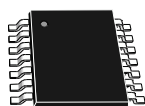
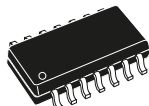


Low power, 1.7 MHz, rail-to-rail output, 36 V operational amplifier



TSOP14



SO14



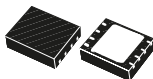
MiniSO8



SO8



SOT23-5



DFN8 (3 x 3 mm)

Features

- Low offset voltage: 1 mV max. @ 25 °C
- Low current consumption: 375 μ A max. / operator @ 36 V
- Wide supply voltage: 2.7 to 36 V
- Gain bandwidth product: 1.7 MHz
- Unity gain stable
- Rail-to-rail output
- Input common mode voltage includes ground
- High ESD tolerance: 4 kV HBM
- EMI hardened
- Extended temperature range: -40 to 125 °C
- Automotive qualification

Applications

- Industrial
- Power supplies
- Automotive

Description

The **TSB621, TSB622, TSB624** are general purpose operational amplifiers featuring an extended supply voltage operating range and rail-to-rail output. They also offer an excellent speed/power consumption ratio with 1.7 MHz gain bandwidth product while consuming less than 375 μ A per operator at 36 V supply voltage.

The **TSB621, TSB622, TSB624** operate over a wide temperature range from -40 °C to 125 °C making these devices ideal for industrial and automotive applications with the associated qualification.

Thanks to the small package size, the **TSB621, TSB622, TSB624** can be used in applications where space on the board is limited. It can thus reduce the overall cost of the PCB.

Maturity status link

[TSB621, TSB622, TSB624](#)

Related products

TSB611, TSB612	For lower power consumption
TSB571, TSB572, TSB514	For higher speed and rail-to-rail inputs
TSB711, TSB712	For a higher precision and speed

1 Pin connections

Figure 1. TSB621 pin connections (top view)

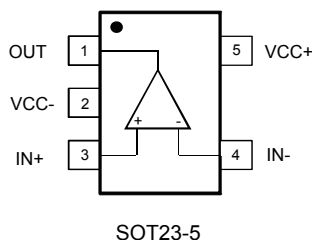
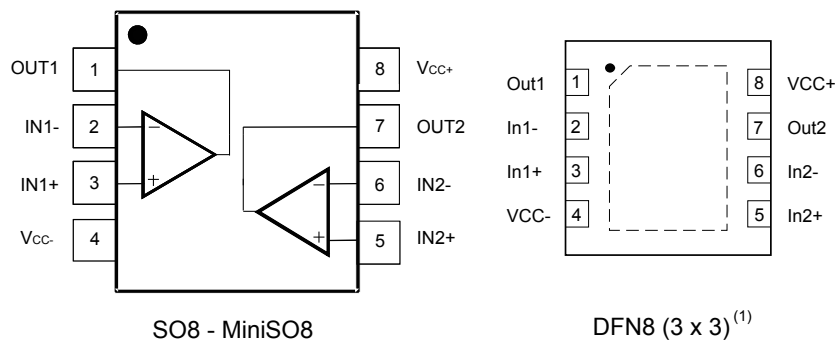


Table 1. TSB621 pin description

Pin n°	Pin name	Description
1	OUT1	Output
2	VCC -	Negative supply voltage
3	IN +	Positive input voltage
4	IN -	Negative input voltage
5	VCC	Positive supply voltage

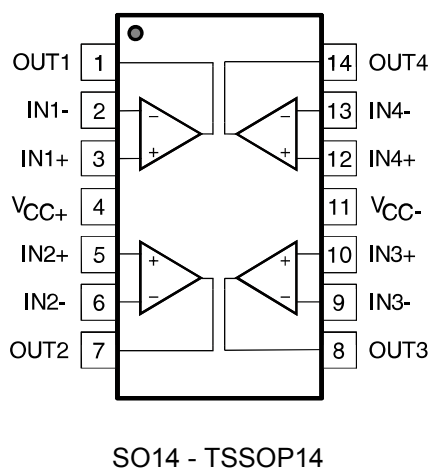
Figure 2. TSB622 pin connections (top view)



⁽¹⁾ Exposed pad can be left floating or connected to ground.

Table 2. TSB622 pin description

Pin n°	Pin name	Description
1	OUT1	Output
2	IN1 -	Negative input voltage
3	IN1 +	Positive input voltage
4	VCC -	Negative supply voltage
5	IN2 +	Positive input voltage
6	IN2 -	Negative input voltage
7	OUT2	Output
8	VCC +	Positive supply voltage

Figure 3. TSB624 pin connections (top view)

Table 3. TSB624 pin description

Pin n°	Pin name	Description
1	OUT1	Output
2	IN1 -	Negative input voltage
3	IN1 +	Positive input voltage
4	VCC +	Positive supply voltage
5	IN2 +	Positive input voltage
6	IN2 -	Negative input voltage
7	OUT2	Output
8	OUT3	Output
9	IN3 -	Negative input voltage
10	IN3 +	Positive input voltage
11	VCC -	Negative supply voltage
12	IN4 +	Positive input voltage
13	IN4 -	Negative input voltage
14	OUT4	Output

2 Absolute maximum ratings and operating conditions

Table 4. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage ⁽¹⁾	40	V
V_{id}	Differential input voltage ⁽²⁾	$\pm V_{CC}$	V
V_{in}	Input voltage	$(V_{CC-}) - 0.2$ to $(V_{CC+}) + 0.2$	V
I_{in}	Input current ⁽³⁾	10	mA
T_{stg}	Storage temperature	-65 to 150	°C
T_j	Junction temperature	150	°C
R_{th-ja}	Thermal resistance junction to ambient ^{(4) (5)}		°C/W
	SO8	125	
	MiniSO8	190	
	DFN8 3x3 WF	40	
	SOT23-5	250	
	SO14	105	
ESD	TSSOP14	100	V
	Human Body Model (HBM TSB621, TSB622) ⁽⁶⁾	4000	
	Human Body Model (HBM TSB624) ⁽⁶⁾	3000	
	Charged Device Model (CDM) ⁽⁷⁾	1500	

1. All voltage values, except differential voltage, are with respect to network ground terminal.
2. The differential voltage is the non-inverting input terminal with respect to the inverting input terminal.
3. Input current must be limited by a resistor in series with the inputs.
4. R_{th} are typical values.
5. Short-circuits can cause excessive heating and destructive dissipation.
6. According to JEDEC standard JESD22-A114F.
7. According to ANSI/ESD STM5.3.1.

Table 5. Operating conditions

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage	2.7 to 36	V
V_{icm}	Common mode voltage on input pins	$(V_{CC-}) - 0.1$ to $(V_{CC+}) - 1$	V
T	Operating free-air temperature range	-40 to 125	°C

3 Electrical characteristics

Table 6. Electrical characteristics $V_{CC+} = 2.7\text{ V}$, $V_{CC-} = 0\text{ V}$, $V_{icm} = V_{CC}/2$, $T = 25\text{ }^{\circ}\text{C}$, $R_L = 10\text{ k}\Omega$ connected to $V_{CC}/2$ (unless otherwise specified)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
DC performance						
V _{IO}	Input offset voltage	T = 25 °C	-1		1	mV
		Tmin < T < Tmax	-1.6		1.6	
Δ V _{IO} /ΔT	Input offset voltage drift	Tmin < T < Tmax		2		μV/°C
I _{IB}	Input bias current	T = 25 °C		15	30	nA
		Tmin < T < Tmax			45	
I _{IO}	Input offset current	T = 25 °C		3	10	
		Tmin < T < Tmax			15	
CMR	Common mode rejection ratio: 20 log (ΔV _{icm} /ΔV _{io})	V _{icm} = - 0.1 to V _{CC} -1 V, V _{OUT} = V _{CC} /2	90	115		dB
		Tmin < T < Tmax	85			
A _{VD}	Large signal voltage gain	V _{OUT} = 0.5 V to (V _{CC} -0.5 V)	90	105		dB
		Tmin < T < Tmax	82			
V _{OH}	High-level output voltage, V _{OH} = V _{CC} - V _{OUT}	T = 25 °C		35	46	mV
		Tmin < T < Tmax			55	
V _{OL}	Low-level output voltage	T = 25 °C		50	60	
		Tmin < T < Tmax			75	
I _{OUT}	I _{sink}	V _{OUT} = V _{CC}	20	27		mA
		Tmin < T < Tmax	10			
	I _{source}	V _{OUT} = 0 V	20	28		
		Tmin < T < Tmax	8			
I _{CC}	Supply current (per channel)	No load, V _{OUT} = V _{CC} /2		280	330	μA
		Tmin < T < Tmax			400	
AC performance						
GBP	Gain bandwidth product	R _L = 10 kΩ, C _L = 100 pF	1	1.45		MHz
		Tmin < T < Tmax	0.7			
Φ _m	Phase margin	R _L = 10 kΩ, C _L = 100 pF		45		degrees
G _m	Gain margin			18		dB
SR	Slew rate	T = 25 °C	0.30	0.53		V/μs
		Tmin < T < Tmax	0.20			
E _N	Equivalent input noise voltage	f = 1 kHz		30		nV/√Hz
THD+N	Total harmonic distortion + noise	f _{in} = 1 kHz, Gain = 1, R _L = 100 kΩ, V _{icm} = (V _{cc} -1 V) / 2, BW = 22 kHz, V _{OUT} = 1 Vpp		0.005		%
C _S	Channel separation	f = 1 kHz		120		dB
t _{rec}	Overload recovery time			2		μs

Table 7. Electrical characteristics $V_{CC+} = 12\text{ V}$, $V_{CC-} = 0\text{ V}$, $V_{icm} = V_{CC}/2$, $T = 25\text{ }^{\circ}\text{C}$, $R_L = 10\text{ k}\Omega$ connected to $V_{CC}/2$ (unless otherwise specified)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
DC performance						
V _{IO}	Input offset voltage	T = 25 °C	-1		1	mV
		Tmin < T < Tmax	-1.6		1.6	
Δ V _{IO} /ΔT	Input offset voltage drift	Tmin < T < Tmax		2		μV/°C
I _{IB}	Input bias current	T = 25 °C		15	30	nA
		Tmin < T < Tmax			45	
I _{IO}	Input offset current	T = 25 °C		3	10	
		Tmin < T < Tmax			15	
CMR	Common mode rejection ratio: 20 log (ΔV _{icm} /ΔV _{io})	V _{icm} = - 0.1 to V _{CC} -1 V, V _{OUT} = V _{CC} /2	100	130		dB
		Tmin < T < Tmax	95			
A _{VD}	Large signal voltage gain	V _{OUT} = 0.5 V to (V _{CC} -0.5 V)	98	115		dB
		Tmin < T < Tmax	90			
V _{OH}	High-level output voltage, V _{OH} = V _{CC} - V _{OUT}	T = 25 °C		68	80	mV
		Tmin < T < Tmax			95	
V _{OL}	Low-level output voltage	T = 25 °C		86	100	
		Tmin < T < Tmax			125	
I _{OUT}	I _{sink}	V _{OUT} = V _{CC}	25	35		mA
		Tmin < T < Tmax	10			
	I _{source}	V _{OUT} = 0 V	30	37		
		Tmin < T < Tmax	15			
I _{CC}	Supply current (per channel)	No load, V _{OUT} = V _{CC} /2		295	345	μA
		Tmin < T < Tmax			420	
AC performance						
GBP	Gain bandwidth product	R _L = 10 kΩ, C _L = 100 pF	1.1	1.55		MHz
		Tmin < T < Tmax	0.8			
Φ _m	Phase margin	R _L = 10 kΩ, C _L = 100 pF		45		degrees
G _m	Gain margin			18		dB
SR	Slew rate	T = 25 °C	0.35	0.58		V/μs
		Tmin < T < Tmax	0.20			
E _N	Equivalent input noise voltage	f = 1 kHz		30		nV/√Hz
THD+N	Total harmonic distortion + noise	f _{in} = 1 kHz, Gain = 1, R _L = 100 kΩ, V _{icm} = (V _{CC} -1 V) / 2, BW = 22 kHz, V _{OUT} = 1 Vpp		0.005		%
C _S	Channel separation	f = 1 kHz		120		dB
t _{rec}	Overload recovery time			2		μs

Table 8. Electrical characteristics $V_{CC+} = 36\text{ V}$, $V_{CC-} = 0\text{ V}$, $V_{icm} = V_{CC}/2$, $T = 25\text{ }^{\circ}\text{C}$, $R_L = 10\text{ k}\Omega$ connected to $V_{CC}/2$ (unless otherwise specified)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
DC performance						
V _{IO}	Input offset voltage	T = 25 °C	-1		1	mV
		Tmin < T < Tmax	-1.6		1.6	
Δ V _{IO} /ΔT	Input offset voltage drift	Tmin < T < Tmax		2		μV/°C
I _{IB}	Input bias current	T = 25 °C		15	30	nA
		Tmin < T < Tmax			45	
I _{IO}	Input offset current	T = 25 °C		3	10	
		Tmin < T < Tmax			15	
CMR	Common mode rejection ratio: 20 log (ΔV _{icm} /ΔV _{io})	V _{icm} = -0.1 to V _{CC} -1 V, V _{OUT} = V _{CC} /2	105	135		dB
		Tmin < T < Tmax	100			
SVR	Supply voltage rejection ratio: 20 log (ΔV _{CC} /ΔV _{io})	V _{CC} = 4.5 to 36 V, V _{icm} = 0 V	100	124		dB
		Tmin < T < Tmax	95			
A _{VD}	Large signal voltage gain	V _{OUT} = 0.5 V to (V _{CC} -0.5 V)	105	120		dB
		Tmin < T < Tmax	100			
V _{OH}	High-level output voltage, V _{OH} = V _{CC} - V _{OUT}	T = 25 °C		110	140	mV
		Tmin < T < Tmax			180	
V _{OL}	Low-level output voltage	T = 25 °C		125	150	
		Tmin < T < Tmax			195	
I _{OUT}	I _{sink}	V _{OUT} = V _{CC}	35	45		mA
		Tmin < T < Tmax	15			
	I _{source}	V _{OUT} = 0 V	35	45		
		Tmin < T < Tmax	25			
I _{CC}	Supply current (per channel)	No load, V _{OUT} = V _{CC} /2		310	375	μA
		Tmin < T < Tmax			420	
AC performance						
GBP	Gain bandwidth product	R _L = 10 kΩ, C _L = 100 pF	1.2	1.7		MHz
		Tmin < T < Tmax	0.95			
Φ _m	Phase margin	R _L = 10 kΩ, C _L = 100 pF		45		degrees
G _m	Gain margin			18		dB
SR	Slew rate	T = 25 °C	0.35	0.60		V/μs
		Tmin < T < Tmax	0.25			
E _N	Equivalent input noise voltage	f = 1 kHz		25		nV/√Hz
THD+N	Total harmonic distortion + noise	f _{in} = 1 kHz, Gain = 1, R _L = 100 kΩ, V _{icm} = (V _{CC} - 1 V) / 2, BW = 22 kHz, V _{OUT} = 1 Vpp		0.005		%
C _S	Channel separation	f = 1 kHz		120		dB
t _{rec}	Overload recovery time			2		μs

4 Typical performance characteristics

Figure 4. Supply current vs. supply voltage

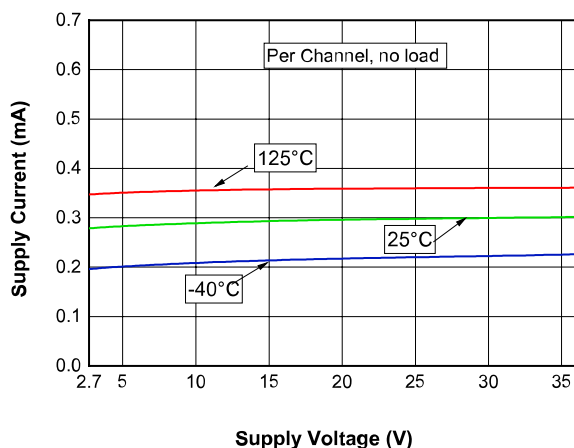


Figure 5. Input offset voltage distribution at $V_{CC} = 2.7\text{ V}$

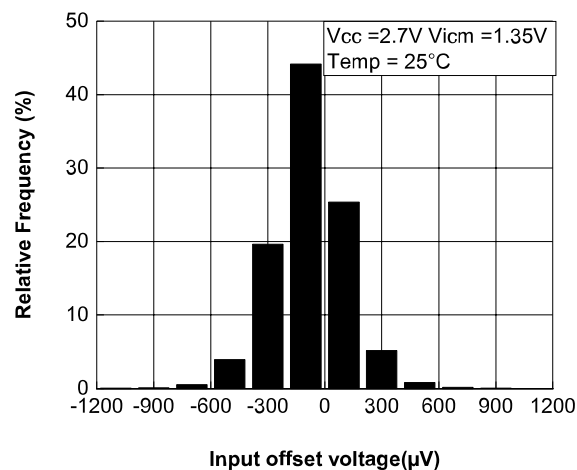


Figure 6. Input offset voltage distribution at $V_{CC} = 12\text{ V}$

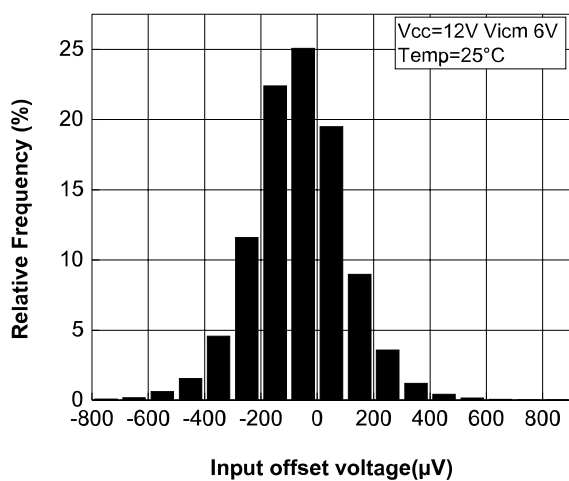


Figure 7. Input offset voltage distribution at $V_{CC} = 36\text{ V}$

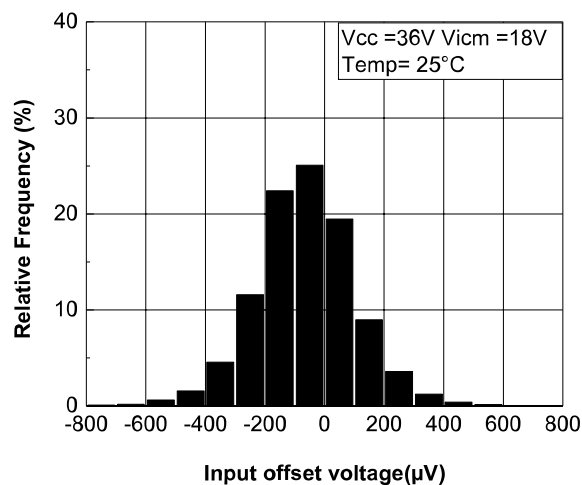


Figure 8. Input offset voltage vs. temperature at $V_{CC} = 36\text{ V}$

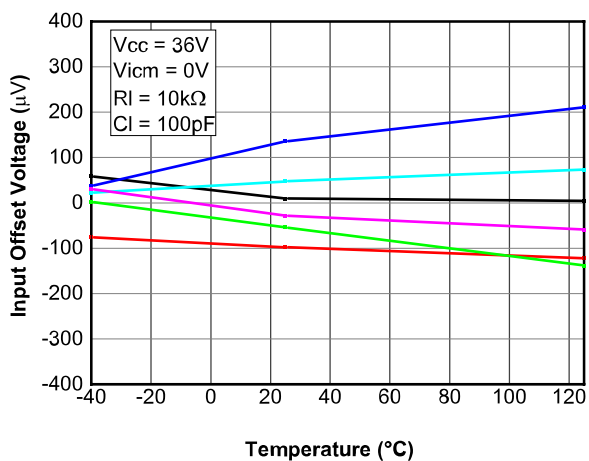


Figure 9. Input offset voltage temperature variation distribution at $V_{CC} = 36\text{ V}$

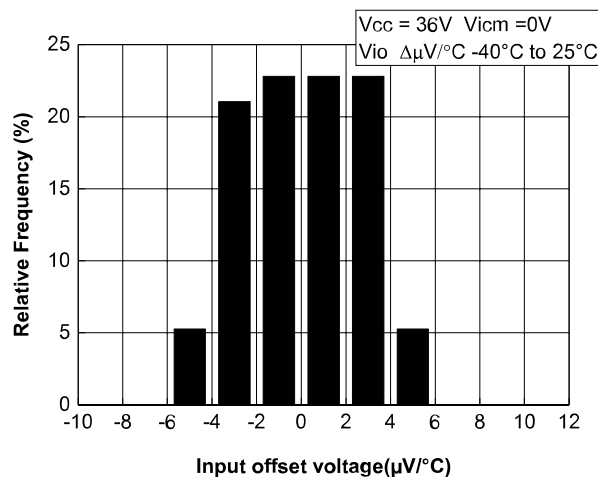


Figure 10. Input offset voltage temperature variation distribution at $V_{CC} = 36\text{ V}$

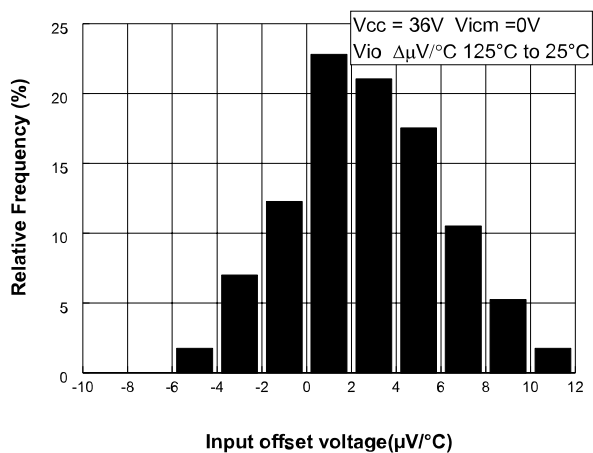


Figure 11. Input offset voltage vs. common-mode voltage at $V_{CC} = 36\text{ V}$

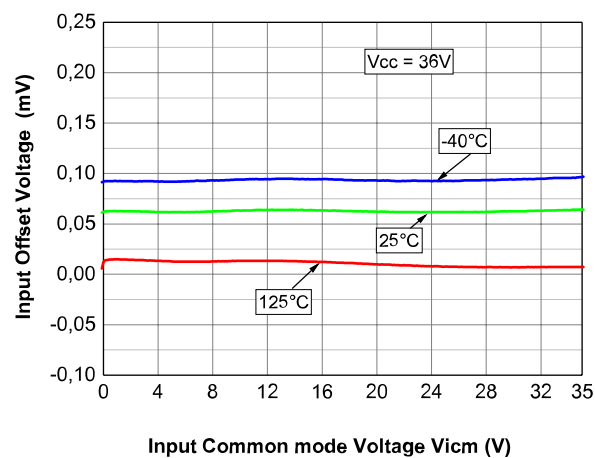


Figure 12. Common-mode reject. ratio CMR at $V_{CC} = 5\text{ V}$

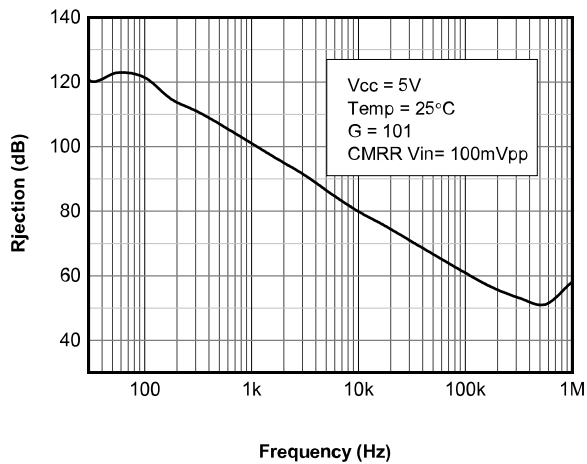


Figure 13. Supply voltage rejection ratio SVR at $V_{CC} = 5\text{ V}$

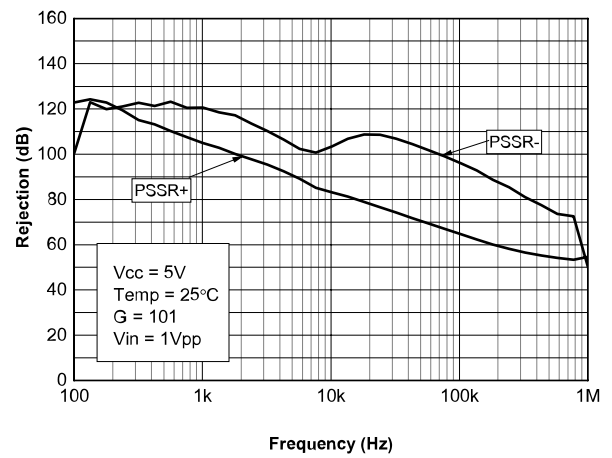


Figure 14. Input bias current vs. temperature

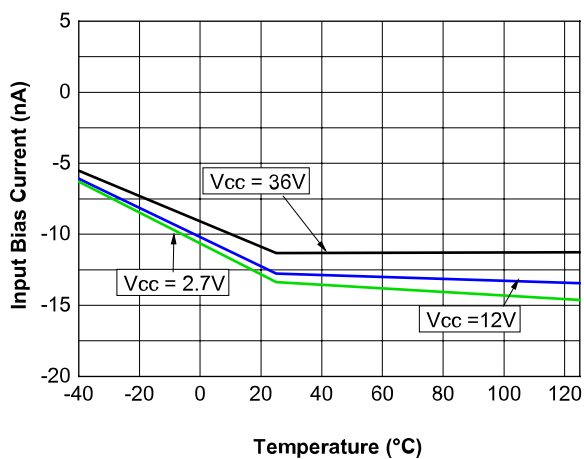


Figure 15. Bode diagram at $V_{CC} = 2.7\text{ V}$

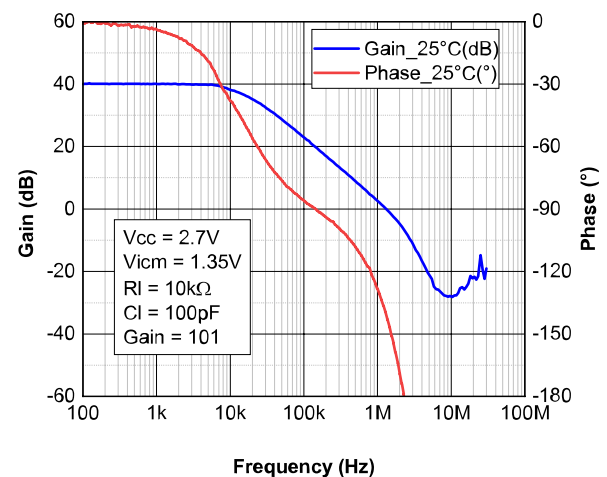


Figure 16. Bode diagram at $V_{CC} = 12\text{ V}$

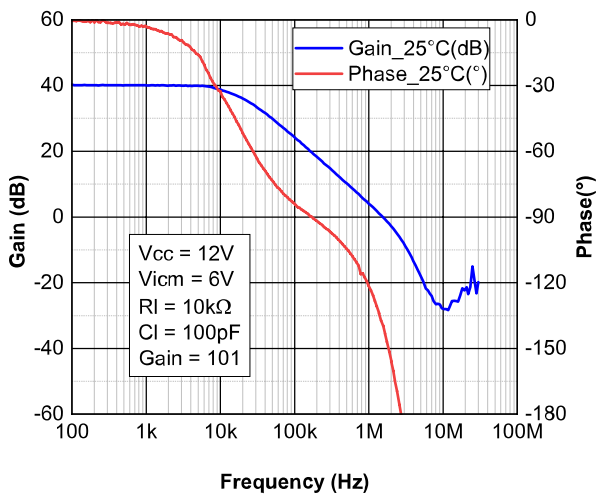


Figure 17. Bode diagram at $V_{CC} = 36\text{ V}$

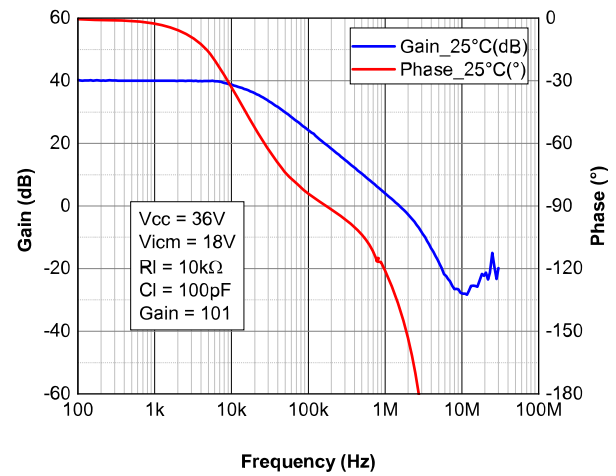


Figure 18. Overshoot vs. capacitive load at $V_{CC} = 36\text{ V}$

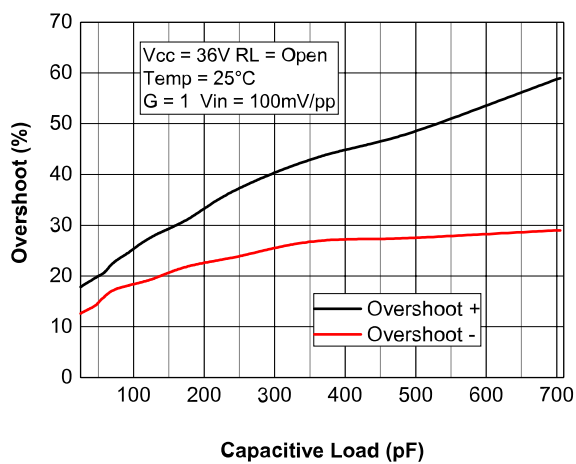


Figure 19. Phase margin vs. capacitive load at $V_{CC} = 2.7\text{ V}$

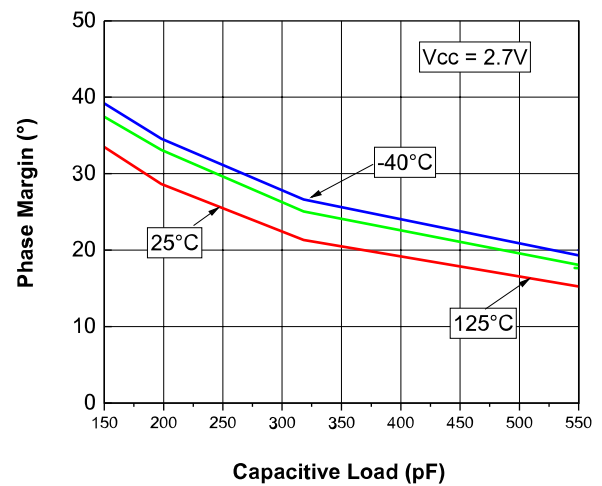


Figure 20. Phase margin vs. capacitive load at $V_{CC} = 12\text{ V}$

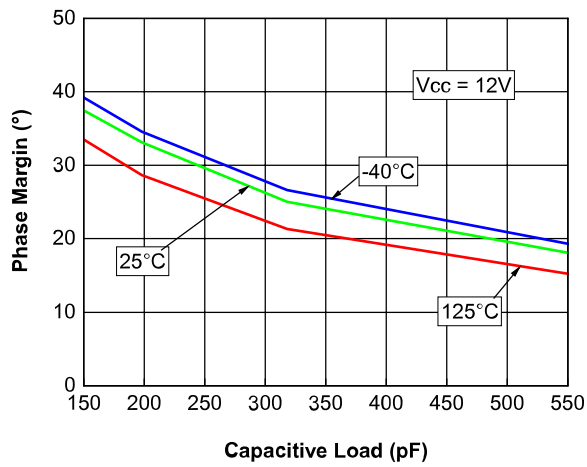


Figure 21. Phase margin vs. capacitive load at $V_{CC} = 36\text{ V}$

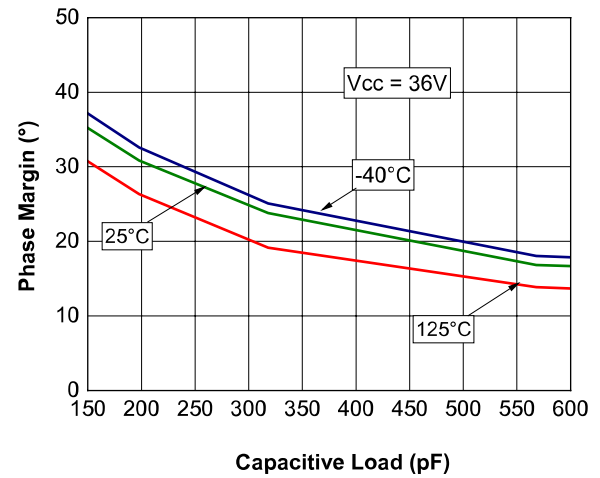


Figure 22. Short-circuit current vs. temperature

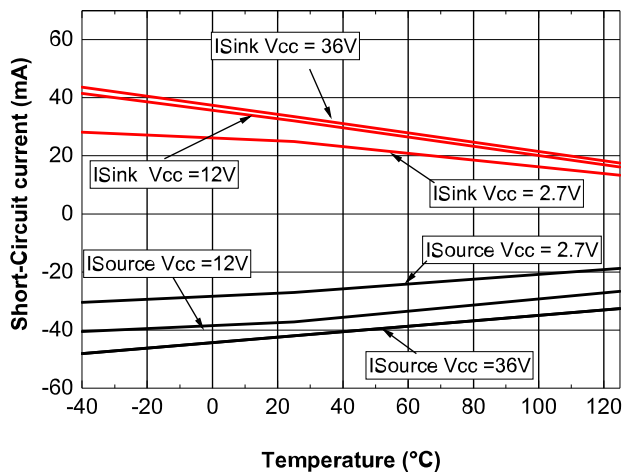


Figure 23. Output source current vs. output voltage at $V_{CC} = 2.7\text{ V}$

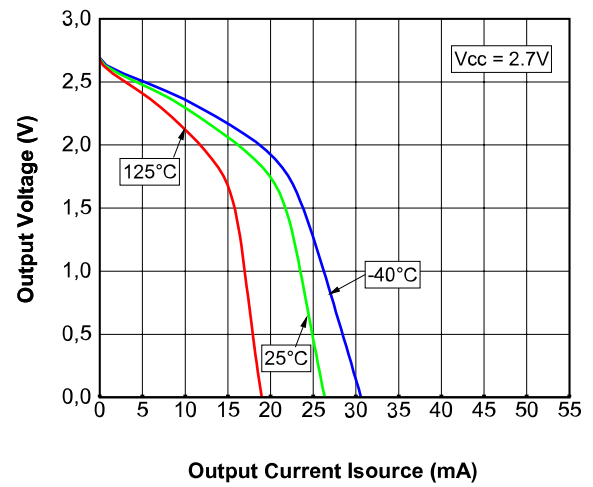


Figure 24. Output source current vs. output voltage at $V_{CC} = 12\text{ V}$

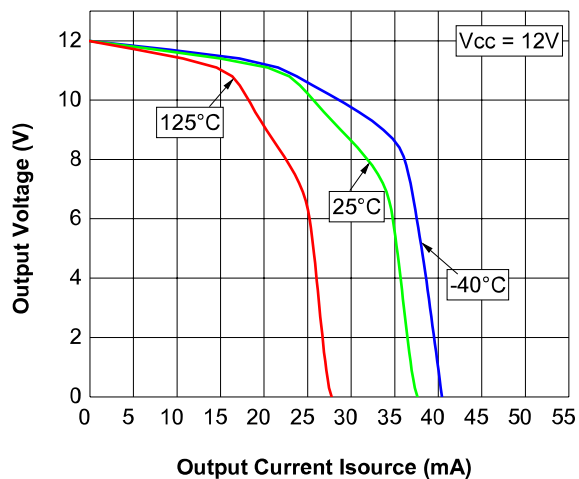


Figure 25. Output source current vs. output voltage at $V_{CC} = 36\text{ V}$

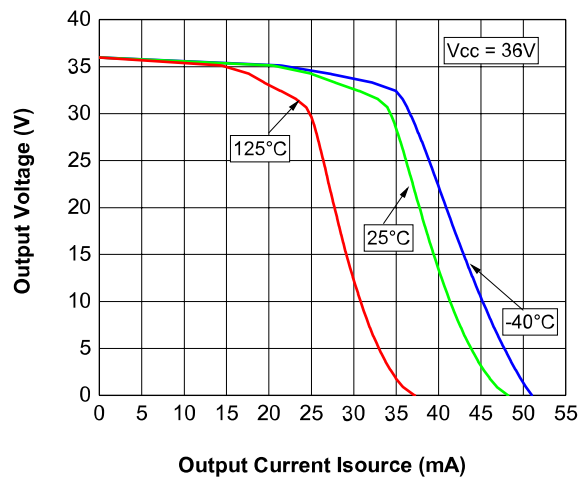


Figure 26. Output sink current vs. output voltage at $V_{CC} = 2.7\text{ V}$

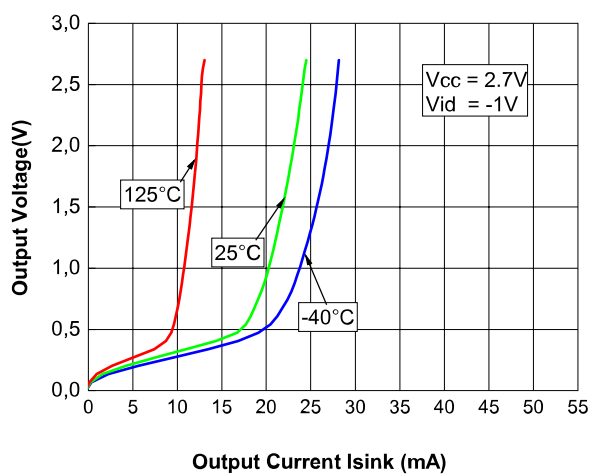


Figure 27. Output sink current vs. output voltage at $V_{CC} = 12\text{ V}$

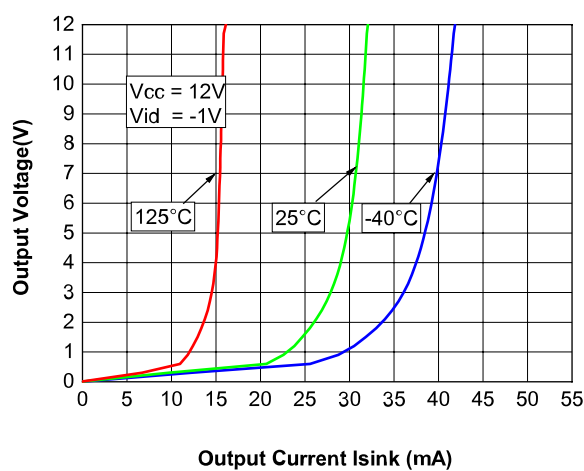


Figure 28. Output sink current vs. output voltage at $V_{CC} = 36\text{ V}$

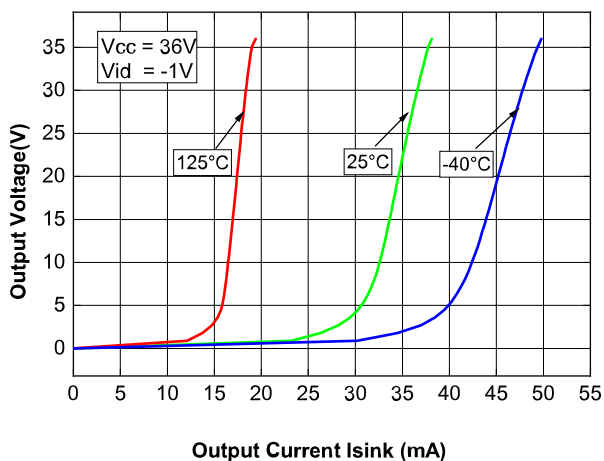


Figure 29. Slew rate at $V_{CC} = 2.7\text{ V}$

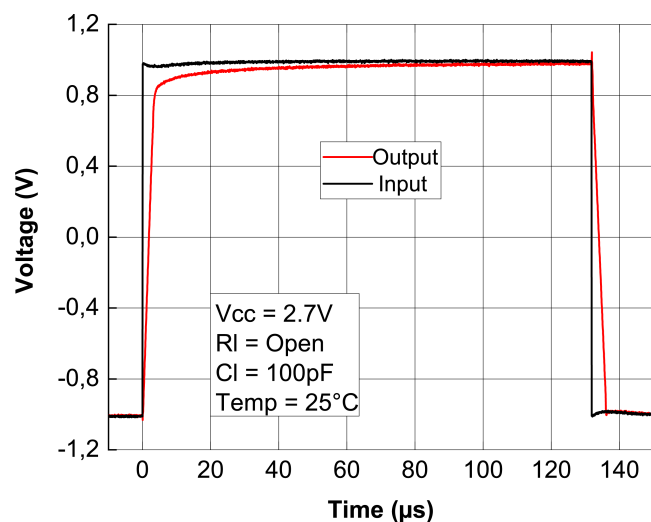


Figure 30. Slew rate at $V_{CC} = 12\text{ V}$

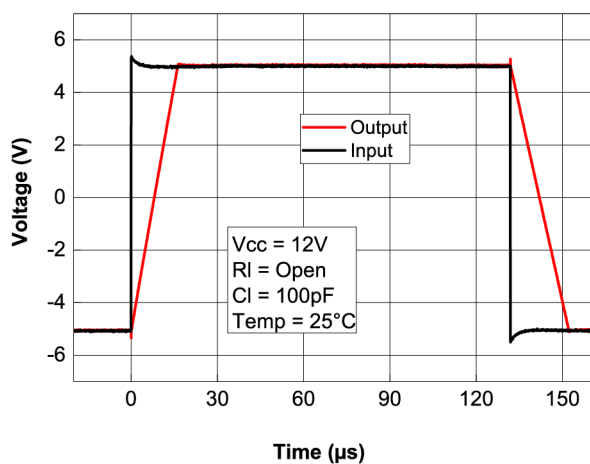


Figure 31. Slew rate at $V_{CC} = 36\text{ V}$

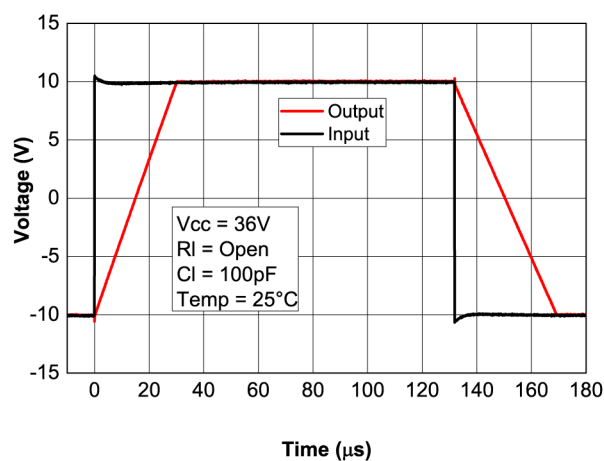


Figure 32. Slew rate vs. temperature at $V_{CC} = 36\text{ V}$

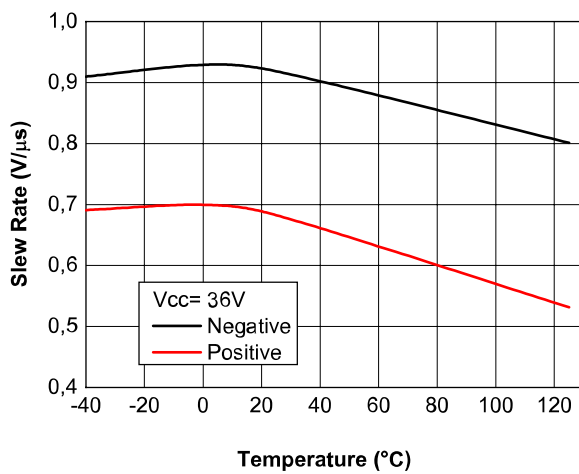


Figure 33. Small signal step response

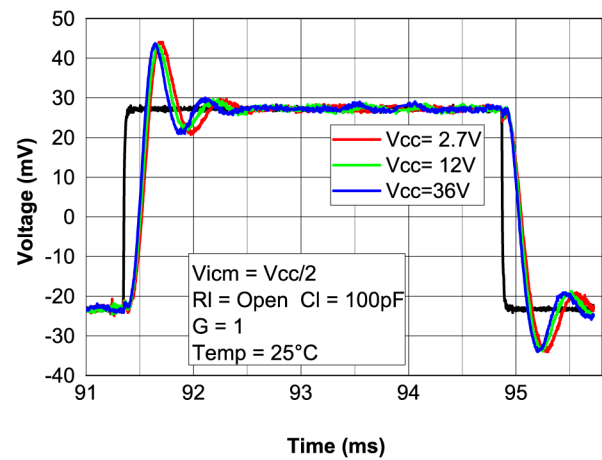


Figure 34. Maximum output voltage vs. frequency

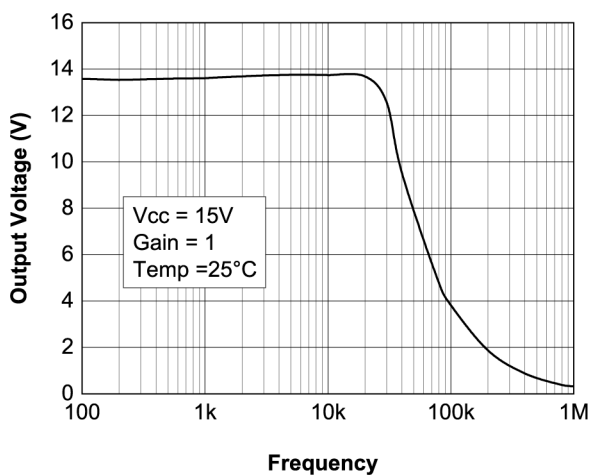


Figure 35. THD+Noise vs. frequency

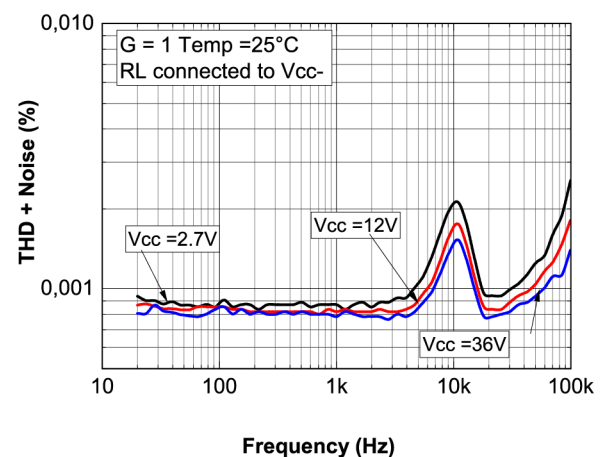


Figure 36. THD+Noise vs. output voltage

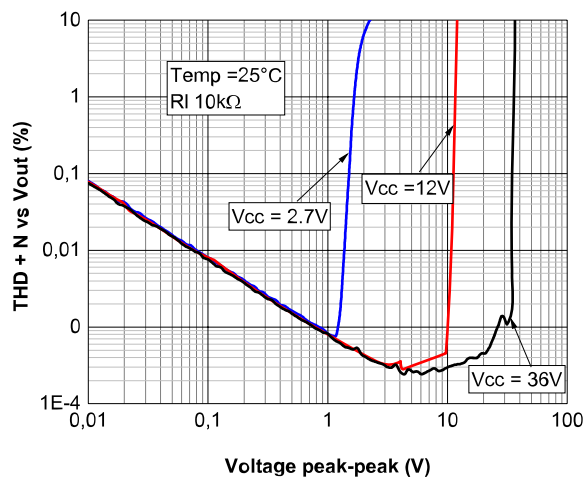


Figure 37. Cross talk vs. frequency

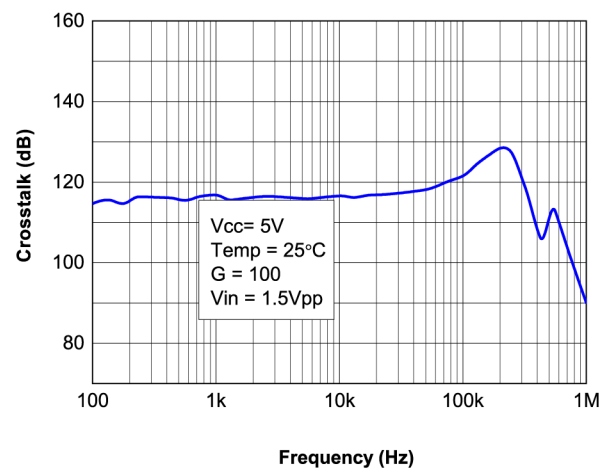
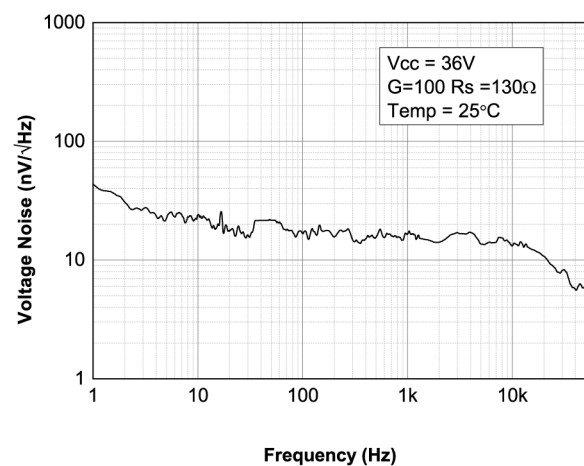


Figure 38. Equivalent input noise voltage vs. frequency

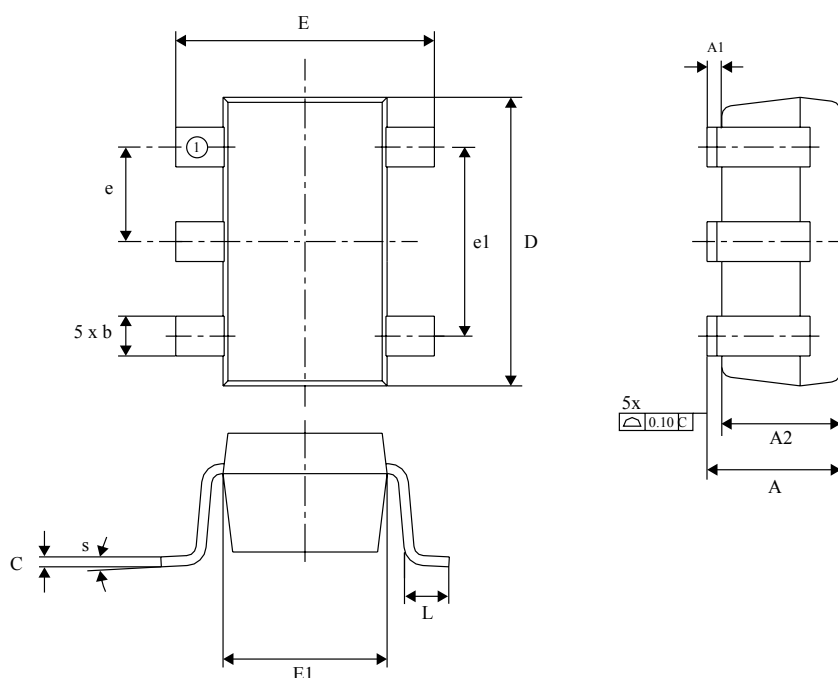


5 Package information

In order to meet environmental requirements, ST offers these devices in different grades of **ECOPACK** packages, depending on their level of environmental compliance. ECOPACK specifications, grade definitions and product status are available at: www.st.com. ECOPACK is an ST trademark.

5.1 SOT23-5 package information

Figure 39. SOT23-5 package outline



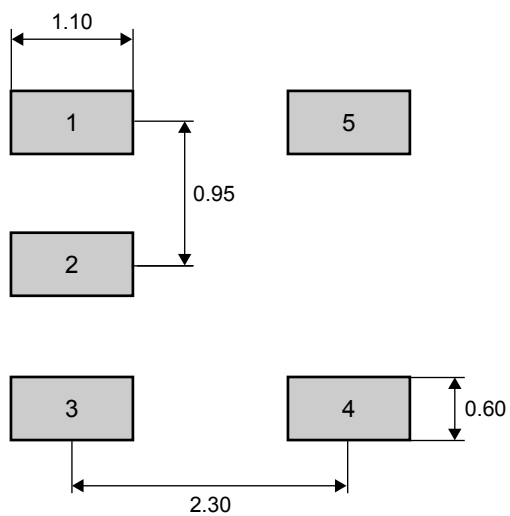
SOT23-5

Table 9. SOT23-5 mechanical data

Symbol	Millimeters			Inches ⁽¹⁾		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.45			0.057
A1	0.00		0.15	0.000		0.006
A2	0.90	1.15	1.30	0.035	0.045	0.051
b	0.30		0.50	0.012		0.020
c	0.08		0.22	0.003		0.009
D		2.90			0.114	
E		2.80			0.110	
E1		1.60			0.063	
e		0.95			0.037	
e1		1.90			0.075	
L	0.30	0.45	0.60	0.012	0.018	0.024
θ	0	4	8	0	4	8

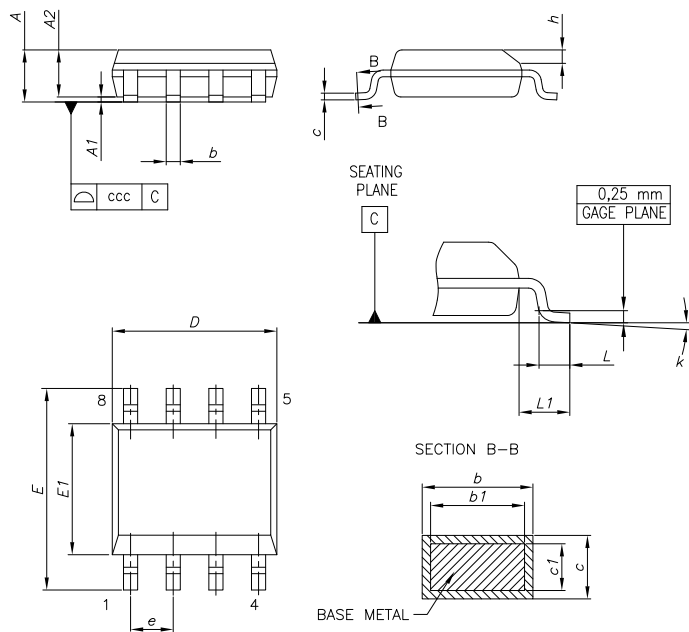
1. Values in inches are converted from mm and rounded to 4 decimal digits.

Figure 40. SOT23-5 recommended footprint



5.2 SO8 package information

Figure 41. SO8 package outline

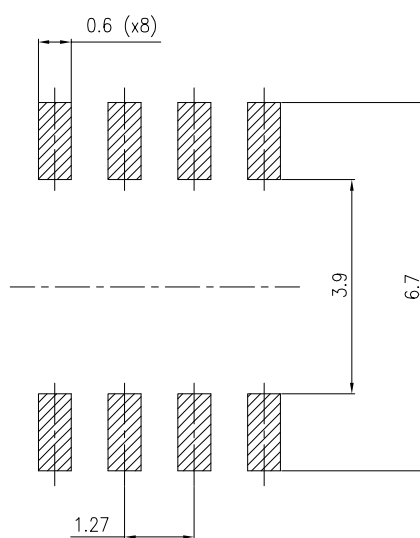


0016023_So-807_fig2_Rev10

Table 10. SO8 mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A			1.75
A1	0.10		0.25
A2	1.25		
b	0.31		0.51
b1	0.28		0.48
c	0.10		0.25
c1	0.10		0.23
D	4.80	4.90	5.00
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e		1.27	
h	0.25		0.50
L	0.40		1.27
L1		1.04	
L2		0.25	
k	0°		8°
ccc			0.10

Figure 42. SO8 recommended footprint



5.3 MiniSO8 package information

Figure 43. MiniSO8 package outline

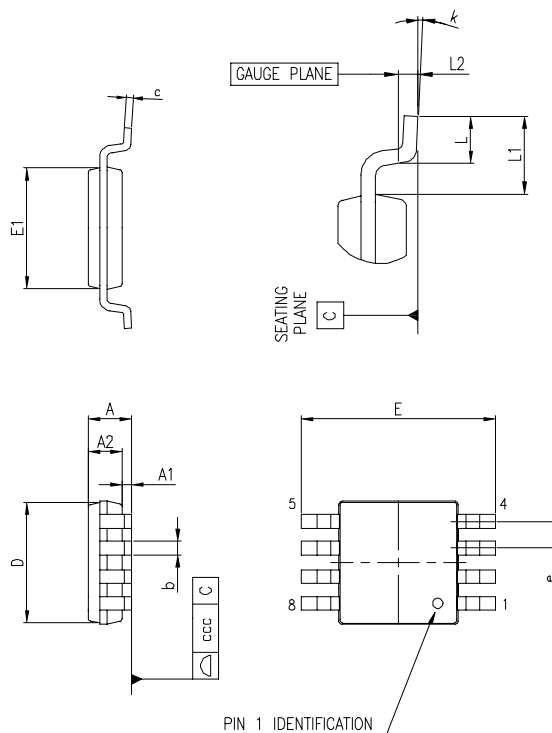
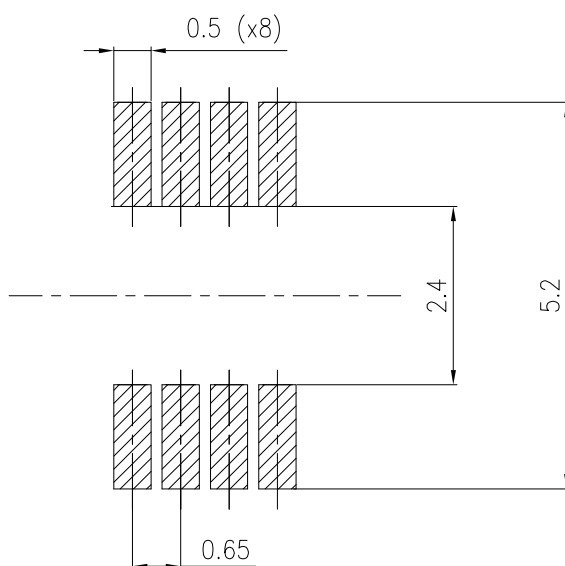


Table 11. MiniSO8 mechanical data

Dim.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.1			0.043
A1	0		0.15	0		0.006
A2	0.75	0.85	0.95	0.03	0.033	0.037
b	0.22		0.4	0.009		0.016
c	0.08		0.23	0.003		0.009
D	2.8	3	3.2	0.11	0.118	0.126
E	4.65	4.9	5.15	0.183	0.193	0.203
E1	2.8	3	3.1	0.11	0.118	0.122
e		0.65			0.026	
L	0.4	0.6	0.8	0.016	0.024	0.031
L1		0.95			0.037	
L2		0.25			0.01	
k	0°		8°	0°		8°
ccc			0.1			0.004

Figure 44. MiniSO8 recommended footprint



5.4 DFN8 3x3 wettable flanks package information (package code: A03Y)

Figure 45. DFN8 3x3 package outline and mechanical data

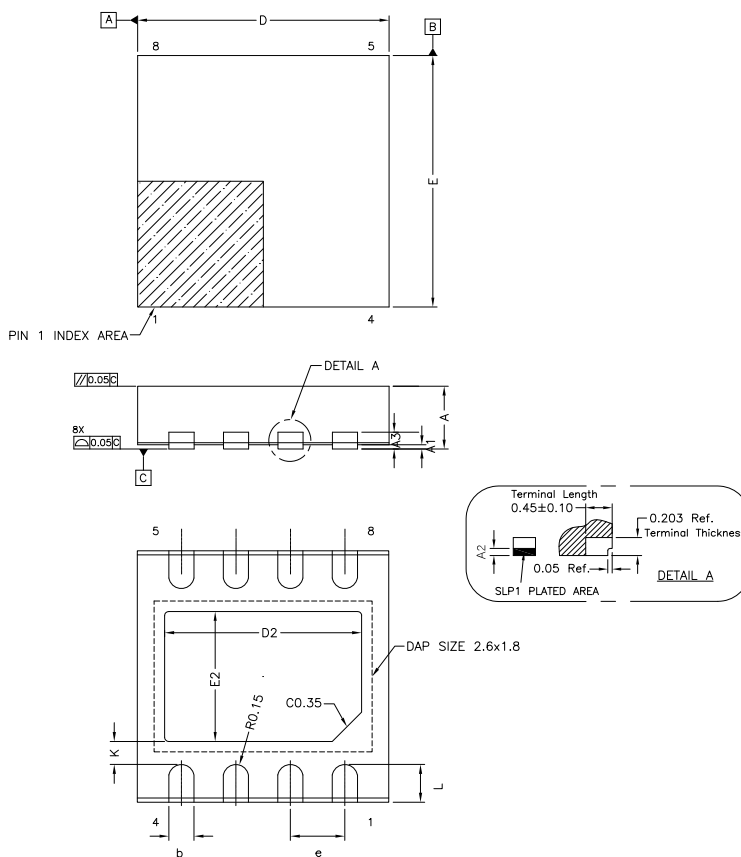
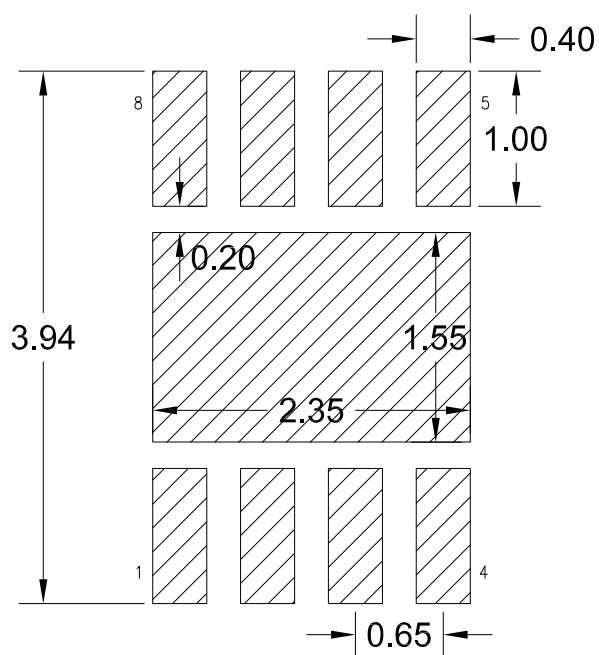


Table 12. DFN8 3x3 mechanical data

Symbol	mm		
	Min.	Typ.	Max.
A	0.70	0.75	0.80
A1	0.0		0.05
A2	0.10		
A3	0.20 Ref.		
b	0.25	0.30	0.35
D	2.95	3.00	3.05
D2	2.25	2.35	2.45
e	0.65 BSC		
E	2.95	3.00	3.05
E2	1.45	1.55	1.65
L	0.35	0.45	0.55
K	0.275 Ref.		

Figure 46. DFN8 3x3 footprint data


5.5 SO14 package information

Figure 47. SO14 package outline

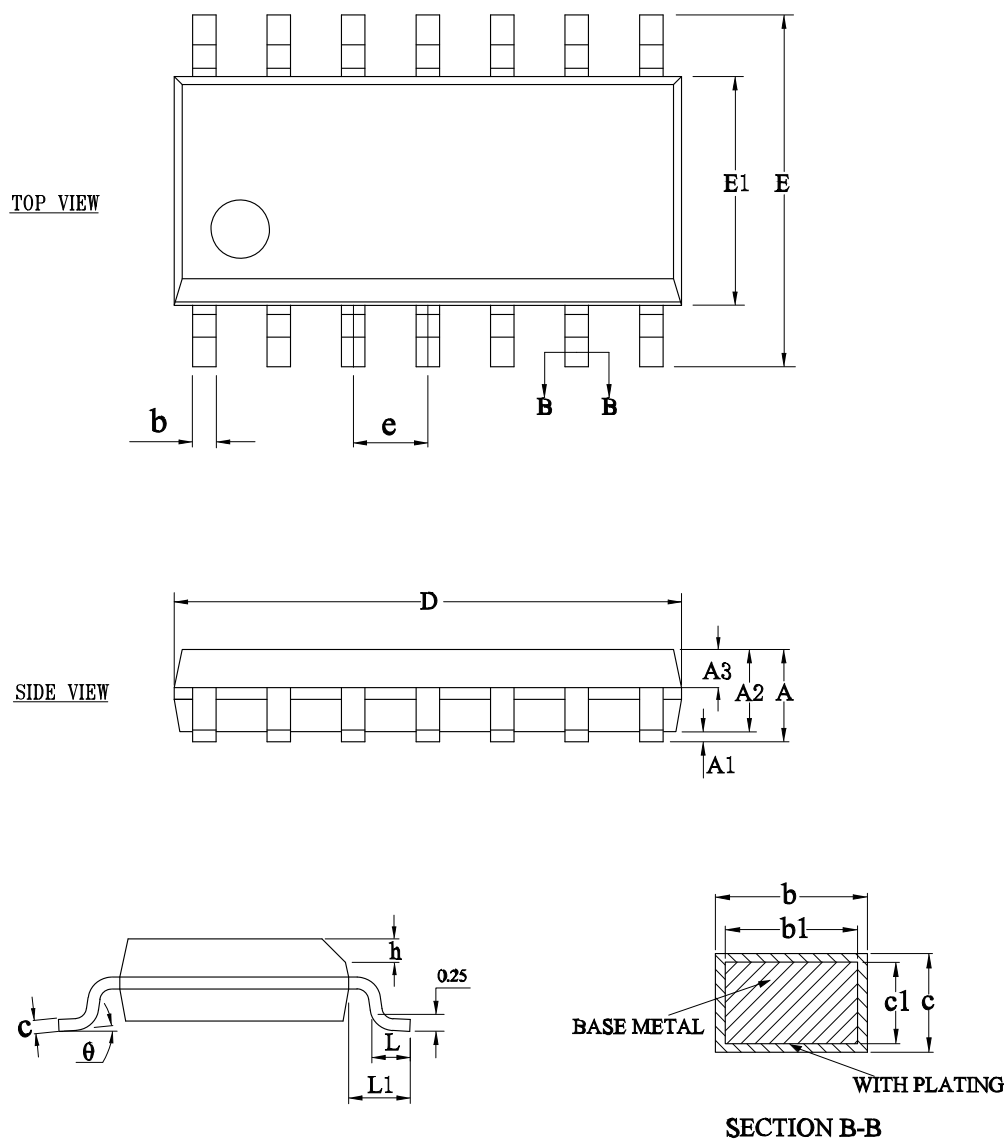
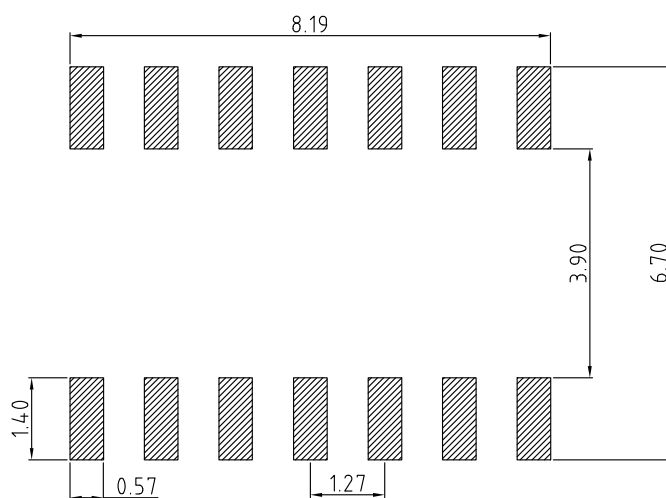


Table 13. SO14 package mechanical data

Dim.	mm		
	Min.	Typ.	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	8.55	8.65	8.75
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e	1.27 BSC		
h	0.25		0.50
L	0.50		0.80
L1	1.05 REF		
	0		8°

Figure 48. SO14 recommended footprint



5.6 TSSOP14 package information

Figure 49. TSSOP14 package outline

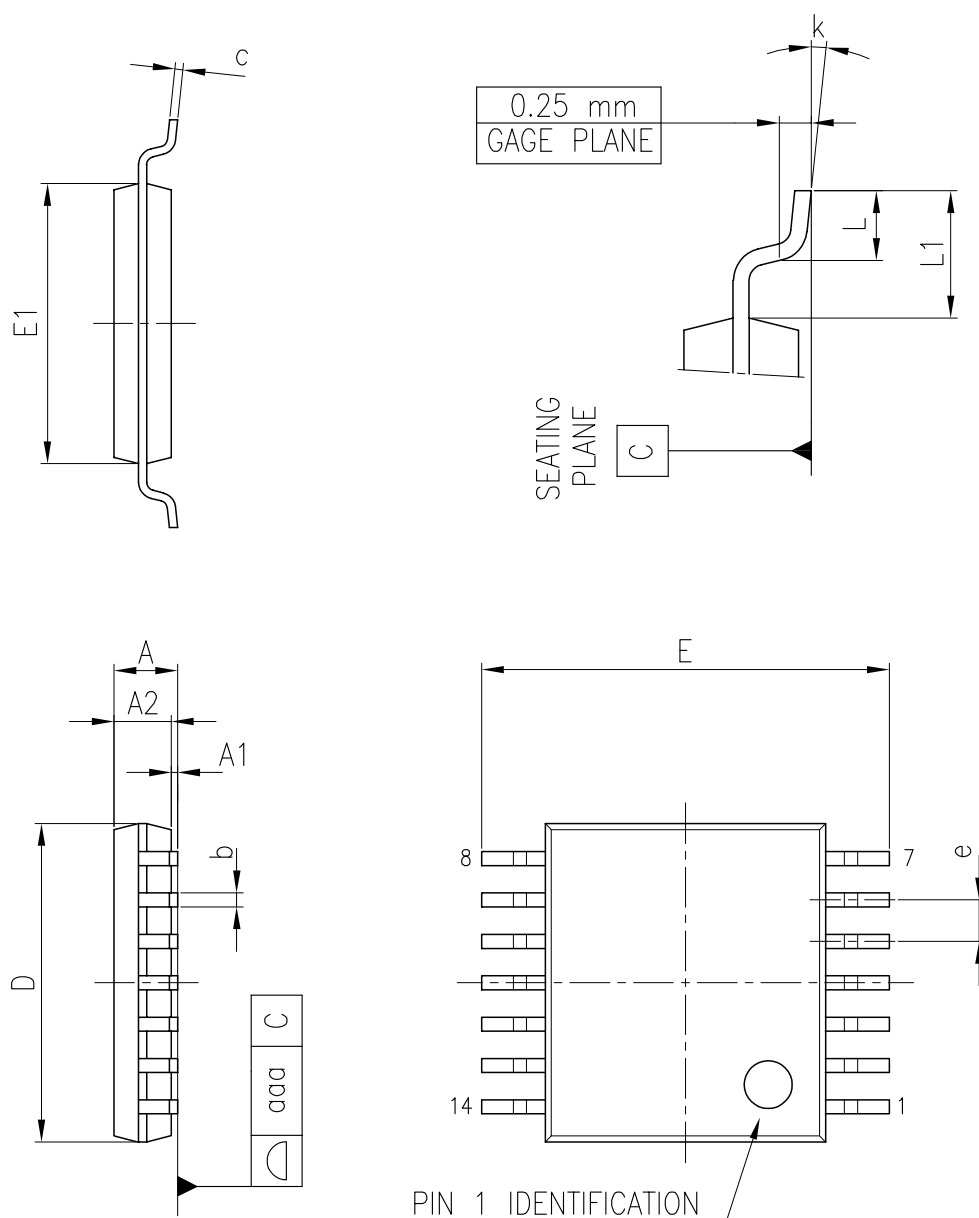


Table 14. TSSOP14 package mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A			1.20
A1	0.05		0.15
A2	0.80	1.00	1.05
b	0.19		0.30
c	0.09		0.20
D	4.90	5.00	5.10
E	6.20	6.40	6.60
E1	4.30	4.40	4.50
e		0.65	
L	0.45	0.60	0.75
L1		1.00	
k	0°		8°
aaa			0.10

6 Ordering information

Table 15. Order code

Order code	Package	Packaging	Marking
TSB621ILT	SOT23-5	Tape & Reel	K2K
TSB621IYLT ⁽¹⁾			K2L
TSB622IDT	SO8		TSB622I
TSB622IYDT ⁽¹⁾			TSB622IY
TSB622IST	MiniSO8		K2K
TSB622IYST ⁽¹⁾			K2L
TSB622IQ3T	DFN8 3x3 WF		K2K
TSB622IYQ3T ⁽¹⁾			K2L
TSB624IDT	SO14		TSB624I
TSB624IYDT ⁽¹⁾			TSB624IY
TSB624IPT	TSSOP14		TSB624I
TSB624IYPT ⁽¹⁾			TSB624IY

1. Qualified and characterized according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 & Q002 or equivalent.

Revision history

Table 16. Document revision history

Date	Revision	Changes
03-Nov-2021	1	Initial release.
15-Feb-2022	2	Updated Figure 2.
01-Dec-2022	3	Added new TSSOP14, SO14 and SOT23-5 packages in Section 5 Package information . Updated Section 1 Pin connections , Table 4. Absolute maximum ratings , phase margin typical value in Table 6 , Table 7 , Table 8 and Section 6 Ordering information .

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Table 7.	Electrical characteristics $V_{CC+} = 12\text{ V}$, $V_{CC-} = 0\text{ V}$, $V_{icm} = V_{CC}/2$, $T = 25\text{ }^{\circ}\text{C}$, $R_L = 10\text{ k}\Omega$ connected to $V_{CC}/2$ (unless otherwise specified)	6
Table 8.	Electrical characteristics $V_{CC+} = 36\text{ V}$, $V_{CC-} = 0\text{ V}$, $V_{icm} = V_{CC}/2$, $T = 25\text{ }^{\circ}\text{C}$, $R_L = 10\text{ k}\Omega$ connected to $V_{CC}/2$ (unless otherwise specified)	7
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