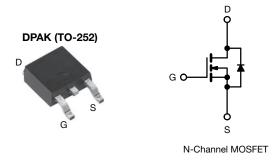
SiHD240N60E

Vishay Siliconix



E Series Power MOSFET



PRODUCT SUMMARY				
V _{DS} (V) at T _J max.	650			
R _{DS(on)} typ. (Ω) at 25 °C	$V_{GS} = 10 V$	0.208		
Q _g max. (nC)	23			
Q _{gs} (nC)	4			
Q _{gd} (nC)	6			
Configuration	Single			

FEATURES

- 4th generation E series technology
- Low figure-of-merit (FOM) Ron x Qg
- Low effective capacitance (C_{o(er)})
- Reduced switching and conduction losses
- Avalanche energy rated (UIS)
- Material categorization: for definitions of compliance please see <u>www.vishay.com/doc?99912</u>

APPLICATIONS

- Server and telecom power supplies
- Switch mode power supplies (SMPS)
- Power factor correction power supplies (PFC)
- Lighting
 - High-intensity discharge (HID)
 - Fluorescent ballast lighting
- Industrial
 - Welding
 - Induction heating
 - Motor drives
 - Battery chargers
 - Solar (PV inverters)

ORDERING INFORMATION				
Package DPAK (TO-252)				
Lead (Pb)-free and halogen-free	SiHD240N60E-GE3			
	SiHD240N60E-T1-GE3			
	SiHD240N60E-T4-GE3			
	SiHD240N60E-T5-GE3			

ABSOLUTE MAXIMUM RATINGS ($T_C = 25$ °C, unless otherwise noted)					
PARAMETER			SYMBOL	LIMIT	UNIT
Drain-source voltage			V _{DS}	600	V
Gate-source voltage			V _{GS}	± 30	v
Continuous drain current (T _J = 150 °C)	V _{GS} at 10 V	T _C = 25 °C T _C = 100 °C	°C I _D	12	
	VGS at 10 V	T _C = 100 °C		7	А
Pulsed drain current ^a			I _{DM}	30	
Linear derating factor				0.63	W/°C
Single pulse avalanche energy ^b			E _{AS}	81	mJ
Maximum power dissipation			PD	78	W
Operating junction and storage temperature range			T _J , T _{stg}	-55 to +150	°C
Drain-source voltage slope $T_J = 125 \text{ °C}$		dv/dt	100		
Reverse diode dv/dt ^d			28	V/ns	
Soldering recommendations (peak temperature) ^c For 10 s			260	°C	

Notes

a. Repetitive rating; pulse width limited by maximum junction temperature

b. V_{DD} = 120 V, starting T_J = 25 °C, L = 28.2 mH, R_g = 25 Ω , I_{AS} = 2.4 A

c. 1.6 mm from case

d. $I_{SD} \leq I_D, \, di/dt$ = 100 A/µs, starting T_J = 25 $^\circ C$

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COMPLIANT

HALOGEN

FREE



Vishay Siliconix

Static Vol	THERMAL RESISTANCE RATINGS								
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	PARAMETER	SYMBOL	TYP.		MAX.		UNIT		
Maximum junction-to-case (drain) $R_{h,uc}$ - 1.6 SPECIFICATIONS (T _J = 25 °C, unless otherwise noted) Test conditions Min. TYP. MAX. UN Static Test conditions Min. TYP. MAX. UN Static Vigs emperature coefficient $\Delta V_{DS}/T_J$ Reference to 25 °C, $I_D = 1 mA$ - 0.63 - 5.0 V////////////////////////////////////	Maximum junction-to-ambient	R _{thJA}	- 62		00.004				
$\begin{array}{ c c c c c } \hline PARAMETER SYMBOL SYMBOL TEST CONDITIONS MIN. TYP. MAX. UN Static $$$ Test conditions $$$ WIN. TYP. MAX. UN $$$ Static $$$$ Test conditions $$$ Works = 0 V, l_p = 250 \muA $$$ 600 $$ - $$$ 0 V, $$$ 0.5 emperature coefficient $$$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$	Maximum junction-to-case (drain)	R _{thJC}	- 1.6				C/W		
$\begin{array}{ c c c c c } \hline PARAMETER SYMBOL SYMBOL TEST CONDITIONS MIN. TYP. MAX. UN Static $$$ Test conditions $$$ WIN. TYP. MAX. UN $$$ Static $$$$ Test conditions $$$ Works = 0 V, l_p = 250 \muA $$$ 600 $$ - $$$ 0 V, $$$ 0.5 emperature coefficient $$$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$									
Static Vol Vol Vol Vol Vol Vol Vol Vol Vol State Vol State Vol <th< td=""><td>SPECIFICATIONS (T_J = 25 $^{\circ}$C, 1</td><td>unless otherwi</td><td>se noted)</td><td></td><td></td><td></td><td></td><td></td><td></td></th<>	SPECIFICATIONS (T _J = 25 $^{\circ}$ C, 1	unless otherwi	se noted)						
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	PARAMETER	SYMBOL	TES	T 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 μΑ	600	-	-	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	$\Delta V_{DS}/T_{J}$	Referenc	e to 25 °C,	$I_D = 1 \text{ mA}$	-	0.63	-	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 (N)	V _{GS(th)}	V _{DS} =	V_{GS} , $I_D = 2$	250 µA	3.0	-	5.0	V
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$		I	\	$I_{\rm GS} = \pm 20$	V	-	-	± 100	nA
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	Gate-source leakage	IGSS	\	/ _{GS} = ± 30	V	-	-	± 1	μA
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	Zour anto unlitera durin comunit		V _{DS} =	600 V, V _G	_S = 0 V	-	-	1	
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	Zero gale voltage drain current	IDSS	V _{DS} = 480 V	, V _{GS} = 0 V	′, T _J = 125 °C	-	-	10	μA
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	Drain-source on-state resistance	R _{DS(on)}	V _{GS} = 10 V	Ic	₀ = 5.5 A	-	0.208	0.240	Ω
Dynamic Input capacitance Ciss V _{GS} = 0 V, V _{DS} = 100 V, f = 1 MHz - 783 - - 783 - - 783 - - 50 - - 50 - - 50 - - 50 - - 50 - - 50 - - 50 - - 50 - - 50 - - 50 - - 187 - - 187 - - 187 - - 187 - - 187 - - 187 - 187 - 187 - 187 - 187 - 187 - 187 - 15 23 - 165 23 100 10 5 5 10 10 5 5 10 10 15 10 10 10 15 30 10 10 11 23 10 10 <	Forward transconductance ^a		V _{DS} =	= 20 V, I _D =	5.5 A	-	4	-	S
Output capacitance C_{oss} $V_{DS} = 100 \text{ V}, f = 1 \text{ MHz}$ $ 50$ $-$ Reverse transfer capacitance C_{rss} r_{rss} $r_{rss} = 100 \text{ V}, f = 1 \text{ MHz}$ $ 5$ $-$ Effective output capacitance, energy related b $C_{o(er)}$ $V_{DS} = 0 \text{ V to } 480 \text{ V}, V_{GS} = 0 \text{ V}$ $ 32$ $ 32$ $-$ Effective output capacitance, time related b $C_{o(tr)}$ $V_{DS} = 0 \text{ V to } 480 \text{ V}, V_{GS} = 0 \text{ V}$ $ 187$ $ 32$ $-$ Total gate charge Q_{gg} Q_{gg} $V_{GS} = 10 \text{ V}$ $I_D = 5.5 \text{ A}, V_{DS} = 480 \text{ V}$ $ 4$ $ nd$ Gate-drain charge Q_{gd} $V_{GS} = 10 \text{ V}$ $I_D = 5.5 \text{ A}, V_{DS} = 480 \text{ V}$ $ 4$ $ nd$ Turn-on delay time $t_{d(on)}$ T_v $V_{GS} = 10 \text{ V}, R_g = 9.1 \Omega$ $ 14$ 28 $ 26$ 52 $-$ Fall time t_f T_f T_f T_f $ 14$ 28 $ 14$ 28 $ 14$ 28 Gate input resistance R_g $f = 1 \text{ MHz}, open drain0.81.53.000Drain-Source Body Diode Characteristics 12 12 30Diode forward currentI_SMOSFET symbolshowing theintegral reversep - n junction diode 12 209418$									
$ \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} = 100 V,		-	783	-	-	
Reverse transfer capacitance C_{rss} $f = 1 \text{ MHz}$ $ 5$ $-$ Effective output capacitance, energy related a $C_{o(er)}$ $V_{DS} = 0 \text{ V}$ to $480 \text{ V}, V_{GS} = 0 \text{ V}$ $ 32$ $-$ Effective output capacitance, time related b $C_{o(tr)}$ $V_{DS} = 0 \text{ V}$ to $480 \text{ V}, V_{GS} = 0 \text{ V}$ $ 187$ $-$ Total gate charge Q_{g} Q_{g} $V_{GS} = 10 \text{ V}$ $I_{D} = 5.5 \text{ A}, V_{DS} = 480 \text{ V}$ $ 44$ $-$ Gate-source charge Q_{gd} Q_{gd} $V_{GS} = 10 \text{ V}$ $I_{D} = 5.5 \text{ A}, V_{DS} = 480 \text{ V}$ $ 44$ $-$ Turn-on delay time $t_{d(on)}$ $V_{GS} = 10 \text{ V}, R_g = 9.1 \Omega$ $ 144$ 28 Turn-off delay time $t_{d(off)}$ $V_{GS} = 10 \text{ V}, R_g = 9.1 \Omega$ $ 144$ 28 Fall time t_f $ 144$ 28 $ 144$ 28 Gate input resistance R_g $f = 1 \text{ MHz}$ open drain 0.8 1.5 3.0 G_G Drain-Source Body Diode Characteristics $P - n$ junction diode $ 12$ P Pulsed diode forward current I_{SM} V_{SD} $T_J = 25 ^{\circ} C, I_S = 5.5 \text{ A}, V_{GS} = 0 \text{ V}$ $ 1.2$ V_{GS} Diode forward voltage V_{SD} $T_J = 25 ^{\circ} C, I_S = 5.5 \text{ A}, V_{GS} = 0 \text{ V}$ $ 1.2$ V_{GS}	Output capacitance	C _{oss}			-	50	-		
$ \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}			-	5	-		
Effective output capacitance, time related b $C_{o(tr)}$ -187-Total gate charge Q_g Q_g $V_{GS} = 10 \text{ V}$ $I_D = 5.5 \text{ A}, V_{DS} = 480 \text{ V}$ -4-ndGate-source charge Q_{gd} Q_{gd} $I_D = 5.5 \text{ A}, V_{DS} = 480 \text{ V}$ -4-ndGate-drain charge Q_{gd} Q_{gd} -1523-4-ndTurn-on delay time $t_{d(on)}$ $V_{CS} = 10 \text{ V}$ $P_D = 480 \text{ V}, I_D = 5.5 \text{ A}, V_{CS} = 10 \text{ V}$ -1428-1428Turn-off delay time $t_{d(off)}$ $V_{CS} = 10 \text{ V}, R_g = 9.1 \Omega$ -1428-1428-1428-1428-1428-1428-1428-1428-14281428142814281428142814281428142814281428142814281428142812121212121212			V_{DS} = 0 V to 480 V, V_{GS} = 0 V		-	32	-	pF	
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $		C _{o(tr)}			-	187	-		
$ \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				-	15	23	1
$ \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}	$V_{GS} = 10 \text{ V}$ $I_D = 5.5 \text{ A}, V_{DS} = 480 \text{ V}$		-	4	-	nC	
Rise time t_r $V_{DD} = 480 \text{ V}, \text{ I}_D = 5.5 \text{ A}, \text{ V}_{GS} = 10 \text{ V}, \text{ Rg} = 9.1 \Omega$ $ 14$ 28 Turn-off delay time $t_{d(off)}$ Fall time t_f Gate input resistance R_g $f = 1 \text{ MHz}, \text{ open drain}$ 0.8 1.5 3.0 $Continuous source-drain diode currentI_SPulsed diode forward currentI_SI_{SM}MOSFET \text{ symbol}showing theintegral reversep - n junction diode 12ADiode forward voltageV_{SD}T_J = 25 \text{ °C}, I_S = 5.5 \text{ A}, V_{GS} = 0 \text{ V} 1.2VReverse recovery timet_{rr}T_L = 25 \text{ °C}, I_S = 5.5 \text{ A} 209418ms$	Gate-drain charge					-	6	-	
$\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)}				-	15	30	
$\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	V _{DD} =			-	14	28	
Gate input resistance R_g $f = 1 \text{ MHz}$, open drain 0.8 1.5 3.0 G Drain-Source Body Diode CharacteristicsContinuous source-drain diode current I_S MOSFET symbol showing the integral reverse $p - n$ junction diode $ 12$ A Pulsed diode forward current I_{SM} $T_J = 25 \ ^{\circ}C$, $I_S = 5.5 \text{ A}$, $V_{GS} = 0 \text{ V}$ $ 1.2$ V Piode forward voltage V_{SD} $T_J = 25 \ ^{\circ}C$, $I_S = 5.5 \text{ A}$, $V_{GS} = 0 \text{ V}$ $ 1.2$ V Reverse recovery time t_{rr} $T_{rr} = 25 \ ^{\circ}C$, $I_S = 16 = 55 \ ^{\circ}A$ $ 209$ 418 rr	Turn-off delay time	t _{d(off)}				-	26	52	ns
Drain-Source Body Diode CharacteristicsContinuous source-drain diode currentIsMOSFET symbol showing the integral reverse $p - n$ junction diode12APulsed diode forward currentIsmIsmTJ = 25 °C, Is = 5.5 A, VGS = 0 V1.2VDiode forward voltageVspTJ = 25 °C, Is = 5.5 A, VGS = 0 V1.2VReverse recovery timetrrTL = 25 °C, Is = 16 = 5.5 A-209418ns	Fall time	t _f			-	14	28		
Drain-Source Body Diode CharacteristicsContinuous source-drain diode currentIsMOSFET symbol showing the integral reverse $p - n$ junction diode12APulsed diode forward currentIsmIsmTJ = 25 °C, Is = 5.5 A, VGS = 0 V1.2VDiode forward voltageVspTJ = 25 °C, Is = 5.5 A, VGS = 0 V1.2VReverse recovery timetrrTL = 25 °C, Is = 16 = 5.5 A-209418ns	Gate input resistance	R _g	f = 1 MHz, open drain		0.8	1.5	3.0	Ω	
Continuous source-drain diode currentIsshowing the integral reverse $p - n$ junction diode12APulsed diode forward currentIsIs $r_{J} = 25 °C$, Is = 5.5 A, VGS = 0 V30Diode forward voltageVSDTJ = 25 °C, Is = 5.5 A, VGS = 0 V1.2VReverse recovery time t_{rr} TJ = 25 °C, Is = 16 = 5.5 A-209418ns									
Pulsed diode forward currentIIII30Diode forward voltageVSD $T_J = 25 \ ^{\circ}C$, $I_S = 5.5 \ ^{\circ}A$, $V_{GS} = 0 \ ^{\circ}V$ 1.2VReverse recovery time t_{rr} $T_J = 25 \ ^{\circ}C$, $I_S = 5.5 \ ^{\circ}A$ 209418ms	Continuous source-drain diode current	I _S	showing the integral reverse		-	-	12		
Reverse recovery time t_{rr} $-$ 209418ns	Pulsed diode forward current	I _{SM}			-	-	30	A	
Reverse recovery time t_{rr} $T_{rr} = 25 \degree C_{rr} = I_0 = 55.4$ $- 209 418 ns$	Diode forward voltage	V _{SD}	T _J = 25 °C, I _S = 5.5 A, V _{GS} = 0 V		-	-	1.2	V	
T ₁ = 25 °C ₁ = -1 ₂ = -55 Δ	Reverse recovery time					-	209	418	ns
Reverse recovery charge Q_{rr} di(dt = 100 A/us V = 25 V = 2.1 4.2 μ C	Reverse recovery charge	Q _{rr}	$T_J = 25 \text{ °C}, I_F = I_S = 5.5 \text{ A},$ di/dt = 100 A/µs, V _R = 25 V		-	2.1	4.2	μC	
	Reverse recovery current				-	18	-	A	

Notes

a. $C_{oss(er)}$ is a fixed capacitance that gives the same energy as C_{oss} while V_{DS} is rising from 0 % to 80 % V_{DSS}

b. $C_{oss(tr)}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 % to 80 % V_{DSS}



SiHD240N60E

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TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)

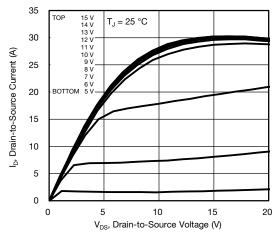
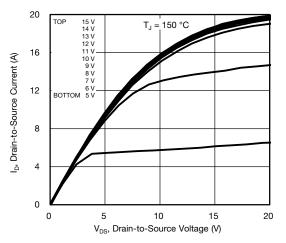


Fig. 1 - Typical Output Characteristics





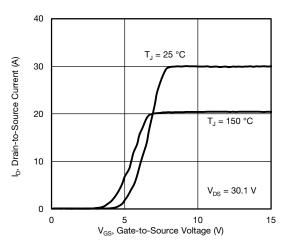


Fig. 3 - Typical Transfer Characteristics

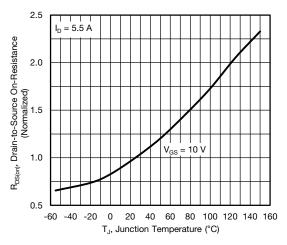


Fig. 4 - Normalized On-Resistance vs. Temperature

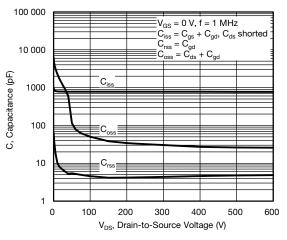


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

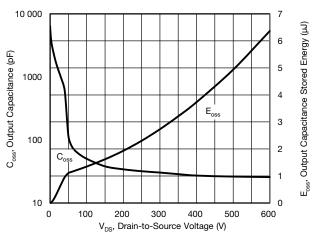


Fig. 6 - $C_{\rm oss}$ and $E_{\rm oss}$ vs. $V_{\rm DS}$

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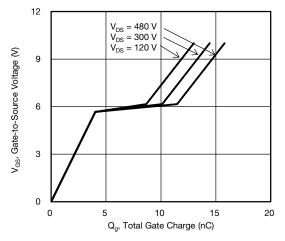


Fig. 7 - Typical Gate Charge vs. Gate-to-Source Voltage

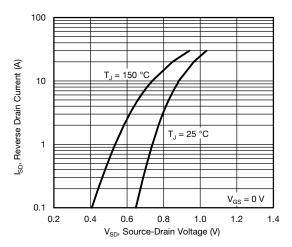


Fig. 8 - Typical Source-Drain Diode Forward Voltage

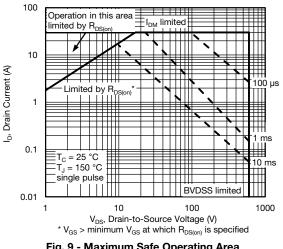


Fig. 9 - Maximum Safe Operating Area

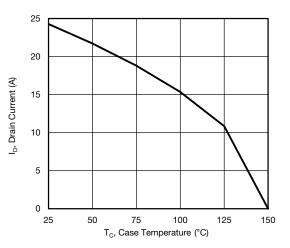


Fig. 10 - Maximum Drain Current vs. Case Temperature

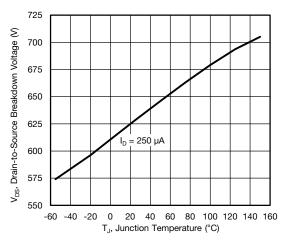
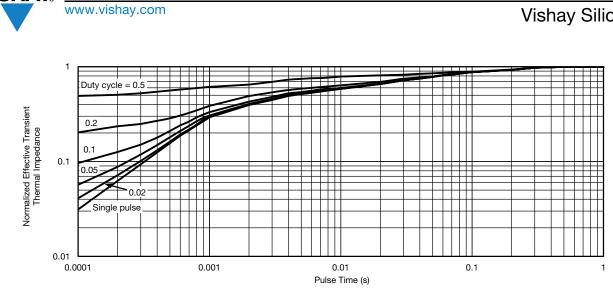
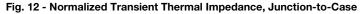


Fig. 11 - Temperature vs. Drain-to-Source Voltage

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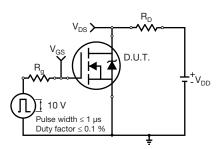


Fig. 13 - Switching Time Test Circuit

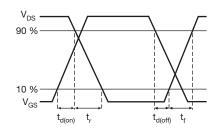


Fig. 14 - Switching Time Waveforms

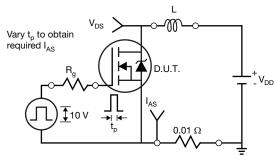


Fig. 15 - Unclamped Inductive Test Circuit

Current regulator Same type as D.U.T

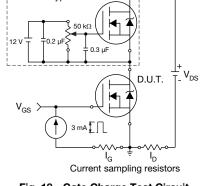


Fig. 18 - Gate Charge Test Circuit

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V_{DD} VDS AS

Fig. 16 - Unclamped Inductive Waveforms

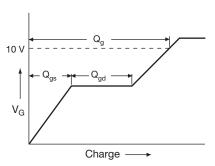
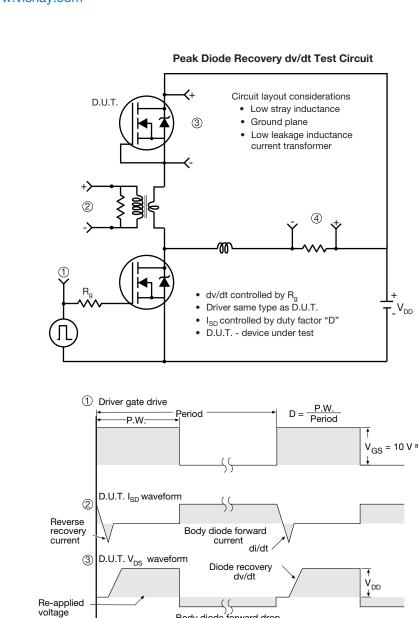


Fig. 17 - Basic Gate Charge Waveform

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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?92100.

Body diode forward drop

55

Fig. 19 - For N-Channel

Ripple ≤ 5 %

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

ł I_{SD}

Inductor current

4

Note

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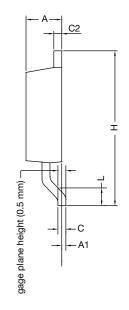


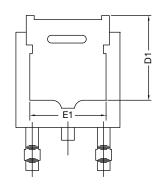


TO-252AA Case Outline

VERSION 1: FACILITY CODE = Y







	MILLIMETERS			
DIM.	MIN.	MAX.		
А	2.18	2.38		
A1	-	0.127		
b	0.64	0.88		
b2	0.76	1.14		
b3	4.95	5.46		
С	0.46	0.61		
C2	0.46	0.89		
D	5.97	6.22		
D1	4.10	-		
E	6.35	6.73		
E1	4.32	-		
Н	9.40	10.41		
е	2.28	2.28 BSC		
e1	4.56	4.56 BSC		
L	1.40	1.78		
L3	0.89	1.27		
L4	-	1.02		
L5	1.01	1.52		

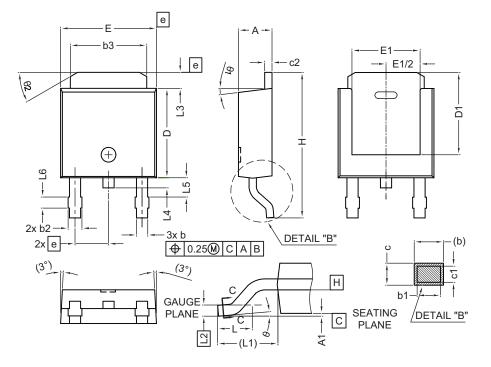
Note

• Dimension L3 is for reference only



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VERSION 2: FACILITY CODE = N



	MILLIMETERS		
DIM.	MIN.	MAX.	
A	2.18	2.39	
A1	-	0.13	
b	0.65	0.89	
b1	0.64	0.79	
b2	0.76	1.13	
b3	4.95	5.46	
С	0.46	0.61	
c1	0.41	0.56	
c2	0.46	0.60	
D	5.97	6.22	
D1	5.21	-	
E	6.35	6.73	
E1	4.32 -		
е	2.29 BSC		
Н	9.94	10.34	

	MILLIMETERS		
DIM.	MIN.	MAX.	
L	1.50	1.78	
L1	2.74	l ref.	
L2	0.51	BSC	
L3	0.89	1.27	
L4	-	1.02	
L5	1.14	1.49	
L6	0.65	0.85	
θ	0°	10°	
θ1	0°	15°	
θ2	25° 35°		

Notes

• Dimensioning and tolerance confirm to ASME Y14.5M-1994

• All dimensions are in millimeters. Angles are in degrees

• Heat sink side flash is max. 0.8 mm

Radius on terminal is optional

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Vishay Siliconix

RECOMMENDED MINIMUM PADS FOR DPAK (TO-252)



Recommended Minimum Pads Dimensions in Inches/(mm)

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