RENESAS

# HA17339A Series

## Quadruple Comparators



REJ03D0675-0300
Rev.3.00
Mar 10, 2006

## Description

The HA17339A series products are comparators designed for general purpose, especially for power control systems.

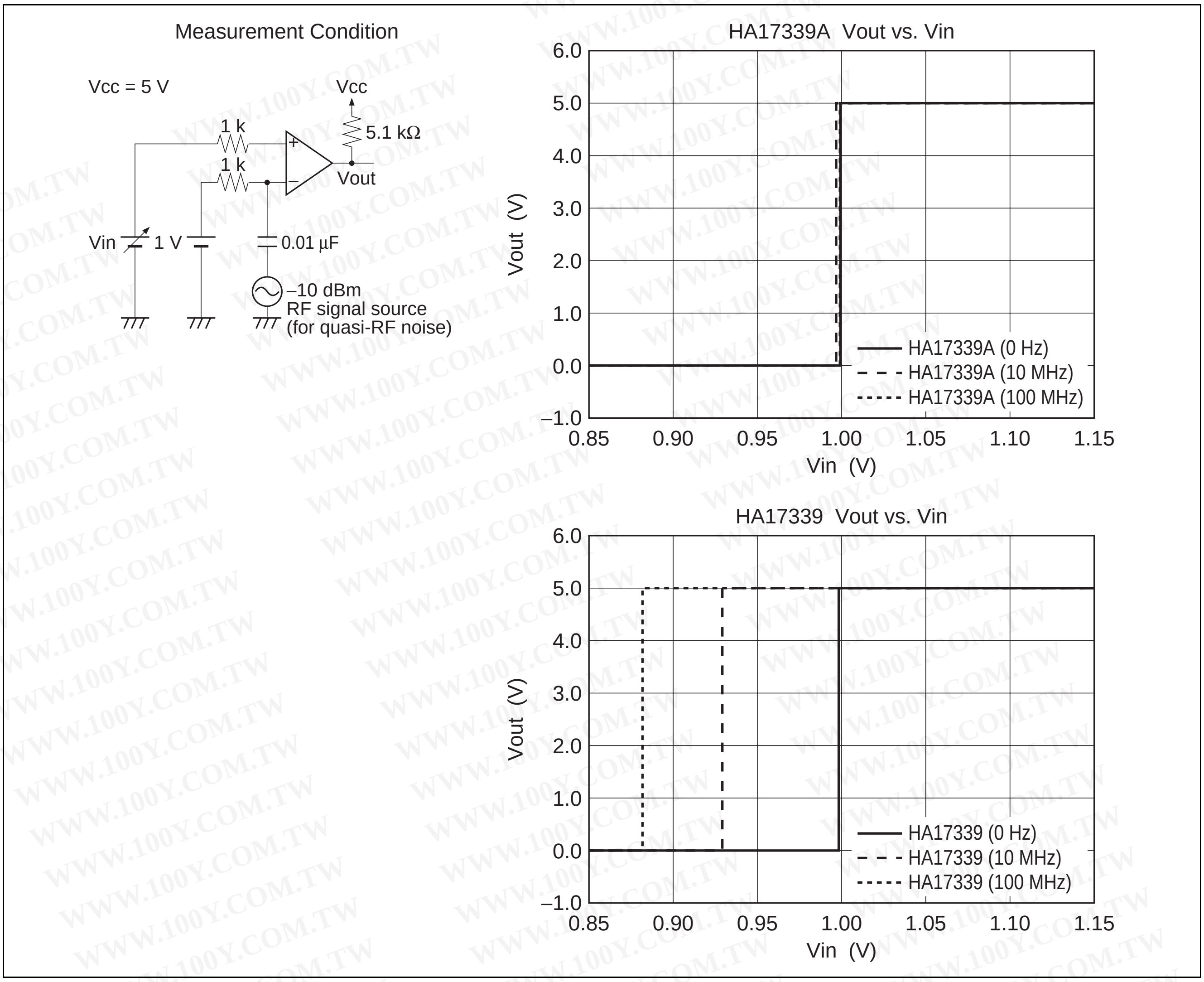
These ICs operate from a single power-supply voltage over a wide range of voltages, and feature a reduced power-supply current since the supply current is independent of the supply voltage.

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

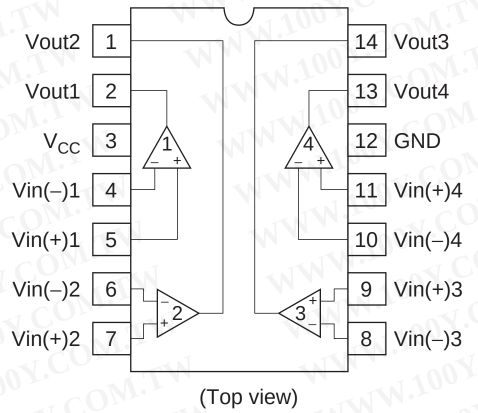
- Low electro-magnetic susceptibility



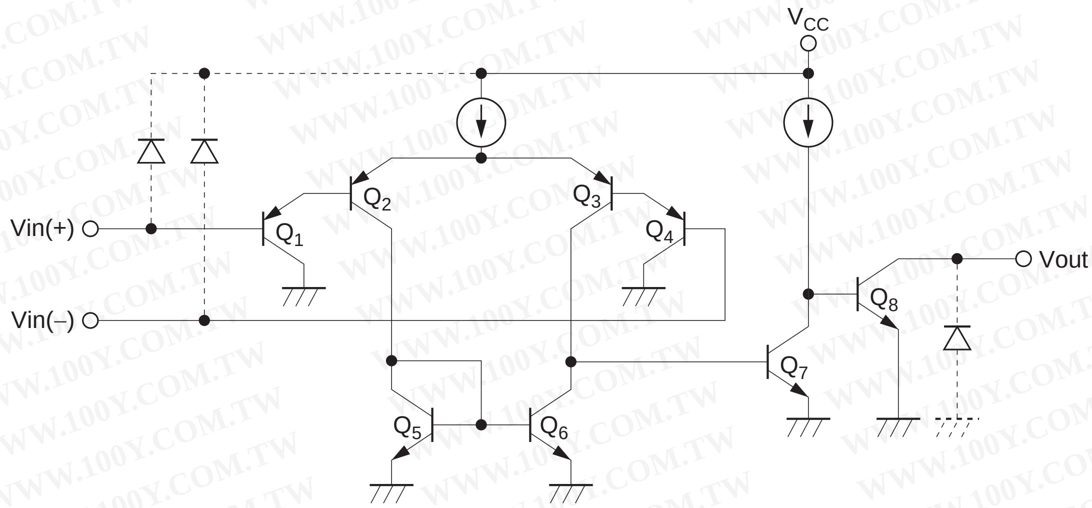

## Ordering Information

| Type No. | Application | Package Name | Package Code |
|---|---|---|---|
| HA17339A | Commercial use | DIP-14 pin | PRDP0014AB-B |
| HA17339AF | | SOP-14 pin (JEITA) | PRSP0014DF-B |
| HA17339ARP | | SOP-14 pin (JEDEC) | PRSP0014DE-A |
| HA17339AT | | 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. HA17339A:
These are the allowable values up to Ta = 50°C. Derate by 8.3 mW/°C above that temperature.

3. HA17339AF/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. HA17339AT:
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, $V_O \le 1.5V$ |
| 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 |

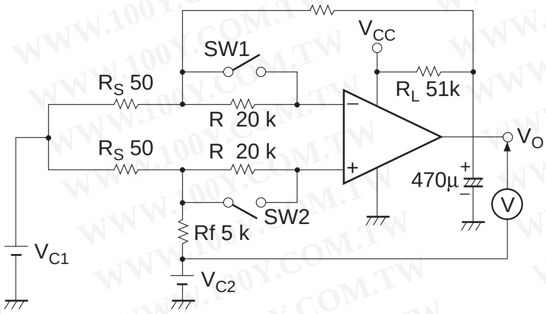
Notes: 1. Voltages more negative than –0.3 V are not allowed for the common-mode input voltage or for either one of the input signal voltages.

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 | $V_{O4}$ |

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

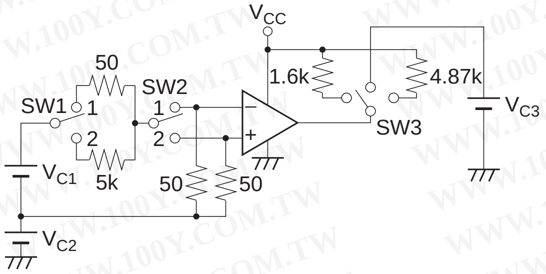
$V_{C2} = 1.4V$

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

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

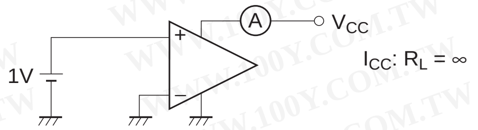
$$I_{IB} = \frac{|V_{O4} - V_{O3}|}{2 \cdot R(1 + Rf / R_S)} \quad (nA)$$

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

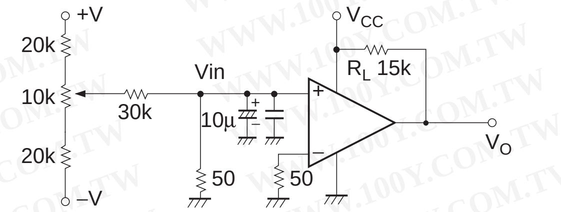



| Item | $V_{C1}$ | $V_{C2}$ | $V_{C3}$ | SW1 | SW2 | SW3 | Unit |
|---|---|---|---|---|---|---|---|
| $V_O$sat | 2V | 0V | — | 1 | 1 | 1 at $V_{CC}$ = 5V<br>3 at $V_{CC}$ = 15V | V |
| Iosink | 2V | 0V | 1.5V | 1 | 1 | 2 | mA |
| $V_{CM}$ | 2V | –1 to $V_{CC}$ | — | 2 | Switched between 1 and 2 | 3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

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

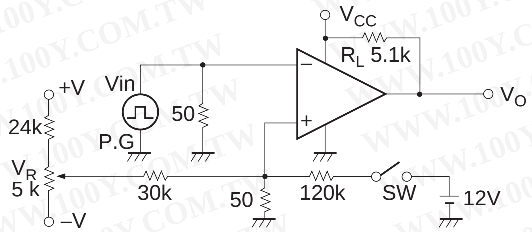


4. Voltage gain ($A_V$) test circuit ($R_L$ = 15kΩ)



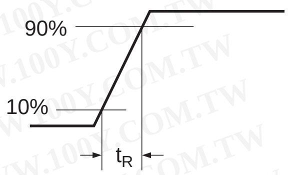

$$A_V = 20 \log \frac{V_{O1} - V_{O2}}{V_{IN1} - V_{IN2}} \quad \text{(dB)}$$

5. Response time ($t_R$) test circuit



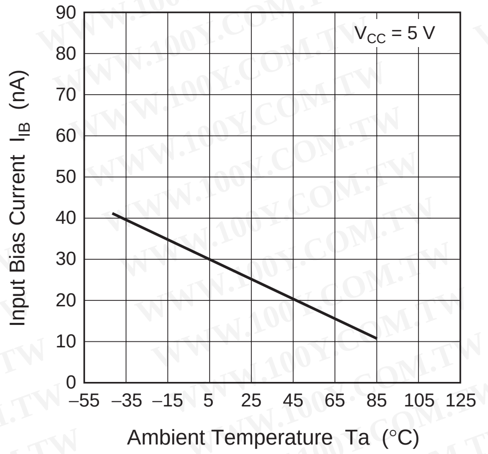

$t_R$: $R_L$ = 5.1kΩ, a 100mV input step voltage that has a 5mV overdrive

- 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.

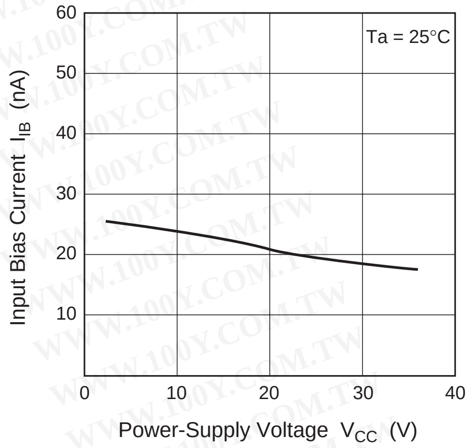


## Characteristic Curves

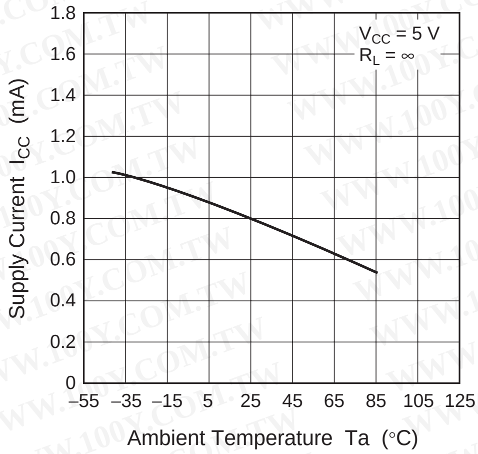
Input Bias Current vs.
Ambient Temperature Characteristics



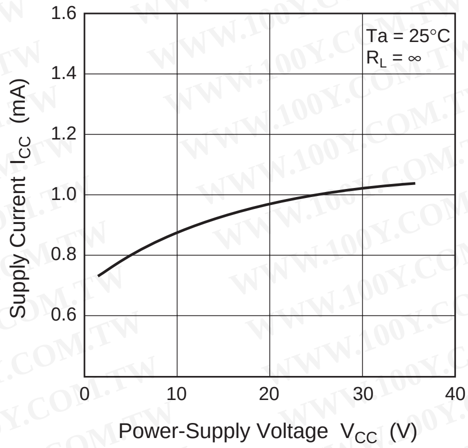

Input Bias Current vs.
Power-Supply Voltage Characteristics



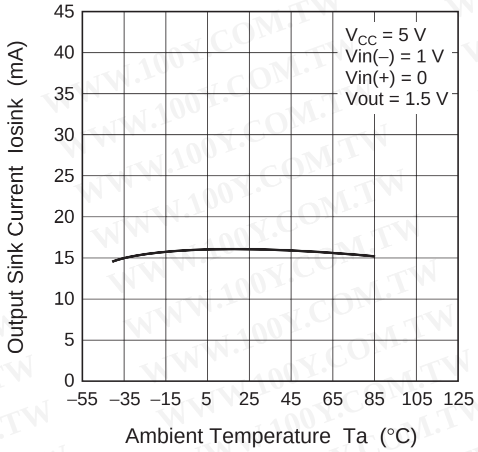

Supply Current vs.
Ambient Temperature Characteristics



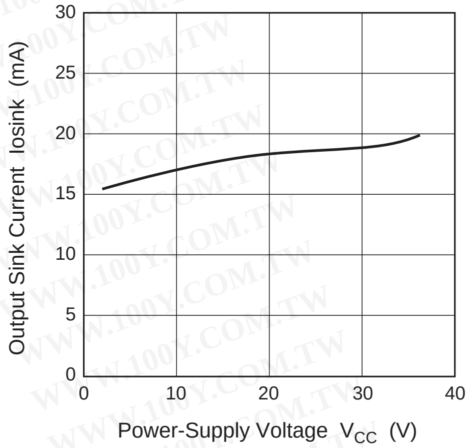

Supply Current vs.
Power-Supply Voltage Characteristics



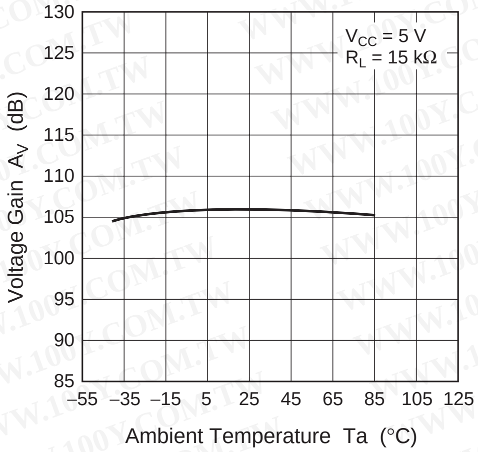
Output Sink Current vs.
Ambient Temperature Characteristics



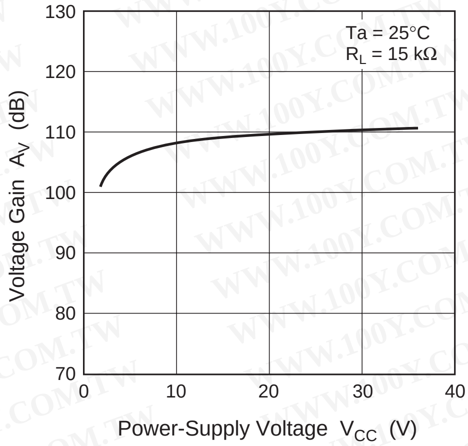

Output Sink Current vs.
Power-Supply Voltage Characteristics




Voltage Gain vs.
Ambient Temperature Characteristics




Voltage Gain vs.
Power-Supply Voltage Characteristics



## HA17339A Application Examples

The HA17339A 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 HA17339A is particularly suited for single-voltage power supply applications. This section presents several sample HA17339A applications.

### HA17339A 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.

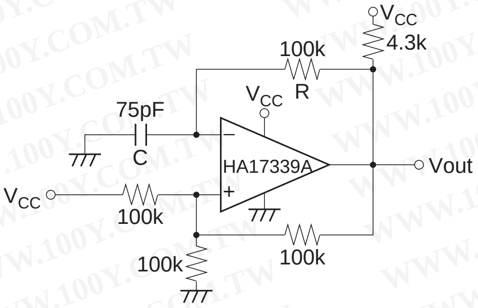



**Figure 1 Square-Wave Oscillator**

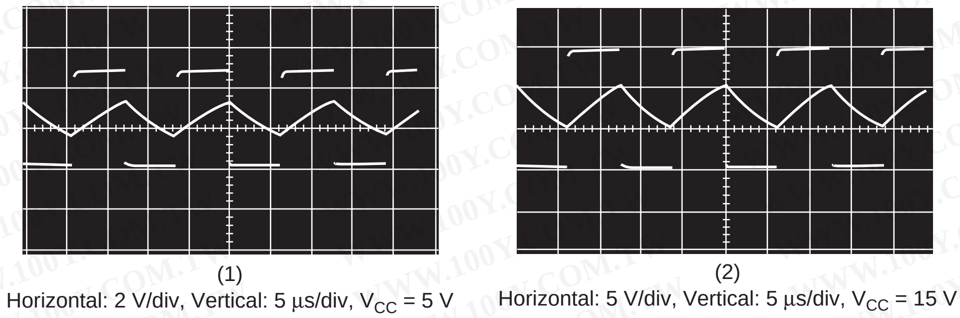



**Figure 2 Operating Waveforms**

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.

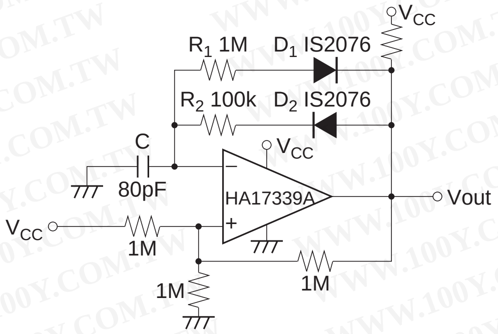
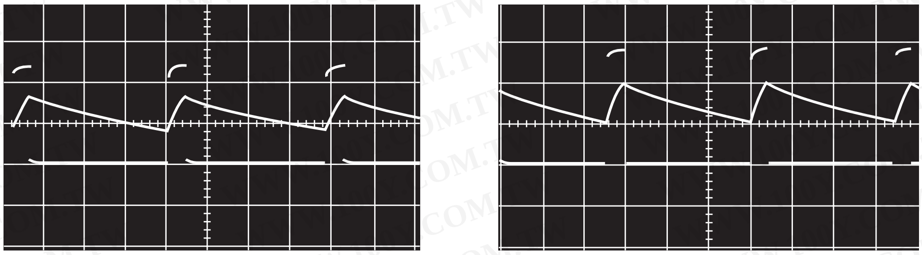



**Figure 3 Pulse Generator**



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.

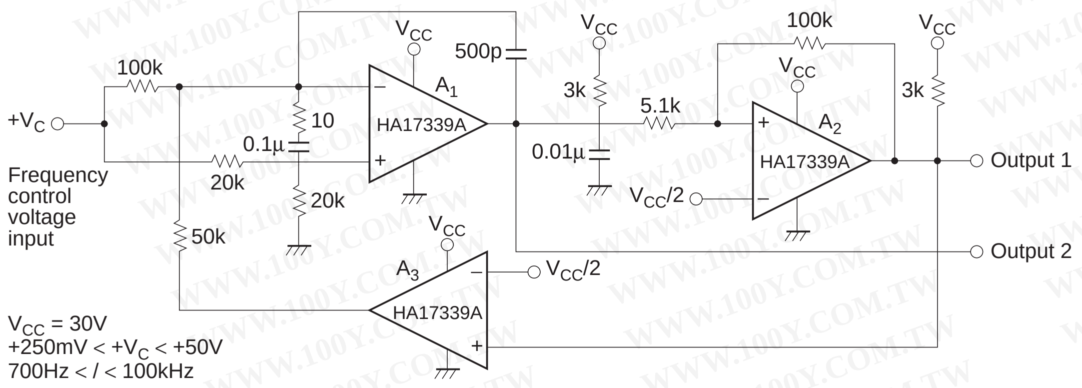



**Figure 5 Voltage Controlled Oscillator**

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.

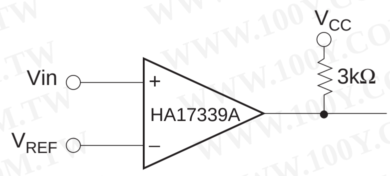



**Figure 6 Basic Comparator**

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.

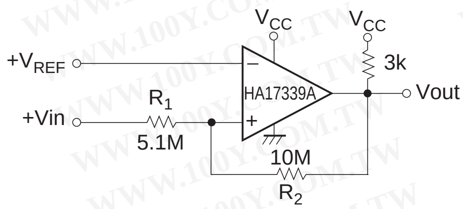



**Figure 7 Noninverting Comparator**

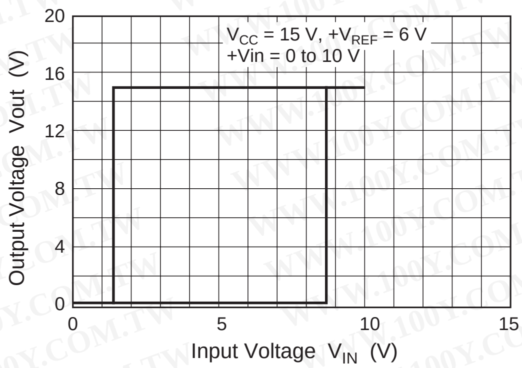



**Figure 8 Noninverting Comparator I/O Transfer Characteristics**





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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.

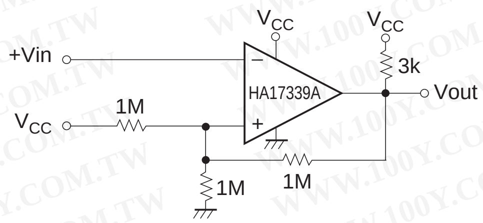



**Figure 9 Inverting Comparator**

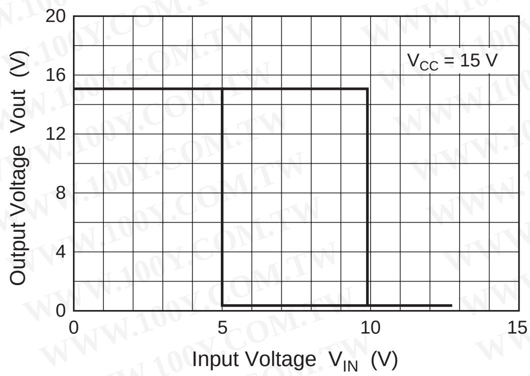



**Figure 10 Inverting Comparator I/O Transfer Characteristics**

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.)

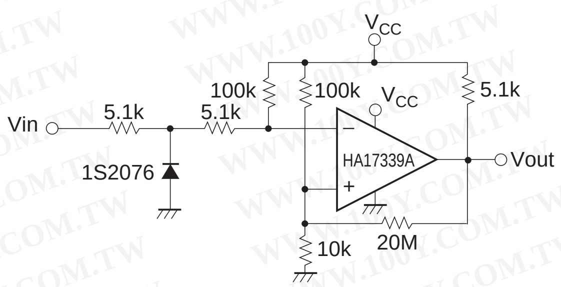
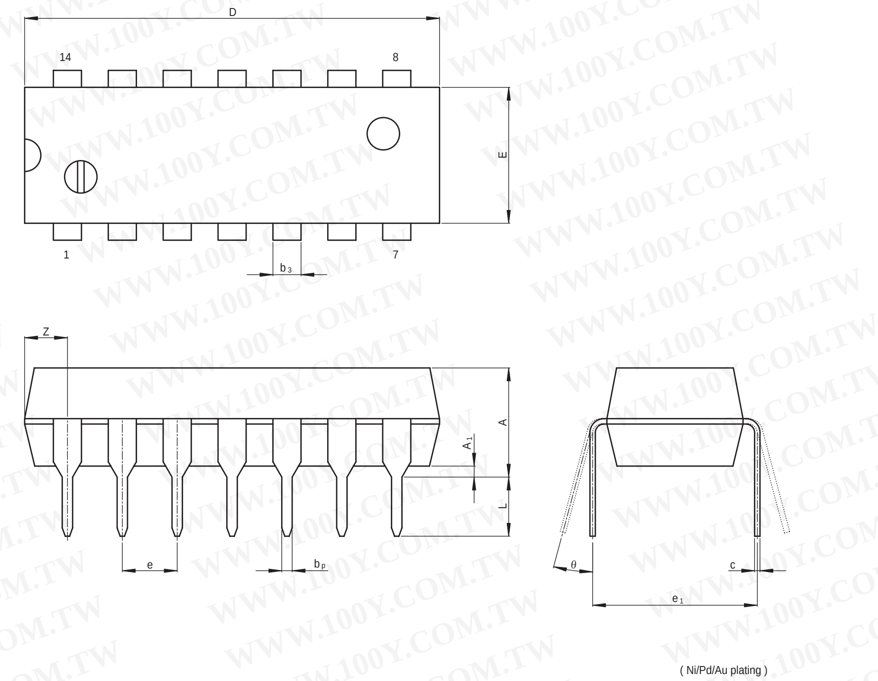



**Figure 11 Zero-Cross Detector**

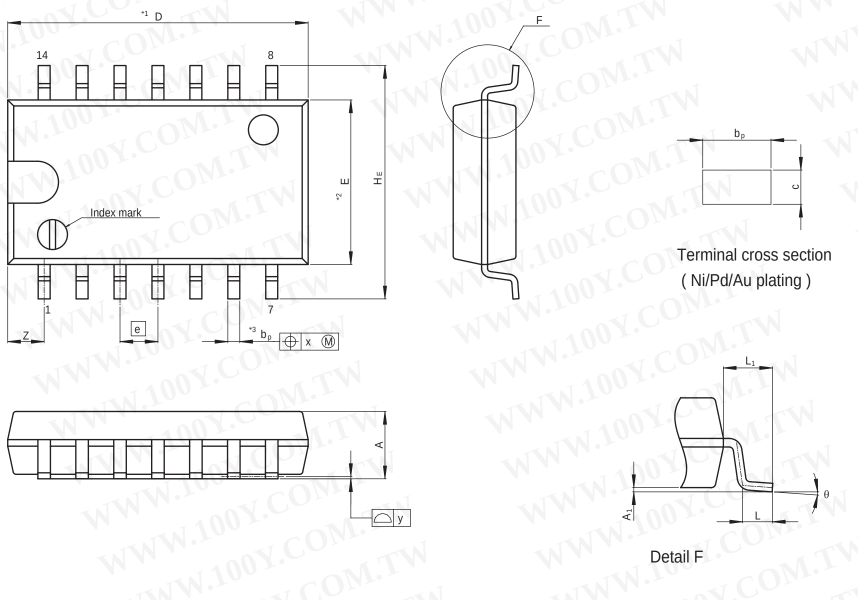
## Package Dimensions

| 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 | — | — |

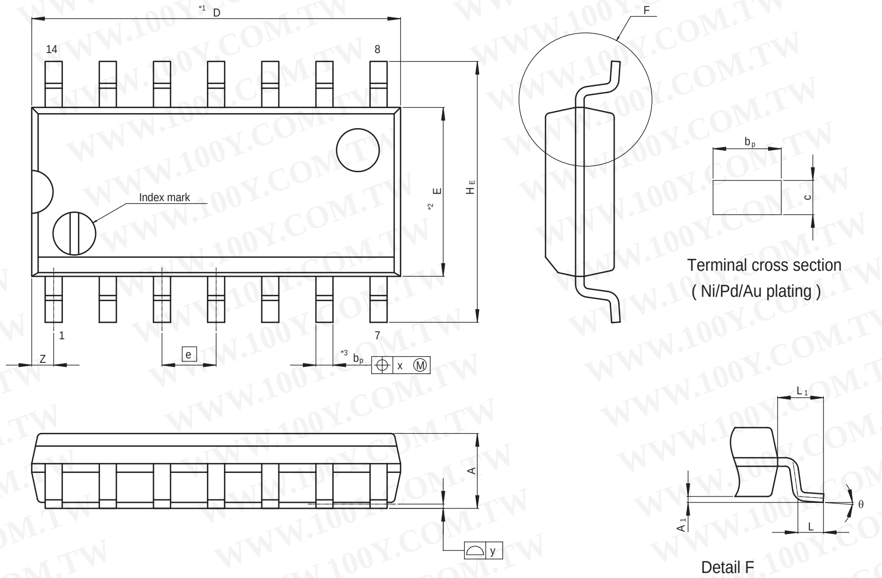
| JEITA Package Code | RENESAS Code | Previous Code | MASS[Typ.] |
|---|---|---|---|
| P-SOP14-5.5x10.06-1.27 | PRSP0014DF-B | FP-14DAV | 0.23g |




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 | — |

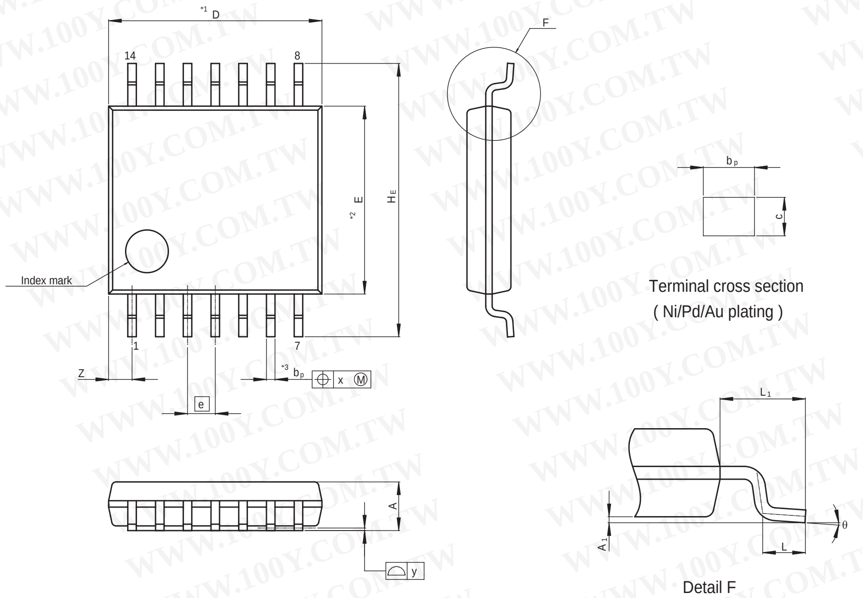
| JEITA Package Code | RENESAS Code | Previous Code | MASS[Typ.] |
|---|---|---|---|
| P-SOP14-3.95x8.65-1.27 | PRSP0014DE-A | FP-14DNV | 0.13g |




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 | — |