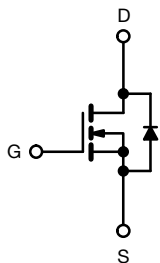


# Power MOSFET

**TO-220 FULLPAK**


N-Channel MOSFET

## FEATURES

- Isolated package
- High voltage isolation = 2.5 kV<sub>RMS</sub> (t = 60 s; f = 60 Hz)
- Sink to lead creepage distance = 4.8 mm
- Dynamic dV/dt rating
- Low thermal resistance
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)


**RoHS**  
COMPLIANT

## 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 molding 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.

## PRODUCT SUMMARY

V <sub>DS</sub> (V)	400	
R <sub>DS(on)</sub> (Ω)	V <sub>GS</sub> = 10 V	1.8
Q <sub>g</sub> max. (nC)	20	
Q <sub>gs</sub> (nC)	3.3	
Q <sub>gd</sub> (nC)	11	
Configuration	Single	

## ORDERING INFORMATION

Package	TO-220 FULLPAK
Lead (Pb)-free	IRFI720GPbF

## ABSOLUTE MAXIMUM RATINGS (T<sub>C</sub> = 25 °C, unless otherwise noted)

PARAMETER				SYMBOL	LIMIT	UNIT
Drain-source voltage				V <sub>DS</sub>	400	V
Gate-source voltage				V <sub>GS</sub>	± 20	
Continuous drain current	V <sub>GS</sub> at 10 V	T <sub>C</sub> = 25 °C	I <sub>D</sub>	2.6	A	
		T <sub>C</sub> = 100 °C		1.7		
Pulsed drain current <sup>a</sup>				I <sub>DM</sub>	10	
Linear derating factor					0.24	W/°C
Single pulse avalanche energy <sup>b</sup>				E <sub>AS</sub>	150	mJ
Repetitive avalanche current <sup>a</sup>				I <sub>AR</sub>	2.6	A
Repetitive avalanche energy <sup>a</sup>				E <sub>AR</sub>	3.0	mJ
Maximum power dissipation		T <sub>C</sub> = 25 °C		P <sub>D</sub>	30	W
Peak diode recovery dV/dt <sup>c</sup>				dV/dt	4.0	V/ns
Operating junction and storage temperature range				T <sub>J</sub> , T <sub>stg</sub>	-55 to +150	°C
Soldering recommendations (peak temperature) <sup>d</sup>		For 10 s			300	
Mounting torque		M3 screw			0.6	Nm

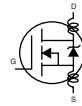

### Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)
- V<sub>DD</sub> = 50 V, starting T<sub>J</sub> = 25 °C, L = 38 mH, R<sub>g</sub> = 25 Ω, I<sub>AS</sub> = 2.6 A (see fig. 12)
- I<sub>SD</sub> ≤ 3.3 A, dI/dt ≤ 65 A/μs, V<sub>DD</sub> ≤ V<sub>DS</sub>, T<sub>J</sub> ≤ 150 °C
- 1.6 mm from case

**THERMAL RESISTANCE RATINGS**

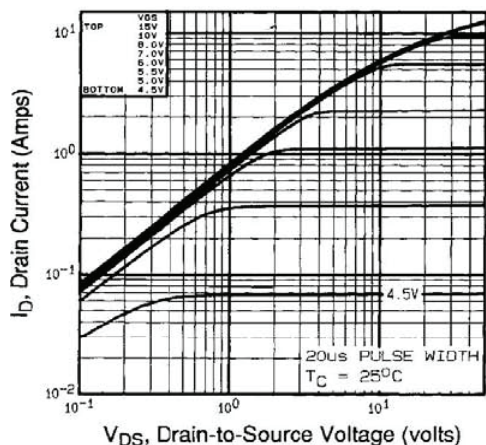
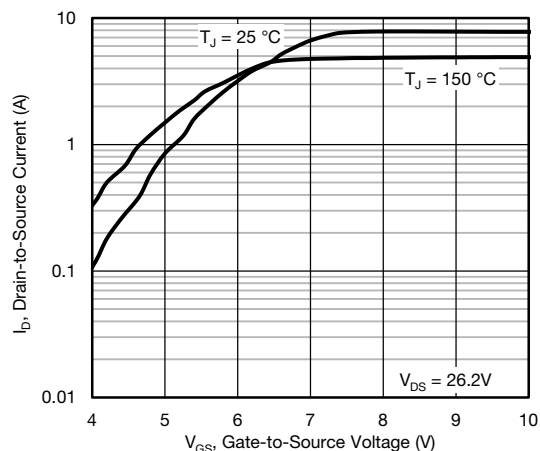
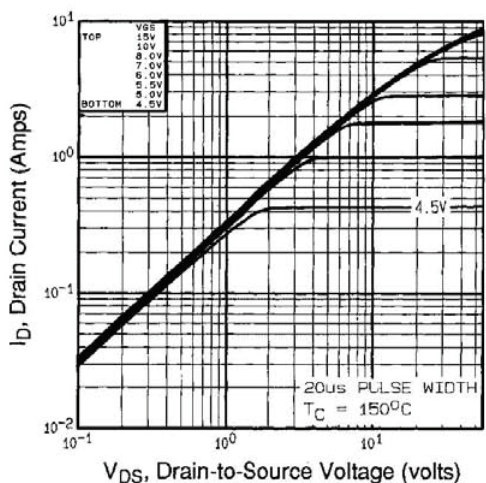
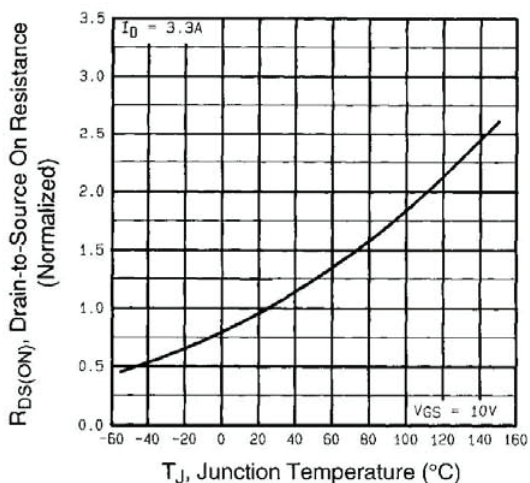
PARAMETER	SYMBOL	TYP.	MAX.	UNIT
Maximum junction-to-ambient	$R_{thJA}$	-	65	°C/W
Maximum junction-to-case (drain)	$R_{thJC}$	-	4.1	

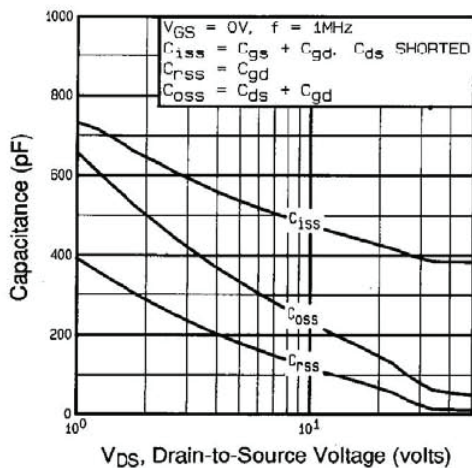
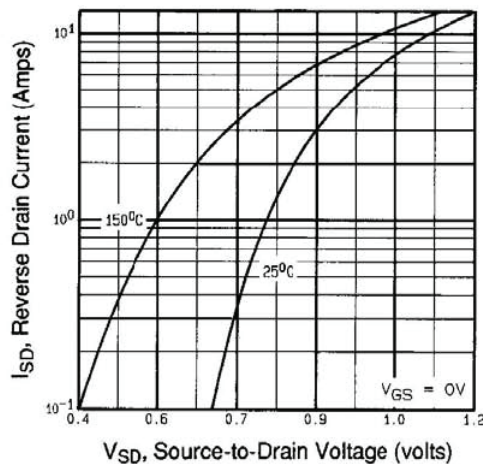
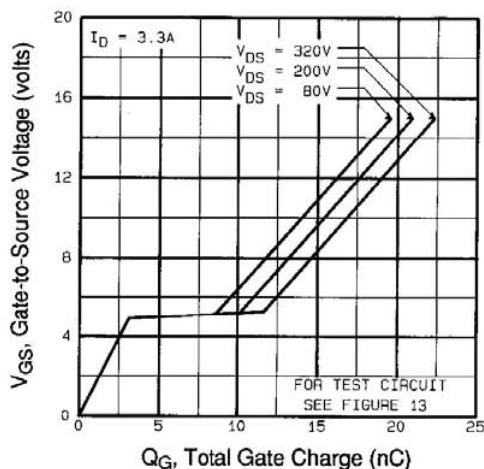
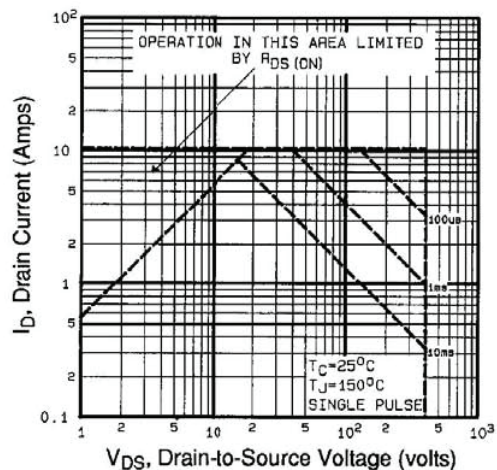
**SPECIFICATIONS** ( $T_J = 25\text{ °C}$ , unless otherwise noted)

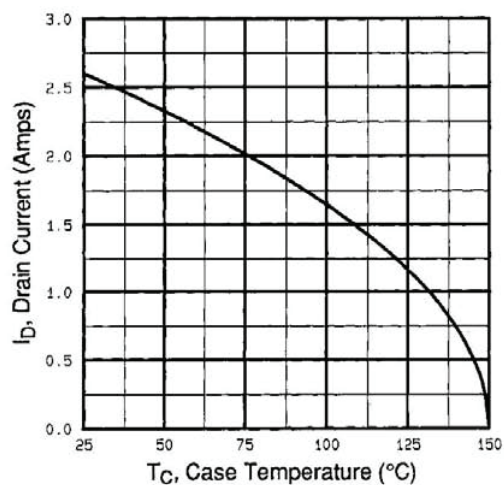
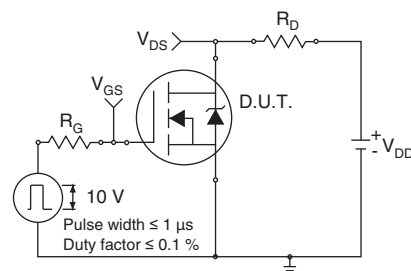
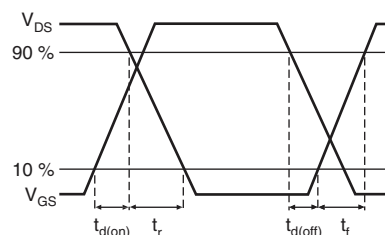
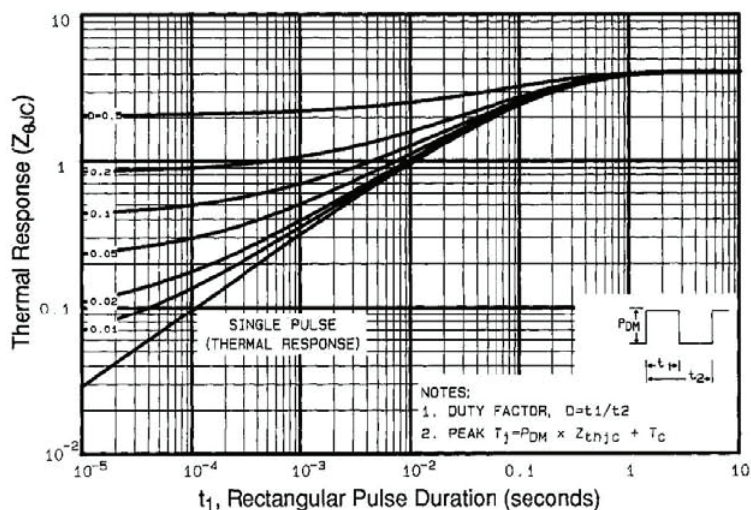
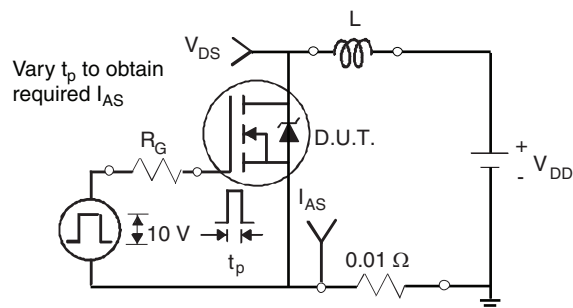
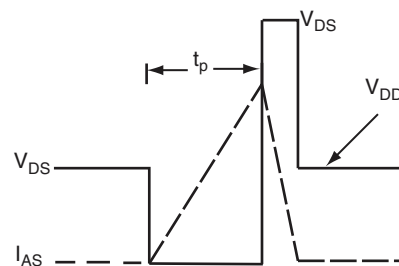
PARAMETER	SYMBOL	TEST CONDITIONS		MIN.	TYP.	MAX.	UNIT
Static							
Drain-ssource breakdown voltage	$V_{DS}$	$V_{GS} = 0\text{ V}$ , $I_D = 250\text{ }\mu\text{A}$		400	-	-	V
$V_{DS}$ temperature coefficient	$\Delta V_{DS}/T_J$	Reference to 25 °C, $I_D = 1\text{ mA}$		-	0.51	-	V/°C
Gate-source threshold 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	$I_{DSS}$	$V_{DS} = 400\text{ V}$ , $V_{GS} = 0\text{ V}$		-	-	25	$\mu\text{A}$
		$V_{DS} = 320\text{ V}$ , $V_{GS} = 0\text{ V}$ , $T_J = 125\text{ }^\circ\text{C}$		-	-	250	
Drain-source on-state resistance	$R_{DS(on)}$	$V_{GS} = 10\text{ V}$	$I_D = 1.6\text{ A}^b$	-	-	1.8	$\Omega$
Forward transconductance	$g_{fs}$	$V_{DS} = 50\text{ V}$ , $I_D = 1.6\text{ A}^b$		1.5	-	-	S
Dynamic							
Input capacitance	$C_{iss}$	$V_{GS} = 0\text{ V}$ , $V_{DS} = 25\text{ V}$ , $f = 1.0\text{ MHz}$ , see fig. 5		-	410	-	pF
Output capacitance	$C_{oss}$			-	120	-	
Reverse transfer capacitance	$C_{rss}$			-	47	-	
Drain to sink capacitance	$C$	$f = 1.0\text{ MHz}$		-	12	-	
Total gate charge	$Q_g$	$V_{GS} = 10\text{ V}$	$I_D = 3.3\text{ A}$ , $V_{DS} = 320\text{ V}$ , see fig. 6 and 13 <sup>b</sup>	-	-	20	nC
Gate-source charge	$Q_{gs}$			-	-	3.3	
Gate-drain charge	$Q_{gd}$			-	-	11	
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 200\text{ V}$ , $I_D = 3.3\text{ A}$ , $R_g = 18\text{ }\Omega$ , $R_D = 56\text{ }\Omega$ , see fig. 10 <sup>b</sup>		-	10	-	ns
Rise time	$t_r$			-	14	-	
Turn-off delay time	$t_{d(off)}$			-	30	-	
Fall time	$t_f$			-	13	-	
Gate input resistance	$R_g$	$f = 1\text{ MHz}$ , open drain		1.2	-	7.3	$\Omega$
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	-	
Drain-Source Body Diode Characteristics							
Continuous source-drain diode current	$I_S$	MOSFET symbol showing the integral reverse p - n junction diode 		-	-	2.6	A
Pulsed diode forward current <sup>a</sup>	$I_{SM}$			-	-	10	
Body diode voltage	$V_{SD}$	$T_J = 25\text{ }^\circ\text{C}$ , $I_S = 2.6\text{ A}$ , $V_{GS} = 0\text{ V}^b$		-	-	1.6	V
Body diode reverse recovery time	$t_{rr}$	$T_J = 25\text{ }^\circ\text{C}$ , $I_F = 3.3\text{ A}$ , $dI/dt = 100\text{ A}/\mu\text{s}^b$		-	300	600	ns
Body diode reverse recovery charge	$Q_{rr}$			-	1.5	3.0	$\mu\text{C}$
Forward turn-on time	$t_{on}$	Intrinsic turn-on time is negligible (turn-on is dominated by $L_S$ and $L_D$ )					

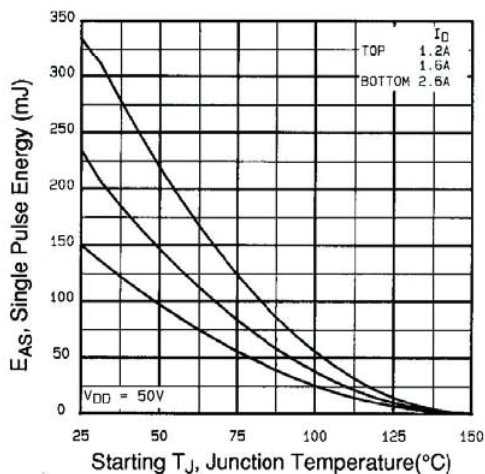
**Notes**

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

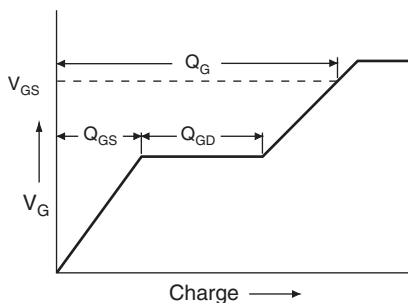
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)

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

**Fig. 3 - Typical Transfer Characteristics**

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

**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**

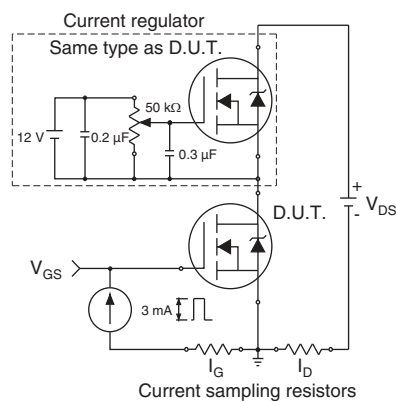

**Fig. 9 - Maximum Drain Current vs. Case Temperature**

**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**



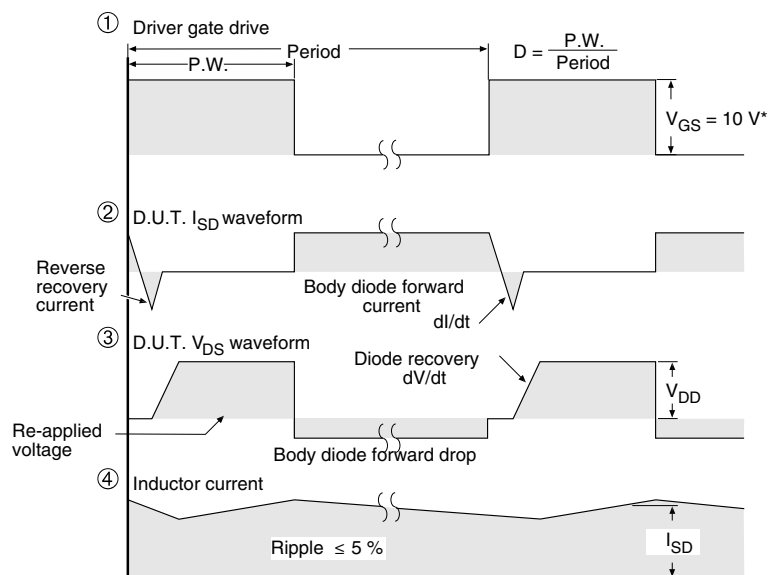
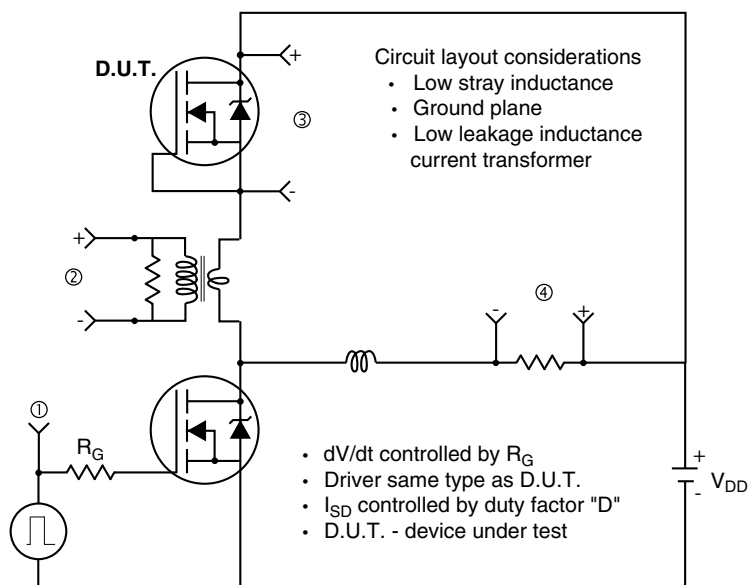
**Fig. 13a - Basic Gate Charge Waveform**



**Fig. 13b - Gate Charge Test Circuit**



### Peak Diode Recovery dV/dt Test Circuit



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

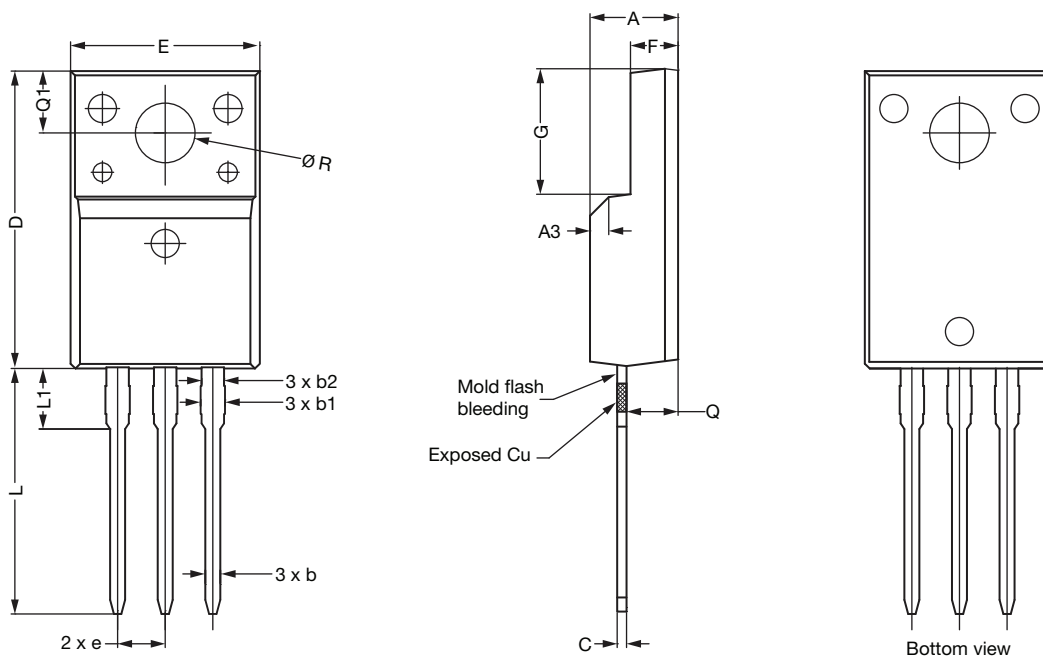
**Fig. 14 - For N-Channel**

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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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