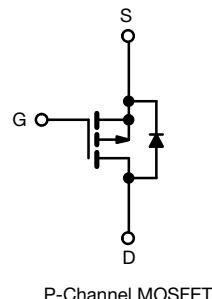
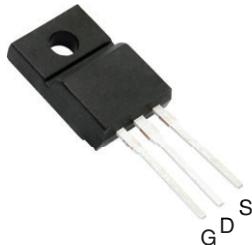


## Power MOSFET

**TO-220 FULLPAK**


P-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
- P-channel
- 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

### PRODUCT SUMMARY

$V_{DS}$ (V)	-200	
$R_{DS(on)}$ ( $\Omega$ )	$V_{GS} = -10$ V	3.0
$Q_g$ (Max.) (nC)	13	
$Q_{gs}$ (nC)	3.2	
$Q_{gd}$ (nC)	7.3	
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 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.

### ORDERING INFORMATION

Package	TO-220 FULLPAK
Lead (Pb)-free	IRFI9610GPbF

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

PARAMETER	SYMBOL	LIMIT	UNIT
Drain-source voltage	$V_{DS}$	-200	
Gate-source voltage	$V_{GS}$	$\pm 20$	V
Continuous drain current	$I_D$	-2.0	A
		-1.3	
Pulsed drain current <sup>a</sup>	$I_{DM}$	-8.0	
Linear derating factor		0.22	W/°C
Single pulse avalanche energy <sup>b</sup>	$E_{AS}$	100	mJ
Repetitive avalanche current <sup>a</sup>	$I_{AR}$	-2.0	A
Repetitive avalanche energy <sup>a</sup>	$E_{AR}$	2.7	mJ
Maximum power dissipation	$P_D$	27	W
Peak diode recovery dV/dt <sup>c</sup>	dV/dt	-11	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,  $L = 51$  mH,  $R_G = 25$   $\Omega$ ,  $I_{AS} = -2.0$  A (see fig. 12)
- $I_{SD} \leq -2.0$  A,  $dI/dt \leq -250$  A/ $\mu$ s,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 150$  °C
- 1.6 mm from case

**THERMAL RESISTANCE RATINGS**

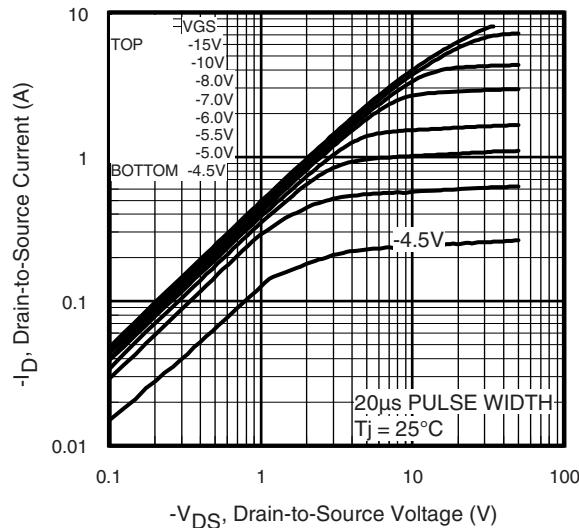
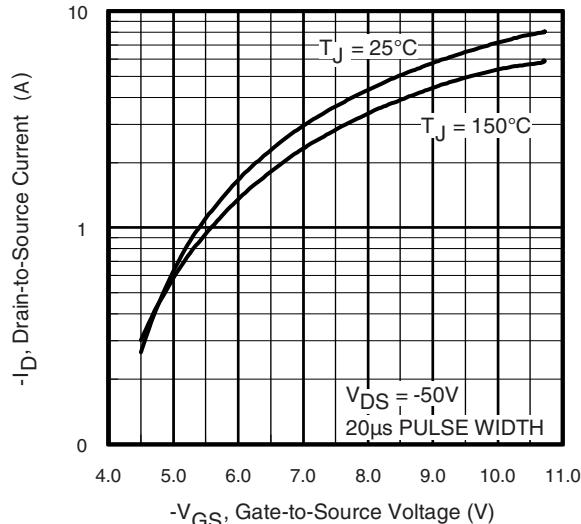
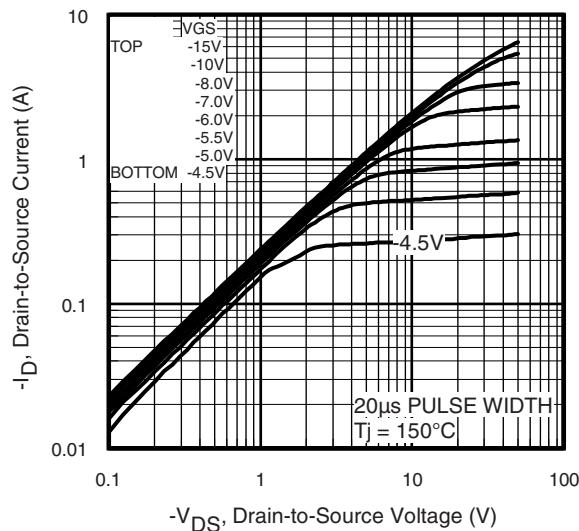
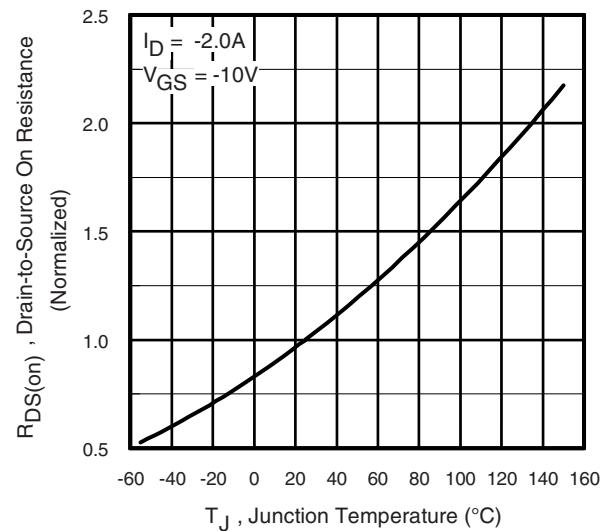
PARAMETER	SYMBOL	TYP.	MAX.	UNIT
Maximum junction-to-ambient	$R_{thJA}$	-	65	$^{\circ}\text{C}/\text{W}$
Maximum junction-to-case (drain)	$R_{thJC}$	-	4.6	

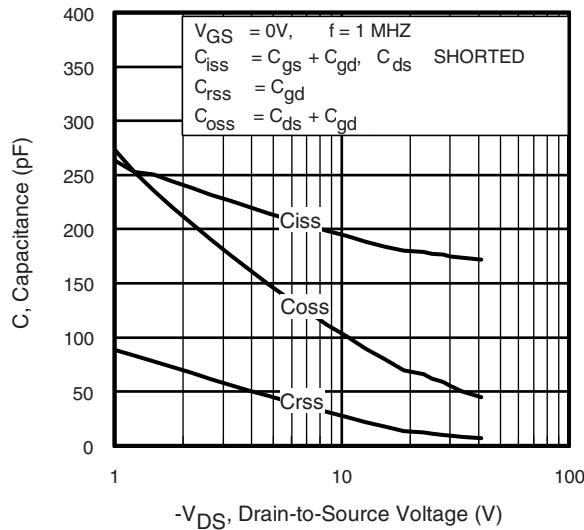
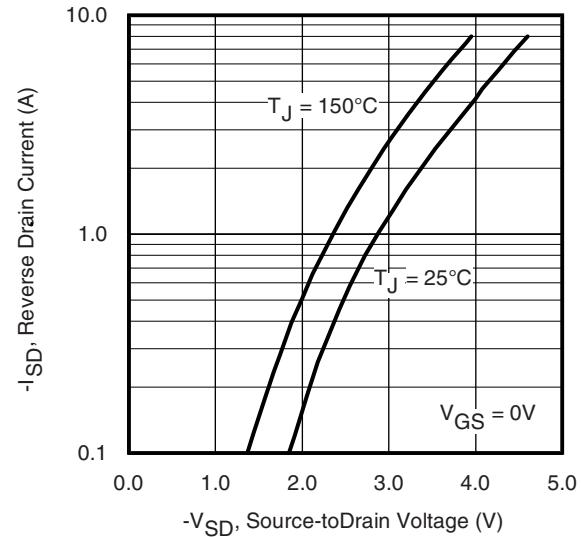
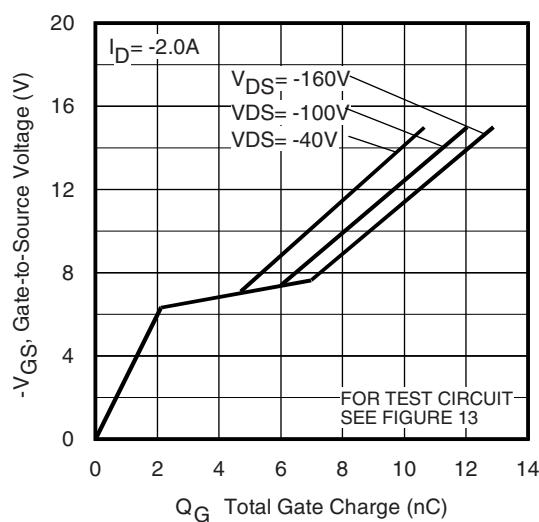
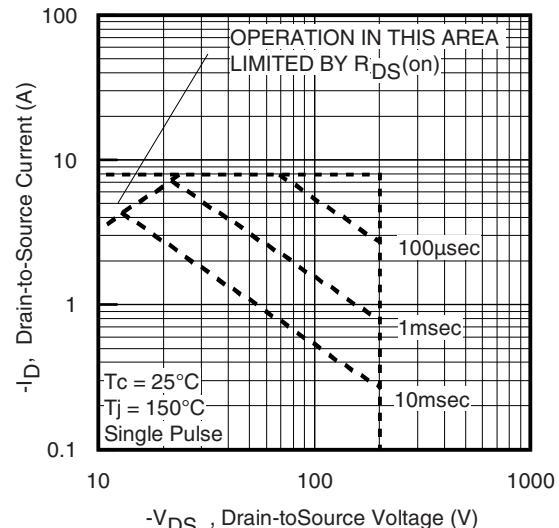
**SPECIFICATIONS**  $T_J = 25 \text{ }^{\circ}\text{C}$ , unless otherwise noted

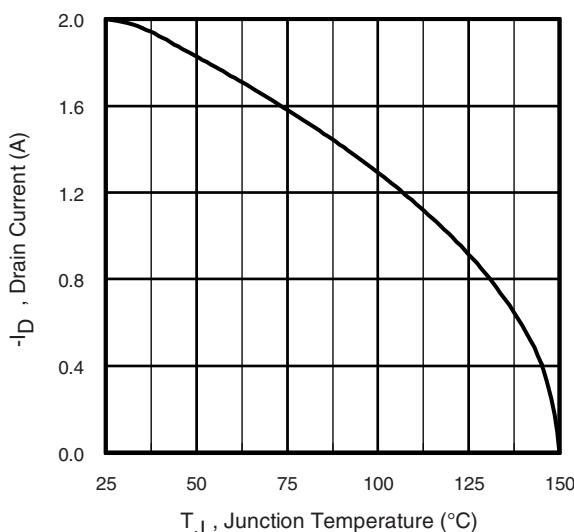
PARAMETER	SYMBOL	TEST CONDITIONS		MIN.	TYP.	MAX.	UNIT	
<b>Static</b>								
Drain-source breakdown voltage	$V_{DS}$	$V_{GS} = 0 \text{ V}$ , $I_D = -250 \mu\text{A}$		-200	-	-	V	
$V_{DS}$ temperature coefficient	$\Delta V_{DS}/T_J$	Reference to $25 \text{ }^{\circ}\text{C}$ , $I_D = -1 \text{ mA}$		-	-0.22	-	$\text{V}/\text{ }^{\circ}\text{C}$	
Gate-source threshold voltage	$V_{GS(\text{th})}$	$V_{DS} = V_{GS}$ , $I_D = -250 \mu\text{A}$		-2.0	-	-4.0	V	
Gate-source leakage	$I_{GSS}$	$V_{GS} = \pm 20 \text{ V}$		-	-	$\pm 100$	nA	
Zero gate voltage drain current	$I_{DSS}$	$V_{DS} = -200 \text{ V}$ , $V_{GS} = 0 \text{ V}$		-	-	-100	$\mu\text{A}$	
		$V_{DS} = -160 \text{ V}$ , $V_{GS} = 0 \text{ V}$ , $T_J = 125 \text{ }^{\circ}\text{C}$		-	-	-500		
Drain-source on-state resistance	$R_{DS(\text{on})}$	$V_{GS} = -10 \text{ V}$	$I_D = -1.2 \text{ A}^b$	-	-	3.0	$\Omega$	
Forward transconductance	$g_{fs}$	$V_{DS} = -50 \text{ V}$ , $I_D = -1.2 \text{ A}^b$		0.7	-	-	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		-	180	-	pF	
Output capacitance	$C_{oss}$			-	66	-		
Reverse transfer capacitance	$C_{rss}$			-	12	-		
Total gate charge	$Q_g$	$V_{GS} = -10 \text{ V}$	$I_D = -2.0 \text{ A}$ , $V_{DS} = -160 \text{ V}$ , see fig. 6 and 13 <sup>b</sup>	-	-	13	nC	
Gate-source charge	$Q_{gs}$			-	-	3.2		
Gate-drain charge	$Q_{gd}$			-	-	7.3		
Turn-on delay time	$t_{d(\text{on})}$			-	12	-		
Rise time	$t_r$	$V_{DD} = -100 \text{ V}$ , $I_D = -2.0 \text{ A}$ , $R_G = 24 \Omega$ , $V_{GS} = -10 \text{ V}$ , see fig. 10 <sup>b</sup>		-	17	-	ns	
Turn-off delay time	$t_{d(\text{off})}$			-	19	-		
Fall time	$t_f$			-	15	-		
Internal drain inductance	$L_D$			-	4.5	-	nH	
Internal source inductance	$L_S$	Between lead, 6 mm (0.25") from package and center of die contact		-	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		-	-	-2.0	A	
Pulsed diode forward current <sup>a</sup>	$I_{SM}$			-	-	-8.0		
Body diode voltage	$V_{SD}$	$T_J = 25 \text{ }^{\circ}\text{C}$ , $I_S = -2.0 \text{ A}$ , $V_{GS} = 0 \text{ V}^b$		-	-	-5.8	V	
Body diode reverse recovery time	$t_{rr}$	$T_J = 25 \text{ }^{\circ}\text{C}$ , $I_F = -2.0 \text{ A}$ , $dI/dt = 100 \text{ A}/\mu\text{s}^b$		-	130	200	ns	
Body diode reverse recovery charge	$Q_{rr}$			-	700	1050	$\mu\text{C}$	
Forward turn-on time	$t_{on}$	Intrinsic turn-on time is negligible (turn-on is dominated by $L_S$ and $L_D$ )						

**Notes**

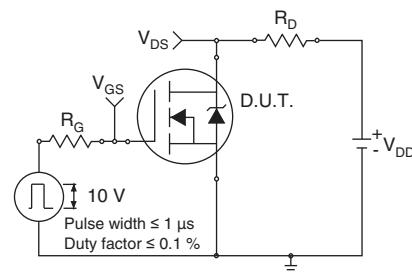
- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)
- Pulse width  $\leq 300 \mu\text{s}$ ; duty cycle  $\leq 2 \%$

**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**

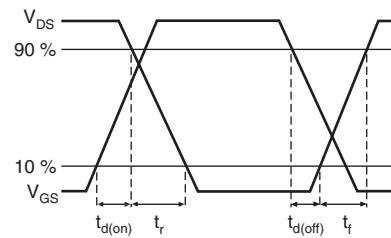

**Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage**

**Fig. 7 - Typical Source-Drain Diode Forward Voltage**

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

**Fig. 8 - Maximum Safe Operating Area**



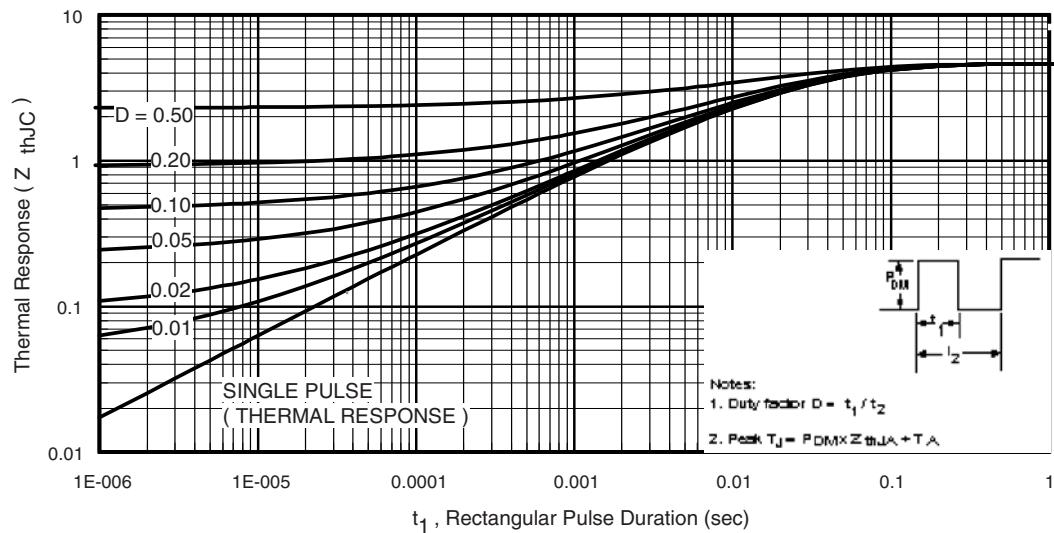
**Fig. 9 - Maximum Drain Current vs. Case Temperature**



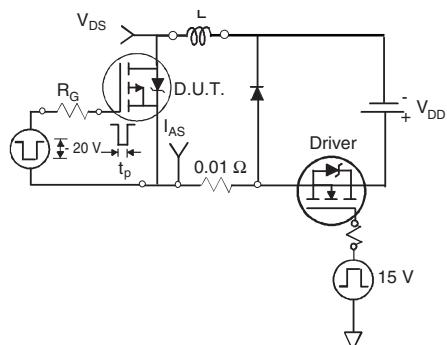
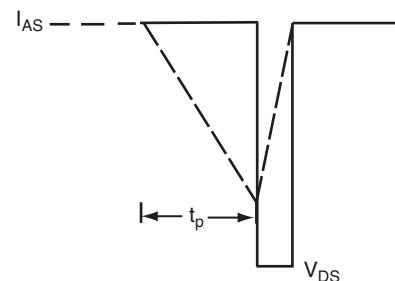
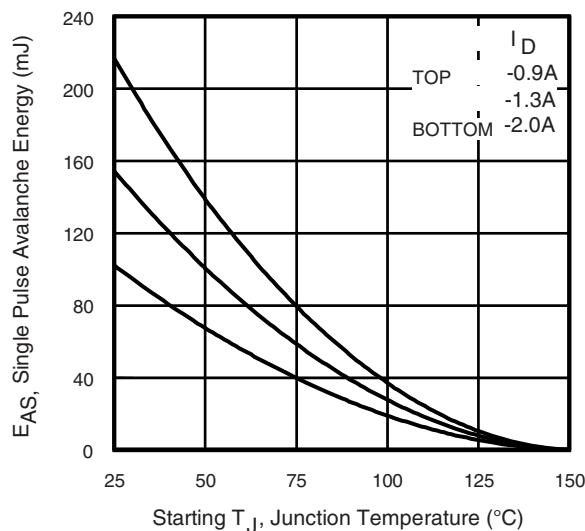
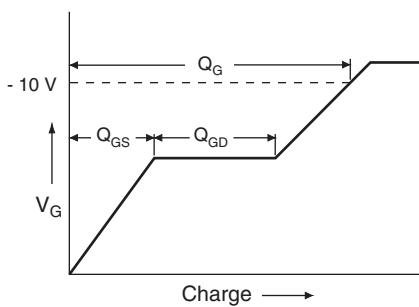
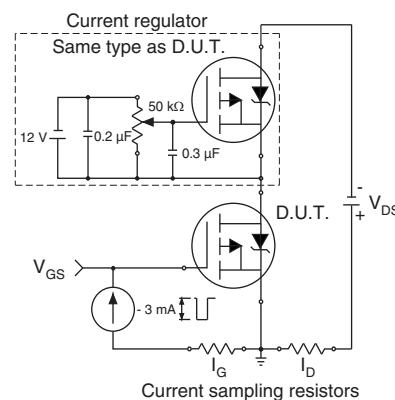
**Fig. 10a - Switching Time Test Circuit**

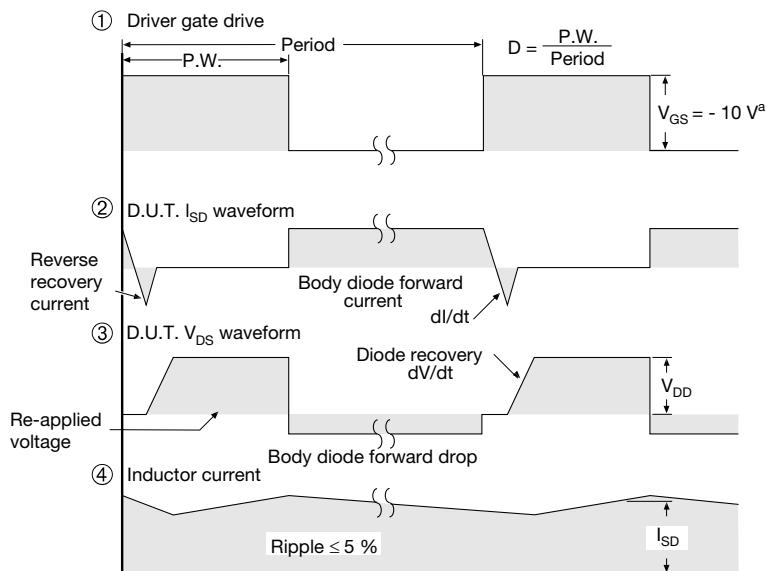
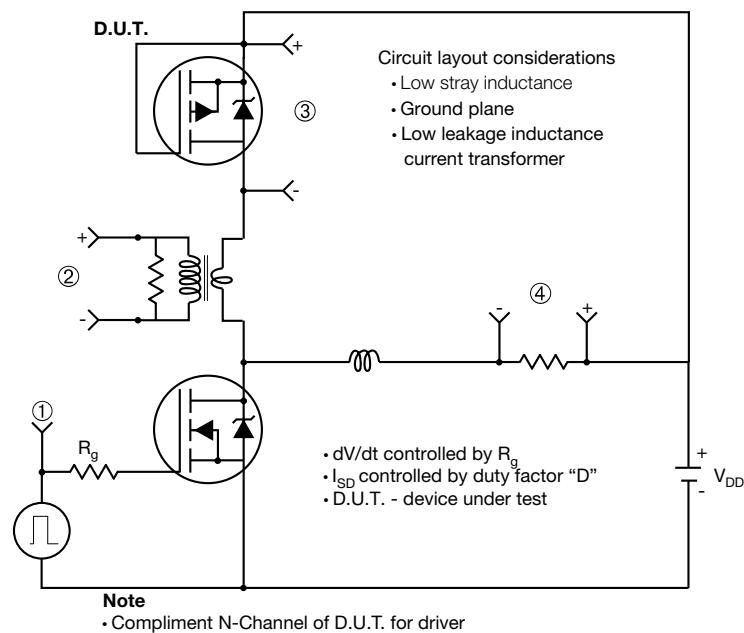


**Fig. 10b - Switching Time Waveforms**



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

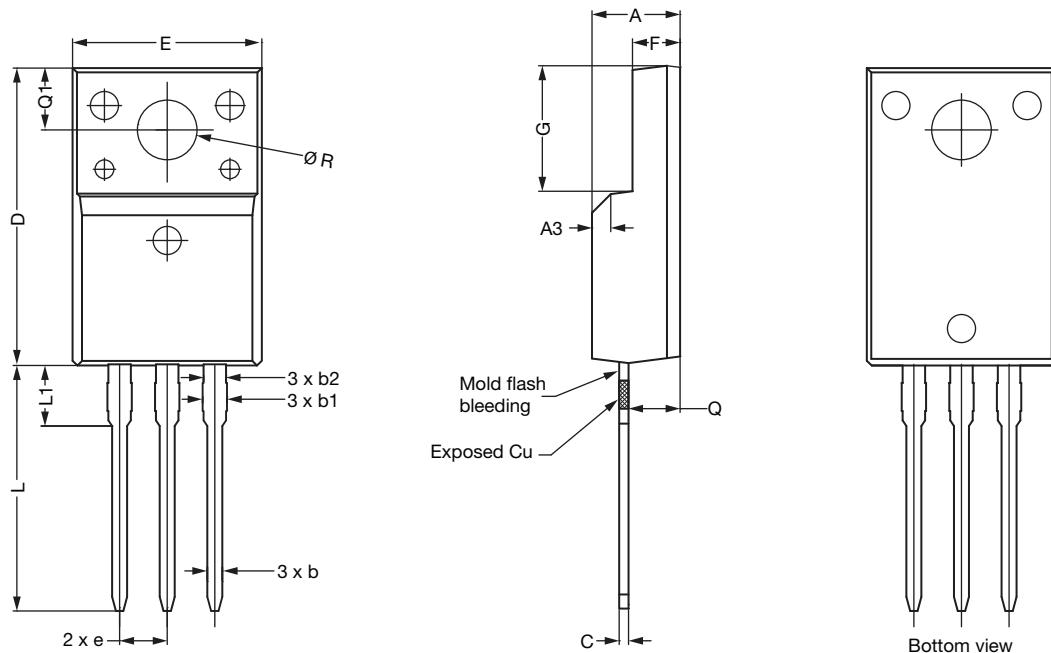

**Fig. 12a - Unclamped Inductive Test Circuit**

**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**

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

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## TO-220 FULLPAK (High Voltage)

### OPTION 1: FACILITY CODE = 9

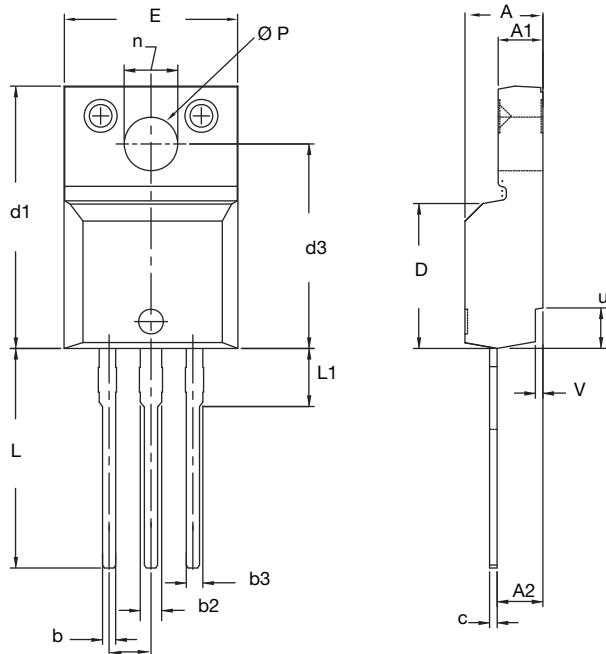


MILLIMETERS			
DIM.	MIN.	NOM.	MAX.
A	4.60	4.70	4.80
b	0.70	0.80	0.91
b1	1.20	1.30	1.47
b2	1.10	1.20	1.30
C	0.45	0.50	0.63
D	15.80	15.87	15.97
e	2.54 BSC		
E	10.00	10.10	10.30
F	2.44	2.54	2.64
G	6.50	6.70	6.90
L	12.90	13.10	13.30
L1	3.13	3.23	3.33
Q	2.65	2.75	2.85
Q1	3.20	3.30	3.40
Ø R	3.08	3.18	3.28

#### 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



	MILLIMETERS		INCHES	
DIM.	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

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

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