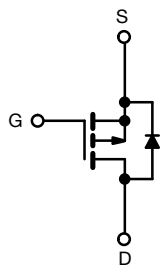
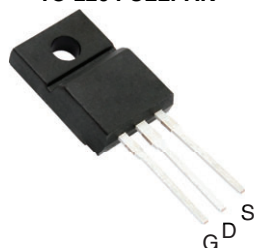


Power MOSFET

TO-220 FULLPAK


P-Channel MOSFET

FEATURES

- Isolated package
- High voltage isolation = 2.5 kV_{RMS} (t = 60 s; f = 60 Hz)
- Sink to lead creepage distance = 4.8 mm
- P-channel
- 175 °C operating temperature
- Dynamic dV/dt rating
- Low thermal resistance
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912


RoHS
COMPLIANT

PRODUCT SUMMARY

V _{DS} (V)	-60	
R _{DS(on)} (Ω)	V _{GS} = -10 V	0.28
Q _g (Max.) (nC)	19	
Q _{gs} (nC)	5.4	
Q _{gd} (nC)	11	
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	IRFI9Z24GPbF

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

PARAMETER	SYMBOL	LIMIT	UNIT
Drain-source voltage	V _{DS}	-60	V
Gate-source voltage	V _{GS}	± 20	
Continuous drain current	I _D	T _C = 25 °C	A
		T _C = 100 °C	
Pulsed drain current ^a	I _{DM}	-34	
Linear derating factor		0.24	W/°C
Single pulse avalanche energy ^b	E _{AS}	200	mJ
Repetitive avalanche current ^a	I _{AR}	-8.5	A
Repetitive avalanche energy ^a	E _{AR}	3.7	mJ
Maximum power dissipation	P _D	37	W
Peak diode recovery dV/dt ^c	dV/dt	-4.5	V/ns
Operating junction and storage temperature range	T _J , T _{stg}	-55 to +175	°C
Soldering recommendations (peak temperature) ^d	For 10 s	300	
Mounting torque	M3 screw	0.6	Nm

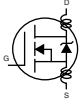
Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)
- V_{DD} = -25 V, starting T_J = 25 °C, L = 3.2 mH, R_G = 25 Ω, I_{AS} = -8.5 A (see fig. 12)
- I_{SD} ≤ -11 A, dI/dt ≤ 140 A/μs, V_{DD} ≤ V_{DS}, T_J ≤ 175 °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	

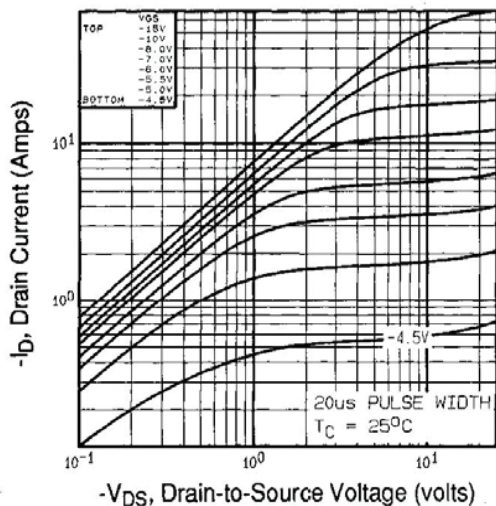
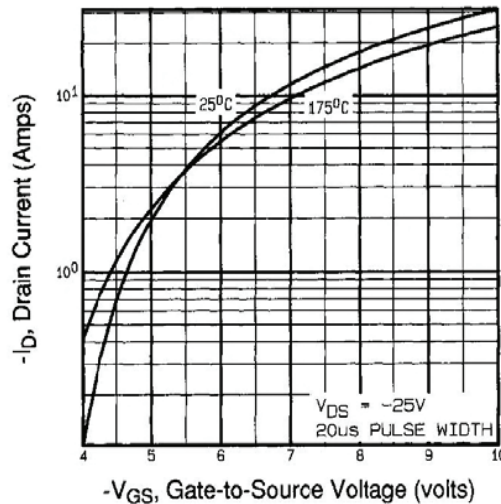
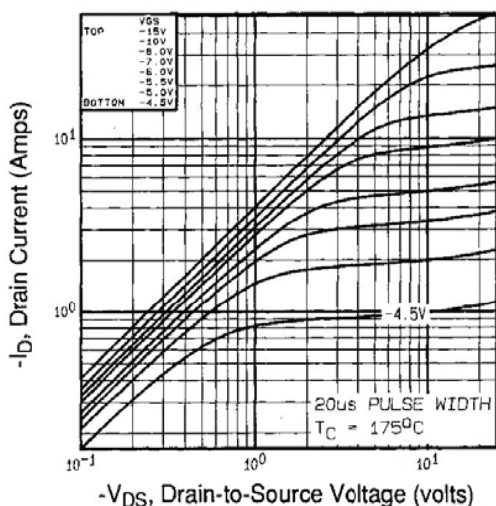
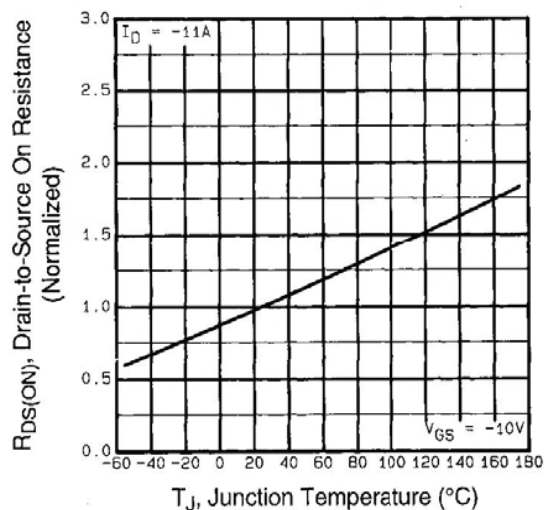
SPECIFICATIONS $T_J = 25\text{ °C}$, unless otherwise noted

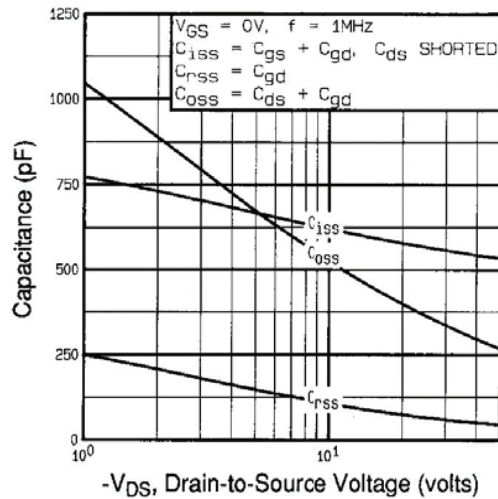
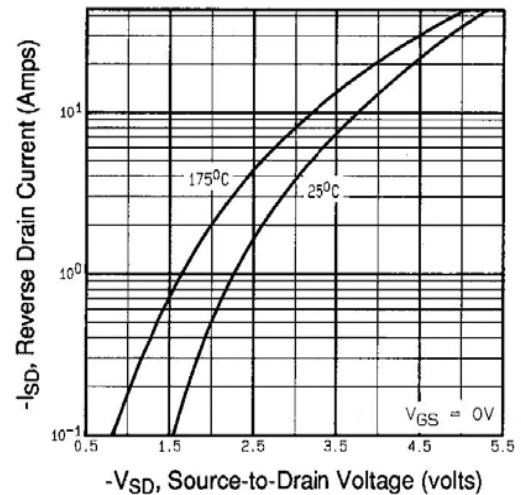
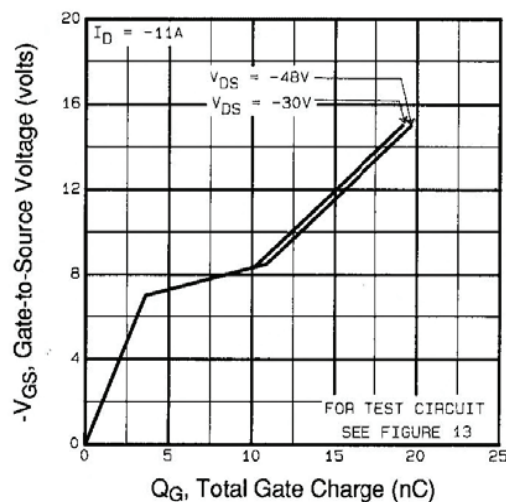
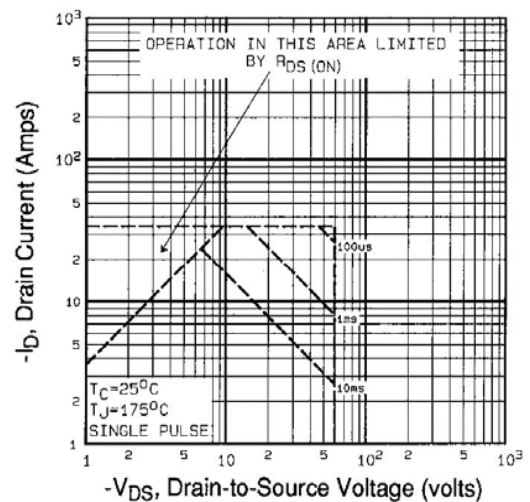
PARAMETER	SYMBOL	TEST CONDITIONS		MIN.	TYP.	MAX.	UNIT		
Static									
Drain-ssource breakdown voltage	V_{DS}	$V_{GS} = 0\text{ V}$, $I_D = -250\text{ }\mu\text{A}$		-60	-	-	V		
V_{DS} temperature coefficient	$\Delta V_{DS}/T_J$	Reference to $25\text{ }^\circ\text{C}$, $I_D = -1\text{ mA}$		-	-0.056	-	V/ $^\circ\text{C}$		
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}	$V_{GS} = \pm 20\text{ V}$		-	-	± 100	nA		
Zero gate voltage drain current	I_{DSS}	$V_{DS} = -60\text{ V}$, $V_{GS} = 0\text{ V}$		-	-	-100	μA		
		$V_{DS} = -48\text{ V}$, $V_{GS} = 0\text{ V}$, $T_J = 150\text{ }^\circ\text{C}$		-	-	-500			
Drain-source on-state resistance	$R_{DS(on)}$	$V_{GS} = -10\text{ V}$	$I_D = -5.1\text{ A}^b$	-	-	0.28	Ω		
Forward transconductance	g_{fs}	$V_{DS} = -25\text{ V}$, $I_D = -5.1\text{ A}^b$		3.2	-	-	S		
Dynamic									
Input capacitance	C_{iss}	$V_{GS} = 0\text{ V}$, $V_{DS} = -25\text{ V}$, $f = 1.0\text{ MHz}$, see fig. 5		-	570	-	pF		
Output capacitance	C_{oss}			-	360	-			
Reverse transfer capacitance	C_{rss}			-	65	-			
Drain to sink capacitance	C	$f = 1.0\text{ MHz}$		-	12	-			
Total gate charge	Q_g	$V_{GS} = -10\text{ V}$	$I_D = -11\text{ A}$, $V_{DS} = -48\text{ V}$, see fig. 6 and 13 ^b	-	-	19	nC		
Gate-source charge	Q_{gs}			-	-	5.4			
Gate-drain charge	Q_{gd}			-	-	11			
Turn-on delay time	$t_{d(on)}$	$V_{DD} = -30\text{ V}$, $I_D = -11\text{ A}$, $R_G = 18\text{ }\Omega$, $R_D = 2.5\text{ }\Omega$, see fig. 10 ^b		-	13	-	ns		
Rise time	t_r			-	68	-			
Turn-off delay time	$t_{d(off)}$			-	15	-			
Fall time	t_f			-	29	-			
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				-	-	-8.5	A
Pulsed diode forward current ^a	I_{SM}					-	-	-34	
Body diode voltage	V_{SD}	$T_J = 25\text{ }^\circ\text{C}$, $I_S = -8.5\text{ A}$, $V_{GS} = 0\text{ V}^b$		-	-	-6.3	V		
Body diode reverse recovery time	t_{rr}	$T_J = 25\text{ }^\circ\text{C}$, $I_F = -11\text{ A}$, $dI/dt = 100\text{ A}/\mu\text{s}^b$		-	100	200	ns		
Body diode reverse recovery charge	Q_{rr}			-	0.32	0.64	μC		
Forward turn-on time	t_{on}	Intrinsic turn-on time is negligible (turn-on is dominated by L_S and L_D)							

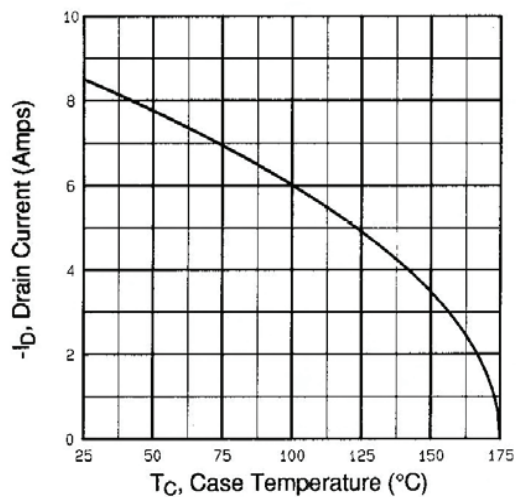
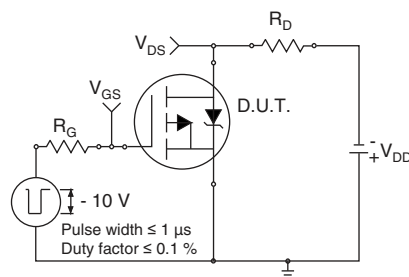
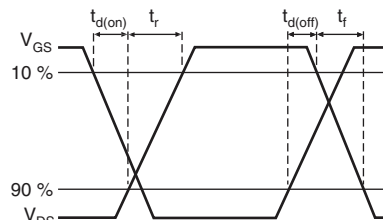
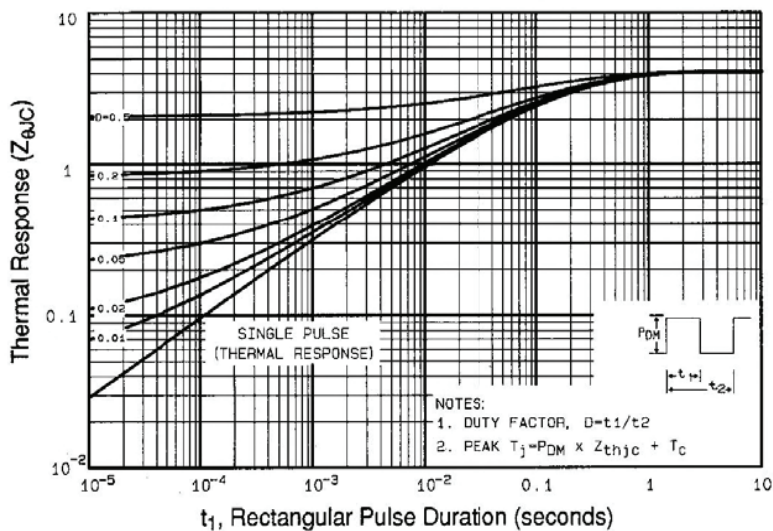
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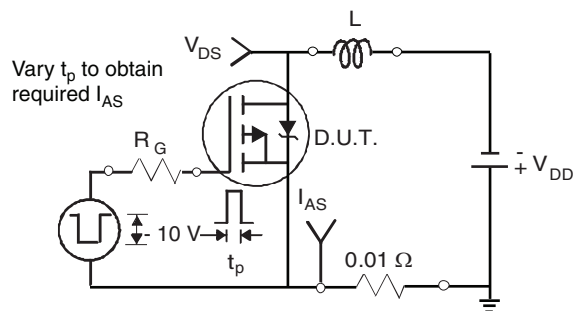
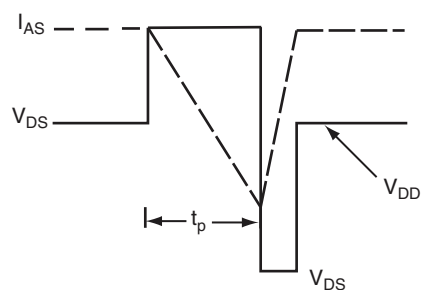
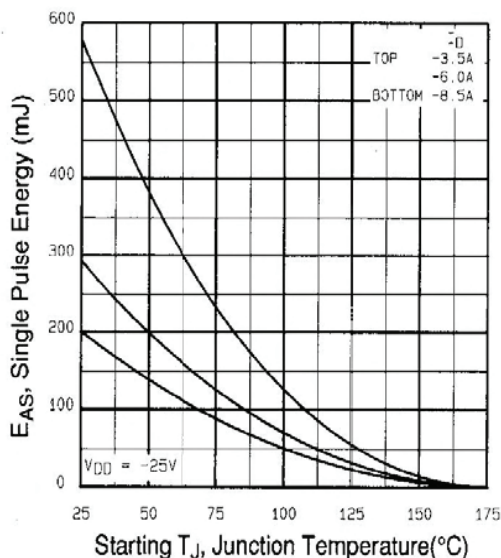
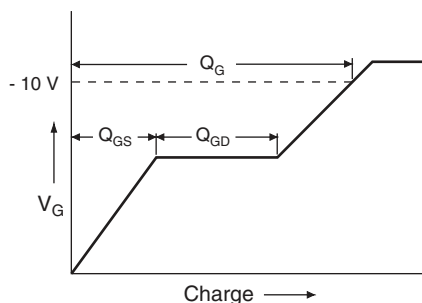
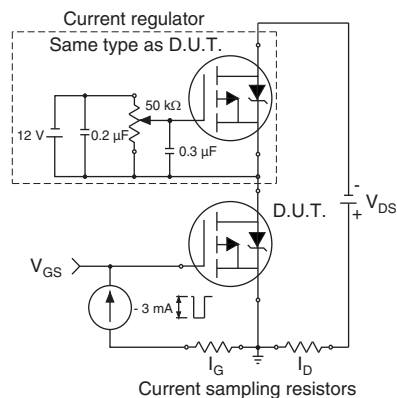
a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)

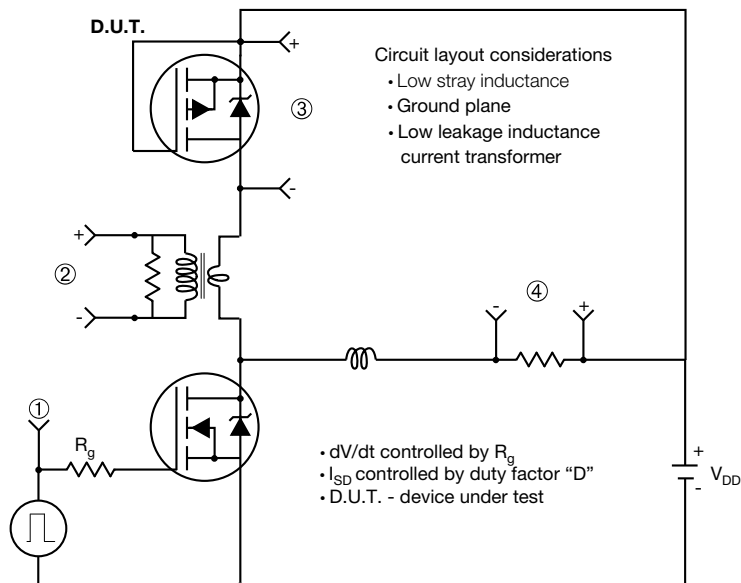
b. Pulse width $\leq 300\text{ }\mu\text{s}$; duty cycle $\leq 2\%$

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, $T_C = 175^\circ\text{C}$

Fig. 4 - Normalized On-Resistance vs. Temperature

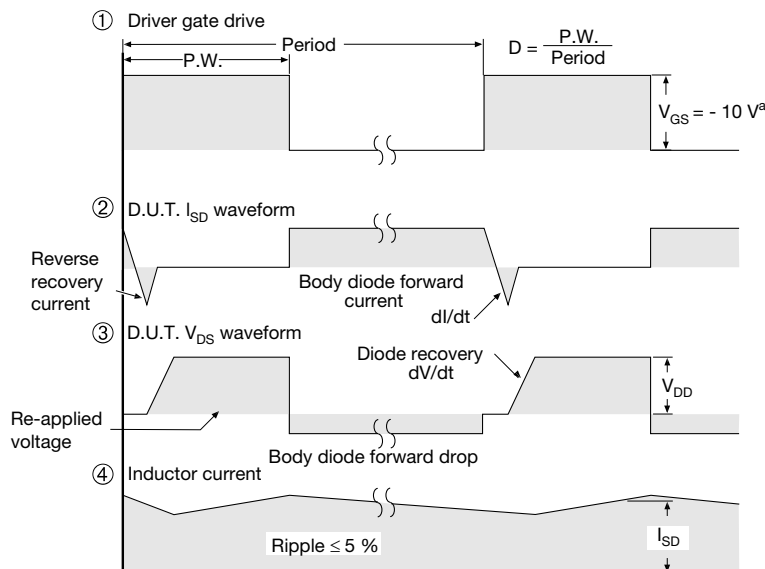

Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

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
• Complement N-Channel of D.U.T. for driver



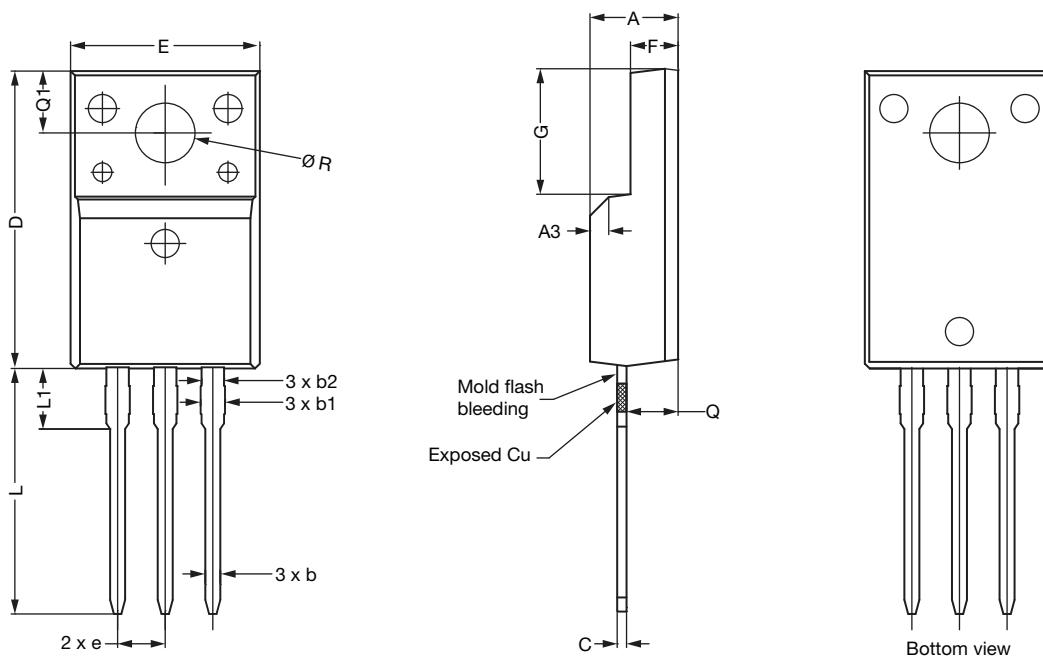
Note
a. V_{GS} = - 5 V for logic level and - 3 V drive devices

Fig. 14 - For P-Channel

Vishay Siliconix maintains worldwide manufacturing capability. Products may be manufactured at one of several qualified locations. Reliability data for Silicon Technology and Package Reliability represent a composite of all qualified locations. For related documents such as package/tape drawings, part marking, and reliability data, see www.vishay.com/ppg?91171.

TO-220 FULLPAK (High Voltage)

OPTION 1: FACILITY CODE = 9



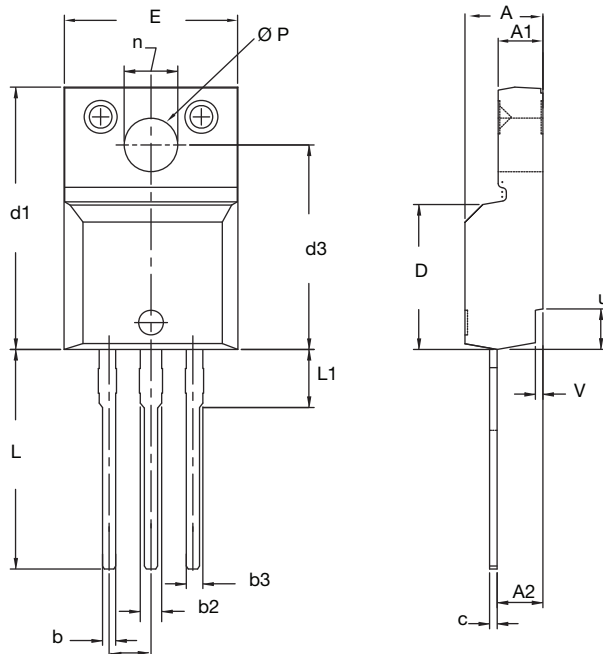
DIM.	MILLIMETERS		
	MIN.	NOM.	MAX.
A	4.60	4.70	4.80
b	0.70	0.80	0.91
b1	1.20	1.30	1.47
b2	1.10	1.20	1.30
C	0.45	0.50	0.63
D	15.80	15.87	15.97
e	2.54 BSC		
E	10.00	10.10	10.30
F	2.44	2.54	2.64
G	6.50	6.70	6.90
L	12.90	13.10	13.30
L1	3.13	3.23	3.33
Q	2.65	2.75	2.85
Q1	3.20	3.30	3.40
Ø R	3.08	3.18	3.28

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 1st character located at the 2nd 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

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 1st character located at the 2nd row of the unit marking



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