

## EXPERIMENT 3

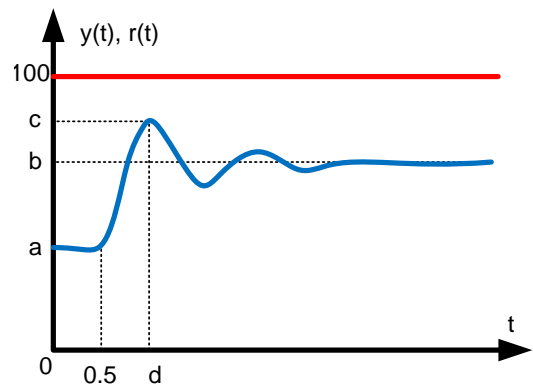
# FAN AND PLATE CONTROL EXPERIMENT SHEET

### 1. Purpose of Experiment

Purpose of this experiment is understanding basic steps for control of a physical system. It is aimed to show that in practice, what kinds of elements are required for control except the physical system. During the experiment, a mathematical model of the physical system will be obtained by using theoretical methods which are learned in the previous lectures. After that, a control system will be implemented by using this mathematical model. Furthermore, it is aimed to give the ability to use SINAMICS G100 motor driver which is used in the control loop.

### 2. Pre-Report

- Find the transfer function of the second order plus dead time system which step response is given on the right. Take last two numbers of your student number as  $n1$  and  $n2$ .  
 $a = 40 + n1$   
 $b = 60 + 0.5 (n1 + n2)$   
 $c = 70 + n2$   
 $d = 0.9 + 0.02 (n1 + n2)$
- Find the discrete transfer function of the systems by choosing a proper sampling time.
- Find PID controller coefficients ( $K_c$ ,  $T_i$  and  $T_d$ ) which give critical damped response for the closed loop system.



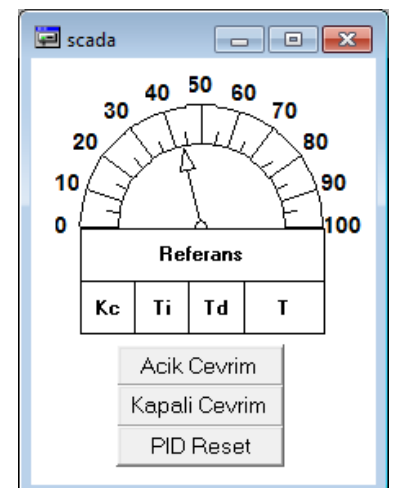
Note: You can bring Control System Design and Computer Controlled Systems lecture notes to the experiment.

### 3. Experiment

1. Open TwinCAT Software. From “Online” tab, click “Login” and connect to the Beckhoff PLC. Again from the “Online” tab, click “Run”.



2. SCADA screen given in the figure will appear. By using this screen, the systems can be run with open or closed loop, controller parameters and sampling time can be changed, step input of the system can be set between 0-100.



3. Open graphic interface. Changes of input signal, control signal and system response can be monitored with this interface.



4. In open loop mode, set the reference signal from the SCADA screen and monitor the system response with the graphic interface.



5. Find the mathematical model of the system by using the open loop system step response.

6. From the mathematical model, find a proper sampling time by using Bode diagram.

7. Find the discrete model of the system.

8. Design a PID controller which provides a critical damped response.

9. Enter the controller parameters and sampling time to the SCADA screen.

10. In closed loop mode, set the reference signal from the SCADA screen and monitor the system response with the graphic interface.

#### **4. Report**

- Detailed description of the experiment set
- Block diagram of the control system
- Calculation of the mathematical model of the system
- Choosing of the sampling time
- Calculation of the discrete model of the system
- Design and results of the controller. Comparing theoretical and practical results.

#### **5. References**

1. Otomatik Kontrol Sistemleri, Benjamin C. Kuo, Çeviri: Prog. Dr. Atilla Bir, 1999
2. PLC ile Endüstriyel Otomasyon, Doç. Dr. Salman Kurtulan, 5. Basım, Birsen Yayınevi, 2008

## APPENDIX 1 – SINAMICS G100

In this experiment, angular position of a metal plate will be controlled. Movement of the plate is provided with air flow. This air flow is obtained with an asynchronous motor and fan set. SINAMICS G100 industrial driver is used to drive the asynchronous motor. Circuit diagram of the motor driver is given in Figure 1.

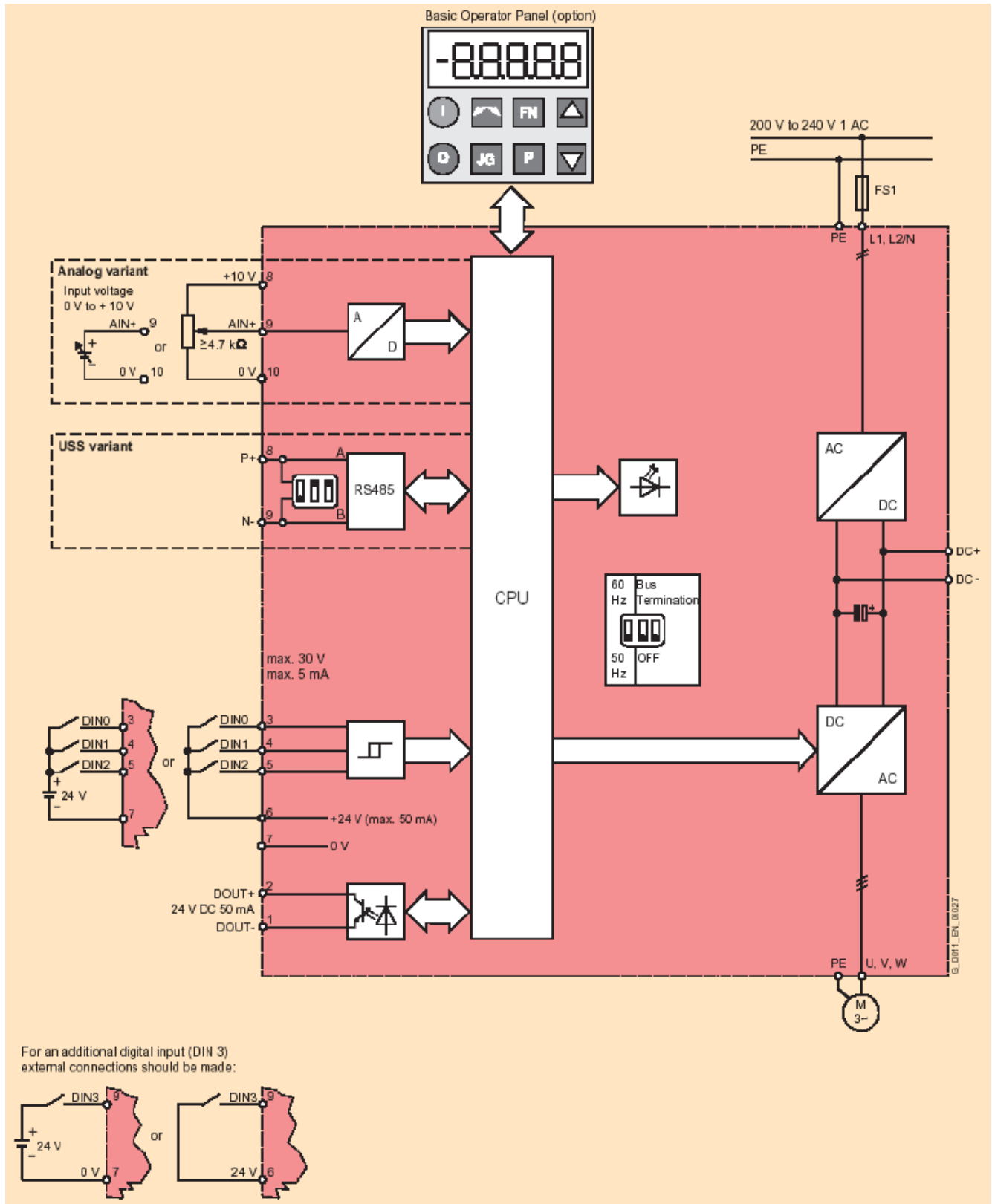


Figure 1: Circuit diagram of SINAMICS G100 driver