Computer Aided Manufacturing

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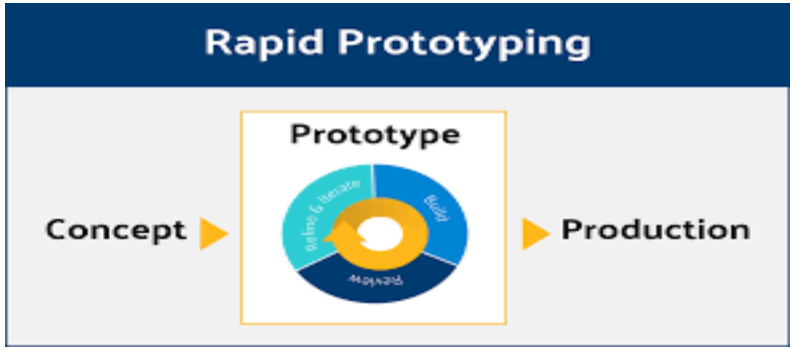
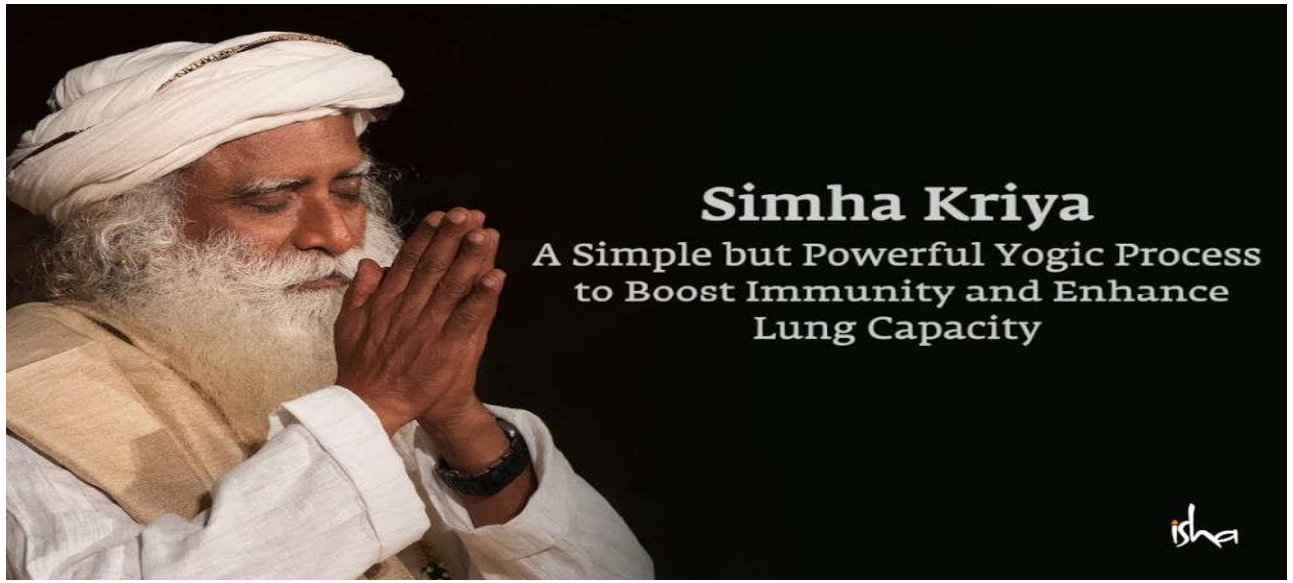


Immunity Boosting Breathing



1 min

Unit II

DRIVES AND CONTROL

Spindle and feed drives - Sensors - Position, Encoders, Proximity, Limit switch - Interfacing system -Microcontroller and PLC based -Introduction to Graphical User interface -Communication protocol -RS232, RS 485, USB, Ethernet -PLC - Ladder diagram -Peripherals -Timer, Counter, Encoder interface, Human Machine Interface

Prerequisites Knowledge

- Working principles of Electronics
- Basics of Communication

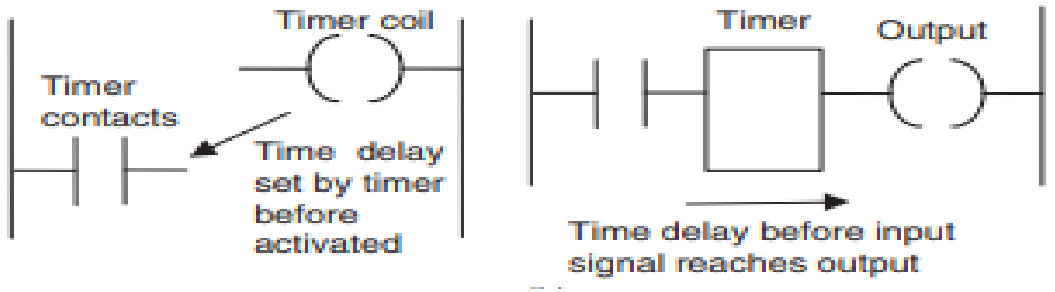
Recap and review of previous class

5 mins

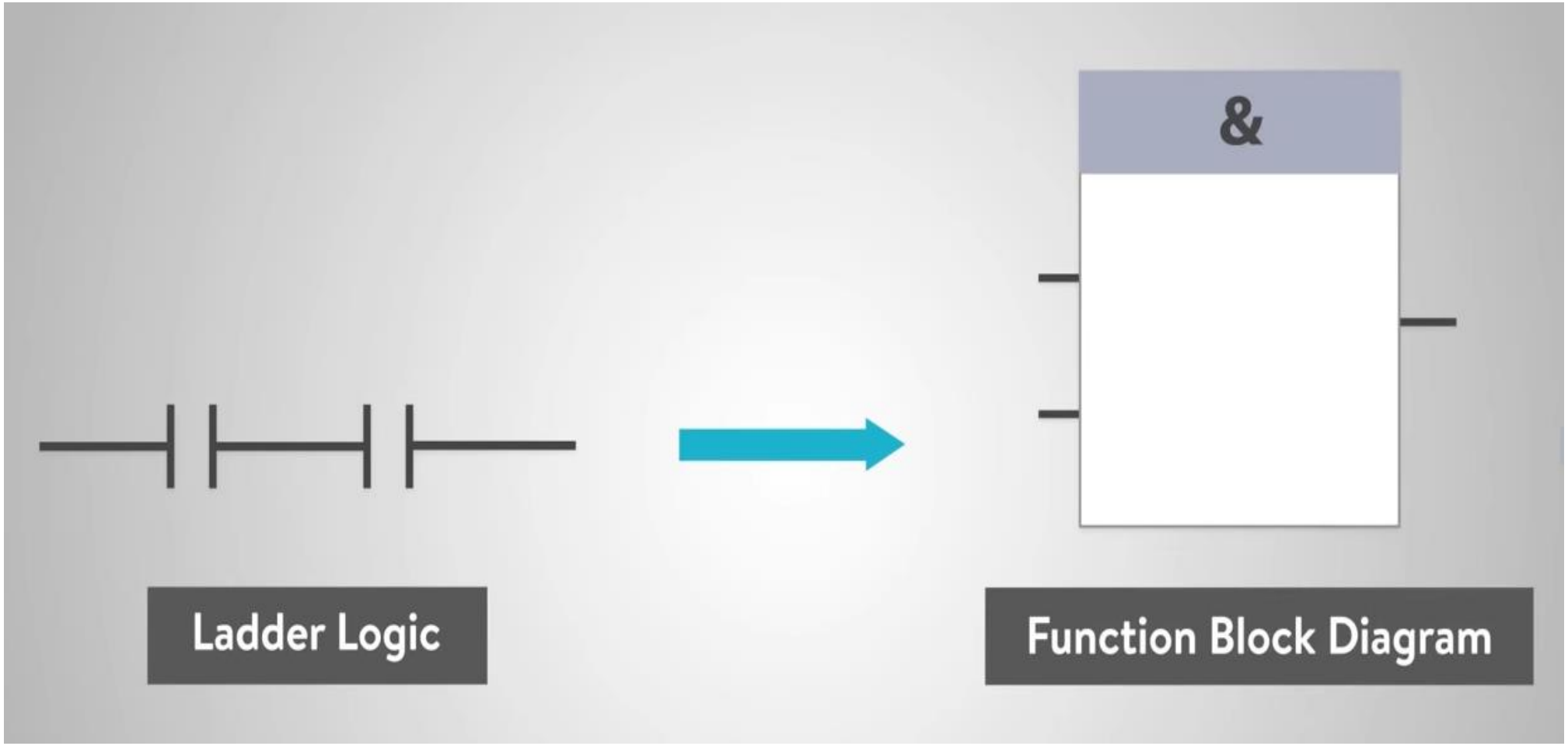
TIMERS

- Used to carry out tasks which involve time delay and time counting.
- A timer circuit is specified by stating the interval to be timed and the conditions or the events that are to start and/or stop the timer.
- They are commonly regarded as relays with coils which, when energized, result in the closing or opening of input contacts after some preset time.

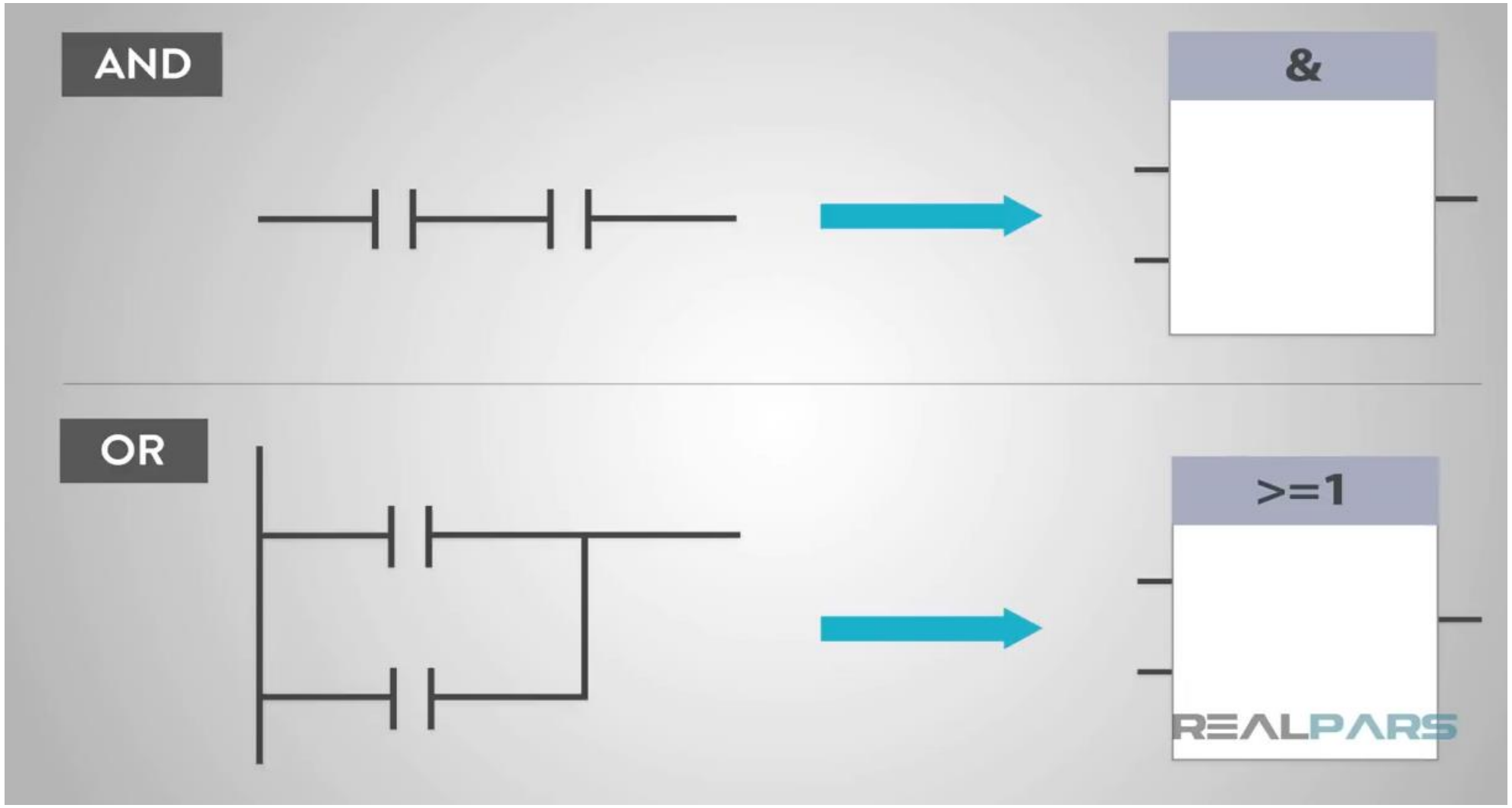
- In many control tasks there is a need to control time. For example, a **motor or a pump might** need to be controlled to operate for a particular interval of time or perhaps be switched on after some time interval. PLCs thus **have timers as built-in devices**. Timers count **seconds or fractions of seconds using the internal CPU clock**.
- A common approach is to consider timers to behave like relays with coils that when energized, result in the closure or opening of contacts after some preset time.
- The timer is thus treated as an output for a rung, with control being exercised over pairs of contacts

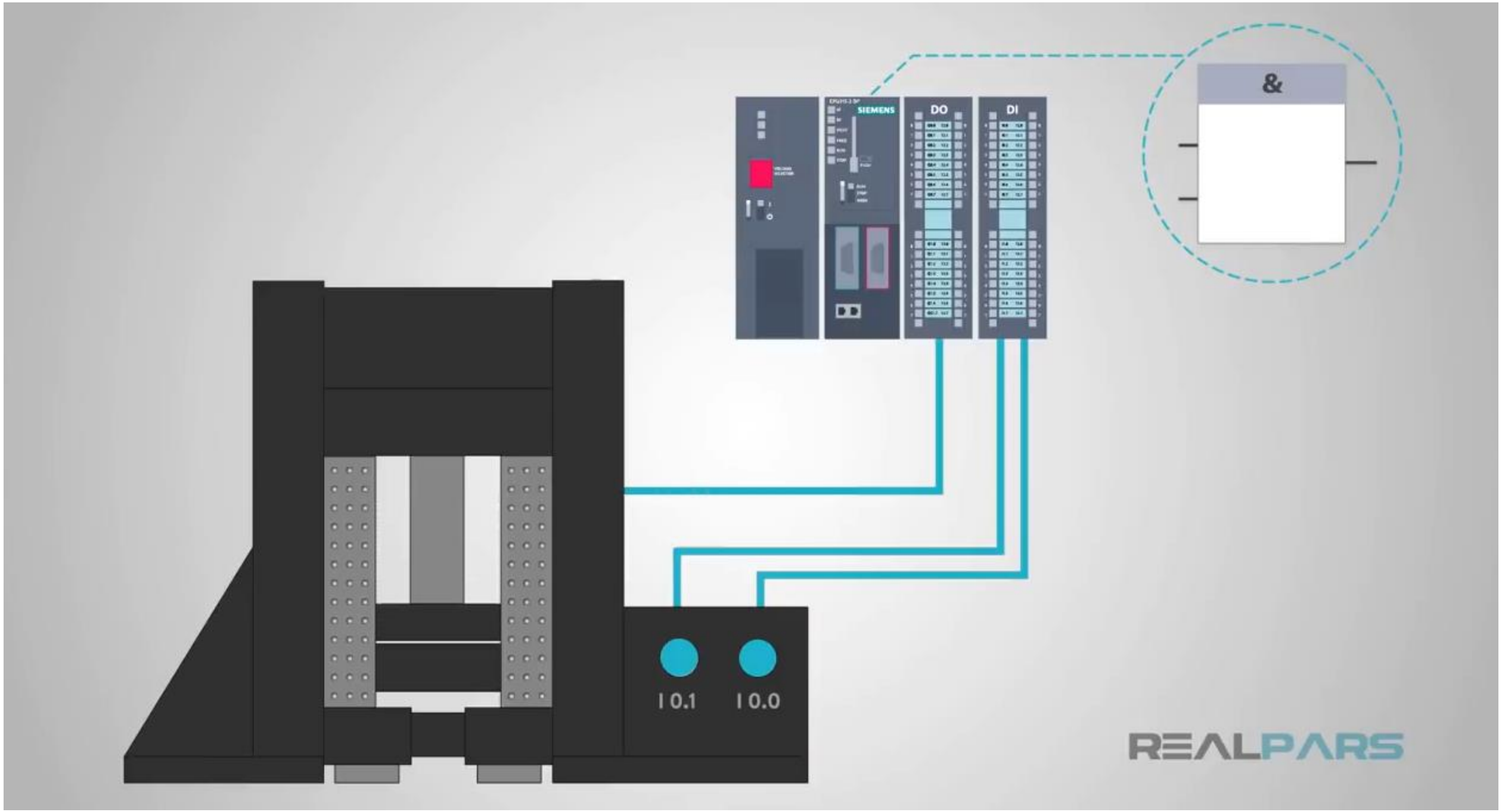


Ladder logic to function Block Diagram



AND or OR

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DI
I 0.1
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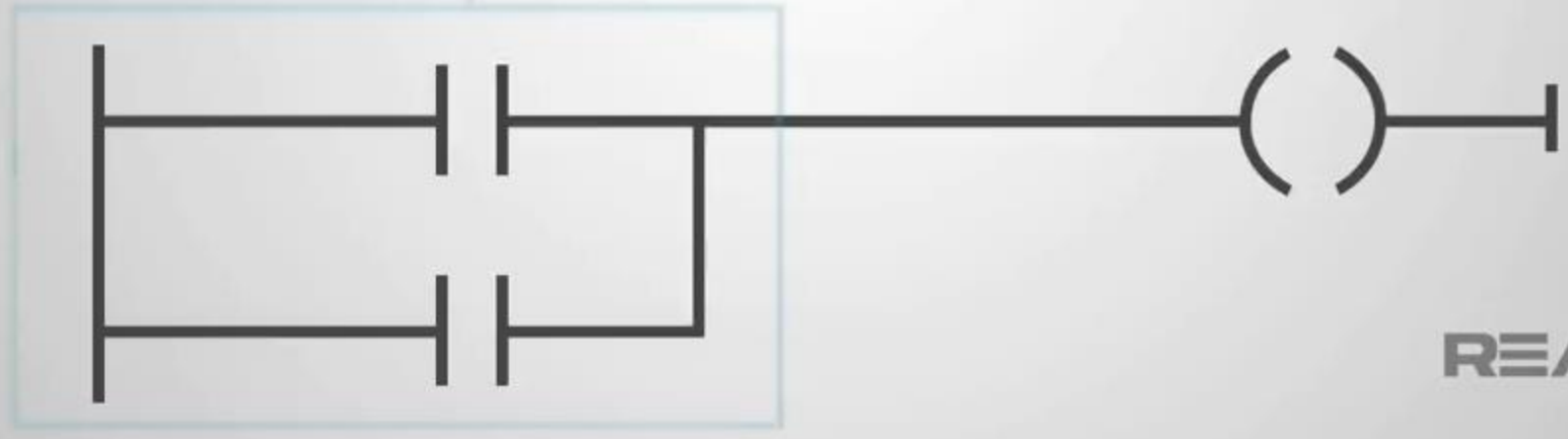
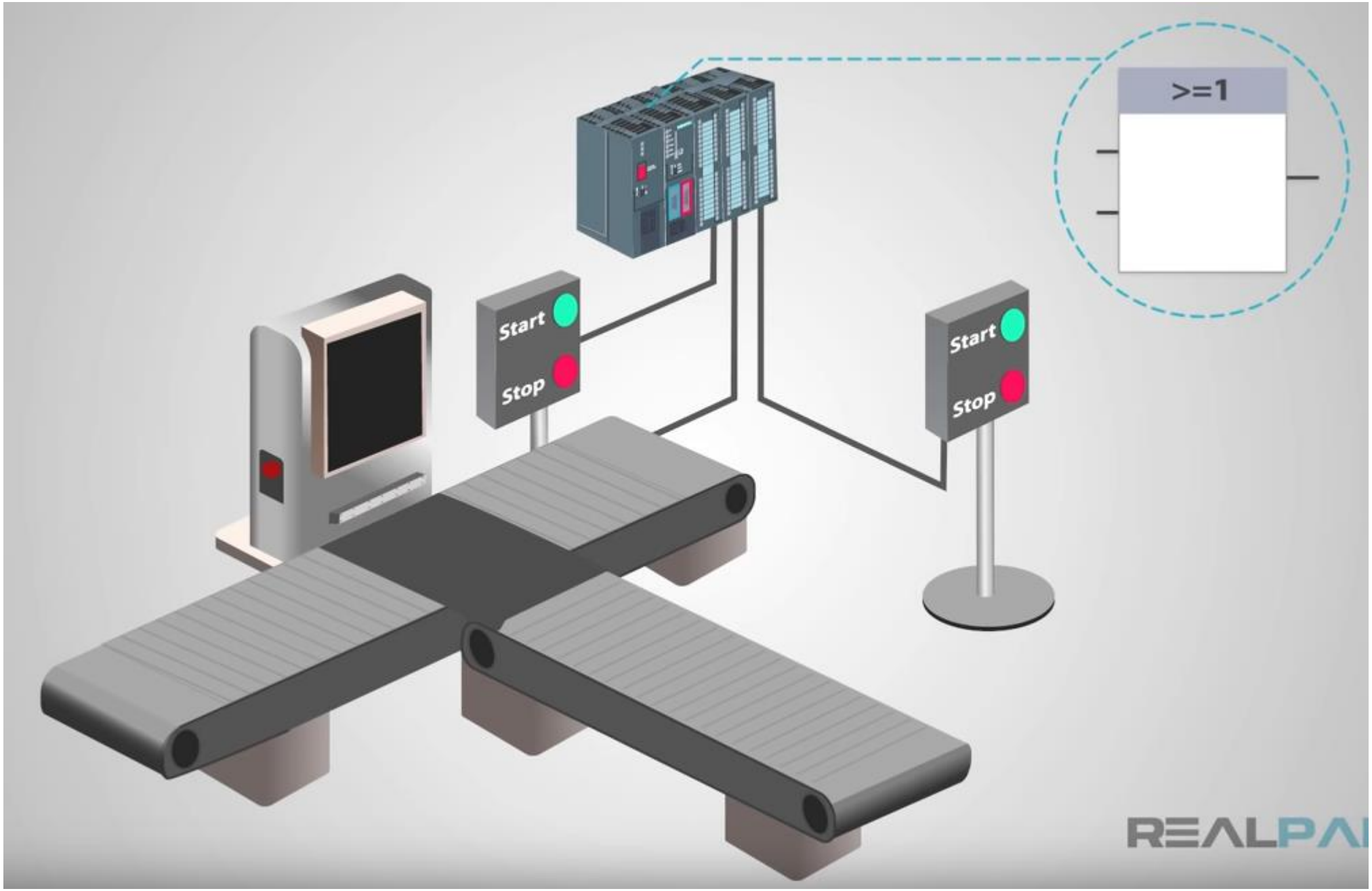
REALPARS

Function Block Diagram

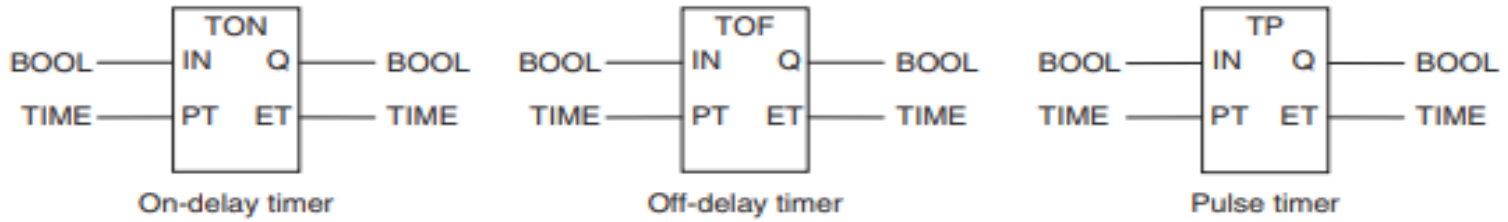
Ladder Logic



REALPARS


>=1
Start
Stop
Start
Stop
REALPA

- **On-delay timers (TON)** come on after a particular time delay Thus as the input goes from 0 to 1, the elapsed time starts to increase, and when it reaches the time specified by the input PT, the output goes to 1. It will work as soon as the rung of ladder logic has been true it will turn OFF immediately but delays to turn ON
- **An off-delay timer (TOF)** is on for a fixed period of time before turning off The timer starts when the input signal changes from 1 to 0. This can keep cooling fans on for a set time after the oven has been turned off. It will turn on immediately when a line of ladder logic is true, but it will delay before turning off.
- **The pulse timer (TP).** This timer gives an output of 1 for a fixed period of time starting when the input goes from 0 to 1 and switching back to 0 when the set time PT has elapsed.

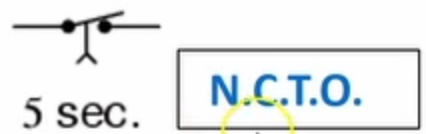


Timed Contact Symbols

- **ON Delay**

Normally-open, timed-closed

Normally-closed, timed-open



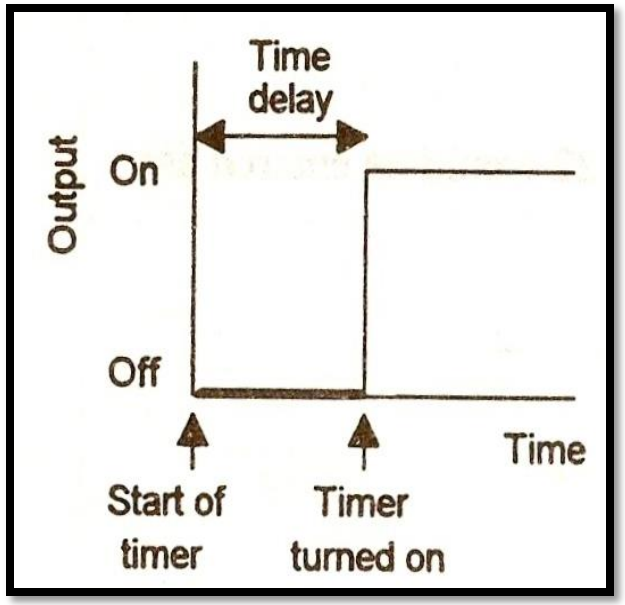
- **OFF Delay**

Normally-open, timed-open

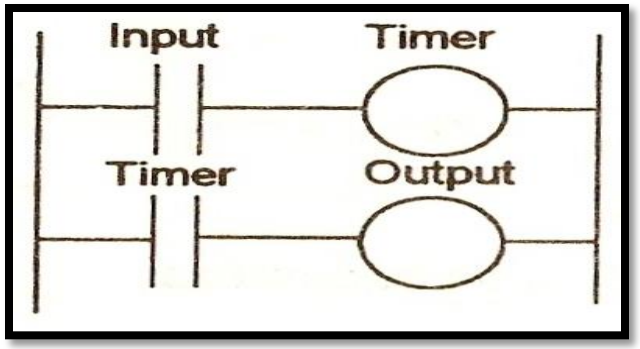
Normally-closed, timed-closed

DELAY-ON TIMERS

- This timer waits for a fixed delay period before turning on.
- When there is an input, the timer is energized and starts timing. After some preset time the contacts associated with the timer close and the output occurs.



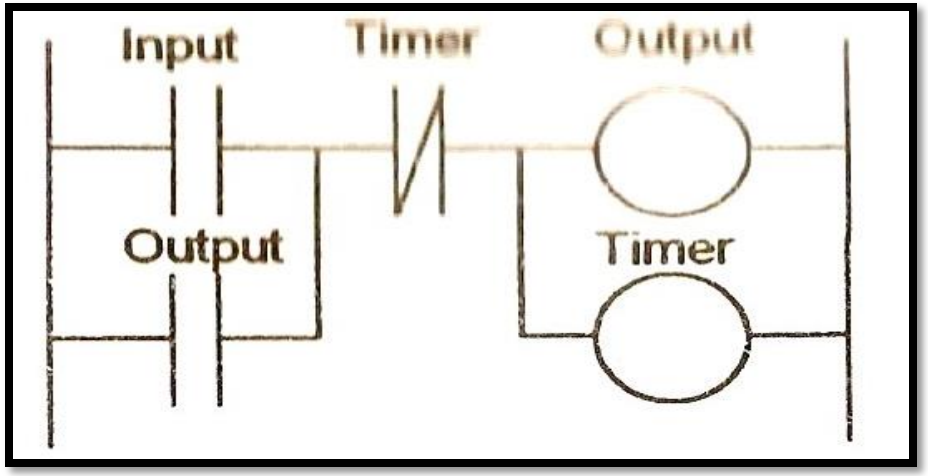
Delay-on timer



Part of program involving delay-on timer

DELAY-OFF TIMERS

- A timer which switches off an output after a time delay.
- When the input contacts are momentarily closed the output is energized and the timer started.
- The output contacts latch the input and keep the output on.
- After a preset time of the timer, the timer comes on and breaks the latch circuit, so switching the output off.

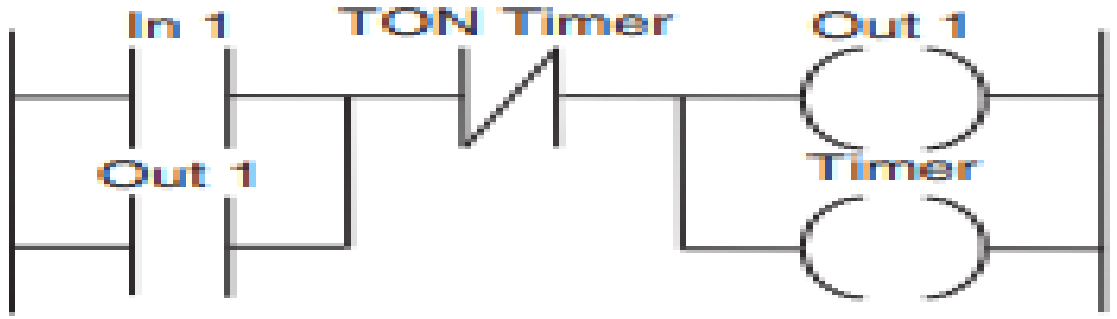


how a on-delay timer can be used to produce an off-delay timer:

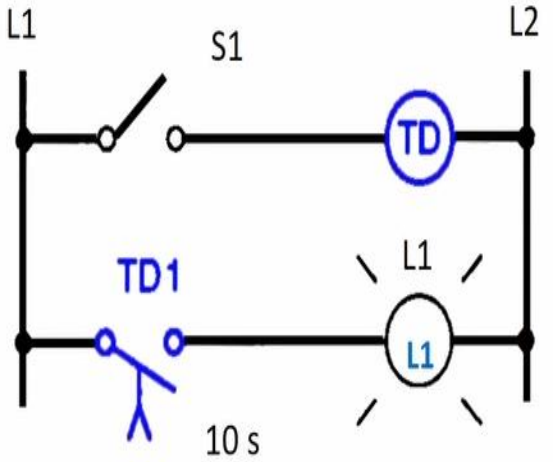
With such an arrangement, when there is a momentary input to In 1, both the output Out 1 and the timer are switched on.

Because the input is latched by the Out 1 contacts, the output remains on. After the preset timer delay, the timer contacts, which are normally closed, open and switch off the output.

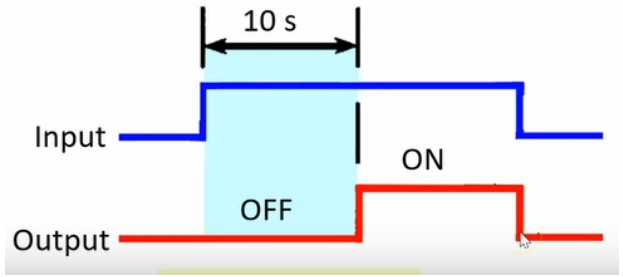
Thus the output starts as on and remains on until the time delay has elapsed



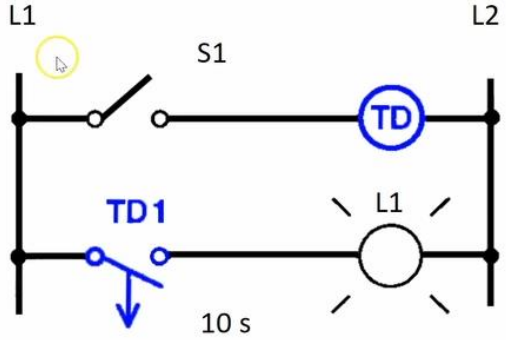
DELAY-ON TIMERS - NO



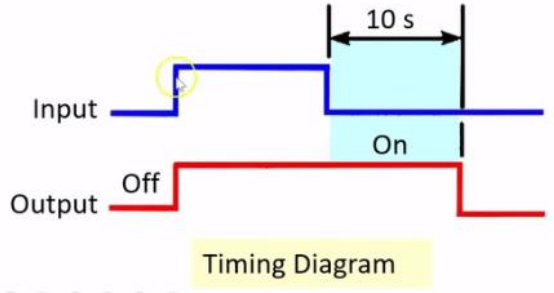
DELAY-ON TIMERS - NC

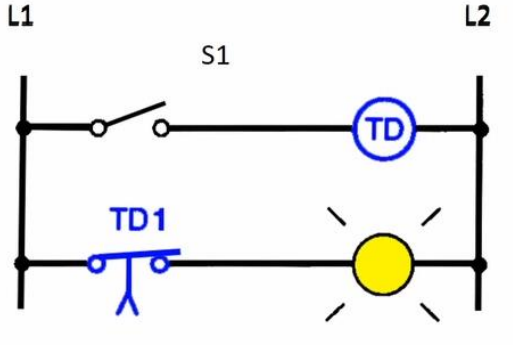


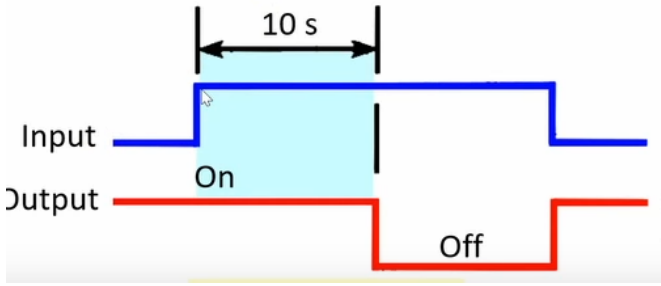
DELAY-OFF TIMERS- NO

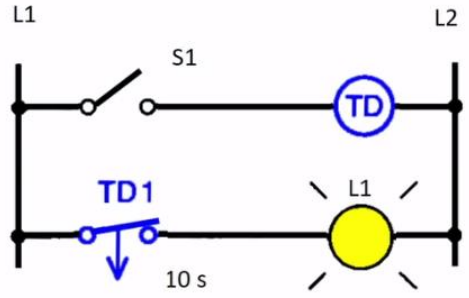


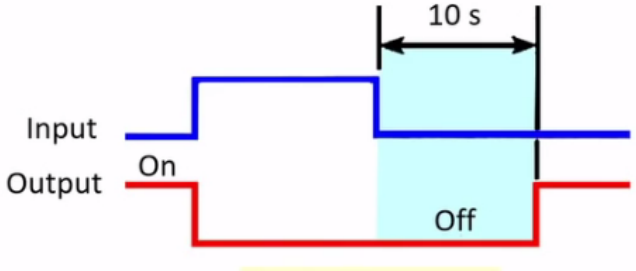
DELAY-OFF TIMERS- NC



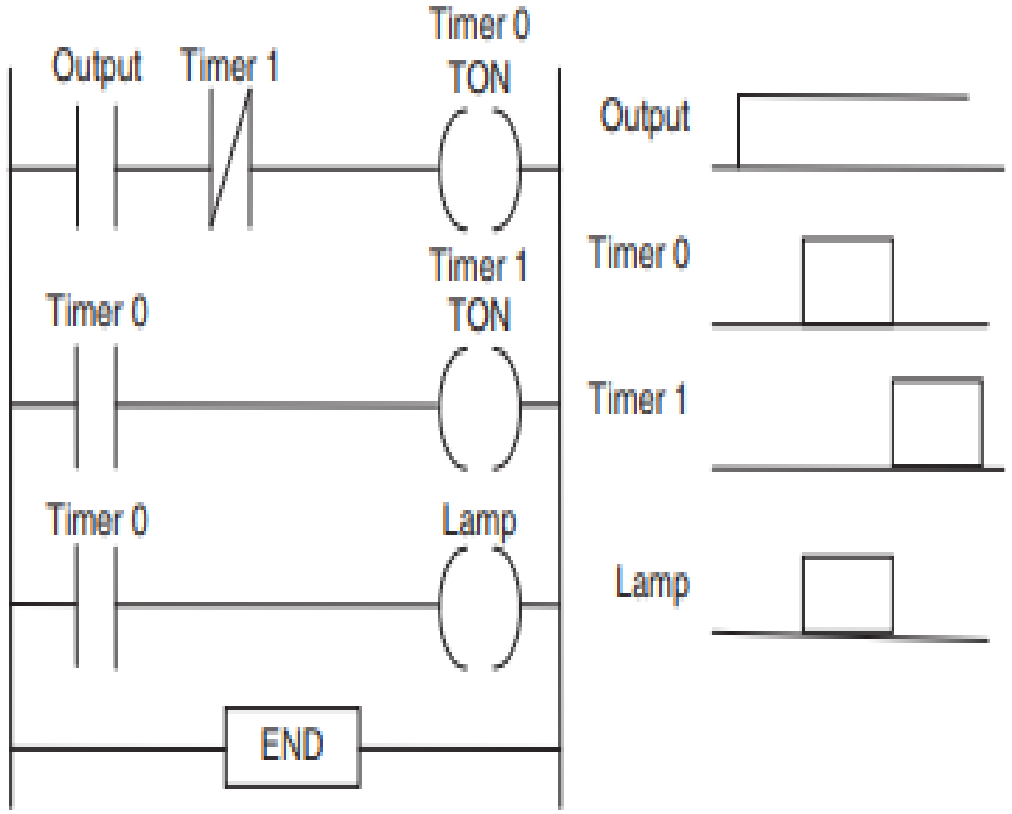








EXAMPLE



As an illustration of programming involving timers, consider the sequencing of traffic lights to give the sequence red only, red plus amber, green, and amber, then repeat. A simple system might just have the sequence triggered by time, with each of the possible states occurring in sequence for a fixed amount of time

that could be used to flash a light on and off as long as there is some output occurring.

Thus we might have both timer 0 and timer 1 set to 1 s.

When the output occurs, timer 0 starts and switches on after 1 s.

This closes the timer 0 contacts and starts timer 1.

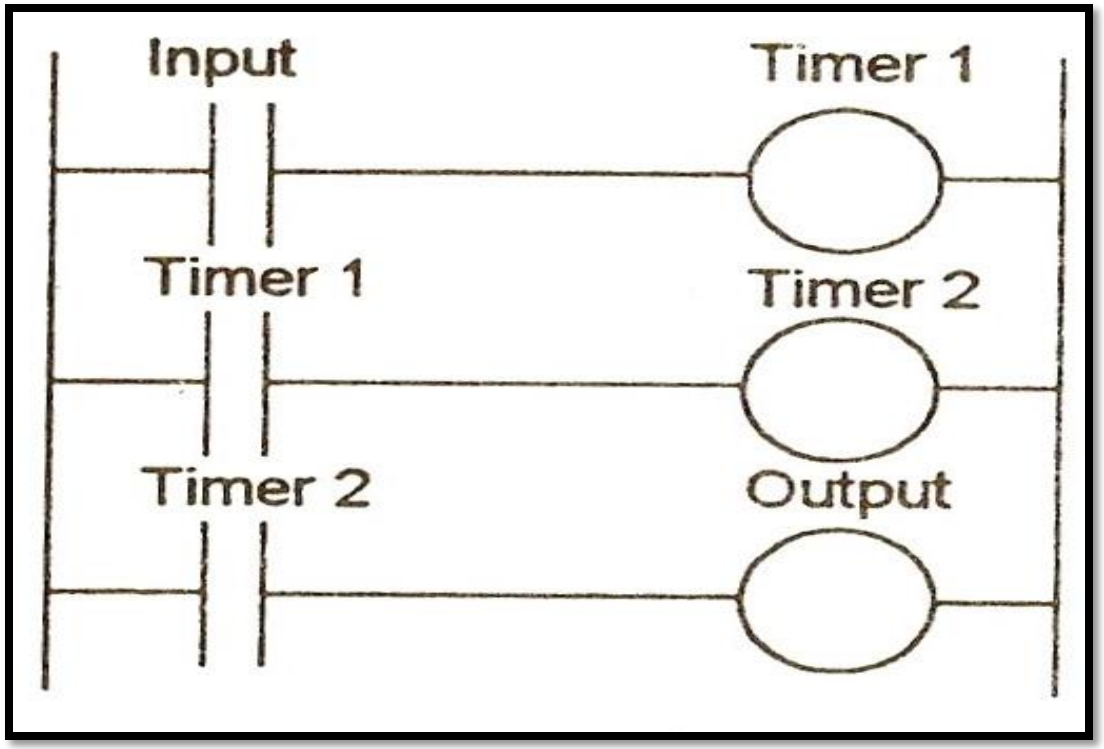
This switches on after 1 s and, in doing so, switches off timer 0.

In so doing, it switches off itself.

The lamp is on only when timer 0 is on, and so we have a program to flash the lamp on and off as long as there is an output.

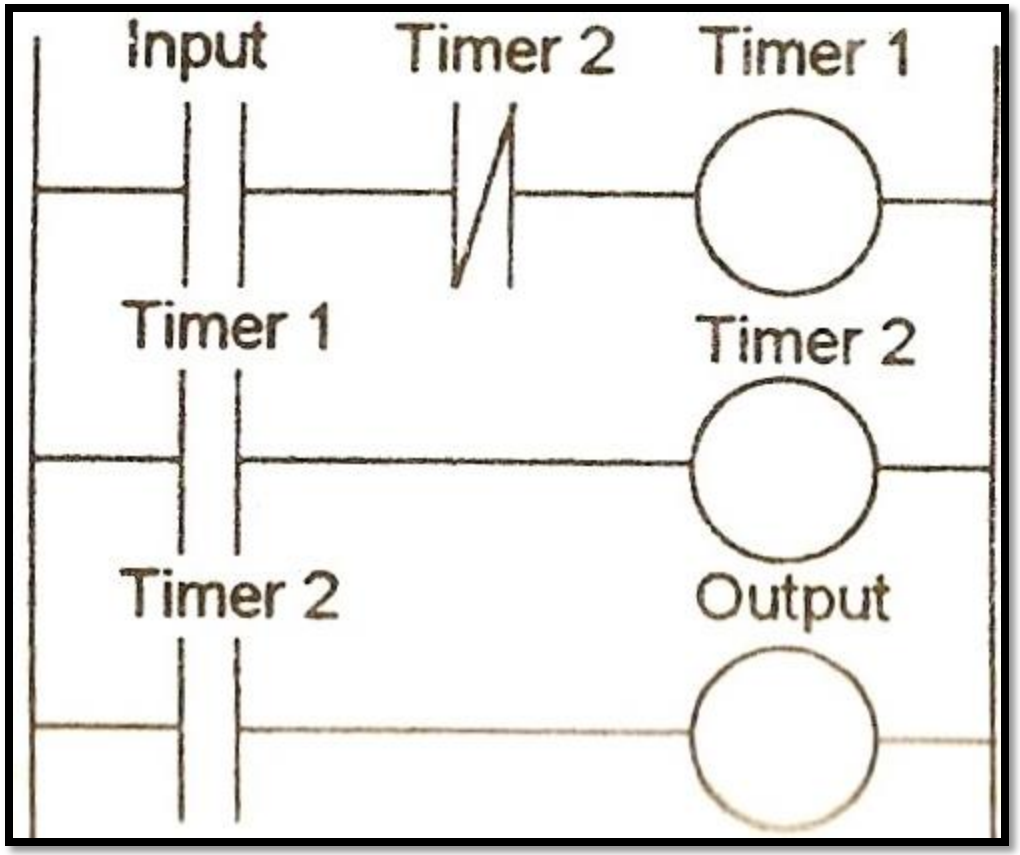
CASCADED TIMERS

- To give larger delay times that which is not possible by just one timer – timers are linked together.
- They are called cascaded timers.



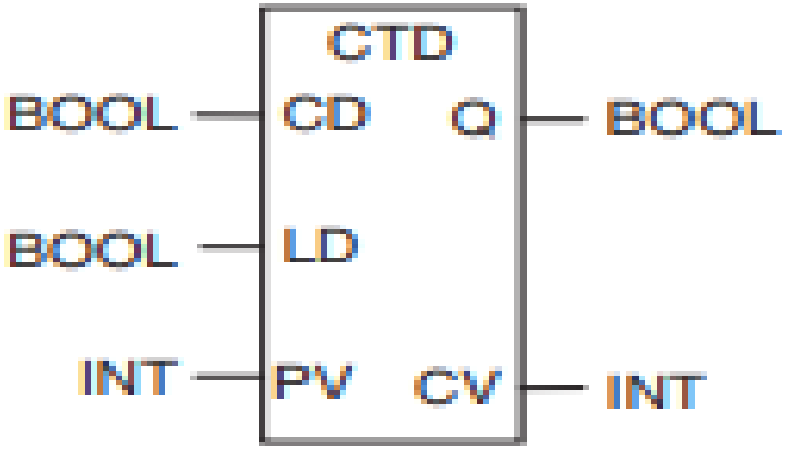
ON-0FF CYCLIC TIMER

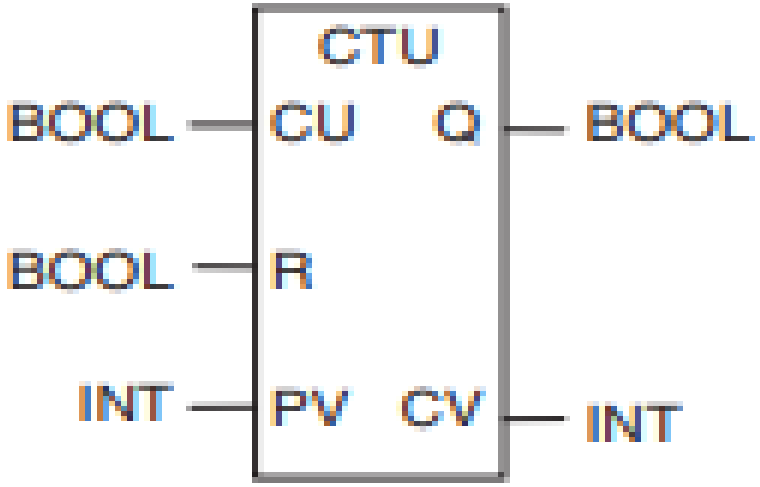
- Used to cause an output to go on for a certain time and then off for a certain period and repeat this cycle.



COUNTERS

- Counters are provided as built-in elements in PLCs and allow the number of occurrences of input signals to be counted. Some uses might include where items have to be counted as they pass along a conveyor belt, the number of revolutions of a shaft, or perhaps the number of people passing through a door.





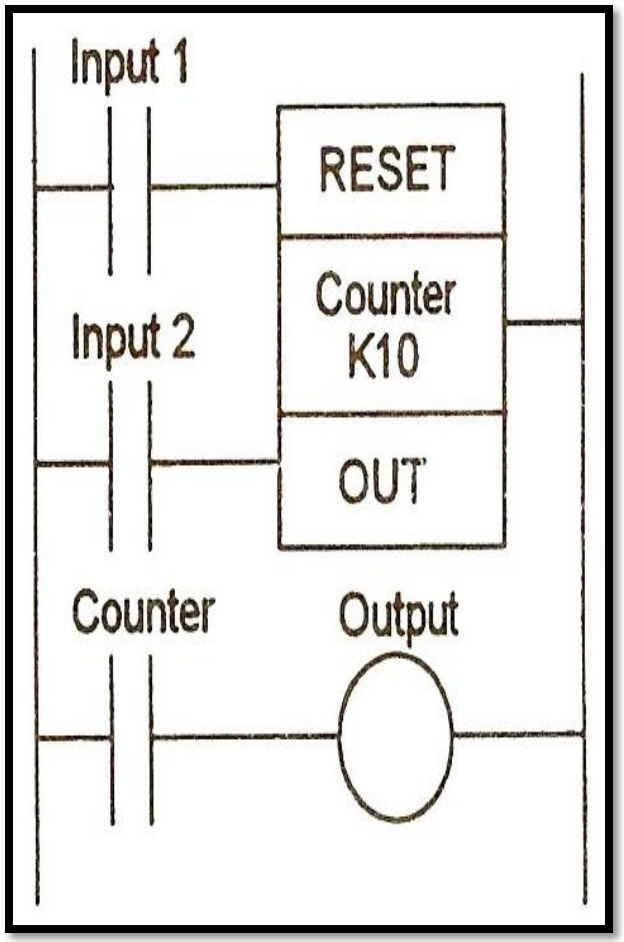
- Used when there is a need to count a specified number of contact operations.

- Two types:

  * **Down- counter**: the counter counts from present value to zero(events are subtracted from the set value) and when zero is reached its contact state changes.

  * **Up-counter**: counts up to the preset value (events are added until the number reaches the set value) and when this is reached its contact changes state. Up-counter in the PLC works on the method of counting no of pulses in Increment order

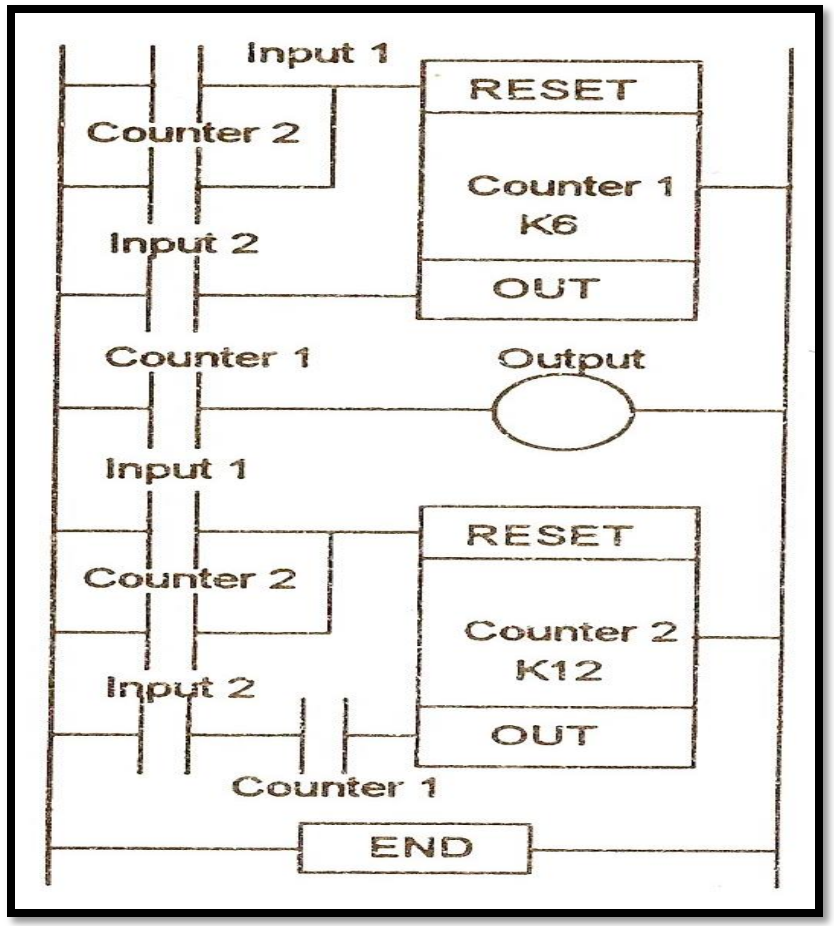
SAMPLE COUNTING PROGRAM



- K10 indicates that the contact state changes on the 10^{th} pulse.
- When input1 closes momentarily, the counter is reset to set value.
- Then the number of pulses resulting from the contacts of input2 closing and opening are counted.
- When it reaches the set value(10), the counter contact closes.
- The output is thus switched on after 10 pulses.
- If the contacts of input1 are momentarily closed during the count, the counter will reset to 10.

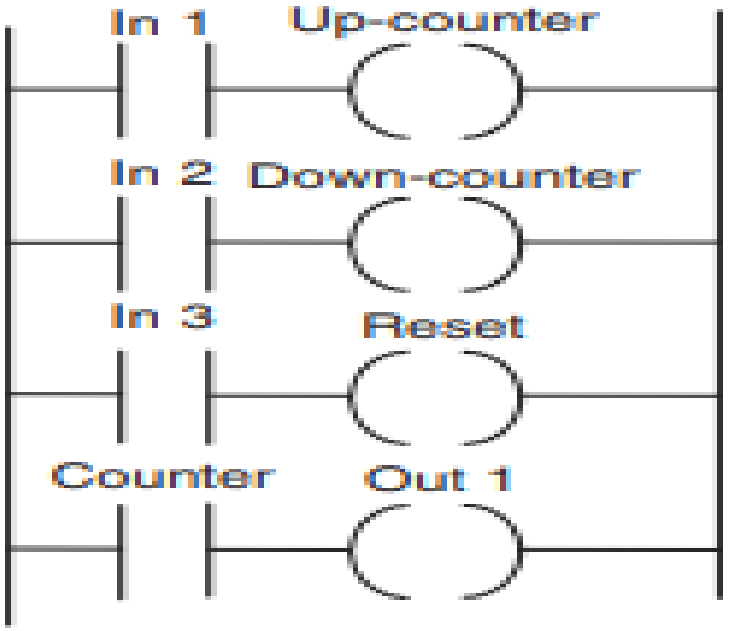
SAMPLE APPLICATION OF COUNTERS

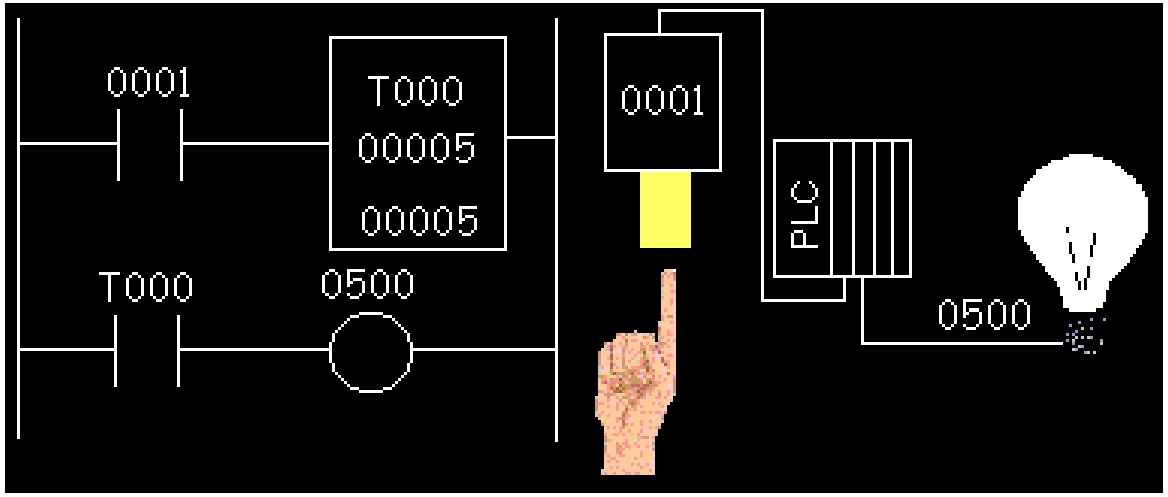
- Consider the problem of the control for a machine which is required to direct 6 items along one path for packaging in a box, and then 12 items along another path for packaging in another box.



Up- and Down-Counting

When an item enters, it gives a pulse on input In 1. This increases the count by 1. Thus each item entering increases the accumulated count by 1. When an item leaves, it gives an input to In 2. This reduces the number by 1. Thus each item leaving reduces the accumulated count by 1. When the accumulated value reaches the preset value, the output Out 1 is switched on





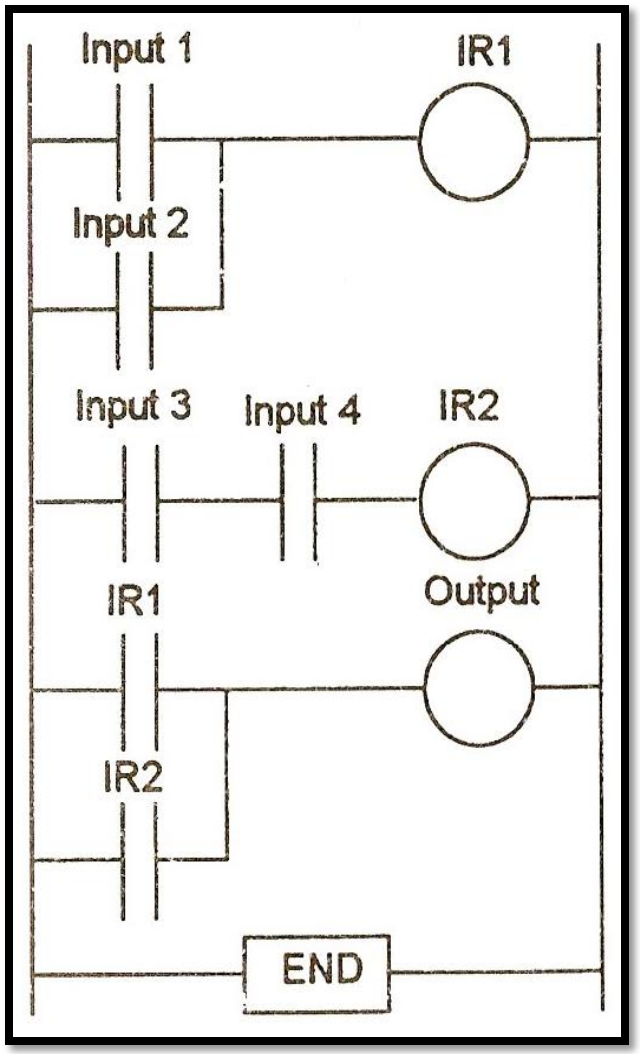
Encoder?

- Simply put, an **encoder** is a sensing device that provides feedback. **Encoders** convert motion to an electrical signal that can be read by some type of control device in a motion control system, such as a counter or **PLC**.
- The **encoder** sends a feedback signal that can be used to determine position, count, speed, or direction.

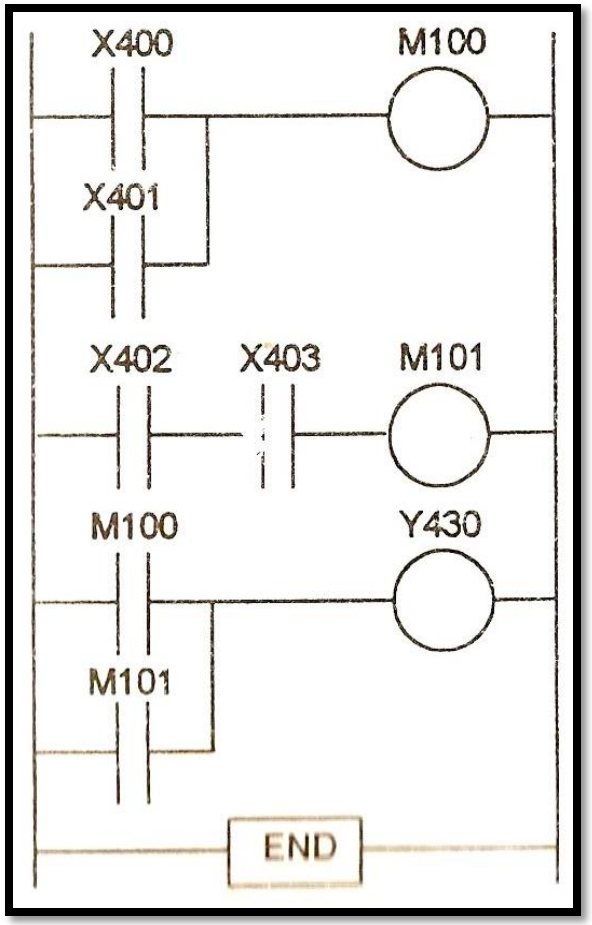
INTERNAL RELAYS

- Also called as auxiliary relay or marker.
- They behave like relays with their associated contacts, but in reality are not actual relays but simulations by the software of the PLC.
- Some have battery back-up – to ensure a safe shut-down of plant in the event of a power failure.
- Useful in implementation of switching sequences.

INTERNAL RELAYS FOR MULTIPLE INPUT CONDITIONS

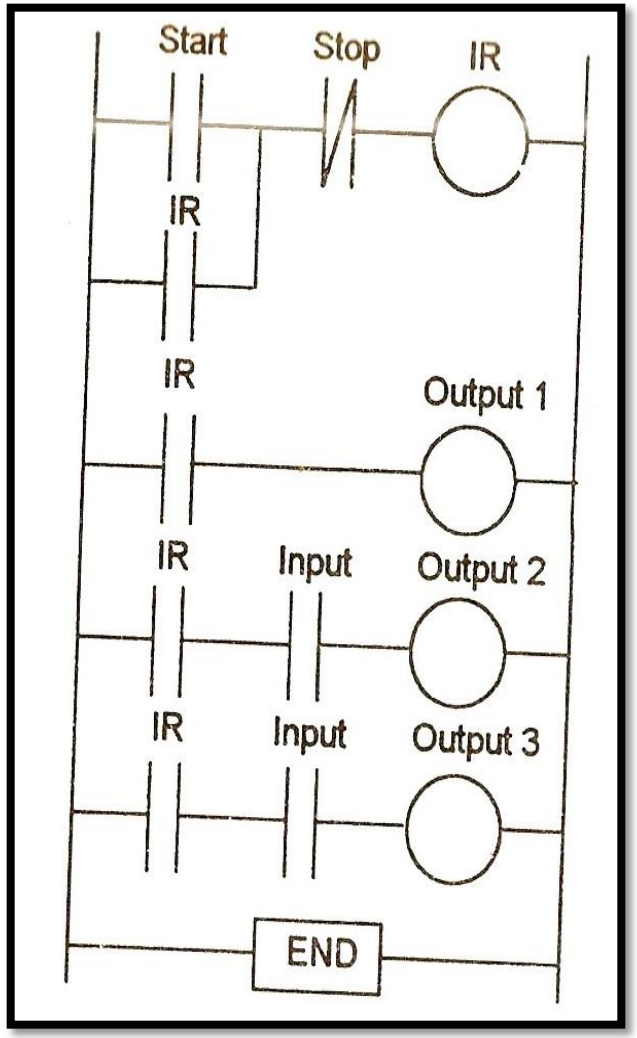


- Excitation of output depends on two different input arrangements.
- First rung- one input arrangement to control the cool IR1.
- Second rung- other input arrangement to control coil IR2.
- The contacts of the two relays are then put in an OR situation to control the output.



Step	Instruction	Notation
0	LD	X400
1	OR	X401
2	OUT	M100
3	LD	X402
4	AND	X403
5	OUT	M101
6	LD	M100
7	OR	M101
8	OUT	Y430
9	END	

INTERNAL RELAYS FOR MULTIPLE OUTPUTS

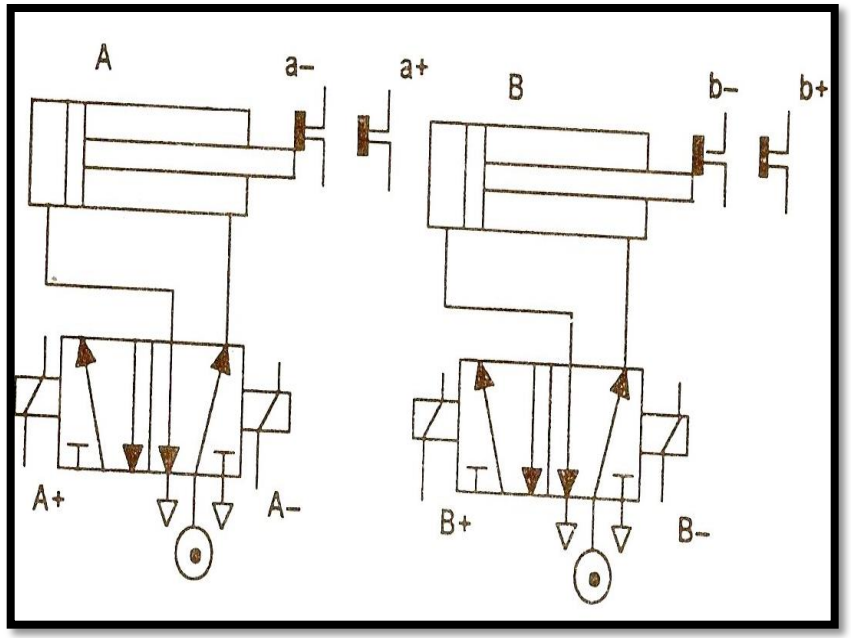


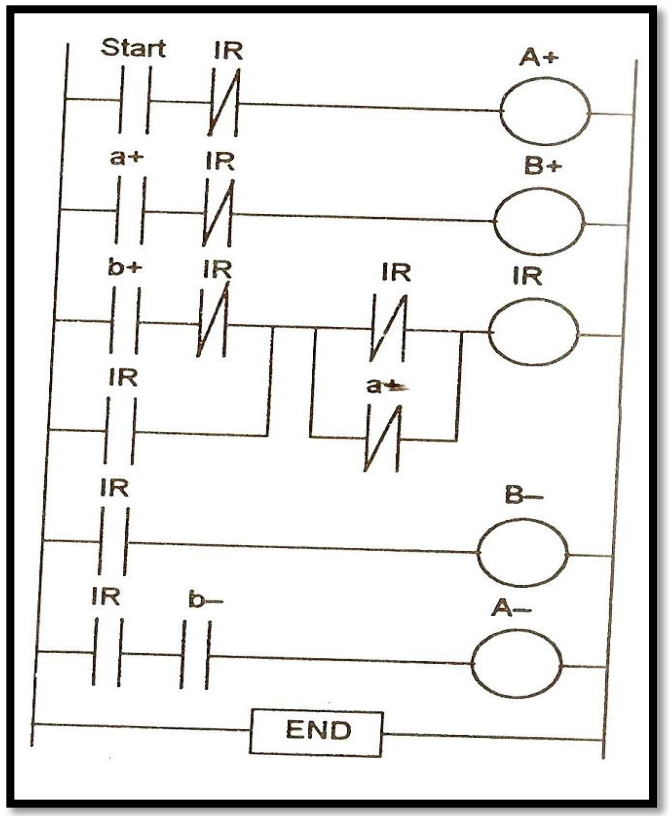
- When the start contacts are closed, the internal relay is activated and latches the input.

- It also starts output 1 and makes it possible for outputs 2 and 3 to be activated.

APPLICATION OF INTERNAL RELAYS-1

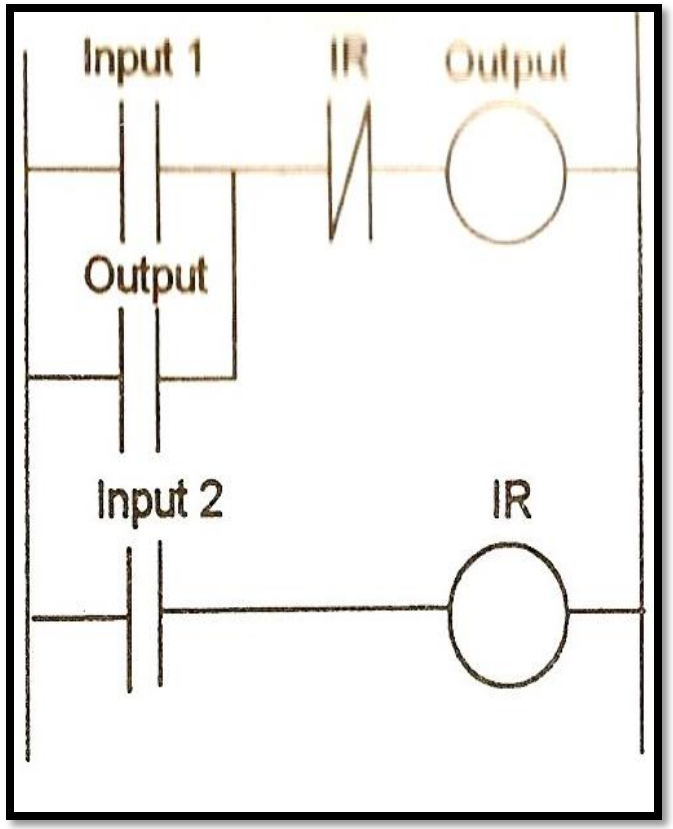
- To automate a pneumatic circuit (2 cylinders) in which double solenoid valves are used in the sequence A+B+B-A-.





APPLICATION OF INTERNAL RELAYS-2

- Used for resetting a latch.



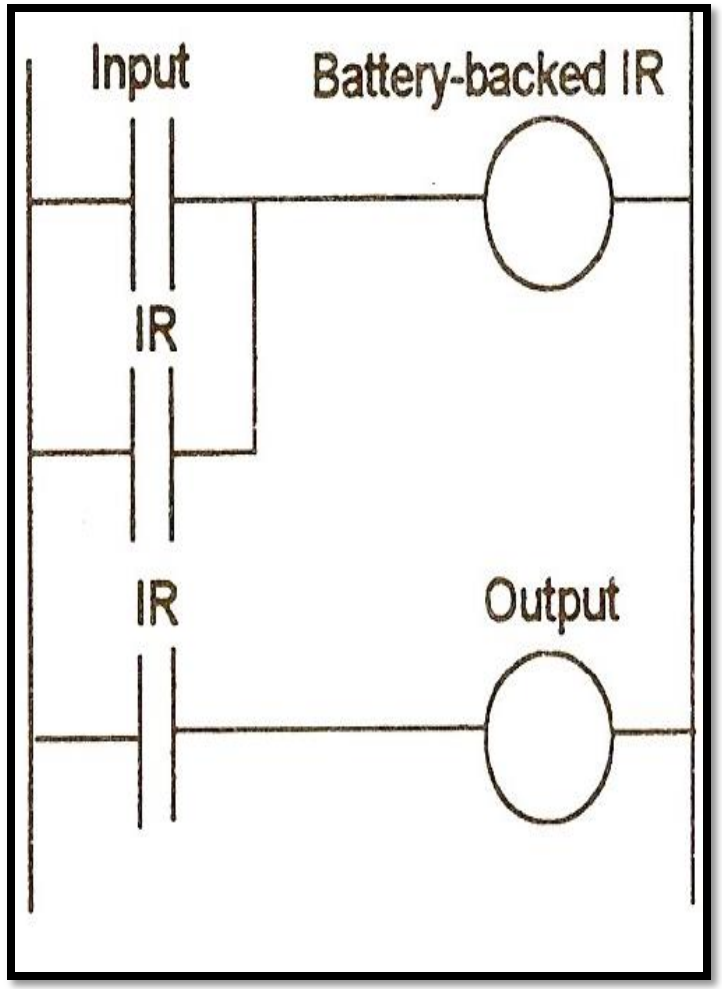
•When the contacts of input 1 are momentarily pressed then the output is energized.

•The contacts of the output are then closed and so the latch the output.

•The output can be unlatched by the internal relay contacts opening.

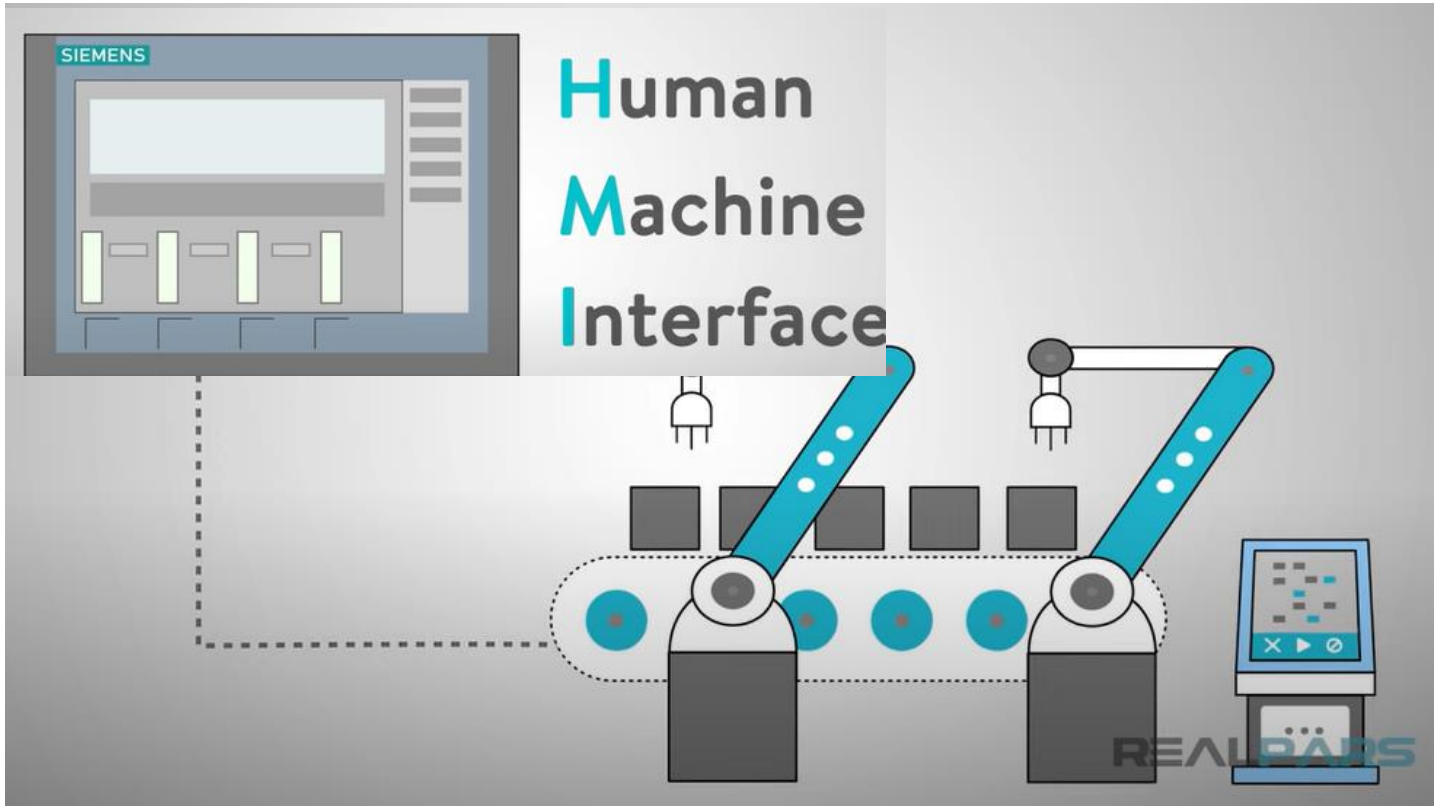
•This will occur if input2 is closed and energizes the coil of the internal relay.

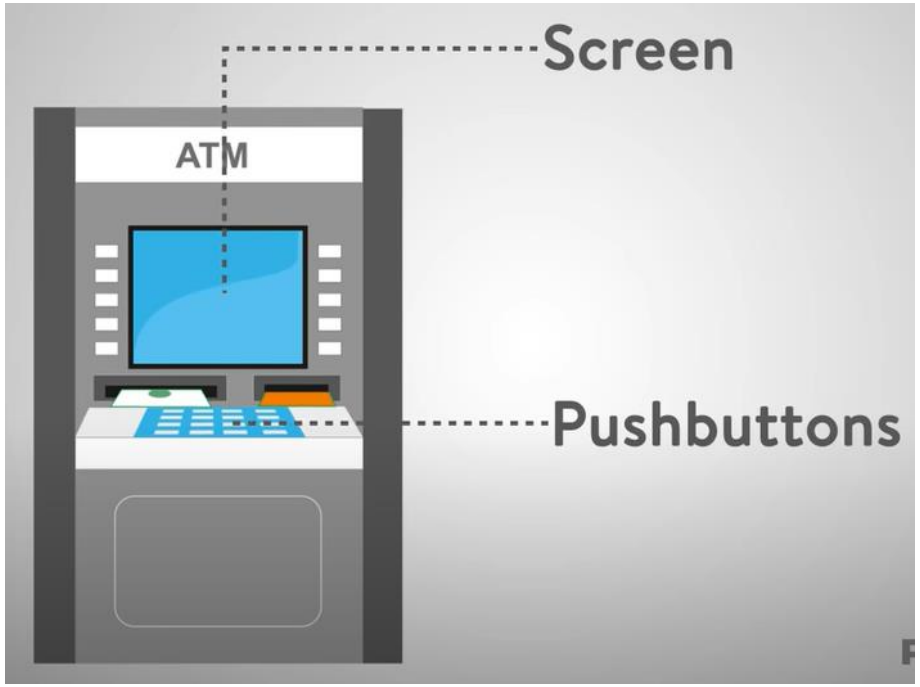
BATTERY BACKED INTERNAL RELAY



- When the contacts of input1 close, the coil of battery backed internal relay is energized.
- This closes the relay contacts and so even if contacts of the input open as a result of power failure the relay contacts remain closed.
- (i.e) the output controlled by the internal relay remains energized, even when there is a power failure.

HUMAN MACHINE INTERFACE (HMI) / MAN MACHINE INTERFACE (MMI)





https://www.youtube.com/watch?v=kujHQgK352o

Human Machine Interface.

- **HMI** is the principal point of contact between the **user and a machine or process**. ... A well-designed **HMI** System **does** more than just present **control functions and information**; it provides an operator with active functions to **perform, feedback on the results of those actions, and information on the system's performance**.

OR

- An **HMI** is a software application that **presents information** to an **operator or user about the state** of a process, and to accept and implement the operators control instructions.
- Typically information is displayed in a **graphic format** (Graphical User Interface or GUI).

In industrial settings, HMIs can be used to:

- Visually display data
- Track production time, trends, and tags
- Oversee KPIs
- Monitor machine inputs and outputs
- And more

Industries using HMI include:

- Energy
- Food and beverage
- Manufacturing
- Oil and gas
- Power
- Recycling
- Transportation
- Water and waste water
- And many more

HMI

Earlier Time Monitoring

Modern Interface

https://www.slideshare.net/geterrdone/hmi-human-machine-interface?qid=740842c0-13d8-43cf-9200-532a23c4e171&v=&b=&from_search=5

HMI functionality

Human Machine Interface (HMI):
Graphical object state presentation, lists, reports

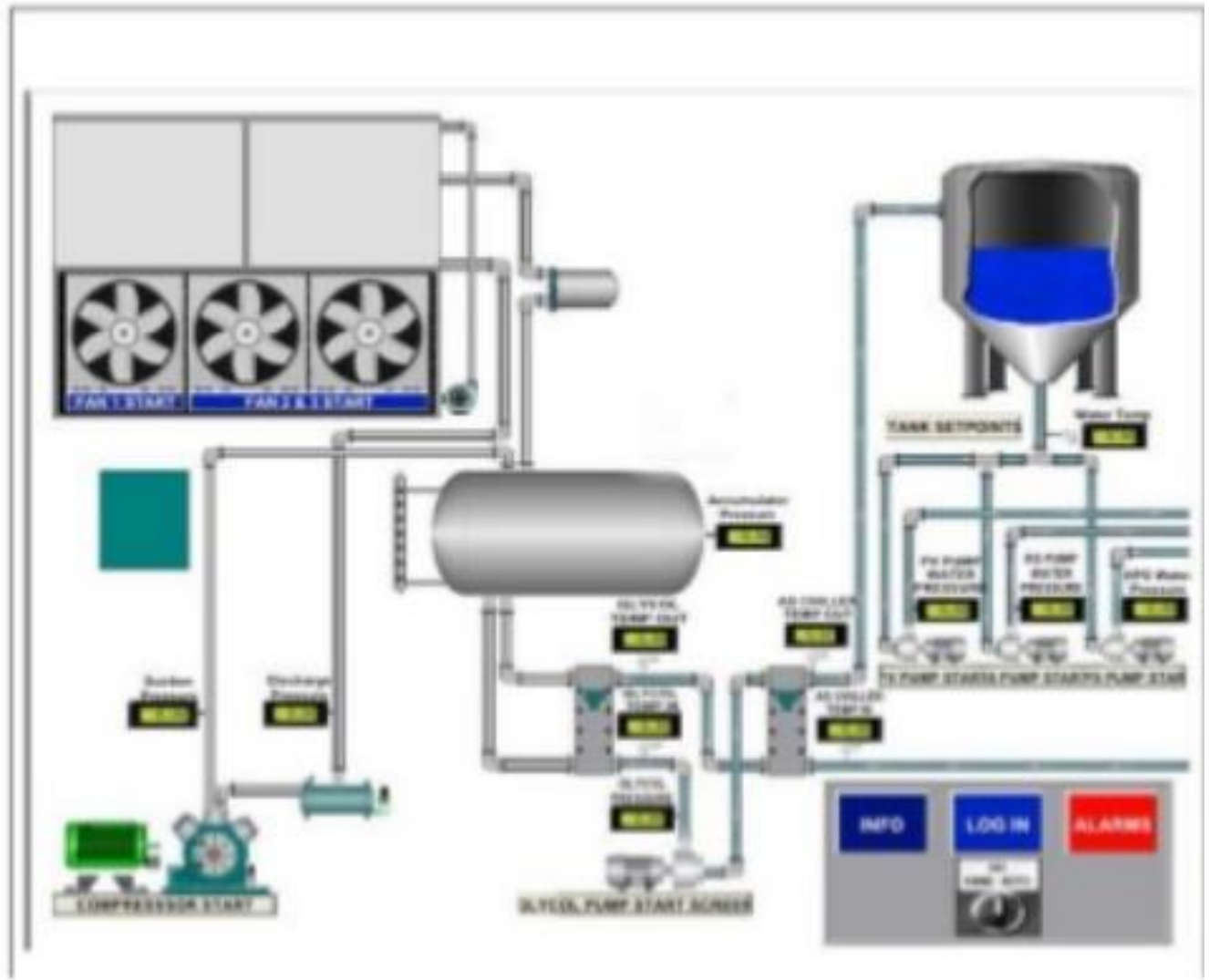
Operator Command handling
change binary commands, set points

Alarm & Events
record specified changes and operator actions

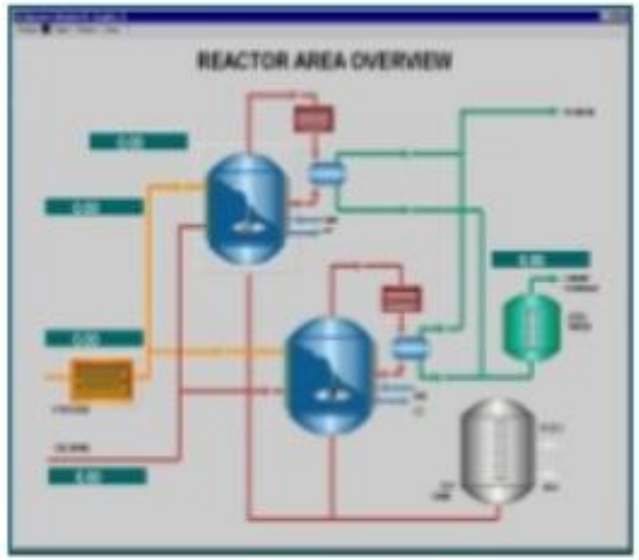
History data base
keep a record of the process values and filter it

Logging
keep logs on the operation of the automation system

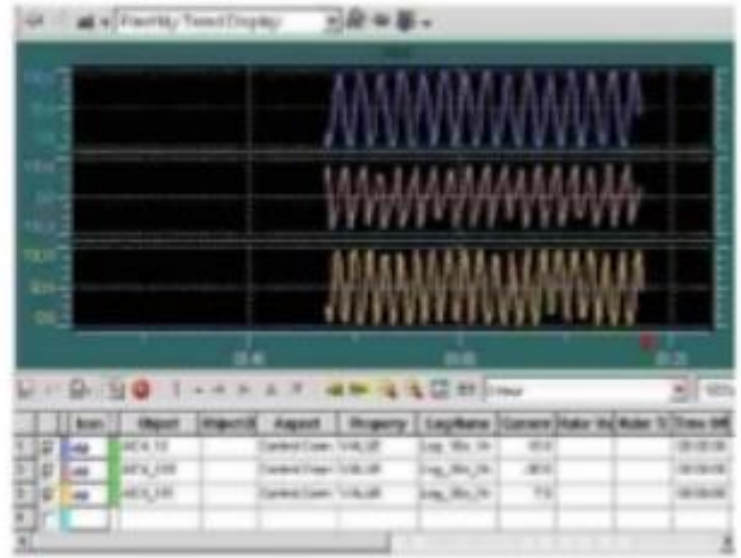
Reporting
generate incident reports



Operator workplace: three main functions



current state



trends and history

alarms and events

What is an alarm, an event ?

Alarm and Event (A&E) consider changes occurring in the plant (process) or in the control system that are worth recording (operator actions, configuration changes,…)

Recorded changes can be of three kinds:
- informative: no action required
  (e.g. "*production terminated at 11:09")*
- warning: plant could stop or be damaged if no corrective action is taken "soon"
  (e.g. "*toner low*")
- blocking: the controller took action to protect the plant and further operation is prevented until the reason is cleared (e.g. "*paper jam*")

What triggers an alarm ?

- binary changes of process variables (individual bits), some variables being dedicated to alarms

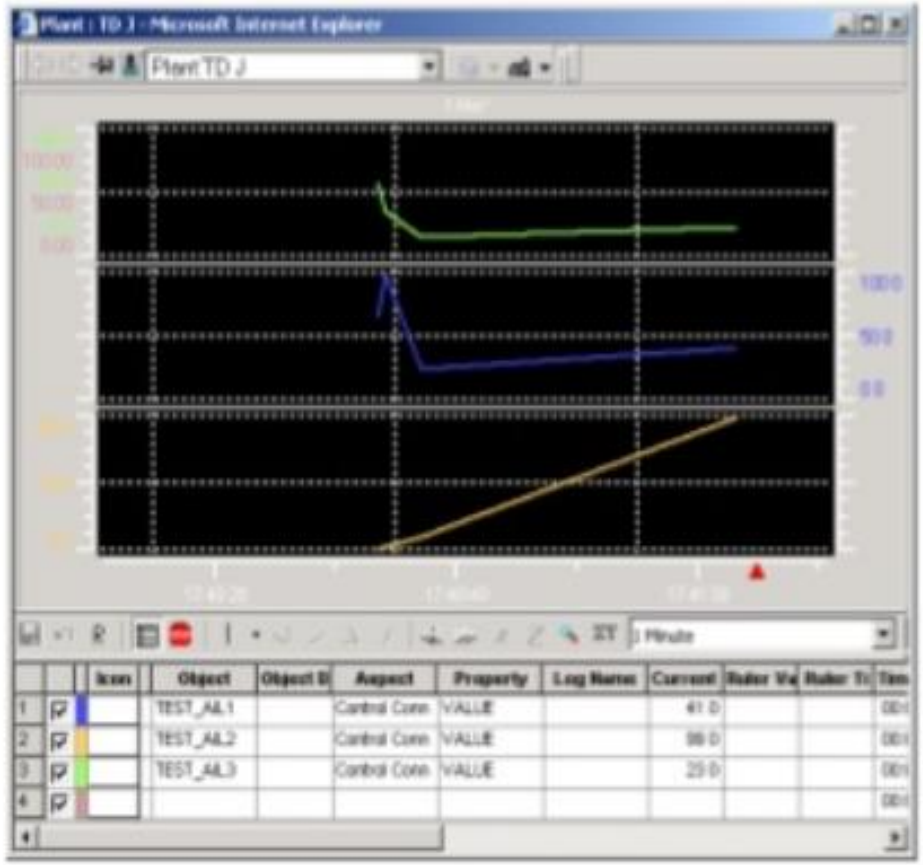
- reception of an analog variable that exceeds some threshold (upper limit, lower limit), the limits being defined in the operator workstation

- reception of an alarm message (from a PLC that can generate such messages)

- computations in the operator workstation
  (e.g. possible quality losses if current trend continues)

- calendar actions
  (e.g. unit 233 did not get preventive maintenance for the last three months)

Trends



Trends allow to follow the behaviour of the plant and to monitor possible excursions.
Monitored process data (sampled or event-driven) are stored in the historical database.

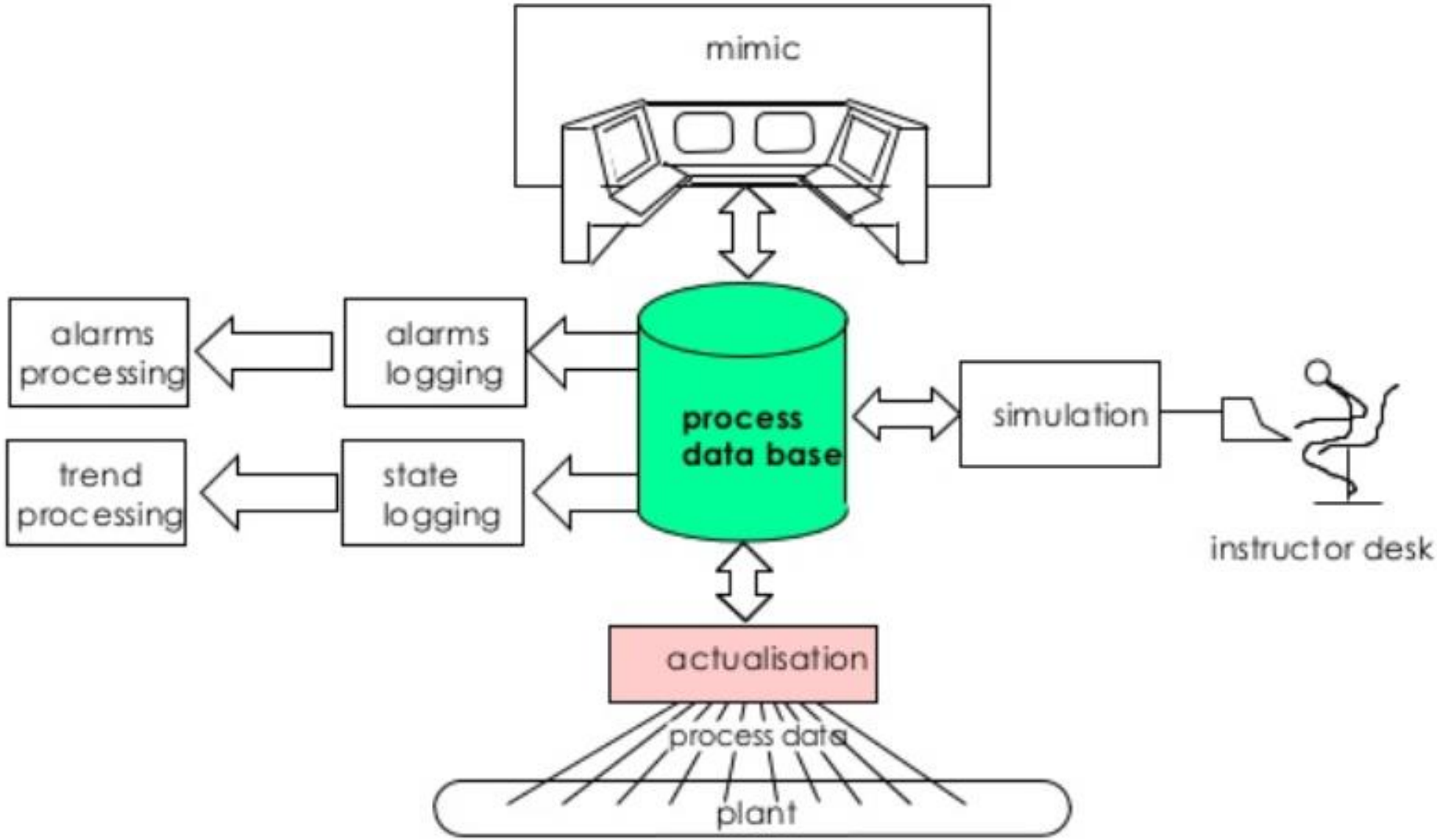
Historian

The historian keeps process relevant data at a lower granularity than the trend recorder,
but with a larger quantity.

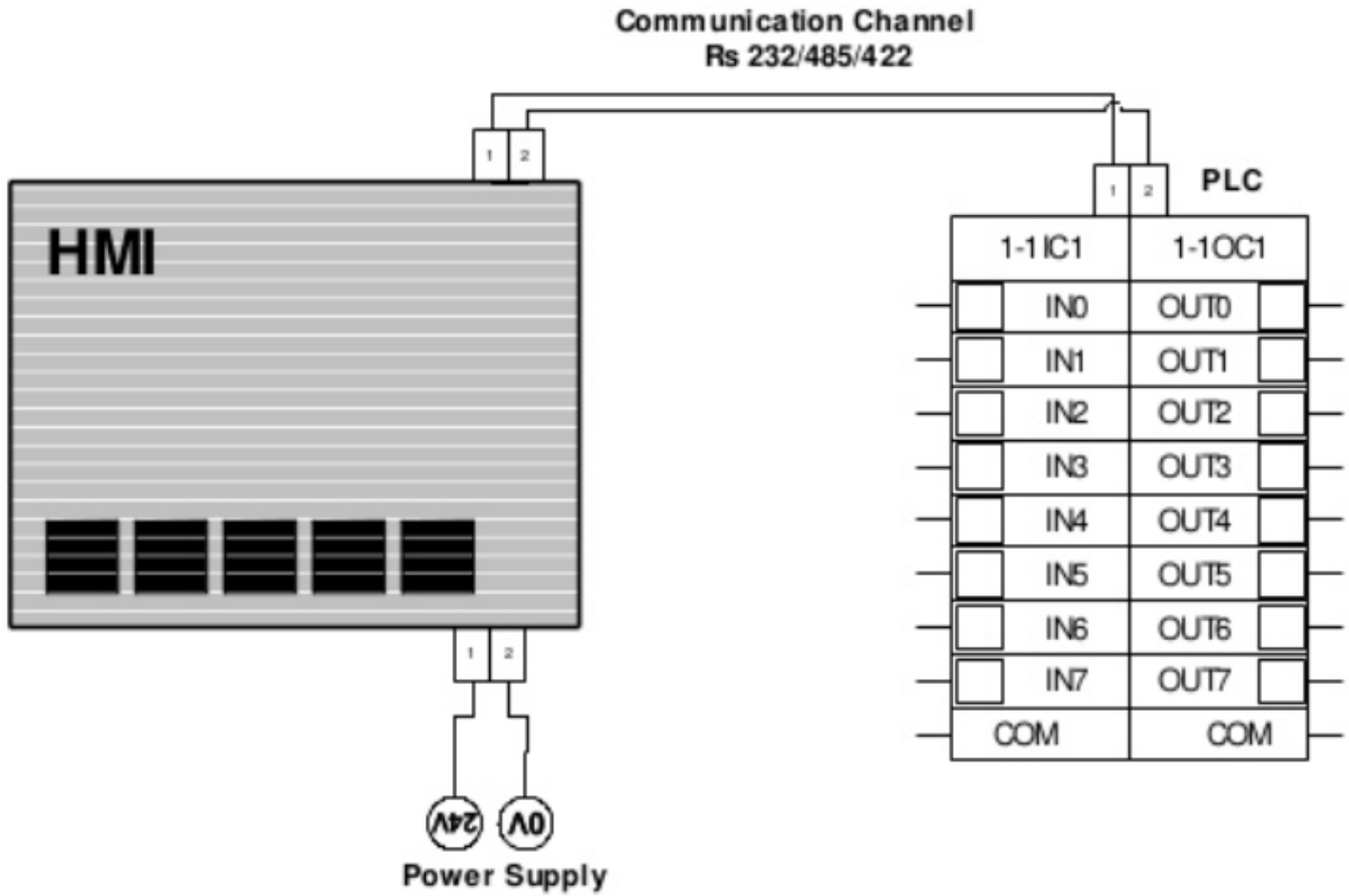
Data from different sources is aggregated in one data base, normally using data compression to keep storage costs low.

Data are analysed according to "calculation engines" to retrieve "metrics":
- performance indicators
- quality monitoring
- analysis of situations (why did batch A worked better than batch B)

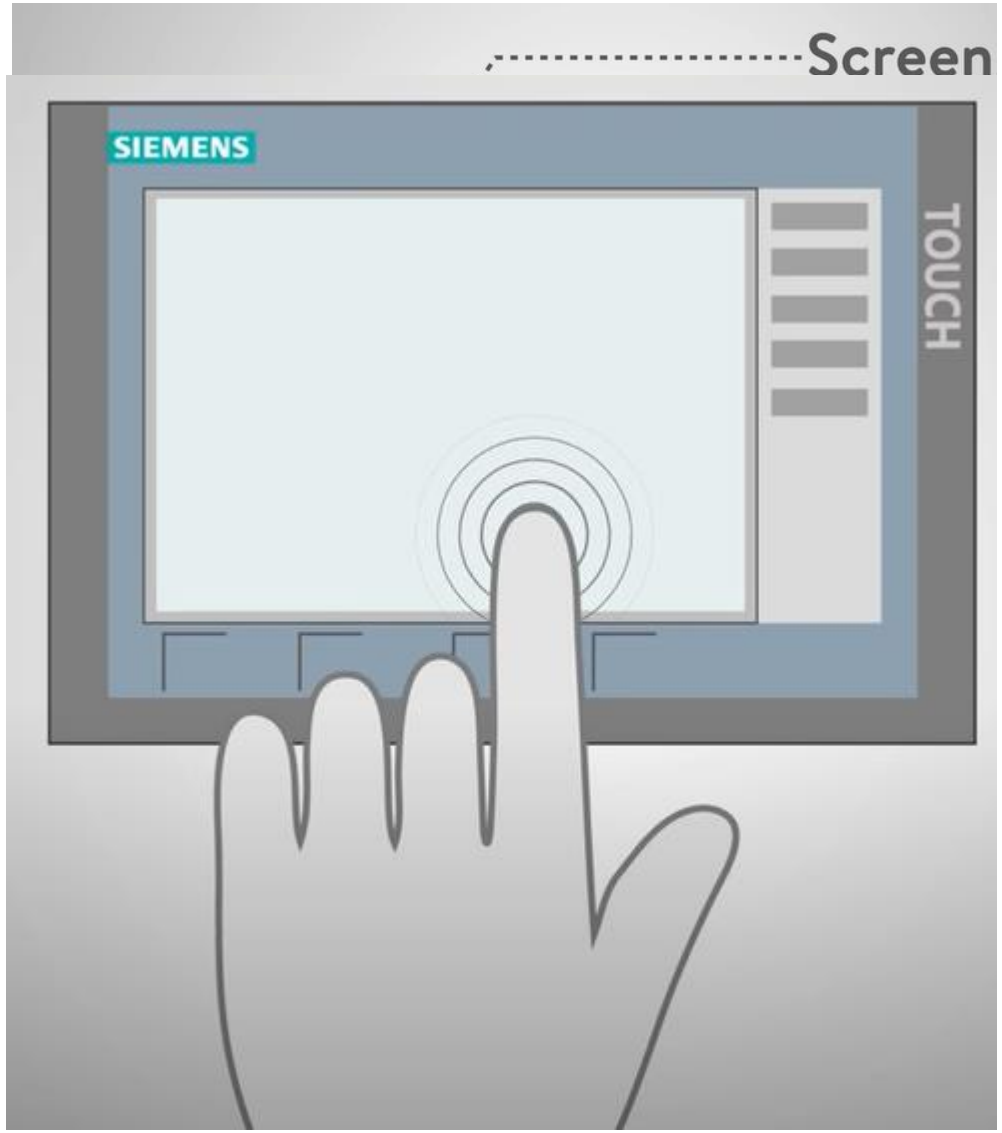
Elements of the operator workstation

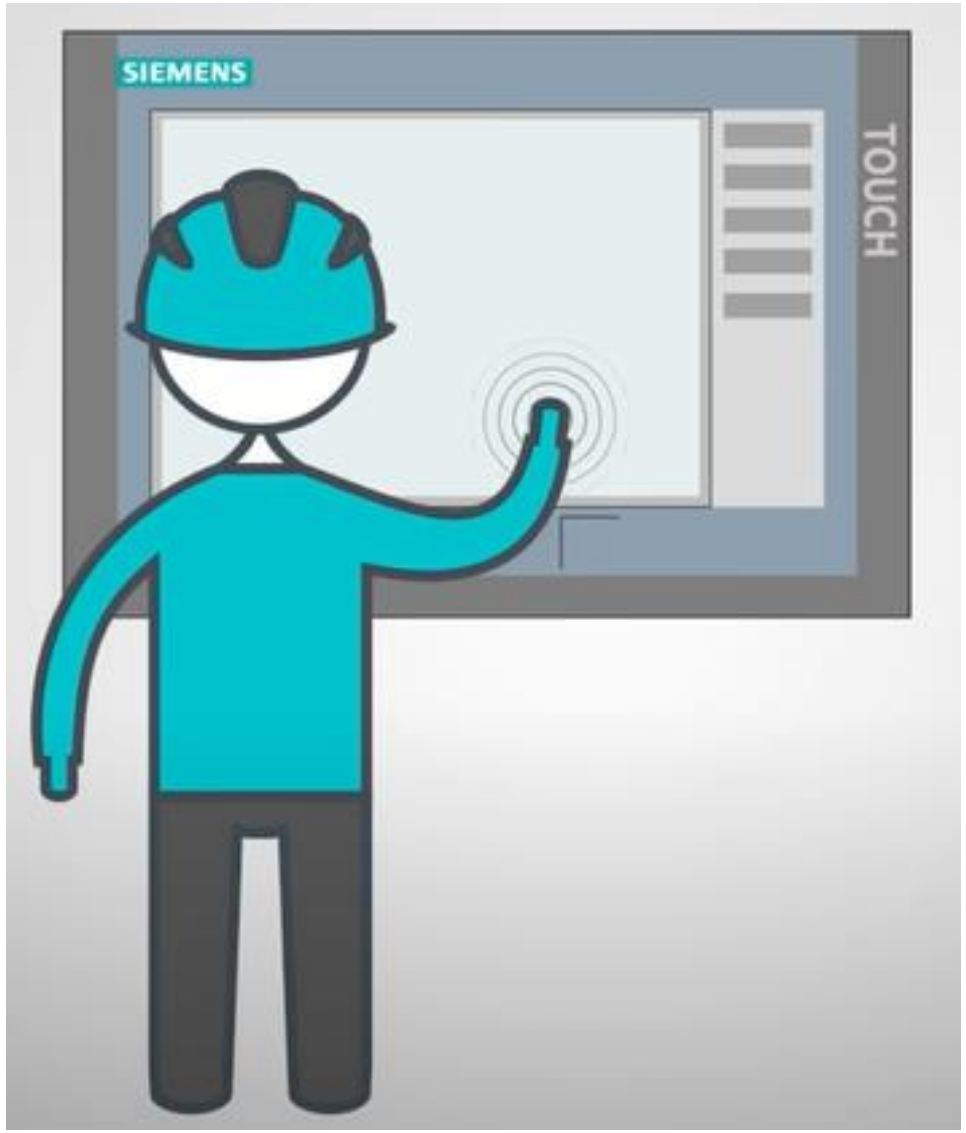


HMI Connections

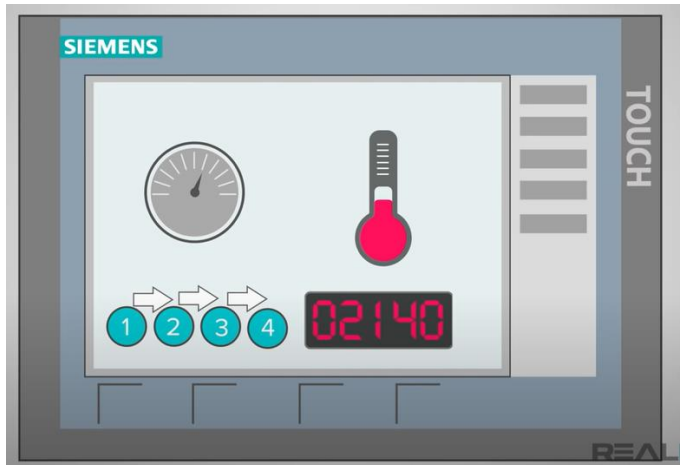


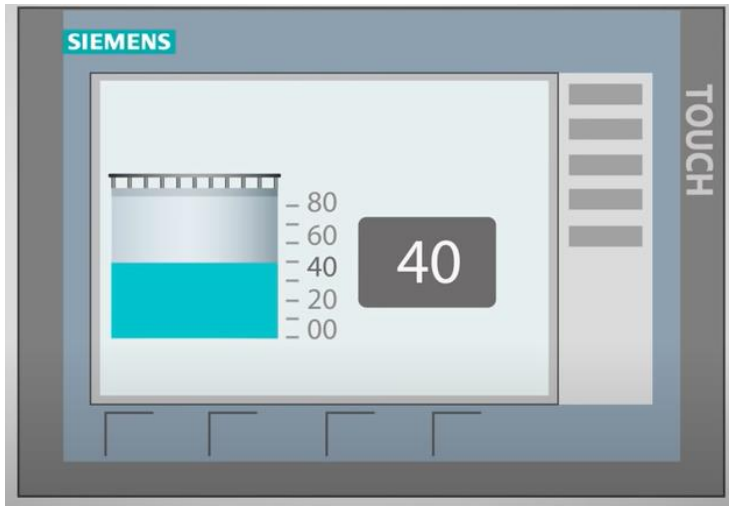
HMI

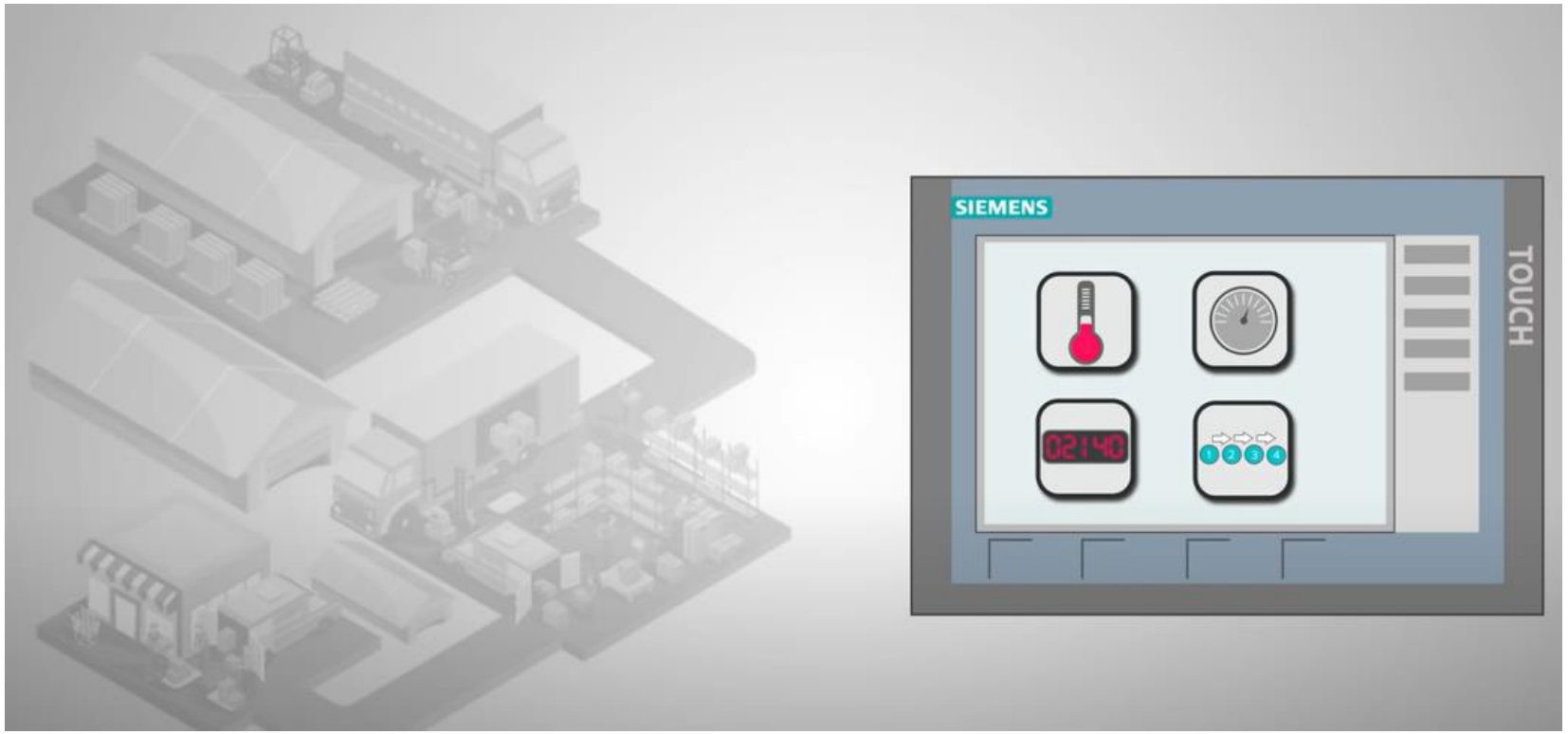




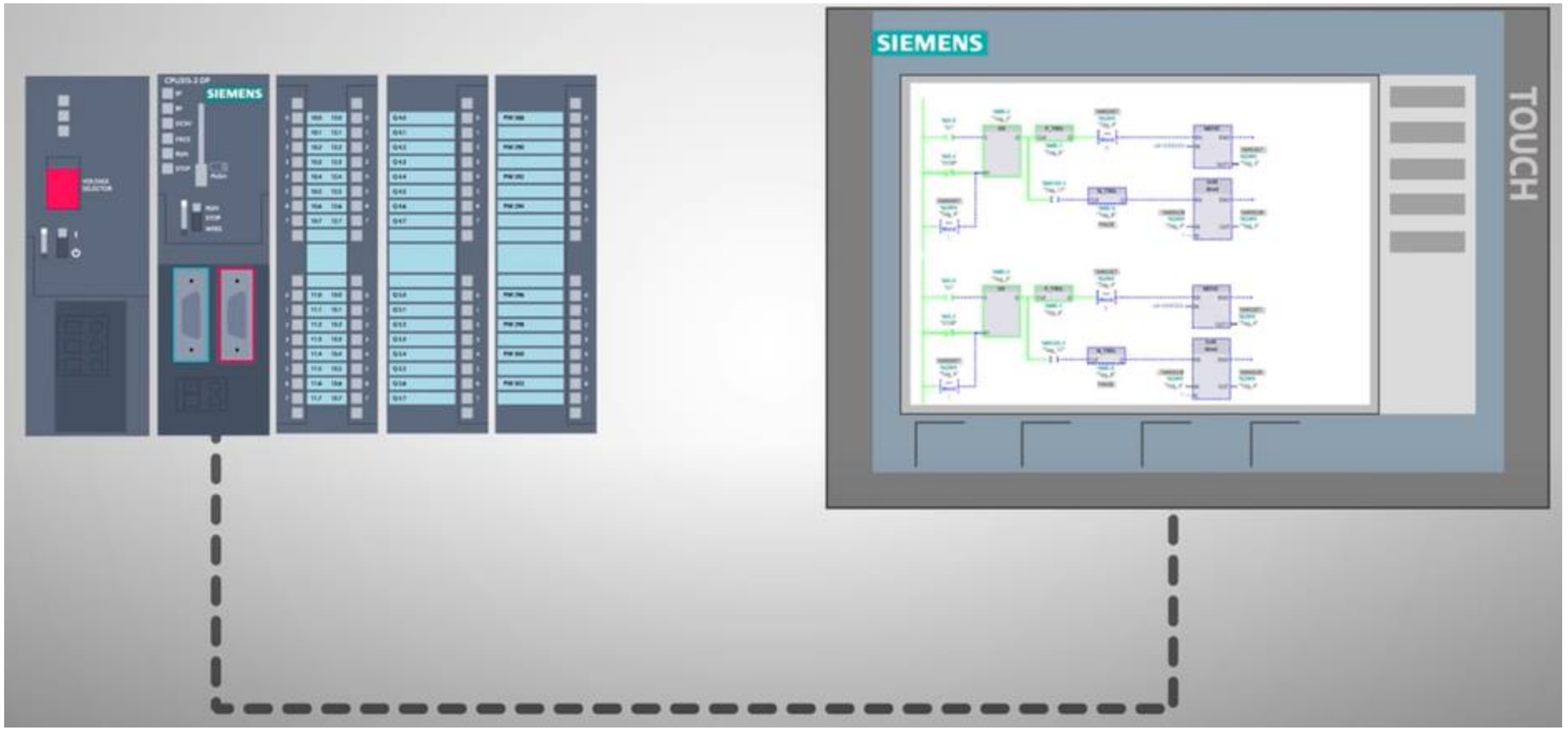
HMI


SIEMENS
TOUCH
1
2
3
4
02140

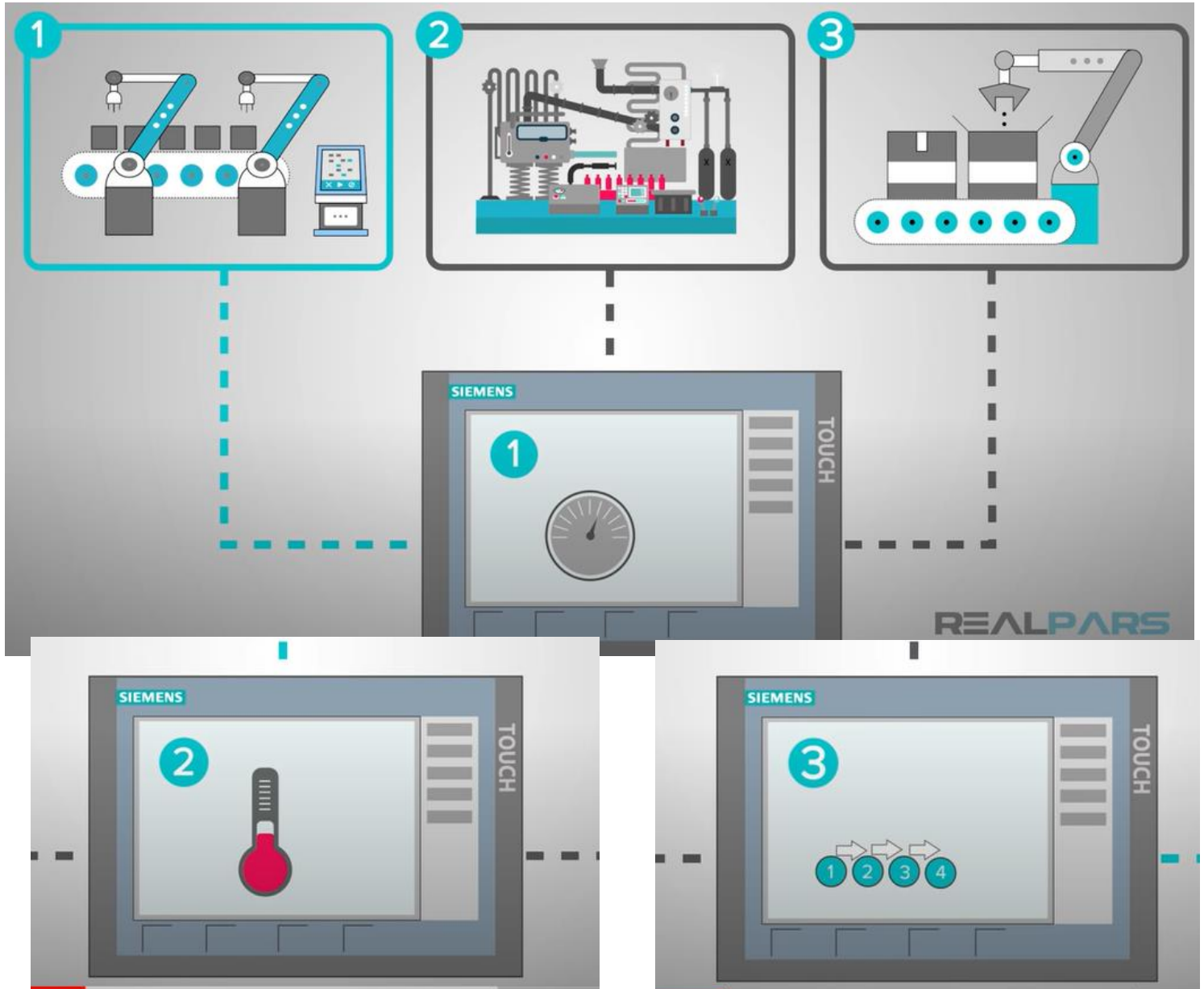

SIEMENS
TOUCH
80
60
40
20
00
40

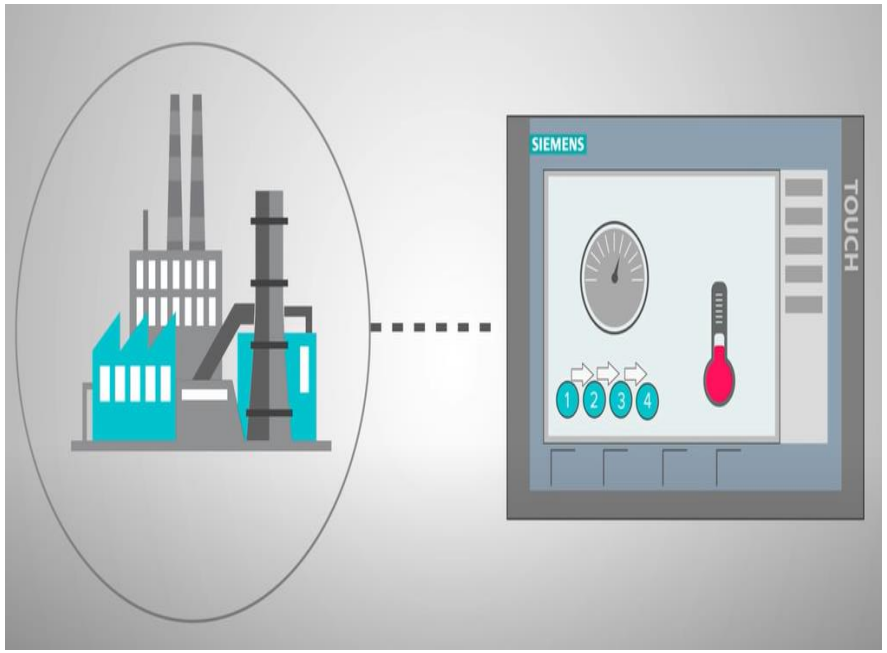

SIEMENS
TOUCH
02140

HMI

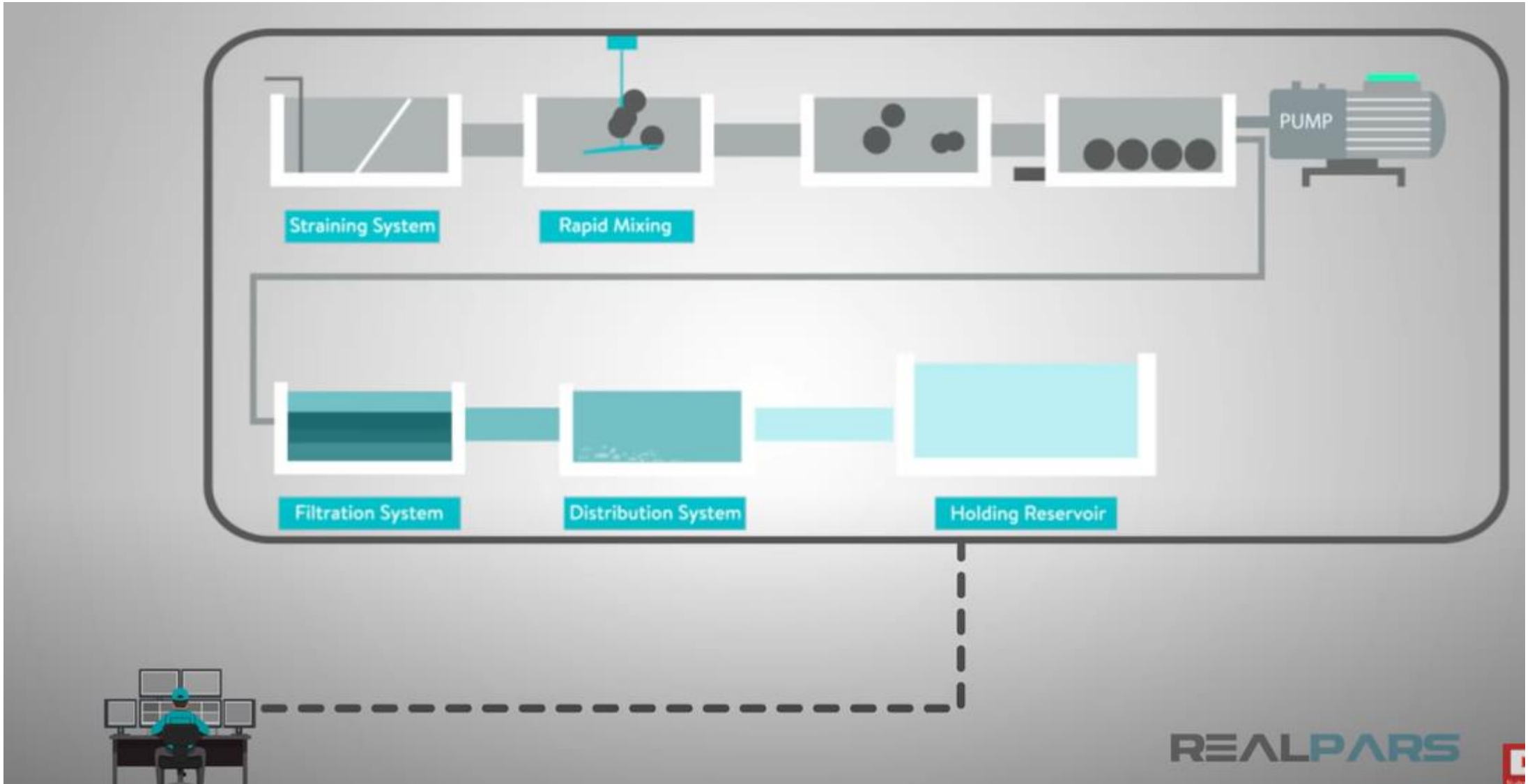


HMI

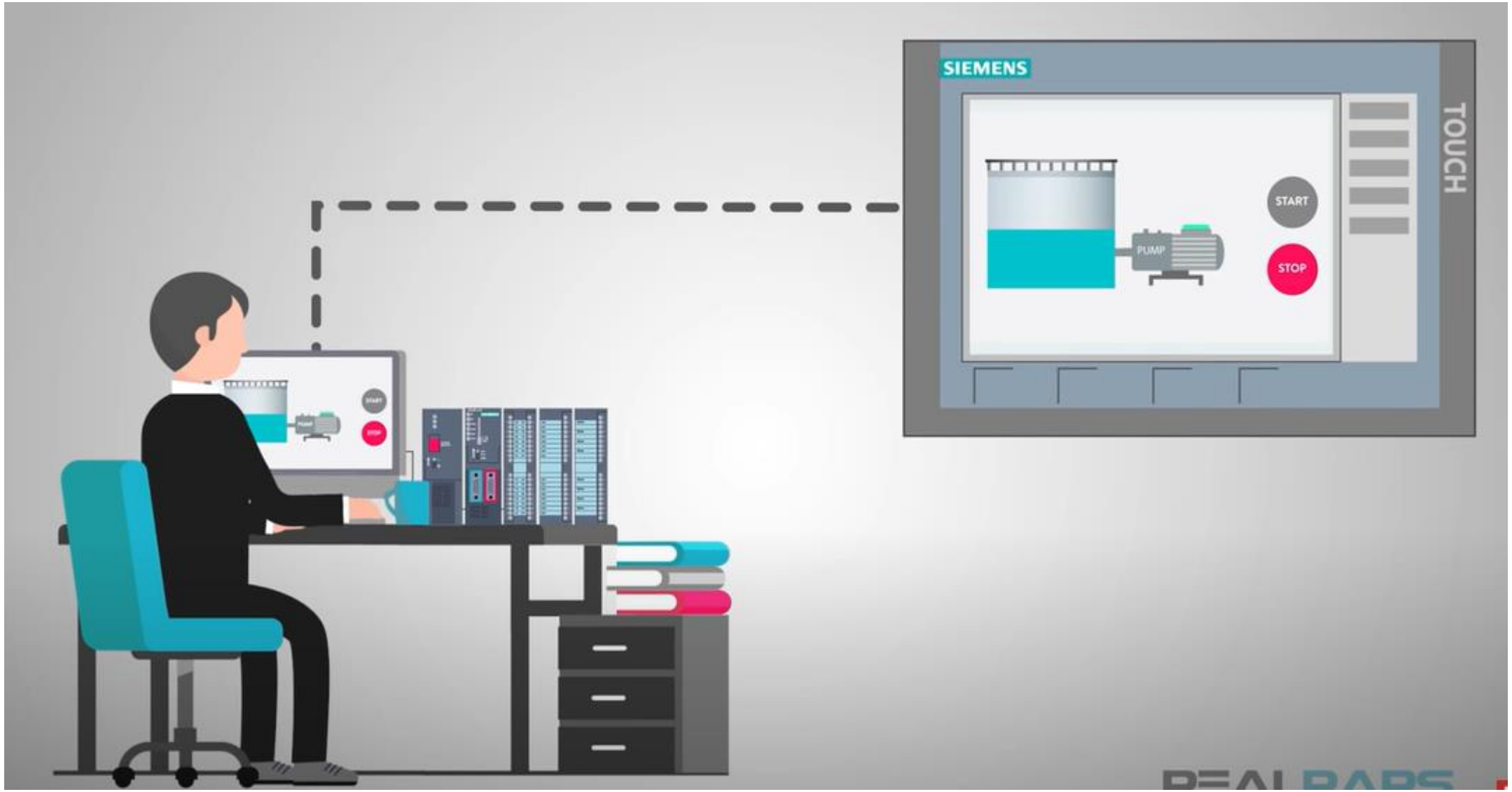




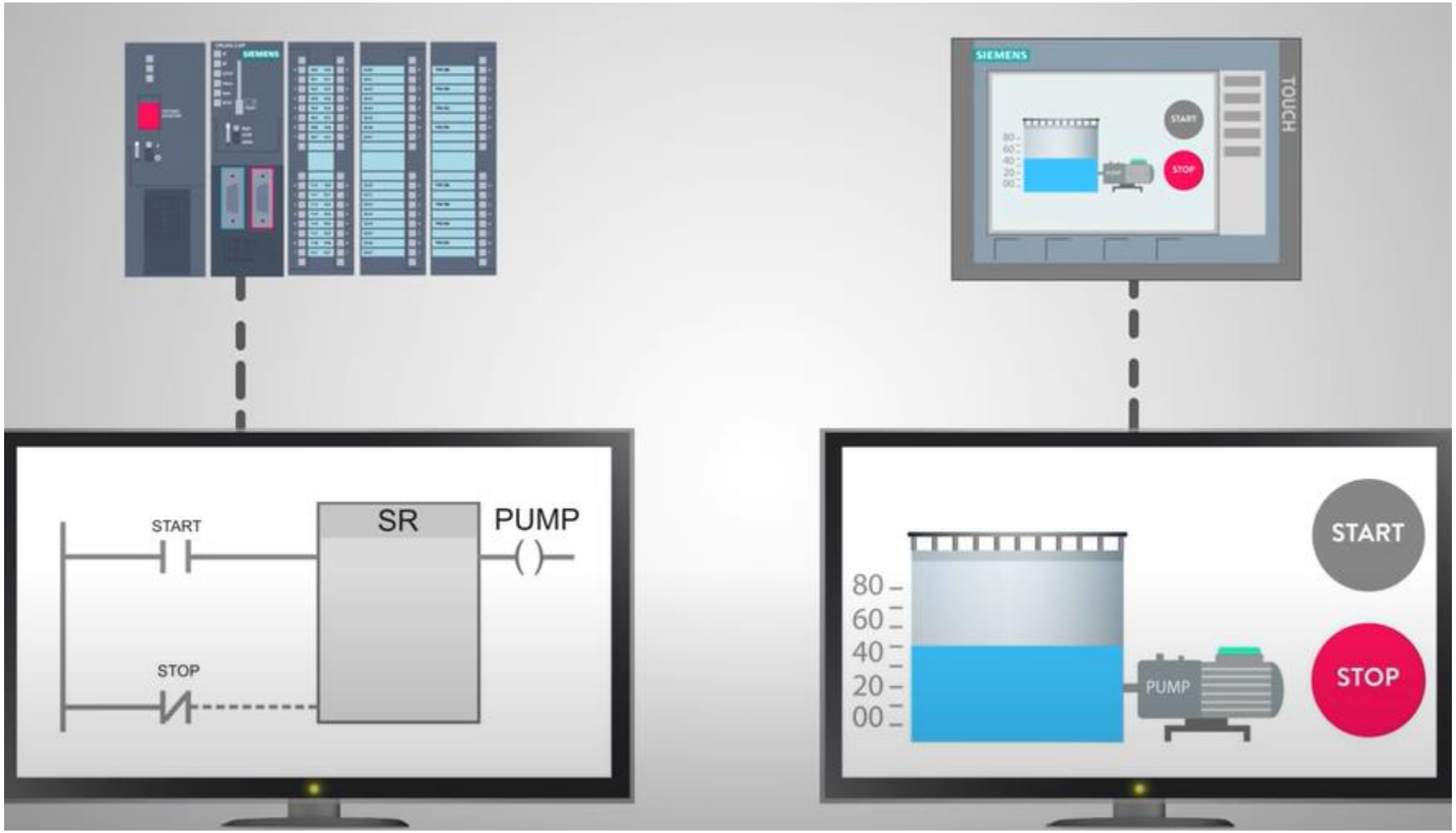
HMI


PUMP
Straining System
Rapid Mixing
Filtration System
Distribution System
Holding Reservoir
REALPARS

HMI



HMI

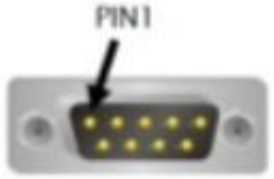

SIEMENS
TOUCH
START
STOP
START
SR
PUMP
STOP
80
60
40
20
00
PUMP
START
STOP

HMI

Communication Channels

DOP-B05 / DOP-B07S(E)515 Series

COM1 Port (Supports Flow Control)

COM Port	PIN	Contact
		RS-232
	1	
	2	RXD
	3	TXD
	4	
	5	GND
	6	
	7	RTS
	8	CTS
	9	

Note: Blank = No Connection.

Ethernet Interface (LAN)

Ethernet Interface (LAN)	PIN	Contact Ethernet
	1	TX+
	2	TX-
	3	RX+
	4	
	5	
	6	RX-
	7	
	8	

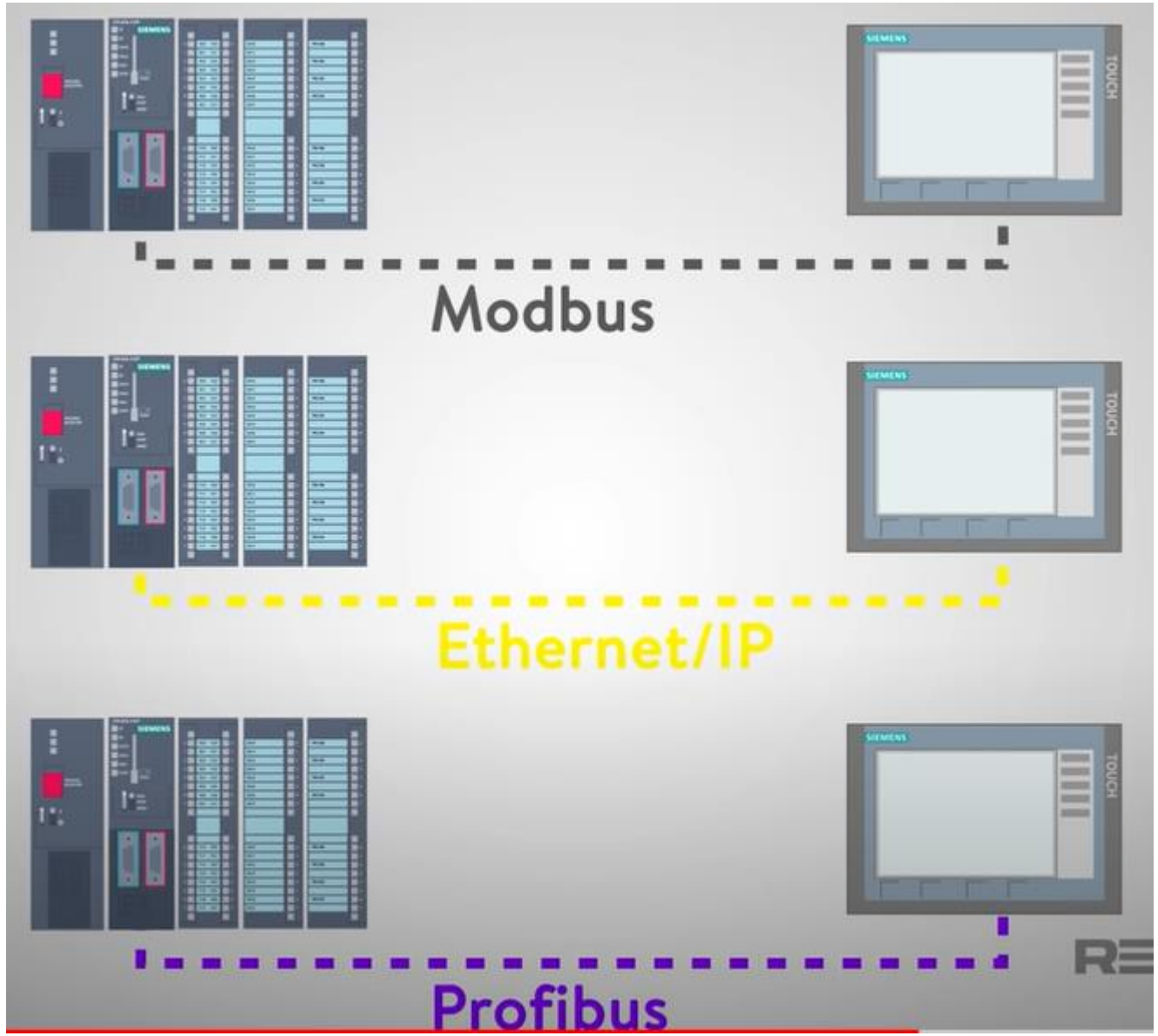
Note: Blank = No Connection.

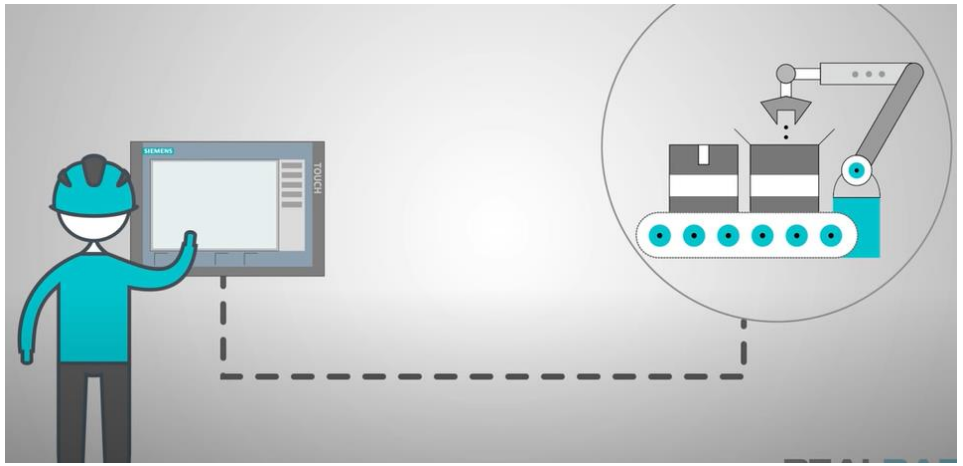
COM2 and COM3 Port

COM Port	PIN	MODE1		MODE2		MODE3	
		COM2	COM3	COM2	COM3	COM2	COM3
		RS-232	RS-485	RS-485	RS-485	RS-232	RS-422
	1			D+			TXD+
	2	RXD				RXD	
	3	TXD				TXD	
	4		D+		D+		RXD+
	5	GND		GND		GND	
	6			D-			TXD-
	7						
	8						
	9		D-		D-		RXD-

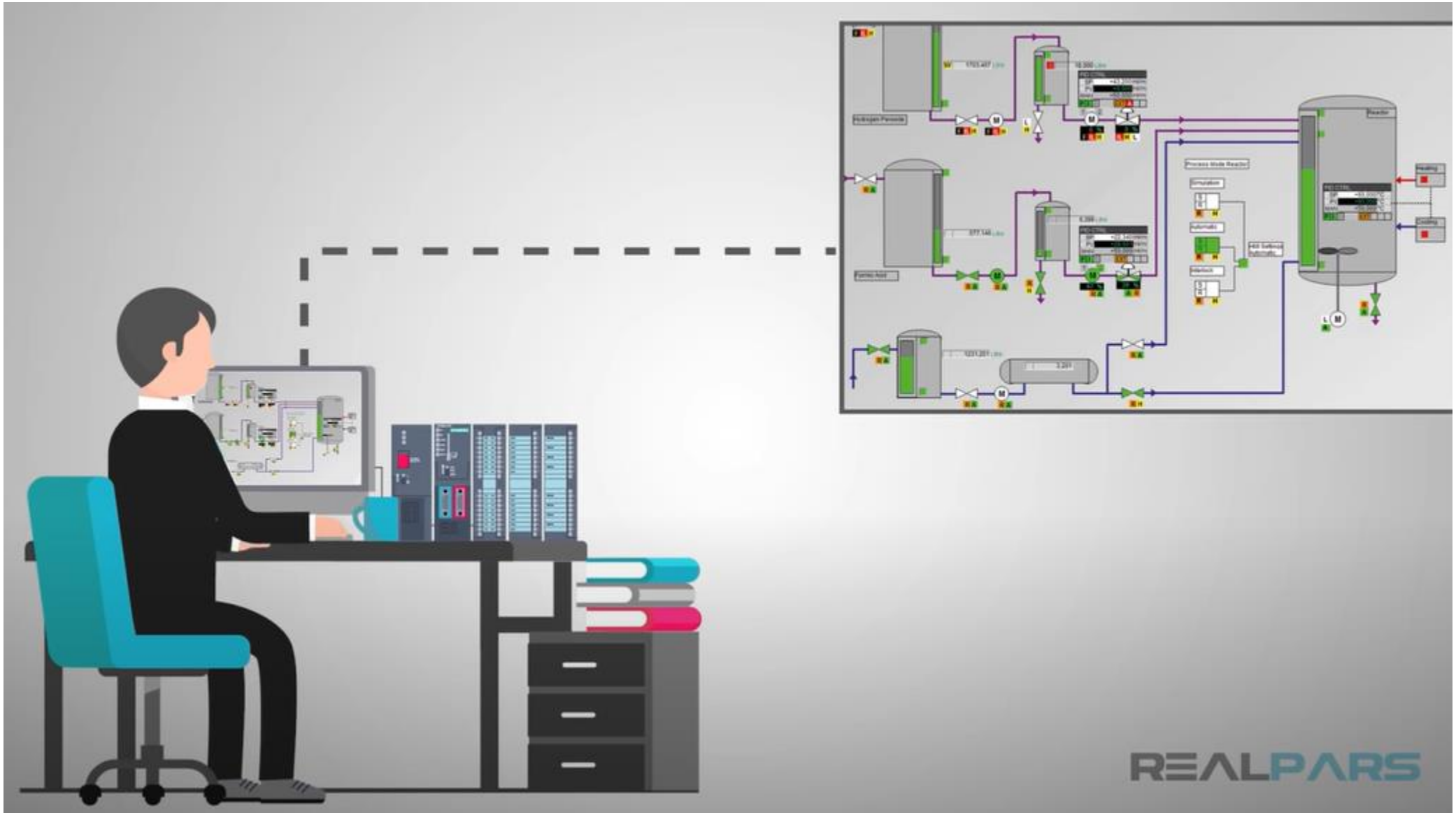
Note1: Blank = No Connection.

HMI

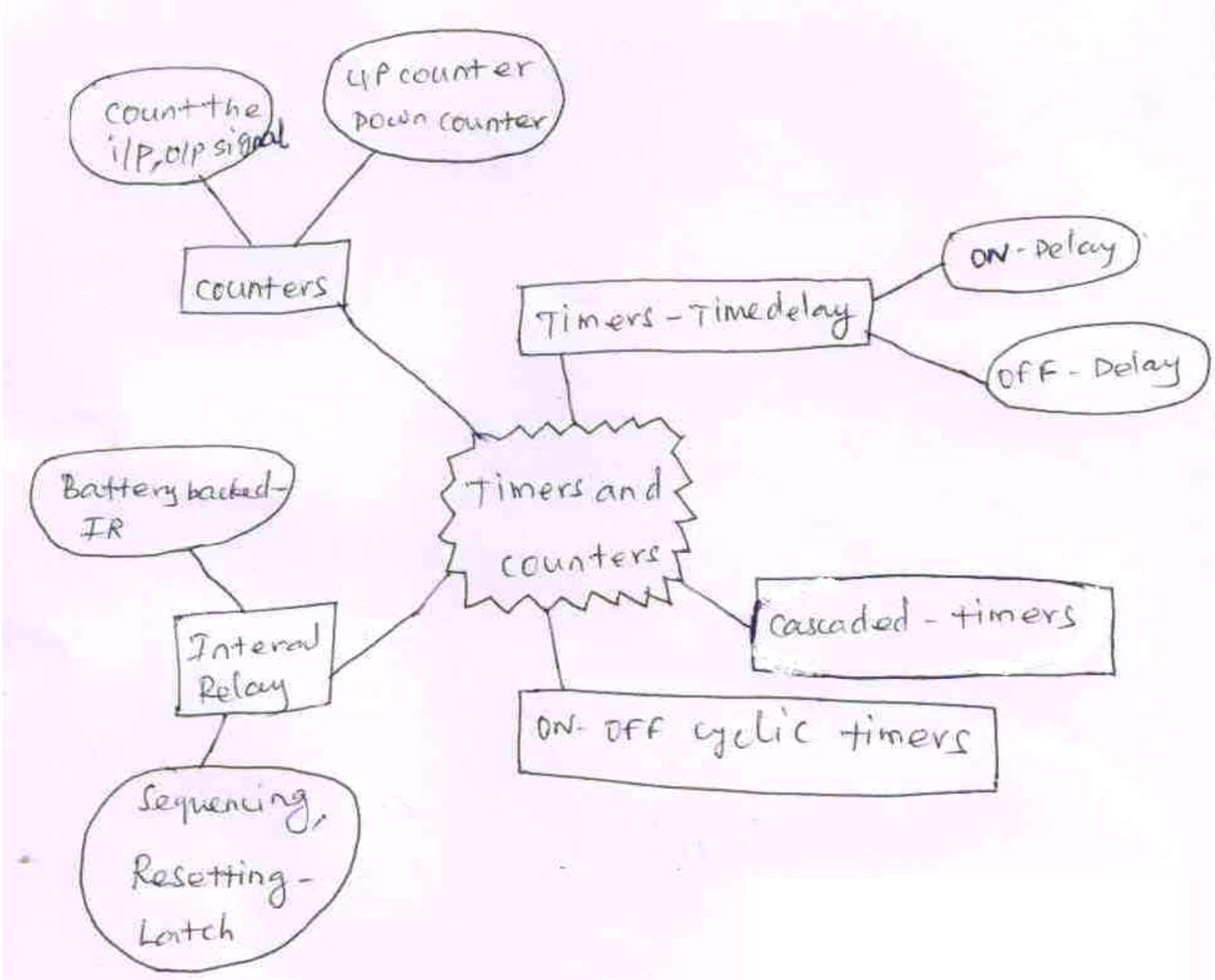




HMI



MINDMAP


Timers and counters
counters
Count the i/p, o/p signal
UP counter
DOWN counter
Timers - Timedelay
ON - Delay
OFF - Delay
Battery backed - IR
Interval Relay
Sequencing, Resetting - Latch
Cascaded - timers
ON- OFF cyclic timers

SUMMARY

- Timers - used to carry out tasks which involve time delay.
- Types - On delay and Off delay timers
- On-off cyclic timer – alternate ON and OFF application.
- Internal Relay - behave like relays
- Application of IR
  - To automate a pneumatic circuit
  - To reset the latch
  - Battery backed IR
- Counters - used to count a specified number of contact operations.
- Types
  - Up - Starts from zero to specified value
  - Down counter – starts from specified value to zero.

Sequencing:

As an illustration of the use of a TON timer, When the input In 1 is on, the output Out 1 is switched on. The contacts associated with this output then start the timer.

The contacts of the timer will close after the preset time delay, in this case 5.5 s. When this happens, output Out 2 is switched on. Thus, following the input In 1, Out 1 is switched on and followed 5.5 s later by Out 2. This illustrates how a timed sequence of outputs can be achieved

Cascaded Timers:

Timers can be linked together (the term cascaded is used) to give longer delay times than are possible with just one timer. Thus we might have timer 1 with a delay time of 999 s. This timer is started when there is an input to In 1. When the 999 s is up, the contacts for timer 1 close.

This then starts timer 2. This has a delay of 100 s. When this time is up, the timer 2 contacts close and there is an output from Out 1

Discussion

10 mins