550nA Nanopower, Rail-to-Rail Input/Output Op-amps

GENERAL DESCRIPTION

The BL3601_3602_3604 operational amplifiers are guaranteed to operate with a single supply voltage as low as 1.4V, while drawing 550nA/Amplifier (TYP) of quiescent current. These devices are also designed to support rail-to-rail input and output operation. This combination of features supports battery-powered and portable applications. The BL3601_3602_3604 have a gain-bandwidth product of 10kHz (TYP) and are unity gain stable. These specifications make the operational amplifiers appropriate for low frequency applications, such as battery current monitoring and sensor conditioning. The single BL3601 is available in Green SOT23-5 packages. The dual BL3602 is available in Green SOP8 ,MSOP8, TDFN8 packages; The Quad BL3604 is available in Green SOP14, TSSOP14.They operate over an ambient temperature range of -40℃ to +125℃

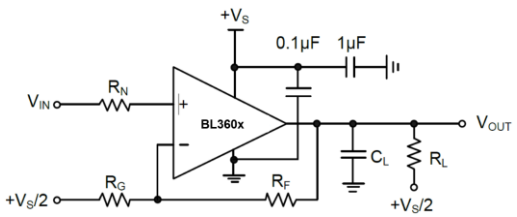
Features

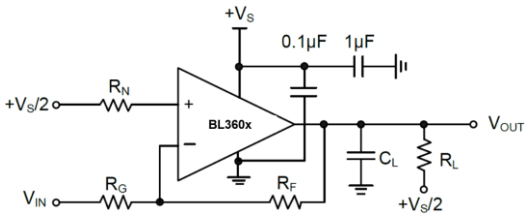
- Wide Supply Voltage Range: 1.4V to 5.5V
- Low Offset Voltage: 0.4mV (TYP)
- Low Quiescent Current: 550nA (TYP)
- Gain-Bandwidth Product: 10kHz (TYP)
- Rail-to-Rail Input and Output
- -40℃ to +125℃ Operating Temperature Range
- Available in Green SOT23-5, SOP8 ,MSOP8, TDFN8,SOP14,TSSOP14 Packages

Applications

Wearable Products
Environment/Gas/Oxygen Sensors
Battery or Solar Powered Device
Handsets and Mobile Accessories

Typical reference design

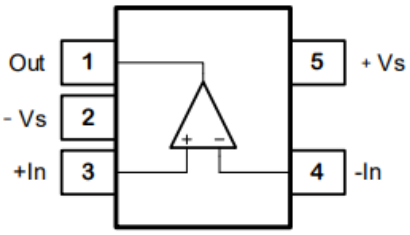




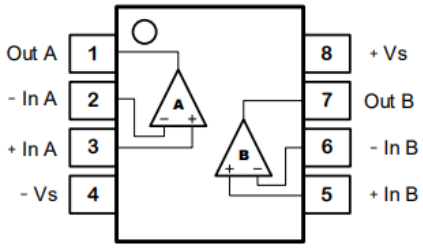
Package and ordering information

MODEL	CHANNEL	ORDER NUMBER	PACKAGE DESCRIPTION	PACKAGE OPTION
BL3601	Single	BL3601FR	SOT23-5	Tape and Reel,3000
BL3602	Dual	BL3602SR	SOP8	Tape and Reel,2500
		BL3602DR	TDFN8	Tape and Reel,3000
		BL3602MR	MSOP8	Tape and Reel,3000
BL3604	Quad	BL3604TR	TSSOP14	Tape and Reel,3000
		BL3604SR	SOP14	Tape and Reel,2500

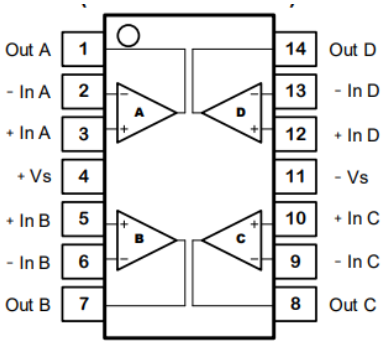
Pin Configuration



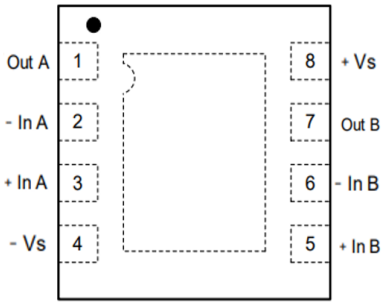
SOT23-5



SOP8/MSOP8



SOP14/TSSOP14



TDFN8

Absolute Maximum Ratings

Condition	Min	Max
Power Supply Voltage (V_{DD} to Vss)	-0.5V	+6V
Analog Input Voltage (IN+ or IN-)	Vss-0.3V	V_{DD}+0.5V
PDB Input Voltage	Vss-0.3V	+6V
Operating Temperature Range	-40°C	+125°C
Junction Temperature	+160°C	
Storage Temperature Range	-55°C	+150°C
Lead Temperature (soldering, 10sec)	+260°C	
Package Thermal Resistance (T_A=+25℃)		
SOP-8, θ_{JA}	125°C/W	
MSOP-8, θ_{JA}	216°C/W	
SOT23-5, θ_{JA}	190°C/W	
SC70-5, θ_{JA}	333°C/W	
ESD Susceptibility		
HBM	5KV	

Electrical Characteristics

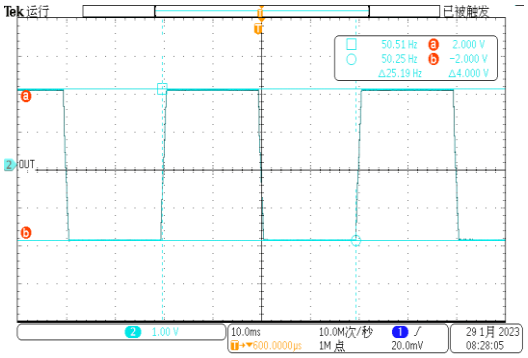
(At VS = +5V, RL = 1MΩ connected to VS/2, V_{CM} = +VS/2 and VOUT = VS/2, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS		BL3601/3602/3604		
			MIN	TYP	MAX	UNITS
	INPUT CHARACTERISTICS					
Input Offset Voltage	V_{OS}	$V_{CM} = V_S/2$		0.4	2	mV
Input Bias Current	I_B			1		pA
Input Offset Current	I_{OS}			1		pA
Common-Mode Voltage Range	V_{CM}	V_S = 5.5V	(-VS) - 0.1		(+VS) + 0.1	V
Common-Mode Rejection Ratio	CMRR	V_S = 5V, V_{CM} = -0.1V to 2.5V	75	84		dB
		V_S = 5V, V_{CM} = -0.1V to 5.1V	60	83		
Open-Loop Voltage Gain	A_{OL}	Vs=1.4V, R_L = 50kΩ, V_O = Vs-0.1V	75	85		dB
		Vs=5V, R_L = 50kΩ, V_O = Vs-0.1V	80	95		
Input Offset Voltage Drift	$\Delta V_{OS}/\Delta_T$	VCM = +VS/2, -40℃ ≤ TA ≤ +125℃		2.5		μV/℃
	OUTPUT CHARACTERISTICS					
Output Voltage Swing from Rail	V_{OH}	Vs=1.4V, R_L = 50kΩ	1.390	1.395		V
	V_{OL}			4.5	10	mV
	V_{OH}	Vs=5V, R_L = 50kΩ	4.995	4.997		V
	V_{OL}			3.5	10	mV
Short Circuit Current	I_{SOURCE}	Vs=5V	30	32		mA
	POWER SUPPLY					
Operating Voltage Range				1.4		V
				5.5		V
Power Supply Rejection Ratio	PSRR	V_S = +1.4V to +5.5V, V_{CM} = +0.5V	80	90		dB
Quiescent Current / Amplifier	I_Q	V_S = 5.5V, V_{CM} = 2.75V		550		nA
	DYNAMIC PERFORMANCE (CL = 100pF)					
Gain-Bandwidth Product	GBP			10		KHz
Slew Rate	SR	G = +1, 2V Output Step		3		V/ms
Phase Margin	PM	+VS = 1.4V to 5.5V		55		°
Input Voltage Noise		+VS = 5.0V, f = 0.1Hz to 10Hz		3.5		μVP-P
Input Voltage Noise Density		+VS = 5.0V, f = 1kHz		100		$nV/\sqrt{Hz}$

Typical Performance characteristics

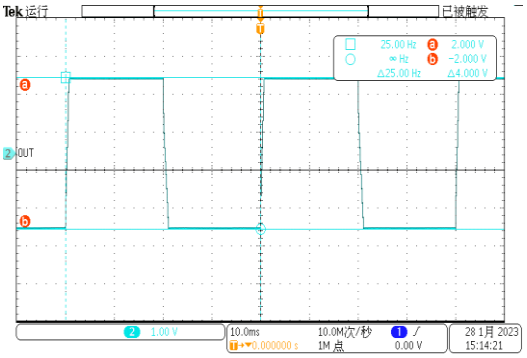
TA = +25°C, +VS = +1.4V to +5.0V, -VS = GND, VCM = +VS/2, VOUT ≈ +VS/2 and RL = 1MΩ to +VS/2, CL = 60pF, unless otherwise noted.

Large Signal Inverting Pulse Response



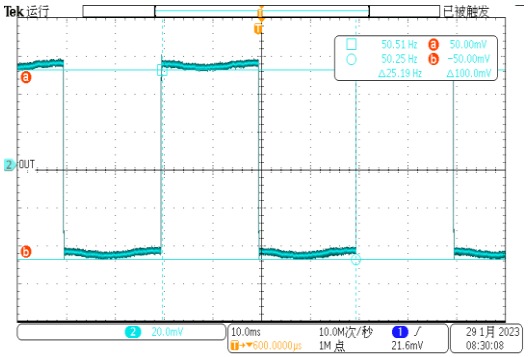
VS=5V RL=100K CL=60PF AV=-1

Large Signal Non-Inverting Pulse Response



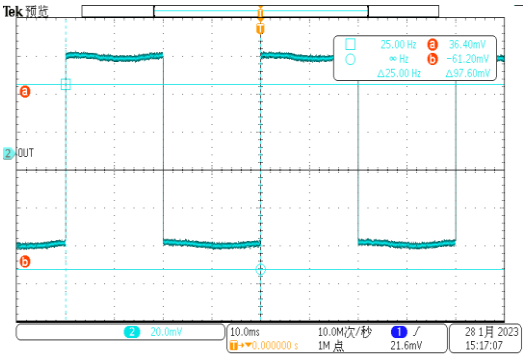
VS=5V RL=100K CL=60PF AV=+1

Small Signal Inverting Pulse Response



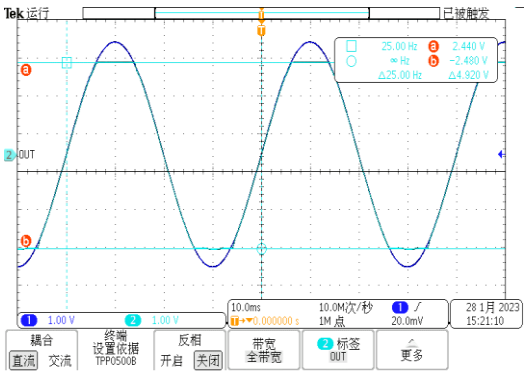
VS=5V RL=100K CL=60PF AV=-1

Small Signal Non-Inverting Pulse Response



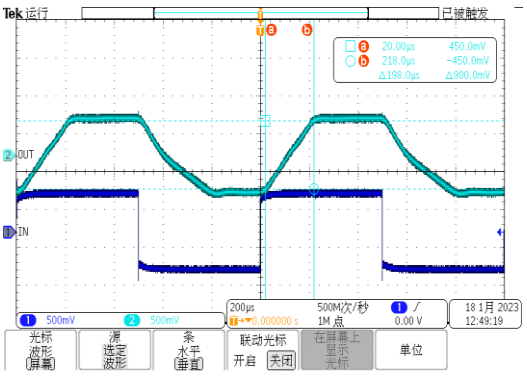
VS=5V RL=100K CL=60PF AV=+1

No Phase Reversal



AV=+1 NO PHASE REVERSAL

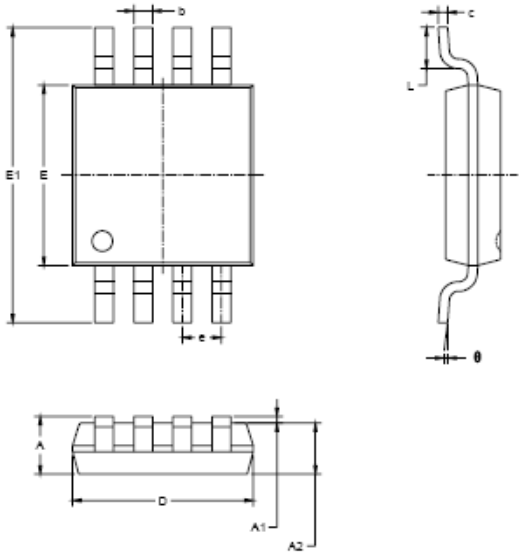
Slew Rate



BL3601 1.4V SR_L_H

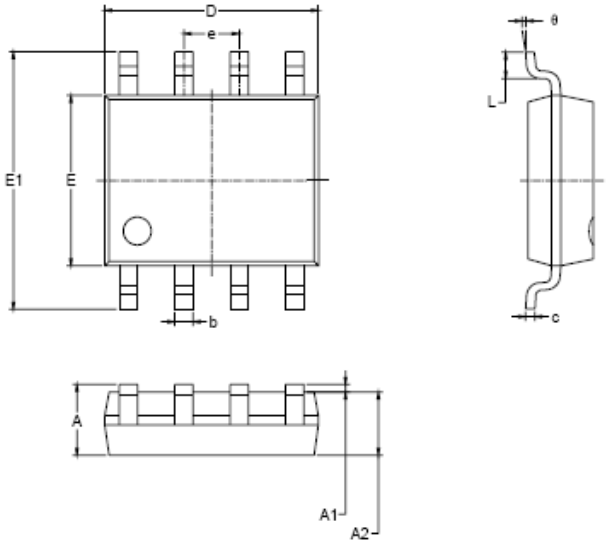
Package Information

MSOP8



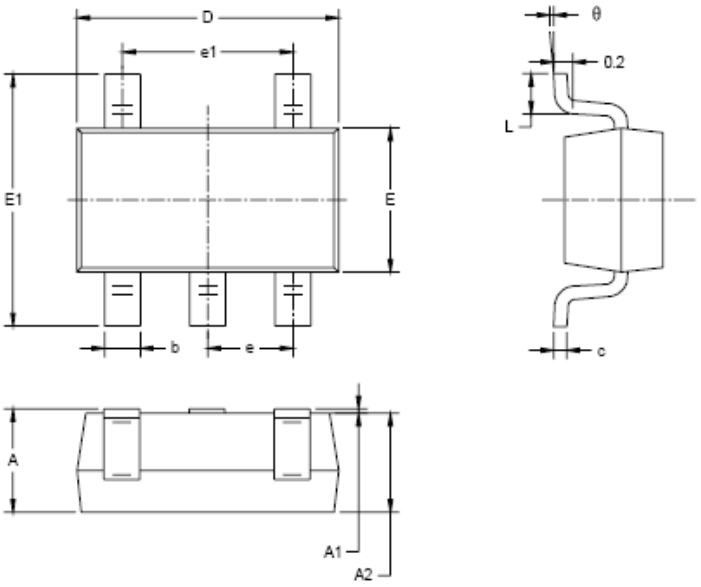
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
e	0.650 BSC		0.026 BSC	
L	0.400	0.800	0.016	0.031
θ	0°	6°	0°	6°

SOP8



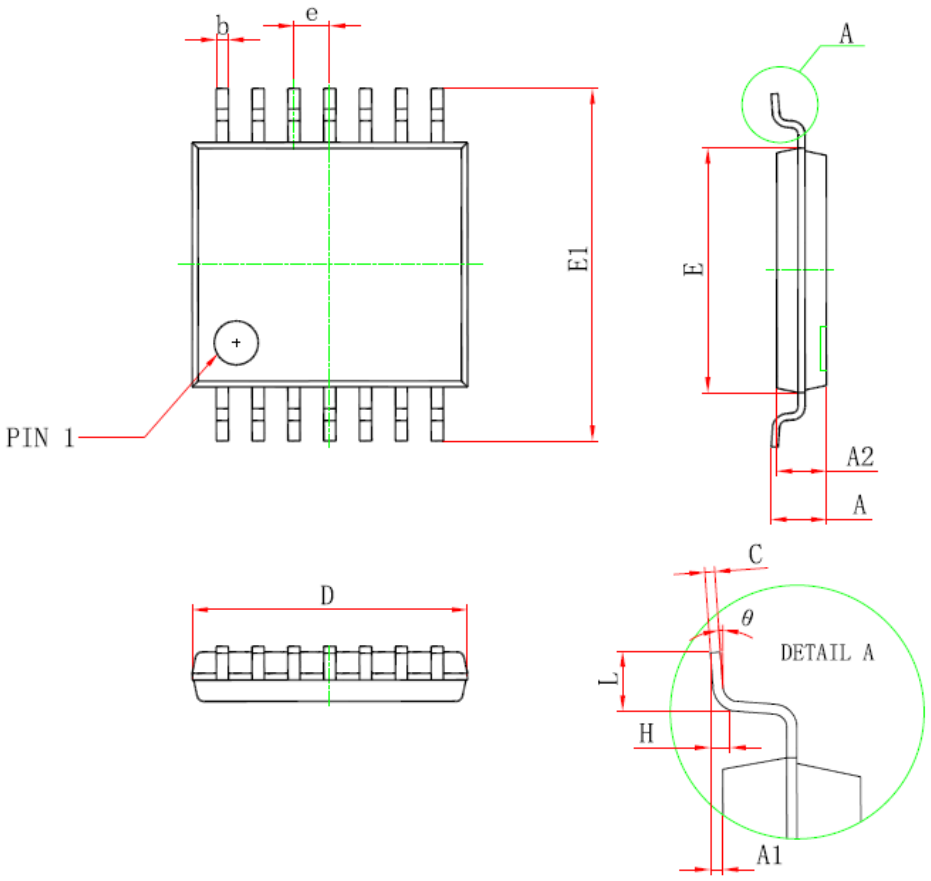
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27 BSC		0.050 BSC	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

SOT23-5



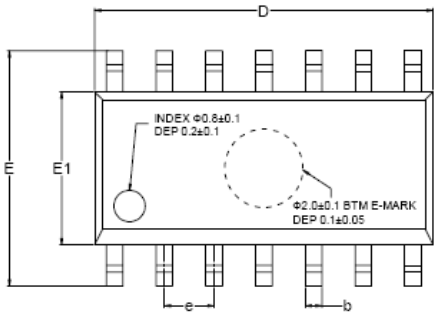
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950 BSC		0.037 BSC	
e1	1.900 BSC		0.075 BSC	
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

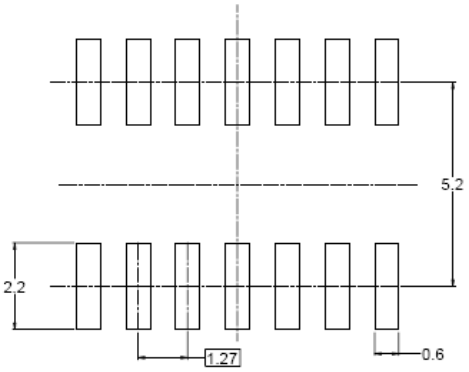
TSSOP14



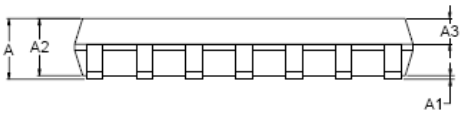
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	**Max**	**Min**	**Max**
D	4.900	5.100	0.193	0.201
E	4.300	4.500	0.169	0.177
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
E1	6.250	6.550	0.246	0.258
A		1.200		0.047
A2	0.800	1.000	0.031	0.039
A1	0.050	0.150	0.002	0.006
e	0.65 (BSC)		0.026(BSC)	
L	0.500	0.700	0.020	0.028
H	0.25(TYP)		0.01(TYP)	
θ	1°	7°	1°	7°

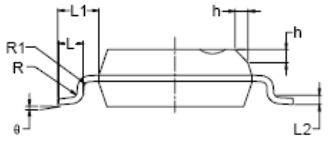
SOP14





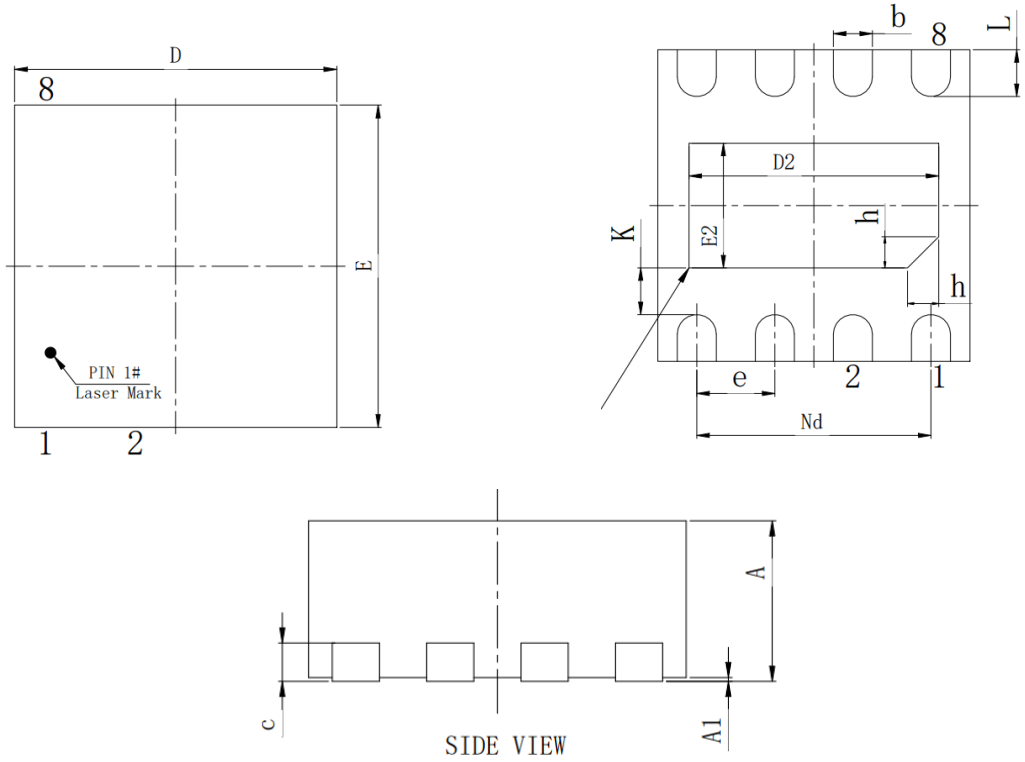
RECOMMENDED LAND PATTERN (Unit: mm)





Symbol	Dimensions In Millimeters			Dimensions In Inches		
	MIN	MOD	MAX	MIN	MOD	MAX
A	1.35		1.75	0.053		0.069
A1	0.10		0.25	0.004		0.010
A2	1.25		1.65	0.049		0.065
A3	0.55		0.75	0.022		0.030
b	0.36		0.49	0.014		0.019
D	8.53		8.73	0.336		0.344
E	5.80		6.20	0.228		0.244
E1	3.80		4.00	0.150		0.157
e	1.27 BSC			0.050 BSC		
L	0.45		0.80	0.018		0.032
L1	1.04 REF			0.040 REF		
L2	0.25 BSC			0.01 BSC		
R	0.07			0.003		
R1	0.07			0.003		
h	0.30		0.50	0.012		0.020
θ	0°		8°	0°		8°

TDFN8



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0. 80	0.85	0. 90
	0. 70	0.75	0. 80
A1	0	0.02	0. 05
b	0. 20	0. 25	0. 30
c	0. 203REF		
D	1. 95	2. 00	2. 05
D2	1. 55	1. 60	1. 65
Nd	1. 50BSC		
e	0. 50BSC		
E	1. 95	2. 00	2. 05
E2	0. 75	0. 80	0. 85
L	0. 25	0.30	0. 35
K	0.25	0.30	0.35
h	0.20REF		