
HA12228F/HA12229F

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

HITACHI

ADE-207-325A
2nd Edition
Dec. 2000

Description

HA12228F/HA12229F are silicon monolithic bipolar IC providing Dolby noise reduction system*, music sensor, PB equalizer system in one chip.

Notes: 1. Dolby is a trademark of Dolby Laboratories Licensing Corporation.

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

2. HA12229F is not built-in Dolby B-NR.

Functions

- PB equalizer × 2 channel
- Music sensor × 1 channel
- Dolby B-NR (Only HA12228F) × 2 channel
- Line mute SW × 2 channel

Features

- Different type of PB equalizer characteristics selection ($120\ \mu\text{s}/70\ \mu\text{s}$) is available with fully electronic control switching built-in.
- Easy interface with the PB head. (The PB-EQ resistance self-containing)
- Changeable to Forward, Reverse-mode for PB head with fully electronic control switching built-in.
- Available to change music sensing level by external resistor.
- Available to change response of music sensor by external capacitor.
- Music sensing level, built-in switch to change a band (MSG_V).
- NR ON/OFF fully electronic control switching built-in. (Only HA12228F)
- Line mute control switching built-in.
- Available to connect direct with MPU.
- These ICs are strong for a cellular phone noise.

HA12228F/HA12229F

Ordering Information

Operating Voltage

Product	Min	Max	Unit
HA12228F	6.5	12	V
HA12229F			

Note: 1. These ICs are designed to operate on single supply.

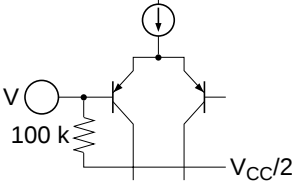
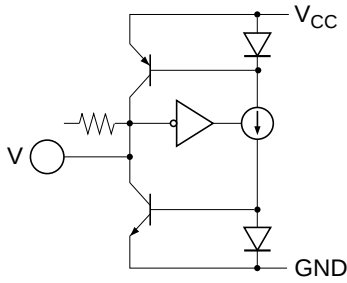
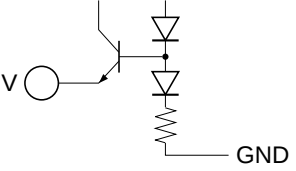
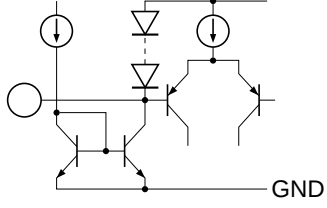
Standard Level

Product	Package	PB-OUT Level
HA12228F	FP-40B	300 mVrms
HA12229F		

Function

Product	PB-EQ	Music Sensor	Mute	Dolby B-NR
HA12228F	○	○	○	○
HA12229F	○	○	○	×

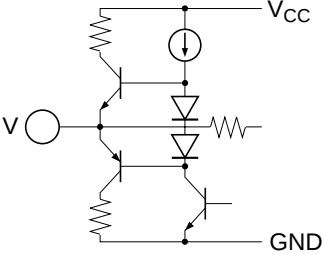
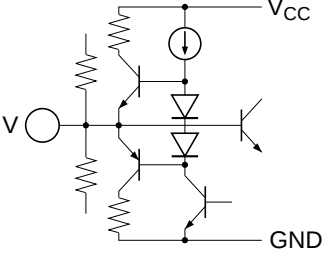
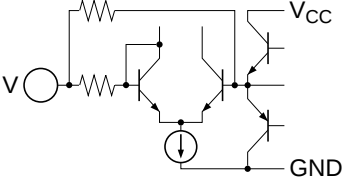
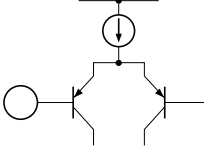
Pin Description, Equivalent Circuit ($V_{CC} = 9\text{ V}$ single supply, $T_a = 25^{\circ}\text{C}$, No Signal,
The value in the table shows typical value.)

Pin No.	Terminal Name	Note	Equivalent Circuit	Description
13	MSI	$V = V_{CC}/2$		MS input ^{*1}
4	TAI(L)			Tape input
27	TAI(R)			
23 ^{*2}	DET(R)	$V = 2.5\text{ V}$		Time constant pin for NR rectifier
8 ^{*2}	DET(L)			
26	RIP	$V = V_{CC}/2$		Ripple filter
5 ^{*3}	Bias	$V = 0.28\text{ V}$		Dolby bias current input
14	MSDET	—		Time constant pin for MS rectifier ^{*1}

Notes: 1. MS: Music Sensor
2. Non connection regarding HA12229F.
3. Test pin regarding HA12229F. Usually open or pull down to GND with 18 kΩ.

HA12228F/HA12229F

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

Pin No.	Terminal Name	Note	Equivalent Circuit	Description
25	PBOUT(R)	$V = V_{CC}/2$		PB output
6	PBOUT(L)			
12	MAOUT			MS amp. output *1
29	EQOUT(R)	$V = V_{CC}/2$		Equalizer output
2	EQOUT(L)			
30	M-OUT(R)	$V = V_{CC}/2$		Equalizer output for time constant
1	M-OUT(L)			
37	FIN(R)	—		Equalizer input (FORWARD)
39	FIN(L)			
35	RIN(R)	—		Equalizer input (REVERSE)
33	RIN(L)			

Note: 1. MS: Music Sensor

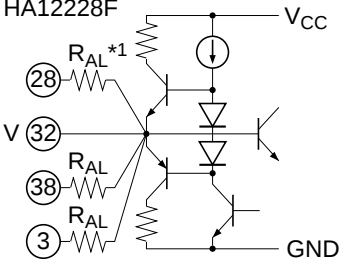
Pin Description, Equivalent Circuit ($V_{CC} = 9\text{ V}$ single supply, $T_a = 25^{\circ}\text{C}$, No Signal,
The value in the table shows typical value.) (cont.)

Pin No.	Terminal Name	Note	Equivalent Circuit	Description
20	MUTE ON/OFF	—		Mode control input
21 * ¹	NR ON/OFF			
19	120/70			
17	F/R			
18	S/R(MS G _v)			
16	MSOUT	—		MS output (to MPU) * ²
10	MS Gv(S)	$V = V_{CC}/2$		MS gain terminal * ²
11	MS Gv(R)			
31	NFI(R)	$V = V_{CC}/2$		Equalizer output for time constant
40	NFI(L)			

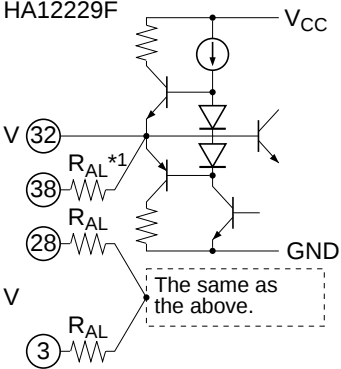
Notes: 1. Non connection regarding HA12229F.
2. MS: Music Sensor

HA12228F/HA12229F

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

Pin No.	Terminal Name	Note	Equivalent Circuit	Description
32	VREF1	$V = V_{CC}/2$	HA12228F 	Reference output
38	VREF2			
28	VREF3			
3	VREF4			

HA12229F

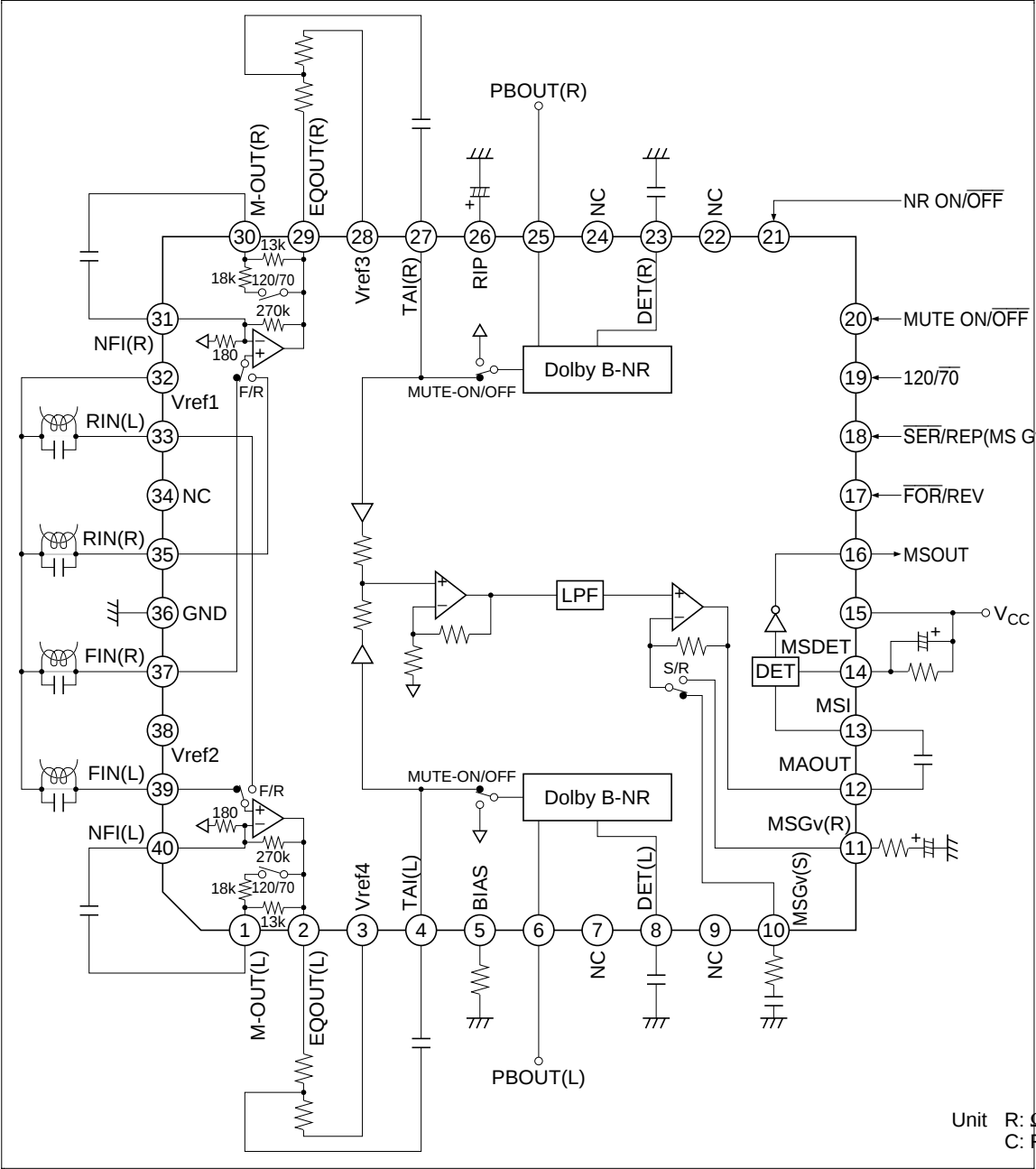


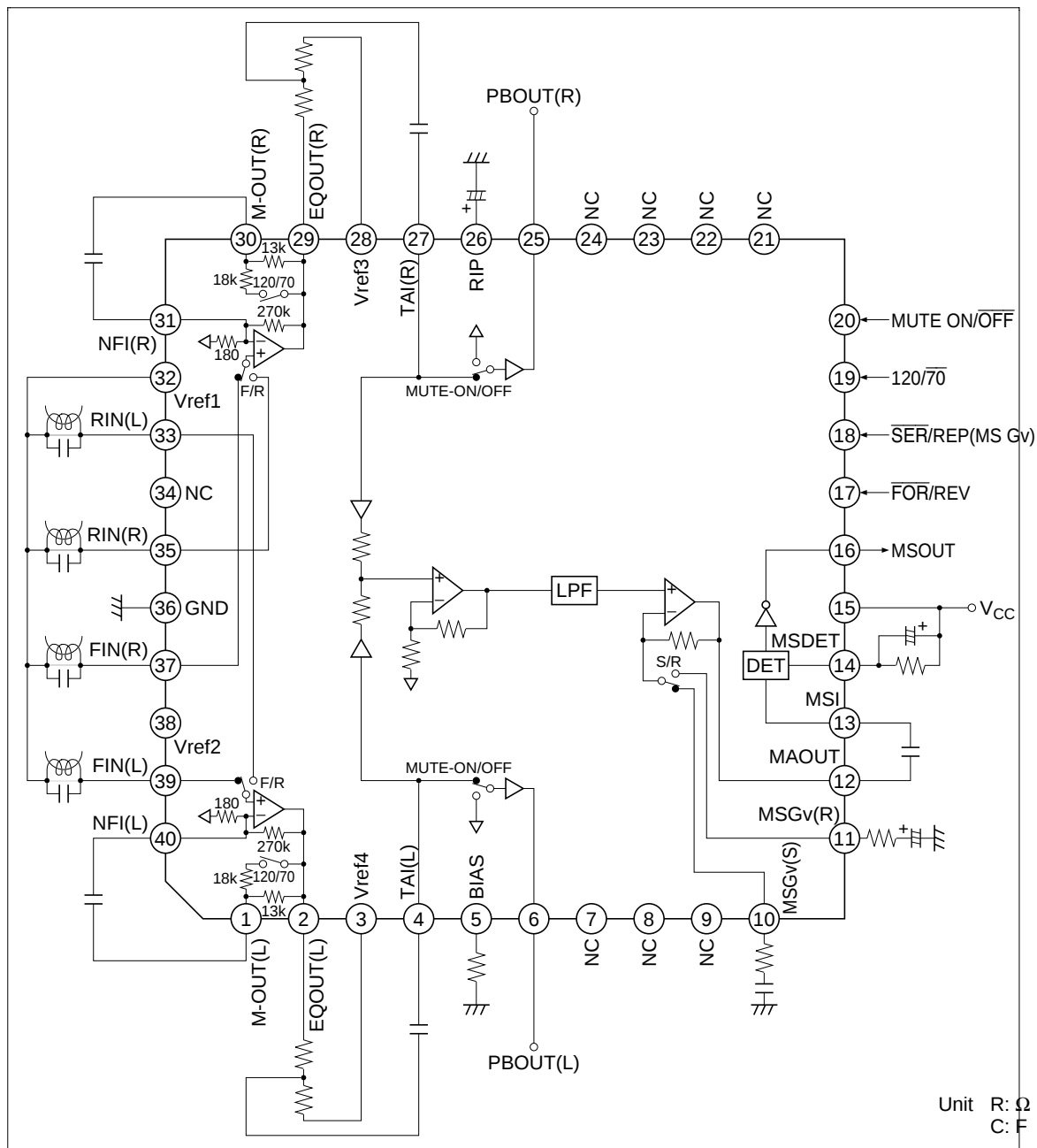
15	V_{CC}	—	V_{CC} pin
36	GND	—	GND pin
7	NC	—	
9			
22			
24			
34			

Note: 1. R_{AL} : Parasitic metal resistance

Block Diagram

HA12228F



HA12229F

Functional Description

Power Supply Range

HA12228F/HA12229F are provided with three line output level, which will permit on optimum overload margin for power supply conditions. And these are designed to operate on single supply only.

Table 1 Supply Voltage Range

Product	Single Supply
HA12228F	6.5 V to 12.0 V
HA12229F	

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

Reference Voltage

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

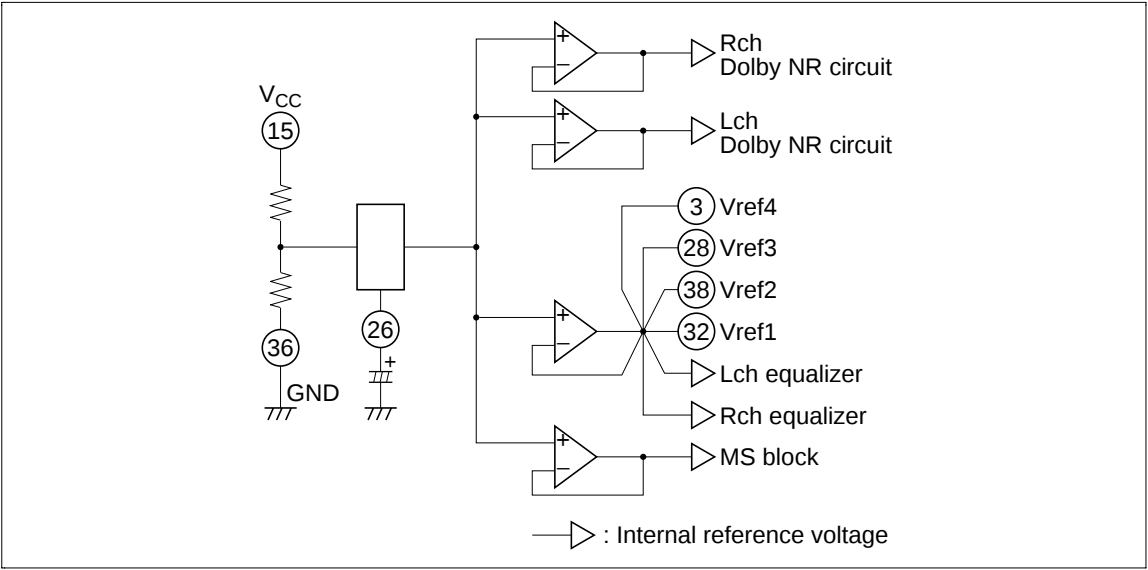


Figure 1a The HA12228F Block Diagram of Reference Supply Voltage

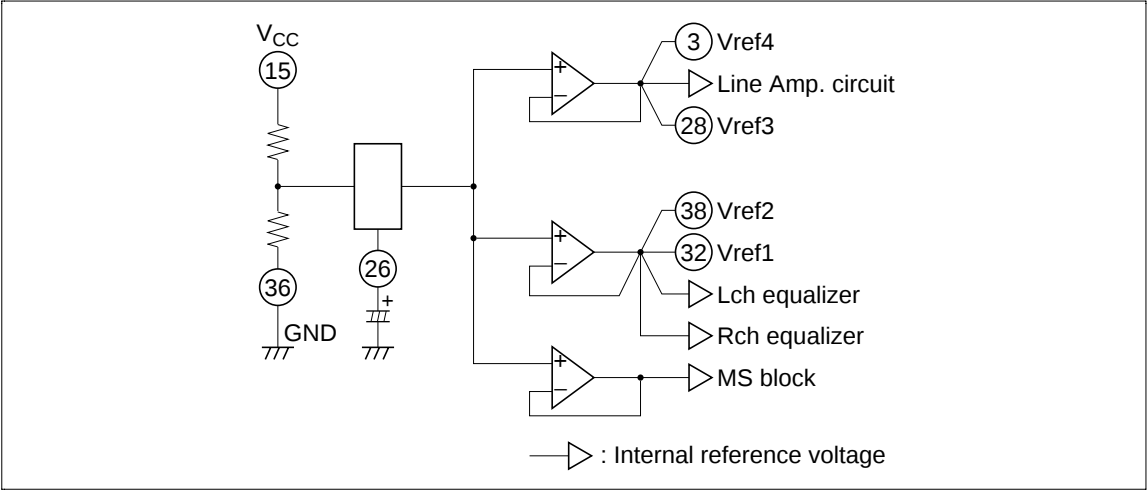


Figure 1b The HA12229F Block Diagram of Reference Supply Voltage

Operating Mode Control

HA12228F/HA12229F provides fully electronic switching circuits. And each operating mode control are controlled by parallel data (DC voltage).

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

Table 2 Threshold Voltage (V_{TH})

Pin No.	Lo	Hi	Unit	Test Condition	
17, 18, 19, 20, 21*	-0.2 to 1.0	3.5 to V _{CC}	V	Input Pin	Measure

Note: * Non connection regarding HA12229F.

Table 3 Switching Truth Table

Pin No.	Pin Name	Lo	Hi
17	Forward/Reverse	Forward	Reverse
18	Search/Repeat	Search (FF or REV)	Repeat (Normal speed)
19	120 μ/70 μ	70 μ (Metal or Chrome)	120 μ (Normal)
20	MUTE ON/OFF	MUTE-OFF	MUTE-ON
21*	NR ON/OFF	NR-OFF	NR-ON

- Notes: * Non connection regarding HA12229F.
1. Each pins are on pulled down with 100 kΩ internal resistor.
Therefore, it will be low-level when each pins are open.
 2. Over shoot level and under shoot level of input signal must be the standardized.
(High: V_{CC}, Low: −0.2 V)
 3. Reducing pop noise is so much better for 10 kΩ to 22 kΩ resisitor and 1 μF to 22 μF capacitor shown figure 2.

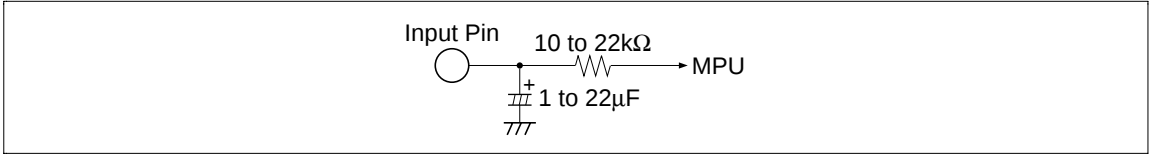


Figure 2 Interface for Reduction of Pop Noise

Input Block Diagram and Level Diagram

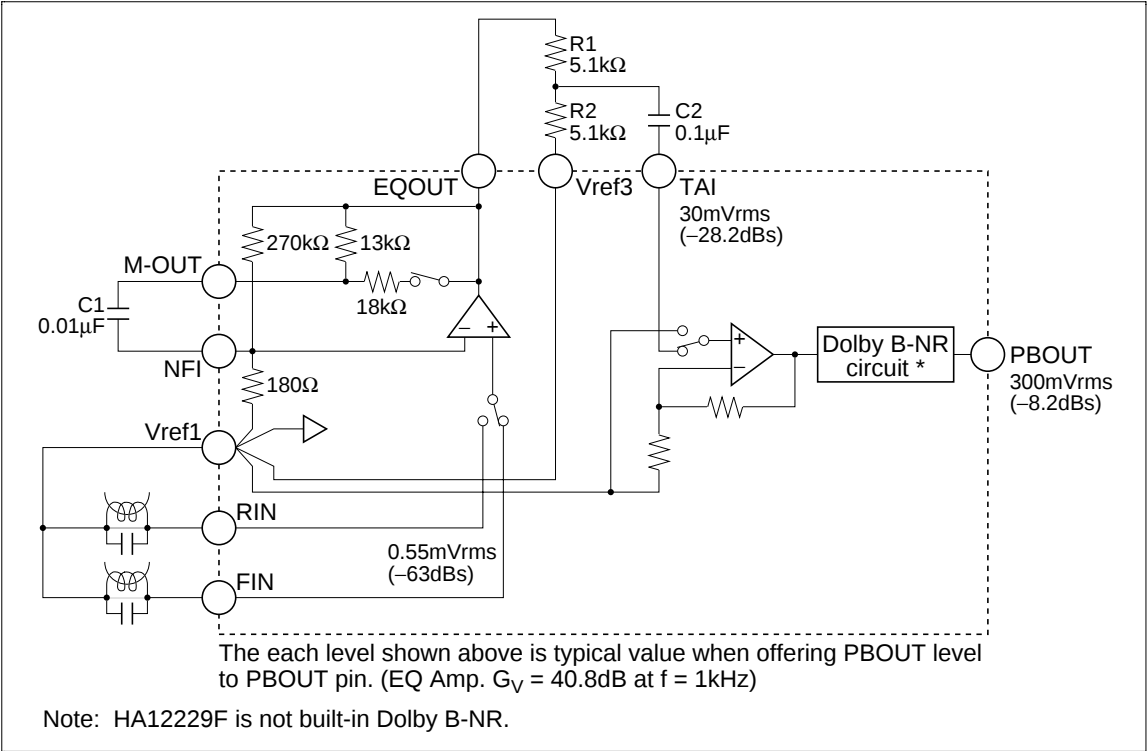


Figure 3 Input Block Diagram

Adjustment of Playback Dolby Level

After replace R5 and R6 with a half-fix volume of 10 kΩ, adjust playback Dolby level.

The Sensitivity Adjustment of Music Sensor

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

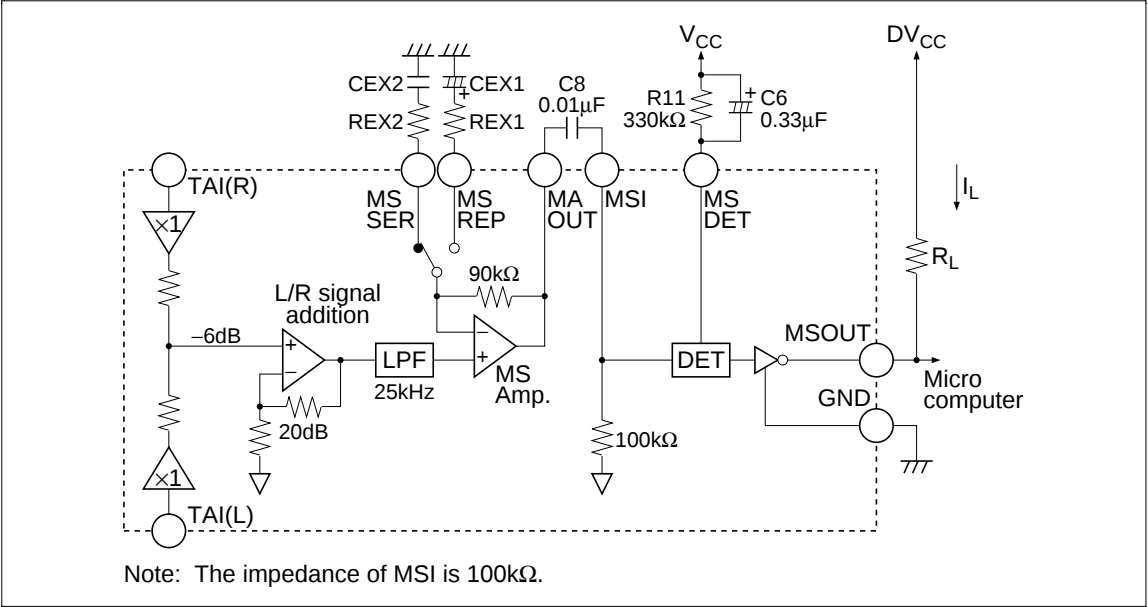


Figure 4 Music Sensor Block Diagram

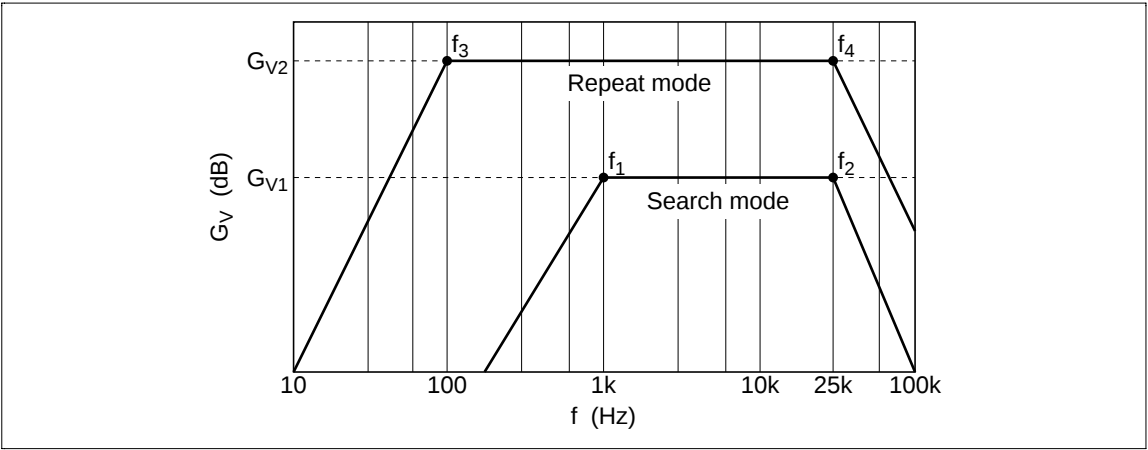


Figure 5 Frequency Response

1. Search mode

$$G_{V1} = 20\text{dB} + 20 \log \left(1 + \frac{90\text{k}}{\text{REX2}} \right) \quad [\text{dB}]$$
$$f_1 = \frac{1}{2\pi \cdot \text{CEX2} \cdot \text{REX2}} \quad [\text{Hz}], \quad f_2 = 25\text{k} \quad [\text{Hz}]$$

2. Repeat mode

$$G_{V2} = 20\text{dB} + 20 \log \left(1 + \frac{90\text{k}}{\text{REX1}} \right) \quad [\text{dB}]$$
$$f_3 = \frac{1}{2\pi \cdot \text{CEX1} \cdot \text{REX1}} \quad [\text{Hz}], \quad f_4 = 25\text{k} \quad [\text{Hz}]$$

G_VIA: L·R signal addition circuit gain.

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

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

- Note:
1. Search mode: G_{V1},

Repeat mode: G_{V2}

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

3. Standard sensing level of music sensor = 130 mVrms

Item	REX1, 2	CEX1, 2	G _{V1, 2}	f _{1, 3}	f _{2, 4}	S (one side channel)	S (both channel)
Search mode	24 kΩ	0.01 μF	33.5 dB	663 Hz	25 kHz	−14.8 dB	−20.8 dB
Repeat mode	2.4 kΩ	1 μF	51.7 dB	66.3 Hz	25 kHz	−33.0 dB	−39.0 dB

Note: S is 6 dB down in case of one-side channel. And this MSpresented hysteresis lestMSOUTterminal should turn over again High level or Low level, in case of thresh S level constantly.

Music Sensor Time Constant

1. Sensing no signal to signal (Attack) is determined by C6, 0.01 μF to 1 μF capacitor C6 can be applicable.

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

Music Sensor Output (MSOUT)

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

$$I_L = \frac{DV_{CC} - \text{MSOUT}_{LO}^*}{R_L}$$

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

Note:

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

The Tolerances of External Components for Dolby NR (Only HA12228F)

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

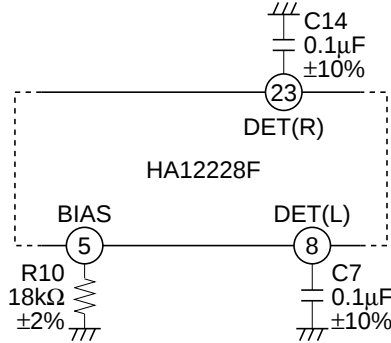


Figure 6 Tolerance of External Components

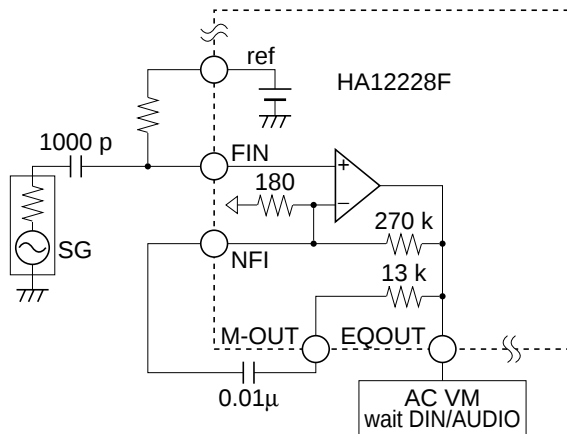
Countermeasure of a Cellular Phone Noise

This IC have reinforced a cellular phone noise countermeasure, to show it hereinafter.

However, it is presumed that this effect change it greatly, by a mount set.

Please sufficiently examine an arrangement of positions, shield method, wiring pattern, in order to obtain a maximum effect.

A high terminal of a noise sensitivity of this IC is FIN, RIN, NFI and RIP.



Note: Test condition

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

Figure 7 Test Circuit

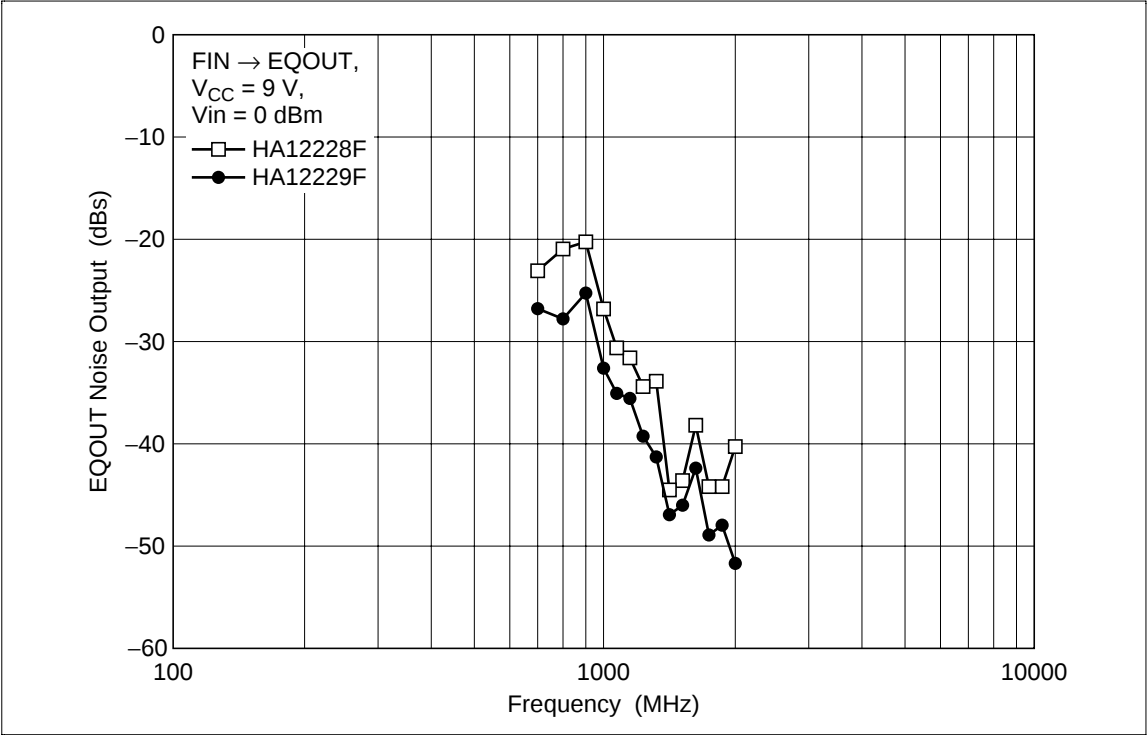


Figure 8 EQOUT Noise Output vs. Transmission Frequency Characteristic

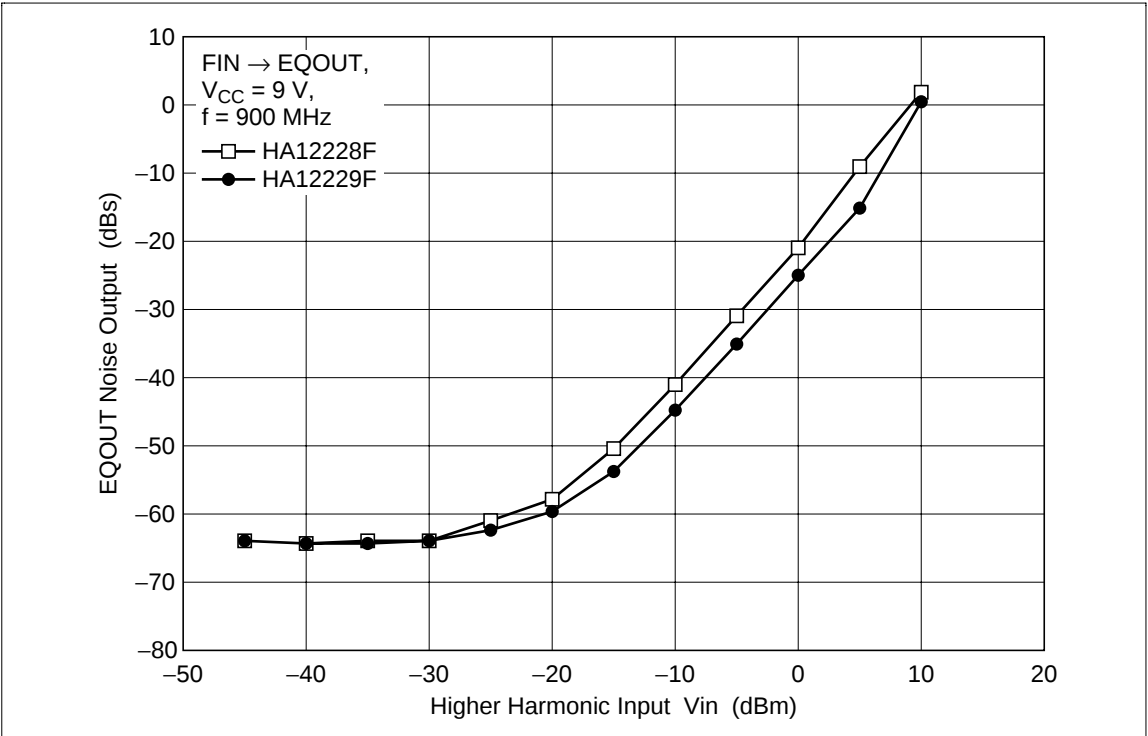


Figure 9 EQOUT Noise Output vs. Transmission Signal Input Level Characteristic

Absolute Maximum Ratings (Ta = 25°C)

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

Electrical Characteristics

HA12228F

(Ta = 25°C, VCC = 9 V, Dolby level 0 dB = PBOUT level 0 dB = PBOUT level 0 dB = 300 mVrms, EQOUT level 0 dB = 60 mVrms)

Item	Symbol	Test Condition										Specification		Application Terminal			
		IC Condition					Test Condition					Specification		Input		Output	
		NR ON/OFF	MUTE 120μ/70μ	SER/REP	FOR/REV	fin (Hz)	PBOUT level (dB)	EQOUT level (dB)	Other	Min	Type	Max	Unit	R	L	R	L
Quiescent current	I _Q	OFF	OFF	SER	FOR	1k	0	—	No signal	4.0	9.5	15.0	mA	—	—	—	15
Input Amp. gain	G _V /A	OFF	OFF	—	—	1k	0	—	—	19.0	20.0	21.0	dB	27	4	25	6
B-type decode cut	DEC 2k (1)	ON	OFF	—	—	2k	-20	—	—	-5.8	-4.3	-2.8	dB	27	4	25	6
	DEC 2k (2)	ON	OFF	—	—	2k	-30	—	—	-10.0	-8.5	-7.0	dB	27	4	25	6
	DEC 5k (1)	ON	OFF	—	—	5k	-20	—	—	-4.7	-3.2	-1.7	dB	27	4	25	6
	DEC 5k (2)	ON	OFF	—	—	5k	-30	—	—	-9.7	-8.2	-6.7	dB	27	4	25	6
PBOUT offset	V _{ofs}	OFF	OFF→ON	—	—	—	—	—	No signal	-150	0	150	mV	—	—	25	6
Signal handling	V _o max	ON	OFF	—	—	1k	—	—	THD=1%	12.0	13.0	—	dB	27	4	25	6
Signal to noise ratio	S/N	ON	OFF	—	—	1k	(0)	—	R _g =10kΩ, CCIR/ARM	70.0	80.0	—	dB	27	4	25	6
Total Harmonic Distortion	THD	ON	OFF	—	—	1k	0	—	—	—	0.05	0.3	%	27	4	25	6
Channel separation	CTRL (1)	—	—	—	FOR	1k	—	(+20)	—	50.0	60.0	—	dB	37	39	29→2	2→29
	CTRL (2)	OFF	OFF	—	—	1k	(+12)	—	—	70.0	80.0	—	dB	27	4	25→6	6→25
MUTE attenuation	CT MUTE	OFF	OFF→ON	—	—	1k	(+12)	—	—	70.0	80.0	—	dB	27	4	25	6
PB-EQ gain	G _V EQ 1k	—	—	120μ	—	FOR/REV	1k	—	0	37.8	40.8	43.8	dB	37/35	39/33	29	2
	G _V EQ 10k(1)	—	—	120μ	—	FOR	10k	—	0	33.9	36.9	39.9	dB	37	39	29	2
	G _V EQ 10k(2)	—	—	70μ	—	FOR	10k	—	0	29.6	32.6	35.6	dB	37	39	29	2
PB-EQ Maximum output level	V _{OM}	—	—	120μ	—	FOR	1k	—	THD=1%	300	600	—	mVrms	37	39	29	2
PB-EQ T.H.D.	THD-EQ	—	—	120μ	—	FOR/REV	1k	—	+14dB	—	0.1	0.3	%	37/35	39/33	29	2
PB-EQ input conversion noise	V _N	—	—	120μ	—	FOR/REV	(1k)	—	R _g =680Ω, DIN-AUDIO	—	0.7	1.5	μVrms	37/35	39/33	29	2
MS sensing level	V _{ON} (1)	OFF	OFF	SER	—	5k	—	—	—	-36.0	-32.0	-28.0	dB	27	4	25	6
	V _{ON} (2)	OFF	OFF	REP	—	5k	—	—	—	-18.0	-14.0	-10.0	dB	27	4	25	6
MS output low level	V _{OL}	OFF	OFF	SER	—	5k	0	—	—	—	1.0	1.5	V	27	4	—	—
MS output leakage current	I _{OH}	—	—	—	—	—	—	—	No signal	—	0.0	2.0	μA	—	—	—	—
Control voltage	V _{IL}	—	—	—	—	—	—	—	—	-0.2	—	1.0	V	—	—	—	17 to 21
	V _{IH}	—	—	—	—	—	—	—	—	3.5	—	V _{CC}	V	—	—	—	—

Notes: 1. VCC = 12V
2. VCC = 6.5V
3. For inputting signal to one side channel

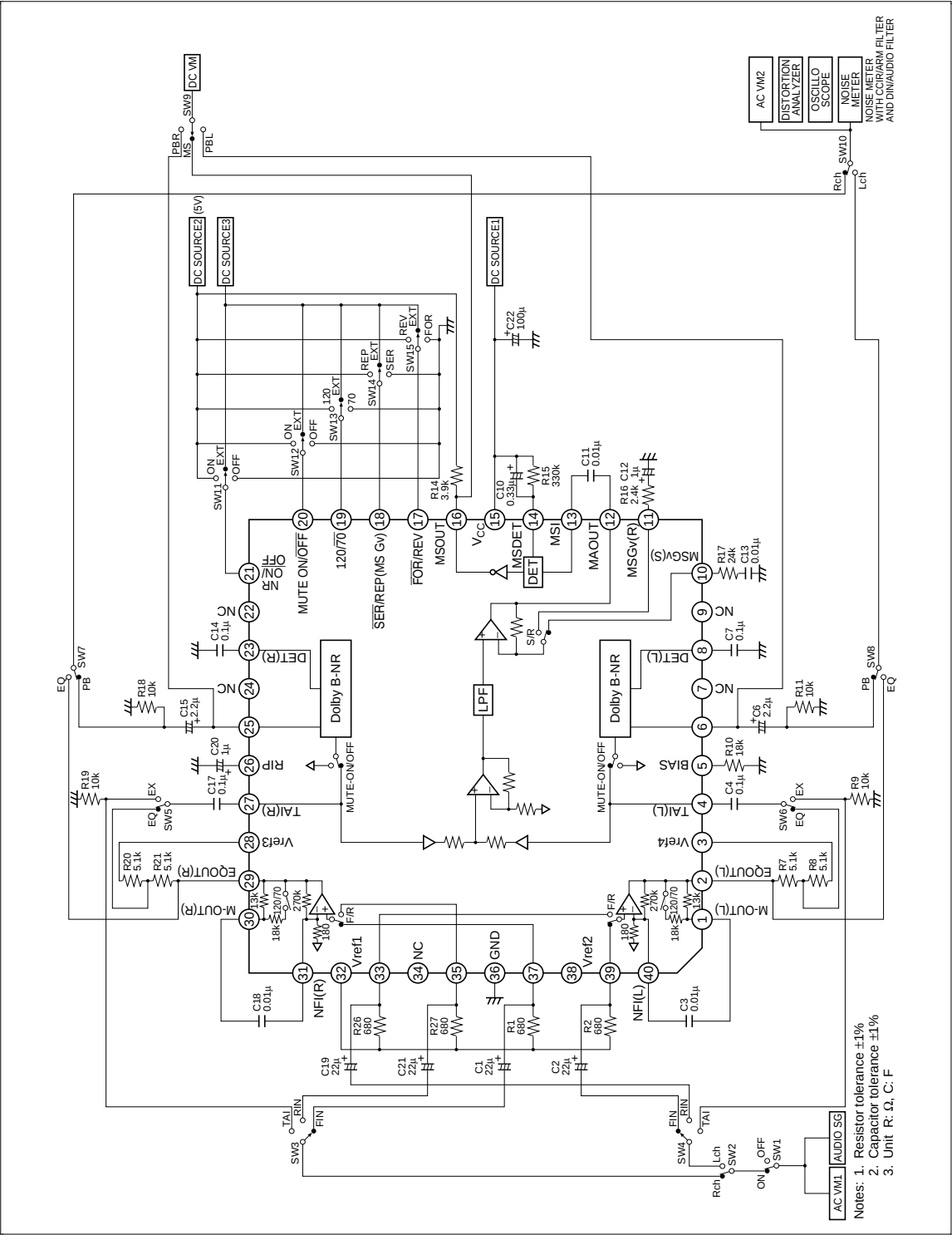
HA12229F

(Ta = 25°C, V_{CC} = 9 V, PBOUT level 0 dB = 300 mVrms, EQOUT level 0 dB = 60 mVrms)

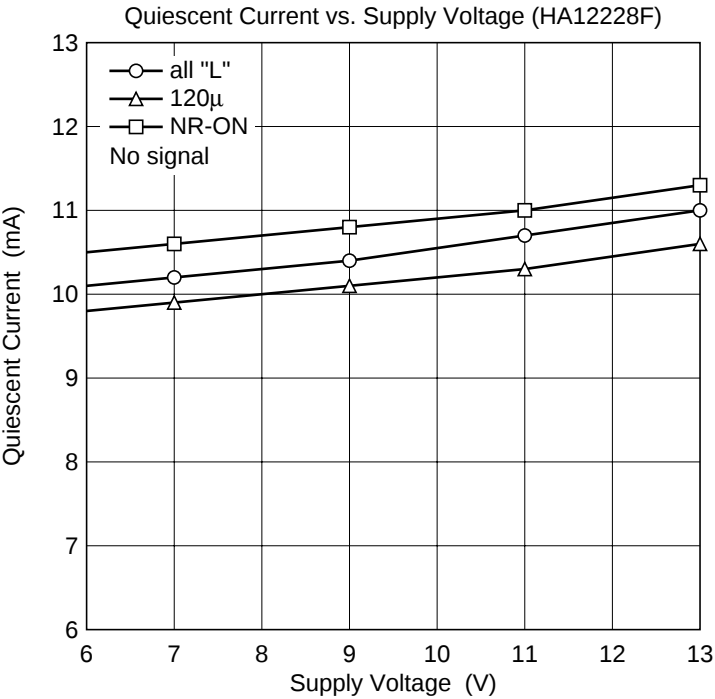
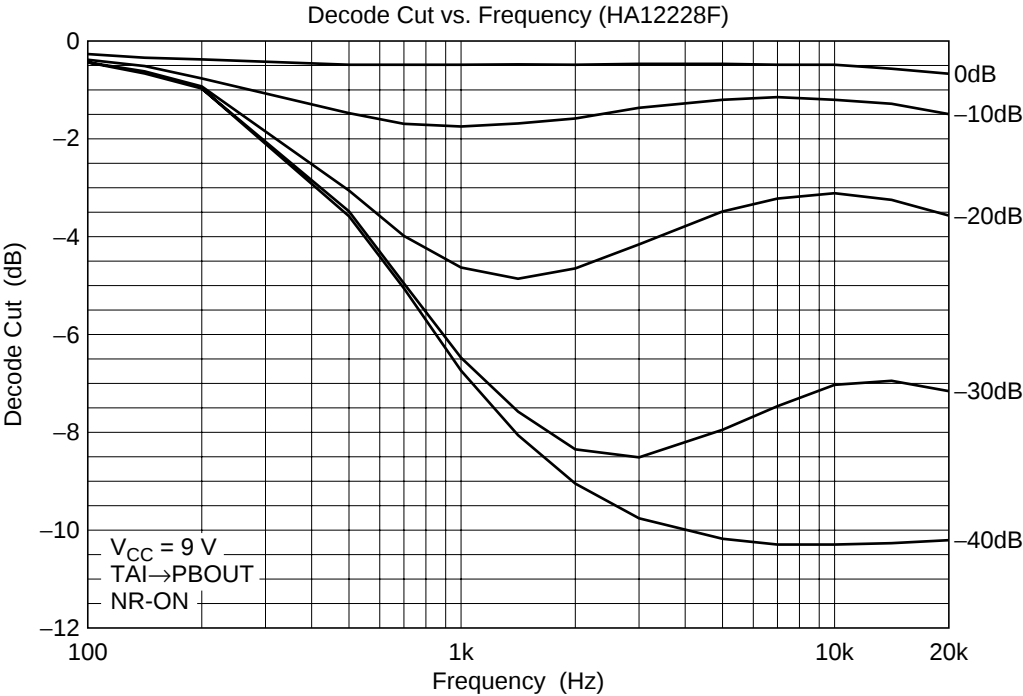
Item	Symbol	Test Condition										Specification				Application Terminal																
		IC Condition					MUTE ON/OFF	120μ/ 70μ	SER/ REP	FOR/ REV	f _{in} (Hz)	PBOUT level (dB)	EQOUT level (dB)	Other			Min			Typ			Max			Unit	Input		Output		COM	Remark
		OFF	70μ	SER	FOR	REV								No signal	3.0	5.0	8.0	19.0	20.0	21.0	dB	27	4	25	6		—150	0	150	mV		
Signal handling	Vo max	OFF	—	—	—	—	1k	—	—	—	THD=1%	12.0	13.0	—	dB	27	4	25	6	2												
Signal to noise ratio	S/N	OFF	—	—	—	—	1k	(0)	—	—	R _g =10kΩ, CCIR/ARM	70.0	80.0	—	dB	27	4	25	6	2												
Total Harmonic Distortion	THD	OFF	—	—	—	—	1k	0	—	—		—	0.05	0.3	%	27	4	25	6													
Channel separation	CTRL (1)	—	—	—	—	—	1k	—	—	(+20)	50.0	60.0	—	dB	37	39	29	2	29	2	29	2	29	2	29	2	29	2	29	2		
Channel separation	CTRL (2)	OFF	—	—	—	—	1k	—	—	(+12)	70.0	80.0	—	dB	27	4	25	6	25	6	25	6	25	6	25	6	25	6	25	6		
MUTE attenuation	CT MUTE	OFF→ ON	—	—	—	—	1k	—	—	(+12)	70.0	80.0	—	dB	27	4	25	6	27	4	25	6	27	4	25	6	27	4	25	6		
PB-EQ gain	G _v EQ 1k	—	120μ	—	—	—	1k	—	—	0	37.8	40.8	43.8	dB	37/35	39/33	29	2	37/35	39/33	29	2	37/35	39/33	29	2	37/35	39/33	29	2		
	G _v EQ 10k(1)	—	120μ	—	—	—	10k	—	—	0	33.9	36.9	39.9	dB	37	39	29	2	37	39	29	2	37	39	29	2	37	39	29	2		
	G _v EQ 10k(2)	—	70μ	—	—	—	10k	—	—	0	29.6	32.6	35.6	dB	37	39	29	2	37	39	29	2	37	39	29	2	37	39	29	2		
PB-EQ Maximum output level	V _{OM}	—	120μ	—	—	—	1k	—	—	—	THD=1%	300	600	—	mVrms	37	39	29	2	37	39	29	2	37/35	39/33	29	2	37/35	39/33	29	2	
PB-EQ T.H.D.	THD-EQ	—	120μ	—	—	—	1k	—	—	+14dB	—	0.1	0.3	%	37/35	39/33	29	2	37/35	39/33	29	2	37/35	39/33	29	2	37/35	39/33	29	2		
PB-EQ input conversion noise	V _N	—	120μ	—	—	—	(1k)	—	—	—	R _g =680Ω, DIN-AUDIO	—	0.7	1.5	μVrms	37/35	39/33	29	2	37/35	39/33	29	2	37/35	39/33	29	2	37/35	39/33	29	2	
MS sensing level	V _{ON} (1)	OFF	—	SER	—	—	5k	—	—	—	−36.0	−32.0	−28.0	dB	27	4	25	6	27	4	25	6	27	4	25	6	27	4	25	6	16	3
	V _{ON} (2)	OFF	—	REP	—	—	5k	—	—	—	−18.0	−14.0	−10.0	dB	27	4	25	6	27	4	25	6	27	4	25	6	27	4	25	6	16	3
MS output low level	V _{OL}	OFF	—	SER	—	—	5k	—	—	0	—	1.0	1.5	V	27	4	—	—	27	4	—	—	27	4	—	—	27	4	—	—	16	
MS output leakage current	I _{OH}	—	—	—	—	—	—	—	—	—	No signal	—	0.0	2.0	μA	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	16	
Control voltage	V _{IL}	—	—	—	—	—	—	—	—	—	−0.2	—	1.0	V	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	17 to	20	
	V _{IH}	—	—	—	—	—	—	—	—	—	3.5	—	V _{CC}	V	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	20	

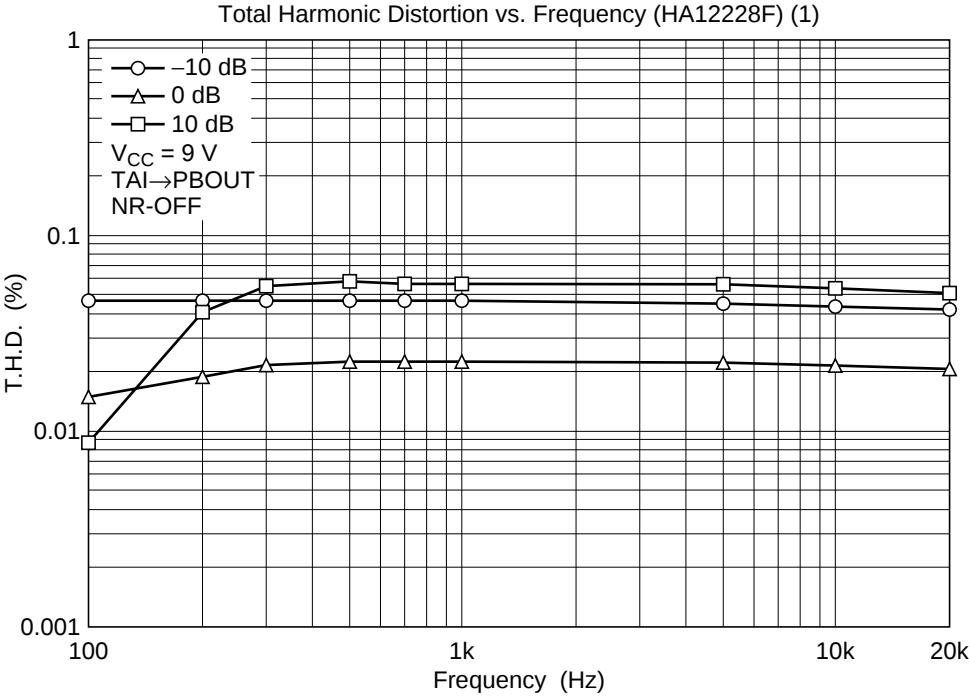
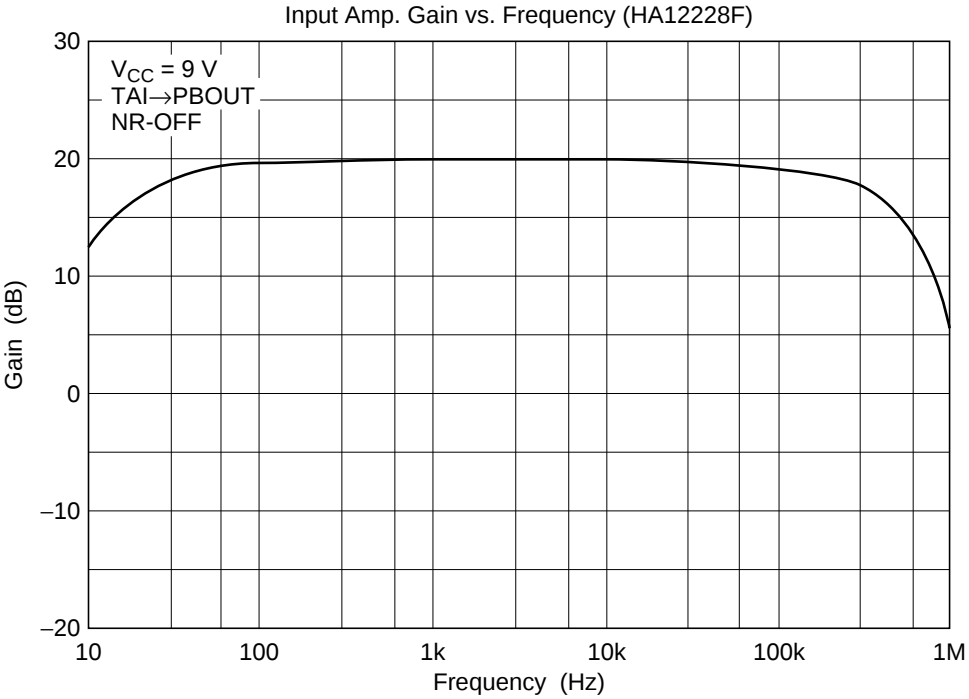
Notes: 1. V_{CC} = 12V
2. V_{CC} = 6.5V
3. For inputting signal to one side channel

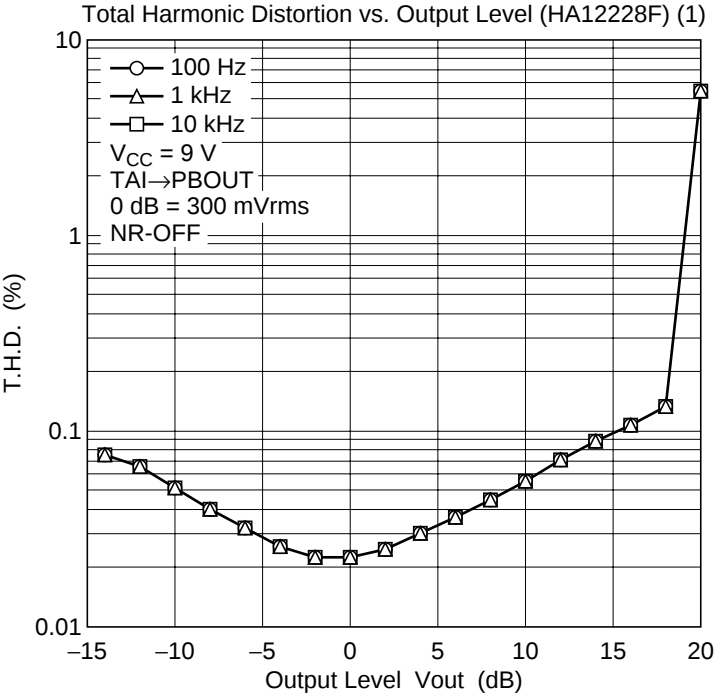
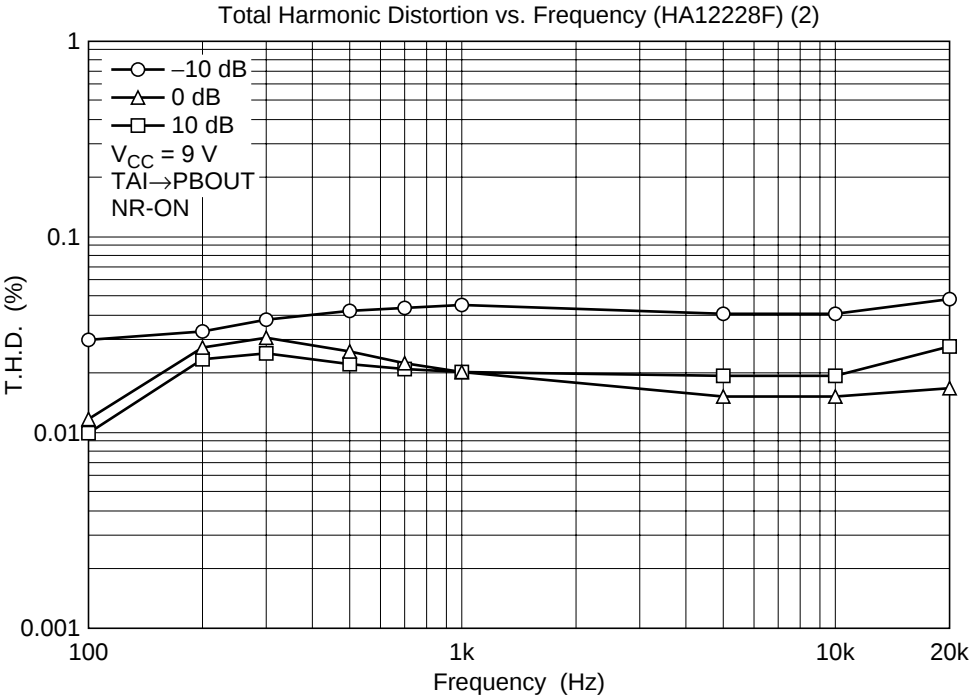
Test Circuit

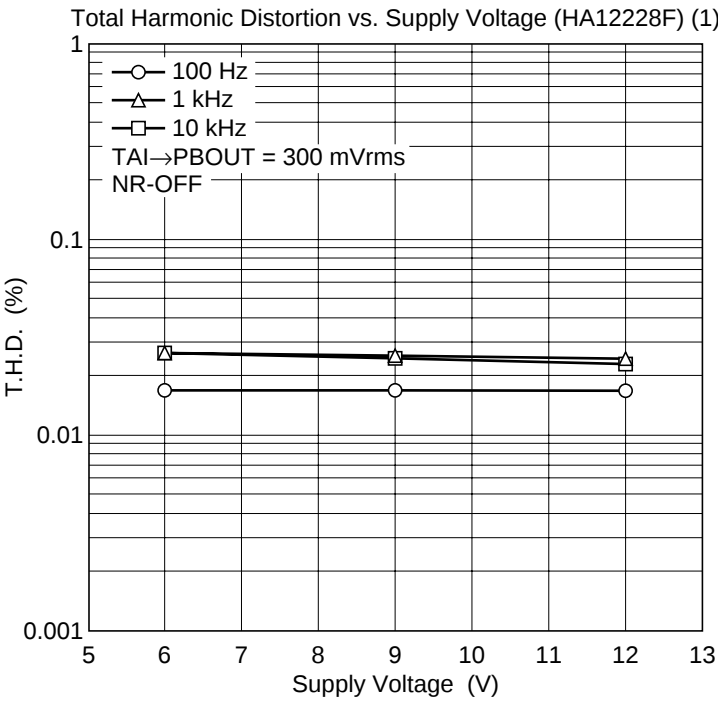
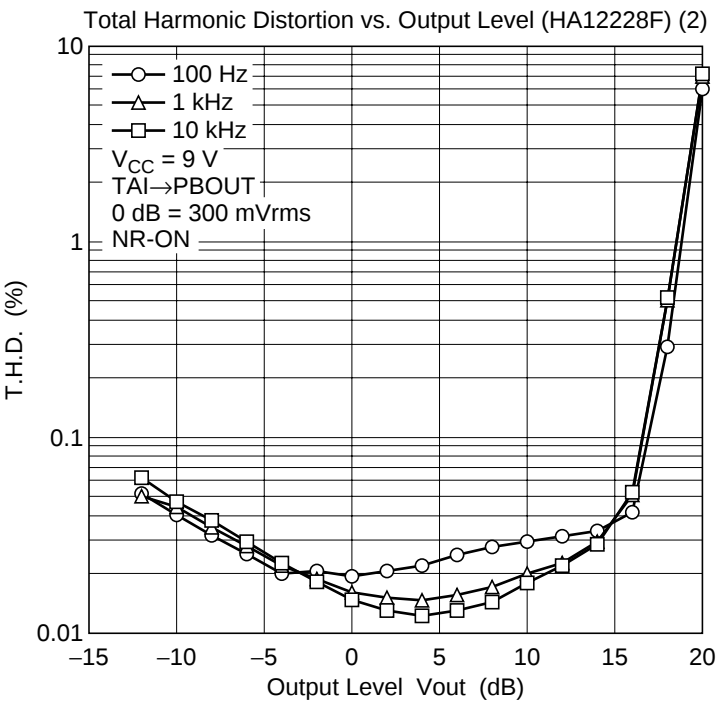


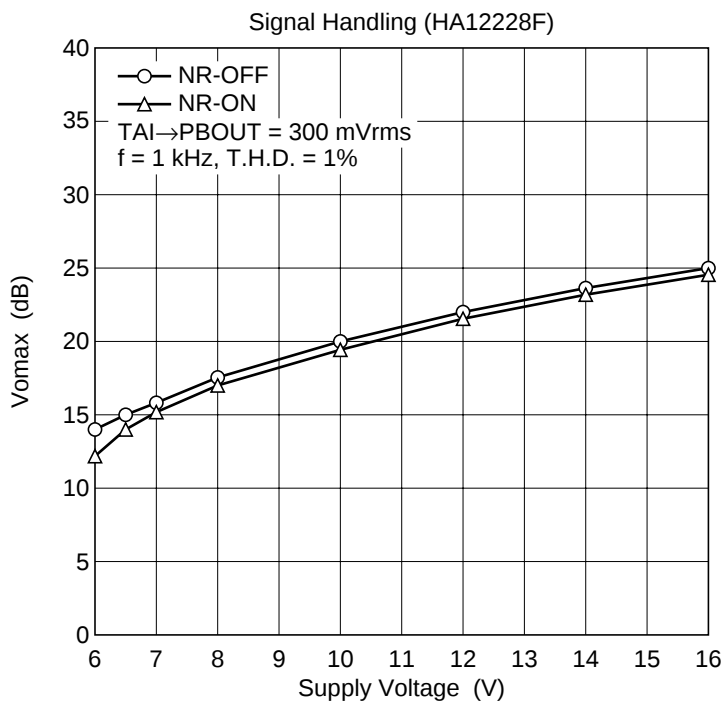
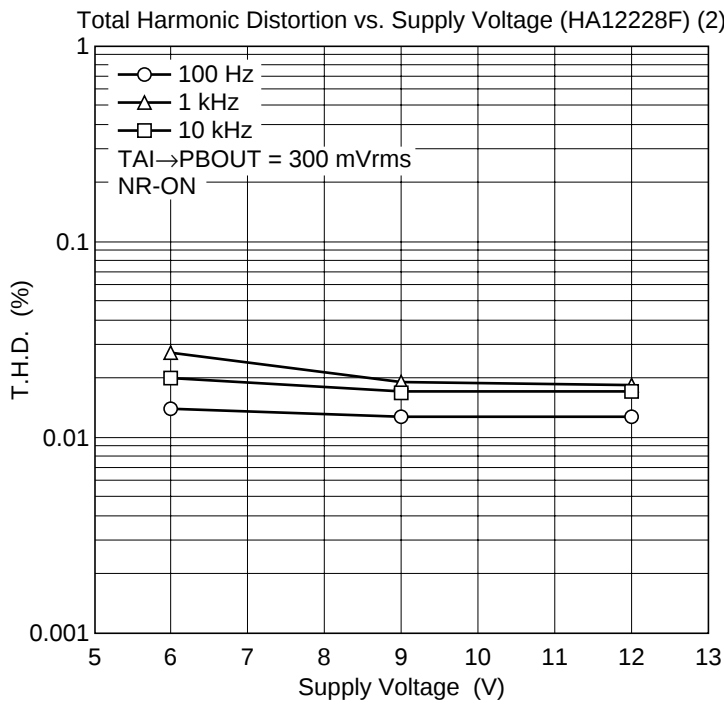
Characteristic Curves

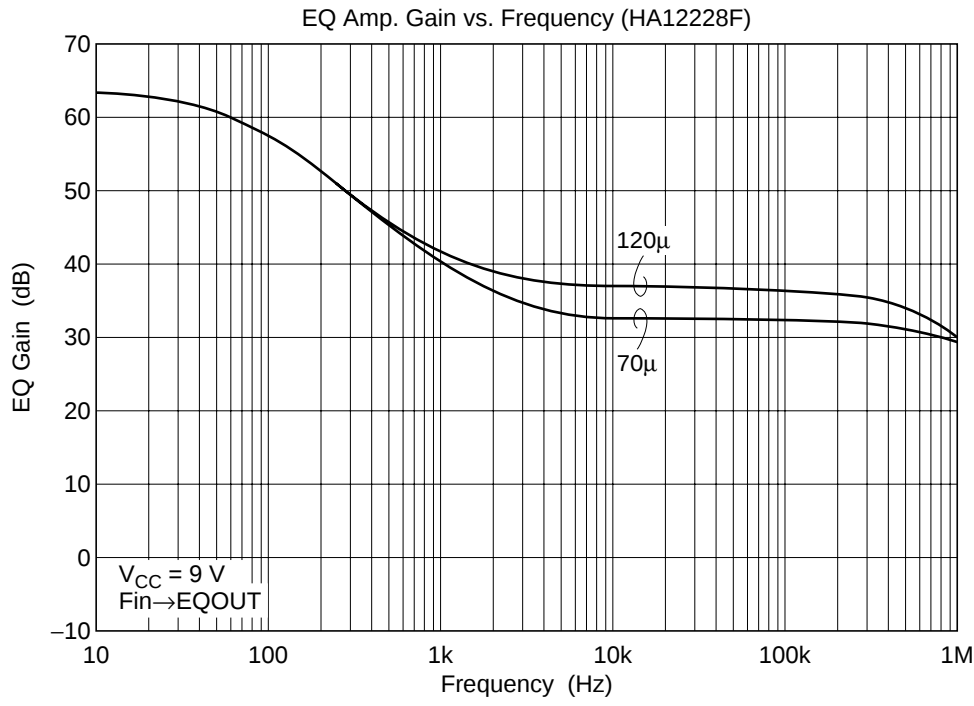
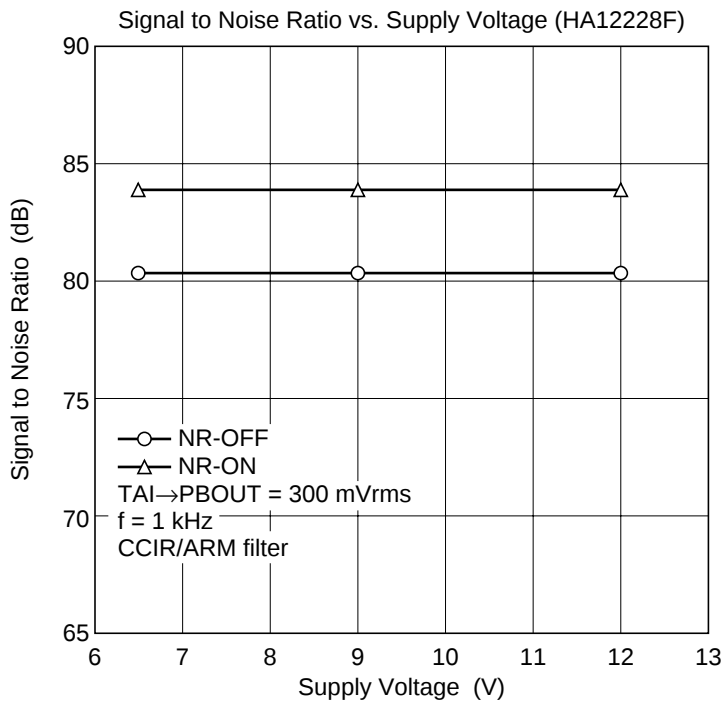


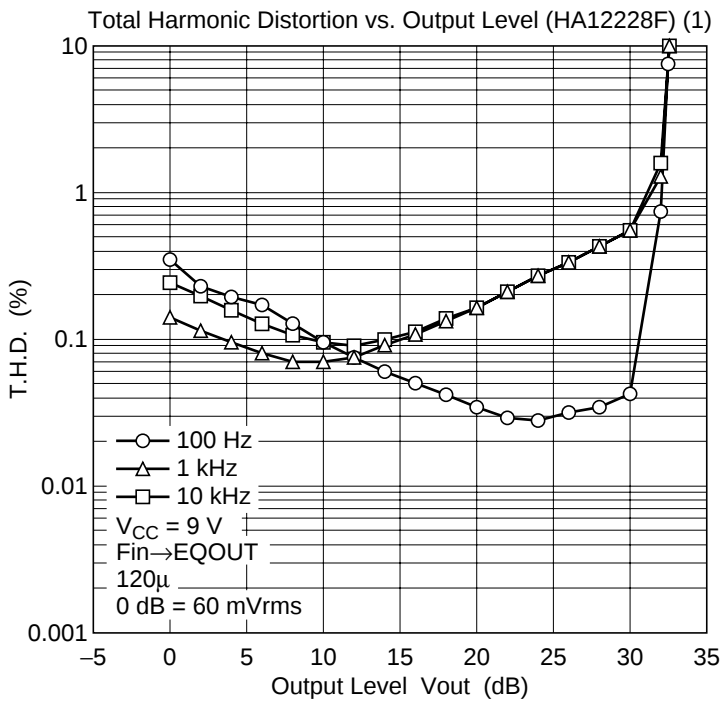
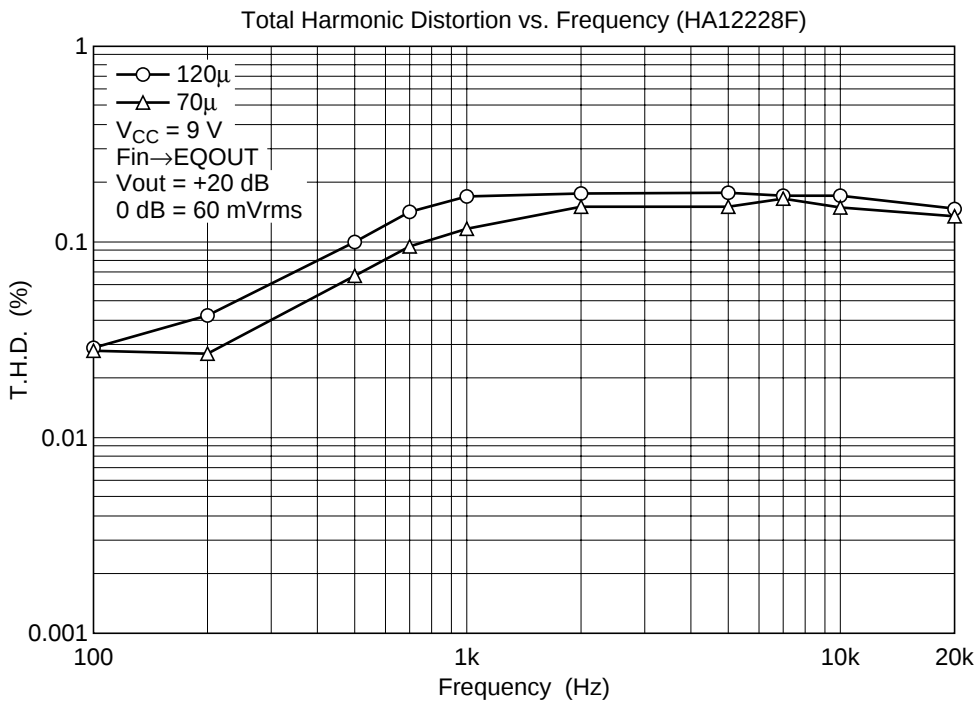


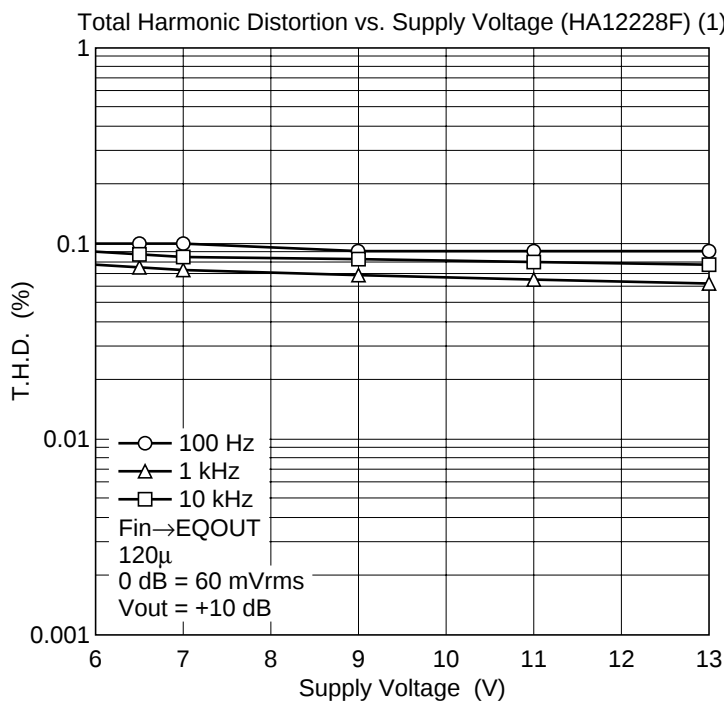
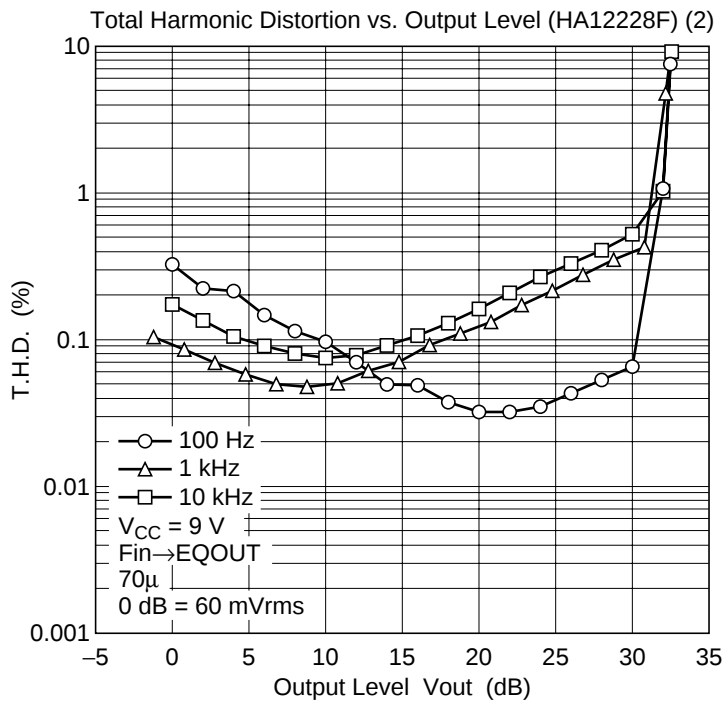


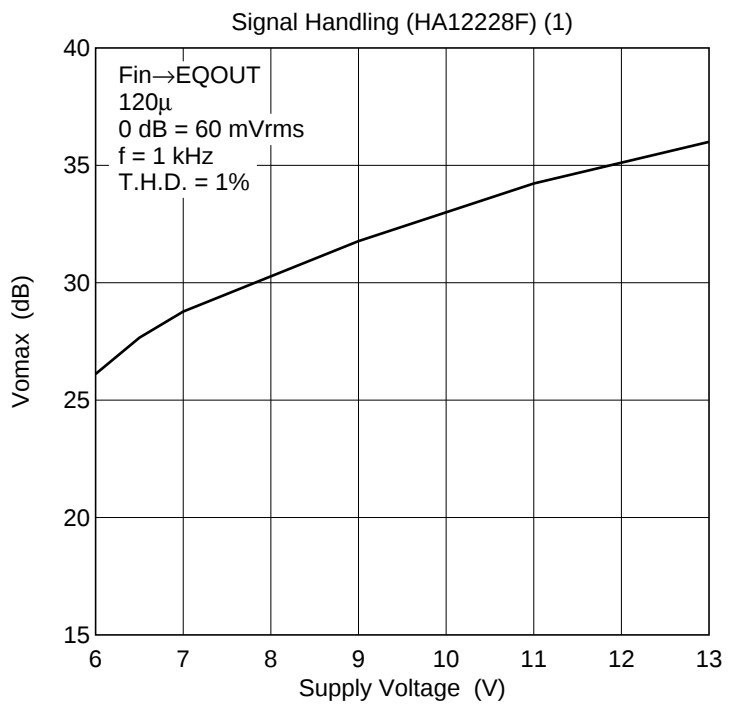
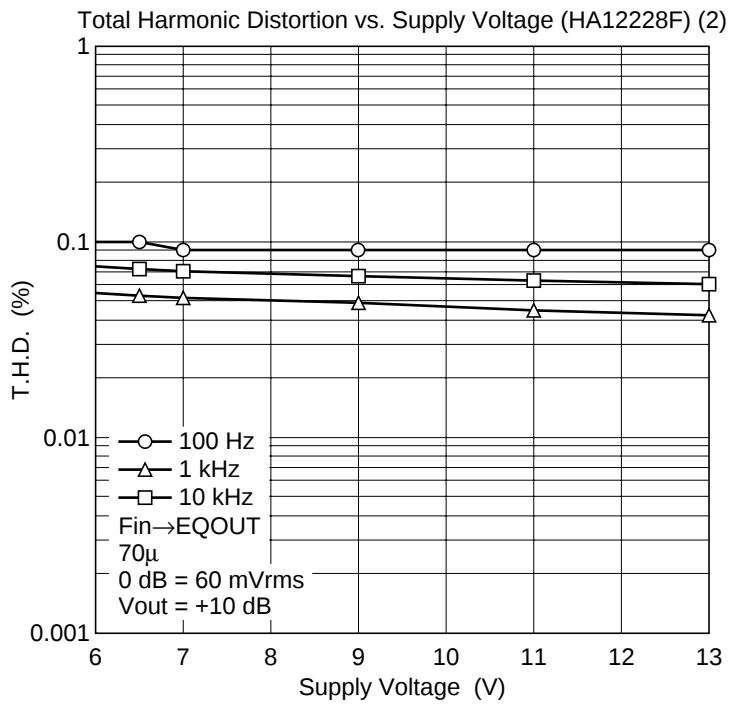


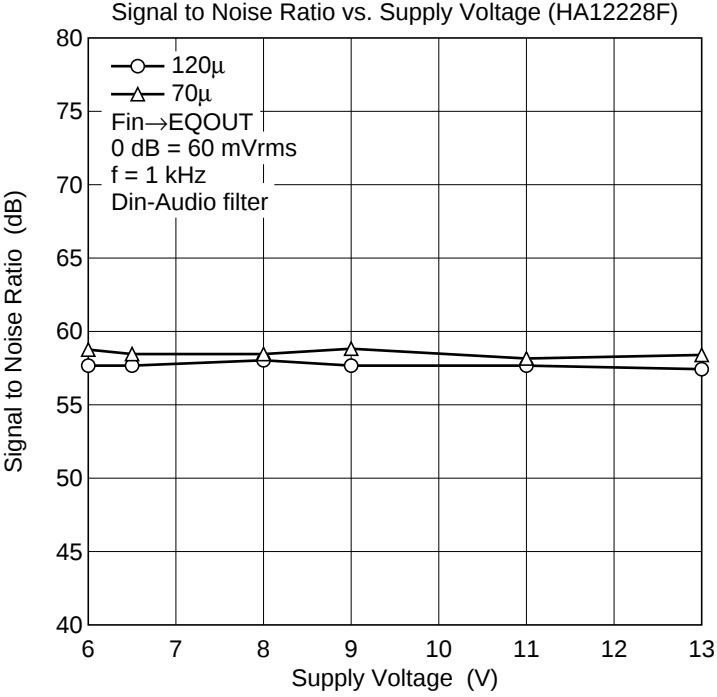
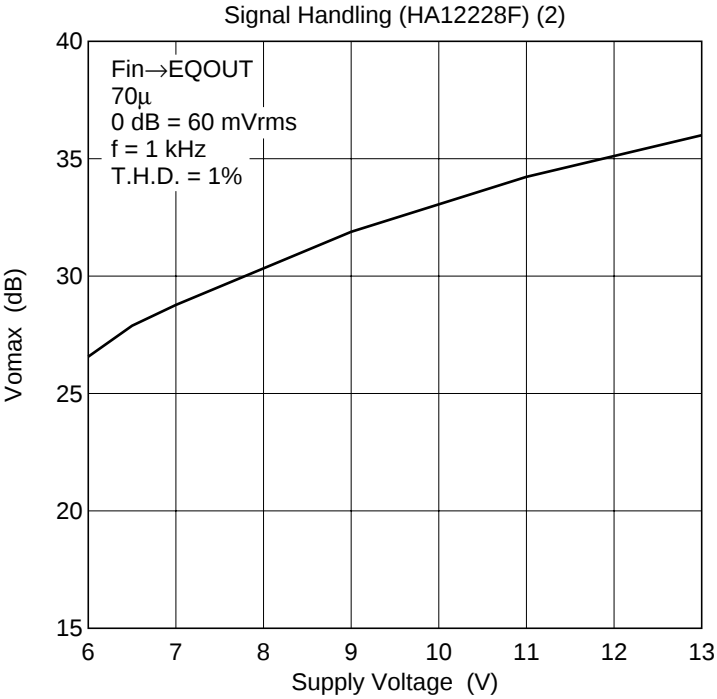


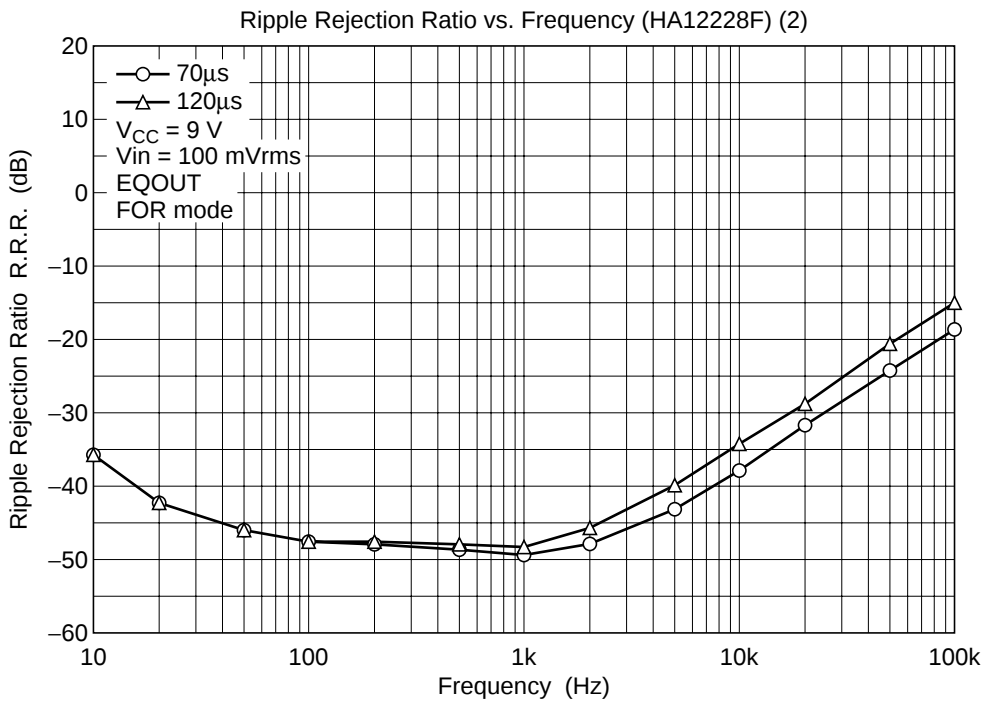
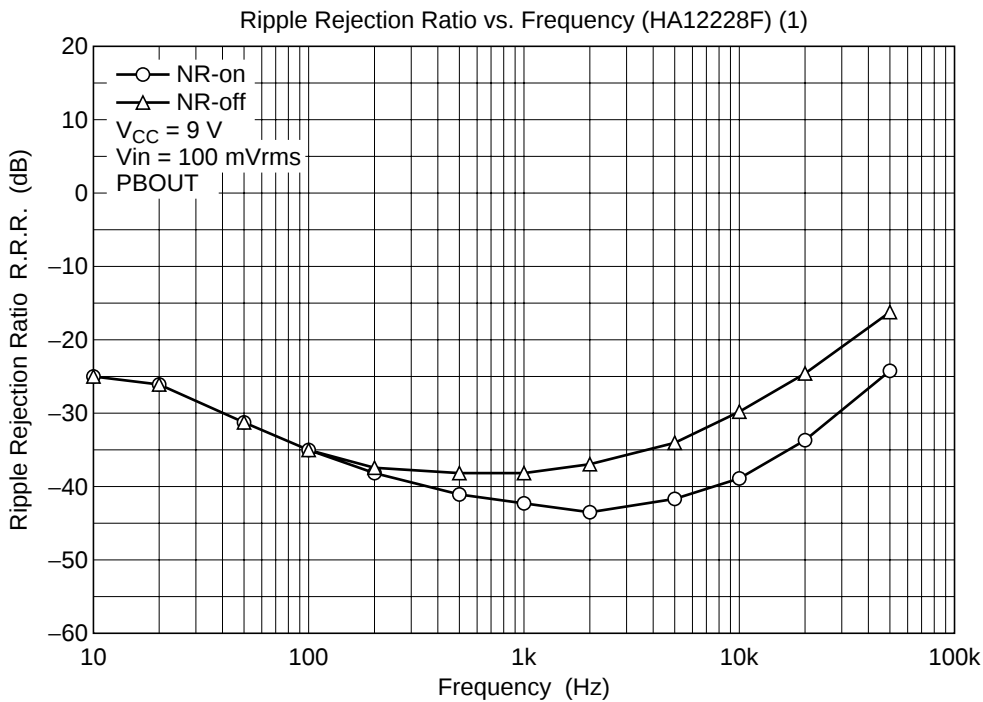


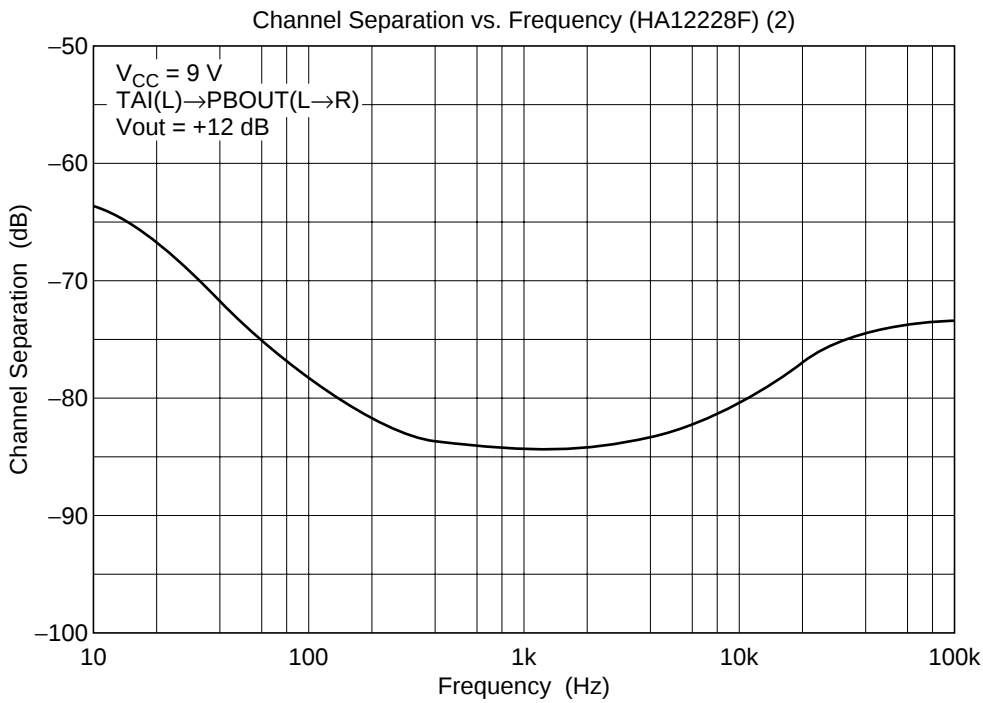
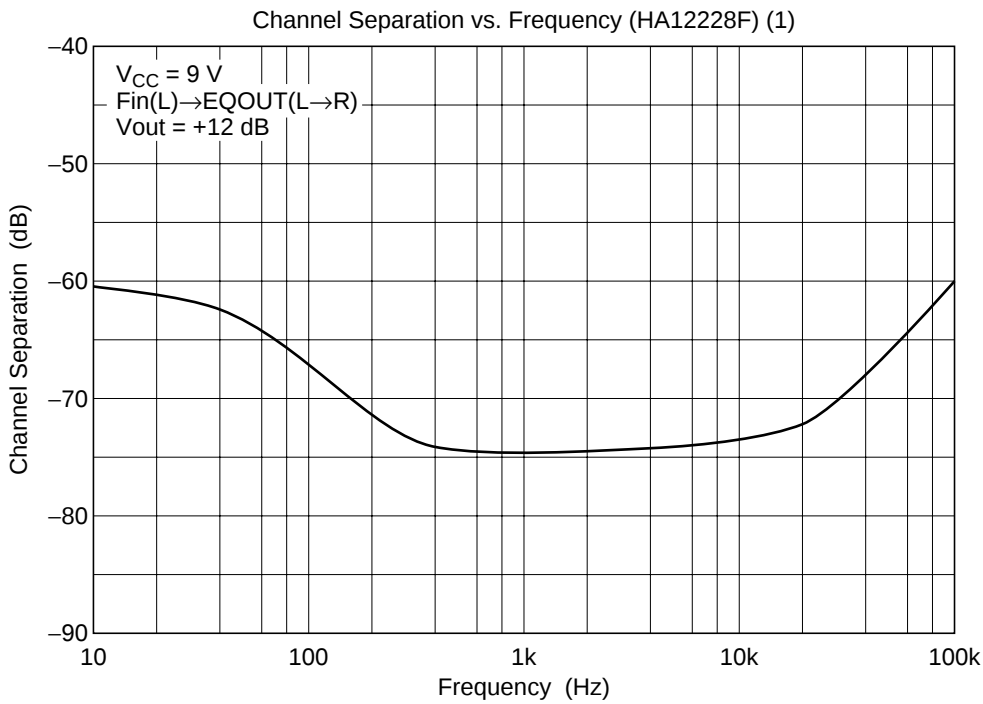


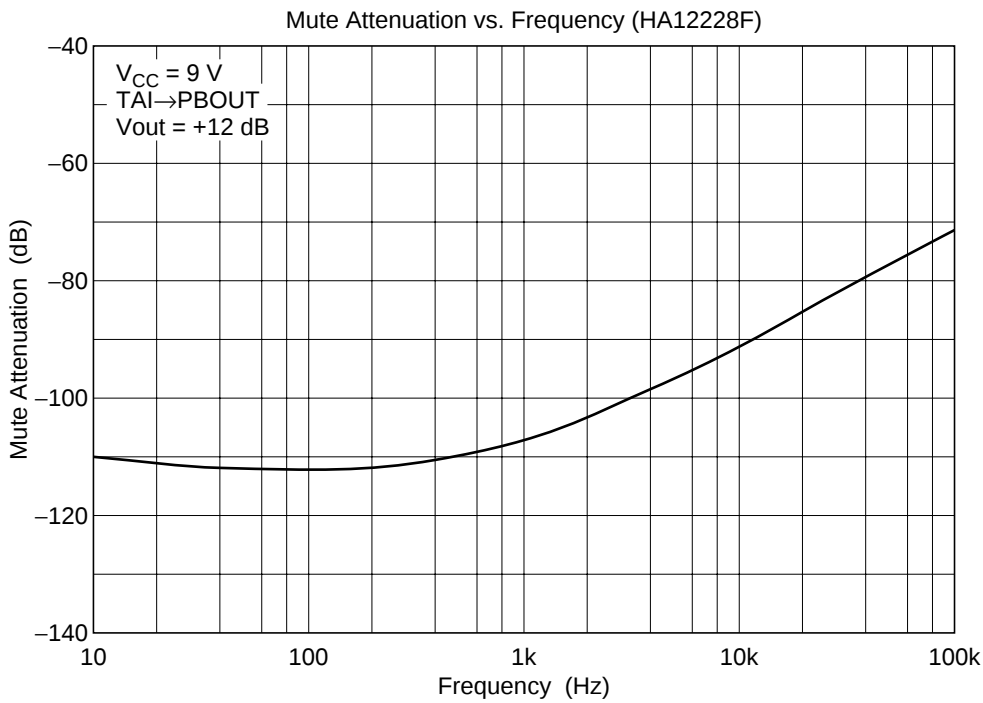
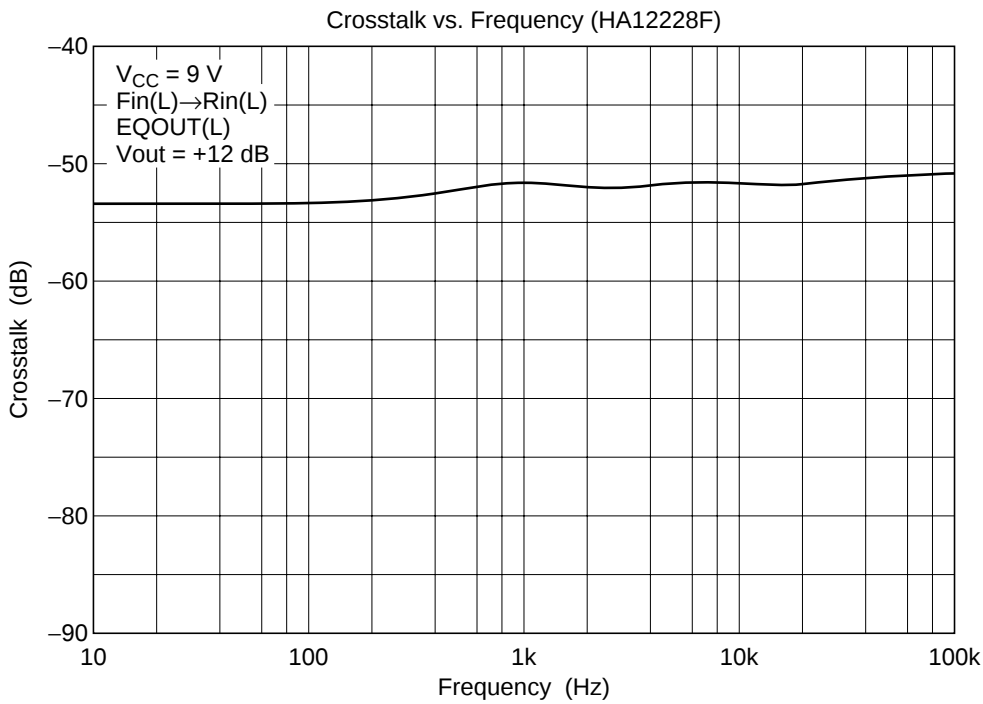


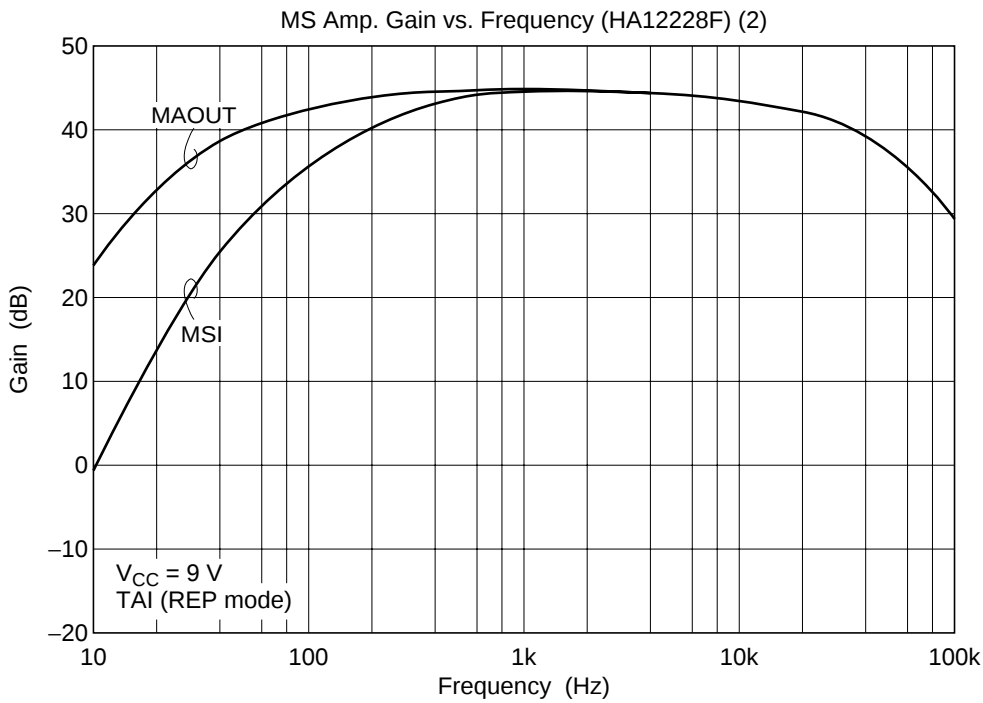
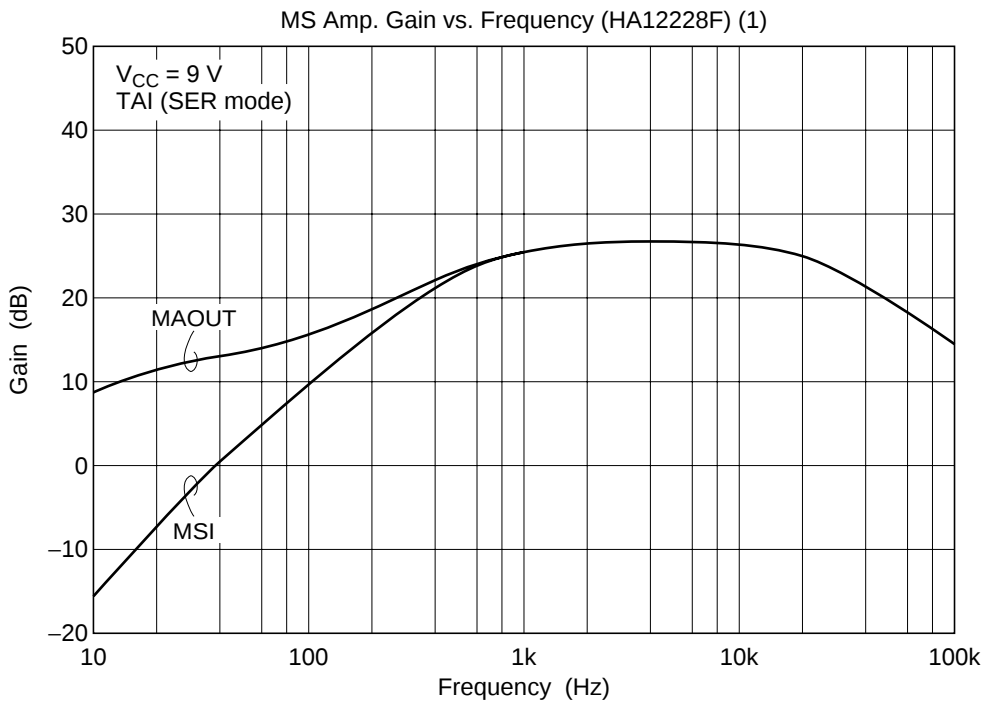


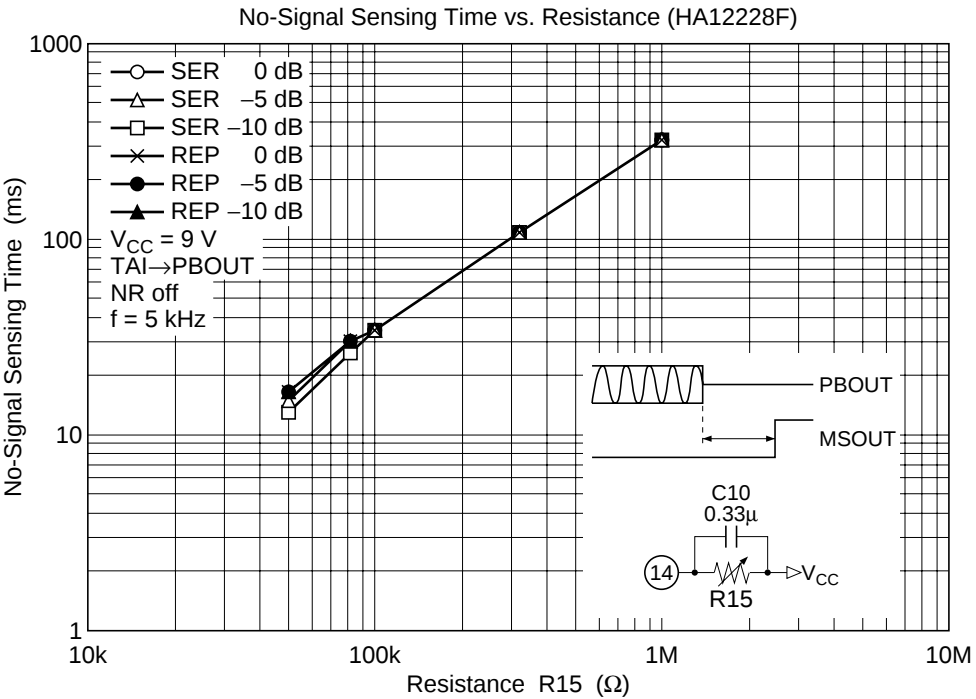
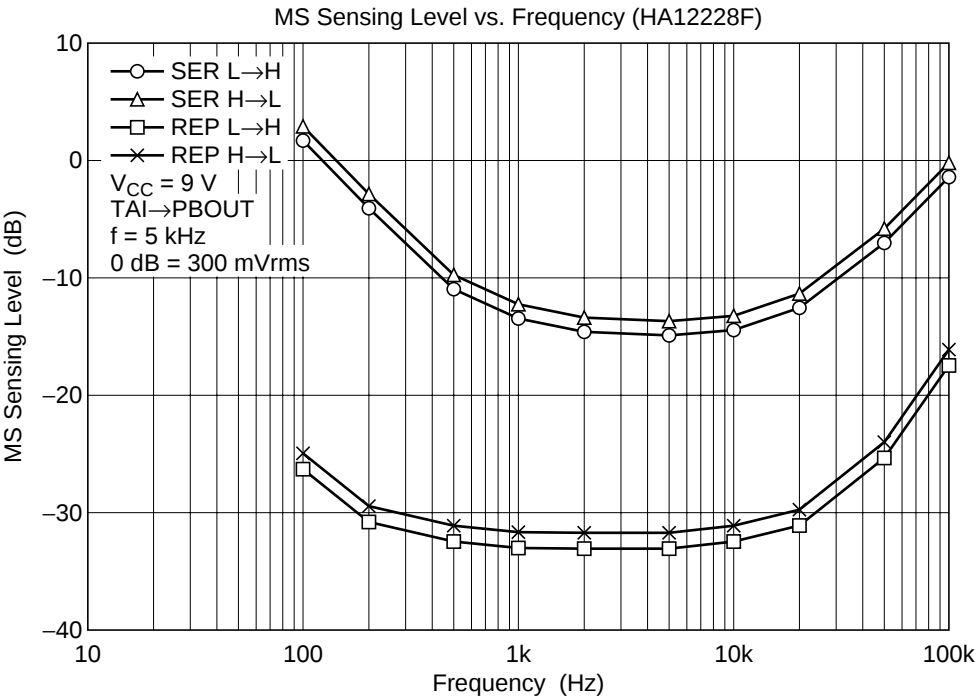


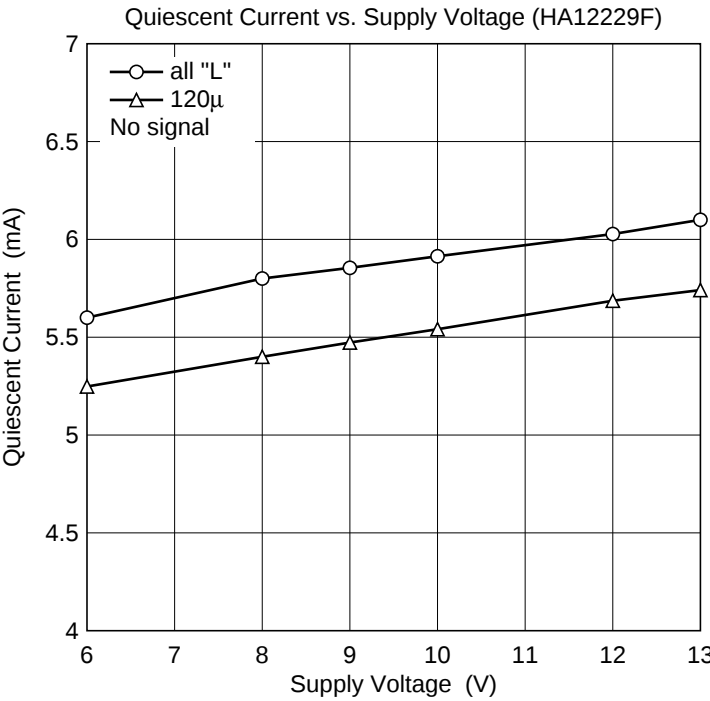
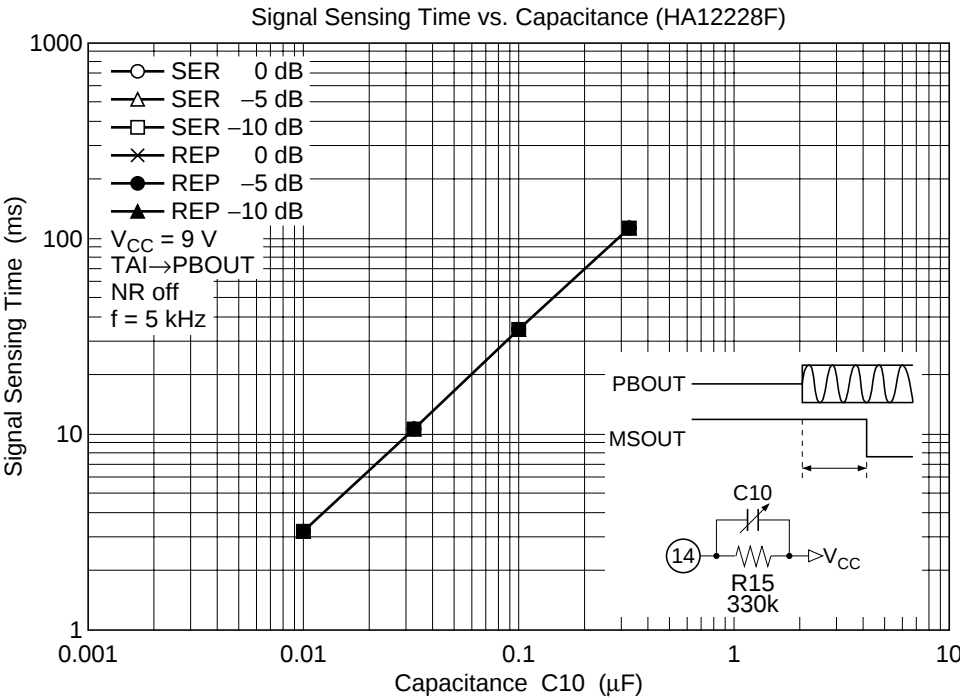


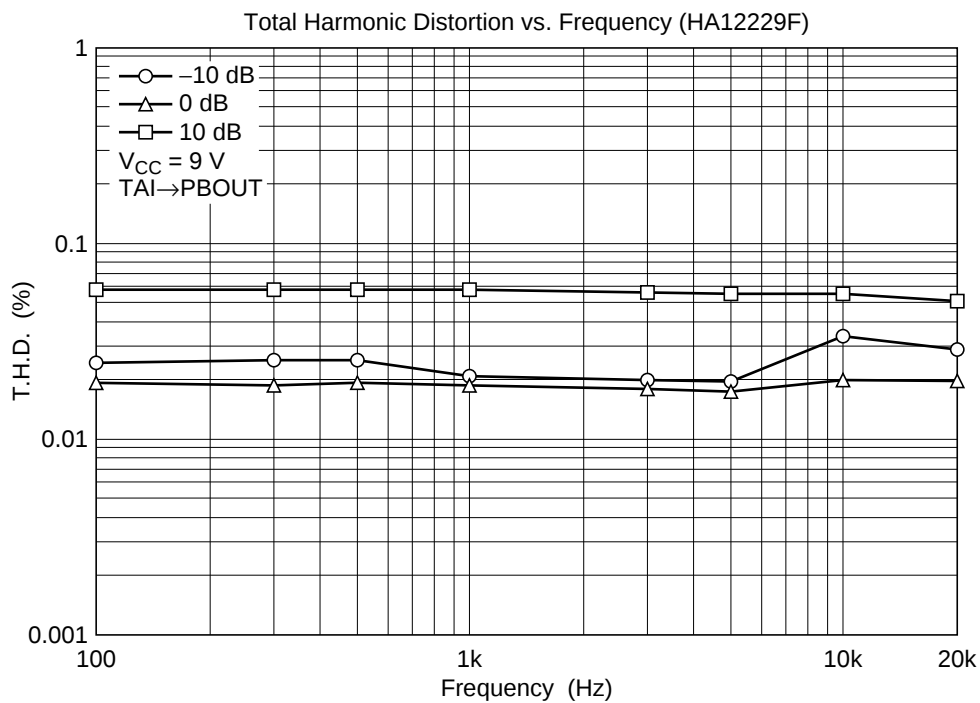
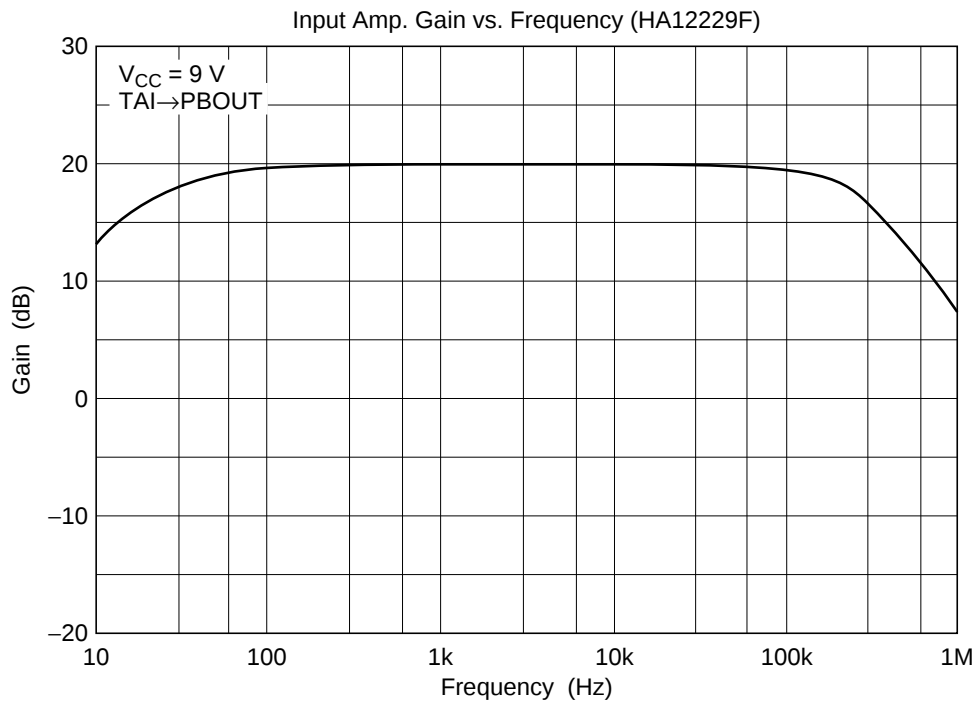


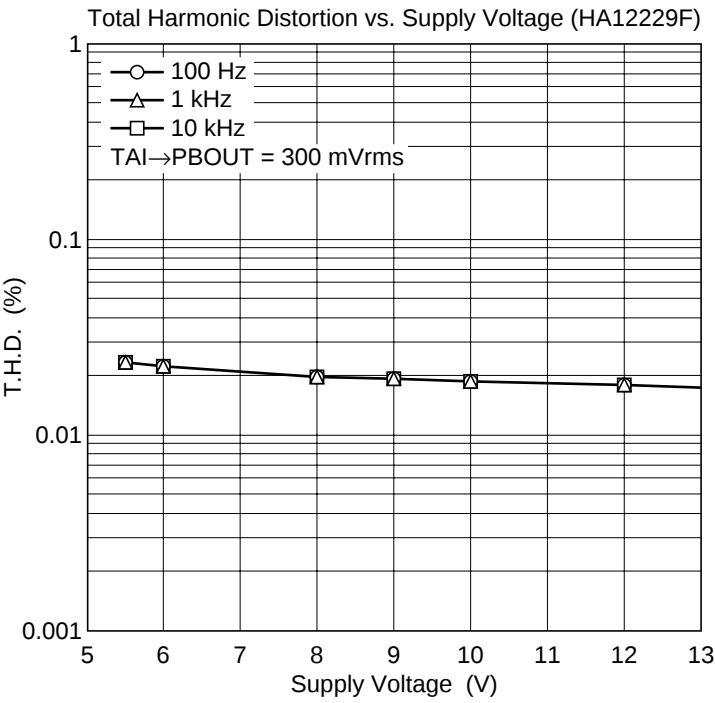
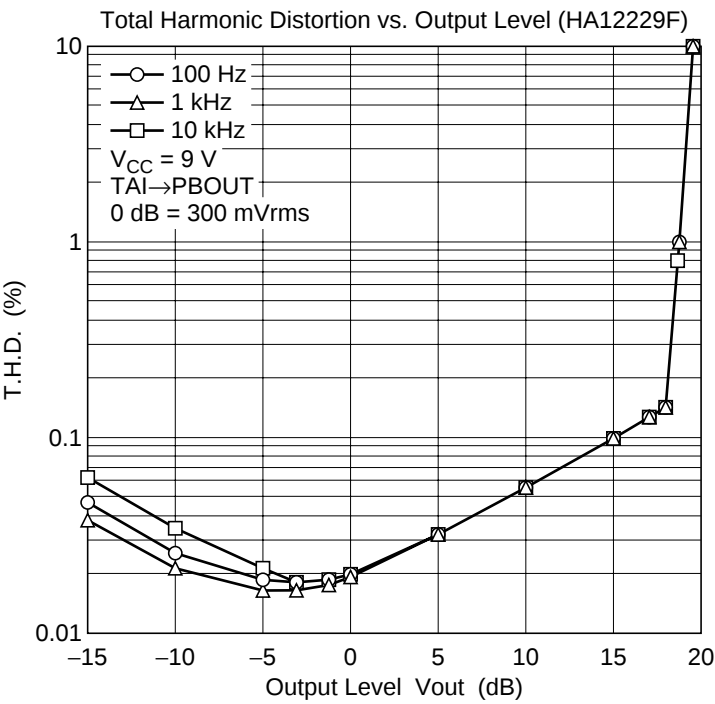


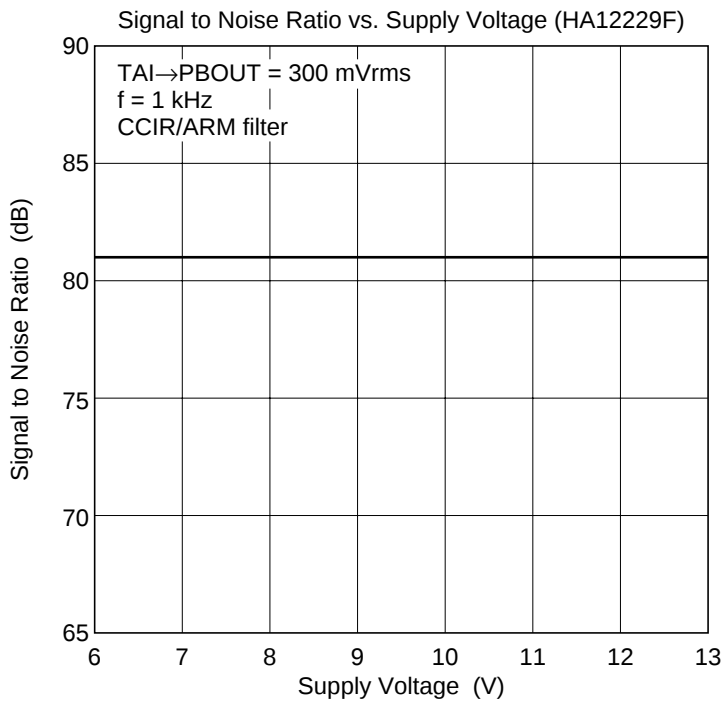
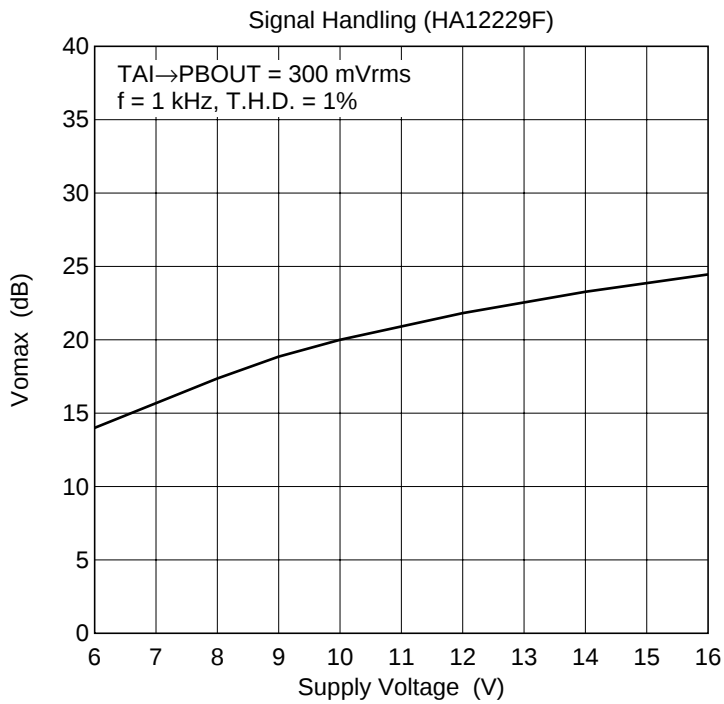


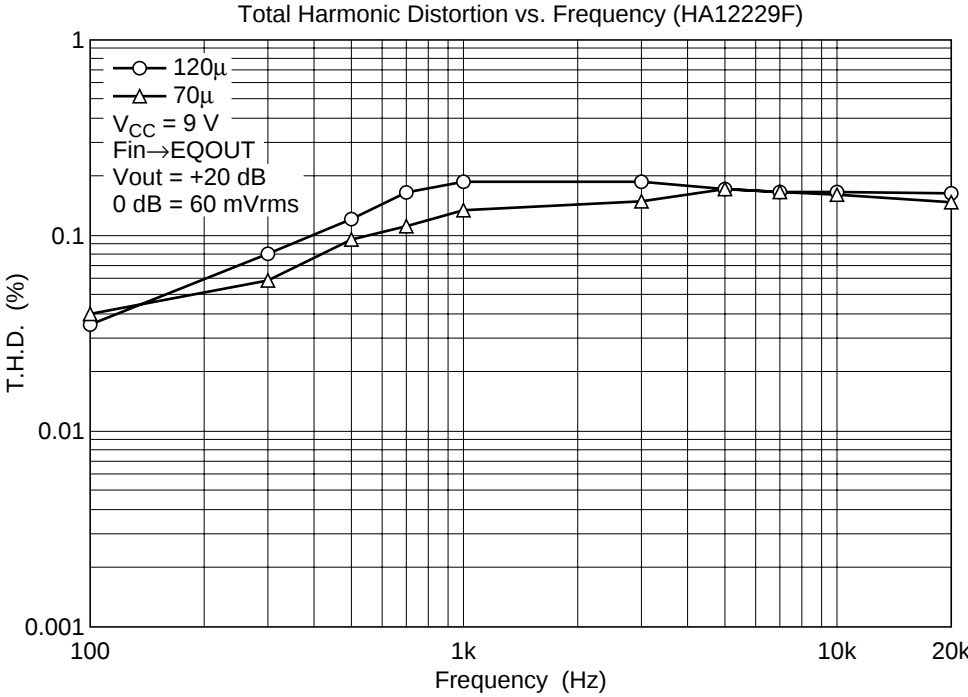
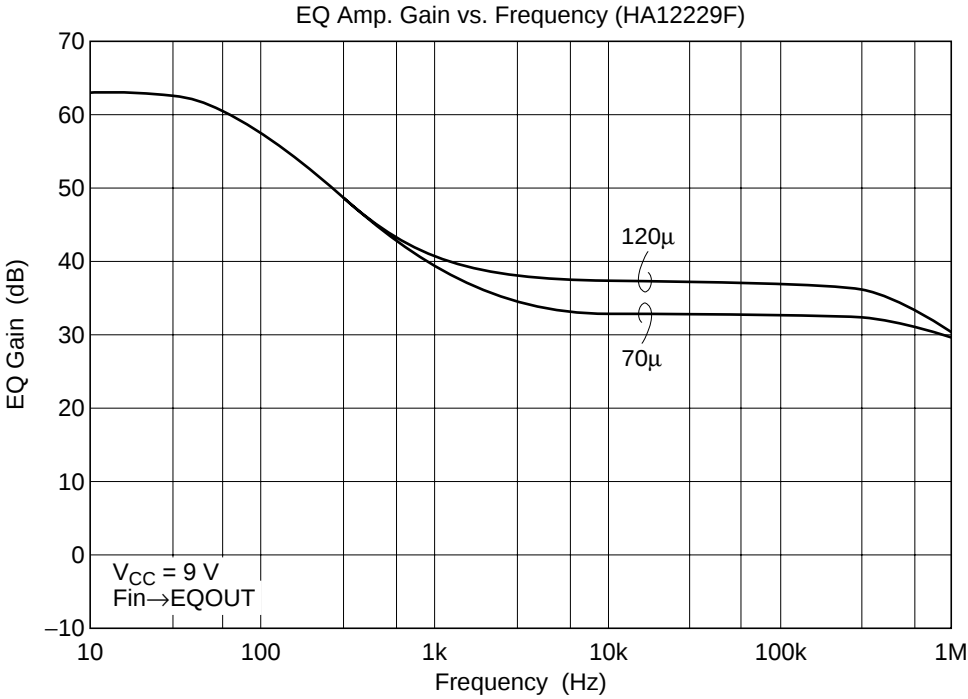


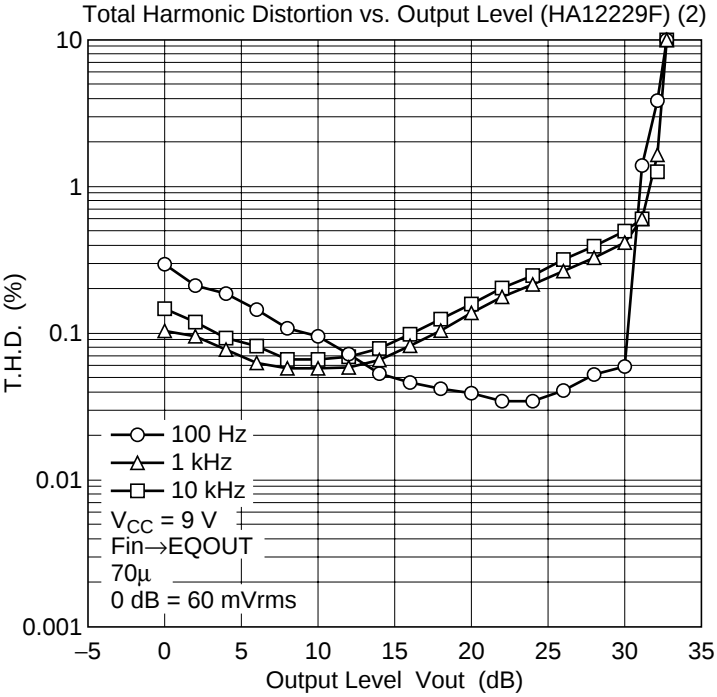
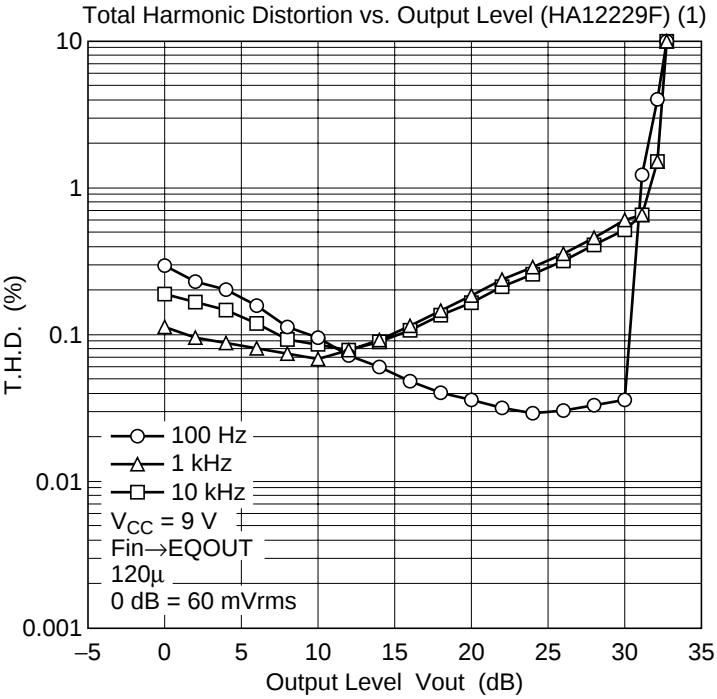


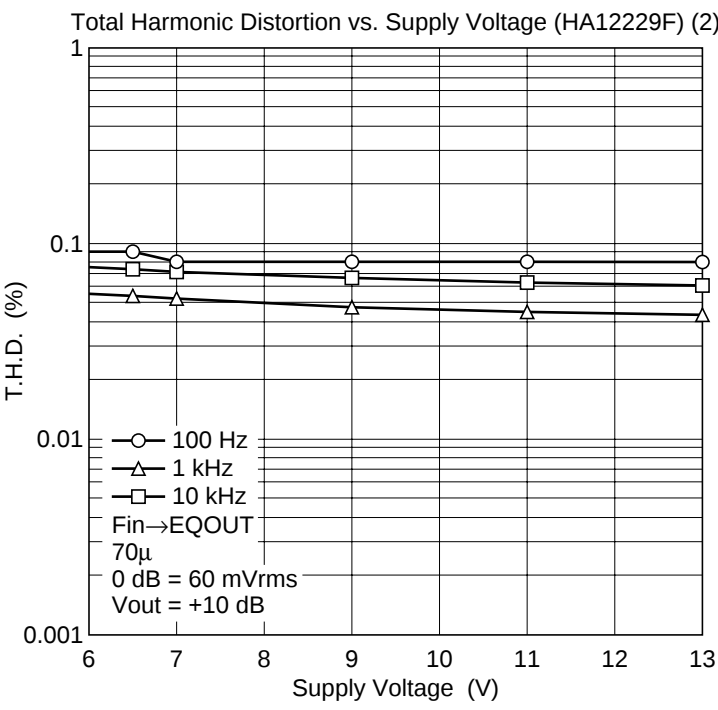
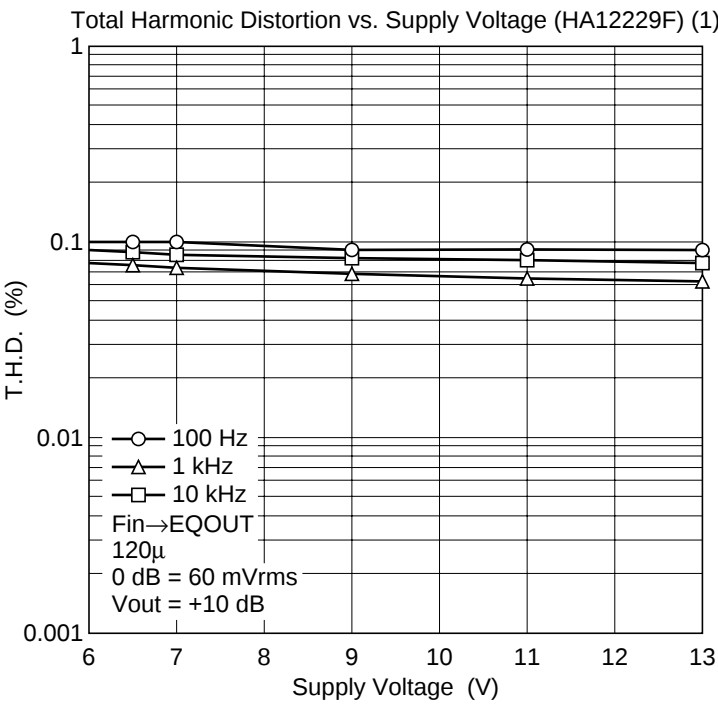


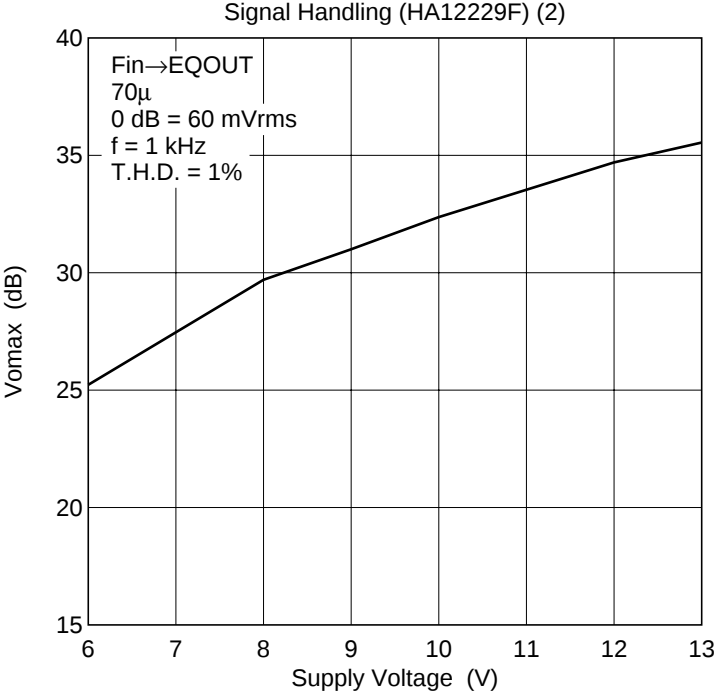
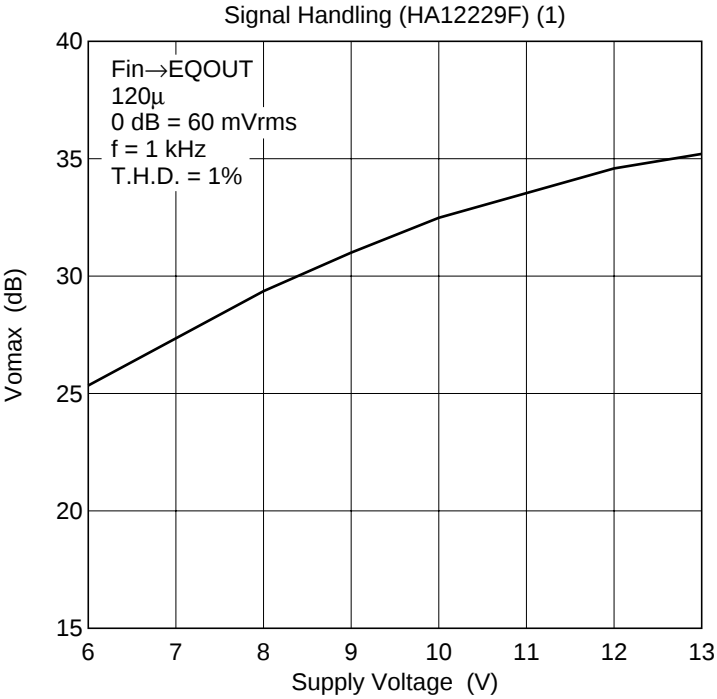


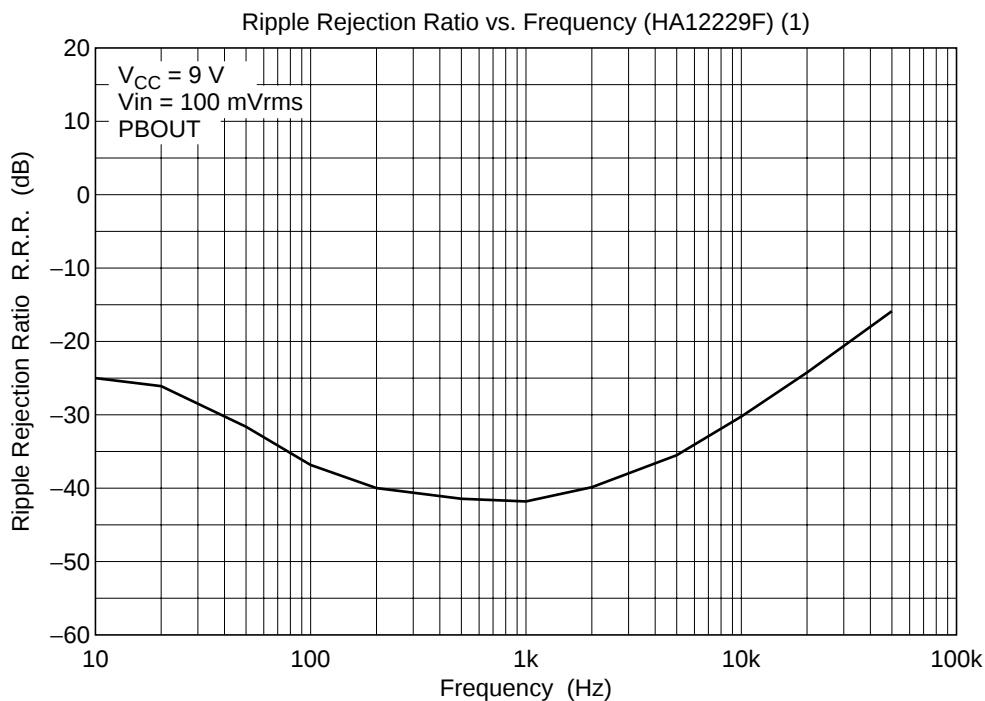
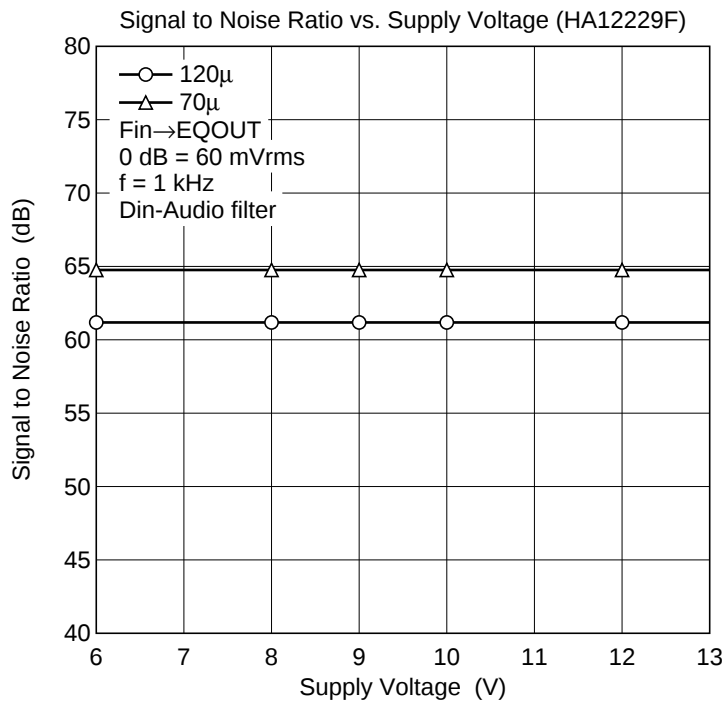


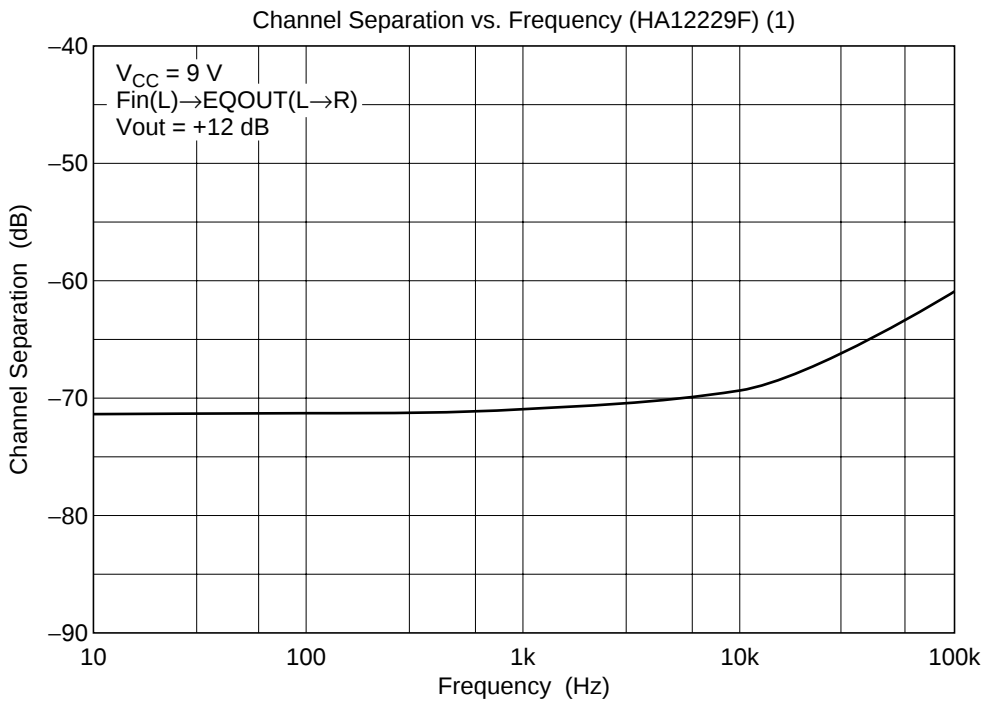
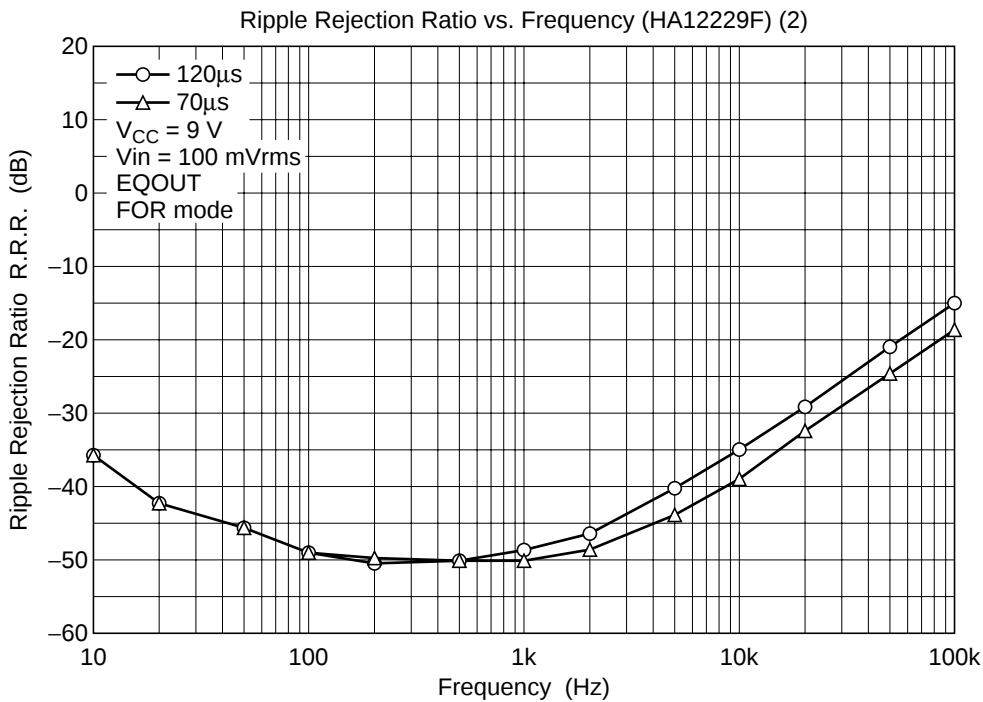


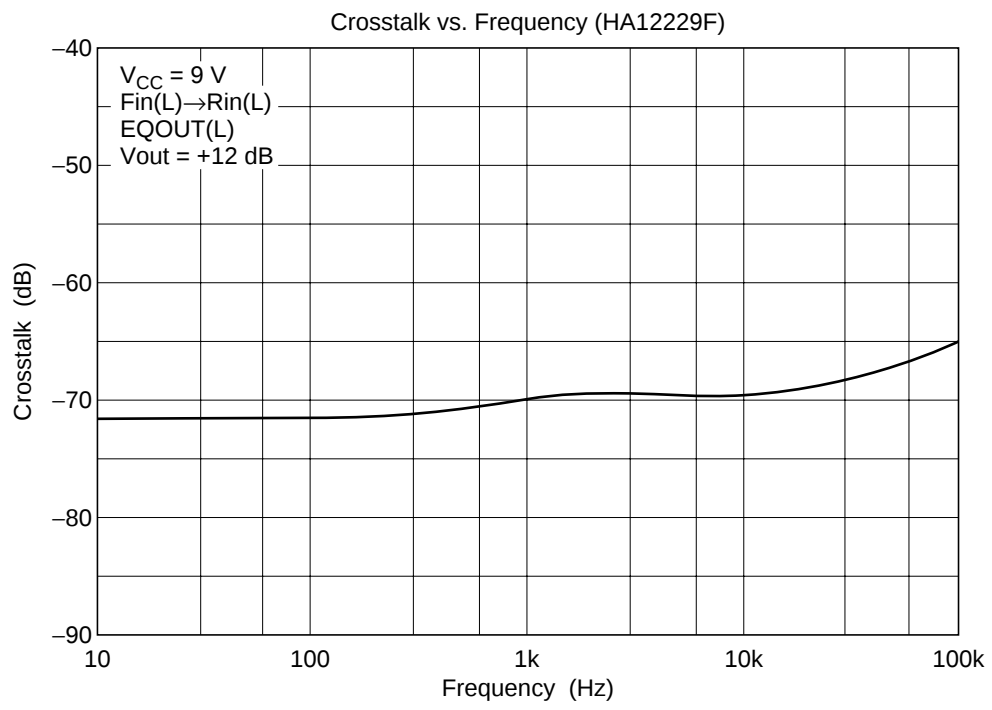
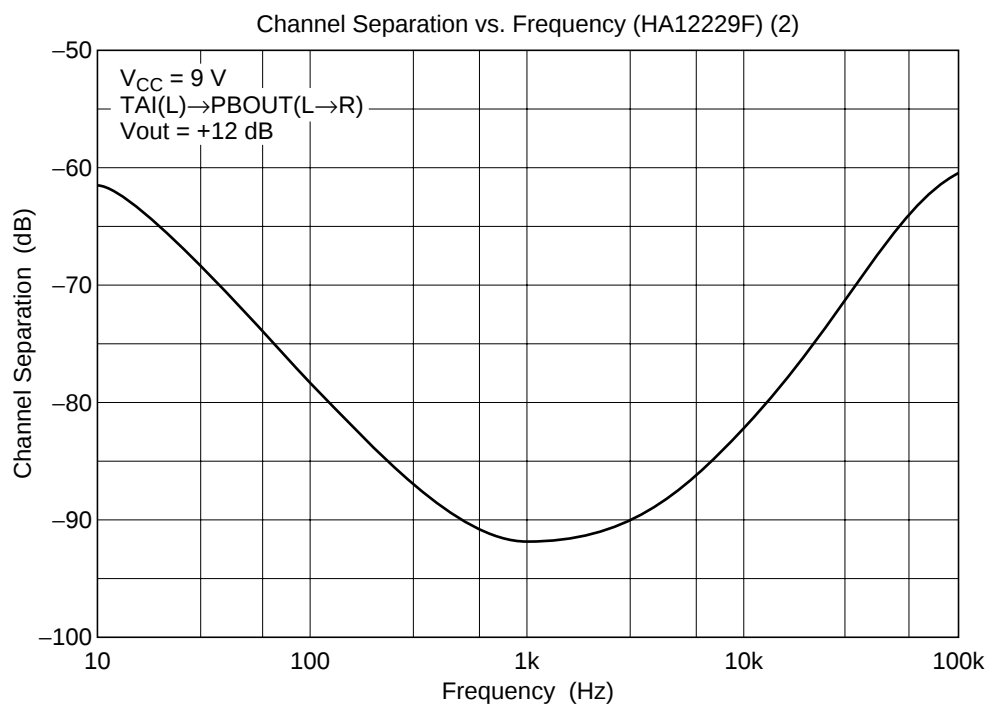


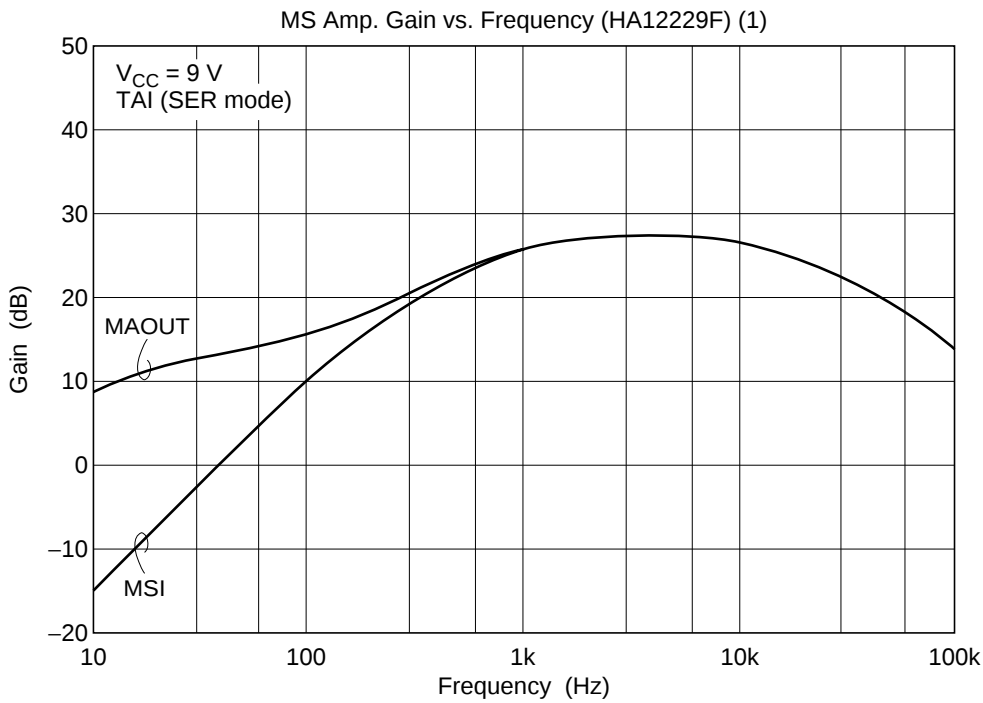
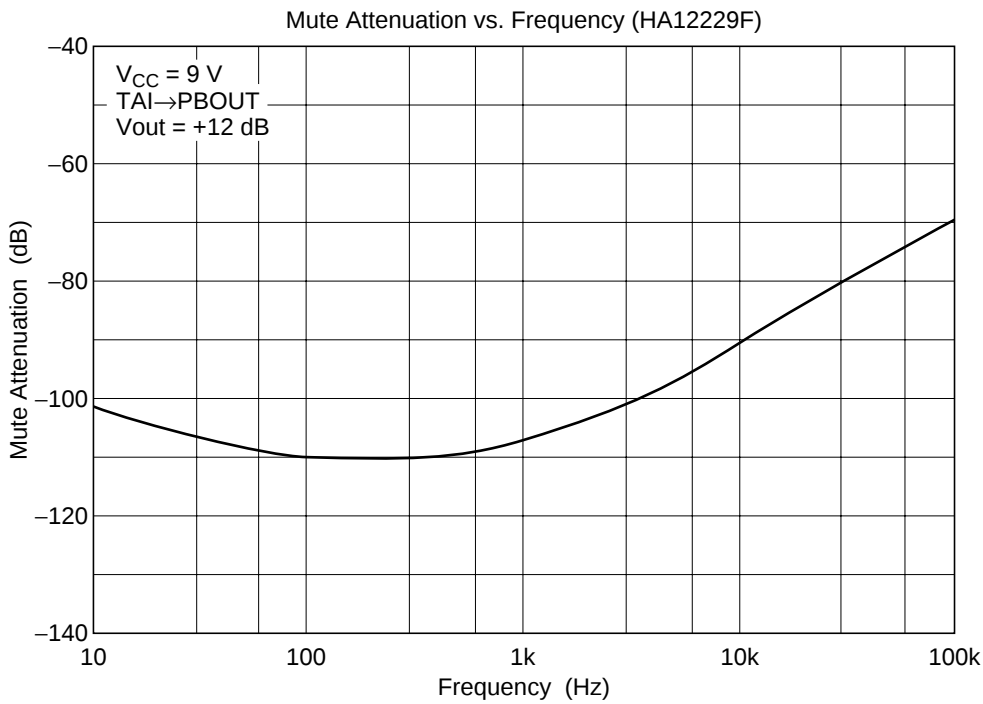


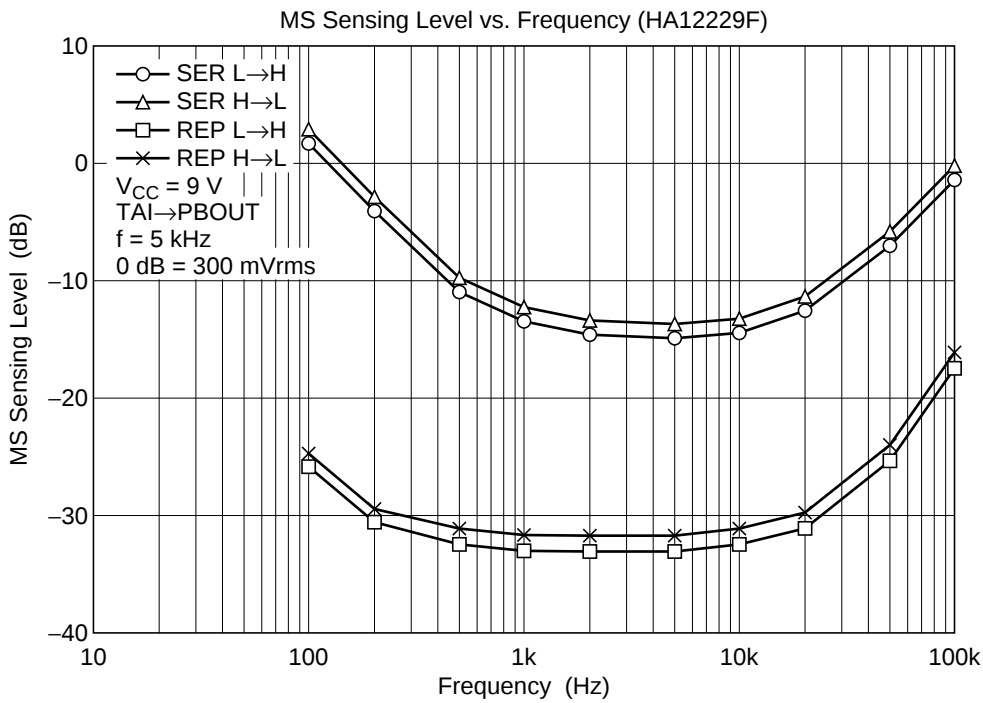
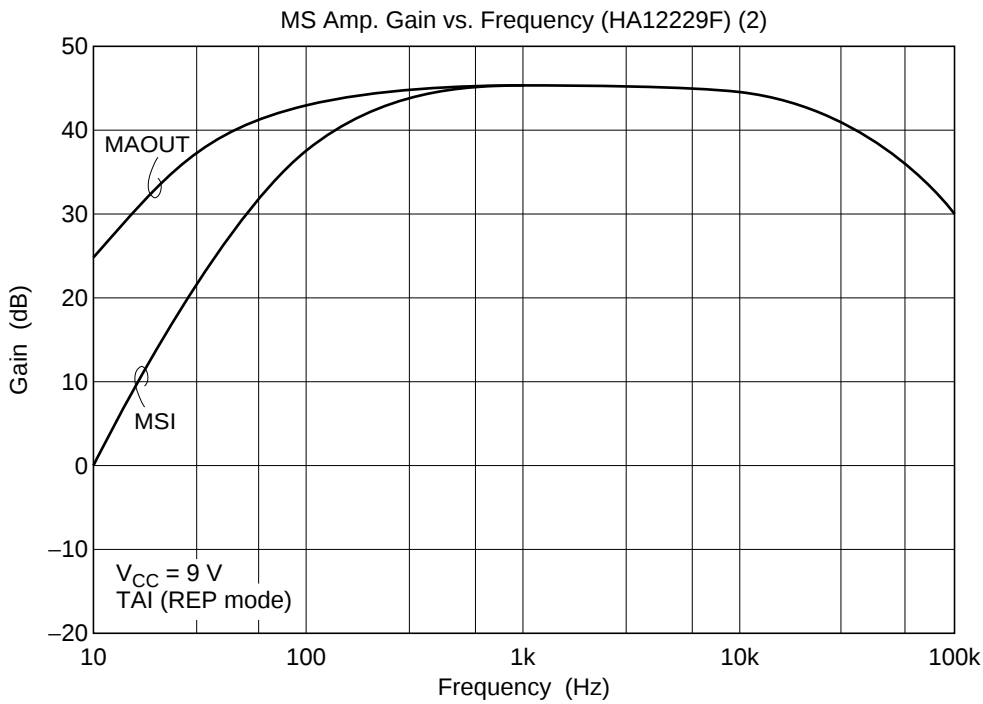


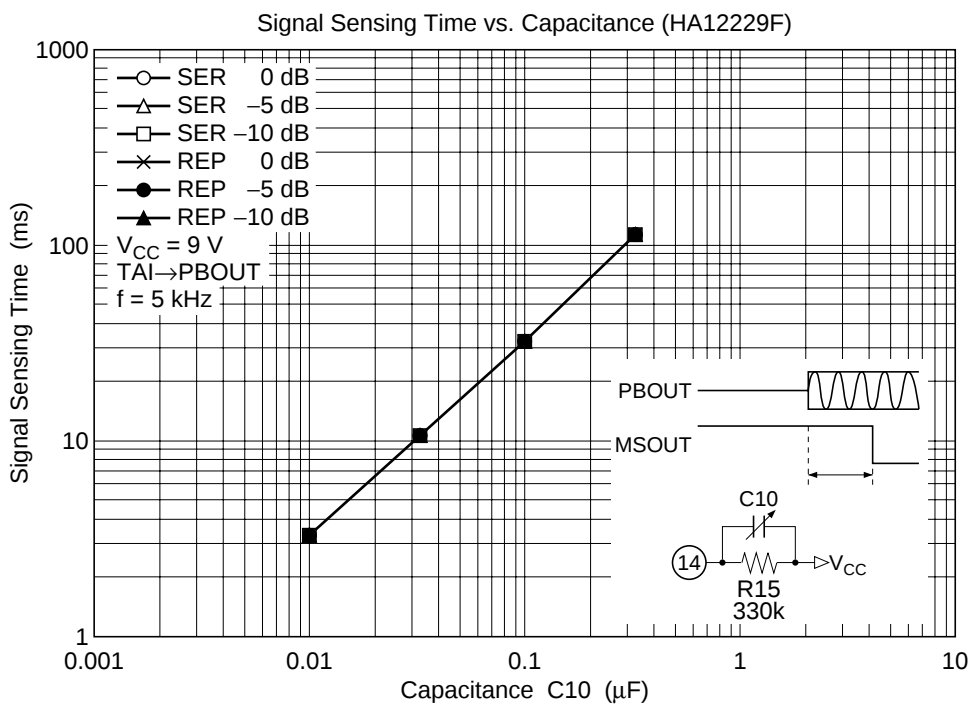
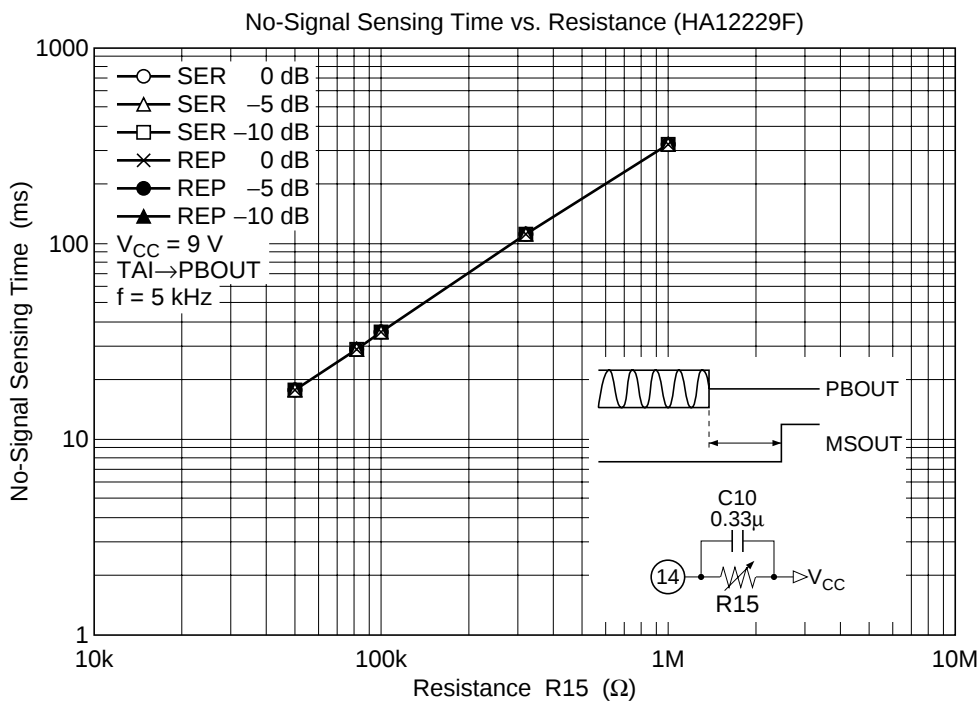






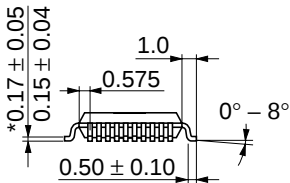
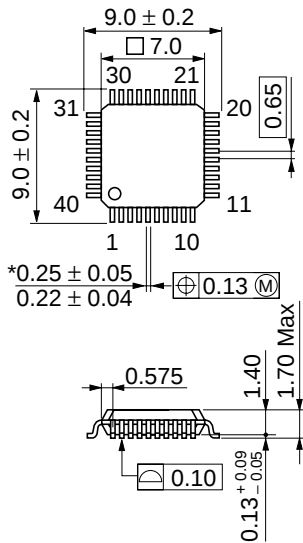






Package Dimensions

Unit: mm



*Dimension including the plating thickness
Base material dimension

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

Cautions

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