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HA17901A Series

Quadruple Comparators

Description

The HA17901A series products are comparators designed for general purpose, especially for power control systems.
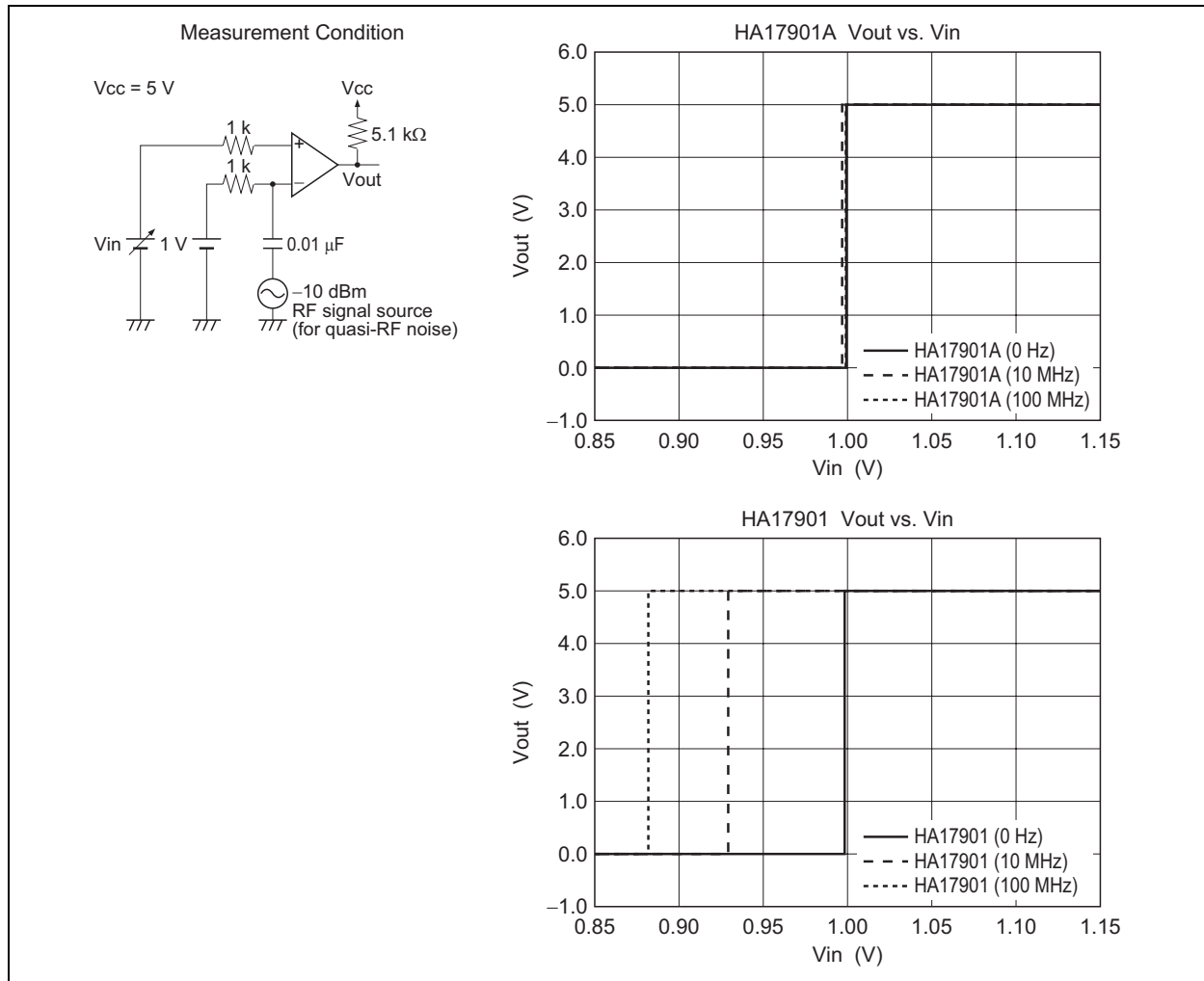
These ICs operate from a single power-supply voltage over a wide range of voltages, and feature a reduced power-supply current since the supply current is independent of the supply voltage.

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

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- Low electro-magnetic susceptibility

Measurement Condition

Vcc = 5 V

Vcc

1 k
5.1 kΩ

1 k

Vout

Vin — 1 V

0.01 μF

−10 dBm
RF signal source
(for quasi-RF noise)

HA17901A Vout vs. Vin

HA17901A (0 Hz)
HA17901A (10 MHz)
HA17901A (100 MHz)

Vout (V) vs. Vin (V)

HA17901 Vout vs. Vin

HA17901 (0 Hz)
HA17901 (10 MHz)
HA17901 (100 MHz)

Vout (V) vs. Vin (V)

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

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Pin Arrangement

(Top view)
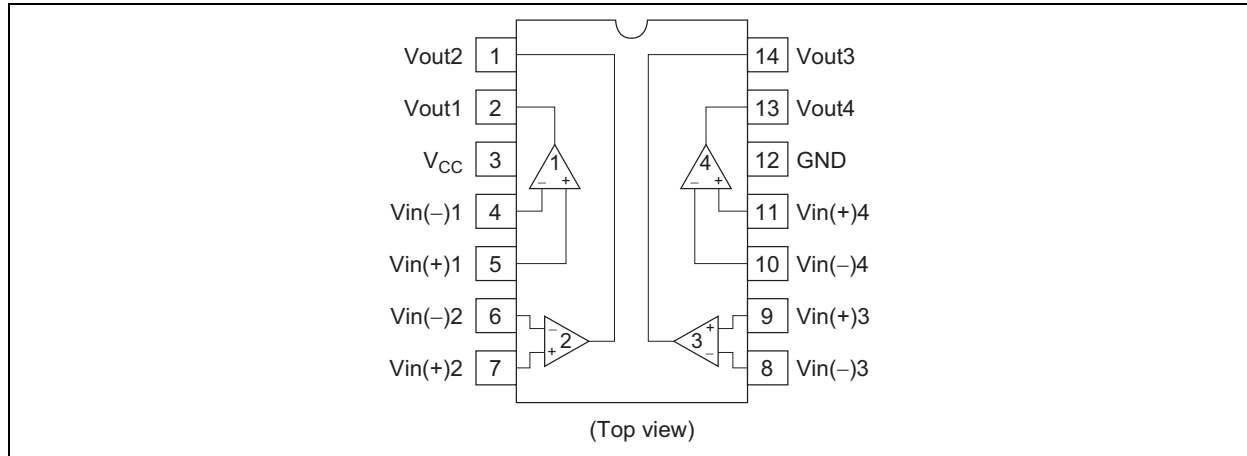
Circuit Structure (1/4)
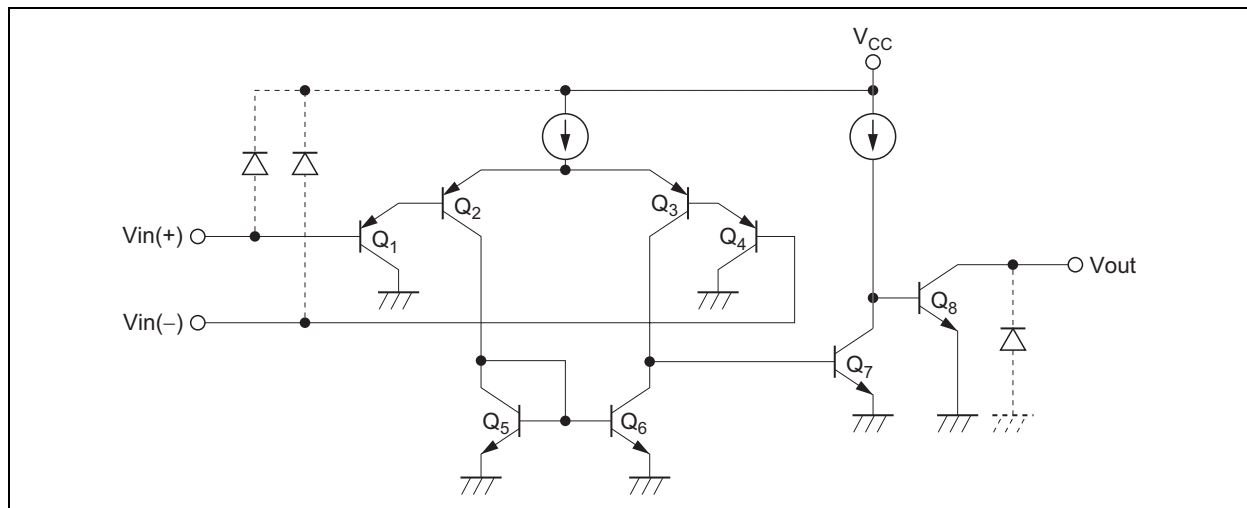
Note: If Input/Output terminals voltage over the absolute maximum ratings, there is possibility of mis-operation, characteristics deterioration and destruction, because of the current's flowing to parasitic diode in IC.
The Input/Output terminals are recommended to be protected with the clamp circuit 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)	±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)

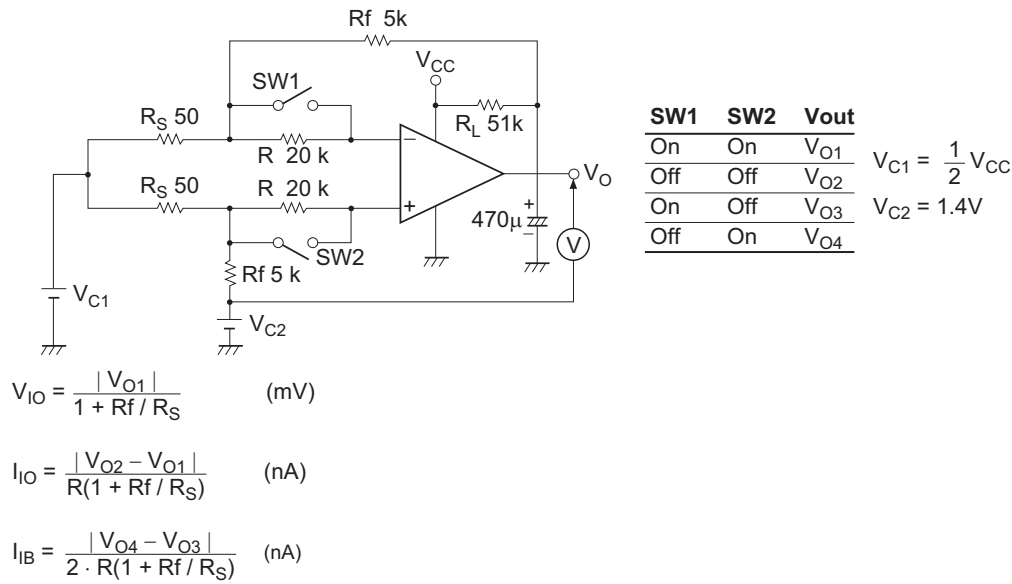| Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Input offset voltage	V_{IO}	—	2	7	mV	Output switching point: when V_O = 1.4V, R_S = 0Ω
Input offset current	I_{IO}	—	5	50	nA	$\mid I_{IN(+)} - I_{IN(-)} \mid$
Input bias current	I_{IB}	—	25	250	nA	$I_{IN(+)}$ or $I_{IN(-)}$
Common-mode input voltage [1]	V_{CM}	0	—	V_{CC}−1.5	V	
Supply current	I_{CC}	—	0.8	2	mA	R_L = ∞
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 ≤ 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.
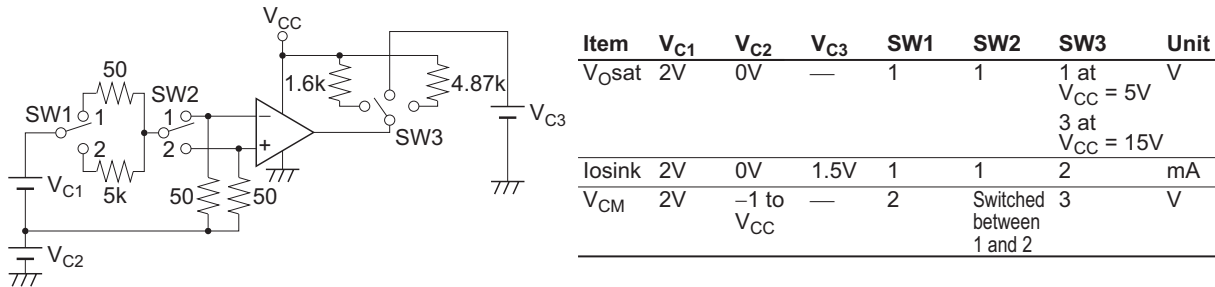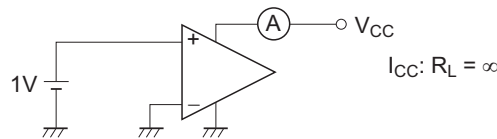
3. Design spec.

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Test Circuits

1. Input offset voltage (V_{IO}), input offset current (I_{IO}), and Input bias current (I_{IB}) test circuit
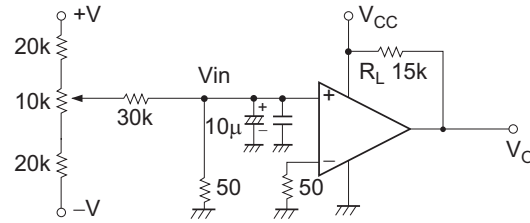

SW1	SW2	Vout
On	On	V_{O1}
Off	Off	V_{O2}
On	Off	V_{O3}
Off	On	V_{O4}

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

$$V_{C2} = 1.4V$$

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

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

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

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}: $R_L = \infty$

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

$$A_V = 20 \log \frac{V_{O1} - V_{O2}}{V_{IN1} - V_{IN2}} \quad \text{(dB)}$$
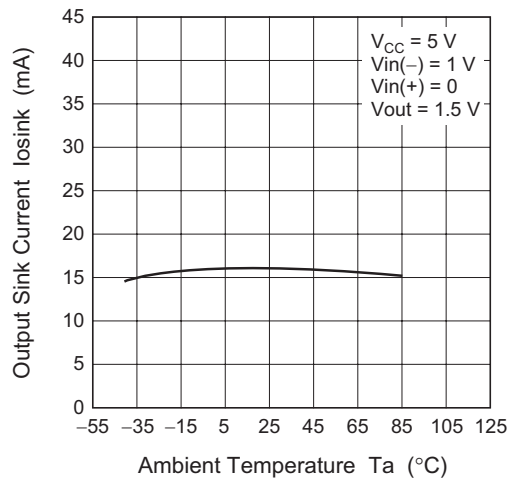
5. Response time (t_R) test circuit
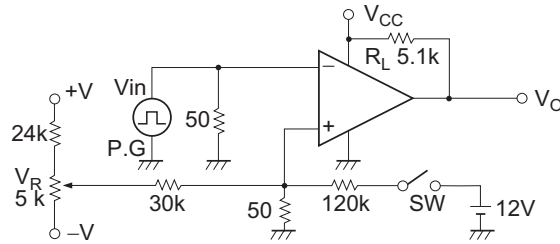
t_R: $R_L = 5.1$ kΩ, a 100 mV input step voltage that has a 5 mV overdrive

— 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.

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Characteristic Curves

Input Bias Current vs. Ambient Temperature Characteristics

V_{CC} = 5 V

Input Bias Current I_{IB} (nA)

Ambient Temperature Ta (°C)

Input Bias Current vs. Power-Supply Voltage Characteristics

Ta = 25°C

Input Bias Current I_{IB} (nA)

Power-Supply Voltage V_{CC} (V)

Supply Current vs. Ambient Temperature Characteristics

V_{CC} = 5 V
R_L = ∞

Supply Current I_{CC} (mA)

Ambient Temperature Ta (°C)

Supply Current vs. Power-Supply Voltage Characteristics

Ta = 25°C
R_L = ∞

Supply Current I_{CC} (mA)

Power-Supply Voltage V_{CC} (V)

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Output Sink Current vs.
Ambient Temperature Characteristics

Output Sink Current vs.
Power-Supply Voltage Characteristics
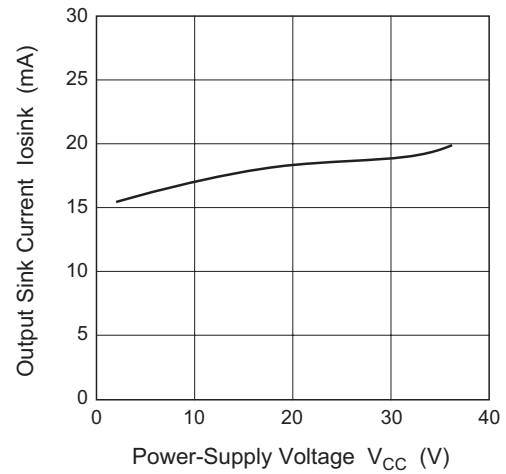
Voltage Gain vs.
Ambient Temperature Characteristics
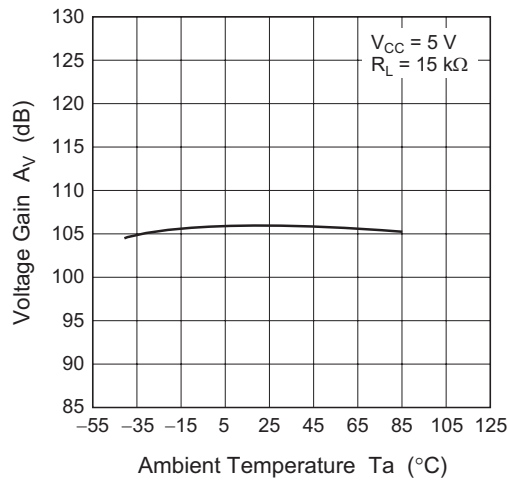
Voltage Gain vs.
Power-Supply Voltage Characteristics

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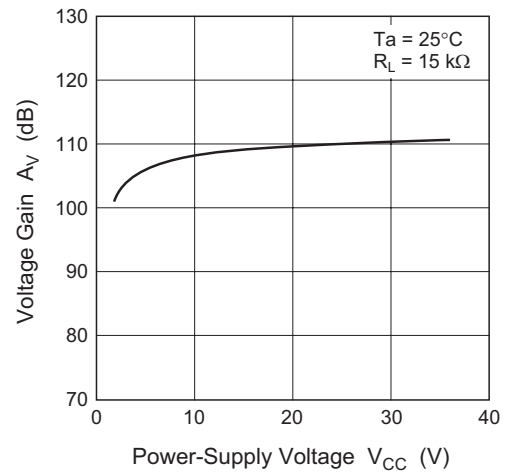
HA17901A Application Examples

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.
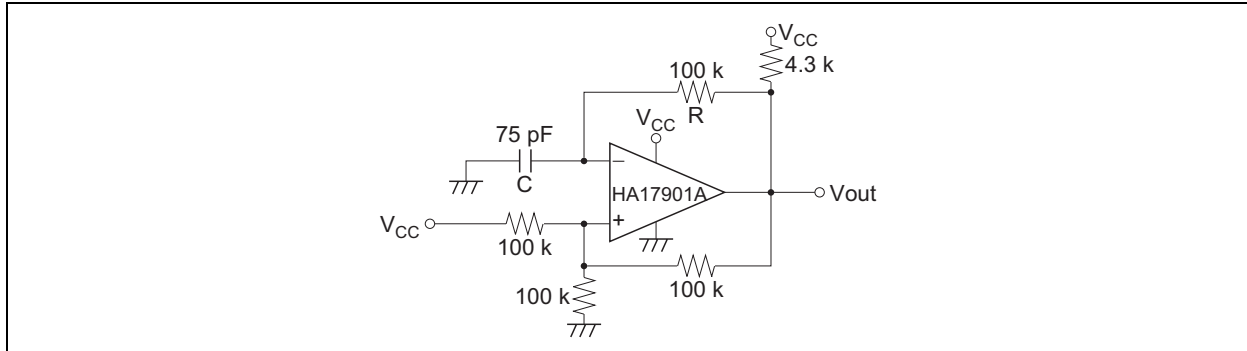
Figure 1 Square-Wave Oscillator

(1)	(2)
Horizontal: 2 V/div, Vertical: 5 µs/div, V_{CC} = 5 V	Horizontal: 5 V/div, Vertical: 5 µs/div, V_{CC} = 15 V
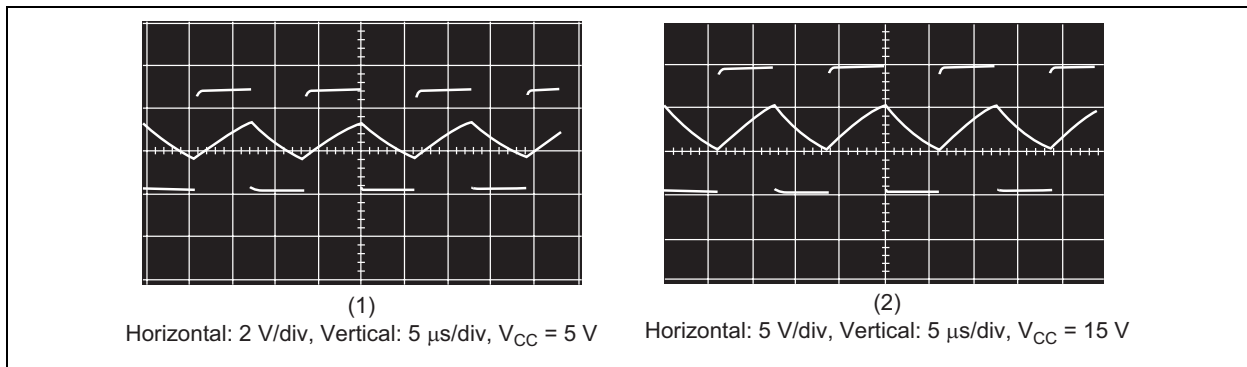
Figure 2 Operating Waveforms

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.
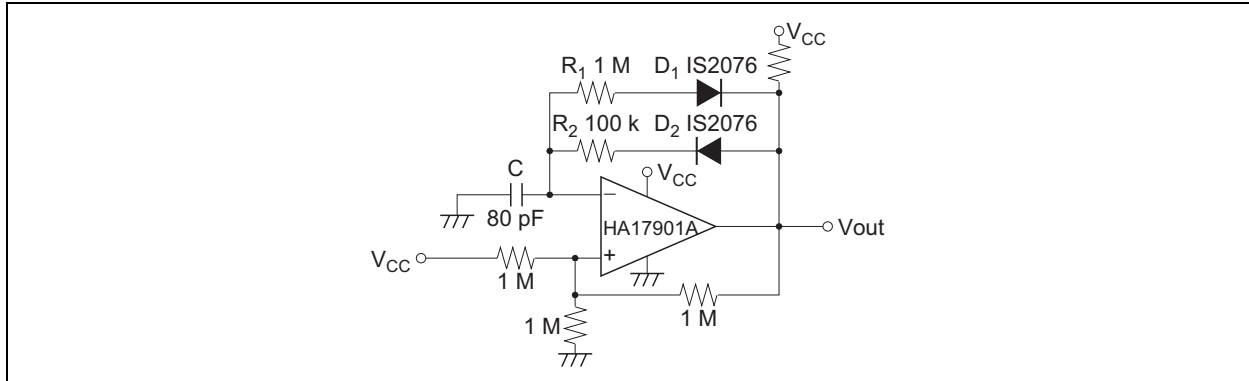
Figure 3   Pulse Generator

Horizontal: 2 V/div, Vertical: 20 μs/div, V_{CC} = 5 V   Horizontal: 5 V/div, Vertical: 20 μs/div, V_{CC} = 15 V
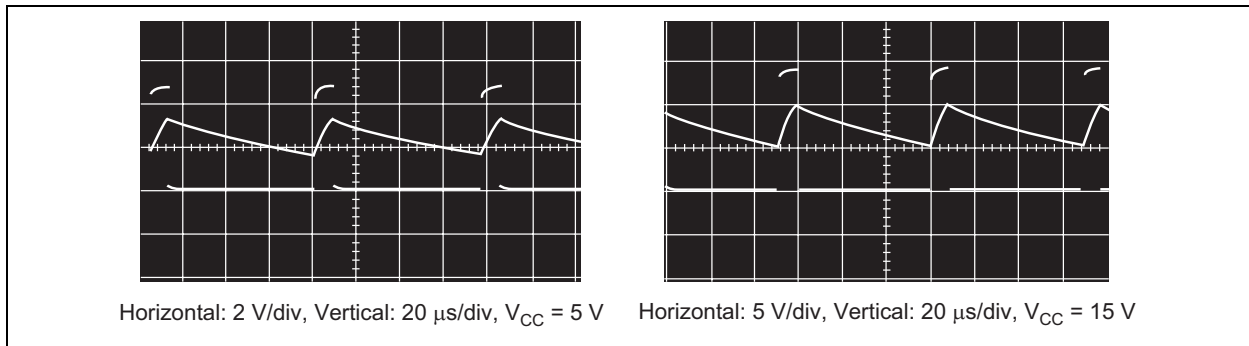
Figure 4   Operating Waveforms

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.
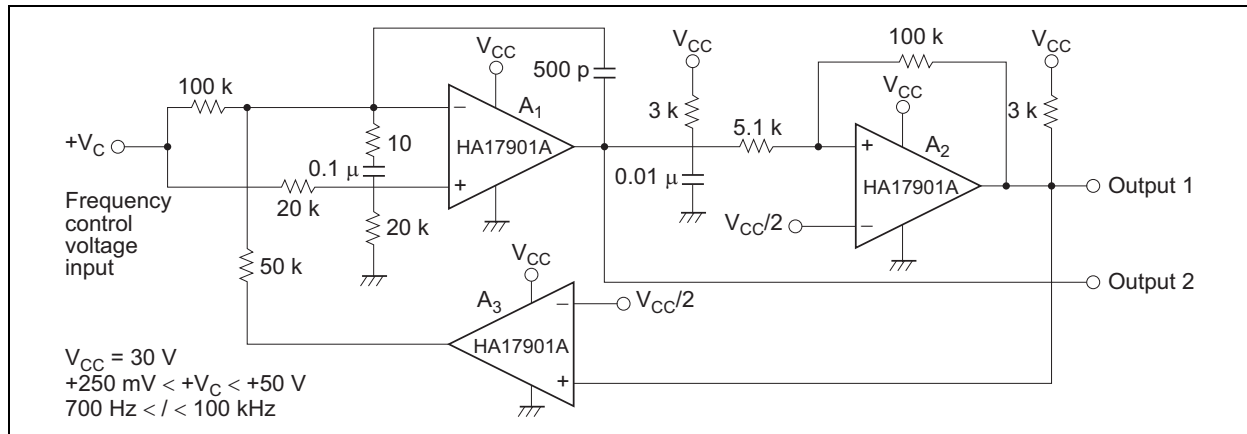
Figure 5   Voltage Controlled Oscillator

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.
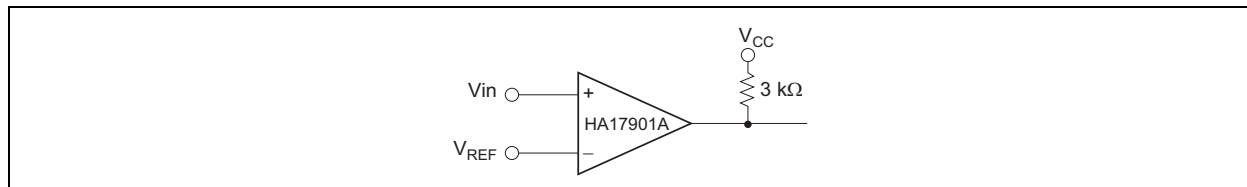
Figure 6   Basic Comparator

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. $+V_{IN} \times 10 \text{ M}/(5.1 \text{ M} + 10 \text{ M}) > 6$ 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.
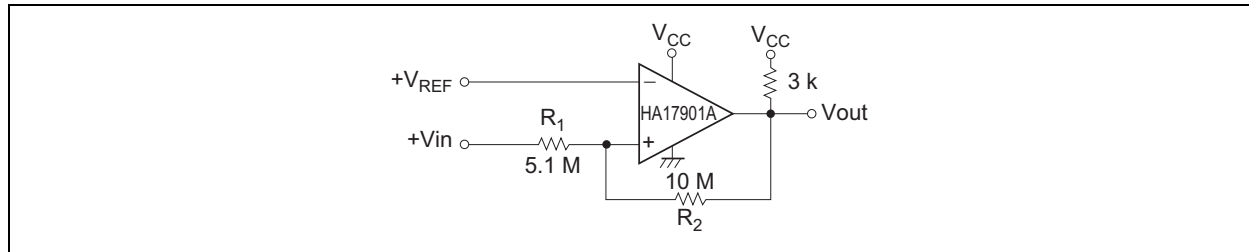
Figure 7   Noninverting Comparator
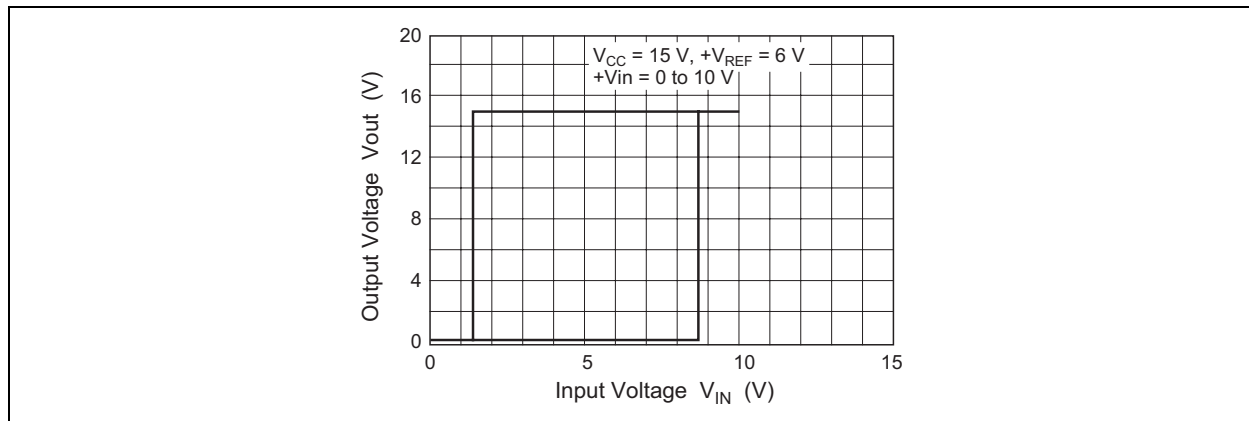
Figure 8   Noninverting Comparator I/O Transfer Characteristics

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.
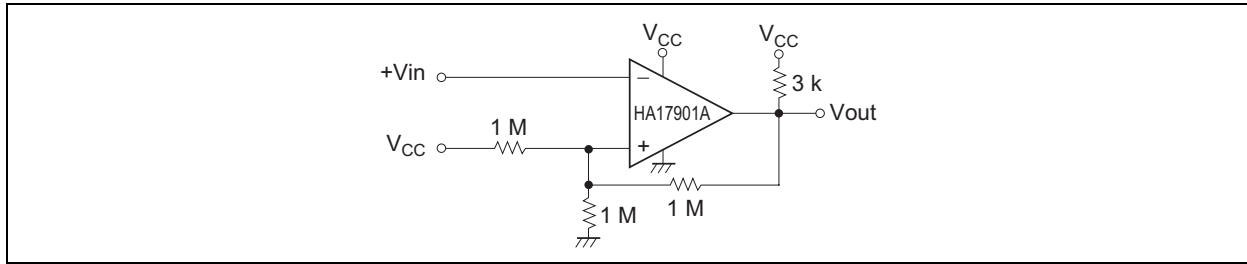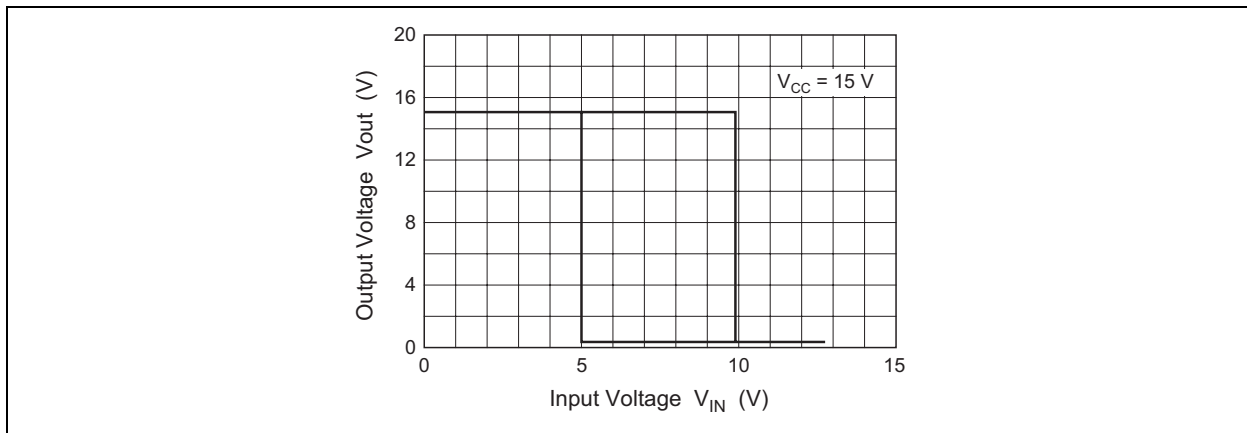

Figure 9 Inverting Comparator

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.)
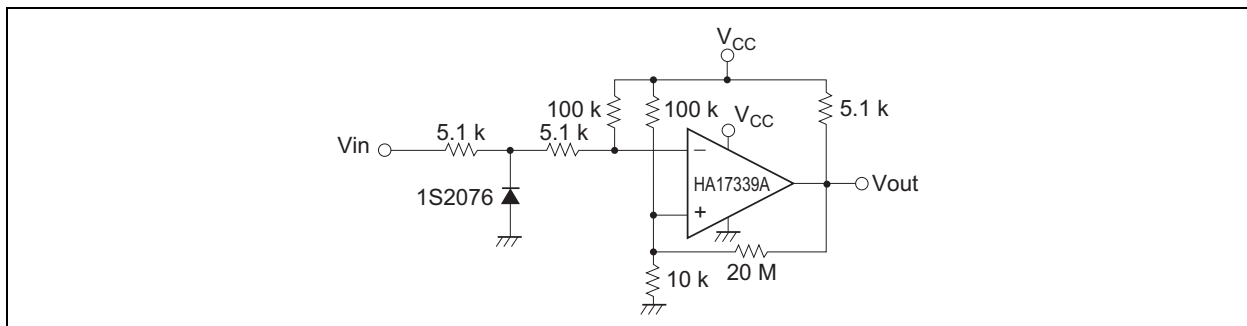

Figure 11 Zero-Cross Detector

Package Dimensions

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

(Ni/Pd/Au plating)

Reference Symbol	Dimension in Millimeters		
	Min	Nom	Max
e₁	—	7.62	—
D	—	19.2	20.32
E	—	6.3	7.4
A	—	—	5.06
A₁	0.51	—	—
bₚ	0.40	0.48	0.56
b₃	—	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.

Terminal cross section
(Ni/Pd/Au plating)

Detail F

Reference Symbol	Dimension in Millimeters		
	Min	Nom	Max
D	—	10.06	10.5
E	—	5.50	—
A₂	—	—	—
A₁	0.00	0.10	0.20
A	—	—	2.20
bₚ	0.34	0.40	0.46
b₁	—	—	—
c	0.15	0.20	0.25
c₁	—	—	—
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
L₁	—	1.15	—

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JEITA Package Code	RENESAS Code	Previous Code	MASS[Typ.]
P-SOP14-3.95x8.65-1.27	PRSP0014DE-A	FP-14DNV	0.13g
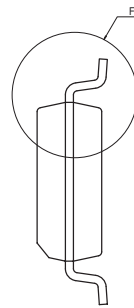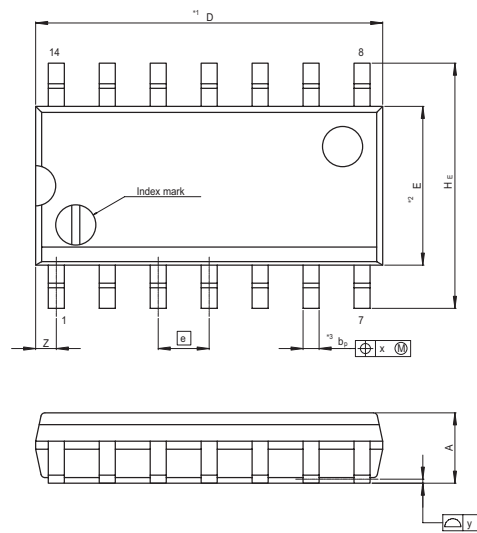
NOTE)
1. DIMENSIONS"*1 (Nom)"AND"*2" DO NOT INCLUDE MOLD FLASH.
2. DIMENSION"*3"DOES NOT INCLUDE TRIM OFFSET.

Terminal cross section
(Ni/Pd/Au plating)

Detail F

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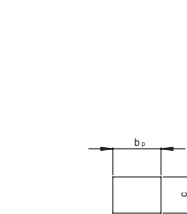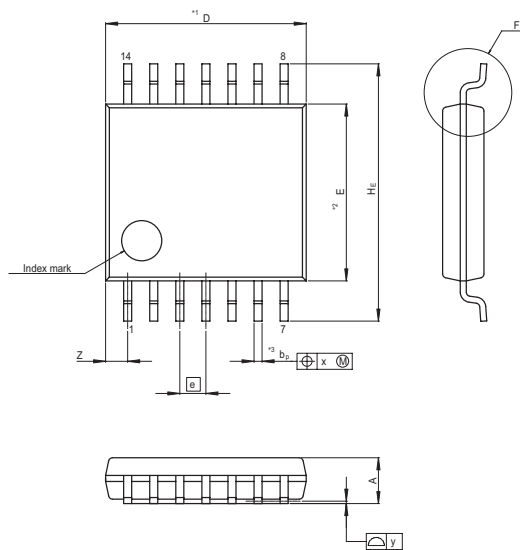
NOTE)
1. DIMENSIONS"*1 (Nom)"AND"*2" DO NOT INCLUDE MOLD FLASH.
2. DIMENSION"*3"DOES NOT INCLUDE TRIM OFFSET.

Terminal cross section
(Ni/Pd/Au plating)

Detail F

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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