

Features

- Supply Voltage: 3V to 36V
- Low Supply Current: 100µA per channel
- Input Common-Mode Voltage Range Includes Ground
- Can Work as Comparator
- Rail to Rail Output
- Bandwidth: 0.9 MHz
- Slew Rate: 0.5V/µs
- Excellent EMI Suppress Performance: 71dB at 1GHz
- Offset Voltage: ±3mV Maximum
- Offset Voltage Temperature Drift: 7 µV/°C
- -40°C to 125°C Operation Temperature Range

Applications

- Power Module
- Sensor Interface
- Motor Control
- Audio

Description

The LM321A/358A/324A series amplifiers are newest high supply voltage amplifiers with low offset, low power and stable frequency response. They incorporate 3PEAK’s proprietary and patented design techniques to achieve very good AC performance with 0.9MHz bandwidth, 0.5V/µs slew rate and maximum 3mV offset while drawing only 100µA of quiescent current per amplifier. The input common-mode voltage range extends to V₋, and the outputs swing rail-to-rail. The LM321A/358A/324A family can be used as plug-in replacements for many commercially available op-amps to reduce power and improve input/output range and performance. The combination of features makes the LM321A/358A/324A ideal choices for power module, industrial control, motor control and audio application.

Pin Configuration

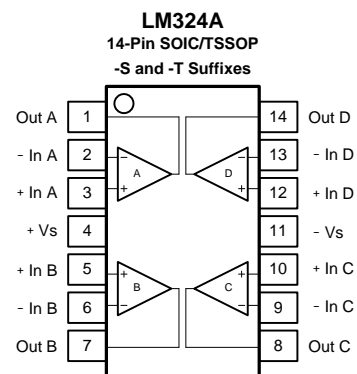
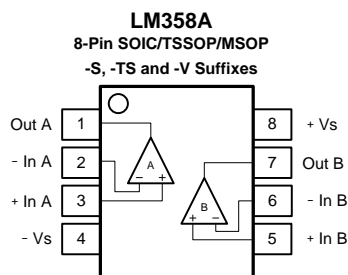
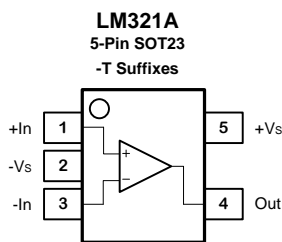


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Revision History

Date	Revision	Notes
2018/3/21	Rev.Pre	Pre-Release Version

Order Information

Order Number	Operating Temperature Range	Package	Marking Information	MSL	Transport Media, Quantity
LM321A-TR ^{Note 1}	-40 to 125°C	5-Pin SOT23	21AXX ^{Note 2}	3	Tape and Reel, 3000
LM358A-SR	-40 to 125°C	8-Pin SOIC	LM358A XXXX ^{Note 3}	3	Tape and Reel, 4000
LM358A-CSR	-40 to 85°C	8-Pin SOIC	LM358A XXXX ^{Note 3}	3	Tape and Reel, 4000
LM358A-F1R	-40 to 125°C	8-Pin DFN 1.5*1.5	58A XXXX ^{Note 3}	3	Tape and Reel, 3000
LM358A-TSR ^{Note 1}	-40 to 125°C	8-Pin TSSOP	LM358A XXXX ^{Note 3}	3	Tape and Reel, 3000
LM358A-VR ^{Note 1}	-40 to 125°C	8-Pin MSOP	LM358A XXXX ^{Note 3}	3	Tape and Reel, 3000
LM324A-SR	-40 to 125°C	14-Pin SOIC	LM324A XXXX ^{Note 3}	3	Tape and Reel, 2500
LM324A-CSR	-40 to 85°C	14-Pin SOIC	LM324A XXXX ^{Note 3}	3	Tape and Reel, 2500
LM324A-TR ^{Note 1}	-40 to 125°C	14-Pin TSSOP	LM324A XXXX ^{Note 3}	3	Tape and Reel, 3000

Note 1: The sample will be ready in 1 month.

Note 2: XX is the date code.

Note 3: XXXX is date code.

Absolute Maximum Ratings ^{Note 1}

Parameters	Rating
Supply Voltage, (+V _S)– (-V _S)	40 V
Input Voltage	(-V _S) – 0.3 to (+V _S) + 0.3
Differential Input Voltage	(+V _S) - (-V _S)
Input Current: +IN, –IN ^{Note 2}	±10mA
Output Short-Circuit Duration ^{Note 3}	Infinite
Maximum Junction Temperature	150°C
Operating Temperature Range	–40 to 125°C
Storage Temperature Range	–65 to 150°C
Lead Temperature (Soldering, 10 sec)	260°C

Note 1: Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.

Note 2: The inputs are protected by ESD protection diodes to each power supply. If the input extends more than 300mV beyond the power supply, the input current should be limited to less than 10mA.

Note 3: A heat sink may be required to keep the junction temperature below the absolute maximum. This depends on the power supply voltage and how many amplifiers are shorted. Thermal resistance varies with the amount of PC board metal connected to the package. The specified values are for short traces connected to the leads.

ESD Rating

Symbol	Parameter	Condition	Minimum Level	Unit
HBM	Human Body Model ESD	MIL-STD-883H Method 3015.8	4	kV
CDM	Charged Device Model ESD	JEDEC-EIA/JESD22-C101E	2	kV

Thermal Information

Package Type	θ_{JA}	θ_{JC}	Unit
5-Pin SOT23	250	81	°C/W
8-Pin SOIC	158	43	°C/W
8-Pin TSSOP	191	44	°C/W
8-Pin MSOP	210	45	°C/W
14-Pin SOIC	120	36	°C/W
14-Pin TSSOP	180	35	°C/W

Electrical Characteristics

All test condition is $V_S = 30V$, $T_A = 25^\circ C$, $R_L = 10k\Omega$, $C_L = 100pF$, unless otherwise noted.

Symbol	Parameter	Conditions	T_A	Min	Typ	Max	Unit
Power Supply							
V_S	Supply Voltage Range			3		36	V
I_Q	Quiescent Current per Amplifier	$V_S = 30V$			110	200	μA
			Operating Range			300	μA
		$V_S = 5V$			100	150	μA
			Operating Range			250	μA
PSRR	Power Supply Rejection Ratio	$V_S = 5V$ to $36V$			120		dB
			Operating Range			90	
Input Characteristics							
V_{OS}	Input Offset Voltage	$V_S = 30V$, $V_{CM} = 0V$ to $28V$		-3	0.1	3	mV
			Operating Range		-7		7
		$V_S = 5V$, $V_{CM} = 0V$ to $3V$		-3	0.1	3	mV
			Operating Range		-7		7
$V_{OS\ TC}$	Input Offset Voltage Drift		Operating Range		7		$\mu V/^\circ C$
I_B	Input Bias Current				60		μA
			Operating Range			600	
I_{OS}	Input Offset Current				60		μA
I_{IN}	Different Input Current	$V_S = 36V$, $V_{ID} = 36V$			5		nA
		$V_S = 36V$, $V_{ID} = 36V$	Operating Range			20	
C_{IN}	Input Capacitance	Differential Mode			5		pF
		Common Mode			5		pF
A_v	Open-loop Voltage Gain				110		dB
			Operating Range			90	
V_{CMR}	Common-mode Input Voltage Range			(V-)		(V+) - 2	V
CMRR	Common Mode Rejection Ratio	$V_{CM} = 0V$ to $28V$			120		dB
			Operating Range			90	
Output Characteristics							
V_{OH}, V_{OL}	Maximum Output Voltage Swing	$R_{LOAD} = 10k\Omega$ to $0V$			200	300	mV
		$R_{LOAD} = 2k\Omega$ to $0V$			1.1	1.3	V
V_{OL}	Maximum Output Voltage Swing Low	$V_S = 5V$, $R_{LOAD} = 10k\Omega$ to $0V$			5		mV
I_{SC}	Output Short-Circuit Current				30		mA
AC Specifications							
GBW	Gain-Bandwidth Product				0.9		MHz
SR	Slew Rate	$G = 1$, $2V$ step			0.5		$V/\mu s$
t_s	Settling Time, 0.1%	$G = 1$, $2V$ step			4		μs

	Settling Time, 0.01%				3.1		μs
PM	Phase Margin	$V_S = 30\text{V}, R_L = 1\text{K}, C_L = 100\text{pF}$			60		$^\circ$
GM	Gain Margin	$V_S = 30\text{V}, R_L = 1\text{K}, C_L = 100\text{pF}$			15		dB
	Channel Separation	$f = 1\text{ kHz to } 20\text{ kHz}$			80		dB
Noise Performance							
E_N	Input Voltage Noise	$f = 0.1\text{Hz to } 10\text{Hz}$			3		μV_{RMS}
e_N	Input Voltage Noise Density	$f = 1\text{kHz}$			70		$\text{nV}/\sqrt{\text{Hz}}$
i_N	Input Current Noise	$f = 1\text{kHz}$			3		$\text{fA}/\sqrt{\text{Hz}}$
THD+N	Total Harmonic Distortion and Noise	$f = 1\text{kHz}, G = 1, R_L = 10\text{k}\Omega,$ $V_{\text{OUT}} = 6\text{V}_{\text{RMS}}$			0.001		%

Typical Performance Characteristics

$V_s = \pm 15V$, $V_{CM} = 0V$, $R_L = 10k\Omega$, unless otherwise specified.

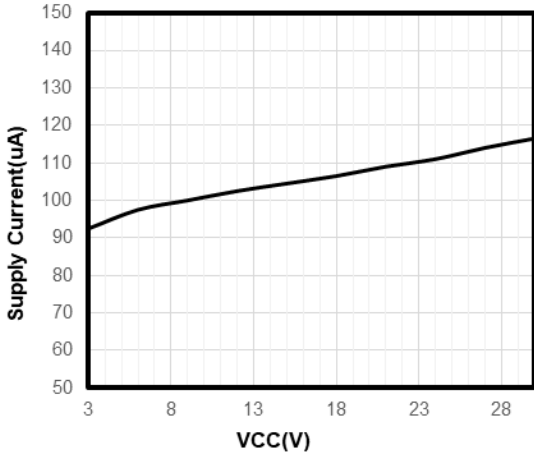


Figure 1. Quiescent Current vs. Supply Voltage

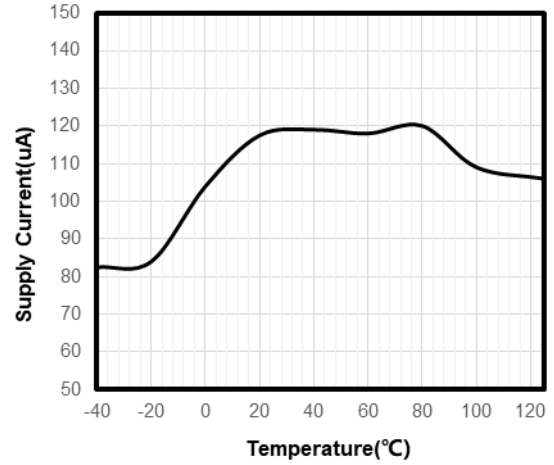


Figure 2. Quiescent Current vs. Temperature

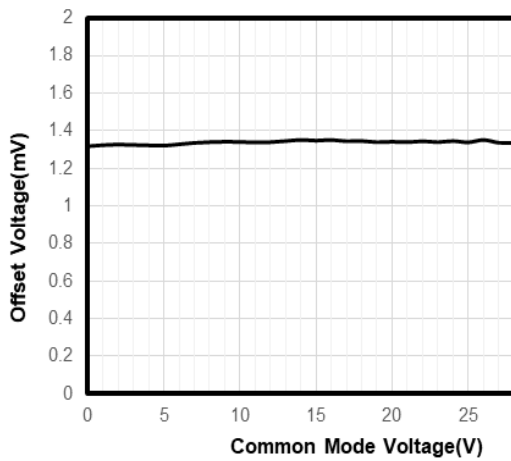


Figure 3. Offset Voltage vs. Common Mode Voltage

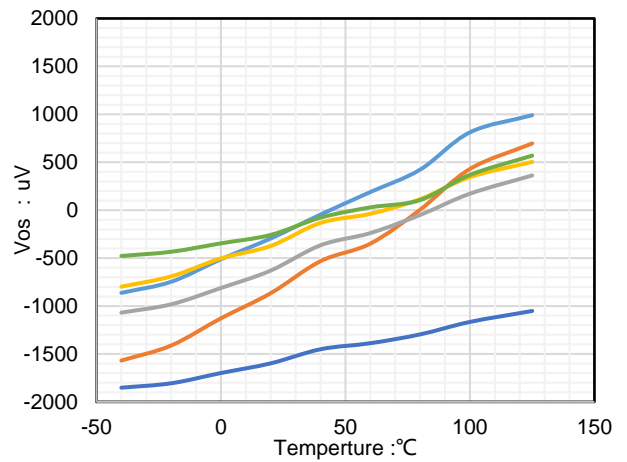


Figure 4. Offset Voltage vs. Temperature

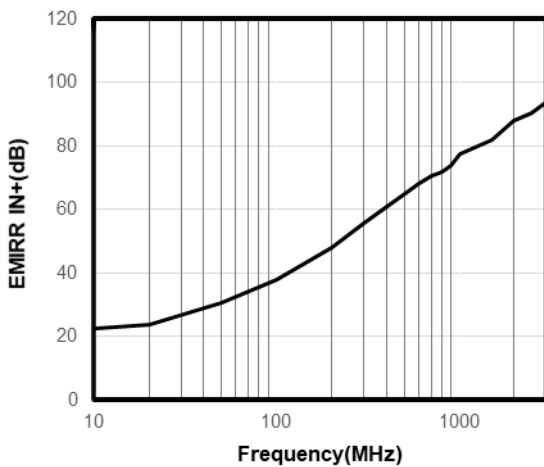


Figure 5. EMIRR+ vs. Frequency

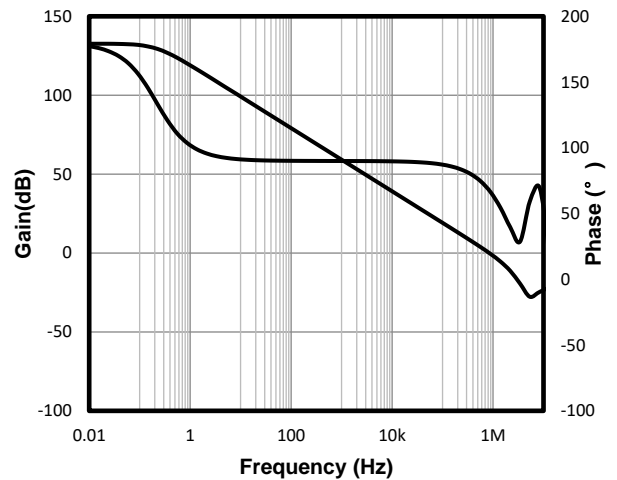


Figure 6. Open Loop Gain and Phase vs. Frequency

$V_s = \pm 15V$, $V_{CM} = 0V$, $R_L = 10k\Omega$, unless otherwise specified.

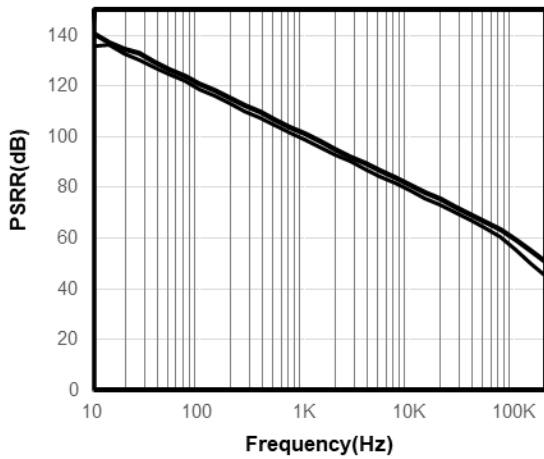


Figure 7. PSRR vs. Frequency

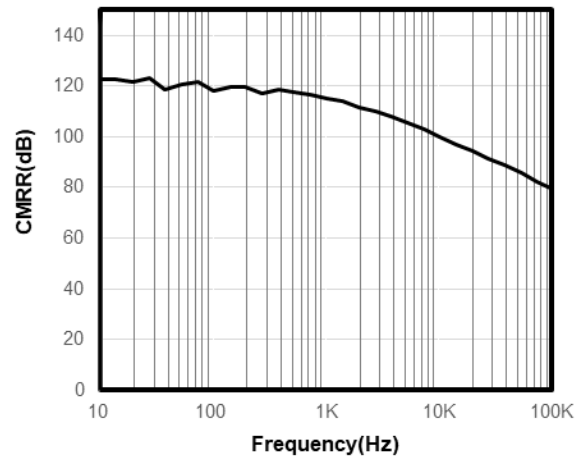


Figure 8. CMRR vs. Frequency

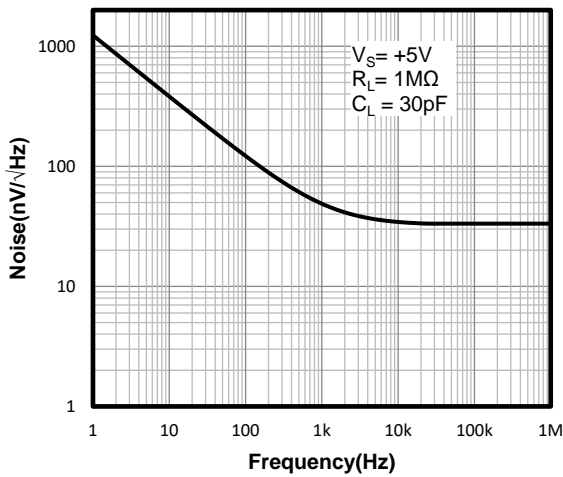


Figure 9. Voltage Noise Spectral Density vs. Frequency

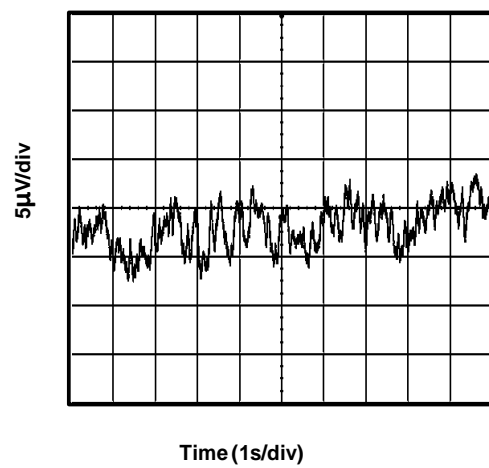
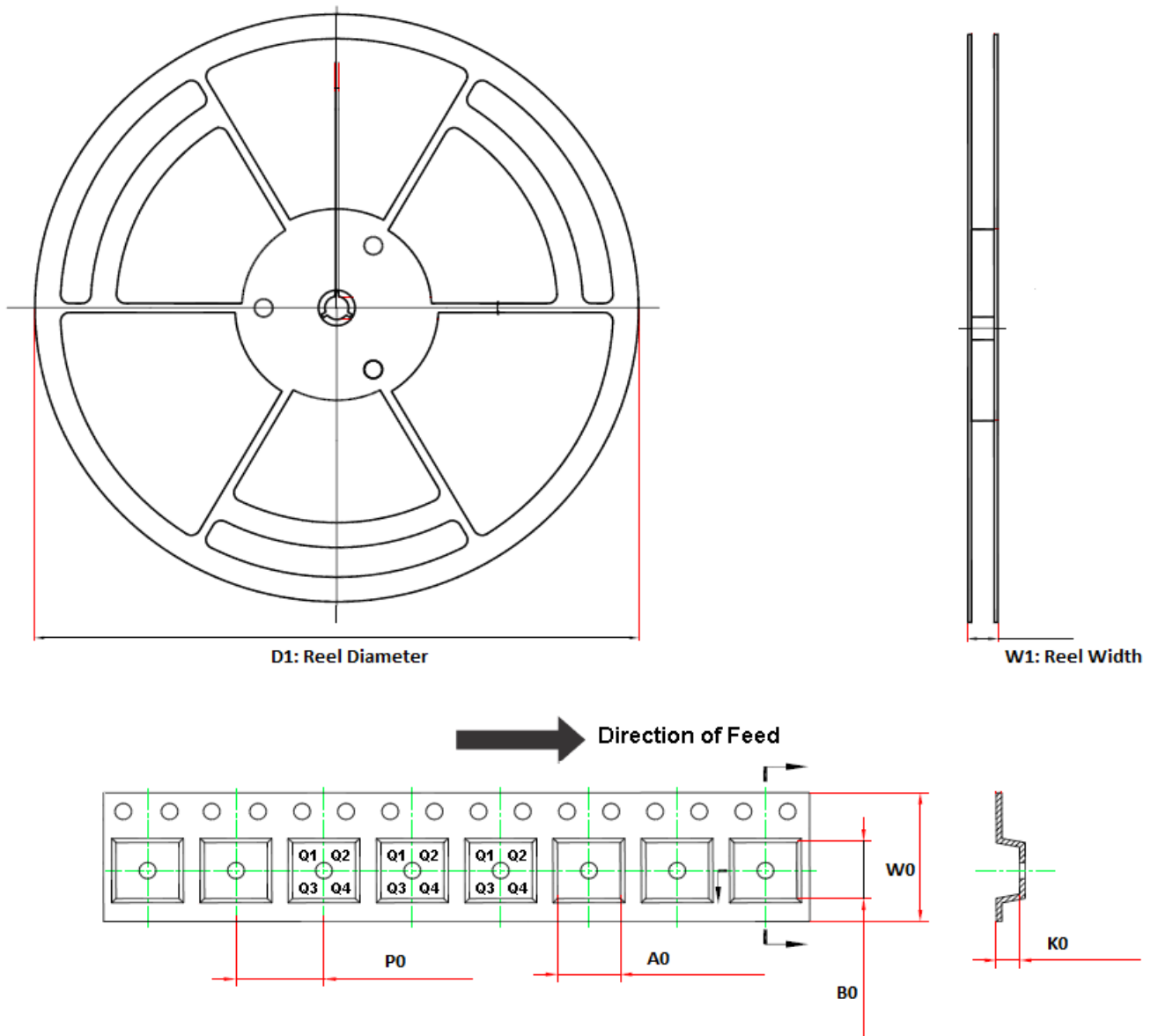
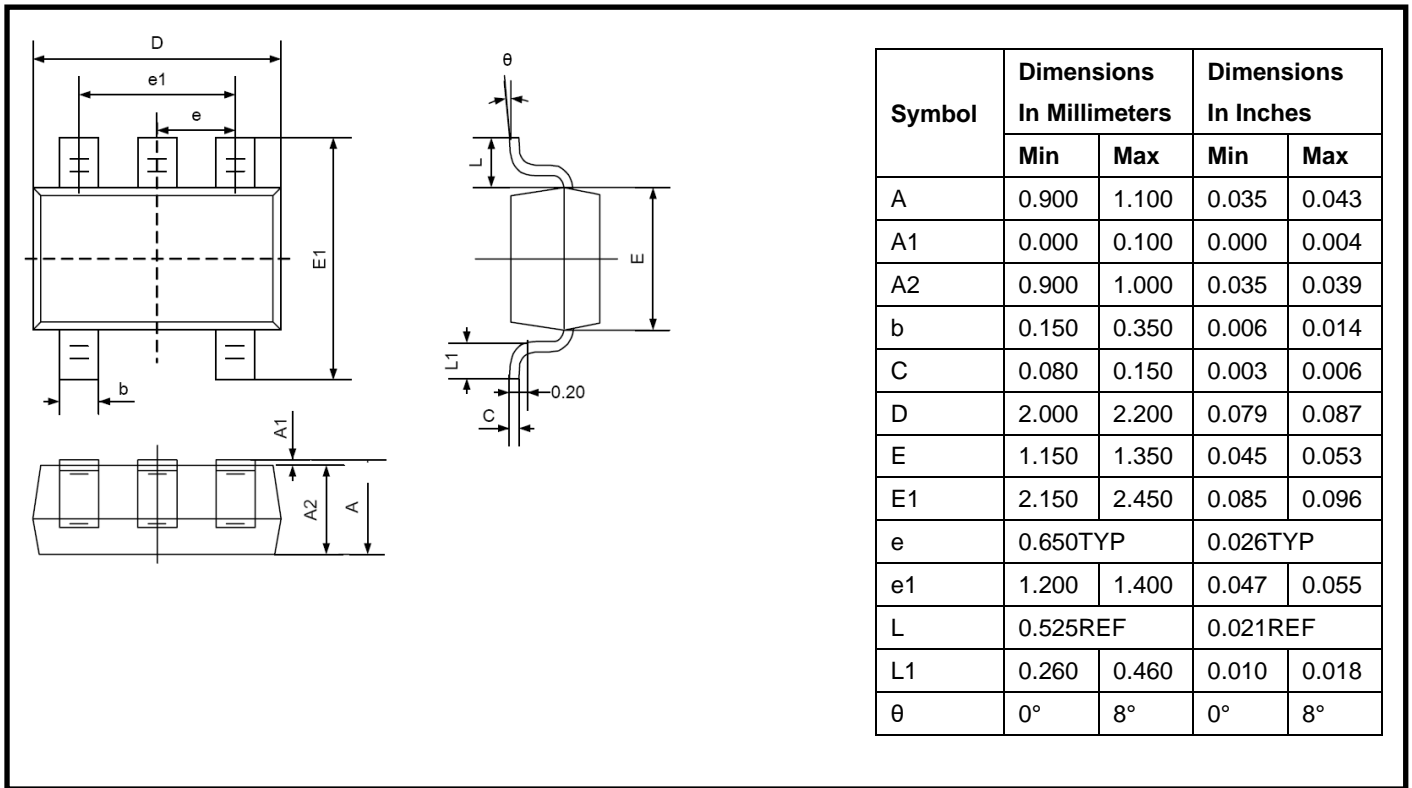
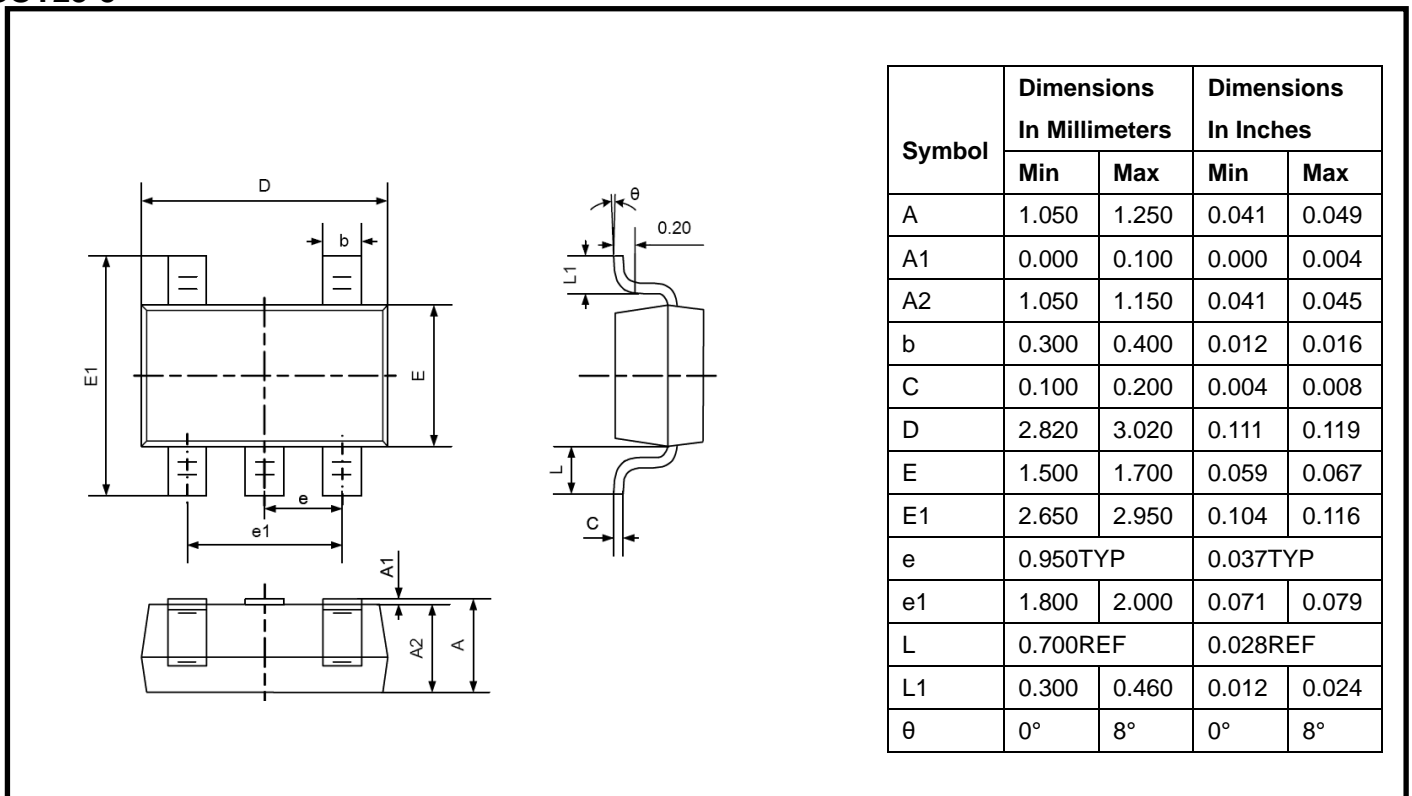


Figure 10. 0.1 Hz TO 10 Hz Input Voltage Noise

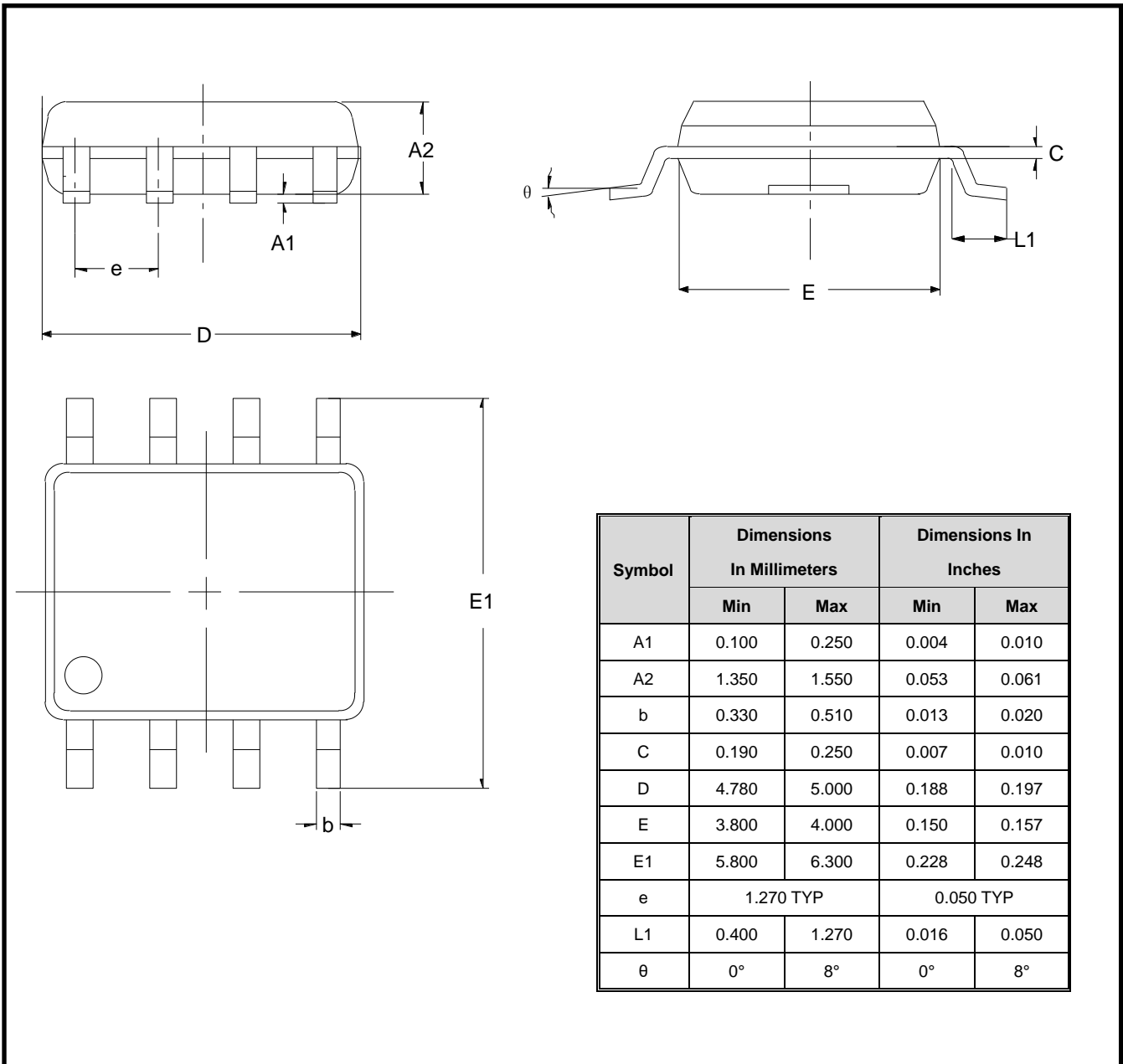
Tape and Reel Information



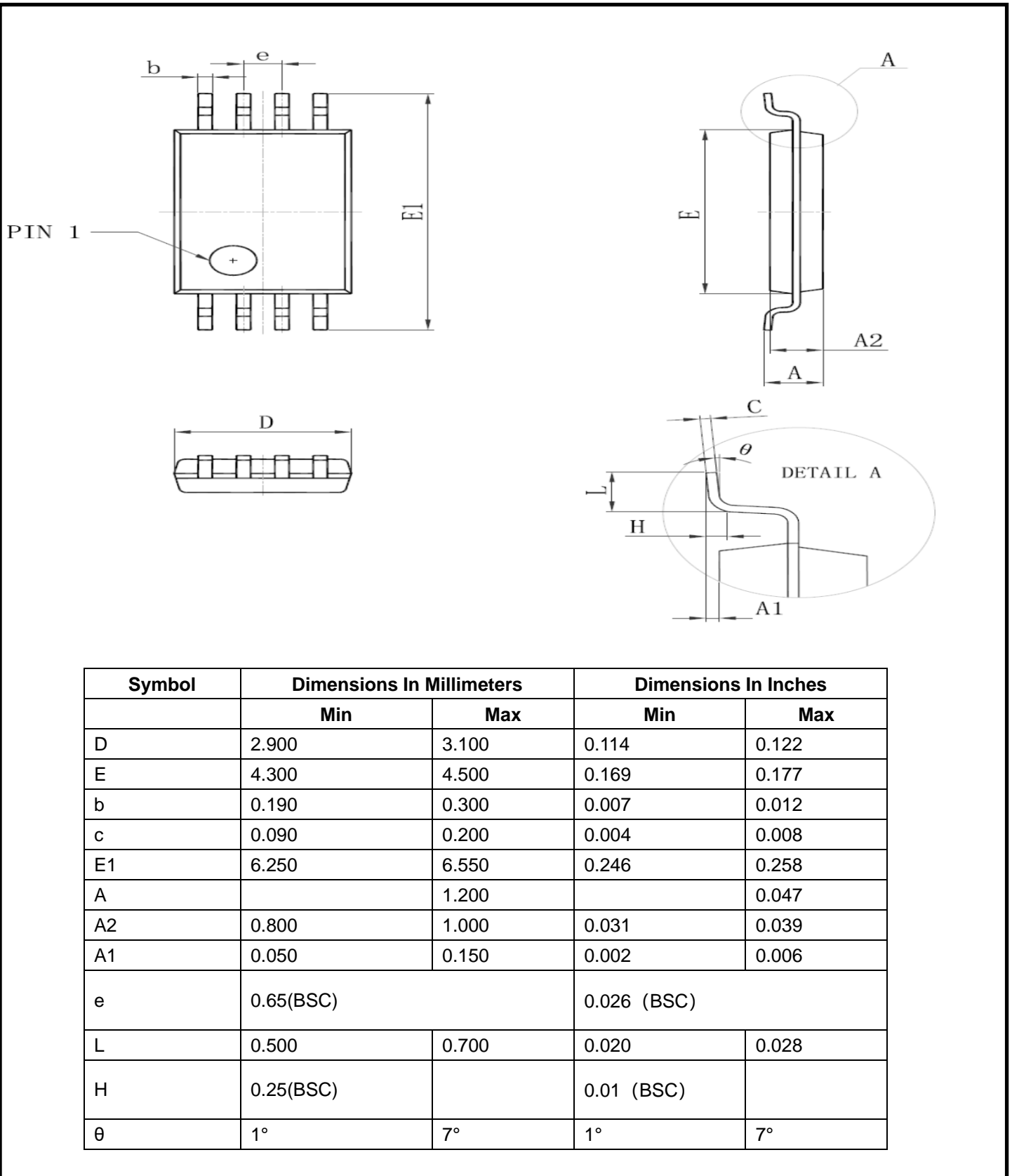
Order Number	Package	D1	W1	A0	B0	K0	P0	W0	Pin1 Quadrant
LM321A-TR	5-Pin SOT23	180.0	13.1	3.2	3.2	1.4	4.0	8.0	Q3
LM358A-SR	8-Pin SOIC	330.0	17.6	6.4	5.4	2.1	8.0	12.0	Q1
LM358A-VR	8-Pin MSOP	330.0	17.6	5.2	3.3	1.5	8.0	12.0	Q1
LM358A-TSR	8-Pin TSSOP	330.0	17.6	6.8	3.3	1.2	8.0	12.0	Q1
LM324A-SR	14-Pin SOIC	330.0	21.6	6.5	9.0	2.1	8.0	16.0	Q1
LM324A-TR	14-Pin TSSOP	330.0	17.6	6.8	5.4	1.2	8.0	12.0	Q1

Package Outline Dimensions
SC70-5 /SOT-353

SOT23-5


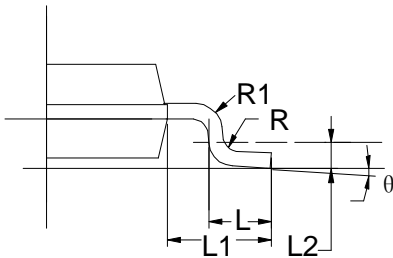
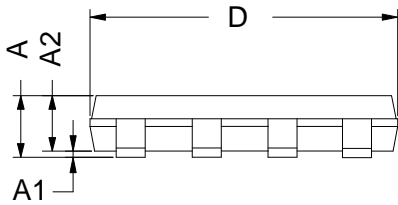
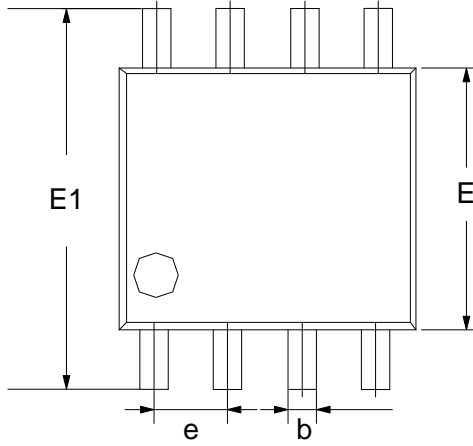
SOP-8



TSSOP-8

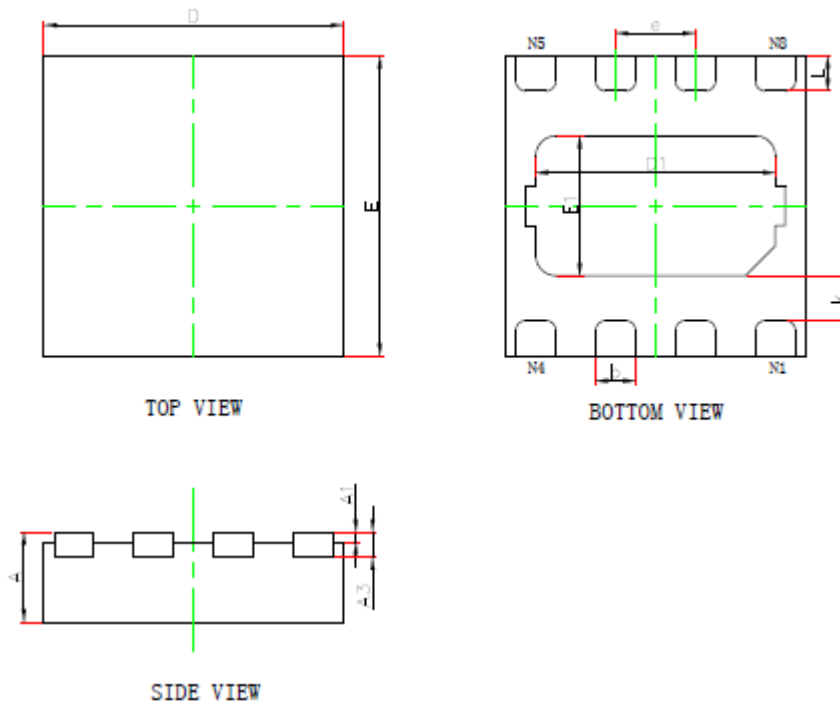


MSOP-8



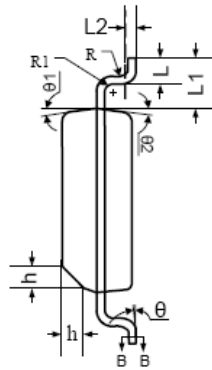
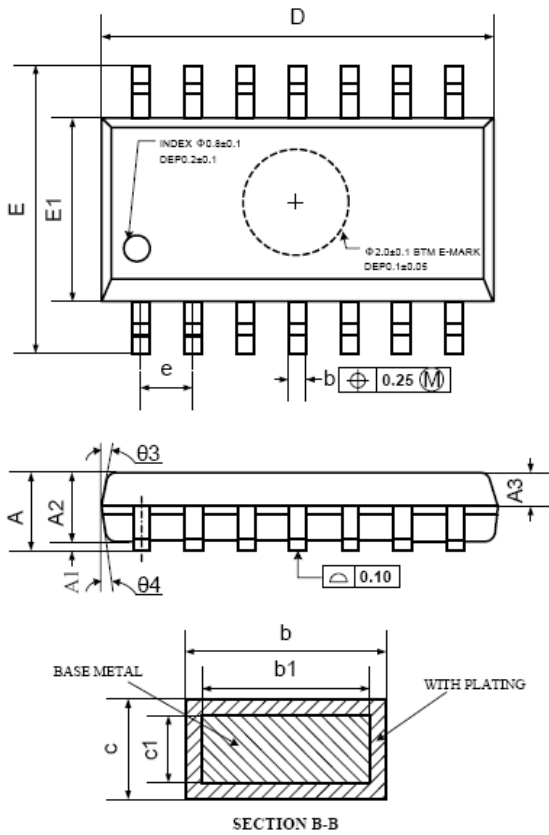
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.800	1.200	0.031	0.047
A1	0.000	0.200	0.000	0.008
A2	0.760	0.970	0.030	0.038
b	0.30 TYP		0.012 TYP	
C	0.15 TYP		0.006 TYP	
D	2.900	3.100	0.114	0.122
e	0.65 TYP		0.026	
E	2.900	3.100	0.114	0.122
E1	4.700	5.100	0.185	0.201
L1	0.410	0.650	0.016	0.026
θ	0°	6°	0°	6°

DFN-8 1.5*1.5



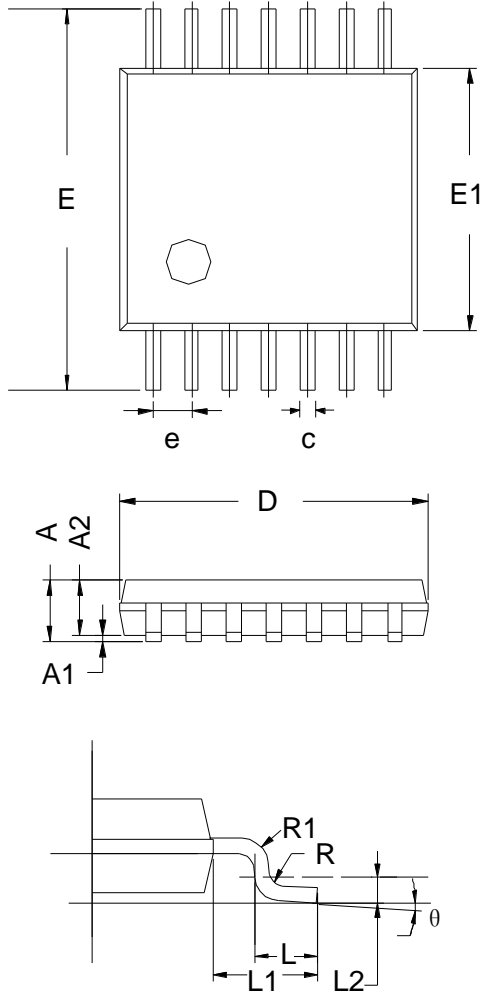
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	0.400	0.500	0.016	0.020
A1	0.000	0.050	0.000	0.002
A3	0.700	0.800		
A3	0.127REF.		0.005REF.	
D	1.450	1.550	0.057	0.061
E	1.450	1.550	0.057	0.061
D1	1.100	1.300	0.043	0.051
E1	0.600	0.800	0.024	0.031
k	0.200MIN.		0.008REF.	
b	0.150	0.250	0.006	0.010
e	0.400TYP.		0.016TYP.	
L	0.099	0.251	0.004	0.010

SOP-14



Symbol	Dimensions In Millimeters		
	MIN	NOM	MAX
A	1.35	1.60	1.75
A1	0.10	0.15	0.25
A2	1.25	1.45	1.65
A3	0.55	0.65	0.75
b	0.36		0.49
b1	0.35	0.40	0.45
c	0.16		0.25
c1	0.15	0.20	0.25
D	8.53	8.63	8.73
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e	1.27 BSC		
L	0.45	0.60	0.80
L1	1.04 REF		
L2	0.25 BSC		
R	0.07		
R1	0.07		
h	0.30	0.40	0.50
θ	0°		8°
$\theta 1$	6°	8°	10°
$\theta 2$	6°	8°	10°
$\theta 3$	5°	7°	9°
$\theta 4$	5°	7°	9°

TSSOP-14



Symbol	Dimensions In Millimeters		
	MIN	TYP	MAX
A	-	-	1.20
A1	0.05	-	0.15
A2	0.90	1.00	1.05
b	0.20	-	0.28
c	0.10	-	0.19
D	4.86	4.96	5.06
E	6.20	6.40	6.60
E1	4.30	4.40	4.50
e	0.65 BSC		
L	0.45	0.60	0.75
L1	1.00 REF		
L2	0.25 BSC		
R	0.09	-	-
θ	0°	-	8°

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