

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.

HA17901, HA17339 Series

Quadruple Comparators



ADE-204-047 (Z)

Rev. 0

Dec. 2000

Description

The HA17901 and HA17339 series products are comparators designed for use in power or control systems.

These IC operate from a single power-supply voltage over a wide range of voltages, and feature a reduced power-supply current since the power-supply voltage is determined independently.

These comparators have the unique characteristic of ground being included in the common-mode input voltage range, even when operating from a single-voltage power supply. These products have a wide range of applications, including limit comparators, simple A/D converters, pulse/square-wave/time delay generators, wide range VCO circuits, MOS clock timers, multivibrators, and high-voltage logic gates.

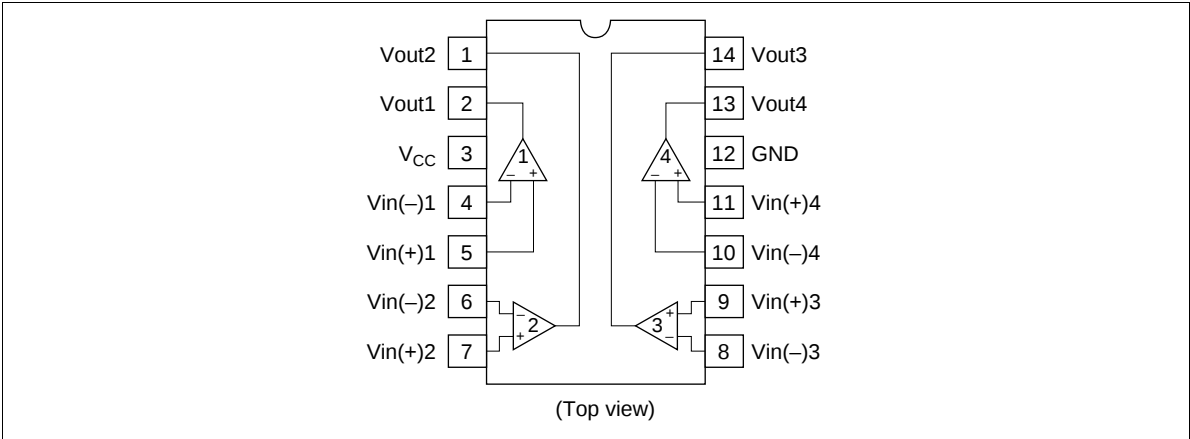
Features

- Wide power-supply voltage range: 2 to 36V
- Extremely low current drain: 0.8mA
- Low input bias current: 25nA
- Low input offset current: 5nA
- Low input offset voltage: 2mV
- The common-mode input voltage range includes ground.
- Low output saturation voltage: 1mV (5 μ A), 70mV (1mA)
- Output voltages compatible with CMOS logic systems

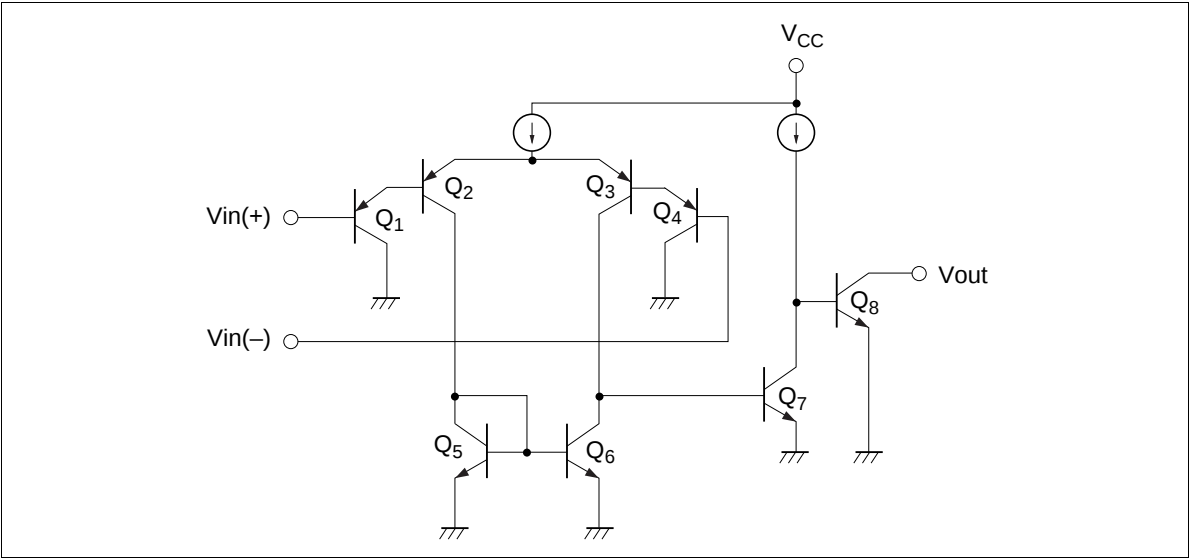
Ordering Information

Type No.	Application	Package
HA17901PJ	Car use	DP-14
HA17901FPJ		FP-14DA
HA17901FPK		FP-14DA
HA17901P	Industrial use	DP-14
HA17901FP		FP-14DA
HA17339	Commercial use	DP-14
HA17339F		FP-14DA

Pin Arrangement



Circuit Structure (1/4)



Absolute Maximum Ratings (Ta = 25°C)

Item	Symbol	17901 P	17901 PJ	17901 FP	17901 FPJ	17901 FPK	17339	17339 F	Unit
Power-supply voltage	V _{CC}	36	36	36	36	36	36	36	V
Differential input voltage	V _{in(diff)}	±V _{CC}	±V _{CC}	±V _{CC}	±V _{CC}	±V _{CC}	±V _{CC}	±V _{CC}	V
Input voltage	V _{in}	−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}	−0.3 to +V _{CC}	−0.3 to +V _{CC}	V
Output current	I _{out} *2	20	20	20	20	20	20	20	mA
Allowable power dissipation	P _T	625*1	625*1	625*3	625*3	625*3	625*1	625*3	mW
Operating temperature	Topr	−20 to +75	−40 to +85	−20 to +75	−40 to +85	−40 to +125	−20 to +75	−20 to +75	°C
Storage temperature	Tstg	−55 to +125	−55 to +125	−55 to +125	−55 to +125	−55 to +150	−55 to +125	−55 to +125	°C
Output pin voltage	V _{out}	36	36	36	36	36	36	36	V

- Notes: 1. These are the allowable values up to Ta = 50°C. Derate by 8.3mW/°C above that temperature.
2. These products can be destroyed if the output and V_{CC} are shorted together. The maximum output current is the allowable value for continuous operation.
3. See notes of SOP Package Usage in Reliability section.

Electrical Characteristics 1 ($V_{CC} = 5V$, $T_a = 25^{\circ}C$)

Item	Symbol	Min	Typ	Max	Unit	Test Condition
Input offset voltage	V_{IO}	—	2	7	mV	Output switching point: when $V_O = 1.4V$, $R_S = 0\Omega$
Input bias current	I_{IB}	—	25	250	nA	$I_{IN(+)}$ or $I_{IN(-)}$
Input offset current	I_{IO}	—	5	50	nA	$I_{IN(+)} - I_{IN(-)}$
Common-mode input voltage* ¹	V_{CM}	0	—	$V_{CC} - 1.5$	V	
Supply current	I_{CC}	—	0.8	2	mA	$R_L = \infty$
Voltage Gain	A_{VD}	—	200	—	V/mV	$R_L = 15k\Omega$
Response time* ²	t_R	—	1.3	—	μs	$V_{RL} = 5V$, $R_L = 5.1k\Omega$
Output sink current	I_{osink}	6	16	—	mA	$V_{IN(-)} = 1V$, $V_{IN(+)} = 0$, $V_O \leq 1.5V$
Output saturation voltage	$V_{O\ sat}$	—	200	400	mV	$V_{IN(-)} = 1V$, $V_{IN(+)} = 0$, $I_{osink} = 3mA$
Output leakage current	I_{LO}	—	0.1	—	nA	$V_{IN(+)} = 1V$, $V_{IN(-)} = 0$, $V_O = 5V$

Notes: 1. Voltages more negative than $-0.3V$ are not allowed for the common-mode input voltage or for either one of the input signal voltages.

2. The stipulated response time is the value for a 100 mV input step voltage that has a 5mV overdrive.

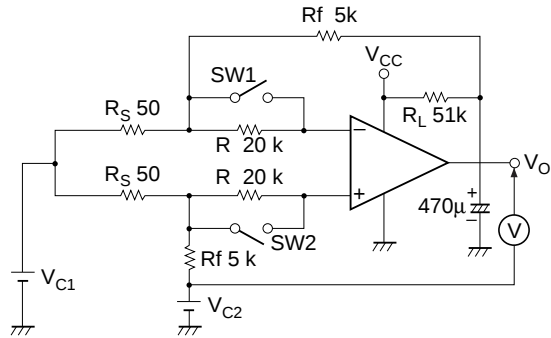
Electrical Characteristics 2 ($V_{CC} = 5V$, $T_a = -41$ to $+125^{\circ}C$)

Item	Symbol	Min	Typ	Max	Unit	Test Condition
Input offset voltage	V_{IO}	—	—	7	mV	Output switching point: when $V_O = 1.4V$, $R_S = 0\Omega$
Input offset current	I_{IO}	—	—	200	nA	$I_{IN(-)} - I_{IN(+)}$
Input bias current	I_{IB}	—	—	500	nA	
Common-mode input voltage* ¹	V_{CM}	0	—	$V_{CC} - 2.0$	V	
Output saturation voltage	$V_{O\ sat}$	—	—	440	mV	$V_{IN(-)} \geq 1V$, $V_{IN(+)} = 0$, $I_{osink} \leq 4mA$
Output leakage current	I_{LO}	—	1.0	—	μA	$V_{IN(-)} = 0V$, $V_{IN(+)} \geq 1V$, $V_O = 30V$
Supply current	I_{CC}	—	—	4.0	mA	All comparators: $R_L = \infty$, All channels ON

Note: 1. Voltages more negative than $-0.3V$ are not allowed for the common-mode input voltage or for either one of the input signal voltages.

Test Circuits

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



SW1	SW2	Vout
On	On	V_{O1}
Off	Off	V_{O2}
On	Off	V_{O3}
Off	On	V_{O4}

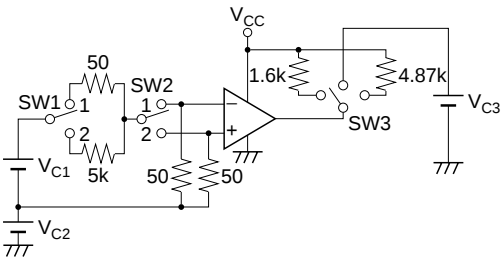
$$V_{C1} = \frac{1}{2} V_{CC}$$
$$V_{C2} = 1.4V$$

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

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

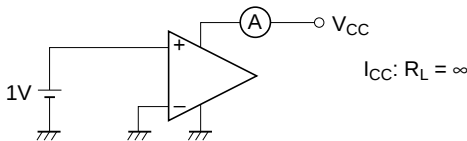
$$I_{IB} = \frac{|V_{O4} - V_{O3}|}{2 \cdot R(1 + R_f / R_S)} \quad (\text{nA})$$

2. Output saturation voltage ($V_o \text{ sat}$) output sink current (I_{osink}), and common-mode input voltage (V_{CM}) test circuit

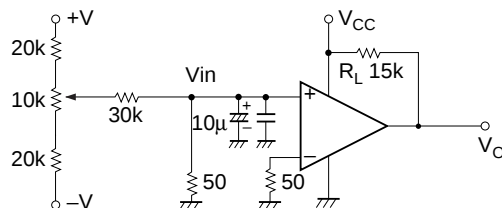


Item	V_{C1}	V_{C2}	V_{C3}	SW1	SW2	SW3	Unit
$V_{O \text{ sat}}$	2V	0V	—	1	1	1 at $V_{CC} = 5V$ 3 at $V_{CC} = 15V$	V
I_{osink}	2V	0V	1.5V	1	1	2	mA
V_{CM}	2V	—1 to V_{CC}	—	2	Switched between 1 and 2	3	V

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

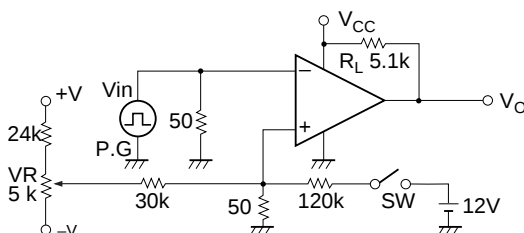


4. Voltage gain (A_{VD}) test circuit ($R_L = 15k\Omega$)



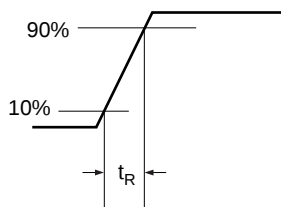
$$A_{VD} = 20 \log \frac{V_{O1} - V_{O2}}{V_{IN1} - V_{IN2}} \quad (\text{dB})$$

5. Response time (t_R) test circuit

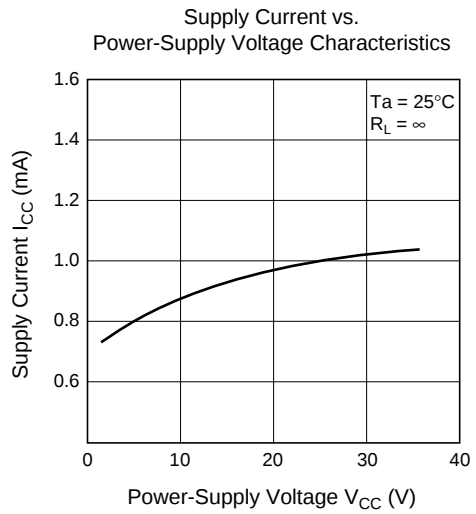
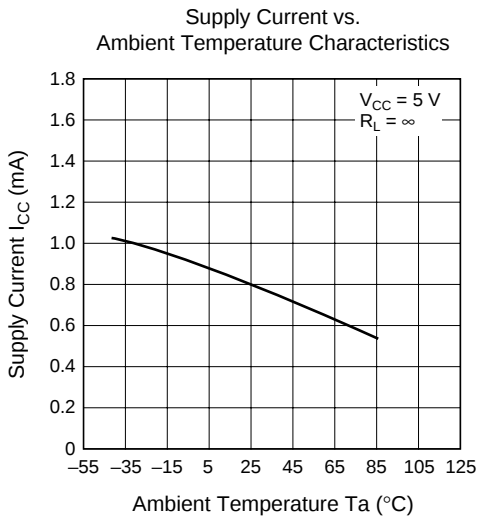
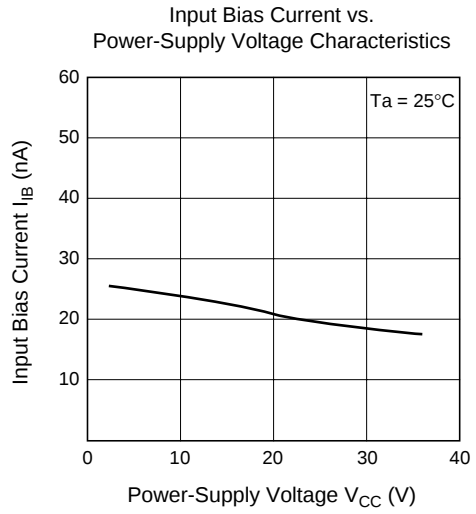
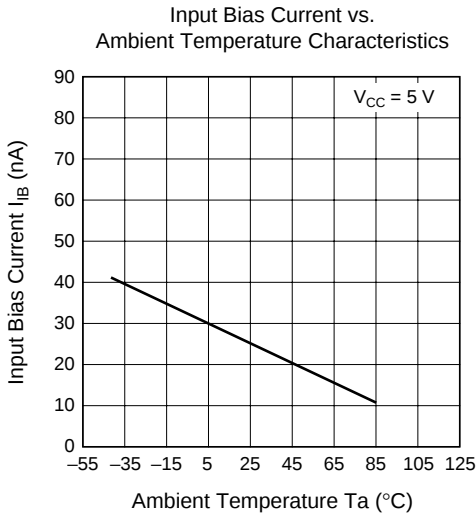


t_R : $R_L = 5.1k\Omega$, a 100mV input step voltage that has a 5mV overdrive

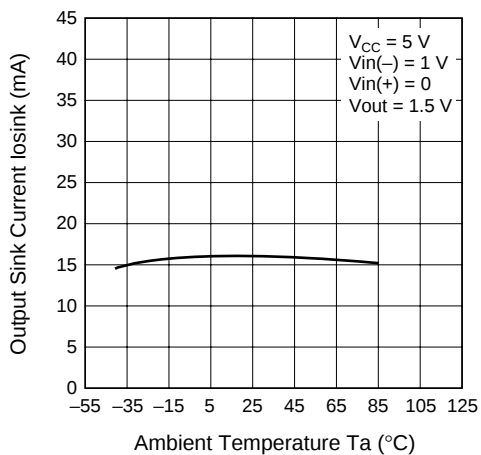
- With V_{IN} not applied, set the switch SW to the off position and adjust V_R so that V_O is in the vicinity of 1.4V.
- Apply V_{IN} and turn the switch SW on.



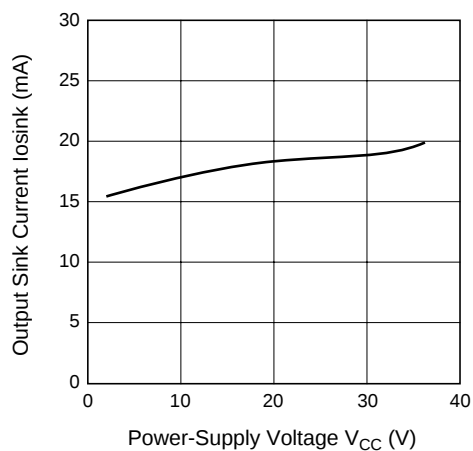
Characteristics Curve



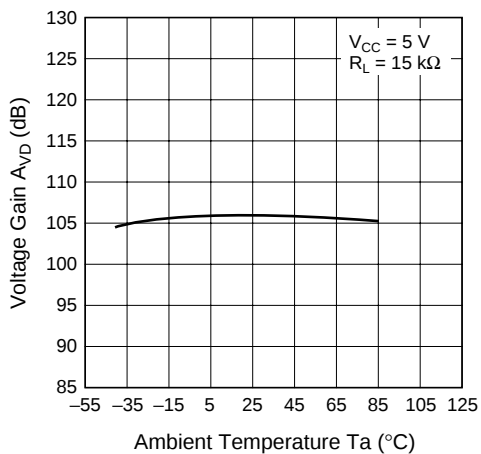
Output Sink Current vs.
Ambient Temperature Characteristics



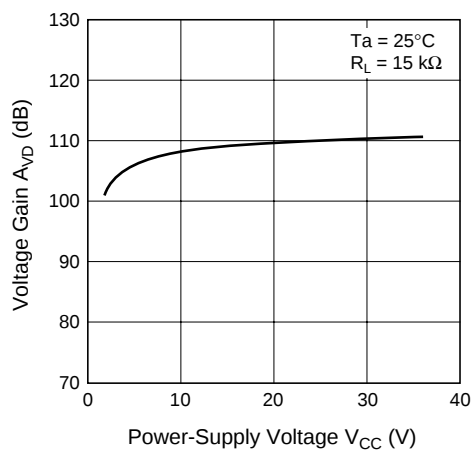
Output Sink Current vs.
Power-Supply Voltage Characteristics



Voltage Gain vs.
Ambient Temperature Characteristics



Voltage Gain vs.
Power-Supply Voltage Characteristics



HA17901 Application Examples

The HA17901 houses four independent comparators in a single package, and operates over a wide voltage range at low power from a single-voltage power supply. Since the common-mode input voltage range starts at the ground potential, the HA17901 is particularly suited for single-voltage power supply applications. This section presents several sample HA17901 applications.

HA17901 Application Notes

1. Square-Wave Oscillator

The circuit shown in figure one has the same structure as a single-voltage power supply astable multivibrator. Figure 2 shows the waveforms generated by this circuit.

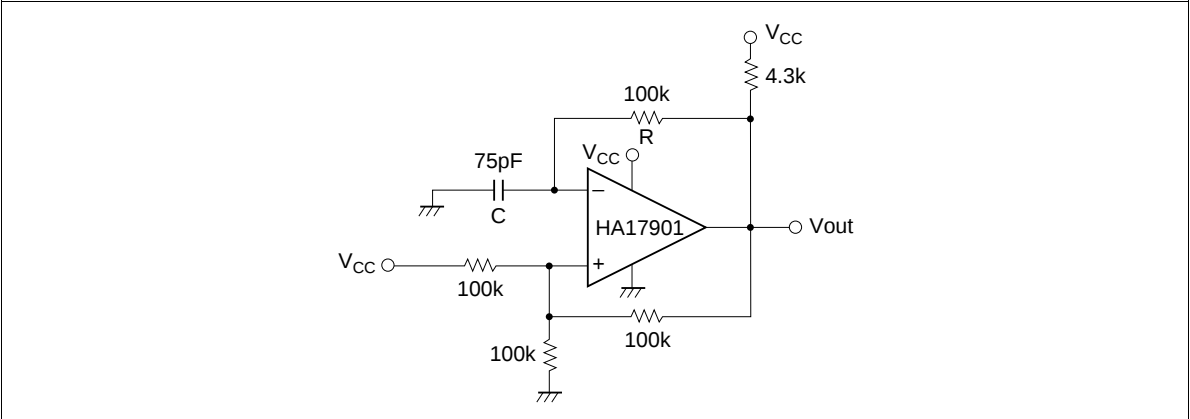


Figure 1 Square-Wave Oscillator

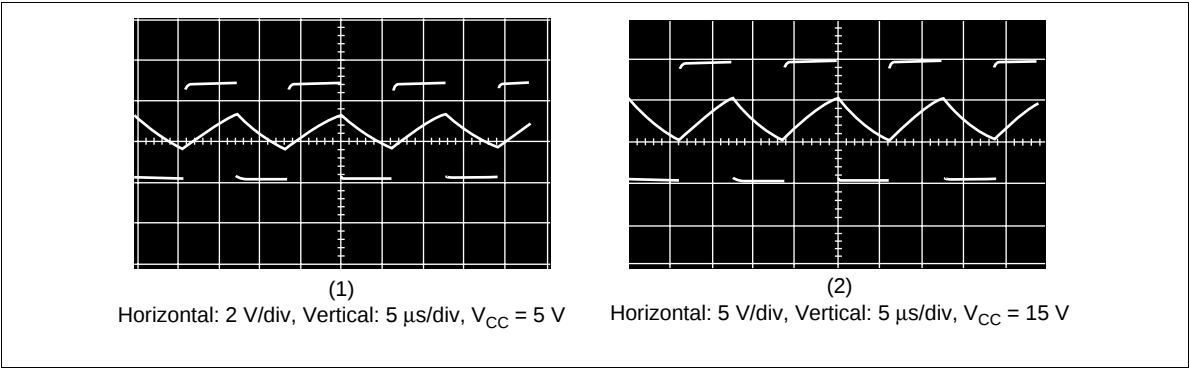


Figure 2 Operating Waveforms

2. Pulse Generator

The charge and discharge circuits in the circuit from figure 1 are separated by diodes in this circuit. (See figure 3.) This allows the pulse width and the duty cycle to be set independently. Figure 4 shows the waveforms generated by this circuit.

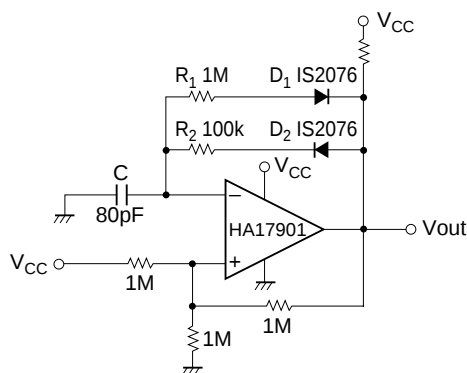
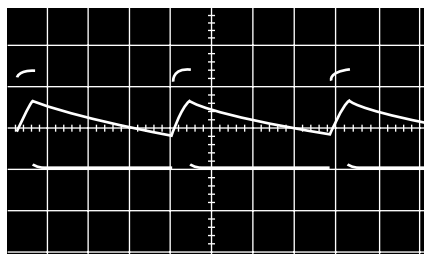
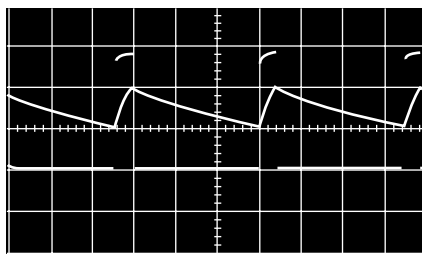


Figure 3 Pulse Generator



Horizontal: 2 V/div, Vertical: 20 μ s/div, $V_{CC} = 5$ V



Horizontal: 5 V/div, Vertical: 20 μ s/div, $V_{CC} = 15$ V

Figure 4 Operating Waveforms

3. Voltage Controlled Oscillator

In the circuit in figure 5, comparator A_1 operates as an integrator, A_2 operates as a comparator with hysteresis, and A_3 operates as the switch that controls the oscillator frequency. If the output V_{out1} is at the low level, the A_3 output will go to the low level and the A_1 inverting input will become a lower level than the A_1 noninverting input. The A_1 output will integrate this state and its output will increase towards the high level. When the output of the integrator A_1 exceeds the level on the comparator A_2 inverting input, A_2 inverts to the high level and both the output V_{out1} and the A_3 output go to the high level. This causes the integrator to integrate a negative state, resulting in its output decreasing towards the low level. Then, when the A_1 output level becomes lower than the level on the A_2 noninverting input, the output V_{out1} is once again inverted to the low level. This operation generates a square wave on V_{out1} and a triangular wave on V_{out2} .

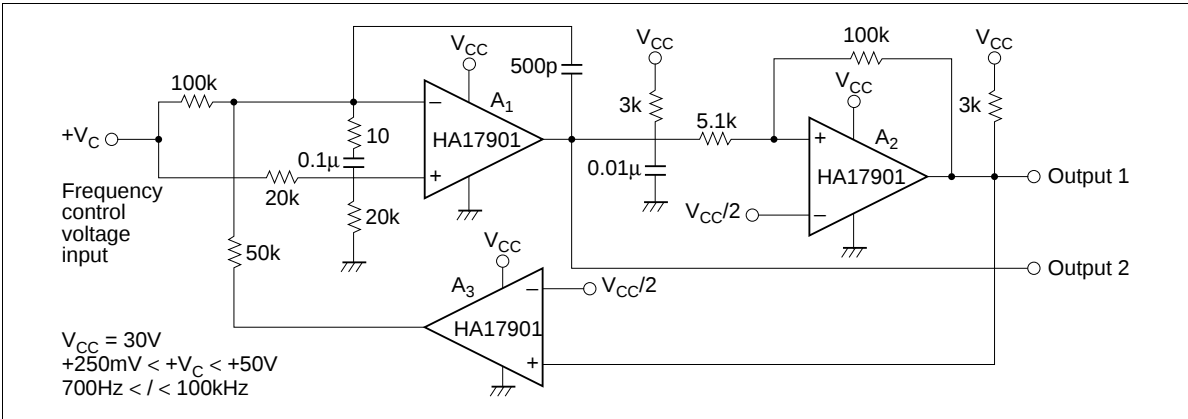


Figure 5 Voltage Controlled Oscillator

4. Basic Comparator

The circuit shown in figure 6 is a basic comparator. When the input voltage V_{IN} exceeds the reference voltage V_{REF} , the output goes to the high level.

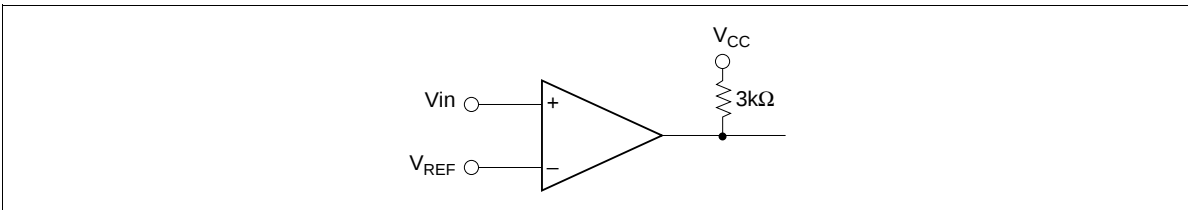


Figure 6 Basic Comparator

5. Noninverting Comparator (with Hysteresis)

Assuming $+V_{IN}$ is 0V, when V_{REF} is applied to the inverting input, the output will go to the low level (approximately 0V). If the voltage applied to $+V_{IN}$ is gradually increased, the output will go high when the value of the noninverting input, $+V_{IN} \times R_2/(R_1 + R_2)$, exceeds $+V_{REF}$. Next, if $+V_{IN}$ is gradually lowered, V_{out} will be inverted to the low level once again when the value of the noninverting input, $(V_{out} - V_{IN}) \times R_1/(R_1 + R_2)$, becomes lower than V_{REF} . With the circuit constants shown in figure 7, assuming $V_{CC} = 15V$ and $+V_{REF} = 6V$, the following formula can be derived, i.e. $+V_{IN} \times 10M/(5.1M + 10M) > 6V$, and V_{out} will invert from low to high when $+V_{IN}$ is $> 9.06V$.

$$(V_{out} - V_{IN}) \times \frac{R_1}{R_1 + R_2} + V_{IN} < 6V$$

(Assuming $V_{out} = 15V$)

When $+V_{IN}$ is lowered, the output will invert from high to low when $+V_{IN} < 1.41V$. Therefore this circuit has a hysteresis of $7.65V$. Figure 8 shows the input characteristics.

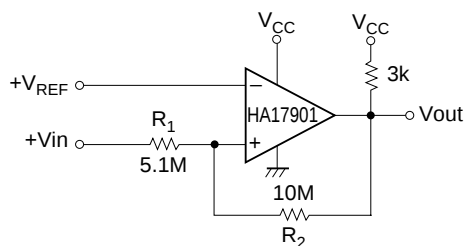


Figure 7 Noninverting Comparator

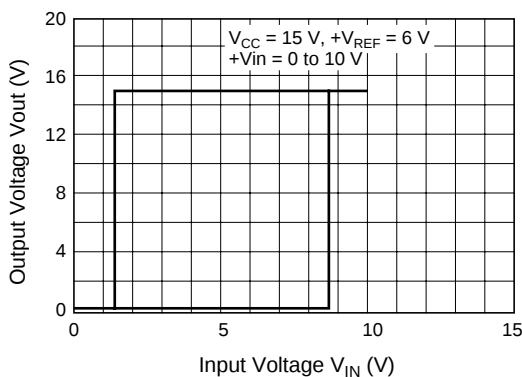


Figure 8 Noninverting Comparator I/O Transfer Characteristics

6. Inverting Comparator (with Hysteresis)

In this circuit, the output V_{out} inverts from high to low when $+V_{IN} > (V_{CC} + V_{out})/3$. Similarly, the output V_{out} inverts from low to high when $+V_{IN} < V_{CC}/3$. With the circuit constants shown in figure 9, assuming $V_{CC} = 15V$ and $V_{out} = 15V$, this circuit will have a 5V hysteresis. Figure 10 shows the I/O characteristics for the circuit in figure 9.

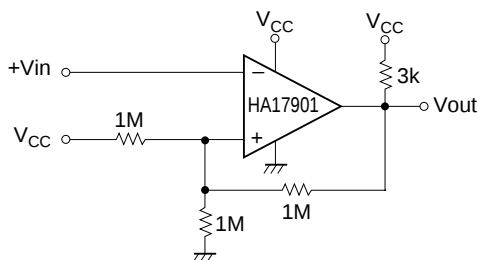


Figure 9 Inverting Comparator

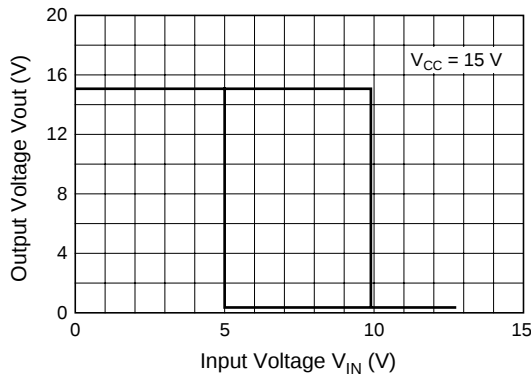


Figure 10 Inverting Comparator I/O Transfer Characteristics

7. Zero-Cross Detector (Single-Voltage Power Supply)

In this circuit, the noninverting input will essentially be held at the potential determined by dividing V_{CC} with $100k\Omega$ and $10k\Omega$ resistors. When V_{IN} is 0V or higher, the output will be low, and when V_{IN} is negative, V_{out} will invert to the high level. (See figure 11.)

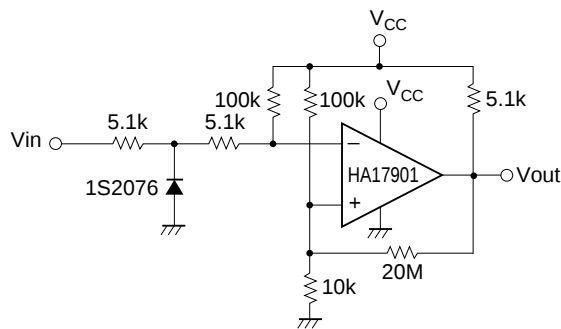
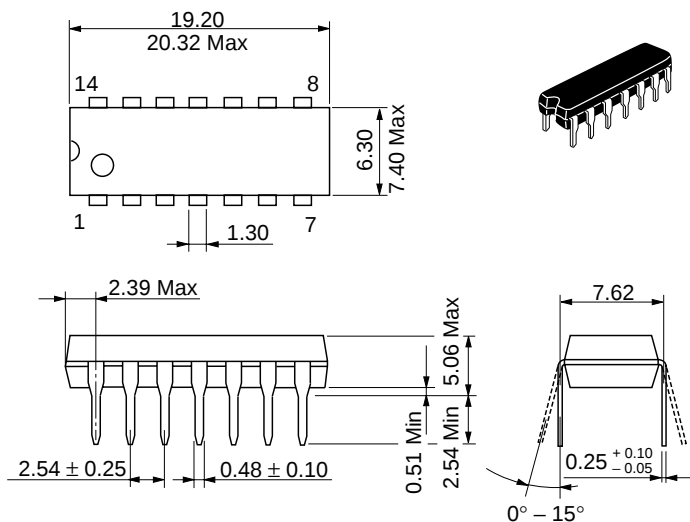


Figure 11 Zero-Cross Detector

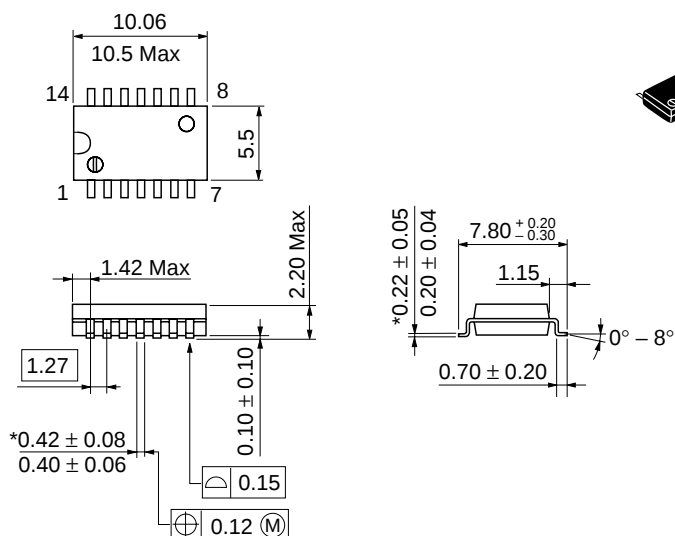
Package Dimensions

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, 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 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) 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>

Copyright © Hitachi, Ltd., 2000. All rights reserved. Printed in Japan.
Colophon 2.0