HA17741/PS
General-Purpose Operational Amplifier
(Frequency Compensated)

HITACHI

Description
The HA17741/PS is an internal phase compensation high-performance operational amplifier, that is appropriate for use in a wide range of applications in the test and control fields.

Features
• High voltage gain : 106 dB (Typ)
• Wide output amplitude : ±13 V (Typ) (at R_L ≥ 2 kΩ)
• Shorted output protection
• Adjustable offset voltage
• Internal phase compensation

Ordering Information

<table>
<thead>
<tr>
<th>Application</th>
<th>Type No.</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial use</td>
<td>HA17741PS</td>
<td>DP-8</td>
</tr>
<tr>
<td>Commercial use</td>
<td>HA17741</td>
<td></td>
</tr>
</tbody>
</table>

Pin Arrangement

(Top view)
HA17741/PS

Circuit Structure

Absolute Maximum Ratings (Ta = 25°C)

<table>
<thead>
<tr>
<th>Item</th>
<th>Symbol</th>
<th>HA17741PS</th>
<th>HA17741</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power-supply voltage</td>
<td>V_{CC}</td>
<td>+18</td>
<td>+18</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>V_{EE}</td>
<td>–18</td>
<td>–18</td>
<td>V</td>
</tr>
<tr>
<td>Input voltage</td>
<td>Vin</td>
<td>±15</td>
<td>±15</td>
<td>V</td>
</tr>
<tr>
<td>Differential input voltage</td>
<td>Vin(diff)</td>
<td>±30</td>
<td>±30</td>
<td>V</td>
</tr>
<tr>
<td>Allowable power dissipation</td>
<td>P_{T}</td>
<td>670 *</td>
<td>670 *</td>
<td>mW</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>Topr</td>
<td>–20 to +75</td>
<td>–20 to +75</td>
<td>°C</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>Tstg</td>
<td>–55 to +125</td>
<td>–55 to +125</td>
<td>°C</td>
</tr>
</tbody>
</table>

Note: These are the allowable values up to Ta = 45°C. Derate by 8.3 mW/°C above that temperature.
Electrical Characteristics

**Electrical Characteristics-1** ($V_{CC} = -V_{EE} = 15 \text{ V}, \, Ta = 25^\circ \text{C}$)

<table>
<thead>
<tr>
<th>Item</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
<th>Test Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input offset voltage</td>
<td>$V_{io}$</td>
<td>—</td>
<td>1.0</td>
<td>6.0</td>
<td>mV</td>
<td>$R_s \leq 10 \text{ k}\Omega$</td>
</tr>
<tr>
<td>Input offset current</td>
<td>$I_{io}$</td>
<td>—</td>
<td>18</td>
<td>200</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>Input bias current</td>
<td>$I_{ib}$</td>
<td>—</td>
<td>75</td>
<td>500</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>Power-supply rejection ratio</td>
<td>$\Delta V_{io}/\Delta V_{cc}$</td>
<td>—</td>
<td>30</td>
<td>150</td>
<td>$\mu$V/V</td>
<td>$R_s \leq 10 \text{ k}\Omega$</td>
</tr>
<tr>
<td>Voltage gain</td>
<td>$A_{vo}$</td>
<td>86</td>
<td>106</td>
<td>—</td>
<td>dB</td>
<td>$R_L \geq 2 \text{ k}\Omega, V_{out} = \pm 10 \text{ V}$</td>
</tr>
<tr>
<td>Common-mode rejection ratio</td>
<td>CMR</td>
<td>70</td>
<td>90</td>
<td>—</td>
<td>dB</td>
<td>$R_s \leq 10 \text{ k}\Omega$</td>
</tr>
<tr>
<td>Common-mode input voltage range</td>
<td>$V_{cm}$</td>
<td>±12</td>
<td>±13</td>
<td>—</td>
<td>V</td>
<td>$R_s \leq 10 \text{ k}\Omega$</td>
</tr>
<tr>
<td>Maximum output voltage amplitude</td>
<td>$V_{op-p}$</td>
<td>±12</td>
<td>±14</td>
<td>—</td>
<td>V</td>
<td>$R_s \leq 10 \text{ k}\Omega$</td>
</tr>
<tr>
<td>Power dissipation</td>
<td>$P_d$</td>
<td>—</td>
<td>65</td>
<td>100</td>
<td>mW</td>
<td>No load</td>
</tr>
<tr>
<td>Slew rate</td>
<td>$SR$</td>
<td>—</td>
<td>1.0</td>
<td>—</td>
<td>V/\mu s</td>
<td>$R_L \geq 2 \text{ k}\Omega$</td>
</tr>
<tr>
<td>Rise time</td>
<td>$t_r$</td>
<td>—</td>
<td>0.3</td>
<td>—</td>
<td>$\mu$s</td>
<td>$V_{in} = 20 \text{ mV}, R_s = 2 \text{ k}\Omega, C_L = 100 \text{ pF}$</td>
</tr>
<tr>
<td>Overshoot</td>
<td>$V_{over}$</td>
<td>—</td>
<td>5.0</td>
<td>—</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>Input resistance</td>
<td>$R_{in}$</td>
<td>0.3</td>
<td>1.0</td>
<td>—</td>
<td>M\Omega</td>
<td></td>
</tr>
</tbody>
</table>

**Electrical Characteristics-2** ($V_{CC} = -V_{EE} = 15 \text{ V}, \, Ta = -20 \text{ to } +75^\circ \text{C}$)

<table>
<thead>
<tr>
<th>Item</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
<th>Test Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input offset voltage</td>
<td>$V_{io}$</td>
<td>—</td>
<td>—</td>
<td>9.0</td>
<td>mV</td>
<td>$R_s \leq 10 \text{ k}\Omega$</td>
</tr>
<tr>
<td>Input offset current</td>
<td>$I_{io}$</td>
<td>—</td>
<td>—</td>
<td>400</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>Input bias current</td>
<td>$I_{ib}$</td>
<td>—</td>
<td>—</td>
<td>1,100</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>Voltage gain</td>
<td>$A_{vo}$</td>
<td>80</td>
<td>—</td>
<td>—</td>
<td>dB</td>
<td>$R_L \geq 2 \text{ k}\Omega, V_{out} = \pm 10 \text{ V}$</td>
</tr>
<tr>
<td>Maximum output voltage amplitude</td>
<td>$V_{op-p}$</td>
<td>±10</td>
<td>—</td>
<td>—</td>
<td>V</td>
<td>$R_L \geq 2 \text{ k}\Omega$</td>
</tr>
</tbody>
</table>
IC Operational Amplifier Application Examples

Multivibrator

A multivibrator is a square wave generator that uses an RC circuit charge/discharge operation to generate the waveform. Multivibrators are widely used as the square wave source in such applications as power supplies and electronic switches.

Multivibrators are classified into three types, astable multivibrators, which have no stable states, monostable multivibrators, which have one stable state, and bistable multivibrators, which have two stable states.

1. Astable Multivibrator

![Figure 1 Astable Multivibrator Operating Circuit](image)

![Figure 2 HA17741 Astable Multivibrator Operating Waveform](image)
2. Monostable Multivibrator

![Monostable Multivibrator Operating Circuit](image)

**Figure 3** Monostable Multivibrator Operating Circuit

**Vertical:**

**Horizontal:**

Circuit constants
- $R_1 = 10 \, \text{k}\Omega$
- $R_2 = 2 \, \text{k}\Omega$
- $R_3 = 40 \, \text{k}\Omega$
- $C_1 = 0.47 \, \mu\text{F}$
- $C_2 = 0.0068 \, \mu\text{F}$
- $R_L = \infty$
- $V_{CC} = 15 \, \text{V}$, $V_{EE} = -15 \, \text{V}$

![Waveform](image)

**Figure 4** HA17741 Monostable Multivibrator Operating Waveform

3. Bistable Multivibrator

![Bistable Multivibrator Operating Circuit](image)

**Figure 5** Bistable Multivibrator Operating Circuit
HA17741/PS

Figure 6  HA17741 Bistable Multivibrator Operating Waveform

Wien Bridge Sine Wave Oscillator

Figure 7  Wien Bridge Sine Wave Oscillator

Figure 8  HA17741 Wien Bridge Sine Wave Oscillator f–C Characteristics
Vertical: 5 V/div  
Horizontal: 0.5 ms/div

Test circuit condition:
- $V_{CC} = 15\, \text{V}$, $V_{EE} = -15\, \text{V}$  
- $R_1 = 110\, \text{k}\, \Omega$, $R_2 = 11\, \text{k}\, \Omega$  
- $C_1 = 0.0015\, \mu\text{F}$, $C_2 = 0.015\, \mu\text{F}$  

Test results:
- $f = 929.7\,\text{Hz}$, T.H.P = 0.06%

**Figure 9  HA17741 Wien Bridge Sine Wave Oscillator Operating Waveform**

**Quadrature Oscillator**

**Figure 10  Quadrature Sine Wave Oscillator**

Figure 10 shows the circuit diagram for a quadrature sine wave oscillator. This circuit consists of two integrators and a limiter circuit, and provides not only a sine wave output, but also a cosine output, that is, it also supplies the waveform delayed by 90°. The output amplitude is essentially determined by the limiter circuit.
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Figure 11  HA17741 Quadrature Sine Wave Oscillator

Figure 12  Sine and Cosine Output Waveforms

Triangular Wave Generator

Figure 13  Triangular Wave Generator Operating Circuit
Figure 14  HA17741 Triangular Wave Generator Operating Waveform

Sawtooth Waveform Generator

Figure 15  Sawtooth Waveform Generator

Figure 16  HA17741 Sawtooth Waveform Generator Operating Waveform
Characteristic Curves

**Voltage Offset Adjustment Circuit**

**Input Offset Current vs. Power-Supply Voltage Characteristics**

**Power Dissipation vs. Power-Supply Voltage Characteristics**

**Voltage Gain vs. Power-Supply Voltage Characteristics**
Maximum output voltage amplitude vs. power-supply voltage characteristics.

Input offset voltage vs. ambient temperature characteristics.

Input offset current vs. ambient temperature characteristics.

Input bias current vs. ambient temperature characteristics.
Maximum Output Voltage Amplitude vs. Load Resistance Characteristics

- $V_{CC} = +15 \text{ V}$
- $V_{EE} = -15 \text{ V}$

Maximum Output Voltage Amplitude $V_{OP-P}$ (V)

- $Vout$ vs. Frequency Characteristics

- $V_{CC} = +15 \text{ V}$, $V_{EE} = -15 \text{ V}$
- $R_L = 10 \text{ k}\Omega$

Input Resistance vs. Frequency Characteristics

- $R_1 = 51 \Omega$, $R_2 = 5.1 \text{ k}\Omega$

See the voltage offset adjustment circuit diagram.
Voltage Gain and Phase vs. Frequency Characteristics (3)

Frequency f (Hz)

Voltage Gain and Phase vs. Frequency Characteristics (4)

Frequency f (Hz)

Impulse Response Characteristics Test Circuit

Vin

2

3

6

Vout

C_L = \frac{2}{R_L}

Vout = \frac{V_2}{V_1} \times 100 (%)

V_{out}

V_{in} = 20 mV

R_L = 2 k\Omega

C_L = 100 pF

Rise time t_r (µs)

0.8

0.6

0.4

0.2

0

±3 ±6 ±9 ±12 ±15 ±18

Power-supply voltage V_{CC}, V_{EE} (V)

Rise time vs. Power-Supply Voltage Characteristics
Overshoot vs. Power-Supply Voltage Characteristics

Impulse Response Characteristics

- \( V_{in} = 20 \text{ mV} \)
- \( R_L = 2 \text{ k\Omega} \)
- \( C_L = 100 \text{ pF} \)

- \( V_{CC} = +15 \text{ V} \)
- \( V_{EE} = -15 \text{ V} \)
- \( R_L = 2 \text{ k\Omega} \)
- \( C_L = 100 \text{ pF} \)
- \( V_{in} = 20 \text{ mV} \)
Package Dimensions

Unit: mm

<table>
<thead>
<tr>
<th>Hitachi Code</th>
<th>JEDEC</th>
<th>EIAJ</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Conforms</td>
<td>Conforms</td>
</tr>
</tbody>
</table>

| Mass (reference value) | 0.54 g |

2.54 ± 0.25
0.48 ± 0.10

0° - 15°
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