



## TSV630 - TSV631

### Rail-to-rail input/output 60 $\mu$ A 880 kHz CMOS operational amplifier

#### Features

- Low offset voltage: 500  $\mu$ V max (A version)
- Low power consumption: 60  $\mu$ A 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

#### Applications

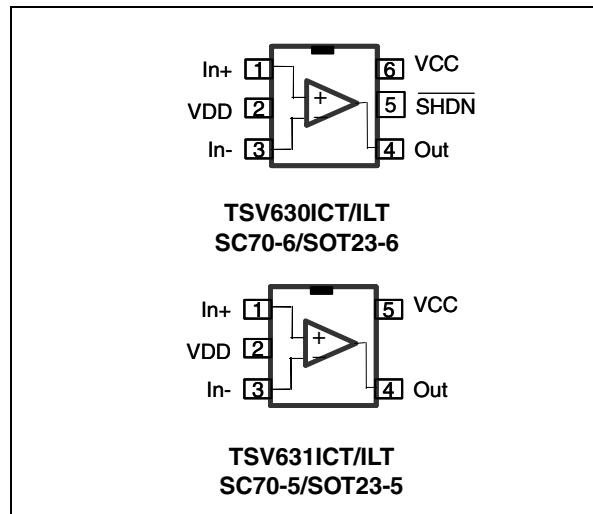
- Battery-powered applications
- Portable devices
- Signal conditioning
- Active filtering
- Medical instrumentation

#### Description

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

With a very low input bias current and low offset voltage (500  $\mu$ V maximum for the A version), the TSV630 and TSV631 are ideal for applications that require precision. The devices can operate at power supplies ranging from 1.5 to 5.5 V, and are therefore ideal for battery-powered devices, extending battery life.

These products feature an excellent speed/power consumption ratio, offering a 880 kHz gain bandwidth while consuming only 60  $\mu$ A at a 5-V supply voltage. These op-amps 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, especially power consumption, product gain bandwidth and slew rate.

The TSV630 provides a shutdown function.

Both the TSV630 and TSV631 have a high tolerance to ESD, sustaining 4 kV for the human body model.

Additionally, they are offered in micropackages, SC70-6 and SOT23-6 for the TSV630 and SC70-5 and SOT23-5 for the TSV631. They are guaranteed for industrial temperature ranges from -40° C to +125° C.

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

# 1 Absolute maximum ratings and operating conditions

**Table 1. Absolute maximum ratings (AMR)**

Symbol	Parameter	Value	Unit
$V_{CC}$	Supply voltage <sup>(1)</sup>	6	V
$V_{id}$	Differential input voltage <sup>(2)</sup>	$\pm V_{CC}$	V
$V_{in}$	Input voltage <sup>(3)</sup>	$V_{DD}-0.2$ to $V_{CC}+0.2$	V
$I_{in}$	Input current <sup>(4)</sup>	10	mA
$\overline{SHDN}$	Shutdown voltage <sup>(3)</sup>	6	V
$T_{stg}$	Storage temperature	-65 to +150	°C
$R_{thja}$	Thermal resistance junction to ambient <sup>(5)(6)</sup> SC70-5 SOT23-5 SOT23-6 SC70-6	205 250 240 232	°C/W
$T_j$	Maximum junction temperature	150	°C
ESD	HBM: human body model <sup>(7)</sup>	4	kV
	MM: machine model <sup>(8)</sup>	300	V
	CDM: charged device model <sup>(9)</sup>	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.
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 k $\Omega$  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  $\Omega$ ), 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	$V_{DD}-0.1$ to $V_{CC}+0.1$	V
$T_{oper}$	Operating free air temperature range	-40 to +125	°C

## 2 Electrical characteristics

**Table 3. Electrical characteristics at  $V_{CC} = +1.8\text{ V}$  with  $V_{DD} = 0\text{ V}$ ,  $V_{icm} = V_{CC}/2$ ,  $T_{amb} = 25^\circ\text{ C}$  and  $R_L$  connected to  $V_{CC}/2$  (unless otherwise specified)**

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
DC performance						
V <sub>io</sub>	Offset voltage	TSV630-TSV631 TSV630A-TSV631A			3 0.5	mV
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub> TSV630-TSV631 TSV630A-TSV631A			4.5 2	
DV <sub>io</sub>	Input offset voltage drift			2		μV/°C
I <sub>io</sub>	Input offset current (V <sub>out</sub> = V <sub>CC</sub> /2)			1	10 <sup>(1)</sup>	pA
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>		1	100	
I <sub>ib</sub>	Input bias current (V <sub>out</sub> = V <sub>CC</sub> /2)			1	10 <sup>(1)</sup>	pA
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>		1	100	
CMR	Common mode rejection ratio 20 log (ΔV <sub>ic</sub> /ΔV <sub>io</sub> )	0 V to 1.8 V, V <sub>out</sub> = 0.9 V	53	74		dB
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>	51			
A <sub>vd</sub>	Large signal voltage gain	R <sub>L</sub> = 10 kΩ, V <sub>out</sub> = 0.5 V to 1.3 V	85	95		dB
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>	80			
V <sub>OH</sub>	High level output voltage	R <sub>L</sub> = 10 kΩ	35	5		mV
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>	50			
V <sub>OL</sub>	Low level output voltage	R <sub>L</sub> = 10 kΩ		4	35	mV
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>			50	
I <sub>out</sub>	I <sub>sink</sub>	V <sub>o</sub> = 1.8 V	6	12		mA
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>	4			
	I <sub>source</sub>	V <sub>o</sub> = 0 V	6	10		mA
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>	4			
I <sub>CC</sub>	Supply current SHDN = V <sub>CC</sub>	No load, V <sub>out</sub> = V <sub>CC</sub> /2	40	50	60	μA
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>			62	
AC performance						
GBP	Gain bandwidth product	R <sub>L</sub> = 2 kΩ, C <sub>L</sub> = 100 pF, f = 100 kHz	700	790		kHz
φ <sub>m</sub>	Phase margin	R <sub>L</sub> = 2 kΩ, C <sub>L</sub> = 100 pF		48		Degrees
G <sub>m</sub>	Gain margin	R <sub>L</sub> = 2 kΩ, C <sub>L</sub> = 100 pF		11		dB
SR	Slew rate	R <sub>L</sub> = 2 kΩ, C <sub>L</sub> = 100 pF, A <sub>v</sub> = 1	0.2	0.27		V/μs
e <sub>n</sub>	Equivalent input noise voltage	f = 1 kHz		65		$\frac{nV}{\sqrt{Hz}}$
		f = 10 kHz		35		

1. Guaranteed by design.

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

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
<b>DC performance</b>						
$I_{CC}$	Supply current in shutdown mode (all operators)	$\overline{\text{SHDN}} < V_{IL}$		2.5	50	nA
		$T_{min} < T_{op} < 85^\circ\text{ C}$			200	nA
		$T_{min} < T_{op} < 125^\circ\text{ C}$			1.5	$\mu\text{A}$
$t_{on}$	Amplifier turn-on time	$R_L = 2\text{ k}$ , $V_{out} = V_{DD} + 0.2$ to $V_{CC} - 0.2$		300		ns
$t_{off}$	Amplifier turn-off time	$R_L = 2\text{ k}$ , $V_{out} = V_{DD} + 0.2$ to $V_{CC} - 0.2$		20		ns
$V_{IH}$	$\overline{\text{SHDN}}$ logic high		1.3			V
$V_{IL}$	$\overline{\text{SHDN}}$ logic low				0.5	V
$I_{IH}$	$\overline{\text{SHDN}}$ current high	$\overline{\text{SHDN}} = V_{CC}$		10		pA
$I_{IL}$	$\overline{\text{SHDN}}$ current low	$\overline{\text{SHDN}} = V_{DD}$		10		pA
$I_{OLeak}$	Output leakage in shutdown mode	$\overline{\text{SHDN}} = V_{DD}$		50		pA
		$T_{min} < T_{op} < 125^\circ\text{ C}$		1		nA

**Table 5.**  $V_{CC} = +3.3\text{ V}$ ,  $V_{DD} = 0\text{ V}$ ,  $V_{icm} = V_{CC}/2$ ,  $T_{amb} = 25^\circ\text{ C}$ ,  $R_L$  connected to  $V_{CC}/2$  (unless otherwise specified)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
DC performance						
V <sub>io</sub>	Offset voltage	TSV630-TSV631 TSV630A-TSV631A			3 0.5	mV
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub> TSV630-TSV631 TSV630A-TSV631A			4.5 2	
DV <sub>io</sub>	Input offset voltage drift			2		μV/°C
I <sub>io</sub>	Input offset current			1	10 <sup>(1)</sup>	pA
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>		1	100	
I <sub>ib</sub>	Input bias current			1	10 <sup>(1)</sup>	pA
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>		1	100	
CMR	Common mode rejection ratio 20 log (ΔV <sub>ic</sub> /ΔV <sub>io</sub> )	0 V to 3.3 V, V <sub>out</sub> = 1.75 V	57	79		dB
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>	53			
A <sub>vd</sub>	Large signal voltage gain	R <sub>L</sub> = 10 kΩ, V <sub>out</sub> = 0.5 V to 2.8 V	88	98		dB
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>	83			
V <sub>OH</sub>	High level output voltage	R <sub>L</sub> = 10 kΩ	35	6		mV
		T <sub>min.</sub> < T <sub>op</sub> < T <sub>max</sub>	50			
V <sub>OL</sub>	Low level output voltage	R <sub>L</sub> = 10 kΩ		7	35	mV
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>			50	
I <sub>out</sub>	I <sub>sink</sub>	V <sub>o</sub> = 3.3 V	30	45		mA
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>	25	42		
	I <sub>source</sub>	V <sub>o</sub> = 0 V	30	38		mA
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>	25			
I <sub>CC</sub>	Supply current SHDN = V <sub>CC</sub>	No load, V <sub>out</sub> = 1.75 V	43	55	64	μA
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>			66	μA
AC performance						
GBP	Gain bandwidth product	R <sub>L</sub> = 2 kΩ, C <sub>L</sub> = 100 pF, f = 100 kHz	710	860		kHz
φ <sub>m</sub>	Phase margin	R <sub>L</sub> = 2 kΩ, C <sub>L</sub> = 100 pF		50		Degrees
G <sub>m</sub>	Gain margin	R <sub>L</sub> = 2 kΩ, C <sub>L</sub> = 100 pF		11		dB
SR	Slew rate	R <sub>L</sub> = 2 kΩ, C <sub>L</sub> = 100 pF, Av = 1	0.22	0.29		V/μs
e <sub>n</sub>	Equivalent input noise voltage	f = 1 kHz		65		$\frac{nV}{\sqrt{Hz}}$

1. Guaranteed by design.

**Table 6. Electrical characteristics at  $V_{CC} = +5\text{ V}$  with  $V_{DD} = 0\text{ V}$ ,  $V_{icm} = V_{CC}/2$ ,  $T_{amb} = 25^\circ\text{ C}$  and  $R_L$  connected to  $V_{CC}/2$  (unless otherwise specified)**

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
DC performance						
V <sub>io</sub>	Offset voltage	TSV630-TSV631 TSV630A-TSV631A			3 0.5	mV
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub> TSV630-TSV631 TSV630A-TSV631A			4.5 2	mV
DV <sub>io</sub>	Input offset voltage drift			2		μV/°C
I <sub>io</sub>	Input offset current (V <sub>out</sub> = V <sub>CC</sub> /2)			1	10 <sup>(1)</sup>	pA
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>		1	100	
I <sub>ib</sub>	Input bias current (V <sub>out</sub> = V <sub>CC</sub> /2)			1	10 <sup>(1)</sup>	pA
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>		1	100	
CMR	Common mode rejection ratio 20 log (ΔV <sub>ic</sub> /ΔV <sub>io</sub> )	0 V to 5 V, V <sub>out</sub> = 2.5 V	60	80		dB
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>	55			
SVR	Supply voltage rejection ratio 20 log (ΔV <sub>CC</sub> /ΔV <sub>io</sub> )	V <sub>CC</sub> = 1.8 to 5 V	75	102		dB
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>				
A <sub>vd</sub>	Large signal voltage gain	R <sub>L</sub> = 10 kΩ, V <sub>out</sub> = 0.5 V to 4.5 V	89	98		dB
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>	84			
V <sub>OH</sub>	High level output voltage	R <sub>L</sub> = 10 kΩ	35	7		mV
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>	50			
V <sub>OL</sub>	Low level output voltage	R <sub>L</sub> = 10 kΩ		6	35	mV
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>			50	
I <sub>out</sub>	I <sub>sink</sub>	V <sub>O</sub> = 5 V	40	69		mA
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>	35	65		
	I <sub>source</sub>	V <sub>O</sub> = 0 V	40	74		mA
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>	36	68		
I <sub>CC</sub>	Supply current SHDN = V <sub>CC</sub>	No load, V <sub>out</sub> = V <sub>CC</sub> /2	50	60	69	μA
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>			72	
AC performance						
GBP	Gain bandwidth product	R <sub>L</sub> = 2 kΩ, C <sub>L</sub> = 100 pF, f = 100 kHz	730	880		kHz
F <sub>u</sub>	Unity gain frequency	R <sub>L</sub> = 2 kΩ, C <sub>L</sub> = 100 pF,		830		kHz
φ <sub>m</sub>	Phase margin	R <sub>L</sub> = 2 kΩ, C <sub>L</sub> = 100 pF		50		Degrees
G <sub>m</sub>	Gain margin	R <sub>L</sub> = 2 kΩ, C <sub>L</sub> = 100 pF		12		dB
SR	Slew rate	R <sub>L</sub> = 2 kΩ, C <sub>L</sub> = 100 pF, A <sub>v</sub> = 1	0.25	0.34		V/μs

**Table 6. Electrical characteristics at  $V_{CC} = +5\text{ V}$  with  $V_{DD} = 0\text{ V}$ ,  $V_{icm} = V_{CC}/2$ ,  $T_{amb} = 25^\circ\text{ C}$  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	$f = 1\text{ kHz}$ $f = 10\text{ kHz}$		65 35		$\frac{\text{nV}}{\sqrt{\text{Hz}}}$
THD+ $e_n$	Total harmonic distortion	$f = 1\text{ kHz}$ , $A_V = 1$ , $R_L = 100\text{ k}\Omega$ $V_{icm} = V_{CC}/2$ , $V_{out} = 2\text{ V}_{PP}$		0.0017		%

1. Guaranteed by design.

**Table 7. Shutdown characteristics  $V_{CC} = 5\text{ V}$** 

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

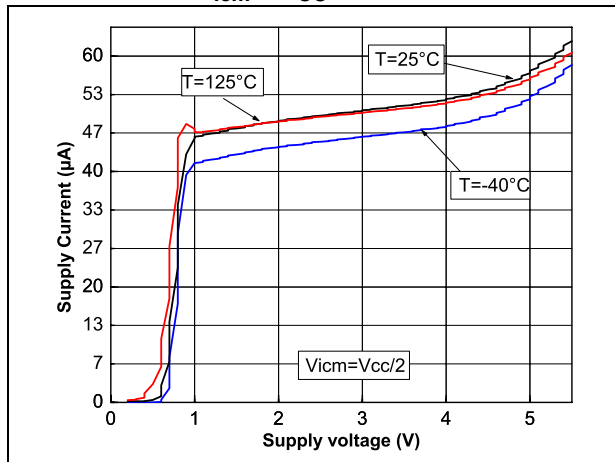
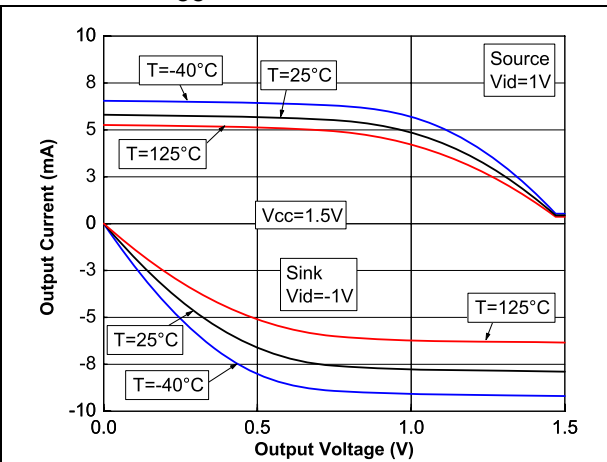
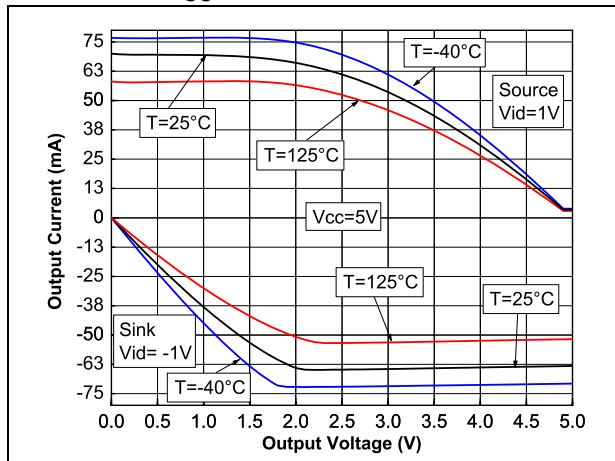
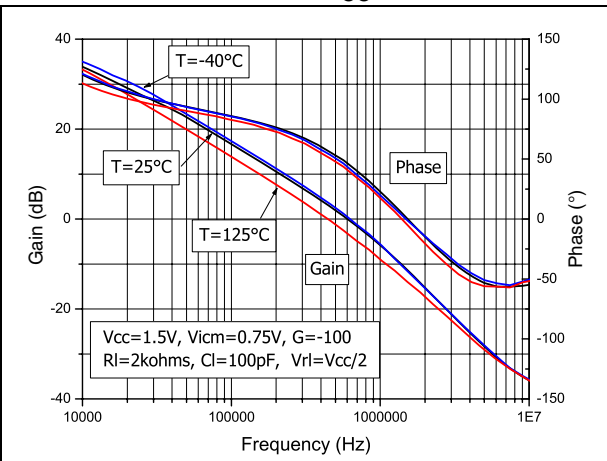
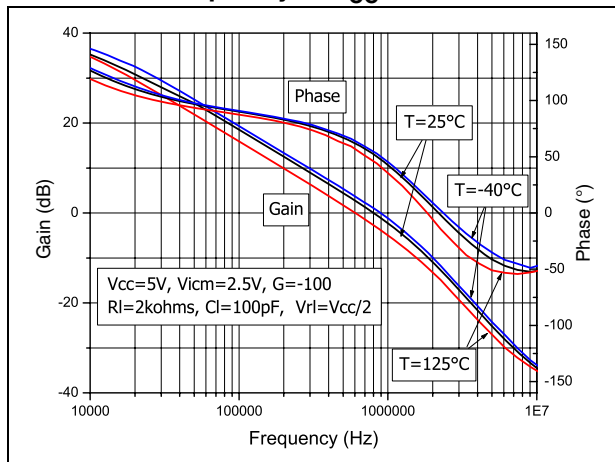
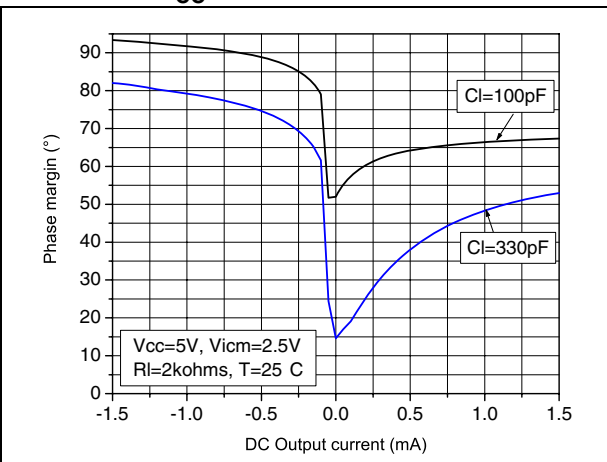
**Figure 1. Supply current vs. supply voltage at  $V_{icm} = V_{CC}/2$** **Figure 2. Output current vs. output voltage at  $V_{CC} = 1.5V$** **Figure 3. Output current vs. output voltage at  $V_{CC} = 5V$** **Figure 4. Voltage gain and phase vs. frequency at  $V_{CC} = 1.5V$** **Figure 5. Voltage gain and phase vs. frequency at  $V_{CC} = 5V$** **Figure 6. Phase margin vs. output current at  $V_{CC} = 5V$** 



Figure 7. Positive slew rate vs. time

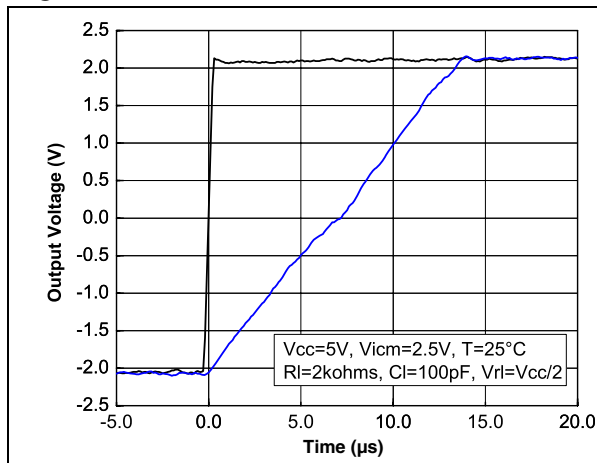


Figure 8. Negative slew rate vs. time

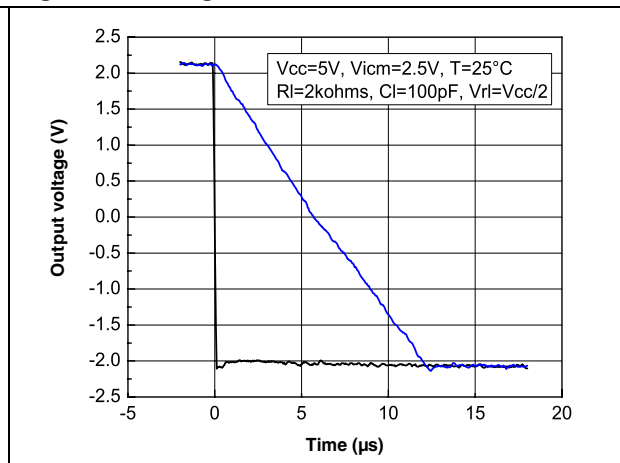


Figure 9. Positive slew rate vs. supply voltage

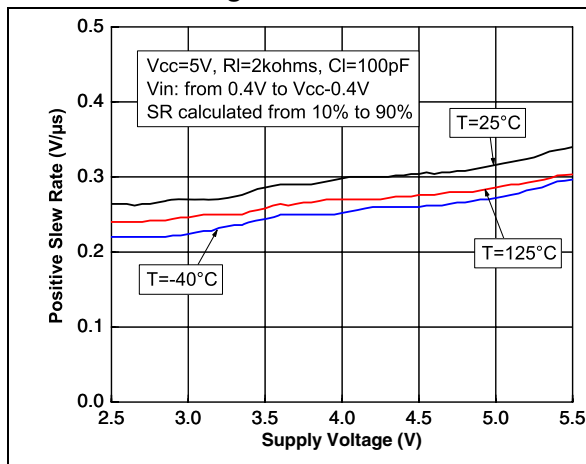


Figure 10. Negative slew rate vs. supply voltage

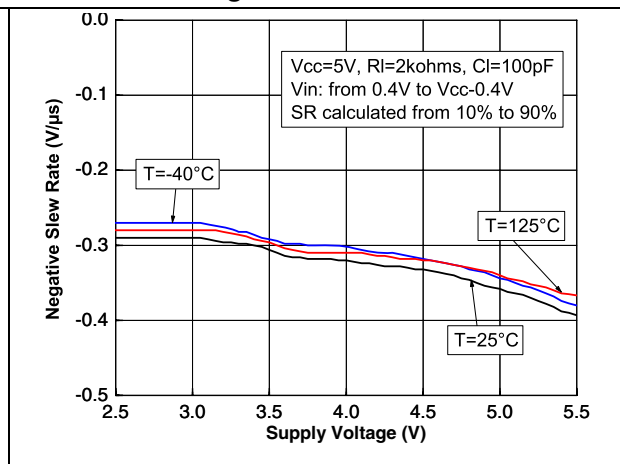
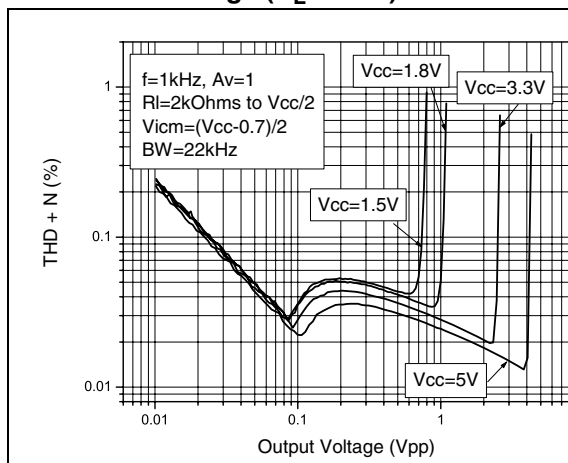
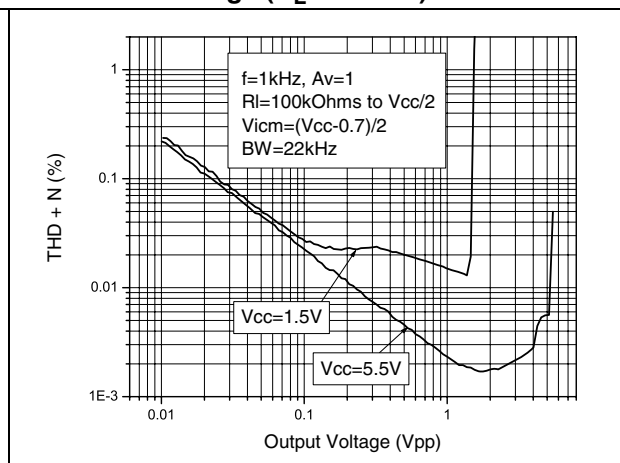
Figure 11. Distortion + noise vs. output voltage ( $R_L = 2\text{ k}\Omega$ )Figure 12. Distortion + noise vs. output voltage ( $R_L = 100\text{ k}\Omega$ )

Figure 13. Distortion + noise vs. frequency

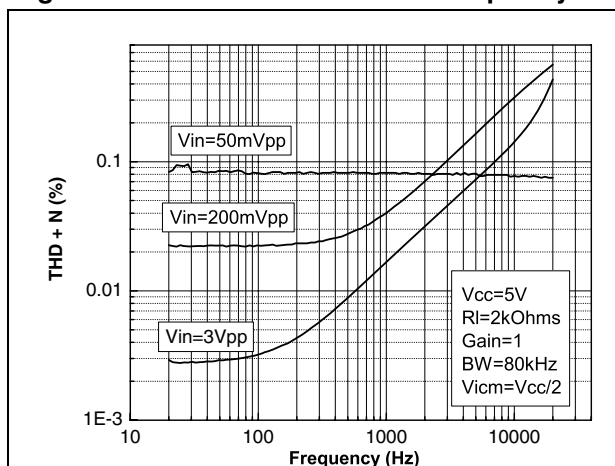


Figure 14. Distortion + noise vs. frequency

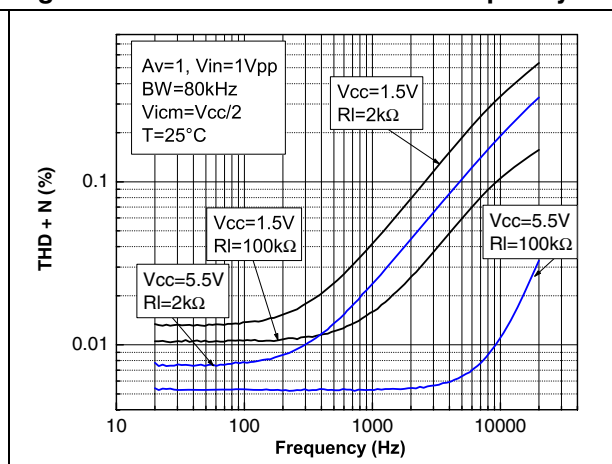
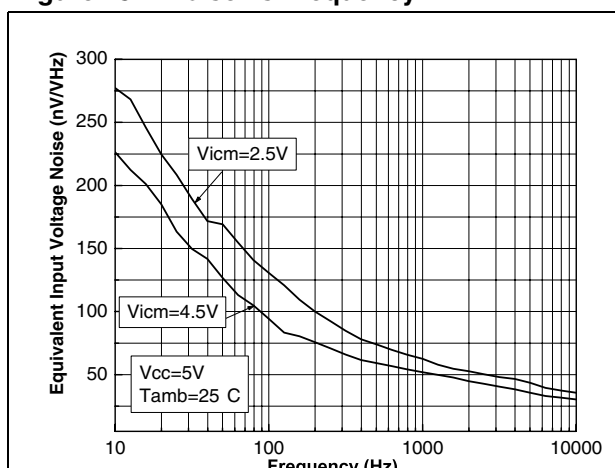


Figure 15. Noise vs. frequency



## 3 Application information

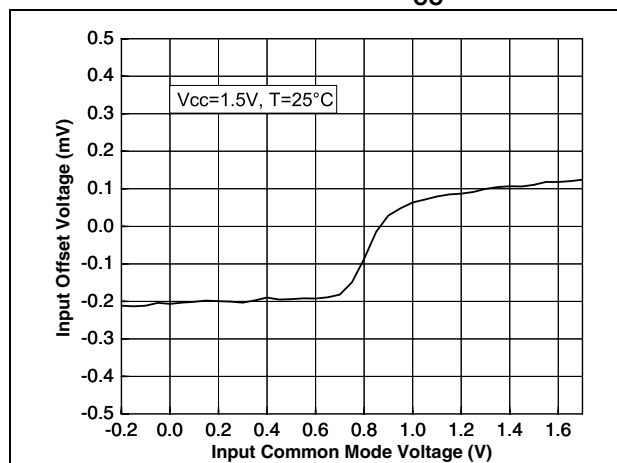
### 3.1 Operating voltages

The TSV630 and TSV631 can operate from 1.5 to 5.5 V. Their 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 TSV63x characteristics at 1.5 V. Additionally, the main specifications are guaranteed in extended temperature ranges from  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ .

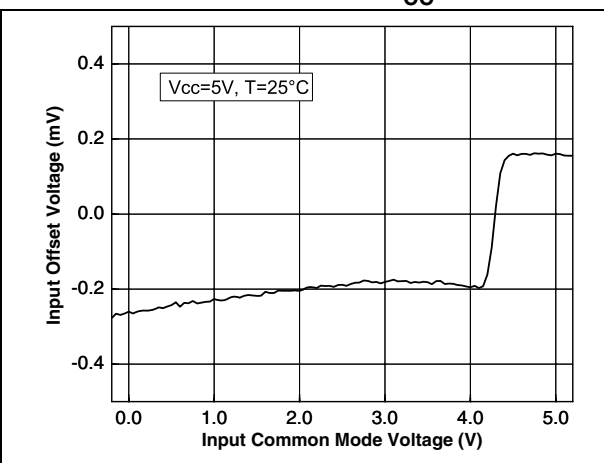
### 3.2 Rail-to-rail input

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  $V_{DD} - 0.1\text{ V}$  to  $V_{CC} + 0.1\text{ V}$ . The transition between the two pairs appears at  $V_{CC} - 0.7\text{ V}$ . 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  $V_{CC} = 1.5\text{ V}$**



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



The device is guaranteed without phase reversal.

### 3.3 Rail-to-rail output

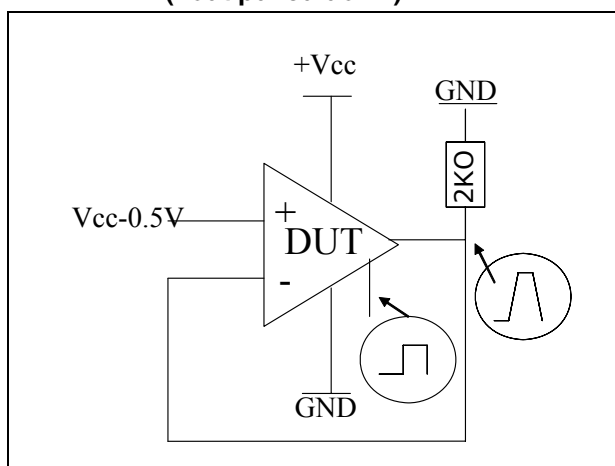
The operational amplifiers' output levels can go close to the rails: 35 mV maximum above and below the rail when connected to a  $10\text{ k}\Omega$  resistive load to  $V_{CC}/2$ .

### 3.4 Shutdown function (TSV630)

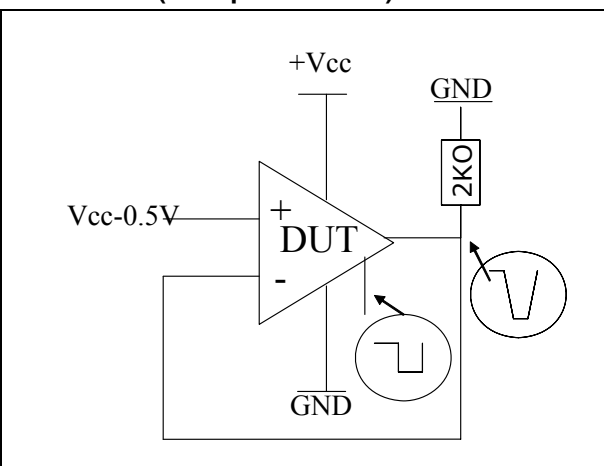
The operational amplifier is enabled when the  $\overline{\text{SHDN}}$  pin is pulled high. To disable the amplifier, the  $\overline{\text{SHDN}}$  must be pulled down to  $V_{DD}$ . When in shutdown mode, the amplifier output is in a high impedance state. The  $\overline{\text{SHDN}}$  pin must never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

The turn-on and turn-off time are calculated for an output variation of  $\pm 200$  mV ([Figure 18](#) and [Figure 19](#) show the test configurations).

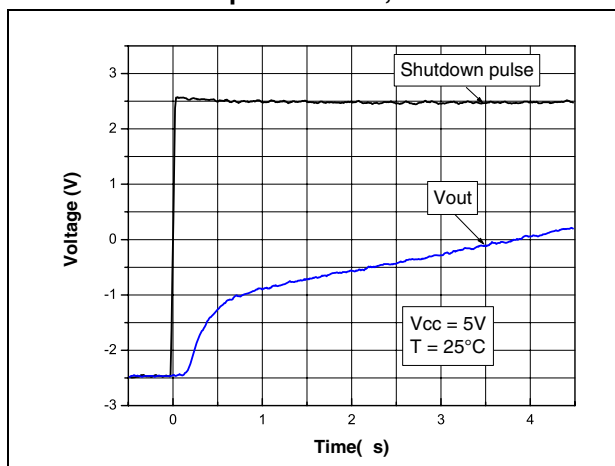
**Figure 18. Test configuration for turn-on time**  
( $V_{out}$  pulled down)



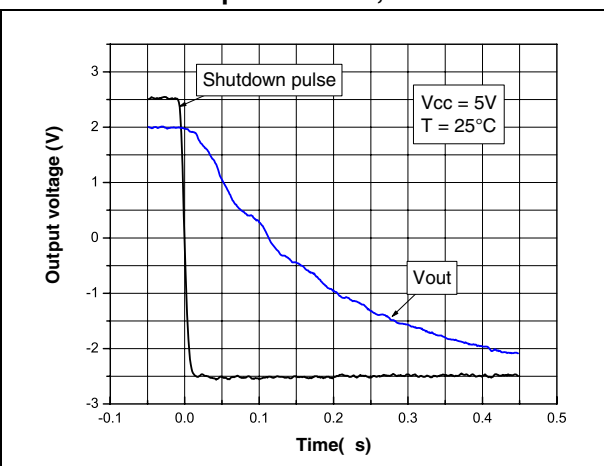
**Figure 19. Test configuration for turn-off time**  
( $V_{out}$  pulled down)



**Figure 20. Turn-on time,  $V_{CC} = 5$  V,  
 $V_{out}$  pulled down,  $T = 25^\circ\text{C}$**



**Figure 21. Turn-off time,  $V_{CC} = 5$  V,  
 $V_{out}$  pulled down,  $T = 25^\circ\text{C}$**



### 3.5 Optimization of DC and AC parameters

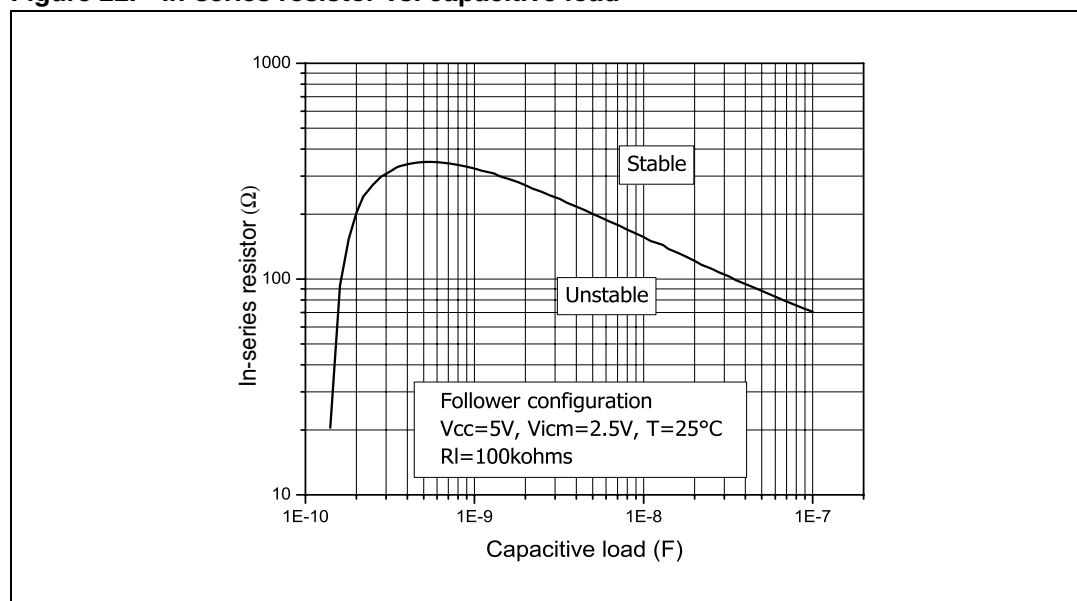
These devices use an innovative approach to reduce the spread of the main DC and AC parameters. An internal adjustment achieves a very narrow spread of the current consumption (60  $\mu$ A typical, min/max at  $\pm 17\%$ ). Parameters linked to the current consumption value, such as GBP, SR and AVd, 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/ $\mu$ s 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 k $\Omega$ . 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 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](http://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<sup>®</sup> packages, depending on their level of environmental compliance. ECOPACK<sup>®</sup> specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK<sup>®</sup> is an ST trademark.

## 4.1 SOT23-5 package mechanical data

Figure 23. SOT23-5L package mechanical drawing

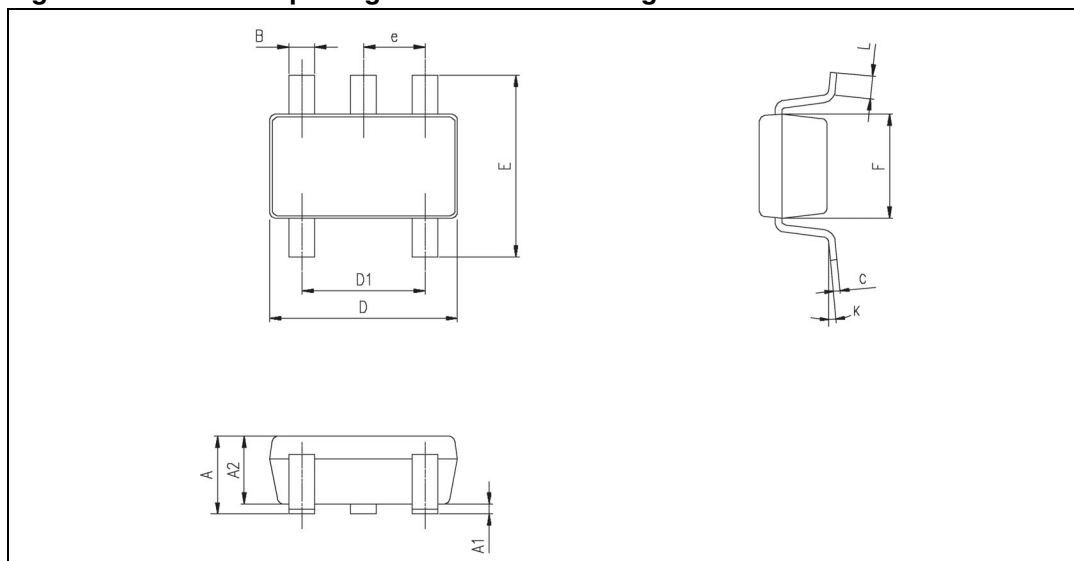


Table 8. SOT23-5L package mechanical data

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 degrees		10 degrees			



## 4.2 SOT23-6 package mechanical data

Figure 24. SOT23-6L package mechanical drawing

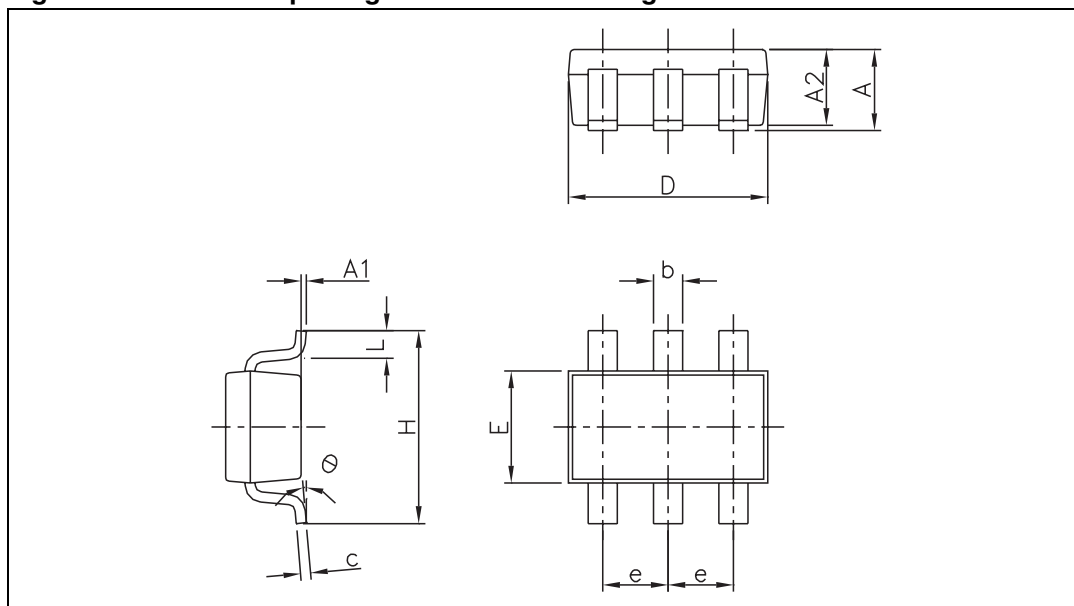


Table 9. SOT23-6L package mechanical data

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
°	0		10°			

### 4.3 SC70-6 (or SOT323-6) package mechanical data

Figure 25. SC70-6 (or SOT323-6) package mechanical drawing

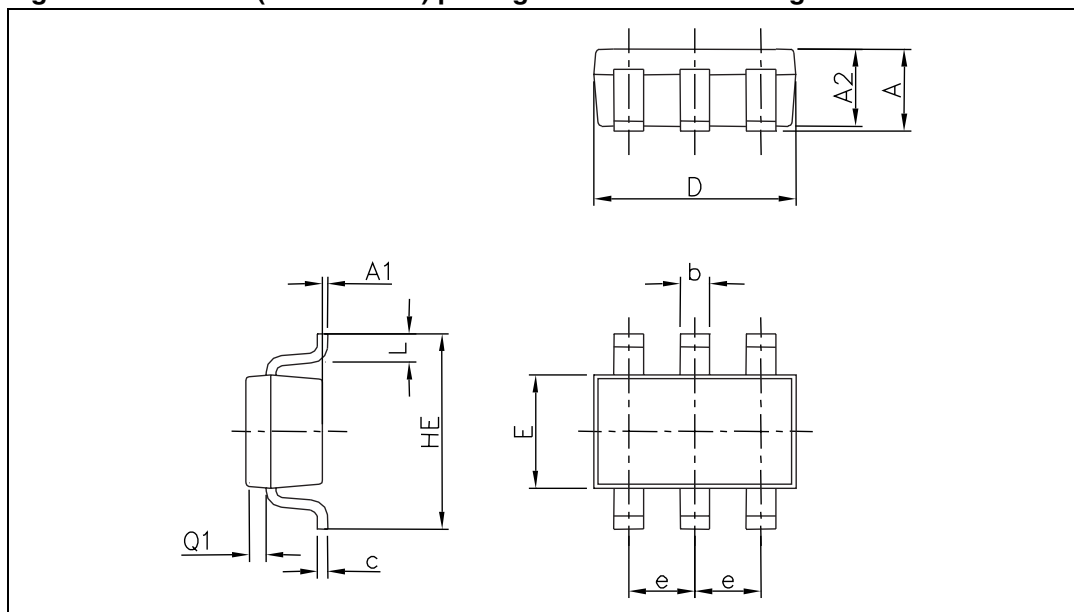
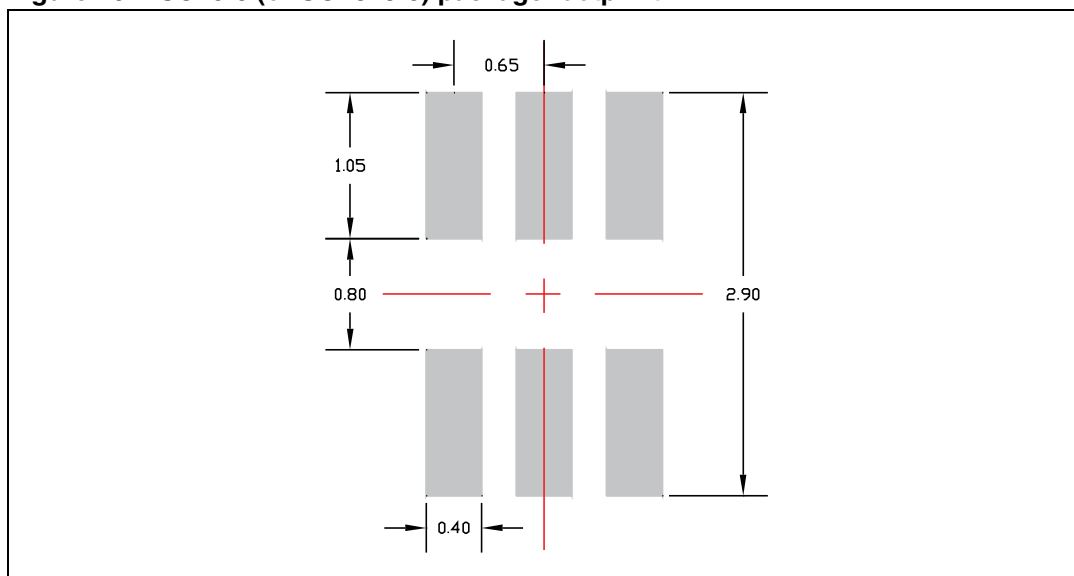


Table 10. SC70-6 (or SOT323-6) package mechanical data

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 26. SC70-6 (or SOT323-6) package footprint**

## 4.4 SC70-5 (or SOT323-5) package mechanical data

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

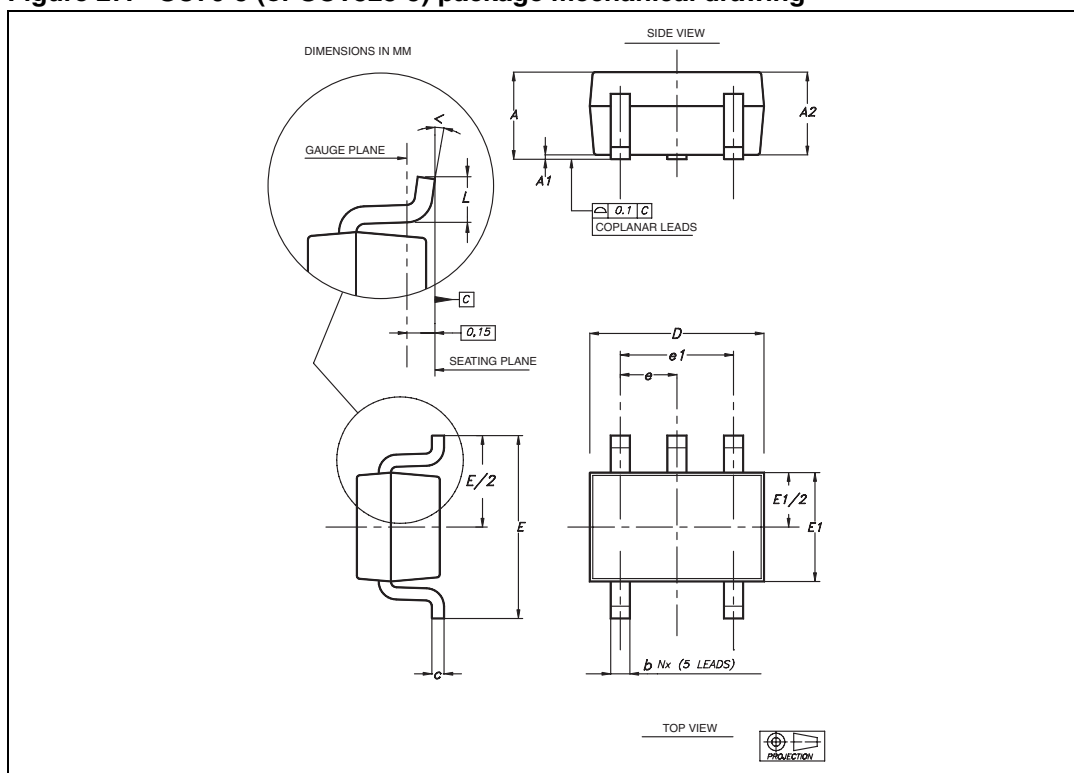


Table 11. SC70-5 (or SOT323-5) package mechanical data

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°			

## 5 Ordering information

Table 12. Order codes

Part number	Temperature range	Package	Packing	Marking
TSV630ILT	-40°C to +125°C	SOT23-6	Tape & reel	K108
TSV630ICT	-40°C to +125°C	SC70-6	Tape & reel	K18
TSV631ILT	-40°C to +125°C	SOT23-5	Tape & reel	K109
TSV631ICT	-40°C to +125°C	SC70-5	Tape & reel	K19
TSV630AILT	-40°C to +125°C	SOT23-6	Tape & reel	K141
TSV630AICT	-40°C to +125°C	SC70-6	Tape & reel	K41
TSV631AILT	-40°C to +125°C	SOT23-5	Tape & reel	K142
TSV631AICT	-40°C to +125°C	SC70-5	Tape & reel	K42

## 6 Revision history

**Table 13. Document revision history**

Date	Revision	Changes
19-Dec-2008	1	Initial release.

**Please Read Carefully:**

Information in this document is provided solely in connection with ST products. STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, modifications or improvements, to this document, and the products and services described herein at any time, without notice.

All ST products are sold pursuant to ST's terms and conditions of sale.

Purchasers are solely responsible for the choice, selection and use of the ST products and services described herein, and ST assumes no liability whatsoever relating to the choice, selection or use of the ST products and services described herein.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted under this document. If any part of this document refers to any third party products or services it shall not be deemed a license grant by ST for the use of such third party products or services, or any intellectual property contained therein or considered as a warranty covering the use in any manner whatsoever of such third party products or services or any intellectual property contained therein.

**UNLESS OTHERWISE SET FORTH IN ST'S TERMS AND CONDITIONS OF SALE ST DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY WITH RESPECT TO THE USE AND/OR SALE OF ST PRODUCTS INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION), OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.**

**UNLESS EXPRESSLY APPROVED IN WRITING BY AN AUTHORIZED ST REPRESENTATIVE, ST PRODUCTS ARE NOT RECOMMENDED, AUTHORIZED OR WARRANTED FOR USE IN MILITARY, AIR CRAFT, SPACE, LIFE SAVING, OR LIFE SUSTAINING APPLICATIONS, NOR IN PRODUCTS OR SYSTEMS WHERE FAILURE OR MALFUNCTION MAY RESULT IN PERSONAL INJURY, DEATH, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE. ST PRODUCTS WHICH ARE NOT SPECIFIED AS "AUTOMOTIVE GRADE" MAY ONLY BE USED IN AUTOMOTIVE APPLICATIONS AT USER'S OWN RISK.**

Resale of ST products with provisions different from the statements and/or technical features set forth in this document shall immediately void any warranty granted by ST for the ST product or service described herein and shall not create or extend in any manner whatsoever, any liability of ST.

ST and the ST logo are trademarks or registered trademarks of ST in various countries.

Information in this document supersedes and replaces all information previously supplied.

The ST logo is a registered trademark of STMicroelectronics. All other names are the property of their respective owners.

© 2008 STMicroelectronics - All rights reserved

STMicroelectronics group of companies

Australia - Belgium - Brazil - Canada - China - Czech Republic - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan - Malaysia - Malta - Morocco - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States of America

[www.st.com](http://www.st.com)

