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# Speed Control of Motor for City Railway System by Using Rotor Position and Speed Detector

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**Abstract.** As a speed control device for motor control, optical encoders are frequently employed, while resolvers are used when mounting of the encoder onto a motor is structurally difficult. Although the resolvers are disadvantageous in the price aspect compared with the encoders, they are useful in the case of control based on the positions of stimulus as absolute positions of the rotor are detected. In the present article, the minimum hardware of filter was used as a method to detect rotary speed of the motor according to the resolver, and a speed detector by digital method according to a program has been presented.

**Keywords:** Speed control, Motor control, Encoder, Resolver

## 1 Introduction

When a motor is controlled, the information on rotary speeds should be detected precisely and fast. while speed detection device should have a low price, accurately measure positions and speeds of the rotor, and allow flexible control methods. For control of a rotating device, movement or rotated positions of the rotating body should be accurately measured by the detection device installed on the rotating shaft. There are resolver and encoder as a detector which has been adopted and used for such method, and these detectors have advantages and disadvantages, respectively.

For estimation of speeds, methods of using an observer are known. While there are excellent characteristics in the range of estimation by the observer even if there is an error of various integers, problems occur in the case of inertia of the object system applied or great variation of loads. For position detection in motors, encoders of optical method are mainly used in general, while encoders or resolvers employing a magnetic method are being used when vibration, etc. are severe. Traction motor for driving vehicles is connected to a truck supporting wheels, requiring solid mechanical

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characteristics for the encoder to detect speeds under operation conditions such as vibration, etc. Thus, magnetic detection method is mainly used for the encoders attached to motors in comparison with encoders of general optical methods. When the controller controls on the basis of rotor positions as in a synchronous motor, the position information is a very important element. Since a technique for accurate estimation of the rotor position should be used in the case of using an encoder of low resolution when a synchronous motor is used as a structure for directly connecting a traction motor to the wheel, the resolver was employed in the present study.

## 2 Design of Detector

Since excitation voltages are to use sine waves, sine waves are generated by Wien bridge, which are amplified to be used as excitation voltages. Since the detector (resolver) is attached to the motor driven by a power converter to output signals including noise caused by leakage flux, etc. the use of filter and differential input circuit to remove the noise is essential. Therefore, the excited signals and the output signals will have a phase lag, and the maximum output voltages should be sampled irrespective of transfer function of the filter. However, in the present study, a circuit operated for the fixed filter was designed by using the block as shown in Fig. 1.

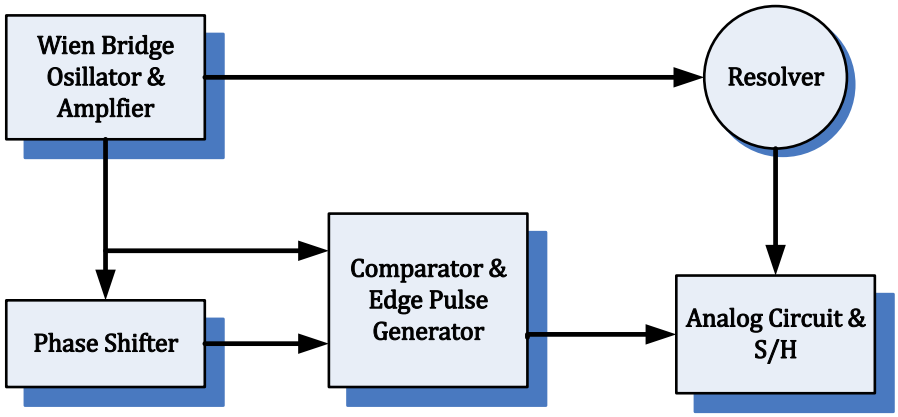


**Fig. 1.** Resolver signal processing

## 4 Position & Speed

The waveforms of cosine and sine obtained from the resolver are inputted in the controller as digital signals, with position and rotary speed of the rotor being calculated by the program. Position of the rotor is calculated as shown by the equation (1).

$$\theta = tan^{-1}\left(\frac{sin\theta}{cos\theta}\right) \quad (1)$$

Since the noise is included in the rotor position according to the equation (1), inaccuracy in position information cannot be excluded.

## 5 Result

As a method for varying the speeds by the program in a controller, step response was measured. While the response was being observed, gains of the PI controller as a speed estimator were determined.

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