

## Power MOSFET



N-Channel MOSFET

### FEATURES

- Dynamic dV/dt rating
- For Automatic insertion
- End stackable
- 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](http://www.vishay.com/doc?99912)


**RoHS**  
COMPLIANT

### PRODUCT SUMMARY

$V_{DS}$ (V)	60	
$R_{DS(on)}$ ( $\Omega$ )	$V_{GS} = 10$ V	0.10
$Q_g$ (Max.) (nC)	25	
$Q_{gs}$ (nC)	5.8	
$Q_{gd}$ (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	IRFD024PbF

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

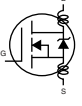

PARAMETER	SYMBOL	LIMIT	UNIT	
Drain-source voltage	$V_{DS}$	60	V	
Gate-source voltage	$V_{GS}$	$\pm 20$		
Continuous drain current	$V_{GS}$ at 10 V	$T_A = 25$ °C	A	
		$T_A = 100$ °C		
Pulsed drain current <sup>a</sup>	$I_{DM}$	20		
Linear derating factor		0.0083	W/°C	
Single pulse avalanche energy <sup>b</sup>	$E_{AS}$	91	mJ	
Maximum power dissipation	$T_A = 25$ °C	$P_D$	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 recommendations (peak temperature) <sup>d</sup>	For 10 s	300		

#### Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)
- $V_{DD} = 25$  V, starting  $T_J = 25$  °C,  $L = 16$  mH,  $R_g = 25$   $\Omega$ ,  $I_{AS} = 2.5$  A (see fig. 12)
- $I_{SD} \leq 17$  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

<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 $25\text{ }^\circ\text{C}$ , $I_D = 1\text{ mA}$	-	0.061	-	V/ $^\circ\text{C}$
Gate-source threshold voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$	2.0	-	-	V
Gate-source leakage	$I_{GSS}$	$V_{GS} = \pm 20\text{ V}$	-	-	$\pm 100$	nA
Zero gate voltage drain current	$I_{DSS}$	$V_{DS} = 60\text{ V}$ , $V_{GS} = 0\text{ V}$	-	-	25	$\mu\text{A}$
		$V_{DS} = 48\text{ V}$ , $V_{GS} = 0\text{ V}$ , $T_J = 150\text{ }^\circ\text{C}$	-	-	250	
Drain-source on-state resistance	$R_{DS(on)}$	$V_{GS} = 10\text{ V}$   $I_D = 1.5\text{ A}^b$	-	-	0.10	$\Omega$
Forward transconductance	$g_{fs}$	$V_{DS} = 25\text{ V}$ , $I_D = 1.5\text{ A}^b$	0.90	-	-	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	-	640	-	$\mu\text{F}$
Output capacitance	$C_{oss}$		-	360	-	
Reverse transfer capacitance	$C_{rss}$		-	79	-	
Total gate charge	$Q_g$	$V_{GS} = 10\text{ V}$   $I_D = 17\text{ A}$ , $V_{DS} = 48\text{ V}$ , see fig. 6 and 13 <sup>b</sup>	-	-	25	nC
Gate-source charge	$Q_{gs}$		-	-	5.8	
Gate-drain charge	$Q_{gd}$		-	-	11	
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 30\text{ V}$ , $I_D = 17\text{ A}$ , $R_g = 18\text{ }\Omega$ , $R_D = 1.7\text{ }\Omega$ , see fig. 10 <sup>b</sup>	-	13	-	ns
Rise time	$t_r$		-	58	-	
Turn-off delay time	$t_{d(off)}$		-	25	-	
Fall time	$t_f$		-	42	-	
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 	-	-	2.5	A
Pulsed diode forward current <sup>a</sup>	$I_{SM}$		-	-	20	
Body diode voltage	$V_{SD}$	$T_J = 25\text{ }^\circ\text{C}$ , $I_S = 2.5\text{ A}$ , $V_{GS} = 0\text{ V}^b$	-	-	1.5	V
Body diode reverse recovery time	$t_{rr}$	$T_J = 25\text{ }^\circ\text{C}$ , $I_F = 17\text{ A}$ , $dI/dt = 100\text{ A}/\mu\text{s}^b$	-	80	180	ns
Body diode reverse recovery charge	$Q_{rr}$		-	0.29	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)

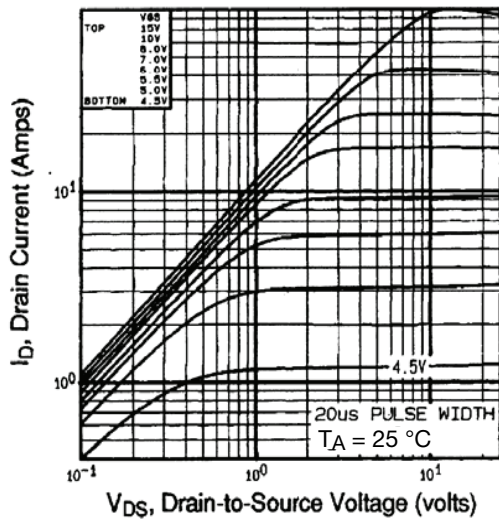


Fig. 1 - Typical Output Characteristics,  $T_A = 25\text{ }^\circ\text{C}$

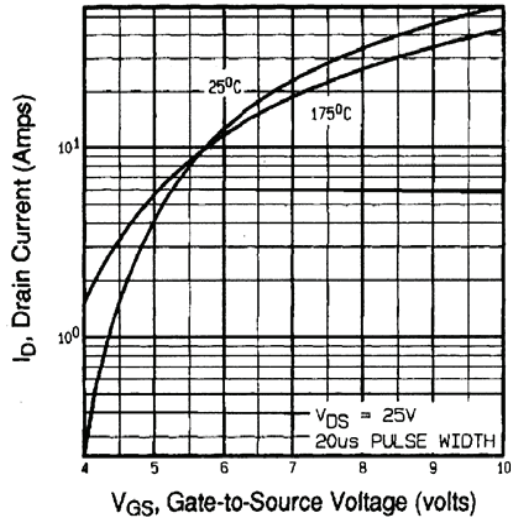


Fig. 2 - Typical Transfer Characteristics

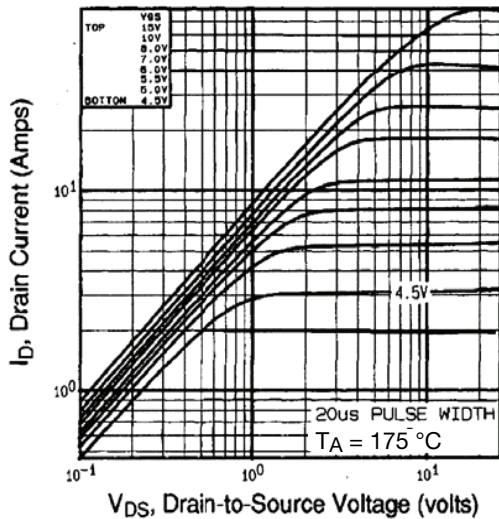


Fig. 1 - Typical Output Characteristics,  $T_A = 175\text{ }^\circ\text{C}$

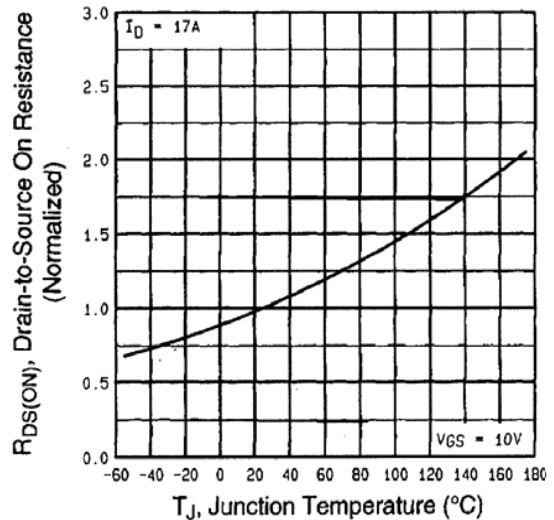


Fig. 3 - Normalized On-Resistance vs. Temperature

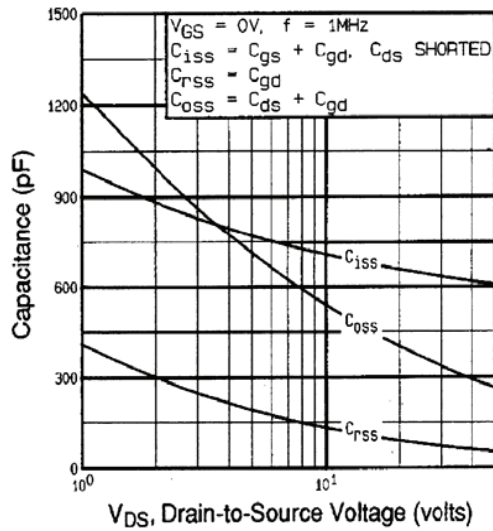


Fig. 4 - Typical Capacitance vs. Drain-to-Source Voltage

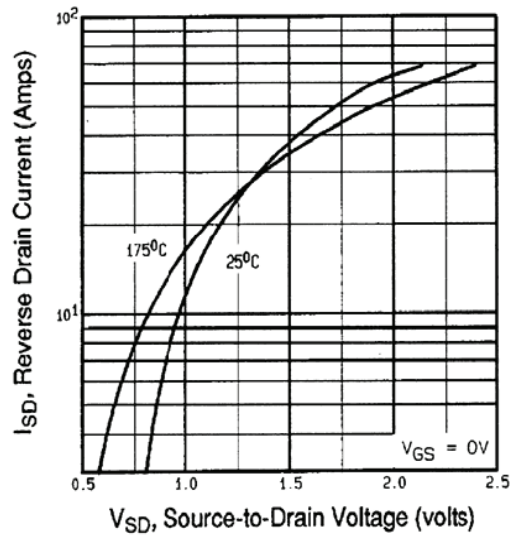


Fig. 6 - Typical Source-Drain Diode Forward Voltage

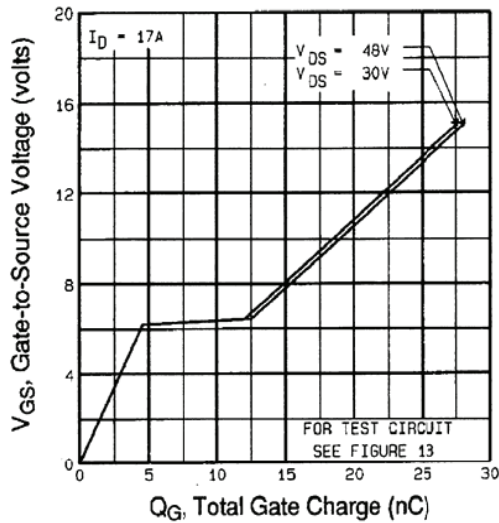


Fig. 5 - Typical Gate Charge vs. Gate-to-Source Voltage

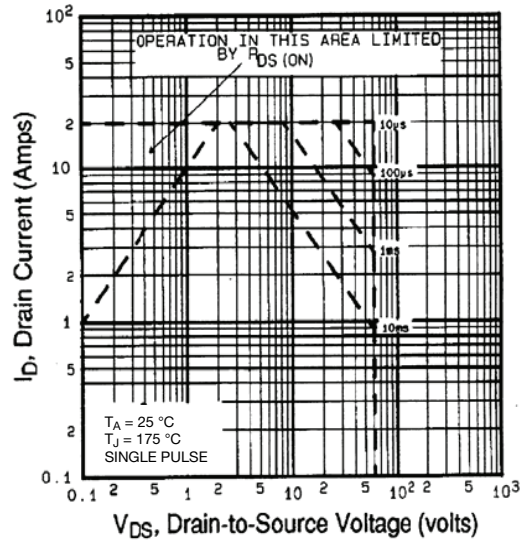


Fig. 2 - Maximum Safe Operating Area

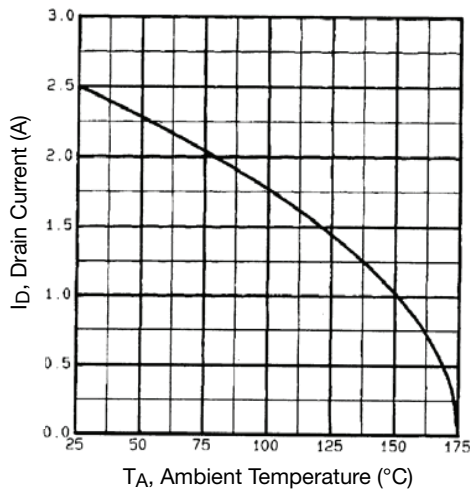


Fig. 7 - Maximum Drain Current vs. Ambient Temperature



Fig. 10a - Switching Time Test Circuit



Fig. 10b - Switching Time Waveforms

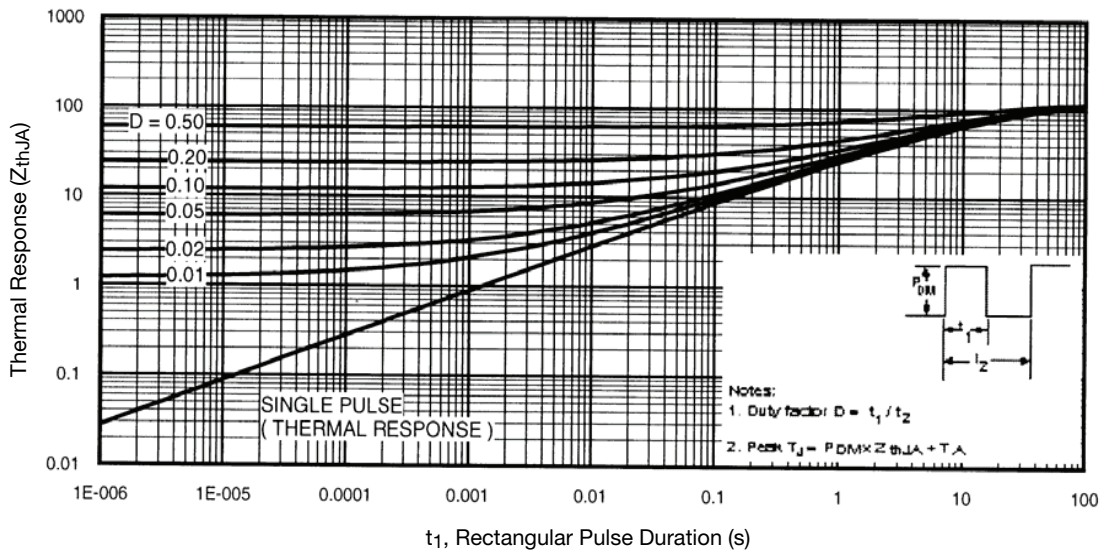


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Ambient



Fig. 12a - Unclamped Inductive Test Circuit

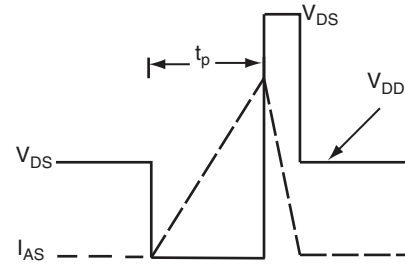


Fig. 12b - Unclamped Inductive Waveforms

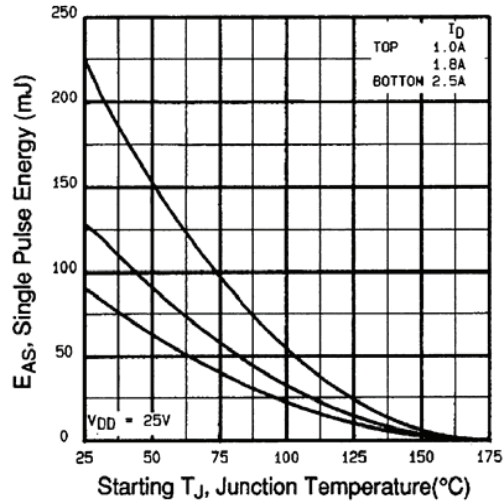


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

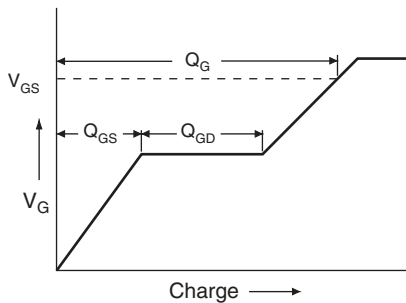


Fig. 13a - Basic Gate Charge Waveform

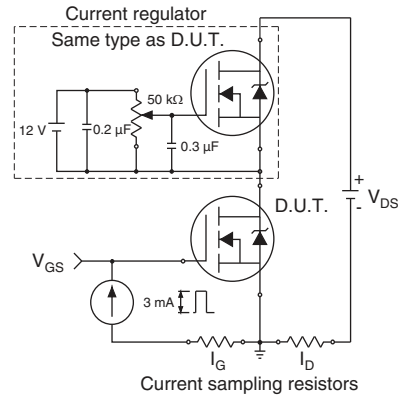


Fig. 13b - Gate Charge Test Circuit

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



**Note**

a.  $V_{GS} = 5\text{ V}$  for logic level devices

**Fig. 14 - For N-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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