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 $R_L \geq 2 \, \text{k} \Omega$
- 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

![Circuit Diagram]

**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 ($V_{CC} = -V_{EE} = 15$ V, $Ta = 25^\circ$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>Rs ≤ 10 kΩ</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>Rs ≤ 10 kΩ</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>Rs ≤ 10 kΩ</td>
</tr>
<tr>
<td>Voltage gain</td>
<td>$A_{VO}$</td>
<td>86</td>
<td>106</td>
<td>---</td>
<td>dB</td>
<td>Rs ≤ 10 kΩ</td>
</tr>
<tr>
<td>Common-mode rejection ratio</td>
<td>CMR</td>
<td>70</td>
<td>90</td>
<td>---</td>
<td>dB</td>
<td>Rs ≤ 10 kΩ</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>Rs ≤ 10 kΩ</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>Rs ≤ 10 kΩ</td>
</tr>
<tr>
<td>Power dissipation</td>
<td>Pd</td>
<td>65</td>
<td>100</td>
<td>mW</td>
<td>No load</td>
<td></td>
</tr>
<tr>
<td>Slew rate</td>
<td>SR</td>
<td>1.0</td>
<td>---</td>
<td>V/μs</td>
<td>Rs ≥ 2 kΩ</td>
<td></td>
</tr>
<tr>
<td>Rise time</td>
<td>$t_r$</td>
<td>0.3</td>
<td>---</td>
<td>μs</td>
<td>Vin = 20 mV, Rs = 2 kΩ, C_L = 100 pF</td>
<td></td>
</tr>
<tr>
<td>Overshoot</td>
<td>Vover</td>
<td>5.0</td>
<td>---</td>
<td>%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input resistance</td>
<td>Rin</td>
<td>0.3</td>
<td>1.0</td>
<td>---</td>
<td>MΩ</td>
<td></td>
</tr>
</tbody>
</table>

## Electrical Characteristics-2 ($V_{CC} = -V_{EE} = 15$ V, $Ta = -20$ to +75°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>Rs ≤ 10 kΩ</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>dB</td>
<td>Rs ≥ 2 kΩ, Vout = ±10 V</td>
<td></td>
</tr>
<tr>
<td>Maximum output voltage amplitude</td>
<td>$V_{OP-P}$</td>
<td>±10</td>
<td>---</td>
<td>V</td>
<td>Rs ≥ 2 kΩ</td>
<td></td>
</tr>
</tbody>
</table>

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**HITACHI**
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

[Vin(+)] 0
[Vin(-)] 0
[Vout] 0

Vertical: 5 V/div
Horizontal: 2 ms/div
Circuit constants
- $R_1 = 8 \, k\Omega$
- $R_2 = 4 \, k\Omega$
- $R_3 = 100 \, k\Omega$
- $C_1 = 0.1 \, \mu F$
- $R_L = \infty$
- $V_{CC} = 15 \, V$
- $V_{EE} = -15 \, V$

Figure 1  Astable Multivibrator Operating Circuit

Figure 2  HA17741 Astable Multivibrator Operating Waveform
2. Monostable Multivibrator

![Monostable Multivibrator Operating Circuit](image)

**Figure 3** Monostable Multivibrator Operating Circuit

<table>
<thead>
<tr>
<th>Circuit constants</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_1 = 10 , k\Omega$, $R_2 = 2 , k\Omega$</td>
</tr>
<tr>
<td>$R_3 = 40 , k\Omega$, $C_1 = 0.47 , \mu F$</td>
</tr>
<tr>
<td>$C_2 = 0.0068 , \mu F$</td>
</tr>
<tr>
<td>$R_L = \infty$</td>
</tr>
<tr>
<td>$V_{CC} = 15 , V$, $V_{EE} = -15 , V$</td>
</tr>
</tbody>
</table>

**Figure 4** HA17741 Monostable Multivibrator Operating Waveform

3. Bistable Multivibrator

![Bistable Multivibrator Operating Circuit](image)

**Figure 5** Bistable Multivibrator Operating Circuit
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
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.
C \text{T1} = 102 \text{ pF} \\
C \text{T2} = 99 \text{ pF} \\
C \text{1} = 106 \text{ pF} \\
V \text{CC} = -15 \text{ V} \\
R \text{T1} = 150 \text{ k}\Omega, R \text{T2} = 150 \text{ k}\Omega \\
R \text{1} = 151.2 \text{ k}\Omega \\
R \text{11} = 15 \text{ k}\Omega, R \text{22} = 10 \text{ k}\Omega \\
R \text{33} = 15 \text{ k}\Omega, R \text{44} = 10 \text{ k}\Omega \\
C \text{T1, T2, 1} \rightarrow 1,000 \text{ pF} \\
\text{Use a Mylar capacitor.} \\
\text{With } V_{\text{P-P}} = 21 \text{ V P-P} \text{ and } R \text{22} = R \text{44} = 10 \text{ k}\Omega \\
\text{the frequency of the sine wave will be under 10 kHz.}

Figure 11   HA17741 Quadrature Sine Wave Oscillator

Vertical: 5 V/div \\
Horizontal: 0.2 ms/div \\
Circuit constants \\
C_{\text{T1}} = 1000 \text{ pF (990)}, C_{\text{T2}} = 1000 \text{ pF (990)} \\
R_{\text{T1}} = 150 \text{ k}\Omega, R_{\text{T2}} = 150 \text{ k}\Omega \\
C_{\text{1}} = 1000 \text{ pF (990)}, R_{\text{1}} = 160 \text{ k}\Omega \\
R_{\text{11}} = 15 \text{ k}\Omega, R_{\text{22}} = 10 \text{ k}\Omega \\
R_{\text{33}} = 16 \text{ V, R}_{\text{44}} = 10 \text{ k}\Omega \\
V_{\text{CC}} = 15 \text{ V, V}_{\text{EE}} = -15 \text{ V}

Figure 12   Sine and Cosine Output Waveforms

Triangular Wave Generator

Figure 13   Triangular Wave Generator Operating Circuit
HA17741/PS

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

- Maximum output voltage amplitude ±V_{OP-P} (V)
- Power-supply voltage V_{CC}, V_{EE} (V)

Input Offset Voltage vs. Ambient Temperature Characteristics

- Input offset voltage V_{O} (mV)
- Ambient temperature T_{a} (°C)

Input Offset Current vs. Ambient Temperature Characteristics

- Input offset current I_{O} (nA)
- Ambient temperature T_{a} (°C)

Input Bias Current vs. Ambient Temperature Characteristics

- Input bias current I_{B} (nA)
- Ambient temperature T_{a} (°C)

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Maximum Output Voltage Amplitude

- ±3
- ±5
- ±7
- ±9
- ±11
- ±13

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

Input Offset Voltage

- V_{CC} = +15 V
- V_{EE} = −15 V
- R_{L} ≤ 10 kΩ

Input Offset Current

- V_{CC} = +15 V
- V_{EE} = −15 V

Input Bias Current

- V_{CC} = +15 V
- V_{EE} = −15 V
Voltage Gain vs. Ambient Temperature Characteristics

Power Dissipation vs. Ambient Temperature Characteristics

Maximum Output Voltage Amplitude vs. Ambient Temperature Characteristics

Output Shorted Current vs. Ambient Temperature Characteristics
Maximum Output Voltage Amplitude vs. Load Resistance Characteristics

Offset Adjustment Characteristics

Maximum Output Voltage Amplitude vs. Frequency Characteristics

Input Resistance vs. Frequency Characteristics
Voltage Gain and Phase vs. Frequency Characteristics (3)

Voltage Gain and Phase vs. Frequency Characteristics (4)

Impulse Response Characteristics Test Circuit

Rise time vs. Power-Supply Voltage Characteristics

V_CC = +15 V
V_EE = −15 V
Closed loop gain = 20 dB

V_CC = +15 V
V_EE = −15 V
Closed loop gain = 0 dB

Vout = \( \frac{V_2}{V_1} \times 100 \) (%)
Overshoot vs. Power-Supply Voltage Characteristics

Impulse Response Characteristics

Vin = 20 mV
RL = 2 kΩ
CL = 100 pF
VCC = +15 V
VEE = −15 V
RL = 2 kΩ
CL = 100 pF
Vin = 20 mV

Output voltage Vout (mV)
Time t (µs)
Package Dimensions

<table>
<thead>
<tr>
<th>Hitachi Code</th>
<th>JEDEC</th>
<th>EIAJ</th>
<th>Mass (reference value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DP-8</td>
<td>Conforms</td>
<td>Conforms</td>
<td>0.54 g</td>
</tr>
</tbody>
</table>

Unit: mm
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