

## Features

- Supply Voltage: 3V to 36V
- Low Supply Current: 700 $\mu$ A per channel
- Rail to Rail Output
- Bandwidth: 4 MHz
- Slew Rate: 15V/ $\mu$ s
- Excellent EMI Suppress Performance
- Offset Voltage:  $\pm$ 3mV Maximum
- Offset Voltage Temperature Drift: 2  $\mu$ V/ $^{\circ}$ C
- Low Noise: 30 nV/ $\sqrt$ Hz at 1kHz
- $-40^{\circ}$ C to  $125^{\circ}$ C Operation Temperature Range

## Applications

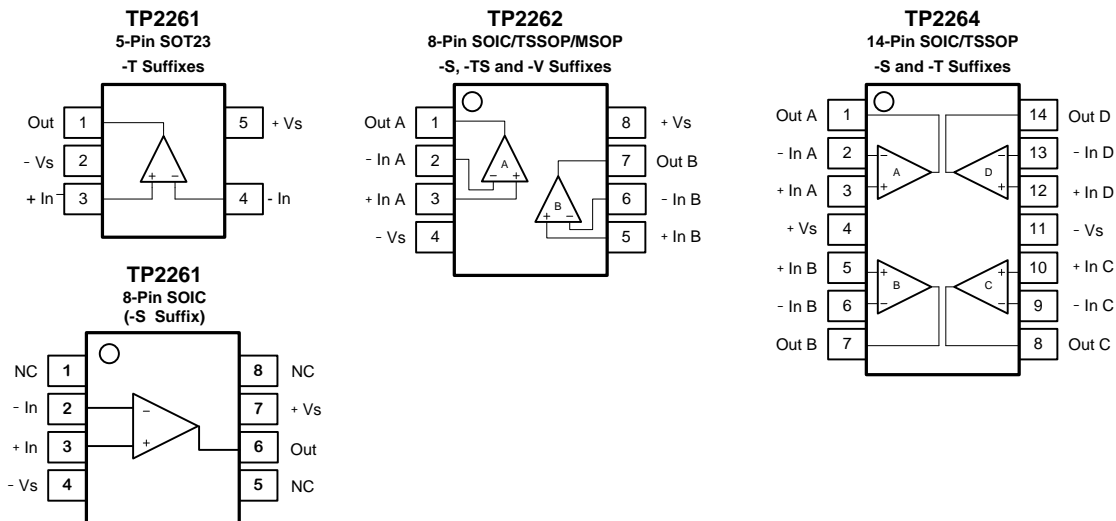
- Active Filters, ASIC Input or Output Amplifier
- Sensor Interface
- Motor Control
- Industrial Control
- Audio

## Description

The TP226X series amplifiers are newest high supply voltage amplifiers with low offset, low power and stable high frequency response. They incorporate 3PEAK's proprietary and patented design techniques to achieve very good AC performance with 4MHz bandwidth, 15V/ $\mu$ s slew rate and low distortion while drawing only 700 $\mu$ A of quiescent current per amplifier. The input common-mode voltage range extends to  $V_{-}$ , and the outputs swing rail-to-rail. The TP226X 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 TP226X ideal choices for industrial control, motor control and portable audio amplification, sound ports, and other consumer Audio.

## Pin Configuration



## Table of Contents

Features .....	1
Applications.....	1
Description.....	1
Pin Configuration .....	1
Table of Contents .....	2
Revision History .....	3
Order Information.....	3
Absolute Maximum Ratings <sup>Note 1</sup> .....	4
ESD Rating.....	4
Thermal Information .....	4
Electrical Characteristics .....	5
Typical Performance Characteristics .....	7
Tape and Reel Information .....	12
Package Outline Dimensions.....	13
SC70-5 /SOT-353.....	13
SOT23-5.....	13
SOP-8 .....	14
TSSOP-8.....	15
MSOP-8 .....	16
SOP-14 .....	17
TSSOP-14.....	18

## Revision History

Date	Revision	Notes
2017/12/21	Rev.Pre	Pre-Release Version

## Order Information

Order Number	Operating Temperature Range	Package	Marking Information	MSL	Transport Media, Quantity
TP2261-SR <sup>Note 1</sup>	-40 to 125°C	8-Pin SOIC	2261 XXXX <sup>Note 3</sup>	3	Tape and Reel, 4000
TP2261-TR <sup>Note 1</sup>	-40 to 125°C	5-Pin SOT23	226XX <sup>Note 2</sup>	3	Tape and Reel, 3000
TP2262-SR	-40 to 125°C	8-Pin SOIC	2262 XXXX <sup>Note 3</sup>	3	Tape and Reel, 4000
TP2262-TSR <sup>Note 1</sup>	-40 to 125°C	8-Pin TSSOP	2262 XXXX <sup>Note 3</sup>	3	Tape and Reel, 3000
TP2262-VR <sup>Note 1</sup>	-40 to 125°C	8-Pin MSOP	2262 XXXX <sup>Note 3</sup>	3	Tape and Reel, 3000
TP2264-SR	-40 to 125°C	14-Pin SOIC	2264 XXXX <sup>Note 3</sup>	3	Tape and Reel, 2500
TP2264-TR <sup>Note 1</sup>	-40 to 125°C	14-Pin TSSOP	2264 XXXX <sup>Note 3</sup>	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 <sup>Note 1</sup>

Parameters	Rating
Supply Voltage, (+V <sub>S</sub> )– (-V <sub>S</sub> )	40 V
Input Voltage	(-V <sub>S</sub> ) – 0.3 to (+V <sub>S</sub> ) + 0.3
Differential Input Voltage	(+V <sub>S</sub> ) - (-V <sub>S</sub> )
Input Current: +IN, –IN <sup>Note 2</sup>	±10mA
Output Short-Circuit Duration <sup>Note 3</sup>	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	2	kV
CDM	Charged Device Model ESD	JEDEC-EIA/JESD22-C101E	1	kV

## Thermal Information

Package Type	θ <sub>JA</sub>	θ <sub>JC</sub>	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  $V_S = 30V$ ,  $T_A = 25^\circ C$ ,  $R_L = 10k\Omega$ , unless otherwise noted.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Power Supply</b>						
$V_S$	Supply Voltage Range		3		36	V
$I_Q$	Quiescent Current per Amplifier	$V_S = 30V$		700	1000	μA
		$V_S = 30V, T_A = -40^\circ C$ to $125^\circ C$				μA
		$V_S = 5V$		600	800	μA
		$V_S = 5V, T_A = -40^\circ C$ to $125^\circ C$				
PSRR	Power Supply Rejection Ratio	$V_S = 3V$ to $36V$		120		dB
		$V_S = 3V$ to $36V, T_A = -40^\circ C$ to $125^\circ C$				
<b>Input Characteristics</b>						
$V_{OS}$	Input Offset Voltage	$V_S = 30V, V_{CM} = 0V$ to $28V$	-3	0.1	3	mV
		$V_S = 30V, V_{CM} = 0V$ to $28V, T_A = -40^\circ C$ to $125^\circ C$				mV
		$V_S = 5V, V_{CM} = 0V$ to $3V$	-3	0.1	3	mV
		$V_S = 5V, V_{CM} = 0V$ to $3V, T_A = -40^\circ C$ to $125^\circ C$				mV
$V_{OS\ TC}$	Input Offset Voltage Drift	$T_A = -40^\circ C$ to $125^\circ C$		2		μV/°C
$I_B$	Input Bias Current			25		pA
		$T_A = -40^\circ C$ to $85^\circ C$		80		pA
		$T_A = -40^\circ C$ to $125^\circ C$		1000		pA
$I_{OS}$	Input Offset Current			25		pA
$I_{IN}$	Different Input Current	$V_S = 36V, V_{ID} = 36V$		1		nA
		$V_S = 36V, V_{ID} = 36V, T_A = -40^\circ C$ to $125^\circ C$		10		nA
$C_{IN}$	Input Capacitance	Differential Mode		5		pF
		Common Mode		5		pF
$A_V$	Open-loop Voltage Gain			120		dB
		$T_A = -40^\circ C$ to $125^\circ C$				dB
$V_{CMR}$	Common-mode Input Voltage Range		(V-)		(V+) - 2	V
CMRR	Common Mode Rejection Ratio	$V_{CM} = 0V$ to $28V$		120		dB
		$V_{CM} = 0V$ to $28V, T_A = -40^\circ C$ to $125^\circ C$				dB
<b>Output Characteristics</b>						
$V_{OH}, V_{OL}$	Maximum Output Voltage Swing	$R_{LOAD} = 10k\Omega$		200	300	mV
		$R_{LOAD} = 10k\Omega, T_A = -40^\circ C$ to $125^\circ C$				mV
$I_{SC}$	Output Short-Circuit Current			32		mA
		$T_A = -40^\circ C$ to $125^\circ C$				mA
<b>AC Specifications</b>						
GBW	Gain-Bandwidth Product			3.5		MHz
SR	Slew Rate	$G = 1, 10V$ step		15		V/μs
$t_{OR}$	Overload Recovery			100		ns

t <sub>s</sub>	Settling Time, 0.1%	G = -1, 10V step		0.8		μs
	Settling Time, 0.01%			1		μs
PM	Phase Margin	V <sub>S</sub> = 36V, R <sub>L</sub> =10K, C <sub>L</sub> =100pF		60		°
GM	Gain Margin	V <sub>S</sub> = 36V, R <sub>L</sub> =10K, C <sub>L</sub> =100pF		15		dB
Noise Performance						
E <sub>N</sub>	Input Voltage Noise	f = 0.1Hz to 10Hz		1.7		μV <sub>RMS</sub>
e <sub>N</sub>	Input Voltage Noise Density	f = 1kHz		30		nV/√Hz
i <sub>N</sub>	Input Current Noise	f = 1kHz		2		fA/√Hz
THD+N	Total Harmonic Distortion and Noise	f = 1kHz, G = 1, R <sub>L</sub> = 10kΩ, V <sub>OUT</sub> = 6V <sub>RMS</sub>		0.0005		%

## Typical Performance Characteristics

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

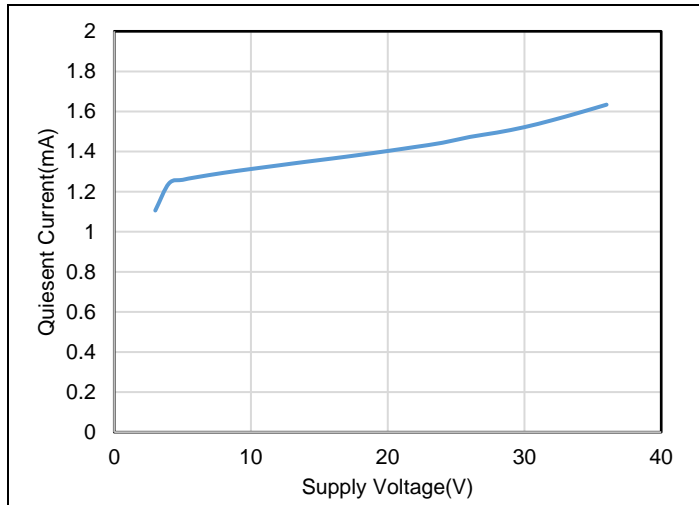


Figure 1. Quiescent Current vs. Supply Voltage, 2ch TP2262

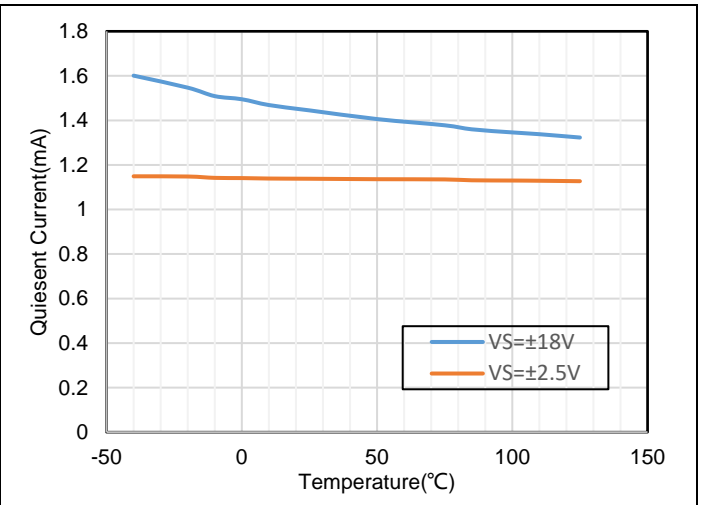


Figure 2. Quiescent Current vs. Temperature, 2ch TP2262

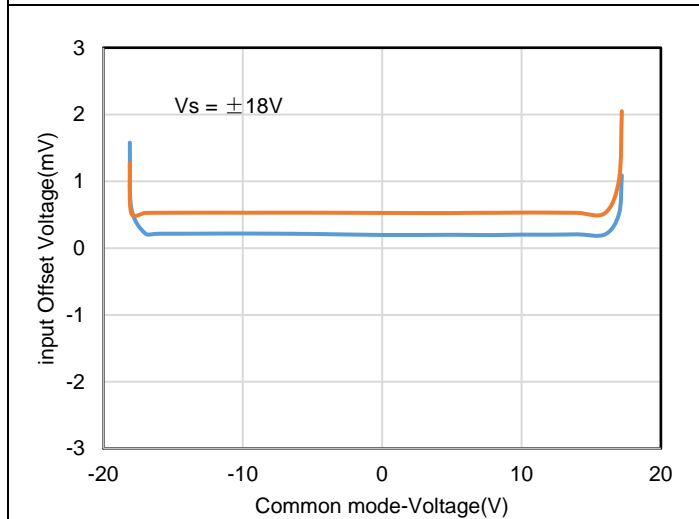


Figure 3. Offset Voltage vs. Common Mode Voltage

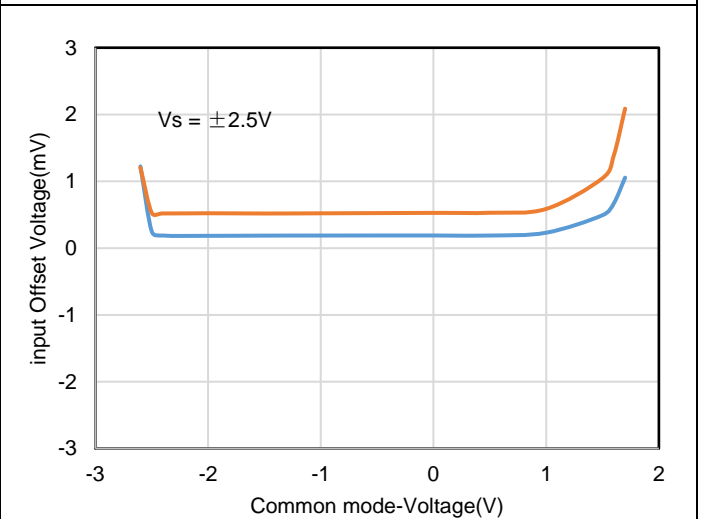


Figure 4. Offset Voltage vs. Common Mode Voltage

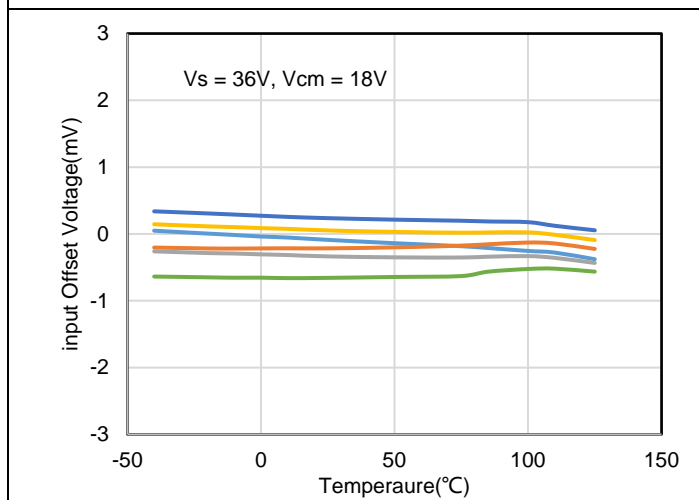


Figure 5.  $V_{OS}$  vs. Temperature

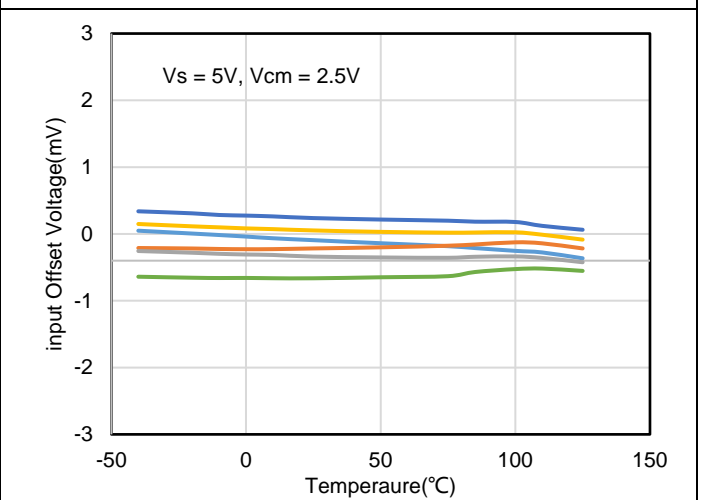
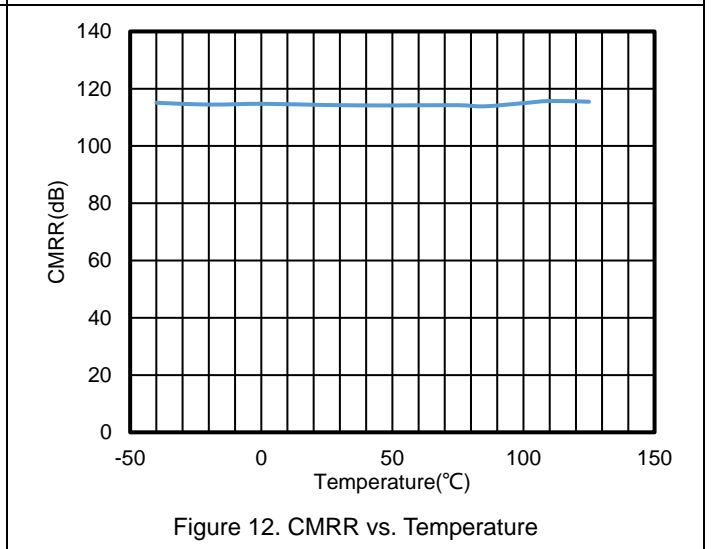
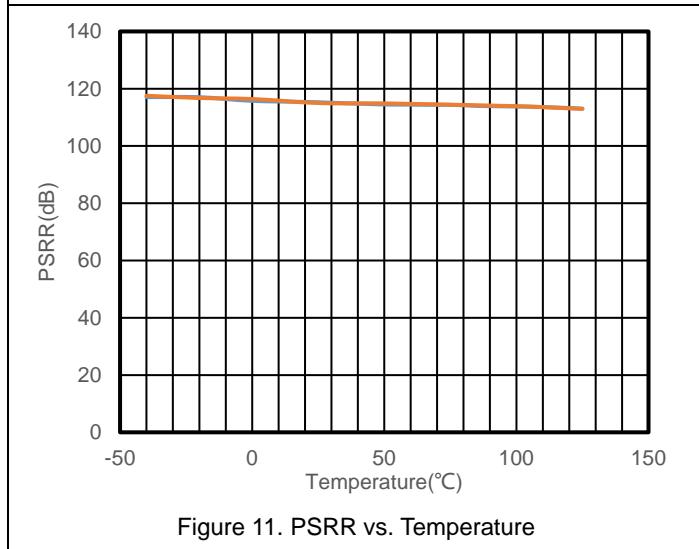
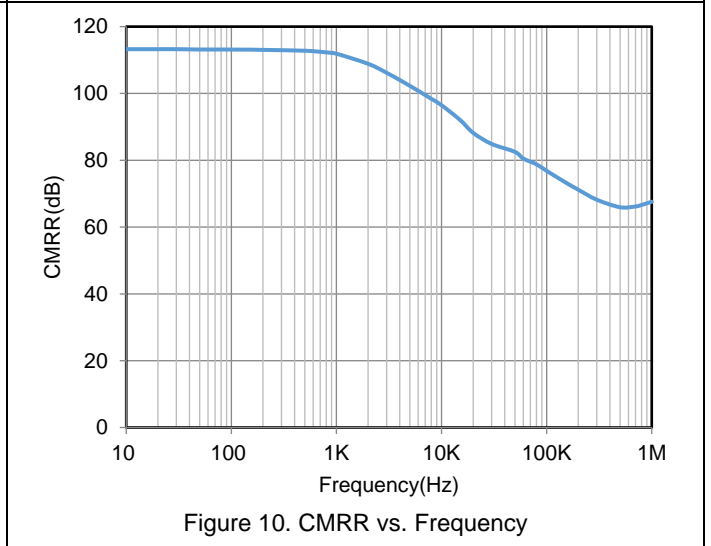
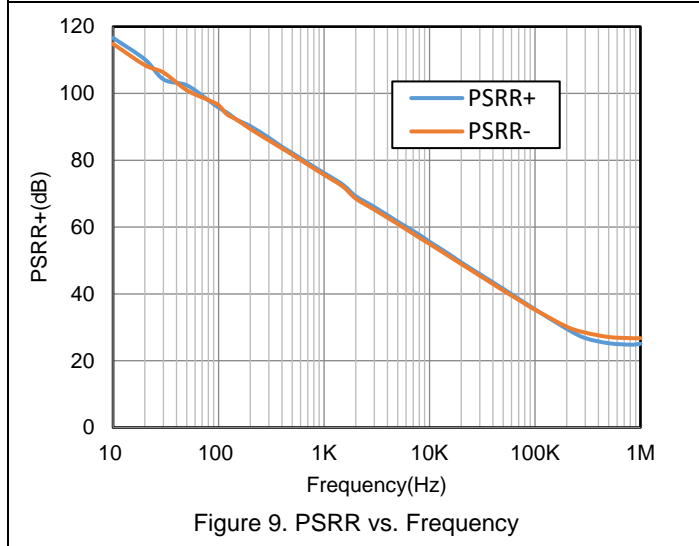
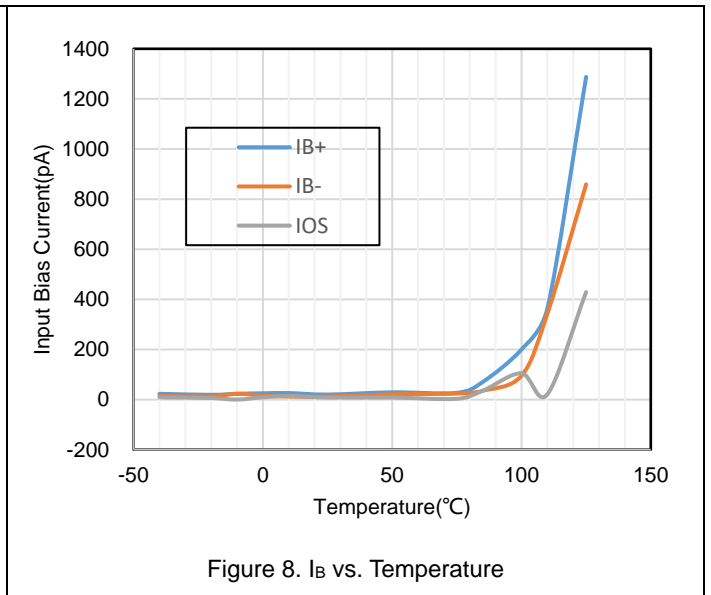
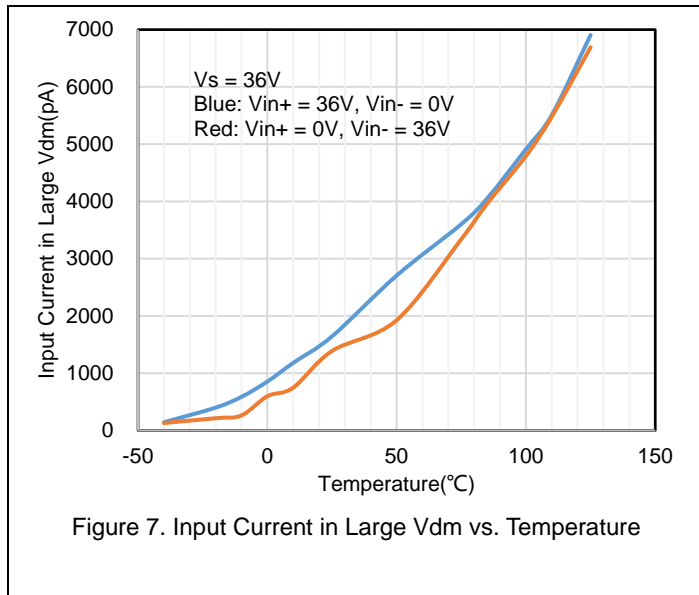


Figure 6.  $V_{OS}$  vs. Temperature

V<sub>s</sub> = ±15V, V<sub>CM</sub> = 0V, R<sub>L</sub> = 10kΩ, unless otherwise specified.





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

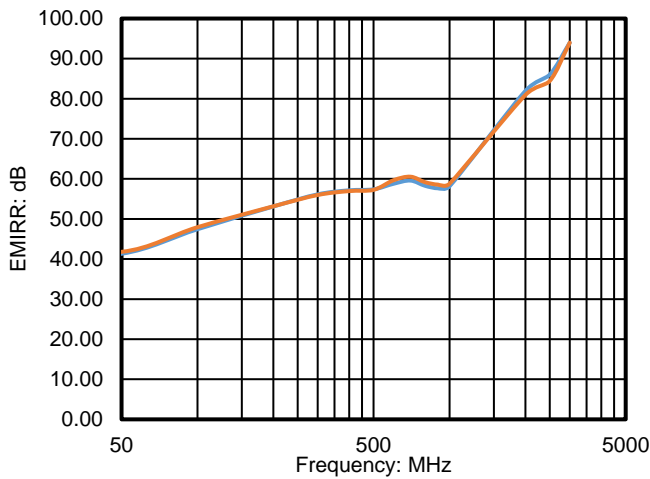


Figure 13. EMIRR+ vs. Frequency

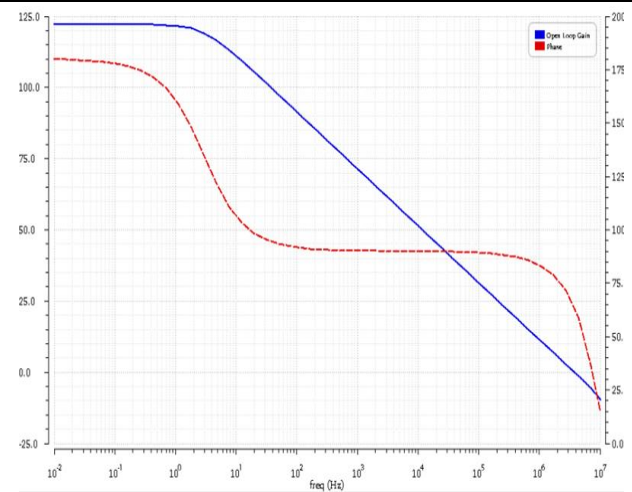


Figure 14. Open Loop Gain and Phase vs. Frequency

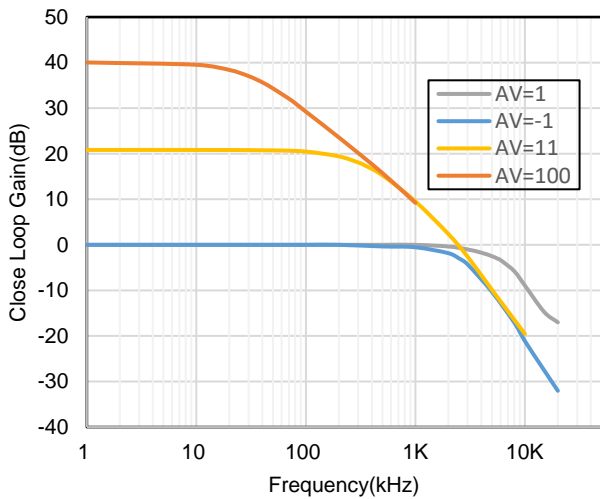
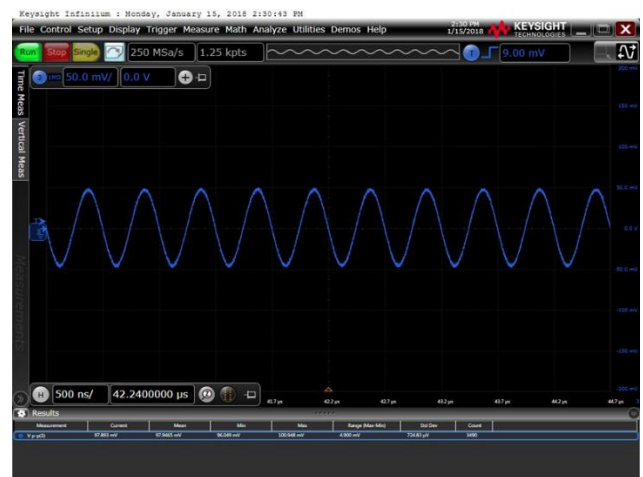


Figure 15. Close Loop Gain and Phase vs. Frequency



$V_s = \pm 1.5V$ ,  $V_{IN} = 100mV_{PP}$ ,  $R_L = 10K$ ,  $C_L = 100pF$ ,  $G = 1$

Figure 16. Waveform under 3V Supply Voltage

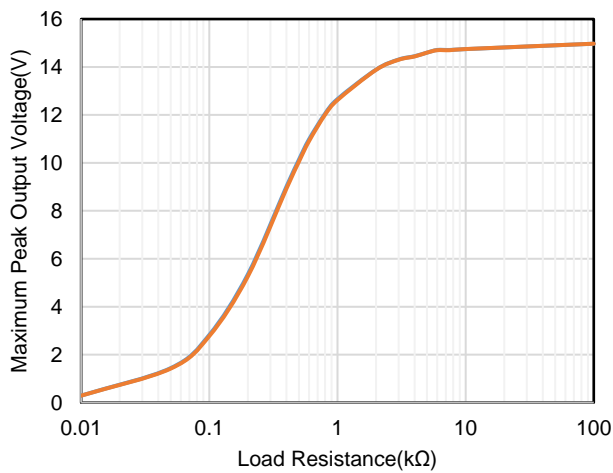


Figure 17. Maximum Peak Output Voltage vs. Load Resistance

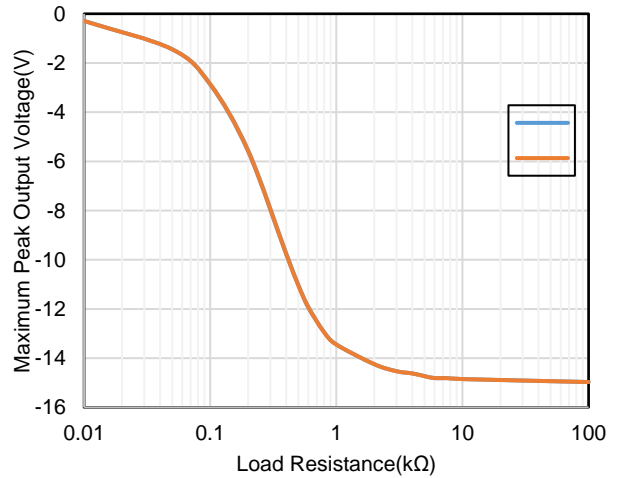


Figure 18. Maximum Peak Output Voltage vs. Load Resistance

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

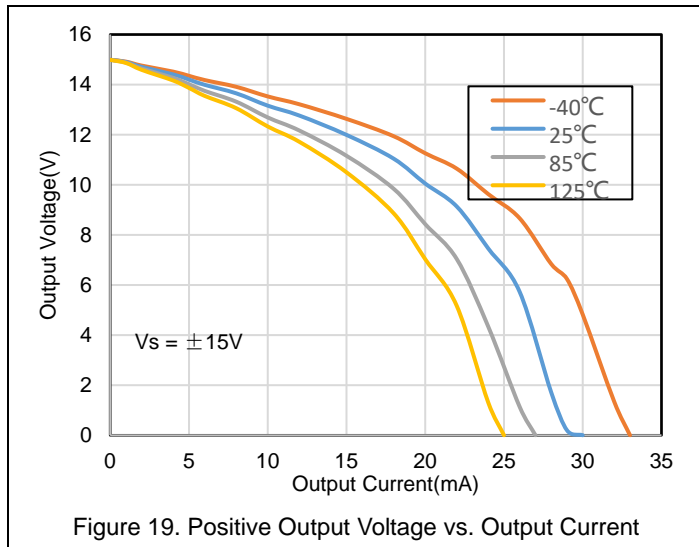


Figure 19. Positive Output Voltage vs. Output Current

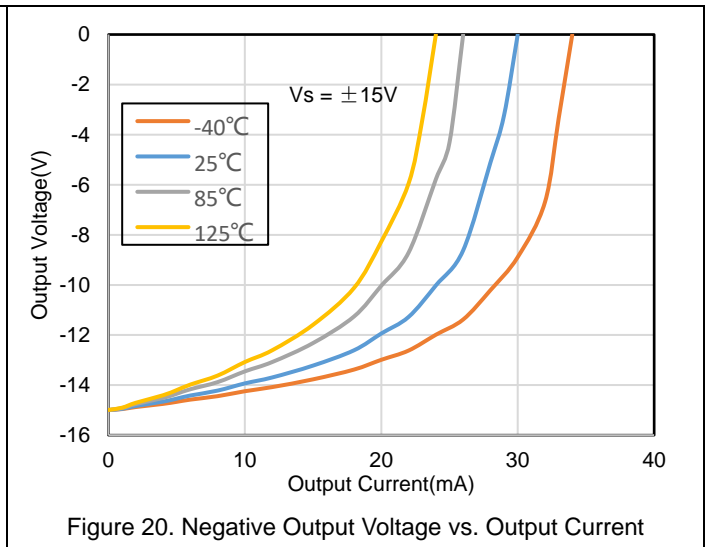


Figure 20. Negative Output Voltage vs. Output Current

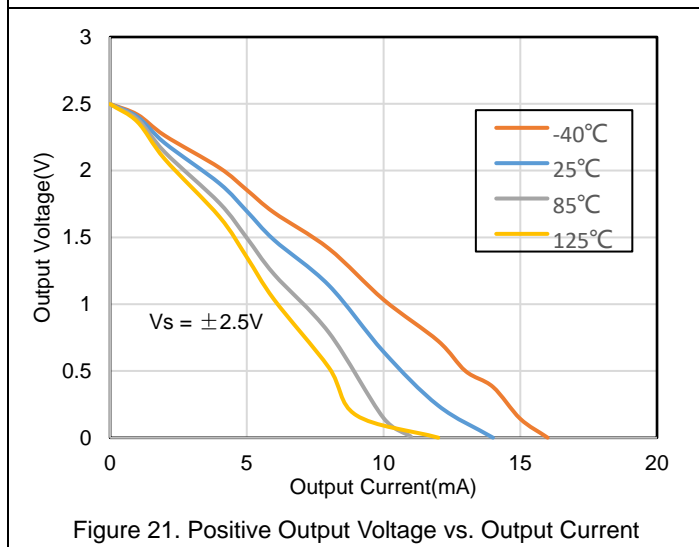


Figure 21. Positive Output Voltage vs. Output Current

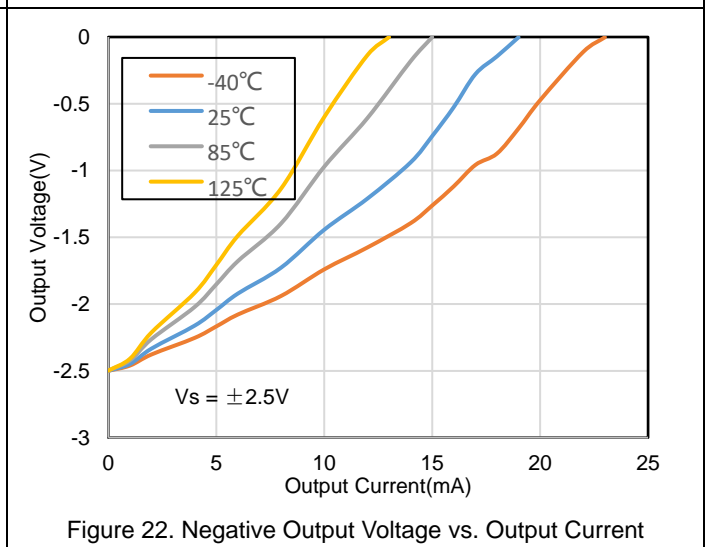
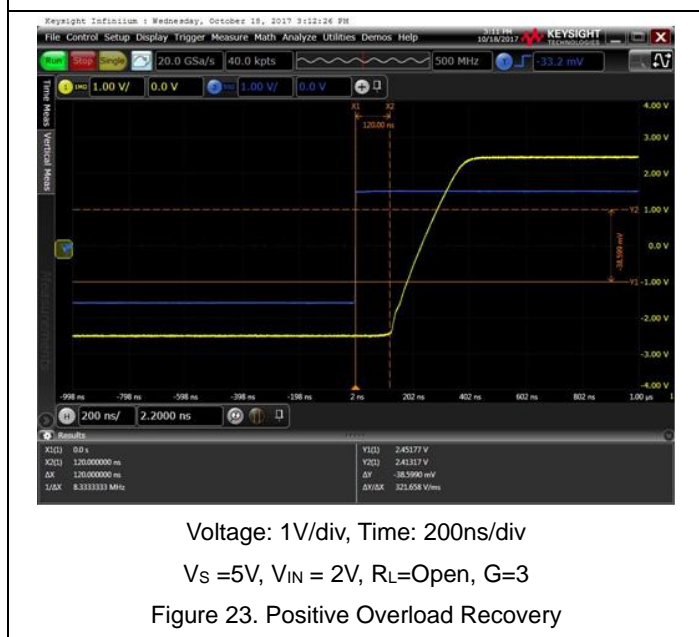
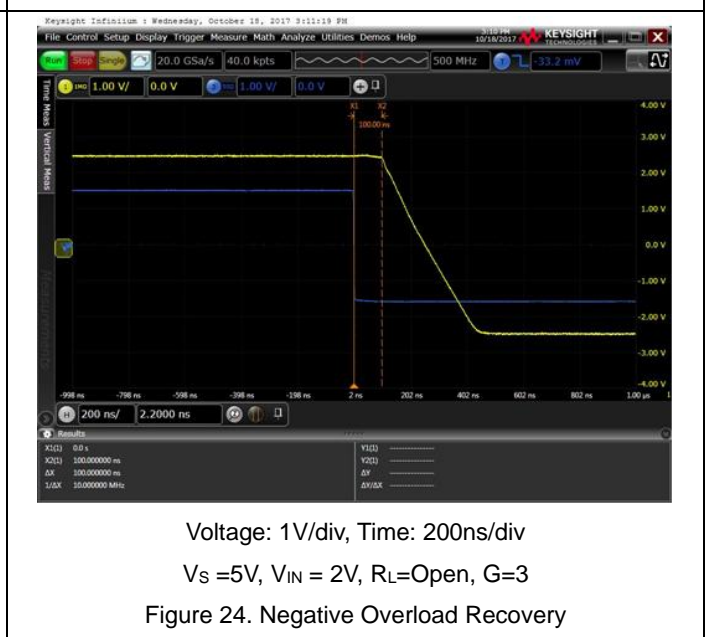


Figure 22. Negative Output Voltage vs. Output Current



Voltage: 1V/div, Time: 200ns/div  
 $V_s = 5V$ ,  $V_{IN} = 2V$ ,  $R_L = \text{Open}$ ,  $G = 3$   
 Figure 23. Positive Overload Recovery



Voltage: 1V/div, Time: 200ns/div  
 $V_s = 5V$ ,  $V_{IN} = 2V$ ,  $R_L = \text{Open}$ ,  $G = 3$   
 Figure 24. Negative Overload Recovery

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



Voltage: 20mV/div, Time: 100ns/div  
 $V_S = \pm 15V$ ,  $R_L = 2K$ ,  $C_L = 100pF$ ,  $G = 1$   
 Figure 25. 100mV Signal Step Response



Voltage: 2V/div, Time: 1 $\mu$ s/div  
 $V_S = \pm 15V$ ,  $R_L = 2K$ ,  $C_L = 100pF$ ,  $G = 1$   
 Figure 26. 10V Signal Step Response

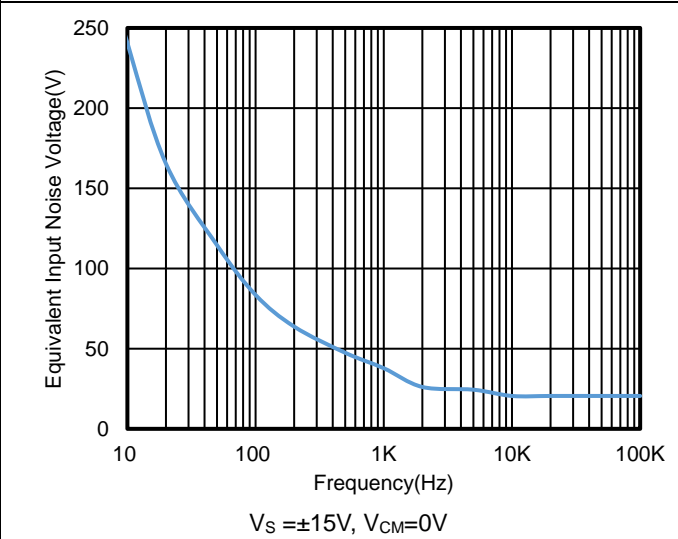


Figure 27. Voltage Noise Spectral Density vs. Frequency  
 $V_S = \pm 15V$ ,  $V_{CM} = 0V$

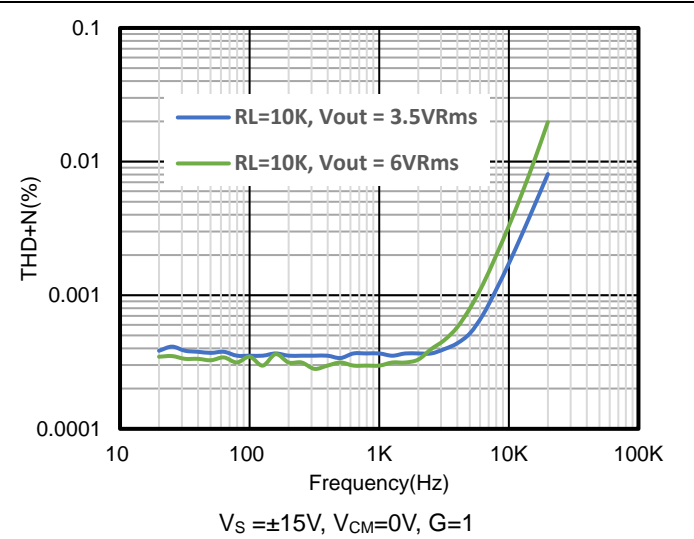
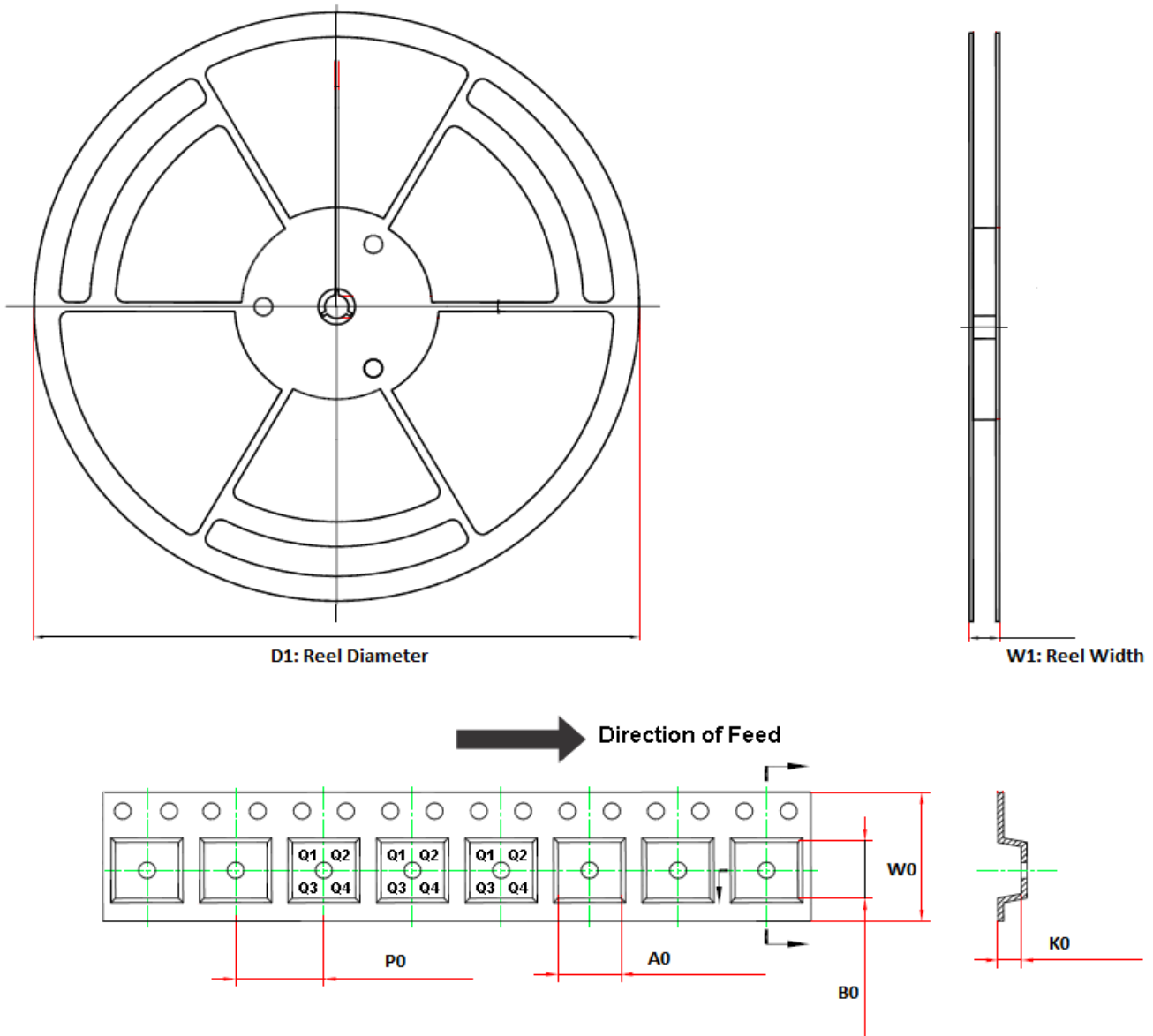


Figure 28. THD+N vs. Frequency  
 $V_S = \pm 15V$ ,  $V_{CM} = 0V$ ,  $G = 1$

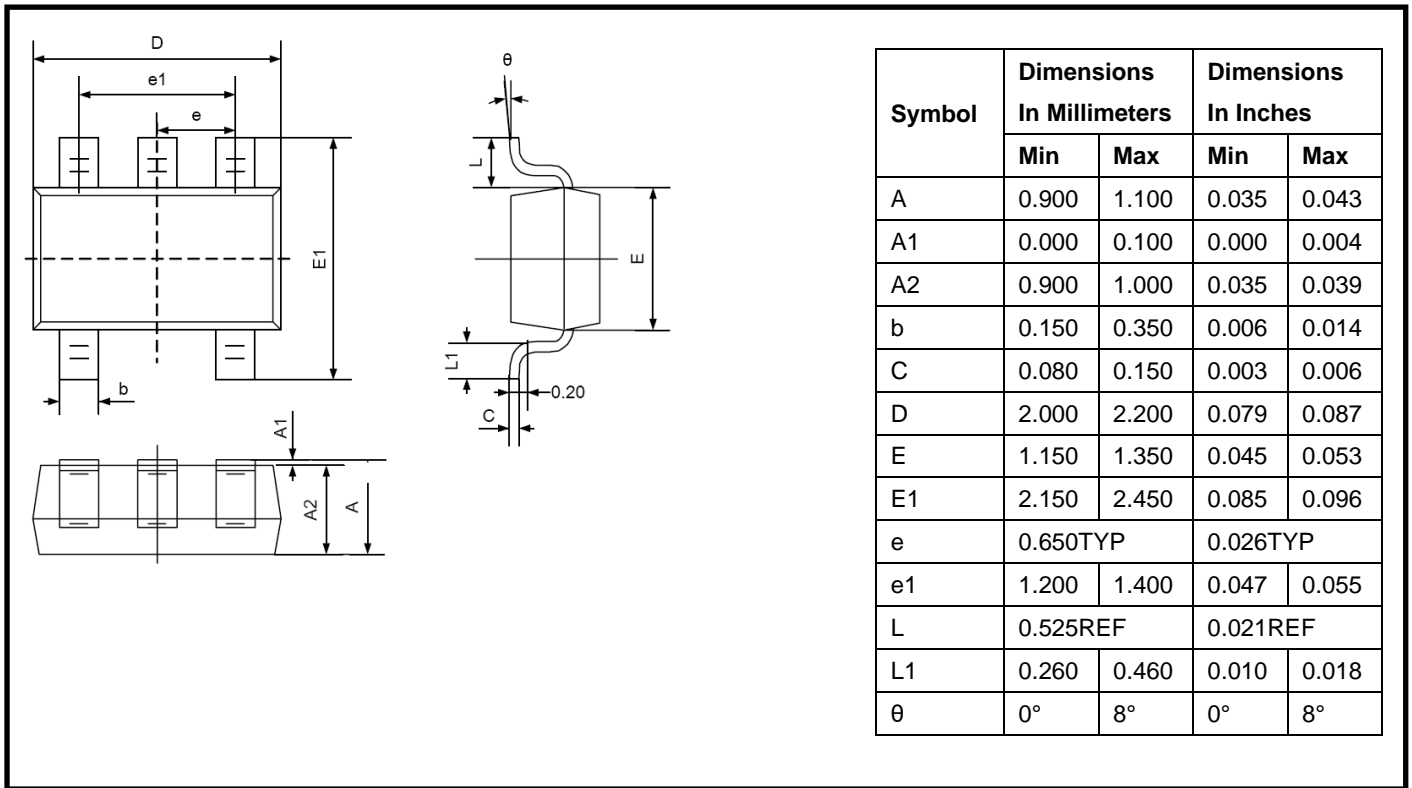
### Tape and Reel Information



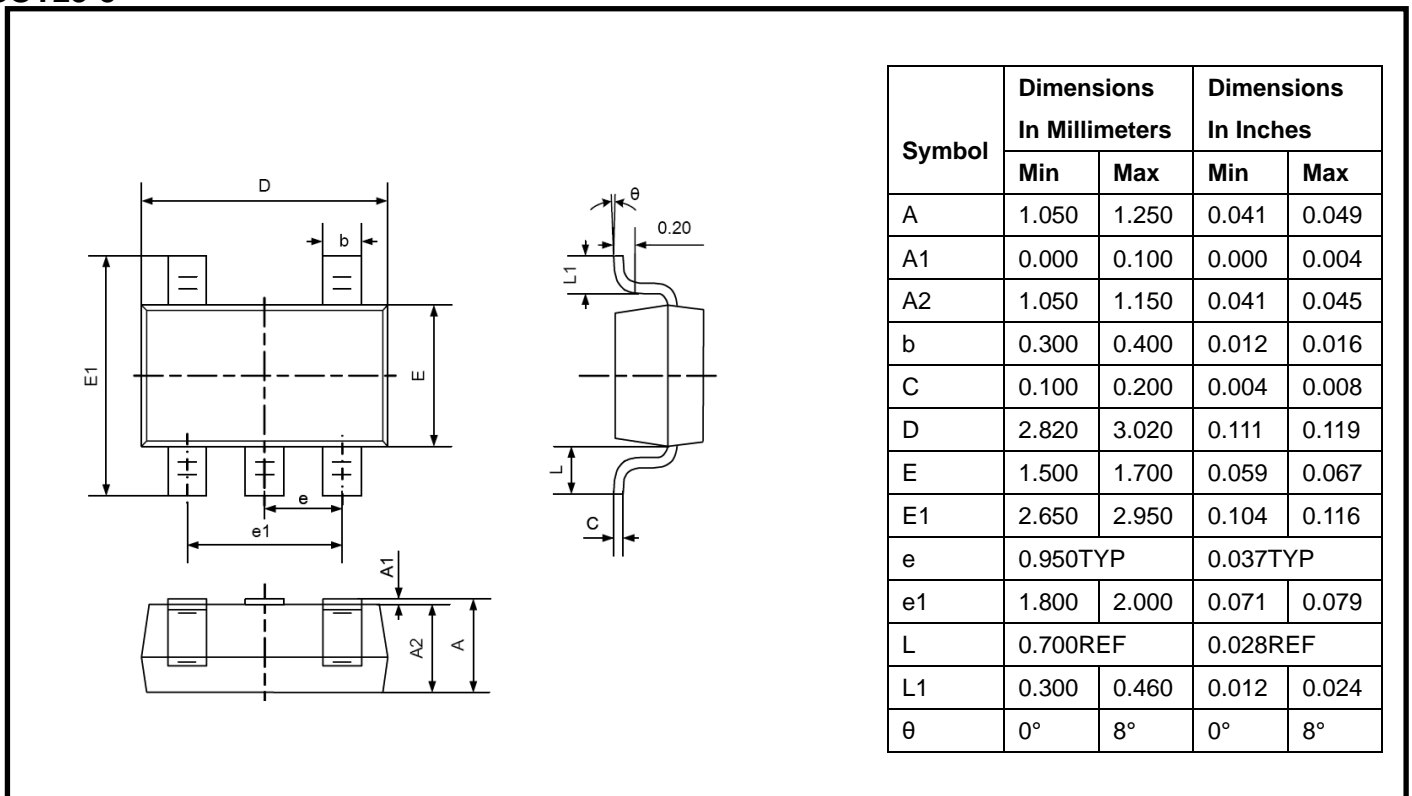
Order Number	Package	D1	W1	A0	B0	K0	P0	W0	Pin1 Quadrant
TP2261-TR	5-Pin SOT23	180.0	13.1	3.2	3.2	1.4	4.0	8.0	Q3
TP2261-SR	8-Pin SOIC	330.0	17.6	6.4	5.4	2.1	8.0	12.0	Q1
TP2262-SR	8-Pin SOIC	330.0	17.6	6.4	5.4	2.1	8.0	12.0	Q1
TP2262-VR	8-Pin MSOP	330.0	17.6	5.2	3.3	1.5	8.0	12.0	Q1
TP2262-TSR	8-Pin TSSOP	330.0	17.6	6.8	3.3	1.2	8.0	12.0	Q1
TP2264-SR	14-Pin SOIC	330.0	21.6	6.5	9.0	2.1	8.0	16.0	Q1
TP2264-TR	14-Pin TSSOP	330.0	17.6	6.8	5.4	1.2	8.0	12.0	Q1

### Package Outline Dimensions

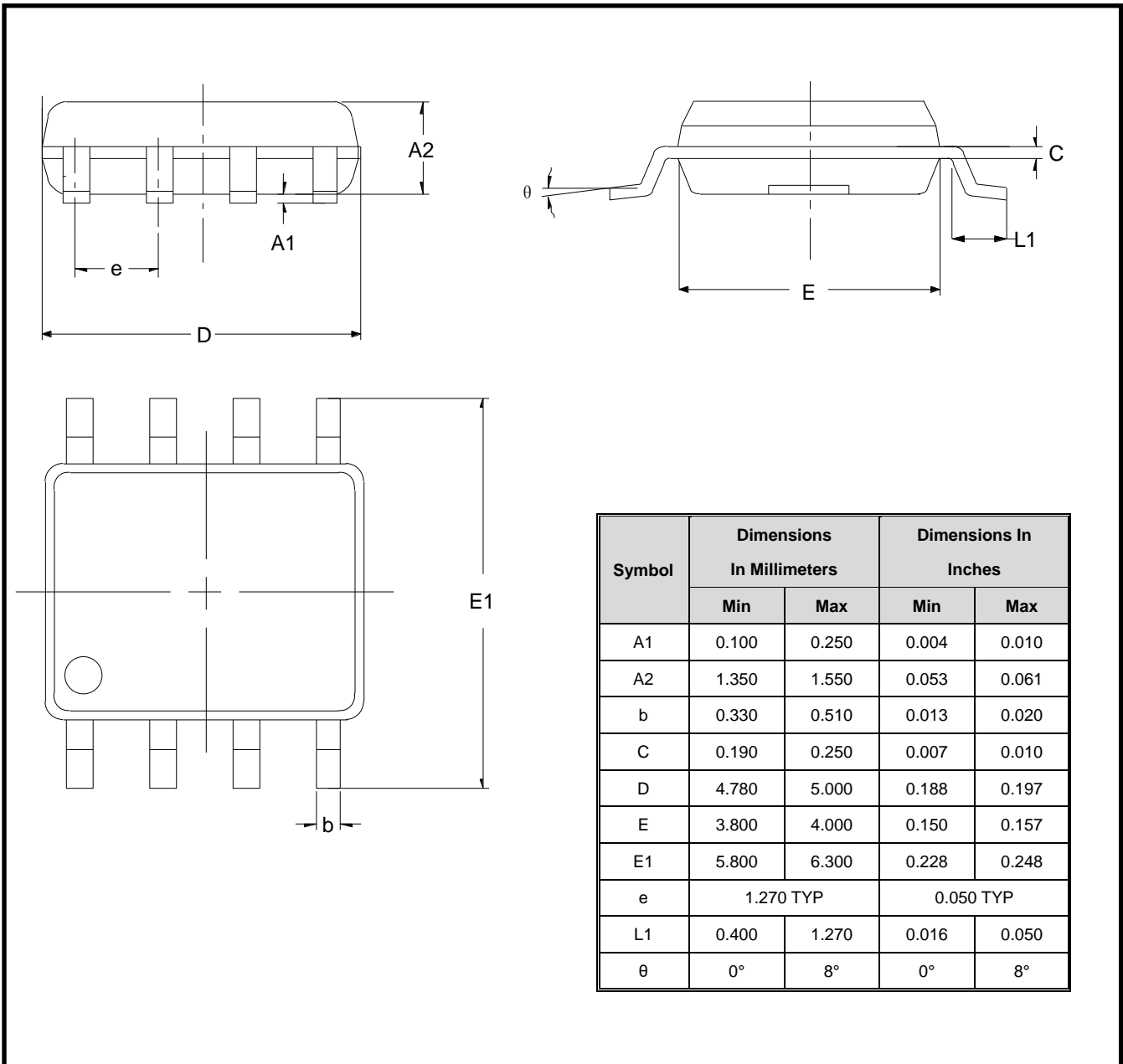
#### SC70-5 /SOT-353



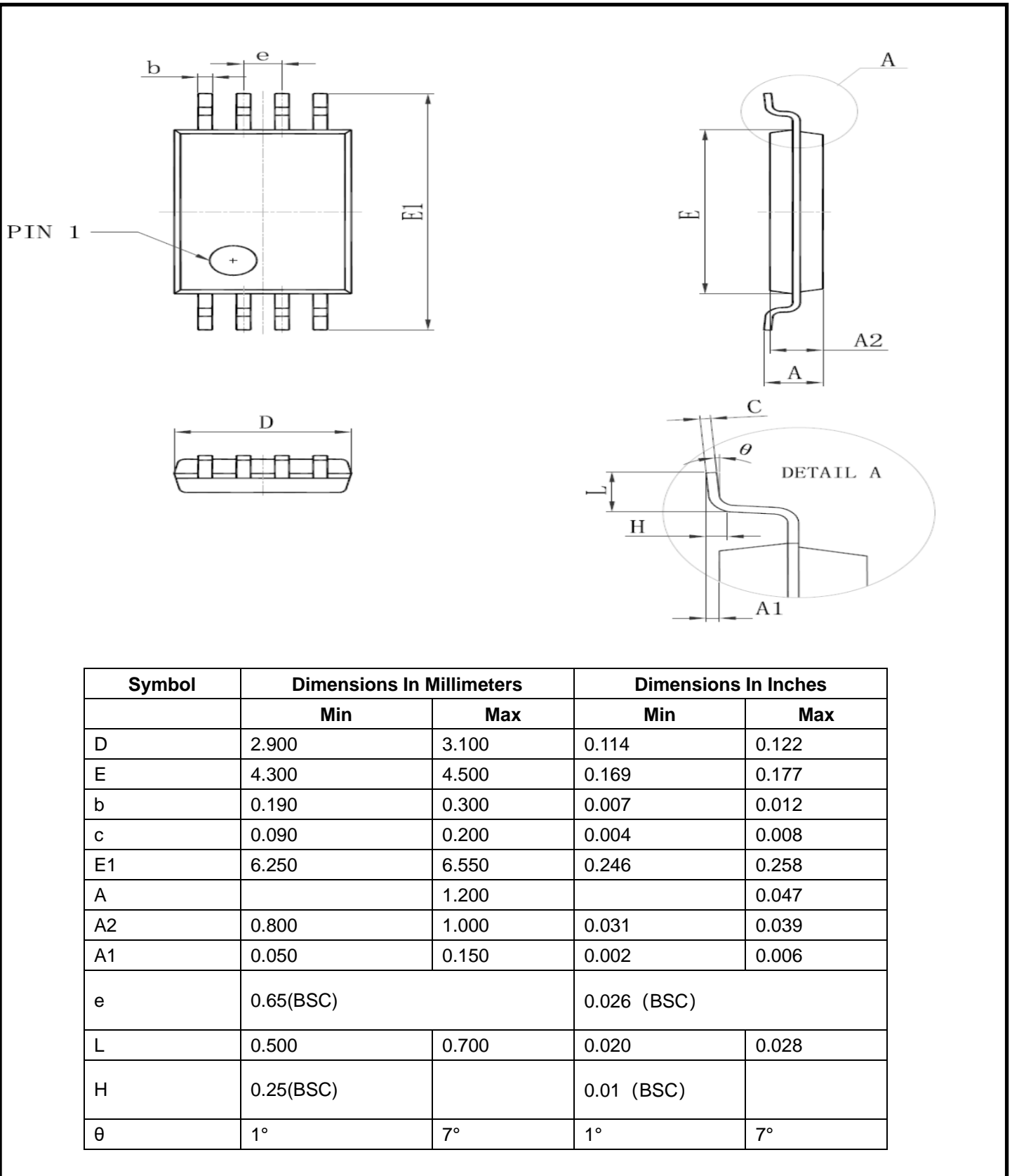
#### SOT23-5



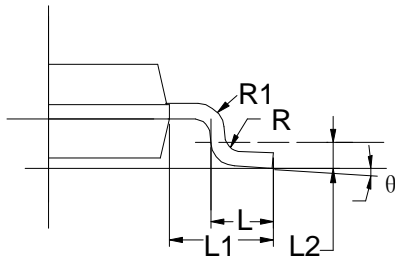
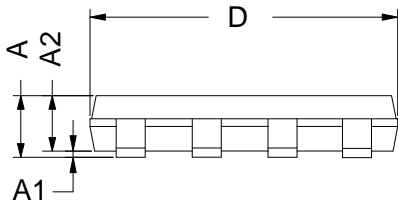
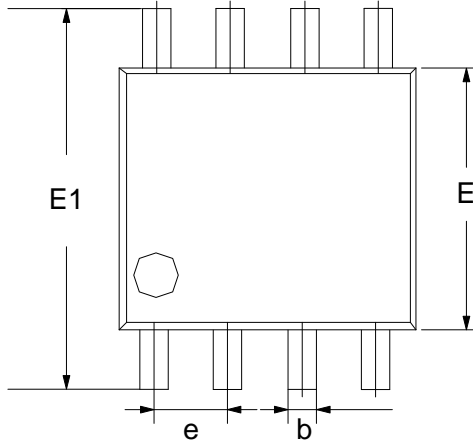
SOP-8



TSSOP-8



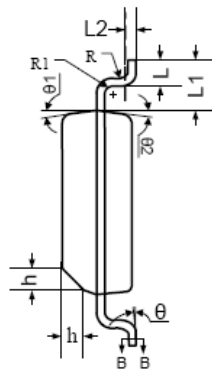
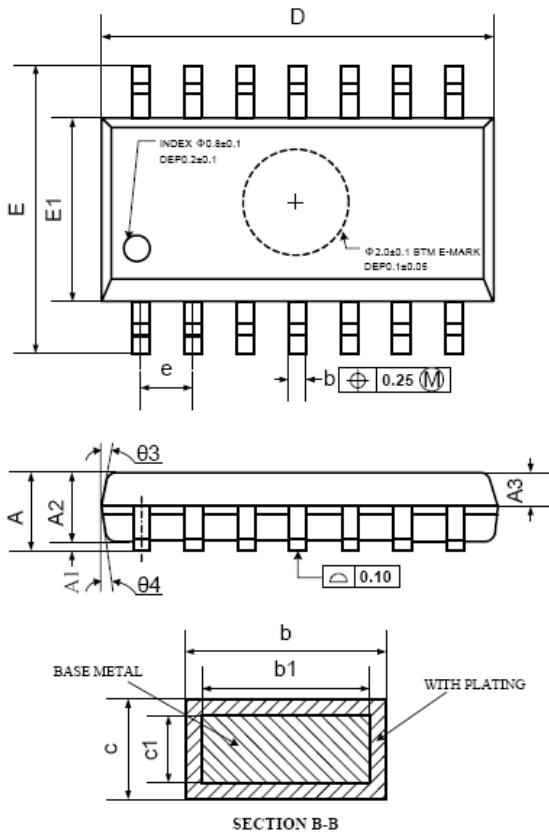
MSOP-8



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
$\theta$	0°	6°	0°	6°

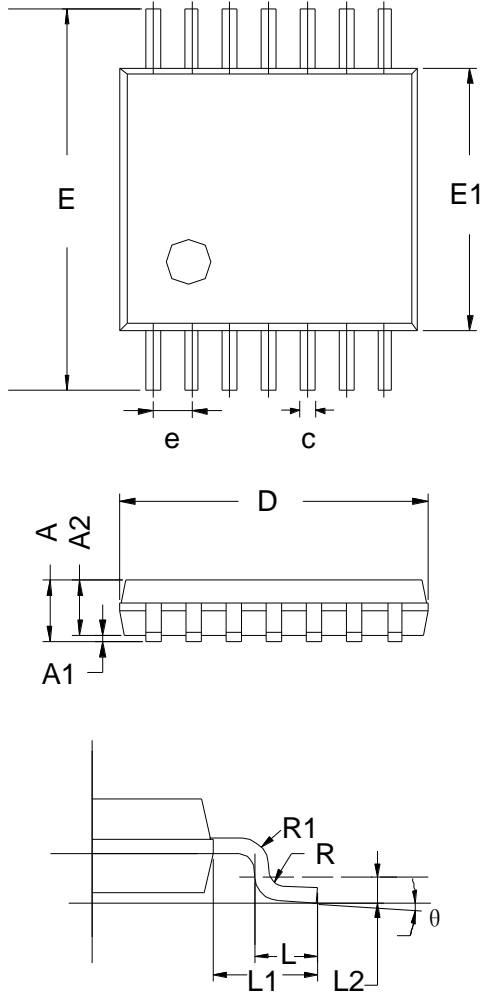


SOP-14



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
$\theta$	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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