Introduction

This week's laboratory consists of two parts. In part A, you will use the NUM PLC to practice exchanging information between the PLC and the CNC. In part B, you will practice programming of logic sequences on the NUM PLC.

Part A: CNC-PLC Communication

It is possible using the PLC program to read some data from the CNC and control the CNC's functions and/or interfaces with external sensors and actuators. In this part, we will perform two mini-experiments to understand how these things can be done.

Imagine that the CNC has been connected to a machine tool and the machine tool has multiple sensors attached to the spindle unit and worktable:

Experiment 1

The first experiment is to set up a program to read sensor inputs and display corresponding error messages. The input ports are connected to the fault detection sensors as follows:

E1 Lubricant Fault (1)

E2 Spindle Overheating (2)

E3 Excessive Tool Wear (3)

E4 Machining Chatter (4)

E5 Spindle Overload (5)

For display, the error code should be stored in the byte variable AN. As AN can only store one error code at a time, the error with larger/largest number, which is more urgent to be addressed, should be written into AN in the presence of multiple errors.

For example, if spindle overheating is detected, AN=2. Then if machining chatter (a kind of harmful self-excited vibration that many damage both the spindle and workpiece) occurs before the overheating is addressed, AN should be overwritten by 4. If the spindle is overloaded, AN should be 5 no matter what other errors exist. If no error is detected, AN=0.

Experiment 2

The second experiment is to automatically control the cycle start and stop. After checking whether a part is loaded (E0), a correct tool change is performed (E1) and the switch E2 is on, begin the cycle by turn on A0. Stop the table if the speed exceeds 100% of the specified max. speed.

The current speed is automatically loaded into the byte variable SP. You can increase the speed by turning the knob on the front panel. The specified max. speed is 212.

Note: the CNC is not really connected to a machine tool, so you still need to use the buttons and LEDs on the front panel to mimic the inputs (E) and the outputs (A, AN).

Syntax of useful operators

- **SEL:** Binary Selection. You may need this operator to overwrite AN or leave the AN unchanged. (Hint: load E#, select the code # if E# is true or select AN if E# is false, write your selection into AN)

Example in IL:

```
LD   TRUE
SEL  3,4    (* IN0 = 3, IN1 =4 *)
ST   Var1   (* result is 4 *)
LD   FALSE
SEL  3,4
ST   Var1   (* result is 3 *)
```

- **LT:** byte comparison, less than

```
LD    SP
LT    BYTE#212
```

Requirements

Simulate the programs on the NUM PLC and get the inspection of the TA. To save the simulation results, take pictures of the CNC front panel in representative cases. The report must include instruction lists, ladder diagrams and simulation results of both experiments.

Part B: NUM PLC ladder logic programming

The second experiment involves programming of logic sequences on NUM PLC.

You will use the ladder logic for programming.

1. First, follow the example in the tutorial section until you become familiarized with operation of the ladder logic programming.

2. Next, generate a ladder logic diagram of the conveyor example problem covered in the class, and then convert it into instruction list.

The report must include printouts of the ladder diagram.