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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.

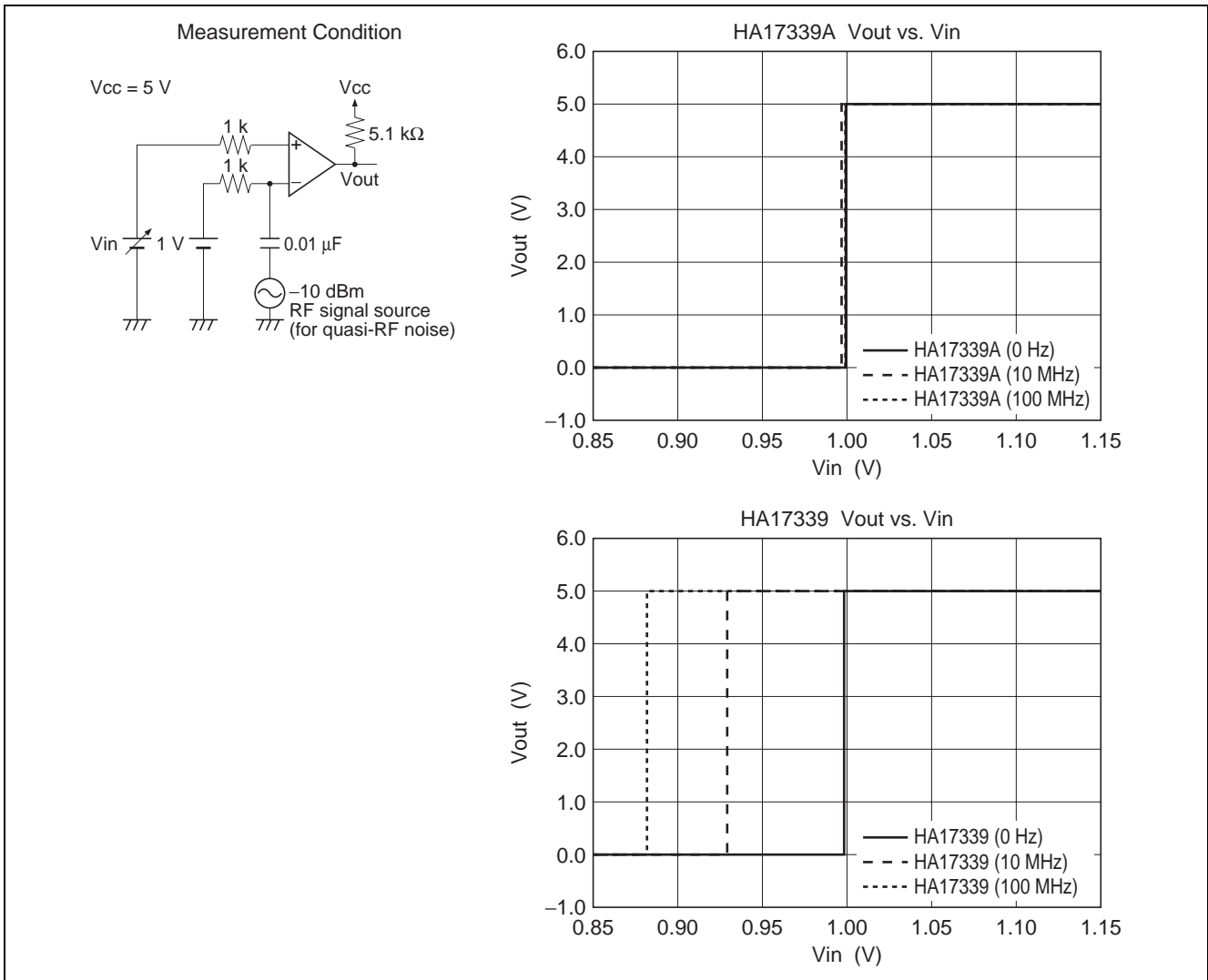
These ICs operate from a single power-supply voltage over a wide range of voltages, and feature a reduced power-supply current since the supply current is independent of the supply voltage.

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

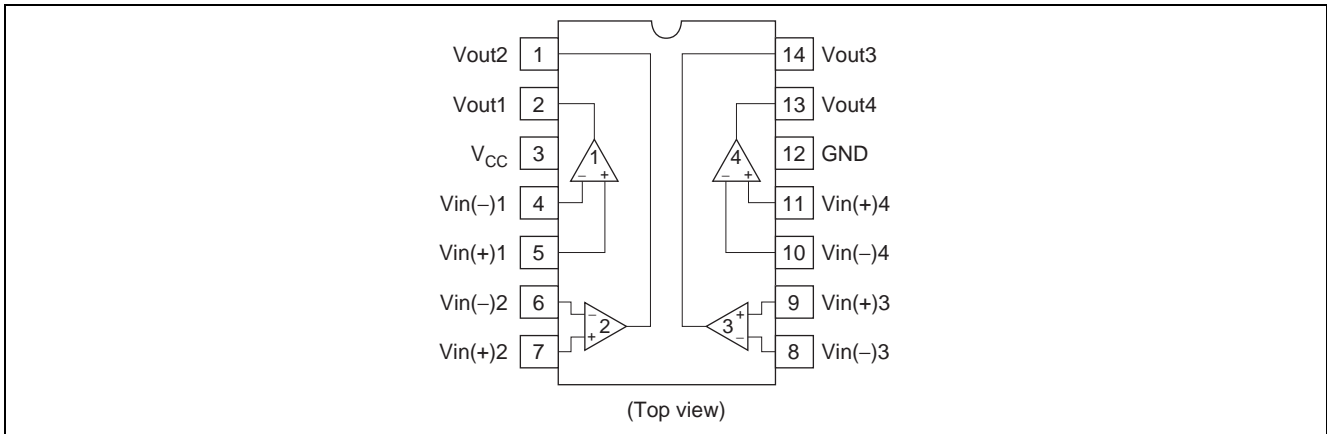
- Low electro-magnetic susceptibility



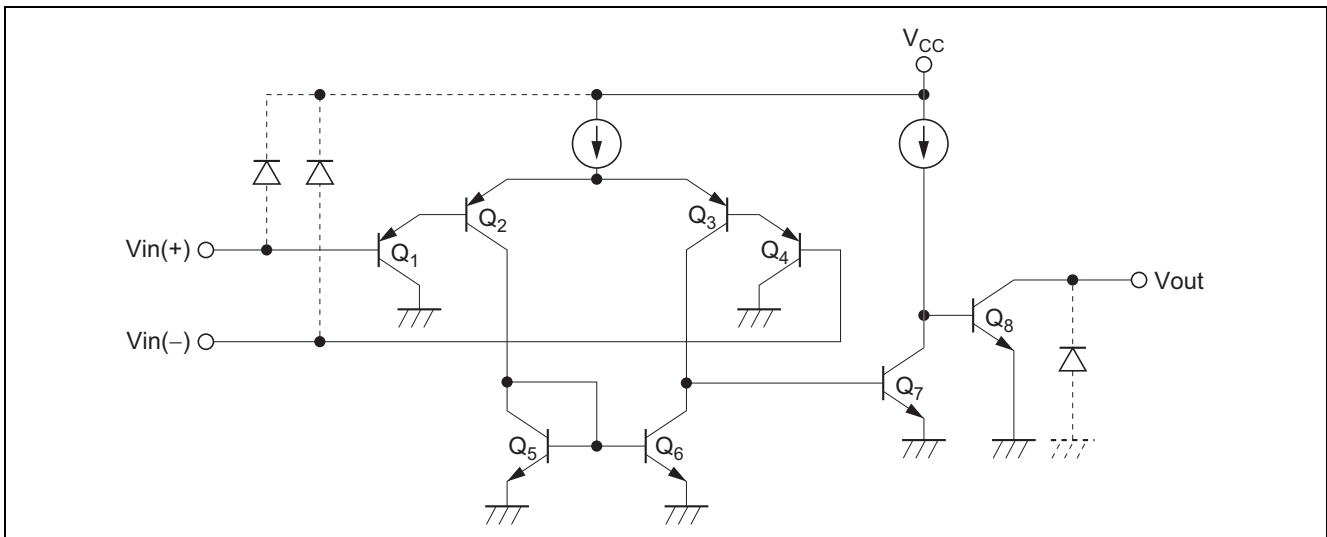
### Ordering Information

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> * <sup>1</sup>	20	mA
Allowable power dissipation	DIP	P <sub>T</sub>	mW
	SOP		
	TSSOP		
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 * <sup>1</sup>	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 * <sup>3</sup>	A <sub>V</sub>	—	(200)	—	V/mV	R <sub>L</sub> = 15kΩ
Response time * <sup>2,3</sup>	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 * <sup>3</sup>	I <sub>LO</sub>	—	(0.1)	—	nA	V <sub>IN(+)</sub> = 1V, V <sub>IN(-)</sub> = 0, V <sub>O</sub> = 5V

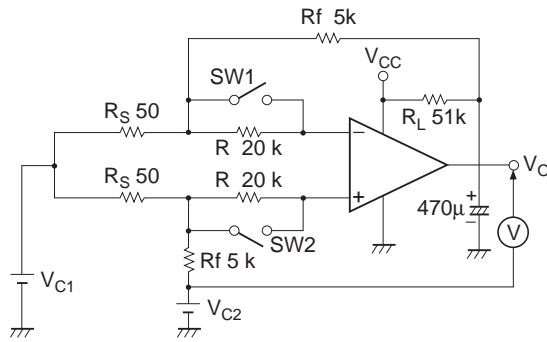
Notes: 1. Voltages more negative than -0.3 V are not allowed for the common-mode input voltage or for either one of the input signal voltages.

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	$V_{O4}$

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

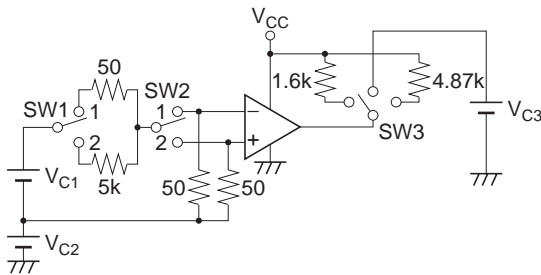
$$V_{C2} = 1.4V$$

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

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

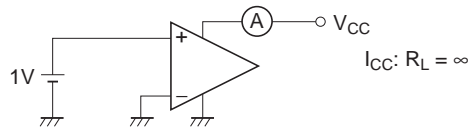
$$I_{IB} = \frac{|V_{O4} - V_{O3}|}{2 \cdot R(1 + R_f / R_S)} \quad (\text{nA})$$

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

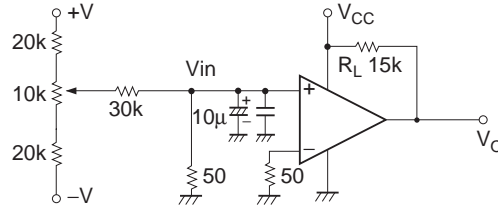


Item	$V_{C1}$	$V_{C2}$	$V_{C3}$	SW1	SW2	SW3	Unit
$V_{O\text{ sat}}$	2V	0V	—	1	1	1 at $V_{CC} = 5V$ 3 at $V_{CC} = 15V$	V
$I_{\text{osink}}$	2V	0V	1.5V	1	1	2	mA
$V_{\text{CM}}$	2V	-1 to $V_{CC}$	—	2	Switched between 1 and 2	3	V

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

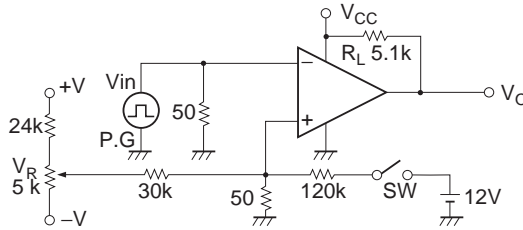


4. Voltage gain ( $A_V$ ) test circuit ( $R_L = 15k\Omega$ )



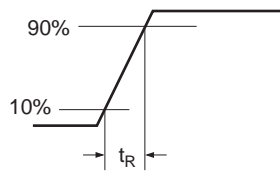
$$A_V = 20 \log \frac{V_{O1} - V_{O2}}{V_{IN1} - V_{IN2}} \quad (\text{dB})$$

5. Response time ( $t_R$ ) test circuit



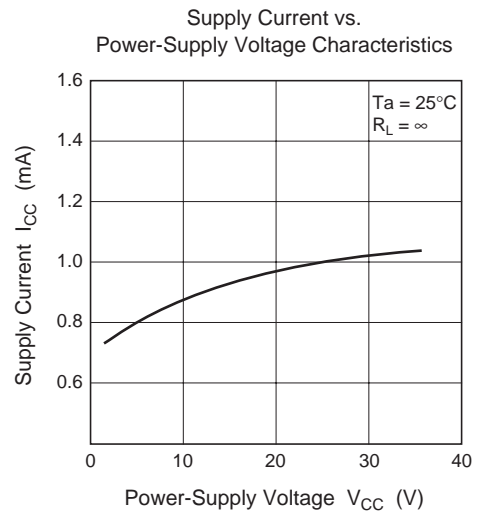
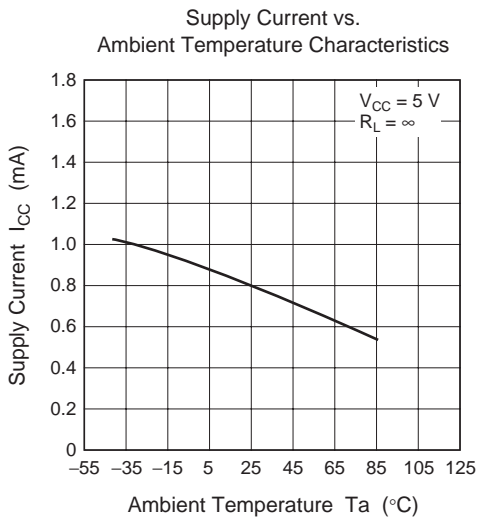
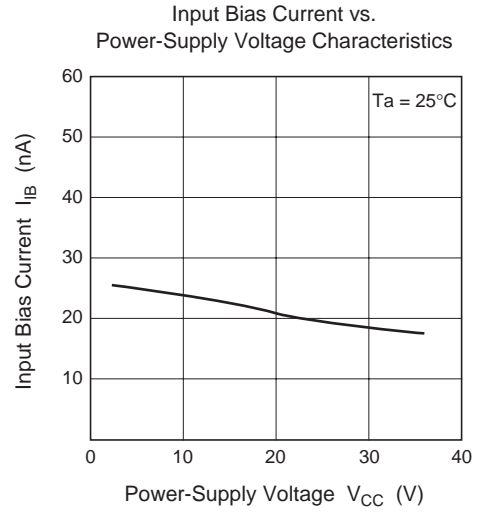
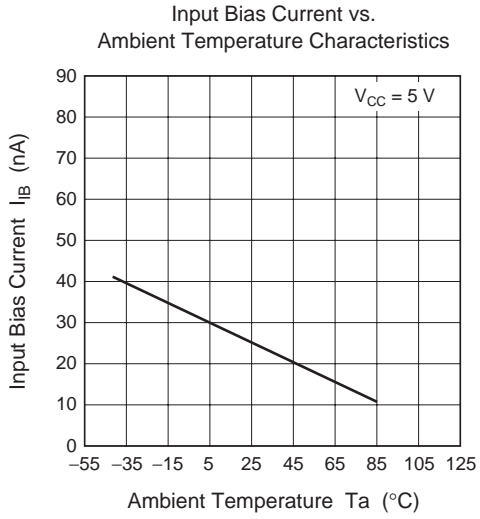
$t_R$ :  $R_L = 5.1k\Omega$ , a 100mV input step voltage that has a 5mV overdrive

- 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.

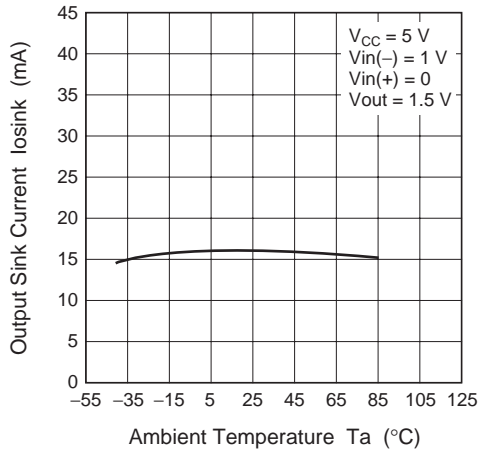




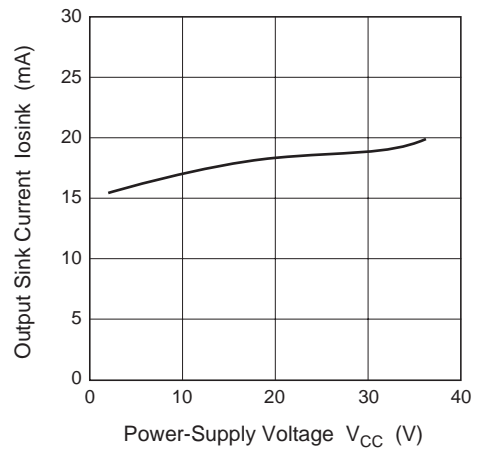
Characteristic Curves



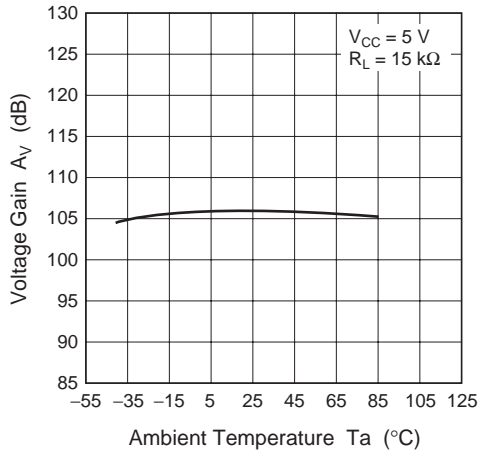
Output Sink Current vs. Ambient Temperature Characteristics



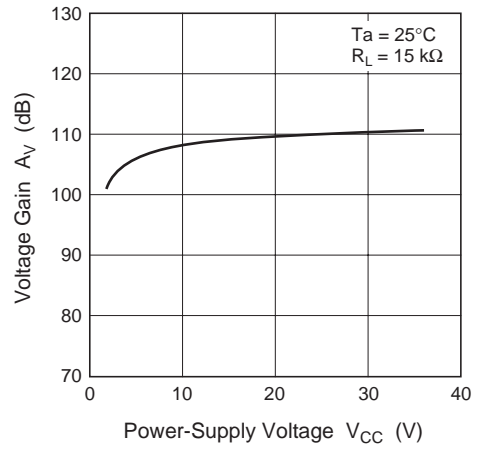
Output Sink Current vs. Power-Supply Voltage Characteristics



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.

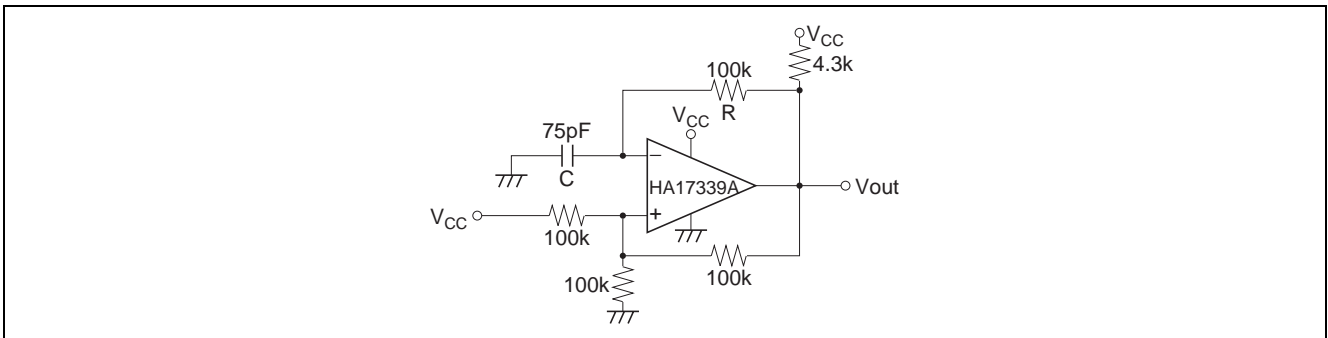


Figure 1 Square-Wave Oscillator

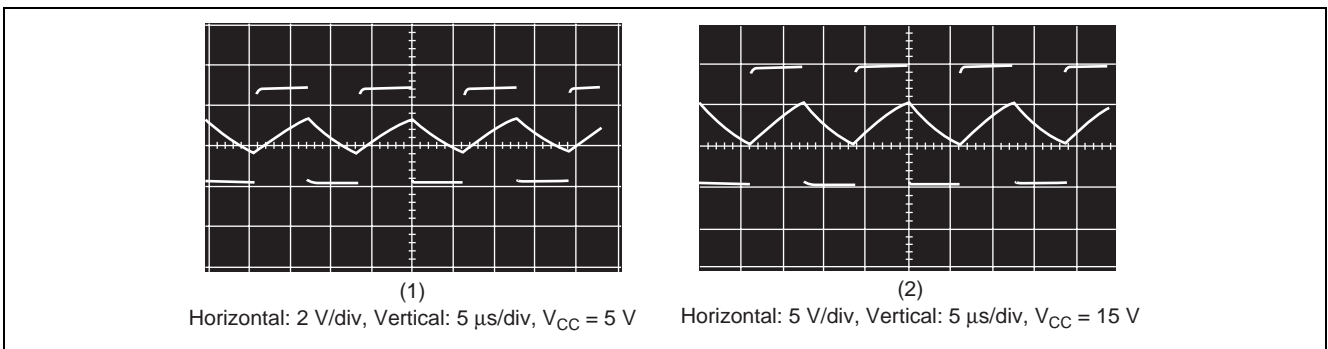


Figure 2 Operating Waveforms

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.

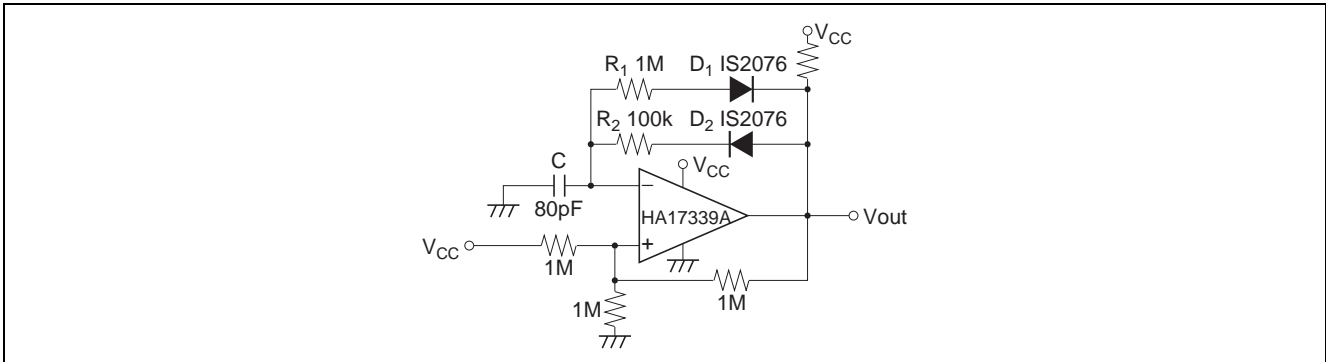


Figure 3 Pulse Generator

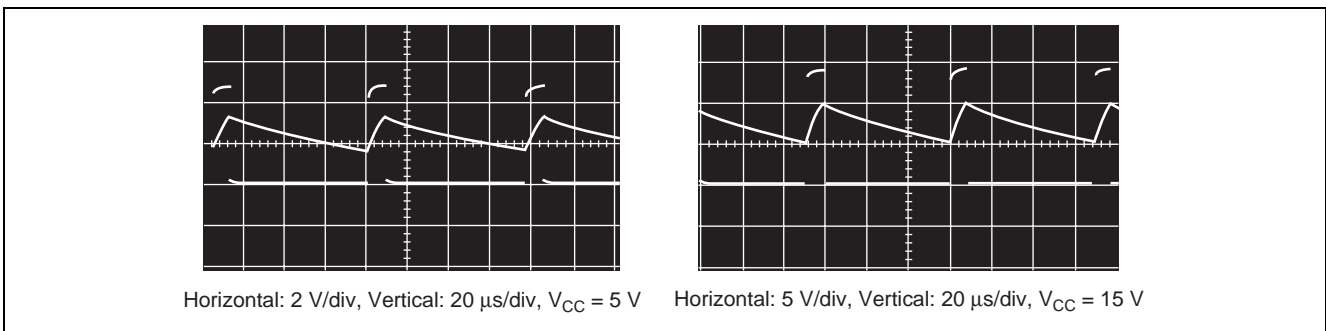


Figure 4 Operating Waveforms

3. Voltage Controlled Oscillator

In the circuit in figure 5, comparator A<sub>1</sub> operates as an integrator, A<sub>2</sub> operates as a comparator with hysteresis, and A<sub>3</sub> operates as the switch that controls the oscillator frequency. If the output Vout1 is at the low level, the A<sub>3</sub> output will go to the low level and the A<sub>1</sub> inverting input will become a lower level than the A<sub>1</sub> noninverting input. The A<sub>1</sub> output will integrate this state and its output will increase towards the high level. When the output of the integrator A<sub>1</sub> exceeds the level on the comparator A<sub>2</sub> inverting input, A<sub>2</sub> inverts to the high level and both the output Vout1 and the A<sub>3</sub> 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<sub>1</sub> output level becomes lower than the level on the A<sub>2</sub> 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.

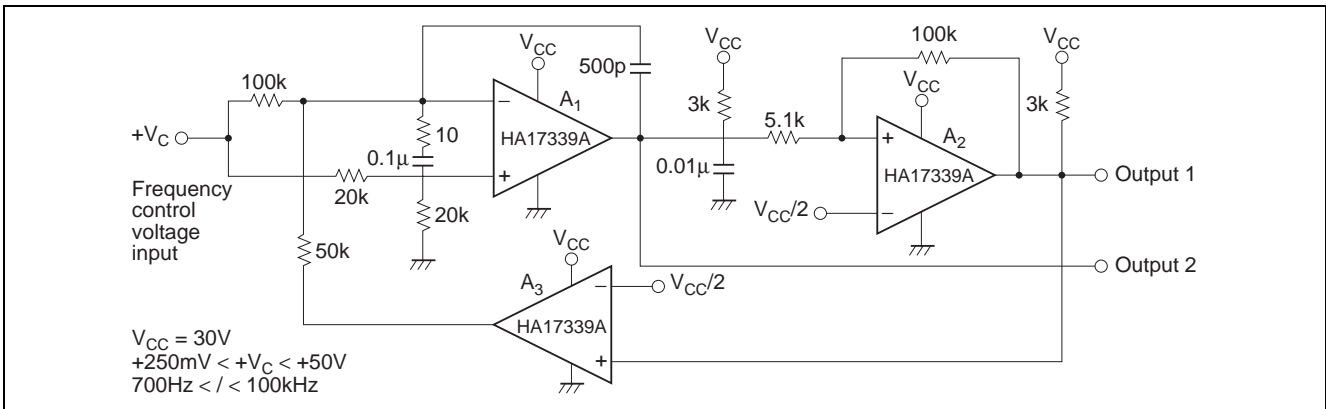


Figure 5 Voltage Controlled Oscillator

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.

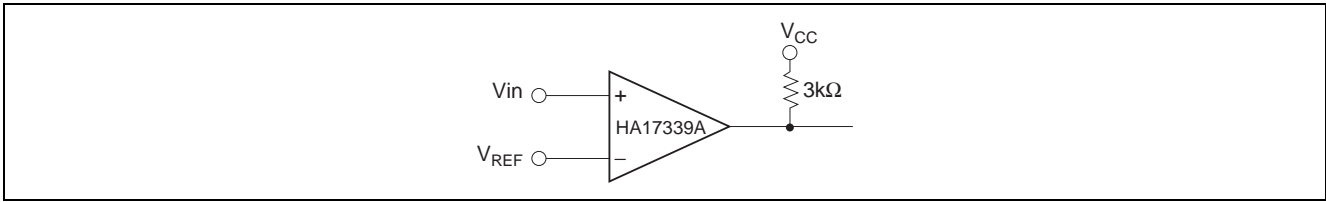


Figure 6 Basic Comparator

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,  $V_{out}$  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.

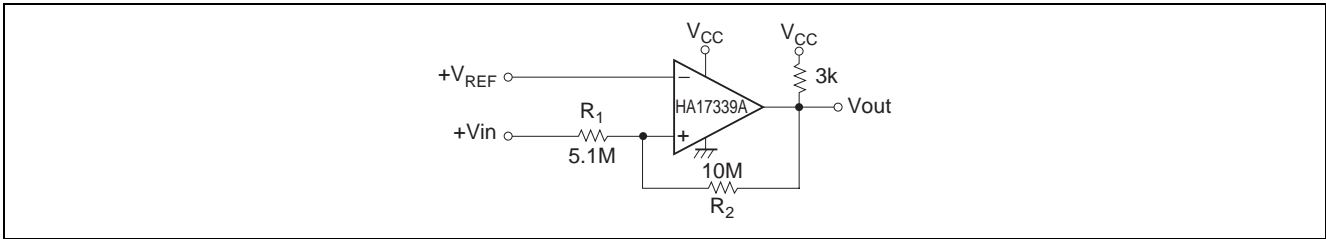


Figure 7 Noninverting Comparator

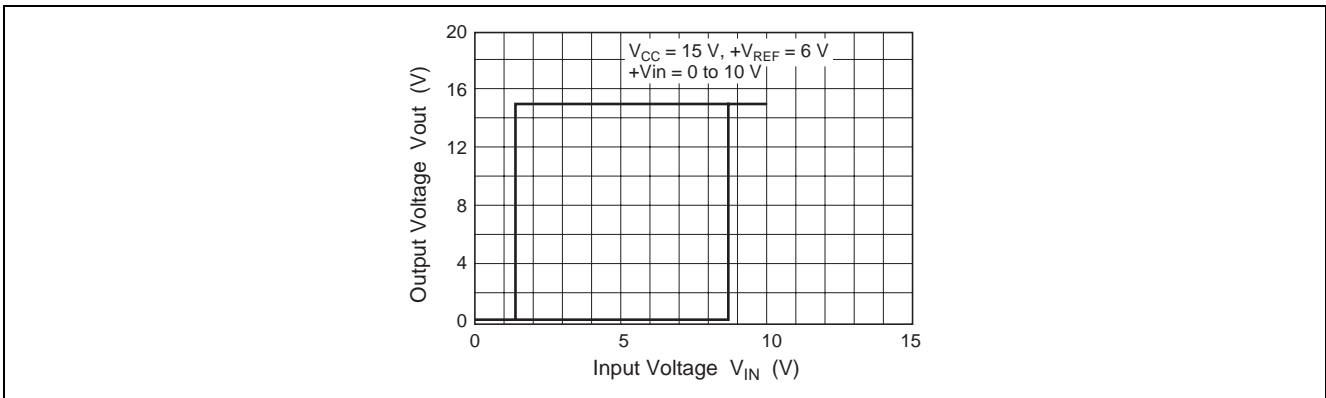


Figure 8 Noninverting Comparator I/O Transfer Characteristics

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.

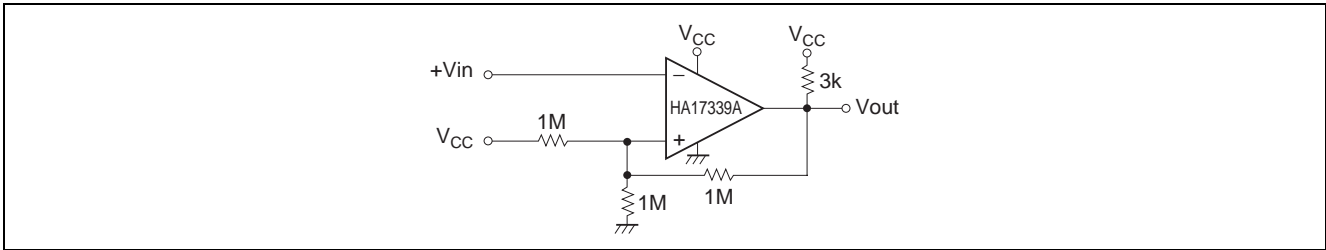


Figure 9 Inverting Comparator

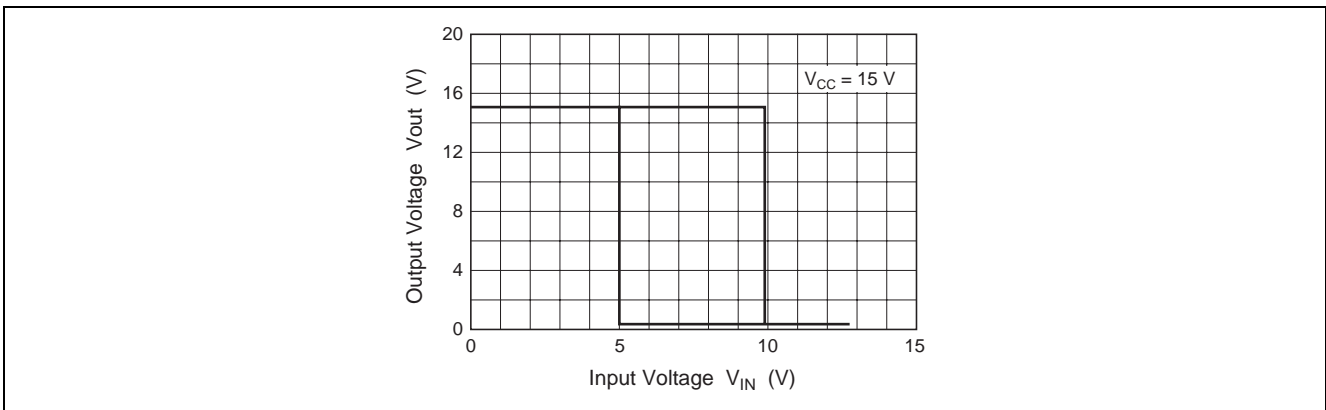


Figure 10 Inverting Comparator I/O Transfer Characteristics

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.)

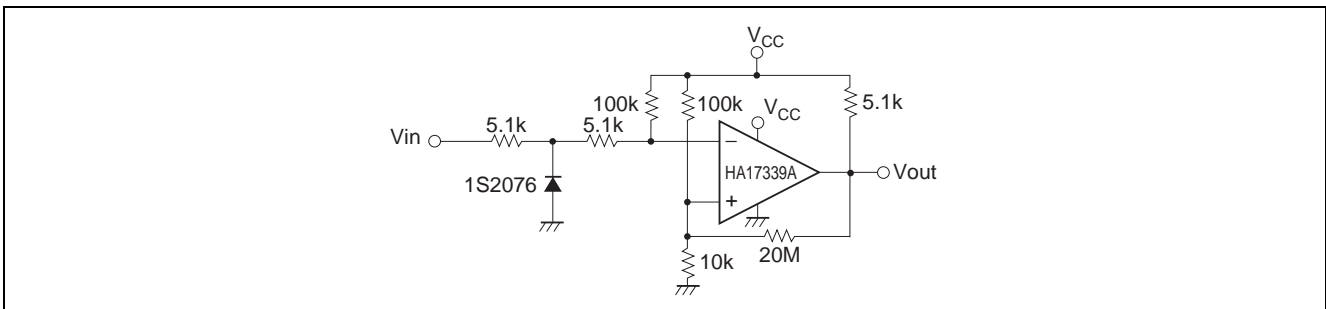
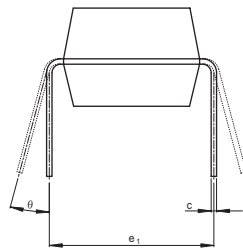
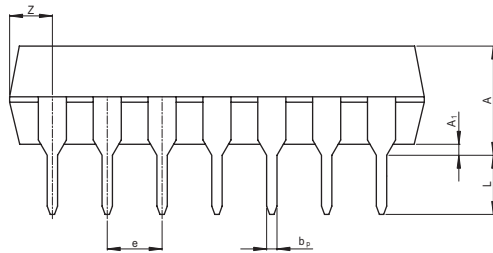
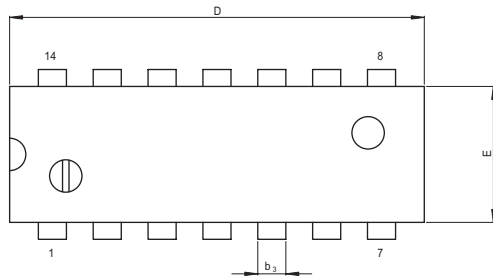


Figure 11 Zero-Cross Detector

Package Dimensions

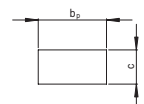
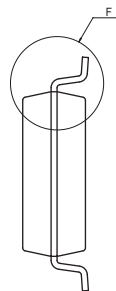
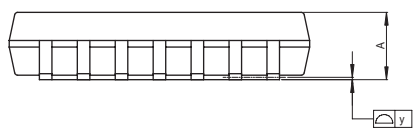
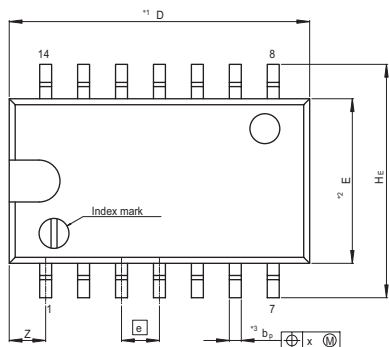
JEITA Package Code	RENESAS Code	Previous Code	MASS[Typ.]
P-DIP14-6.3x19.2-2.54	PRDP0014AB-B	DP-14AV	0.97g



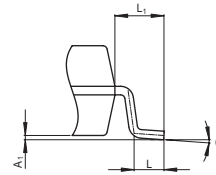
(Ni/Pd/Au plating)

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)



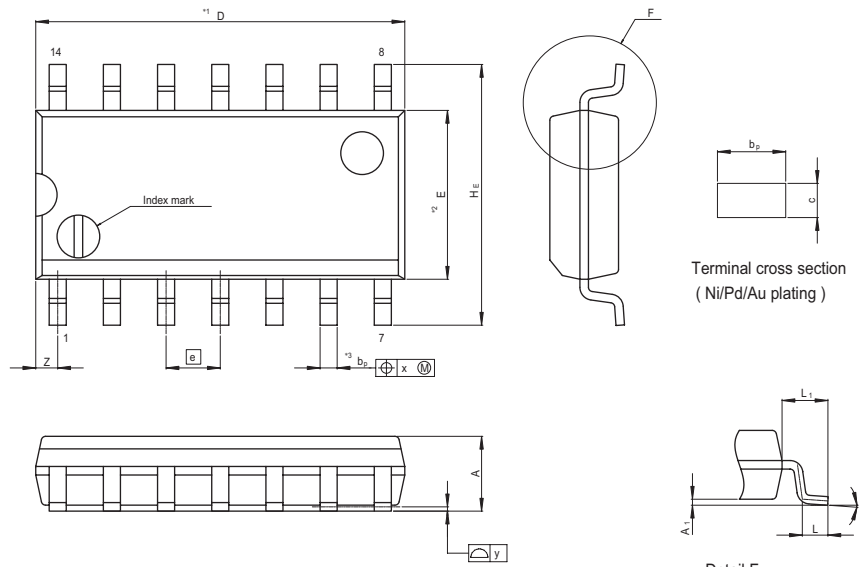
Detail F

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

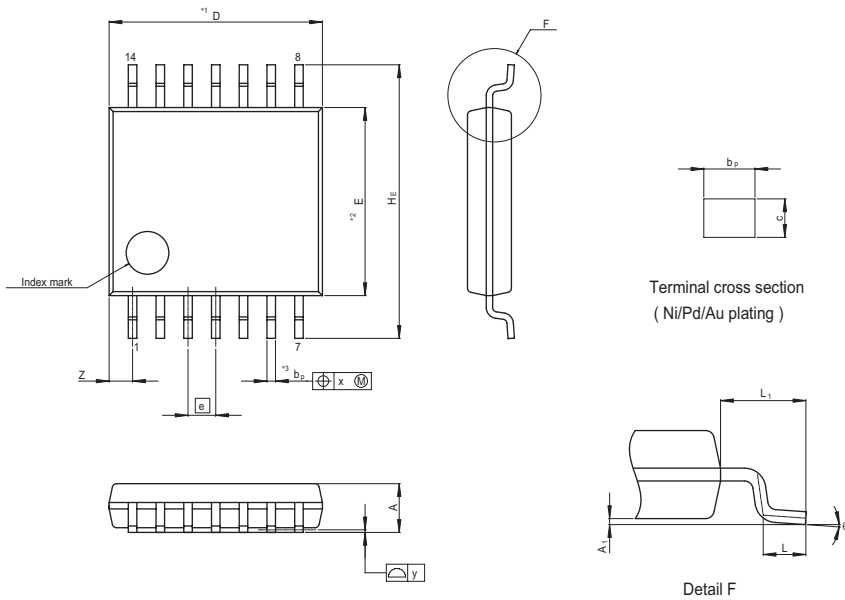
JEITA Package Code	RENESAS Code	Previous Code	MASS[Typ.]
P-SOP14-3.95x8.65-1.27	PRSP0014DE-A	FP-14DNV	0.13g



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	—



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