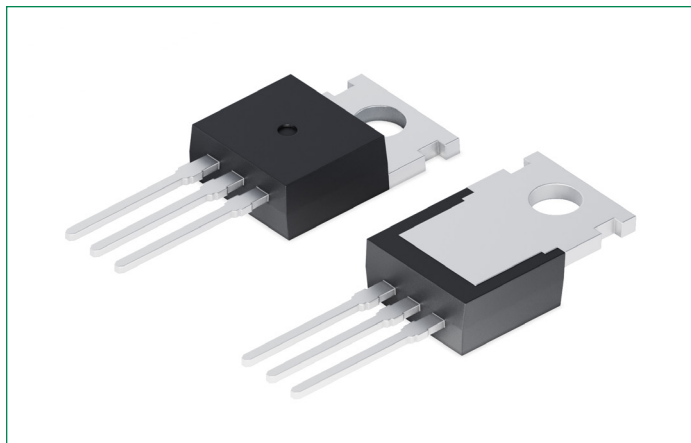


# IOTP86N20X4

## 200 V, 13 mΩ X4-Class Power MOSFET™



### Features:

- International Standard Package
- Low  $R_{DS(on)}$  and  $Q_G$
- Avalanche Rated
- Low Package Inductance

### Advantages:

- High Power Density
- Easy to Mount
- Space Savings

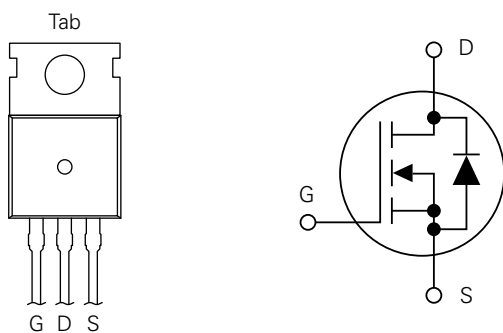
### Applications:

- Switch-Mode and Resonant-Mode Power Supplies
- DC-DC Converters
- PFC Circuits
- AC and DC Motor Drives
- Robotics and Servo Controls

### Product Summary

Characteristic	Value	Unit
$V_{DSS}$	200	V
$I_{D25}$	86	A
$R_{DS(on)}$	13	mΩ

### Pinout Diagram (TO-220-3L)



**G:** Gate; **D:** Drain; **S:** Source; **Tab:** Drain

## Maximum Ratings

Symbol	Characteristics	Conditions	Value	Units
$V_{DSS}$	Drain-Source Voltage	$T_J = 25^\circ\text{C}$ to $175^\circ\text{C}$	200	V
$V_{DGR}$	Drain-Gate Voltage	$T_J = 25^\circ\text{C}$ to $175^\circ\text{C}$ , $R_{GS} = 1\text{ M}\Omega$	200	V
$V_{GS}$	Gate-Source Voltage	Continuous	$\pm 20$	V
$V_{GSM}$		Transient	$\pm 30$	
$I_{D25}$	Drain Current	$T_C = 25^\circ\text{C}$	86	A
$I_{DM}$		$T_C = 25^\circ\text{C}$ , Pulse width limited by $T_{JM}$	160	
$I_A$	Avalanche Current	$T_C = 25^\circ\text{C}$	43	A
$E_{AS}$	Avalanche Energy	$T_C = 25^\circ\text{C}$	500	mJ
dV/dt	Reverse Diode dV/dt	$I_S \leq I_{DM}$ , $V_{DD} \leq V_{DSS}$ , $T_J \leq 150^\circ\text{C}$	50	V/ns
$P_D$	Power Dissipation	$T_C = 25^\circ\text{C}$	300	W
$T_J$	Operating Junction Temperature	–	-55 to +175	°C
$T_{JM}$	Maximum Junction Temperature	–	175	
$T_{stg}$	Storage Temperature	–	-55 to +175	
$T_L$	Lead Temperature for Soldering	1.6 mm (0.062 in.) from case for 10 s	300	°C
$M_D$	Mounting Torque	–	1.13 / 10	Nm/lb.in
W	Weight	–	3	g

## Thermal Characteristics

Symbol	Characteristic	Value			Unit
		Min.	Typ.	Max.	
$R_{th,JC}$	Thermal Resistance, junction-to-case	–	–	0.50	°C/W
$R_{th,CS}$	Thermal Resistance, case-to-sink	–	0.50	–	°C/W

## Electrical Characteristics – Static ( $T_J = 25^\circ\text{C}$ unless otherwise specified)

Symbol	Characteristic	Conditions	Value			Unit
			Min.	Typ.	Max.	
$BV_{DSS}$	Drain-Source Breakdown Voltage	$I_D = 250\ \mu\text{A}$ , $V_{GS} = 0\text{ V}$	200	–	–	V
$V_{GS(th)}$	Gate Threshold Voltage	$I_D = 250\ \mu\text{A}$ , $V_{DS} = V_{GS}$	2.5	–	4.5	V
$I_{GSS}$	Gate-Source Leakage Current	$V_{DS} = 0\text{ V}$ , $V_{GS} = \pm 20\text{ V}$	–	–	$\pm 100$	nA
$I_{DSS}$	Drain-Source Current	$V_{DS} = V_{DSS}$ , $V_{GS} = 0\text{ V}$	–	–	5	$\mu\text{A}$
		$V_{DS} = V_{DSS}$ , $V_{GS} = 0\text{ V}$ , $T_J = 150^\circ\text{C}$	–	–	300	$\mu\text{A}$
$R_{DS(on)}$	Drain-Source On-Resistance <sup>1</sup>	$V_{GS} = 10\text{ V}$ , $I_D = 0.5 \times I_{D25}$	–	11	13	m $\Omega$

**Note 1:** Pulse test,  $t \leq 300\ \mu\text{s}$ , duty cycle,  $d \leq 2\%$

**Electrical Characteristics – Dynamic** ( $T_J = 25^\circ\text{C}$  unless otherwise specified)

Symbol	Characteristic	Conditions	Value			Unit
			Min.	Typ.	Max.	
$g_{fs}$	Transconductance <sup>1</sup>	$V_{DS} = 10\text{ V}, I_D = 0.5 \times I_{D25}$	50	82	–	S
$R_{Gi}$	Gate Input Resistance	–	–	4.75	–	$\Omega$
$C_{iss}$	Input Capacitance	$V_{GS} = 0\text{ V}, V_{DS} = 25\text{ V}, f = 1\text{ MHz}$	–	2250	–	pF
$C_{oss}$	Output Capacitance		–	660	–	pF
$C_{rss}$	Reverse Transfer Capacitance		–	185	–	pF
$Q_{g(on)}$	Total Gate Charge	$V_{GS} = 10\text{ V}, V_{DS} = 0.5 \times V_{DSS},$ $I_D = 0.5 \times I_{D25}$	–	70	–	nC
$Q_{gs}$	Gate-Source Charge		–	20	–	
$Q_{gd}$	Gate-Drain Charge		–	38	–	
$t_{d(on)}$	Turn-on Delay Time	<b>Resistive Switching</b> $V_{GS} = 10\text{ V}, V_{DS} = 0.5 \times V_{DSS},$ $I_D = 0.5 \times I_{D25}, R_{G(ext)} = 10\ \Omega$	–	27	–	ns
$t_r$	Rise Time		–	38	–	
$t_{d(off)}$	Turn-off Delay Time		–	76	–	
$t_f$	Fall Time		–	35	–	

**Source-Drain Diode Characteristics** ( $T_J = 25^\circ\text{C}$  unless otherwise specified)

Symbol	Characteristic	Conditions	Value			Unit
			Min.	Typ.	Max.	
$I_S$	Continuous Diode Forward Current	$V_{GS} = 0\text{ V}$	–	–	86	A
$I_{SM}$	Diode Pulse Current	Repetitive, Pulse width limited by $T_{JM}$	–	–	344	A
$V_{SD}$	Diode Forward Voltage <sup>1</sup>	$I_F = I_S, V_{GS} = 0\text{ V}$	–	–	1.4	V
$t_{rr}$	Reverse Recovery Time	$I_F = 43\text{ A}, -di/dt = 200\text{ A}/\mu\text{s},$ $V_r = 100\text{ V}$	–	96	–	ns
$I_{rm}$	Reverse Recovery Charge		–	16.7	–	A
$Q_{rm}$	Reverse Recovery Current		–	0.8	–	$\mu\text{C}$

**Note 1:** Pulse test,  $t \leq 300\ \mu\text{s}$ , duty cycle,  $d \leq 2\%$

## Characteristic Curves

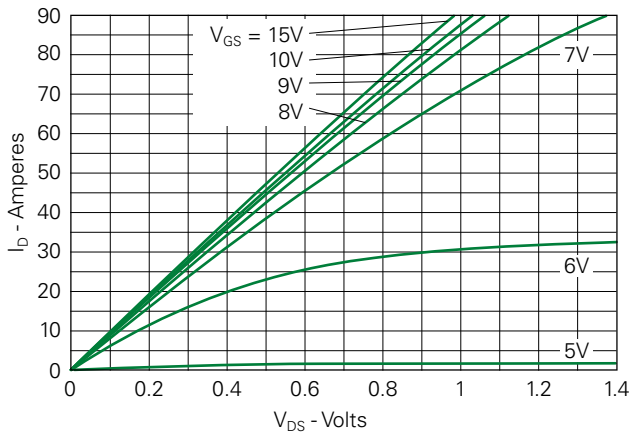
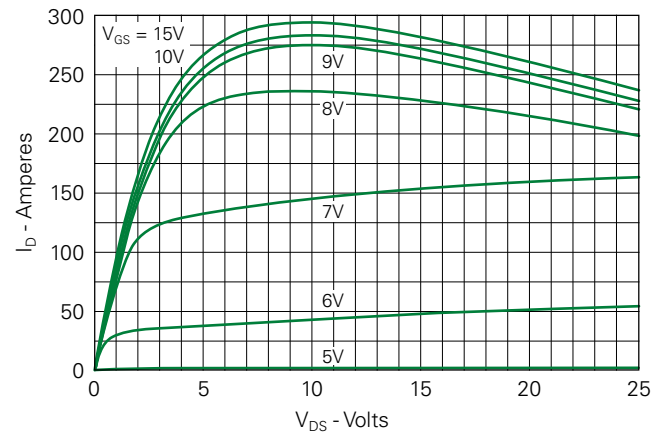
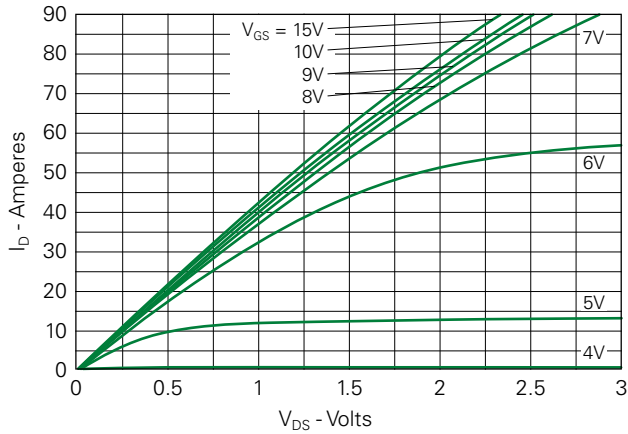
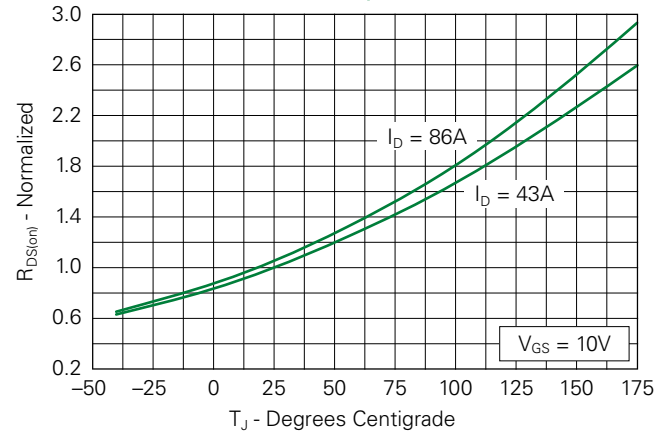
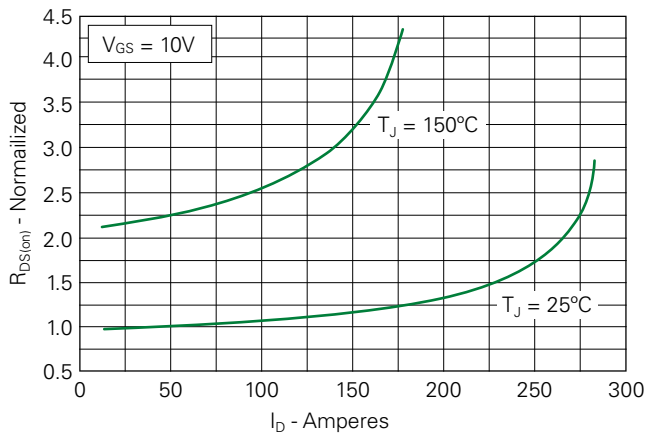
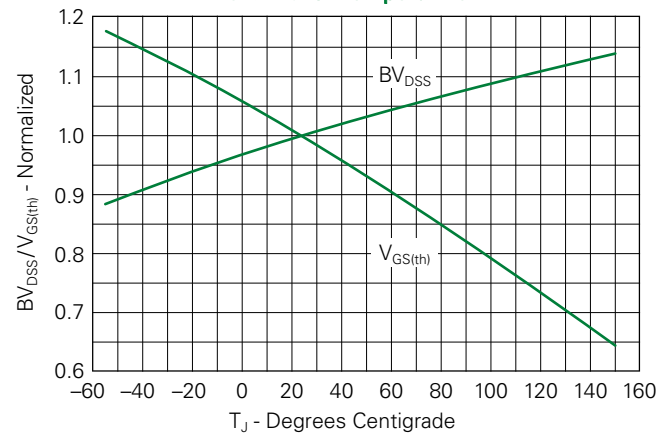
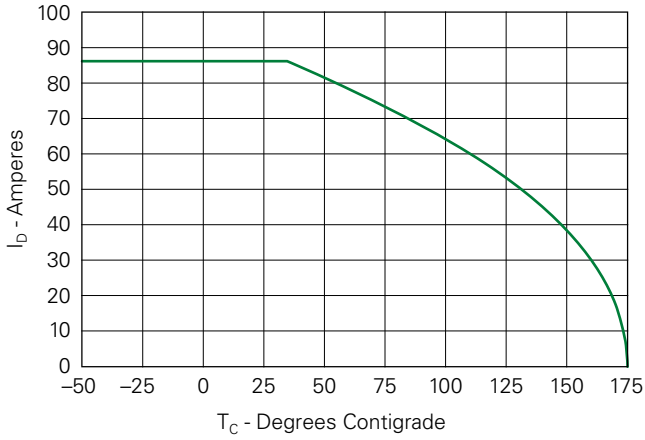
Fig. 1. Output Characteristics @  $T_J = 25^\circ\text{C}$ Fig. 2. Extended Output Characteristics @  $T_J = 25^\circ\text{C}$ Fig. 3. Output Characteristics @  $T_J = 150^\circ\text{C}$ Fig. 4.  $R_{DS(on)}$  Normalized to  $I_D = 43\text{A}$  Value vs. Junction TemperatureFig. 5.  $R_{DS(on)}$  Normalized to  $I_D = 43\text{A}$  Value vs. Drain Current

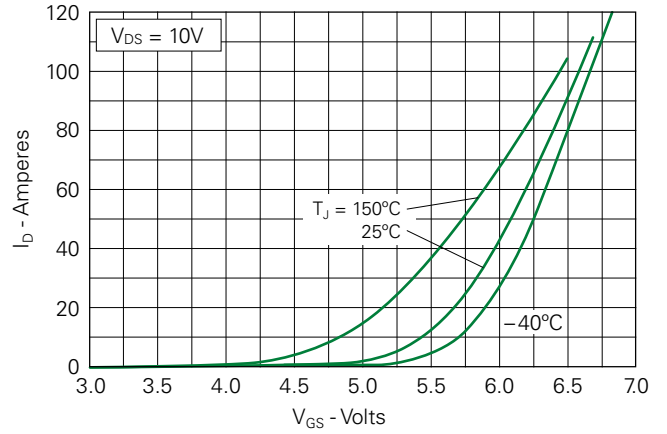
Fig. 6. Normalized Breakdown &amp; Threshold Voltages vs. Junction Temperature



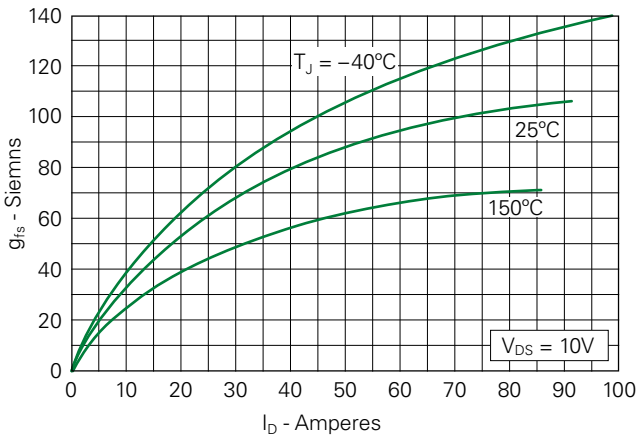
**Fig. 7. Maxium Drain Current vs. Case Temperature**



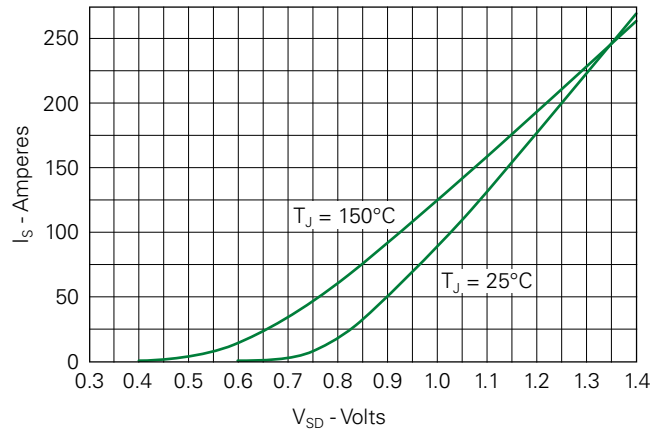
**Fig. 8. Input Admittance**



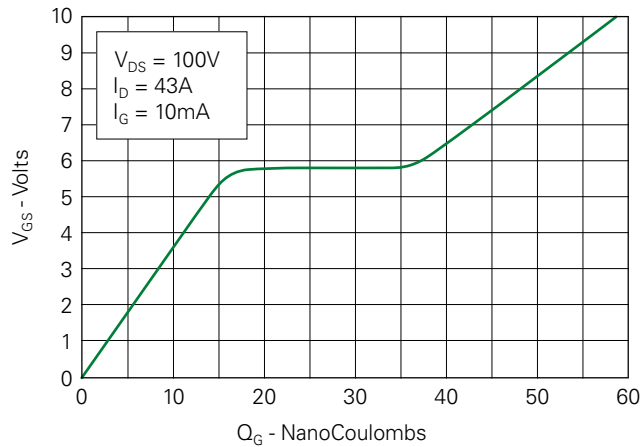
**Fig. 9. Transconductance**



**Fig. 10. Forward Voltage Drop of Intrinsic Diode**



**Fig. 11. Gate Charge**



**Fig. 12. Capacitance**

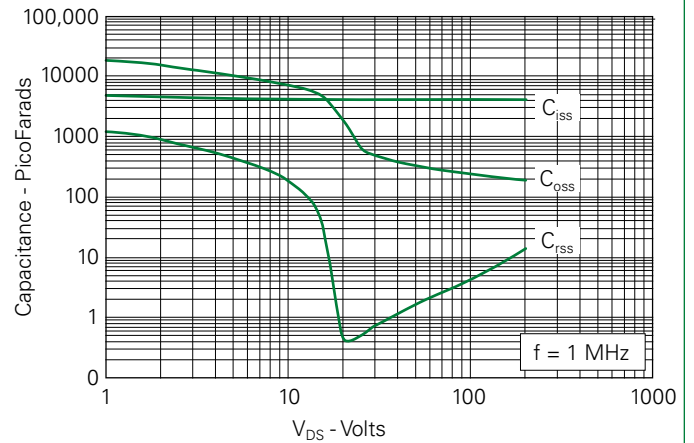


Fig. 13. Output Capacitance Stored Energy

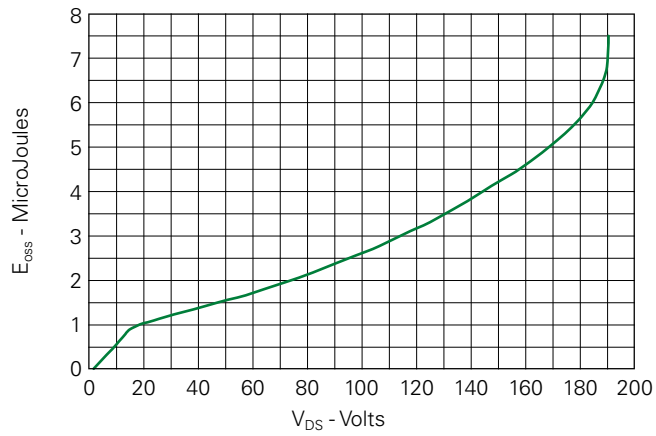


Fig. 14. Forward-Bias Safe Operating Area

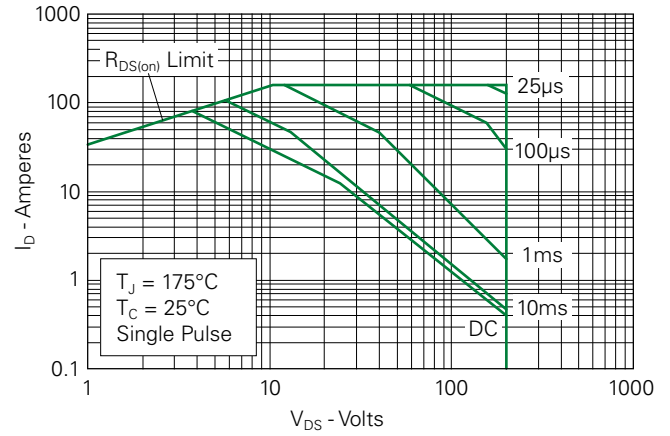
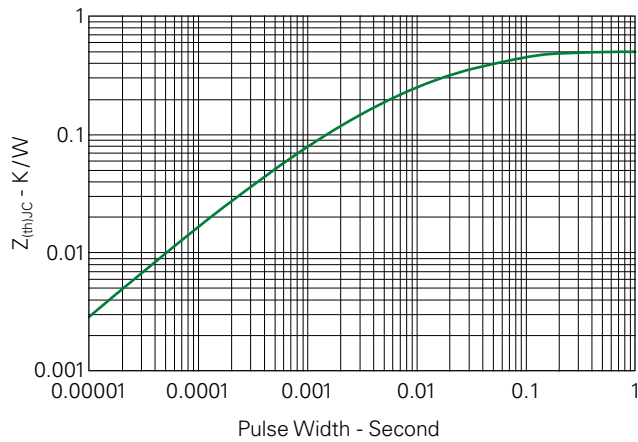
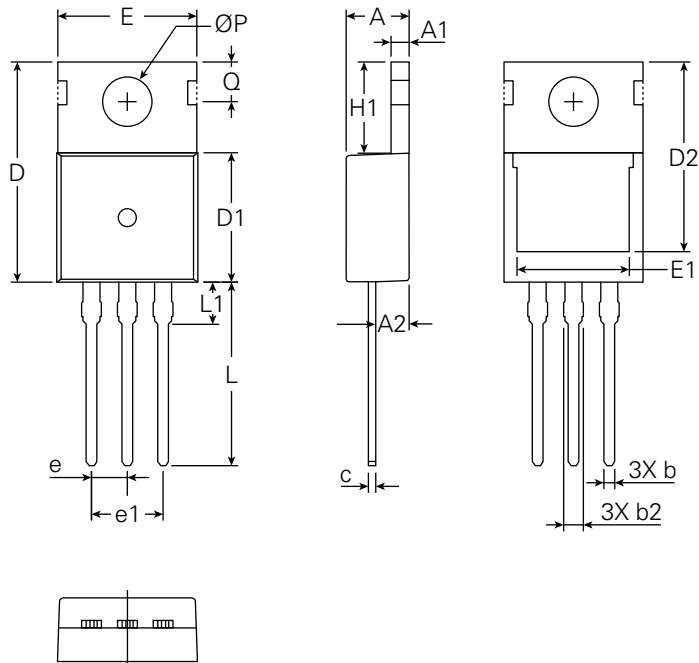


Fig. 15. Maximum Transient Thermal Impedance



## Part Outline Drawing (TO-220-3L)



Symbol	Inches			Millimeters		
	Min.	Typical	Max.	Min.	Typical	Max
A	0.169	–	0.185	4.30	–	4.70
A1	0.047	–	0.055	1.20	–	1.40
A2	0.079	–	0.106	2.00	–	2.70
b	0.024	–	0.039	0.60	–	1.00
b2	0.045	–	0.057	1.15	–	1.45
c	0.014	–	0.026	0.35	–	0.65
D	0.587	–	0.626	14.90	–	15.90
D1	0.335	–	0.370	8.50	–	9.40
(D2)	0.500	–	0.531	12.70	–	13.50
E	0.382	–	0.406	9.70	–	10.30
(E1)	0.283	–	0.323	7.20	–	8.20
e	0.100 BSC			2.45 BSC		
e1	0.200 BSC			5.08 BSC		
H1	0.244	–	0.268	6.20	–	6.80
L	0.492	–	0.547	12.50	–	13.90
L1	0.110	–	0.154	2.80	–	3.90
ØP	0.134	–	0.150	3.40	–	3.80
Q	0.106	–	0.126	2.70	–	3.20

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