

# HA12231FP

Audio Signal Processor for Car Deck (PB 1 Chip)

## HITACHI

ADE-207-327A (Z)  
2nd Edition  
Jan. 2001

### Description

HA12231FP is silicon monolithic bipolar IC providing PB equalizer system and music sensor system in one chip.

### Functions

- PB equalizer   × 2 channel
- Music sensor   × 1 channel
- Line amp.       × 2 channel
- Line mute       × 2 channel

### Features

- No use external parts for PB equalizer. (Fixed characteristics built-in)
- Available to change music sensing level by external resistor.
- Available to change frequency response of music sensor by external capacitor.
- Different type of PB equalizer characteristics selection (120  $\mu$ s/70  $\mu$ s) is available.
- Line mute ON/OFF is available.
- This IC is strong for a cellular phone noise.

### Ordering Information

| Product   | Package | PBOUT-Level | Functions |              |      |
|-----------|---------|-------------|-----------|--------------|------|
|           |         |             | PB-EQ     | Music Sensor | Mute |
| HA12231FP | FP-20DA | 450 mVrms   | ○         | ○            | ○    |

# HA12231FP

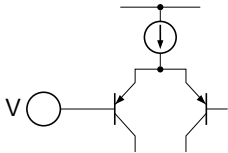
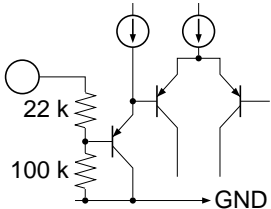
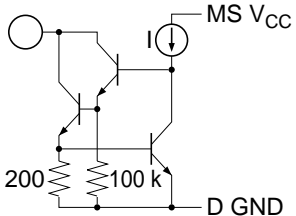
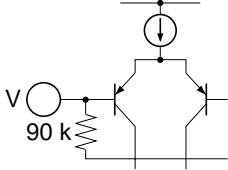
**Pin Description, Equivalent Circuit** ( $V_{CC} = 9\text{ V}$ , A system of single supply voltage,  $T_a = 25^\circ\text{C}$ , No Signal, The value in the table shows typical value.)

| Pin No. | Pin Name | Note           | Equivalent Circuit | Description                     |
|---------|----------|----------------|--------------------|---------------------------------|
| 16      | TAI(L)   | $V = V_{CC}/2$ |                    | Tape input                      |
| 5       | TAI(R)   |                |                    |                                 |
| 14      | RIP      | $V = V_{CC}/2$ |                    | Ripple filter                   |
| 13      | MS DET   | $V = V_{CC}$   |                    | Time constant pin for rectifier |
| 15      | PBOUT(L) | $V = V_{CC}/2$ |                    | PB output                       |
| 6       | PBOUT(R) |                |                    |                                 |
| 1       | VREF     | $V = V_{CC}/2$ |                    | Reference output                |
| 17      | EQOUT(L) | $V = V_{CC}/2$ |                    | Equalizer output ( $120\ \mu$ ) |
| 4       | EQOUT(R) |                |                    |                                 |

Note: MS: Music Sensor

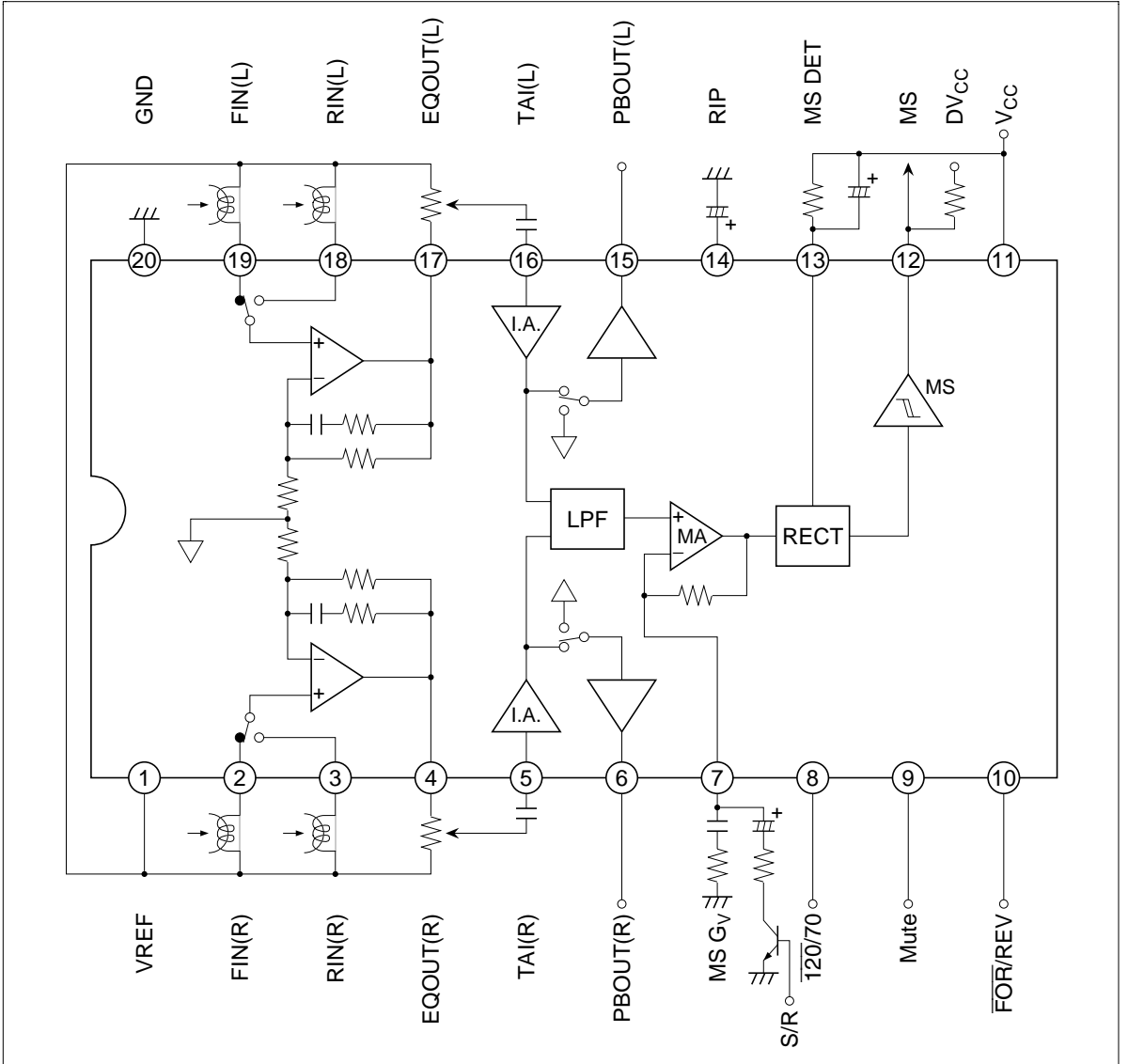
**HITACHI**

**Pin Description, Equivalent Circuit** ( $V_{CC} = 9\text{ V}$ , A system of single supply voltage,  $T_a = 25^\circ\text{C}$ , No Signal, The value in the table shows typical value.) (cont.)

| Pin No. | Pin Name                    | Note           | Equivalent Circuit  | Description          |
|---------|-----------------------------|----------------|---|----------------------|
| 11      | $V_{CC}$                    | —              |   | Power supply         |
| 19      | FIN(L)                      | —              |    | Equalizer input      |
| 18      | RIN(L)                      |                |   |                      |
| 3       | RIN(R)                      |                |   |                      |
| 2       | FIN(R)                      |                |   |                      |
| 9       | Mute                        | —              |    | Mode control input   |
| 10      | $\overline{\text{FOR/REV}}$ |                |   |                      |
| 8       | $\overline{\text{I20/70}}$  |                |   |                      |
| 12      | MS                          | —              |   | MS output (to MPU) * |
| 7       | MS $G_v$                    | $V = V_{CC}/2$ |  | MS gain pin *        |
| 20      | GND                         | —              |   | GND pin              |

Note: MS: Music Sensor

## Block Diagram



**Absolute Maximum Ratings** ( $T_a = 25^{\circ}\text{C}$ )

| <b>Item</b>           | <b>Symbol</b> | <b>Rating</b> | <b>Unit</b>        | <b>Note</b>                   |
|-----------------------|---------------|---------------|--------------------|-------------------------------|
| Supply voltage        | $V_{cc}$ Max  | 15            | V                  |                               |
| Power dissipation     | $P_d$         | 400           | mW                 | $T_a \leq 85^{\circ}\text{C}$ |
| Operating temperature | $T_{opr}$     | -40 to +85    | $^{\circ}\text{C}$ |                               |
| Storage temperature   | $T_{stg}$     | -55 to +125   | $^{\circ}\text{C}$ |                               |

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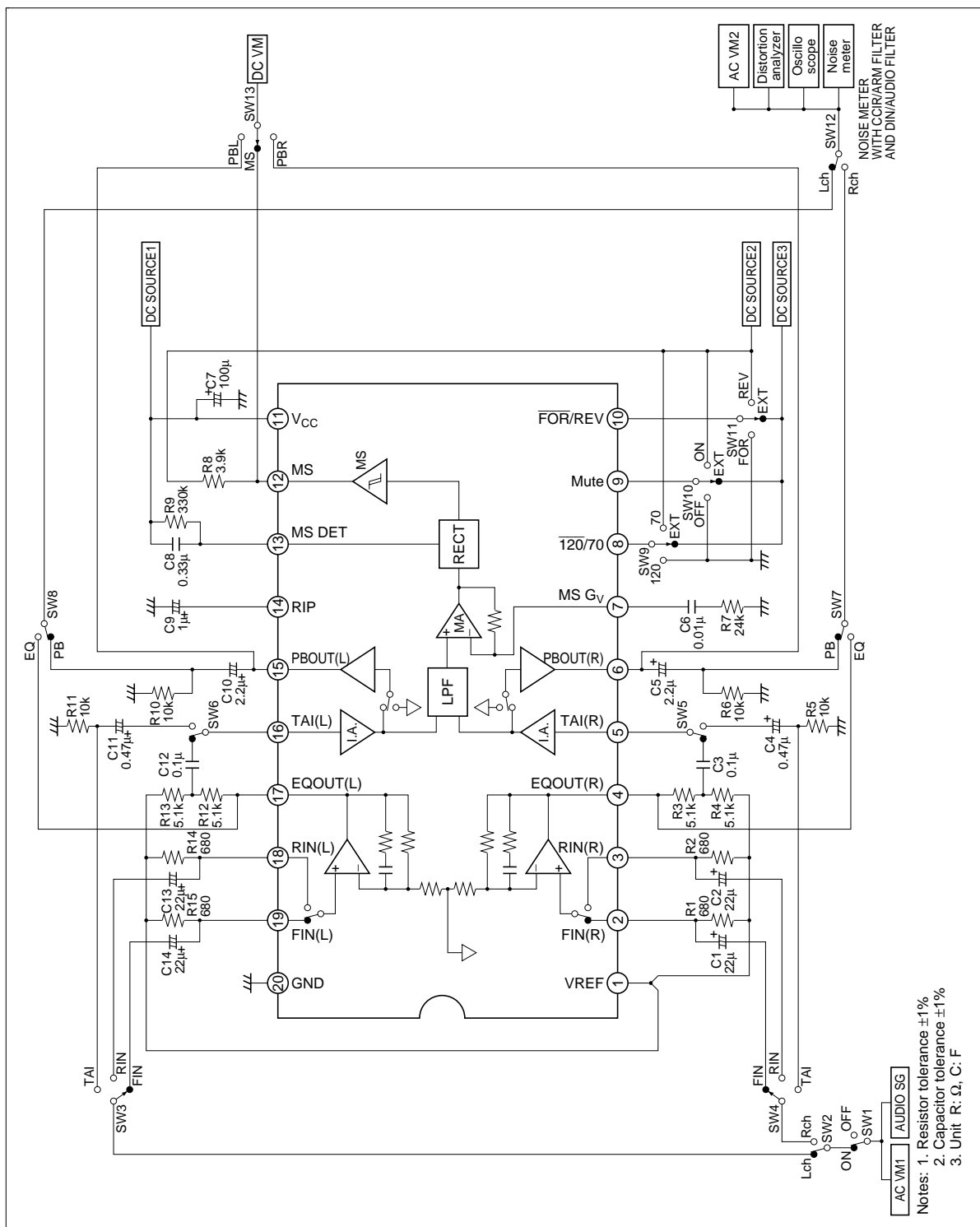
## Electrical Characteristics

(Ta = 25°C, V<sub>CC</sub> = 9 V, PBOUIT Level = 450 mVrms (= 0 dB))

| Item                                   | Symbol                   | Test Condition |              |         |                  |                             |       |       |                 |       |     | Application Terminal | Re-mark |          |   |   |
|--|--------------------------|----------------|--------------|---------|------------------|-----------------------------|-------|-------|-----------------|-------|-----|----------------------|---------|----------|---|---|
|  |                          | IC Condition   |              |         | Specification    |                             |       |       | Input           |       |     |                      |         | Output   |   |   |
|  |                          | INPUT          | OUTPUT       | fin(Hz) | PBOUIT level(dB) | Other                       | Min   | Typ   | Max             | Unit  | R   |                      |         | L        | R | L |
| Quiescent current                      | I <sub>Q</sub>           | —              | —            | —       | —                | No signal                   | —     | 6.0   | 9               | mA    | —   | —                    | —       | 11       |   |   |
| Input AMP. gain                        | G <sub>V</sub> /A        | TAI            | PBOUIT       | 1k      | 0                | —                           | 22.5  | 23.5  | 24.5            | dB    | 5   | 16                   | 6       | 15       |   |   |
| Signal handling                        | Vomax                    | TAI            | PBOUIT       | 1k      | —                | THD = 1%                    | 12.0  | 13.0  | —               | dB    | 5   | 16                   | 6       | 15       |   |   |
| T.H.D.                                 | THD                      | TAI            | PBOUIT       | 1k      | 0                | —                           | —     | 0.05  | 0.3             | %     | 5   | 16                   | 6       | 15       |   |   |
| Channel separation                     | CT RL                    | FIN            | PBOUIT       | 1k      | 12               | —                           | 50.0  | 60.0  | —               | dB    | 2   | 19                   | 6→15    | →6       |   |   |
| PB-EQ gain                             | G <sub>V</sub> EQ 1k     | FIN/RIN        | EQOUT        | 1k      | 0                | 120μs                       | 37.0  | 40.0  | 43.0            | dB    | 2/3 | 19/18                | 4       | 17       |   |   |
|  | G <sub>V</sub> EQ 10k(1) | FIN            | EQOUT        | 10k     | 0                | 120μs                       | 33.0  | 36.0  | 39.0            | dB    | 2   | 19                   | 4       | 17       |   |   |
|  | G <sub>V</sub> EQ 10k(2) | FIN            | EQOUT        | 10k     | 0                | 70μs                        | 29.0  | 32.0  | 35.0            | dB    | 2   | 19                   | 4       | 17       |   |   |
| PB-EQ maximum output                   | V <sub>OM</sub>          | FIN/RIN        | EQOUT        | 1k      | —                | THD = 1%                    | 300   | 600   | —               | mVrms | 2/3 | 19/18                | 4       | 17       |   |   |
| PB-EQ THD                              | THD-EQ                   | FIN/RIN        | EQOUT        | 1k      | 0                | —                           | —     | 0.1   | 0.5             | %     | 2/3 | 19/18                | 4       | 17       |   |   |
| Noise voltage level converted in input | V <sub>N</sub>           | FIN/RIN        | EQOUT        | (1k)    | (0)              | Rg = 680Ω, Din-Audio Filter | —     | 1.2   | 2.0             | μVrms | 2/3 | 19/18                | 4       | 17       |   |   |
| MS sensing level                       | V <sub>ON</sub>          | TAI            | PBOUIT MSOUT | 5k      | —                | —                           | -18.0 | -14.0 | -10.0           | dB    | 5   | 16                   | 6       | 15       |   |   |
| MS output low level                    | V <sub>OL</sub>          | TAI            | PBOUIT MSOUT | 5k      | 0                | —                           | —     | 1.0   | 1.5             | V     | 5   | 16                   | 6       | 15       |   |   |
| MS output leak current                 | I <sub>OH</sub>          | —              | MSOUT        | —       | —                | No signal                   | —     | 0.0   | 2.0             | μA    | —   | —                    | 12      | 12       |   |   |
| MUTE attenuation                       | Mute                     | TAI            | PBOUIT       | 1k      | 12               | —                           | 70.0  | 80.0  | —               | dB    | 5   | 16                   | 6       | 15       |   |   |
| Control voltage                        | V <sub>IL</sub>          | —              | —            | —       | —                | —                           | -0.2  | —     | 1.0             | V     | —   | —                    | —       | 8, 9, 10 |   |   |
|  | V <sub>IH</sub>          | —              | —            | —       | —                | —                           | 3.5   | —     | V <sub>CC</sub> | —     | —   | —                    | —       | —        |   |   |

Note: 1. V<sub>CC</sub> = 7.2 V

Test Circuit



Notes: 1. Resistor tolerance  $\pm 1\%$   
 2. Capacitor tolerance  $\pm 1\%$   
 3. Unit R:  $\Omega$ , C: F

## Functional Description

### Power Supply Range

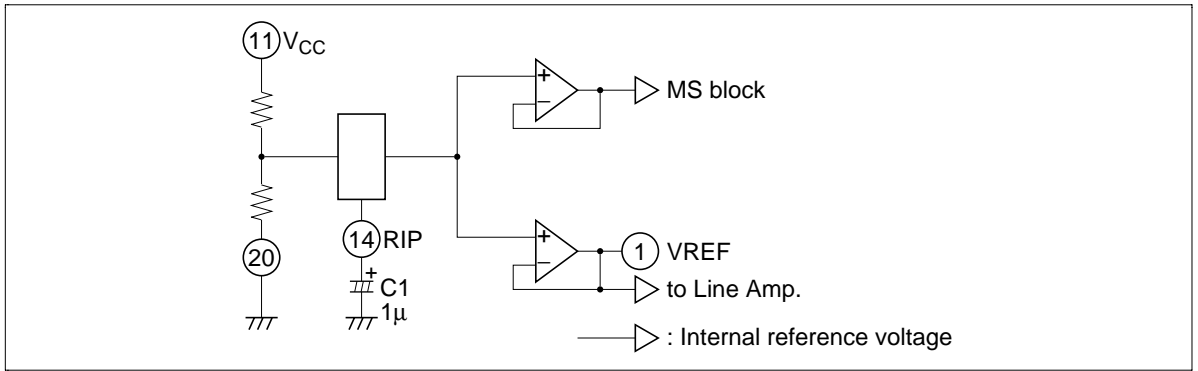
HA12231FP is designed to operate on single supply only.

**Table 1** Supply Voltage Range

| Product   | Single Supply   |
|-----------|-----------------|
| HA12231FP | 7.2 V to 12.0 V |

### Reference Voltage

HA12231FP provides the reference voltage of half the supply voltage that is the signal grounds. As the peculiarity of this device, the capacitor for the ripple filter is very small about 1/100 compared with their usual value. The block diagram is shown as figure 1.



**Figure 1** The Block Diagram of Reference Supply Voltage

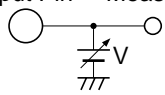


**Operating Mode Control**

HA12231FP provides fully electronic switching circuits. And each operating mode control are controlled by parallel data (DC voltage).

When a power supply of this IC is cut off, for a voltage, in addition to a mode control terminal even though as do not destruct it, in series for resistance.

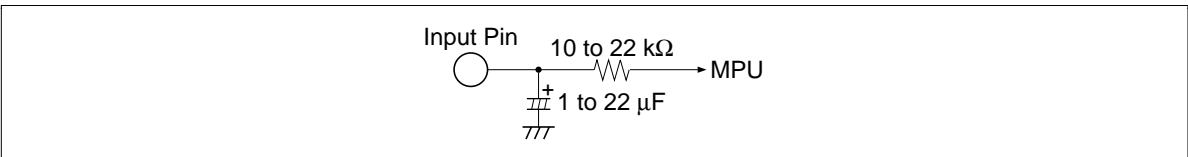
**Table 2 Threshold Voltage ( $V_{TH}$ )**

| Pin No.  | Lo          | Hi              | Unit | Test Condition  |
|----------|-------------|-----------------|------|---|
| 8, 9, 10 | -0.2 to 1.0 | 3.5 to $V_{CC}$ | V    | Input Pin Measure<br> |

**Table 3 Switching Truth Table**

| Pin No. | Pin Name             | Low                | High                       |
|---------|----------------------|--------------------|----------------------------|
| 8       | $\overline{120/70}$  | 120 $\mu$ (Normal) | 70 $\mu$ (Metal or Chrome) |
| 9       | Mute                 | Mute OFF           | Mute ON                    |
| 10      | $\overline{FOR/REV}$ | Forward            | Reverse                    |

- Notes:
1. Each pins are on pulled down with 100 k $\Omega$  internal resistor. Therefore, it will be low-level when each pins are open.
  2. Over shoot level and under shoot level of input signal must be the standardized. (High:  $V_{CC}$ , Low: -0.2 V)
  3. Reducing pop noise is so much better for 10 k $\Omega$  to 22 k $\Omega$  resisor and 1  $\mu$ F to 22  $\mu$ F capacitor shown figure 2.



**Figure 2 Interface for Reduction of Pop Noise**

## Input Block Diagram and Level Diagram

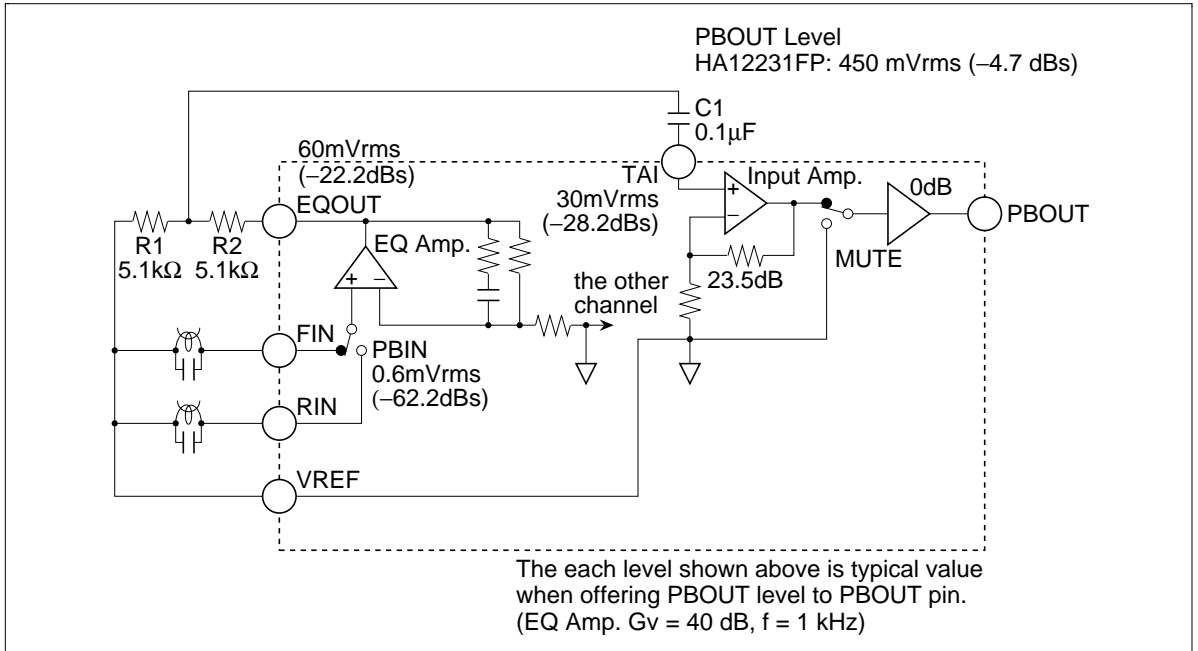


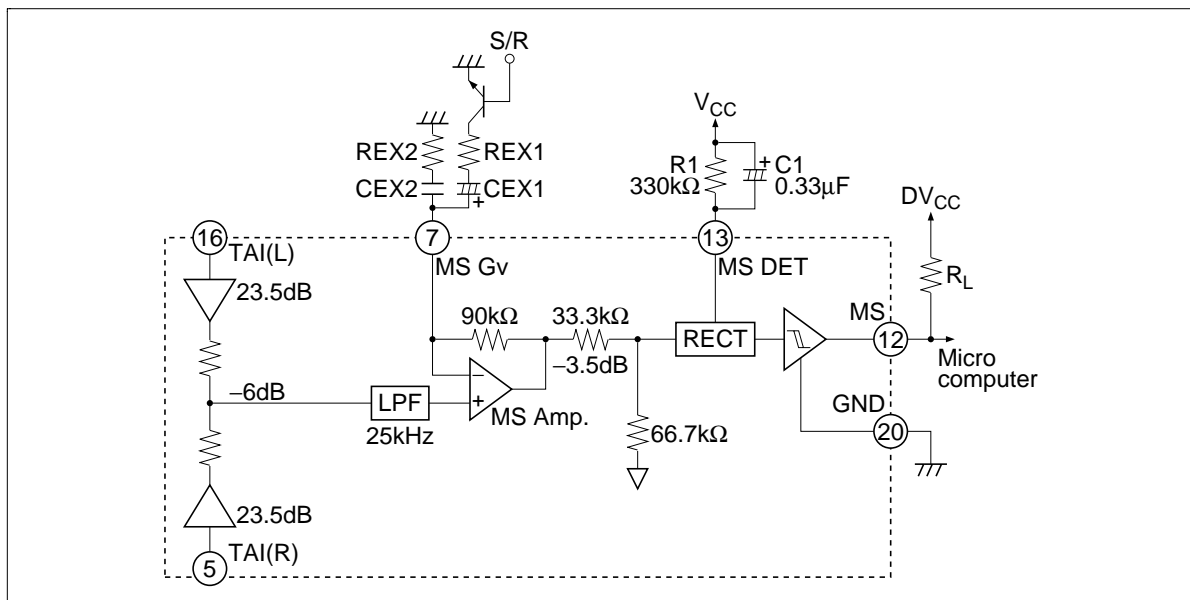
Figure 3 Input Block Diagram

### Adjustment of Playback Reference Operate Level

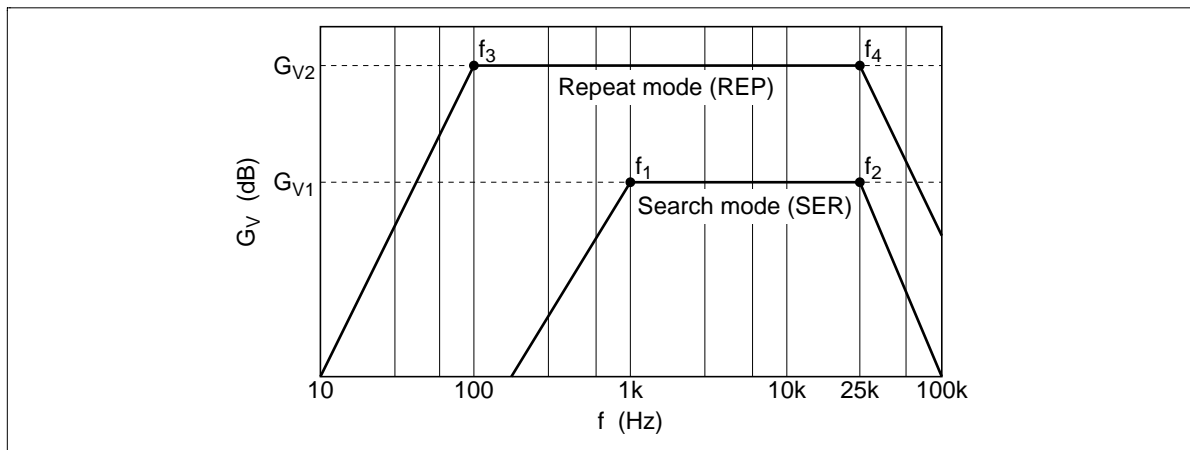
After replace R1 and R2 with a half-fix volume of 10 kΩ, adjust playback reference operate level.

**The Sensitivity Adjustment of Music Sensor**

Adjusting MS Amp. gain by external resistor, the sensitivity of music sensor can set up. The music sensor block diagram is shown in figure 4, and frequency response is shown in figure 5.



**Figure 4 Music Sensor Block Diagram**



**Figure 5 Frequency Response**

## 1. Search mode

$$G_{V1} = (23.5\text{dB} - 3.5\text{dB}) + 20\log\left(1 + \frac{90\text{k}}{\text{REX2}}\right) \text{ [dB]}$$

$$f_1 = \frac{1}{2\pi \cdot \text{CEX2} \cdot \text{REX2}} \text{ [Hz]}, f_2 = 25\text{k} \text{ [Hz]}$$

## 2. Repeat mode

$$G_{V2} = (23.5\text{dB} - 3.5\text{dB}) + 20\log\left(1 + \frac{90\text{k}}{\text{REX1}}\right) \text{ [dB]}$$

$$f_3 = \frac{1}{2\pi \cdot \text{CEX1} \cdot \text{REX1}} \text{ [Hz]}, f_4 = 25\text{k} \text{ [Hz]}$$

The sensitivity of music sensor (S) is computed by the formula mentioned below.

$$S = 12.7 - G_V \text{ [dB]}$$

S is 6 dB down in case of one-side channel.

Notes: 1. Search mode:  $G_{V1}$ , Repeat mode:  $G_{V2}$

2. Standard level of TAI pin (Dolby level correspondence) = 30 mVrms

3. Standard sensing level of music sensor = 130 mVrms

| Item        | REX1, 2 | CEX1, 2 | $G_{V1, 2}$ | $f_{1, 3}$ | $f_{2, 4}$ | S<br>(one side<br>channel) | S<br>(both<br>channel) |
|-------------|---------|---------|-------------|------------|------------|----------------------------|------------------------|
| Search mode | 24 kΩ   | 0.01 μF | 33.5 dB     | 663 Hz     | 25 kHz     | -14.8 dB                   | -20.8 dB               |
| Repeat mode | 2.4 kΩ  | 1 μF    | 51.7 dB     | 66.3 Hz    | 25 kHz     | -33.0 dB                   | -39.0 dB               |

Note: This MS presented hysteresis lest MS(OUT) terminal should turn over again High level or Low level, in case of thresh S level constantly.

## Music Sensor Time Constant

1. Sensing no signal to signal (Attack) is determined by C1, 0.01 μF to 1 μF capacitor C1 can be applicable.
2. Sensing signal to no signal (Recovery) is determined by C1 and R1, however preceding (1), 100 kΩ to 1 MΩ can be applicable.

## Music Sensor Output (MS(OUT))

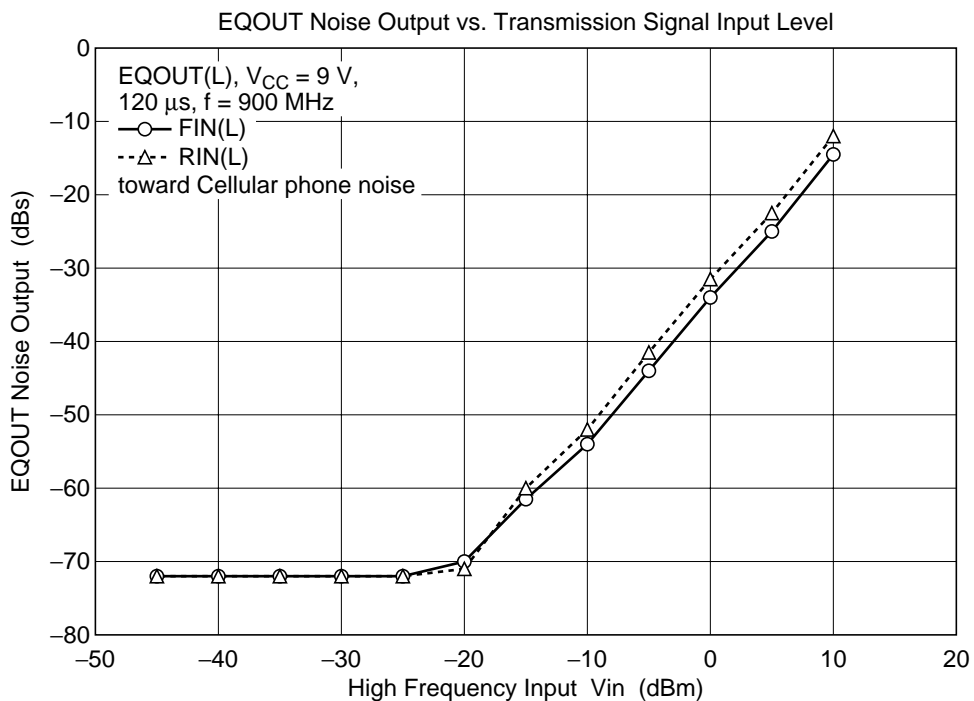
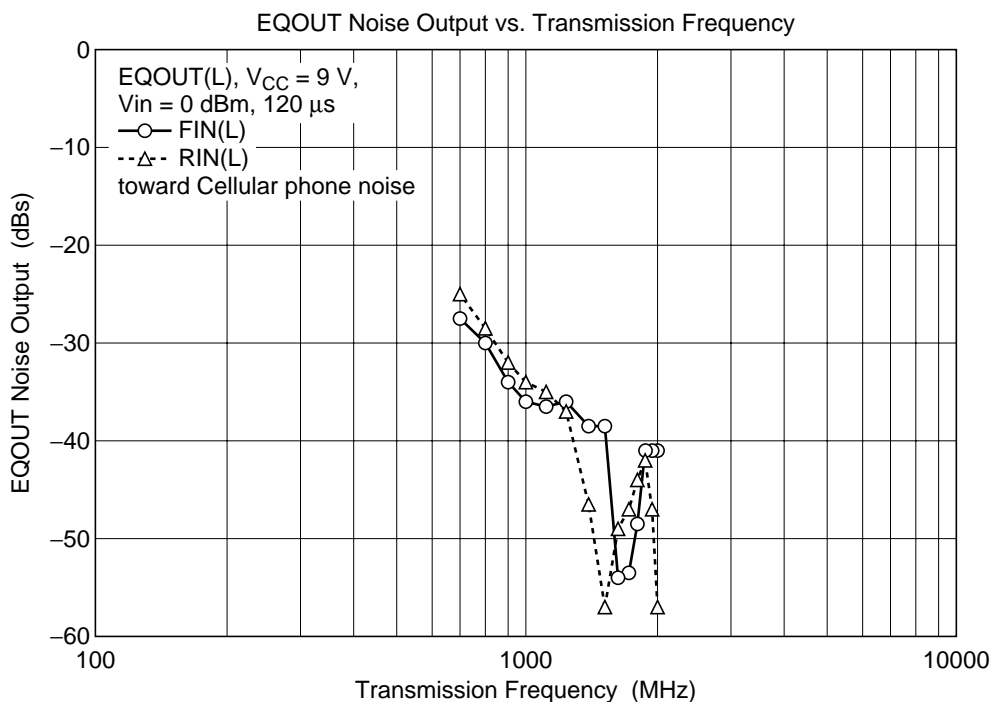
As for the internal circuit of music sensor block, music sensor output pin is connected to the collector of NPN type directly, therefore, output level will be “high” when sensing no signal. And output level will be “low” when sensing signal.

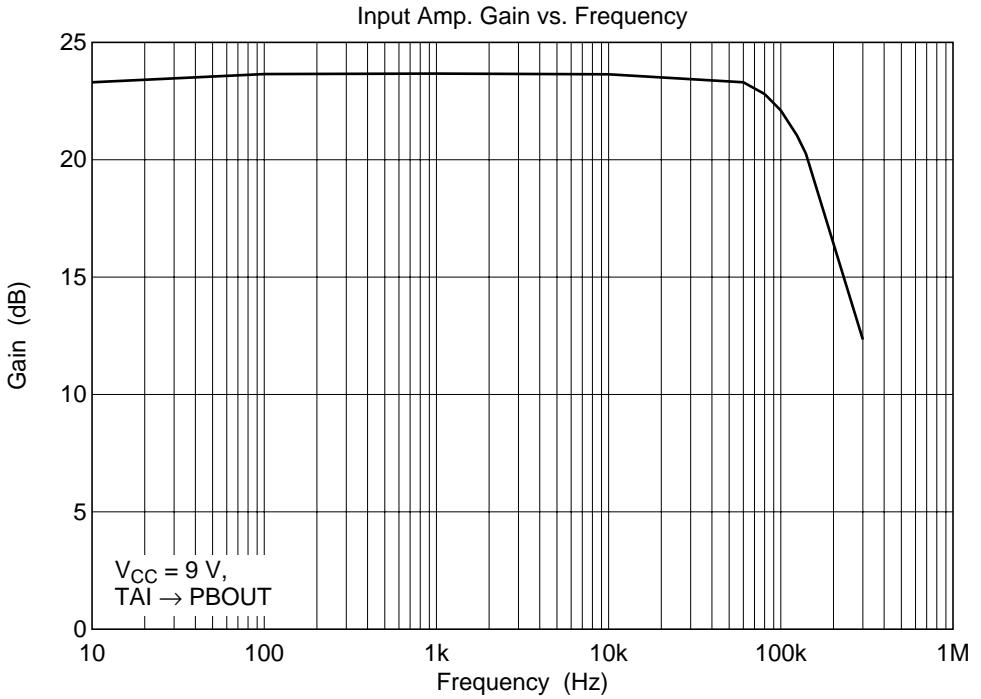
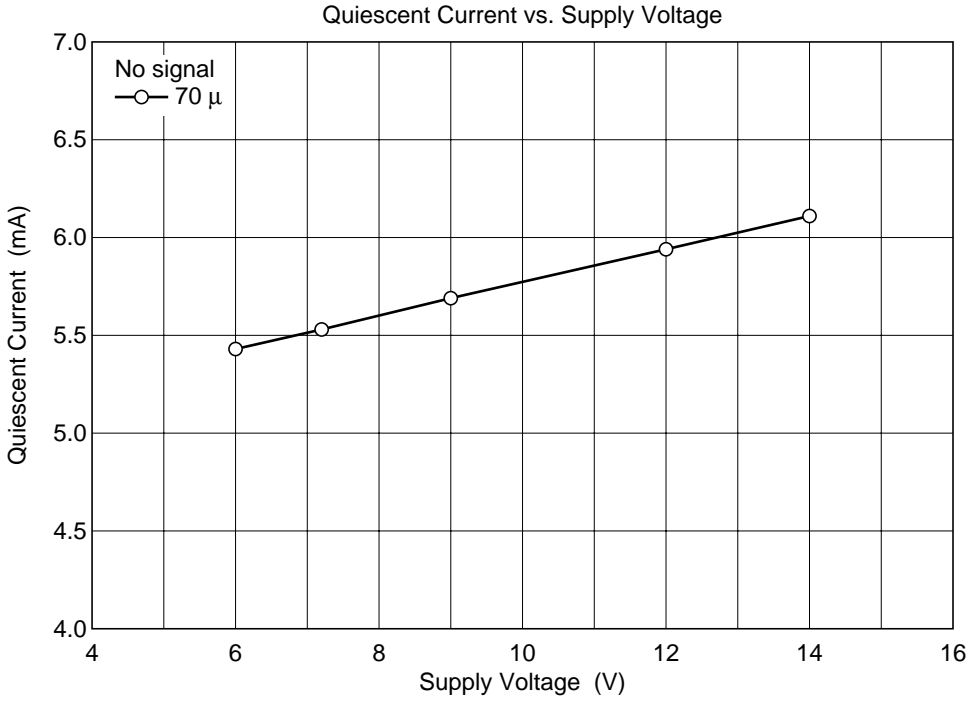
$$I_L = \frac{DV_{CC} - \text{MS(OUT)}_{LO}^*}{R_L}$$

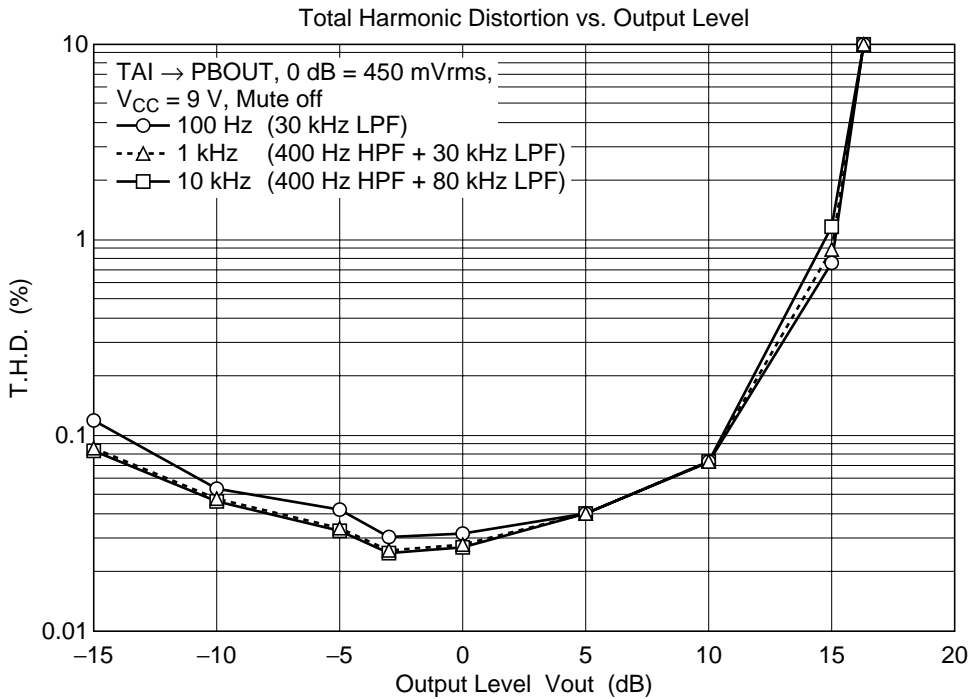
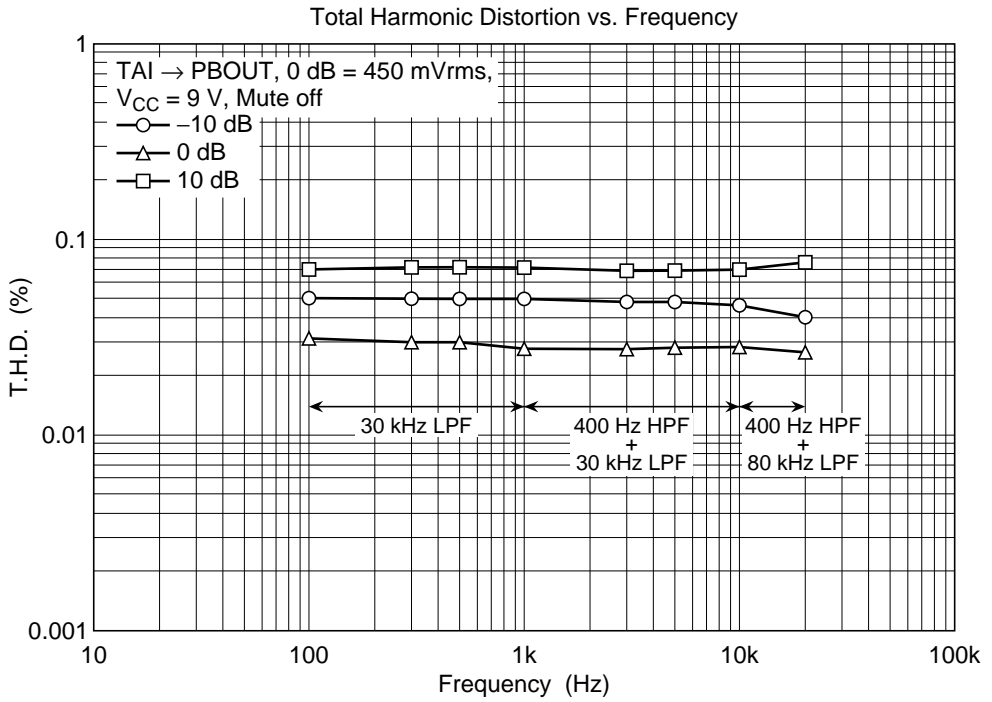
\* MS(OUT)<sub>LO</sub> : Sensing signal (about 1V)

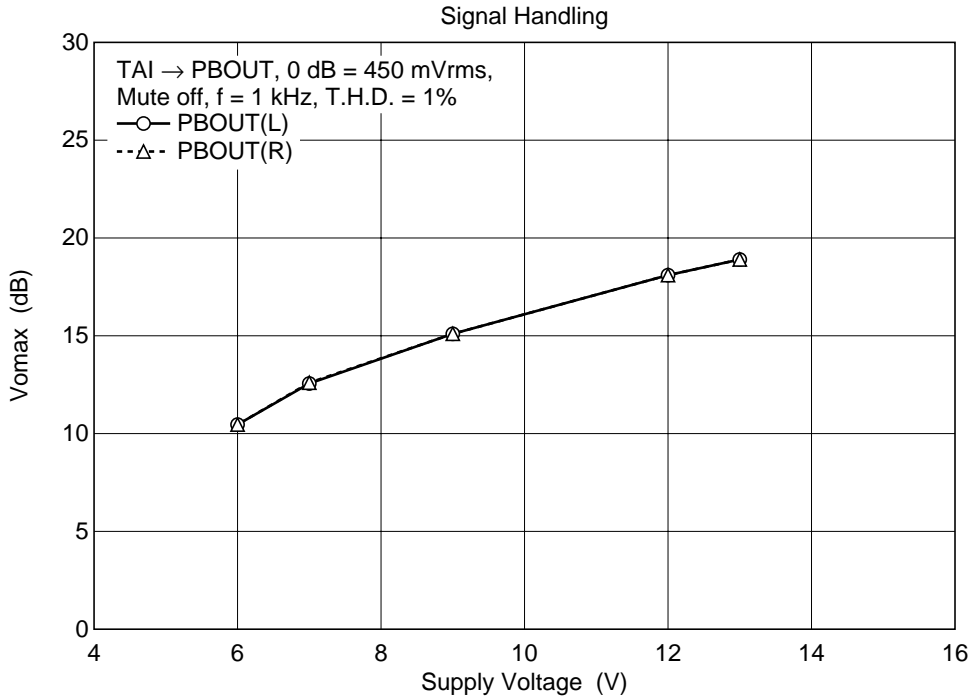
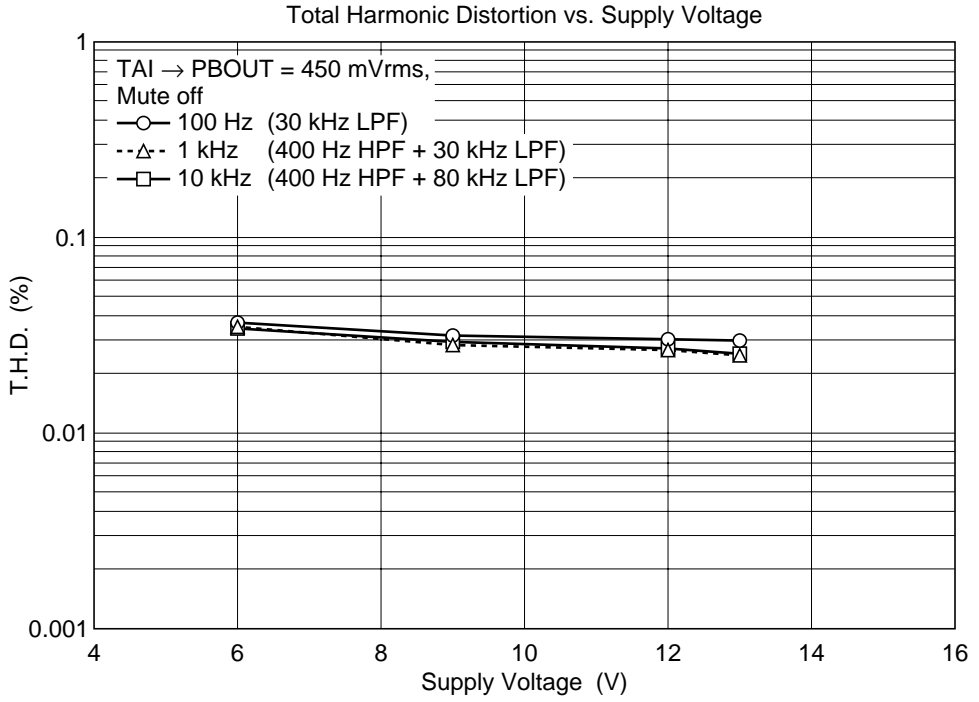
Note: Supply voltage of MS(OUT) pin must be less than  $V_{CC}$  voltage.

Characteristic Curves

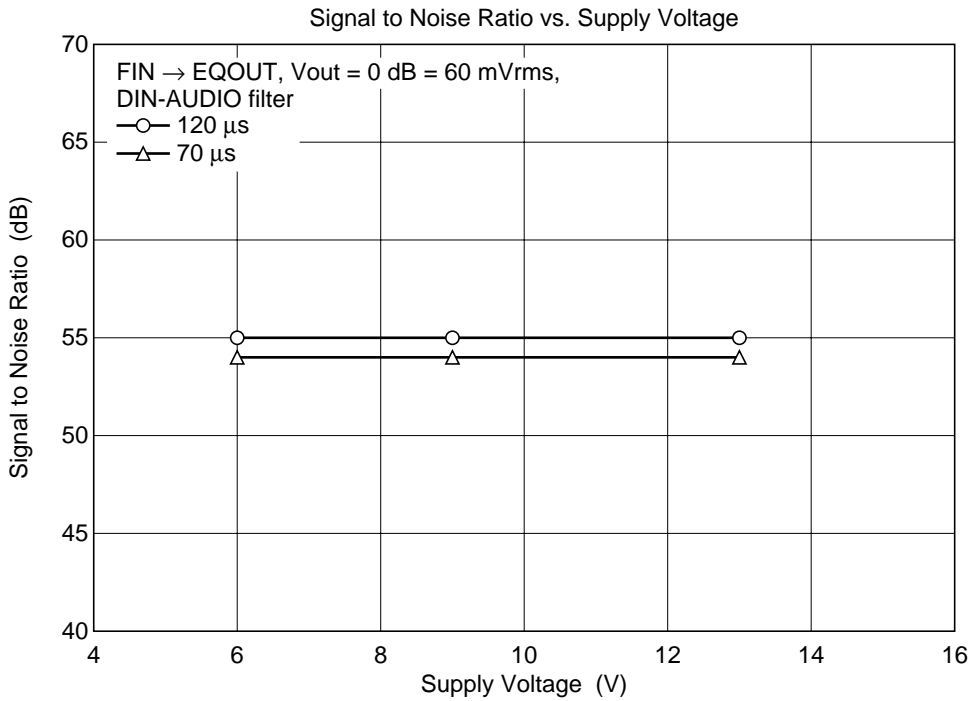
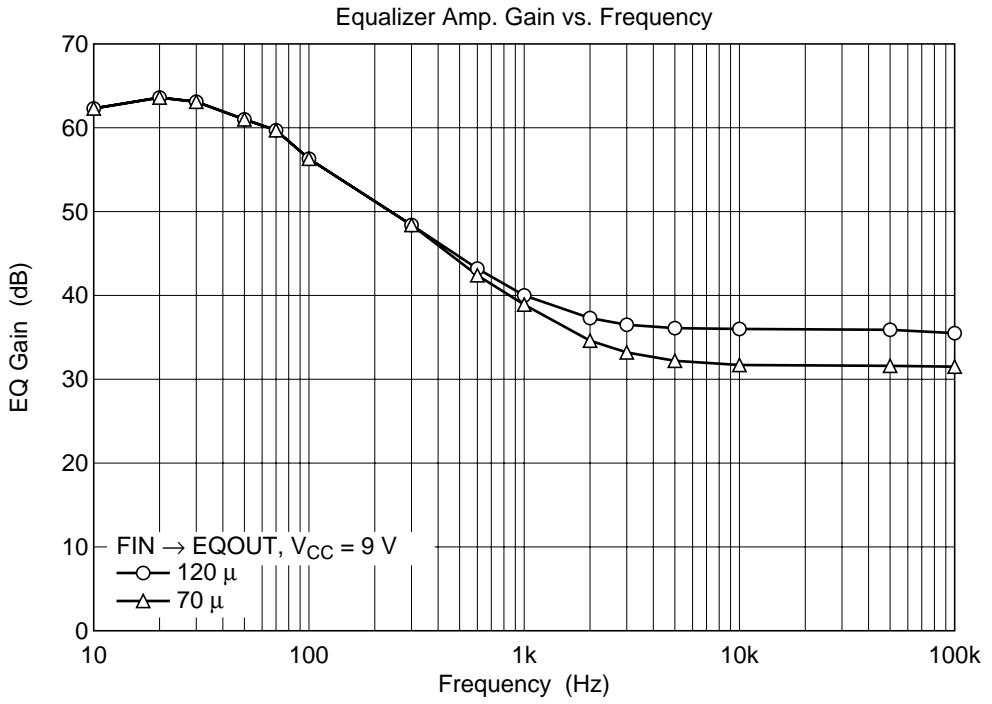


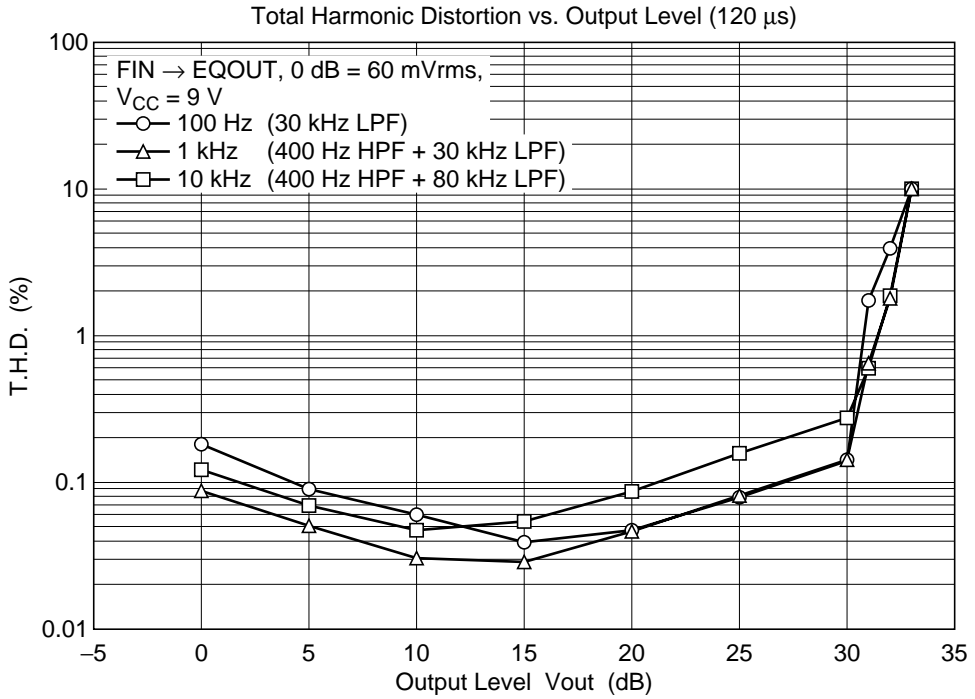
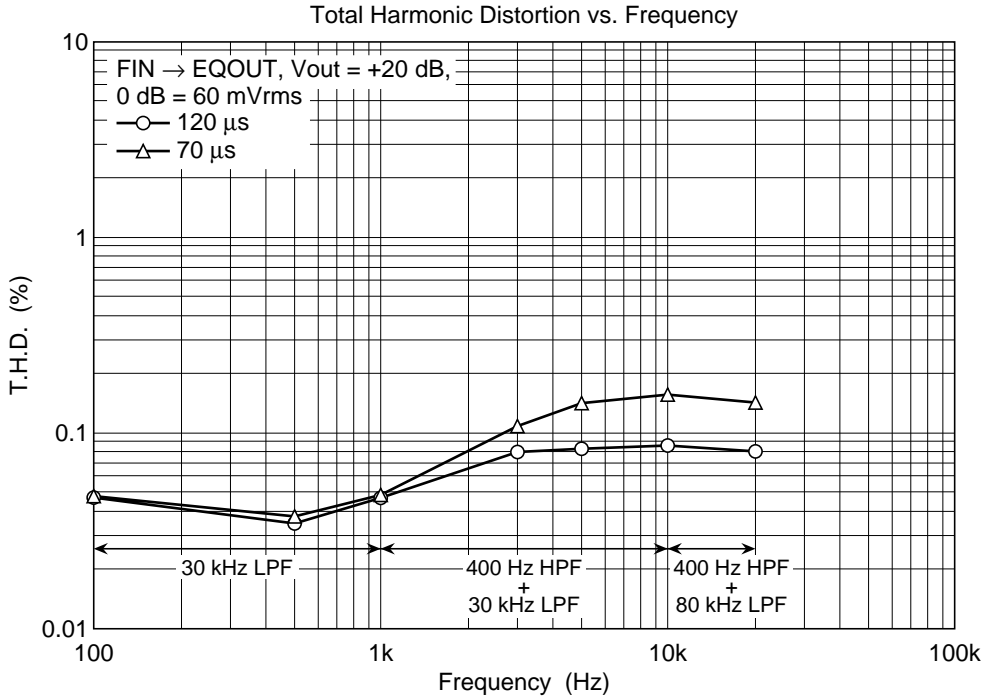


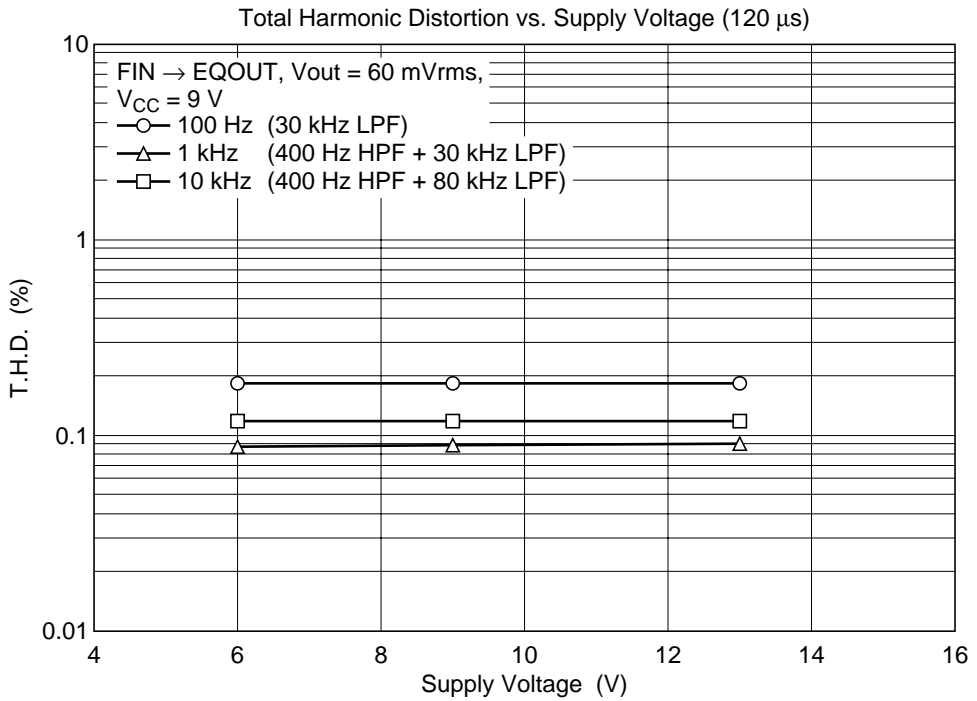
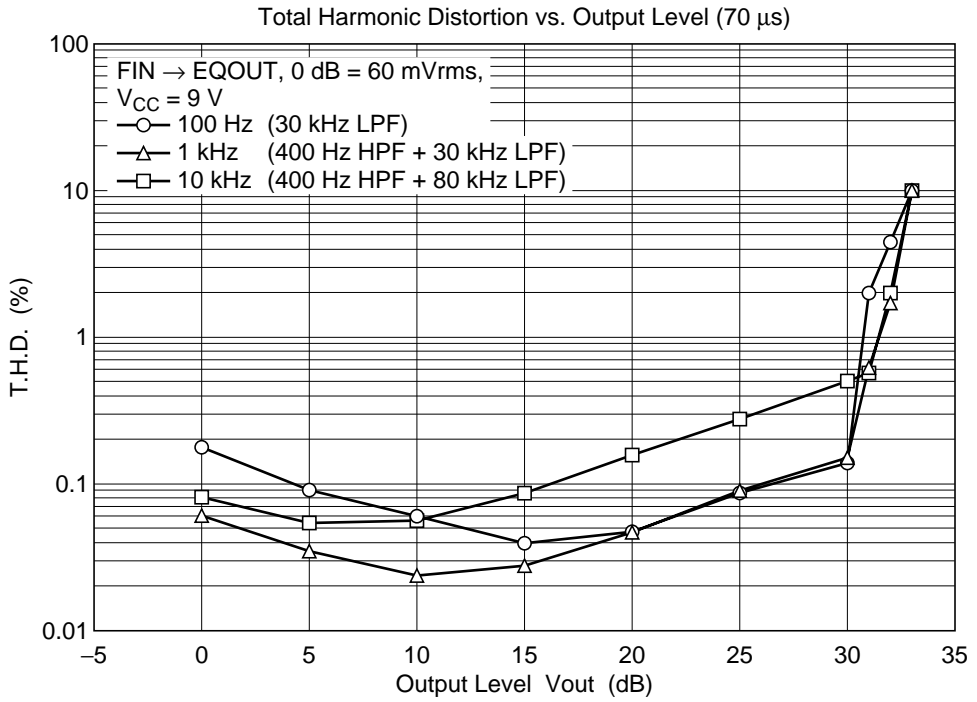


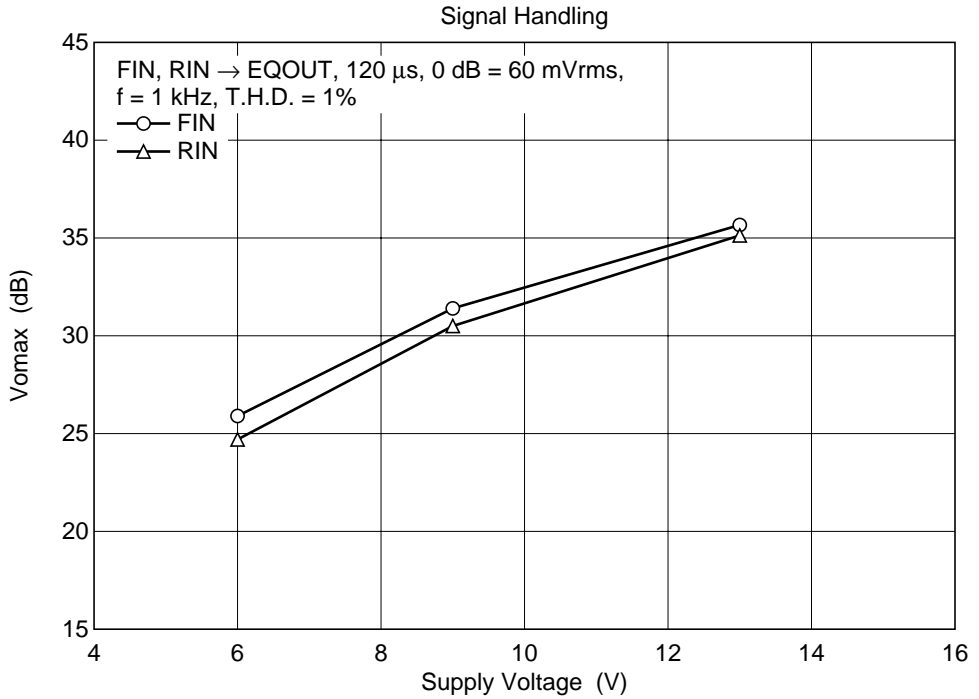
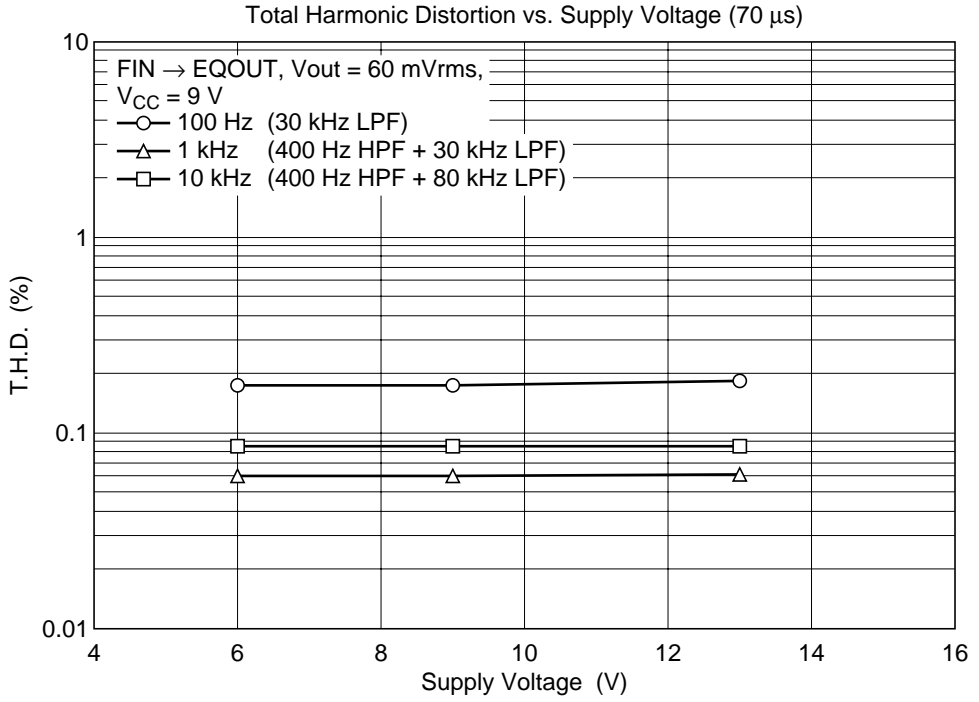


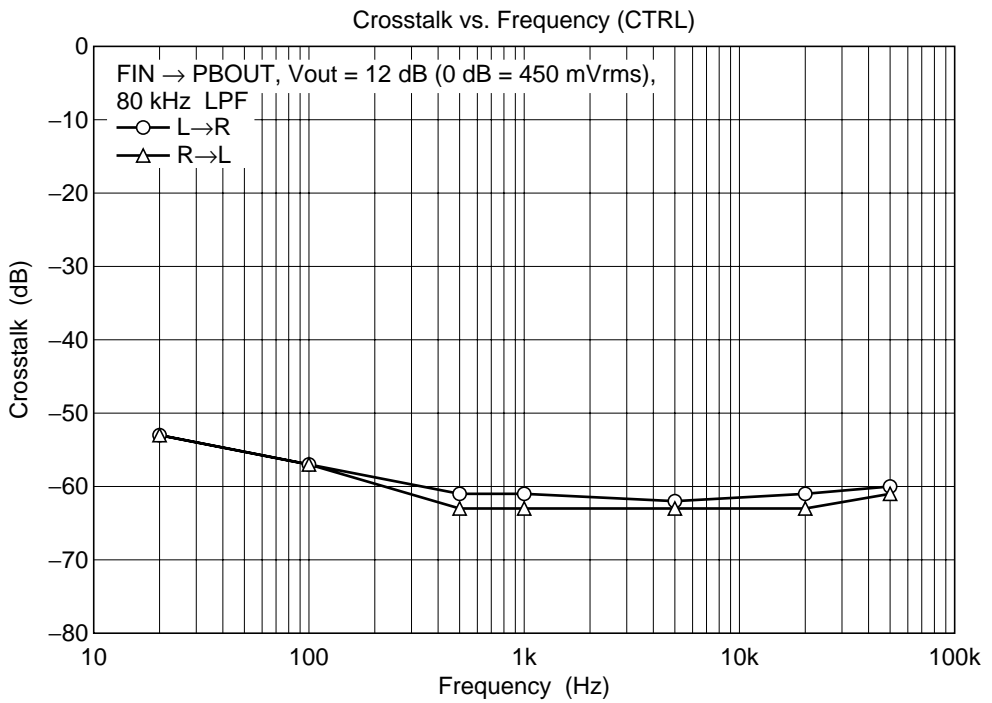
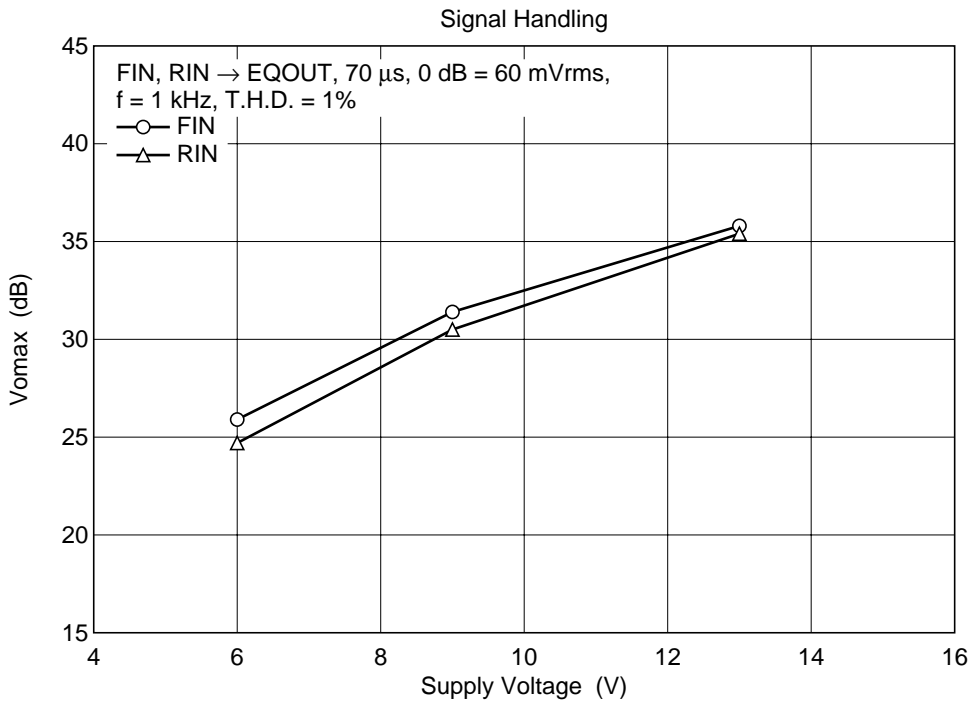


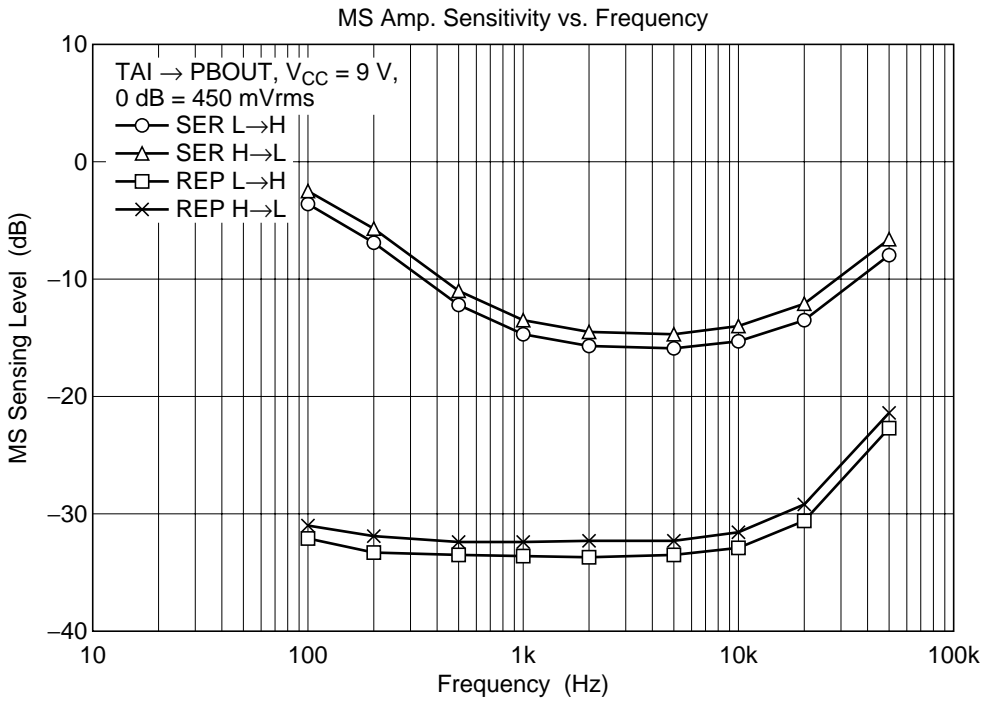
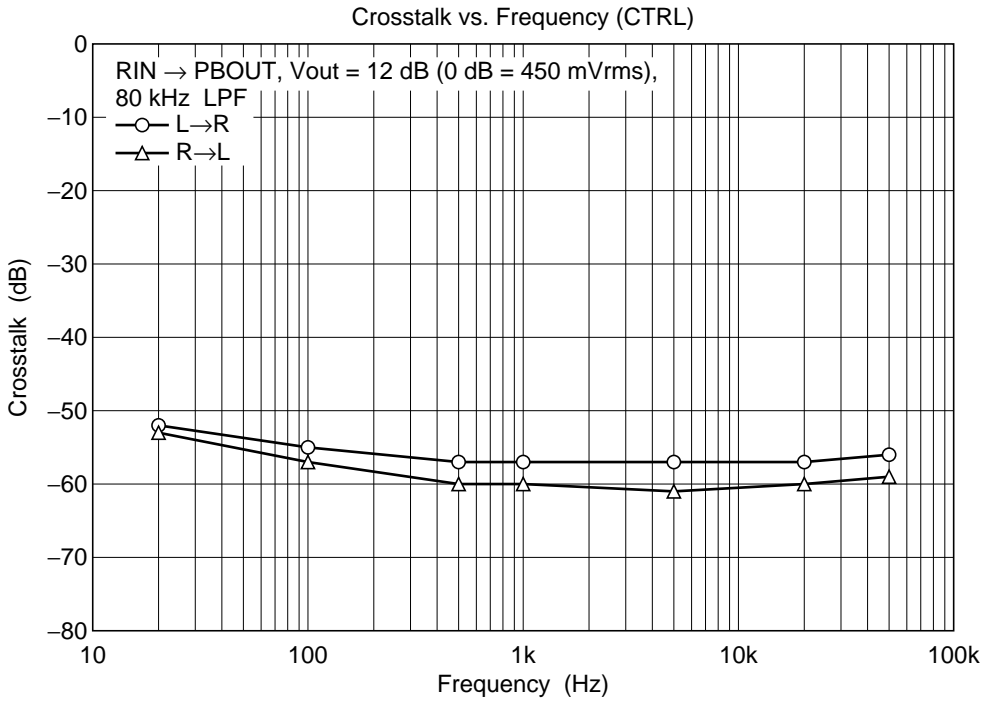


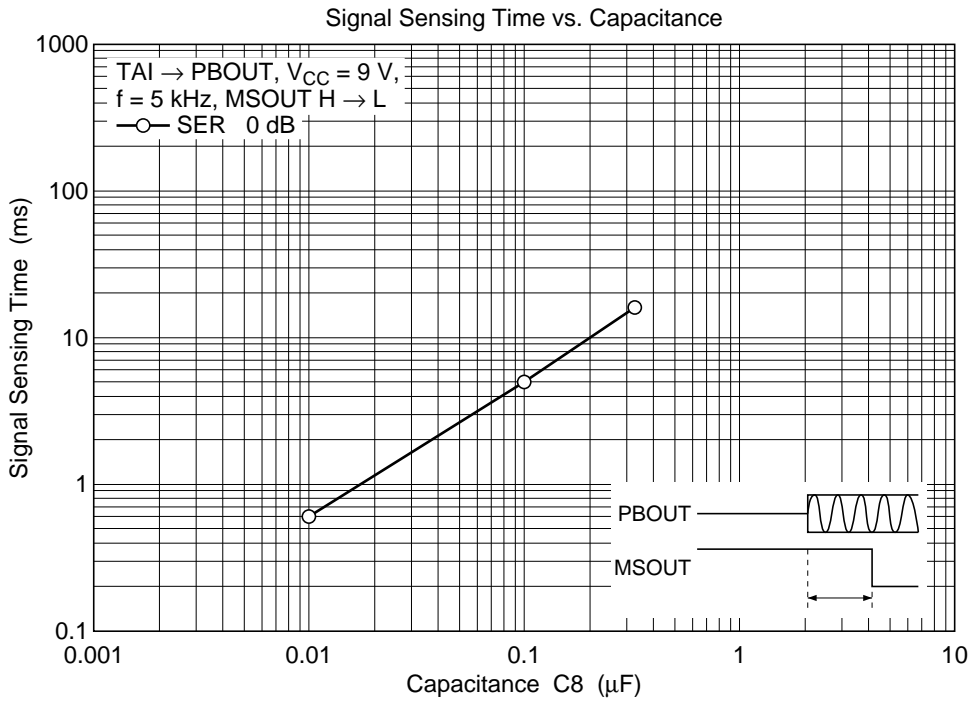
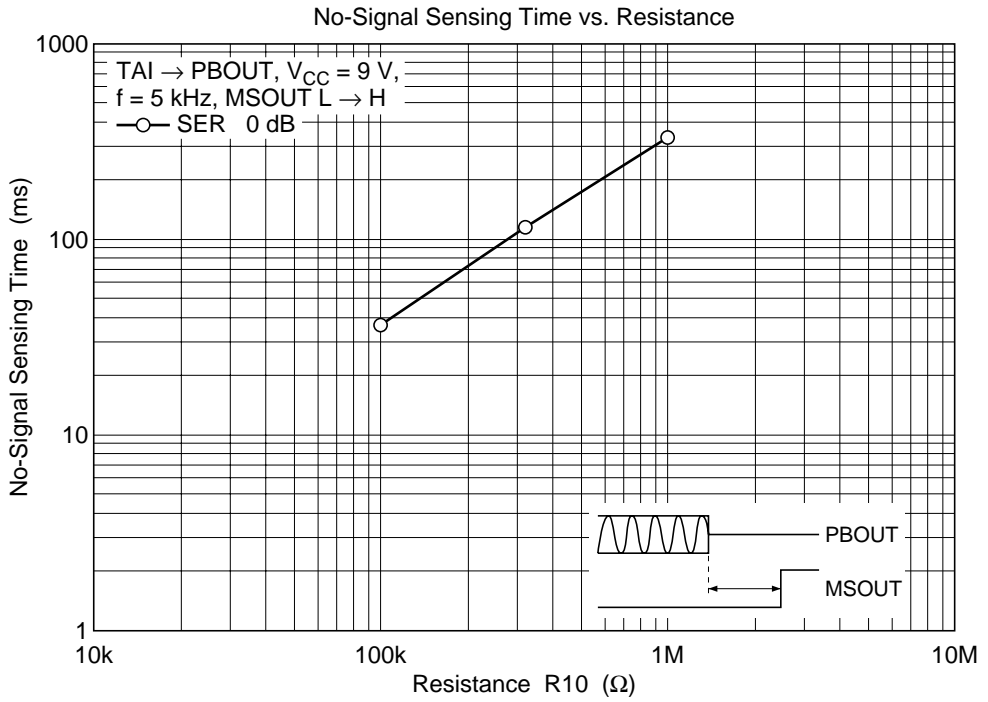






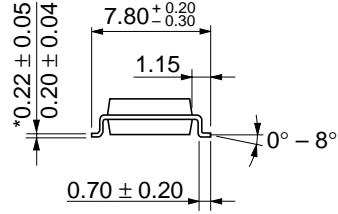
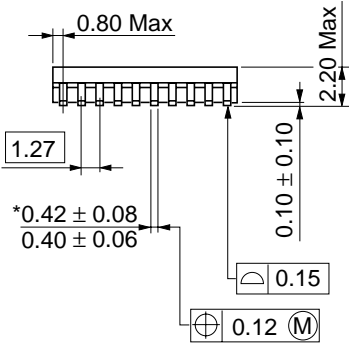
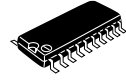
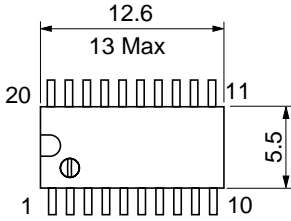






## Package Dimensions

Unit: mm



\*Dimension including the plating thickness  
Base material dimension

|                        |          |
|------------------------|----------|
| Hitachi Code           | FP-20DA  |
| JEDEC                  | —        |
| EIAJ                   | Conforms |
| Mass (reference value) | 0.31 g   |



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