

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 SOT-23-5, SC70-5 packages. The dual BL3602 is available in Green SOP-8 ,MSOP8 packages. They operate over an ambient temperature range of -40°C to +125°C

Features:

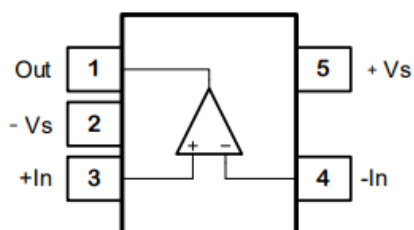
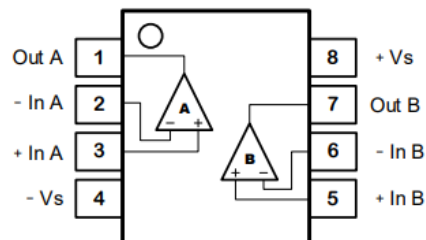
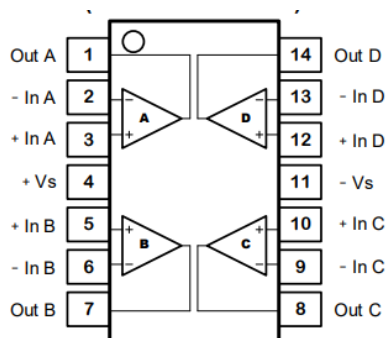
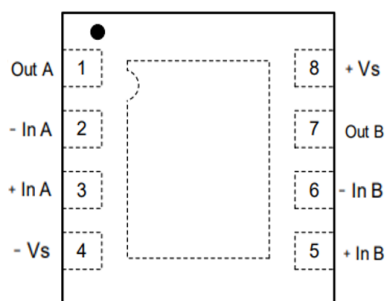
- Wide Supply Voltage Range: 1.4V to 5.5V
- Low Offset Voltage: 0.4mV (TYP)
- Low Quiescent Current: 550nA (TYP)
- Gain-Bandwidth Product: 10kHz (TYP)
- Rail-to-Rail Input and Output
- -40°C to +125°C Operating Temperature Range
- Available in Green SOT-23-5, SC70-5 ,SOP-8 ,MSOP8,SOP14,TSSOP14 Packages

Applications:

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

Package and ordering information:

MODEL	CHANNEL	ORDER NUMBER	PACKAGE DESCRIPTION	PACKAGE OPTION
BL3601	Single	BL3601CR	SC70-5	Tape and Reel,3000
		BL3601FR	SOT23-5	Tape and Reel,3000
BL3602	Dual	BL3602SR	SOP-8	Tape and Reel,2500
		BL3602DR	TDFN-8	Tape and Reel,3000
		BL3602MR	MSOP-8	Tape and Reel,3000
BL3604	Quad	BL3604TR	TSSOP-14	Tape and Reel,3000
		BL3604SR	SOP-14	Tape and Reel,2500

Pin Configuration

SOT23-5/SC70

SOP8/MSOP8

SOP14/TSSOP14

TDFN-8
Absolute Maximum Ratings:

Condition	Min	Max
Power Supply Voltage (V_{DD} to V_{SS})	-0.5V	+6V
Analog Input Voltage ($IN+$ or $IN-$)	$V_{SS}-0.3V$	$V_{DD}+0.5V$
PDB Input Voltage	$V_{SS}-0.3V$	+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 ($T_A=+25^\circ C$)		
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

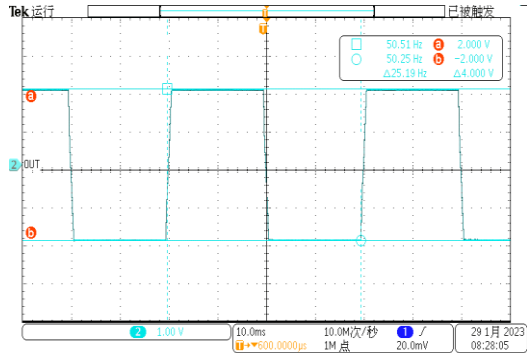
 (At $V_S = +5V$, $R_L = 1M\Omega$ connected to $V_S/2$, and $V_{OUT} = V_S/2$, unless otherwise noted.)

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}	$V_S = 5.5V$	$(-V_S) - 0.1$		$(+V_S) + 0.1$	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}	$V_S=1.4V, R_L = 50k\Omega, V_O = V_S-0.1V$	75	85		dB
		$V_S=5V, R_L = 50k\Omega, V_O = V_S-0.1V$	80	95		
Input Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	$V_{CM} = +V_S/2, -40^\circ C \leq T_A \leq +125^\circ C$		2.5		$\mu V/^\circ C$
OUTPUT CHARACTERISTICS						
Output Voltage Swing from Rail	V_{OH}	$V_S=1.4V, R_L = 50k\Omega$	1.390	1.395		V
	V_{OL}			4.5	10	mV
	V_{OH}	$V_S=5V, R_L = 50k\Omega$	4.995	4.997		V
	V_{OL}			3.5	10	mV
Short Circuit Current	I_{SOURCE}	$V_S=5V$	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			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	$+V_S = 1.4V$ to $5.5V$		55		°
Input Voltage Noise		$+V_S = 5.0V, f = 0.1Hz$ to $10Hz$		3.5		$\mu VP-P$
Input Voltage Noise Density		$+V_S = 5.0V, f = 1kHz$		100		nV/\sqrt{Hz}

Typical Performance characteristics

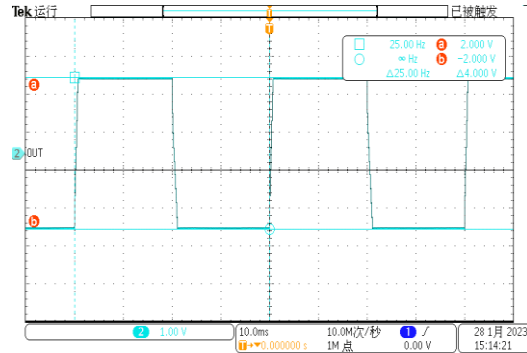
TA = +25°C, +VS = +1.4V to +5.0V, -VS = GND, VCM = +VS/2, VOUT ≈ +VS/2 and RL = 1MΩ to +VS/2, CL = 60pF, unless otherwise noted.

Large Signal Inverting Pulse Response



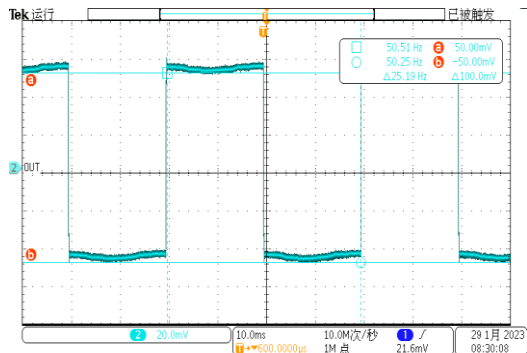
VS=5V RL=100K CL=60PF AV=-1

Large Signal Non-Inverting Pulse Response



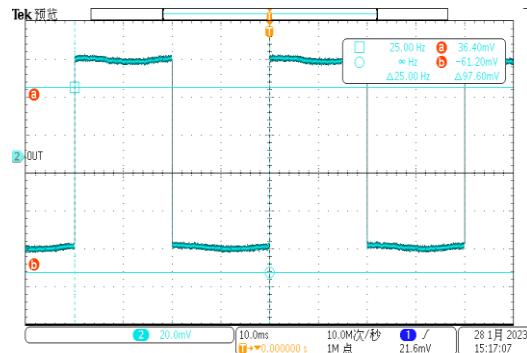
VS=5V RL=100K CL=60PF AV=+1

Small Signal Inverting Pulse Response



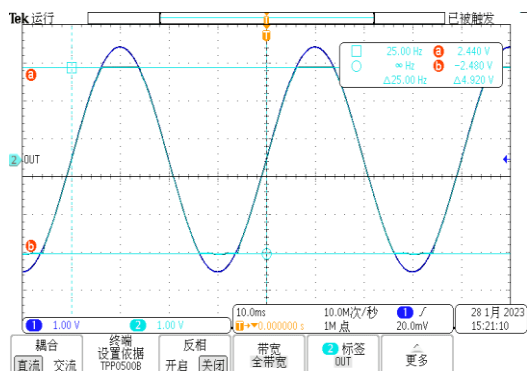
VS=5V RL=100K CL=60PF AV=-1

Small Signal Non-Inverting Pulse Response



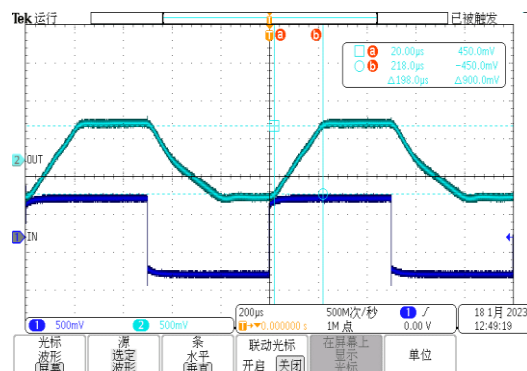
VS=5V RL=100K CL=60PF AV=+1

No Phase Reversal



AV=+1 NO PHASE REVERSAL

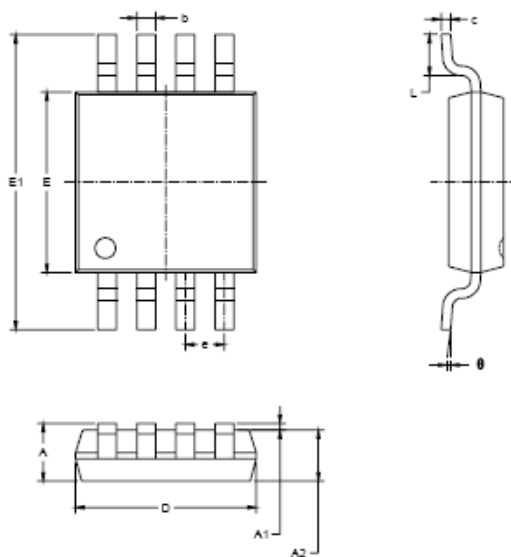
Slew Rate



BL3601 1.4V SR_L_H

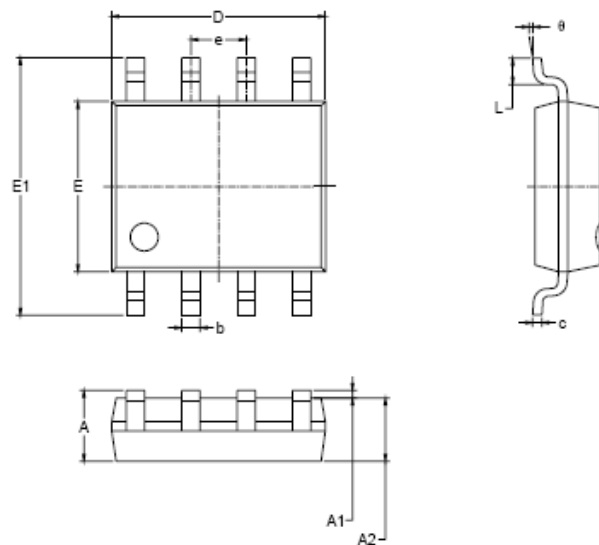
Package Information

MSOP-8



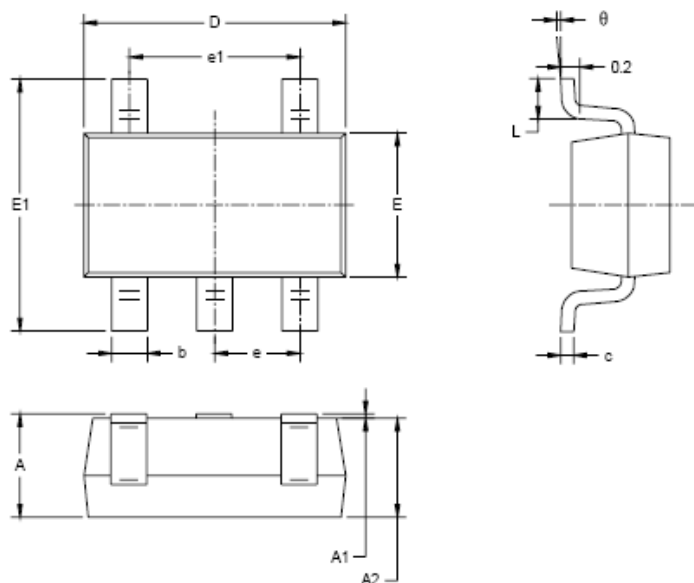
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
e	0.650 BSC		0.026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

SOP-8



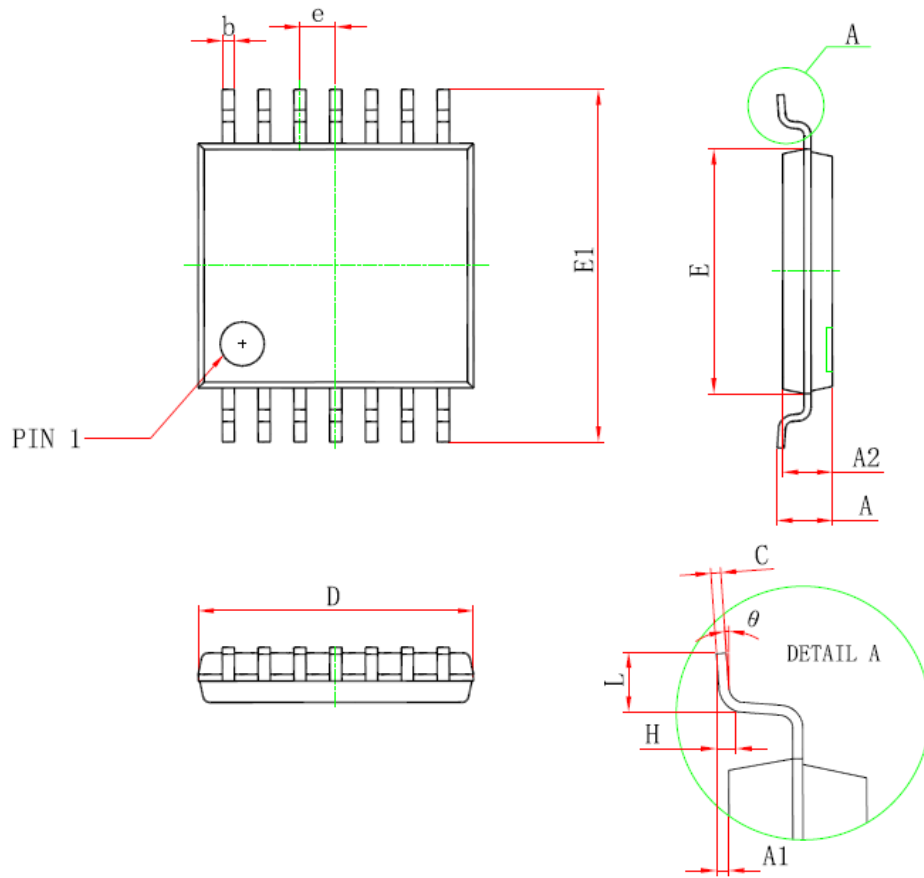
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27 BSC		0.050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

SOT23-5



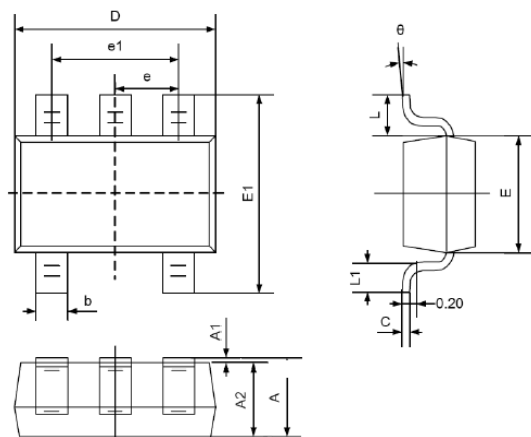
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.600	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950 BSC		0.037 BSC	
e1	1.900 BSC		0.075 BSC	
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

TSSOP-14

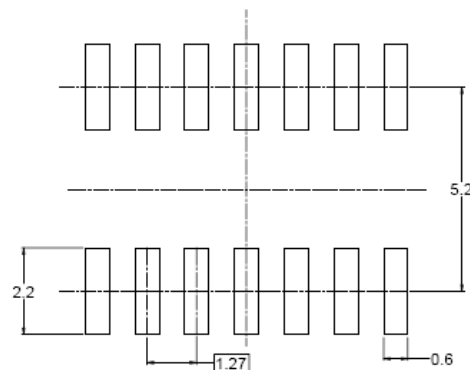
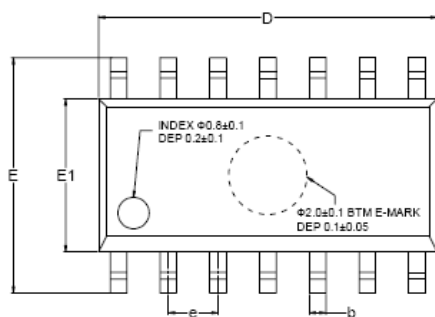


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
D	4.900	5.100	0.193	0.201
E	4.300	4.500	0.169	0.177
b	0.190	0.300	0.007	0.012
e	0.090	0.200	0.004	0.008
E1	6.250	6.550	0.246	0.258
A		1.200		0.047
A2	0.800	1.000	0.031	0.039
A1	0.050	0.150	0.002	0.006
e	0.65 (BSC)		0.026 (BSC)	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

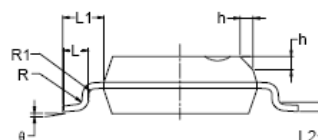
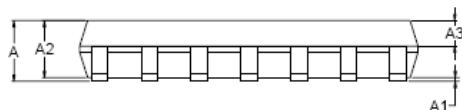
SC70-5



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.900	1.100	0.035	0.043
A1	0.000	0.100	0.000	0.004
A2	0.900	1.000	0.035	0.039
b	0.150	0.350	0.006	0.014
C	0.080	0.150	0.003	0.006
D	2.000	2.200	0.079	0.087
E	1.150	1.350	0.045	0.053
E1	2.150	2.450	0.085	0.096
e	0.650TYP		0.026TYP	
e1	1.200	1.400	0.047	0.055
L	0.525REF		0.021REF	
L1	0.260	0.460	0.010	0.018
theta	0° 8°		0° 8°	

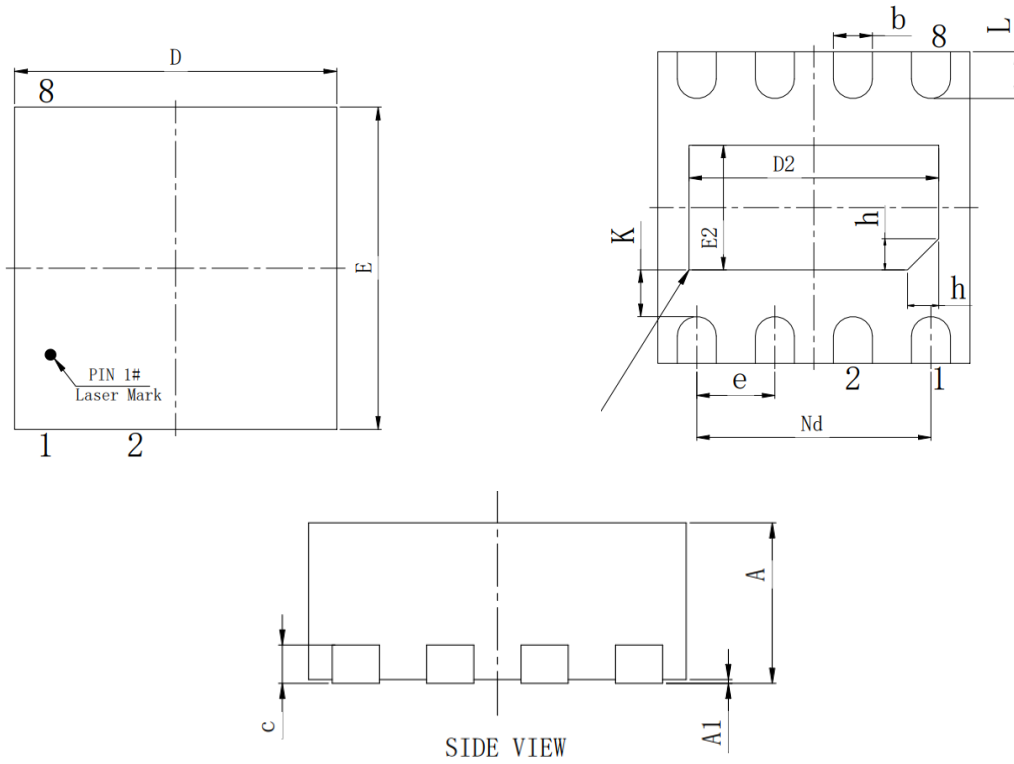
SOP-14


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°

TDFN-8



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		