

# NDF10N60ZH

## Product Preview

# N-Channel Power MOSFET 600 V, 0.75 $\Omega$

### Features

- Low ON Resistance
- Low Gate Charge
- Zener Diode-protected Gate
- 100% Avalanche Tested
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

### ABSOLUTE MAXIMUM RATINGS ( $T_C = 25^\circ\text{C}$ unless otherwise noted)

Rating	Symbol	Typ	Unit
Drain-to-Source Voltage	$V_{DSS}$	600	V
Continuous Drain Current, $R_{\theta JC}$	$I_D$	10 (Note 2)	A
Continuous Drain Current $T_A = 100^\circ\text{C}$ , $R_{\theta JC}$	$I_D$	5.7 (Note 2)	A
Pulsed Drain Current, $V_{GS} @ 10\text{ V}$	$I_{DM}$	36 (Note 2)	A
Power Dissipation, $R_{\theta JC}$ (Note 1)	$P_D$	36	W
Gate-to-Source Voltage	$V_{GS}$	$\pm 30$	V
Single Pulse Avalanche Energy, $L = 6.0\text{ mH}$ , $I_D = 10\text{ A}$	$E_{AS}$	300	mJ
ESD (HBM) (JESD22-A114)	$V_{ESD}$	3900	V
RMS Isolation Voltage ( $t = 0.3\text{ sec.}$ , R.H. $\leq 30\%$ , $T_A = 25^\circ\text{C}$ ) (Figure 14)	$V_{ISO}$	4500	V
Peak Diode Recovery	$dv/dt$	4.5 (Note 3)	V/ns
Continuous Source Current (Body Diode)	$I_S$	10	A
Maximum Temperature for Soldering Leads	$T_L$	260	$^\circ\text{C}$
Operating Junction and Storage Temperature Range	$T_J, T_{stg}$	-55 to 150	$^\circ\text{C}$

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

1. Surface mounted on FR4 board using 1 in sq. pad size, 1 oz cu
2. Limited by maximum junction temperature
3.  $I_S \leq 10\text{ A}$ ,  $di/dt \leq 200\text{ A}/\mu\text{s}$ ,  $V_{DD} = 80\% BV_{DSS}$

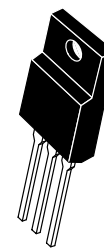
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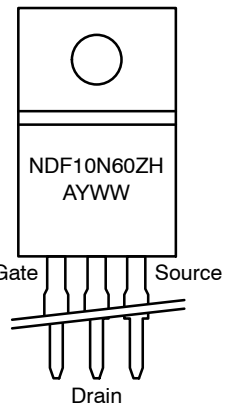
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$V_{DSS}$	$R_{DS(ON)} \text{ (MAX) @ } 5\text{ A}$
600 V	0.75 $\Omega$

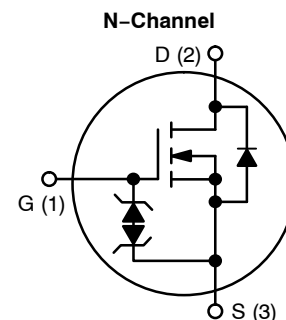


TO-220FP  
CASE 221AH  
STYLE 1

### MARKING DIAGRAM



- A = Location Code
- Y = Year
- WW = Work Week
- H = Halogen Free Package



### ORDERING INFORMATION

Device	Package	Shipping
NDF10N60ZH	TO-220FP	50 Units / Rail (In Development)

# NDF10N60ZH

## THERMAL RESISTANCE

Parameter	Symbol	Typ	Unit
Junction-to-Case (Drain)	$R_{\theta JC}$	3.4	$^{\circ}\text{C}/\text{W}$
Junction-to-Ambient Steady State (Note 4)	$R_{\theta JA}$	50	

## ELECTRICAL CHARACTERISTICS ( $T_J = 25^{\circ}\text{C}$ unless otherwise noted)

Characteristic	Test Conditions	Symbol	Min	Typ	Max	Unit
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### OFF CHARACTERISTICS

Drain-to-Source Breakdown Voltage	$V_{GS} = 0\text{ V}, I_D = 1\text{ mA}$	$BV_{DSS}$	600			V
Breakdown Voltage Temperature Coefficient	Reference to $25^{\circ}\text{C}$ , $I_D = 1\text{ mA}$	$\Delta BV_{DSS}/\Delta T_J$		0.6		$\text{V}/^{\circ}\text{C}$
Drain-to-Source Leakage Current	$V_{DS} = 600\text{ V}, V_{GS} = 0\text{ V}$	$I_{DSS}$			1	$\mu\text{A}$
					50	
Gate-to-Source Forward Leakage	$V_{GS} = \pm 20\text{ V}$	$I_{GSS}$			$\pm 10$	$\mu\text{A}$

### ON CHARACTERISTICS (Note 5)

Static Drain-to-Source On-Resistance	$V_{GS} = 10\text{ V}, I_D = 5.0\text{ A}$	$R_{DS(on)}$		0.65	0.75	$\Omega$
Gate Threshold Voltage	$V_{DS} = V_{GS}, I_D = 100\ \mu\text{A}$	$V_{GS(th)}$	3.0		4.5	V
Forward Transconductance	$V_{DS} = 15\text{ V}, I_D = 10\text{ A}$	$g_{FS}$		7.9		S

### DYNAMIC CHARACTERISTICS

Input Capacitance	$V_{DS} = 25\text{ V}, V_{GS} = 0\text{ V},$ $f = 1.0\text{ MHz}$	$C_{iss}$		1425		$\mu\text{F}$
Output Capacitance		$C_{oss}$		150		
Reverse Transfer Capacitance		$C_{rss}$		35		
Total Gate Charge	$V_{DD} = 300\text{ V}, I_D = 10\text{ A},$ $V_{GS} = 10\text{ V}$	$Q_g$		47		$\text{nC}$
Gate-to-Source Charge		$Q_{gs}$		9.0		
Gate-to-Drain ("Miller") Charge		$Q_{gd}$		26		
Plateau Voltage		$V_{GP}$		6.3		
Gate Resistance		$R_g$		1.5		$\Omega$

### RESISTIVE SWITCHING CHARACTERISTICS

Turn-On Delay Time	$V_{DD} = 300\text{ V}, I_D = 10\text{ A},$ $V_{GS} = 10\text{ V}, R_G = 5\ \Omega$	$t_{d(on)}$		15		ns
Rise Time		$t_r$		31		
Turn-Off Delay Time		$t_{d(off)}$		40		
Fall Time		$t_f$		23		

### SOURCE-DRAIN DIODE CHARACTERISTICS ( $T_C = 25^{\circ}\text{C}$ unless otherwise noted)

Diode Forward Voltage	$I_S = 10\text{ A}, V_{GS} = 0\text{ V}$	$V_{SD}$			1.6	V
Reverse Recovery Time	$V_{GS} = 0\text{ V}, V_{DD} = 30\text{ V}$ $I_S = 10\text{ A}, di/dt = 100\text{ A}/\mu\text{s}$	$t_{rr}$		395		ns
Reverse Recovery Charge		$Q_{rr}$		3.0		$\mu\text{C}$

4. Insertion mounted

5. Pulse Width  $\leq 380\ \mu\text{s}$ , Duty Cycle  $\leq 2\%$ .

# NDF10N60ZH

## TYPICAL CHARACTERISTICS

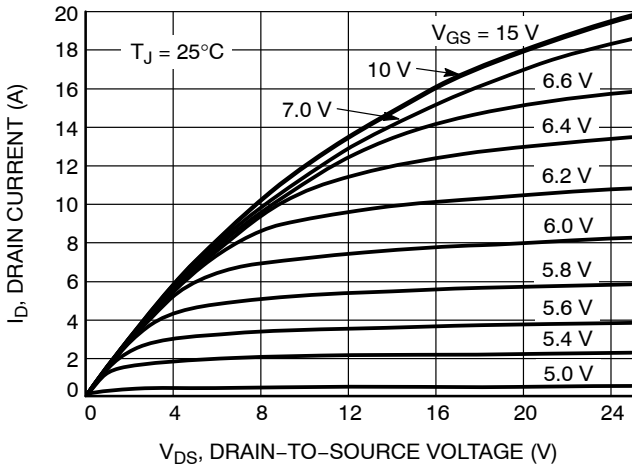


Figure 1. On-Region Characteristics

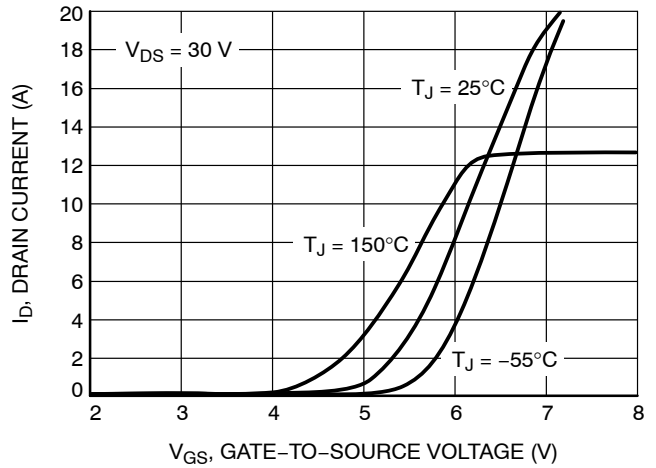


Figure 2. Transfer Characteristics

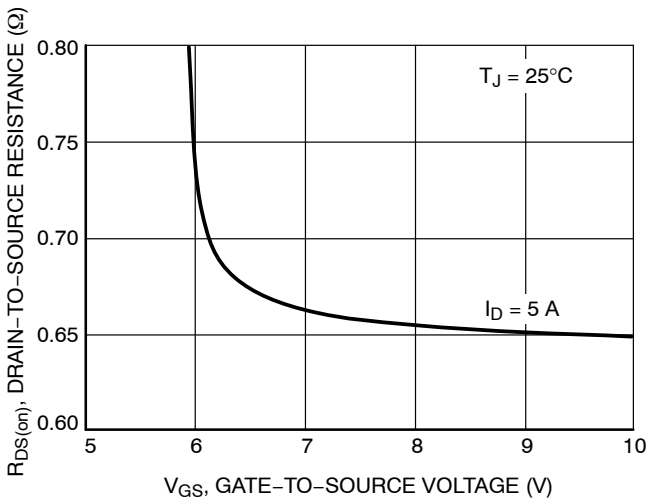


Figure 3. On-Resistance vs. Gate Voltage

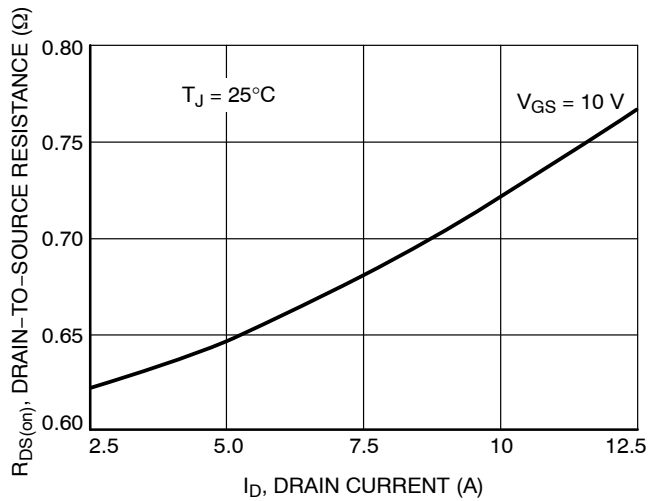


Figure 4. On-Resistance vs. Drain Current and Gate Voltage

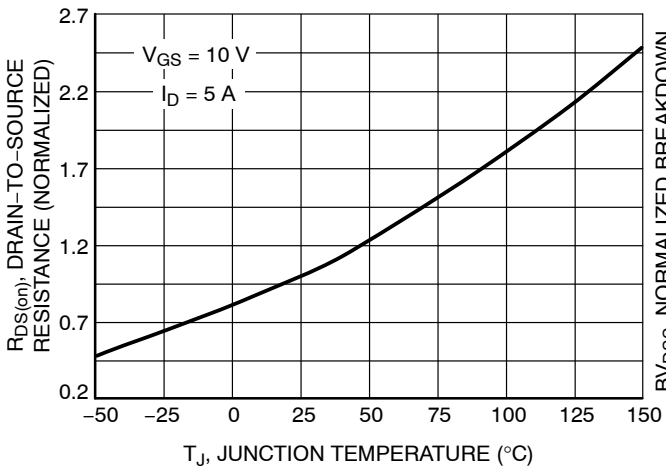


Figure 5. On-Resistance Variation with Temperature

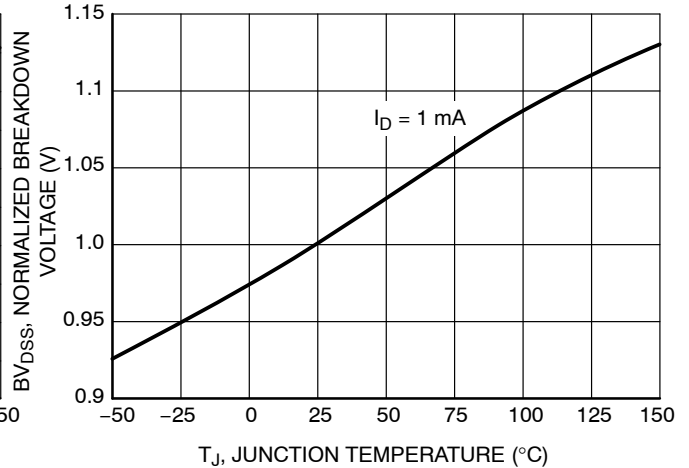
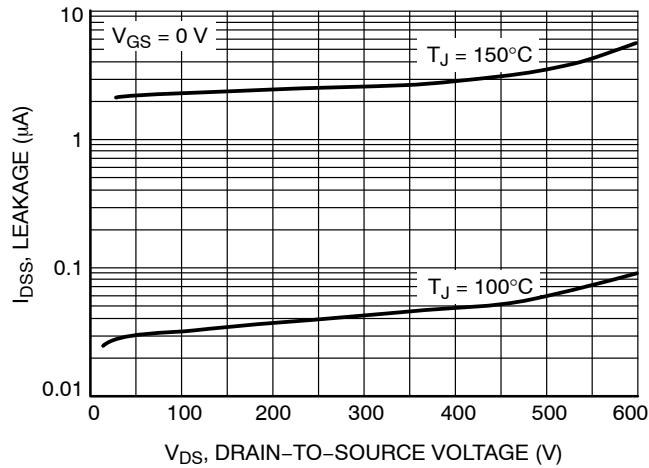


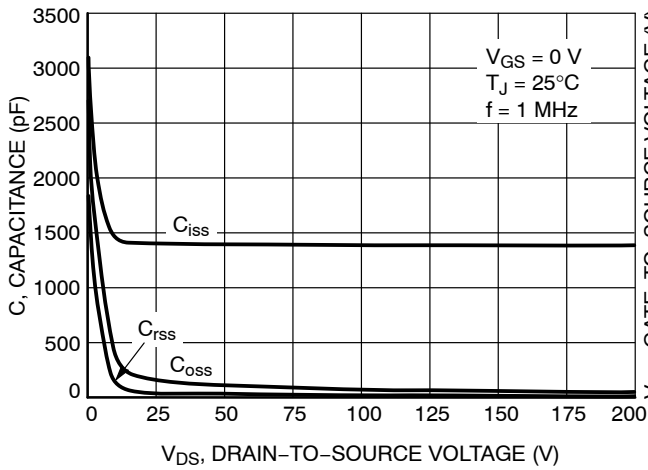
Figure 6.  $BV_{DSS}$  Variation with Temperature

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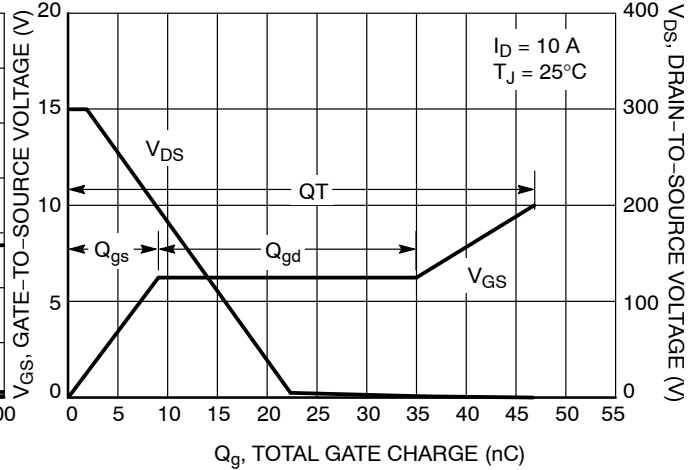
## TYPICAL CHARACTERISTICS



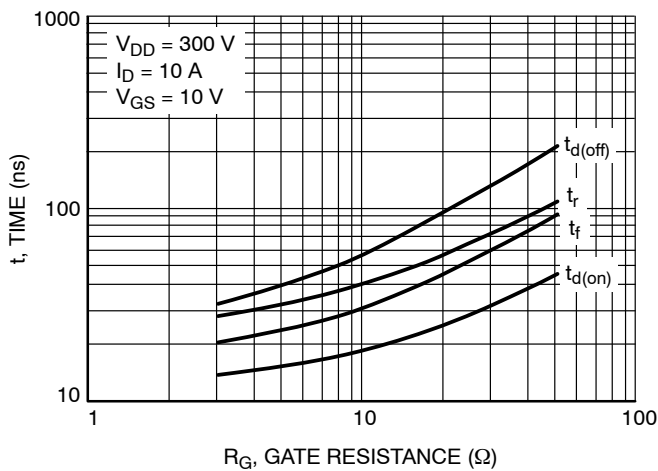
**Figure 7. Drain-to-Source Leakage Current vs. Voltage**



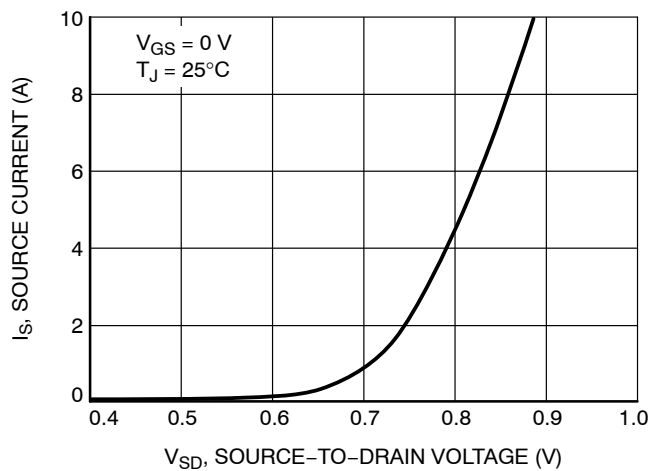
**Figure 8. Capacitance Variation**



**Figure 9. Gate-to-Source and Drain-to-Source Voltage vs. Total Charge**



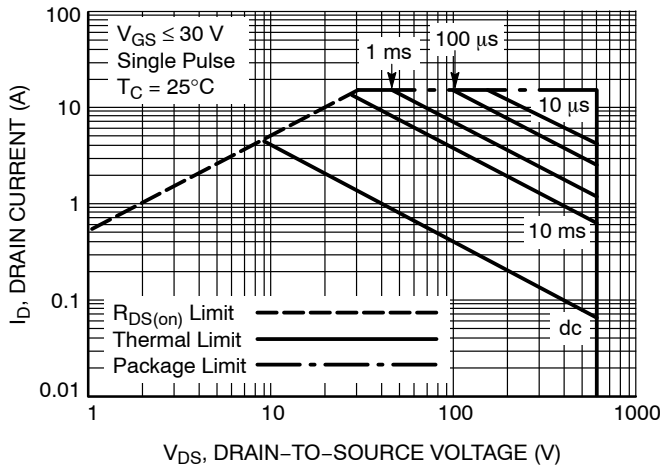
**Figure 10. Resistive Switching Time Variation vs. Gate Resistance**



**Figure 11. Diode Source Current vs. Forward Voltage**

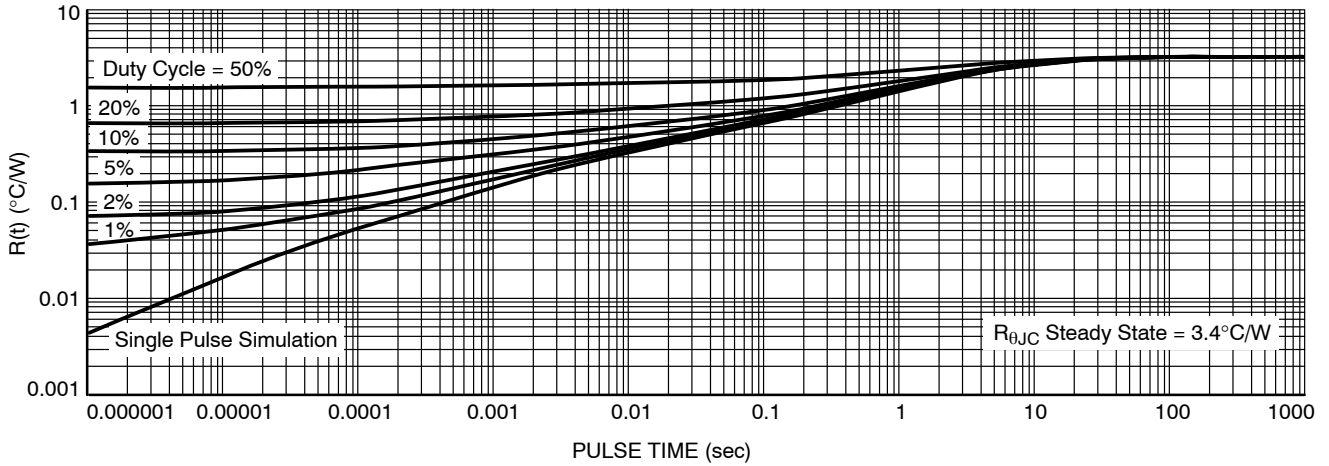
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## TYPICAL CHARACTERISTICS

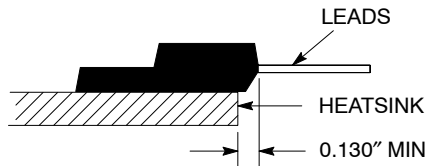


Mounted on 2" sq. FR4 board (1" sq. 2 oz. Cu 0.06" thick single sided) with one die operating

**Figure 12. Maximum Rated Forward Biased Safe Operating Area**



**Figure 13. Thermal Impedance (Junction-to-Case)**



**Figure 14. Mounting Position for Isolation Test**

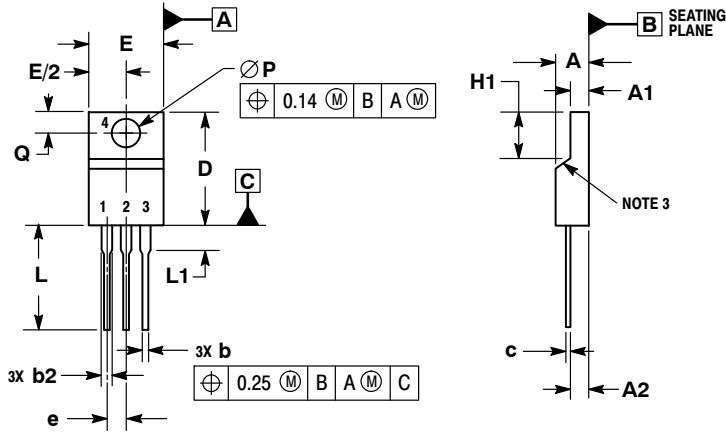
Measurement made between leads and heatsink with all leads shorted together.

\*For additional mounting information, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

# NDF10N60ZH

## PACKAGE DIMENSIONS

TO-220 FULLPACK, 3-LEAD  
CASE 221AH-01  
ISSUE O



**NOTES:**

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. CONTOUR UNCONTROLLED IN THIS AREA.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH AND GATE PROTRUSIONS. MOLD FLASH AND GATE PROTRUSIONS NOT TO EXCEED 0.13 PER SIDE. THESE DIMENSIONS ARE TO BE MEASURED AT OUTERMOST EXTREME OF THE PLASTIC BODY.
5. DIMENSION b2 DOES NOT INCLUDE DAMBAR PROTRUSION. LEAD WIDTH INCLUDING PROTRUSION SHALL NOT EXCEED 2.00.

DIM	MILLIMETERS	
	MIN	MAX
A	4.30	4.70
A1	2.50	2.90
A2	2.50	2.70
b	0.54	0.84
b2	1.10	1.40
c	0.49	0.79
D	14.22	15.88
E	9.65	10.67
e	2.54 BSC	
H1	5.97	6.48
L	12.70	14.73
L1	---	2.80
P	3.00	3.40
Q	2.80	3.20

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