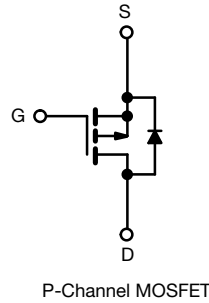
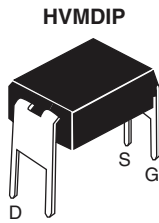


## Power MOSFET



P-Channel MOSFET

### FEATURES

- Dynamic dV/dt rating
- Repetitive avalanche rated
- For automatic insertion
- End stackable
- P-channel
- Fast switching
- 175 °C operating temperature
- 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)	-60	
$R_{DS(on)}$ ( $\Omega$ )	$V_{GS} = -10$ 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 4 pin DIP package is a low cost machine-insertable case style which can be stacked in multiple combinations on standard 0.1" pin centers. The dual drain serves as a thermal link to the mounting surface for power dissipation levels up to 1 W.

### ORDERING INFORMATION

Package	HVMDIP
Lead (Pb)-free	IRFD9024PbF

### ABSOLUTE MAXIMUM RATINGS ( $T_A = 25$ °C, unless otherwise noted)

PARAMETER	SYMBOL	LIMIT	UNIT
Drain-source voltage	$V_{DS}$	-60	V
Gate-source voltage	$V_{GS}$	$\pm 20$	
Continuous drain current	$I_D$	$T_A = 25$ °C	-1.6
		$T_A = 100$ °C	-1.1
Pulsed drain current <sup>a</sup>	$I_{DM}$	-13	A
Linear derating factor		0.0083	W/°C
Single pulse avalanche energy <sup>b</sup>	$E_{AS}$	140	mJ
Repetitive avalanche current <sup>a</sup>	$I_{AR}$	-1.6	A
Repetitive avalanche energy <sup>a</sup>	$E_{AR}$	0.13	mJ
Maximum power dissipation	$P_D$	1.3	W
Peak diode recovery dv/dt <sup>c</sup>	dV/dt	-4.5	V/ns
Operating junction and storage temperature range	$T_J, T_{stg}$	-55 to + 175	°C
Soldering rRecommendations (peak temperature) <sup>d</sup>	For 10 s	300 <sup>d</sup>	

#### Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)
- $V_{DD} = -25$  V, starting  $T_J = 25$  °C,  $L = 15$  mH,  $R_g = 25$   $\Omega$ ,  $I_{AS} = -3.2$  A (see fig. 12)
- $I_{SD} \leq -11$  A,  $di/dt \leq 140$  A/ $\mu$ s,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 175$  °C
- 1.6 mm from case

<b>THERMAL RESISTANCE RATINGS</b>				
PARAMETER	SYMBOL	TYP.	MAX.	UNIT
Maximum Junction-to-Ambient	$R_{thJA}$	-	120	°C/W

<b>SPECIFICATIONS</b> ( $T_J = 25\text{ }^\circ\text{C}$ , unless otherwise noted)							
PARAMETER	SYMBOL	TEST CONDITIONS		MIN.	TYP.	MAX.	UNIT
<b>Static</b>							
Drain-Source Breakdown Voltage	$V_{DS}$	$V_{GS} = 0\text{ V}, I_D = -250\text{ }\mu\text{A}$		-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/°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	$I_{DSS}$	$V_{DS} = -60\text{ V}, V_{GS} = 0\text{ V}$		-	-	-100	$\mu\text{A}$
		$V_{DS} = -48\text{ V}, V_{GS} = 0\text{ V}, T_J = 150\text{ }^\circ\text{C}$		-	-	-500	
Drain-Source On-State Resistance	$R_{DS(on)}$	$V_{GS} = -10\text{ V}$	$I_D = -0.96\text{ A}^b$	-	-	0.28	$\Omega$
Forward Transconductance	$g_{fs}$	$V_{DS} = -25\text{ V}, I_D = -0.96\text{ A}^b$		1.3	-	-	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		-	570	-	pF
Output Capacitance	$C_{oss}$			-	360	-	
Reverse Transfer Capacitance	$C_{rss}$			-	65	-	
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 <sup>b</sup>	-	-	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 <sup>b</sup>		-	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		-	4.0	-	nH
Internal Source Inductance	$L_S$			-	6.0	-	
<b>Drain-Source Body Diode Characteristics</b>							
Continuous Source-Drain Diode Current	$I_S$	MOSFET symbol showing the integral reverse p - n junction diode		-	-	-1.6	A
Pulsed Diode Forward Current <sup>a</sup>	$I_{SM}$			-	-	-13	
Body Diode Voltage	$V_{SD}$	$T_J = 25\text{ }^\circ\text{C}, I_S = -1.6\text{ A}, V_{GS} = 0\text{ V}^b$		-	-	-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	$\mu\text{C}$
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)

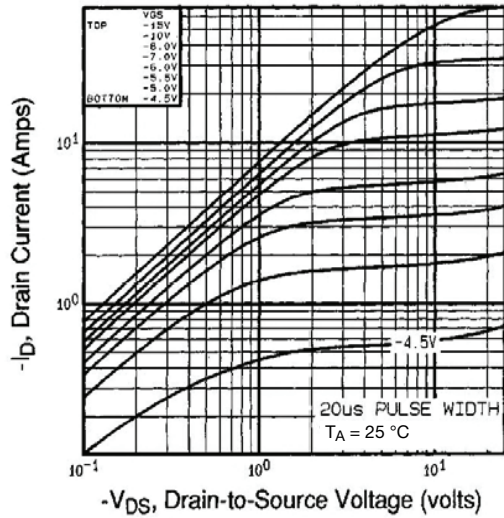


Fig. 1 - Typical Output Characteristics,  $T_A = 25\text{ }^\circ\text{C}$

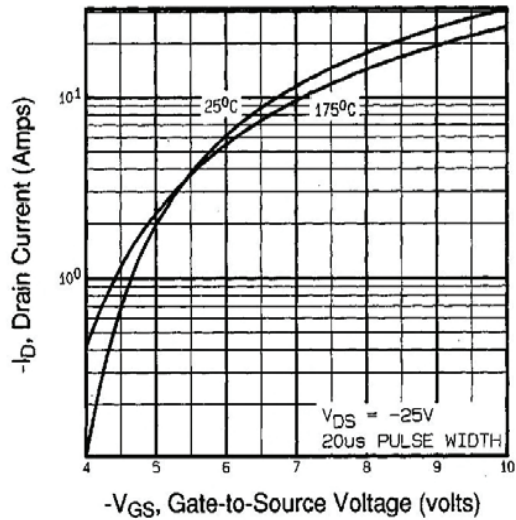


Fig. 2 - Typical Transfer Characteristics

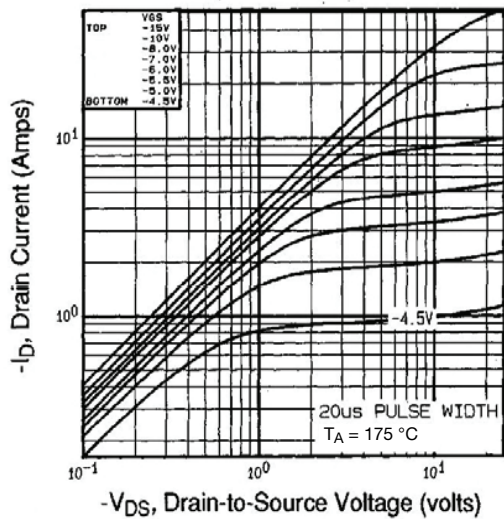


Fig. 1 - Typical Output Characteristics,  $T_A = 175\text{ }^\circ\text{C}$

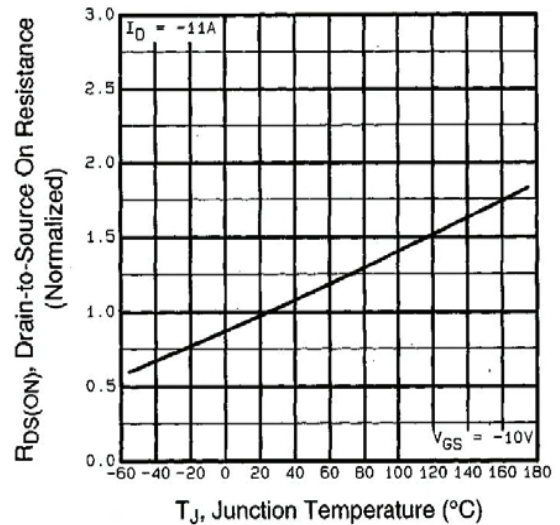


Fig. 3 - Normalized On-Resistance vs. Temperature

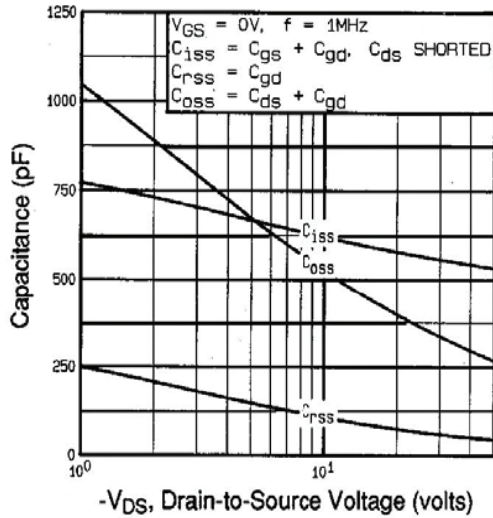


Fig. 4 - Typical Capacitance vs. Drain-to-Source Voltage

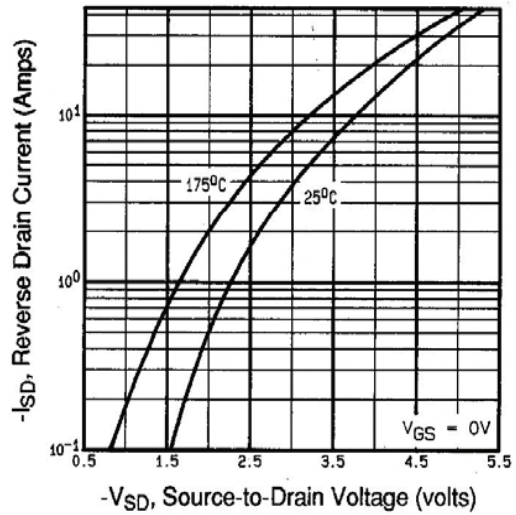


Fig. 6 - Typical Source-Drain Diode Forward Voltage

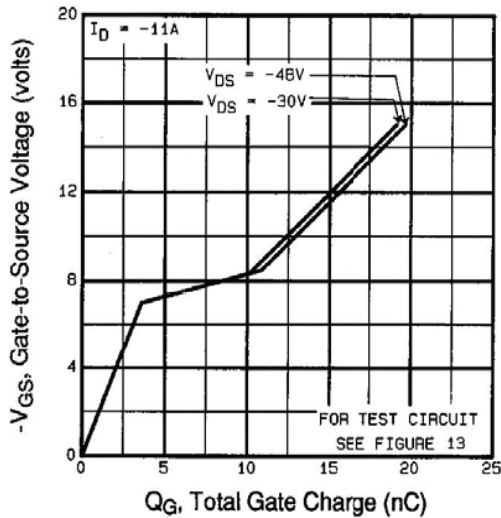


Fig. 5 - Typical Gate Charge vs. Gate-to-Source Voltage

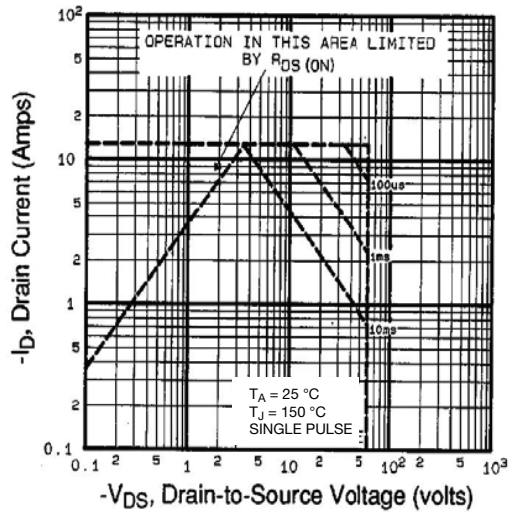


Fig. 7 - Maximum Safe Operating Area

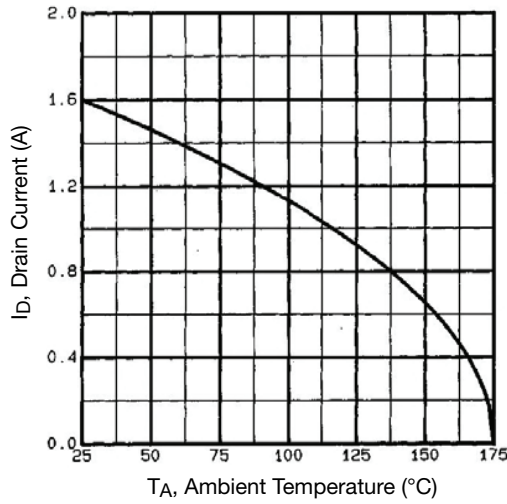


Fig. 8 - Maximum Drain Current vs. Ambient Temperature

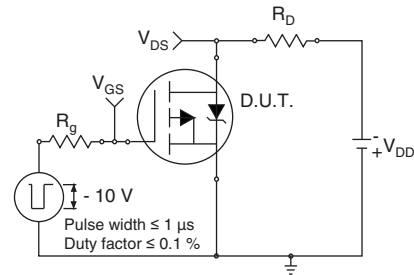


Fig. 10a - Switching Time Test Circuit

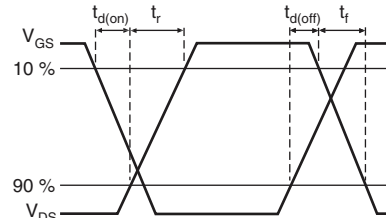


Fig. 10b - Switching Time Waveforms

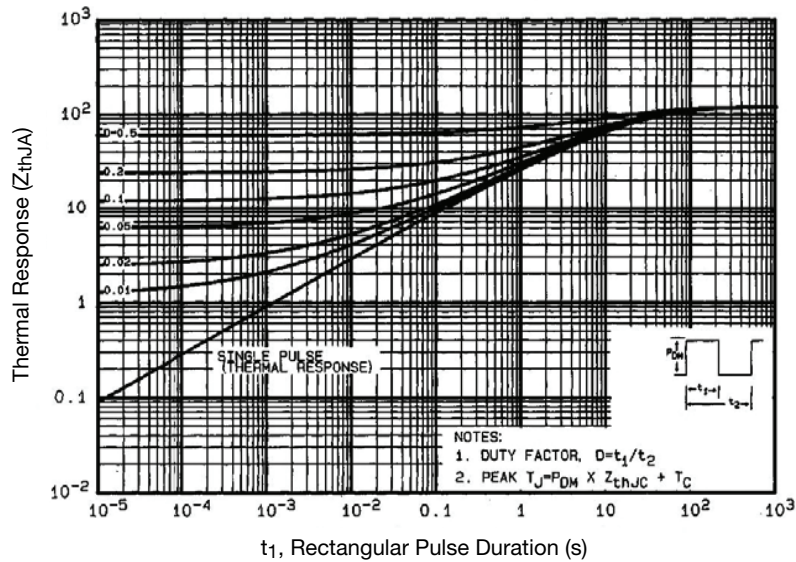


Fig. 9 - Maximum Effective Transient Thermal Impedance, Junction-to-Ambient

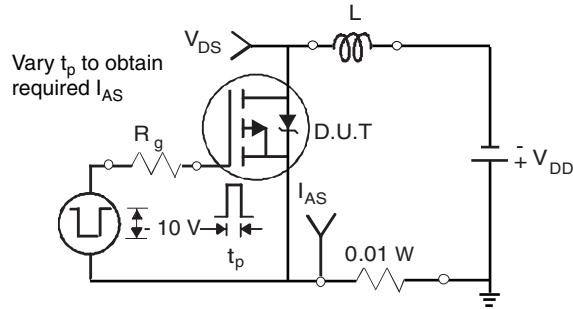


Fig. 12a - Unclamped Inductive Test Circuit

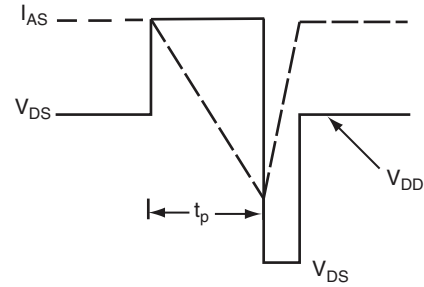


Fig. 12b - Unclamped Inductive Waveforms

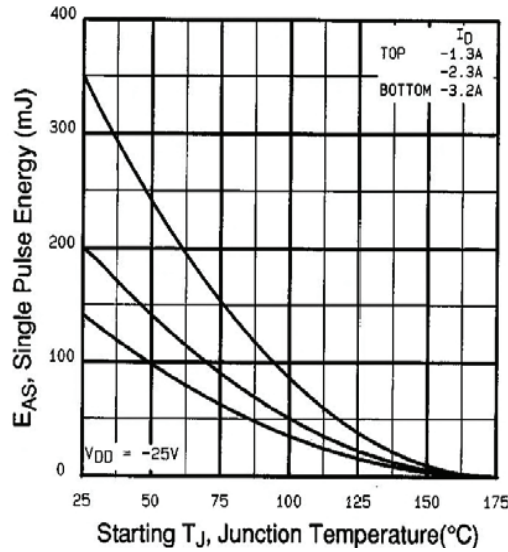


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

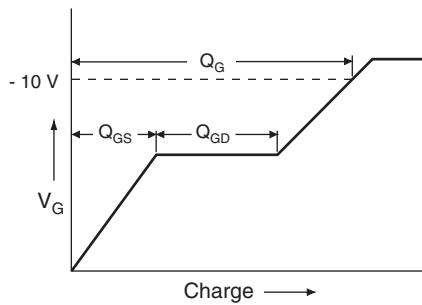


Fig. 13a - Basic Gate Charge Waveform

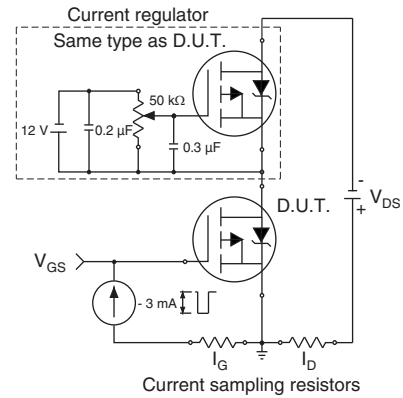
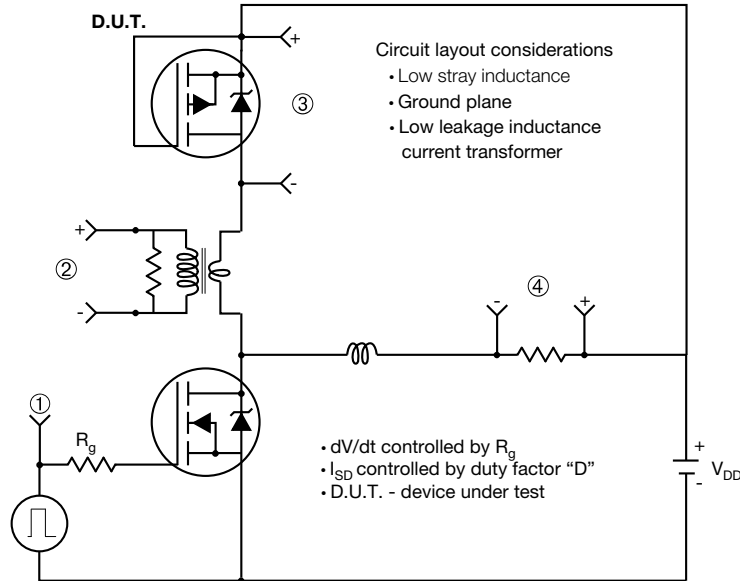


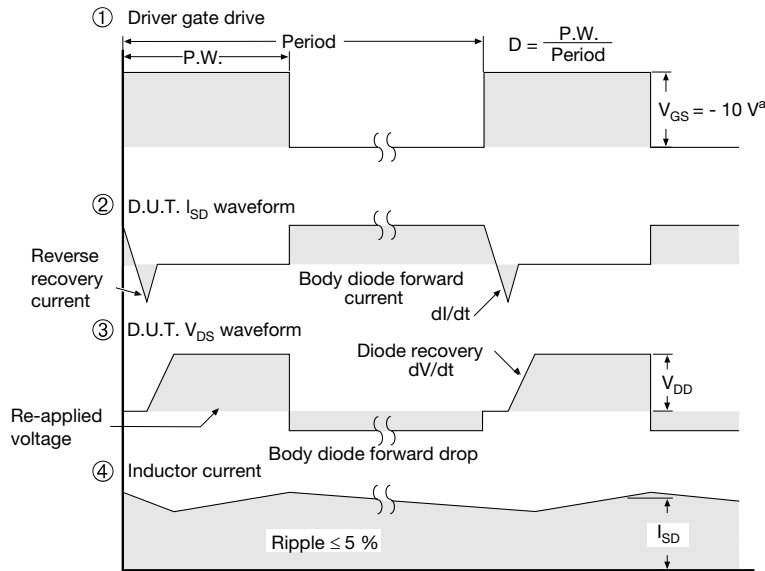
Fig. 13b - Gate Charge Test Circuit

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



**Note**

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



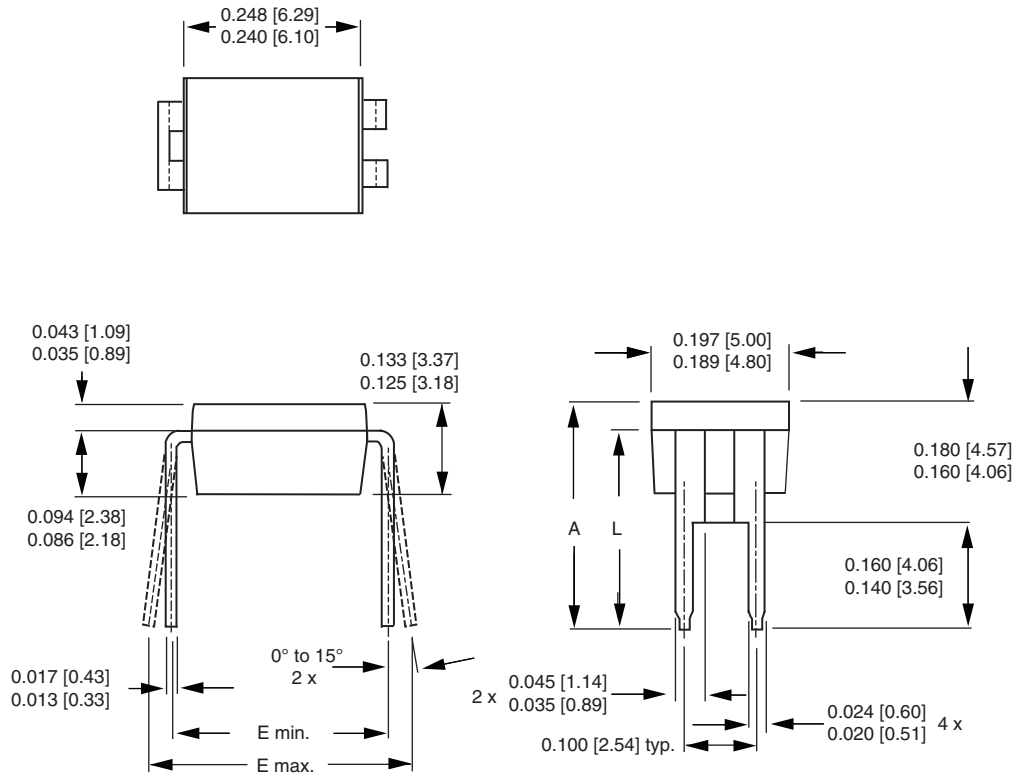
**Note**

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

**Fig. 10 - For P-Channel**

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## HVM DIP (High voltage)



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.310	0.330	7.87	8.38
E	0.300	0.425	7.62	10.79
L	0.270	0.290	6.86	7.36

ECN: X10-0386-Rev. B, 06-Sep-10  
DWG: 5974

### Note

- Package length does not include mold flash, protrusions or gate burrs. Package width does not include interlead flash or protrusions.





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