

### Features

- Quad micro power op amp
- Wide range of supply voltage: 1.6V~5.5V
- High input impedance
- Single supply operation
- Low current consumption: < 5 $\mu$ A per amp
- Rail to rail output
- Provides both sink and source output drive capability
- Common mode input extends below negative rail
- Pin compatible with LM324/WT274 (14-pin DIP)
- 14-pin DIP/SOP package

### Applications

- Battery powered system
- Sensor amplifier
- Low power gain blocks
- Low power comparators
- Signal detectors
- Active filters
- Caller ID systems
- Communication systems

### General Description

The HT9274 is a CMOS quad micro-power operational amplifier featuring high input impedance, extremely low power, high gain and high stability.

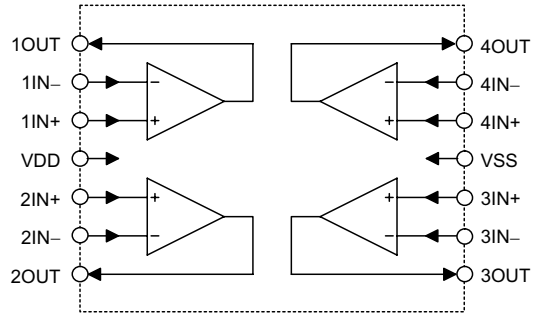
It allows common mode input voltage range which extends below the negative rail, output swings to both rails with a reasonable sink and source capability of the output drive current. This cost-effective device is suitable for high

gain, low frequency, low power applications, especially ideal for battery powered systems where  $\mu$ A range of standby current is essential for long battery life span. For example, in multi-standard Caller ID systems, HT9274 is ideal as a low power line signal monitor/detector, and in car alarm systems, the HT9274 is excellent for piezo vibratile detector signal amplifier application.

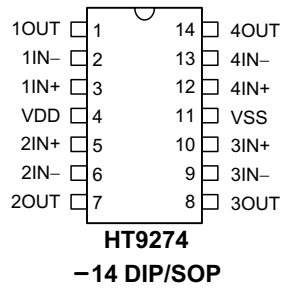
### Comparison Table

ITEM	Operating Voltage	Operating Current	Output Source Current	Output Sink Current	Input Bias Current	GBW	Max. load (To VDD or VSS)
HT9274	1.6~5.5V	5 $\mu$ A	500 $\mu$ A	500 $\mu$ A	1pA	0.1MHz	>10k $\Omega$
WT274	1.35~10V	9 $\mu$ A	16 $\mu$ A	2mA	1pA	0.1MHz	>500k $\Omega$
LM324	3~32V	400 $\mu$ A	20mA	8mA	45nA	1MHz	>2k $\Omega$

**Block Diagram**



**Pin Assignment**



**Pin Description**

Pin No.	Pin Name	I/O	Internal Connection	Description
1	1OUT	O	CMOS OUT	Output pin of the op amp 1
2	1IN-	I	PMOS IN	Inverting input pin of the op amp 1
3	1IN+	I	PMOS IN	Noninverting input pin of the op amp 1
4	VDD	—	—	Positive power supply
5	2IN+	I	PMOS IN	Noninverting input pin of the op amp 2
6	2IN-	I	PMOS IN	Inverting input pin of the op amp 2
7	2OUT	O	CMOS OUT	Output pin of the op amp 2
8	3OUT	O	CMOS OUT	Output pin of the op amp 3
9	3IN-	I	PMOS IN	Inverting input pin of the op amp 3
10	3IN+	I	PMOS IN	Noninverting input pin of the op amp 3
11	VSS	—	—	Negative power supply
12	4IN+	I	PMOS IN	Noninverting input pin of the op amp 4
13	4IN-	I	PMOS IN	Inverting input pin of the op amp 4
14	4OUT	O	CMOS OUT	Output pin of the op amp 4

**Absolute Maximum Ratings**

Supply Voltage .....-0.3V to 6V      Storage Temperature.....-50°C to 125°C  
 Input Voltage ..... $V_{SS}-0.3V$  to  $V_{DD}+0.3V$       Operating Temperature .....-20°C to 75°C

Note: These are stress ratings only. Stresses exceeding the range specified under "Absolute Maximum Ratings" may cause substantial damage to the device. Functional operation of this device at other conditions beyond those listed in the specification is not implied and prolonged exposure to extreme conditions may affect device reliability.

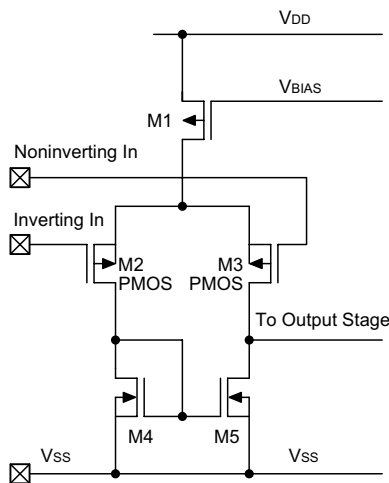
**Electrical Characteristics**
 $T_a=25^{\circ}\text{C}$ 

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V <sub>DD</sub>	Conditions				
V <sub>OS</sub>	Input Offset Voltage	5V	V <sub>o</sub> =1.4V	—	—	5	mV
$\Delta V_{OS}/\Delta T$	Temperature Coefficient of V <sub>OS</sub>	5V	—	—	2	—	$\mu\text{V}/^{\circ}\text{C}$
I <sub>OS</sub>	Input Offset Current	5V	V <sub>i</sub> =V <sub>o</sub> =1.4V -20°C<T <sub>a</sub> <75°C	—	1	100	pA
I <sub>b</sub>	Input Bias Current	5V	V <sub>i</sub> =V <sub>o</sub> =1.4V -20°C<T <sub>a</sub> <75°C	—	1	150	pA
V <sub>OUT+</sub>	Positive Output Voltage Swing	5V	R <sub>L</sub> =1M $\Omega$ V <sub>IN+</sub> -V <sub>IN-</sub> ≥10mV	4.9	4.95	—	V
V <sub>OUT-</sub>	Negative Output Voltage Swing	5V	R <sub>L</sub> =1M $\Omega$ V <sub>IN-</sub> -V <sub>IN+</sub> ≥10mV	—	0.01	0.05	V
A <sub>VOL</sub>	Large Signal Voltage Gain	5V	V <sub>i</sub> =1.4V R <sub>L</sub> =1M $\Omega$ V <sub>O</sub> =1 to 4V	20	200	—	V/mV
GBW	Gain Band Width Product	5V	R <sub>L</sub> =1M $\Omega$ C <sub>L</sub> =100pF	—	0.1	—	MHz
CMRR	Common Mode Rejection Ratio	5V	V <sub>o</sub> =1.4V V <sub>i</sub> =0V	60	80	—	dB
PSRR	Power Supply Rejection Ratio	1.8~5V	V <sub>o</sub> =1.4V	60	80	—	dB
I <sub>CC</sub>	Supply Current Per Single Amplifier	5V	A <sub>v</sub> =1 V <sub>o</sub> =1.4V No load	—	3	5	$\mu\text{A}$
SR	Slew Rate at Unity Gain	5V	No load	—	0.03	—	V/ $\mu\text{s}$
$\Phi_m$	Phase Margin at Unity Gain	5V	R <sub>L</sub> =1M $\Omega$ C <sub>L</sub> =100pF	—	55	—	Degree
e <sub>n</sub>	Input Equivalent Noise Voltage	5V	f=1kHz R <sub>S</sub> =10 $\Omega$	$\Sigma$	50	$\Sigma$	nV/ $\sqrt{\text{Hz}}$
V <sub>01</sub> /V <sub>02</sub>	Cross Talk Attenuation	5V	—	—	100	—	dB
I <sub>OH</sub>	Output Source Current	5V	V <sub>IN+</sub> -V <sub>IN-</sub> ≥10mV	-300	-500	—	$\mu\text{A}$
I <sub>OL</sub>	Output Sink Current	5V	V <sub>IN-</sub> -V <sub>IN+</sub> ≥10mV	300	500	—	$\mu\text{A}$

## Functional Description

### Input stage

The input stage of op amps are nominal PMOS differential amplifiers (see the following diagram), therefore the common mode input voltage can extend to  $V_{SS}-0.6V$ . On the other hand the common mode input voltage has to be maintained below  $(V_{DD}-1)V$  to keep the input device (M2 and M3) active. This implies that when using HT9274 as a voltage follower, the input as well as output active range will be limited between  $V_{SS} \sim V_{DD}-1V$  (approx.). Avoid applying any voltage greater than  $V_{DD}+0.6V$  or less than  $V_{SS}-0.6V$  to the input pins, otherwise the internal input protection devices may be damaged.



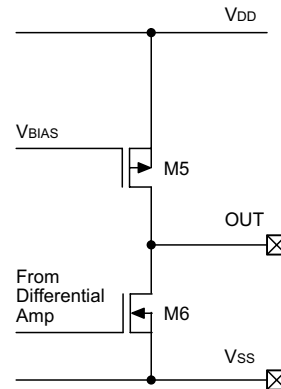
Since the input impedance of PMOS is inherently very high, it can directly couple to high impedance elements without loading effect. For example, coupling to ceramic transducers, integrating capacitor and resistor networks.

Actually the extremely high input impedance is its major advantage over the bipolar counterpart, in some application fields such as integrators where the input current of op amp can cause significant error, the HT9274 is a better choice than the popular LM324.

### Output stage

The HT9274 uses push-pull CMOS configuration as the output stage of op amps to minimize low power consumption and to provide adequate output driving current.

Note that the output is an unbuffered structure, therefore the open loop gain will be affected by the load resistor since the voltage gain of this stage can be expressed as  $(gm5+gm6) \times R_L$ .

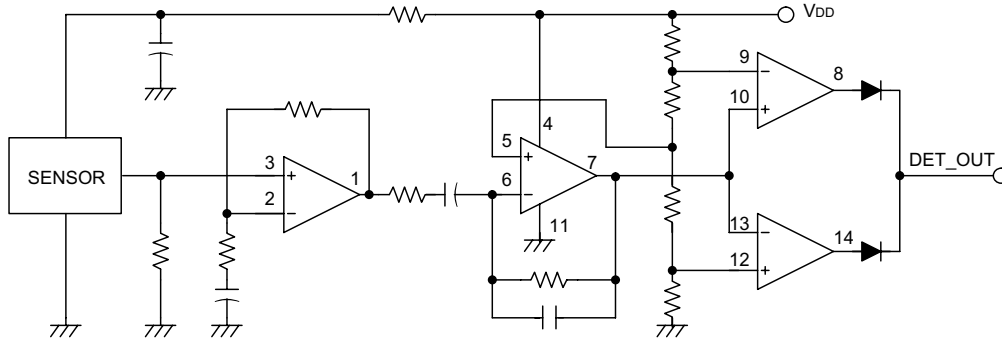


Because of the consideration for minimized power consumption, the max. output current is limited to about  $400\mu A$  for both source and sink drive. This is believed to be enough for most low power systems, however it is recommended to use the load resistor of  $>10k\Omega$  for normal applications. In case of heavy load driving, an external buffer stage using bipolar transistors is recommended.

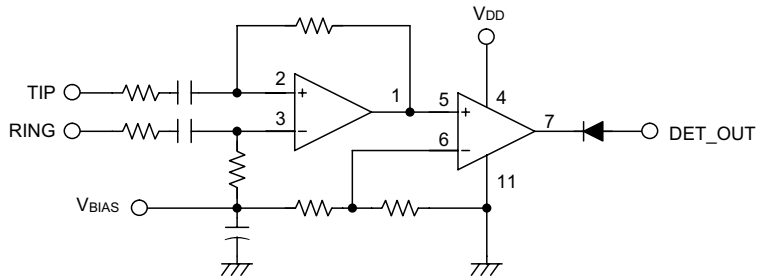
The HT9274 is internally compensated for AC stability and capable to withstand up to a  $100pF$  capacitive load.

Application Circuits

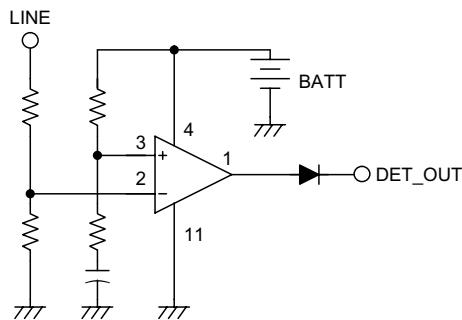
Micro power sensor amplifier & detector



Micro power line signal monitor



Micro power line voltage monitor



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