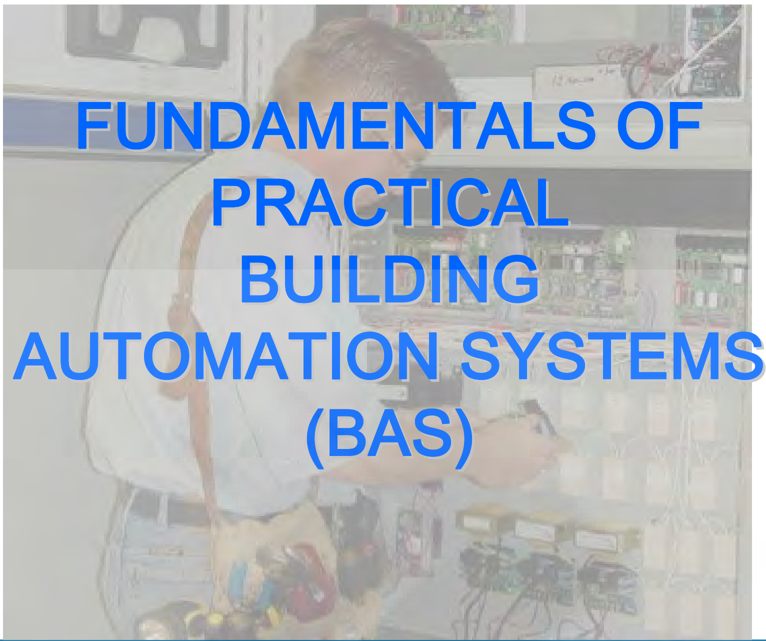

FUNDAMENTALS OF PRACTICAL BUILDING AUTOMATION SYSTEMS (BAS)

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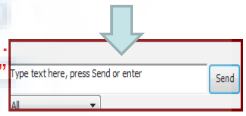
RH

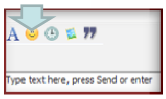
Welcome to this webinar with Dr Steve Mackay

There are at least 3 ways to interact with your presenter today.

1. Use the ***Text*** tab, near bottom left of your screen. Type the message in the space next to the "Send" button, then enter or click Send. (Ensure "All" is selected in the drop-down menu under the typing area)



2. Use the ***Emoticons*** selection in the text window – choose an emoticon then click send or enter.



3. ***Talk!*** Click the **Push To Talk** button. The button will change to yellow when you are queued, then green to show that your microphone is live.

Remember to click it again when you have spoken

This 45 minute session will commence shortly

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Steve Mackay

- Dean of Engineering
- Background in Control and Instrumentation
- 30 years experience in mining, oil and gas, electrical and manufacturing industries

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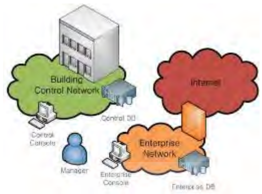
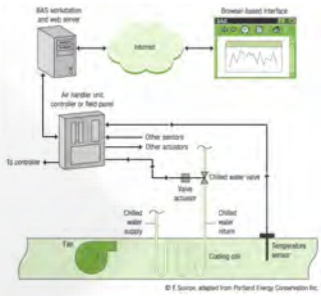
Objectives

- Identify the key building blocks of a BAS
- Discuss some useful functions of a BAS
- Discuss HVAC control and troubleshooting





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Topics

- Building Blocks of a BAS
- HVAC Controls and Instrumentation

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1.0 Introduction to a BAS

- Data acquisition and control system.
- Also known as an energy management system.
- Automated, computer-controlled method of controlling and managing the energy use in a building.
- It helps reduce and optimize energy expenses while also ensuring a comfortable environment.

Introduction

- Incorporates various functionalities provided by the control system of a building.
- Comprise a computerized, intelligent network of electronic devices that are designed to monitor and control the lighting, internal climate and other systems in a building.
- Optimized energy usage, safety, security, information, communication and entertainment facilities.

Introduction

- BAS maintains the internal climate of building within a specified range.
- This is achieved by
  - *regulating temperature and humidity*
  - *regulating lighting based on parameters such as occupancy, ambient light & timing schedule*
  - *monitoring system performance & device failures*
  - *generating useful data/notifications to building operations & maintenance staff.*

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Direct Digital Control (DDC)

- In a basic control loop; a sensor, controller & controlled device interact to control a medium.
- Controller is a distinct piece of hardware.
- In a Direct Digital Control (DDC) system, controller function takes place in software.

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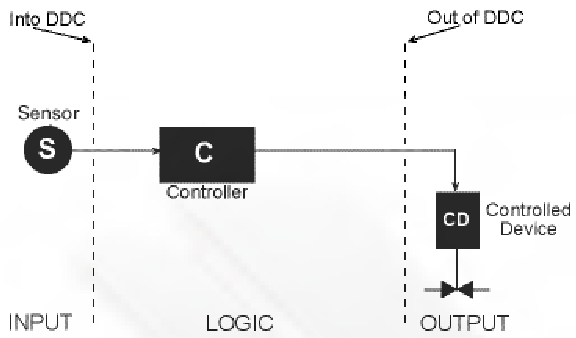
Direct Digital Control (DDC)



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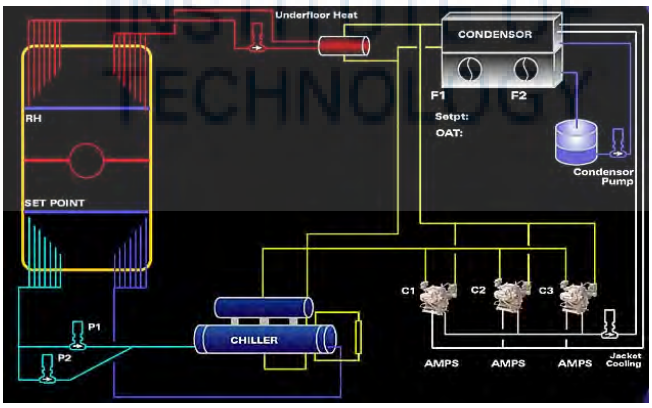
Direct Digital Control (DDC)

- A DDC application can be readily identified by the graphical user interface.



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Direct Digital Control (DDC)

- Essentially an Input/Output device.
- Inputs from sensors and equipment such as temp/water levels.
- Outputs are sent to equipment such as HVAC & pumps.
- A logical bridging of the systems with the programming results in an automated sequence of operations for controlling the building systems.

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Direct Digital Control (DDC)

- An example:
  - Based on the reservoir level, DDC controller may switch on the auxiliary pumps to top up the reservoir

    or
  - shut down the ventilation system blowers in case of a fire, to prevent smoke from blowing throughout the building.

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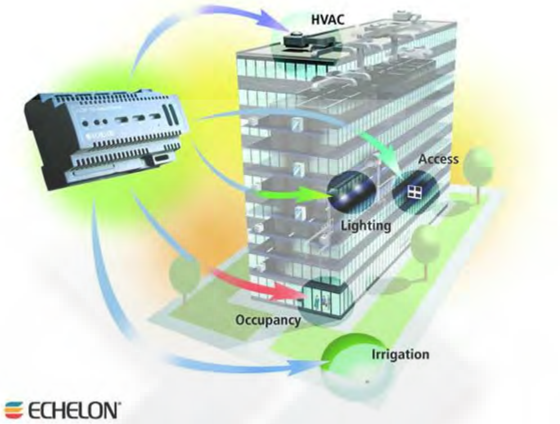
2.0 HVAC Controls and Instrumentation



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Introduction

- Control refers to a state where the required or specified parameters are maintained within the required range.
- Instrumentation refers to the instruments & devices that aid in this function.
- Control systems are responsible for executing fundamental functions like sequencing of startup & shutdown operations, control of the equipment during operation & overall unit protection.

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Introduction

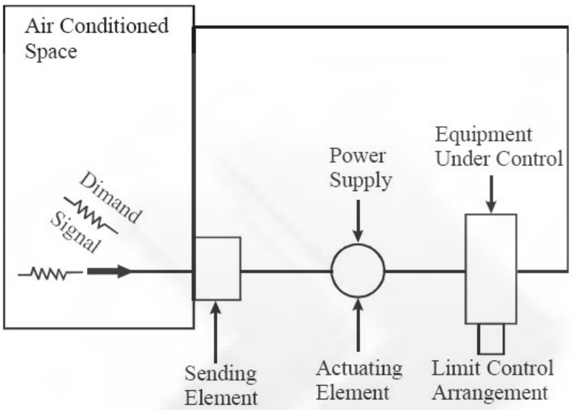
- **Basic control functions in HVAC:**
  - *Ensuring proper and trouble free operation of the system.*
  - *Safeguarding the plant against accidents.*
  - *Ensuring efficient plant operation.*

Elements of Control

- Common elements of a control system
  - controlling element
  - actuating element
  - limit control system
  - equipment to be controlled.

Elements of Control

Basic elements of a control system



Elements of Control

- *Controlling element takes signal from the room as per the requirement (either temp or humidity).*
- *It then actuates the actuating element for providing the required conditions.*
- *Control elements are used to control temp, humidity & pressure.*

Elements of Control

- Common measuring elements of a control system:
  - *Temperature measuring element*
  - *Humidity measuring element*

Control System Types

- 5 types of controls commonly used:
  - » *Self acting Control*
  - » *Pneumatic control*
  - » *Hydraulic control*
  - » *Electric control*
  - » *Electronic control*

Methods of Control

- Control mode is used to indicate the way the controller acts on the signal it receives & kind of movement it produces on the actuator.
- Various methods of control are
- *- Simple two position control*
- *- Timed two position control*
- *- Floating control*
- *- Simple proportional control*
- *- Proportional plus integral derivative (P+I+D) control*

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Methods of Control - Simple Two-Position Control

- Simplest form of control also known as *ON-OFF* control.
- There are only 2 values of manipulated variables; maximum & zero.
- Sensing element switches on full capacity when temp falls to the lower value of the differential.
- It switches the capacity to zero when upper value of the differential is reached.

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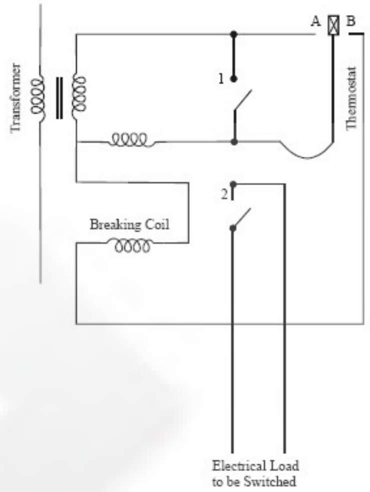
Methods of Control - Simple Two-Position Control

- *Illustration of the way a controlled variable alters with respect to time, when an air heater battery is switched on and off.*



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Methods of Control - Simple Two-Position Control

- *Overshoot & undershoot occur because of the total lag.*
- *n on-off controllers, if lag is large, control is poor.*
- *For a correct application; this is a simple, cheap & excellent form of control.*
- *Typically, ON-OFF controls are used in applications where overshoot & undershoot do not affect the process a great deal.*

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Methods of Control - Timed Two-Position Control

- In two-position control, load & capacity do not match.
- Eg: If the load is 50%, plant will be ON for half the time & OFF for half the time.
- In such a case, during every hour, the plant can either be ON for 30 minutes and OFF for 30 minutes or it can switch between ON and OFF every alternate minute.
- However, a 30 min ON-OFF cycle would provide a larger variance in controlled variable than a one-minute cycle.
- The lower the value of the room air temp, longer is the period that the plant remains ON, which is desirable.
- To achieve this, two position control can be provided with a timed variation of capacity which gives a smaller differential gap.

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Methods of Control - Floating Control

- Unlike ***ON-OFF*** control, here, the final control element floats in a fixed position as long as value of the controlled variable lies between the two chosen limits.
- When value of the controlled variable reaches the upper limit, the final control element is actuated to open at a constant rate.
- During this movement, if the value of the controlled variable starts to fall in response to the control element, movement of the control element stops & it remains in the new position and partly open.
- It remains in this position until the controlled condition again reaches a value equal to the limit.

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Methods of Control - Floating Control

- *Final control element is energized to move in a particular direction depending on the deviation.*
- *A positive deviation causes movement of the element in one direction.*
- *A negative deviation causes movement in the reverse direction.*

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Methods of Control - Proportional Control

- Control action is said to be simple proportional, when o/p signal from controller is directly proportional to deviation.
- If this o/p signal is used to vary the position of modulating valve, then there is only one valve position for each value of the controlled variable.

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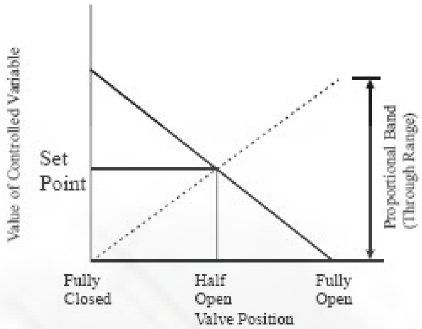
Methods of Control - Proportional Control



Offset is an inherent feature of proportional control.

Direct & reverse action are used to denote the manner in which final control element moves in response to the signals it receives from the sensor.

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Methods of Control - Proportional Control

- **Example:**
- A room suffering from heat gain is offset by means of a fan coil unit fed with chilled water.
- Output is regulated by an electrically actuated motorized valve.
- When room temp rises, controlling thermostat sends an increasing signal to motorized valve & this is termed as direct acting.
- If controller drives the motorized valve to close, chilled water flow is reduced & this is undesirable.
- A reversing relay is added to the control circuit, to drive motorized valve to open & thus, control becomes a reverse action.

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Methods of Control - PID Control

- PID *(Proportional-Integral-Derivative)* control action allows the process control to accurately maintain the set point, by adjusting the control outputs.
- It continuously adjusts the o/p, depending on the relative positions of the process temp & set point.
- PID control functions are commonly used in today's controls.
- These functions when used properly allow for precise control of difficult processes.
- It allows o/p to be a value other than 100% or 0%.
- Temp can be controlled around set point without oscillations.

Methods of Control - PID Control

- **Tuning**

"Many control manufactures provide various facilities in their controls that allow user to easily tune (adjust) the PID parameters in accordance with their process".

Methods of Control - PID Control

- **Tuning on demand, with upset**
  - This facility typically determines PID parameters by inducing an upset in the process.
  - The controls proportioning is shut off (on-off mode) & control is allowed to oscillate around a set point.
  - This allows control to measure the response of the process when heat is applied & removed (or cooling is applied).
  - From this data, control can calculate & load the appropriate PID parameters.
  - While some manufactures perform this procedure at set point, others do it at different values.

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Methods of Control - PID Control

- ***Adaptive tuning***
  - **This mode tunes the PID parameters without introducing any upsets.**
  - **When a control is utilizing this function, it is constantly monitoring the process variable for any oscillation around the set point.**
  - **If there is an oscillation, control adjusts the PID parameters, in an attempt to eliminate it.**
  - **This is ideal for processes where load characteristics change drastically while the process is running.**
  - **It cannot be used effectively if the process has externally induced upsets for which the control would not possibly tune out.**

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Parameters to be controlled

- Common variables used in an air conditioning system:
  - » Temp of air inside the air-conditioned space.
  - » Supply air temp to a system.
  - » Return air temp from the air-conditioned space.
  - » Dew point temp.
  - » Water temp in a heating or cooling system.
  - » Duct pressures.
  - » Evaporator pressure.
  - » Condenser pressure.
  - » Relative humidity of air entering or leaving the space.
  - » Flow of water or air.

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Typical Control Systems

- Typical controls in a HVAC system:
  - » Preheat and humidification control (Winter Air-conditioning)
  - » Cooling, dehumidification and reheat control. (Summer Air-conditioning)
  - » Face and by-pass control
  - » All year round air-conditioning system
  - » Zone control system

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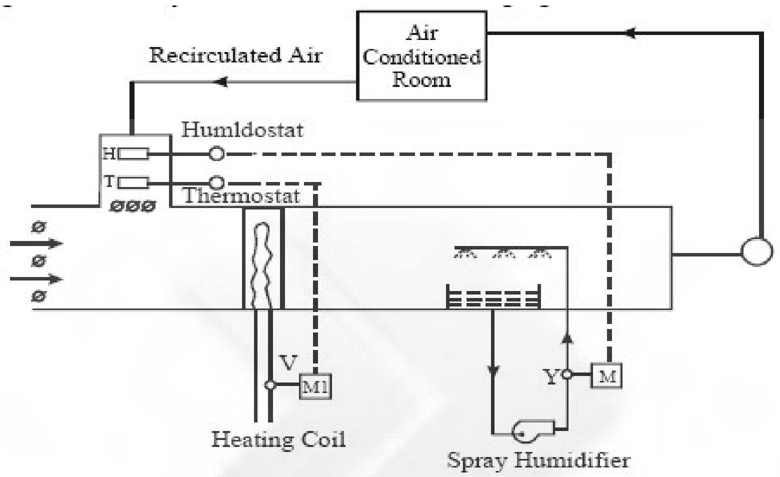
Preheat and Humidification Control



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Preheat and Humidification Control

- This system typically has a thermostat and humidistat located in the duct that circulates conditioned air through the space to be conditioned.
- Humidistat controls movement of motorized valve located on the sprayer of the humidifier.
- Thermostat controls the motorized valve located on the steam line of the heating coil.
- As latent heat load or sensible heat load changes in the room, temp or humidity change will be corrected by steam flow in the heating coil or spray quantity in the humidifier, controlled by thermostat & humidistat respectively.

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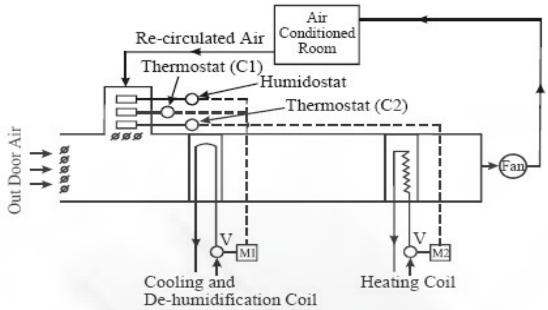
Cooling, Dehumidification and Reheat Control



- ***Here, thermostat controls the movement of the motorized valve located in the chilled water line entering the cooling & dehumidifying coil.***
- ***Humidistat controls the motorized valve on the steam line entering the heating coil.***

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Cooling, Dehumidification and Reheat Control

- As latent heat load or sensible heat load changes in the room, the temp change will be corrected.
- This is done by a correction in the chilled water flow through the cooling & dehumidifying coil.
- Similarly, humidity change will be corrected by a correction in the steam flow through the reheat coil.

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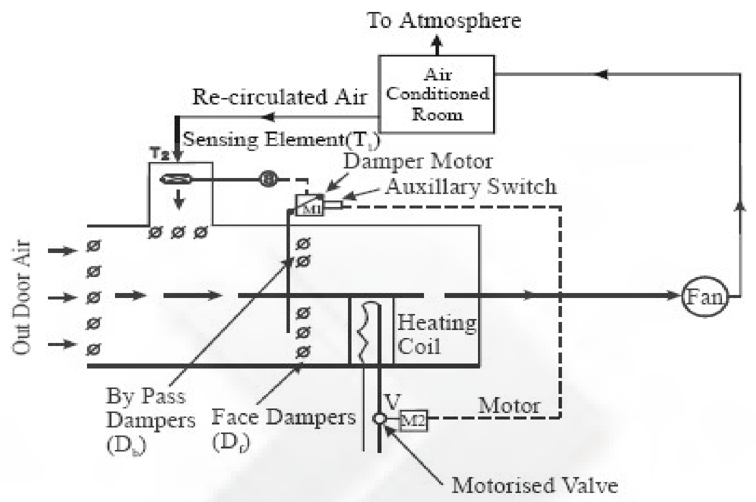
Face and by-pass control system



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Face and by-pass control system

- *Let us consider that outside conditions are fixed & room load conditions are changed.*
- *Eg: When sensible heat load in the room reduces, temp of air leaving the room (temp of re-circulated air) will increase.*
- *This temp rise will be sensed by sensor (S), which will give a signal to motor (M1) to start.*
- *The motor is mechanically connected through levers to the dampers (Db).*
- *Motor will increase air bypass by opening these dampers and decrease the airflow through the dampers (Df).*

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Face and by-pass control system

- *It is also possible to arrange the system such that when dampers (Df) close completely, heating medium is shut off by operation of the motorized valve.*
- *This system can be effectively used for a wide range of conditions.*
- *A similar arrangement can be used for cooling applications also.*

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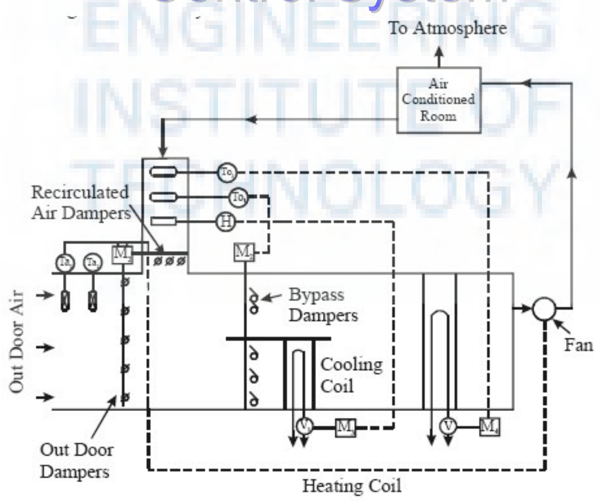
All Year Round Air-Conditioning Control System



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All Year Round Air-Conditioning Control System

- Quantity of outdoor & recirculated air is controlled by thermostats T01 and T02.
- These are designed such that when outdoor air temp is either above or below set point, outdoor air quantity is changed by the action of damper motor M1, until minimum set quantity is reached.
- Thermostats TC1 & TC2 perform similar functions as discussed previously.
- Temp of air leaving the cooling coil is controlled by motor M2, which controls the face & bypass dampers.

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All Year Round Air-Conditioning Control System

- *Humidity is controlled separately by motor M3 by changing the quantity of cold fluid passing through motorized valve, at inlet of cooling coil.*
- *Signal to motor is received by humidistat (H).*
- *Under conditions of high humidity, humidistat (H) keeps the valve open, to provide high dehumidification.*

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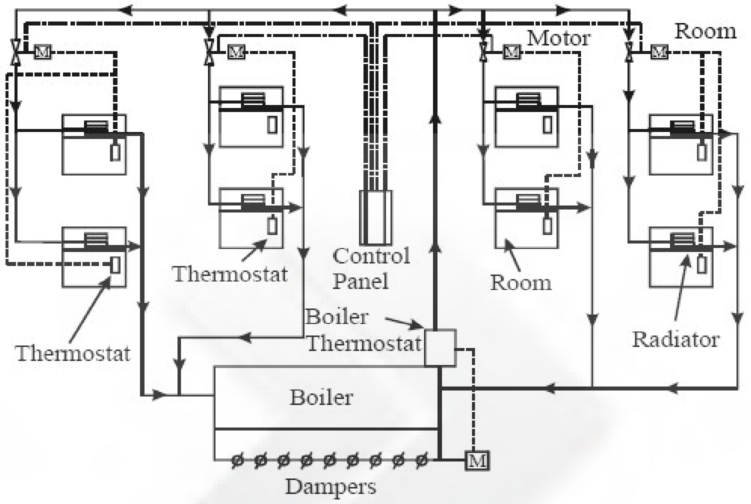
Zone Control System



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Zone Control System

- *Zone control is used in buildings that possess a no. of exterior aspects of considerable area, each of which is thermally affected in differently, according to their exposure to atmospheric changes.*
- *Changes in direction of sun, wind & rain result in rooms with varying temps.*
- *Heat input to these rooms should be different, in accordance with prevailing conditions.*
- *This is done by sectioning the circulating mains as shown.*

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Zone Control System

- Regulating valves introduced in each section are controlled by their respective thermostats.
- A separate thermostat is used to control the heat from the boiler to the mains.

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Appendix E

Practicals: Part 1

E.1 Practical Examples

The following exercises will demonstrate some of the techniques you will need to use in larger full scale projects. They may show you some of the traps that can befall the unwary.

Worked solutions to these tasks that are supplied at the end of this appendix.

Task 1
Toggle an Output

The Problem

Given a single pushbutton (Input 1), program Output 1 so that it changes state once each time the button is pressed.

The Rules

If the PLC you are using supports transitional contacts, you may use ONE other internal address. If you do not have transitional contacts, two internal addresses may be used.

Task 2
Pushbutton Multiple Selection

The Problem

Imagine you have a display screen with two simple P+I controllers on it. (See example given under Analog Control)

The operator may adjust either SetPoint or either Output, four choices in all. Because we will be using a dedicated pair of pushbuttons to "Raise" and "Lower" we must "Select" button to select which of these four we want, one step each time the "Select" button (Input 1) is pressed. In addition, when we have selected Controller 1 (SetPoint or Output) we may toggle Controller 1 between Automatic and Manual using Input 3. Similarly for Controller 2, using the same Input.

The Rules

(i) If we are not displaying the screen (Input 2 = OFF), then all four selections must be OFF and both Controllers must retain their A/M status regardless of what we might try. When this screen is selected (Input 2 = ON), we commence at Controller 1 SetPoint. Pressing Select will bring up Controller 1 Output, Controller 2 SetPoint, Controller 2 Output, back to Controller 1 SetPoint.

(ii) That is fine if both Controllers are in Manual. If Controller 1 is in Auto Mode we must skip Controller 1 Output. If Controller 2 is in Auto we must skip Controller 2 Output.

Allocated I/O are :	Input 1	Step selection advance
	Input 2	This screen is selected
	Input 3	Auto/Manual toggle button
	Output 1	Controller 1 SetPoint
	Output 2	Controller 1 Output
	Output 3	Controller 2 SetPoint
	Output 4	Controller 2 Output
	Output 5	Controller 1 Automatic
	Output 6	Controller 2 Automatic

Notes

Task 3
Sequential Startup

The Problem

A series of Outputs must Operate in strict sequence, each for its own preset time (minimum 5 seconds). At the changeover, the previous Output must stay on for two seconds after the new one comes on. Think of a domestic reticulation timer.

The Rules

The sequence will start when Sequence Start (Input 1) is pressed and continue through five Outputs unless Sequence Stop (Input 2) is pressed.

Each time must be independently adjustable.

Notes

Task 4
Multiple Recipe Sequence

The Problem

Given task three is working, modify it so that you can "load" a different set of times for each step by pressing a single button (Input 3 for Recipe 1, Input 4 for recipe 2, etc.).

The Rules

You must not be able to change horses in mid stream. Once a sequence has commenced, its times may not be interfered with.

Notes

Task 5
Valve Limit Switch Monitoring

The Problem

A large valve has both Open and Closed Limit Switches. When a Solenoid Valve is OFF, the valve must show Closed, when the Solenoid Valve is ON the valve must show Open. If not, raise an alarm (Output 1), and ensure the alarm stays on for at least 10 seconds so the Supervisory system can notice it.

The Rules

When the valve changes state we must tolerate the Limits being wrong for a time to give the actuator time to move, 8 seconds will do for our purpose. We will simulate this valve with 3 Inputs, Input 1 to represent the SV, Input 2 to represent the Open limit and Input 3 to represent the Closed limit. Oh by the way, a limit switch being OFF when it should be ON is just as bad as it being ON when it should be OFF, and we must not tolerate both limits ON together, for any time.

Allocated I/O	Input 1	Toggle Output PB
	Input 4	Valve Open Limit Su
	Input 5	Valve Closed Limit Su
	Input 7	Valve Output Indication
	Input 8	Valve Alarm Indication

Notes

Task 6
Split Range Valves

The Problem

An analog Controller will drive one of two valves. For example a Temperature Controller may need to open a Hot Water valve to raise the Temperature or a Cold Water valve to lower the measured temperature. Similarly a pH Controller may add acid or alkali to a waste stream.

The Rules

We must never have both valves open at once.

At zero % Controller Output valve A is fully open.

At 100% Controller Output valve B is fully open.

At some mid-value both valves will be fully shut.

Assume both valves fail shut, ie signal to Open. Calculate the formulae and write the logic to generate each valve Output.

Simple case:- x = 50%
Harder case:- x can be varied by setting a register between say 40% and 60%

For simplicity assume the Controller Output and both valve Outputs have a range of 0 to 1000 (=0 to 100%)

Task 7
Multiple Step Sequence with Common Timers

This is for the speedsters who have plenty of time

The Problem

Fifteen timer steps with overlap as per Task 4. Five possible recipes.

The Rules

You may use a total of only TWO Timer blocks. It must be possible to "Skip" a step by presetting zero time. Otherwise 5 seconds minimum.

Notes

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Task 1
Toggle an Output

The Answer

IDC COURSE - AUTOMATION USING PLCs - PRACTICAL SESSIONS

SUGGESTED SOLUTIONS TO PRACTICAL PROBLEMS
**** TASK 1 - TOGGLE AN OUTPUT **** 08:41 PM Dec 29 1994

Long Comment for NETWORK 0001 Segment: 01
TASK 1 - TOGGLE AN OUTPUT
This solution has been written in a "Universal" fashion, i.e ignoring Modicons Transitional Contacts.
The extra output bit is used to "Remember" the state of the Input last scan.
NETWORK 0001 Segment: 01

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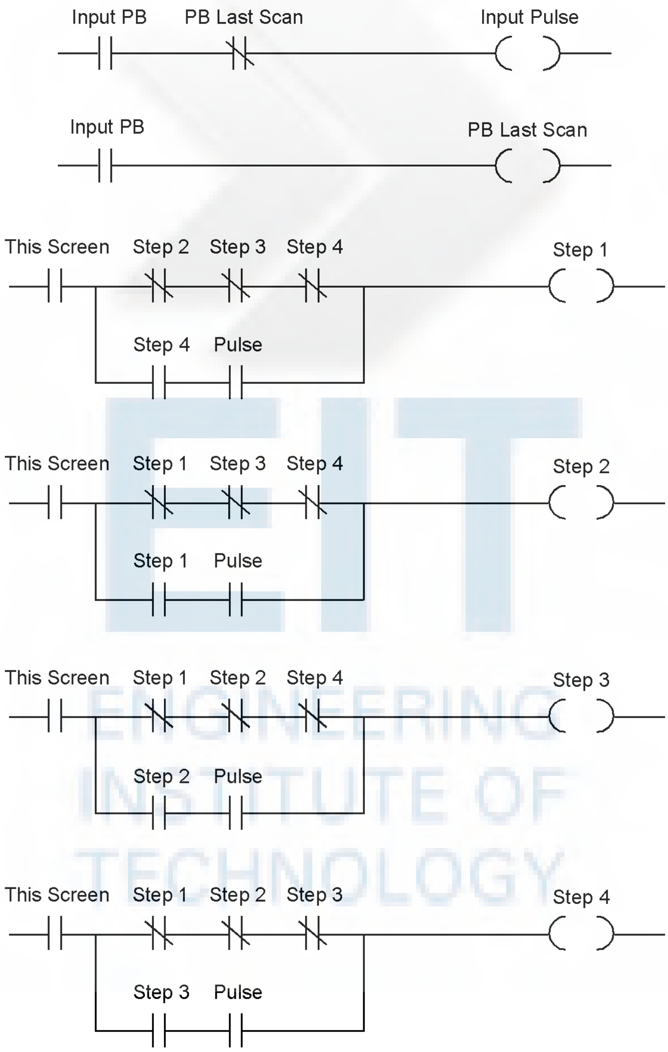
Task 2
Pushbutton Multiple Selection

The Answer

This problem can be approached many ways, there is no one "right' answer, even for a particular PLC. However, some "obvious" methods contain surprising traps for young players, as we shall see.

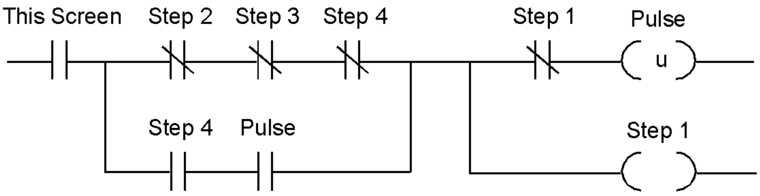
An apparently simple approach is to have a pulse generator followed by four latching rungs, as follows (simplifying to the first part only, four steps in sequence).



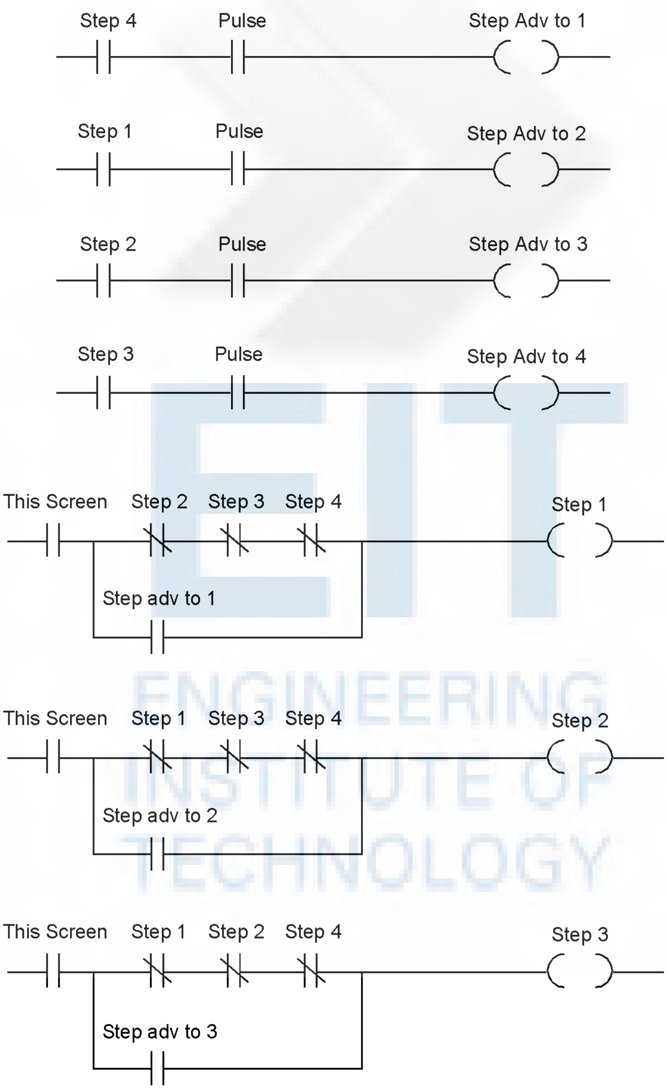
This looks superficially right, except a single pulse will advance all the way from Step 1 to Step 4 in a single scan!

Reversing the order of Programming only partially solves the problem, we will still tend to "skip" one step.

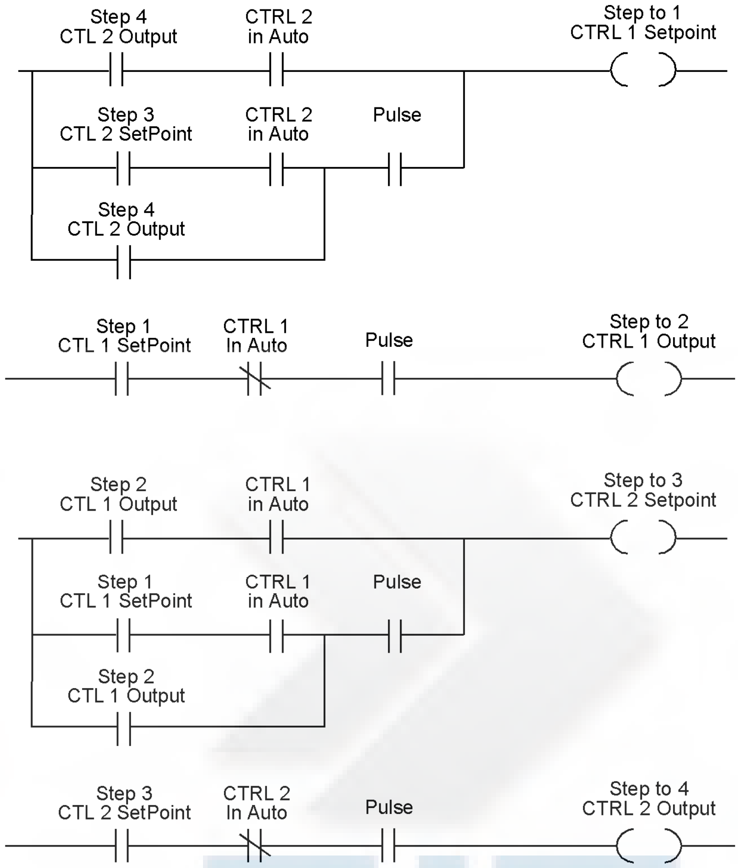
If we have latch and unlatch coils in our program, we can overcome this by clearing the pulse immediately we have used it. Eg



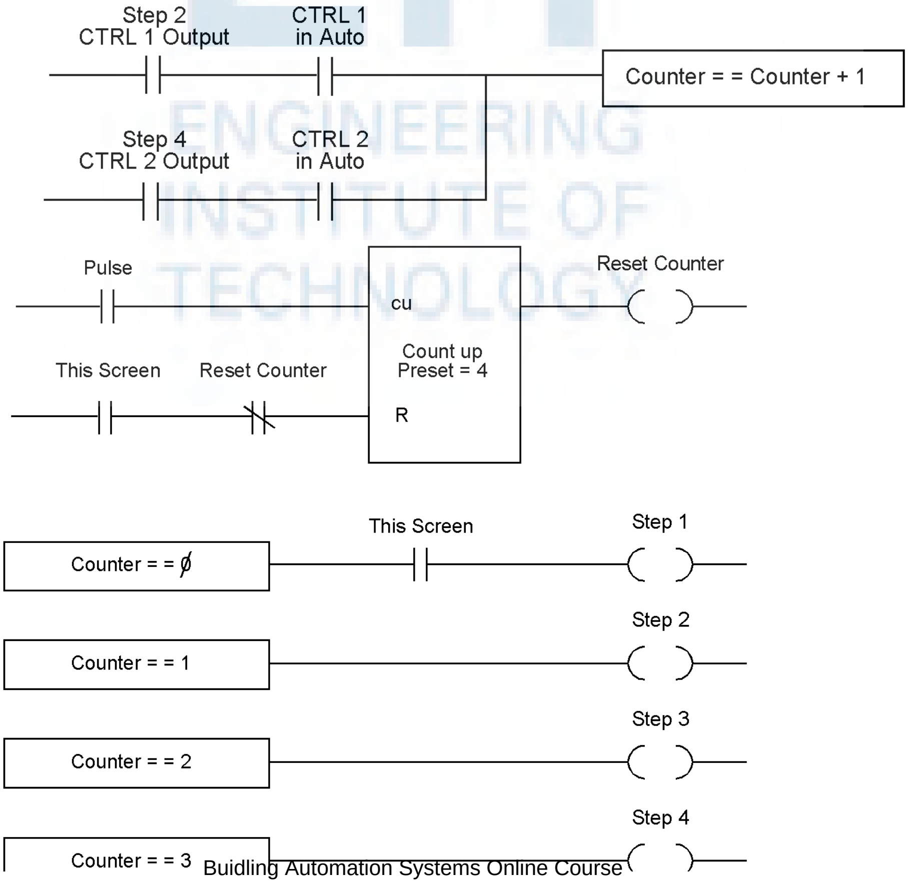
Another secure strategy is to separate the "step advance" signals from the step latches, programming four rungs to provide "step" pulses, followed by four latches.



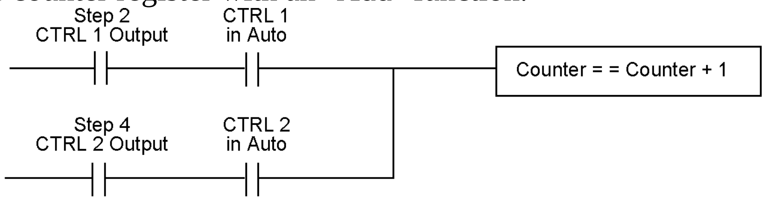
The requirements of Controllers in Auto Mode (Steps 2 and 4 may have to be skipped) complicates the first four rungs.



Another useable strategy is to use a Counter, the exact behaviour depends on the PLC model. Steps 1,2,3,4 are represented by the Counter register equal to 0,1,2,3. 4 = Too Far



W must now make special provision for "Skipping" Steps 2 and 4 if required. We can add 1 to the counter register with an "Add" function.



Note:
These diagrams do not represent any particular brand of PLC.

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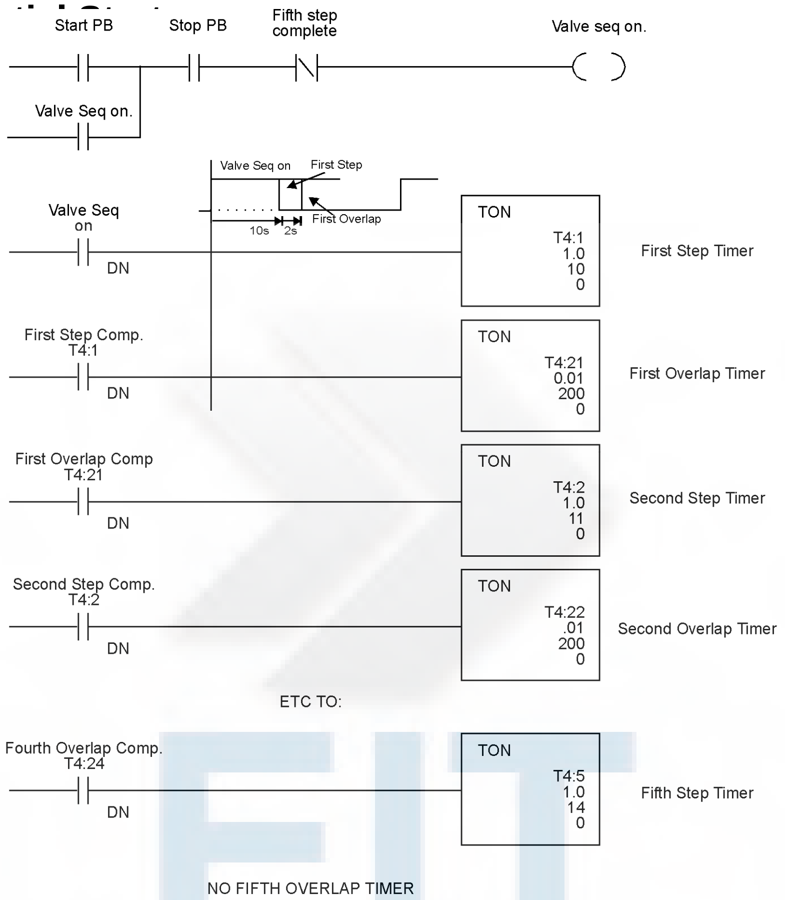
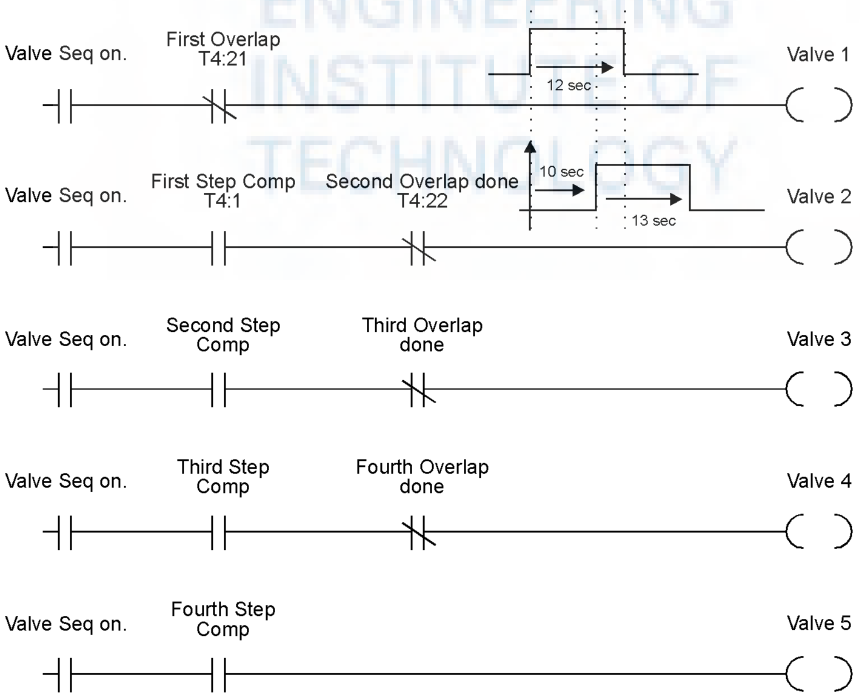
Task 3
Se


Start PB
Stop PB
Fifth step complete
Valve seq on.
Valve Seq on.
Valve Seq on
First Step
First Overlap
10s
2s
Valve Seq on
DN
TON
T4:1
1.0
10
0
First Step Timer
First Step Comp.
T4:1
DN
TON
T4:21
0.01
200
0
First Overlap Timer
First Overlap Comp
T4:21
DN
TON
T4:2
1.0
11
0
Second Step Timer
Second Step Comp.
T4:2
DN
TON
T4:22
.01
200
0
Second Overlap Timer
ETC TO:
Fourth Overlap Comp.
T4:24
DN
TON
T4:5
1.0
14
0
Fifth Step Timer
NO FIFTH OVERLAP TIMER


Valve Seq on.
First Overlap
T4:21
12 sec
Valve 1
Valve Seq on.
First Step Comp
T4:1
Second Overlap done
T4:22
10 sec
13 sec
Valve 2
Valve Seq on.
Second Step Comp
Third Overlap done
Valve 3
Valve Seq on.
Third Step Comp
Fourth Overlap done
Valve 4
Valve Seq on.
Fourth Step Comp
Valve 5

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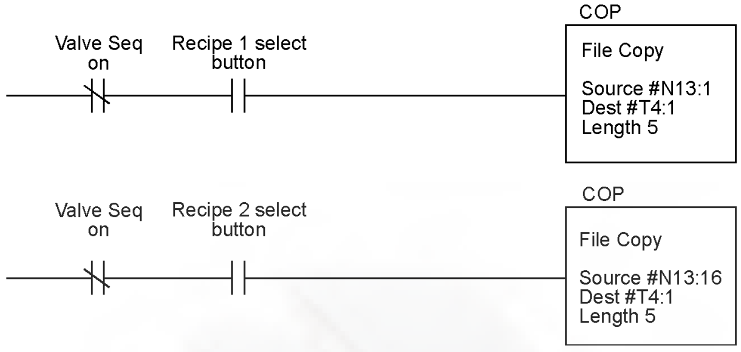
Task 4
Multiple Recipe Sequence



Because Timer Files use 3 words per Timer, and the second register is the Preset, when we set Length = 5, we take 15 words from file N13, and transfer them to 5 Timers.

The presets for Recipe 1 are in N13:2
N13:5
N13:8
N13:11
N13:14

Intermediate Addresses should be Zero.

The presets for recipe 2 are inN13:17
N13:20
N13:23
N13:26
N13:29

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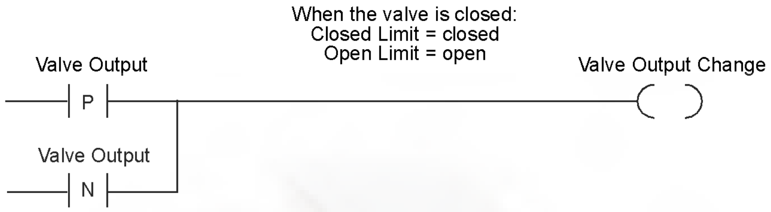
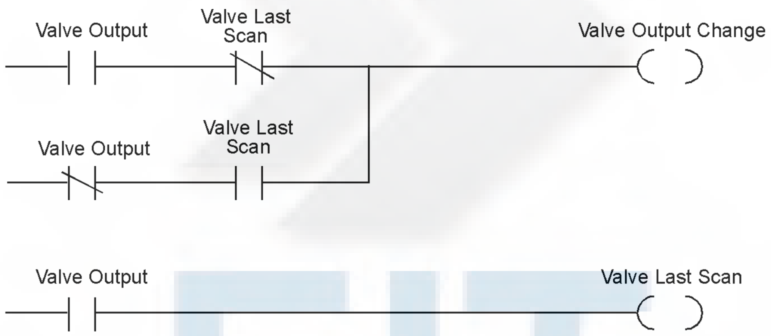
Task 5
Valve Limit Switch Monitoring

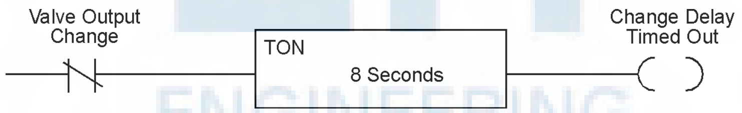
The first step is to produce a Pulse every time the Valve Output changes state. You may care to attach this to the "toggle Output" you built in task 1. With transitional contacts it is easy:



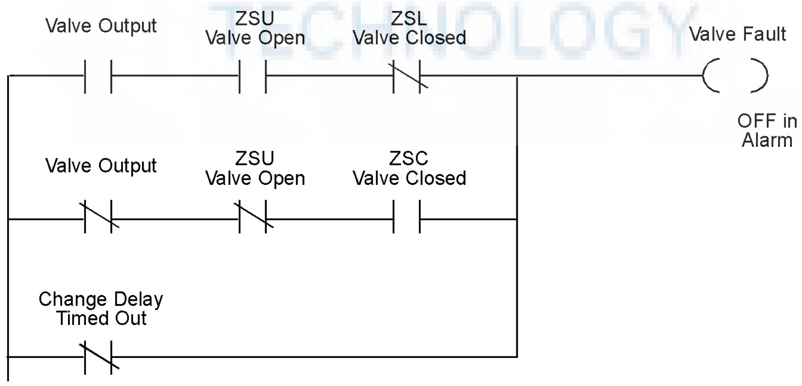
If you do not have transitionals, eg A/B, do not despair.



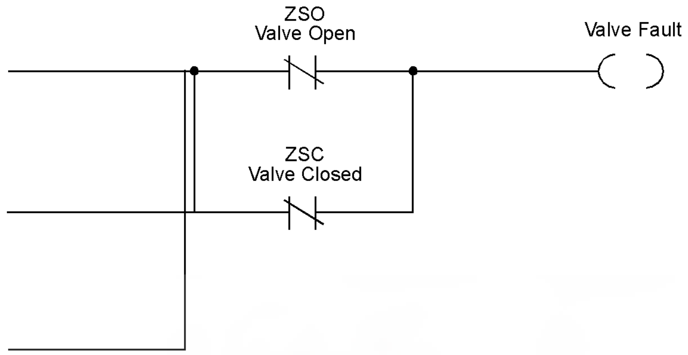
This change-of-state pulse drives a Timer OFF, or resets a Timer ON, to override any potential alarm for 8 seconds from a change-of-state.



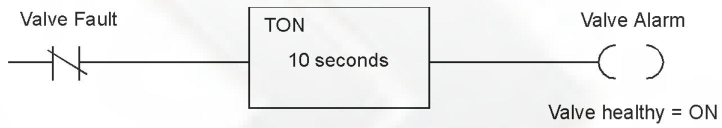
Now we compare the Valve Output with the Limits. Both must be in correct state or the Alarm bit turns OFF.



Remember the requirements that both limits closed causes an immediate alarm. Add the following:



The 10 second timer extends the alarm.



Task 6
Split Range Valves

The Answer

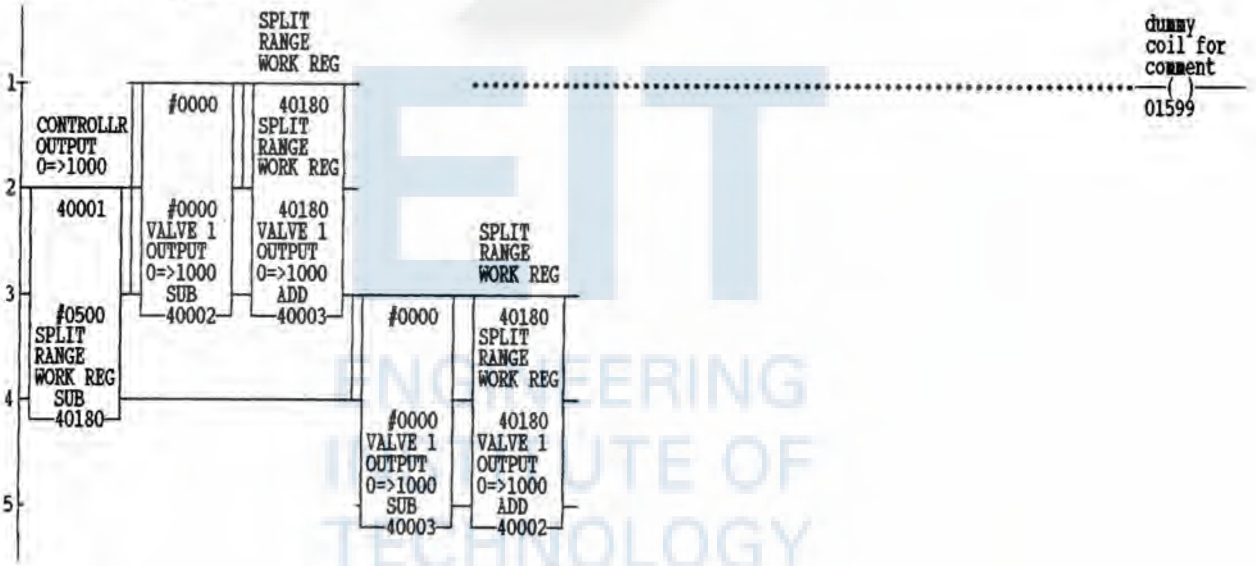
IDC COURSE - AUTOMATION USING PLCs - PRACTICAL SESSIONS

SUGGESTED SOLUTIONS TO PRACTICAL PROBLEMS
**** TASK 6 - SPLIT RANGE VALVES ****

10:02 PM Dec 29 1994

Long Comment for NETWORK 0009 Segment: 01
SPLIT RANGE VALVE
This simple example assumes that the Analog Range for the Controller Output and the two Valve Outputs is 0 to 1000 counts.
The SUB block does double duty - deciding which Valve should open and also calculating the Absolute difference between Controller Output and 500.
Above 500, Valve 1 is clamped closed, and Valve 2 moves, to reach full scale when the Controller Output is 1000
Below 500, Valve 2 is clamped closed, and Valve 1 moves, to reach full scale when the Controller Output is zero.

NETWORK 0009 Segment: 01



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Task 7
Multiple Step Sequence with Common Timers

The Answer

IDC COURSE - AUTOMATION USING PLCs - PRACTICAL SESSIONS

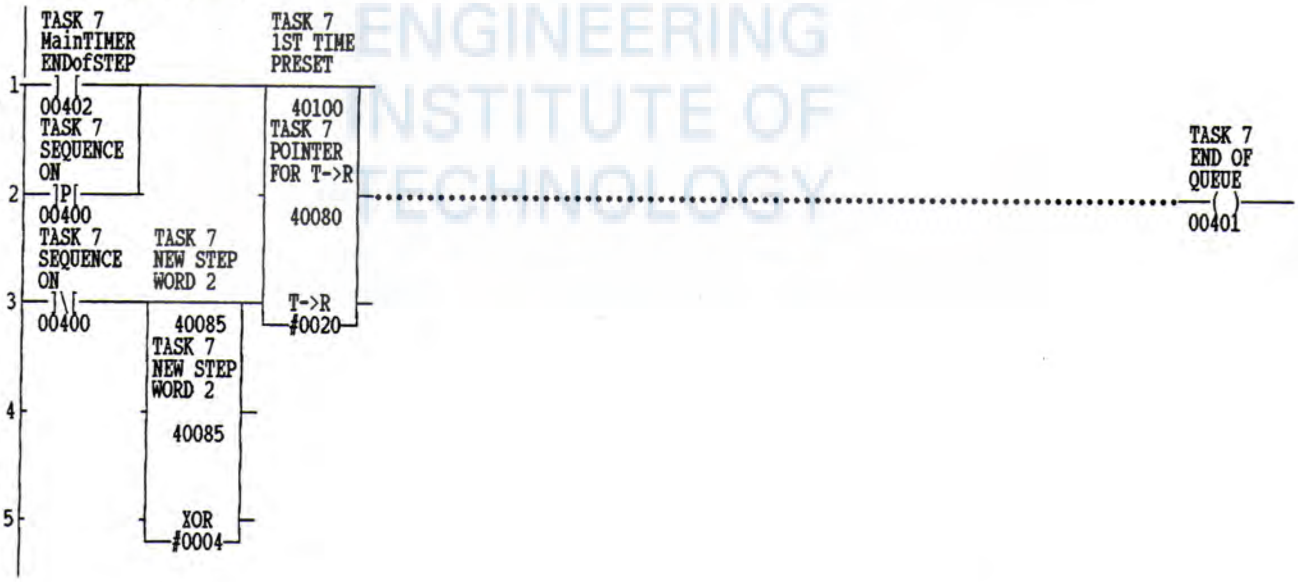
SUGGESTED SOLUTIONS TO PRACTICAL PROBLEMS
**** TASK 7 - MULTIPLE STEP SEQUENCE WITH COMMON TIMERS **** 09:05 AM Dec 30 1994

Long Comment for NETWORK 0011 Segment: 01
TASK 7
This is part of the answer to a more advanced problem.
The first Network establishes a "Sequence On" latch which might be more complex in "Real Life".
Note we have assumed the STOP button is Fail Safe.

NETWORK 0011 Segment: 01

Long Comment for NETWORK 0012 Segment: 01
TASK 7
This Network uses a Table to Register to select the Preset Time, in seconds, from a Table.
The T>R advances to the first Table entry when the sequence switches on, and advances one entry each scan that the Main Timer (End of Step) is ON.
When the sequence of NOT on, the T>R is reset, and the block of four Registers which contains both the New Step and Last Step Registers is cleared to zero.
Note, to provide for multiple recipes, the Table would be loaded with the required set of values, but ONLY when the Sequence is NOT on.

NETWORK 0012 Segment: 01



IDC COURSE - AUTOMATION USING PLCs - PRACTICAL SESSIONS

SUGGESTED SOLUTIONS TO PRACTICAL PROBLEMS

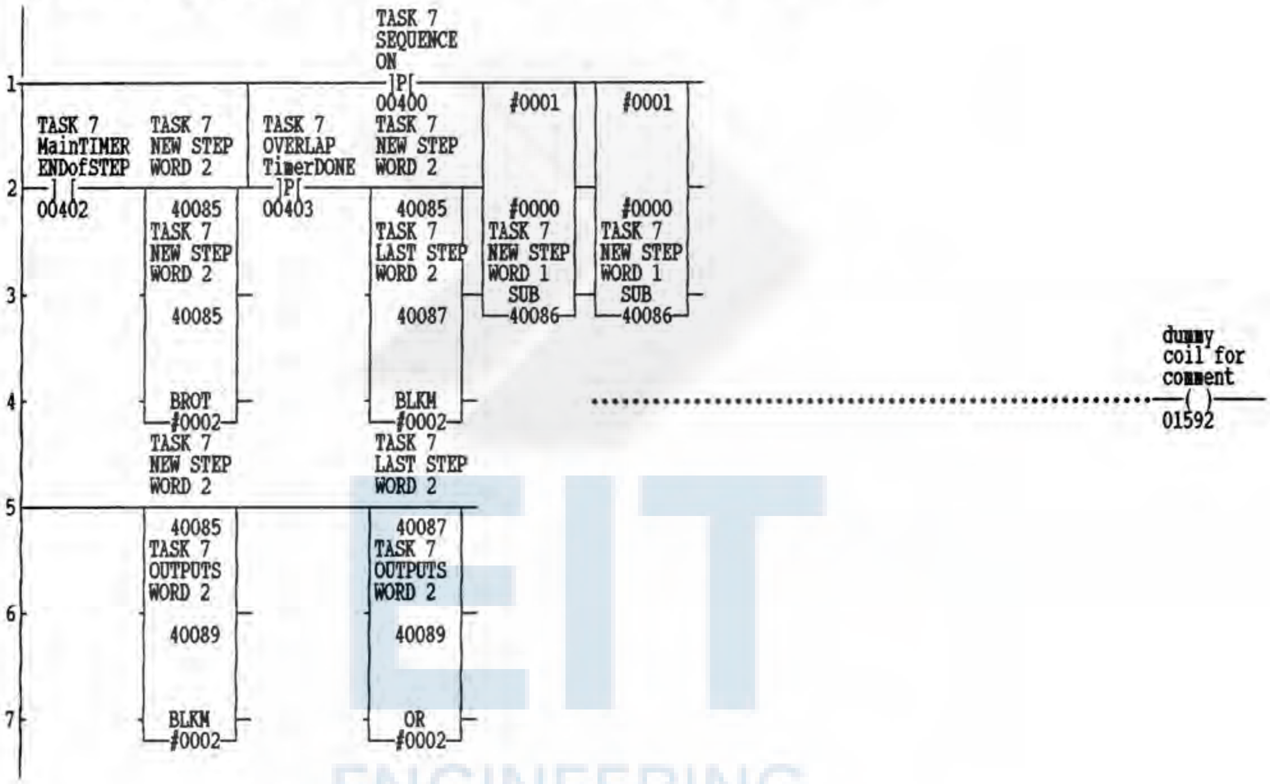
09:05 AM Dec 30 1994

Long Comment for NETWORK 0013 Segment: 01

TASK 7

This Network contains four key elements.
Firstly, when the sequence is first turned ON, the first Output is set ON by SUB blocks, so the BROT can work.
Secondly, whenever the Main Timer says to step advance, the BROT advances the Bit in the "NEW STEP" pair of Registers. We have used two Registers so we can go beyond 16 Steps maximum.
Thirdly, after two seconds the "Last Step" Registers are made equal to the "New Step" Registers.
Finally, the New Step and Last Step Registers are ORed together to form the Outputs.
These two Registers would be transferred to Discrete Outputs in a "Real" solution.

NETWORK 0013 Segment: 01



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SUGGESTED SOLUTIONS TO PRACTICAL PROBLEMS

09:05 AM Dec 30 1994

Long Comment for NETWORK 0014 Segment: 01
TASK 7
The Main Timer obtains its Preset from the T>R above.
When it times out it resets both itself and the Overlap (2 second) timer, which starts timing immediately.
The SUB block is used to detect an invalid Preset, i.e. less than three seconds, which would make a nonsense of the Overlap. If a zero, 1 or 2 second Preset is detected, it has the same effect as the Main Timer being ON, i.e. both the T>R and the BROT will advance another step on the next Scan.

NETWORK 0014 Segment: 01