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CEDM Controller with Pulse Width Modulation Method for Step Motor-Type -CEDM

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1. Introduction

The step motor is a DC electric machine with inner and output stator in coolant medium inside a strong housing in integral reactor.
Developed CEDM Controller is being developed with a new design concept to improve the systems' availability and reduce the operating failure.
And Switched Mode Power Supply is also being developed with new control technique for regulating individual CEDM power source. Motor driving phase sequences is selected to full step mode and Pulse Width Modulation Method is introduced for operating step motor. Due to fast switching frequency (20kHz), filter size is very smaller than conventional filter size.
Because of using two kind of position sensor, position calculation is more precise.
The objective of this paper is to introduce and to explain the developed CEDM controller & SMPS and provides the test of control waves (PWM signal) .

2. Major Function & configuration

Each CEDM is an integral unit consisting of a step motor and a mechanical CEDM set. CEDMCS controls the CEA motion speed with a 0.25mm/sec or 2mm/sec velocity and it also regulates the magnetic force in order to pull or drop the CEAs.

CEDM control system consists of a microprocessor board, photo coupler, switch driver and a SMPS. SMPS is the power conversion equipment for modulating the frequency of the AC power source. Main function of the SMPS is to provide a modulated/varied 4 phase pulse voltage source for the step motors which move CEAs up or down.

SMPS is composed of a 3 phase rectifier, switching device, photo coupler and switching drivers and a snubber circuit(if necessary).

Fig 1 shows overall block diagram of developed step motor controller. Microprocessor-based system is industrial computer which calculates position value from the pulse counting value and ultrasonic sensing value

Microprocessor-based system also provides command signal for controller which generates the pulse wave. SMPS controller is composed of L297 and other auxiliary devices. L297 chip performs major function of SMPS controller.

Following selective functions are provided in SMPS controller.
-clockwise or counter clockwise rotation or hold status
-full step mode technique
-switching frequency

3. CEA control & position calculation

Conventional CEDM controller is magnetic-jack type driver using SMPS which is composed of thyristor module whereas developed CEDM controller is based on Microprocessor system and IGBT Module which is easily controlled than thyristor module
It is possible for developed controller to be precisely controlled and accurate position calculation and also availability is improved

1) Improvement of the Control Accuracy
In normal operation, CEDM controller generates four(4) trimmed pulse power by every second for driving the Step Motor. This control method is very high accurate. Control accuracy is below 0.25m and is lower than 3cm of conventional CEDM controller.

Fig 2. shows the PWM signal which initiate the IGBT module. Trimmed pulse power is provided for each step motor and switching frequency is 20kHz. Because of fast switching frequency, low pass filter for eliminating the high frequency noise is smaller

X axis shows time division and Y axis shows voltage division. And pulse waves are A, B, C, D phase pulse waves respectively from upper to lower. Step motor driving sequence was selected to full step mode technique. Full step mode technique (two-phase-on) is to magnetize stators in following sequence

-Clockwise rotation : A-B, B-C, C-D, D-A
-Count clockwise rotation : A-D, D-C, C-B, B-A

2) Precise CEA position Calculation
Precise CEA position calculation is very important for monitoring the CEA position and a precise CEA control.
CEA Position is calculated by using following major input signals ; two(2) ultrasonic sensor, four(4) pulse counting for driving the step motor.

Table 1 shows the input signals, CEA movement, motion speed and direction of two sensor, respectively. Input signals are pulse counting values and ultrasonic sensing value. When one(1) cycle of four(4) phase pulse waves is completed, CEA is moved by 0.25mm up or down. If pulse sequence is clockwise rotation, CEA moves up. If pulse sequence is counter clockwise rotation, CEA moves down.
As CEA is not moved(hold), only two(2) phase pulse waves are provide for step motor.
Ultrasonic sensing value is used for checking mechanical action.
In case of CEA stuck event, system can check CEA position by using the ultra sensing value. Whereas it is impossible to check CEA position by using the pulse counting values in same environment.

Table 1. Major Input for position calculation

	Hole sensor (Pulse Counting)		Ultrasonic sensor	
Input	4 pulse	2 pulse	2 input	
Movement	Up/down	Hold	move	Hold
Speed	0.25mm/sec	0	Motion Check	0
Direction	Up/down direction		N/A	

4. Conclusion

CEDM Controller involving SMPS was developed with a new design concept and control technique to improve systems' availability and accuracy.
PWM method and full step mode technique(two-phase-on) are adopted to develop controller and CEA position calculation is more precise than conventional calculation method.

In this paper, new CEDM controller concept is proposed and compared with conventional CEDM controller. Advantages of the controller are the following

-More easy switching device control
; IGBT module VS thyristor module
-Improvement of Control Accuracy
; 0.25mm/second
-Precise CEA position calculation
; combination of two sensing values
-Minimization of low pass filter size

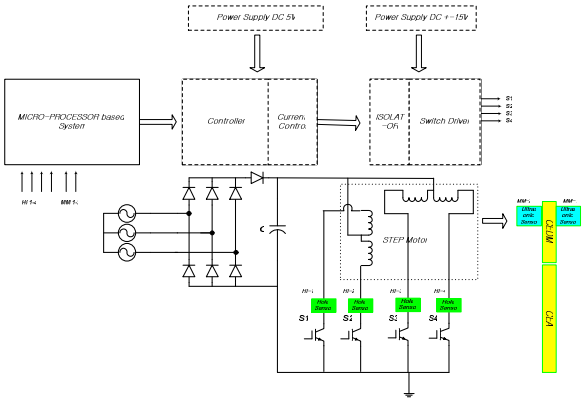

Figure 1. Simplified Block Diagram of the developed Step Motor Controller.

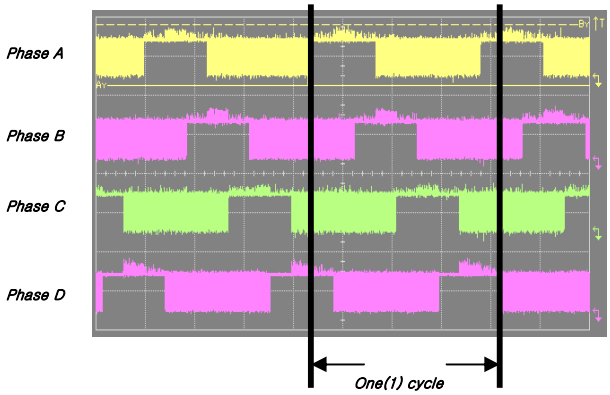

Figure 2. PWM signal (Phase A,B,C,D) in controller for operating the Step Motor

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