HA17901, HA17339 Series

Quadruple Comparators

HITACHI

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

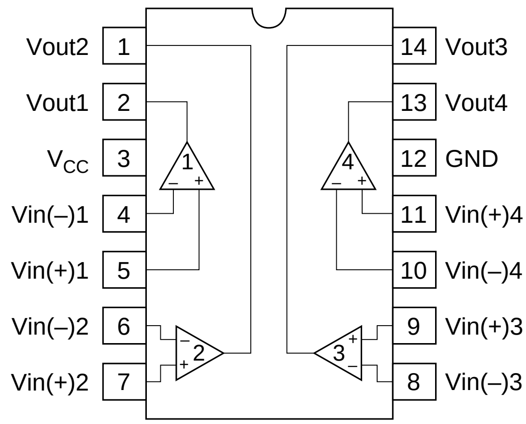
- Wide power-supply voltage range: 2 to 36V
- Extremely low current drain: 0.8mA
- Low input bias current: 25nA
- Low input offset current: 5nA
- Low input offset voltage: 2mV
- The common-mode input voltage range includes ground.
- Low output saturation voltage: 1mV (5µA), 70mV (1mA)
- Output voltages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

Hitachi semiconductor

Ordering Information

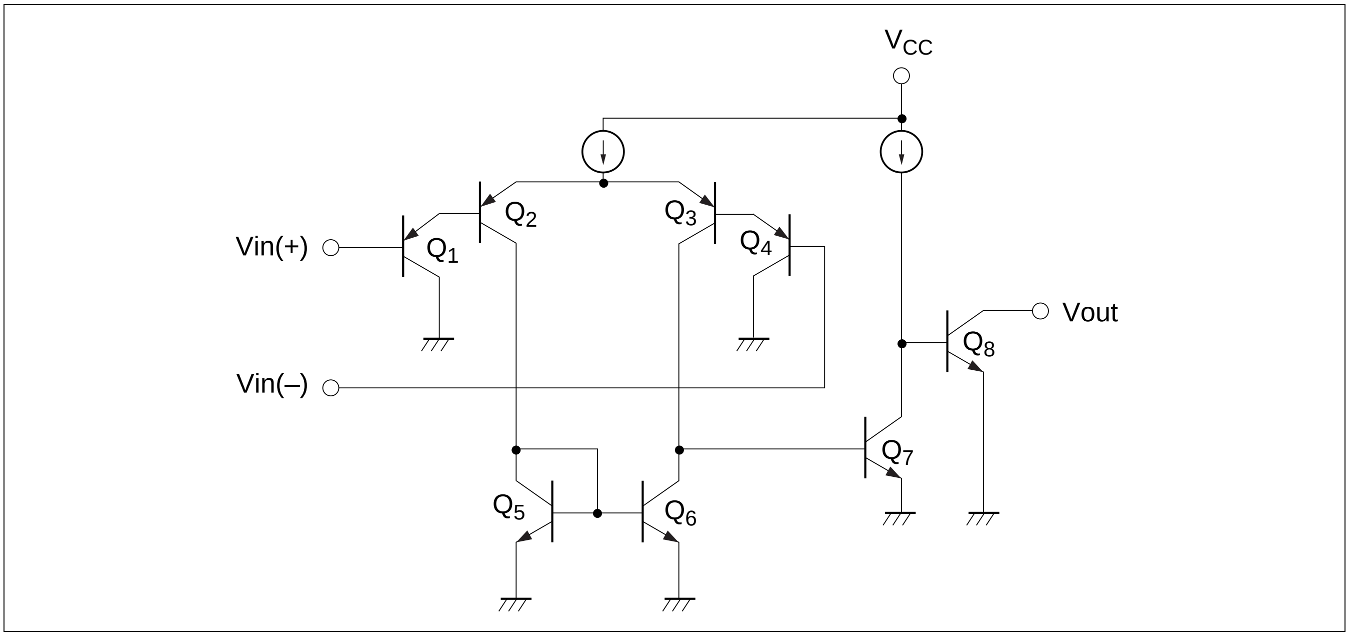
Type No.	Application	Package
HA17901PJ	Car use	DP-14
HA17901FPJ		FP-14DA
HA17901FPK		FP-14DA
HA17901P	Industrial use	DP-14
HA17901FP		FP-14DA
HA17339	Commercial use	DP-14
HA17339F		FP-14DA

Pin Arrangement



(Top view)

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	Vin(diff)	$\pm V_{CC}$	$\pm V_{CC}$	$\pm V_{CC}$	$\pm V_{CC}$	$\pm V_{CC}$	$\pm V_{CC}$	$\pm V_{CC}$	V
Input voltage	Vin	–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	Iout*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	Vout	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, Ta = 25°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 = 0Ω
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 = 15kΩ
Response time*2	t_R	—	1.3	—	µs	V_{RL} = 5V, R_L = 5.1kΩ
Output sink current	Iosink	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, Iosink = 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.

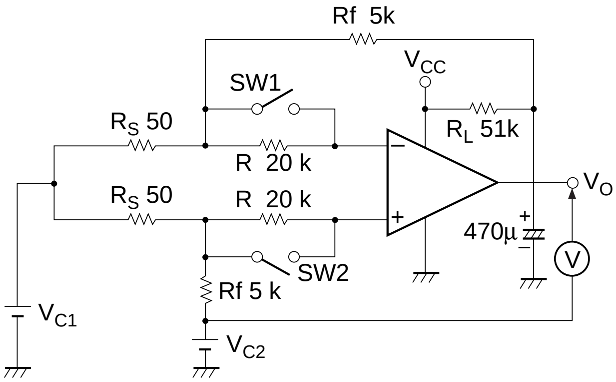
Electrical Characteristics 2 (V_{CC} = 5V, Ta = – 41 to + 125°C)

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 = 0Ω
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, Iosink ≤ 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}

$V_{C1} = \frac{1}{2} V_{CC}$

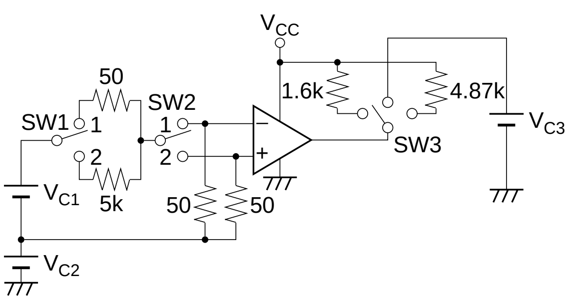
$V_{C2} = 1.4V$

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

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

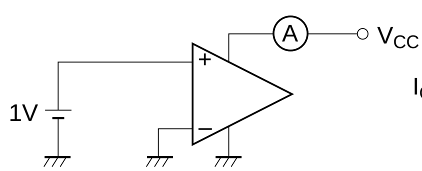
$$I_{IB} = \frac{|V_{O4} - V_{O3}|}{2 \cdot R(1 + Rf / R_S)} \quad \text{(nA)}$$

2. Output saturation voltage (V_O sat) output sink current (Iosink), and common-mode input voltage (V_{CM}) test circuit



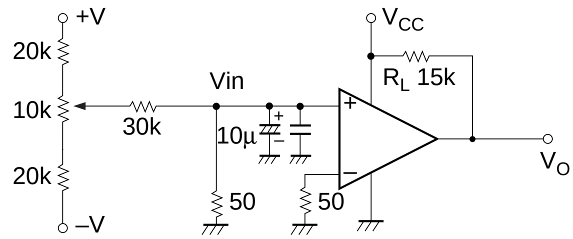
Item	V_{C1}	V_{C2}	V_{C3}	SW1	SW2	SW3	Unit
$V_O$sat	2V	0V	—	1	1	1 at V_{CC} = 5V 3 at V_{CC} = 15V	V
Iosink	2V	0V	1.5V	1	1	2	mA
V_{CM}	2V	–1 to V_{CC}	—	2	Switched between 1 and 2	3	V

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



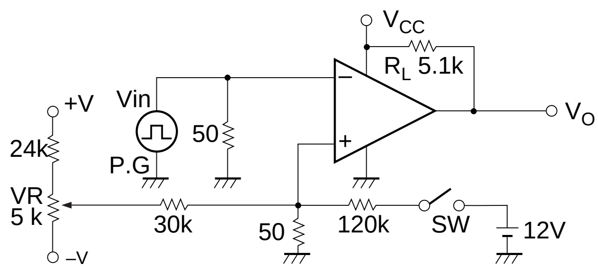
I_{CC}: $R_L = \infty$

4. Voltage gain (A_{VD}) test circuit (R_L = 15kΩ)



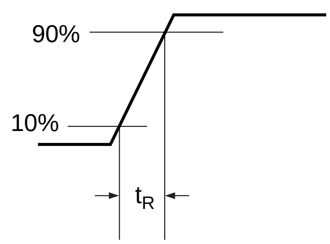
$$A_{VD} = 20 \log \frac{V_{O1} - V_{O2}}{V_{IN1} - V_{IN2}} \quad \text{(dB)}$$

5. Response time (t_R) test circuit

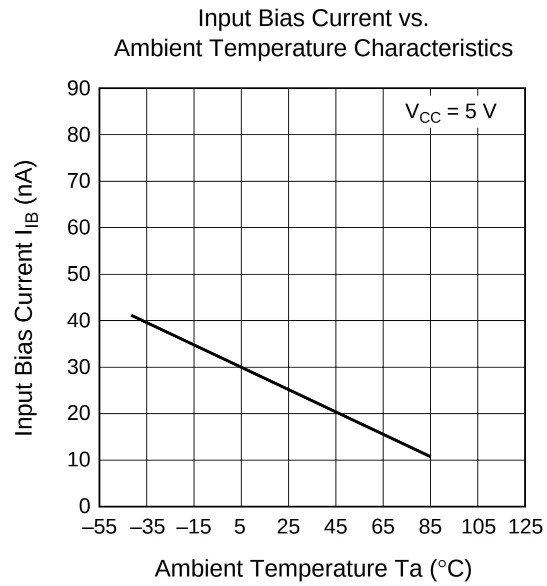


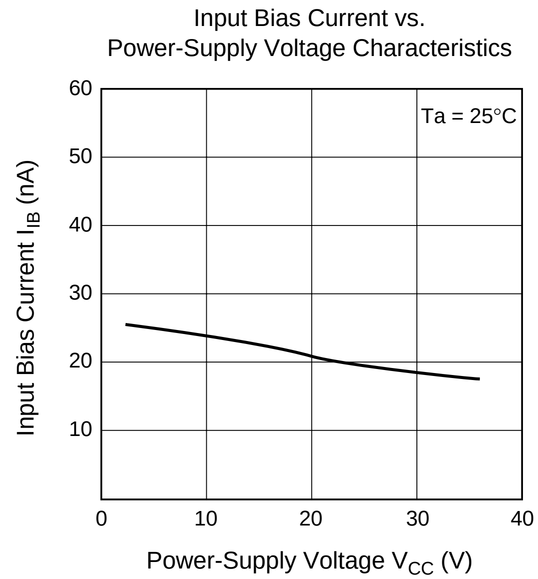
t_R: R_L = 5.1kΩ, a 100mV input step voltage that has a 5mV overdrive

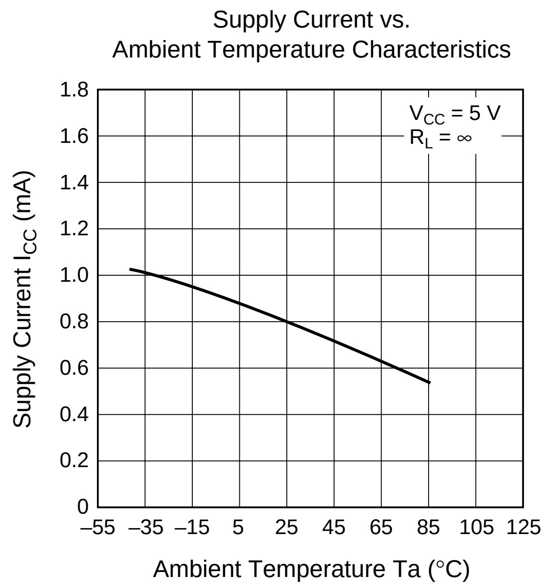
- With V_{IN} not applied, set the switch SW to the off position and adjust V_R so that V_O is in the vicinity of 1.4V.
- Apply V_{IN} and turn the switch SW on.

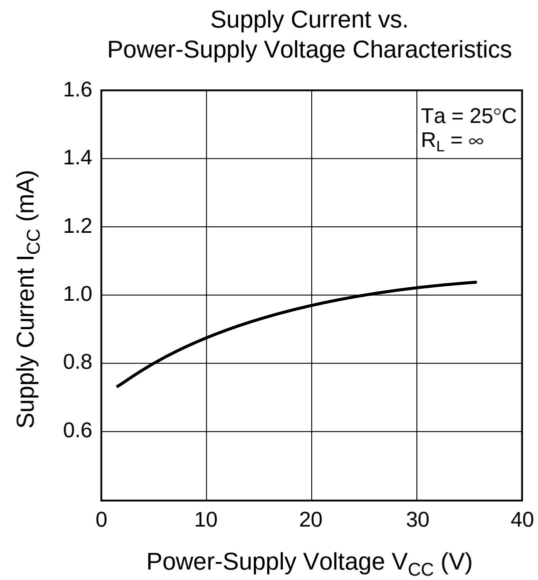


Characteristics Curve

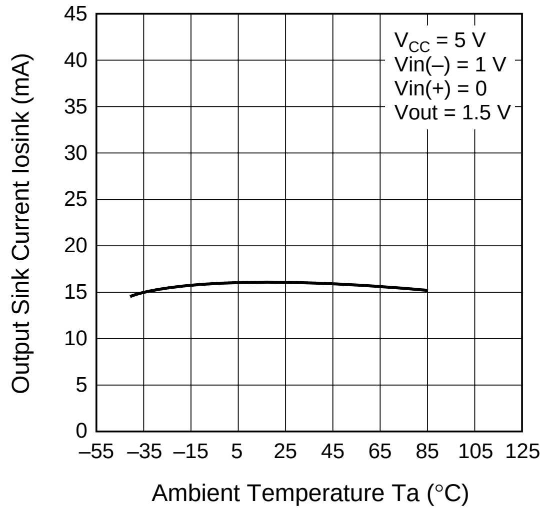




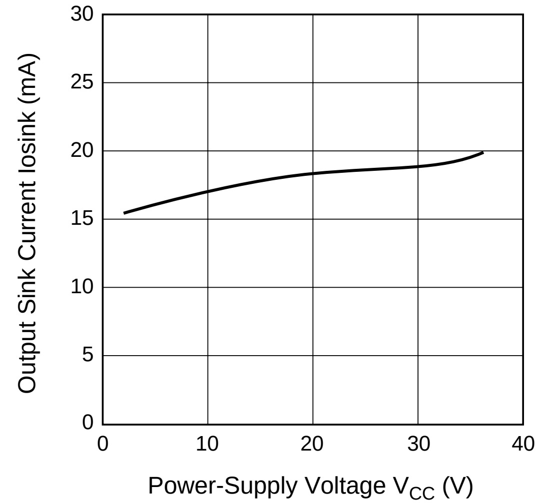




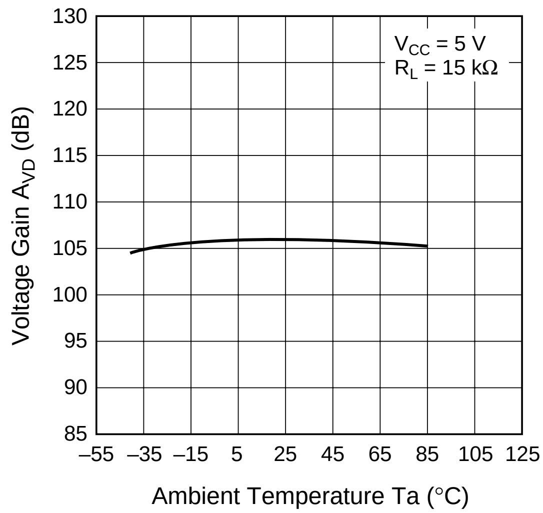
Output Sink Current vs.
Ambient Temperature Characteristics



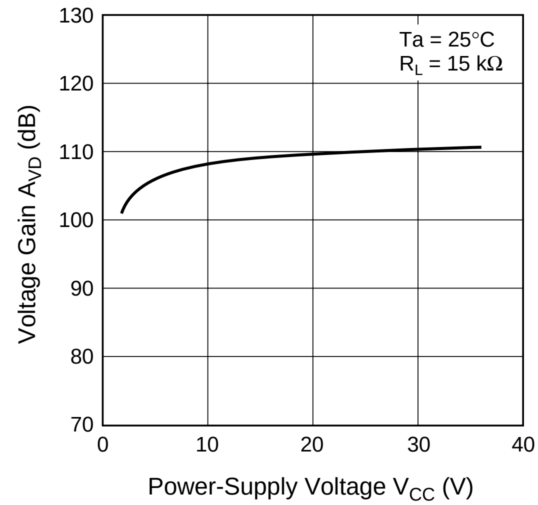
Output Sink Current vs.
Power-Supply Voltage Characteristics



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.

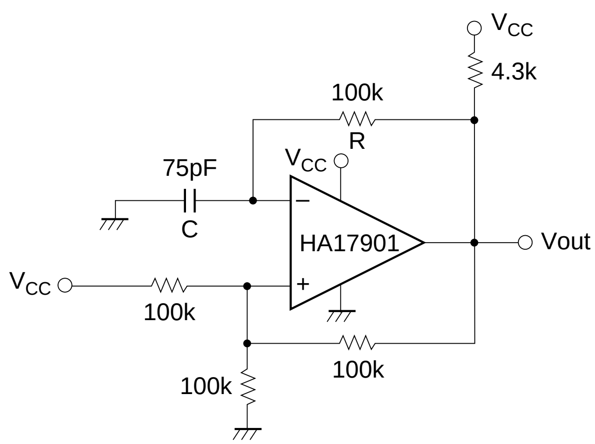
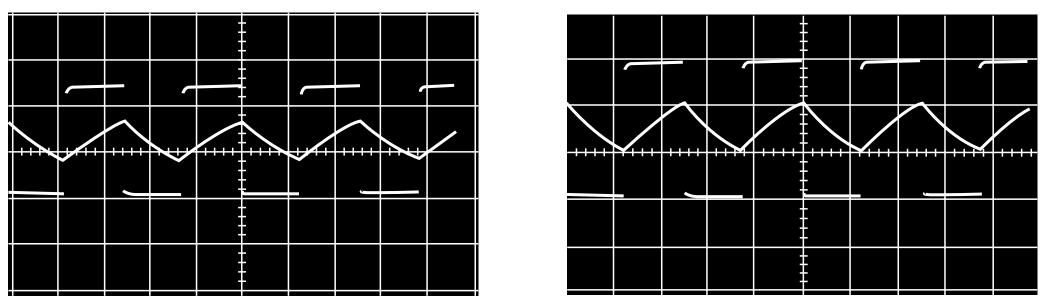


Figure 1 Square-Wave Oscillator



(1)
Horizontal: 2 V/div, Vertical: 5 µs/div, V_{CC} = 5 V

(2)
Horizontal: 5 V/div, Vertical: 5 µs/div, V_{CC} = 15 V

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.

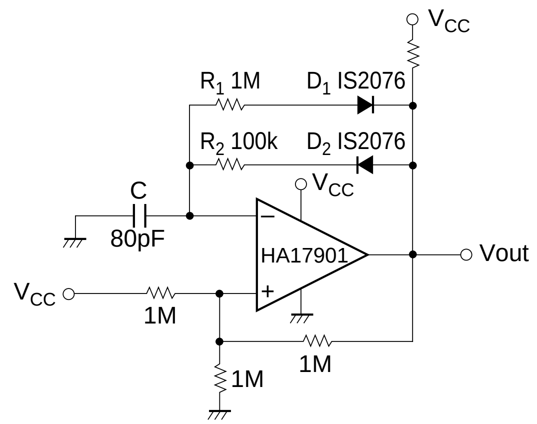
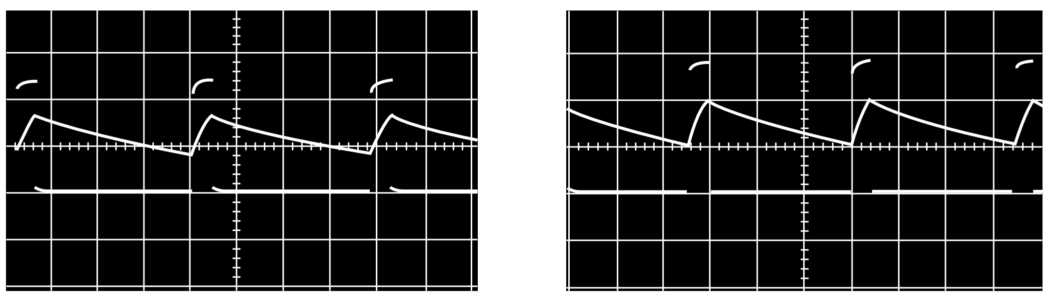


Figure 3 Pulse Generator



Horizontal: 2 V/div, Vertical: 20 µs/div, V_{CC} = 5 V

Horizontal: 5 V/div, Vertical: 20 µs/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 Vout1 is at the low level, the A_3 output will go to the low level and the A1 inverting input will become a lower level than the A1 noninverting input. The A1 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 Vout1 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 Vout1 is once again inverted to the low level. This operation generates a square wave on Vout1 and a triangular wave on Vout2.

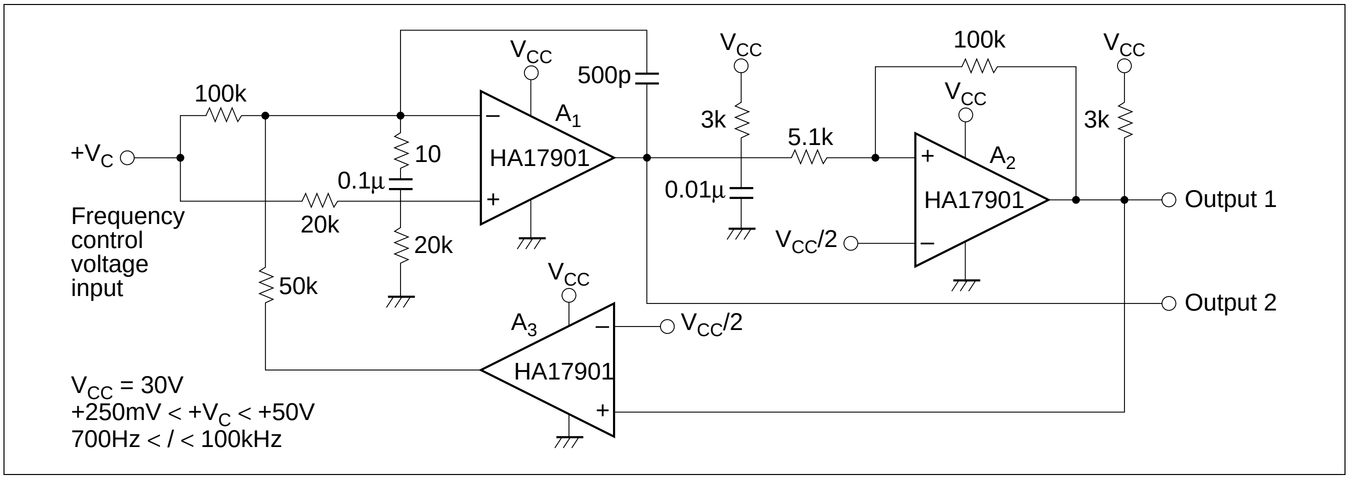


Figure 5 Voltage Controlled Oscillator

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.

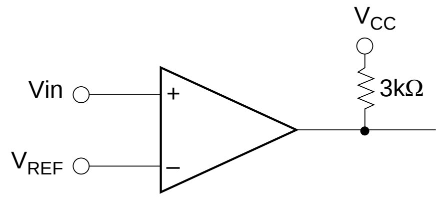


Figure 6 Basic Comparator

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, Vout will be inverted to the low level once again when the value of the noninverting input, $(Vout - V_{IN}) \times R_1/(R_1 + R_2)$, 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 Vout will invert from low to high when $+V_{IN}$ is > 9.06V.

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

(Assuming Vout = 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.

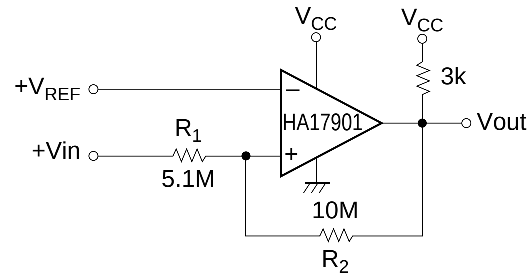


Figure 7 Noninverting Comparator

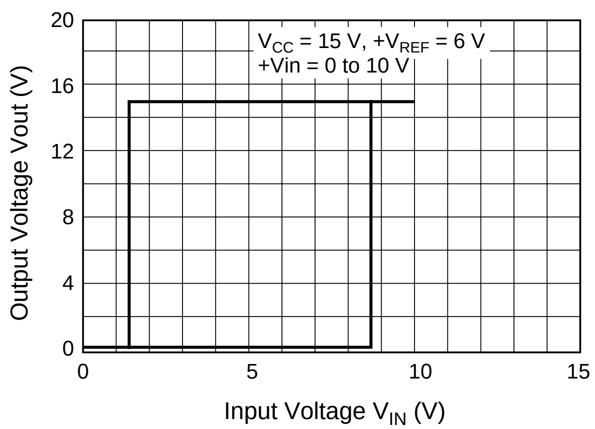


Figure 8 Noninverting Comparator I/O Transfer Characteristics

6. Inverting Comparator (with Hysteresis)

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

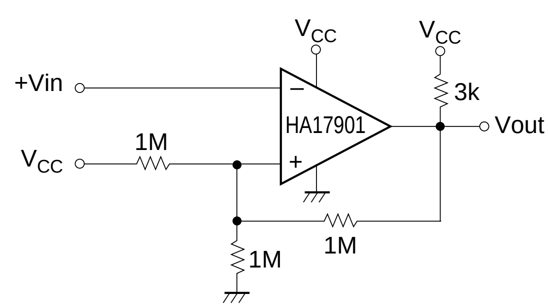


Figure 9 Inverting Comparator

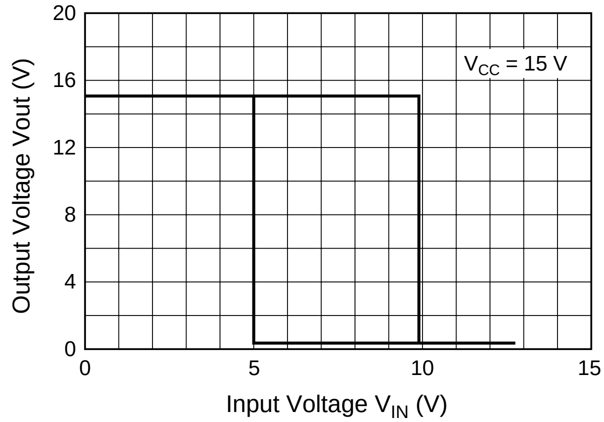


Figure 10 Inverting Comparator I/O Transfer Characteristics

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

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

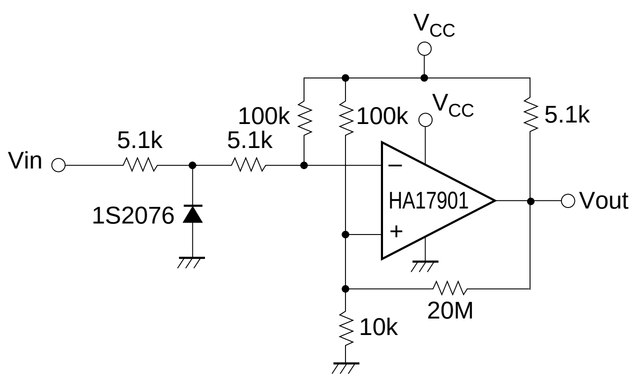
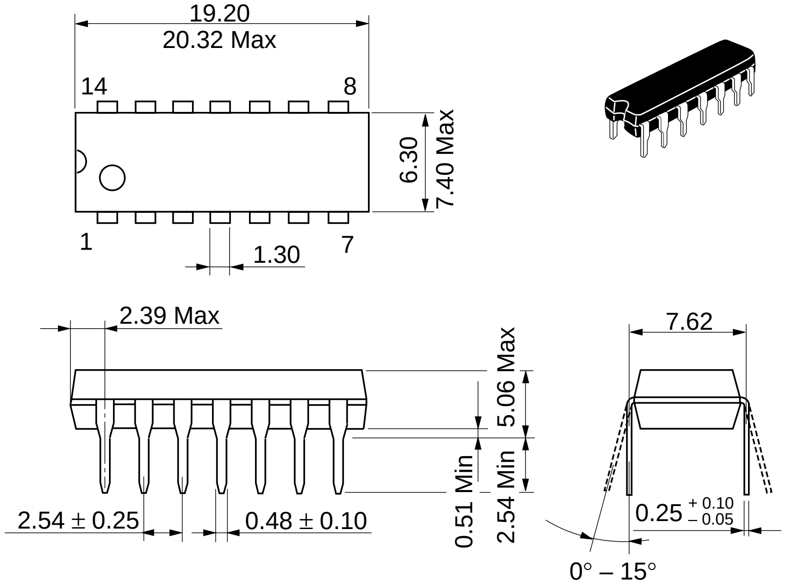


Figure 11 Zero-Cross Detector

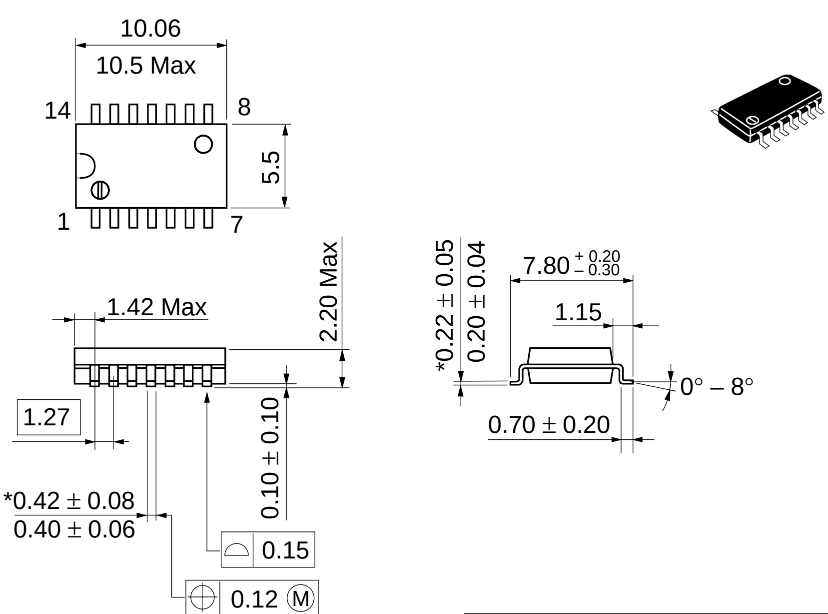
Package Dimensions

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 (Singapore)	: http://www.has.hitachi.com.sg/grp3/sicd/index.htm
	Asia (Taiwan)	: 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 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) 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