

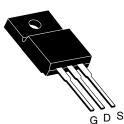


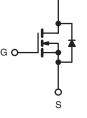
D Series Power MOSFET

PRODUCT	SUMMARY	

V _{DS} (V) at T _J max.	450)
R _{DS(on)} max. at 25 °C (Ω)	$V_{GS} = 10 V$	0.6
Q _g max. (nC)	30	
Q _{gs} (nC)	4	
Q _{gd} (nC)	7	
Configuration	Sing	le

TO-220 FULLPAK





D

N-Channel MOSFET

FEATURES

- Optimal Design
 - Low Area Specific On-Resistance
 - Low Input Capacitance (Ciss)
 - Reduced Capacitive Switching Losses
 - High Body Diode Ruggedness
 - Avalanche Energy Rated (UIS)
- Optimal Efficiency and Operation
 - Low Cost
 - Simple Gate Drive Circuitry
 - Low Figure-of-Merit (FOM): Ron x Qa
 - Fast Switching
- Compliant to RoHS Directive 2011/65/EU

Note

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

APPLICATIONS

Consumer Electronics
 Displays (LCD or Plasma TV)

- Server and Telecom Power Supplies
- SMPSIndustrial
 - Welding
 - Induction Heating
 - Motor Drives
- Battery Chargers

ORDERING INFORMATION	
Package	TO-220 FULLPAK
Lead (Pb)-free	SiHF10N40D-E3

ABSOLUTE MAXIMUM RATINGS (T _C =	= 25 °C, unless otherwis	se noted)		
PARAMETER		SYMBOL	LIMIT	UNIT
Drain-Source Voltage		V _{DS}	400	
Gate-Source Voltage		N/	± 30	V
Gate-Source Voltage AC (f > 1 Hz)		V _{GS}	30	
Continuous Drain Current /T - 150 °C/8	$V_{GS} \text{ at } 10 \text{ V} \qquad \frac{T_{C} = 25 \text{ °C}}{T_{C} = 100 \text{ °C}}$	1	10	
Continuous Drain Current (T _J = 150 °C) ^e	$T_{\rm C} = 100 ^{\circ}{\rm C}$	ID	6	А
Pulsed Drain Current ^a		I _{DM}	23	
Linear Derating Factor			0.26	W/°C
Single Pulse Avalanche Energy ^b		E _{AS}	194	mJ
Maximum Power Dissipation		PD	33	W
Operating Junction and Storage Temperature Range	9	T _J , T _{stg}	- 55 to + 150	°C
Drain-Source Voltage Slope	T _J = 125 °C	dV/dt	24	V/ns
Reverse Diode dV/dt ^d		uv/di	0.6	v/ns
Soldering Recommendations (Peak Temperature)	for 10 s		300 ^c	°C

Notes

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

b. V_{DD} = 50 V, starting T_J = 25 °C, L = 2.3 mH, R_g = 25 $\Omega,$ I_{AS} = 13 A.

c. 1.6 mm from case.

d. $I_{SD} \leq I_D$, starting $T_J = 25$ °C.

e. Limited by maximum junction temperature.

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Maximum Junction-to-Ambient RnJA - 65 "C/W Maximum Junction-to-Case (Drain) RnJC - 3.8 "C/W SPECIFICATIONS (T_J = 25 °C, unless otherwise noted) Test Conditions Min. TYP. MAX. UI Static Drain-Source Breakdown Voltage VDS VCS = 0 V, 1p = 250 µA 400 - - 0.53 - V/OS Static VDS VDS = VCS = 0 V, 1p = 250 µA 3 - 5 - 100 T - 100 T - 100 - 100 - 100 - - 100 - 100 - 100 - 100 - 100 - - 100 - 100 - - 100 - 100 - - 100 - - 100 - - 100 - - 100 - - 100 - - 100 - 100 - 100 - </th <th>THERMAL RESISTANCE RATI</th> <th>NGS</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th>	THERMAL RESISTANCE RATI	NGS							
Maximum Junction-to-Case (Drain) Rinuc - 3.8 °C/W SPECIFICATIONS (T _J = 25 °C, unless otherwise noted) PARAMETER SYMBOL TEST CONDITIONS Min. TYP. MAX. Uit Static Drain-Source Breakdown Voltage V_{DS} $V_{CS} = 0$ V, $I_D = 250 \ \mu A$ 400 - - .	PARAMETER	SYMBOL	TYP. MAX.			UNIT			
Maximum Junction-to-Case (Drain) $R_{n,JC}$ - 3.8 SPECIFICATIONS (T _J = 25 °C, unless otherwise noted) PARAMETER SYMBOL TEST CONDITIONS Min. TYP. MAX. UU Static Test conditions Min. TYP. MAX. UU Static Test conditions Min. TYP. MAX. UU Static Reference to 25 °C, (p = 250 µA 400 - - 1.53 V. Gate-Source Intershold Voltage (N) Voss (M) Reference to 25 °C, (p = 250 µA 3 - 5 C. Gate-Source Leakage I.oss Vos = 400 V, Vos = 0 V - 1 10 I Vos = 30 V Vos = 30 V Vos = 30 V C - 10 I Drain-Source On-State Resistance Rolson Vos = 10 V Ios = 5 A - 0.5 0.6 2 Dynamic Dynamic Vos = 10 V, Io = 5 A - 2.7 - 10 I Dynanic Coiss Vos = 0 V	Maximum Junction-to-Ambient	R _{thJA}	-		65			°0.00	
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	Maximum Junction-to-Case (Drain)	R _{thJC}	-		3.8			-0/w	
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	SPECIFICATIONS (T ₁ = 25 °C 1	nless 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		-	T CONDIT	IONS	MIN.	TYP.	MAX.	UNIT
	Static							1	1
	Drain-Source Breakdown Voltage	V _{DS}	V _{GS} :	= 0 V, I _D =	250 µA	400	-	-	V
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $						-	0.53	-	V/°C
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $						3	-	5	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	()				-	-	± 100	nA
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$						-	-	1	
$\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	I _{DSS}	-	-	-	-	-	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)}		1		-	0.5	0.6	Ω
DynamicInput Capacitance C_{iss} $V_{GS} = 0 V$, $V_{DS} = 100 V$, $f = 1 MHz$ $ 526$ $ -$ Output Capacitance C_{oss} $V_{GS} = 100 V$, $f = 1 MHz$ $ 59$ $ -$ Effective output capacitance, energy related® C_{oter} $V_{GS} = 0 V$, $V_{DS} = 0 V to 320 V$ $ 666$ $-$ Effective output capacitance, time related® C_{oter} $V_{GS} = 0 V$, $V_{DS} = 0 V to 320 V$ $ 666$ $-$ Total Gate Charge Q_g $Gate-Source ChargeQ_{gd}V_{GS} = 10 VI_D = 5 A, V_{DS} = 320 V 4Turn-On Delay Timet_{d(on)}Rise Timet_rV_{QS} = 10 V, I_D = 10 A,V_{GS} = 10 V, I_B = 10 A,V_{GS} = 10 V, R_g = 9.1 \Omega 1836Fall Timet_rV_{GS} = 10 V, R_g = 9.1 \Omega 1428Gate Input ResistanceR_gf = 1 MHz, open drain 1.836FullTimet_fMOSFET symbolshowing thenot grave reversep - n junction diode 10Dide Forward CurrentI_{SM}MOSFET symbolshowing then - n unction diode 10Dide Forward VoltageV_{SD}T_J = 25 °C, I_F = I_S = 5 A,dI/dt = 100 A/\mus, V_R = 25 V 1.6$	Forward Transconductance			= 50 V, I _D	= 5 A	-	2.7	-	S
Output CapacitanceCoss $V_{DS} = 100 \text{ V},$ f = 1 MHz-59-Reverse Transfer CapacitanceCrss $V_{DS} = 100 \text{ V},$ f = 1 MHz-9-Effective output capacitance, energy related ^a $C_{o(er)}$ $V_{GS} = 0 \text{ V},$ $V_{DS} = 0 \text{ V to } 320 \text{ V}$ -66-Effective output capacitance, time related ^b Q_g $V_{GS} = 10 \text{ V}$ $V_{DS} = 0 \text{ V to } 320 \text{ V}$ -66-Total Gate Charge Q_g Q_{gd} $V_{GS} = 10 \text{ V}$ $I_D = 5 \text{ A}, V_{DS} = 320 \text{ V}$ -4-Gate-Drain Charge Q_{gd} $V_{GS} = 10 \text{ V}$ $I_D = 5 \text{ A}, V_{DS} = 320 \text{ V}$ -4-rTurn-On Delay Time $t_{d(on)}$ $V_{GS} = 10 \text{ V}, R_g = 9.1 \Omega$ -1836-Fall Time t_f $V_{CS} = 10 \text{ V}, R_g = 9.1 \Omega$ -1428Gate Input Resistance R_g f = 1 MHz, open drain-1.8-9Drain-Source Body Diode Characteristics $MOSFET$ symbol showing the integral reverse $p - n$ junction diode10Pulsed Diode Forward Current I_{SM} $MOSFET$ symbol showing the integral reverse $p - n$ junction diode1.2Diode Forward Voltage V_{SD} $T_J = 25 \text{ °C}, I_S = 5 \text{ A}, V_{GS} = 0 \text{ V}$ 1.2Reverse Recovery Time t_{rr} T_r -230-rReverse Recovery Charge Q_{rr} $M_J X_J N_B = 25 \text{ V}$	Dynamic						1	1	
$\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}		$V_{ab} = 0.$,	-	526	-	
Reverse Transfer Capacitance C_{rss} $f = 1 \text{ MHz}$ $ 9$ $-$ Effective output capacitance, energy related ^a $C_{o(er)}$ $V_{GS} = 0 \text{ V}$, $V_{DS} = 0 \text{ V to } 320 \text{ V}$ $ 666$ $ 666$ $-$ Effective output capacitance, time related ^a $C_{o(tr)}$ $V_{GS} = 0 \text{ V}$, $V_{DS} = 0 \text{ V to } 320 \text{ V}$ $ 666$ $ 666$ $-$ Total Gate Charge Q_{g} Q_{gs} $V_{GS} = 10 \text{ V}$ $I_D = 5 \text{ A}, V_{DS} = 320 \text{ V}$ $ 44$ $ -$ Gate-Drain Charge Q_{gd} Q_{gd} $V_{GS} = 10 \text{ V}$ $I_D = 5 \text{ A}, V_{DS} = 320 \text{ V}$ $ 41$ $ -$ Turn-On Delay Time $t_{d(on)}$ t_r r r 112 24 $ 18$ 366 Turn-Off Delay Time $t_{d(off)}$ $V_{GS} = 10 \text{ V}, R_g = 9.1 \Omega$ $ 14$ 28 $ 14$ 28 Fall Time t_r r r r r r r r r Gate Input Resistance R_g $f = 1 \text{ MHz}$, open drain $ 1.8$ $ r$ Drain-Source Body Diode Characteristics r r r r r r Pulsed Diode Forward Current I_S $NOSFET$ symbol showing the integral reverse $p - n$ junction diode r $ r$ 10 Diode Forward Voltage V_{SD} $T_J = 25 °C$, $I_S = 5 A$, $V_{GS} = 0 V$ $ 1.2$ r <t< td=""><td>Output Capacitance</td><td>C_{oss}</td><td colspan="2" rowspan="2">V_{DS} = 100 V,</td><td>-</td><td>59</td><td>-</td><td rowspan="2">-</td></t<>	Output Capacitance	C _{oss}	V _{DS} = 100 V,		-	59	-	-	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	Reverse Transfer Capacitance				-	9	-		
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	Effective output capacitance, energy related ^a	C _{o(er)}		$V_{GS} = 0 V$		-	66	-	pF
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	Effective output capacitance, time related ^b	C _{o(tr)}	V _D			-	84	-	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	Total Gate Charge	Qq				-	15	30	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	Gate-Source Charge		V _{GS} = 10 V	I _D = 5 /	A, V _{DS} = 320 V	-	4	-	nC
Rise Time t_r Turn-Off Delay Time t_r Turn-Off Delay Time $t_{d(off)}$ Fall Time t_f Gate Input Resistance R_g Gate Input Resistance R_g f = 1 MHz, open drain-Image: Diameter Di	Gate-Drain Charge	Q _{gd}				-	7	-	
Turn-Off Delay Time $t_{d(off)}$ $V_{DD} = 400 V$, $I_D = 10 A$, $V_{GS} = 10 V$, $R_g = 9.1 \Omega$ -1836Fall Time t_f r -1428Gate Input Resistance R_g $f = 1 MHz$, open drain-1.8-Drain-Source Body Diode CharacteristicsContinuous Source-Drain Diode CurrentIsMOSFET symbol showing the integral reverse $p - n$ junction diode10Diode Forward Voltage V_{SD} $T_J = 25 °C$, $I_S = 5 A$, $V_{GS} = 0 V$ 1.2Reverse Recovery Time t_{rr} $T_J = 25 °C$, $I_F = I_S = 5 A$, dl/dt = 100 A/µs, $V_R = 25 V$ -1.6-	Turn-On Delay Time	t _{d(on)}				-	12	24	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	Rise Time	tr	- 	- 400 \/ I-	– 10 A	-	18	36	
Fall Time t_f -1428Gate Input Resistance R_g $f = 1 \text{ MHz}$, open drain-1.8-9Drain-Source Body Diode CharacteristicsContinuous Source-Drain Diode CurrentIsMOSFET symbol showing the integral reverse $p - n$ junction diode10Pulsed Diode Forward CurrentIsM $T_J = 25 ^{\circ} C$, $I_S = 5 A$, $V_{GS} = 0 V$ 40Diode Forward Voltage V_{SD} $T_J = 25 ^{\circ} C$, $I_S = 5 A$, $V_{GS} = 0 V$ 1.2Reverse Recovery Time t_{rr} $T_J = 25 ^{\circ} C$, $I_F = I_S = 5 A$, 	Turn-Off Delay Time	t _{d(off)}				-	18	36	ns
Drain-Source Body Diode CharacteristicsContinuous Source-Drain Diode CurrentIsMOSFET symbol showing the integral reverse $p - n$ junction diode10Pulsed Diode Forward CurrentIsMIsMTJ = 25 °C, Is = 5 A, VGS = 0 V40Diode Forward VoltageVSDTJ = 25 °C, Is = 5 A, VGS = 0 V1.2Reverse Recovery TimetrrTJ = 25 °C, Is = 5 A, dI/dt = 100 A/µs, V_B = 25 V-230-	Fall Time				-	14	28		
Drain-Source Body Diode CharacteristicsContinuous Source-Drain Diode CurrentIsMOSFET symbol showing the integral reverse $p - n$ junction diode10Pulsed Diode Forward CurrentIsMIsMTJ = 25 °C, Is = 5 A, VGS = 0 V40Diode Forward VoltageVSDTJ = 25 °C, Is = 5 A, VGS = 0 V1.2Reverse Recovery TimetrrTJ = 25 °C, Is = 5 A, dI/dt = 100 A/µs, V_B = 25 V-230-	Gate Input Resistance	R _q	f = 1 MHz, open drain		-	1.8	-	Ω	
Continuous Source-Drain Diode CurrentIsshowing the integral reverse p - n junction diode10Pulsed Diode Forward CurrentIsMIsM $p - n junction diode40Diode Forward VoltageV_{SDT_J = 25 °C, I_S = 5 A, V_{GS} = 0 V1.2Reverse Recovery Timet_{rr}T_J = 25 °C, I_F = I_S = 5 A,dl/dt = 100 A/µs, V_R = 25 V1.6-$	Drain-Source Body Diode Characteristic								1
Pulsed Diode Forward CurrentIsmIntegral reverse p - n junction diode40Diode Forward Voltage V_{SD} $T_J = 25 \ ^{\circ}C$, $I_S = 5 \ ^{\circ}A$, $V_{GS} = 0 \ ^{\circ}V$ 1.2Reverse Recovery Time t_{rr} $T_J = 25 \ ^{\circ}C$, $I_F = I_S = 5 \ ^{\circ}A$, dl/dt = 100 A/µs, $V_R = 25 \ ^{\circ}V$ 1.6-	Continuous Source-Drain Diode Current	I _S				-	-	10	
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	Pulsed Diode Forward Current	I _{SM}	Ũ			-	-	40	A
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	Diode Forward Voltage	V _{SD}	T _J = 25 °	C, I _S = 5 A	, V _{GS} = 0 V	-	-	1.2	V
Reverse Recovery Charge Q_{rr} $T_J = 25 \ ^{\circ}C$, $I_F = I_S = 5 \ A$, $dl/dt = 100 \ A/\mu s$, $V_R = 25 \ V$ -1.6-	Reverse Recovery Time		-			-	230	-	ns
di/dt = 100 /v µ3, v _R = 23 v	Reverse Recovery Charge		$T_J = 2$	25 °C, I _F = I	$_{\rm S} = 5 {\rm A},$	-	1.6	-	μC
	Reverse Recovery Current	I _{RRM}	ai/at =	του A/μs,	v _R = ∠ɔ v	-	14	-	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_{DS} . 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_{DS} .



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TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)

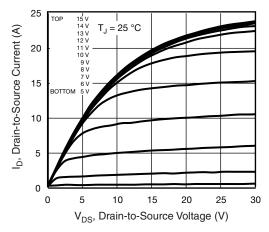


Fig. 1 - Typical Output Characteristics

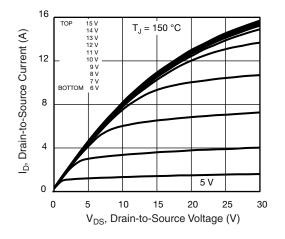


Fig. 2 - Typical Output Characteristics

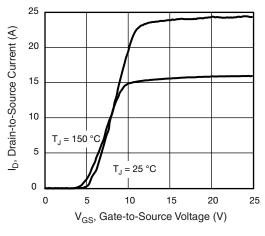


Fig. 3 - Typical Transfer Characteristics

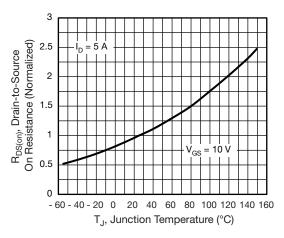


Fig. 4 - Normalized On-Resistance vs. Temperature

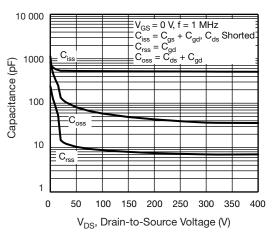


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

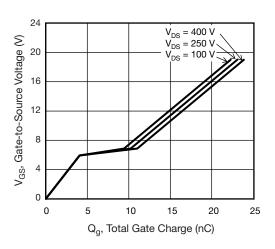


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

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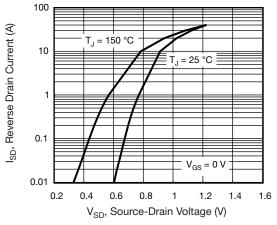
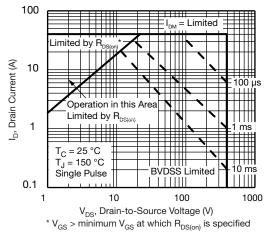
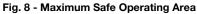


Fig. 7 - Typical Source-Drain Diode Forward Voltage





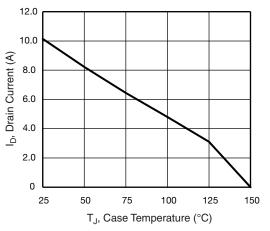


Fig. 9 - Maximum Drain Current vs. Case Temperature

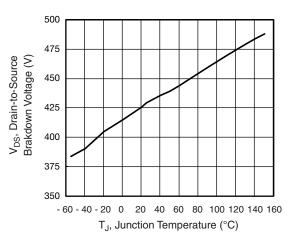


Fig. 10 - Temperature vs. Drain-to-Source Voltage

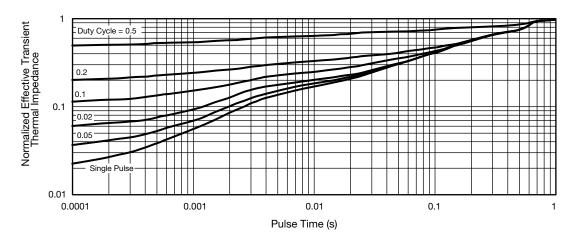


Fig. 11 - Normalized Thermal Transient Impedance, Junction-to-Case

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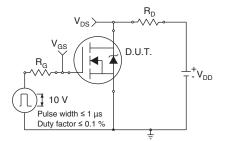


Fig. 12 - Switching Time Test Circuit



Fig. 13 - Switching Time Waveforms

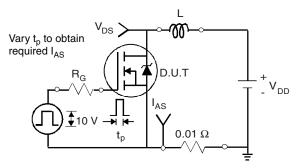


Fig. 14 - Unclamped Inductive Test Circuit

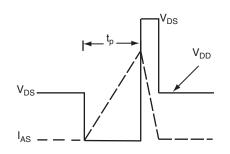


Fig. 15 - Unclamped Inductive Waveforms

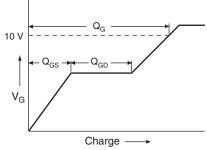


Fig. 16 - Basic Gate Charge Waveform

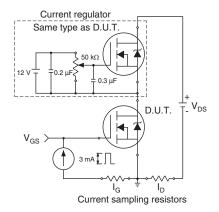


Fig. 17 - Gate Charge Test Circuit

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Peak Diode Recovery dV/dt Test Circuit

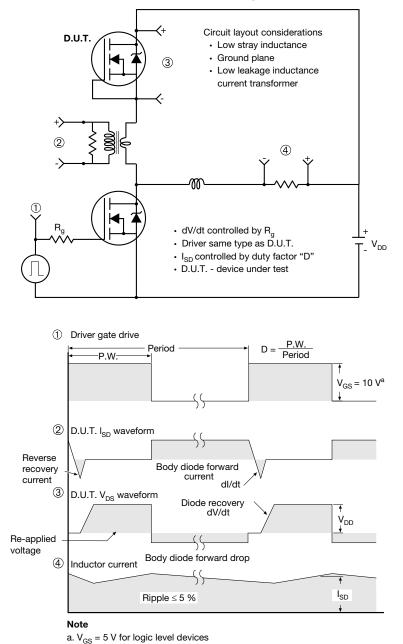


Fig. 18 - For N-Channel

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?91500.

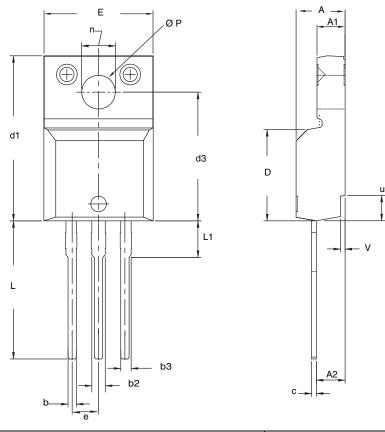
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Package Information

Vishay Siliconix

TO-220 FULLPAK (HIGH VOLTAGE)



	MILLIN	METERS	INC	HES
DIM.	MIN.	MAX.	MIN.	MAX.
А	4.570	4.830	0.180	0.190
A1	2.570	2.830	0.101	0.111
A2	2.510	2.850	0.099	0.112
b	0.622	0.890	0.024	0.035
b2	1.229	1.400	0.048	0.055
b3	1.229	1.400	0.048	0.055
С	0.440	0.629	0.017	0.025
D	8.650	9.800	0.341	0.386
d1	15.88	16.120	0.622	0.635
d3	12.300	12.920	0.484	0.509
E	10.360	10.630	0.408	0.419
е	2.54	BSC	0.100 BSC	
L	13.200	13.730	0.520	0.541
L1	3.100	3.500	0.122	0.138
n	6.050	6.150	0.238	0.242
ØР	3.050	3.450	0.120	0.136
u	2.400	2.500	0.094	0.098
V	0.400	0.500	0.016	0.020

Notes

1. To be used only for process drawing. 2. These dimensions apply to all TO-220, FULLPAK leadframe versions 3 leads. 3. All critical dimensions should C meet $C_{pk} > 1.33$.

4. All dimensions include burrs and plating thickness.

5. No chipping or package damage.



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