High voltage rail to rail low noise operational amplifier

Description

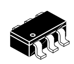
The HT228X series amplifiers are newest high supply voltage amplifiers with low offset, low power and stable high frequency response. 15V/μs slew rate and low distortion while drawing only typical 700μA of quiescent current per amplifier. The input common-mode voltage range extends to V–, and the outputs swing rail-to-rail. The HT228X 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 HT228X ideal choices for industrial control, motor control and portable audio amplification, sound ports, and other consumer audio.

Features

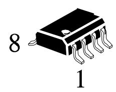
- Supply Voltage: 3V to 36V
- Low Supply Current: Maximum 1000μA per channel
- Differential Input Voltage Range to Supply Rail, can Work as Comparator
- Input Rail to $-V_S$, Rail to Rail Output
- Fast Response: 3.5 MHz Bandwidth, 15V/μs Slew Rate, 100ns Overload Recovery
- Very Low THD+N: 0.0005% at Gain = 1, 1kHz
- Excellent EMIRR: 60dB at 900MHz
- 2KV HBM, 1KV CDM, 150mA Latch Up
- –40°C to 125°C Operation Temperature Range

Applications

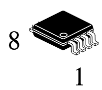
- Sensor Interface
- Motor Control
- Industrial Control
- Audio



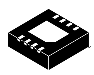
SOT23-5 T SUFFIX
HT2281ARTZ



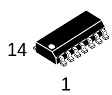
SOP8 R SUFFIX
HT2282ARZ
HT2281ARZ



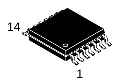
MSOP8 M SUFFIX
HT2282ARMZ
HT2281ARMZ



DFN8(2*2) Q SUFFIX
HT2282ARQZ



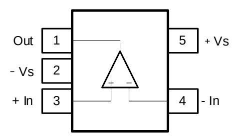
QFN8(2*2) R SUFFIX
HT2284ARZ

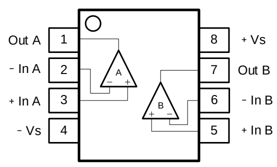


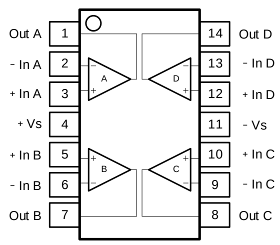
TSSOP14 T SUFFIX
HT2284ARTZ

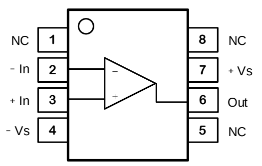
T_A = -40° to 125°C for all packages.

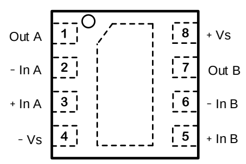
Pin Configuration











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	ANSI/ESDA/JEDEC JS-001	2	kV
CDM	Charged Device Model ESD	ANSI/ESDA/JEDEC JS-002	1	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 DFN 3*3	120	50	°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°C, R_L = 10kΩ to V_S/2, 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, HT2281			1000	1500	μA
			-40°C to 125°C			1700	μA
		V_S = 5V, HT2281			850	1300	μA
			-40°C to 125°C			1500	μA
		V_S = 30V, HT2282/HT2284			700	1000	μA
			-40°C to 125°C			1200	uA
		V_S = 5V,HT2282/HT2284			600	850	μA
			-40°C to 125°C			1000	μA
PSRR	Power Supply Rejection Ratio	V_S = 3V to 36V		95	120		dB
			-40°C to 125°C	90			dB
Input Characteristics							
V_{OS}	Input Offset Voltage	V_S = 30V, V_{CM} = 0V to 28V		-2	0.1	2	mV
			-40°C to 85°C	-2.5		2.5	mV
			-40°C to 125°C	-3		3	mV
		V_S = 30V, V_{CM} = 28.5V		-3		3	mV
			-40°C to 125°C	-4		4	mV
		V_S = 5V, V_{CM} = 2.5V		-2	0.1	2	mV
			-40°C to 125°C	-3		3	mV
V_{OS} TC	Input Offset Voltage Drift		-40°C to 125°C		2		μV/°C
I_B	Input Bias Current				25		pA
			-40°C to 85°C		80		pA
			-40°C to 125°C		1000		pA
I_{OS}	Input Offset Current				25		pA
I_{IN}	Different Input Current	V_S = 36V, V_{ID} = 36V			10		nA
			-40°C to 125°C		100		nA
C_{IN}	Input Capacitance	Differential Mode			5		pF
		Common Mode			2.5		pF
Av	Open-loop Voltage Gain			105	120		dB
			-40°C to 125°C	100			dB
V_{CMR}	Common-mode Input Voltage Range			(V-)		(V+) – 1.5	V
CMRR	Common Mode Rejection Ratio	V_{CM} = 0V to 28V		105	130		dB
			-40°C to 125°C	100			dB

Output Characteristics							
V_{OH}	Output Swing from Positive Rail	R_{LOAD} = 10kΩ to $V_S/2$			200	300	mV
			-40°C to 125°C			450	mV
		R_{LOAD} = 2kΩ to $V_S/2$			1.1	1.4	V
			-40°C to 125°C			2	V
V_{OL}	Output Swing from Negative Rail	R_{LOAD} = 10kΩ to $V_S/2$			200	300	mV
			-40°C to 125°C			450	mV
		R_{LOAD} = 2kΩ to $V_S/2$			0.8	1	V
			-40°C to 125°C			1.6	V
I_{SC}	Output Short-Circuit Current			25	32		mA
			-40°C to 85°C	20			mA
			-40°C to 125°C	15			mA
AC Specifications							
GBW	Gain-Bandwidth Product				3.5		MHz
SR	Slew Rate	G = 1, 10V step			15		V/μs
		Open Loop		9	15		V/μs
			-40°C to 85°C	7			V/μs
			-40°C to 125°C	6			V/μs
t_{OR}	Overload Recovery				100		ns
t_S	Settling Time, 0.1%	G = -1, 10V step			0.8		μs
	Settling Time, 0.01%				1		μs
PM	Phase Margin	V_S = 36V, R_L=10K, C_L=100pF			60		°
GM	Gain Margin	V_S = 36V, R_L=10K, C_L=100pF			15		dB
Noise Performance							
E_N	Input Voltage Noise	f = 0.1Hz to 10Hz			1.7		μV_{RMS}
e_N	Input Voltage Noise Density	f = 1kHz			30		nV/√Hz
i_N	Input Current Noise	f = 1kHz			2		fA/√Hz
THD+N	Total Harmonic Distortion and Noise	f = 1kHz, G =1, R_L = 10kΩ, V_{OUT} = $6V_{RMS}$			0.0005		%

Typical Performance Characteristics

V_S = ±15V, V_{CM} = 0V, R_L = 10kΩ, unless otherwise specified.

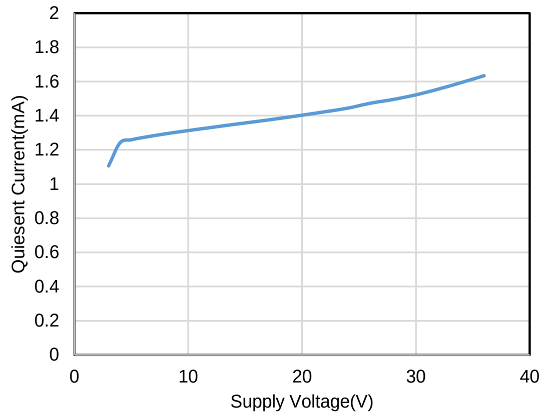


Figure 1. Quiescent Current vs. Supply Voltage, 2ch HT2282

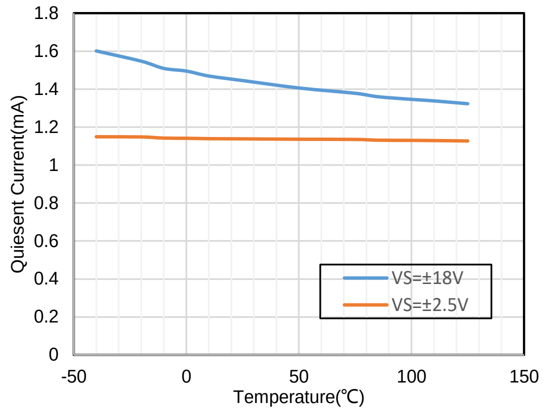


Figure 2. Quiescent Current vs. Temperature, 2ch HT2282

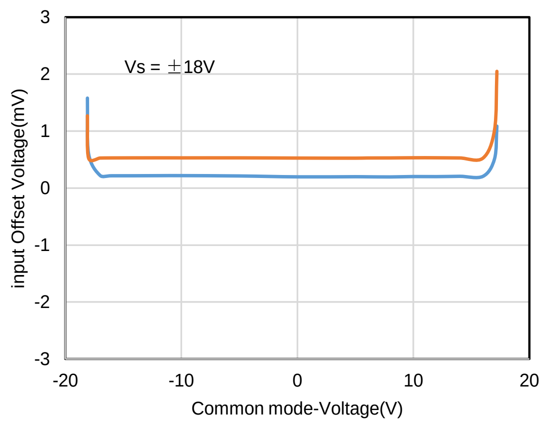


Figure 3. Offset Voltage vs. Common Mode Voltage

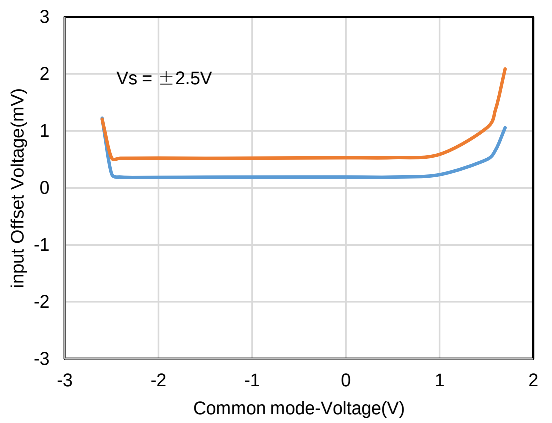


Figure 4. Offset Voltage vs. Common Mode Voltage

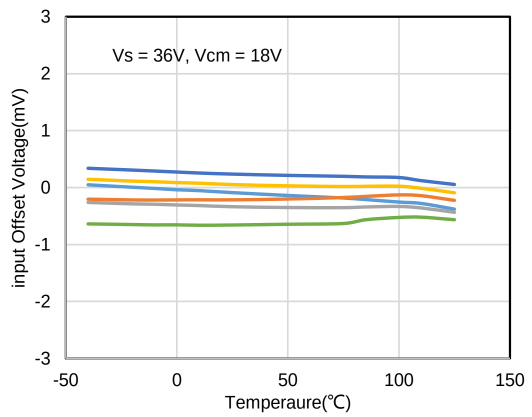


Figure 5. V_{OS} vs. Temperature

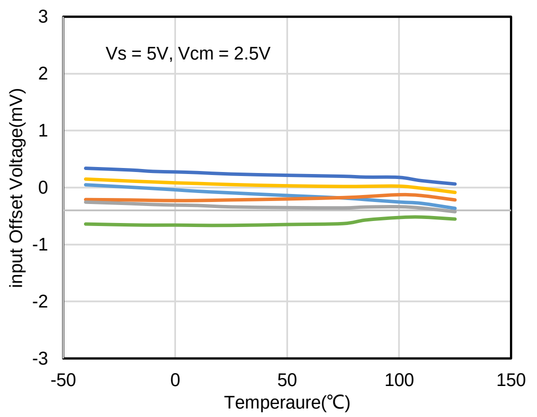


Figure 6. V_{OS} vs. Temperature

V_S = ±15V, V_{CM} = 0V, R_L = 10kΩ, unless otherwise specified.

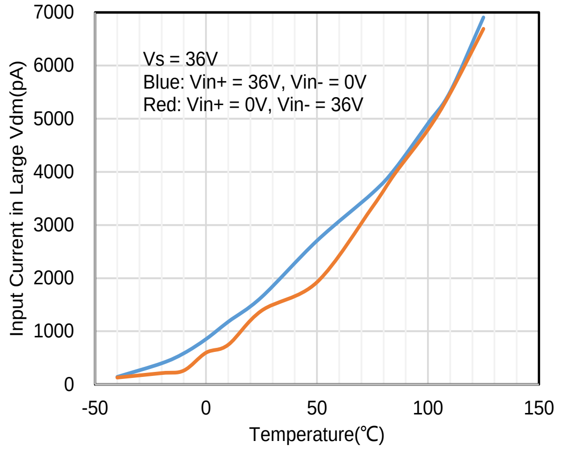


Figure 7. Input Current in Large Vdm vs. Temperature

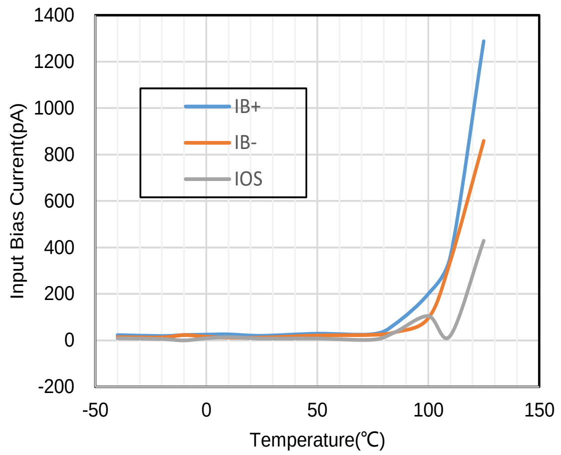


Figure 8. I_B vs. Temperature

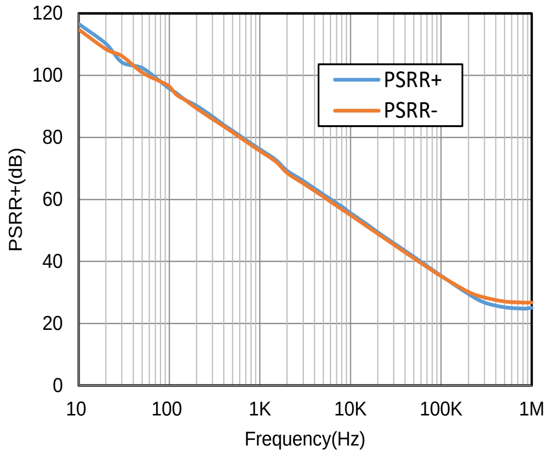


Figure 9. PSRR vs. Frequency

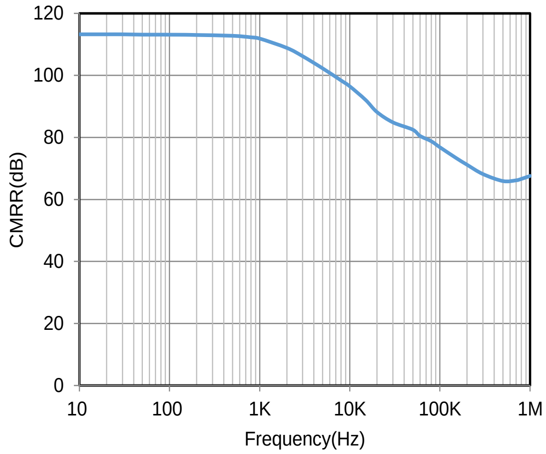


Figure 10. CMRR vs. Frequency

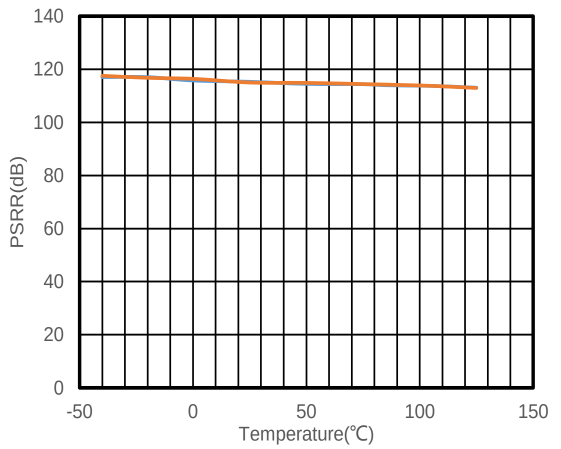


Figure 11. PSRR vs. Temperature

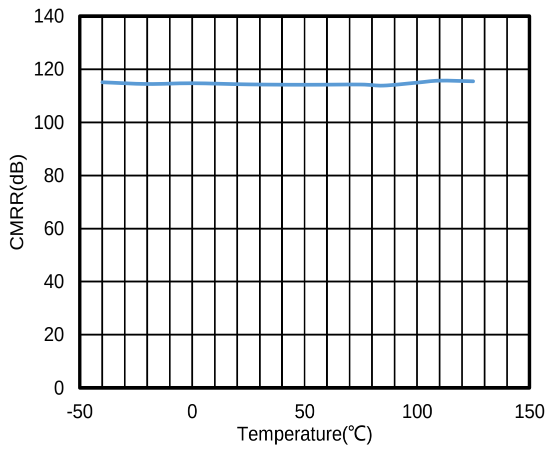


Figure 12. CMRR vs. Temperature

V_S = ±15V, V_{CM} = 0V, R_L = 10kΩ, unless otherwise specified.

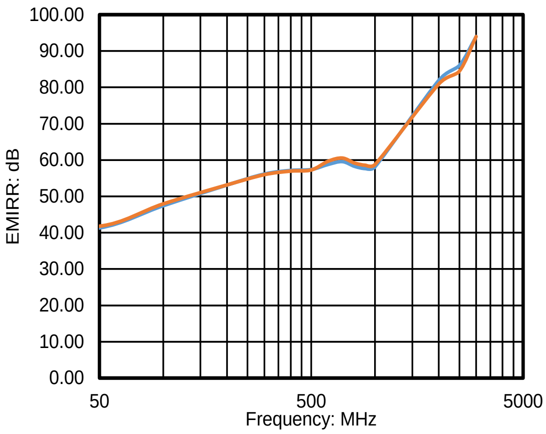


Figure 13. EMIRR+- vs. Frequency

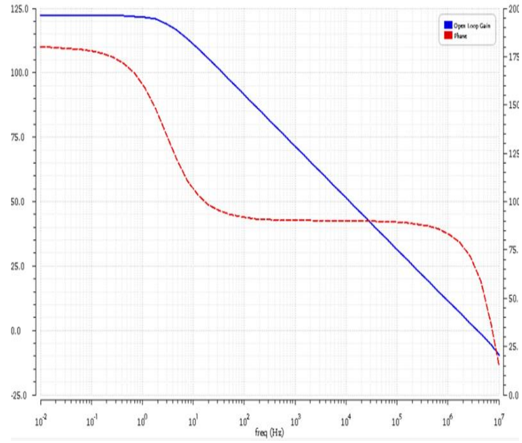


Figure 14. Open Loop Gain and Phase vs. Frequency

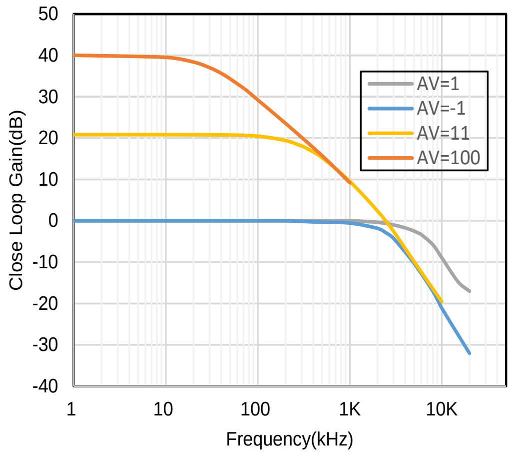
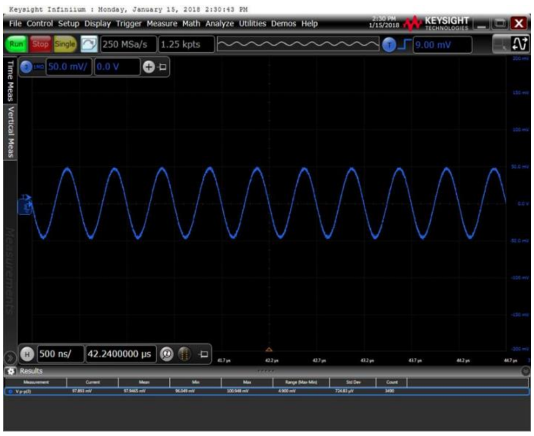


Figure 15. Close Loop Gain and Phase vs. Frequency



V_S =±1.5V, V_{IN}=100mV_{PP}, R_L=10K, C_L=100pF, G=1

Figure 16. Waveform under 3V Supply Voltage

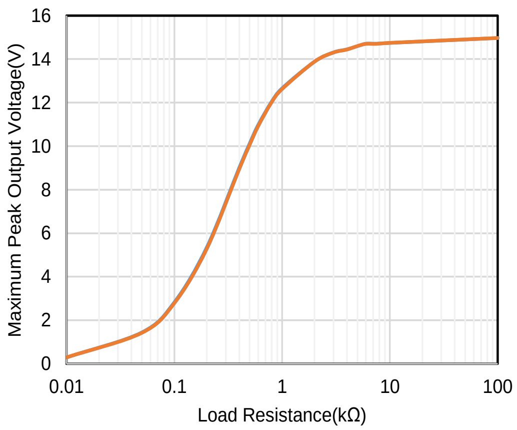


Figure 17. Maximum Peak Output Voltage vs. Load Resistance

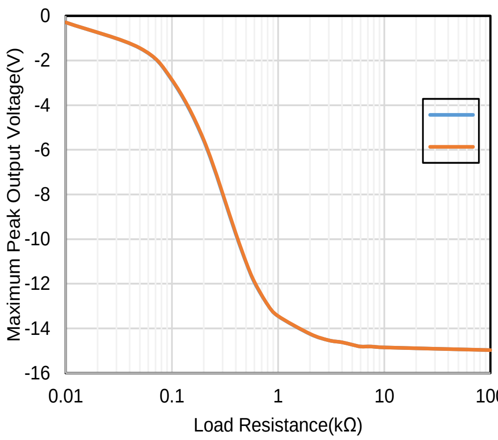


Figure 18. Maximum Peak Output Voltage vs. Load Resistance

V_S = ±15V, V_{CM} = 0V, R_L = 10kΩ, unless otherwise specified.

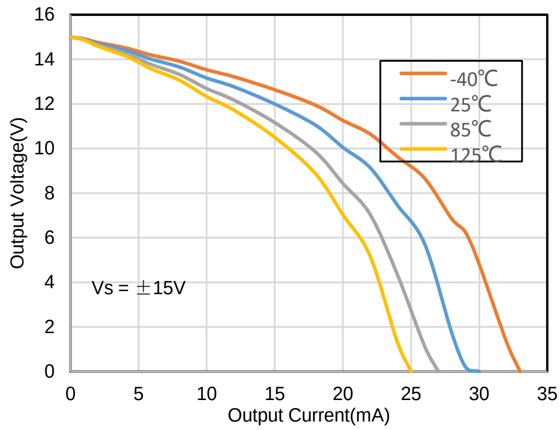


Figure 19. Positive Output Voltage vs. Output Current

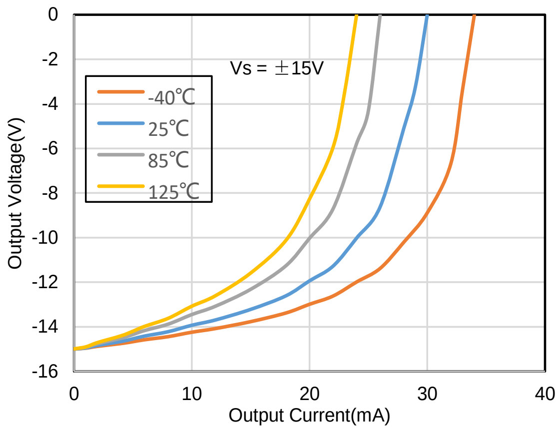


Figure 20. Negative Output Voltage vs. Output Current

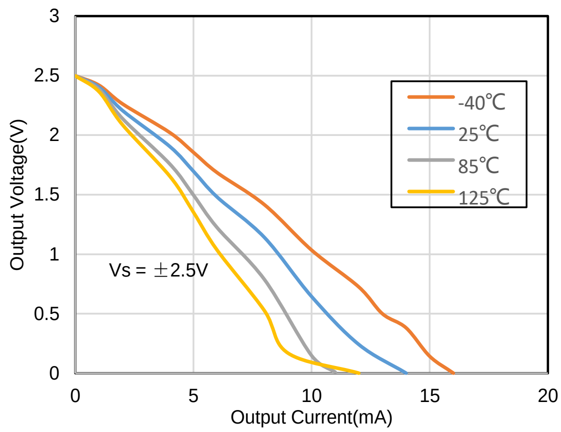


Figure 21. Positive Output Voltage vs. Output Current

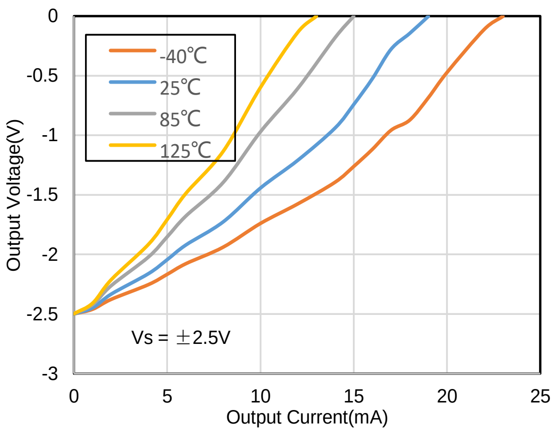


Figure 22. Negative Output Voltage vs. Output Current

Voltage: 1V/div, Time: 200ns/div

V_S =5V, V_{IN} = 2V, R_L=Open, G=3

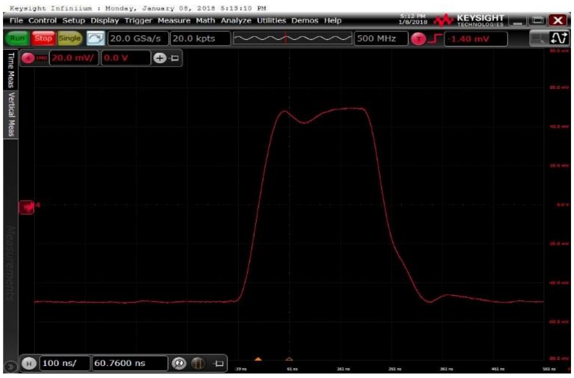
Figure 23. Positive Overload Recovery

Voltage: 1V/div, Time: 200ns/div

V_S =5V, V_{IN} = 2V, R_L=Open, G=3

Figure 24. Negative Overload Recovery

V_S = ±15V, V_{CM} = 0V, R_L = 10kΩ, unless otherwise specified.



Voltage: 20mV/div, Time: 100ns/div

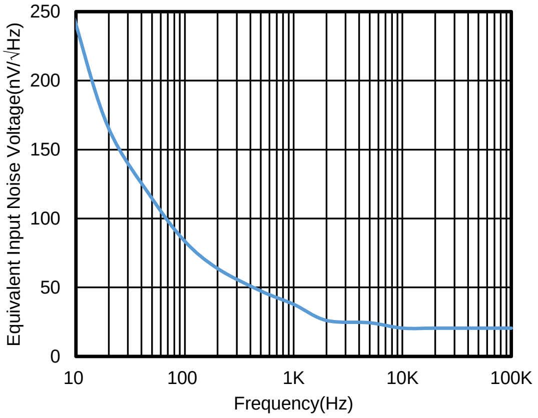
V_S =±15V, R_L=2K, C_L=100pF, G=1

Figure 25. 100mV Signal Step Response

Voltage: 2V/div, Time: 1μs/div

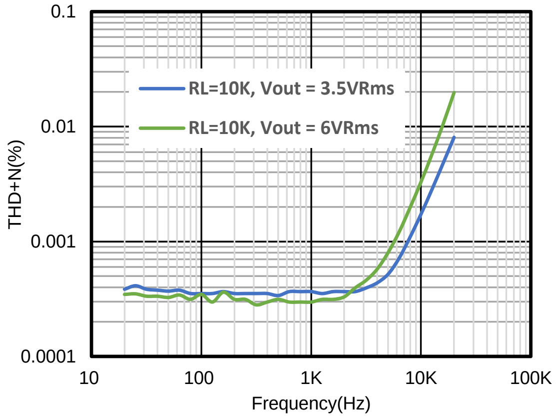
V_S =±15V, R_L=2K, C_L=100pF, G=1

Figure 26. 10V Signal Step Response



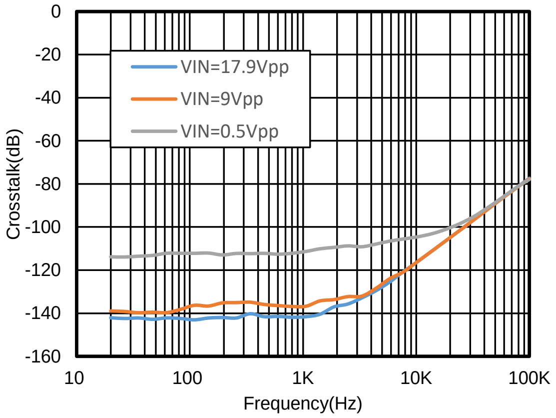
V_S =±15V, V_{CM}=0V

Figure 27. Voltage Noise Spectral Density vs. Frequency



V_S =±15V, V_{CM}=0V, G=1

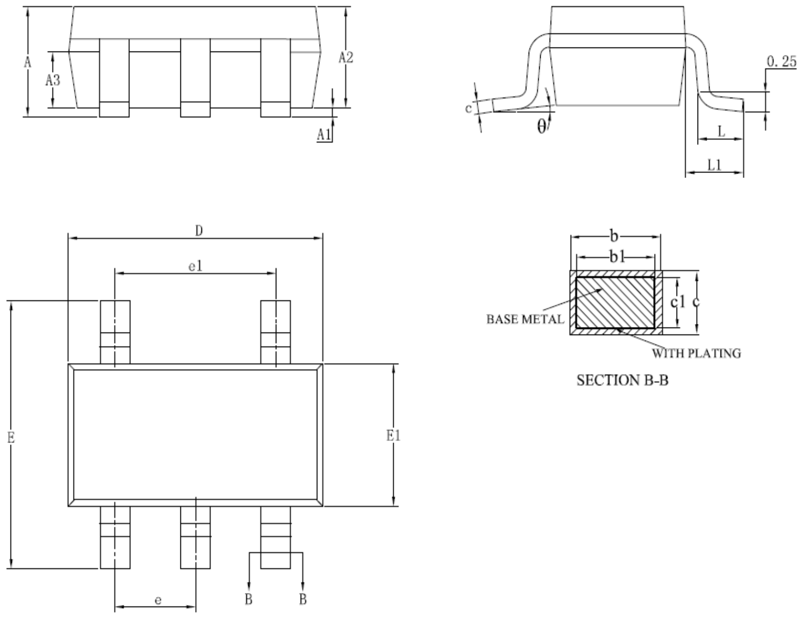
Figure 28. THD+N vs. Frequency



V_S =±15V, V_{CM}=0V

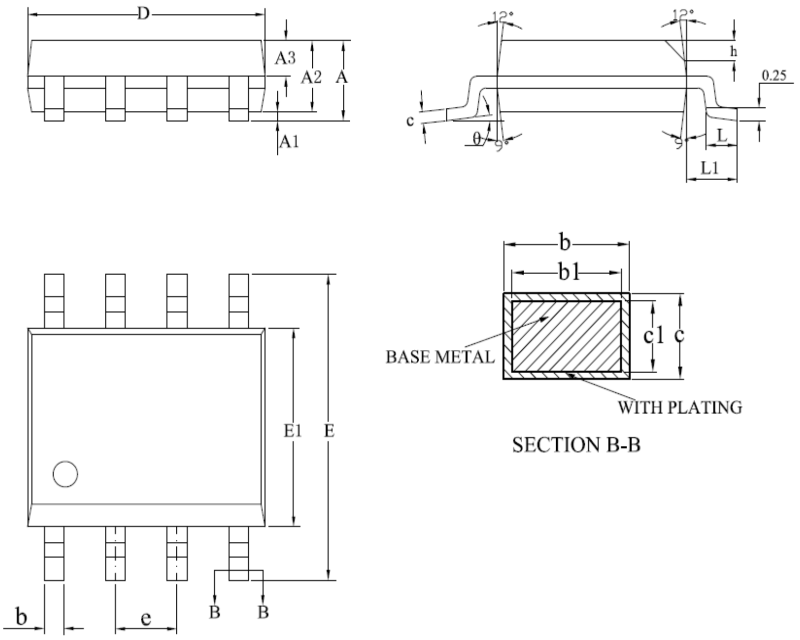
Figure 29. Crosstalk vs. Frequency

SOT23-5



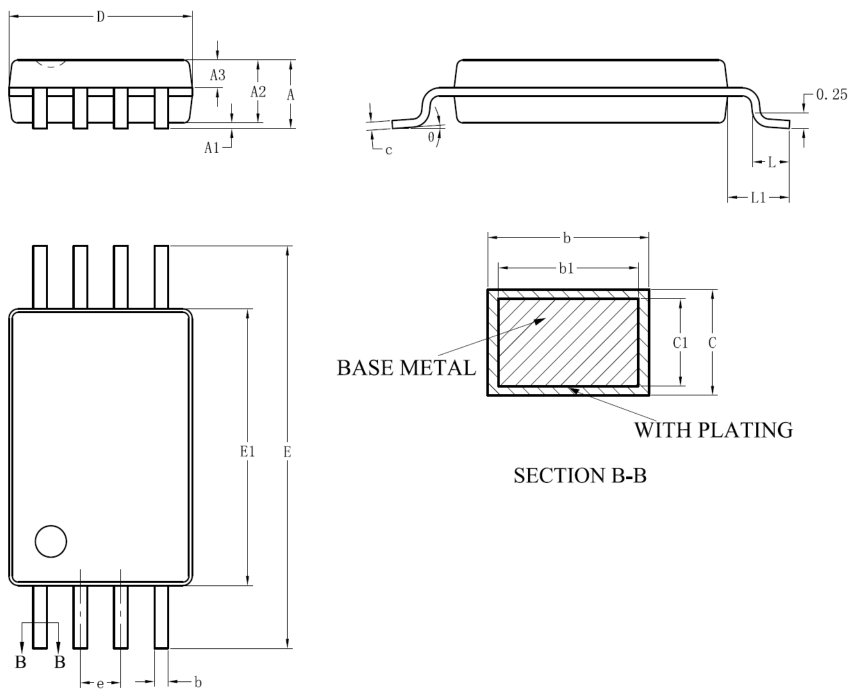
SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	—	—	1.25
A1	0.04	—	0.10
A2	1.00	1.10	1.20
A3	0.60	0.65	0.70
b	0.33	—	0.41
b1	0.32	0.35	0.38
c	0.15	—	0.19
c1	0.14	0.15	0.16
D	2.82	2.92	3.02
E	2.60	2.80	3.00
E1	1.50	1.60	1.70
e	0.95BSC		
e1	1.90BSC		
L	0.30	—	0.60
L1	0.60REF		
θ	0	—	8°

SOIC-8



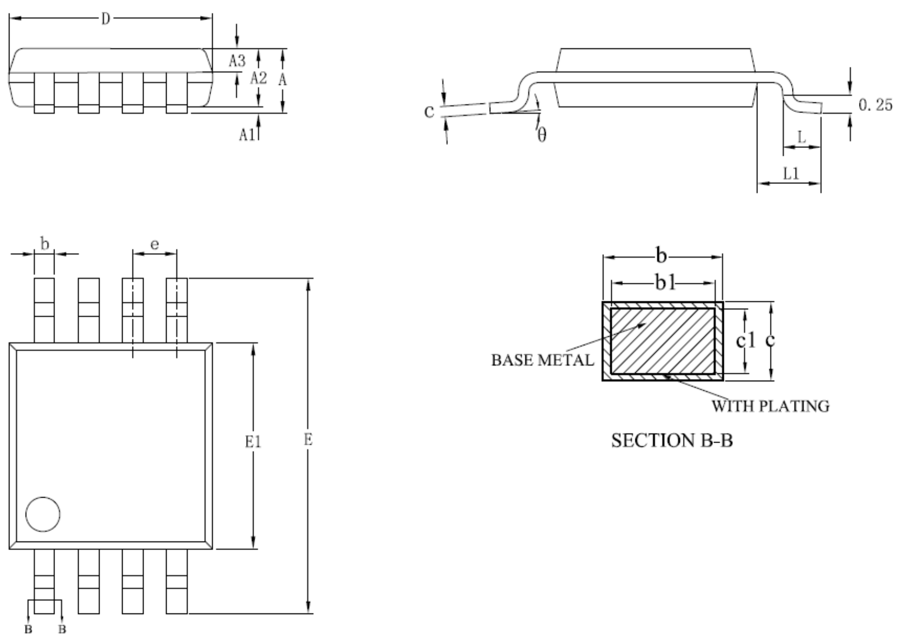
SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	—	—	1.75
A1	0.10	—	0.225
A2	1.30	1.40	1.50
A3	0.60	0.65	0.70
b	0.39	—	0.47
b1	0.38	0.41	0.44
c	0.20	—	0.24
c1	0.19	0.20	0.21
D	4.80	4.90	5.00
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e	1.27BSC		
h	0.25	—	0.50
L	0.50	—	0.80
L1	1.05REF		
θ	0	—	8°

TSSOP-8



<table>
<tr><th rowspan="2">SYMBOL</th><th colspan="3">MILLIMETER</th></tr>
<tr><th>MIN</th><th>NOM</th><th>MAX</th></tr>
<tr><td>A</td><td>—</td><td>—</td><td>1.20</td></tr>
<tr><td>A1</td><td>0.05</td><td>—</td><td>0.15</td></tr>
<tr><td>A2</td><td>0.90</td><td>1.00</td><td>1.05</td></tr>
<tr><td>A3</td><td>0.39</td><td>0.44</td><td>0.49</td></tr>
<tr><td>b</td><td>0.20</td><td>—</td><td>0.28</td></tr>
<tr><td>b1</td><td>0.19</td><td>0.22</td><td>0.25</td></tr>
<tr><td>c</td><td>0.13</td><td>—</td><td>0.17</td></tr>
<tr><td>c1</td><td>0.12</td><td>0.13</td><td>0.14</td></tr>
<tr><td>D</td><td>2.90</td><td>3.00</td><td>3.10</td></tr>
<tr><td>E1</td><td>4.30</td><td>4.40</td><td>4.50</td></tr>
<tr><td>E</td><td>6.20</td><td>6.40</td><td>6.60</td></tr>
<tr><td>e</td><td colspan="3">0.65BSC</td></tr>
<tr><td>L</td><td>0.45</td><td>—</td><td>0.75</td></tr>
<tr><td>L1</td><td colspan="3">1.00REF</td></tr>
<tr><td>θ</td><td>0</td><td>—</td><td>8°</td></tr>
</table>

MSOP-8



<table>
<tr><th rowspan="2">SYMBOL</th><th colspan="3">MILLIMETER</th></tr>
<tr><th>MIN</th><th>NOM</th><th>MAX</th></tr>
<tr><td>A</td><td>—</td><td>—</td><td>1.10</td></tr>
<tr><td>A1</td><td>0.05</td><td>—</td><td>0.15</td></tr>
<tr><td>A2</td><td>0.75</td><td>0.85</td><td>0.95</td></tr>
<tr><td>A3</td><td>0.30</td><td>0.35</td><td>0.40</td></tr>
<tr><td>b</td><td>0.28</td><td>—</td><td>0.36</td></tr>
<tr><td>b1</td><td>0.27</td><td>0.30</td><td>0.33</td></tr>
<tr><td>c</td><td>0.15</td><td>—</td><td>0.19</td></tr>
<tr><td>c1</td><td>0.14</td><td>0.15</td><td>0.16</td></tr>
<tr><td>D</td><td>2.90</td><td>3.00</td><td>3.10</td></tr>
<tr><td>E</td><td>4.70</td><td>4.90</td><td>5.10</td></tr>
<tr><td>E1</td><td>2.90</td><td>3.00</td><td>3.10</td></tr>
<tr><td>e</td><td colspan="3">0.65BSC</td></tr>
<tr><td>L</td><td>0.40</td><td>—</td><td>0.70</td></tr>
<tr><td>L1</td><td colspan="3">0.95REF</td></tr>
<tr><td>θ</td><td>0</td><td>—</td><td>8°</td></tr>
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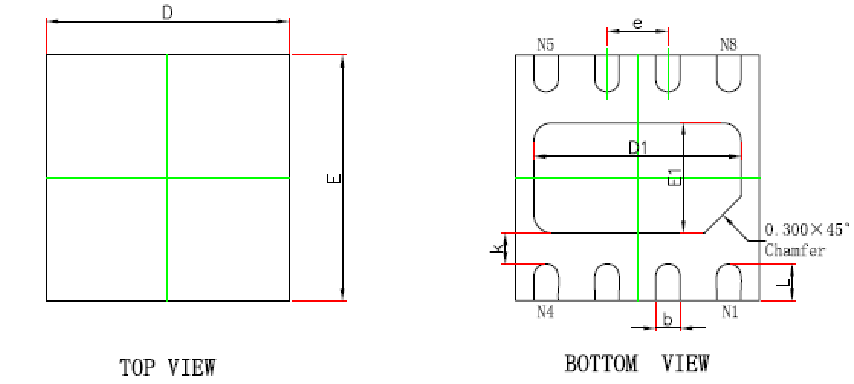
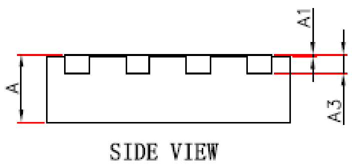
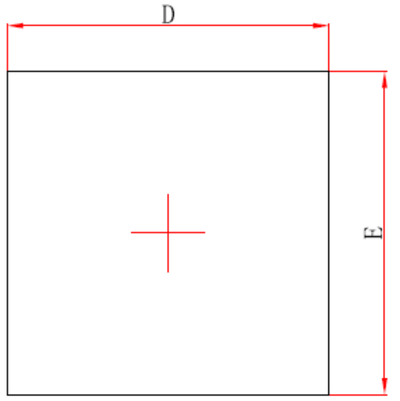
DFN8 2*2



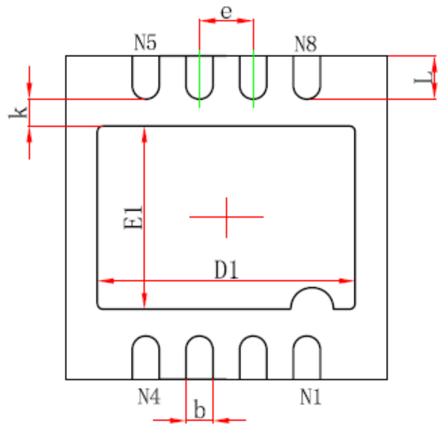


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Norm.		Norm.	
A	0.550+/-0.050		0.022+/-0.002	
A1	0.000	0.050	0.000	0.002
A3	0.152REF.		0.006REF.	
D	2.000+/-0.100		0.079+/-0.004	
E	2.000+/-0.100		0.079+/-0.004	
D1	1.700+/-0.100		0.067+/-0.004	
E1	0.900+/-0.100		0.035+/-0.004	
k	0.200MIN.		0.008MIN.	
b	0.200+/-0.050		0.008+/-0.002	
e	0.500TYP.		0.020TYP.	
L	0.300+/-0.050		0.012+/-0.002	

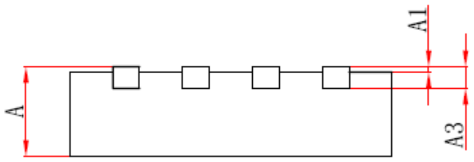
DFN8 3*3



Top View



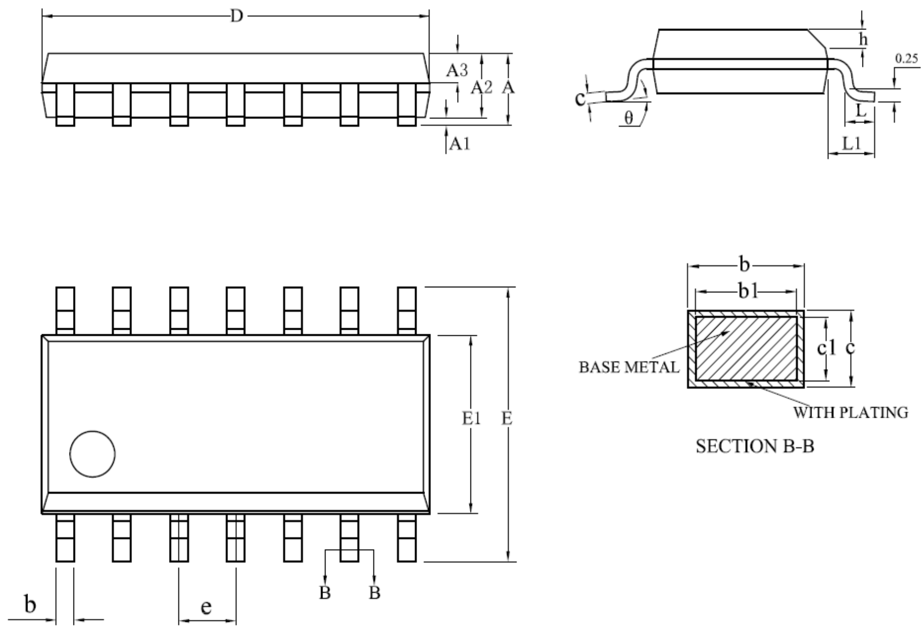
Bottom View



Side View

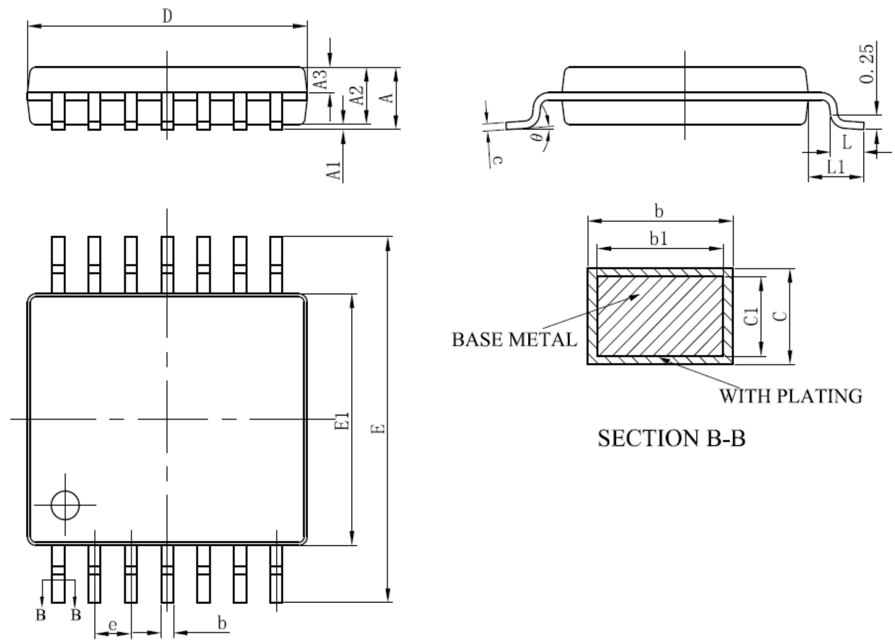
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	0.700/0.800	0.800/0.900	0.028/0.031	0.031/0.035
A1	0.000	0.050	0.000	0.002
A3	0.203REF.		0.008REF.	
D	2.924	3.076	0.115	0.121
E	2.924	3.076	0.115	0.121
D1	2.300	2.500	0.091	0.098
E1	1.600	1.800	0.063	0.071
k	0.200MIN.		0.008MIN.	
b	0.200	0.300	0.008	0.012
e	0.500TYP.		0.020TYP.	
L	0.324	0.476	0.013	0.019

SOIC-14



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	—	—	1.75
A1	0.05	—	0.225
A2	1.30	1.40	1.50
A3	0.60	0.65	0.70
b	0.39	—	0.47
b1	0.38	0.41	0.44
c	0.20	—	0.24
c1	0.19	0.20	0.21
D	8.55	8.65	8.75
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e	1.27BSC		
h	0.25	—	0.50
L	0.50	—	0.80
L1	1.05REF		
θ	0	—	8°

TSSOP-14



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	—	—	1.20
A1	0.05	—	0.15
A2	0.90	1.00	1.05
A3	0.39	0.44	0.49
b	0.20	—	0.28
b1	0.19	0.22	0.25
c	0.13	—	0.17
c1	0.12	0.13	0.14
D	4.90	5.00	5.10
E1	4.30	4.40	4.50
E	6.20	6.40	6.60
e	0.65BSC		
L	0.45	0.60	0.75
L1	1.00BSC		
θ	0	—	8°