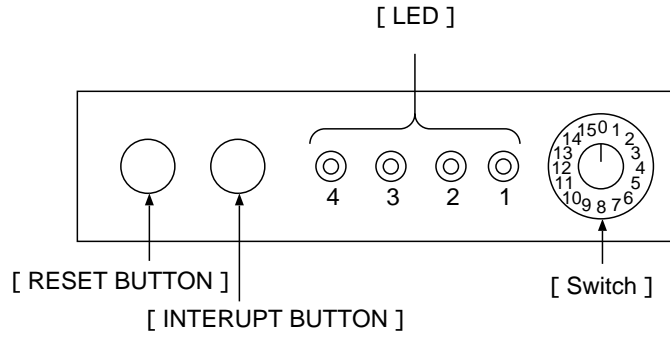
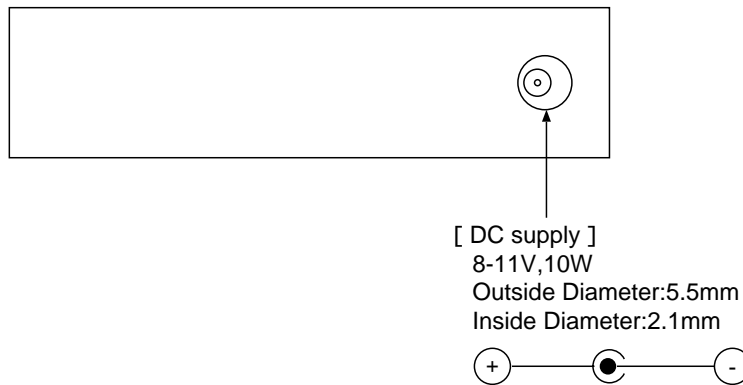


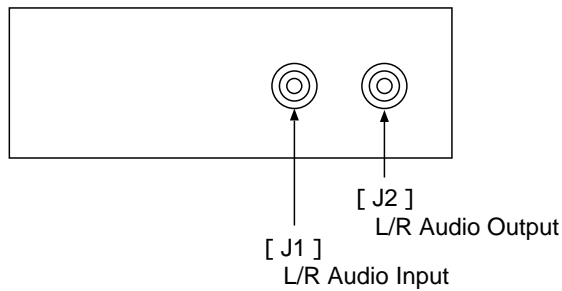
1 Introduction of the Controller



☒ 1: Front



☒ 2: Back



☒ 3: Right side

2 Hardware

DSP	AnalogDevicesADSP – 2181(16bitfixed – point)
Codec	AnalogDevicesAD1847(16bit)
Samplint Rate	Max48kHz
the number of Audio Input	2
the number of Audio Output	2
Input Signal	max $2V_{\text{rms}}$
Output Signal	max $1V_{\text{rms}}$
PowerSupply	8 – 11V, 10W

3 Operation Mode

0. LED check
1. Estimation of the error path \hat{c}
2. Adaptive FIR controller with filtered-x LMS algorithm
3. Fixed FIR controller
4. Adaptive FIR controller with leaky filtered-x LMS algorithm
5. Level display of right channel input signal
6. Adaptive FIR filter for feedback cancellation
7. Fixed FIR filter for feedback cancellation
8. Setting sampling frequency
9. Setting step size
10. Setting tap length
11. Setting Leak coefficient

4 Running the controller

1. Connecting controller with peripherals

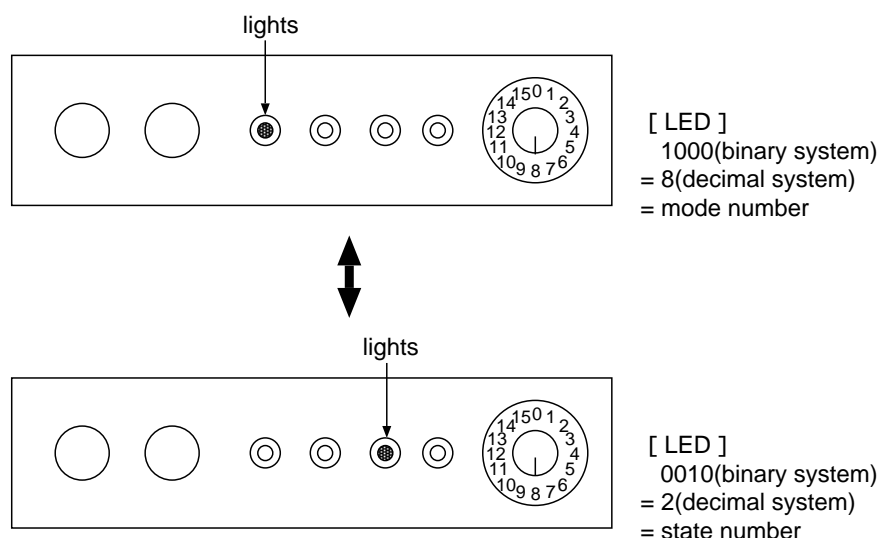
Connect the controller with the peripherals according to “5 input/output signals” (pp.7-8)

2. Starting controller

1. Connect the controller with the AC adapter
2. Push the RESET switch
3. Four LEDs light sequentially when the controller starts normally.

3. Setting parameters

Set the parameters according to “6. operation parameter” (p.8) and “3. operation mode” (p.2). The initial value of each parameter is the value of the state number 0. First, to set each parameter, set the toggle switch to the operation mode number. When setting the sampling frequency, set the toggle switch to 8, when setting the step size, set the toggle switch to 9, when setting the step size, set the toggle switch to 10, and when setting the leak coefficient, set the toggle switch to 11. When you push the INTERRUPT switch once, the state number increases by 1, and when you push the interrupt switch 16 times, the state number returns to 0. For instance, to set the sampling frequency 4kHz, set the toggle switch to 8 and push the INTERRUPT switch twice. LEDs blink alternately as follows, after the setting.



4. Starting and stopping operation

To start the operation with the mode from 1 to 7, set the toggle switch to the operation mode and push the INTERRUPT switch. After starting an operation, push the INTERRUPT switch to restart the operation. To stop the operation, set the toggle switch to 0 and push the INTERRUPT switch.

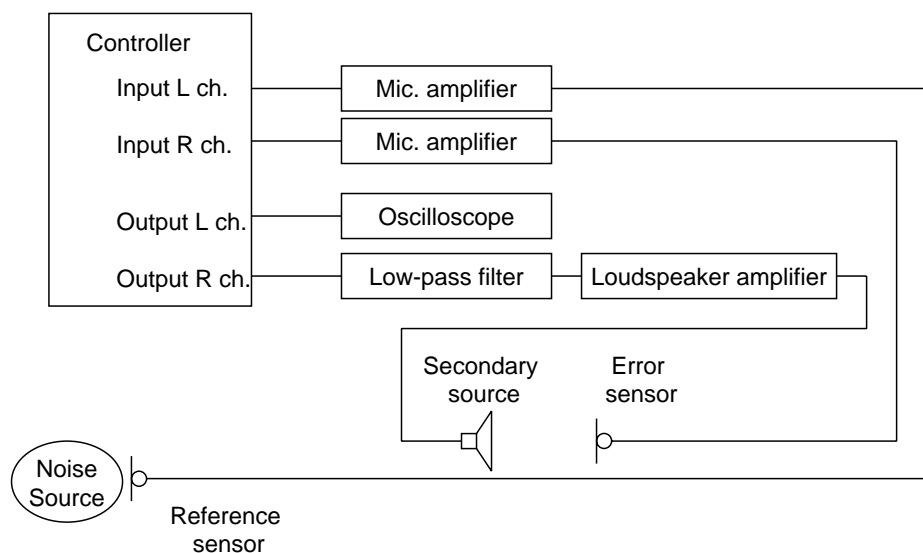
4.1 Example –adaptive ANC with filtered-x LMS algorithm

0. Peripherals

- Controller ×1
- Oscilloscope ×1
- Loudspeaker amplifier ×1
- Loudspeaker ×1(secondarysource)
- Microphone amplifier ×2channels
- Microphones ×2(errorsensorandnoisesensor)
- Low-pass filter ×1

1. Connecting controller with peripherals

Connect the controller with the peripherals as follows,



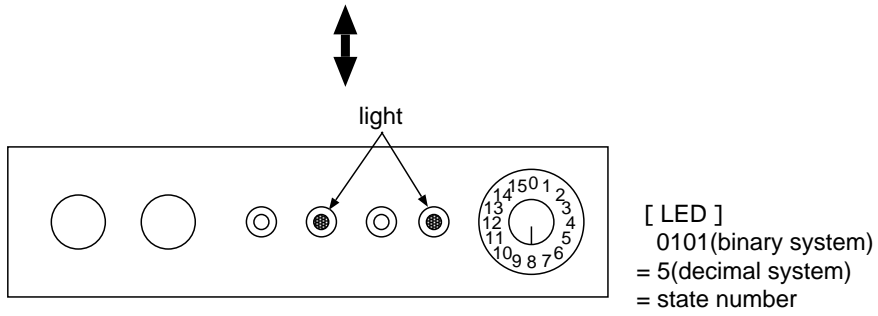
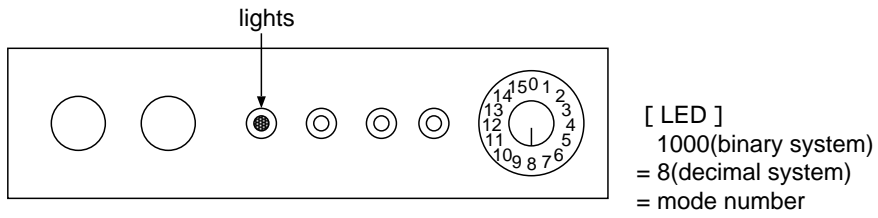
2. Start controller

3. Setting parameters

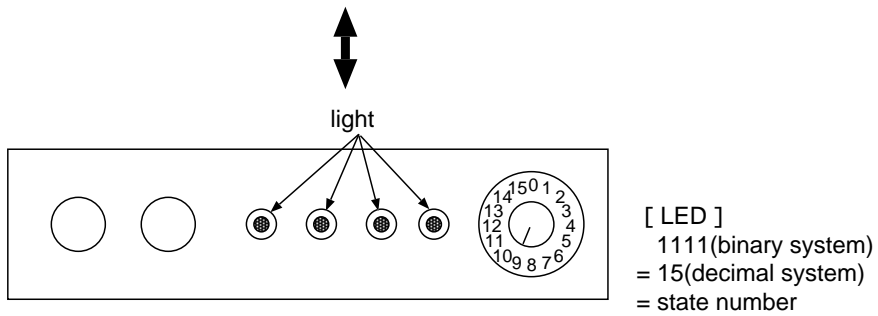
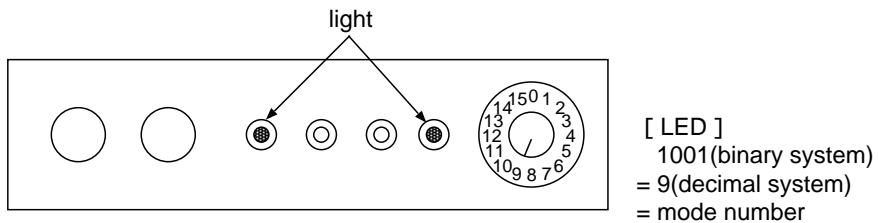
To set the sampling frequency 2kHz, the step size 0.00098, and the tap length 768, operate the controller as follows. First, to set the sampling frequency, set the toggle switch to 8, and push the INTERRUPT switch 5 times. And, confirm LEDs blink as shown in figure 4. Second, to set the step size, set the toggle switch to 9, and push the INTERRUPT switch 15 times. And, confirm LEDs blink as shown in figure 5. Finally, to set the tap length, set the toggle switch to 10, and push the INTERRUPT switch 4 times. And, confirm LEDs blink as shown in figure 6.

4. Estimating the error path

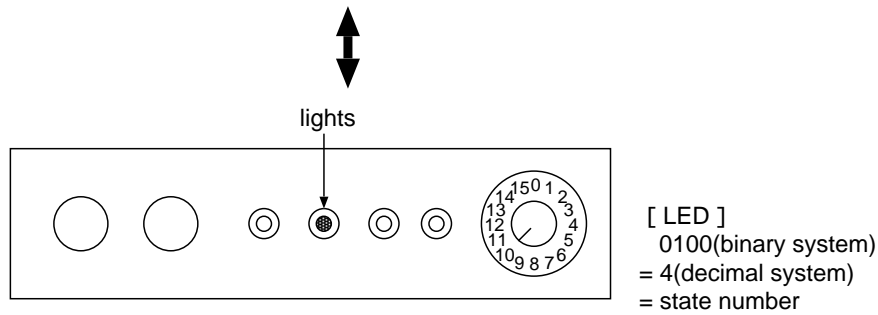
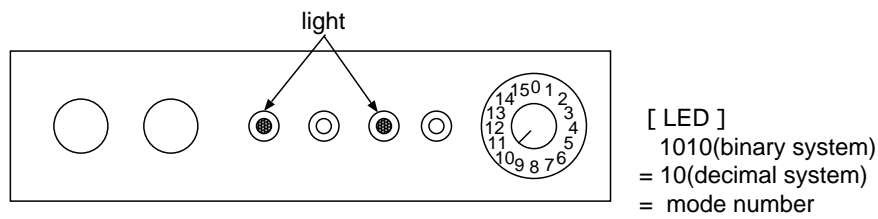
Start estimating the error path by setting the toggle switch to 1 and pushing the INTERRUPT switch. You can confirm the error of the estimation, which is the left channel output, by the oscilloscope. If the error path is estimated well, the signal



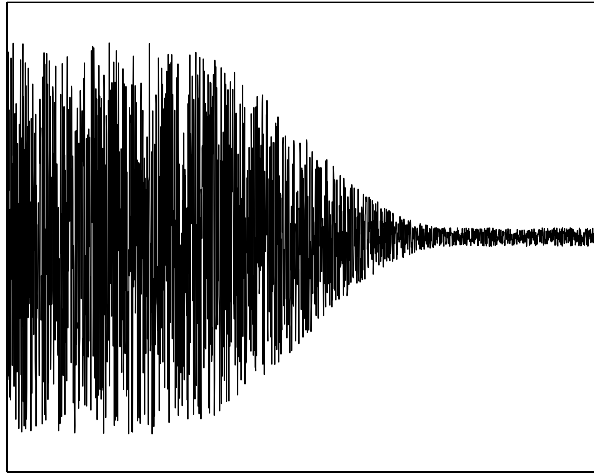
☒ 4: Sampling frequency



☒ 5: Step size



☒ 6: Tap length



⊗ 7: Estimation error

becomes small gradually, and finally becomes stationary as shown in figure 7. If you don't have an oscilloscope, you can confirm the state of the estimation by the LEDs on the front panel. When the estimation error is large, left LEDs light. And, LEDs disappear gradually from the left when the error becomes small. When the error path is not estimated well, adjust the volume of the loudspeaker amplifier of the secondary source and the volume of the amplifier of the error sensor. To stop the operation, set the toggle switch to 0 and push the INTERRUPT switch.

5. Adaptive control with LMS algorithm To start the control, set the toggle switch to 2 and push the INTERRUPT switch.

5 Input/Output signals

- mode 1

- Left channel output : Estimation signal
 - Right channel output : Secondary source
 - Left channel input : none
 - Right channel input : Error sensor

- mode 2

- Left channel output : none
 - Right channel output : Signal to secondary source
 - Left channel input : Reference signal
 - Right channel input : Error signal

- mode 3

- Left channel output : none
 - Right channel output : Signal to secondary source
 - Left channel input : Reference signal
 - Right channel input : none

- mode 4

- Left channel output : none
 - Right channel output : Signal to secondary source
 - Left channel input : Reference signal
 - Right channel input : Error signal

- mode 5

- Left channel output : Amplitude of the signal
 - Right channel output : none
 - Left channel input : none
 - Right channel input : Signal

- mode 6

- “ Feedback cancellation”

- Left channel output : Reference signal to the other controller
 - Right channel output : none
 - Left channel input : The other controller’s signal to secondary source
 - Right channel input : Reference signal

- “Prediction error measurement ”

- Left channel output : Prediction error signal
 - Right channel output : none
 - Left channel input : Reference signal
 - Right channel input : Error signal

- mode 7

- Left channel output : Reference signal to the other controller
 - Right channel output : none
 - Left channel input : The other controller’s signal to secondary source
 - Right channel input : Reference signal

6 Parameters

State number	Sampling frequency mode 8	Step size mode 9	Tap length mode 10	Leak coefficient mode 11
0(initial)	6,000	0.002	1,024	0.999969
1	4,800	0.0039	960	0.99976
2	4,000	0.0078	896	0.9995
3	3,000	0.0156	832	0.9993
4	2,400	0.03125	768	0.999
5	2,000	0.0625	704	0.9988
6	1,500	0.125	640	0.9985
7	1,000	0.25	576	0.9983
8	750	0.5	512	0.998
9	500	0.99997	448	0.9978
10	48,000	0	384	0.9976
11	24,000	0.00006	320	0.9973
12	16,000	0.00012	256	0.997
13	12,000	0.00024	192	0.9968
14	9,600	0.00049	128	0.9966
15	8,000	0.00098	64	0.9963