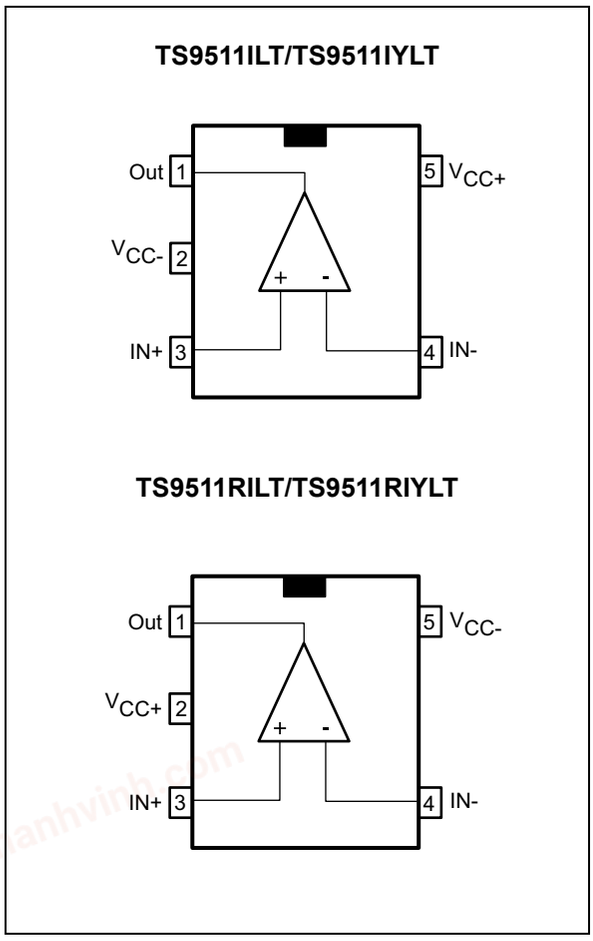
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TS9511

Precision rail-to-rail input/output 3 MHz single operational amplifier

Datasheet - production data



Applications

- Signal conditioning
- Automotive applications
- Laptop/notebook computers
- Transformer/line drivers
- Personal entertainment (CD players)
- Portable communication (cell phones, pagers)
- Digital-to-analog converter buffers
- Portable headphone speaker drivers

Description

The TS9511 device is a single, precision rail-to-rail operational amplifier whose supply voltage range extends from 2.7 V to 12 V.

Its high-precision performance associated with an SOT23-5 package make it suitable for a wide range of demanding applications, such as industrial, automotive, consumer, and computer applications.

Features

- Good precision: 800 µV max.
- Rail-to-rail input and output
- Wide supply voltage range: 2.7 V to 12 V
- High-speed (3 MHz, 1 V/µs)
- Low consumption (900 µA at 3 V)
- Supply voltage rejection ratio: 85 dB
- Micropackage: SOT23-5

This is information on a product in full production. www.st.com

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Contents

1 Absolute maximum ratings and operating conditions 3

2 Electrical characteristics 4

3 Package information 8

3.1 SOT23-5 package information 9

4 Ordering information 10

5 Revision history 10

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1 Absolute maximum ratings and operating conditions

Table 1. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage(1)	14	V
V_{id}	Differential input voltage(2)	±1	
V_{in}	Input voltage(3)	V_{DD}-0.3 to V_{CC}+0.3	
T_{stg}	Storage temperature range	-65 to +150	°C
T_j	Maximum junction temperature	150	
R_{thja}	Thermal resistance junction-to-ambient(4) SOT23-5	250	°C/W
R_{thjc}	Thermal resistance junction-to-case(4) SOT23-5	81	
ESD	HBM: human body model(5)	1	kV
	MM: machine model(6)	100	V
	CDM: charged device model(7)	1.5	kV
	Latch-up immunity	200	mA
	Lead temperature (soldering, 10 sec.)	260	°C

1. All voltage values, except differential voltage, are with respect to network ground terminal.
2. The differential voltage is the non-inverting input terminal with respect to the inverting input terminal. If V_{id} > ±1 V, the maximum input current must not exceed ±1 mA. In this case (V_{id} > ±1 V), an input series resistor must be added to limit input current.
3. Do not exceed 14 V.
4. Short-circuits can cause excessive heating and destructive dissipation. R_{th} are typical values.
5. Human body model: a 100 pF capacitor is charged to the specified voltage, then discharged through a 1.5 kΩ resistor between two pins of the device. This is done for all couples of connected pin combinations while the other pins are floating.
6. 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). This is done for all couples of connected pin combinations while the other pins are floating.
7. Charged device model: all pins and the package are charged together to the specified voltage and then discharged directly to ground through only one pin. This is done for all pins.

Table 2. Operating conditions

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage	2.7 to 12	V
V_{icm}	Common mode input voltage range	V_{DD} -0.2 to V_{CC} +0.2	
T_{oper}	Operating free air temperature range	-40 to +125	°C

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2 Electrical characteristics

Table 3. Electrical characteristics at V_{CC} = +3 V, V_{DD} = 0 V , V_{icm} = V_{CC}/2, R_L connected to V_{CC}/2, T_{amb} = 25 °C (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{io}	Input offset voltage $T_{min} \le T_{amb} \le T_{max}$			800 1500	µV
$\Delta V_{io}/\Delta T$	Input offset voltage drift		2		µV/°C
I_{io}	Input offset current $T_{min} \le T_{amb} \le T_{max}$		1	30 80	nA
I_{ib}	Input bias current $T_{min} \le T_{amb} \le T_{max}$		30	70 150	
CMR	Common mode rejection ratio $T_{min} \le T_{amb} \le T_{max}$	60 55	90		dB
SVR	Supply voltage rejection ratio, V_{CC} = 2.7 to 3.3 V $T_{min} \le T_{amb} \le T_{max}$	65 60	90		
A_{vd}	Large signal voltage gain, V_o = 2 V_{pk-pk}, R_L = 600 Ω $T_{min} \le T_{amb} \le T_{max}$	70 65	80		
V_{OH}	High level output voltage, R_L = 600 Ω $T_{min} \le T_{amb} \le T_{max}$	2.8 2.8	2.9		V
V_{OL}	Low level output voltage, R_L = 600 Ω $T_{min} \le T_{amb} \le T_{max}$		80	250 250	mV
I_{sc}	Output short-circuit current	10	20		mA
I_{CC}	Supply current (per amplifier), no load, V_{icm} = V_{CC}/2 $T_{min} \le T_{amb} \le T_{max}$		0.8	1 1.2	
GBP	Gain bandwidth product R_L = 10 kΩ, C_L = 100 pF		3		MHz
SR	Slew rate R_L = 10 kΩ, C_L = 100 pF		1		V/µs
∅m	Phase margin at unit gain R_L = 10k Ω, C_L = 100 pF		58		Degrees
Gm	Gain margin R_L = 10k Ω, C_L = 100 pF		12		dB
e_n	Equivalent input noise voltage f = 1 kHz		25		$\frac{nV}{\sqrt{Hz}}$
THD	Total harmonic distortion V_{out} = 4 V_{pk-pk}, F = 10 kHz, A_V = 2, R_L =10 kΩ		0.01		%

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Table 4. Electrical characteristics at V_{CC} = +5 V, V_{DD} = 0 V, V_{icm} = V_{CC}/2, R_L connected to V_{CC}/2, T_{amb} = 25 °C (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{io}	Input offset voltage $T_{min} \le T_{amb} \le T_{max}$			800 1500	µV
$\Delta V_{io}/\Delta T$	Input offset voltage drift		2		µV/°C
I_{io}	Input offset current V_{icm} = V_{CC}/2 $T_{min} \le T_{amb} \le T_{max}$		1	30 80	nA
I_{ib}	Input bias current $T_{min} \le T_{amb} \le T_{max}$		30	70 150	
CMR	Common mode rejection ratio $T_{min} \le T_{amb} \le T_{max}$	60 55	90		dB
SVR	Supply voltage rejection ratio, V_{CC} = 4 to 5 V $T_{min} \le T_{amb} \le T_{max}$	65 60	90		
A_{vd}	Large signal voltage gain, V_o = 2 V_{pk-pk}, R_L = 600 Ω $T_{min} \le T_{amb} \le T_{max}$	75 70	86		
V_{OH}	High level output voltage, R_L = 600 Ω $T_{min} \le T_{amb} \le T_{max}$	4.7 4.7	4.8		V
V_{OL}	Low level output voltage, R_L = 600 Ω $T_{min} \le T_{amb} \le T_{max}$		80	300 300	mV
I_{sc}	Output short-circuit current	10	20		mA
I_{CC}	Supply current (per amplifier), no load, V_{icm} = V_{CC}/2 $T_{min} \le T_{amb} \le T_{max}$		0.95	1.2 1.3	
GBP	Gain bandwidth product R_L = 10 kΩ, C_L = 100 pF		3		MHz
SR	Slew rate R_L = 10 kΩ, C_L = 100 pF		1		V/µs
∅m	Phase margin at unit gain R_L = 10k Ω, C_L = 100 pF		61		Degrees
Gm	Gain margin R_L = 10k Ω, C_L =100 pF		13		dB
e_n	Equivalent input noise voltage f = 1 kHz		25		$\frac{nV}{\sqrt{Hz}}$
THD	Total harmonic distortion V_{out} = 4 V_{pk-pk}, F = 10 kHz, A_V = 2, R_L = 10 kΩ		0.01		%

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Figure 1. Supply current vs. supply voltage

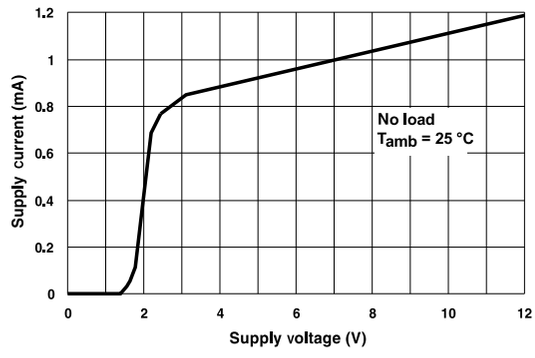


Figure 2. Supply current vs. temperature

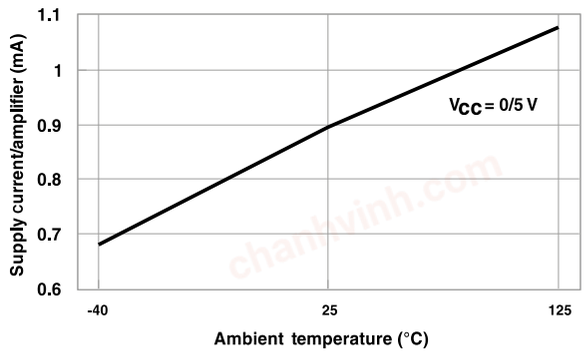


Figure 3. Output short-circuit current vs. output voltage

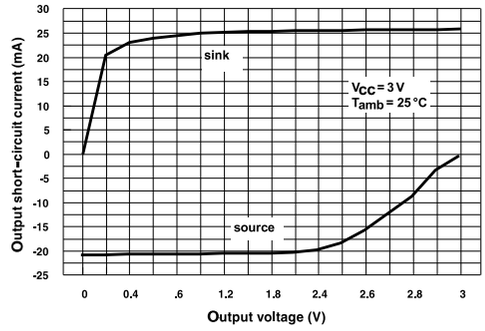


Figure 4. Output short-circuit current vs. temperature

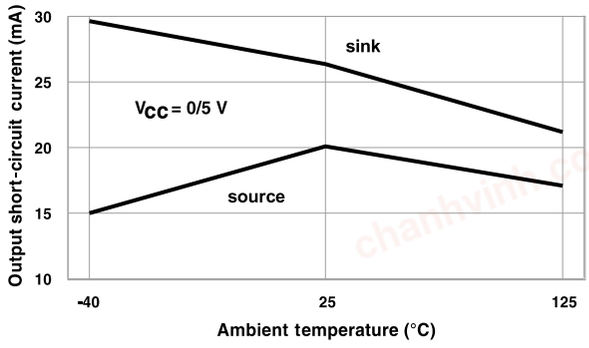


Figure 5. Voltage gain and phase vs. frequency, R_L = 600 Ω, C_L = 100 pF

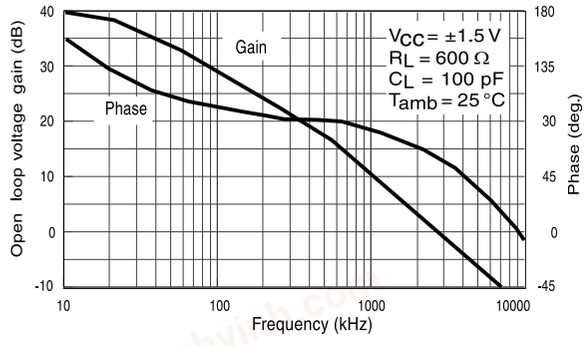
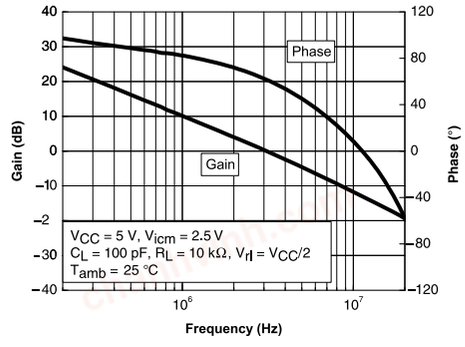


Figure 6. Voltage gain and phase vs. frequency, R_L = 10 kΩ, C_L = 100 pF



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Figure 7. Slew rate vs. temperature

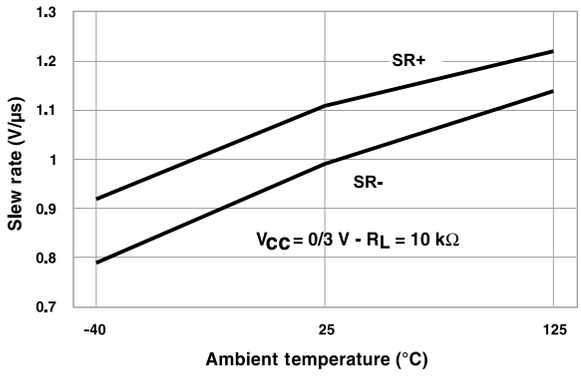


Figure 8. THD + noise vs. V_{out}, R_L = 600 Ω

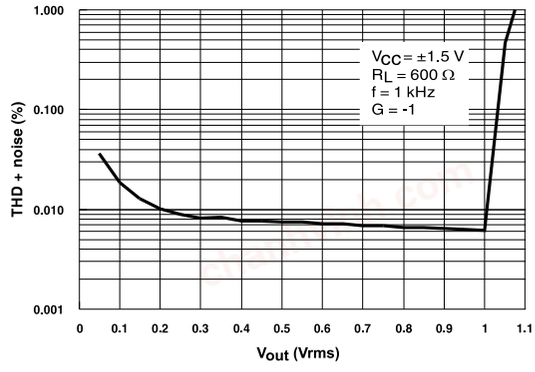


Figure 9. THD + noise vs. V_{out}, R_L = 2 kΩ

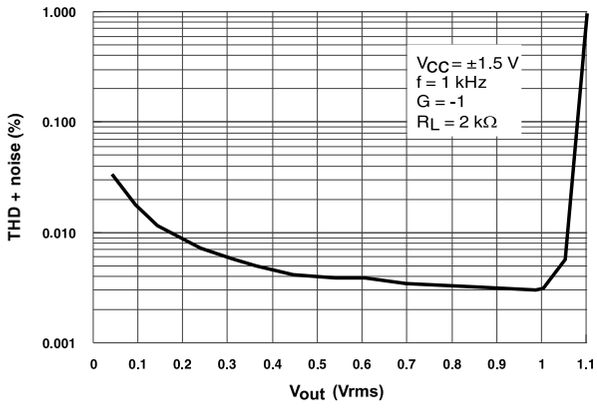


Figure 10. THD + noise vs. frequency

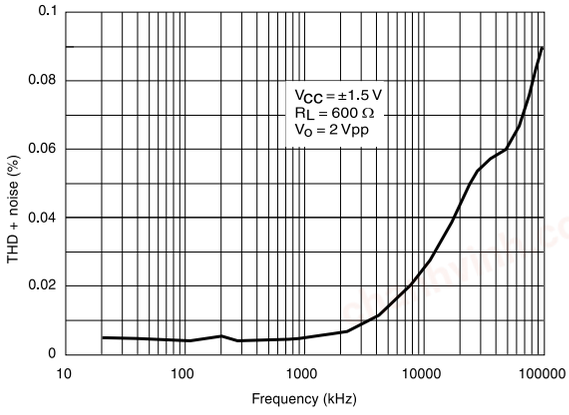
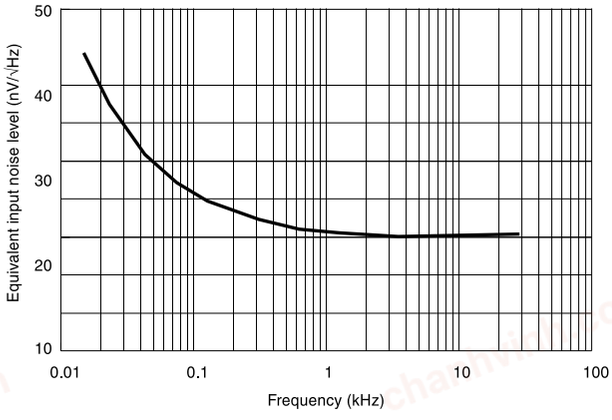


Figure 11. Equivalent input noise voltage vs. frequency



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3 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.

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3.1 SOT23-5 package information

Figure 12. SOT23-5 package outline

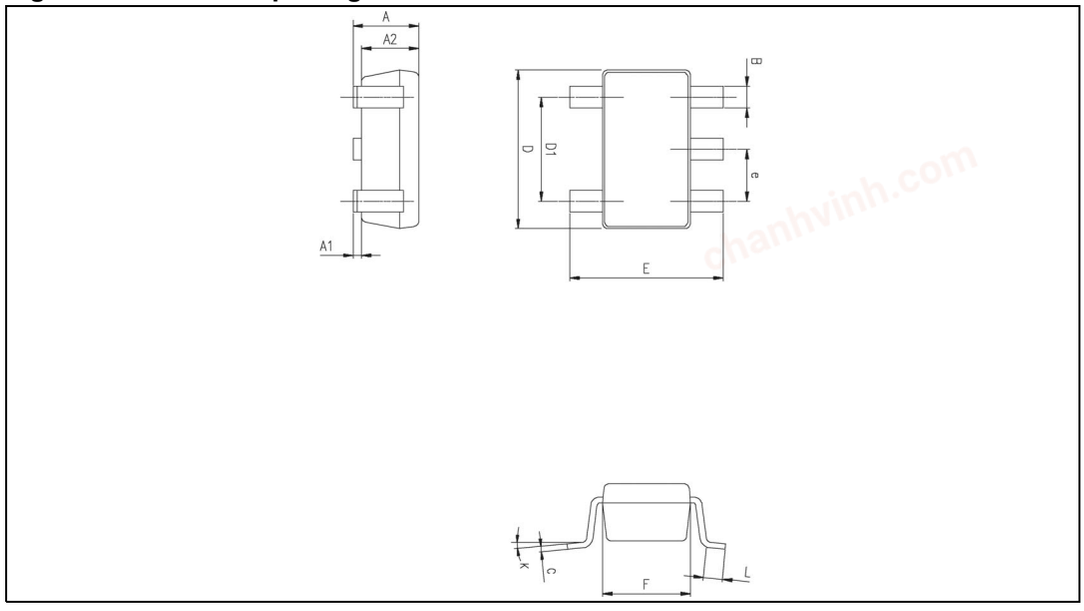


Table 5. SOT23-5 package mechanical data

Symbol	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	0 degrees		10 degrees

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4 Ordering information

Table 6. Order codes

Order code	Temperature range	Package	Packing	Marking
TS9511ILT	-40 °C to +125 °C	SOT23-5L	Tape and reel	K1A1
TS9511RILT				K1A3
TS9511IYLT(1)		SOT23-5L (automotive grade)		K1A2
TS9511RIYLT(1)				K1A4

1. Qualified and characterized according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 and Q 002 or equivalent.

5 Revision history

Table 7. Document revision history

Date	Revision	Changes
25-Jun-2009	1	Initial release.
17-Dec-2009	2	Modified CMR, SVR, A_{vd}, V_{OH}, V_{OL}, I_{SC} and I_{CC} values in *Table 3* and *Table 4*.
19-Sep-2012	3	Updated title of *Figure 8* and *Figure 9* (added conditions). Updated TS9511IYLT order code (qualified status) in *Table 6*. Minor corrections throughout document.
23-Nov-2012	4	Updated *Table 5* Updated markings of *Table 6*
17-Jul-2013	5	Added two new order codes: TS9511RILT and TS9511RIYLT with associated new pinout configuration. *Table 6*: added footnote *1.*
25-Jul-2013	6	Updated pinout numbers in cover page.

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