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# HA17339A Series

## Quadruple Comparators

REJ03D0675-0300

Rev.3.00

Mar 10, 2006

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### Description

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

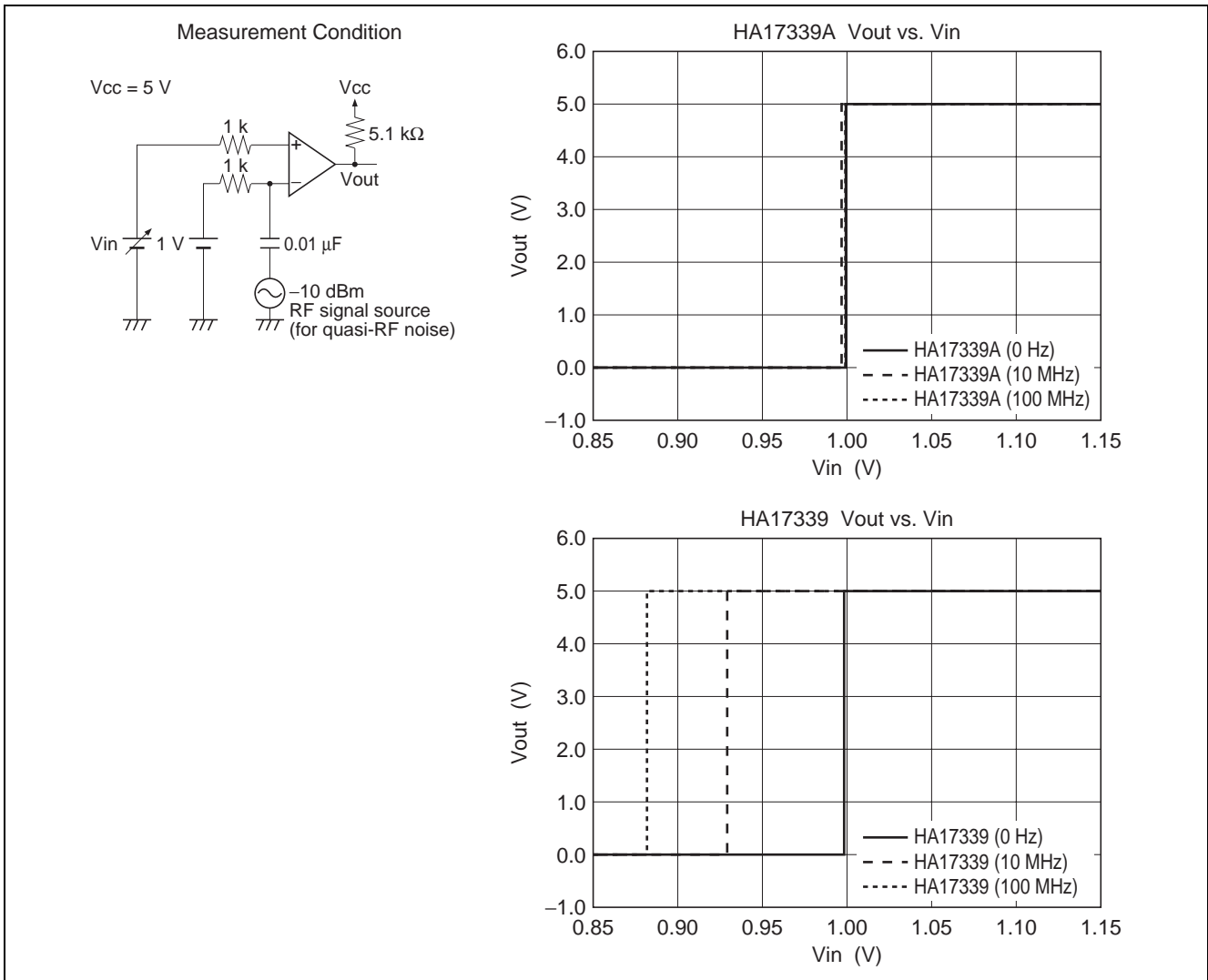
These ICs operate from a single power-supply voltage over a wide range of voltages, and feature a reduced power-supply current since the supply current is independent of the supply voltage.

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

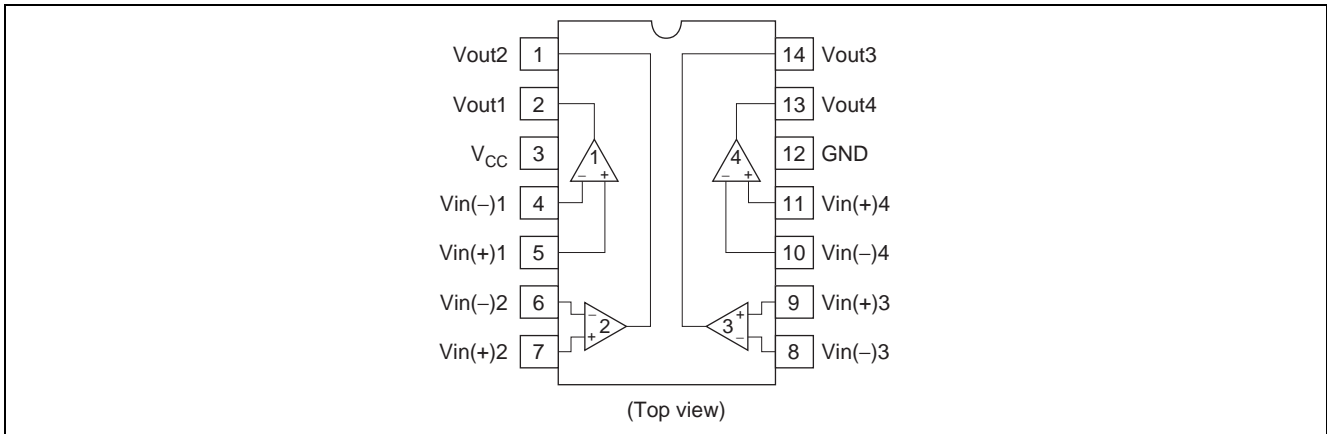
- Low electro-magnetic susceptibility



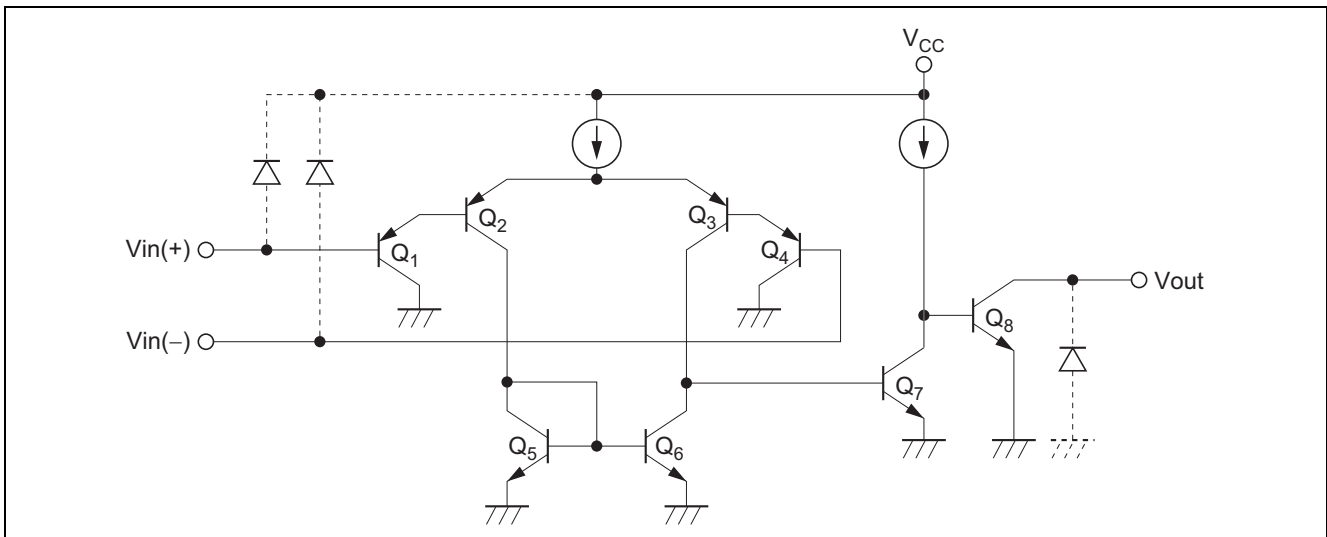
### Ordering Information

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 <sub>CC</sub>	36	V
Differential input voltage	V <sub>in(diff)</sub>	±V <sub>CC</sub>	V
Input voltage	V <sub>in</sub>	-0.3 to +V <sub>CC</sub>	V
Output pin voltage	V <sub>out</sub>	-0.3 to +36	V
Output current	I <sub>out</sub> *1	20	mA
Allowable power dissipation	DIP	P <sub>T</sub>	625 *2
	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<sub>CC</sub> 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 mm 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 mm 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<sub>CC</sub> = 5 V, Ta = 25°C)

Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Input offset voltage	V <sub>IO</sub>	—	2	7	mV	Output switching point: when V <sub>O</sub> = 1.4V, R <sub>S</sub> = 0Ω
Input offset current	I <sub>IO</sub>	—	5	50	nA	I <sub>IN(+)</sub> - I <sub>IN(-)</sub>
Input bias current	I <sub>IB</sub>	—	25	250	nA	I <sub>IN(+)</sub> or I <sub>IN(-)</sub>
Common-mode input voltage *1	V <sub>CM</sub>	0	—	V <sub>CC</sub> -1.5	V	
Supply current	I <sub>CC</sub>	—	0.8	2	mA	R <sub>L</sub> = ∞
Voltage Gain *3	A <sub>V</sub>	—	(200)	—	V/mV	R <sub>L</sub> = 15kΩ
Response time *2,3	t <sub>R</sub>	—	(1.3)	—	μs	V <sub>RL</sub> = 5V, R <sub>L</sub> = 5.1kΩ
Output sink current	I <sub>O(sink)</sub>	6	16	—	mA	V <sub>IN(-)</sub> = 1V, V <sub>IN(+)</sub> = 0, V <sub>O</sub> ≤ 1.5V
Output saturation voltage	V <sub>O(sat)</sub>	—	200	400	mV	V <sub>IN(-)</sub> = 1V, V <sub>IN(+)</sub> = 0, I <sub>osink</sub> = 3mA
Output leakage current *3	I <sub>LO</sub>	—	(0.1)	—	nA	V <sub>IN(+)</sub> = 1V, V <sub>IN(-)</sub> = 0, V <sub>O</sub> = 5V

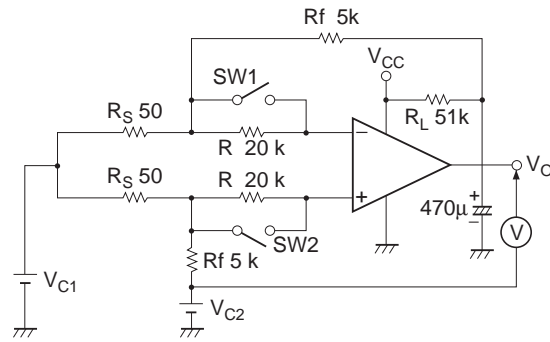
Notes: 1. Voltages more negative than -0.3 V are not allowed for the common-mode input voltage or for either one of the input signal voltages.

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	$V_{O4}$

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

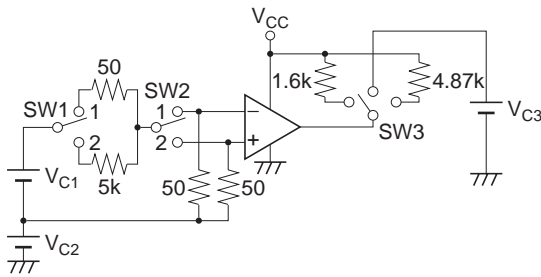
$$V_{C2} = 1.4V$$

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

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

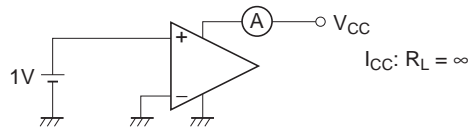
$$I_{IB} = \frac{|V_{O4} - V_{O3}|}{2 \cdot R(1 + R_f / R_S)} \quad (\text{nA})$$

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

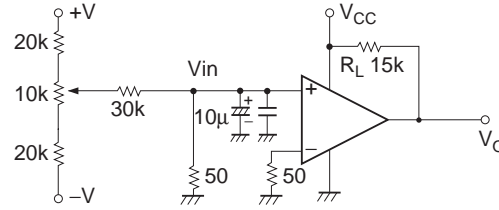


Item	$V_{C1}$	$V_{C2}$	$V_{C3}$	SW1	SW2	SW3	Unit
$V_{O\text{ sat}}$	2V	0V	—	1	1	1 at $V_{CC} = 5V$ 3 at $V_{CC} = 15V$	V
$I_{\text{osink}}$	2V	0V	1.5V	1	1	2	mA
$V_{\text{CM}}$	2V	-1 to $V_{CC}$	—	2	Switched between 1 and 2	3	V

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

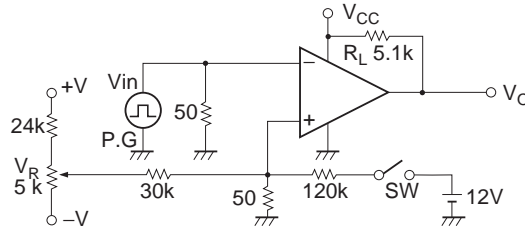


4. Voltage gain ( $A_V$ ) test circuit ( $R_L = 15k\Omega$ )



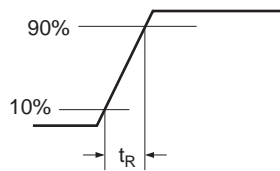
$$A_V = 20 \log \frac{V_{O1} - V_{O2}}{V_{IN1} - V_{IN2}} \quad (\text{dB})$$

5. Response time ( $t_R$ ) test circuit

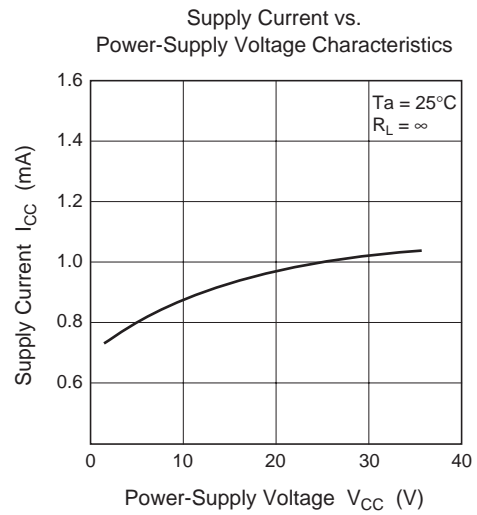
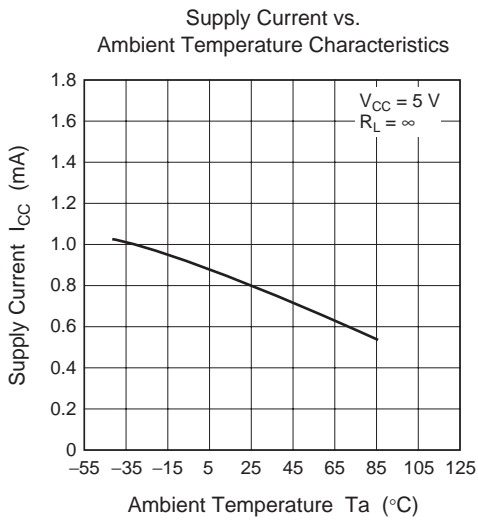
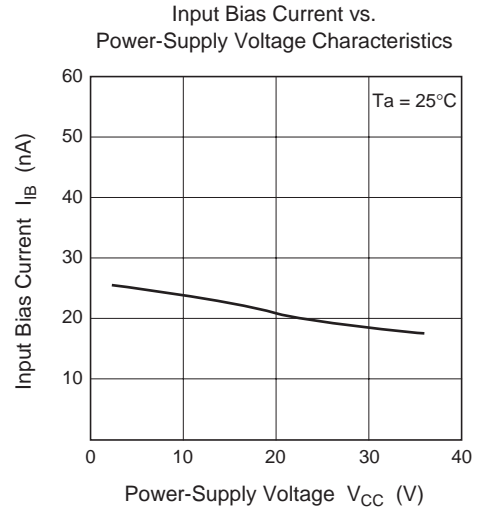
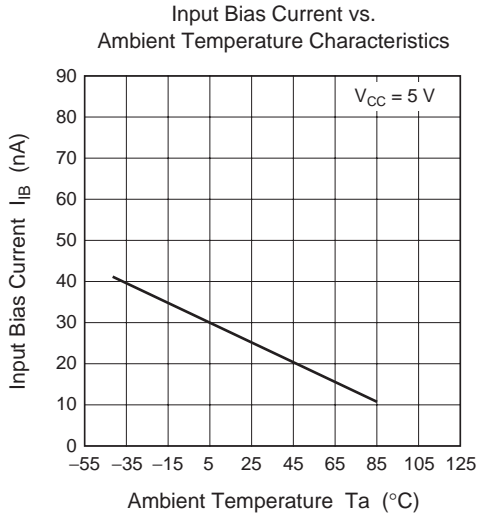


$t_R$ :  $R_L = 5.1k\Omega$ , a 100mV input step voltage that has a 5mV overdrive

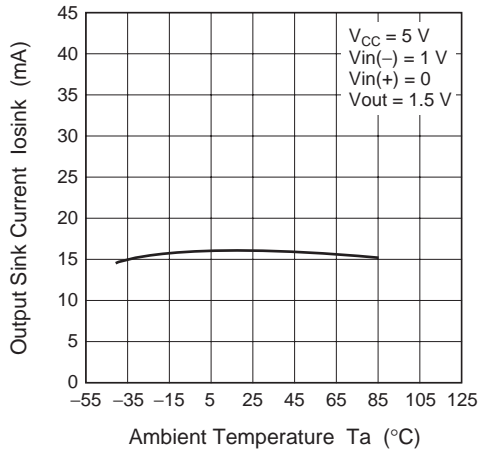
- With  $V_{IN}$  not applied, set the switch SW to the off position and adjust  $V_R$  so that  $V_O$  is in the vicinity of 1.4V.
- Apply  $V_{IN}$  and turn the switch SW on.



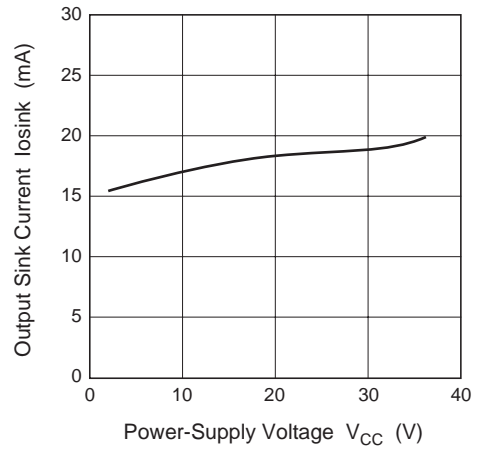
Characteristic Curves



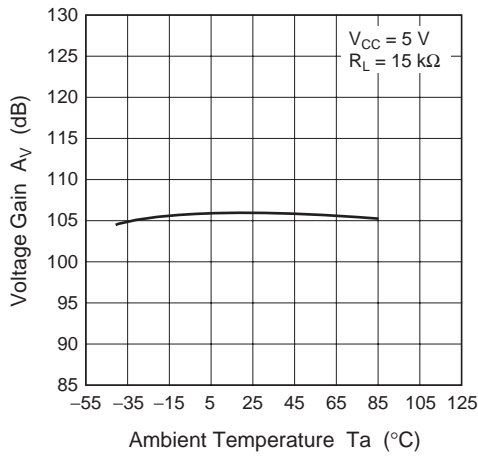
Output Sink Current vs. Ambient Temperature Characteristics



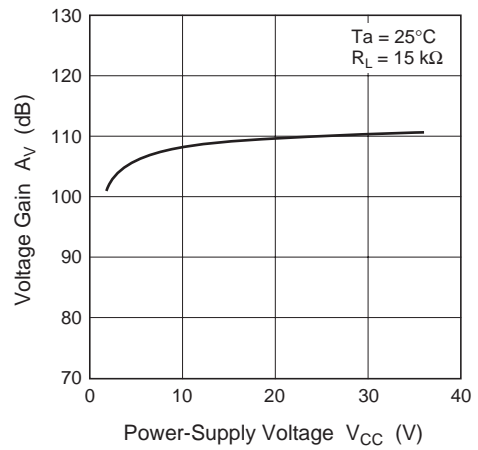
Output Sink Current vs. Power-Supply Voltage Characteristics



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.

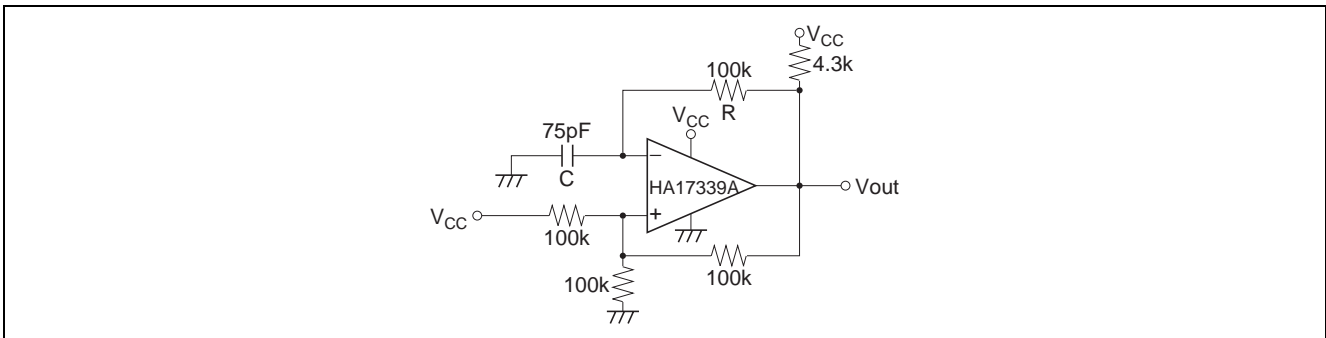


Figure 1 Square-Wave Oscillator

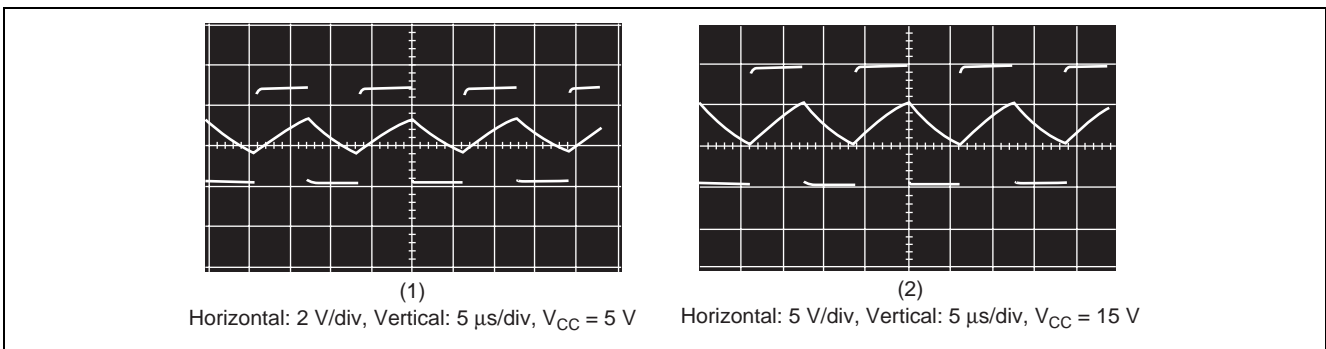


Figure 2 Operating Waveforms

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.

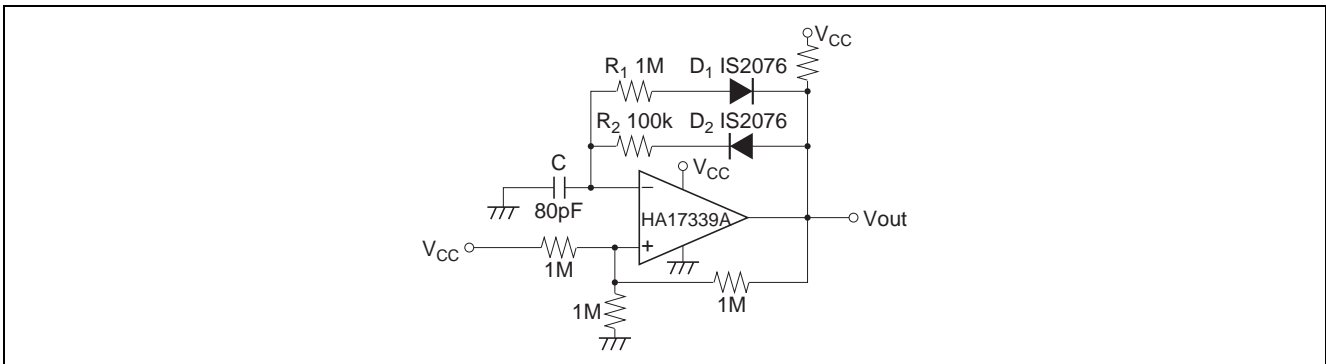


Figure 3 Pulse Generator

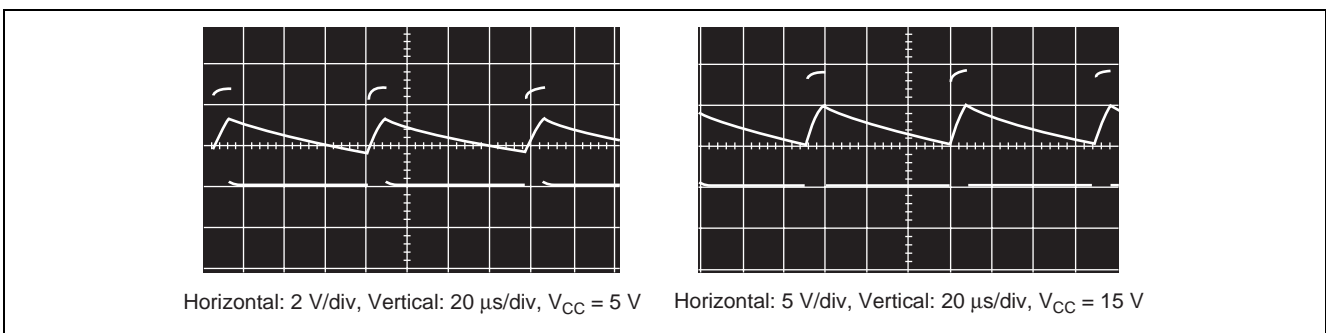


Figure 4 Operating Waveforms

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  $V_{out2}$ .

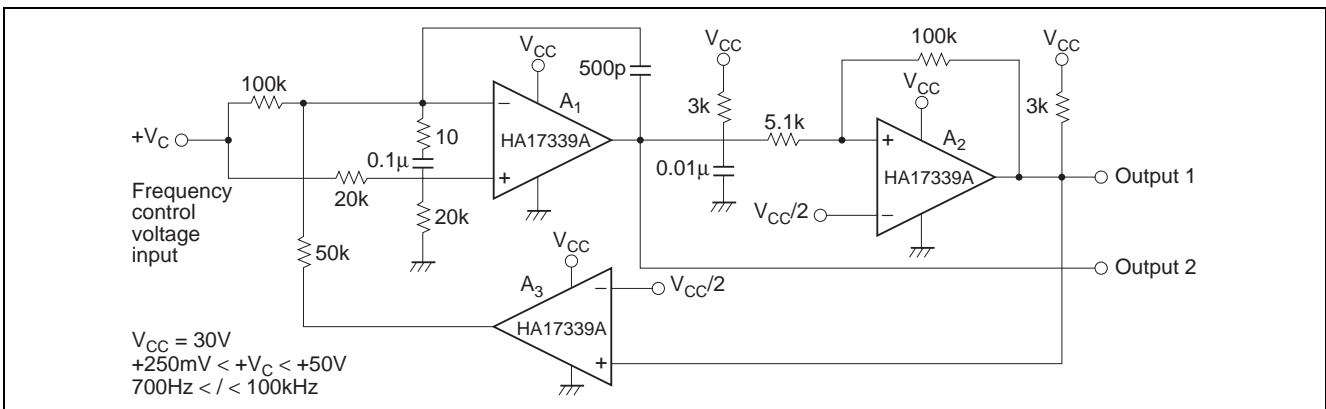


Figure 5 Voltage Controlled Oscillator

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.

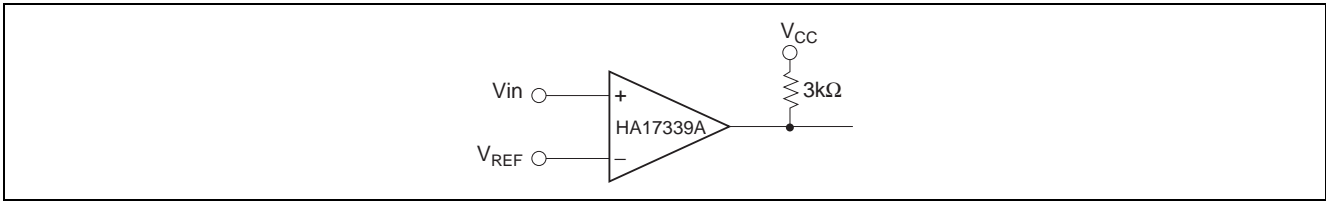


Figure 6 Basic Comparator

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.

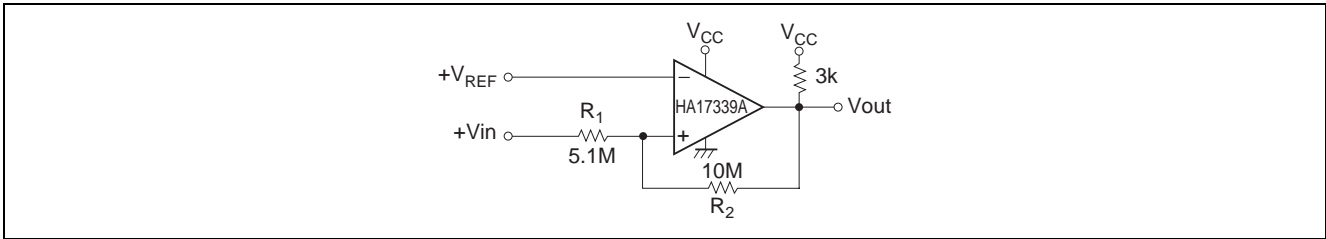


Figure 7 Noninverting Comparator

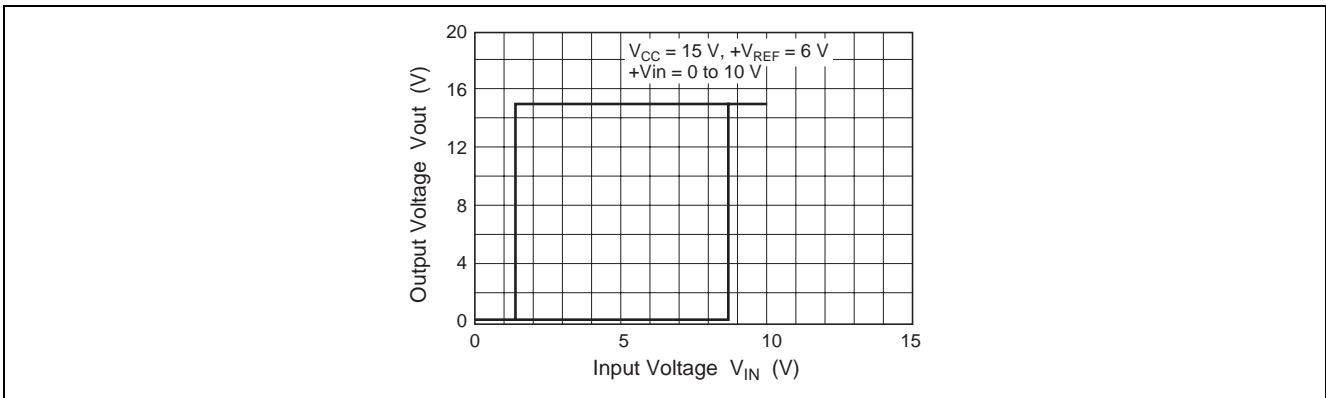


Figure 8 Noninverting Comparator I/O Transfer Characteristics

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.

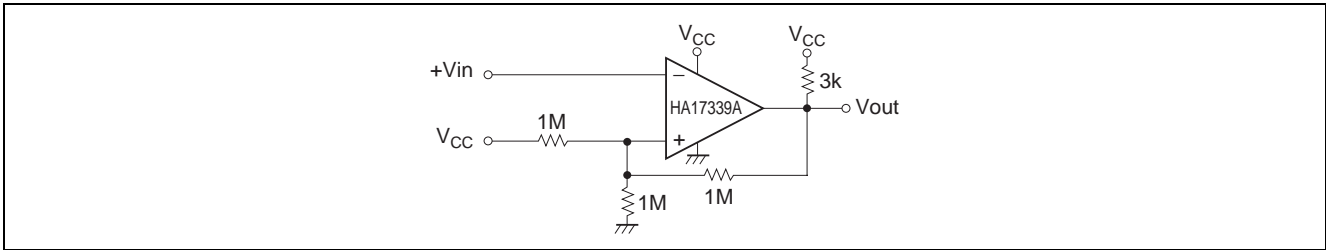


Figure 9 Inverting Comparator

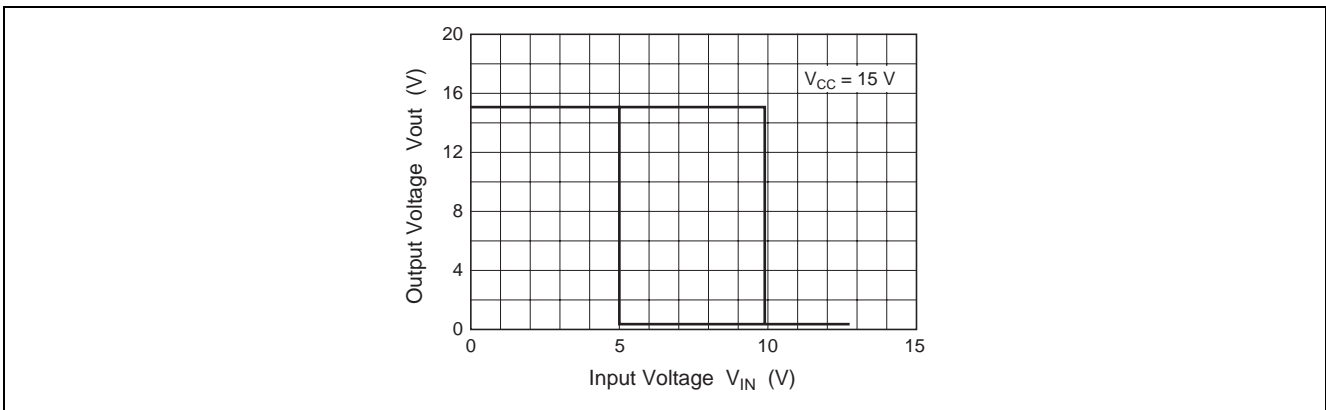


Figure 10 Inverting Comparator I/O Transfer Characteristics

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.)

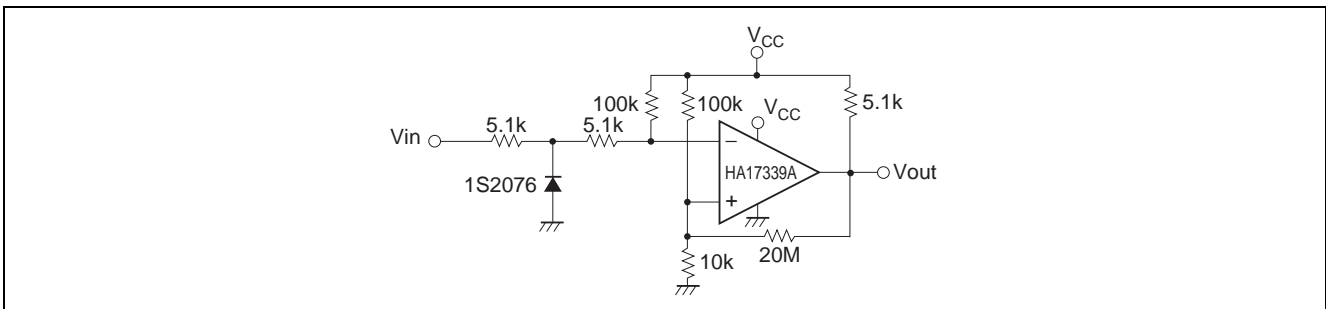
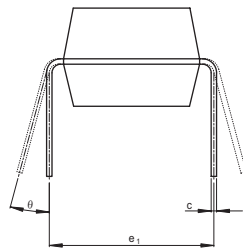
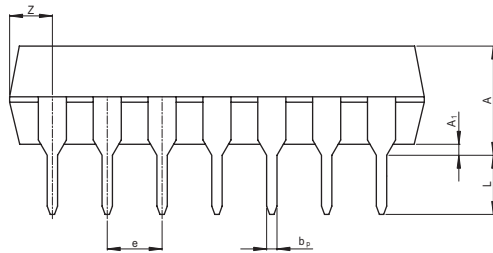
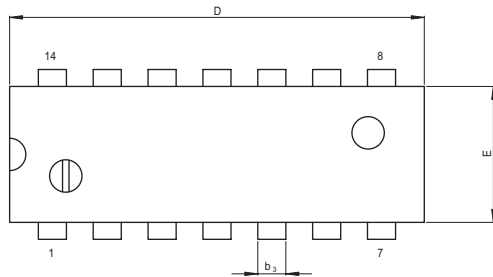


Figure 11 Zero-Cross Detector

Package Dimensions

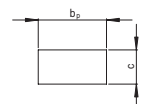
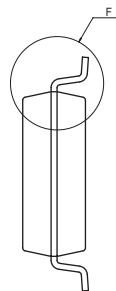
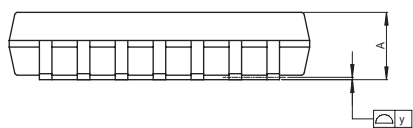
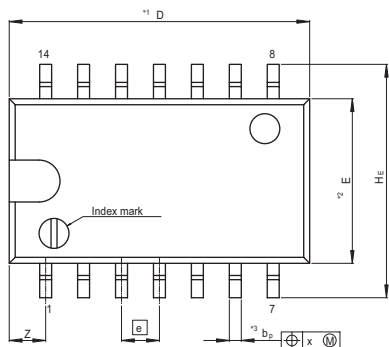
JEITA Package Code	RENESAS Code	Previous Code	MASS[Typ.]
P-DIP14-6.3x19.2-2.54	PRDP0014AB-B	DP-14AV	0.97g



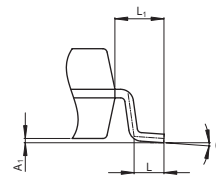
(Ni/Pd/Au plating)

Reference Symbol	Dimension in Millimeters		
	Min	Nom	Max
e <sub>1</sub>	—	7.62	—
D	—	19.2	20.32
E	—	6.3	7.4
A	—	—	5.06
A <sub>1</sub>	0.51	—	—
b <sub>p</sub>	0.40	0.48	0.56
b <sub>3</sub>	—	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



Terminal cross section (Ni/Pd/Au plating)



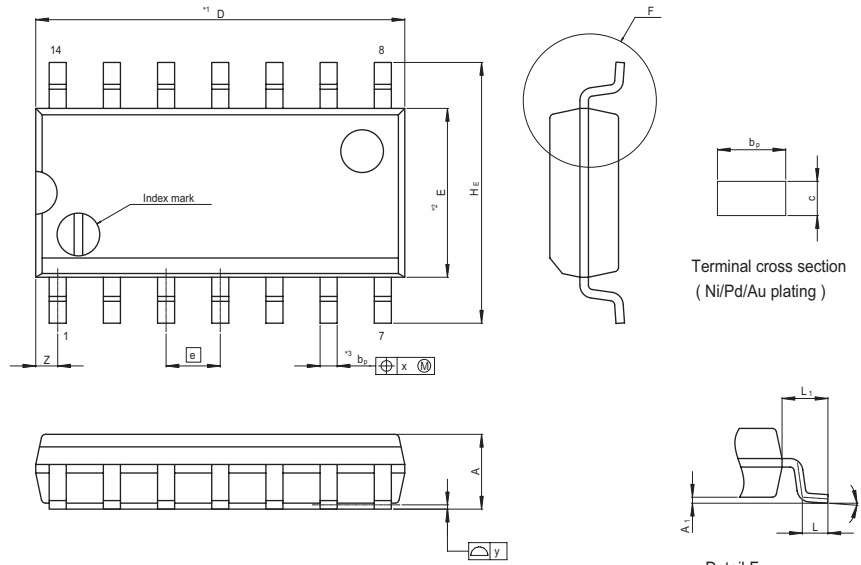
Detail F

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 <sub>2</sub>	—	—	—
A <sub>1</sub>	0.00	0.10	0.20
A	—	—	2.20
b <sub>p</sub>	0.34	0.40	0.46
b <sub>1</sub>	—	—	—
c	0.15	0.20	0.25
c <sub>1</sub>	—	—	—
θ	0°	—	8°
H <sub>E</sub>	7.50	7.80	8.00
Ⓧ	—	1.27	—
x	—	—	0.12
y	—	—	0.15
Z	—	—	1.42
L	0.50	0.70	0.90
L <sub>1</sub>	—	1.15	—

# HA17339A Series

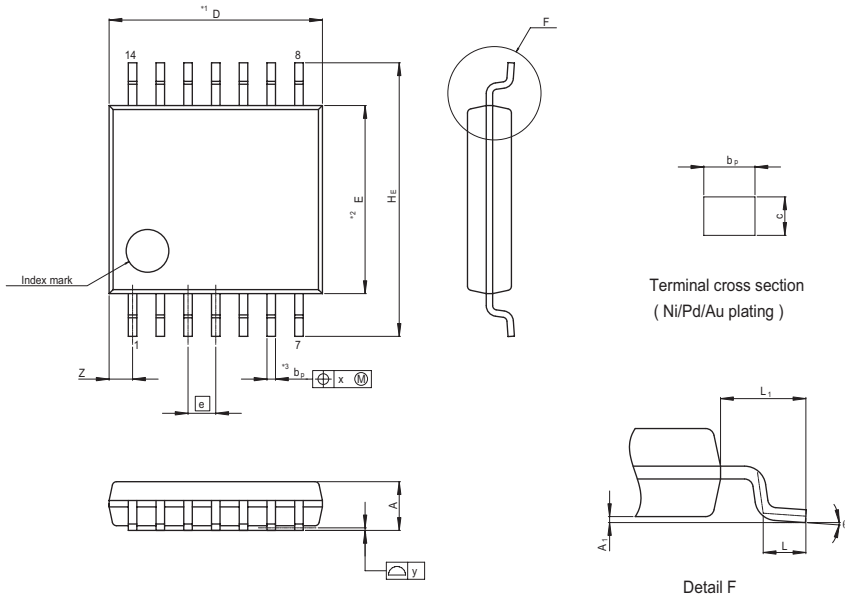
JEITA Package Code	RENESAS Code	Previous Code	MASS[Typ.]
P-SOP14-3.95x8.65-1.27	PRSP0014DE-A	FP-14DNV	0.13g



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 <sub>2</sub>	—	—	—
A <sub>1</sub>	0.10	0.14	0.25
A	—	—	1.75
b <sub>P</sub>	0.34	0.40	0.46
b <sub>1</sub>	—	—	—
c	0.15	0.20	0.25
c <sub>1</sub>	—	—	—
θ	0°	—	8°
H <sub>E</sub>	5.80	6.10	6.20
Ⓜ	—	1.27	—
x	—	—	0.25
y	—	—	0.15
Z	—	—	0.635
L	0.40	0.60	1.27
L <sub>1</sub>	—	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 <sub>2</sub>	—	—	—
A <sub>1</sub>	0.03	0.07	0.10
A	—	—	1.10
b <sub>P</sub>	0.15	0.20	0.25
b <sub>1</sub>	—	—	—
c	0.10	0.15	0.20
c <sub>1</sub>	—	—	—
θ	0°	—	8°
H <sub>E</sub>	6.20	6.40	6.60
Ⓜ	—	0.65	—
x	—	—	0.13
y	—	—	0.10
Z	—	—	0.83
L	0.4	0.5	0.6
L <sub>1</sub>	—	1.0	—

**Keep safety first in your circuit designs!**

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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.

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