

---

# HA17902 Series

## Quad Operational Amplifier

# HITACHI

---

### Description

The HA17902 is an internal phase compensation quad operational amplifier that operates on a single-voltage power supply and is appropriate for use in a wide range of general-purpose control equipment.

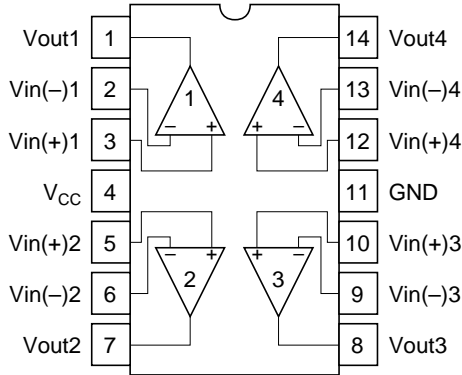
### Features

- Wide usable power-supply voltage range and single-voltage supply operation
- Internal phase compensation
- Wide common-mode voltage range and operation for inputs close to the 0 level

### Ordering Information

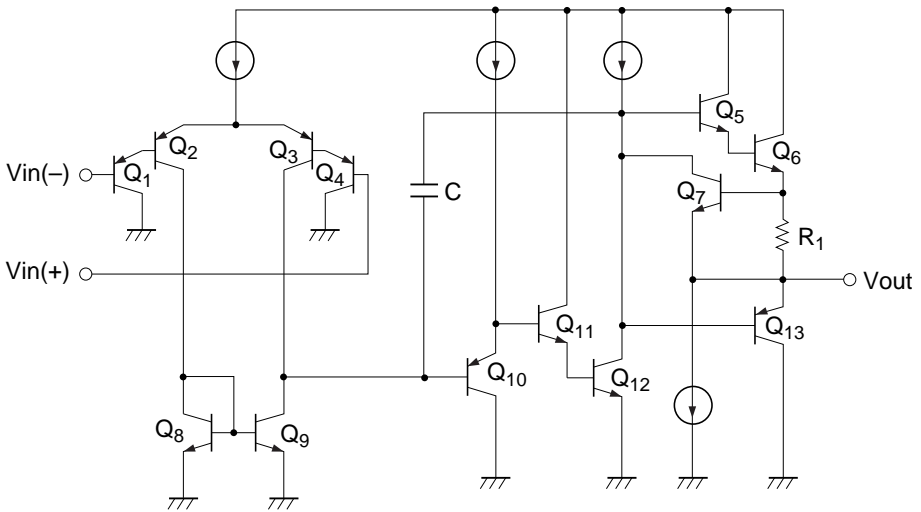
Type No.	Application	Package
HA17902PJ	Car use	DP-14
HA17902FPJ		FP-14DA
HA17902FPK		FP-14DA
HA17902P	Industrial use	DP-14
HA17902FP		FP-14DA
HA17902	Commercial use	DP-14

## Pin Arrangement



(Top view)

## Circuit Structure (1/4)



**Absolute Maximum Ratings (Ta = 25°C)**

Item	Symbol	HA17902/ P	HA17902 PJ	HA17902 FP	HA17902 FPJ	HA17902 FPK	Unit
Power supply voltage	V <sub>CC</sub>	28	28	28	28	28	V
Sink current	I <sub>o sink</sub>	50	50	50	50	25	mA
Allowable power dissipation	P <sub>T</sub>	625* <sup>1</sup>	625* <sup>1</sup>	625* <sup>2</sup>	625* <sup>2</sup>	625* <sup>2</sup>	mW
Common-mode input voltage	V <sub>CM</sub>	-0.3 to V <sub>CC</sub>	-0.3 to V <sub>CC</sub>	-0.3 to V <sub>CC</sub>	-0.3 to V <sub>CC</sub>	-0.3 to V <sub>CC</sub>	V
Differential-mode input voltage	V <sub>in(diff)</sub>	±V <sub>CC</sub>	±V <sub>CC</sub>	±V <sub>CC</sub>	±V <sub>CC</sub>	±V <sub>CC</sub>	V
Operating temperature	Topr	-20 to +75	-40 to +85	-20 to +75	-40 to +85	-40 to +125	°C
Storage temperature	Tstg	-55 to +125	-55 to +125	-55 to +125	-55 to +125	-55 to +150	°C

Notes: 1. These are the allowable values up to Ta = 50°C. Derate by 8.3mW/°C above that temperature.  
 2. See notes on SOP Package Usage in Reliability section.

# HA17902 Series

## Electrical Characteristics 1 ( $V_{CC} = +15V$ , $T_a = 25^\circ C$ )

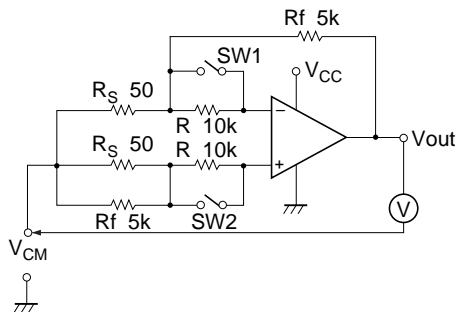
Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Input offset voltage	$V_{IO}$	—	3	8	mV	$V_{CM} = 7.5V$ , $R_S = 50\Omega$ , $R_f = 5k\Omega$
Input offset current	$I_{IO}$	—	5	50	nA	$I_{IO} =  I_1^- - I_1^+ $ , $V_{CM} = 7.5V$
Input bias current	$I_{IB}$	—	30	500	nA	$V_{CM} = 7.5V$
Power-supply rejection ratio	PSRR	—	93	—	dB	$f = 100Hz$ , $R_S = 1k\Omega$ , $R_f = 100k\Omega$
Voltage gain	$A_{VD}$	75	90	—	dB	$R_S = 1k\Omega$ , $R_f = 100k\Omega$ , $R_L = \infty$
Common-mode rejection ratio	CMR	—	80	—	dB	$R_S = 50\Omega$ , $R_f = 5k\Omega$
Common-mode input voltage range	$V_{CM}$	-0.3	—	13.5	V	$R_S = 1k\Omega$ , $R_f = 100k\Omega$ , $f = 100Hz$
Maximum output voltage amplitude	$V_{OP-P}$	—	13.6	—	V	$f = 100Hz$ , $R_S = 1k\Omega$ , $R_f = 100k\Omega$ , $R_L = 20k\Omega$
Output voltage	$V_{OH1}$	13.2	13.6	—	V	$I_{OH} = -1mA$
	$V_{OH2}$	12	13.3	—	V	$I_{OH} = -10mA$
	$V_{OL1}$	—	0.8	1	V	$I_{OL} = 1mA$
	$V_{OL2}$	—	1.1	1.8	V	$I_{OL} = 10mA$
Output source current	Io source	15	—	—	mA	$V_{OH} = 10V$
Output sink current	Io sink	3	9	—	mA	$V_{OL} = 1V$
Supply current	$I_{CC}$	—	0.8	2	mA	$V_{in} = GND$ , $R_L = \infty$
Slew rate	SR	—	0.19	—	V/ $\mu s$	$f = 1.5kHz$ , $V_{CM} = 7.5V$ , $R_L = \infty$
Channel separation	CS	—	120	—	dB	$f = 1kHz$

## Electrical Characteristics 2 ( $V_{CC} = +15V$ , $T_a = -40$ to $125^\circ C$ )

Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Input offset voltage	$V_{IO}$	—	—	8	mV	$V_{CM} = 7.5V$ , $R_S = 50\Omega$ , $R_f = 5k\Omega$
Input offset current	$I_{IO}$	—	—	200	nA	$V_{CM} = 7.5V$ , $I_{IO} =  I_1^- - I_1^+ $
Input bias current	$I_{IB}$	—	—	500	nA	$V_{CM} = 7.5V$
Common-mode input voltage range	$V_{CM}$	0	—	13.0	V	$R_S = 1k\Omega$ , $R_f = 100k\Omega$ , $f = 100Hz$
Output voltage	$V_{OH}$	13.0	—	—	V	$I_{OH} = -1mA$
	$V_{OL}$	—	—	1.3	V	$I_{OL} = 1mA$
Supply current	$I_{CC}$	—	—	4	mA	$V_{in} = GND$ , $R_L = \infty$

**Test Circuits**

1. Input offset voltage ( $V_{IO}$ ), input offset current ( $I_{IO}$ ), and Input bias current ( $I_{IB}$ ) test circuit



SW1	SW2	$V_O$
On	On	$V_{O1}$
Off	Off	$V_{O2}$
On	Off	$V_{O3}$
Off	On	$V_{O4}$

$$V_{CM} = \frac{1}{2} V_{CC}$$

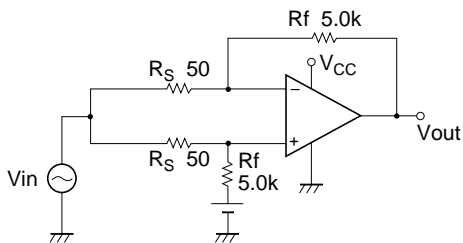
$$V_{IO} = \frac{V_{O1}}{1 + R_f / R_S} \quad (\text{mV})$$

$$I_{IO} = \frac{V_{O2} - V_{O1}}{R(1 + R_f / R_S)} \quad (\text{nA})$$

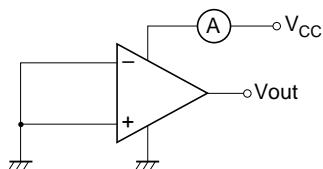
$$I_{IB} = \frac{|V_{O4} - V_{O3}|}{2 \cdot R(1 + R_f / R_S)} \quad (\text{nA})$$

2. Common-mode rejection ratio (CMR) test circuit

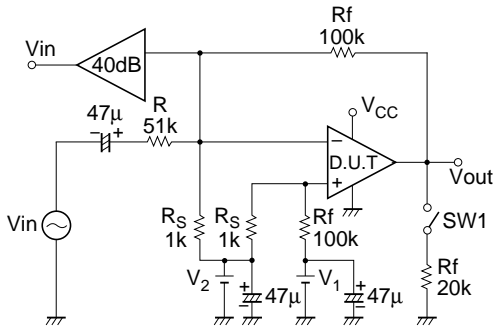
$$\text{CMR} = 20 \log \frac{V_{IN} \cdot R_f}{V_O \cdot R_S} \quad (\text{dB})$$



3. Supply current ( $I_{CC}$ ) test circuit



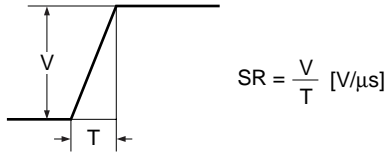
4. Voltage gain ( $A_{VD}$ ), slew rate (SR), common-mode input voltage range ( $V_{CM}$ ), and maximum output voltage amplitude ( $V_{OP-P}$ ) test circuit.



- (1)  $A_{VD}$ :  $R_S = 1k\Omega$ ,  $R_f = 100k\Omega$ ,  $R_L = \infty$ ,  $V_1 = V_2 = 1/2 V_{CC}$

$$A_{VD} = 20 \log \frac{V_O}{V_{IN}} + 40 \quad (\text{dB})$$

- (2) SR:  $f = 1.5kHz$ ,  $R_L = \infty$ ,  $V_1 = V_2 = 1/2 V_{CC}$

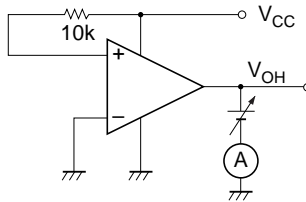


- (3)  $V_{CM}$ :  $R_S = 1k\Omega$ ,  $R_f = 100k\Omega$ ,  $f = 100Hz$ ,  $V_1 = 1/2 V_{CC}$ ,  $R_L = \infty$ , and the value of  $V_2$  just slightly prior to the point where the output waveform changes.

- (4)  $V_{OP-P}$ :  $R_S = 1k\Omega$ ,  $R_f = 100k\Omega$ ,  $R_L = 20k\Omega$ ,  $f = 100Hz$ ,  $V_{OP-P} = V_{OH} \leftrightarrow V_{OL} \text{ [V}_{P-P}\text{]}$

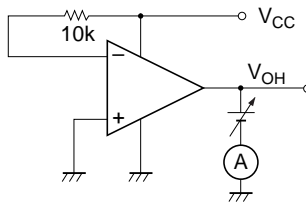
5. Output source current ( $I_{osource}$ ) test circuit

$I_o$  source:  $V_{OH} = 10V$

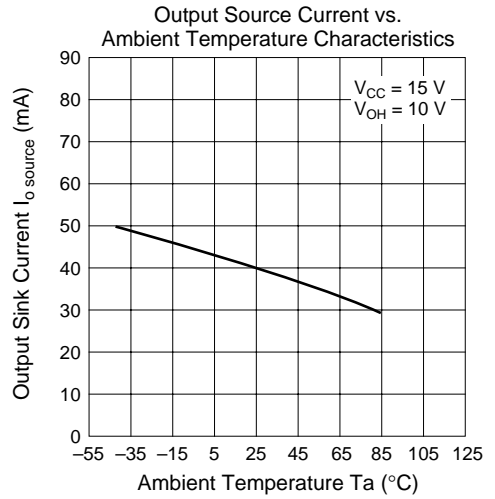
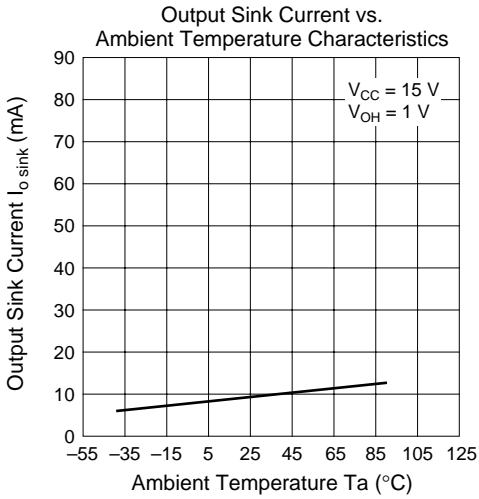
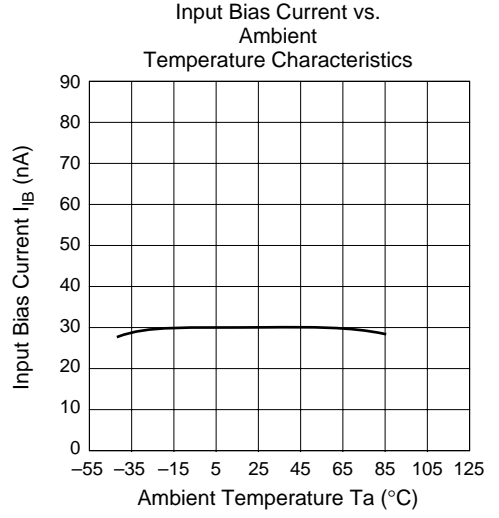
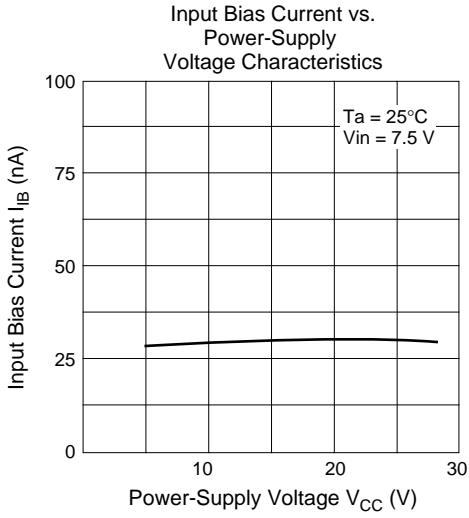


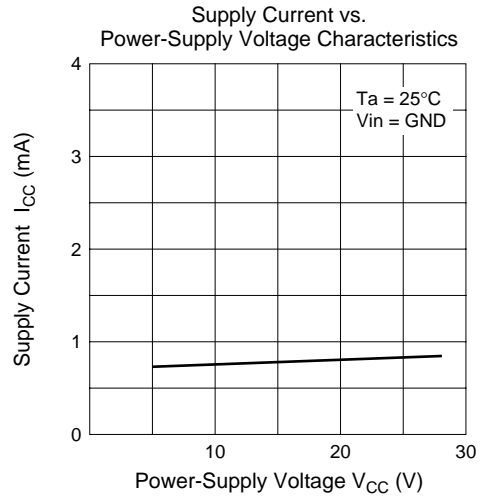
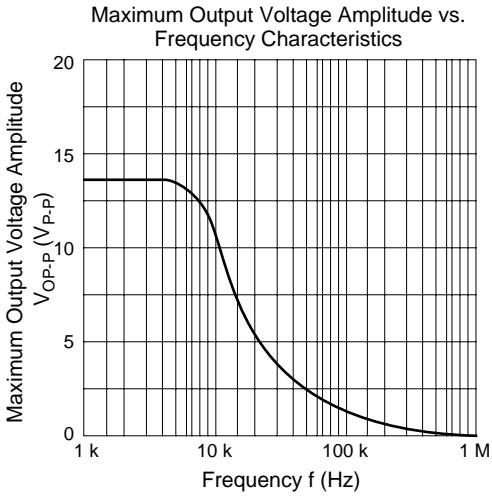
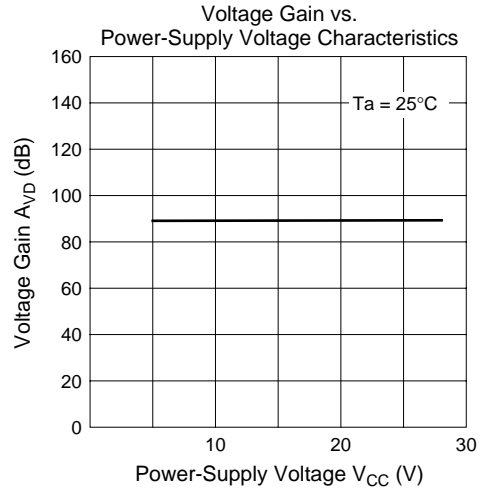
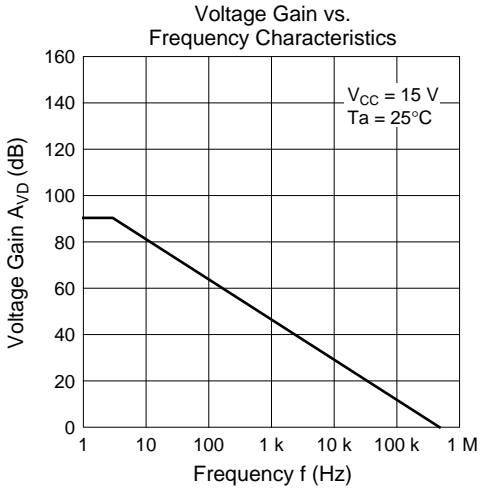
6. Output sink current ( $I_{osink}$ ) test circuit

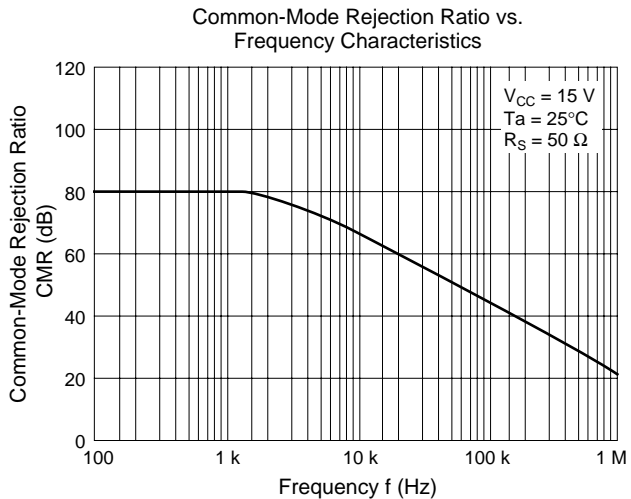
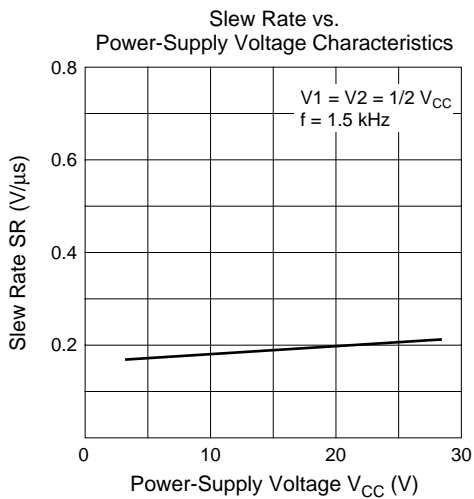
$I_o$  sink:  $V_{OL} = 1V$

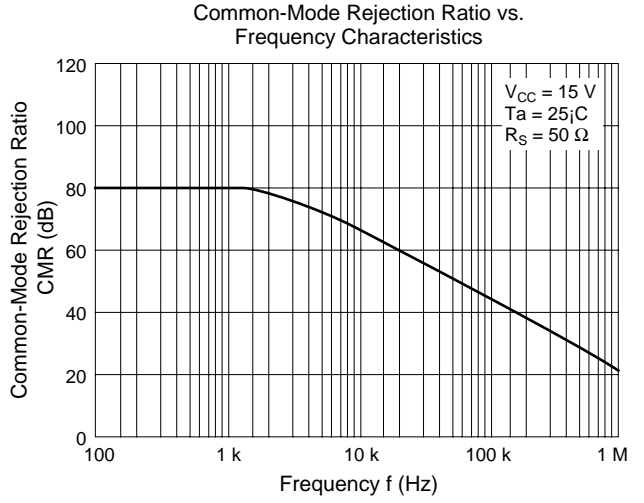
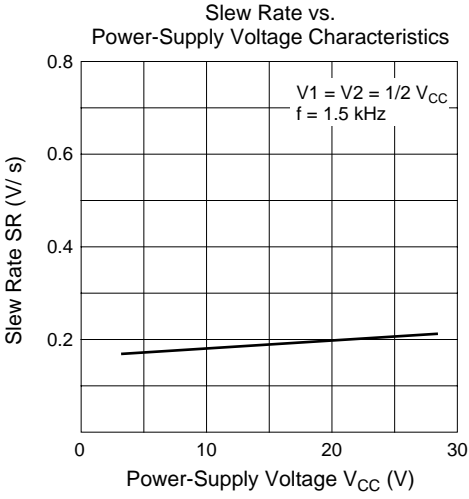


Characteristics Curve









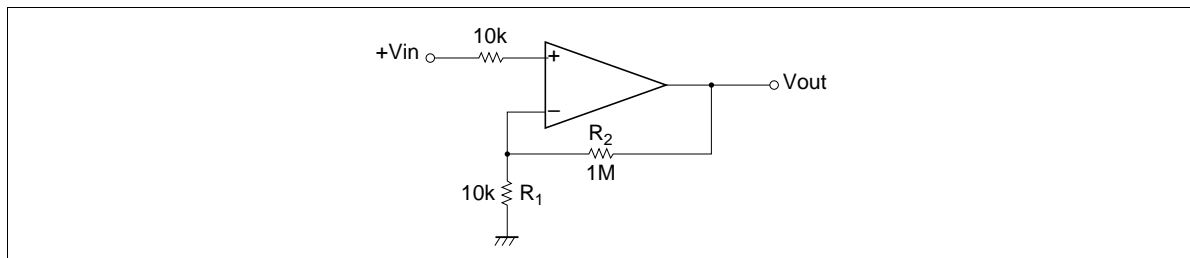
## HA17902 Application Examples

The HA17902 is a quad operational amplifier, and consists of four operational amplifier circuits and one bias current circuit. It features single-voltage power supply operation, internal phase compensation, a wide zero-cross bandwidth, a low input bias current, and a high open-loop gain. Thus the HA17902 can be used in a wide range of applications. This section describes several applications using the HA17902.

### 1. Noninverting Amplifier

Figure 1 shows the circuit diagram for a noninverting amplifier. The voltage gain of this amplifier is given by the following formula.

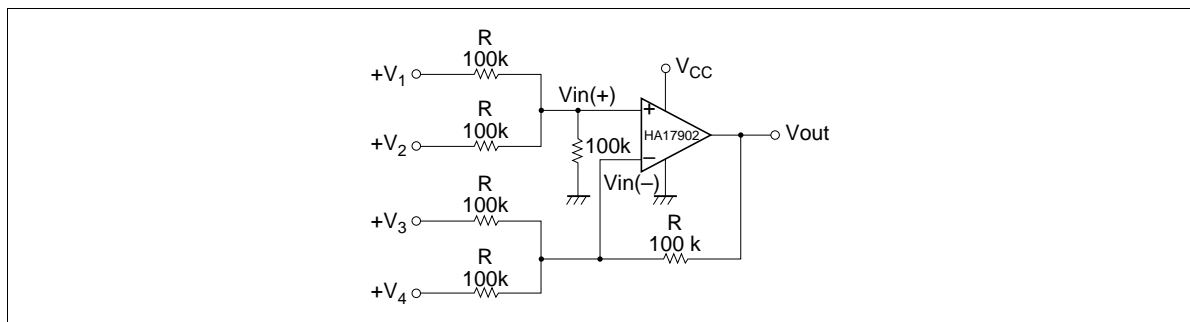
$$\frac{V_{out}}{V_{in}} = 1 + \frac{R_2}{R_1}$$



**Figure 1 Noninverting Amplifier**

### 2. Summing Amplifier

Since the circuit shown in figure 2 applies  $+V_1$  and  $+V_2$  to the noninverting input and  $+V_3$  and  $+V_4$  to the inverting input, the total output will be  $V_{out} = V_1 + V_2 - V_3 - V_4$ .

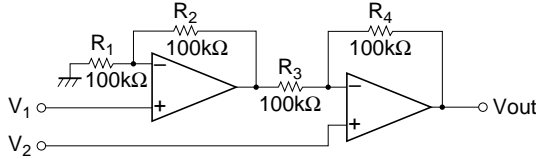


**Figure 2 Summing Amplifier**

### 3. High Input Impedance DC Differential Amplifier

The circuit shown in figure 3 is a high input impedance DC differential amplifier. This circuit's common-mode rejection ratio (CMR) depends on the matching between the  $R_1/R_2$  and  $R_4/R_3$  resistance ratios. This amplifier's output is given by the following formula.

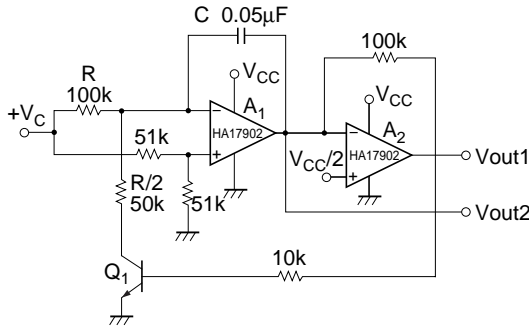
$$V_{out} = \left(1 + \frac{R_4}{R_3}\right) (V_2 - V_1)$$



**Figure 3 High Input Impedance DC Differential Amplifier**

### 4. Voltage Controlled Oscillator

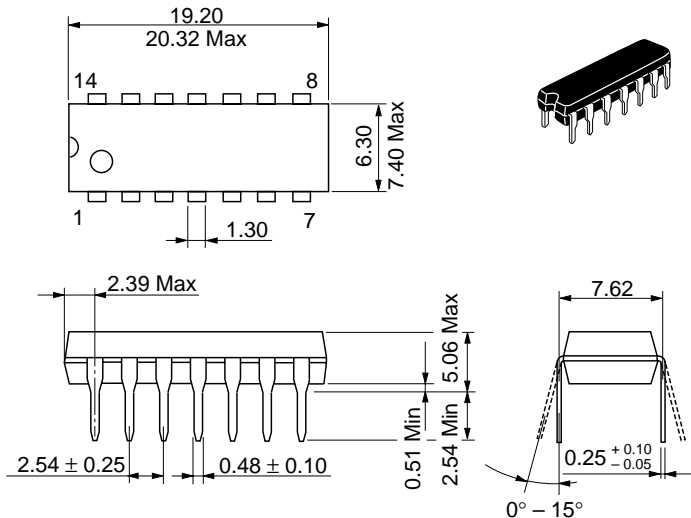
Figure 4 shows an oscillator circuit in which the amplifier  $A_1$  is an integrator, the amplifier  $A_2$  is a comparator, and transistor  $Q_1$  operates as a switch that controls the oscillator frequency. If the output  $V_{out1}$  is at the low level, this will cut off transistor  $Q_1$  and cause the  $A_1$  inverting input to go to a higher potential than the noninverting input. Therefore,  $A_1$  will integrate this negative input state and its output level will decrease. When the  $A_1$  integrator output becomes lower than the  $A_2$  comparator noninverting input level ( $V_{CC}/2$ ) the comparator output goes high. This turns on transistor  $Q_1$  causing the integrator to integrate a positive input state and for its output to increase. This operation generates a square wave on  $V_{out1}$  and a triangular wave on  $V_{out2}$ .



**Figure 4 Voltage Controlled Oscillator**

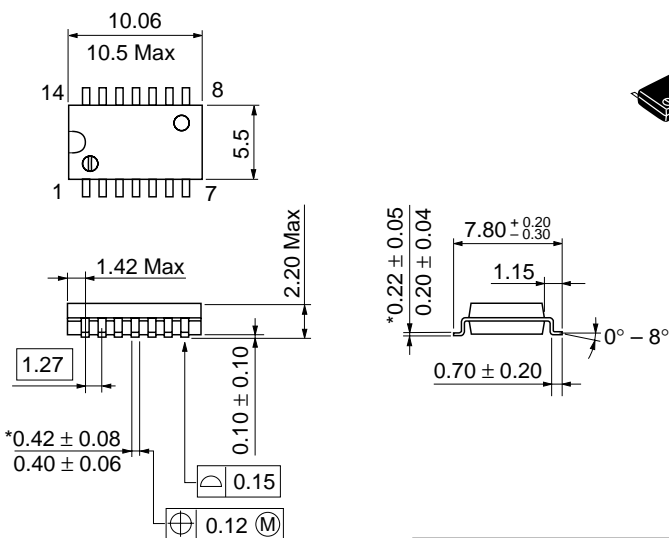
Package Dimensions

Unit: mm



Hitachi Code	DP-14
JEDEC	Conforms
EIAJ	Conforms
Mass (reference value)	0.97 g

Unit: mm



\*Dimension including the plating thickness  
Base material dimension

Hitachi Code	FP-14DA
JEDEC	—
EIAJ	Conforms
Mass (reference value)	0.23 g

## Cautions

1. Hitachi neither warrants nor grants licenses of any rights of Hitachi's or any third party's patent, copyright, trademark, or other intellectual property rights for information contained in this document. Hitachi bears no responsibility for problems that may arise with third party's rights, including intellectual property rights, in connection with use of the information contained in this document.
2. Products and product specifications may be subject to change without notice. Confirm that you have received the latest product standards or specifications before final design, purchase or use.
3. Hitachi makes every attempt to ensure that its products are of high quality and reliability. However, contact Hitachi's sales office before using the product in an application that demands especially high quality and reliability or where its failure or malfunction may directly threaten human life or cause risk of bodily injury, such as aerospace, aeronautics, nuclear power, combustion control, transportation, traffic, safety equipment or medical equipment for life support.
4. Design your application so that the product is used within the ranges guaranteed by Hitachi particularly for maximum rating, operating supply voltage range, heat radiation characteristics, installation conditions and other characteristics. Hitachi bears no responsibility for failure or damage when used beyond the guaranteed ranges. Even within the guaranteed ranges, consider normally foreseeable failure rates or failure modes in semiconductor devices and employ systemic measures such as fail-safes, so that the equipment incorporating Hitachi product does not cause bodily injury, fire or other consequential damage due to operation of the Hitachi product.
5. This product is not designed to be radiation resistant.
6. No one is permitted to reproduce or duplicate, in any form, the whole or part of this document without written approval from Hitachi.
7. Contact Hitachi's sales office for any questions regarding this document or Hitachi semiconductor products.

# HITACHI

## Hitachi, Ltd.

Semiconductor & Integrated Circuits.

Nippon Bldg., 2-6-2, Ohite-machi, Chiyoda-ku, Tokyo 100-0004, Japan

Tel: Tokyo (03) 3270-2111 Fax: (03) 3270-5109

URL      NorthAmerica      : <http://semiconductor.hitachi.com/>  
          Europe                : <http://www.hitachi-eu.com/hel/ecg>  
          Asia (Singapore)    : <http://www.has.hitachi.com.sg/grp3/sicd/index.htm>  
          Asia (Taiwan)        : [http://www.hitachi.com.tw/E/Product/SICD\\_Frame.htm](http://www.hitachi.com.tw/E/Product/SICD_Frame.htm)  
          Asia (HongKong)    : <http://www.hitachi.com.hk/eng/bo/grp3/index.htm>  
          Japan                 : <http://www.hitachi.co.jp/Sicd/indx.htm>

## For further information write to:

Hitachi Semiconductor  
(America) Inc.  
179 East Tasman Drive,  
San Jose, CA 95134  
Tel: <1> (408) 433-1990  
Fax: <1> (408) 433-0223

Hitachi Europe GmbH  
Electronic components Group  
Dornacher Straße 3  
D-85622 Feldkirchen, Munich  
Germany  
Tel: <49> (89) 9 9180-0  
Fax: <49> (89) 9 29 30 00

Hitachi Europe Ltd.  
Electronic Components Group.  
Whitebrook Park  
Lower Cookham Road  
Maidenhead  
Berkshire SL6 8YA, United Kingdom  
Tel: <44> (1628) 585000  
Fax: <44> (1628) 778322

Hitachi Asia Pte. Ltd.  
16 Collyer Quay #20-00  
Hitachi Tower  
Singapore 049318  
Tel: 535-2100  
Fax: 535-1533

Hitachi Asia Ltd.  
Taipei Branch Office  
3F, Hung Kuo Building, No.167,  
Tun-Hwa North Road, Taipei (105)  
Tel: <886> (2) 2718-3666  
Fax: <886> (2) 2718-8180

Hitachi Asia (Hong Kong) Ltd.  
Group III (Electronic Components)  
7/F., North Tower, World Finance Centre,  
Harbour City, Canton Road, Tsim Sha Tsui,  
Kowloon, Hong Kong  
Tel: <852> (2) 735 9218  
Fax: <852> (2) 730 0281  
Telex: 40815 HITEC HX

Copyright ' Hitachi, Ltd., 1998. All rights reserved. Printed in Japan.

# HITACHI