TSV629x, TSV629xA

Micropower, wide bandwidth CMOS operational amplifiers

Features

- Rail-to-rail input and output
- Low power consumption: 29 µA typ, 36 µA max
- Low supply voltage: 1.5 – 5.5 V
- High gain bandwidth product: 1.3 MHz typ
- Stable when used in gain configuration
- Low power shutdown mode: 5 nA typ
- Good accuracy: 800 µV max (A version)
- Low input bias current: 1 pA typ
- Micropackages: MiniSO-8, SOT23-8, MiniSO-10, TSSOP14, TSSOP16
- EMI hardened operational amplifiers
- High tolerance to ESD: 4 kV HBM
- Extended temperature range: -40 to +125° C

Applications

- Battery-powered applications
- Portable devices
- Signal conditioning
- Active filtering
- Medical instrumentation

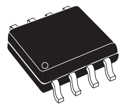
Description

The TSV6292, TSV6293, TSV6294 and TSV6295 dual and quad operational amplifiers offer a high bandwidth of 1.3 MHz while consuming only 29 µA. They must be used in a gain configuration (equal or above +4 or -3).

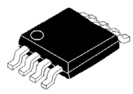
The TSV629x series features low voltage, low power operation and rail-to-rail input and output. The devices also offer an ultra-low input bias current and low input offset voltage.

The TSV6293 (dual) and TSV6295 (quad) have two shutdown pins for reduced power consumption.

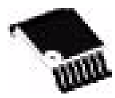
SOT23-8



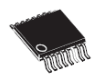
SO-8



MiniSO-8/10



TSSOP-14



TSSOP-16

These features make the TSV629x family ideal for sensor interfaces, battery supplied and portable applications, as well as active filtering.

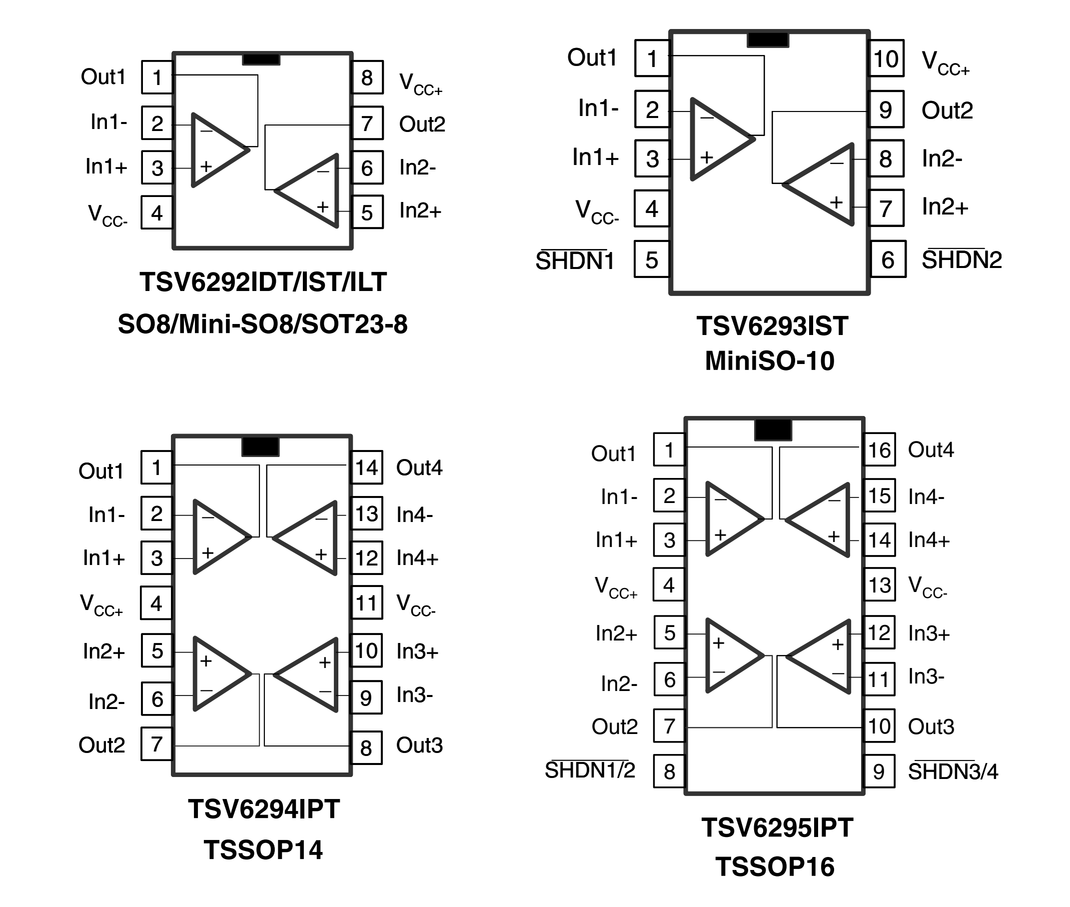
Table 1. Device summary

Reference	Dual version		Quad version	
	Without standby	With standby	Without standby	With standby
TSV629x	TSV6292	TSV6293	TSV6294	TSV6295
TSV629xA	TSV6292A	TSV6293A	TSV6294A	TSV6295A

Contents

1 Package pin connections

Figure 1. Pin connections for each package (top view)



2 Absolute maximum ratings and operating conditions

Table 2. Absolute maximum ratings (AMR)

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage(1)	6	V
V_{id}	Differential input voltage (2)	$\pm V_{CC}$	V
V_{in}	Input voltage (3)	V_{CC-} - 0.2 to V_{CC+}+ 0.2	V
I_{in}	Input current (4)	10	mA
$\overline{SHDN}$	Shutdown voltage(3)	V_{CC-} - 0.2 to V_{CC+}+ 0.2	V
T_{stg}	Storage temperature	-65 to +150	°C
R_{thja}	Thermal resistance junction to ambient(5)(6) SOT23-8 MiniSO-8 SO-8 Mini-SO10 TSSOP14 TSSOP16	 105 190 125 113 100 95	°C/W
T_j	Maximum junction temperature	150	°C
ESD	HBM: human body model(7)	4	kV
	MM: machine model(8)	200	V
	CDM: charged device model(9)	1.5	kV
	Latch-up immunity	200	mA

1. All voltage values, except differential voltages are with respect to network ground terminal.
2. Differential voltages are the non-inverting input terminal with respect to the inverting input terminal.
3. V_{CC}-V_{in} must not exceed 6 V, V_{in} must not exceed 6V.
4. Input current must be limited by a resistor in series with the inputs.
5. Short-circuits can cause excessive heating and destructive dissipation.
6. Rth are typical values.
7. Human body model: 100 pF discharged through a 1.5 kΩ resistor between two pins of the device, done for all couples of pin combinations with other pins floating.
8. Machine model: a 200 pF capacitor is charged to the specified voltage, then discharged directly between two pins of the device with no external series resistor (internal resistor < 5 Ω), done for all couples of pin combinations with other pins floating.
9. Charged device model: all pins plus package are charged together to the specified voltage and then discharged directly to ground.

Table 3. Operating conditions

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage	1.5 to 5.5	V
V_{icm}	Common mode input voltage range	V_{CC-} - 0.1 to V_{CC+} + 0.1	V
T_{oper}	Operating free air temperature range	-40 to +125	°C

3 Electrical characteristics

Table 4. Electrical characteristics at V_{CC+} = +1.8 V with V_{CC-} = 0 V, V_{icm} = $V_{CC}/2$, T_{amb} = 25° C, and R_L connected to $V_{CC}/2$ (unless otherwise specified)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
DC performance						
V_{io}	Offset voltage	TSV629x TSV629xA TSV6293AIST - MiniSO-10			4 0.8 1	mV
		TSV629x -$T_{min} < T_{op} < T_{max}$ TSV629xA - $T_{min} < T_{op} < T_{max}$ TSV6293AIST - $T_{min} < T_{op} < T_{max}$			6 2 2.2	
DV_{io}	Input offset voltage drift			2		µV/°C
I_{io}	Input offset current ($V_{out} = V_{CC}/2$)			1	10[1]	pA
		$T_{min} < T_{op} < T_{max}$		1	100	pA
I_{ib}	Input bias current ($V_{out} = V_{CC}/2$)			1	10[1]	pA
		$T_{min} < T_{op} < T_{max}$		1	100	pA
CMR	Common mode rejection ratio 20 log ($\Delta V_{ic}/\Delta V_{io}$)	0 V to 1.8 V, V_{out} = 0.9 V	53	74		dB
		$T_{min} < T_{op} < T_{max}$	51			dB
A_{vd}	Large signal voltage gain	R_L= 10 kΩ, V_{out}= 0.5 V to 1.3 V	78	95		dB
		$T_{min} < T_{op} < T_{max}$	73			dB
V_{OH}	High level output voltage	R_L = 10 kΩ $T_{min} < T_{op} < T_{max}$	35 50	5		mV
V_{OL}	Low level output voltage	R_L = 10 kΩ $T_{min} < T_{op} < T_{max}$		4	35 50	mV
I_{out}	Isink	V_{out} = 1.8 V	6	12		mA
		$T_{min} < T_{op} < T_{max}$	4			
	Isource	V_{out} = 0 V	6	10		
		$T_{min} < T_{op} < T_{max}$	4			
I_{CC}	Supply current (per operator)	No load, $V_{out}=V_{CC}/2$		25	31	µA
		$T_{min} < T_{op} < T_{max}$			33	µA
AC performance						
GBP	Gain bandwidth product	R_L = 10 kΩ, C_L = 100 pF		1.1		MHz
Gain	Minimum gain for stability	Phase margin = 60°, R_f = 10kΩ, R_L = 10 kΩ, C_L = 20 pF, T_{op} = 25° C		+4 -3		V/V
SR	Slew rate	R_L = 10 kΩ, C_L = 100 pF, V_{out} = 0.5 V to 1.3V		0.33		V/µs

1. Guaranteed by design.

Table 5. Shutdown characteristics V_{CC} = 1.8 V (TSV6293, TSV6295)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
DC performance						
I_{CC}	Supply current in shutdown mode (all operators)	$\overline{SHDN} = V_{CC-}$		2.5	50	nA
		$T_{min} < T_{op} < 85°$ C			200	nA
		$T_{min} < T_{op} < 125°$ C			1.5	µA
t_{on}	Amplifier turn-on time	R_L = 5 k, Vout = V_{CC-} to V_{CC-} + 0.2 V		200		ns
t_{off}	Amplifier turn-off time	R_L = 5 k, Vout = V_{CC+} - 0.5 V to V_{CC+} - 0.7 V		20		ns
V_{IH}	$\overline{SHDN}$ logic high		1.35			V
V_{IL}	$\overline{SHDN}$ logic low				0.6	V
I_{IH}	$\overline{SHDN}$ current high	$\overline{SHDN} = V_{CC+}$		10		pA
I_{IL}	$\overline{SHDN}$ current low	$\overline{SHDN} = V_{CC-}$		10		pA
I_{OLeak}	Output leakage in shutdown mode	$\overline{SHDN} = V_{CC-}$		50		pA
		$T_{min} < T_{op} < 125°$ C		1		nA

Table 6. V_{CC+} = +3.3 V, V_{CC-} = 0 V, V_{icm} = $V_{CC}/2$, T_{amb} = 25° C, R_L connected to $V_{CC}/2$ (unless otherwise specified)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
DC performance						
V_{io}	Offset voltage	TSV629x TSV629xA TSV6293AIST - MiniSO-10			4 0.8 1	mV
		TSV629x - $T_{min} < T_{op} < T_{max}$ TSV629xA - $T_{min} < T_{op} < T_{max}$ TSV6293AIST - $T_{min} < T_{op} < T_{max}$			6 2 2.2	mV
DV_{io}	Input offset voltage drift			2		μV/°C
I_{io}	Input offset current			1	10(1)	pA
		$T_{min} < T_{op} < T_{max}$		1	100	pA
I_{ib}	Input bias current			1	10(1)	pA
		$T_{min} < T_{op} < T_{max}$		1	100	pA
CMR	Common mode rejection ratio 20 log ($\Delta V_{ic}/\Delta V_{io}$)	0 V to 3.3 V, V_{out} = 1.65 V	57	79		dB
		$T_{min} < T_{op} < T_{max}$	53			dB
A_{vd}	Large signal voltage gain	R_L=10 kΩ, V_{out}= 0.5 V to 2.8 V	81	98		dB
		$T_{min} < T_{op} < T_{max}$	76			dB
V_{OH}	High level output voltage	R_L = 10 kΩ $T_{min} < T_{op} < T_{max}$	35 50	5		mV
V_{OL}	Low level output voltage	R_L = 10 kΩ $T_{min} < T_{op} < T_{max}$		4	35 50	mV
I_{out}	Isink	V_o = 5 V	23	45		mA
		$T_{min} < T_{op} < T_{max}$	20			mA
	Isource	V_o = 0 V	23	38		mA
		$T_{min} < T_{op} < T_{max}$	20			mA
I_{CC}	Supply current (per operator)	No load, V_{out}= 2.5 V		26	33	μA
		$T_{min} < T_{op} < T_{max}$			35	μA
AC performance						
GBP	Gain bandwidth product	R_L = 10 kΩ, C_L = 100 pF		1.2		MHz
Gain	Minimum gain for stability	Phase margin = 60°, R_f = 10kΩ, R_L = 10 kΩ, C_L = 20 pF, T_{op} = 25° C		+4 -3		V/V
SR	Slew rate	R_L = 10 kΩ, C_L = 100 pF, V_{out} = 0.5 V to 2.8 V		0.4		V/μs

1. Guaranteed by design.

Table 7. V_{CC+} = +5 V, V_{CC-} = 0 V, V_{icm} = $V_{CC}/2$, T_{amb} = 25° C, R_L connected to $V_{CC}/2$ (unless otherwise specified)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
DC performance						
V_{io}	Offset voltage	TSV629x TSV629xA TSV6293AIST - MiniSO-10			4 0.8 1	mV
		TSV629x - $T_{min} < T_{op} < T_{max}$ TSV629xA - $T_{min} < T_{op} < T_{max}$ TSV629xA - $T_{min} < T_{op} < T_{max}$			6 2 2.2	
DV_{io}	Input offset voltage drift			2		µV/°C
I_{io}	Input offset current			1	10(1)	pA
		$T_{min} < T_{op} < T_{max}$		1	100	pA
I_{ib}	Input bias current			1	10(1)	pA
		$T_{min} < T_{op} < T_{max}$		1	100	pA
CMR	Common mode rejection ratio 20 log ($\Delta V_{ic}/\Delta V_{io}$)	0 V to 5 V, V_{out} = 2.5 V	60	80		dB
		$T_{min} < T_{op} < T_{max}$	55			
A_{vd}	Large signal voltage gain	R_L=10 kΩ, V_{out} = 0.5 V to 4.5 V	85	98		dB
		$T_{min} < T_{op} < T_{max}$	80			
SVR	Supply voltage rejection ratio 20 log ($\Delta V_{CC}/\Delta V_{io}$)	V_{CC} = 1.8 to 5 V	75	102		dB
		$T_{min} < T_{op} < T_{max}$	73			
EMIRR	EMI rejection ratio EMIRR = -20 log ($V_{RFpeak}/\Delta V_{io}$)	V_{RF} = 100 mV_{rms}, f = 400 MHz		61		dB
		V_{RF} = 100 mV_{rms}, f = 900 MHz		85		
		V_{RF} = 100 mV_{rms}, f = 1800 MHz		92		
		V_{RF} = 100 mV_{rms}, f = 2400 MHz		83		
V_{OH}	High level output voltage	R_L = 10 kΩ	35	7		mV
		$T_{min} < T_{op} < T_{max}$	50			
V_{OL}	Low level output voltage	R_L = 10 kΩ		6	35	mV
		$T_{min} < T_{op} < T_{max}$			50	
I_{out}	I_{sink}	V_o = 5 V	40	69		mA
		$T_{min} < T_{op} < T_{max}$	35			
	I_{source}	V_o = 0 V	40	74		mA
		$T_{min} < T_{op} < T_{max}$	35			
I_{CC}	Supply current (per operator)	No load, V_{out} = 2.5 V		29	36	µA
		$T_{min} < T_{op} < T_{max}$			38	µA

Table 7. V_{CC+} = +5 V, V_{CC-} = 0 V, V_{icm} = V_{CC}/2, T_{amb} = 25° C, R_L connected to V_{CC}/2 (unless otherwise specified) (continued)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
AC performance						
GBP	Gain bandwidth product	R_L = 10 kΩ, C_L = 100 pF		1.3		MHz
Gain	Minimum gain for stability	Phase margin = 60°, R_f = 10kΩ, R_L = 10 kΩ, C_L = 20 pF, T_{op} = 25° C		+4 -3		V/V
SR	Slew rate	R_L = 10 kΩ, C_L = 100 pF, V_{out} = 0.5 V to 4.5 V		0.5		V/µs
e_n	Equivalent input noise voltage	f = 1 kHz		77		$\frac{nV}{\sqrt{Hz}}$
THD+N	Total harmonic distortion + noise	Av = -10, f_{in} = 1 kHz, R_L= 100 kΩ, V_{icm} = Vcc/2, Vout = 1 V_{rms}, BW = 22 kHz		0.03		%

1. Guaranteed by design.

Table 8. Shutdown characteristics at V_{CC} = 5 V (TSV6293, TSV6295)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
DC performance						
I_{CC}	Supply current in shutdown mode (all operators)	$\overline{SHDN}$ = V_{IL}		5	50	nA
		T_{min} < T_{op} < 85° C			200	nA
		T_{min} < T_{op} < 125° C			1.5	µA
t_{on}	Amplifier turn-on time	R_L = 5 kΩ, V_{out} = V_{CC-} to V_{CC-} + 0.2 V		200		ns
t_{off}	Amplifier turn-off time	R_L = 5 kΩ, V_{out} = V_{CC+} - 0.5 V to V_{CC+} - 0.7 V		20		ns
V_{IH}	$\overline{SHDN}$ logic high		2			V
V_{IL}	$\overline{SHDN}$ logic low				0.8	V
I_{IH}	$\overline{SHDN}$ current high	$\overline{SHDN}$ = V_{CC+}		10		pA
I_{IL}	$\overline{SHDN}$ current low	$\overline{SHDN}$ = V_{CC-}		10		pA
I_{OLeak}	Output leakage in shutdown mode	$\overline{SHDN}$ = V_{CC-}		50		pA
		T_{min} < T_{op} < 125° C		1		nA

Figure 2. Supply current vs. supply voltage at $V_{icm} = V_{CC}/2$

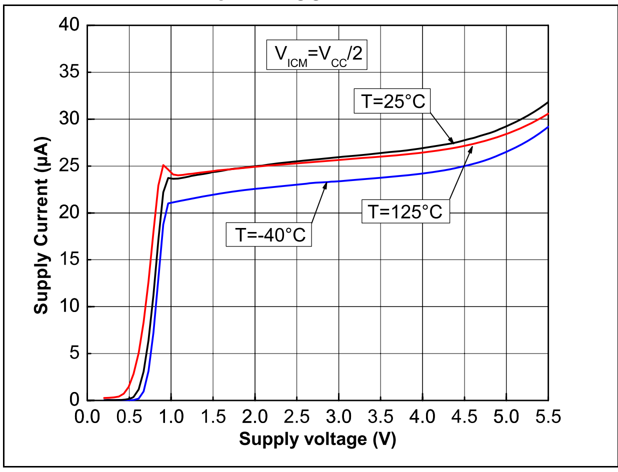


Figure 3. Output current vs. output voltage at $V_{CC} = 1.5$ V

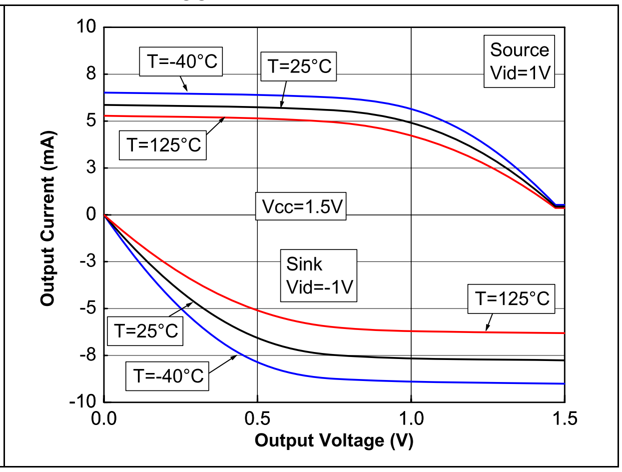


Figure 4. Output current vs. output voltage at $V_{CC} = 5$ V

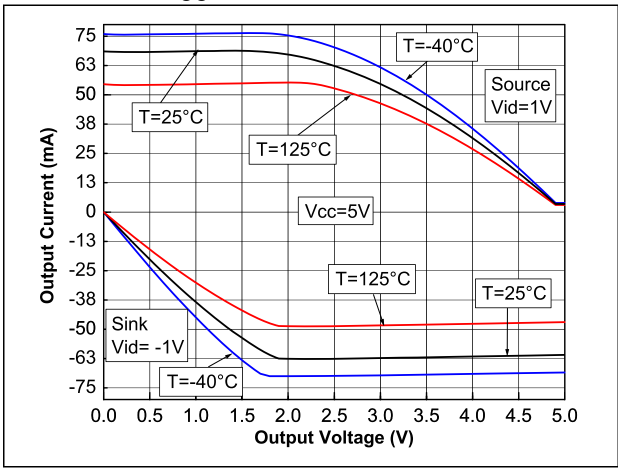


Figure 5. Closed loop frequency response, gain = -10 at $V_{CC} = 1.5$ V & $V_{CC} = 5$ V

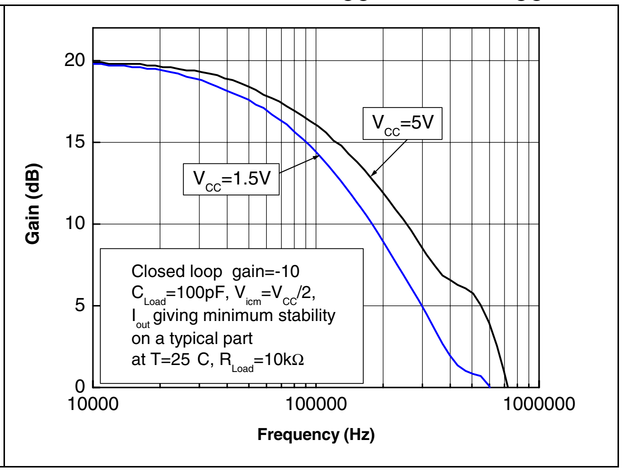


Figure 6. Closed loop frequency response, gain = -3, $V_{CC} = 1.5$ V

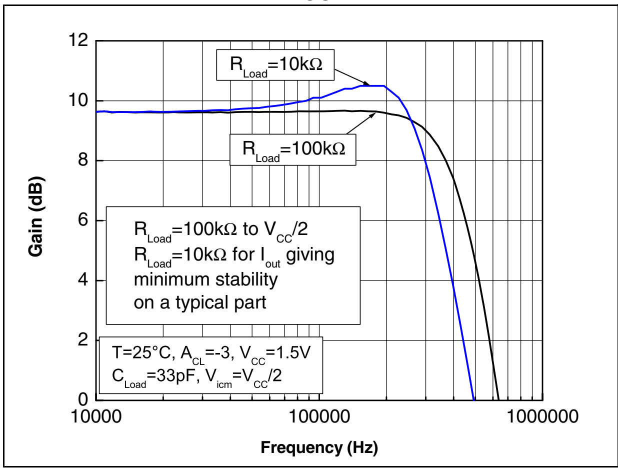


Figure 7. Closed loop frequency response, gain = -3, $V_{CC} = 5$ V

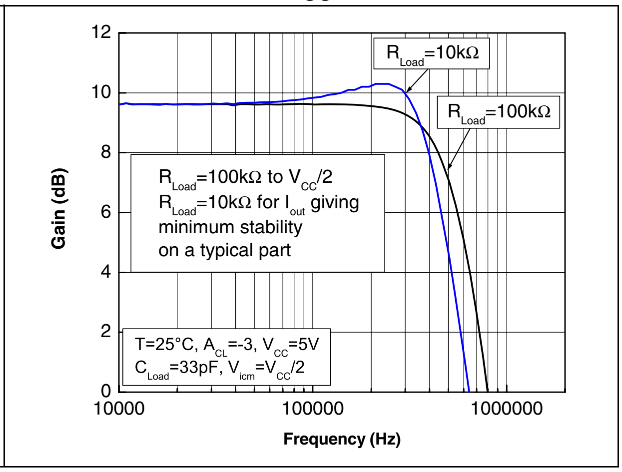


Figure 8. Positive slew rate vs. supply voltage in closed loop

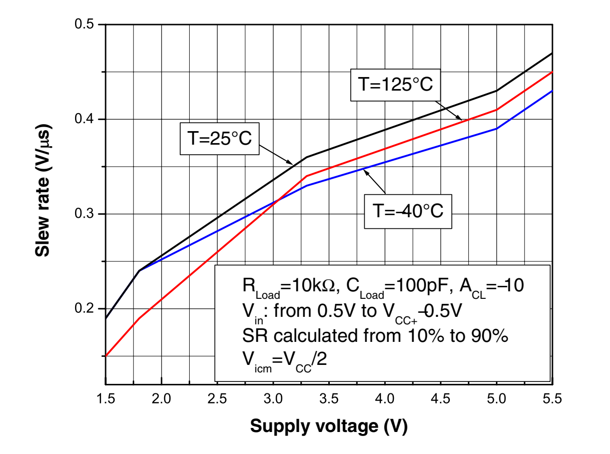


Figure 9. Negative slew rate vs. supply voltage in closed loop

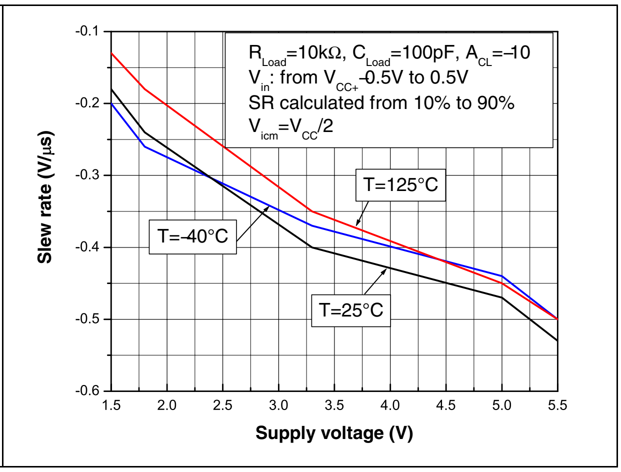


Figure 10. Slew rate vs. supply voltage in open loop

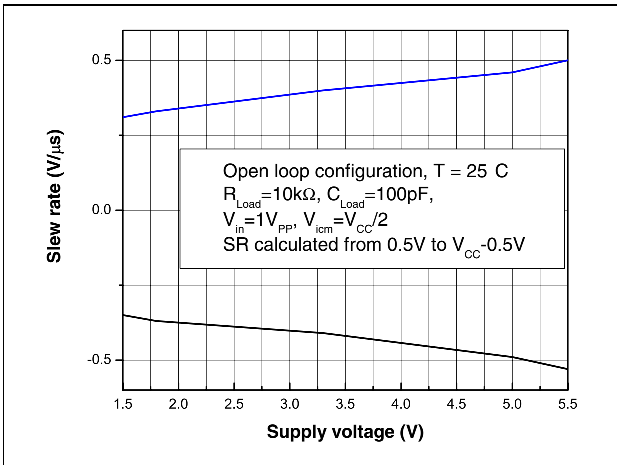


Figure 11. Slew rate timing in open loop

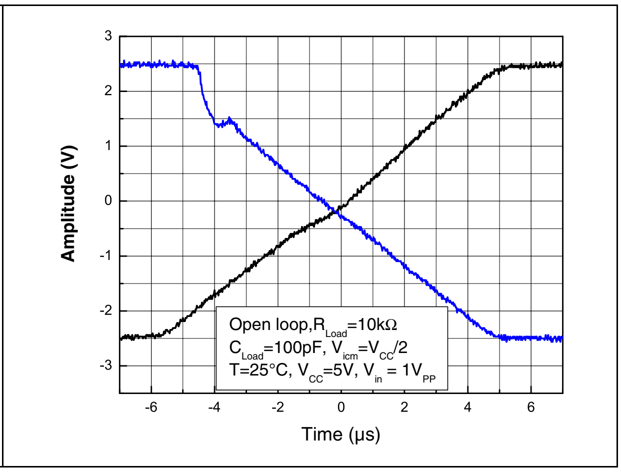


Figure 12. Slew rate timing in closed loop

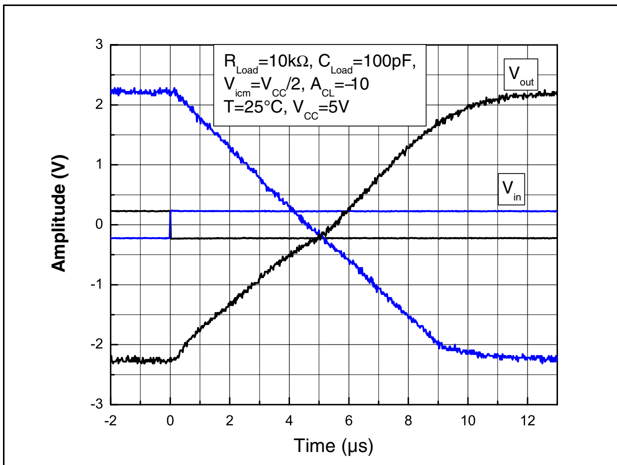


Figure 13. Noise at V_{CC} = 5 V

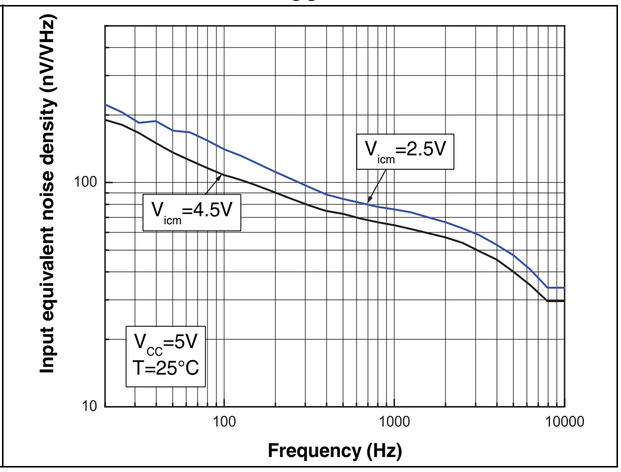


Figure 14. Distortion + noise vs. output voltage at V_{CC} = 1.8 V

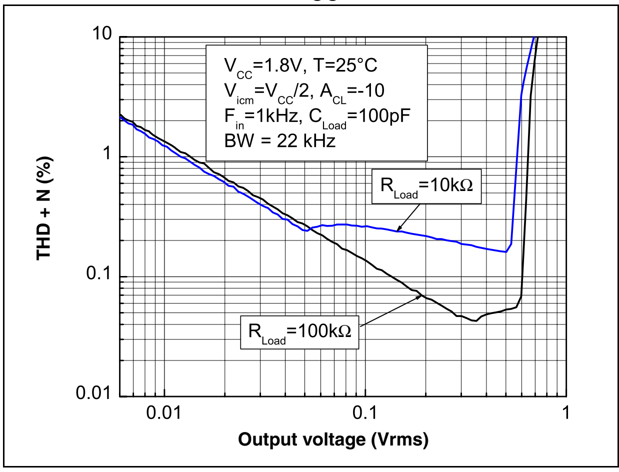


Figure 15. Distortion + noise vs. output voltage at V_{CC} = 5 V

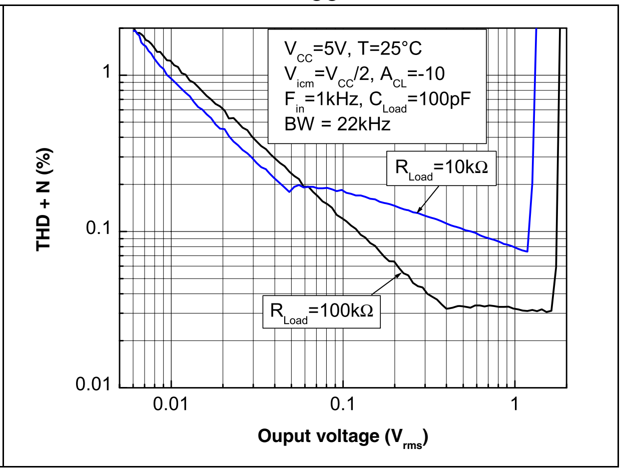


Figure 16. Distortion + noise vs. frequency at V_{CC} = 1.8 V

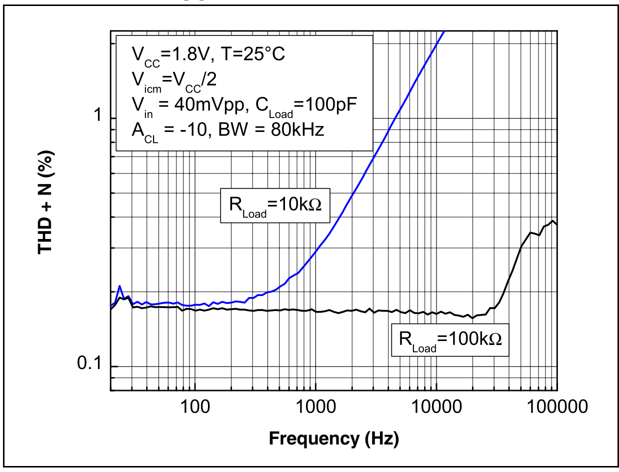


Figure 17. Distortion + noise vs. frequency at V_{CC} = 5 V

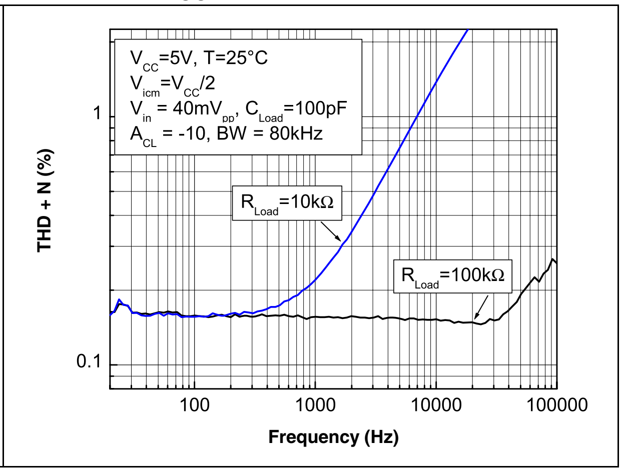
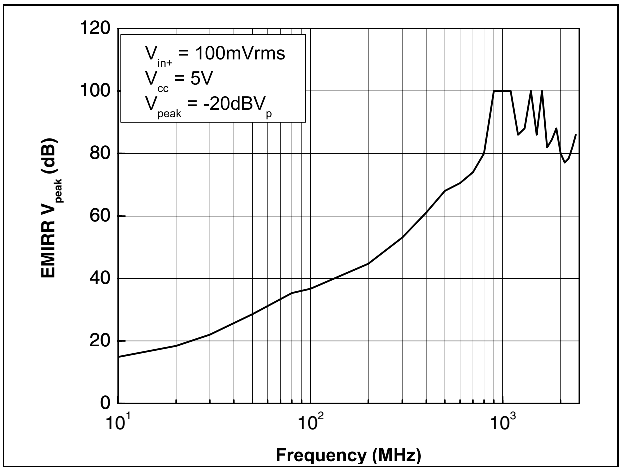


Figure 18. EMIRR vs. frequency at Vcc = 5 V, T = 25° C



4 Application information

4.1 Operating voltages

The TSV629x can operate from 1.5 to 5.5 V. The devices' parameters are fully specified for 1.8, 3.3 and 5 V power supplies. However, the parameters are very stable in the full V_{CC} range and several characterization curves show the TSV629x characteristics at 1.5 V. Additionally, the main specifications are guaranteed in extended temperature ranges from -40° C to +125° C.

4.2 Rail-to-rail input

The TSV629x are built with two complementary PMOS and NMOS input differential pairs. The devices have a rail-to-rail input, and the input common mode range is extended from V_{CC-} - 0.1 V to V_{CC+} + 0.1 V. The transition between the two pairs appears at V_{CC+} - 0.7 V. In the transition region, the performance of CMR, SVR, V_{io} (*Figure 19* and *Figure 20*) and THD is slightly degraded.

Figure 19. Input offset voltage vs input common mode at V_{CC} = 1.5 V

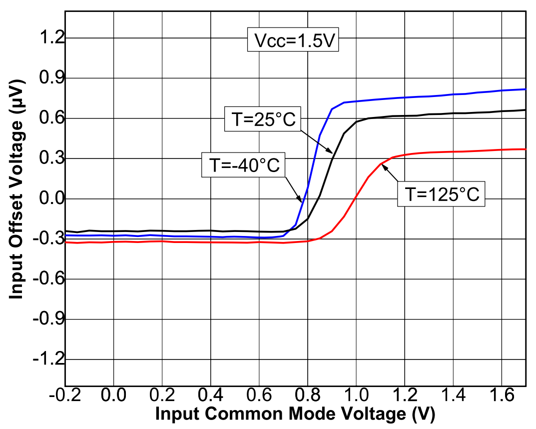
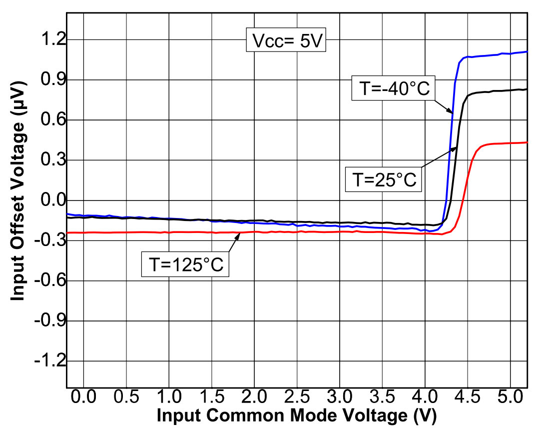


Figure 20. Input offset voltage vs input common mode at V_{CC} = 5 V



The devices are guaranteed without phase reversal.

4.3 Rail-to-rail output

The operational amplifiers' output level can go close to the rails: 35 mV maximum above and below the rail when connected to a 10 kΩ resistive load to $V_{CC}/2$.

4.4 Optimization of DC and AC parameters

These devices use an innovative approach to reduce the spread of the main DC and AC parameters. An internal adjustment achieves a very narrow spread of current consumption (29 µA typical, min/max at ±17%). Parameters linked to the current consumption value, such as GBP, SR and A_{vd} benefit from this narrow dispersion.

4.5 Shutdown function (TSV6293, TSV6295)

The operational amplifier is enabled when the $\overline{SHDN}$ pin is pulled high. To disable the amplifier, the $\overline{SHDN}$ must be pulled down to V_{CC-}. When in shutdown mode, the amplifier output is in a high impedance state. The $\overline{SHDN}$ pin must never be left floating but tied to V_{CC+} or V_{CC-}. The turn-on and turn-off times are calculated for an output variation of ±200 mV (*Figure 21* and *Figure 22* show the test configurations).

Figure 21. Test configuration for turn-on time (Vout pulled down)

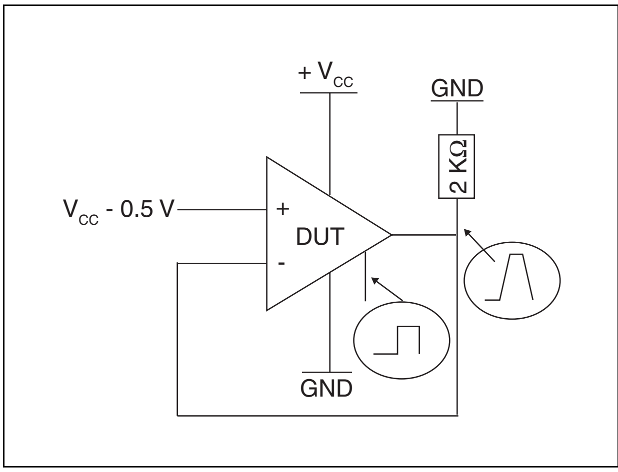


Figure 22. Test configuration for turn-off time (Vout pulled down)

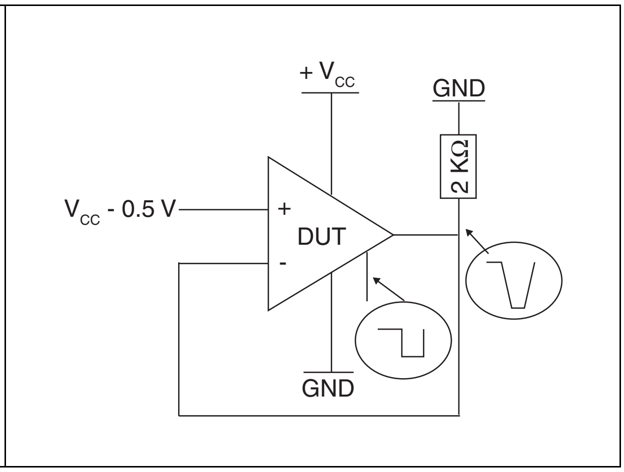


Figure 23. Turn-on time, V_{CC} = 5 V, Vout pulled down, T = 25° C

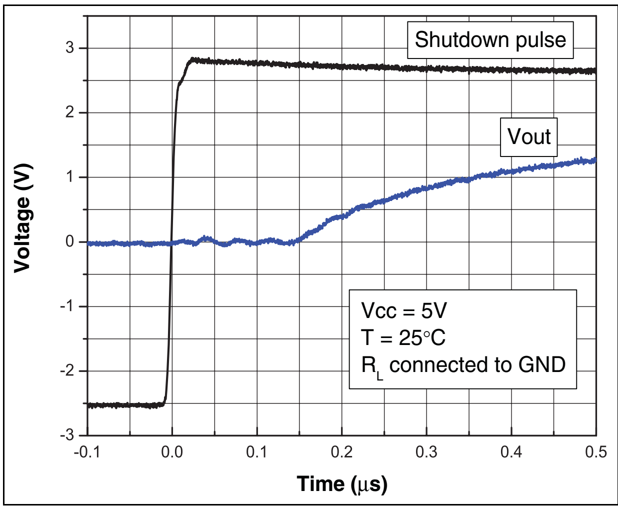
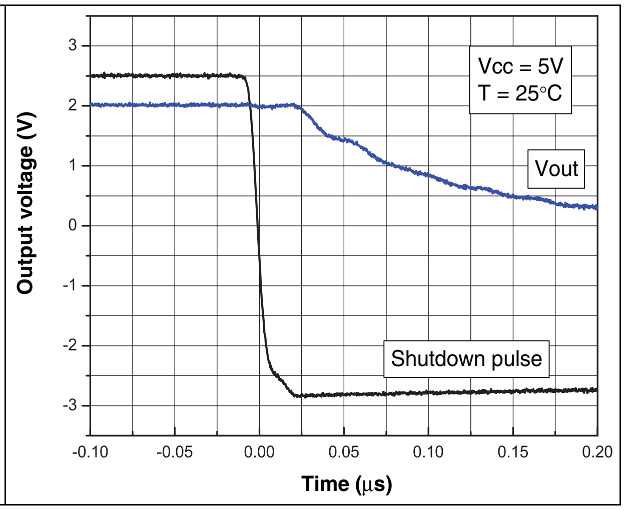


Figure 24. Turn-off time, V_{CC} = 5 V, Vout pulled down, T = 25° C



4.6 Driving resistive and capacitive loads

These products are micropower, low-voltage operational amplifiers optimized to drive rather large resistive loads, above 5 kΩ For lower resistive loads, the THD level may significantly increase.

The amplifiers have a relatively low internal compensation capacitor, making them very fast while consuming very little. They are ideal when used in a non-inverting configuration or in an inverting configuration in the following conditions:

- |Gain| ≥ 3 in an inverting configuration (C_L = 20 pF, R_L = 100 kΩ) or |gain| ≥ 10 (C_L = 100 pF, R_L = 100 kΩ)
- Gain ≥ +4 in a non-inverting configuration (C_L = 20 pF, R_L = 100kΩ) or gain ≥ +11 (C_L = 100 pF, R_L= 100 kΩ)

As these operational amplifiers are not unity gain stable, the TSV62x (29 µA, 420 kHz) or TSV63x (60 µA, 880 kHz) – which are unity gain stable – might be a solution for your application.

Table 9. Related products

Part #	Icc (µA) at 5V	GBP (MHz)	SR (V/µs)	Minimum gain for stability (C_{Load} = 100 pF)
TSV622-3-4-5	29	0.42	0.14	1
TSV6292-3-4-5	29	1.3	0.5	+11
TSV632-3-4-5	60	0.88	0.34	1
TSV6392-3-4-5	60	2.4	1.1	+11

4.7 PCB layouts

For correct operation, it is advised to add 10 nF decoupling capacitors as close as possible to the power supply pins.

4.8 Macromodel

Two accurate macromodels (with or without shutdown feature) of the TSV629x are available on STMicroelectronics' web site at www.st.com. This model is a trade-off between accuracy and complexity (that is, time simulation) of the TSV629x operational amplifiers. It emulates the nominal performances of a typical device within the specified operating conditions mentioned in the datasheet. It also helps to validate a design approach and to select the right operational amplifier, but it does not replace on-board measurements.

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 SOT23-8 package information

Figure 25. SOT23-8 package mechanical drawing

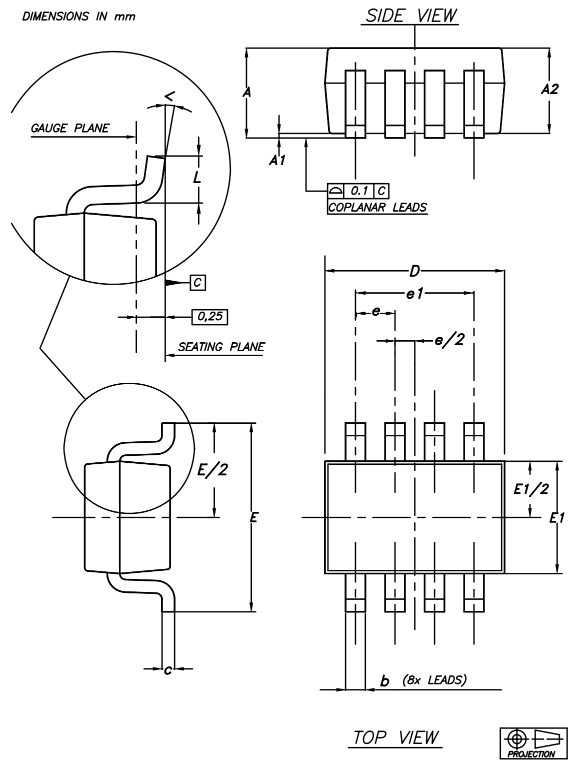


Table 10. SOT23-8 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.45			0.057
A1			0.15			0.006
A2	0.90		1.30	0.035		0.051
b	0.22		0.38	0.009		0.015
c	0.08		0.22	0.003		0.009
D	2.80		3	0.110		0.118
E	2.60		3	0.102		0.118
E1	1.50		1.75	0.059		0.069
e		0.65			0.026	
e1		1.95			0.077	
L	0.30		0.60	0.012		0.024
<	0°		8°			

5.2 SO-8 package information

Figure 26. SO-8 package mechanical drawing

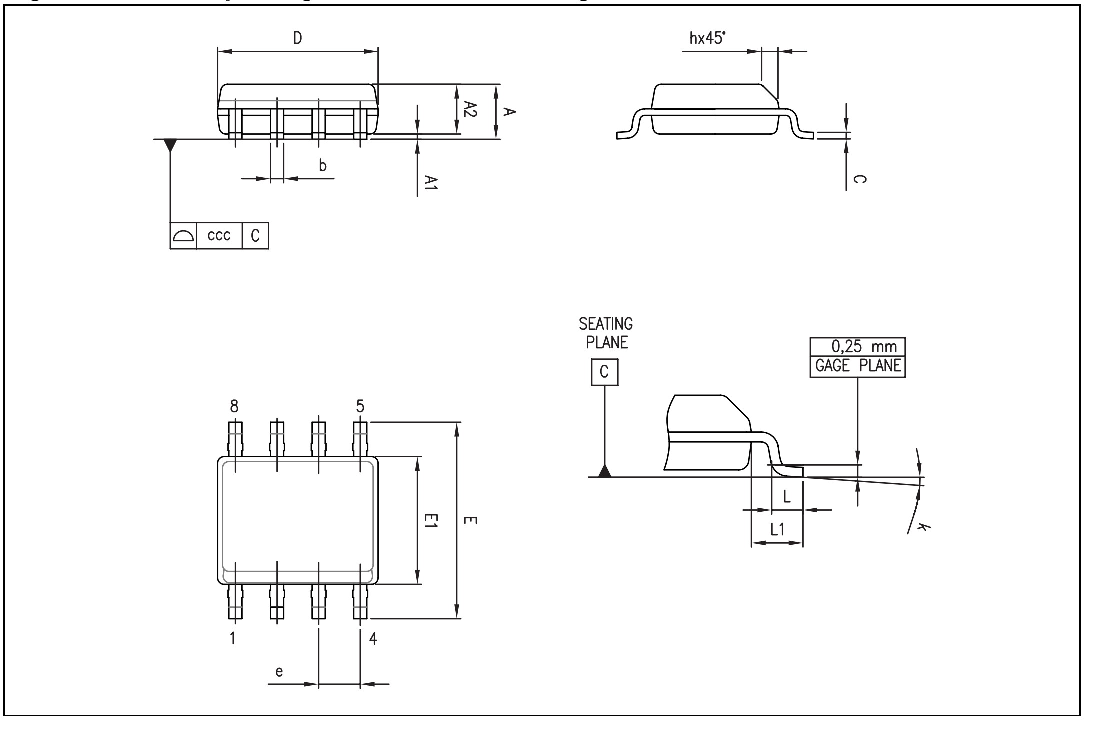


Table 11. SO-8 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
A1	0.10		0.25	0.004		0.010
A2	1.25			0.049		
b	0.28		0.48	0.011		0.019
c	0.17		0.23	0.007		0.010
D	4.80	4.90	5.00	0.189	0.193	0.197
E	5.80	6.00	6.20	0.228	0.236	0.244
E1	3.80	3.90	4.00	0.150	0.154	0.157
e		1.27			0.050	
h	0.25		0.50	0.010		0.020
L	0.40		1.27	0.016		0.050
L1		1.04			0.040	
k	0		8°	1°		8°
ccc			0.10			0.004

5.3 MiniSO-8 package information

Figure 27. MiniSO-8 package mechanical drawing

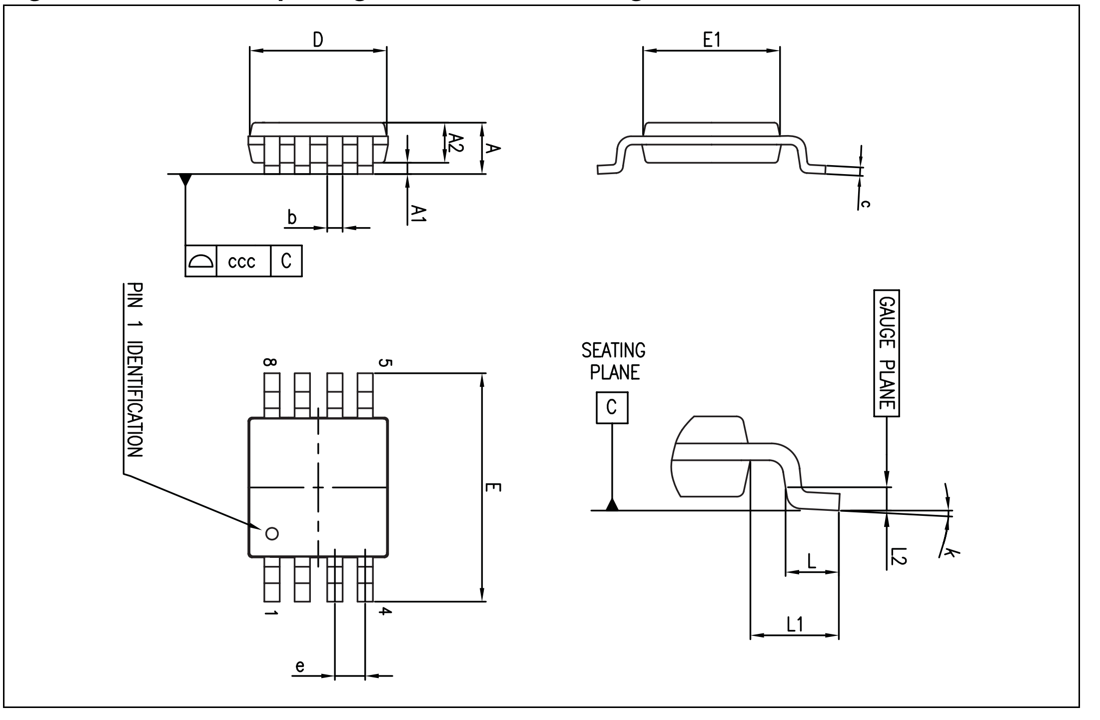


Table 12. MiniSO-8 package mechanical data

Ref.	Dimensions					
	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	0.030	0.033	0.037
b	0.22		0.40	0.009		0.016
c	0.08		0.23	0.003		0.009
D	2.80	3.00	3.20	0.11	0.118	0.126
E	4.65	4.90	5.15	0.183	0.193	0.203
E1	2.80	3.00	3.10	0.11	0.118	0.122
e		0.65			0.026	
L	0.40	0.60	0.80	0.016	0.024	0.031
L1		0.95			0.037	
L2		0.25			0.010	
k	0°		8°	0°		8°
ccc			0.10			0.004

5.4 MiniSO-10 package information

Figure 28. MiniSO-10 package mechanical drawing

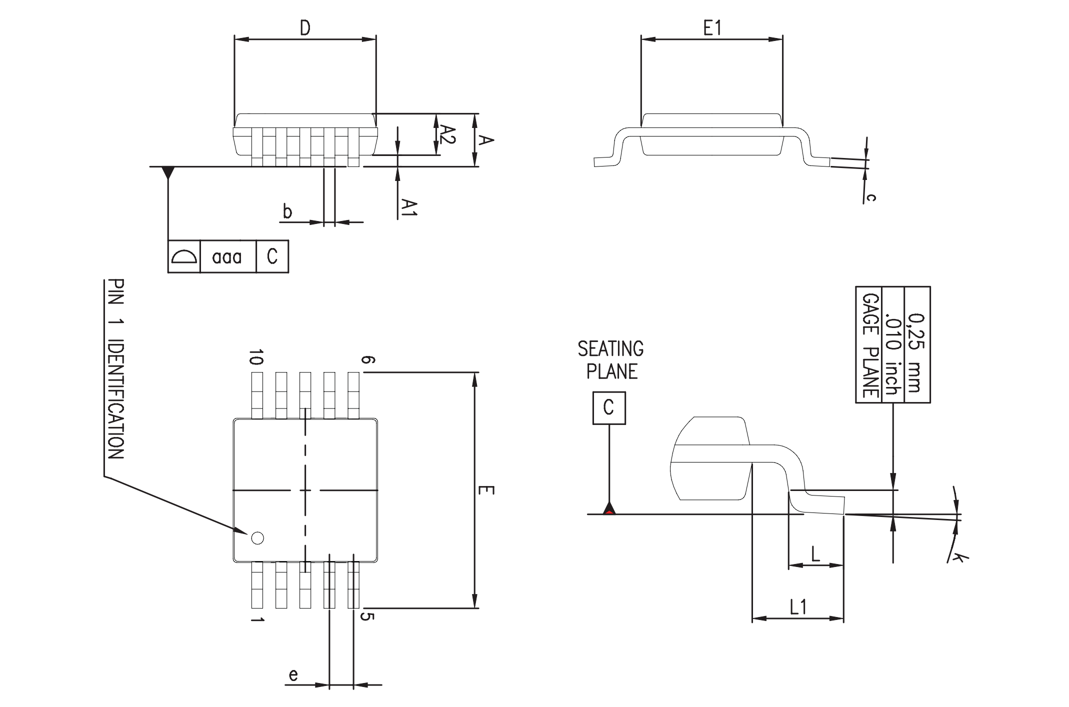


Table 13. MiniSO-10 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.10			0.043
A1	0.05	0.10	0.15	0.002	0.004	0.006
A2	0.78	0.86	0.94	0.031	0.034	0.037
b	0.25	0.33	0.40	0.010	0.013	0.016
c	0.15	0.23	0.30	0.006	0.009	0.012
D	2.90	3.00	3.10	0.114	0.118	0.122
E	4.75	4.90	5.05	0.187	0.193	0.199
E1	2.90	3.00	3.10	0.114	0.118	0.122
e		0.50			0.020	
L	0.40	0.55	0.70	0.016	0.022	0.028
L1		0.95			0.037	
k	0°	3°	6°	0°	3°	6°
aaa			0.10			0.004

5.5 TSSOP14 package information

Figure 29. TSSOP14 package mechanical drawing

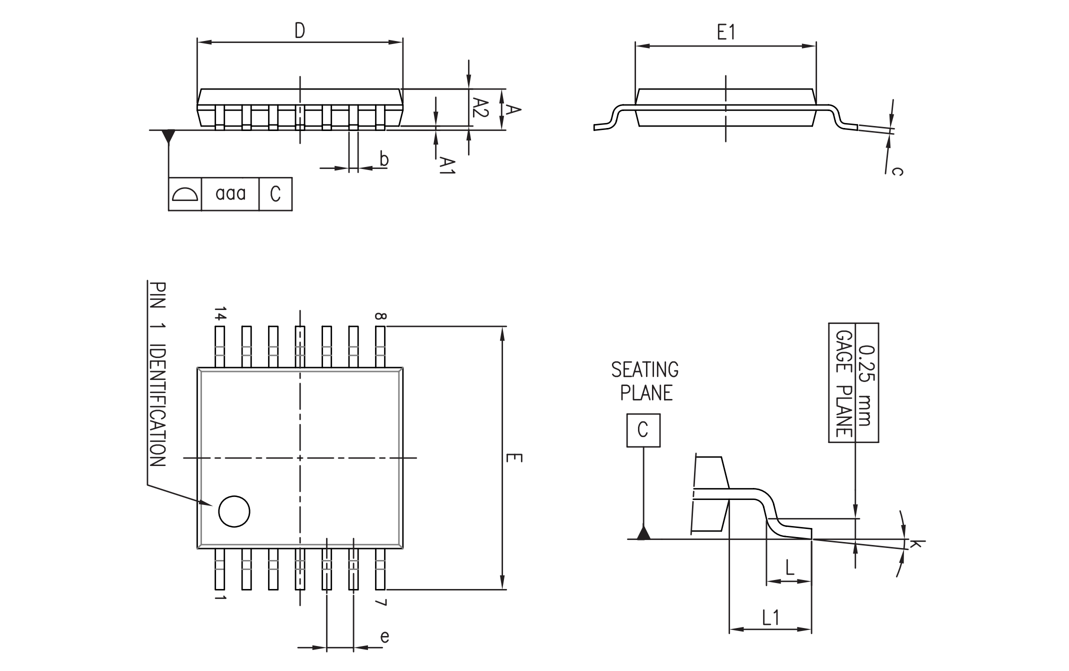


Table 14. TSSOP14 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.20			0.047
A1	0.05		0.15	0.002	0.004	0.006
A2	0.80	1.00	1.05	0.031	0.039	0.041
b	0.19		0.30	0.007		0.012
c	0.09		0.20	0.004		0.0089
D	4.90	5.00	5.10	0.193	0.197	0.201
E	6.20	6.40	6.60	0.244	0.252	0.260
E1	4.30	4.40	4.50	0.169	0.173	0.176
e		0.65			0.0256	
L	0.45	0.60	0.75	0.018	0.024	0.030
L1		1.00			0.039	
k	0°		8°	0°		8°
aaa			0.10			0.004

5.6 TSSOP16 package information

Figure 30. TSSOP16 package mechanical drawing

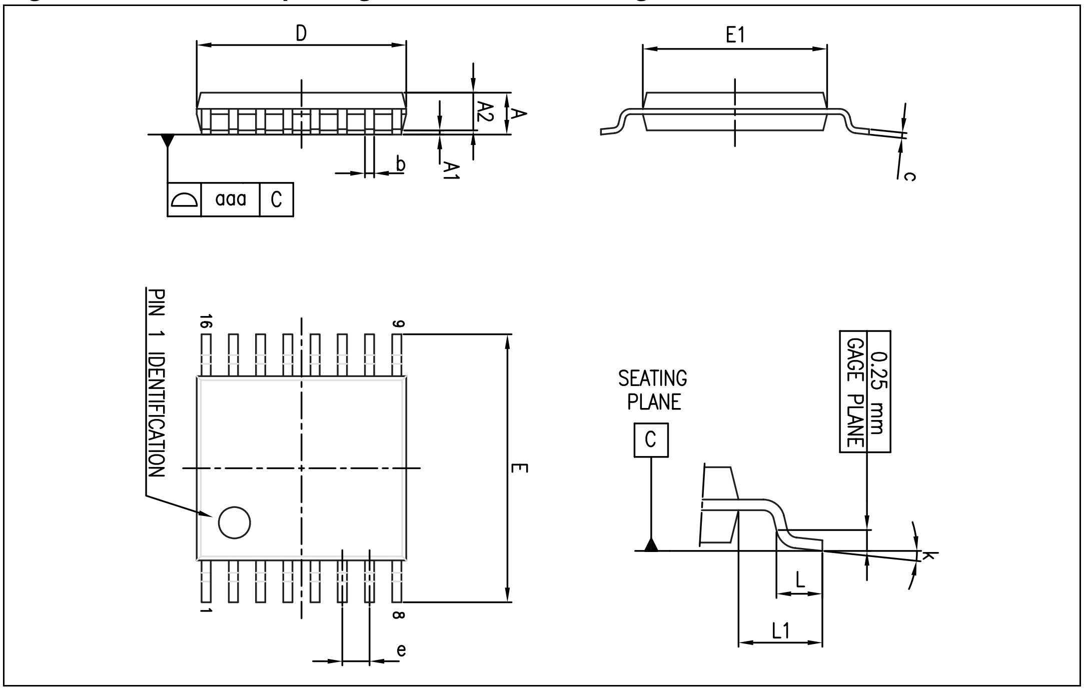


Table 15. TSSOP16 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.20			0.047
A1	0.05		0.15	0.002		0.006
A2	0.80	1.00	1.05	0.031	0.039	0.041
b	0.19		0.30	0.007		0.012
c	0.09		0.20	0.004		0.008
D	4.90	5.00	5.10	0.193	0.197	0.201
E	6.20	6.40	6.60	0.244	0.252	0.260
E1	4.30	4.40	4.50	0.169	0.173	0.177
e		0.65			0.0256	
k	0°		8°	0°		8°
L	0.45	0.60	0.75	0.018	0.024	0.030
L1		1.00			0.039	
aaa			0.10			0.004

6 Ordering information

Table 16. Order codes

Part number	Temperature range	Package	Packing	Marking
TSV6292ID/DT	-40° C to +125° C	SO-8	Tube and tape & reel	V6292I
TSV6292AID/DT				V6292AI
TSV6292IST		MiniSO-8	Tape & reel	K114
TSV6292AIST				K144
TSV6292ILT		SOT23-8	Tape & reel	K114
TSV6293IST		MiniSO-10	Tape & reel	K134
TSV6293AIST				K135
TSV6294IPT		TSSOP-14	Tape & reel	V6294
TSV6294AIPT				V6294A
TSV6295IPT		TSSOP-16	Tape & reel	V6295
TSV6295AIPT				V6295A

7 Revision history

Table 17. Document revision history

Date	Revision	Changes
14-Jan-2010	1	Initial release.
01-Mar-2010	2	Corrected error in *Table 16: Order codes*: TSV6295 offered in TSSOP-16 package.