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Renesas Technology Corp.
Customer Support Dept.
April 1, 2003

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HA12216F/HA12221F Series

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



ADE-207-254E (Z)

6th Edition
Dec. 2000

Description

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

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

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

2. HA12221F series does not include Dolby B NR.

Functions

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

Features

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

HA12216F/HA12221F Series

Ordering Information

Operating Voltage

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

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

Standard Level

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

Function

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

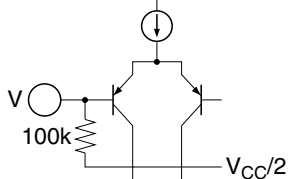
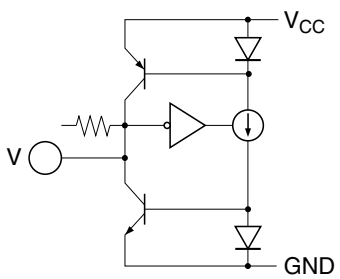
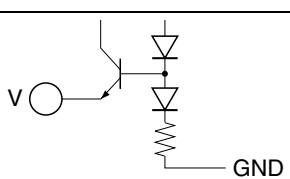
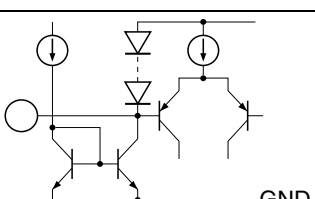
Parallel-Data Format

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

Note: Non connection regarding HA12221F series.

HA12216F/HA12221F Series

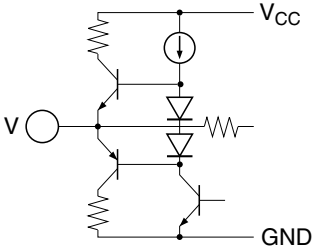
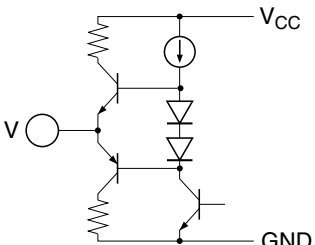
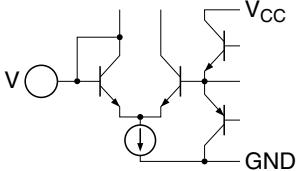
Pin Description, Equivalent Circuit ($V_{CC} = 9\text{ V}$, A system of single supply voltage, $T_a = 25^\circ\text{C}$, No Signal, The value in the show typical value.)

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

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

HA12216F/HA12221F Series

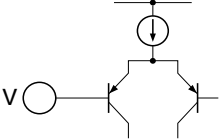
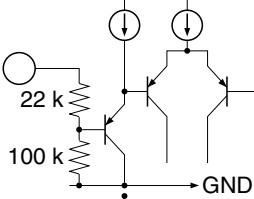
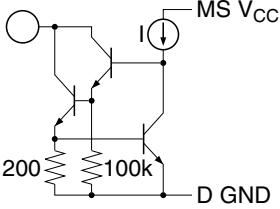
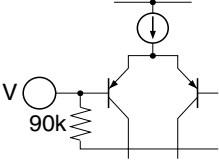
Pin Description, Equivalent Circuit ($V_{CC} = 9\text{ V}$, A system of single supply voltage, $T_a = 25^\circ\text{C}$, No Signal, The value in the show typical value.) (cont)

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

Note: 1. MS: Music Sensor

HA12216F/HA12221F Series

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

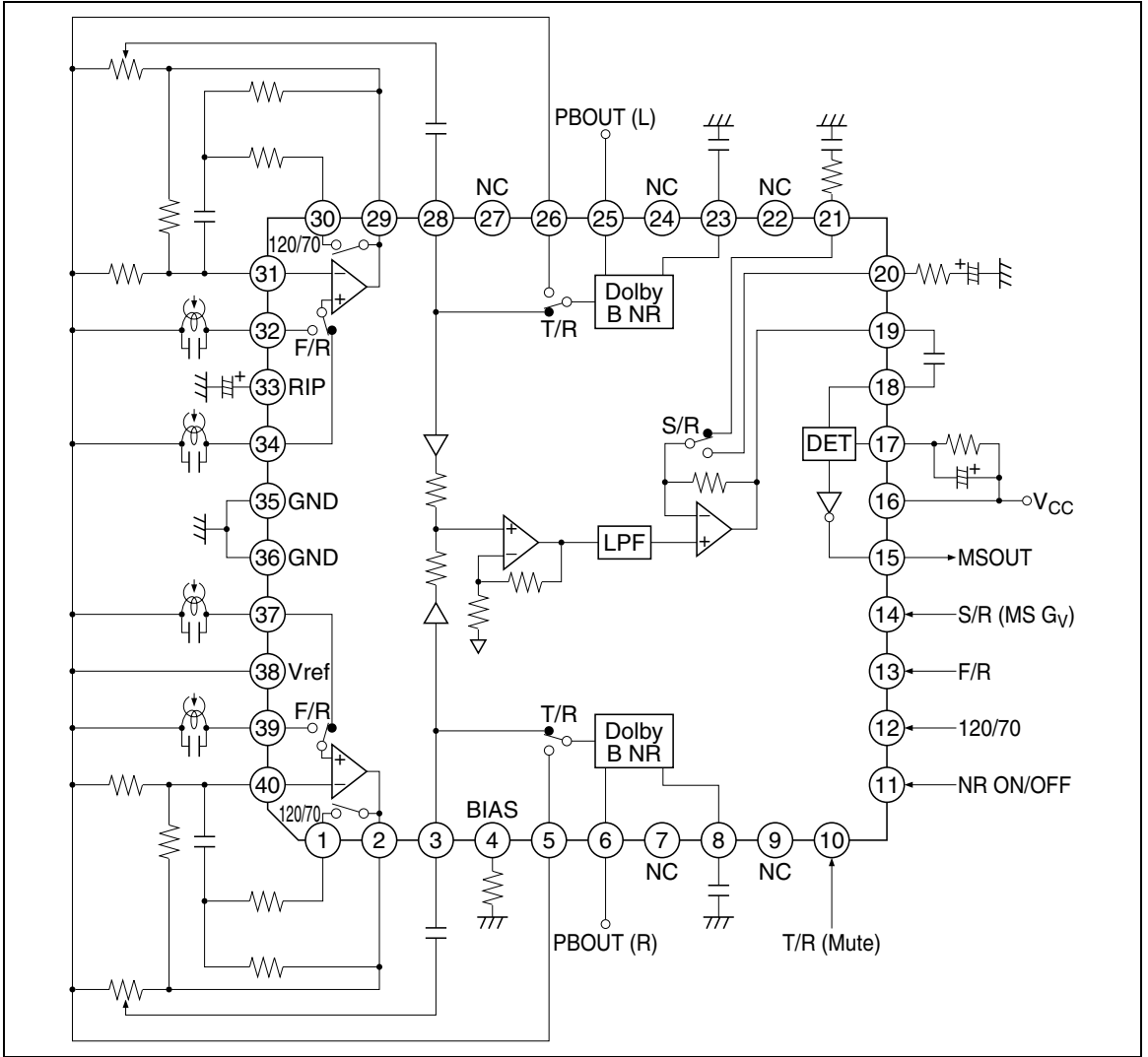
Pin No.	Terminal Name	Note	Equivalent Circuit	Pin Description
34	FIN (L)	—		Equalizer input (Forward)
37	FIN (R)			
32	RIN (L)			Equalizer input (Reverse)
39	RIN (R)			
31	NFI (L)			Negative feedback
40	NFI (R)			
10	T/R (Mute)	—		Mode control input
11 ^{*2}	NR ON/OFF			
12	120/70			
13	F/R			
14	S/R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

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

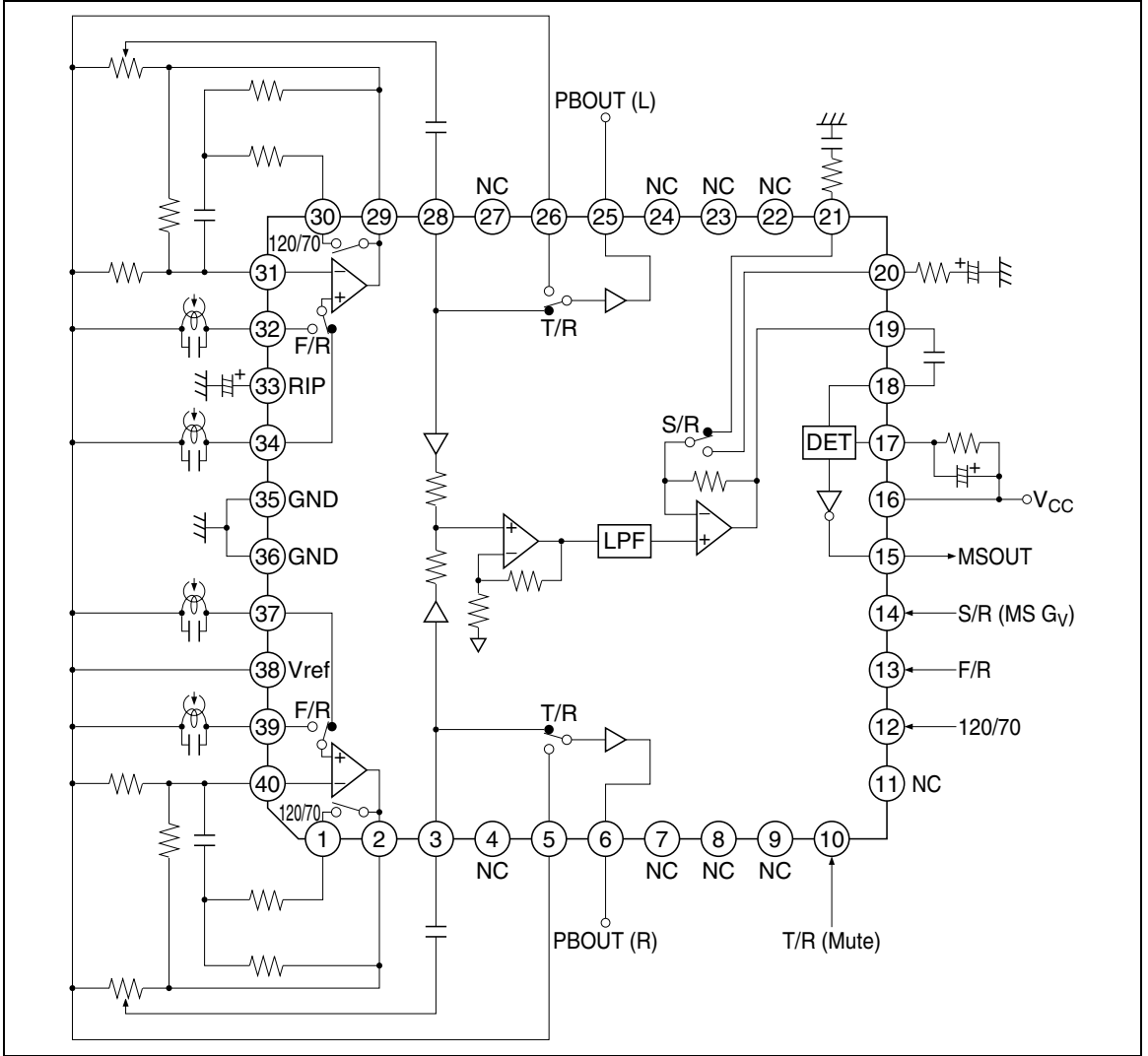
HA12216F/HA12221F Series

Block Diagram

HA12216F Series



HA12221F Series



HA12216F/HA12221F Series

Functional Description

Power Supply Range

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

Table 1 Supply Voltage Range

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

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

Reference Voltage

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

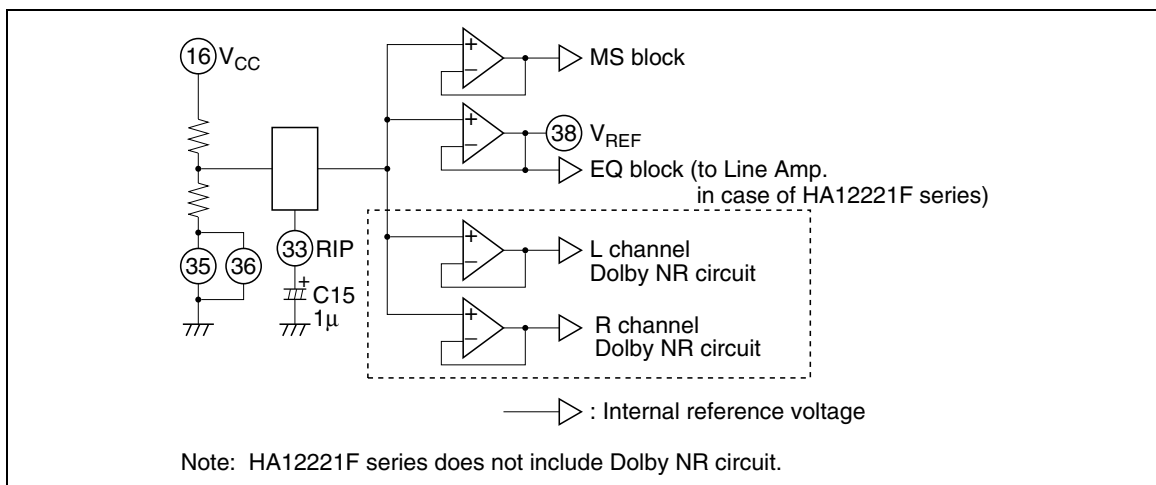


Figure 1 The Block Diagram of Reference Supply Voltage

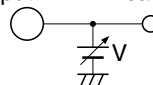
Operating Mode Control

HA12216F/HA12221F series provides fully electronic switching circuits. And each operating mode control are controlled by parallel data (DC voltage).

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

Table 2 Threshold Voltage (V_{TH})

Pin No.	Lo	Hi	Unit	Test Condition
10, 11*, 12, 13, 14	-0.2 to 1.0	3.5 to V_{CC}	V	Input Pin Measure



Note: * Non connection regarding HA12221F series.

Table 3 Switching Truth Table

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

Notes: * Non connection regarding HA12221F series.

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

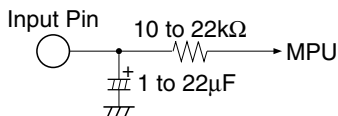


Figure 2 Interface for Reduction of Pop Noise

HA12216F/HA12221F Series

Input Block Diagram and Level Diagram

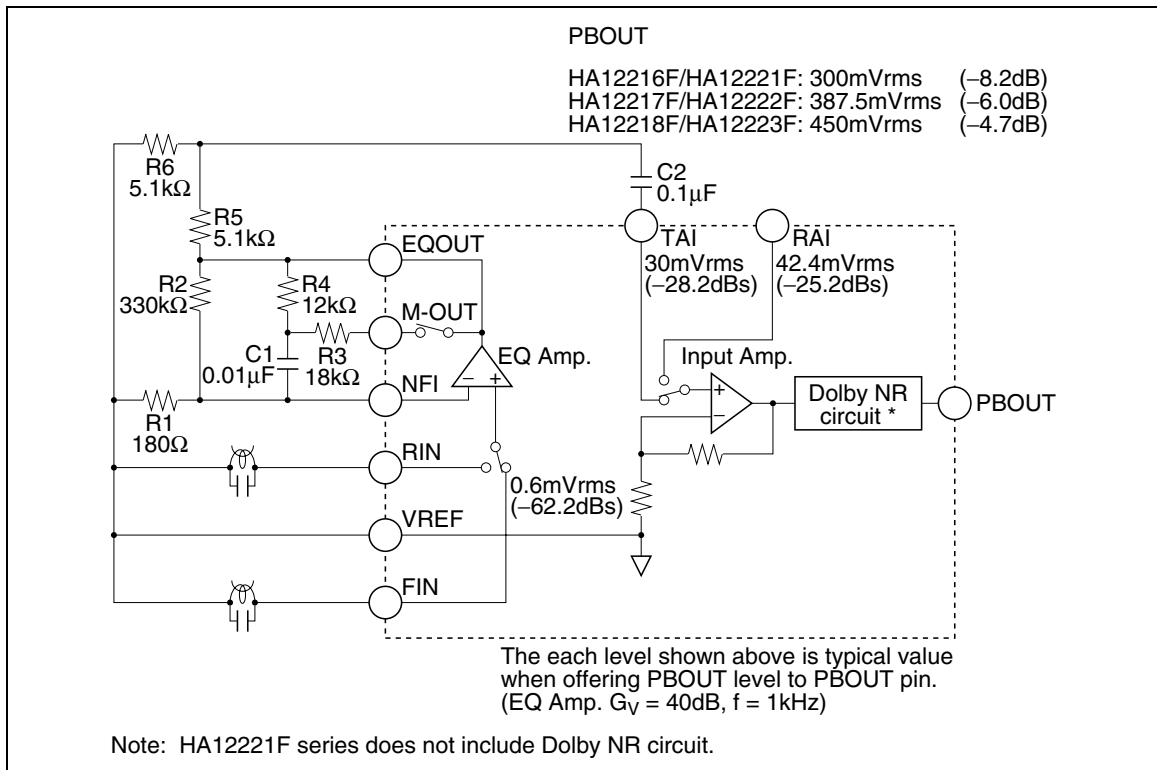


Figure 3 Input Block Diagram

Adjustment of Playback Reference Operate Level

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

The Sensitivity Adjustment of Music Sensor

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

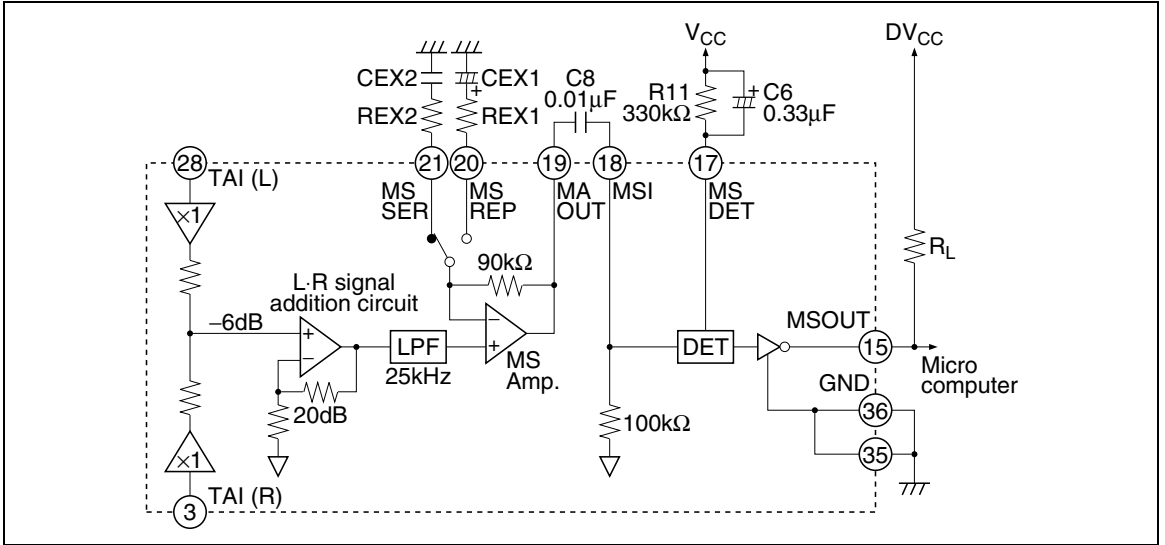


Figure 4 Music Sensor Block Diagram

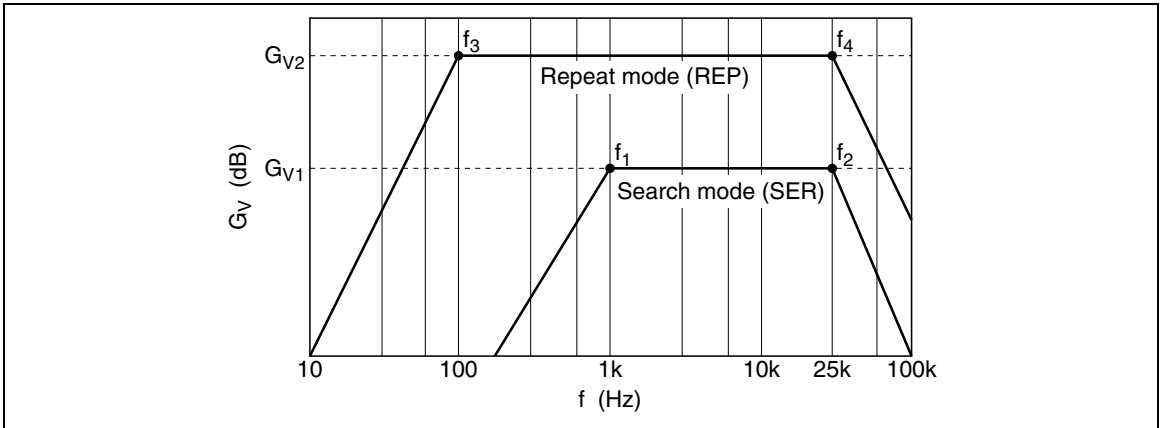


Figure 5 Frequency Response

HA12216F/HA12221F Series

1. Search mode

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

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

2. Repeat mode

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

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

G_{VIA} : L-R signal addition circuit gain.

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

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

- 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 k Ω	0.01 μ F	33.5 dB	663 Hz	25 kHz	-14.8 dB	-20.8 dB
Repeat mode	2.4 k Ω	1 μ F	51.7 dB	66.3 Hz	25 kHz	-33.0 dB	-39.0 dB

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

Music Sensor Time Constant

- Sensing no signal to signal (Attack) is determined by C6, 0.01 μ F to 1 μ F capacitor C6 can be applicable.
- Sensing signal to no signal (Recovery) is determined by C6 and R11, however preceding (1), 100 k Ω to 1 M Ω 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 HA12216F Series)

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

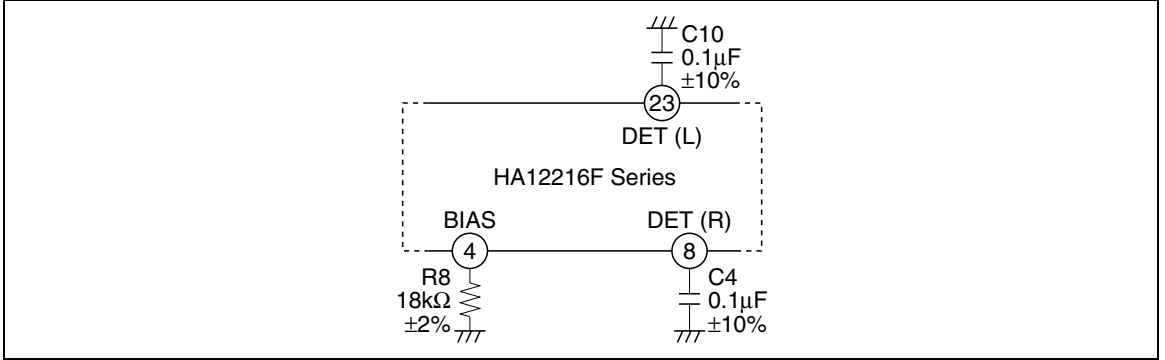


Figure 6 Tolerance of External Components

Countermeasure of a Cellular Phone Noise

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

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

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

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

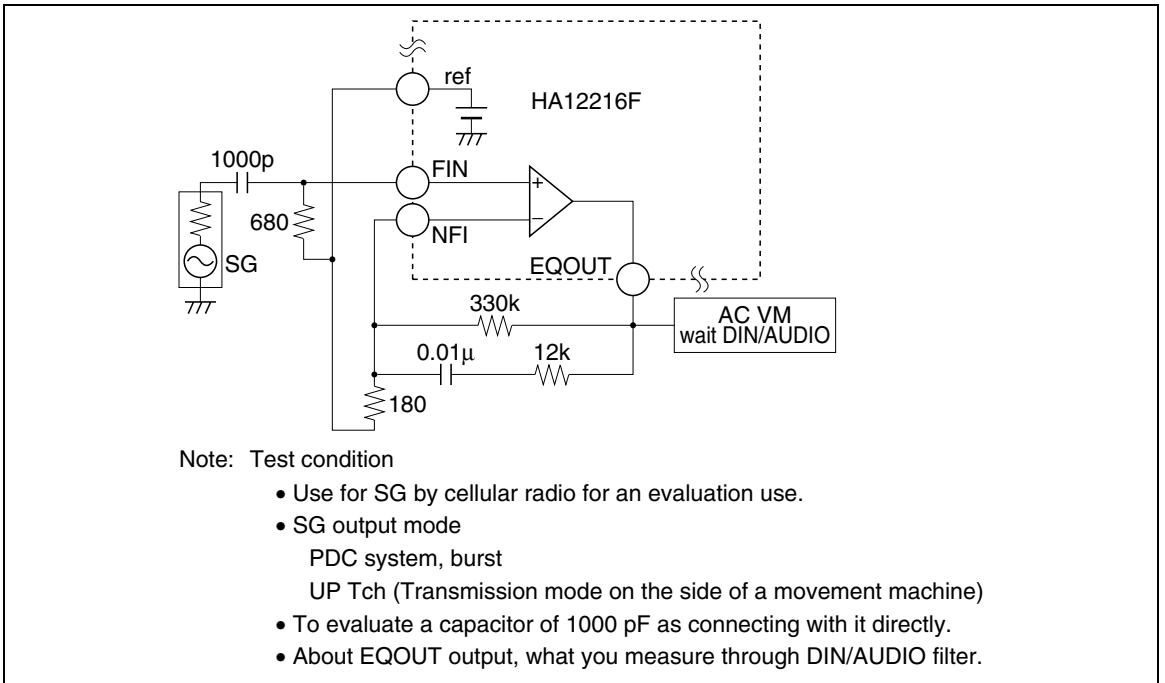


Figure 7 Test Circuit

HA12216F/HA12221F Series

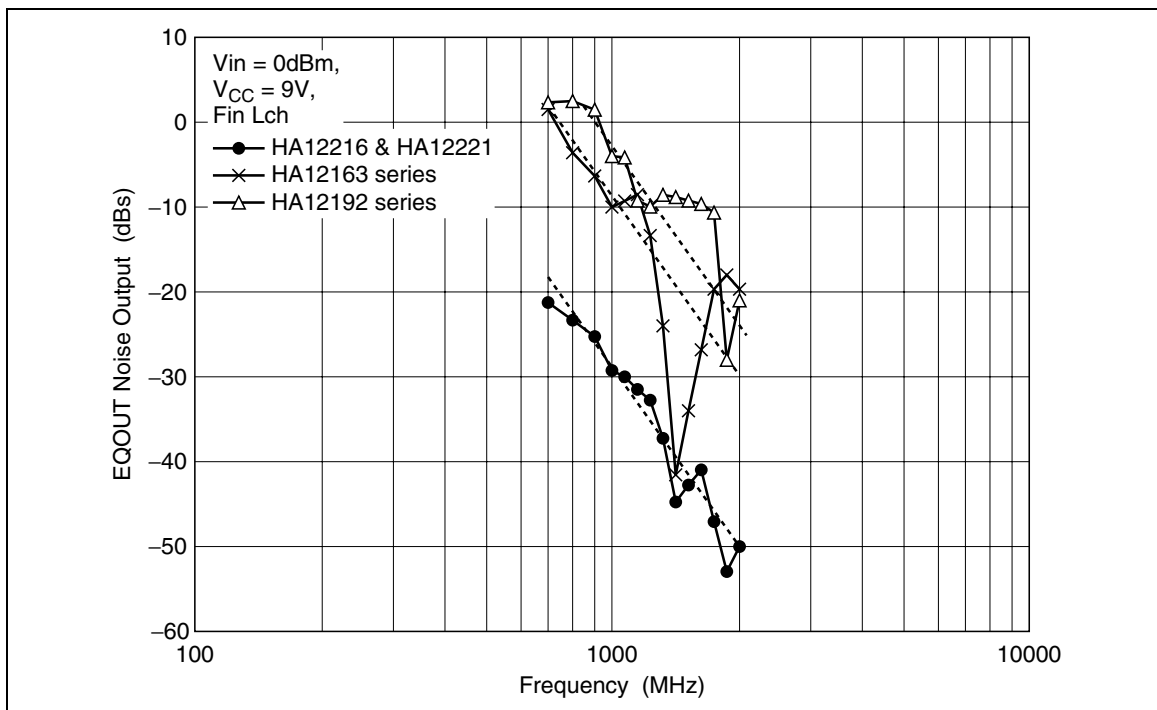


Figure 8 EQOUT Noise Output vs. Transmission Frequency Characteristic

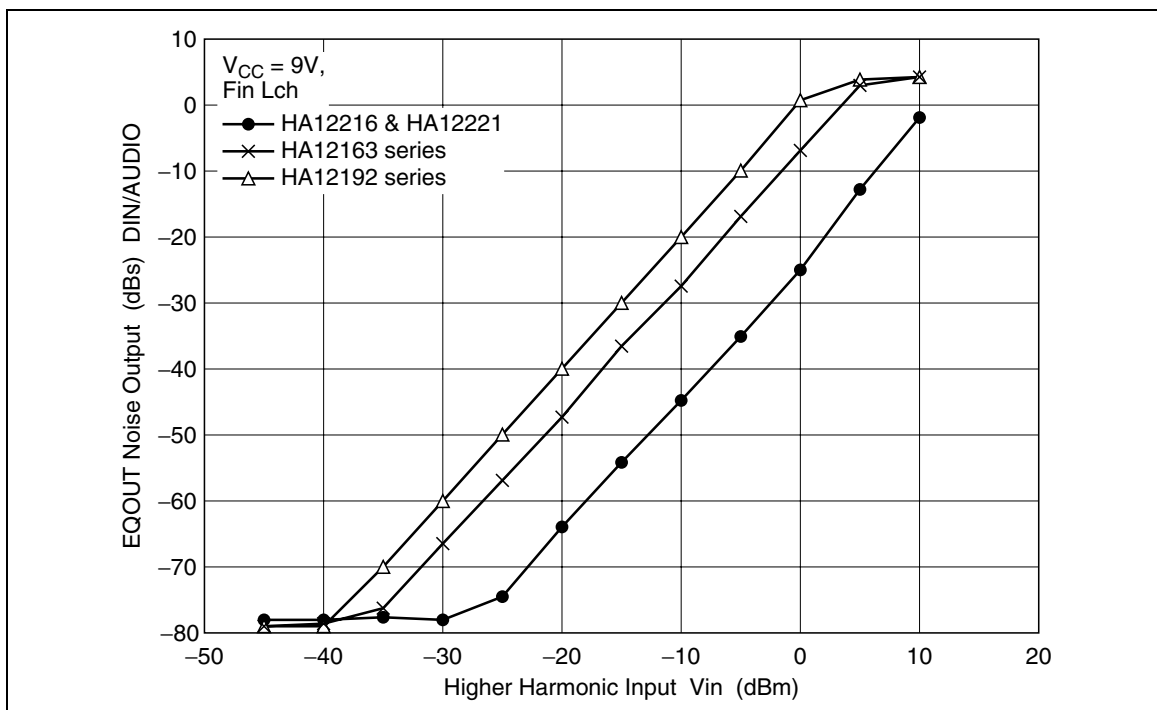


Figure 9 EQOUT Noise Output vs. Transmission

Absolute Maximum Ratings (Ta = 25°C)

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

HA12216F/HA12221F Series

Electrical Characteristics

HA12216F Series

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

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

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



HA12221F Series

(Ta = 25°C, Vcc = 9.0 V, PBOUIT Level 300 mVrms(HA12221F), 387.5 mVrms(HA12222F), 450 mVrms(HA12223F))

Item	Symbol	IC Condition						Test Condition						Application Terminal																		
		120μ/70μ		F/R		T/R		S/R		Input		Output		PBOUIT level (dB)		Min		Typ		Max		Unit		Input		Output		Remark				
		F	T	F	T	F	T	F	T	f _{in} (Hz)	Output	PBOUIT level (dB)	f _{in} (Hz)	Output	min	max	min	typ	max	min	typ	max	R	L	R	L						
Quiescent current	I _Q	70μ	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		16			
Input Amp. gain	HA12221F	G _{VIA} TAI	—	—	T	—	TAI	PBOUIT	1k	0	—	—	—	—	No signal	19.0	20.0	21.0	16.0	17.0	18.0	3	28	6	25	—	—	—	—			
	HA12222F	G _{VIA} RAI	—	—	R	—	RAI	PBOUIT	1k	0	—	—	—	—	—	21.2	22.2	23.2	18.2	19.2	20.2	5	26	—	—	—	—	—	—			
		G _{VIA} TAI	—	—	R	—	TAI	PBOUIT	1k	0	—	—	—	—	—	22.5	23.5	24.5	19.5	20.5	21.5	3	28	—	—	—	—	—	—	—		
	HA12223F	G _{VIA} TAI	—	—	T	—	TAI	PBOUIT	1k	0	—	—	—	—	—	19.5	20.5	21.5	15.0	16.0	17.0	3	28	6	25	—	—	—	—	—		
PBOUIT offset	V _{ofs}	—	—	T↔R	—	—	—	PBOUIT	1k	—	—	—	—	V _{CC} =12V, No signal	-15.0	0.0	15.0	70.0	80.0	—	3	28	6	25	—	—	—	—	—			
Signal handling	V _{o max}	—	—	T	—	TAI	PBOUIT	1k	—	—	—	—	—	THD=1%	12.0	13.0	—	50.0	60.0	—	3	28	6	25	—	—	—	—	—	1		
Signal to noise ratio	S/N	—	—	T	—	TAI	PBOUIT	(1k)	(0)	(0)	—	—	—	Fg=10kΩ, CCI/ARM	70.0	80.0	—	70.0	80.0	—	(3)	(28)	6	25	—	—	—	—	—	—		
T.H.D.	THD	—	—	T	—	TAI	PBOUIT	1k	0	—	—	—	—	—	—	—	—	—	—	—	3	28	6	25	—	—	—	—	—	—		
Channel separation	CT RL (1)	—	—	R	—	RAI	PBOUIT	1k	(+12)	—	—	—	—	—	—	—	—	—	—	—	3	28	6	25	—	—	—	—	—	—		
	CT RL (2)	120μ	F	T	—	FIN	PBOUIT	1k	(+12)	—	—	—	—	—	—	—	—	—	—	—	37	34	—	—	—	—	—	—	—	—		
Crosstalk	CT EQ→RAI	120μ	F	T→R	—	FIN	PBOUIT	1k	(+12)	—	—	—	—	—	—	—	—	—	—	—	37	34	6	25	—	—	—	—	—	—		
	CT RAI→EQ	120μ	F	R→T	—	RAI	PBOUIT	1k	(+12)	—	—	—	—	—	—	—	—	—	—	—	5	26	—	—	—	—	—	—	—	—		
PB-EQ gain	G _V EQ 1k	120μ	F/R	—	—	FIN/RIN	EQOUT	1k	—	—	—	—	—	V _{in} =0.6mVrms	37.0	40.0	43.0	33.0	36.0	39.0	37	34	—	—	—	—	—	—	—	—		
	G _V EQ 10k(1)	120μ	F	—	—	FIN	EQOUT	10k	—	—	—	—	—	—	29.0	32.0	35.0	29.0	32.0	35.0	37	34	—	—	—	—	—	—	—	—		
	G _V EQ 10k(2)	70μ	F	—	—	FIN	EQOUT	10k	—	—	—	—	—	—	—	—	—	—	—	—	37	34	—	—	—	—	—	—	—	—		
PB-EQ Max output level	V _{OM}	120μ	F/R	—	—	FIN	EQOUT	1k	—	—	—	—	—	THD=1%	300	600	—	300	600	—	37/39	34/32	2	29	—	—	—	—	—	—	1	
PB-EQ THD	THD-EQ	120μ	F/R	—	—	FIN/RIN	EQOUT	1k	—	—	—	—	—	V _{in} =3mVrms	—	0.1	0.3	—	—	—	37/39	34/32	2	29	—	—	—	—	—	—	—	
Noise level converted in input	V _N	120μ	F/R	—	—	FIN/RIN	EQOUT	(1k)	—	—	—	—	—	Fg=680Ω, DIN-AUDIO	—	0.7	1.5	—	—	—	(37/39)	(34/32)	2	29	—	—	—	—	—	—	—	
MS sensitivity level	V _{ON} (1)	—	—	T	R	TAI	PBOUIT	5k	—	—	—	—	—	—	-36	-32	-28	-36	-32	-28	3	28	2	29	15	—	—	—	—	—	—	
	V _{ON} (2)	—	—	T	S	TAI	PBOUIT	5k	—	—	—	—	—	—	-18	-14	-10	-18	-14	-10	—	—	—	—	—	—	—	—	—	—	—	
MS output low level	V _{OL}	—	—	T	S	TAI	MSOUT	5k	0	—	—	—	—	—	—	—	—	—	—	—	3	28	—	—	—	—	—	—	—	—	—	
MS output leak current	I _{OH}	—	—	—	—	—	MSOUT	—	—	—	—	—	—	No signal	—	0.0	2.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
Control voltage	V _{IL}	—	—	—	—	—	—	—	—	—	—	—	—	—	-0.2	—	1.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	V _{IH}	—	—	—	—	—	—	—	—	—	—	—	—	—	3.5	—	V _{CC}	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

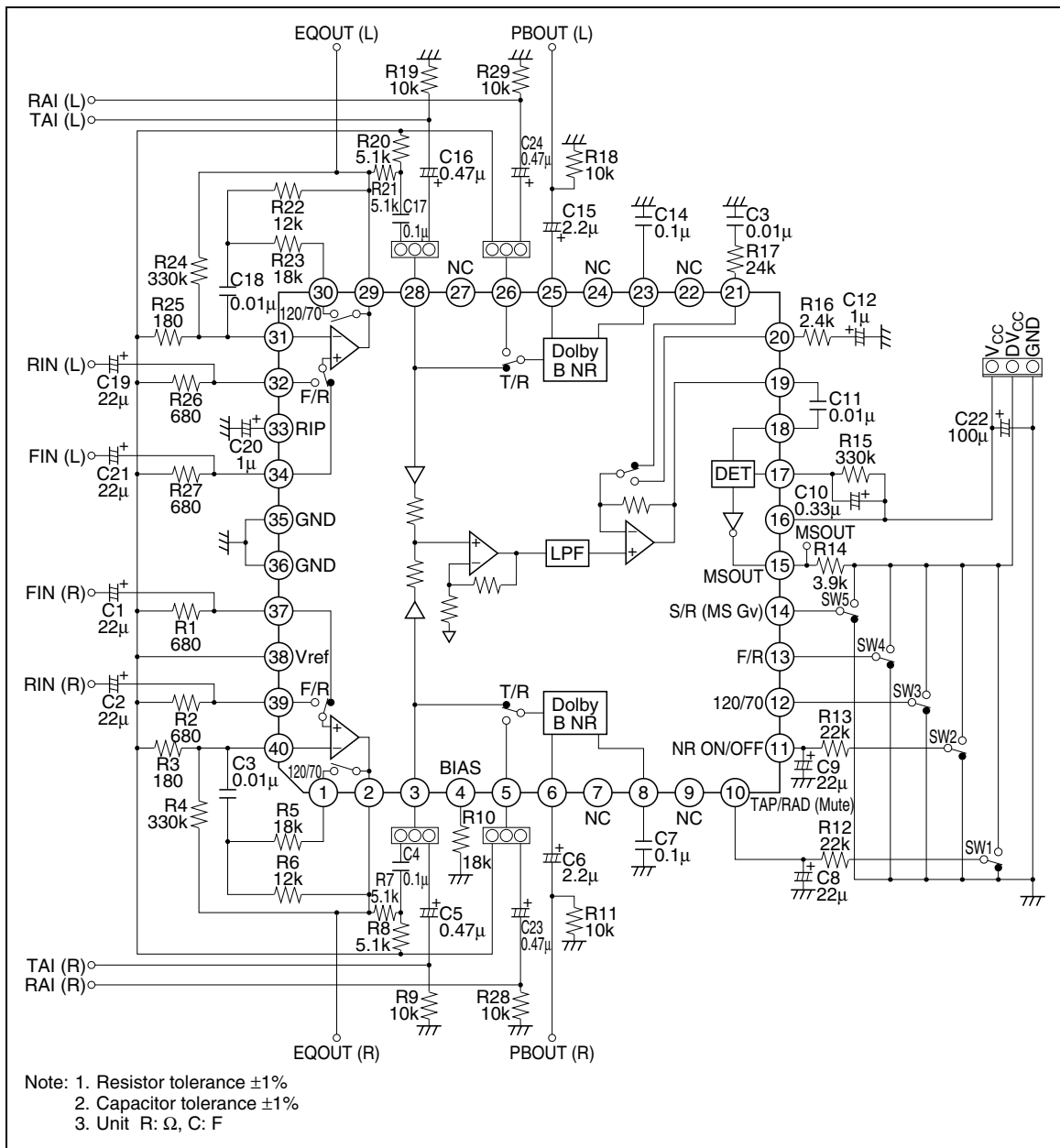
Note: 1. HA12221F: V_{CC} = 6.5V
 HA12222F: V_{CC} = 6.8V
 HA12223F: V_{CC} = 7.2V



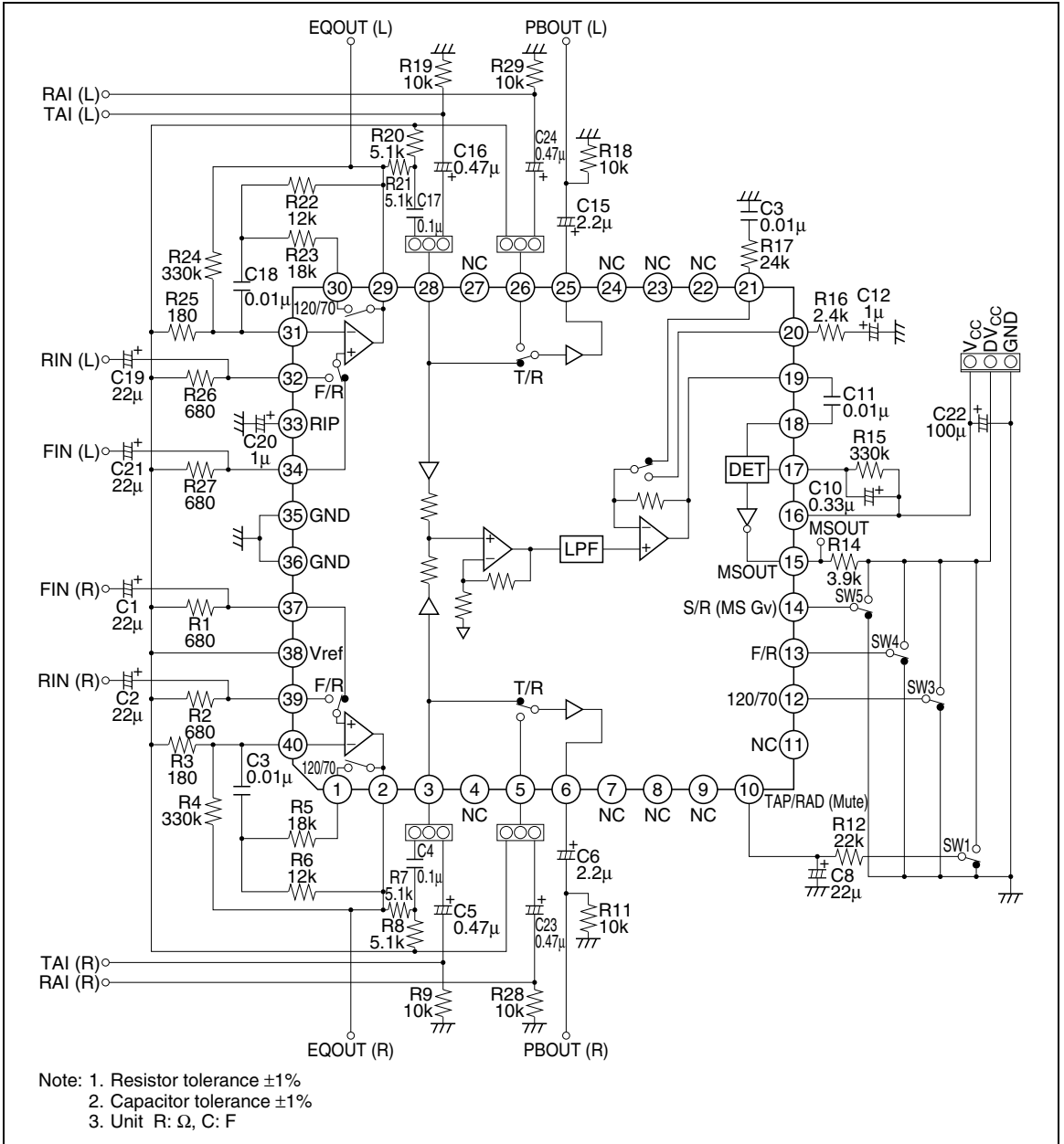
HA12216F/HA12221F Series

Test Circuit

HA12216F Series

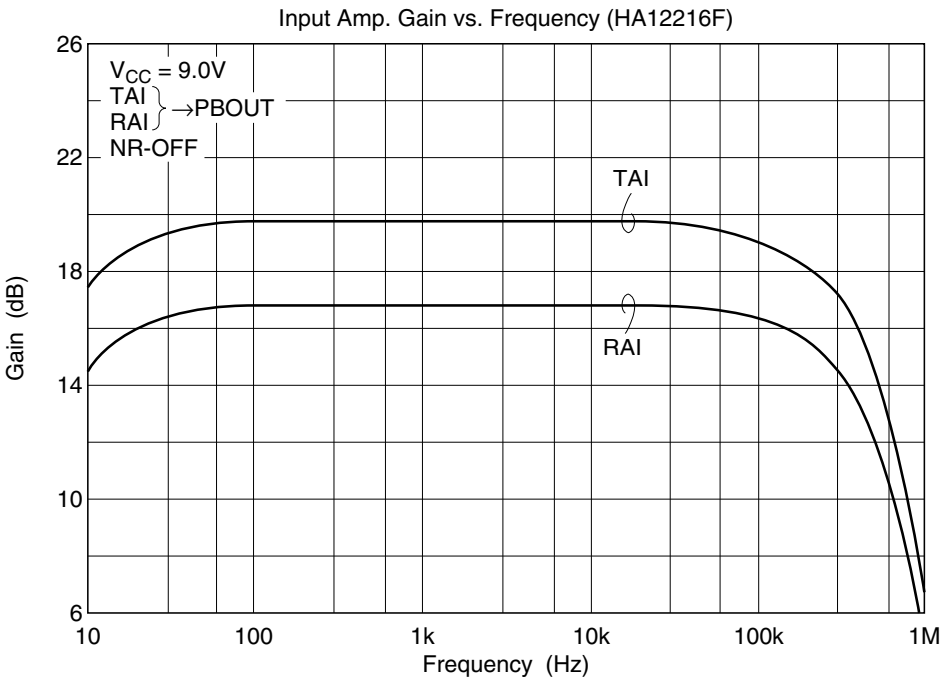
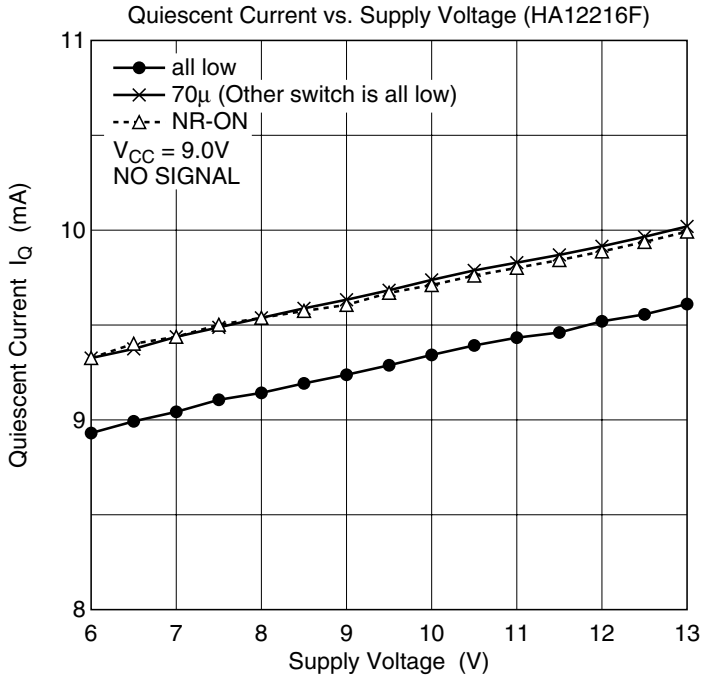


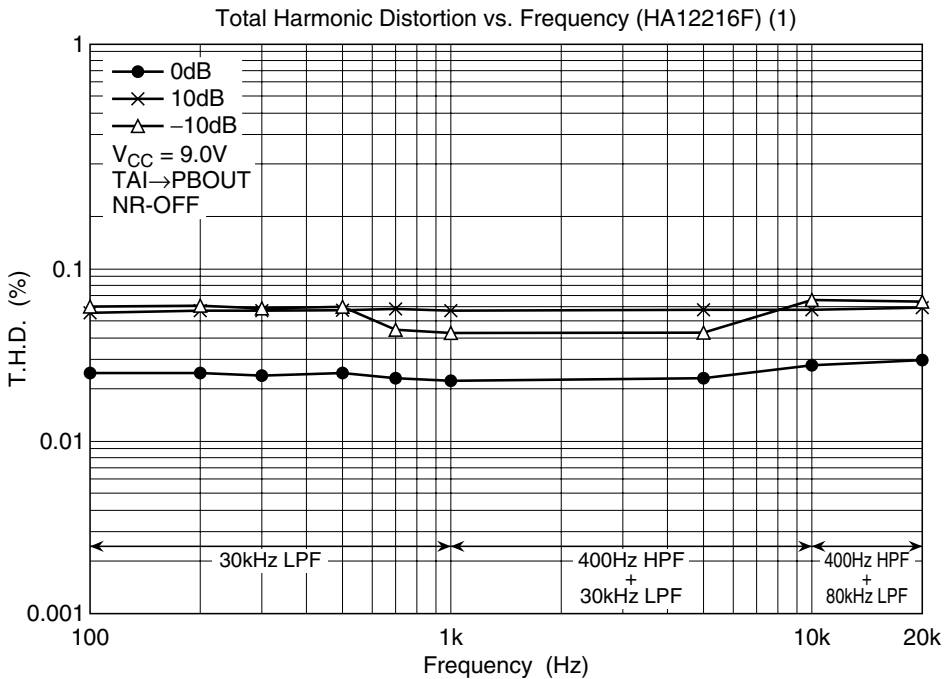
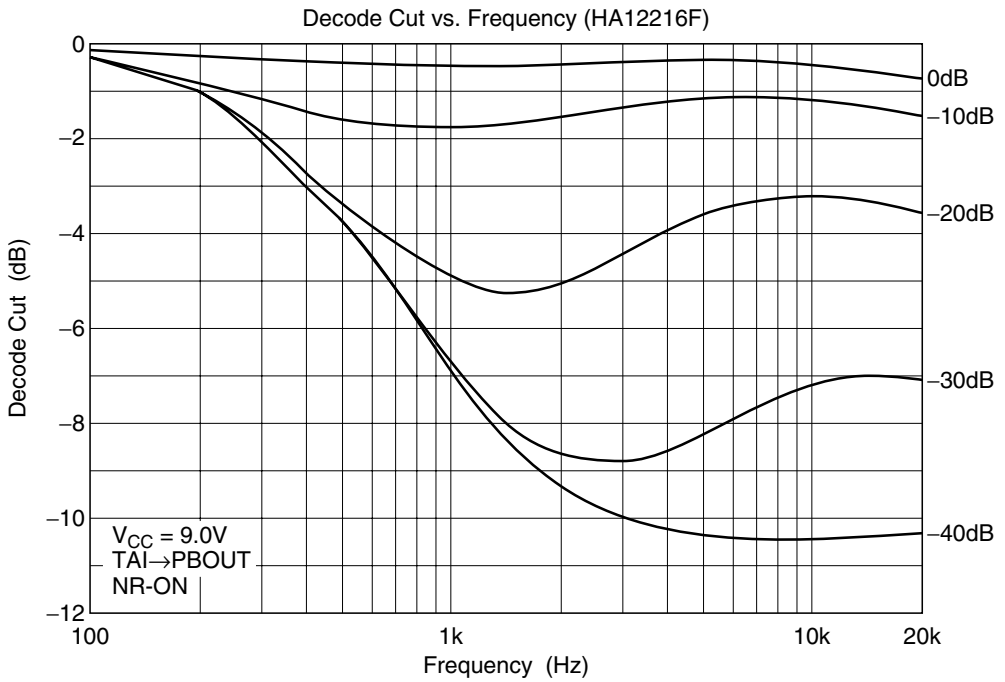
HA12221F Series



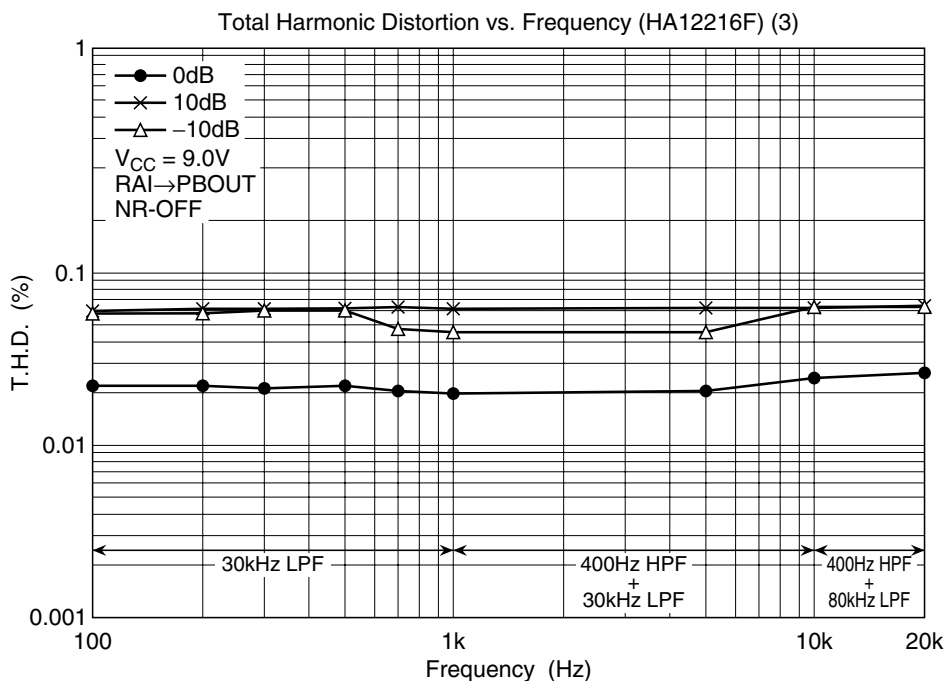
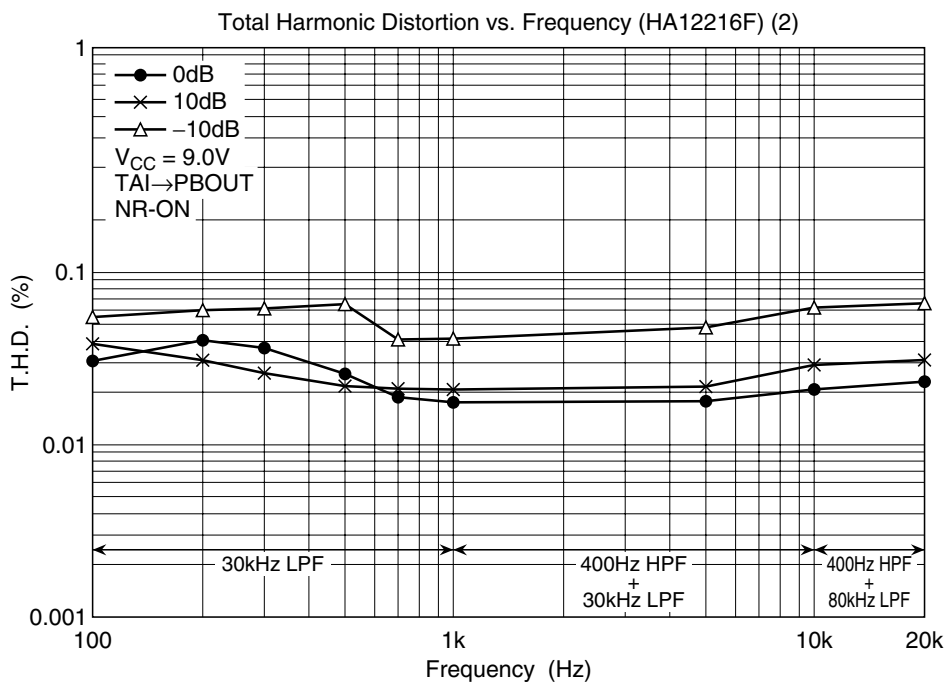
HA12216F/HA12221F Series

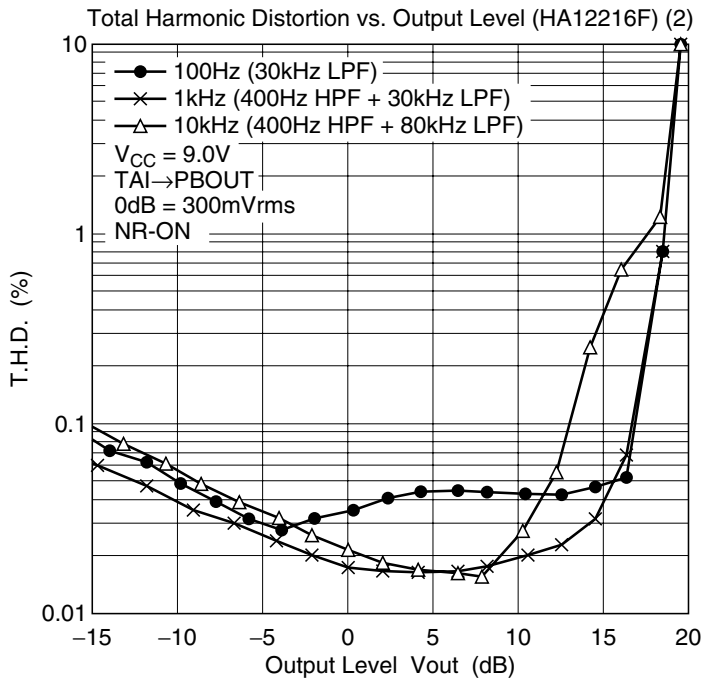
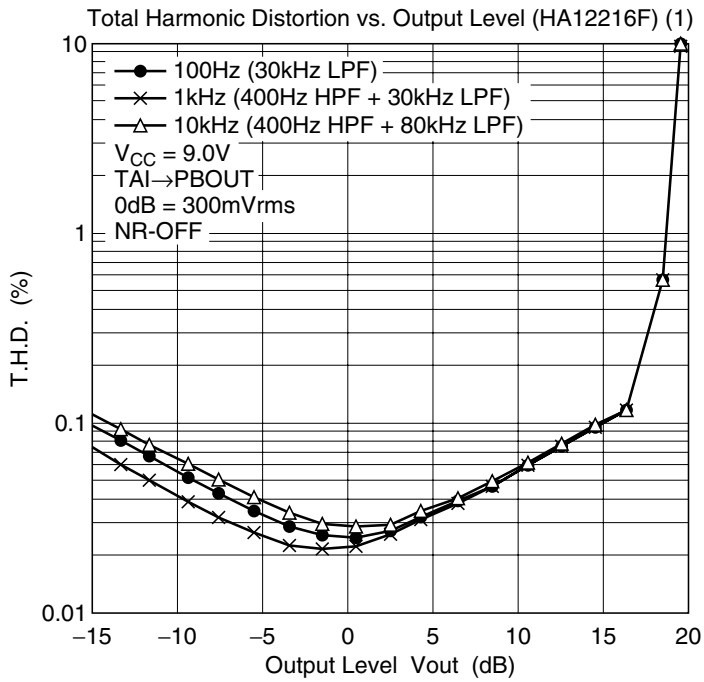
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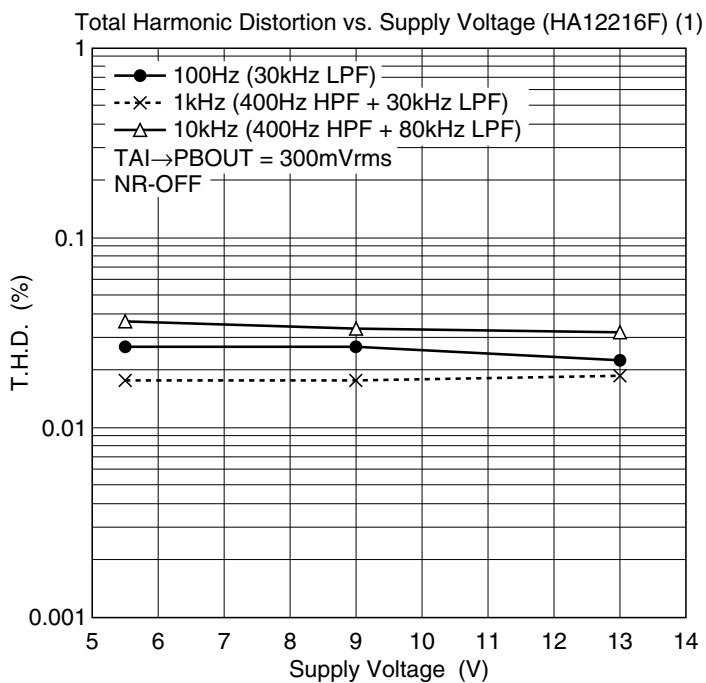
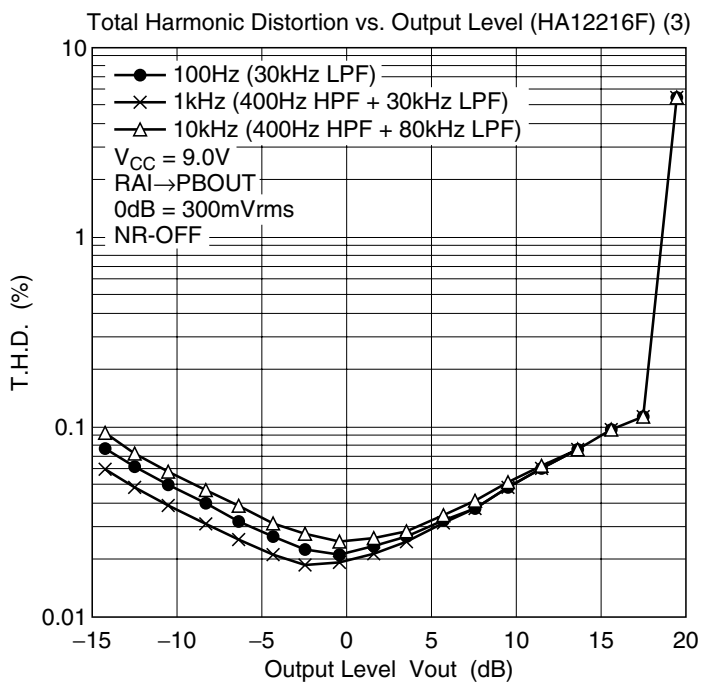


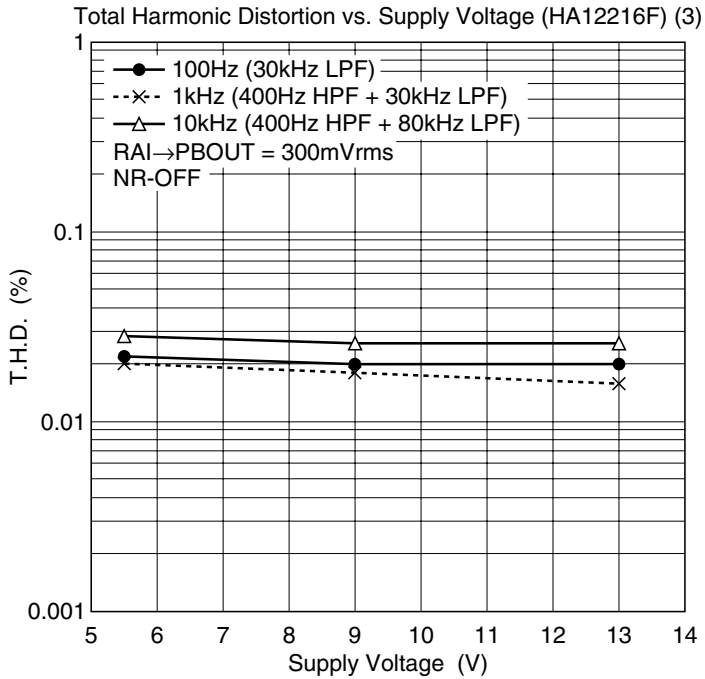
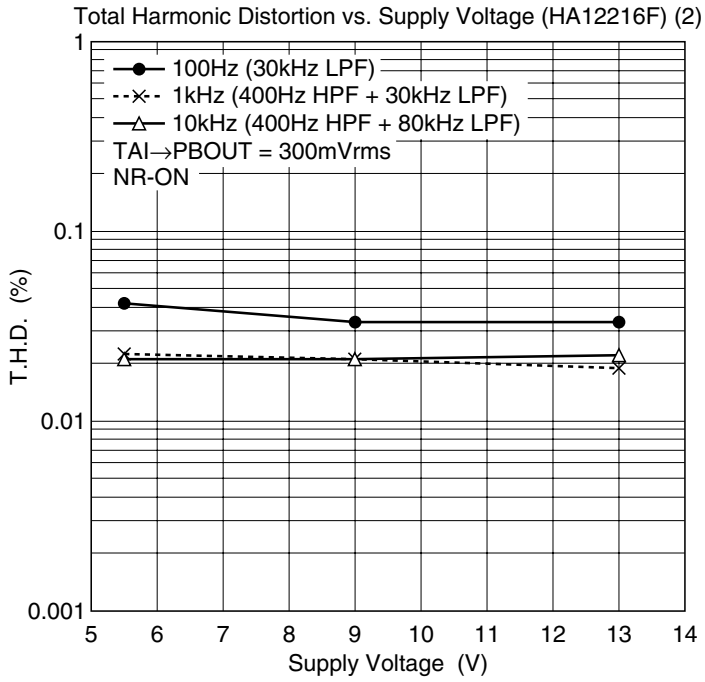
HA12216F/HA12221F Series

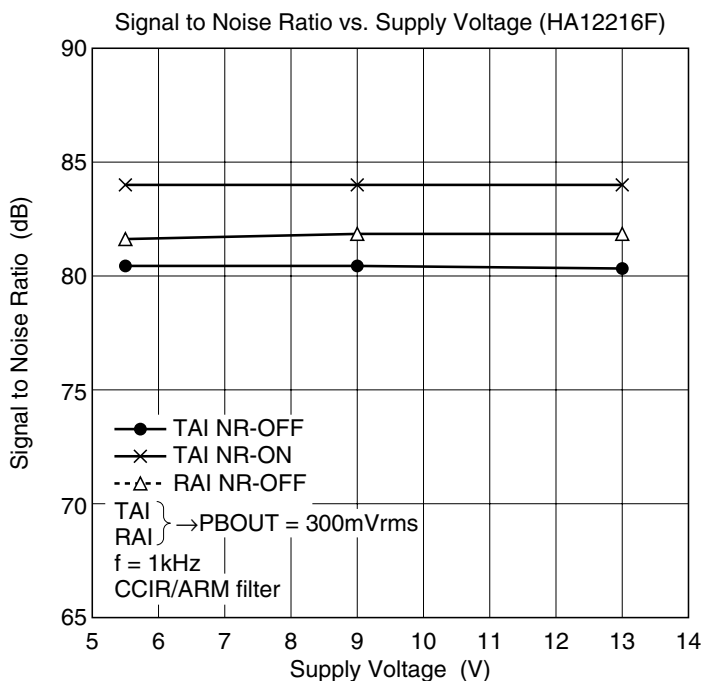
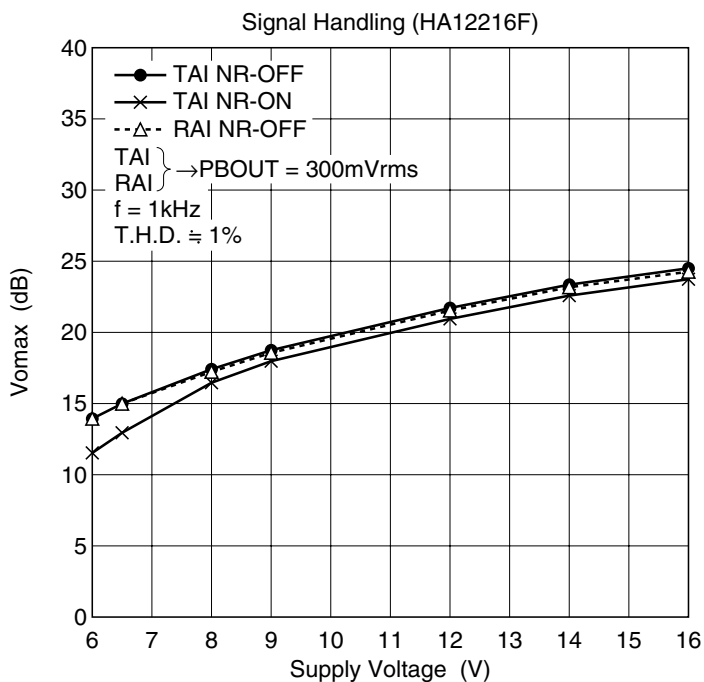


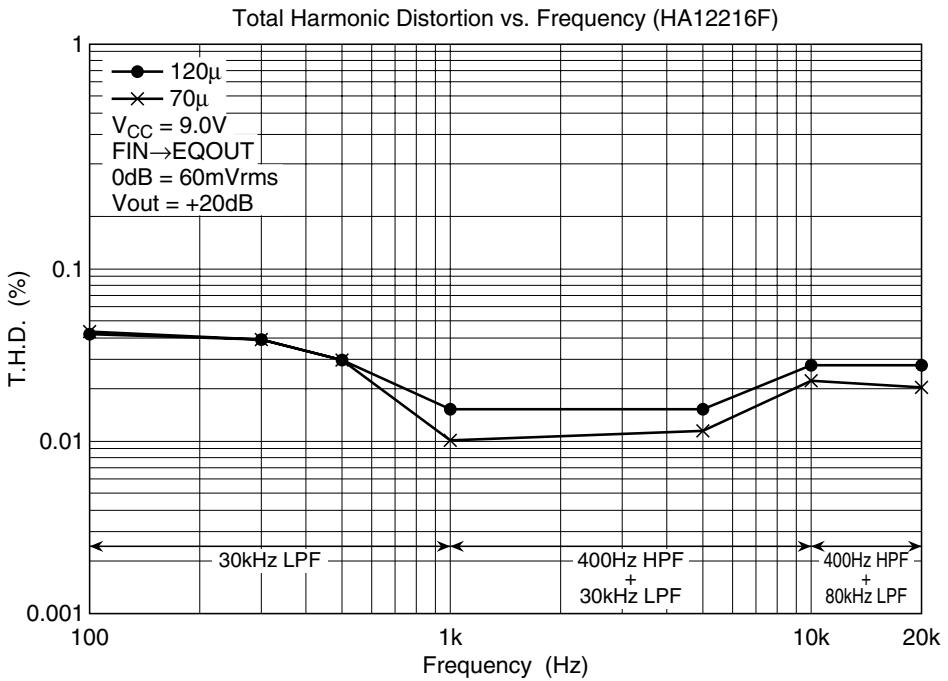
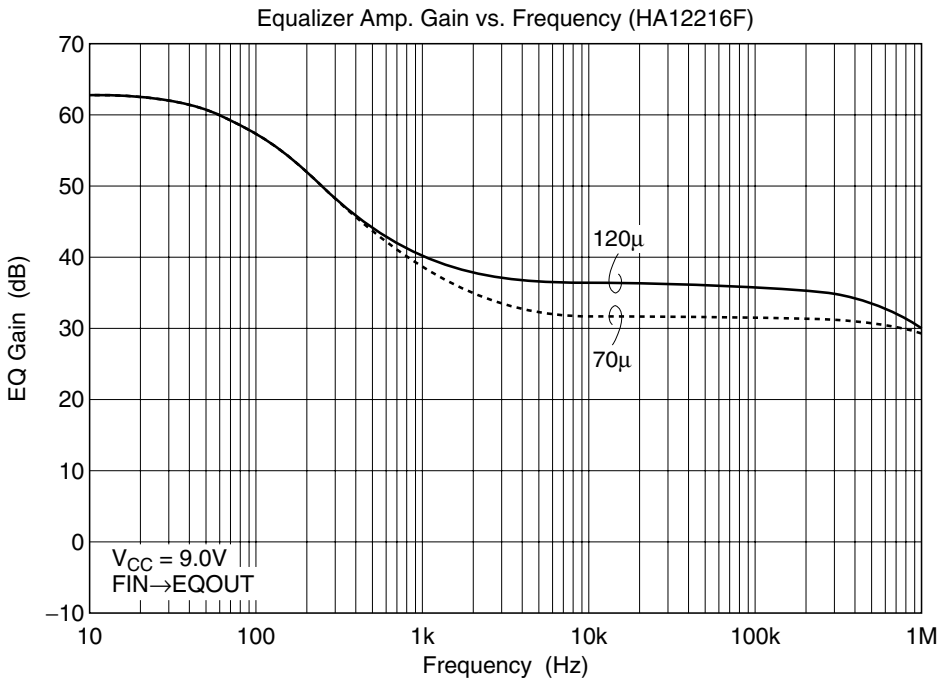


HA12216F/HA12221F Series

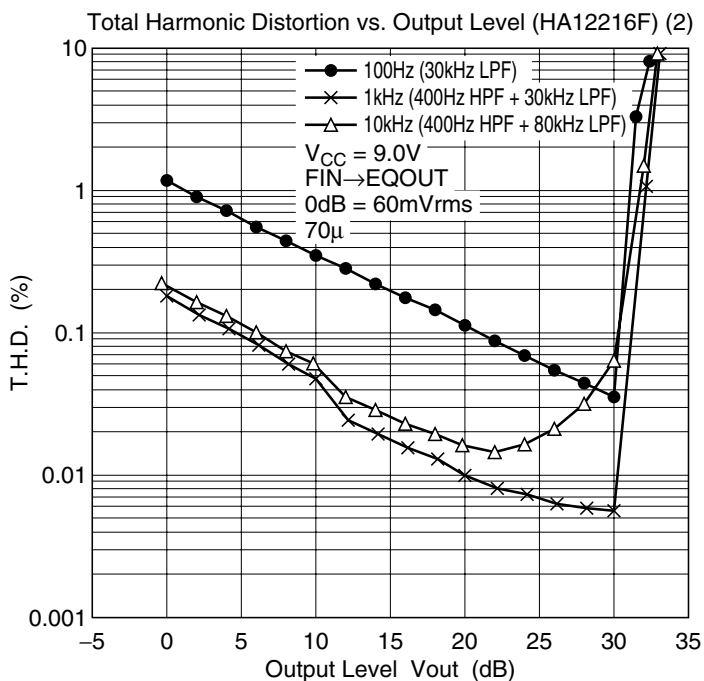
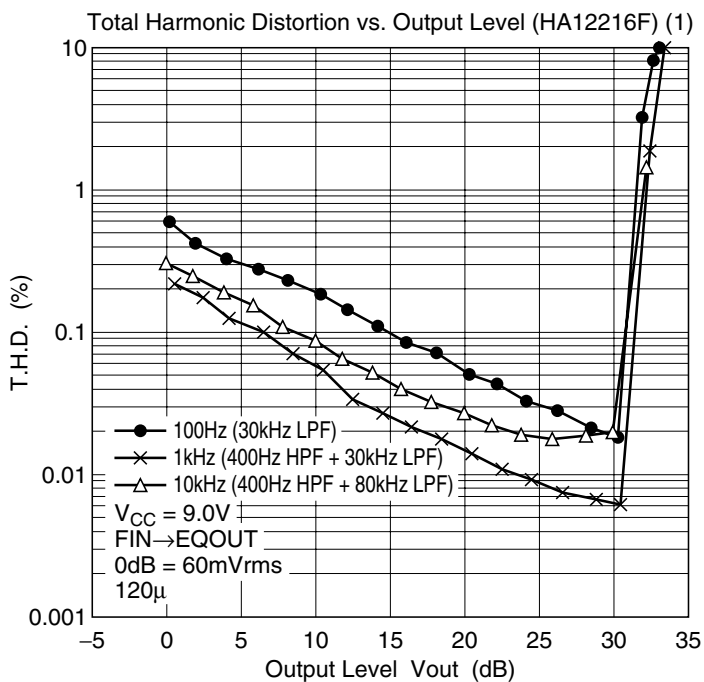


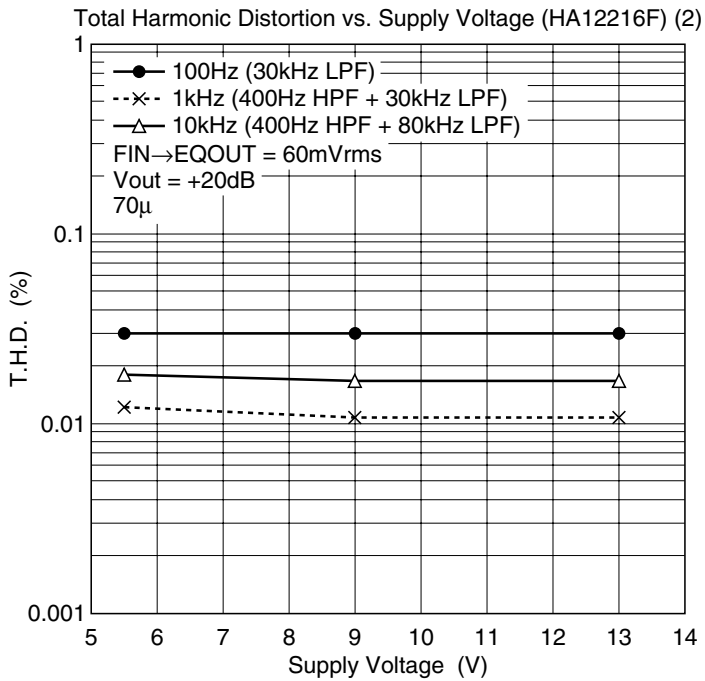
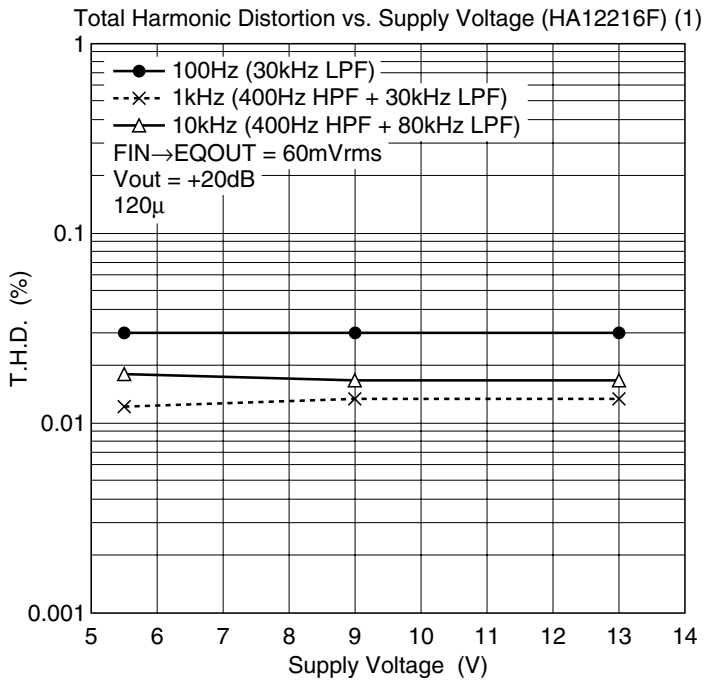


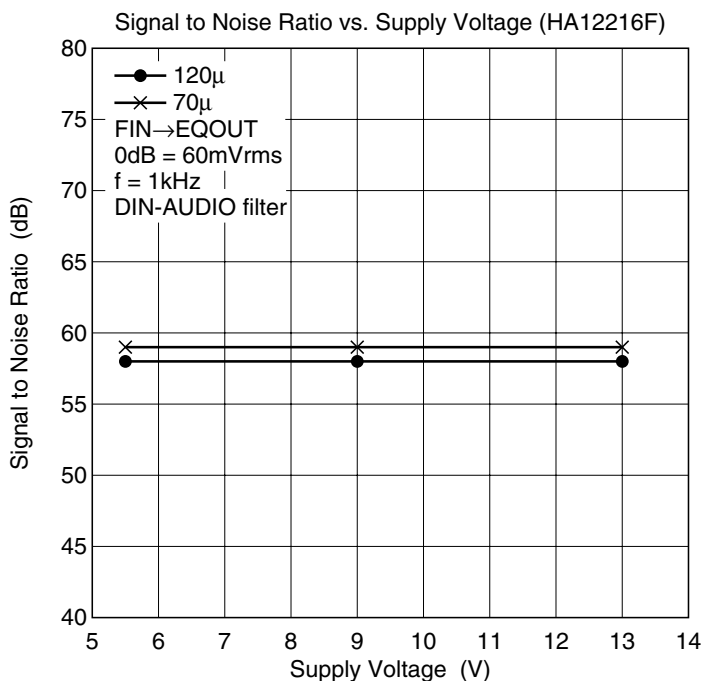
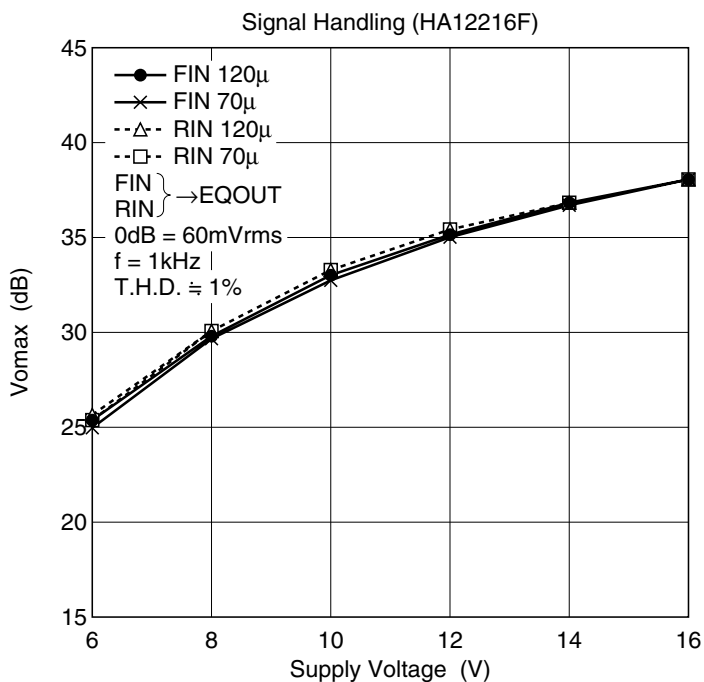


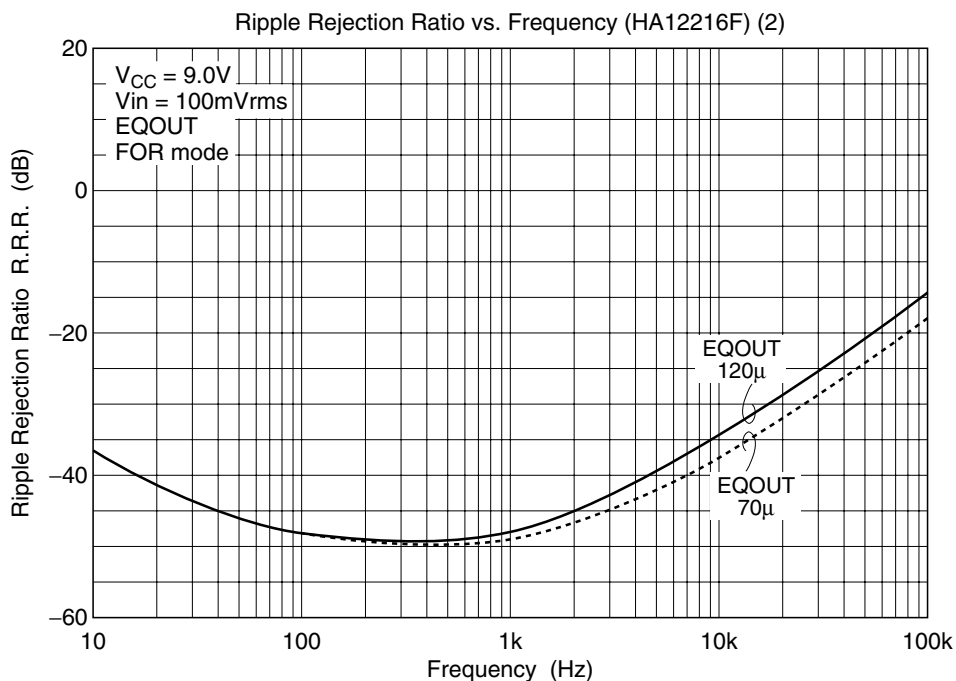
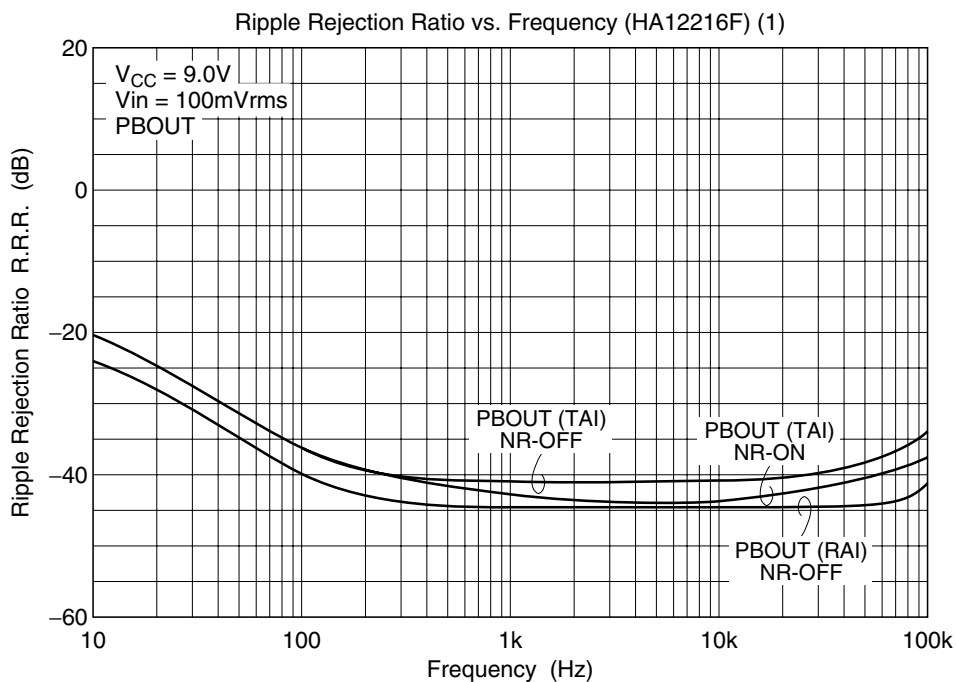


HA12216F/HA12221F Series



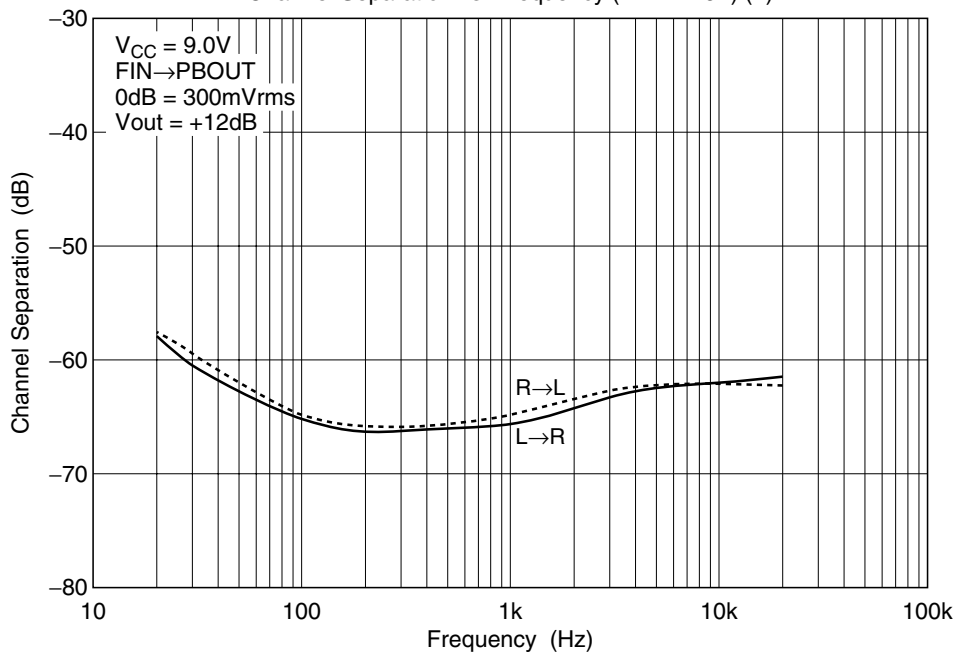




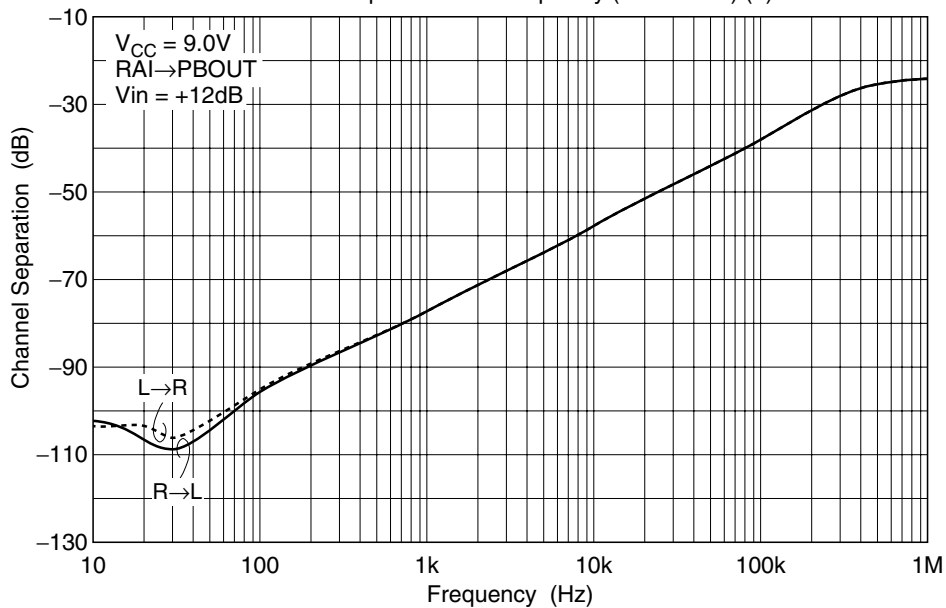


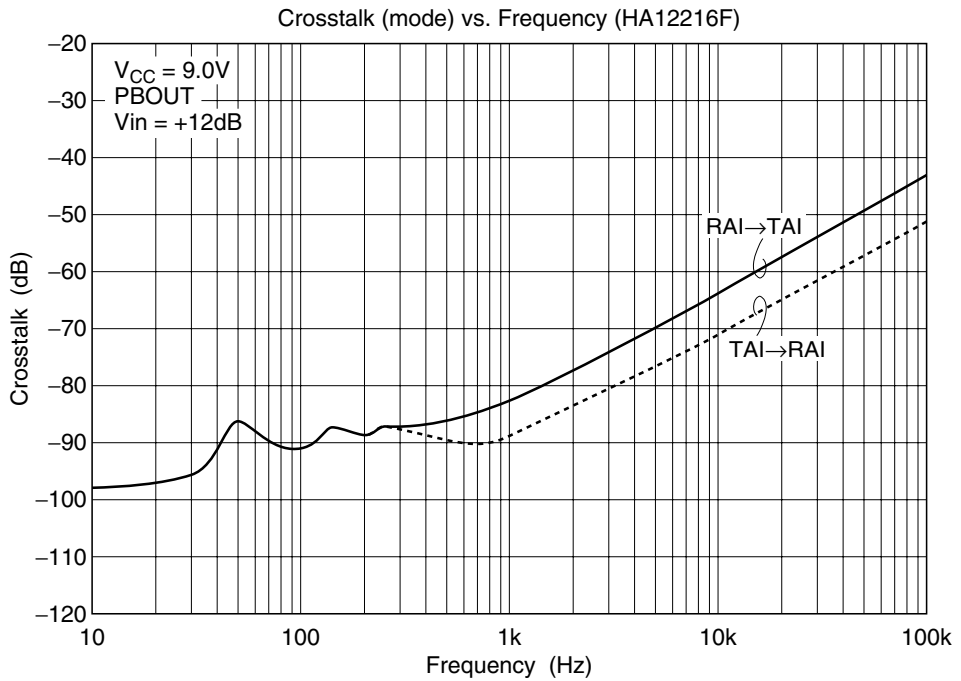
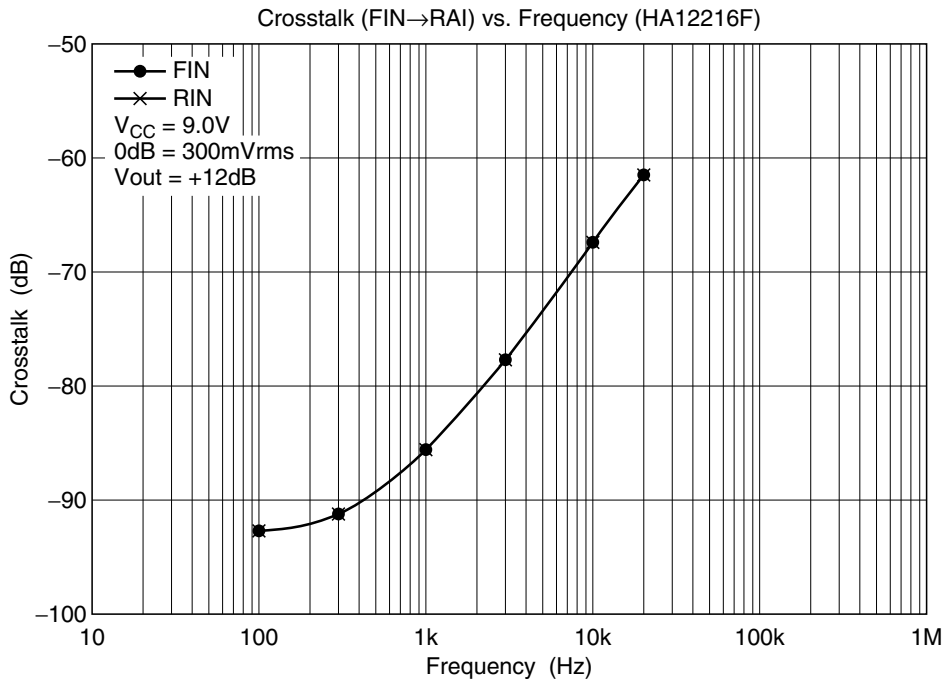
HA12216F/HA12221F Series

Channel Separation vs. Frequency (HA12216F) (1)



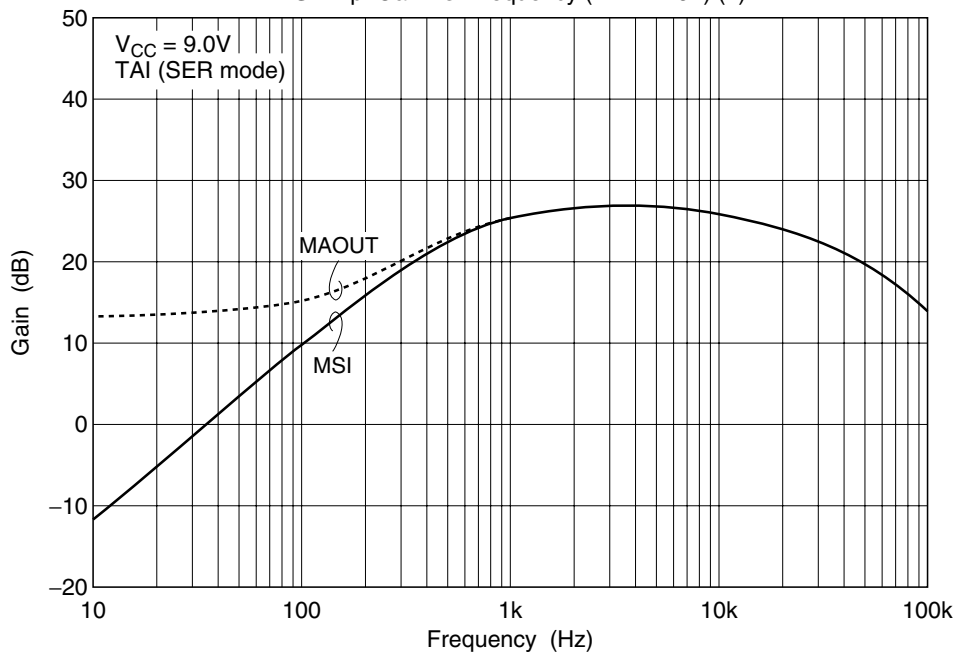
Channel Separation vs. Frequency (HA12216F) (2)



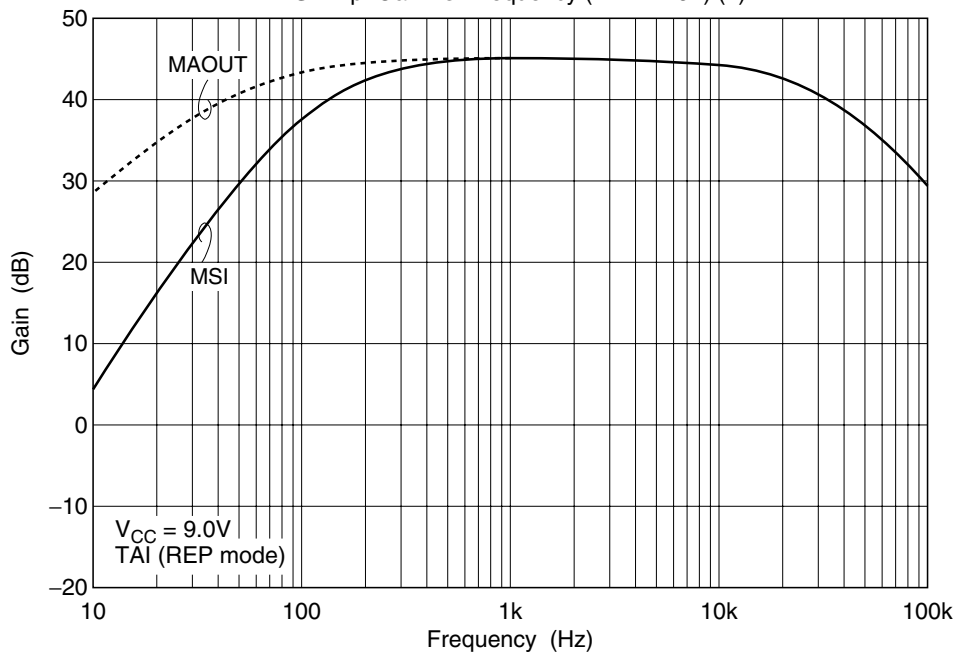


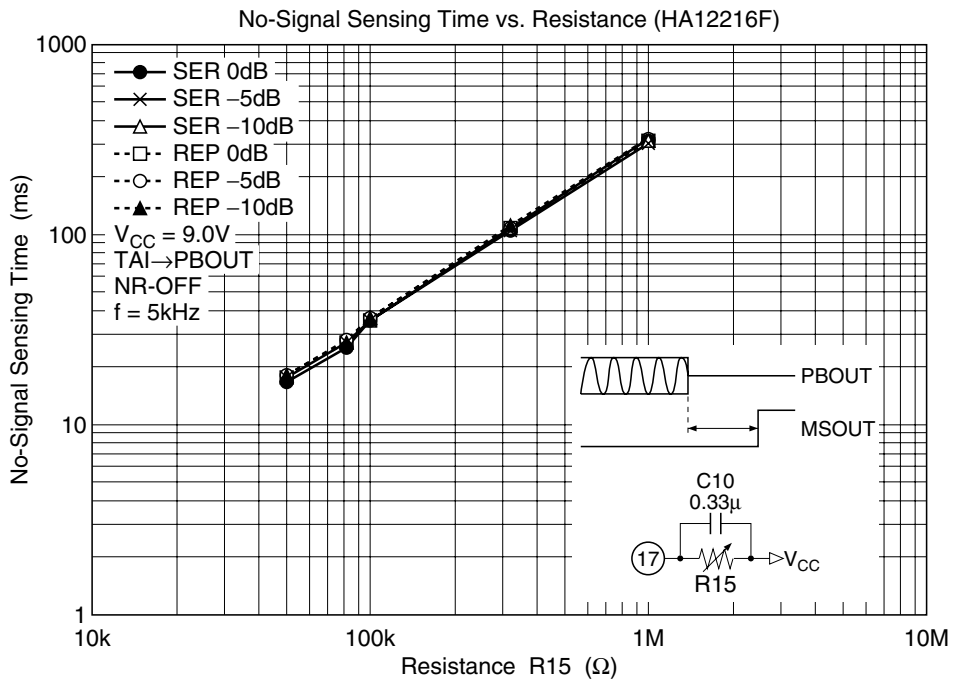
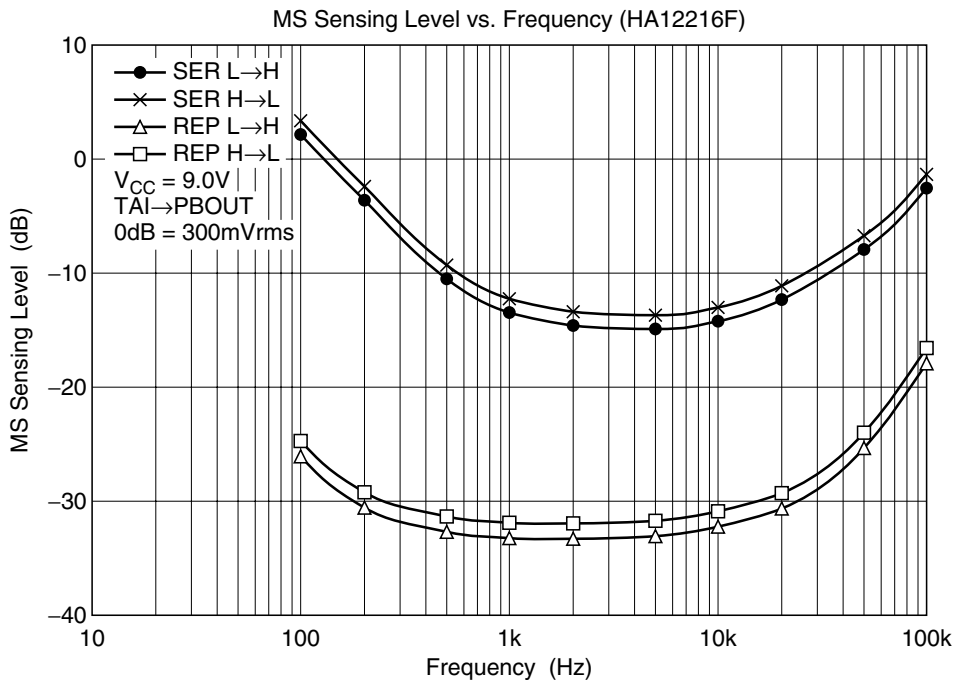
HA12216F/HA12221F Series

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



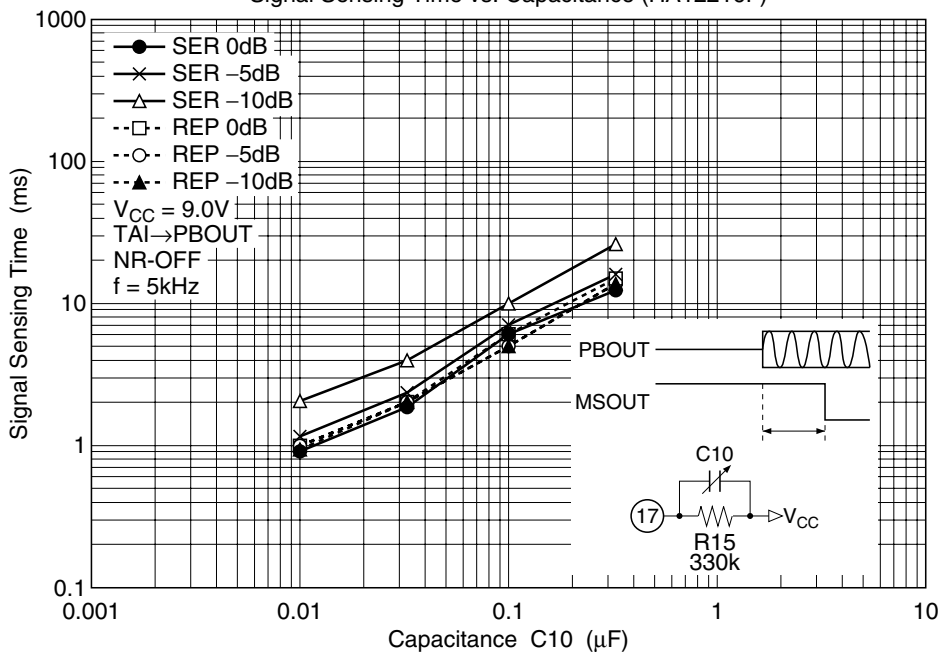
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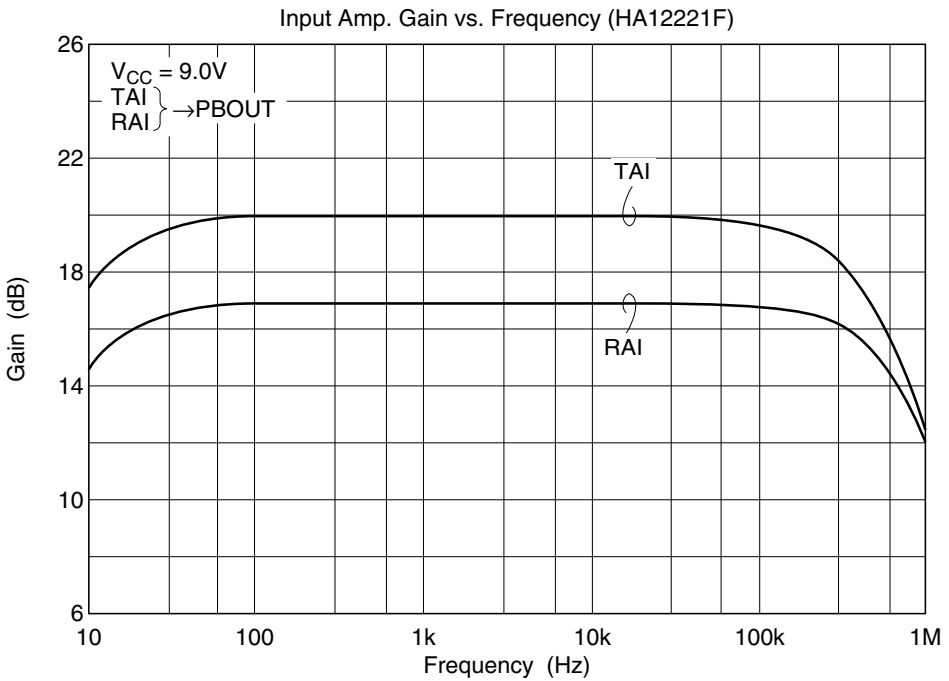
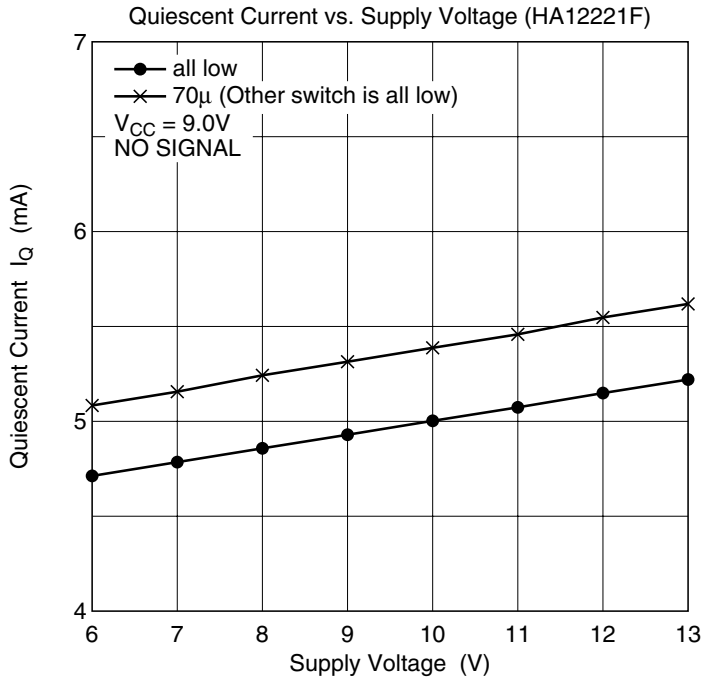




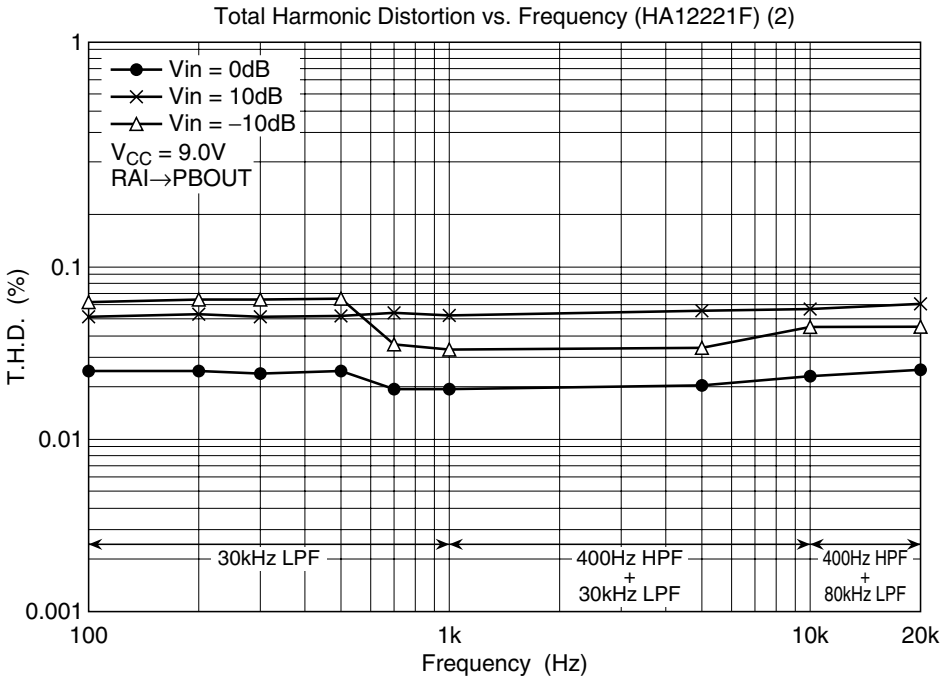
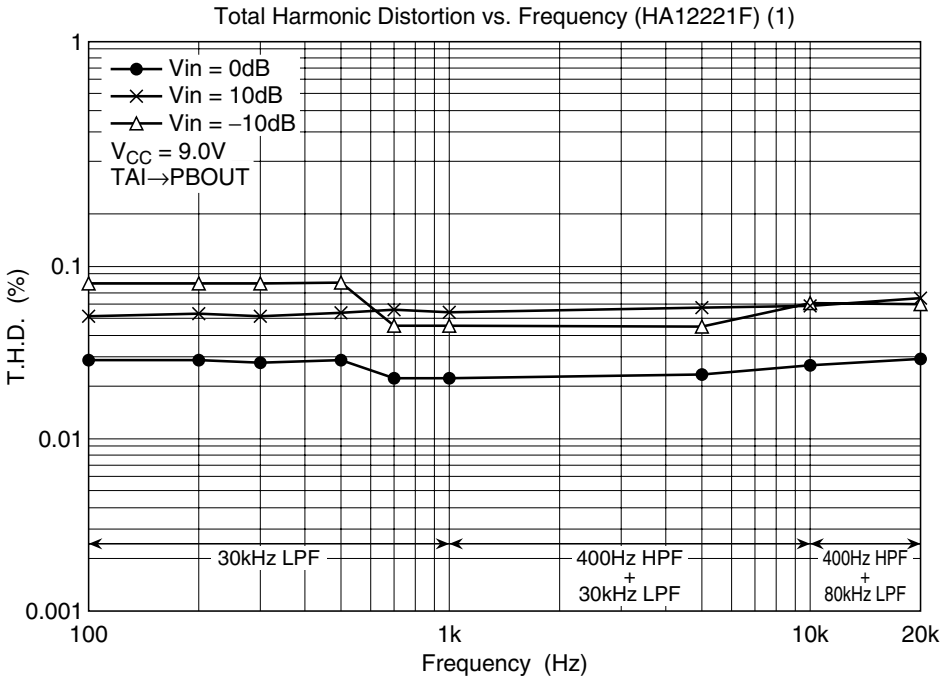
HA12216F/HA12221F Series

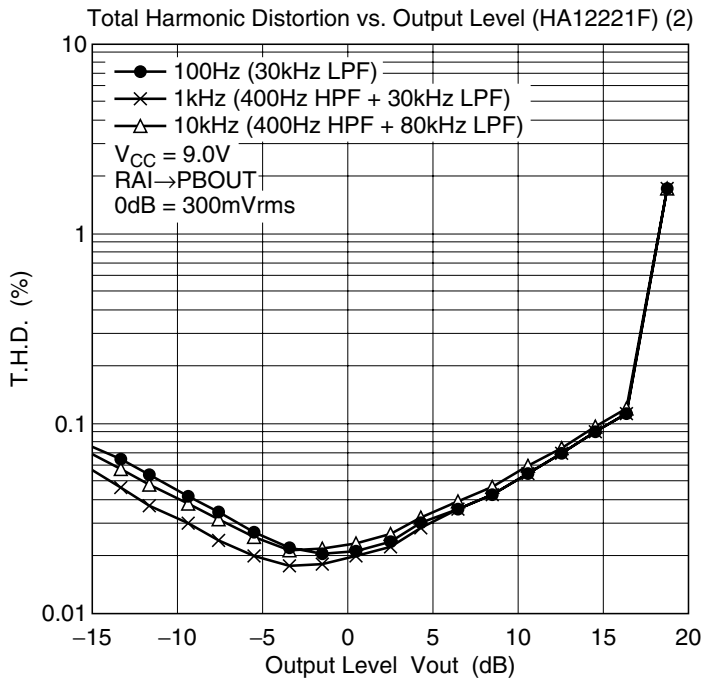
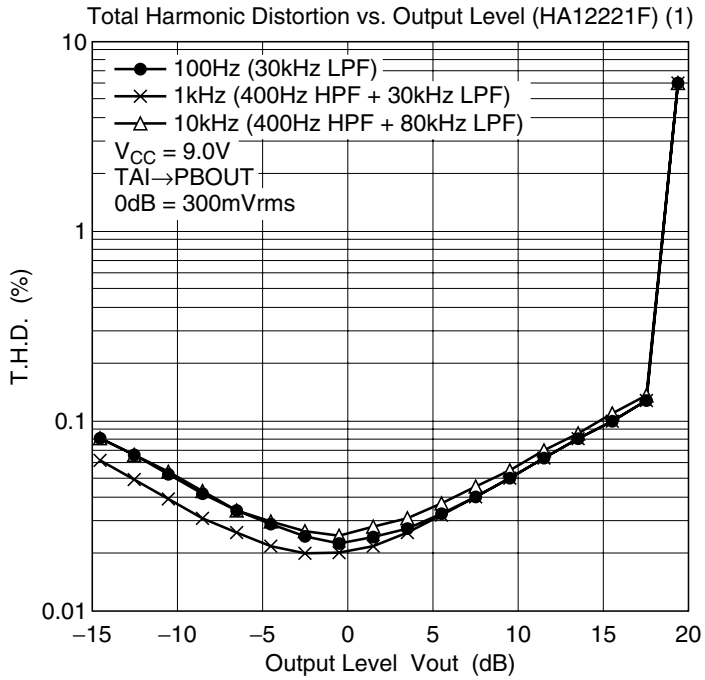
Signal Sensing Time vs. Capacitance (HA12216F)

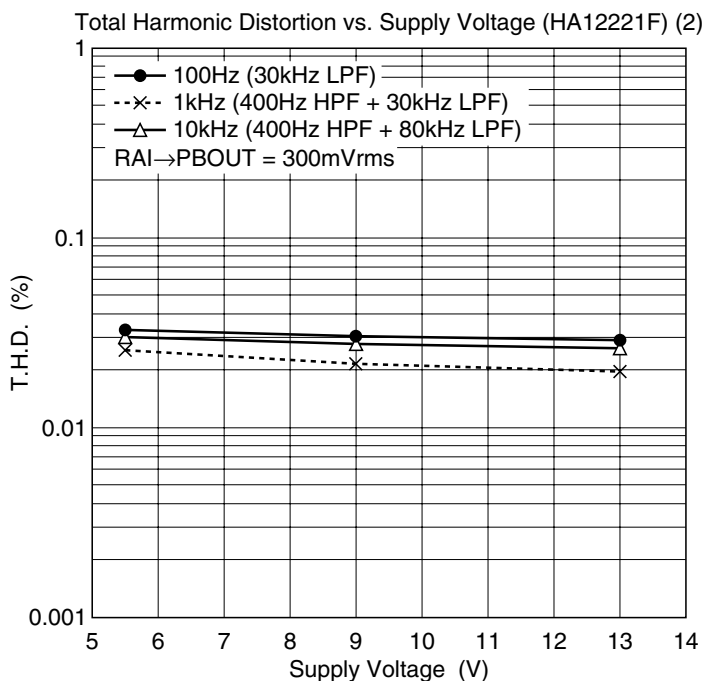
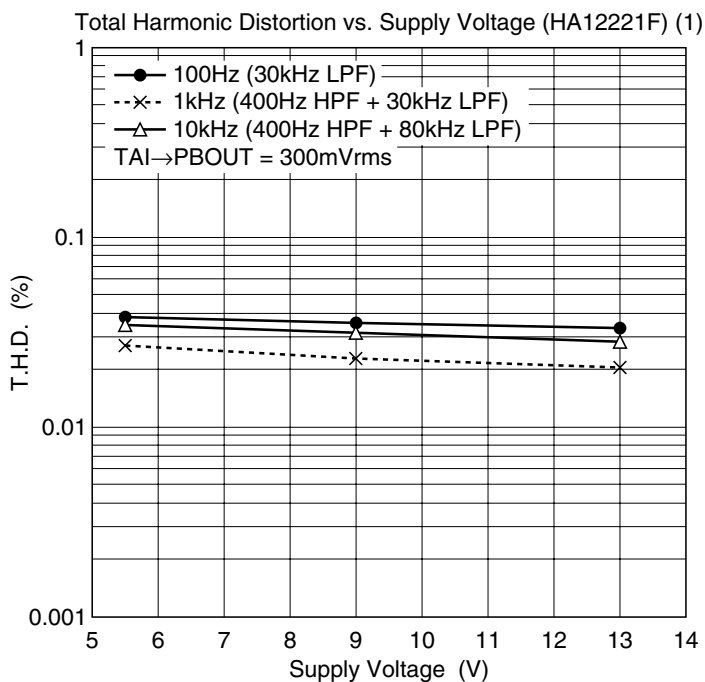


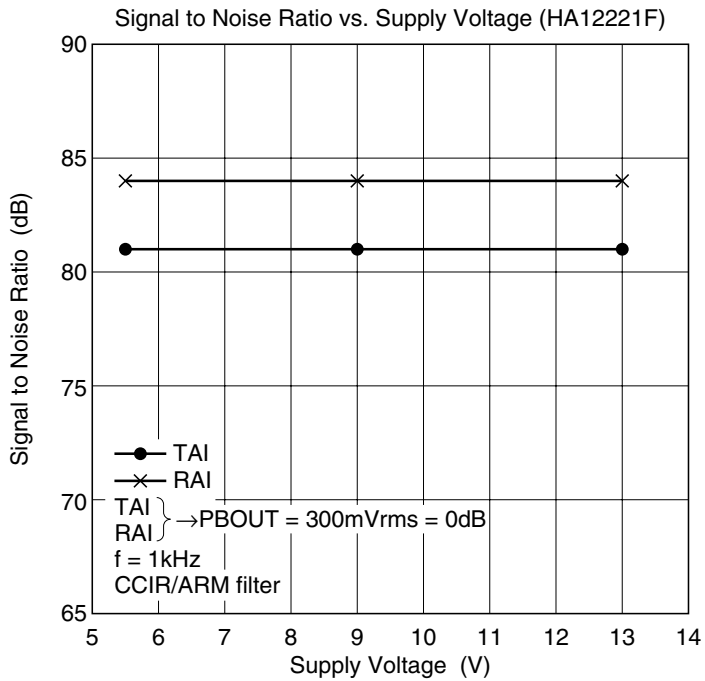
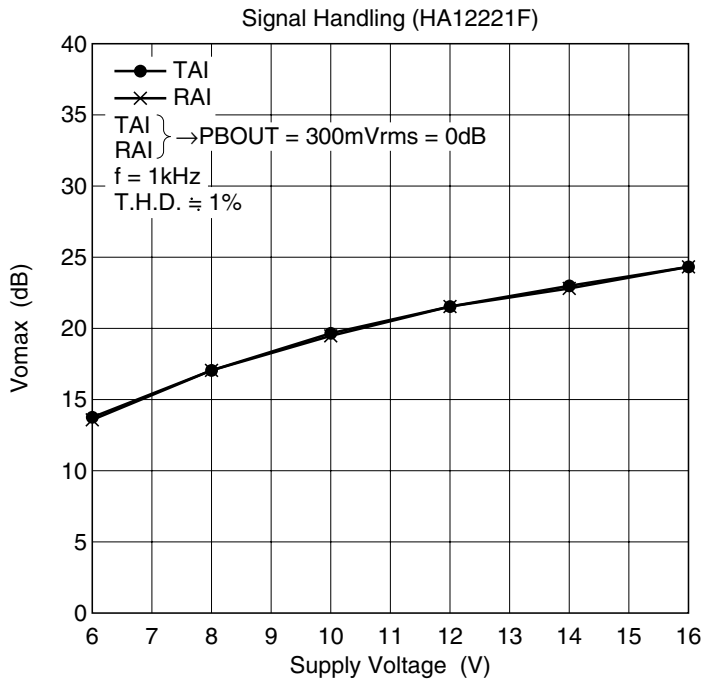


HA12216F/HA12221F Series



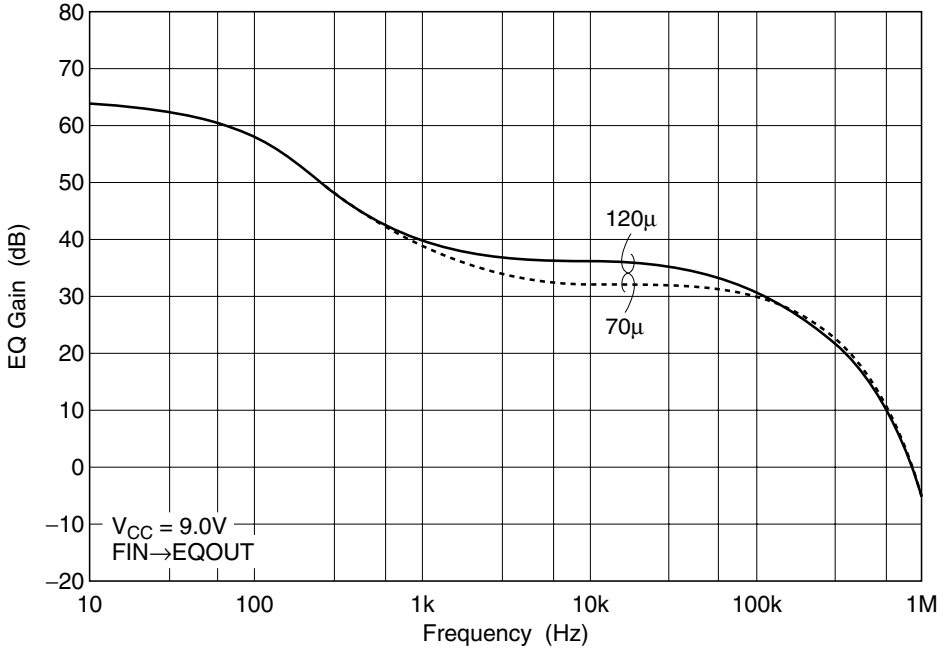




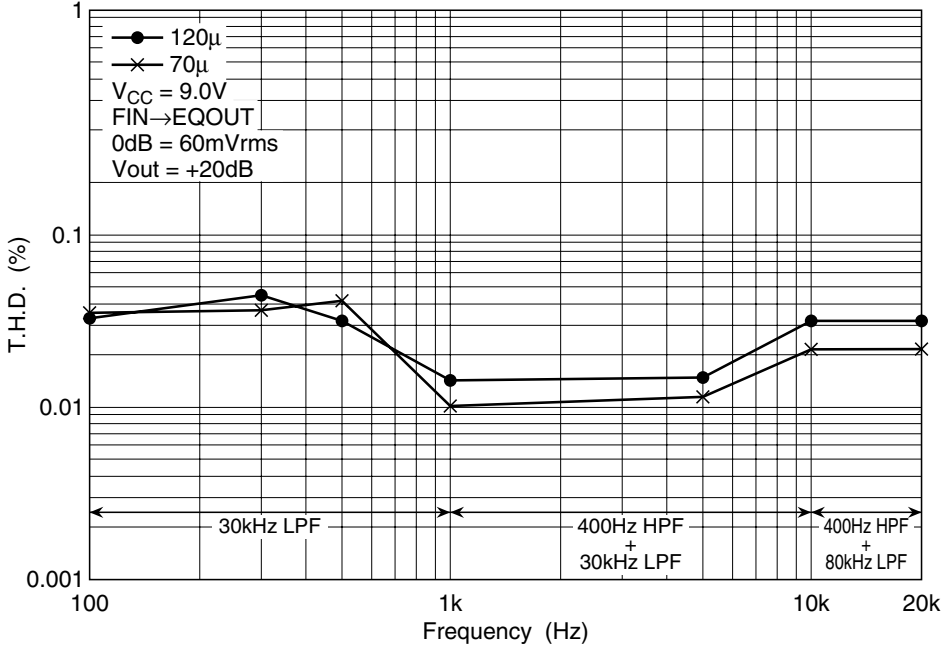


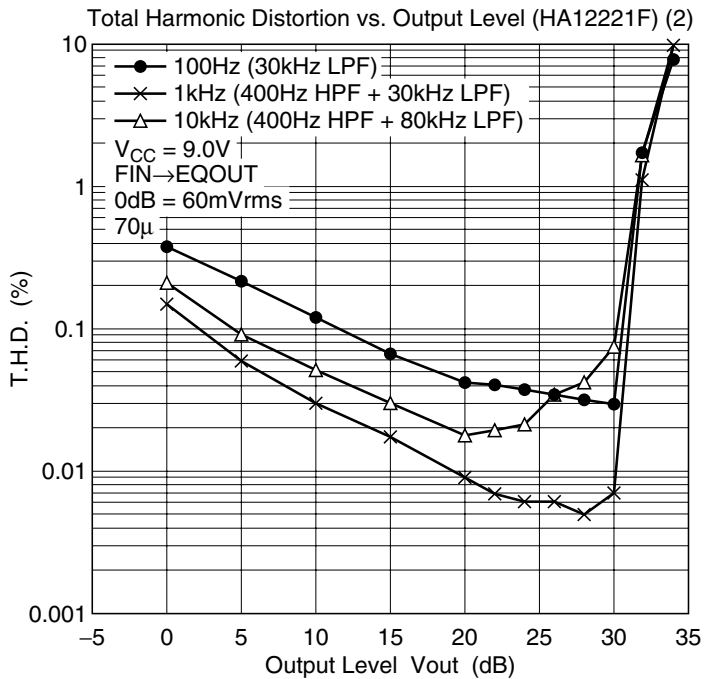
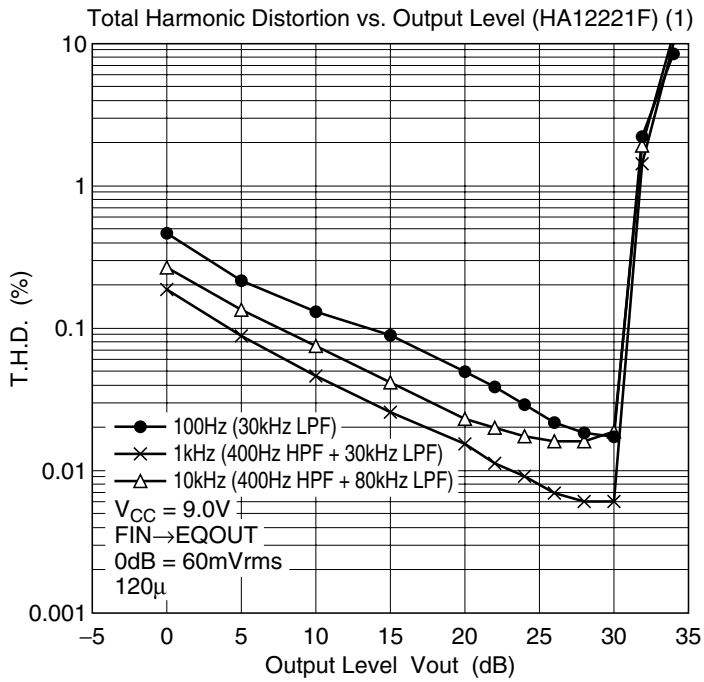
HA12216F/HA12221F Series

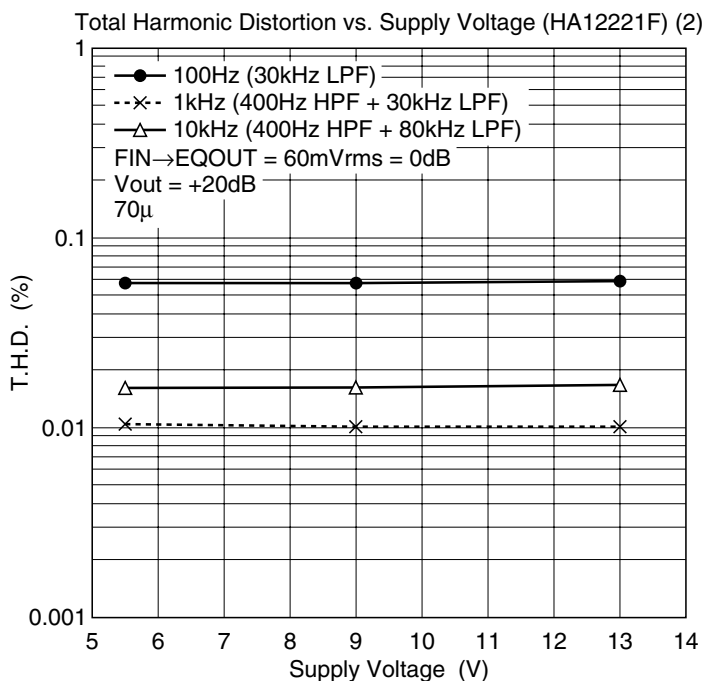
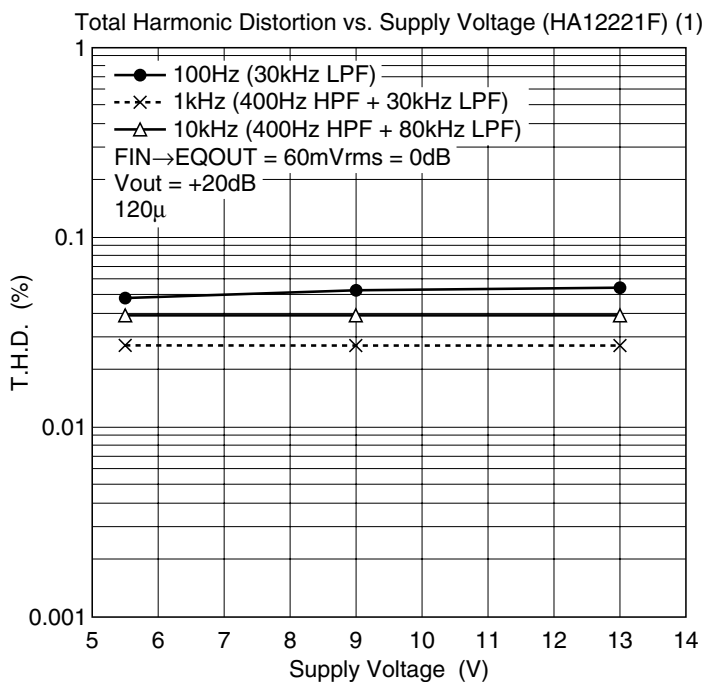
Equalizer Amp. Gain vs. Frequency (HA12221F)

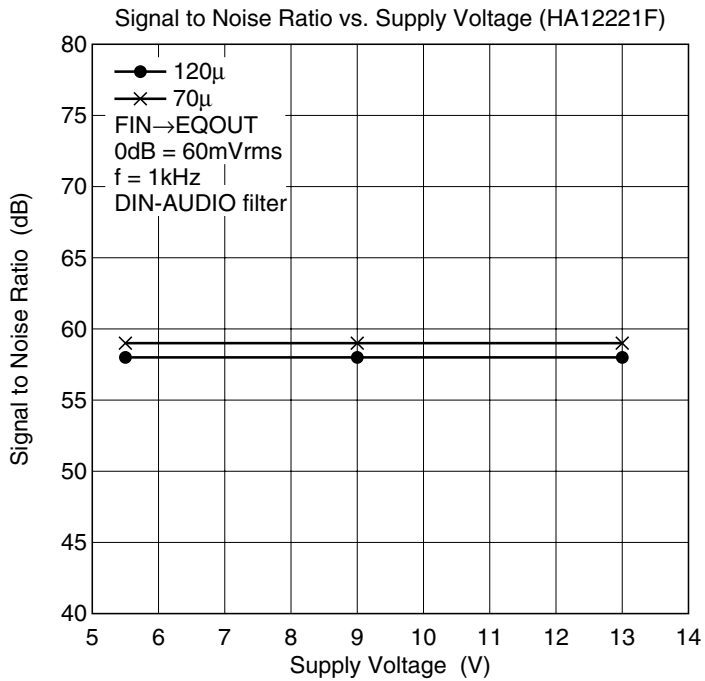
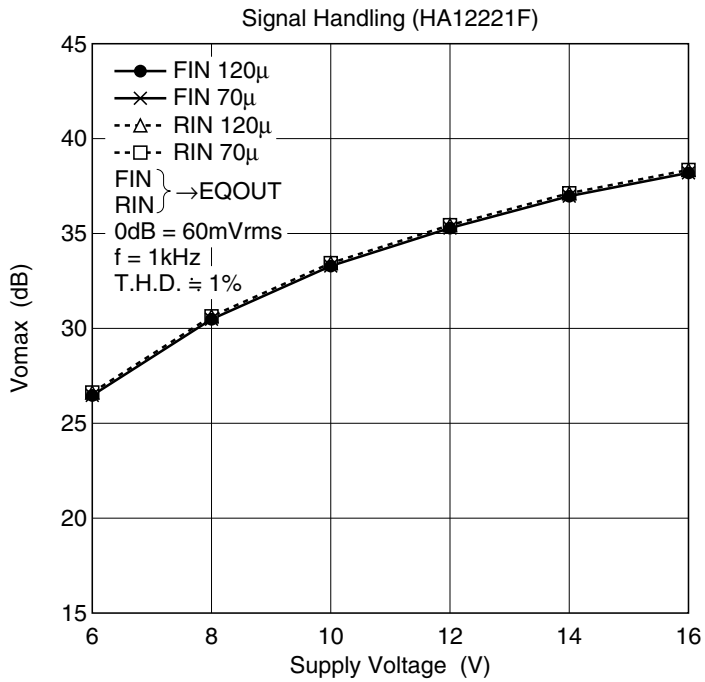


Total Harmonic Distortion vs. Frequency (HA12221F)

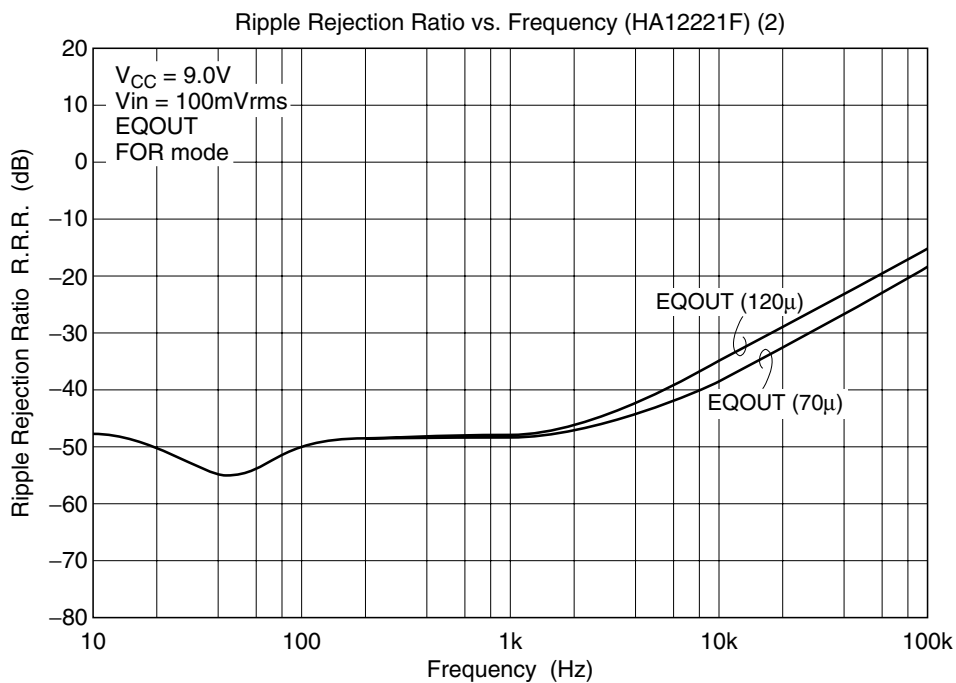
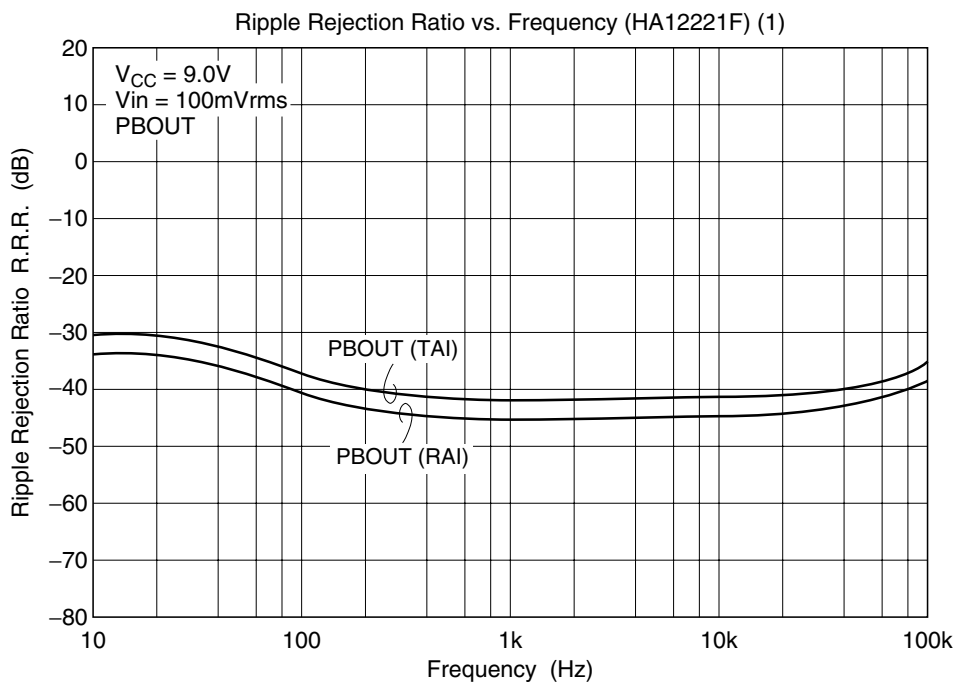


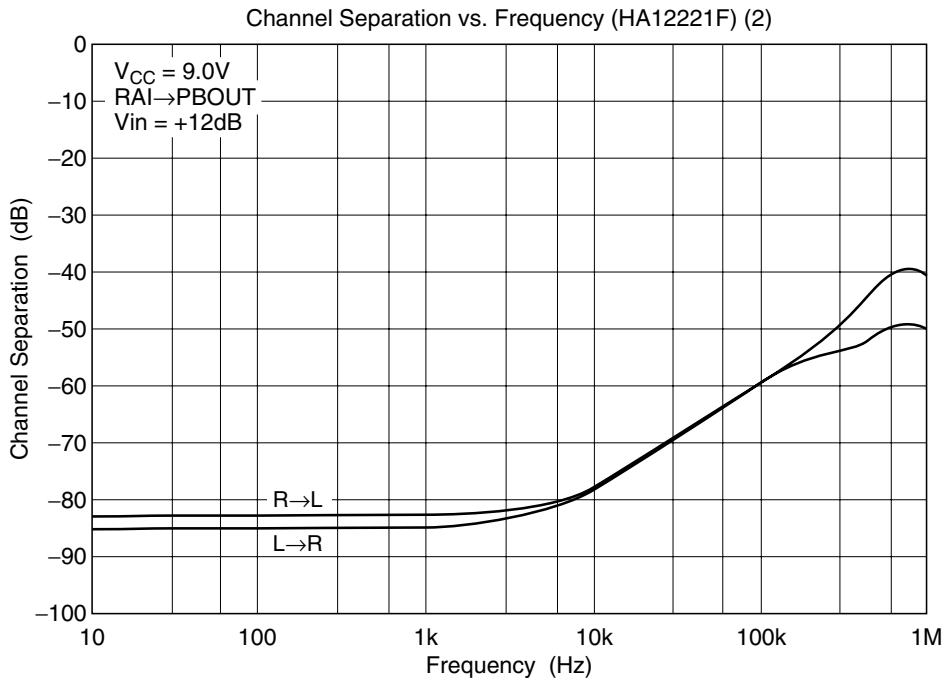
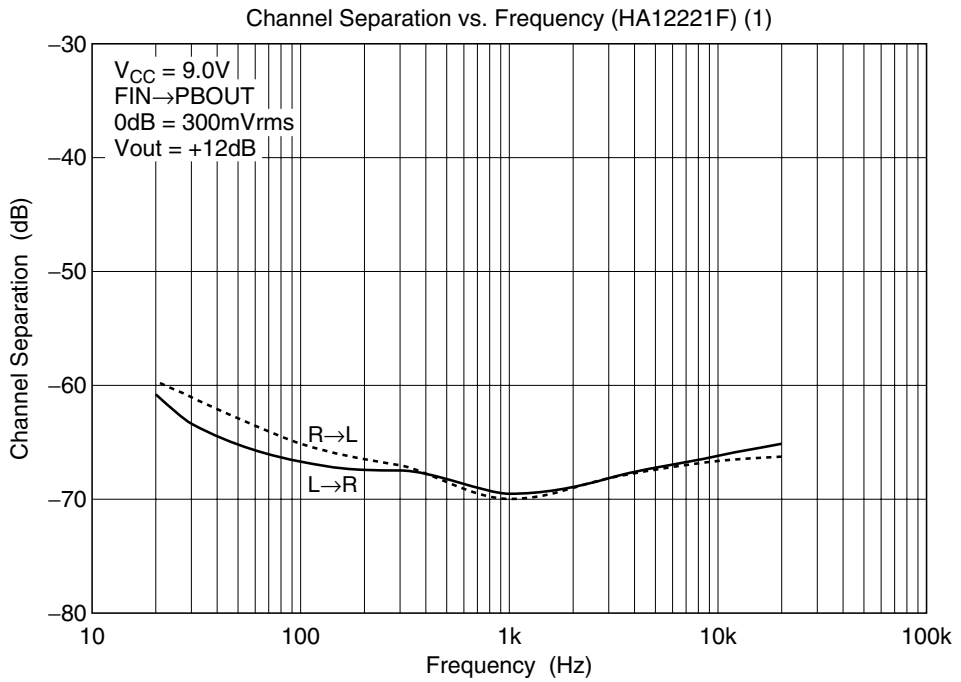




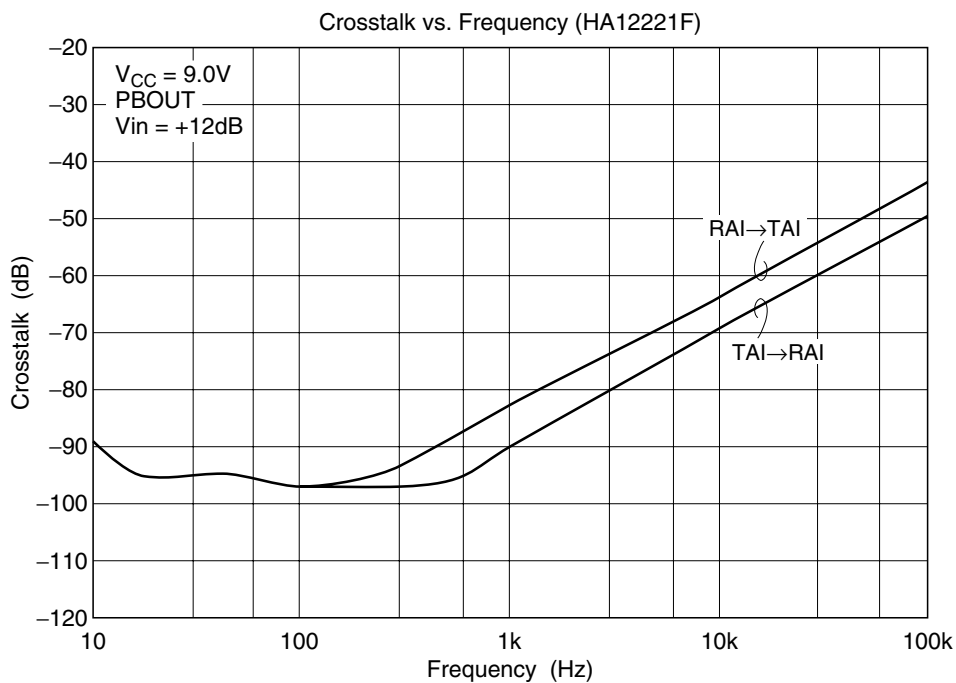
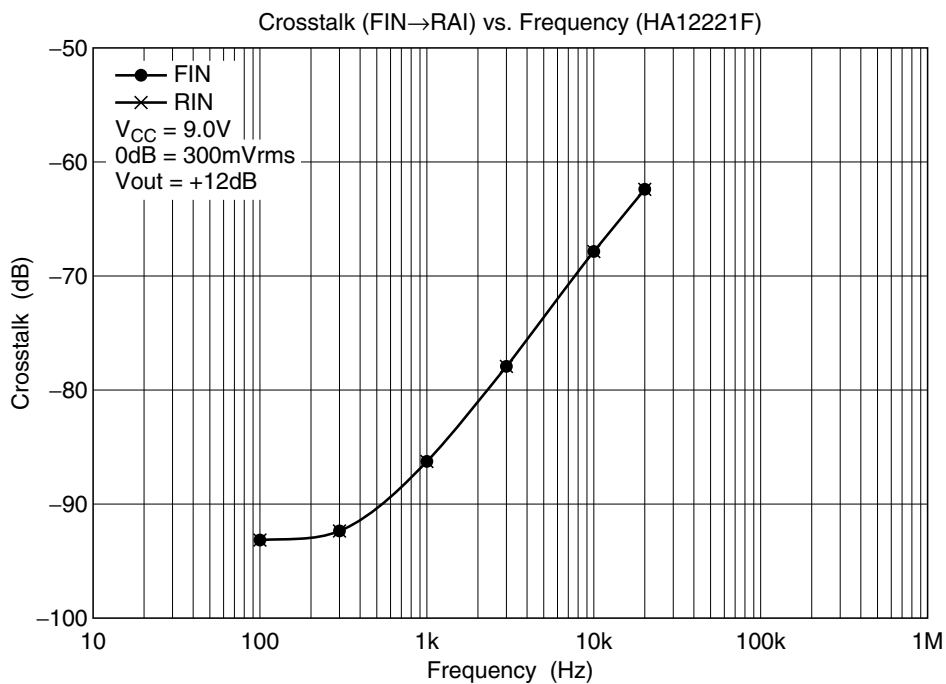


HA12216F/HA12221F Series

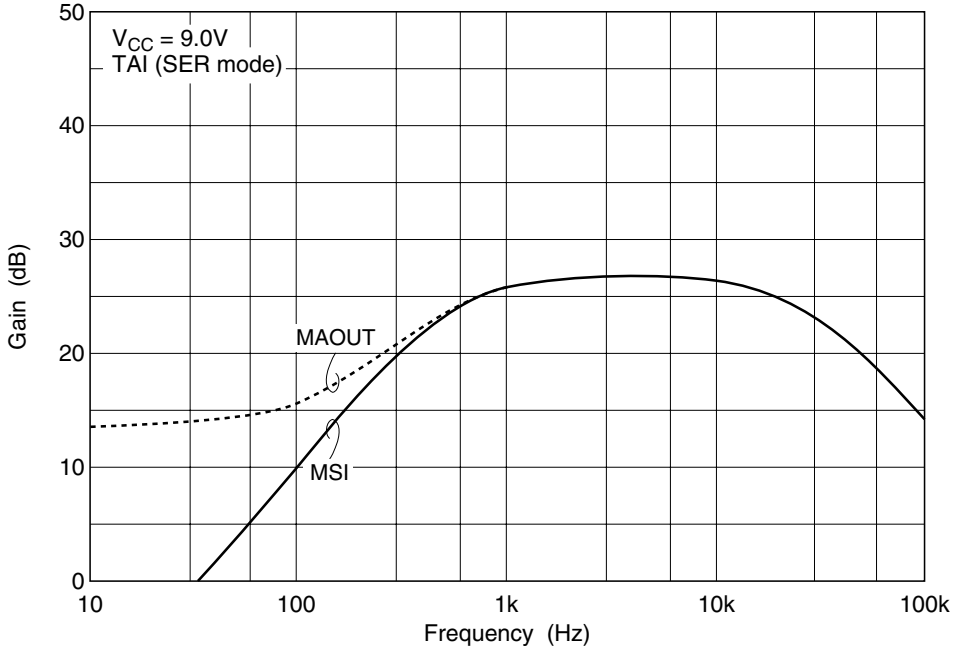




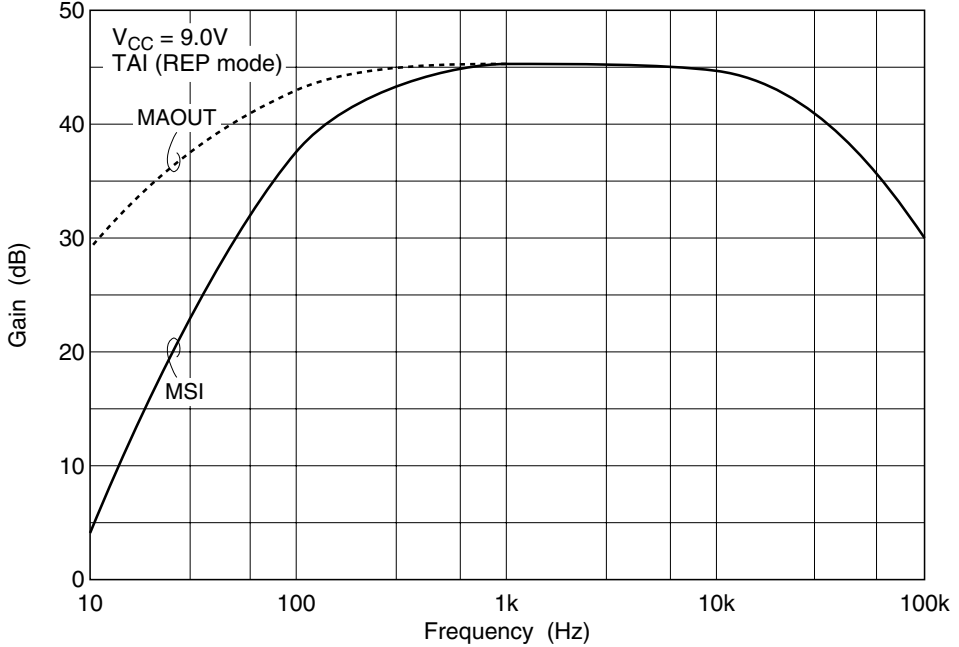
HA12216F/HA12221F Series



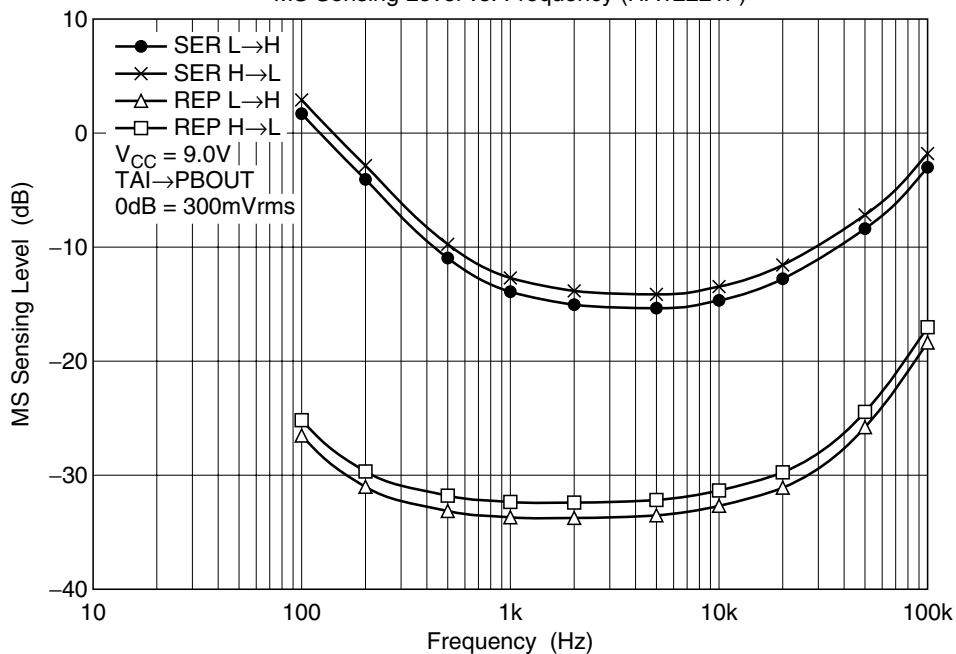
MS Amp. Gain vs. Frequency (HA12221F) (1)



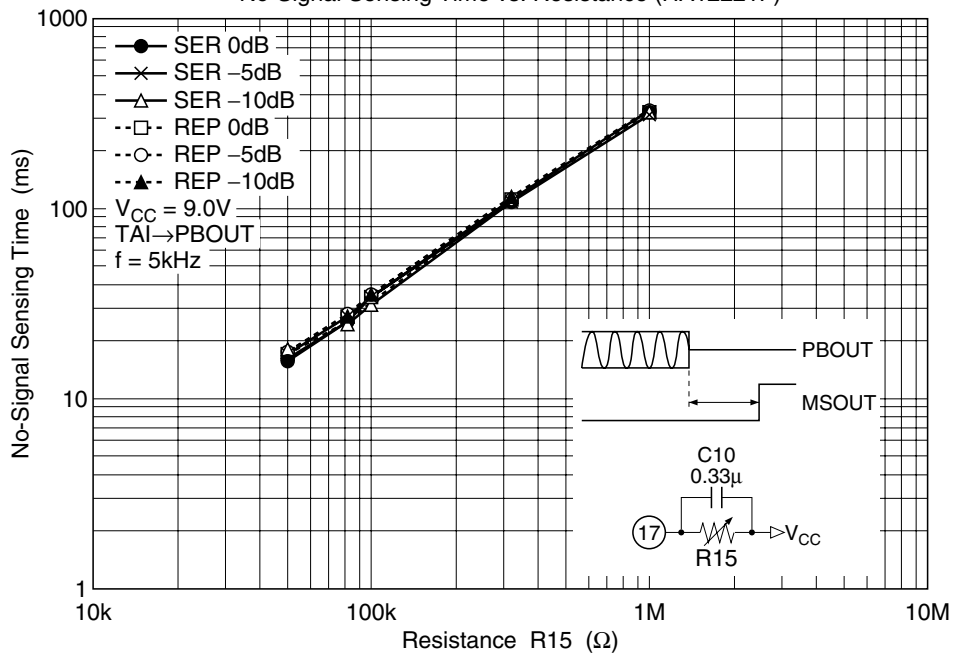
MS Amp. Gain vs. Frequency (HA12221F) (2)



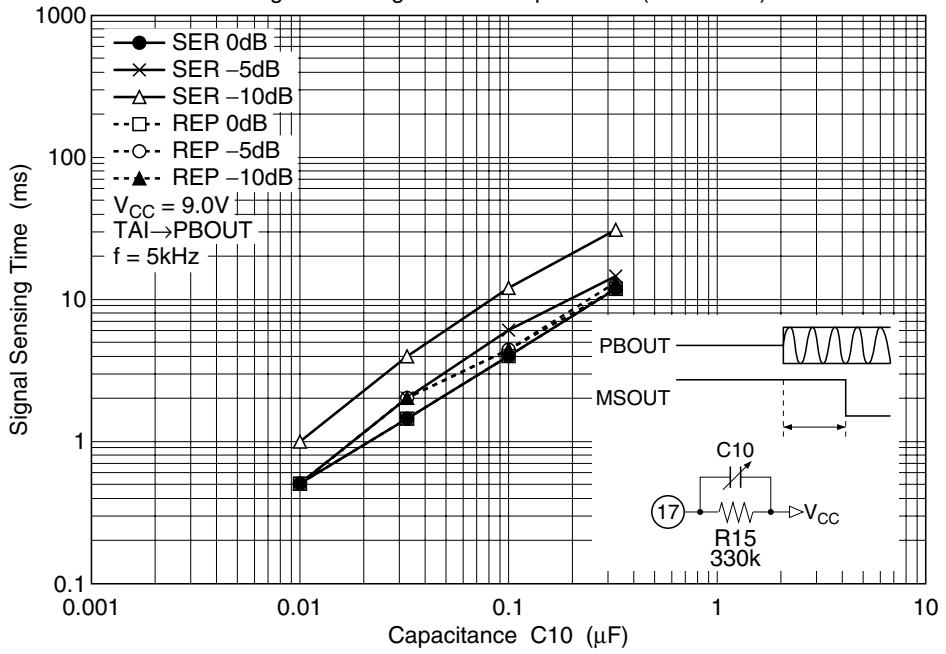
MS Sensing Level vs. Frequency (HA12221F)



No-Signal Sensing Time vs. Resistance (HA12221F)



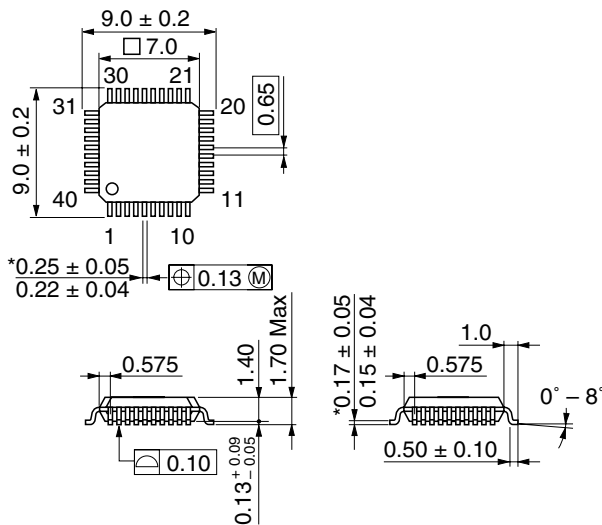
Signal Sensing Time vs. Capacitance (HA12221F)



HA12216F/HA12221F Series

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

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