RENESAS

HA17901A Series

Quadruple Comparators

REJ03D0806-0100
Rev.1.00
Mar 10, 2006

Description

The HA17901A series products are comparators designed for general purpose, especially for power control systems.

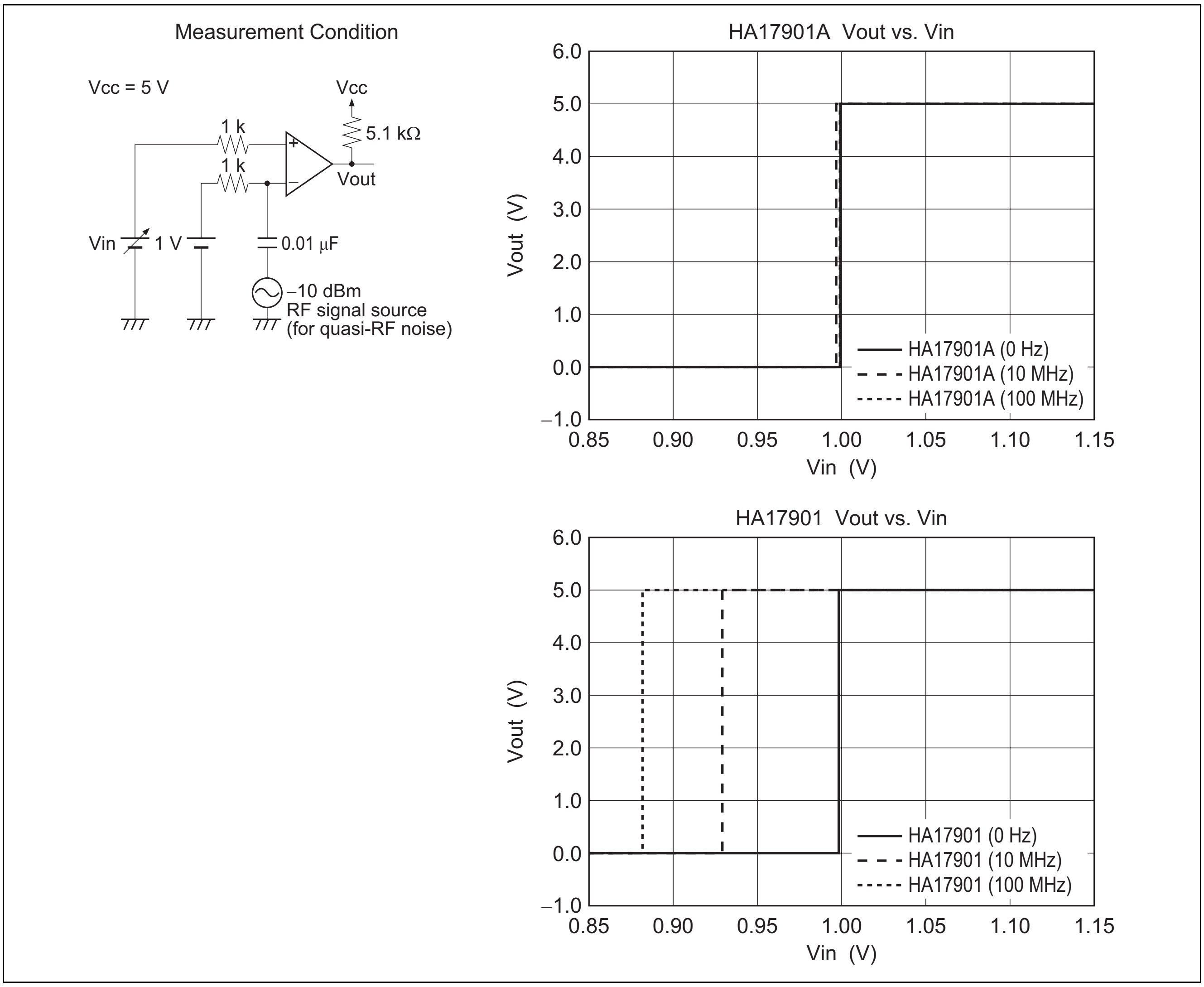
These ICs operate from a single power-supply voltage over a wide range of voltages, and feature a reduced power-supply current since the supply current is independent of the supply voltage.

These comparators have the merit which ground is included in the common-mode input voltage range at a single-voltage power supply operation. 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 36 V
- Very low supply current : 0.8 mA Typ.
- Low input bias current : 25 nA Typ.
- Low input offset current : 5 nA Typ.
- Low input offset voltage : 2 mV Typ.
- The common-mode input voltage range includes ground
- Output voltages compatible with CMOS logic systems

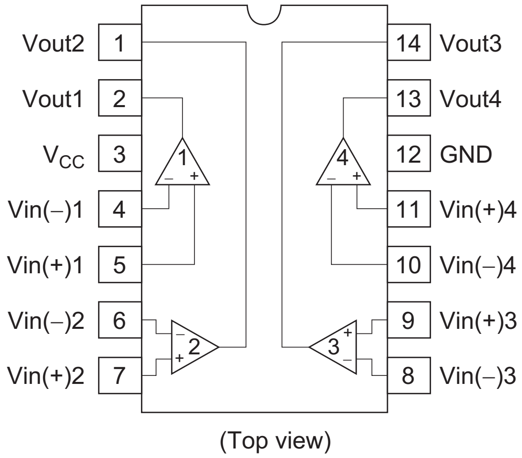
- Low electro-magnetic susceptibility



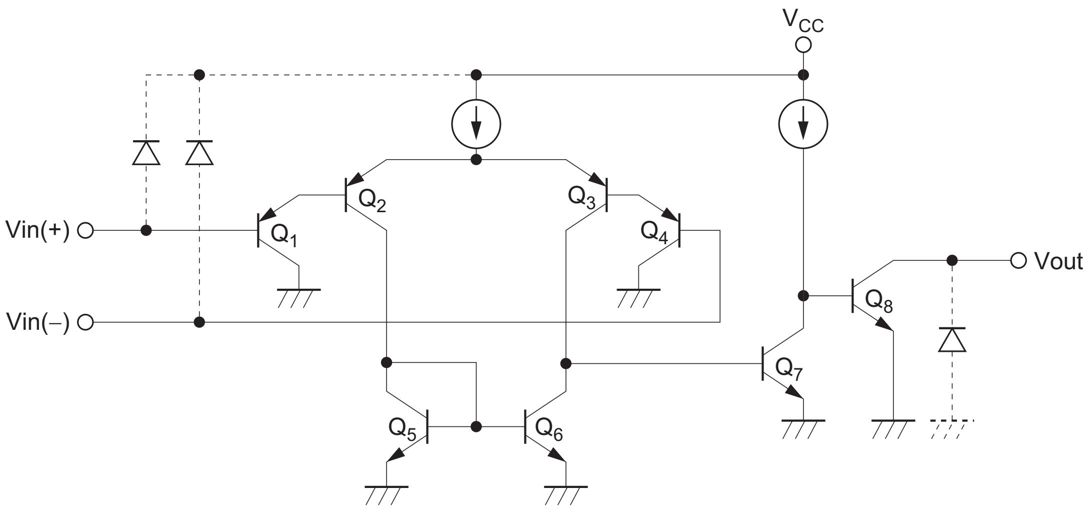
Ordering Information

Type No.	Application	Package Name	Package Code
HA17901AP	Industry use	DIP-14 pin	PRDP0014AB-B
HA17901AFP		SOP-14 pin (JEITA)	PRSP0014DF-B
HA17901ARP		SOP-14 pin (JEDEC)	PRSP0014DE-A
HA17901AT		TSSOP-14 pin	PTSP0014JA-B

Pin Arrangement



Circuit Structure (1/4)



Note: If Input/Output terminals voltage over the absolute maximum ratings, there is possibility of mis-operation, characteristics deterioration and destruction, because of the current's flowing to parasitic diode in IC.
The Input/Output terminals are recommended to be protected with the clamp circuit which using the diode with low forward voltage (like schottky barrier diode) when there is a possibility for the Input/Output terminals voltage exceeds the absolute maximum ratings.

Absolute Maximum Ratings

(Ta = 25°C)

Item		Symbol	Ratings	Unit
Power supply voltage		V_{CC}	36	V
Differential input voltage		Vin(diff)	$\pm V_{CC}$	V
Input voltage		Vin	–0.3 to $+V_{CC}$	V
Output pin voltage		Vout	–0.3 to +36	V
Output current		Iout *1	20	mA
Allowable power dissipation	DIP	P_T	625 *2	mW
	SOP		625 *3	
	TSSOP		400 *4	
Operating temperature		Topr	–40 to +85	°C
Storage temperature		Tstg	–55 to +125	°C

Notes: 1. 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.

2. HA17901AP:
These are the allowable values up to Ta = 50°C. Derate by 8.3 mW/°C above that temperature.

3. HA17901AFP/ARP:
When it is mounted on glass epoxy board of 40 mm × 40 mm × 1.6 mmt with 10% wiring density, value at Ta ≤ 25°C. If Ta > 25°C, derated by 6.25 mW/°C.
When it is mounted on glass epoxy board of 40 mm × 40 mm × 1.6 mmt with 30% wiring density. If Ta > 32°C, derated by 6.70 mW/°C.

4. HA17901AT:
These are the allowable values up to Ta = 25°C. Derate by 4 mW/°C above that temperature.

Electrical Characteristics

(V_{CC} = 5 V, Ta = 25°C)

Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Input offset voltage	V_{IO}	—	2	7	mV	Output switching point: when V_O = 1.4V, R_S = 0Ω
Input offset current	I_{IO}	—	5	50	nA	$\lvert I_{IN(+)} - I_{IN(-)} \rvert$
Input bias current	I_{IB}	—	25	250	nA	$I_{IN(+)}$ or $I_{IN(-)}$
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 *3	A_V	—	(200)	—	V/mV	R_L = 15kΩ
Response time *2,3	t_R	—	(1.3)	—	µs	V_{RL} = 5V, R_L = 5.1kΩ
Output sink current	$I_{O(sink)}$	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 *3	I_{LO}	—	(0.1)	—	nA	$V_{IN(+)}$ = 1V, $V_{IN(-)}$ = 0, V_O = 5V

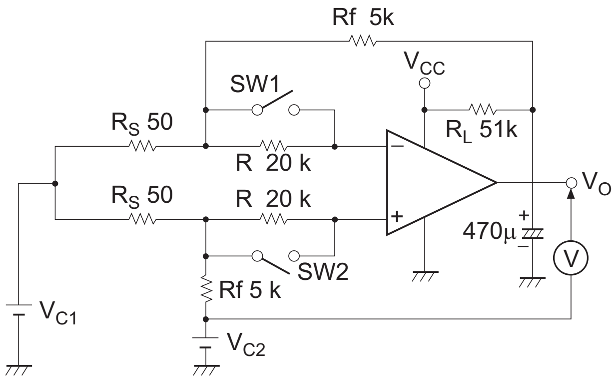
Notes: 1. Voltages more negative than –0.3 V are not allowed for the common-mode input voltage or for either one of the input signal voltages.

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

3. Design spec.

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}

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

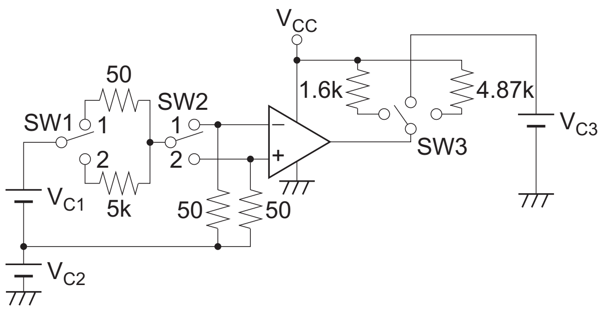
$V_{C2} = 1.4V$

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

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

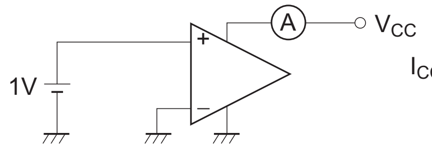
$$I_{IB} = \frac{|V_{O4} - V_{O3}|}{2 \cdot R(1 + Rf / R_S)} \quad (nA)$$

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



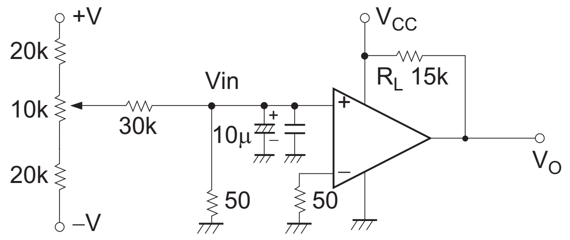
Item	V_{C1}	V_{C2}	V_{C3}	SW1	SW2	SW3	Unit
$V_O$sat	2V	0V	—	1	1	1 at V_{CC} = 5V 3 at V_{CC} = 15V	V
Iosink	2V	0V	1.5V	1	1	2	mA
V_{CM}	2V	–1 to V_{CC}	—	2	Switched between 1 and 2	3	V

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



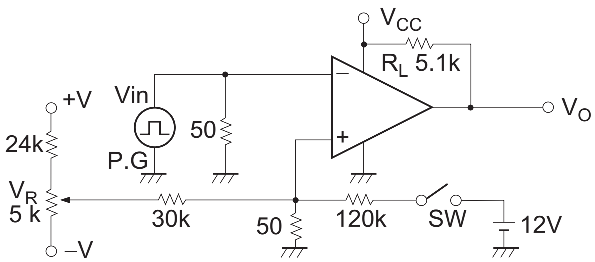
I_{CC}: $R_L = \infty$

4. Voltage gain (A_V) test circuit (R_L = 15 kΩ)



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

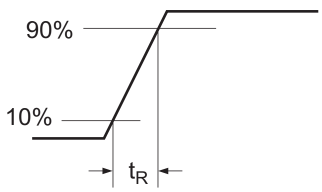
5. Response time (t_R) test circuit



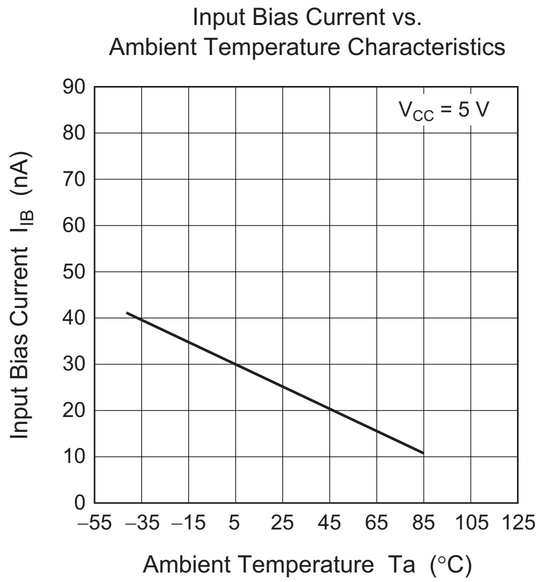
t_R: R_L = 5.1 kΩ, a 100 mV input step voltage that has a 5 mV overdrive

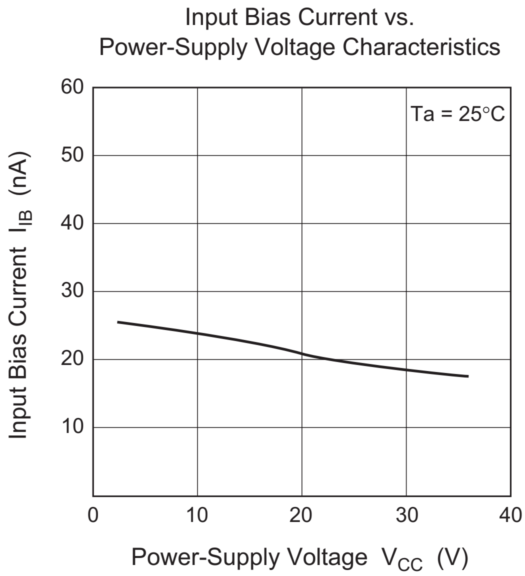
— With V_{IN} not applied, set the switch SW to the off position and adjust V_R so that V_O is in the vicinity of 1.4 V.

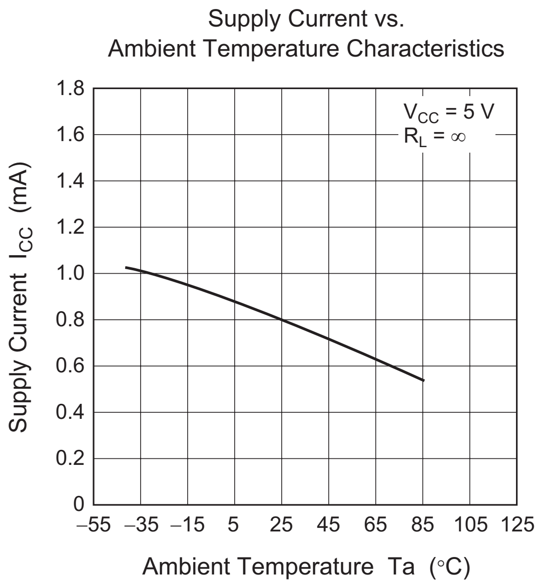
— Apply V_{IN} and turn the switch SW on.

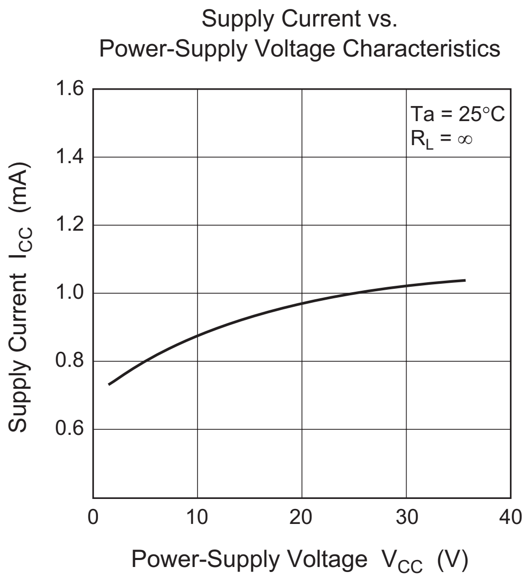


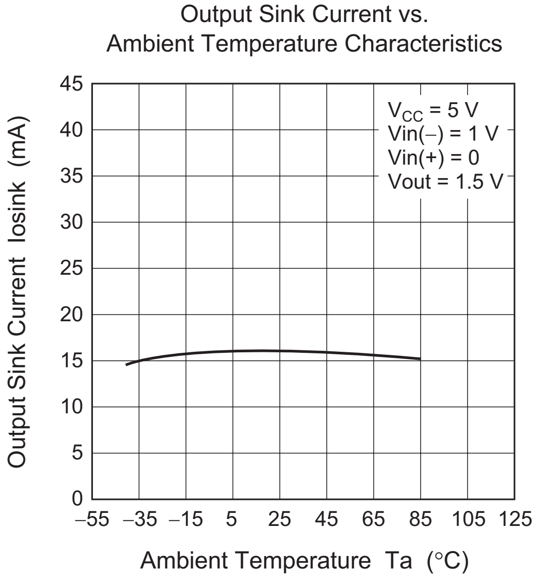
Characteristic Curves

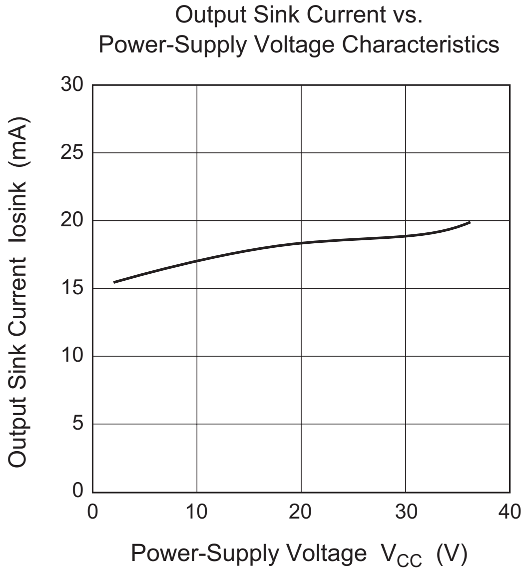


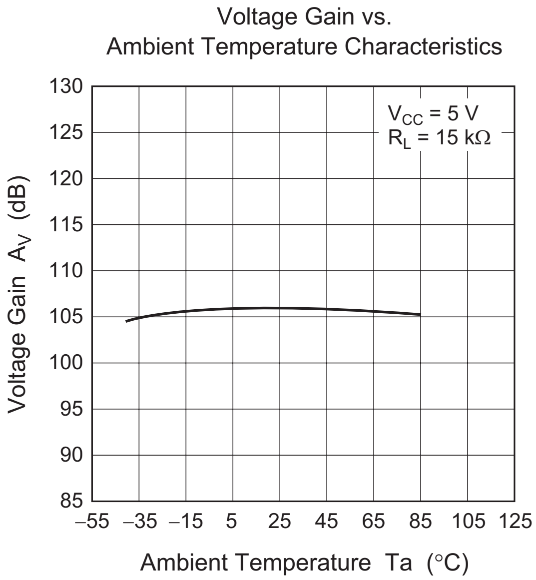


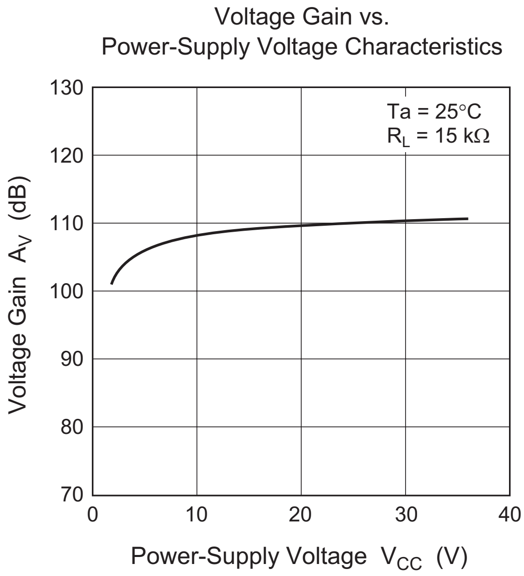





Output Sink Current vs.
Ambient Temperature Characteristics
V_{CC} = 5 V
Vin(–) = 1 V
Vin(+) = 0
Vout = 1.5 V
Output Sink Current Iosink (mA)
45 40 35 30 25 20 15 10 5 0
–55 –35 –15 5 25 45 65 85 105 125
Ambient Temperature Ta (°C)


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 V_{CC} (V)


Voltage Gain vs.
Ambient Temperature Characteristics
V_{CC} = 5 V
R_L = 15 kΩ
Voltage Gain A_V (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)


Voltage Gain vs.
Power-Supply Voltage Characteristics
Ta = 25°C
R_L = 15 kΩ
Voltage Gain A_V (dB)
130 120 110 100 90 80 70
0 10 20 30 40
Power-Supply Voltage V_{CC} (V)

HA17901A Application Examples

The HA17901A 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 HA17901A is particularly suited for single-voltage power supply applications. This section presents several sample HA17901A applications.

1. Square-Wave Oscillator

   The circuit shown in figure 1 has the same structure as a single-voltage power supply astable multivibrator. Figure 2 shows the waveforms generated by this circuit.

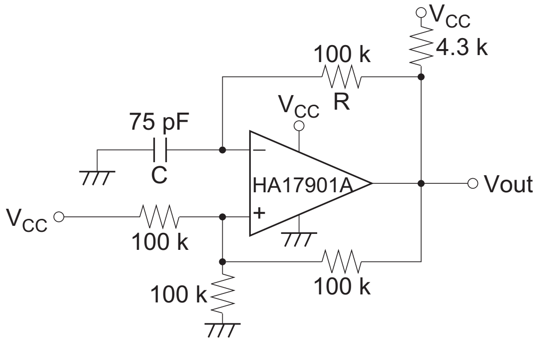


Figure 1 Square-Wave Oscillator

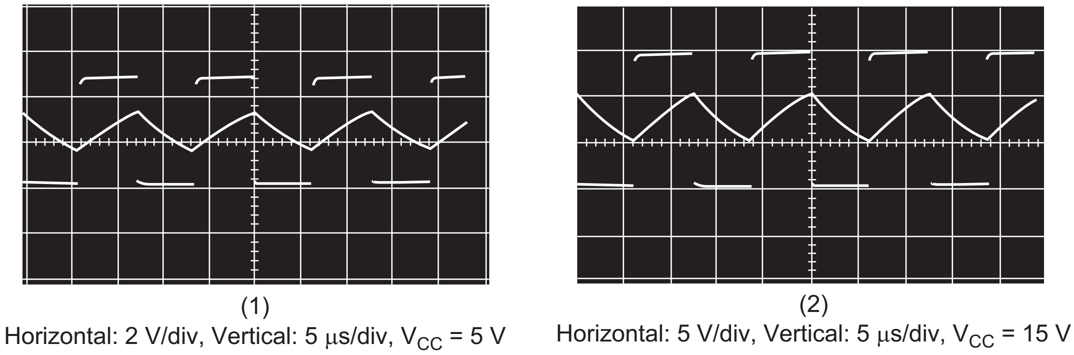


Figure 2 Operating Waveforms

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.

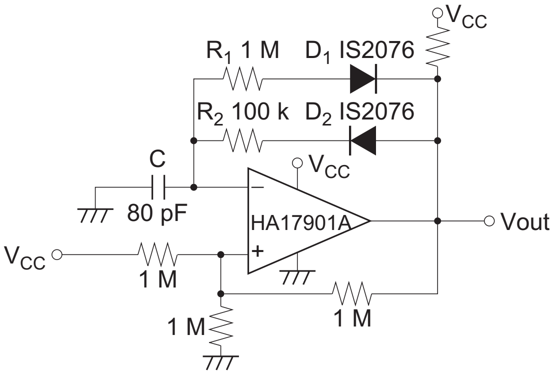
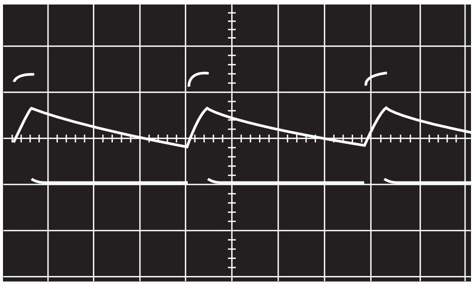
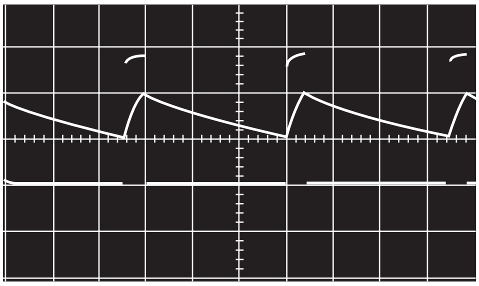


Figure 3 Pulse Generator



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 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 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.

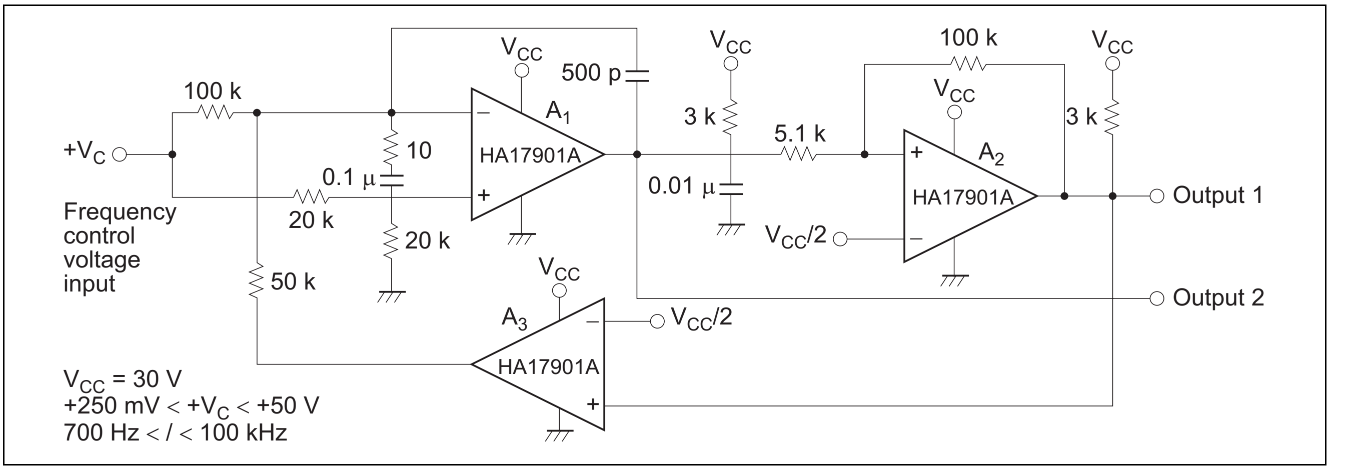


Figure 5   Voltage Controlled Oscillator

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.

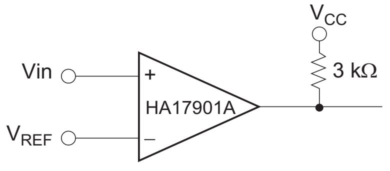


Figure 6   Basic Comparator

5. Noninverting Comparator (with Hysteresis)

Assuming $+V_{IN}$ is 0 V, when V_{REF} is applied to the inverting input, the output will go to the low level (approximately 0 V). 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} = 15 V and $+V_{REF}$ = 6 V, the following formula can be derived, i.e. $+V_{IN} \times 10\ M/(5.1\ M + 10\ M) > 6\ V$, and Vout will invert from low to high when $+V_{IN}$ is > 9.06 V.

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

(Assuming Vout = 15V)

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

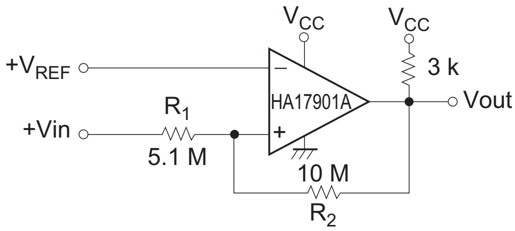


Figure 7 Noninverting Comparator

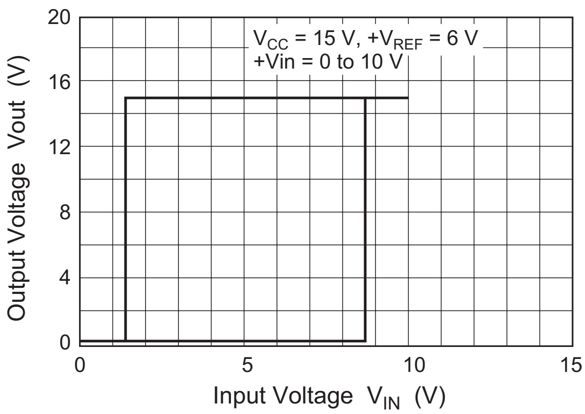


Figure 8 Noninverting Comparator I/O Transfer Characteristics

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} = 15 V and Vout = 15 V, this circuit will have a 5 V hysteresis. Figure 10 shows the I/O characteristics for the circuit in figure 9.

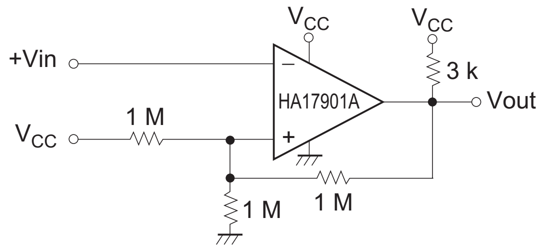


Figure 9 Inverting Comparator

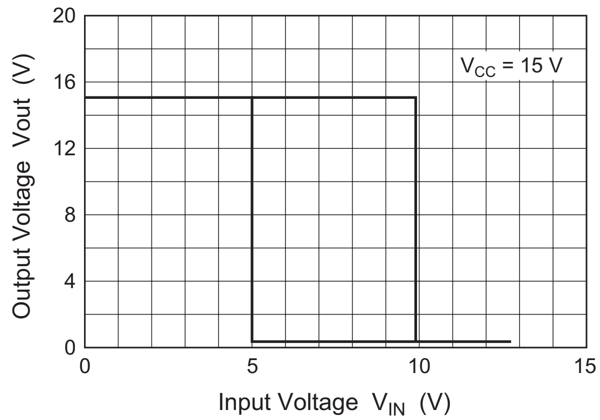


Figure 10 Inverting Comparator I/O Transfer Characteristics

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 100 kΩ and 10 kΩ resistors. When V_{IN} is 0 V or higher, the output will be low, and when V_{IN} is negative, Vout will invert to the high level. (See figure 11.)

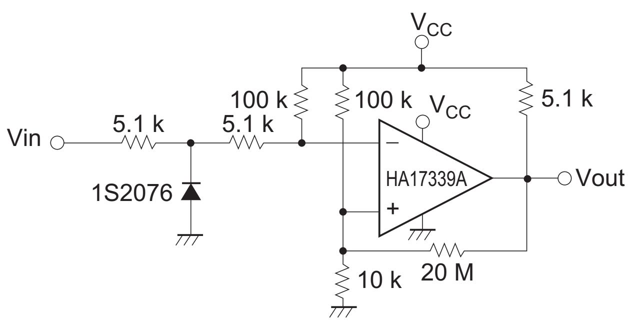
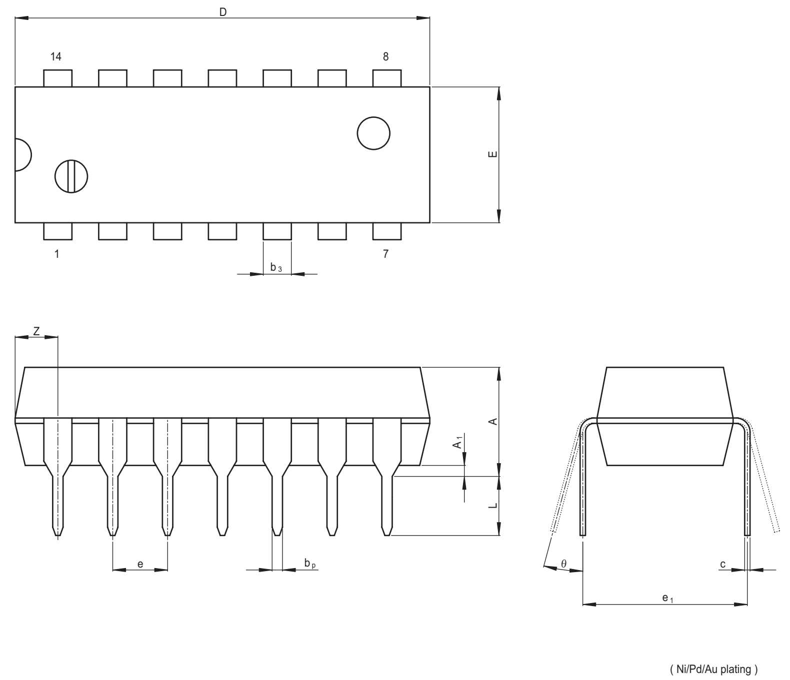


Figure 11 Zero-Cross Detector

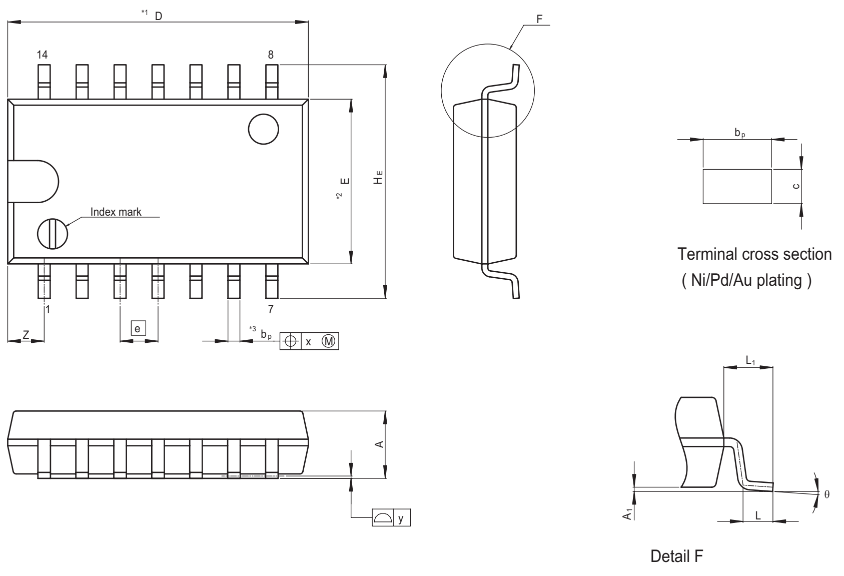
Package Dimensions

JEITA Package Code	RENESAS Code	Previous Code	MASS[Typ.]
P-DIP14-6.3x19.2-2.54	PRDP0014AB-B	DP-14AV	0.97g



Reference Symbol	Dimension in Millimeters		
	Min	Nom	Max
e_1	—	7.62	—
D	—	19.2	20.32
E	—	6.3	7.4
A	—	—	5.06
A_1	0.51	—	—
b_p	0.40	0.48	0.56
b_3	—	1.30	—
c	0.19	0.25	0.31
θ	0°	—	15°
e	2.29	2.54	2.79
Z	—	—	2.39
L	2.54	—	—

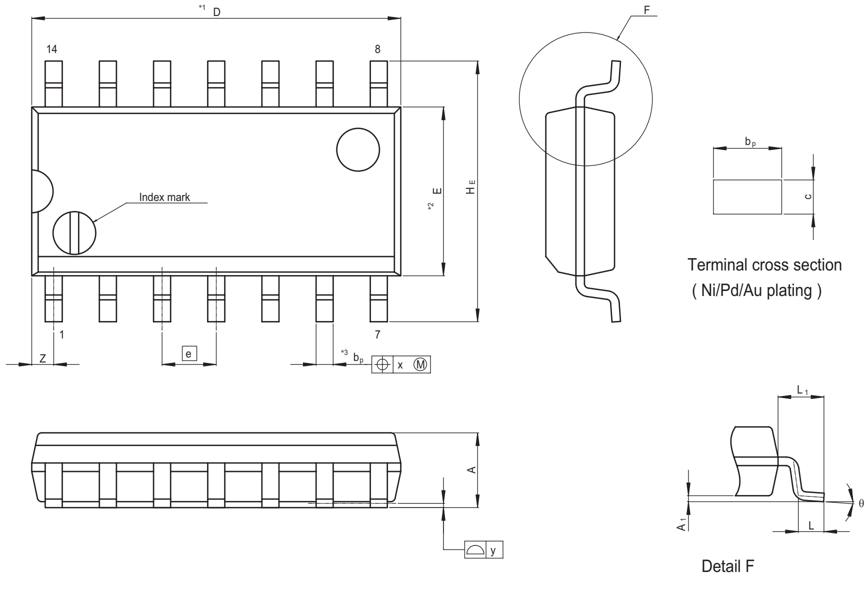
JEITA Package Code	RENESAS Code	Previous Code	MASS[Typ.]
P-SOP14-5.5x10.06-1.27	PRSP0014DF-B	FP-14DAV	0.23g



NOTE)
1. DIMENSIONS"*1 (Nom)"AND"*2" DO NOT INCLUDE MOLD FLASH.
2. DIMENSION"*3"DOES NOT INCLUDE TRIM OFFSET.

Reference Symbol	Dimension in Millimeters		
	Min	Nom	Max
D	—	10.06	10.5
E	—	5.50	—
A_2	—	—	—
A_1	0.00	0.10	0.20
A	—	—	2.20
b_p	0.34	0.40	0.46
b_1	—	—	—
c	0.15	0.20	0.25
c_1	—	—	—
θ	0°	—	8°
H_E	7.50	7.80	8.00
e	—	1.27	—
x	—	—	0.12
y	—	—	0.15
Z	—	—	1.42
L	0.50	0.70	0.90
L_1	—	1.15	—

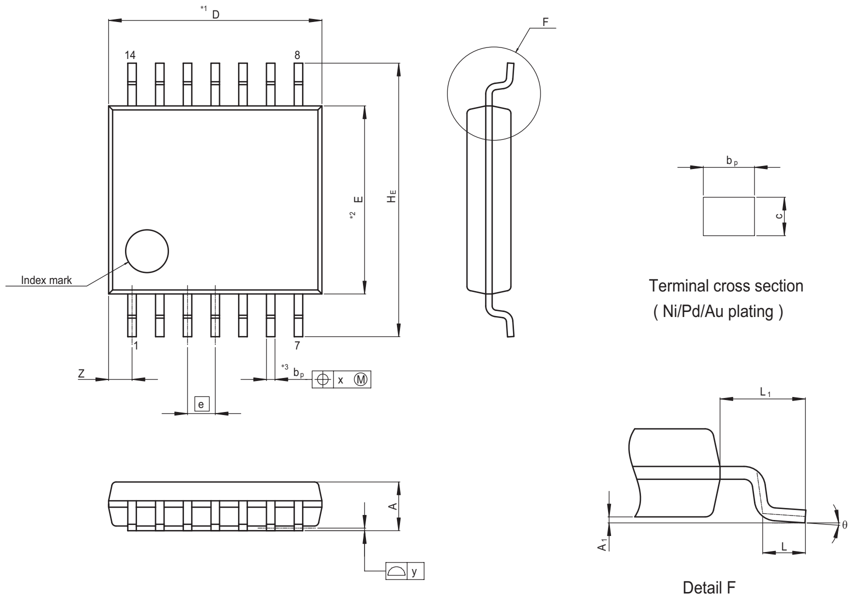
JEITA Package Code	RENESAS Code	Previous Code	MASS[Typ.]
P-SOP14-3.95x8.65-1.27	PRSP0014DE-A	FP-14DNV	0.13g



NOTE)
1. DIMENSIONS"*1 (Nom)"AND"*2" DO NOT INCLUDE MOLD FLASH.
2. DIMENSION"*3"DOES NOT INCLUDE TRIM OFFSET.

Reference Symbol	Dimension in Millimeters Min	Nom	Max
D	—	8.65	9.05
E	—	3.95	—
A_2	—	—	—
A_1	0.10	0.14	0.25
A	—	—	1.75
b_p	0.34	0.40	0.46
b_1	—	—	—
c	0.15	0.20	0.25
c_1	—	—	—
θ	0°	—	8°
H_E	5.80	6.10	6.20
e	—	1.27	—
x	—	—	0.25
y	—	—	0.15
Z	—	—	0.635
L	0.40	0.60	1.27
L_1	—	1.08	—

JEITA Package Code	RENESAS Code	Previous Code	MASS[Typ.]
P-TSSOP14-4.4x5-0.65	PTSP0014JA-B	TTP-14DV	0.05g



NOTE)
1. DIMENSIONS"*1 (Nom)"AND"*2" DO NOT INCLUDE MOLD FLASH.
2. DIMENSION"*3"DOES NOT INCLUDE TRIM OFFSET.

Reference Symbol	Dimension in Millimeters Min	Nom	Max
D	—	5.00	5.30
E	—	4.40	—
A_2	—	—	—
A_1	0.03	0.07	0.10
A	—	—	1.10
b_p	0.15	0.20	0.25
b_1	—	—	—
c	0.10	0.15	0.20
c_1	—	—	—
θ	0°	—	8°
H_E	6.20	6.40	6.60
e	—	0.65	—
x	—	—	0.13
y	—	—	0.10
Z	—	—	0.83
L	0.4	0.5	0.6
L_1	—	1.0	—

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