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April 1, 2003

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# HA12216F/HA12221F Series

Audio Signal Processor for Car Deck
(Decode only Dolby B type NR with PB Amp.)

ADE-207-254E (Z)

6th Edition
Dec. 2000

## Description

HA12216F/HA12221F series are silicon monolithic bipolar IC providing Dolby B type noise reduction, music sensor, PB equalizer system in one chip.

Note: 1. Dolby is a trademark of Dolby Laboratories Licensing Corporation.
A license from Dolby Laboratories Licensing Corporation is required for the use of this IC.
2. HA12221F series does not include Dolby B NR.

## Functions

- PB equalizer × 2 channel
- Music sensor × 1 channel
- Dolby B NR (Only HA12216F series) × 2 channel
- Line mute (Tape radio) SW × 2 channel

## Features

- Different type of PB equalizer characteristics selection (120 µs/70 µs) is available with fully electronic control switching built-in.
- Changeable to Forward, Reverse-mode for PB head with fully electronic control switching built-in.
- Available to change music sensing level by external resistor.
- Available to change response of music sensor by external capacitor.
- Music sensing level, built-in switch to change a band ($MSG_V$).
- NR ON/OFF fully electronic control switching built-in. (Only HA12216F series)
- Line mute (Tape radio) control switching built-in.
- Available to connect direct with MPU.
- These ICs are strong for a cellular phone noise. (18 dB improvement from HA12163)

## Ordering Information

### Operating Voltage

| Product | Min | Max | Unit |
|---|---|---|---|
| HA12216F/HA12221F | 6.5 | 12 | V |
| HA12217F/HA12222F | 6.8 | 12 | V |
| HA12218F/HA12223F | 7.2 | 12 | V |

Note: 1. These ICs are designed to operate on single supply.
2. HA12217F and HA12218F, HA12222F and HA12223F are develop, there meets comply with your demands.

### Standard Level

| Product | Package | PB-OUT Level |
|---|---|---|
| HA12216F/HA12221F | FP-40 | 300 mVrms |
| HA12217F/HA12222F | FP-40 | 387.5 mVrms |
| HA12218F/HA12223F | FP-40 | 450 mVrms |

### Function

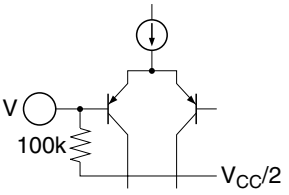
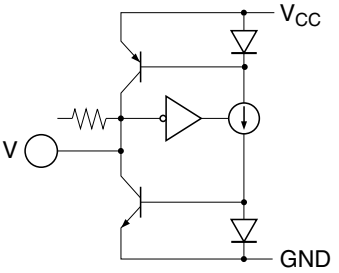
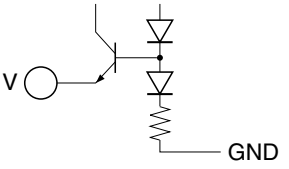
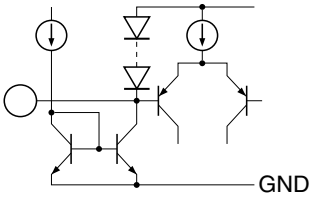
| Product | PB-EQ | Music Sensor | Mute | Dolby B NR |
|---|---|---|---|---|
| HA12216F series | ❍ | ❍ | ❍ | ❍ |
| HA12221F series | ❍ | ❍ | ❍ | × |

## Parallel-Data Format

| Pin No. | Pin Name | Lo | Hi |
|---|---|---|---|
| 10 | TAPE/RADIO | TAPE | RADIO |
| 11* | NR ON/OFF | NR OFF | NR ON |
| 12 | 120 μ/70 μ | 120 μ (Normal) | 70 μ (Metal or Chrome) |
| 13 | Forward/Reverse | Forward | Reverse |
| 14 | Search/Repeat | Search (FF or REV) | Repeat (Normal Speed) |

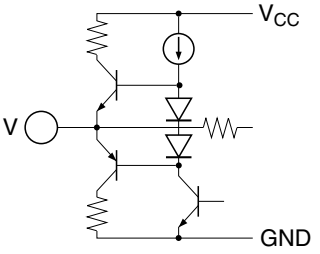
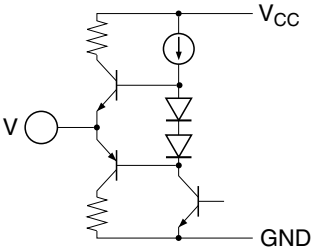
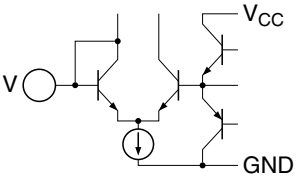
Note: Non connection regarding HA12221F series.

**Pin Description, Equivalent Circuit** ($V_{CC}$ = 9 V, A system of single supply voltage, Ta = 25°C, No Signal, The value in the show typical value.)

| Pin No. | Terminal Name | Note | Equivalent Circuit | Pin Description |
|---|---|---|---|---|
| 18 | MSI | V = $V_{CC}$/2 |  | MS input *1 |
| 28 | TAI (L) | | | Tape input |
| 3 | TAI (R) | | | |
| 26 | RAI (L) | | | Radio input (Mute) |
| 5 | RAI (R) | | | |
| 23 *2 | DET (L) | V = 2.5V |  | Time constant pin for rectifier |
| 8 *2 | DET (R) | | | |
| 33 | RIP | V = $V_{CC}$/2 | | Ripple filter |
| 4 *2 | Bias | V = 0.28V |  | Dolby bias current input |
| 17 | MSDET | — |  | Time constant pin for rectifier |

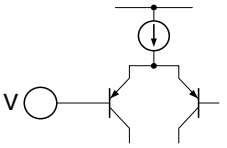
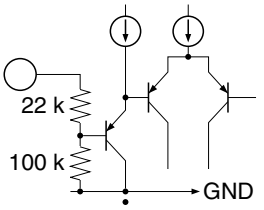
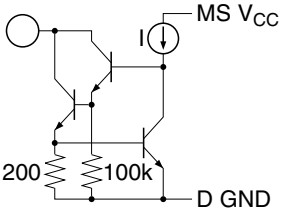
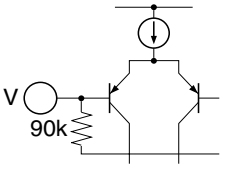
Note: 1. MS: Music Sensor
2. Non connection regarding HA12221F series.

**Pin Description, Equivalent Circuit** ($V_{CC}$ = 9 V, A system of single supply voltage, Ta = 25°C, No Signal, The value in the show typical value.) (cont)

| Pin No. | Terminal Name | Note | Equivalent Circuit | Pin Description |
|---|---|---|---|---|
| 25 | PBOUT (L) | V = $V_{CC}$/2 |  | PB output |
| 6 | PBOUT (R) | | | |
| 19 | MAOUT | V = $V_{CC}$/2 |  | MS amp. output *1 |
| 38 | VREF | | | Reference output |
| 29 | EQOUT (L) | | | Equalizer output (120µ) |
| 2 | EQOUT (R) | | | |
| 30 | M-OUT (L) | V = $V_{CC}$/2 |  | Equalizer output (70µ) |
| 1 | M-OUT (R) | | | |
| 16 | $V_{CC}$ | — | | Power supply |
| 7 | NC | — | | No connection |
| 9 | | | | |
| 22 | | | | |
| 24 | | | | |
| 27 | | | | |

Note: 1. MS: Music Sensor

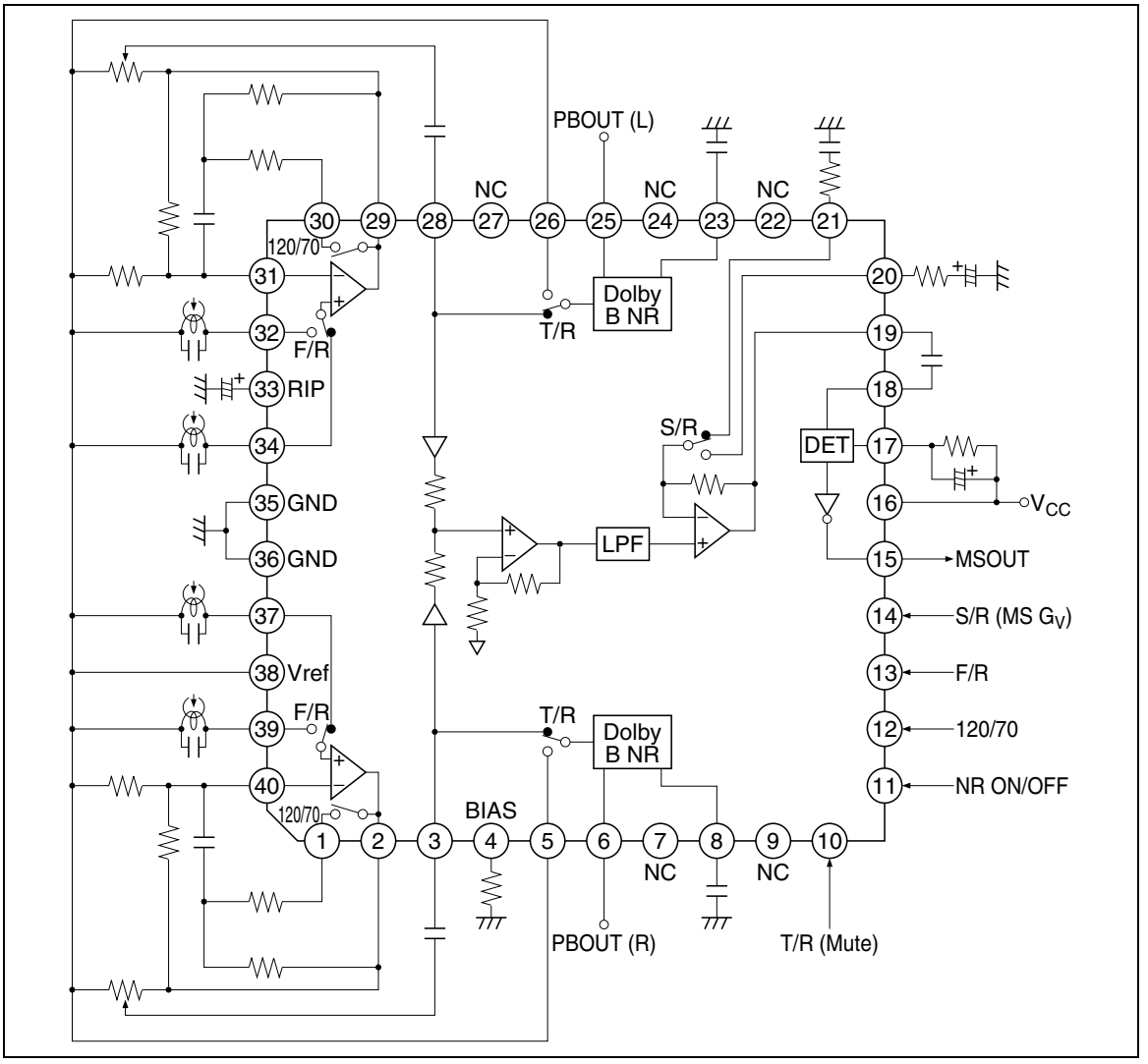
**Pin Description, Equivalent Circuit** ($V_{CC}$ = 9 V, A system of single supply voltage, Ta = 25°C, No Signal, The value in the show typical value.) (cont)

| Pin No. | Terminal Name | Note | Equivalent Circuit | Pin Description |
|---|---|---|---|---|
| 34 | FIN (L) | — |  | Equalizer intput (Forward) |
| 37 | FIN (R) | | | |
| 32 | RIN (L) | | | Equalizer intput (Reverse) |
| 39 | RIN (R) | | | |
| 31 | NFI (L) | | | Negative feedback |
| 40 | NFI (R) | | | |
| 10 | T/R (Mute) | — |  | Mode control input |
| 11 *2 | NR ON/OFF | | | |
| 12 | 120/70 | | | |
| 13 | F/R | | | |
| 14 | S/R (MS $G_v$) | | | |
| 15 | MSOUT | — |  | MS output (to MPU) *1 |
| 20 | MS $G_v$ (R) | V = $V_{CC}$/2 |  | MS gain terminal *1 |
| 21 | MS $G_v$ (S) | | | |
| 35 | GND | — | | GND pin |
| 36 | | | | |

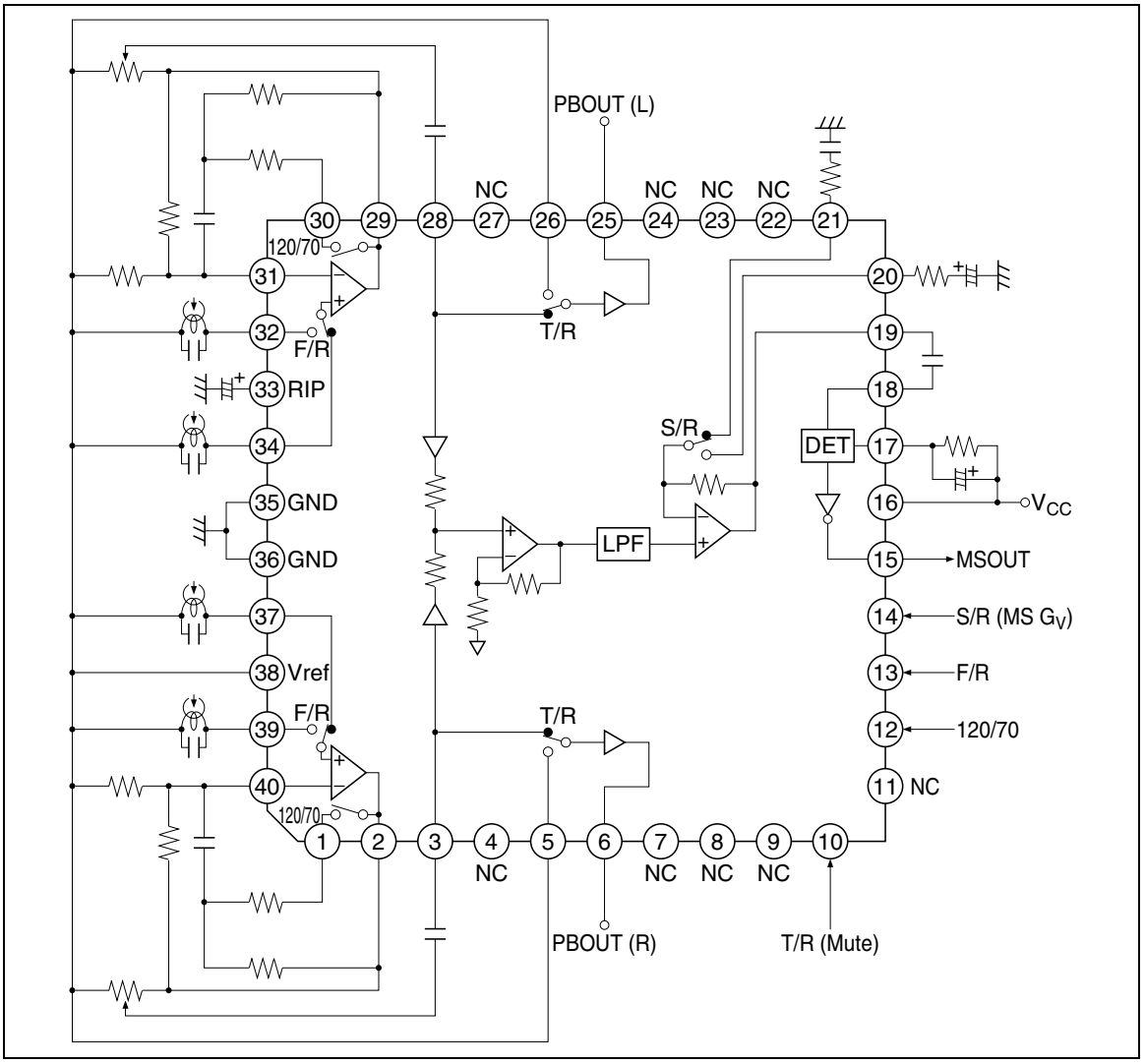
Note: 1. MS: Music Sensor
2. Non connection regarding HA12221F series.

## Block Diagram

### HA12216F Series



**HA12221F Series**



## Functional Description

### Power Supply Range

HA12216F/HA12221F series are provided with three line output level, which will permit on optimum overload margin for power supply conditions. And these are designed to operate on single supply only.

**Table 1 Supply Voltage Range**

| Product | Single Supply |
|---|---|
| HA12216F/HA12221F | 6.5 V to 12.0 V |
| HA12217F/HA12222F | 6.8 V to 12.0 V |
| HA12218F/HA12223F | 7.2 V to 12.0 V |

Note: The lower limit of supply voltage depends on the line output reference level.
The minimum value of the overload margin is specified as 12 dB by Dolby Laboratories.

### Reference Voltage

These devices provide the reference voltage of half the supply voltage that is the signal grounds. As the peculiarity of these devices, 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.

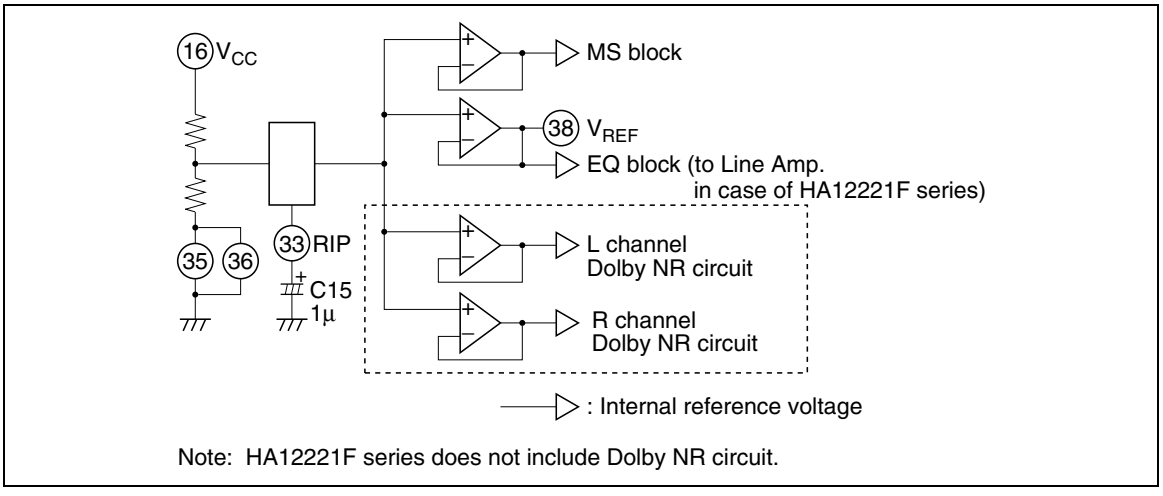


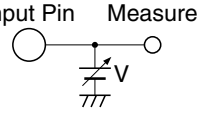

**Figure 1 The Block Diagram of Reference Supply Voltage**

**Operating Mode Control**

HA12216F/HA12221F series 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 |
|---|---|---|---|---|
| 10, 11*, 12, 13, 14 | –0.2 to 1.0 | 3.5 to $V_{CC}$ | V |  |



Note: * Non connection regarding HA12221F series.

**Table 3 Switching Truth Table**

| Pin No. | Lo | Hi |
|---|---|---|
| 10 | TAPE | RADIO |
| 11* | NR OFF | NR ON |
| 12 | 120 μ (Normal) | 70 μ (Metal or Chrome) |
| 13 | FORWARD | REVERSE |
| 14 | SER (FF or REV) | REP (Normal Speed) |

Notes: * Non connection regarding HA12221F series.

1. Each pins are on pulled down with 100 kΩ 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 kΩ to 22 kΩ resisitor and 1 μF to 22 μF capacitor shown figure 2.

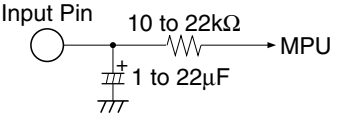




**Figure 2 Interface for Reduction of Pop Noise**

**Input Block Diagram and Level Diagram**

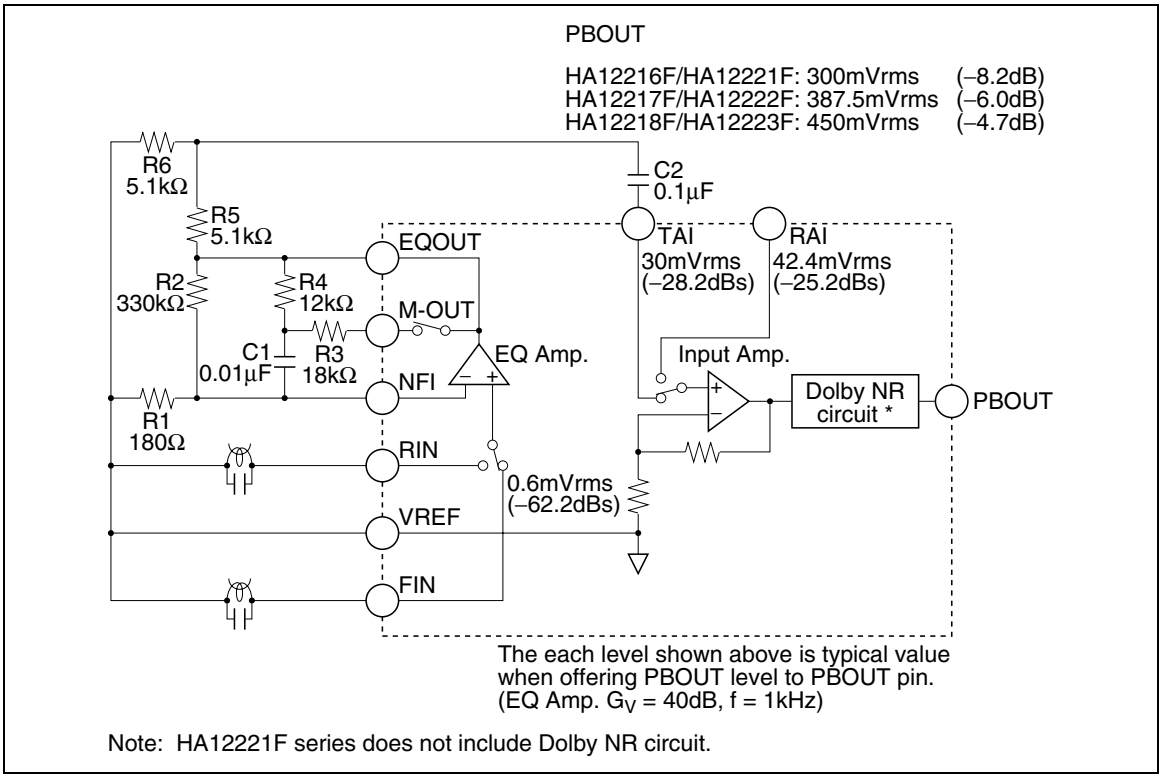



**Figure 3 Input Block Diagram**

**Adjustment of Playback Reference Operate Level**

After replace R5 and R6 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.

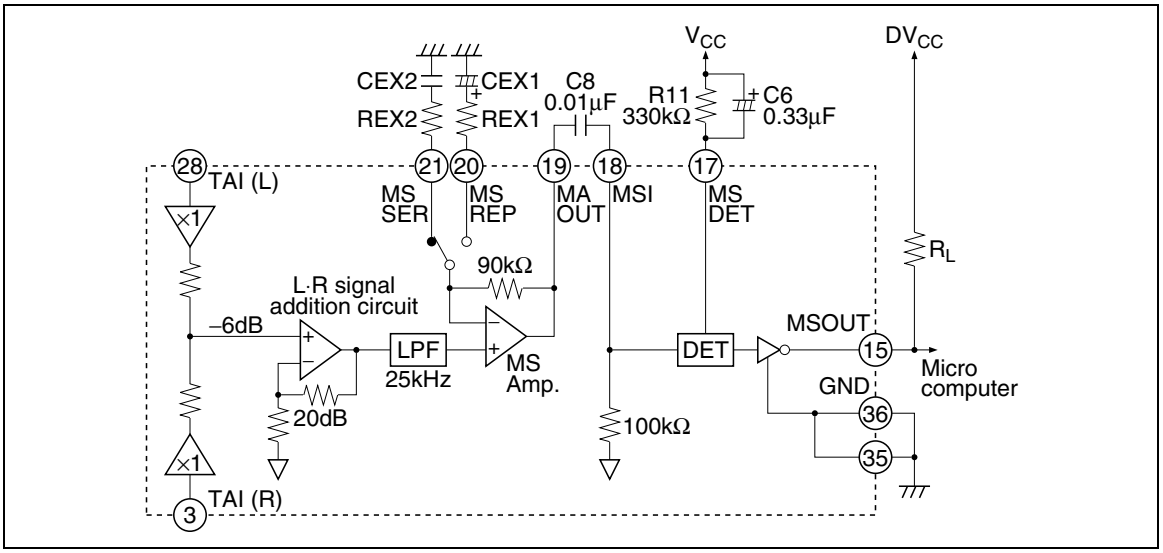



**Figure 4 Music Sensor Block Diagram**

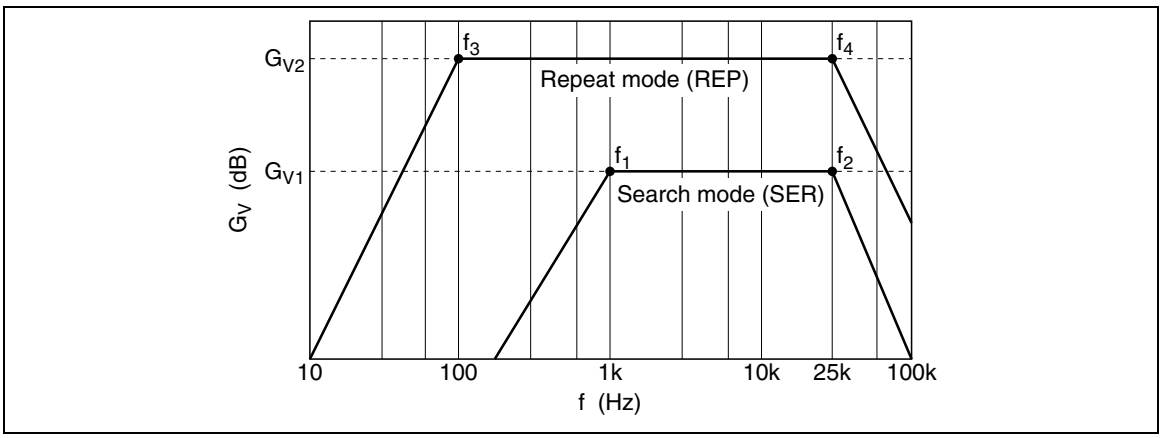



**Figure 5 Frequency Response**

1. Serch mode

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

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

2. Repeat mode

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

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

$G_V$IA: L·R signal addition circuit gain.

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

$$S = -\left(G_V{}^{*1} - 20\log\frac{130^{*3}}{30^{*2}}\right) = 12.7 - G_V \quad [dB]$$

Note: 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 (one side channel) | S (both 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: S is 6 dB down in case of one-side channel. And this MS presented hysteresis lest MSOUT terminal should turn over again Hi level or Lo level, in case of thresh S level constantly.

**Music Sensor Time Constant**

1. Sensing no signal to signal (Attack) is determined by C6, 0.01 µF to 1 µF capacitor C6 can be applicable.
2. Sensing signal to no signal (Recovery) is determined by C6 and R11, however preceding (1), 100 kΩ to 1 MΩ can be applicable.

**Music Sensor Output (MSOUT)**

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.

$$I_L = \frac{DV_{CC} - MSOUT_{LO}{}^*}{R_L}$$

* $MSOUT_{LO}$ : Sensing signal (about 1V)

Note: 1. Supply voltage of MSOUT pin must be less than $V_{CC}$ voltage.

**The Tolerances of External Components for Dolby NR** (Only HA12216F Series)

For adequate Dolby NR tracking response, take external components shown below.
Also, leak is small capacity, and please employ a good quality object.

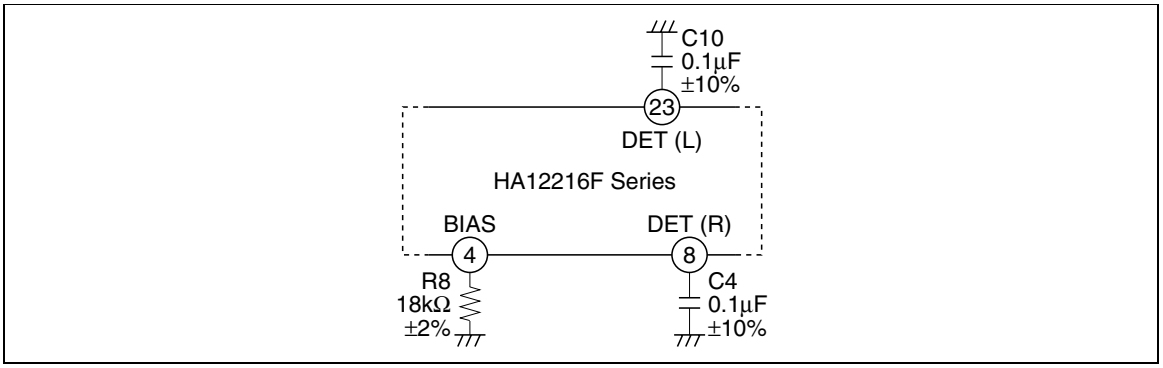
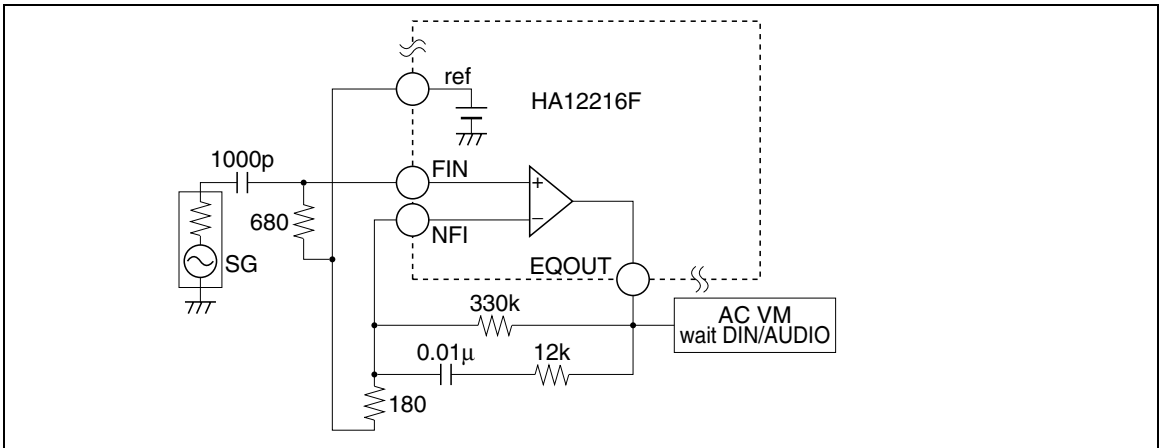



**Figure 6 Tolerance of External Components**

**Countermeasure of a Cellular Phone Noise**

This IC have reinforced a cellular phone noise countermeasure, to show it hereinafter.
However, it is presumed that this effect change it greatly, by a mount set.
Please sufficiently examine an arrangement of positions, shield method, wiring pattern, in order to oftain a maximum effect.
A high terminal of a noise sensitivity of this IC is FIN, RIN, NFI and RIP.




Note: Test condition

- Use for SG by cellular radio for an evaluation use.
- SG output mode
  PDC system, burst
  UP Tch (Transmission mode on the side of a movement machine)
- To evaluate a capacitor of 1000 pF as connecting with it directly.
- About EQOUT output, what you measure through DIN/AUDIO filter.

**Figure 7 Test Circuit**

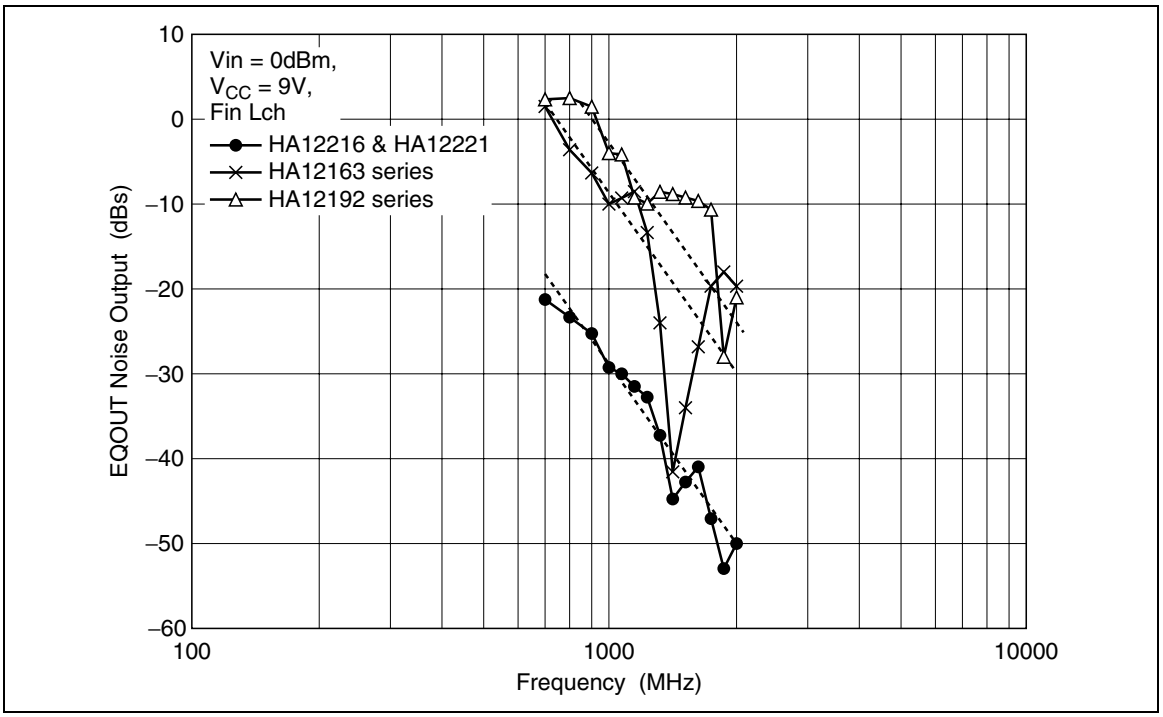



**Figure 8 EQOUT Noise Output vs. Transmission Frequency Characteristic**

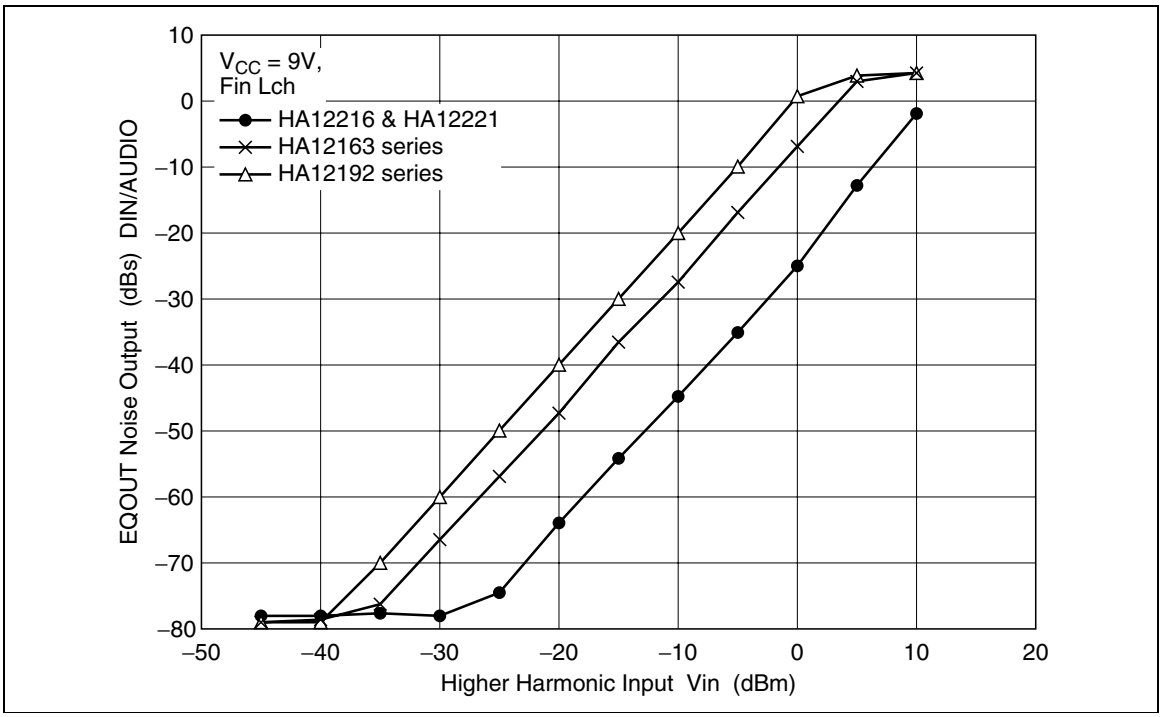



**Figure 9 EQOUT Noise Output vs. Transmission**

## Absolute Maximum Ratings (Ta = 25°C)

| Item | Symbol | Rating | Unit | Note |
|---|---|---|---|---|
| Maximum supply voltage | $V_{cc}$ Max | 16 | V | |
| Power dissipation | Pd | 400 | mW | Ta ≤ 85°C |
| Operating temperature | Topr | –40 to +85 | °C | |
| Storage temperature | Tstg | –55 to +125 | °C | |

## Electrical Characteristics

### HA12216F Series

(Ta = 25°C, $V_{CC}$ = 9.0 V, PBOUT Level 300 mVrms(HA12216F) 387.5 mVrms(HA12217F) 450 mVrms(HA12218F))

| Item | | Symbol | Test Condition: IC Condition: NR ON/OFF | 120µ/70µ | F/R | T/R | S/R | Input | Output | fin (Hz) | PBOUT level (dB) | | Min | Typ | Max | Unit | Application Terminal: Input R | Input L | Output R | Output L | | Remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Quiescent current | | $I_Q$ | ON | 70µ | F | T | S | — | — | — | — | No signal | 4.0 | 9.5 | 15.0 | mA | — | — | — | — | 16 | |
| Input Amp. gain | HA12216F | $G_V$IA TAI | OFF | — | — | T | — | TAI | PBOUT | 1k | 0 | | 18.8 | 19.8 | 20.8 | dB | 3 | 28 | 6 | 25 | | |
| | | $G_V$IA RAI | OFF | — | — | R | — | RAI | PBOUT | 1k | 0 | | 15.8 | 16.8 | 17.8 | | 5 | 26 | | | | |
| | HA12217F | $G_V$IA TAI | OFF | — | — | T | — | TAI | PBOUT | 1k | 0 | | 21.2 | 22.2 | 23.2 | | 3 | 28 | | | | |
| | | $G_V$IA RAI | OFF | — | — | R | — | RAI | PBOUT | 1k | 0 | | 18.2 | 19.2 | 20.2 | | 5 | 26 | | | | |
| | HA12218F | $G_V$IA TAI | OFF | — | — | T | — | TAI | PBOUT | 1k | 0 | | 22.5 | 23.5 | 24.5 | | 3 | 28 | | | | |
| | | $G_V$IA RAI | OFF | — | — | R | — | RAI | PBOUT | 1k | 0 | | 19.5 | 20.5 | 21.5 | | 5 | 26 | | | | |
| B-type decode cut | | DEC-2k (1) | ON | — | — | T | — | TAI | PBOUT | 2k | –20 | | 2.8 | 4.3 | 5.8 | dB | 3 | 28 | 6 | 25 | | |
| | | DEC-2k (2) | ON | — | — | T | — | TAI | PBOUT | 2k | –30 | | 7.0 | 8.5 | 10.0 | | | | | | | |
| | | DEC-5k (1) | ON | — | — | T | — | TAI | PBOUT | 5k | –20 | | 1.7 | 3.2 | 4.7 | | | | | | | |
| | | DEC-5k (2) | ON | — | — | T | — | TAI | PBOUT | 5k | –30 | | 6.7 | 8.2 | 9.7 | | | | | | | |
| PBOUT offset | | Vofs | OFF | — | — | T↔R | — | — | PBOUT | — | — | $V_{CC}$=12V, No signal | –150 | 0.0 | 150 | mV | 3 | 28 | 6 | 25 | | |
| Signal handling | | Vo max | ON | — | — | T | — | TAI | PBOUT | 1k | — | THD=1% | 12.0 | 13.0 | — | dB | 3 | 28 | 6 | 25 | | 1 |
| Signal to noise ratio | | S/N | ON | — | — | T | — | TAI | PBOUT | (1k) | (0) | Rg=10kΩ, CCIR/ARM | 70.0 | 80.0 | — | dB | (3) | (28) | 6 | 25 | | |
| T.H.D. | | THD | ON | — | — | T | — | TAI | PBOUT | 1k | 0 | | — | 0.05 | 0.3 | % | 3 | 28 | 6 | 25 | | |
| Channel separation | | CT RL (1) | OFF | — | — | R | — | RAI | PBOUT | 1k | (+12) | | 70.0 | 80.0 | — | dB | 3 | 28 | 6→25 | 25→6 | | |
| | | CT RL (2) | OFF | 120µ | F | T | — | FIN | PBOUT | 1k | (+12) | | 50.0 | 60.0 | — | | 37 | 34 | | | | |
| Crosstalk | | CT EQ→RAI | OFF | 120µ | F | T→R | — | FIN | PBOUT | 1k | (+12) | | 70.0 | 80.0 | — | dB | 37 | 34 | 6 | 25 | | |
| | | CT RAI→EQ | OFF | 120µ | F | R→T | — | RAI | PBOUT | 1k | (+12) | | 50.0 | 60.0 | — | | 5 | 26 | | | | |
| PB-EQ gain | | $G_V$ EQ 1k | — | 120µ | F/R | — | — | FIN/RIN | EQOUT | 1k | — | Vin=0.6mVrms | 37.0 | 40.0 | 43.0 | dB | 37/39 | 34/32 | 2 | 29 | | |
| | | $G_V$ EQ 10k(1) | — | 120µ | F | — | — | FIN | EQOUT | 10k | — | | 33.0 | 36.0 | 39.0 | | 37 | 34 | | | | |
| | | $G_V$ EQ 10k(2) | — | 70µ | F | — | — | FIN | EQOUT | 10k | — | | 29.0 | 32.0 | 35.0 | | 37 | 34 | | | | |
| PB-EQ Max output level | | $V_{OM}$ | — | 120µ | F/R | — | — | FIN | EQOUT | 1k | — | THD=1% | 300 | 600 | — | mVrms | 37/39 | 34/32 | 2 | 29 | | 1 |
| PB-EQ THD | | THD-EQ | — | 120µ | F/R | — | — | FIN/RIN | EQOUT | 1k | — | Vin=3mVrms | — | 0.1 | 0.3 | % | 37/39 | 34/32 | 2 | 29 | | |
| Noise level converted in input | | $V_N$ | — | 120µ | F/R | — | — | FIN/RIN | EQOUT | (1k) | — | Rg=680Ω, DIN-AUDIO | — | 0.7 | 1.5 | µVrms | (37/39) | (34/32) | 2 | 29 | | |
| MS sensitivity level | | $V_{ON}$ (1) | — | — | — | T | R | TAI | PBOUT | 5k | — | | –36 | –32 | –28 | dB | 3 | 28 | 2 | 29 | 15 | |
| | | $V_{ON}$ (2) | — | — | — | T | S | TAI | PBOUT | 5k | — | | –18 | –14 | –10 | | | | | | | |
| MS output low level | | $V_{OL}$ | — | — | — | T | S | TAI | MSOUT | 5k | 0 | | — | 1.0 | 1.5 | V | 3 | 28 | — | — | 15 | |
| MS output leak current | | $I_{OH}$ | — | — | — | — | — | — | MSOUT | — | — | No signal | — | 0.0 | 2.0 | µA | — | — | — | — | 15 | |
| Control voltage | | $V_{IL}$ | — | — | — | — | — | — | — | — | — | | –0.2 | — | 1.0 | V | — | — | — | — | 10 to 14 | |
| | | $V_{IH}$ | — | — | — | — | — | — | — | — | — | | 3.5 | — | $V_{CC}$ | | | | | | | |

Note: 1. HA12216F: $V_{CC}$ = 6.5V
HA12217F: $V_{CC}$ = 6.8V
HA12218F: $V_{CC}$ = 7.2V

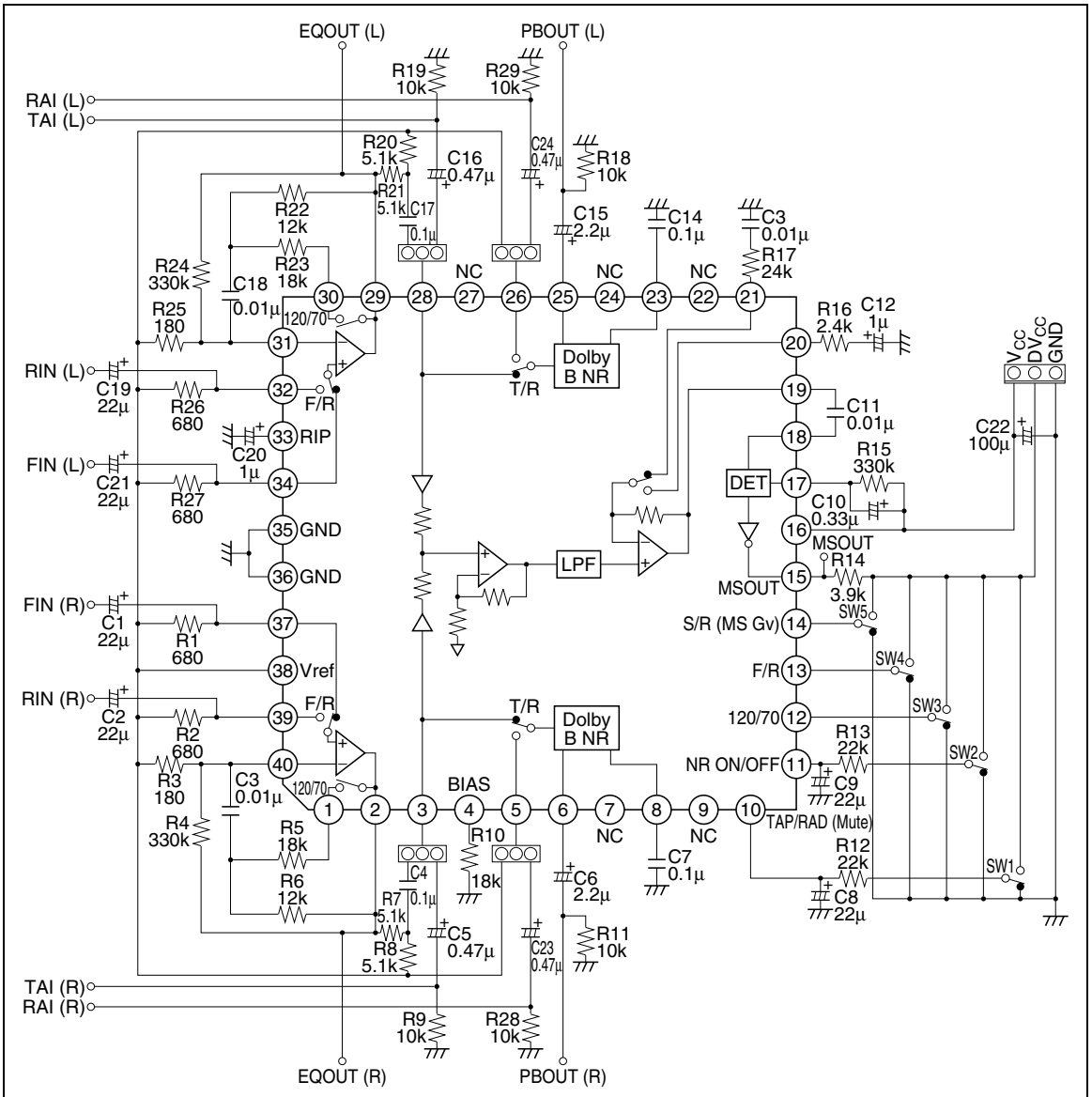
(Ta = 25°C, $V_{CC}$ = 9.0 V, PBOUT Level 300 mVrms(HA12221F) 387.5 mVrms(HA12222F) 450 mVrms(HA12223F))

| Item | | Symbol | Test Condition | | | | | | | | | Min | Typ | Max | Unit | Application Terminal | | | | | Remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | IC Condition | | | | | | | | | | | | | Input | | Output | | | |
| | | | 120µ/70µ | F/R | T/R | S/R | Input | Output | fin (Hz) | PBOUT level (dB) | | | | | | R | L | R | L | | |
| Quiescent current | | $I_Q$ | 70µ | F | T | S | — | — | — | — | No signal | 3.0 | 5.0 | 8.0 | mA | — | — | — | — | 16 | |
| Input Amp. gain | HA12221F | $G_V$IA TAI | — | — | T | — | TAI | PBOUT | 1k | 0 | | 19.0 | 20.0 | 21.0 | dB | 3 | 28 | 6 | 25 | | |
| | | $G_V$IA RAI | — | — | R | — | RAI | PBOUT | 1k | 0 | | 16.0 | 17.0 | 18.0 | | 5 | 26 | | | | |
| | HA12222F | $G_V$IA TAI | — | — | T | — | TAI | PBOUT | 1k | 0 | | 21.2 | 22.2 | 23.2 | | 3 | 28 | | | | |
| | | $G_V$IA RAI | — | — | R | — | RAI | PBOUT | 1k | 0 | | 18.2 | 19.2 | 20.2 | | 5 | 26 | | | | |
| | HA12223F | $G_V$IA TAI | — | — | T | — | TAI | PBOUT | 1k | 0 | | 22.5 | 23.5 | 24.5 | | 3 | 28 | | | | |
| | | $G_V$IA RAI | — | — | R | — | RAI | PBOUT | 1k | 0 | | 19.5 | 20.5 | 21.5 | | 5 | 26 | | | | |
| PBOUT offset | | Vofs | — | — | T↔R | — | — | PBOUT | — | — | $V_{CC}$=12V, No signal | –150 | 0.0 | 150 | mV | 3 | 28 | 6 | 25 | | |
| Signal handling | | Vo max | — | — | T | — | TAI | PBOUT | 1k | — | THD=1% | 12.0 | 13.0 | — | dB | 3 | 28 | 6 | 25 | | 1 |
| Signal to noise ratio | | S/N | — | — | T | — | TAI | PBOUT | (1k) | (0) | Rg=10kΩ, CCIR/ARM | 70.0 | 80.0 | — | dB | (3) | (28) | 6 | 25 | | |
| T.H.D. | | THD | — | — | T | — | TAI | PBOUT | 1k | 0 | | — | 0.05 | 0.3 | % | 3 | 28 | 6 | 25 | | |
| Channel separation | | CT RL (1) | — | — | R | — | RAI | PBOUT | 1k | (+12) | | 70.0 | 80.0 | — | dB | 3 | 28 | 6→25 | 25→6 | | |
| | | CT RL (2) | 120µ | F | T | — | FIN | PBOUT | 1k | (+12) | | 50.0 | 60.0 | — | | 37 | 34 | | | | |
| Crosstalk | | CT EQ→RAI | 120µ | F | T→R | — | FIN | PBOUT | 1k | (+12) | | 70.0 | 80.0 | — | dB | 37 | 34 | 6 | 25 | | |
| | | CT RAI→EQ | 120µ | F | R→T | — | RAI | PBOUT | 1k | (+12) | | 50.0 | 60.0 | — | | 5 | 26 | | | | |
| PB-EQ gain | | $G_V$ EQ 1k | 120µ | F/R | — | — | FIN/RIN | EQOUT | 1k | — | Vin=0.6mVrms | 37.0 | 40.0 | 43.0 | dB | 37/39 | 34/32 | 2 | 29 | | |
| | | $G_V$ EQ 10k(1) | 120µ | F | — | — | FIN | EQOUT | 10k | — | | 33.0 | 36.0 | 39.0 | | 37 | 34 | | | | |
| | | $G_V$ EQ 10k(2) | 70µ | F | — | — | FIN | EQOUT | 10k | — | | 29.0 | 32.0 | 35.0 | | 37 | 34 | | | | |
| PB-EQ Max output level | | $V_{OM}$ | 120µ | F/R | — | — | FIN | EQOUT | 1k | — | THD=1% | 300 | 600 | — | mVrms | 37/39 | 34/32 | 2 | 29 | | 1 |
| PB-EQ THD | | THD-EQ | 120µ | F/R | — | — | FIN/RIN | EQOUT | 1k | — | Vin=3mVrms | — | 0.1 | 0.3 | % | 37/39 | 34/32 | 2 | 29 | | |
| Noise level converted in input | | $V_N$ | 120µ | F/R | — | — | FIN/RIN | EQOUT | (1k) | — | Rg=680Ω, DIN-AUDIO | — | 0.7 | 1.5 | µVrms | (37/39) | (34/32) | 2 | 29 | | |
| MS sensitivity level | | $V_{ON}$ (1) | — | — | T | R | TAI | PBOUT | 5k | — | | –36 | –32 | –28 | dB | 3 | 28 | 2 | 29 | 15 | |
| | | $V_{ON}$ (2) | — | — | T | S | TAI | PBOUT | 5k | — | | –18 | –14 | –10 | | | | | | | |
| MS output low level | | $V_{OL}$ | — | — | T | S | TAI | MSOUT | 5k | 0 | | — | 1.0 | 1.5 | V | 3 | 28 | — | — | 15 | |
| MS output leak current | | $I_{OH}$ | — | — | — | — | — | MSOUT | — | — | No signal | — | 0.0 | 2.0 | µA | — | — | — | — | 15 | |
| Control voltage | | $V_{IL}$ | — | — | — | — | — | — | — | — | | –0.2 | — | 1.0 | V | — | — | — | — | 10 to 14 | |
| | | $V_{IH}$ | — | — | — | — | — | — | — | — | | 3.5 | — | $V_{CC}$ | | | | | | | |

Note: 1. HA12221F: $V_{CC}$ = 6.5V
HA12222F: $V_{CC}$ = 6.8V
HA12223F: $V_{CC}$ = 7.2V

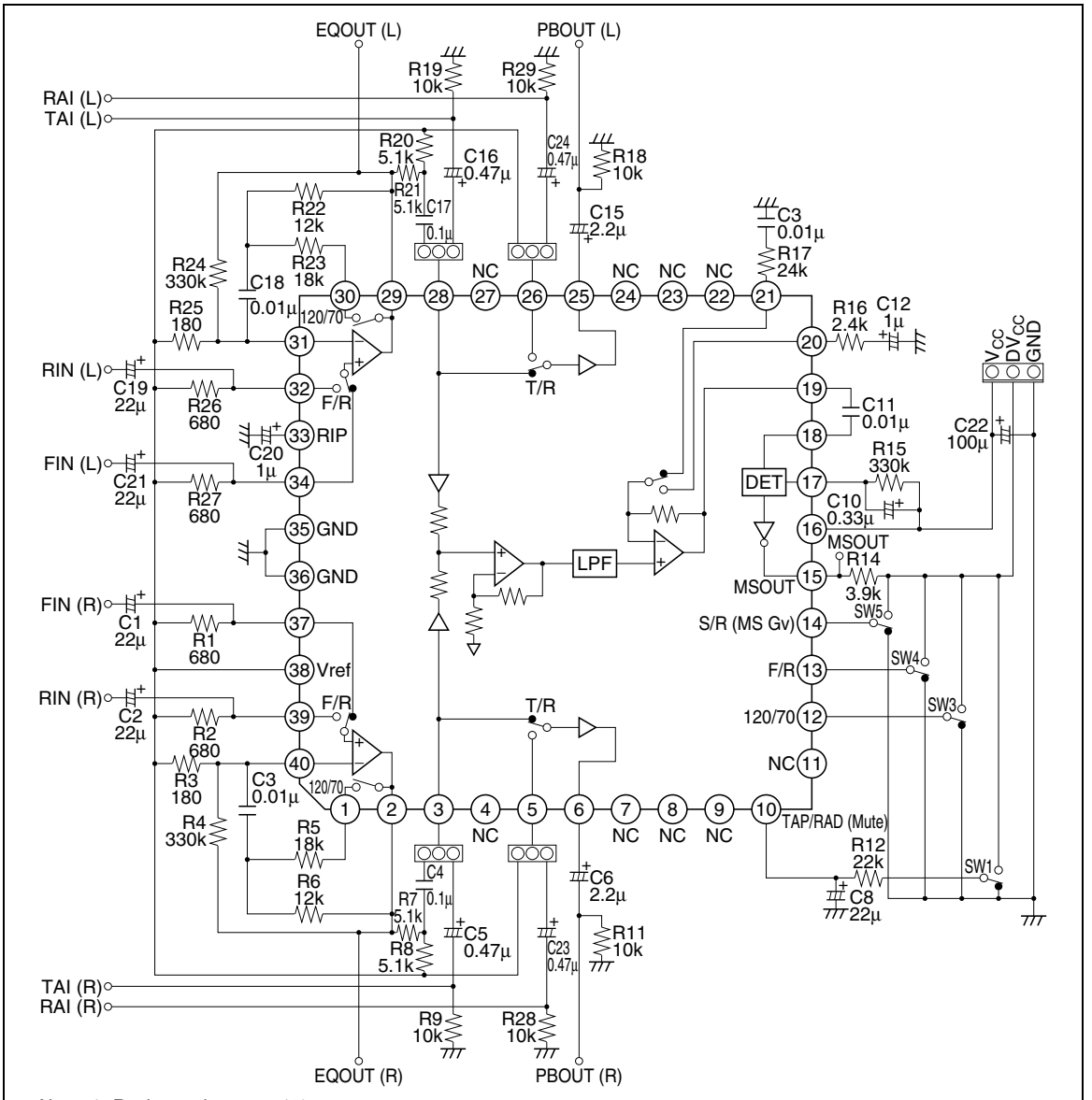
## Test Circuit

### HA12216F Series




Note: 1. Resistor tolerance ±1%
2. Capacitor tolerance ±1%
3. Unit R: Ω, C: F

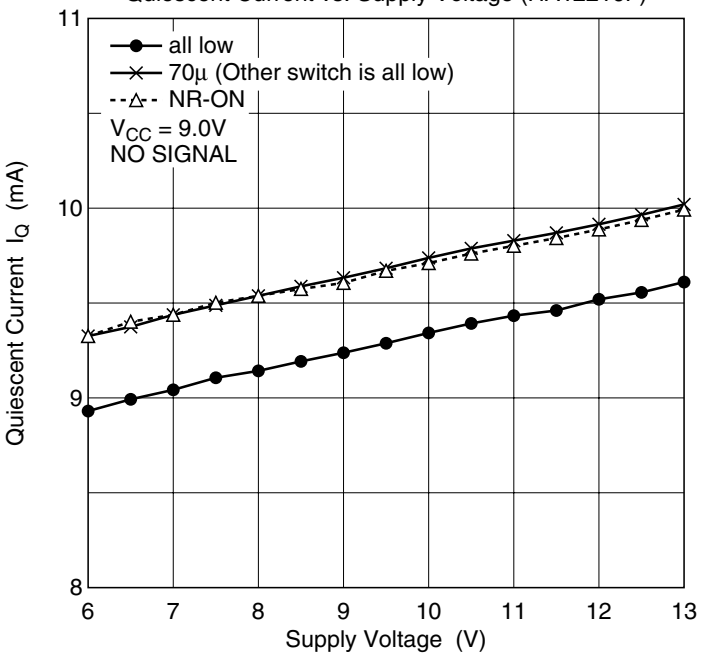
**HA12221F Series**



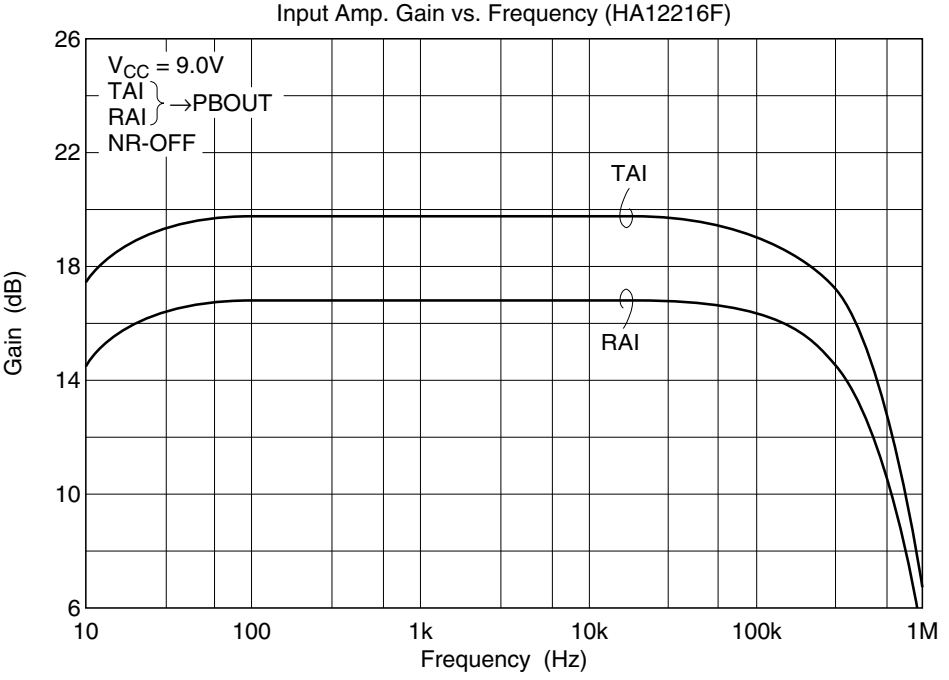

Note: 1. Resistor tolerance ±1%
2. Capacitor tolerance ±1%
3. Unit R: Ω, C: F

## Characteristic Curves

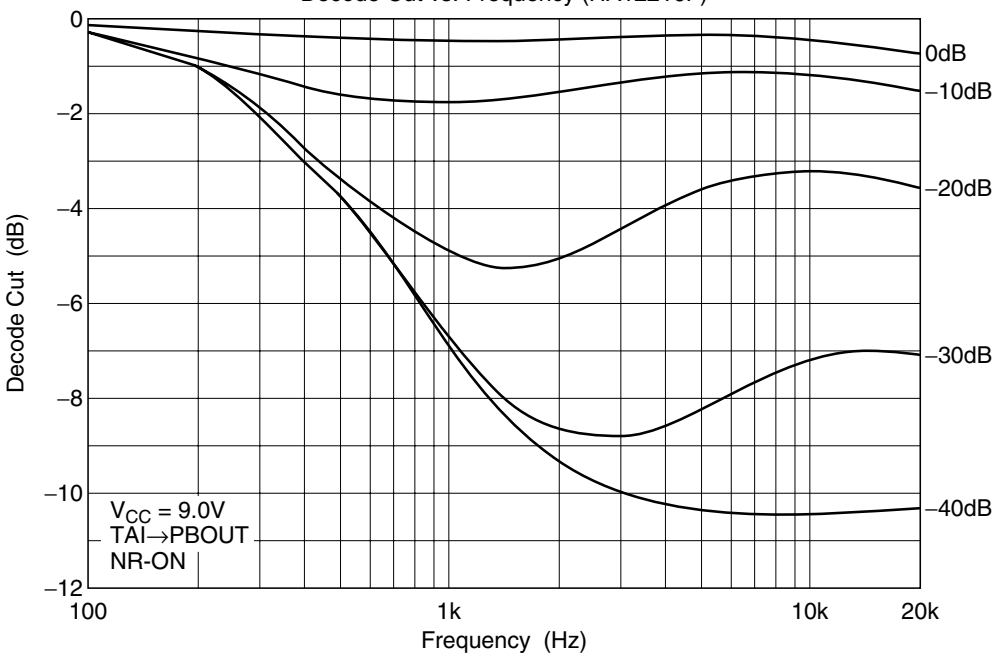
Quiescent Current vs. Supply Voltage (HA12216F)



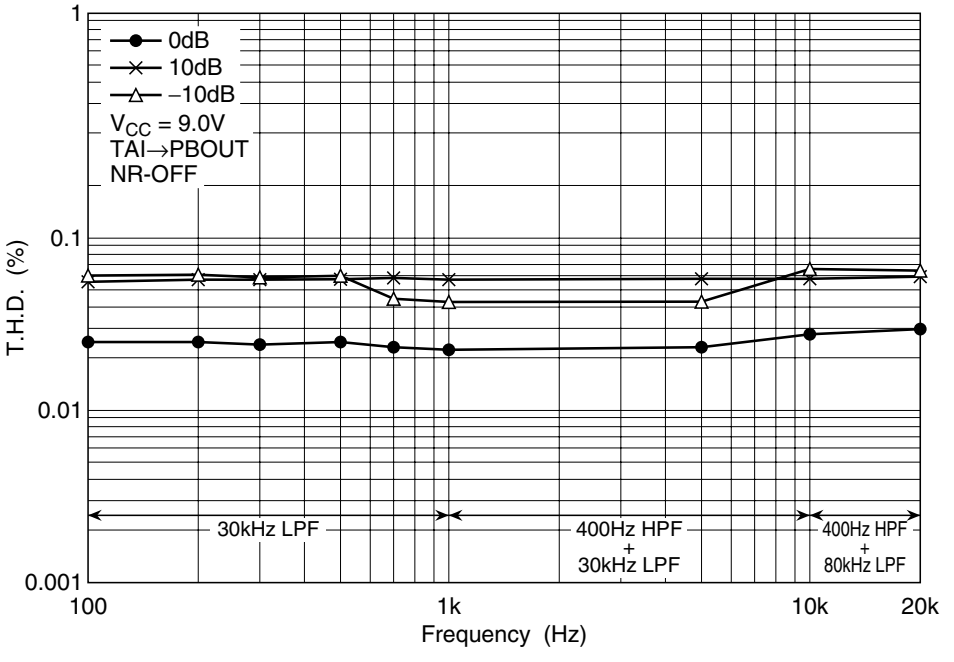

Input Amp. Gain vs. Frequency (HA12216F)



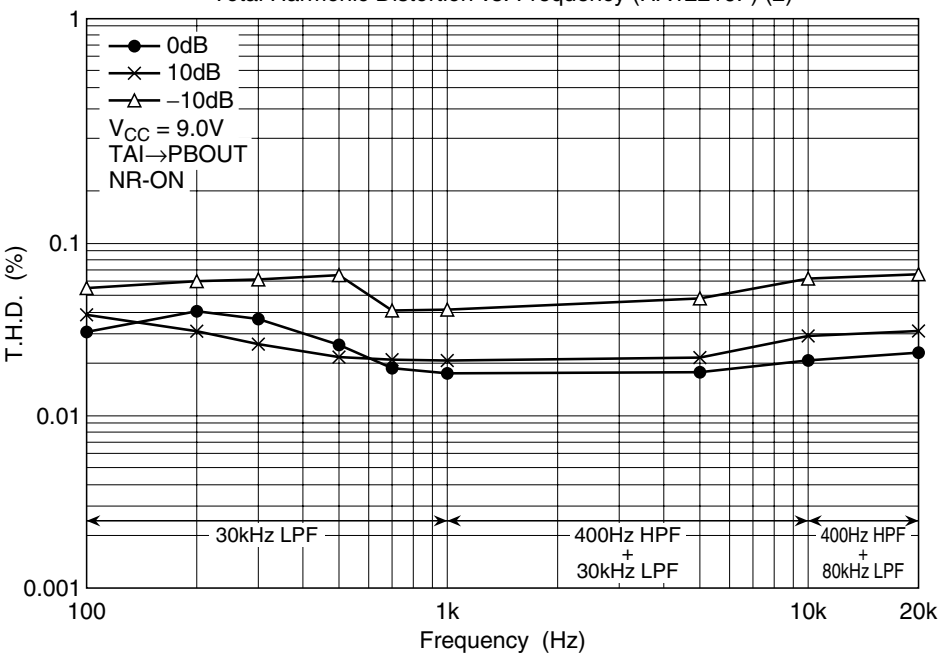
Decode Cut vs. Frequency (HA12216F)



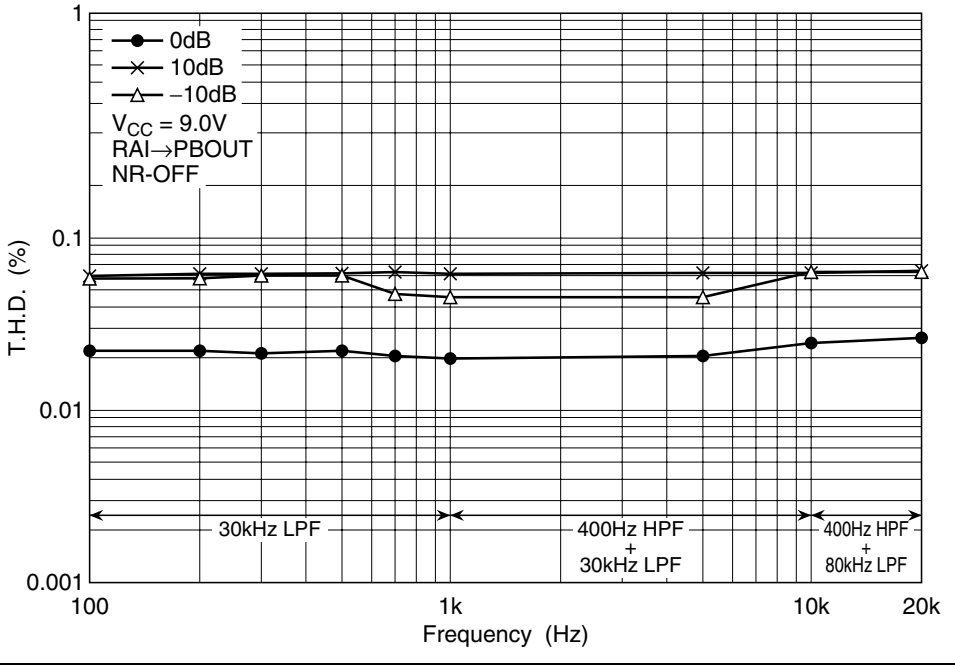

Total Harmonic Distortion vs. Frequency (HA12216F) (1)



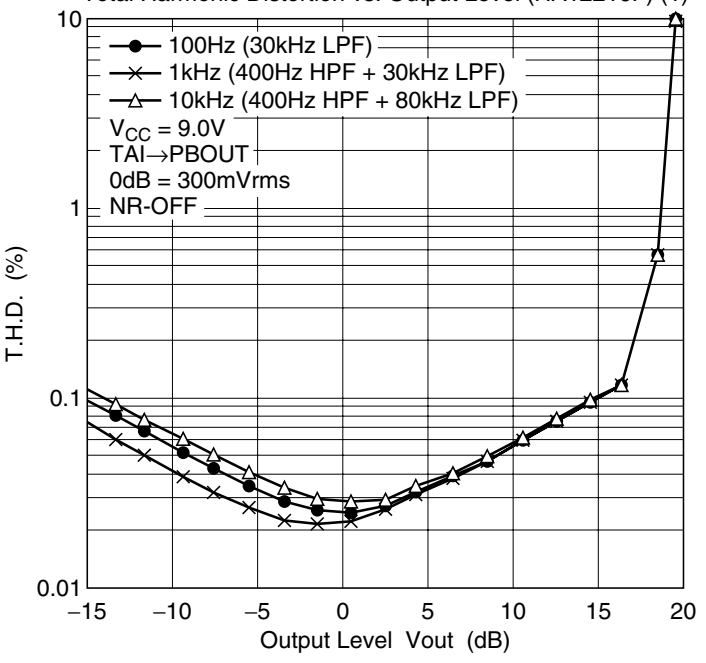
Total Harmonic Distortion vs. Frequency (HA12216F) (2)



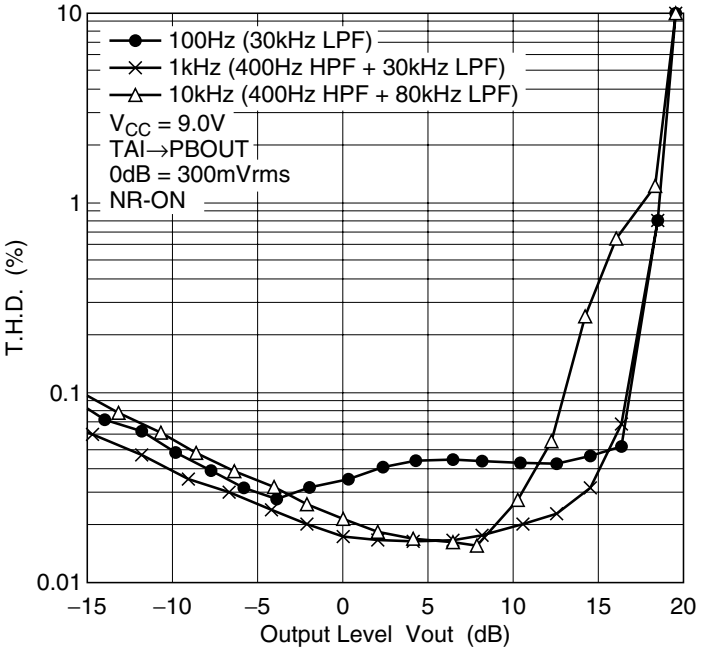

Total Harmonic Distortion vs. Frequency (HA12216F) (3)



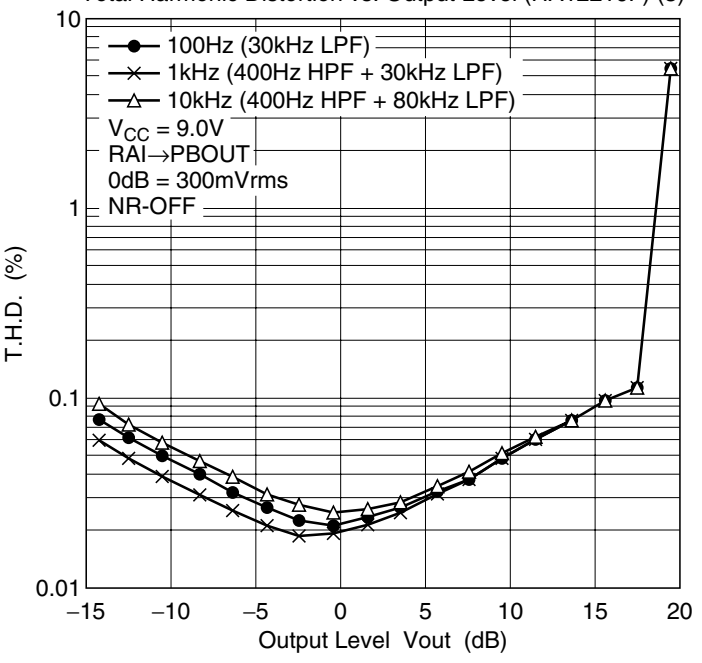
Total Harmonic Distortion vs. Output Level (HA12216F) (1)



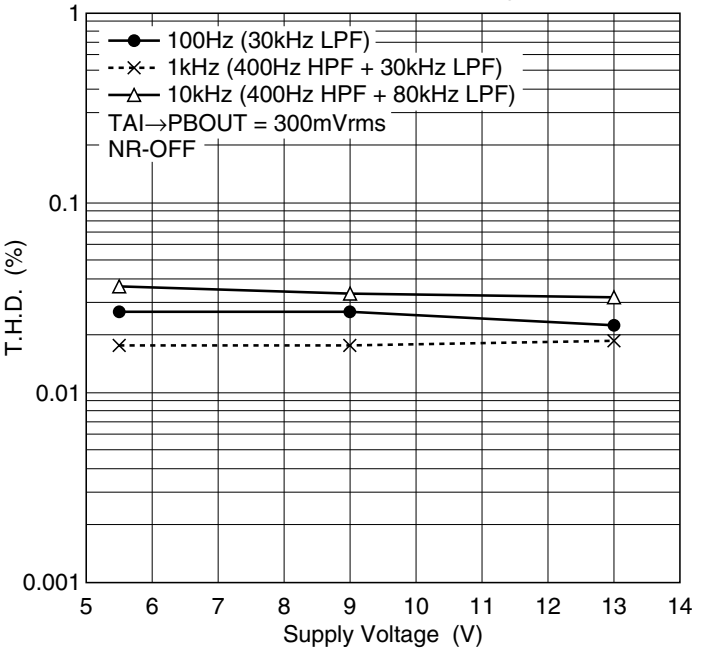

Total Harmonic Distortion vs. Output Level (HA12216F) (2)



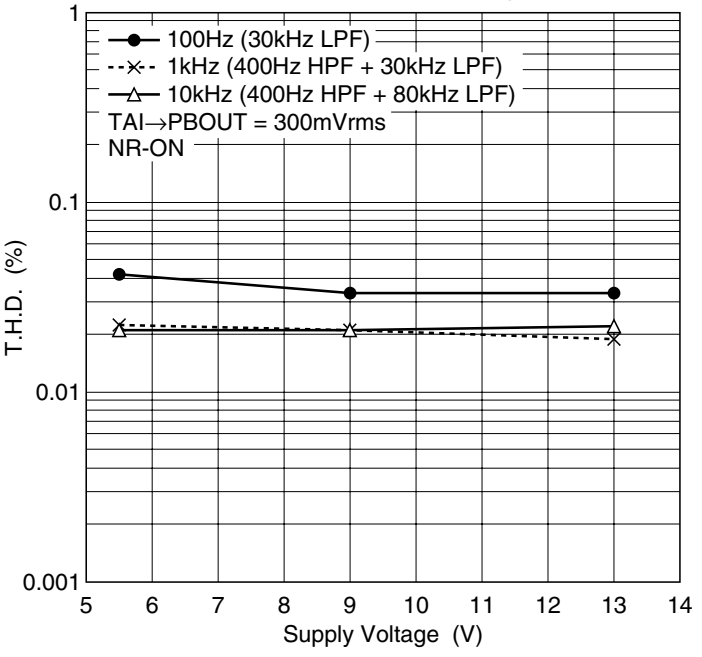
Total Harmonic Distortion vs. Output Level (HA12216F) (3)



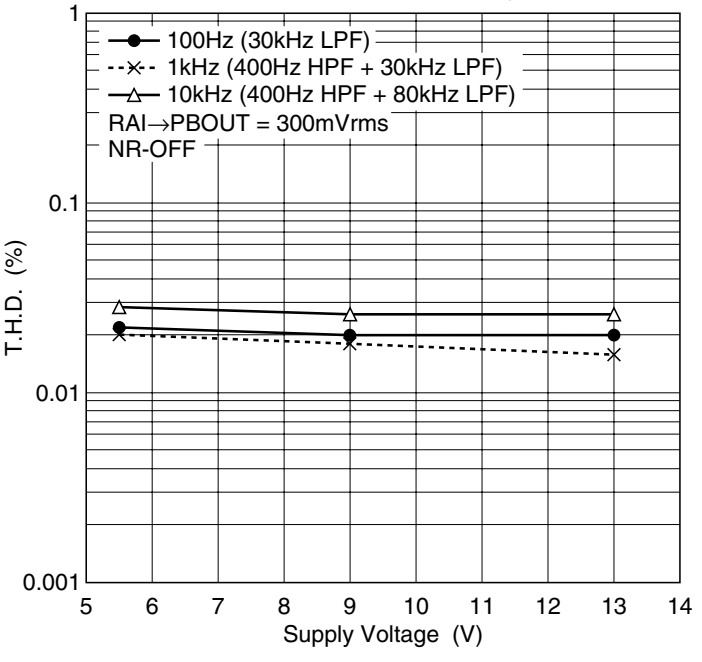

Total Harmonic Distortion vs. Supply Voltage (HA12216F) (1)



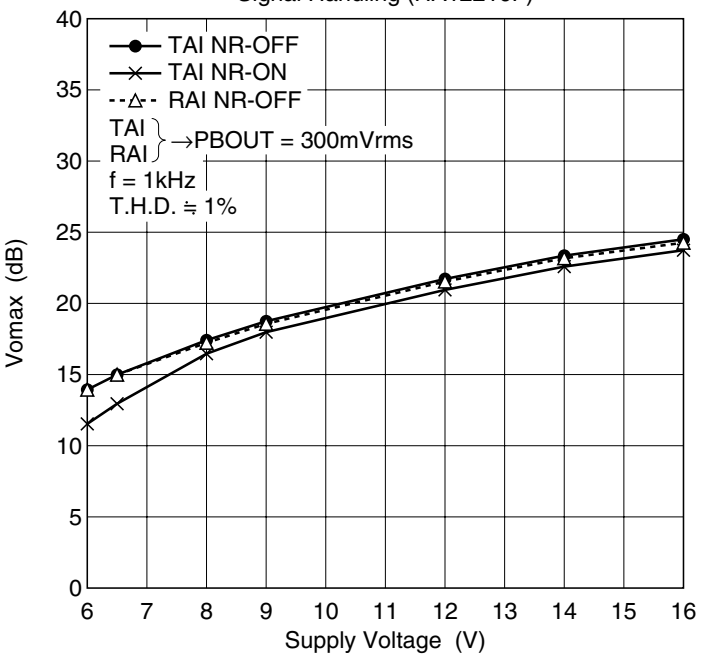
Total Harmonic Distortion vs. Supply Voltage (HA12216F) (2)



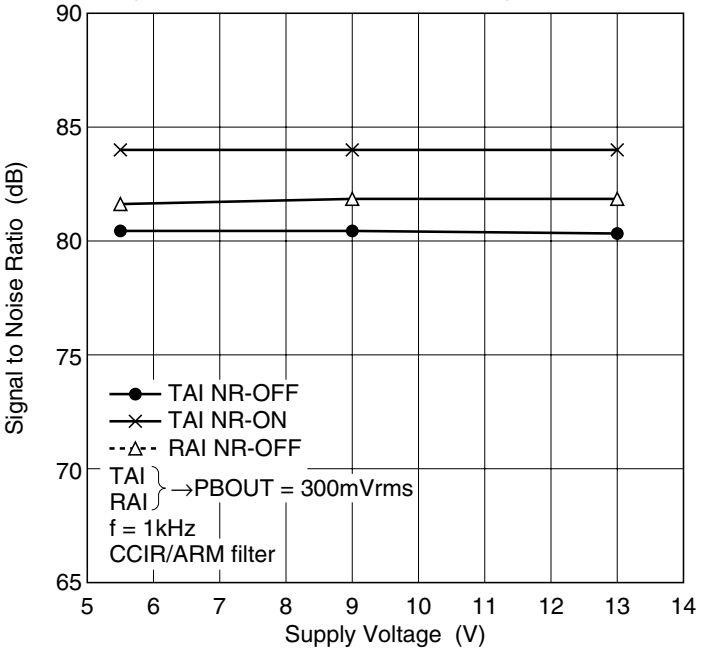

Total Harmonic Distortion vs. Supply Voltage (HA12216F) (3)



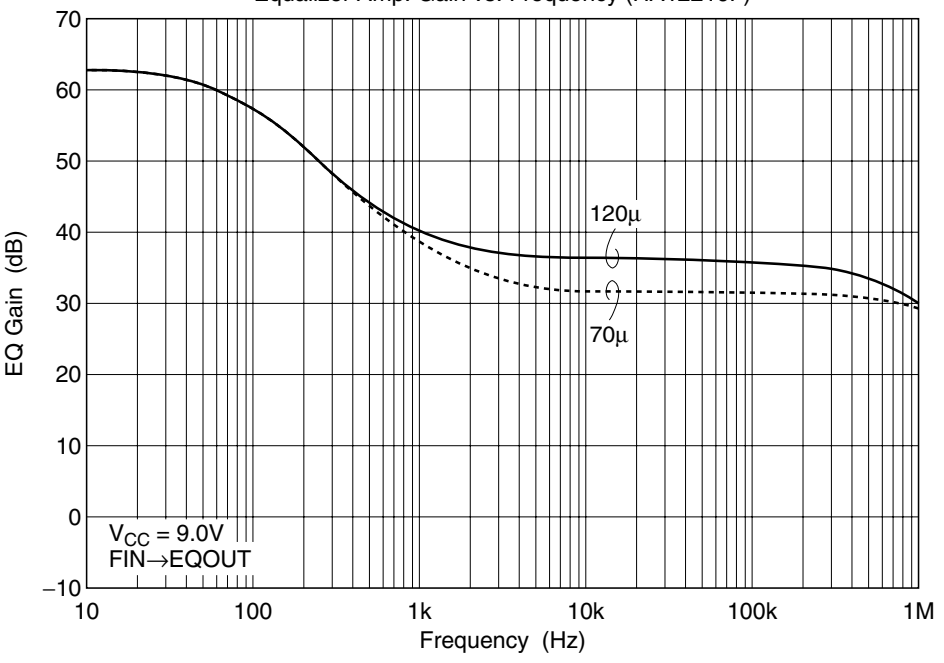
Signal Handling (HA12216F)



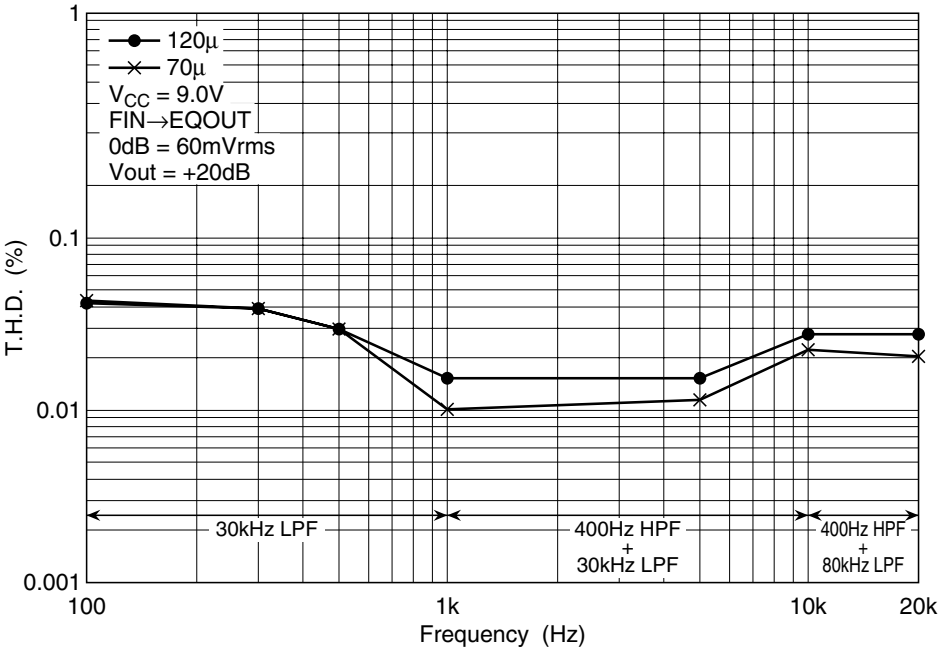

Signal to Noise Ratio vs. Supply Voltage (HA12216F)



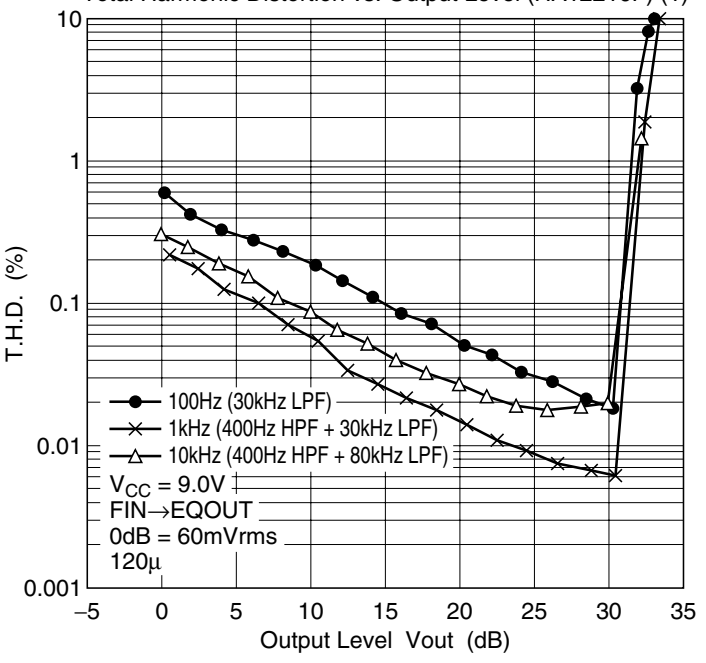
Equalizer Amp. Gain vs. Frequency (HA12216F)



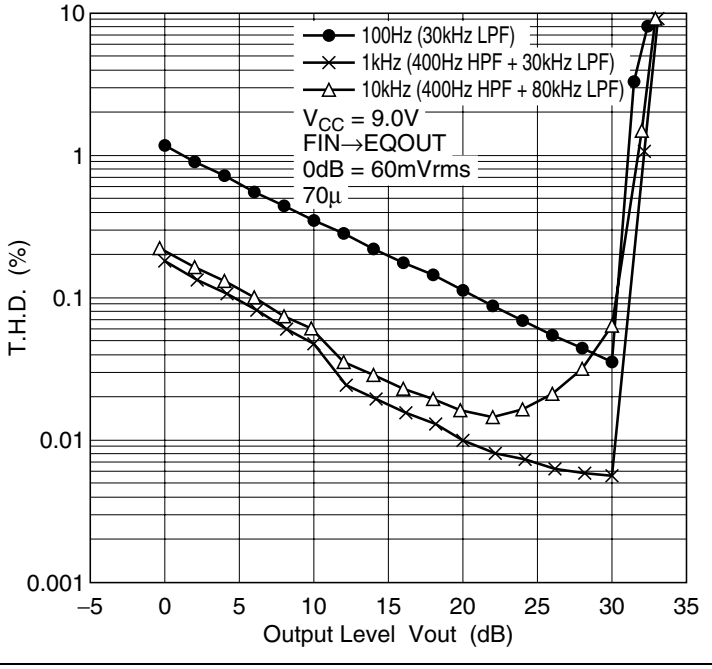

Total Harmonic Distortion vs. Frequency (HA12216F)



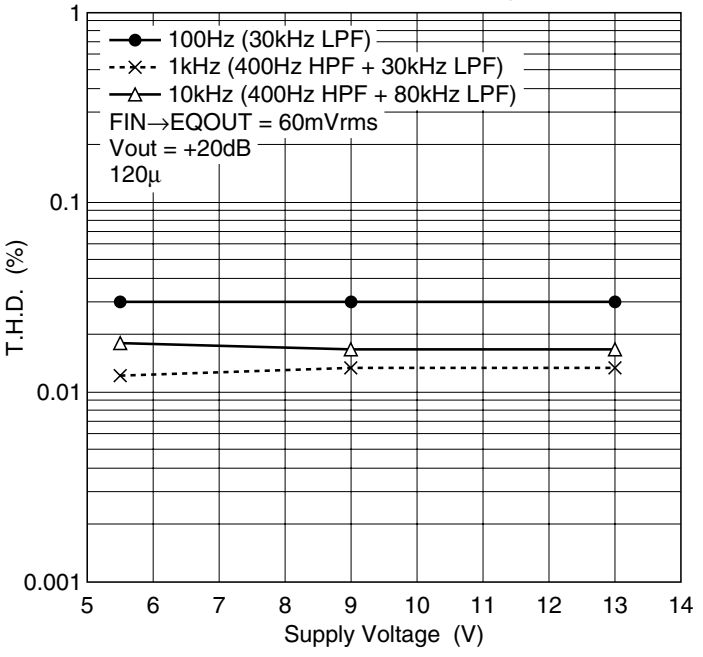
Total Harmonic Distortion vs. Output Level (HA12216F) (1)



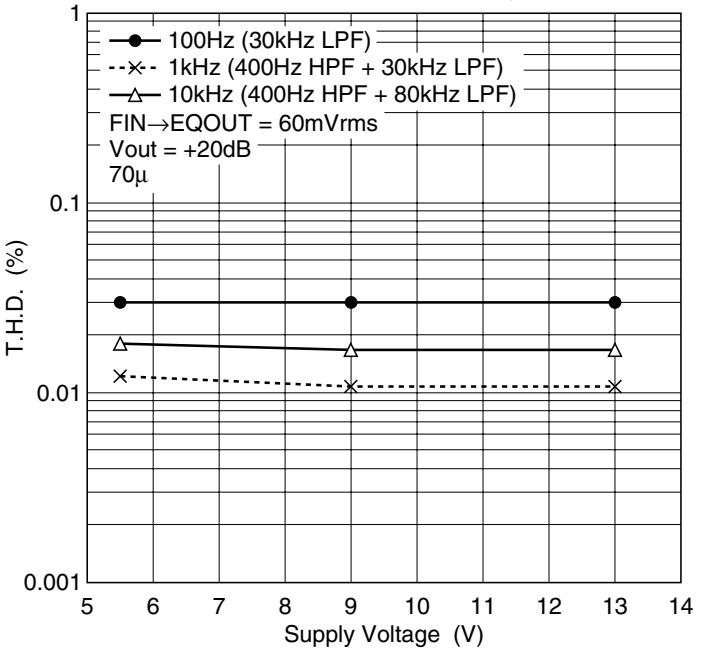

Total Harmonic Distortion vs. Output Level (HA12216F) (2)



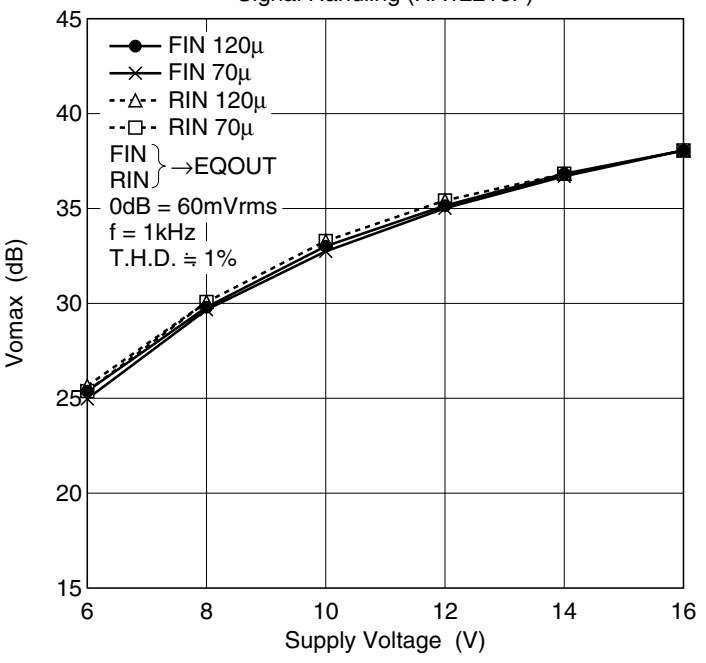
Total Harmonic Distortion vs. Supply Voltage (HA12216F) (1)



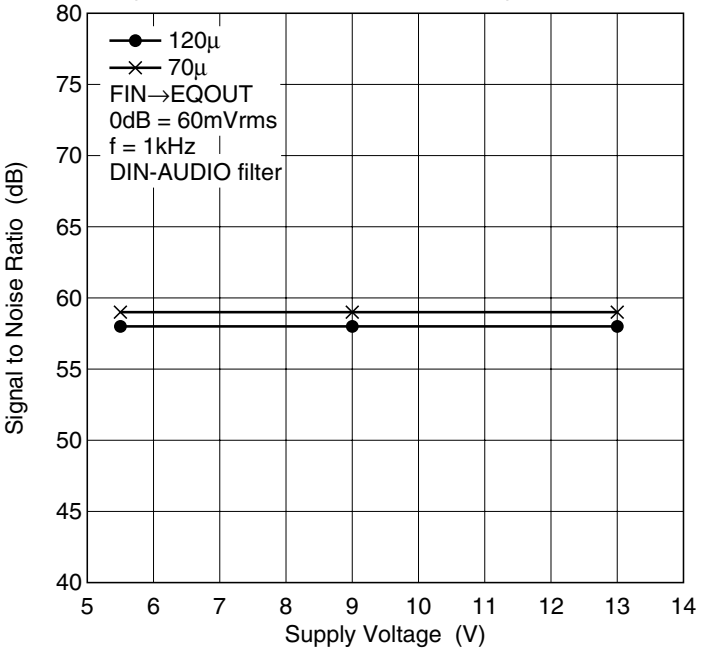

Total Harmonic Distortion vs. Supply Voltage (HA12216F) (2)



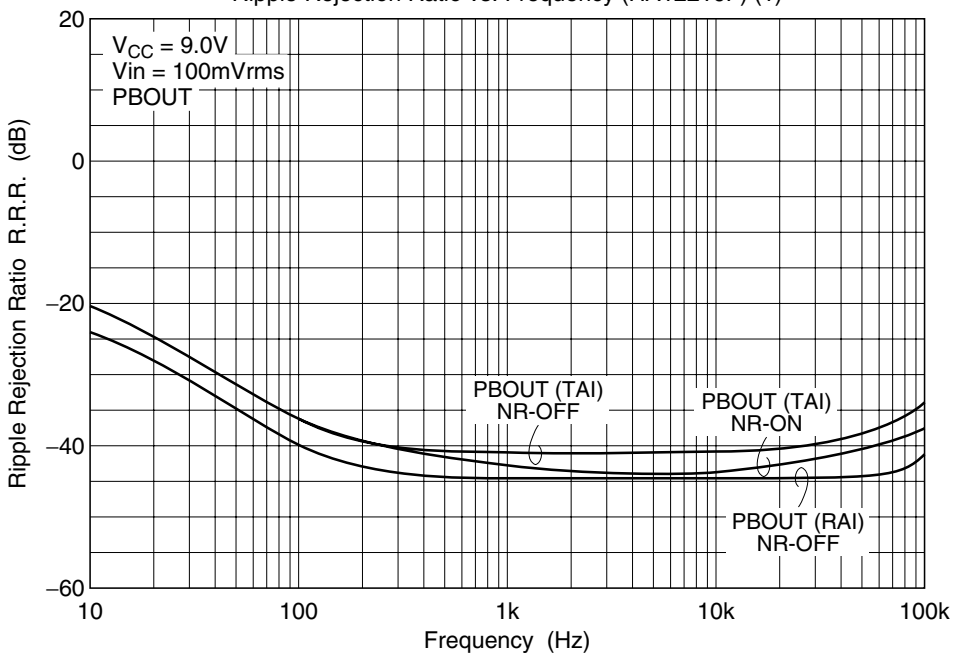
Signal Handling (HA12216F)



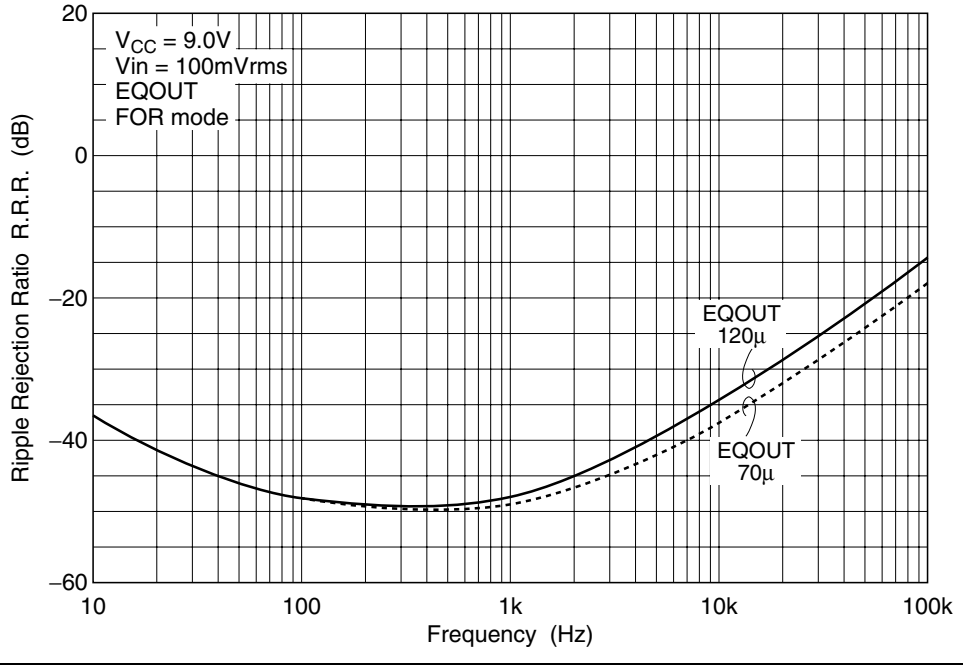

Signal to Noise Ratio vs. Supply Voltage (HA12216F)



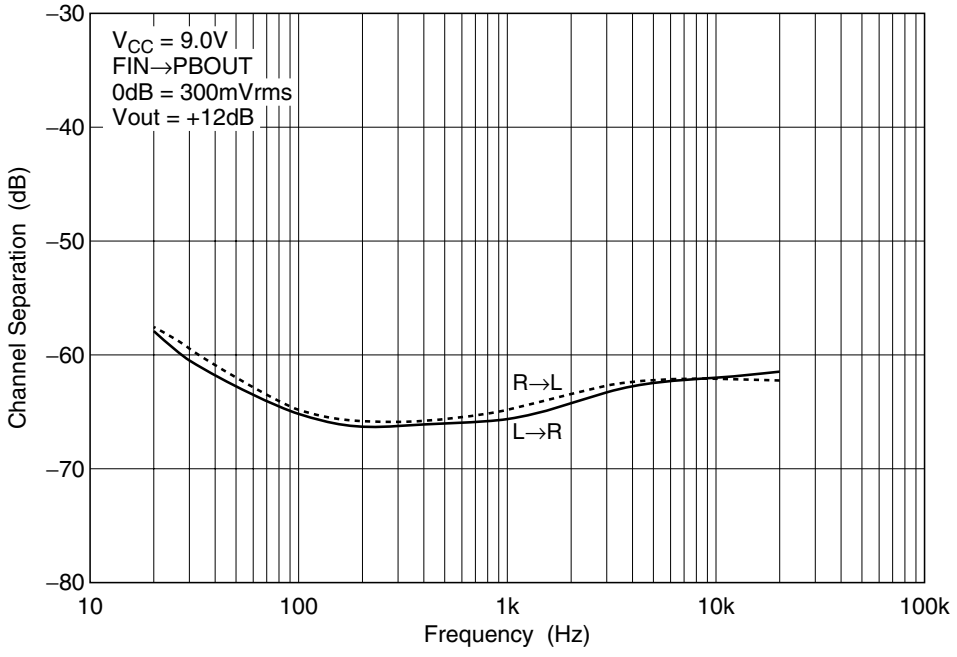
Ripple Rejection Ratio vs. Frequency (HA12216F) (1)



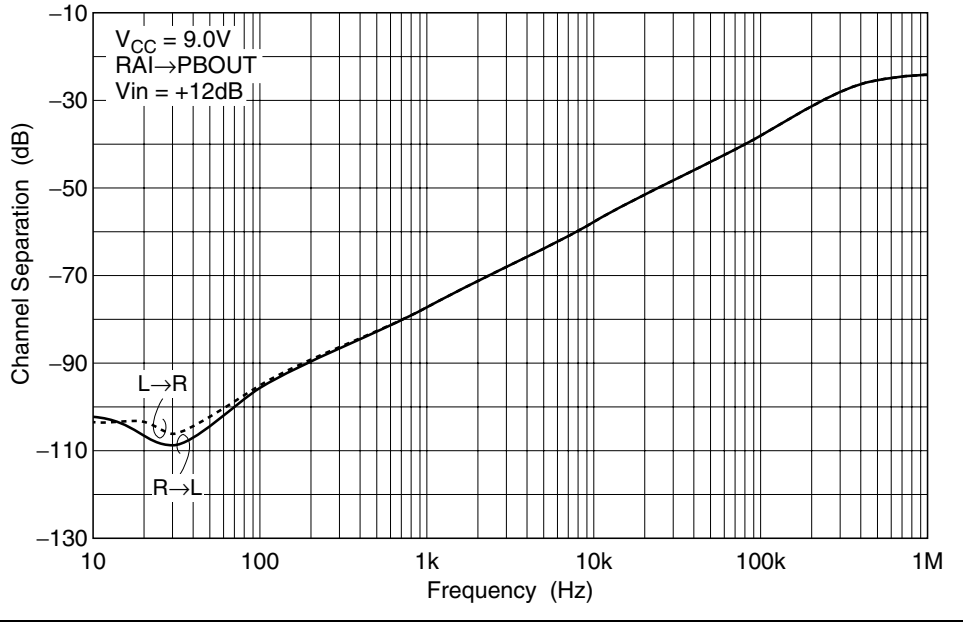

Ripple Rejection Ratio vs. Frequency (HA12216F) (2)

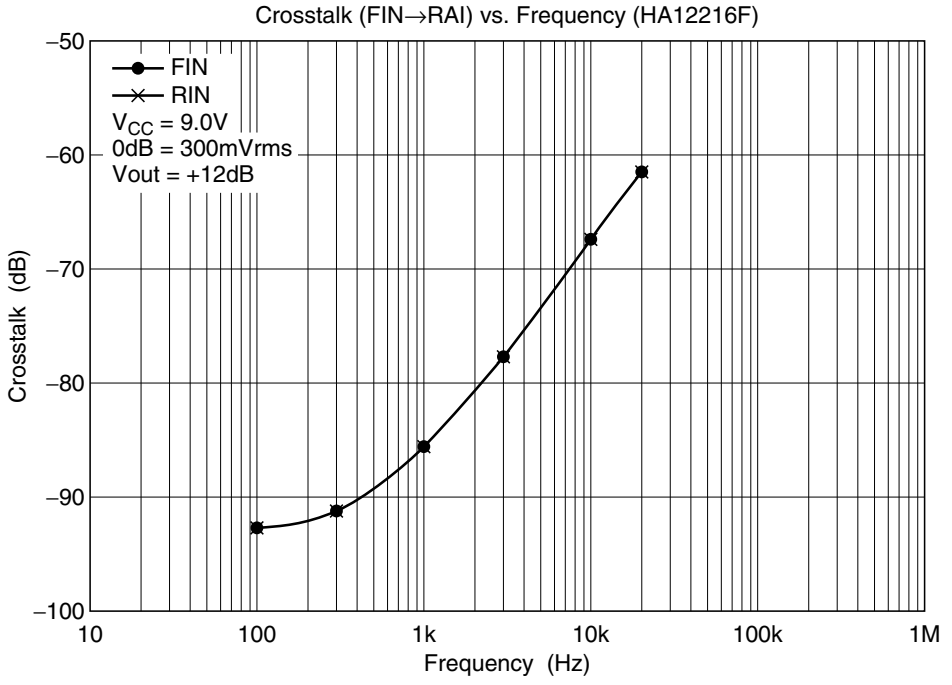


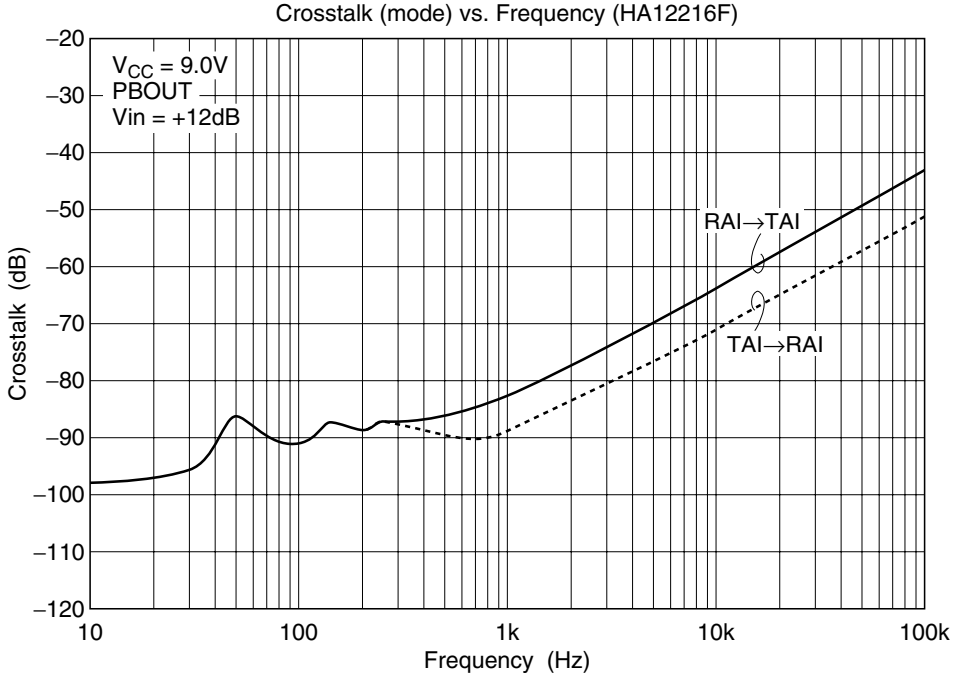
Channel Separation vs. Frequency (HA12216F) (1)



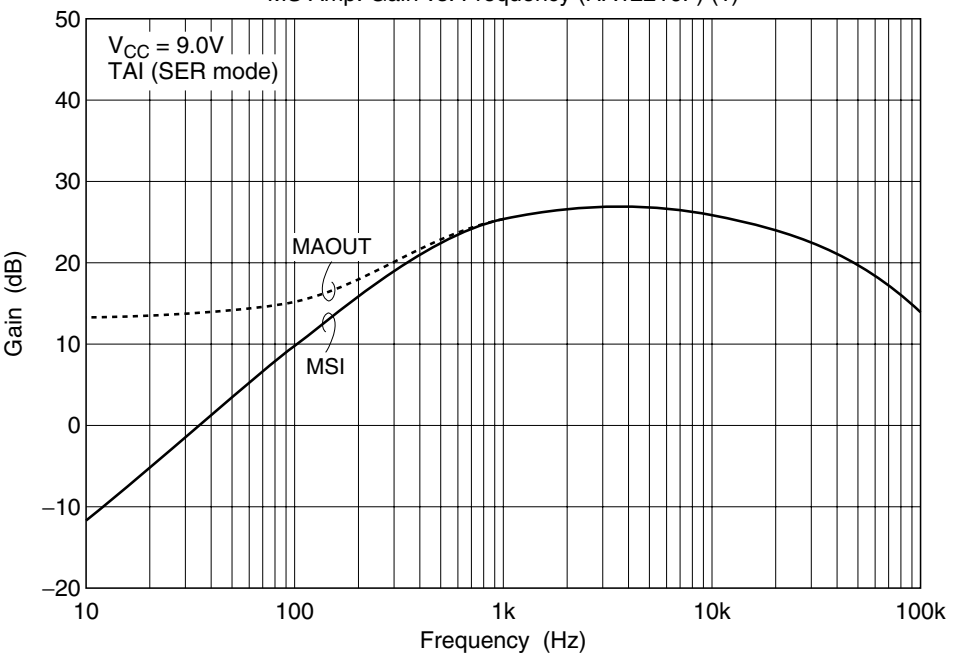

Channel Separation vs. Frequency (HA12216F) (2)



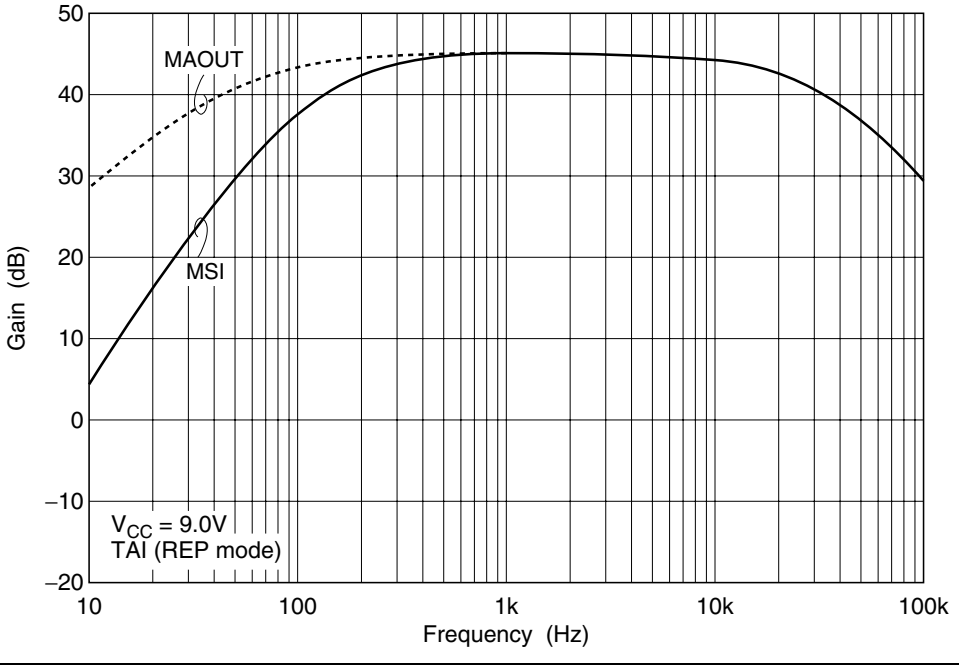

Crosstalk (FIN→RAI) vs. Frequency (HA12216F)
FIN
RIN
$V_{CC}$ = 9.0V
0dB = 300mVrms
Vout = +12dB
Crosstalk (dB)
−50
−60
−70
−80
−90
−100
10
100
1k
10k
100k
1M
Frequency (Hz)


Crosstalk (mode) vs. Frequency (HA12216F)
$V_{CC}$ = 9.0V
PBOUT
Vin = +12dB
RAI→TAI
TAI→RAI
Crosstalk (dB)
−20
−30
−40
−50
−60
−70
−80
−90
−100
−110
−120
10
100
1k
10k
100k
Frequency (Hz)

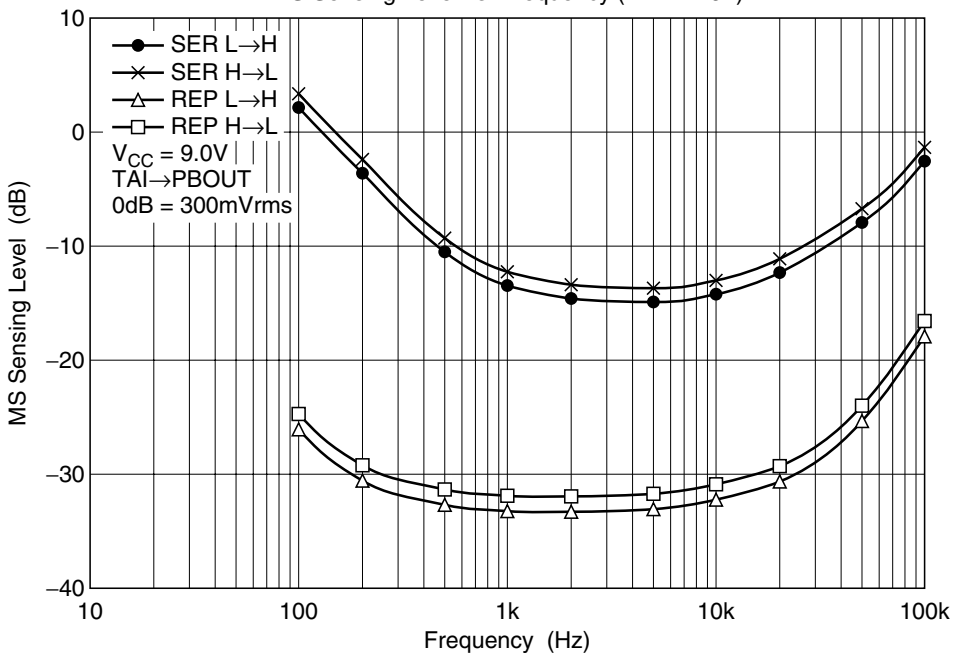
MS Amp. Gain vs. Frequency (HA12216F) (1)



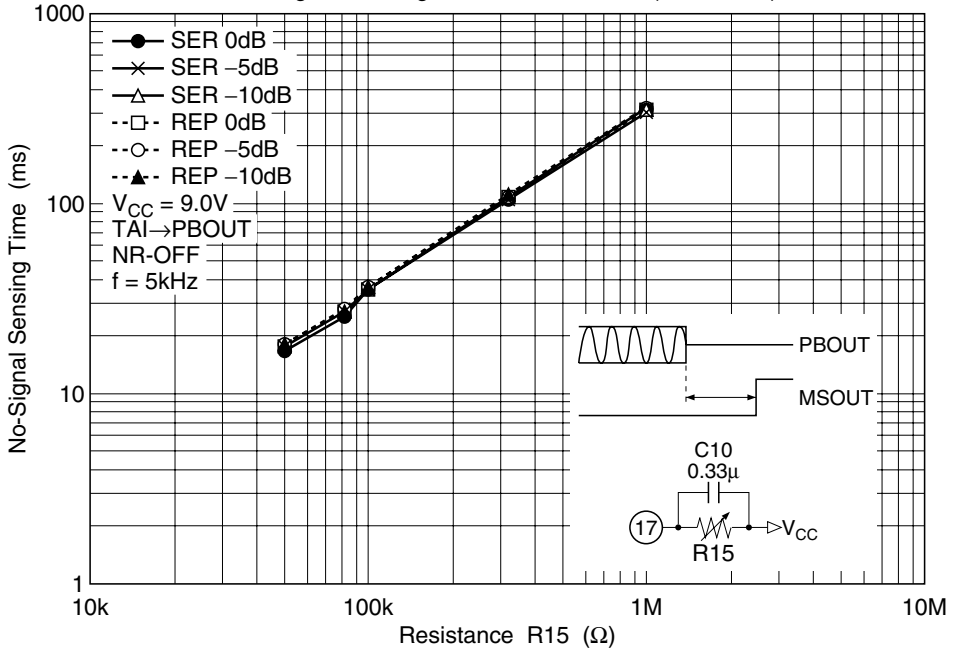

MS Amp. Gain vs. Frequency (HA12216F) (2)

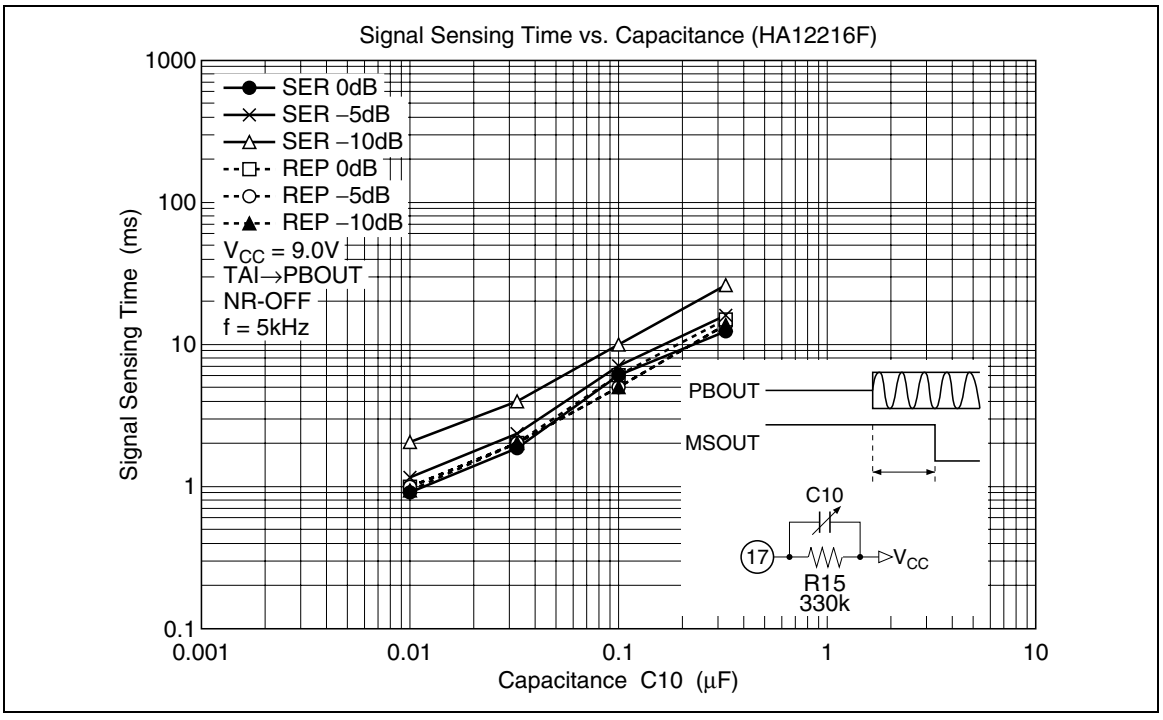


MS Sensing Level vs. Frequency (HA12216F)

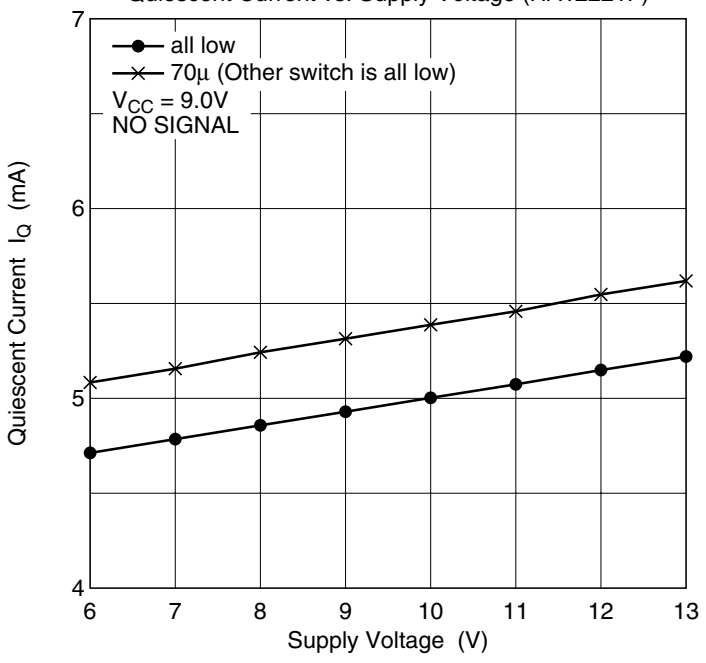



No-Signal Sensing Time vs. Resistance (HA12216F)

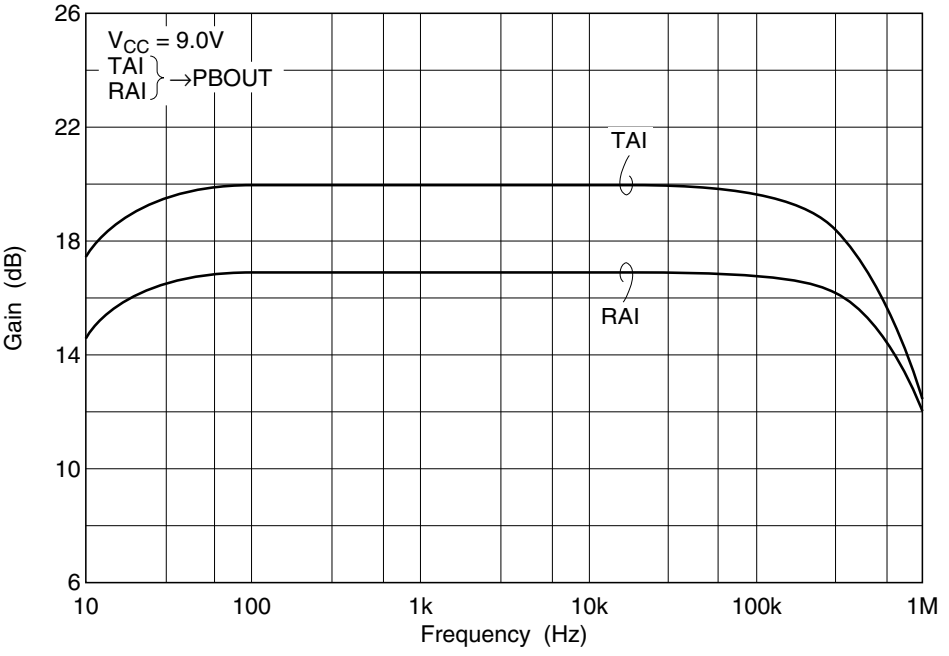



Signal Sensing Time vs. Capacitance (HA12216F)
1000
100
10
1
0.1
0.001
0.01
0.1
1
10
Signal Sensing Time (ms)
Capacitance C10 (μF)
SER 0dB
SER –5dB
SER –10dB
REP 0dB
REP –5dB
REP –10dB
VCC = 9.0V
TAI→PBOUT
NR-OFF
f = 5kHz
PBOUT
MSOUT
C10
17
VCC
R15
330k

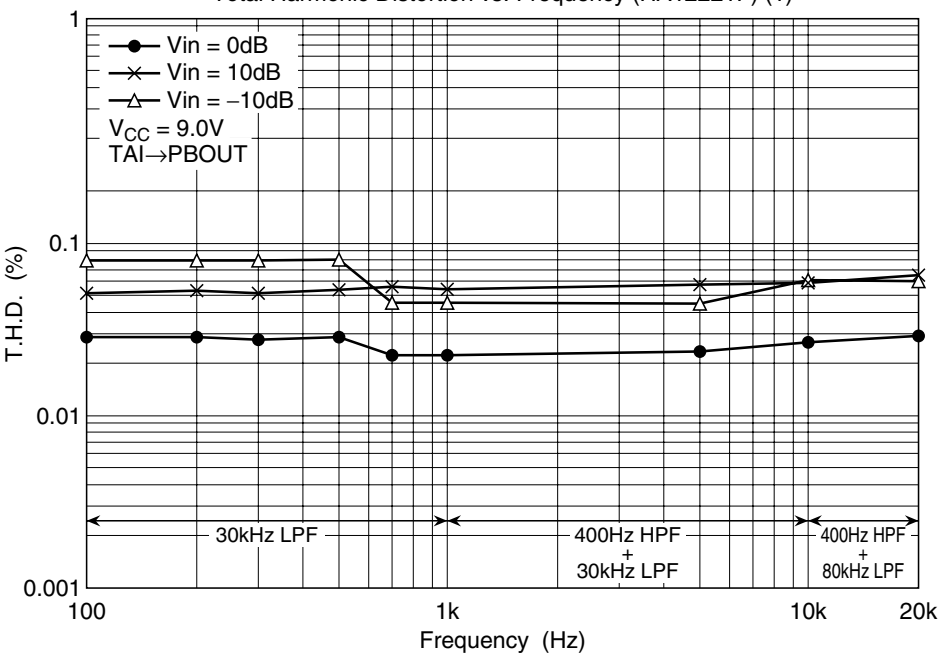
Quiescent Current vs. Supply Voltage (HA12221F)



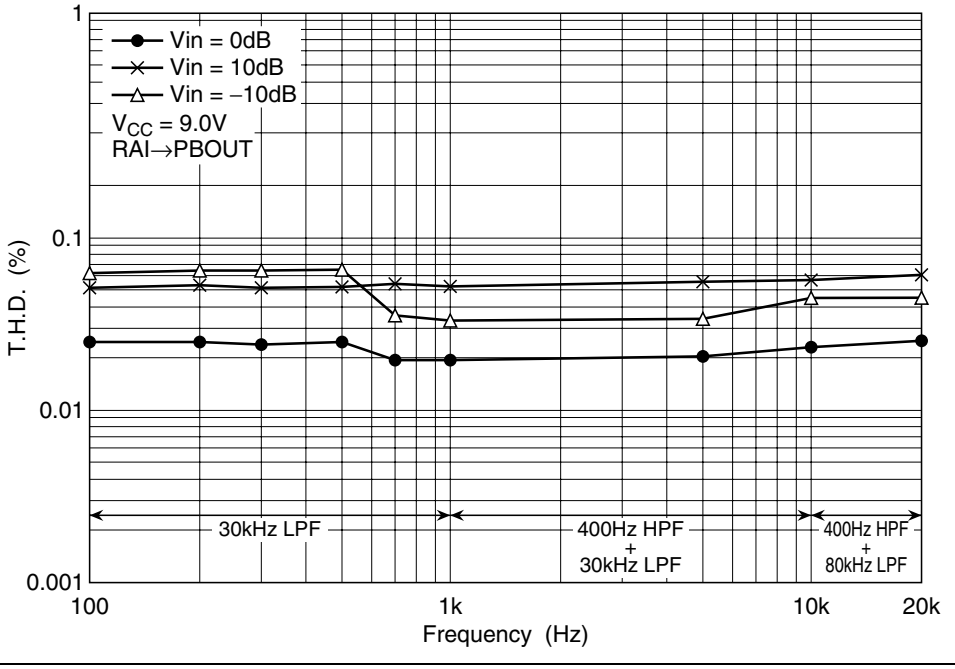

Input Amp. Gain vs. Frequency (HA12221F)



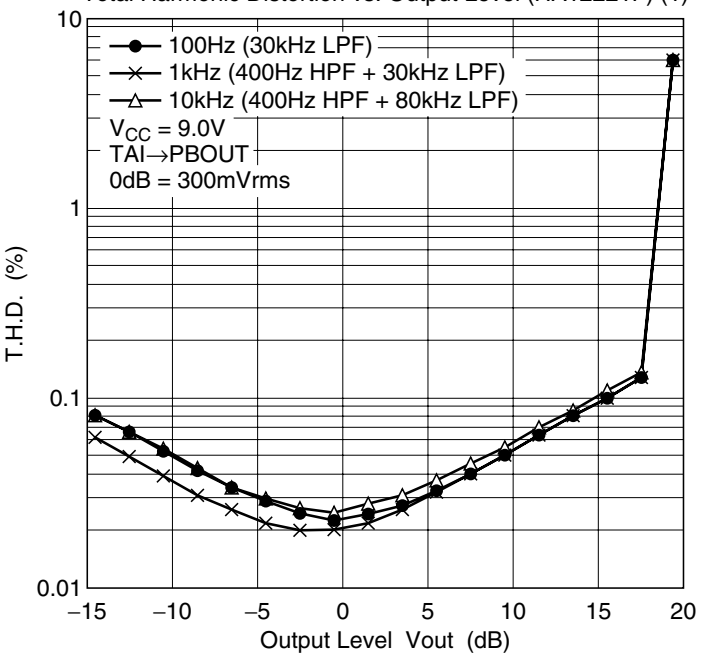
Total Harmonic Distortion vs. Frequency (HA12221F) (1)



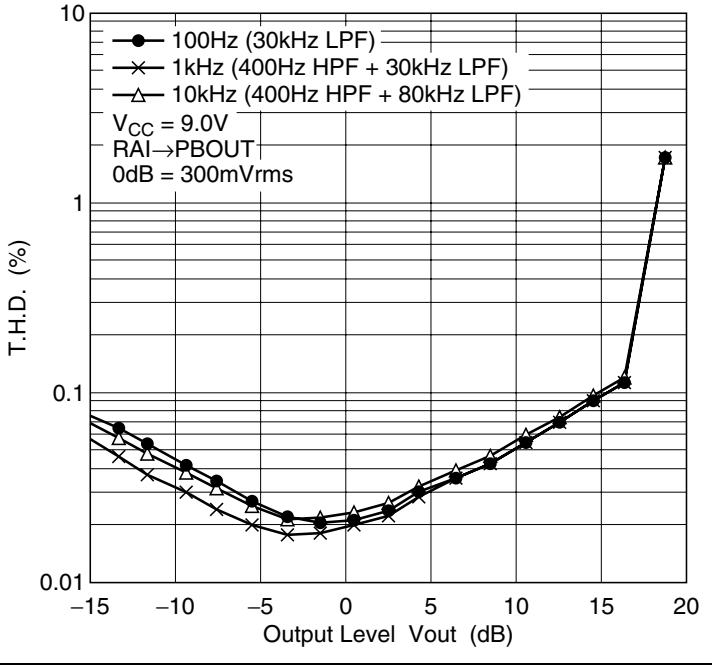

Total Harmonic Distortion vs. Frequency (HA12221F) (2)



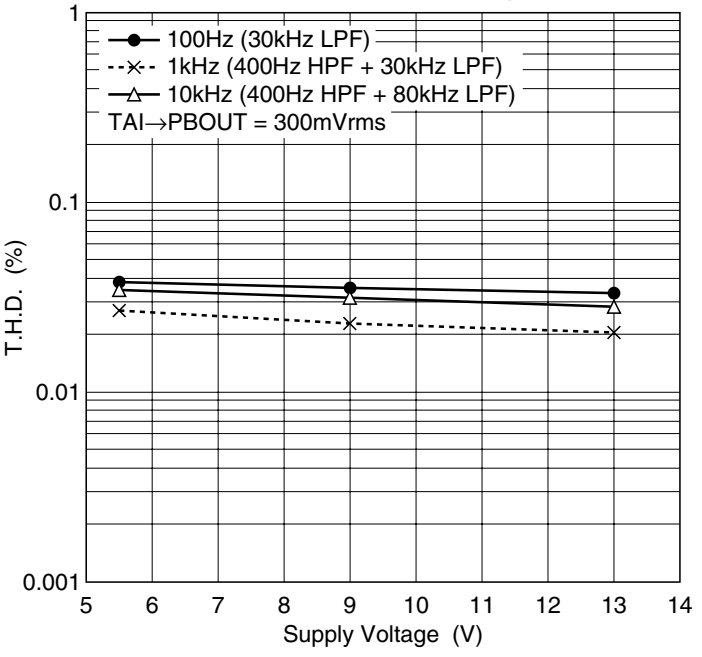
Total Harmonic Distortion vs. Output Level (HA12221F) (1)



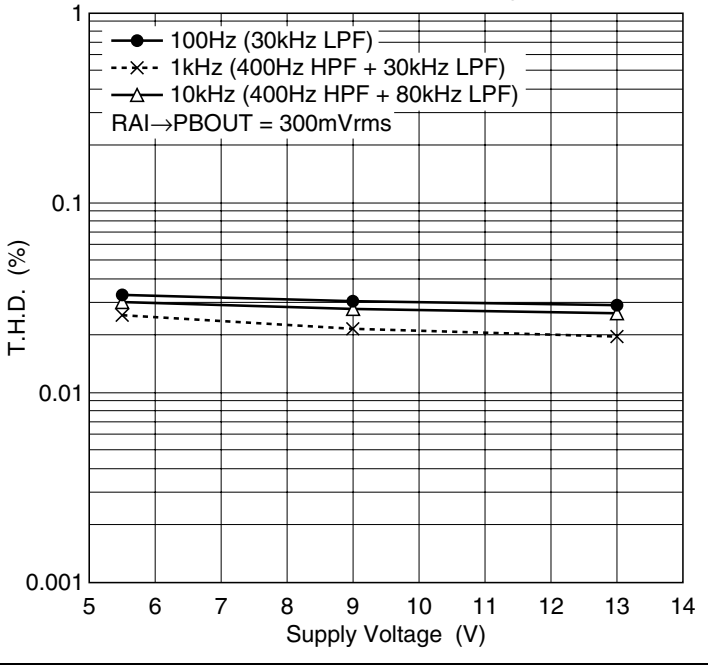

Total Harmonic Distortion vs. Output Level (HA12221F) (2)



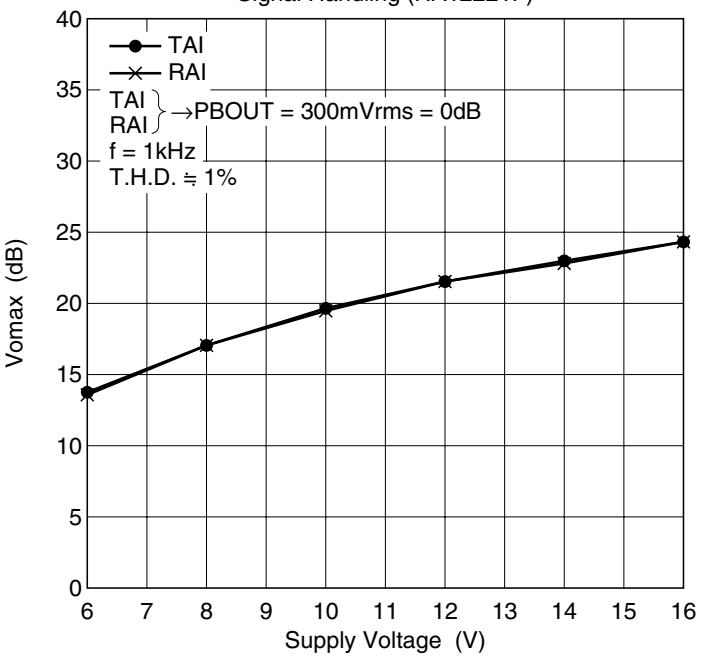
Total Harmonic Distortion vs. Supply Voltage (HA12221F) (1)



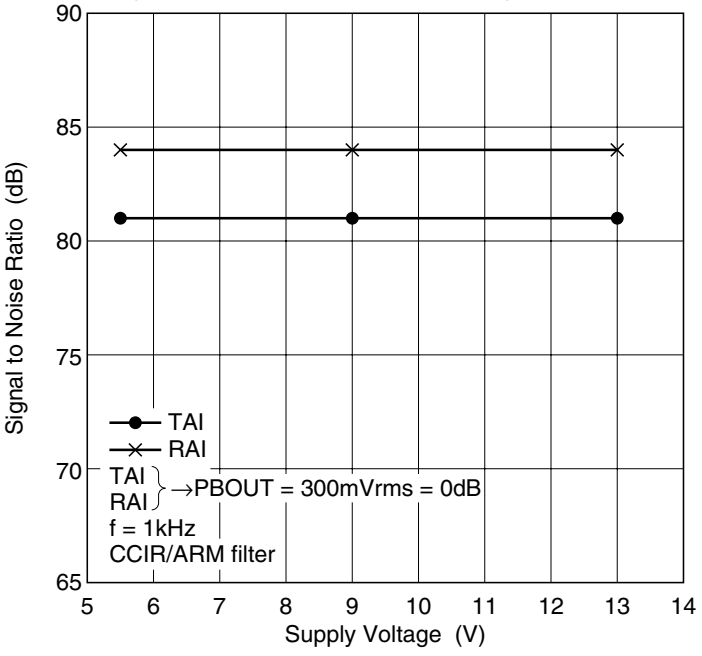

Total Harmonic Distortion vs. Supply Voltage (HA12221F) (2)



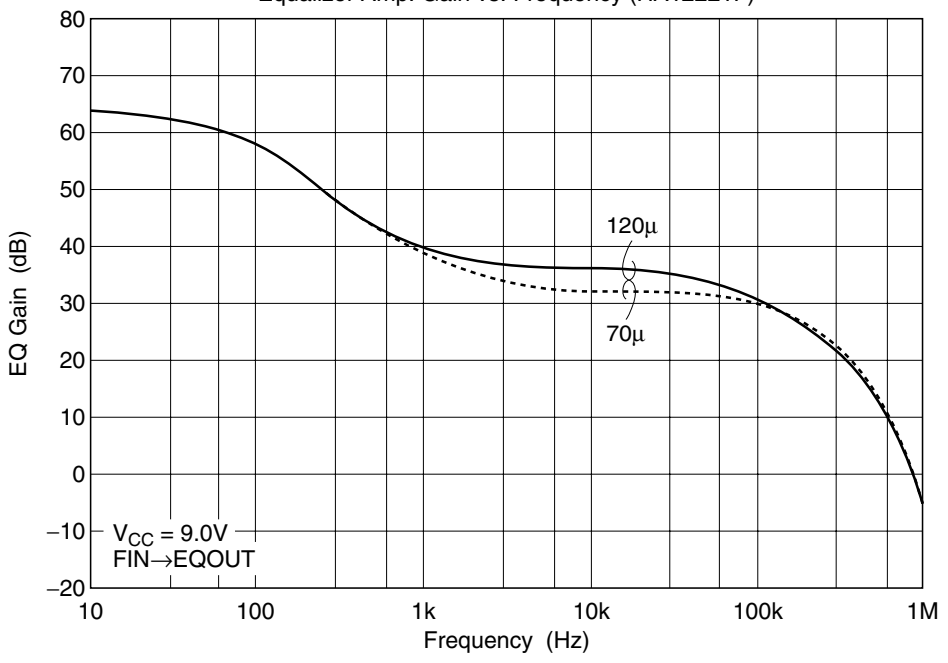
Signal Handling (HA12221F)



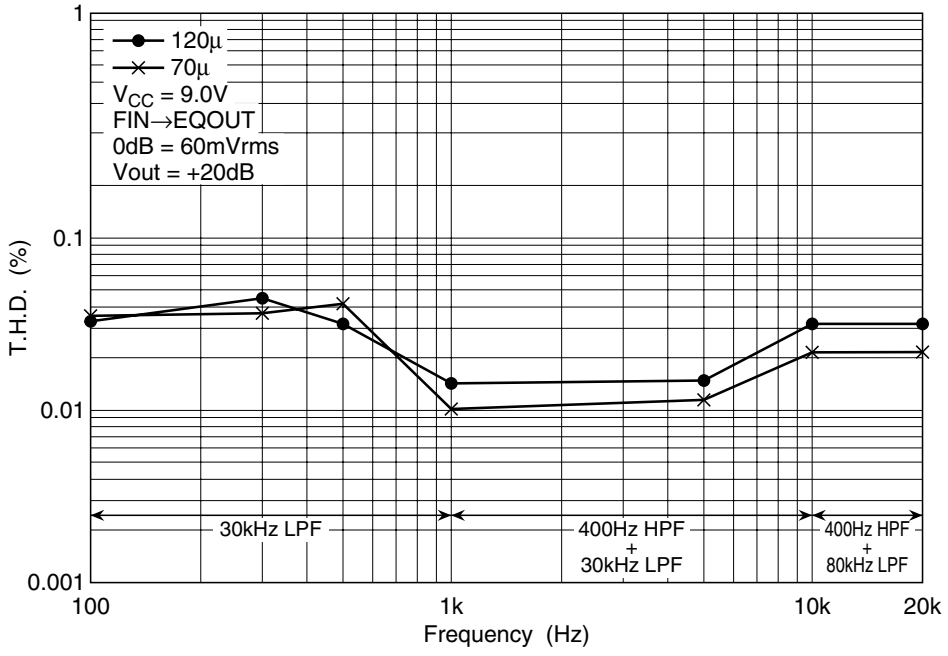

Signal to Noise Ratio vs. Supply Voltage (HA12221F)



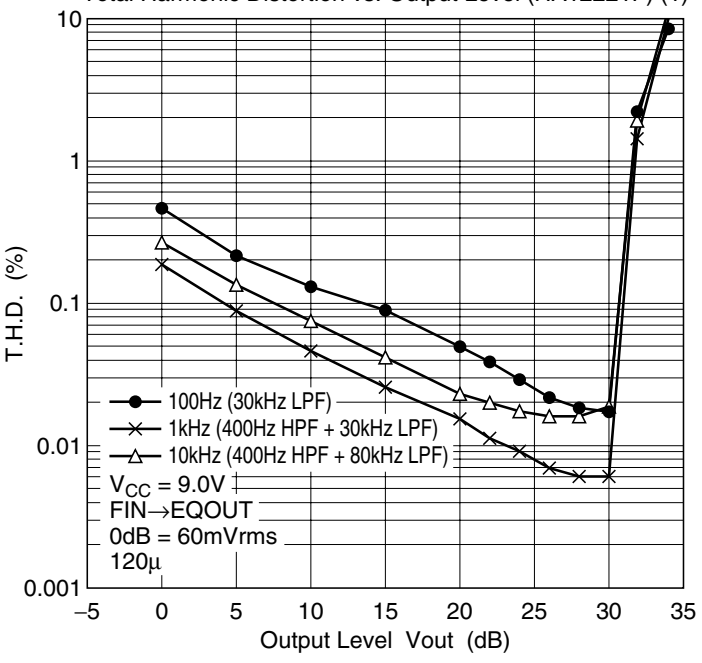
Equalizer Amp. Gain vs. Frequency (HA12221F)



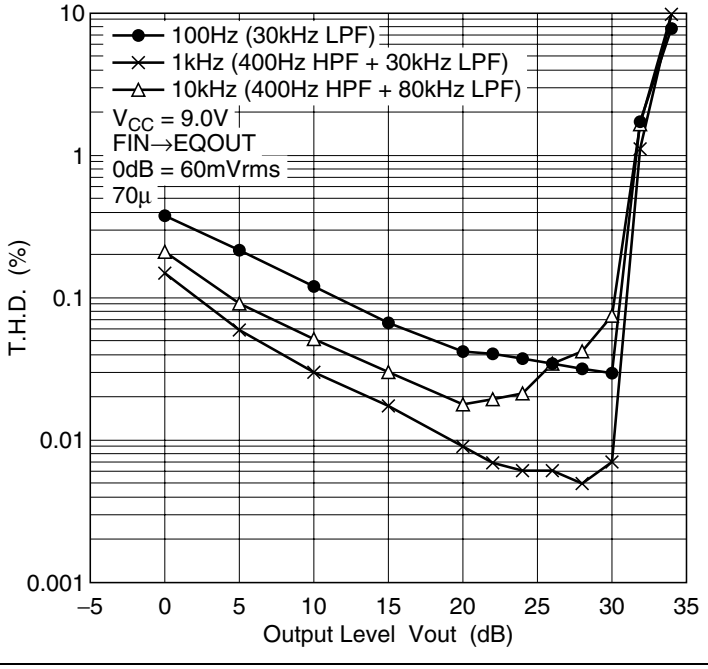

Total Harmonic Distortion vs. Frequency (HA12221F)



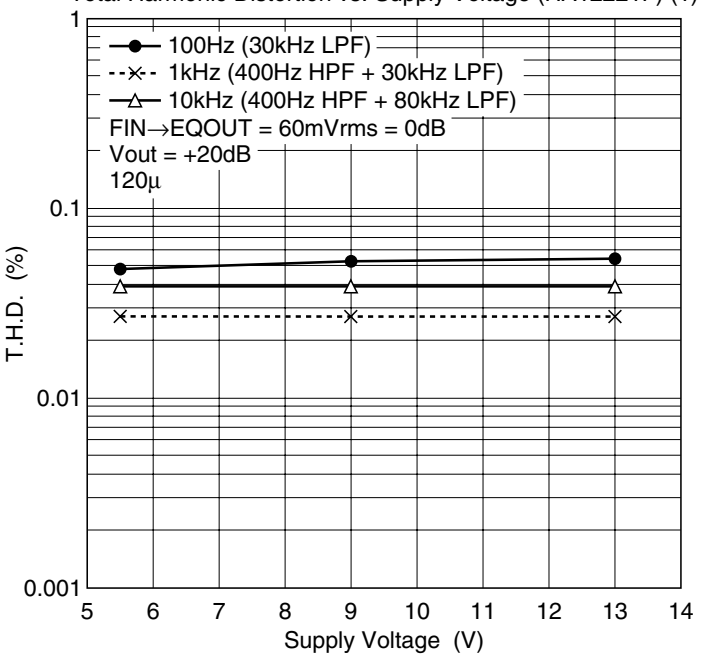
Total Harmonic Distortion vs. Output Level (HA12221F) (1)



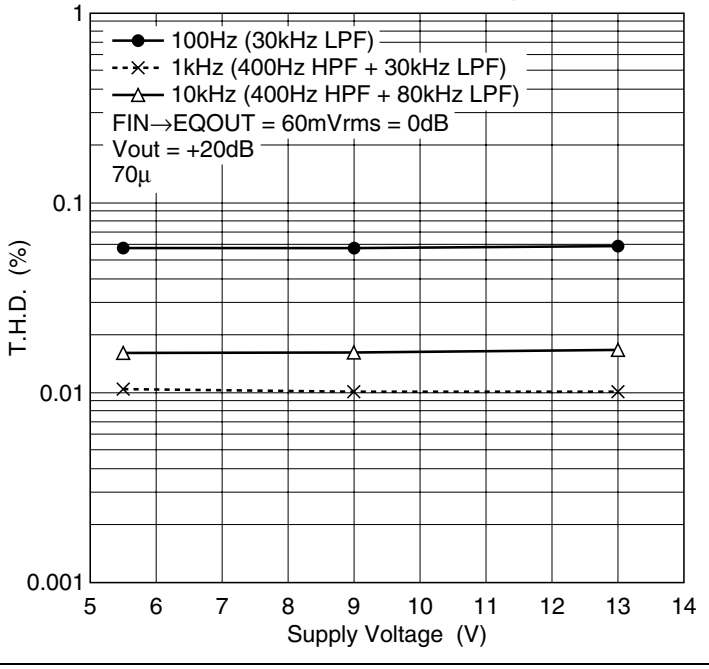

Total Harmonic Distortion vs. Output Level (HA12221F) (2)



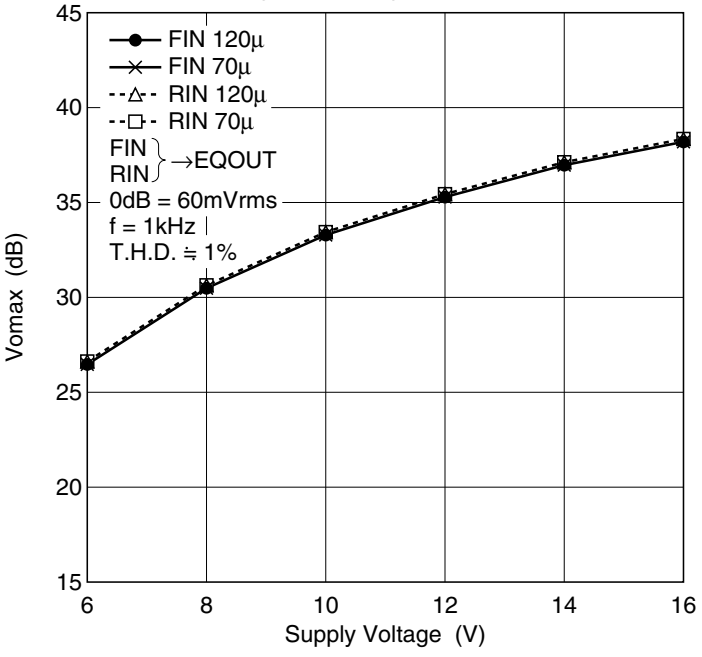
Total Harmonic Distortion vs. Supply Voltage (HA12221F) (1)



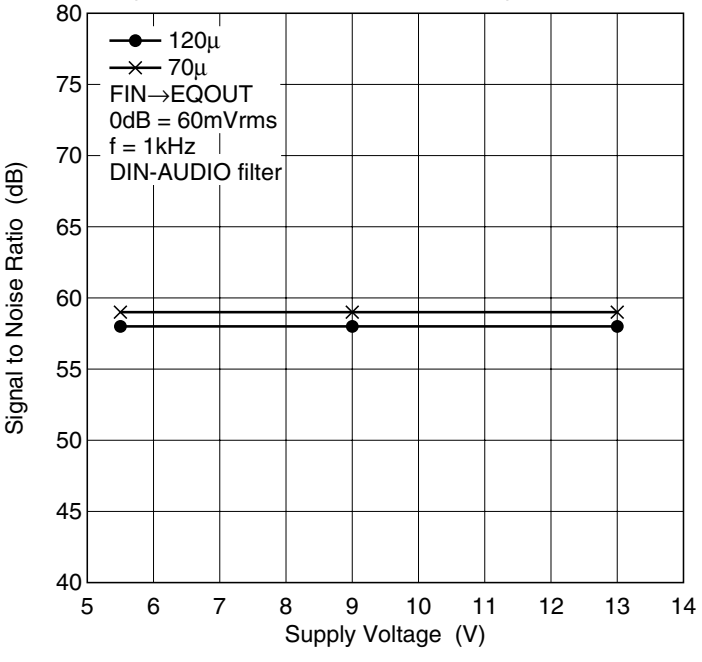

Total Harmonic Distortion vs. Supply Voltage (HA12221F) (2)



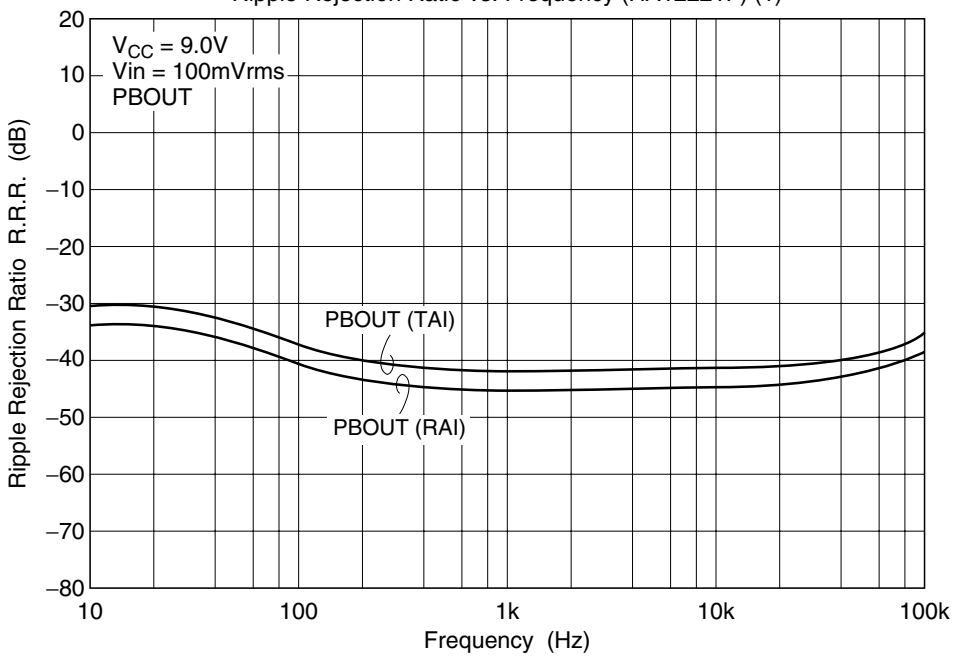
Signal Handling (HA12221F)



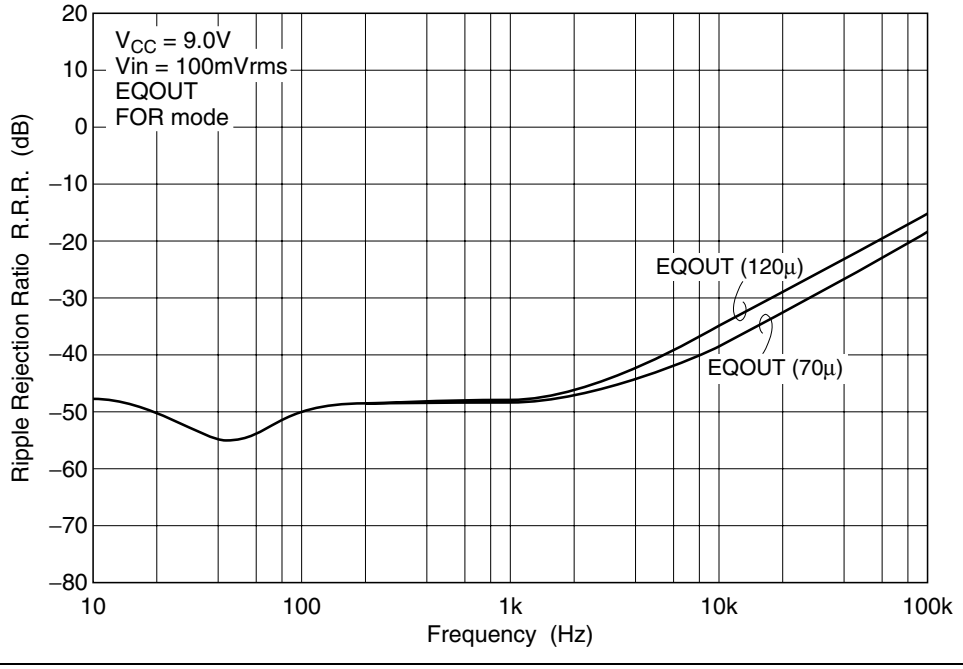

Signal to Noise Ratio vs. Supply Voltage (HA12221F)



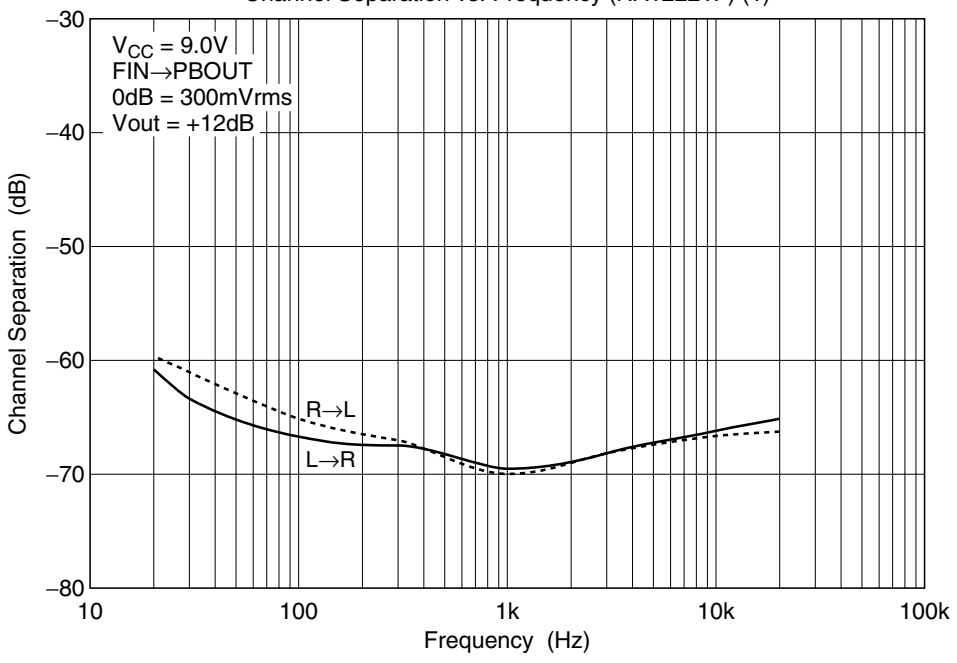
Ripple Rejection Ratio vs. Frequency (HA12221F) (1)



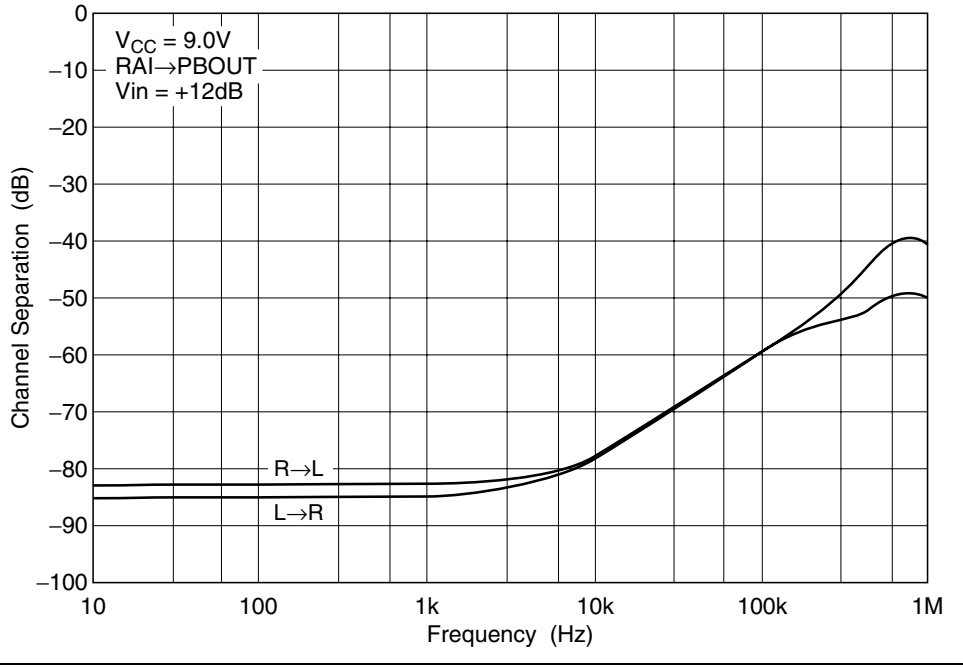

Ripple Rejection Ratio vs. Frequency (HA12221F) (2)



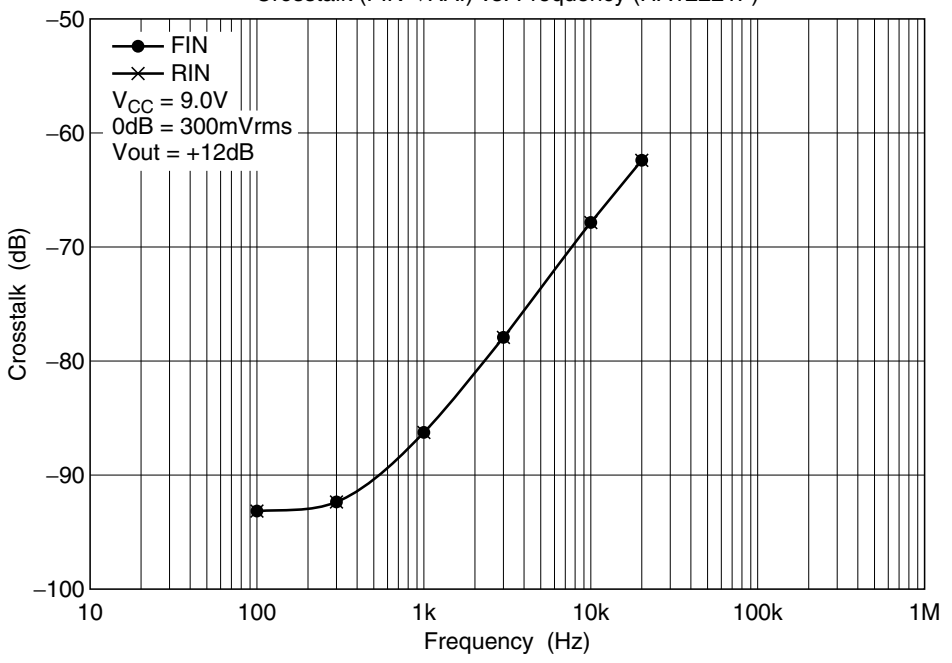
Channel Separation vs. Frequency (HA12221F) (1)



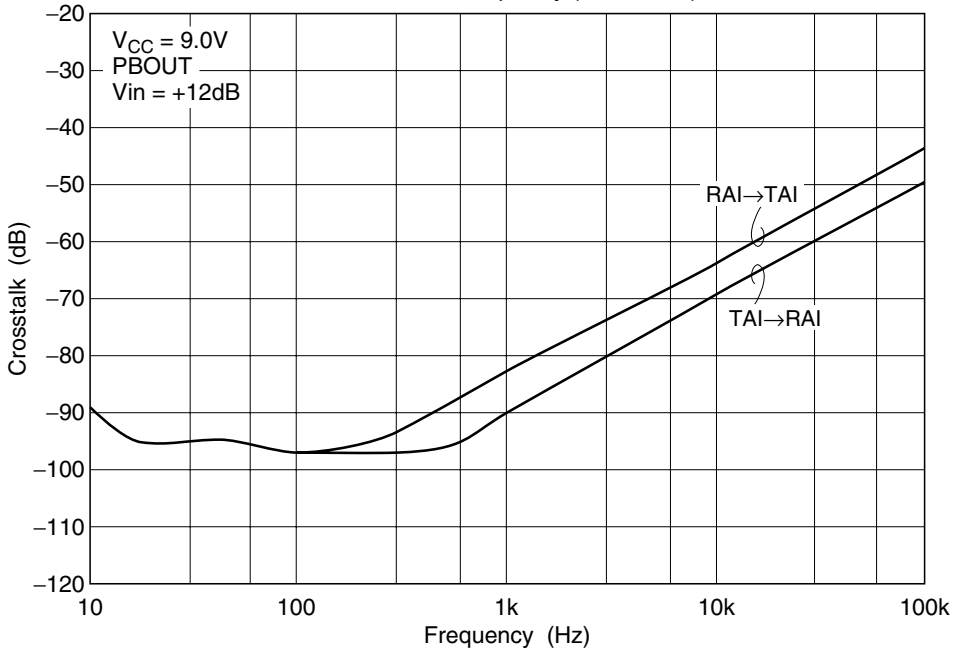

Channel Separation vs. Frequency (HA12221F) (2)



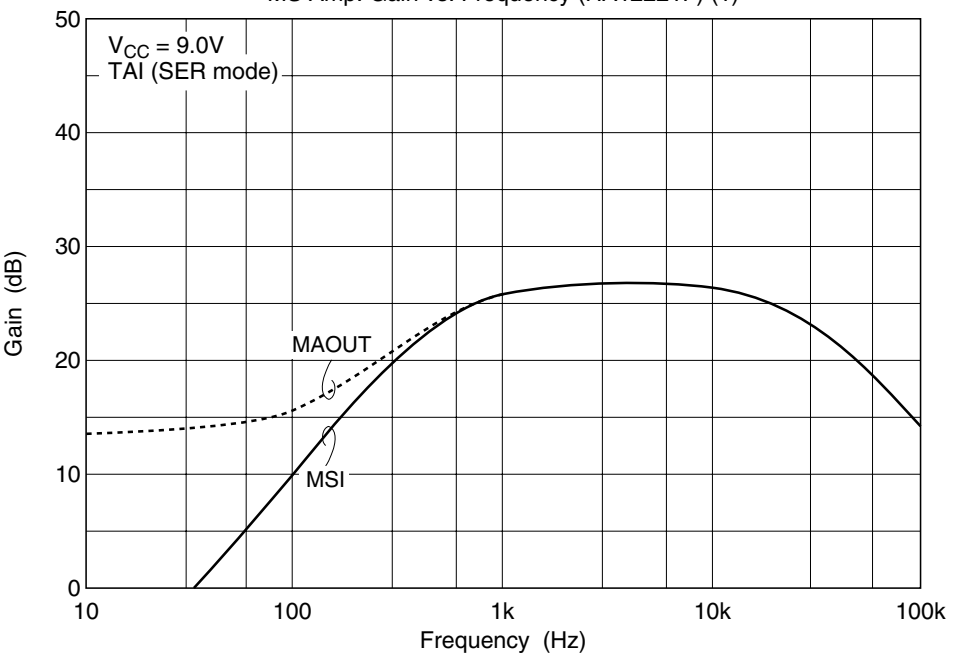
Crosstalk (FIN→RAI) vs. Frequency (HA12221F)



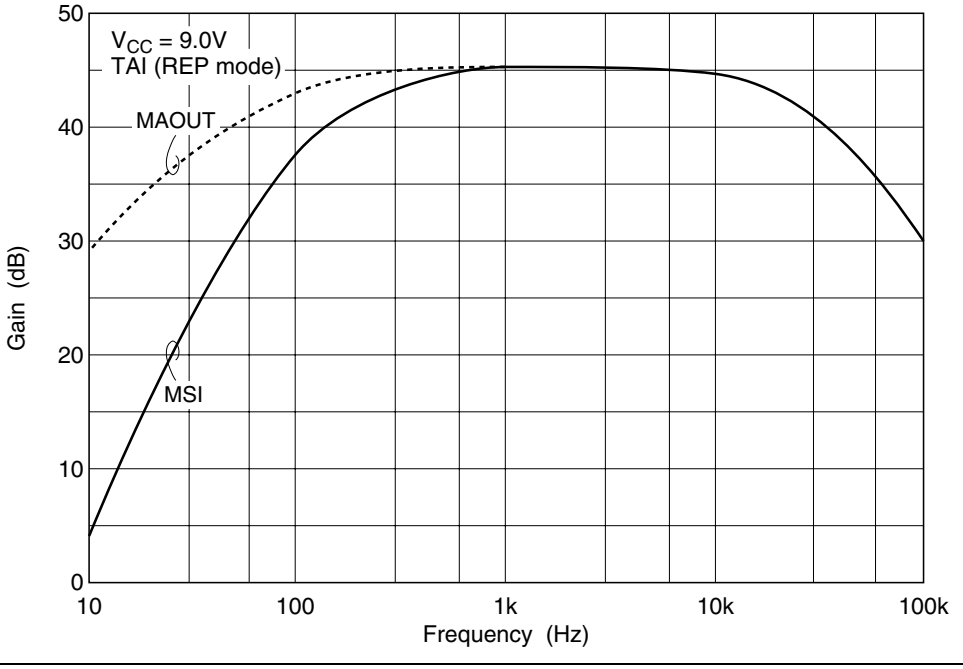

Crosstalk vs. Frequency (HA12221F)



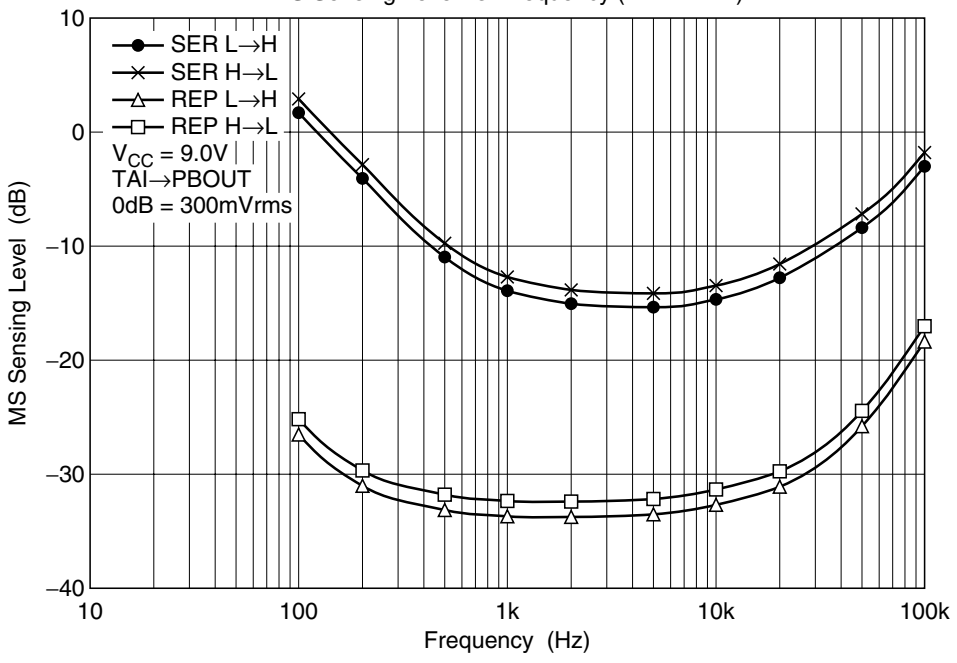
MS Amp. Gain vs. Frequency (HA12221F) (1)



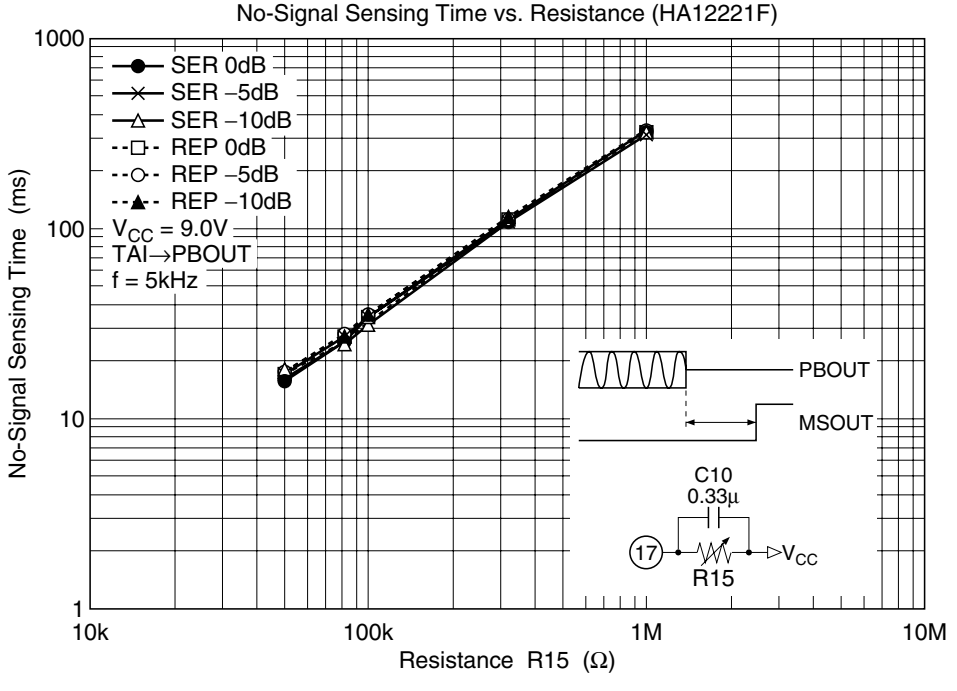

MS Amp. Gain vs. Frequency (HA12221F) (2)

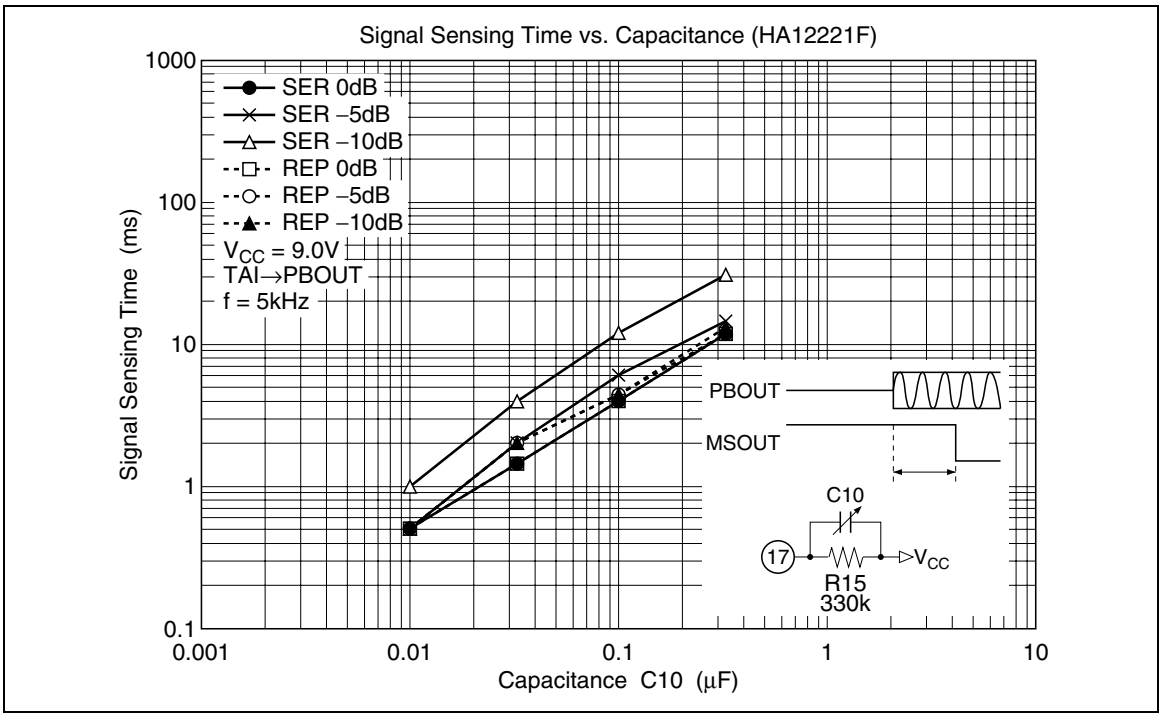


MS Sensing Level vs. Frequency (HA12221F)



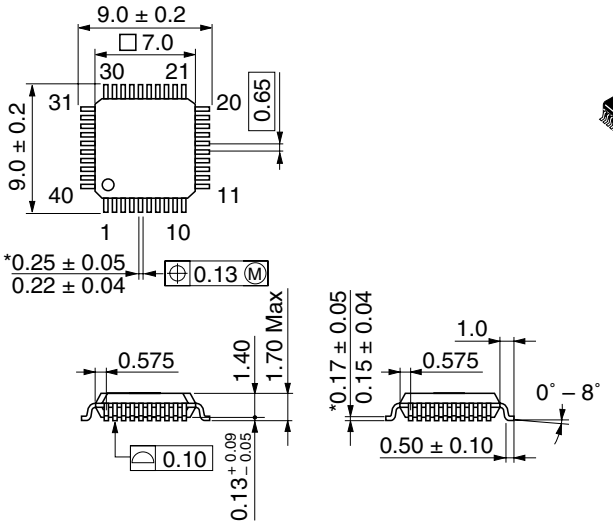

No-Signal Sensing Time vs. Resistance (HA12221F)




Signal Sensing Time vs. Capacitance (HA12221F)
1000
100
10
1
0.1
0.001
0.01
0.1
1
10
Signal Sensing Time (ms)
Capacitance C10 (μF)
SER 0dB
SER –5dB
SER –10dB
REP 0dB
REP –5dB
REP –10dB
VCC = 9.0V
TAI→PBOUT
f = 5kHz
PBOUT
MSOUT
C10
17
VCC
R15
330k

## Package Dimensions

Unit: mm




| | |
|---|---|
| Hitachi Code | FP-40B |
| JEDEC | — |
| EIAJ | Conforms |
| Mass (reference value) | 0.2 g |

*Dimension including the plating thickness
Base material dimension

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**Hitachi, Ltd.**
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Hitachi Europe GmbH
Electronic Components Group
Dornacher Straße 3
D-85622 Feldkirchen, Munich
Germany
Tel: <49> (89) 9 9180-0
Fax: <49> (89) 9 29 30 00

Hitachi Europe Ltd.
Electronic Components Group.
Whitebrook Park
Lower Cookham Road
Maidenhead
Berkshire SL6 8YA, United Kingdom
Tel: <44> (1628) 585000
Fax: <44> (1628) 585160

Hitachi Asia Ltd.
Hitachi Tower
16 Collyer Quay #20-00,
Singapore 049318
Tel : <65>-538-6533/538-8577
Fax : <65>-538-6933/538-3877
URL : http://www.hitachi.com.sg

Hitachi Asia Ltd.
(Taipei Branch Office)
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Tel : <886>-(2)-2718-3666
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Hitachi Asia (Hong Kong) Ltd.
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