

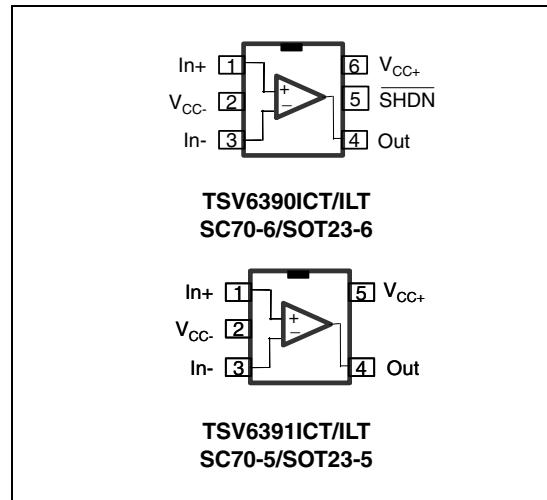


# TSV6390, TSV6390A, TSV6391, TSV6391A

Micropower (60  $\mu$ A), wide bandwidth (2.4 MHz) CMOS op-amps

## 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: 2.4 MHz typical
- Stable in gain configuration (-3 or +4)
- Low power shutdown mode: 5 nA typical
- High output current: 63 mA at  $V_{CC} = 5$  V
- Low input bias current: 1 pA typical
- Rail-to-rail input and output
- Extended temperature range: -40°C to +125°C
- 4 kV human body model



## Applications

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

## Description

The TSV6390 and TSV6391 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 TSV6390 and TSV6391 are ideal for applications requiring 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.

When used with a gain (above -3 or +4), these products feature an excellent speed/power consumption ratio, offering a 2.4 MHz gain bandwidth product while consuming only 60  $\mu$ A at a 5 V supply voltage.

The TSV6390 comes with a shutdown function.

Both the TSV6390 and TSV6391 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 TSV6390 and SC70-5 and SOT23-5 for the TSV6391. They are guaranteed for industrial temperature ranges from -40° C to +125° C.

All these features combined make the TSV6390 and TSV6391 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 <sup>(1)</sup>	6	V
$V_{id}$	Differential input voltage <sup>(2)</sup>	$\pm V_{CC}$	V
$V_{in}$	Input voltage <sup>(3)</sup>	$V_{CC-} - 0.2$ to $V_{CC+} + 0.2$	V
$I_{in}$	Input current <sup>(4)</sup>	10	mA
$V_{SHDN}$	Shutdown voltage <sup>(3)</sup>	$V_{CC-} - 0.2$ to $V_{CC+} + 0.2$	V
$T_{stg}$	Storage temperature	-65 to +150	°C
$R_{thja}$	Thermal resistance junction to ambient <sup>(5)(6)</sup>		
	SC70-5	205	
	SOT23-5	250	°C/W
	SOT23-6	240	
	SC70-6	232	
$T_j$	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,  $V_{in}$  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 $V_{CC+} + 0.1$	V
$T_{oper}$	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,  $V_{icm} = V_{CC}/2$ ,  $T_{amb} = 25^\circ C$  and  $R_L$  connected to  $V_{CC}/2$  (unless otherwise specified)**

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
<b>DC performance</b>						
$V_{io}$	Offset voltage	TSV6390-TSV6391 TSV6390A-TSV6391A $T_{min} < T_{op} < T_{max}$ TSV6390-TSV6391 TSV6390A-TSV6391A			3 0.5 4.5 2	mV
$DV_{io}$	Input offset voltage drift			2		$\mu V/^{\circ}C$
$I_{io}$	Input offset current <sup>(1)</sup> ( $V_{out} = V_{CC}/2$ )			1 10 1 100		pA
$I_{ib}$	Input bias current <sup>(1)</sup> ( $V_{out} = V_{CC}/2$ )			1 10 1 100		pA
CMR	Common mode rejection ratio 20 log ( $\Delta V_{io}/\Delta V_{io}$ )	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	$R_L = 10 \text{ k}\Omega$ , $V_{out} = 0.5$ V to 1.3 V	85	95		dB
		$T_{min} < T_{op} < T_{max}$	80			
$V_{OH}$	High level output voltage	$R_L = 10 \text{ k}\Omega$	35	5		mV
		$T_{min} < T_{op} < T_{max}$	50			
$V_{OL}$	Low level output voltage	$R_L = 10 \text{ k}\Omega$		4	35	mV
		$T_{min} < T_{op} < T_{max}$			50	
$I_{out}$	$I_{sink}$	$V_{out} = 1.8$ V	6	12		mA
		$T_{min} < T_{op} < T_{max}$	4			
	$I_{source}$	$V_{out} = 0$ V	6	10		mA
		$T_{min} < T_{op} < T_{max}$	4			
$I_{CC}$	Supply current $SHDN = V_{CC}$	No load, $V_{out} = V_{CC}/2$	40	50	60	$\mu A$
		$T_{min} < T_{op} < T_{max}$			62	
<b>AC performance</b>						
GBP	Gain bandwidth product	$R_L = 10 \text{ k}\Omega$ , $C_L = 100 \text{ pF}$		2		MHz
Gain	Minimum gain for stability	Phase margin = 60°, $R_f = 10 \text{ k}\Omega$ , $R_L = 10 \text{ k}\Omega$ , $C_L = 20 \text{ pF}$		+4 -3		V/V
SR	Slew rate	$R_L = 10 \text{ k}\Omega$ , $C_L = 100 \text{ pF}$ , $V_{out} = 0.5$ V to 1.3 V		0.7		V/ $\mu$ s
$e_n$	Equivalent input noise voltage	$f = 1$ kHz $f = 10$ kHz		60 33		$\frac{nV}{\sqrt{Hz}}$

1. Guaranteed by design.

**Table 4. Shutdown characteristics  $V_{CC} = 1.8$  V (TSV6390)**

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
<b>DC performance</b>						
$I_{CC}$	Supply current in shutdown mode (all operators)	$\overline{SHDN} = V_{CC-}$		2.5	50	nA
		$T_{min} < T_{op} < 85^\circ C$			200	nA
		$T_{min} < T_{op} < 125^\circ C$			1.5	$\mu A$
$t_{on}$	Amplifier turn-on time	$R_L = 2 k\Omega$ $V_{out} = V_{CC-} \text{ to } V_{CC-} + 0.2 V$		300		ns
$t_{off}$	Amplifier turn-off time	$R_L = 2 k\Omega$ , $V_{out} = V_{CC+} - 0.5 V$ to $V_{CC+} - 0.7 V$		20		ns
$V_{IH}$	$\overline{SHDN}$ logic high		1.3			V
$V_{IL}$	$\overline{SHDN}$ logic low				0.5	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
		$T_{min} < T_{op} < T_{max}$		1		nA

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

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
<b>DC performance</b>						
$V_{io}$	Offset voltage	TSV6390-TSV6391			3	mV
		TSV6390A-TSV6391A			0.5	
$DV_{io}$	Input offset voltage drift	$T_{min} < T_{op} < T_{max}$			4.5	
		TSV6390-TSV6391			2	$\mu\text{V}/^\circ\text{C}$
$I_{io}$	Input offset current <sup>(1)</sup>	TSV6390A-TSV6391A			100	pA
		$T_{min} < T_{op} < T_{max}$		1	1	
$I_{ib}$	Input bias current <sup>(1)</sup>	$T_{min} < T_{op} < T_{max}$		10		pA
		0 V to 3.3 V, $V_{out} = 1.65$ V	57	79		
$CMR$	Common mode rejection ratio 20 log ( $\Delta V_{ic}/\Delta V_{io}$ )	$T_{min} < T_{op} < T_{max}$	53			dB
		$R_L = 10 \text{ k}\Omega, V_{out} = 0.5 \text{ V to } 2.8 \text{ V}$	88	98		
$A_{vd}$	Large signal voltage gain	$T_{min} < T_{op} < T_{max}$	83			
		$R_L = 10 \text{ k}\Omega$	35	6		mV
$V_{OH}$	High level output voltage	$T_{min} < T_{op} < T_{max}$	50			
		$R_L = 10 \text{ k}\Omega$			35	
$V_{OL}$	Low level output voltage	$T_{min} < T_{op} < T_{max}$			50	mV
		$R_L = 10 \text{ k}\Omega$		7		
$I_{out}$	$I_{sink}$	$V_{out} = 3.3 \text{ V}$	23	45		mA
		$T_{min} < T_{op} < T_{max}$	20	42		
	$I_{source}$	$V_{out} = 0 \text{ V}$	23	38		
		$T_{min} < T_{op} < T_{max}$	20			mA
$I_{CC}$	Supply current $\overline{SHDN} = V_{CC}$	No load, $V_{out} = V_{CC}/2$	43	55	64	$\mu\text{A}$
		$T_{min} < T_{op} < T_{max}$			66	$\mu\text{A}$
<b>AC performance</b>						
GBP	Gain bandwidth product	$R_L = 10 \text{ k}\Omega, C_L = 100 \text{ pF}$		2.2		MHz
Gain	Minimum gain for stability	Phase margin = 60°, $R_f = 10 \text{ k}\Omega$ , $R_L = 10 \text{ k}\Omega, C_L = 20 \text{ pF}$		+4 -3		V/V
SR	Slew rate	$R_L = 10 \text{ k}\Omega, C_L = 100 \text{ pF}$ , $V_{out} = 0.5 \text{ V to } 2.8 \text{ V}$		0.9		V/ $\mu\text{s}$
$e_n$	Equivalent input noise voltage	$f = 1 \text{ kHz}$		65		$\frac{\text{nV}}{\sqrt{\text{Hz}}}$

1. Guaranteed by design.

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

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
<b>DC performance</b>						
$V_{io}$	Offset voltage	TSV6390-TSV6391 TSV6390A-TSV6391A			3 0.5	mV
		$T_{min} < T_{op} < T_{max}$ TSV6390-TSV6391 TSV6390A-TSV6391A			4.5 2	mV
$DV_{io}$	Input offset voltage drift			2		$\mu V/^\circ C$
$I_{io}$	Input offset current <sup>(1)</sup> ( $V_{out} = V_{CC}/2$ )			1	10	pA
		$T_{min} < T_{op} < T_{max}$		1	100	
$I_{ib}$	Input bias current <sup>(1)</sup> ( $V_{out} = V_{CC}/2$ )			1	10	pA
		$T_{min} < T_{op} < T_{max}$		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	93		dB
		$T_{min} < T_{op} < T_{max}$	73			
$A_{vd}$	Large signal voltage gain	$R_L = 10 k\Omega$ , $V_{out} = 0.5$ V to 4.5 V	89	98		dB
		$T_{min} < T_{op} < T_{max}$	84			
$V_{OH}$	High level output voltage	$R_L = 10 k\Omega$	35	7		mV
		$T_{min} < T_{op} < T_{max}$	50			
$V_{OL}$	Low level output voltage	$R_L = 10 k\Omega$		6	35	mV
		$T_{min} < T_{op} < T_{max}$			50	
$I_{out}$	$I_{sink}$	$V_{out} = 5$ V	40	65		mA
		$T_{min} < T_{op} < T_{max}$	35			
	$I_{source}$	$V_{out} = 0$ V	40	72		mA
		$T_{min} < T_{op} < T_{max}$	35			
$I_{CC}$	Supply current $\overline{SHDN} = V_{CC}$	No load, $V_{out} = V_{CC}/2$	50	60	69	$\mu A$
		$T_{min} < T_{op} < T_{max}$			72	
<b>AC performance</b>						
GBP	Gain bandwidth product	$R_L = 10 k\Omega$ , $C_L = 100 pF$		2.4		MHz
Gain	Minimum gain for stability	Phase margin = 60°, $R_f = 10 k\Omega$ , $R_L = 10 k\Omega$ , $C_L = 20 pF$ ,		+4 -3		V/V
SR	Slew rate	$R_L = 10 k\Omega$ , $C_L = 100 pF$		1.1		V/ $\mu$ s

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

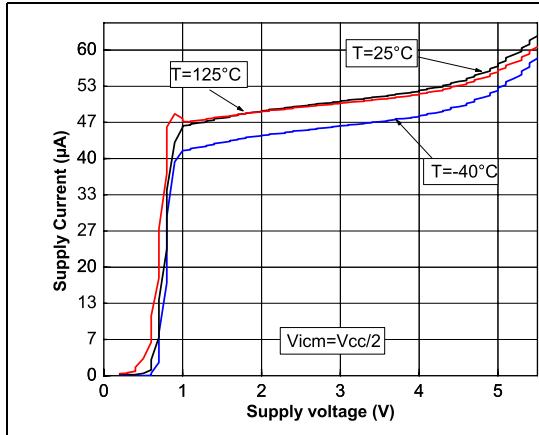
Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
$e_n$	Equivalent input noise voltage	$f = 1$ kHz $f = 10$ kHz		60 33		$\frac{nV}{\sqrt{Hz}}$
THD+N	Total harmonic distortion + noise	$A_v = -10$ , $f_{in} = 1$ kHz, $R = 100$ k $\Omega$ $V_{icm} = V_{CC}/2$ , $V_{in} = 40$ mVpp		0.11		%

1. Guaranteed by design.

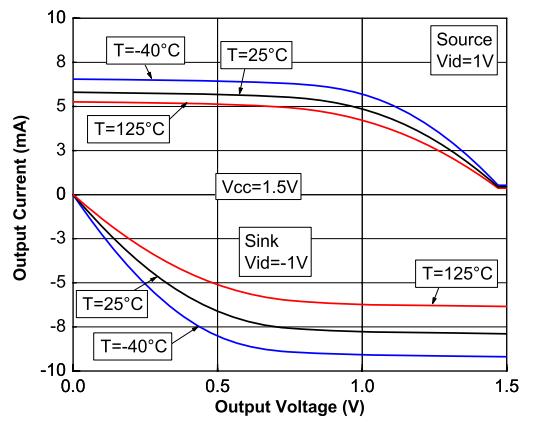
**Table 7. Shutdown characteristics  $V_{CC} = 5$  V (TSV6390)**

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
<b>DC performance</b>						
$I_{CC}$	Supply current in shutdown mode (all operators)	$SHDN = V_{CC-}$		5	50	nA
		$T_{min} < T_{op} < 85^\circ C$			200	nA
		$T_{min} < T_{op} < 125^\circ C$			1.5	$\mu A$
$t_{on}$	Amplifier turn-on time	$R_L = 2$ k $\Omega$ $V_{out} = V_{CC-}$ to $V_{CC+} + 0.2$ V		300		ns
$t_{off}$	Amplifier turn-off time	$R_L = 2$ $\Omega$ , $V_{out} = V_{CC+} - 0.5$ V to $V_{CC+} - 0.7$ V		30		ns
$V_{IH}$	SHDN logic high		4.5			V
$V_{IL}$	SHDN logic low				0.5	V
$I_{IH}$	SHDN current high	$SHDN = V_{CC+}$		10		pA
$I_{IL}$	SHDN current low	$SHDN = V_{CC-}$		10		pA
$I_{OLeak}$	Output leakage in shutdown mode	$SHDN = V_{CC-}$		50		pA
		$T_{min} < T_{op} < T_{max}$		1		nA

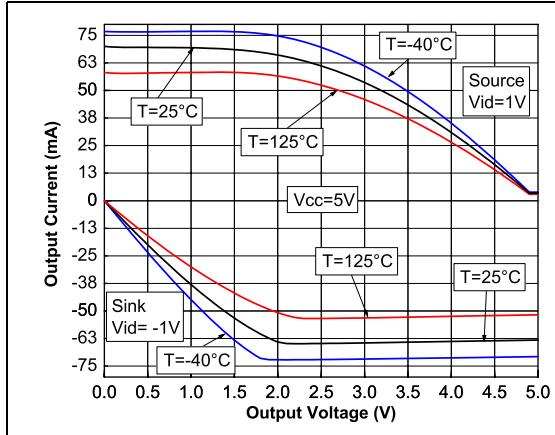
**Figure 1. Supply current vs. supply voltage at  $V_{icm} = V_{CC}/2$**



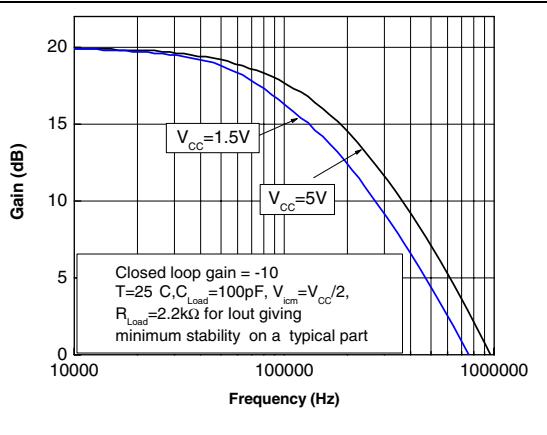
**Figure 2. Output current vs. output voltage at  $V_{CC} = 1.5 \text{ V}$**



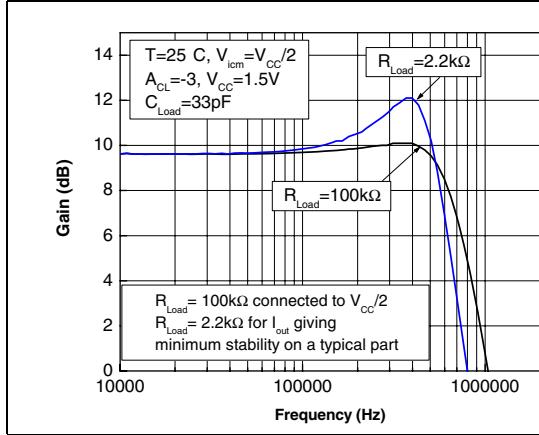
**Figure 3. Output current vs. output voltage at  $V_{CC} = 5 \text{ V}$**



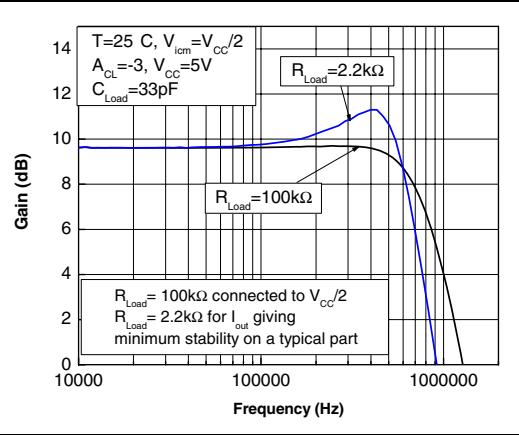
**Figure 4. Peaking at closed loop gain = -10**

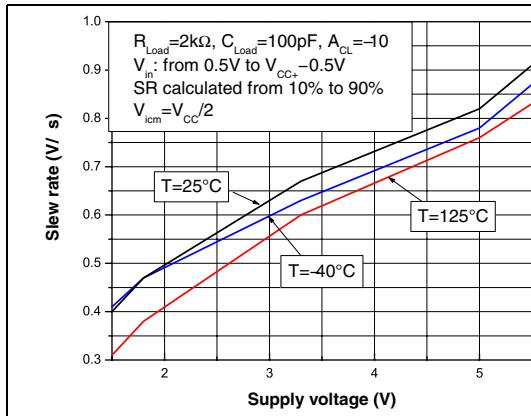
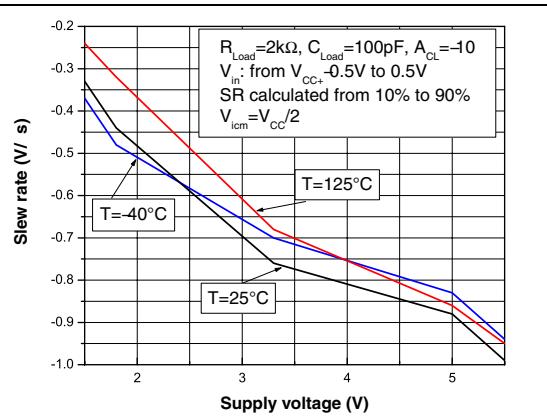
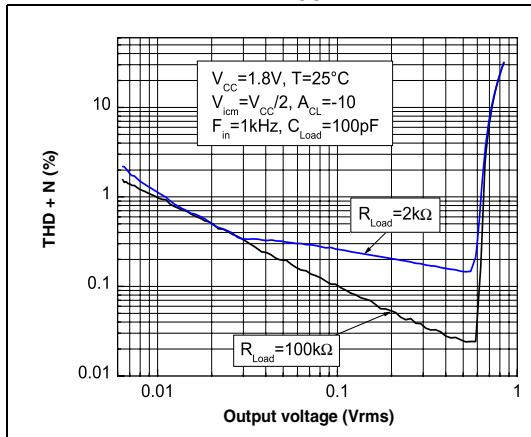
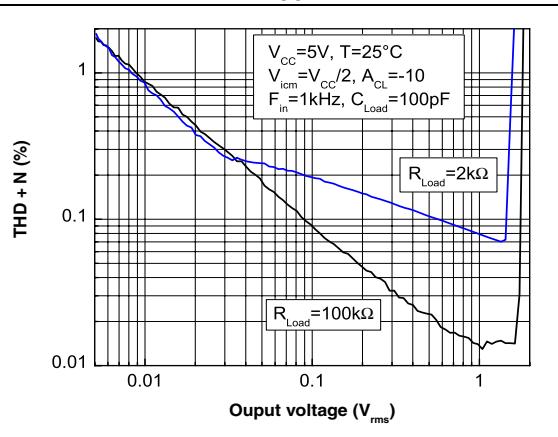
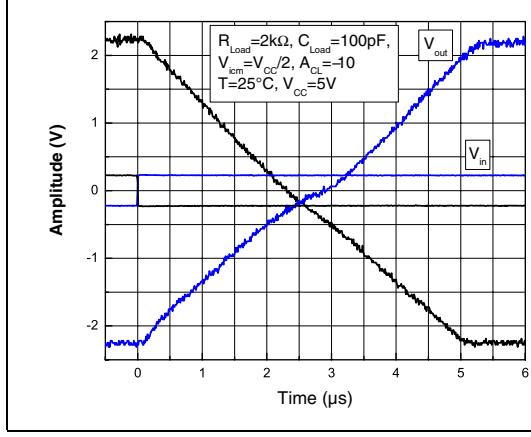
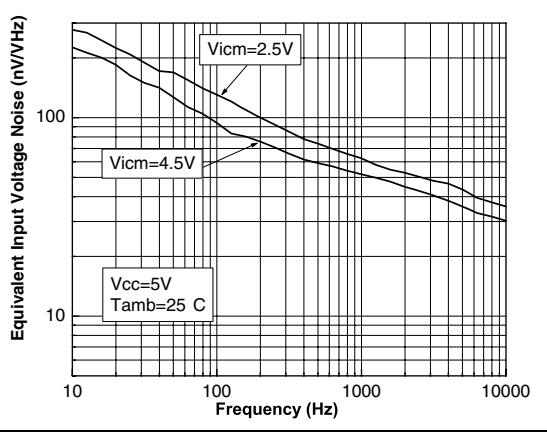


**Figure 5. Peaking at closed loop gain = -3 at  $V_{CC} = 1.5 \text{ V}$**



**Figure 6. Peaking at closed loop gain = -3 at  $V_{CC} = 5 \text{ V}$**



**Figure 7. Positive slew rate vs. supply voltage****Figure 8. Negative slew rate vs. supply voltage****Figure 9. Distortion + noise vs. output voltage at  $V_{CC} = 1.8$  V****Figure 10. Distortion + noise vs. output voltage at  $V_{CC} = 5$  V****Figure 11. Slew rate timing****Figure 12. Noise vs. frequency at  $V_{CC} = 5$  V**

### 3 Application information

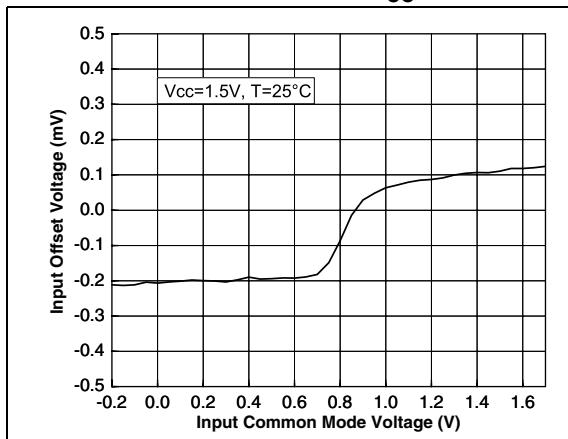
#### 3.1 Operating voltages

The TSV6390 and TSV6391 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 TSV639x characteristics at 1.5 V. Additionally, the main specifications are guaranteed in extended temperature ranges from -40° C to +125° C.

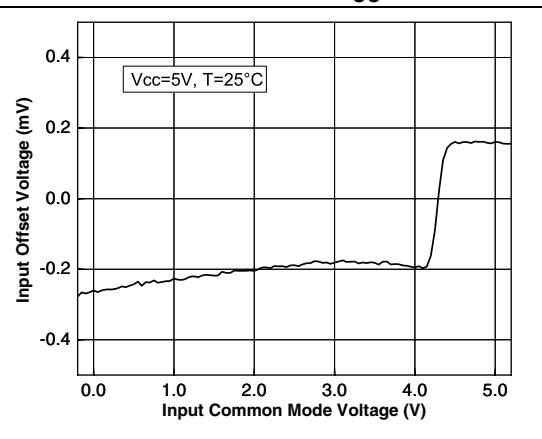
#### 3.2 Rail-to-rail input

The TSV6390 and TSV6391 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 13](#) and [Figure 14](#) for  $V_{io}$  vs.  $V_{icm}$ ).

**Figure 13. Input offset voltage vs input common mode at  $V_{CC} = 1.5$  V**



**Figure 14. Input offset voltage vs input common mode at  $V_{CC} = 5$  V**



The devices are 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 kΩ resistive load to  $V_{CC}/2$ .

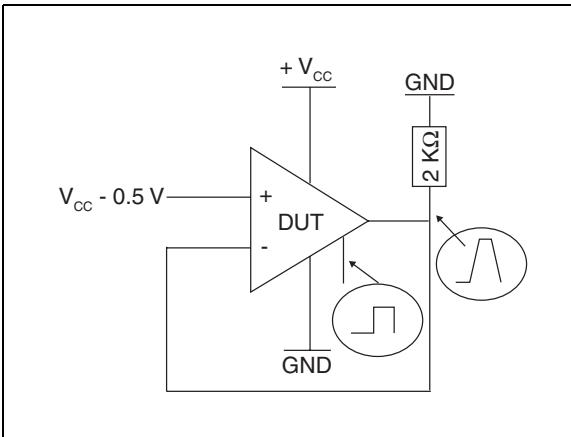
#### 3.4 Shutdown function (TSV6390)

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

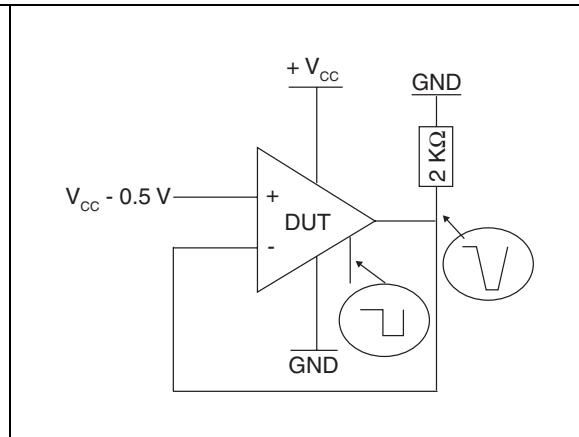


The turn-on and turn-off times are calculated for an output variation of  $\pm 200$  mV ([Figure 15](#) and [Figure 16](#) show the test configurations).

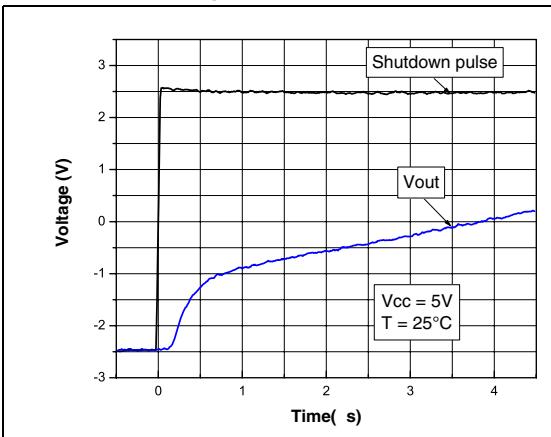
**Figure 15. Test configuration for turn-on time (Vout pulled down)**



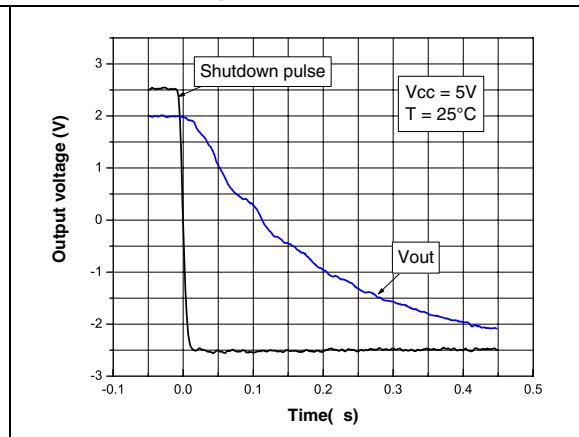
**Figure 16. Test configuration for turn-off time (Vout pulled down)**



**Figure 17. Turn-on time,  $V_{CC} = 5$  V, Vout pulled down,  $T = 25^\circ C$**



**Figure 18. Turn-off time,  $V_{CC} = 5$  V, Vout pulled down,  $T = 25^\circ C$**



### 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  $A_{Vd}$ , benefit from this narrow dispersion.

### 3.6 Driving resistive and capacitive loads

These products are micropower, 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.

These operational 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.

- $|IGain| \geq 3$  in an inverting configuration ( $C_L = 20$  pF,  $R_L = 100$  k $\Omega$ ) or  $|Gain| \geq 10$  ( $C_L = 100$  pF,  $R_L = 100$  k $\Omega$ )
- $Gain \geq +4$  in a non-inverting configuration ( $C_L = 20$  pF,  $R_L = 100$  k $\Omega$ ) or  $gain \geq +11$  ( $C_L = 100$  pF,  $R_L = 100$  k $\Omega$ )

As these operational amplifiers are not unity gain stable, for a low closed-loop gain it is recommended to use the TSV62x (29  $\mu$ A, 420 kHz) or TSV63x (60  $\mu$ A, 880 kHz) which are unity gain stable.

**Table 8. Related products**

Part #	I <sub>cc</sub> ( $\mu$ A) at 5 V	GBP (MHz)	SR (V/ $\mu$ s)	Minimum gain for stability ( $C_{Load} = 100$ pF)
TSV620-1	29	0.42	0.14	1
TSV6290-1	29	1.3	0.5	+11
TSV630-1	60	0.88	0.34	1
TSV6390-1	60	2.4	1.1	+11

### 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 TSV6390 and TSV6391 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 TSV639x 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](http://www.st.com).  
ECOPACK® is an ST trademark.

## 4.1 SOT23-5 package mechanical data

Figure 19. SOT23-5L package mechanical drawing

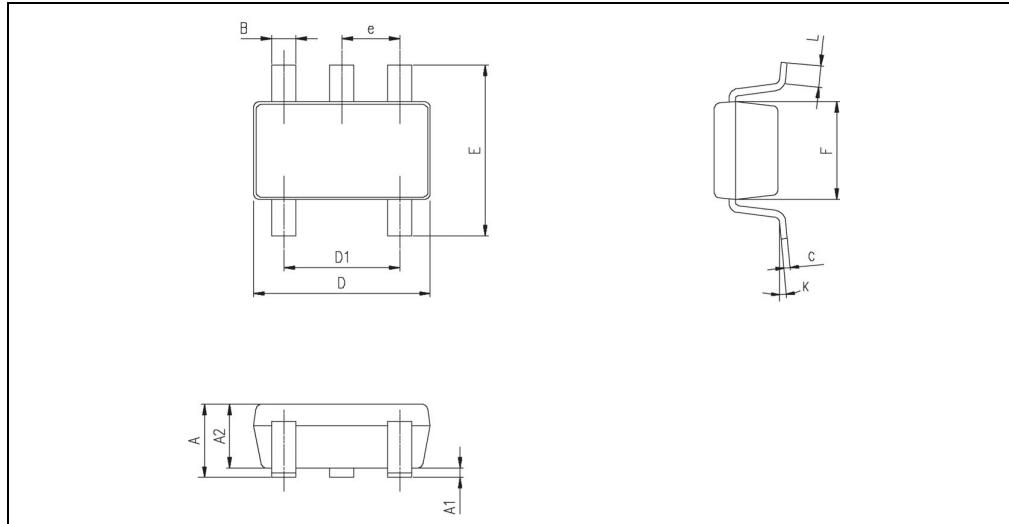


Table 9. SOT23-5L package mechanical data

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°		10°			

## 4.2 SOT23-6 package mechanical data

Figure 20. SOT23-6L package mechanical drawing

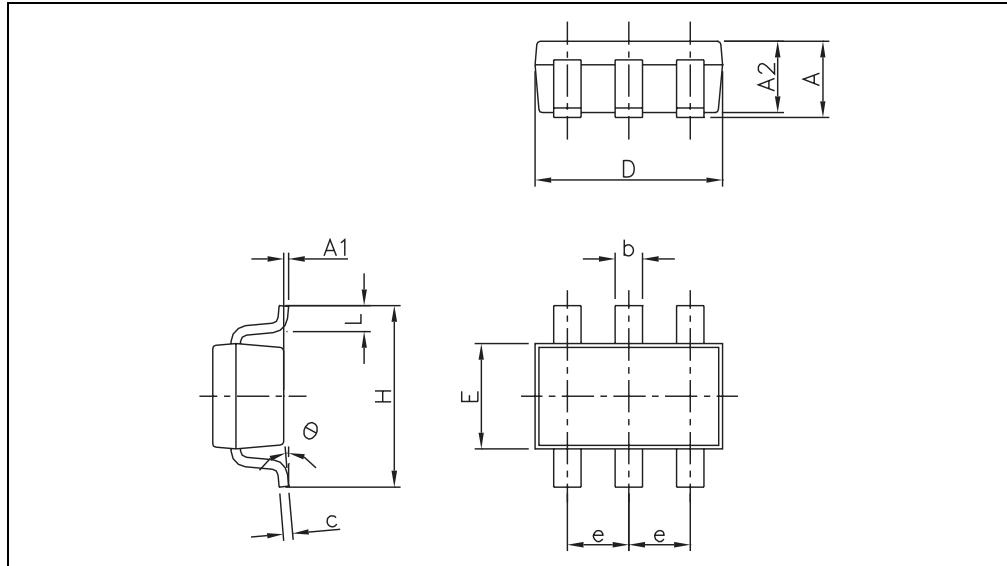


Table 10. SOT23-6L package mechanical data

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

Figure 21. SC70-5 (or SOT323-5) package mechanical drawing

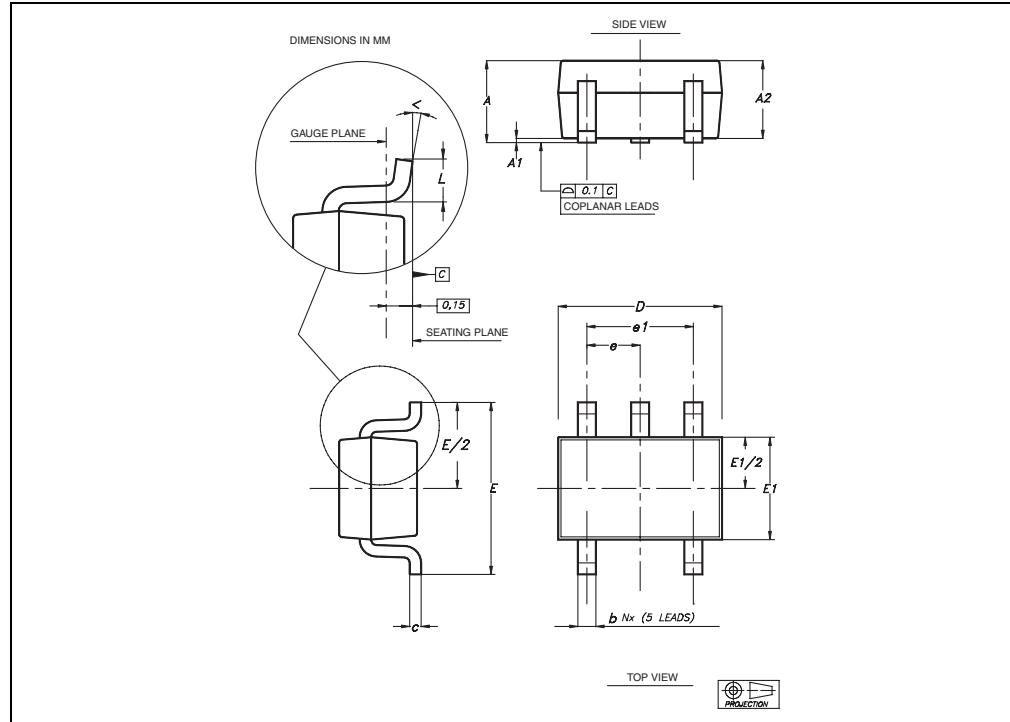


Table 11. SC70-5 (or SOT323-5) package mechanical data

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°			

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

Figure 22. SC70-6 (or SOT323-6) package mechanical drawing

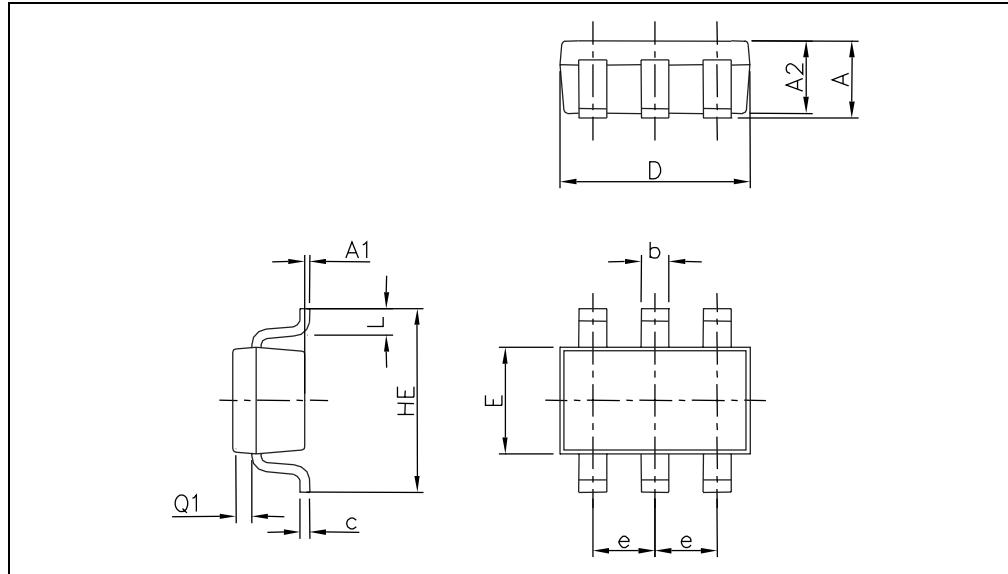
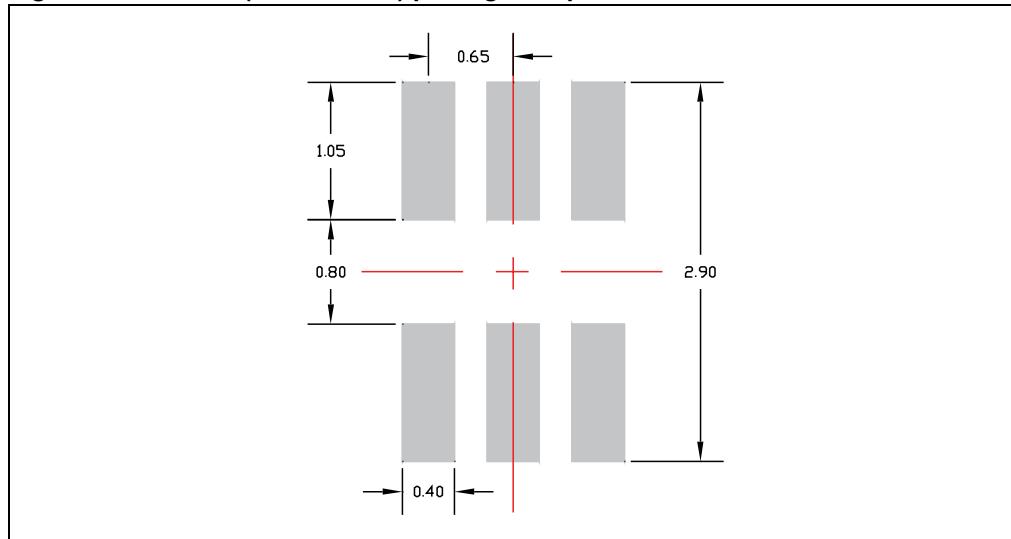


Table 12. SC70-6 (or SOT323-6) package mechanical data

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

## 5 Ordering information

**Table 13. Order codes**

Part number	Temperature range	Package	Packing	Marking
TSV6390ILT	-40°C to +125°C	SOT23-6	Tape & reel	K109
TSV6390ICT		SC70-6		K19
TSV6390AILT		SOT23-6		K142
TSV6390AICT		SC70-6		K42
TSV6391ILT		SOT23-5		K108
TSV6391ICT		SC70-5		K20
TSV6391AILT		SOT23-5		K141
TSV6391AICT		SC70-5		K41

## 6 Revision history

**Table 14. Document revision history**

Date	Revision	Changes
09-Mar-2010	1	Initial release.



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