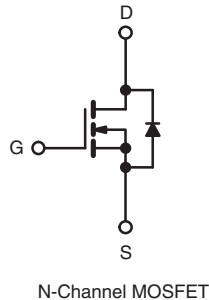
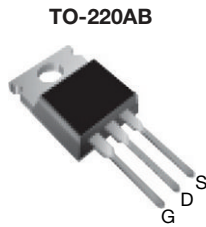


## EF Series Power MOSFET with Fast Body Diode

PRODUCT SUMMARY		
$V_{DS}$ (V) at $T_J$ max.	650	
$R_{DS(on)}$ max. at 25 °C ( $\Omega$ )	$V_{GS} = 10$ V	0.123
$Q_g$ (Max.) (nC)	120	
$Q_{gs}$ (nC)	17	
$Q_{gd}$ (nC)	33	
Configuration	Single	



### FEATURES

- Fast body diode MOSFET using E series technology
- Reduced  $t_{rr}$ ,  $Q_{rr}$ , and  $I_{RRM}$
- Low figure-of-merit (FOM):  $R_{on} \times Q_g$
- Low input capacitance ( $C_{iss}$ )
- Low switching losses due to reduced  $Q_{rr}$
- Ultra low gate charge ( $Q_g$ )
- Avalanche energy rated (UIS)
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



**RoHS**  
COMPLIANT  
HALOGEN  
**FREE**

### APPLICATIONS

- Telecommunications
  - Server and telecom power supplies
- Lighting
  - High intensity discharge (HID)
  - Light emitting diodes (LEDs)
- Consumer and computing
  - ATX power supplies
- Industrial
  - Welding
  - Battery chargers
- Renewable energy
  - Solar (PV inverters)
- Switch mode power supplies (SMPS)
  - LLC
  - Phase shifted bridge (ZVS)
  - 3-level inverter
  - AC/DC bridge

ORDERING INFORMATION	
Package	TO-220AB
Lead (Pb)-free and Halogen-free	SiHP28N60EF-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	$V_{GS}$	$\pm 30$		
Continuous Drain Current ( $T_J = 150$ °C)	$V_{GS}$ at 10 V	$T_C = 25$ °C	28	A
		$T_C = 100$ °C	18	
Pulsed Drain Current <sup>a</sup>	$I_{DM}$	75		
Linear Derating Factor		2	W/°C	
Single Pulse Avalanche Energy <sup>b</sup>	$E_{AS}$	691	mJ	
Maximum Power Dissipation	$P_D$	250	W	
Operating Junction and Storage Temperature Range	$T_J, T_{stg}$	-55 to +150	°C	
Drain-Source Voltage Slope	$dV/dt$	$T_J = 125$ °C	70	V/ns
Reverse Diode $dV/dt$ <sup>d</sup>		13		
Soldering Recommendations (Peak Temperature) <sup>c</sup>	for 10 s	300	°C	

#### Notes

- Repetitive rating; pulse width limited by maximum junction temperature.
- $V_{DD} = 50$  V, starting  $T_J = 25$  °C,  $L = 28.2$  mH,  $R_g = 25$   $\Omega$ ,  $I_{AS} = 7$  A.
- 1.6 mm from case.
- $I_{SD} \leq I_D$ ,  $dI/dt = 100$  A/ $\mu$ s, starting  $T_J = 25$  °C.



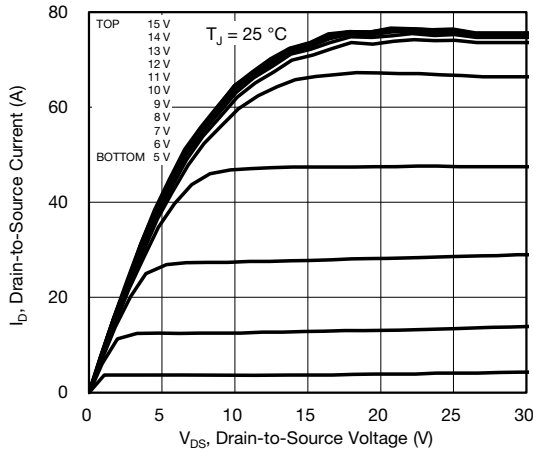
THERMAL RESISTANCE RATINGS				
PARAMETER	SYMBOL	TYP.	MAX.	UNIT
Maximum Junction-to-Ambient	$R_{thJA}$	-	62	°C/W
Maximum Junction-to-Case (Drain)	$R_{thJC}$	-	0.5	

SPECIFICATIONS ( $T_J = 25\text{ }^\circ\text{C}$ , unless otherwise noted)							
PARAMETER	SYMBOL	TEST CONDITIONS		MIN.	TYP.	MAX.	UNIT
<b>Static</b>							
Drain-Source Breakdown Voltage	$V_{DS}$	$V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}$		600	-	-	V
$V_{DS}$ Temperature Coefficient	$\Delta V_{DS}/T_J$	Reference to $25\text{ }^\circ\text{C}, I_D = 1\text{ mA}$		-	0.76	-	V/°C
Gate-Source Threshold Voltage (N)	$V_{GS(th)}$	$V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$		2.0	-	4.0	V
Gate-Source Leakage	$I_{GSS}$	$V_{GS} = \pm 20\text{ V}$		-	-	$\pm 100$	nA
		$V_{GS} = \pm 30\text{ V}$		-	-	$\pm 1$	$\mu\text{A}$
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{DS} = 480\text{ V}, V_{GS} = 0\text{ V}$		-	-	1	$\mu\text{A}$
		$V_{DS} = 480\text{ V}, V_{GS} = 0\text{ V}, T_J = 125\text{ }^\circ\text{C}$		-	-	2	mA
Drain-Source On-State Resistance	$R_{DS(on)}$	$V_{GS} = 10\text{ V}$	$I_D = 14\text{ A}$	-	0.107	0.123	$\Omega$
Forward Transconductance	$g_{fs}$	$V_{DS} = 30\text{ V}, I_D = 14\text{ A}$		-	9.7	-	S
<b>Dynamic</b>							
Input Capacitance	$C_{iss}$	$V_{GS} = 0\text{ V},$ $V_{DS} = 100\text{ V},$ $f = 1\text{ MHz}$		-	2714	-	pF
Output Capacitance	$C_{oss}$			-	123	-	
Reverse Transfer Capacitance	$C_{rss}$			-	6	-	
Effective output capacitance, energy related <sup>a</sup>	$C_{o(er)}$	$V_{GS} = 0\text{ V}, V_{DS} = 0\text{ V to } 480\text{ V}$		-	98	-	pF
Effective output capacitance, time related <sup>b</sup>	$C_{o(tr)}$			-	356	-	
Total Gate Charge	$Q_g$	$V_{GS} = 10\text{ V}$	$I_D = 14\text{ A}, V_{DS} = 480\text{ V}$	-	80	120	nC
Gate-Source Charge	$Q_{gs}$			-	17	-	
Gate-Drain Charge	$Q_{gd}$			-	33	-	
Turn-On Delay Time	$t_{d(on)}$	$V_{DD} = 480\text{ V}, I_D = 14\text{ A}$ $R_g = 9.1\text{ }\Omega, V_{GS} = 10\text{ V}$		-	24	48	ns
Rise Time	$t_r$			-	40	80	
Turn-Off Delay Time	$t_{d(off)}$			-	82	123	
Fall Time	$t_f$			-	39	78	
Gate Input Resistance	$R_g$			$f = 1\text{ MHz}, \text{open drain}$		-	
<b>Drain-Source Body Diode Characteristics</b>							
Continuous Source-Drain Diode Current	$I_S$	MOSFET symbol showing the integral reverse p - n junction diode		-	-	28	A
Pulsed Diode Forward Current	$I_{SM}$			-	-	70	
Diode Forward Voltage	$V_{SD}$	$T_J = 25\text{ }^\circ\text{C}, I_S = 11\text{ A}, V_{GS} = 0\text{ V}$		-	0.9	1.2	V
Reverse Recovery Time	$t_{rr}$	$T_J = 25\text{ }^\circ\text{C}, I_F = I_S = 14\text{ A},$ $di/dt = 100\text{ A}/\mu\text{s}, V_R = 25\text{ V}$		-	142	284	ns
Reverse Recovery Charge	$Q_{rr}$			-	0.97	1.94	$\mu\text{C}$
Reverse Recovery Current	$I_{RRM}$			-	13.2	-	A

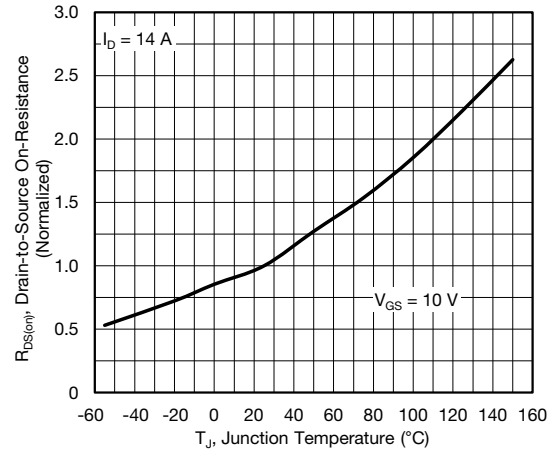
**Notes**

- 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 charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 % to 80 %  $V_{DS}$ .

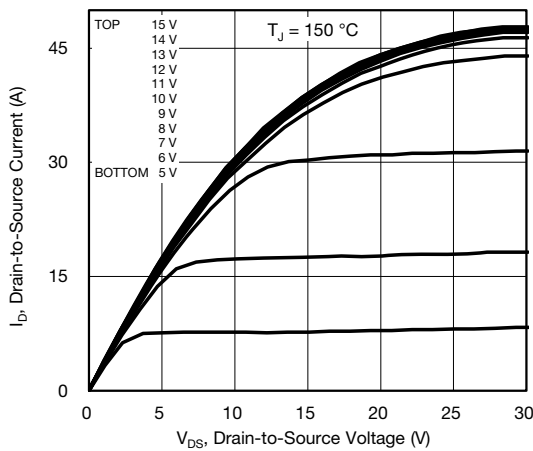
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



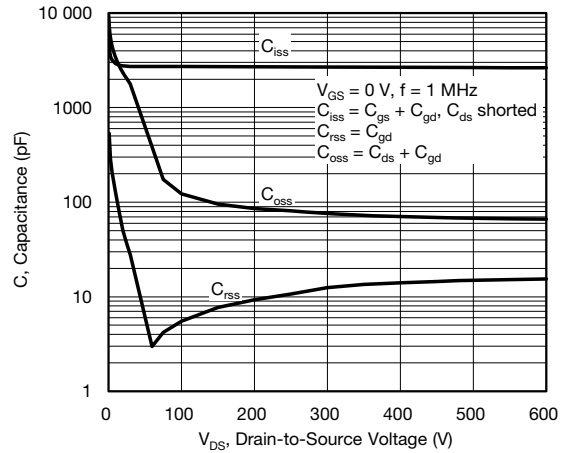
**Fig. 1 - Typical Output Characteristics**



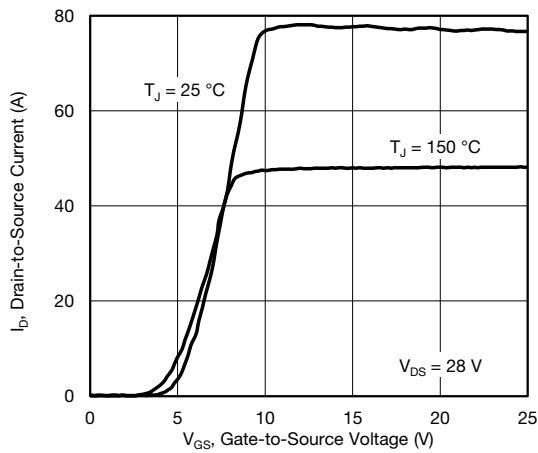
**Fig. 4 - Normalized On-Resistance vs. Temperature**



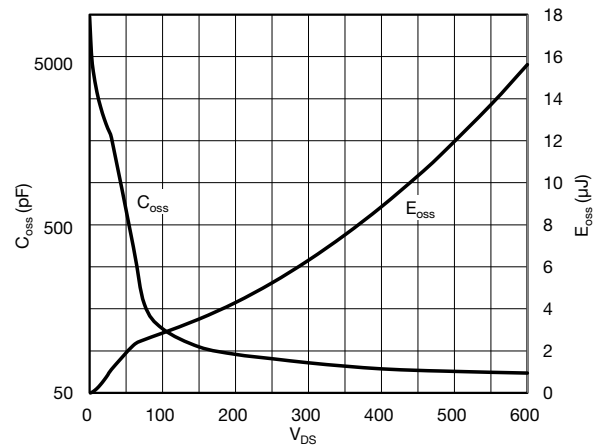
**Fig. 2 - Typical Output Characteristics**



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



**Fig. 3 - Typical Transfer Characteristics**



**Fig. 6 - C<sub>oss</sub> and E<sub>oss</sub> vs. V<sub>DS</sub>**

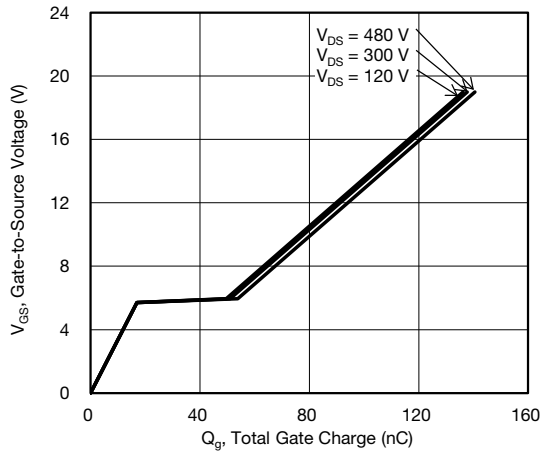


Fig. 7 - Typical Gate Charge vs. Gate-to-Source Voltage

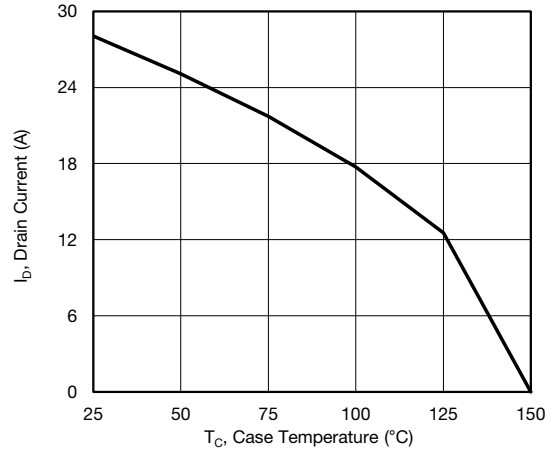


Fig. 10 - Maximum Drain Current vs. Case Temperature

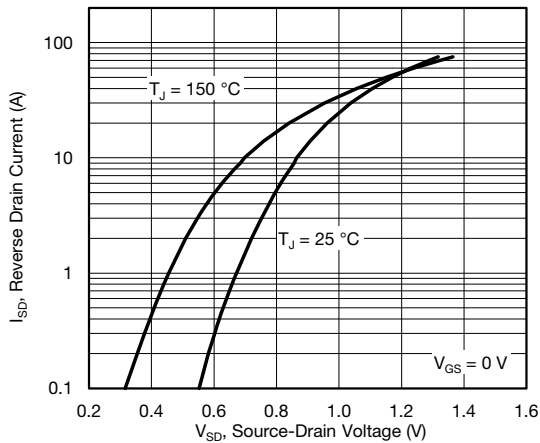


Fig. 8 - Typical Source-Drain Diode Forward Voltage

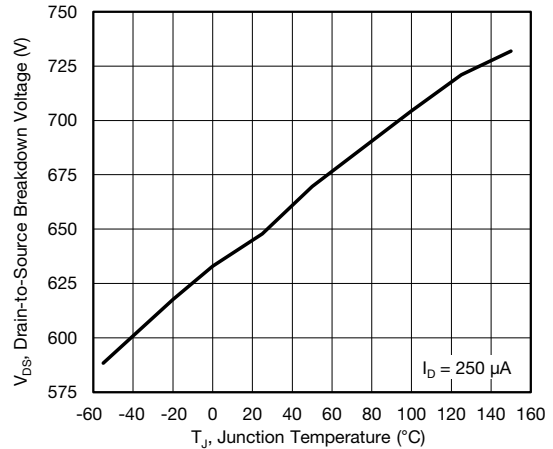


Fig. 11 - Typical Drain-to-Source Voltage vs. Temperature

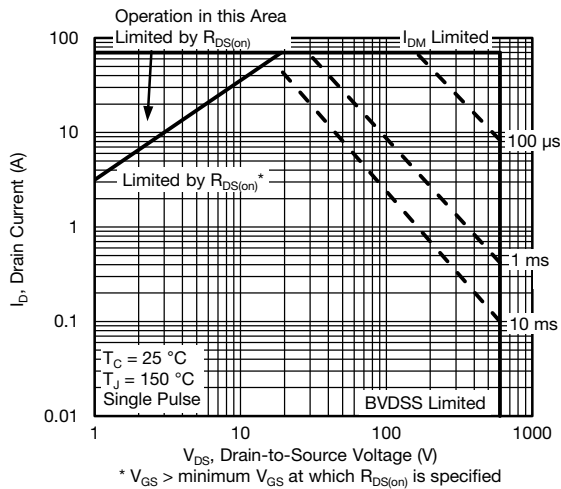


Fig. 9 - Maximum Safe Operating Area

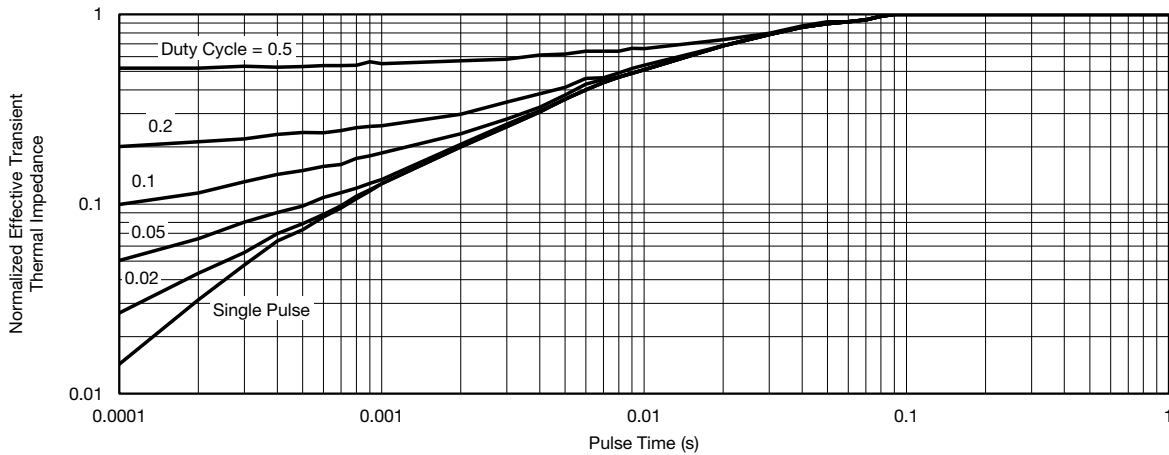


Fig. 12 - Normalized Thermal Transient Impedance, Junction-to-Case



Fig. 13 - Switching Time Test Circuit

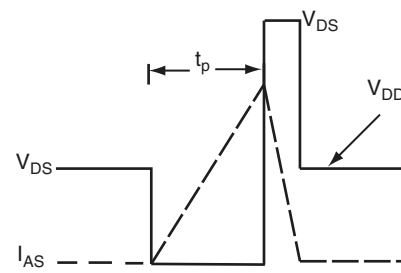


Fig. 16 - Unclamped Inductive Waveforms

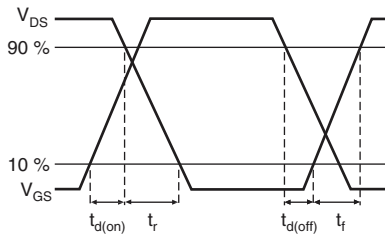


Fig. 14 - Switching Time Waveforms

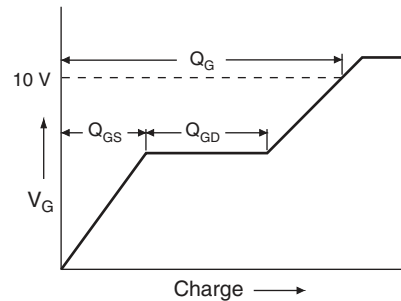


Fig. 17 - Basic Gate Charge Waveform

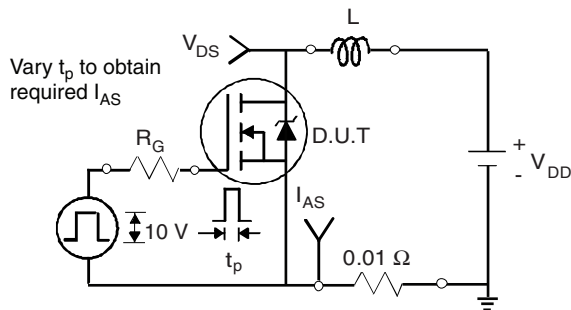
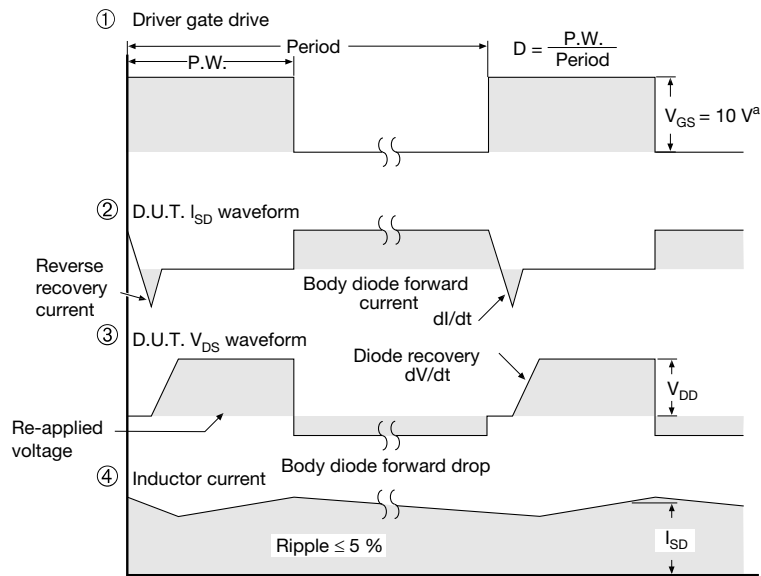
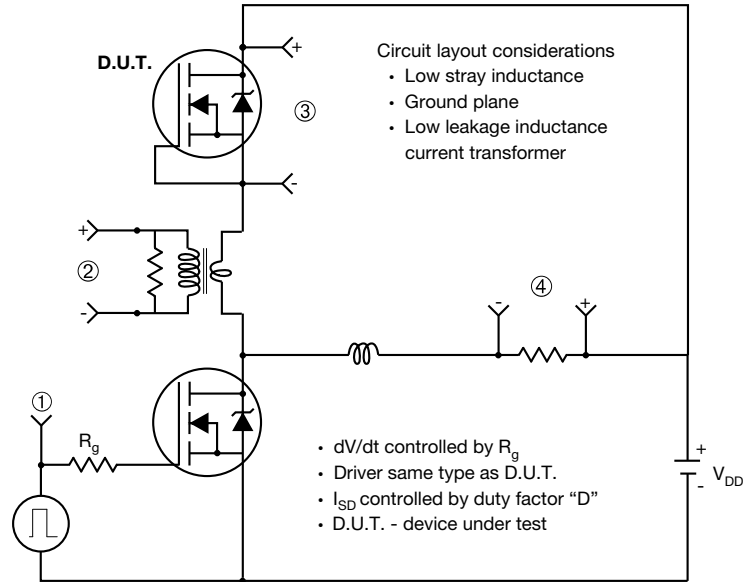


Fig. 15 - Unclamped Inductive Test Circuit



Fig. 18 - Gate Charge Test Circuit

Peak Diode Recovery dV/dt Test Circuit



Note

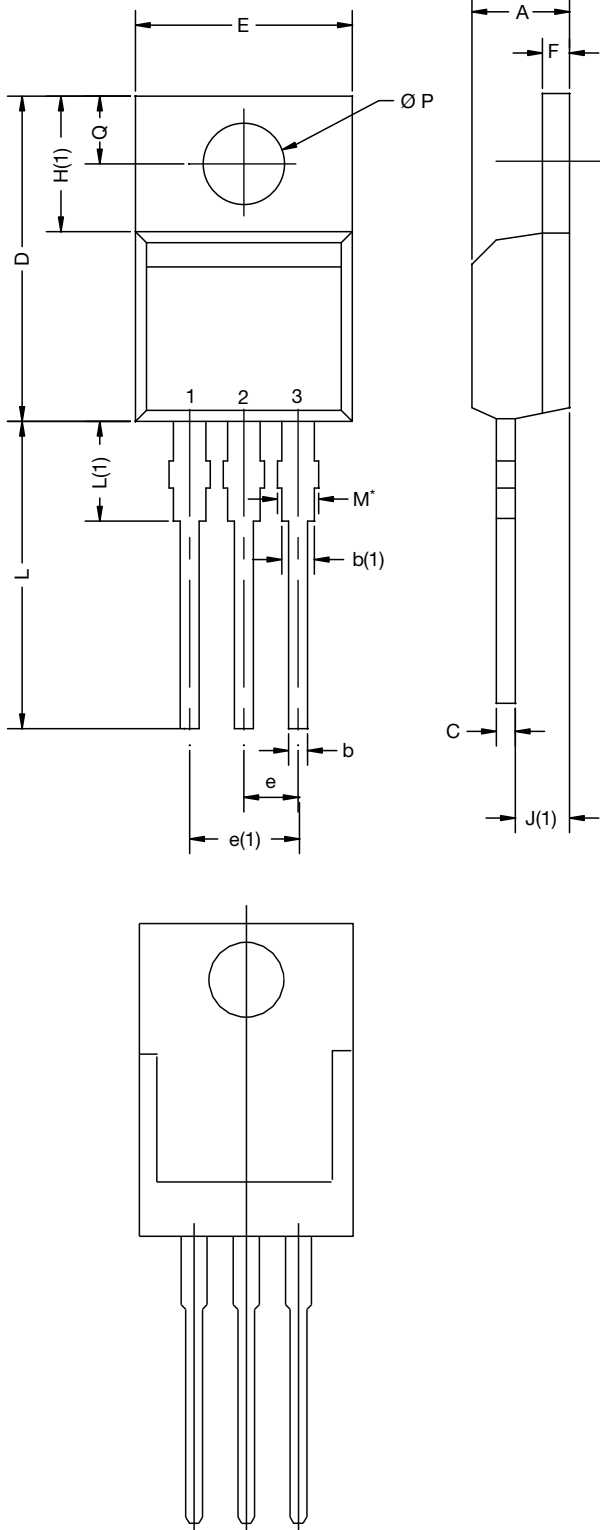
a.  $V_{GS} = 5 V$  for logic level devices

Fig. 19 - For N-Channel

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### TO-220-1



DIM.	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	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
c	0.36	0.61	0.014	0.024
D	14.33	15.85	0.564	0.624
E	9.96	10.52	0.392	0.414
e	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
Ø P	3.53	3.94	0.139	0.155
Q	2.59	3.00	0.102	0.118

ECN: X15-0003-Rev. A, 19-Jan-15  
DWG: 6031

#### Notes

- M\* = 0.052 inches to 0.064 inches (dimension including protrusion), heatsink hole for HVM
- Outline conforms to JEDEC® outline TO-220AB with exception of dimension F



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**Please note that some Vishay documentation may still make reference to RoHS Directive 2002/95/EC. We confirm that all the products identified as being compliant to Directive 2002/95/EC conform to Directive 2011/65/EU.**

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- Оперативные поставки широкого спектра электронных компонентов отечественного и импортного производства напрямую от производителей и с крупнейших мировых складов;
- Поставка более 17-ти миллионов наименований электронных компонентов;
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- Лицензия ФСБ на осуществление работ с использованием сведений, составляющих государственную тайну;
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- Подбор аналогов;
- Консультации по применению компонента;
- Поставка образцов и прототипов;
- Техническая поддержка проекта;
- Защита от снятия компонента с производства.



#### Как с нами связаться

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**Электронная почта:** [org@eplast1.ru](mailto:org@eplast1.ru)

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