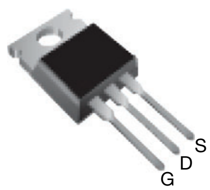
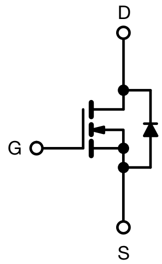
EF Series Power MOSFET With Fast Body Diode

TO-220AB





N-Channel MOSFET

FEATURES

- Fast body diode MOSFET using E series technology
- Reduced t_{rr}, Q_{rr}, and I_{RRM}
- Low figure-of-merit (FOM): R_{on} x Q_g
- Low input capacitance (C_{iss})
- Increased robustness due to low 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

RoHS COMPLIANT
HALOGEN FREE Available

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 suppliers (SMPS)
- Applications using the following topologies
  - LLC
  - Phase shifted bridge (ZVS)
  - 3-level inverter
  - AC/DC bridge

PRODUCT SUMMARY		
V_{DS} (V) at T_J max.	650	
$R_{DS(on)}$ max. at 25 °C (Ω)	V_{GS} = 10 V	0.176
Q_g (Max.) (nC)	84	
Q_{gs} (nC)	14	
Q_{gd} (nC)	24	
Configuration	Single	

ORDERING INFORMATION	
Package	TO-220AB
Lead (Pb)-free and halogen-free	SiHP21N60EF-BE3
	SiHP21N60EF-GE3

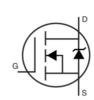
ABSOLUTE MAXIMUM RATINGS (T_C = 25 °C, unless otherwise noted)

PARAMETER			SYMBOL	LIMIT	UNIT
Drain-source voltage			V_{DS}	600	V
Gate-source voltage			V_{GS}	± 30	
Continuous drain current (T_J = 150 °C)	V_{GS} at 10 V	T_C = 25 °C	I_D	21	A
		T_C = 100 °C		14	
Pulsed drain current [a]			I_{DM}	53	
Linear derating factor				1.8	W/°C
Single pulse avalanche energy [b]			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	T_J = 125 °C		dV/dt	70	V/ns
Reverse diode dV/dt [d]				50	
Soldering recommendations (peak temperature) [c]	For 10 s			300	°C

Notes

a. Repetitive rating; pulse width limited by maximum junction temperature
b. V_{DD} = 50 V, starting T_J = 25 °C, L = 28.2 mH, R_g = 25 Ω, I_{AS} = 5.1 A
c. 1.6 mm from case
d. $I_{SD} \leq I_D$, dI/dt = 900 A/μs, 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 °C, unless otherwise noted)							
PARAMETER	SYMBOL	TEST CONDITIONS		MIN.	TYP.	MAX.	UNIT
Static							
Drain-source breakdown voltage	V_{DS}	V_{GS} = 0 V, I_D = 250 μA		600	-	-	V
V_{DS} temperature coefficient	$\Delta V_{DS}/T_J$	Reference to 25 °C, I_D = 1 mA		-	0.59	-	V/°C
Gate-source threshold Voltage (N)	$V_{GS(th)}$	V_{DS} = V_{GS}, I_D = 250 μA		2.0	-	4.0	V
Gate-source leakage	I_{GSS}	V_{GS} = ± 20 V		-	-	± 100	nA
		V_{GS} = ± 30 V		-	-	± 1	μA
Zero gate voltage drain current	I_{DSS}	V_{DS} = 480 V, V_{GS} = 0 V		-	-	1	μA
		V_{DS} = 480 V, V_{GS} = 0 V, T_J = 125 °C		-	-	500	
Drain-source on-state resistance	$R_{DS(on)}$	V_{GS} = 10 V	I_D = 11 A	-	0.153	0.176	Ω
Forward transconductance	g_{fs}	V_{DS} = 30 V, I_D = 11 A		-	7	-	S
Dynamic							
Input capacitance	C_{iss}	V_{GS} = 0 V, V_{DS} = 100 V, f = 1 MHz		-	2030	-	pF
Output capacitance	C_{oss}			-	105	-	
Reverse transfer capacitance	C_{rss}			-	5	-	
Effective output capacitance, energy related [a]	$C_{o(er)}$	V_{GS} = 0 V, V_{DS} = 0 V to 480 V		-	86	-	
Effective output capacitance, time related [b]	$C_{o(tr)}$			-	299	-	
Total gate charge	Q_g	V_{GS} = 10 V	I_D = 11 A, V_{DS} = 480 V	-	56	84	nC
Gate-source charge	Q_{gs}			-	14	-	
Gate-drain charge	Q_{gd}			-	24	-	
Turn-on delay time	$t_{d(on)}$	V_{DD} = 480 V, I_D = 11 A, R_g = 9.1 Ω, V_{GS} = 10 V		-	21	42	ns
Rise time	t_r			-	31	62	
Turn-off delay time	$t_{d(off)}$			-	59	89	
Fall time	t_f			-	27	54	
Gate input resistance	R_g	f = 1 MHz, open drain		0.2	0.56	1.2	Ω
Drain-Source Body Diode Characteristics							
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}			-	-	53	
Diode forward voltage	V_{SD}	T_J = 25 °C, I_S = 11 A, V_{GS} = 0 V		-	0.9	1.2	V
Reverse recovery time	t_{rr}	T_J = 25 °C, I_F = I_S = 11 A, dI/dt = 100 A/μs, V_R = 400 V		-	135	270	ns
Reverse recovery charge	Q_{rr}			-	0.76	1.52	μC
Reverse recovery current	I_{RRM}			-	11	-	A

Notes

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

f. $C_{oss(tr)}$ 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)

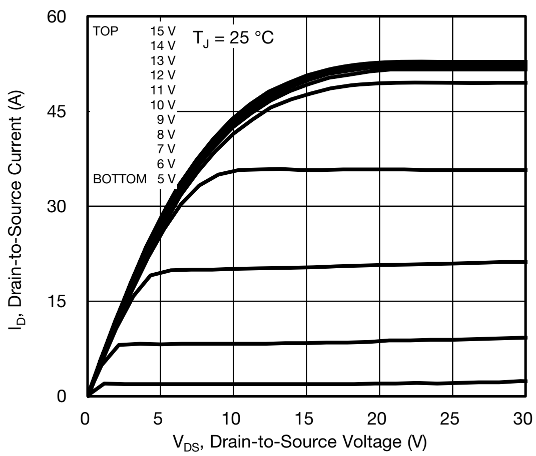


Fig. 1 - Typical Output Characteristics, T_J = 25 °C

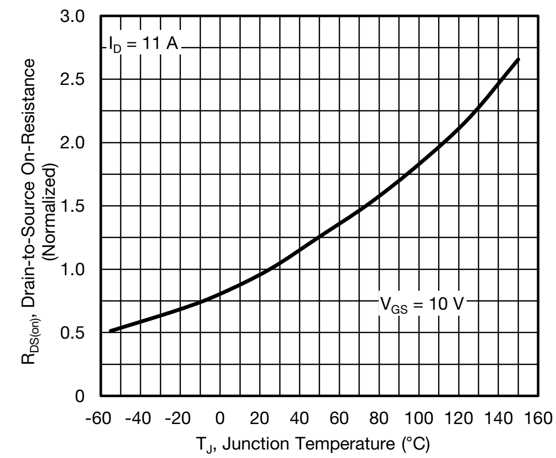


Fig. 4 - Normalized On-Resistance vs. Temperature

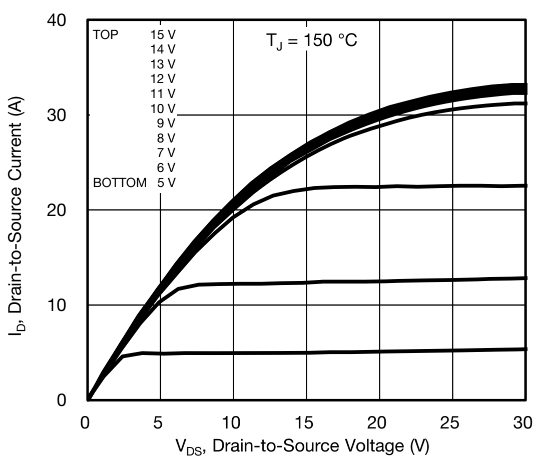


Fig. 2 - Typical Output Characteristics, T_J = 150 °C

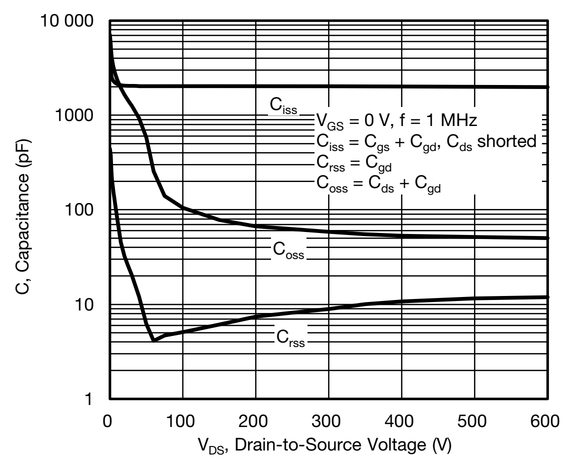


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

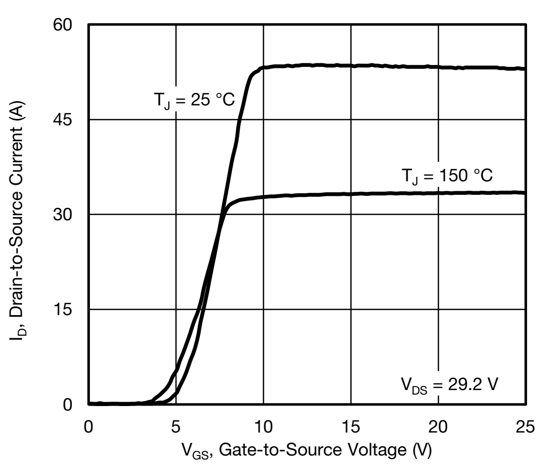


Fig. 3 - Typical Transfer Characteristics

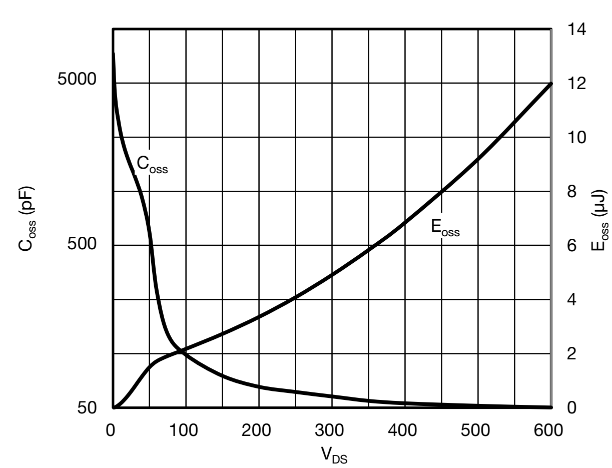


Fig. 6 - C_{oss} and E_{oss} vs. V_{DS}

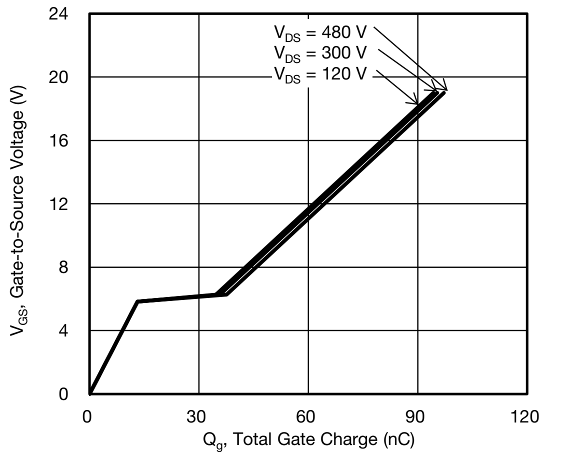


Fig. 7 - Typical Gate Charge vs. Gate-to-Source Voltage

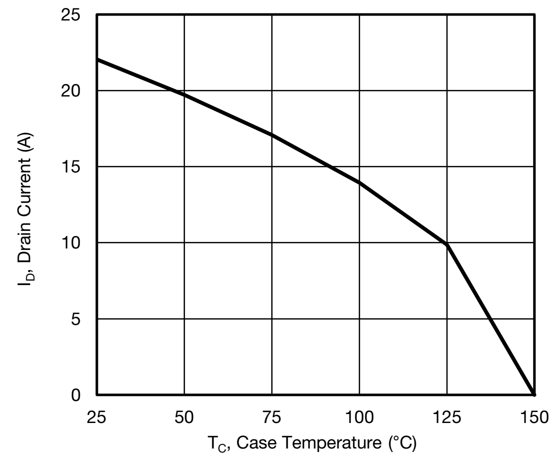


Fig. 10 - Maximum Drain Current vs. Case Temperature

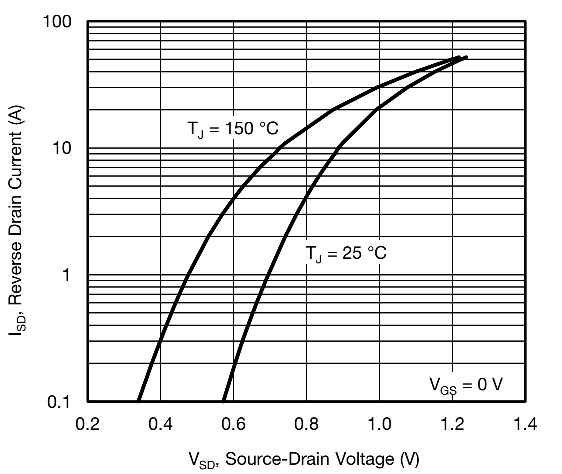


Fig. 8 - Typical Source-Drain Diode Forward Voltage

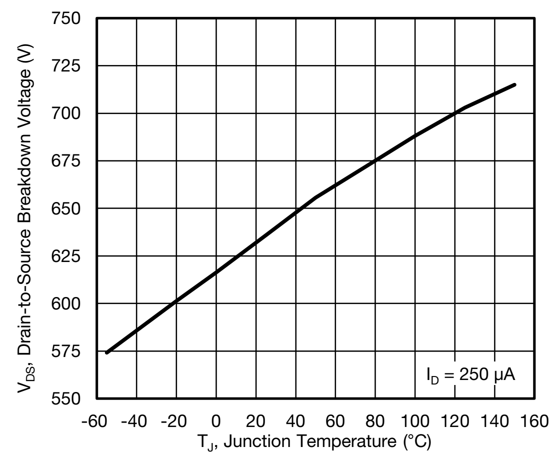


Fig. 11 - Typical Drain-to-Source Voltage vs. Temperature

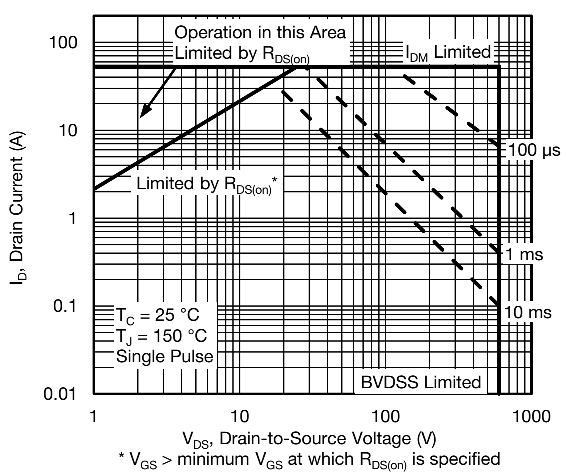


Fig. 9 - Maximum Safe Operating Area

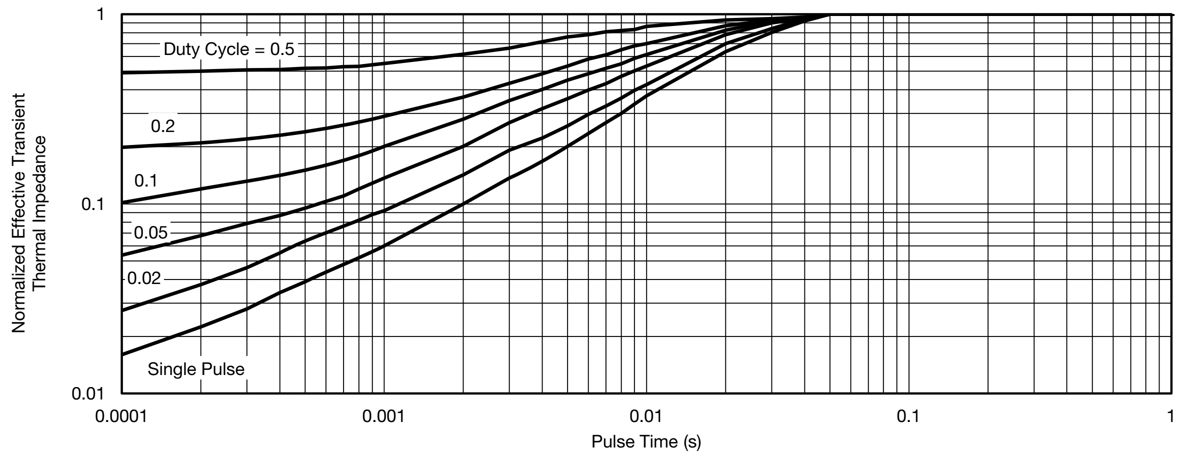


Fig. 12 - Normalized Thermal Transient Impedance, Junction-to-Case

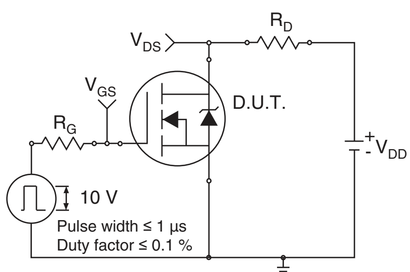


Fig. 13 - Switching Time Test Circuit

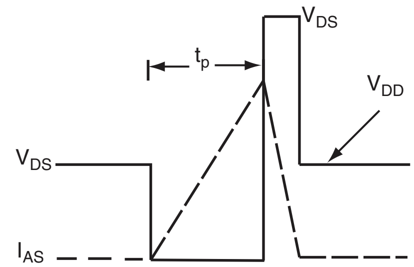


Fig. 16 - Unclamped Inductive Waveforms

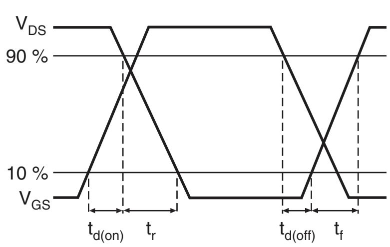


Fig. 14 - Switching Time Waveforms

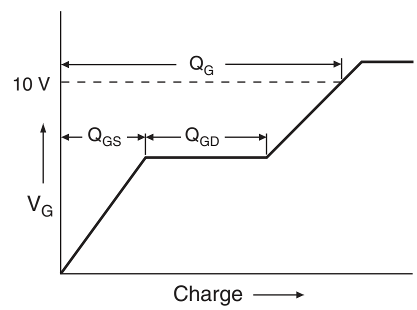


Fig. 17 - Basic Gate Charge Waveform

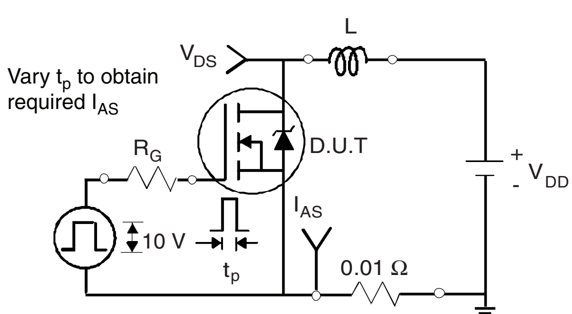


Fig. 15 - Unclamped Inductive Test Circuit

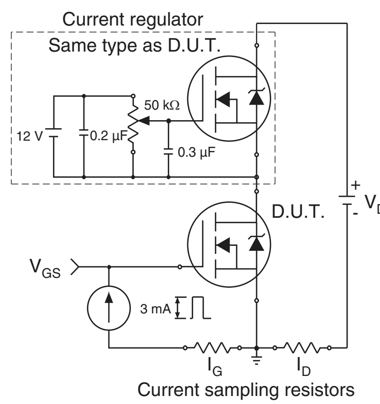
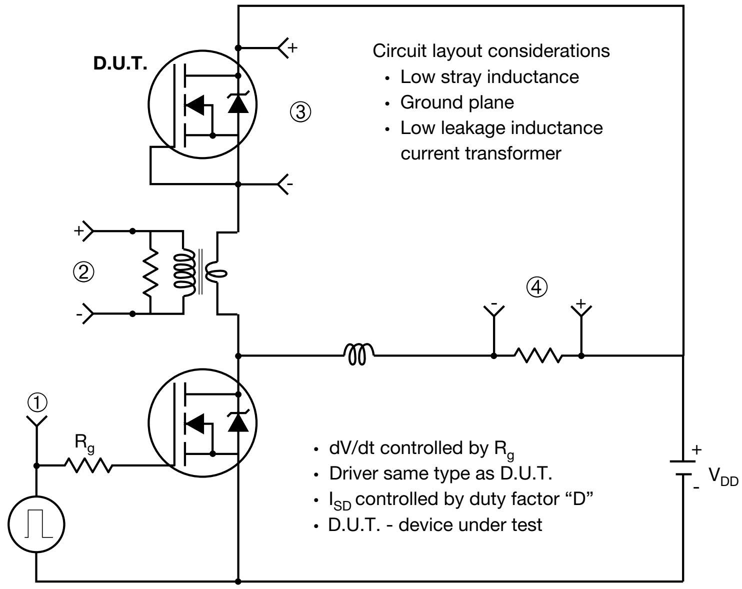
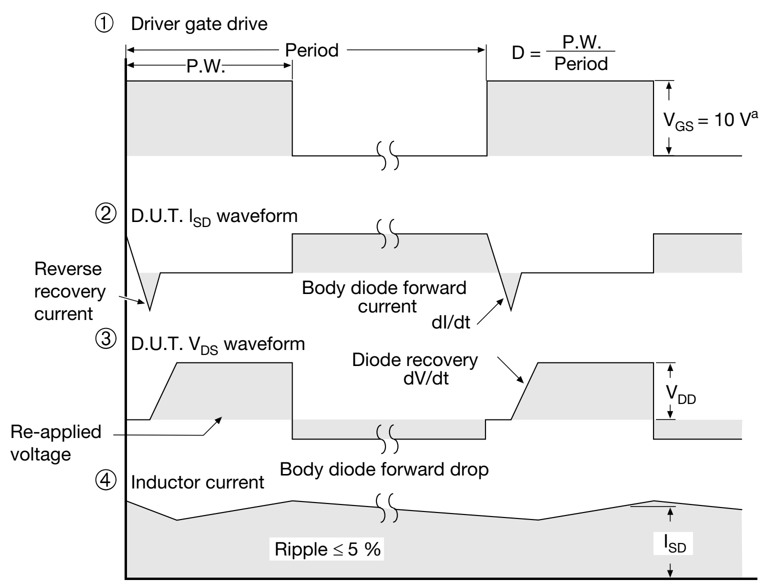


Fig. 18 - Gate Charge Test Circuit

Peak Diode Recovery dV/dt Test Circuit



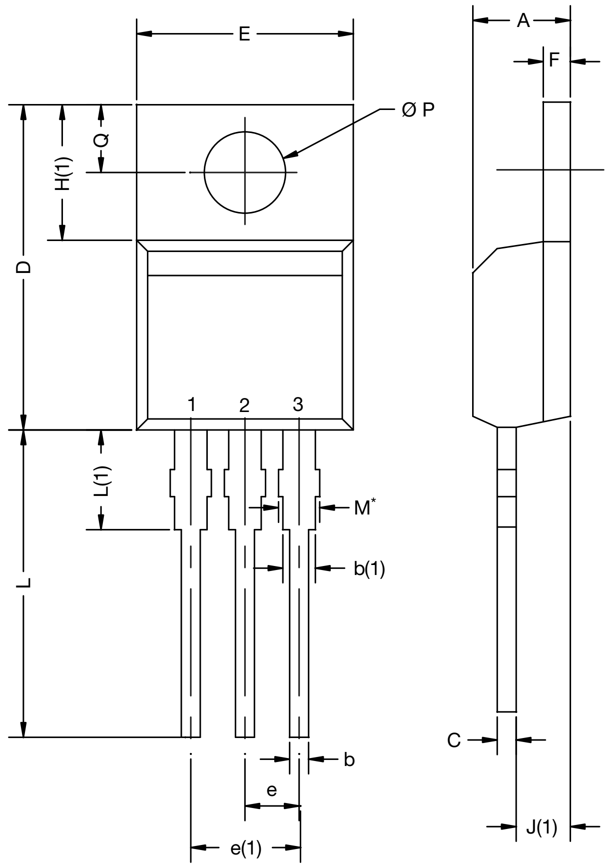


Note

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

Fig. 19 - For N-Channel

TO-220-1



DIM.	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	4.24	4.65	0.167	0.183
b	0.69	1.02	0.027	0.040
b(1)	1.14	1.78	0.045	0.070
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	1.14	1.40	0.045	0.055
H(1)	6.10	6.71	0.240	0.264
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	2.54	3.00	0.100	0.118
ECN: E21-0621-Rev. D, 04-Nov-2021 DWG: 6031				

Note

- M* = 0.052 inches to 0.064 inches (dimension including protrusion), heatsink hole for HVM

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