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# HA17902 Series

## Quad Operational Amplifier

# HITACHI

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### 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.

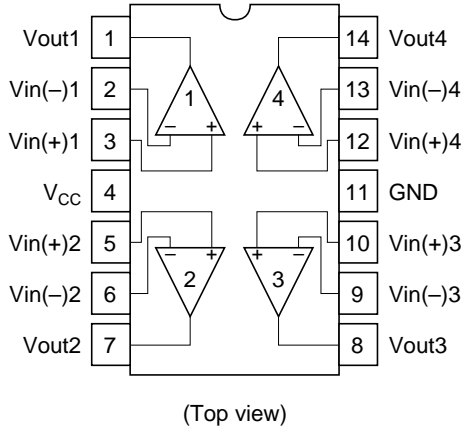
### Features

- 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

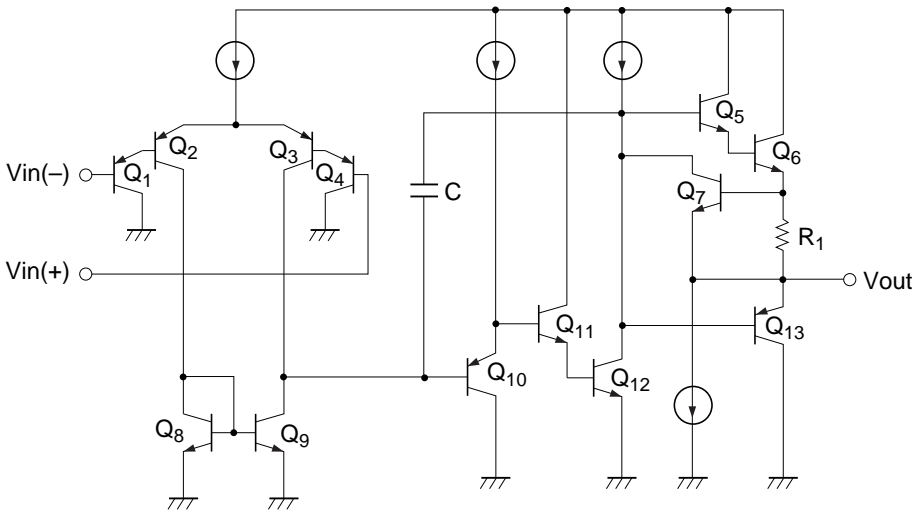
### Ordering Information

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



## 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	T <sub>opr</sub>	-20 to +75	-40 to +85	-20 to +75	-40 to +85	-40 to +125	°C
Storage temperature	T <sub>stg</sub>	-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 ( $V_{CC} = +15V$ , $T_a = 25^\circ C$ )

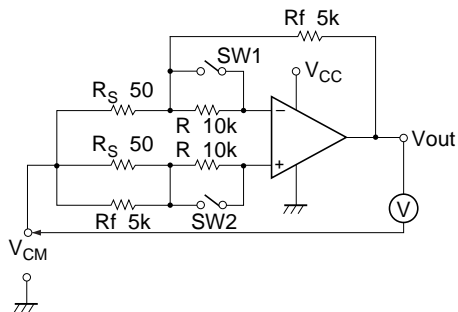
Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Input offset voltage	$V_{IO}$	—	3	8	mV	$V_{CM} = 7.5V$ , $R_S = 50\Omega$ , $R_f = 5k\Omega$
Input offset current	$I_{IO}$	—	5	50	nA	$I_{IO} =  I_1^- - I_1^+ $ , $V_{CM} = 7.5V$
Input bias current	$I_{IB}$	—	30	500	nA	$V_{CM} = 7.5V$
Power-supply rejection 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	$V_{O4}$

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

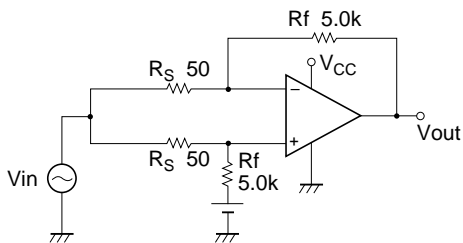
$$V_{IO} = \frac{V_{O1}}{1 + R_f / R_S} \quad (\text{mV})$$

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

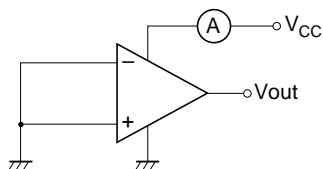
$$I_{IB} = \frac{|V_{O4} - V_{O3}|}{2 \cdot R(1 + R_f / R_S)} \quad (\text{nA})$$

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

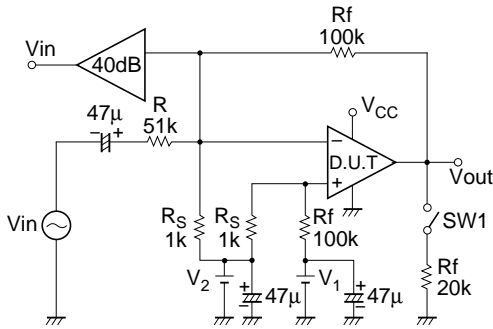
$$\text{CMR} = 20 \log \frac{V_{IN} \cdot R_f}{V_O \cdot R_S} \quad (\text{dB})$$



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



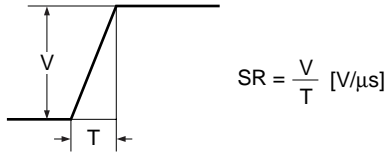
4. Voltage gain ( $A_{VD}$ ), slew rate (SR), common-mode input voltage range ( $V_{CM}$ ), and maximum output voltage amplitude ( $V_{OP-P}$ ) test circuit.



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

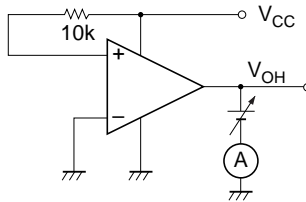


- (3)  $V_{CM}$ :  $R_S = 1k\Omega$ ,  $R_f = 100k\Omega$ ,  $f = 100\text{Hz}$ ,  $V_1 = 1/2 V_{CC}$ ,  $R_L = \infty$ , and the value of  $V_2$  just slightly prior to the point where the output waveform changes.

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

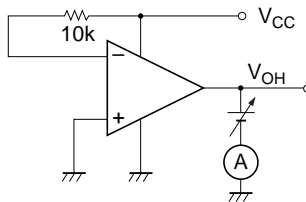
5. Output source current ( $I_{osource}$ ) test circuit

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

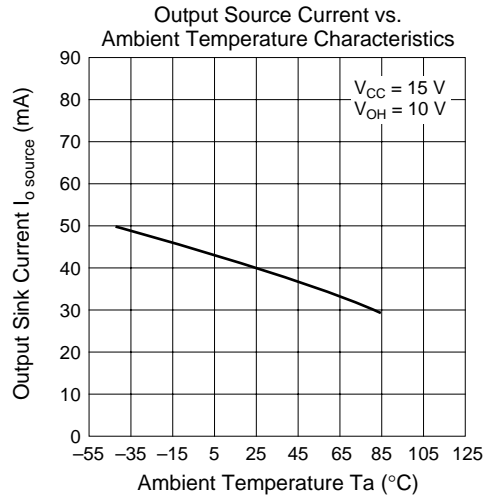
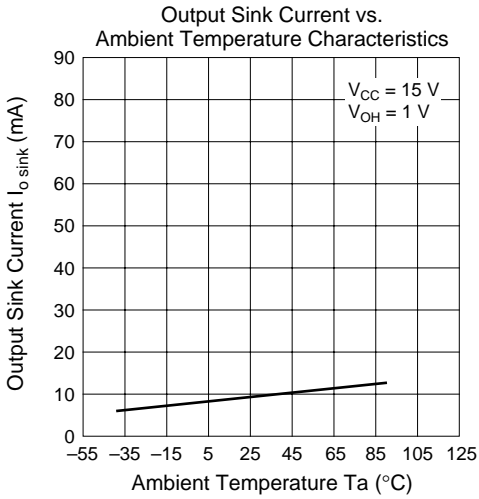
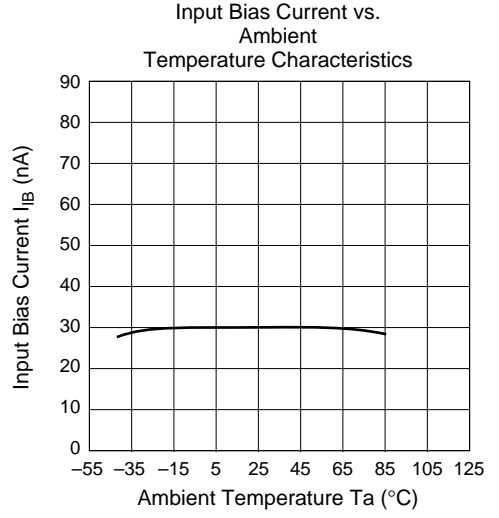
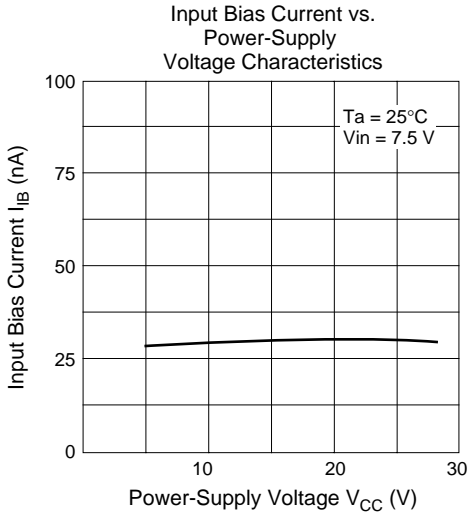


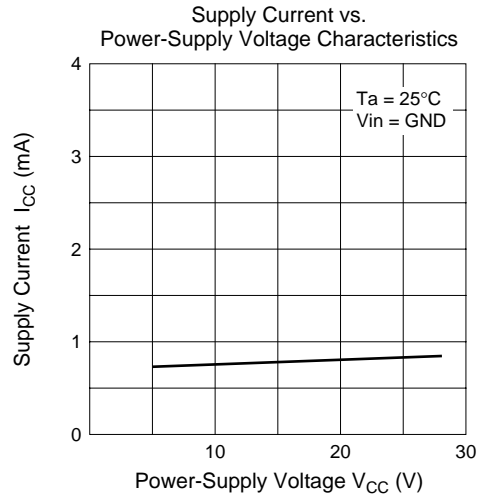
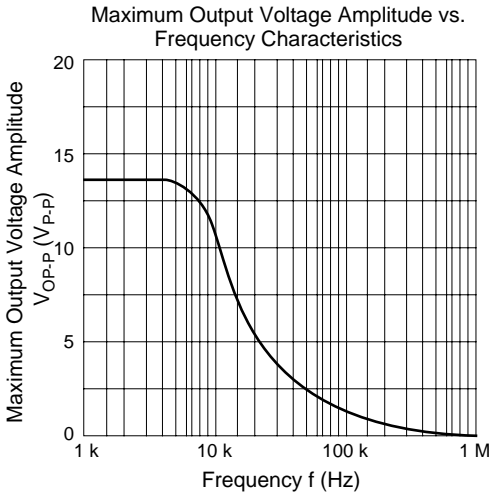
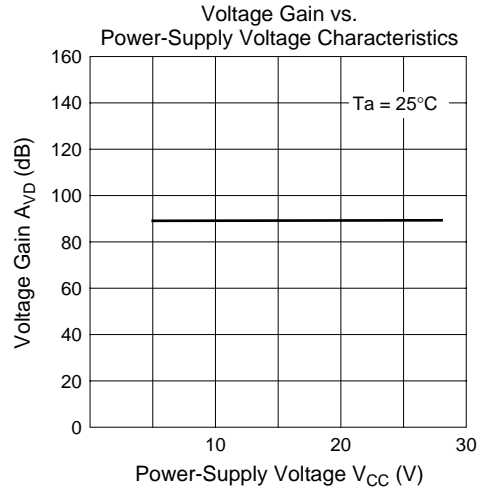
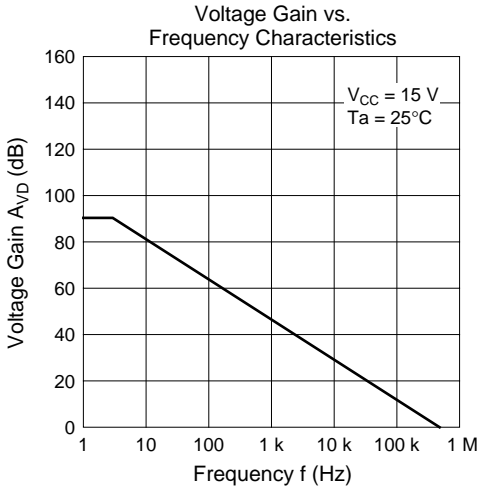
6. Output sink current ( $I_{osink}$ ) test circuit

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

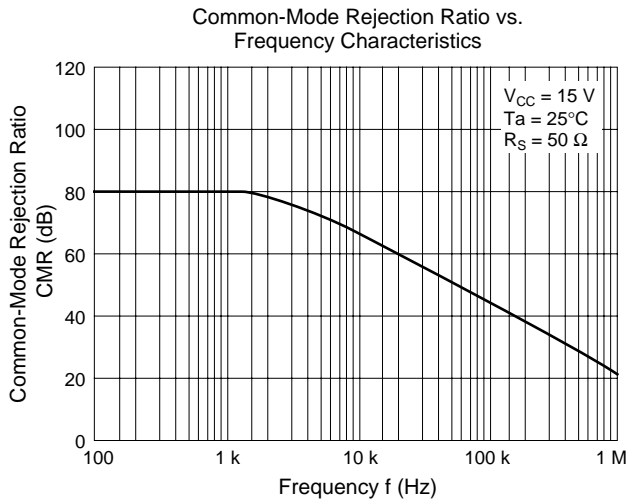
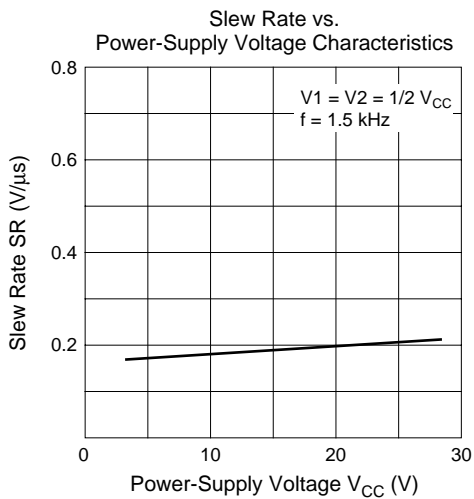


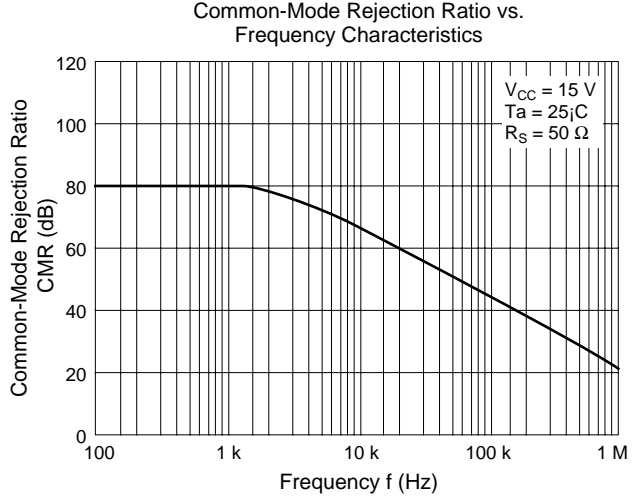
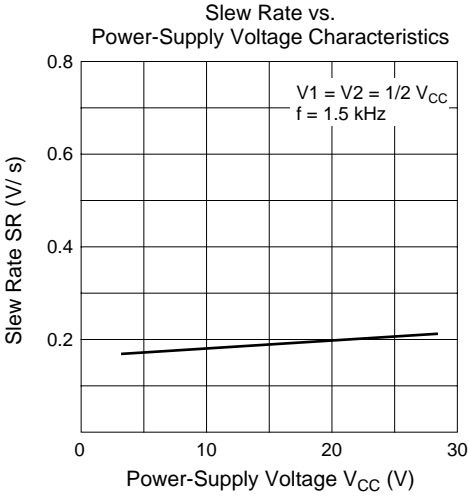
Characteristics Curve











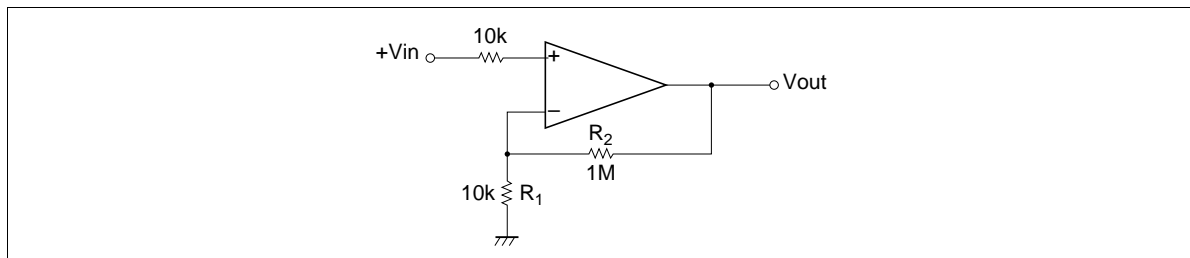
## HA17902 Application Examples

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.

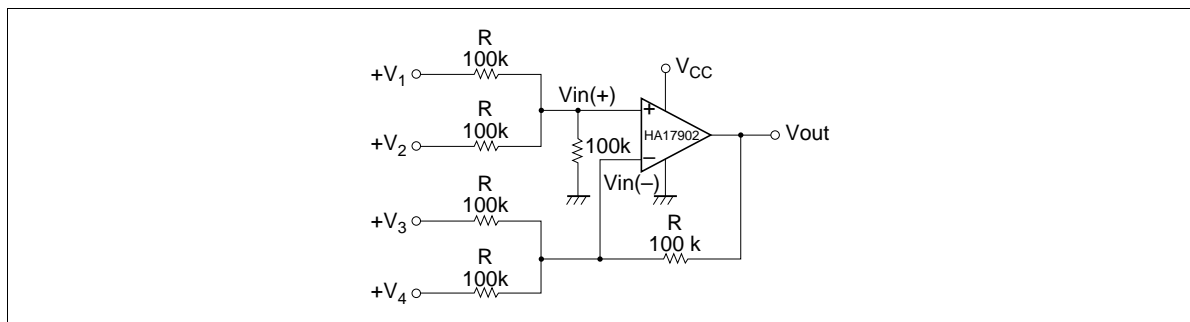
$$\frac{V_{out}}{V_{in}} = 1 + \frac{R_2}{R_1}$$



**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  $V_{out} = V_1 + V_2 - V_3 - V_4$ .

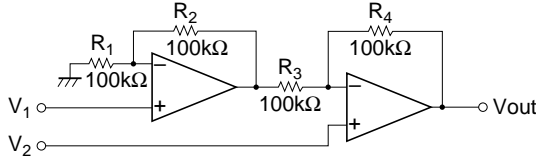


**Figure 2 Summing Amplifier**

### 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.

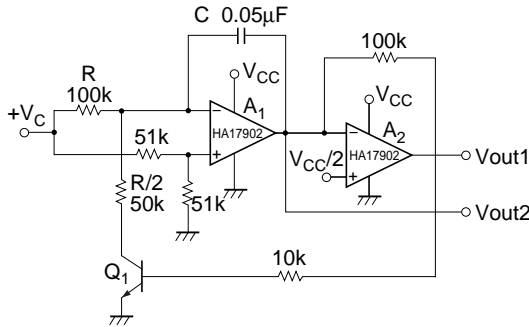
$$V_{out} = \left(1 + \frac{R_4}{R_3}\right) (V_2 - V_1)$$



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

### 4. Voltage Controlled Oscillator

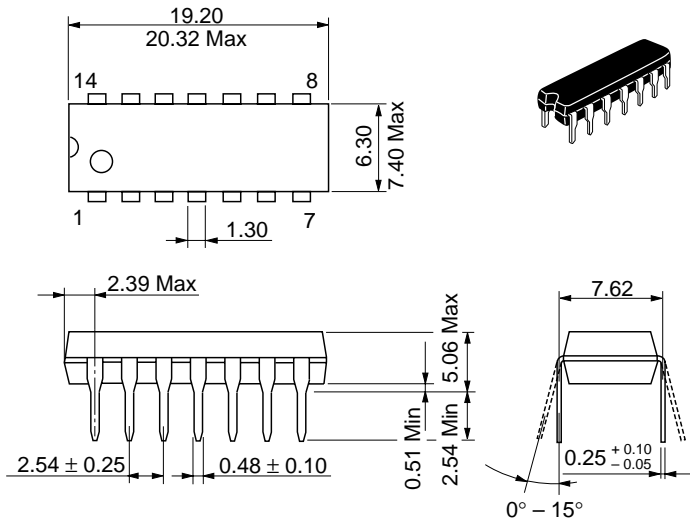
Figure 4 shows an oscillator circuit in which the amplifier  $A_1$  is an integrator, the amplifier  $A_2$  is a comparator, and transistor  $Q_1$  operates as a switch that controls the oscillator frequency. If the output  $V_{out1}$  is at the low level, this will cut off transistor  $Q_1$  and cause 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**

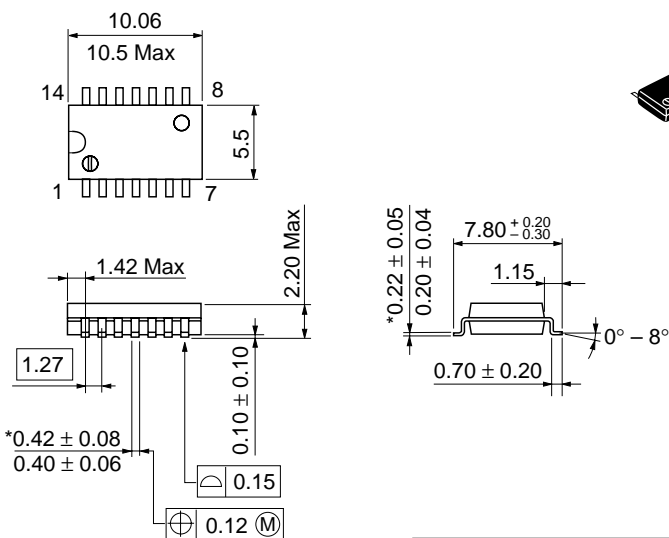
Package Dimensions

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

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