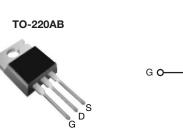


Vishay Siliconix

Power MOSFET

PRODUCT SUMMARY					
V _{DS} (V)	200				
R _{DS(on)} (Ω)	V _{GS} = 10 V 1.5				
Q _g (Max.) (nC)	8.2				
Q _{gs} (nC)	1.8				
Q _{gd} (nC)	4.5				
Configuration	Single				



S N-Channel MOSFET

FEATURES

- Dynamic dV/dt Rating
- Repetitive Avalanche Rated
- 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-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	IRF610PbF
Leau (Fb)-free	SiHF610-E3
SnPb	IRF610
	SiHF610

ABSOLUTE MAXIMUM RATINGS ($T_C = 25 \text{ °C}$, unless otherwise PARAMETER			SYMBOL	LIMIT	UNIT	
Drain-Source Voltage			V _{DS}	200	V	
Gate-Source Voltage			V _{GS}	± 20	V	
Cantinuous Drain Current	$T_{\rm C} = 25 ^{\circ}{\rm C}$			3.3		
Continuous Drain Current	V _{GS} at 10 V	$T_C = 100 \ ^\circ C$	I _D	2.1	А	
Pulsed Drain Current ^a			I _{DM}	10		
Linear Derating Factor				0.29	W/°C	
Single Pulse Avalanche Energy ^b			E _{AS}	64	mJ	
Repetitive Avalanche Current ^a			I _{AR}	3.3	А	
Repetitive Avalanche Energy ^a			E _{AR}	3.6	mJ	
Maximum Power Dissipation	T _C = 25 °C		P _D	36	W	
Peak Diode Recovery dV/dt ^c			dV/dt	5.0	V/ns	
Operating Junction and Storage Temperature Range			T _J , T _{stg}	- 55 to + 150		
Soldering Recommendations (Peak Temperature)	for	10 s		300 ^d	°C	
Manatine Terrar	6-32 or M3 screw			10	lbf ⋅ in	
Mounting Torque				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 = 8.8 mH, $R_g = 25 \Omega$, $I_{AS} = 3.3$ A (see fig. 12).

c. $I_{SD} \leq 3.3$ A, dI/dt \leq 70 A/µs, $V_{DD} \leq V_{DS}$, $T_J \leq 150$ °C.

d. 1.6 mm from case.

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

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COMPLIANT

Vishay Siliconix



Static VDS	THERMAL RESISTANCE RATI	NGS								
Case-to-Sink, Flat, Greased Surface R_{BLG} 0.50 $ 3.5$ $^{\circ}CW$ SPECIFICATIONS ($T_{ij} = 25 ^{\circ}C$, unless otherwise noted) Maximum Junction-to-Case (Drain) Min. VW SPECIFICATIONS ($T_{ij} = 25 ^{\circ}C$, unless otherwise noted) Max. UN SPECIFICATIONS ($T_{ij} = 25 ^{\circ}C$, $Unless otherwise noted) Parameter SYMBOL TEST CONDITIONS Min. TYP. MAX. UN Vog 50 V, V_{ij} = 250 \mu A 200 - 4.0 V/C Caste-Source Laakage loss Vog 200 V, Vgg 200 V, Vgg 200 V, Vgg 0 - 2 Vog 200 V, Vgg 0 V, Vgg$	PARAMETER	SYMBOL	TYP.		MAX.	MAX.		UNIT		
Maximum Junction-to-Case (Drain) R_{BUC} - 3.5 SPECIFICATIONS (T _J = 25 °C, unless otherwise noted) Fast condition Min. TYP. MAX. UNIT Static Drain-Source Breakdown Voltage V _{OS} V _{OS} = 0 V, I _D = 250 µA 200 - - V Gate-Source Dreshold Voltage V _{OS} V _{OS} = 0 V, I _D = 250 µA 2.0 - 4.0 V V Gate-Source Dreshold Voltage V _{OS} (W) Vos Vos Vos 0.20 µA 2.0 - 4.0 V V Gate-Source Dreshold Voltage V _{OS} (W) Vos Vos 0.20 µA 2.0 - 4.0 V V Care-Source Dreshold Voltage V _{OS} (W) Vos 20 V, V _S = 0 V - - 250 µA Zero Gate Voltage Drain Current Ipss V _{OS} = 10 V V _{OS} = 0 V, I _J = 125 °C - 255 µA Iput Capacitance Coss V _{OS} = 10 V V _{OS} = 50 V, I _D = 2.0 A ^b 0.8 - - 8.2 Iput Capacitance	Maximum Junction-to-Ambient	R _{thJA}	-		-					
	Case-to-Sink, Flat, Greased Surface	R _{thCS}	0.50				°C/W			
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	Maximum Junction-to-Case (Drain)	R _{thJC}	-							
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$										
Static VDS VGS = 0 V, ID = 250 μ A 200 - - V Orain-Source Breakdown Voltage V_{DS} $V_{CS} = 0 V, ID = 250 \mu$ A 200 - - V/CC Gate-Source Threshold Voltage $V_{DS} T_{J}$ Reference to 25 °C, ID = 1 mA - 0.30 - V/CC Gate-Source Leakage IdSS $V_{DS} = V_{SS}$, ID = 250 μ A 2.0 - 4.0 V Zero Gate Voltage Drain Current IdDSS $V_{DS} = 200 V, V_{GS} = 0 V$ - - 250 μ A Drain-Source On-State Resistance $R_{DS(on)}$ $V_{GS} = 10 V$ Ib = 2.0 Ab - - 1.5 Ω Dynamic Input Capacitance C_{GSS} $V_{DS} = 50 V, I_D = 2.0 Ab$ 0.8 - - S Output Capacitance C_{GSS} $V_{DS} = 10 V$ Ib = 2.0 Ab 0.8 - - 8.2 Gate-Source Charge Q_g $V_{CS} = 10 V$ Ib = 3.3 A, V_{OS} = 160 V, Is = 3.3 A, V_{OS} = 160 V, Is = 3.3 A, Is = 160 V,	SPECIFICATIONS (T _J = 25 °C, u	nless otherw	ise noted)							
$\begin{split} & \text{Drain-Source Breakdown Voltage} & V_{DS} & V_{GS} = 0 \text{ V}, \text{ I}_{D} = 250 \ \mu\text{A} & 200 & - & - & V \\ V_{DS} \text{ Temperature Coefficient} & \Delta V_{DS}/T_J & \text{Reference to } 25 ^{\circ} \text{ C}, \text{ I}_{D} = 1 \text{ mA} & - & 0.30 & - & V^{\text{rec}} \\ & \text{Gate-Source Threshold Voltage} & V_{GS(\text{H})} & V_{DS} = V_{GS, \text{ I}_{D}} = 250 \ \mu\text{A} & 2.0 & - & 4.0 & V \\ & \text{Gate-Source Leakage} & I_{GSS} & V_{GS} = ± 20 V & - & - & \pm \pm 100 & \text{nA} \\ \hline & V_{DS} = 200 V, V_{QS} = 0 V & - & - & 25 & \mu\text{A} \\ \hline & V_{DS} = 200 V, V_{QS} = 0 V & - & - & 250 & \mu\text{A} \\ \hline & V_{DS} = 200 V, V_{QS} = 0 V & - & - & 250 & \mu\text{A} \\ \hline & V_{DS} = 200 V, V_{QS} = 0 V & - & - & 250 & \mu\text{A} \\ \hline & Drain-Source On-State Resistance & R_{DS(\text{OI}} & V_{QS} = 160 V, V_{BS} = 0 V, V_{DS} = 125 ^{\circ} \text{ C} & - & 250 & \mu\text{A} \\ \hline & \text{Forward Transconductance} & g_{\text{fs}} & V_{DS} = 50 V, \text{ I}_{D} = 2.0 \ \text{A}^{\text{b}} & 0.8 & - & - & \text{S} \\ \hline & \text{Drain-Source On-State Resistance} & R_{DS(\text{OI}} & V_{DS} = 50 V, \text{ I}_{D} = 2.0 \ \text{A}^{\text{b}} & 0.8 & - & - & \text{S} \\ \hline & \text{Drain-Source On-State Resistance} & R_{DS(\text{OI}} & V_{DS} = 50 V, \text{ I}_{D} = 2.0 \ \text{A}^{\text{b}} & 0.8 & - & - & \text{S} \\ \hline & \text{Drain-Source On-State Resistance} & G_{ess} & & & & & & & & & & & & & & & & & & $	PARAMETER	SYMBOL	TEST	CONDITI	ONS	MIN.	TYP.	MAX.	UNIT	
	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	50 µA	200	-	-	V	
Gate-Source Leakage Ioss VGS = ± 20 V - + 100 nA Zaro Gate Voltage Drain Current IDSS VGS = 20 V, VGS = 0 V - - 25 μ A Drain-Source On-State Resistance RpSion) VGS = 10 V Ib = 2.0 Ab - - 250 μ A Forward Transconductance grs VGS = 50 V, Ib = 2.0 Ab - - 1.5 Ω Output Capacitance Cress VGS = 0 V, VGS = 10 V, Ib = 3.3 A, VGS = 0 V, GS = 10 V, Ib = 3.3 A, VGS = 0 V, IC = 3.3 A, VGS = 0	V _{DS} Temperature Coefficient	$\Delta V_{DS}/T_{J}$	Reference	to 25 °C,	I _D = 1 mA	-	0.30	-	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	50 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	s = ± 20 \	/	-	-	± 100	nA	
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	Zeus Osta Maltana Dusia Ouwant		V _{DS} = 2	00 V, V _{GS}	= 0 V	-	-	25	μA	
$ \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	V _{DS} = 160 V, V	$V_{\rm GS} = 0 \rm V,$	T _J = 125 °C	-	-	250		
	Drain-Source On-State Resistance	R _{DS(on)}	V _{GS} = 10 V	١ _D	₀ = 2.0 A ^b	-	-	1.5	Ω	
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	Forward Transconductance	9 _{fs}	V _{DS} = 5	0 V, I _D = 2	2.0 A ^b	0.8	-	-	S	
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	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}	$V_{DS} = 25 V,$		-	140	-	pF		
Reverse transfer Capacitance C_{rss} -15-Total Gate Charge Q_g Q_{gs} $V_{GS} = 10 \text{ V}$ $I_D = 3.3 \text{ A}, V_{DS} = 160 \text{ V}, see fig. 6 and 13^b$ 8.21.8nCGate-Drain Charge Q_{gd} Q_{gd} $V_{GS} = 10 \text{ V}$ $I_D = 3.3 \text{ A}, V_{DS} = 160 \text{ V}, see fig. 6 and 13^b$ 4.5-4.5Turn-On Delay Time $t_{d(on)}$ T_r $V_{DD} = 100 \text{ V}, I_D = 3.3 \text{ A}, R_D = 30 \Omega, see fig. 10^b$ -8.21.41.6-1.41.61.41.61.4-1.6-1.61.41.61.41.61.4-1.61.41.61.61.41.61.61.61.6<	Output Capacitance	C _{oss}			-	53	-			
$ \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}			-	15	-			
$ \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			-	-	8.2	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				-	-	1.8			
Rise TimetrV_{DD} = 100 V, I_D = 3.3 A, Rg = 24 \Omega, R_D = 30 \Omega, see fig. 10b-17Turn-Off Delay Time $t_{d(off)}$ Fall Time t_f Internal Drain InductanceL_DInternal Source InductanceL_SDrain-Source Body Diode CharacteristicsContinuous Source-Drain Diode CurrentIsPulsed Diode Forward CurrentaIsMOSFET symbol showing the integral reverse p - n junction diode101010Body Diode Reverse Recovery Timetrr trrTure Diode Reverse Recovery ChargeQrr1500.60-0.60-0.60-0.60-0.600.60 <td>Gate-Drain Charge</td> <td></td> <td></td> <td colspan="2"></td> <td>-</td> <td>-</td> <td>4.5</td> <td>1</td>	Gate-Drain Charge					-	-	4.5	1	
$\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)}				-	8.2	-		
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	Rise Time	t _r			-	17	-	- ns		
$ \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)}			-	14	-			
Internal Drain HuddetaileLp6 mm (0.25") from package and center of die contact-4.3-nHInternal Source InductanceLs6 mm (0.25") from package and center of die contact-7.5-nHDrain-Source Body Diode CharacteristicsMOSFET symbol showing the integral reverse p - n junction diode-7.5-nHPulsed Diode Forward CurrentaIsMOSFET symbol showing the integral reverse p - n junction diode3.3ABody Diode VoltageVsDTJ = 25 °C, Is = 3.3 A, VGS = 0 Vb2.0VBody Diode Reverse Recovery TimetrrTJ = 25 °C, IF = 3.3 A, dI/dt = 100 A/µsb-150310nsTu = 25 °C, IF = 3.3 A, dI/dt = 100 A/µsb-0.601.4µC	Fall Time	t _f				-	8.9	-	1	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	Internal Drain Inductance	L _D	6 mm (0.25") from package and center of		-	4.5	-	nH		
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	Internal Source Inductance	Ls			-	7.5	-			
Continuous Source-Drain Diode Currentisshowing the integral reverse p - n junction diode3.3APulsed Diode Forward Currenta I_{SM} I_{SM} $T_J = 25 \text{ °C}, I_S = 3.3 \text{ A}, V_{GS} = 0 \text{ Vb}$ 10Body Diode Voltage V_{SD} $T_J = 25 \text{ °C}, I_S = 3.3 \text{ A}, V_{GS} = 0 \text{ Vb}$ 2.0VBody Diode Reverse Recovery Time t_{rr} $T_J = 25 \text{ °C}, I_F = 3.3 \text{ A}, dl/dt = 100 \text{ A/µsb}$ -150310nsBody Diode Reverse Recovery Charge Q_{rr} $V_J = 25 \text{ °C}, I_F = 3.3 \text{ A}, dl/dt = 100 \text{ A/µsb}$ -0.601.4µC	Drain-Source Body Diode Characteristic	s								
Pulsed Diode Forward Currenta I_{SM} Integrat reverse p - n junction diode $ 10$ Body Diode Voltage V_{SD} $T_J = 25 \ ^{\circ}C$, $I_S = 3.3 \ A$, $V_{GS} = 0 \ V^b$ $ 2.0 \ V$ Body Diode Reverse Recovery Time t_{rr} $T_J = 25 \ ^{\circ}C$, $I_F = 3.3 \ A$, $dI/dt = 100 \ A/\mu s^b$ $ 150 \ 310 \ ns$ Body Diode Reverse Recovery Charge Q_{rr} $T_J = 25 \ ^{\circ}C$, $I_F = 3.3 \ A$, $dI/dt = 100 \ A/\mu s^b$ $ 0.60 \ 1.4 \ \mu C$	Continuous Source-Drain Diode Current	I _S	showing the integral reverse		-	-	3.3	Δ		
Body Diode Reverse Recovery Time t_{rr} $T_J = 25 \text{ °C}, I_F = 3.3 \text{ A}, dI/dt = 100 \text{ A/}\mu\text{s}^b$ -150310nsBody Diode Reverse Recovery Charge Q_{rr} $T_J = 25 \text{ °C}, I_F = 3.3 \text{ A}, dI/dt = 100 \text{ A/}\mu\text{s}^b$ -0.601.4 μC	Pulsed Diode Forward Current ^a	I _{SM}			-	-	10			
Body Diode Reverse Recovery Charge Q_{rr} $T_J = 25 \ ^{\circ}C$, $I_F = 3.3 \ ^{\circ}A$, $dI/dt = 100 \ ^{\circ}A/\mu s^b$ -0.601.4 μC	Body Diode Voltage	V_{SD}	$T_{J} = 25 \ ^{\circ}C, I_{S} = 3.3 \ A, V_{GS} = 0 \ V^{b}$		-	-	2.0	V		
Body Diode Reverse Recovery Charge Q _{rr} - 0.60 1.4 μC	Body Diode Reverse Recovery Time	t _{rr}	T 25 °C I	2 2 A 41/	dt - 100 A/usb	-	150	310	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}	$J = 25 \text{ °C}, I_F = 3.3 \text{ A}, \text{ dl/dt} = 100 \text{ A/}\mu\text{s}^{0}$		-	0.60	1.4	μC		
	Forward Turn-On Time	t _{on}	Intrinsic turn	-on time i	s negligible (turn	-on is do	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 $\leq 300~\mu s;$ duty cycle $\leq 2~\%.$

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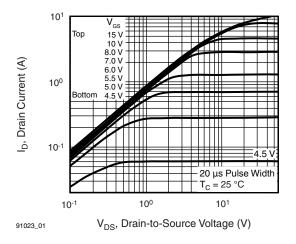


Fig. 1 - Typical Output Characteristics, T_C = 25 °C

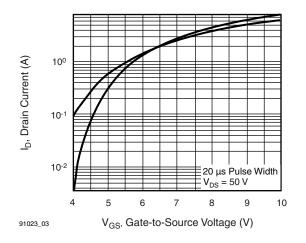


Fig. 3 - Typical Transfer Characteristics

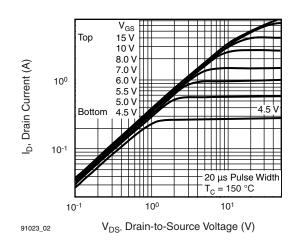


Fig. 2 - Typical Output Characteristics, T_C = 150 °C

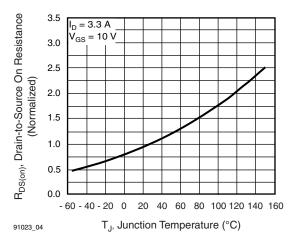


Fig. 4 - Normalized On-Resistance vs. Temperature

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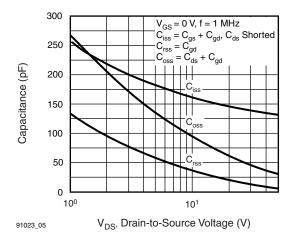


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

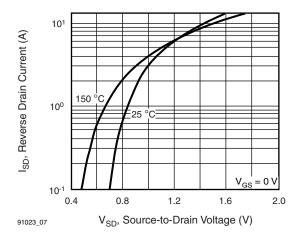


Fig. 7 - Typical Source-Drain Diode Forward Voltage

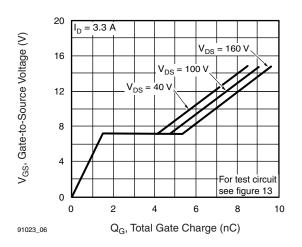


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

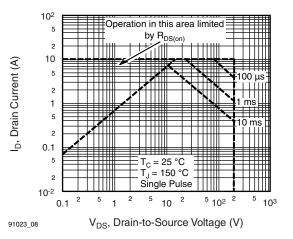


Fig. 8 - Maximum Safe Operating Area

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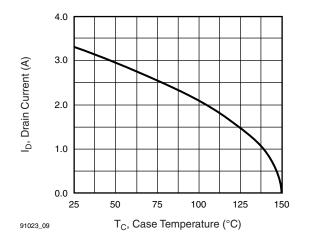


Fig. 9 - Maximum Drain Current vs. Case Temperature

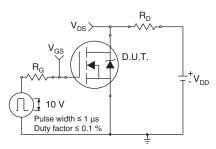


Fig. 10a - Switching Time Test Circuit

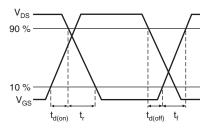


Fig. 10b - Switching Time Waveforms

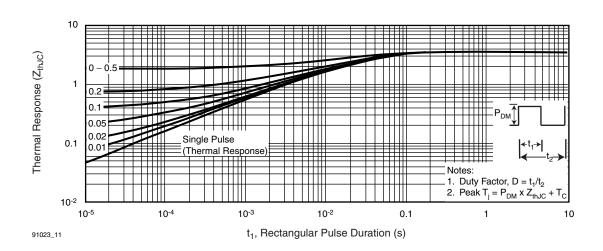


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

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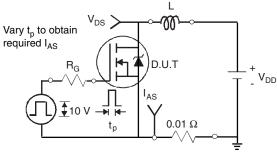


Fig. 12a - Unclamped Inductive Test Circuit

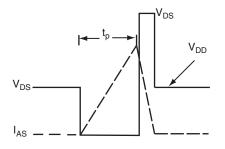


Fig. 12b - Unclamped Inductive Waveforms

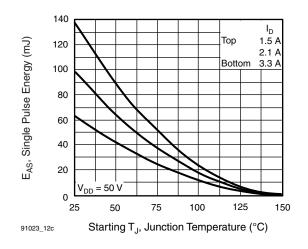


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

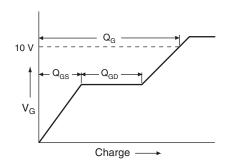


Fig. 13a - Basic Gate Charge Waveform

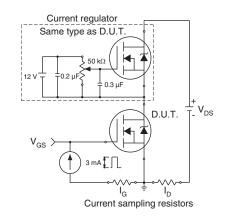
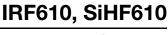


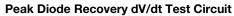
Fig. 13b - Gate Charge Test Circuit

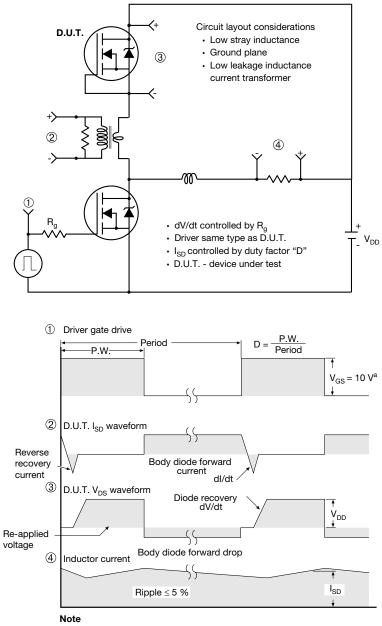
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a. $V_{GS} = 5$ V for logic level devices

Fig. 14 - For N-Channel

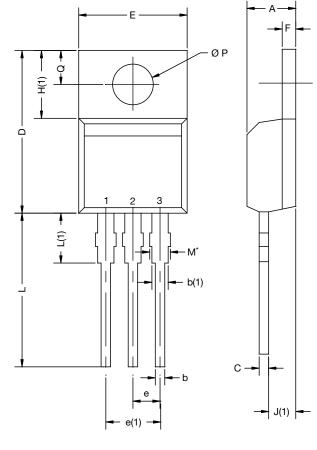
Vishay Siliconix maintains worldwide manufacturing capability. Products may be manufactured at one of several qualified locations. Reliability data for Silicon Technology and Package Reliability represent a composite of all qualified locations. For related documents such as package/tape drawings, part marking, and reliability data, see http://www.vishay.com/ppg?91023.

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TO-220-1

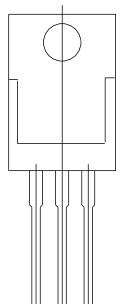


	MILLIMETERS		INCHES		
DIM.	MIN.	MAX.	MIN.	MAX.	
А	4.14	4.70	0.163	0.185	
b	0.69	1.02	0.027	0.040	
b(1)	1.14	1.73	0.045	0.068	
С	0.36	0.61	0.014	0.024	
D	14.33	15.85	0.564	0.624	
Е	9.96	10.52	0.392	0.414	
е	2.41	2.67	0.095	0.105	
e(1)	4.88	5.28	0.192	0.208	
F	0.43	1.40	0.017	0.055	
H(1)	6.10	6.48	0.240	0.255	
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	
ØΡ	3.53	3.94	0.139	0.155	
Q	2.59	3.00	0.102	0.118	
ECN: X15- DWG: 603 ⁻	0003-Rev. A, I	19-Jan-15			

Notes

- M^{\star} = 0.052 inches to 0.064 inches (dimension including protrusion), heatsink hole for HVM

- Outline conforms to $\mathsf{JEDEC}^{\circledast}$ outline TO-220AB with exception of dimension F



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