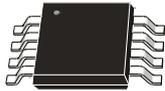
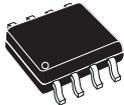


Very high accuracy (20 μ V), zero drift, rail to rail output, 8 MHz, 36 V op amp



MiniSO8



SO8

Features

- Low offset voltage: 20 μ V max @ 25 °C
- Rail-to-rail output
- Wide supply voltage: 4 to 36 V
- Gain bandwidth product: 8 MHz
- Slew rate: 5 V/ μ s
- Low noise: 11 nV/ $\sqrt{\text{Hz}}$
- High ESD tolerance: 4 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 guarantee of 20 μ V 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 an 8 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.

Maturity status link

[TSB192](#)

Related products

[TSB182](#)

For lower speed

1 Pin description

Figure 1. Pin connections (top view)

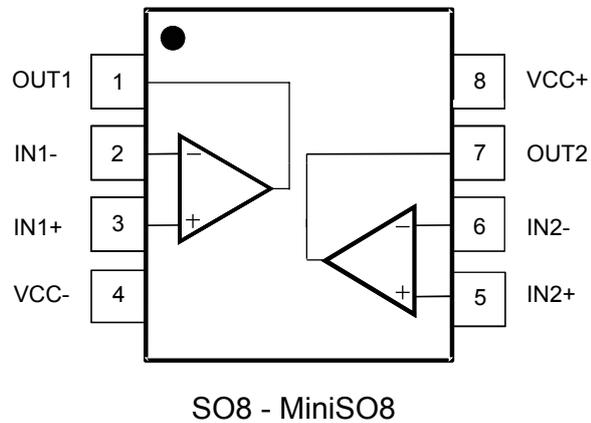


Table 1. Pin description

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/ μ s
I_{IN}	Input current ⁽³⁾	10	mA
T_{stg}	Storage temperature	-65 to 150	$^{\circ}$ C
T_j	Junction temperature	150	$^{\circ}$ C
R_{th-ja}	Thermal resistance junction to ambient ^{(4) (5)}		$^{\circ}$ C/W
	SO8	125	
	MiniSO8	190	
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. 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 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	$^{\circ}$ C

3 Electrical characteristics

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
DC performance						
V_{IO}	Input offset voltage	$V_{ICM} = V_{CC}/2$				μV
		$T = 25\text{ }^\circ\text{C}$	-20		+20	
		$T_{min} < T < T_{max}$	-30		+30	
		$V_{ICM} = 0\text{ V}$				
		$T = 25\text{ }^\circ\text{C}$	-20		+20	
		$T_{min} < T < T_{max}$	-30		+30	
$ \Delta V_{IO}/\Delta T $	Input offset voltage drift	$T_{min} < T < T_{max}$		10	100	$\text{nV}/^\circ\text{C}$
I_{IB}	Input bias current	$T = 25\text{ }^\circ\text{C}$			400	pA
		$T_{min} < T < T_{max}$			400	
I_{IO}	Input offset current	$T = 25\text{ }^\circ\text{C}$			600	pA
		$T_{min} < T < T_{max}$			600	
CMR	Common-mode rejection ratio	$0\text{ V} \leq V_{ICM} \leq V_{CC} - 2.5\text{ V}$, $V_{OUT} = V_{CC}/2$	122	140		dB
		$T_{min} < T < T_{max}$	105			
Avd	Large signal voltage gain	$0.6\text{ V} \leq V_{OUT} \leq V_{CC} - 0.6\text{ V}$, $R_L = 2\text{ k}\Omega$	120	137		dB
		$T_{min} < T < T_{max}$	110			
		$0.25\text{ V} \leq V_{OUT} \leq V_{CC} - 0.25\text{ V}$	120	144		
		$T_{min} < T < T_{max}$	115			
V_{OL}	Output swing from negative rail	$R_L = 2\text{ k}\Omega$, $T = 25\text{ }^\circ\text{C}$		51	65	mV
		$T_{min} < T < T_{max}$			100	
		$R_L = 10\text{ k}\Omega$, $T = 25\text{ }^\circ\text{C}$		21	30	
		$T_{min} < T < T_{max}$			40	
V_{OH}	Output swing from positive rail	$R_L = 2\text{ k}\Omega$, $T = 25\text{ }^\circ\text{C}$		50	65	mV
		$T_{min} < T < T_{max}$			100	
		$R_L = 10\text{ k}\Omega$, $T = 25\text{ }^\circ\text{C}$		11	20	
		$T_{min} < T < T_{max}$			25	
I_{OUT}	Isink	OUT connected to V_{CC+} , $V_{ID} = -0.5\text{ V}$				mA
		$T = 25\text{ }^\circ\text{C}$	21	32		
		$T_{min} < T < T_{max}$	13			
	Isource	OUT connected to V_{CC-} , $V_{ID} = +0.5\text{ V}$				
		$T = 25\text{ }^\circ\text{C}$	20	25		
		$T_{min} < T < T_{max}$	12			
I_{CC}	Supply current (per channel)	No load, $V_{OUT} = V_{CC}/2$		1.5	1.9	mA
		$T_{min} < T < T_{max}$			2.2	
AC performance						
GBP	Gain bandwidth product	$R_L = 10\text{ k}\Omega$, $C_L = 47\text{ pF}$		7.8		MHz
SR	Slew rate	$T = 25\text{ }^\circ\text{C}$		5		$\text{V}/\mu\text{s}$

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Φ_m	Phase margin	$R_L = 10\text{ k}\Omega$, $C_L = 47\text{ pF}$		46		$^\circ$
Gm	Gain margin	$R_L = 10\text{ k}\Omega$, $C_L = 47\text{ pF}$		11		dB
En	Equivalent input noise voltage	f = 1 kHz		11		nV/ $\sqrt{\text{Hz}}$
		0.1 to 10 Hz		250		nVpp
THD+N	Total harmonic distortion + noise	f = 1 kHz, G = 1, $V_{ICM} = 1.5\text{ V}$ $V_{OUT} = 2\text{ Vpp}$		0.001		%
Cs	Channel separation	f = 1 kHz		150		dB
trec	Overload recovery time	G = -10, $V_{OUT} = 1\text{ V}$ 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 $V_{CC} = 12\text{ V}$, $V_{ICM} = V_{CC}/2$, $R_L = 10\text{ k}\Omega$ connected to $V_{CC}/2$ (unless otherwise specified).

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
DC performance						
V_{IO}	Input offset voltage	$V_{ICM} = V_{CC}/2$				μV
		$T = 25\text{ }^\circ\text{C}$	-20		+20	
		$T_{min} < T < T_{max}$	-30		+30	
		$V_{ICM} = 0\text{ V}$				
		$T = 25\text{ }^\circ\text{C}$	-20		+20	
		$T_{min} < T < T_{max}$	-30		+30	
$ \Delta V_{IO}/\Delta T $	Input offset voltage drift	$T_{min} < T < T_{max}$		10	100	$\text{nV}/^\circ\text{C}$
I_{IB}	Input bias current	$T = 25\text{ }^\circ\text{C}$			400	pA
		$T_{min} < T < T_{max}$			400	
I_{IO}	Input offset current	$T = 25\text{ }^\circ\text{C}$			600	pA
		$T_{min} < T < T_{max}$			600	
CMR	Common-mode rejection ratio	$0\text{ V} \leq V_{ICM} \leq V_{CC} - 2.5\text{ V}$, $V_{OUT} = V_{CC}/2$	132	144		dB
		$T_{min} < T < T_{max}$	115			
A _{vd}	Large signal voltage gain	$0.6\text{ V} \leq V_{OUT} \leq V_{CC} - 0.6\text{ V}$, $R_L = 2\text{ k}\Omega$	120	136		dB
		$T_{min} < T < T_{max}$	115			
		$0.25\text{ V} \leq V_{OUT} \leq V_{CC} - 0.25\text{ V}$	124	136		
		$T_{min} < T < T_{max}$	120			
V_{OL}	Output swing from negative rail	$R_L = 2\text{ k}\Omega$, $T = 25\text{ }^\circ\text{C}$		106	125	mV
		$T_{min} < T < T_{max}$			200	
		$R_L = 10\text{ k}\Omega$, $T = 25\text{ }^\circ\text{C}$		32	40	
		$T_{min} < T < T_{max}$			55	
V_{OH}	Output swing from positive rail	$R_L = 2\text{ k}\Omega$, $T = 25\text{ }^\circ\text{C}$		120	145	mV
		$T_{min} < T < T_{max}$			220	
		$R_L = 10\text{ k}\Omega$, $T = 25\text{ }^\circ\text{C}$		25	35	
		$T_{min} < T < T_{max}$			45	
I_{OUT}	Isink	OUT connected to V_{CC+} , $V_{ID} = -0.5\text{ V}$				mA
		$T = 25\text{ }^\circ\text{C}$	21	32		
		$T_{min} < T < T_{max}$	13			
	Isource	OUT connected to V_{CC-} , $V_{ID} = +0.5\text{ V}$				
		$T = 25\text{ }^\circ\text{C}$	20	25		
		$T_{min} < T < T_{max}$	10			
I_{CC}	Supply current (per channel)	No load, $V_{OUT} = V_{CC}/2$		1.5	1.9	mA
		$T_{min} < T < T_{max}$			2.2	
AC performance						
GBP	Gain bandwidth product	$R_L = 10\text{ k}\Omega$, $C_L = 47\text{ pF}$		8.2		MHz
SR	Slew rate	$T = 25\text{ }^\circ\text{C}$		5		$\text{V}/\mu\text{s}$
Φ_m	Phase margin	$R_L = 10\text{ k}\Omega$, $C_L = 47\text{ pF}$		36		$^\circ$
G _m	Gain margin	$R_L = 10\text{ k}\Omega$, $C_L = 47\text{ pF}$		9		dB

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
En	Equivalent input noise voltage	f = 1 kHz		11		nV/ $\sqrt{\text{Hz}}$
		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 $V_{CC} = 36\text{ V}$, $V_{ICM} = V_{CC}/2$, $R_L = 10\text{ k}\Omega$ connected to $V_{CC}/2$ (unless otherwise specified).

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
DC performance						
V_{IO}	Input offset voltage	$V_{ICM} = V_{CC}/2$				μV
		$T = 25\text{ }^\circ\text{C}$	-20		+20	
		$T_{min} < T < T_{max}$	-30		+30	
		$V_{ICM} = 0\text{ V}$				
		$T = 25\text{ }^\circ\text{C}$	-20		+20	
		$T_{min} < T < T_{max}$	-30		+30	
$ \Delta V_{IO}/\Delta T $	Input offset voltage drift	$T_{min} < T < T_{max}$		10	100	$\text{nV}/^\circ\text{C}$
I_{IB}	Input bias current	$T = 25\text{ }^\circ\text{C}$			500	pA
		$T_{min} < T < T_{max}$			500	
I_{IO}	Input offset current	$T = 25\text{ }^\circ\text{C}$			800	pA
		$T_{min} < T < T_{max}$			800	
CMR	Common-mode rejection ratio	$0\text{ V} \leq V_{ICM} \leq V_{CC} - 2.5\text{ V}$, $V_{OUT} = V_{CC}/2$	130	143		dB
		$T_{min} < T < T_{max}$	121			
SVR	Supply voltage rejection ratio	$V_{CC} = 4\text{ to }36\text{ V}$	130	150		dB
		$T_{min} < T < T_{max}$	127			
A _{vd}	Large signal voltage gain	$1\text{ V} \leq V_{OUT} \leq V_{CC} - 2.5\text{ V}$, $R_L = 2\text{ k}\Omega$	130	145		dB
		$T_{min} < T < T_{max}$	115			
		$0.25\text{ V} \leq V_{OUT} \leq V_{CC} - 0.25\text{ V}$	140	164		
		$T_{min} < T < T_{max}$	130			
V_{OL}	Output swing from negative rail	$R_L = 2\text{ k}\Omega$, $T = 25\text{ }^\circ\text{C}$		300	430	mV
		$T_{min} < T < T_{max}$			550	
		$R_L = 10\text{ k}\Omega$, $T = 25\text{ }^\circ\text{C}$		72	85	
		$T_{min} < T < T_{max}$			120	
V_{OH}	Output swing from positive rail	$R_L = 2\text{ k}\Omega$, $T = 25\text{ }^\circ\text{C}$		380	450	mV
		$T_{min} < T < T_{max}$			700	
		$R_L = 10\text{ k}\Omega$, $T = 25\text{ }^\circ\text{C}$		75	85	
		$T_{min} < T < T_{max}$			125	
I_{OUT}	Isink	OUT connected to V_{CC+} , $V_{ID} = -0.5\text{ V}$				mA
		$T = 25\text{ }^\circ\text{C}$	21	31		
		$T_{min} < T < T_{max}$	13			
	Isource	OUT connected to V_{CC-} , $V_{ID} = +0.5\text{ V}$				
		$T = 25\text{ }^\circ\text{C}$	20	24		
		$T_{min} < T < T_{max}$	12			
I_{CC}	Supply current (per channel)	No load, $V_{OUT} = V_{CC}/2$		1.5	1.9	mA
		$T_{min} < T < T_{max}$			2.2	
AC performance						
GBP	Gain bandwidth product	$R_L = 10\text{ k}\Omega$, $C_L = 47\text{ pF}$		8.2		MHz
SR	Slew rate	$T = 25\text{ }^\circ\text{C}$		5		$\text{V}/\mu\text{s}$

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Φ_m	Phase margin	$R_L = 10\text{ k}\Omega$, $C_L = 47\text{ pF}$		42		$^\circ$
Gm	Gain margin	$R_L = 10\text{ k}\Omega$, $C_L = 47\text{ pF}$		9		dB
En	Equivalent input noise voltage	f = 1 kHz		11		nV/ $\sqrt{\text{Hz}}$
		0.1 to 10 Hz		250		nVpp
THD+N	Total harmonic distortion + noise	f = 1 kHz, G = 1, $V_{OUT} = 2\text{Vpp}$		0.001		%
Cs	Channel separation	f = 1 kHz		150		dB
trec	Overload recovery time	G = -10, $V_{OUT} = 1\text{ V}$ 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

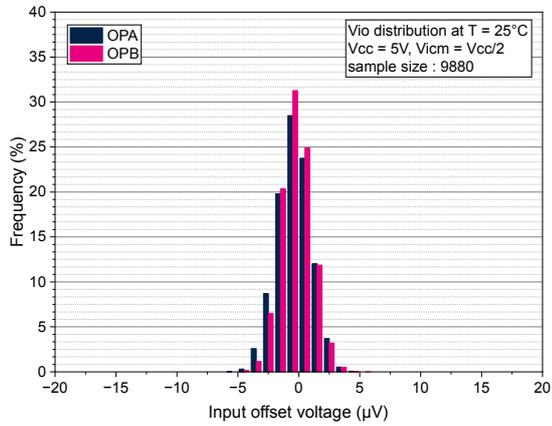
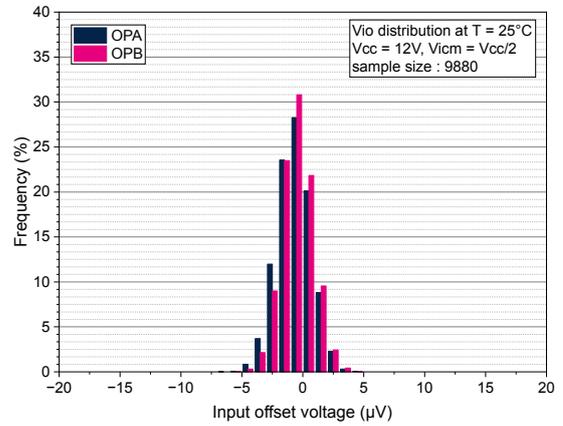
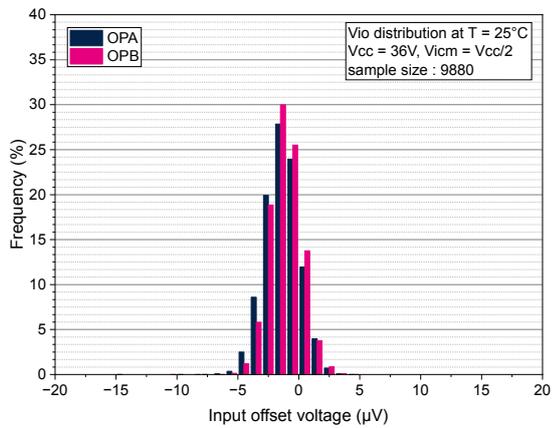
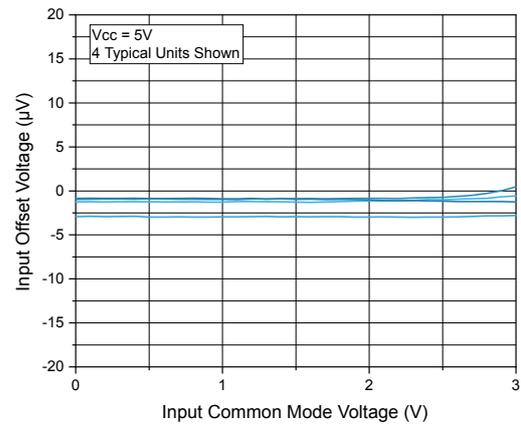
Figure 2. Vio distribution @ Vcc = 5 V

Figure 3. Vio distribution @ Vcc = 12 V

Figure 4. Vio distribution @ Vcc = 36 V

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


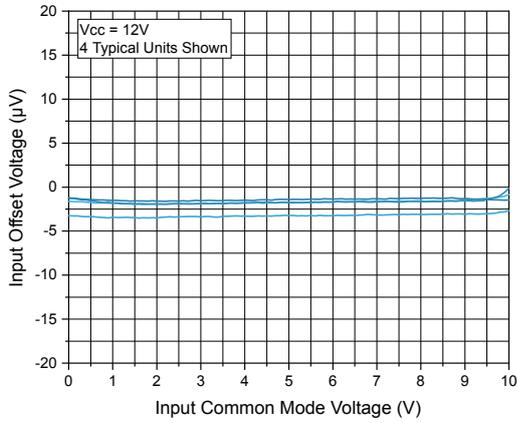
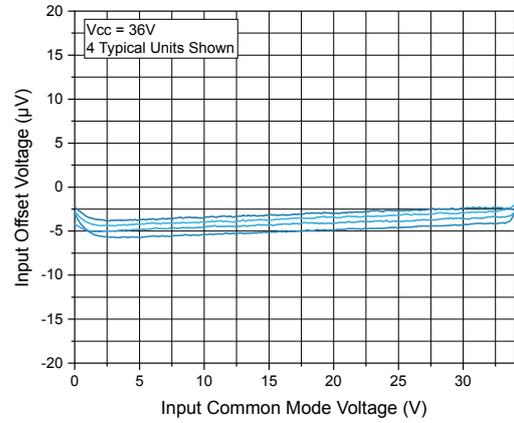
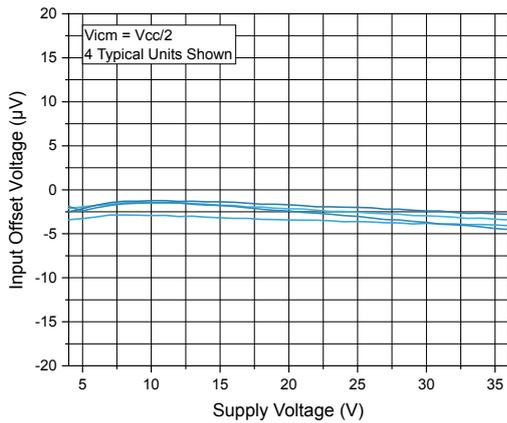
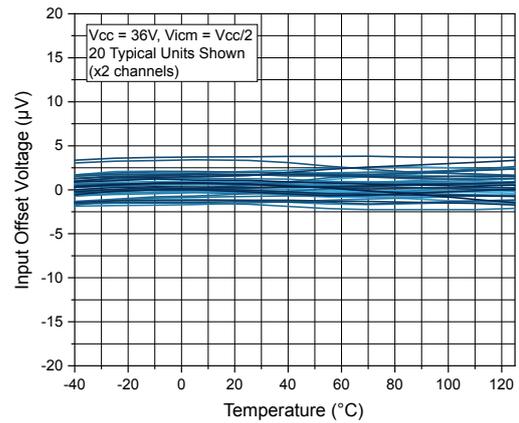
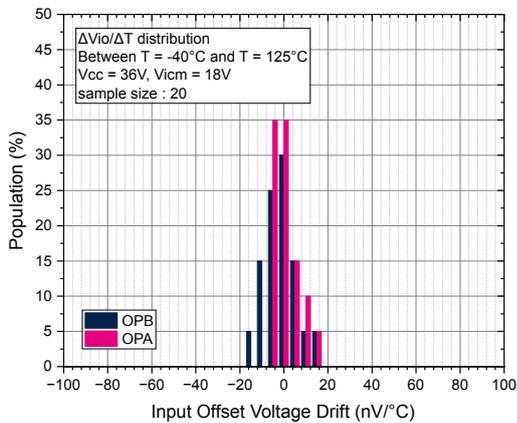
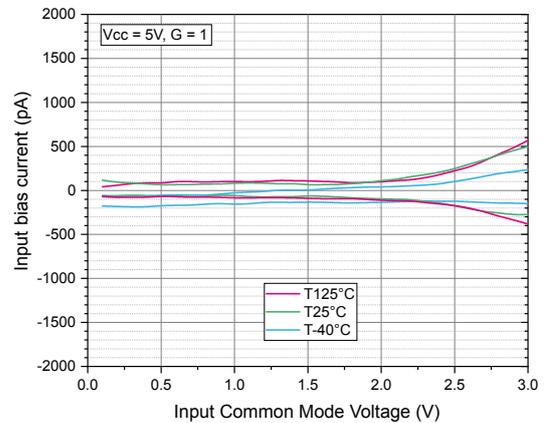
Figure 6. Vio vs. Vicm @ Vcc = 12 V

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

Figure 8. Vio vs. Vcc

Figure 9. Vio vs. temperature

Figure 10. Vio drift in temperature distribution

Figure 11. Iib vs. Vicm @ Vcc = 5 V


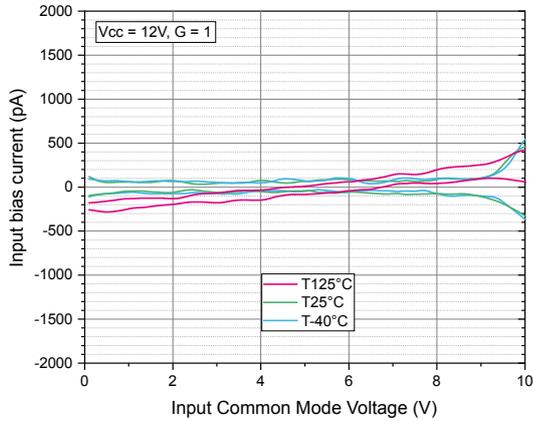
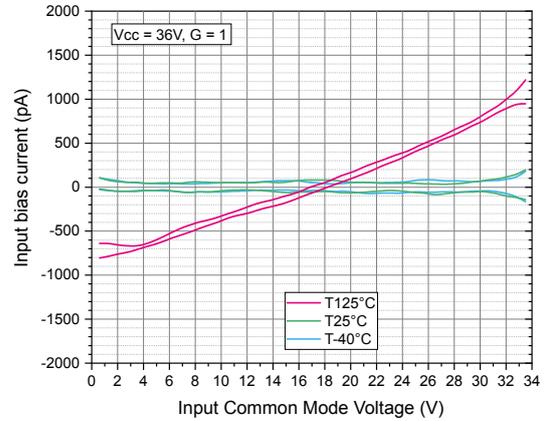
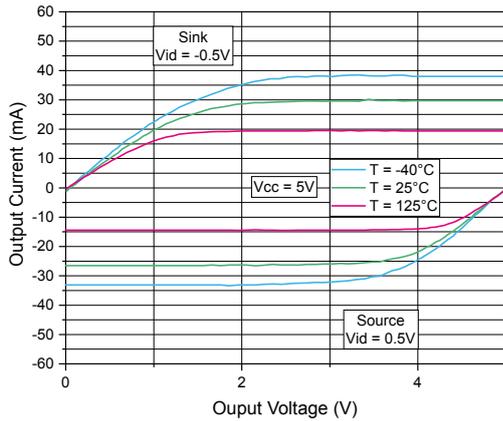
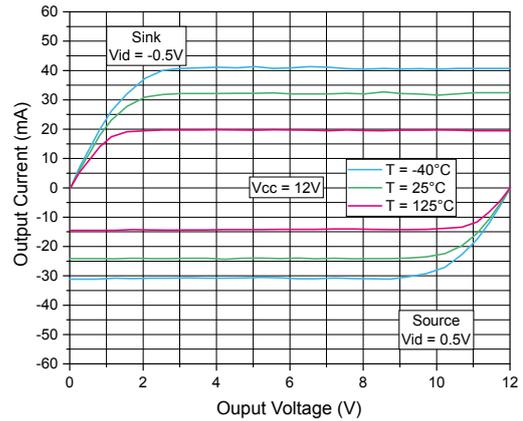
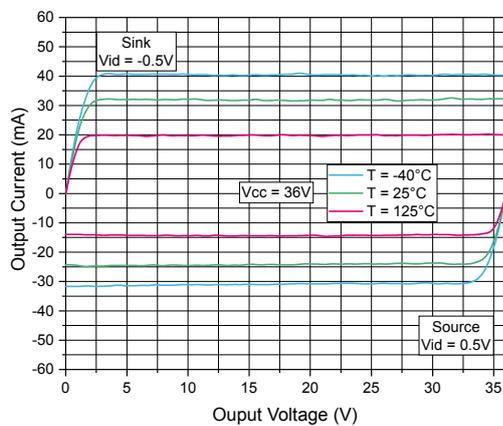
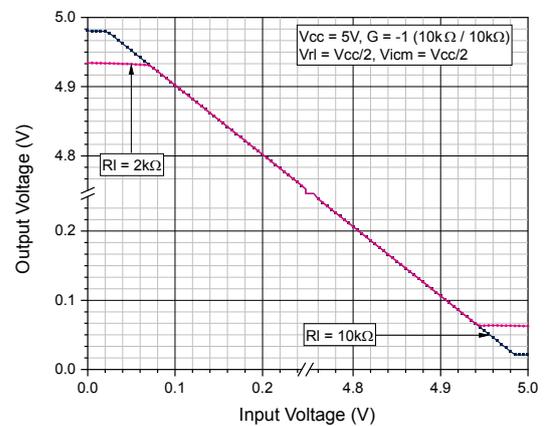
Figure 12. lib vs. Vicm @ Vcc = 12 V

Figure 13. lib vs. Vicm @ Vcc = 36 V

Figure 14. Iout @ Vcc = 5 V

Figure 15. Iout @ Vcc = 12 V

Figure 16. Iout @ Vcc = 36 V

Figure 17. Linearity @ Vcc = 5 V


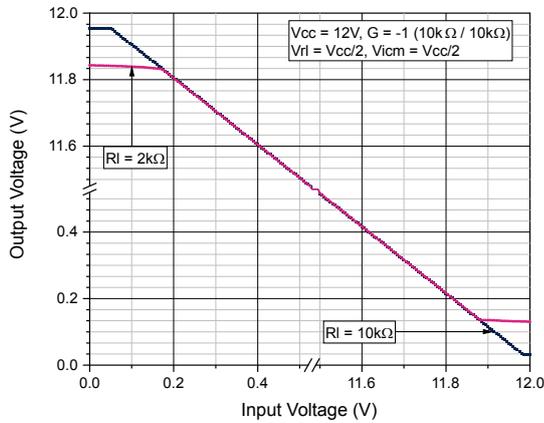
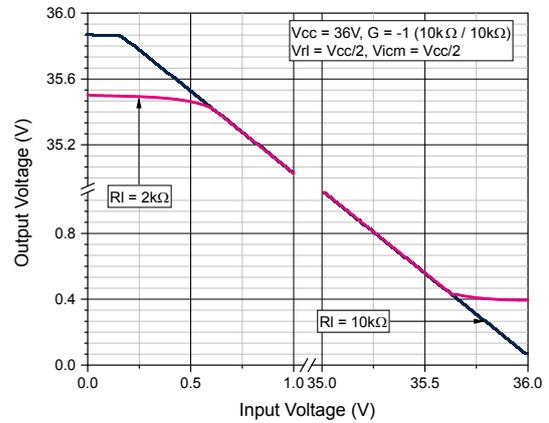
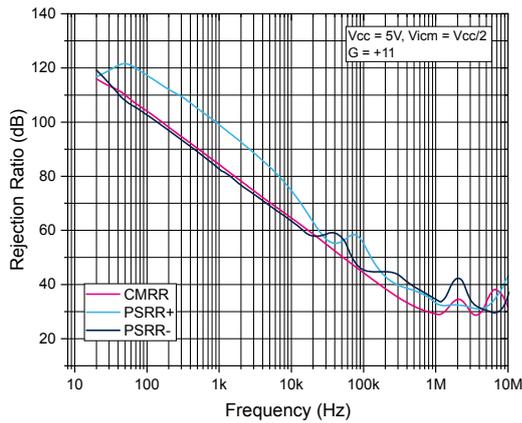
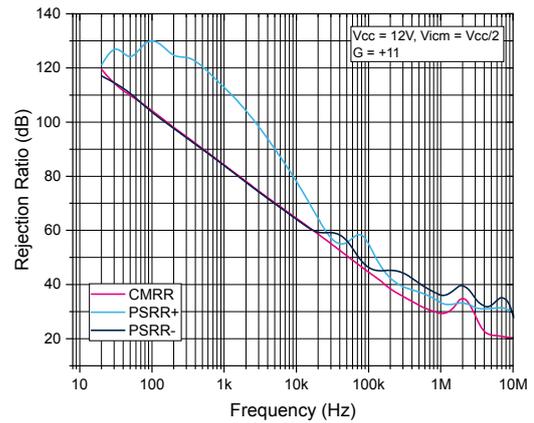
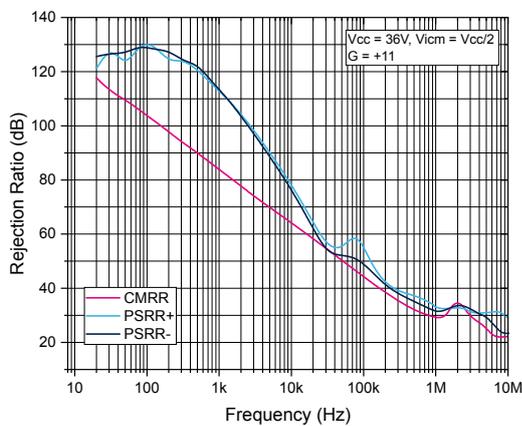
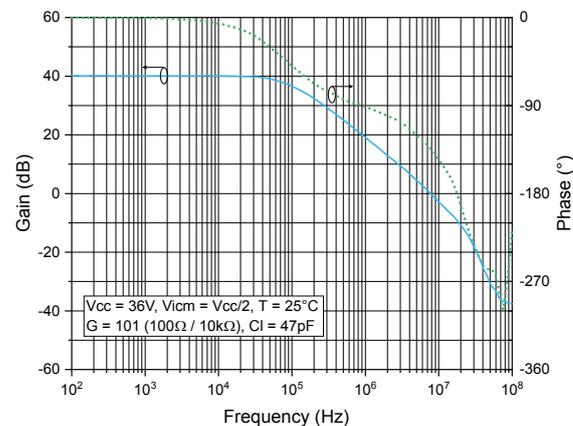
Figure 18. Linearity @ Vcc = 12 V

Figure 19. Linearity @ Vcc = 36 V

Figure 20. PSRR and CMRR @ Vcc = 5 V

Figure 21. PSRR and CMRR @ Vcc = 12 V

Figure 22. PSRR and CMRR @ Vcc = 36 V

Figure 23. Bode diagram @ Vcc = 36 V


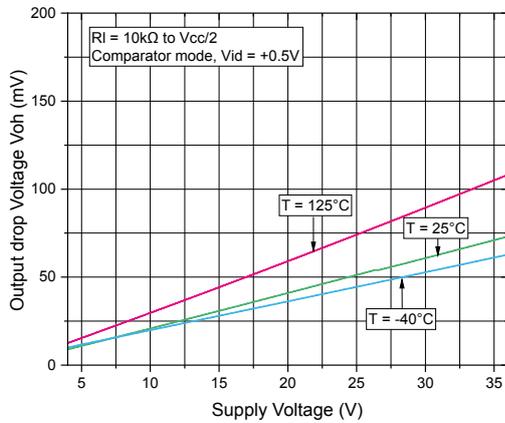
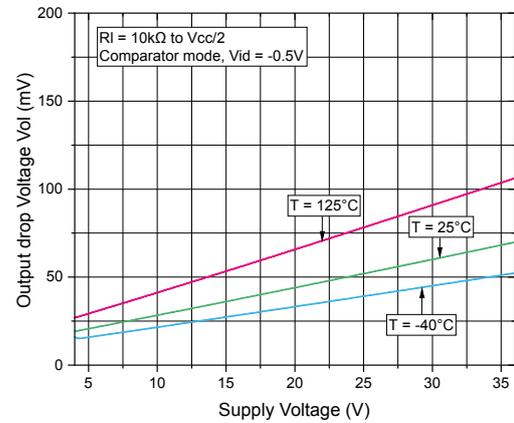
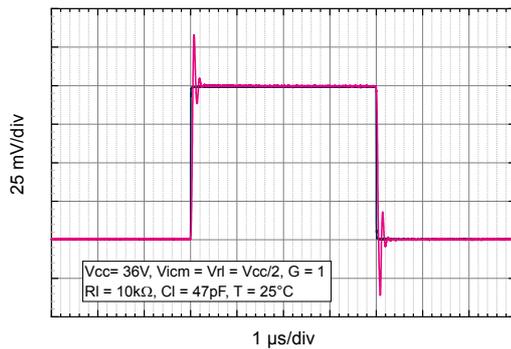
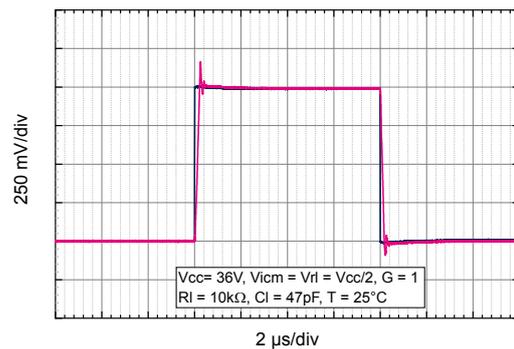
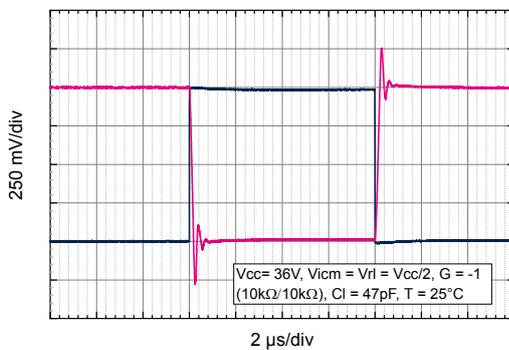
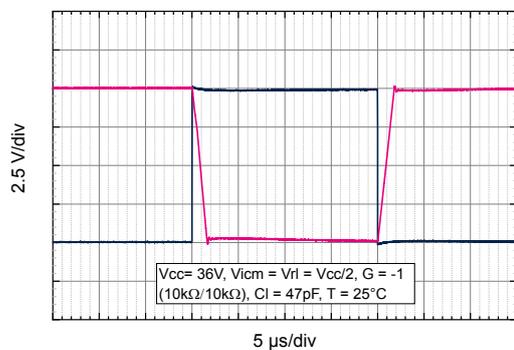
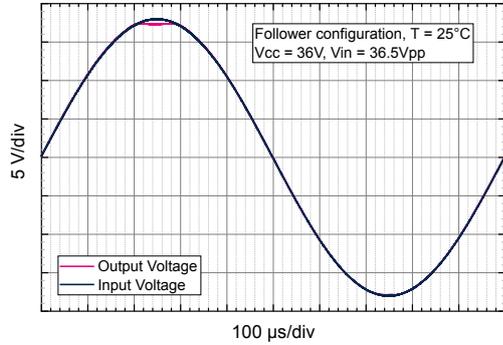
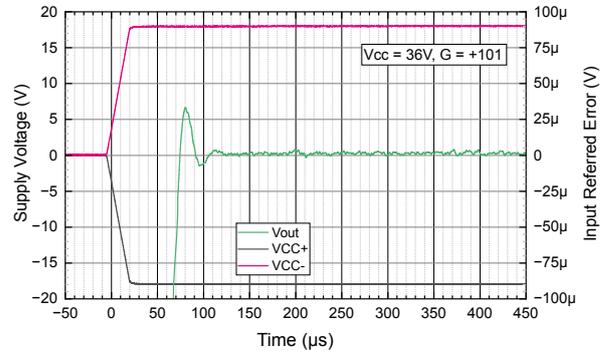
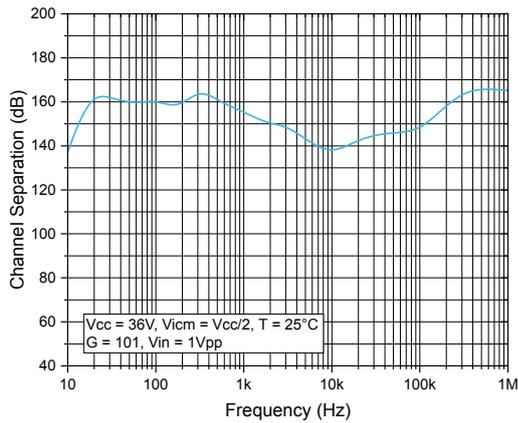
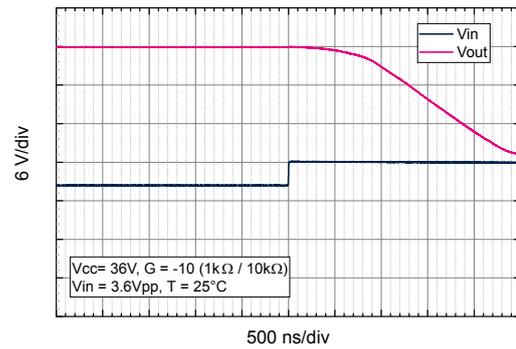
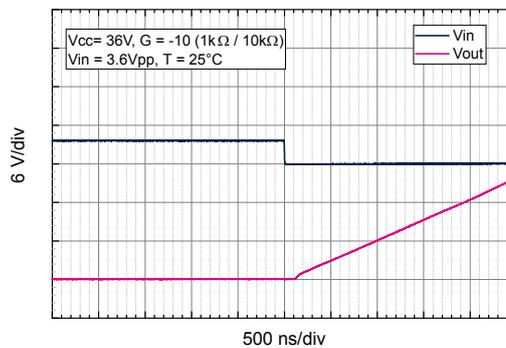
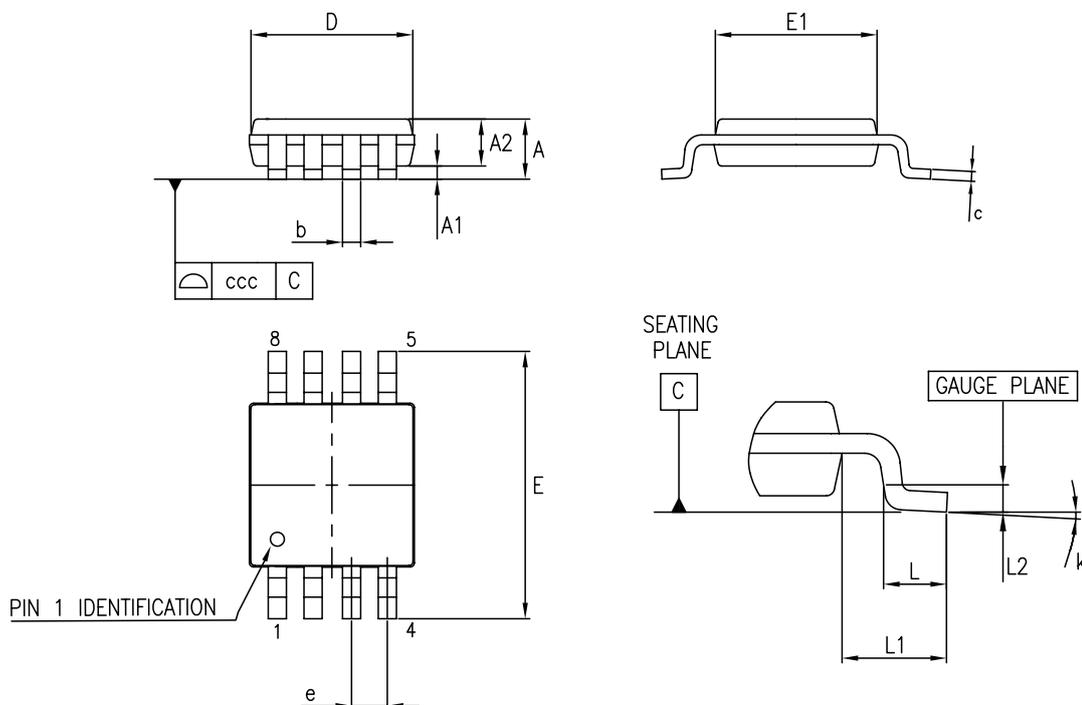
Figure 24. Voh vs. supply voltage

Figure 25. Vol vs. supply voltage

Figure 26. Small step response with gain = 1

Figure 27. Step response with gain = 1

Figure 28. Small step response with gain = -1

Figure 29. Step response with gain = -1


Figure 30. Phase reversal free

Figure 31. Start-up behavior

Figure 32. Cross talk

Figure 33. Overvoltage recovery (negative step)

Figure 34. Overvoltage recovery (positive step)


5 Package information

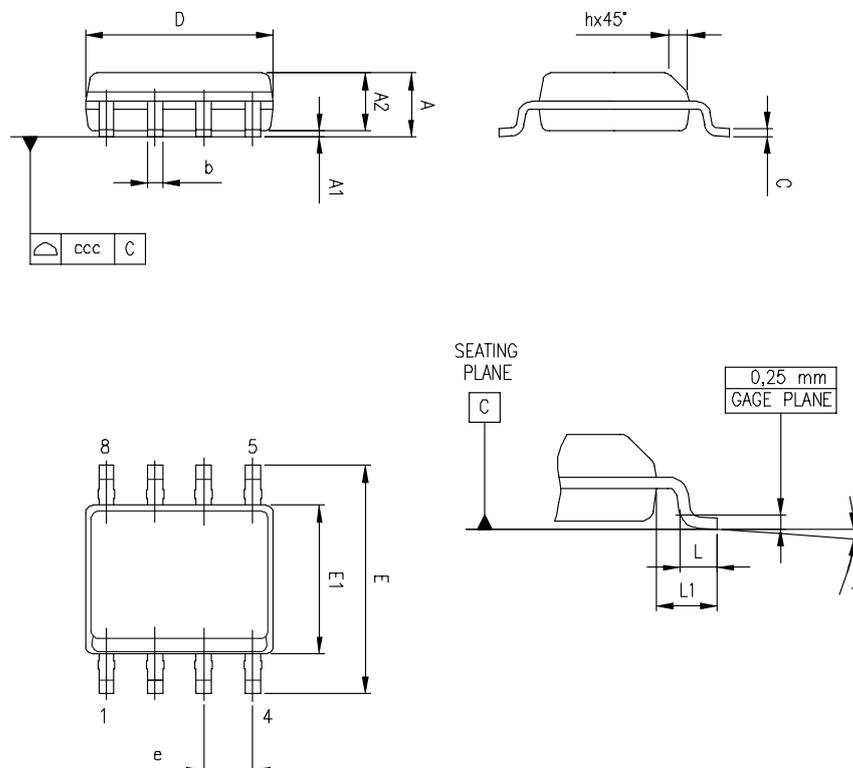
To meet environmental requirements, ST offers these devices in different grades of **ECOPACK** packages, depending on their level of environmental compliance. ECOPACK specifications, grade definitions, and product status are available at: www.st.com. ECOPACK is an ST trademark.

5.1 MiniSO8 package information

Figure 35. 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 36. 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.

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