text{ V}$		-	-	-25	$\mu\text{A}$
		$V_{DS} = -200\text{ V}$ , $V_{GS} = 0\text{ V}$ , $T_J = 150\text{ }^\circ\text{C}$		-	-	-250	
Drain-source on-state resistance	$R_{DS(on)}$	$V_{GS} = -10\text{ V}$	$I_D = -2.5\text{ A}^b$	-	-	1.0	$\Omega$
Forward transconductance	$g_{fs}$	$V_{DS} = -50\text{ V}$ , $I_D = -4.1\text{ A}^b$		2.2	-	-	S
<b>Dynamic</b>							
Input capacitance	$C_{iss}$	$V_{GS} = 0\text{ V}$ , $V_{DS} = -25\text{ V}$ , $f = 1.0\text{ MHz}$ , see fig. 5		-	680	-	pF
Output capacitance	$C_{oss}$			-	170	-	
Reverse transfer capacitance	$C_{rss}$			-	40	-	
Drain to sink capacitance	$C$	$f = 1.0\text{ MHz}$		-	12	-	
Total gate charge	$Q_g$	$V_{GS} = -10\text{ V}$	$I_D = -4.1\text{ A}$ , $V_{DS} = -200\text{ V}$ , see fig. 6 and 13 <sup>b</sup>	-	-	38	nC
Gate-source charge	$Q_{gs}$			-	-	8.0	
Gate-drain charge	$Q_{gd}$			-	-	18	
Turn-on delay time	$t_{d(on)}$	$V_{DD} = -130\text{ V}$ , $I_D = -4.1\text{ A}$ , $R_G = 12\text{ }\Omega$ , $R_D = 31\text{ }\Omega$ , see fig. 10 <sup>b</sup>		-	12	-	ns
Rise time	$t_r$			-	23	-	
Turn-off delay time	$t_{d(off)}$			-	34	-	
Fall time	$t_f$			-	21	-	
Internal drain inductance	$L_D$	Between lead, 6 mm (0.25") from package and center of die contact		-	4.5	-	nH
Internal source inductance	$L_S$			-	7.5	-	
<b>Drain-Source Body Diode Characteristics</b>							
Continuous source-drain diode current	$I_S$	MOSFET symbol showing the integral reverse p - n junction diode		-	-	-4.1	A
Pulsed diode forward current <sup>a</sup>	$I_{SM}$			-	-	-16	
Body diode voltage	$V_{SD}$	$T_J = 25\text{ }^\circ\text{C}$ , $I_S = -4.1\text{ A}$ , $V_{GS} = 0\text{ V}^b$		-	-	-6.5	V
Body diode reverse recovery time	$t_{rr}$	$T_J = 25\text{ }^\circ\text{C}$ , $I_F = -4.1\text{ A}$ , $dI/dt = -100\text{ A}/\mu\text{s}^b$		-	190	290	ns
Body diode reverse recovery charge	$Q_{rr}$			-	1.5	2.2	$\mu\text{C}$
Forward turn-on time	$t_{on}$	Intrinsic turn-on time is negligible (turn-on is dominated by $L_S$ and $L_D$ )					

**Notes**

- a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)  
 b. Pulse width  $\leq 300\text{ }\mu\text{s}$ ; duty cycle  $\leq 2\%$

**TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted

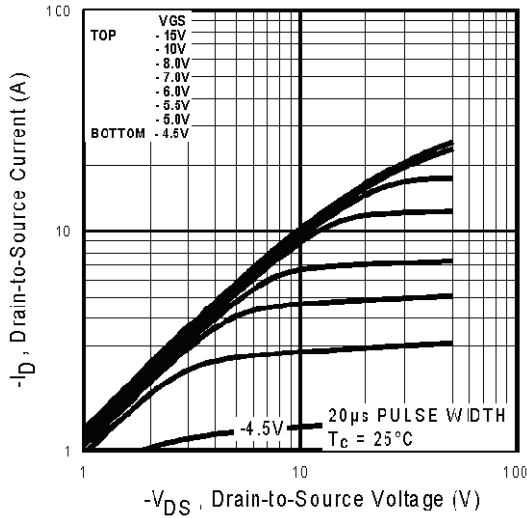


Fig. 1 - Typical Output Characteristics,  $T_c = 25\text{ }^\circ\text{C}$

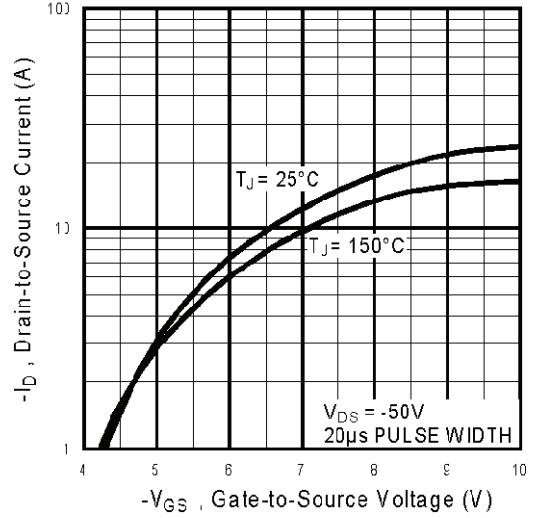


Fig. 3 - Typical Transfer Characteristics

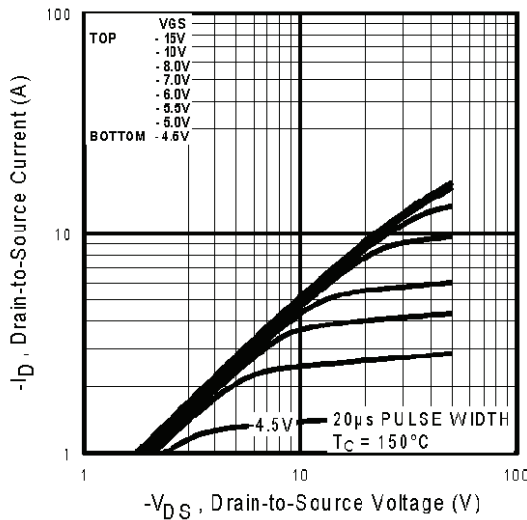


Fig. 2 - Typical Output Characteristics,  $T_c = 150\text{ }^\circ\text{C}$

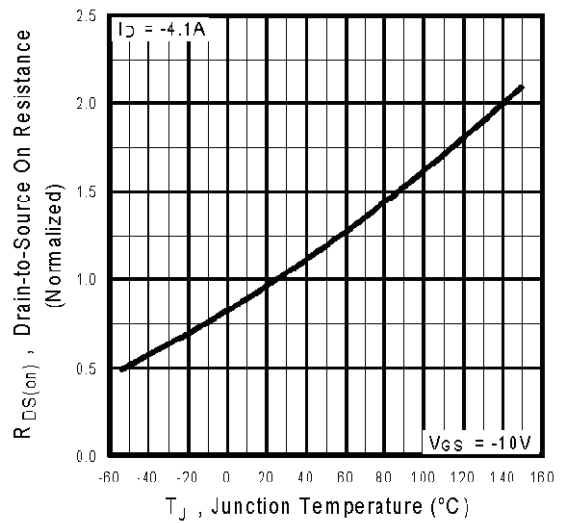


Fig. 4 - Normalized On-Resistance vs. Temperature

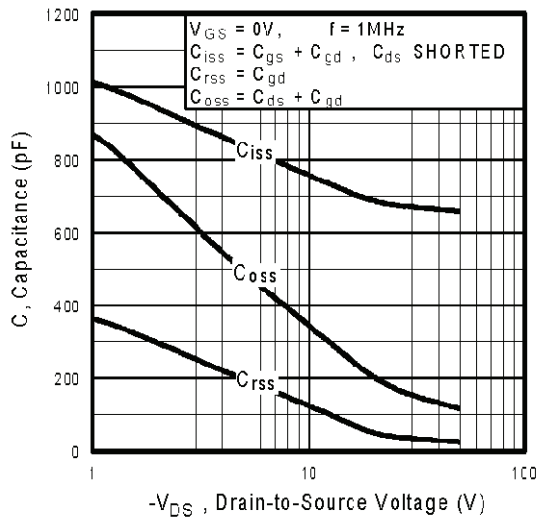


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

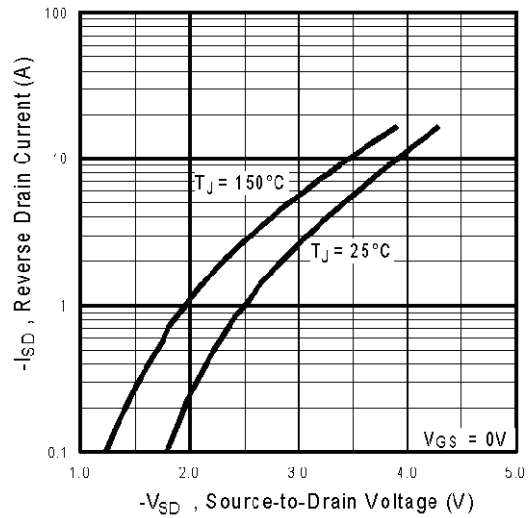


Fig. 7 - Typical Source-Drain Diode Forward Voltage

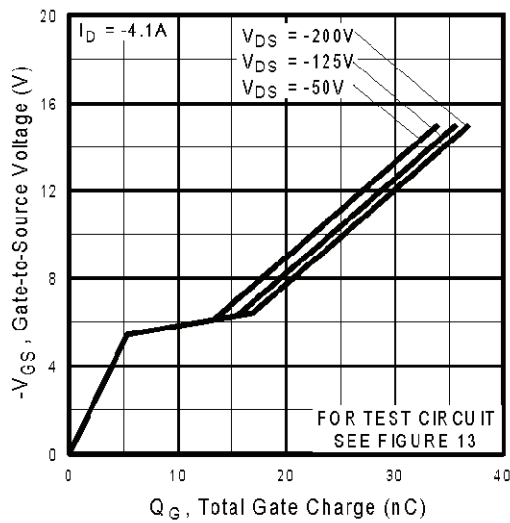


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

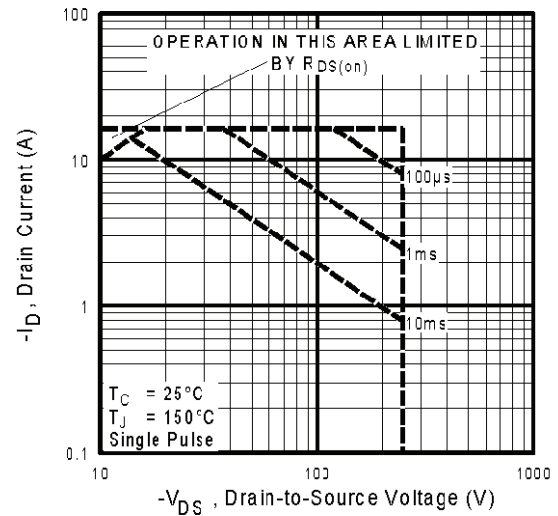


Fig. 8 - Maximum Safe Operating Area

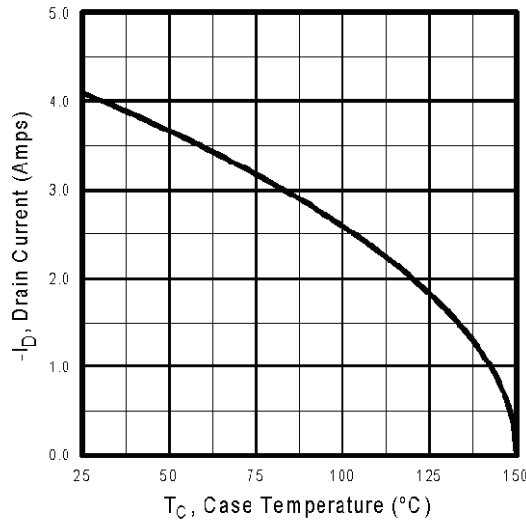


Fig. 9 - Maximum Drain Current vs. Case Temperature

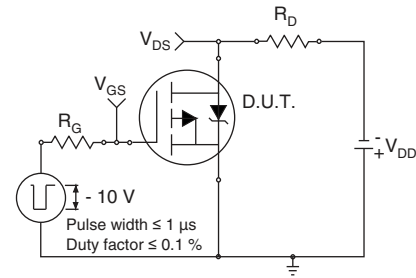


Fig. 10a - Switching Time Test Circuit

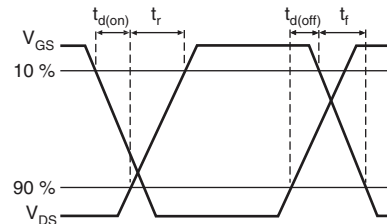


Fig. 10b - Switching Time Waveforms

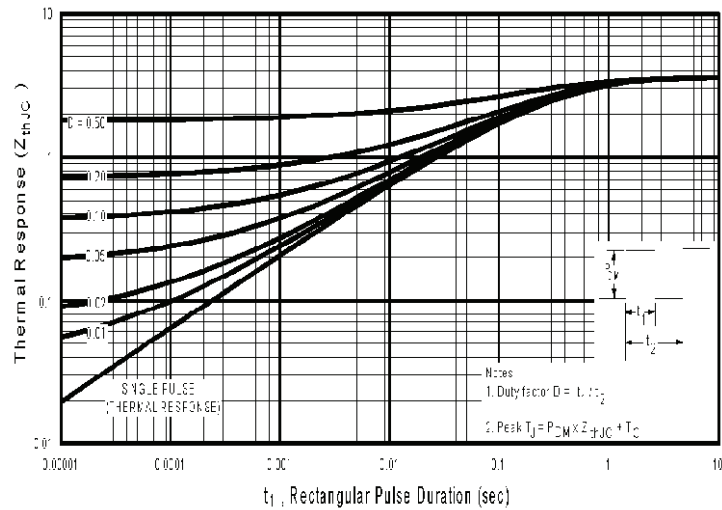


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

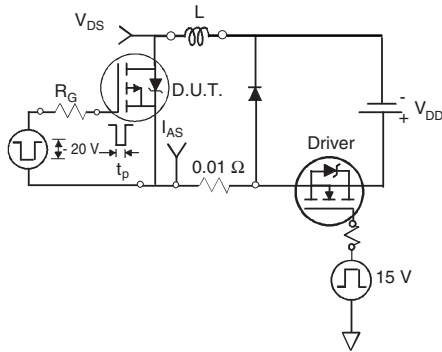


Fig. 12a - Unclamped Inductive Test Circuit

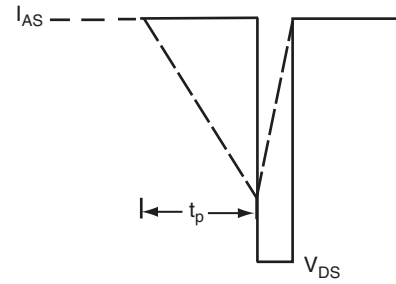


Fig. 12b - Unclamped Inductive Waveforms

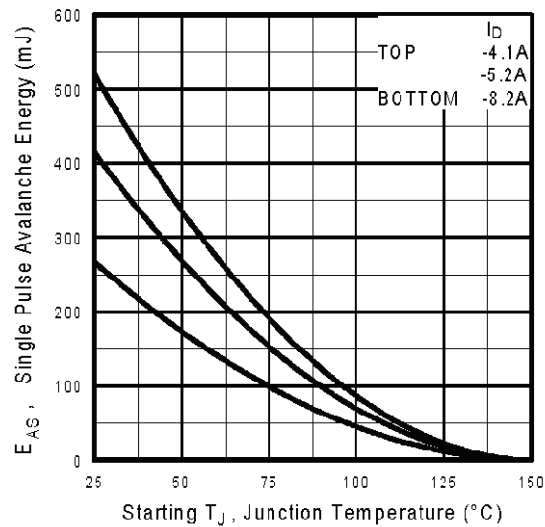


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

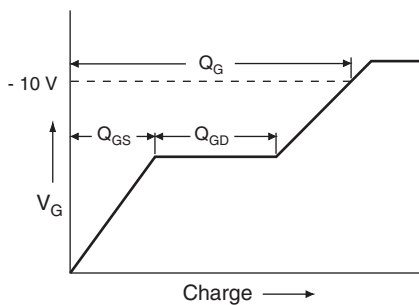


Fig. 13a - Basic Gate Charge Waveform

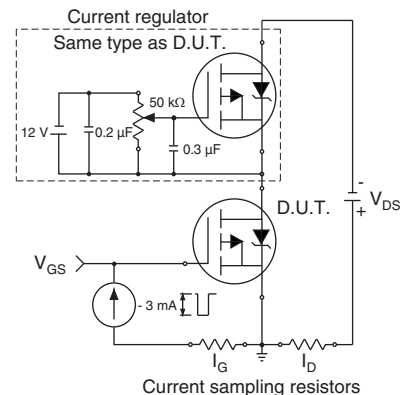
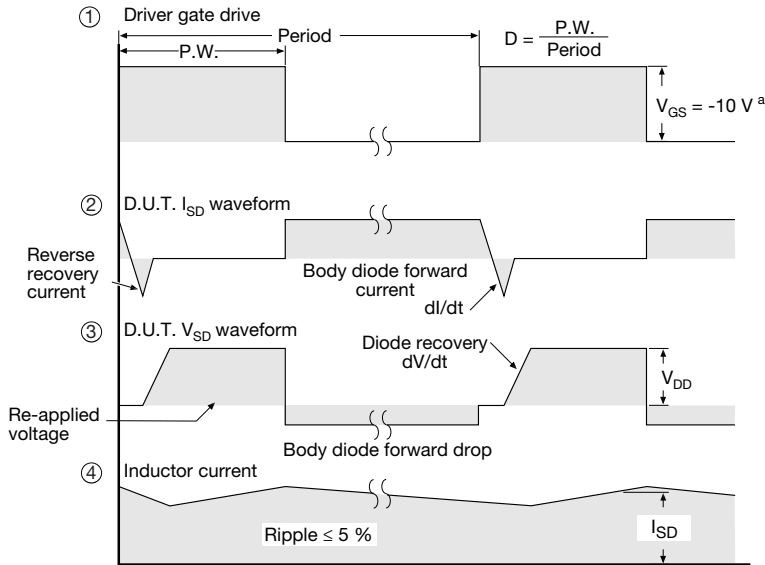
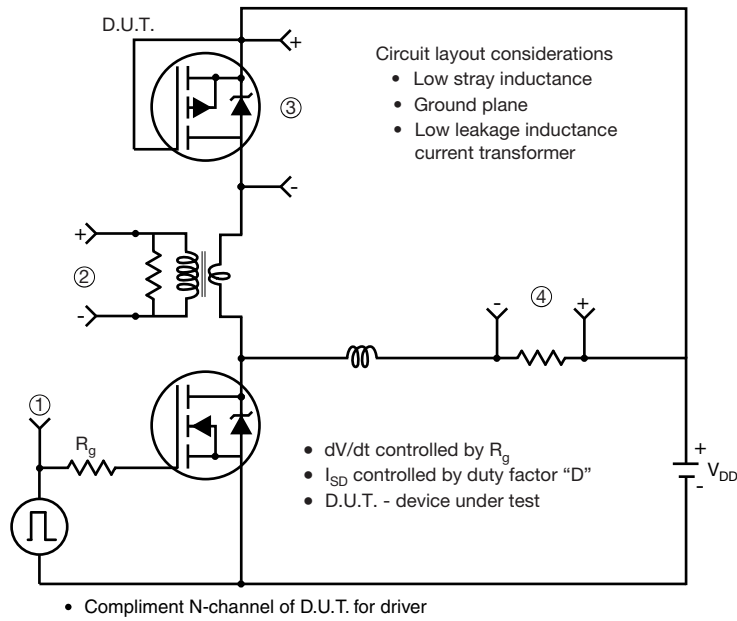


Fig. 13b - Gate Charge Test Circuit

**Peak Diode Recovery dV/dt Test Circuit**



**Note**

a.  $V_{GS} = -5\text{ V}$  for logic level and  $-3\text{ V}$  drive devices

**Fig. 14 - For P-Channel**

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# TO-220 FULLPAK (High Voltage)

## OPTION 1: FACILITY CODE = 9



DIM.	MILLIMETERS		
	MIN.	NOM.	MAX.
A	4.60	4.70	4.80
b	0.70	0.80	0.91
b1	1.20	1.30	1.47
b2	1.10	1.20	1.30
C	0.45	0.50	0.63
D	15.80	15.87	15.97
e	2.54 BSC		
E	10.00	10.10	10.30
F	2.44	2.54	2.64
G	6.50	6.70	6.90
L	12.90	13.10	13.30
L1	3.13	3.23	3.33
Q	2.65	2.75	2.85
Q1	3.20	3.30	3.40
Ø R	3.08	3.18	3.28

### Notes

1. To be used only for process drawing
2. These dimensions apply to all TO-220 FULLPAK leadframe versions 3 leads
3. All critical dimensions should C meet  $C_{pk} > 1.33$
4. All dimensions include burrs and plating thickness
5. No chipping or package damage
6. Facility code will be the 1<sup>st</sup> character located at the 2<sup>nd</sup> row of the unit marking





OPTION 2: FACILITY CODE = Y



DIM.	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	4.570	4.830	0.180	0.190
A1	2.570	2.830	0.101	0.111
A2	2.510	2.850	0.099	0.112
b	0.622	0.890	0.024	0.035
b2	1.229	1.400	0.048	0.055
b3	1.229	1.400	0.048	0.055
c	0.440	0.629	0.017	0.025
D	8.650	9.800	0.341	0.386
d1	15.88	16.120	0.622	0.635
d3	12.300	12.920	0.484	0.509
E	10.360	10.630	0.408	0.419
e	2.54 BSC		0.100 BSC	
L	13.200	13.730	0.520	0.541
L1	3.100	3.500	0.122	0.138
n	6.050	6.150	0.238	0.242
Ø P	3.050	3.450	0.120	0.136
u	2.400	2.500	0.094	0.098
V	0.400	0.500	0.016	0.020

ECN: E19-0180-Rev. D, 08-Apr-2019  
DWG: 5972

Notes

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2. These dimensions apply to all TO-220 FULLPAK leadframe versions 3 leads
3. All critical dimensions should C meet  $C_{pk} > 1.33$
4. All dimensions include burrs and plating thickness
5. No chipping or package damage
6. Facility code will be the 1<sup>st</sup> character located at the 2<sup>nd</sup> row of the unit marking



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