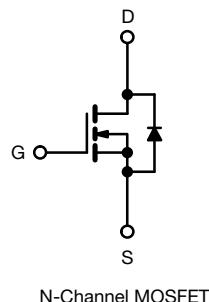


EF Series Power MOSFET With Fast Body Diode

Thin-Lead TO-220 FULLPAK

PRODUCT SUMMARY

V_{DS} (V) at T_J max.	650	
$R_{DS(on)}$ typ. (Ω) at 25 °C	$V_{GS} = 10$ V	0.168
Q_g max. (nC)	32	
Q_{gs} (nC)	7	
Q_{gd} (nC)	7	
Configuration	Single	

FEATURES

- 4th generation E series technology
- Low figure-of-merit (FOM) $R_{on} \times Q_g$
- Low effective capacitance ($C_{o(er)}$)
- Reduced switching and conduction losses
- Avalanche energy rated (UIS)
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912



RoHS
COMPLIANT
HALOGEN
FREE

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
 - Solar (PV inverters)

ORDERING INFORMATION

Package	Thin-Lead TO-220 FULLPAK	
Lead (Pb)-free and halogen-free	SIHA186N60EF-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) ^e	V_{GS} at 10 V	8.4	A
		5.3	
Pulsed drain current ^a	I_{DM}	43	
Linear derating factor		0.26	W/°C
Single pulse avalanche energy ^b	E_{AS}	24	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	$T_J = 125$ °C	100	V/ns
Reverse diode dv/dt ^d		50	
Soldering recommendations (peak temperature) ^c	For 10 s	260	°C
Mounting torque	M3 screw	0.6	Nm

Notes

- Repetitive rating; pulse width limited by maximum junction temperature
- $V_{DD} = 120$ V, starting $T_J = 25$ °C, $L = 28.2$ mH, $R_g = 25$ Ω, $I_{AS} = 1.3$ A
- 1.6 mm from case
- $I_{SD} \leq I_D$, $di/dt = 700$ A/μs, starting $T_J = 25$ °C
- Limited by maximum junction temperature

THERMAL RESISTANCE RATINGS

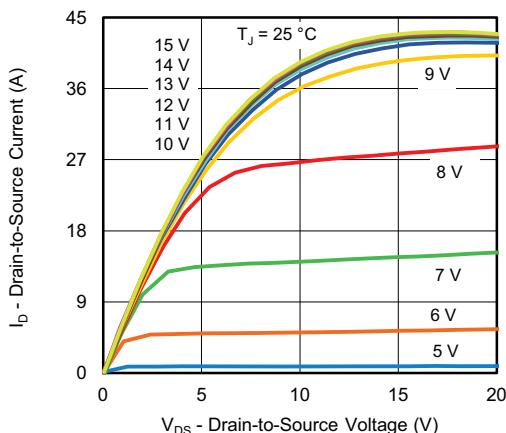
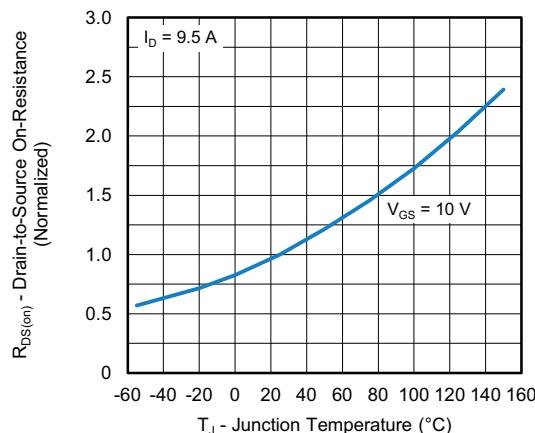
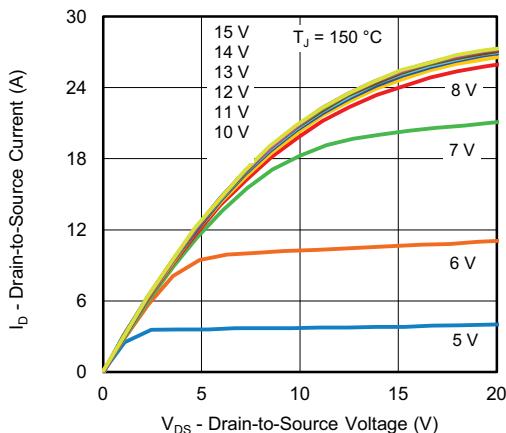
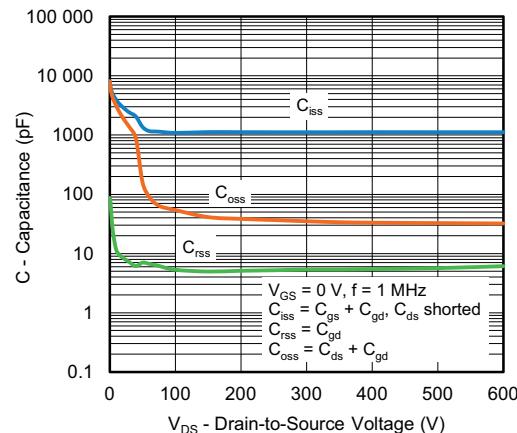
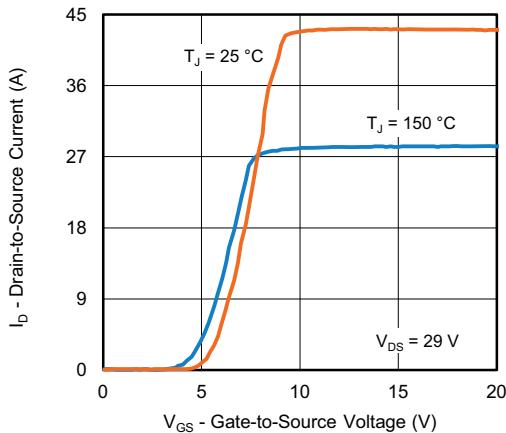
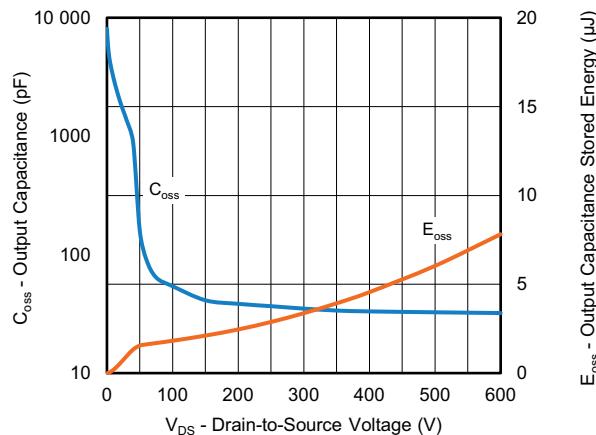
PARAMETER	SYMBOL	TYP.	MAX.	UNIT
Maximum junction-to-ambient	R_{thJA}	-	65	
Maximum junction-to-case (drain)	R_{thJC}	-	3.8	°C/W

SPECIFICATIONS (T_J = 25 °C, unless otherwise noted)

PARAMETER	SYMBOL	TEST CONDITIONS		MIN.	TYP.	MAX.	UNIT
Static							
Drain-source breakdown voltage	V_{DS}	$V_{GS} = 0 \text{ V}$, $I_D = 250 \mu\text{A}$		600	-	-	V
V_{DS} temperature coefficient	$\Delta V_{DS}/T_J$	Reference to 25 °C, $I_D = 1 \text{ mA}$		-	0.69	-	V/°C
Gate-source threshold voltage (N)	$V_{GS(th)}$	$V_{DS} = V_{GS}$, $I_D = 250 \mu\text{A}$		3.0	-	5.0	V
Gate-source leakage	I_{GSS}	$V_{GS} = \pm 20 \text{ V}$		-	-	± 100	nA
		$V_{GS} = \pm 30 \text{ V}$		-	-	± 1	μA
Zero gate voltage drain current	I_{DSS}	$V_{DS} = 480 \text{ V}$, $V_{GS} = 0 \text{ V}$		-	-	1	μA
		$V_{DS} = 480 \text{ V}$, $V_{GS} = 0 \text{ V}$, $T_J = 125 \text{ °C}$		-	-	2	mA
Drain-source on-state resistance	$R_{DS(on)}$	$V_{GS} = 10 \text{ V}$	$I_D = 9.5 \text{ A}$	-	0.168	0.193	Ω
Forward transconductance ^a	g_{fs}	$V_{DS} = 20 \text{ V}$, $I_D = 9.5 \text{ A}$		-	5.4	-	S
Dynamic							
Input capacitance	C_{iss}	$V_{GS} = 0 \text{ V}$, $V_{DS} = 100 \text{ V}$, $f = 1 \text{ MHz}$		-	1081	-	pF
Output capacitance	C_{oss}			-	52	-	
Reverse transfer capacitance	C_{rss}			-	5	-	
Effective output capacitance, energy related ^a	$C_{o(er)}$	$V_{DS} = 0 \text{ V}$ to 480 V, $V_{GS} = 0 \text{ V}$		-	40	-	pF
Effective output capacitance, time related ^b	$C_{o(tr)}$			-	247	-	
Total gate charge	Q_g			-	21	32	nC
Gate-source charge	Q_{gs}	$V_{GS} = 10 \text{ V}$	$I_D = 9.5 \text{ A}$, $V_{DS} = 480 \text{ V}$	-	7	-	
Gate-drain charge	Q_{gd}			-	7	-	
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 480 \text{ V}$, $I_D = 9.5 \text{ A}$, $V_{GS} = 10 \text{ V}$, $R_g = 9.1 \Omega$		-	14	28	ns
Rise time	t_r			-	23	46	
Turn-off delay time	$t_{d(off)}$			-	25	50	
Fall time	t_f			-	16	32	
Gate input resistance	R_g	$f = 1 \text{ MHz}$, open drain		0.3	0.7	1.4	Ω
Drain-Source Body Diode Characteristics							
Continuous source-drain diode current	I_S	MOSFET symbol showing the integral reverse p - n junction diode		-	-	18	A
Pulsed diode forward current	I_{SM}			-	-	43	
Diode forward voltage	V_{SD}	$T_J = 25 \text{ °C}$, $I_S = 9.5 \text{ A}$, $V_{GS} = 0 \text{ V}$		-	-	1.2	V
Reverse recovery time	t_{rr}	$T_J = 25 \text{ °C}$, $I_F = I_S = 9.5 \text{ A}$, $di/dt = 100 \text{ A}/\mu\text{s}$, $V_R = 400 \text{ V}$		-	111	222	ns
Reverse recovery charge	Q_{rr}			-	0.6	1.2	μC
Reverse recovery current	I_{RRM}			-	10	-	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 - C_{oss} and E_{oss} vs. V_{DS}

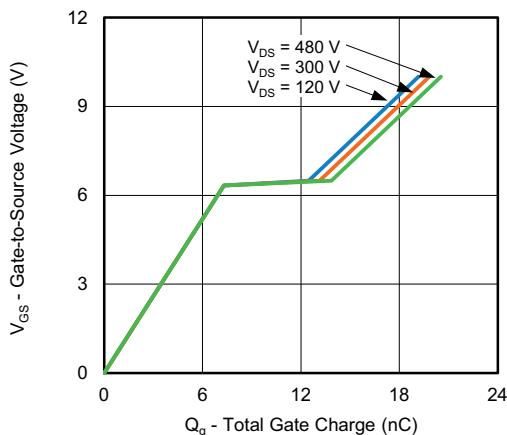


Fig. 7 - Typical Gate Charge vs. Gate-to-Source Voltage

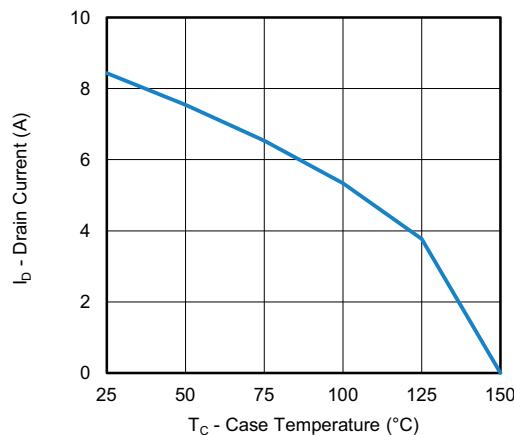


Fig. 10 - Maximum Drain Current vs. Case Temperature

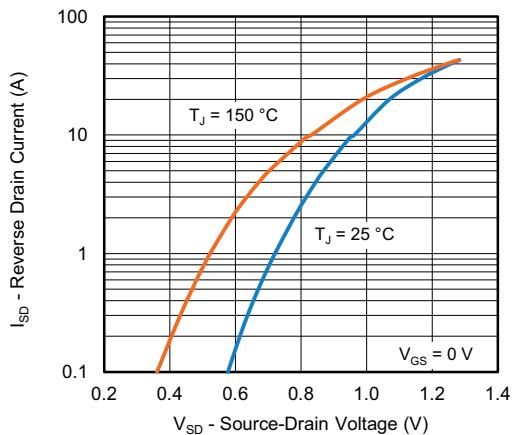


Fig. 8 - Typical Source-Drain Diode Forward Voltage

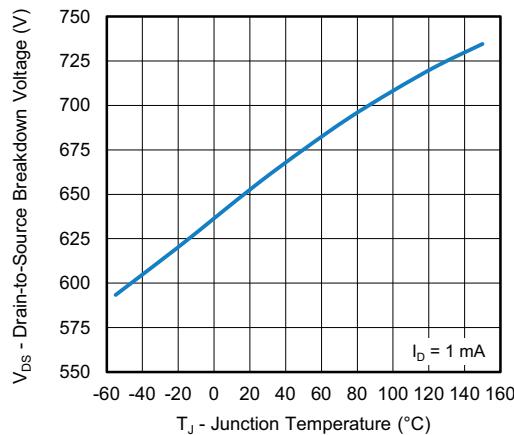


Fig. 11 - Temperature vs. Drain-to-Source Voltage

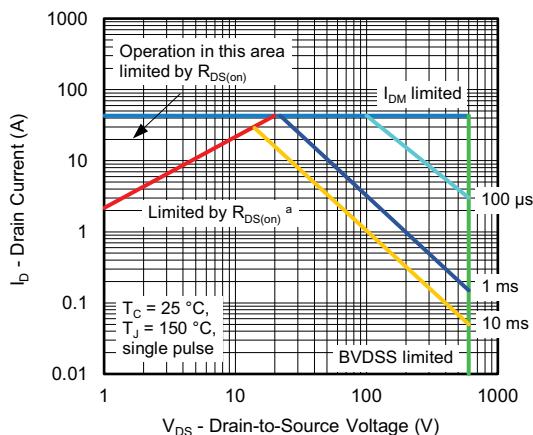


Fig. 9 - Maximum Safe Operating Area

Note

a. $V_{GS} >$ minimum V_{GS} at which $R_{DS(on)}$ is specified

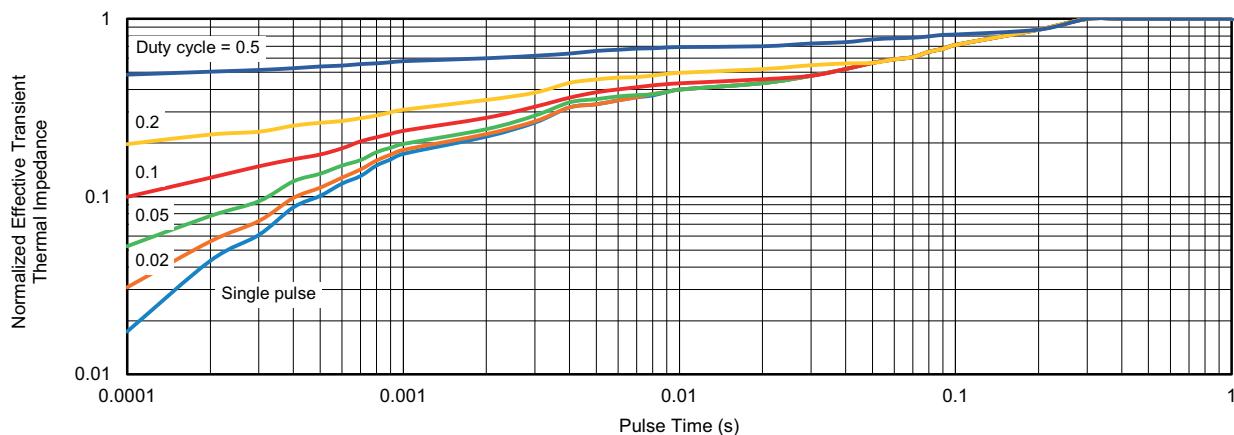


Fig. 12 - Normalized Transient Thermal Impedance, Junction-to-Case

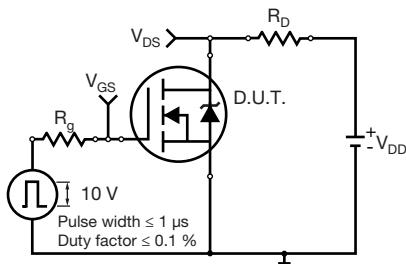


Fig. 13 - Switching Time Test Circuit

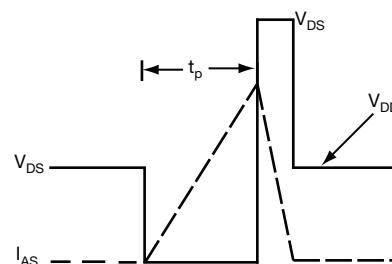


Fig. 16 - Unclamped Inductive Waveforms

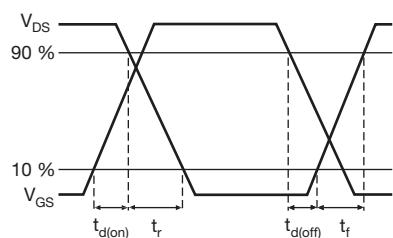


Fig. 14 - Switching Time Waveforms

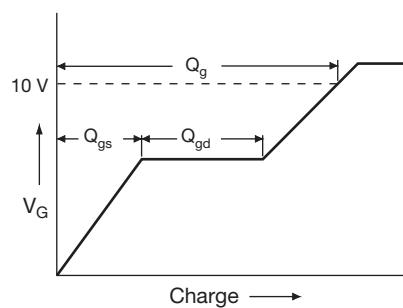


Fig. 17 - Basic Gate Charge Waveform

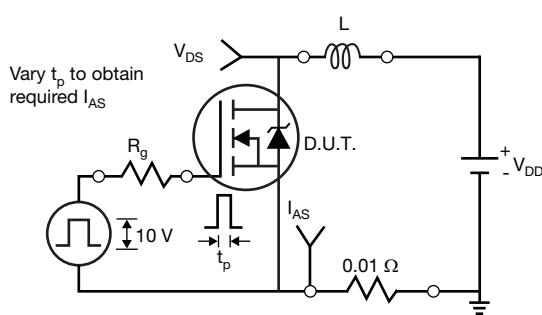


Fig. 15 - Unclamped Inductive Test Circuit

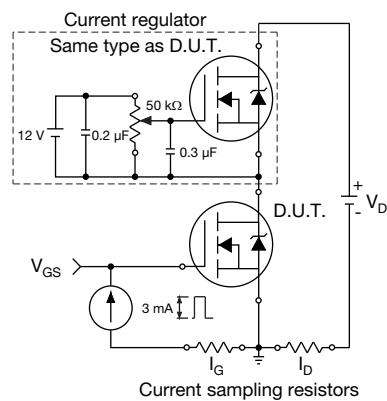


Fig. 18 - Gate Charge Test Circuit

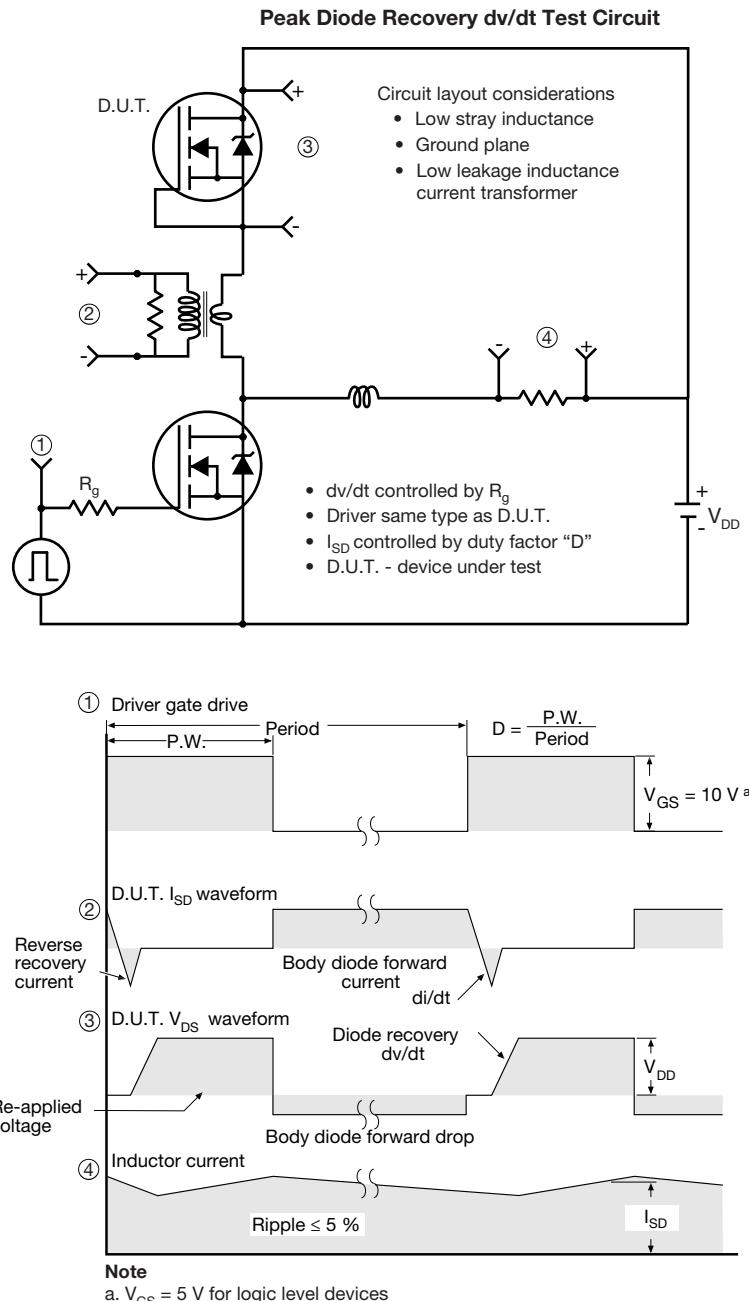
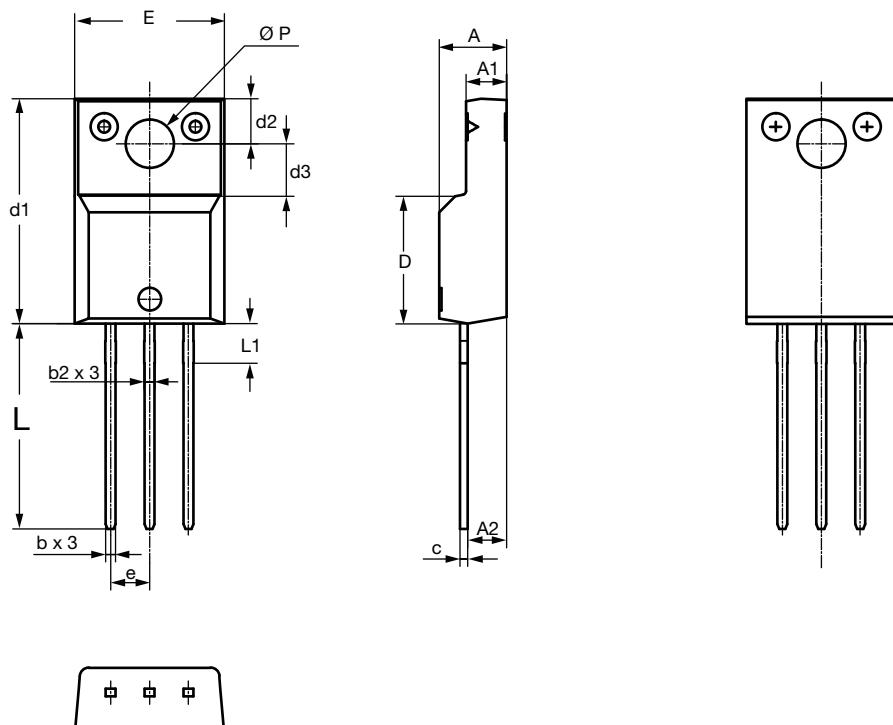


Fig. 19 - For N-Channel

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TO-220 FULLPAK Thin Lead



SYMBOL	DIMENSIONS			
	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	4.30	4.70	0.169	0.185
A1	2.50	2.90	0.098	0.114
A2	2.40	2.80	0.094	0.110
b	0.60	0.80	0.024	0.031
b2	0.60	0.90	0.024	0.035
c	-	0.60	-	0.024
D	8.30	8.70	0.327	0.342
d1	14.70	15.30	0.579	0.602
d2	2.90	3.10	0.114	0.122
d3	3.30	3.70	0.130	0.146
E	9.70	10.30	0.382	0.406
e	2.50	2.70	0.098	0.106
L	13.40	13.80	0.528	0.543
L1	1.00	2.80	0.039	0.110
Ø P	3.00	3.40	0.118	0.134

ECN: E20-0684-Rev. D, 28-Dec-2020
DWG: 6021

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