

# 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.

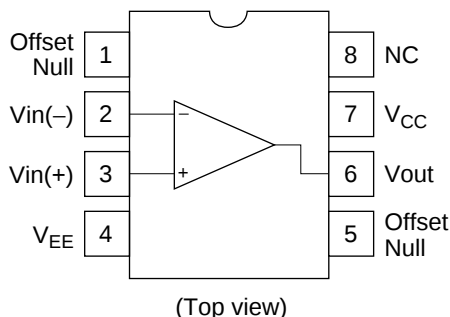
## Features

- High voltage gain : 106 dB (Typ)
- Wide output amplitude :  $\pm 13$  V (Typ) (at  $R_L \geq 2$  k $\Omega$ )
- Shorted output protection
- Adjustable offset voltage
- Internal phase compensation

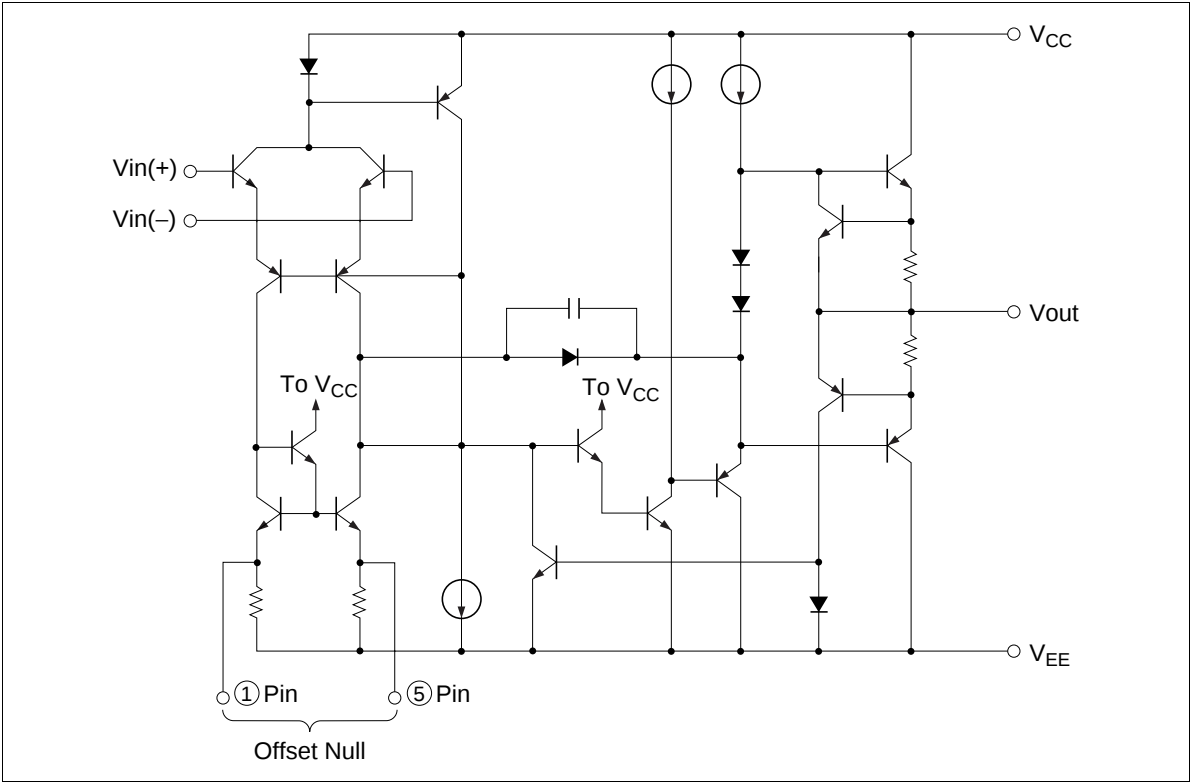
## Ordering Information

| Application    | Type No.  | Package |
|----------------|-----------|---------|
| Industrial use | HA17741PS | DP-8    |
| Commercial use | HA17741   |         |

## Pin Arrangement



Circuit Structure



Absolute Maximum Ratings (Ta = 25°C)

| Item                        | Symbol         | Ratings     |             | Unit |
|-----------------------------|----------------|-------------|-------------|------|
|                             |                | HA17741PS   | HA17741     |      |
| Power-supply voltage        | $V_{CC}$       | +18         | +18         | V    |
|                             | $V_{EE}$       | -18         | -18         | V    |
| Input voltage               | $V_{in}$       | ±15         | ±15         | V    |
| Differential input voltage  | $V_{in(diff)}$ | ±30         | ±30         | V    |
| Allowable power dissipation | $P_T$          | 670 *       | 670 *       | mW   |
| Operating temperature       | $T_{opr}$      | -20 to +75  | -20 to +75  | °C   |
| Storage temperature         | $T_{stg}$      | -55 to +125 | -55 to +125 | °C   |

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 ( $V_{CC} = -V_{EE} = 15\text{ V}$ , $T_a = 25^\circ\text{C}$ )

| Item                             | Symbol                        | Min      | Typ      | Max | Unit             | Test Condition                                            |
|----------------------------------|-------------------------------|----------|----------|-----|------------------|-----------------------------------------------------------|
| Input offset voltage             | $V_{IO}$                      | —        | 1.0      | 6.0 | mV               | $R_s \leq 10\text{ k}\Omega$                              |
| Input offset current             | $I_{IO}$                      | —        | 18       | 200 | nA               |                                                           |
| Input bias current               | $I_{IB}$                      | —        | 75       | 500 | nA               |                                                           |
| Power-supply rejection ratio     | $\Delta V_{IO}/\Delta V_{CC}$ | —        | 30       | 150 | $\mu\text{V/V}$  | $R_s \leq 10\text{ k}\Omega$                              |
|                                  | $\Delta V_{IO}/\Delta V_{EE}$ | —        | 30       | 150 | $\mu\text{V/V}$  | $R_s \leq 10\text{ k}\Omega$                              |
| Voltage gain                     | $A_{VD}$                      | 86       | 106      | —   | dB               | $R_L \geq 2\text{ k}\Omega$ , $V_{out} = \pm 10\text{ V}$ |
| Common-mode rejection ratio      | CMR                           | 70       | 90       | —   | dB               | $R_s \leq 10\text{ k}\Omega$                              |
| Common-mode input voltage range  | $V_{CM}$                      | $\pm 12$ | $\pm 13$ | —   | V                | $R_s \leq 10\text{ k}\Omega$                              |
| Maximum output voltage amplitude | $V_{OP-P}$                    | $\pm 12$ | $\pm 14$ | —   | V                | $R_L \geq 10\text{ k}\Omega$                              |
|                                  |                               | $\pm 10$ | $\pm 13$ | —   | V                | $R_L \geq 2\text{ k}\Omega$                               |
| Power dissipation                | $P_d$                         | —        | 65       | 100 | mW               | No load                                                   |
| Slew rate                        | SR                            | —        | 1.0      | —   | V/ $\mu\text{s}$ | $R_L \geq 2\text{ k}\Omega$                               |
| Rise time                        | $t_r$                         | —        | 0.3      | —   | $\mu\text{s}$    | $V_{in} = 20\text{ mV}$ , $R_L = 2\text{ k}\Omega$ ,      |
| Overshoot                        | $V_{over}$                    | —        | 5.0      | —   | %                | $C_L = 100\text{ pF}$                                     |
| Input resistance                 | $R_{in}$                      | 0.3      | 1.0      | —   | M $\Omega$       |                                                           |

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

| Item                             | Symbol     | Min      | Typ | Max   | Unit | Test Condition                                            |
|----------------------------------|------------|----------|-----|-------|------|-----------------------------------------------------------|
| Input offset voltage             | $V_{IO}$   | —        | —   | 9.0   | mV   | $R_s \leq 10\text{ k}\Omega$                              |
| Input offset current             | $I_{IO}$   | —        | —   | 400   | nA   |                                                           |
| Input bias current               | $I_{IB}$   | —        | —   | 1,100 | nA   |                                                           |
| Voltage gain                     | $A_{VD}$   | 80       | —   | —     | dB   | $R_L \geq 2\text{ k}\Omega$ , $V_{out} = \pm 10\text{ V}$ |
| Maximum output voltage amplitude | $V_{OP-P}$ | $\pm 10$ | —   | —     | V    | $R_L \geq 2\text{ k}\Omega$                               |

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

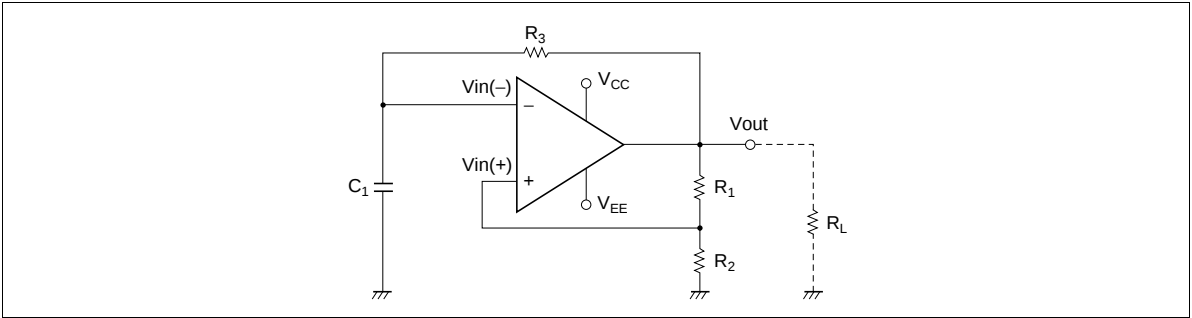


Figure 1 Astable Multivibrator Operating Circuit

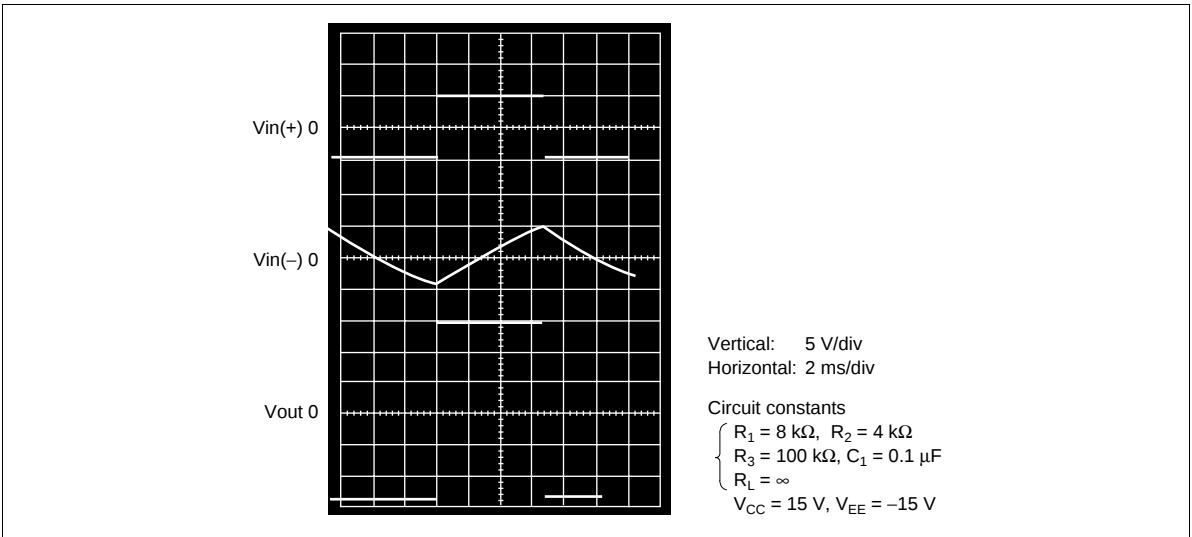


Figure 2 HA17741 Astable Multivibrator Operating Waveform

2. Monostable Multivibrator

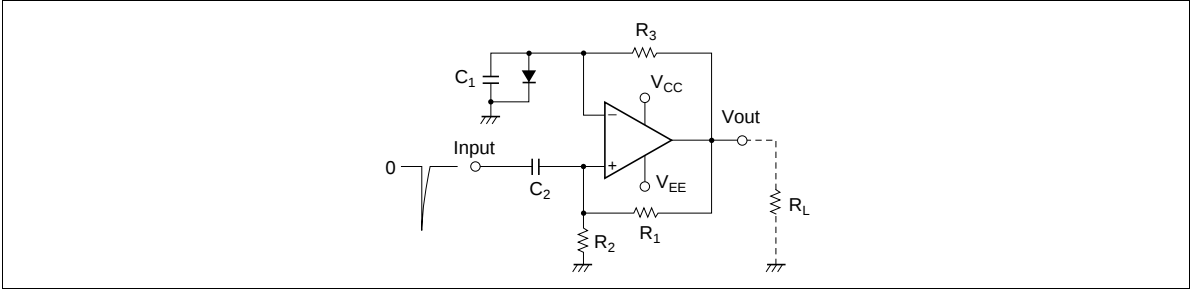


Figure 3 Monostable Multivibrator Operating Circuit

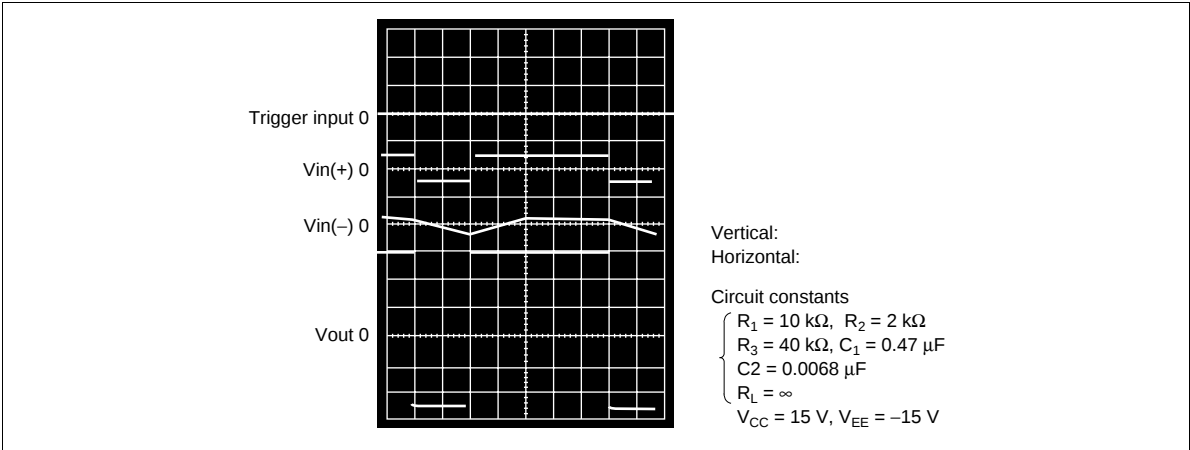


Figure 4 HA17741 Monostable Multivibrator Operating Waveform

3. Bistable Multivibrator

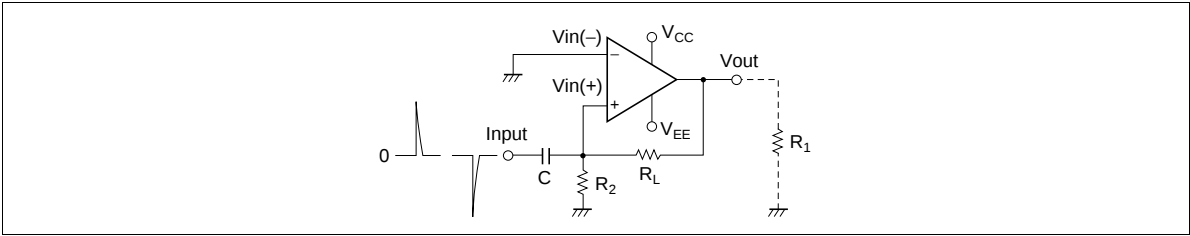


Figure 5 Bistable Multivibrator Operating Circuit

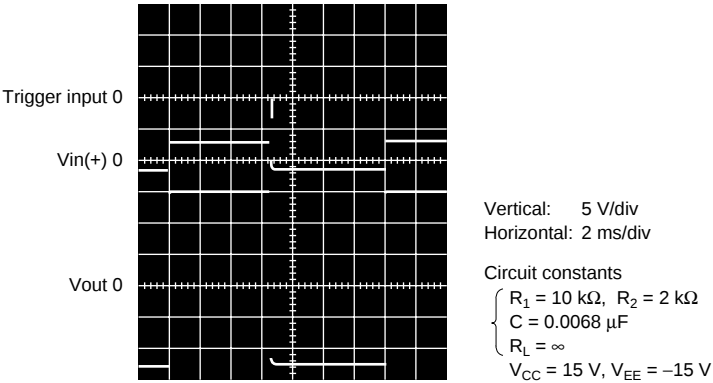


Figure 6 HA17741 Bistable Multivibrator Operating Waveform

Wien Bridge Sine Wave Oscillator

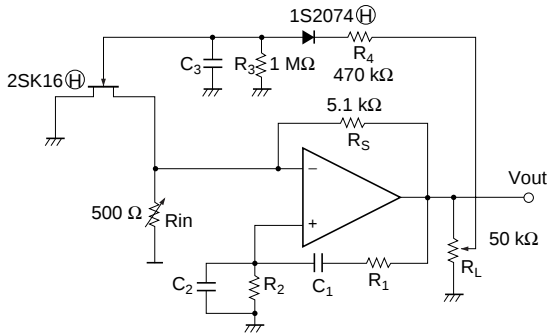


Figure 7 Wien Bridge Sine Wave Oscillator

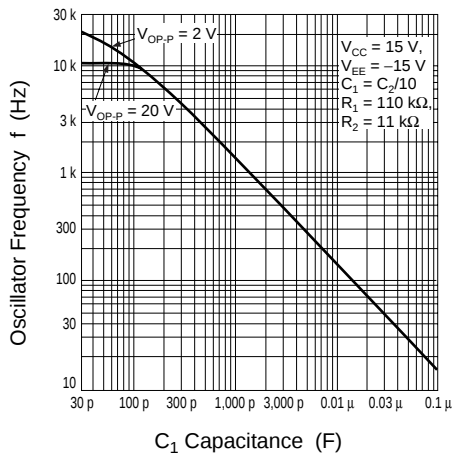
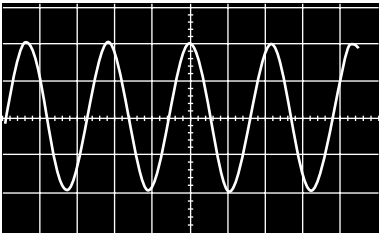


Figure 8 HA17741 Wien Bridge Sine Wave Oscillator  $f$ - $C$  Characteristics



Vertical: 5 V/div  
Horizontal: 0.5 ms/div

Test circuit condition

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

Test results

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

Figure 9 HA17741 Wien Bridge Sine Wave Oscillator Operating Waveform

Quadrature Oscillator

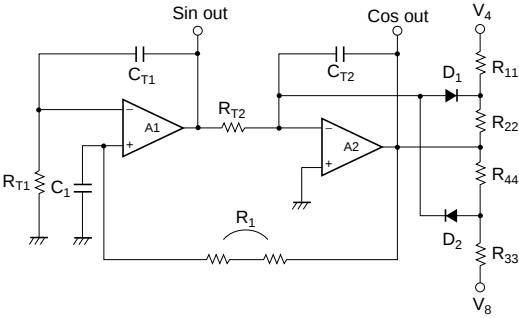


Figure 10 Quadrature Sine Wave Oscillator

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.

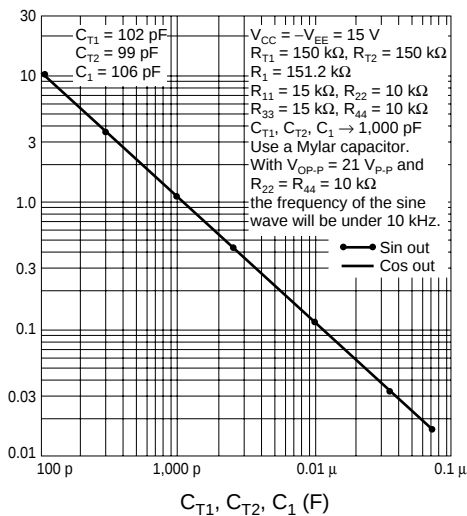
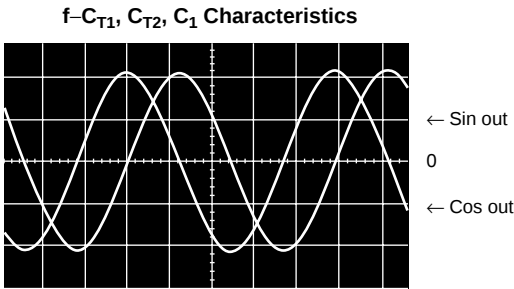


Figure 11 HA17741 Quadrature Sine Wave Oscillator



Circuit constants  
 $C_{T1} = 1000$  pF (990),  $C_{T2} = 1000$  pF (990)  
 $R_{T1} = 150$  k $\Omega$ ,  $R_{T2} = 150$  k $\Omega$   
 $C_1 = 1000$  pF (990),  $R_1 = 160$  k $\Omega$   
 $R_{11} = 15$  k $\Omega$ ,  $R_{22} = 10$  k $\Omega$   
 $R_{33} = 16$  V,  $R_{44} = 10$  k $\Omega$   
 $V_{CC} = 15$  V,  $V_{EE} = -15$  V

Figure 12 Sine and Cosine Output Waveforms

Triangular Wave Generator

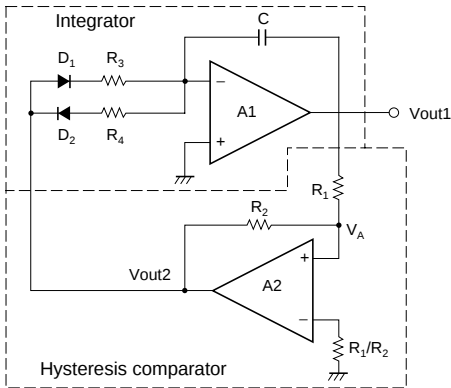


Figure 13 Triangular Wave Generator Operating Circuit

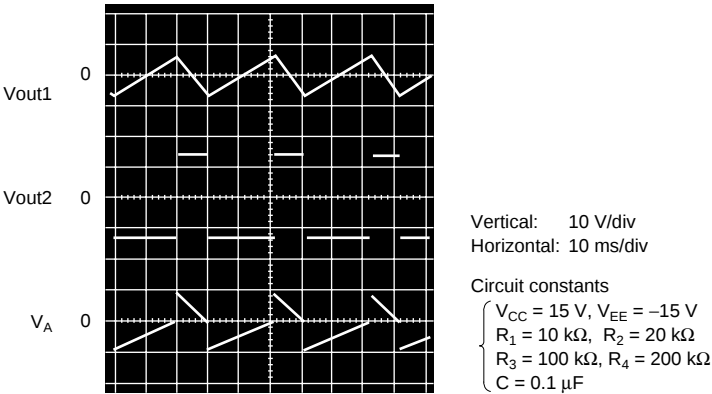


Figure 14 HA17741 Triangular Wave Generator Operating Waveform

Sawtooth Waveform Generator

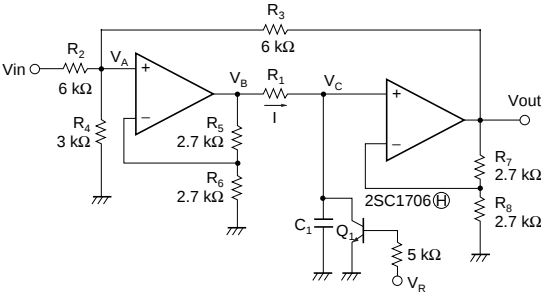


Figure 15 Sawtooth Waveform Generator

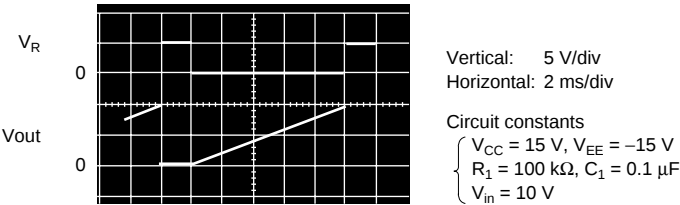
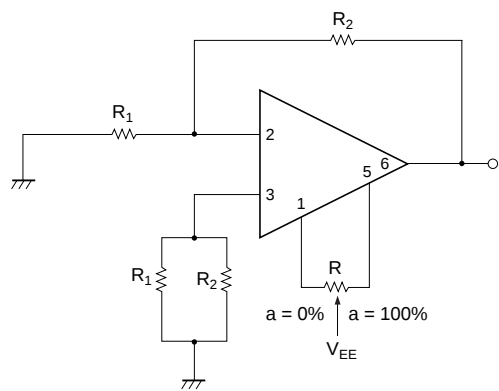


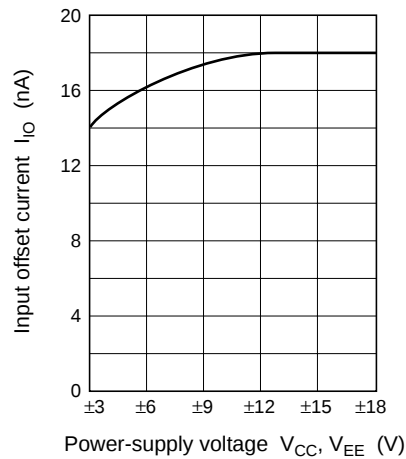
Figure 16 HA17741 Sawtooth Waveform Generator Operating Waveform

Characteristic Curves

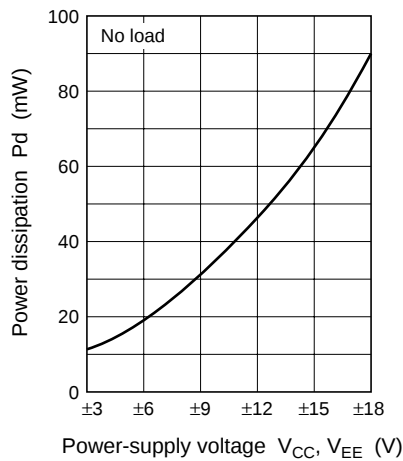
Voltage Offset Adjustment Circuit



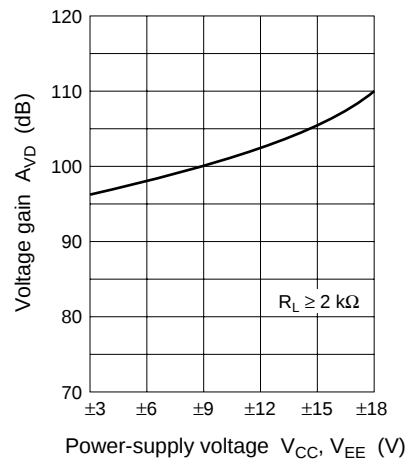
Input Offset Current vs. Power-Supply Voltage Characteristics



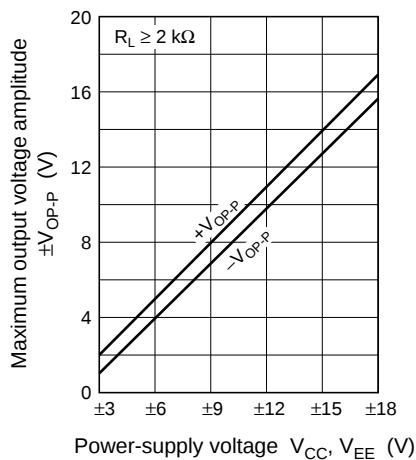
Power Dissipation vs. Power-Supply Voltage Characteristics



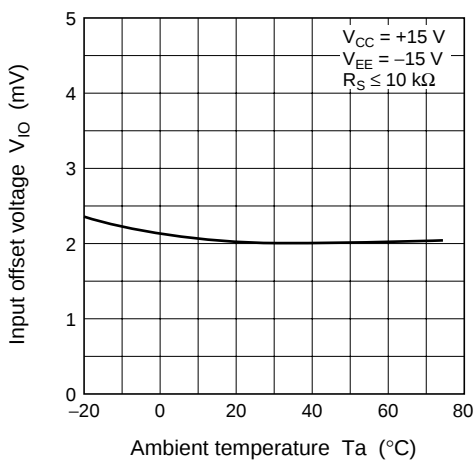
Voltage Gain vs. Power-Supply Voltage Characteristics



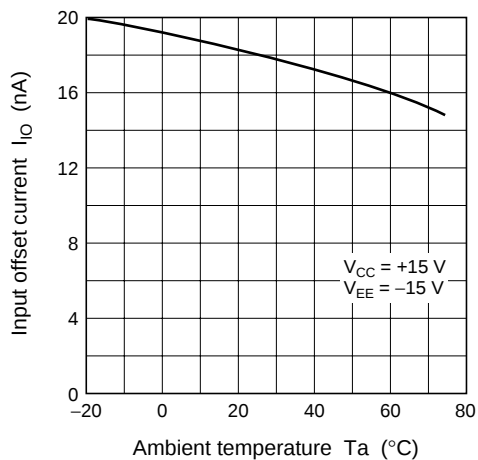
Maximum Output Voltage Amplitude vs.  
Power-Supply Voltage Characteristics



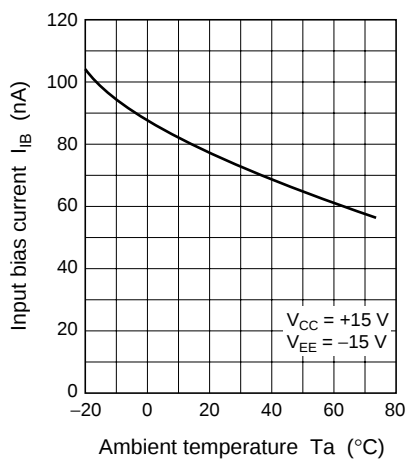
Input Offset Voltage vs.  
Ambient Temperature Characteristics



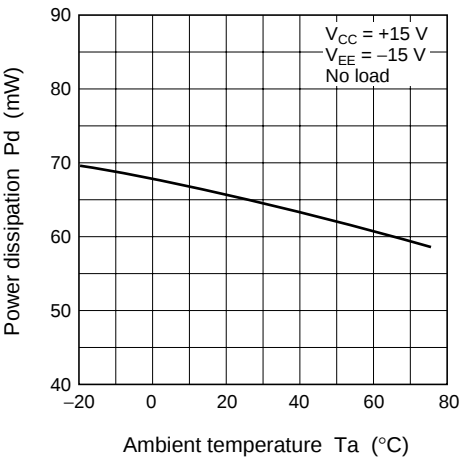
Input Offset Current vs.  
Ambient Temperature Characteristics



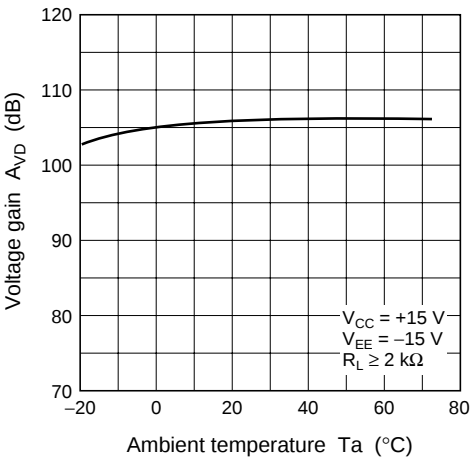
Input Bias Current vs.  
Ambient Temperature Characteristics



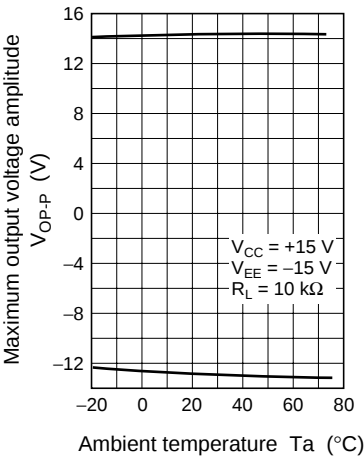
Power Dissipation vs.  
Ambient Temperature Characteristics



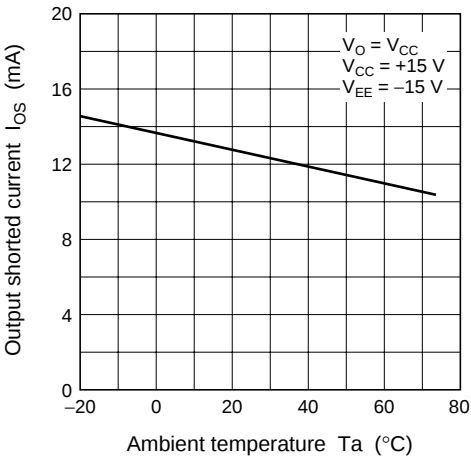
Voltage Gain vs.  
Ambient Temperature Characteristics



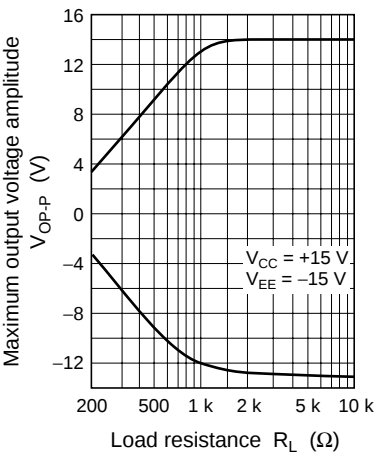
Maximum Output Voltage Amplitude vs.  
Ambient Temperature Characteristics



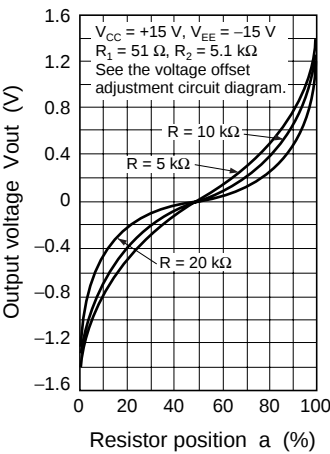
Output Shorted Current vs.  
Ambient Temperature Characteristics



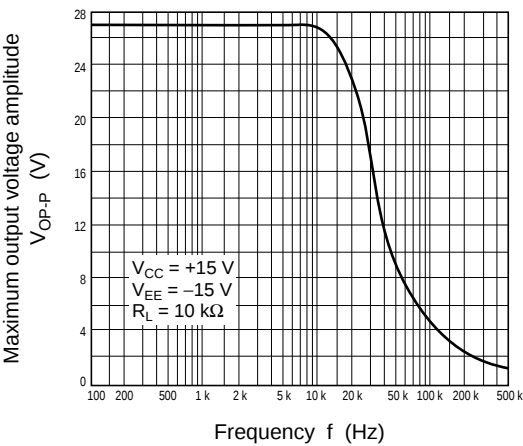
Maximum Output Voltage Amplitude vs.  
Load Resistance Characteristics



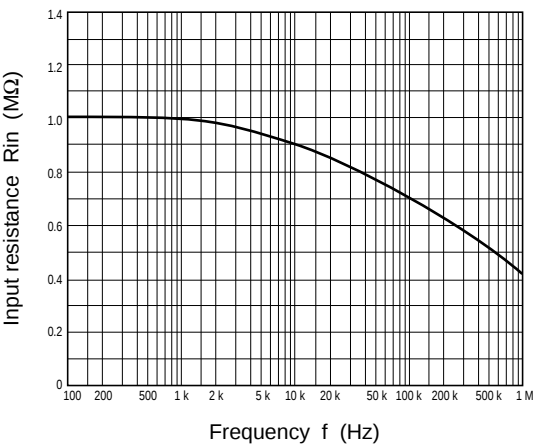
Offset Adjustment  
Characteristics



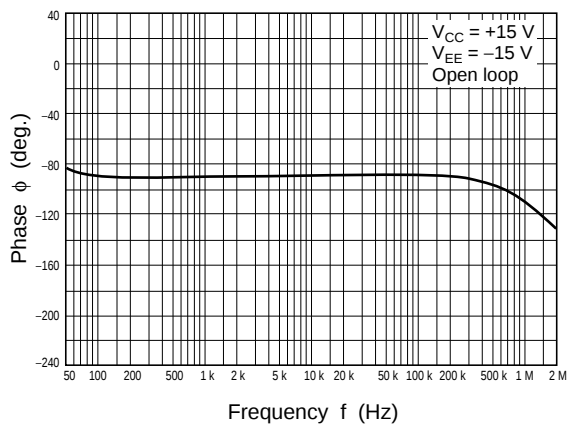
Maximum Output Voltage Amplitude vs.  
Frequency Characteristics



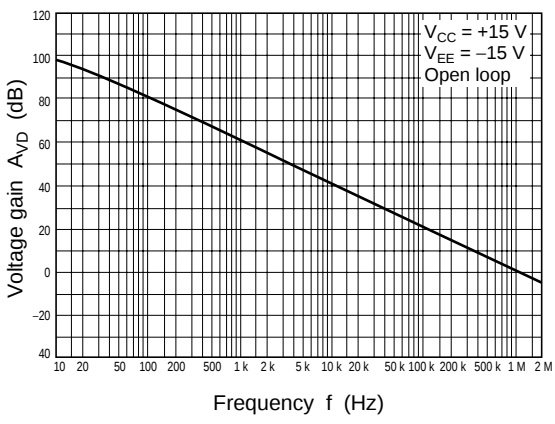
Input Resistance vs.  
Frequency Characteristics



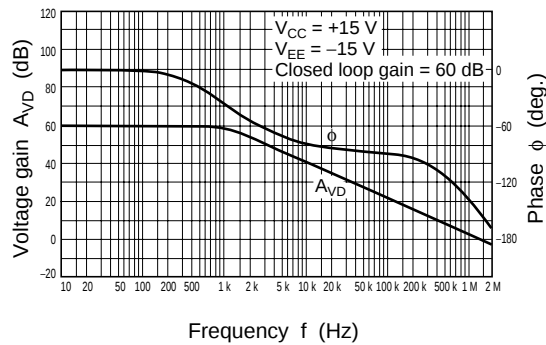
Phase vs.  
Frequency Characteristics



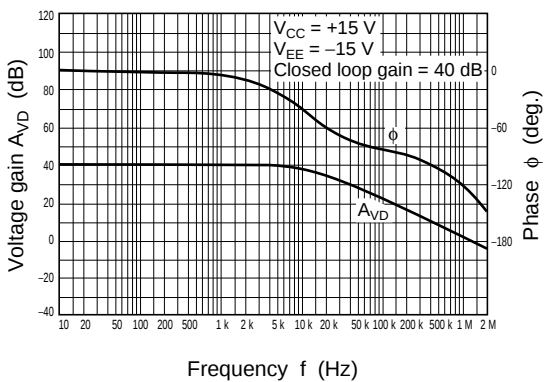
Voltage Gain vs  
Frequency Characteristics



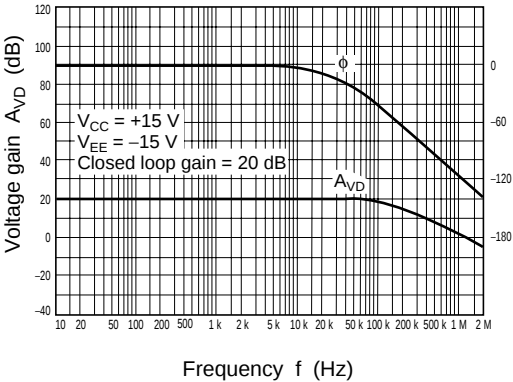
Voltage Gain and Phase vs.  
Frequency Characteristics (1)



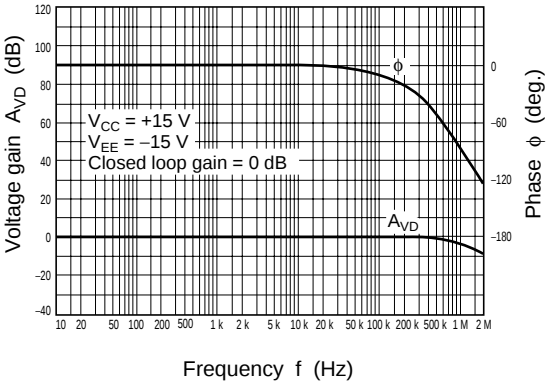
Voltage Gain and Phase vs.  
Frequency Characteristics (2)



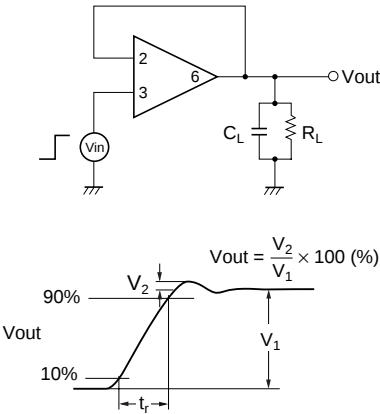
Voltage Gain and Phase vs. Frequency Characteristics (3)



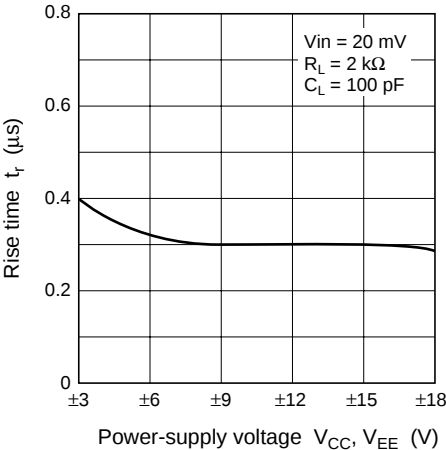
Voltage Gain and Phase vs. Frequency Characteristics (4)



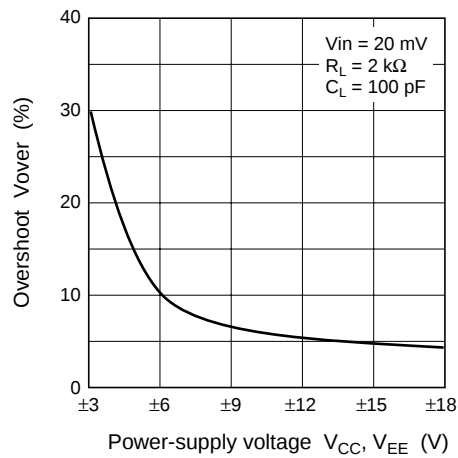
Impulse Response Characteristics Test Circuit



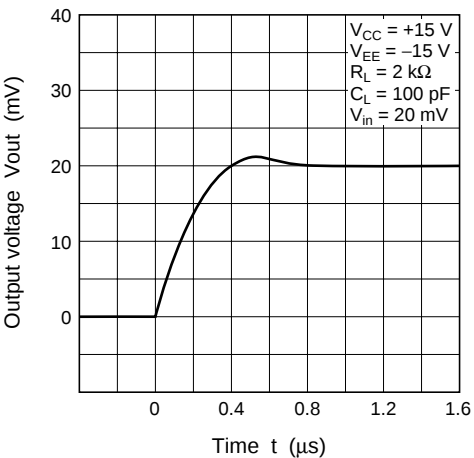
Rise time vs. Power-Supply Voltage Characteristics



Overshoot vs.  
Power-Supply Voltage Characteristics

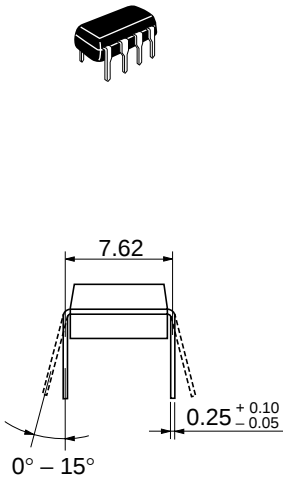
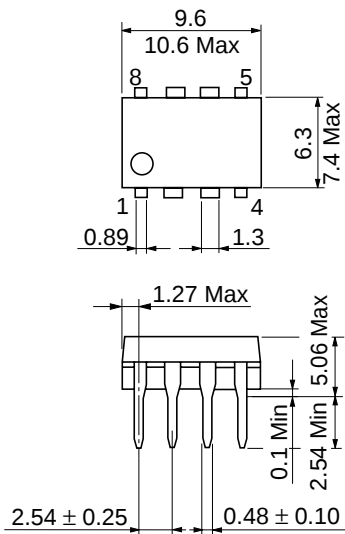


Impulse Response  
Characteristics



Package Dimensions

Unit: mm



|                        |          |
|------------------------|----------|
| Hitachi Code           | DP-8     |
| JEDEC                  | Conforms |
| EIAJ                   | Conforms |
| Mass (reference value) | 0.54 g   |

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