

### Features

- Low supply voltage: 1.5 V – 5.5 V
- Rail-to-rail input and output
- Low input offset voltage: 800  $\mu$ V max (A version)
- Low power consumption: 29  $\mu$ A typical
- Gain bandwidth product: 1.3 MHz typical
- Stable when used in gain configuration
- Micropackages: SOT23-5, SC70-5
- Low input bias current: 1 pA typical
- Extended temperature range: -40 to 125  $^{\circ}$ C
- 4 kV human body model

### Description

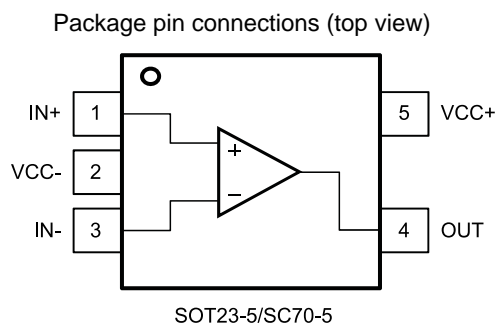
The the TSV6291 are single operational amplifiers with a high bandwidth which consume only 29  $\mu$ A. They must be used in a gain configuration ( $G < -3$ ,  $G > 4$ ).

With a very low input bias current and low offset voltage (800  $\mu$ V maximum for the A version), the TSV629family of devices is ideal for applications requiring precision. The devices can operate at a power supply ranging from 1.5 to 5.5 V, and therefore suit battery-powered devices, extending battery life.

### Applications

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

### Package pin connections



### Absolute maximum ratings and operating conditions

Absolute maximum ratings (AMR)

Symbol	Parameter	Value	Unit
V <sub>CC</sub>	Supply voltage <sup>(1)</sup>	6	V
V <sub>id</sub>	Differential input voltage <sup>(2)</sup>	±V <sub>CC</sub>	
V <sub>in</sub>	Input voltage <sup>(3)</sup>	(V <sub>CC-</sub> ) - 0.2 to (V <sub>CC+</sub> ) + 0.2	
I <sub>in</sub>	Input current <sup>(4)</sup>	10	mA
$\overline{\text{SHDN}}$	Shutdown voltage <sup>(3)</sup>	(V <sub>CC-</sub> ) - 0.2 to (V <sub>CC+</sub> ) + 0.2	V
T <sub>stg</sub>	Storage temperature	-65 to 150	°C
T <sub>j</sub>	Maximum junction temperature	150	
R <sub>thja</sub>	Thermal resistance junction-to-ambient <sup>(5)(6)</sup>	SOT23-5 250 SC70-5 205	°C/W

<sup>(1)</sup>All voltage values, except differential voltage, are with respect to network ground terminal.

<sup>(2)</sup>Differential voltages are the non-inverting input terminal with respect to the inverting input terminal.

<sup>(3)</sup>V<sub>CC</sub> - V<sub>in</sub> must not exceed 6 V, V<sub>in</sub> must not exceed 6 V.

<sup>(4)</sup>Input current must be limited by a resistor in series with the inputs.

<sup>(5)</sup>R<sub>th</sub> are typical values.

<sup>(6)</sup>Short-circuits can cause excessive heating and destructive dissipation.

<sup>(7)</sup>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.

<sup>(8)</sup>Machine mode: 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.

<sup>(9)</sup>Charged device model: all pins plus package are charged together to the specified voltage and then discharged directly to the ground.

#### Operating conditions

Symbol	Parameter	Value	Unit
V <sub>CC</sub>	Supply voltage	1.5 to 5.5	V
V <sub>icm</sub>	Common mode input voltage range	(V <sub>CC-</sub> ) - 0.1 to (V <sub>CC+</sub> ) + 0.1	
T <sub>oper</sub>	Operating free air temperature range	-40 to 125	°C

## Electrical characteristics

Electrical characteristics at (VCC+) = 1.8 V with (VCC-) = 0 V, Vicm = VCC/2, Tamb = 25 °C, and RL connected to VCC/2 (unless otherwise specified)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
V <sub>io</sub>	Offset voltage	TSV6291			4	mV
		TSV6291A			0.8	
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub> , TSV6291			6	
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub> , TSV6291A			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 <sup>(1)</sup>	T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>		1	10	pA
				1	100	
I <sub>ib</sub>	Input bias current, V <sub>out</sub> = V <sub>CC</sub> /2 <sup>(1)</sup>	T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>		1	10	pA
				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	78	95		dB
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>	73			
V <sub>OH</sub>	High-level output voltage, V <sub>OH</sub> = V <sub>CC</sub> - V <sub>out</sub>	R <sub>L</sub> = 10 kΩ		5	35	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>	Isink	V <sub>out</sub> = 1.8 V	6	12		mA
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>	4			
	Isource	V <sub>out</sub> = 0 V	6	10		
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>	4			
I <sub>cc</sub>	Supply current (per operator)	No load, V <sub>out</sub> = V <sub>CC</sub> /2		25	31	μA
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>			33	
GBP	Gain bandwidth product	R <sub>L</sub> = 10 kΩ, C <sub>L</sub> = 100 pF		1.1		MHz
Gain	Minimum gain for stability	Phase margin = 60°, R <sub>f</sub> = 10 kΩ, R <sub>L</sub> = 10 kΩ, C <sub>L</sub> = 20 pF		4		V/V
					-3	
SR	Slew rate	R <sub>L</sub> = 10 kΩ, C <sub>L</sub> = 100 pF, V <sub>out</sub> = 0.5 V to 1.3 V		0.33		V/μs

## Micropower with high merit factor cmos operational amplifiers

(VCC+) = 3.3 V, (VCC-) = 0 V, Vicm = VCC/2, Tamb = 25 °C, RL connected to VCC/2 (unless otherwise specified)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
V <sub>io</sub>	Offset voltage	TSV6291			4	mV
		TSV6291A			0.8	
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub> , TSV6291			6	
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub> , TSV6291A			2	
DV <sub>io</sub>	Input offset voltage drift			2		μV/°C
I <sub>io</sub>	Input offset current <sup>(1)</sup>	T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>		1	10	pA
				1	100	
I <sub>ib</sub>	Input bias current <sup>(1)</sup>	T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>		1	10	
				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> = 1.65 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	81	98		
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>	76			
V <sub>OH</sub>	High-level output voltage, V <sub>OH</sub> = V <sub>CC</sub> - V <sub>out</sub>	R <sub>L</sub> = 10 kΩ		5	35	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	
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>			50	
I <sub>out</sub>	Isink	V <sub>out</sub> = 5 V	23	45		mA
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>	20			
	Isource	V <sub>out</sub> = 0 V	23	38		
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>	20			
I <sub>CC</sub>	Supply current (per operator)	No load, V <sub>out</sub> = 2.5 V		26	33	μA
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>			35	
GBP	Gain bandwidth product	R <sub>L</sub> = 10 kΩ, C <sub>L</sub> = 100 pF		1.2		MHz
Gain	Minimum gain for stability	Phase margin = 60°, R <sub>f</sub> = 10 kΩ, R <sub>L</sub> = 10 kΩ, C <sub>L</sub> = 20 pF		4		V/V
				-3		
SR	Slew rate	R <sub>L</sub> = 10 kΩ, C <sub>L</sub> = 100 pF, V <sub>out</sub> = 0.5 V to 2.8 V		0.4		V/μs

## Micropower with high merit factor cmos operational amplifiers

(VCC+) = 5 V, (VCC-) = 0 V, Vicm = VCC/2, Tamb = 25 °C, RL connected to VCC/2 (unless otherwise specified)

Symbol	Parameter		Min.	Typ.	Max.	Unit
V <sub>io</sub>	Offset voltage	TSV6291			4	mV
		TSV6291A			0.8	
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub> , TSV6291			6	
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub> , TSV6291A			2	
DV <sub>io</sub>	Input offset voltage drift			2		μV/°C
I <sub>io</sub>	Input offset current <sup>(1)</sup>			1	10	pA
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>		1	100	
I <sub>ib</sub>	Input bias current <sup>(1)</sup>			1	10	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>	73			
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	85	98		dB
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>	80			
V <sub>OH</sub>	High-level output voltage, V <sub>OH</sub> = V <sub>CC</sub> - V <sub>out</sub>	R <sub>L</sub> = 10 kΩ		7	35	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>out</sub> = 5 V	40	69		mA
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>	35			
	I <sub>source</sub>	V <sub>out</sub> = 0 V	40	74		
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>	35			
I <sub>CC</sub>	Supply current (per operator)	No load, V <sub>out</sub> = 2.5 V		30	36	μA
		T <sub>min</sub> < T <sub>op</sub> < T <sub>max</sub>			38	
GBP	Gain bandwidth product	R <sub>L</sub> = 10 kΩ, C <sub>L</sub> = 100 pF		1.3		MHz
Gain	Minimum gain for stability	Phase margin = 60 °, R <sub>f</sub> = 10 kΩ, R <sub>L</sub> = 10 kΩ, C <sub>L</sub> = 20 pF		4		V/V
					-3	
SR	Slew rate	R <sub>L</sub> = 10 kΩ, C <sub>L</sub> = 100 pF, V <sub>out</sub> = 0.5 V to 4.5 V		0.5		V/μs
e <sub>n</sub>	Equivalent input noise voltage	f = 1 kHz		70		nV/√Hz
THD	Total harmonic distortion	A <sub>v</sub> = -10, f <sub>in</sub> = 1 kHz, R <sub>L</sub> = 100 kΩ, V <sub>icm</sub> = V <sub>CC</sub> /2, V <sub>in</sub> = 40 mVpp		0.15		%

## Electrical characteristic curves

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

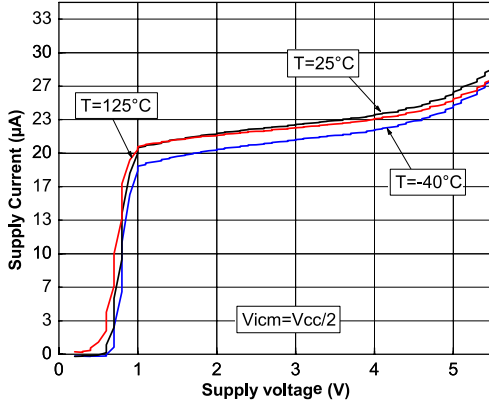


Figure 3: Output current vs. output voltage at  $V_{CC} = 1.5 V$

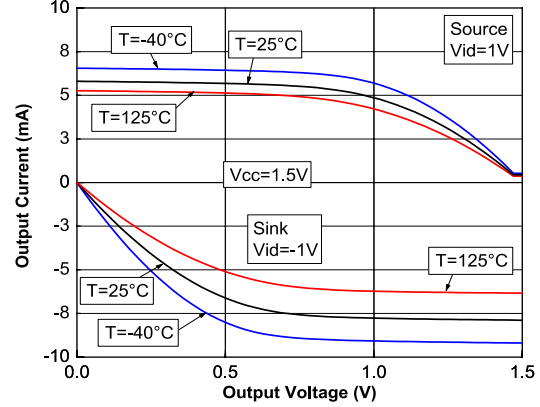


Figure 4: Output current vs. output voltage at  $V_{CC} = 5 V$

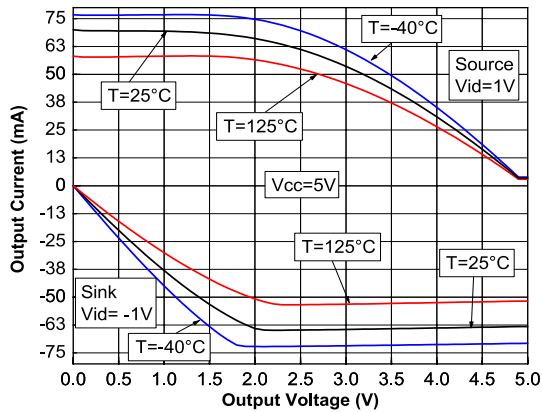


Figure 5: Peaking at closed loop gain = -10 at  $V_{CC} = 1.5 V$  and  $V_{CC} = 5 V$

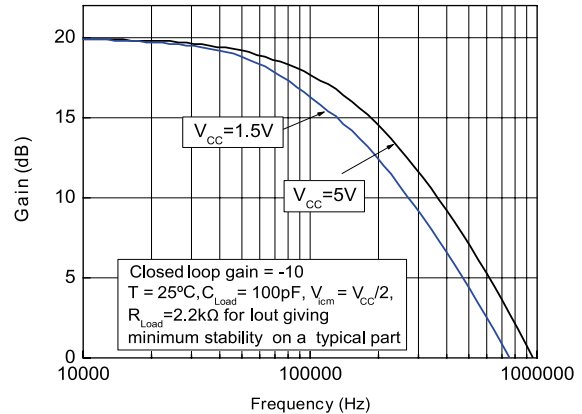


Figure 6: Peaking at closed loop gain = -3,  $V_{CC} = 1.5 V$

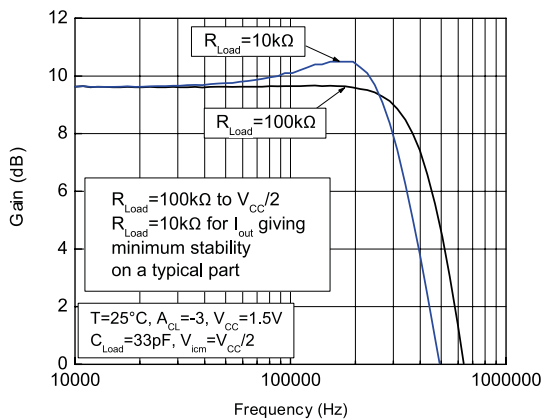


Figure 7: Peaking at closed loop gain = -3,  $V_{CC} = 5 V$

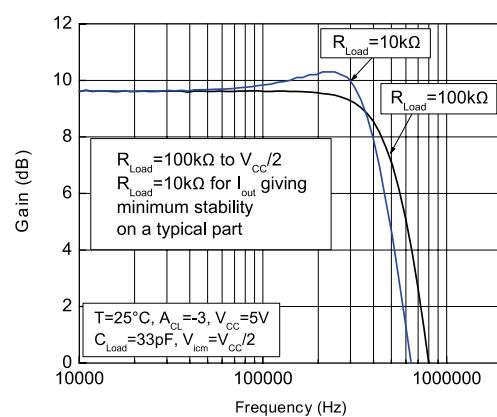


Figure 8: Positive slew rate vs. supply voltage in closed loop

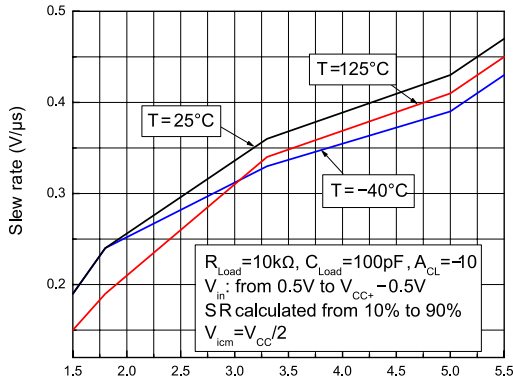


Figure 9: Negative slew rate vs. supply voltage in closed loop

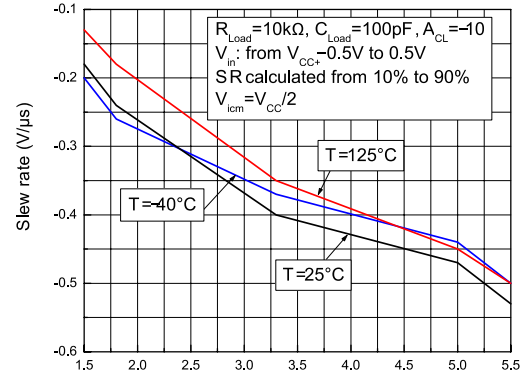


Figure 10: Slew rate vs. supply voltage in open loop

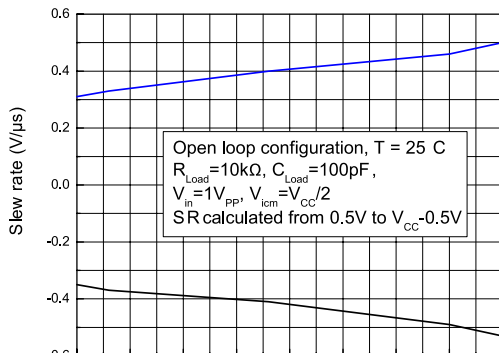


Figure 11: Slew rate timing in open loop

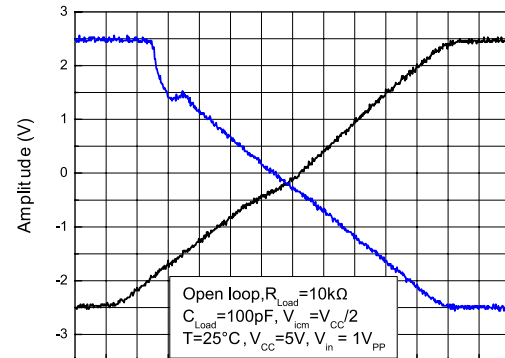


Figure 12: Slew rate timing in closed loop

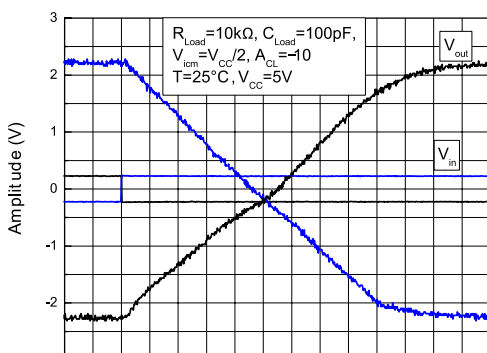


Figure 13: Noise at VCC = 5 V

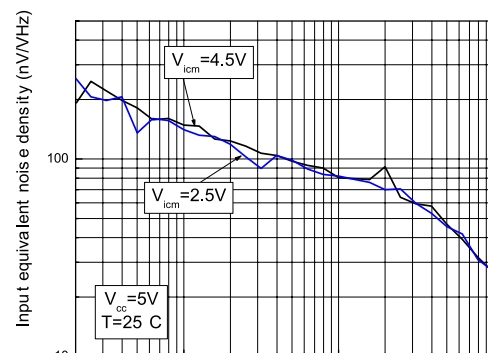


Figure 14: Distortion + noise vs. output voltage at VCC = 1.8 V

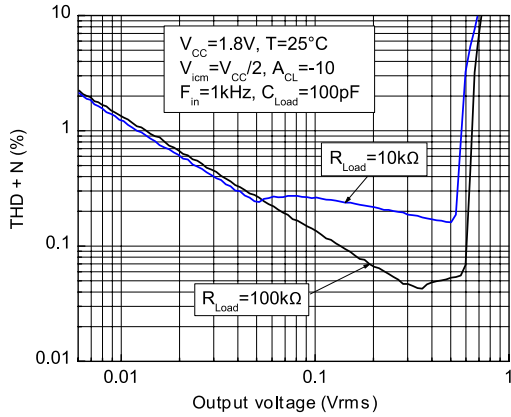


Figure 15: Distortion + noise vs. output voltage at VCC = 5 V

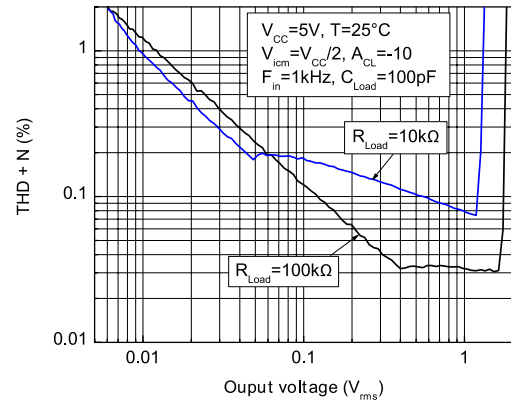


Figure 16: Distortion + noise vs. frequency at VCC = 1.8 V

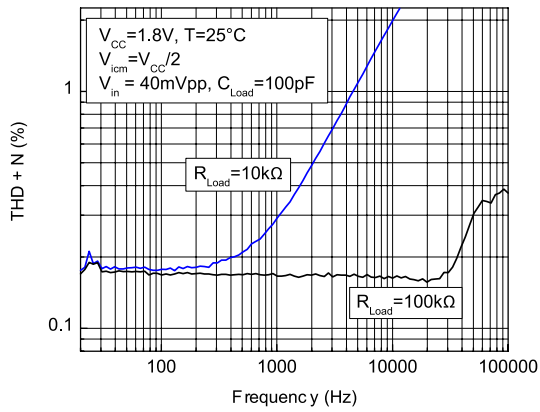


Figure 17: Distortion + noise vs. frequency at VCC = 5 V

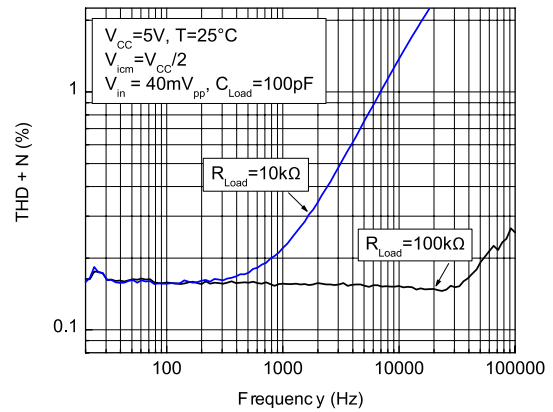




Figure 18: Input offset voltage vs. input common mode at VCC = 1.5 V

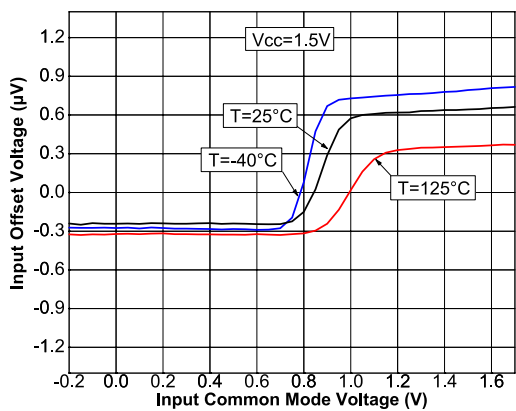


Figure 19: Input offset voltage vs. input common mode at VCC = 5 V

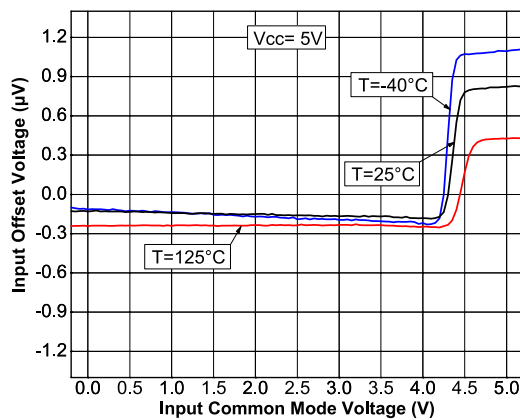


Figure 20: Test configuration for turn-on time (Vout pulled down)

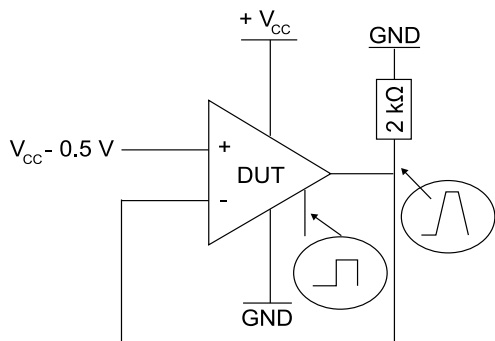


Figure 21: Test configuration for turn-off time (Vout pulled down)

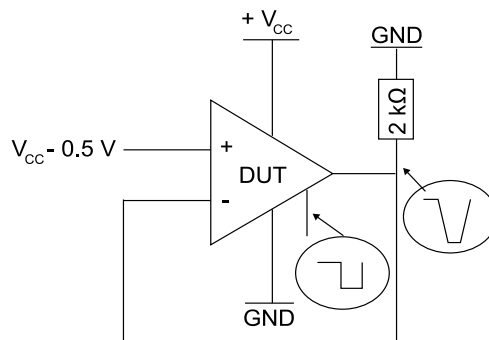


Figure 22: Turn-on time, VCC = 5 V, Vout pulled down, T = 25 °C

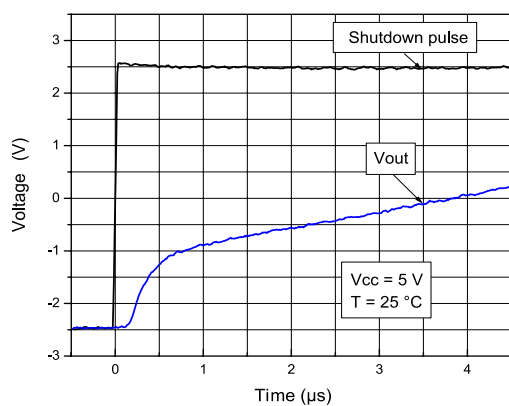
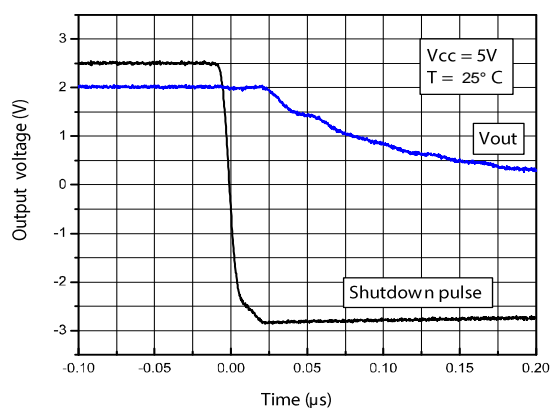
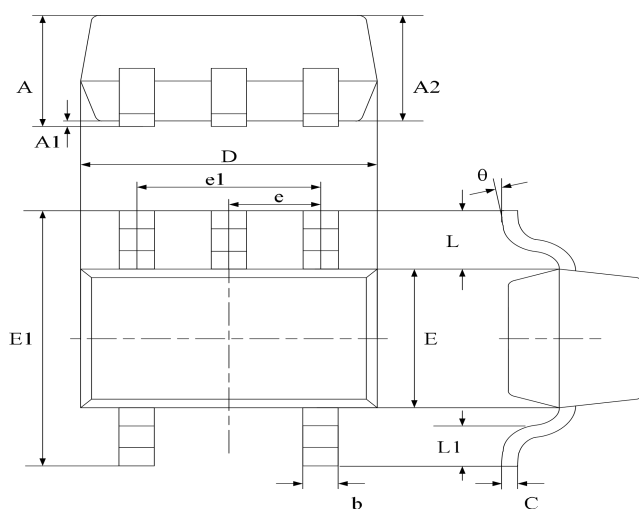


Figure 23: Turn-off time, VCC= 5 V, Vout pulled down, T = 25 °C



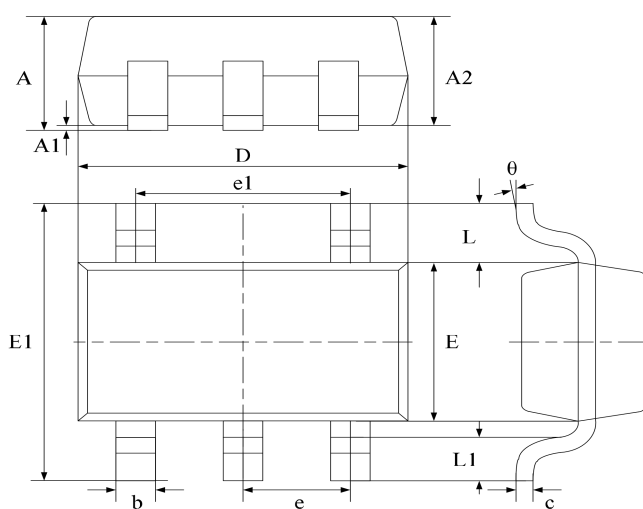
## Package Information

### SC70-5 (SOT353)



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.800	1.100	0.035	0.043
A1	0.000	0.100	0.000	0.004
A2	0.800	0.900	0.035	0.039
b	0.150	0.350	0.006	0.014
C	0.080	0.150	0.003	0.006
D	1.8500	2.150	0.079	0.087
E	1.100	1.400	0.045	0.053
E1	1.950	2.200	0.085	0.096
e	0.850 typ.		0.026 typ.	
e1	1.200	1.400	0.047	0.055
L	0.42 ref.		0.021 ref.	
L1	0.260	0.460	0.010	0.018
theta	0°	8°	0°	8°

### SOT23-5



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.040	1.350	0.042	0.055
A1	0.040	0.150	0.002	0.006
A2	1.000	1.200	0.041	0.049
b	0.380	0.480	0.015	0.020
c	0.110	0.210	0.004	0.009
D	2.720	3.120	0.111	0.127
E	1.400	1.800	0.057	0.073
E1	2.600	3.000	0.106	0.122
e	0.950 typ.		0.037 typ.	
e1	1.900 typ.		0.078 typ.	
L	0.700 ref.		0.028 ref.	
L1	0.300	0.600	0.012	0.024
theta	0°	8°	0°	8°

**Ordering information**

Order code	Package	Baseqty	Deliverymode	Marking
UMW TSV6291AILT	SOT23-5	3000	Tape and reel	K113 U
UMW TSV6291ILT	SOT23-5	3000	Tape and reel	K107 U
UMW TSV6291AICT	SC70-5	3000	Tape and reel	K15 U

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[NJM2904CRB1-TE1](#) [UPC4570G2-E1-A](#) [UPC4741G2-E1-A](#) [UPC4574GR-9LG-E1-A](#) [NJM8532RB1-TE1](#) [EL2250CS](#) [EL5100IS](#) [EL5104IS](#)  
[EL5127CY](#) [EL5127CYZ](#) [EL5133IW](#) [EL5152IS](#) [EL5156IS](#) [EL5162IS](#) [EL5202IY](#) [EL5203IY](#) [EL5204IY](#) [EL5210CS](#) [EL5210CYZ](#)  
[EL5211IYE](#) [EL5220CY](#) [EL5223CLZ](#) [EL5223CR](#) [EL5224ILZ](#) [EL5227CLZ](#) [EL5227CRZ](#) [EL5244CS](#) [EL5246CS](#) [EL5246CSZ](#) [EL5250IY](#)  
[EL5251IS](#) [EL5257IS](#) [EL5260IY](#) [EL5261IS](#)