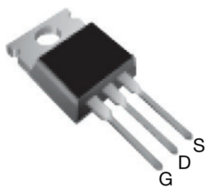
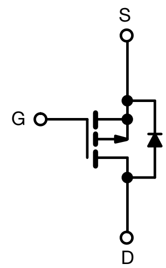
Power MOSFET

TO-220AB





P-Channel MOSFET

FEATURES

- Dynamic dV/dt rating
- Repetitive avalanche rated
- P-channel
- 175 °C operating temperature
- Fast switching
- Ease of paralleling
- Simple drive requirements
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

Pb Available

RoHS* Available

Note

* This datasheet provides information about parts that are RoHS-compliant and / or parts that are non RoHS-compliant. For example, parts with lead (Pb) terminations are not RoHS-compliant. Please see the information / tables in this datasheet for details

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

ORDERING INFORMATION	
Package	TO-220AB
Lead (Pb)-free	IRF9Z24PbF
Lead (Pb)-free and halogen-free	IRF9Z24PbF-BE3

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	V_{GS} at 10 V	T_C = 25 °C	I_D	-11	A
		T_C = 100 °C		-7.7	
Pulsed drain current [a]			I_{DM}	-44	
Linear derating factor				0.40	W/°C
Single pulse avalanche energy [b]			E_{AS}	240	mJ
Repetitive avalanche current [a]			I_{AR}	-11	A
Repetitive avalanche energy [a]			E_{AR}	6.0	mJ
Maximum power dissipation	T_C = 25 °C		P_D	60	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	6-32 or M3 screw			10	lbf · in
				1.1	N · m

Notes

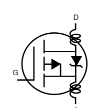
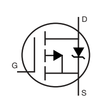
a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)

b. V_{DD} = -25 V, starting T_J = 25 °C, L = 2.3 mH, R_g = 25 Ω, I_{AS} = -11 A (see fig. 12)

c. $I_{SD} \leq$ -11 A, dI/dt ≤ 140 A/μs, $V_{DD} \leq V_{DS}$, $T_J \leq$ 175 °C

d. 1.6 mm from case

THERMAL RESISTANCE RATINGS				
PARAMETER	**SYMBOL**	**TYP.**	**MAX.**	**UNIT**
Maximum junction-to-ambient	R_{thJA}	-	62	°C/W
Case-to-sink, flat, greased surface	R_{thCS}	0.50	-	
Maximum junction-to-case (drain)	R_{thJC}	-	2.5	

SPECIFICATIONS (T_J = 25 °C, unless otherwise noted)						
PARAMETER	**SYMBOL**	**TEST CONDITIONS**	**MIN.**	**TYP.**	**MAX.**	**UNIT**
Static						
Drain-source breakdown voltage	V_{DS}	V_{GS} = 0 V, I_D = -250 μA	-60	-	-	V
V_{DS} temperature coefficient	$\Delta V_{DS}/T_J$	Reference to 25 °C, I_D = -1 mA	-	-0.056	-	V/°C
Gate-source threshold voltage	$V_{GS(th)}$	V_{DS} = V_{GS}, I_D = -250 μA	-2.0	-	-4.0	V
Gate-source leakage	I_{GSS}	V_{GS} = ± 20 V	-	-	± 100	nA
Zero gate voltage drain current	I_{DSS}	V_{DS} = -60 V, V_{GS} = 0 V	-	-	-100	μA
		V_{DS} = -48 V, V_{GS} = 0 V, T_J = 150 °C	-	-	-500	
Drain-source on-state resistance	$R_{DS(on)}$	V_{GS} = -10 V; I_D = -6.6 A [b]	-	-	0.28	Ω
Forward transconductance	g_{fs}	V_{DS} = -25 V, I_D = -6.6 A [b]	1.4	-	-	S
Dynamic						
Input capacitance	C_{iss}	V_{GS} = 0 V, V_{DS} = -25 V, f = 1.0 MHz, see fig. 5	-	570	-	pF
Output capacitance	C_{oss}		-	360	-	
Reverse transfer capacitance	C_{rss}		-	65	-	
Total gate charge	Q_g	V_{GS} = -10 V; I_D = -11 A, V_{DS} = -48 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 V, I_D = -11 A, R_g = 18 Ω, R_D = 2.5 Ω, see fig. 10 [b]	-	13	-	ns
Rise time	t_r		-	68	-	
Turn-off delay time	$t_{d(off)}$		-	15	-	
Fall time	t_f		-	29	-	
Gate input resistance	R_g	f = 1 MHz, open drain	0.5	-	3.5	Ω
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 	-	-	-11	A
Pulsed diode forward current [a]	I_{SM}		-	-	-44	
Body diode voltage	V_{SD}	T_J = 25 °C, I_S = -11 A, V_{GS} = 0 V [b]	-	-	-6.3	V
Body diode reverse recovery time	t_{rr}	T_J = 25 °C, I_F = -11 A, dI/dt = 100 A/μs [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)				

Notes

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

b. Pulse width ≤ 300 μs; duty cycle ≤ 2 %

TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)

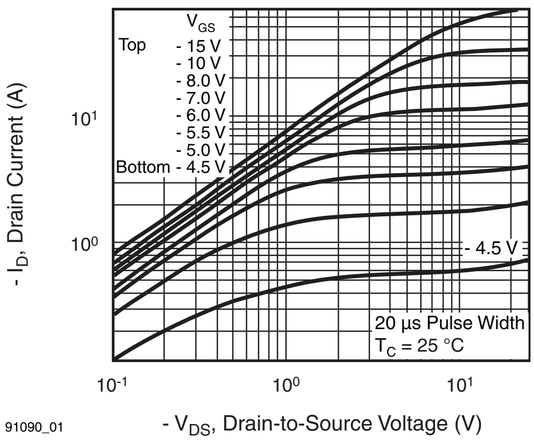


Fig. 1 - Typical Output Characteristics, T_C = 25 °C

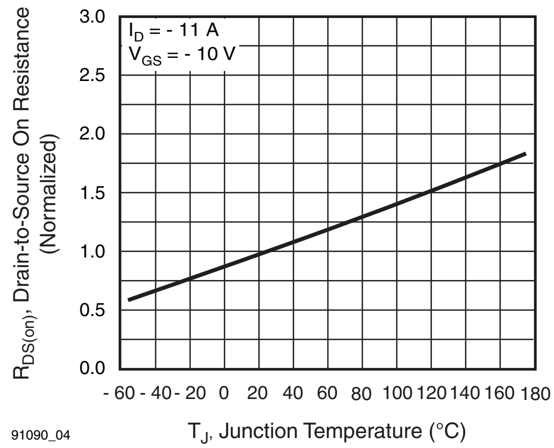


Fig. 4 - Normalized On-Resistance vs. Temperature

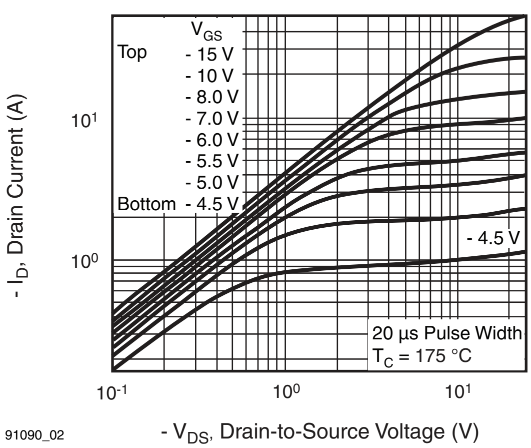


Fig. 2 - Typical Output Characteristics, T_C = 175 °C

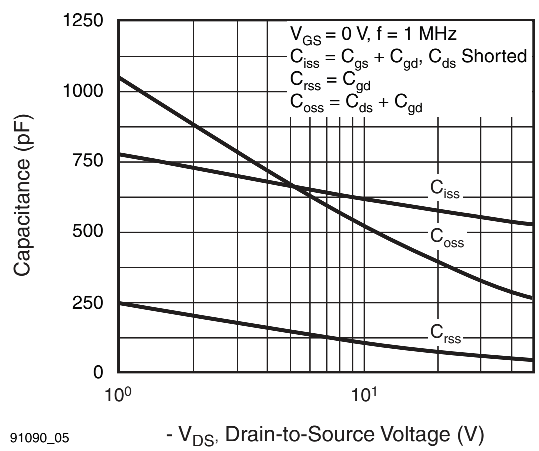


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

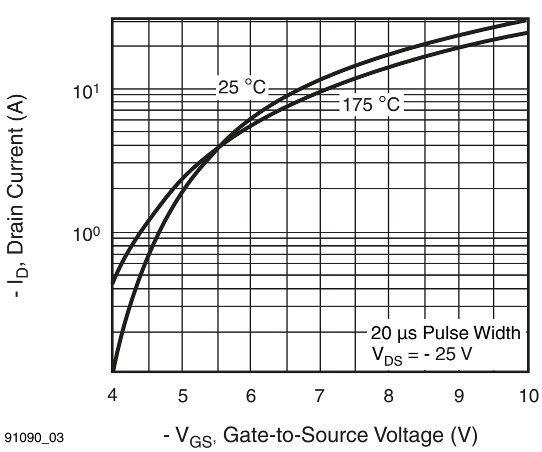


Fig. 3 - Typical Transfer Characteristics

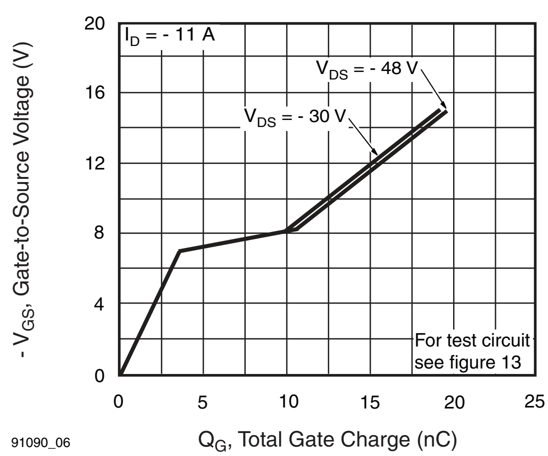


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

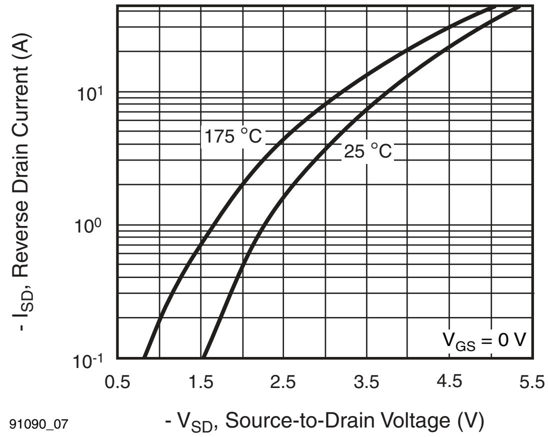


Fig. 7 - Typical Source-Drain Diode Forward Voltage

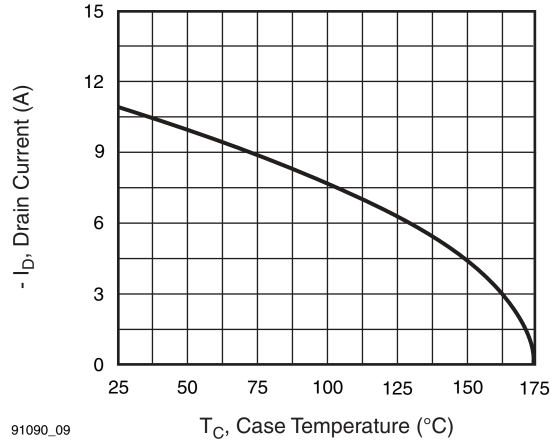


Fig. 9 - Maximum Drain Current vs. Case Temperature

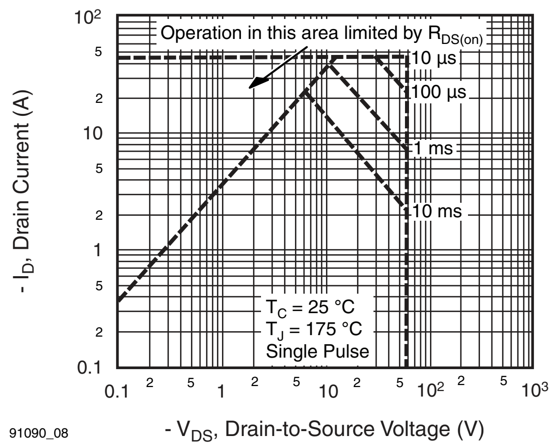


Fig. 8 - Maximum Safe Operating Area

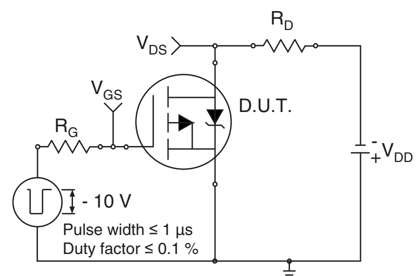


Fig. 10a - Switching Time Test Circuit

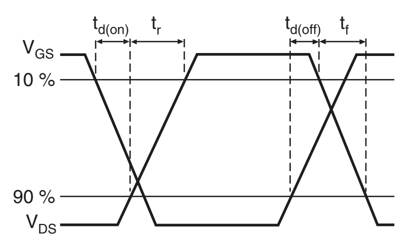


Fig. 10b - Switching Time Waveforms

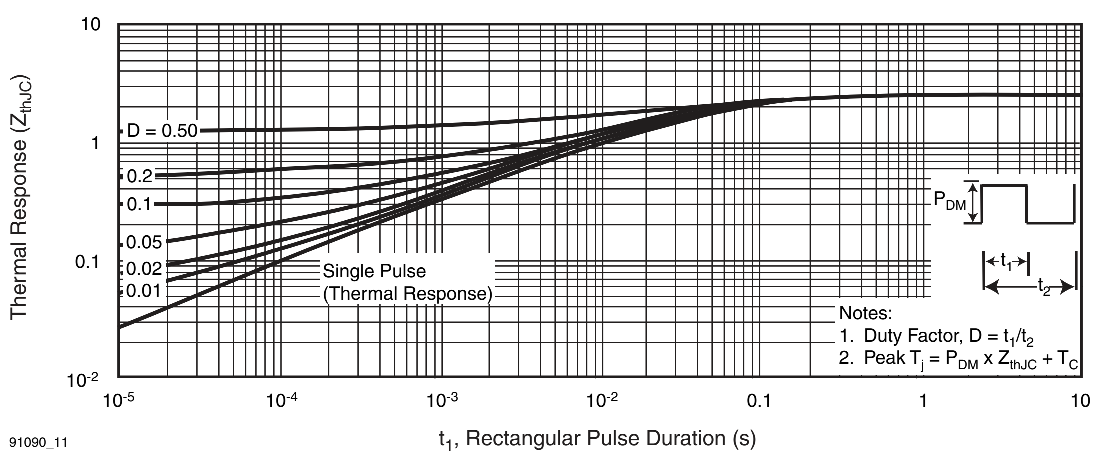


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

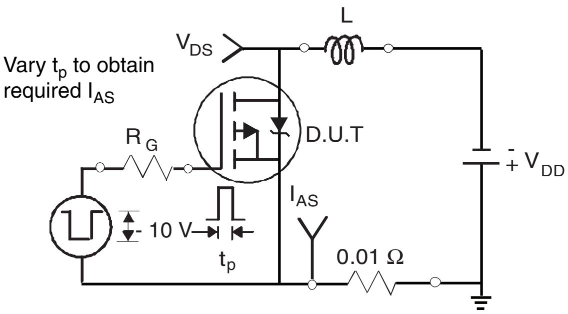


Fig. 12a - Unclamped Inductive Test Circuit

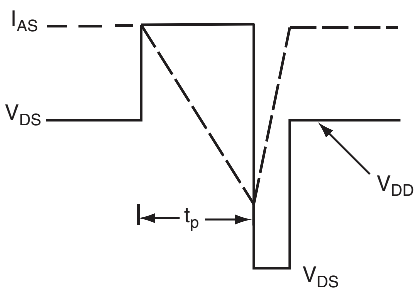


Fig. 12b - Unclamped Inductive Waveforms

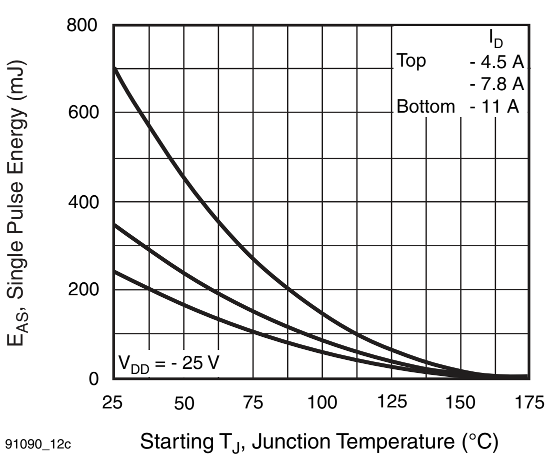


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

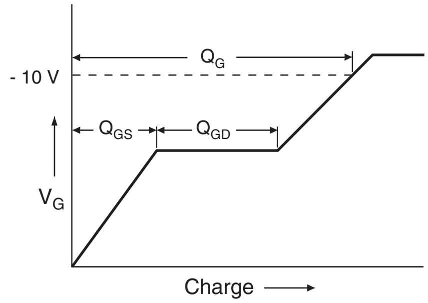


Fig. 13a - Basic Gate Charge Waveform

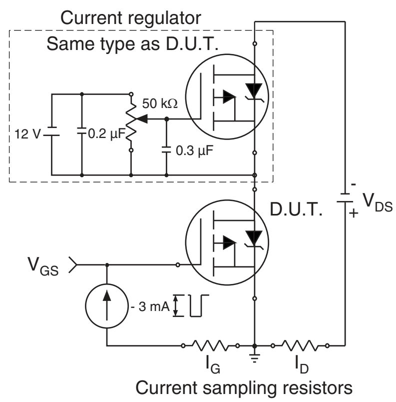
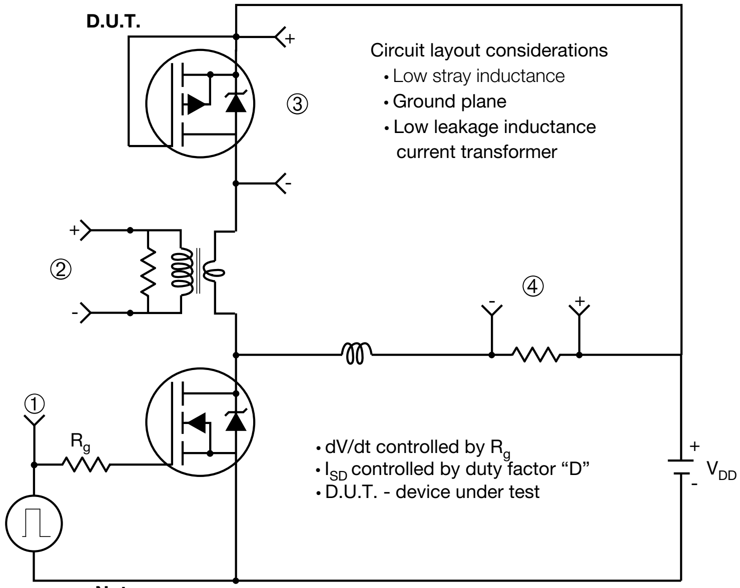
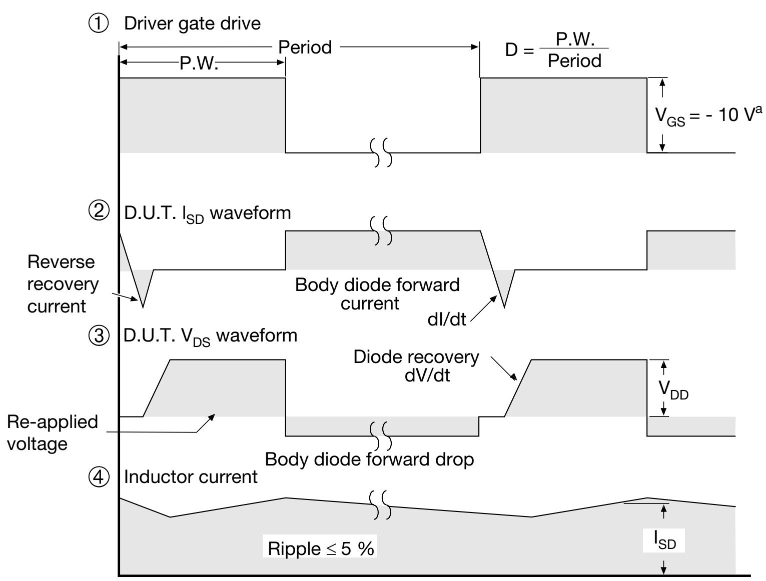


Fig 13b - Gate Charge Test Circuit

Peak Diode Recovery dV/dt Test Circuit



Note
- Compliment N-Channel of D.U.T. for driver

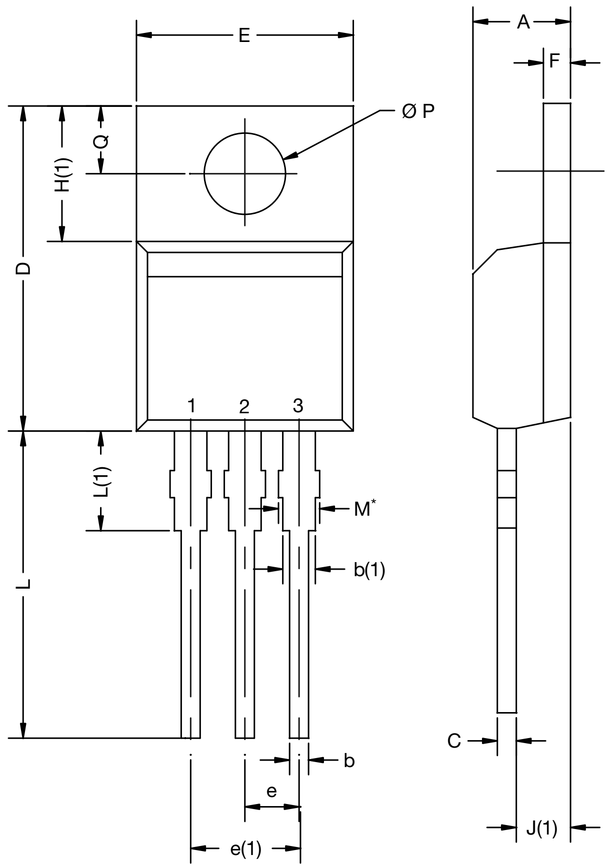


Note
a. V_{GS} = - 5 V for logic level and - 3 V drive devices

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?91090.

TO-220-1

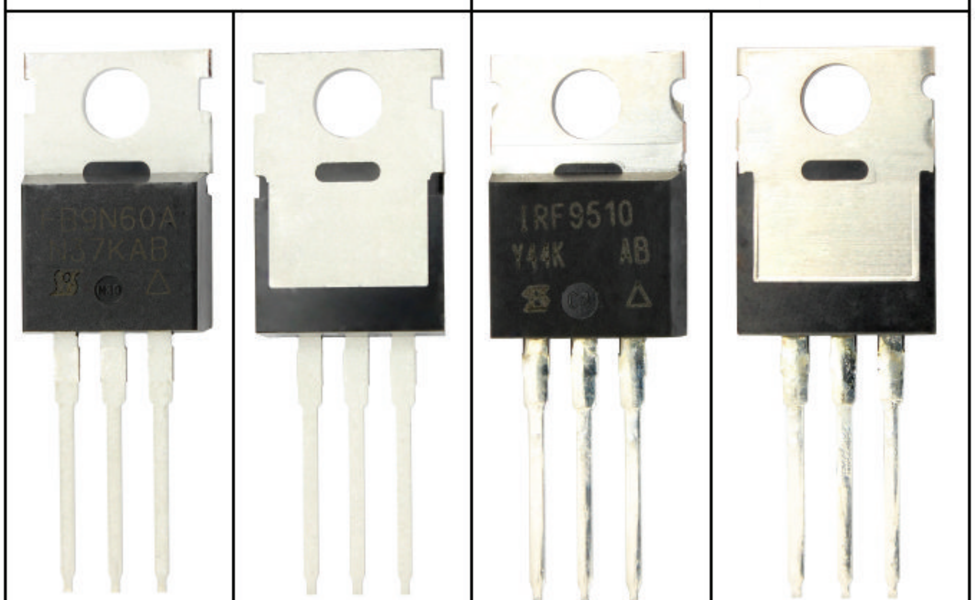


DIM.	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	4.24	4.65	0.167	0.183
b	0.69	1.02	0.027	0.040
b(1)	1.14	1.78	0.045	0.070
c	0.36	0.61	0.014	0.024
D	14.33	15.85	0.564	0.624
E	9.96	10.52	0.392	0.414
e	2.41	2.67	0.095	0.105
e(1)	4.88	5.28	0.192	0.208
F	1.14	1.40	0.045	0.055
H(1)	6.10	6.71	0.240	0.264
J(1)	2.41	2.92	0.095	0.115
L	13.36	14.40	0.526	0.567
L(1)	3.33	4.04	0.131	0.159
Ø P	3.53	3.94	0.139	0.155
Q	2.54	3.00	0.100	0.118
ECN: X15-0364-Rev. C, 14-Dec-15 DWG: 6031				

Note

- M* = 0.052 inches to 0.064 inches (dimension including protrusion), heatsink hole for HVM

Package Picture	
ASE	Xi'an



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