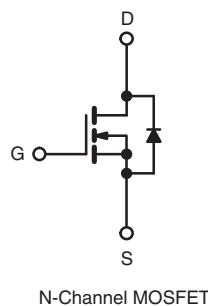
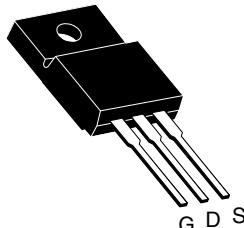


## D Series Power MOSFET

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	Single

**TO-220 FULLPAK**


### FEATURES

- Optimal Design
  - Low Area Specific On-Resistance
  - Low Input Capacitance ( $C_{iss}$ )
  - 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):  $R_{on} \times Q_g$
  - Fast Switching
- Compliant to RoHS Directive 2011/65/EU


**RoHS\***  
COMPLIANT

### Note

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

### APPLICATIONS

- Consumer Electronics
  - Displays (LCD or Plasma TV)
- Server and Telecom Power Supplies
  - SMPS
- Industrial
  - 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 otherwise noted)

PARAMETER	SYMBOL	LIMIT	UNIT
Drain-Source Voltage	$V_{DS}$	400	
Gate-Source Voltage	$V_{GS}$	$\pm 30$	V
Gate-Source Voltage AC ( $f > 1$ Hz)		30	
Continuous Drain Current ( $T_J = 150$ °C) <sup>e</sup>	$I_D$	10	A
		6	
Pulsed Drain Current <sup>a</sup>	$I_{DM}$	23	
Linear Derating Factor		0.26	W/°C
Single Pulse Avalanche Energy <sup>b</sup>	$E_{AS}$	194	mJ
Maximum Power Dissipation	$P_D$	33	W
Operating Junction and Storage Temperature Range	$T_J, T_{stg}$	- 55 to + 150	°C
Drain-Source Voltage Slope	$dV/dt$	24	V/ns
Reverse Diode $dV/dt$ <sup>d</sup>		0.6	
Soldering Recommendations (Peak Temperature)	for 10 s	300 <sup>c</sup>	°C

#### Notes

- Repetitive rating; pulse width limited by maximum junction temperature.
- $V_{DD} = 50$  V, starting  $T_J = 25$  °C,  $L = 2.3$  mH,  $R_g = 25$  Ω,  $I_{AS} = 13$  A.
- 1.6 mm from case.
- $I_{SD} \leq I_D$ , starting  $T_J = 25$  °C.
- Limited by maximum junction temperature.

**THERMAL RESISTANCE RATINGS**

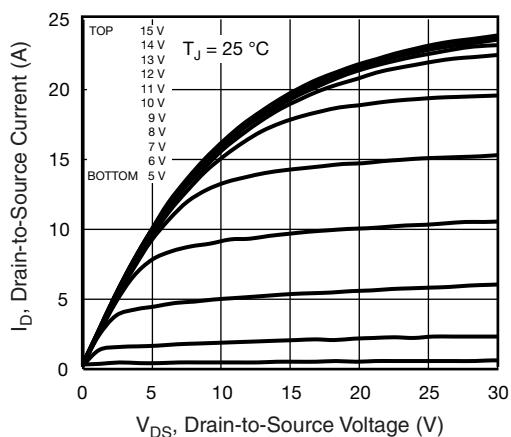
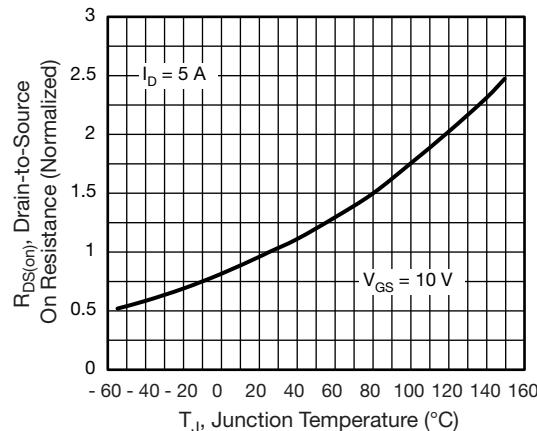
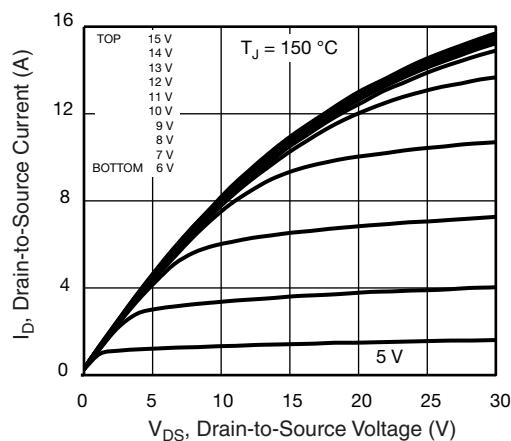
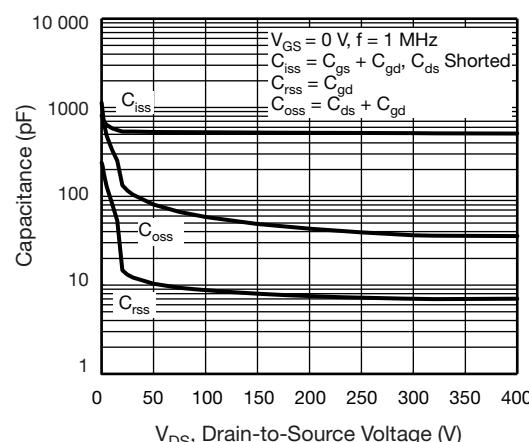
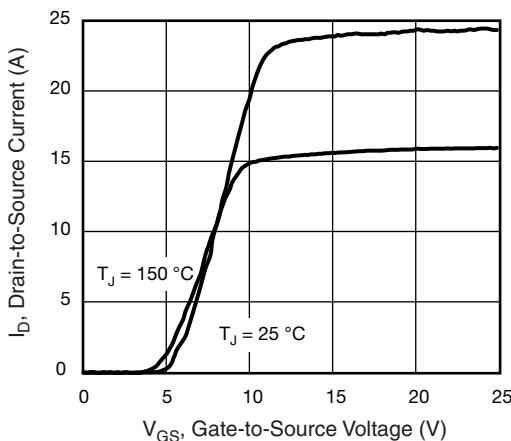
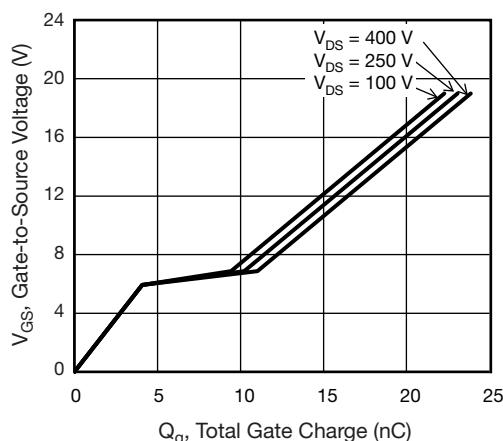
PARAMETER	SYMBOL	TYP.	MAX.	UNIT
Maximum Junction-to-Ambient	$R_{thJA}$	-	65	$^{\circ}\text{C}/\text{W}$
Maximum Junction-to-Case (Drain)	$R_{thJC}$	-	3.8	

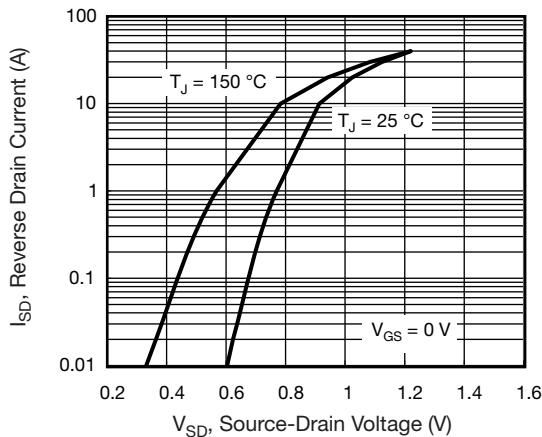
**SPECIFICATIONS (T<sub>J</sub> = 25 °C, unless otherwise noted)**

PARAMETER	SYMBOL	TEST CONDITIONS		MIN.	TYP.	MAX.	UNIT
<b>Static</b>							
Drain-Source Breakdown Voltage	$V_{DS}$	$V_{GS} = 0 \text{ V}$ , $I_D = 250 \mu\text{A}$		400	-	-	V
$V_{DS}$ Temperature Coefficient	$\Delta V_{DS}/T_J$	Reference to 25 °C, $I_D = 250 \mu\text{A}$		-	0.53	-	V/°C
Gate-Source Threshold Voltage (N)	$V_{GS(th)}$	$V_{DS} = V_{GS}$ , $I_D = 250 \mu\text{A}$		3	-	5	V
Gate-Source Leakage	$I_{GSS}$	$V_{GS} = \pm 30 \text{ V}$		-	-	$\pm 100$	nA
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{DS} = 400 \text{ V}$ , $V_{GS} = 0 \text{ V}$		-	-	1	$\mu\text{A}$
		$V_{DS} = 320 \text{ V}$ , $V_{GS} = 0 \text{ V}$ , $T_J = 125 \text{ }^{\circ}\text{C}$		-	-	10	
Drain-Source On-State Resistance	$R_{DS(on)}$	$V_{GS} = 10 \text{ V}$	$I_D = 5 \text{ A}$	-	0.5	0.6	$\Omega$
Forward Transconductance	$g_{fs}$	$V_{DS} = 50 \text{ V}$ , $I_D = 5 \text{ A}$		-	2.7	-	S
<b>Dynamic</b>							
Input Capacitance	$C_{iss}$	$V_{GS} = 0 \text{ V}$ , $V_{DS} = 100 \text{ V}$ , $f = 1 \text{ MHz}$		-	526	-	pF
Output Capacitance	$C_{oss}$			-	59	-	
Reverse Transfer Capacitance	$C_{rss}$			-	9	-	
Effective output capacitance, energy related <sup>a</sup>	$C_{o(er)}$	$V_{GS} = 0 \text{ V}$ , $V_{DS} = 0 \text{ V to } 320 \text{ V}$		-	66	-	pF
Effective output capacitance, time related <sup>b</sup>	$C_{o(tr)}$			-	84	-	
Total Gate Charge	$Q_g$	$V_{GS} = 10 \text{ V}$	$I_D = 5 \text{ A}$ , $V_{DS} = 320 \text{ V}$	-	15	30	nC
Gate-Source Charge	$Q_{gs}$			-	4	-	
Gate-Drain Charge	$Q_{gd}$			-	7	-	
Turn-On Delay Time	$t_{d(on)}$	$V_{DD} = 400 \text{ V}$ , $I_D = 10 \text{ A}$ , $V_{GS} = 10 \text{ V}$ , $R_g = 9.1 \Omega$		-	12	24	ns
Rise Time	$t_r$			-	18	36	
Turn-Off Delay Time	$t_{d(off)}$			-	18	36	
Fall Time	$t_f$			-	14	28	
Gate Input Resistance	$R_g$	$f = 1 \text{ MHz}$ , open drain		-	1.8	-	$\Omega$
<b>Drain-Source Body Diode Characteristics</b>							
Continuous Source-Drain Diode Current	$I_S$	MOSFET symbol showing the integral reverse p - n junction diode		-	-	10	A
Pulsed Diode Forward Current	$I_{SM}$			-	-	40	
Diode Forward Voltage	$V_{SD}$	$T_J = 25 \text{ }^{\circ}\text{C}$ , $I_S = 5 \text{ A}$ , $V_{GS} = 0 \text{ V}$		-	-	1.2	V
Reverse Recovery Time	$t_{rr}$	$T_J = 25 \text{ }^{\circ}\text{C}$ , $I_F = I_S = 5 \text{ A}$ , $dl/dt = 100 \text{ A}/\mu\text{s}$ , $V_R = 25 \text{ V}$		-	230	-	ns
Reverse Recovery Charge	$Q_{rr}$			-	1.6	-	
Reverse Recovery Current	$I_{RRM}$			-	14	-	A

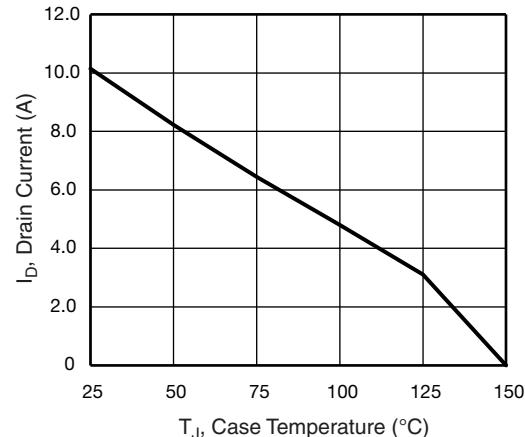
**Notes**

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 %  $V_{DS}$ .

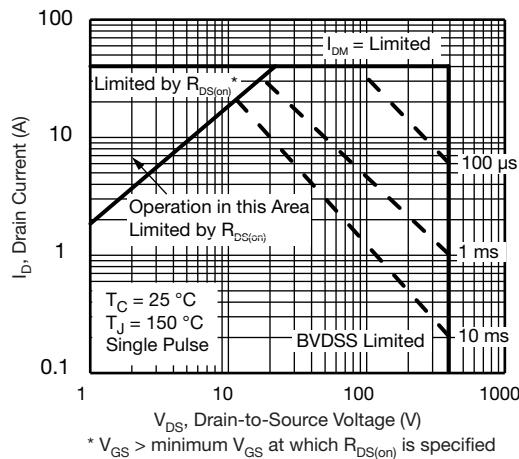
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)

**Fig. 1 - Typical Output Characteristics**

**Fig. 4 - Normalized On-Resistance vs. Temperature**

**Fig. 2 - Typical Output Characteristics**

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

**Fig. 3 - Typical Transfer Characteristics**

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



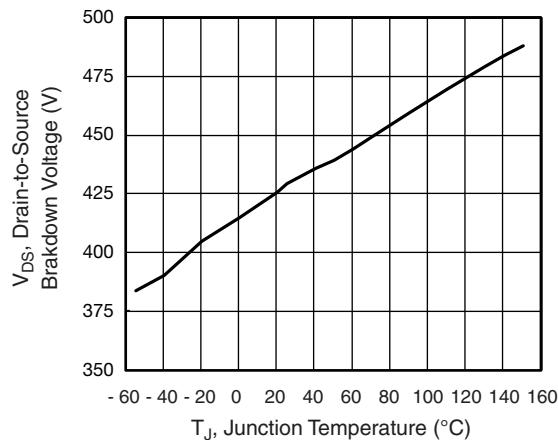
**Fig. 7 - Typical Source-Drain Diode Forward Voltage**



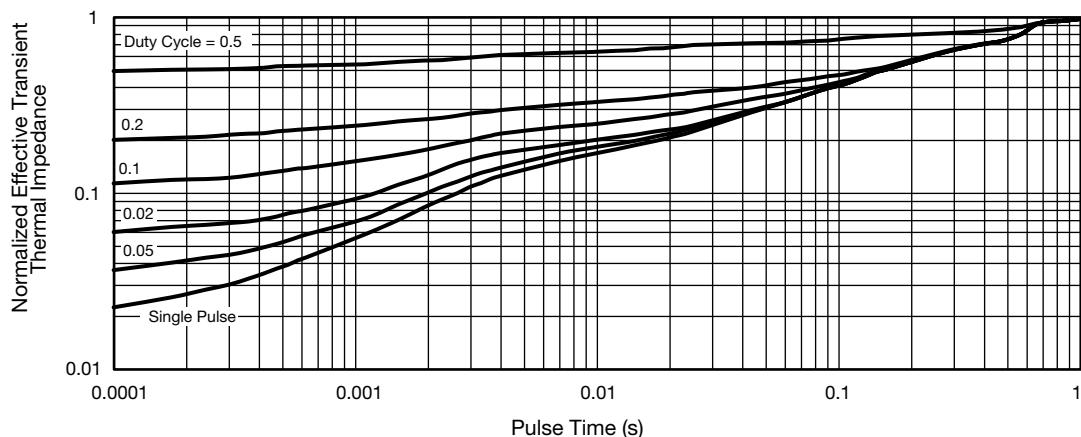
**Fig. 9 - Maximum Drain Current vs. Case Temperature**



**Fig. 8 - Maximum Safe Operating Area**



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



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

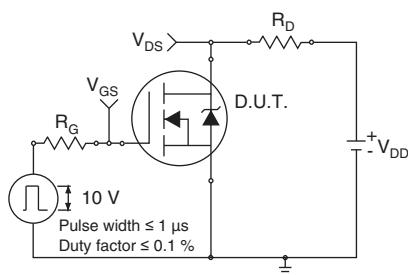


Fig. 12 - Switching Time Test Circuit

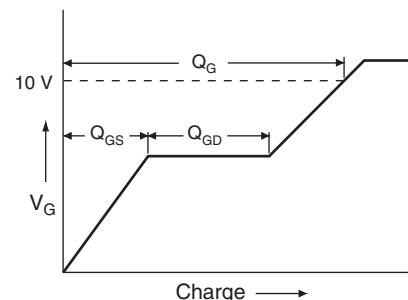


Fig. 16 - Basic Gate Charge Waveform

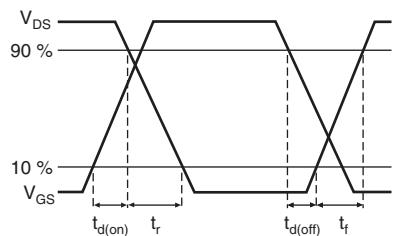


Fig. 13 - Switching Time Waveforms

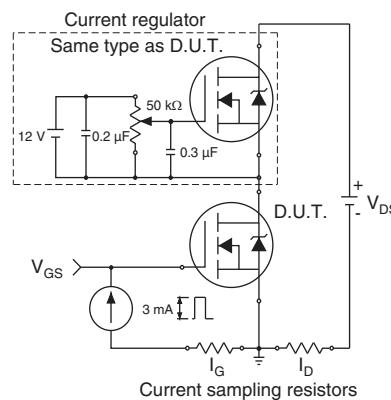


Fig. 17 - Gate Charge Test Circuit

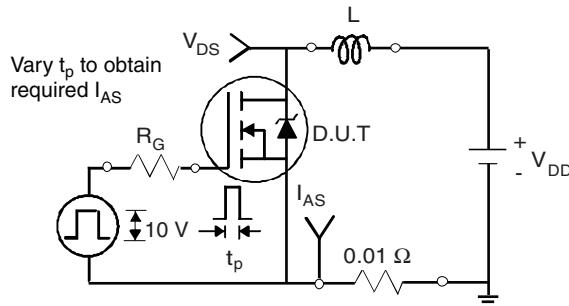


Fig. 14 - Unclamped Inductive Test Circuit

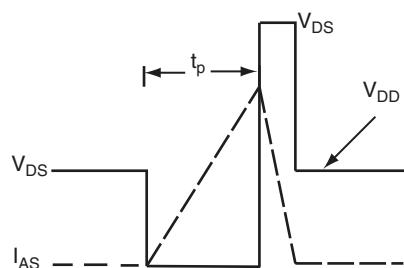
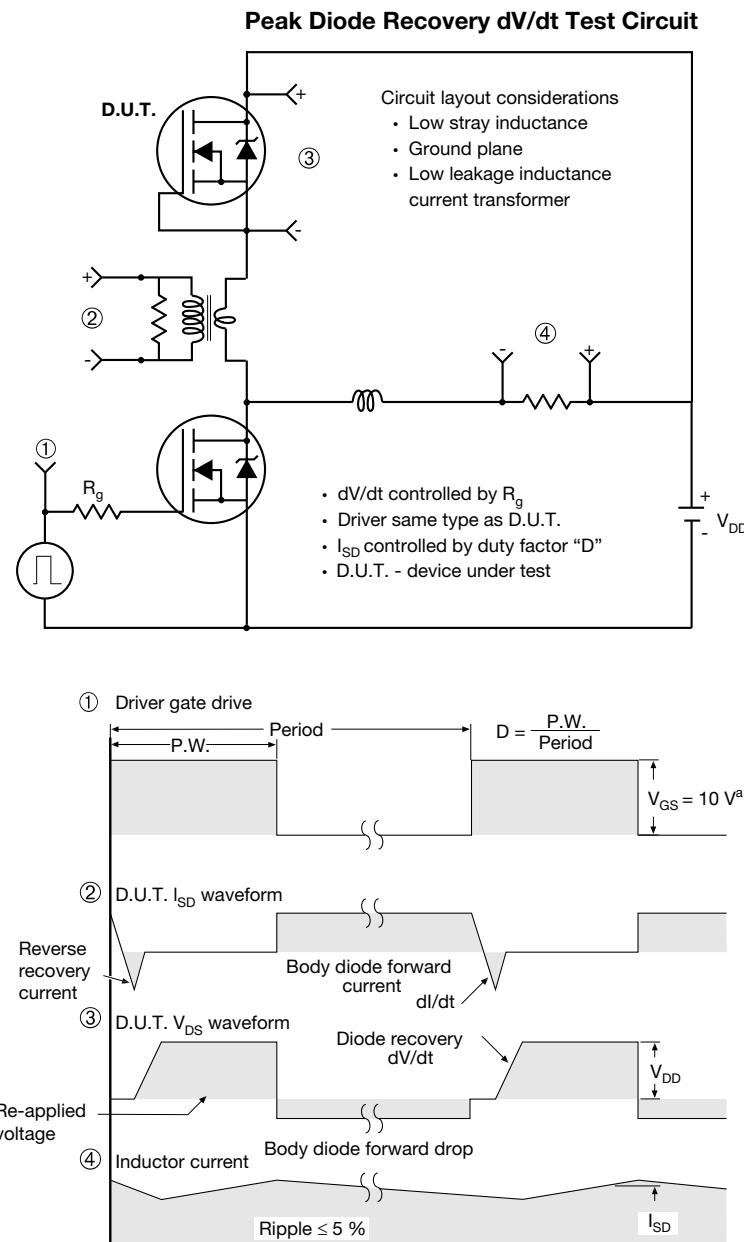


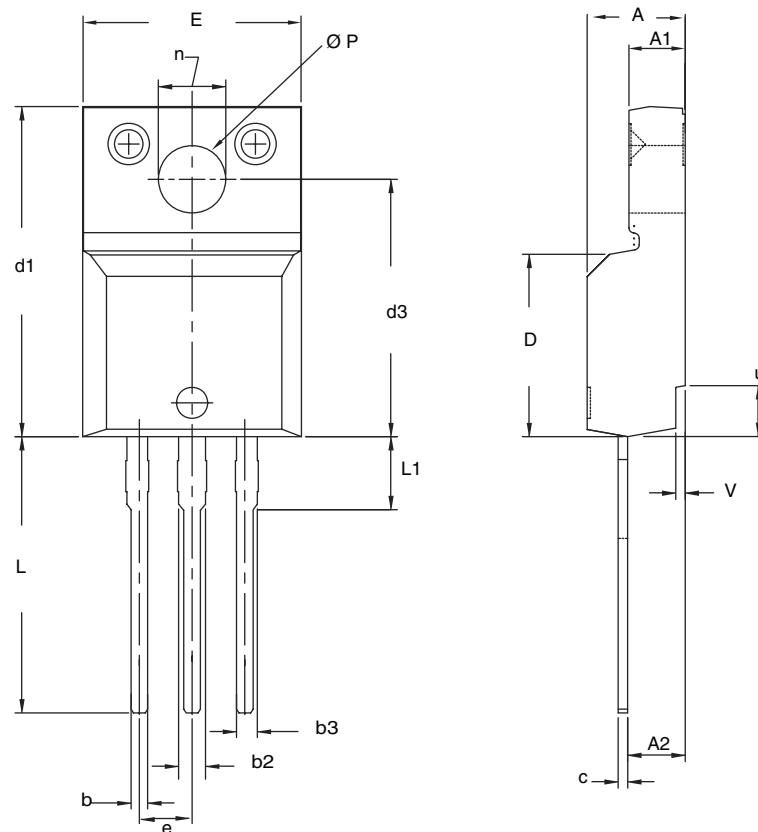
Fig. 15 - Unclamped Inductive Waveforms



**Fig. 18 - For N-Channel**

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### TO-220 FULLPAK (HIGH VOLTAGE)



DIM.	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	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
c	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
e	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
ØP	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

ECN: X09-0126-Rev. B, 26-Oct-09  
DWG: 5972

#### 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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