HA17902 Series

Quad Operational Amplifier

HITACHI

Description

The HA17902 is an internal phase compensation quad operational amplifier that operates on a single-voltage power supply and is appropriate for use in a wide range of general-purpose control equipment.

Features

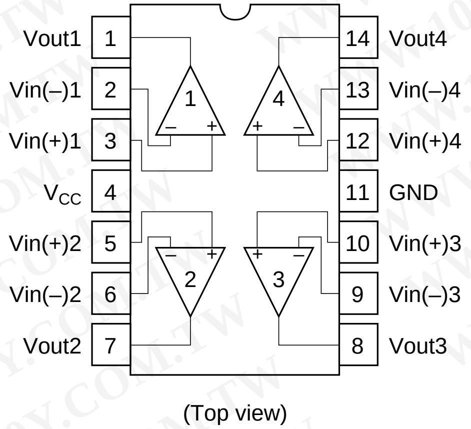
- Wide usable power-supply voltage range and single-voltage supply operation
- Internal phase compensation
- Wide common-mode voltage range and operation for inputs close to the 0 level

Ordering Information

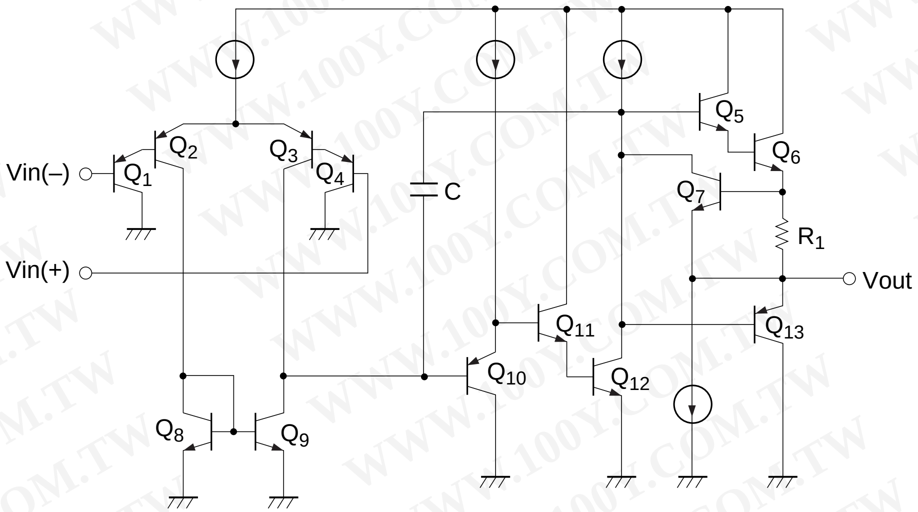
Type No.	Application	Package
HA17902PJ	Car use	DP-14
HA17902FPJ		FP-14DA
HA17902FPK		FP-14DA
HA17902P	Industrial use	DP-14
HA17902FP		FP-14DA
HA17902	Commercial use	DP-14

Hitachi semiconductor

Pin Arrangement



Circuit Structure (1/4)



Absolute Maximum Ratings (Ta = 25°C)

Item	Symbol	HA17902/ P	HA17902 PJ	HA17902 FP	HA17902 FPJ	HA17902 FPK	Unit
Power supply voltage	V_{CC}	28	28	28	28	28	V
Sink current	Io sink	50	50	50	50	25	mA
Allowable power dissipation	P_T	625*1	625*1	625*2	625*2	625*2	mW
Common-mode input voltage	V_{CM}	–0.3 to V_{CC}	–0.3 to V_{CC}	–0.3 to V_{CC}	–0.3 to V_{CC}	–0.3 to V_{CC}	V
Differential-mode input voltage	Vin(diff)	$\pm V_{CC}$	$\pm V_{CC}$	$\pm V_{CC}$	$\pm V_{CC}$	$\pm V_{CC}$	V
Operating temperature	Topr	–20 to +75	–40 to +85	–20 to +75	–40 to +85	–40 to +125	°C
Storage temperature	Tstg	–55 to +125	–55 to +125	–55 to +125	–55 to +125	–55 to +150	°C

Notes: 1. These are the allowable values up to Ta = 50°C. Derate by 8.3mW/°C above that temperature.
2. See notes on SOP Package Usage in Reliability section.

Electrical Characteristics 1 (V_{CC} = + 15V, Ta = 25°C)

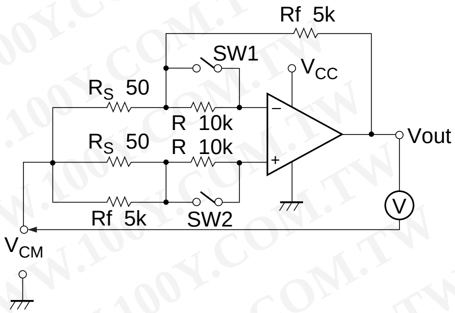
Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Input offset voltage	V_{IO}	—	3	8	mV	V_{CM} = 7.5V, R_S = 50Ω, Rf = 5kΩ
Input offset current	I_{IO}	—	5	50	nA	$I_{IO} = \| I_I^- - I_I^+ \|$, V_{CM} = 7.5V
Input bias current	I_{IB}	—	30	500	nA	V_{CM} = 7.5V
Power-supply rejection ratio	PSRR	—	93	—	dB	f = 100Hz, R_S = 1kΩ, Rf = 100kΩ
Voltage gain	A_{VD}	75	90	—	dB	R_S = 1kΩ, Rf = 100kΩ, RL = ∞
Common-mode rejection ratio	CMR	—	80	—	dB	R_S = 50Ω, Rf = 5kΩ
Common-mode input voltage range	V_{CM}	–0.3	—	13.5	V	R_S = 1kΩ, Rf = 100kΩ, f = 100Hz
Maximum output voltage amplitude	V_{OP-P}	—	13.6	—	V	f = 100Hz, R_S = 1kΩ, Rf = 100kΩ, R_L = 20kΩ
Output voltage	V_{OH1}	13.2	13.6	—	V	I_{OH} = –1mA
	V_{OH2}	12	13.3	—	V	I_{OH} = –10mA
	V_{OL1}	—	0.8	1	V	I_{OL} = 1mA
	V_{OL2}	—	1.1	1.8	V	I_{OL} = 10mA
Output source current	Io source	15	—	—	mA	V_{OH} = 10V
Output sink current	Io sink	3	9	—	mA	V_{OL} = 1V
Supply current	I_{CC}	—	0.8	2	mA	Vin = GND, R_L = ∞
Slew rate	SR	—	0.19	—	V/µs	f = 1.5kHz, V_{CM} = 7.5V, R_L = ∞
Channel separation	CS	—	120	—	dB	f = 1kHz

Electrical Characteristics 2 (V_{CC} = + 15V, Ta = – 40 to 125°C)

Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Input offset voltage	V_{IO}	—	—	8	mV	V_{CM} = 7.5V, R_S = 50Ω, Rf = 5kΩ
Input offset current	I_{IO}	—	—	200	nA	V_{CM} = 7.5V , $I_{IO} = \| I_I^- - I_I^+ \|$
Input bias current	I_{IB}	—	—	500	nA	V_{CM} = 7.5V
Common-mode input voltage range	V_{CM}	0	—	13.0	V	R_S = 1kΩ, Rf = 100kΩ, f = 100Hz
Output voltage	V_{OH}	13.0	—	—	V	I_{OH} = –1mA
	V_{OL}	—	—	1.3	V	I_{OL} = 1mA
Supply current	I_{CC}	—	—	4	mA	Vin = GND, R_L = ∞

Test Circuits

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



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

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

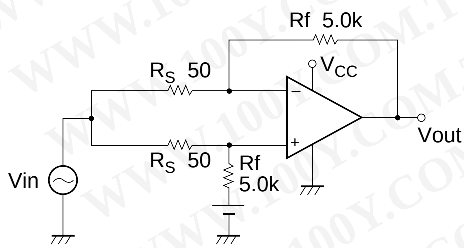
$$V_{IO} = \frac{V_{O1}}{1 + Rf / R_S} \quad \text{(mV)}$$

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

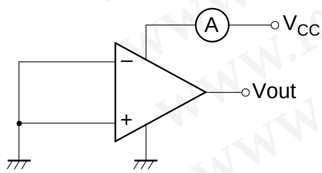
$$I_{IB} = \frac{|V_{O4} - V_{O3}|}{2 \cdot R(1 + Rf / R_S)} \quad \text{(nA)}$$

2. Common-mode rejection ratio (CMR) test circuit

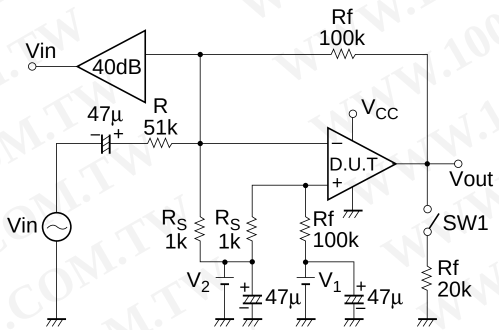
$$CMR = 20 \log \frac{V_{IN} \cdot Rf}{V_O \cdot R_S} \quad \text{(dB)}$$



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



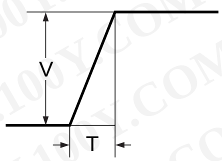
4. Voltage gain (A_{VD}), slew rate (SR), common-mode input voltage range (V_{CM}), and maximum output voltage amplitude (V_{OP-P}) test circuit.



(1) A_{VD}: $R_S = 1k\Omega$, $Rf = 100k\Omega$, $R_L = \infty$, $V_1 = V_2 = 1/2\ V_{CC}$

$$A_{VD} = 20 \log \frac{V_O}{V_{IN}} + 40 \quad \text{(dB)}$$

(2) SR: f = 1.5kHz, $R_L = \infty$, $V_1 = V_2 = 1/2\ V_{CC}$



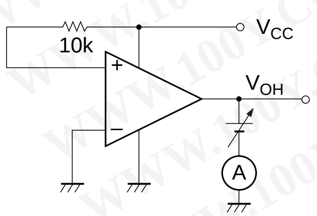
$$SR = \frac{V}{T} \quad [V/\mu s]$$

(3) V_{CM}: $R_S = 1k\Omega$, $Rf = 100k\Omega$, f = 100Hz, $V_1 = 1/2\ V_{CC}$, $R_L = \infty$,
and the value of V_2 just slightly prior to the point where the output waveform changes.

(4) V_{OP-P}:$R_S = 1k\Omega$, $Rf = 100k\Omega$, R_L: $20k\Omega$, f = 100Hz, $V_{OP-P} = V_{OH} \leftrightarrow V_{OL}$ [V_{P-P}]

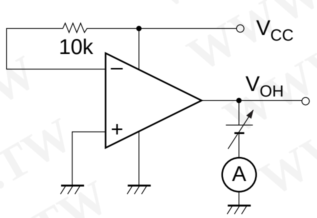
5. Output source current (Iosource) test circuit

Io source: $V_{OH} = 10V$

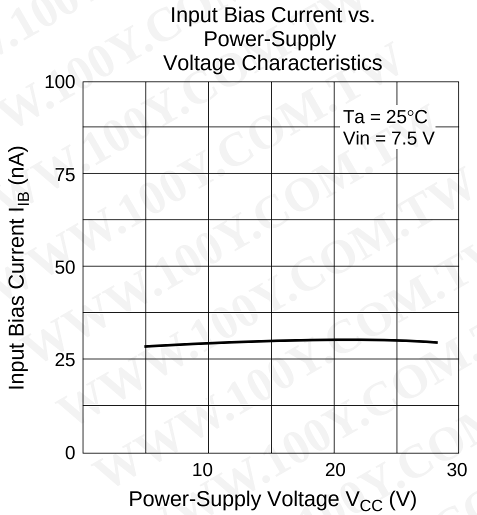


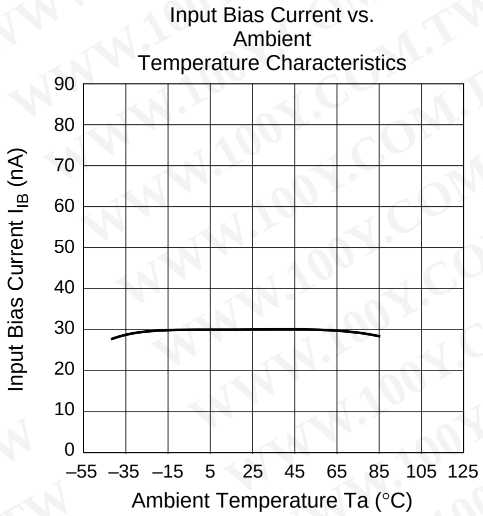
6. Output sink current (Iosink) test circuit

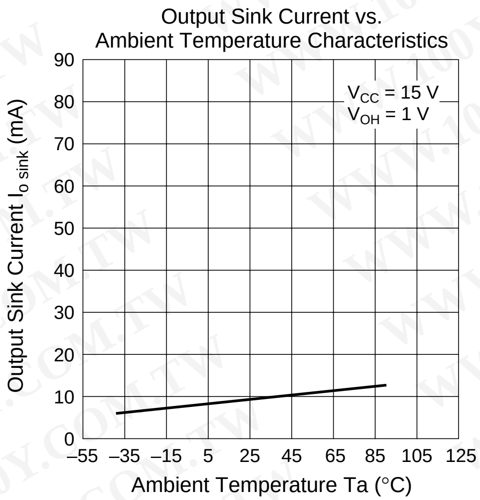
Io sink: $V_{OL} = 1V$

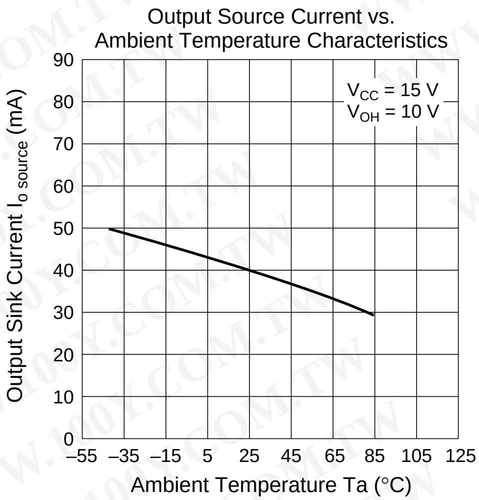


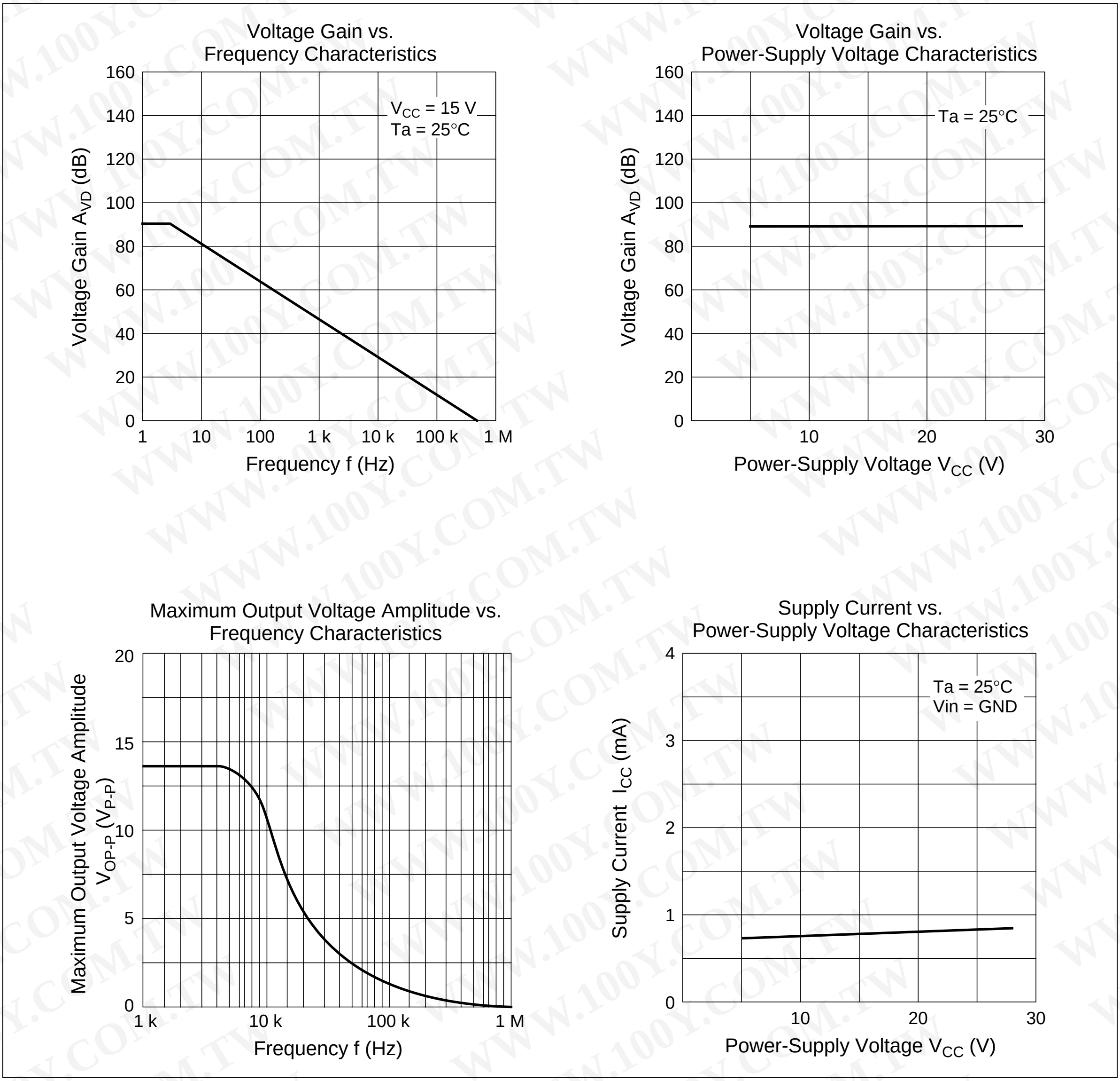
Characteristics Curve

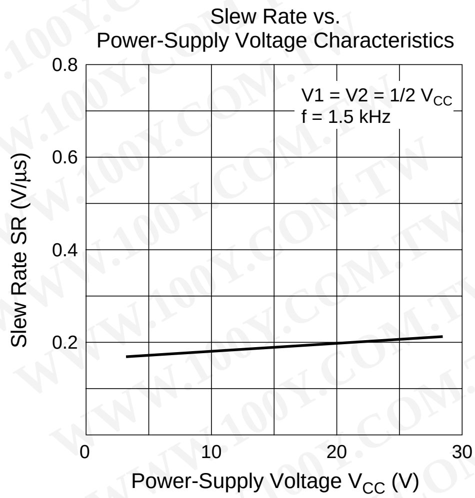




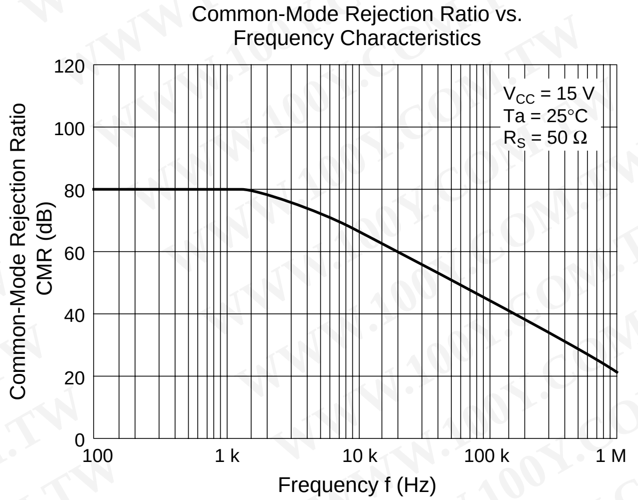




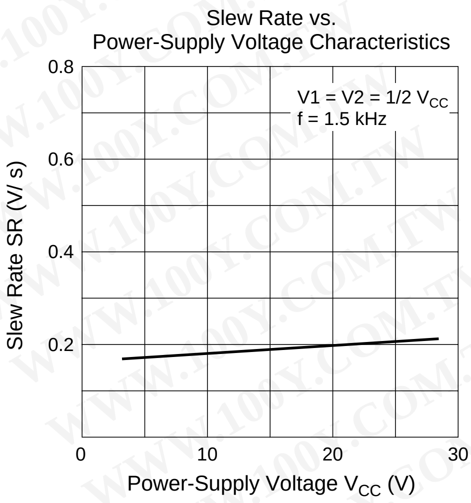

Voltage Gain vs.
Frequency Characteristics
VCC = 15 V
Ta = 25°C
160
140
120
100
80
60
40
20
0
Voltage Gain AVD (dB)
1
10
100
1 k
10 k
100 k
1 M
Frequency f (Hz)
Voltage Gain vs.
Power-Supply Voltage Characteristics
Ta = 25°C
Voltage Gain AVD (dB)
10
20
30
Power-Supply Voltage VCC (V)
Maximum Output Voltage Amplitude vs.
Frequency Characteristics
20
15
10
5
0
Maximum Output Voltage Amplitude
VOP-P (VP-P)
1 k
10 k
100 k
1 M
Frequency f (Hz)
Supply Current vs.
Power-Supply Voltage Characteristics
Ta = 25°C
Vin = GND
4
3
2
1
0
Supply Current ICC (mA)
10
20
30
Power-Supply Voltage VCC (V)

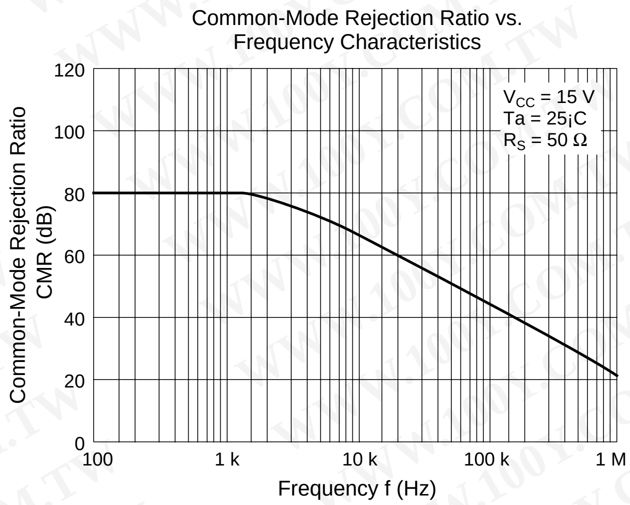


Slew Rate vs.
Power-Supply Voltage Characteristics
V1 = V2 = 1/2 VCC
f = 1.5 kHz
Slew Rate SR (V/µs)
0.8
0.6
0.4
0.2
0
10
20
30
Power-Supply Voltage VCC (V)



Common-Mode Rejection Ratio vs.
Frequency Characteristics
VCC = 15 V
Ta = 25°C
RS = 50 Ω
Common-Mode Rejection Ratio
CMR (dB)
120
100
80
60
40
20
0
100
1 k
10 k
100 k
1 M
Frequency f (Hz)


Slew Rate vs.
Power-Supply Voltage Characteristics
V1 = V2 = 1/2 V_{CC}
f = 1.5 kHz
Slew Rate SR (V/ s)
0.8
0.6
0.4
0.2
0
10
20
30
Power-Supply Voltage V_{CC} (V)


Common-Mode Rejection Ratio vs.
Frequency Characteristics
V_{CC} = 15 V
Ta = 25¡C
R_S = 50 Ω
Common-Mode Rejection Ratio
CMR (dB)
120
100
80
60
40
20
0
100
1 k
10 k
100 k
1 M
Frequency f (Hz)

HA17902 Application Examples

The HA17902 is a quad operational amplifier, and consists of four operational amplifier circuits and one bias current circuit. It features single-voltage power supply operation, internal phase compensation, a wide zero-cross bandwidth, a low input bias current, and a high open-loop gain. Thus the HA17902 can be used in a wide range of applications. This section describes several applications using the HA17902.

1. Noninverting Amplifier

   Figure 1 shows the circuit diagram for a noninverting amplifier. The voltage gain of this amplifier is given by the following formula.

$$\frac{Vout}{Vin} = 1 + \frac{R2}{R1}$$

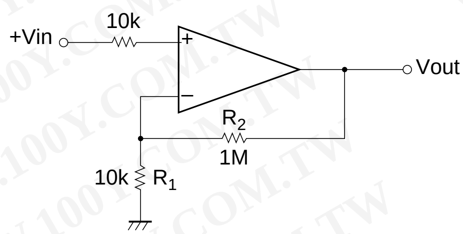


Figure 1 Noninverting Amplifier

2. Summing Amplifier

   Since the circuit shown in figure 2 applies $+V_1$ and $+V_2$ to the noninverting input and $+V_3$ and $+V_4$ to the inverting input, the total output will be $Vout = V_1 + V_2 - V_3 - V_4$.

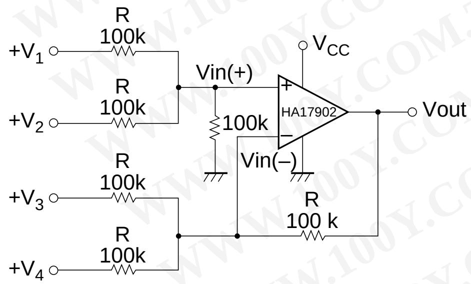


Figure 2 Summing Amplifier

3. High Input Impedance DC Differential Amplifier

The circuit shown in figure 3 is a high input impedance DC differential amplifier. This circuit's common-mode rejection ratio (CMR) depends on the matching between the R_1/R_2 and R_4/R_3 resistance ratios. This amplifier's output is given by the following formula.

$$Vout = \left(1 + \frac{R_4}{R_3}\right)(V_2 - V_1)$$

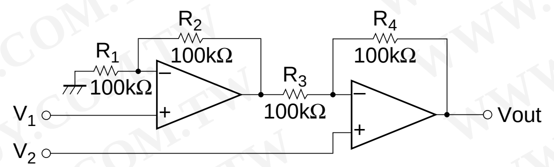


Figure 3 High Input Impedance DC Differential Amplifier

4. Voltage Controlled Oscillator

Figure 4 shows an oscillator circuit in which the amplifier A_1 is an integrator, the amplifier A_2 is a comparator, and transistor Q_1 operates as a switch that controls the oscillator frequency. If the output Vout1 is at the low level, this will cut off transistor Q1 and cause the A_1 inverting input to go to a higher potential than the noninverting input. Therefore, A_1 will integrate this negative input state and its output level will decrease. When the A_1 integrator output becomes lower than the A_2 comparator noninverting input level ($V_{CC}/2$) the comparator output goes high. This turns on transistor Q_1 causing the integrator to integrate a positive input state and for its output to increase. This operation generates a square wave on Vout1 and a triangular wave on Vout2.

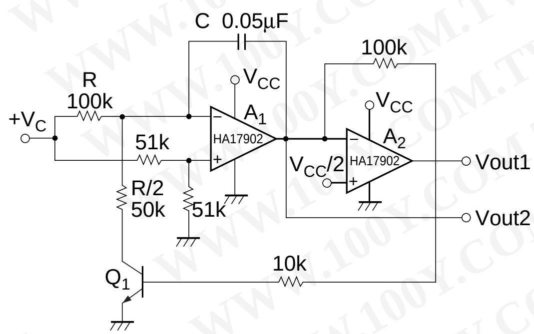
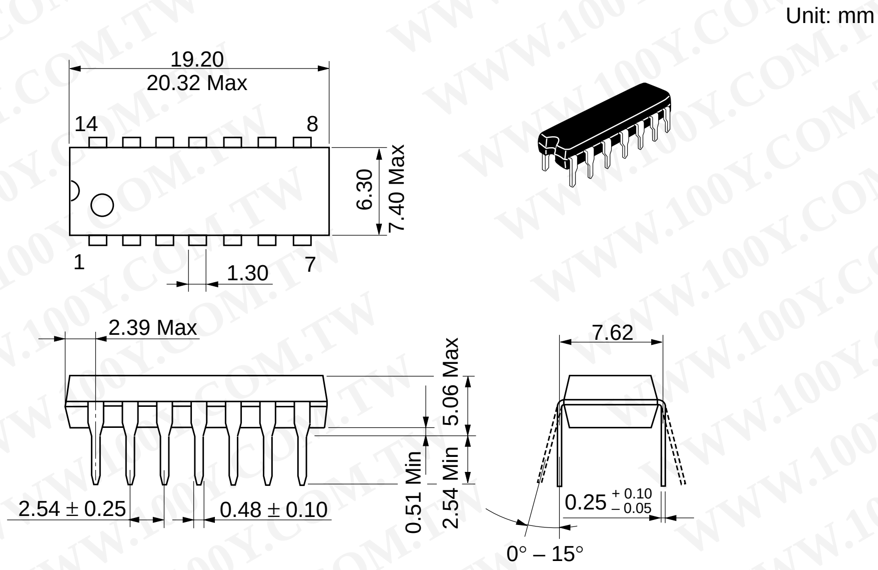
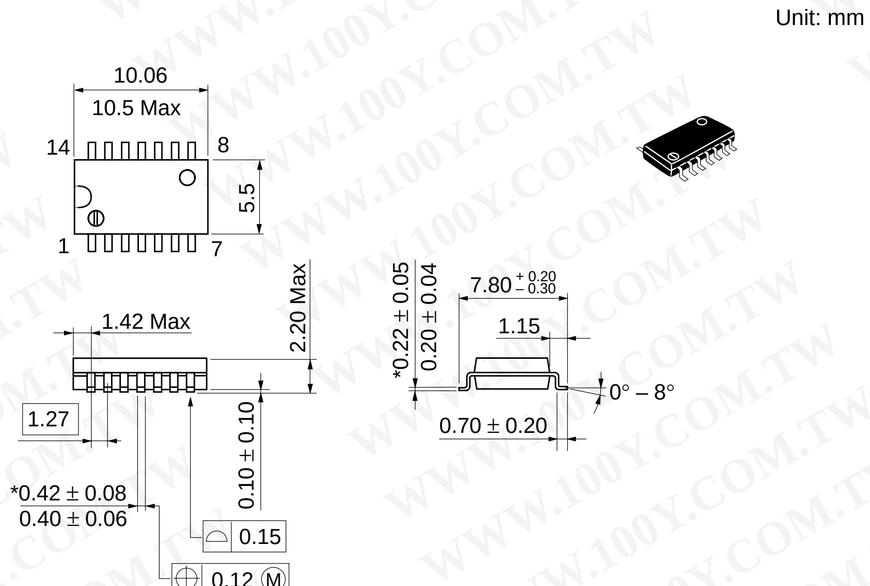


Figure 4 Voltage Controlled Oscillator

Package Dimensions



Hitachi Code	DP-14
JEDEC	Conforms
EIAJ	Conforms
Mass (reference value)	0.97 g



Hitachi Code	FP-14DA
JEDEC	—
EIAJ	Conforms
Mass (reference value)	0.23 g

*Dimension including the plating thickness
Base material dimension

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