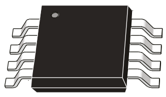
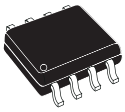
Very high accuracy (20 µV), zero drift, rail to rail output, 9 MHz, 36 V op amp



MiniSO8



SO8

Maturity status link
TSB192

Related products	
TSB182	For lower speed

Features

- Low offset voltage: 20 µV max @ 25 °C
- Rail-to-rail output
- Wide supply voltage: 4 to 36 V
- Gain bandwidth product: 9 MHz
- Slew rate: 5 V/µs
- Low noise: 11 nV/√Hz
- High ESD tolerance: 2 kV HBM
- Extended temperature range: -40 to 125 °C
- Automotive qualification

Applications

- Industrial
- Power supplies
- Automotive

Description

The TSB192 is a very high-precision, dual-operational amplifier with a maximum adding guarantee of 20 µV on input offset voltage. It can operate over an extended supply voltage operating range and features rail-to-rail output. It offers an excellent speed/power consumption ratio with a 9 MHz gain bandwidth product, while consuming 2.2 mA max across temperature per channel over a large supply voltage range.

The TSB192 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 TSB192 can be used in applications where space on the board is limited. It can thus reduce the overall cost of the PCB.

1 Pin description

Figure 1. Pin connections (top view)

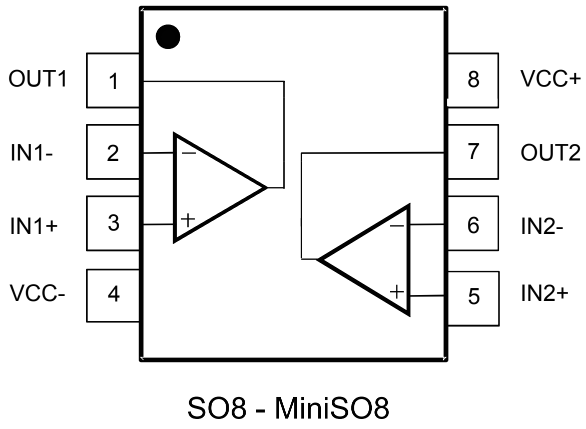


Table 1. Pin description

Pin	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)	± 1.4	V
V_{IN}	Input voltage	$(V_{CC-}) - 0.3$ to $(V_{CC+}) + 0.3$	V
V_{OUT}	Output voltage, fast transient, $\Delta V_{OUT}/\Delta t$	20	V/µs
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) SO8 MiniSO8	 125 190	°C/W
ESD	Human Body Model (HBM) (6)	2000	V
	Charged Device Model (CDM) (7)	1000	

1. *All voltage values, except differential voltage, are with respect to the 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. *Rth 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 3. Operating conditions

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage	4 to 36	V
V_{ICM}	Common-mode voltage on input pins	(V_{CC-}) to $(V_{CC+}) - 2 .5$	V
T	Operating free-air temperature range	-40 to 125	°C

3 Electrical characteristics

Table 4. Electrical characteristics V_{CC} = 5 V, V_{ICM} = $V_{CC}/2$, R_L = 10 kΩ connected to $V_{CC}/2$ (unless otherwise specified).

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
DC performance						
V_{IO}	Input offset voltage	V_{ICM} = $V_{CC}/2$				µV
		T = 25 °C	-20		+20	
		Tmin < T < Tmax	-30		+30	
		V_{ICM} = 0 V				
		T = 25 °C	-20		+20	
		Tmin < T < Tmax	-30		+30	
$\|\Delta V_{IO}/\Delta T\|$	Input offset voltage drift	Tmin < T < Tmax		10	80	nV/°C
I_{IB}	Input bias current	T = 25 °C			400	pA
		Tmin < T < Tmax			400	
I_{IO}	Input offset current	T = 25 °C			600	
		Tmin < T < Tmax			600	
CMR	Common-mode rejection ratio	0 V ≤ V_{ICM} ≤ V_{CC} - 2.5 V, V_{OUT} = $V_{CC}/2$	122	140		dB
		Tmin < T < Tmax	105			
Avd	Large signal voltage gain	0.6 V ≤ V_{OUT} ≤ V_{CC} - 0.6 V, R_L = 2 kΩ	120	137		dB
		Tmin < T < Tmax	110			
		0.25 V ≤ V_{OUT} ≤ V_{CC} - 0.25 V	120	144		
		Tmin < T < Tmax	115			
V_{OL}	Output swing from negative rail	R_L = 2 kΩ, T = 25 °C		51	65	mV
		Tmin < T < Tmax			100	
		R_L = 10 kΩ, T = 25 °C		21	30	
		Tmin < T < Tmax			40	
V_{OH}	Output swing from positive rail	R_L = 2 kΩ, T = 25 °C		50	65	
		Tmin < T < Tmax			100	
		R_L = 10 kΩ, T = 25 °C		11	20	
		Tmin < T < Tmax			25	
I_{OUT}	Isink	OUT connected to V_{CC+}, V_{ID} = -0.5 V				mA
		T = 25 °C	21	32		
		Tmin < T < Tmax	13			
	Isource	OUT connected to V_{CC-}, V_{ID} = +0.5 V				
		T = 25 °C	20	25		
		Tmin < T < Tmax	12			
I_{CC}	Supply current (per channel)	No load, V_{OUT} = $V_{CC}/2$		1.5	1.9	mA
		Tmin < T < Tmax			2.2	
AC performance						
GBP	Gain bandwidth product	R_L = 10 kΩ, C_L = 47 pF		9		MHz
SR	Slew rate	T = 25 °C		5		V/µs

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Φm	Phase margin	R_L = 10 kΩ, C_L = 47 pF		46		°
Gm	Gain margin	R_L = 10 kΩ, C_L = 47 pF		11		dB
En	Equivalent input noise voltage	f = 1 kHz		11		nV/√Hz
		0.1 to 10 Hz		250		nVpp
THD+N	Total harmonic distortion + noise	f = 1 kHz, G = 1, V_{ICM} = 1.5 V V_{OUT} = 2Vpp		0.001		%
Cs	Channel separation	f = 1 kHz		150		dB
trec	Overload recovery time	G = -10, V_{OUT} = 1 V saturated to V_{CC}/2		0.1		µs
Ts	Settling time	0.1% to final value, G = 1, 1 V step		1		µs

Table 5. Electrical characteristics V_{CC} = 12 V, V_{ICM} = V_{CC}/2, R_L = 10 kΩ connected to V_{CC}/2 (unless otherwise specified).

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
DC performance						
V_{IO}	Input offset voltage	V_{ICM} = V_{CC}/2				µV
		T = 25 °C	-20		+20	
		Tmin < T < Tmax	-30		+30	
		V_{ICM} = 0 V				
		T = 25 °C	-20		+20	
		Tmin < T < Tmax	-30		+30	
$\lvert \Delta V_{IO}/\Delta T \rvert$	Input offset voltage drift	Tmin < T < Tmax		10	80	nV/°C
I_{IB}	Input bias current	T = 25 °C			400	pA
		Tmin < T < Tmax			400	
I_{IO}	Input offset current	T = 25 °C			600	
		Tmin < T < Tmax			600	
CMR	Common-mode rejection ratio	0 V ≤ V_{ICM} ≤ V_{CC} - 2.5 V, V_{OUT} = V_{CC}/2	132	144		dB
		Tmin < T < Tmax	115			
Avd	Large signal voltage gain	0.6 V ≤ V_{OUT} ≤ V_{CC} - 0.6 V, R_L = 2 kΩ	120	136		dB
		Tmin < T < Tmax	115			
		0.25 V ≤ V_{OUT} ≤ V_{CC} - 0.25 V	124	136		
		Tmin < T < Tmax	120			
V_{OL}	Output swing from negative rail	R_L = 2 kΩ, T = 25 °C		106	125	mV
		Tmin < T < Tmax			200	
		R_L = 10 kΩ, T = 25 °C		32	40	
		Tmin < T < Tmax			55	
V_{OH}	Output swing from positive rail	R_L = 2 kΩ, T = 25 °C		120	145	
		Tmin < T < Tmax			220	
		R_L = 10 kΩ, T = 25 °C		25	35	
		Tmin < T < Tmax			45	
I_{OUT}	Isink	OUT connected to V_{CC+}, V_{ID} = -0.5 V				mA
		T = 25 °C	21	32		
		Tmin < T < Tmax	13			
	Isource	OUT connected to V_{CC-}, V_{ID} = +0.5 V				
		T = 25 °C	20	25		
		Tmin < T < Tmax	10			
I_{CC}	Supply current (per channel)	No load, V_{OUT} = V_{CC}/2		1.5	1.9	mA
		Tmin < T < Tmax			2.2	
AC performance						
GBP	Gain bandwidth product	R_L = 10 kΩ, C_L = 47 pF		9.1		MHz
SR	Slew rate	T = 25 °C		5		V/µs
Φm	Phase margin	R_L = 10 kΩ, C_L = 47 pF		36		°
Gm	Gain margin	R_L = 10 kΩ, C_L = 47 pF		9		dB

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
En	Equivalent input noise voltage	f = 1 kHz		11		nV/√Hz
		0.1 to 10 Hz		250		nVpp
THD+N	Total harmonic distortion + noise	f = 1 kHz, G = 1, V_{OUT} = 2Vpp		0.001		%
Cs	Channel separation	f = 1 kHz		150		dB
trec	Overload recovery time	G = -10, V_{OUT} = 1 V saturated to $V_{CC}/2$		0.3		µs
Ts	Settling time	0.1% to final value, G = 1, 1 V step		0.8		µs

Table 6. Electrical characteristics V_{CC} = 36 V, V_{ICM} = V_{CC}/2, R_L = 10 kΩ connected to V_{CC}/2 (unless otherwise specified).

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
		DC performance				
V_{IO}	Input offset voltage	V_{ICM} = V_{CC}/2				µV
		T = 25 °C	-20		+20	
		Tmin < T < Tmax	-30		+30	
		V_{ICM} = 0 V				
		T = 25 °C	-20		+20	
		Tmin < T < Tmax	-30		+30	
$\|\Delta V_{IO}/\Delta T\|$	Input offset voltage drift	Tmin < T < Tmax		10	80	nV/°C
I_{IB}	Input bias current	T = 25 °C			500	pA
		Tmin < T < Tmax			500	
I_{IO}	Input offset current	T = 25 °C			800	
		Tmin < T < Tmax			800	
CMR	Common-mode rejection ratio	0 V ≤ V_{ICM} ≤ V_{CC} - 2.5 V, V_{OUT} = V_{CC}/2	130	143		dB
		Tmin < T < Tmax	121			
SVR	Supply voltage rejection ratio	V_{CC} = 4 to 36 V	130	150		dB
		Tmin < T < Tmax	127			
Avd	Large signal voltage gain	1 V ≤ V_{OUT} ≤ V_{CC} - 2.5 V, R_L = 2 kΩ	130	145		dB
		Tmin < T < Tmax	115			
		0.25 V ≤ V_{OUT} ≤ V_{CC} - 0.25 V	140	164		
		Tmin < T < Tmax	130			
V_{OL}	Output swing from negative rail	R_L = 2 kΩ, T = 25 °C		300	430	mV
		Tmin < T < Tmax			550	
		R_L = 10 kΩ, T = 25 °C		72	85	
		Tmin < T < Tmax			120	
V_{OH}	Output swing from positive rail	R_L = 2 kΩ, T = 25 °C		380	450	
		Tmin < T < Tmax			700	
		R_L = 10 kΩ, T = 25 °C		75	85	
		Tmin < T < Tmax			125	
I_{OUT}	Isink	OUT connected to V_{CC+}, V_{ID} = -0.5 V				mA
		T = 25 °C	21	31		
		Tmin < T < Tmax	13			
	Isource	OUT connected to V_{CC-}, V_{ID} = +0.5 V				
		T = 25 °C	20	24		
		Tmin < T < Tmax	12			
I_{CC}	Supply current (per channel)	No load, V_{OUT} = V_{CC}/2		1.5	1.9	mA
		Tmin < T < Tmax			2.2	
		AC performance				
GBP	Gain bandwidth product	R_L = 10 kΩ, C_L = 47 pF		9.2		MHz
SR	Slew rate	T = 25 °C		5		V/µs

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Φm	Phase margin	R_L = 10 kΩ, C_L = 47 pF		42		°
Gm	Gain margin	R_L = 10 kΩ, C_L = 47 pF		9		dB
En	Equivalent input noise voltage	f = 1 kHz		11		nV/√Hz
		0.1 to 10 Hz		250		nVpp
THD+N	Total harmonic distortion + noise	f = 1 kHz, G = 1, V_{OUT} = 2Vpp		0.001		%
Cs	Channel separation	f = 1 kHz		150		dB
trec	Overload recovery time	G = -10, V_{OUT} = 1 V saturated to V_{CC}/2		0.5		µs
Ts	Settling time	0.1% to final value, G = 1, 1 V step		0.8		µs

4 Typical performance characteristics

Figure 2. Vio distribution at Vcc = 5 V

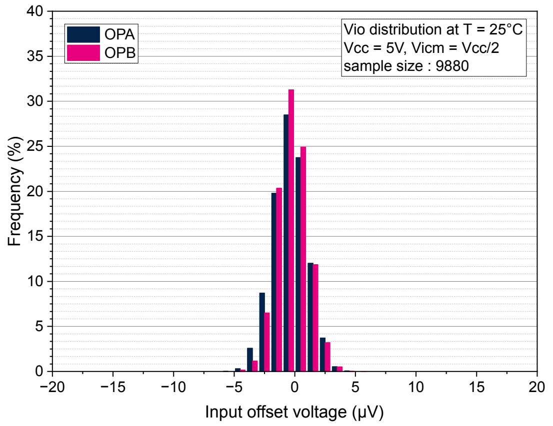


Figure 3. Vio distribution at Vcc = 12 V

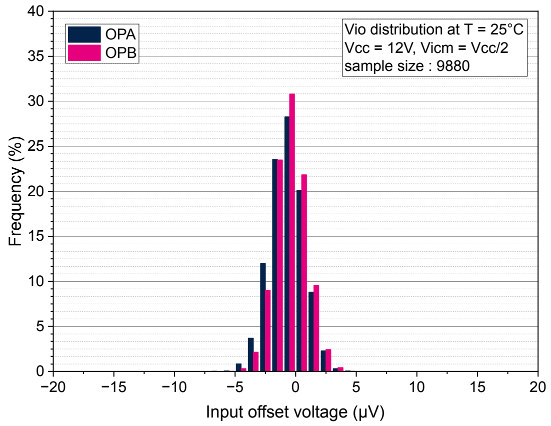


Figure 4. Vio distribution at Vcc = 36 V

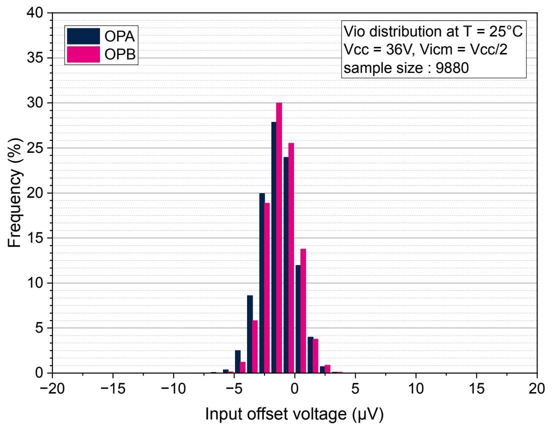


Figure 5. Vio vs. Vicm at Vcc = 5 V

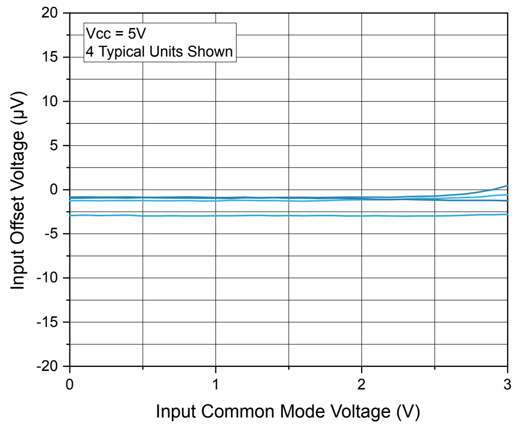


Figure 6. Vio vs. Vicm at Vcc = 12 V

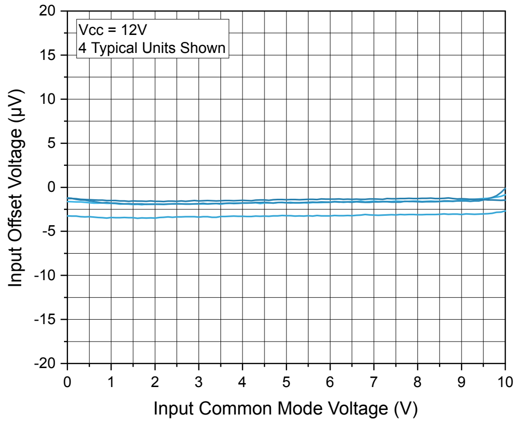


Figure 7. Vio vs. Vicm at Vcc = 36 V

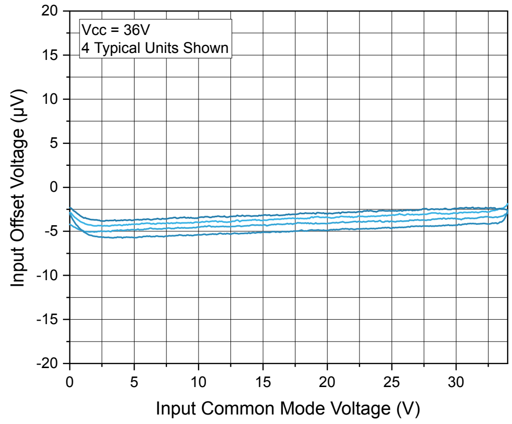


Figure 8. Vio vs. Vcc

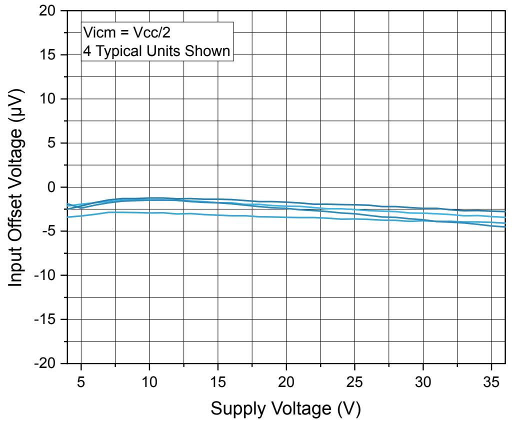


Figure 9. Vio vs. temperature

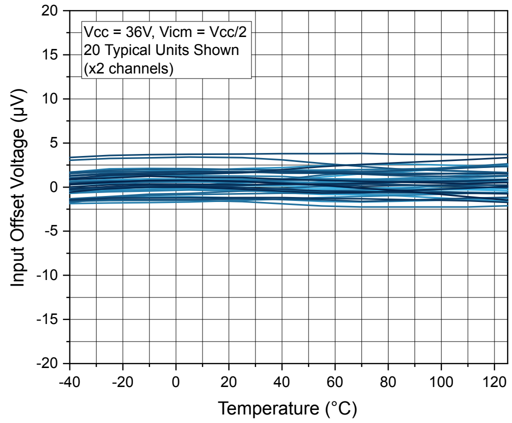


Figure 10. Vio drift in temperature distribution

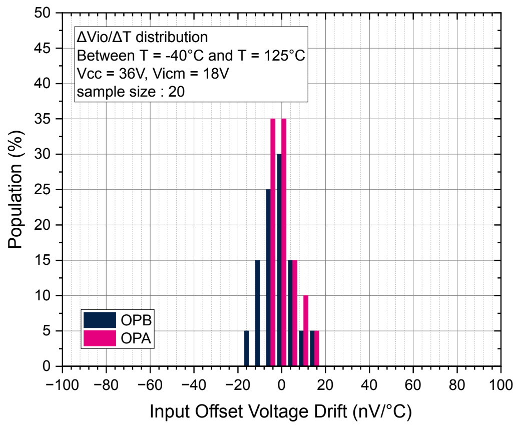


Figure 11. Icc vs. Vicm at Vcc=5V

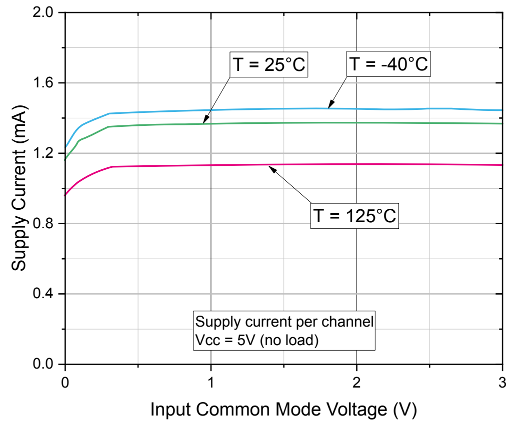


Figure 12. Icc vs. Vicm at Vcc=12V

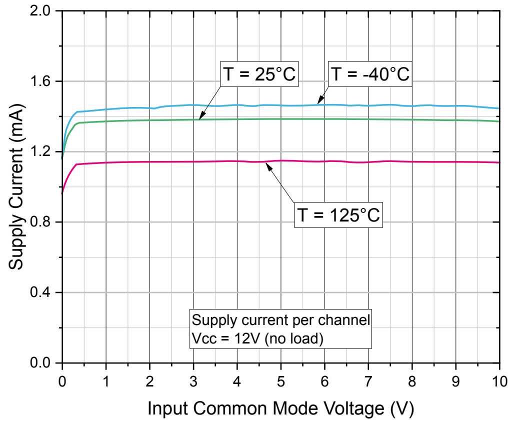


Figure 13. Icc vs. Vicm at Vcc=36V

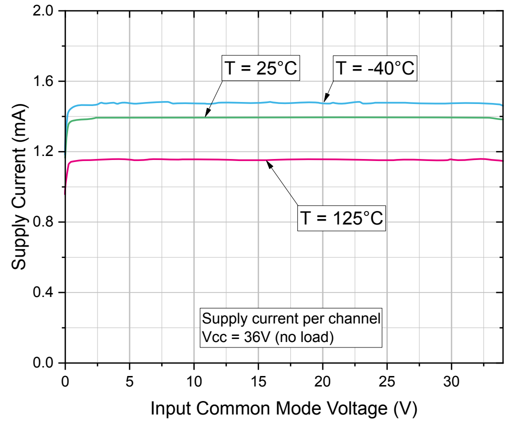


Figure 14. Icc vs. Vcc

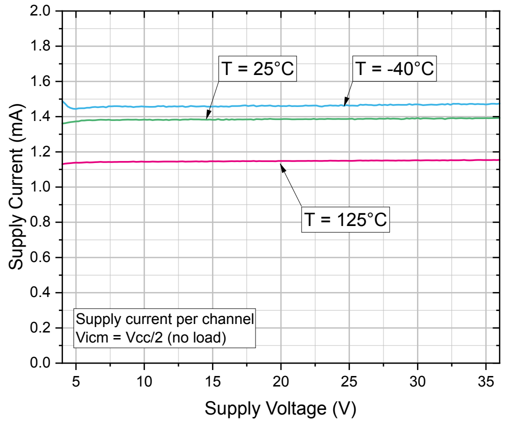


Figure 15. Iib vs. Vicm at Vcc = 5 V

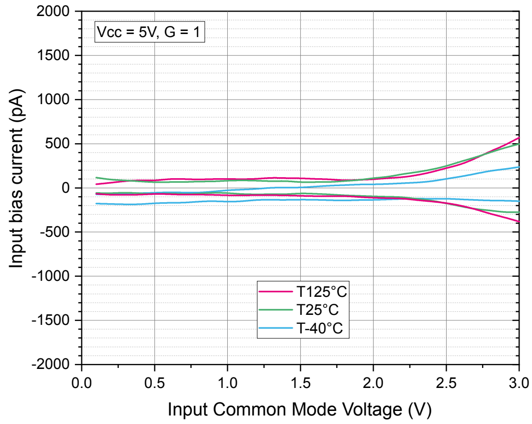


Figure 16. Iib vs. Vicm at Vcc = 12 V

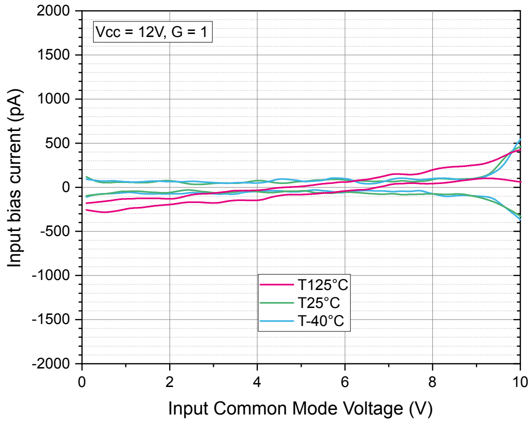


Figure 17. Iib vs. Vicm at Vcc = 36 V

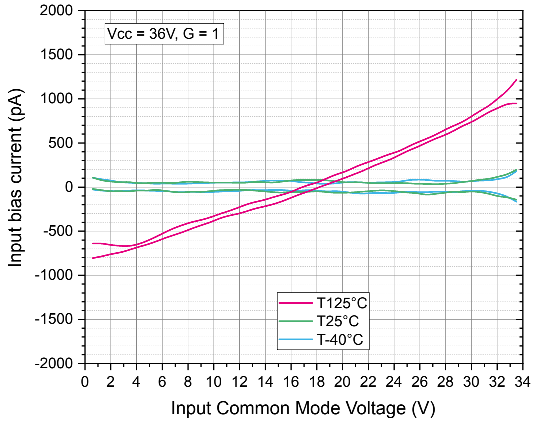


Figure 18. Iout at Vcc = 5 V

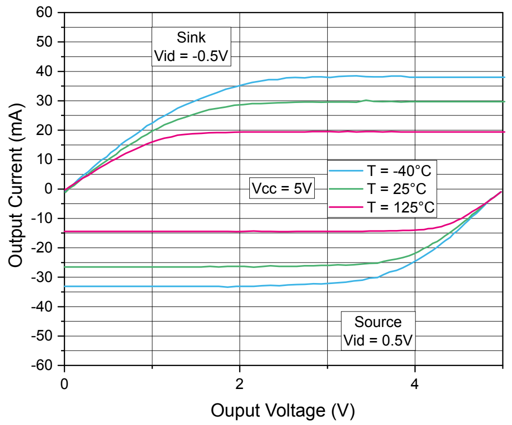


Figure 19. Iout at Vcc = 12 V

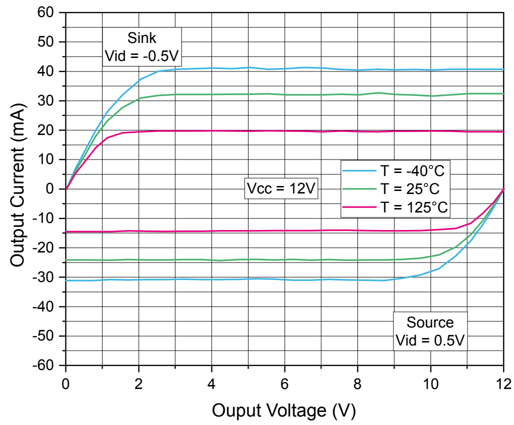


Figure 20. Iout at Vcc = 36 V

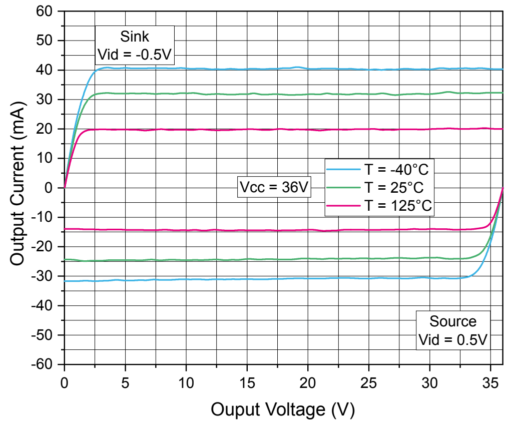


Figure 21. Linearity at Vcc = 5 V

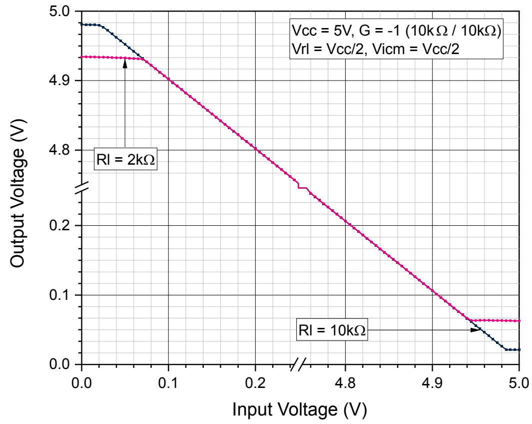


Figure 22. Linearity at Vcc = 12 V

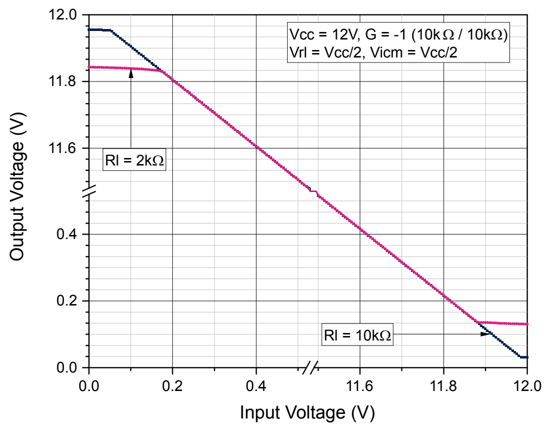


Figure 23. Linearity at Vcc = 36 V

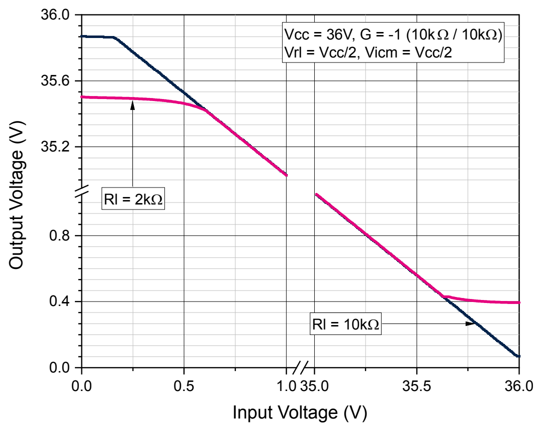


Figure 24. PSRR and CMRR at Vcc = 5 V

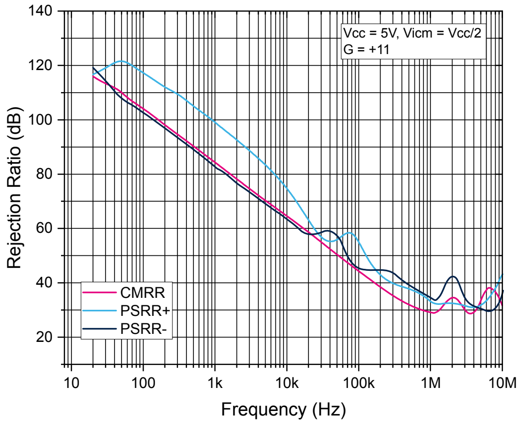


Figure 25. PSRR and CMRR at Vcc = 12 V

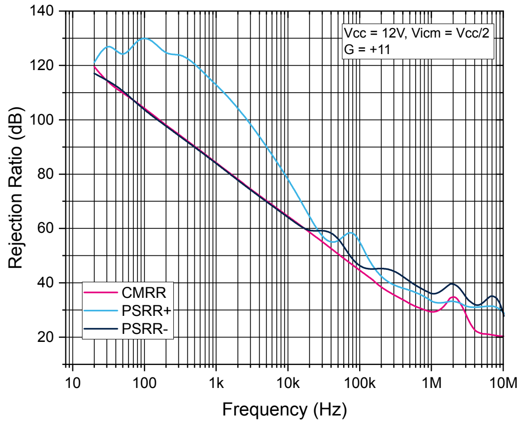


Figure 26. PSRR and CMRR at Vcc = 36 V

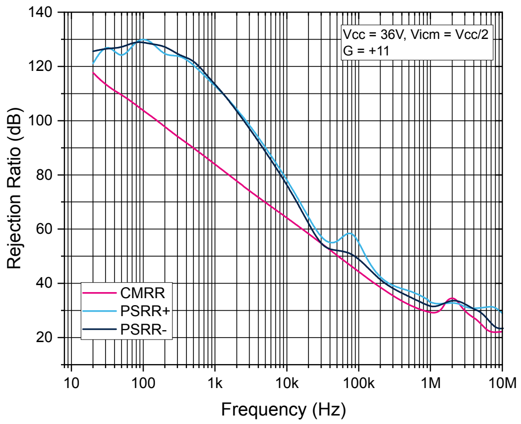


Figure 27. Bode plot at Vcc = 5 V

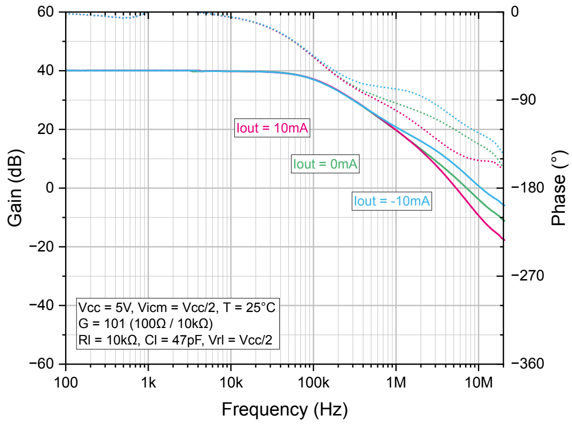


Figure 28. Bode plot at Vcc = 36 V

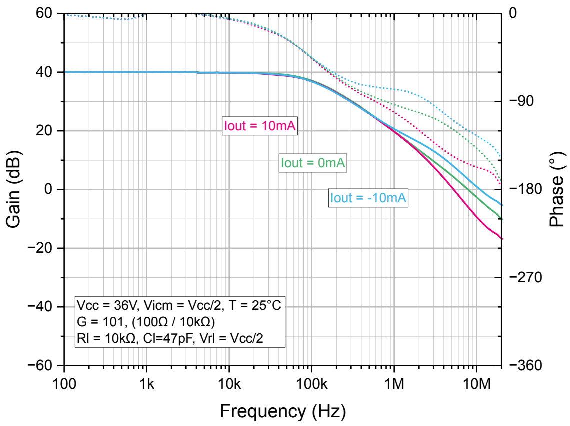


Figure 29. Slew rate vs. Vicm at Vcc = 5 V

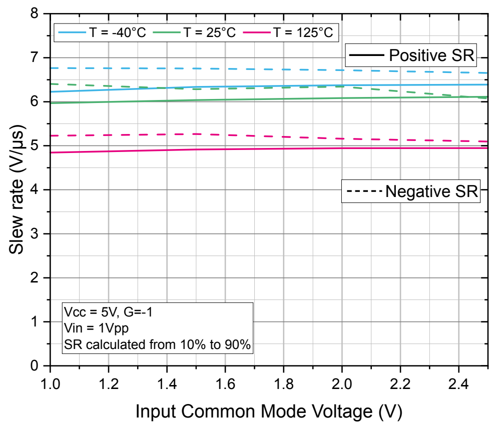


Figure 30. Slew rate vs. Vicm at Vcc = 36 V

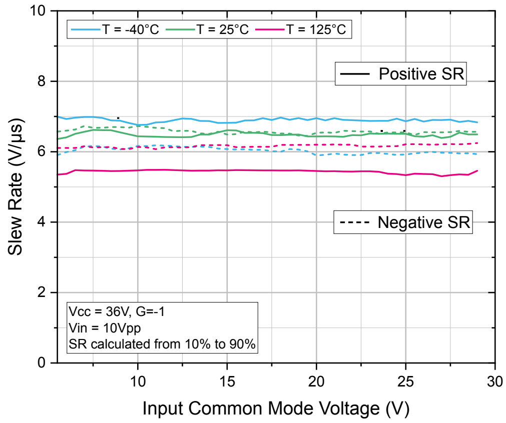


Figure 31. Output voltage vs. input voltage at Vcc = 5 V

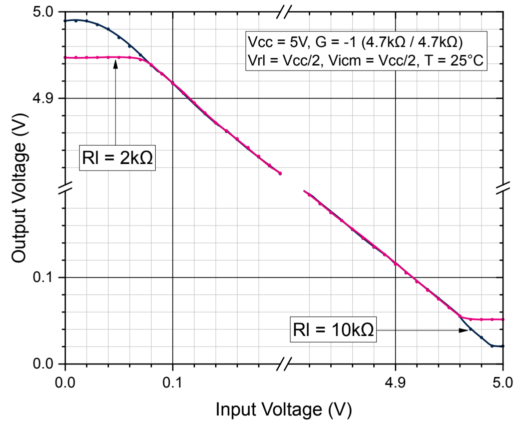


Figure 32. Output voltage vs. input voltage at Vcc = 36 V

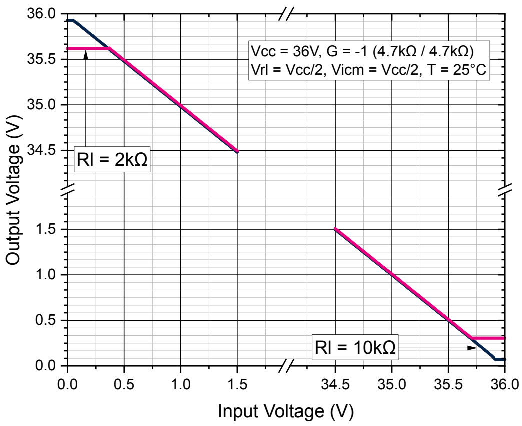


Figure 33. THD vs. frequency

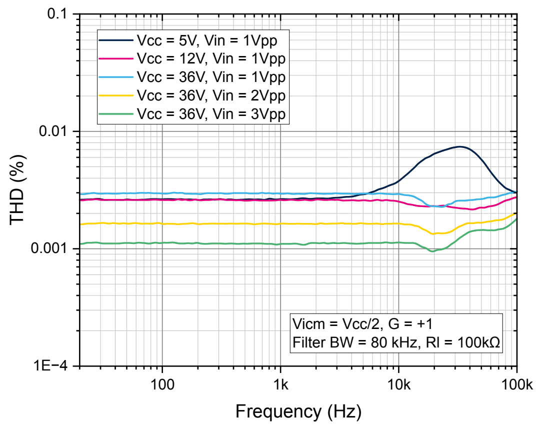


Figure 34. Voh vs. supply voltage

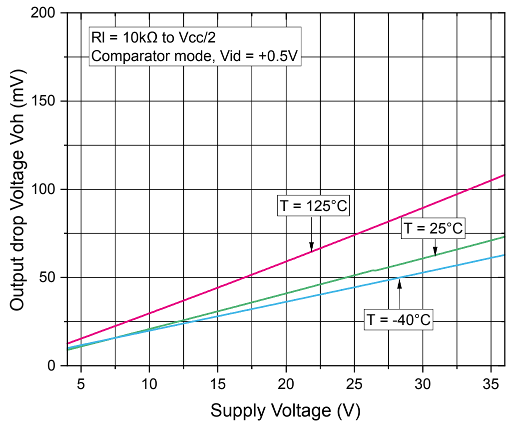


Figure 35. Vol vs. supply voltage

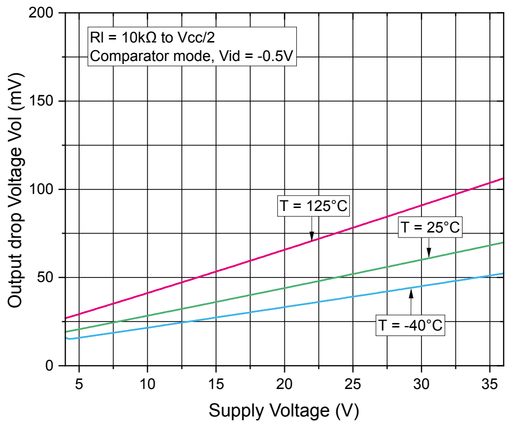


Figure 36. Voltage noise density vs. frequency

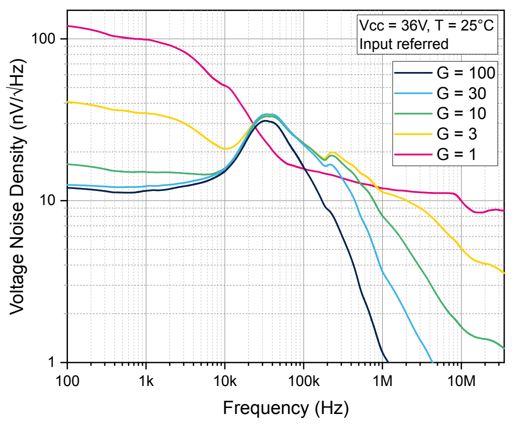


Figure 37. Noise vs. time at Vcc = 36 V

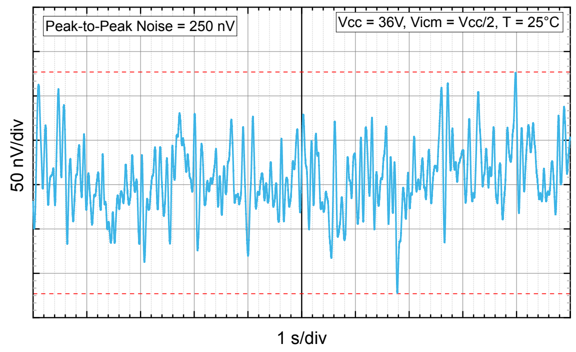


Figure 38. Small step response with gain = 1

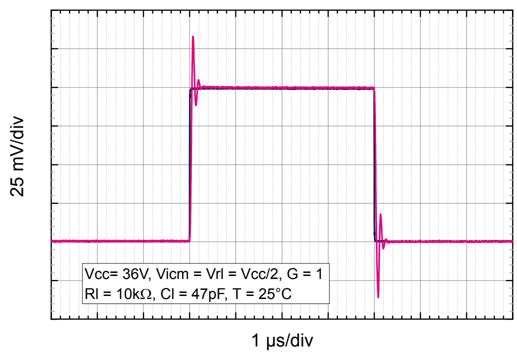


Figure 39. Step response with gain = 1

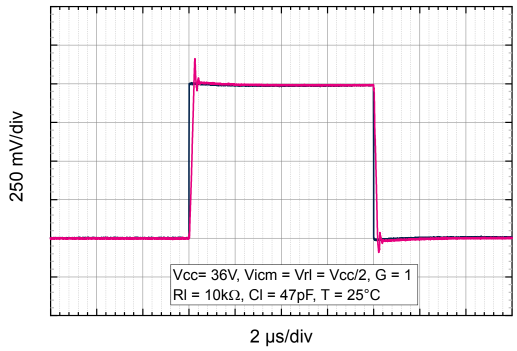


Figure 40. Small step response with gain = -1

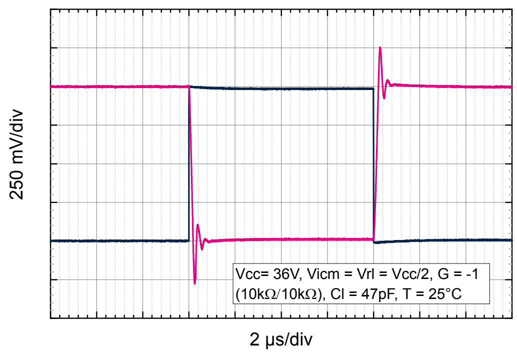


Figure 41. Step response with gain = -1

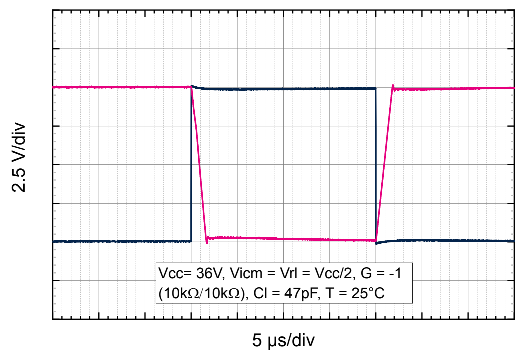


Figure 42. Phase reversal free

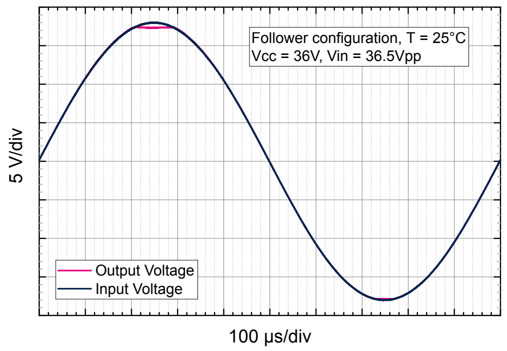


Figure 43. Start-up behavior

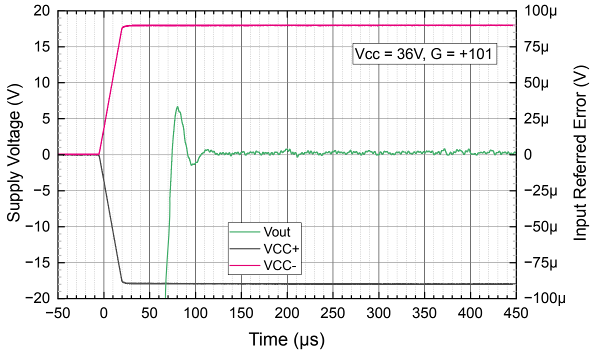


Figure 44. Channel separation vs. frequency

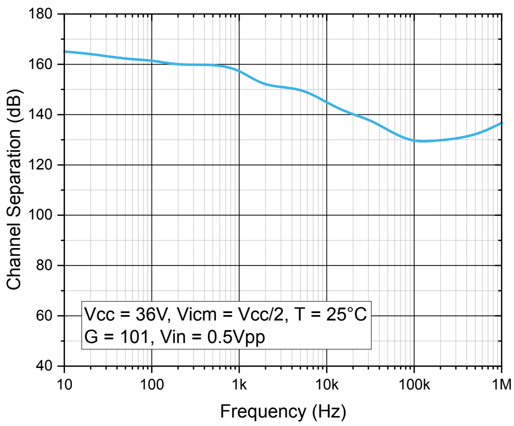


Figure 45. DPI vs Frequency at Vcc = 36 V

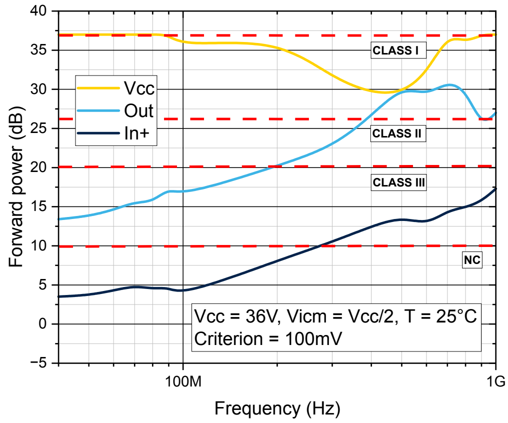


Figure 46. Overvoltage recovery (negative step)

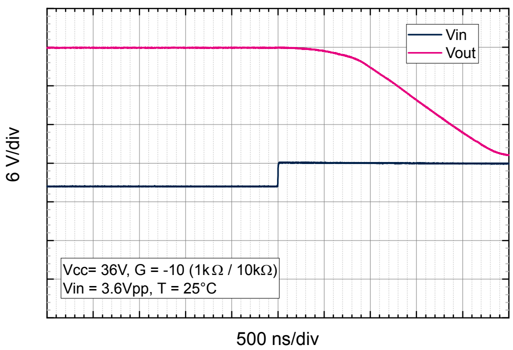


Figure 47. Overvoltage recovery (positive step)

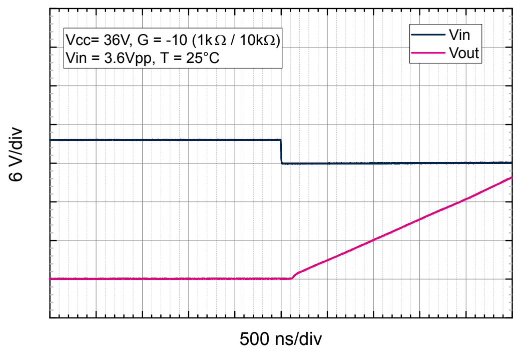


Figure 48. Small step overshoot vs. load capacitance

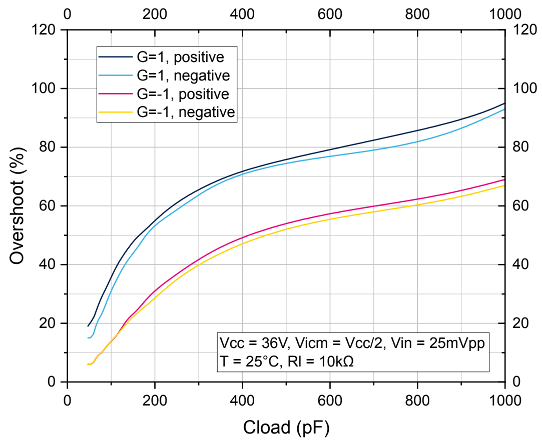


Figure 49. Settling time 2% vs. Riso

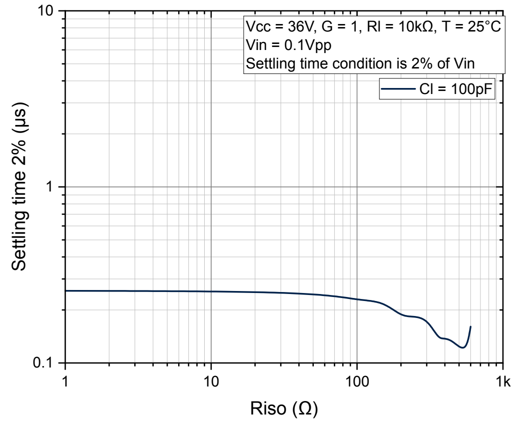


Figure 50. Settling time on negative input step

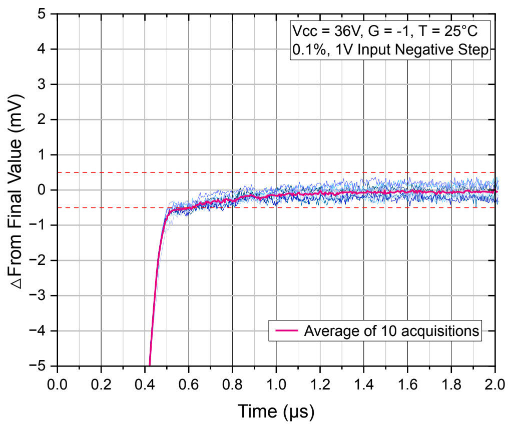
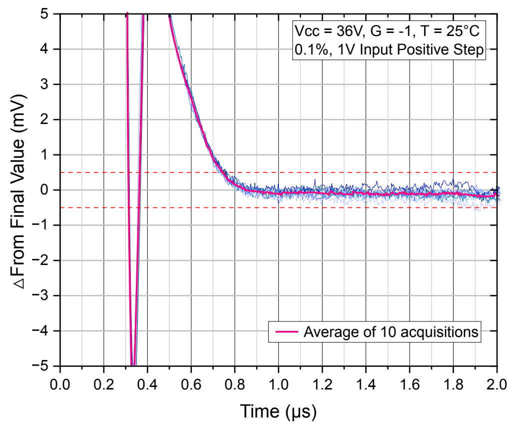


Figure 51. Settling time on positive input step



5 Package information

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 MiniSO8 package information

Figure 52. MiniSO8 package outline

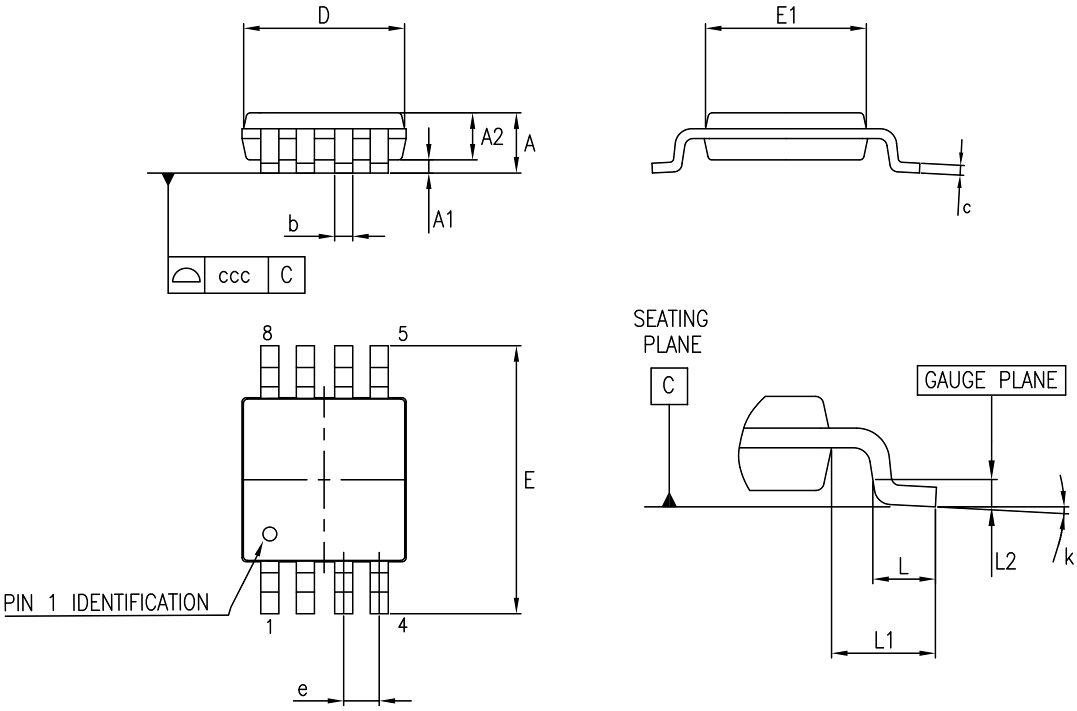


Table 7. MiniSO8 mechanical data

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

5.2 SO8 package information

Figure 53. SO8 package outline

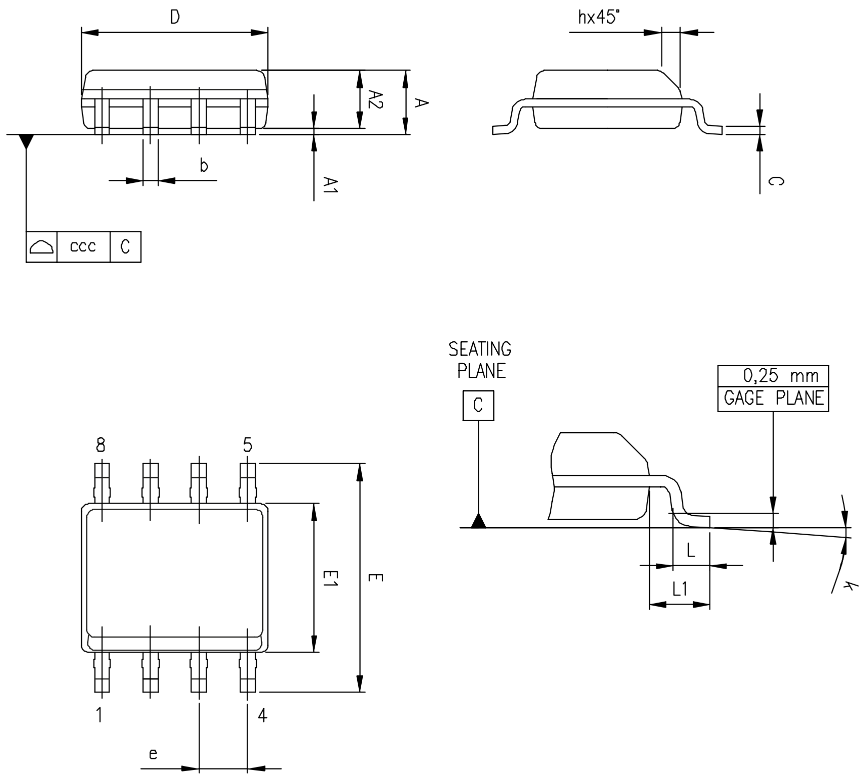


Table 8. SO8 mechanical data

Dim.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
A1	0.1		0.25	0.004		0.01
A2	1.25			0.049		
b	0.28		0.48	0.011		0.019
c	0.17		0.23	0.007		0.01
D	4.8	4.9	5	0.189	0.193	0.197
E	5.8	6	6.2	0.228	0.236	0.244
E1	3.8	3.9	4	0.15	0.154	0.157
e		1.27			0.05	
h	0.25		0.5	0.01		0.02
L	0.4		1.27	0.016		0.05
L1		1.04			0.04	
k	0		8 °	1 °		8 °
ccc			0.1			0.004

6 Ordering information

Table 9. Order code

Order code	Package	Packaging	Marking
TSB192IDT	SO8	Tape & reel	TSB192I
TSB192IST	MiniSO8		K245

Revision history

Table 10. Document revision history

Date	Revision	Changes
10-Feb-2026	1	Initial release.
16-Jun-2026	2	Corrected typo error on HBM ESD value on the cover page. Updated gain bandwidth product typical value. Added curves in Section 4: Typical performance characteristics.

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