

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



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
- Micropackage: SO8, MiniSO8, DFN8 3x3 Wettable flanks

Maturity status link

[TSB622](#)

Related products

TSB612	For lower speed
TSB572	For higher speed and rail-to-rail inputs
TSB712	For a higher precision and speed

Applications

- Industrial
- Power supplies
- Automotive

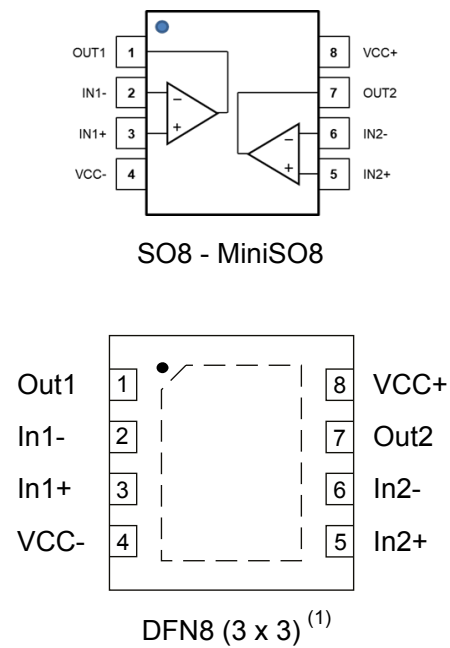
Description

The **TSB622** is a general purpose dual operational amplifier featuring an extended supply voltage operating range and rail-to-rail output. It also offers 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 **TSB622** operates over a wide temperature range from -40 °C to 125 °C making this device ideal for industrial and automotive applications with the associated qualification.

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

1 Pin connections

Figure 1. Pin connections (top view)


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

Table 1. 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

2 Absolute maximum ratings and operating conditions

Table 2. 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	
ESD	DFN8 3x3 WF	40	V
	Human Body Model (HBM) ⁽⁶⁾	4000	
	Machine Model (MM) ⁽⁷⁾	200	
	Charged Device Model (CDM) ⁽⁸⁾	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 JEDEC standard JESD22-A115A.
8. According to ANSI/ESD STM5.3.1.

Table 3. 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 4. Electrical characteristics $V_{CC+} = 2.7\text{ V}$, $V_{CC-} = 0\text{ V}$, $V_{icm} = V_{CC}/2$, $T = 25\text{ °C}$, $R_L = 10\text{ k}\Omega$ connected to $V_{CC}/2$ (unless otherwise specified)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
DC performance						
V_{IO}	Input offset voltage	$T = 25\text{ °C}$	-1		1	mV
		$T_{min} < T < T_{max}$	-1.6		1.6	
$ \Delta V_{IO}/\Delta T $	Input offset voltage drift	$T_{min} < T < T_{max}$		2		$\mu\text{V}/\text{°C}$
I_{IB}	Input bias current	$T = 25\text{ °C}$		15	30	nA
		$T_{min} < T < T_{max}$			45	
I_{IO}	Input offset current	$T = 25\text{ °C}$		3	10	
		$T_{min} < T < T_{max}$			15	
CMR	Common mode rejection ratio: $20 \log (\Delta V_{icm}/\Delta V_{io})$	$V_{icm} = -0.1\text{ to }V_{CC} - 1\text{ V}$, $V_{OUT} = V_{CC}/2$	90	115		dB
		$T_{min} < T < T_{max}$	85			
A_{VD}	Large signal voltage gain	$V_{OUT} = 0.5\text{ V to } (V_{CC} - 0.5\text{ V})$	90	105		dB
		$T_{min} < T < T_{max}$	82			
V_{OH}	High-level output voltage, $V_{OH} = V_{CC} - V_{OUT}$	$T = 25\text{ °C}$		35	46	mV
		$T_{min} < T < T_{max}$			55	
V_{OL}	Low-level output voltage	$T = 25\text{ °C}$		50	60	
		$T_{min} < T < T_{max}$			75	
I_{OUT}	I_{sink}	$V_{OUT} = V_{CC}$	20	27		mA
		$T_{min} < T < T_{max}$	10			
	I_{source}	$V_{OUT} = 0\text{ V}$	20	28		
		$T_{min} < T < T_{max}$	8			
I_{CC}	Supply current (per channel)	No load, $V_{OUT} = V_{CC}/2$		280	330	μA
		$T_{min} < T < T_{max}$			400	
AC performance						
GBP	Gain bandwidth product	$R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$	1	1.45		MHz
		$T_{min} < T < T_{max}$	0.7			
Φ_m	Phase margin	$R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$		60		degrees
G_m	Gain margin			18		dB
SR	Slew rate	$T = 25\text{ °C}$	0.30	0.53		V/ μs
		$T_{min} < T < T_{max}$	0.20			
E_N	Equivalent input noise voltage	$f = 1\text{ kHz}$		30		nV/ $\sqrt{\text{Hz}}$
THD+N	Total harmonic distortion + noise	$f_{in} = 1\text{ kHz}$, Gain = 1, $R_L = 100\text{ k}\Omega$, $V_{icm} = (V_{CC} - 1\text{ V}) / 2$, BW = 22 kHz, $V_{OUT} = 1\text{ Vpp}$		0.005		%
C_S	Channel separation	$f = 1\text{ kHz}$		120		dB
t_{rec}	Overload recovery time			2		μs

Table 5. 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	$T = 25\text{ }^{\circ}\text{C}$	-1		1	mV
		$T_{min} < T < T_{max}$	-1.6		1.6	
$ \Delta V_{IO}/\Delta T $	Input offset voltage drift	$T_{min} < T < T_{max}$		2		$\mu\text{V}/^{\circ}\text{C}$
I_{IB}	Input bias current	$T = 25\text{ }^{\circ}\text{C}$		15	30	nA
		$T_{min} < T < T_{max}$			45	
I_{IO}	Input offset current	$T = 25\text{ }^{\circ}\text{C}$		3	10	
		$T_{min} < T < T_{max}$			15	
CMR	Common mode rejection ratio: $20 \log (\Delta V_{icm}/\Delta V_{io})$	$V_{icm} = -0.1 \text{ to } V_{CC} - 1\text{ V}$, $V_{OUT} = V_{CC}/2$	100	130		dB
		$T_{min} < T < T_{max}$	95			
A_{VD}	Large signal voltage gain	$V_{OUT} = 0.5\text{ V to } (V_{CC} - 0.5\text{ V})$	98	115		dB
		$T_{min} < T < T_{max}$	90			
V_{OH}	High-level output voltage, $V_{OH} = V_{CC} - V_{OUT}$	$T = 25\text{ }^{\circ}\text{C}$		68	80	mV
		$T_{min} < T < T_{max}$			95	
V_{OL}	Low-level output voltage	$T = 25\text{ }^{\circ}\text{C}$		86	100	mV
		$T_{min} < T < T_{max}$			125	
I_{OUT}	I_{sink}	$V_{OUT} = V_{CC}$	25	35		mA
		$T_{min} < T < T_{max}$	10			
	I_{source}	$V_{OUT} = 0\text{ V}$	30	37		
		$T_{min} < T < T_{max}$	15			
I_{CC}	Supply current (per channel)	No load, $V_{OUT} = V_{CC}/2$		295	345	μA
		$T_{min} < T < T_{max}$			420	
AC performance						
GBP	Gain bandwidth product	$R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$	1.1	1.55		MHz
		$T_{min} < T < T_{max}$	0.8			
Φ_m	Phase margin	$R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$		60		degrees
G_m	Gain margin			18		dB
SR	Slew rate	$T = 25\text{ }^{\circ}\text{C}$	0.35	0.58		$\text{V}/\mu\text{s}$
		$T_{min} < T < T_{max}$	0.20			
E_N	Equivalent input noise voltage	$f = 1\text{ kHz}$		30		$\text{nV}/\sqrt{\text{Hz}}$
THD+N	Total harmonic distortion + noise	$f_{in} = 1\text{ kHz}$, Gain = 1, $R_L = 100\text{ k}\Omega$, $V_{icm} = (V_{CC} - 1\text{ V}) / 2$, BW = 22 kHz, $V_{OUT} = 1\text{ V}_{pp}$		0.005		%
C_S	Channel separation	$f = 1\text{ kHz}$		120		dB
t_{rec}	Overload recovery time			2		μs

Table 6. 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	$T = 25\text{ }^{\circ}\text{C}$	-1		1	mV
		$T_{min} < T < T_{max}$	-1.6		1.6	
$ \Delta V_{IO}/\Delta T $	Input offset voltage drift	$T_{min} < T < T_{max}$		2		$\mu\text{V}/^{\circ}\text{C}$
I_{IB}	Input bias current	$T = 25\text{ }^{\circ}\text{C}$		15	30	nA
		$T_{min} < T < T_{max}$			45	
I_{IO}	Input offset current	$T = 25\text{ }^{\circ}\text{C}$		3	10	
		$T_{min} < T < T_{max}$			15	
CMR	Common mode rejection ratio: $20 \log (\Delta V_{icm}/\Delta V_{io})$	$V_{icm} = -0.1 \text{ to } V_{CC} - 1\text{ V}$, $V_{OUT} = V_{CC}/2$	105	135		dB
		$T_{min} < T < T_{max}$	100			
SVR	Supply voltage rejection ratio: $20 \log (\Delta V_{CC}/\Delta V_{io})$	$V_{CC} = 4.5 \text{ to } 36\text{ V}$, $V_{icm} = 0\text{ V}$	100	124		dB
		$T_{min} < T < T_{max}$	95			
A_{VD}	Large signal voltage gain	$V_{OUT} = 0.5\text{ V to } (V_{CC} - 0.5\text{ V})$	105	120		dB
		$T_{min} < T < T_{max}$	100			
V_{OH}	High-level output voltage, $V_{OH} = V_{CC} - V_{OUT}$	$T = 25\text{ }^{\circ}\text{C}$		110	140	mV
		$T_{min} < T < T_{max}$			180	
V_{OL}	Low-level output voltage	$T = 25\text{ }^{\circ}\text{C}$		125	150	
		$T_{min} < T < T_{max}$			195	
I_{OUT}	I_{sink}	$V_{OUT} = V_{CC}$	35	45		mA
		$T_{min} < T < T_{max}$	15			
	I_{source}	$V_{OUT} = 0\text{ V}$	35	45		
		$T_{min} < T < T_{max}$	25			
I_{CC}	Supply current (per channel)	No load, $V_{OUT} = V_{CC}/2$		310	375	μA
		$T_{min} < T < T_{max}$			420	
AC performance						
GBP	Gain bandwidth product	$R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$	1.2	1.7		MHz
		$T_{min} < T < T_{max}$	0.95			
Φ_m	Phase margin	$R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$		58		degrees
G_m	Gain margin			18		dB
SR	Slew rate	$T = 25\text{ }^{\circ}\text{C}$	0.35	0.60		$\text{V}/\mu\text{s}$
		$T_{min} < T < T_{max}$	0.25			
E_N	Equivalent input noise voltage	$f = 1\text{ kHz}$		25		$\text{nV}/\sqrt{\text{Hz}}$
THD+N	Total harmonic distortion + noise	$f_{in} = 1\text{ kHz}$, Gain = 1, $R_L = 100\text{ k}\Omega$, $V_{icm} = (V_{CC} - 1\text{ V}) / 2$, BW = 22 kHz, $V_{OUT} = 1\text{ Vpp}$		0.005		%
C_S	Channel separation	$f = 1\text{ kHz}$		120		dB
t_{rec}	Overload recovery time			2		μs

4 Typical performance characteristics

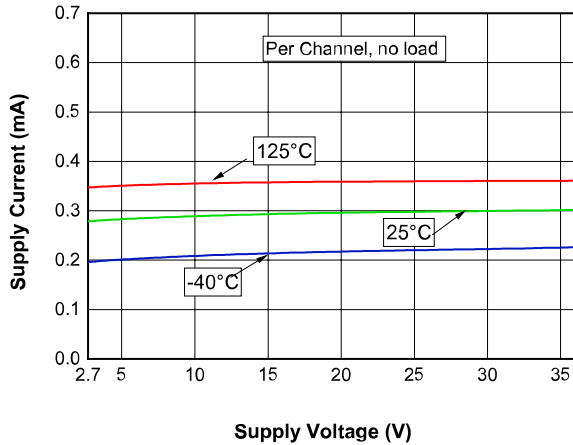
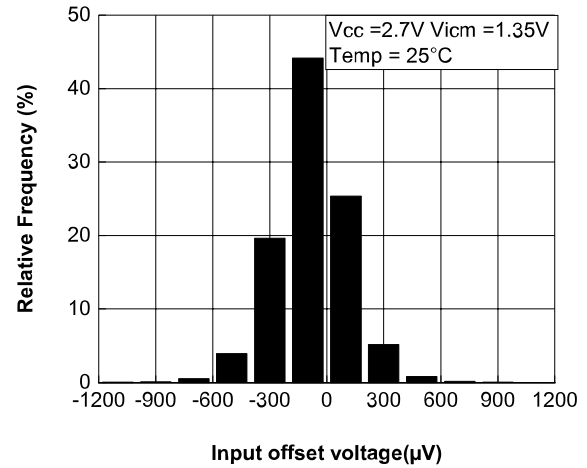
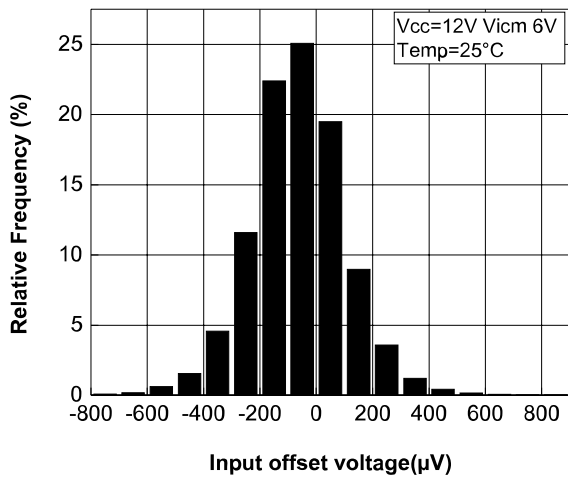
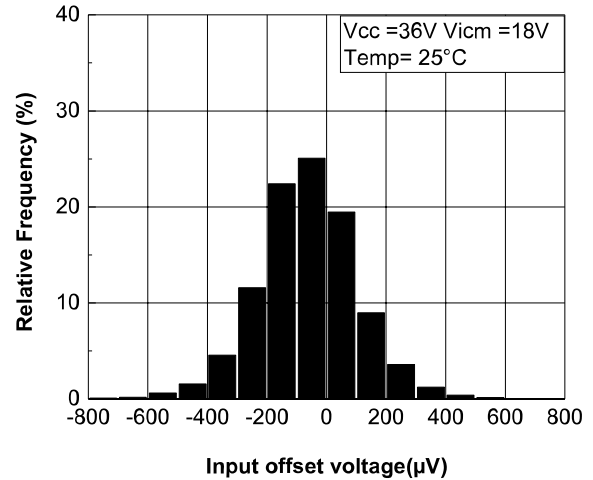
Figure 2. Supply current vs. supply voltage

Figure 3. Input offset voltage distribution at $V_{CC} = 2.7\text{ V}$

Figure 4. Input offset voltage distribution at $V_{CC} = 12\text{ V}$

Figure 5. Input offset voltage distribution at $V_{CC} = 36\text{ V}$


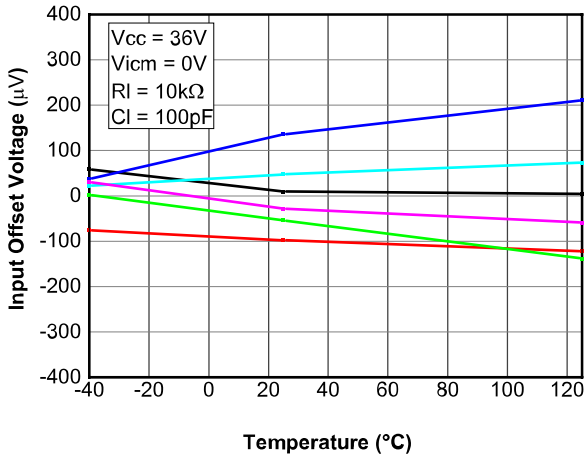
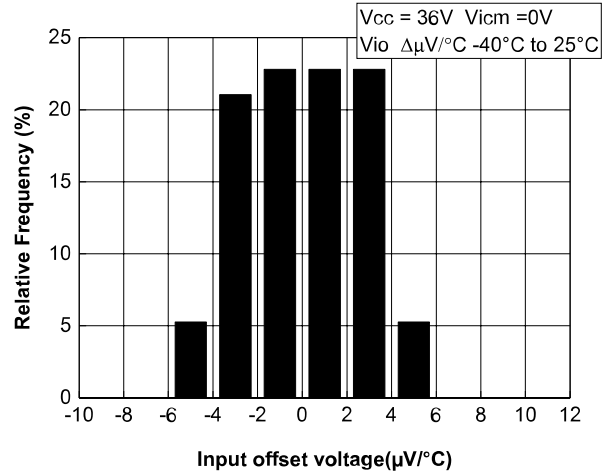
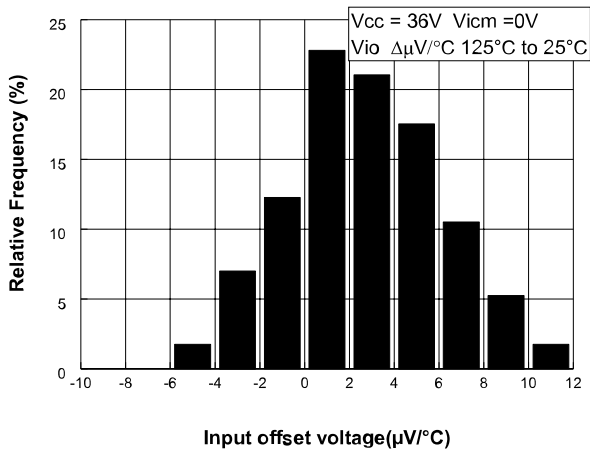
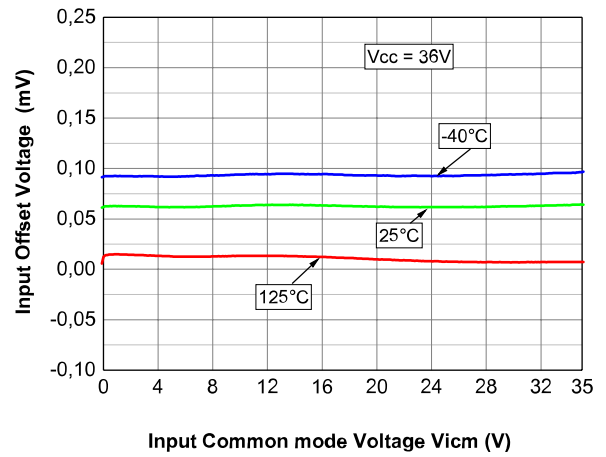
Figure 6. Input offset voltage vs. temperature at $V_{CC} = 36\text{ V}$

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

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

Figure 9. Input offset voltage vs. common-mode voltage at $V_{CC} = 36\text{ V}$


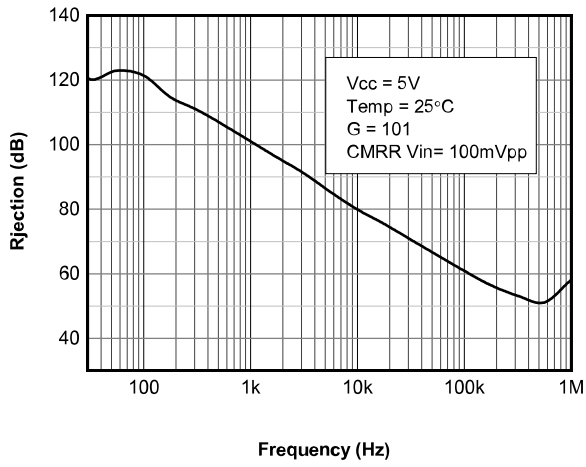
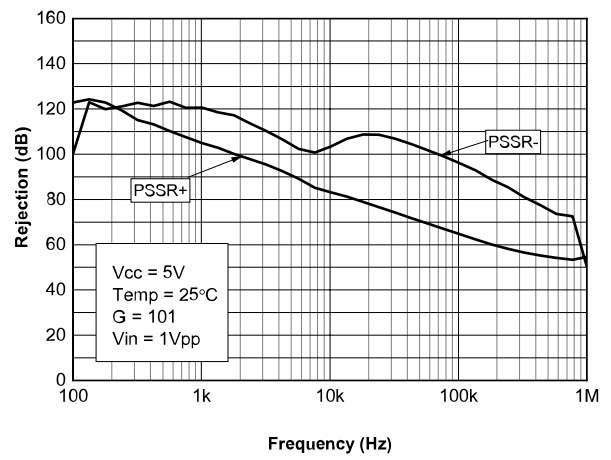
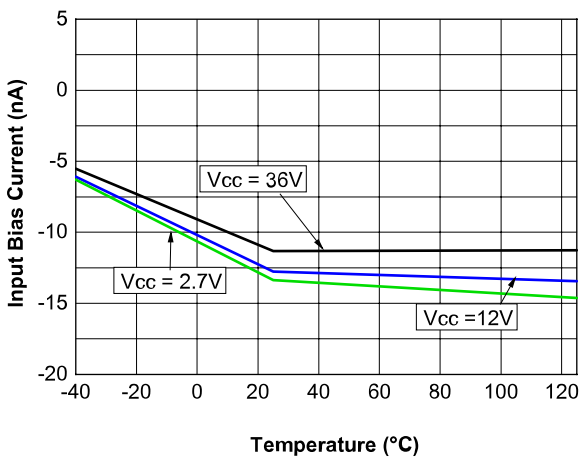
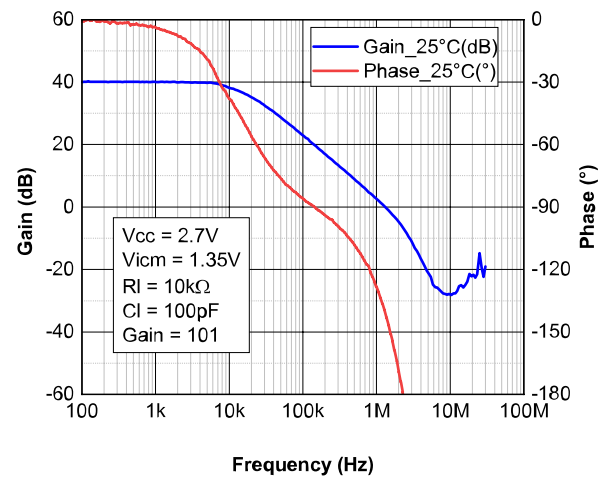
Figure 10. Common-mode reject. ratio CMR at $V_{CC} = 5\text{ V}$

Figure 11. Supply voltage rejection ratio SVR at $V_{CC} = 5\text{ V}$

Figure 12. Input bias current vs. temperature

Figure 13. Bode diagram at $V_{CC} = 2.7\text{ V}$


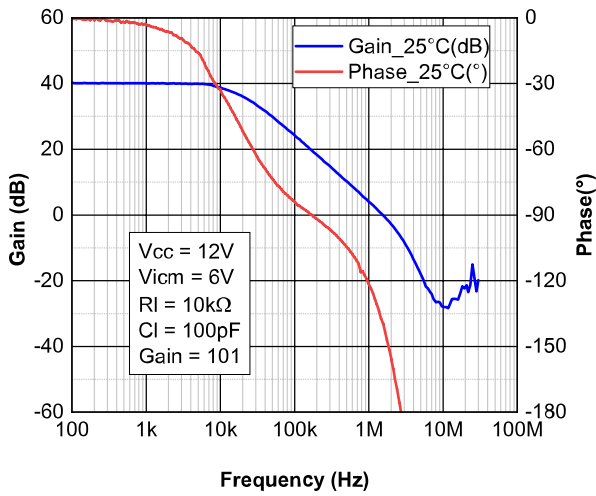
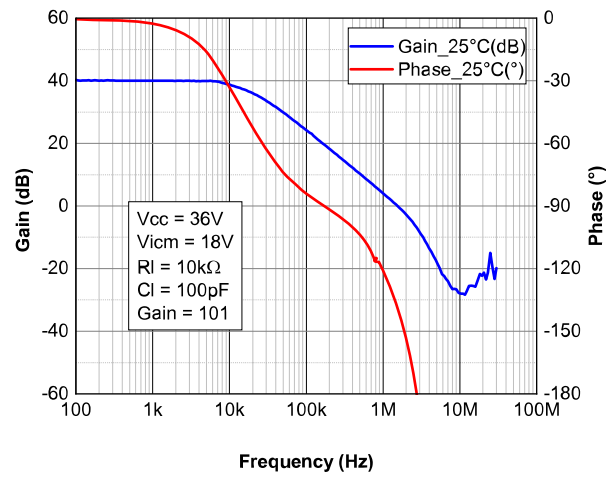
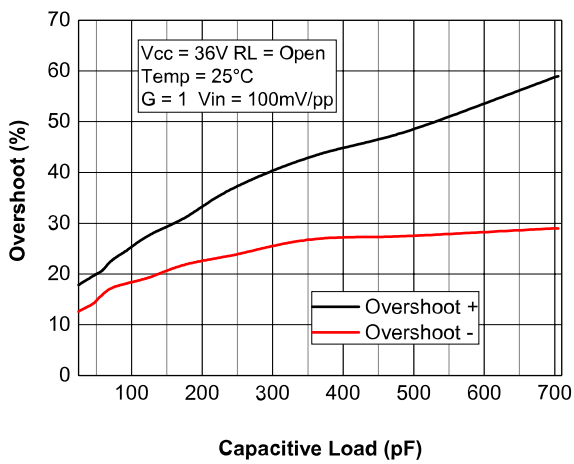
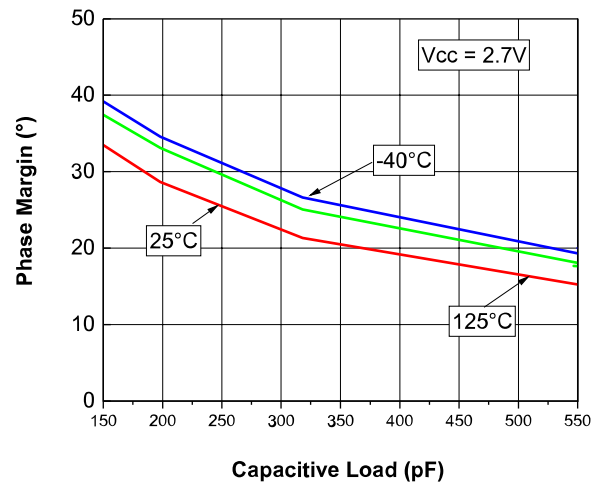
Figure 14. Bode diagram at $V_{CC} = 12\text{ V}$

Figure 15. Bode diagram at $V_{CC} = 36\text{ V}$

Figure 16. Overshoot vs. capacitive load at $V_{CC} = 36\text{ V}$

Figure 17. Phase margin vs. capacitive load at $V_{CC} = 2.7\text{ V}$


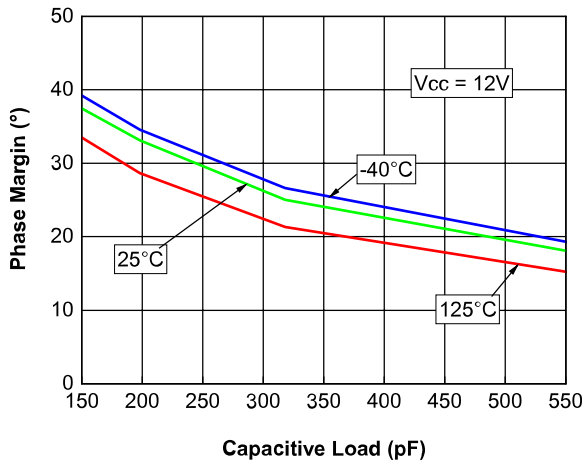
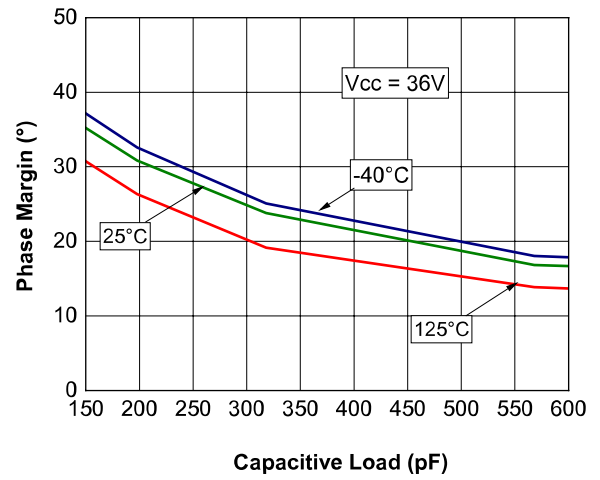
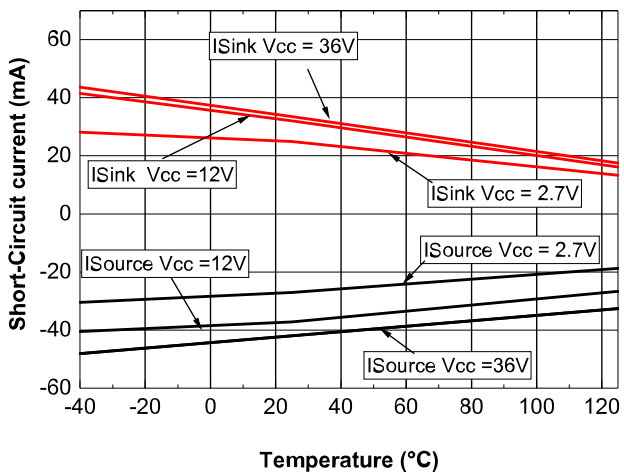
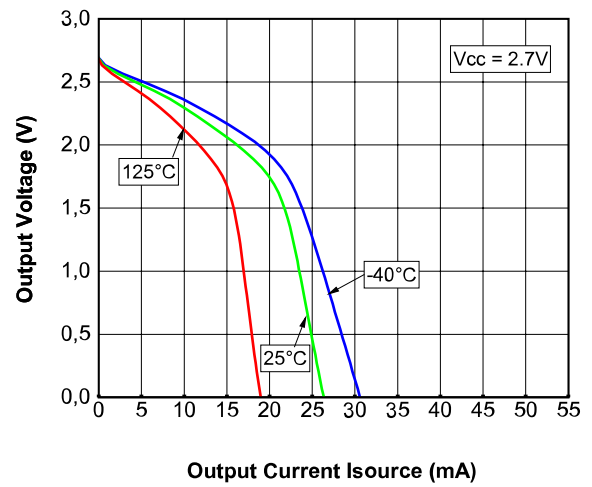
Figure 18. Phase margin vs. capacitive load at $V_{CC} = 12\text{ V}$

Figure 19. Phase margin vs. capacitive load at $V_{CC} = 36\text{ V}$

Figure 20. Short-circuit current vs. temperature

Figure 21. Output source current vs. output voltage at $V_{CC} = 2.7\text{ V}$


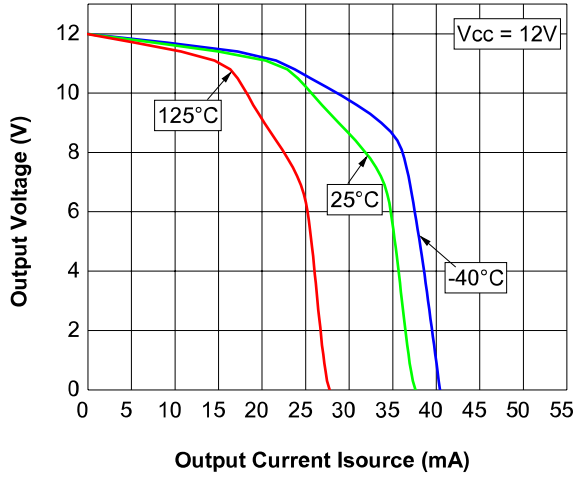
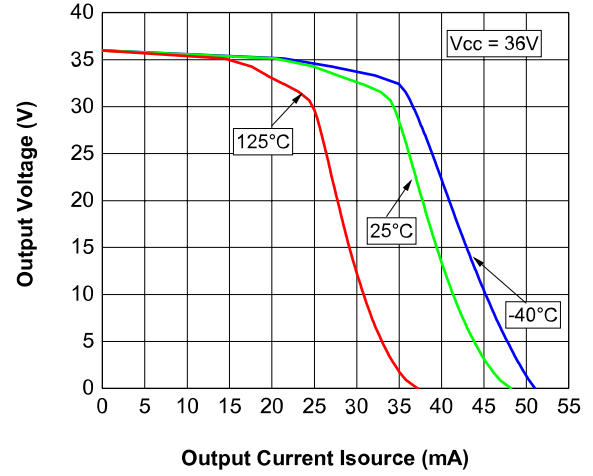
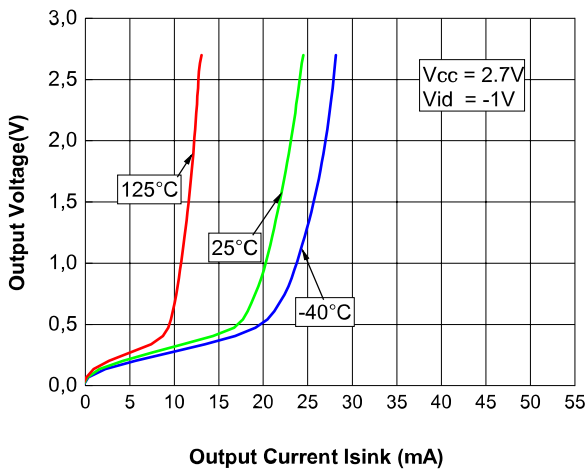
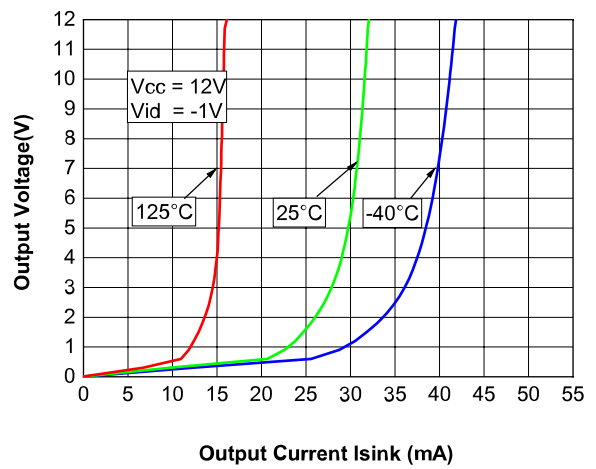
Figure 22. Output source current vs. output voltage at $V_{CC} = 12\text{ V}$

Figure 23. Output source current vs. output voltage at $V_{CC} = 36\text{ V}$

Figure 24. Output sink current vs. output voltage at $V_{CC} = 2.7\text{ V}$

Figure 25. Output sink current vs. output voltage at $V_{CC} = 12\text{ V}$


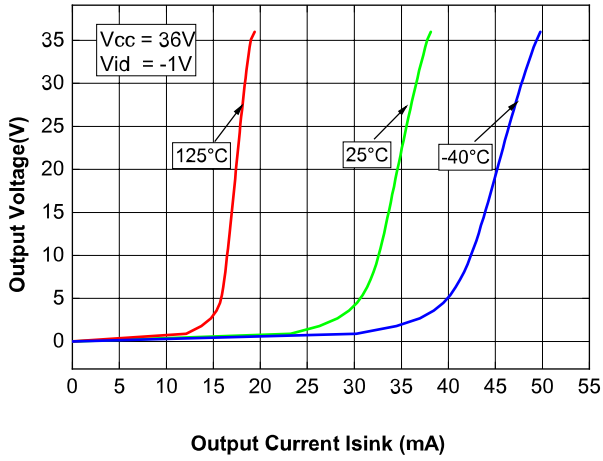
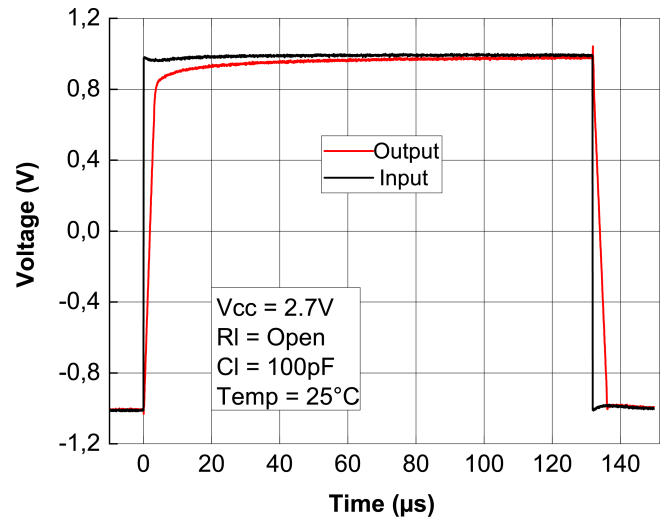
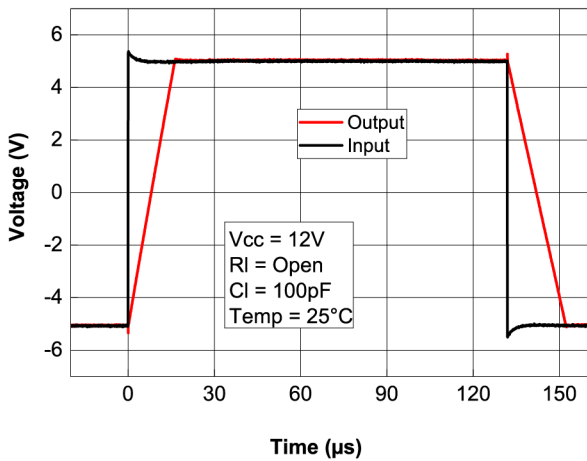
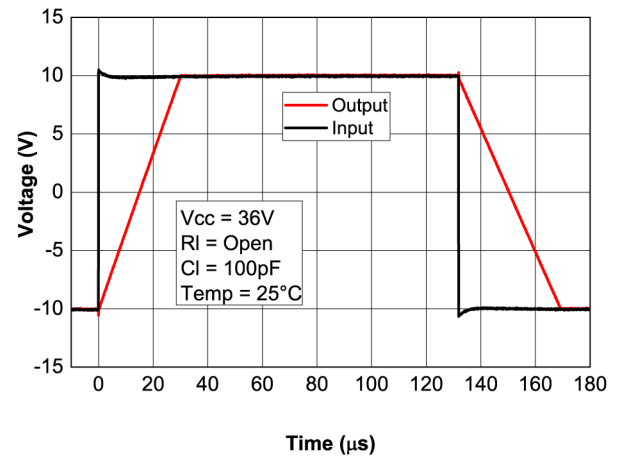
Figure 26. Output sink current vs. output voltage at $V_{CC} = 36\text{ V}$

Figure 27. Slew rate at $V_{CC} = 2.7\text{ V}$

Figure 28. Slew rate at $V_{CC} = 12\text{ V}$

Figure 29. Slew rate at $V_{CC} = 36\text{ V}$


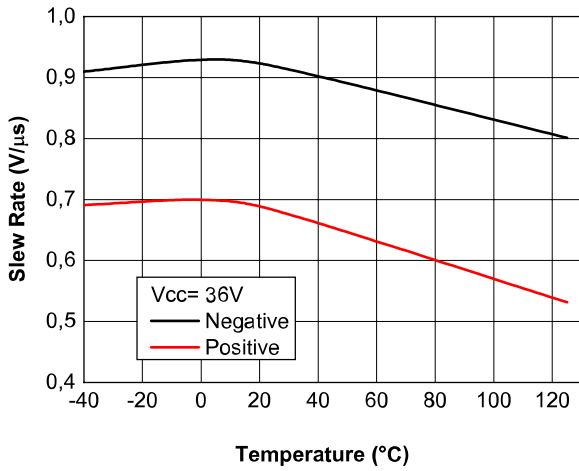
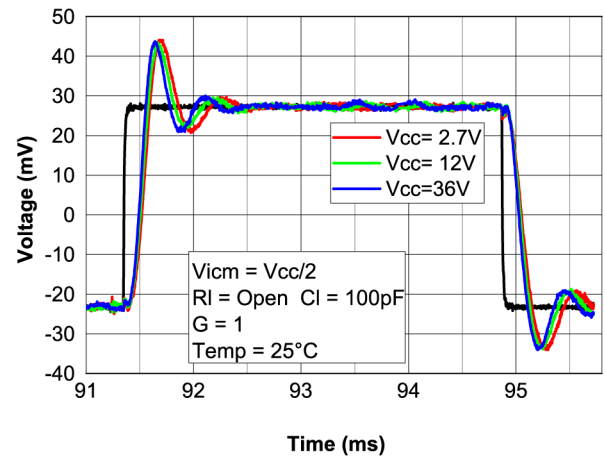
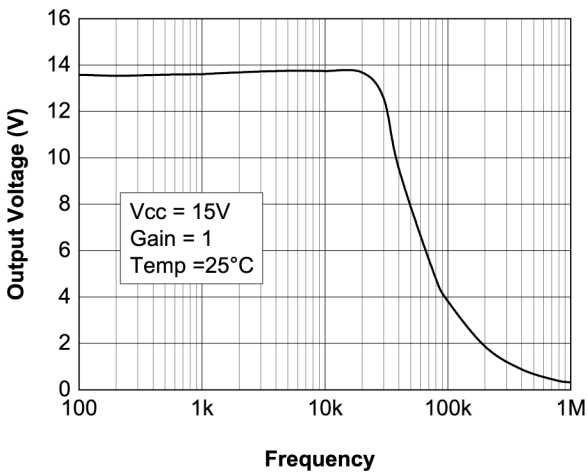
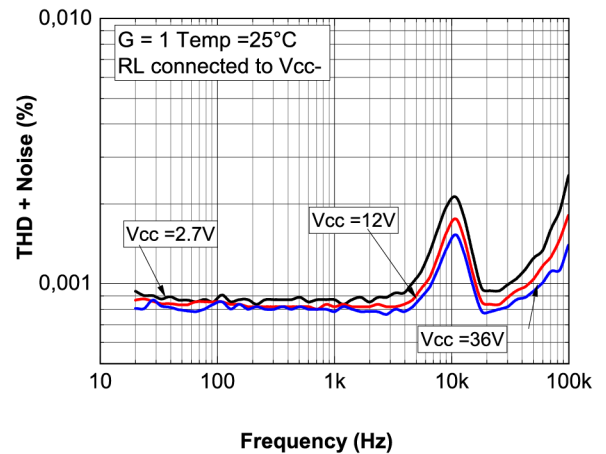
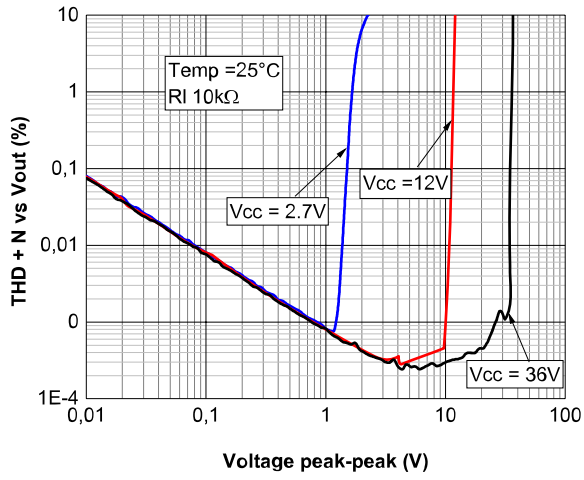
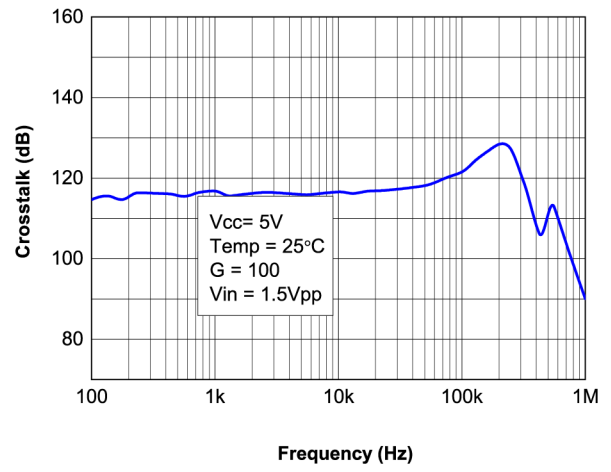
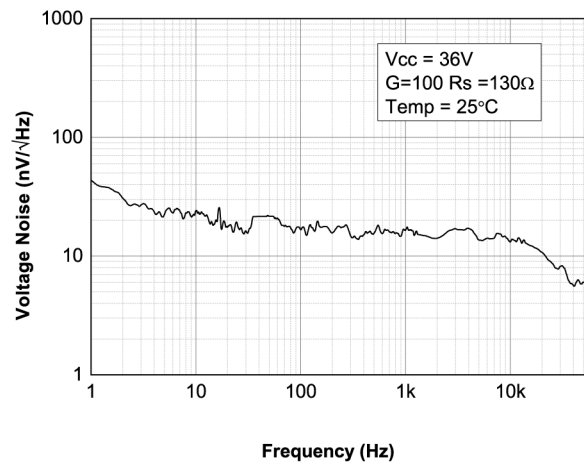
Figure 30. Slew rate vs. temperature at $V_{CC} = 36\text{ V}$

Figure 31. Small signal step response

Figure 32. Maximum output voltage vs. frequency

Figure 33. THD+Noise vs. frequency


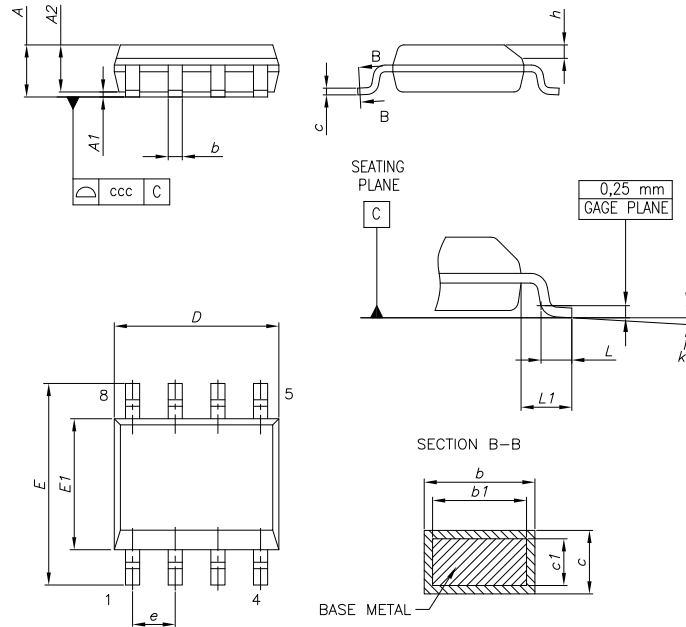
Figure 34. THD+Noise vs. output voltage

Figure 35. Cross talk vs. frequency

Figure 36. 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 SO8 package information

Figure 37. SO8 package outline



0016023_So-807_fig2_Rev10

Table 7. 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

5.2 MiniSO8 package information

Figure 38. MiniSO8 package outline

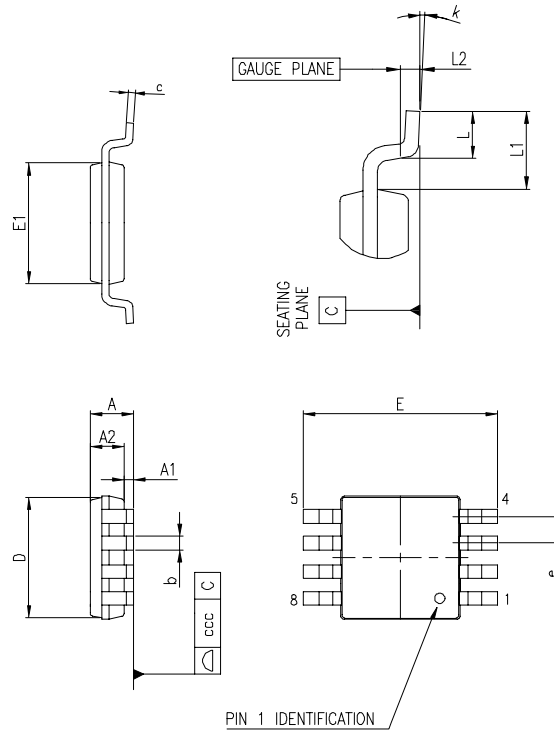


Table 8. MiniSO8 mechanical data

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

5.3 DFN8 3x3 package information

Figure 39. DFN8 3x3 package outline and mechanical data

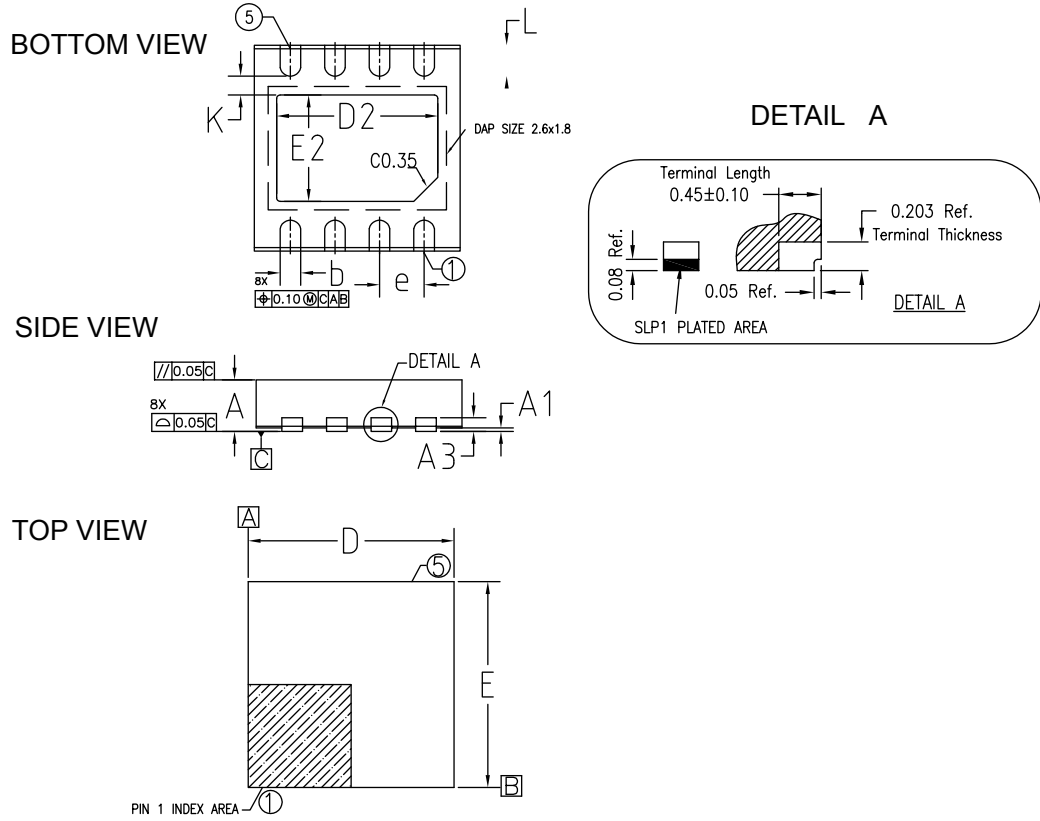
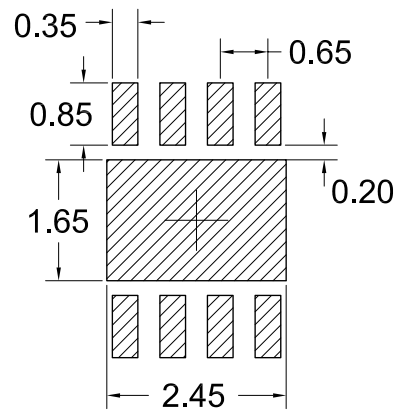


Table 9. DFN8 3x3 mechanical data

Symbol	mm		
	Min.	Typ.	Max.
A	0.70	0.75	0.80
A1	0.0		0.05
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		2.75 Ref.	
N		8	

Figure 40. DFN8 3x3 footprint data



6 Ordering information

Table 10. Order code

Order code	Package	Packaging	Marking
TSB622IDT	SO8	Tape & Reel	TSB622I
TSB622IYDT ⁽¹⁾			TSB622IY
TSB622IST	MiniSO8		K2K
TSB622IYST ⁽¹⁾			K2L
TSB622IQ3T	DFN8 3x3 WF		K2K
TSB622IYQ3T ⁽¹⁾			K2L

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

Revision history

Table 11. Document revision history

Date	Revision	Changes
03-Nov-2021	1	Initial release.
15-Feb-2022	2	Updated Figure 2 .

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Table 5.	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)	5
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