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Application of Programmable Logic Controllers in Controlling Temperature in Extrusion Process Using Analog Inputs in Cable Manufacturing Industries.

Sudheer Kumar Jain[1], Dr A S Zadgaonkar[2], Dr Sanjeev Kumar Gupta[3]
[1]*Research Scholar, Department of Electronics& Communication, RNTU Bhopal*
[2]*Ex. VC Raman University Bilaspur*
[3]*Principal RNT University Bhopal*

Abstract: *Automation has come up with solutions towards; Higher productivity,Superior quality of end product,Efficient usage of energy and raw materials and Improved safety in working conditions etc.*
Programmable Logic Controllers are important element, who are playing major role in it in automation of process Industries. For anolog signals it has provided economic solutions. Here we have given short description on utility of function blocks FC 105 and 106 in controling temperature in various zones of Extruder. This function of PLC is useful for other analog signals also i.e. Pressure, Flow, conductivity ,density, sound etc.. Some of the objective which are of directly use of an Industrial Automation Electronic Engineer to serve Industries in order to boost up productivity are as follows;

OBJECTIVES
- *Basics of PLC hardware system.*
- *Application of Converter in calibrating RTD , Thermocouple over conventional Basics of PLC hardware system,*
- *Configuring Analog signals and Addressing Digital and Analog Inputs and Outputs in it.*
- *Configuring FC 105*
- *Utilizing comparator, Adder etc*
- *Configuring FC 106.*
- *Advantage of using FC 105 and FC 106 over traditional use of hardware in automation.*
- *Perform PLC Hardware Configuration for Global Data Communication.*
- *Develop and test PLC programs.*

Keywords: *PLC, Hardware, RTD, Thermocouple, Digital Analog.*

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I. Introduction:

In industries we used to optimize process parameter i.e. Temperature, Pressure, level, flow etc. They have different units of measurement. The PLC is basically a programmed interface between the field input elements like limit switches, sensors, transducers, push buttons etc and the final control elements like actuators, solenoid valves, dampers, drives, LEDs, hooters etc. Here it will take analogue inputs from converter.

It is having combination of Software and hardware, we need to utilize the academic concepts of Electronic Converters in, Electrical & Instrumentation Engineer in their subjects of Digital Electronics, Electrical Machines, Instrumentation & measurement, Computer fundamentals, C C+, Microprocessor etc form their Bachelor of Engineering.[1],[2]

Here we have taken case of 5 zones of Extruder in cable manufacturing Industry. by using function FC 105 and FC 106 in programming, we can go for Integrating analog signals in PLC coming from field. These converter's provide 4-20 ma output or 0-10 v dc output. By using it we can replace electronic controller and save breakdown, inventory, energy etc.

As for as extrusion process electric control panel is conecers, it has PLC, Relays, Power and control wiring etc.and Programmable Logic Controller consists of the following:
1. Input Modules 2CPU with processor and program memory 3.Output modules, 4.Bus system and 5.Power supply.

PLC programming[1][2][3]

The PLC; like computer, is a software driven equipment. Working of the PLC or say controlling the machine or process is decided by the user through 'User Program'.Depending upon the process control requirement the user prepares the program, meaning "writes the instructions". These instructions are then stored in the "User Memory "or "Program Memory "of CPU in the form of machine code. To carry out programming, we need a Programming Unit. Or PC or Laptop Computer. The latest trend is to use a general purpose Laptop Computer as programming unit by loading it with appropriate software.Here we will use Simatic Manager 5.5, Siemens Germany.

The programming can be done either "On-line "or "Off-line".Off-line programming means writing of instructions in the memory of the programming unit and then simply loading it into the CPU memory.

In On-line programming the programming unit is directly connected to the programming port of the CPU and then the instructions are directly written into the user memory of CPU.

After the commissioning the program is transferred to the CPU and the controller can now operate independent of the programming unit.

We can write the User-Program in any of the following forms:

1.Ladder Diagram (LAD),2.Statement List (STL) and 3.Control System Flowchart (CSF)

Statement List (STL)[3]

The "Statement List" method (STL) uses mnemonic abbreviations in programming. The statement consists of: An operation which specifies what is to be done. An operandwhich specifies where the operation is to be done. It consists of Operand Identifier and Parameter.

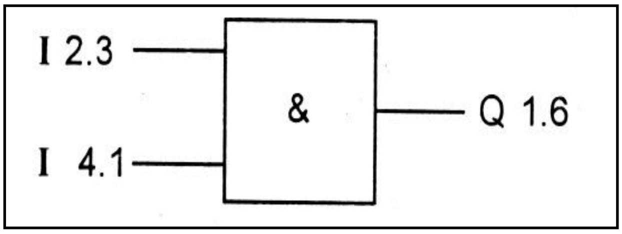
For example: The statement I 2.3 conveys that the operation is to be performed with the signal at input (indicated by I) with address 2.3.

A I 2.3
A I 3.5
=Q 4.0

Control System Flowchart (CSF)[3]

- The Control System Flowchart method (CSF) uses digital graphical symbols to formulate the control task.

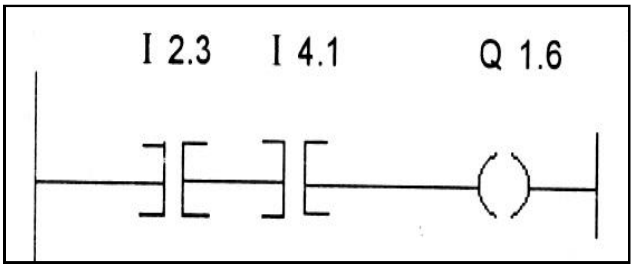
e.g.



- This method is preferred by those users who are familiar with the logic symbols/logical machine and process sequence.

Ladder Diagram (LAD)[3]

- The "Ladder Diagram "method (LAD) uses relay logic symbols to formulate the control task. This arrangement gives the LAD method the appearance of the schematic circuit diagram of a hardwired control. This is the most common method, which is being used with almost every PLC system.



These are three methods of program representation for the same control logic.

We can take use of ladder programming for our application of scaling and un scaling in Simatic Manager functions FC 105 and FC106.At field in hardware we use converters for conversion from different types of field analogue inputs to uniform analogue input i.e. 4 to 20 mA and 0 to 10 vdc.

Interfacing of Instrument-Here we will discuss about interfacing of instrumentation with PLC.In advance automation systems we have communicate all field instruments with PLC. Generally we get to types of output and input signals from instrument it may be digital or analogue signal. The signal elements (input Element) are wired to the input section of the PLC. These elements sense the dynamic status of the machine operation or process.**Inputs are of 2 types;1.Digital and 2. Analog**

Digital inputs: These inputs have only two states, viz., ON or OFF (digitally 1 or 0) therefore these are also called as discrete inputs. Elements used to give the various commands for e.g. Push buttons, limits switches, Selector witches, Proximity switches, level switches and Pressure switches etc. are directly connected to the input of the PLC.

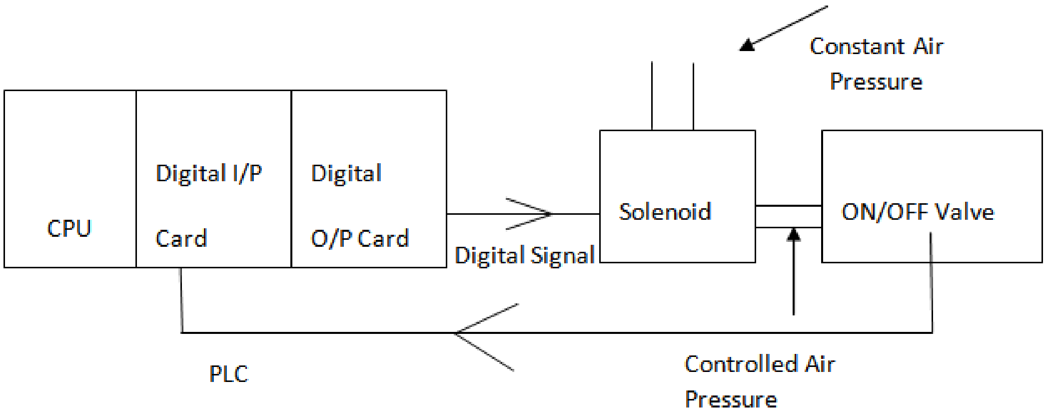
Analog inputs: These inputs have multiple states and rather continuously changing one and are having a range of values. Electrically these are categorized into two:

Voltage: The commonly used ranges are1. 0 to 10 Vdc -unipolar; 2. –10 to + 10 Vdc -bipolar and 3. –5 to 5 Vdc

Current: The commonly used ranges are 1. 0 to 20mA and 2. 4 to 20mA

The field parameters like pressure, flow, temperature etc. are converted to electrical parameters through transducers and are converted further to the above voltage / current signals through transmitters. The output of transmitters is then connected to analog inputs of the PLC. The PLC in turn converts these voltage / current signals to their equivalent digital values through the analog to digital values through the analog to digital converters. The most commonly used range is 4-20 MA, as it has no voltage drop for longer distances and wire cut can be detected as the minimum signal voltage is 4mA.The actuating elements (output elements) are wired to the output section. Output are classified into two: 1.Digital 2.Analog

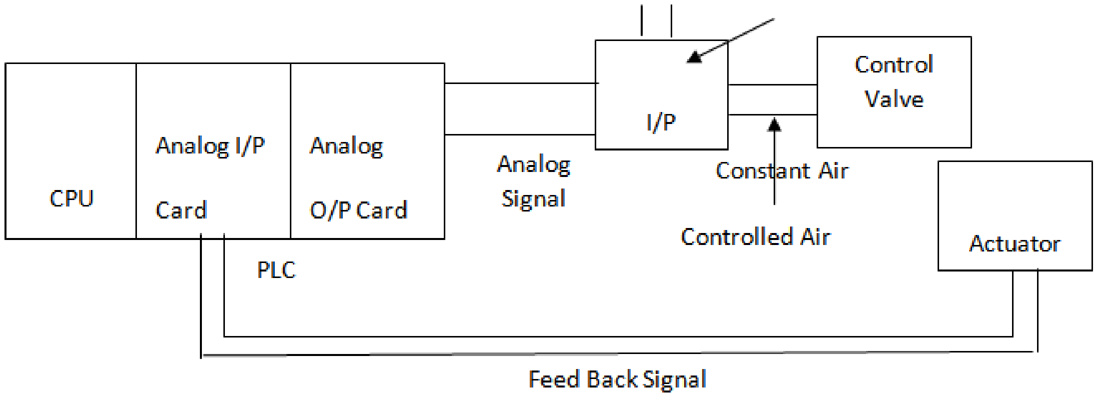
Digital Output: These have only two states, viz., ON or OFF (digitally) 1 or 0) therefore these are also called as discrete outputs. These elements are mainly actuators like contactors. Relays, solenoid coils,. Here relay get energised with output directly connected to Heater. Output of FC 106 make ON/OFF of electric heater It's typical example is as follows;



Analog Output: These output have multiple states and rather continuously changing one and having a range of values. Electrically these are categorized into two.

1. **Voltage:** The commonly used ranges are; 1.0 to 10VDC - unipolar; 2. -10 to +10VDC - bipolar;3.0 to 5VDC
2. **Current:** The commonly used ranges are:1. 0 to 20ma and2. 4 to 20ma

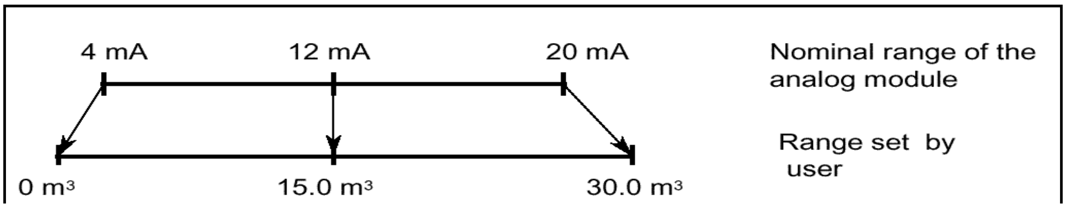
In case of analog outputs, the digital value is converted to analog signals and signals are fed to actuators such as control valves. These control valves in turn open/close from 0 to 10% depending on digital values fed.It's typical Example is as follows;



Analog Value Conversion: Scaling Values (SCALE): FC105-

Reading in and Scaling an Analog Value - FC105

Function FC105 reads in an analog value from an analog input module, signals coming from RTD placed at Extruder and outputs a value in the scale range specified by the user.



Parameter	Declaration	Data Type	Memory Area	Description
EN	Input	BOOL	I, Q, M, D, L	Enable input with signal state of 1 activates the box
ENO	Output	BOOL	I, Q, M, D, L	Enable output has a signal state of 1 if the function executed without error
IN	Input	INT	I, Q, M, D, L, P, or constant	The input value to be scaled to a REAL value in engineering units
HI_LIM	Input	REAL	I, Q, M, D, L, P, or constant	Upper limit in engineering units
LO_LIM	Input	REAL	I, Q, M, D, L, P, or constant	Lower limit in engineering units
BIPOLAR	Input	BOOL	I, Q, M, D, L	A signal state of 1 indicates the input value is bipolar and a signal state of 0 indicates unipolar
OUT	Output	REAL	I, Q, M, D, L, P, or constant	The result of the scale conversion
RET_VAL	Output	WORD	I, Q, M, D, L, P	Returns a value of W#16#0000 if the instruction executes without error; see Error Information for values other than W#16#0000

The Scaling Values (SCALE) function takes an integervalue (IN) and converts it to a real value in engineering units scaled between a low and a high limit (LO_LIM and HI_LIM). The result is written to OUT.

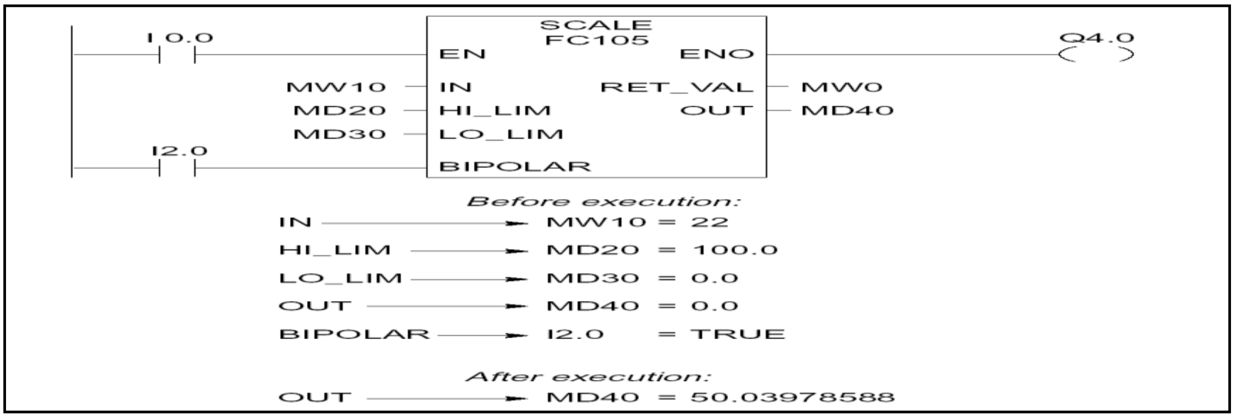
Scaling Values (FC105) Parameters

BIPOLAR: The input integer value is assumed to be between-27648 and +27648

UNIPOLAR: The input integer value is assumed to be between 0 and 27648.

Example

In next page, it is shown that how the SCALE instruction works. If the signal state of input I0.0 is 1 (activated), the SCALE function is executed. In this example, the integer value 22 will be converted to a REAL value scaled between 0.0 and 100.0 and written to OUT. The input value is BIPOLAR as indicated by the signal state of I2.0.If the function is executed without error, the signal states of ENO and Q4.0 are set to 1 and RET_VAL is set equal to W#16#0000.



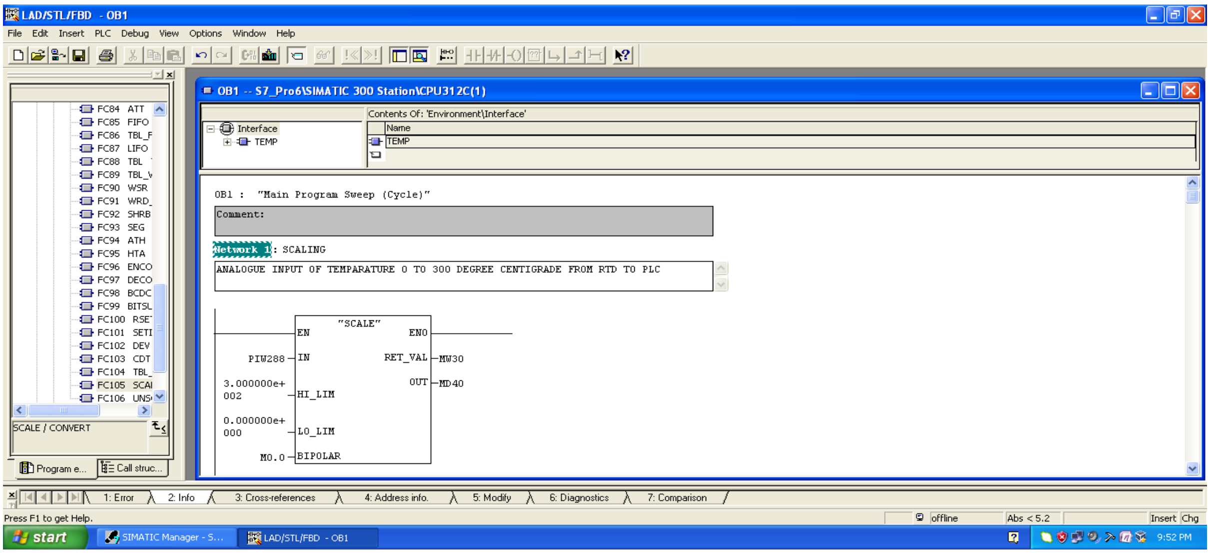
Extruder -Cable Manufacturing

Calibration table:

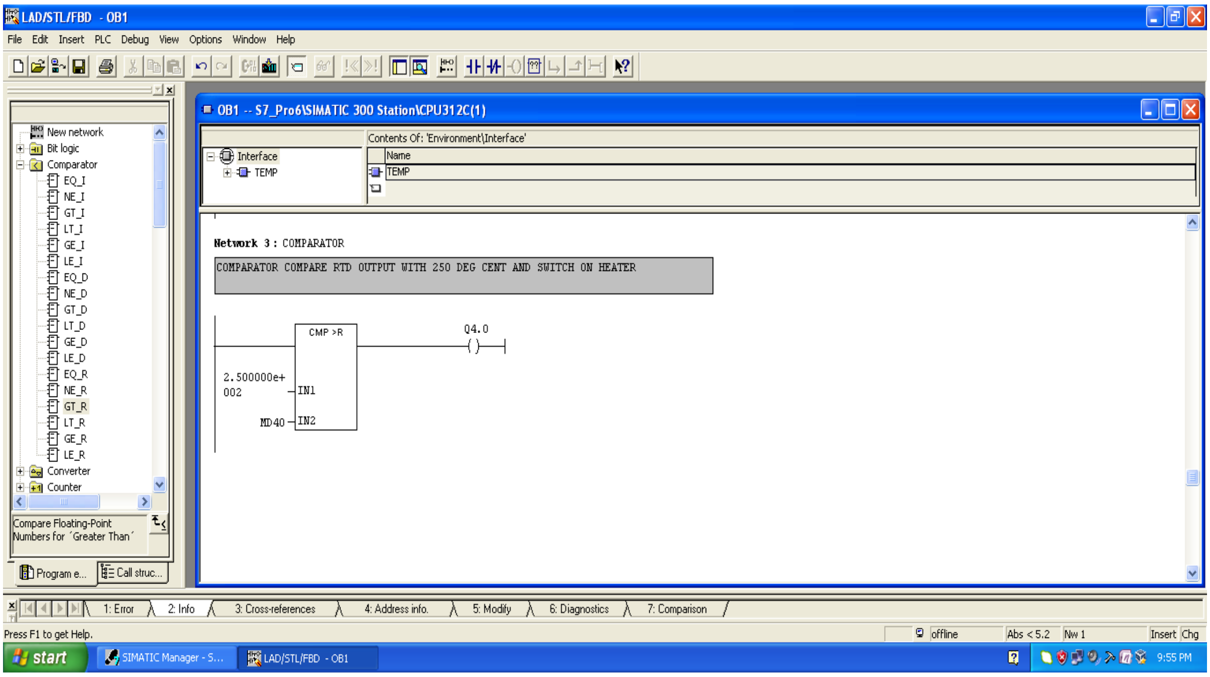
We used to calibrate our signals of temperature from heating unit of field using a Thermocouple or RTD as sensor, which are wired to converter. Analogue output of converter is wired to analogue input channel of PLC

Type of signal	Feedback sensor	Lower limit	Higher limit	Process parameter	Output of sensor	Analogue input of PLC
Temperature	RTD	0 deg cent	300 deg cent	0 deg cent	100 ohm	0 volt DC/4 mA
				75 deg cent	140 ohm	2.5 volt DC/8mA
				150 deg cent	180 ohm	5 volt DC/12mA
				300 deg cent	260 ohm	10 volt DC/20mA
	Thermocouple			75 deg cent	12 mV	2.5 volt DC/8mA
				150 deg cent	6 mV	5 volt DC/12mA
				300 deg cent	12 mV	10 volt DC/20mA

Value of Analogue input coming to PLC is taken as PIW288 in FC105.



Output of FC105 is stored in memory double integer word (real) as MD40. Our requirement of keeping heating unit temperature of 250 deg cent is controlled by actuating electric heater using output from AC relay. Coil of AC relay is operated through PLC digital output Q4.0. We use to program it in LADDER LOGIC with comparator in real mode, which compares MD40 output of FC105 in last network of LADDER LOGIC with required process value- 250.00 deg cent.



Here are getting 2 measure advantage; 1.We see that converter in hardware form is making analogue input card to accept various types process parameters in standard format of 0-10 volt DC or 4- 20 mA DC and we are able to save no. of chords and revenue, this becomes possible due to programming of FC105 block of Simatic Manager software.

2. By using it we can replace electronic controller and save breakdown, inventory,energy etc.

Terminologies
PLC- Programmable Logic Controller

DI- Digital Input
DO-Digital Output
AI- Analog Input
AO- Analog Output
I/O- Input Output,

Hardware and Software Requirement:
PLC- S7-300/400 series
Software – Simatic Manager
Communication Cable (PC to PLC) - PC Adapter
Networking Cable- Profibus cable
Laptop computer
Profibus connectors -9 PIN with on/off selector mode
Electronic Converter ohm to ma/v DC

II. Conclusion

We see that new generation PLC not only handle process conventional but provide economic solutions for analogue Signals.

Interfacing of PLC with various MMI software. Further enhances the plant operation, Visualization, Alarming, trending, data logging etc. This has led to elimination of number of hardware operating stations. Full plant operation can now be done by single operator console.

Output from different make and so on. Industrial Ethernet and SCADA Systems help in automation of multi-location plants and utilities.

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