TS912

Rail-to-rail CMOS dual operational amplifier

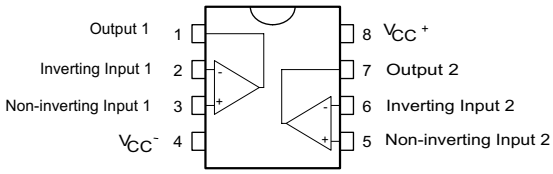
Features

- Rail-to-rail input and output voltage ranges
- Single (or dual) supply operation from 2.7V to 16V
- Extremely low input bias current: 1pA typ.
- Low input offset voltage: 2mV max.
- Specified for 600Ω and 100Ω loads
- Low supply current: 200µA/ampli (V_{CC} = 3V)
- Latch-up immunity
- ESD tolerance: 3kV
- Spice macromodel included in this specification

N
DIP-8
(Plastic package)

D
SO-8
(Plastic micropackage)

Pin connections (top view)



Description

The TS912 is a rail-to-rail CMOS dual operational amplifier designed to operate with a single or dual supply voltage.

The input voltage range V_{icm} includes the two supply rails V_{CC}^+ and V_{CC}^-.

The output reaches:

- V_{CC}^- +30mV, V_{CC}^+ -40mV, with R_L = 10kΩ
- V_{CC}^- +300mV, V_{CC}^+ -400mV, with R_L = 600Ω

This product offers a broad supply voltage operating range from 2.7V to 16V and supply current of only 200µA/amp (V_{CC} = 3V).

Source and sink output current capability is typically 40mA (at V_{CC} = 3V), fixed by an internal limitation circuit.

1 Absolute maximum ratings and operating conditions

Table 1. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage (1)	18	V
V_{id}	Differential input voltage (2)	±18	V
V_i	Input voltage (3)	-0.3 to 18	V
I_{in}	Current on inputs	±50	mA
I_o	Current on outputs	±130	mA
T_{stg}	Storage temperature	-65 to +150	°C
T_j	Maximum junction temperature	150	°C
R_{thja}	Thermal resistance junction to ambient (4) DIP8 SO-8	 85 125	°C/W
R_{thjc}	Thermal resistance junction to case (4) DIP8 SO-8	 41 40	°C/W
ESD	HBM: human body model(5)	3	kV
	MM: machine model(6)	200	V
	CDM: charged device model(7)	1500	V

1. All voltage values, except differential voltage are with respect to network ground terminal.
2. Differential voltages are non-inverting input terminal with respect to the inverting input terminal.
3. The magnitude of input and output voltages must never exceed V_{CC}^+ +0.3V.
4. Short-circuits can cause excessive heating. Destructive dissipation can result from simultaneous short-circuits on all amplifiers. These values are typical.
5. Human body model: A 100pF capacitor is charged to the specified voltage, then discharged through a 1.5kΩ 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 200pF capacitor is charged to the specified voltage, then discharged directly between two pins of the device with no external series resistor (internal resistor < 5Ω). 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 the 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 16	V
V_{icm}	Common mode input voltage range	V_{CC}^--0.2 to V_{CC}^++0.2	V
T_{oper}	Operating free air temperature range	-40 to + 125	°C

3 Electrical characteristics

Table 3. V_{CC}^+ = 3V, V_{CC}^- = 0V, R_L, C_L connected to V_{CC}/2, T_{amb} = 25°C (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{io}	Input offset voltage (V_{ic} = V_o = V_{CC}/2) TS912 TS912A TS912B $T_{min} \le T_{amb} \le T_{max}$ TS912 TS912A TS912B			 10 5 2 12 7 3	mV
ΔV_{io}	Input offset voltage drift		5		µV/°C
I_{io}	Input offset current (1) $T_{min} \le T_{amb} \le T_{max}$		1	100 200	pA
I_{ib}	Input bias current (1) $T_{min} \le T_{amb} \le T_{max}$		1	150 300	pA
I_{CC}	Supply current (per amplifier, A_{VCL} = 1, no load) $T_{min} \le T_{amb} \le T_{max}$		200	300 400	µA
CMR	Common mode rejection ratio V_{ic} = 0 to 3V, V_o = 1.5V		70		dB
SVR	Supply voltage rejection ratio (V_{CC}^+ = 2.7 to 3.3V, V_o = V_{CC}/2)	50	80		dB
A_{vd}	Large signal voltage gain (R_L = 10kΩ, V_o = 1.2V to 1.8V) $T_{min} \le T_{amb} \le T_{max}$	3 2	10		V/mV
V_{OH}	High level output voltage (V_{id} = 1V) R_L = 100kΩ R_L = 10kΩ R_L = 600Ω R_L = 100Ω $T_{min} \le T_{amb} \le T_{max}$ R_L = 10kΩ R_L = 600Ω	 2.95 2.9 2.3 2.8 2.1	 2.96 2.6 2		V
V_{OL}	Low level output voltage (V_{id} = -1V) R_L = 100kΩ R_L = 10kΩ R_L = 600Ω R_L = 100Ω $T_{min} \le T_{amb} \le T_{max}$ R_L = 10kΩ R_L = 600Ω		 30 300 900	 50 70 400 100 600	mV
I_o	Output short-circuit current (V_{id} = ±1V) Source (V_o = V_{CC}^-) Sink (V_o = V_{CC}^+)	 20 20	 40 40		mA
GBP	Gain bandwidth product (A_{VCL} = 100, R_L = 10kΩ, C_L = 100pF, f = 100kHz)		0.8		MHz

Table 3. V_{CC}^+ = 3V, V_{CC}^- = 0V, R_L, C_L connected to V_{CC}/2, T_{amb} = 25°C (unless otherwise specified) (continued)

Symbol	Parameter	Min.	Typ.	Max.	Unit
SR^+	Slew rate (A_{VCL} = 1, R_L = 10kΩ, C_L = 100pF, V_i = 1.3V to 1.7V)		0.4		V/µs
SR^-	Slew rate (A_{VCL} = 1, R_L = 10kΩ, C_L = 100pF, V_i = 1.3V to 1.7V)		0.3		V/µs
ϕm	Phase margin		30		Degrees
en	Equivalent input noise voltage (R_S = 100Ω, f = 1kHz)		30		nV/√Hz

1. Maximum values include unavoidable inaccuracies of the industrial tests.

Table 4. $V_{CC}^+ = 5V$, $V_{CC}^- = 0V$, R_L, C_L connected to $V_{CC}/2$, $T_{amb} = 25°C$ (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{io}	Input offset voltage ($V_{ic} = V_o = V_{CC}/2$) TS912 TS912A TS912B $T_{min} \le T_{amb} \le T_{max}$ TS912 TS912A TS912B			 10 5 2 12 7 3	mV
ΔV_{io}	Input offset voltage drift		5		µV/°C
I_{io}	Input offset current (1) $T_{min} \le T_{amb} \le T_{max}$		1	100 200	pA
I_{ib}	Input bias current (1) $T_{min} \le T_{amb} \le T_{max}$		1	150 300	pA
I_{CC}	Supply current (per amplifier, $A_{VCL} = 1$, no load) $T_{min} \le T_{amb} \le T_{max}$		230	350 450	µA
CMR	Common mode rejection ratio V_{ic} = 1.5 to 3.5V, V_o = 2.5V	60	85		dB
SVR	Supply voltage rejection ratio (V_{CC}^+ = 3 to 5V, $V_o = V_{CC}/2$)	55	80		dB
A_{vd}	Large signal voltage gain (R_L = 10kΩ, V_o = 1.5V to 3.5V) $T_{min} \le T_{amb} \le T_{max}$	10 7	40		V/mV
V_{OH}	High level output voltage (V_{id} = 1V) R_L = 100kΩ R_L = 10kΩ R_L = 600Ω R_L = 100Ω $T_{min} \le T_{amb} \le T_{max}$ R_L = 10kΩ R_L = 600Ω	 4.95 4.9 4.25 4.8 4.1	 4.95 4.55 3.7		V
V_{OL}	Low level output voltage (V_{id} = -1V) R_L = 100kΩ R_L = 10kΩ R_L = 600Ω R_L = 100Ω $T_{min} \le T_{amb} \le T_{max}$ R_L = 10kΩ R_L = 600Ω		 40 350 1400	 50 100 500 150 750	mV
I_o	Output short-circuit current (V_{id} = ±1V) Source ($V_o = V_{CC}^-$) Sink ($V_o = V_{CC}^+$)	 45 45	 65 65		mA
GBP	Gain bandwidth product (A_{VCL} = 100, R_L = 10kΩ, C_L = 100pF, f = 100kHz)		1		MHz
SR^+	Slew rate (A_{VCL} = 1, R_L = 10kΩ, C_L = 100pF, V_i = 1V to 4V)		0.8		V/µs
SR^-	Slew rate (A_{VCL} = 1, R_L = 10kΩ, C_L = 100pF, V_i = 1V to 4V)		0.6		V/µs

Table 4. V_{CC}^+ = 5V, V_{CC}^- = 0V, R_L, C_L connected to V_{CC}/2, T_{amb} = 25°C (unless otherwise specified) (continued)

Symbol	Parameter	Min.	Typ.	Max.	Unit
en	Equivalent input noise voltage (R_S = 100Ω, f = 1kHz)		30		nV/√Hz
V_{O1}/V_{O2}	Channel separation (f = 1kHz)		120		dB
ϕm	Phase margin		30		Degrees

1. Maximum values include unavoidable inaccuracies of the industrial tests.

Table 5. V_{CC}^+ = 10V, V_{CC}^- = 0V, R_L, C_L connected to $V_{CC}/2$, T_{amb} = 25°C (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{io}	Input offset voltage ($V_{ic} = V_o = V_{CC}/2$) TS912 TS912A TS912B $T_{min} \le T_{amb} \le T_{max}$ TS912 TS912A TS912B			 10 5 2 12 7 3	mV
ΔV_{io}	Input offset voltage drift		5		µV/°C
I_{io}	Input offset current (1) $T_{min} \le T_{amb} \le T_{max}$		1	100 200	pA
I_{ib}	Input bias current (1) $T_{min} \le T_{amb} \le T_{max}$		1	150 300	pA
I_{CC}	Supply current (per amplifier, A_{VCL} = 1, no load) $T_{min} \le T_{amb} \le T_{max}$		400	600 700	µA
CMR	Common mode rejection ratio V_{ic} = 3 to 7V, V_o = 5V V_{ic} = 0 to 10V, V_o = 5V	 60 50	 90 75		dB
SVR	Supply voltage rejection ratio (V_{CC}^+ = 5 to 10V, $V_o = V_{CC}/2$)	60	90		dB
A_{vd}	Large signal voltage gain (R_L = 10kΩ, V_o = 2.5V to 7.5V) $T_{min} \le T_{amb} \le T_{max}$	15 10	50		V/mV
V_{OH}	High level output voltage (V_{id} = 1V) R_L = 100kΩ R_L = 10kΩ R_L = 600Ω R_L = 100Ω $T_{min} \le T_{amb} \le T_{max}$ R_L = 10kΩ R_L = 600Ω	 9.95 9.85 9 9.8 8.8	 9.95 9.35 7.8		V
V_{OL}	Low level output voltage (V_{id} = -1V) R_L = 100kΩ R_L = 10kΩ R_L = 600Ω R_L = 100Ω $T_{min} \le T_{amb} \le T_{max}$ R_L = 10kΩ R_L = 600Ω		 50 650 2300	 50 150 800 150 900	mV
I_o	Output short circuit current (V_{id} = ±1V) Source ($V_o = V_{CC}^-$) Sink ($V_o = V_{CC}^+$)	 45 50	 65 75		mA
GBP	Gain bandwidth product (A_{VCL} = 100, R_L = 10kΩ, C_L = 100pF, f = 100kHz)		1.4		MHz

Table 5. V_{CC}^+ = 10V, V_{CC}^- = 0V, R_L, C_L connected to V_{CC}/2, T_{amb} = 25°C (unless otherwise specified) (continued)

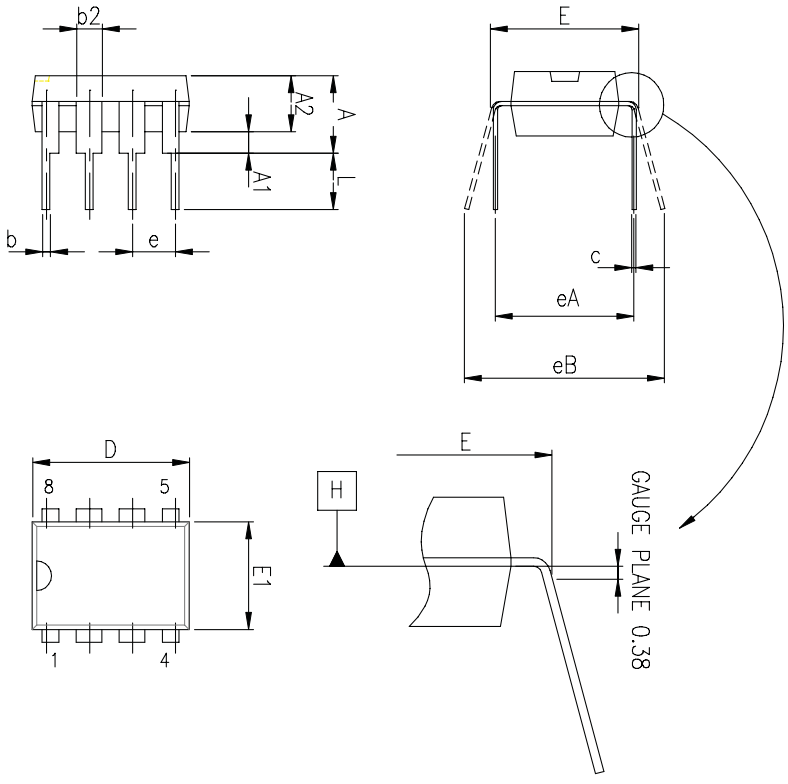
Symbol	Parameter	Min.	Typ.	Max.	Unit
SR^+	Slew rate (A_{VCL} = 1, R_L = 10kΩ, C_L = 100pF, V_i = 2.5V to 7.5V)		1.3		V/µs
SR^-	Slew rate (A_{VCL} = 1, R_L = 10kΩ, C_L = 100pF, V_i = 2.5V to 7.5V)		0.8		V/µs
ϕm	Phase margin		40		Degrees
en	Equivalent input noise voltage (R_S = 100Ω, f = 1kHz)		30		nV/√Hz
THD	Total harmonic distortion (A_{VCL} = 1, R_L = 10kΩ, C_L = 100pF, V_o = 4.75V to 5.25V, f = 1kHz)		0.02		%
C_{in}	Input capacitance		1.5		pF

1. Maximum values include unavoidable inaccuracies of the industrial tests.

5.1 DIP-8 package mechanical data

Figure 15. DIP8 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			5.33			0.210
A1	0.38			0.015		
A2	2.92	3.30	4.95	0.115	0.130	0.195
b	0.36	0.46	0.56	0.014	0.018	0.022
b2	1.14	1.52	1.78	0.045	0.060	0.070
c	0.20	0.25	0.36	0.008	0.010	0.014
D	9.02	9.27	10.16	0.355	0.365	0.400
E	7.62	7.87	8.26	0.300	0.310	0.325
E1	6.10	6.35	7.11	0.240	0.250	0.280
e		2.54			0.100	
eA		7.62			0.300	
eB			10.92			0.430
L	2.92	3.30	3.81	0.115	0.130	0.150



6 Ordering information

Table 6. Order codes

Part number	Temperature range	Package	Packing	Marking
TS912IN	-40°C, +125°C	DIP8	Tube	TS912IN
TS912AIN				TS912AIN
TS912ID TS912IDT		SO-8	Tube or Tape & reel	912I
TS912AID TS912AIDT				912AI
TS912BID TS912BIDT				912BI
TS912IYD TS912IYDT(1)		SO-8 (Automotive grade level)		912IY
TS912AIYD TS912AIYDT(1)				912AIY
TS912BIYD TS912BIYDT(1)				912BY

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