AKD4452-SA
AK4452 Sound Quality Evaluation Board Rev.1

GENERAL DESCRIPTION

The AKD4452-SA is an evaluation board for the AK4452 (32-bit 2ch DAC) that supports AV-Receiver, DVD-Audios, Car-Audio Systems. It integrates differential output low pass filters, allowing quick evaluation with digital audio interface.

■ **Ordering guide**

AKD4452-SA --- Evaluation board for AK4452
（Control software is packed with this board）

FUNCTION

□ **3 type digital audio interface**
- **Optical input**
- **COAX input**
- **External input**

□ **Low Pass Filters (LPF) for Pre-amplifier Outputs**

□ 2**ch Analog outputs**

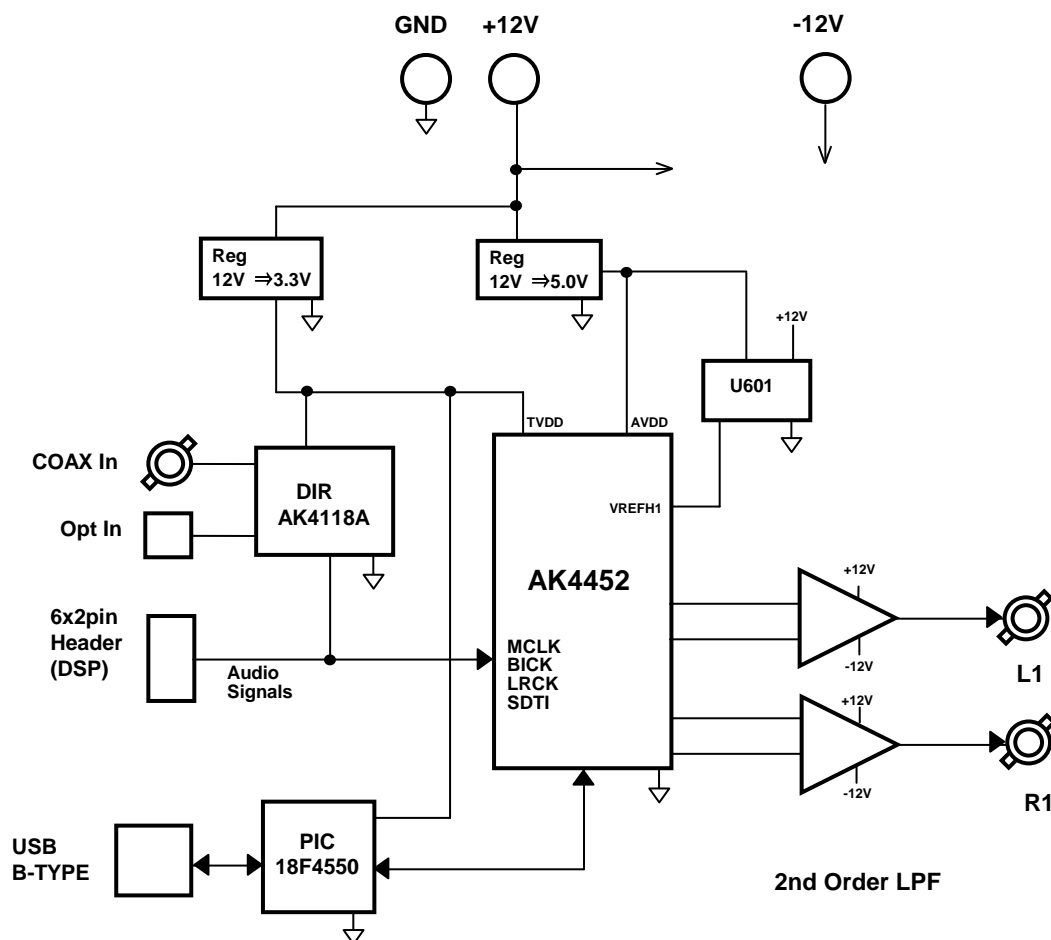□ **USB Port for Serial control**

Figure 1.AKD4452-SA Block Diagram
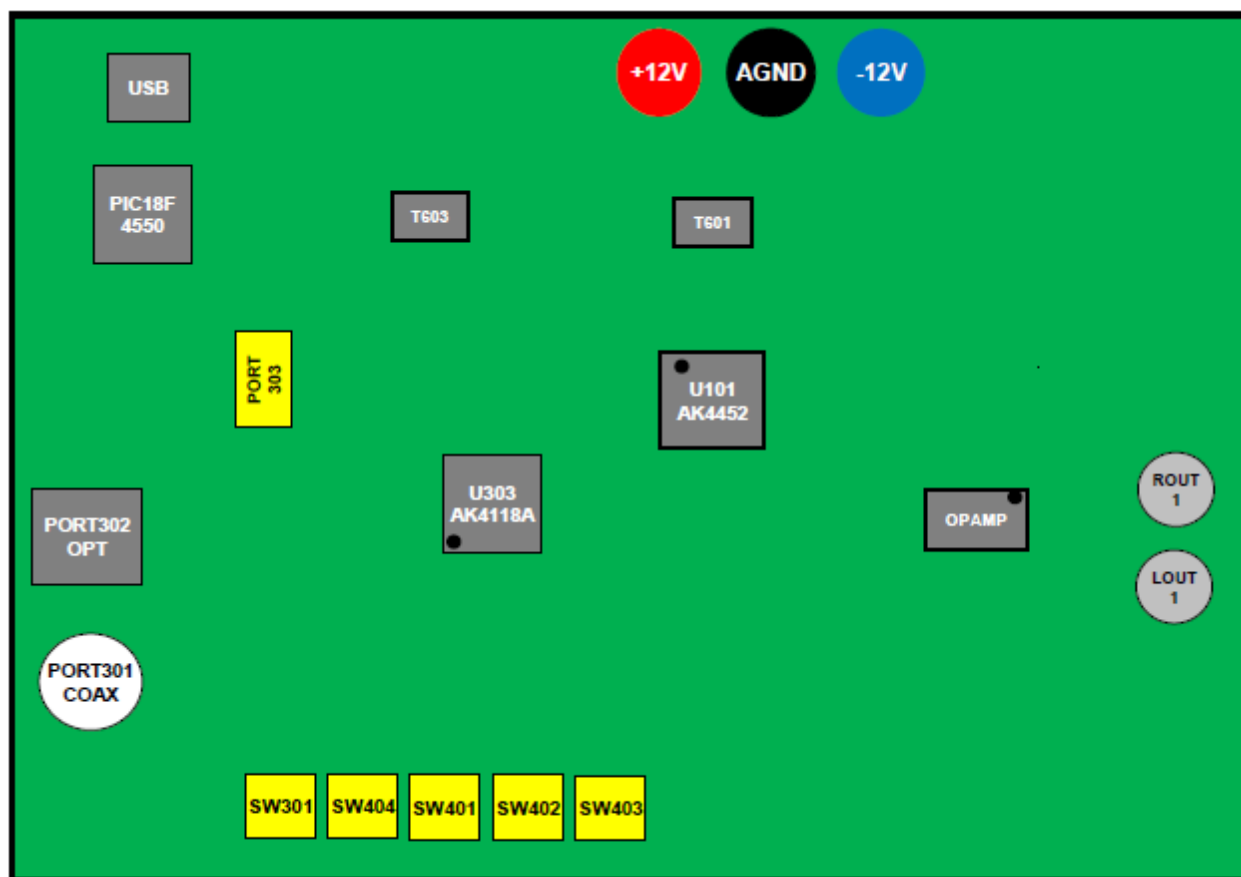
Board Diagram

■ **Board Diagram**

Figure 2.AKD4452-SA Board Diagram

■ **Description**

(1) Connector for Power supply
+12V、-12V、GND
Terminals for power supply. Refer to Table1.

(2) AOUTL1/AOUTR1
RCA Jack for analog outputs.

(3) COAX、OPT
Input SPDIF signal to AK4118A.
When using the COAX：R305=0Ω、R306=Open（Default）
When using the OPT：R305=Open、R306=0Ω

(4) AK4118A
AK4118A outputs digital data to AK4452 as DIR.

(5) PORT303
External digital data inputs to AK4452
MCLK、BICK、LRCK、SDTI1/DSDR1、TSMO1
When using the PORT3：R313=R314=R315=R316=Open
R319=R320=R321=R322=51Ω
When using the AK4118A：R313=R314=R315=R316=51Ω （Default）
R319=R320=R321=R322=Open （Default）

(6) USB
USB port. It is possible to set up the registers of AK4452 from PC via the USB port.

(7) PIC18F4550
USB control IC.

(8) SW301
Setting switch for AK4118A.Upside is "Hi", downside is "Lo".
Refer to Table2.SW301 setting.

(9)   SW401
Setting switch for AK4452.Upside is "Hi", downside is "Lo"
Refer to Table5.SW401 setting.

(10) SW402
Power down switch for AK4452.Upside is "Hi (on)", downside is "Lo (off)"

(11) SW403
Mute switch for AK4452.
Push：AK4452 is mute
Release：AK4452 is unmute

(12) SW404
Power down switch for AK4118A.Upside is "Hi (on)", downside is "Lo (off)"

Evaluation Board Manual

■**Operation sequence**

[1] Set up power supplies
    The power should be separated from the source of a power supplier.

Name of connector	Color of connector	Voltage	Use application	Comment and attention
+12V	Red	+12V	·Regulator ·OP-Amp	Should always be connected.
-12V	Blue	-12V	·OP-Amp	Should always be connected.
GND	Black	0V	·Ground	Should always be connected.

Table 1. Power supply line setting

[2] Switch setting
    It should be set to match the mode.

(1) SW301 setting

No.	Switch Name	Function	default
1	DIF2	DIF2-pin of AK4118A	Hi
2	DIF1	DIF1-pin of AK4118A	Lo
3	DIF0	DIF0-pin of AK4118A	Lo
4	OCKS1	OCKS1-pin of AK4118A	Hi
5	OCKS0	OCKS0-pin of AK4118A	Lo

Table 2. SW301 setting

Mode	DIF2 pin	DIF1 pin	DIF0 pin	DAUX	SDTO	LRCK	I/O	BICK	I/O	
0	0	0	0	24bit, Left justified	16bit, Right justified	H/L	O	64fs	O	
1	0	0	1	24bit, Left justified	18bit, Right justified	H/L	O	64fs	O	
2	0	1	0	24bit, Left justified	20bit, Right justified	H/L	O	64fs	O	
3	0	1	1	24bit, Left justified	24bit, Right justified	H/L	O	64fs	O	
4	1	0	0	24bit, Left justified	24bit, Left justified	H/L	O	64fs	O	default
5	1	0	1	24bit, I^2S	24bit, I^2S	L/H	O	64fs	O	
6	1	1	0	24bit, Left justified	24bit, Left justified	H/L	I	64-128fs	I	
7	1	1	1	24bit, I^2S	24bit, I^2S	L/H	I	64-128fs	I	

Table 3. AK4118A Audio interface format

OCKS1 pin	OCKS0 pin	(X'tal)	MCKO1	MCKO2	fs (max)	
0	0	256fs	256fs	256fs	96 kHz	
0	1	256fs	256fs	128fs	96 kHz	
1	0	512fs	512fs	256fs	48 kHz	default
1	1	128fs	128fs	64fs	192 kHz	

Table 4. AK4118A MCLK setting

(2) SW401 setting

No.	Switch Name	Function	default
1	I2C	I2C pin of AK4452 H：I2C mode L：SPI mode	Hi
2	PS	PS pin of AK4452 H：Parallel mode L：Serial mode	Hi
3	DCHAIN	DCHAIN pin of AK4452（Parallel mode only） H：DCHAIN mode L：Normal mode	Lo
4	TDM0	TDM0 pin of AK4452（Parallel mode only）	Lo
5	TDM1	TDM1 pin of AK4452（Parallel mode only）	Lo
6	DIF	DIF pin of AK4452（Parallel mode only） H：32bit I2S compatible L：32bit LSB justified	Lo
7	CAD0-I2C	CAD0 pin of AK4452（I2C mode only）	Lo
8	CAD0-SPI	CAD0 pin of AK4452（SPI mode only）	Lo
9	CAD1	CAD1 pin of AK4452（Serial mode only）	Lo

Table 5.SW401 setting

(3) SW402/SW403/SW404 setting

SW402	AK4452-PDN	Power down switch for AK4452 Hi：Power up Lo：Power down ※Should be "Hi" during operation AK4452.
SW403	MUTE	Mute switch for AK4452（Parallel mode only） Release：Unmute Push：Mute
SW404	AK4118-PDN	Power down switch for AK4118A Hi：Power up Lo：Power down ※Should be "Hi" during operation AK4118A.

Table6.SW402/SW403/SW404 setting

[3] USB connect (Serial mode only)
Connect the board to PC with the USB cable.

[4] Power on
Turn on the power to the board. In case of serial mode, startup AK4452 control software.

[5] Setup the control registers (Serial mode only)
Refer to "Control soft manual".

Control Soft Manual

■ Evaluation Board and Control Soft Settings

1. Set an evaluation board properly.
2. Connect a USB control box (AKUSBIF-B) and an evaluation board.
   Pay attention about direction of the 10pin header when connecting to an AKUSBIF-B.
3. Connect a PC (IBM-AT compatible) and the USB control box (AKUSBIF-B).
   The USB control box is recognized as HID (Human Interface Device) on the PC.
   It is not necessary to install a new driver.
4. Start up the control program.
   When the screen does not display "AKUSBIF-B" at bottom left, reconnect the PC and the USB control box, and push the [Port Reset] button.
5. Proceed evaluation by following the process below.

[Support OS]
   Windows XP / Vista / 7
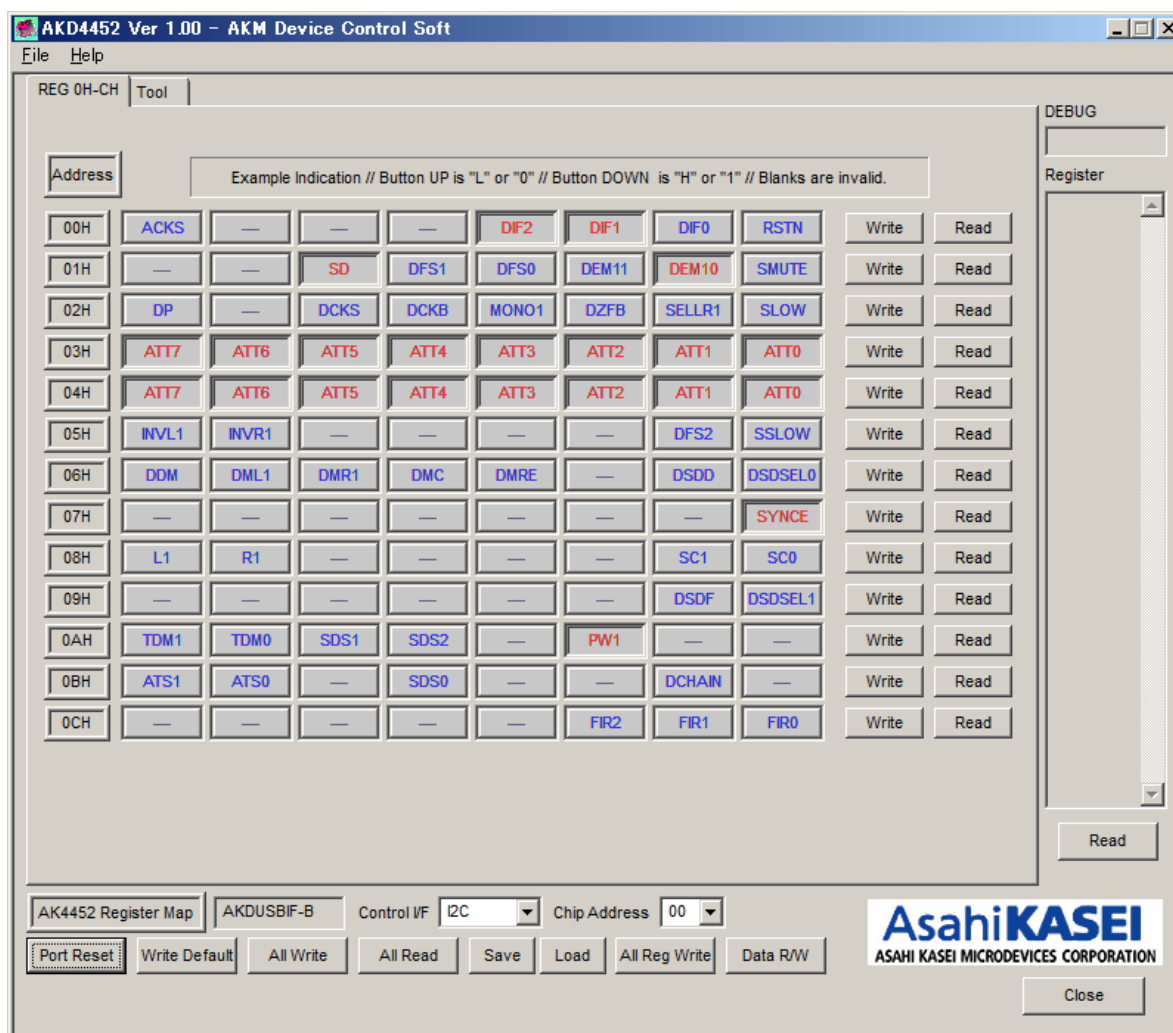
Figure3.Control Software Window

■ **Operation Overview**

Function, register map and testing tool can be controlled by this control soft. These controls are selected by upper tabs.

Buttons which are frequently used such as register initializing button "Write Default", are located outside of the switching tab window. Refer to the "■ Dialog Boxes" for details of each dialog box setting.

1.   [Port Reset]: For when connecting to PC
               Click this button after the control soft starts up when connecting to PC.

2.   [Write Default]: Initializes Registers
               When the device is reset by a hardware reset, use this button to initialize the registers.

3.   [All Write]: Executes write commands for all registers displayed.

4.   [All Read]: Executes read commands for all registers displayed.

5.   [Save]: Saves current register settings to a file.

6.   [Load]: Executes data write from a saved file.

7.   [All Req Write]: Opens "All Req Write" dialog box.

8.   [Data R/W]: Opens "Data R/W" dialog box

9.   [Sequence]: Opens "Sequence" dialog box.

10. [Sequence (File)]: Opens "Sequence(File)" dialog box.

11. [Read]: Reads current register settings and displays on to the register area (on the right of the main window).
               This is different from [All Read] button, it does not reflect to a register map, only displaying register settings in hexadecimal.

■ **Tab Functions**

1. **[REG]: Register Map**

This tab is for a register writing and reading.

Each bit on the register map is a push-button switch.
Button Down indicates "H" or "1" and the bit name is in red (when read only it is in deep red).
Button Up indicates "L" or "0" and the bit name is in blue (when read only it is in gray)

Grayout registers are Read Only registers. They can not be controlled.

The registers which is not defined in the datasheet are indicated as "---".
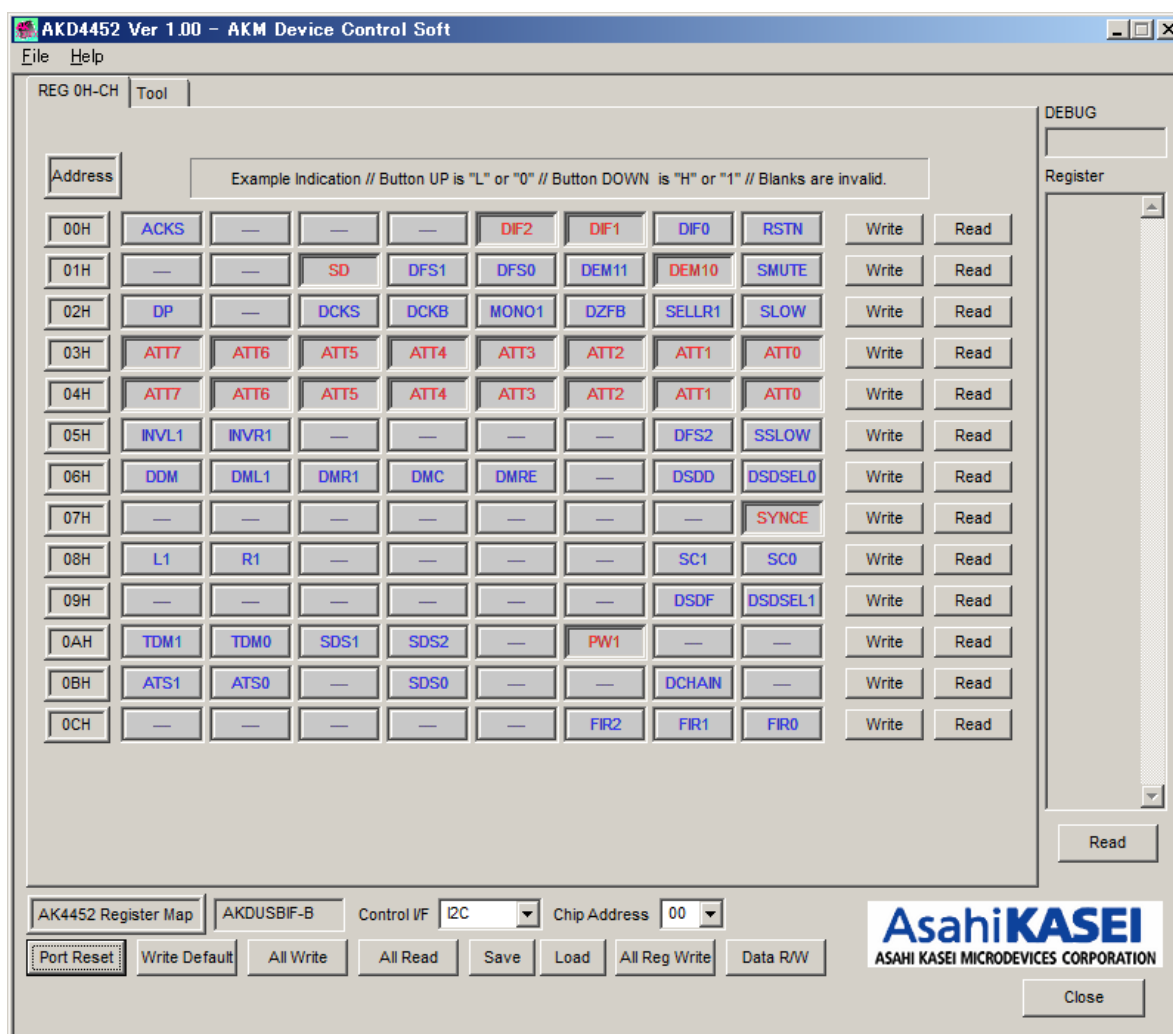
Figure4.Window of [REG]

1-1. [Write]: Data Writing Dialog

It is for when changing two or more bits on the same address at the same time.

Click [Write] button located on the right of the each corresponded address for a pop-up dialog box.

When the checkbox is checked, the data will be "H" or "1". When the checkbox is not checked, the data will be "L" or "0". Click [OK] to write setting values to the registers, or click [Cancel] to cancel this setting.
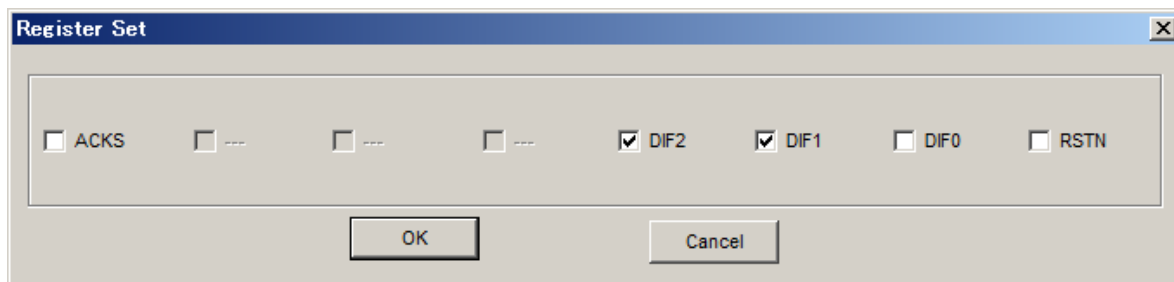
Figure5.Window of [Register Set]

1-2. [Read]: Data Read (I2C mode only)

Click [Read] button located on the right of the each corresponded address to execute a register read.

After register reading, the display will be updated regarding to the register status.
Button Down indicates "H" or "1" and the bit name is in red (when read only it is in deep red).
Button Up indicates "L" or "0" and the bit name is in blue (when read only it is in gray)

Please be aware that button statuses will be changed by a Read command.

2. [Tool]: Testing Tools

Evaluation testing tools are available in this tab.
Click buttons for each testing tool.
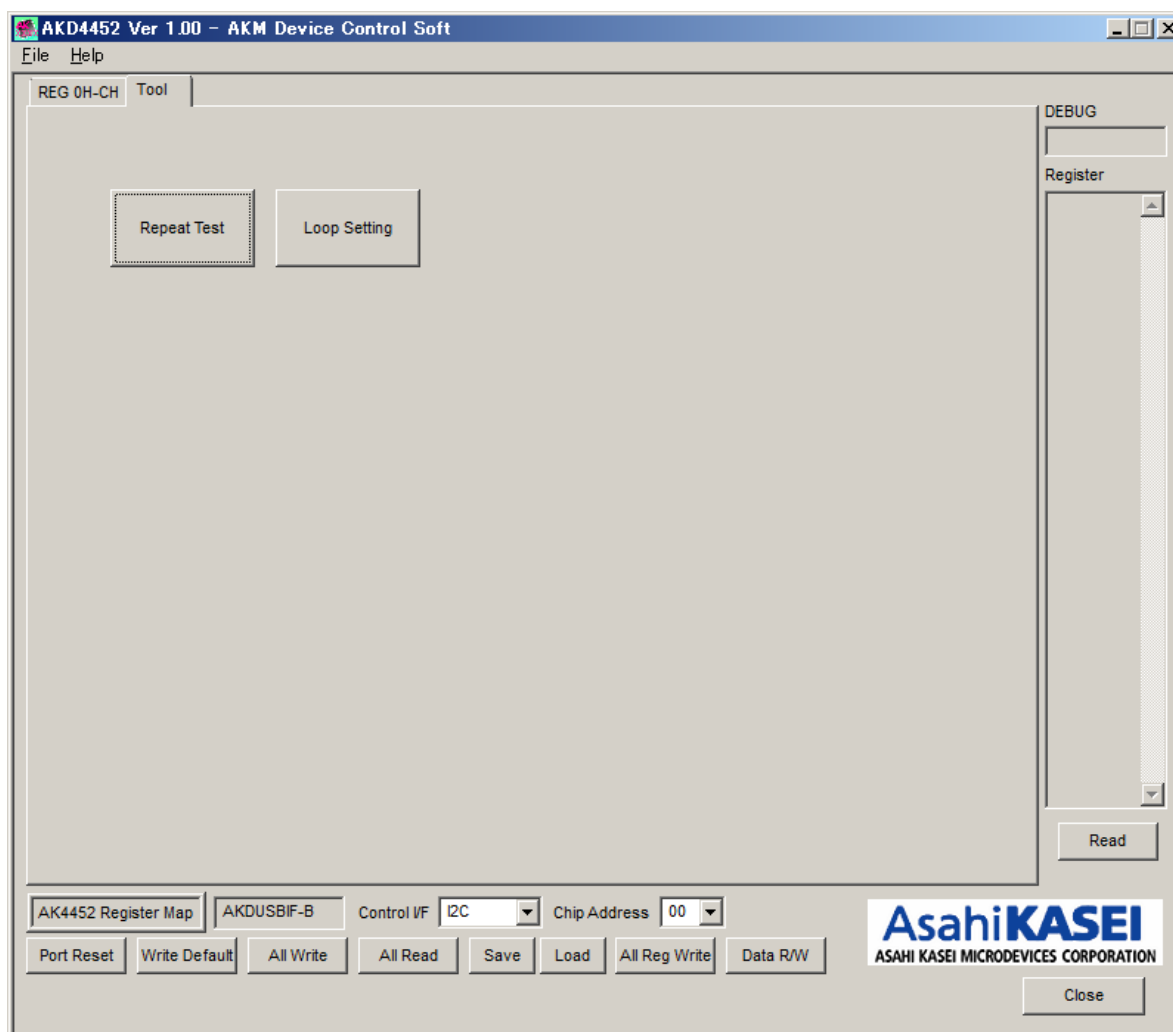
Figure 6.Window of [Tool]

2-1.[Repeat Test] : Repeat Test Dialog

Click [Repeat Test] button in the Test tab to open a repeat test dialog shown below.
Repeat writing test can be executed by this dialog.

Figure 7.Window of [Repeat Test]

[Start] Button   : Starts the repeat test.
             A dialog for saving a file of the test result will open when clicking this button.
             Name the file.
             Test will start after specifying a saving file.
[Close] Button   : Closes this dialog and finishes the process.
[Address] Box   : Data writing address in hexadecimal numbers.
[Start Data] Box   : Start data in hexadecimal numbers.
[End Data] Box   : End data in hexadecimal numbers.
[Step] Box   : Data write step interval.
[Repeat Count] Box : Repeat count of the test writing.
[Up and Down] Box : Data write flow is changed as below.
        • Checked: Writes in step interval from the start data to the end data and turn back from the end data to
               the start data.
      [Example]   Start Data = 00, End Data = 05, Step = 1, [ ]…for 1 count.
      Data flow: [00→01→02→03→04→05→05→04→03→02→01→00] x Repeat Count
      Number

        • Not checked: Writes in step interval from the start data to the end data and finishes writing.
      [Example]   Start Data = 00, End Data = 05, Step = 1, [ ]…for 1 count.
      Data flow: [00→01→02→03→04→05] x Repeat Count Number

[Sampling Frequency] Box: Selects sampling frequency 44.1kHz/48kHz
[Count] Box   : Indicates the count number during a repeat test.
[Lch Level] Box   : Indicates the Lch Level during a repeat test.

2-2.[Loop Setting] : Loop Dialog

Click [Loop Setting] button in the Tool tab to open loop setting dialog as shown below.
Writing test can be executed.
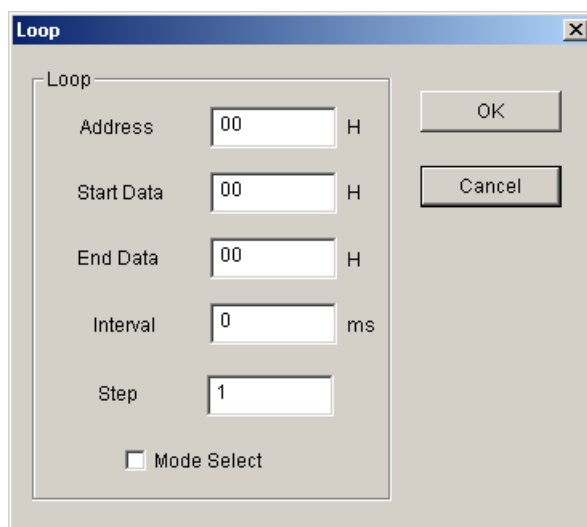
Figure 8.Window of [Loop]

[OK] Button   : Starts the test.
[Cancel] Button   : Closes the dialog and finishes the process.
[Address] Box   : Data writing address in hexadecimal numbers.
[Start Data] Box   : Start data in hexadecimal numbers.
[End Data] Box   : End data in hexadecimal numbers.
[Interval] Box   : Data write interval time.
[Step] Box   : Data write step interval.
[Mode Select] Box   : Mode select check box.

 • Checked: Writes in step interval from the start data to the end data and turn back from the end data
              to the start data.
   [Example]   Start Data = 00, End Data = 05, Step = 1
   Data flow: 00→01→02→03→04→05→05→04→03→02→01→00

 • Not Checked: Writes in step interval from the start data to the end data and finishes writing.
   [Example]   Start Data = 00, End Data = 05, Step = 1
   Data flow: 00→01→02→03→04→05

■ Dialog Boxes

1. [All Reg Write]: All Reg Write dialog box

Click [All Reg Write] button in the main window to open register setting files.
Register setting files saved by [SAVE] button can be applied.
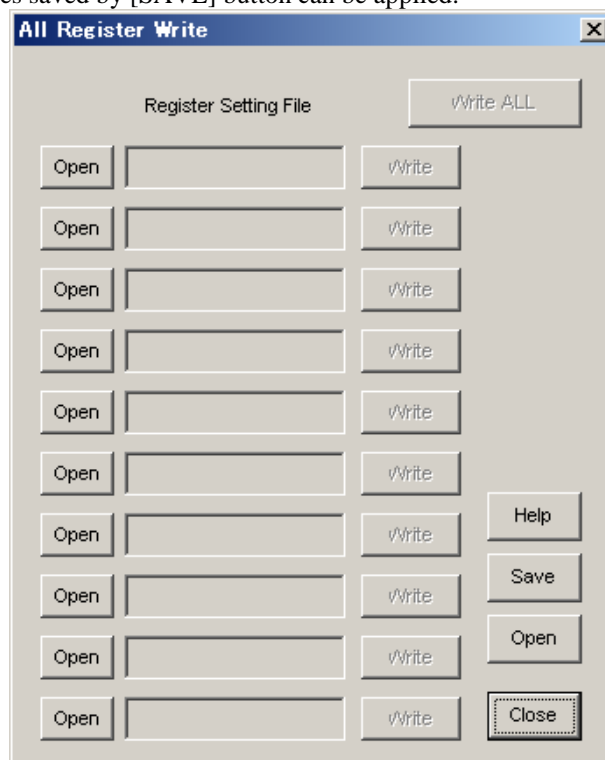
Figure9.Window of [All Reg Write]

[Open (left)]: Selects a register setting file (*.akr).
[Write]: Executes register writing by the setting of selected file.
[Write All]: Executes all register writings.
           Selected files are executed in descending order.

[Help]: Opens a help window.
[Save]: Saves a register setting file assignment. The file name is "*.mar".
[Open (right)]: Opens a saved register setting file assignment "*. mar".
[Close]: Closes the dialog box and finish the process.

~ Operating Suggestions ~

1. Those files saved by [Save] button and opened by [Open] button on the right of the dialog "*.mar" should be stored in the same folder.
2. When register settings are changed by [Save] button in the main window, re-read the file to reflect new register settings.

2. [Data R/W]: Data R/W Dialog Box

Click the [Data R/W] button in the main window for data read/write dialog box.
Data write is available to specified address.
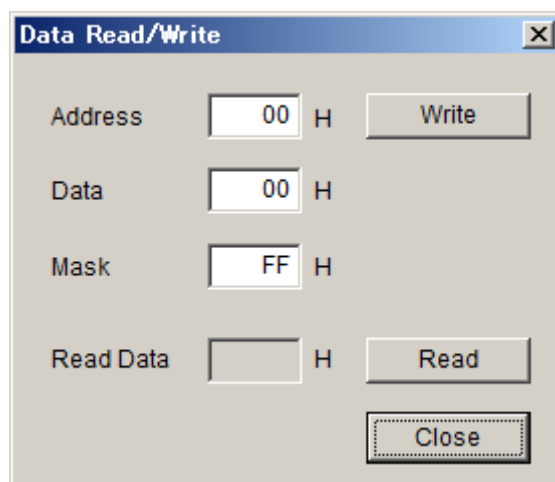
Figure 10. Window of [Data R/W]

[Address] Box: Input data address in hexadecimal numbers for data writing.
[Data] Box   : Input data in hexadecimal numbers.
[Mask] Box   : Input mask data in hexadecimal numbers.
                 This is "AND" processed input data.

[Write]: Writs the data generated from Data and Mask values to the address specified by "Address" box.

[Read]: Reads data from the address specified by "Address" box.
        The result will be shown in the Read Data Box in hexadecimal numbers.

[Close]: Closes the dialog box and finishes the process.
         Data writing can be cancelled by this button instead of executing a write command.

*The register map will be updated after executing [Write] or [Read] commands.

Measurement Results

    ・ Measurement unit   : Audio Precision, SYS-2722 (No.00103)
    ・ MCKI   : 512fs
    ・ BICK   : 64fs
    ・ fs   : 44.1kHz、96kHz、192kHz
    ・ Bit   : 24bit
    ・ Input Frequency   : 1kHz
    ・ Power Supply   : ±12V, GND
                         AVDD=VREHH=5.0V (Regulator)、TVDD=3.3V (Regulator)
    ・ Pass   : COAX→AK4118A(DIR) → AK4452 → AOUT
    ・ Temperature   : Room
    ・ Board Setting   : Parallel Mode
    ・ External OP-AMP   : NM2043D

[Measurement Results]

1. fs=44.1kHz, MCLK=512fs, BICK=64fs

		Result		Unit
		Lch	Rch	
DAC1 : SDTI1 => DAC1 => L/ROUT1				
S/(N+D)	fs = 44.1kHz (0dBFS)	105.0	105.1	dB
DR	fs = 44.1kHz (-60dBFS, A-Weighted)	114.8	114.7	dB
S/N	fs = 44.1kHz (No Inputs, A-weighted)	114.8	114.8	dB

2. fs=96kHz, MCLK=256fs, BICK=64fs

		Result		Unit
		Lch	Rch	
DAC1 : SDTI1 => DAC1 => L/ROUT1				
S/(N+D)	fs = 96kHz (0dBFS)	102.0	102.0	dB
DR	fs = 96kHz (-60dBFS, A-Weighted)	114.6	114.6	dB
S/N	fs = 96kHz (No Inputs, A-weighted)	114.8	114.5	dB

3. fs=192kHz, MCLK=128fs, BICK=64fs

		Result		Unit
		Lch	Rch	
DAC1 : SDTI1 => DAC1 => L/ROUT1				
S/(N+D)	fs = 192kHz (0dBFS)	102.3	102.2	dB
DR	fs = 192kHz (-60dBFS, A-Weighted)	114.5	114.5	dB
S/N	fs = 192kHz (No Inputs, A-weighted)	114.7	114.7	dB

[Plot Data]
1.   fs=44.1kHz, MCLK=512fs, BICK=64fs
    DAC1 : SDTI1 => DAC1 => L/ROUT1
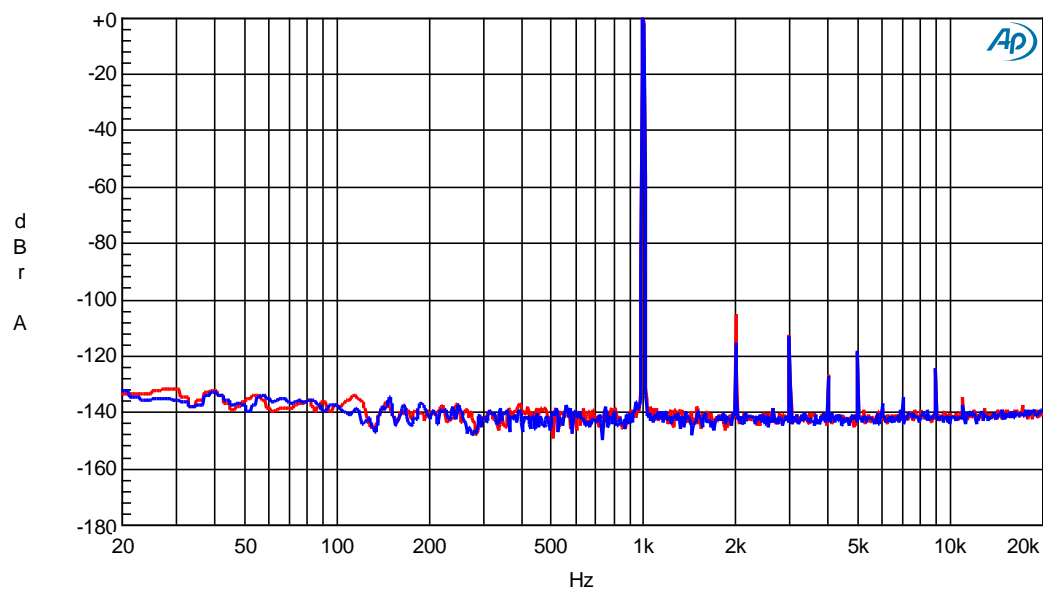
Figure 11.FFT (0dBFS) [fs = 44.1kHz]
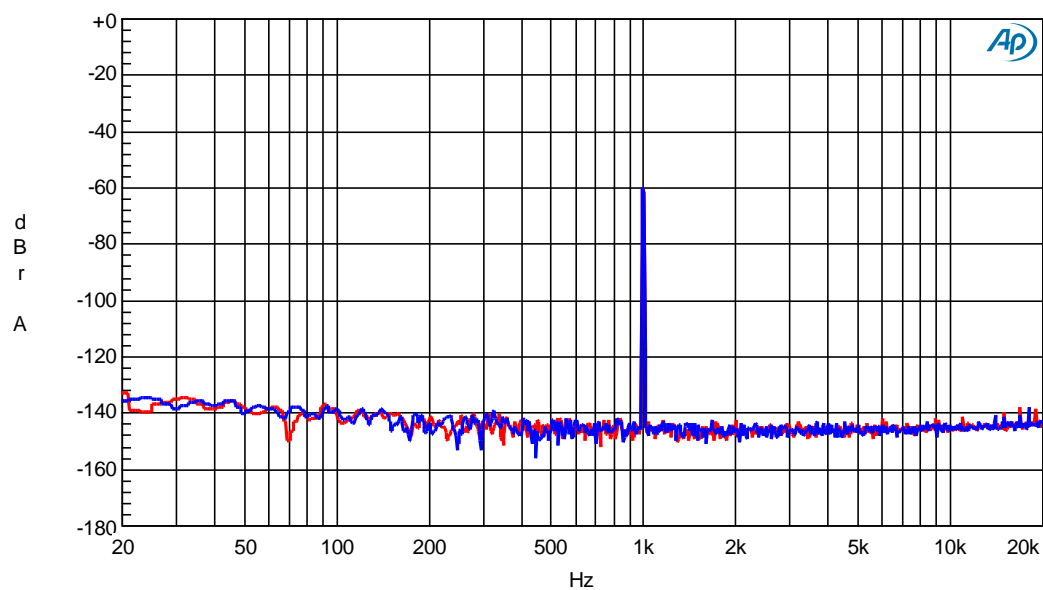
Figure 12.FFT (-60dBFS) [fs = 44.1kHz]
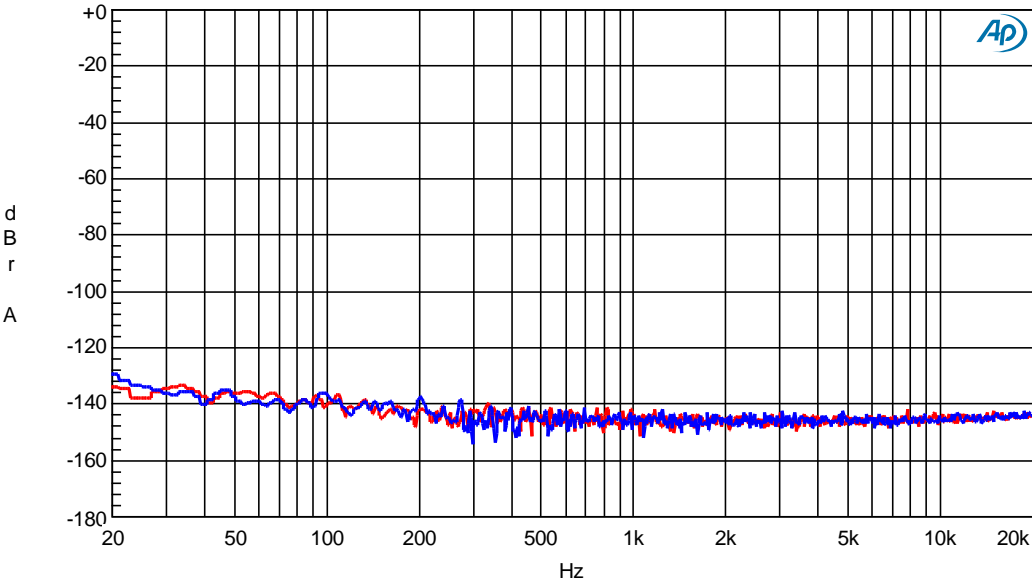
Figure 13.FFT (No Inputs fs=44.1kHz]
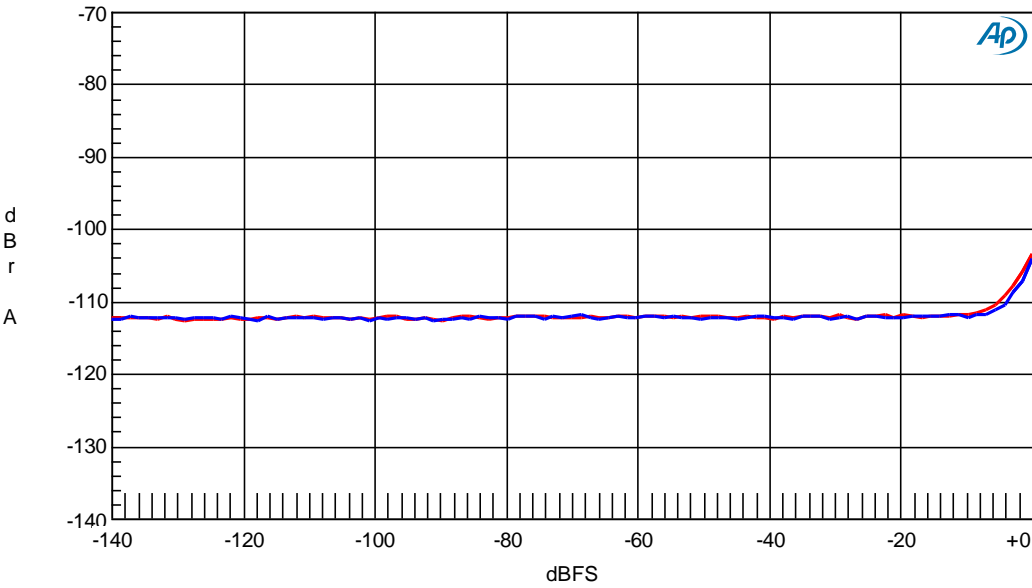
Figure 14.THD+N vs. Amplitude (Input Level) [fs = 44.1kHz]
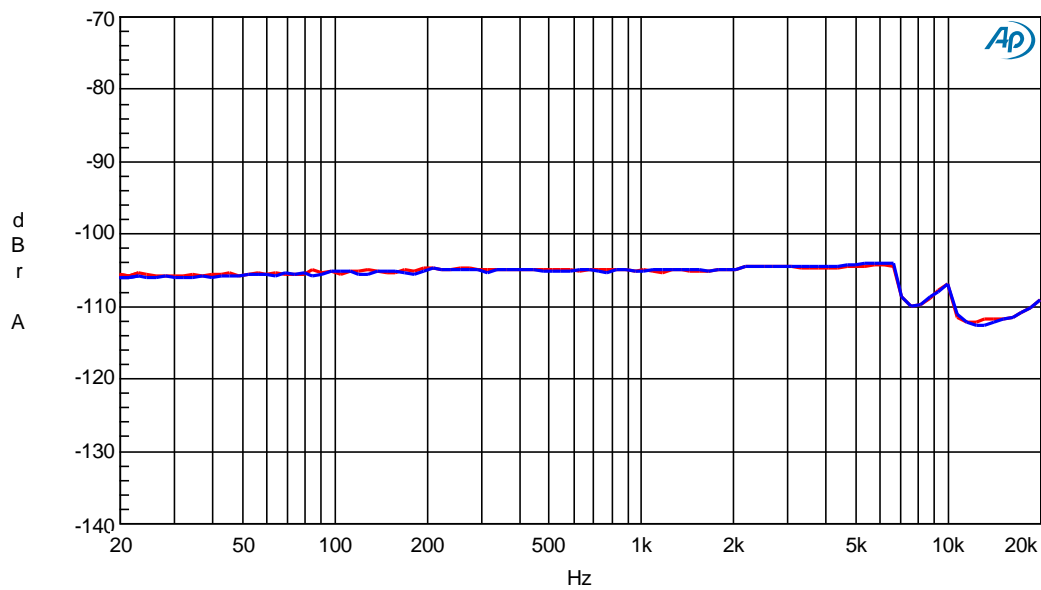
Figure 15.THD+N vs. Input Frequency [fs = 44.1kHz, 0dBFS Inputs]
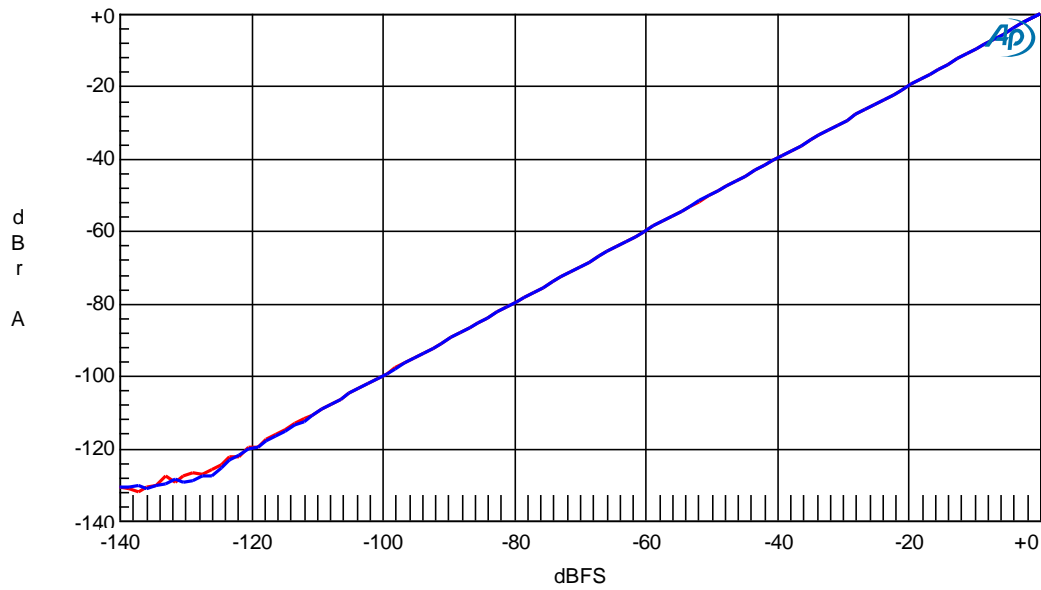

Figure 16.Linearity [fs = 44.1kHz]
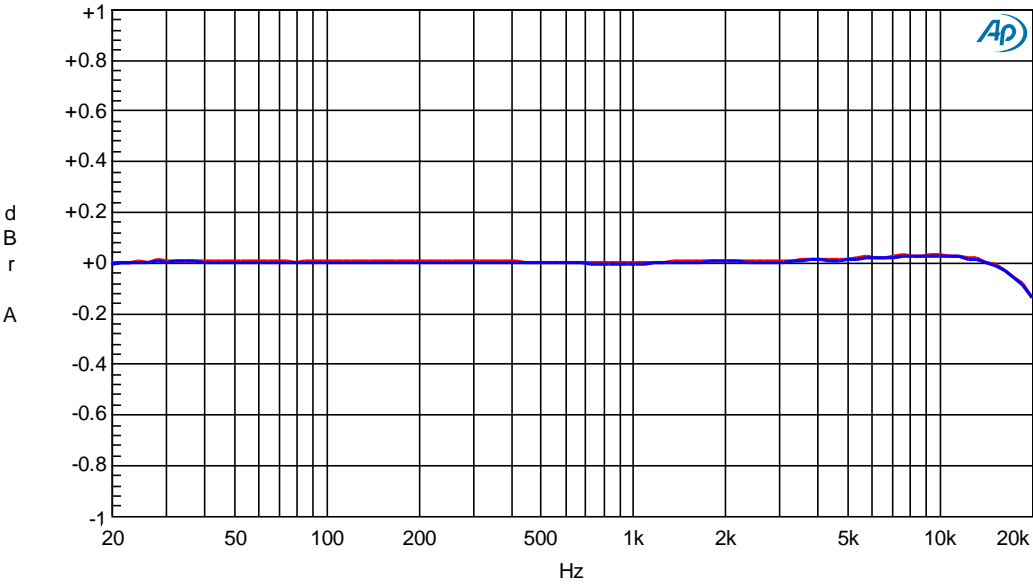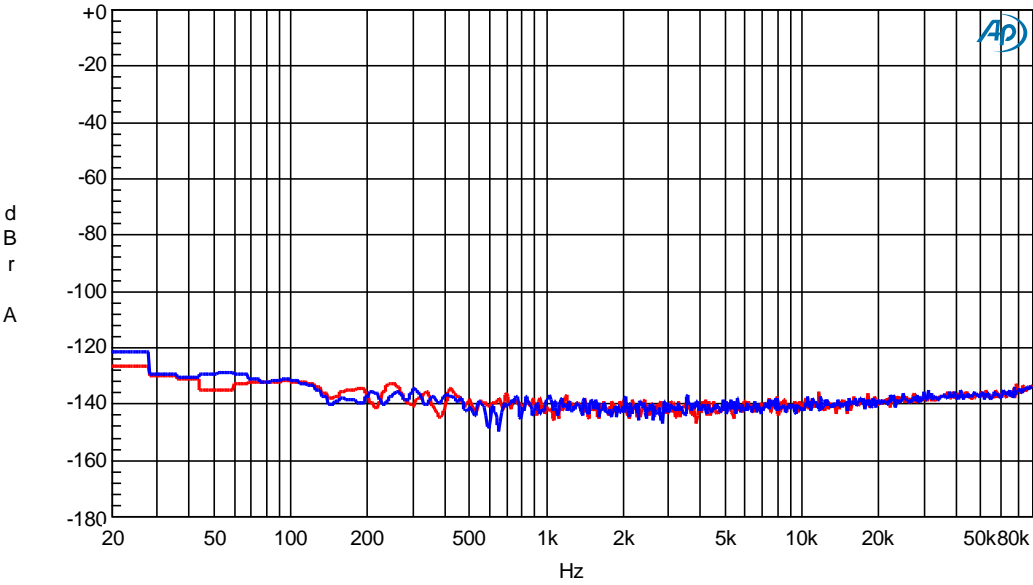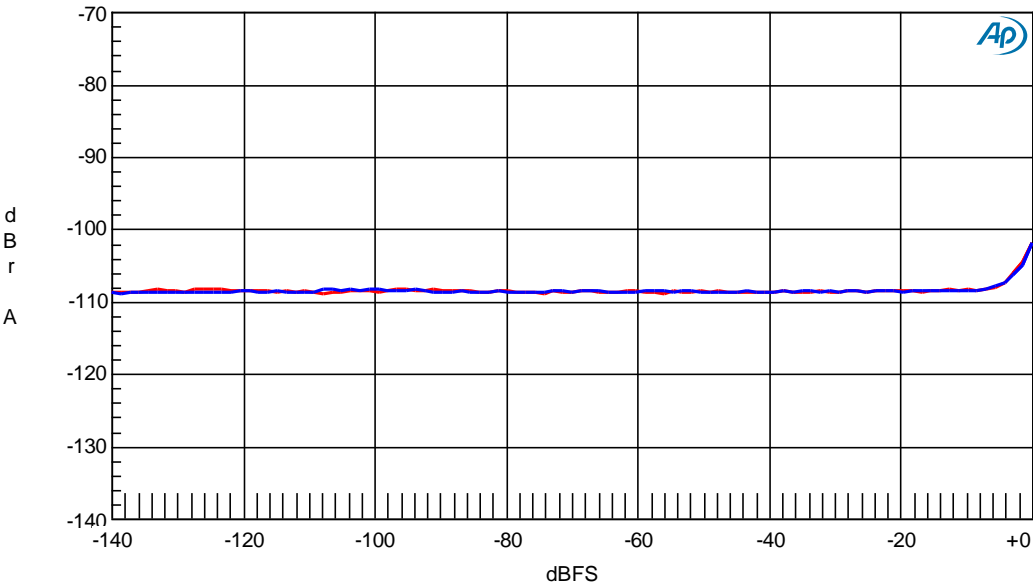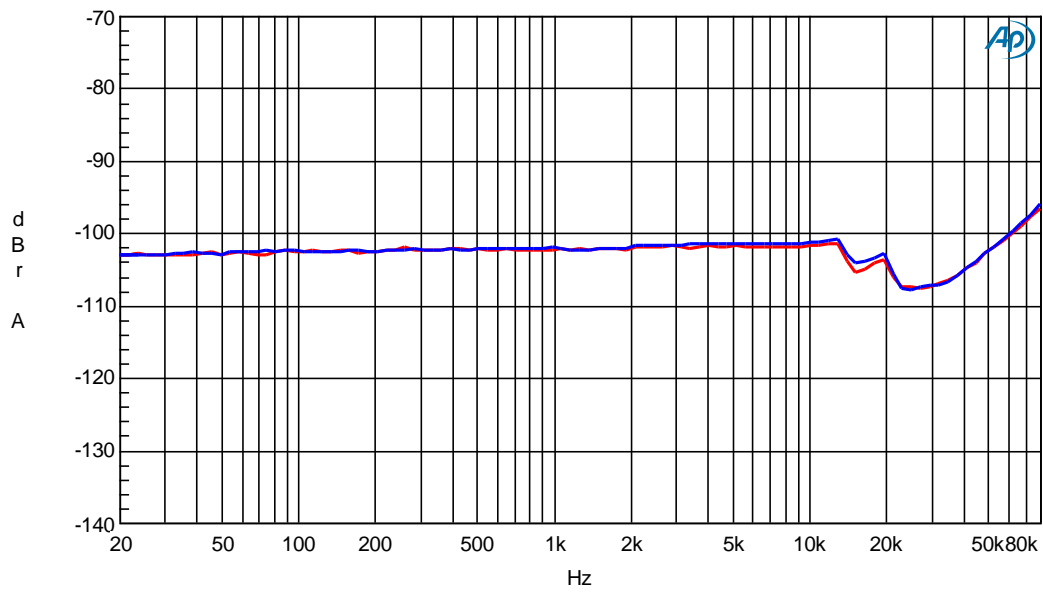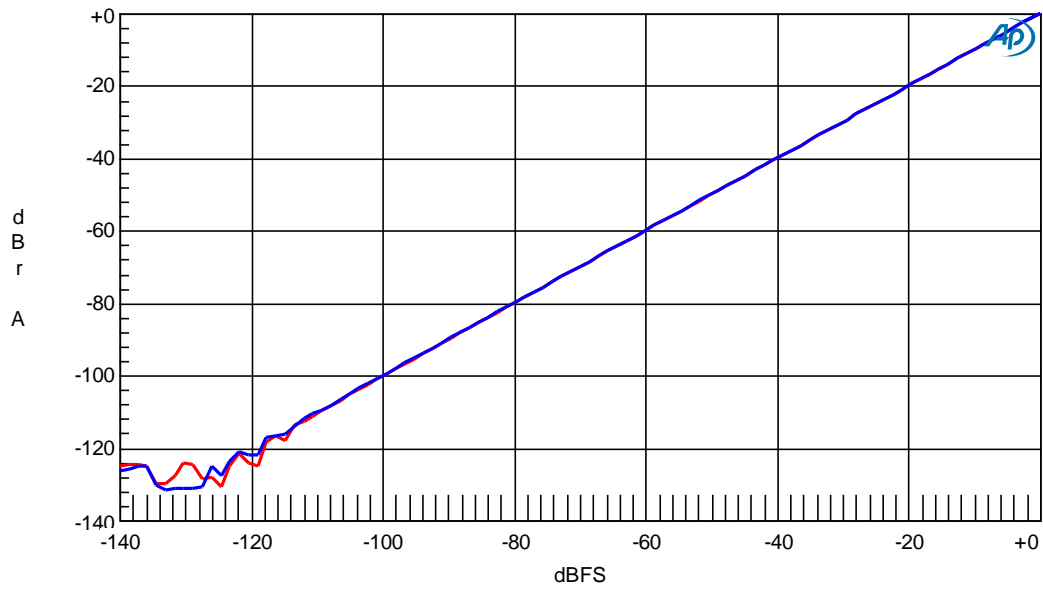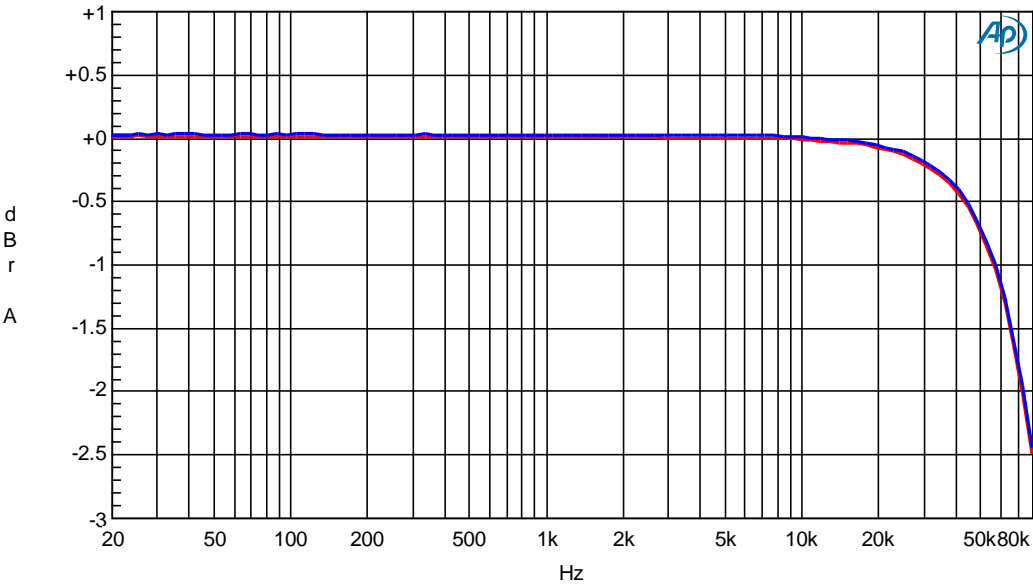
Figure 17.Frequency Response [fs = 44.1kHz]
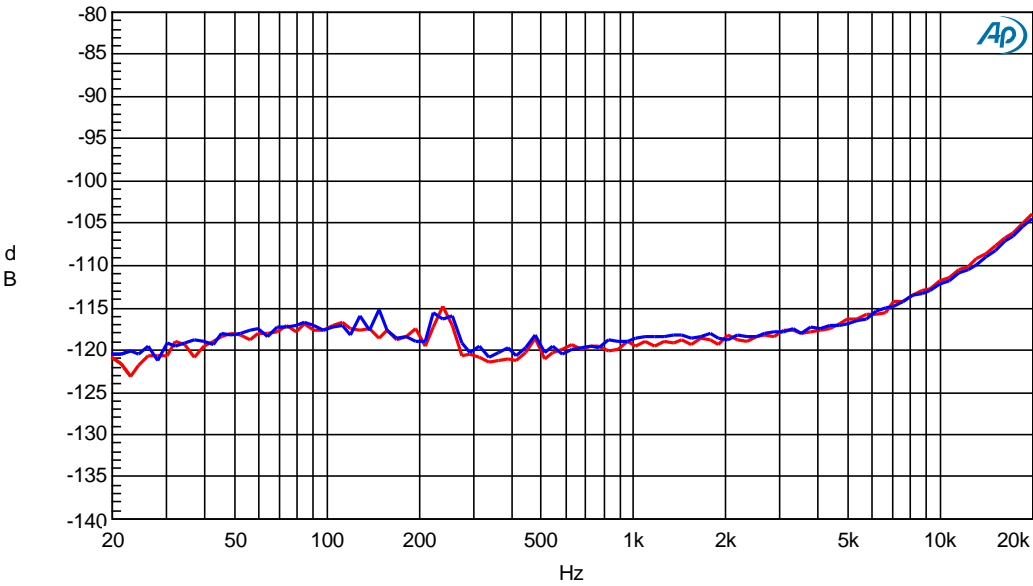
Figure 18.Crosstalk [fs = 44.1kHz]

[Plot Data]
2. fs=96kHz, MCLK=256fs, BICK=64fs
    DAC1 : SDTI1 => DAC1 => L/ROUT1
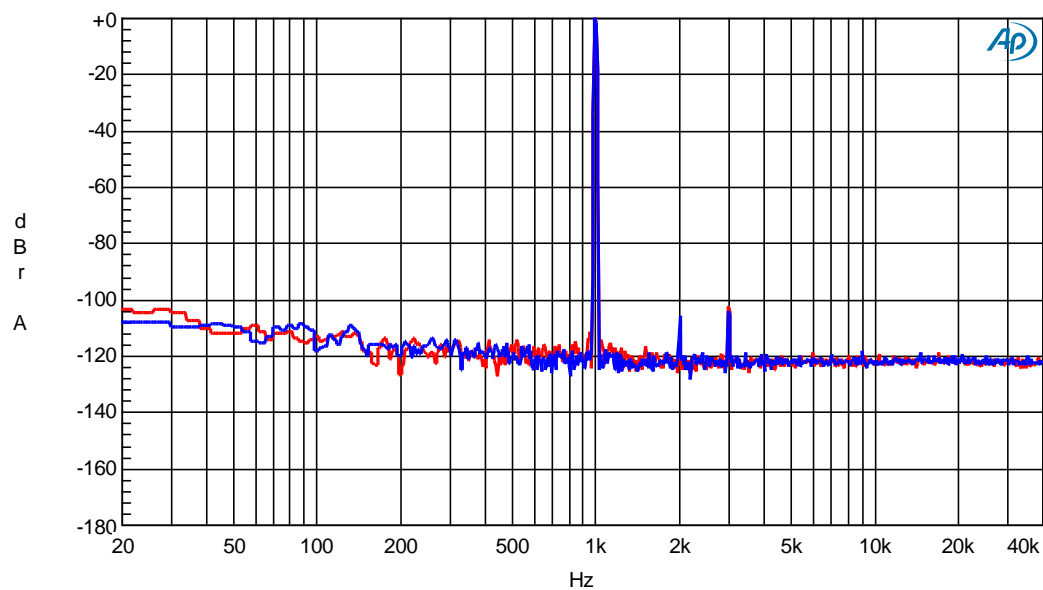
Figure 19.FFT (0dBFS) [fs = 96kHz]
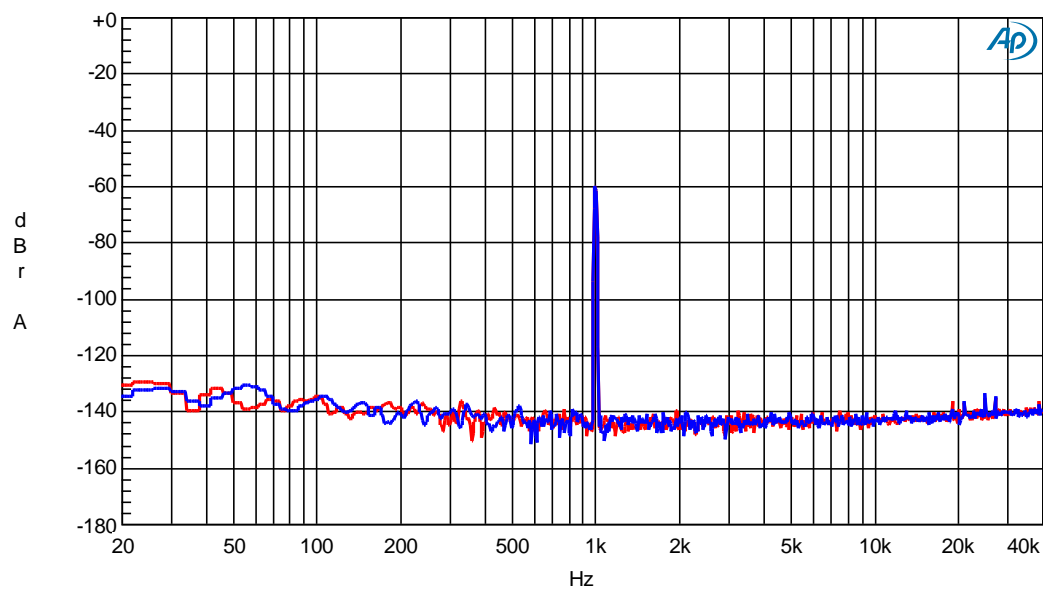
Figure 20.FFT (-60dBFS) [fs = 96kHz]
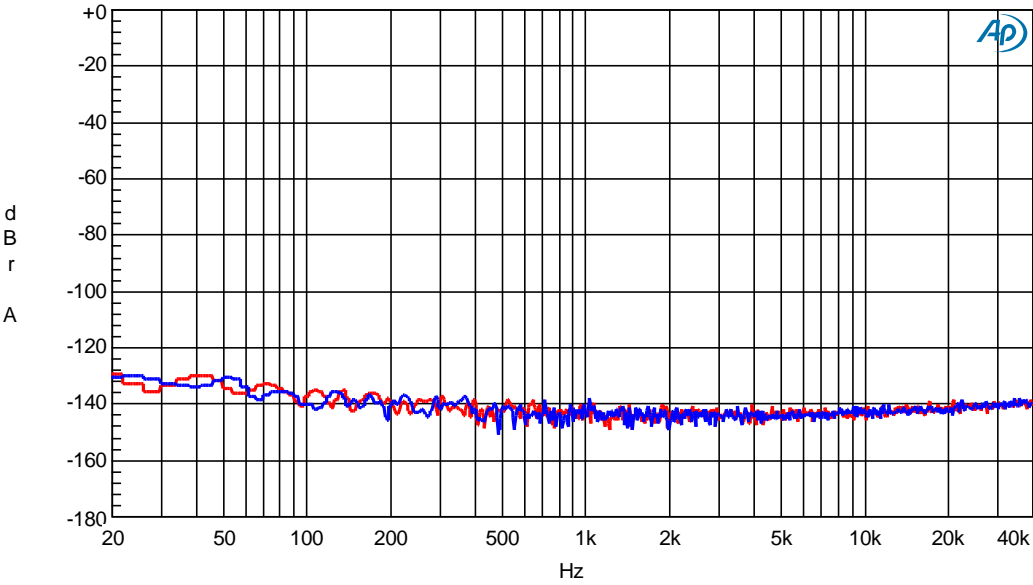
Figure 21.FFT (No Inputs fs=96kHz]
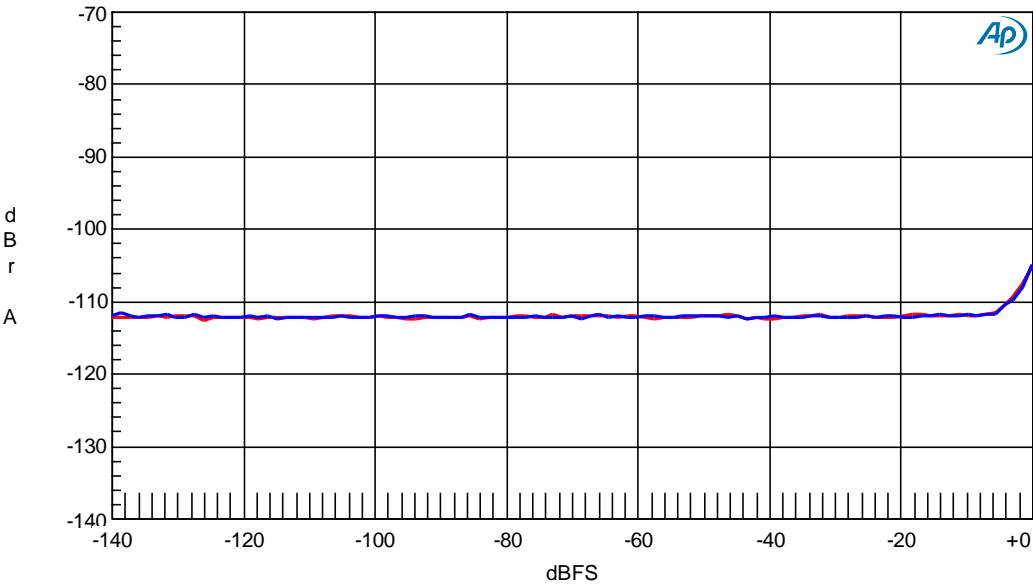
Figure 22.THD+N vs. Amplitude (Input Level) [fs = 96kHz]
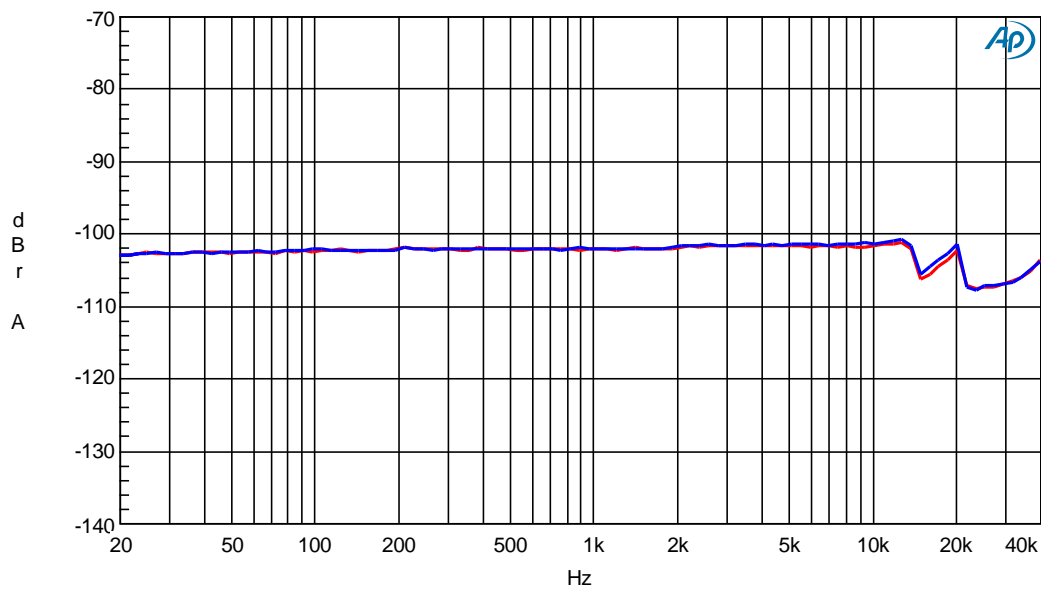
Figure 23.THD+N vs. Input Frequency [fs = 96kHz, 0dBFS Inputs]
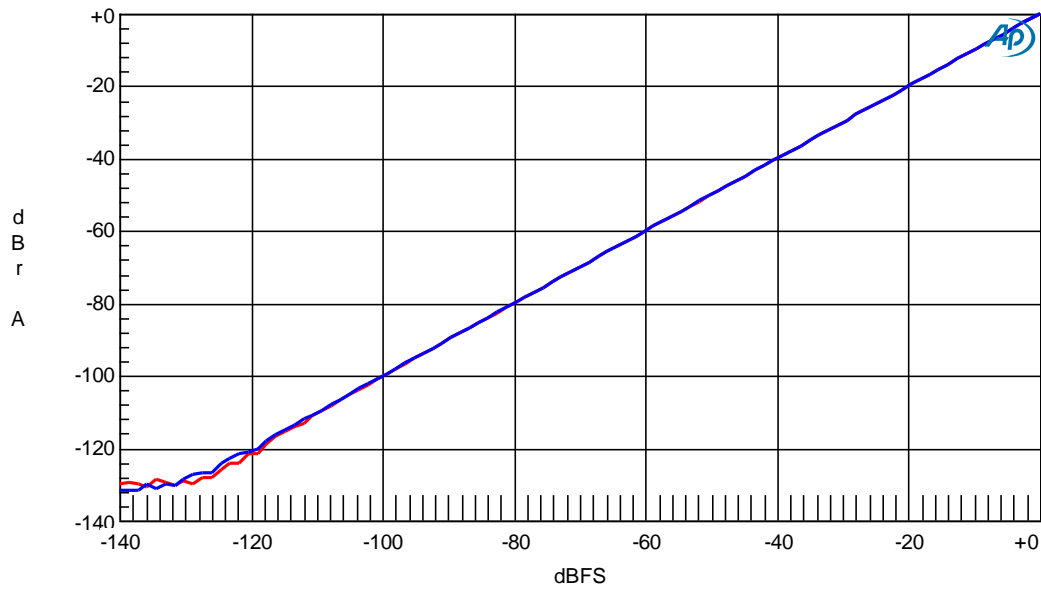
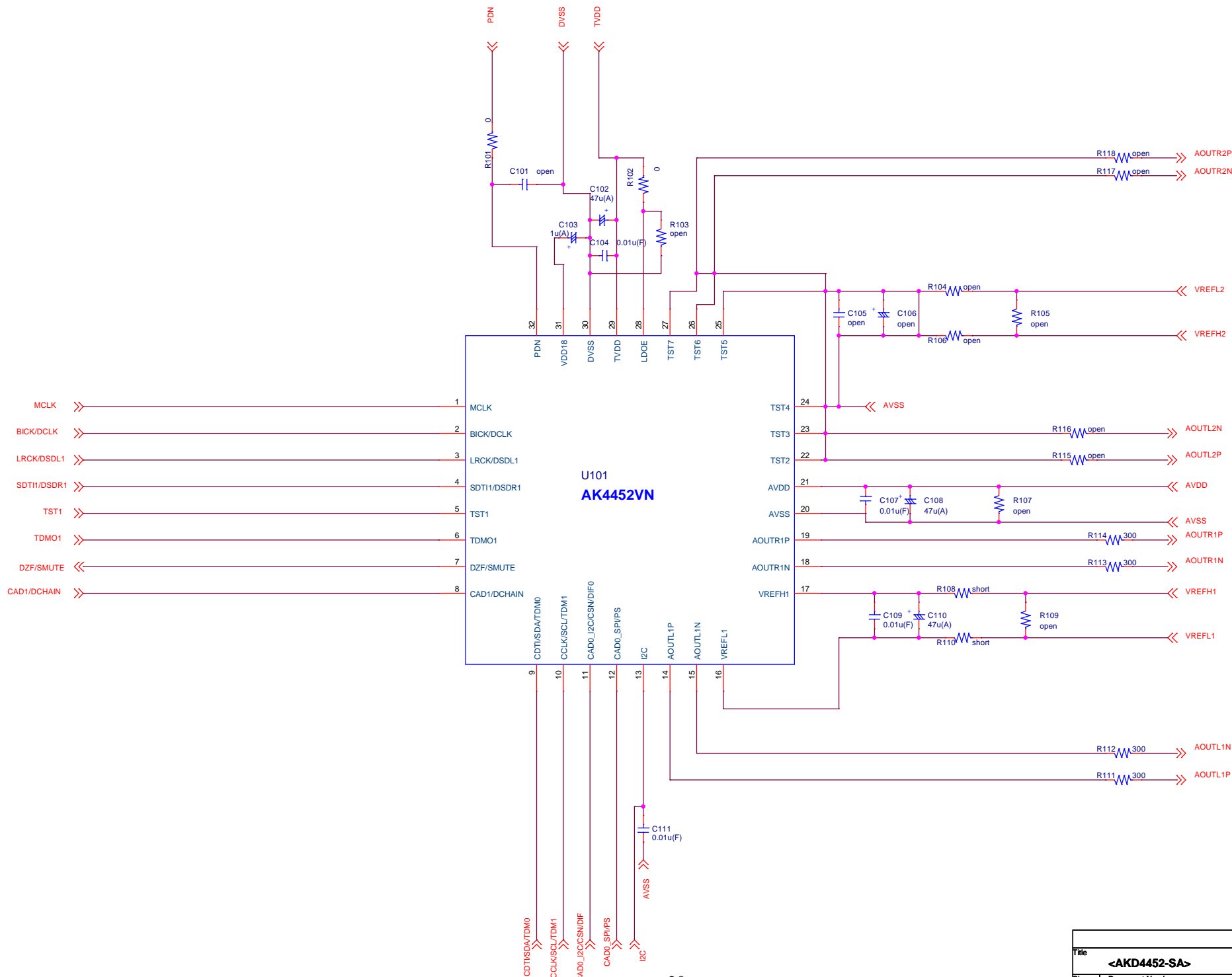Figure 24.Linearity [fs = 96kHz]
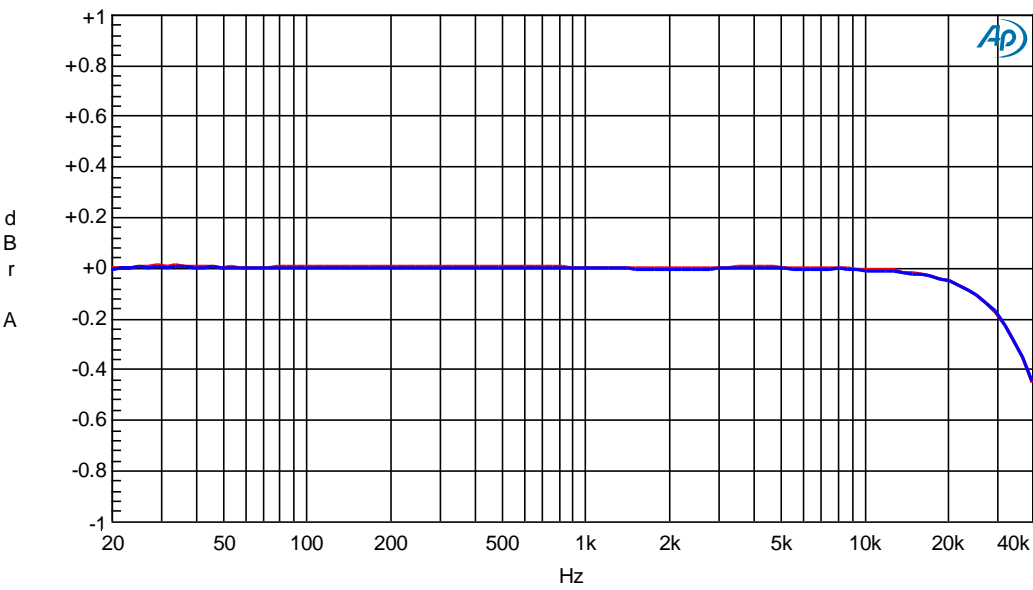
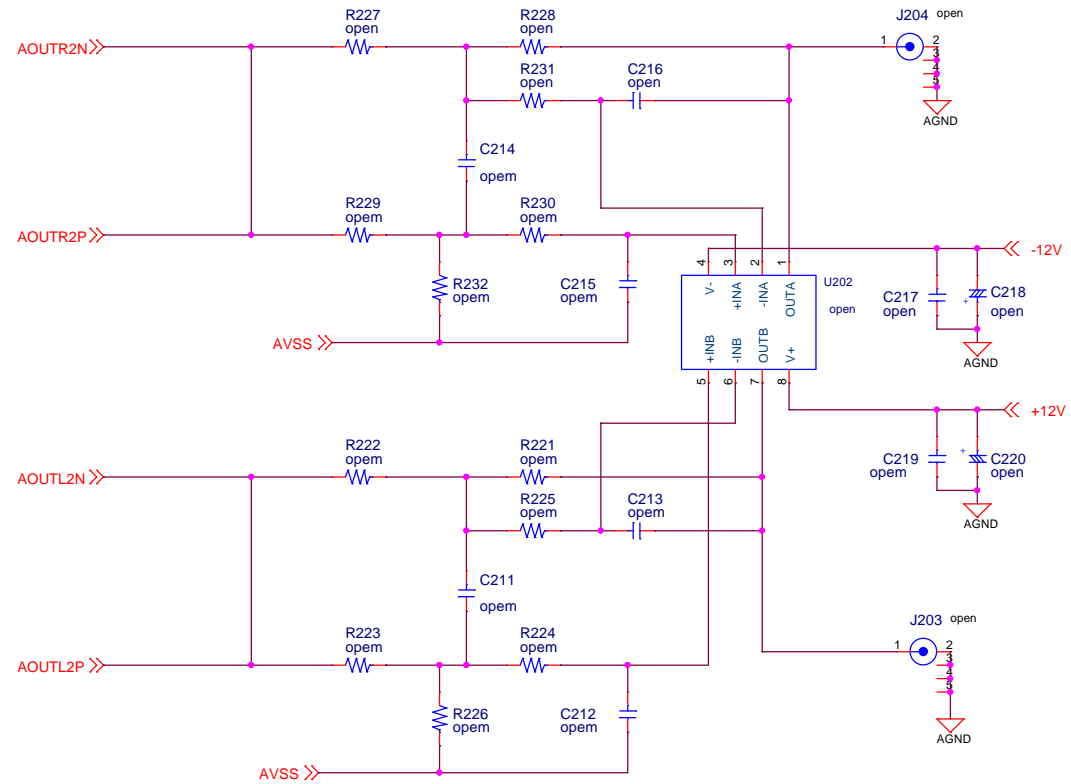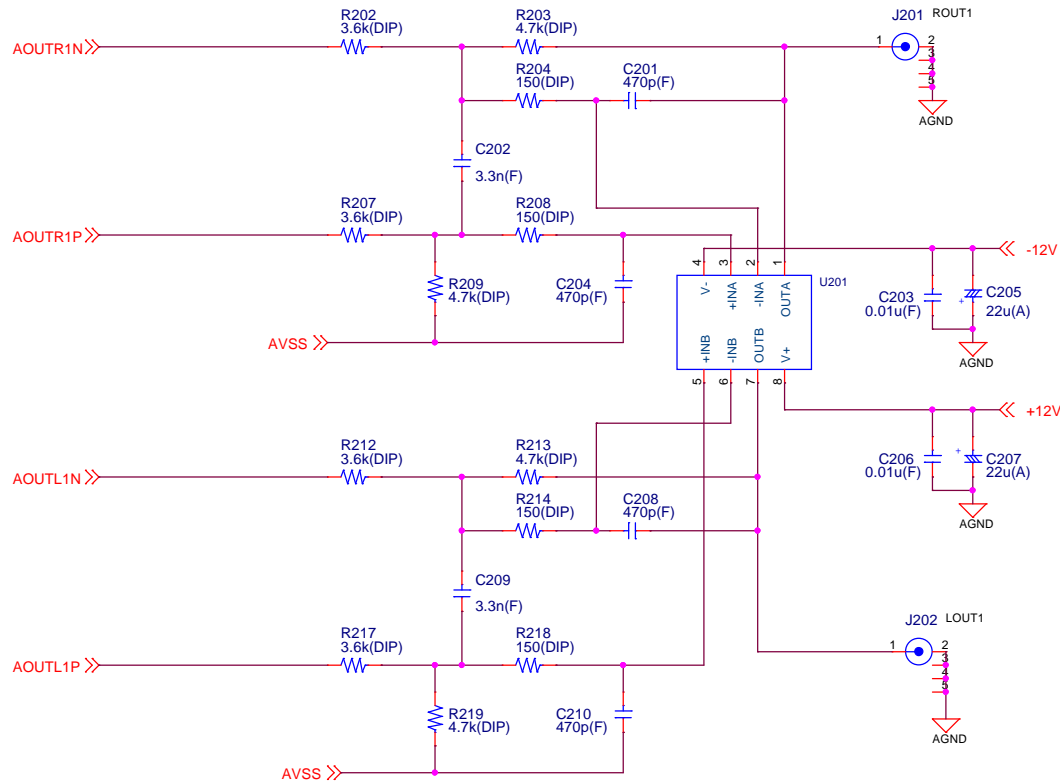Figure 25.Frequency Response [fs = 96kHz]
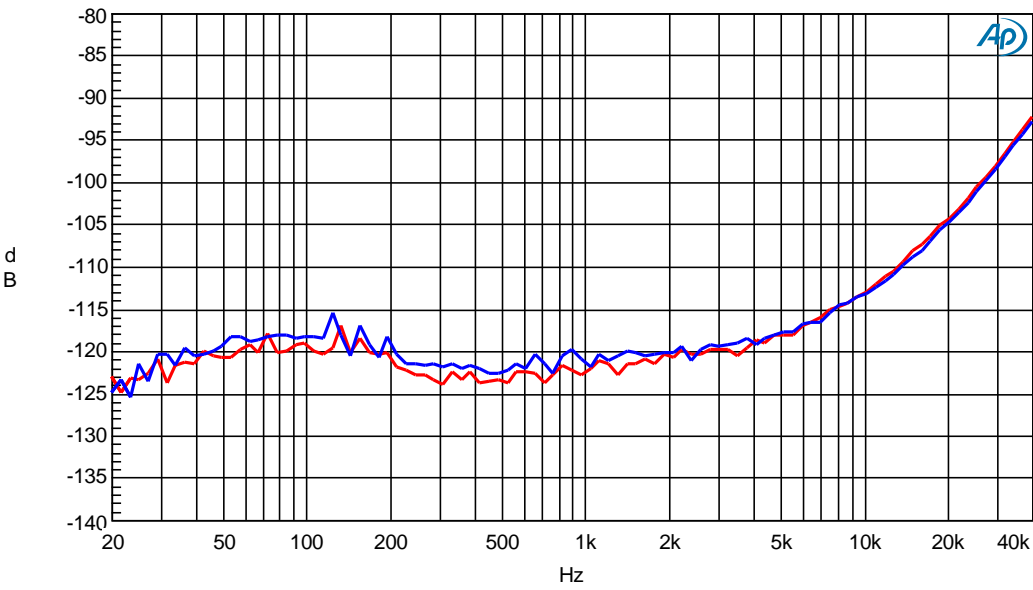
Figure 26.Crosstalk [fs = 96kHz]

[Plot Data]
3. fs=192kHz, MCLK=128fs, BICK=64fs
   DAC1 : SDTI1 => DAC1 => L/ROUT1
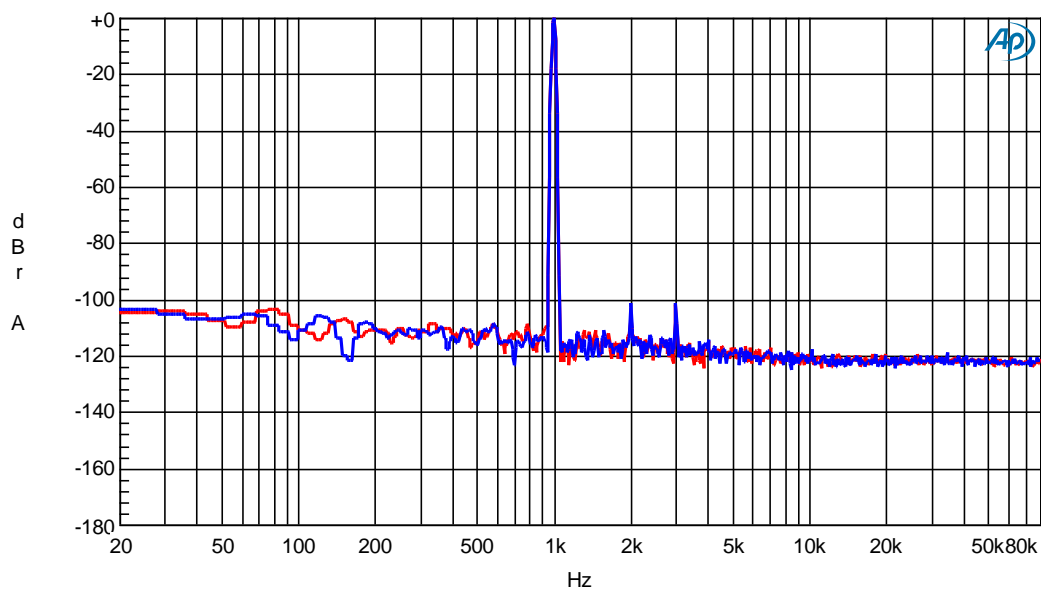
Figure 27.FFT (0dBFS) [fs = 192kHz]
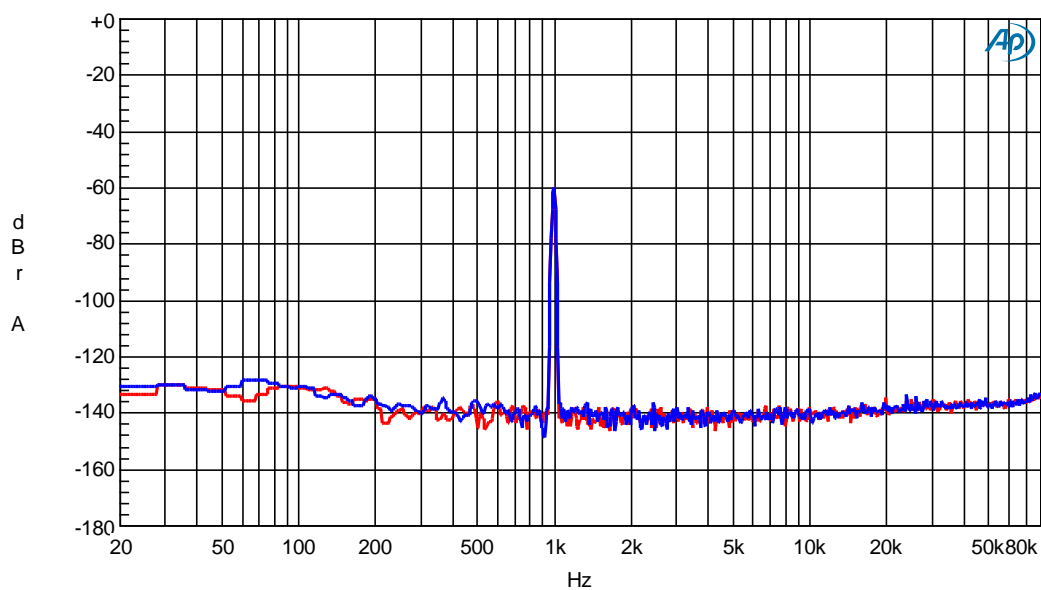
Figure 28.FFT (-60dBFS) [fs = 192kHz]

Figure 29.FFT (No Inputs fs=192kHz]

Figure 30.THD+N vs. Amplitude (Input Level) [fs = 192kHz]

Figure 31.THD+N vs. Input Frequency [fs = 192kHz, 0dBFS Inputs]

Figure 32.Linearity [fs = 192kHz]

Figure 33.Frequency Response [fs = 192kHz]
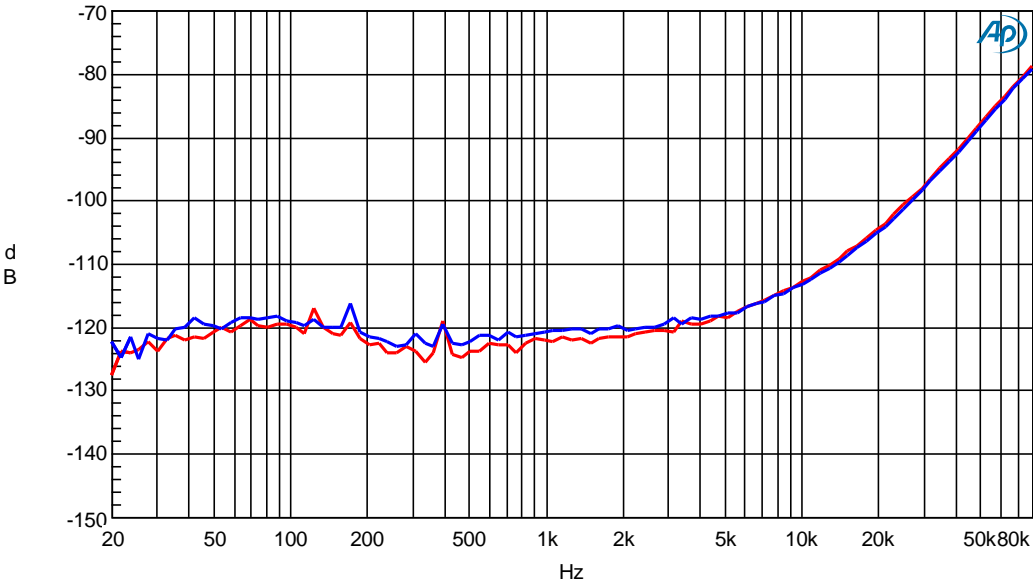
Figure 34.Crosstalk [fs = 192kHz]

REVISION HISTORY

Date (yy/mm/dd)	Manual Revision	Board Revision	Reason	Page	Contents
14/10/23	KM118700	0	First edition		
16/10/12	KM118701	1	Modification		Schematic changed
17/02/01	KM118702	1	Modification		Update Measurement Results

U101
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R202
3.6k(DIP)

R203
4.7k(DIP)

R204
150(DIP)

C201
470p(F)

J201 ROUT1

AOUTR1N

AGND

R202
3.6k(DIP)

C202
3.3n(F)

R207
3.6k(DIP)

R208
150(DIP)

AOUTR1P

R209
4.7k(DIP)

C204
470p(F)

AVSS

U201

V- +INA -INA OUTA

+INB -INB OUTB V+

-12V

C203
0.01u(F)

C205
22u(A)

AGND

+12V

C206
0.01u(F)

C207
22u(A)

AGND

R212
3.6k(DIP)

R213
4.7k(DIP)

R214
150(DIP)

C208
470p(F)

AOUTL1N

C209
3.3n(F)

R217
3.6k(DIP)

R218
150(DIP)

AOUTL1P

R219
4.7k(DIP)

C210
470p(F)

AVSS

J202 LOUT1

AGND

R227
open

R228
open

R231
open

C216
open

J204 open

AOUTR2N

AGND

C214
opem

R229
opem

R230
opem

AOUTR2P

R232
opem

C215
opem

AVSS

U202 open

V- +INA -INA OUTA

+INB -INB OUTB V+

-12V

C217
open

C218
open

AGND

+12V

C219
opem

C220
open

AGND

R222
opem

R221
opem

R225
opem

C213
opem

AOUTL2N

C211
opem

R223
opem

R224
opem

AOUTL2P

R226
opem

C212
opem

AVSS

J203 open

AGND

- 30-

PORT301
COAX
2 1
4
6
R302 75
C301 1u
R305 10
DVSS2

R316 5.1 — MCLK
R313 10 — BICK/DCLK
R315 0 — LRCK/DSDL1

D3.3V
L301 10uH(DIP)
D3.3V
PORT302
VCC 3
GND 2
OUT 1
OPT
R307 470
R306 open

C303
C304 47u(A)
0.01u(F)
D3.3V

C305 0.01u(F)
C307 10u(A)
DVSS2

C306 0.01u(F)
R308 10k

R314 51 — SDTI1/DSDR1
R336 open — TST1
— TDMO1

48 47 46 45 44 43 42 41 40 39 38 37
RX3 VSS4 RX2 TEST1 RX1 RX0 NC VSS3 VCOM R AVDD INT1

U303
AK4118A
AK4118A

1 IPS0
2 NC
3 DIF0
4 TEST2
5 DIF1
6 VSS1
7 DIF2
8 IPS1
9 P/SN
10 XTL0
11 XTL1
12 VIN

D3.3V
DIF0
DIF1
DIF2

36 INT0 — INT0
35 OCKS0 — OCKS0
34 OCKS1 — OCKS1
33 CM1
32 CM0
31 PDN — 4118-PDN
30 XTI
29 XTO
28 DAUX
27 MCKO2
26 BICK
25 SDTO

13 14 15 16 17 18 19 20 21 22 23 24
TVDD NC TX0 TX1 BOUT COUT UOUT VOUT DVDD VSS2 MCKO1 LRCK

C310 0.01u(F)
C309 0.01u(F)
C311 10u(A)
C312 47u(A)
R323 0

D3.3V
SW301
SW DIP-5
10 9 8 7 6
1 2 3 4 5
DIF2 DIF1 DIF0 OCKS1 OCKS0

D3.3V
D3.3V

R317 51
R318 0
R319 open
R320 open
R321 open
R322 open

PORT303
HEADER 6X2
12 11
10 9
8 7
6 5
4 3
2 1

R324 10k
R325 0
R326 10k
R327 10k
R328 10k
R329 10k

OCKS0
OCKS1
DIF0
DIF1
DIF2

R330 10k
R331 10k
R332 10k
R333 10k
R334 10k

H
L

1:MCLK   2:GND
3:BICK/DLCLK 4:GND
5:LRCK/DSDL1 6:GND
7:SDTI1/DSDR1 8:GND
9:N.C.   10:GND
11:TDMO1   12:GND

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SILK-SCREEN
1:VDD
2:MCLR
3:PGD
4:PGC
5:GND

PIC18F4550
TQFP 44-PIN
U502

PIC18F4550

USB(B type)

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J601
+12V

C601
470u(A)
AGND

R602 short
+12V

J602
-12V

R601 short
-12V

C602
470u(A)
ANGD

J603
GND

AVSS
DVSS
DVSS2
AGND

+12V-->+5V
T601
NJM78M05FA
IN GND OUT

C603
47u(A)
C604
0.01u(F)
AGND
C605
0.01u(F)
C606
47u(A)

R612 3k(DIP)

C618
100u(A)
C615
0.01u(F)
AGND

U601
4 V-
3 +INA
2 -INA
1 OUTA
5 +INB
6 -INB
7 OUTB
8 V+

R604 short
AVDD

R605 short
VREFH1

R606 open
VREFH2

+12V

C616
0.01u(F)
C617
10u(A)

VREFL1
VREFL2
AGND

+12V-->+3.3V
T603
uPC29M33HF
IN GND OUT

C611
47u(A)
C612
0.01u(F)
C613
0.01u(F)
C614
47u(A)

R608 short
TVDD

R609 short
D3.3V

DVSS

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