HA12215F

Audio Signal Processor for Cassette Deck
(Dolby B-type NR with Recording System)

HITACHI

ADE-207-253D (Z)

Target Specification
5th Edition
Oct. 1999

Description

HA12215F is silicon monolithic bipolar IC providing Dolby noise reduction system*[1], music sensor system, REC equalizer system and each electronic control switch 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.

Functions

- Dolby B-NR × 2 channel
- REC equalizer × 2 channel
- Music sensor × 1 channel
- Pass amp. × 2 channel
- Each electronic control switch to change REC equalizer, bias, etc.

Features

- REC equalizer is very small number of external parts and have 6 types of frequency characteristics built-in.
- 2 types of input for PB, 1 type of input for REC.
- 70µ - PB equalizer changing system built-in.
- Dolby NR with dubbing double cassette decks.
  Unprocessed signal output available from recording out terminals during PB mode.
- Provide stable music sensor system, available to design music sensing time and level.
- Controllable from direct micro-computer output.
- Bias oscillator control switch built-in.
- NR ON / OFF and REC / PB fully electronic control switching built-in.
- Normal-speed / high-speed, Normal / Crom / Metal and PB equalizer fully electronic control switching built-in.
- Available to reduce substrate-area because of high integration and small external parts.

Ordering Information

Operating Voltage

Product	V_{CC} (V)	V_{EE} (V)	Note
HA12215F	+6.0 to +7.5	–7.5 to –6.0	$\lvert V_{CC} + V_{EE} \rvert < 1.0$ V

Standard Level

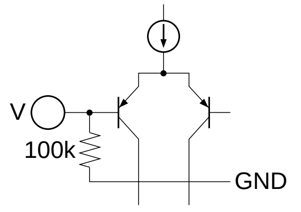
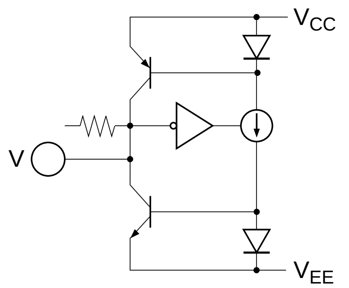
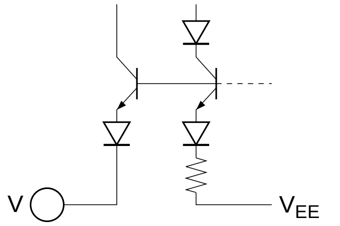
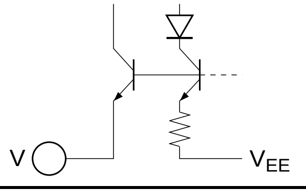
Product	Package	PB-OUT Level	REC-OUT Level	Dolby Level
HA12215F	FP-56	580 mVrms	300 mVrms	300 mVrms

Function

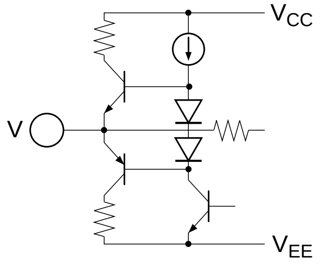
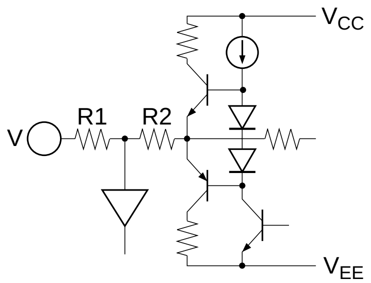
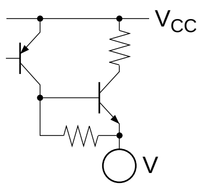
Product	Dolby B-NR	REC-EQ	Music Sensor	Pass Amp.	REC / PB Selection	ALC
HA12215F	❍	❍	❍	❍	❍	❍

Note: Depending on the employed REC / PB head and test tape characteristics, there is a rare case that the REC-EQ characteristics of this LSI can not be matched to the required characteristics because of built-in resistors which determined the REC-EQ parameters in this case, please inquire the responsible agent because the adjustment built-in resistor is necessary.

Pin Description, Equivalent Circuit (V_{CC} = ±7 V, A system of split supply voltage, Ta = 25°C, No Signal, The value in the show typical value.)

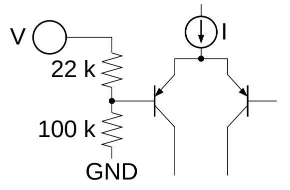
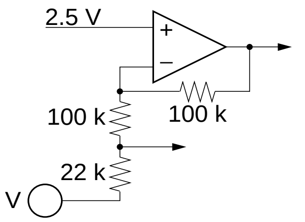
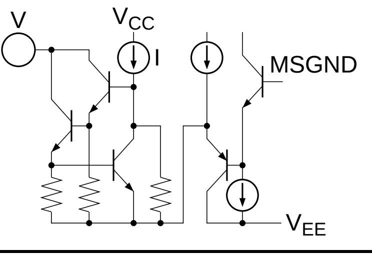
Pin No.	Terminal Name	Note	Equivalent Circuit	Pin Description
51	AIN (R)	V = GND		PB A Deck input
48	AIN (L)			
53	BIN (R)	V = GND		PB B Deck input
46	BIN (L)			
56	RIN (R)	V = GND		REC input
43	RIN (L)			
5	EQIN (R)	V = GND		REC equalizer input
38	EQIN (L)			
1	DET (R)	V = V_{EE}+2.7V		Time constant pin for Dolby-NR
42	DET (L)			
2	BIAS1	V = V_{EE}+0.6V		Dolby bias current input
41	BIAS2	V = V_{EE}+1.3V		REC equalizer bias current input

Pin Description, Equivalent Circuit (V_{CC} = ±7 V, A system of split supply voltage, Ta = 25°C, No Signal, The value in the show typical value.) (cont)

Pin No.	Terminal Name	Note	Equivalent Circuit	Pin Description
3	PBOUT (R)	V = GND		PB output
40	PBOUT (L)			
4	RECOUT (R)	V = GND		REC output
39	RECOUT (L)			
7	EQOUT (R)	V = GND		REC equalizer output
36	EQOUT (L)			
28	MAOUT	V = GND		MS Amp. output *[1]
8	ROUT (R)	V = GND		Input Amp. output
35	ROUT (L)			
52	ABO (R)	R1 = 15 k R2 = 12 k		Time constant pin for PB equalizer (70μ)
47	ABO (L)			
6	BOOST (R)	R1 = 4.8 k R2 = 4.8 k		Time constant pin for low boost
37	BOOST (L)			
31	BIAS (M)	V = V_{cc} – 0.7V		REC bias current output
32	BIAS (C)			
33	BIAS (N)			

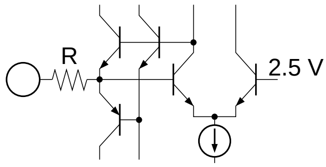
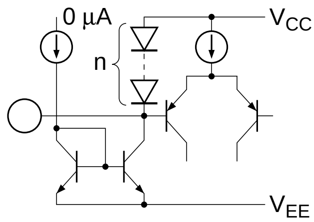
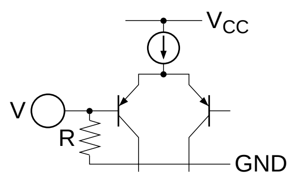
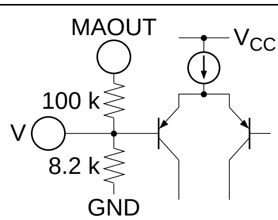
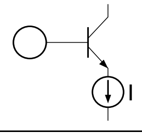
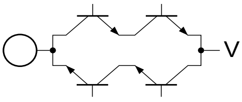
Note: 1. MS: Music Sensor

Pin Description, Equivalent Circuit (V_{CC} = ±7 V, A system of split supply voltage, Ta = 25°C, No Signal, The value in the show typical value.) (cont)

Pin No.	Terminal Name	Note	Equivalent Circuit	Pin Description
21	V_{CC}	V = V_{CC}		Power supply
49	GND	V = 0V		GND pin
50	V_{EE}	V = V_{EE}		Negative power supply
45, 54	NC	No connection		No connection
15	ALC $\overline{\text{ON}}$/OFF	I = 50 µA		Mode control input
16	PB $\overline{\text{A}}$/B			
17	A $\overline{\text{120}}$/70			
18	$\overline{\text{NORM}}$/HIGH			
19	B $\overline{\text{NORM}}$/$\overline{\text{CROM}}$/ METAL			
20	BIAS ON/$\overline{\text{OFF}}$			
22	RM $\overline{\text{ON}}$/OFF			
23	NR ON/$\overline{\text{OFF}}$			
25	LM ON/$\overline{\text{OFF}}$			
24	$\overline{\text{REC}}$/$\overline{\text{PB}}$/PASS			Mode control input
26	MSOUT	I = 0 µA		MS output (to MPU) *[1]

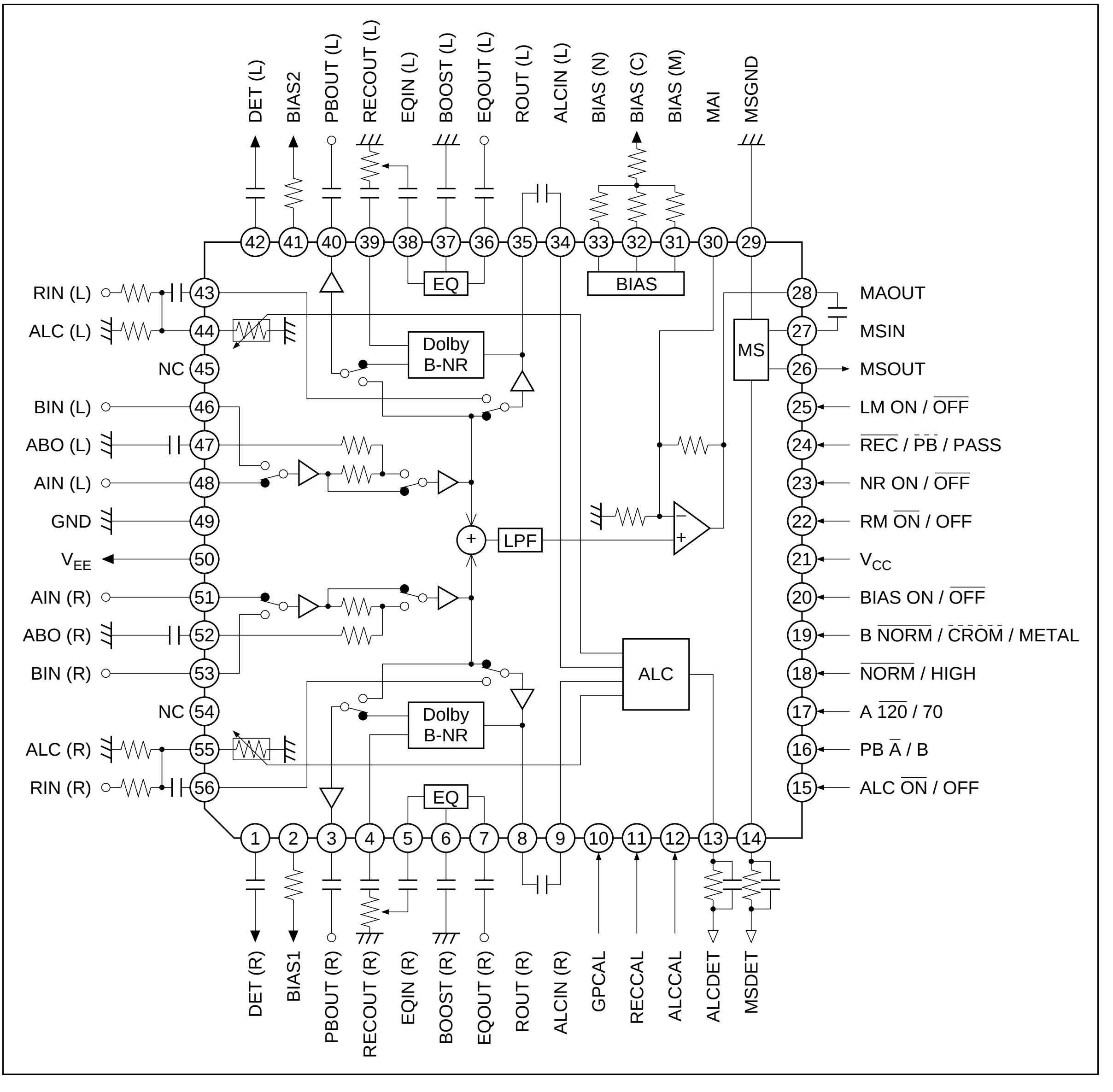
Note: 1. MS: Music Sensor

Pin Description, Equivalent Circuit (V_{CC} = ±7 V, A system of split supply voltage, Ta = 25°C, No Signal, The value in the show typical value.) (cont)

Pin No.	Terminal Name	Note	Equivalent Circuit	Pin Description
10	GPCAL	R = 110 kΩ		GP gain calibration terminal
11	RECCAL	R = 110 kΩ		REC gain calibration terminal
12	ALCCAL	R = 140 kΩ		ALC operation level calibration terminal
14	MSDET	n = 6		Time constant pin for MS *1
13	ALCDET	n = 2		
27	MSIN	R = 50 kΩ		MS input *1
9	ALCIN (R)	R = 100 kΩ		
34	ALCIN (L)			
30	MAI	V = GND		MS Amp. input *1
29	MS GND	I = ±100 µA		MS output voltage level control pin *1
55	ALC (R)	V = GND		Variable impedance for attenuation
44	ALC (L)			

Note: 1. MS: Music Sensor

Block Diagram



Parallel-Data Format

Pin No.	Pin Name	Lo	Mid	Hi	MODE “Pin Open”
15	ALC $\overline{\text{ON}}$/OFF	ALC ON	—	ALC OFF	Lo
16	PB $\overline{\text{A}}$/B	Ain *1	—	Bin *1	Lo
17	A $\overline{\text{120}}$/70	*1	—	*1	Lo
22	RM $\overline{\text{ON}}$/OFF	REC MUTE ON	—	REC MUTE OFF	Lo
20	BIAS ON/$\overline{\text{OFF}}$	BIAS OFF	—	BIAS ON	Lo
23	NR ON/$\overline{\text{OFF}}$	NR OFF	—	NR ON	Lo
24	$\overline{\text{REC}}$/PB/PASS	REC MODE	PB MODE	REC MODE PASS	Mid
25	LM ON/$\overline{\text{OFF}}$	LINE MUTE OFF	—	LINE MUTE ON	Lo
18	$\overline{\text{NORM}}$/HIGH	Normal speed	—	High speed	Lo
19	B $\overline{\text{NORM}}$/CROM/ METAL	REC EQ Normal *1 Bias Normal	REC EQ CROM *1 Bias CROM	REC EQ METAL *1 Bias METAL	Lo

Note: 1. PB EQ logic

PB EQ Logic

A $\overline{\text{120}}$/70	B $\overline{\text{NORM}}$ / CROM / METAL	PB Lo	PB Hi
Lo	Lo	FLAT	FLAT
Lo	Hi or Mid	FLAT	70 µ
Hi	Lo	70 µ	FLAT
Hi	Hi or Mid	70 µ	70 µ

Functional Description

Power Supply Range

HA12215F is designed to operate on split supply.

Table 1 Supply Voltage

Product	V_{CC} (V)	V_{EE} (V)	Note
HA12215F	+6.0 to +7.5	–7.5 to –6.0	$\| V_{CC} + V_{EE} \| < 1.0$ 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

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

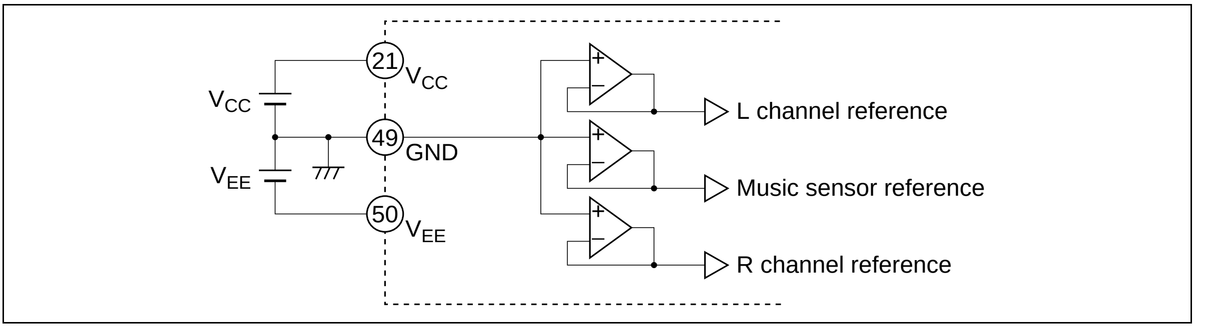
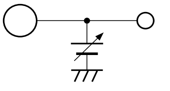


Figure 1 Reference Voltage

Operating Mode Control

HA12215F provide fully electronic switching circuits. And each operating mode control is controlled by parallel data (DC voltage).

Table 2 Control Voltage

Pin No.	Lo	Mid	Hi	Unit	Test Condition
15, 16, 17, 18, 20, 22, 23, 25	–0.2 to 1.0	—	4.0 to V_{CC}	V	Input Pin Measure 
19, 24	–0.2 to 1.0	2.0 to 3.0	4.0 to V_{CC}	V	

Notes: 1. Each pins are on pulled down with 100 kΩ internal resistor. Therefore, it will be low-level when each pins are open. But pin 24 is mid-level when it is open.

2. Over shoot level and under shoot level of input signal must be the standardized (High: V_{CC}, Low: –0.2 V).

3. For reduction of pop noise, connect 1 µF to 22 µF capacitor with mode control pins. But it is impossible to reduce completely in regard to Line mute, therefore, use external mute at the same time.

Input Block Diagram and Level Diagram

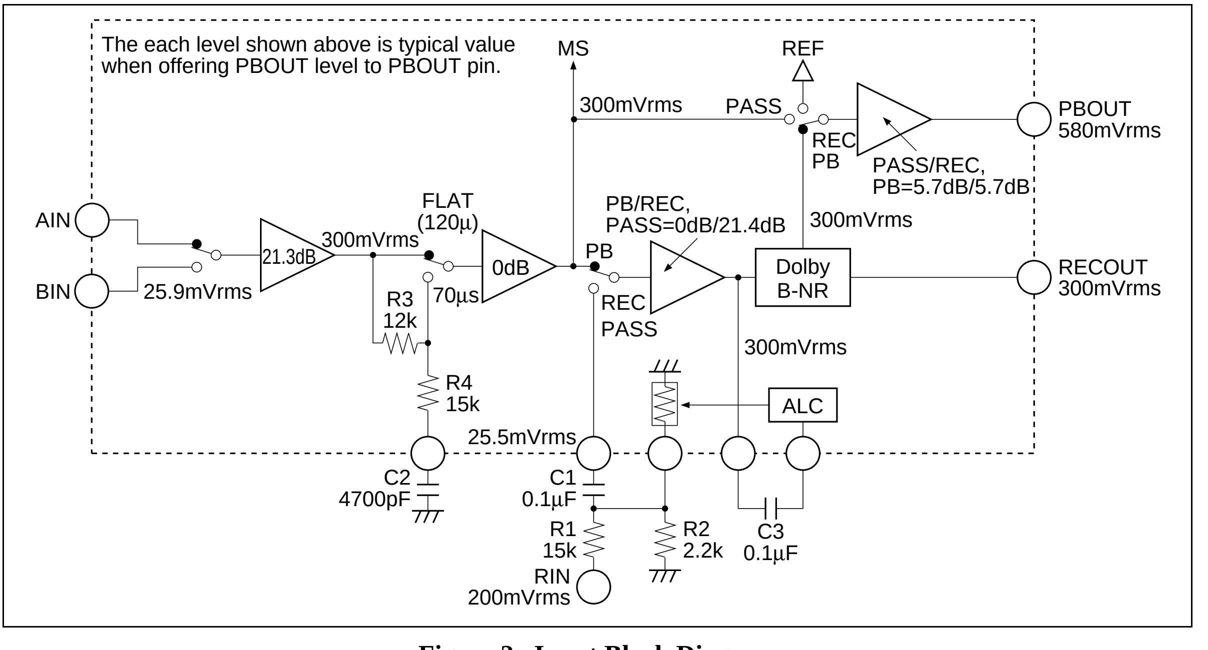


Figure 2 Input Block Diagram

PB Equalizer

By switching logical input level of pin 17 (for Ain) and pin 19 (for Bin), you can equalize corresponding to tape position at play back mode.

With the capacity C2 capacitance that we showed for figure 2 70 µs by the way figure seem to 3 they are decided.

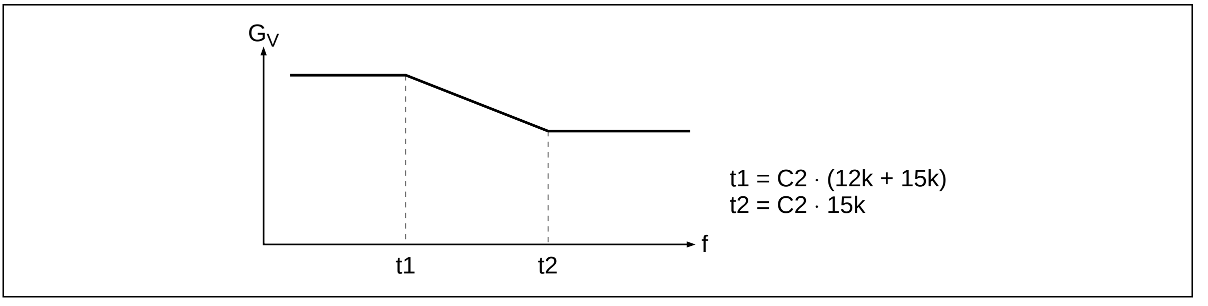


Figure 3 Frequency Characteristic of PB Equalizer

The Sensitivity Adjustment of Music Sensor

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

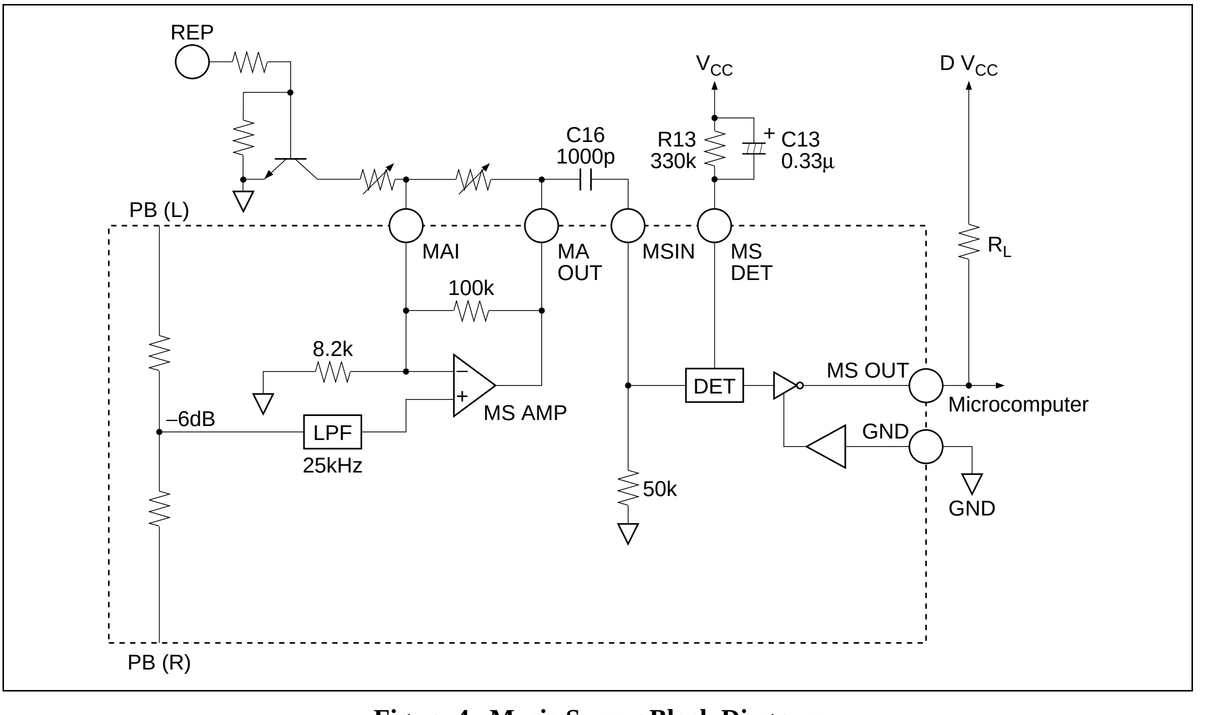


Figure 4 Music Sensor Block Diagram

The Sensitivity of Music Sensor

A standard level of MS input pin 25.9 mVrms, therefore, the sensitivity of music sensor (S) can request it, by lower formulas.

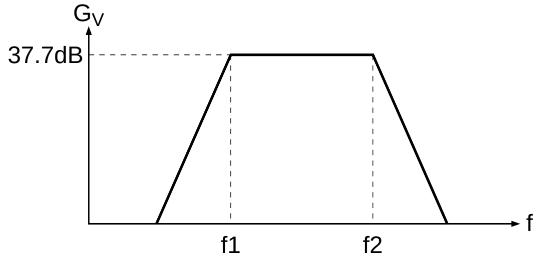
A = MS Amp Gain*1
B = PB input Gain × (1/2)*2
C = Sensed voltage
20log (A × B) = D [dB]
C = 130 [mVrms] (Intenally voltage in a standard)
PB input Gain = 21.3 [dB]

$$S = 20\log \frac{C}{25.9 \cdot A \cdot B} \quad [dB]$$

S = 14 – D [dB]

Notes: 1. When there is not a regulation outside.
2. Case of one-sided channel input.

But necessary to consider the same attenuation quantity practically, on account of A(B) have made frequency response.



$$f1 = \frac{1}{2\pi \cdot C16 \cdot 50k} \quad [Hz]$$

f2 = 25k [Hz]

Figure 5 Frequency Characteristic of MSIN

Occasion of the external component of figure 4, f1 is 3.18 kHz.

Time constant of detection

Figure 6(1) generally shows that detection time is in proportion to value of capacitor C13. But, with Attack*[2] and Recovery*[3] the detection time differs exceptionally.

Notes 2. Attack : Non- music to Music
3. Recovery : Music to Non-music

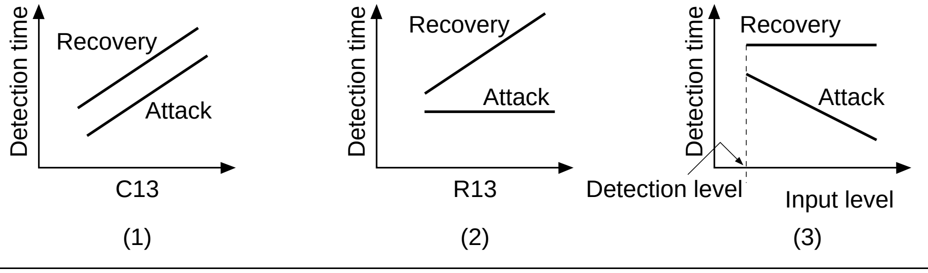


Figure 6 Function Characteristic of MS

Like the figure 6(2), Recovery time is variably possible by value of resistor R13. But Attack time gets about fixed value. Attack time has dependence by input level. When a large signal is inputted, Attack time is short tendency.

Music Sensor Output (MSOUT)

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

Connection with microcomputer, it is requested to use external pull up resistor (R_L = 10 kΩ to 22 kΩ)

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

The Tolerances of External Components

For Dolby NR precision securing, please use external components shown at figure 7. If leak-current are a few electrolytic-capacitor, it can be applicable to C5 and C23.

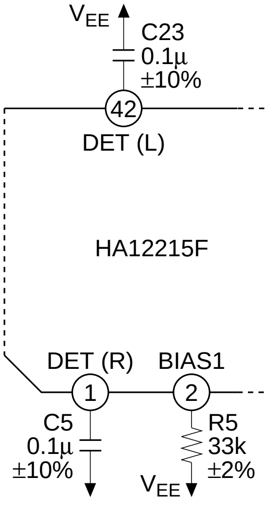


Figure 7 Tolerance of External Components

Low-Boost

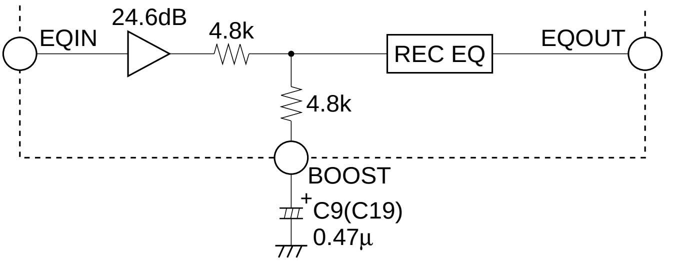


Figure 8 Example of Low Boost Circuit

External components shown figure 8 gives frequency response to take 6 dB boost. And cut off frequency can request it, by C9 (C19).

REC Equalizer

The outlines of REC Equalizing frequency characteristics are shown by figure 9. Those peak level can be set up by supplying voltage. (0 V to 5 V, GND = 0 V) to pin 10 (GPCAL).

And whole band gain can be set up by supplying voltage (0 V to 5 V, GND = 0 V) to pin 11 (RECCAL).

Both setting up range are ±4.5 dB. In case that you do not need setting up, pin 10, pin 11 should be open bias.

Note: Depending on the employed REC/PB head and test tape characteristics, there is a rare case that the REC-EQ characteristics of this LSI can not be matched to the required characteristics because of built-in resistors which determined the REC-EQ parameters in this care, please inquire the responsible agent because of the adjustment of built-in resistor is necessary.

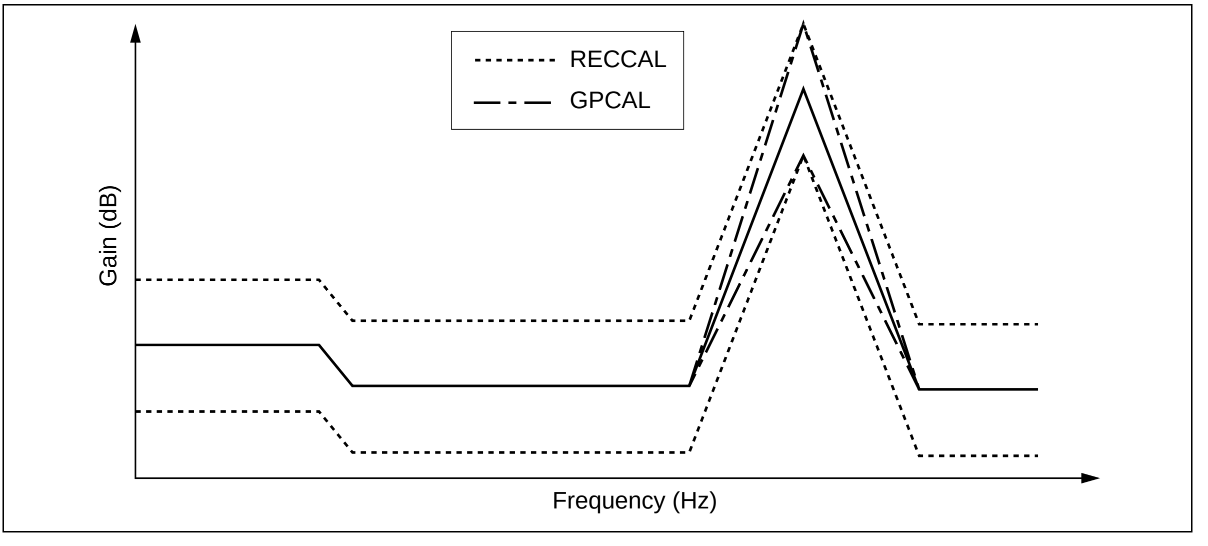


Figure 9 Frequency Characteristics of REC Equalizer

Bias Switch

HA12215F built-in DC voltage generator for bias oscillator and its bias switches.

External resistor R19, R20, R21 which corresponded with tape positions and bias out voltage are relater with below.

$$V_{bias} \fallingdotseq \left(\frac{R22}{(R19 \text{ or } R20 \text{ or } R21) + R22} \right) \times (V_{CC} - V_{EE} - 0.7) + V_{EE} \quad [V]$$

Bias switch follows to a logic of pin 19 (B / Norm / Crom / Metal).

Note: A current that flows at bias out pin, please use it less than 5 mA.

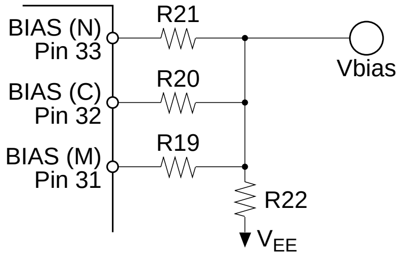


Figure 10 External Components of Bias Block

Automatic Level Control

ALC is the input decay rate variable system. It has internal variable resistors of pin 55 (pin 44) by RECOUT signal that is inputted to pin 9 (pin 34).

The operation is similitude to MS, detected by pin 13.

The signal input pin is pin 56 (pin 43). Resistor R1, R2 and capacitor C2, external components, for the input circuit are commended as figure 12. There are requested to use value of the block diagram figure for performance maintenance of S/N, T.H.D. etc.

Figure 11 shows the relation with R1 front RIN point and ROUT.

ALC operation level acts for the center of +4.5 dB at tape position TYPE I, IV and the center of +2.5 dB at tape position TYPE II, to standard level (300 mVrms).

Then, adopted maximum value circuit, ALC is operated by a large channel of a signal.

ALC ON/OFF can switch it by pin 15. Please do ALC ON, after it does for one time ALC OFF inevitably, for ALC time to start usefully (when switching PB → PASS, when switching PB → PASS), in order to reset ALC circuit.

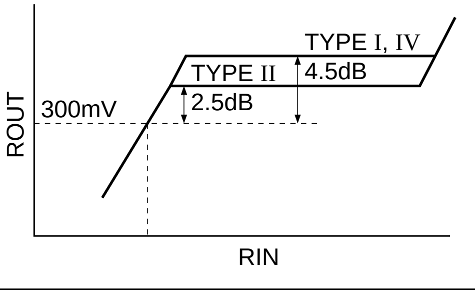


Figure 11 ALC Operation Level

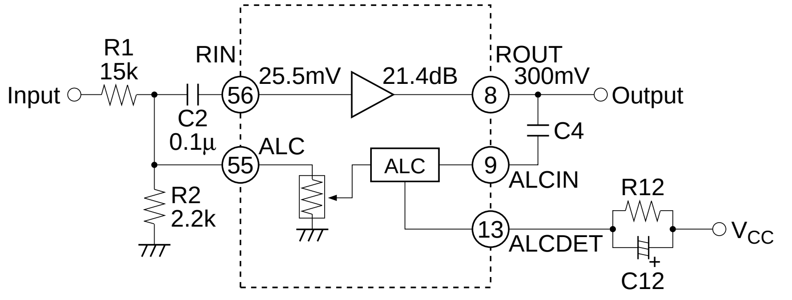


Figure 12 ALC Block Diagram

ALC Operation Level Necessary

ALC operation level is variable to pin 12 bias (ALC-CAL: 0 to 5 V), and its range is ±4.0 dB.

Unnecessary, pin 12 is unforced.

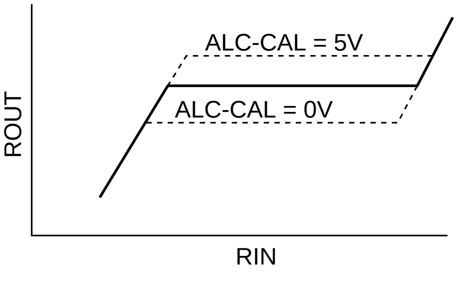


Figure 13 ALC-CAL Characteristics

Absolute Maximum Ratings

Item	Symbol	Rating	Unit	Note
Max supply voltage	V_{CC} max	16	V	
Power dissipation	Pd	625	mW	Ta ≤ 75°C
Operating temperature	Topr	–40 to +75	°C	
Storage temperature	Tstg	–55 to +125	°C	

Electrical Characteristics

(Ta = 25°C, V_{CC} = ±7 V, Dolby Level = REC-OUT Level = 300 mVrms = 0 dB)

Item	Symbol	Test Condition: IC Condition *1: NR ON/OFF	REC/PB /PASS	A/B	120µ/ 70µ	LINE MUTE	B N/C/M	fin (Hz)	RECOUT level (dB)	Other	Min	Typ	Max	Unit	Application Terminal: Input R	Input L	Output R	Output L	COM	Remark
Quiescent current	I_Q	OFF	PB	A	120	OFF	NORM	—	—	No signal	—	—	35.0	mA	—	—	—	—	—	
Input AMP. gain	G_V PB	OFF	PB	A/B	120	OFF	NORM	1k	0		25.5	27.0	28.5	dB	51/53	48/46	3	40	—	
	G_V REC	OFF	REC	A	120	OFF	NORM	1k	0		25.0	26.5	28.0		56	43	3	40	—	
B-type Encode boost	ENC 2k (1)	ON	REC	A	120	OFF	NORM	2k	–20		2.8	4.3	5.8	dB	56	43	4	39	—	
	ENC 2k (2)	ON	REC	A	120	OFF	NORM	2k	–30		7.0	8.5	10.0		56	43	4	39	—	
	ENC 5k (1)	ON	REC	A	120	OFF	NORM	5k	–20		1.7	3.2	4.7		56	43	4	39	—	
	ENC 5k (2)	ON	REC	A	120	OFF	NORM	5k	–30		6.7	8.2	9.7		56	43	4	39	—	
Signal handling	Vo max	ON	REC	A	120	OFF	NORM	1k	—	THD=1%	12.0	13.0	—	dB	56	43	4	39	—	2
Signal to noise ratio	S/N	ON	REC	A	120	OFF	NORM	1k	—	Rg=5.1kΩ, CCIR/ARM	64.0	70.0	—	dB	56	43	4	39	—	
Total Harmonic Distortion	THD	ON	REC	A	120	OFF	NORM	1k	0		—	0.05	0.3	%	56	43	4	39	—	
Channel separation	CTRL (1)	OFF	PB	A/B	120	OFF	NORM	1k	+12		70.0	80.0	—	dB	51/53	48/46	3	40	—	
	CTRL (2)	OFF	REC	A	120	OFF	NORM	1k	+12		70.0	85.0	—		56	43	3	40	—	
Crosstalk	CT A/B	OFF	PB	A/B	120	OFF	NORM	1k	+12		70.0	80.0	—	dB	51/53	48/46	3	40	—	
	CT R/P	OFF	REC/PB	A	120	OFF	NORM	1k	+12		70.0	80.0	—		51/56	48/43	3	40	—	
Pass AMP. gain	G_V PA	OFF	PASS	A/B	120	OFF	NORM	1k	0	G_V PA – G_V PB	25.5	27.0	28.5	dB	51/53	48/46	3	40	—	
Gain deviation	ΔG_V	OFF	PASS	A/B	120	OFF	NORM	1k	0		–1.0	0.0	1.0	dB	51/53	48/46	3	40	—	
MUTE ATT.	MUTE	OFF	PB	A	120	ON	NORM	1k	+12		70.0	80.0	—	dB	51	48	3	40	—	
70µ EQ gain	G_V EQ 1k	OFF	PB	A/B	70	OFF	NORM	1k	0		24.0	25.5	27.0	dB	51/53	48/46	3	40	—	
	G_V EQ 10k	OFF	PB	A/B	70	OFF	NORM/ CROM	10k	0		20.8	22.3	23.8		51/53	48/46	3	40	—	
MS sensing level	V_{ON}	OFF	PB	A	120	OFF	NORM	5k	—		–26.0	–22.0	–18.0	dB	51	48	—	—	—	3
MS output low level	V_{OL}	OFF	PB	A	120	OFF	NORM	—	—		—	1.0	1.5	V	51	48	—	—	—	
MS output leak current	I_{OH}	OFF	PB	A	120	OFF	NORM	—	—		—	—	2.0	µA	—	—	—	—	—	
ALC operate level	ALC (1)	OFF	REC	A	120	OFF	NORM, METAL	1k	+12		2.0	4.5	7.0	dB	56	43	4	39	—	
	ALC (2)	OFF	REC	A	120	OFF	CROM	1k	+12		0.0	2.5	5.0		56	43	4	39	—	

Notes: 1. Other IC-condition : REC-MUTE OFF, Normal tape, Normal speed, Bias OFF
2. V_{CC} = ±6.0 V
3. For inputting signal to one side channel

Electrical Characteristics (cont)

(Ta = 25°C, V_{CC} = ±7 V)

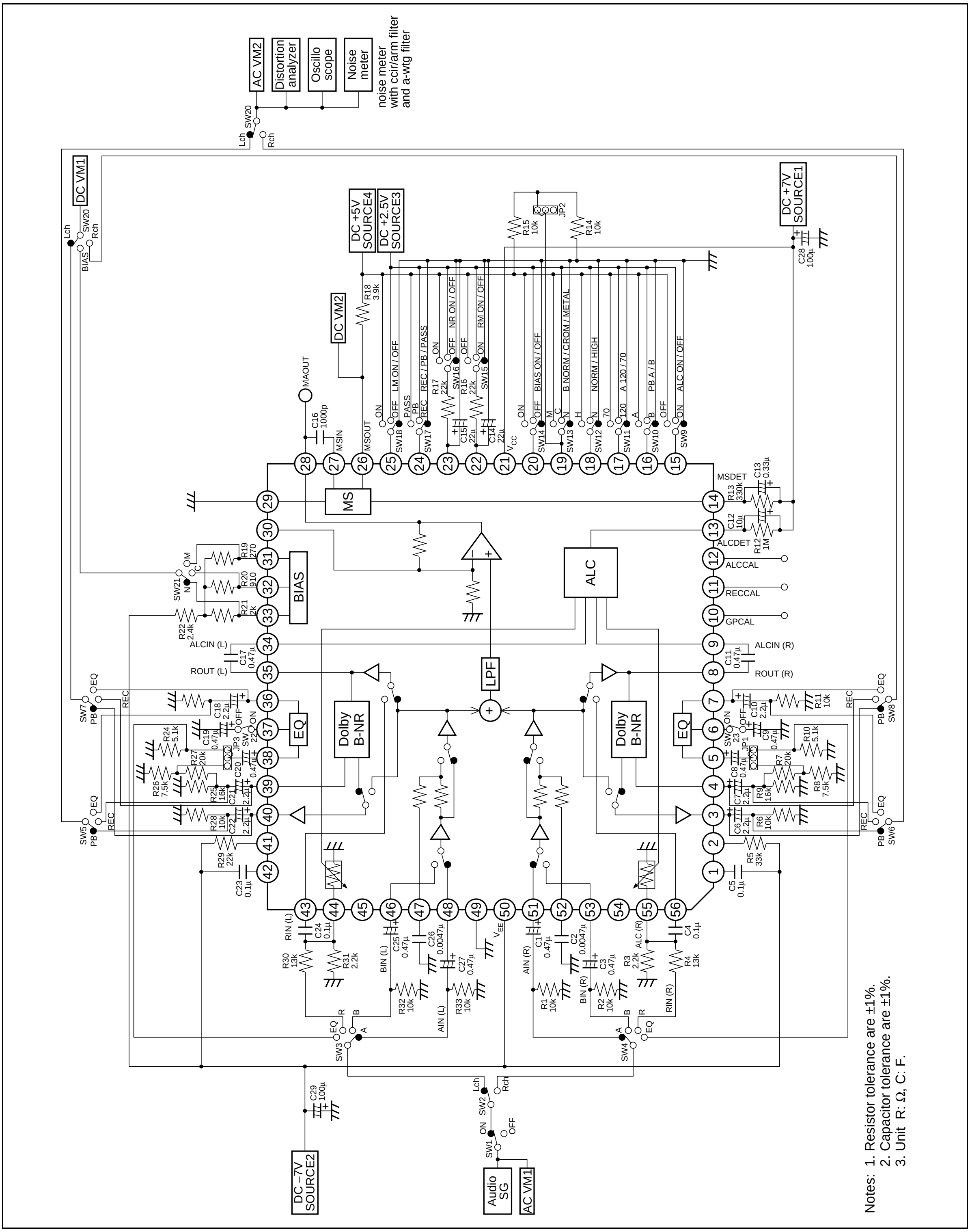
Item	Symbol	Test Condition: TAPE	Test Condition: SPEED	Test Condition		Min	Typ	Max	Unit	Application Terminal: Input R	Input L	Output R	Output L	COM	Remark
Equalizer S/N	S/N (EQ)	NORM	NORM	Rg = 5.1kΩ, A-WTG Filter (0dB = –5dBs at EQOUT)	SW22 (L), SW23 (R) OFF	55	58	—	dB	5	38	7	36	—	
Equalizer maximum input	Vin max (EQ)	NORM	NORM	f = 1kHz, THD = 1%, Vin = –26dBs = 0dB	SW22 (L), SW23 (R) OFF	10.5	12.5	—	dB	5	38	7	36	—	
Equalizer total harmonic distortion	T.H.D.1 (EQ)	NORM	NORM	f = 1kHz, Vin = –26dBs	SW22 (L), SW23 (R) OFF	—	0.2	0.5	%	5	38	7	36	—	
	T.H.D.2 (EQ)			f = 1kHz, Vin = –30dBs	SW22 (L), SW23 (R) OFF	—	0.2	0.5	%	5	38	7	36	—	
Equalizer offset voltage	Vofs (EQ)	NORM	NORM	No-Signal	SW22 (L), SW23 (R) OFF	–500	0	500	mV	5	38	7	36	—	
Equalizer frequency response (NORM - NORM)	$G_{VEQ-NN1}$	NORM	NORM	f = 3kHz, Vin = –46dBs	SW22 (L), SW23 (R) OFF	18.8	20.3	21.8	dB	5	38	7	36	—	
	$G_{VEQ-NN2}$			f = 8kHz, Vin = –46dBs	SW22 (L), SW23 (R) OFF	23.9	25.9	27.9	dB	5	38	7	36	—	
	$G_{VEQ-NN3}$			f = 12kHz, Vin = –46dBs	SW22 (L), SW23 (R) OFF	30.1	32.6	35.1	dB	5	38	7	36	—	
Equalizer frequency response (CROM - NORM)	$G_{VEQ-CN1}$	CROM	NORM	f = 3kHz, Vin = –46dBs	SW22 (L), SW23 (R) OFF	23.3	24.8	26.3	dB	5	38	7	36	—	
	$G_{VEQ-CN2}$			f = 8kHz, Vin = –46dBs	SW22 (L), SW23 (R) OFF	28.5	30.5	32.5	dB	5	38	7	36	—	
	$G_{VEQ-CN3}$			f = 12kHz, Vin = –46dBs	SW22 (L), SW23 (R) OFF	34.0	36.5	39.0	dB	5	38	7	36	—	
Equalizer frequency response (METAL - NORM)	$G_{VEQ-MN1}$	METAL	NORM	f = 3kHz, Vin = –46dBs	SW22 (L), SW23 (R) OFF	24.1	25.6	27.1	dB	5	38	7	36	—	
	$G_{VEQ-MN2}$			f = 8kHz, Vin = –46dBs	SW22 (L), SW23 (R) OFF	25.9	27.9	29.9	dB	5	38	7	36	—	
	$G_{VEQ-MN3}$			f = 12kHz, Vin = –46dBs	SW22 (L), SW23 (R) OFF	28.3	30.8	33.3	dB	5	38	7	36	—	
Equalizer frequency response (NORM - High)	$G_{VEQ-NH1}$	NORM	HIGH	f = 5kHz, Vin = –46dBs	SW22 (L), SW23 (R) OFF	15.0	16.5	18.0	dB	5	38	7	36	—	
	$G_{VEQ-NH2}$			f = 15kHz, Vin = –46dBs	SW22 (L), SW23 (R) OFF	19.9	21.9	23.9	dB	5	38	7	36	—	
	$G_{VEQ-NH3}$			f = 20kHz, Vin = –46dBs	SW22 (L), SW23 (R) OFF	23.4	25.9	28.4	dB	5	38	7	36	—	
Equalizer frequency Response (CROM - High)	$G_{VEQ-CH1}$	CROM	HIGH	f = 5kHz, Vin = –46dBs	SW22 (L), SW23 (R) OFF	19.9	21.4	22.9	dB	5	38	7	36	—	
	$G_{VEQ-CH2}$			f = 15kHz, Vin = –46dBs	SW22 (L), SW23 (R) OFF	23.7	25.7	27.7	dB	5	38	7	36	—	
	$G_{VEQ-CH3}$			f = 20kHz, Vin = –46dBs	SW22 (L), SW23 (R) OFF	26.9	29.4	31.9	dB	5	38	7	36	—	
Equalizer frequency response (METAL - High)	$G_{VEQ-MH1}$	METAL	HIGH	f = 5kHz, Vin = –46dBs	SW22 (L), SW23 (R) OFF	21.4	22.9	24.4	dB	5	38	7	36	—	
	$G_{VEQ-MH2}$			f = 15kHz, Vin = –46dBs	SW22 (L), SW23 (R) OFF	22.0	24.0	26.0	dB	5	38	7	36	—	
	$G_{VEQ-MH3}$			f = 20kHz, Vin = –46dBs	SW22 (L), SW23 (R) OFF	23.5	26.0	28.5	dB	5	38	7	36	—	
REC-MUTE attenuation	REC-MUTE	NORM	NORM	f = 1kHz, Vin = –14dBs	SW22 (L), SW23 (R) OFF	60	70	—	dB	5	38	7	36	—	

Electrical Characteristics (cont)

(Ta = 25°C, V_{CC} = ±7 V)

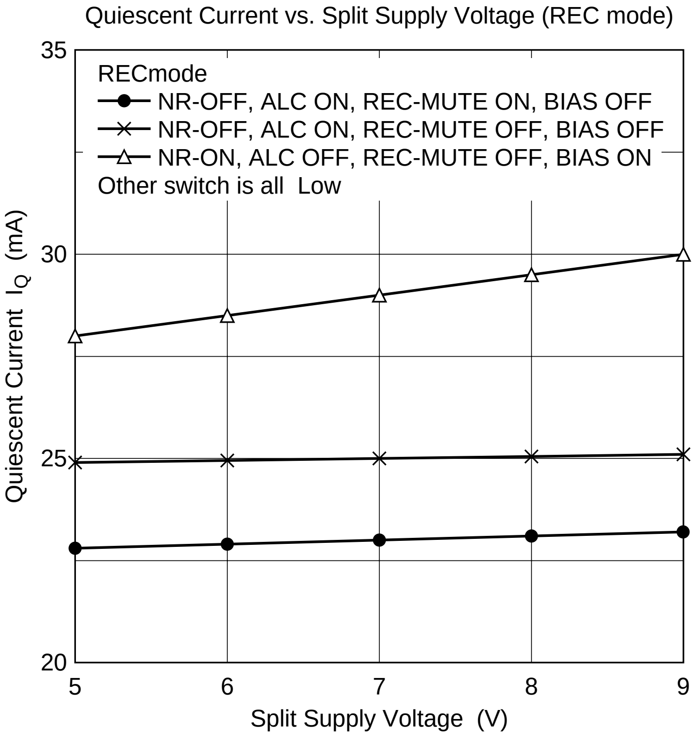
Item	Symbol	Test Condition: TAPE	Test Condition: SPEED	Test Condition		Min	Typ	Max	Unit	Application Terminal: Input R	Input L	Output R	Output L	COM	Remark
REC CAL response	R-CAL1	NORM	NORM	f = 3kHz, Vin = –46dBs, $V_{REC\text{-}CAL}$ = 5V	$G_{V\ EQ\text{-}NN1}$ = 0dB	3.0	4.5	6.0	dB	5	38	7	36	—	
	R-CAL2			f = 3kHz, Vin = –46dBs, $V_{REC\text{-}CAL}$ = 0V		–6.0	–4.5	–3.0	dB	5	38	7	36	—	
GP CAL response	GP-CAL1	NORM	NORM	f = 12kHz, Vin = –46dBs, $V_{GP\text{-}CAL}$ = 0V	$G_{V\ EQ\text{-}NN3}$ = 0dB	3.0	4.5	6.0	dB	5	38	7	36	—	
	GP-CAL2			f = 12kHz, Vin = –46dBs, $V_{GP\text{-}CAL}$ = 5V		–6.0	–4.5	–3.0	dB	5	38	7	36	—	
ALC CAL response	ALC-CAL1	NORM	NORM	f = 1kHz, $V_{ALC\text{-}CAL}$ = 0V	ALC (1) = 0dB	—	–4.0	–3.0	dB	56	43	4	39	—	
	ALC-CAL2			f = 1kHz, $V_{ALC\text{-}CAL}$ = 5V		3.0	4.0	—	dB	56	43	4	39	—	
Bias out maximum level	Bias on	R_L = 2.4kΩ + 270Ω				V_{CC} –1.4	V_{CC} –0.7	—	V	—	—	—	—	—	31 to 33
Bias out offset	Bias off	R_L = 2.4kΩ + 270Ω				V_{EE} –0.1	V_{EE}	V_{EE} +0.1	V	—	—	—	—	—	31 to 33
Control voltage	V_{IL}					–0.2	—	1.0	V	—	—	—	—	—	15 to 20, 22 to 25
	V_{IM}					2.0	—	3.0	V	—	—	—	—	—	19, 24
	V_{IH}					4.0	—	5.3	V	—	—	—	—	—	15 to 20, 22 to 25

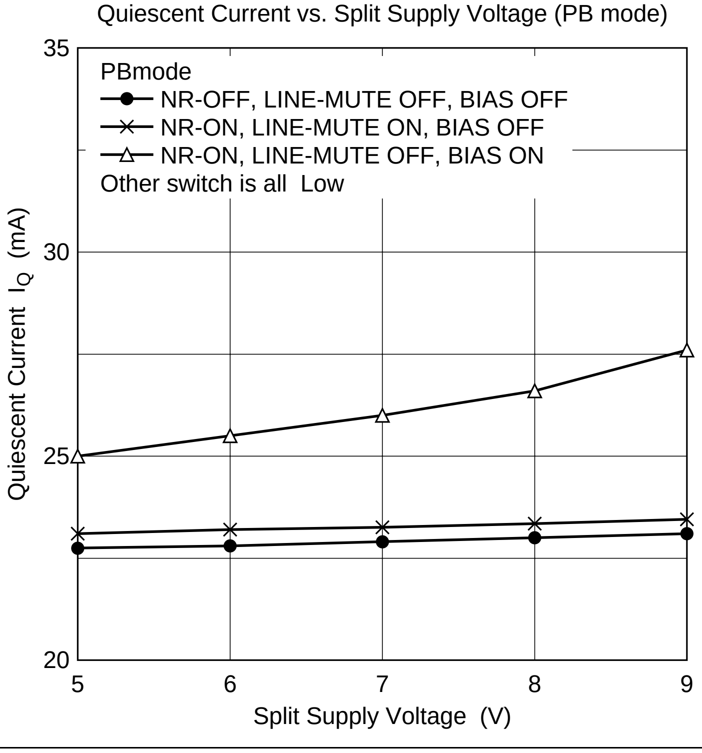
Test Circuit



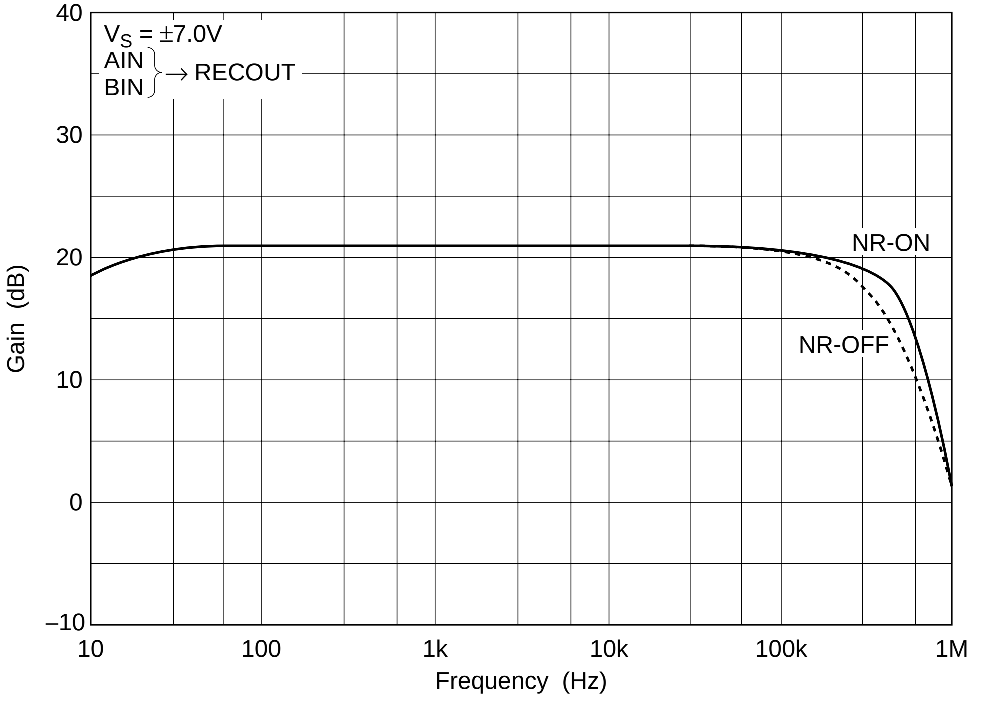
Notes: 1. Resistor tolerance are ±1%.
2. Capacitor tolerance are ±1%.
3. Unit R: Ω, C: F.

Characteristic Curves

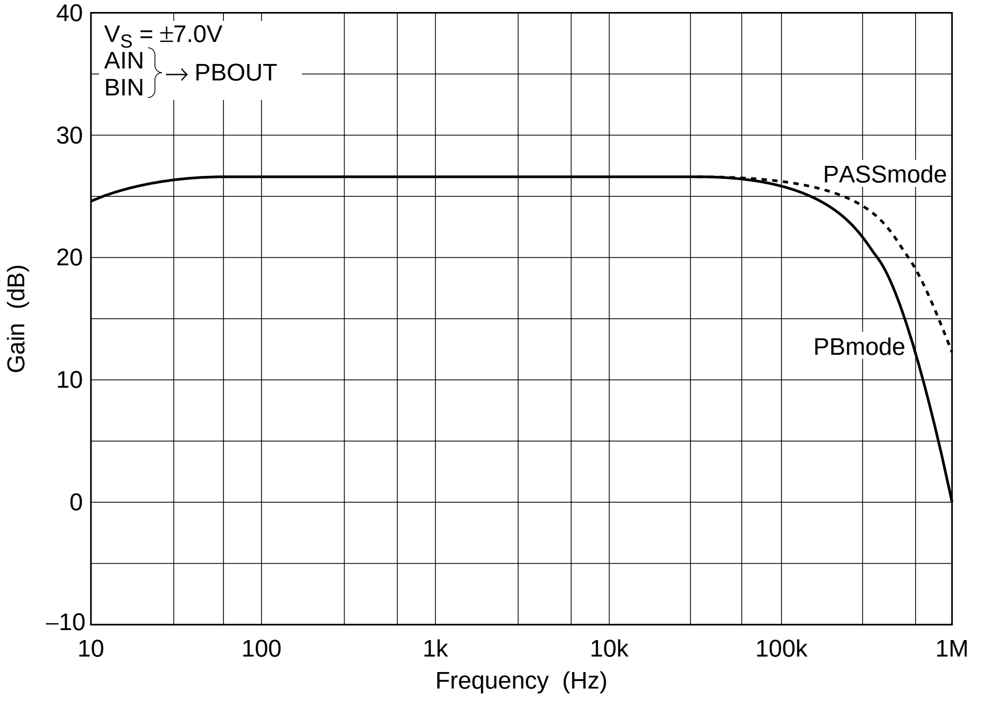




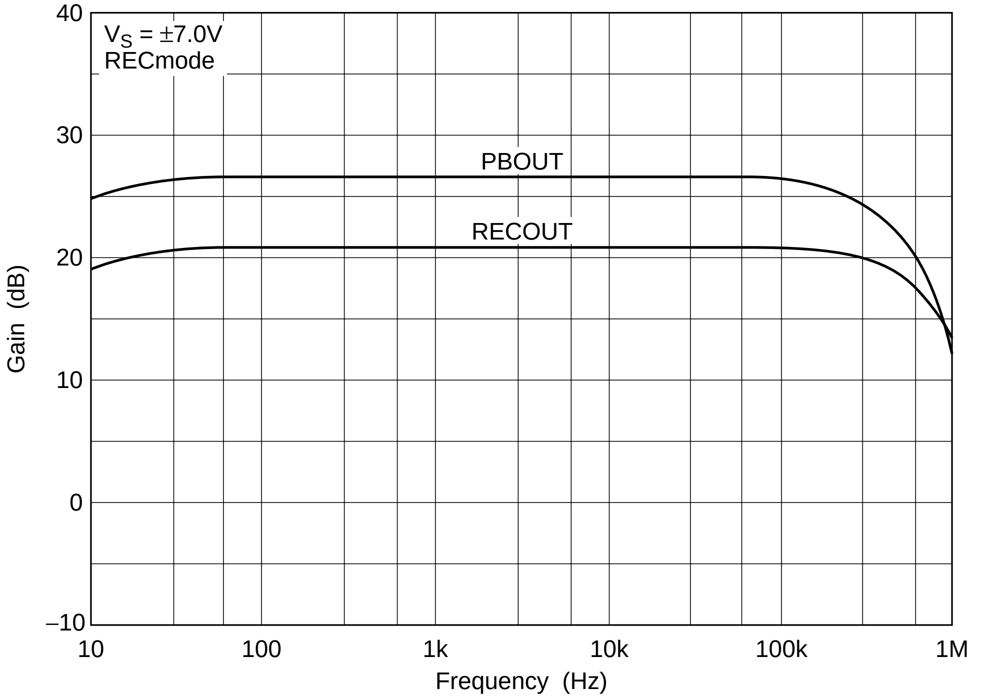
Input Amp. Gain vs. Frequency (1)



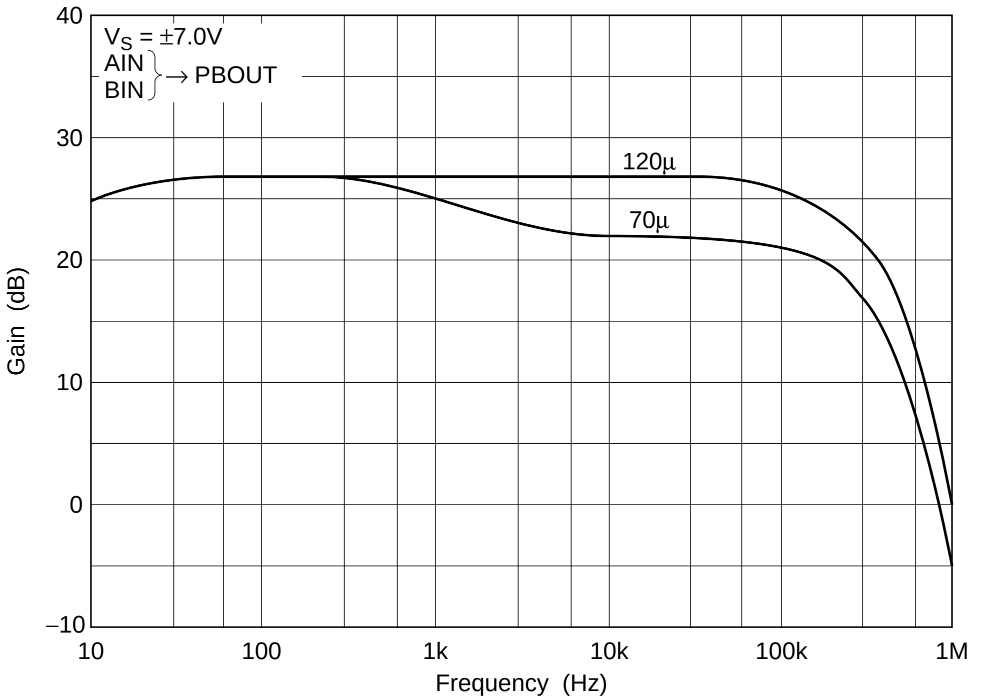
Input Amp. Gain vs. Frequency (2)

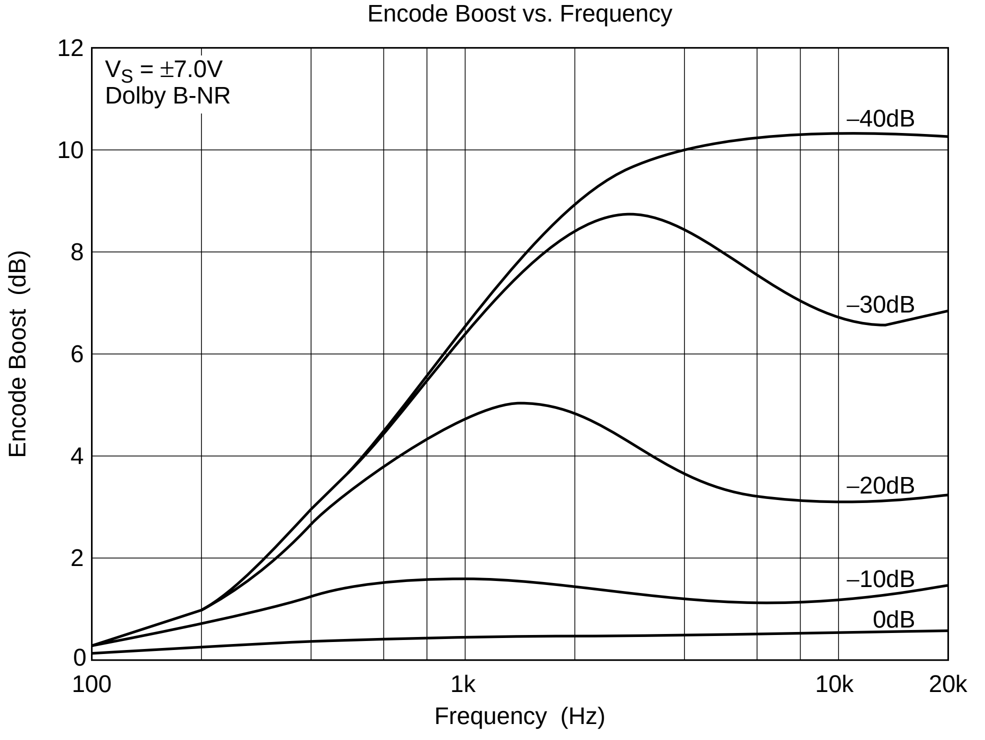


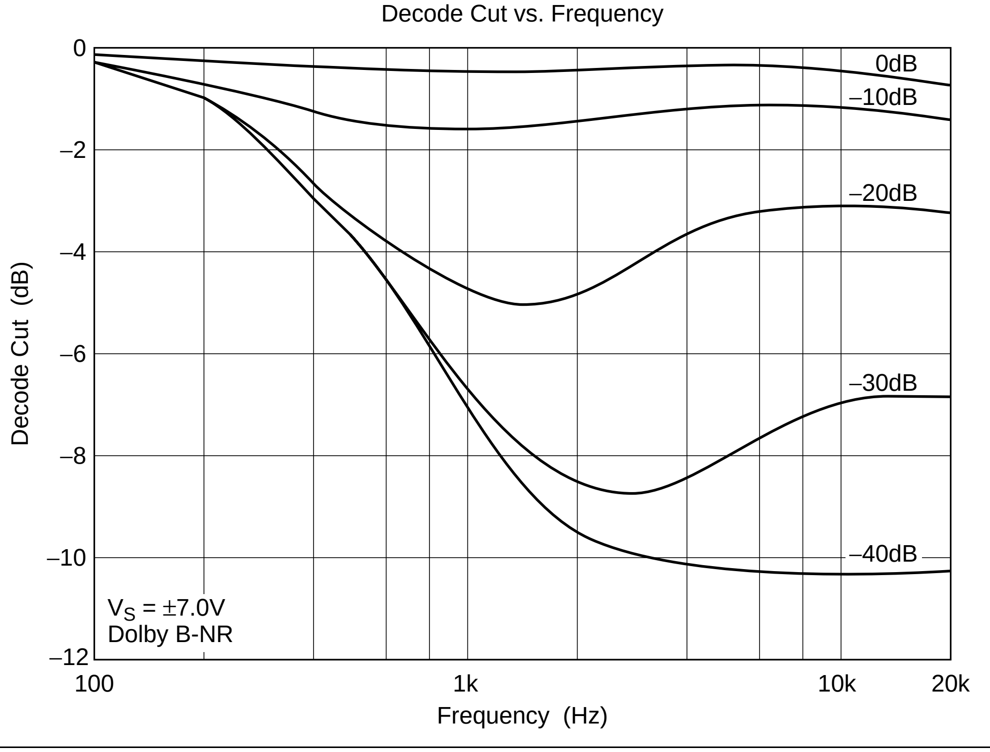
Input Amp. Gain vs. Frequency (3)

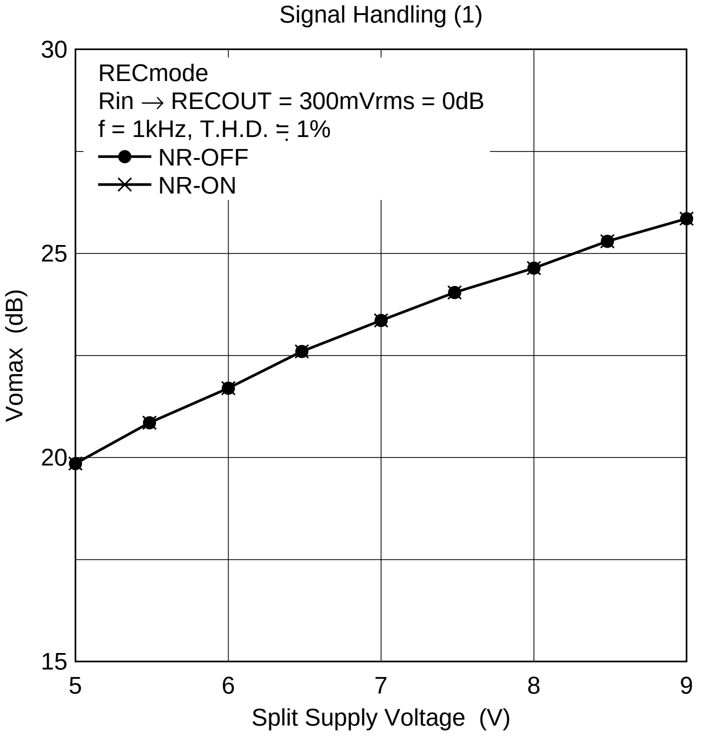


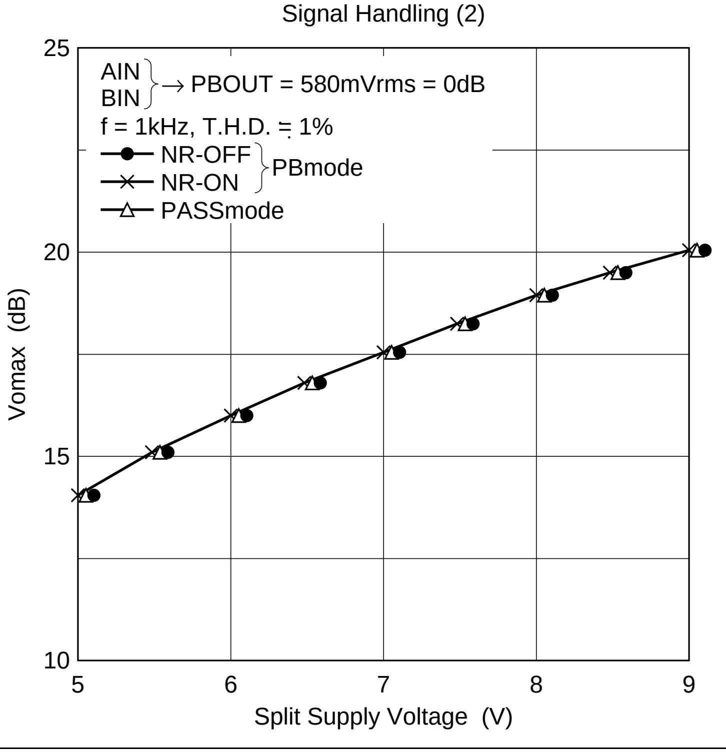
Input Amp. Gain vs. Frequency (4)



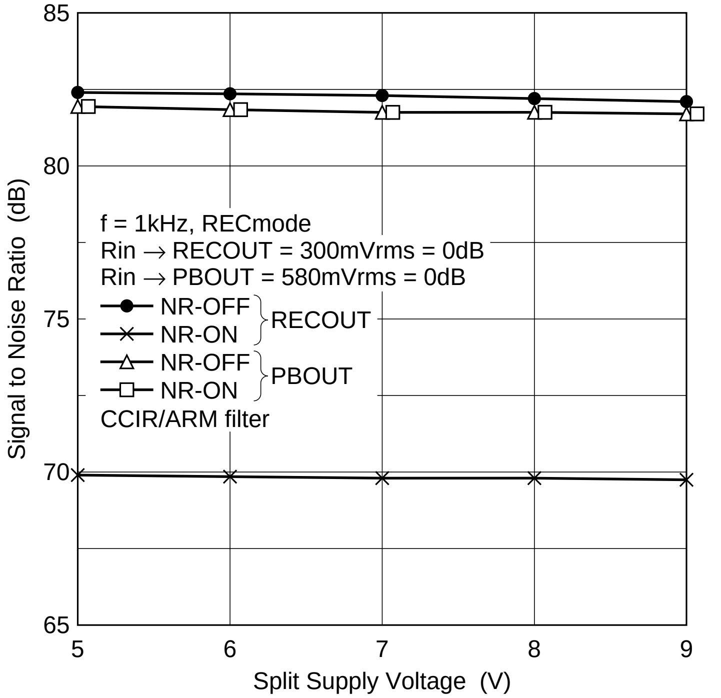

Encode Boost vs. Frequency
12
10
8
6
4
2
0
V_S = ±7.0V
Dolby B-NR
–40dB
–30dB
–20dB
–10dB
0dB
Encode Boost (dB)
100
1k
10k
20k
Frequency (Hz)


Decode Cut vs. Frequency
0
–2
–4
–6
–8
–10
–12
0dB
–10dB
–20dB
–30dB
–40dB
V_S = ±7.0V
Dolby B-NR
Decode Cut (dB)
100
1k
10k
20k
Frequency (Hz)

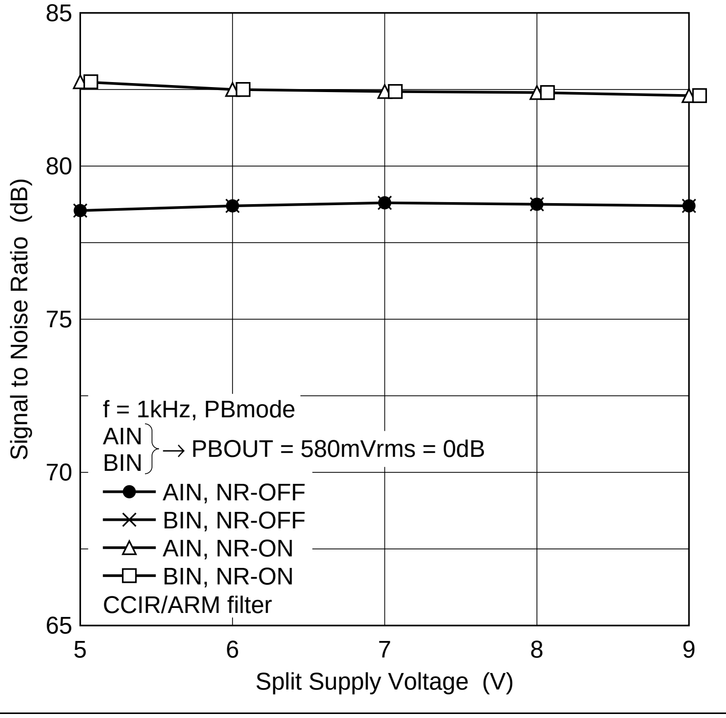

Signal Handling (1)
RECmode
Rin → RECOUT = 300mVrms = 0dB
f = 1kHz, T.H.D. ≒ 1%
NR-OFF
NR-ON
30
25
20
15
5
6
7
8
9
Vomax (dB)
Split Supply Voltage (V)

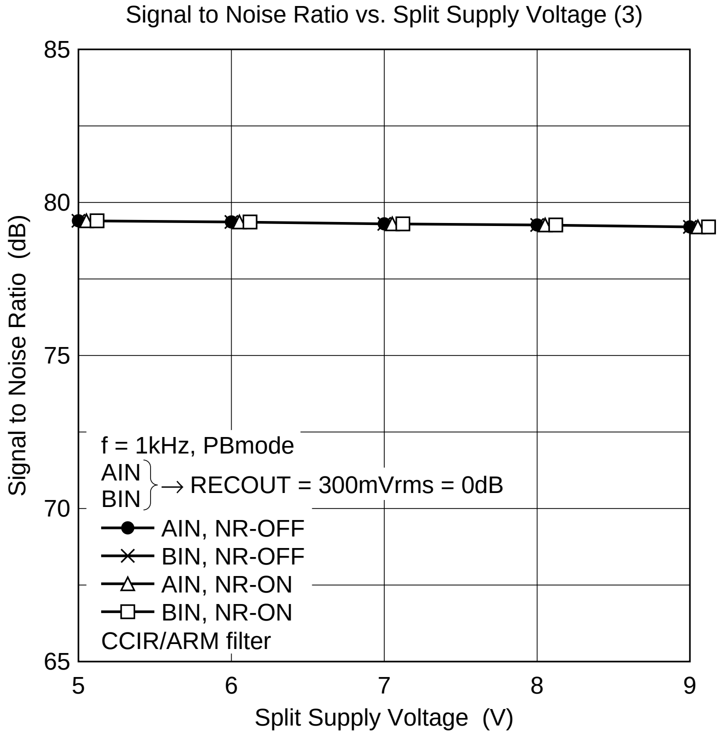

Signal Handling (2)
AIN
BIN
→ PBOUT = 580mVrms = 0dB
f = 1kHz, T.H.D. ≒ 1%
NR-OFF
NR-ON
PBmode
PASSmode
25
20
15
10
5
6
7
8
9
Vomax (dB)
Split Supply Voltage (V)

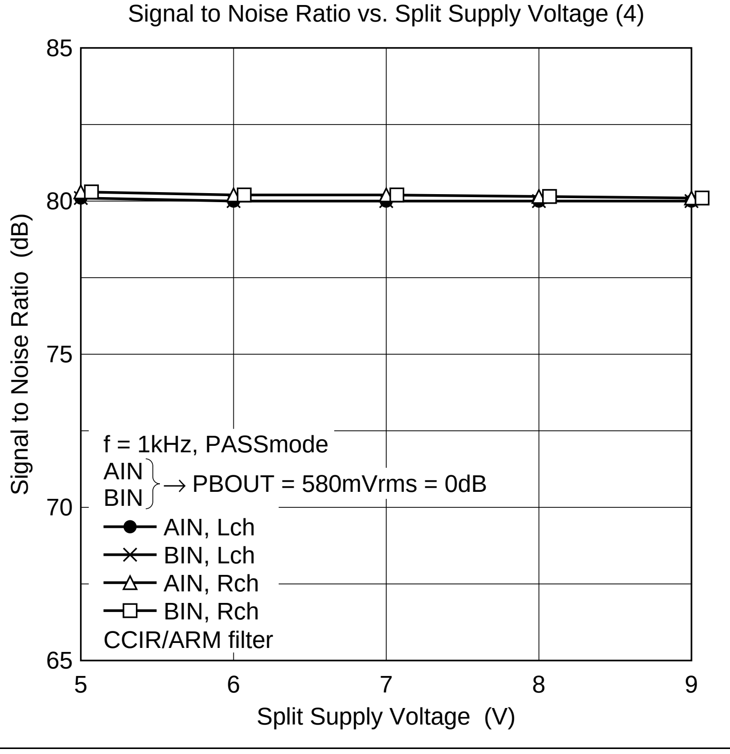
Signal to Noise Ratio vs. Split Supply Voltage (1)

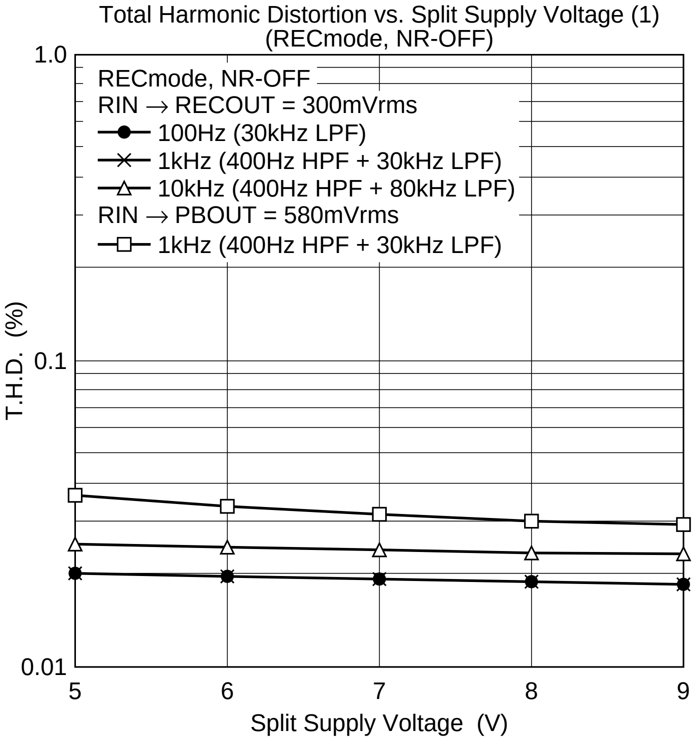


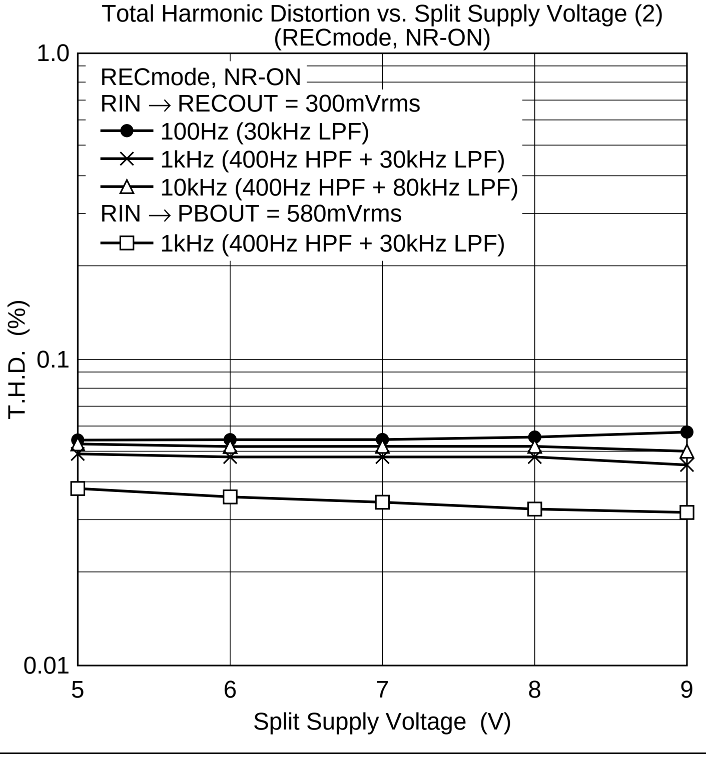
Signal to Noise Ratio vs. Split Supply Voltage (2)

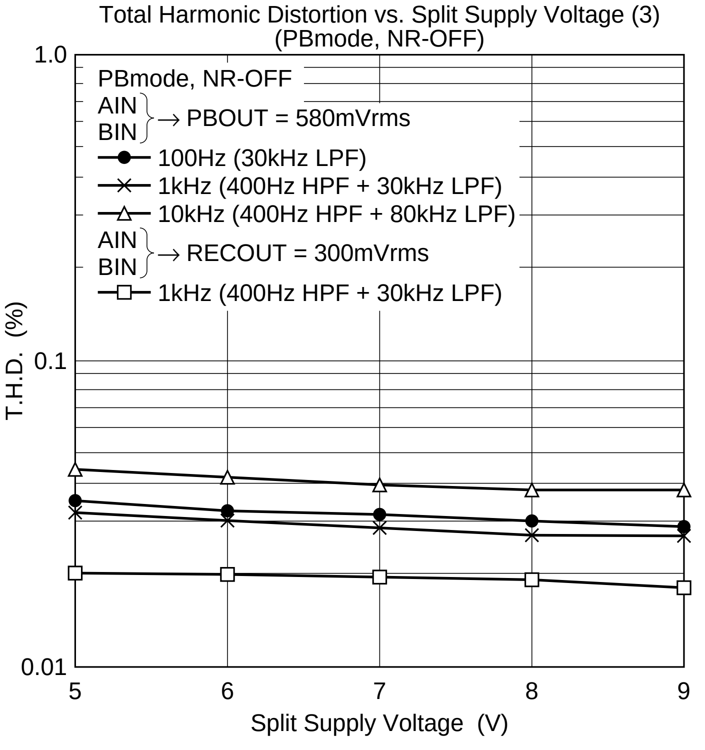


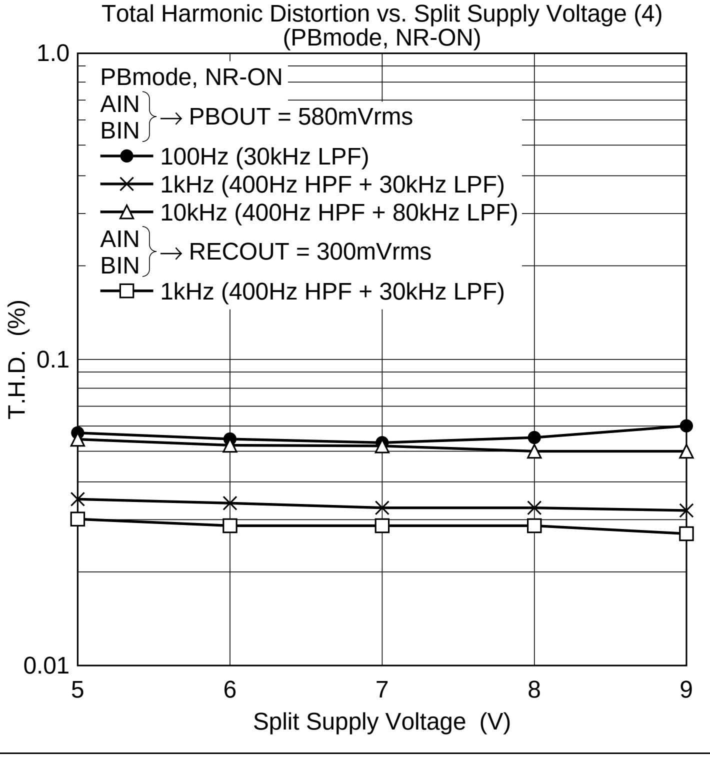

Signal to Noise Ratio vs. Split Supply Voltage (3)
Signal to Noise Ratio (dB)
85
80
75
70
65
5
6
7
8
9
Split Supply Voltage (V)
f = 1kHz, PBmode
AIN
BIN
→ RECOUT = 300mVrms = 0dB
AIN, NR-OFF
BIN, NR-OFF
AIN, NR-ON
BIN, NR-ON
CCIR/ARM filter

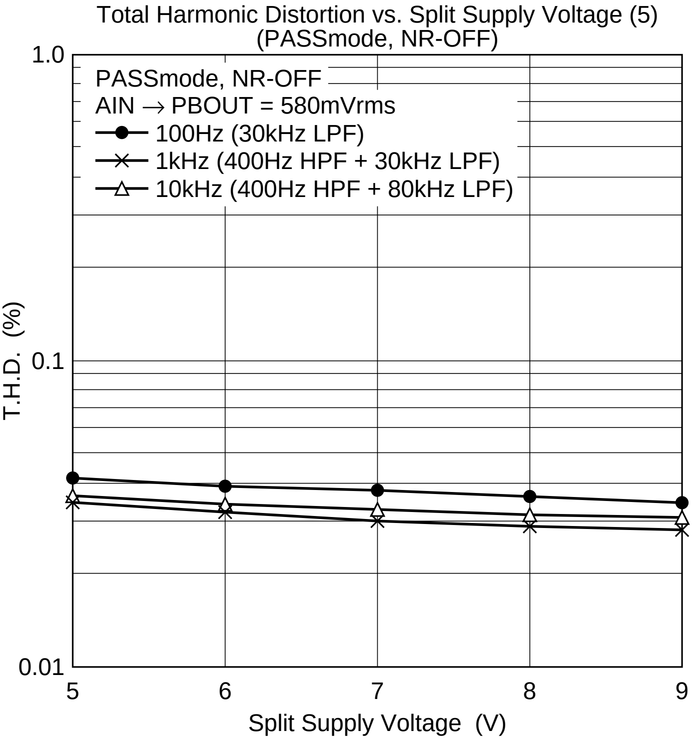

Signal to Noise Ratio vs. Split Supply Voltage (4)
Signal to Noise Ratio (dB)
85
80
75
70
65
5
6
7
8
9
Split Supply Voltage (V)
f = 1kHz, PASSmode
AIN
BIN
→ PBOUT = 580mVrms = 0dB
AIN, Lch
BIN, Lch
AIN, Rch
BIN, Rch
CCIR/ARM filter

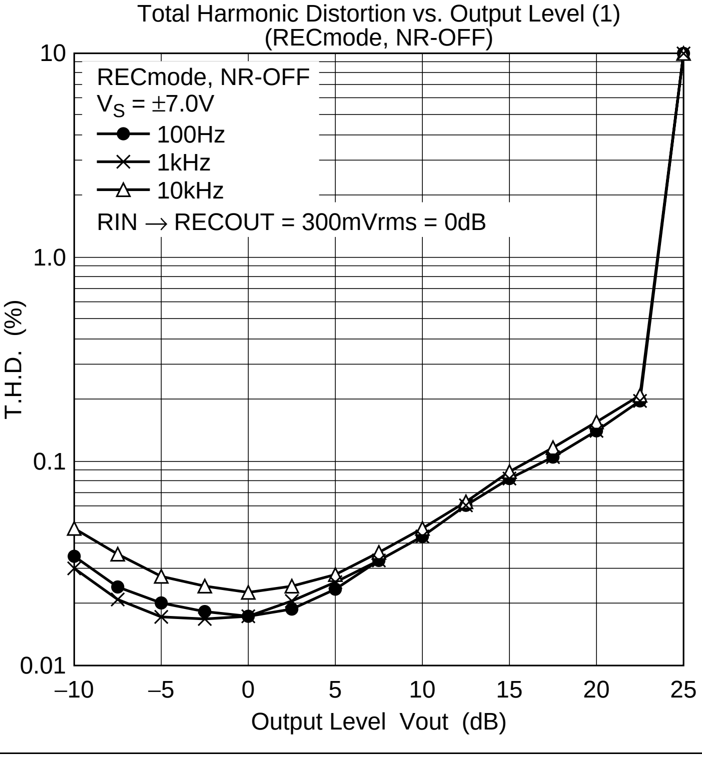

Total Harmonic Distortion vs. Split Supply Voltage (1)
(RECmode, NR-OFF)
RECmode, NR-OFF
RIN → RECOUT = 300mVrms
100Hz (30kHz LPF)
1kHz (400Hz HPF + 30kHz LPF)
10kHz (400Hz HPF + 80kHz LPF)
RIN → PBOUT = 580mVrms
1kHz (400Hz HPF + 30kHz LPF)
T.H.D. (%)
1.0
0.1
0.01
5
6
7
8
9
Split Supply Voltage (V)

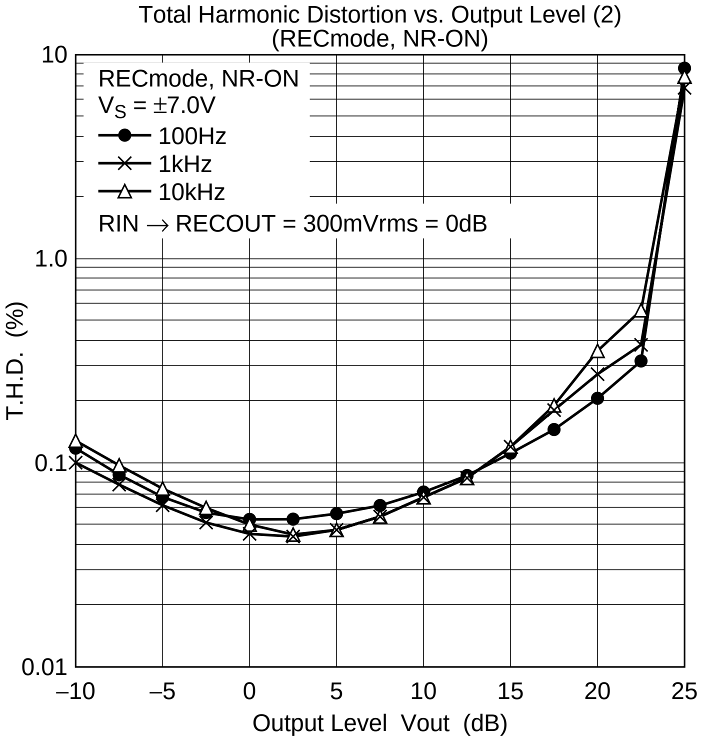

Total Harmonic Distortion vs. Split Supply Voltage (2)
(RECmode, NR-ON)
RECmode, NR-ON
RIN → RECOUT = 300mVrms
100Hz (30kHz LPF)
1kHz (400Hz HPF + 30kHz LPF)
10kHz (400Hz HPF + 80kHz LPF)
RIN → PBOUT = 580mVrms
1kHz (400Hz HPF + 30kHz LPF)
T.H.D. (%)
1.0
0.1
0.01
5
6
7
8
9
Split Supply Voltage (V)

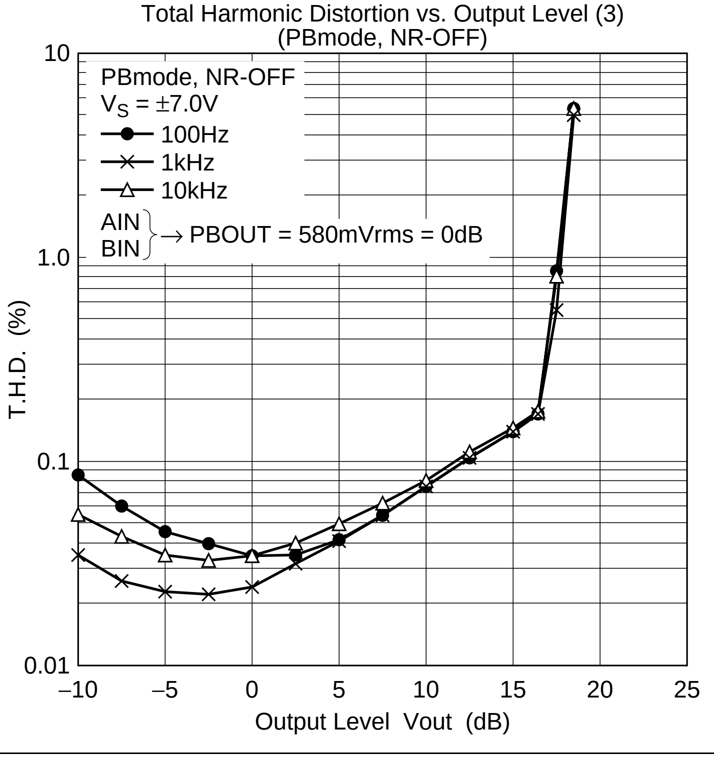

Total Harmonic Distortion vs. Split Supply Voltage (3)
(PBmode, NR-OFF)
PBmode, NR-OFF
AIN
BIN
→ PBOUT = 580mVrms
100Hz (30kHz LPF)
1kHz (400Hz HPF + 30kHz LPF)
10kHz (400Hz HPF + 80kHz LPF)
AIN
BIN
→ RECOUT = 300mVrms
1kHz (400Hz HPF + 30kHz LPF)
T.H.D. (%)
1.0
0.1
0.01
5
6
7
8
9
Split Supply Voltage (V)

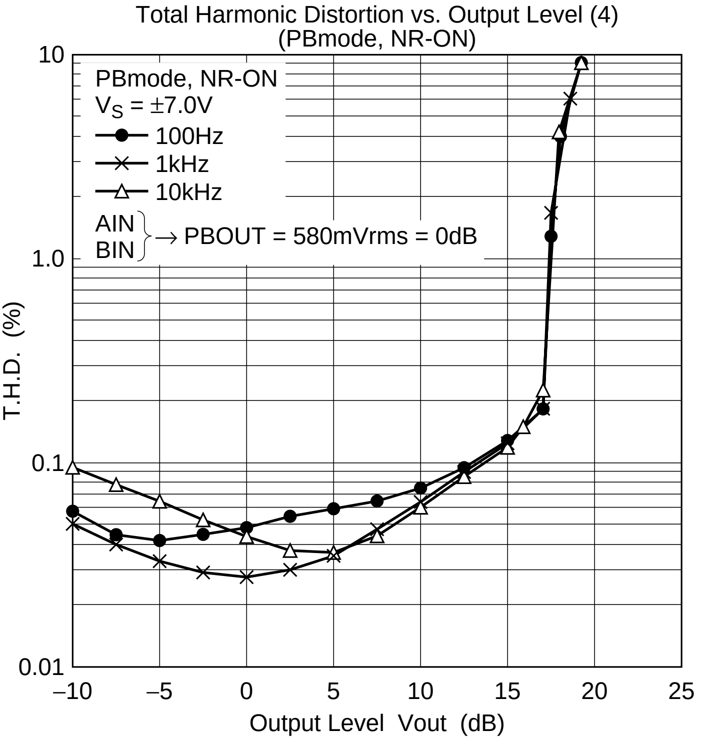

Total Harmonic Distortion vs. Split Supply Voltage (4)
(PBmode, NR-ON)
PBmode, NR-ON
AIN
BIN
→ PBOUT = 580mVrms
100Hz (30kHz LPF)
1kHz (400Hz HPF + 30kHz LPF)
10kHz (400Hz HPF + 80kHz LPF)
AIN
BIN
→ RECOUT = 300mVrms
1kHz (400Hz HPF + 30kHz LPF)
T.H.D. (%)
1.0
0.1
0.01
5
6
7
8
9
Split Supply Voltage (V)

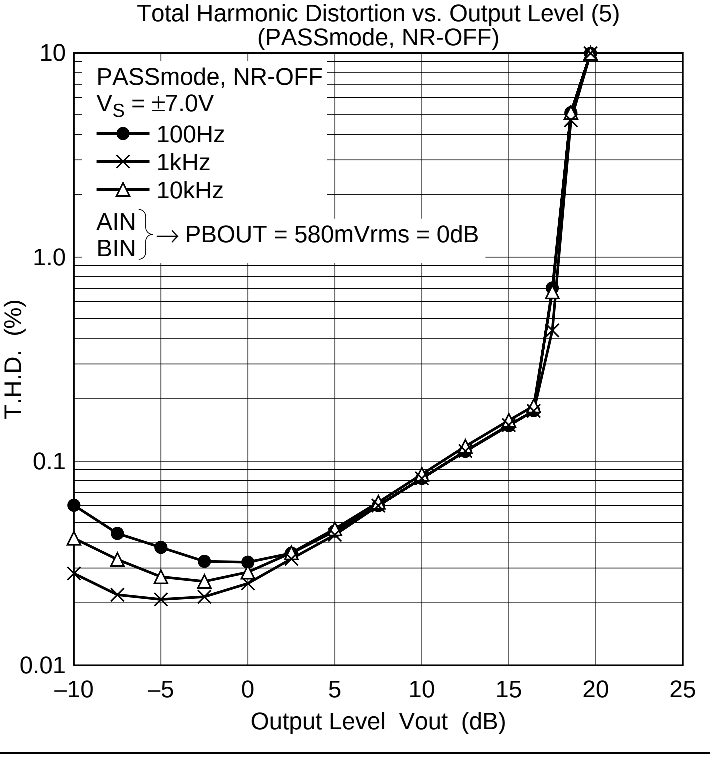

Total Harmonic Distortion vs. Split Supply Voltage (5)
(PASSmode, NR-OFF)
PASSmode, NR-OFF
AIN → PBOUT = 580mVrms
100Hz (30kHz LPF)
1kHz (400Hz HPF + 30kHz LPF)
10kHz (400Hz HPF + 80kHz LPF)
T.H.D. (%)
1.0
0.1
0.01
5
6
7
8
9
Split Supply Voltage (V)


Total Harmonic Distortion vs. Output Level (1)
(RECmode, NR-OFF)
RECmode, NR-OFF
VS = ±7.0V
100Hz
1kHz
10kHz
RIN → RECOUT = 300mVrms = 0dB
T.H.D. (%)
10
1.0
0.1
0.01
–10
–5
0
5
10
15
20
25
Output Level Vout (dB)

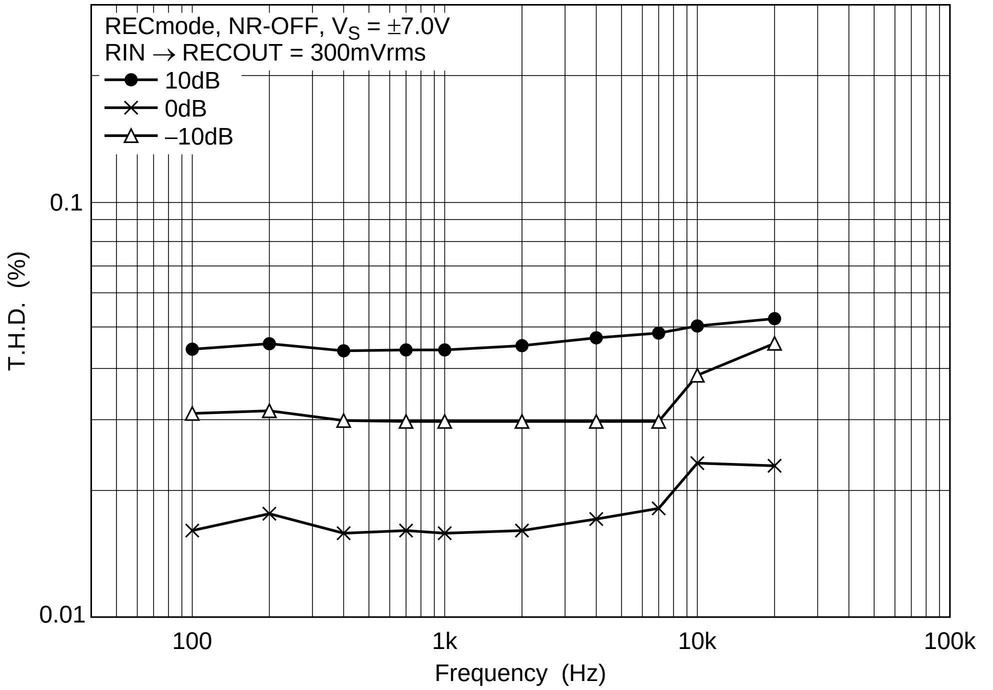

Total Harmonic Distortion vs. Output Level (2)
(RECmode, NR-ON)
RECmode, NR-ON
V_S = ±7.0V
100Hz
1kHz
10kHz
RIN → RECOUT = 300mVrms = 0dB
T.H.D. (%)
10
1.0
0.1
0.01
–10
–5
0
5
10
15
20
25
Output Level Vout (dB)


Total Harmonic Distortion vs. Output Level (3)
(PBmode, NR-OFF)
PBmode, NR-OFF
V_S = ±7.0V
100Hz
1kHz
10kHz
AIN
BIN
→ PBOUT = 580mVrms = 0dB
T.H.D. (%)
10
1.0
0.1
0.01
–10
–5
0
5
10
15
20
25
Output Level Vout (dB)

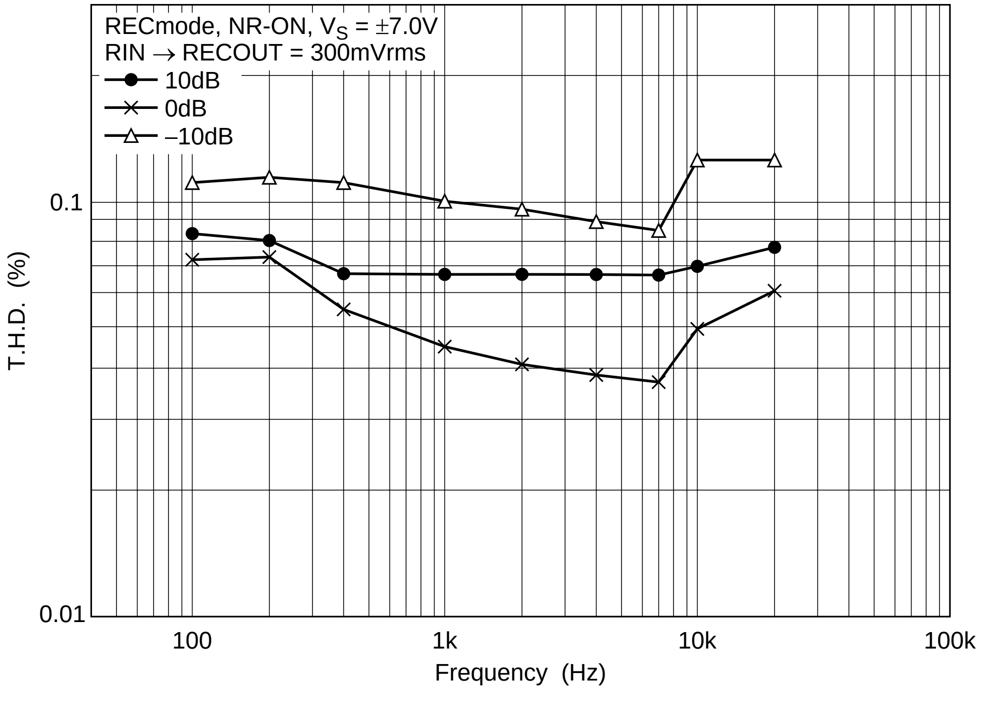

Total Harmonic Distortion vs. Output Level (4)
(PBmode, NR-ON)
PBmode, NR-ON
VS = ±7.0V
100Hz
1kHz
10kHz
AIN
BIN
→ PBOUT = 580mVrms = 0dB
T.H.D. (%)
10
1.0
0.1
0.01
–10
–5
0
5
10
15
20
25
Output Level Vout (dB)


Total Harmonic Distortion vs. Output Level (5)
(PASSmode, NR-OFF)
PASSmode, NR-OFF
VS = ±7.0V
100Hz
1kHz
10kHz
AIN
BIN
→ PBOUT = 580mVrms = 0dB
T.H.D. (%)
10
1.0
0.1
0.01
–10
–5
0
5
10
15
20
25
Output Level Vout (dB)

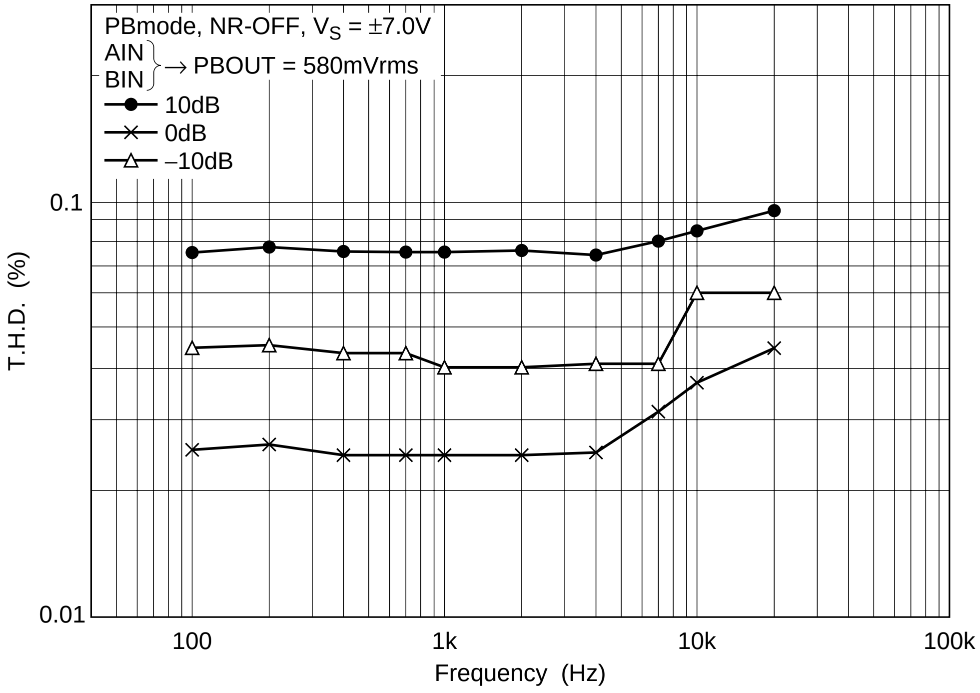
Total Harmonic Distortion vs. Frequency (1)



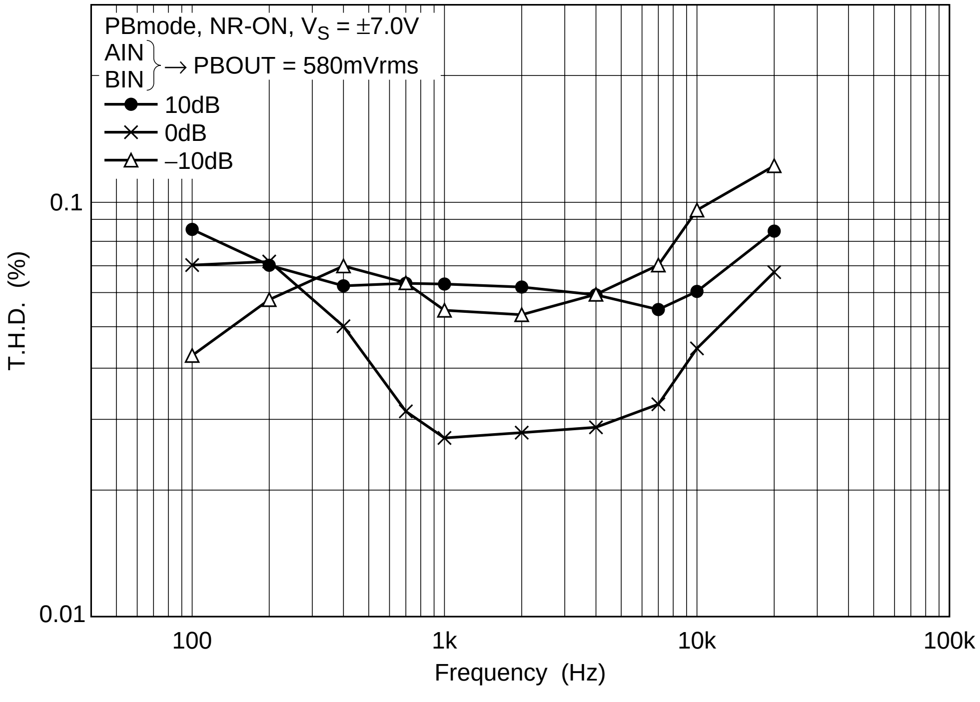
Total Harmonic Distortion vs. Frequency (2)



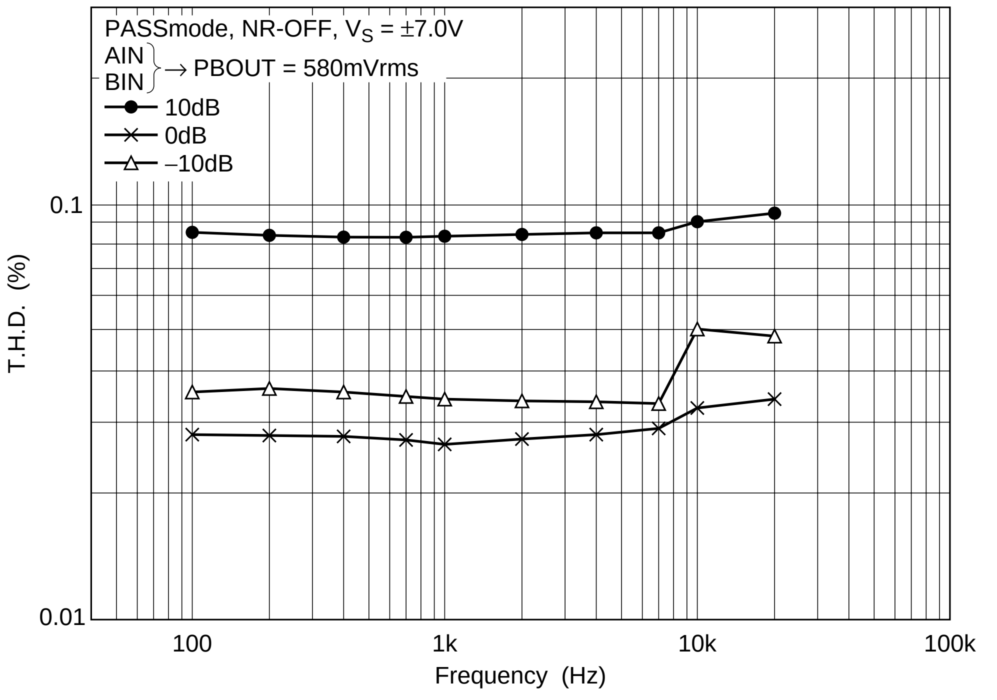
Total Harmonic Distortion vs. Frequency (3)



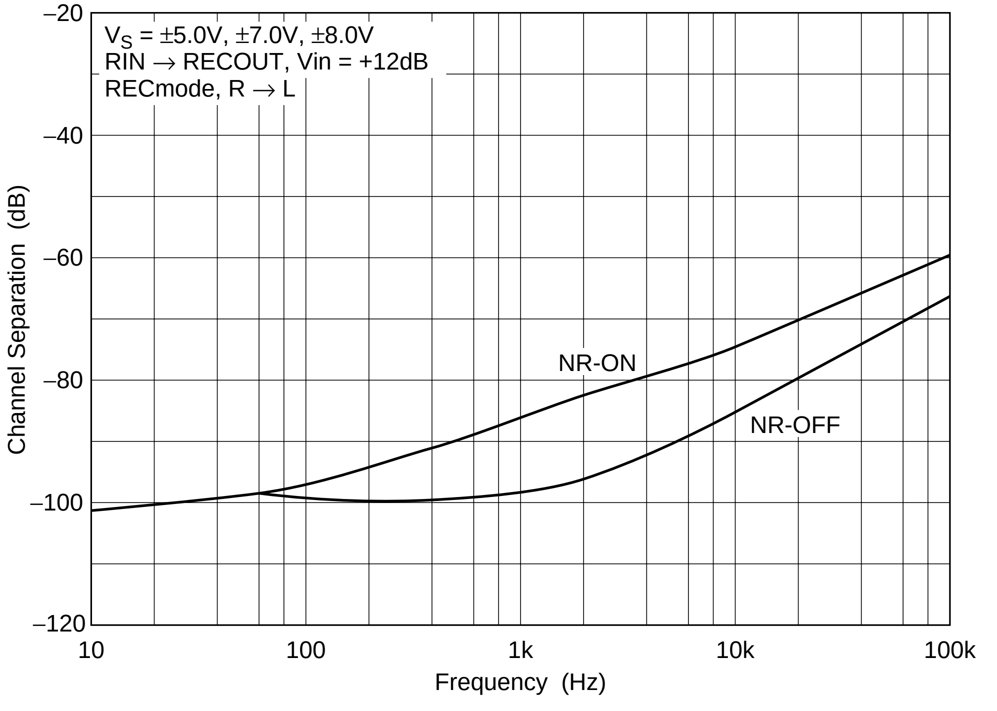
Total Harmonic Distortion vs. Frequency (4)



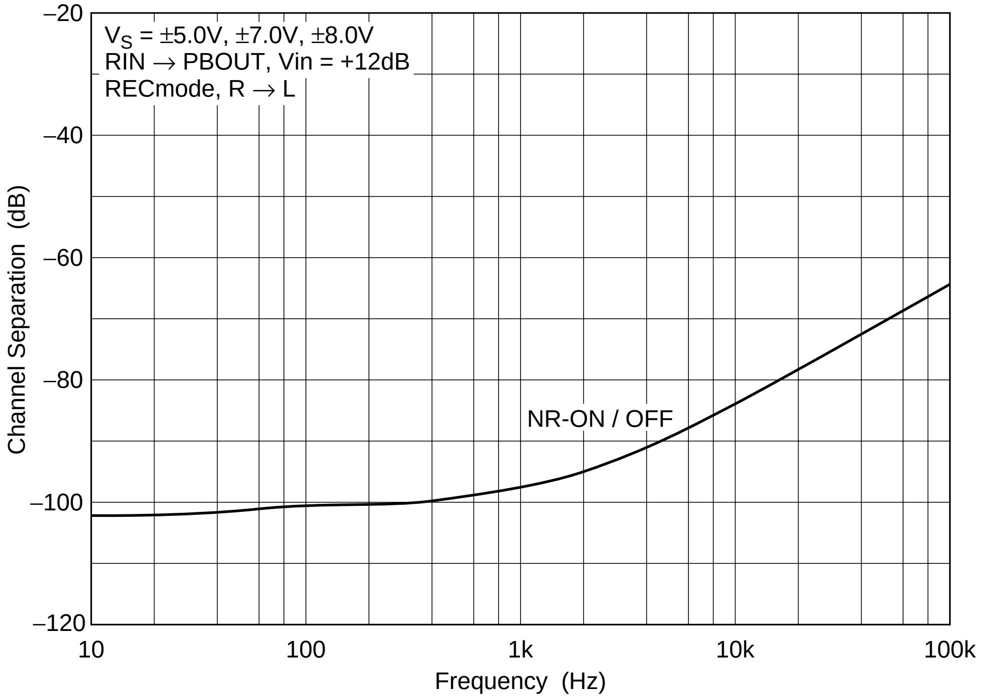
Total Harmonic Distortion vs. Frequency (5)



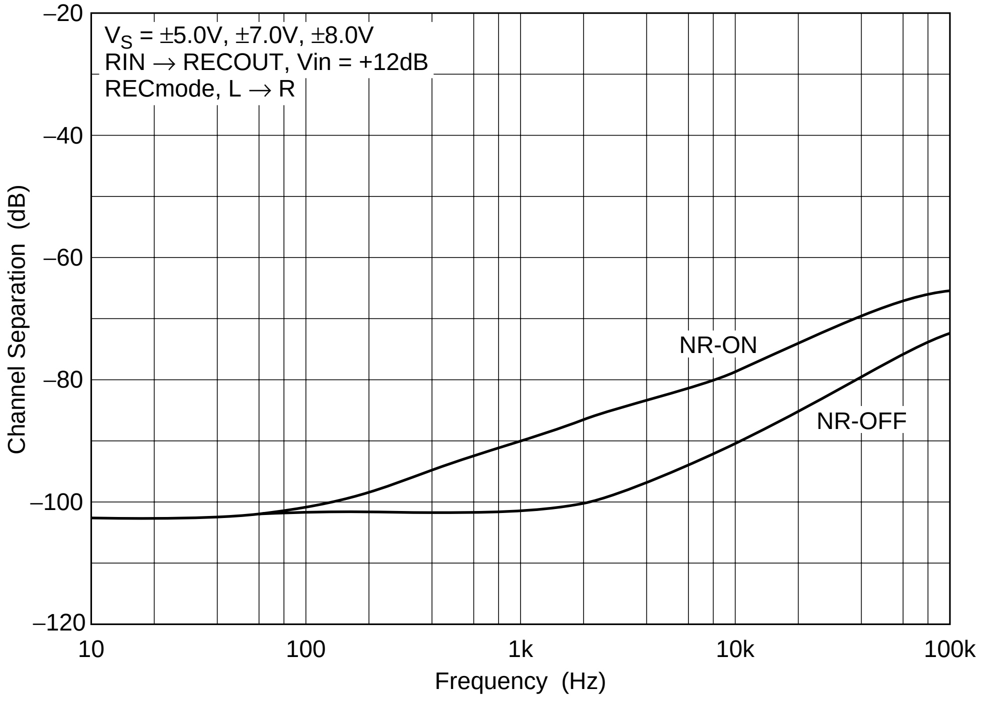
Channel Separation vs. Frequency (R→L) (1)

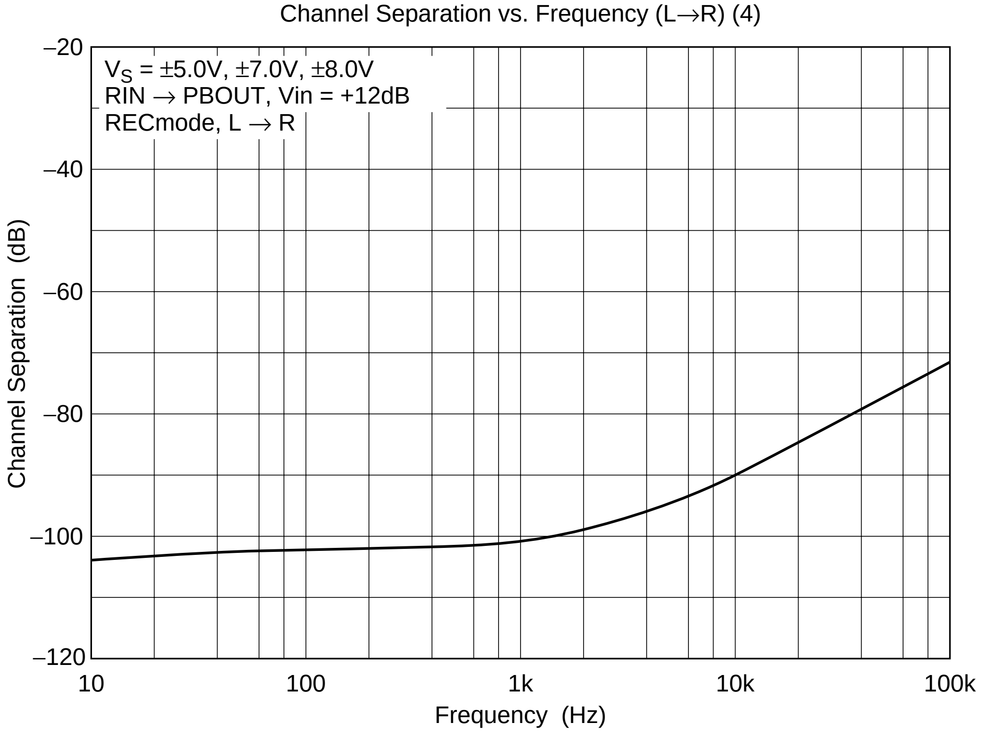


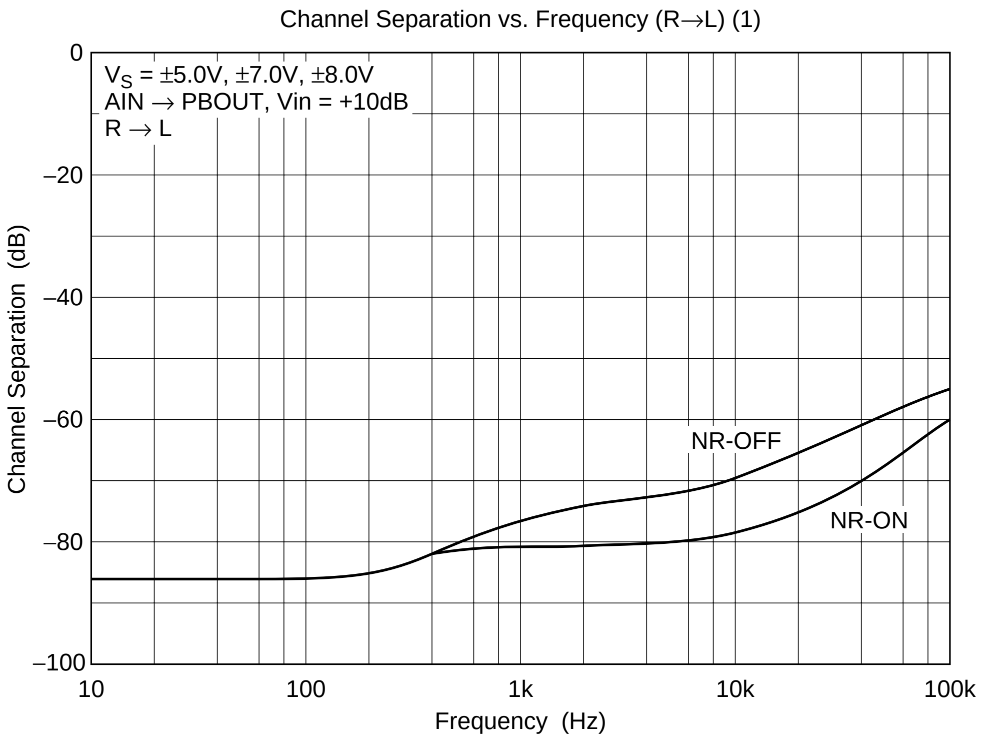
Channel Separation vs. Frequency (R→L) (2)

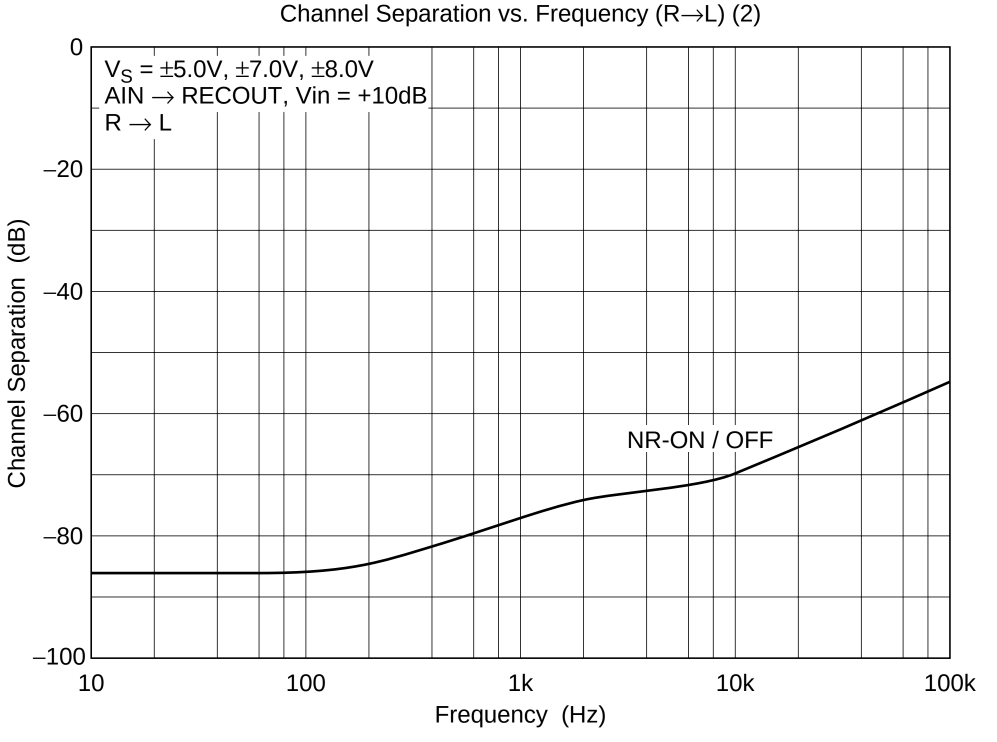


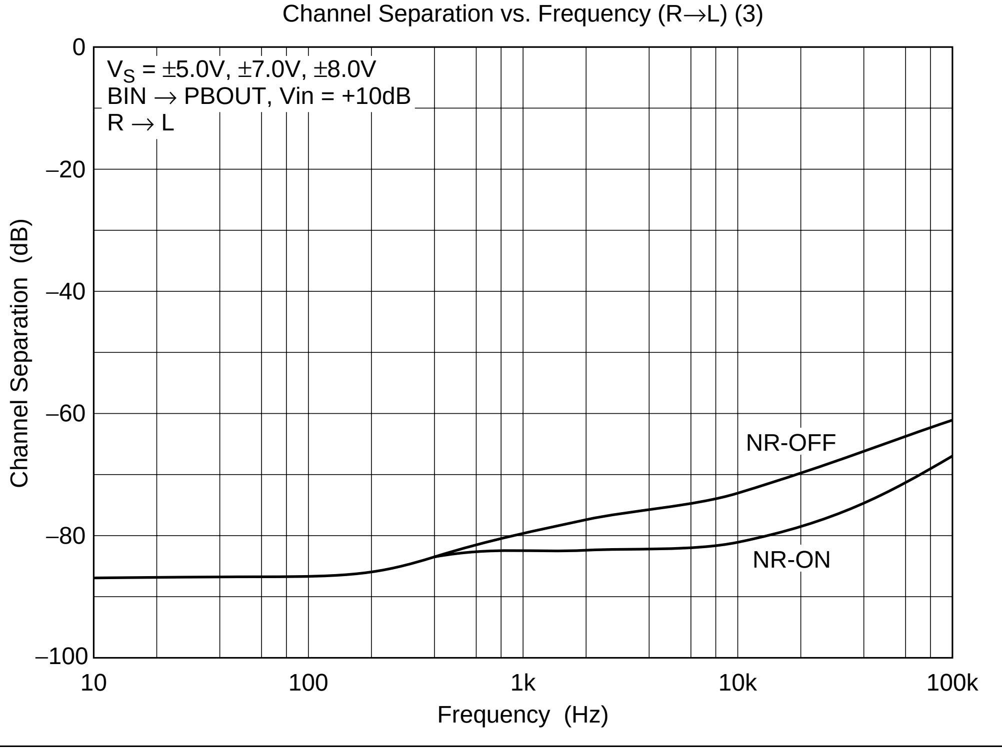
Channel Separation vs. Frequency (L→R) (3)

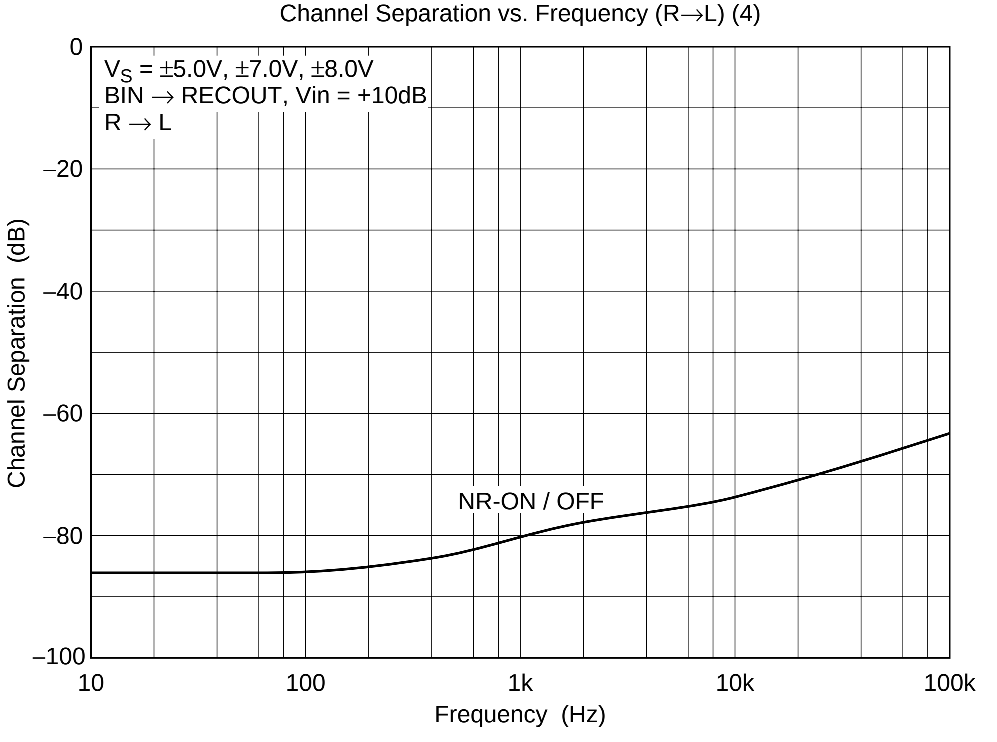


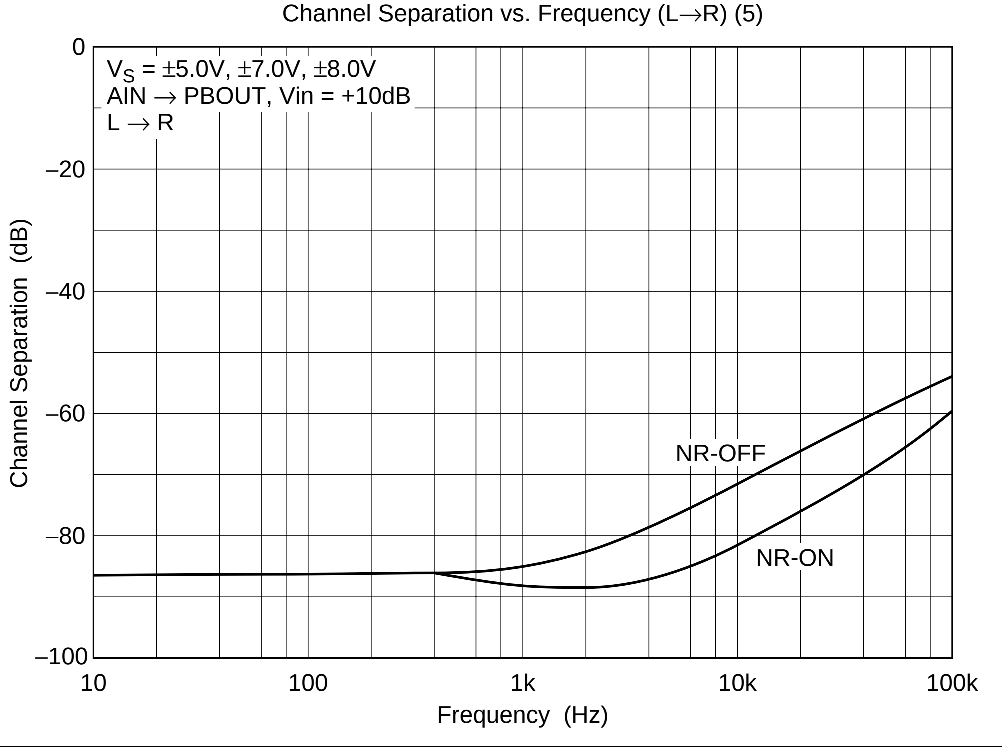

Channel Separation vs. Frequency (L→R) (4)
VS = ±5.0V, ±7.0V, ±8.0V
RIN → PBOUT, Vin = +12dB
RECmode, L → R
Channel Separation (dB)
–20
–40
–60
–80
–100
–120
10
100
1k
10k
100k
Frequency (Hz)


Channel Separation vs. Frequency (R→L) (1)
VS = ±5.0V, ±7.0V, ±8.0V
AIN → PBOUT, Vin = +10dB
R → L
NR-OFF
NR-ON
Channel Separation (dB)
0
–20
–40
–60
–80
–100
10
100
1k
10k
100k
Frequency (Hz)

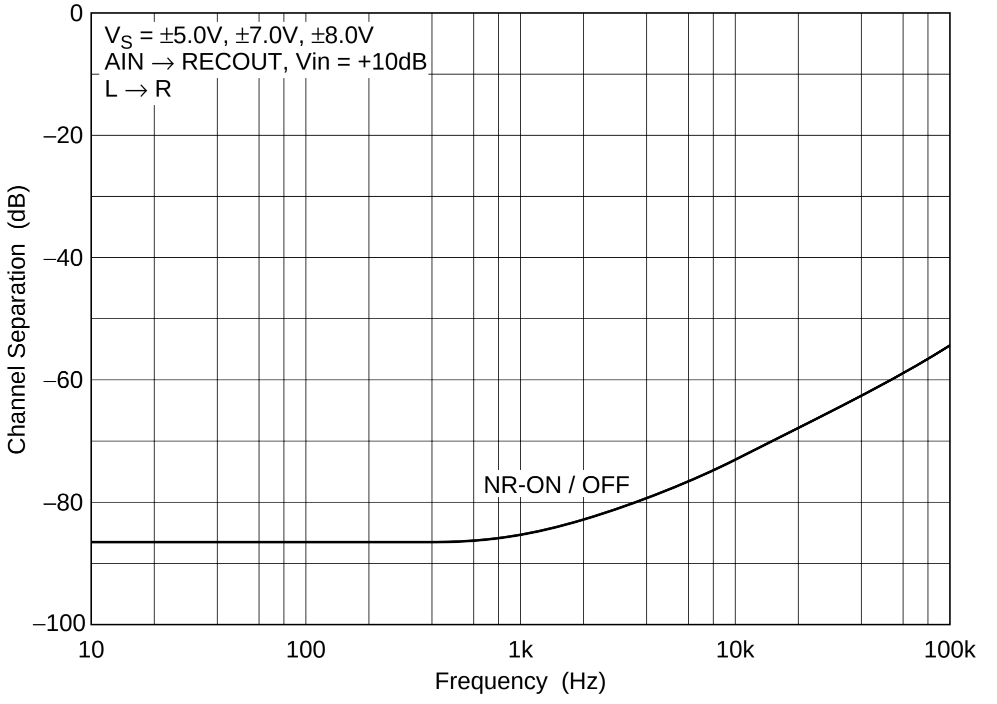

Channel Separation vs. Frequency (R→L) (2)
VS = ±5.0V, ±7.0V, ±8.0V
AIN → RECOUT, Vin = +10dB
R → L
NR-ON / OFF
Channel Separation (dB)
0
–20
–40
–60
–80
–100
10
100
1k
10k
100k
Frequency (Hz)


Channel Separation vs. Frequency (R→L) (3)
VS = ±5.0V, ±7.0V, ±8.0V
BIN → PBOUT, Vin = +10dB
R → L
NR-OFF
NR-ON
Channel Separation (dB)
0
–20
–40
–60
–80
–100
10
100
1k
10k
100k
Frequency (Hz)

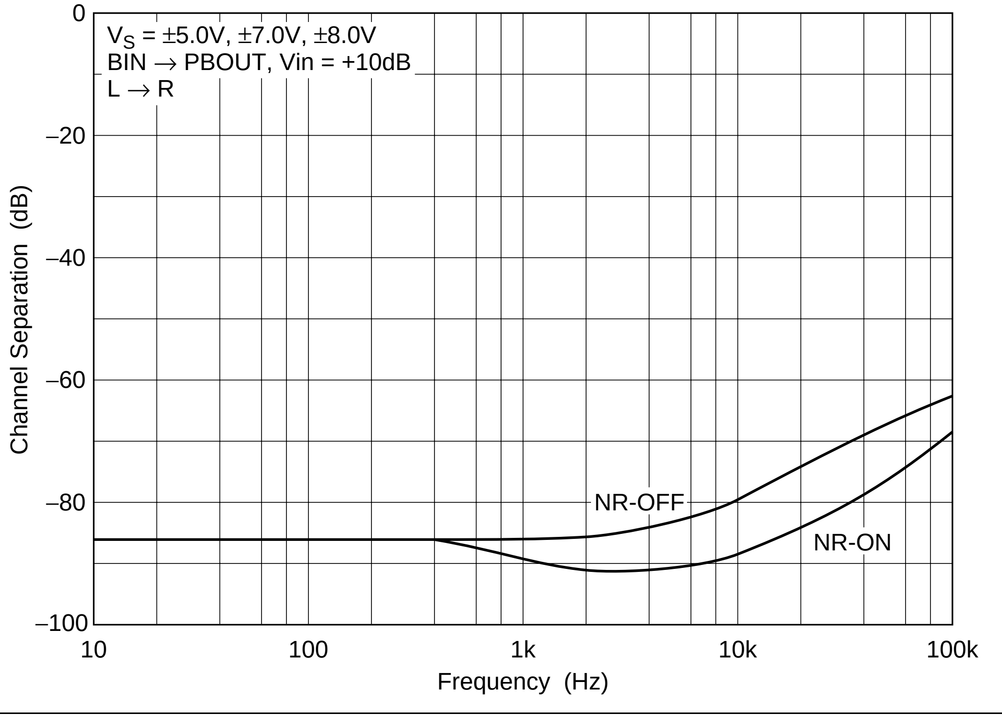

Channel Separation vs. Frequency (R→L) (4)
VS = ±5.0V, ±7.0V, ±8.0V
BIN → RECOUT, Vin = +10dB
R → L
NR-ON / OFF
Channel Separation (dB)
0
–20
–40
–60
–80
–100
10
100
1k
10k
100k
Frequency (Hz)


Channel Separation vs. Frequency (L→R) (5)
VS = ±5.0V, ±7.0V, ±8.0V
AIN → PBOUT, Vin = +10dB
L → R
NR-OFF
NR-ON
Channel Separation (dB)
0
–20
–40
–60
–80
–100
10
100
1k
10k
100k
Frequency (Hz)

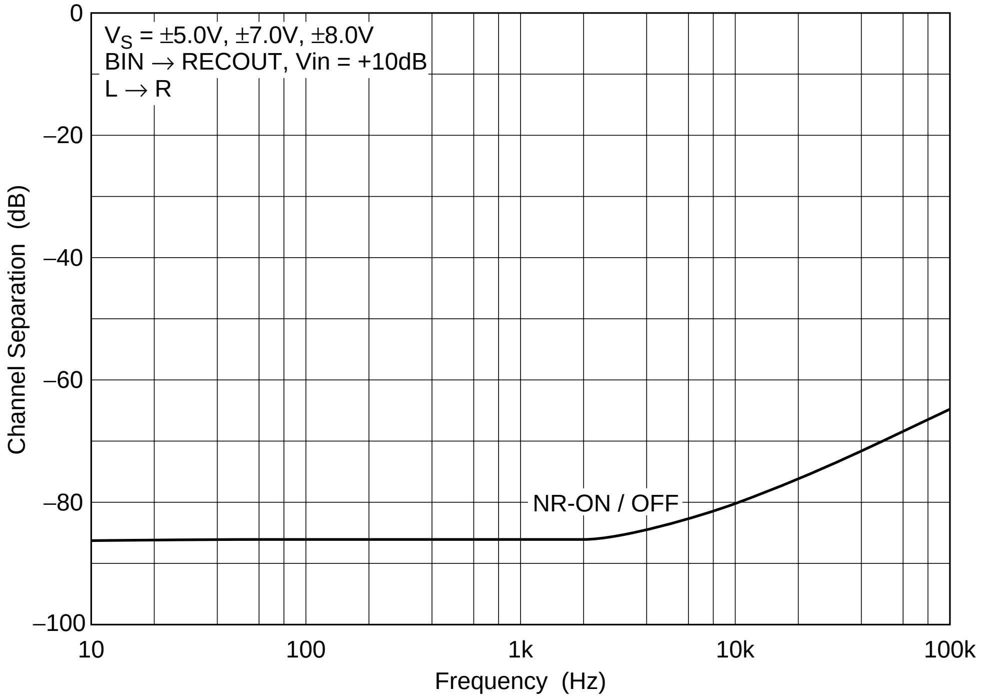
Channel Separation vs. Frequency (L→R) (6)



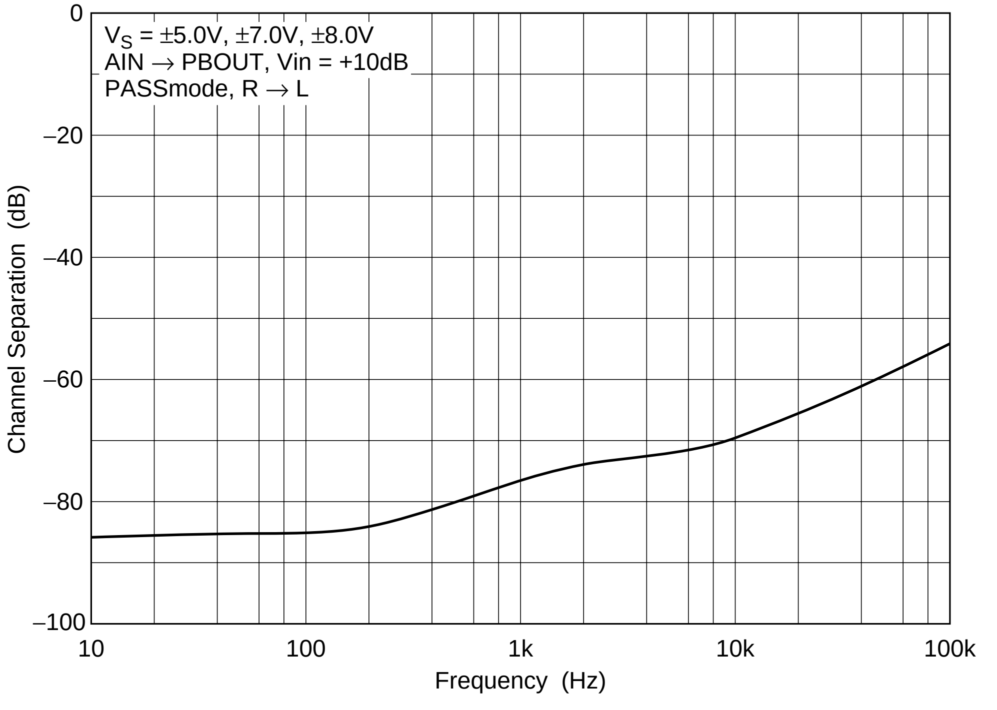
Channel Separation vs. Frequency (L→R) (7)

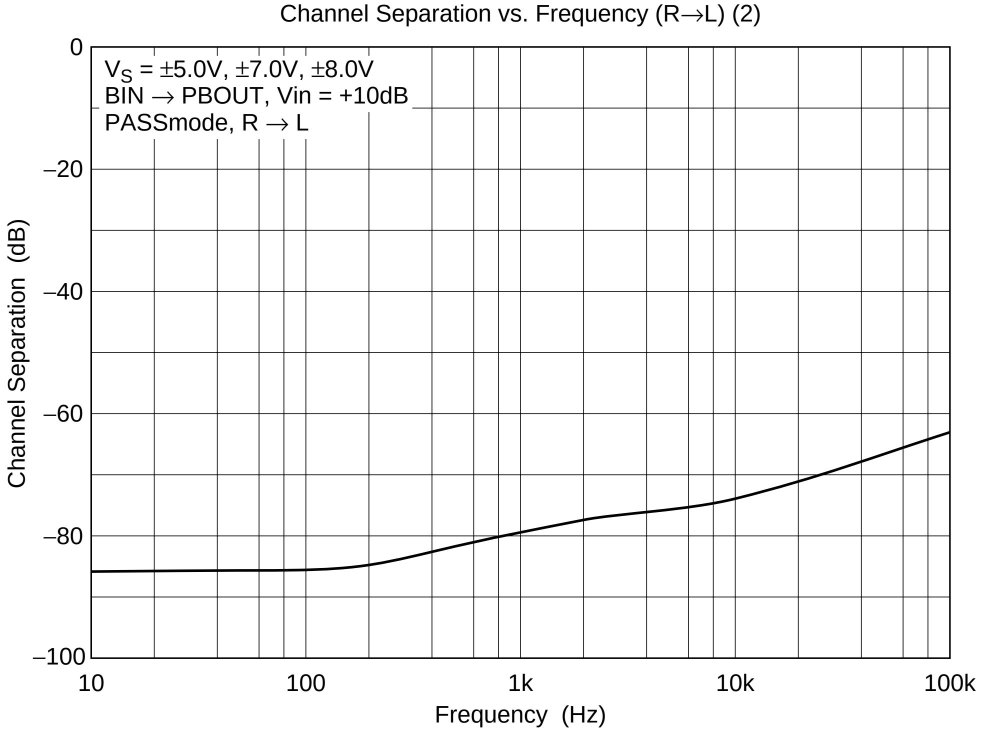


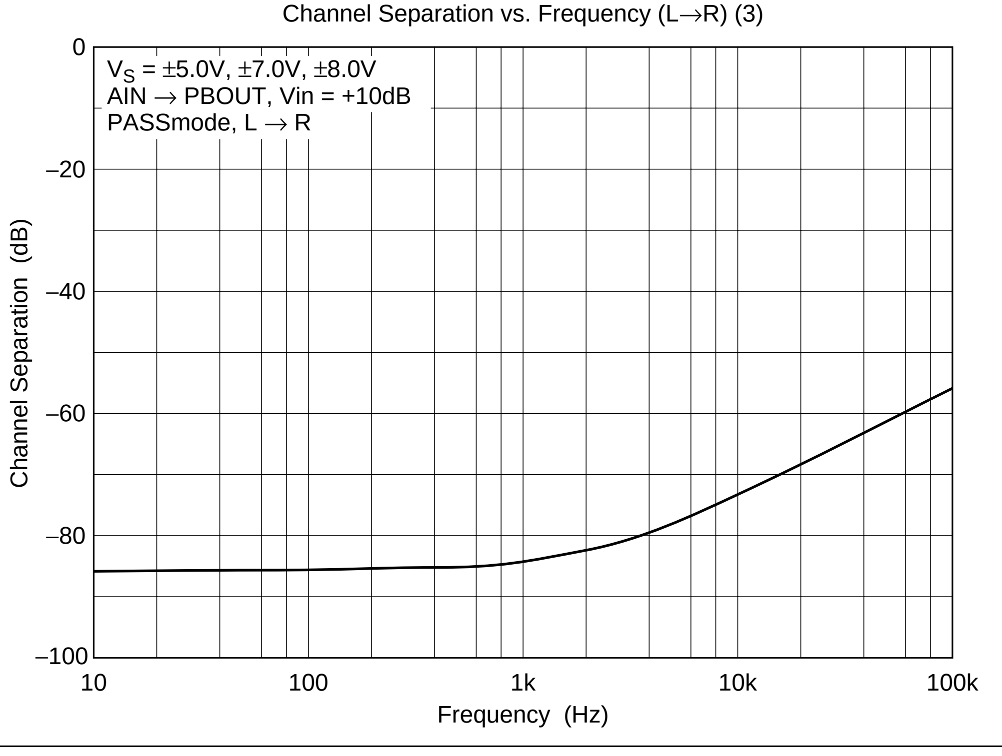
Channel Separation vs. Frequency (L→R) (8)

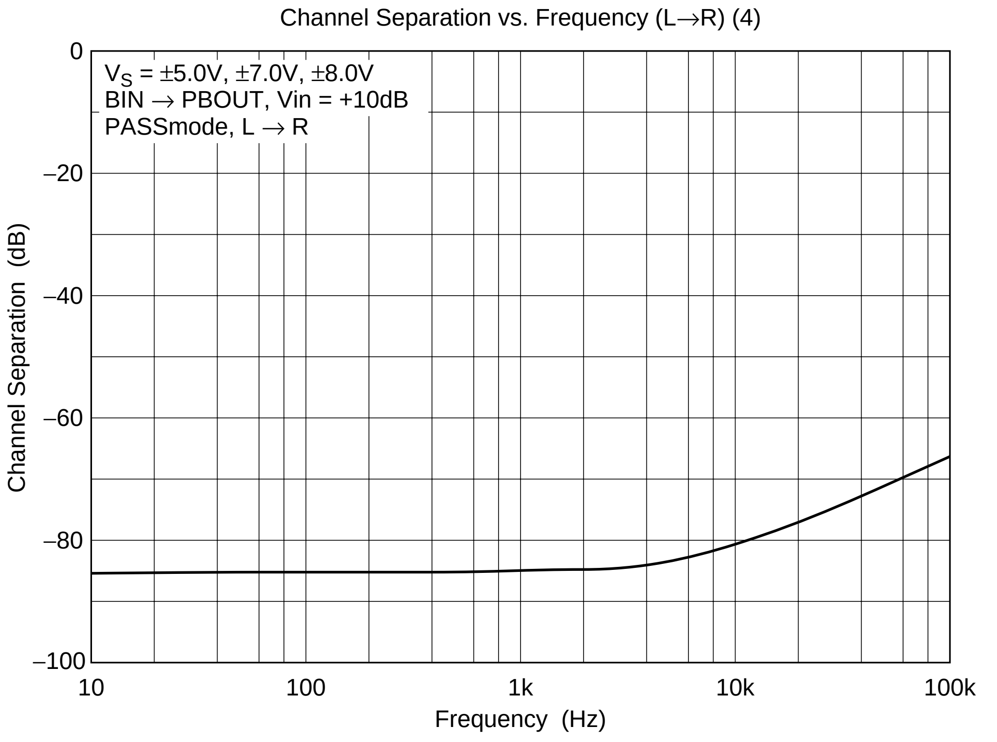


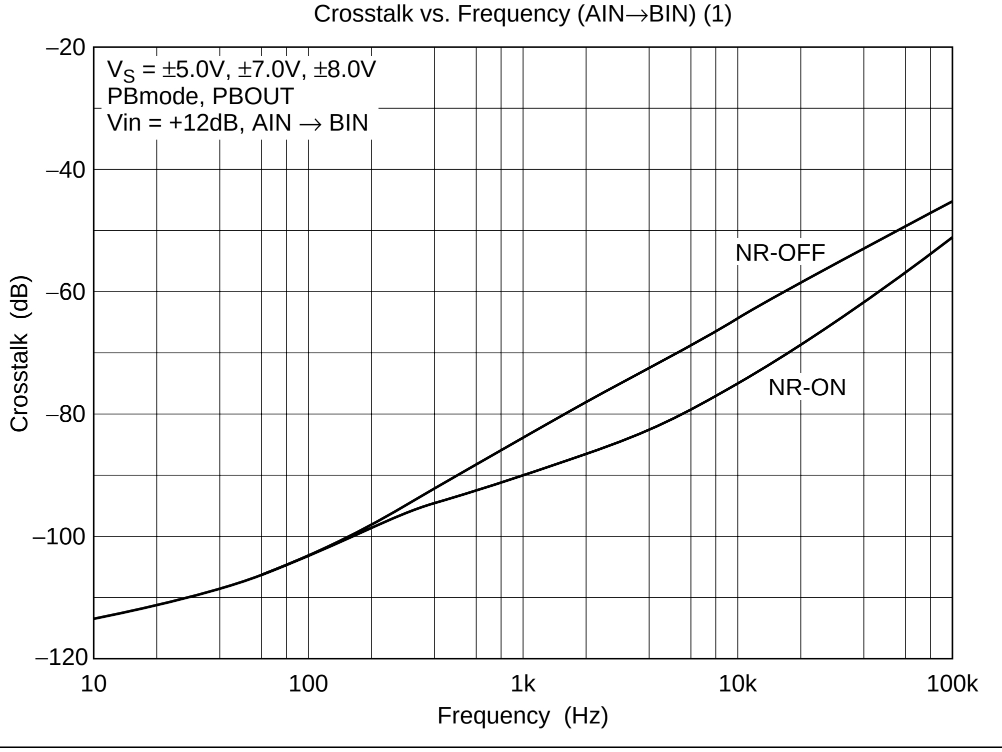
Channel Separation vs. Frequency (R→L) (1)



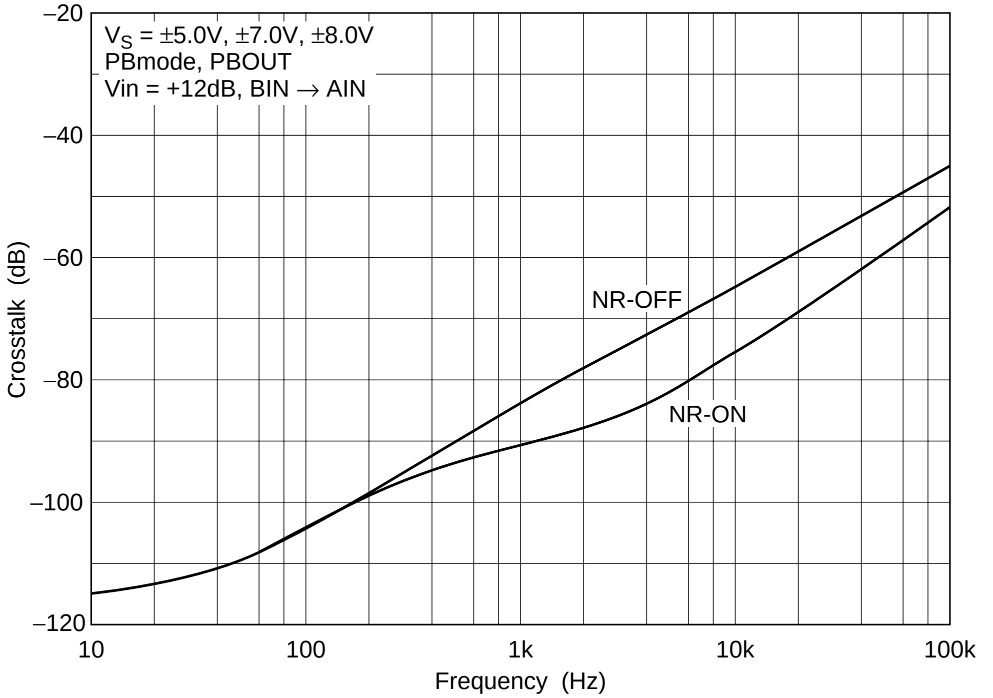

Channel Separation vs. Frequency (R→L) (2)
V_S = ±5.0V, ±7.0V, ±8.0V
BIN → PBOUT, Vin = +10dB
PASSmode, R → L
Channel Separation (dB)
0
–20
–40
–60
–80
–100
10
100
1k
10k
100k
Frequency (Hz)


Channel Separation vs. Frequency (L→R) (3)
V_S = ±5.0V, ±7.0V, ±8.0V
AIN → PBOUT, Vin = +10dB
PASSmode, L → R
Channel Separation (dB)
0
–20
–40
–60
–80
–100
10
100
1k
10k
100k
Frequency (Hz)

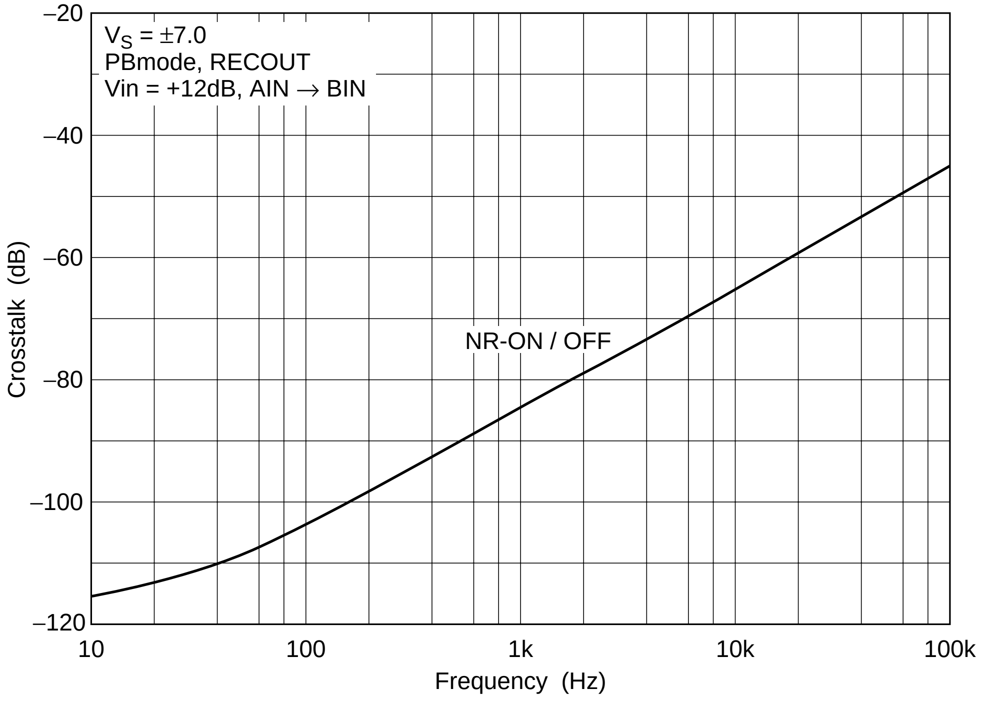

Channel Separation vs. Frequency (L→R) (4)
VS = ±5.0V, ±7.0V, ±8.0V
BIN → PBOUT, Vin = +10dB
PASSmode, L → R
0
–20
–40
–60
–80
–100
Channel Separation (dB)
10
100
1k
10k
100k
Frequency (Hz)


Crosstalk vs. Frequency (AIN→BIN) (1)
VS = ±5.0V, ±7.0V, ±8.0V
PBmode, PBOUT
Vin = +12dB, AIN → BIN
NR-OFF
NR-ON
–20
–40
–60
–80
–100
–120
Crosstalk (dB)
10
100
1k
10k
100k
Frequency (Hz)

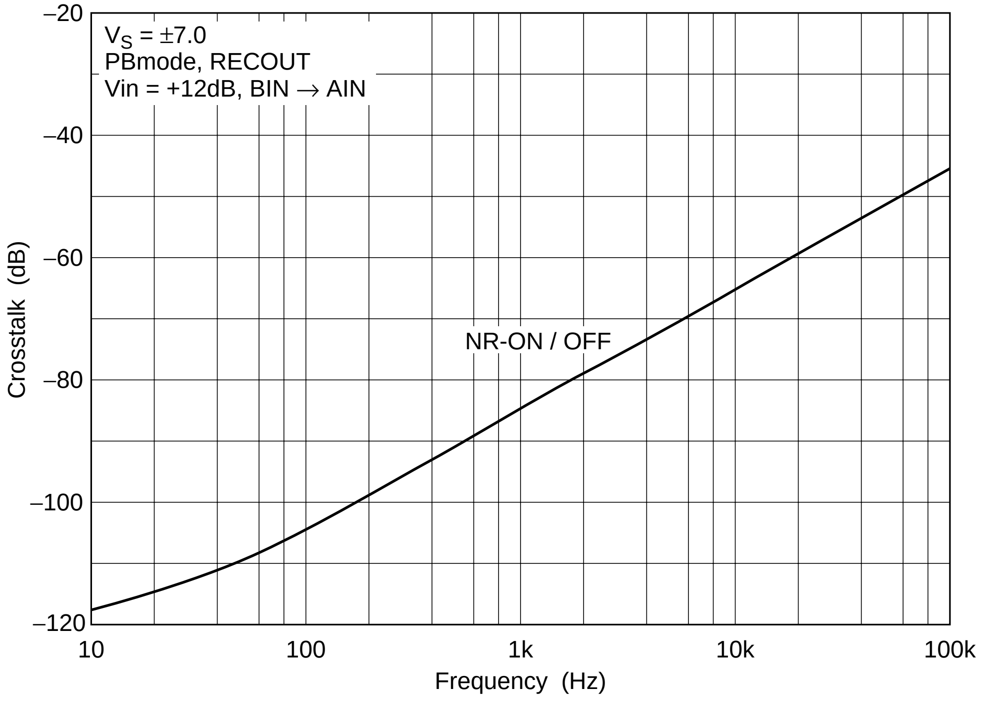
Crosstalk vs. Frequency (BIN→AIN) (2)



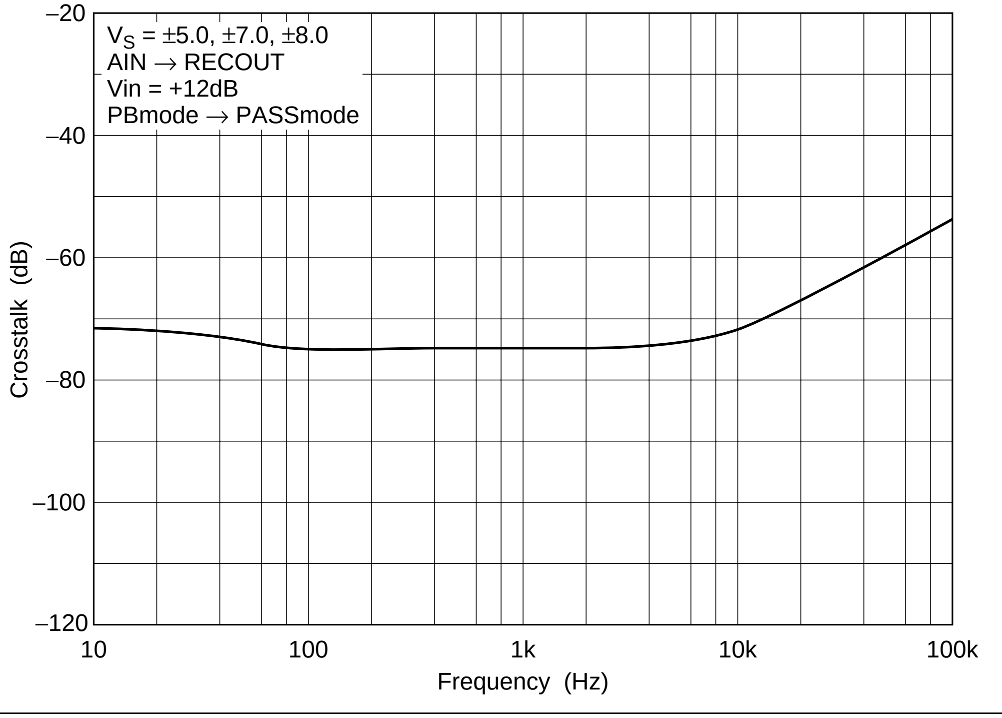
Crosstalk vs. Frequency (AIN→BIN) (3)

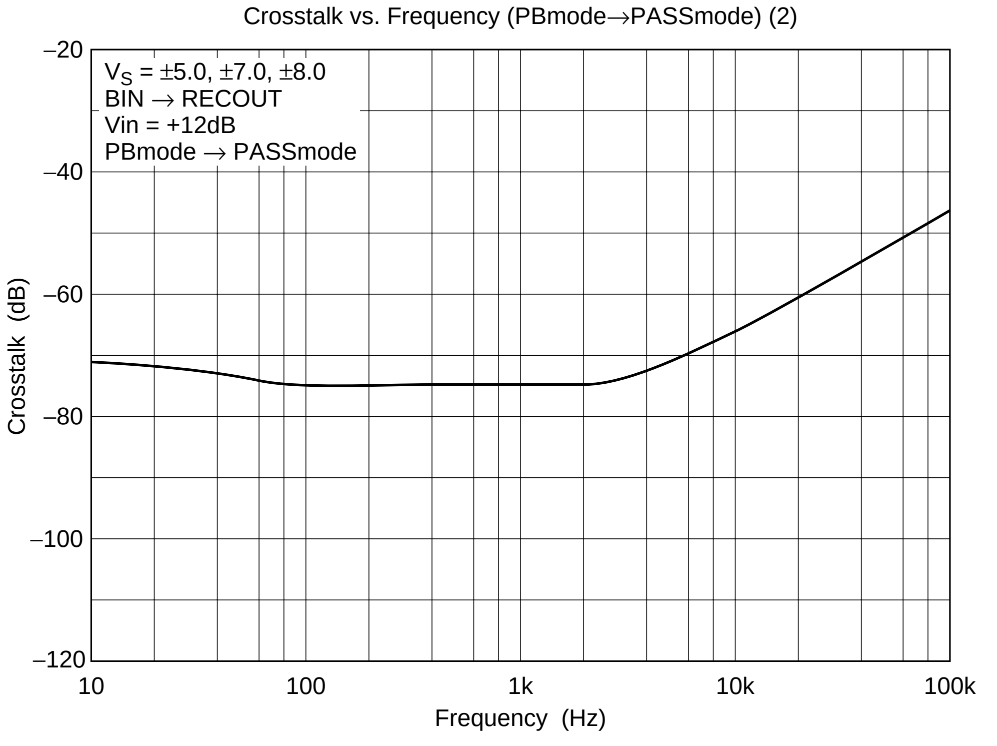


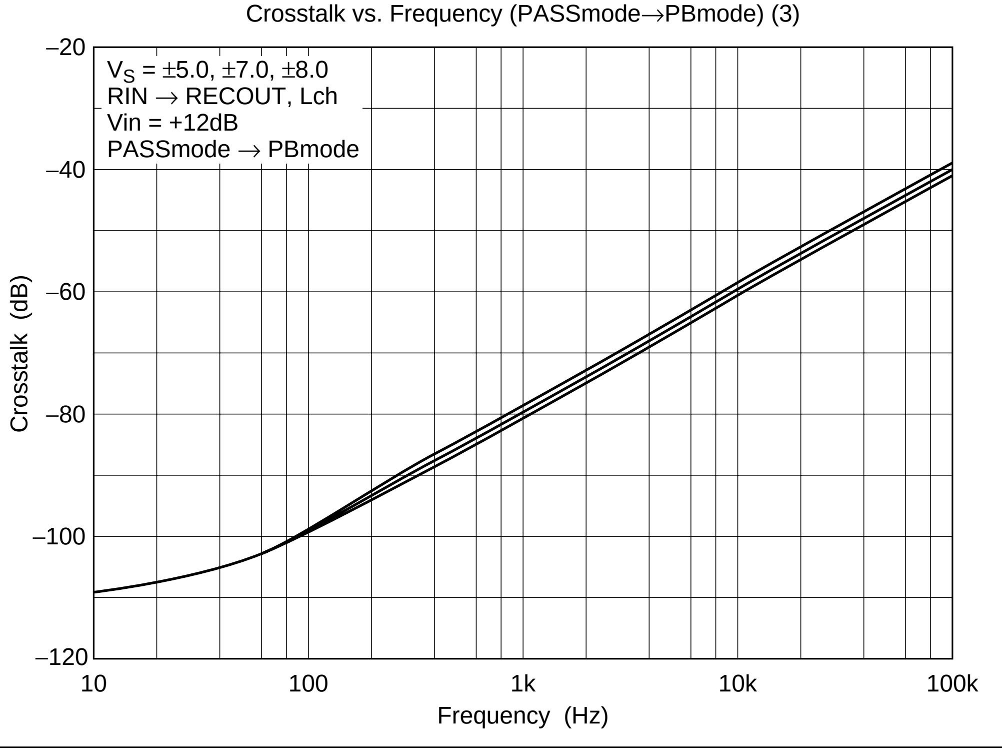
Crosstalk vs. Frequency (BIN→AIN) (4)



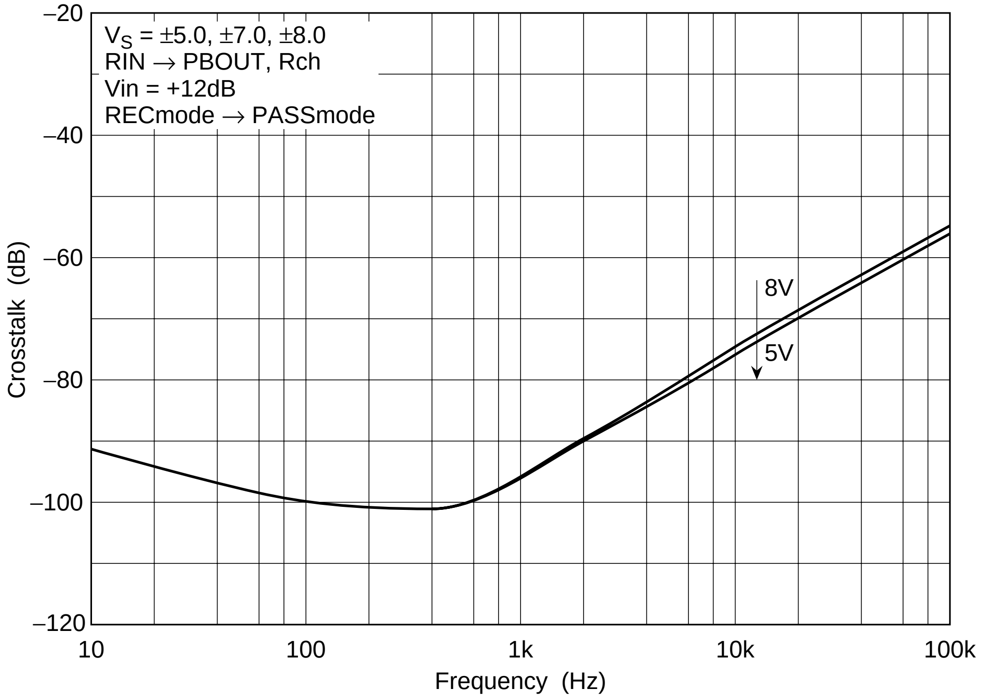
Crosstalk vs. Frequency (PBmode→PASSmode) (1)



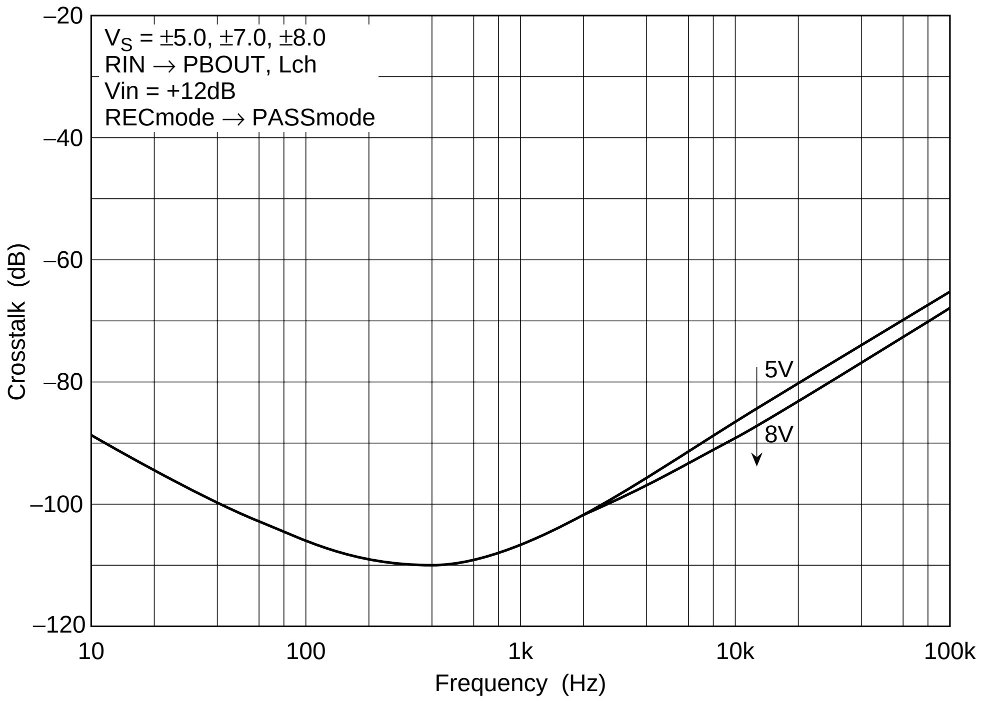

Crosstalk vs. Frequency (PBmode→PASSmode) (2)
VS = ±5.0, ±7.0, ±8.0
BIN → RECOUT
Vin = +12dB
PBmode → PASSmode
–20
–40
–60
–80
–100
–120
Crosstalk (dB)
10
100
1k
10k
100k
Frequency (Hz)


Crosstalk vs. Frequency (PASSmode→PBmode) (3)
VS = ±5.0, ±7.0, ±8.0
RIN → RECOUT, Lch
Vin = +12dB
PASSmode → PBmode
–20
–40
–60
–80
–100
–120
Crosstalk (dB)
10
100
1k
10k
100k
Frequency (Hz)

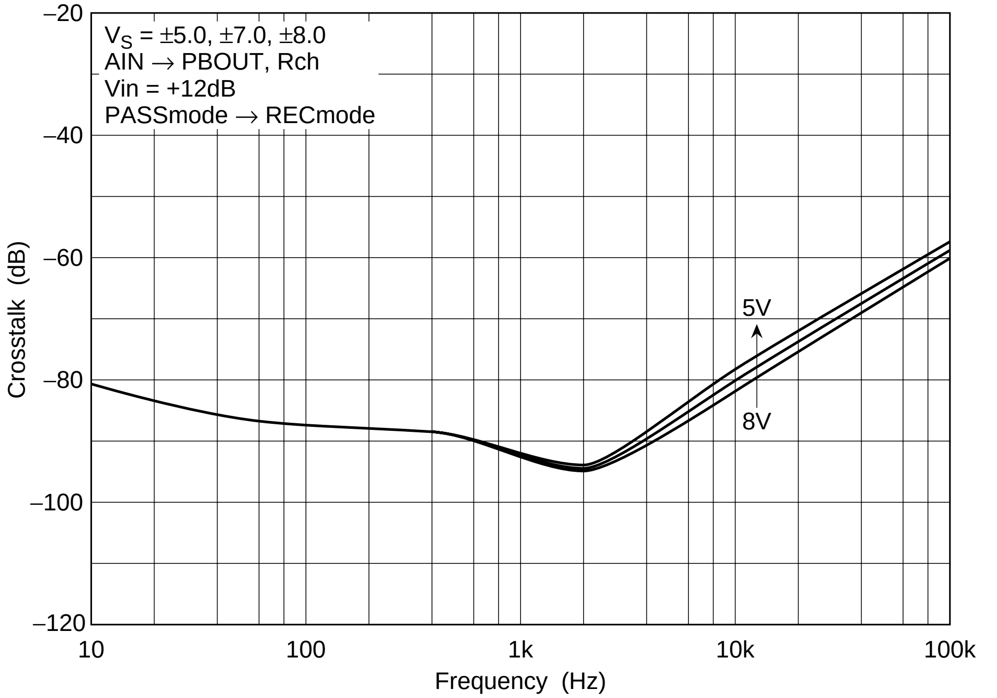
Crosstalk vs. Frequency (RECmode→PASSmode) (Rch) (1)



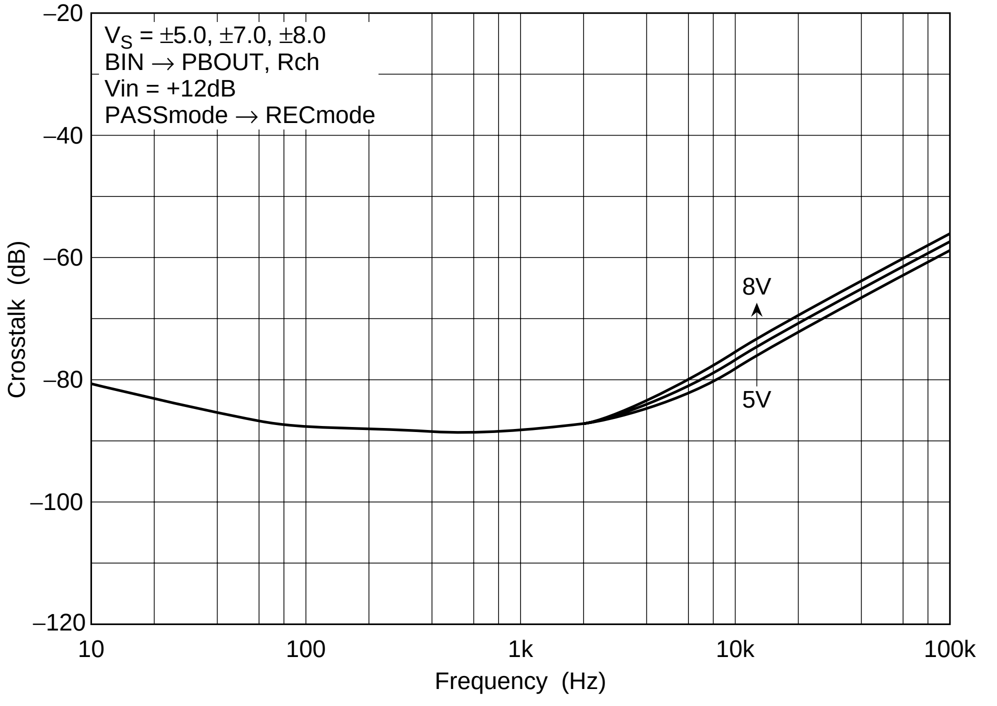
Crosstalk vs. Frequency (RECmode→PASSmode) (Lch) (2)



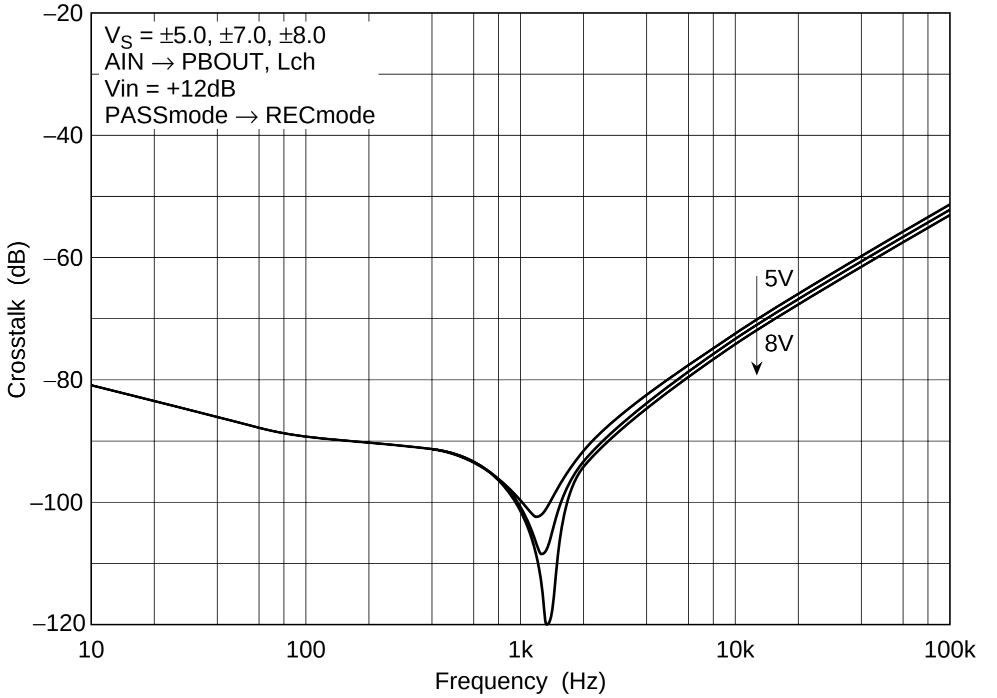
Crosstalk vs. Frequency (PASSmode→RECmode) (Rch) (1)



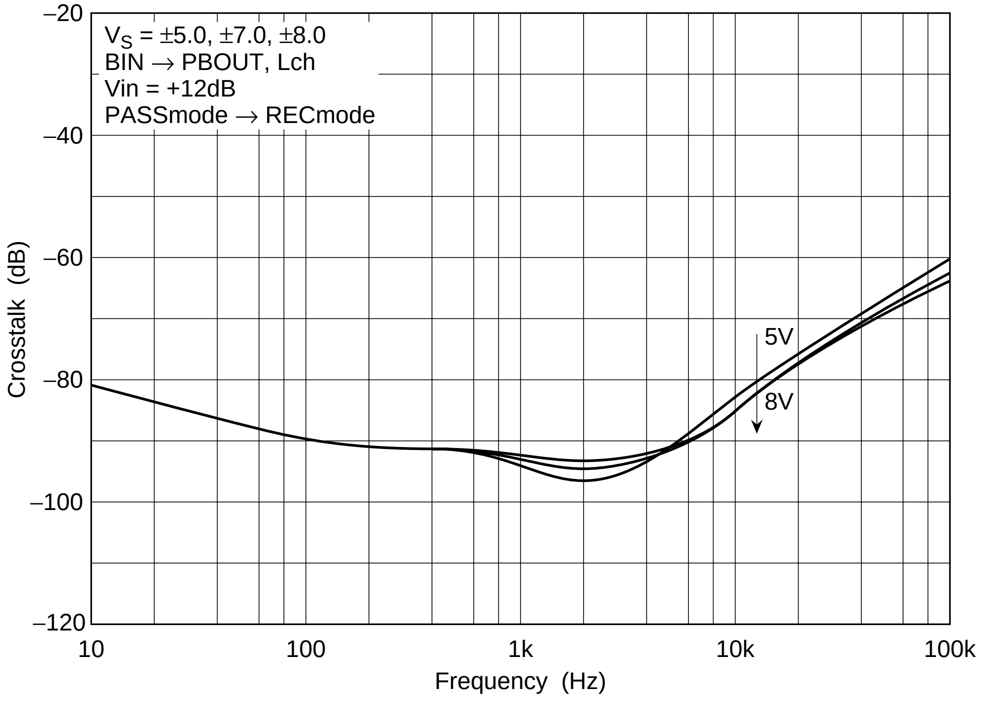
Crosstalk vs. Frequency (PASSmode→RECmode) (Rch) (2)

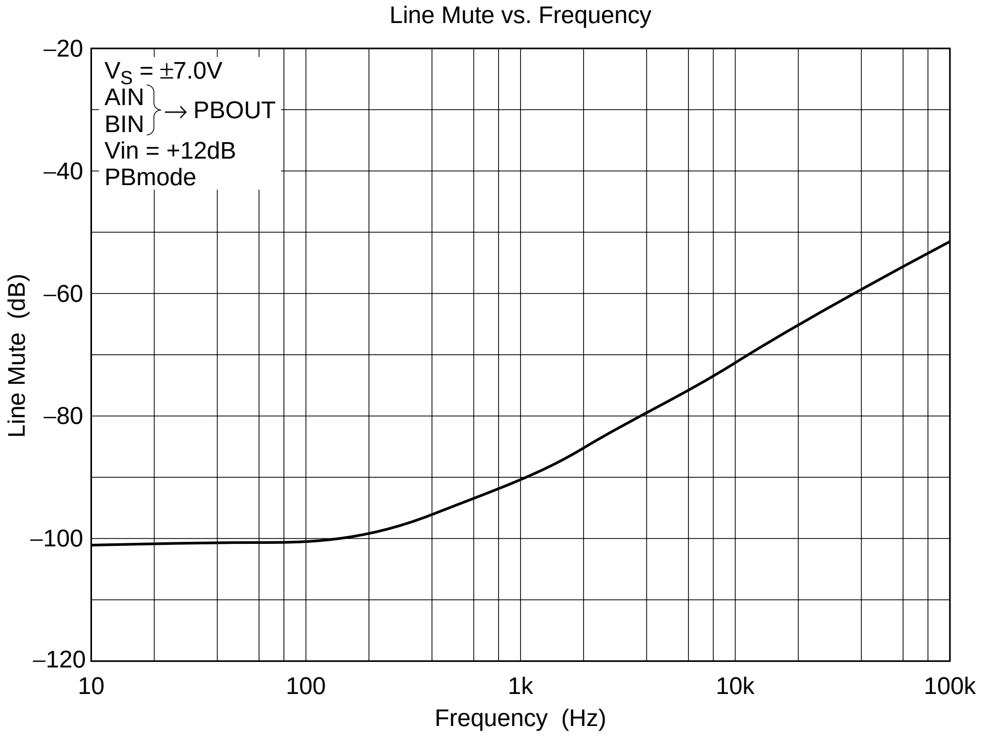


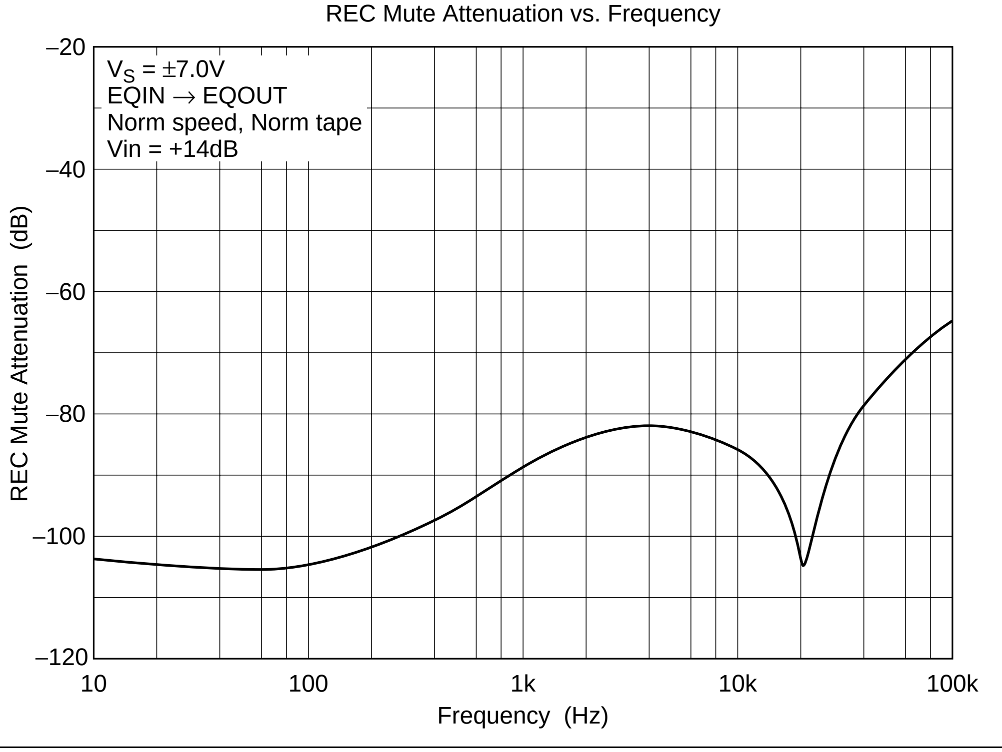
Crosstalk vs. Frequency (PASSmode→RECmode) (Lch) (3)

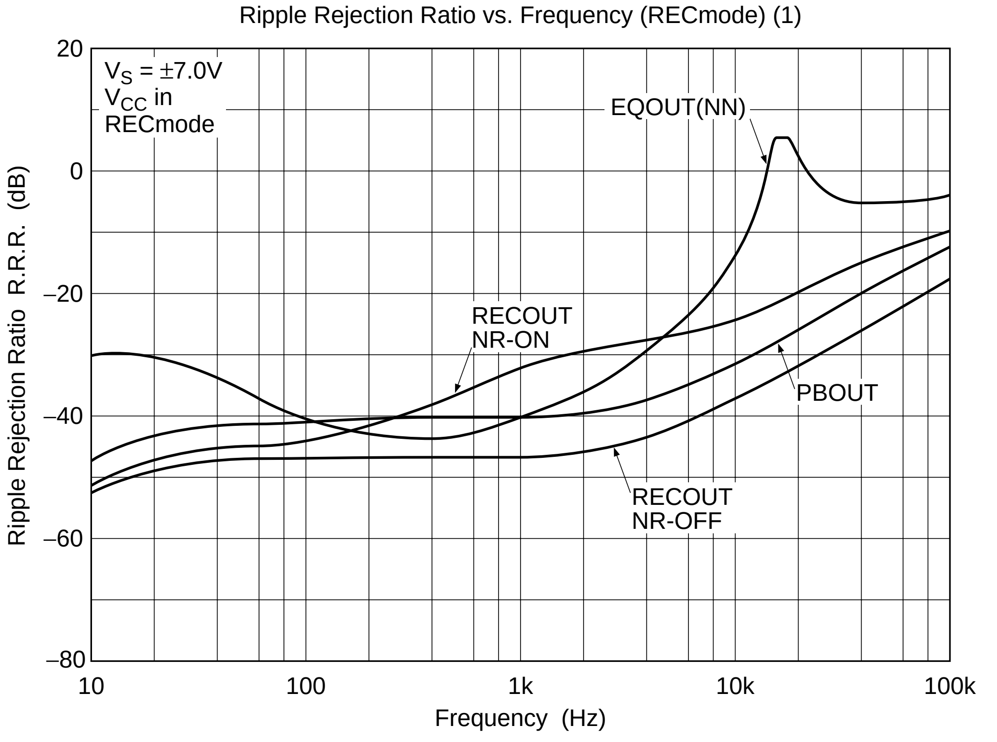


Crosstalk vs. Frequency (PASSmode→RECmode) (Lch) (4)

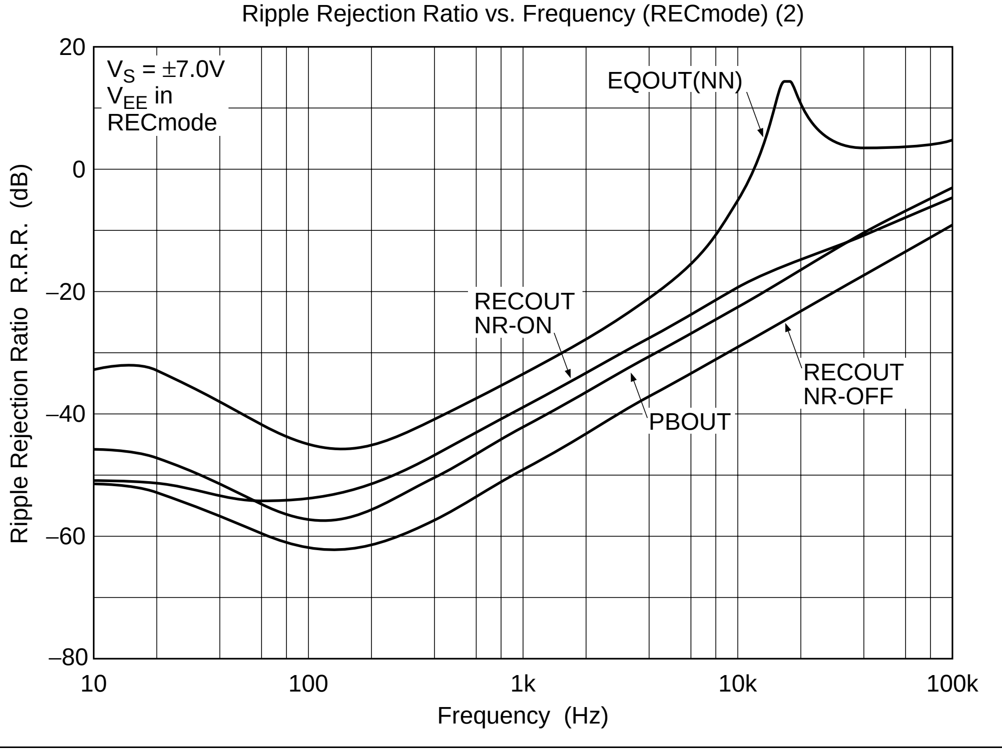



Line Mute vs. Frequency
V_S = ±7.0V
AIN
BIN
→ PBOUT
Vin = +12dB
PBmode
–20
–40
–60
–80
–100
–120
Line Mute (dB)
10
100
1k
10k
100k
Frequency (Hz)


REC Mute Attenuation vs. Frequency
V_S = ±7.0V
EQIN → EQOUT
Norm speed, Norm tape
Vin = +14dB
–20
–40
–60
–80
–100
–120
REC Mute Attenuation (dB)
10
100
1k
10k
100k
Frequency (Hz)

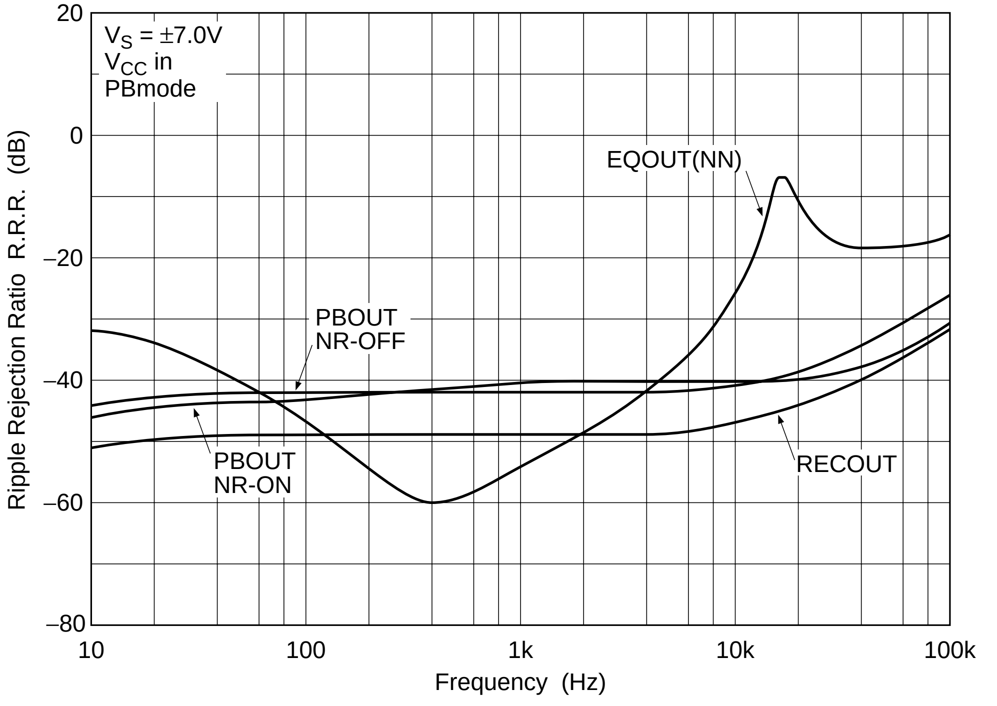


Ripple Rejection Ratio vs. Frequency (RECmode) (1)
VS = ±7.0V
VCC in
RECmode
EQOUT(NN)
RECOUT
NR-ON
PBOUT
RECOUT
NR-OFF
20
0
–20
–40
–60
–80
10
100
1k
10k
100k
Frequency (Hz)
Ripple Rejection Ratio R.R.R. (dB)

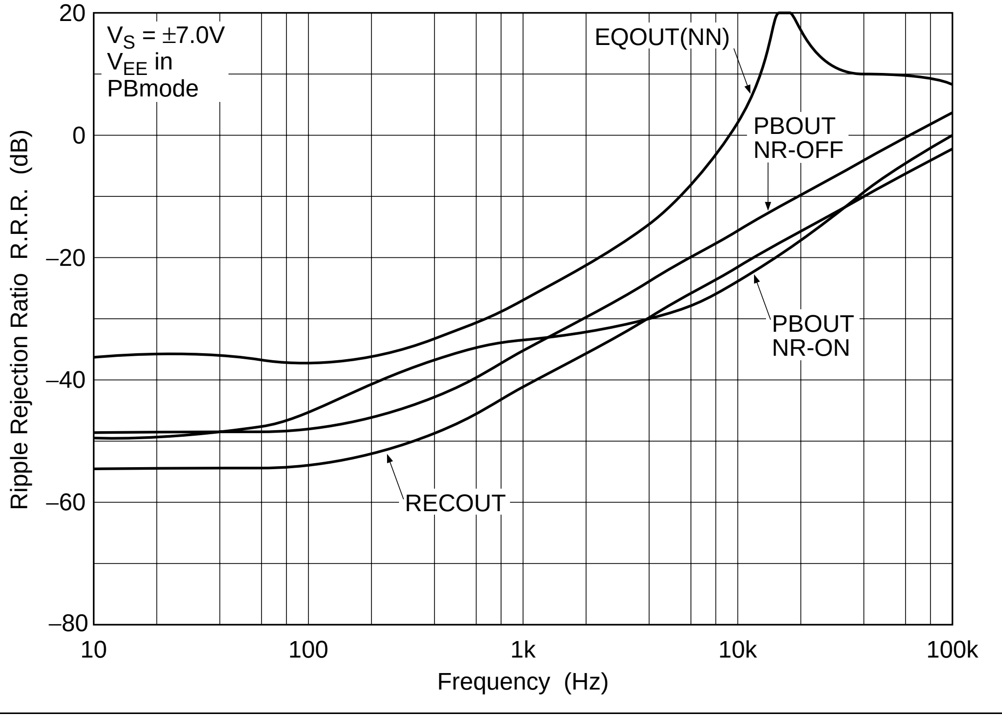


Ripple Rejection Ratio vs. Frequency (RECmode) (2)
VS = ±7.0V
VEE in
RECmode
EQOUT(NN)
RECOUT
NR-ON
PBOUT
RECOUT
NR-OFF
20
0
–20
–40
–60
–80
10
100
1k
10k
100k
Frequency (Hz)
Ripple Rejection Ratio R.R.R. (dB)

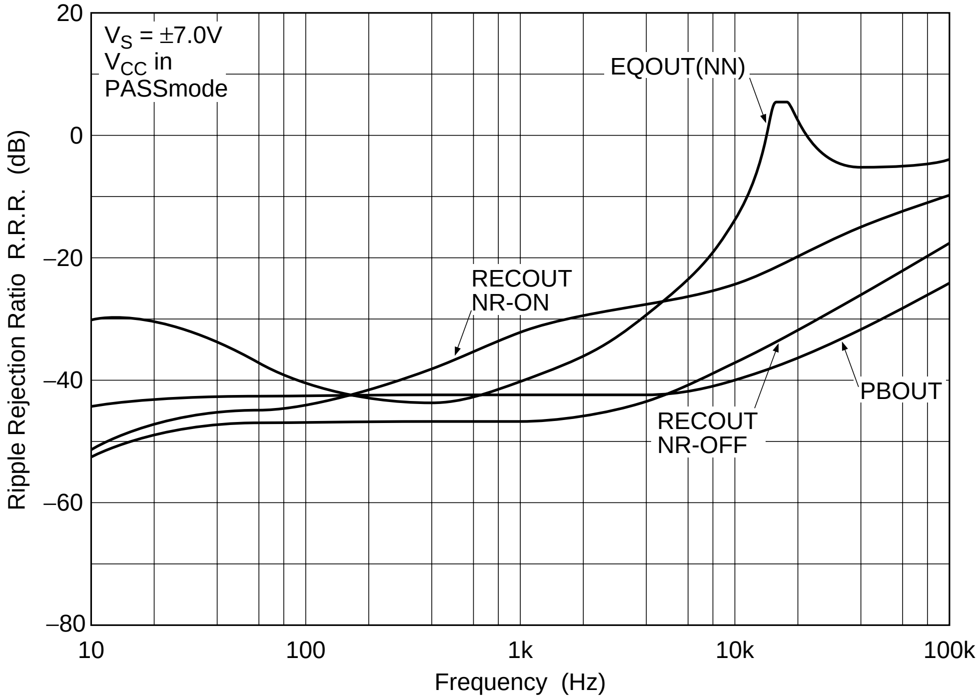
Ripple Rejection Ratio vs. Frequency (PBmode) (1)



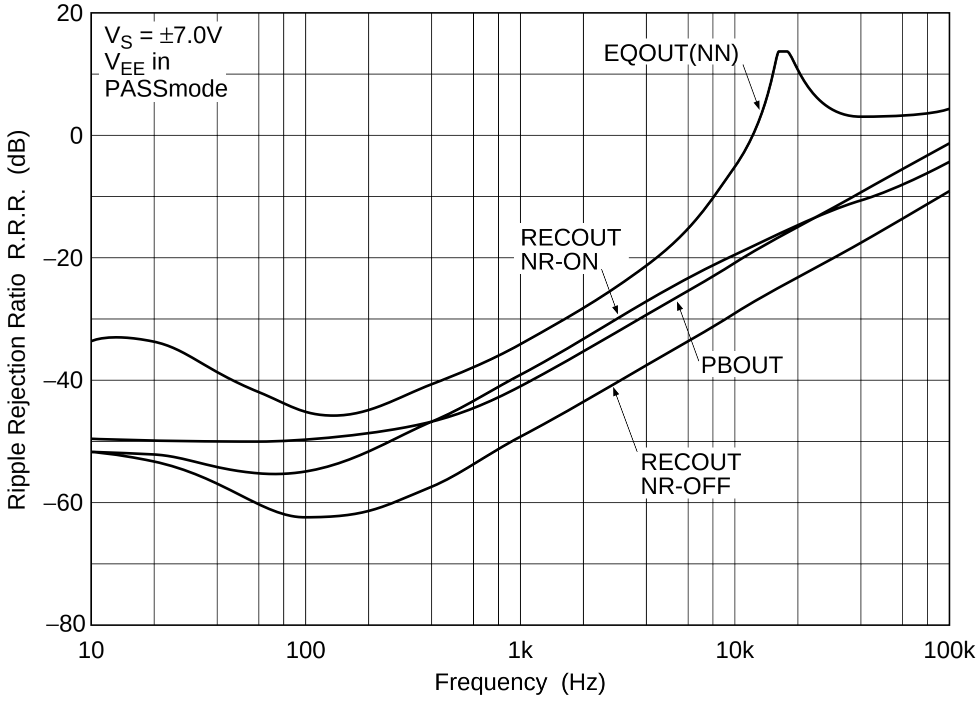
Ripple Rejection Ratio vs. Frequency (PBmode) (2)



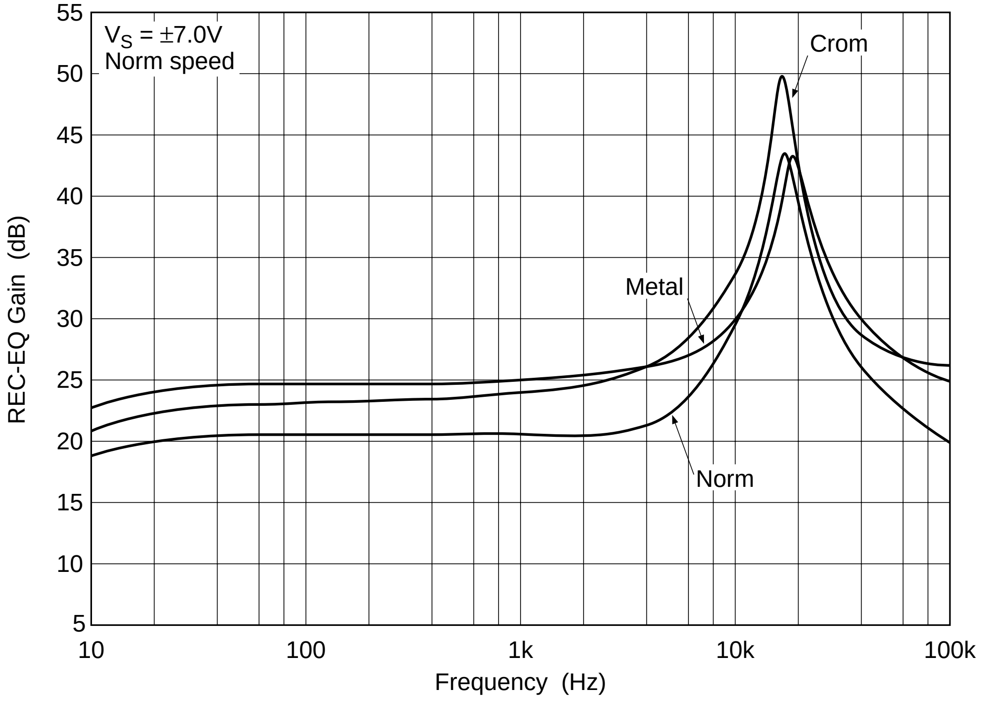
Ripple Rejection Ratio vs. Frequency (PASSmode) (1)



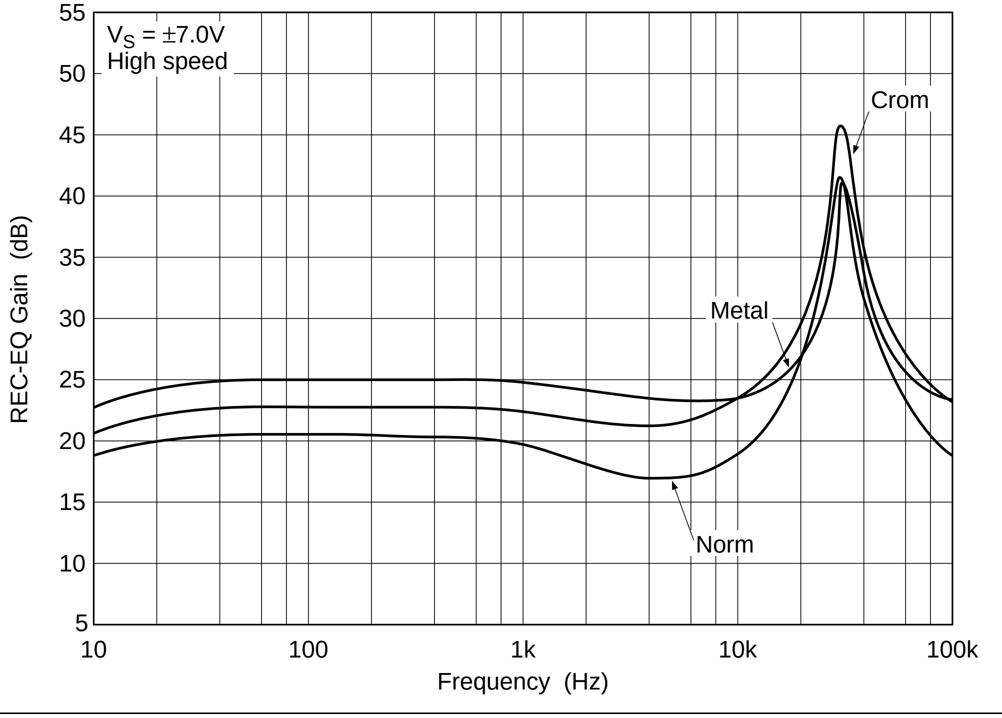
Ripple Rejection Ratio vs. Frequency (PASSmode) (2)



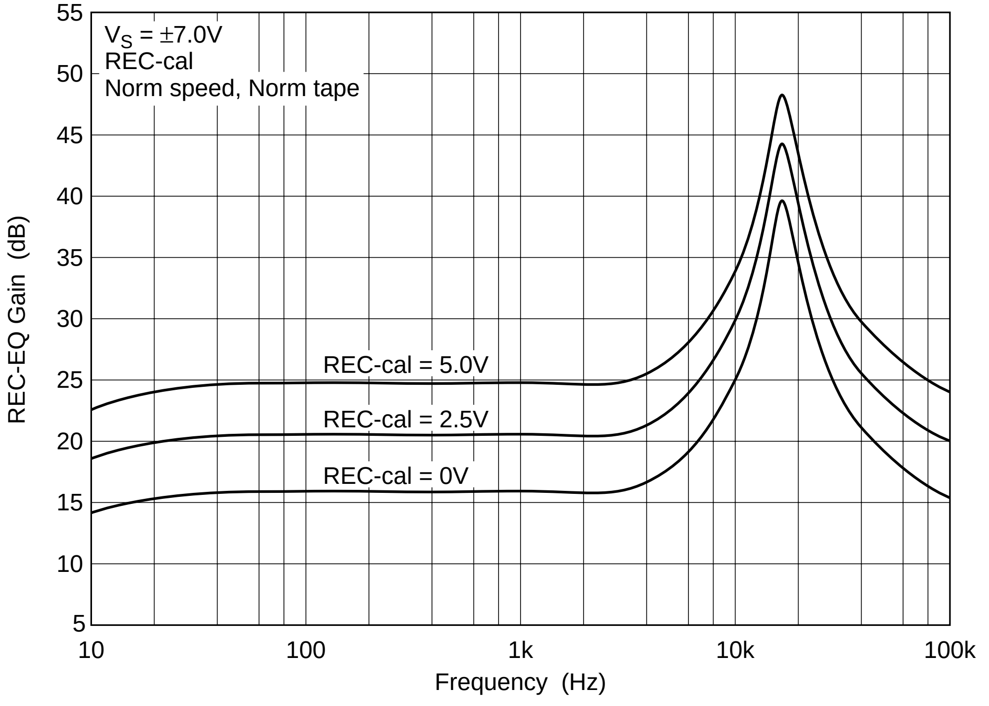
Equalizer Amp. Gain vs. Frequency (1)



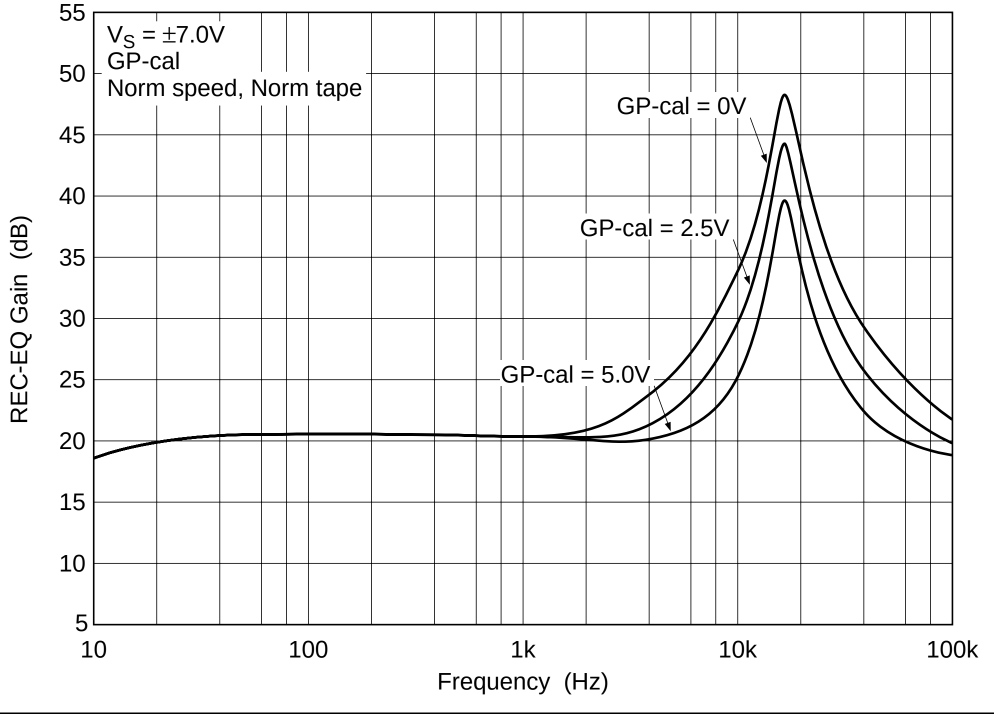
Equalizer Amp. Gain vs. Frequency (2)



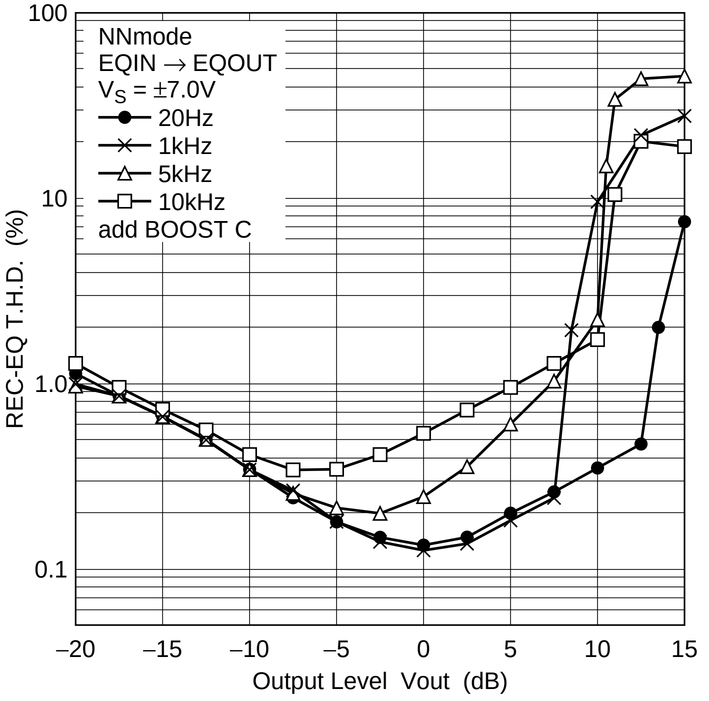
Equalizer Amp. Gain vs. Frequency (RECcal)



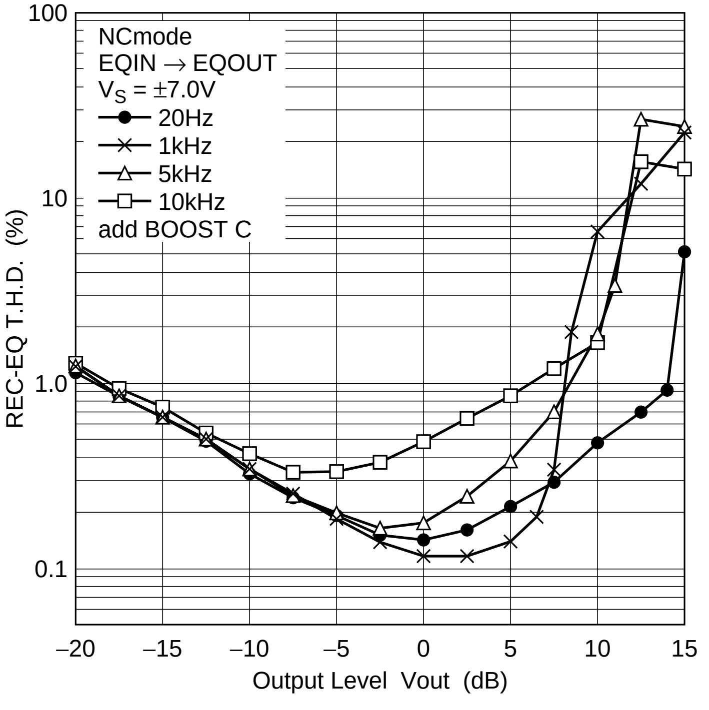
Equalizer Amp. Gain vs. Frequency (GPcal)



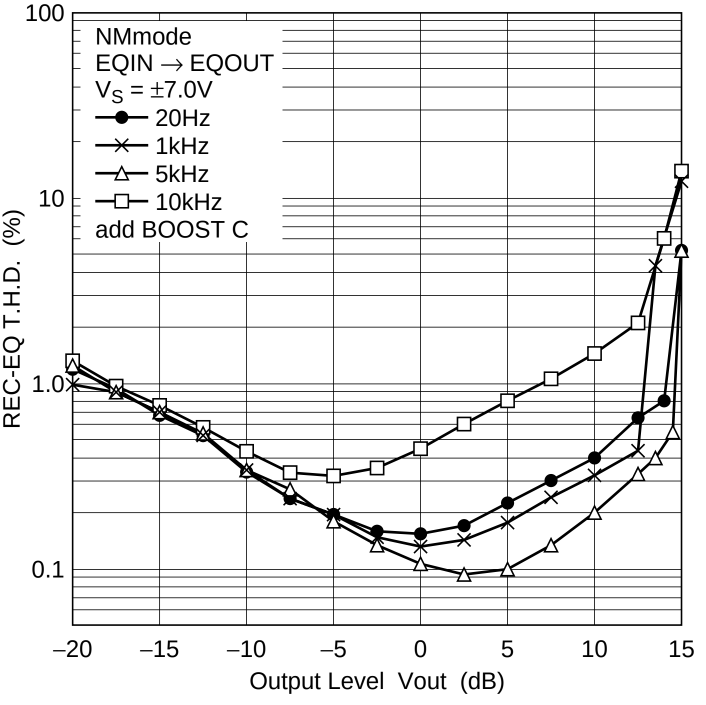
Equalizer Total Harmonic Distortion vs. Output Level (1)



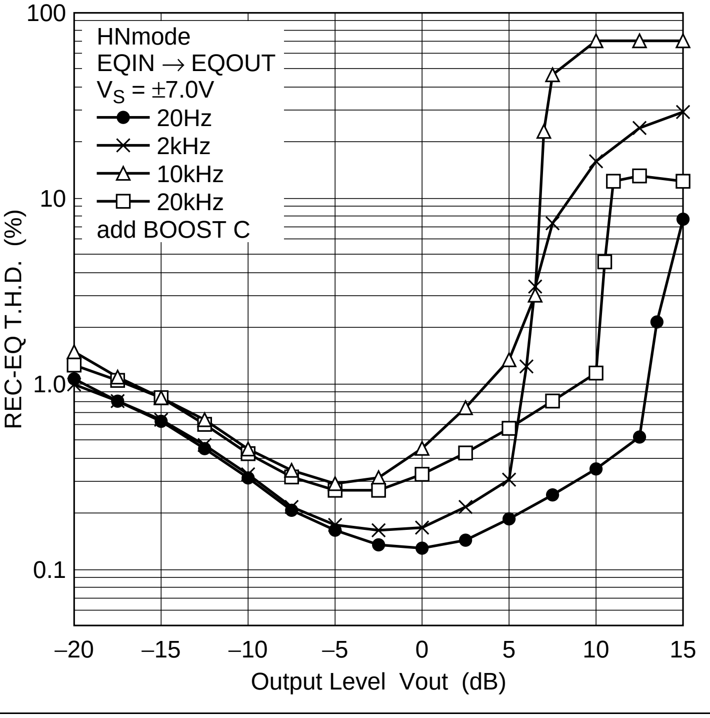
Equalizer Total Harmonic Distortion vs. Output Level (2)



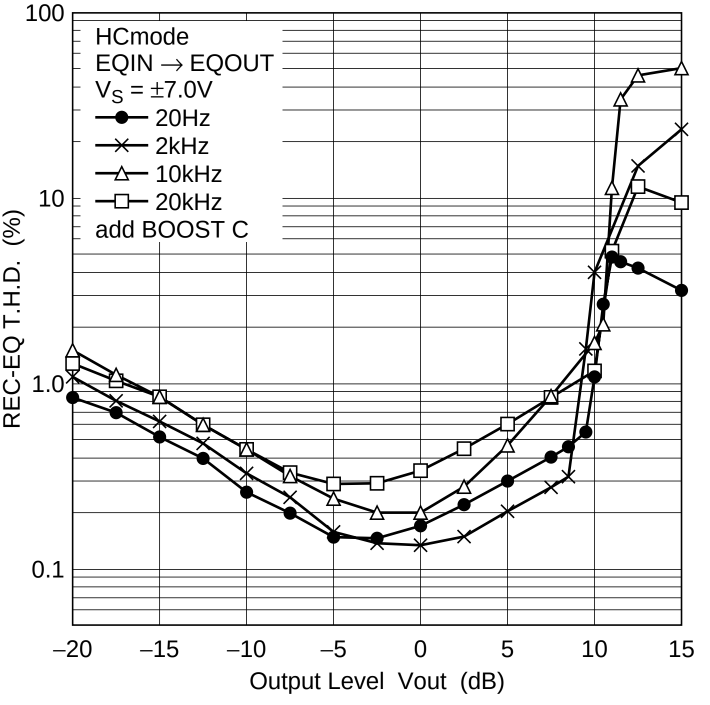
Equalizer Total Harmonic Distortion vs. Output Level (3)



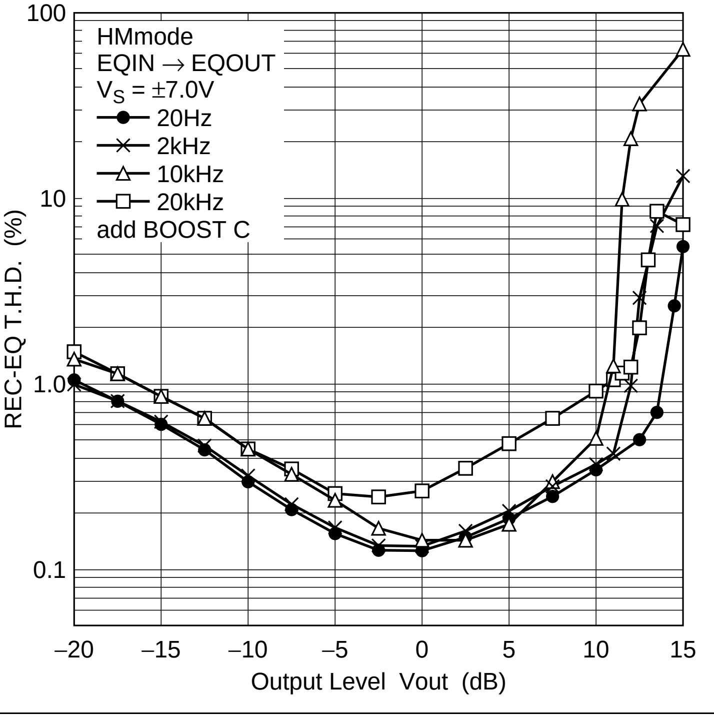
Equalizer Total Harmonic Distortion vs. Output Level (4)



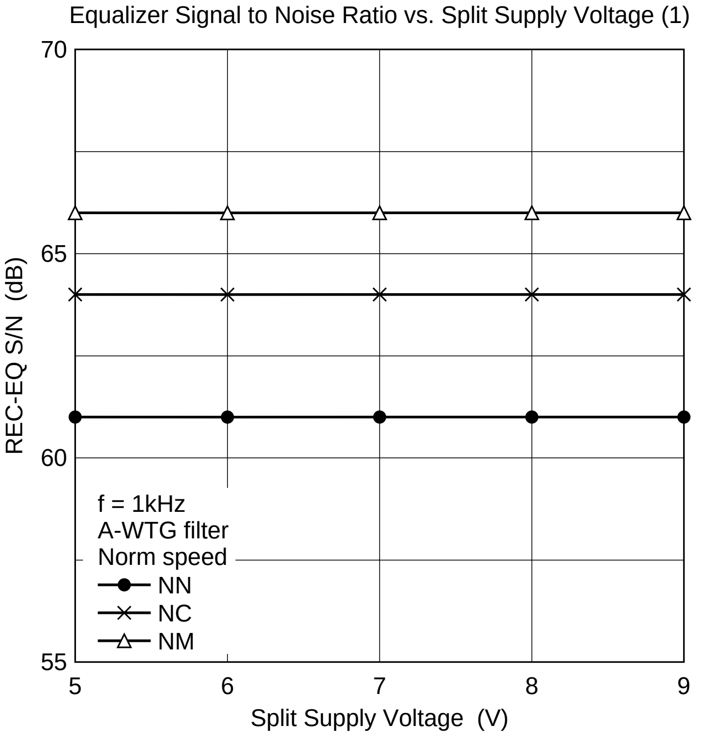
Equalizer Total Harmonic Distortion vs. Output Level (5)

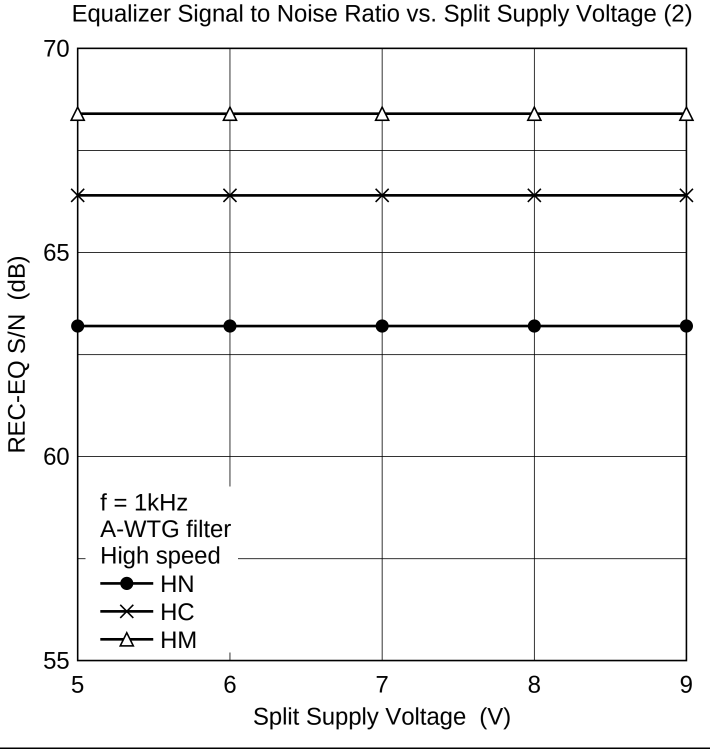


Equalizer Total Harmonic Distortion vs. Output Level (6)

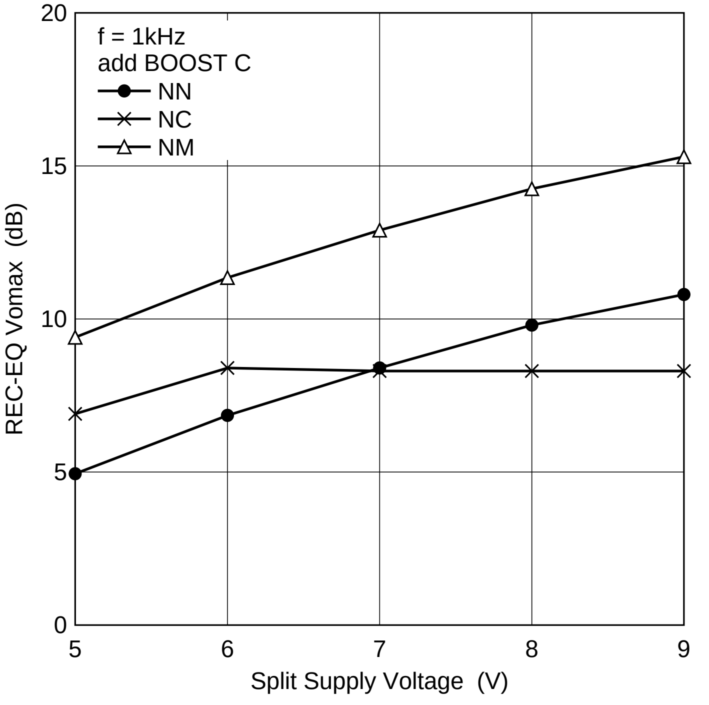


HITACHI

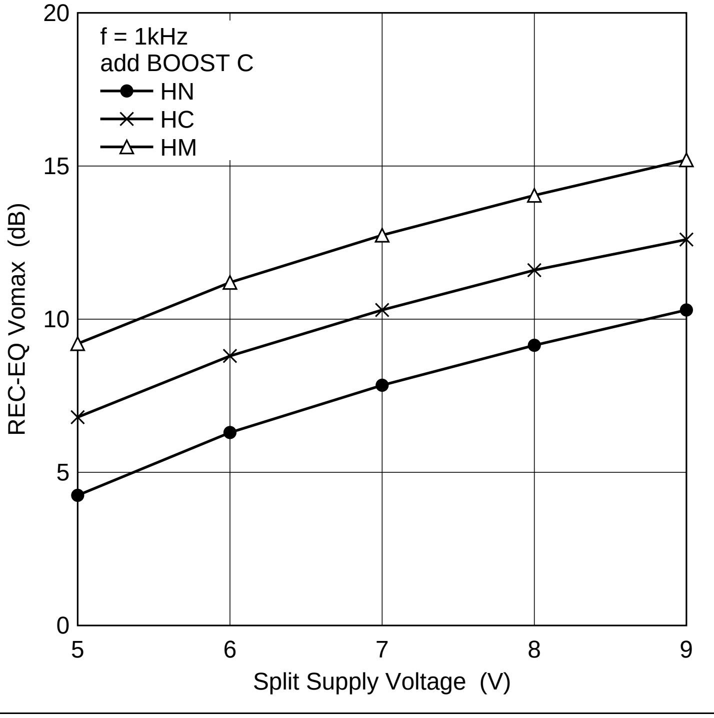

Equalizer Signal to Noise Ratio vs. Split Supply Voltage (1)
70
65
60
55
REC-EQ S/N (dB)
f = 1kHz
A-WTG filter
Norm speed
NN
NC
NM
5
6
7
8
9
Split Supply Voltage (V)

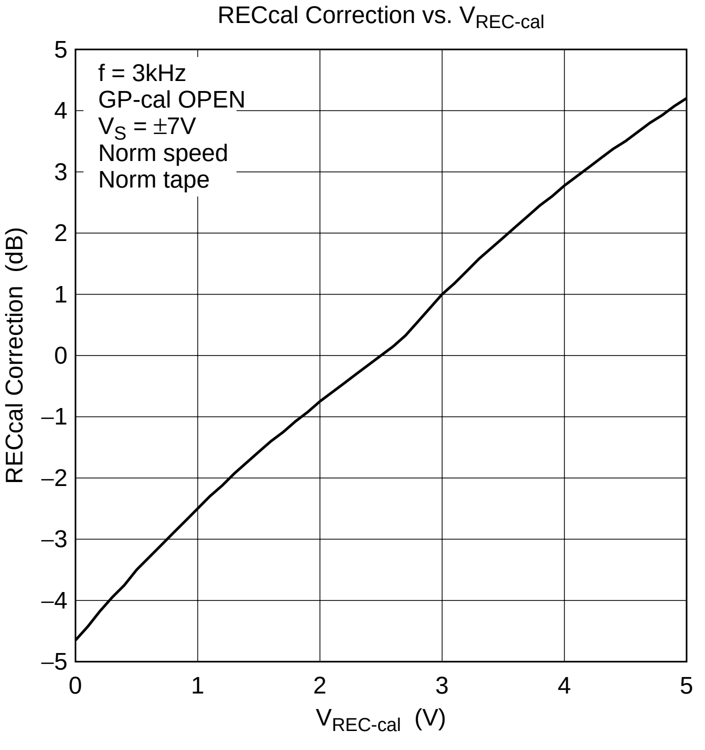

Equalizer Signal to Noise Ratio vs. Split Supply Voltage (2)
70
65
60
55
REC-EQ S/N (dB)
f = 1kHz
A-WTG filter
High speed
HN
HC
HM
5
6
7
8
9
Split Supply Voltage (V)

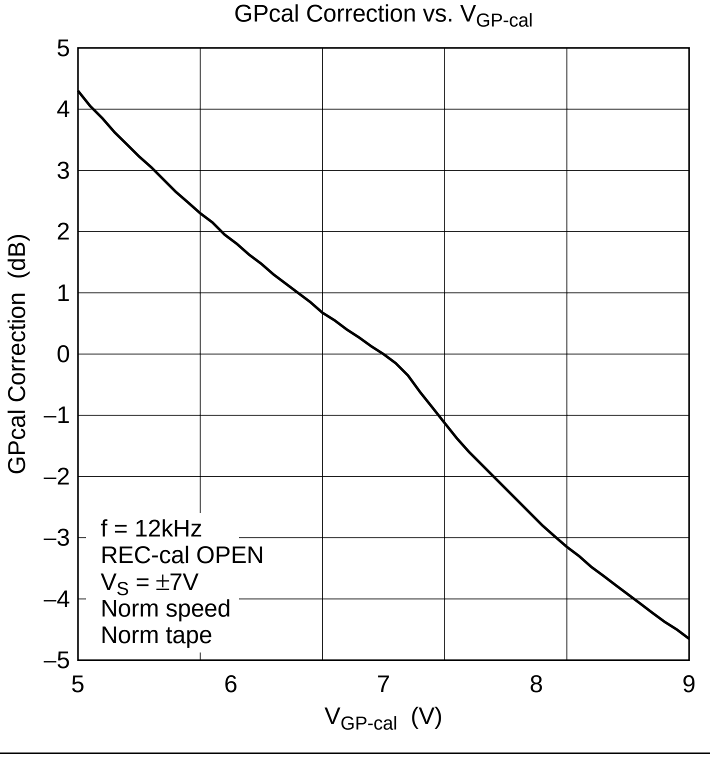
Equalizer Vomax vs. Split Supply Voltage (1)



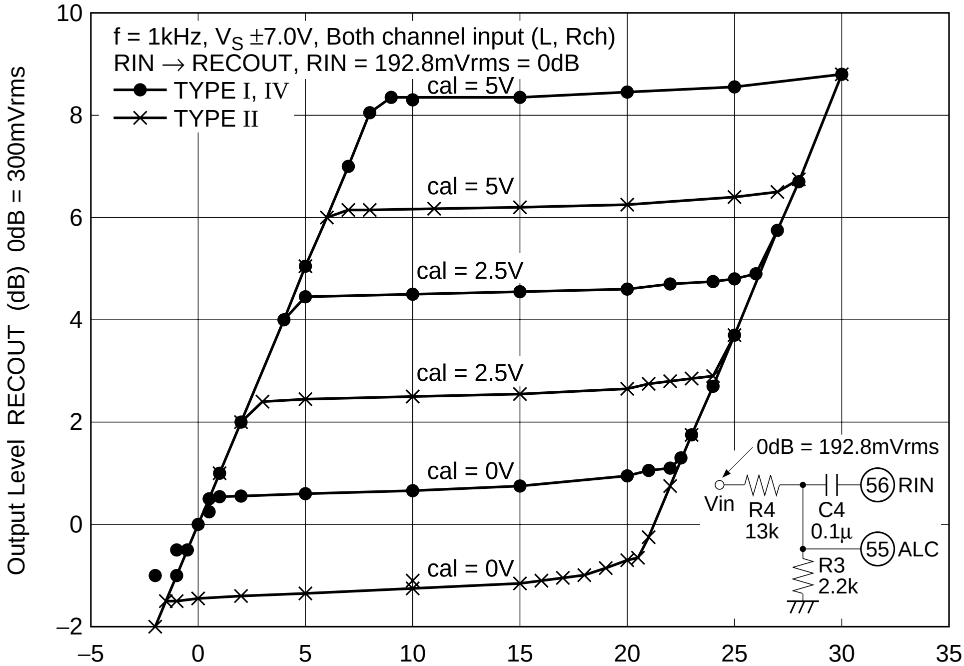
Equalizer Vomax vs. Split Supply Voltage (2)



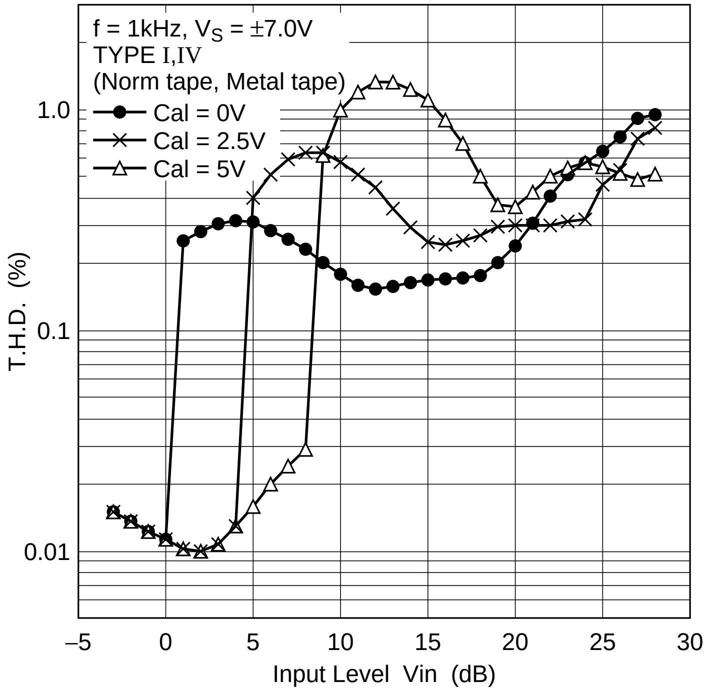

RECcal Correction vs. $V_{REC\text{-}cal}$
f = 3kHz
GP-cal OPEN
$V_S = \pm7V$
Norm speed
Norm tape
RECcal Correction (dB)
5
4
3
2
1
0
–1
–2
–3
–4
–5
0
1
2
3
4
5
$V_{REC\text{-}cal}$ (V)


GPcal Correction vs. $V_{GP\text{-}cal}$
f = 12kHz
REC-cal OPEN
$V_S = \pm7V$
Norm speed
Norm tape
GPcal Correction (dB)
5
4
3
2
1
0
–1
–2
–3
–4
–5
5
6
7
8
9
$V_{GP\text{-}cal}$ (V)

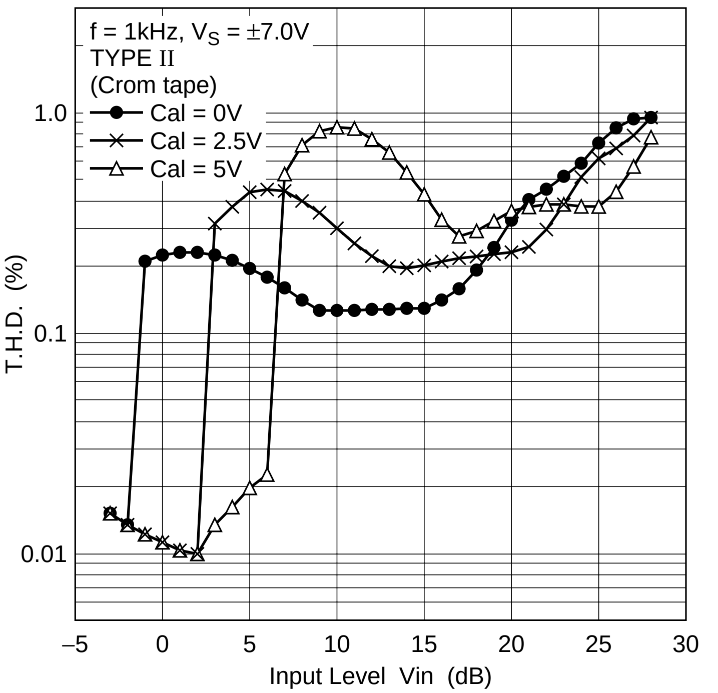
ALC Operate Level vs. Input Level



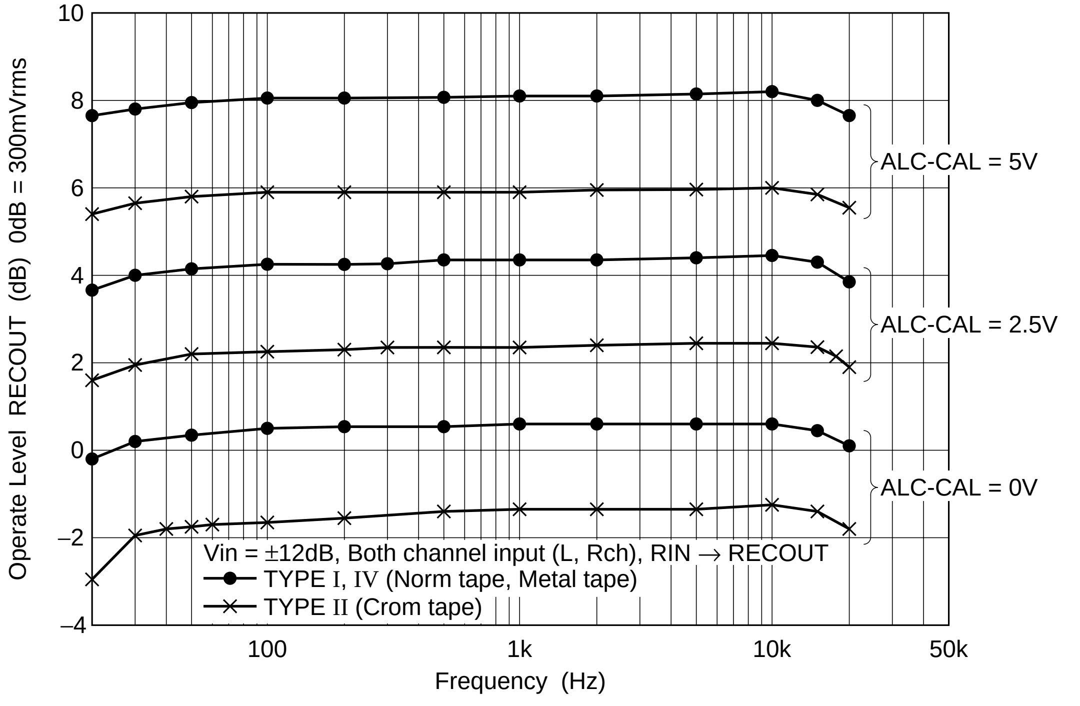
ALC Total Harmonic Distortion vs. Input Level (1)



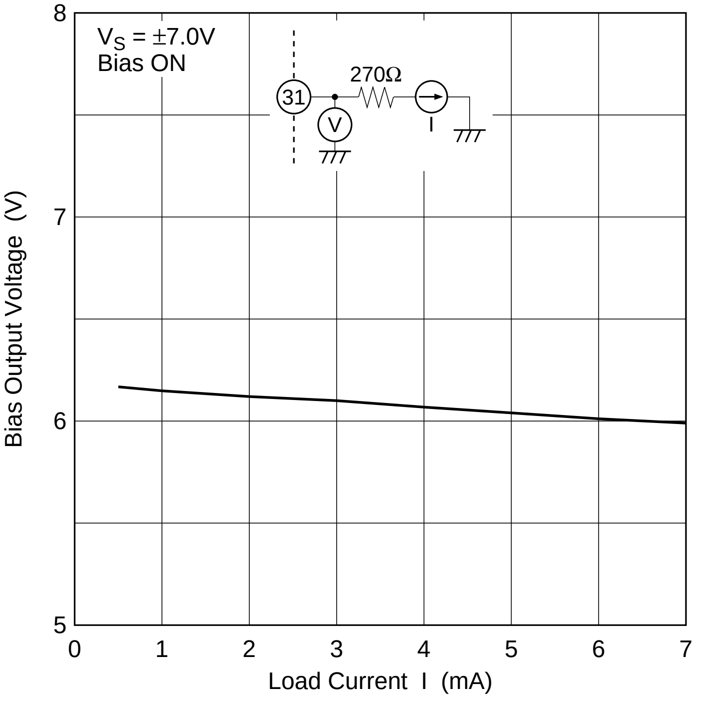
ALC Total Harmonic Distortion vs. Input Level (2)



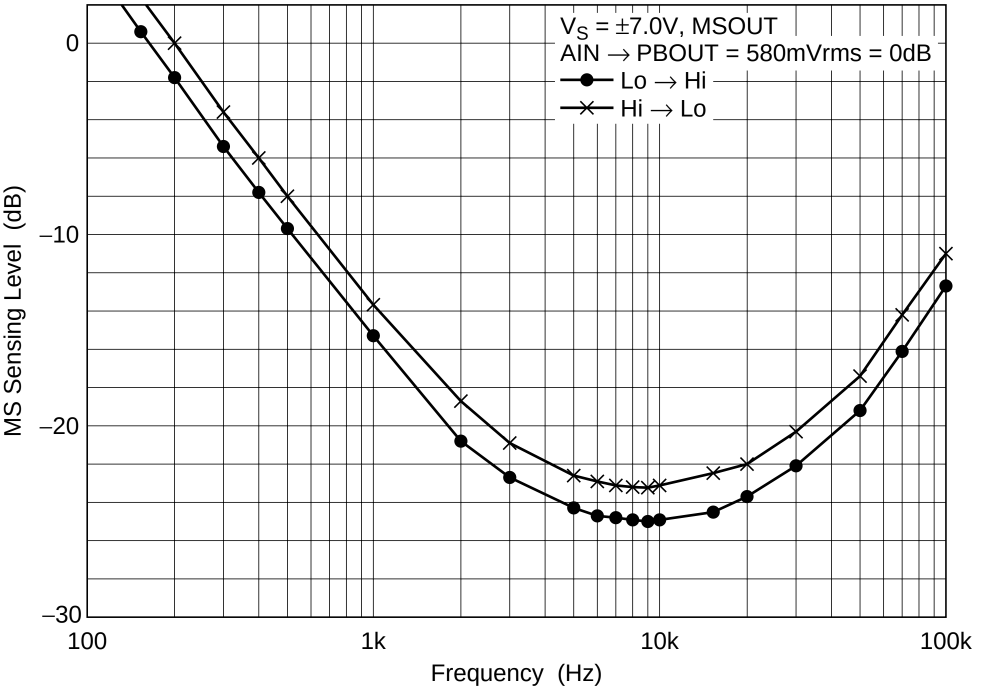
ALC Operate Level vs. Frequency

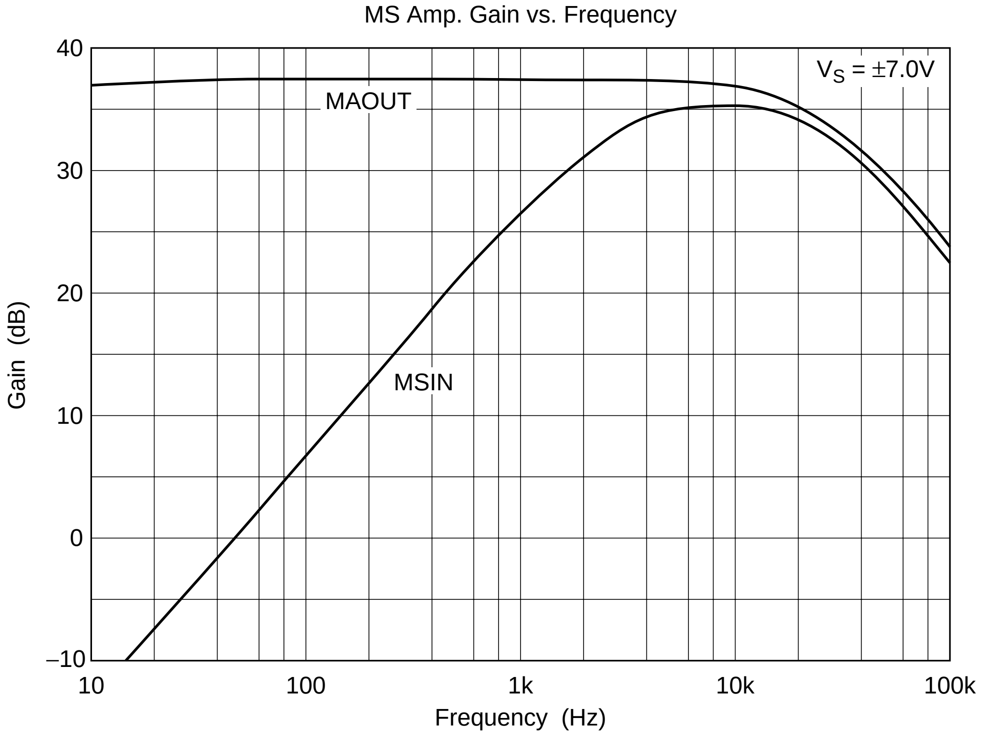


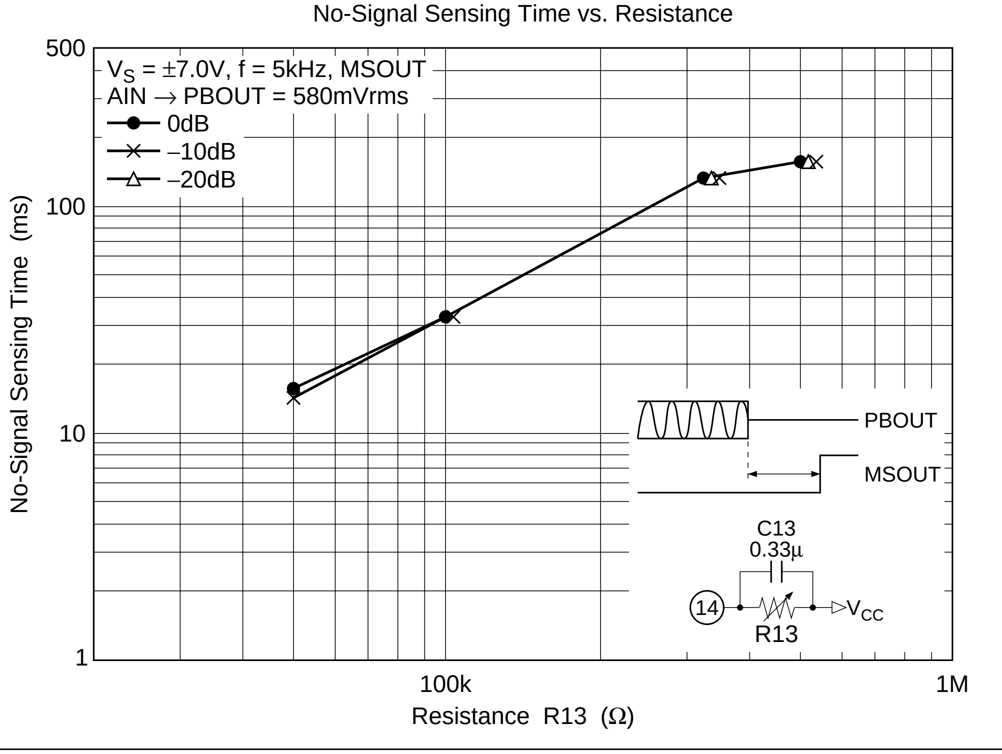
Bias Output Voltage vs. Load Current

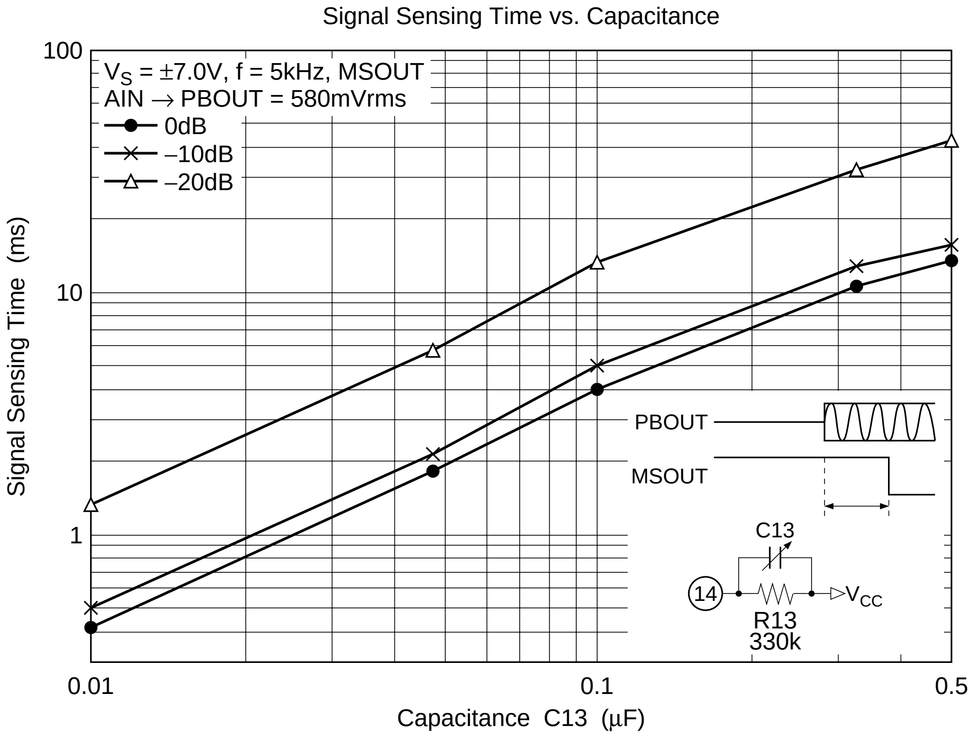


MS Sensing Level vs. Frequency

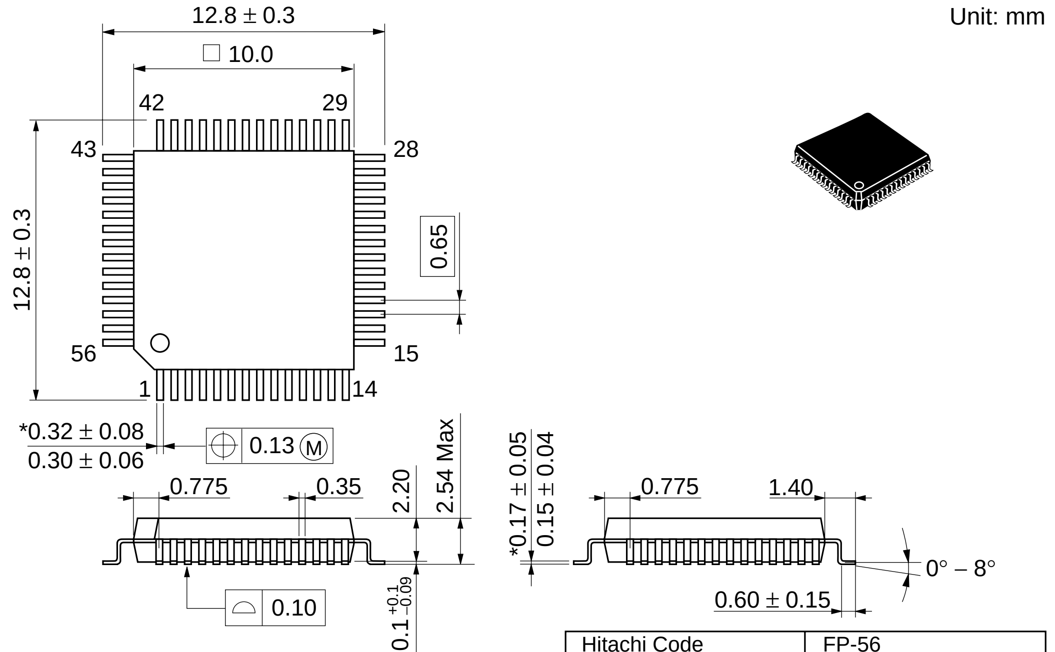



MS Amp. Gain vs. Frequency
VS = ±7.0V
MAOUT
MSIN
Gain (dB)
40
30
20
10
0
–10
10
100
1k
10k
100k
Frequency (Hz)


No-Signal Sensing Time vs. Resistance
VS = ±7.0V, f = 5kHz, MSOUT
AIN → PBOUT = 580mVrms
0dB
–10dB
–20dB
PBOUT
MSOUT
C13
0.33µ
14
VCC
R13
No-Signal Sensing Time (ms)
500
100
10
1
100k
1M
Resistance R13 (Ω)


Signal Sensing Time vs. Capacitance
VS = ±7.0V, f = 5kHz, MSOUT
AIN → PBOUT = 580mVrms
0dB
–10dB
–20dB
100
10
1
Signal Sensing Time (ms)
0.01
0.1
0.5
Capacitance C13 (µF)
PBOUT
MSOUT
C13
14
VCC
R13
330k

Package Dimensions



*Dimension including the plating thickness
Base material dimension

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

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