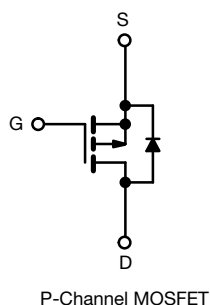
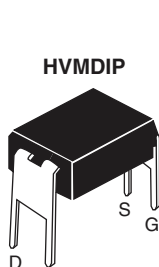


## Power MOSFET



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 servers 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	A
		$T_A = 100$ °C	
Pulsed drain current <sup>a</sup>	$I_{DM}$	-13	
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

**THERMAL RESISTANCE RATINGS**

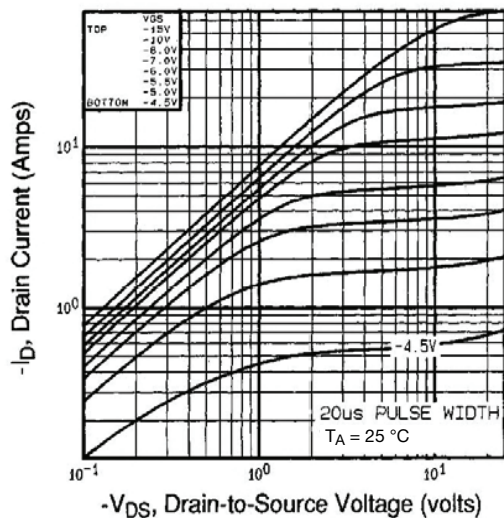
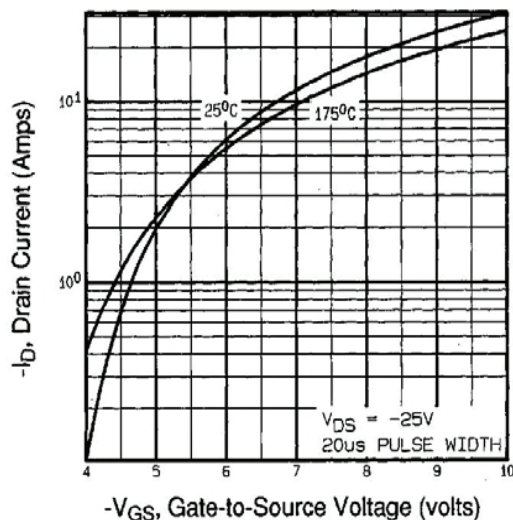
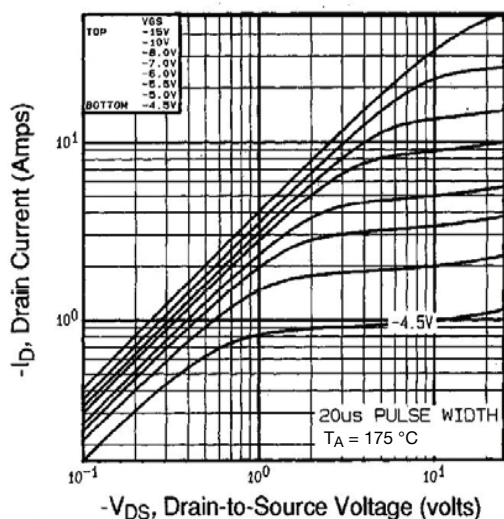
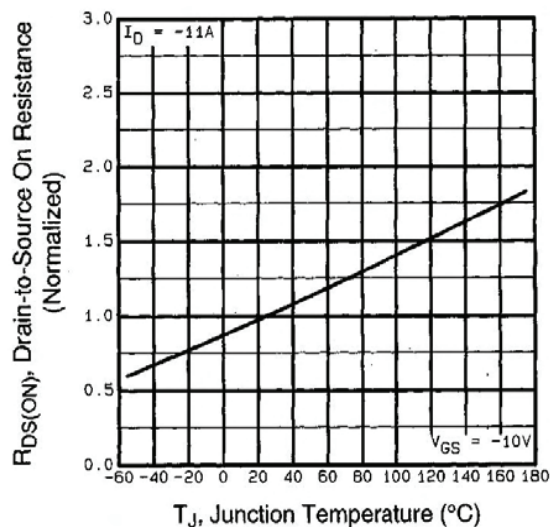
PARAMETER	SYMBOL	TYP.	MAX.	UNIT
Maximum Junction-to-Ambient	$R_{thJA}$	-	120	°C/W

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

PARAMETER	SYMBOL	TEST CONDITIONS		MIN.	TYP.	MAX.	UNIT
Static							
Drain-Source Breakdown Voltage	V <sub>DS</sub>	V <sub>GS</sub> = 0 V, I <sub>D</sub> = -250 μA		-60	-	-	V
V <sub>DS</sub> Temperature Coefficient	ΔV <sub>DS</sub> /T <sub>J</sub>	Reference to 25 °C, I <sub>D</sub> = -1 mA		-	-0.056	-	V/°C
Gate-Source Threshold Voltage	V <sub>GS(th)</sub>	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = -250 μA		-2.0	-	-4.0	V
Gate-Source Leakage	I <sub>GSS</sub>	V <sub>GS</sub> = ± 20 V		-	-	± 100	nA
Zero Gate Voltage Drain Current	I <sub>DSS</sub>	V <sub>DS</sub> = -60 V, V <sub>GS</sub> = 0 V		-	-	-100	μA
		V <sub>DS</sub> = -48 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 150 °C		-	-	-500	
Drain-Source On-State Resistance	R <sub>DS(on)</sub>	V <sub>GS</sub> = -10 V	I <sub>D</sub> = -0.96 A <sup>b</sup>	-	-	0.28	Ω
Forward Transconductance	g <sub>fs</sub>	V <sub>DS</sub> = -25 V, I <sub>D</sub> = -0.96 A <sup>b</sup>		1.3	-	-	S
Dynamic							
Input Capacitance	C <sub>iss</sub>	V <sub>GS</sub> = 0 V V <sub>DS</sub> = -25 V f = 1.0 MHz, see fig. 5		-	570	-	pF
Output Capacitance	C <sub>oss</sub>			-	360	-	
Reverse Transfer Capacitance	C <sub>rss</sub>			-	65	-	
Total Gate Charge	Q <sub>g</sub>	V <sub>GS</sub> = -10 V	I <sub>D</sub> = -11 A, V <sub>DS</sub> = -48 V see fig. 6 and 13 <sup>b</sup>	-	-	19	nC
Gate-Source Charge	Q <sub>gs</sub>			-	-	5.4	
Gate-Drain Charge	Q <sub>gd</sub>			-	-	11	
Turn-On Delay Time	t <sub>d(on)</sub>	V <sub>DD</sub> = -30 V, I <sub>D</sub> = -11 A R <sub>g</sub> = 18 Ω, R <sub>D</sub> = 2.5 Ω, see fig. 10 <sup>b</sup>		-	13	-	ns
Rise Time	t <sub>r</sub>			-	68	-	
Turn-Off Delay Time	t <sub>d(off)</sub>			-	15	-	
Fall Time	t <sub>f</sub>			-	29	-	
Internal Drain Inductance	L <sub>D</sub>	Between lead, 6 mm (0.25") from package and center of die contact 		-	4.0	-	nH
Internal Source Inductance	L <sub>S</sub>			-	6.0	-	
Drain-Source Body Diode Characteristics							
Continuous Source-Drain Diode Current	I <sub>S</sub>	MOSFET symbol showing the integral reverse p - n junction diode 		-	-	-1.6	A
Pulsed Diode Forward Current <sup>a</sup>	I <sub>SM</sub>			-	-	-13	
Body Diode Voltage	V <sub>SD</sub>	T <sub>J</sub> = 25 °C, I <sub>S</sub> = -1.6 A, V <sub>GS</sub> = 0 V <sup>b</sup>		-	-	-6.3	V
Body Diode Reverse Recovery Time	t <sub>rr</sub>	T <sub>J</sub> = 25 °C, I <sub>F</sub> = -11 A, dI/dt = 100 A/μs <sup>b</sup>		-	100	200	ns
Body Diode Reverse Recovery Charge	Q <sub>rr</sub>			-	0.32	0.64	μC
Forward Turn-On Time	t <sub>on</sub>	Intrinsic turn-on time is negligible (turn-on is dominated by L <sub>S</sub> and L <sub>D</sub> )					

**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,  $T_A = 25\text{ °C}$** 

**Fig. 2 - Typical Transfer Characteristics**

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

**Fig. 3 - Normalized On-Resistance vs. Temperature**

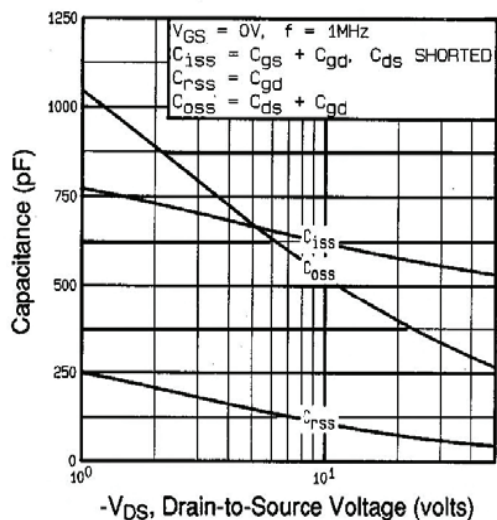


Fig. 4 - Typical Capacitance vs. Drain-to-Source Voltage

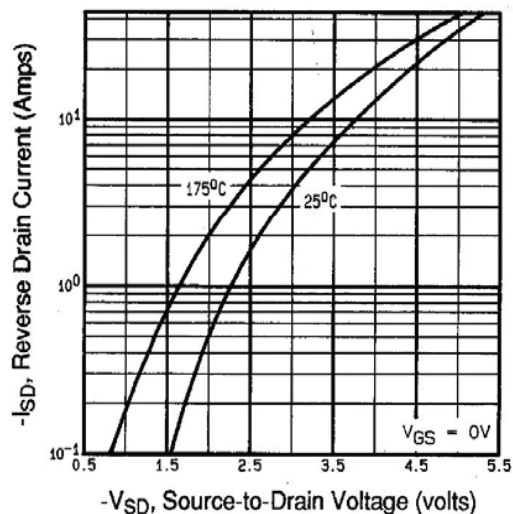


Fig. 6 - Typical Source-Drain Diode Forward Voltage

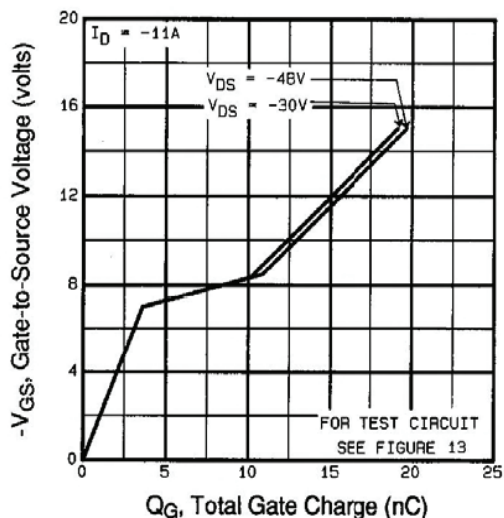


Fig. 5 - Typical Gate Charge vs. Gate-to-Source Voltage

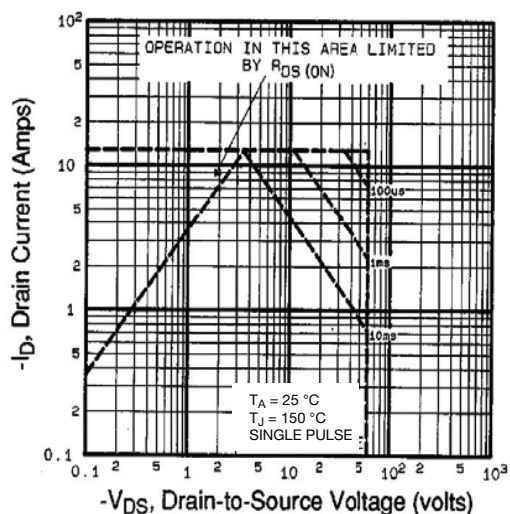
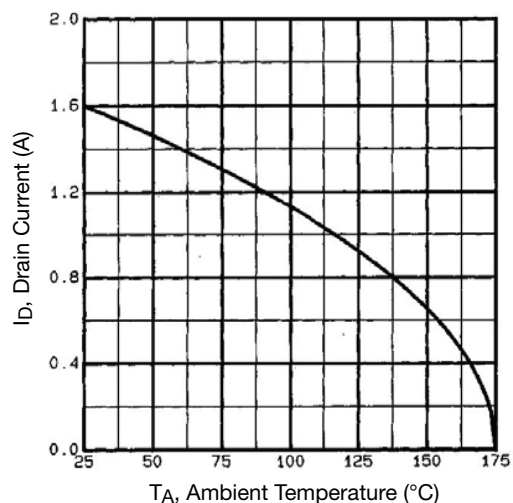
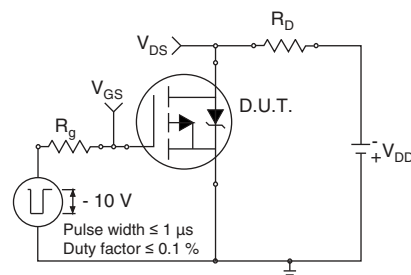
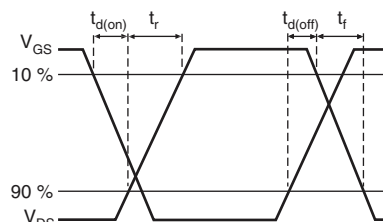
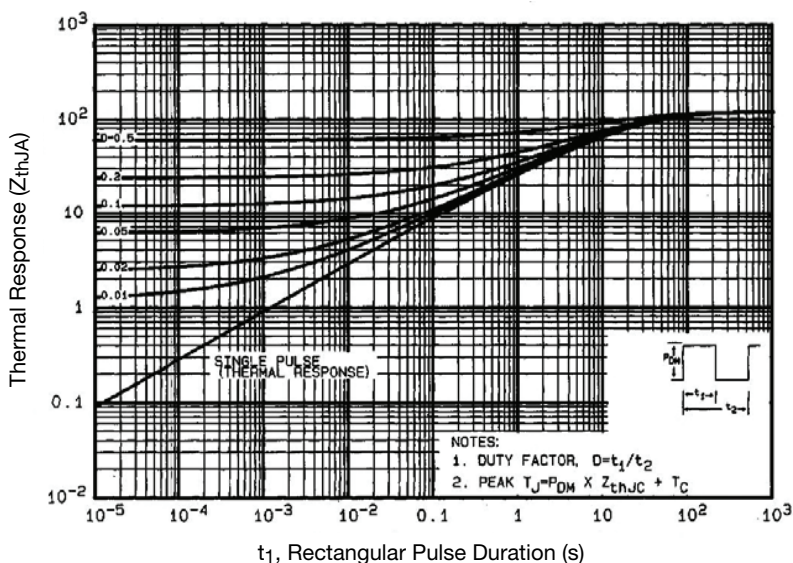
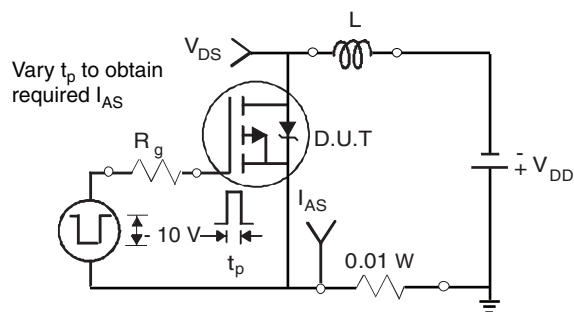
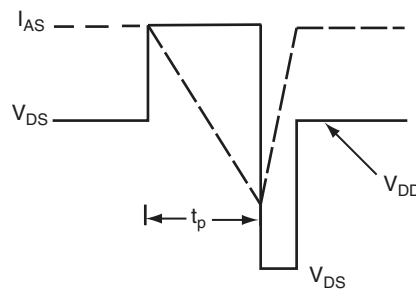
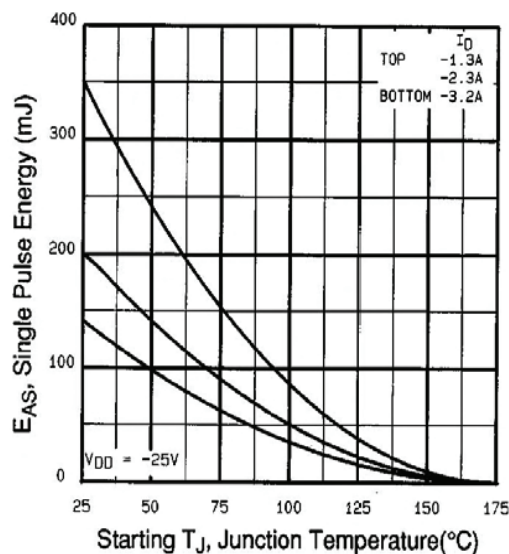
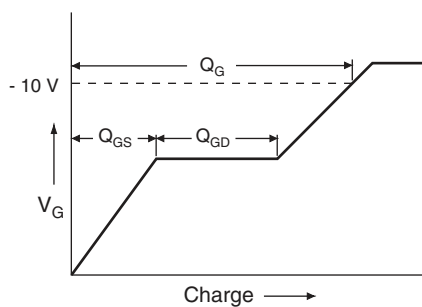
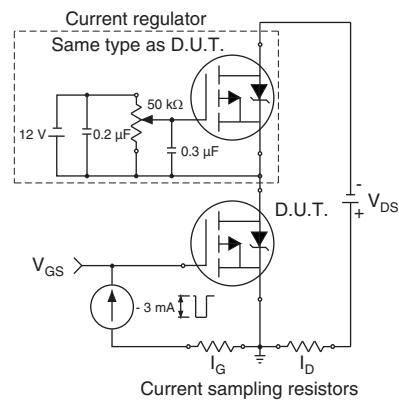
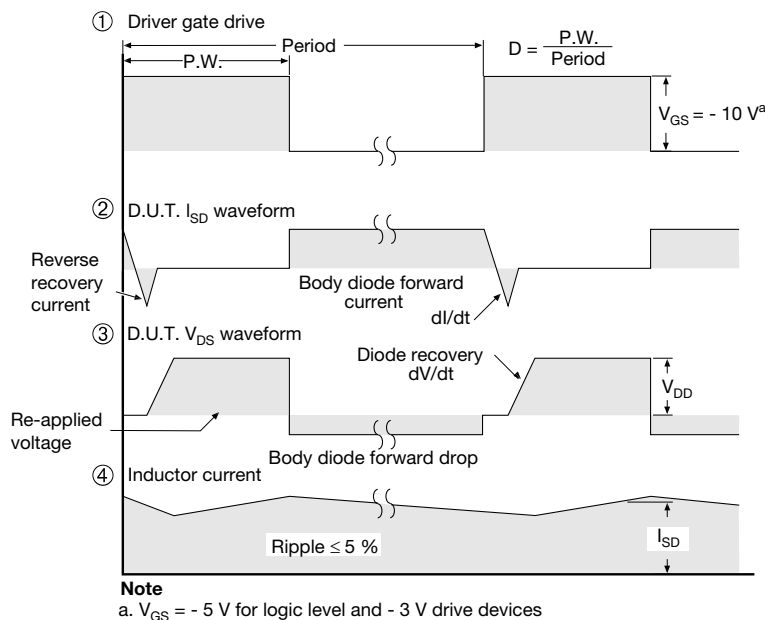
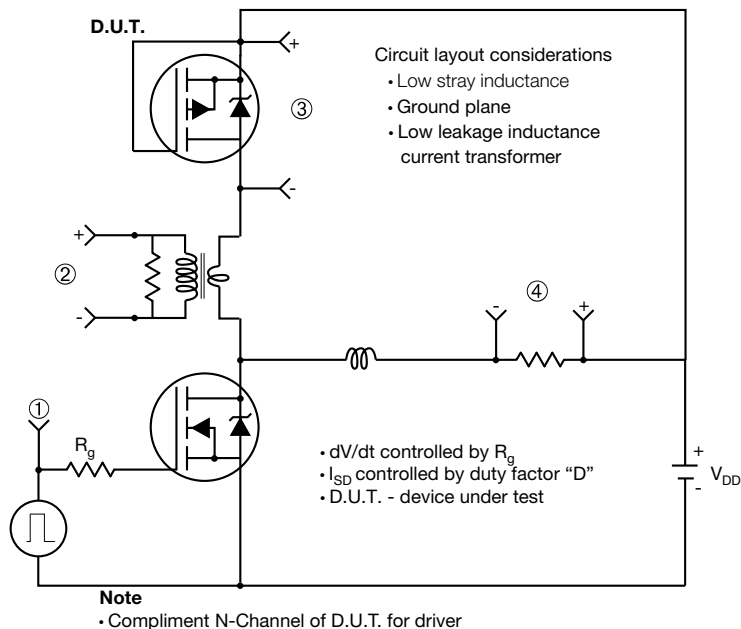


Fig. 7 - Maximum Safe Operating Area


**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**

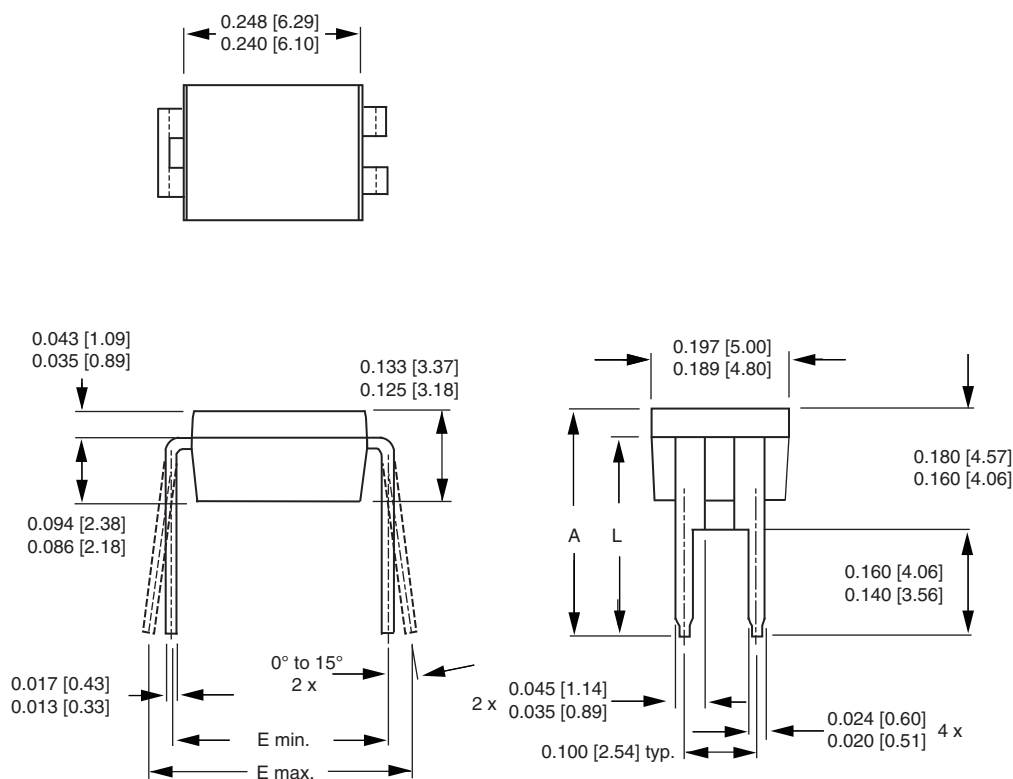
## Peak Diode Recovery dV/dt Test Circuit



**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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