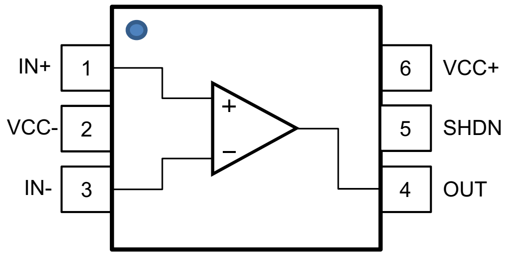
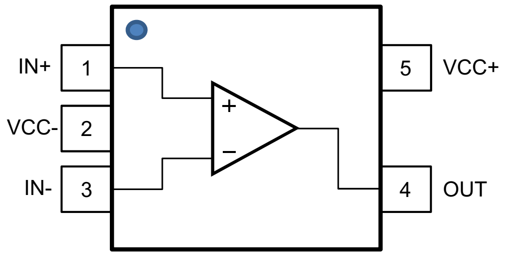
TSV630, TSV630A, TSV631, TSV631A

Rail-to-rail input/output, 60 µA, 880 kHz, 5 V CMOS operational amplifiers

Datasheet - production data



SC70-6/SOT23-6 (TSV630)



SC70-5/SOT23-5 (TSV631)

Features

- Low offset voltage: 500 µV max (A version)
- Low power consumption: 60 µA typ at 5 V
- Low supply voltage: 1.5 V - 5.5 V
- Gain bandwidth product: 880 kHz typ
- Unity gain stability
- Low power shutdown mode: 5 nA typ
- High output current: 63 mA at V_{CC} = 5 V
- Low input bias current: 1 pA typ
- Rail-to-rail input and output
- Extended temperature range: -40°C to +125°C
- Automotive qualification

Related products

- See the TSV52x series for higher merit factor (1.15 MHz for 45 µA)
- See the TSV61x (120 kHz for 9 µA) or the TSV62x (420 kHz for 29 µA) for more power savings

Applications

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

Description

The TSV630 and TSV631 devices are single operational amplifiers offering low voltage, low power operation, and rail-to-rail input and output.

These devices have a very low input bias current and a low offset voltage making them ideal for applications that require precision. They can operate at power supplies ranging from 1.5 V to 5.5 V, and are therefore very suitable for battery-powered devices, extending battery life.

These op-amps feature an excellent speed/power consumption ratio, offering an 880 kHz gain bandwidth while consuming only 60 µA at a 5 V supply voltage. They are unity gain stable for capacitive loads up to 100 pF.

The devices are internally adjusted to provide very narrow dispersion of AC and DC parameters. The TSV630 provides a shutdown function. Both devices are offered in micropackages and are guaranteed for industrial temperature ranges from -40° C to +125° C.

These features combined make the TSV630 and TSV631 ideal for sensor interfaces, battery-supplied and portable applications, as well as active filtering.

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1 Absolute maximum ratings and operating conditions

Table 1. 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_{in}	Input voltage(3)	V_{CC-} -0.2 to V_{CC+} +0.2	
I_{in}	Input current(4)	10	mA
$\overline{SHDN}$	Shutdown voltage(3)	6	V
T_{stg}	Storage temperature	-65 to +150	°C
R_{thja}	Thermal resistance junction to ambient(5)(6) SC70-6 SOT23-6 SC70-5 SOT23-5	 232 240 205 250	°C/W
T_j	Maximum junction temperature	150	°C
ESD	HBM: human body model(7)	4	kV
	MM: machine model(8)	300	V
	CDM: charged device model(9)	1.5	kV
	Latchup immunity	200	mA

1. All voltage values, except the differential voltage, is with respect to network ground terminal.
2. The differential voltage is the non-inverting input terminal with respect to the inverting input terminal.
3. V_{CC}-V_{in} must not exceed 6 V.
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. R_{th} 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 the ground.

Table 2. 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	
T_{oper}	Operating free air temperature range	-40 to +125	°C

2 Electrical characteristics

Table 3. 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	TSV630-TSV631 TSV630A-TSV631A			3 0.5	mV
		$T_{min} < T_{op} < T_{max}$ TSV630-TSV631 TSV630A-TSV631A			4.5 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	
I_{ib}	Input bias current ($V_{out} = V_{CC}/2$)			1	10[1]	
		$T_{min} < T_{op} < T_{max}$		1	100	
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			
A_{vd}	Large signal voltage gain	R_L= 10 kΩ, V_{out} = 0.5 V to 1.3 V	85	95		
		$T_{min} < T_{op} < T_{max}$	80			
V_{OH}	High level output voltage	R_L = 10 kΩ	35	5		mV
		$T_{min} < T_{op} < T_{max}$	50			
V_{OL}	Low level output voltage	R_L = 10 kΩ		4	35	
		$T_{min} < T_{op} < T_{max}$			50	
I_{out}	I_{sink}	V_o = 1.8 V	6	12		mA
		$T_{min} < T_{op} < T_{max}$	4			
	I_{source}	V_o = 0 V	6	10		
		$T_{min} < T_{op} < T_{max}$	4			
I_{CC}	Supply current $\overline{SHDN}$ = V_{CC+}	No load, V_{out} =$V_{CC}/2$	40	50	60	µA
		$T_{min} < T_{op} < T_{max}$			62	
AC performance						
GBP	Gain bandwidth product	R_L = 2 kΩ, C_L=100 pF, f= 100 kHz	700	790		kHz
ϕm	Phase margin	R_L = 2 kΩ, C_L = 100 pF		48		Degrees
G_m	Gain margin			11		dB
SR	Slew rate	R_L = 2 kΩ, C_L = 100 pF, Av = 1	0.2	0.27		V/µs
e_n	Equivalent input noise voltage	f = 1 kHz f = 10 kHz		67 53		$\frac{nV}{\sqrt{Hz}}$

1. Guaranteed by design.

Table 4. Shutdown characteristics $V_{CC} = 1.8$ V

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	
		$T_{min} < T_{op} < 125°$ C			1.5	µA
t_{on}	Amplifier turn-on time	$R_L = 2$ k, Vout = $V_{CC-} + 0.2$ to $V_{CC} - 0.2$		300		ns
t_{off}	Amplifier turn-off time	$R_L = 2$ k, Vout = $V_{CC-} + 0.2$ to $V_{CC+} - 0.2$		20		
V_{IH}	$\overline{SHDN}$ logic high		1.3			V
V_{IL}	$\overline{SHDN}$ logic low				0.5	
I_{IH}	$\overline{SHDN}$ current high	$\overline{SHDN} = V_{CC+}$		10		pA
I_{IL}	$\overline{SHDN}$ current low	$\overline{SHDN} = V_{CC-}$		10		
I_{OLeak}	Output leakage in shutdown mode	$\overline{SHDN} = V_{CC-}$		50		
		$T_{min} < T_{op} < 125°$ C		1		nA

Table 5. Electrical characteristics at 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	TSV630-TSV631 TSV630A-TSV631A			3 0.5	mV
		$T_{min} < T_{op} < T_{max}$ TSV630-TSV631 TSV630A-TSV631A			4.5 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	
I_{ib}	Input bias current			1	10(1)	
		$T_{min} < T_{op} < T_{max}$		1	100	
CMR	Common mode rejection ratio 20 log ($\Delta V_{ic}/\Delta V_{io}$)	0 V to 3.3 V, V_{out} = 1.75 V	57	79		dB
		$T_{min} < T_{op} < T_{max}$	53			
A_{vd}	Large signal voltage gain	R_L = 10 kΩ, V_{out} = 0.5 V to 2.8 V	88	98		
		$T_{min} < T_{op} < T_{max}$	83			
V_{OH}	High level output voltage	R_L = 10 kΩ	35	6		mV
		$T_{min.} < T_{op} < T_{max}$	50			
V_{OL}	Low level output voltage	R_L = 10 kΩ		7	35	
		$T_{min} < T_{op} < T_{max}$			50	
I_{out}	I_{sink}	V_o = 3.3 V	30	45		mA
		$T_{min} < T_{op} < T_{max}$	25	42		
	I_{source}	V_o = 0 V	30	38		
		$T_{min} < T_{op} < T_{max}$	25			
I_{CC}	Supply current $\overline{SHDN} = V_{CC+}$	No load, V_{out} = 1.75 V	43	55	64	µA
		$T_{min} < T_{op} < T_{max}$			66	
AC performance						
GBP	Gain bandwidth product	R_L = 2 kΩ, C_L = 100 pF, f = 100 kHz	710	860		kHz
φm	Phase margin	R_L = 2 kΩ, C_L = 100 pF		50		Degrees
G_m	Gain margin			11		dB
SR	Slew rate	R_L = 2 kΩ, C_L = 100 pF, Av = 1	0.22	0.29		V/µs
e_n	Equivalent input noise voltage	f = 1 kHz f = 10 kHz		64 51		$\frac{nV}{\sqrt{Hz}}$

1. Guaranteed by design.

Table 6. Electrical characteristics at V_{CC+} = +5 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	TSV630-TSV631 TSV630A-TSV631A			3 0.5	mV
		$T_{min} < T_{op} < T_{max}$ TSV630-TSV631 TSV630A-TSV631A			4.5 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	
I_{ib}	Input bias current ($V_{out} = V_{CC}/2$)			1	10[1]	
		$T_{min} < T_{op} < T_{max}$		1	100	
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			
SVR	Supply voltage rejection ratio 20 log ($\Delta V_{CC}/\Delta V_{io}$)	V_{CC} = 1.8 to 5 V	75	102		
		$T_{min} < T_{op} < T_{max}$				
A_{vd}	Large signal voltage gain	R_L= 10 kΩ, V_{out}= 0.5 V to 4.5 V	89	98		
		$T_{min} < T_{op} < T_{max}$	84			
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	
		$T_{min} < T_{op} < T_{max}$			50	
I_{out}	I_{sink}	V_o = 5 V	40	69		mA
		$T_{min} < T_{op} < T_{max}$	35	65		
	I_{source}	V_o = 0 V	40	74		
		$T_{min} < T_{op} < T_{max}$	36	68		
I_{CC}	Supply current $\overline{SHDN}$ = V_{CC+}	No load, $V_{out}=V_{CC}/2$	50	60	69	µA
		$T_{min} < T_{op} < T_{max}$			72	
AC performance						
GBP	Gain bandwidth product	R_L = 2 kΩ, C_L= 100 pF, f = 100 kHz	730	880		kHz
F_u	Unity gain frequency	R_L = 2 kΩ, C_L = 100 pF,		830		kHz
φm	Phase margin			50		Degrees
G_m	Gain margin			12		dB
SR	Slew rate	R_L = 2 kΩ, C_L = 100 pF, Av = 1	0.25	0.34		V/µs

Table 6. Electrical characteristics at V_{CC+} = +5 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) (continued)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
e_n	Equivalent input noise voltage	f = 1 kHz f = 10 kHz		60 47		$\frac{nV}{\sqrt{Hz}}$
THD+e_n	Total harmonic distortion	f = 1 kHz, A_V = 1, R_L = 100 kΩ, V_{icm} = $V_{CC}/2$, Vout = 2 V_{PP}		0.0017		%

1. Guaranteed by design.

Table 7. Shutdown characteristics V_{CC} = 5 V

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
DC performance						
I_{CC}	Supply current in shutdown mode (all operators)	$\overline{\text{SHDN}}$ = V_{CC-}		5	50	nA
		T_{min} < T_{op} < 85° C			200	
		T_{min} < T_{op} < 125° C			1.5	µA
t_{on}	Amplifier turn-on time	R_L = 2 k, Vout = V_{CC-} + 0.2 to V_{CC+} - 0.2		300		ns
t_{off}	Amplifier turn-off time	R_L = 2 k, Vout = V_{CC-} + 0.2 to V_{CC+} - 0.2		30		
V_{IH}	$\overline{\text{SHDN}}$ logic high		4.5			V
V_{IL}	$\overline{\text{SHDN}}$ logic low				0.5	
I_{IH}	$\overline{\text{SHDN}}$ current high	$\overline{\text{SHDN}}$ = V_{CC+}		10		pA
I_{IL}	$\overline{\text{SHDN}}$ current low	$\overline{\text{SHDN}}$ = V_{CC-}		10		
I_{OLeak}	Output leakage in shutdown mode	$\overline{\text{SHDN}}$ = V_{CC-}		50		
		T_{min} < T_{op} < 125° C		1		nA

Figure 1. Supply current vs. supply voltage at $V_{icm} = V_{CC}/2$

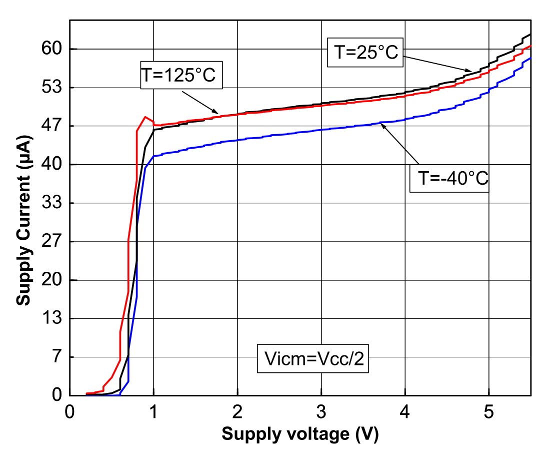


Figure 2. Output current vs. output voltage at V_{CC} = 1.5 V

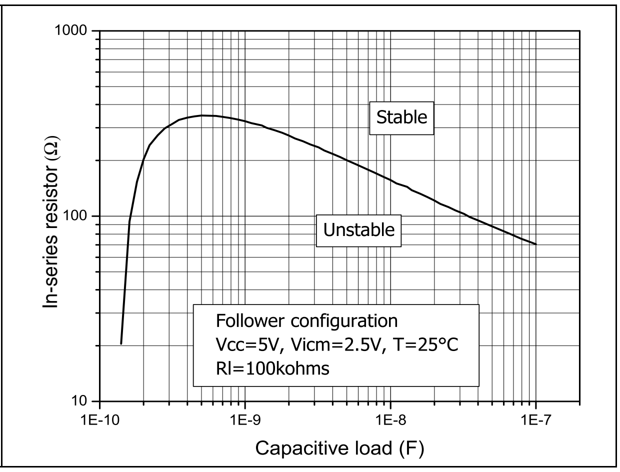


Figure 3. Output current vs. output voltage at V_{CC} = 5 V

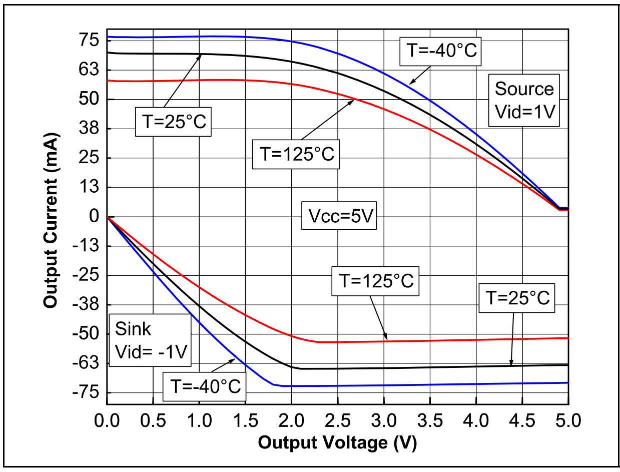


Figure 4. Voltage gain and phase vs. frequency at V_{CC} = 1.5 V

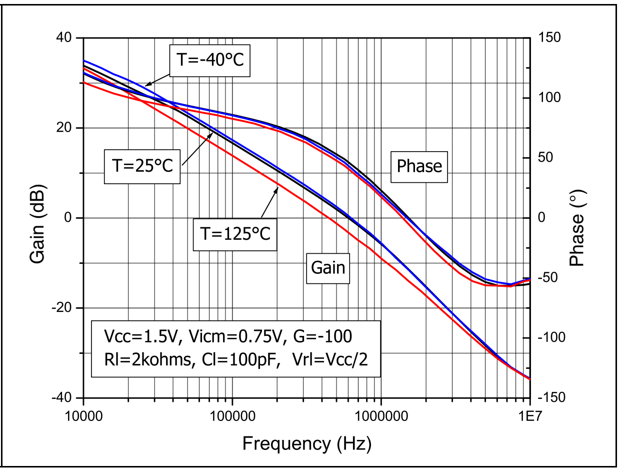


Figure 5. Voltage gain and phase vs. frequency at V_{CC} = 5 V

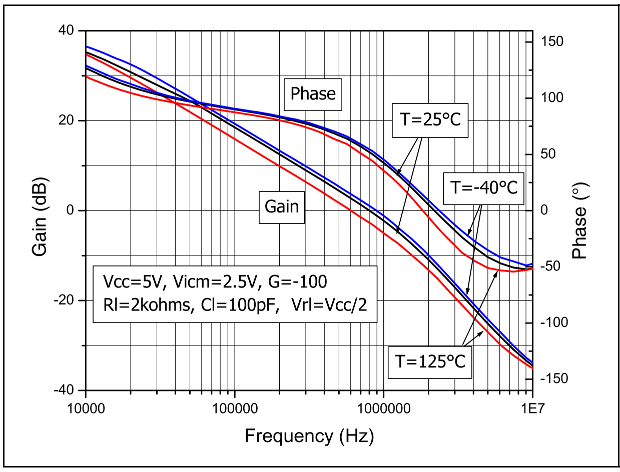


Figure 6. Phase margin vs. output current at V_{CC} = 5 V

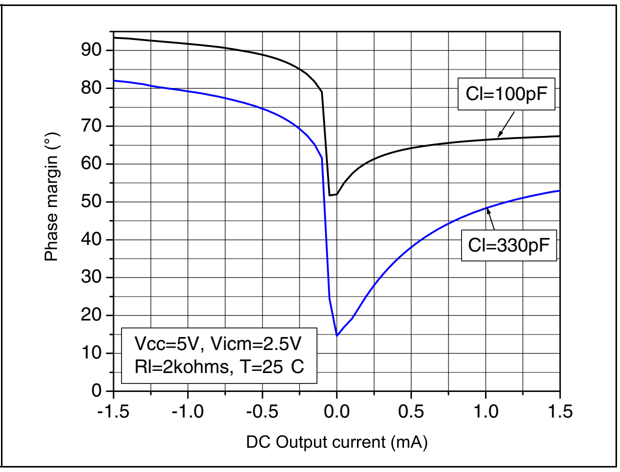


Figure 7. Positive slew rate vs. time

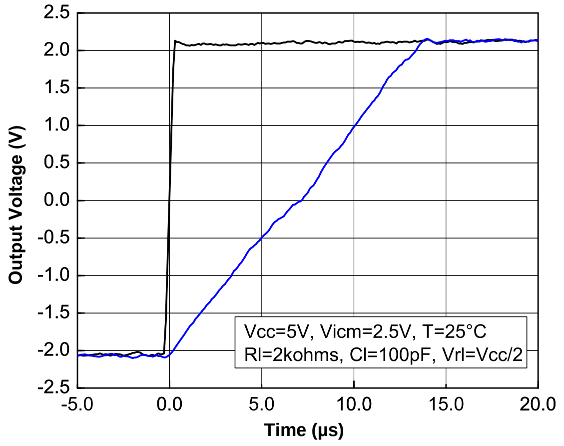


Figure 8. Negative slew rate vs. time

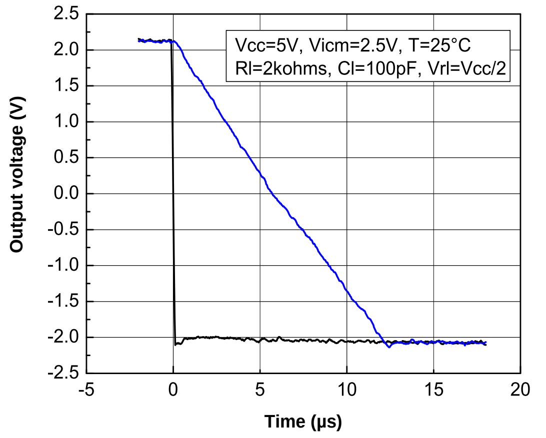


Figure 9. Positive slew rate vs. supply voltage

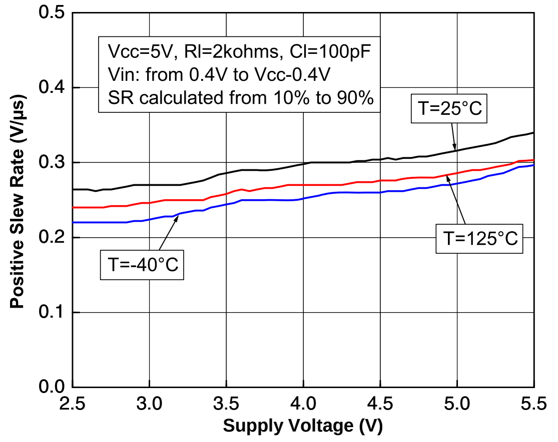


Figure 10. Negative slew rate vs. supply voltage

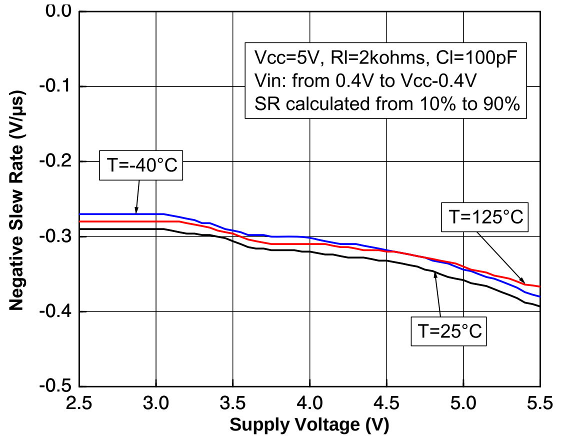


Figure 11. Distortion + noise vs. output voltage (R_L = 2 kΩ)

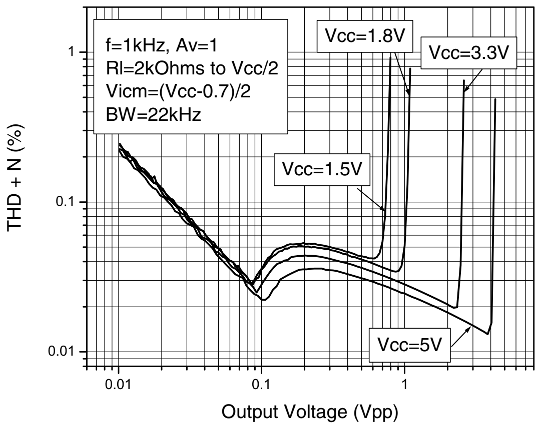


Figure 12. Distortion + noise vs. output voltage (R_L = 100 kΩ)

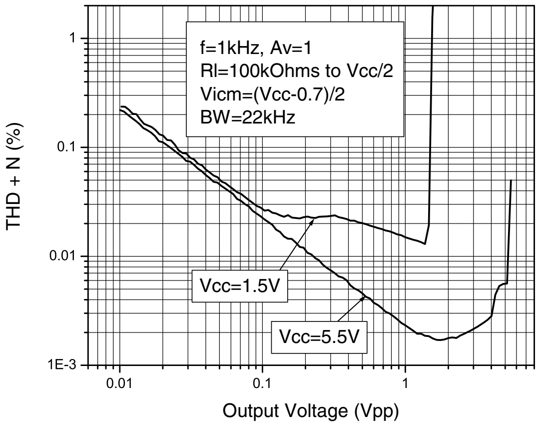


Figure 13. Distortion + noise vs. frequency and input voltage

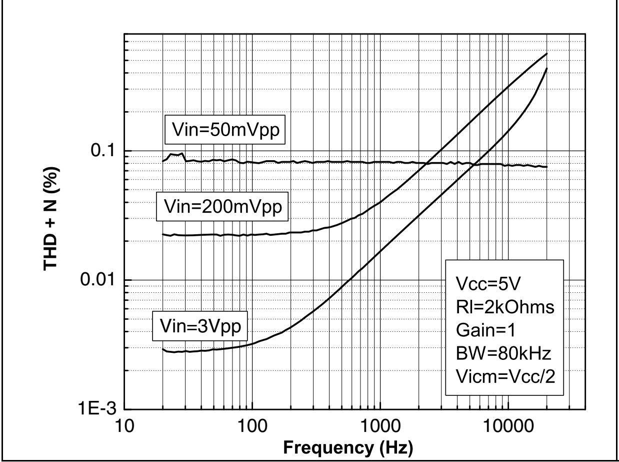


Figure 14. Distortion + noise vs. frequency and output load resistor

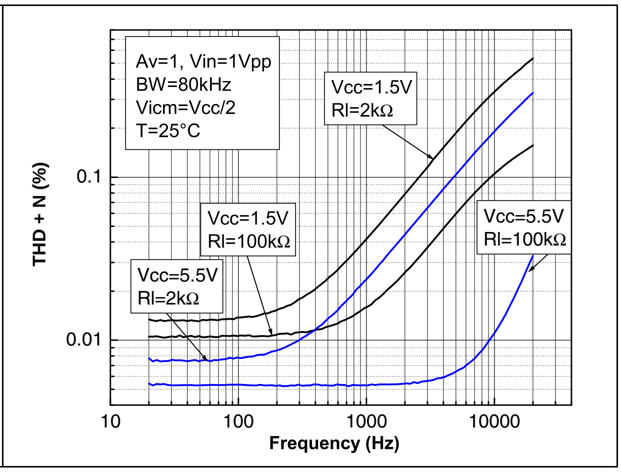
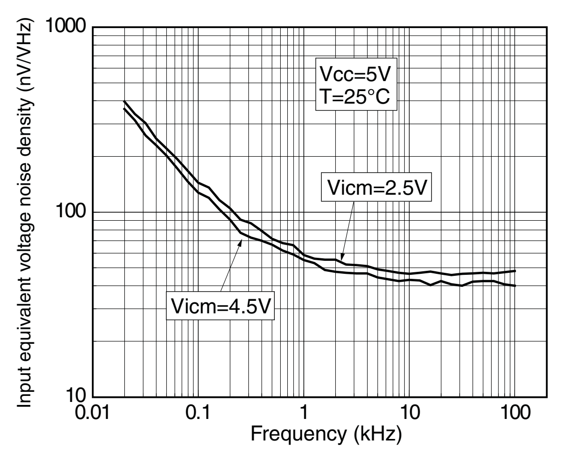


Figure 15. Noise vs. frequency



3 Application information

3.1 Operating voltages

The TSV630 and TSV631 can operate from 1.5 V to 5.5 V. Their parameters are fully specified for 1.8-V, 3.3-V, and 5-V power supplies. However, the parameters are very stable in the full V_{CC} range and several characterization curves show the TSV63x characteristics at 1.5 V. Additionally, the main specifications are guaranteed in extended temperature ranges from -40° C to +125° C.

3.2 Rail-to-rail input

The TSV630 and TSV631 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 CMRR, PSRR, V_{io} and THD is slightly degraded (as shown in *Figure 16* and *Figure 17* for V_{io} vs. V_{icm}).

Figure 16. Input offset voltage vs input common mode at V_{CC} = 1.5 V

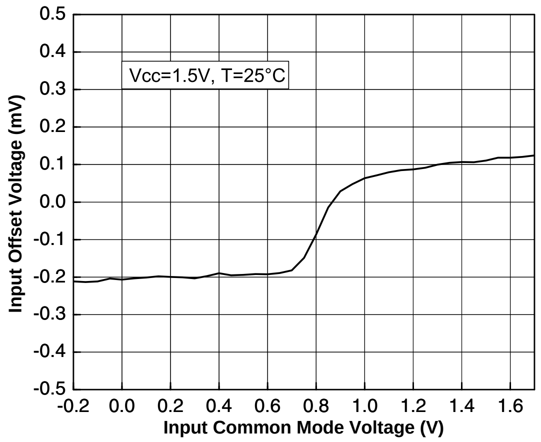
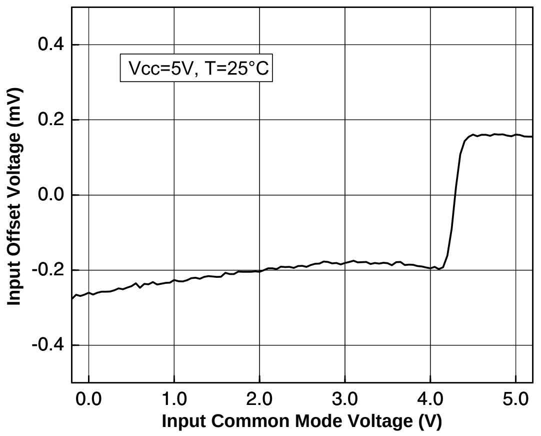


Figure 17. Input offset voltage vs input common mode at V_{CC} = 5 V



The device is guaranteed without phase reversal.

3.3 Rail-to-rail output

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

3.4 Shutdown function (TSV630)

The operational amplifier is enabled when the $\overline{\text{SHDN}}$ pin is pulled high. To disable the amplifier, the $\overline{\text{SHDN}}$ must be pulled down to V_{CC-}. When in shutdown mode, the amplifier output is in a high impedance state. The $\overline{\text{SHDN}}$ pin must never be left floating, but must be tied to V_{CC+} or V_{CC-}.

The turn-on and turn-off time are calculated for an output variation of ±200 mV (*Figure 18* and *Figure 19* show the test configurations).

Figure 20 and *Figure 21* show the amplifier output voltage behavior when the SHDN pin is toggled high and low.

Figure 18. Test configuration for turn-on time (Vout pulled down)

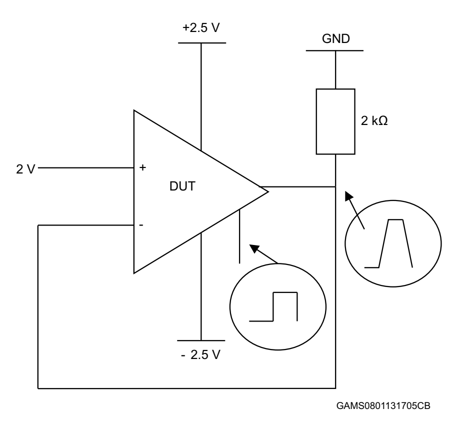


Figure 19. Test configuration for turn-off time (Vout pulled down)

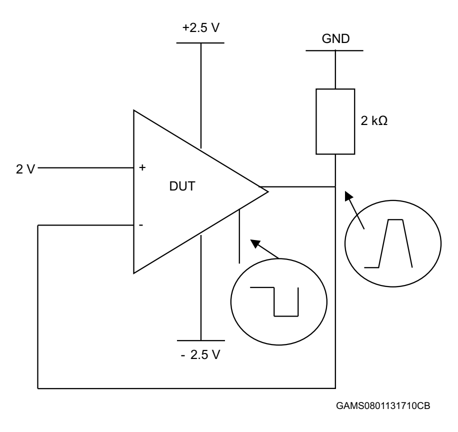


Figure 20. Turn-on time, V_{CC} = ±2.5 V, Vout pulled down, T = 25 ° C

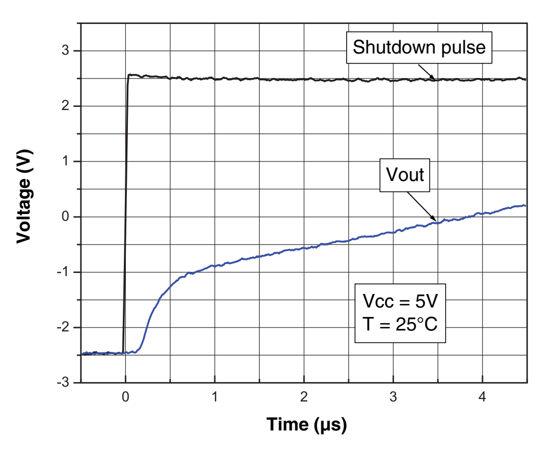
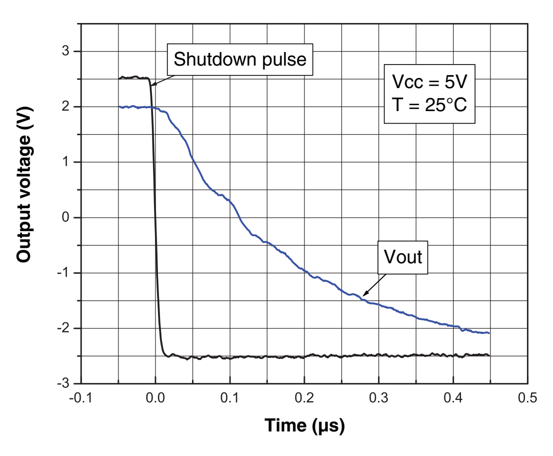


Figure 21. Turn-off time, V_{CC} = ±2.5 V, Vout pulled down, T = 25 ° C



3.5 Optimization of DC and AC parameters

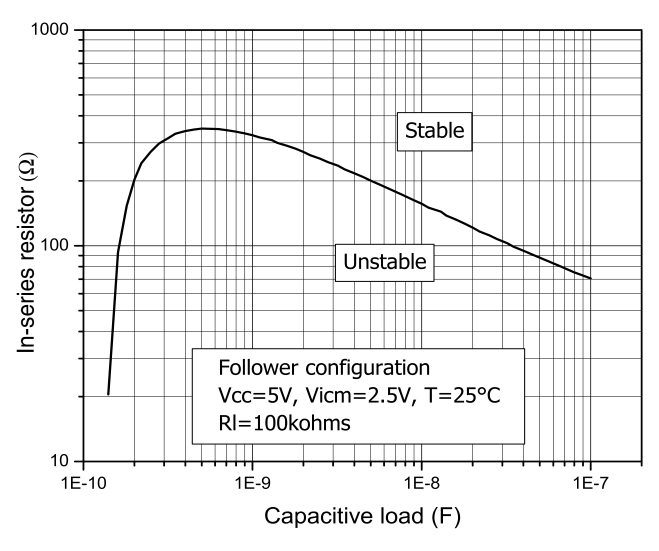
These devices use an innovative approach to reduce the spread of the main DC and AC parameters. An internal adjustment achieves a very narrow spread of the current consumption (60 µA typical, min/max at ±17 %). Parameters linked to the current consumption value, such as GBP, SR and AVd, benefit from this narrow dispersion. All parts present a similar speed and the same behavior in terms of stability. In addition, the minimum values of GBP and SR are guaranteed (GBP = 730 kHz minimum and SR = 0.25 V/µs minimum).

3.6 Driving resistive and capacitive loads

These products are micro-power, low-voltage operational amplifiers optimized to drive rather large resistive loads, above 2 kΩ. For lower resistive loads, the THD level may significantly increase.

In a *follower* configuration, these operational amplifiers can drive capacitive loads up to 100 pF with no oscillations. When driving larger capacitive loads, adding an in-series resistor at the output can improve the stability of the devices (see *Figure 22* for recommended in-series resistor values). Once the in-series resistor value has been selected, the stability of the circuit should be tested on the bench and simulated with the simulation model.

Figure 22. In-series resistor vs. capacitive load



3.7 PCB layouts

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

3.8 Macromodel

An accurate macromodel of the TSV630 and TSV631 is 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 TSV63x 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*.

4 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.

4.1 SC70-6 (or SOT323-6) package mechanical data

Figure 23. SC70-6 (or SOT323-6) package mechanical drawing

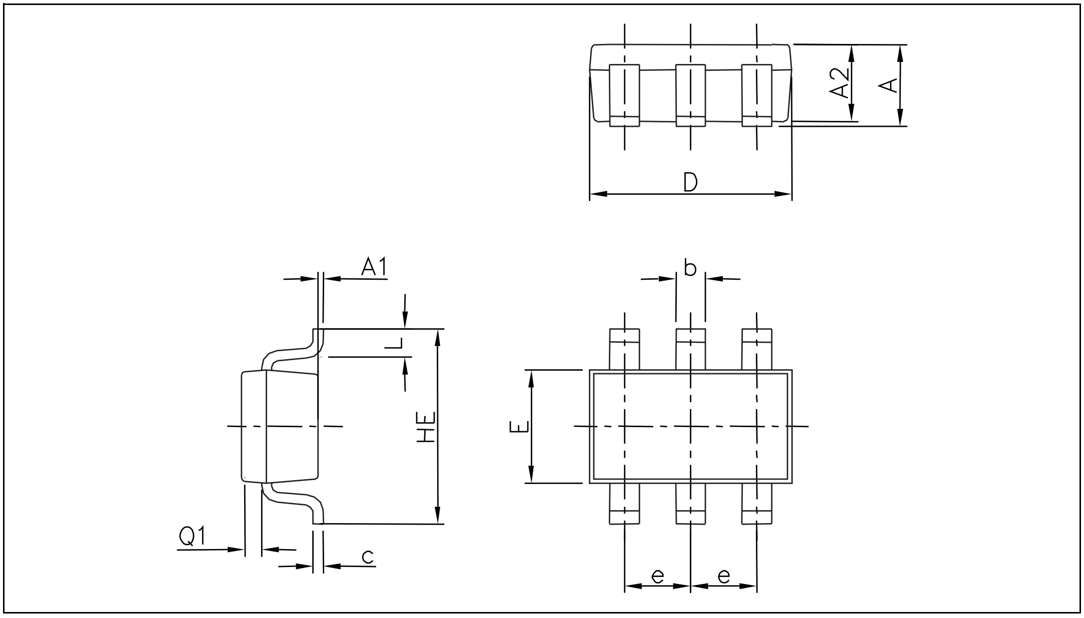
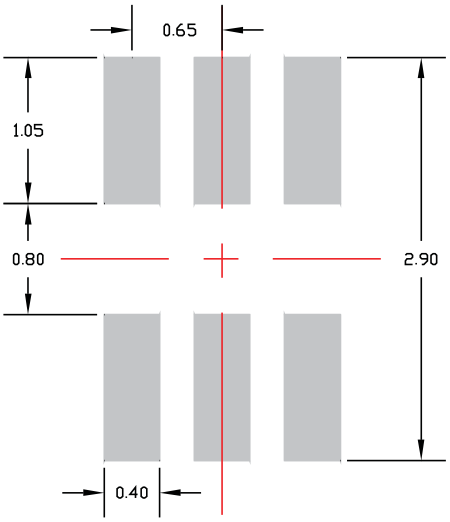


Table 8. SC70-6 (or SOT323-6) package mechanical data

Ref	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	0.80		1.10	0.031		0.043
A1			0.10			0.004
A2	0.80		1.00	0.031		0.039
b	0.15		0.30	0.006		0.012
c	0.10		0.18	0.004		0.007
D	1.80		2.20	0.071		0.086
E	1.15		1.35	0.045		0.053
e		0.65			0.026	
HE	1.80		2.40	0.071		0.094
L	0.10		0.40	0.004		0.016
Q1	0.10		0.40	0.004		0.016

Figure 24. SC70-6 (or SOT323-6) package footprint



4.2 SOT23-6 package mechanical data

Figure 25. SOT23-6 package mechanical drawing

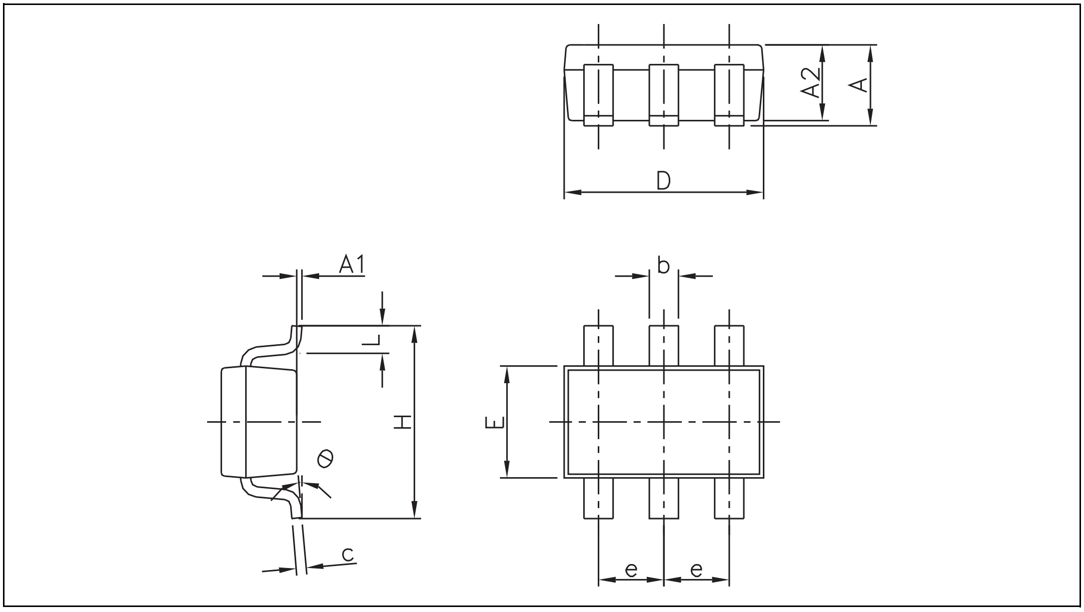


Table 9. SOT23-6 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	0.90		1.45	0.035		0.057
A1			0.10			0.004
A2	0.90		1.30	0.035		0.051
b	0.35		0.50	0.013		0.019
c	0.09		0.20	0.003		0.008
D	2.80		3.05	0.110		0.120
E	1.50		1.75	0.060		0.069
e		0.95			0.037	
H	2.60		3.00	0.102		0.118
L	0.10		0.60	0.004		0.024
θ	0 °		10 °	0 °		10 °

4.3 SC70-5 (or SOT323-5) package mechanical data

Figure 26. SC70-5 (or SOT323-5) package mechanical drawing

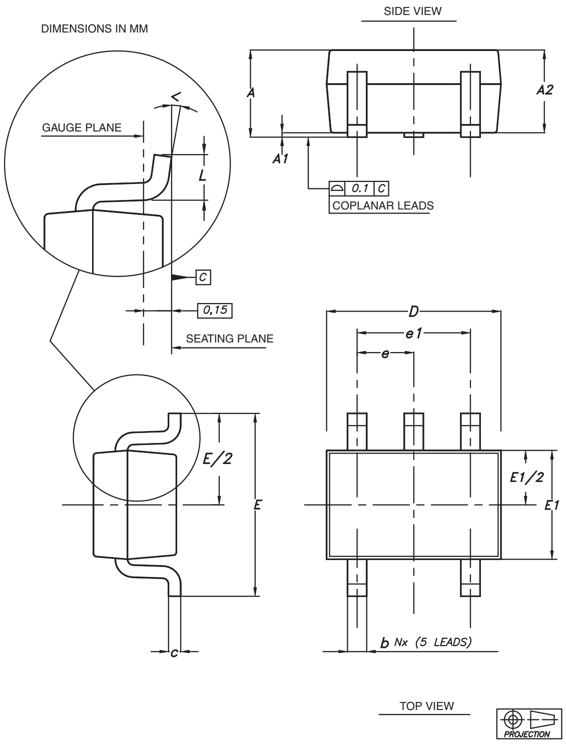


Figure 27. SC70-5 (or SOT323-5) package mechanical data

Ref	Dimensions					
	Millimeters			Inches		
	Min	Typ	Max	Min	Typ	Max
A	0.80		1.10	0.315		0.043
A1			0.10			0.004
A2	0.80	0.90	1.00	0.315	0.035	0.039
b	0.15		0.30	0.006		0.012
c	0.10		0.22	0.004		0.009
D	1.80	2.00	2.20	0.071	0.079	0.087
E	1.80	2.10	2.40	0.071	0.083	0.094
E1	1.15	1.25	1.35	0.045	0.049	0.053
e		0.65			0.025	
e1		1.30			0.051	
L	0.26	0.36	0.46	0.010	0.014	0.018
<	0°		8°			

4.4 SOT23-5 package mechanical data

Figure 28. SOT23-5 package mechanical drawing

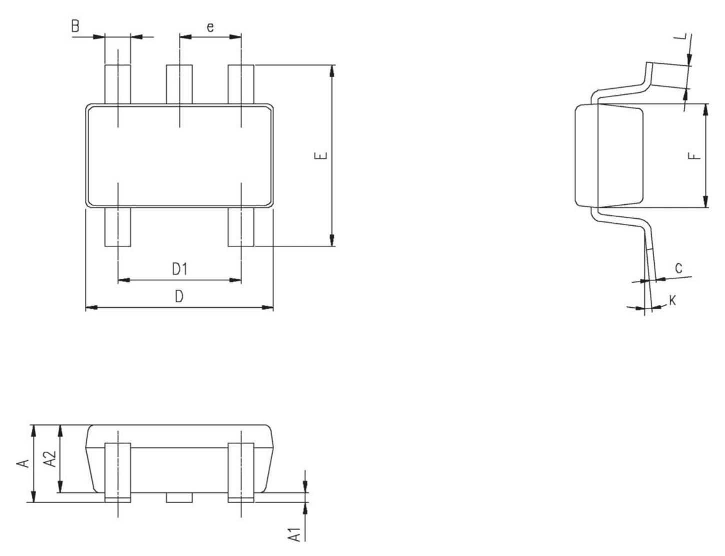


Table 10. SOT23-5 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	0.90	1.20	1.45	0.035	0.047	0.057
A1			0.15			0.006
A2	0.90	1.05	1.30	0.035	0.041	0.051
B	0.35	0.40	0.50	0.013	0.015	0.019
C	0.09	0.15	0.20	0.003	0.006	0.008
D	2.80	2.90	3.00	0.110	0.114	0.118
D1		1.90			0.075	
e		0.95			0.037	
E	2.60	2.80	3.00	0.102	0.110	0.118
F	1.50	1.60	1.75	0.059	0.063	0.069
L	0.10	0.35	0.60	0.004	0.013	0.023
K	0 °		10 °	0 °		10 °

5 Ordering information

Table 11. Order codes

Order code	Temperature range	Package	Packing	Marking
TSV630ILT	-40°C to +125°C	SOT23-6	Tape and reel	K108
TSV630ICT		SC70-6		K18
TSV631ILT		SOT23-5		K109
TSV631ICT		SC70-5		K19
TSV631IYLT(1)		SOT23-5		K10C
TSV630AILT		SOT23-6		K141
TSV630AICT		SC70-6		K41
TSV631AILT		SOT23-5		K142
TSV631AICT		SC70-5		K42

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

6 Revision history

Table 12. Document revision history

Date	Revision	Changes
19-Dec-2008	1	Initial release.
17-Aug-2009	2	Added root part numbers TSV630A and TSV631A on cover page.
13-Aug-2012	3	– Corrected the “Equivalent input noise voltage” values in *Table 3*, *5* and *6*. – Updated *Figure 15: Noise vs. frequency*.
22-Mar-2013	4	*Features*: added “automotive qualification” Added *Related products* *Description*: updated Updated titles of *Figure 13* and *Figure 14*. Updated *Section 3.4: Shutdown function (TSV630)*. Updated *Table 11: Order codes*.

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