Application of the Integrated Signal Converting Circuit in the Nuclear Fields

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1. Introduction

In the present nuclear fields, all Instrument and Control (I&C) applications are operating by the analog method using the analog device and passive things. It is hard to make miniaturization of modules and robust system against noise, reliability is decreased also because malfunctions are occurred very often. In order to solve these problems, we suggest that adopt the digital method using the digital device and active things in the nuclear fields. In these papers represented, from these results of the investigation [1].

2. System Architecture

In this paper describe, the digital system has application using variety integrated device, advanced manufacture, validation and verification to improve present I&C system in nuclear fields. And also written, compared advanced performance and results. Especially it describes stable operation and robust circuit against noise.

2.1 Circuit Description

The basic concept of whole system is constructed using digital signal processor likes master function and four kinds of modules like slave generally. The modules are communicating each other by VME bus system. Especially I&C system is consisted of bistable module, coincidence module, Reactor trip initiation module, maintenance module and so on [1].

It will describe digital to analog converter among signal converting systems from now on. The following circuit is one approach to make the conversion from stepwise digital information to a voltage. It's called an R-2R ladder. Both 'H' and 'L' indicate the levels of analog output in the converter [2].
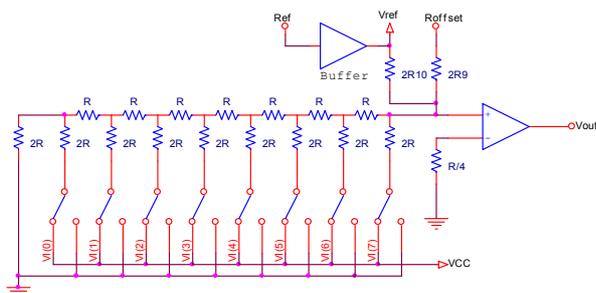

Figure 1. The basic circuit of N-channel ladder network in the general digital to analog converter.

The analog output signal is responded by digital input signal from D_0 to D_n node. It can calculate by (1) equation that shown below [3].

$$V_o = \frac{D_0 \times 2^0 + D_1 \times 2^1 + D_2 \times 2^2 + ... + D_n \times 2^n}{2^{n-1}} V_{ref} \quad (1)$$

It can increases high precision from the number of channel of a ladder circuit. Therefore, the N-channel ladder circuit can get voltage resolution of (2) equation likes below [3].

$$\text{Voltage Resolution} = \frac{V_{ref}}{2^n} \quad (2)$$

A block diagram of all modules is related that is shown in below. It is supplied more detailed information that is general signal converting devices to make sure.
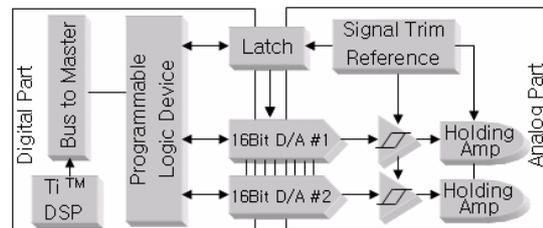

Figure 2. The functional block diagram in the digital to analog converting device.

The below figure is simply shown a functional block diagram that is applied to Digital to Analog Converter(DAC) for real time dual duplex operation for next generation nuclear field.

It also consist of VME bus system, power isolation, signal isolation for protection circuit against inadequate environment, signal buffer for trimming, output signal holding amplifier.

All of these circuits are operating by the digital signal processor assembly language, the VHDL code sources for high reliability. Almost logics are realized programmable logic than compose of analog component and transistor logic like passive things. Because a programmable logic is more stable than connect each other logic on external board.
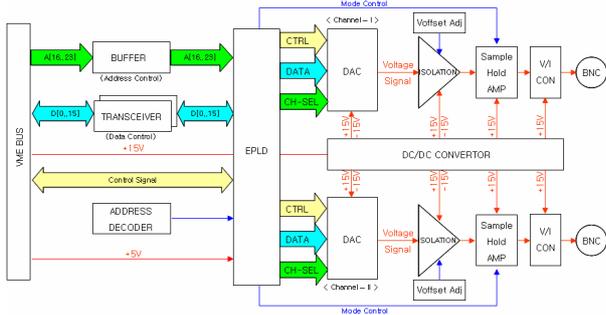
Figure 3. The signal converting system in VME bus network for example digital to analog converting scheme.

2.2 Performance Description

The most of I&C signal that is used in nuclear field is a linear format, voltage and current, in specific range.

The below code is made by the VHDL structure. It should be able to see a saw shape analog signal that is operating dual channels on the oscilloscope. And operating object of latch system must be tracking and holding an output signal that is required by destination needs.

```
process(sysclk, ch_flag)
begin
    if(ch_flag='00000010') then
            /* address decoding code
        if(sysclk'event and sysclk='1') then
            /* channel decoding code
            case temp1 is
                when reg0 =>
                    /* digital to analog convering function code
                    /* appendix test table code
                    /* johnson counter parameter table
            end case;
        end if;
    end if;
end process;
```

Figure 4. The sample code for signal converting in system.

For our analysis, digital signal converted into analog signal. In below figure digital signal supplied using a Johnson counter as input signal, therefore output analog signal generated within the range of 0 to +10V unipolar signal. It can also generated -10V to +10V bipolar signal. This voltage signal rang is common to adopt signal converting system for using mechanical control system or to change easily current signal, frequency form and so on.
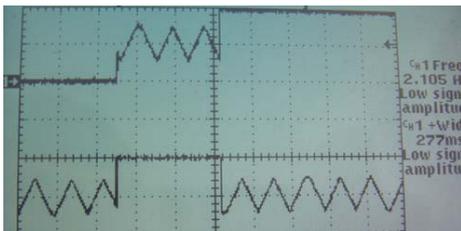

Figure 5. The signal that digital to analog converted (input Johnson counter to device, output analog signal 0 to +10V).
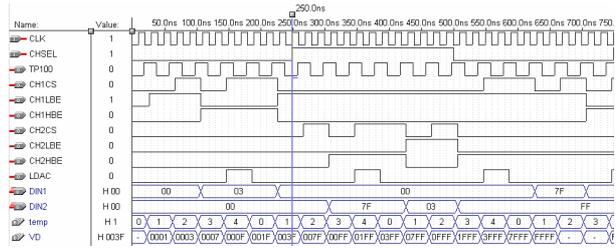

Figure 5. Simulation response of D-A converting function.

2.3 Simulation Description

According to this paper, the signal converting system is more weight on nuclear field than others. So it needs more precise output signal and stable operation in any environment. The following results are compared between converting circuit with analog and digital method.
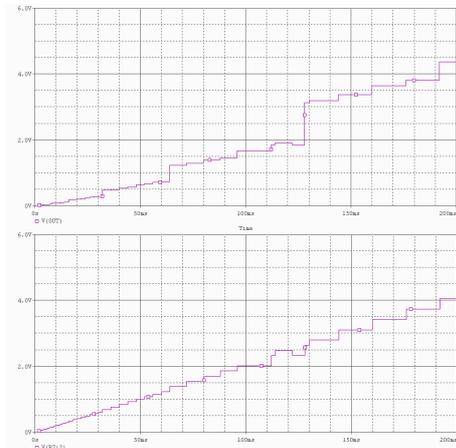

Figure 6. Cadence Spectra simulated result of D-A converting circuit with (a) analog circuit, (b) digital circuit.

3. Conclusion

The purpose of this paper is to introduce a method of signal converting that is used to digital things. Moreover, two concepts are suggested in this paper. As follows: First, to adopt the integrated converting device can get not only stable operation but also precise output signal much than associated analog things. Second, it makes more easily maintenance and can consist of the circuit simply. And it recommends circuit of design schematic by duplication and redundancy system.

REFERENCES

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[3] Robert Boylestad, Louis Nashelsky, "Electronic Devices and Circuit Theory, 7th Edition", p.829 to 833, 1999.