To all our customers

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

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HA12231FP

Audio Signal Processor for Car Deck (PB 1 Chip)

ADE-207-327A (Z)

2nd Edition
Jan. 2001

Description

HA12231FP is silicon monolithic bipolar IC providing PB equalizer system and music sensor system in one chip.

Functions

- PB equalizer × 2 channel
- Music sensor × 1 channel
- Line amp. × 2 channel
- Line mute × 2 channel

Features

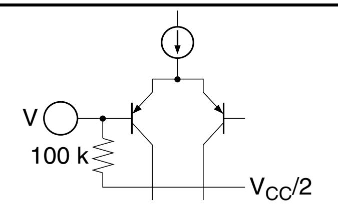
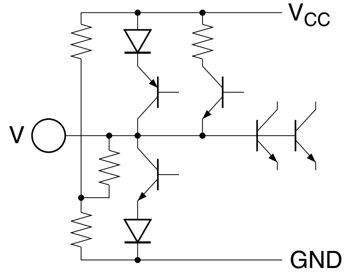
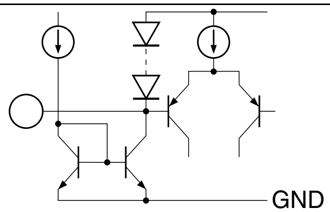
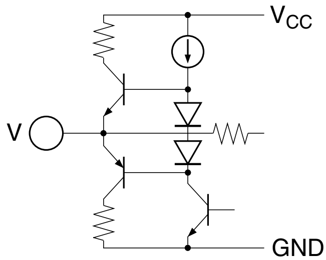
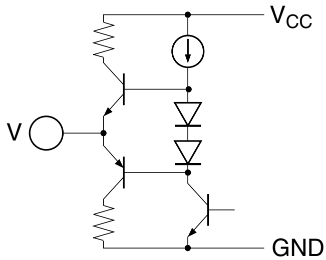
- No use external parts for PB equalizer. (Fixed characteristics built-in)
- Available to change music sensing level by external resistor.
- Available to change frequency response of music sensor by external capacitor.
- Different type of PB equalizer characteristics selection (120 µs/70 µs) is available.
- Line mute ON/OFF is avalable.
- This IC is strong for a cellular phone noise.

Ordering Information

			Functions		
Product	Package	PBOUT-Level	PB-EQ	Music Sensor	Mute
HA12231FP	FP-20DA	450 mVrms	❍	❍	❍

Pin Description, Equivalent Circuit

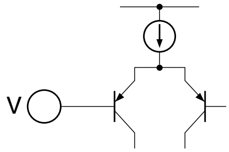
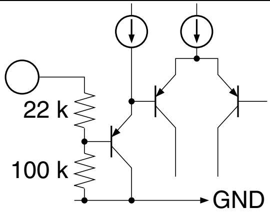
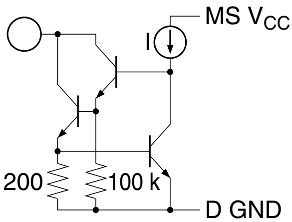
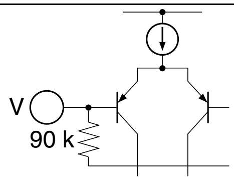
(V_{cc} = 9 V, A system of single supply voltage, Ta = 25°C, No Signal,
The value in the table shows typical value.)

Pin No.	Pin Name	Note	Equivalent Circuit	Description
16	TAI(L)	$V = V_{cc}/2$		Tape input
5	TAI(R)			
14	RIP	$V = V_{cc}/2$		Ripple filter
13	MS DET	$V = V_{cc}$		Time constant pin for rectifier
15	PBOUT(L)	$V = V_{cc}/2$		PB output
6	PBOUT(R)			
1	VREF	$V = V_{cc}/2$		Reference output
17	EQOUT(L)	$V = V_{cc}/2$		Equalizer output (120 µ)
4	EQOUT(R)			

Note: MS: Music Sensor

Pin Description, Equivalent Circuit

(V_{CC} = 9 V, A system of single supply voltage, Ta = 25°C, No Signal,
The value in the table shows typical value.) (cont.)

Pin No.	Pin Name	Note	Equivalent Circuit	Description
11	V_{CC}	—		Power supply
19	FIN(L)	—		Equalizer input
18	RIN(L)			
3	RIN(R)			
2	FIN(R)			
9	Mute	—		Mode control input
10	$\overline{FOR}$/REV			
8	$\overline{120}$/70			
12	MS	—		MS output (to MPU) *
7	MS G_v	V = V_{CC}/2		MS gain pin *
20	GND	—		GND pin

Note: MS: Music Sensor

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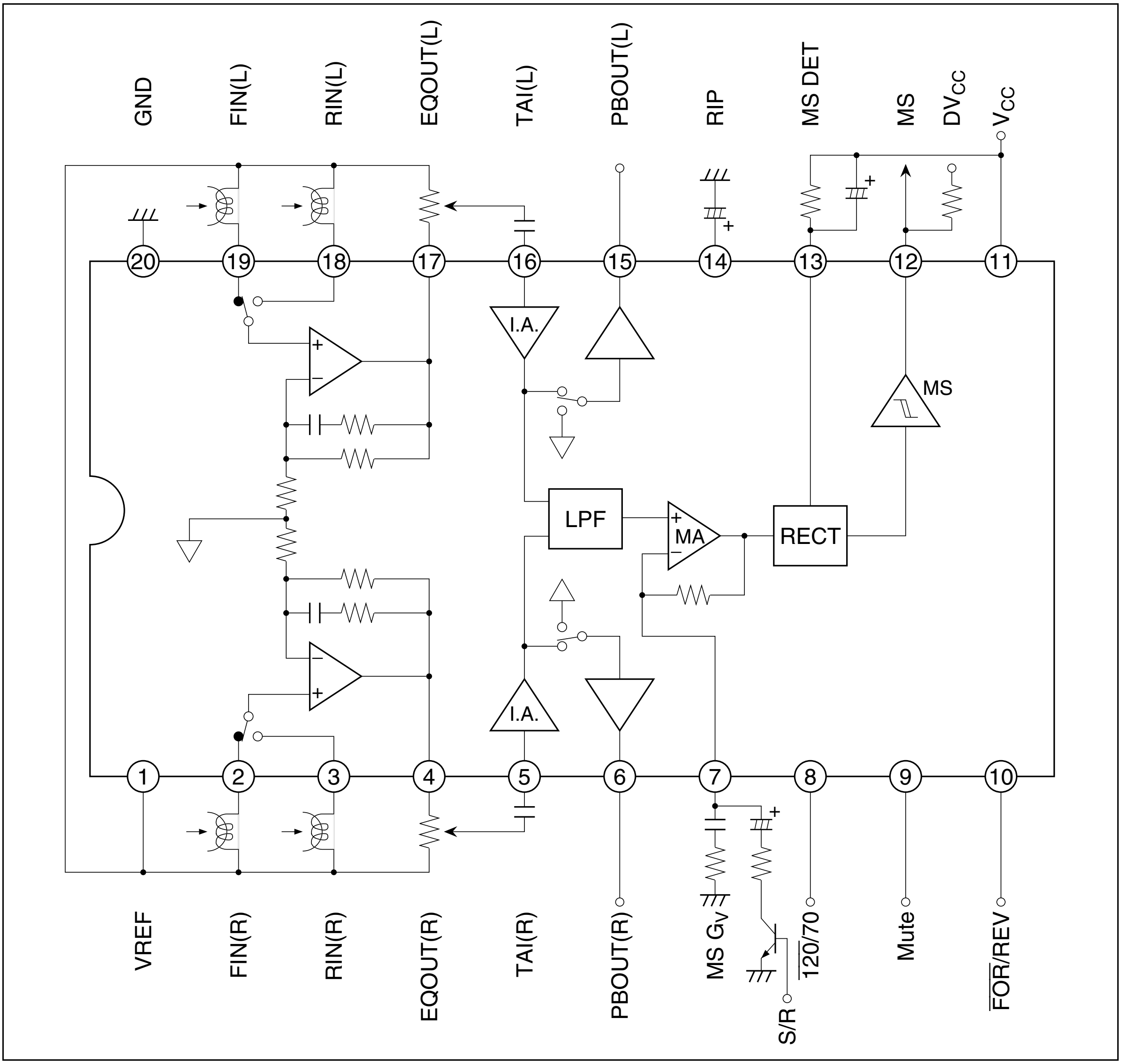
Block Diagram



Absolute Maximum Ratings

(Ta = 25°C)

Item	Symbol	Rating	Unit	Note
Supply voltage	V_{CC} Max	15	V	
Power dissipation	Pd	400	mW	Ta ≤ 85°C
Operating temperature	Topr	–40 to +85	°C	
Storage temperature	Tstg	–55 to +125	°C	

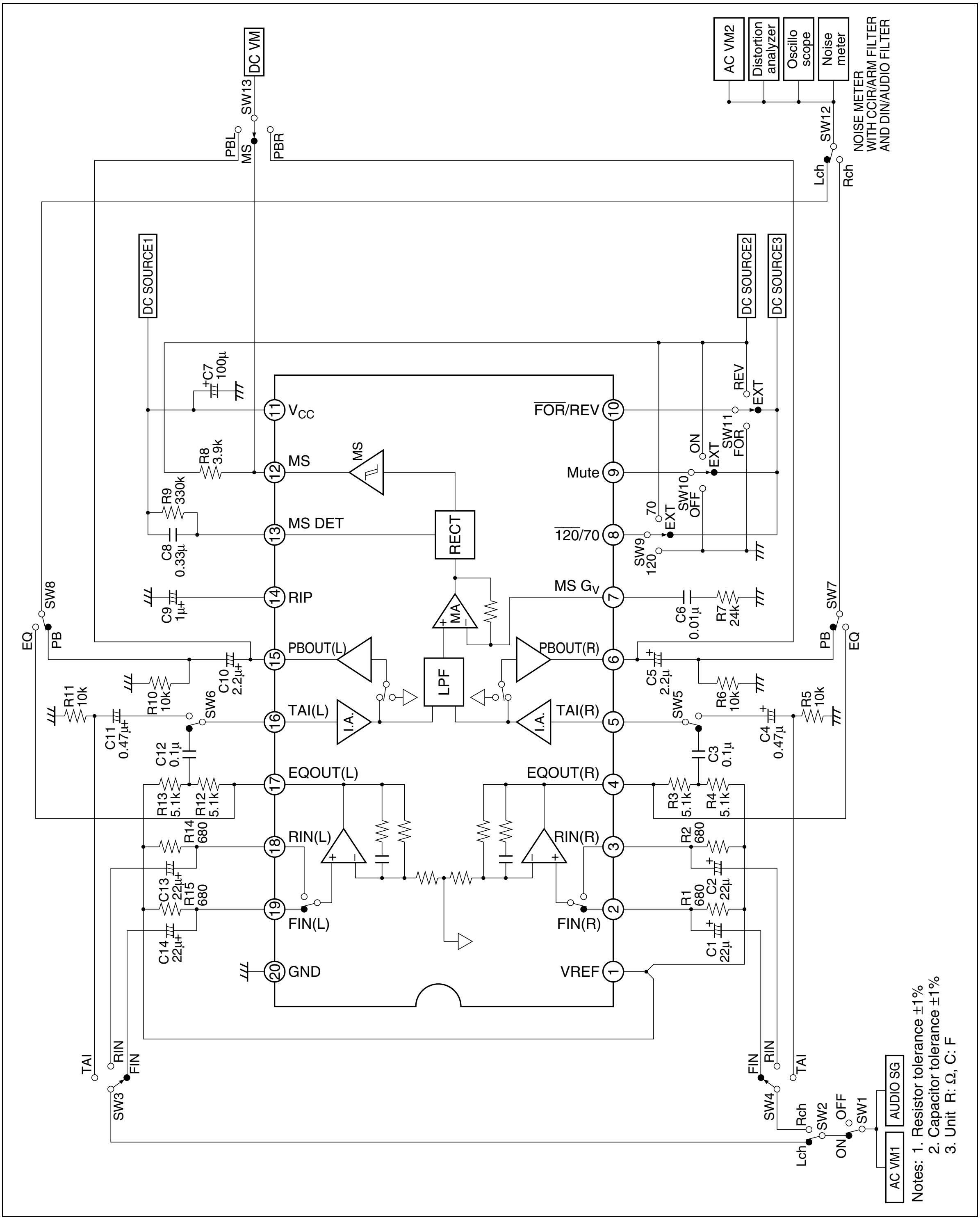
Electrical Characteristics

(Ta = 25°C, V_{CC} = 9 V, PBOUT Level = 450 mVrms (= 0 dB))

Item	Symbol	Test Condition: IC Condition: INPUT	Test Condition: IC Condition: OUTPUT	Test Condition: IC Condition: fin(Hz)	Test Condition: IC Condition: PBOUT level(dB)	Test Condition: Other	Specification: Min	Specification: Typ	Specification: Max	Unit	Application Terminal: Input: R	Application Terminal: Input: L	Application Terminal: Output: R	Application Terminal: Output: L	Application Terminal	Re-mark
Quiescent current	I_Q	—	—	—	—	No signal	—	6.0	9	mA	—	—	—	—	11	
Input AMP. gain	G_VIA	TAI	PBOUT	1k	0		22.5	23.5	24.5	dB	5	16	6	15	—	
Signal handling	Vomax	TAI	PBOUT	1k	—	THD = 1%	12.0	13.0	—	dB	5	16	6	15	—	*1
T.H.D.	THD	TAI	PBOUT	1k	0		—	0.05	0.3	%	5	16	6	15	—	
Channel separation	CT RL	FIN	PBOUT	1k	12		50.0	60.0	—	dB	2	19	6→ 15	15→ 6	—	
PB-EQ gain	G_V EQ 1k	FIN/RIN	EQOUT	1k	0	120µs	37.0	40.0	43.0	dB	2/3	19/18	4	17	—	
	G_V EQ 10k(1)	FIN	EQOUT	10k	0	120µs	33.0	36.0	39.0	dB	2	19	4	17	—	
	G_V EQ 10k(2)	FIN	EQOUT	10k	0	70µs	29.0	32.0	35.0	dB	2	19	4	17	—	
PB-EQ maximum output	V_{OM}	FIN/RIN	EQOUT	1k	—	THD = 1%	300	600	—	mVrms	2/3	19/18	4	17	—	*1
PB-EQ THD	THD-EQ	FIN/RIN	EQOUT	1k	0		—	0.1	0.5	%	2/3	19/18	4	17	—	
Noise voltage level converted in input	VN	FIN/RIN	EQOUT	(1k)	(0)	Rg = 680Ω, Din-Audio Filter	—	1.2	2.0	µVrms	2/3	19/18	4	17	—	
MS sensing level	V_{ON}	TAI	PBOUT MSOUT	5k	—		–18.0	–14.0	–10.0	dB	5	16	6	15	12	
MS output low level	V_{OL}	TAI	PBOUT MSOUT	5k	0		—	1.0	1.5	V	5	16	6	15	12	
MS output leak current	I_{OH}	—	MSOUT	—	—	No signal	—	0.0	2.0	µA	—	—	12	12	—	
MUTE attenuation	Mute	TAI	PBOUT	1k	12		70.0	80.0	—	dB	5	16	6	15	—	
Control voltage	V_{IL}	—	—	—	—		–0.2	—	1.0	V	—	—	—	—	8, 9, 10	
	V_{IH}						3.5	—	V_{CC}							

Note: 1. V_{CC} = 7.2 V

Test Circuit



Functional Description

Power Supply Range

HA12231FP is designed to operate on single supply only.

Table 1 Supply Voltage Range

Product	Single Supply
HA12231FP	7.2 V to 12.0 V

Reference Voltage

HA12231FP provides the reference voltage of half the supply voltage that is the signal grounds. As the peculiarity of this device, 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.

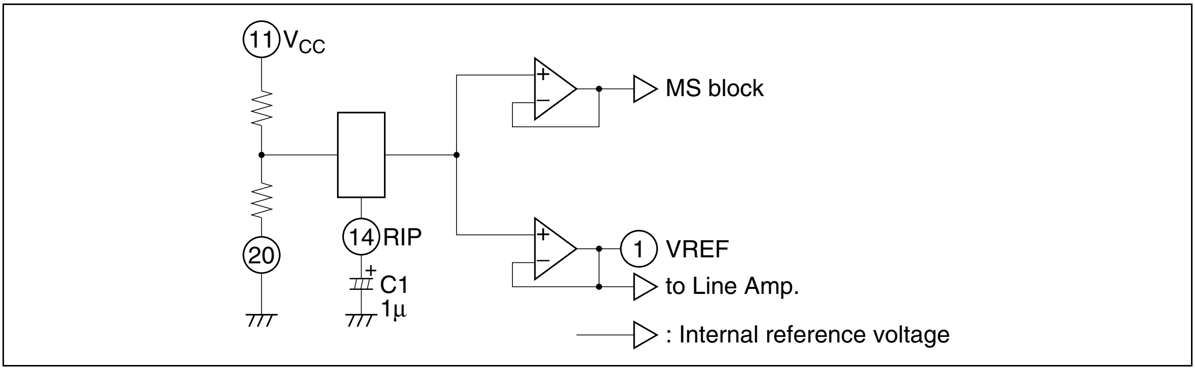


Figure 1 The Block Diagram of Reference Supply Voltage

Operating Mode Control

HA12231FP 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})

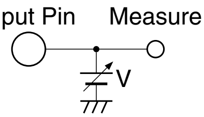
Pin No.	Lo	Hi	Unit	Test Condition
8, 9, 10	–0.2 to 1.0	3.5 to V_{CC}	V	

Table 3 Switching Truth Table

Pin No.	Pin Name	Low	High
8	$\overline{120}$/70	120 µ (Normal)	70 µ (Metal or Chrome)
9	Mute	Mute OFF	Mute ON
10	$\overline{\text{FOR}}$/REV	Forward	Reverse

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: V_{CC}, Low: –0.2 V)
3. Reducing pop noise is so much better for 10 kΩ to 22 kΩ resisitor and 1 µF to 22 µF capacitor shown figure 2.

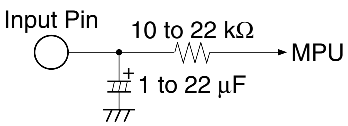


Figure 2 Interface for Reduction of Pop Noise

Input Block Diagram and Level Diagram

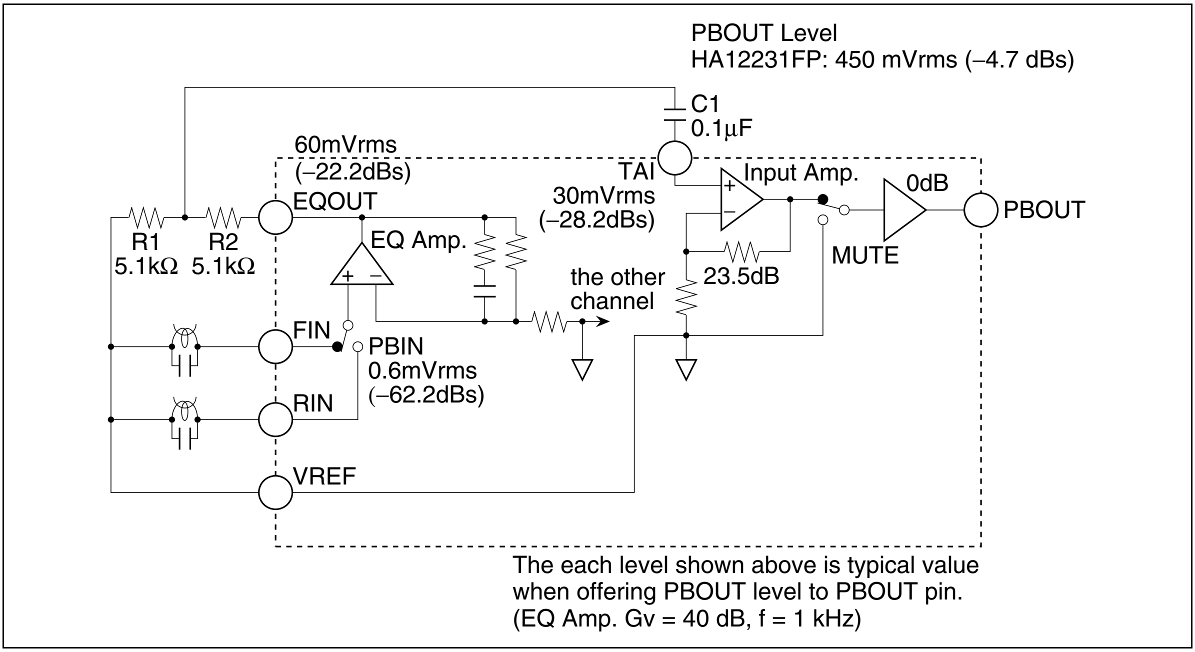


Figure 3 Input Block Diagram

Adjustment of Playback Reference Operate Level

After replace R1 and R2 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.

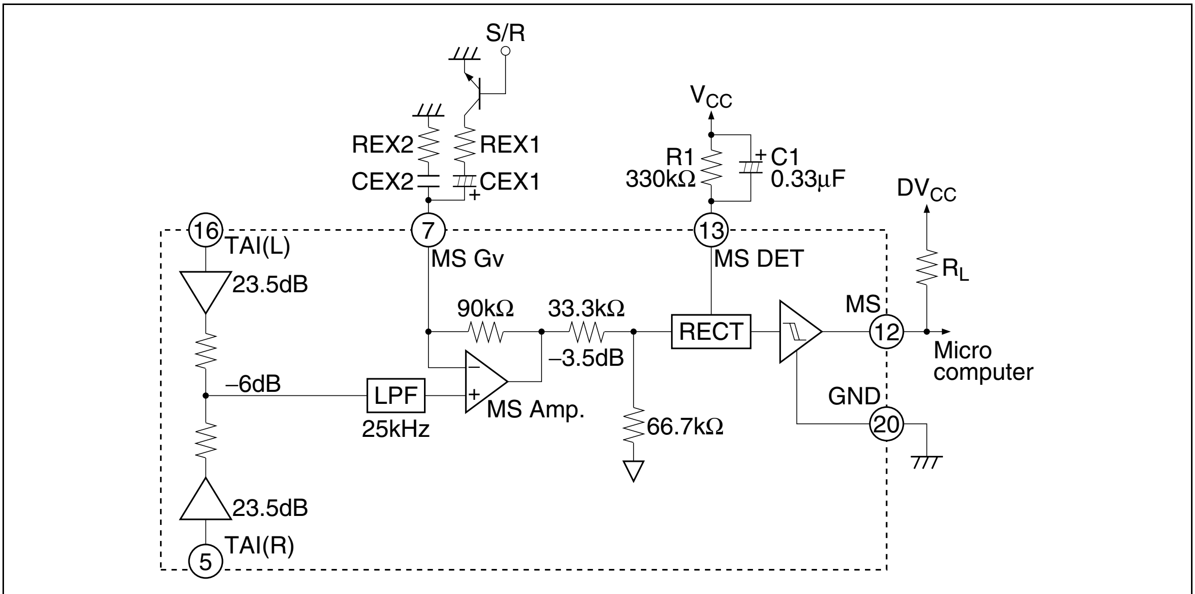


Figure 4 Music Sensor Block Diagram

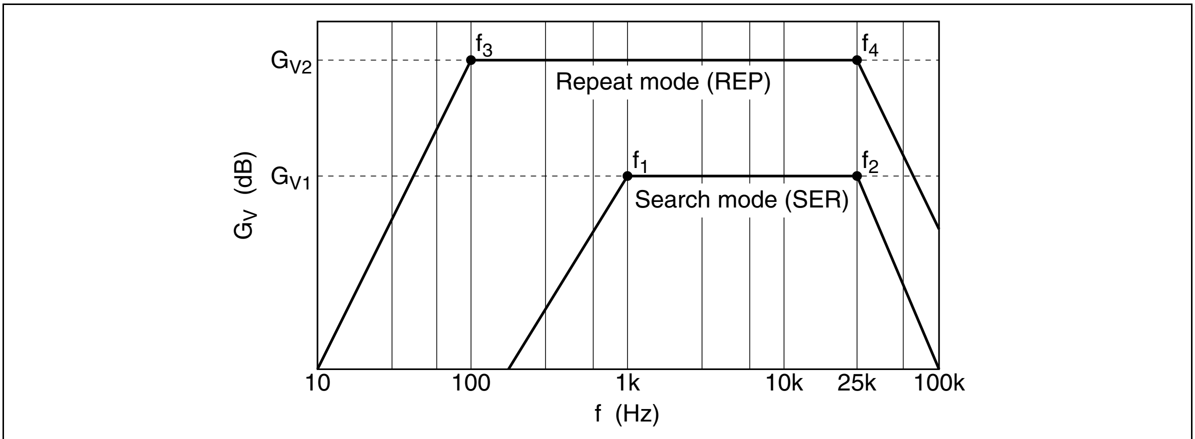


Figure 5 Frequency Response

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1. Search mode

$$G_{V1} = (23.5dB - 3.5dB) + 20\log\left(1 + \frac{90k}{REX2}\right) \quad [dB]$$

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

2. Repeat mode

$$G_{V2} = (23.5dB - 3.5dB) + 20\log\left(1 + \frac{90k}{REX1}\right) \quad [dB]$$

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

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

$$S = 12.7 - G_V \quad [dB]$$

S is 6 dB down in case of one-side channel.

Notes: 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: This MS presented hysteresis lest MS(OUT) terminal 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 C1, 0.01 µF to 1 µF capacitor C1 can be applicable.
2. Sensing signal to no signal (Recovery) is determined by C1 and R1, however preceding (1), 100 kΩ to 1 MΩ can be applicable.

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.

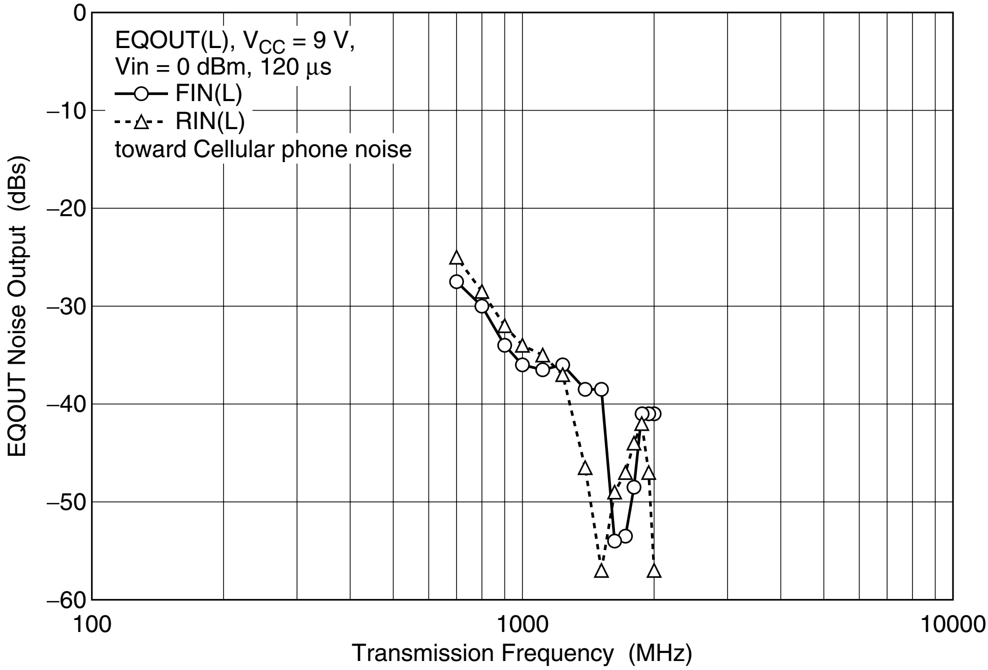
$$I_L = \frac{DV_{CC} - MS(OUT)_{LO}^*}{R_L}$$

* $MS(OUT)_{LO}$: Sensing signal (about 1V)

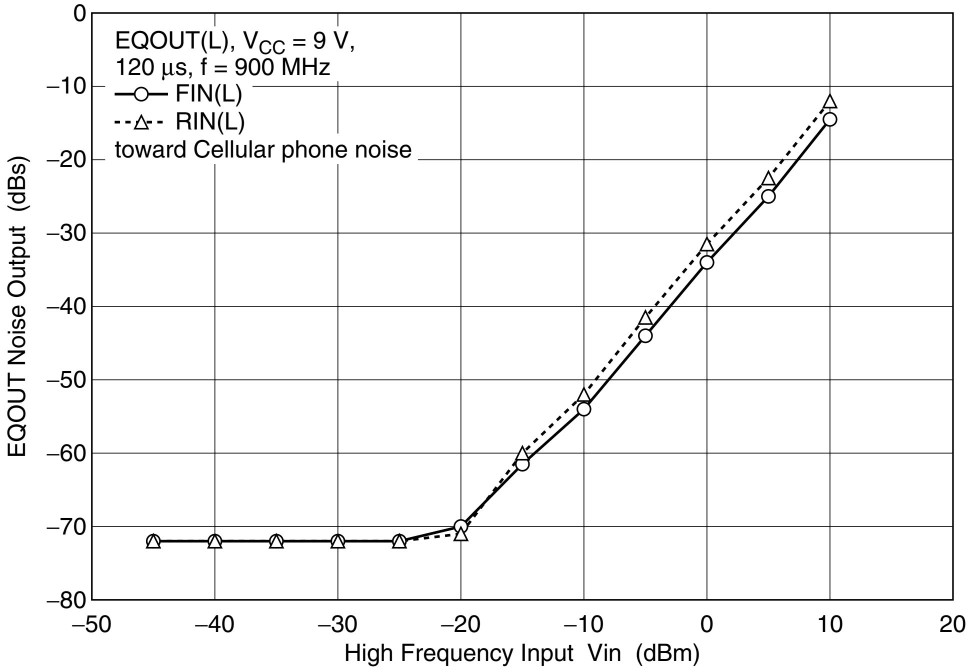
Note: Supply voltage of MS(OUT) pin must be less than V_{CC} voltage.

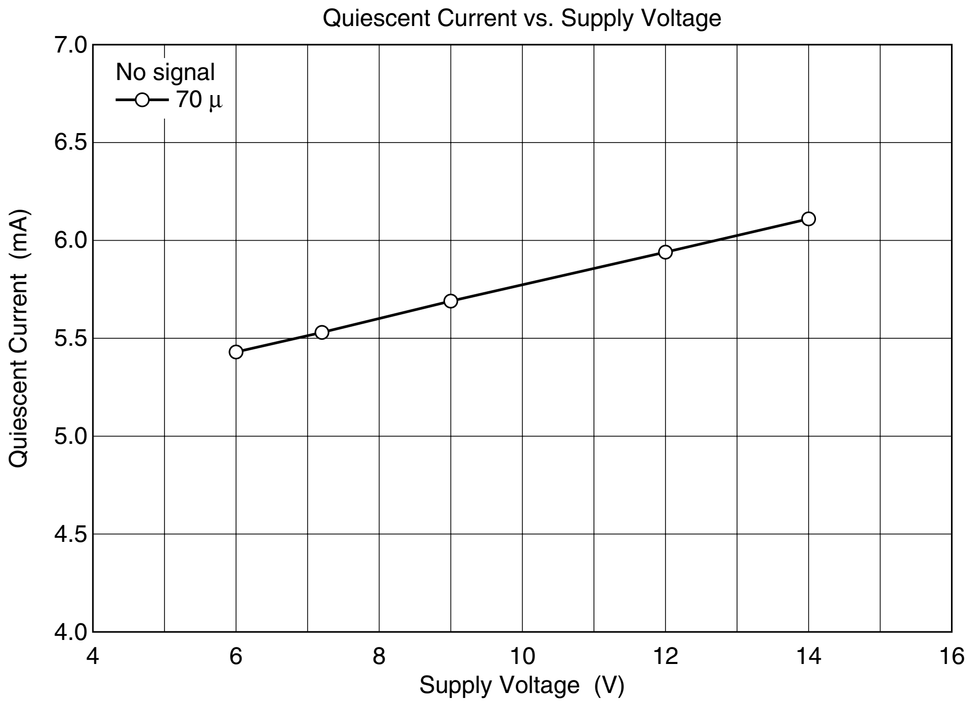
Characteristic Curves

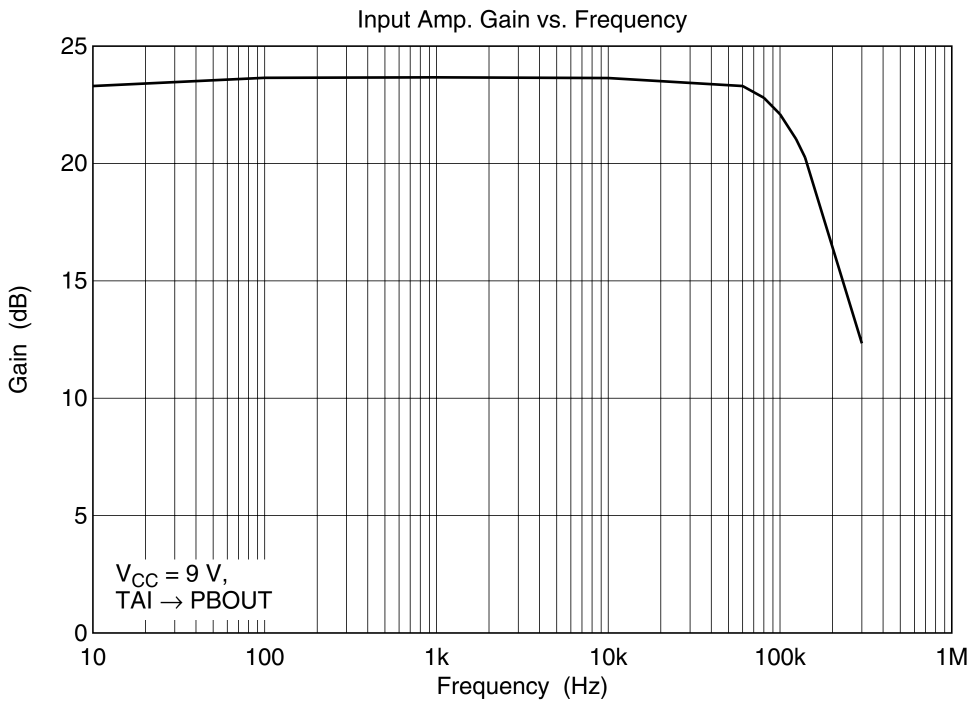
EQOUT Noise Output vs. Transmission Frequency

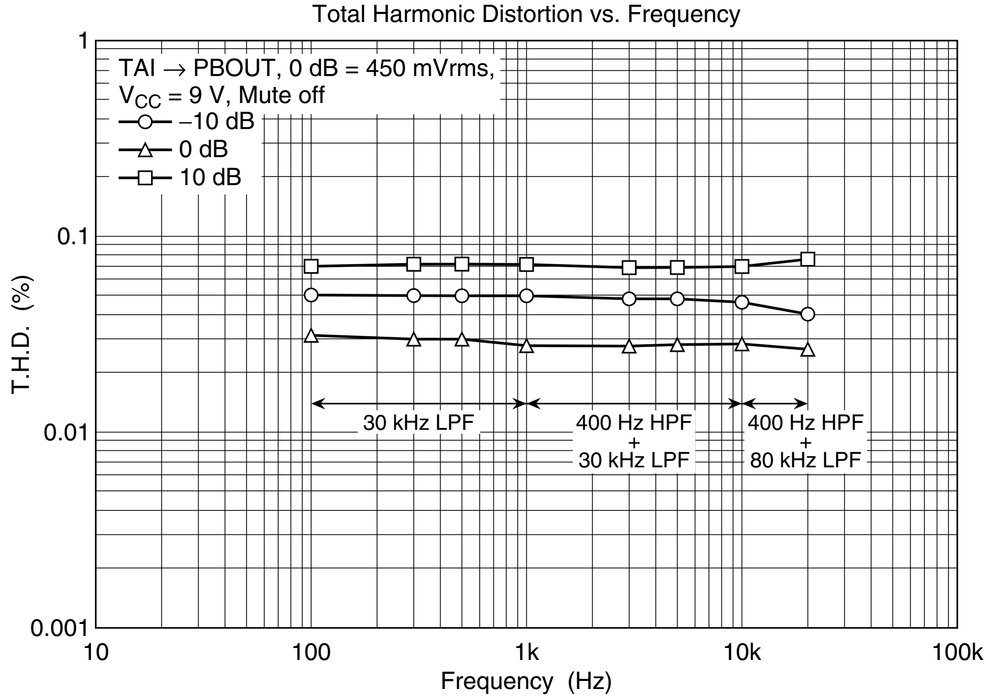


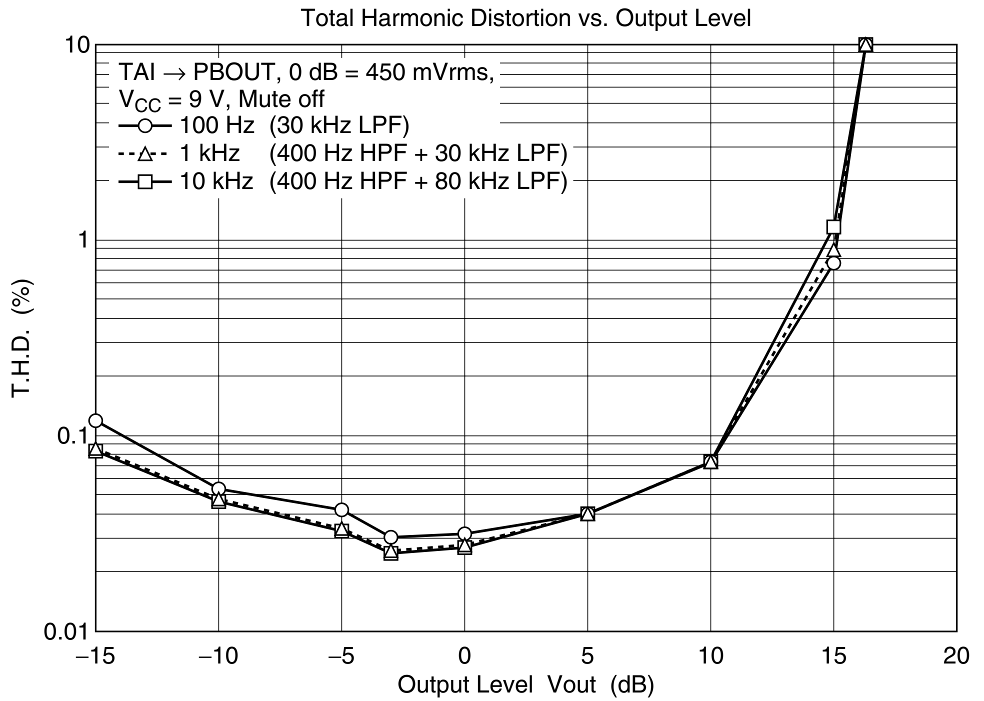
EQOUT Noise Output vs. Transmission Signal Input Level

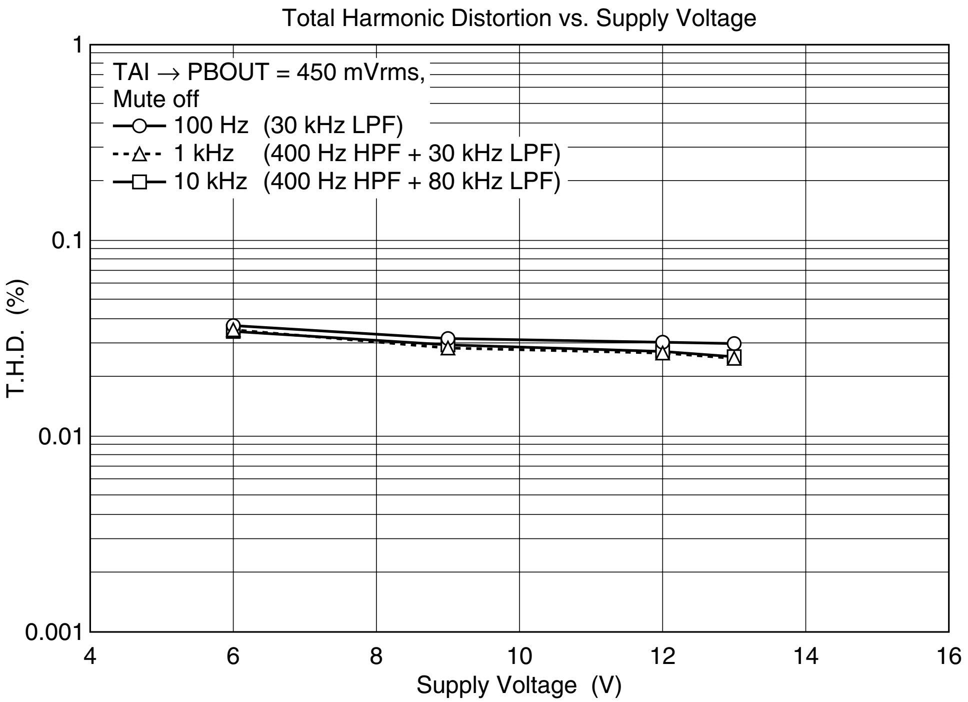


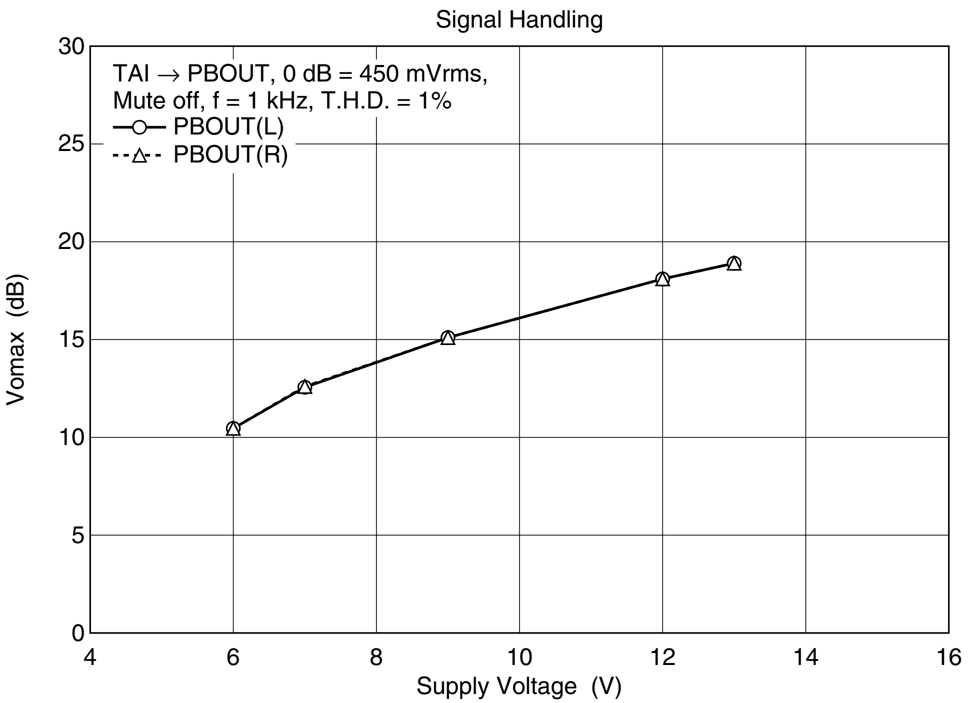

Quiescent Current vs. Supply Voltage
No signal
70 μ
Quiescent Current (mA)
7.0
6.5
6.0
5.5
5.0
4.5
4.0
4
6
8
10
12
14
16
Supply Voltage (V)

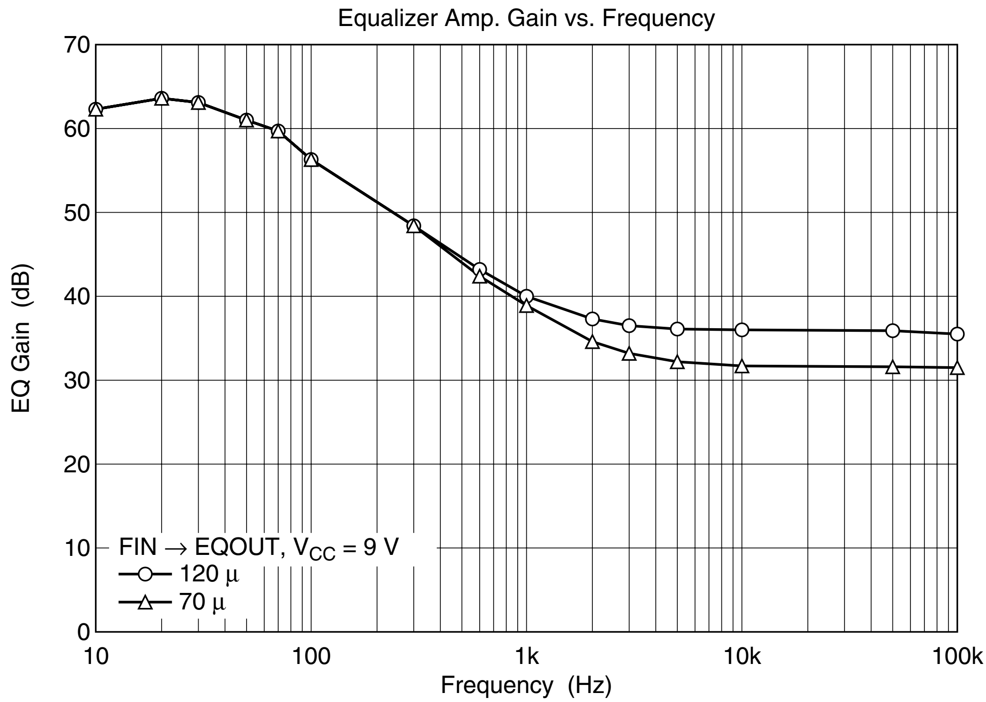

Input Amp. Gain vs. Frequency
Gain (dB)
25
20
15
10
5
0
10
100
1k
10k
100k
1M
Frequency (Hz)
VCC = 9 V,
TAI → PBOUT

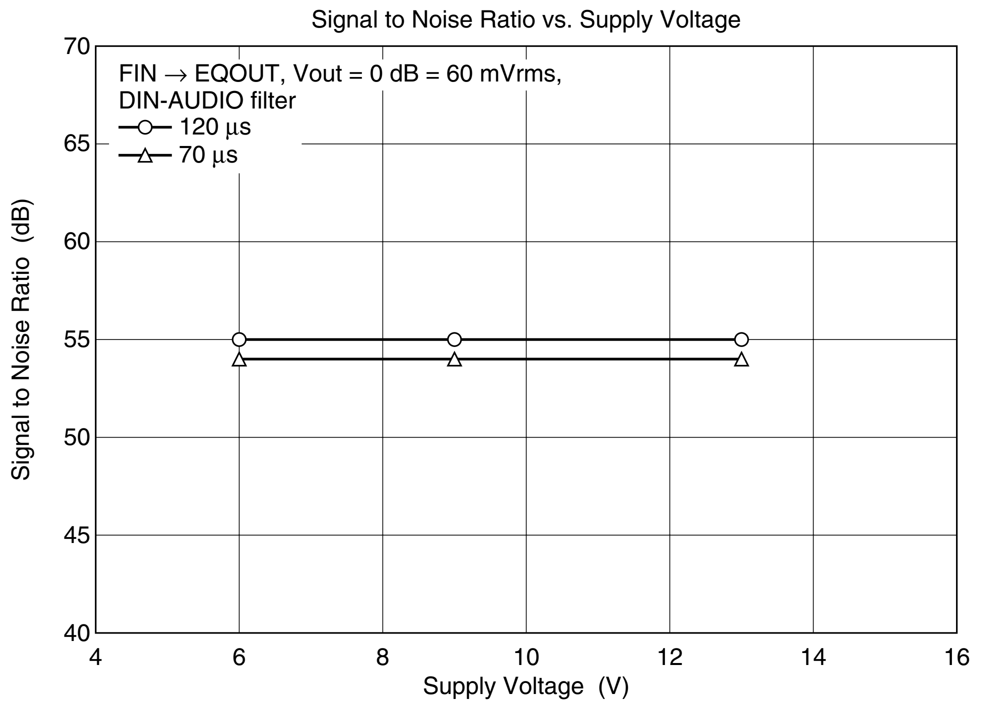

Total Harmonic Distortion vs. Frequency
TAI → PBOUT, 0 dB = 450 mVrms,
VCC = 9 V, Mute off
–10 dB
0 dB
10 dB
30 kHz LPF
400 Hz HPF + 30 kHz LPF
400 Hz HPF + 80 kHz LPF
T.H.D. (%)
1
0.1
0.01
0.001
10
100
1k
10k
100k
Frequency (Hz)


Total Harmonic Distortion vs. Output Level
TAI → PBOUT, 0 dB = 450 mVrms,
VCC = 9 V, Mute off
100 Hz (30 kHz LPF)
1 kHz (400 Hz HPF + 30 kHz LPF)
10 kHz (400 Hz HPF + 80 kHz LPF)
T.H.D. (%)
10
1
0.1
0.01
–15
–10
–5
0
5
10
15
20
Output Level Vout (dB)


Total Harmonic Distortion vs. Supply Voltage
TAI → PBOUT = 450 mVrms,
Mute off
100 Hz (30 kHz LPF)
1 kHz (400 Hz HPF + 30 kHz LPF)
10 kHz (400 Hz HPF + 80 kHz LPF)
T.H.D. (%)
1
0.1
0.01
0.001
4
6
8
10
12
14
16
Supply Voltage (V)


Signal Handling
TAI → PBOUT, 0 dB = 450 mVrms,
Mute off, f = 1 kHz, T.H.D. = 1%
PBOUT(L)
PBOUT(R)
Vomax (dB)
30
25
20
15
10
5
0
4
6
8
10
12
14
16
Supply Voltage (V)


Equalizer Amp. Gain vs. Frequency
EQ Gain (dB)
70
60
50
40
30
20
10
0
FIN → EQOUT, V_{CC} = 9 V
120 μ
70 μ
10
100
1k
10k
100k
Frequency (Hz)


Signal to Noise Ratio vs. Supply Voltage
Signal to Noise Ratio (dB)
70
65
60
55
50
45
40
FIN → EQOUT, Vout = 0 dB = 60 mVrms,
DIN-AUDIO filter
120 μs
70 μs
4
6
8
10
12
14
16
Supply Voltage (V)

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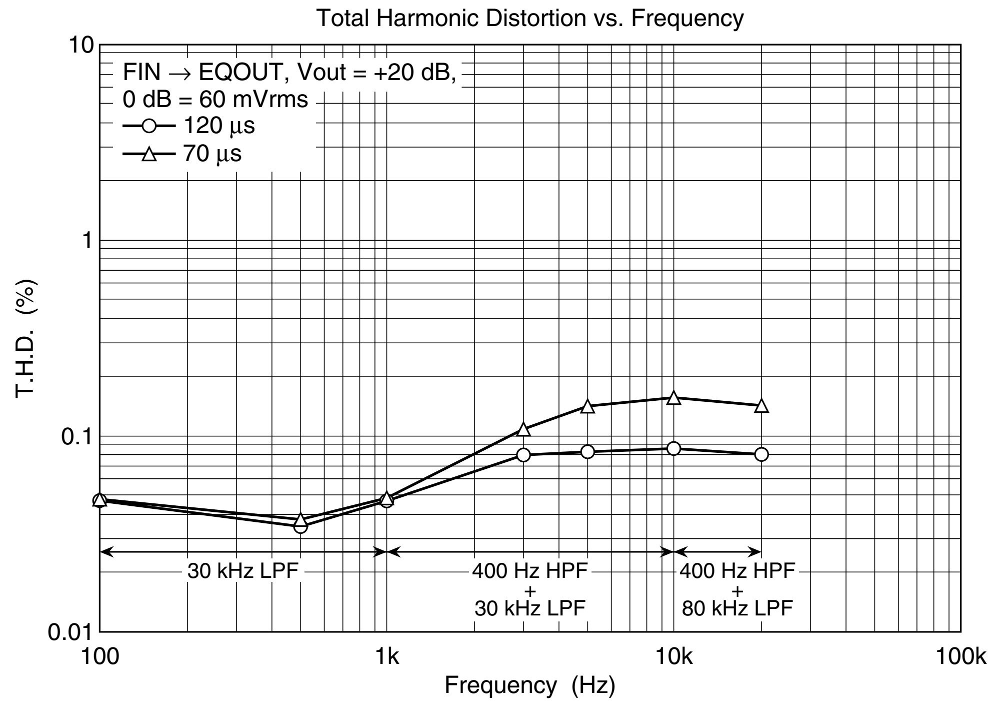
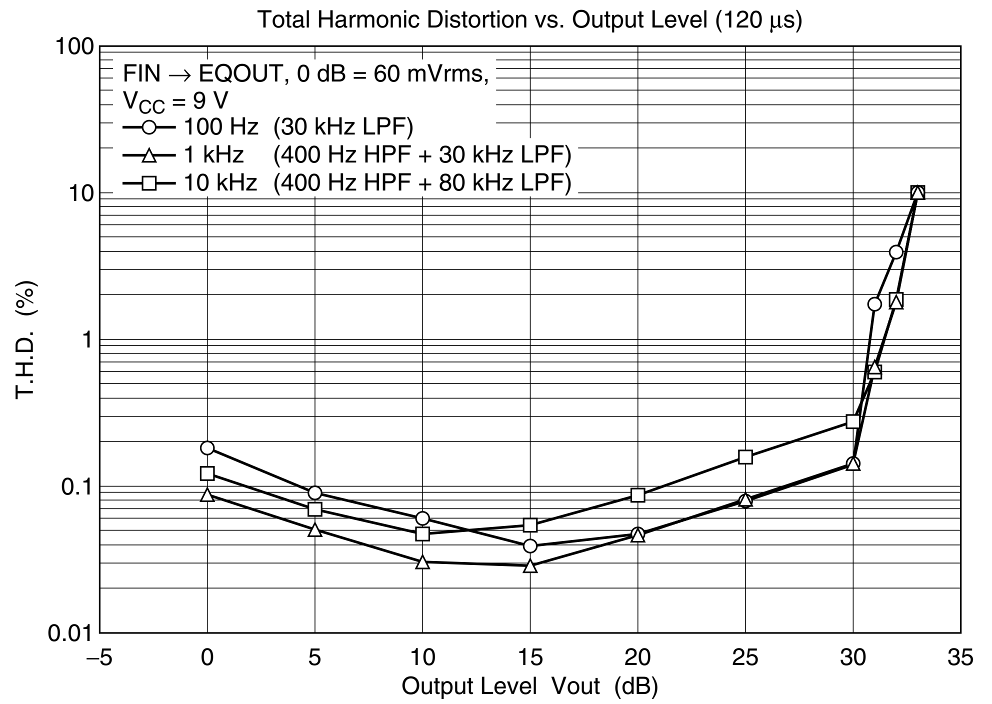
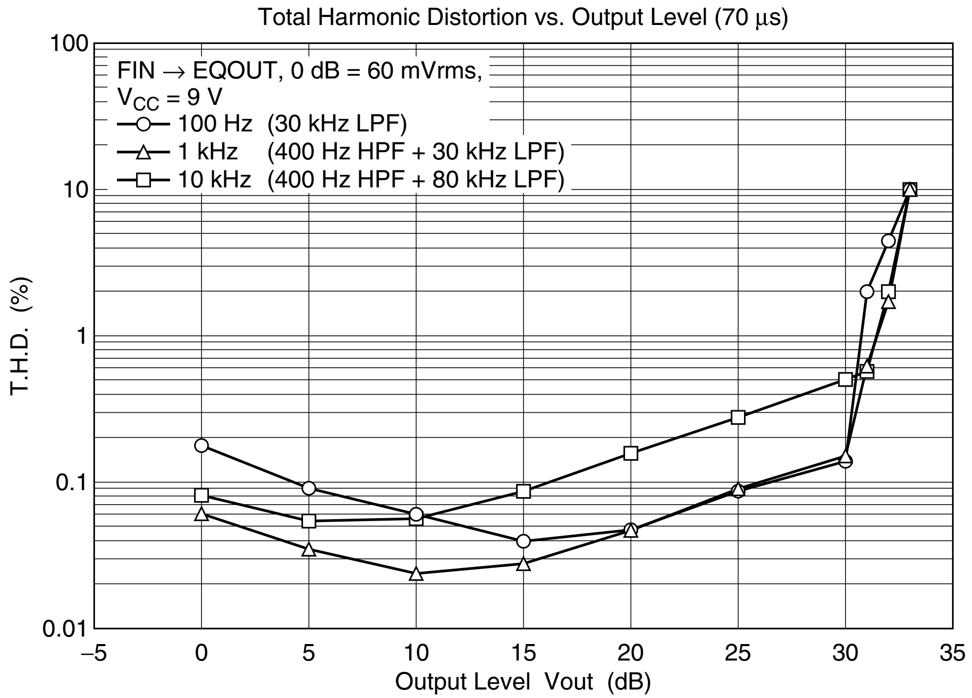
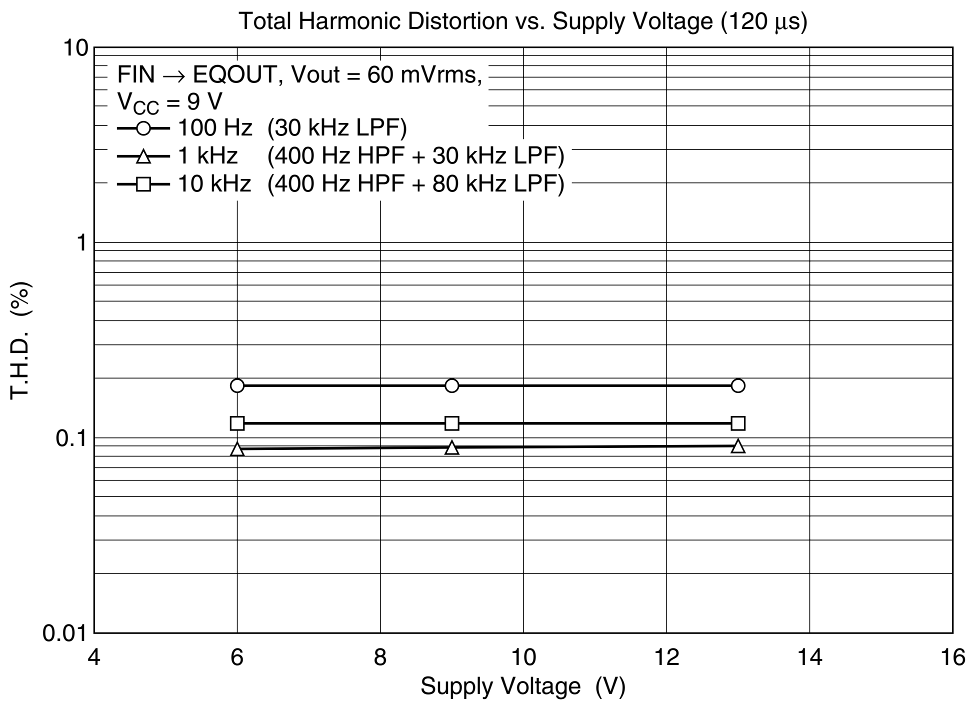


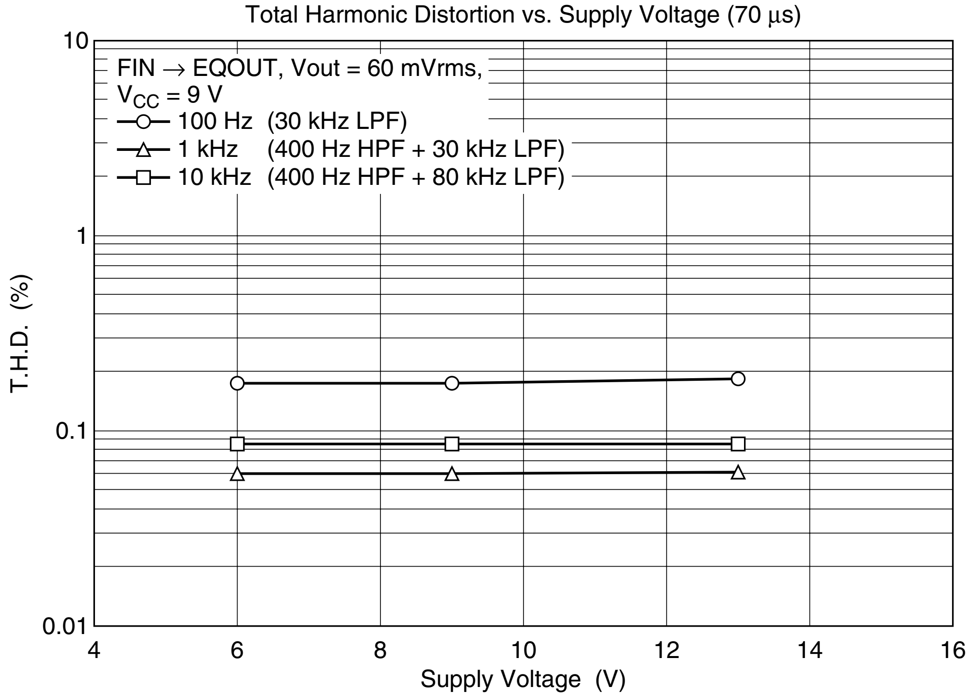
Total Harmonic Distortion vs. Frequency
FIN → EQOUT, Vout = +20 dB,
0 dB = 60 mVrms
120 µs
70 µs
T.H.D. (%)
10
1
0.1
0.01
30 kHz LPF
400 Hz HPF + 30 kHz LPF
400 Hz HPF + 80 kHz LPF
100
1k
10k
100k
Frequency (Hz)

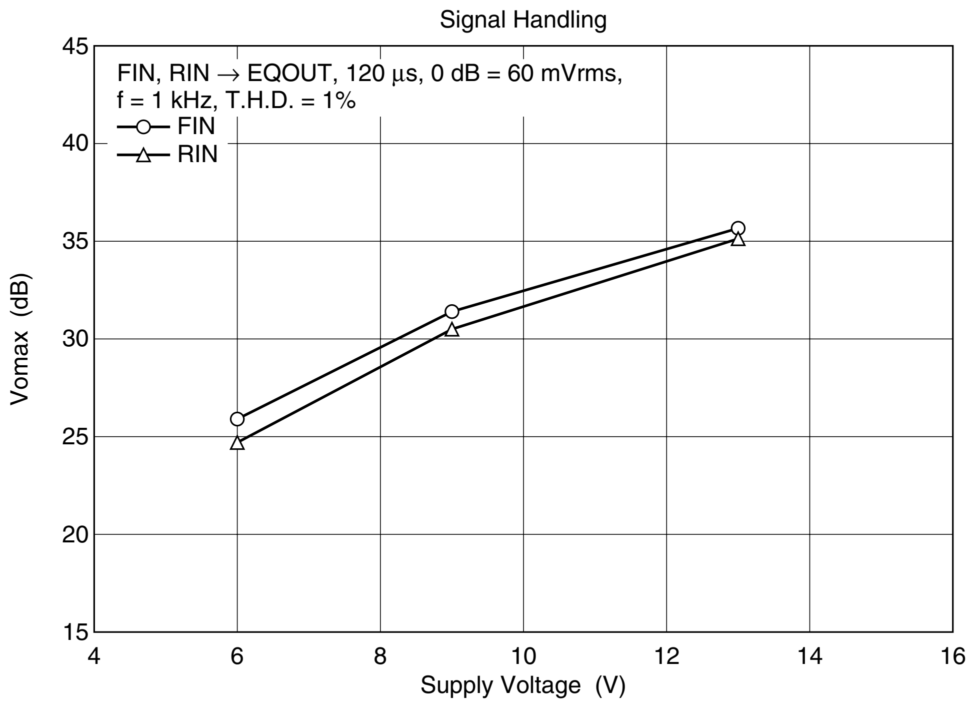


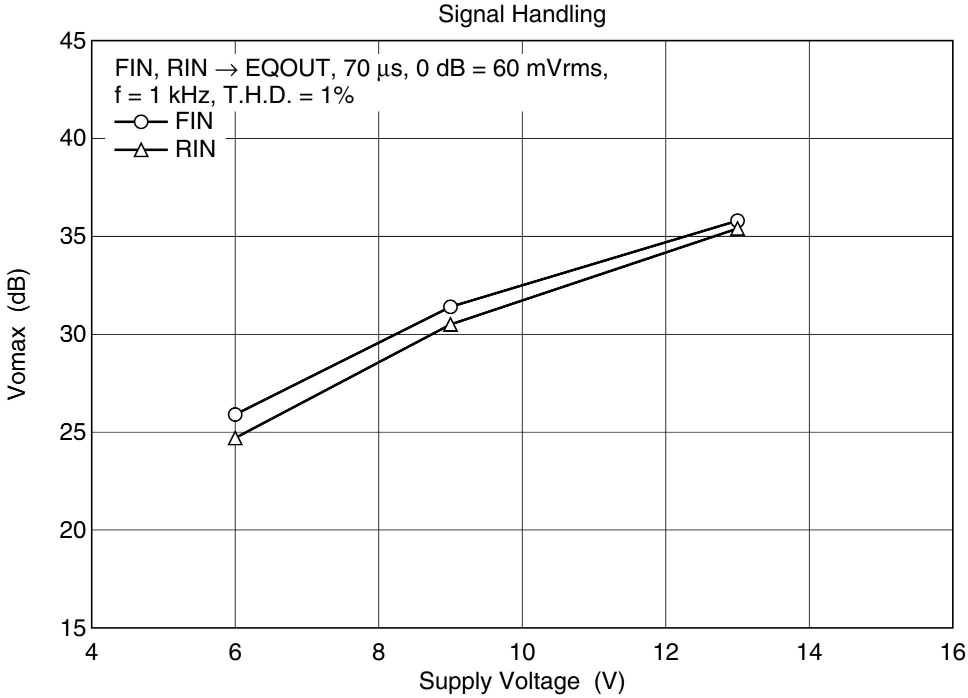
Total Harmonic Distortion vs. Output Level (120 µs)
FIN → EQOUT, 0 dB = 60 mVrms,
VCC = 9 V
100 Hz (30 kHz LPF)
1 kHz (400 Hz HPF + 30 kHz LPF)
10 kHz (400 Hz HPF + 80 kHz LPF)
T.H.D. (%)
100
10
1
0.1
0.01
–5
0
5
10
15
20
25
30
35
Output Level Vout (dB)

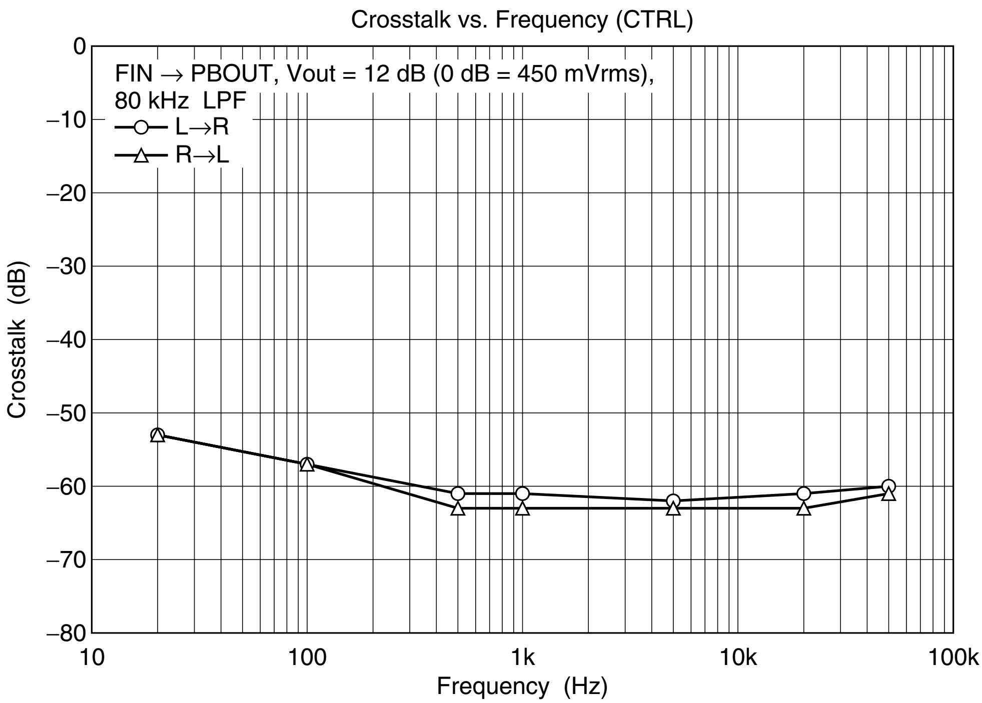

Total Harmonic Distortion vs. Output Level (70 µs)
FIN → EQOUT, 0 dB = 60 mVrms,
VCC = 9 V
100 Hz (30 kHz LPF)
1 kHz (400 Hz HPF + 30 kHz LPF)
10 kHz (400 Hz HPF + 80 kHz LPF)
T.H.D. (%)
Output Level Vout (dB)

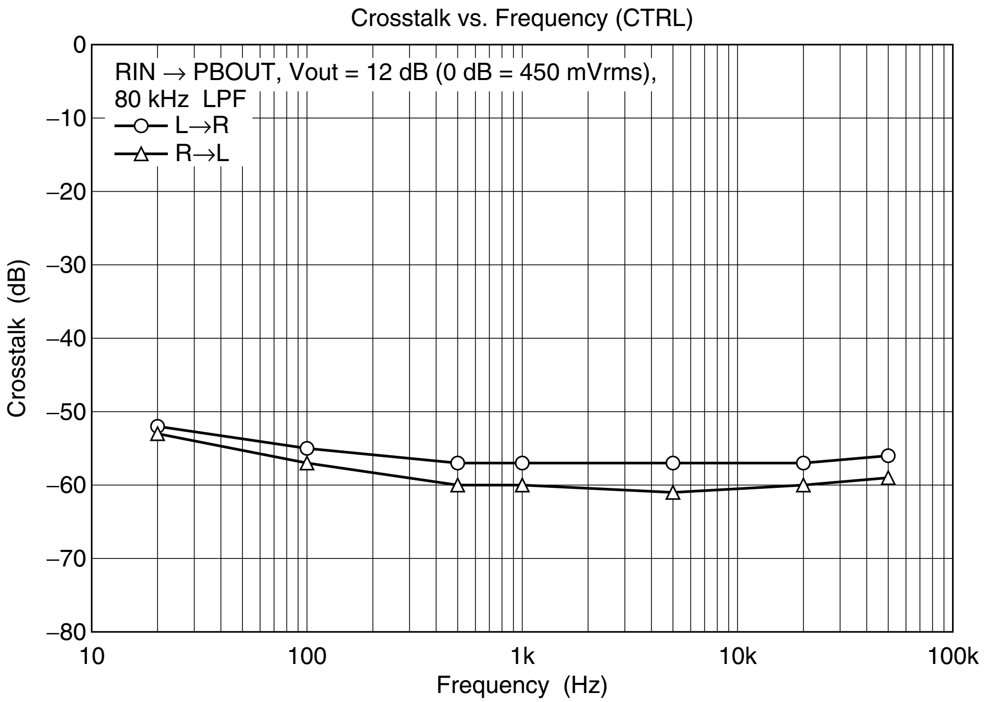

Total Harmonic Distortion vs. Supply Voltage (120 µs)
FIN → EQOUT, Vout = 60 mVrms,
VCC = 9 V
100 Hz (30 kHz LPF)
1 kHz (400 Hz HPF + 30 kHz LPF)
10 kHz (400 Hz HPF + 80 kHz LPF)
T.H.D. (%)
Supply Voltage (V)

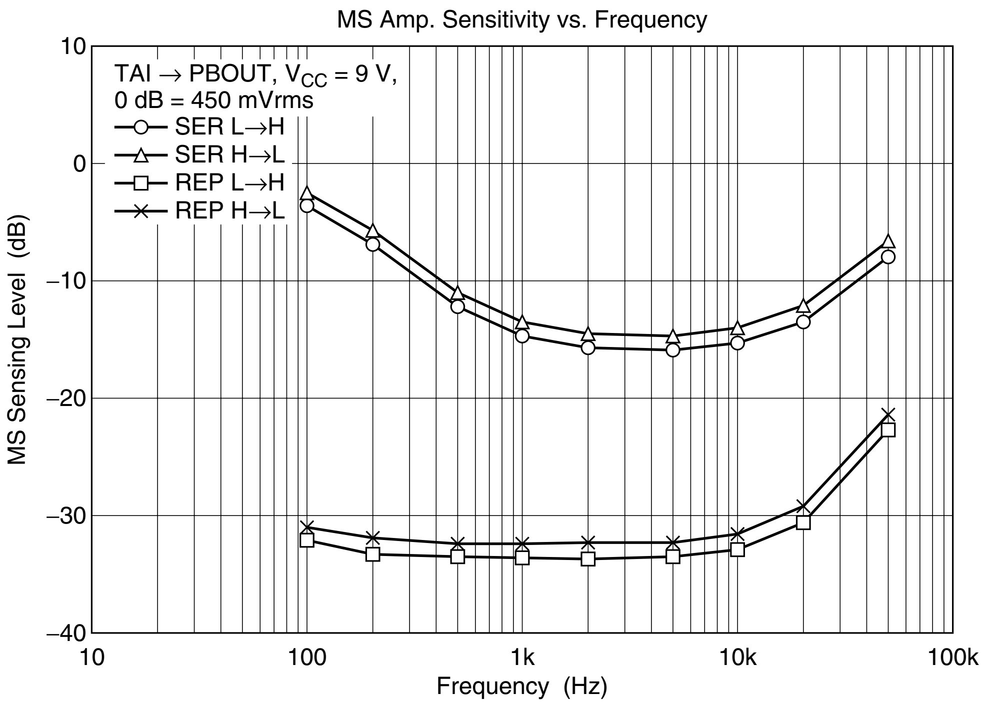

Total Harmonic Distortion vs. Supply Voltage (70 µs)
FIN → EQOUT, Vout = 60 mVrms,
VCC = 9 V
100 Hz (30 kHz LPF)
1 kHz (400 Hz HPF + 30 kHz LPF)
10 kHz (400 Hz HPF + 80 kHz LPF)
T.H.D. (%)
10
1
0.1
0.01
4
6
8
10
12
14
16
Supply Voltage (V)

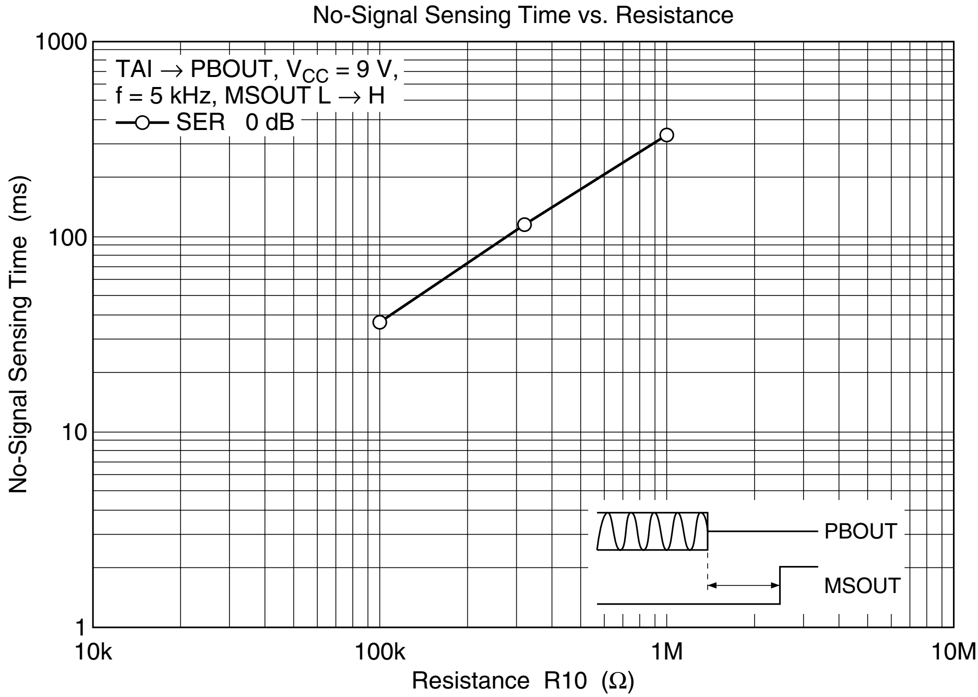

Signal Handling
FIN, RIN → EQOUT, 120 µs, 0 dB = 60 mVrms,
f = 1 kHz, T.H.D. = 1%
FIN
RIN
Vomax (dB)
45
40
35
30
25
20
15
4
6
8
10
12
14
16
Supply Voltage (V)

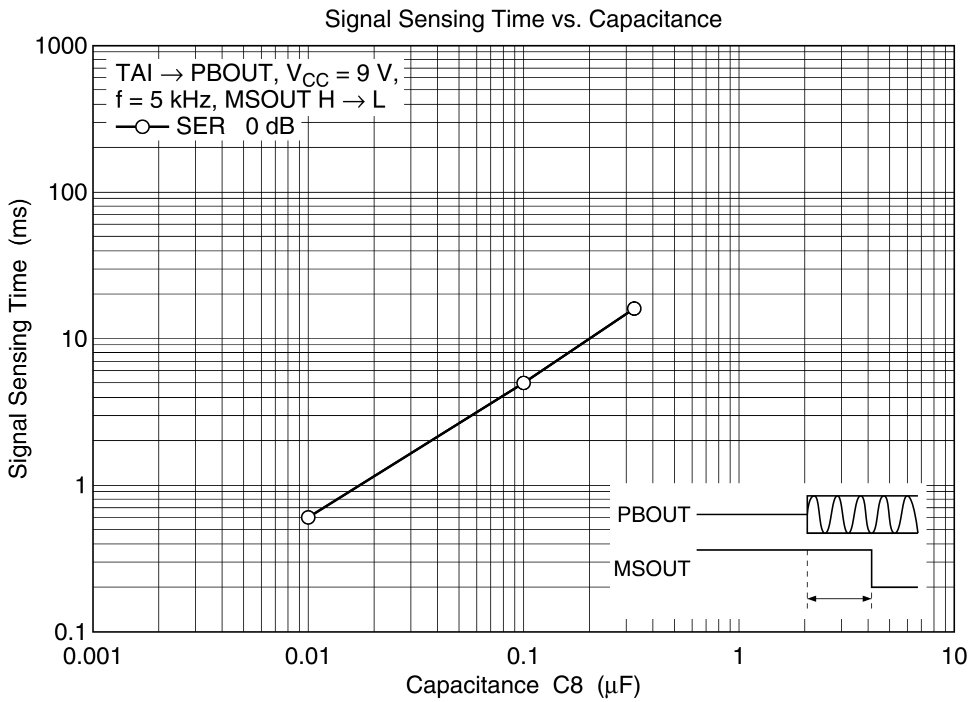

Signal Handling
FIN, RIN → EQOUT, 70 µs, 0 dB = 60 mVrms,
f = 1 kHz, T.H.D. = 1%
FIN
RIN
Vomax (dB)
Supply Voltage (V)
45
40
35
30
25
20
15
4
6
8
10
12
14
16


Crosstalk vs. Frequency (CTRL)
FIN → PBOUT, Vout = 12 dB (0 dB = 450 mVrms),
80 kHz LPF
L→R
R→L
Crosstalk (dB)
Frequency (Hz)
0
–10
–20
–30
–40
–50
–60
–70
–80
10
100
1k
10k
100k


Crosstalk vs. Frequency (CTRL)
RIN → PBOUT, Vout = 12 dB (0 dB = 450 mVrms),
80 kHz LPF
L→R
R→L
Crosstalk (dB)
0
–10
–20
–30
–40
–50
–60
–70
–80
10
100
1k
10k
100k
Frequency (Hz)

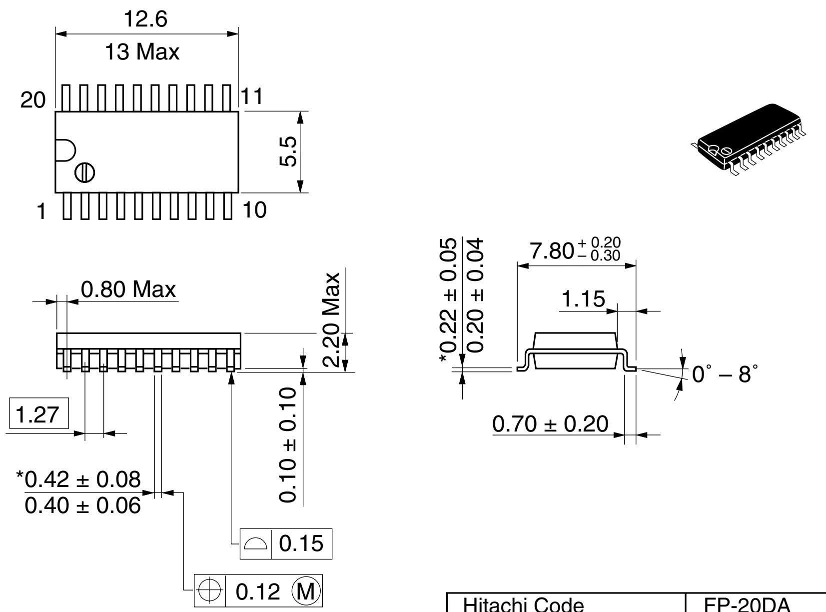

MS Amp. Sensitivity vs. Frequency
TAI → PBOUT, VCC = 9 V,
0 dB = 450 mVrms
SER L→H
SER H→L
REP L→H
REP H→L
MS Sensing Level (dB)
10
0
–10
–20
–30
–40
10
100
1k
10k
100k
Frequency (Hz)


No-Signal Sensing Time vs. Resistance
TAI → PBOUT, VCC = 9 V,
f = 5 kHz, MSOUT L → H
SER 0 dB
No-Signal Sensing Time (ms)
1000
100
10
1
10k
100k
1M
10M
Resistance R10 (Ω)
PBOUT
MSOUT


Signal Sensing Time vs. Capacitance
TAI → PBOUT, VCC = 9 V,
f = 5 kHz, MSOUT H → L
SER 0 dB
Signal Sensing Time (ms)
1000
100
10
1
0.1
0.001
0.01
0.1
1
10
Capacitance C8 (µF)
PBOUT
MSOUT

Package Dimensions

As of July, 2002
Unit: mm



Hitachi Code	FP-20DA
JEDEC	—
JEITA	Conforms
Mass (reference value)	0.31 g

*Dimension including the plating thickness
Base material dimension

RENESAS

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Sales Offices

HITACHI

Hitachi, Ltd.
Semiconductor & Integrated Circuits
Nippon Bldg., 2-6-2, Ohte-machi, Chiyoda-ku, Tokyo 100-0004, Japan
Tel: (03) 3270-2111 Fax: (03) 3270-5109

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For further information write to:

Hitachi Semiconductor
(America) Inc.
179 East Tasman Drive
San Jose,CA 95134
Tel: <1> (408) 433-1990
Fax: <1>(408) 433-0223

Hitachi Europe Ltd.
Electronic Components Group
Whitebrook Park
Lower Cookham Road
Maidenhead
Berkshire SL6 8YA, United Kingdom
Tel: <44> (1628) 585000
Fax: <44> (1628) 778322

Hitachi Europe GmbH
Electronic Components Group
Dornacher Str 3
D-85622 Feldkirchen
Postfach 201, D-85619 Feldkirchen
Germany
Tel: <49> (89) 9 9180-0
Fax: <49> (89) 9 29 30 00

Hitachi Asia Ltd.
Hitachi Tower
16 Collyer Quay #20-00
Singapore 049318
Tel : <65>-6538-6533/6538-8577
Fax : <65>-6538-6933/6538-3877
URL : http://semiconductor.hitachi.com.sg

Hitachi Asia Ltd.
(Taipei Branch Office)
4/F, No. 167, Tun Hwa North Road
Hung-Kuo Building
Taipei (105), Taiwan
Tel : <886>-(2)-2718-3666
Fax : <886>-(2)-2718-8180
Telex : 23222 HAS-TP
URL : http://semiconductor.hitachi.com.tw

Hitachi Asia (Hong Kong) Ltd.
Group III (Electronic Components)
7/F., North Tower
World Finance Centre,
Harbour City, Canton Road
Tsim Sha Tsui, Kowloon Hong Kong
Tel : <852>-2735-9218
Fax : <852>-2730-0281
URL : http://semiconductor.hitachi.com.hk

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