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.

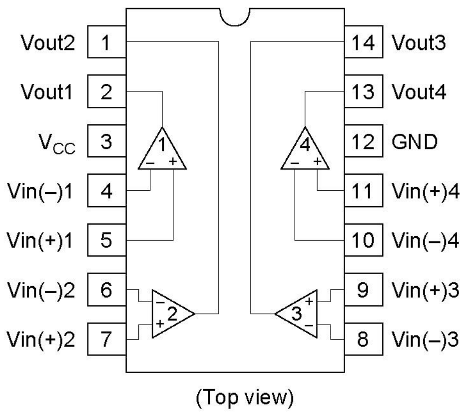
Features

- 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

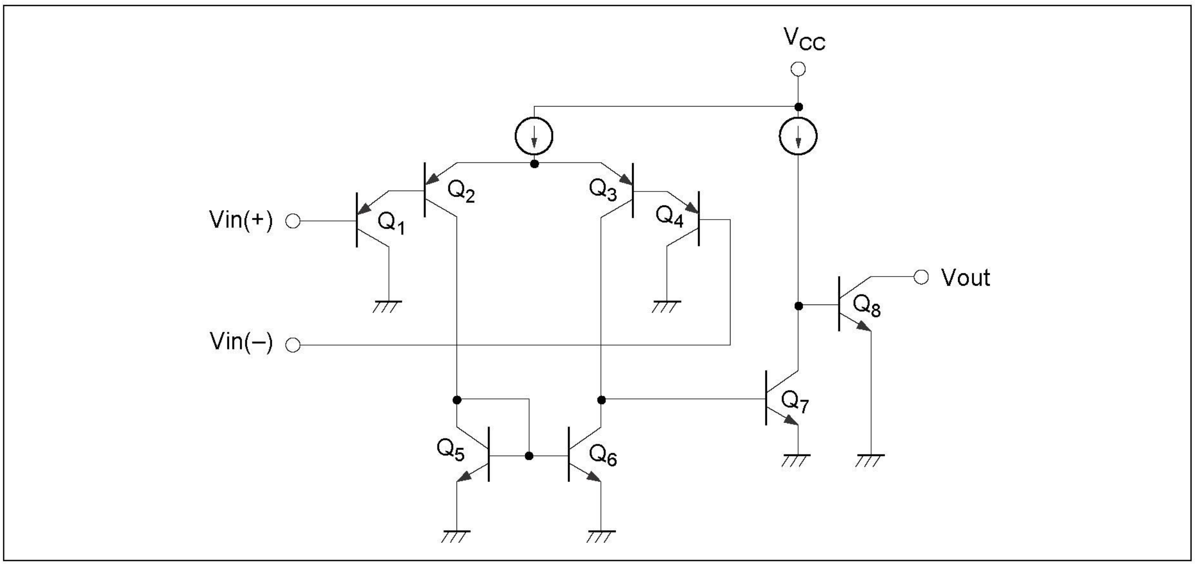
Ordering Information

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	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.

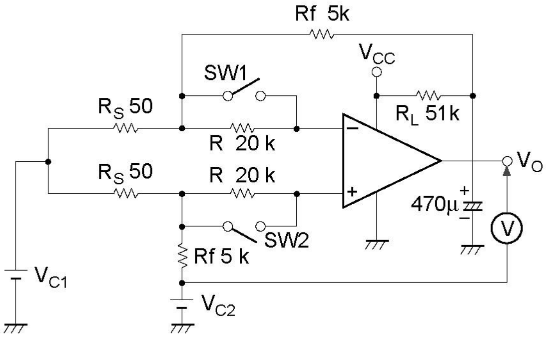
Electrical Characteristics 2 (V_{CC} = 5V, Ta = – 41 to + 125°C)

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 $\leq$ 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}

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

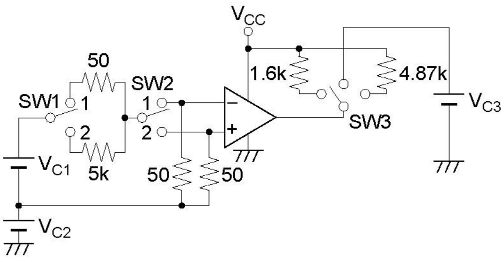
$V_{C2} = 1.4V$

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

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

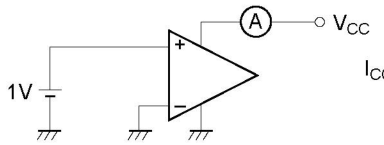
$$I_{IB} = \frac{|V_{O4} - V_{O3}|}{2 \cdot R(1 + Rf/R_S)} \quad (nA)$$

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



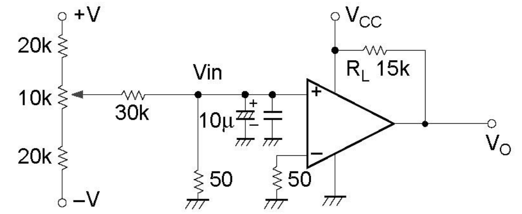
Item	V_{C1}	V_{C2}	V_{C3}	SW1	SW2	SW3	Unit
$V_O$sat	2V	0V	—	1	1	1 at V_{CC} = 5V 3 at V_{CC} = 15V	V
Iosink	2V	0V	1.5V	1	1	2	mA
V_{CM}	2V	–1 to V_{CC}	—	2	Switched between 1 and 2	3	V

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



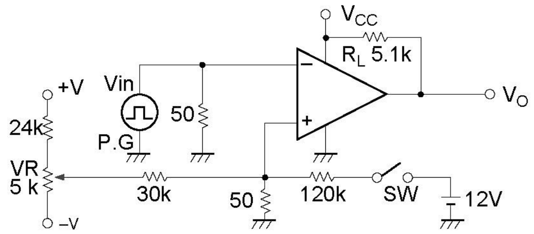
I_{CC}: $R_L = \infty$

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



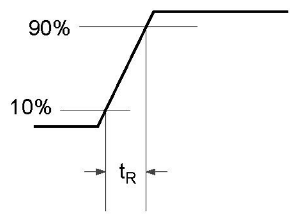
$$A_{VD} = 20 \log \frac{V_{O1} - V_{O2}}{V_{IN1} - V_{IN2}} \quad (dB)$$

5. Response time (t_R) test circuit



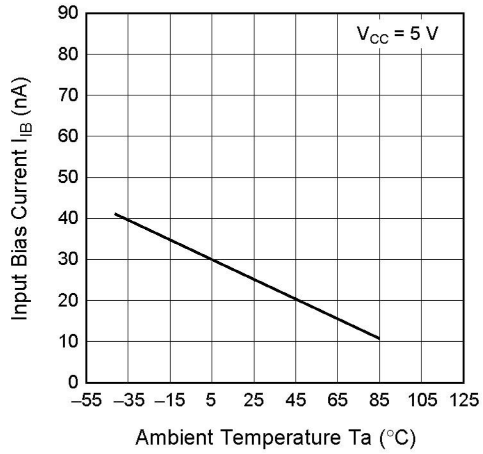
t_R: R_L = 5.1kΩ, a 100mV input step voltage that has a 5mV overdrive

- 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.

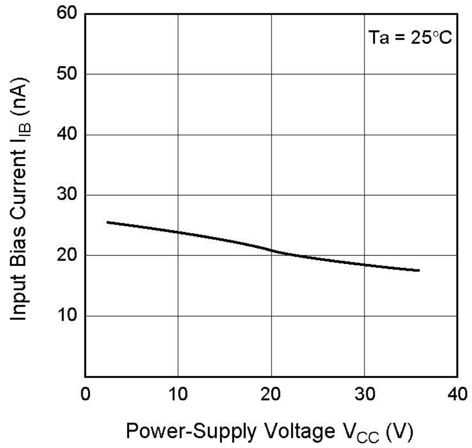


Characteristics Curve

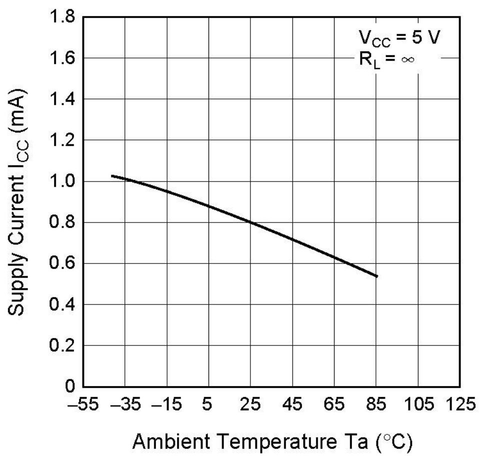
Input Bias Current vs.
Ambient Temperature Characteristics



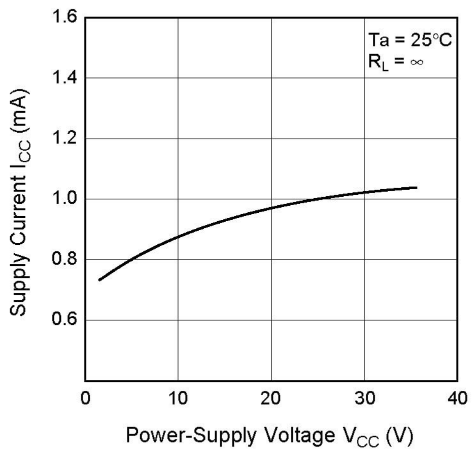
Input Bias Current vs.
Power-Supply Voltage Characteristics

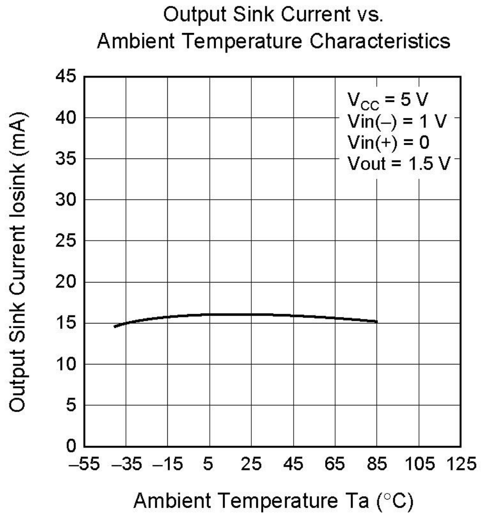


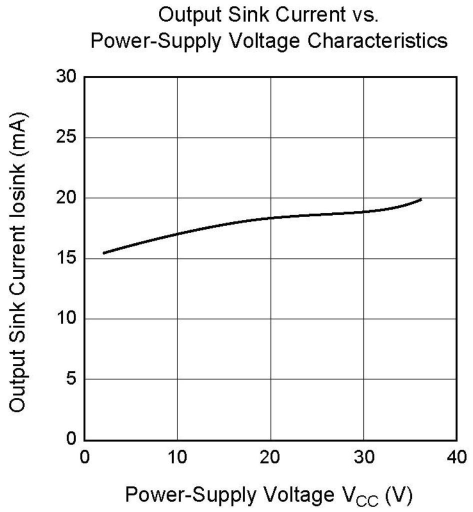
Supply Current vs.
Ambient Temperature Characteristics

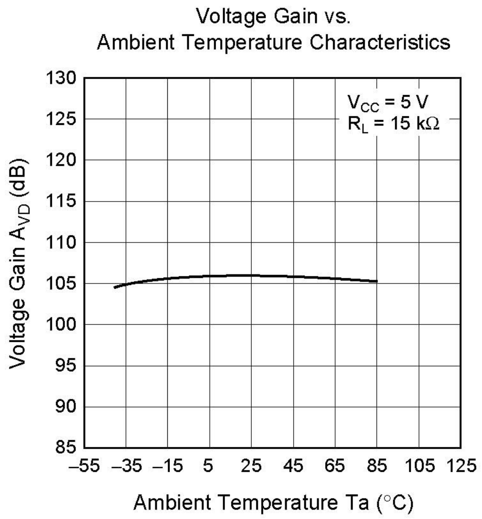


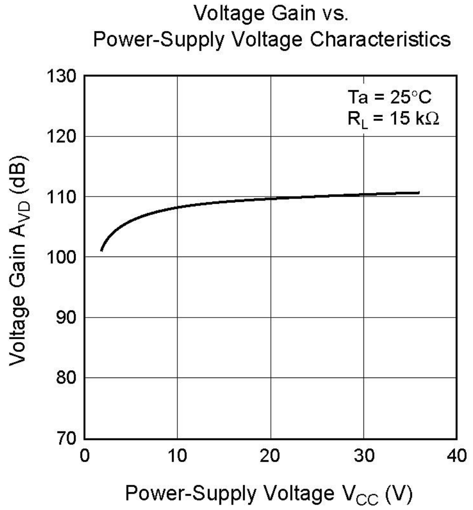
Supply Current vs.
Power-Supply Voltage Characteristics




Output Sink Current vs.
Ambient Temperature Characteristics
Output Sink Current Iosink (mA)
45
40
35
30
25
20
15
10
5
0
–55 –35 –15 5 25 45 65 85 105 125
Ambient Temperature Ta (°C)
VCC = 5 V
Vin(–) = 1 V
Vin(+) = 0
Vout = 1.5 V


Output Sink Current vs.
Power-Supply Voltage Characteristics
Output Sink Current Iosink (mA)
30
25
20
15
10
5
0
0 10 20 30 40
Power-Supply Voltage VCC (V)


Voltage Gain vs.
Ambient Temperature Characteristics
Voltage Gain AVD (dB)
130
125
120
115
110
105
100
95
90
85
–55 –35 –15 5 25 45 65 85 105 125
Ambient Temperature Ta (°C)
VCC = 5 V
RL = 15 kΩ


Voltage Gain vs.
Power-Supply Voltage Characteristics
Voltage Gain AVD (dB)
130
120
110
100
90
80
70
0 10 20 30 40
Power-Supply Voltage VCC (V)
Ta = 25°C
RL = 15 kΩ

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.

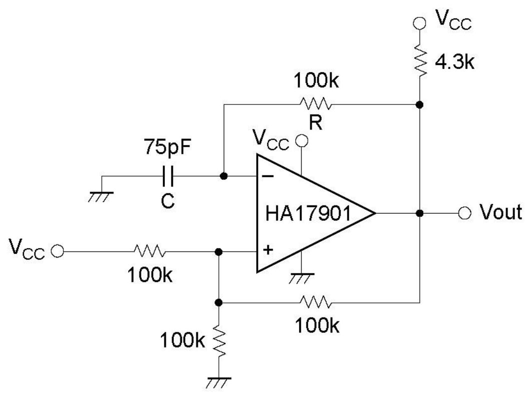


Figure 1 Square-Wave Oscillator

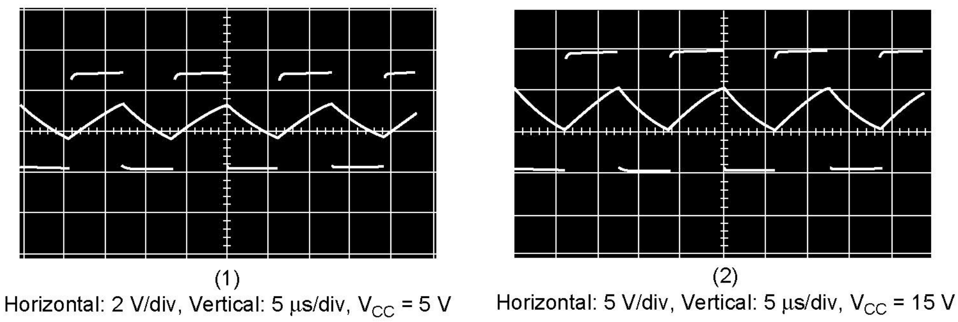


Figure 2 Operating Waveforms

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.

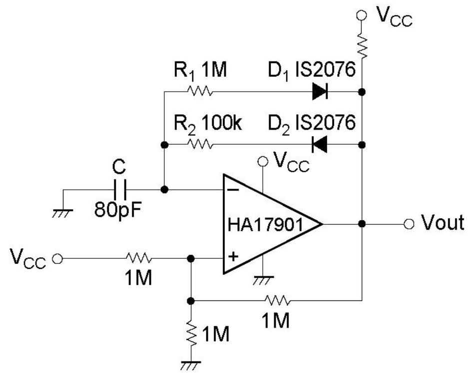
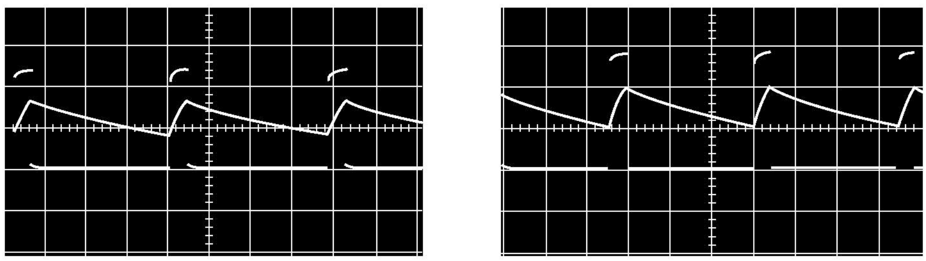


Figure 3 Pulse Generator



Horizontal: 2 V/div, Vertical: 20 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.

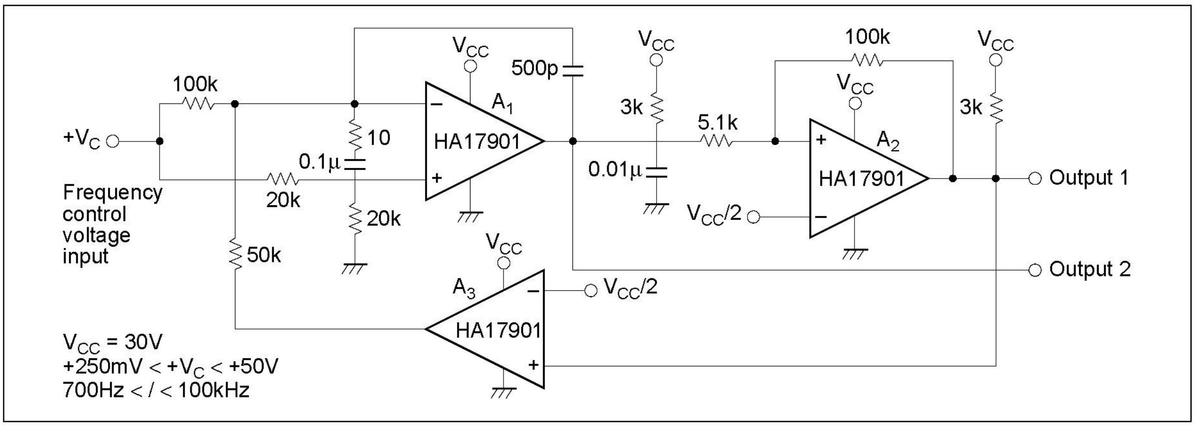


Figure 5 Voltage Controlled Oscillator

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.

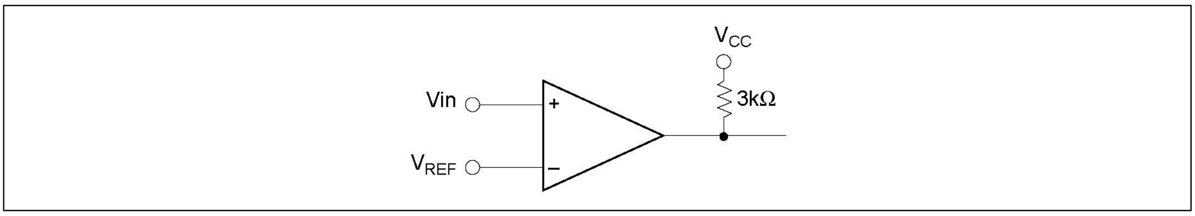


Figure 6 Basic Comparator

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.

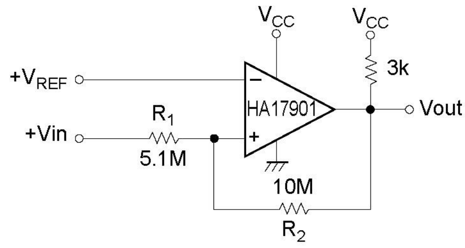


Figure 7 Noninverting Comparator

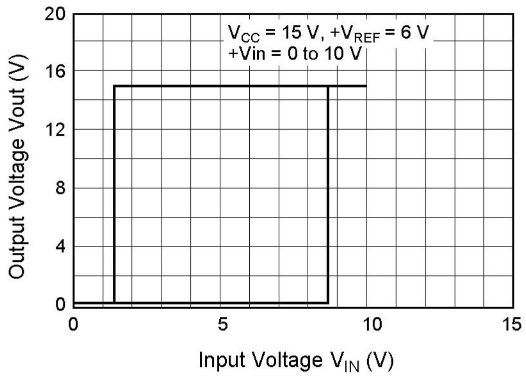


Figure 8 Noninverting Comparator I/O Transfer Characteristics

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.

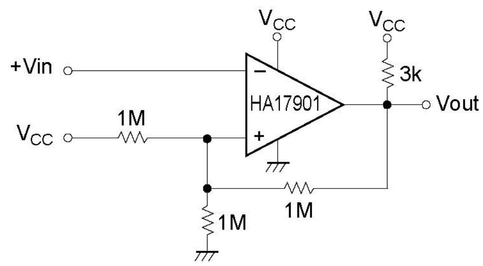


Figure 9 Inverting Comparator

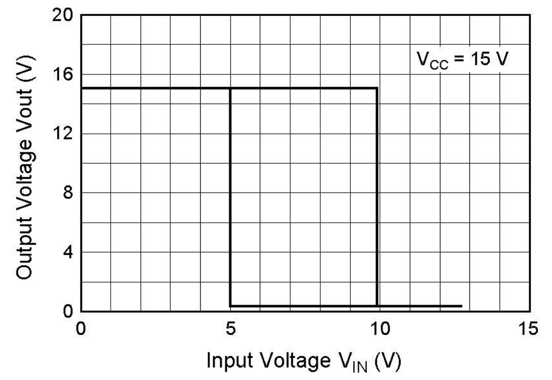


Figure 10 Inverting Comparator I/O Transfer Characteristics

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.)

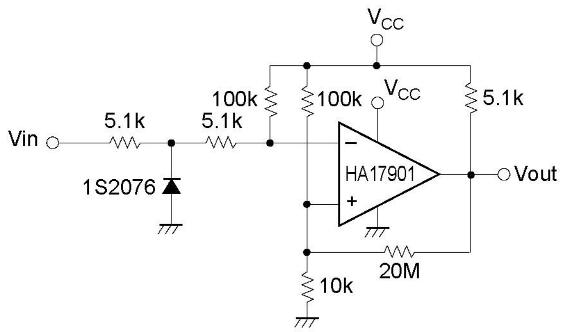
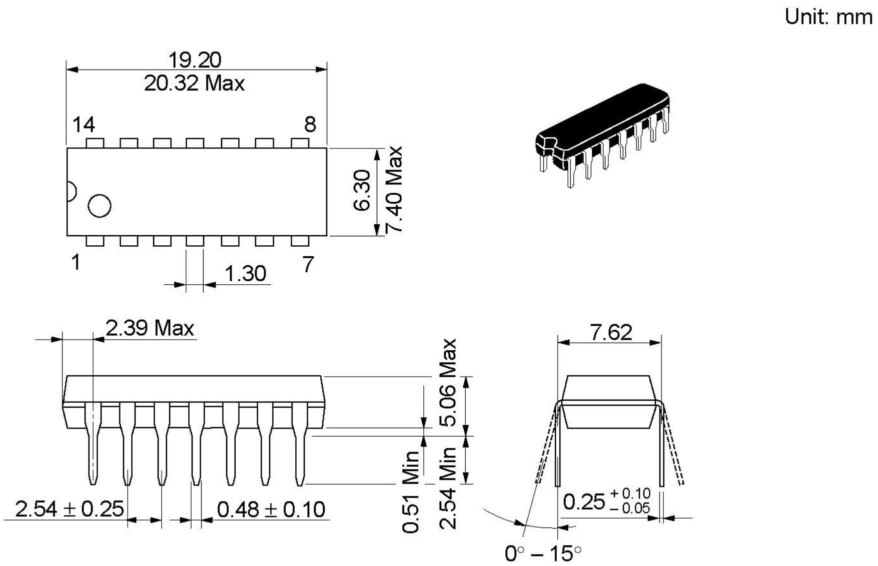
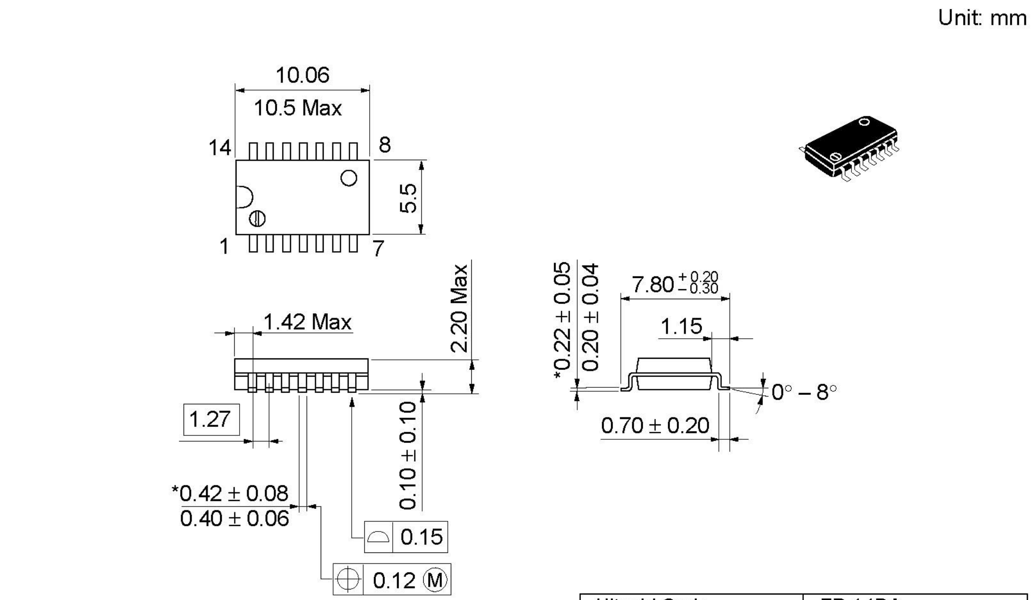


Figure 11 Zero-Cross Detector

Package Dimensions



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



*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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