# HA12163 Series

Audio Signal Processor for Car Deck and Cassette Deck
(Dolby B-type NR with PB Amp)

HITACHI

ADE-207-059C (Z)
4th Edition
Jun. 1999

## Description

HA12163 series are silicon monolithic bipolar IC providing Dolby noise reduction system*, music sensor and PB equalizer system in one chip.

## Functions

- PB equalizer × 2 channel
- Dolby B-NR × 2 channel
- Music sensor × 1 channel

## Features

- Different type of PB equalizer characteristics selection (normal/chrome or metal) is available with fully electronic control switching built-in.
- 2 type of input selection (radio/tape) is available.
- Changeable to forward, reverse-mode for PB head with fully electronic control switching built-in.
- Available to change music sensing level by external resistor.
- Music sensing level selection is available with fully electronic control switching built-in.
- Available to change frequency response of music sensor.
- NR-on/off and REC/PB fully electronic control switching built-in.
- 4 type of PB-out level.
- Available to allow common PCB designs with HA12173 series.



Hitachi semiconductor

## Ordering Information

| | PB-OUT level | Dolby level | REC-OUT level | Unit | Package |
|---|---|---|---|---|---|
| HA12163 | 300 | 300 | 300 | mVrms | FP–56 |
| HA12166F | | | | | FP–48 |
| HA12164 | 450 | 300 | 300 | mVrms | FP–56 |
| HA12165 | 580 | 300 | 300 | mVrms | FP–56 |
| HA12160 | 550 | 300 | 300 | mVrms | FP–56 |

Notes: 1. PB-OUT level above shown is typical value when adjusting Dolby level at Rec-out with NR-off mode.
2. HA12166F is only changes by package from HA12163. It is the same electrical characteristics that HA12163.

## Absolute Maximum Ratings

| Item | Symbol | Ratings | Unit |
|---|---|---|---|
| Supply voltage | $V_{CC}$ max | 16 | V |
| Power dissipation*[1] | Pd | 400*[2] | mW |
| Operating temperature | Topr | –40 to +85 | °C |
| Storage temperature | Tstg | –55 to +125 | °C |

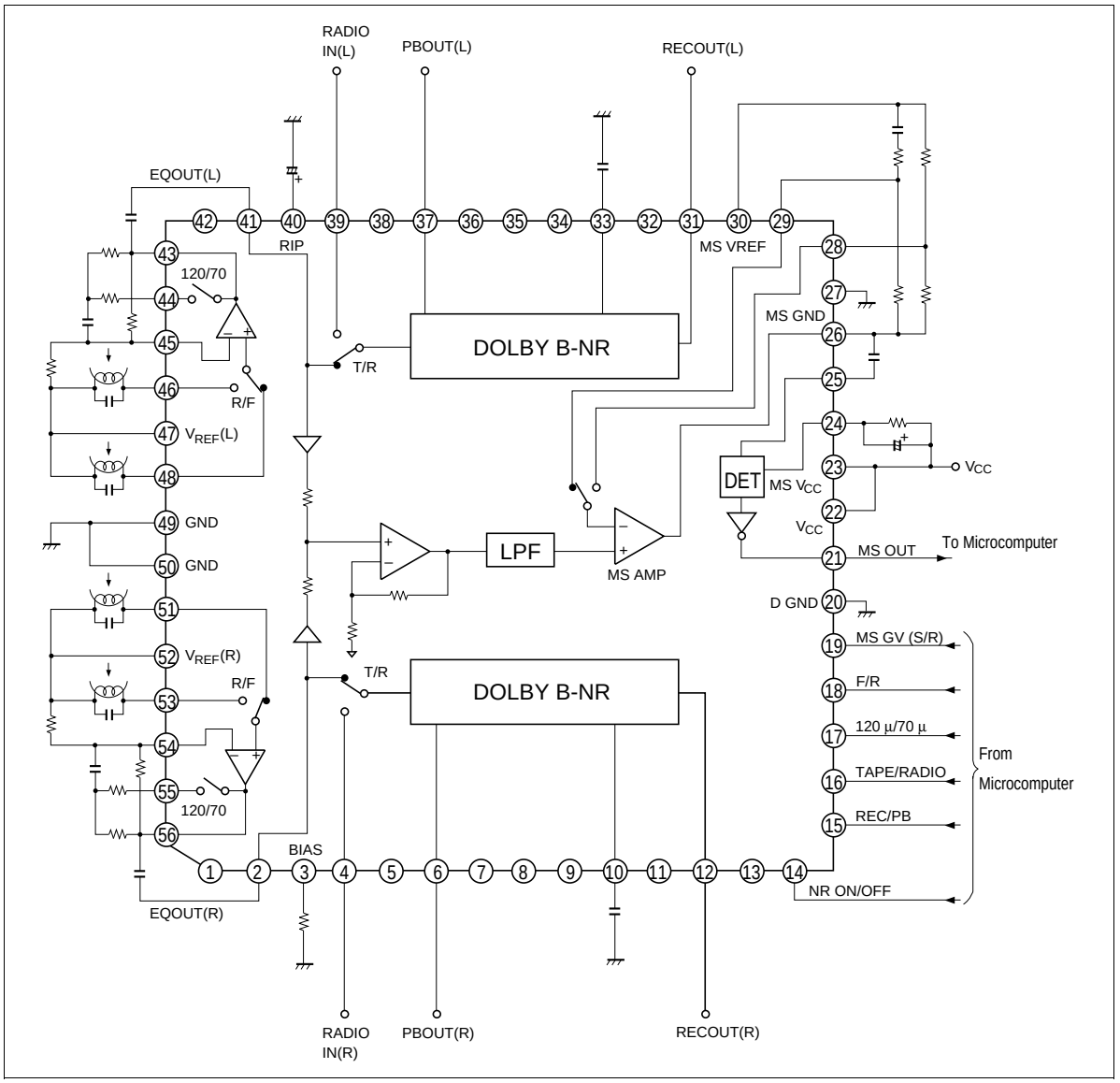
Notes: 1. Value at Ta ≤ 85°C
2. HA12166F = 360 mW

## Operating Voltage Range

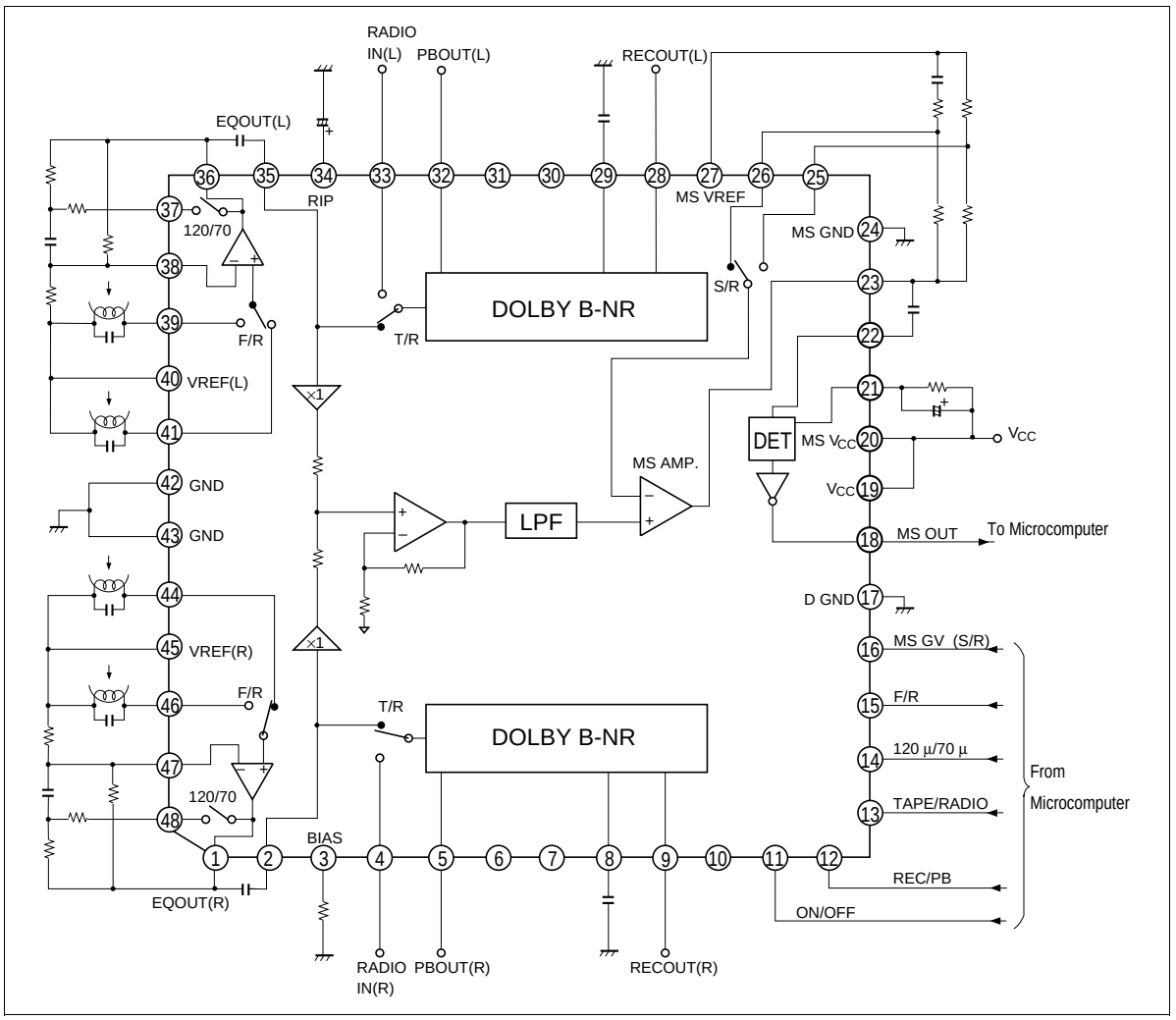
| Type | Min | Max | Unit |
|---|---|---|---|
| HA12163, HA12166F | 6.5 | 16 | V |
| HA12164 | 7.2 | 16 | V |
| HA12165 | 8.5 | 16 | V |
| HA12160 | 8.2 | 16 | V |

Note: 1. The minimum operating voltage of HA12163 series are different from the HA12173 series (Dolby B/C–type).

## **Block Diagram** (HA12163/164/165/160)



## Block Diagram (HA12166F)



**Electrical Characteristics** (Ta = 25°C Dolby level 300 mVrms (Rec-out pin))

HA12163, HA12166F $V_{CC}$ = 9.0 V HA12164 $V_{CC}$ = 9.0 V
HA12165 $V_{CC}$ = 12 V HA12160 $V_{CC}$ = 9.0 V

| Item | | Symbol | Min | Typ | Max | Unit | Test conditions | Note |
|---|---|---|---|---|---|---|---|---|
| Quiescent current | | $I_Q$ | 6.0 | 11.0 | 17.0 | mA | No input | No Signal NR-ON,70 µ |
| Input | HA12163 | GvIA TAI | 18.5 | 20.0 | 21.5 | dB | Vin = 0 dB, f = 1 kHz | |
| amp | HA12166F | GvIA RAI | 15.5 | 17.0 | 18.5 | | | |
| gain | HA12164 | GvIA TAI | 22.0 | 23.5 | 25.0 | | Vin = 0 dB, f = 1 kHz | |
| | | GvIA RAI | 19.0 | 20.5 | 22.0 | | | |
| | HA12165 | GvIA TAI | 24.2 | 25.7 | 27.2 | | Vin = 0 dB, f = 1 kHz | |
| | | GvIA RAI | 21.2 | 22.7 | 24.2 | | | |
| | HA12160 | GvIA TAI | 23.7 | 25.2 | 26.7 | | Vin = 0 dB, f = 1 kHz | |
| | | GvIA RAI | 20.7 | 22.2 | 23.7 | | | |
| B-type encode | | ENC –2k (1) | 2.8 | 4.3 | 5.8 | dB | Vin = –20 dB, f = 2 kHz | |
| boost | | ENC –2k (2) | 7.0 | 8.5 | 10.0 | | Vin = –30 dB, f = 2 kHz | |
| | | ENC –5k (1) | 1.7 | 3.2 | 4.7 | | Vin = –20 dB, f = 5 kHz | |
| | | ENC –5k (2) | 6.7 | 8.2 | 9.7 | | Vin = –30 dB, f = 5 kHz | |
| Signal handling | | Vo max | 12.0 | 13.0 | — | dB | THD = 1%, f = 1 kHz | *1 |
| Signal to noise ratio | | S/N | 64.0 | 70.0 | — | dB | Rg = 5.1 kΩ, CCIR/ARM | |
| THD | | THD | — | 0.05 | 0.3 | % | Vin = 0 dB, f = 1 kHz | |
| Channel | | CT RL (1) | 70.0 | 85.0 | — | dB | Vin = 0 dB, f = 1 kHz | RAI input |
| separation | | CT RL (2) | 50.0 | 60.0 | — | | Vin = 0.6 mVrms, f = 1 kHz | EQ input |
| Crosstalk | | CT EQ → RAI | 70.0 | 80.0 | — | | | EQ input |
| | | CT RAI → EQ | 50.0 | 60.0 | — | | Vin = 0 dB, f = 1 kHz | RAI input |
| PB - EQ gain | | Gv EQ 1k | 37.0 | 40.0 | 43.0 | dB | Vin = 0.6 mVrms, f = 1 kHz | 120 µ |
| | | Gv EQ 10k (1) | 33.0 | 36.0 | 39.0 | | Vin = 0.6 mVrms, f = 10 kHz | |
| | | Gv EQ 10k (2) | 29.0 | 32.0 | 35.0 | | | 70 µ |
| PB - EQ maximum output | | VoM | 300 | 600 | — | mVrms | THD = 1%, f = 1 kHz | *1 |
| PB - EQ THD | | THD - EQ | — | 0.05 | 0.3 | % | Vin = 0.6 mVrms, f = 1 kHz | |
| Noise voltage level converted in input | | $V_N$ | — | 0.7 | 1.5 | µVrms | Rg = 680 Ω, DIN - AUDIO | |
| MS sensing level | | $V_{ON}$ (1) | –36.0 | –32.0 | –28.0 | dB | f = 5 kHz, Normal speed | |
| | | $V_{ON}$ (2) | –18.0 | –14.0 | –10.0 | | f = 5 kHz, High speed | |

**Electrical Characteristics** (Ta = 25°C Dolby level 300 mVrms (Rec-out pin)) (cont)

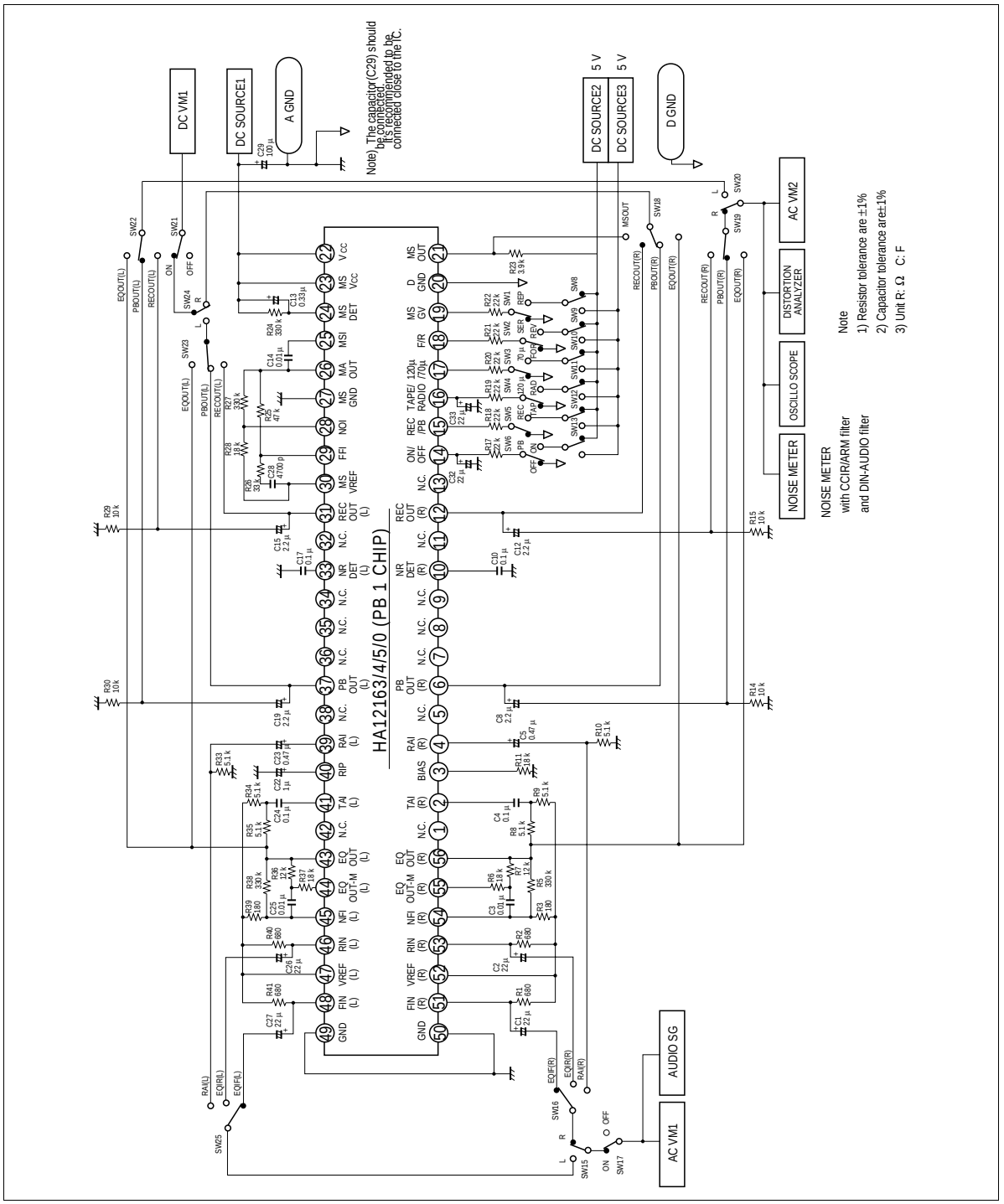
HA12163, HA12166F $V_{CC}$ = 9.0 V HA12164 $V_{CC}$ = 9.0 V
HA12165 $V_{CC}$ = 12 V HA12160 $V_{CC}$ = 9.0 V

| Item | Symbol | Min | Typ | Max | Unit | Test conditions | Note |
|---|---|---|---|---|---|---|---|
| MS output low level | $V_{OL}$ | — | 1.0 | 1.5 | V | | |
| MS output leak current | $I_{OH}$ | — | 0.0 | 2.0 | µA | | |
| Control voltage | $V_{IL}$ | –0.2 | — | 1.5 | V | | |
| | $V_{IH}$ | 3.5 | — | 5.3 | | | |

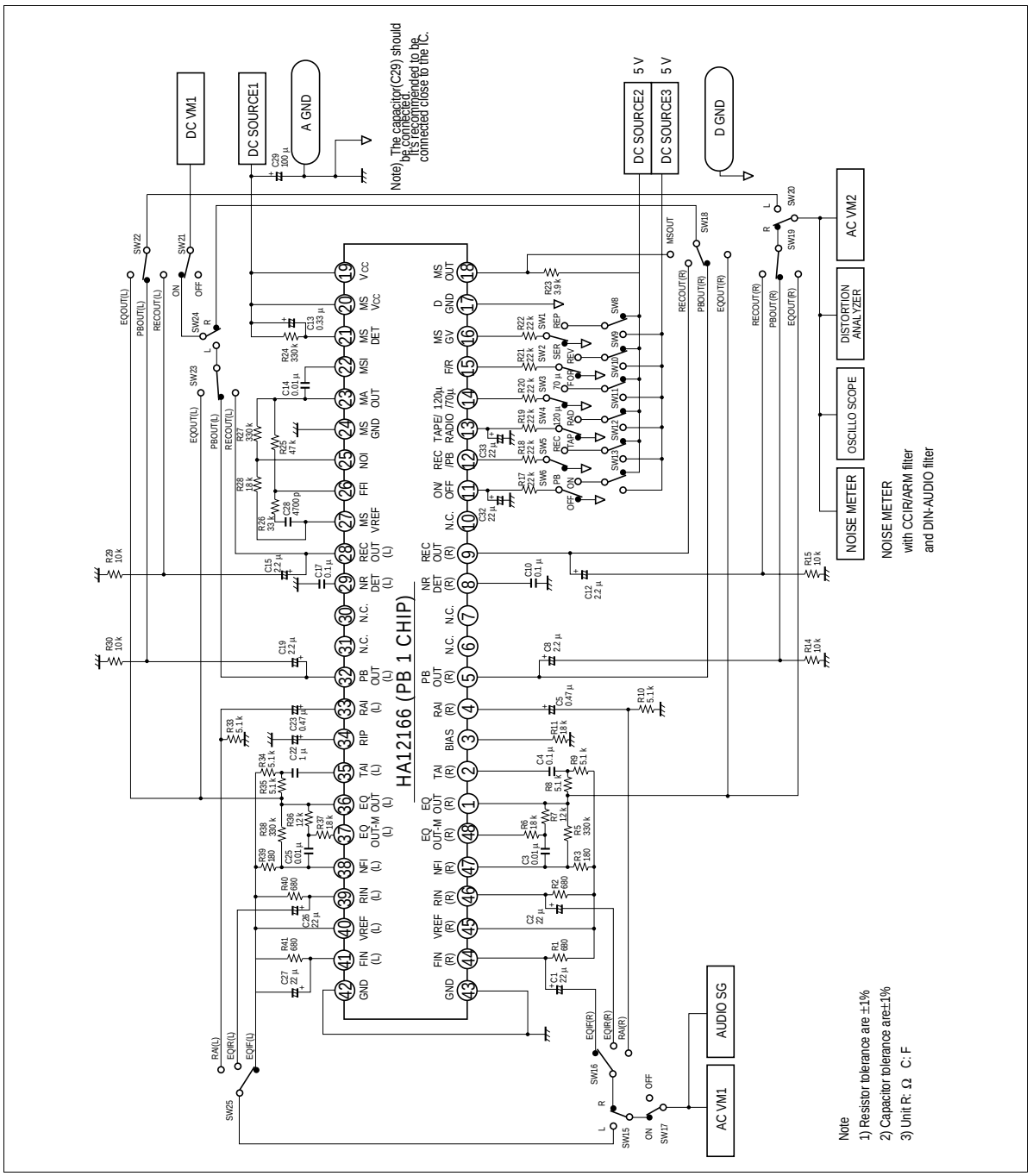
Note: 1. HA12163 HA12166F $V_{CC}$ = 6.5 V, HA12164 $V_{CC}$ = 7.2 V, HA12165 $V_{CC}$ = 8.5 V,HA12160 $V_{CC}$ = 8.2 V

## Test Circuit

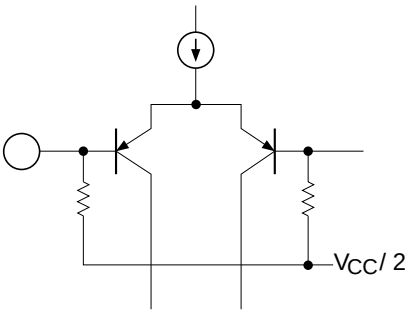
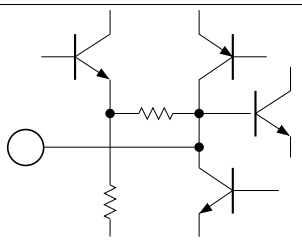
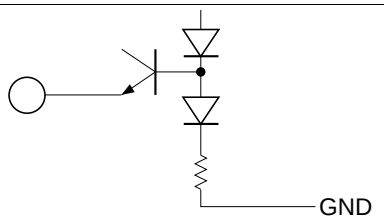
### HA12163/164/165/160



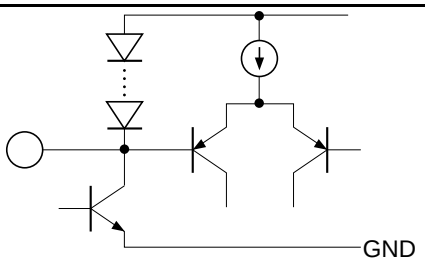
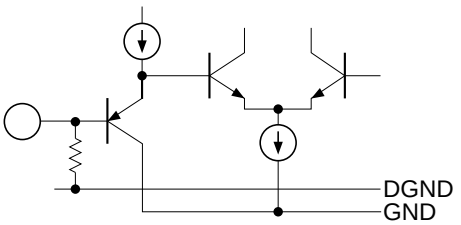
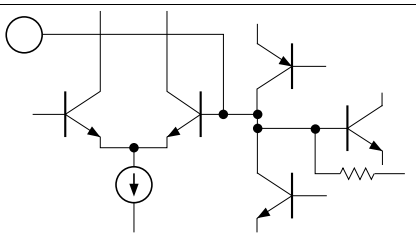
**HA12166F**


HA12166 (PB 1 CHIP)
DC VM1
DC SOURCE1
A GND
D GND
DC SOURCE2
DC SOURCE3
5 V
5 V
Note) The capacitor(C29) should be connected. It's recommended to be connected close to the IC.
NOISE METER
OSCILLO SCOPE
DISTORTION ANALYZER
AC VM2
NOISE METER with CCIR/ARM filter and DIN-AUDIO filter
AUDIO SG
AC VM1
Note
1) Resistor tolerance are ±1%
2) Capacitor tolerance are±1%
3) Unit R: Ω C: F

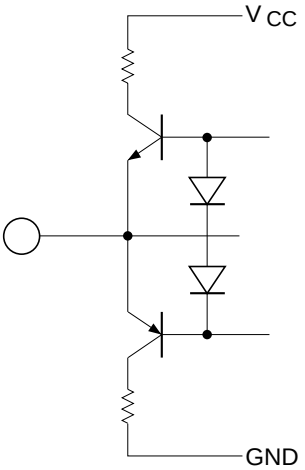
**Pin Description** ($V_{CC}$ = 9 V Single supply, Ta = 25°C, No signal, The value in the table show typical value)

| Pin No. | | Terminal | | DC | | |
|---|---|---|---|---|---|---|
| QFP-48 | QFP-56 | name | Zin | voltage | Equivalent circuit | Description |
| 2 | 2 | TAI | 100 kΩ | $V_{CC}$/2 |  | Tape input |
| 35 | 41 | | | | | |
| 4 | 4 | RAI | | | | Radio input |
| 33 | 39 | | | | | |
| 22 | 25 | MSI | | | | Music sensor rectifier input |
| 8 | 10 | NR DET | — | 2.5 V |  | Time constant pin for rectifier |
| 29 | 33 | | | | | |
| 3 | 3 | BIAS | — | 0.28 V |  | Reference current input |

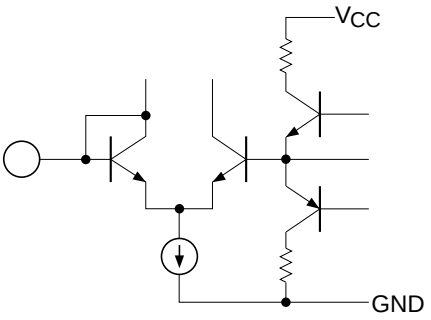
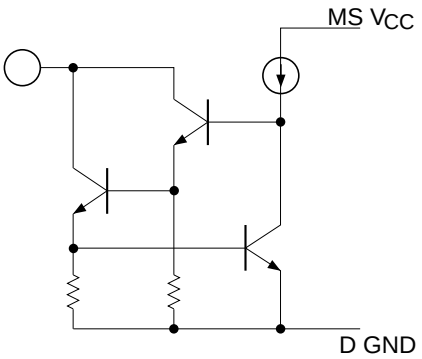
**Pin Description** ($V_{CC}$ = 9 V Single supply, Ta = 25°C, No signal, The value in the table show typical value) (cont)

| Pin No. | | Terminal | | DC | | |
|---|---|---|---|---|---|---|
| QFP-48 | QFP-56 | name | Zin | voltage | Equivalent circuit | Description |
| 21 | 24 | MS DET | — | $V_{CC}$ |  | Time constant pin for rectifier |
| 16 | 19 | MS GV | 100 kΩ | — |  | Mode control input |
| 34 | 40 | RIP | — | $V_{CC}/2$ |  | Ripple filter |

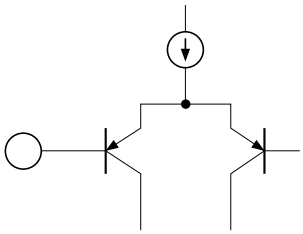
**Pin Description** ($V_{CC}$ = 9 V Single supply, Ta = 25°C, No signal, The value in the table show typical value) (cont)

| Pin No. | | Terminal | | DC | | |
|---|---|---|---|---|---|---|
| QFP-48 | QFP-56 | name | Zin | voltage | Equivalent circuit | Description |
| 1 | 43 | EQ OUT | — | $V_{CC}/2$ |  | Equalizer output |
| 36 | 56 | | | | | |
| 5 | 6 | PB OUT | | | | Play back (Decode) output |
| 32 | 37 | | | | | |
| 27 | 30 | MS $V_{REF}$ | | | | Reference voltage buffer output |
| 23 | 26 | MA OUT | | | | Music sensor amp output |
| 40 | 47 | $V_{REF}$ | | | | Reference voltage buffer output |
| 45 | 52 | | | | | |
| 9 | 12 | REC OUT | | | | Recording (Encode) output |
| 28 | 31 | | | | | |

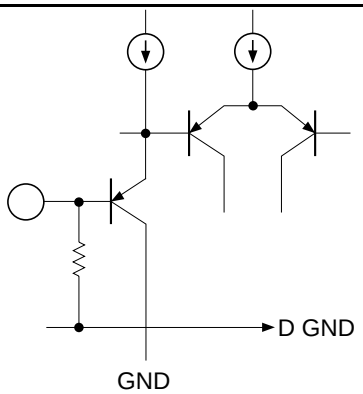
**Pin Description** ($V_{CC}$ = 9 V Single supply, Ta = 25°C, No signal, The value in the table show typical value) (cont)

| Pin No. | | Terminal | | DC | | |
|---|---|---|---|---|---|---|
| QFP-48 | QFP-56 | name | Zin | voltage | Equivalent circuit | Description |
| 37 | 44 | EQ OUT-M | — | $V_{CC}/2$ | | Equalizer |
| 48 | 55 | | | |  | output (Metal) |
| 18 | 21 | MS OUT | — | — |  | Music sensor output to MPU |
| 19 | 22 | $V_{CC}$ | — | $V_{CC}$ | — | Power supply |
| 20 | 23 | MS $V_{CC}$ | | | | |
| 17 | 20 | D GND | — | 0.0 V | — | Digital (Logic) ground |
| 24 | 27 | MS GND | | | | Music sensor ground |
| 42 | 49 | GND | | | | Ground |
| 43 | 50 | | | | | |

**Pin Description** ($V_{CC}$ = 9 V Single supply, Ta = 25°C, No signal, The value in the table show typical value) (cont)

| Pin No. | | Terminal | | DC | | |
|---|---|---|---|---|---|---|
| QFP-48 | QFP-56 | name | Zin | voltage | Equivalent circuit | Description |
| 41 | 48 | $F_{IN}$ | — | $V_{CC}/2$ |  | PB - EQ input for Forward |
| 44 | 51 | | | | | |
| 39 | 46 | $R_{IN}$ | | | | PB - EQ input for Reverse |
| 46 | 53 | | | | | |
| 38 | 45 | NFI | | | | Negative feedback terminal of PB - EQ amp |
| 47 | 54 | | | | | |
| 25 | 28 | NOI | | | | Negative feedback input for Normal speed |
| 26 | 29 | FFI | | | | Negative feedback input for FF or REW |

**Pin Description** ($V_{CC}$ = 9 V Single supply, Ta = 25°C, No signal, The value in the table show typical value) (cont)

| Pin No. | | Terminal | | DC | | |
|---|---|---|---|---|---|---|
| QFP-48 | QFP-56 | name | Zin | voltage | Equivalent circuit | Description |
| 11 | 14 | ON/OFF | 100 kΩ | — |  | Mode control input |
| 12 | 15 | REC/PB | | | | |
| 13 | 16 | TAPE/ RADIO | | | | |
| 14 | 17 | 120 µ/70 µ | | | | |
| 15 | 18 | F/R | | | | |
| 6 | 1 | NC | — | — | — | No |
| 7 | 5 | | | | | connection |
| 10 | 7 | | | | | |
| 30 | 8 | | | | | |
| 31 | 9 | | | | | |
| | 11 | | | | | |
| | 13 | | | | | |
| | 32 | | | | | |
| | 34 | | | | | |
| | 35 | | | | | |
| | 36 | | | | | |
| | 38 | | | | | |
| | 42 | | | | | |

## Application Note

1. Power Supply Range

   HA12163 series are provided with four line output level, which will permit on optimum overload margin for power supply conditions. And this series are designd to operate on single supply only. In case of split supply use, please consult with sales engineer.

**Table 1 Supply Voltage**

| | HA12163 | HA12164 | HA12165 | HA12160 |
|---|---|---|---|---|
| Single supply | 6.5 V to 16.0 V | 7.2 V to 16.0 V | 8.5 V to 16.0 V | 8.2 V to 16.0 V |

A. 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.

B. In the reverse-voltage conditions such as 'D-GND is higher than $V_{CC}$' or 'D-GND is lower than GND', excessive current flows into the D-GND to destory this IC. To prevent such destruction, pay attention to the followings on using.

   Short-circuit the D-GND and GND directory on the board mounting this IC.

2. 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 Reference voltage are provided for the left channel and the right channel separately. The block diagram is shown as figure 1.

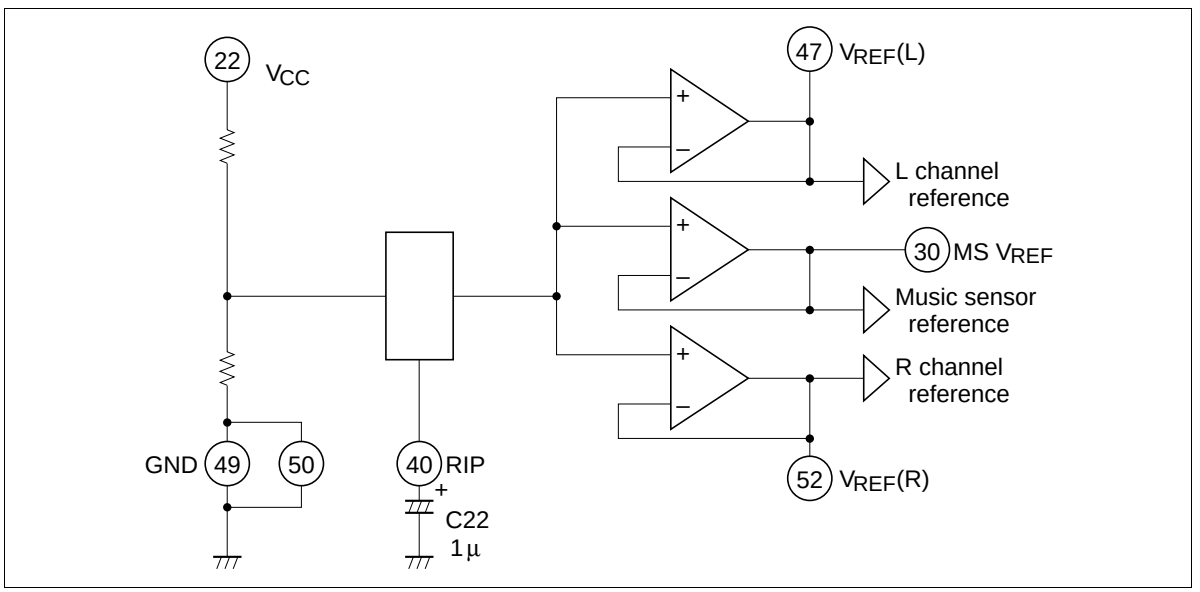



**Figure 1 The Block Diagram of Reference Voltage Supply**

3. Operating Mode Control

HA12163 series provide fully electronic switching circuits. And each operating mode control are controlled by parallel data (DC voltage).

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

| Pin No. | Low | High | Unit | Test conditions |
|---|---|---|---|---|
| 14, 15, 16, 17, 18, 19 | –0.2 to 1.5 | 3.5 to 5.3 | V | Input Pin — 22 k — Measure, V |

**Table 3 Switching Truth Table**

| Pin No. | Low | High |
|---|---|---|
| 14 | NR - OFF | NR - ON |
| 15 | PB | REC |
| 16 | TAPE | RADIO |
| 17 | 120 µ (NORMAL) | 70 µ (METAL or CHROME) |
| 18 | FORWARD | REVERSE |
| 19 | SER (FF or REV) | REP (NORMAL SPEED) |

Notes: 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: 5.3 V, Low: –0.2 V)
3. When connecting microcomputer or Logic-IC with HA12163 series directly, there is apprehension of rush-current under some transition timming of raising voltage or falling voltage at $V_{CC}$ ON/OFF.
On using, connect protective resistors of 10 to 22 kΩ to all the control pins. It is shown is test circuit on this data sheet. And pins fixed to low level should be preferably open.
4. Pay attention not to make digital GND voltage lower than GND voltage.

4. Input Block Diagram and Level Diagram

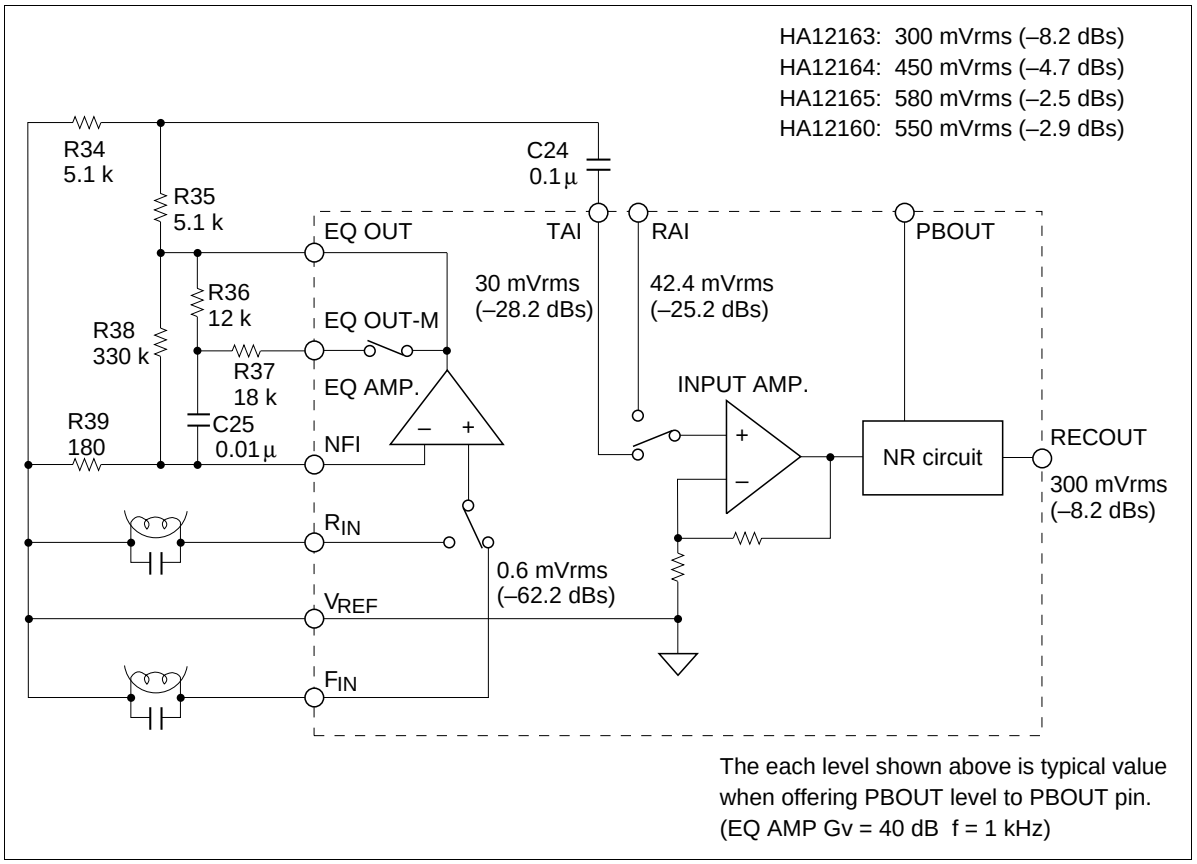



**Figure 2 Input Block Diagram**

5. Adjustment of Playback Dolby Level

   After replace R34 and R35 with a half-fix volume of 10 kΩ, adjust RECOUT level to be Dolby level with playback mode.

6. Note on Connecting with Tape Head to IC

This IC has no internal resistor to give the DC bias current to equalizer amp, therefore the DC bias current will give through the head. This IC provides the Vref buffer output pin for Rch and Lch separately (has two Vref terminal). In case of use that the Rch and Lch reference of head are connected commonly, please use one of Vref terminals of IC (47 pin or 52 pin) for head reference. If both 47 pin and 52 pin of IC are connected, rush current give the great damage to IC. The application circuit is shown in figure 3.

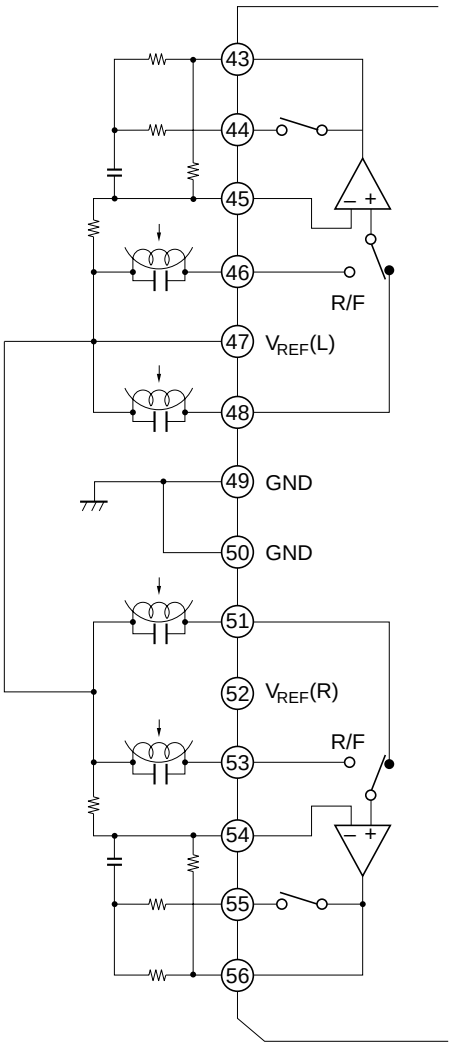



**Figure 3 Application Circuit**

7. The Sensitivity Adjustment of a Music Sensor

   Adjusting MS AMP gain by external resistor, the sensitivity of music sensor can set up.

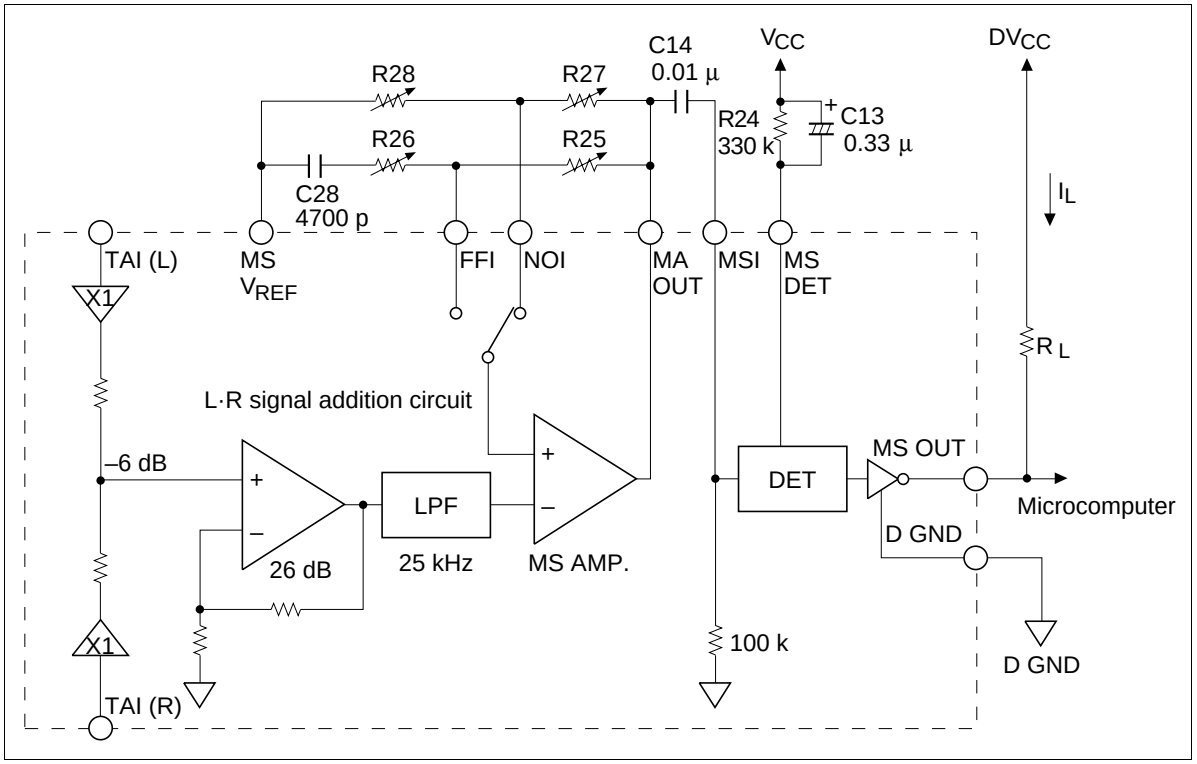



**Figure 4 Music Sensor Block Diagram**

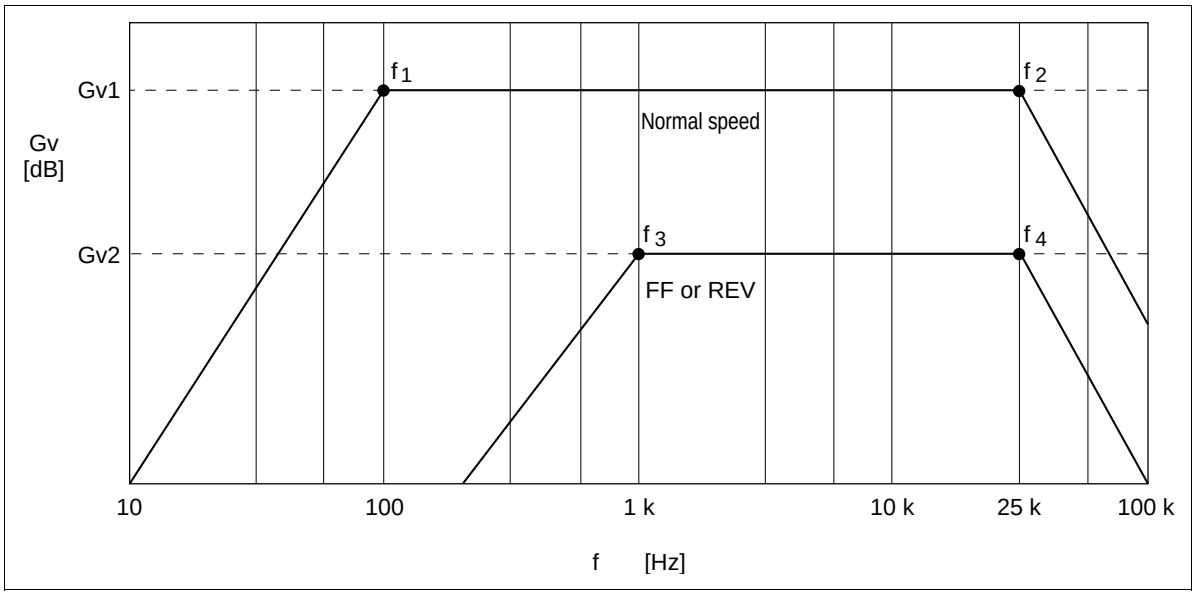



**Figure 5 Frequency Response**

A. Normal mode

$$Gv1 = 20\log\left(1+\frac{R27}{R28}\right)[dB]$$

$$f1=\frac{1}{2\cdot\pi\cdot C14\cdot 100\,k}[Hz], f2 = 25\,k\,[Hz]$$

B. FF or REW mode

$$Gv2 = 20\log\left(1+\frac{R25}{R26}\right)[dB]$$

$$f3=\frac{1}{2\cdot\pi\cdot C28\cdot R26}[Hz], f4 = 25\,k\,[Hz]$$

A standard level of TAI pin is 30 mVrms and the gain for TAI to MS AMP input is 10, therefore, the other channel sensitivity of music sensor (S) is computed by the formula mentioned below.

$$S = 20\log\left(\frac{C}{30}\cdot\frac{1}{10\cdot A}\right)[dB]$$

A = MS AMP. gain (B dB)

C = The sensing level of music sensor

S = –7.3–B [dB]  C = 130 mVrms (typ.)

S is 6 dB up in case of the both channels.

8. 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.

Connection with microcomputer, design $I_L$ at 1 mA typ.

$$I_L = \frac{DV_{CC} - MSOUT_{Lo}\,*}{R_L}$$

* $MSOUT_{Lo}$: sensing signal (about 1 V)

Notes: 1. Supply voltage of MS OUT pin must be less than $V_{CC}$ voltage.

2. MS $V_{CC}$ pin and $V_{CC}$ pin are required the same voltage.

9. The Tolerances of External Components for Dolby NR-block
   For adequate Dolby NR tracking response, take external components shown below.

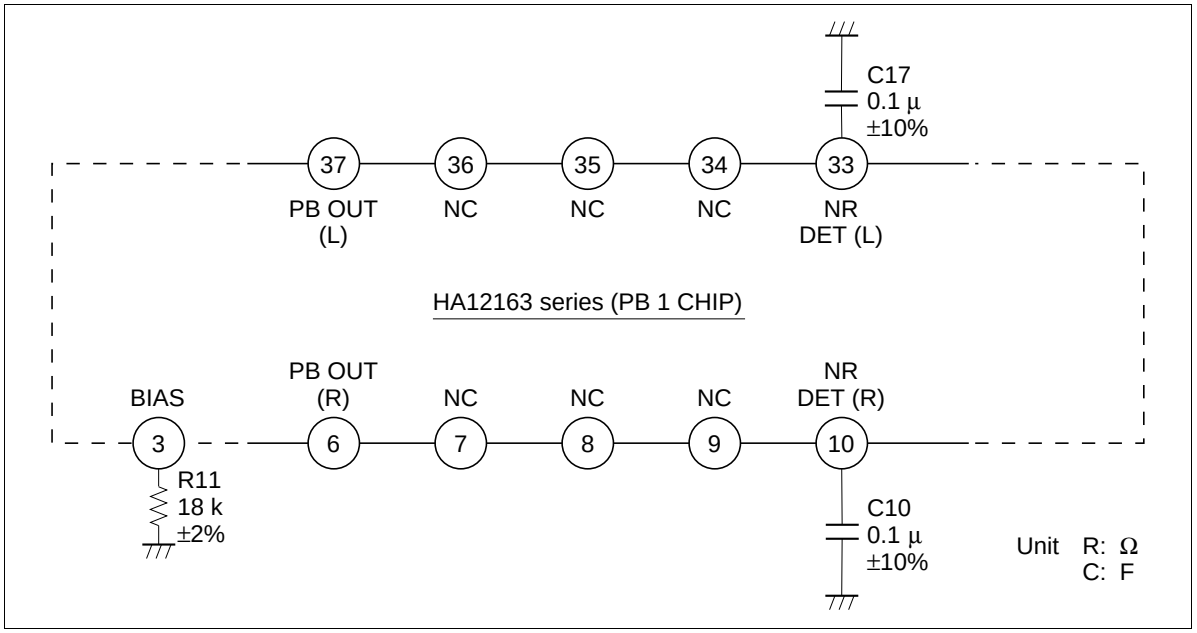



**Figure 6 Tolerances of External Components**

10. PB Equalizer for Double Speed

PB equalizer can be design for double speed by using external components shown in figure 7. Application data is shown in figure 8.

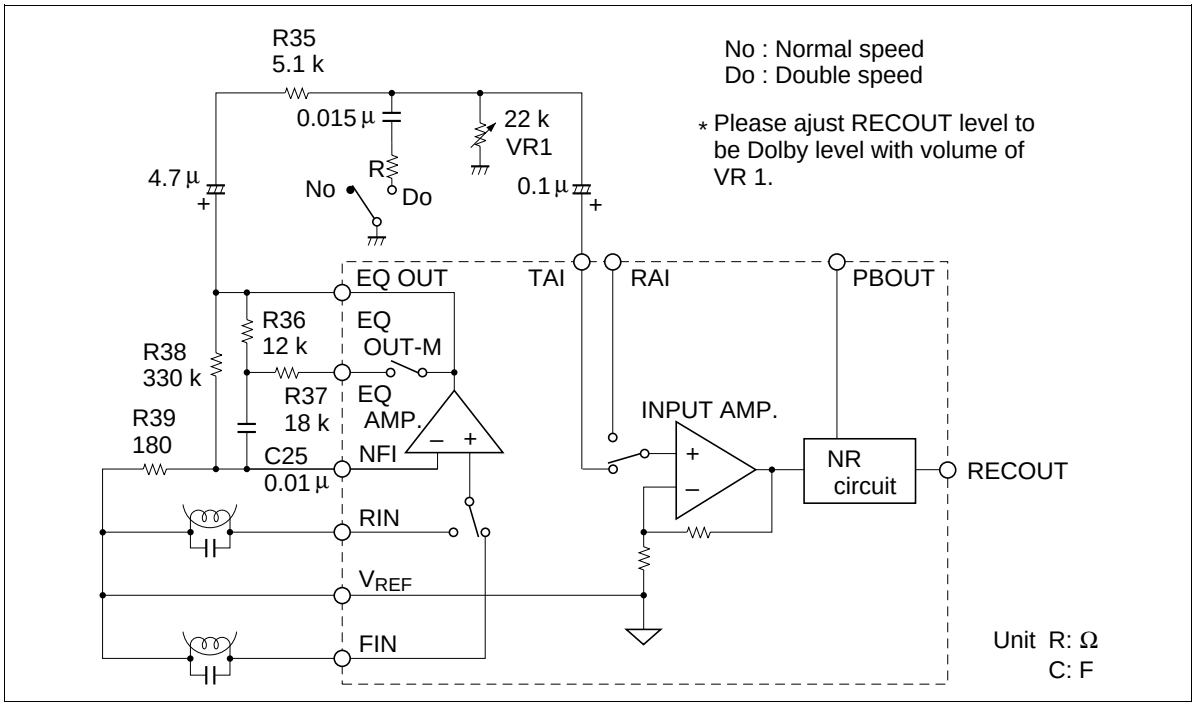



**Figure 7 Application Circuit for Double Speed**

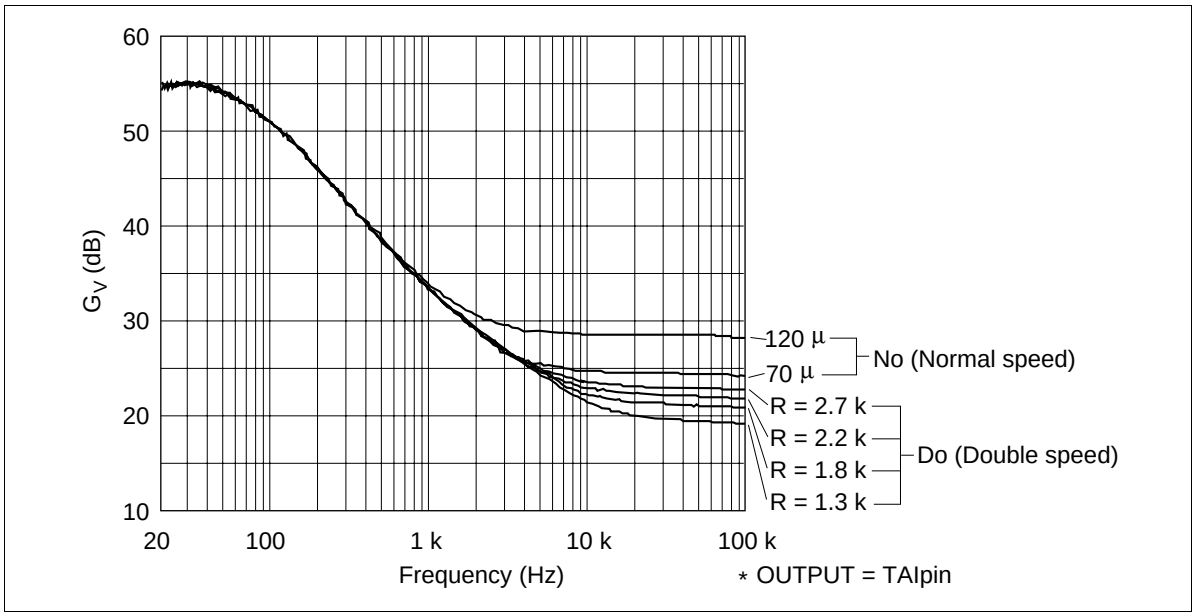
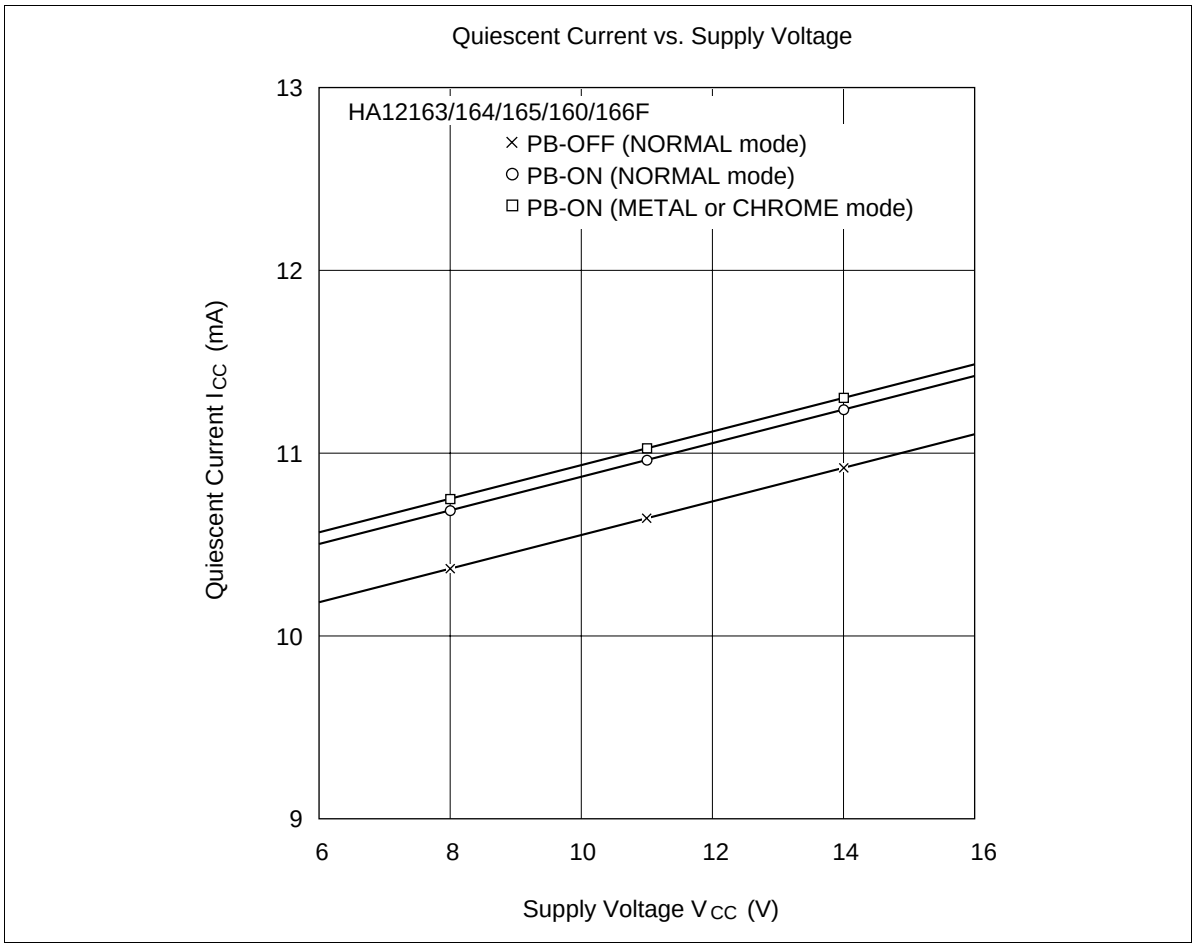


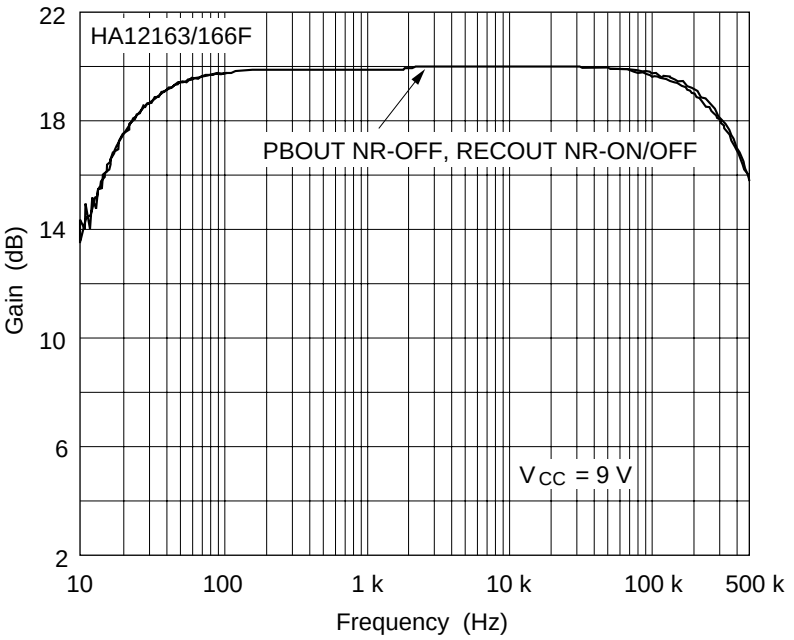

**Figure 8 Application Data**

## Typical Characteristic Curves

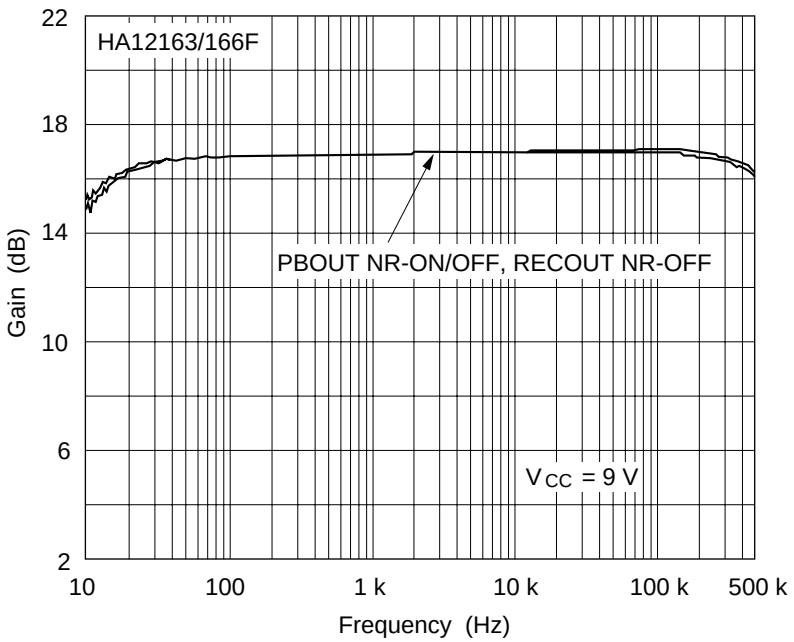


**HA12163 Data**

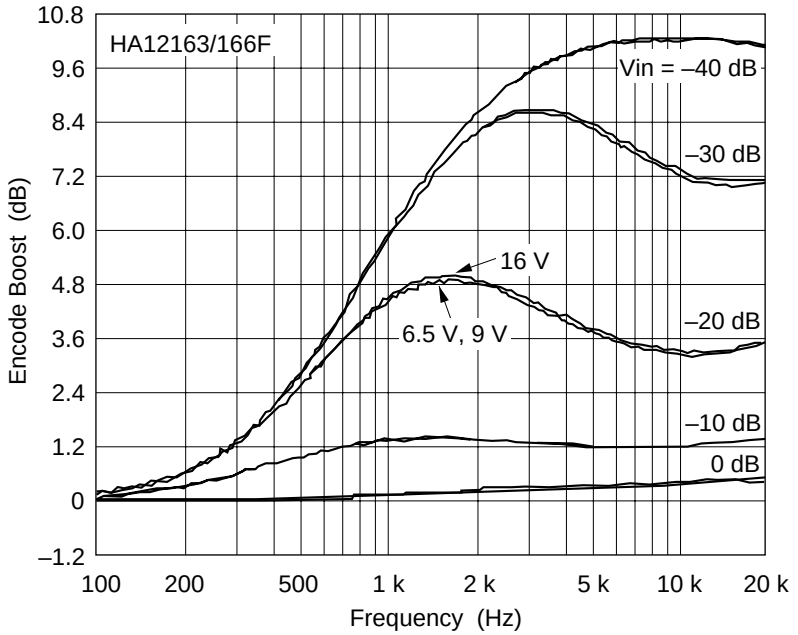
TAIin Input Amp. Gain vs. Frequency (PBmode)



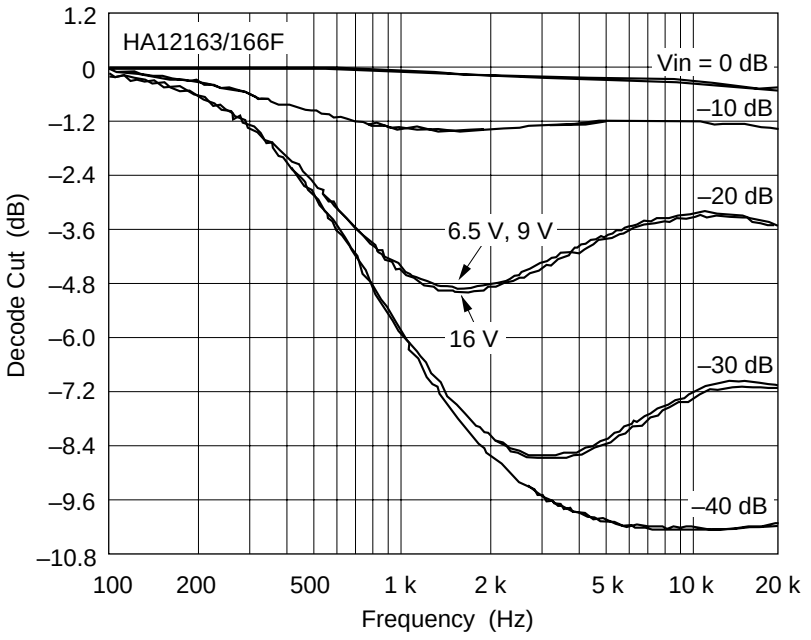

RAIin Input Amp. Gain vs. Frequency (RECmode)



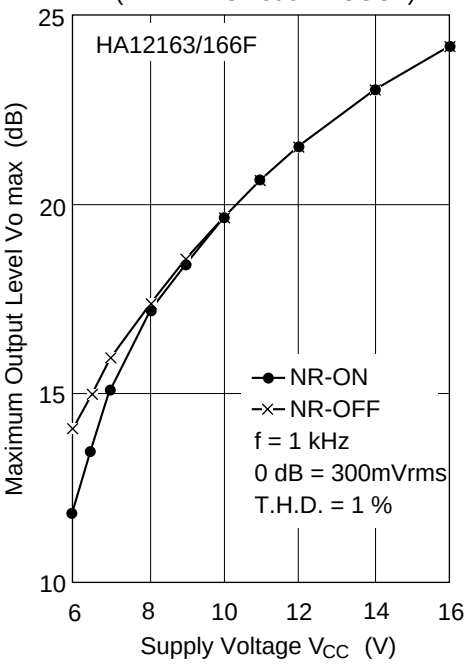
Encode Boost vs. Frequency ($V_{CC}$ = 6.5 V, 9 V, 16 V)



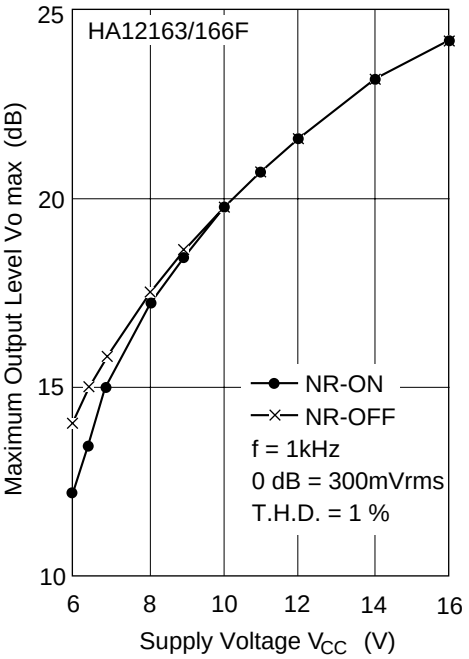

Decode Cut vs. Frequency ($V_{CC}$ = 6.5 V, 9 V, 16 V)



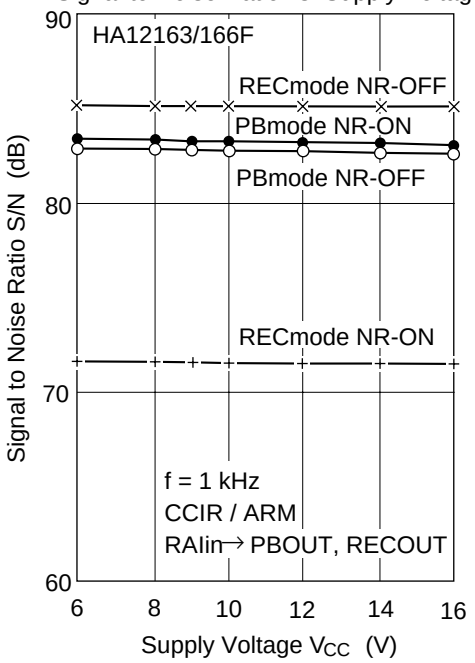
Maximum Output Level vs. Supply Voltage (1)
(RAIin RECmode RECOUT)



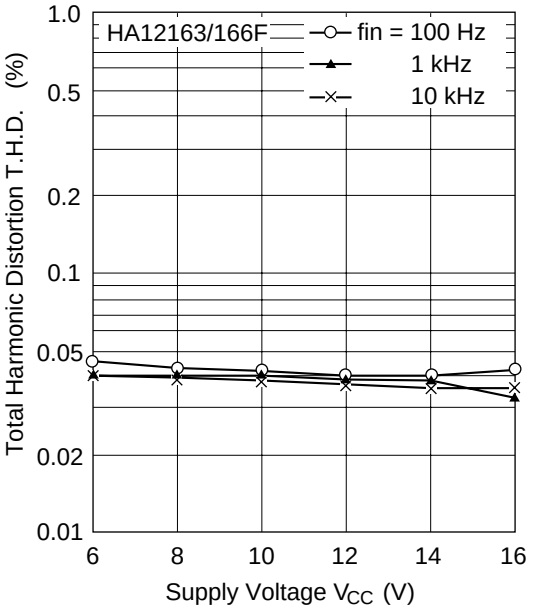

Maximum Output Level vs. Supply Voltage (2)
(RAIin PBmode PBOUT)



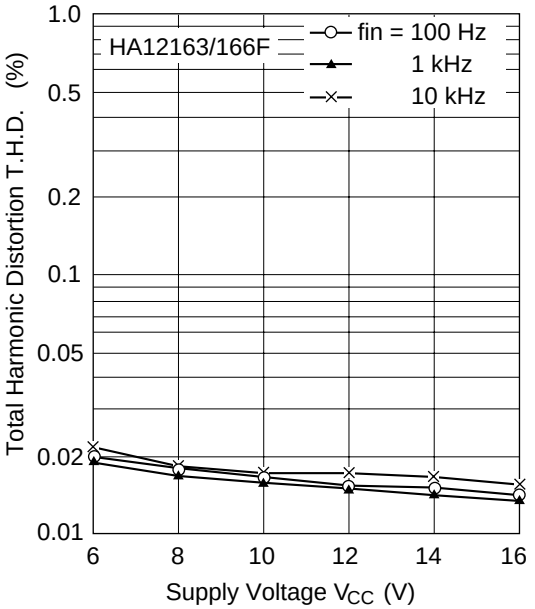
Signal to Noise Ratio vs. Supply Voltage



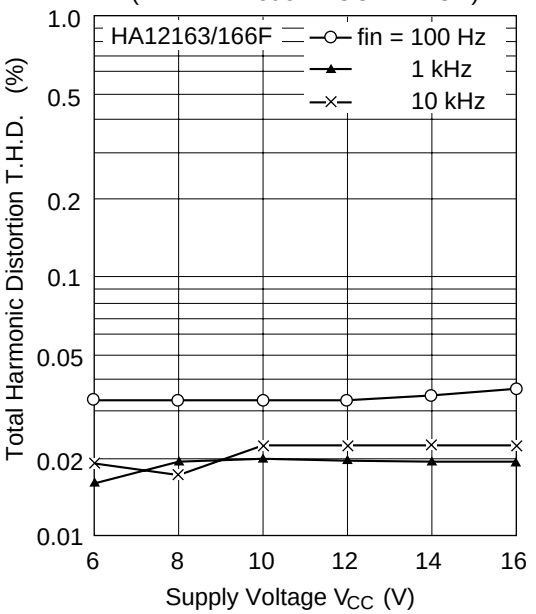

Total Harmonic Distortion vs. Supply Voltage (1)
(RAIin RECmode RECOUT NR-ON)



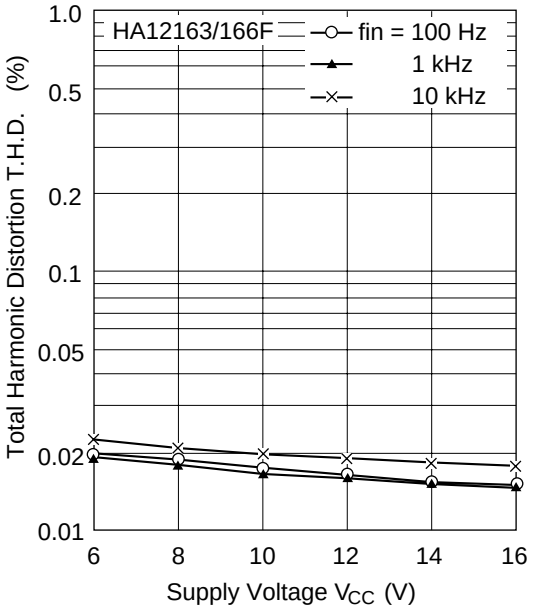
Total Harmonic Distortion vs. Supply Voltage (2)
(RAIin RECmode RECOUT NR-OFF)



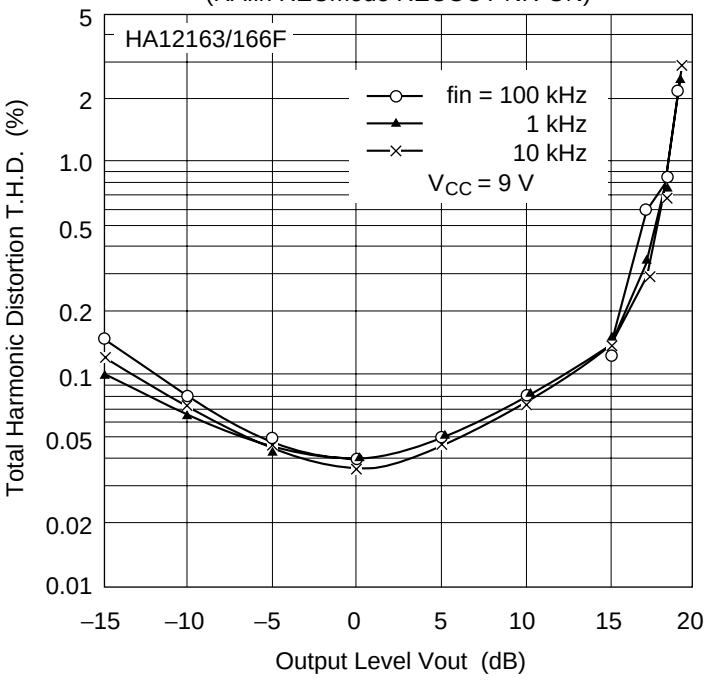

Total Harmonic Distortion vs. Supply Voltage (3)
(RAIin PBmode PBOUT NR-ON)



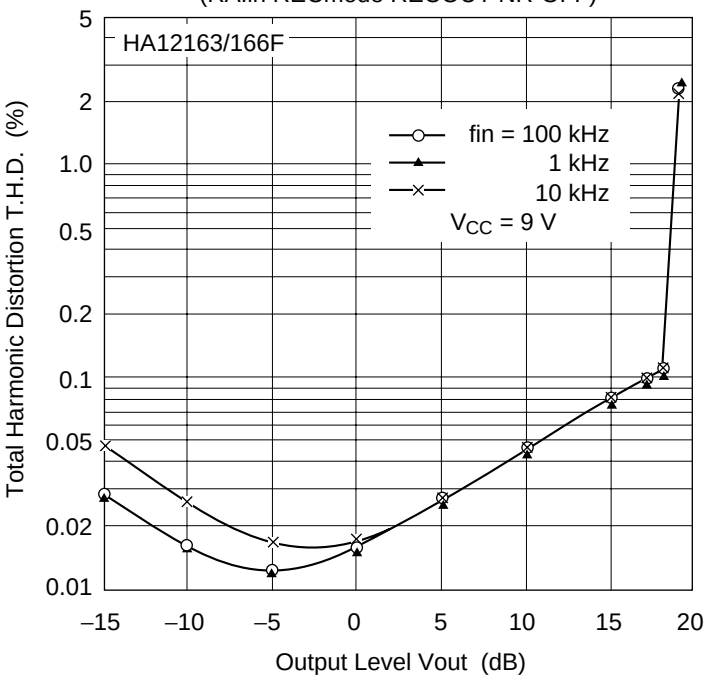
Total Harmonic Distortion vs. Supply Voltage (4)
(RAIin PBmode PBOUT NR-OFF)



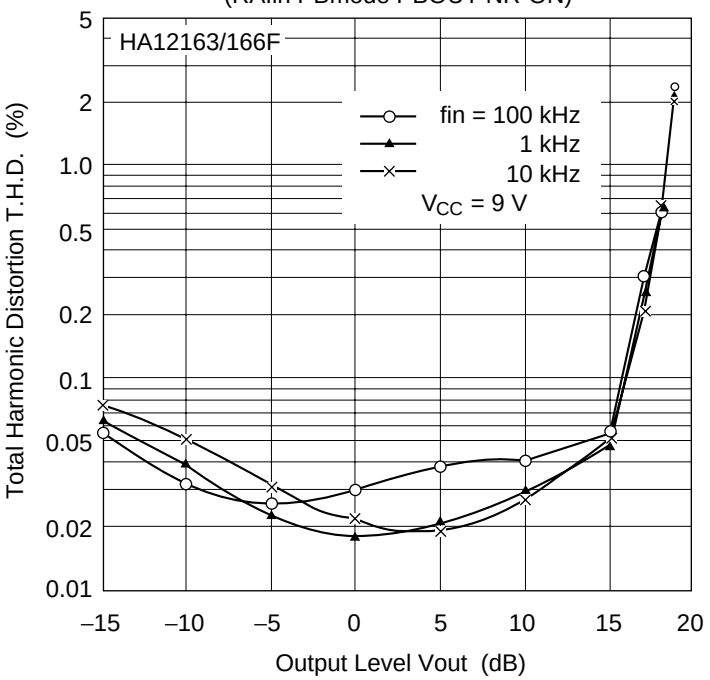

Total Harmonic Distortion vs. Output Level (1)
(RAIin RECmode RECOUT NR-ON)



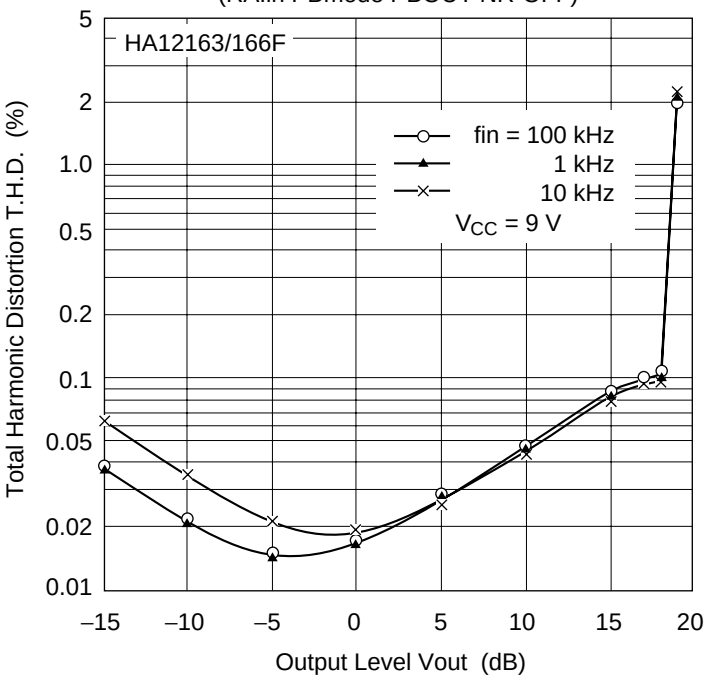
Total Harmonic Distortion vs. Output Level (2)
(RAIin RECmode RECOUT NR-OFF)



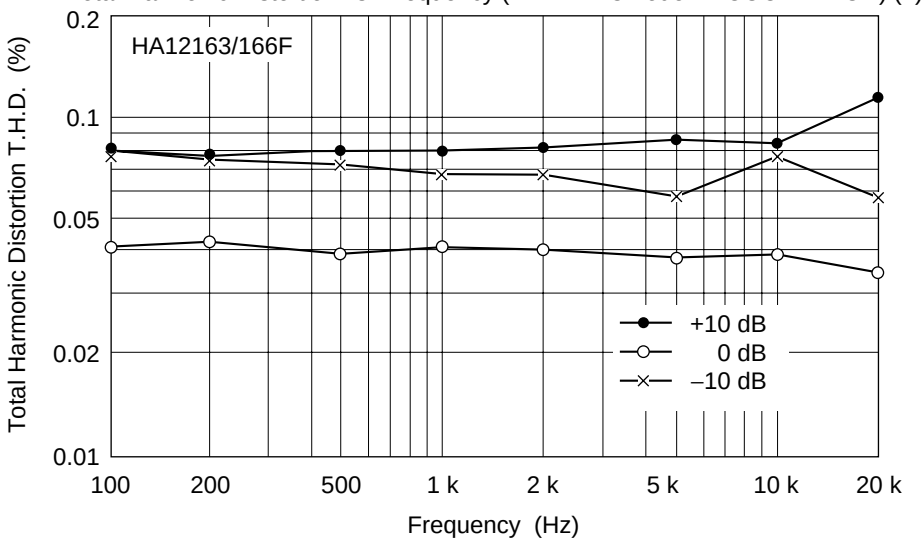

Total Harmonic Distortion vs. Output Level (3)
(RAIin PBmode PBOUT NR-ON)



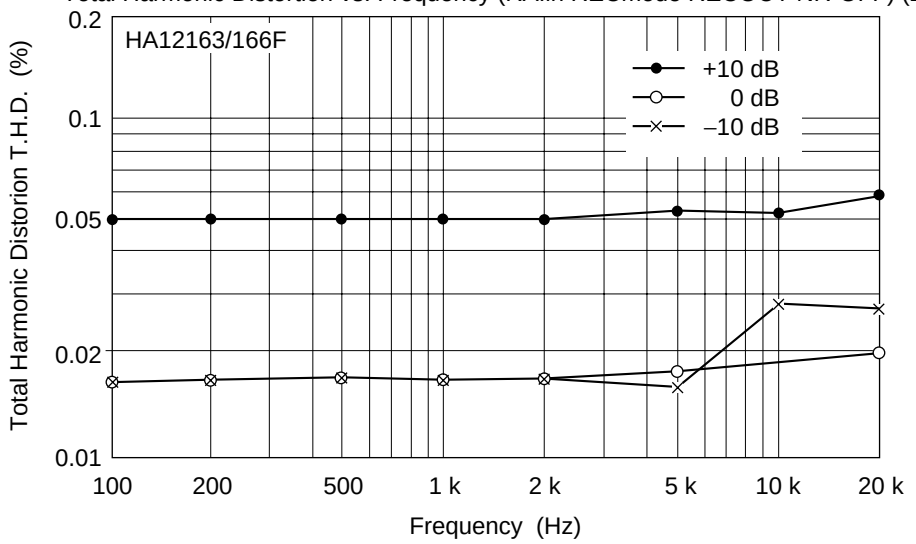
Total Harmonic Distortion vs. Output Level (4)
(RAIin PBmode PBOUT NR-OFF)



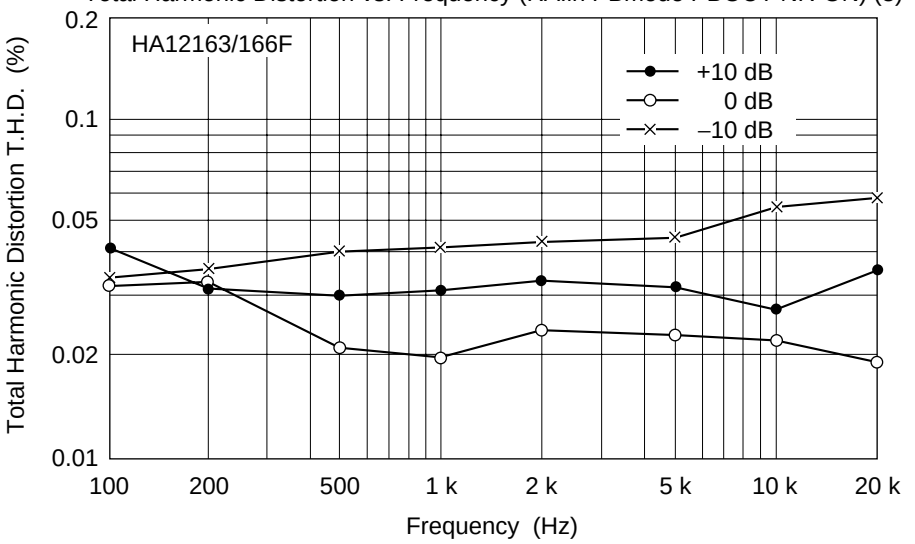

Total Harmonic Distortion vs. Frequency (RAIin RECmode RECOUT NR-ON) (1)



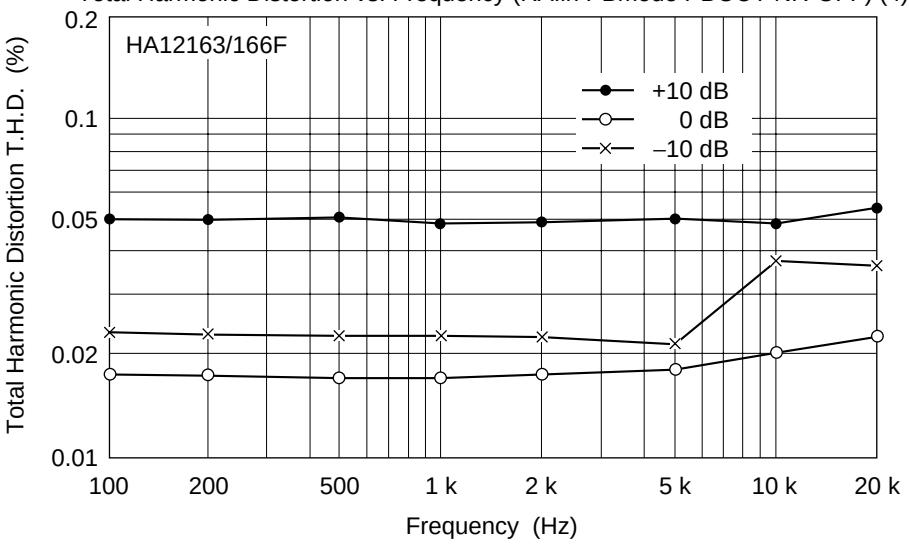
Total Harmonic Distortion vs. Frequency (RAlin RECmode RECOUT NR-OFF) (2)



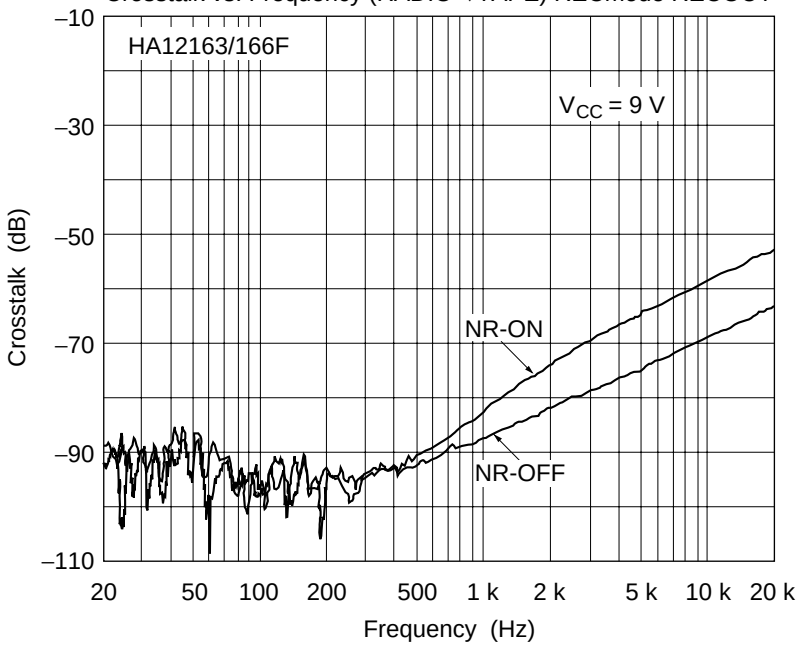

Total Harmonic Distortion vs. Frequency (RAlin PBmode PBOUT NR-ON) (3)



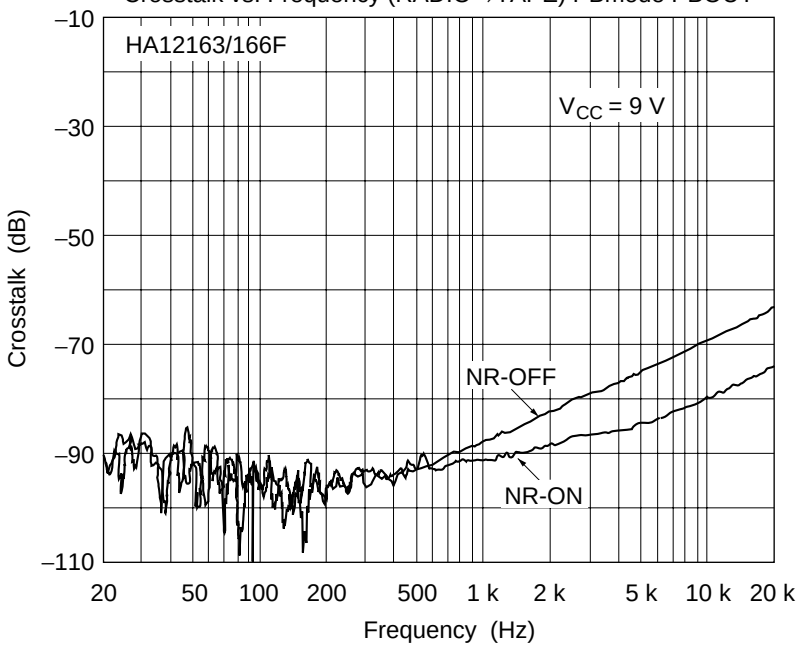
Total Harmonic Distortion vs. Frequency (RAlin PBmode PBOUT NR-OFF) (4)



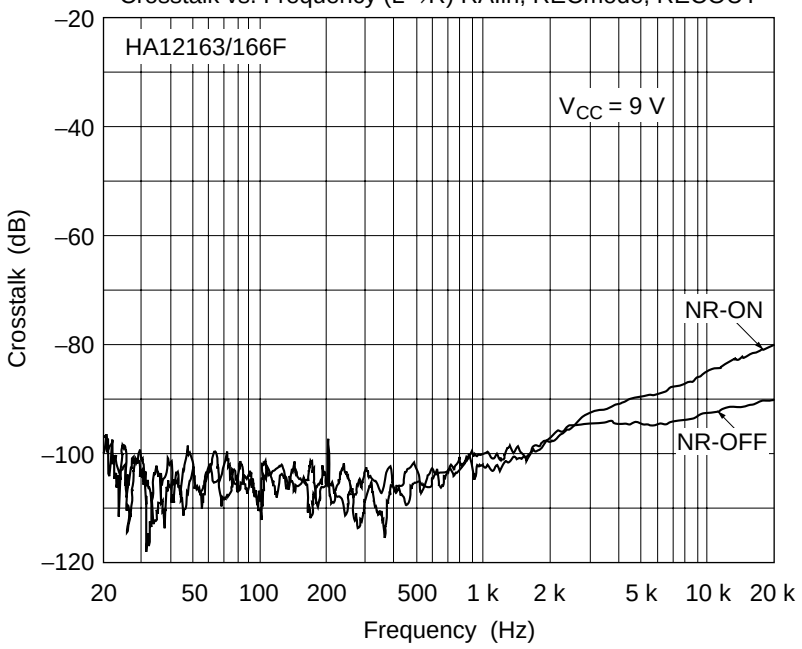

Crosstalk vs. Frequency (RADIO→TAPE) RECmode RECOUT



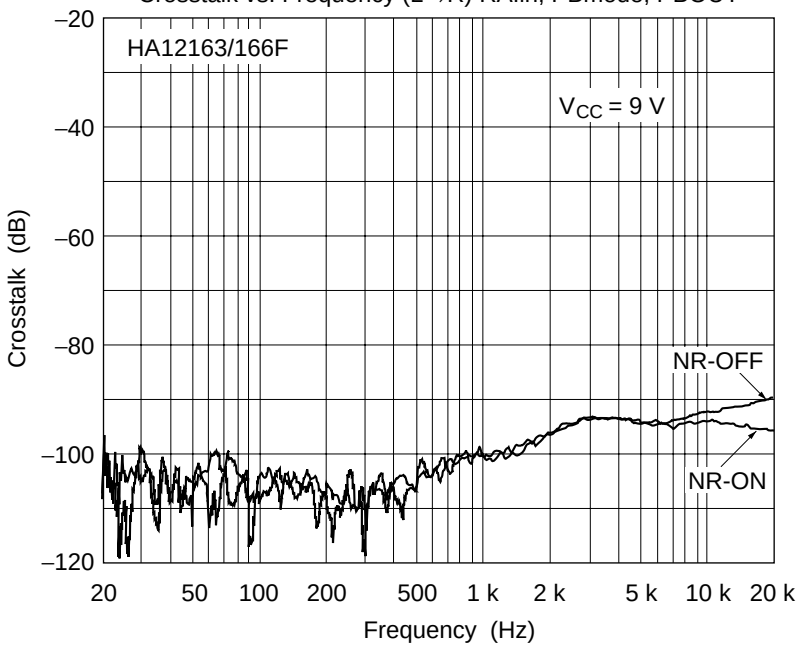
Crosstalk vs. Frequency (RADIO→TAPE) PBmode PBOUT



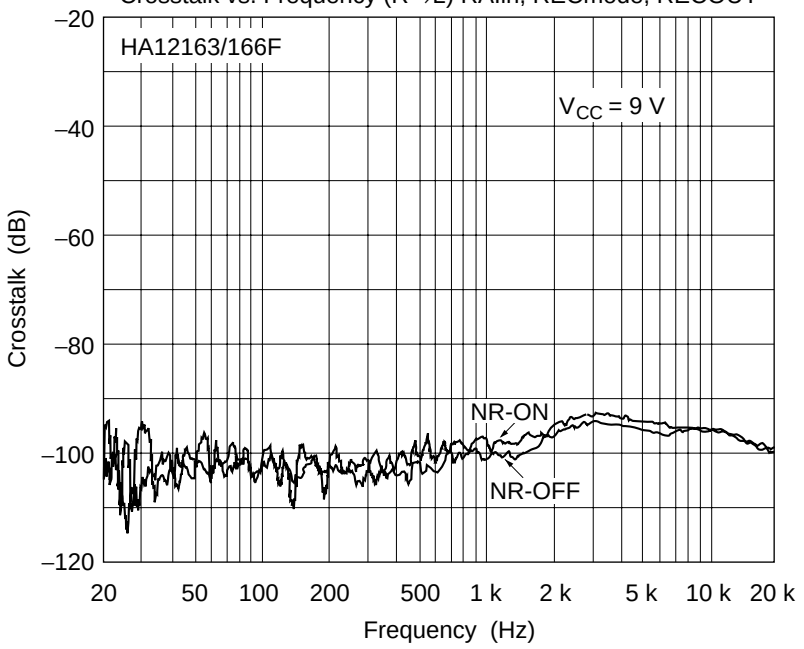

Crosstalk vs. Frequency (L→R) RAIin, RECmode, RECOUT

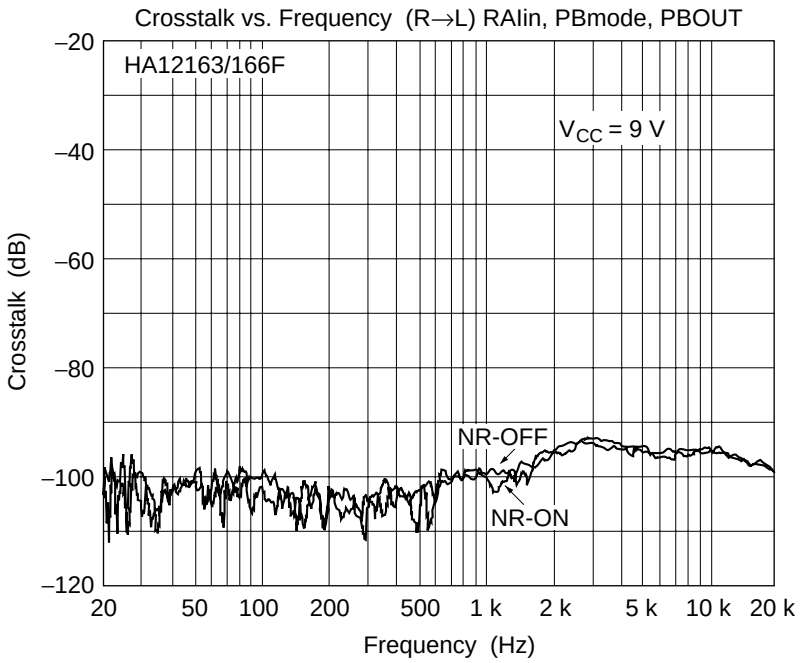


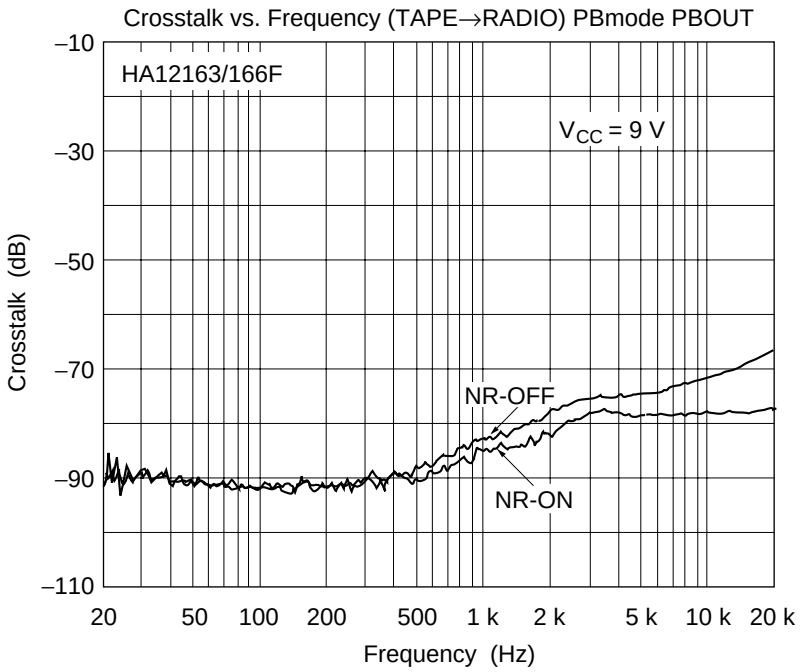
Crosstalk vs. Frequency (L→R) RAIin, PBmode, PBOUT



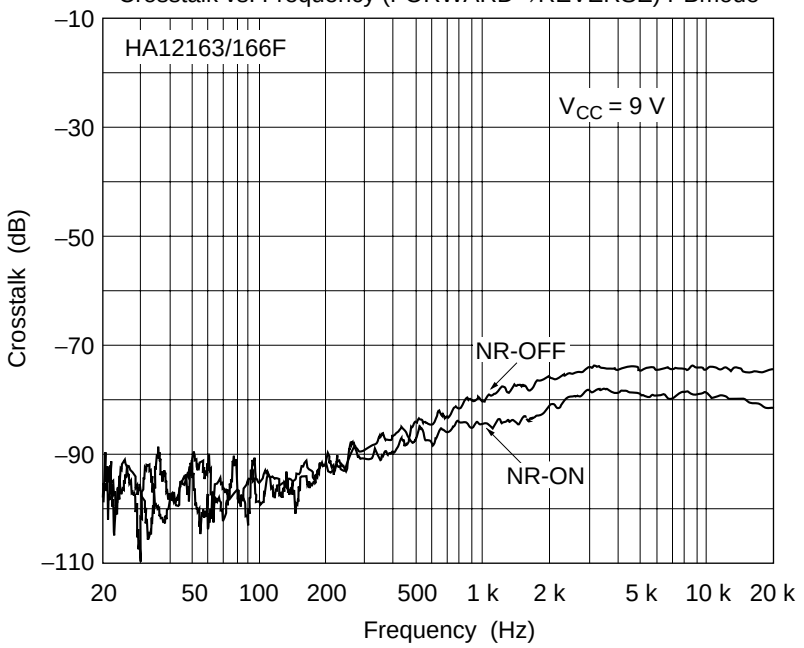

Crosstalk vs. Frequency (R→L) RAIin, RECmode, RECOUT



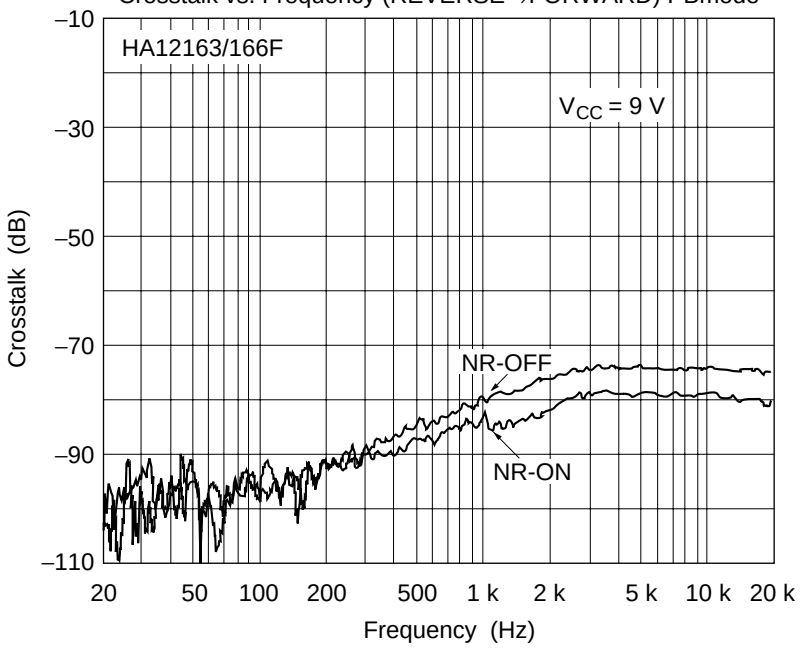

Crosstalk vs. Frequency (R→L) RAIin, PBmode, PBOUT
HA12163/166F
$V_{CC}$ = 9 V
NR-OFF
NR-ON
Crosstalk (dB)
–20
–40
–60
–80
–100
–120
20
50
100
200
500
1 k
2 k
5 k
10 k
20 k
Frequency (Hz)


Crosstalk vs. Frequency (TAPE→RADIO) PBmode PBOUT
HA12163/166F
$V_{CC}$ = 9 V
NR-OFF
NR-ON
Crosstalk (dB)
–10
–30
–50
–70
–90
–110
20
50
100
200
500
1 k
2 k
5 k
10 k
20 k
Frequency (Hz)

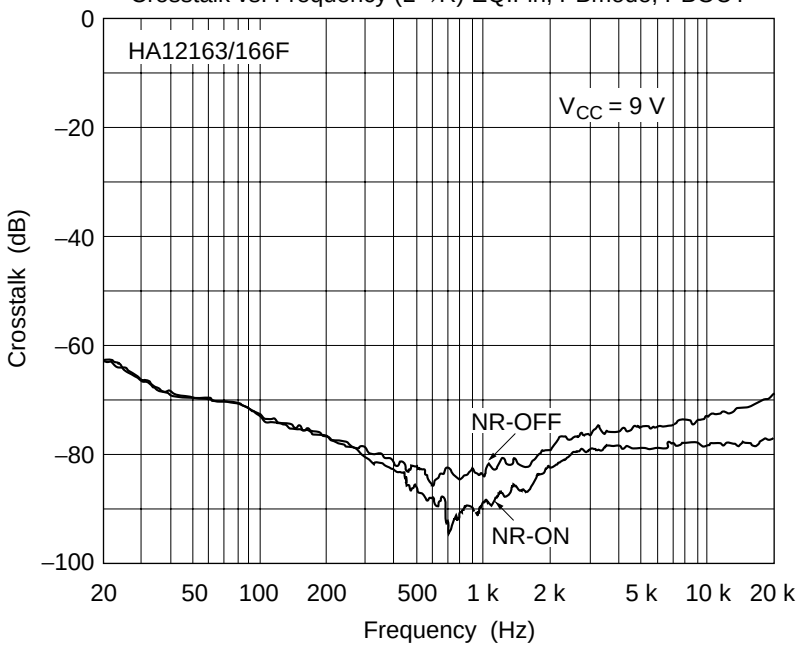
Crosstalk vs. Frequency (FORWARD→REVERSE) PBmode



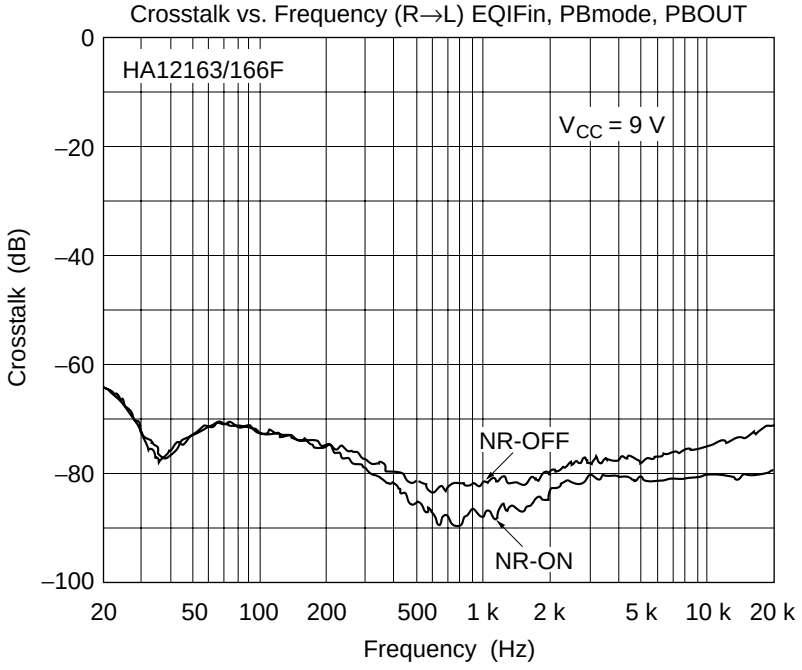

Crosstalk vs. Frequency (REVERSE→FORWARD) PBmode



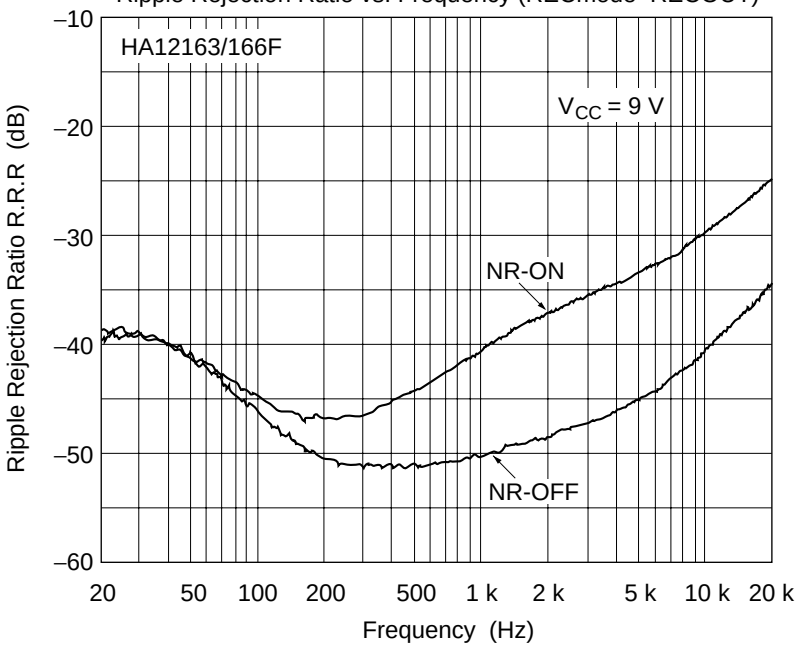
Crosstalk vs. Frequency (L→R) EQIFin, PBmode, PBOUT



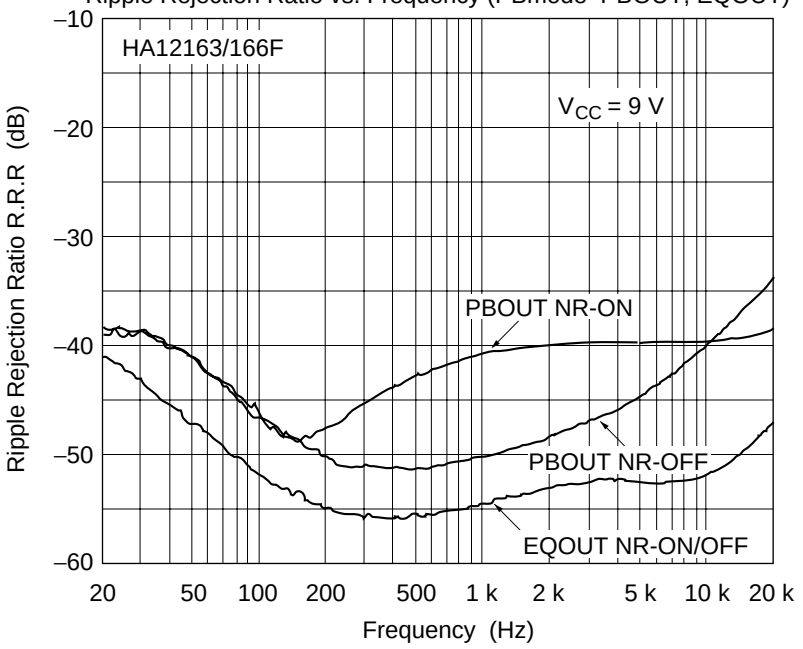

Crosstalk vs. Frequency (R→L) EQIFin, PBmode, PBOUT



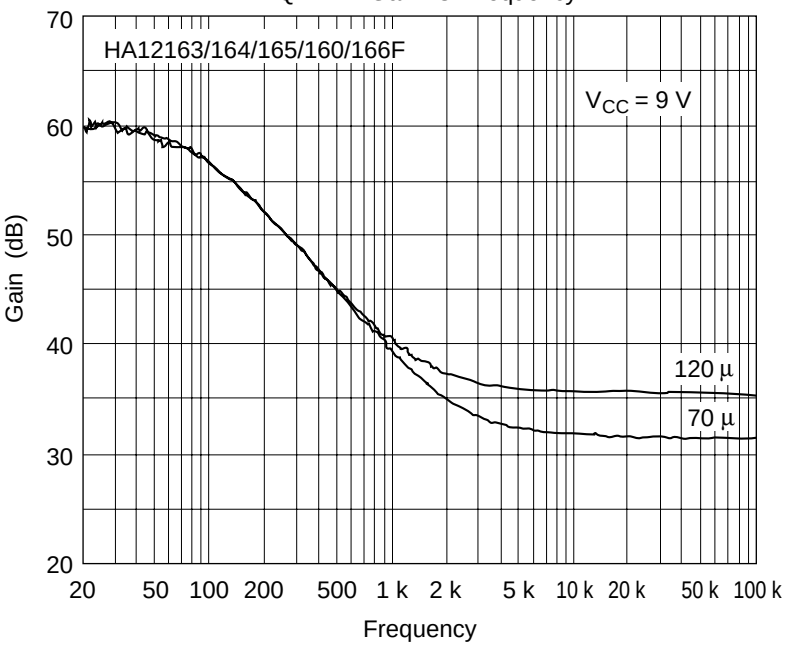
Ripple Rejection Ratio vs. Frequency (RECmode RECOUT)



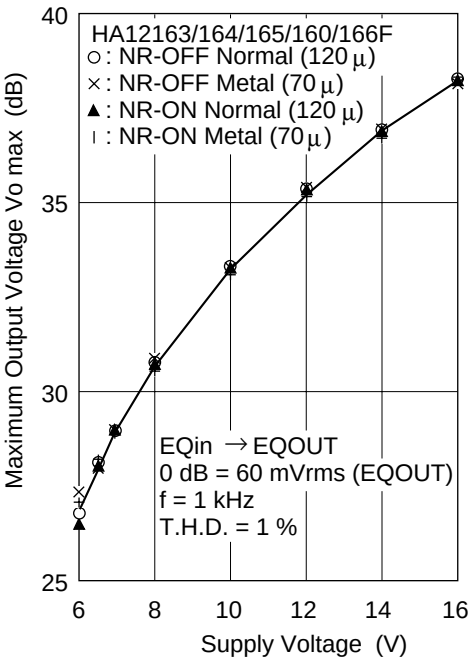

Ripple Rejection Ratio vs. Frequency (PBmode PBOUT, EQOUT)

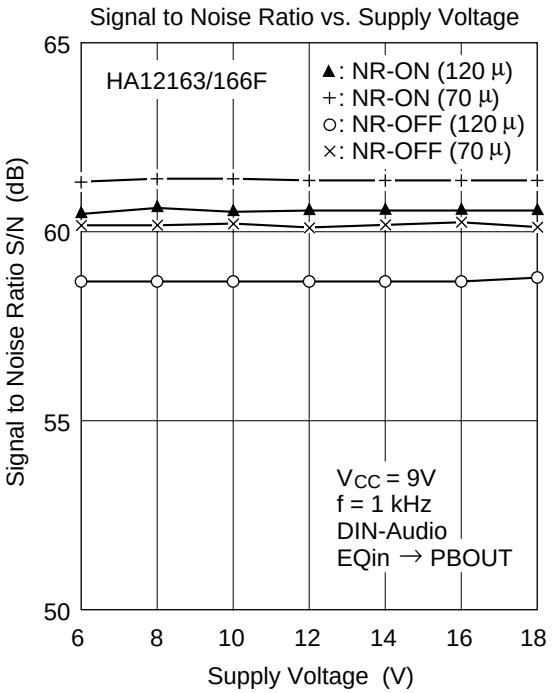


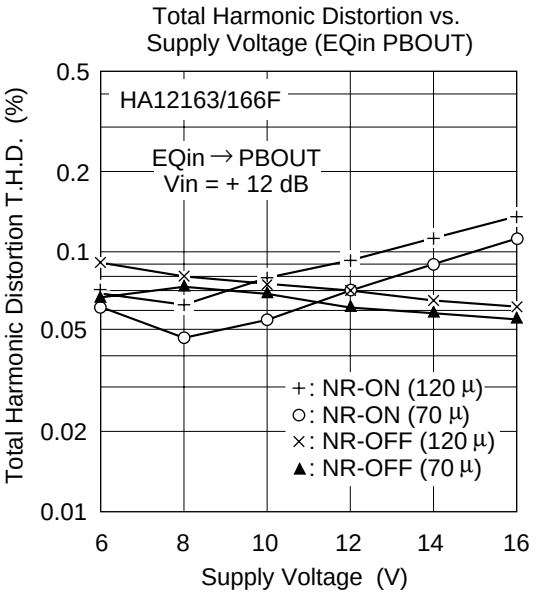
EQ-AMP. Gain vs. Frequency



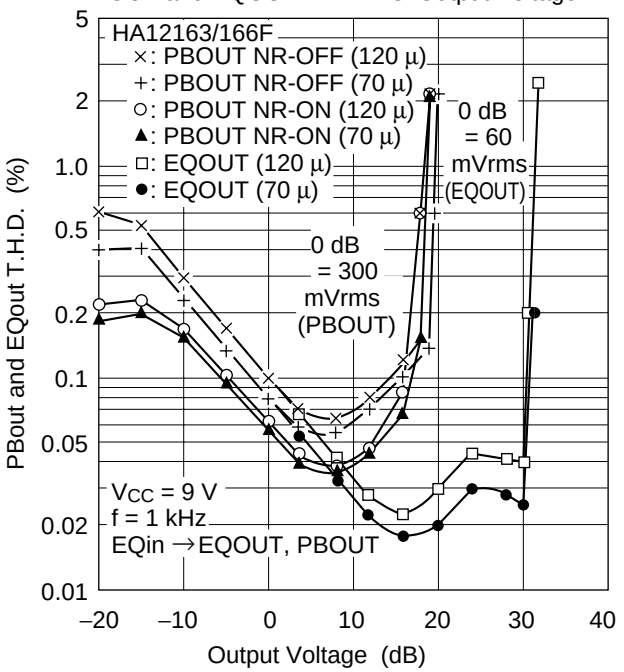

EQout Maximum Output Level vs. Supply Voltage



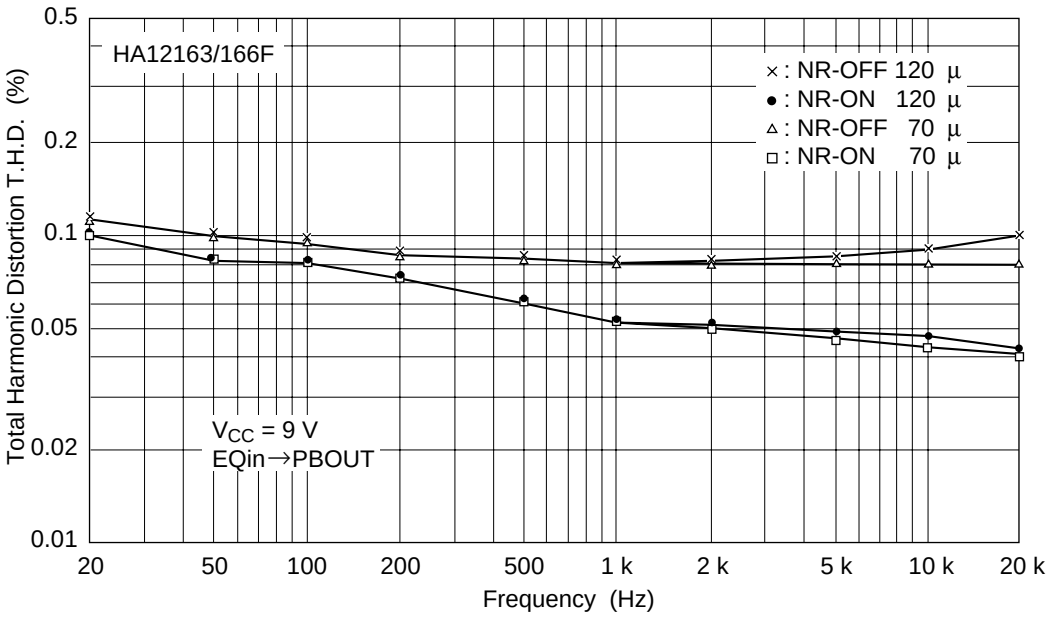

Signal to Noise Ratio vs. Supply Voltage
HA12163/166F
▲: NR-ON (120 μ)
+: NR-ON (70 μ)
○: NR-OFF (120 μ)
×: NR-OFF (70 μ)
VCC = 9V
f = 1 kHz
DIN-Audio
EQin → PBOUT
Signal to Noise Ratio S/N (dB)
65
60
55
50
6
8
10
12
14
16
18
Supply Voltage (V)


Total Harmonic Distortion vs.
Supply Voltage (EQin PBOUT)
HA12163/166F
EQin → PBOUT
Vin = + 12 dB
+: NR-ON (120 μ)
○: NR-ON (70 μ)
×: NR-OFF (120 μ)
▲: NR-OFF (70 μ)
Total Harmonic Distortion T.H.D. (%)
0.5
0.2
0.1
0.05
0.02
0.01
6
8
10
12
14
16
Supply Voltage (V)

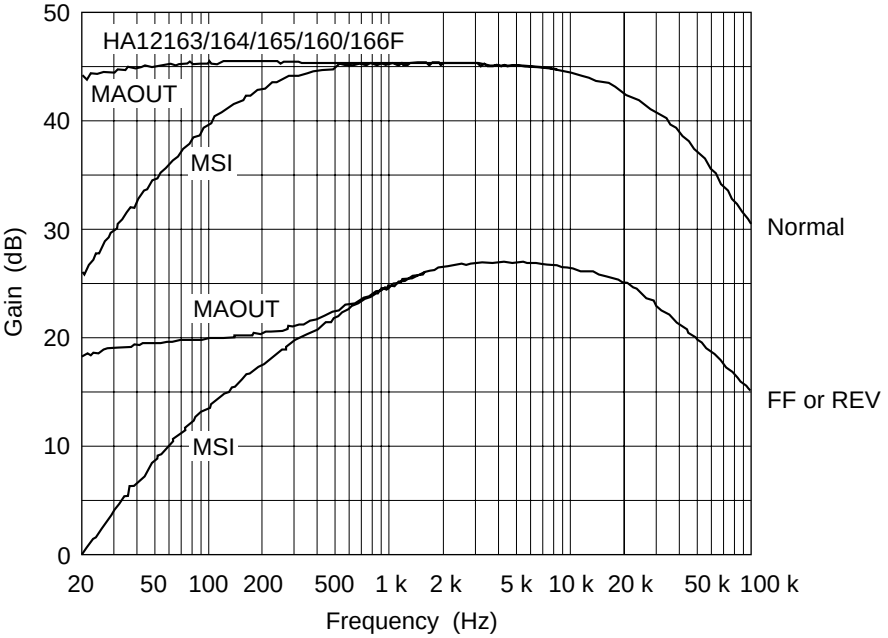
PBOUT and EQOUT T.H.D. vs. Output Voltage



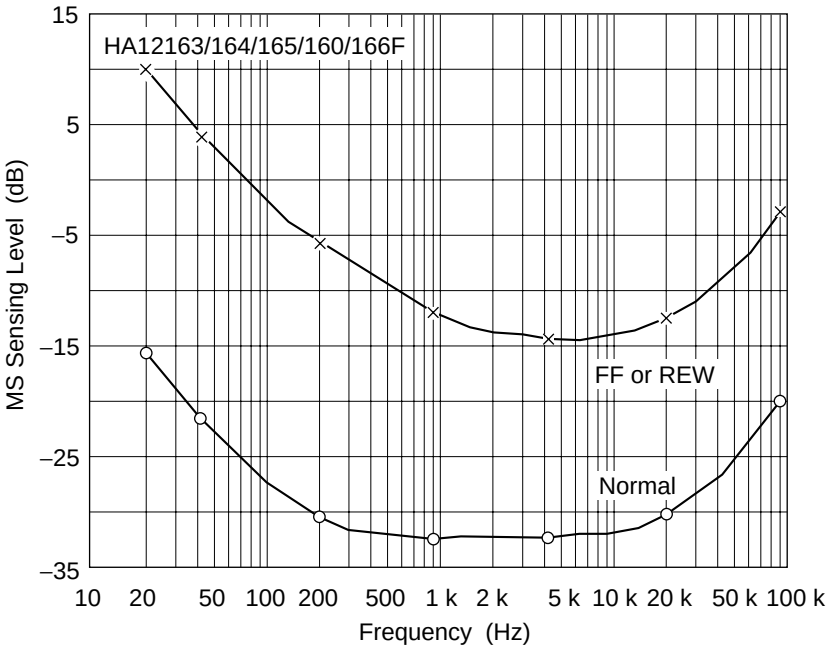

Total Harmonic Distortion vs. Frequency (EQin PBmode PBOUT)



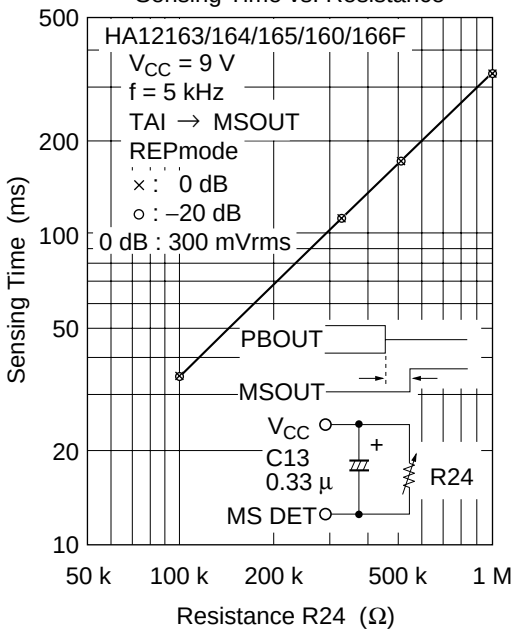
MS-AMP. Gain vs. Frequency



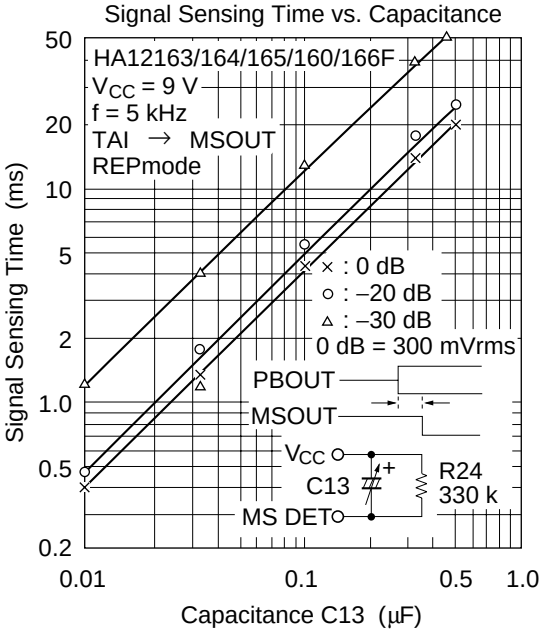

MS Sensing Level vs. Frequency



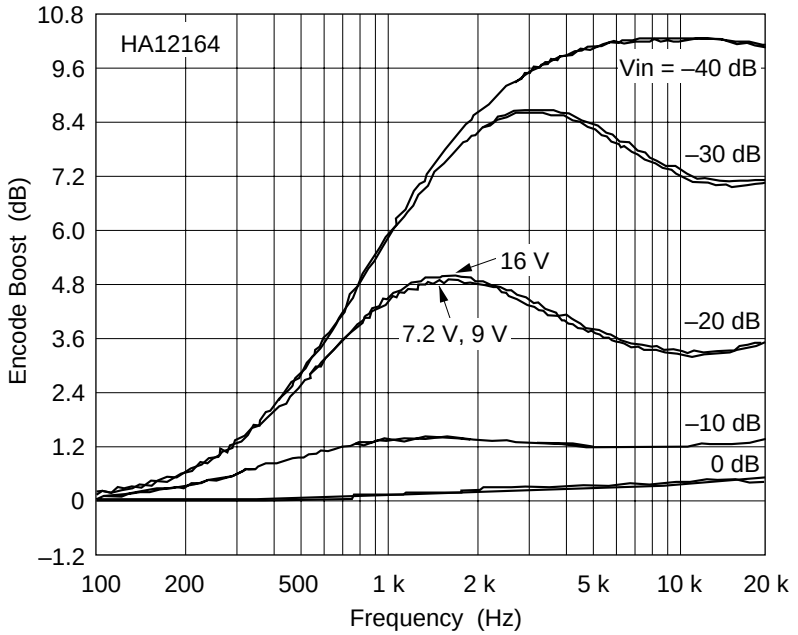
Sensing Time vs. Resistance



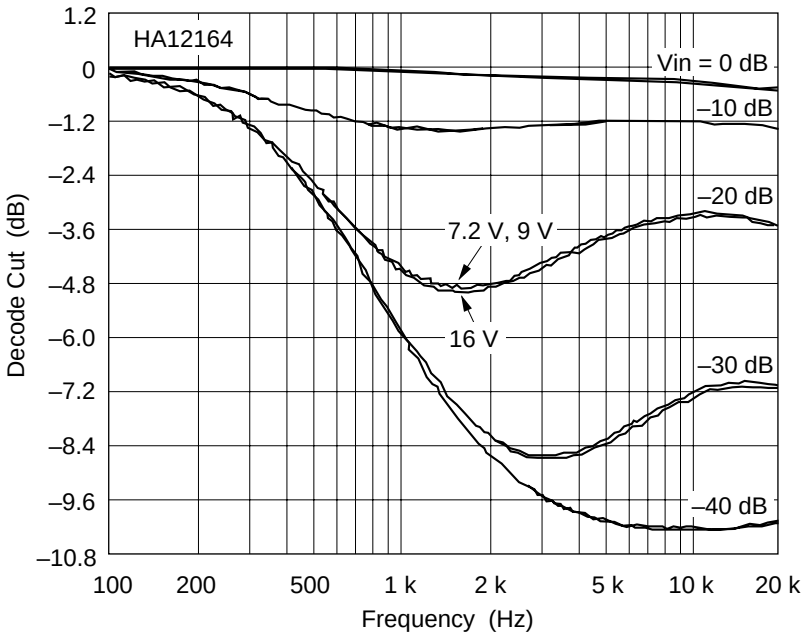

Signal Sensing Time vs. Capacitance



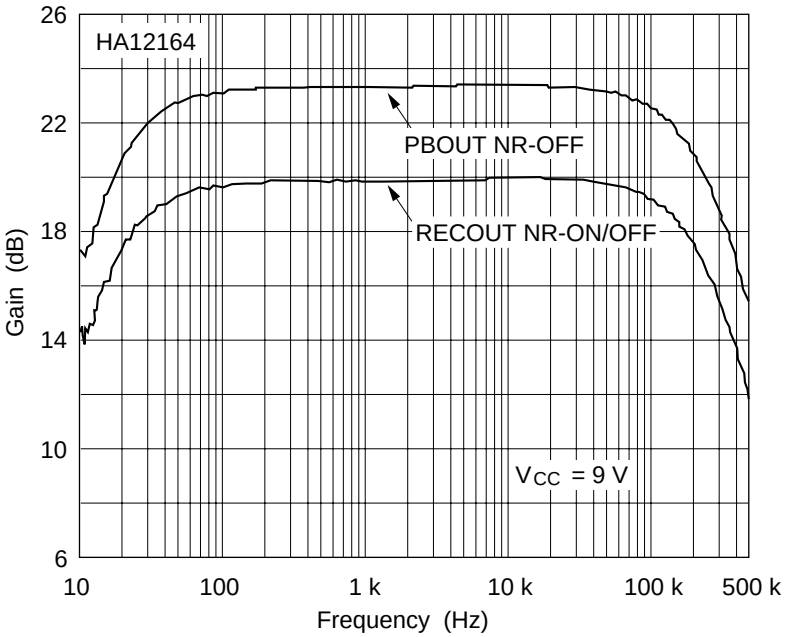
Encode Boost vs. Frequency ($V_{CC}$ = 7.2 V, 9 V, 16 V)



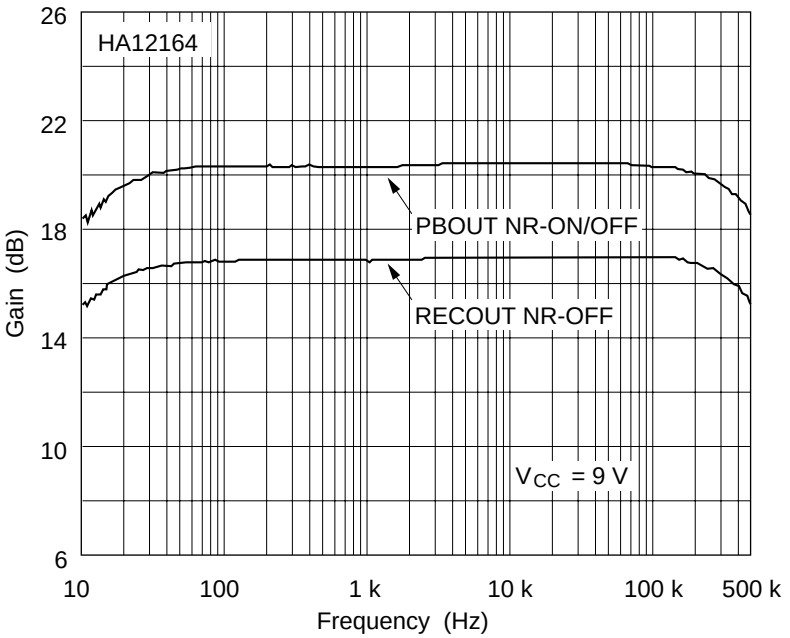

Decode Cut vs. Frequency ($V_{CC}$ = 7.2 V, 9 V, 16 V)



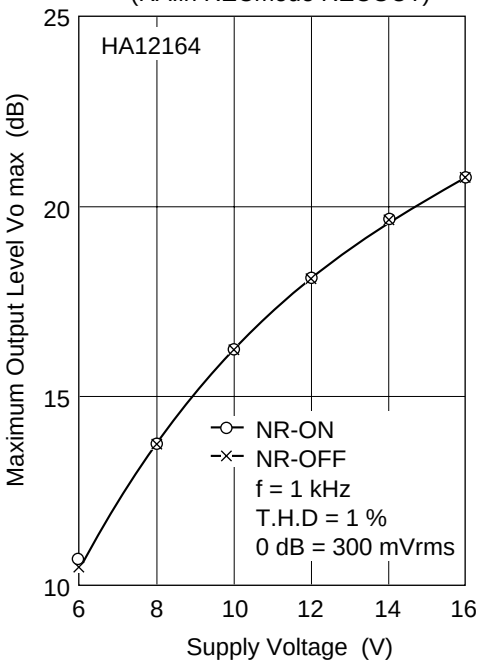
TAIin Input Amp. Gain vs. Frequency (PBmode)



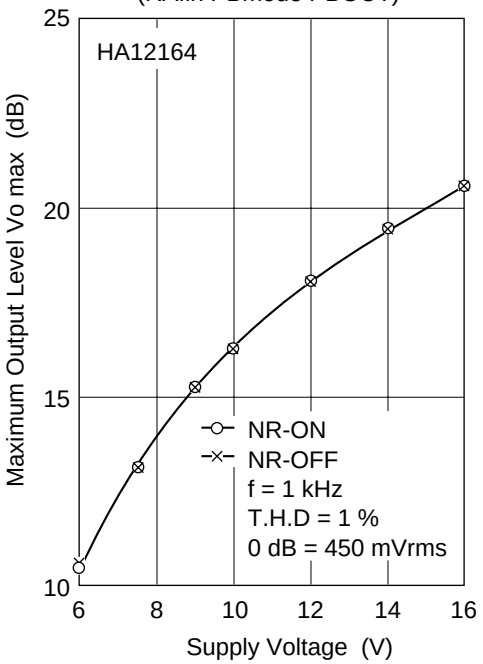

RAIin Input Amp. Gain vs. Frequency (RECmode)



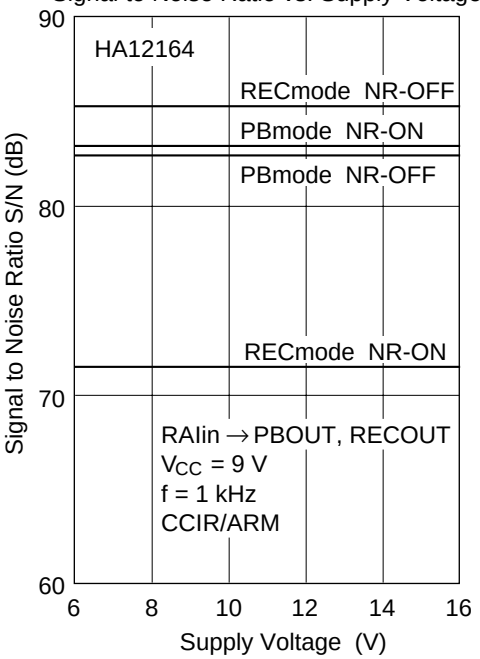
Maximum Output Level vs. Supply Voltage (1)
(RAIin RECmode RECOUT)



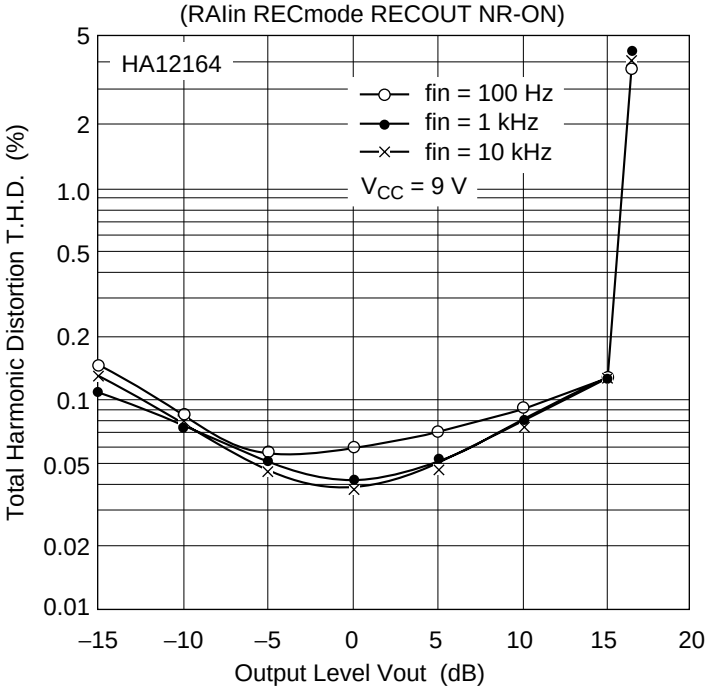

Maximum Output Level vs. Supply Voltage (2)
(RAIin PBmode PBOUT)



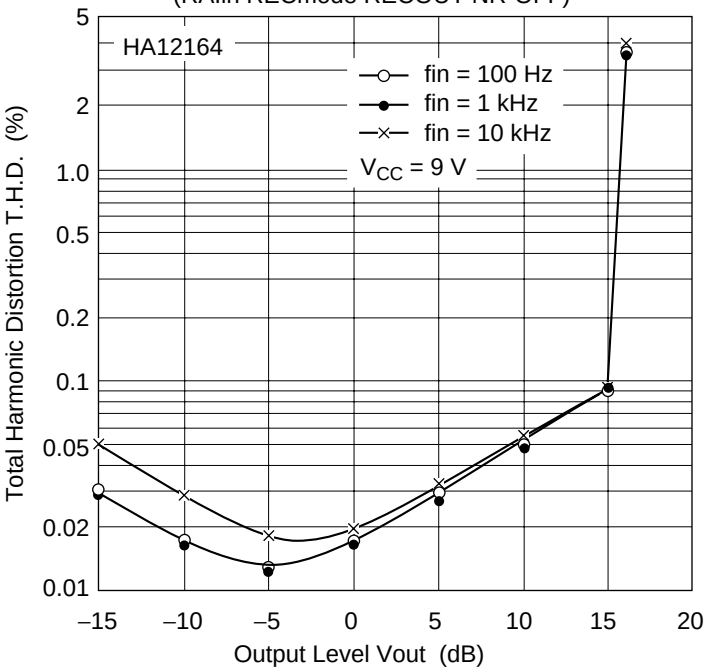
Signal to Noise Ratio vs. Supply Voltage



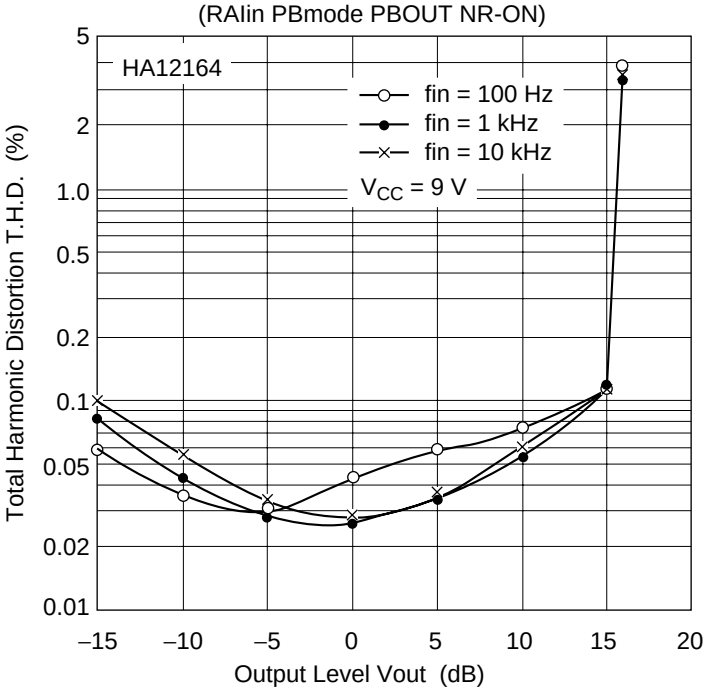

Total Harmonic Distortion vs. Output Level (1)
(RAIin RECmode RECOUT NR-ON)



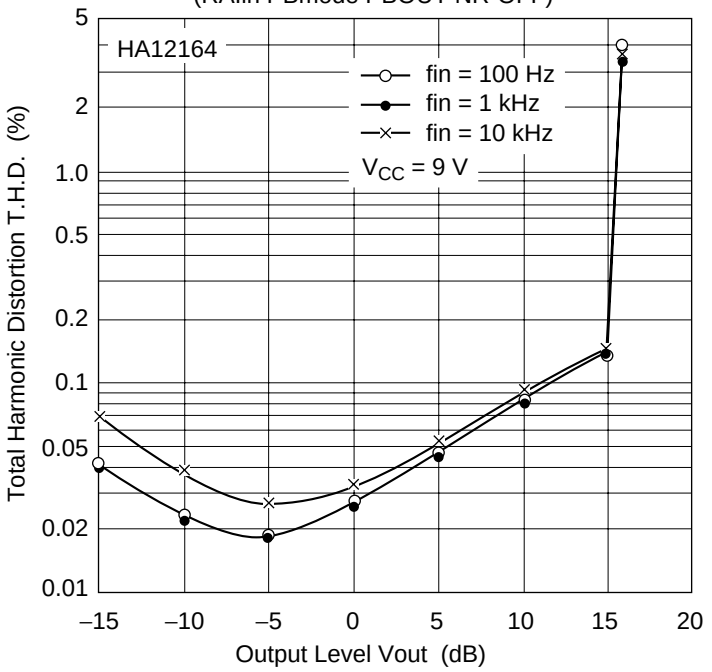
Total Harmonic Distortion vs. Output Level (2)
(RAIin RECmode RECOUT NR-OFF)



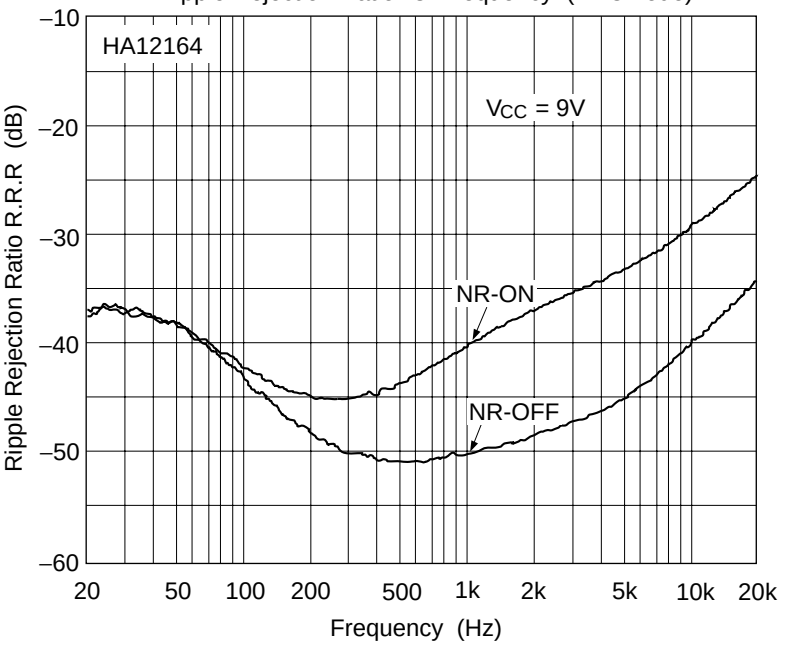

Total Harmonic Distortion vs. Output Level (3)
(RAIin PBmode PBOUT NR-ON)

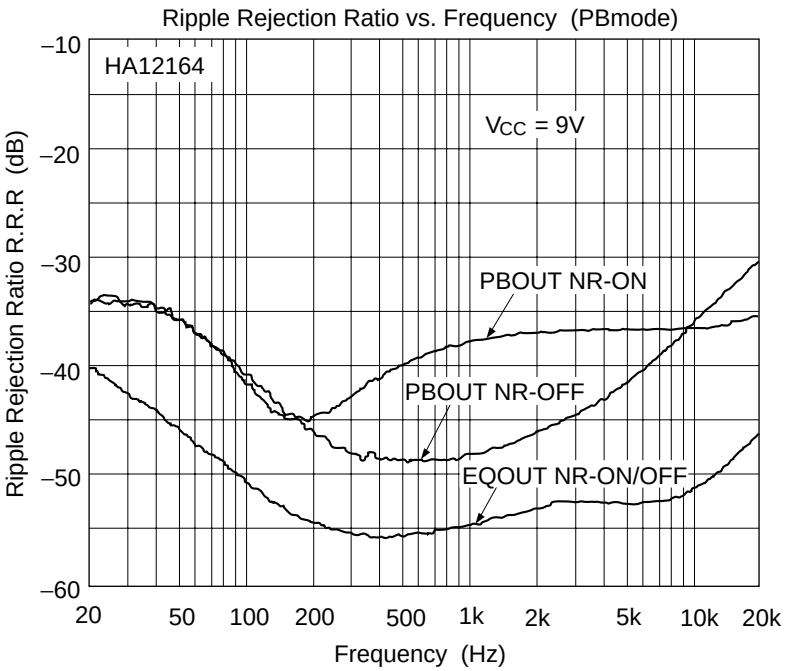


Total Harmonic Distortion vs. Output Level (4)
(RAIin PBmode PBOUT NR-OFF)

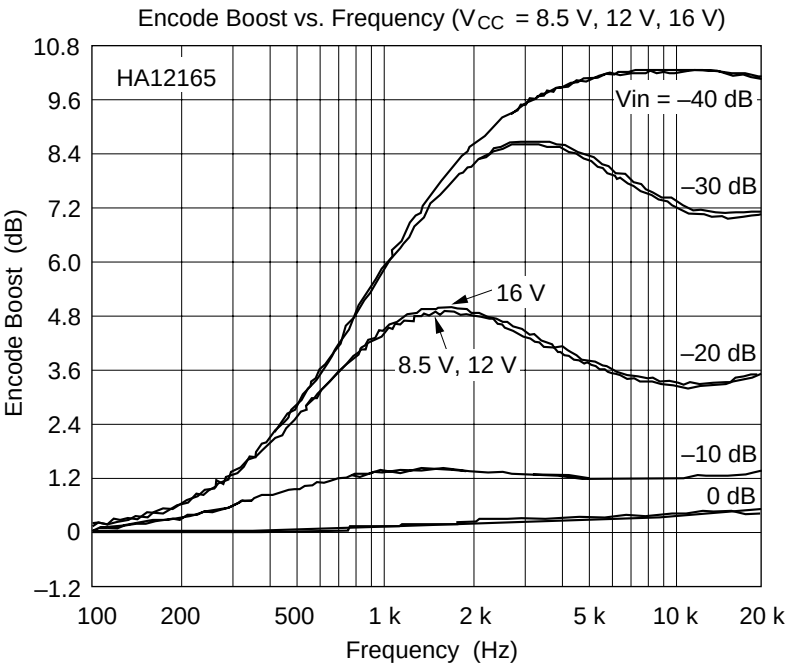



Ripple Rejection Ratio vs. Frequency (RECmode)

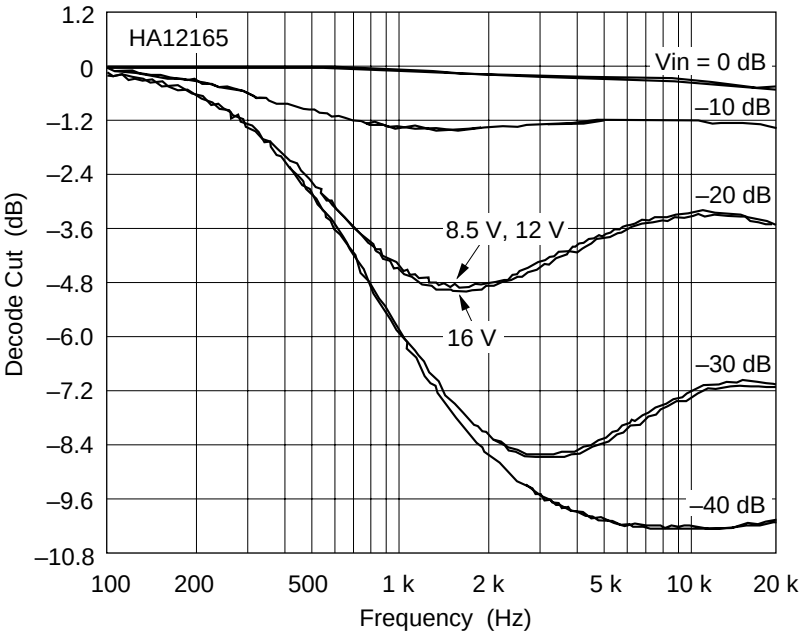




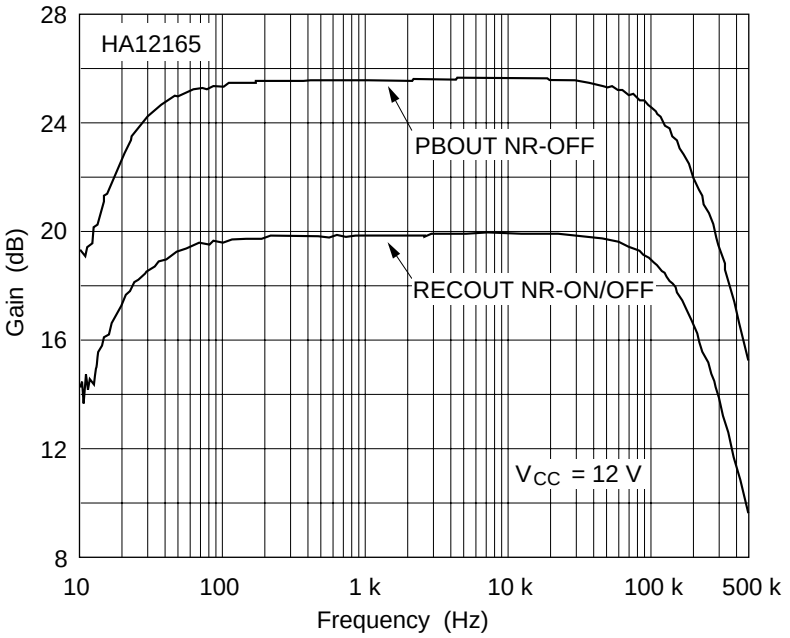

**HA12165 Data**



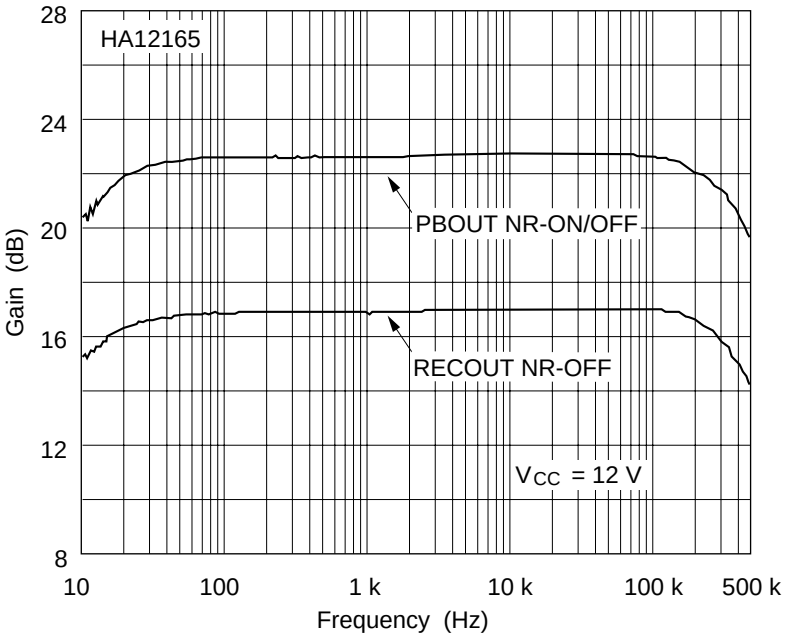
Decode Cut vs. Frequency ($V_{CC}$ = 8.5 V, 12 V, 16 V)



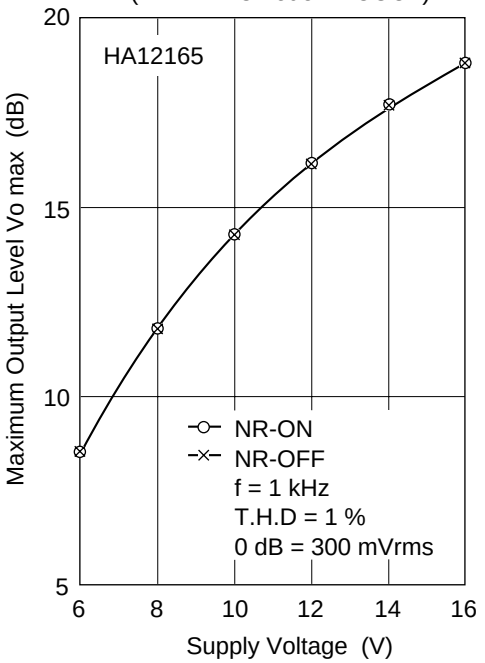

TAIin Input Amp. Gain vs. Frequency (PBmode)



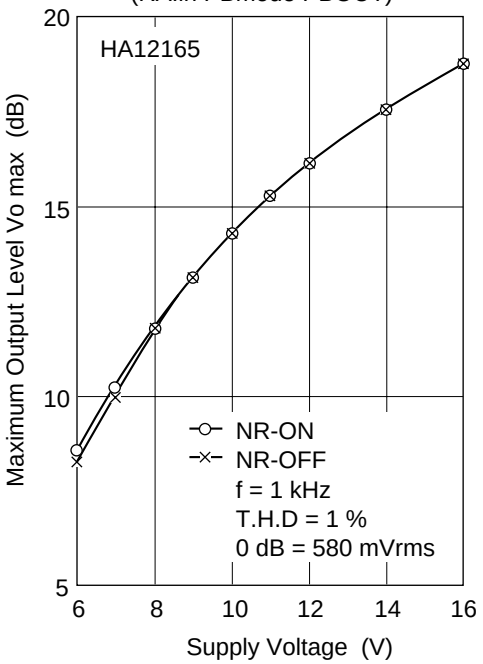
RAIin Input Amp. Gain vs. Frequency (RECmode)



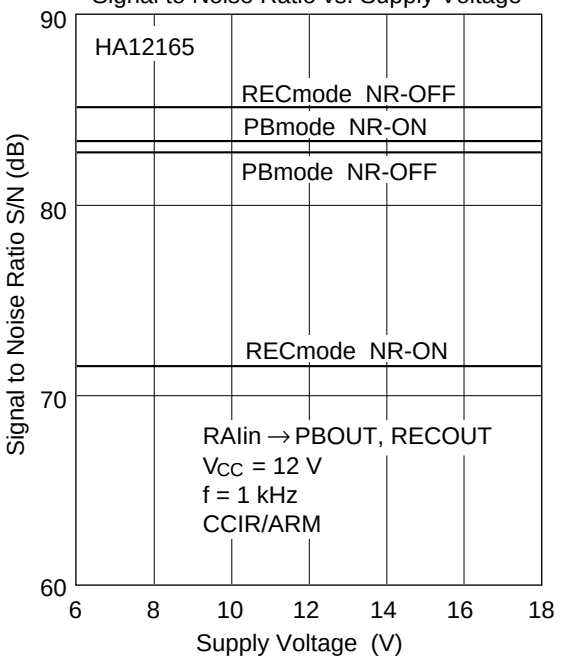

Maximum Output Level vs. Supply Voltage (1)
(RAIin RECmode RECOUT)



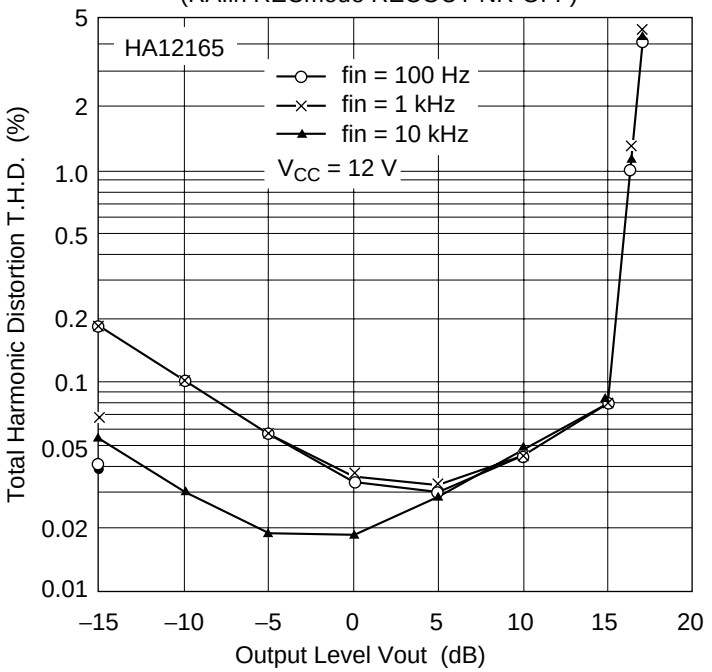
Maximum Output Level vs. Supply Voltage (2)
(RAIin PBmode PBOUT)



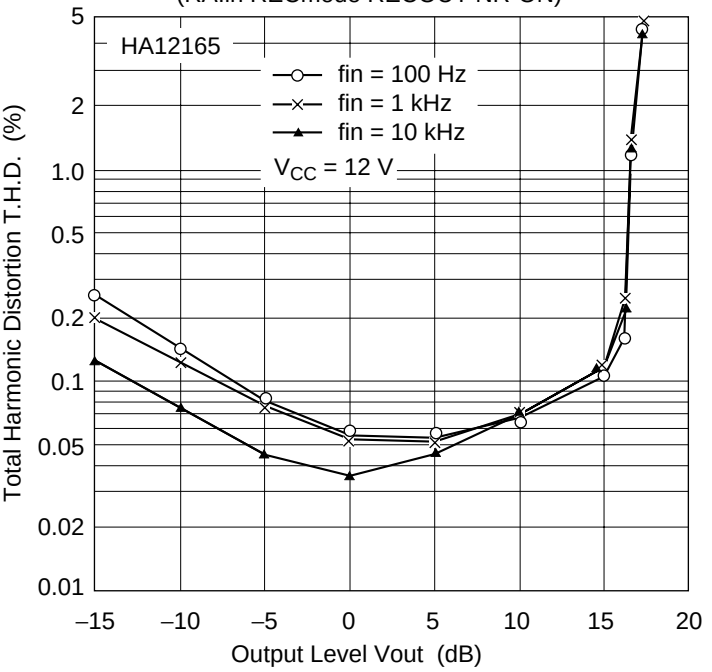

Signal to Noise Ratio vs. Supply Voltage



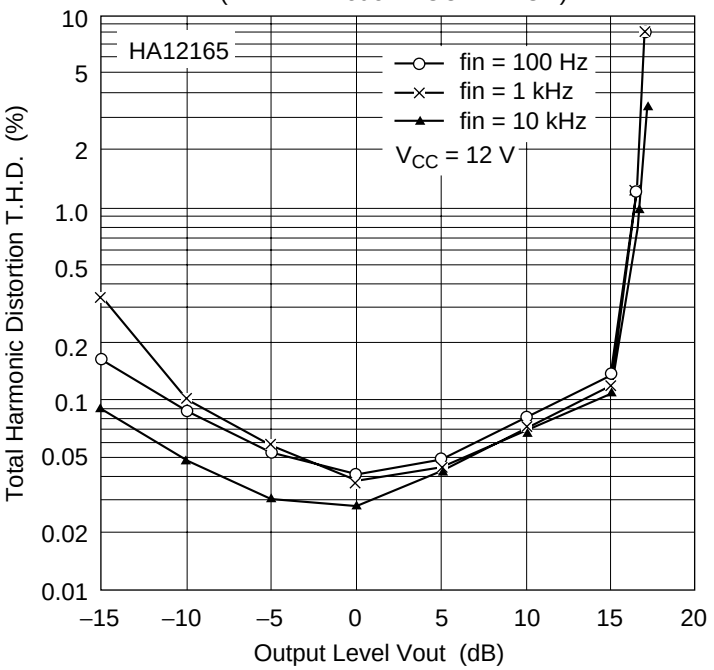
Total Harmonic Distortion vs. Output Level (1)
(RAIin RECmode RECOUT NR-OFF)



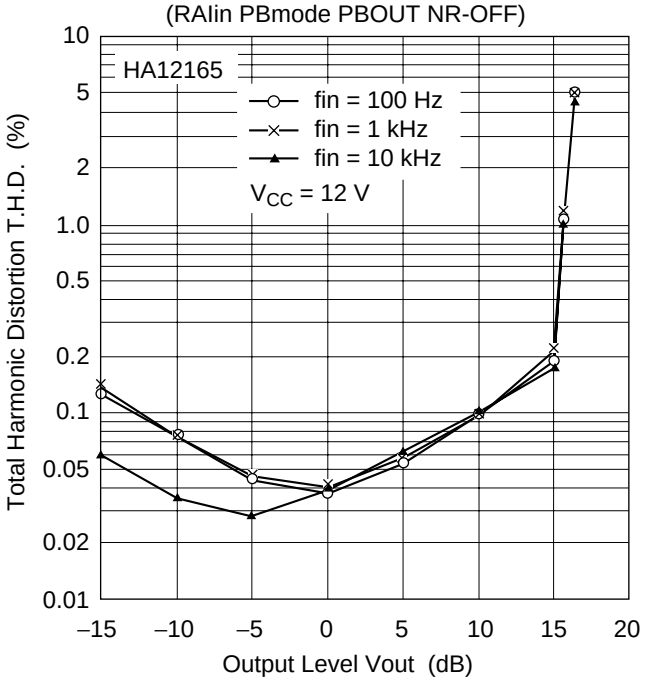

Total Harmonic Distortion vs. Output Level (2)
(RAIin RECmode RECOUT NR-ON)



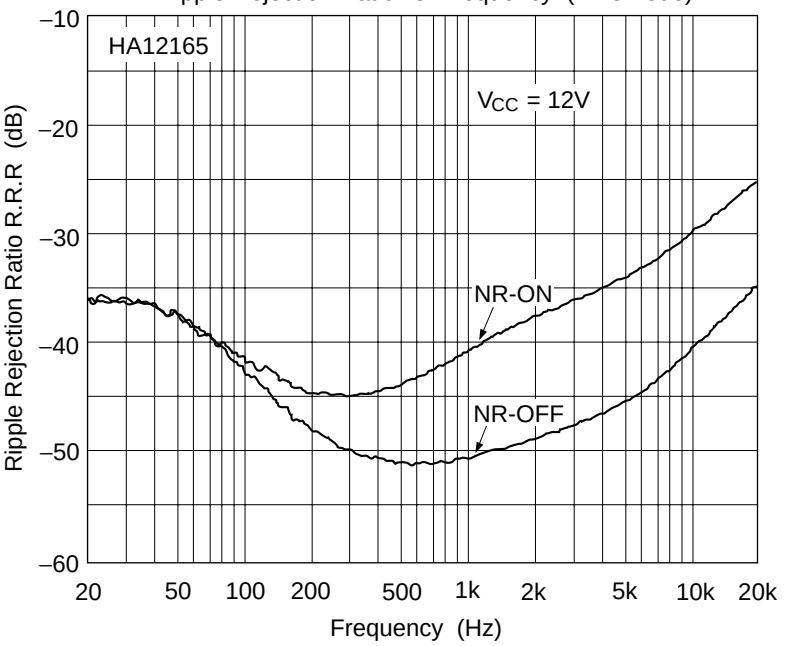
Total Harmonic Distortion vs. Output Level (3)
(RAIin PBmode PBOUT NR-ON)



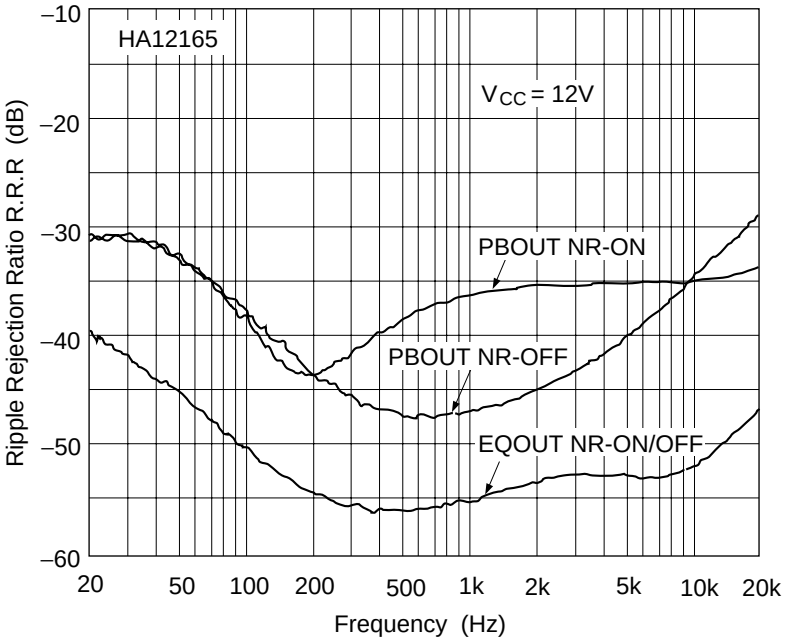

Total Harmonic Distortion vs. Output Level (4)
(RAIin PBmode PBOUT NR-OFF)



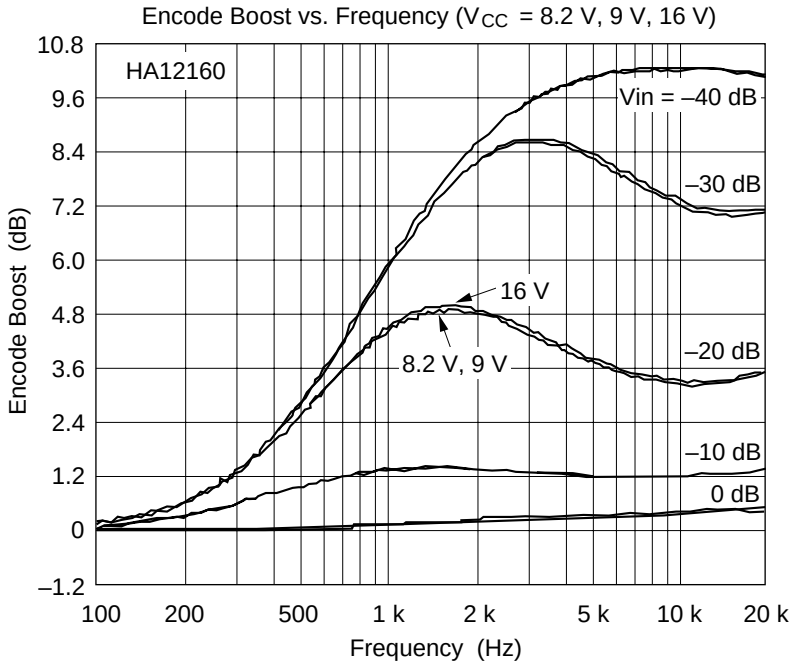
Ripple Rejection Ratio vs. Frequency (RECmode)

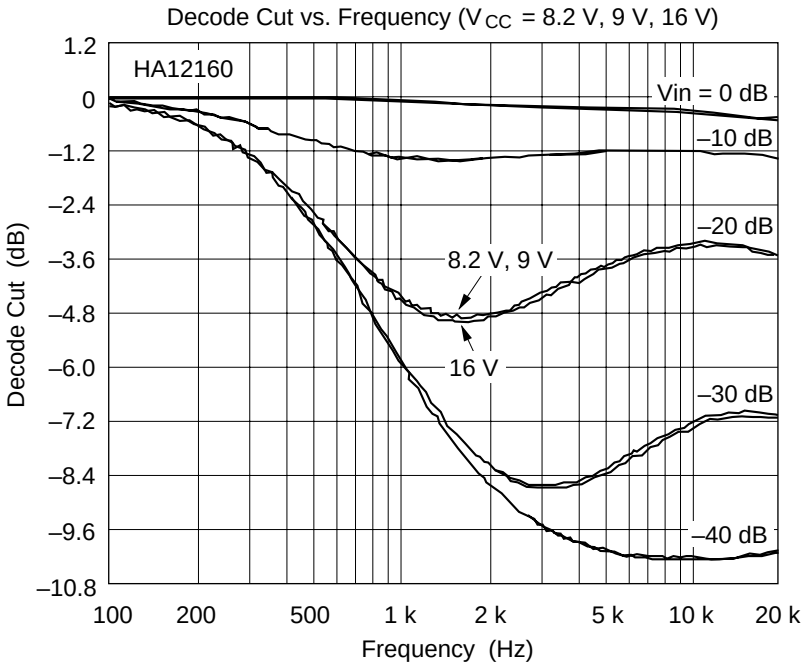



Ripple Rejection Ratio vs. Frequency (PBmode)

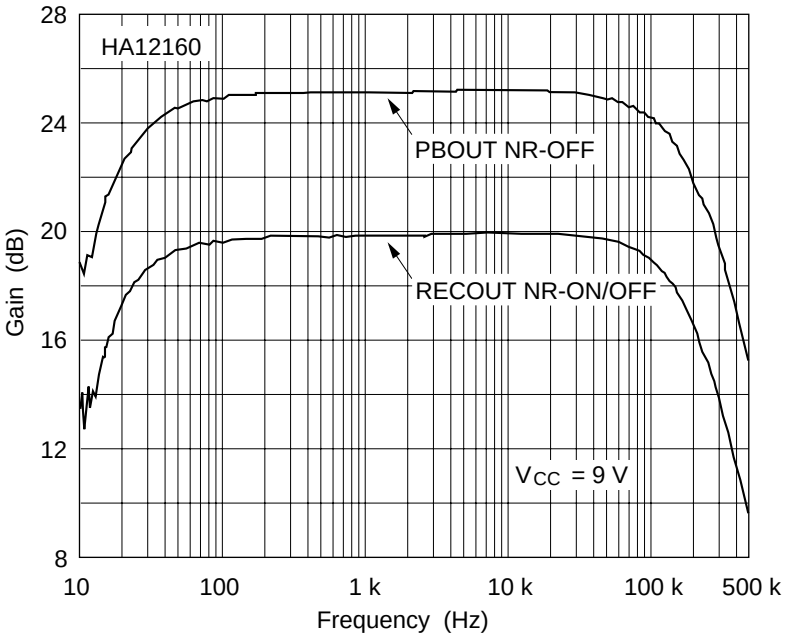


**HA12160 Data**

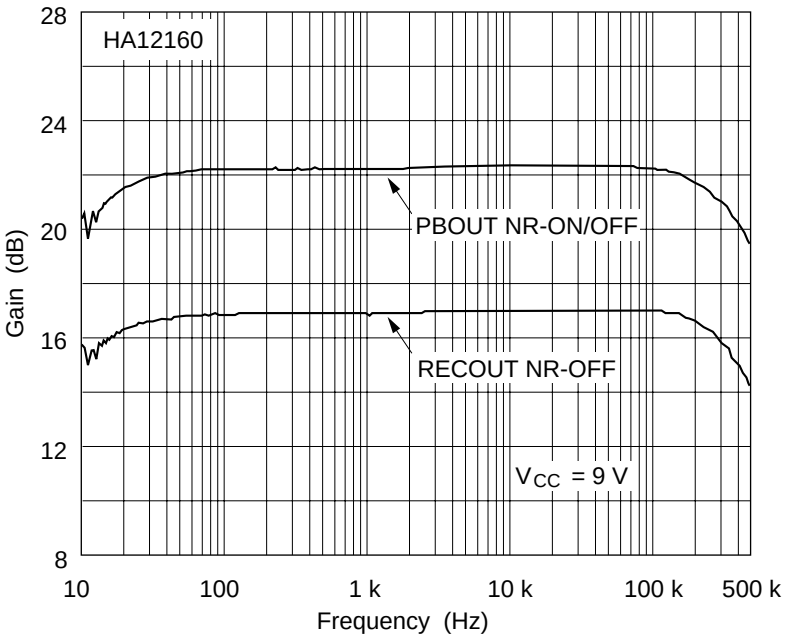


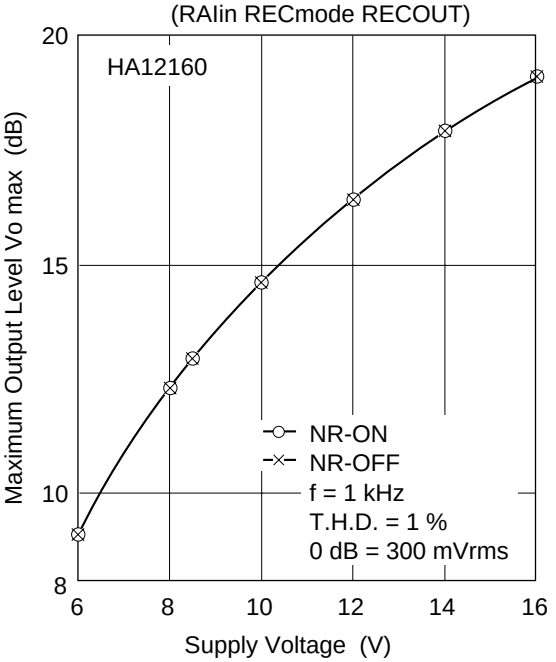
TAIin Input Amp. Gain vs. Frequency (PBmode)



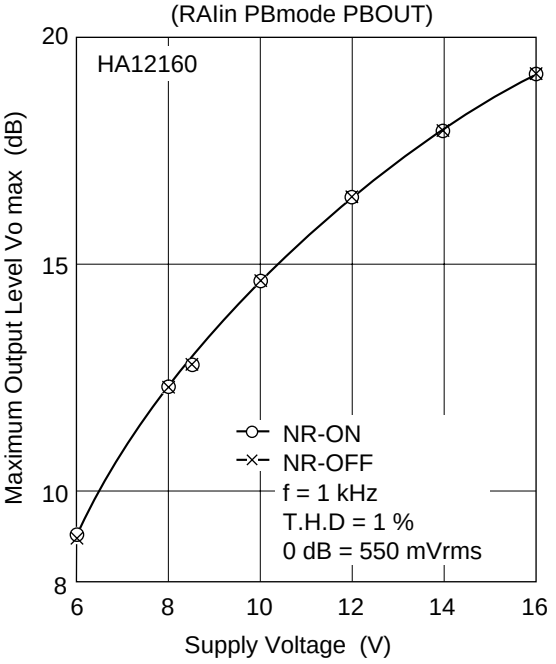

RAIin Input Amp. Gain vs. Frequency (RECmode)



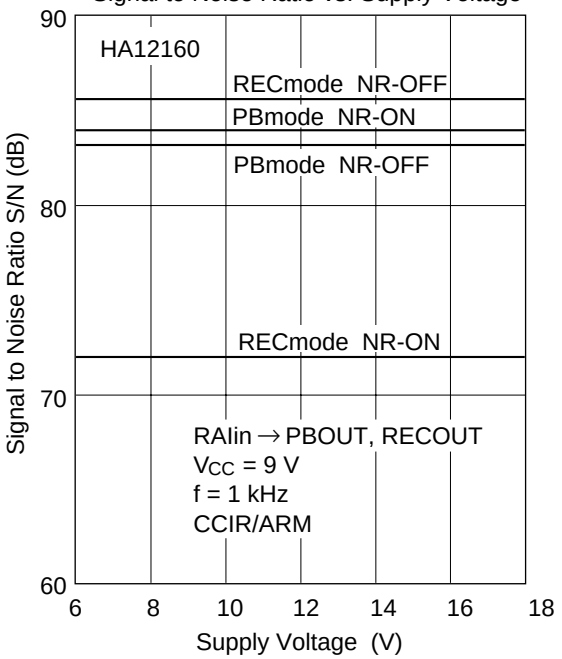
Maximum Output Level vs. Supply Voltage (1)
(RAIin RECmode RECOUT)



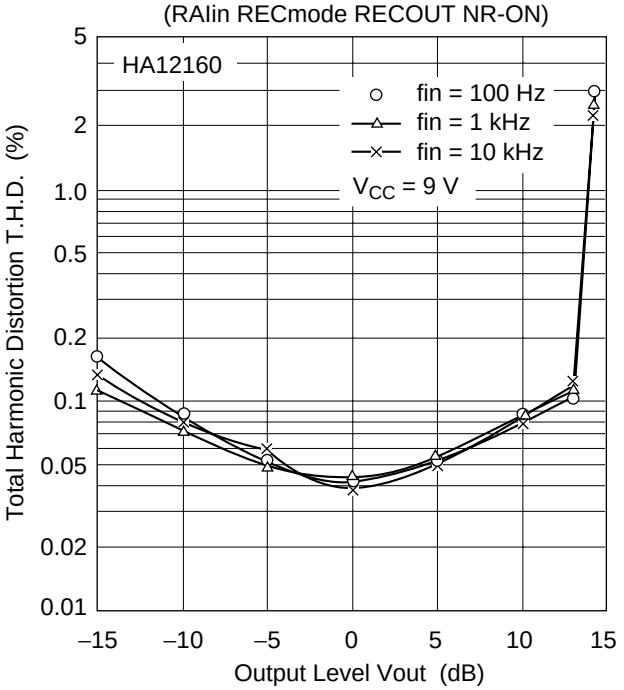

Maximum Output Level vs. Supply Voltage (2)
(RAIin PBmode PBOUT)



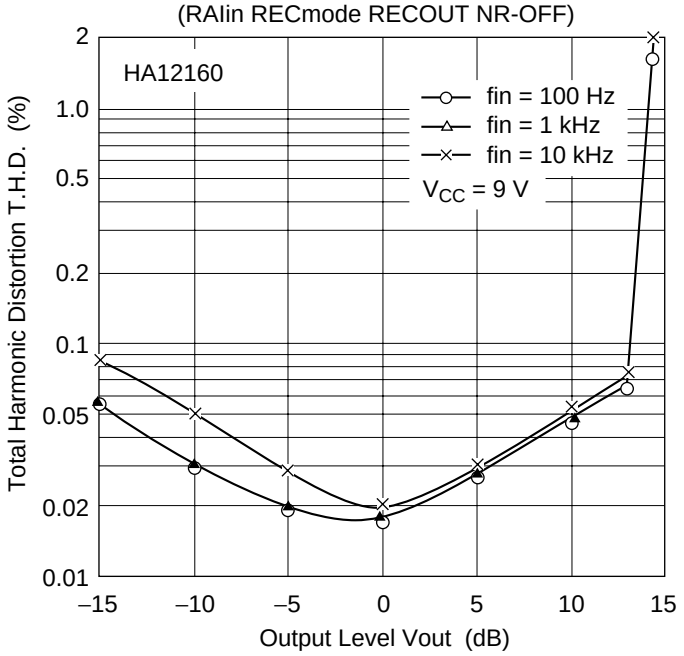
Signal to Noise Ratio vs. Supply Voltage



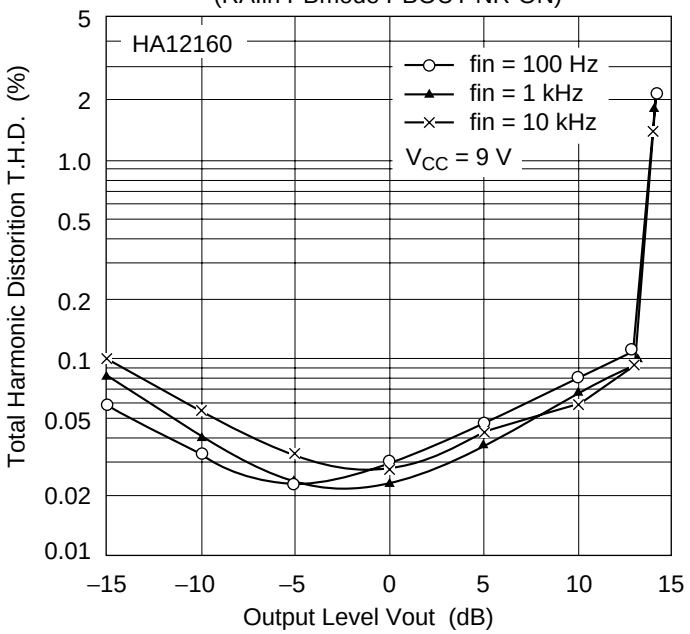

Total Harmonic Distortion vs. Output Level (1)
(RAIin RECmode RECOUT NR-ON)



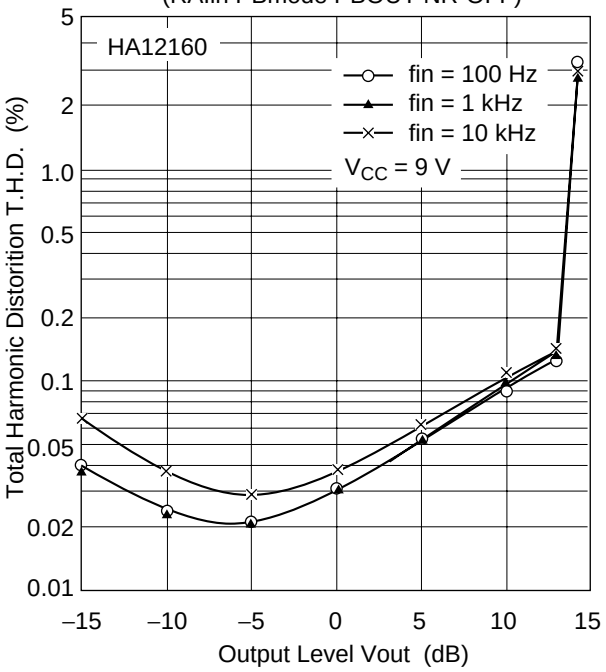
Total Harmonic Distortion vs. Output Level (2)
(RAIin RECmode RECOUT NR-OFF)



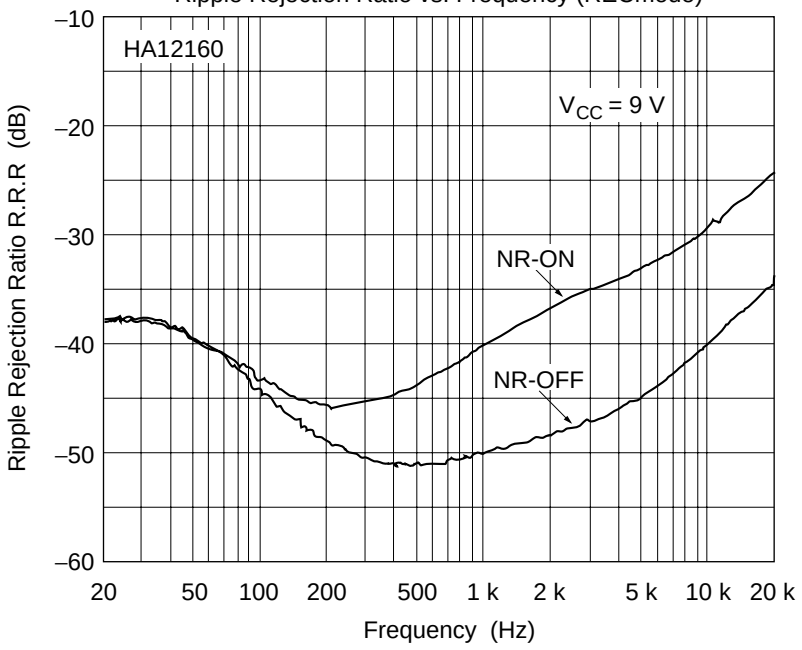

Total Harmonic Distortion vs. Output Level (3)
(RAIin PBmode PBOUT NR-ON)

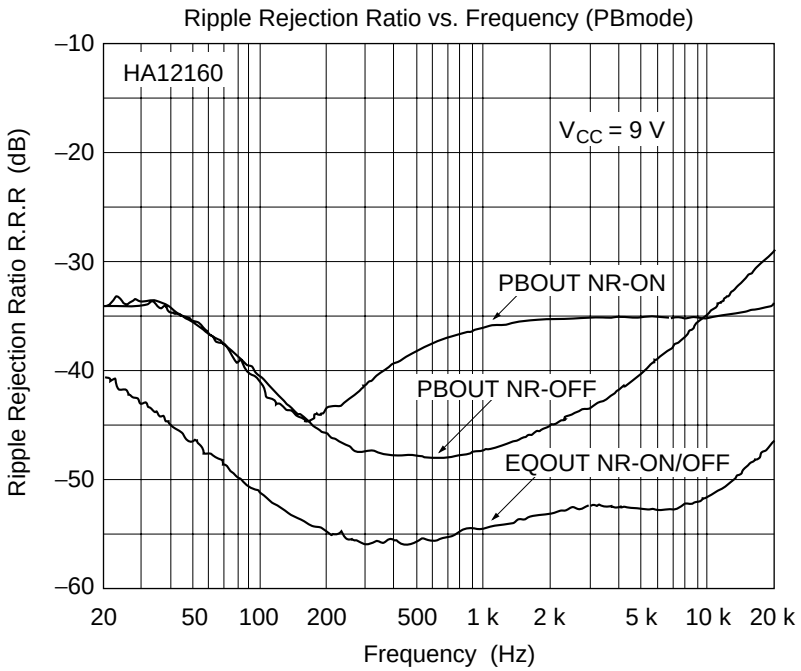


Total Harmonic Distortion vs. Output Level (4)
(RAIin PBmode PBOUT NR-OFF)



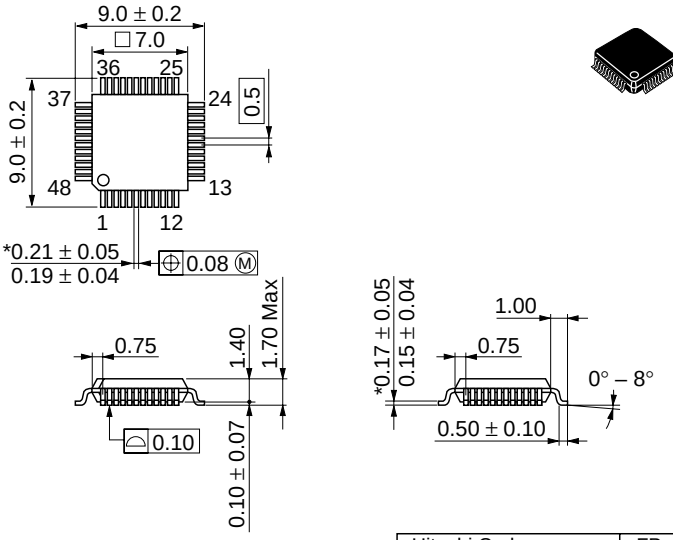

Ripple Rejection Ratio vs. Frequency (RECmode)




Ripple Rejection Ratio vs. Frequency (PBmode)
HA12160
$V_{CC}$ = 9 V
PBOUT NR-ON
PBOUT NR-OFF
EQOUT NR-ON/OFF
Ripple Rejection Ratio R.R.R (dB)
–10
–20
–30
–40
–50
–60
20
50
100
200
500
1 k
2 k
5 k
10 k
20 k
Frequency (Hz)

## Package Dimensions

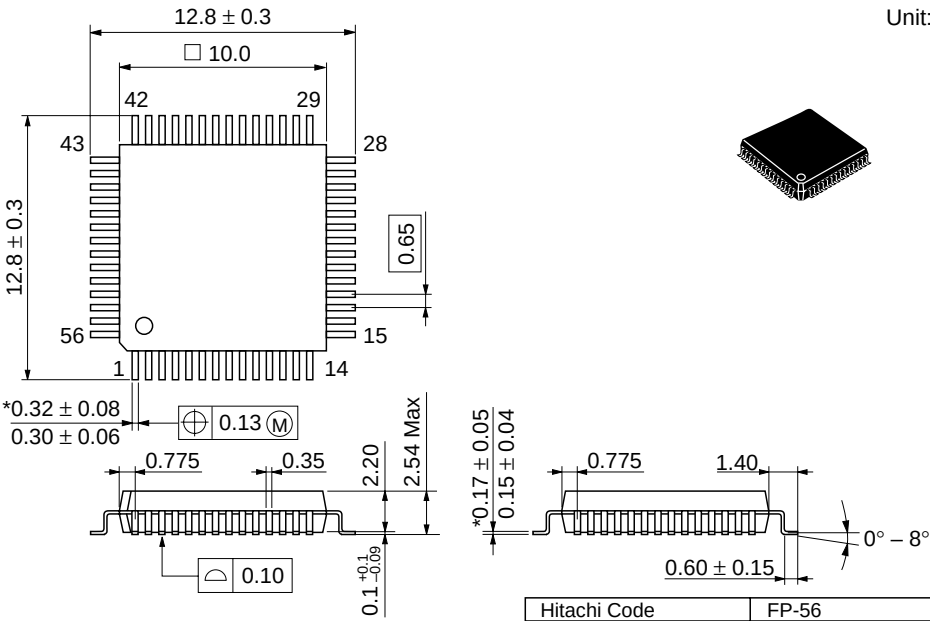
Unit: mm




| | |
|---|---|
| Hitachi Code | FP-48 |
| JEDEC | — |
| EIAJ | Conforms |
| Weight (reference value) | 0.2 g |

*Dimension including the plating thickness
Base material dimension

Unit: mm




| | |
|---|---|
| Hitachi Code | FP-56 |
| JEDEC | — |
| EIAJ | — |
| Weight (reference value) | 0.5 g |

*Dimension including the plating thickness
Base material dimension

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