

## E Series Power MOSFET

PRODUCT SUMMARY	
$V_{DS}$ (V) at $T_J$ max.	650
$R_{DS(on)}$ max. at 25 °C ( $\Omega$ )	$V_{GS} = 10$ V   0.18
$Q_g$ max. (nC)	86
$Q_{gs}$ (nC)	11
$Q_{gd}$ (nC)	24
Configuration	Single

### FEATURES

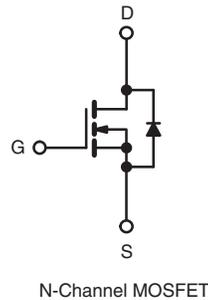
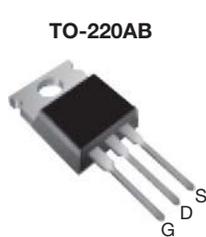
- Low Figure-of-Merit (FOM)  $R_{on} \times Q_g$
- Low Input Capacitance ( $C_{iss}$ )
- Reduced Switching and Conduction Losses
- Ultra Low Gate Charge ( $Q_g$ )
- Avalanche Energy Rated (UIS)
- Material categorization: For definitions please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



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

### 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
  - Renewable Energy
  - Solar (PV Inverters)



ORDERING INFORMATION	
Package	TO-220AB
Lead (Pb)-free	SiHP22N60E-E3
Lead (Pb)-free and Halogen-free	SiHP22N60E-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	$V_{GS}$	$\pm 20$	
Gate-Source Voltage AC ( $f > 1$ Hz)		30	
Continuous Drain Current ( $T_J = 150$ °C)	$V_{GS}$ at 10 V	$T_C = 25$ °C	A
		$T_C = 100$ °C	
Pulsed Drain Current <sup>a</sup>	$I_{DM}$	56	
Linear Derating Factor		1.8	W/°C
Single Pulse Avalanche Energy <sup>b</sup>	$E_{AS}$	367	mJ
Maximum Power Dissipation	$P_D$	227	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	V/ns
Reverse Diode $dV/dt^d$		11	
Soldering Recommendations (Peak Temperature)	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,  $R_g = 25$   $\Omega$ ,  $I_{AS} = 5.1$  A.
- 1.6 mm from case.
- $I_{SD} \leq I_D$ ,  $dI/dt = 100$  A/ $\mu$ s, starting  $T_J = 25$  °C.

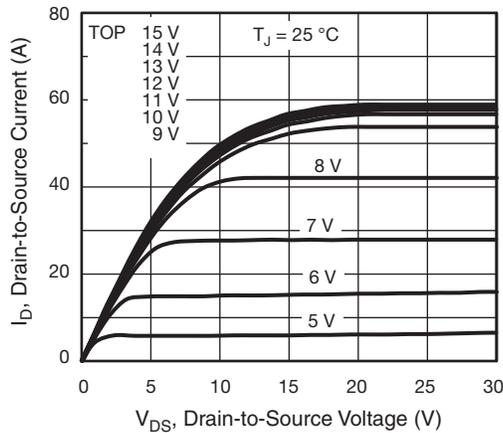
THERMAL RESISTANCE RATINGS				
PARAMETER	SYMBOL	TYP.	MAX.	UNIT
Maximum Junction-to-Ambient	$R_{thJA}$	-	62	°C/W
Maximum Junction-to-Case (Drain)	$R_{thJC}$	-	0.55	

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 $25\text{ }^\circ\text{C}, I_D = 250\text{ }\mu\text{A}$		-	0.71	-	V/°C
Gate-Source Threshold Voltage (N)	$V_{GS(th)}$	$V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$		2	-	4	V
Gate-Source Leakage	$I_{GSS}$	$V_{GS} = \pm 20\text{ V}$		-	-	$\pm 100$	nA
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{DS} = 600\text{ V}, V_{GS} = 0\text{ V}$		-	-	1	$\mu\text{A}$
		$V_{DS} = 480\text{ V}, V_{GS} = 0\text{ V}, T_J = 125\text{ }^\circ\text{C}$		-	-	10	
Drain-Source On-State Resistance	$R_{DS(on)}$	$V_{GS} = 10\text{ V}$	$I_D = 11\text{ A}$	-	0.15	0.18	$\Omega$
Forward Transconductance	$g_{fs}$	$V_{DS} = 8\text{ V}, I_D = 5\text{ A}$		-	6.4	-	S
<b>Dynamic</b>							
Input Capacitance	$C_{iss}$	$V_{GS} = 0\text{ V}, V_{DS} = 100\text{ V}, f = 1\text{ MHz}$		-	1920	-	$\mu\text{F}$
Output Capacitance	$C_{oss}$			-	90	-	
Reverse Transfer Capacitance	$C_{rss}$			-	6	-	
Effective Output Capacitance, Energy Related <sup>a</sup>	$C_{o(er)}$	$V_{DS} = 0\text{ V to } 480\text{ V}, V_{GS} = 0\text{ V}$		-	73	-	$\mu\text{F}$
Effective Output Capacitance, Time Related <sup>b</sup>	$C_{o(tr)}$			-	263	-	
Total Gate Charge	$Q_g$	$V_{GS} = 10\text{ V}$	$I_D = 11\text{ A}, V_{DS} = 480\text{ V}$	-	57	86	nC
Gate-Source Charge	$Q_{gs}$			-	11	-	
Gate-Drain Charge	$Q_{gd}$			-	24	-	
Turn-On Delay Time	$t_{d(on)}$	$V_{DD} = 380\text{ V}, I_D = 11\text{ A}, V_{GS} = 10\text{ V}, R_g = 4.7\text{ }\Omega$		-	18	36	ns
Rise Time	$t_r$			-	27	54	
Turn-Off Delay Time	$t_{d(off)}$			-	66	99	
Fall Time	$t_f$			-	35	70	
Gate Input Resistance	$R_g$	$f = 1\text{ MHz}, \text{open drain}$		-	0.77	-	$\Omega$
<b>Drain-Source Body Diode Characteristics</b>							
Continuous Source-Drain Diode Current	$I_S$	MOSFET symbol showing the integral reverse p - n junction diode 		-	-	21	A
Pulsed Diode Forward Current	$I_{SM}$			-	-	56	
Diode Forward Voltage	$V_{SD}$	$T_J = 25\text{ }^\circ\text{C}, I_S = 11\text{ A}, V_{GS} = 0\text{ V}$		-	-	1.2	V
Reverse Recovery Time	$t_{rr}$	$T_J = 25\text{ }^\circ\text{C}, I_F = I_S = 11\text{ A}, dI/dt = 100\text{ A}/\mu\text{s}, V_R = 25\text{ V}$		-	344	-	ns
Reverse Recovery Charge	$Q_{rr}$			-	5.3	-	$\mu\text{C}$
Reverse Recovery Current	$I_{RRM}$			-	28	-	A

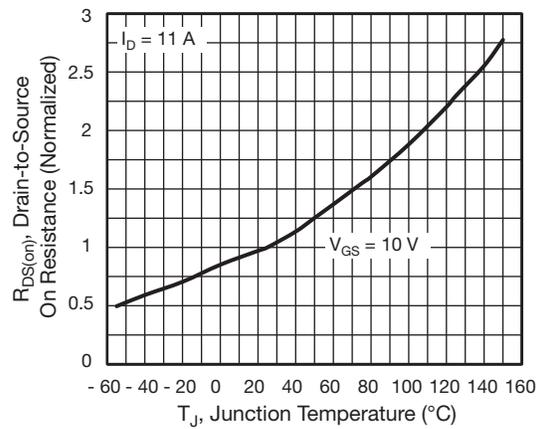
**Notes**

- 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 %  $V_{DSS}$ .

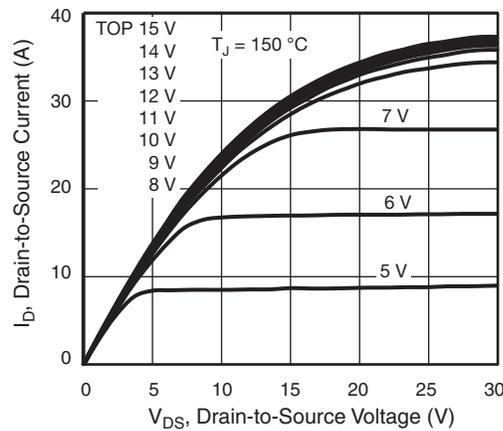
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



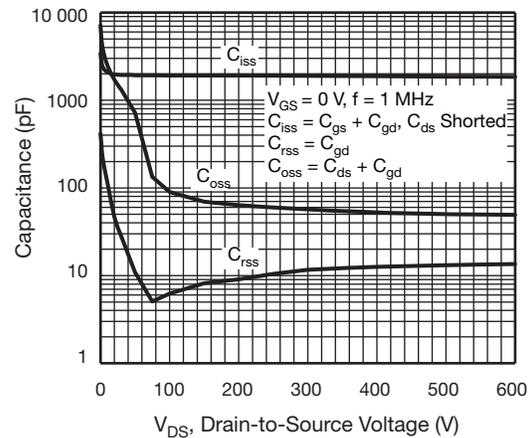
**Fig. 1 - Typical Output Characteristics**



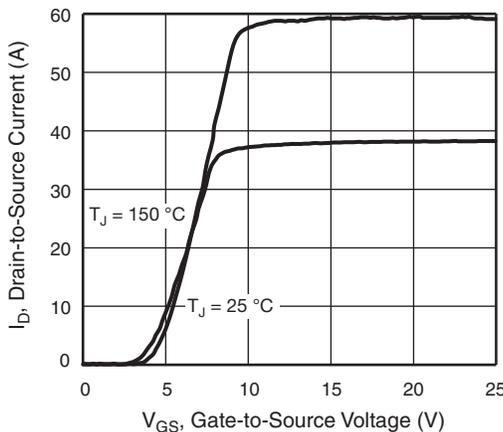
**Fig. 4 - Normalized On-Resistance vs. Temperature**



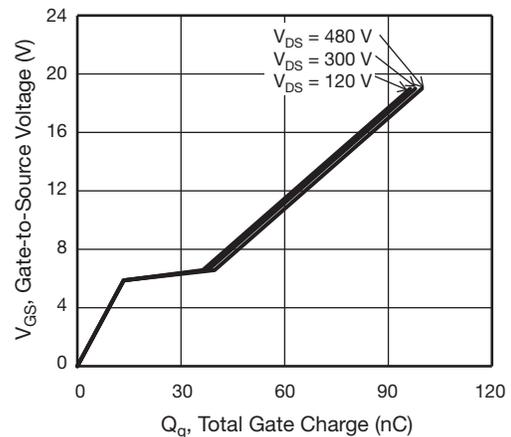
**Fig. 2 - Typical Output Characteristics**



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



**Fig. 3 - Typical Transfer Characteristics**



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

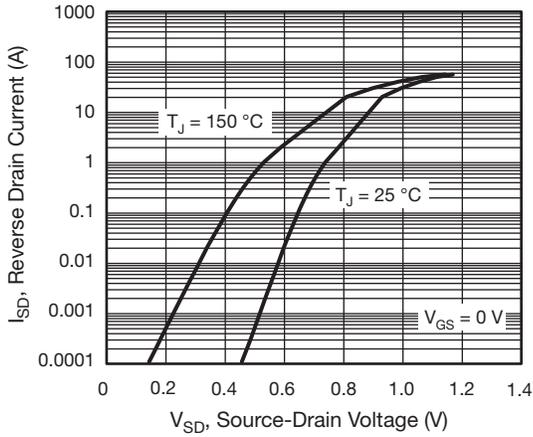


Fig. 7 - Typical Source-Drain Diode Forward Voltage

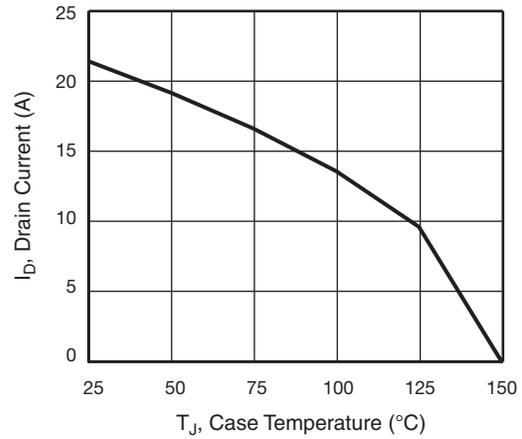


Fig. 9 - Maximum Drain Current vs. Case Temperature

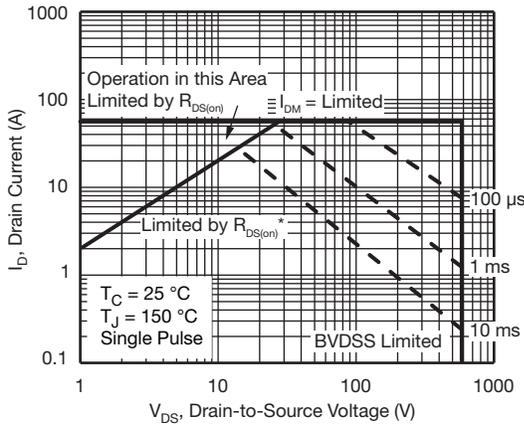


Fig. 8 - Maximum Safe Operating Area

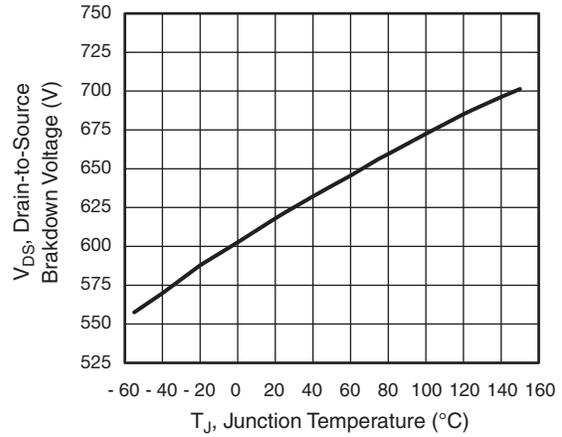


Fig. 10 - Temperature vs. Drain-to-Source Voltage

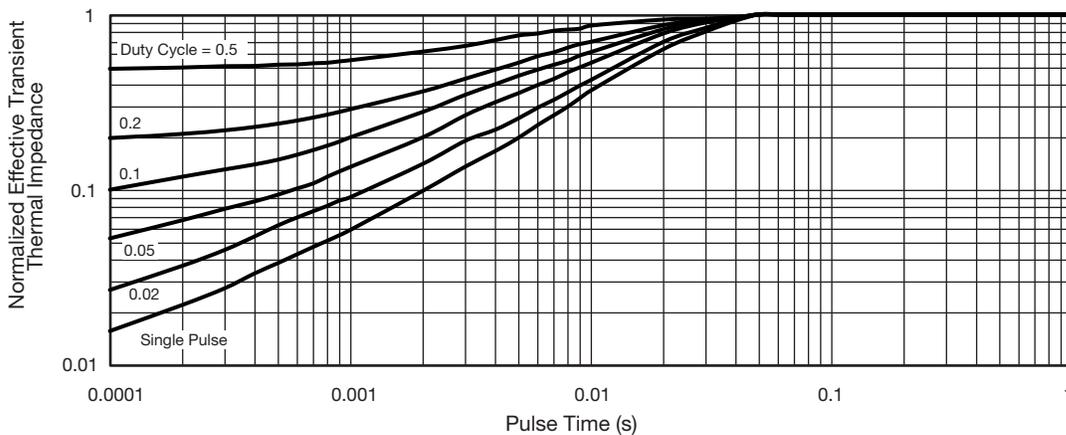
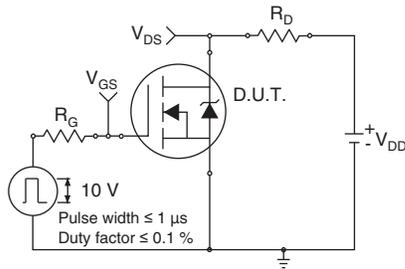
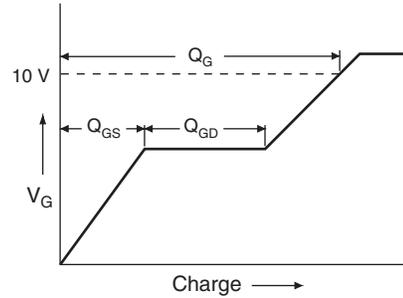


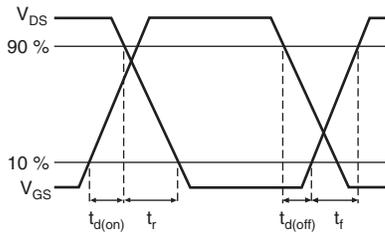
Fig. 11 - Normalized Thermal Transient Impedance, Junction-to-Case



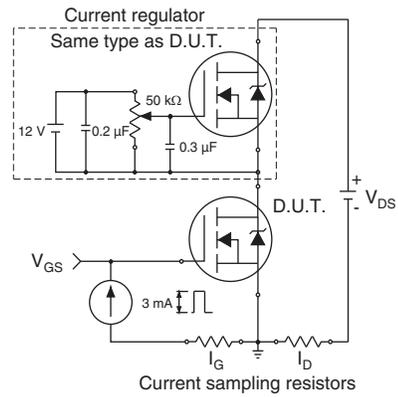
**Fig. 12 - Switching Time Test Circuit**



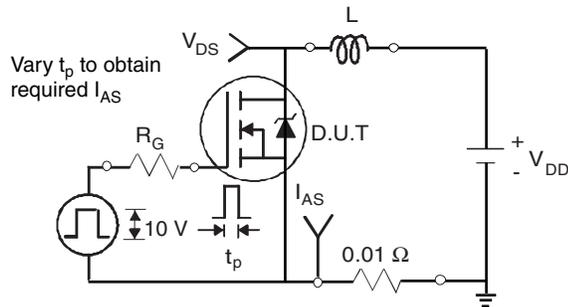
**Fig. 16 - Basic Gate Charge Waveform**



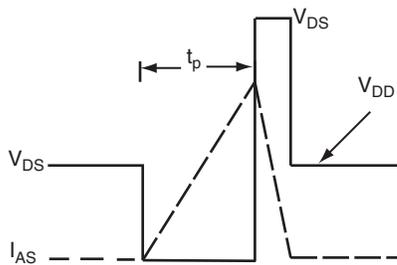
**Fig. 13 - Switching Time Waveforms**



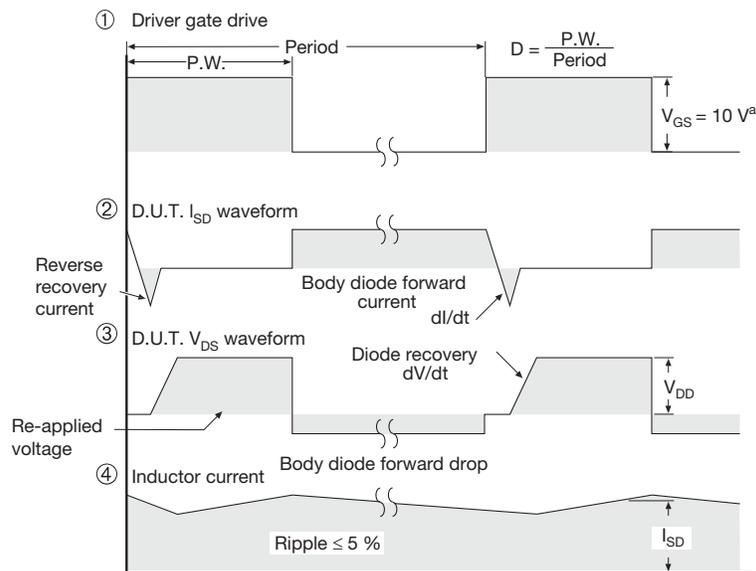
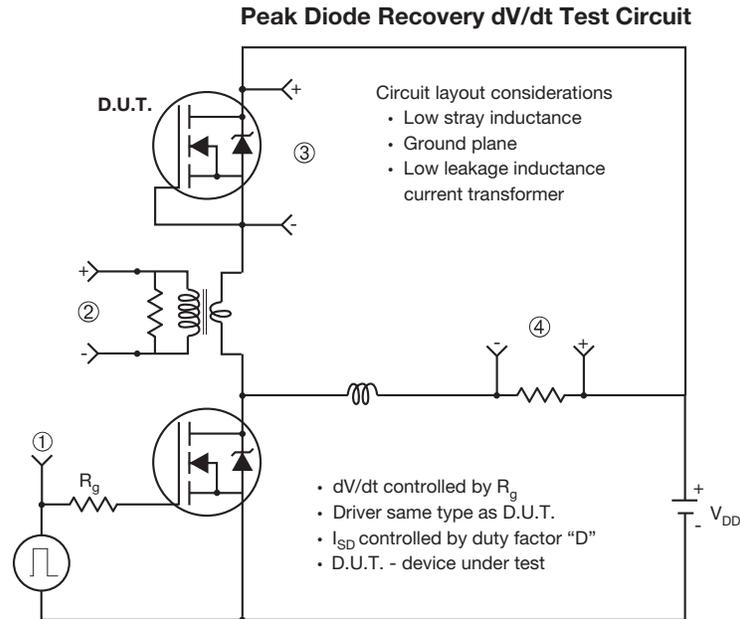
**Fig. 17 - Gate Charge Test Circuit**



**Fig. 14 - Unclamped Inductive Test Circuit**



**Fig. 15 - Unclamped Inductive Waveforms**



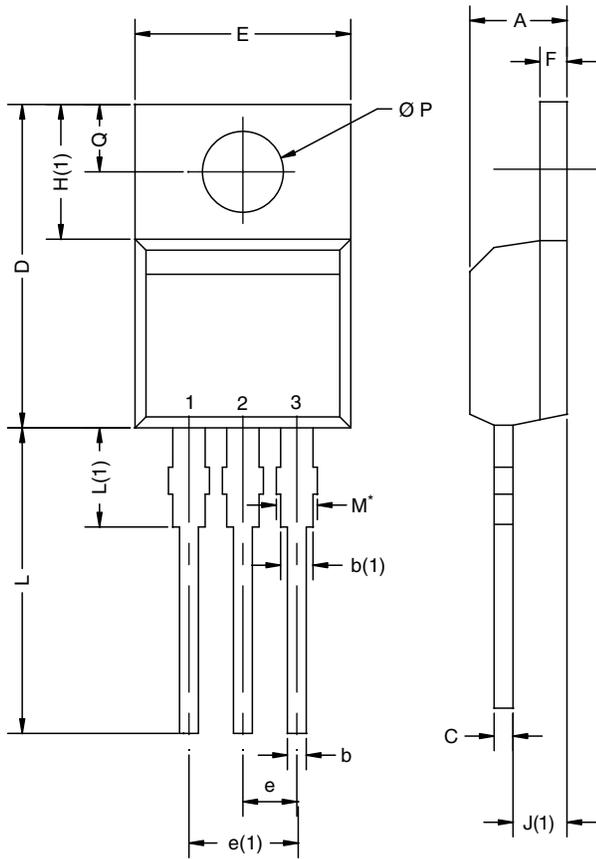
**Note**

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

**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?91470](http://www.vishay.com/ppg?91470).

## TO-220AB

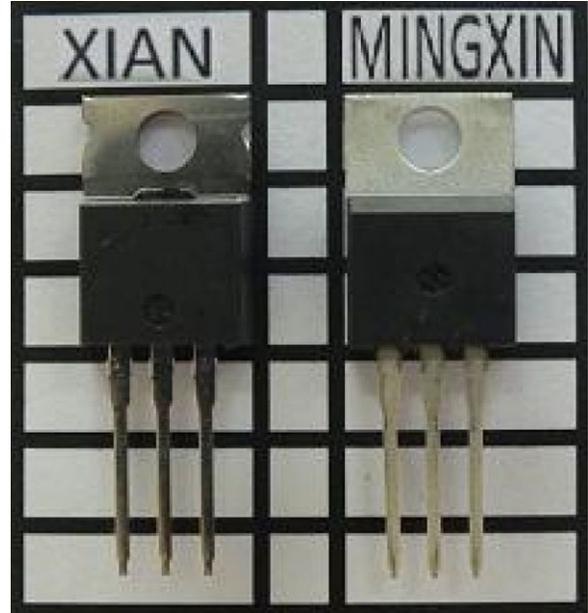


DIM.	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	4.25	4.65	0.167	0.183
b	0.69	1.01	0.027	0.040
b(1)	1.20	1.73	0.047	0.068
c	0.36	0.61	0.014	0.024
D	14.85	15.49	0.585	0.610
E	10.04	10.51	0.395	0.414
e	2.41	2.67	0.095	0.105
e(1)	4.88	5.28	0.192	0.208
F	1.14	1.40	0.045	0.055
H(1)	6.09	6.48	0.240	0.255
J(1)	2.41	2.92	0.095	0.115
L	13.35	14.02	0.526	0.552
L(1)	3.32	3.82	0.131	0.150
$\varnothing P$	3.54	3.94	0.139	0.155
Q	2.60	3.00	0.102	0.118

ECN: X12-0208-Rev. N, 08-Oct-12  
DWG: 5471

### Notes

- \* M = 1.32 mm to 1.62 mm (dimension including protrusion)  
Heatsink hole for HVM
- Xi'an and Mingxin actual photo





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