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
- 2ch Analog outputs
- USB Port for Serial control

Figure 1. AKD4452-SA Block Diagram
Figure 2. AKD4452-SA Board Diagram
## Description

1. Connector for Power supply
   +12V, -12V, GND
   Terminals for power supply. Refer to Table 1.

2. AOUTL1/AOUTR1
   RCA Jack for analog outputs.

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

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

5. PORT303
   External digital data inputs to AK4452
   MCLK, BICK, LRCK/DSDL1, SDTI1/DSDR1, TDMO1
   When using the PORT3: R313=R314=R315=Open
   R319=R320=R321=R322=51 Ω
   When using the AK4118A: R313=R314=R315=R316=51 Ω (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 Table 2. SW301 setting.

9. SW401
   Setting switch for AK4452. Upside is “Hi”, downside is “Lo”
   Refer to Table 5. 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)”
Operation sequence

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

<table>
<thead>
<tr>
<th>Name of connector</th>
<th>Color of connector</th>
<th>Voltage</th>
<th>Use application</th>
<th>Comment and attention</th>
</tr>
</thead>
<tbody>
<tr>
<td>+12V</td>
<td>Red</td>
<td>+12V</td>
<td>Regulator</td>
<td>Should always be connected.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>OP-Amp</td>
<td></td>
</tr>
<tr>
<td>-12V</td>
<td>Blue</td>
<td>-12V</td>
<td>OP-Amp</td>
<td>Should always be connected.</td>
</tr>
<tr>
<td>GND</td>
<td>Black</td>
<td>0V</td>
<td>Ground</td>
<td>Should always be connected.</td>
</tr>
</tbody>
</table>

Table 1. Power supply line setting

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

(1) SW301 setting

<table>
<thead>
<tr>
<th>No.</th>
<th>Switch Name</th>
<th>Function</th>
<th>default</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>DIF2</td>
<td>DIF2-pin of AK4118A</td>
<td>Hi</td>
</tr>
<tr>
<td>2</td>
<td>DIF1</td>
<td>DIF1-pin of AK4118A</td>
<td>Lo</td>
</tr>
<tr>
<td>3</td>
<td>DIF0</td>
<td>DIF0-pin of AK4118A</td>
<td>Lo</td>
</tr>
<tr>
<td>4</td>
<td>OCKS1</td>
<td>OCKS1-pin of AK4118A</td>
<td>Hi</td>
</tr>
<tr>
<td>5</td>
<td>OCKS0</td>
<td>OCKS0-pin of AK4118A</td>
<td>Lo</td>
</tr>
</tbody>
</table>

Table 2. SW301 setting

<table>
<thead>
<tr>
<th>Mode</th>
<th>DIF2 pin</th>
<th>DIF1 pin</th>
<th>DIF0 pin</th>
<th>DAUX</th>
<th>SDTO</th>
<th>LRCK</th>
<th>BICK</th>
<th>I/O</th>
<th>I/O</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>24bit, Left justified</td>
<td>16bit, Right justified</td>
<td>H/L</td>
<td>O</td>
<td>64fs</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>24bit, Left justified</td>
<td>18bit, Right justified</td>
<td>H/L</td>
<td>O</td>
<td>64fs</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>24bit, Left justified</td>
<td>20bit, Right justified</td>
<td>H/L</td>
<td>O</td>
<td>64fs</td>
<td>O</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>24bit, Left justified</td>
<td>24bit, Right justified</td>
<td>H/L</td>
<td>O</td>
<td>64fs</td>
<td>O</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>24bit, Left justified</td>
<td>24bit, Left justified</td>
<td>H/L</td>
<td>O</td>
<td>64fs</td>
<td>O</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>24bit, I’S</td>
<td>24bit, I’S</td>
<td>L/H</td>
<td>O</td>
<td>64fs</td>
<td>O</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>24bit, Left justified</td>
<td>24bit, Left justified</td>
<td>H/L</td>
<td>I</td>
<td>64-128fs</td>
<td>I</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>24bit, I’S</td>
<td>24bit, I’S</td>
<td>L/H</td>
<td>I</td>
<td>64-128fs</td>
<td>I</td>
</tr>
</tbody>
</table>

Table 3. AK4118A Audio interface format

<table>
<thead>
<tr>
<th>OCKS1 pin</th>
<th>OCKS0 pin</th>
<th>MCKO1</th>
<th>fs (max)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>256fs</td>
<td>96 kHz</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>256fs</td>
<td>96 kHz</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>512fs</td>
<td>48 kHz</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>128fs</td>
<td>192 kHz</td>
</tr>
</tbody>
</table>

Table 4. AK4118A MCLK setting
(2) SW401 setting

<table>
<thead>
<tr>
<th>No.</th>
<th>Switch Name</th>
<th>Function</th>
<th>default</th>
</tr>
</thead>
</table>
| 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. |

Table 6. 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 software manual”.

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[AKD4452-SA]

[KM118703] 2019/06

- 5 -
Evaluation Board and Control Software Settings

1. Set an evaluation board properly.
2. Connect a PC (IBM-AT compatible) and the USB cable.
   The USB I/F is recognized as HID (Human Interface Device) on the PC.
   It is not necessary to install a new driver.
3. Start up the control program.
   When the screen does not display “AKUSBIF-B” at bottom left, reconnect the PC and the USB cable, and push the [Port Reset] button.
4. Proceed evaluation by following the process below.

[Support OS]
   Windows XP / Vista / 7
Operation Overview

Function, register map and testing tool can be controlled by this control software. 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 software 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 “---”.

![Figure 4. Window of [ REG ]](image-url)
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.

![Register Set](image)

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.

![Repeat Test Dialog](image)

- **[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.

![Loop Dialog](image)

- **[ 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→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.

![Figure 9: Window of [All Reg Write]](image)

- [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.

![Data Read/Write Dialog Box](image)

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]**: Writes 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.00069)
- **MCKI**: 512fs
- **BICK**: 64fs
- **fs**: 44.1kHz, 96kHz, 192kHz
- **Bit**: 24bit
- **Input Frequency**: 1kHz
- **Power Supply**: ±12V, GND
  - AVDD=VREFH=+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**

<table>
<thead>
<tr>
<th>DAC1 : SDTI1 =&gt; DAC1 =&gt; L/ROUT1</th>
<th>Result</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lch</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Rch</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>S/(N+D)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>fs = 44.1kHz (0dBFS)</strong></td>
<td>105.3</td>
<td>105.4 dB</td>
</tr>
<tr>
<td><strong>DR</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>fs = 44.1kHz (-60dBFS, A-Weighted)</strong></td>
<td>114.9</td>
<td>114.7 dB</td>
</tr>
<tr>
<td><strong>S/N</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>fs = 44.1kHz (No Inputs, A-weighted)</strong></td>
<td>115.0</td>
<td>114.8 dB</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>DAC1 : SDTI1 =&gt; DAC1 =&gt; L/ROUT1</th>
<th>Result</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lch</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Rch</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>S/(N+D)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>fs = 96kHz (0dBFS)</strong></td>
<td>102.5</td>
<td>102.6 dB</td>
</tr>
<tr>
<td><strong>DR</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>fs = 96kHz (-60dBFS, A-Weighted)</strong></td>
<td>114.6</td>
<td>114.3 dB</td>
</tr>
<tr>
<td><strong>S/N</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>fs = 96kHz (No Inputs, A-weighted)</strong></td>
<td>114.7</td>
<td>114.5 dB</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>DAC1 : SDTI1 =&gt; DAC1 =&gt; L/ROUT1</th>
<th>Result</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lch</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Rch</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>S/(N+D)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>fs = 192kHz (0dBFS)</strong></td>
<td>102.6</td>
<td>102.3 dB</td>
</tr>
<tr>
<td><strong>DR</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>fs = 192kHz (-60dBFS, A-Weighted)</strong></td>
<td>114.5</td>
<td>114.3 dB</td>
</tr>
<tr>
<td><strong>S/N</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>fs = 192kHz (No Inputs, A-weighted)</strong></td>
<td>114.6</td>
<td>114.5 dB</td>
</tr>
</tbody>
</table>
[Plot Data]

1. $fs=44.1\text{kHz}$, $MCLK=512fs$, $B\text{ICK}=64fs$

DAC1 : SDTI1 $\rightarrow$ DAC1 $\rightarrow$ L/ROUT1

Figure 11. FFT (0dBFS) [$fs = 44.1\text{kHz}$]

Figure 12. FFT (-60dBFS) [$fs = 44.1\text{kHz}$]
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. \( fs=96\text{kHz}, \ MCLK=256\text{fs}, \ \text{BICK}=64\text{fs} \)
   \[ \text{DAC1 : SDTI1} \Rightarrow \text{DAC1} \Rightarrow \text{L/ROUT1} \]

Figure 19. FFT (0dBFS) \( [fs = 96\text{kHz}] \)

Figure 20. FFT (-60dBFS) \( [fs = 96\text{kHz}] \)
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]
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 $f_s=192$kHz)

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

<table>
<thead>
<tr>
<th>Date (yy/mm/dd)</th>
<th>Manual Revision</th>
<th>Board Revision</th>
<th>Reason</th>
<th>Page</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>14/10/23</td>
<td>KM118700</td>
<td>0</td>
<td>First edition</td>
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