

DESCRIPTION

The CM6400 is an advanced highly-integrated single-chip USB audio solution designed for USB headsets and other audio applications. The CM6400 integrates a 5-band digital equalizer (EQ) processing unit with up-to-4 presets to fit different applications, or improve headphone SPL characteristics.

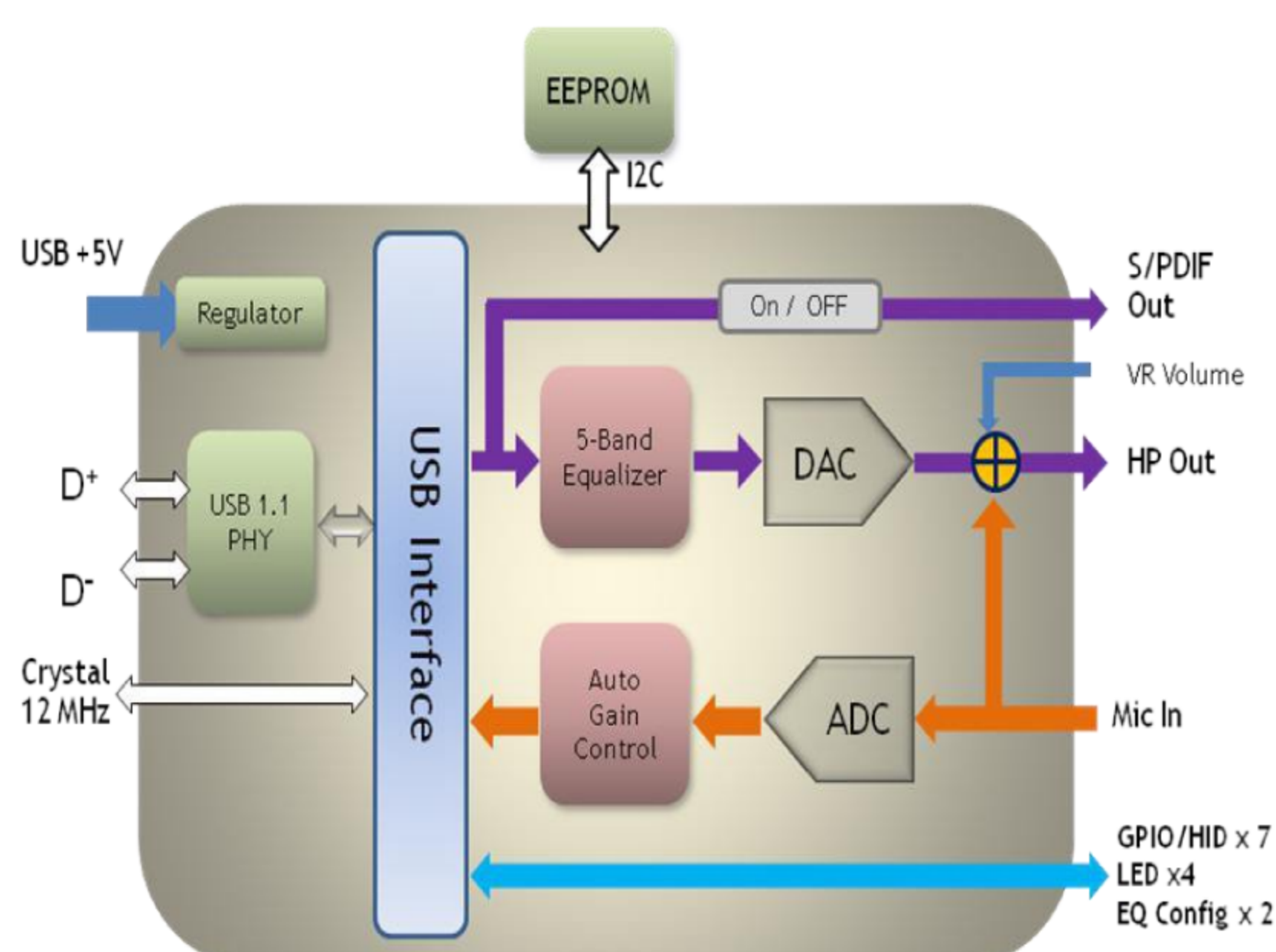
In addition, the CM6400 has embedded mic AGC (Auto-Gain-Control) and clipping-protection functionalities that automatically adjust the variant sound input scale to get rid of large signal clipping, and also to maintain a constant recording level when in use.

With outstanding SNR/THD audio performance that exceeds the WHQL standard, and with its versatile HW functions, the CM6400 is an ideal all-in-one USB headset chip that will allow you to further differentiate your product ideas.

FEATURE HIGHLIGHTS

- Integrated 5-band equalizer hardware with up to 4 preset modes (default/music, movies, gaming and communication) selected using 2 control pins. The gain value of each band can also be customized by EEPROM parameters.
- Built-in AGC (Automatic Gain Control) and clipping protection for microphone recording (enabled by EEPROM)
- Mic-IN signal clipping-detection LED indicator
- Multimedia Play-Pause/Stop/Next/Previous HID hot-key controls
- Supports a serial 24C02 EEPROM programming interface for customizing VID/PID/Product String/Manufacture String/Serial Number/Volume Range /Initial Volume/HID_Disable/EQ/AGC and other configurations
- Windows® VISTA Premium- & Windows® 7 Logo Program-compatible

BLOCK DIAGRAM



APPLICATIONS

- Value-added USB gaming headsets with optimized gaming audio EQ modes and mic AGC
- Value-added USB VOIP headsets/handsets with optimized communication EQ mode and mic AGC
- USB microphone recording chip with mic AGC and clipping-detection LED indicator
- USB audio dongles or docking station
- USB speakers with EQ features
- Game console headsets

NOTICES

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Revision Notes

Revision	Date	Description
0.90	2010/04/19	First formal release of product datasheet
0.95	2010/05/19	<ul style="list-style-type: none"> • Correct pin #1 POWSEL state definition and pull-up by default • Modify pin #41 DVSS to A-A Mixer_Enable configuration pin • Swap EQ_SEL0/1 pin values for movie and communication EQ presets
0.96	2010/06/07	<ul style="list-style-type: none"> • Add feature note: DAC will support only 48K & 44.1KHz when HW EQ is enabled • Add feature note: ADC default gain range in USB descriptors for mic-In is 0dB ~ +45dB (initial value= +30dB); DAC gain range 0 dB ~ -40dB (initial= -9dB); wide analog mixer gain range -30dB ~ +32dB (default range is -10dB ~ +22dB, initial value= 0dB, HW muted by default) • Remove adaptive synchronization mode
0.97.	2010/07/15	<ul style="list-style-type: none"> • Fixed USB bus-power mode and removed remote wakeup support • Configurable USB audio topologies • Added VR volume/regulator into block diagram • Updated power consumption data • Corrected AGC gain step to 1.5dB/step and GPIO to 7 pins • Updated HP/Line-out default gain range to max. 0dB; default mic-In gain range to min. 0dB in chapter 7.5 audio performance table • Audio performance data minor updates
1.0	2010/08/10	Added notes in analog performance Note 1 for capless HP-out design
1.01	2010/08/17	Corrected pin 14, pin 15 assignment wording
1.02	2010/10/08	<p>1. Corrected some typo in the datasheet:</p> <ul style="list-style-type: none"> • Corrected wrong EQ (1,0) value description for 2 presets in feature description: 11 for movies, 10 for communication (p.7) • Corrected wrong EQ selection pin value description for game mode (EQ_SEL1=0, EQ_SEL0=1) and communication mode (EQ_SEL1=1, EQ_SEL0=0) in 6.1.2 (p.18) • Modified pin#1 “dot” indicator in the pin-out diagram to match the real IC top marking and removed initial text “X” for some pin names (p.9) • Revised max. operating temp to 70°C (p.29) <p>2. Added EQ usage scenarios (p.17) and gain value description for each EQ preset mode (p.18)</p> <p>3. Added green package wording (p.8)</p>
1.03	2011/10/21	Add definition for VOLADJ setting
1.04	2012/05/18	<ul style="list-style-type: none"> • BInterval value changed from 1ms to 2m (p.17) • Update description on the behavior of AGC (p.20)
1.05	2012/11/02	<ul style="list-style-type: none"> • Reformat

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CM6400

USB Single-Chip Headset Audio Solution with 5-Band EQ DSP and Mic AGC



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1 Description and Overview

The CM6400 is a versatile USB single-chip audio solution specifically designed for USB headsets and other audio applications. All necessary analog and digital modules are embedded in the CM6400, including stereo DAC, 16/32-ohms headphone amplifier, capless HP-out, stereo ADC, microphone pre-amplifier, independent mic voltage bias, PLL, power regulator and USB transceiver modules. Moreover, the CM6400 has an integrated 5-band hardware digital equalizer (EQ) processing unit with 4 default preset modes (default/music, movies, gaming and communication).

Customers can also fully customize EQ preset parameters to compensate the SPL (Sound Pressure Level) performance over all in-band audio frequencies for their headphones. And with embedded mic AGC (Auto-Gain-Control) functionality, the CM6400 automatically adjust gains according to the variance in input signals to avoid large signal clipping caused by environmental noises, acoustics echo or loud speaking voices. This helps maintain a constant and comfortable recording-level range during recording and verbal communication. In addition, the clipping-detection LED indicator alerts users when there is feedback from over-volume sound inputs while recording.

The CM6400 supports standard HID-compliant volume control and playback control pins, including Play-Pause/ Stop/Previous/Next hot-key buttons. It also provides an analog DC VR volume control option. The CM6400 complies with Windows® Vista/7 WHQL logo program audio quality and stereo mic requirements, and delivers ≥ 96 dB signal-to-noise ratio high-quality audio for both DAC and ADC. Both the DAC and ADC support 16-bit resolution and variant 48KHz, 44.1KHz, 32KHz, 22.05KHz, 16KHz, 11.025KHz, 8KHz sampling rates.

2 Features

USB Compliance

- USB specification 2.0 full speed-compliant and USB-IF-certified
- USB audio device class specification 1.0-compliant
- USB HID device class specification 1.1-compliant

Architecture

- Supports control/interrupt/isochroous data transfers
- USB suspend/resume support
- Embedded USB transceiver and power-on reset circuit
- Single 12MHz crystal input with on-chip PLL
- Supports USB audio control, isochroous-out, isochroous-in and interrupt-in endpoints
- Serial 24C02 EEPROM programming interface supported for customizing VID/PID/Product String/Manufacture String/Serial Number/Volume Range/Initial Volume/HID_Disable/EQ/AGC and other configurations
- Integrates a 5-band hardware equalizer with up to 4 preset modes (00_Default/Music, 11_Movies, 01_Gaming, 10_Communication) selectable by 2 HW control pins. The gain value of each band can be customized using EEPROM parameters (center frequency and bandwidth can also be changed when using one EQ preset mode)
- Built-in AGC (Automatic Gain Control) for microphone recording (enabled by EEPROM)
- Playback soft-mute/zero-cross function
- MCU/EEPROM/GPIO control via HID/vender command interface, with 16-byte data transfer bandwidth for MCU read/write support)
- Supports up to 7 GPIO pins, configured by EEPROM
- Embedded power-on-reset block
- USB bus-power mode with high-power (500mA) and low-power (100mA, default) mode options, selectable by external selection pin
- Single 5V power supply with embedded 5V-to-4.5V and 5V-to-3.3V regulators

Audio I/O

- Two-channel DAC output with 16-ohm headphone amplifier that supports 16-bit resolution and 48KHz, 44.1KHz, 32KHz, 22.05KHz, 16KHz, 11.025KHz, 8KHz sampling rates (only 48K & 44.1KHz are available)

when EQ function is enabled)

- Two-channel ADC input supports 16-bit resolution and 48KHz, 44.1KHz, 32KHz, 22.05KHz, 16KHz, 11.025KHz, and 8KHz sampling rates (only 48K & 44.1KHz are available when EQ function is enabled)
- Supports stereo mic input with independent voltage bias pins and analog mixer (monitoring) function
- Supports DC/ADC offset cancellation high-pass filter
- Supports optional digital S/PDIF output (up to 48KHz/16bit) compatible with AES/EBU IEC-60958 specifications (default on, but not reported in USB audio descriptor)
- Wide mic-In ADC gain range from -12dB to +45dB for microphone pre-amp (default reported range is 0dB ~ +45dB, initial value= +30dB)
- DAC gain range 0 dB ~ -40dB (initial= -9dB)
- Wide analog mixer gain range -30dB ~ +32dB (default range is -10dB ~ +22dB, initial value= 0dB, HW muted by default). Analog mixer could be enabled/disabled by pin #41 MIXER_EN.
- Configurable USB audio topology to headset/speaker/microphone modes by EEPROM
- Adaptive synchronization mode for microphone-only mode

Control Interface

- Featuring Microsoft® HID controls including Vol_Up/Vol_Dn/Playback_Mute/Record_Mute/Play_Pause/Stop /Previous/Next hot-key buttons (enabled by default)
- Optional analog DC VR volume control pin with internal ADC potentiometer
- I2C master/slave mode control interface
- Supports 4 LED indicator control pins: Operation status/Playback_Mute/Recording_Mute (enabled by default)/Mic clipping-detection (enabled by EEPROM)

General

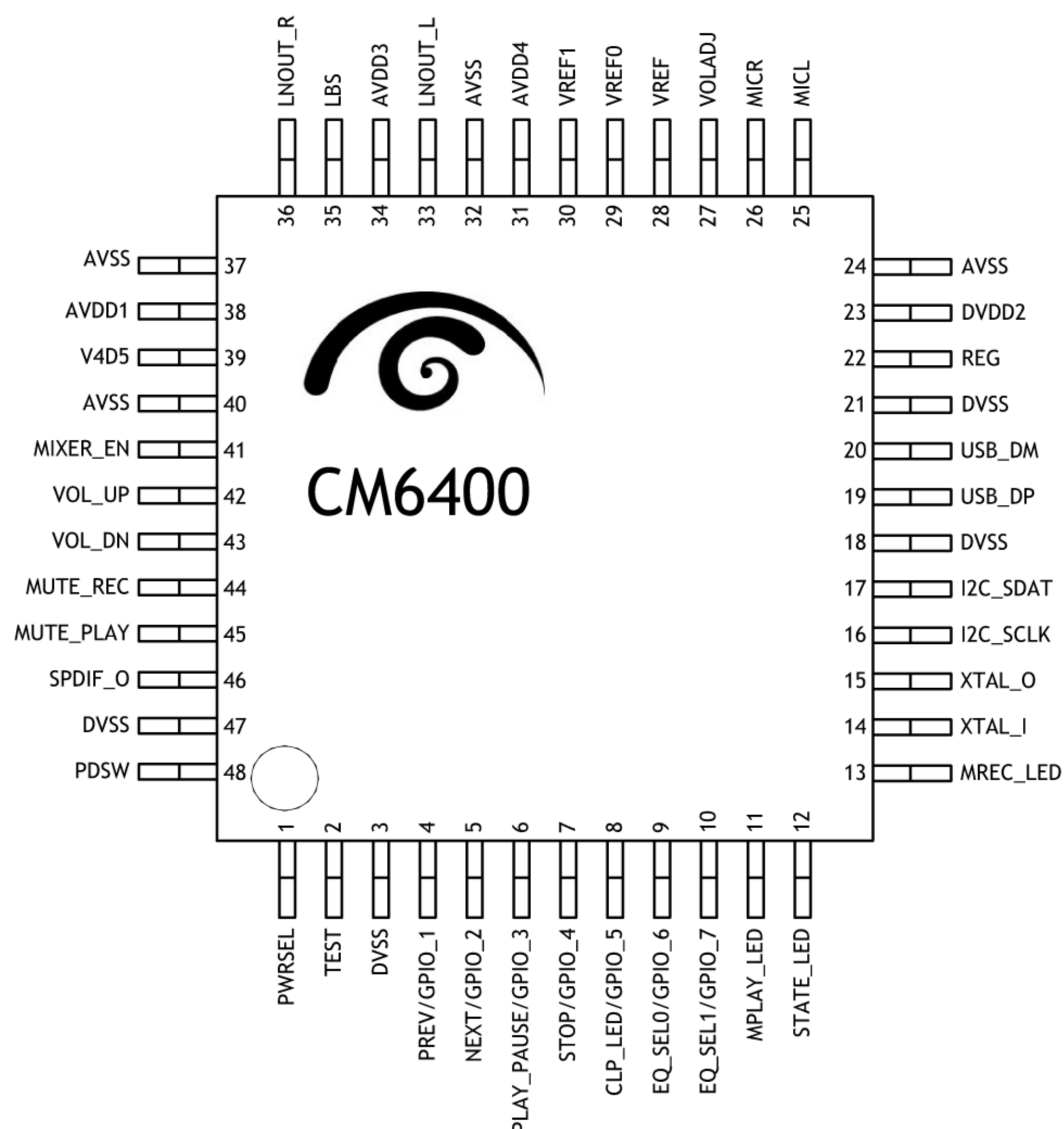
- Industry-standard small-footprint LQFP-48 green package
- Plug & Play on Windows® XP/Vista/7, and Mac® OS X and Linux supports the standard USB audio class 1.0 device driver
- Windows® VISTA Premium/Windows® 7 Logo Program

3 Pin Assignment

3.1 Pin Assignment by Pin Number

Pin #	Signal Name	Pin #	Signal Name	Pin #	Signal Name	Pin #	Signal Name
1	PWRSEL	13	MREC_LED	25	MICL	37	AVSS
2	TEST	14	XTAL_I	26	MICR	38	AVDD1
3	DVSS	15	XTAL_O	27	VOLADJ	39	V4D5
4	PREV / GPIO_1	16	I2C_SCLK	28	VREF	40	AVSS
5	NEXT / GPIO_2	17	I2C_SDAT	29	VREF0	41	MIXER_EN
6	PLAY_PAUSE / GPIO_3	18	DVSS	30	VREF1	42	VOL_UP
7	STOP / GPIO_4	19	USB_DP	31	AVDD4	43	VOL_DN
8	CLP_LED / GPIO_5	20	USB_DM	32	AVSS	44	MUTE_REC
9	EQ_SELO / GPIO_6	21	DVSS	33	LNOUT_L	45	MUTE_PLAY
10	EQ_SEL1 / GPIO_7	22	REG	34	AVDD3	46	SPDIF_O
11	MPLAY_LED	23	DVDD2	35	LBS	47	DVSS
12	STATE_LED	24	AVSS	36	LNOUT_R	48	PDSW

3.2 Pin-Out Diagram



Pin Assignments (Top View, LQFP-48 7mm x7mm, Green Package)

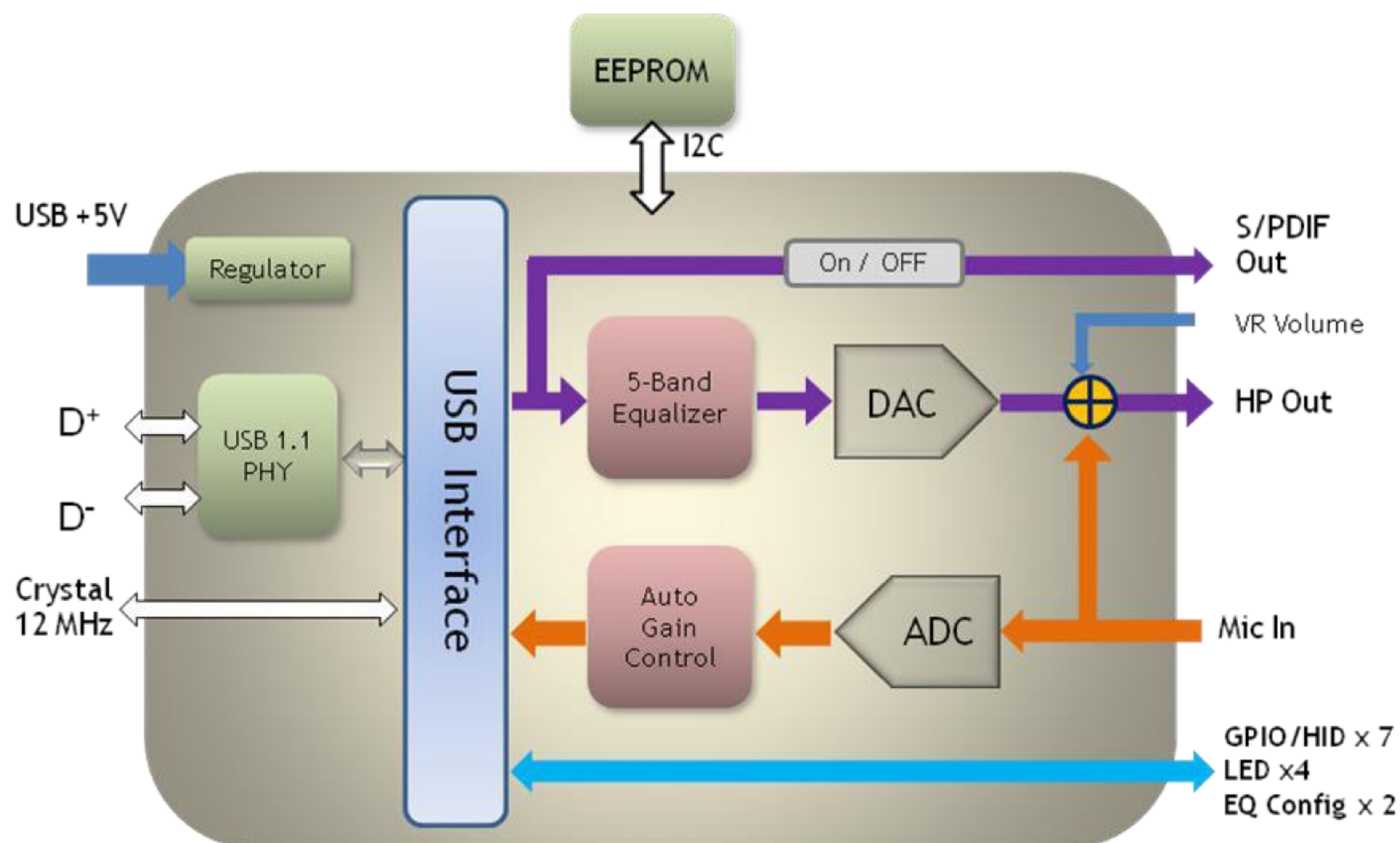
3.3 Pin Descriptions

Pin #	Symbol	Type	Description
1	PWRSEL	DI, PU	Power consumption selector 0: 500mA/1: 100mA
2	TEST	DI, PD	Test mode enable
3	DVSS	VSS	Digital circuit ground
4	PREV / GPIO_1	DI, PU	USB HID previous track button General purpose input/output
5	NEXT / GPIO_2	DI, PU	USB HID next track button General purpose input/output
6	PLAY_PAUSE / GPIO_3	DI, PU	USB HID play/pause button General purpose input/output
7	STOP / GPIO_4	DI, PU	USB HID stop button General purpose input/output
8	CLP_LED / GPIO_5	DI, PU	Mic recording signal LED clipping indicator General purpose input/output
9	EQ_SEL0 / GPIO_6	DI, PU	EQ mode select pin 0 (4 modes); pull-down=0, pull-up=1 General purpose input/output
10	EQ_SEL1 / GPIO_7	DI, PU	EQ mode select pin 1 (4 modes); pull-down=0, pull-up=1 General purpose input/output
11	MPLAY_LED	DO	Mute playback LED
12	STATE_LED	DO	USB config./playback/record operation status indicator (Device ready= ON, playback/record= flashing)
13	MREC_LED	DO	Mute record LED
14	XTAL_I	AI	12MHz crystal input
15	XTAL_O	AO	12MHz crystal output
16	I2C_SCLK	DIO, OD	2-wire (I2C) interface: clock
17	I2C_SDAT	DIO, OD	2-wire (I2C) interface: data
18	DVSS	VSS	Digital circuit ground
19	USB_DP	AIO	USB 1.1 PHY differential signal DP
20	USB_DM	AIO	USB 1.1 PHY differential signal DM
21	DVSS	VSS	Digital circuit ground
22	REG	VDD	3.3V regulator output, connected to bulk capacitor

23	DVDD2	VDD	Digital circuit power
24	AVSS	VSS	Analog circuit ground
25	MICL	AI	Microphone input: left channel
26	MICR	AI	Microphone input: right channel
27	VOLADJ	AI	Adjustable resistor for DAC volume control Minimal 2.25V(-42dB); Maximum 0V (0dB)
28	VREF	AO	Analog circuit voltage reference
29	VREF0	AO	Microphone bias: left channel
30	VREF1	AO	Microphone bias: right channel
31	AVDD4	VDD	Analog circuit power
32	AVSS	VDD	Analog circuit ground
33	LNOUT_L	AO	Line-out/HP-out: left channel
34	AVDD3	VDD	Analog circuit power
35	LBS	AO	Common mode output for cap-less line-out
36	LNOUT_R	AO	Line-out/HP-out: Right channel
37	AVSS	VSS	Analog circuit ground
38	AVDD1	VDD	Analog circuit power
39	V4D5	AO	4.5V regulator output, connected to bulk capacitor
40	AVSS	VSS	Analog circuit ground
41	MIXER_EN	DI_PU	Analog mixer disable/enable pin for monitoring input to output (0: Disable, 1: Enable)
42	VOL_UP	DI, PU	USB HID volume up button
43	VOL_DN	DI, PU	USB HID volume down button
44	MUTE_REC	DI, PU	USB HID mute record button
45	MUTE_PLAY	DI, PU	USB HID mute playback button
46	SPDIF_O	DO	S/PDIF output
47	DVSS	VSS	Digital circuit ground
48	PDSW	DO, OD	Power down output control pin, active high

Notes: DI/DO/DIO - Digital Input/Output/Bi-Directional Pad
 AI/AO/AIO - Analog Input/ Output/Bi-Directional Pad
 SR - Slew Rate Control
 ST - Schmitt Trigger
 PD/PU - Pull Down/Pull Up
 5VT - 5 Volt Tolerant (3.3V Pad)
 OD - Open Drain

4 Block Diagram



CM6400 Block Diagram

7 Electrical Characteristics

7.1 Absolute Maximum Rating

Parameter	Symbol	Min	Typ	Max	Units
Storage temperature	-	-25	-	+120	°C
Operating ambient temperature	-	-15	25	70	°C
Digital supply voltage(DVDD)	-	4.5	5.0	5.5	V
Analog supply voltage(AVDD)	-	4.5	5.0	5.5	V
I/O Pin voltage	-	GND	-	V _{DD}	V
ESD (human body mode)	-	-	±4000	-	V
ESD (machine mode)	-	-	±200	-	V

7.2 Recommended Operating Conditions

Operation conditions				
	Min	Typ	Max	Unit
Analog supply voltage	-	5.0	-	V
Digital supply voltage	-	5.0	-	V
Operating ambient temperature	-	25	-	°C
Crystal clock	-	12.000	-	MHz

7.3 Power Consumption

Test Conditions: AVDD/DVDD = 5.0V, DGND =0V, Sample Rate=48KHz, 16Bit, TA=+25°C, Operation: HP-Out Playback + Mic-In Recording + EQ enabled, SPDIF-Out disabled

Power Consumption				
	Min	Typ	Max	Unit
Total power consumption (Playback + Record + EQ)	-	67		mA
Standby power consumption	-	67	-	mA
Suspend mode power consumption	-	890	-	uA

7.4 DC Characteristics

DC Characteristics					
Parameter	Symbol	Min	Typ	Max	Units
Input voltage range	V _{in}	-0.3	V _{DD}	V _{DD} +0.3	V
Output voltage range	V _{out}	0	-	V _{DD}	V
High level input voltage	V _{ih}	0.7V _{DD}	-	-	V
Low level input voltage	V _{il}	-	-	0.3V _{DD}	V
High level output voltage	V _{oh}	TBD	-	V _{DD}	V
Low level output voltage	V _{ol}	0	-	0.4	V
Input leakage current	I _{il}	-10	-	10	uA
Output leakage current	I _{ol}	-10	-	10	uA
Output buffer driver current	-	-	8	-	mA
SPDIF transmit output driver current	-	-	8	-	mA

7.5 Audio Performance

Test Item	Min	Typ	Max	Unit
DAC (10K Ohm Line Loading)				
Resolution	-	16	-	Bits
THD + N (20~20KHz)	-91	-88	-86	dB
SNR	-	100	-	dB
Dynamic range	-	98	-	dB
Frequency response 4KHz	<20	-	>20K	Hz
Frequency response 44.1KHz	<20	-	>20K	Hz
Passband ripple (p-p)	-	0.276	-	dB
Line-out cross talk (20~20KHz)	-115	-110	-100	dB
Interchannel phase delay (20~20KHz)	-1.22deg	-	+0.012deg	degree
Full-scale output voltage (rms)	-	1.35	-	Vrms
DAC (32 Ohm Headphone Loading + Cascaded 27 ohms in line)				
Resolution	-	16	-	Bits
THD + N (20~20KHz)	-91	-72	-	dB
SNR	-	100	-	dB
Dynamic range	-	98	-	dB
Frequency response 48KHz	20	-	>20K	Hz
Frequency response 44.1KHz	20	-	>20K	Hz
Passband ripple (p-p)	-	0.286	-	dB
Interchannel phase delay (20~20KHz)	-0.05deg	-	+0.15deg	degree
Full-scale output voltage (rms)	-	0.73 ¹	-	Vrms
ADC				
Resolution	-	16	-	bit
THD + N (20~20KHz)	-90	-86	-	dB
SNR	-	96	-	dB
Dynamic range	-	96	-	dB
Frequency response 48KHz	<20	-	>20K	Hz
Frequency response 44.1KHz	<20	-	>20K	Hz
Passband ripple (p-p)	-	-	0.043	dB
Full-scale input voltage (rms)	-	1.233	-	Vrms
Headphone/Line-Out Gain				
Volume control level	-40	-	0 ²	dB
Volume control step	-	1	-	dB/Steps
Microphone Input Gain				
ADC gain adjustment range	0 ²	-	+45	dB
ADC gain adjustment steps	-	1.5 ³	-	dB/Step

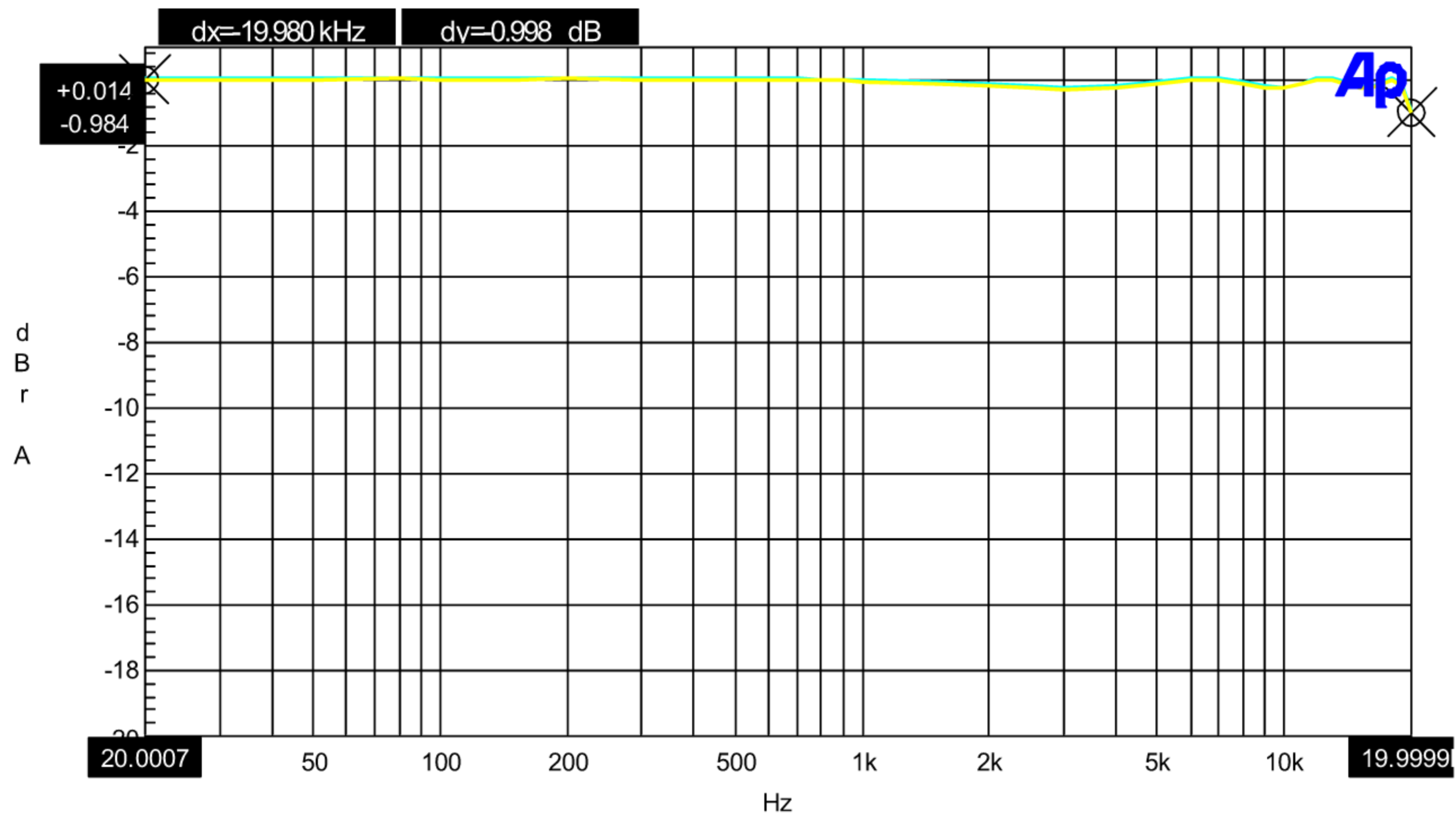
Mixer gain adjustment	-10	-	+22 ²	dB
Mixer gain adjustment steps	-	1.0	-	dB/Step

- Notes:
1. It's recommended to at least cascade 27-ohms resistors on HP output circuit pathes for typical 32ohms load headphone to avoid over-driving and keep comfortable sound pressure. The resistor value should be carefully selected by customers depending on the headphone driver's impedance and sensitivity. Without 27-ohms, the full-scale output will be 1.3Vrms. For Capless headphone design, 75-ohms resistors are recommended for better cross-talk and coupling capacitors should be replaced by 0-ohms resistors for shorting.
 2. All these are reported gain range by default
 3. The real hardware gain step for ADC is 1.5dB though the reported gain step to the host system is 1.0dB

7.5.1 Line-Out Freq Response @ 48KHz Sample Rate (10K Ohm Loading)

Audio Precision

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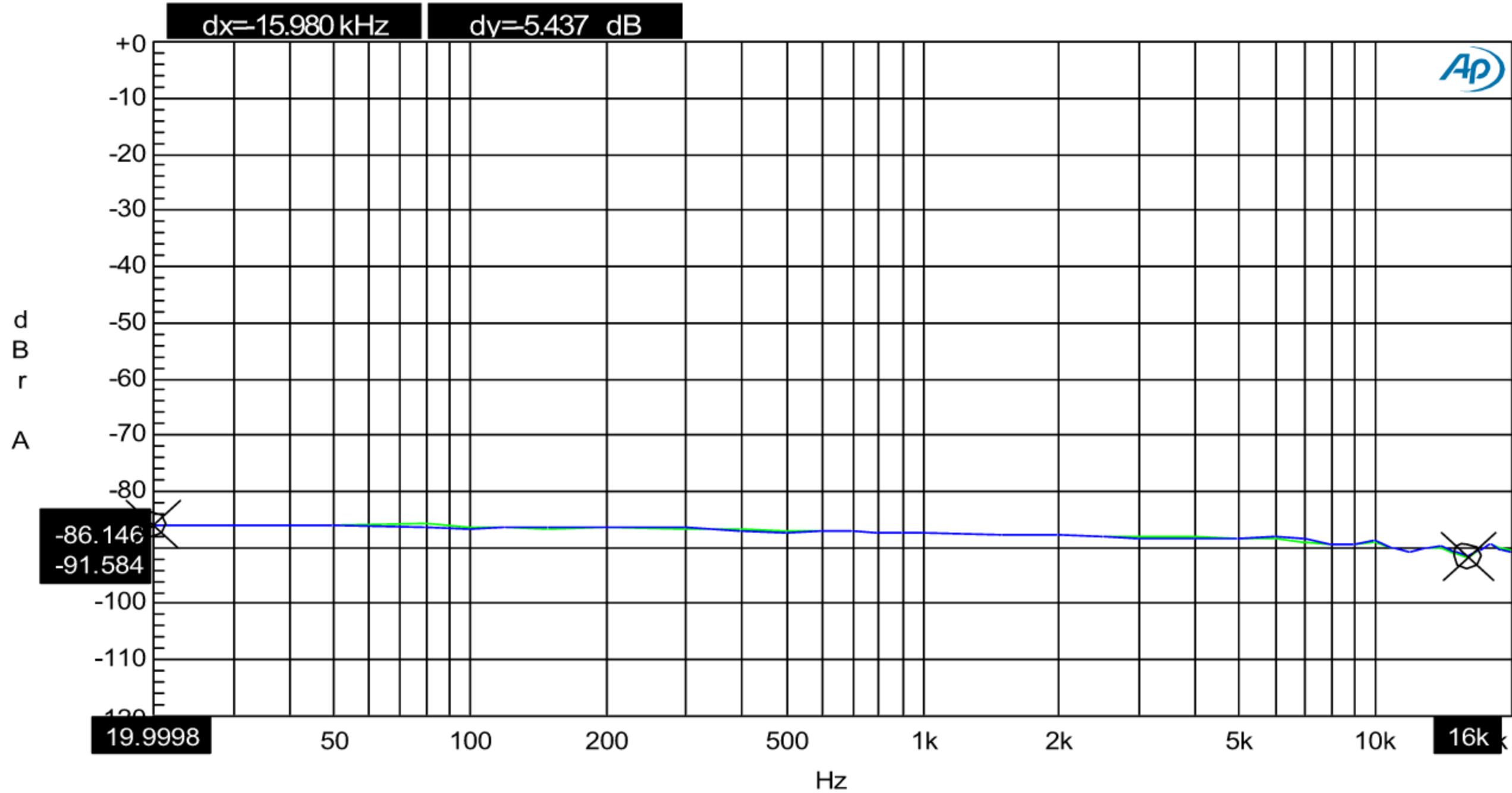
Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment	Cursor1	Cursor2
1	1	Cyan	Solid	2	Anlr.Ampl	Left		-0.937 dBr A	+0.056 dBr A
1	2	Yellow	Solid	2	Anlr.Ampl	Left		*-0.984 dBr A	*+0.014 dBr A

Vista-D-AFR+PR.at27

7.5.2 Line-Out THD+N @ 48KHz sample rate (10K Ohm Loading)

Audio Precision

07/06/10 12:23:59



Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment	Cursor1
1	1	Blue	Solid	1	Anlr.THd+N Ampl	Left		*-91.584 dBr
1	2	Green	Solid	1	Anlr.THd+N Ampl	Left		-91.643 dBr A

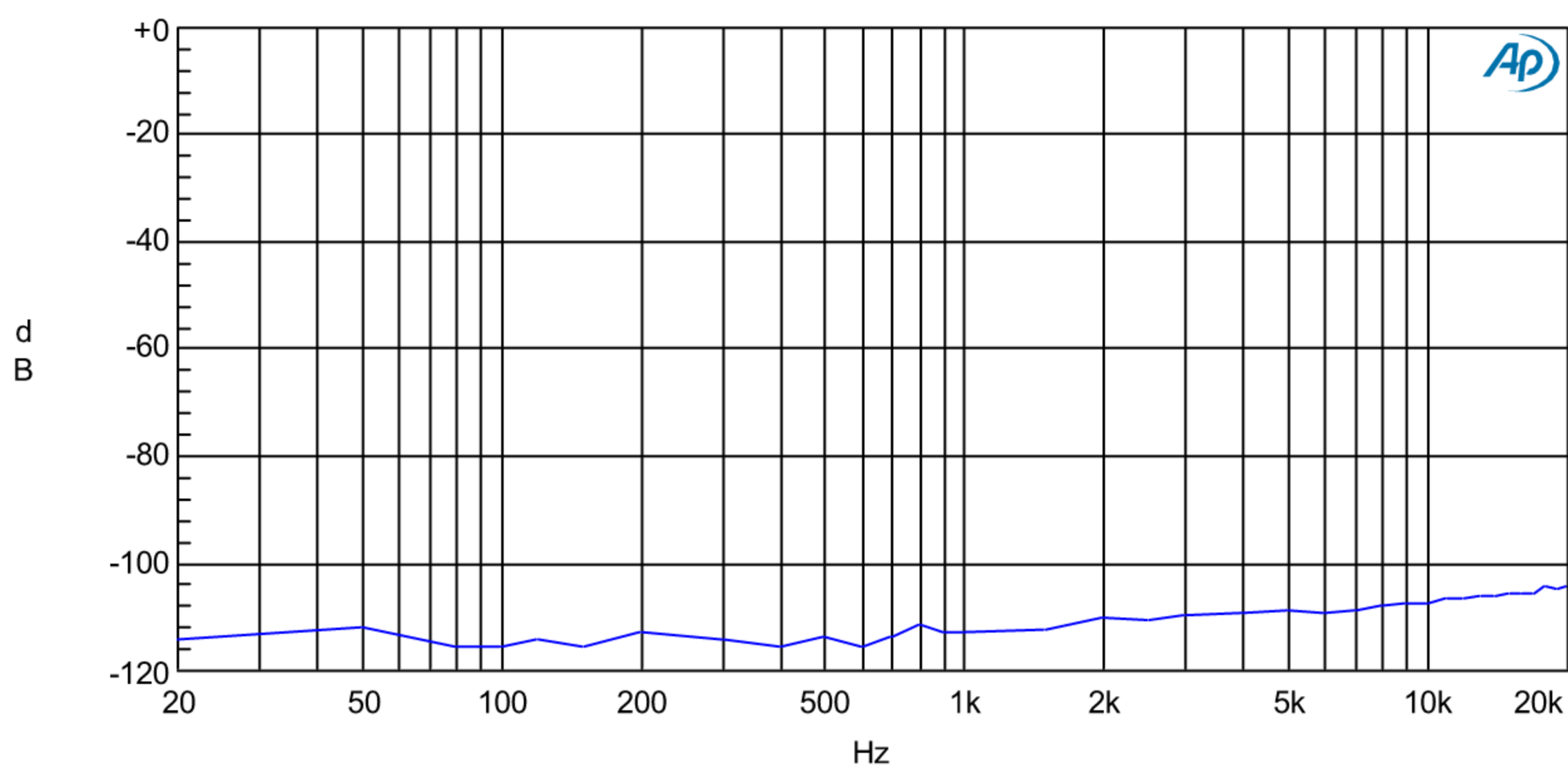
Vista-D-A THD+N.at27

7.5.3 Line-Out Cross-Talk @ 48KHz sample rate (10K Ohm Loading)

Cross-Talk L

Audio Precision

07/06/10 12:28:08



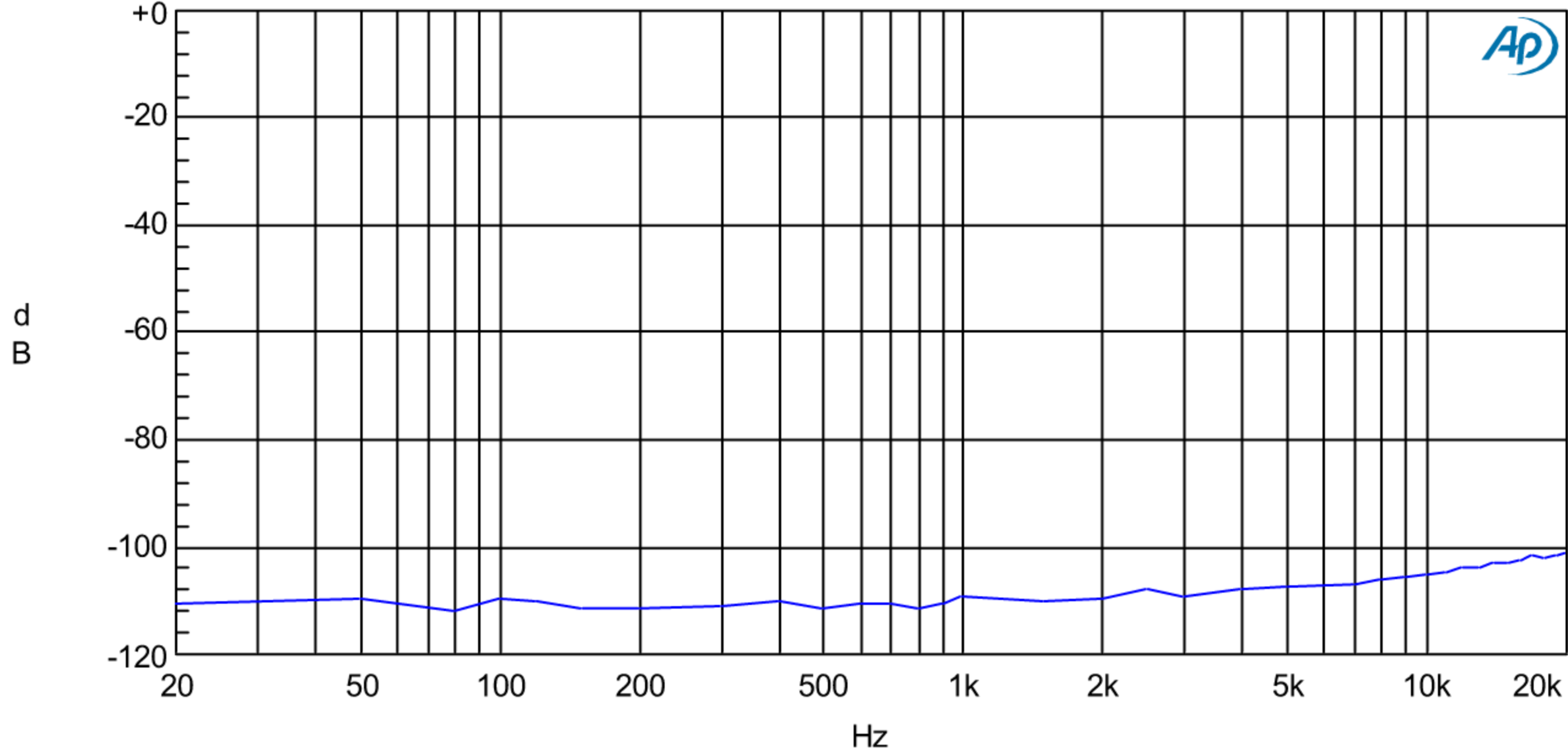
Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment
1	1	Blue	Solid	1	Anlr.Crosstalk	Left	

Vista-D-A-Crosstalk-L.at27

Cross-Talk R

Audio Precision

07/06/10 14:26:00



Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment
1	1	Blue	Solid	1	Anlr.Crosstalk	Left	

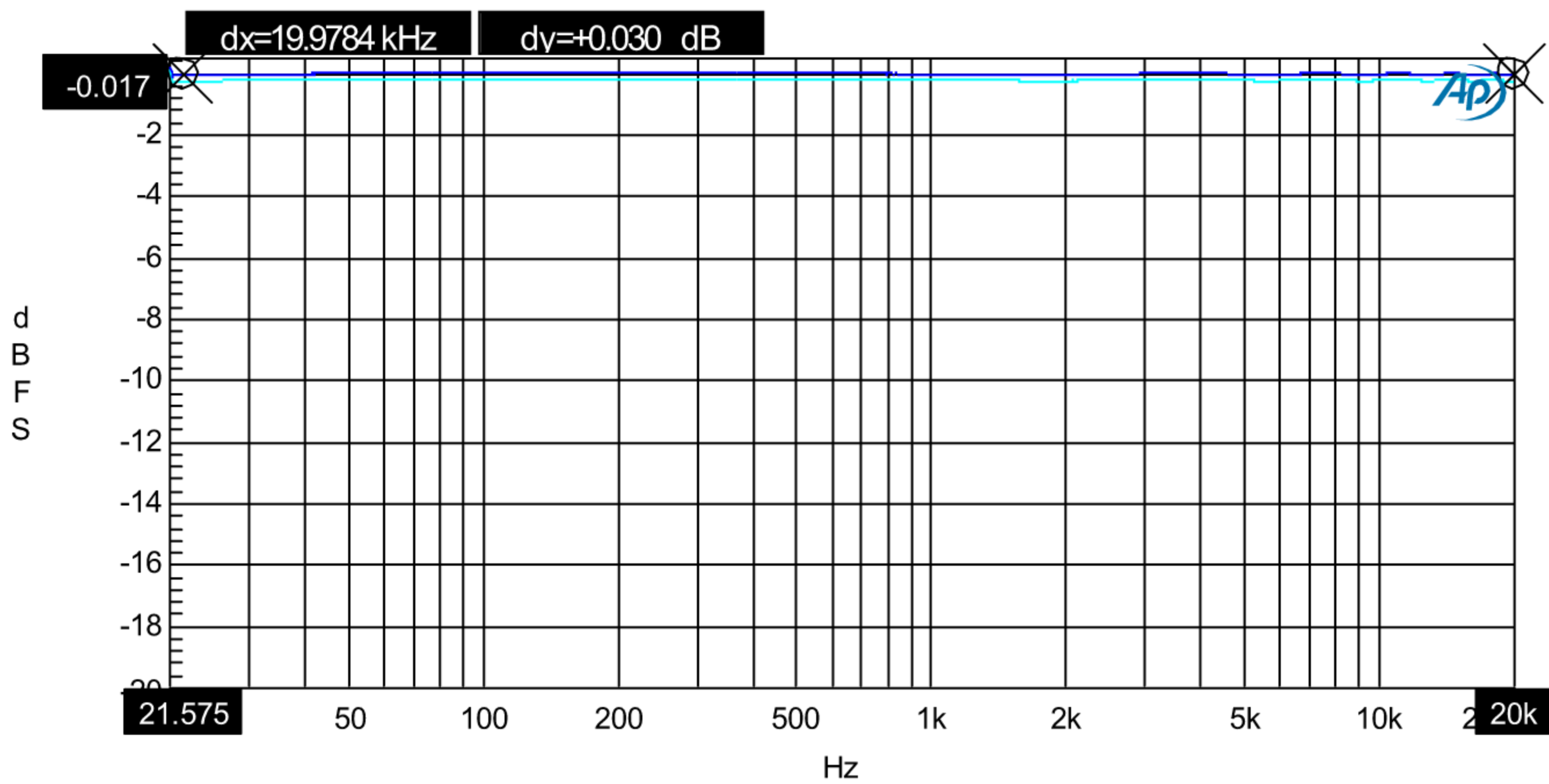
Vista-D-A Crosstalk-R.at27

7.5.4 Microphone Input Freq Response @ 48KHz Sample Rate

Audio Precision

A-D FREQUENCY RESPONSE

07/06/10 17:47:19



Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment	Cursor1
1	1	Blue	Solid	1	DSP Anlr.Level A	Left		*-0.047 dBFS
1	2	Cyan	Solid	1	DSP Anlr.Level B	Left		-0.248 dBFS

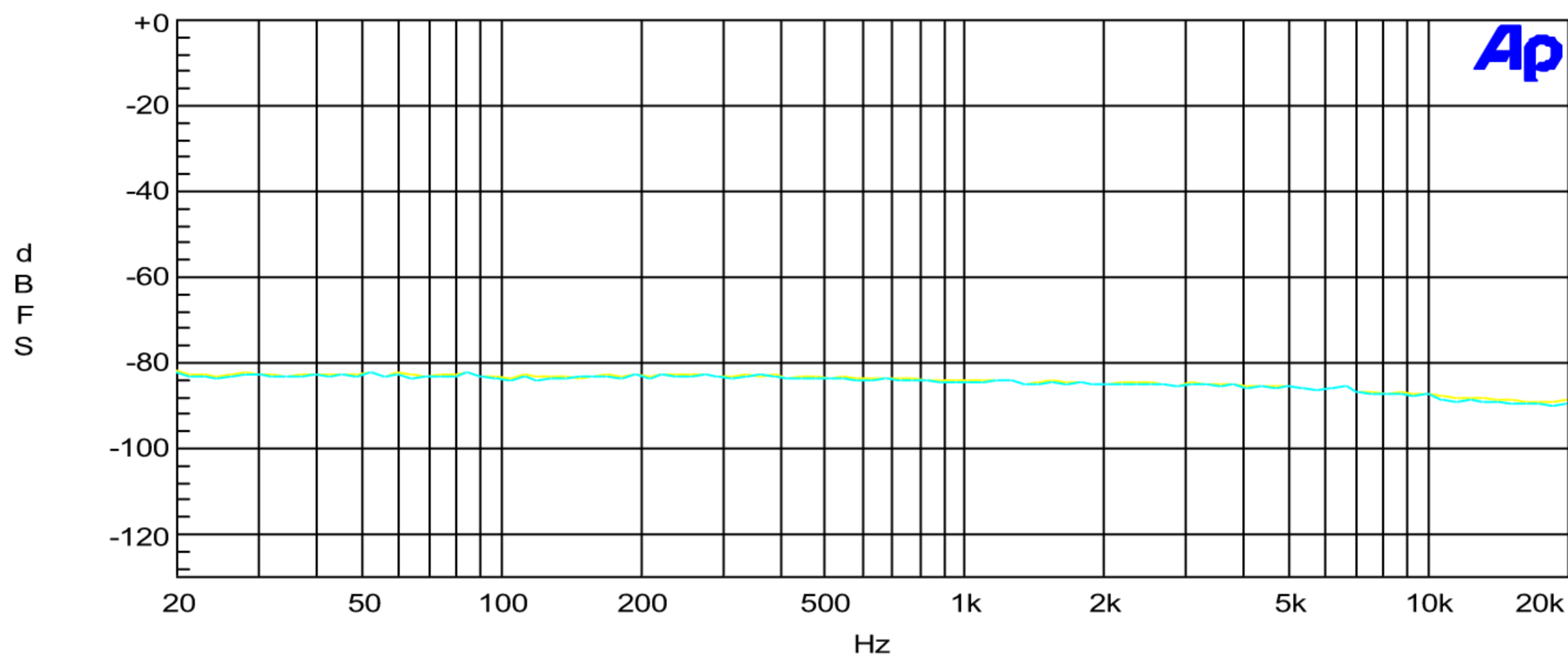
Vista-A-D Frequency Response.at2c

7.5.5 Microphone Input THD+N @ 48KHz Sample Rate

Audio Precision

A-D THD+N vs FREQUENCY

04/07/10 12:11:37



Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment
1	1	Yellow	Solid	1	DSP Anlr.TH+D+N Ampl A	Left	
1	2	Cyan	Solid	1	DSP Anlr.TH+D+N Ampl B	Left	

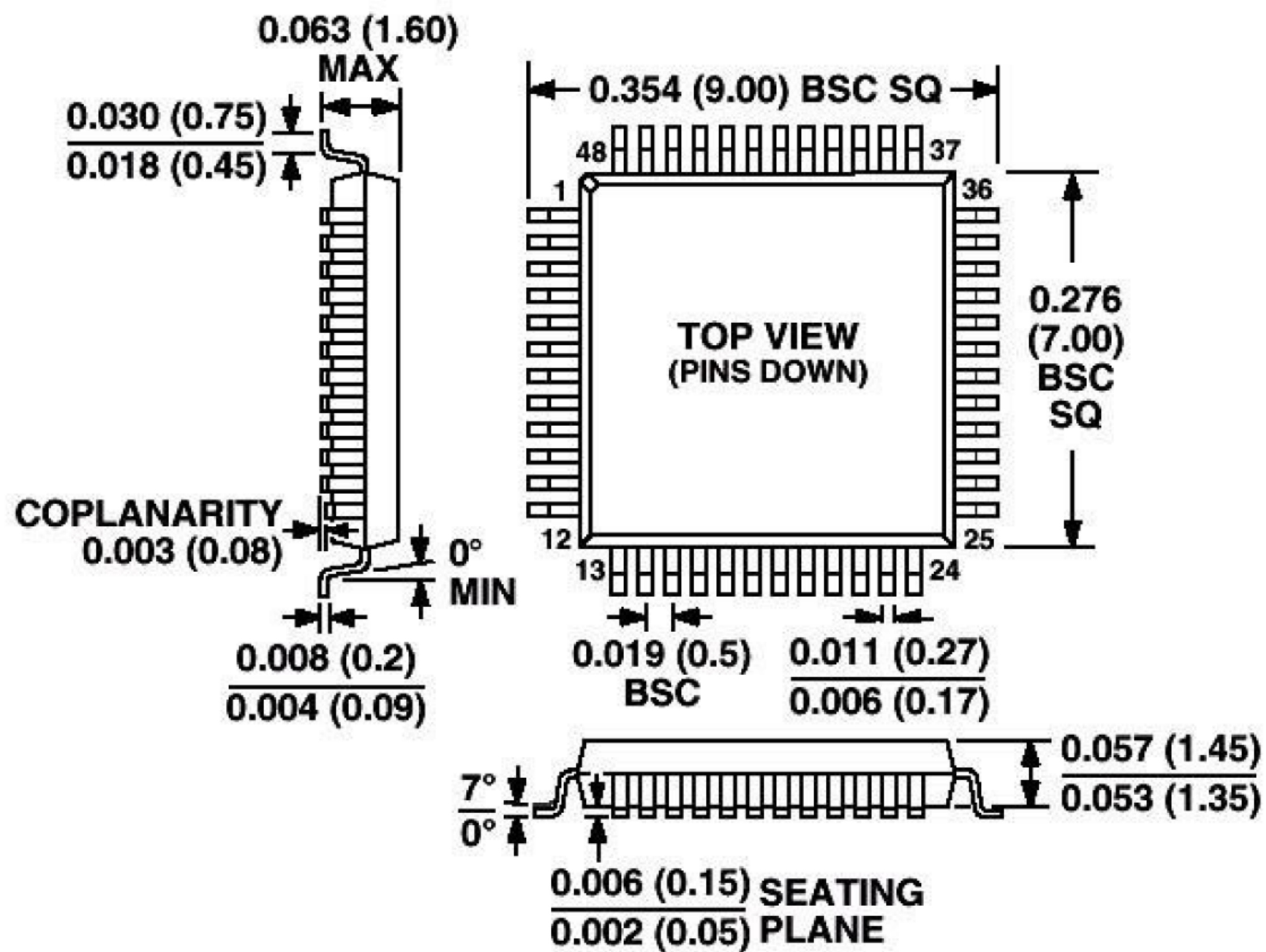
Vista-A-D THD+N.at2c

8 Package Dimensions

Model Number	Package	Operating Ambient Temperature	Supply Range
CM6400	48-Pin LQFP, 7mm × 7mm × 1.4mm (plastic)	-15°C to +70°C	DVdd = 5V, AVdd = 5V

Note: Outline dimensions are shown in inches and millimeters

48-Lead Thin Plastic Quad Flatpack (LQFP)



CM6400 Package Dimensions

Reference

- USB specification 2.0-compliant
- USB audio device class definition, version 1.0-compliant
- USB device human interface device class definition, version 1.11-compliant

— End of Specifications —

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