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.

* Dolby is a trademark of Dolby Laboratories Licensing Corporation.
A license from Dolby Laboratories Licensing Corporation is required for the use of this IC.

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

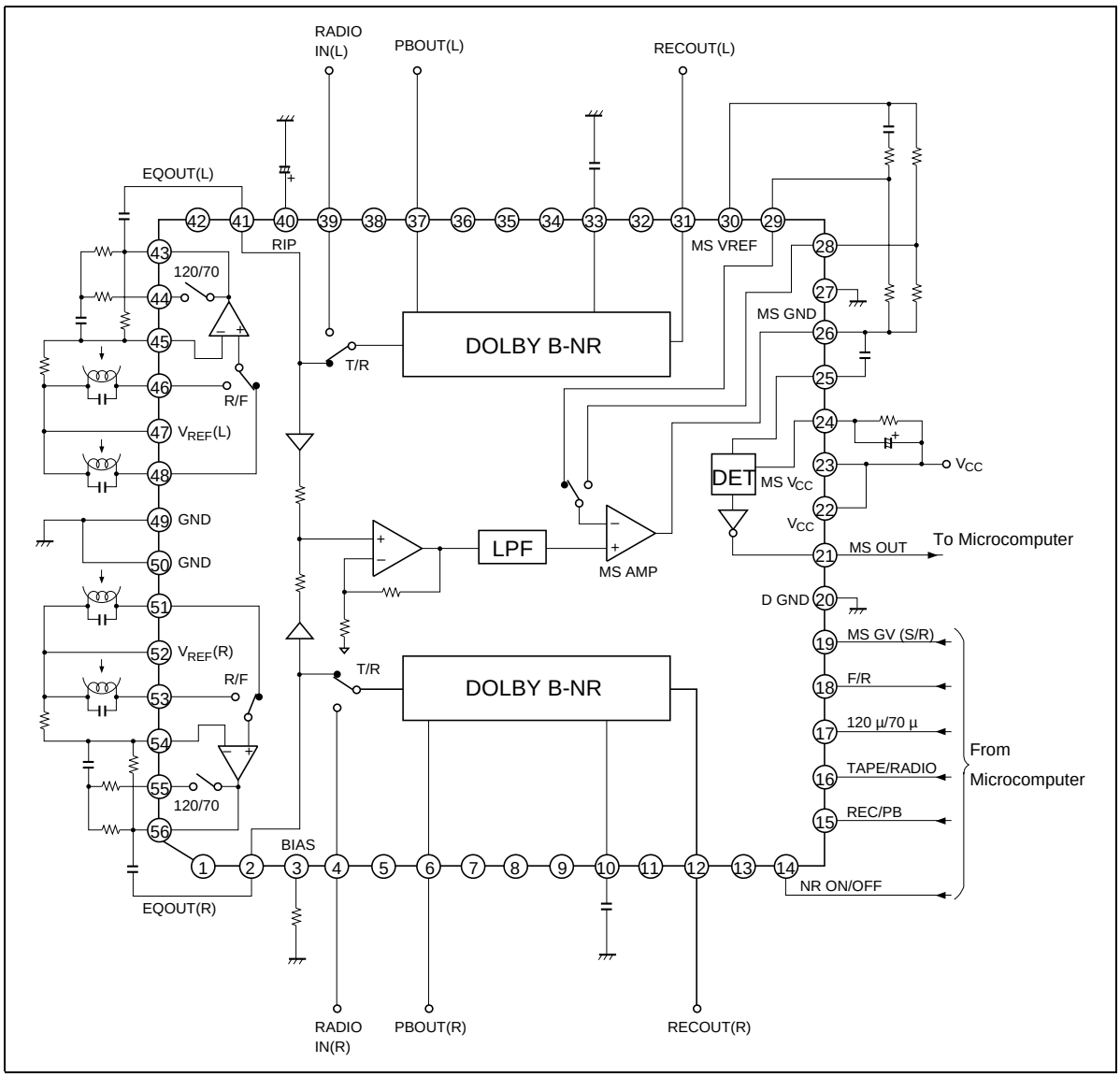
Notes: 1. Value at Ta ≤ 85°C
2. HA12166F = 360 mW

Operating Voltage Range

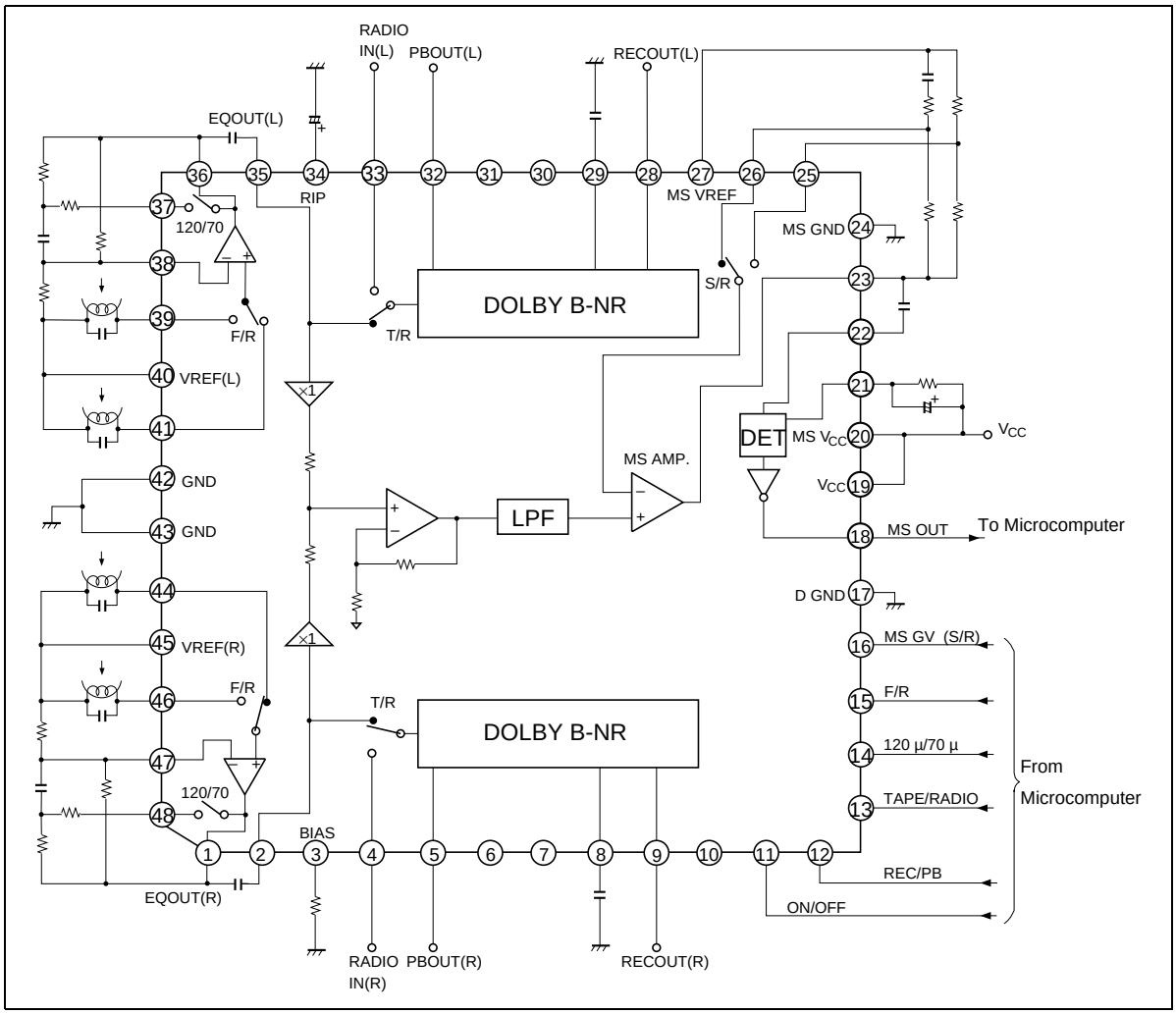
Type	Min	Max	Unit
HA12163, HA12166F	6.5	16	V
HA12164	7.2	16	V
HA12165	8.5	16	V
HA12160	8.2	16	V

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)

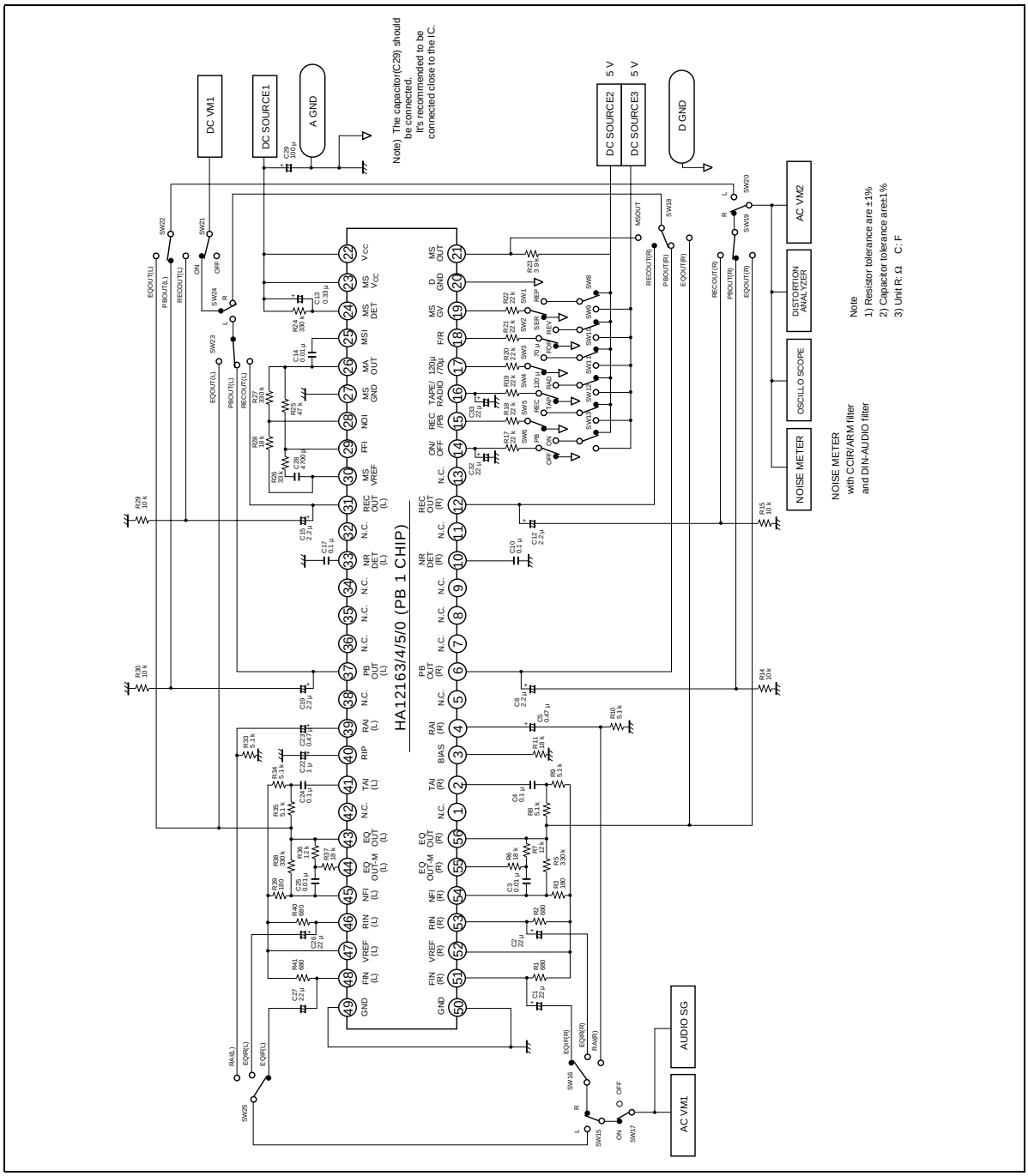
HA12163, HA12166F V_{CC} = 9.0 V HA12164 V_{CC} = 9.0 V
HA12165 V_{CC} = 12 V HA12160 V_{CC} = 9.0 V

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			

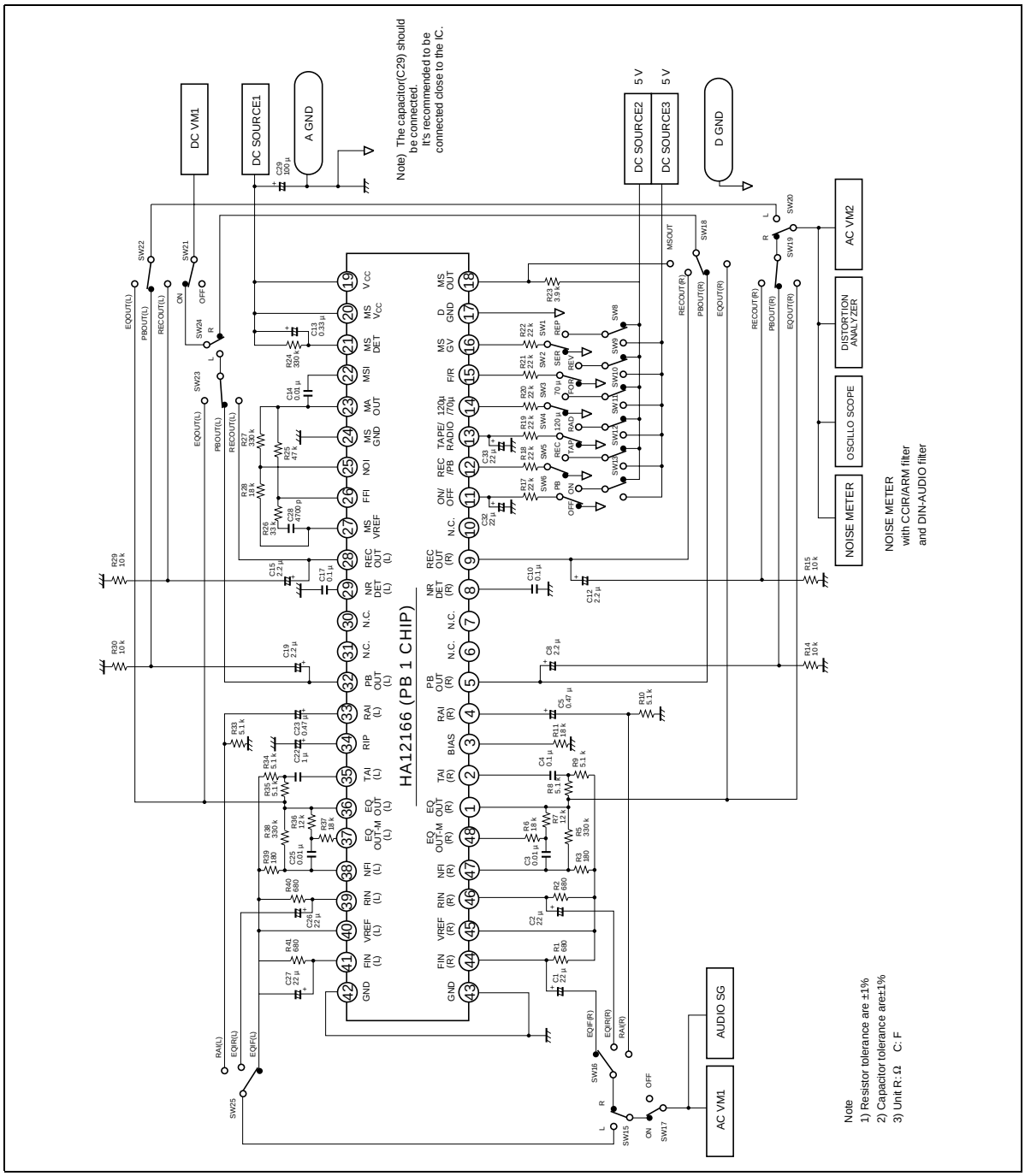
Note: 1. HA12163 HA12166F V_{CC} = 6.5 V, HA12164 V_{CC} = 7.2 V, HA12165 V_{CC} = 8.5 V,HA12160 V_{CC} = 8.2 V

Test Circuit

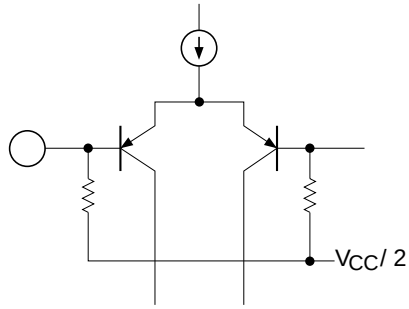
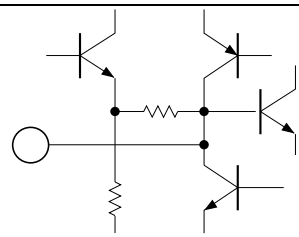
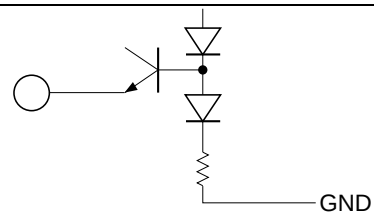
HA12163/164/165/160



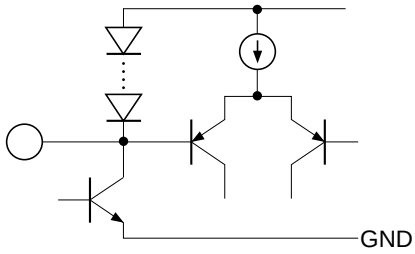
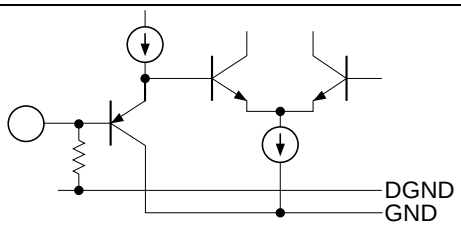
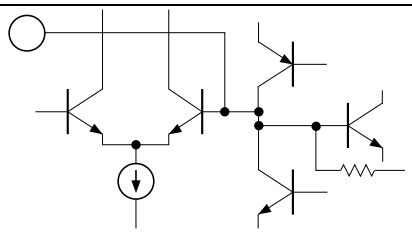
HA12166F


HA12166 (PB 1 CHIP)
Note) The capacitor(C29) should be connected. It's recommended to be connected close to the IC.
DC VM1
DC SOURCE1
A GND
DC SOURCE2
DC SOURCE3
D GND
5 V
AC VM2
DISTORTION ANALYZER
OSCILLO SCOPE
NOISE METER
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

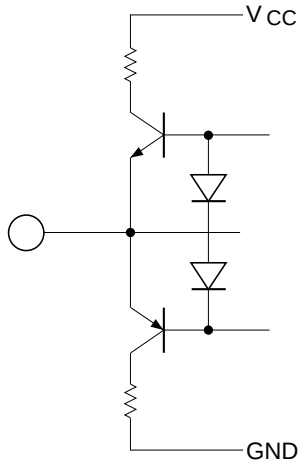
Pin Description (V_{CC} = 9 V Single supply, Ta = 25°C, No signal, The value in the table show typical value)

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

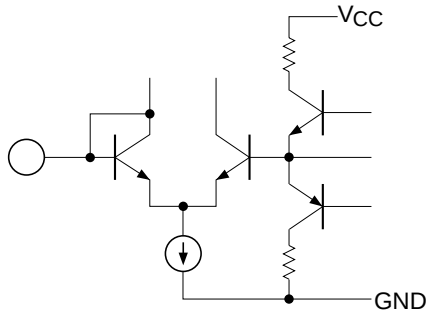
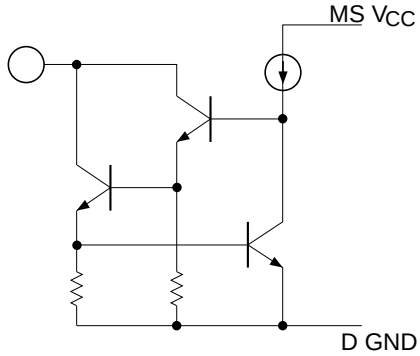
Pin Description (V_{CC} = 9 V Single supply, Ta = 25°C, No signal, The value in the table show typical value) (cont)

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

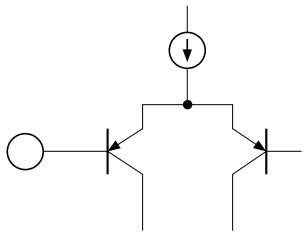
Pin Description (V_{CC} = 9 V Single supply, Ta = 25°C, No signal, The value in the table show typical value) (cont)

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					

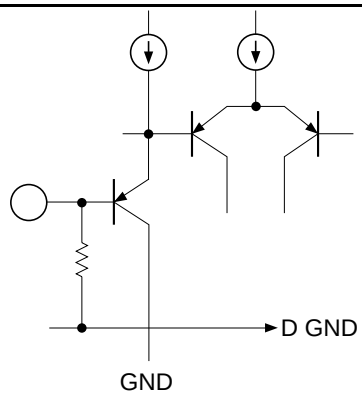
Pin Description (V_{CC} = 9 V Single supply, Ta = 25°C, No signal, The value in the table show typical value) (cont)

Pin No.		Terminal		DC		
QFP-48	QFP-56	name	Zin	voltage	Equivalent circuit	Description
37	44	EQ OUT-M	—	V_{cc}/2		Equalizer output (Metal)
48	55					
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 connection
7	5					
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.

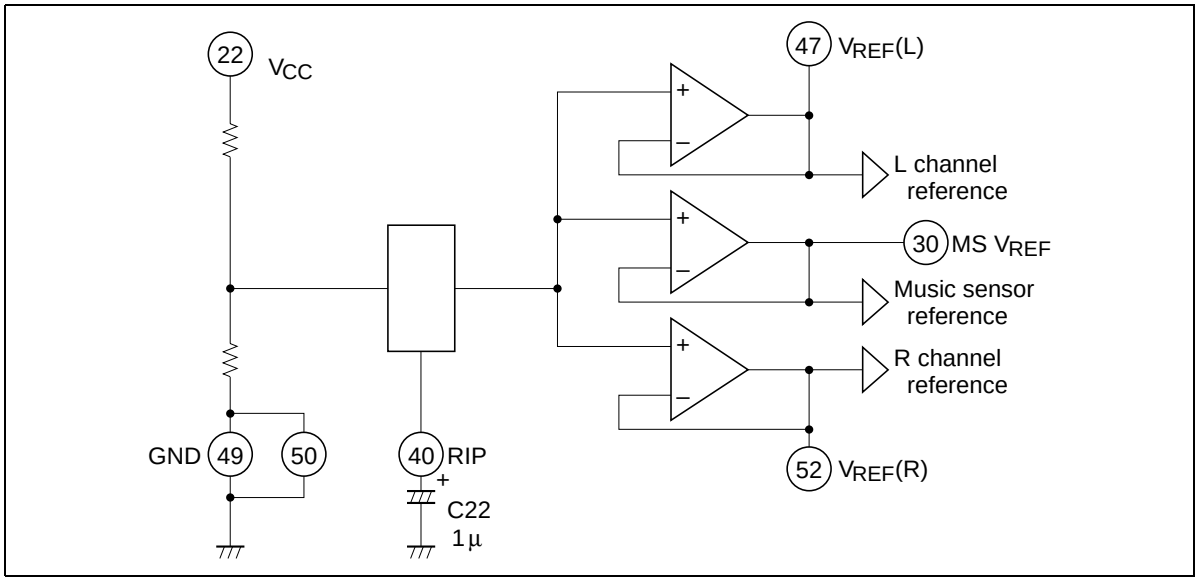


Figure 1 The Block Diagram of Reference Voltage Supply

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

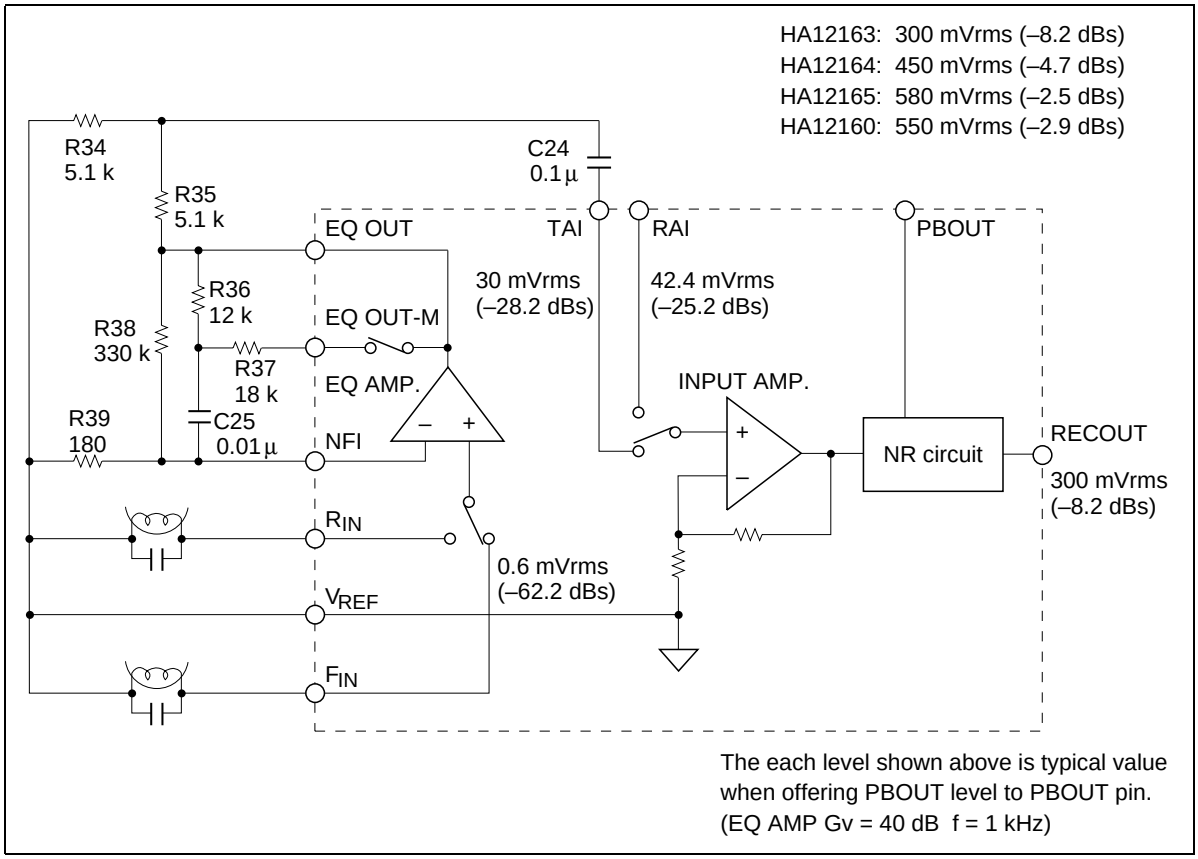


Figure 2 Input Block Diagram

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.

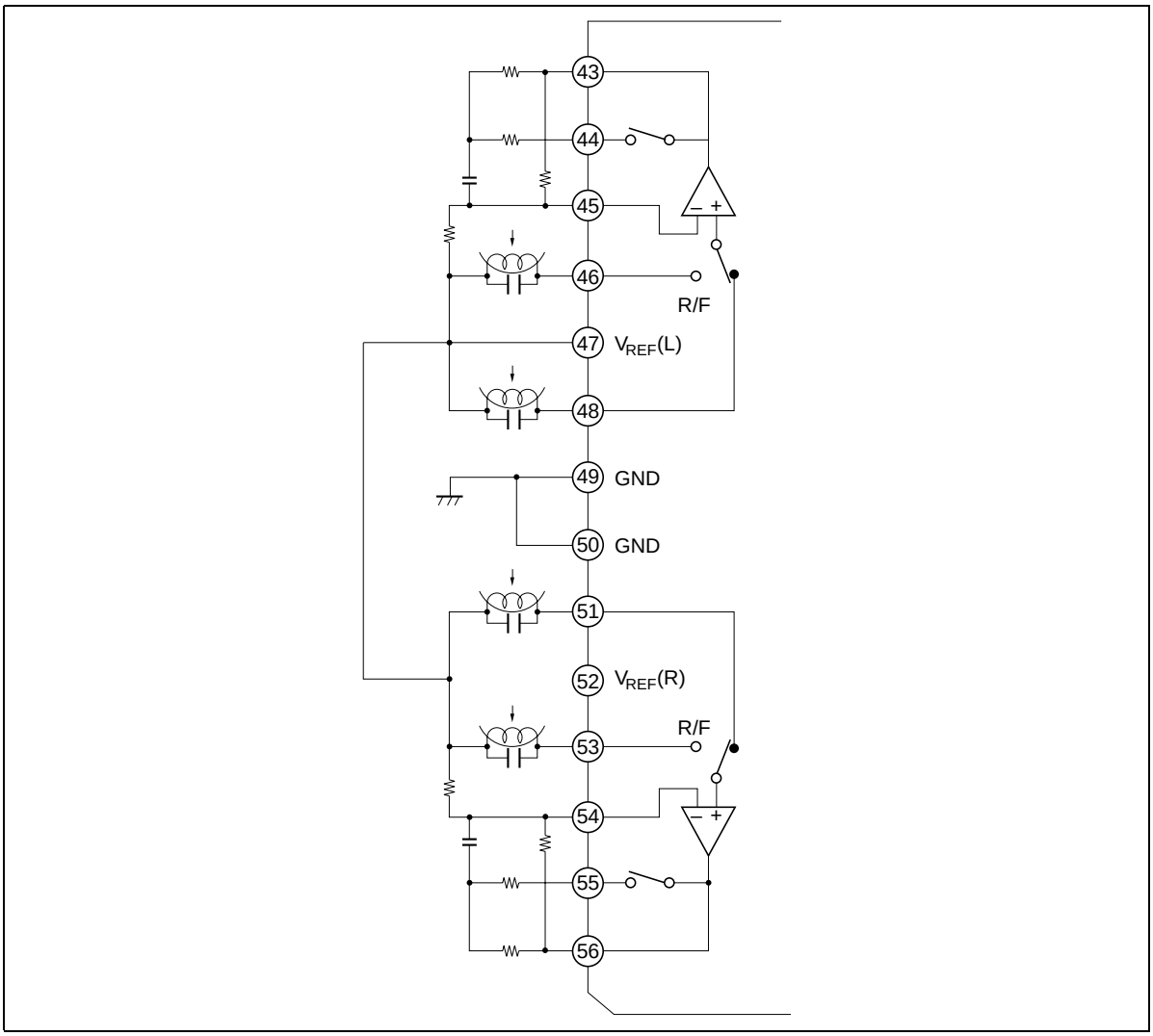


Figure 3 Application Circuit

7. The Sensitivity Adjustment of a Music Sensor

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

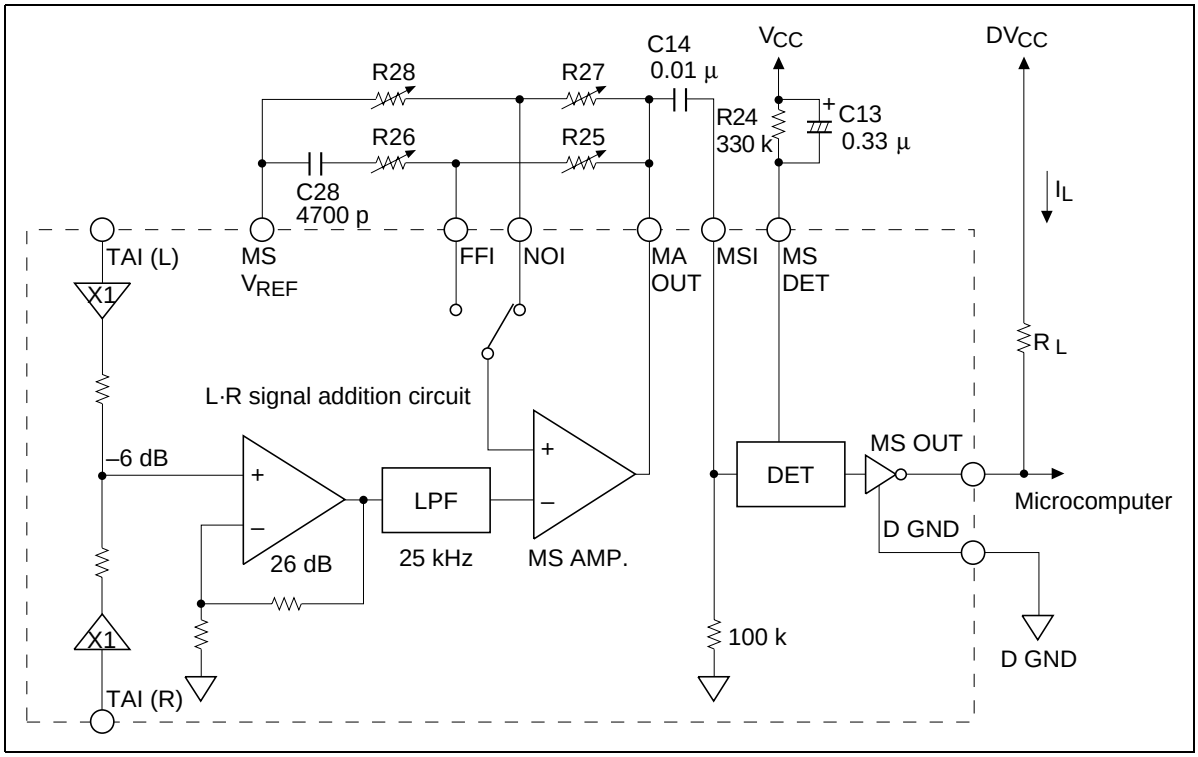


Figure 4 Music Sensor Block Diagram

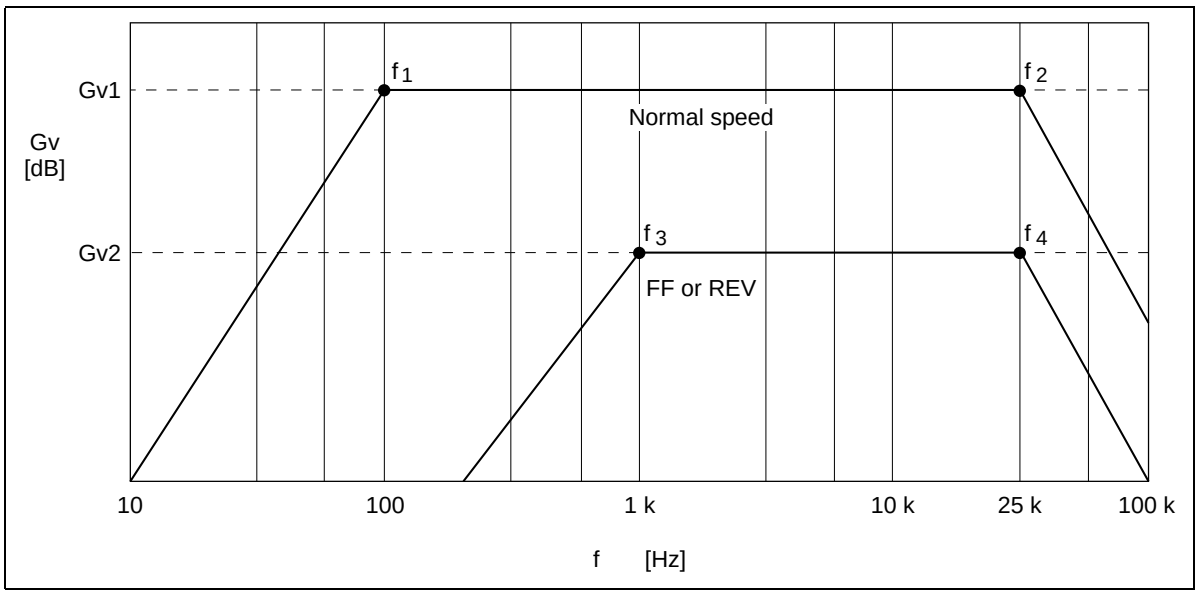


Figure 5 Frequency Response

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

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

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

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.

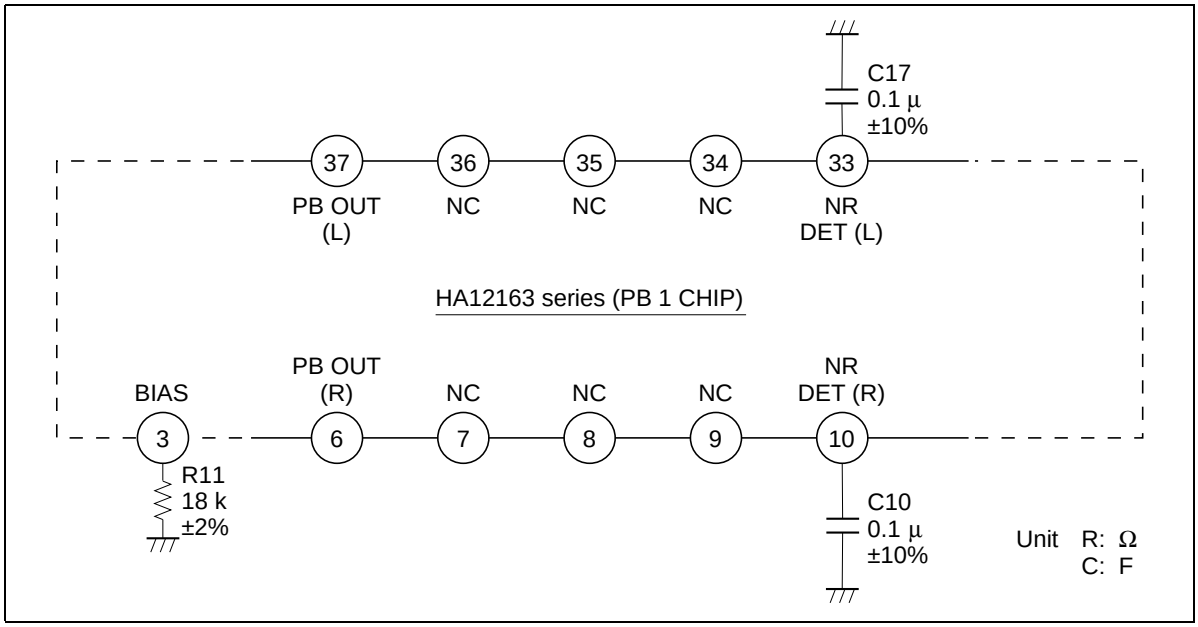


Figure 6 Tolerances of External Components

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.

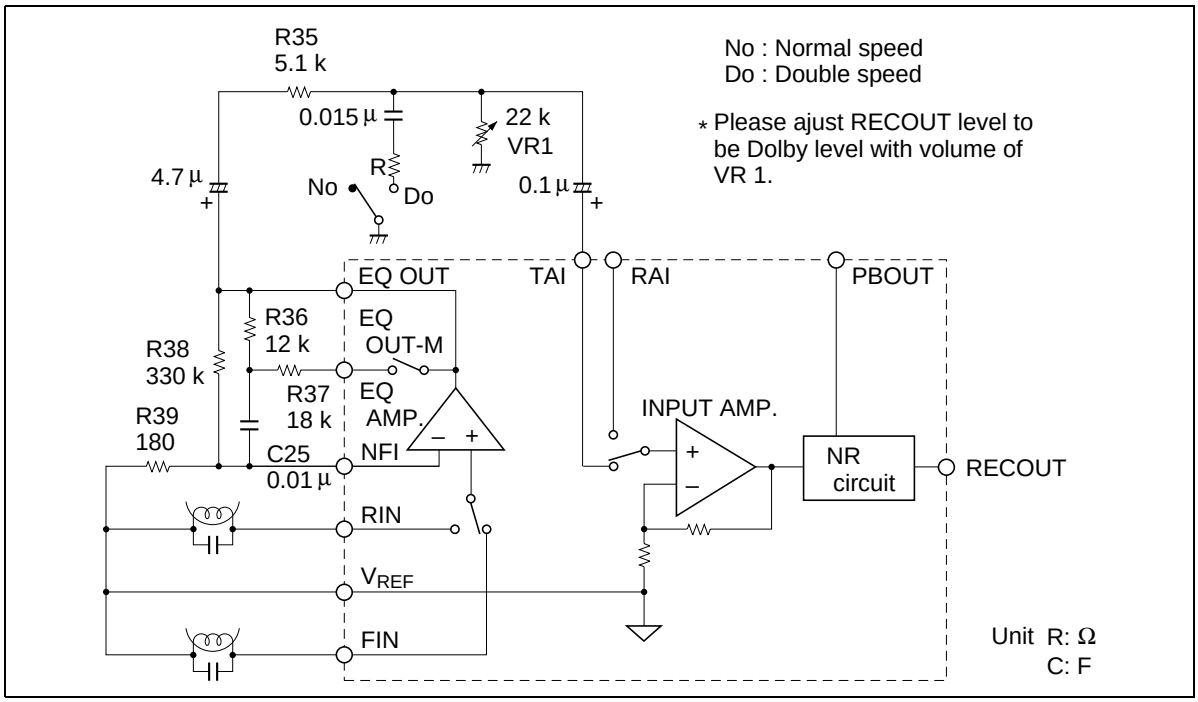


Figure 7 Application Circuit for Double Speed

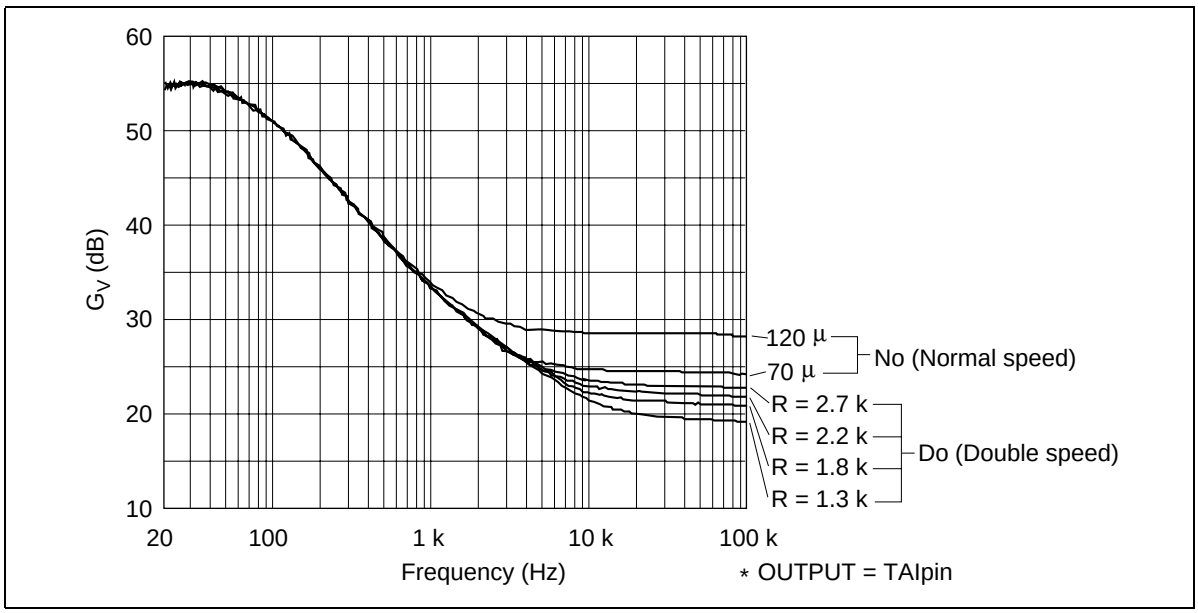
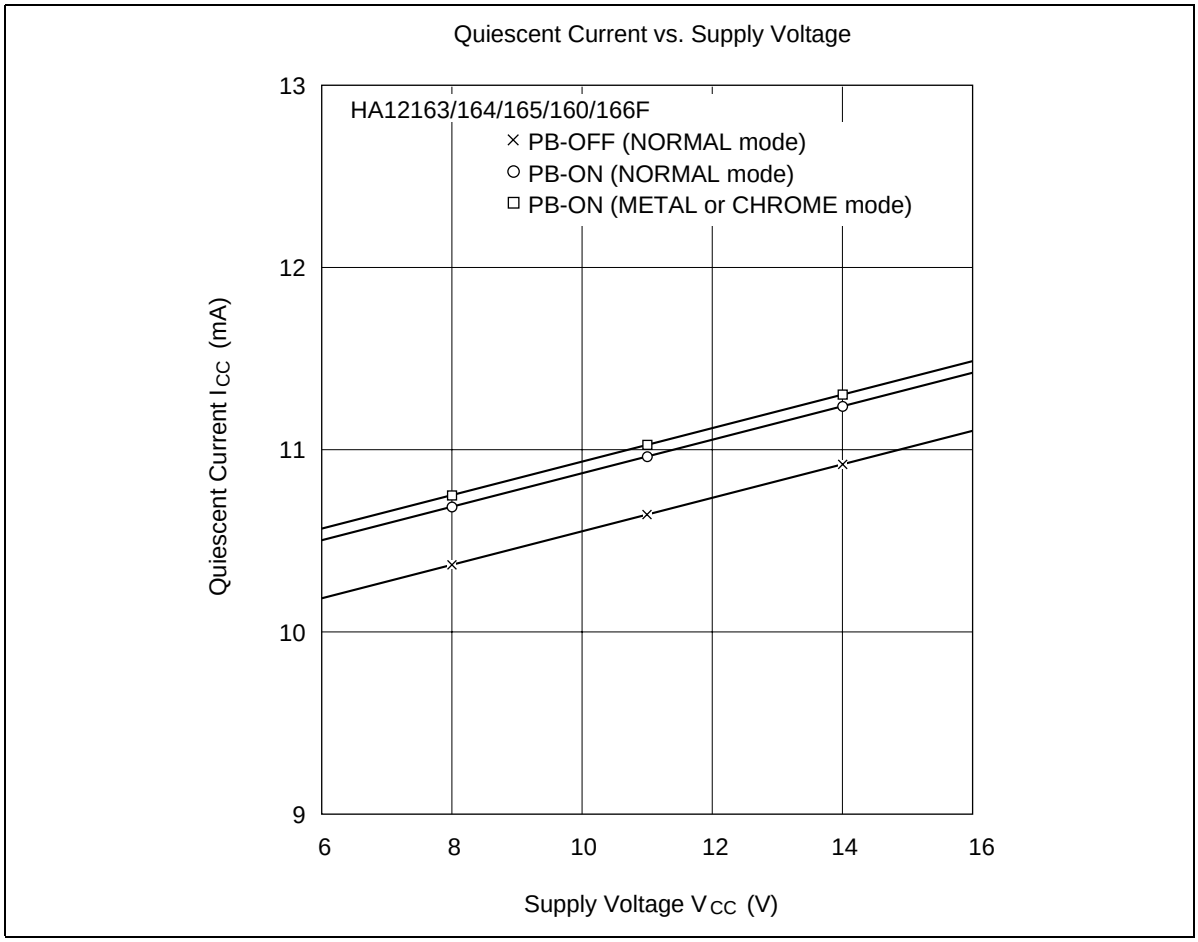


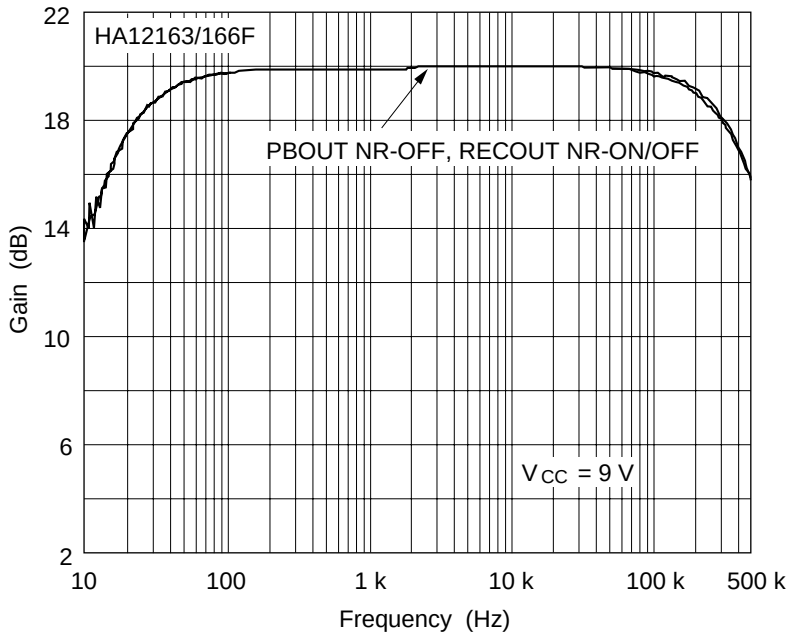
Figure 8 Application Data

Typical Characteristic Curves

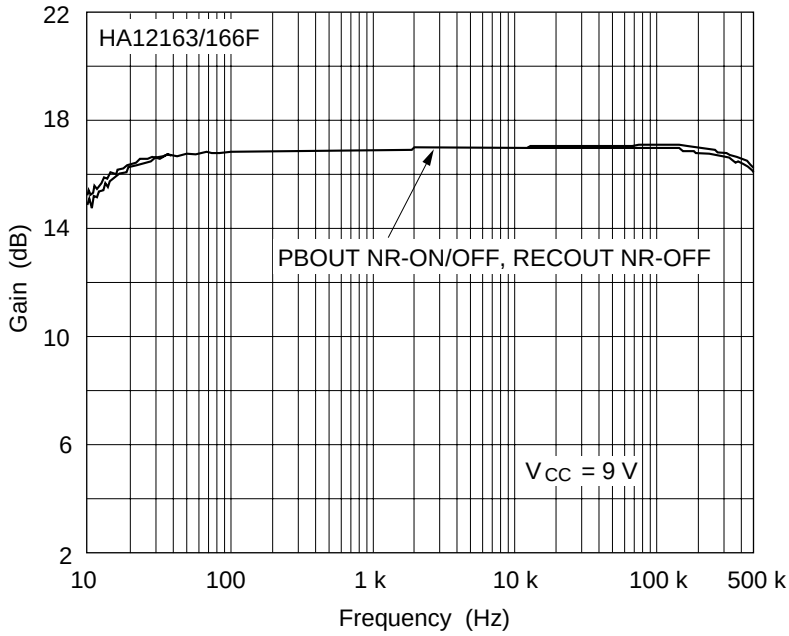


HA12163 Data

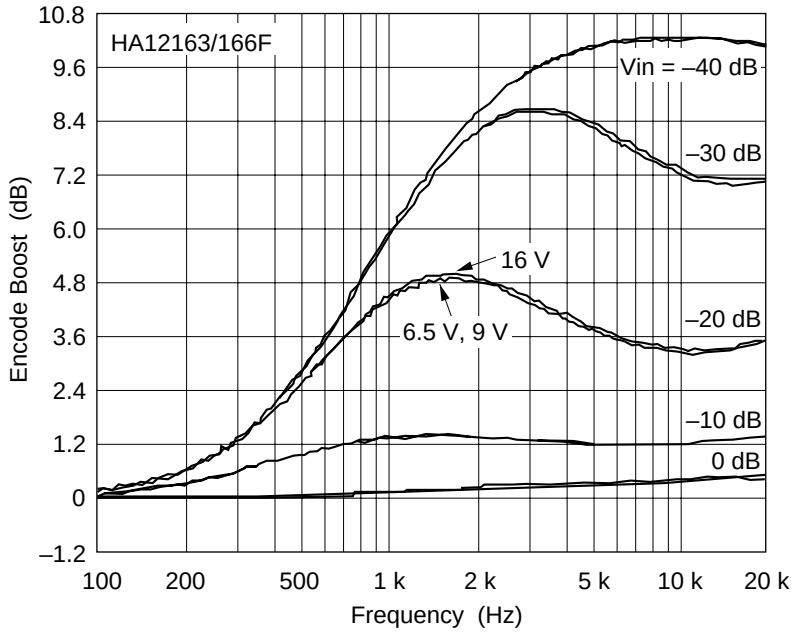
TAIin Input Amp. Gain vs. Frequency (PBmode)



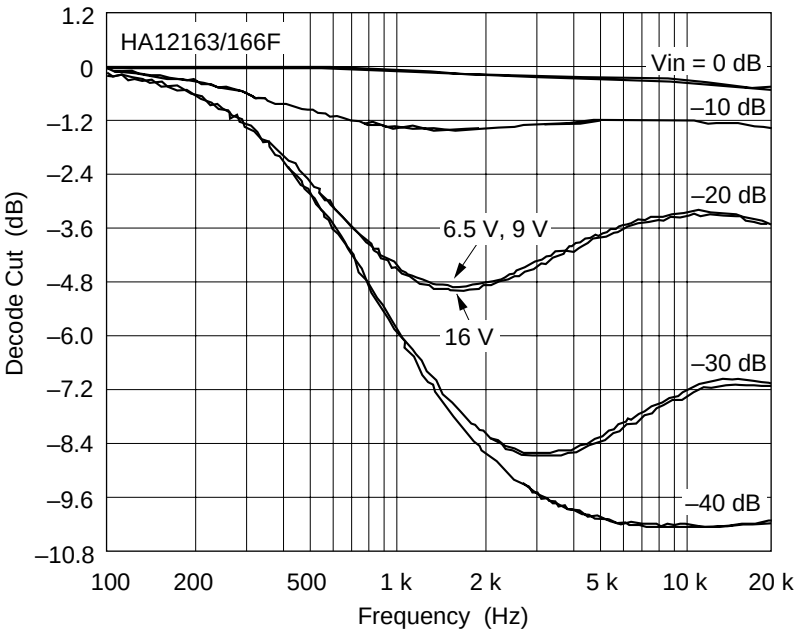
RAIin Input Amp. Gain vs. Frequency (RECmode)



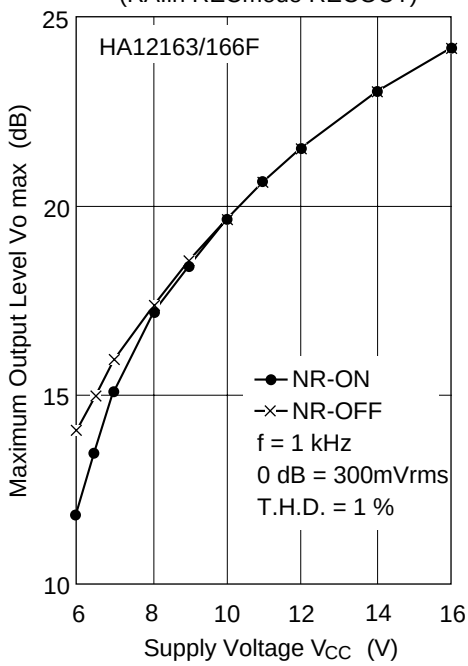
Encode Boost vs. Frequency (V_{CC} = 6.5 V, 9 V, 16 V)



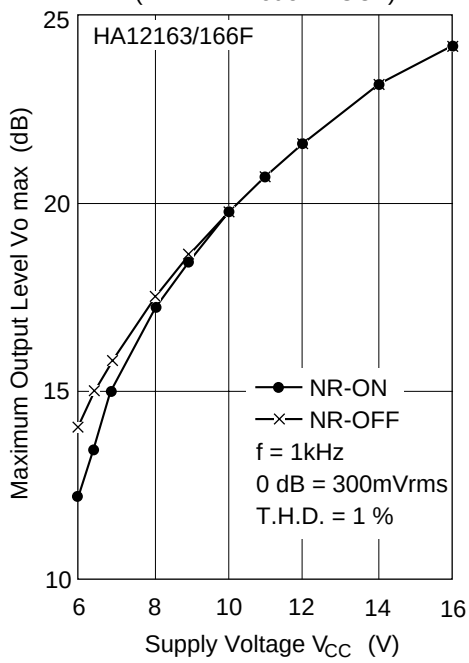
Decode Cut vs. Frequency (V_{CC} = 6.5 V, 9 V, 16 V)



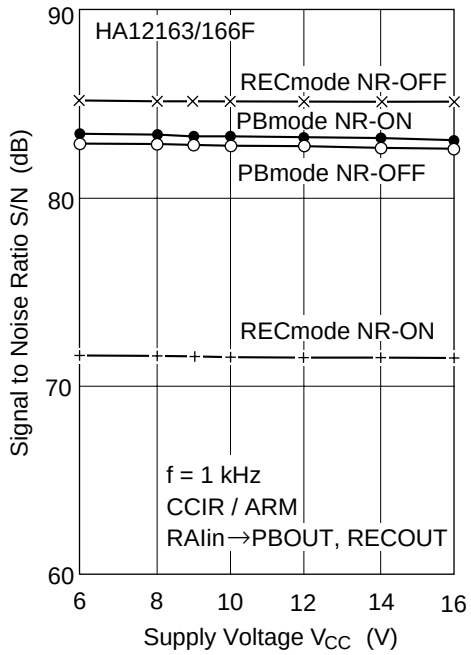
Maximum Output Level vs. Supply Voltage (1)
(RAIin RECmode RECOUT)



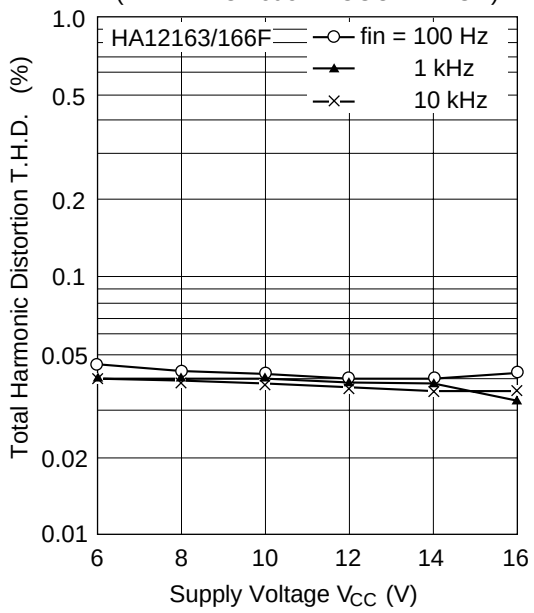
Maximum Output Level vs. Supply Voltage (2)
(RAIin PBmode PBOUT)



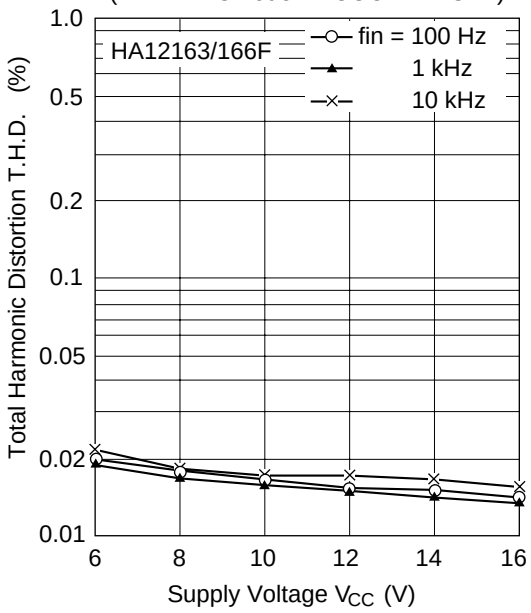
Signal to Noise Ratio vs. Supply Voltage



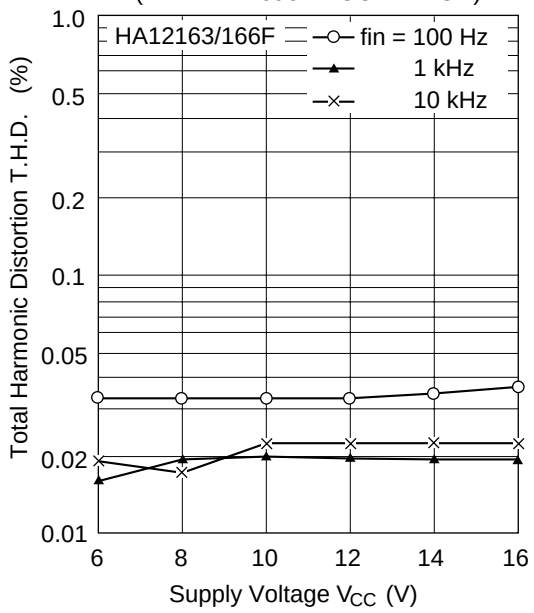
Total Harmonic Distortion vs. Supply Voltage (1)
(RAIin RECmode RECOUT NR-ON)



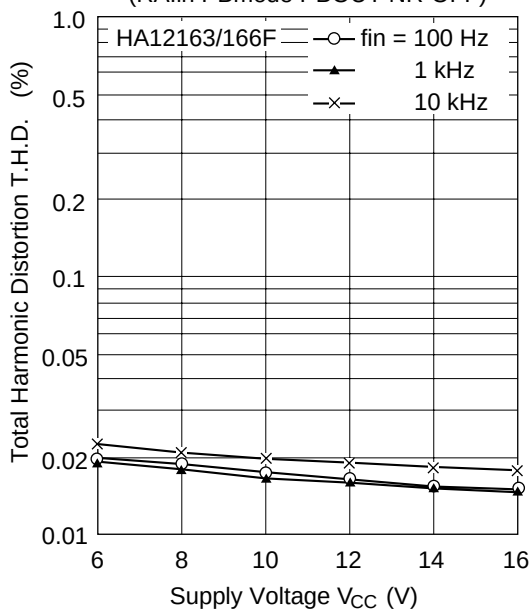
Total Harmonic Distortion vs. Supply Voltage (2)
(RAIin RECmode RECOUT NR-OFF)



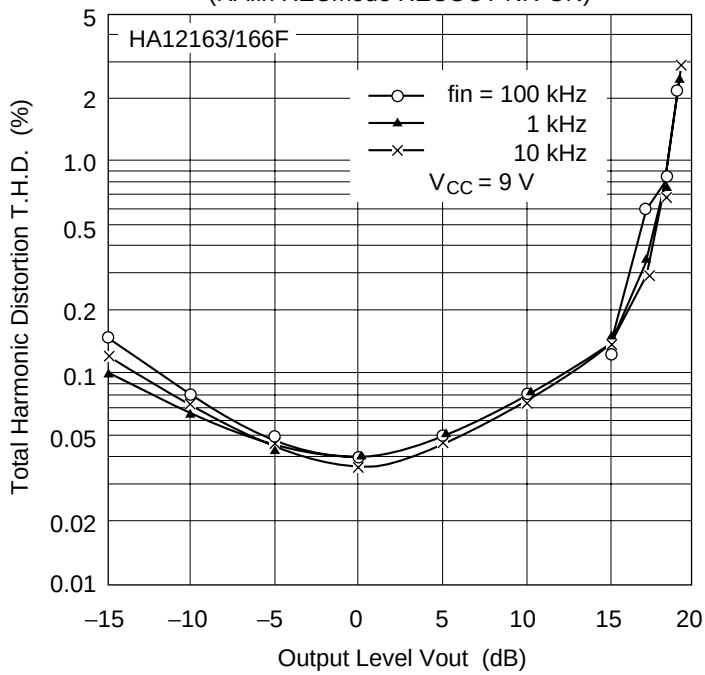
Total Harmonic Distortion vs. Supply Voltage (3)
(RAIin PBmode PBOUT NR-ON)



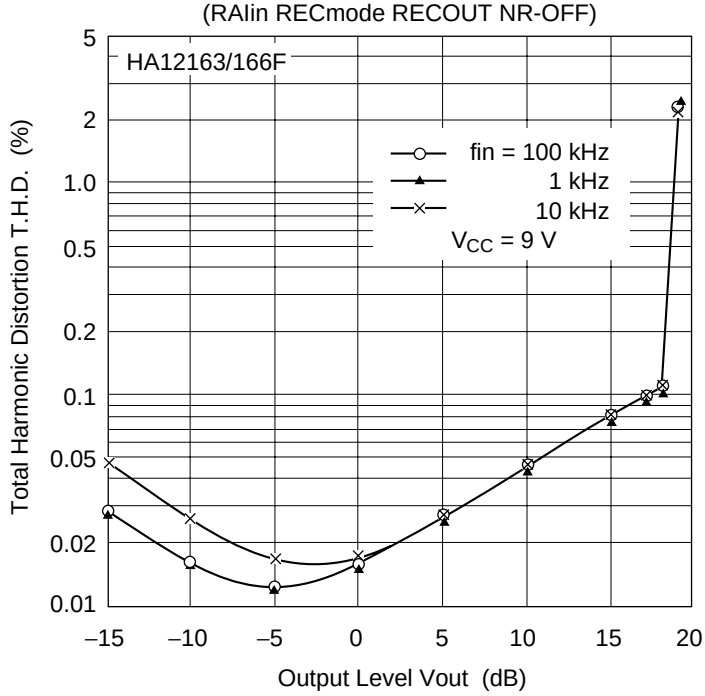
Total Harmonic Distortion vs. Supply Voltage (4)
(RAIin PBmode PBOUT NR-OFF)



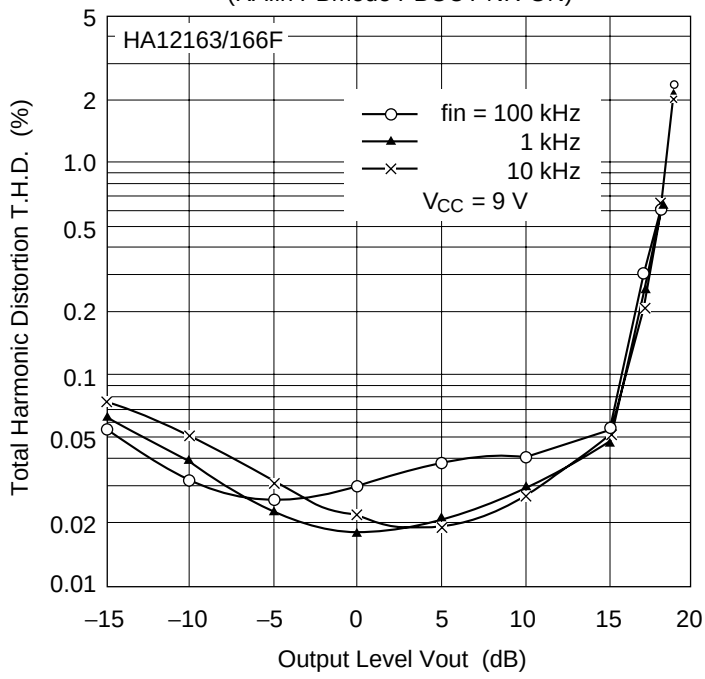
Total Harmonic Distortion vs. Output Level (1)
(RAIin RECmode RECOUT NR-ON)



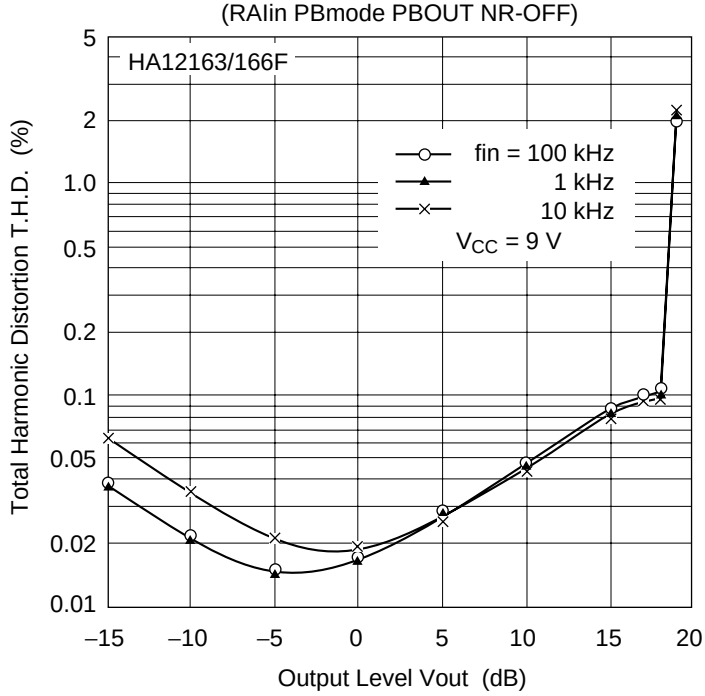
Total Harmonic Distortion vs. Output Level (2)
(RAIin RECmode RECOUT NR-OFF)



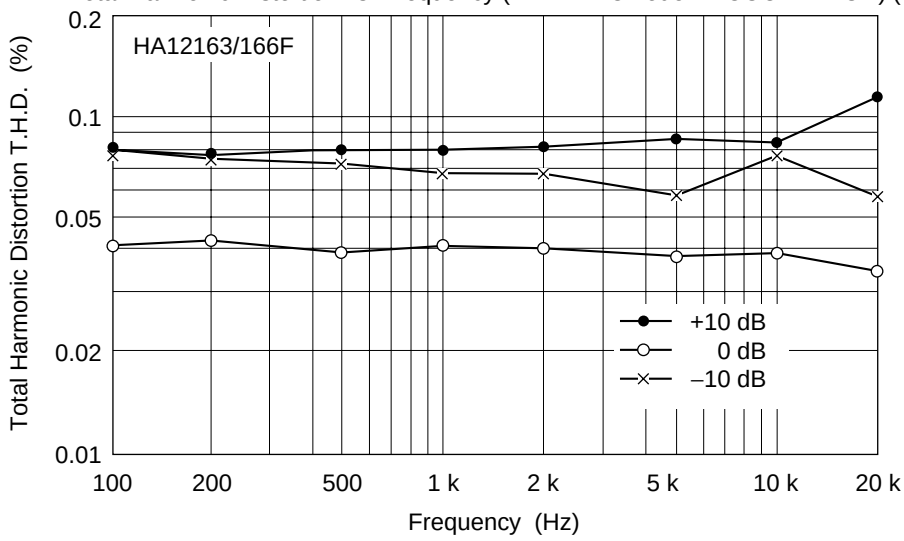
Total Harmonic Distortion vs. Output Level (3)
(RAIin PBmode PBOUT NR-ON)



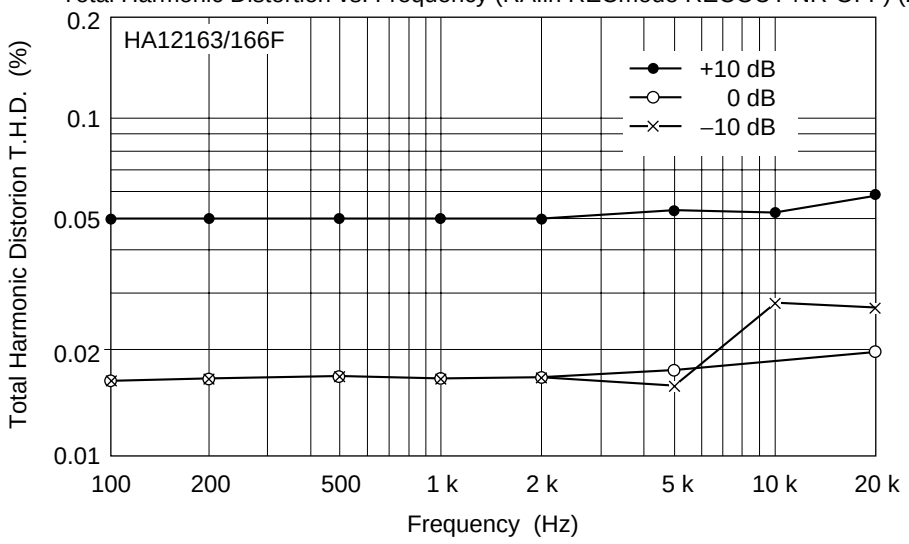
Total Harmonic Distortion vs. Output Level (4)
(RAIin PBmode PBOUT NR-OFF)



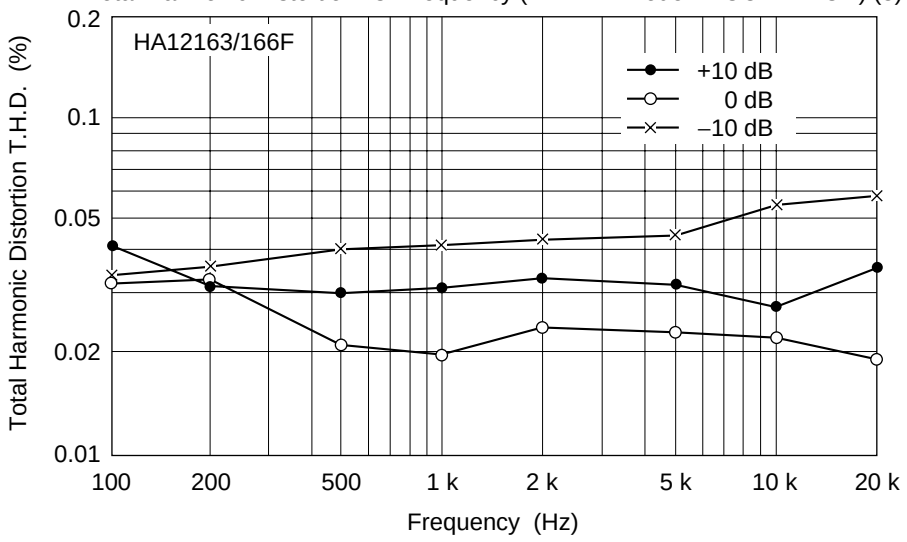
Total Harmonic Distortion vs. Frequency (RAIin RECmode RECOUT NR-ON) (1)



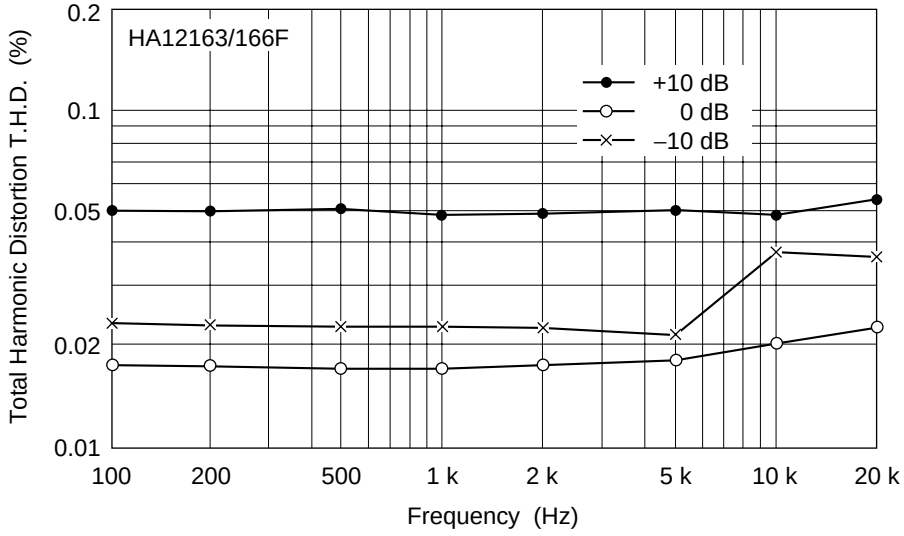
Total Harmonic Distortion vs. Frequency (RAIin RECmode RECOUT NR-OFF) (2)



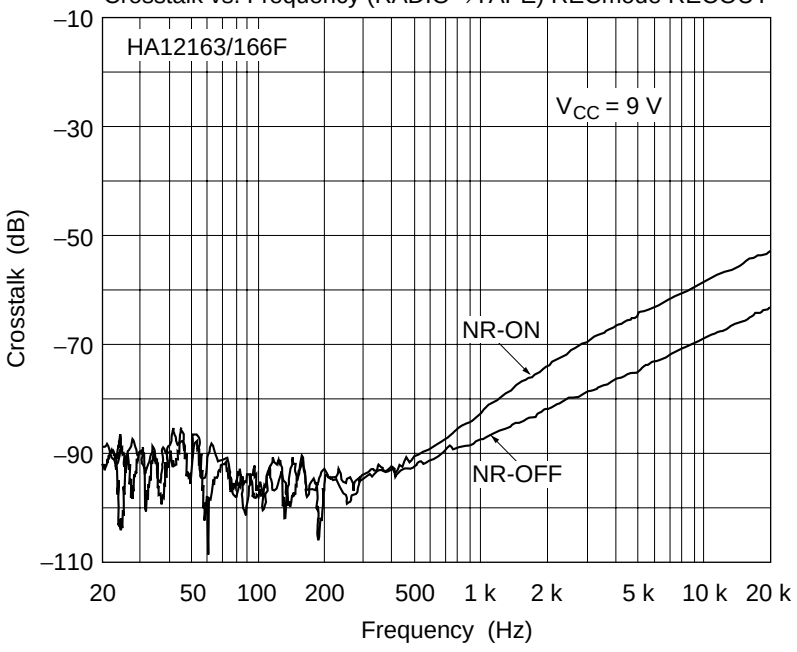
Total Harmonic Distortion vs. Frequency (RAIin PBmode PBOUT NR-ON) (3)



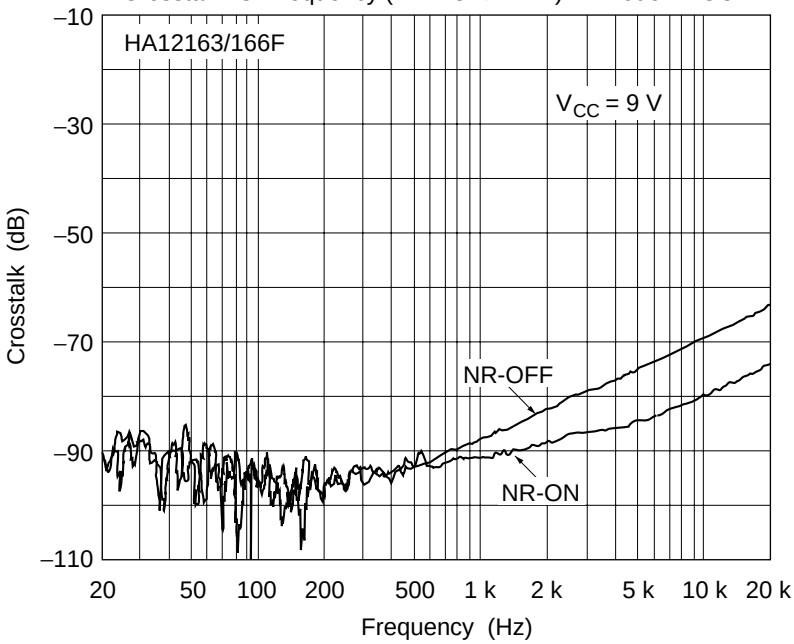
Total Harmonic Distortion vs. Frequency (RAIin PBmode PBOUT NR-OFF) (4)



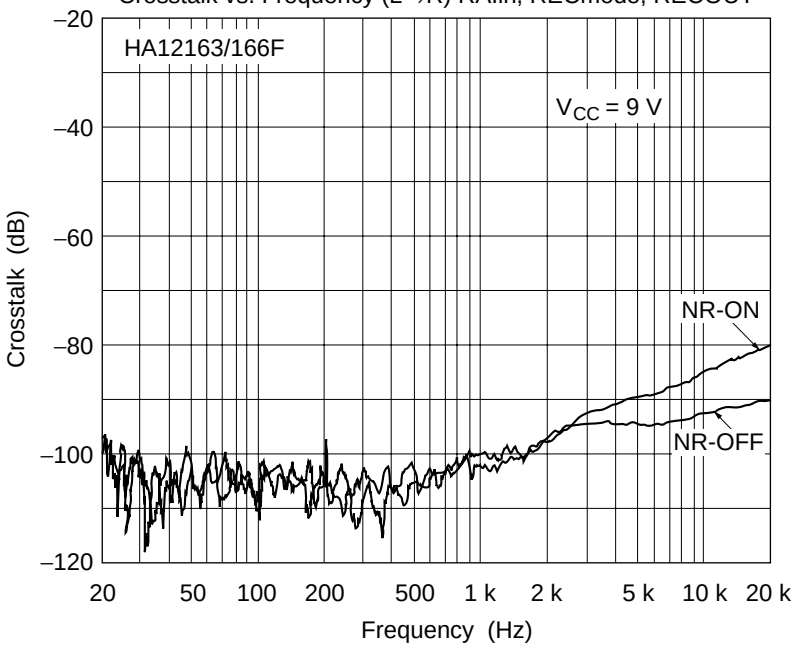
Crosstalk vs. Frequency (RADIO→TAPE) RECmode RECOUT



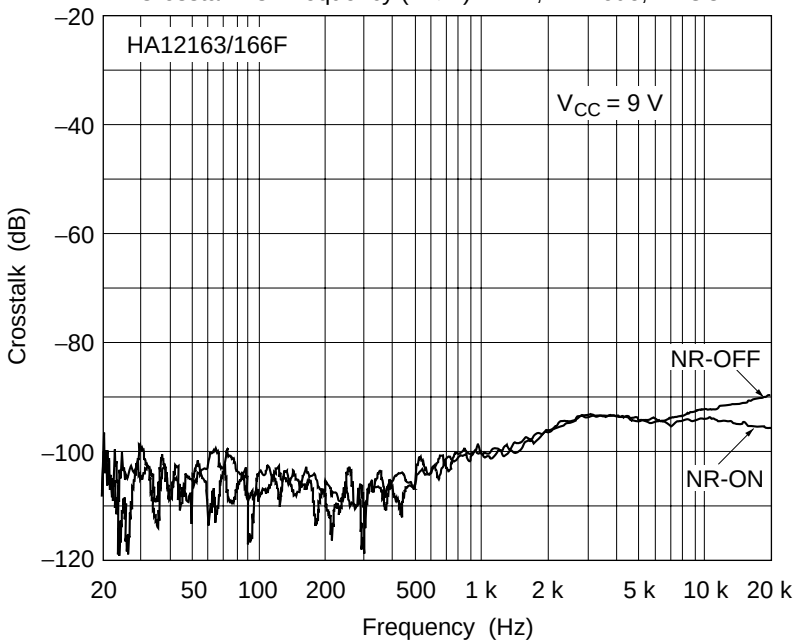
Crosstalk vs. Frequency (RADIO→TAPE) PBmode PBOUT



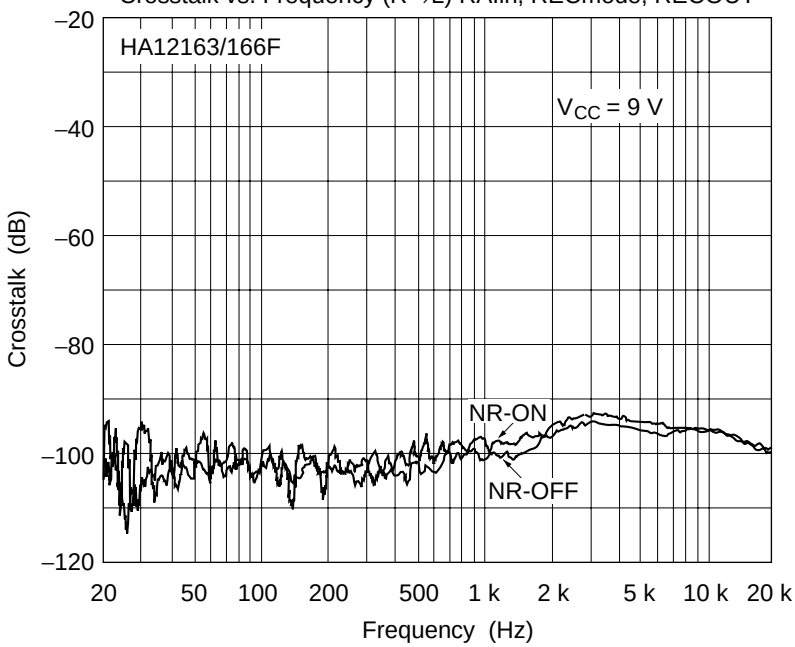
Crosstalk vs. Frequency (L→R) RAIin, RECmode, RECOUT



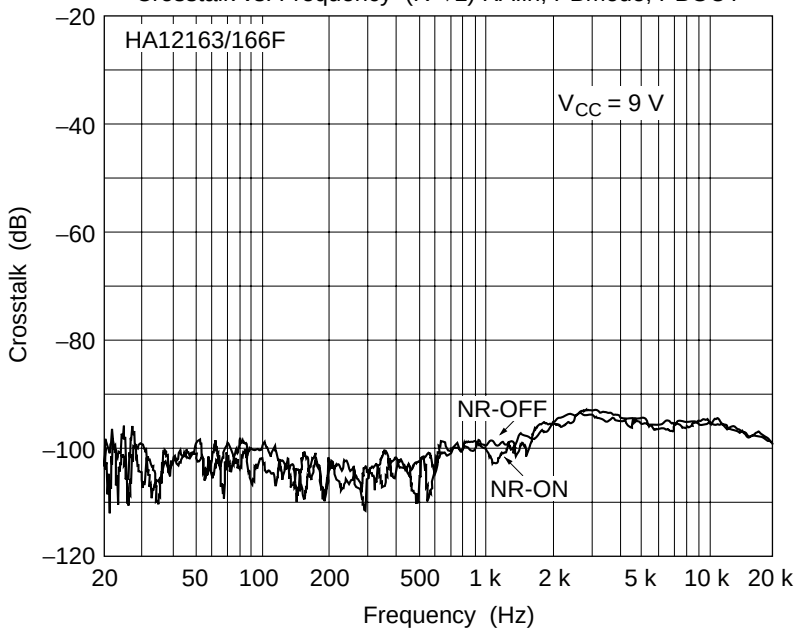
Crosstalk vs. Frequency (L→R) RAIin, PBmode, PBOUT



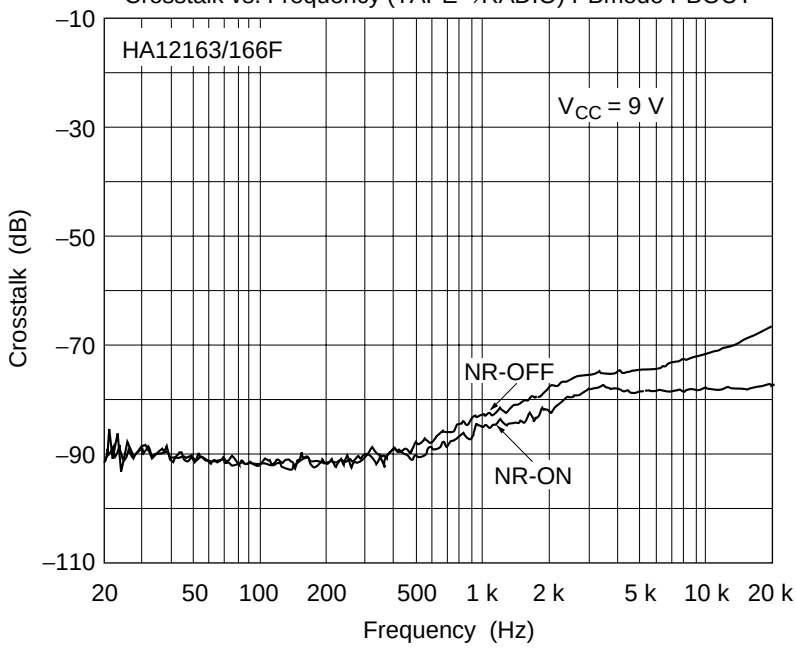
Crosstalk vs. Frequency (R→L) RAIin, RECmode, RECOUT



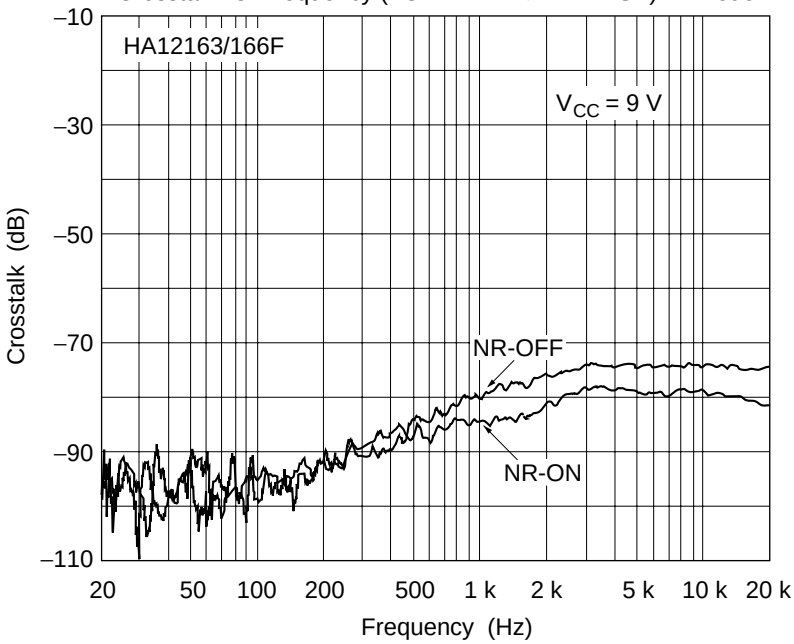
Crosstalk vs. Frequency (R→L) RAIin, PBmode, PBOUT



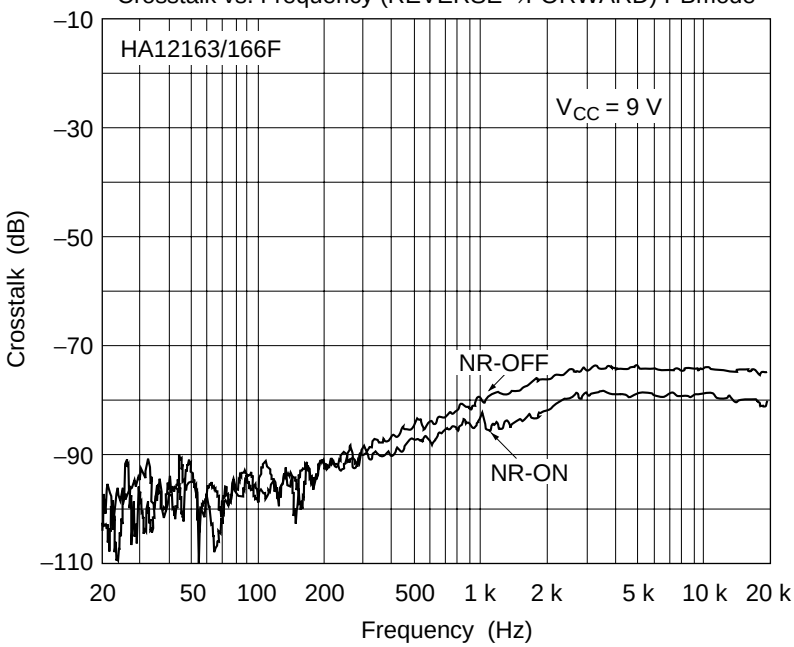
Crosstalk vs. Frequency (TAPE→RADIO) PBmode PBOUT

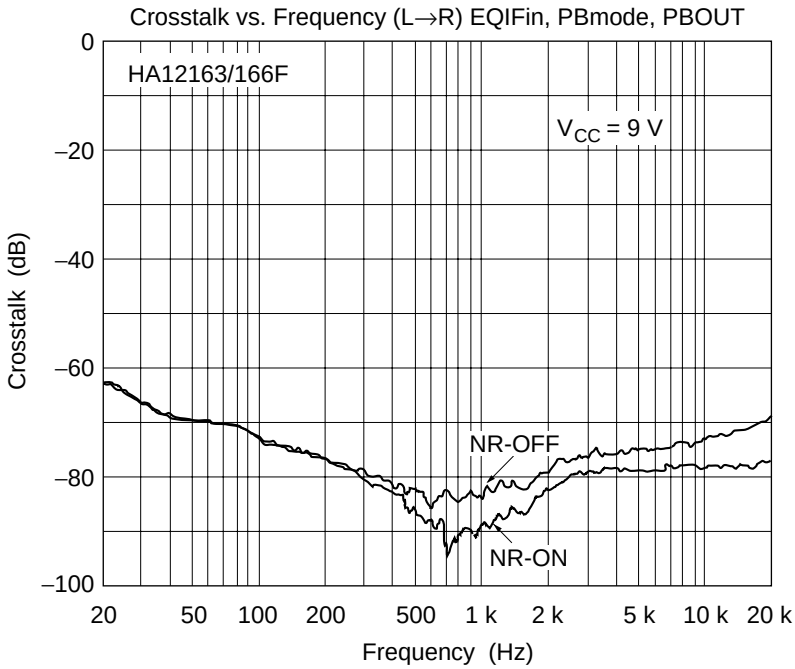


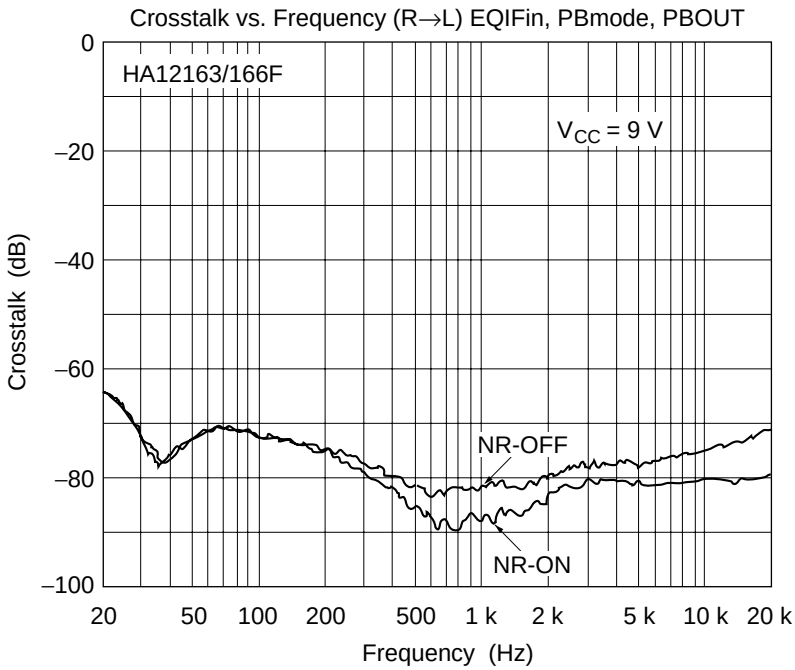
Crosstalk vs. Frequency (FORWARD→REVERSE) PBmode



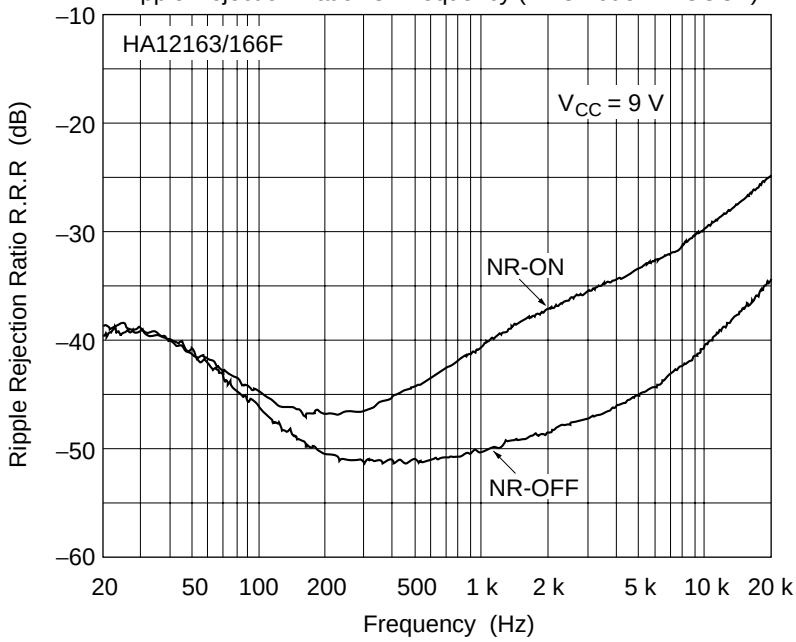
Crosstalk vs. Frequency (REVERSE→FORWARD) PBmode



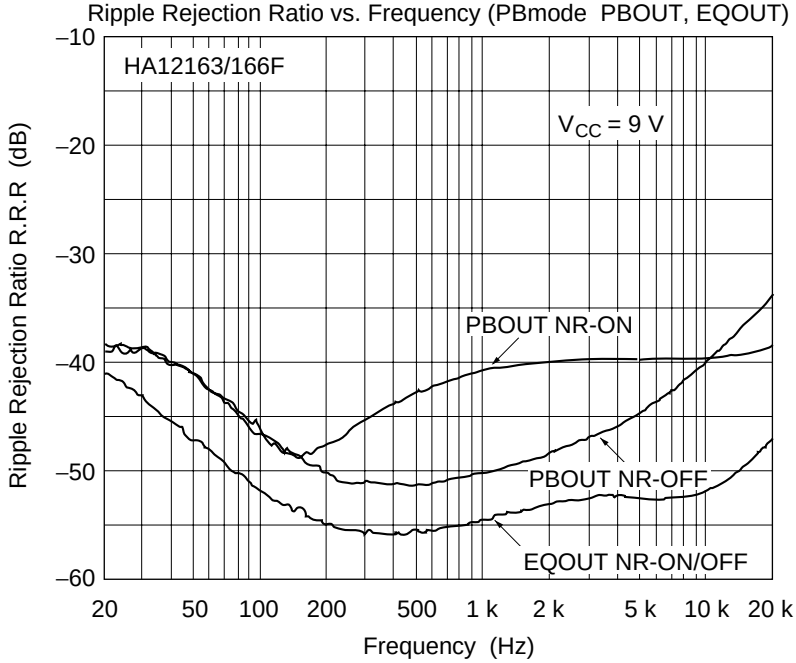

Crosstalk vs. Frequency (L→R) EQIFin, PBmode, PBOUT
HA12163/166F
V_{CC} = 9 V
NR-OFF
NR-ON
Crosstalk (dB)
0
–20
–40
–60
–80
–100
20
50
100
200
500
1 k
2 k
5 k
10 k
20 k
Frequency (Hz)


Crosstalk vs. Frequency (R→L) EQIFin, PBmode, PBOUT
HA12163/166F
V_{CC} = 9 V
NR-OFF
NR-ON
Crosstalk (dB)
0
–20
–40
–60
–80
–100
20
50
100
200
500
1 k
2 k
5 k
10 k
20 k
Frequency (Hz)

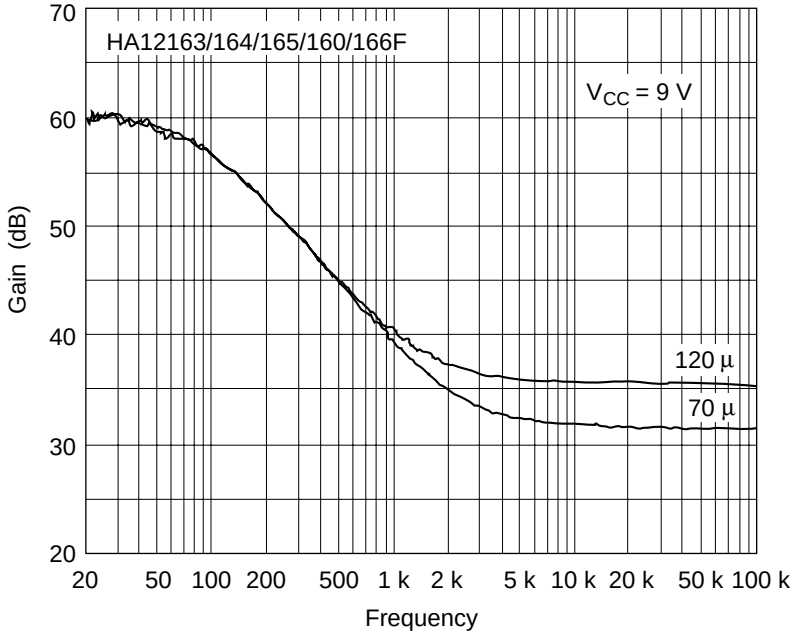
Ripple Rejection Ratio vs. Frequency (RECmode RECOUT)



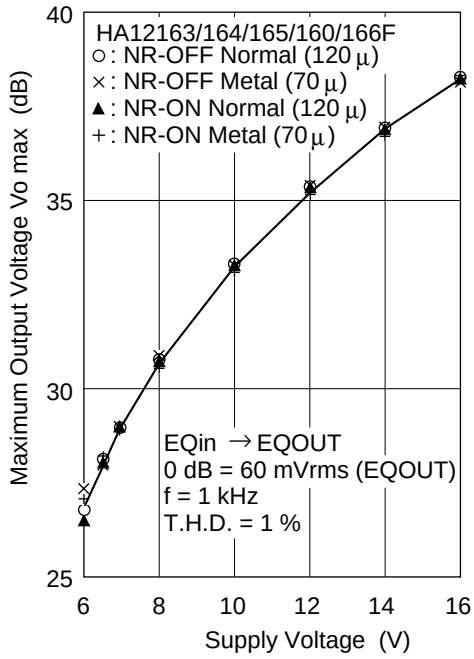
Ripple Rejection Ratio vs. Frequency (PBmode PBOUT, EQOUT)



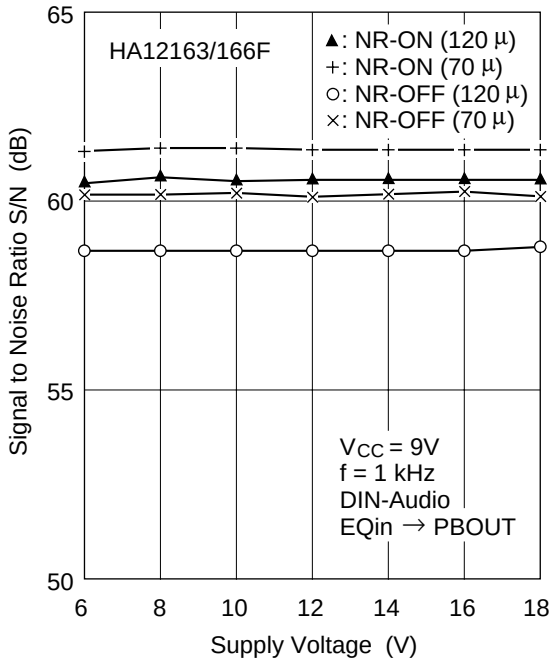
EQ-AMP. Gain vs. Frequency



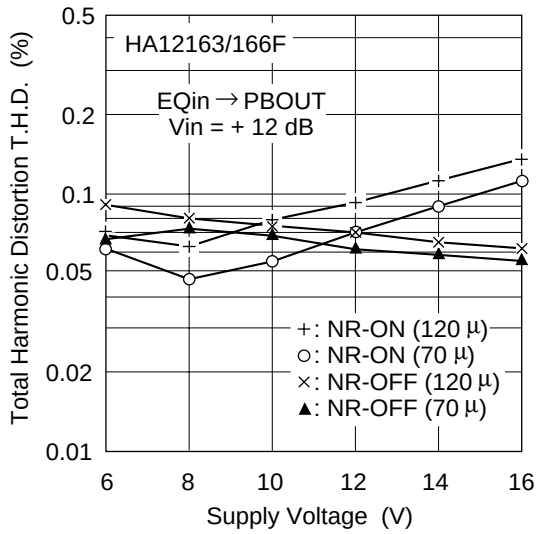
EQout Maximum Output Level vs. Supply Voltage



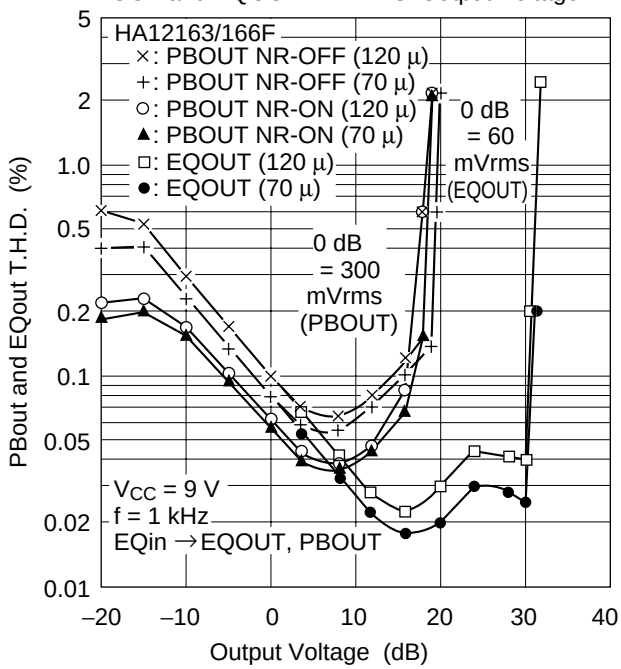
Signal to Noise Ratio vs. Supply Voltage



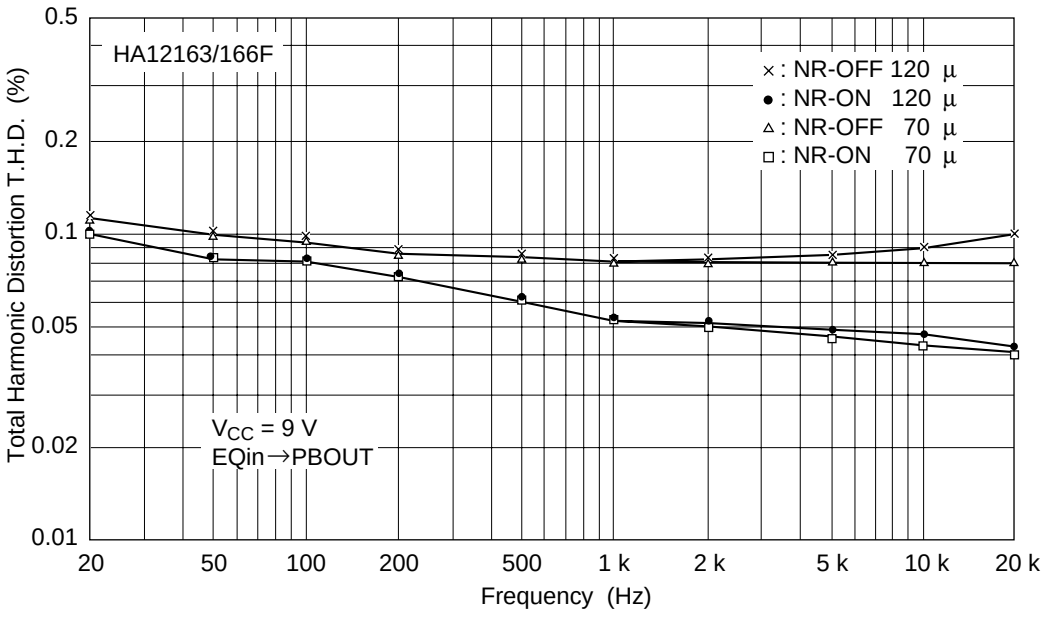
Total Harmonic Distortion vs.
Supply Voltage (EQin PBOUT)



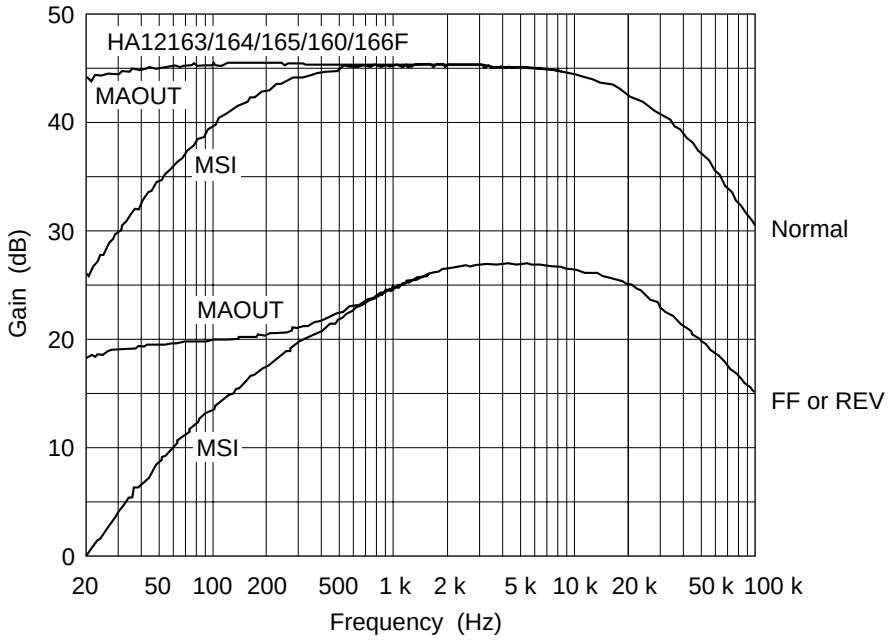
PBOUT and EQOUT T.H.D. vs. Output Voltage



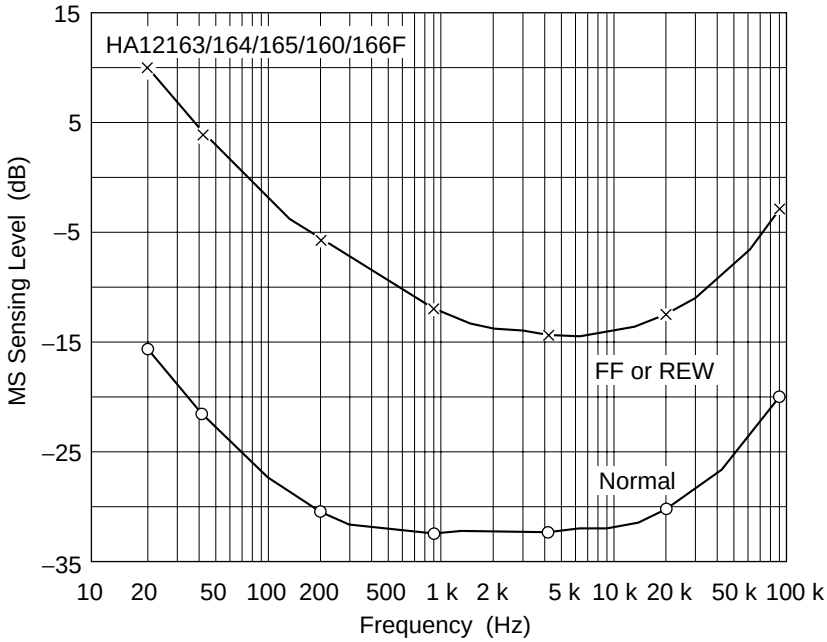
Total Harmonic Distortion vs. Frequency (EQin PBmode PBOUT)



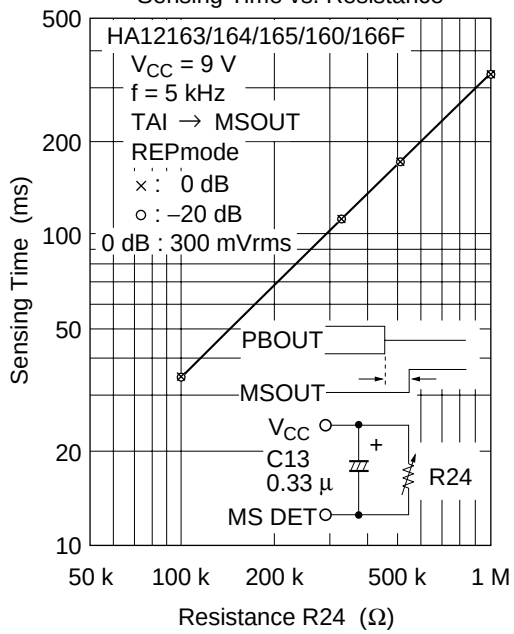
MS-AMP. Gain vs. Frequency



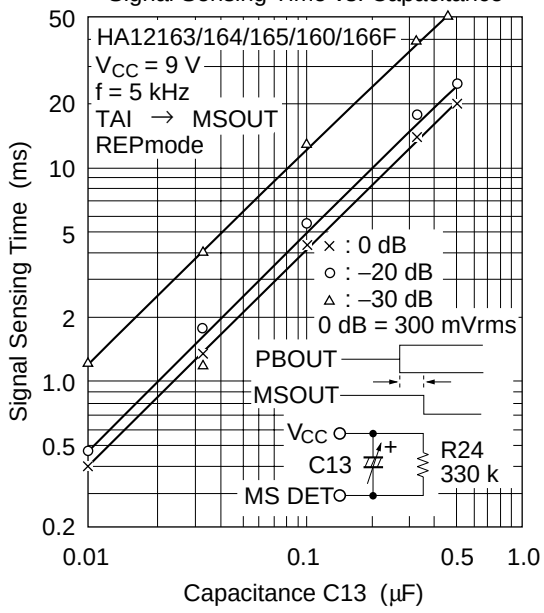
MS Sensing Level vs. Frequency



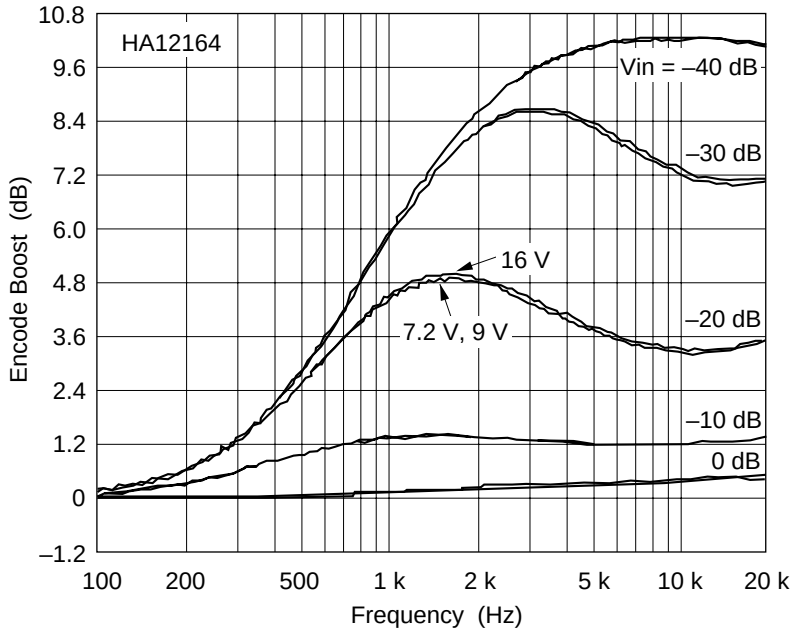
Sensing Time vs. Resistance



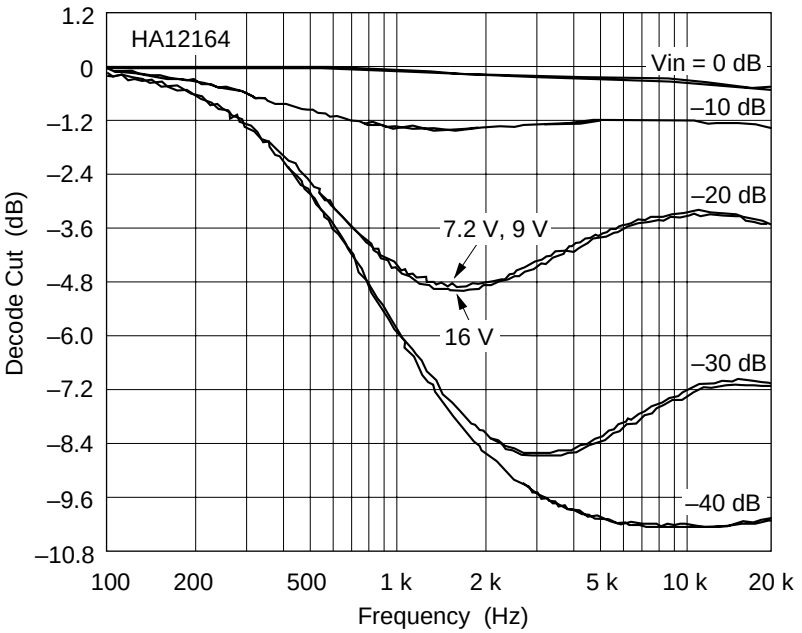
Signal Sensing Time vs. Capacitance



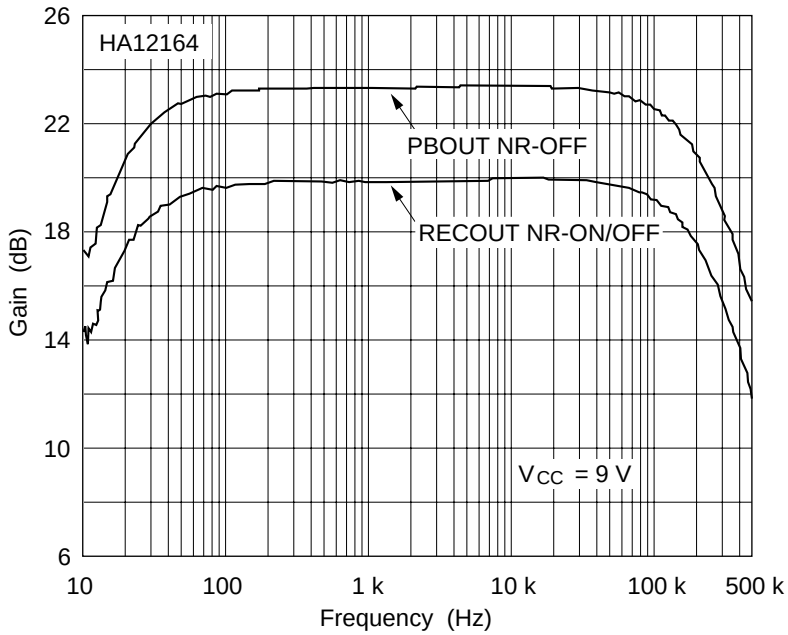
Encode Boost vs. Frequency (V_{CC} = 7.2 V, 9 V, 16 V)



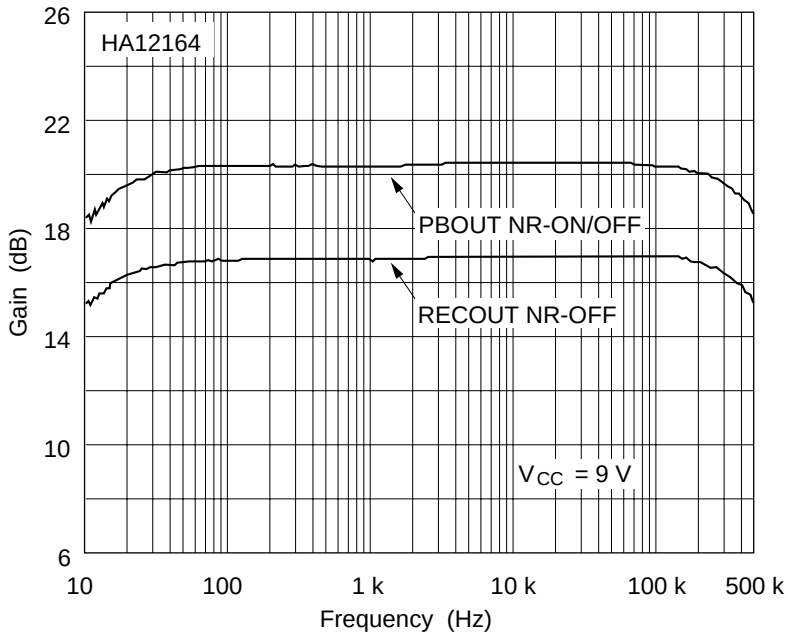
Decode Cut vs. Frequency (V_{CC} = 7.2 V, 9 V, 16 V)



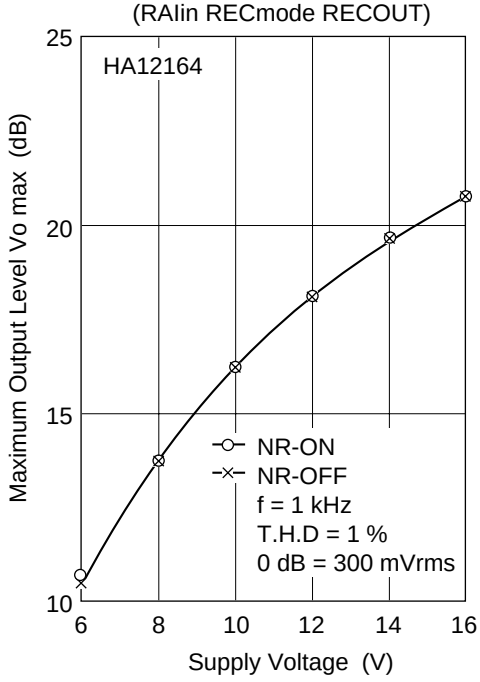
TAIin Input Amp. Gain vs. Frequency (PBmode)



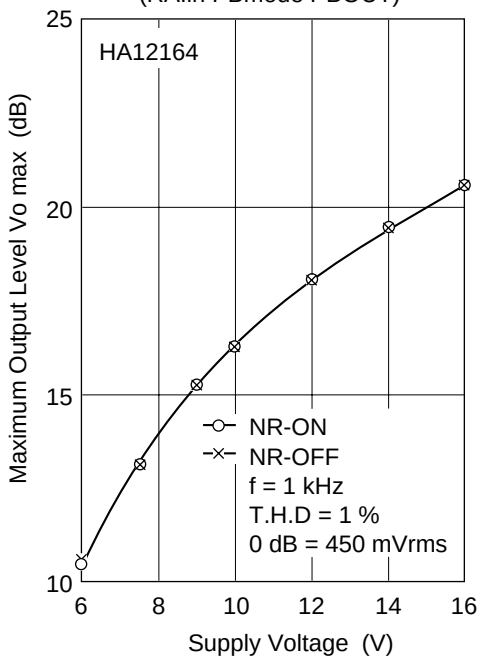
RAIin Input Amp. Gain vs. Frequency (RECmode)



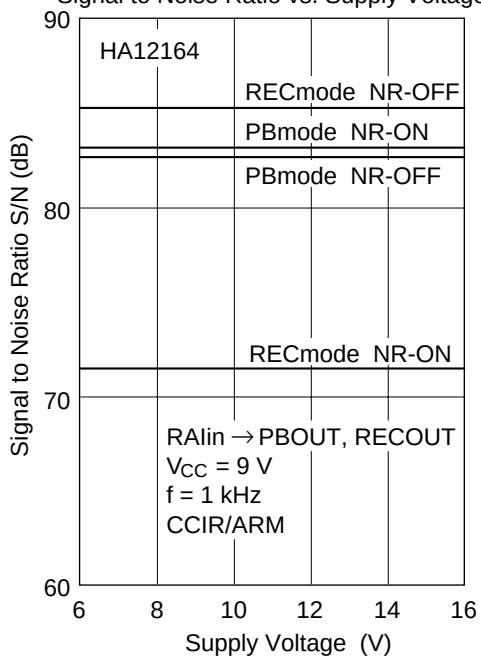
Maximum Output Level vs. Supply Voltage (1)
(RAIin RECmode RECOUT)



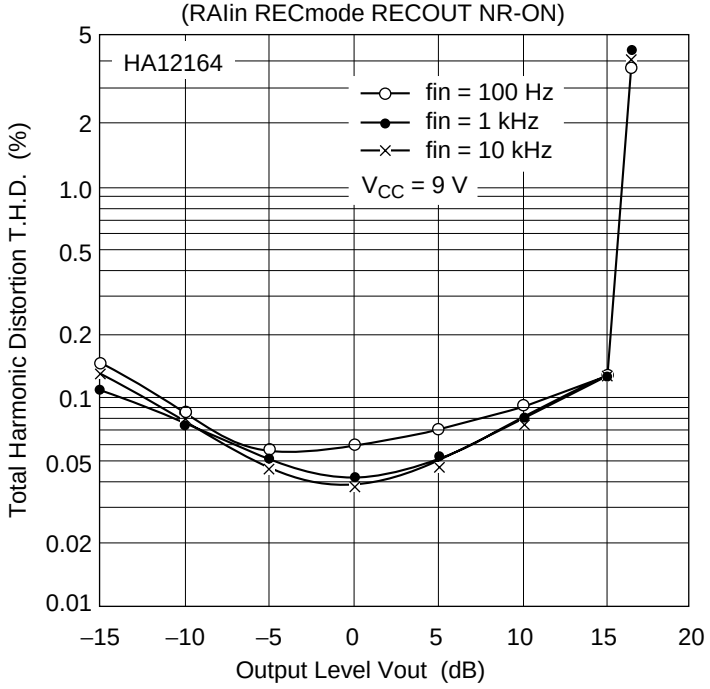
Maximum Output Level vs. Supply Voltage (2)
(RAIin PBmode PBOUT)



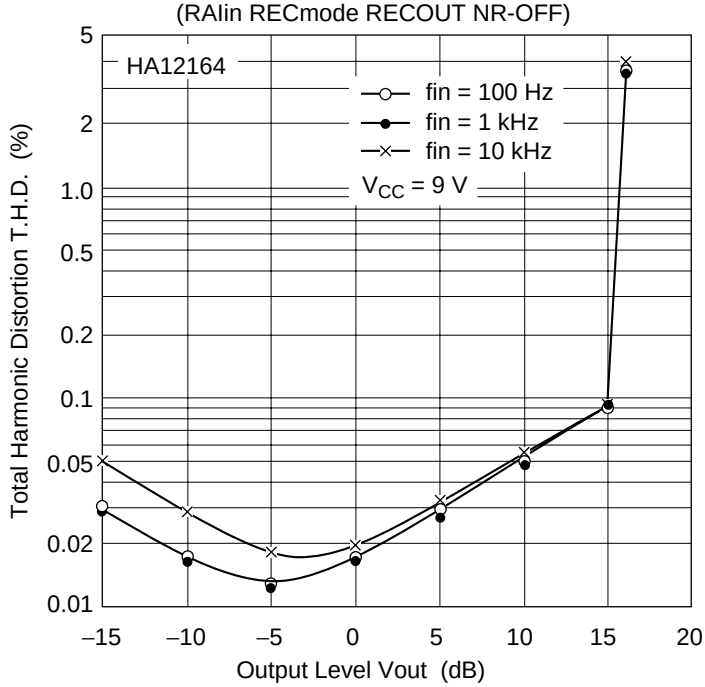
Signal to Noise Ratio vs. Supply Voltage



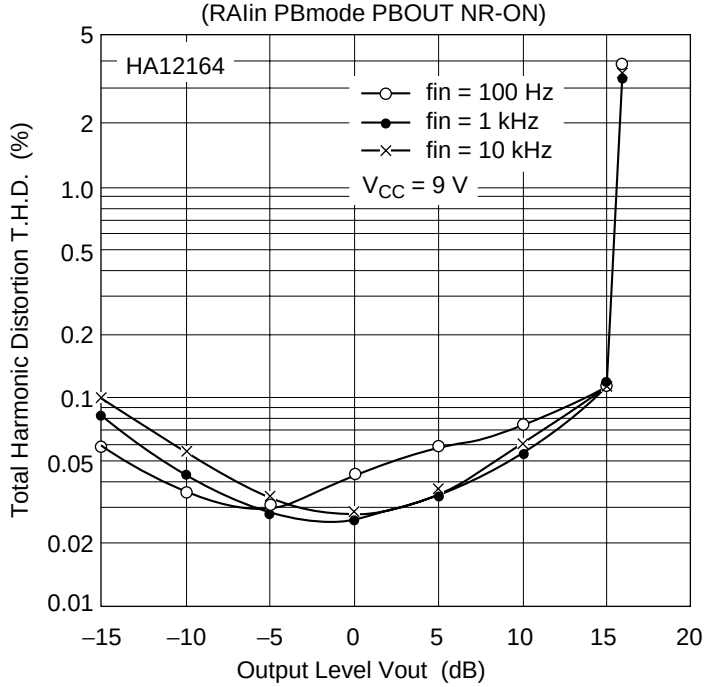
Total Harmonic Distortion vs. Output Level (1)
(RAIin RECmode RECOUT NR-ON)



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

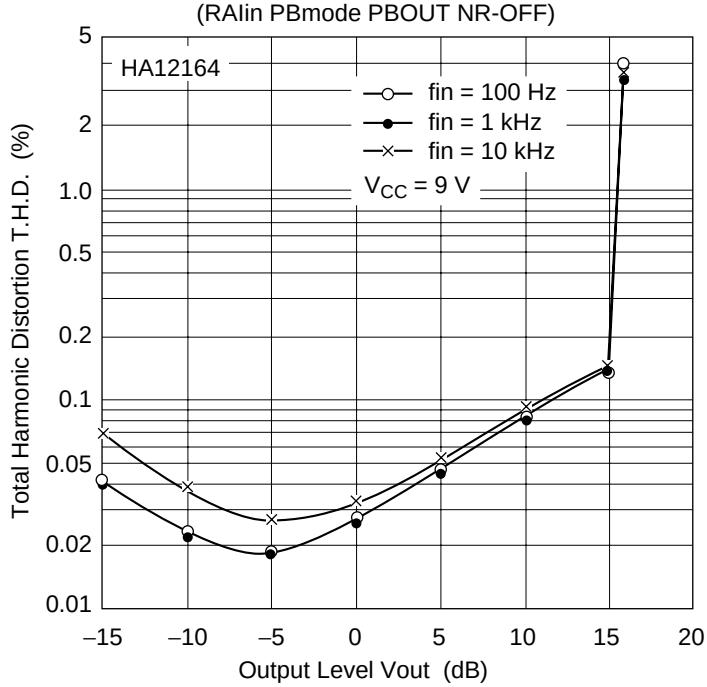


Total Harmonic Distortion vs. Output Level (3)
(RAIin PBmode PBOUT NR-ON)

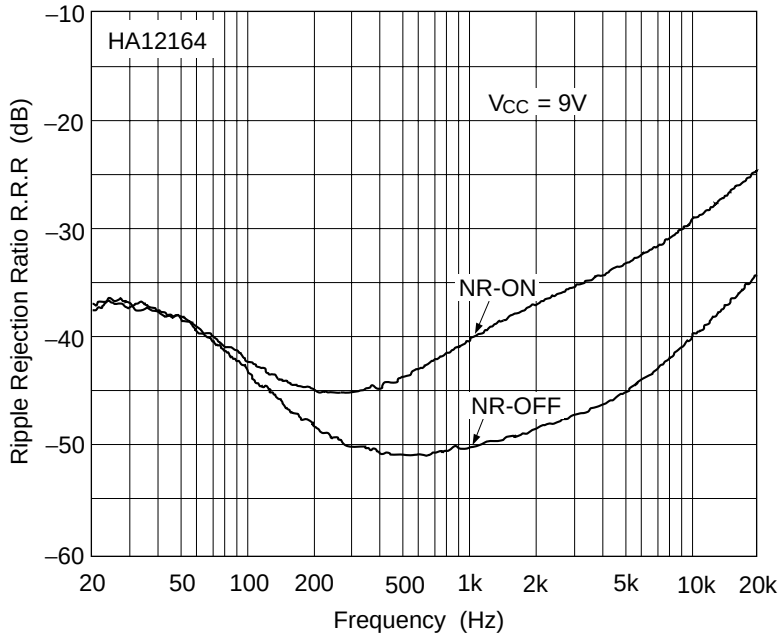


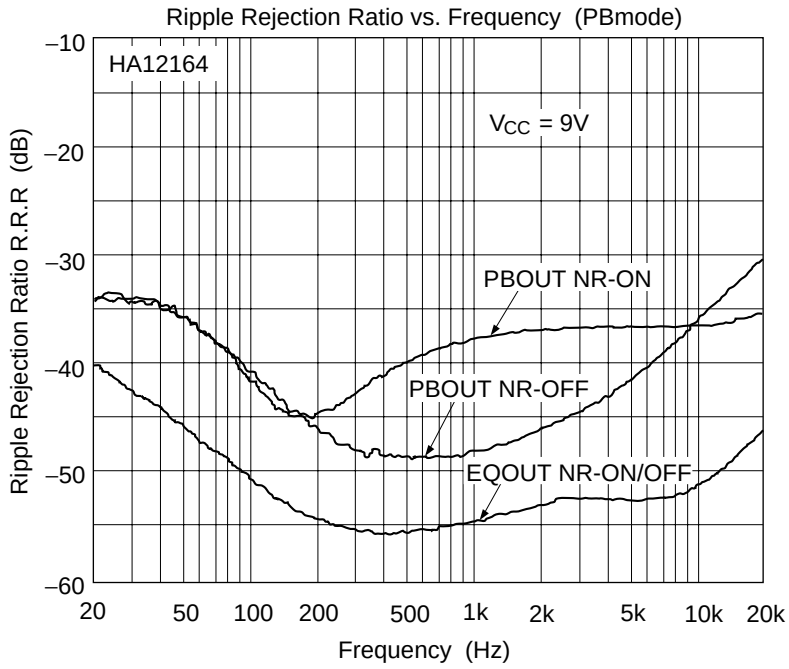
HITACHI

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

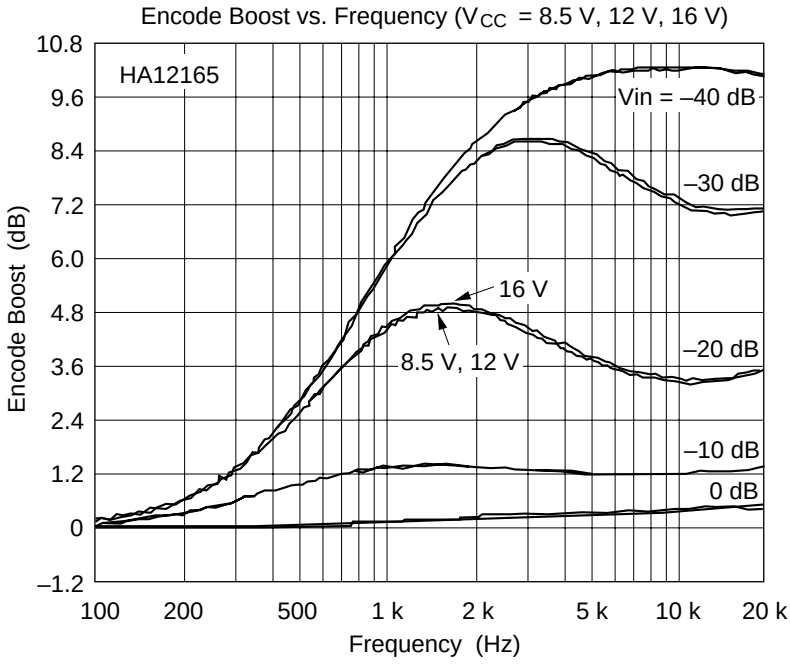


Ripple Rejection Ratio vs. Frequency (RECmode)

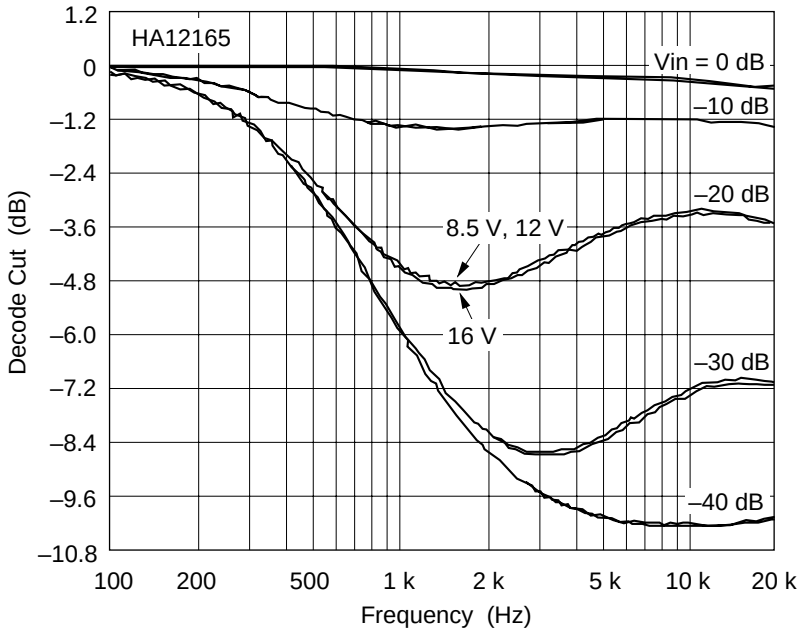




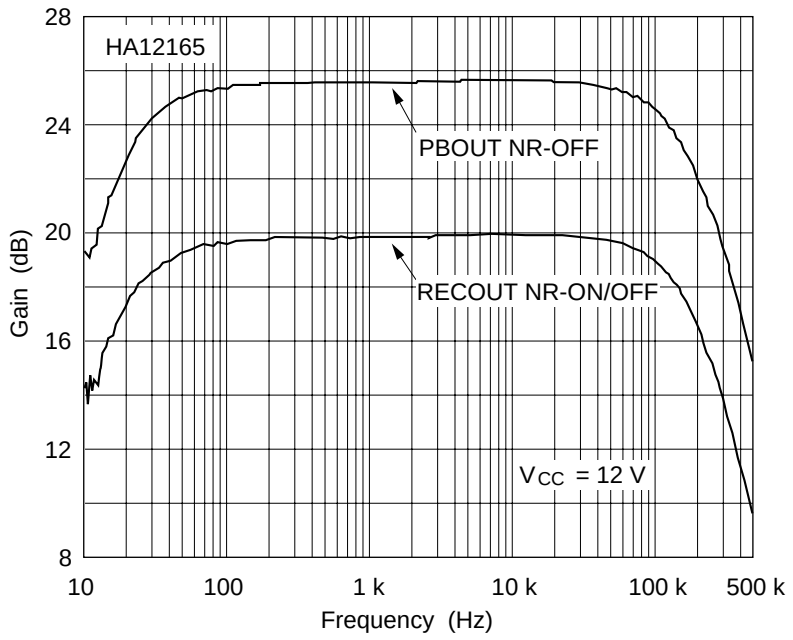
HA12165 Data



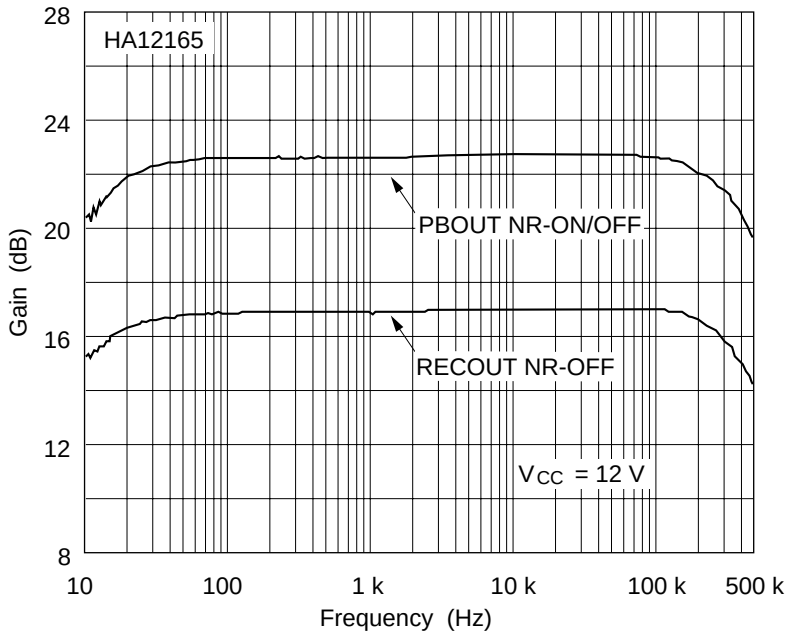
Decode Cut vs. Frequency (V_{CC} = 8.5 V, 12 V, 16 V)



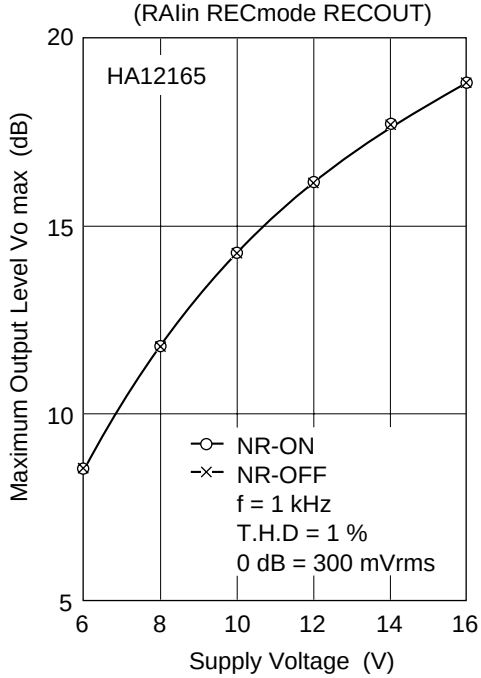
TAIin Input Amp. Gain vs. Frequency (PBmode)



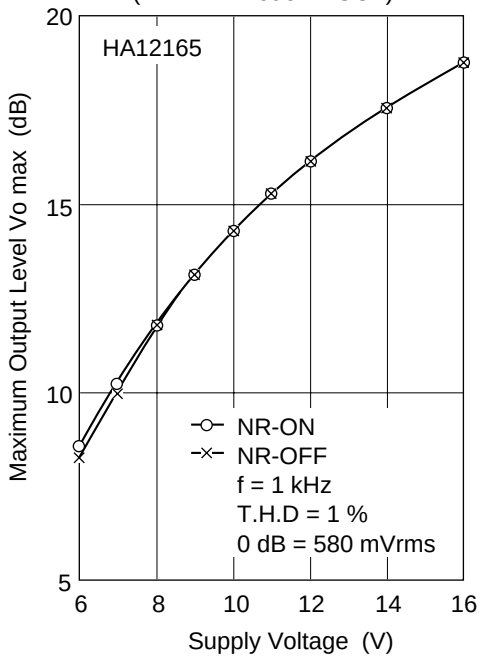
RAIin Input Amp. Gain vs. Frequency (RECmode)



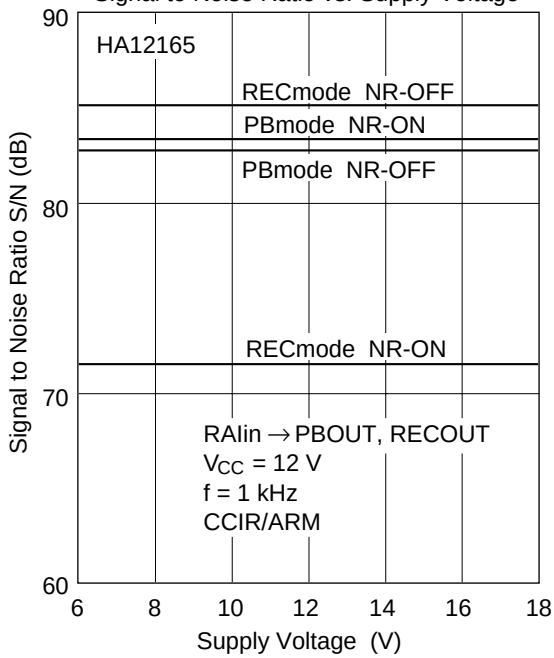
Maximum Output Level vs. Supply Voltage (1)
(RAIin RECmode RECOUT)



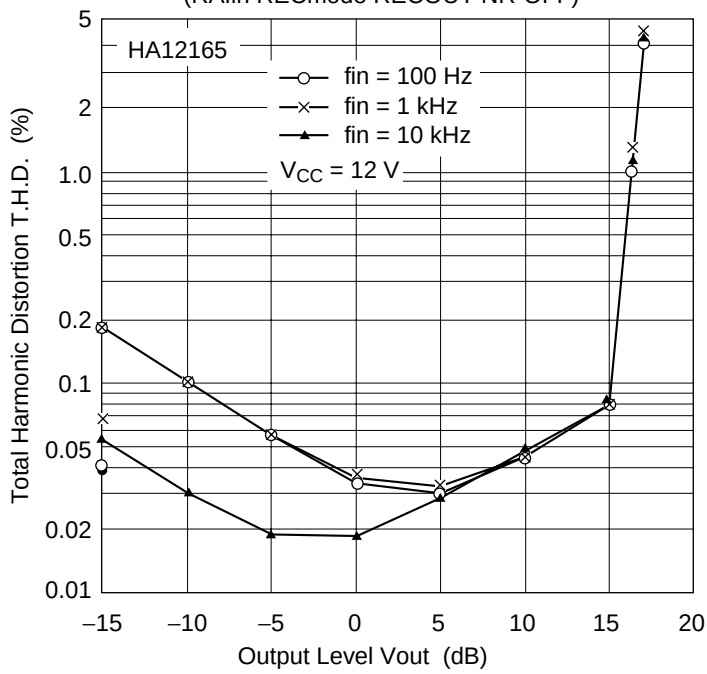
Maximum Output Level vs. Supply Voltage (2)
(RAIin PBmode PBOUT)



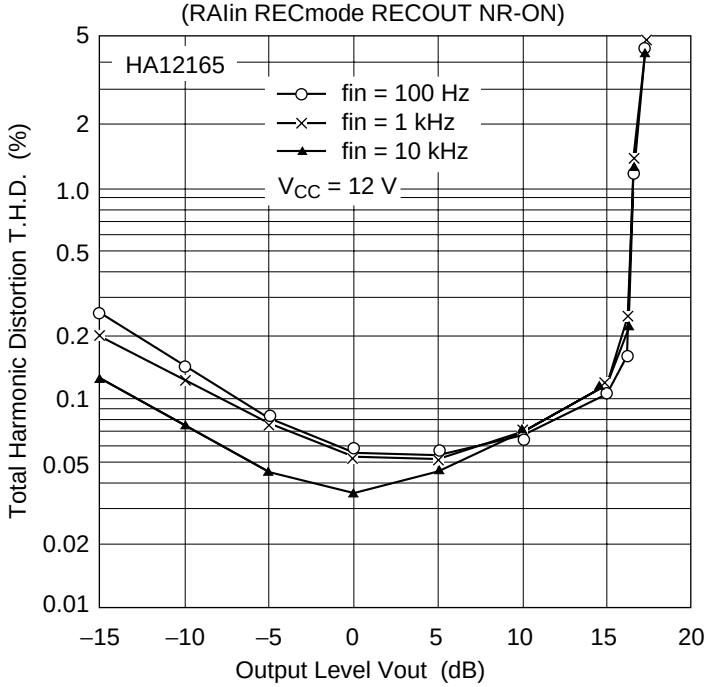
Signal to Noise Ratio vs. Supply Voltage



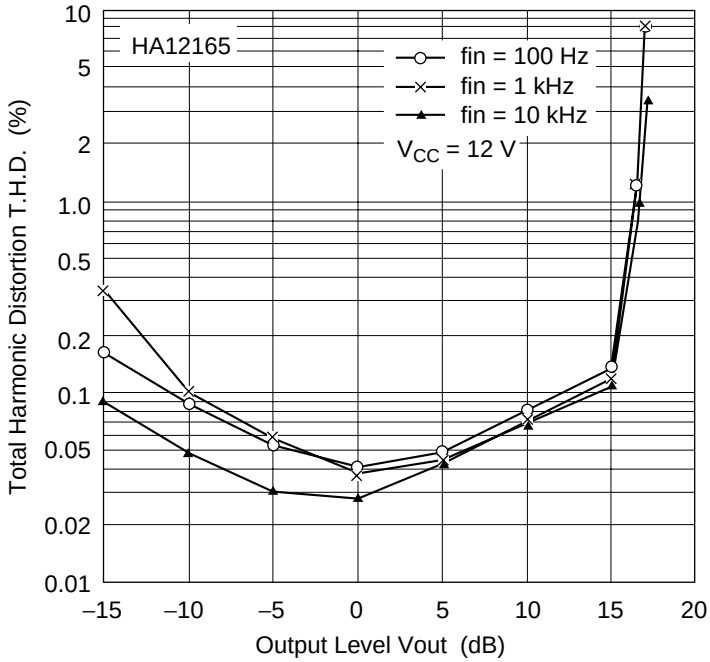
Total Harmonic Distortion vs. Output Level (1)
(RAIin RECmode RECOUT NR-OFF)



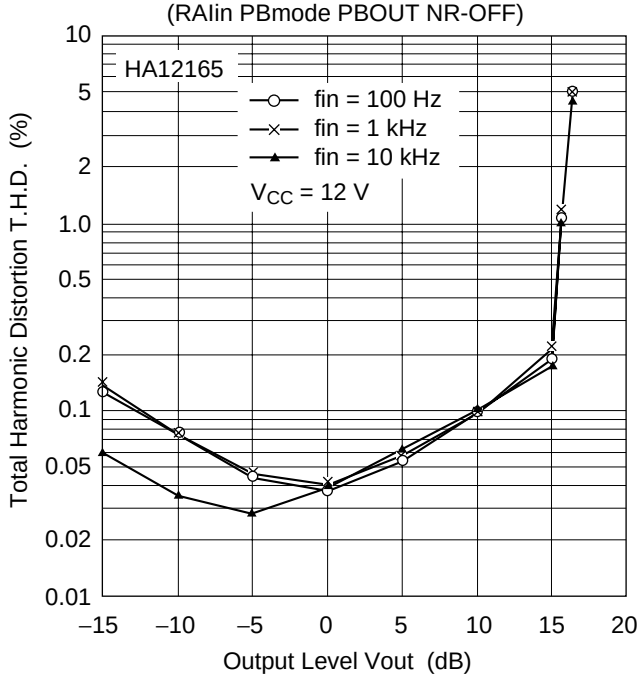
Total Harmonic Distortion vs. Output Level (2)
(RAIin RECmode RECOUT NR-ON)



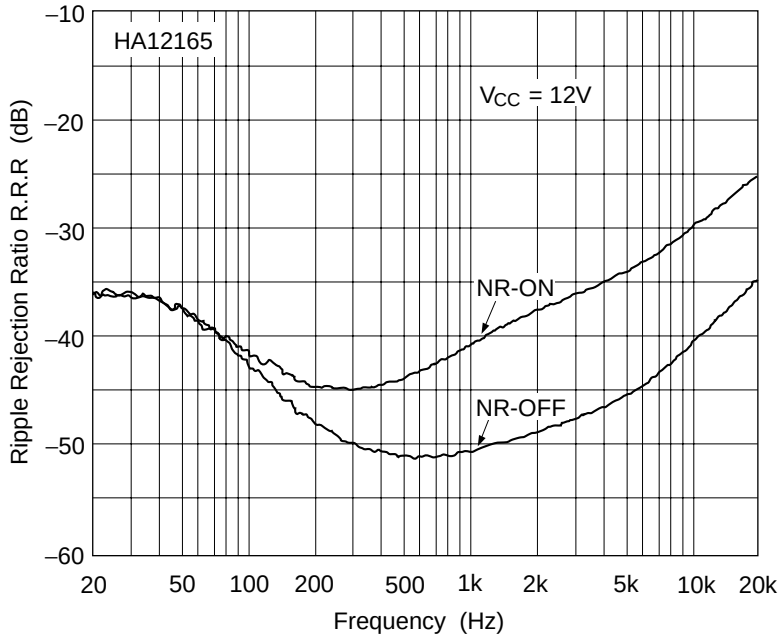
Total Harmonic Distortion vs. Output Level (3)
(RAIin PBmode PBOUT NR-ON)



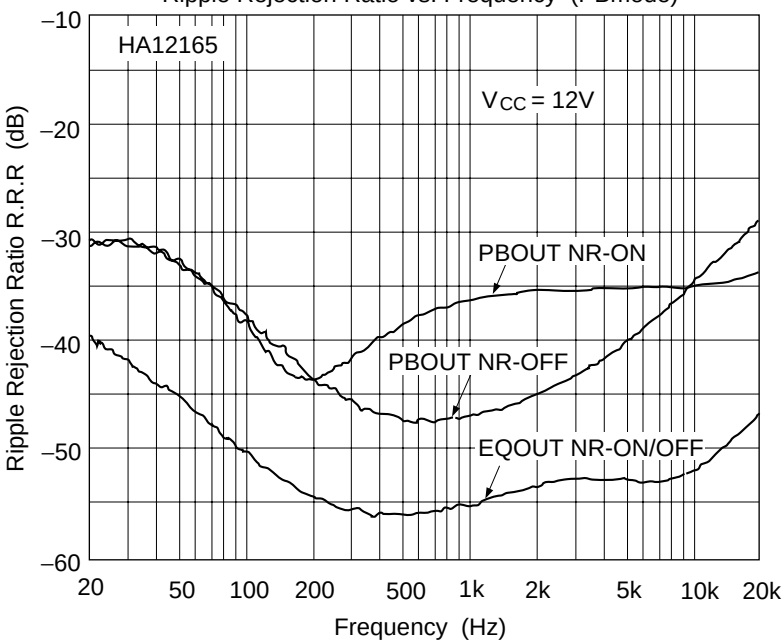
Total Harmonic Distortion vs. Output Level (4)
(RAIin PBmode PBOUT NR-OFF)



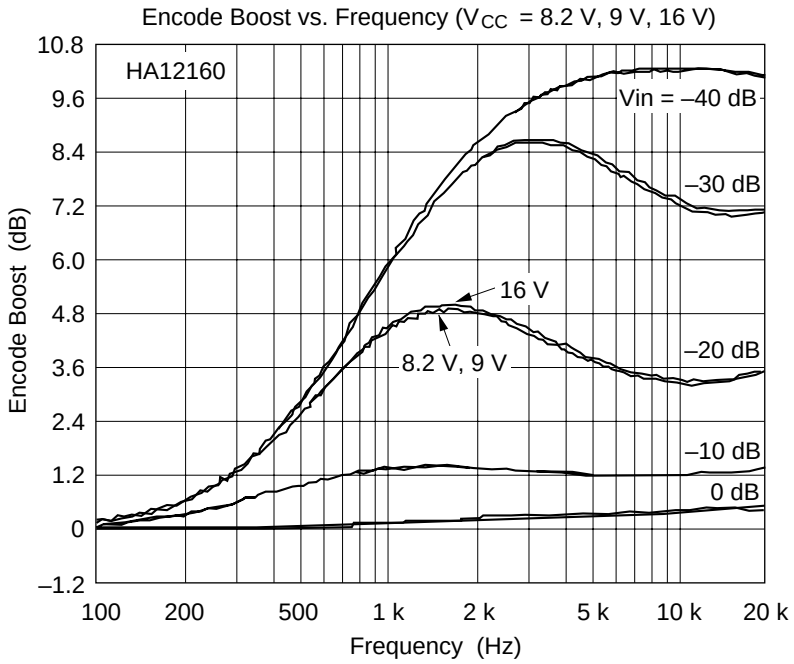
Ripple Rejection Ratio vs. Frequency (RECmode)

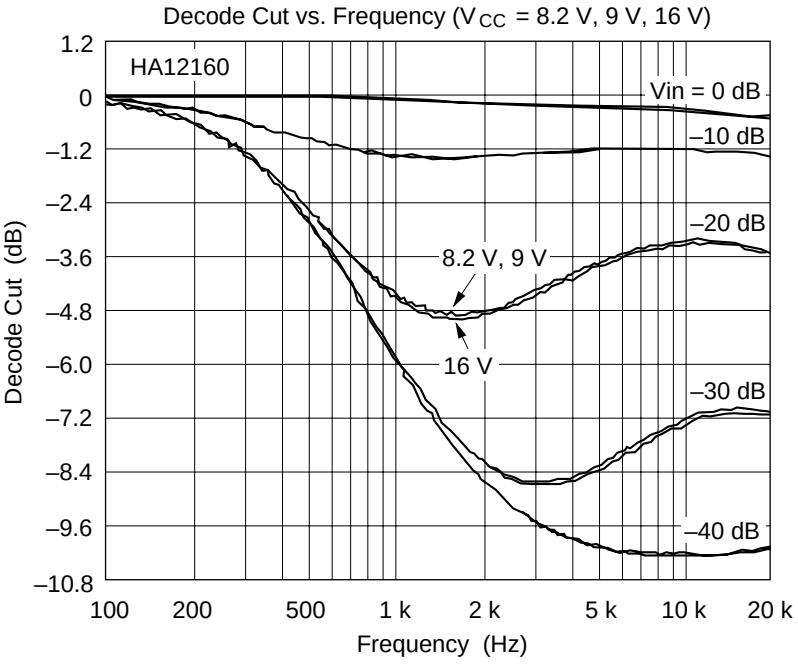


Ripple Rejection Ratio vs. Frequency (PBmode)

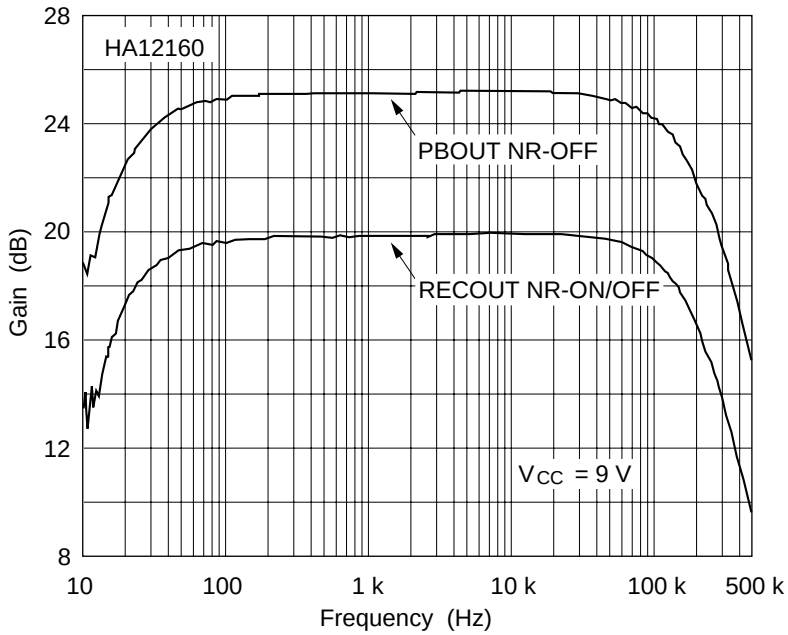


HA12160 Data

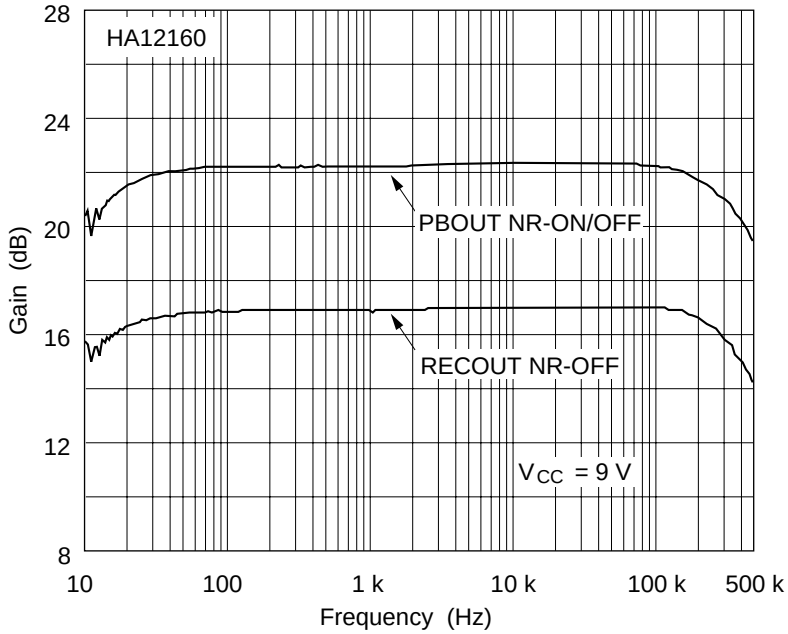




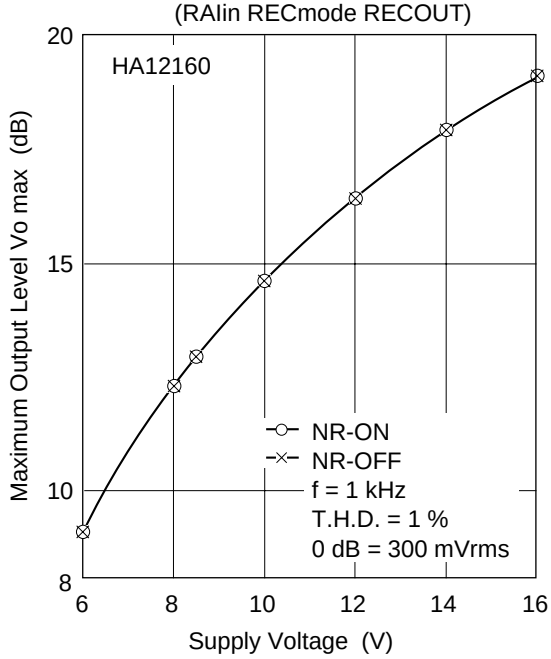
TAIin Input Amp. Gain vs. Frequency (PBmode)



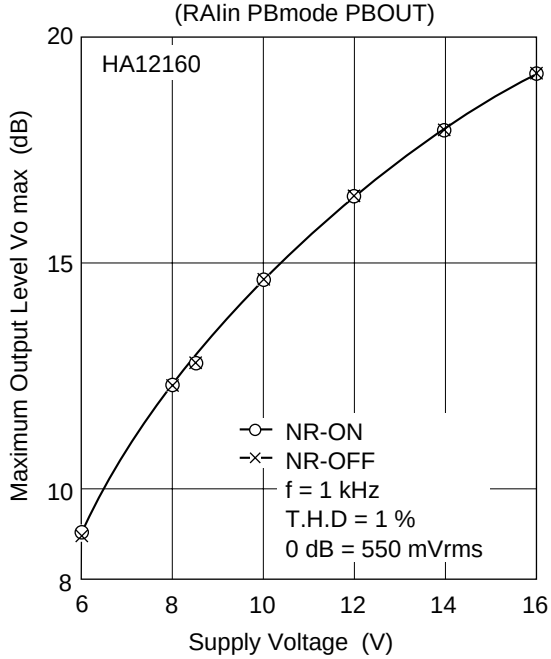
RAIin Input Amp. Gain vs. Frequency (RECmode)



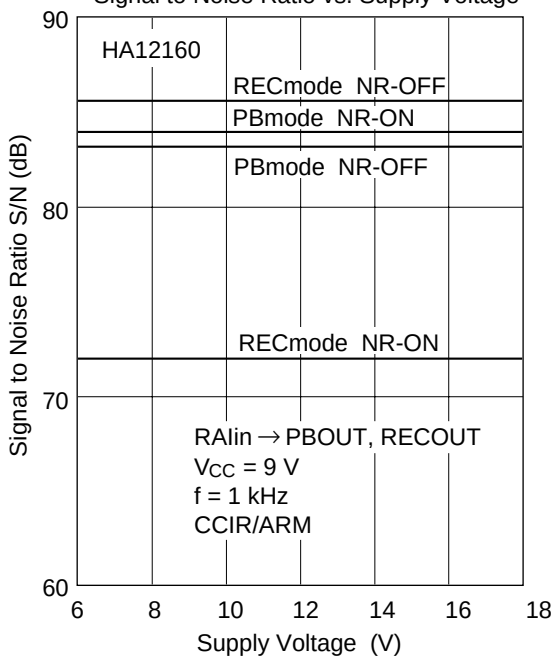
Maximum Output Level vs. Supply Voltage (1)
(RAIin RECmode RECOUT)



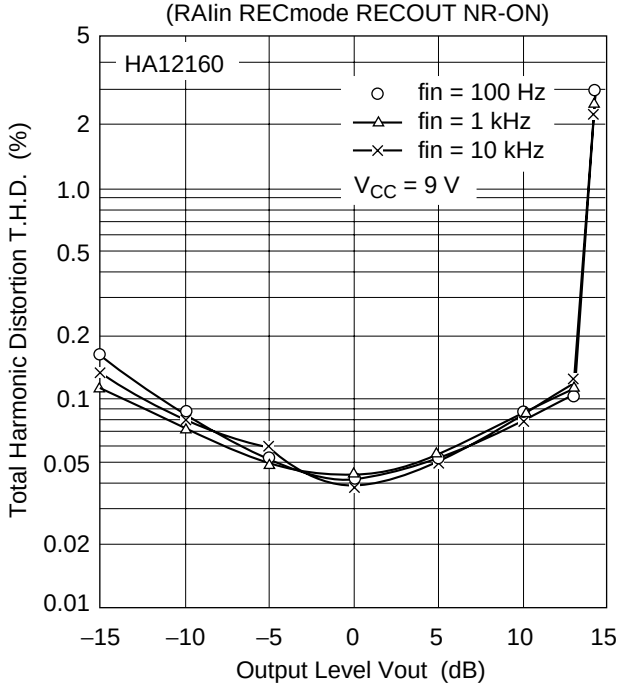
Maximum Output Level vs. Supply Voltage (2)
(RAIin PBmode PBOUT)



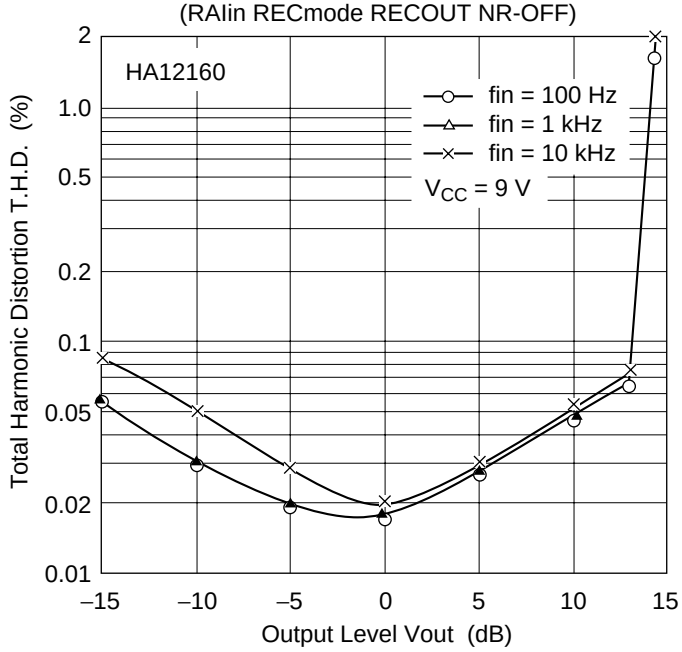
Signal to Noise Ratio vs. Supply Voltage



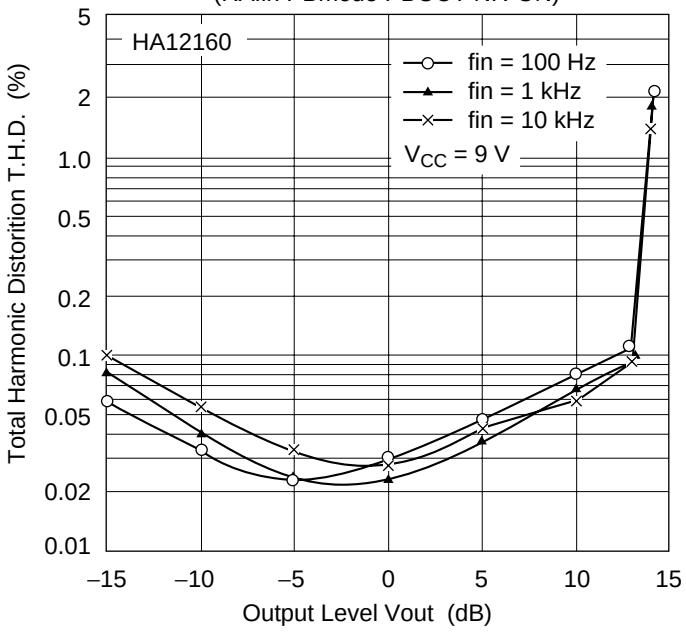
Total Harmonic Distortion vs. Output Level (1)
(RAIin RECmode RECOUT NR-ON)



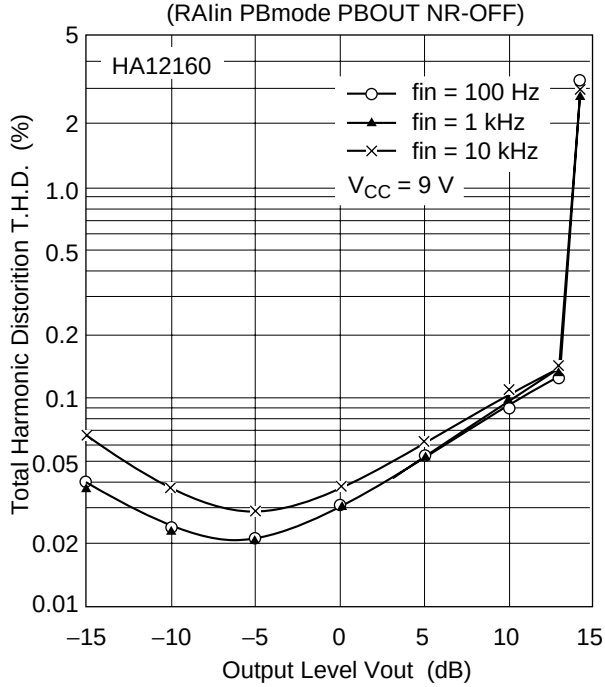
Total Harmonic Distortion vs. Output Level (2)
(RAIin RECmode RECOUT NR-OFF)



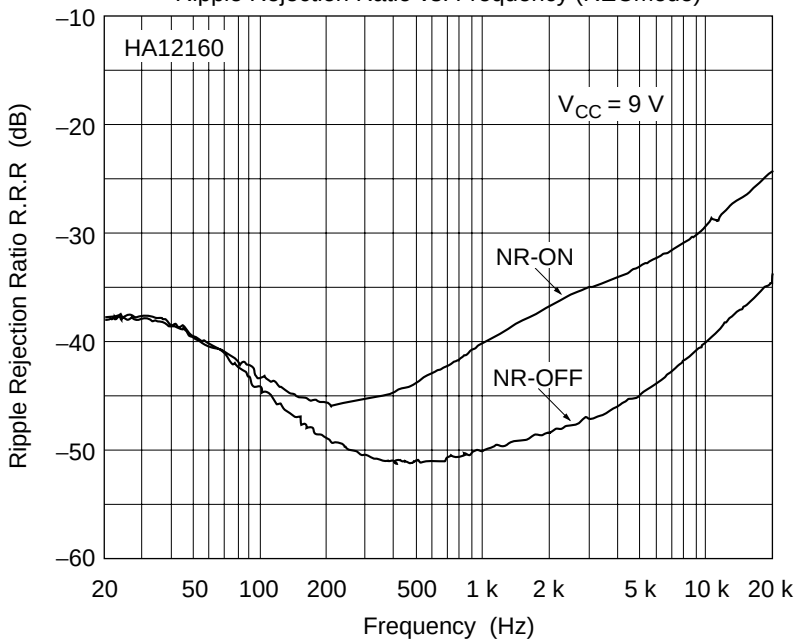
Total Harmonic Distortion vs. Output Level (3)
(RAIin PBmode PBOUT NR-ON)

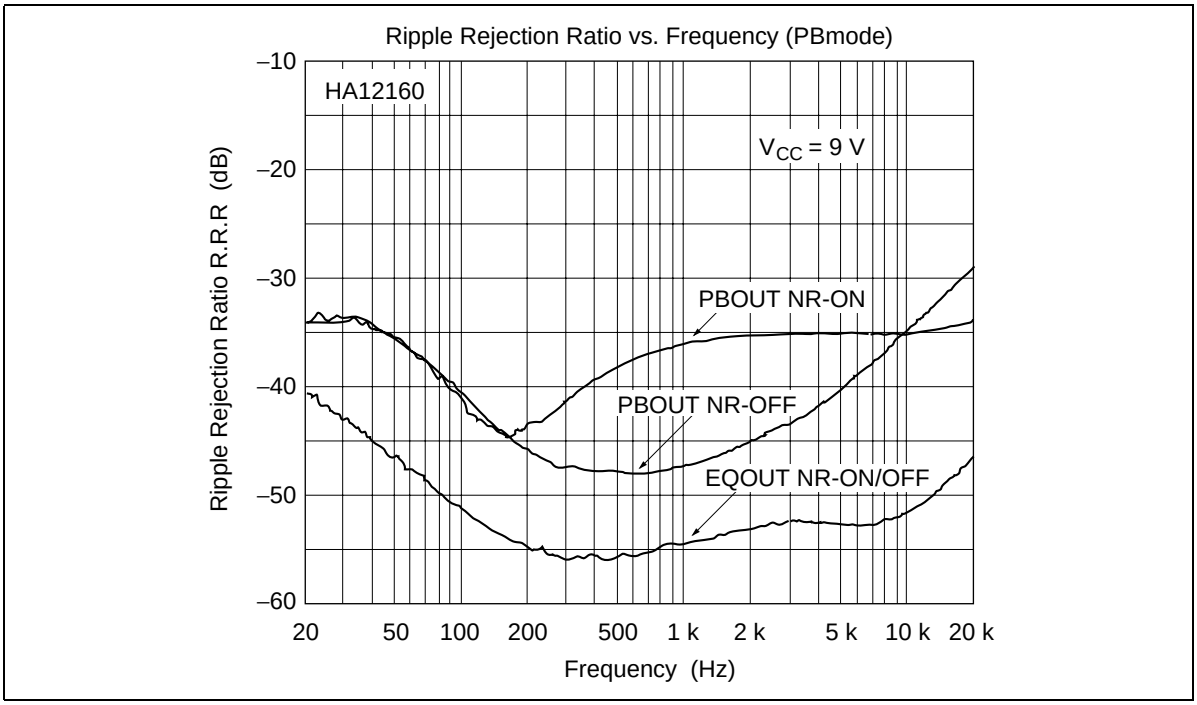


Total Harmonic Distortion vs. Output Level (4)
(RAIin PBmode PBOUT NR-OFF)



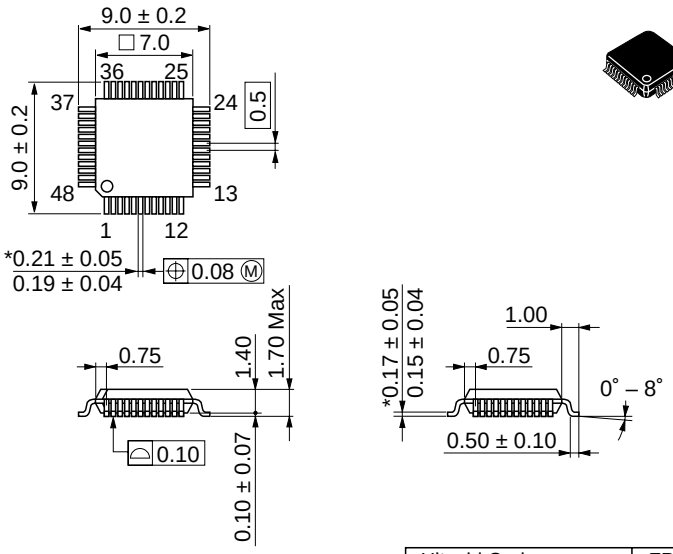
Ripple Rejection Ratio vs. Frequency (RECmode)




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

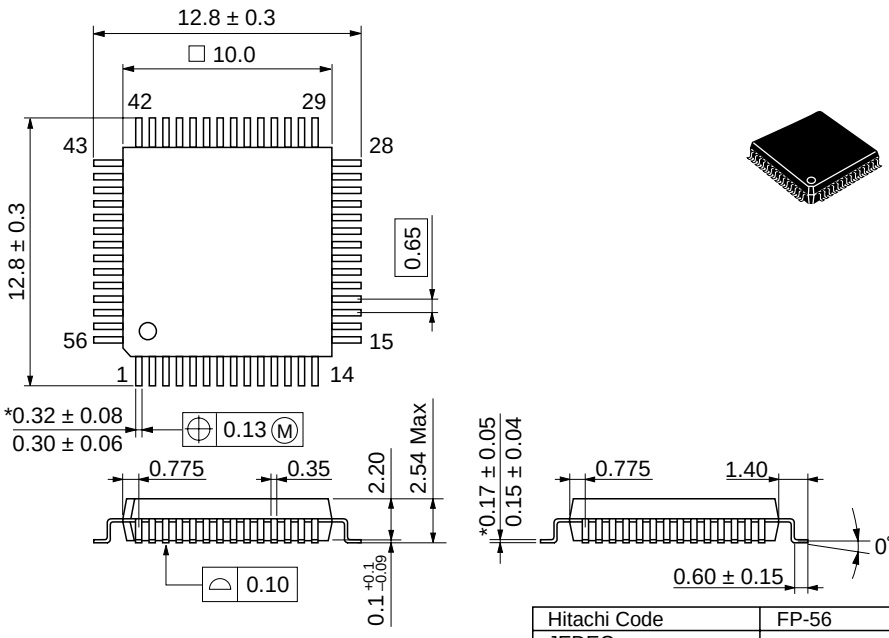
Unit: mm



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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