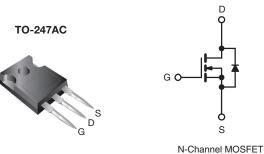


Vishay Siliconix



Power MOSFET

PRODUCT SUMMARY					
V _{DS} (V)	500				
R _{DS(on)} (Ω)	$V_{GS} = 10 V$	0.85			
Q _g (Max.) (nC)	63				
Q _{gs} (nC)	11				
Q _{gd} (nC)	30				
Configuration	Single				



FEATURES

- Dynamic dV/dt Rating
- Repetitive Avalanche Rated
- Isolated Central Mounting Hole
- · Fast Switching
- Ease of Paralleling
- Simple Drive Requirements
- Compliant to RoHS Directive 2002/95/EC

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-247AC package preferred for is commercial-industrial applications where higher power levels preclude the use of TO-220AB devices. The TO-247AC is similar but superior to the earlier TO-218 package because of its isolated mounting hole. It also provides greater creepage distances between pins to meet the requirements of most safety specifications.

ORDERING INFORMATION	
Package	TO-247AC
Lead (Pb)-free	IRFP440PbF
	SiHFP440-E3
SnPb	IRFP440
	SiHFP440

ABSOLUTE MAXIMUM RATINGS ($T_c = 25 \text{ °C}$, unless otherwise noted)							
PARAMETER			SYMBOL	LIMIT	UNIT		
Drain-Source Voltage			V _{DS}	500	V		
Gate-Source Voltage			V _{GS}	± 20	V		
Continuous Drain Current	V _{GS} at 10 V	$T_{C} = 25 \text{ °C}$ $T_{C} = 100 \text{ °C}$	1	8.8			
		T _C = 100 °C	ID	5.6	A		
Pulsed Drain Current ^a			I _{DM}	35			
Linear Derating Factor				1.2	W/°C		
Single Pulse Avalanche Energy ^b			E _{AS}	480	mJ		
Repetitive Avalanche Current ^a			I _{AR}	8.8	A		
Repetitive Avalanche Energy ^a			E _{AR}	15	mJ		
Maximum Power Dissipation	T _C =	25 °C	PD	150	W		
Peak Diode Recovery dV/dt ^c			dV/dt	3.5	V/ns		
Operating Junction and Storage Temperature Range			T _J , T _{stg}	- 55 to + 150	°C		
Soldering Recommendations (Peak Temperature)	for	10 s		300 ^d			
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} = 50 V, starting T_J = 25 °C, L = 11 mH, R_g = 25 Ω , I_{AS} = 8.8 A (see fig. 12).

c. $I_{SD} \le 8.8$ A, dI/dt ≤ 100 A/µs, $V_{DD} \le V_{DS}$, $T_J \le 150$ °C.

d. 1.6 mm from case.

* Pb containing terminations are not RoHS compliant, exemptions may apply

Document Number: 91228 S11-0444-Rev. B, 14-Mar-11 www.vishay.com



Vishay Siliconix



Static V _{DS} V _{GS} = 0 V, I _D = 250 μA 500 - V	THERMAL RESISTANCE RATI	NGS							
Case-to-Sink, Flat, Greased Surface R_{HCS} 0.24 $ 0.83$ $^{\circ}CW$ SPECIFICATIONS (T _g = 25 °C, unless otherwise noted) TEST CONDITIONS Min. TYP. MAX. UNIT State Test conditions Min. TYP. MAX. UNIT State Test conditions Min. TYP. MAX. UNIT Organsource Breakdown Votage Vos Vos State State No.8 Vos C.0.2 Vos Vos State Organsource Breakdown Votage Vos Vos State No.8 Vos State	PARAMETER	SYMBOL	TYP.		MAX.		UNIT		
Maximum Junction-to-Case (Drain) $R_{h,uc}$ - 0.83 SPECIFICATIONS (T _J = 25 °C, unless otherwise noted) Far Conditions Min. TYP. MAX. UNIT Static Drain-Source Breakdown Voltage V _{DS} V _{GS} = 0 V, I _D = 250 µA 500 - - V Gate-Source Inveshold Voltage V _{DS} Reference to 25 °C, I _D = 1 mA - 0.78 - V/C Gate-Source Inveshold Voltage V _{DS} (T _J) Reference to 25 °C, I _D = 1 mA - 0.78 - V/C Gate-Source Inveshold Voltage V _{DS} (T _J) Reference to 25 °C, I _D = 1 mA - 0.78 - V/C Gate-Source Inveshold Voltage V _{DS} (T _J) Reference to 25 °C, I _D = 1 mA - 0.78 - V/C Orain-Source Co-State Resistance V _{DS} = 400 V, V _{DS} = 0 V - - 2.50 µ Orain-Source Co-State Resistance Gaus V _{DS} = 50 V, I _D = 5.3 Å - - 0.85 Ω Output Capacitance Coss V _{DS} = 10 V I _D = 5.0 Å, R_S = 60 V, C - <td>Maximum Junction-to-Ambient</td> <td>R_{thJA}</td> <td colspan="2" rowspan="2"></td> <td></td> <td colspan="2"></td> <td></td>	Maximum Junction-to-Ambient	R _{thJA}							
	Case-to-Sink, Flat, Greased Surface	R _{thCS}					°C/W		
$\begin{array}{ c c c c c c } \hline PARAMETER SYMBOL SYMBOL TEST CONDITIONS MIN. TYP. MAX. UNIT State State $$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$	Maximum Junction-to-Case (Drain)	R _{thJC}	- 0.83						
$\begin{array}{ c c c c c c } \hline PARAMETER SYMBOL SYMBOL TEST CONDITIONS MIN. TYP. MAX. UNIT State State $$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$									
Static VDS VDS VDS VDS State Drain-Source Breakdown Voltage $\Delta V_{DS} T_{J}$ Reference to 25 C, to = 1 mA - 0.78 - V/C Gate-Source Intreshold Voltage VDS VDS 200 - 4.0 V Cate-Source Leakage IDSS VDS 200 - 4.0 V Zaro Gate Voltage Drain Current IDSS VDS = 500 V, VDS = 0 V - - 250 µ Prain-Source Con-State Resistance RDS(m) VDS = 10 V ID = 5.3 A ^D - 0.85 0 Drain-Source Con-State Resistance RDS(m) VDS = 500 V, VDS = 0 V, TJ = 125 °C - - 0.85 0 Drain-Source Charge Qgs VDS = 500 V, VDS = 0 V, TJ = 5.3 A ^D - 0.85 0 0 - 0.85 0 0 - 0.85 0 0 - 0.85 0 0 - 0.85 0 0 - 0.85 0 0 - 0.85 </td <td>SPECIFICATIONS ($T_J = 25 \text{ °C}$, u</td> <td>Inless otherwi</td> <td>ise noted)</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>	SPECIFICATIONS ($T_J = 25 \text{ °C}$, u	Inless otherwi	ise noted)						
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	PARAMETER	SYMBOL	TEST	CONDIT	IONS	MIN.	TYP.	MAX.	UNIT
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	Static								
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	Drain-Source Breakdown Voltage	V _{DS}	$V_{GS} = 0$) V, I _D = 2	250 µA	500	-	-	V
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	V _{DS} Temperature Coefficient	$\Delta V_{DS}/T_{J}$	Reference	to 25 °C,	, I _D = 1 mA	-	0.78	-	V/°C
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	Gate-Source Threshold Voltage	V _{GS(th)}	$V_{DS} = V$	′ _{GS} , I _D = 2	250 µA	2.0	-	4.0	V
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	Gate-Source Leakage	I _{GSS}	VG	_{iS} = ± 20	V	-	-	± 100	nA
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	Zava Cata Valtaga Drain Current	-			_S = 0 V	-	-	25	
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	Zero Gate voltage Drain Current	IDSS			-	-	250	μA	
DynamicInput CapacitanceCissVGS = 0 V, VDS = 25 V, f = 1.0 MHz, see fig. 5-1300-Output CapacitanceCoss $V_{GS} = 0 V,$ VDS = 25 V, f = 1.0 MHz, see fig. 5-1300-Reverse Transfer CapacitanceCrssf = 1.0 MHz, see fig. 5-120-Total Gate ChargeQg Qga $V_{GS} = 10 V$ $I_D = 8.0 A, V_{DS} = 400 V$ see fig. 6 and 13b63Gate-Drain ChargeQgd $V_{GS} = 10 V$ $I_D = 8.0 A, V_{DS} = 400 V$ see fig. 6 and 13b63Turn-On Delay Timet_d(off) $V_{GS} = 10 V$ $V_{GS} = 31 \Omega$, see fig. 10b14Rise Timetr $V_{CS} = 10 V$ $V_{DS} = 250 V, I_D = 8.0 A,$ $R_g = 9.1 \Omega, R_D = 31 \Omega$, see fig. 10b-14-Fall Timetr $V_{DS} = 250 V, I_D = 8.0 A,$ $G mm (0.25^{\circ})$ from package and center of die contact-5.0Internal Drain InductanceL_DBetween lead, $6 mm (0.25^{\circ})$ from package and center of die contact-5.0Internal Source InductanceL_SMOSFET symbol shwing the integral reverse $p - n$ junction diode8.8APulsed Diode Characteristics3.52.0VBody Diode Reverse Recovery Timetr,T_J = 25 °C, I_S = 8.8 A, V_{GS} = 0 V^b2.0VBody Diode Reverse Recovery ChargeQrrT_J = 25 °C, I_S = 8.0 A, dI/dt = 100 A/\mu s^b	Drain-Source On-State Resistance	R _{DS(on)}	$V_{GS} = 10 V$	I	_D = 5.3 A ^b	-	-	0.85	Ω
$ \begin{array}{ c c c c c c c } \hline Input Capacitance & C_{iss} & V_{GS} = 0 \ V, & V_{DS} = 25 \ V, & I_{DS} = 25 \ V, & I_{S} = 10 \ MHz, see fig. 5 & I_{C} & 310 & - & P \\ \hline & & 310 & - & P \\ \hline & & 310 & - & P \\ \hline & & 310 & - & P \\ \hline & & 310 & - & P \\ \hline & & 120 & - & I_{C} & I_{$	Forward Transconductance	9 _{fs}	V _{DS} = 5	0 V, I _D =	5.3 A ^b	5.3	-	-	S
$ \begin{array}{ c c c c c c } \hline U_{DU} U_{D} Capacitance & C_{oss} & V_{DS} = 25 \ V, & f = 1.0 \ MHz, see fig. 5 & f = 1.0 \ MHz, see fig. 5 & f = 1.0 \ MHz, see fig. 5 & f = 1.0 \ MHz, see fig. 5 & f = 1.0 \ MHz, see fig. 5 & f = 1.0 \ MHz, see fig. 5 & f = 1.0 \ MHz, see fig. 6 \ and 13^b & - & 63 & f = 1.0 \ MHz, see fig. 6 \ and 13^b & - & 63 & f = 1.0 \ MHz, see fig. 6 \ and 13^b & - & 63 & f = 1.0 \ MHz, see fig. 6 \ and 13^b & - & 63 & f = 1.0 \ MHz, see fig. 6 \ and 13^b & - & 63 & f = 1.0 \ MHz, see fig. 6 \ and 13^b & - & 63 & f = 1.0 \ MHz, see fig. 6 \ and 13^b & - & 63 & f = 1.0 \ MHz, see fig. 6 \ and 13^b & - & 63 & f = 1.0 \ MHz, see fig. 6 \ and 13^b & - & - & 63 & f = 1.0 \ MHz, see fig. 6 \ and 13^b & - & - & 30 & f = 1.0 \ MHz, see fig. 6 \ and 13^b & - & - & 30 & f = 1.0 \ MHz, see fig. 6 \ and 13^b & - & - & 30 & f = 1.0 \ MHz, see fig. 6 \ and 13^b & - & - & 30 & f = 1.0 \ MHz, see fig. 6 \ and 13^b & - & - & 30 & f = 1.0 \ MHz, see fig. 6 \ and 13^b & - & - & - & 30 & f = 1.0 \ MHz, see fig. 6 \ and 13^b & - & - & - & - & - & - & - & - & - & $	Dynamic								
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	Input Capacitance	C _{iss}	V _{GS} = 0 V,		-	1300	-	pF	
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	Output Capacitance	C _{oss}	V _{DS} = 25 V,			-	310		-
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	Reverse Transfer Capacitance	C _{rss}	f = 1.0 MHz, see fig. 5			-	120		-
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	Total Gate Charge	Qg				-	-	63	nC
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	Gate-Source Charge	Q _{gs}	V _{GS} = 10 V	$V_{GS} = 10 V$		-	-	11	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	Gate-Drain Charge	Q _{gd}		566	ig. 6 and 135	-	-	30	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	Turn-On Delay Time	t _{d(on)}		1		-	14	-	
$\begin{tabular}{ c c c c c c } \hline Turn-Off Delay Time & t_d(off) & R_g = 9.1 \ \Omega, \ R_D = 31 \ \Omega, \ see fig. 10^b & - & 49 & - & \\ \hline R_g = 9.1 \ \Omega, \ R_D = 31 \ \Omega, \ see fig. 10^b & - & 20 & - & \\ \hline - & 20 & - & & \\ \hline - & 20 & - & & \\ \hline - & 5.0 & - & & \\ \hline - & 13 & - & & \\ \hline - & 14 & & \\ \hline - & 13 & - & & \\ \hline - & 13$	Rise Time		V _{DD} = 2	V _{DD} = 250 V. I _D = 8.0 A.		-	23	-	
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	Turn-Off Delay Time	t _{d(off)}	$B_{a} = 9.1 \Omega$, $B_{D} = 31 \Omega$, see fig. 10^{b}		-	49	-	ns	
Internal Drain InductanceLD6 mm (0.25") from package and center of die contact-5.0-nHInternal Source InductanceLs A_S A_S -13nHDrain-Source Body Diode CharacteristicsContinuous Source-Drain Diode CurrentIsMOSFET symbol showing the integral reverse p - n junction diode8.8APulsed Diode Forward CurrentaIsMOSFET symbol showing the integral reverse p - n junction diode8.8ABody Diode VoltageVsDTJ = 25 °C, Is = 8.8 A, VGS = 0 Vb2.0VBody Diode Reverse Recovery Timetrr TJ = 25 °C, IF = 8.0 A, dI/dt = 100 A/µsb-460970nsBody Diode Reverse Recovery ChargeQrrTJ = 25 °C, IF = 8.0 A, dI/dt = 100 A/µsb-3.57.6µC	Fall Time	t _f		0	,,	-	20	-	
Internal Source InductanceLspackage and center of die contactImage: Contact of the contact of	Internal Drain Inductance	L _D	6 mm (0.25") from package and center of		-	5.0	-		
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	Internal Source Inductance	L _S			-	13	-	nH	
Continuous source-brain blode currentIsshowing the integral reverse p - n junction diode8.8APulsed Diode Forward CurrentaIsIs I_{SM} $T_J = 25 ^{\circ}C$, Is = 8.8 A, VGS = 0 Vb35ABody Diode VoltageVSD $T_J = 25 ^{\circ}C$, Is = 8.8 A, VGS = 0 Vb2.0VBody Diode Reverse Recovery Time t_{rr} $T_J = 25 ^{\circ}C$, IF = 8.0 A, dI/dt = 100 A/µsb-460970nsBody Diode Reverse Recovery Charge Q_{rr} Q_{rr} -3.57.6µC	Drain-Source Body Diode Characteristic	cs					•	•	
Pulsed Diode Forward CurrentaI I SMIntegration diodeI P - n junction diode35Body Diode VoltageVSDTJ = 25 °C, IS = 8.8 A, VGS = 0 Vb2.0VBody Diode Reverse Recovery TimetrrTJ = 25 °C, IF = 8.0 A, dI/dt = 100 A/µsb-460970nsBody Diode Reverse Recovery ChargeQrr3.57.6µC	Continuous Source-Drain Diode Current	I _S	showing the lintegral reverse		-	-	8.8	A	
Body Diode Reverse Recovery Time t_{rr} $T_J = 25 \ ^{\circ}C$, $I_F = 8.0 \ ^{\circ}A$, $dI/dt = 100 \ ^{\circ}A/\mu s^b$ -460970nsBody Diode Reverse Recovery Charge Q_{rr} $T_J = 25 \ ^{\circ}C$, $I_F = 8.0 \ ^{\circ}A$, $dI/dt = 100 \ ^{\circ}A/\mu s^b$ -3.57.6 μC	Pulsed Diode Forward Current ^a	I _{SM}			-	-	35		
Body Diode Reverse Recovery Charge Q_{rr} $T_J = 25 \ ^{\circ}C$, $I_F = 8.0 \ ^{\circ}A$, $dl/dt = 100 \ ^{\circ}A/\mu s^b$ -3.57.6 μC	Body Diode Voltage	V _{SD}	$T_J = 25 \text{ °C}, I_S = 8.8 \text{ A}, V_{GS} = 0 \text{ V}^{b}$		-	-	2.0	V	
Body Diode Reverse Recovery Charge Q _{rr} - 3.5 7.6 µC	Body Diode Reverse Recovery Time	t _{rr}			-	460	970	ns	
Forward Turn-On Time ton Intrinsic turn-on time is negligible (turn-on is dominated by L _S and L _D)	Body Diode Reverse Recovery Charge	Q _{rr}			-	3.5	7.6	μC	
	Forward Turn-On Time	t _{on}	Intrinsic turn-on time is negligible (turn			i-on is dor	minated b	y L _S and	L _D)

Notes

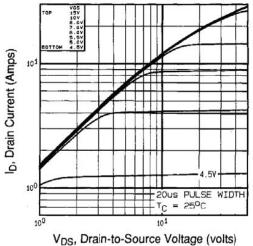
a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).

b. Pulse width \leq 300 µs; duty cycle \leq 2 %.

www.vishay.com 2 Document Number: 91228 S11-0444-Rev. B, 14-Mar-11



Vishay Siliconix



TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)

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

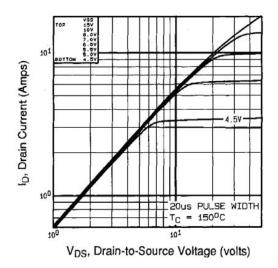


Fig. 2 - Typical Output Characteristics, T_C = 150 °C

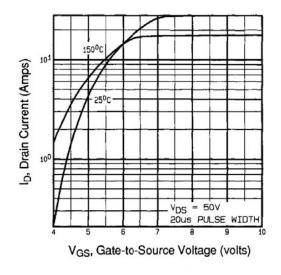


Fig. 3 - Typical Transfer Characteristics

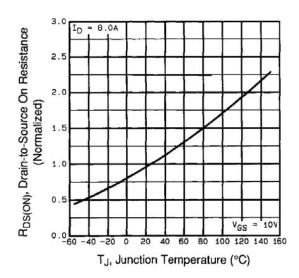


Fig. 4 - Normalized On-Resistance vs. Temperature

Document Number: 91228 S11-0444-Rev. B, 14-Mar-11

www.vishay.com 3

Vishay Siliconix



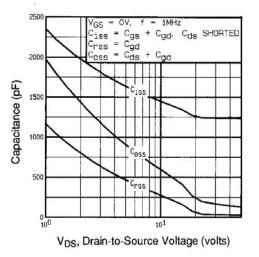


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

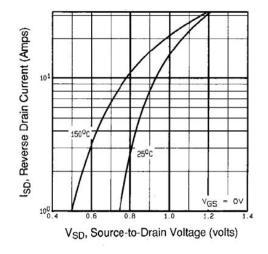


Fig. 7 - Typical Source-Drain Diode Forward Voltage

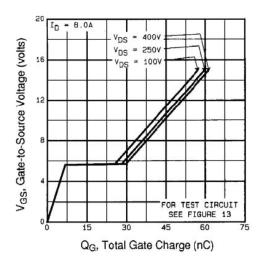


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

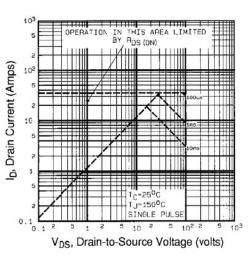


Fig. 8 - Maximum Safe Operating Area

Document Number: 91228 S11-0444-Rev. B, 14-Mar-11



Vishay Siliconix

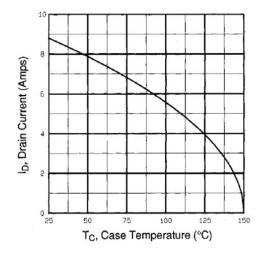


Fig. 9 - Maximum Drain Current vs. Case Temperature

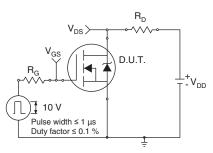


Fig. 10a - Switching Time Test Circuit

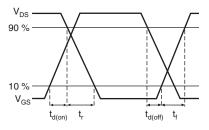


Fig. 10b - Switching Time Waveforms

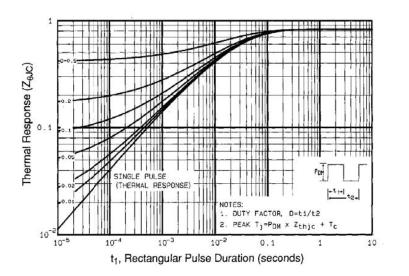


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

Vishay Siliconix



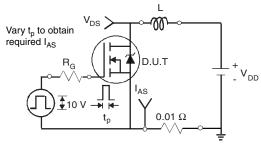


Fig. 12a - Unclamped Inductive Test Circuit

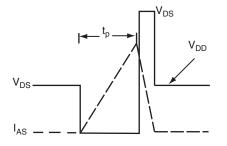


Fig. 12b - Unclamped Inductive Waveforms

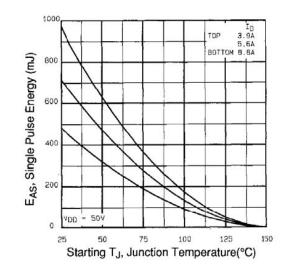


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

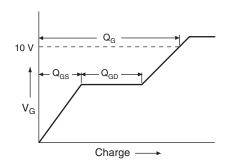
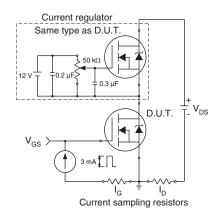


Fig. 13a - Basic Gate Charge Waveform



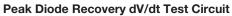


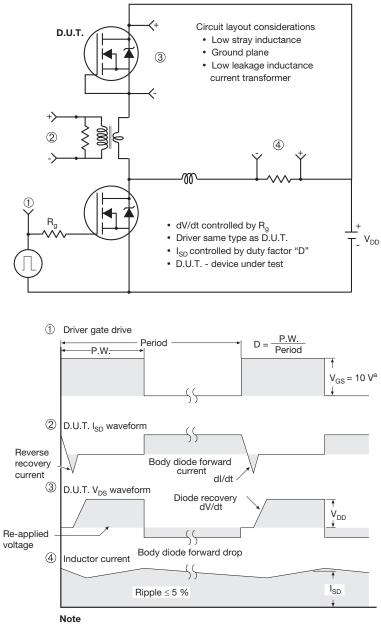
Document Number: 91228 S11-0444-Rev. B, 14-Mar-11



Vishay Siliconix







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

Fig.14 - For N-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?91228.

Document Number: 91228 S11-0444-Rev. B, 14-Mar-11 www.vishay.com



Vishay

Disclaimer

ALL PRODUCT, PRODUCT SPECIFICATIONS AND DATA ARE SUBJECT TO CHANGE WITHOUT NOTICE TO IMPROVE RELIABILITY, FUNCTION OR DESIGN OR OTHERWISE.

Vishay Intertechnology, Inc., its affiliates, agents, and employees, and all persons acting on its or their behalf (collectively, "Vishay"), disclaim any and all liability for any errors, inaccuracies or incompleteness contained in any datasheet or in any other disclosure relating to any product.

Vishay makes no warranty, representation or guarantee regarding the suitability of the products for any particular purpose or the continuing production of any product. To the maximum extent permitted by applicable law, Vishay disclaims (i) any and all liability arising out of the application or use of any product, (ii) any and all liability, including without limitation special, consequential or incidental damages, and (iii) any and all implied warranties, including warranties of fitness for particular purpose, non-infringement and merchantability.

Statements regarding the suitability of products for certain types of applications are based on Vishay's knowledge of typical requirements that are often placed on Vishay products in generic applications. Such statements are not binding statements about the suitability of products for a particular application. It is the customer's responsibility to validate that a particular product with the properties described in the product specification is suitable for use in a particular application. Parameters provided in datasheets and/or specifications may vary in different applications and performance may vary over time. All operating parameters, including typical parameters, must be validated for each customer application by the customer's technical experts. Product specifications do not expand or otherwise modify Vishay's terms and conditions of purchase, including but not limited to the warranty expressed therein.

Except as expressly indicated in writing, Vishay products are not designed for use in medical, life-saving, or life-sustaining applications or for any other application in which the failure of the Vishay product could result in personal injury or death. Customers using or selling Vishay products not expressly indicated for use in such applications do so at their own risk and agree to fully indemnify and hold Vishay and its distributors harmless from and against any and all claims, liabilities, expenses and damages arising or resulting in connection with such use or sale, including attorneys fees, even if such claim alleges that Vishay or its distributor was negligent regarding the design or manufacture of the part. Please contact authorized Vishay personnel to obtain written terms and conditions regarding products designed for such applications.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted by this document or by any conduct of Vishay. Product names and markings noted herein may be trademarks of their respective owners.