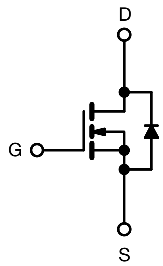
E Series Power MOSFET with Fast Body Diode

Thin-Lead TO-220 FULLPAK



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})
- 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

RoHS COMPLIANT
HALOGEN FREE Available

APPLICATIONS

- Telecommunications
  - Server and telecom power supplies
- Lighting
  - High-intensity discharge (HID)
  - Fluorescent ballast lighting
- Consumer and computing
  - ATX power supplies
- Industrial
  - Welding
  - Battery chargers
- Renewable energy
  - Solar (PV inverters)
- Switch mode power supplies (SMPS)
- Applications using the following topologies
  - LCC
  - Phase shifted bridge (ZVS)
  - 3-level inverter
  - AC/DC bridge

PRODUCT SUMMARY		
V_{DS} (V) at T_J max.	700	
$R_{DS(on)}$ max. (Ω) at 25 °C	V_{GS} = 10 V	0.18
Q_g max. (nC)	106	
Q_{gs} (nC)	14	
Q_{gd} (nC)	33	
Configuration	Single	

ORDERING INFORMATION	
Package	Thin-Lead TO-220 FULLPAK
Lead (Pb)-free	SiHA21N65EF-E3
Lead (Pb)-free and halogen-free	SiHA21N65EF-GE3

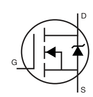
ABSOLUTE MAXIMUM RATINGS (T_C = 25 °C, unless otherwise noted)

PARAMETER			SYMBOL	LIMIT	UNIT
Drain-source voltage			V_{DS}	650	V
Gate-source voltage			V_{GS}	± 30	
Continuous drain current (T_J = 150 °C) [e]	V_{GS} at 10 V	T_C = 25 °C	I_D	21	A
		T_C = 100 °C		13	
Pulsed drain current [a]			I_{DM}	53	
Linear derating factor				0.28	W/°C
Single pulse avalanche energy [b]			E_{AS}	367	mJ
Maximum power dissipation			P_D	35	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	37	V/ns
Reverse diode dV/dt [d]				31	
Soldering recommendations (peak temperature) [c]	for 10 s			300	°C
Mounting torque	M3 screw			0.6	Nm

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 = 100 A/μs, starting T_J = 25 °C
e. Limited by maximum junction temperature

THERMAL RESISTANCE RATINGS				
PARAMETER	SYMBOL	TYP.	MAX.	UNIT
Maximum junction-to-ambient	R_{thJA}	-	65	°C/W
Maximum junction-to-case (drain)	R_{thJC}	-	3.6	

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	650	-	-	V
V_{DS} temperature coefficient	$\Delta V_{DS}/T_J$	Reference to 25 °C, I_D = 1 mA	-	0.67	-	V/°C
Gate-source threshold voltage (N)	$V_{GS(th)}$	V_{DS} = V_{GS}, I_D = 250 μA	2	-	4	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} = 520 V, V_{GS} = 0 V	-	-	1	μA
		V_{DS} = 520 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	-	0.15	0.18	Ω
Forward transconductance	g_{fs}	V_{DS} = 30 V, I_D = 11 A	-	7.0	-	S
Dynamic						
Input capacitance	C_{iss}	V_{GS} = 0 V, V_{DS} = 100 V, f = 1 MHz	-	2322	-	pF
Output capacitance	C_{oss}		-	105	-	
Reverse transfer capacitance	C_{rss}		-	4	-	
Effective output capacitance, energy related [a]	$C_{o(er)}$	V_{DS} = 0 V to 520 V, V_{GS} = 0 V	-	84	-	
Effective output capacitance, time related [b]	$C_{o(tr)}$		-	293	-	
Total gate charge	Q_g	V_{GS} = 10 V, I_D = 11 A, V_{DS} = 520 V	-	71	106	nC
Gate-source charge	Q_{gs}		-	14	-	
Gate-drain charge	Q_{gd}		-	33	-	
Turn-on delay time	$t_{d(on)}$	V_{DD} = 520 V, I_D = 11 A, V_{GS} = 10 V, R_g = 9.1 Ω	-	22	44	ns
Rise time	t_r		-	34	68	
Turn-off delay time	$t_{d(off)}$		-	68	102	
Fall time	t_f		-	42	84	
Gate input resistance	R_g	f = 1 MHz, open drain	-	0.78	-	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 = 25 V	-	160	-	ns
Reverse recovery charge	Q_{rr}		-	1.2	-	μC
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_{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)

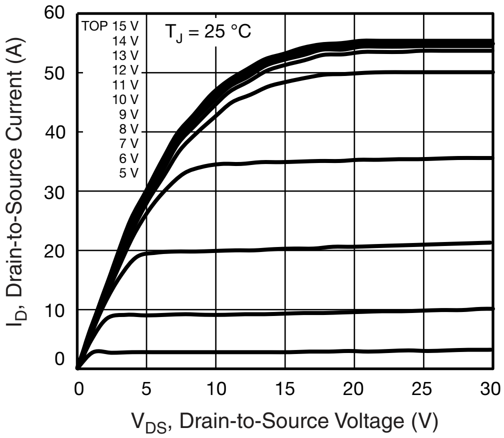


Fig. 1 - Typical Output Characteristics

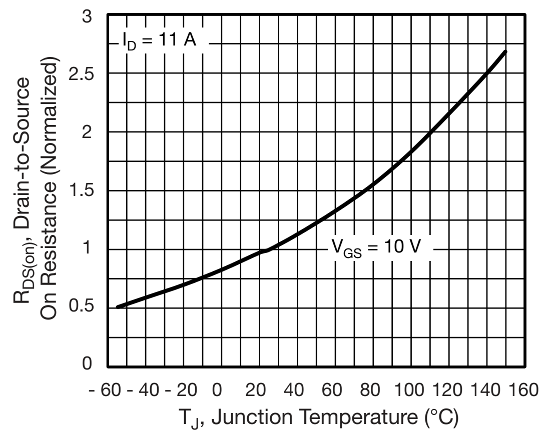


Fig. 4 - Normalized On-Resistance vs. Temperature

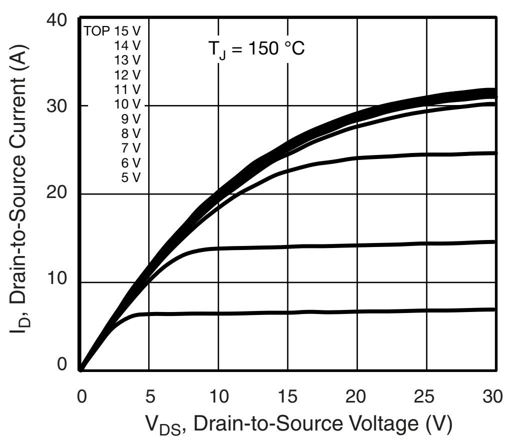


Fig. 2 - Typical Output Characteristics

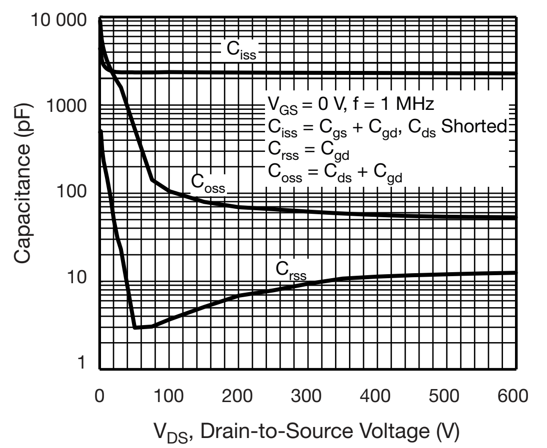


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

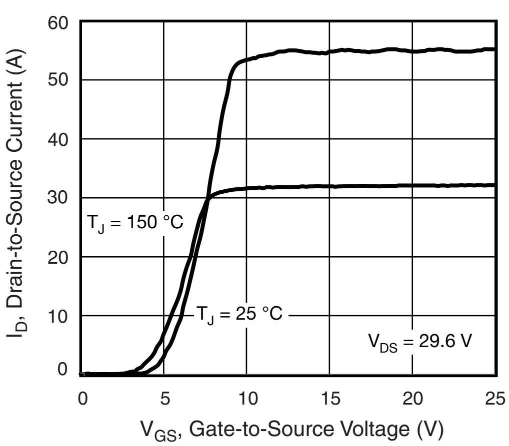


Fig. 3 - Typical Transfer Characteristics

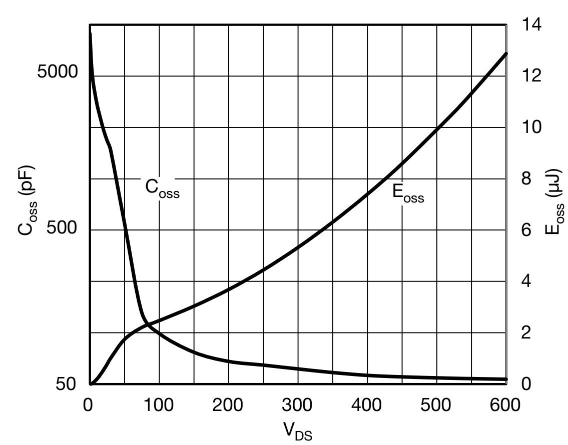


Fig. 6 - C_{oss} and E_{oss} vs. V_{DS}

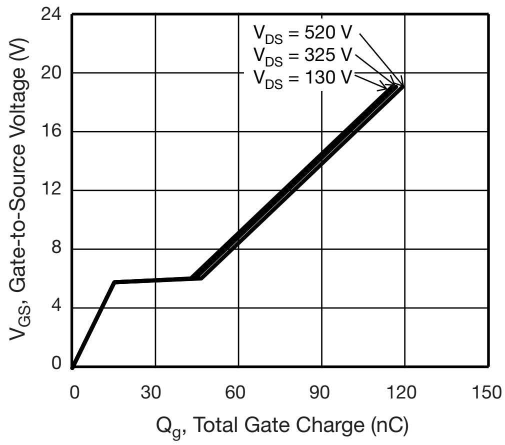


Fig. 7 - Typical Gate Charge vs. Gate-to-Source Voltage

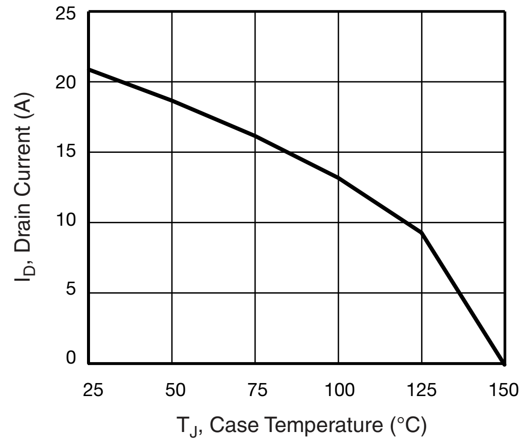


Fig. 10 - Maximum Drain Current vs. Case Temperature

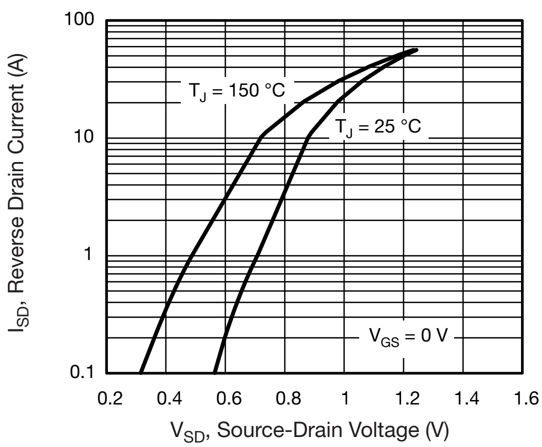


Fig. 8 - Typical Source-Drain Diode Forward Voltage

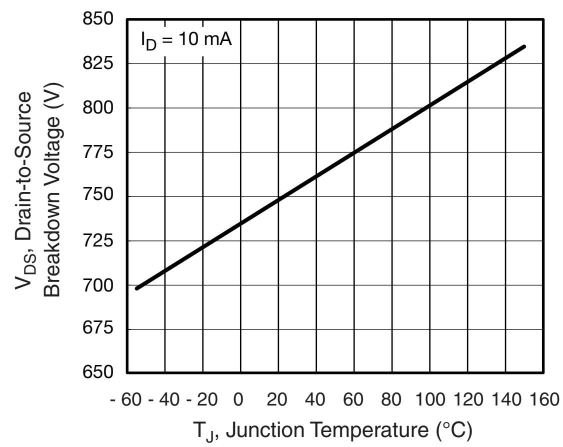
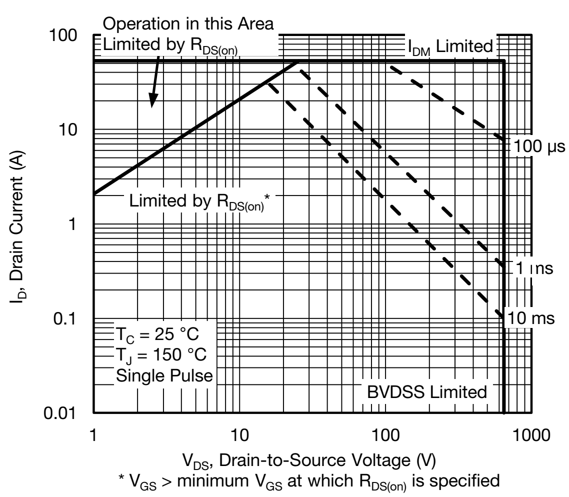


Fig. 11 - Temperature vs. Drain-to-Source Voltage



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

Fig. 9 - Maximum Safe Operating Area

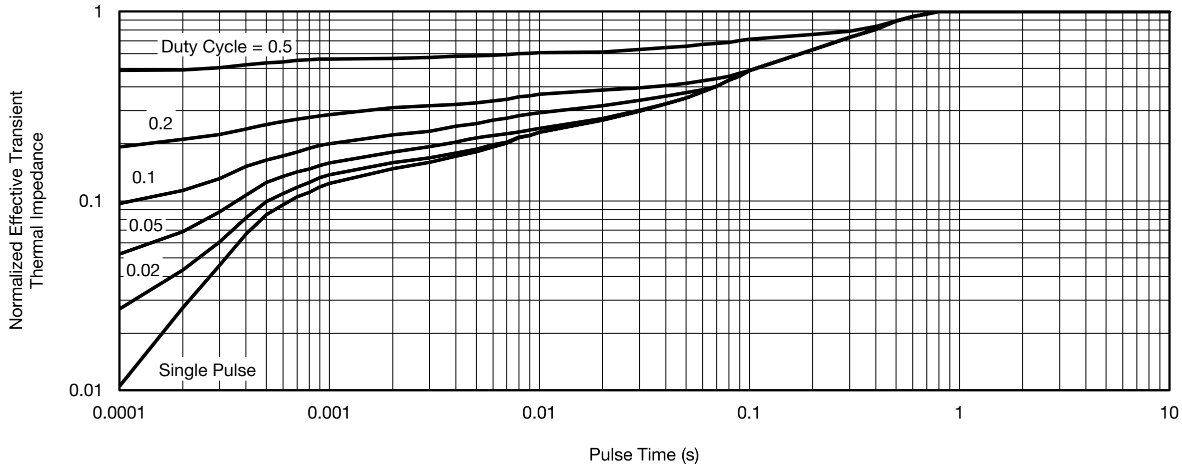


Fig. 12 - Normalized Thermal Transient Impedance, Junction-to-Case

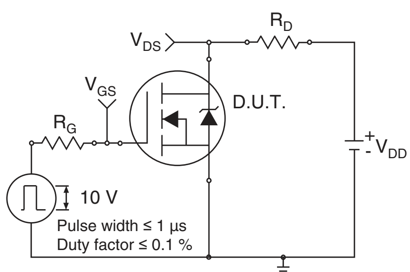


Fig. 13 - Switching Time Test Circuit

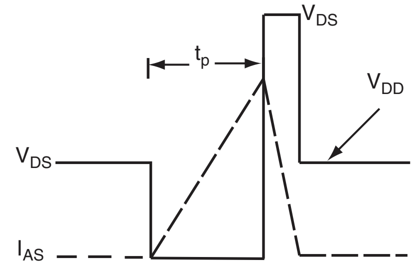


Fig. 16 - Unclamped Inductive Waveforms

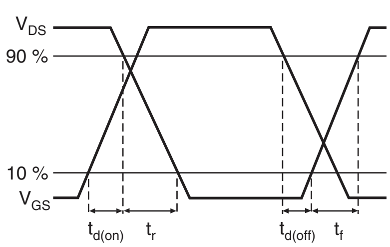


Fig. 14 - Switching Time Waveforms

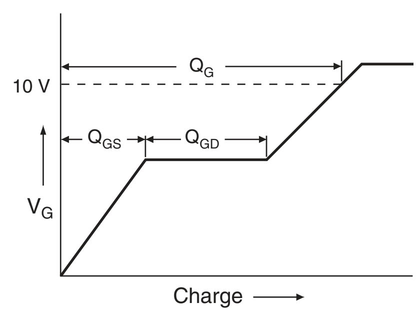


Fig. 17 - Basic Gate Charge Waveform

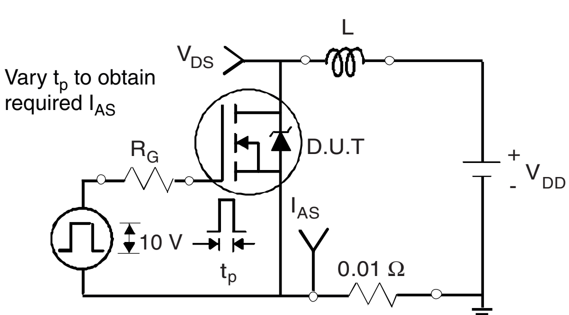


Fig. 15 - Unclamped Inductive Test Circuit

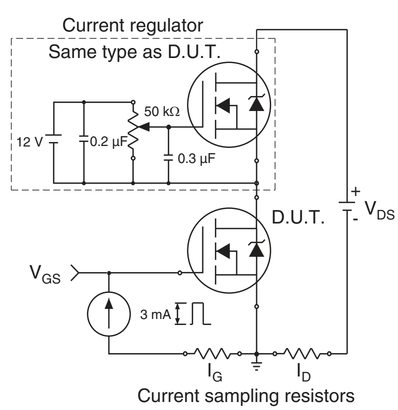
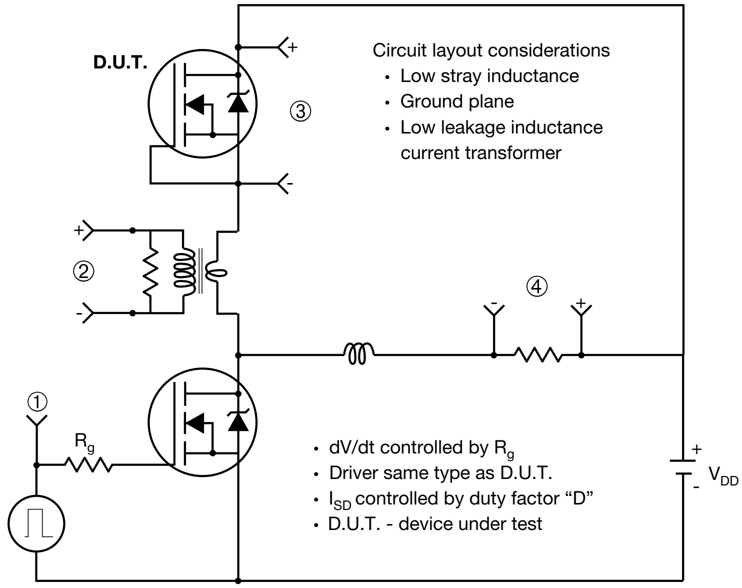
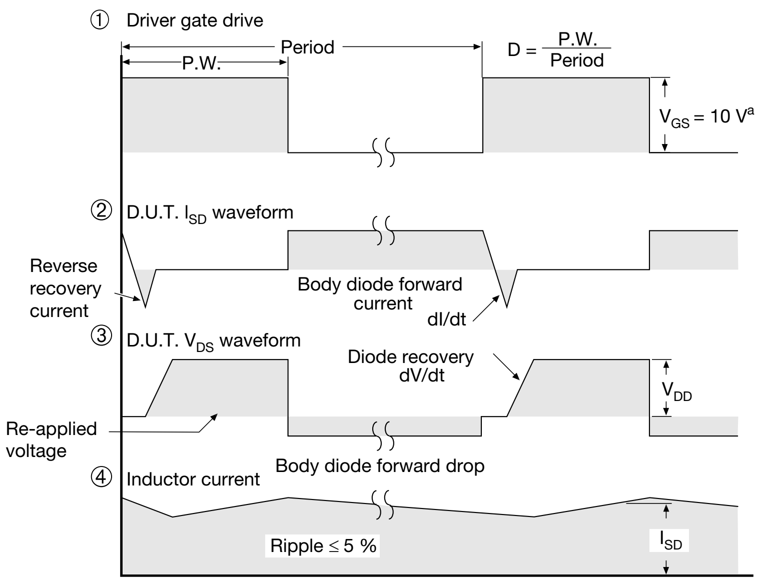


Fig. 18 - Gate Charge Test Circuit

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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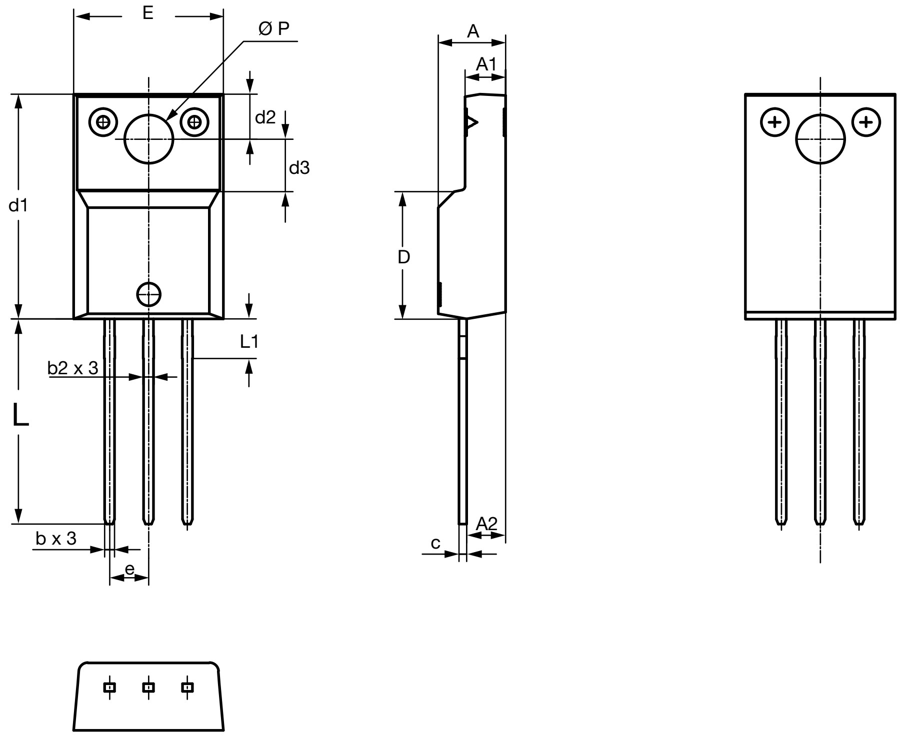
TO-220 FULLPAK Thin Lead



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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