To all our customers

Regarding the change of names mentioned in the document, such as Hitachi Electric and Hitachi XX, to Renesas Technology Corp.

The semiconductor operations of Mitsubishi Electric and Hitachi were transferred to Renesas Technology Corporation on April 1st 2003. These operations include microcomputer, logic, analog and discrete devices, and memory chips other than DRAMs (flash memory, SRAMs etc.) Accordingly, although Hitachi, Hitachi, Ltd., Hitachi Semiconductors, and other Hitachi brand names are mentioned in the document, these names have in fact all been changed to Renesas Technology Corp. Thank you for your understanding. Except for our corporate trademark, logo and corporate statement, no changes whatsoever have been made to the contents of the document, and these changes do not constitute any alteration to the contents of the document itself.

Renesas Technology Home Page: http://www.renesas.com

Renesas Technology Corp.
Customer Support Dept.
April 1, 2003

Cautions

Keep safety first in your circuit designs!

1. Renesas Technology Corporation puts the maximum effort into making semiconductor products better and more reliable, but there is always the possibility that trouble may occur with them. Trouble with semiconductors may lead to personal injury, fire or property damage.
   Remember to give due consideration to safety when making your circuit designs, with appropriate measures such as (i) placement of substitutive, auxiliary circuits, (ii) use of nonflammable material or (iii) prevention against any malfunction or mishap.

Notes regarding these materials

1. These materials are intended as a reference to assist our customers in the selection of the Renesas Technology Corporation product best suited to the customer's application; they do not convey any license under any intellectual property rights, or any other rights, belonging to Renesas Technology Corporation or a third party.
2. Renesas Technology Corporation assumes no responsibility for any damage, or infringement of any third-party's rights, originating in the use of any product data, diagrams, charts, programs, algorithms, or circuit application examples contained in these materials.
3. All information contained in these materials, including product data, diagrams, charts, programs and algorithms represents information on products at the time of publication of these materials, and are subject to change by Renesas Technology Corporation without notice due to product improvements or other reasons. It is therefore recommended that customers contact Renesas Technology Corporation or an authorized Renesas Technology Corporation product distributor for the latest product information before purchasing a product listed herein.
   The information described here may contain technical inaccuracies or typographical errors.
   Renesas Technology Corporation assumes no responsibility for any damage, liability, or other loss rising from these inaccuracies or errors.
   Please also pay attention to information published by Renesas Technology Corporation by various means, including the Renesas Technology Corporation Semiconductor home page (http://www.renesas.com).
4. When using any or all of the information contained in these materials, including product data, diagrams, charts, programs, and algorithms, please be sure to evaluate all information as a total system before making a final decision on the applicability of the information and products. Renesas Technology Corporation assumes no responsibility for any damage, liability or other loss resulting from the information contained herein.
5. Renesas Technology Corporation semiconductors are not designed or manufactured for use in a device or system that is used under circumstances in which human life is potentially at stake. Please contact Renesas Technology Corporation or an authorized Renesas Technology Corporation product distributor when considering the use of a product contained herein for any specific purposes, such as apparatus or systems for transportation, vehicular, medical, aerospace, nuclear, or undersea repeater use.
6. The prior written approval of Renesas Technology Corporation is necessary to reprint or reproduce in whole or in part these materials.
7. If these products or technologies are subject to the Japanese export control restrictions, they must be exported under a license from the Japanese government and cannot be imported into a country other than the approved destination.
   Any diversion or reexport contrary to the export control laws and regulations of Japan and/or the country of destination is prohibited.
8. Please contact Renesas Technology Corporation for further details on these materials or the products contained therein.

HA17902 Series

Quad Operational Amplifier

ADE-204-045 (Z)
Rev. 0
Dec. 2000

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.

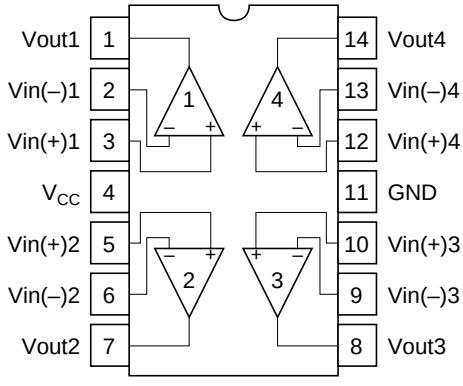
Features

- 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

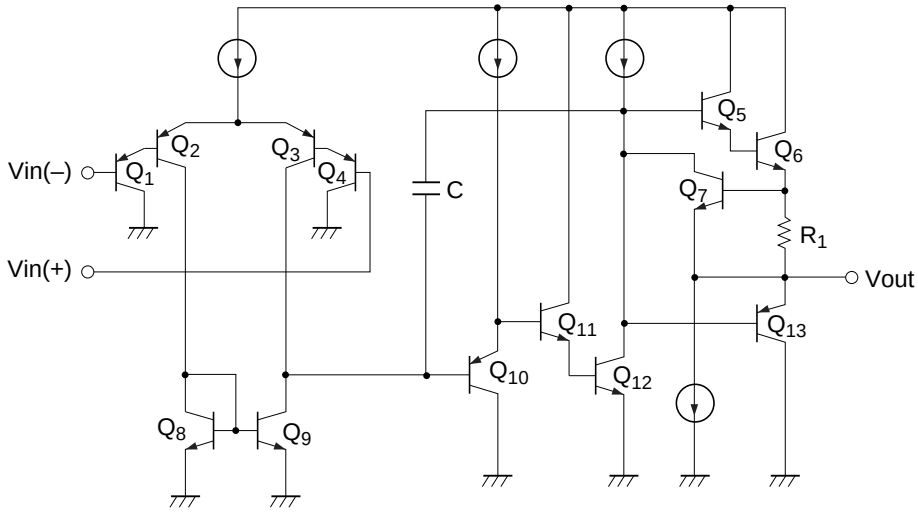
Type No.	Application	Package
HA17902PJ	Car use	DP-14
HA17902FPJ		FP-14DA
HA17902FPK		FP-14DA
HA17902P	Industrial use	DP-14
HA17902FP		FP-14DA
HA17902	Commercial use	DP-14

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_{CC}	28	28	28	28	28	V
Sink current	Io sink	50	50	50	50	25	mA
Allowable power dissipation	P_T	625*[1]	625*[1]	625*[2]	625*[2]	625*[2]	mW
Common-mode input voltage	V_{CM}	–0.3 to V_{CC}	–0.3 to V_{CC}	–0.3 to V_{CC}	–0.3 to V_{CC}	–0.3 to V_{CC}	V
Differential-mode input voltage	Vin(diff)	$\pm V_{CC}$	$\pm V_{CC}$	$\pm V_{CC}$	$\pm V_{CC}$	$\pm V_{CC}$	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.

Electrical Characteristics 1 (V_{CC} = + 15V, Ta = 25°C)

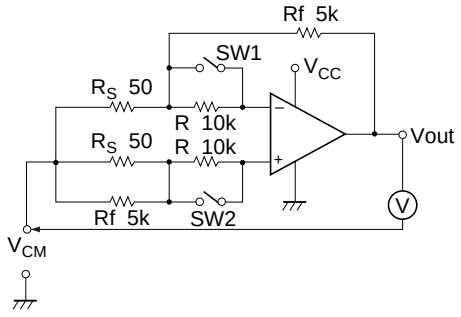
Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Input offset voltage	V_{IO}	—	3	8	mV	V_{CM} = 7.5V, R_S = 50Ω, Rf = 5kΩ
Input offset current	I_{IO}	—	5	50	nA	$I_{IO} = \lvert I_I^- - I_I^+ \rvert$, V_{CM} = 7.5V
Input bias current	I_{IB}	—	30	500	nA	V_{CM} = 7.5V
Power-supply rejection ratio	PSRR	—	93	—	dB	f = 100Hz, R_S = 1kΩ, Rf = 100kΩ
Voltage gain	A_{VD}	75	90	—	dB	R_S = 1kΩ, Rf = 100kΩ, RL = ∞
Common-mode rejection ratio	CMR	—	80	—	dB	R_S = 50Ω, Rf = 5kΩ
Common-mode input voltage range	V_{CM}	–0.3	—	13.5	V	R_S = 1kΩ, Rf = 100kΩ, f = 100Hz
Maximum output voltage amplitude	V_{OP-P}	—	13.6	—	V	f = 100Hz, R_S = 1kΩ, Rf = 100kΩ, R_L = 20kΩ
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	Vin = GND, R_L = ∞
Slew rate	SR	—	0.19	—	V/µs	f = 1.5kHz, V_{CM} = 7.5V, R_L = ∞
Channel separation	CS	—	120	—	dB	f = 1kHz

Electrical Characteristics 2 (V_{CC} = + 15V, Ta = – 40 to 125°C)

Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Input offset voltage	V_{IO}	—	—	8	mV	V_{CM} = 7.5V, R_S = 50Ω, Rf = 5kΩ
Input offset current	I_{IO}	—	—	200	nA	V_{CM} = 7.5V , $I_{IO} = \lvert I_I^- - I_I^+ \rvert$
Input bias current	I_{IB}	—	—	500	nA	V_{CM} = 7.5V
Common-mode input voltage range	V_{CM}	0	—	13.0	V	R_S = 1kΩ, Rf = 100kΩ, 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	Vin = GND, R_L = ∞

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}

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

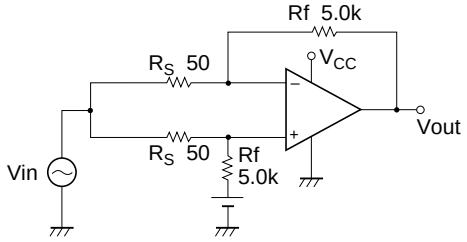
$$V_{IO} = \frac{V_{O1}}{1 + Rf / R_S} \quad \text{(mV)}$$

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

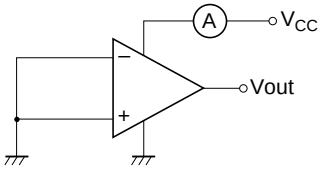
$$I_{IB} = \frac{| V_{O4} - V_{O3} |}{2 \cdot R(1 + Rf / R_S)} \quad \text{(nA)}$$

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

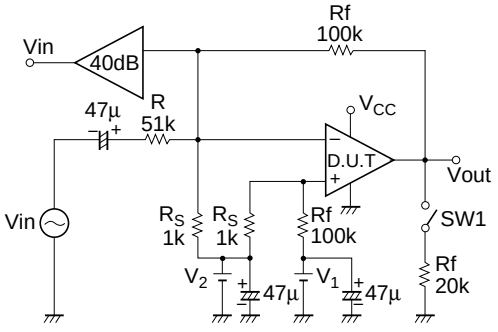
$$CMR = 20 \log \frac{V_{IN} \cdot Rf}{V_O \cdot R_S} \quad \text{(dB)}$$



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



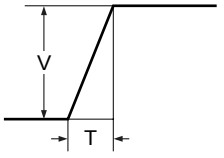
4. Voltage gain (A_{VD}), slew rate (SR), common-mode input voltage range (V_{CM}), and maximum output voltage amplitude (V_{OP-P}) test circuit.



(1) A_{VD}: R_S = 1kΩ, Rf = 100kΩ, R_L = ∞, $V_1 = V_2$ = 1/2 V_{CC}

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

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

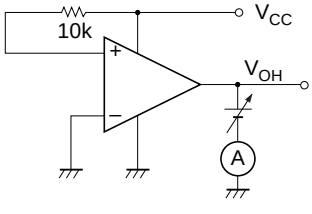


$$SR = \frac{V}{T} \ [V/\mu s]$$

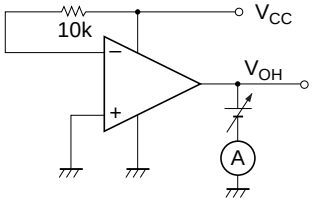
(3) V_{CM}: R_S = 1kΩ, Rf = 100kΩ, f = 100Hz, V_1 = 1/2 V_{CC}, R_L = ∞,
and the value of V_2 just slightly prior to the point where the output waveform changes.

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

5. Output source current (Iosource) test circuit
Io source: V_{OH} = 10V

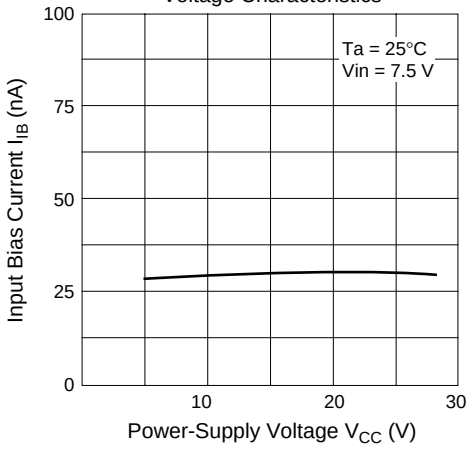


6. Output sink current (Iosink) test circuit
Io sink: V_{OL} = 1V

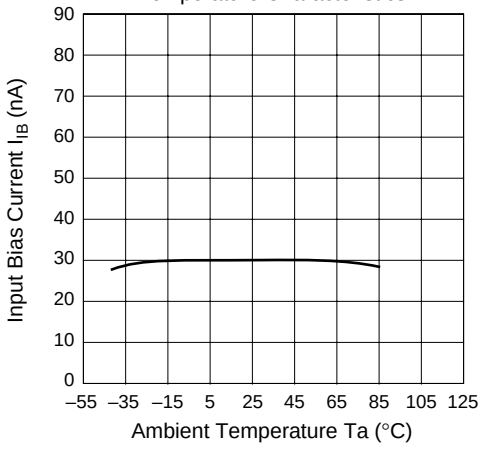


Characteristics Curve

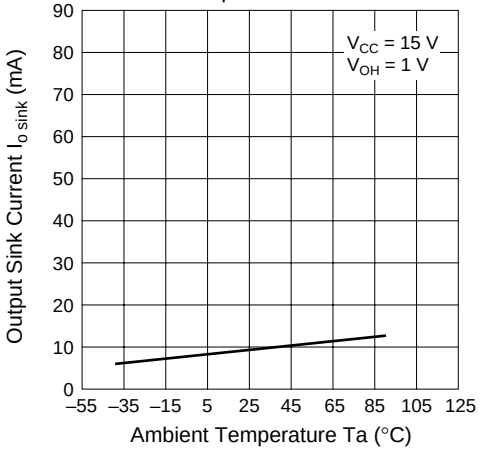
Input Bias Current vs. Power-Supply Voltage Characteristics



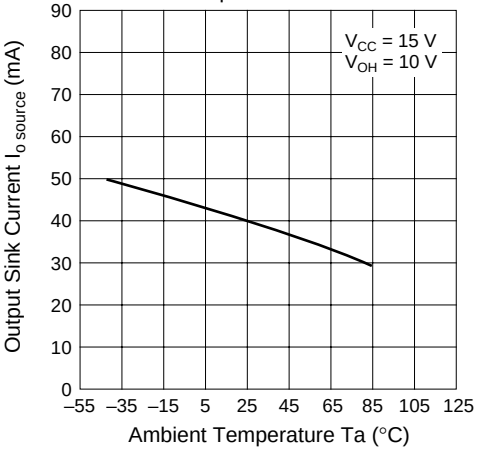
Input Bias Current vs. Ambient Temperature Characteristics



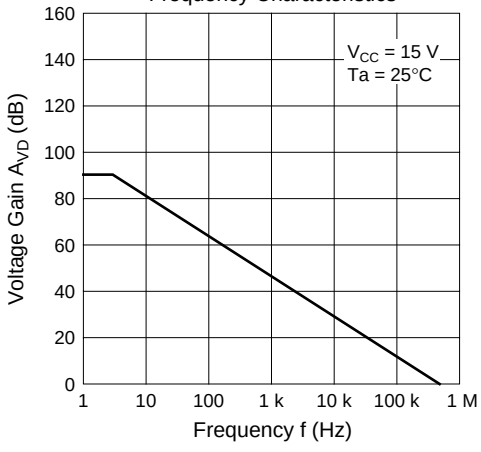
Output Sink Current vs. Ambient Temperature Characteristics



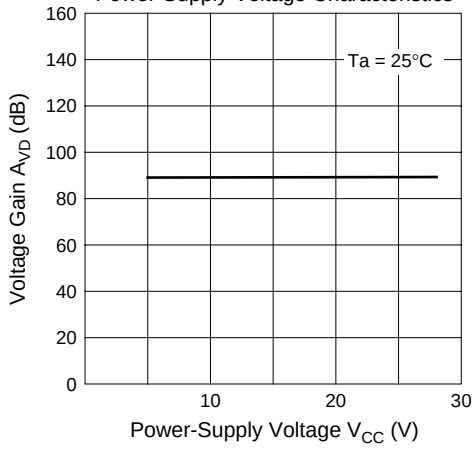
Output Source Current vs. Ambient Temperature Characteristics



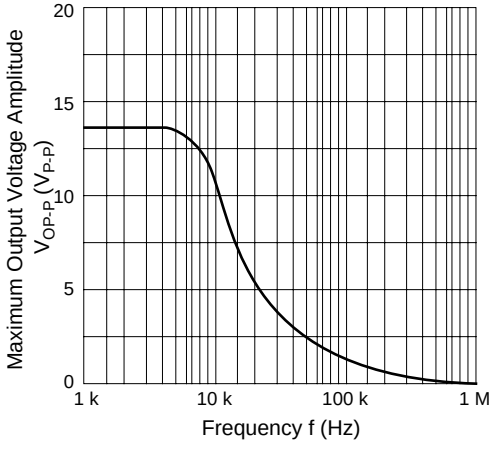
Voltage Gain vs.
Frequency Characteristics



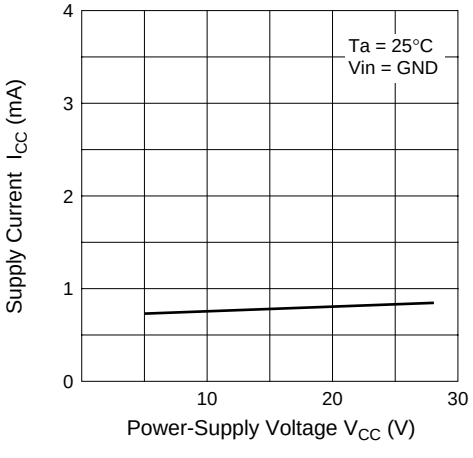
Voltage Gain vs.
Power-Supply Voltage Characteristics



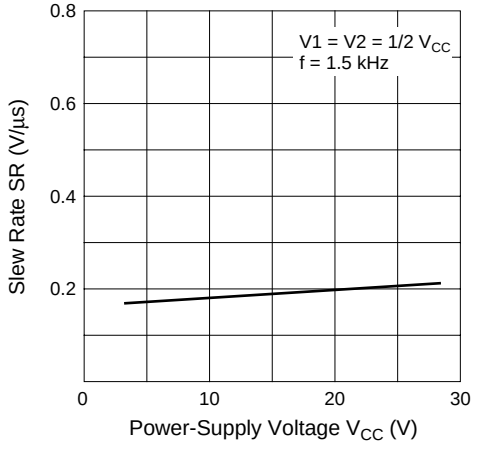
Maximum Output Voltage Amplitude vs.
Frequency Characteristics



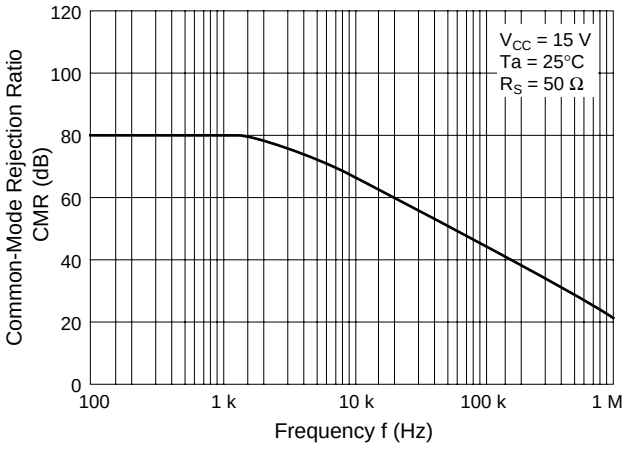
Supply Current vs.
Power-Supply Voltage Characteristics



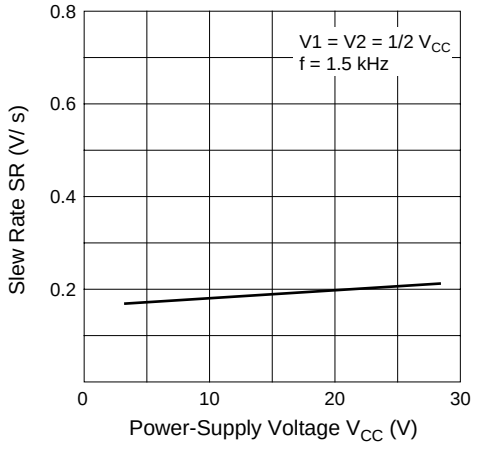
Slew Rate vs.
Power-Supply Voltage Characteristics



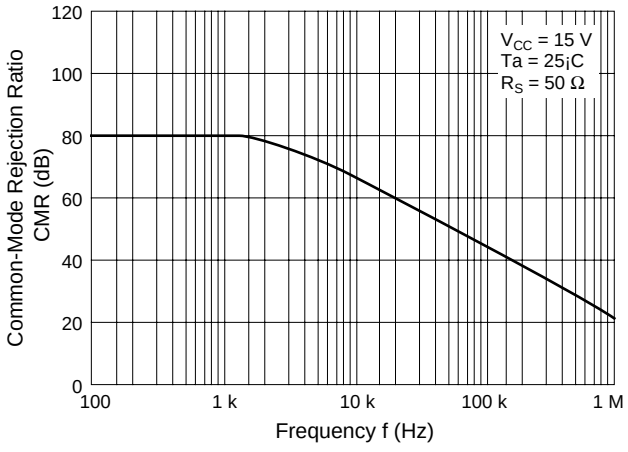
Common-Mode Rejection Ratio vs.
Frequency Characteristics



Slew Rate vs.
Power-Supply Voltage Characteristics



Common-Mode Rejection Ratio vs.
Frequency Characteristics



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.

$$\frac{Vout}{Vin} = 1 + \frac{R2}{R1}$$

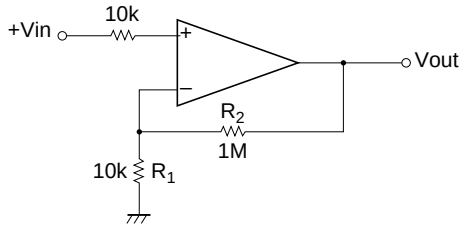


Figure 1 Noninverting Amplifier

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 $Vout = V_1 + V_2 – V_3 – V_4$.

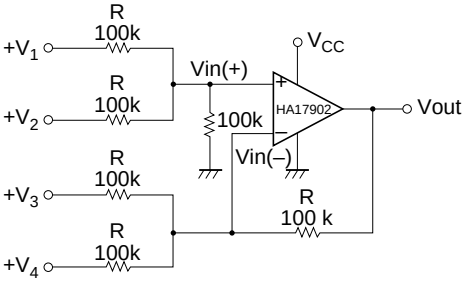


Figure 2 Summing Amplifier

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.

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

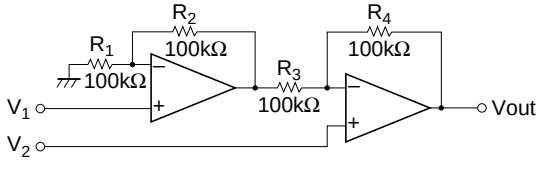


Figure 3 High Input Impedance DC Differential Amplifier

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 Vout1 is at the low level, this will cut off transistor Q1 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 Vout1 and a triangular wave on Vout2.

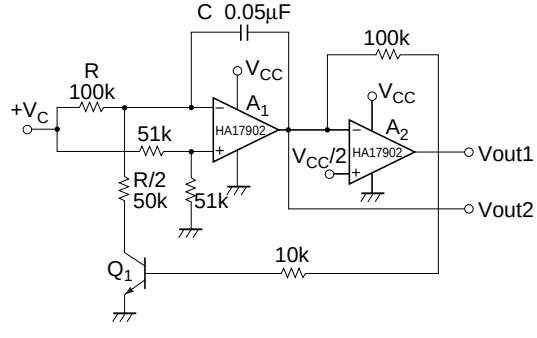
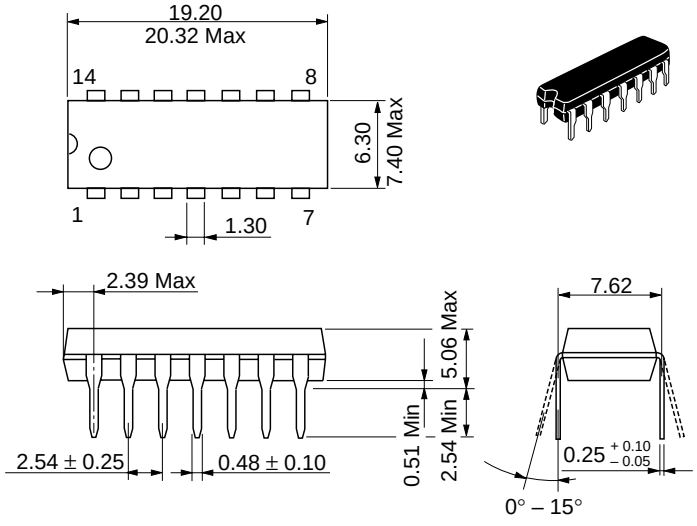


Figure 4 Voltage Controlled Oscillator

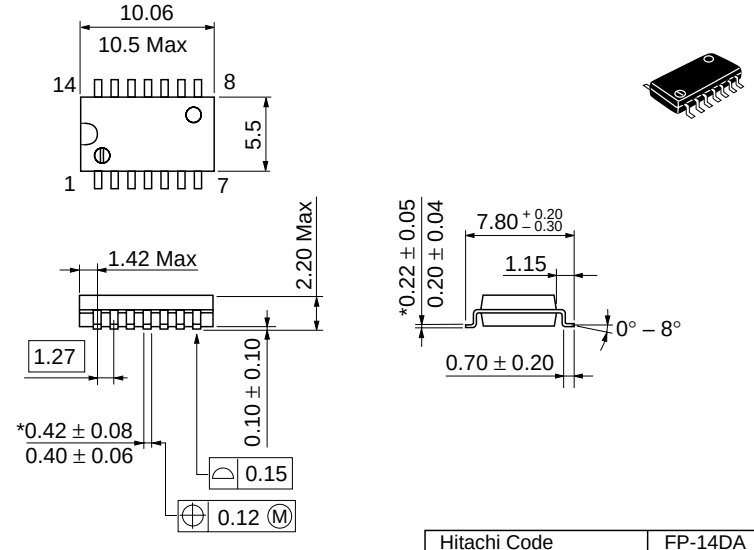
Package Dimensions

Unit: mm



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

Unit: mm



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

*Dimension including the plating thickness
Base material dimension

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, Ohte-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 : http://sicapac.hitachi-asia.com
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 Straβe 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) 585160

Hitachi Asia Ltd.
Hitachi Tower
16 Collyer Quay #20-00,
Singapore 049318
Tel : <65>-538-6533/538-8577
Fax : <65>-538-6933/538-3877
URL : http://www.hitachi.com.sg

Hitachi Asia Ltd.
(Taipei Branch Office)
4/F, No. 167, Tun Hwa North Road,
Hung-Kuo Building,
Taipei (105), Taiwan
Tel : <886>-(2)-2718-3666
Fax : <886>-(2)-2718-8180
Telex : 23222 HAS-TP
URL : http://www.hitachi.com.tw

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
URL : http://www.hitachi.com.hk

Colophon 2.0

RENESAS