Comparison of Preamplifiers for Low-power Consumption Design

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1. Introduction

The commonly used electronic devices in radiation detector system are the preamplifier, the amplifier, ADC, and etc. to extract the signal from the detector and to process the signal. These components are composed of semiconductor devices like BJT, MOSFET, OPAMP, and etc. Performance and power consumption of these components are various according to the composition of semiconductor devices [1 - 2].

In this study, preamplifiers, which are composed of high efficiency semiconductor devices, are compared to design low-power consumption and high performance preamplifier. To confirm the purpose, preamplifiers are designed for low-power consumption and high gain by some OPAMP (Operational Amplifier). The comparison was performed by experimental result and design simulation.

2. Circuit Design of a Preamplifier

The current signal coming from the radiation sensor is converted to voltage signal by FET semiconductor device. The capacitor (C_c) is used for RC circuit to define pulse shaping time and it also prevents the DC signal. R_f, C_f and R_1 decide the gain of preamplifier. The schematic diagram of the circuit is shown in Fig.1 [3].

3. Experiments and Results

3.1 Experiments

To compare the designed circuit, which is composed of various OPAMPs, hybrid-type preamplifier (SP-110) was used and experimented [4]. An ORTEC 572 amplifier, an ORTEC 448 research pulser, and a ULS1202 MCA were used. The experimental setup is shown in Fig.2.

The value of test pulse signal was fixed as below.

■ *Test pulse values*
○ Amplitude: 4mV
○ Decay time constant: 50usec
○ Pulse/sec: 5
○ Rise time: 100nsec

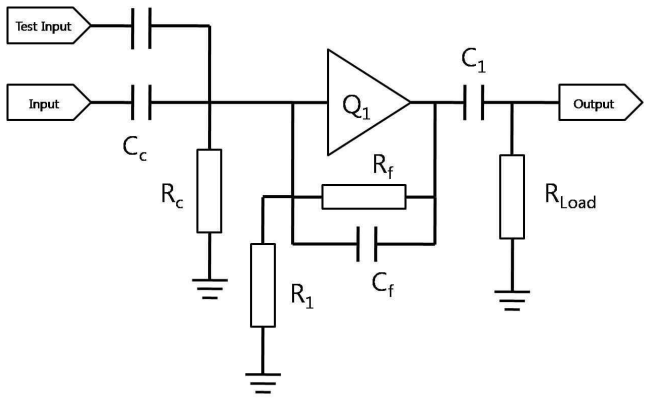

Fig.1. The schematic diagram of AD829A Preamplifier circuit. (C_c=100 nF, R_c=1 kΩ, R_f=2.2 kΩ, C_f=60 pF, R_1=300 Ω, C_1=4.7 uF, R_{Load}=47 Ω)

Fig.2. ORTEC572 amplifier, ULS1202 MCA, and Preamplifier (SP-110) using experiments.

AD829A and AD8510 OPAMPs were used in a fabricated preamplifier circuit design. These are suitable semiconductor devices for radiation detector [5].

3.2 Results

The output signal of SP-110 is shown in Fig.3. It showed that the output signal was very stable and reliable. Before measuring the power consumption, the output signal of a fabricated preamplifier was normalized.

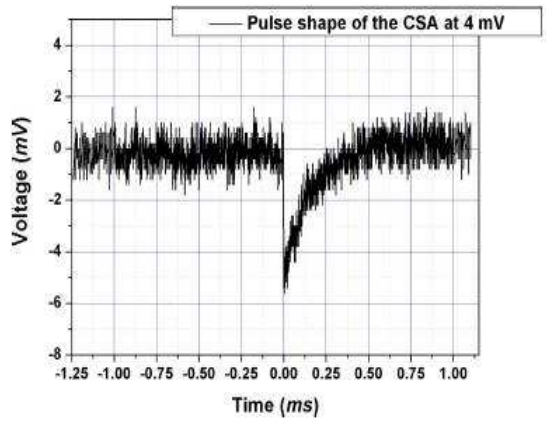

Fig.3. SP-110 Preamplifier Output signal

The value of amplitude and time constant was almost the same as SP-110 output signal. The value of power consumption and gain of preamplifiers is shown in Table.1 and the preamplifier output signal of AD829A and AD8510 are shown in Fig.4.

The result of preamplifier showed that AD829A and AD8510 was very powerful device to use in front-end detector. As a result, the AD8510 OPAMP was more suitable to operate as preamplifier circuit with low-power dissipation than the AD829A. Also, it has very high voltage gain in low bias (±5V).

Table 1: Output Value of Preamplifiers

	Power consumption (mW)	Voltage Gain (Output/Input)
SP-110	144	7.09
AD 829A	60	9.18
AD 8510	35	9.7

4. Conclusions

In this study, we confirmed the advantages of low-power consumption device, especially the AD8510 OPAMP. All results considered, as the lower power device uses, the more power saving during the operation.

In conclusion, the detector using low-power devices is required in various fields such as environmental monitoring, industrial, medical, and etc. The radiation imaging system needs low power dissipation in the whole detection system, because of its large-scaled radiation detector. With the developed circuit we assumed that the low power device for radiation imaging system is applicable.

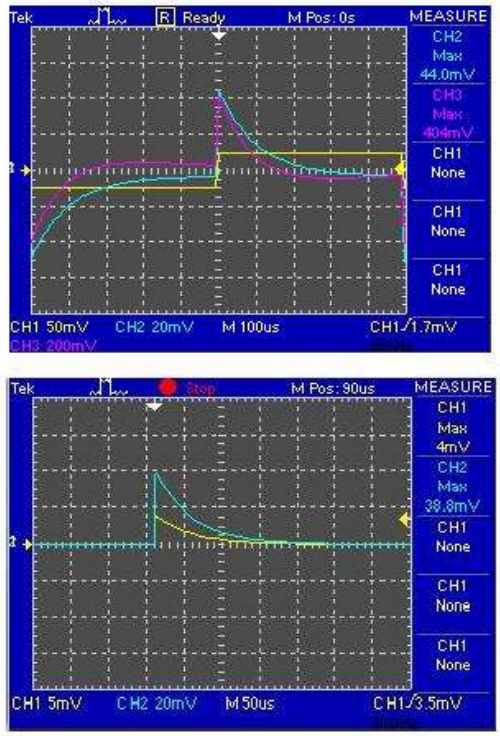

Fig.4. Pulse shape of AD829A(upper) and AD8510 (lower) output signal

Acknowledgments

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