Theory

On-off control is perhaps the simplest type of feedback control strategy. The strategy is similar to that of a relay. The following equations define the output of on-off controller:

$$\text{Output of the controller} = \begin{cases} \text{'}\textit{Output when ON}\text{' if the controller is in the ON state} \\ \text{'}\textit{Output when OFF}\text{' if the controller is in the OFF state} \end{cases}$$

where '*output when ON*' and '*output when OFF*' are values determined based on the application

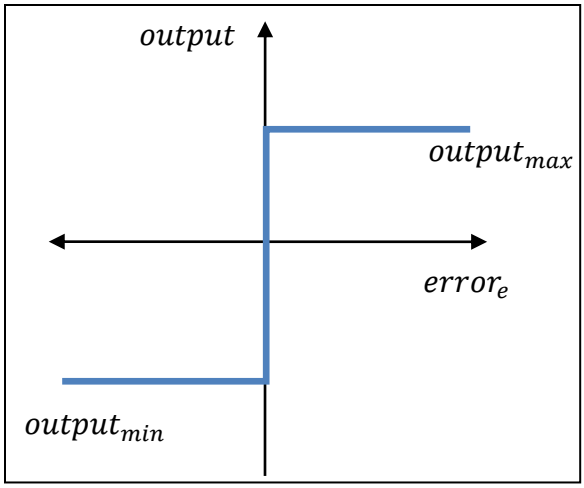
- When the ON-OFF controller is in the ON state, the controller remains in the ON state until the input to the controller falls below the value of the switch OFF point.
- Conversely, when the On-OFF controller is in the OFF state, it remains in the OFF state until the input exceeds the value of the SWITCH ON point.
- The ON-OFF controller is initially in the OFF state.
- In short, the On-OFF controller output one of two values ('output when ON' or 'output when OFF') based on the value of the input signal.

<u>ON-OFF Control variations</u>

A simple ON-OFF strategy is

$$\text{Output} = \begin{cases} output_{max} \; if \; 0 < e, e = r - y \\ output_{min} \quad if \; 0 > e, e = r - y \end{cases}$$

The control strategy is that maximum corrective action is always used, hence the name ON-OFF control.



A system under ON-OFF control will always oscillate. To avoid rapid switching between the ON and OFF states, it is common to introduce a hysteresis in the switch. The input-output relation for an ON-OFF controller with hysteresis is shown in below figure.

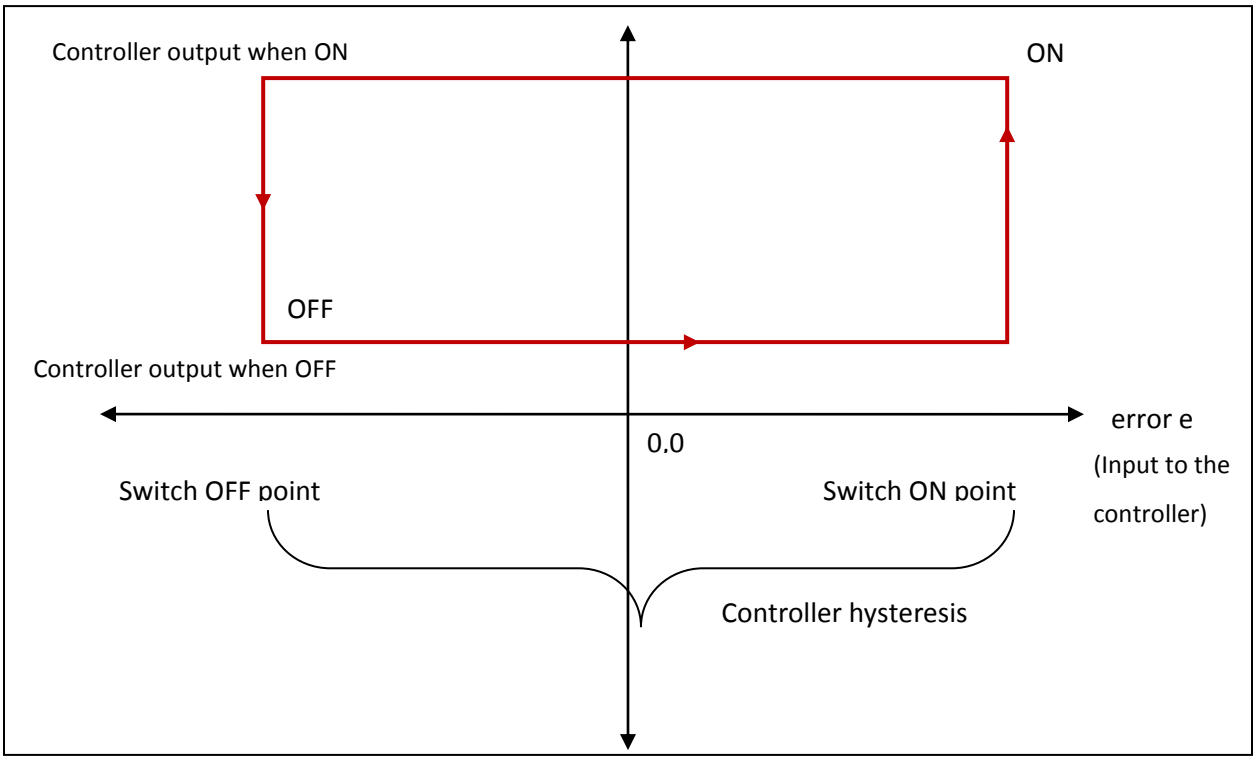
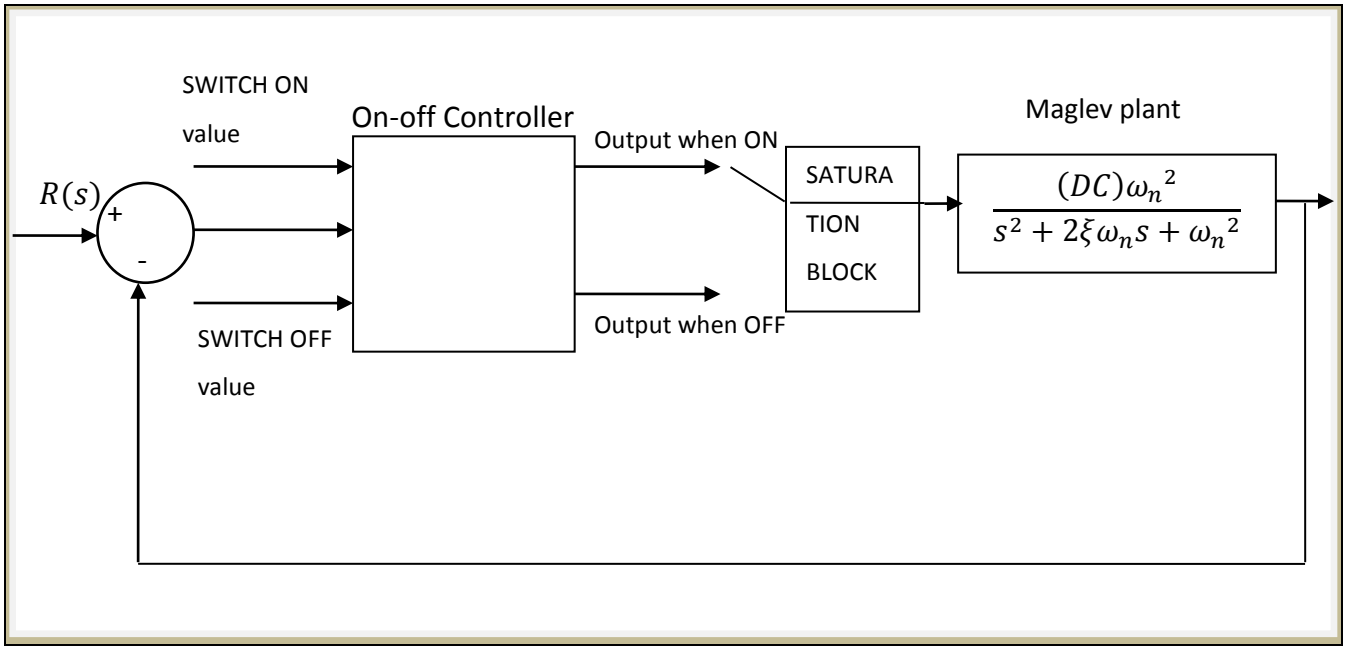


Figure: Input and output relation for On-Off controller in the hysteresis

The summary of various terms is as follows:

- **Output when OFF**: specifies the value of the controller output when the controller is in the OFF state.
- **Output when ON**: specifies the value of the controller output when the controller is in the ON state.
- **SWITCH OFF point**: specifies the value below which the input (to the controller) must fall to the ON state to the OFF state.
- **SWITCH ON point**: specifies the value above which the input (to the controller) must rise to switch from the OFF state to the ON state.

The block diagram of the ON-OFF control strategy is shown below (for the Maglev plant)



A saturation block is included in the above diagram. It basically limits the range of the input signal to the Maglev plant (for operational safety reasons).The upper and lower limits of the saturation block are to be specified.

The ‘controller hysteresis’ specifies the value that the input must exceed to switch from the OFF state to the ON state. It is used to configure the SWITCH ON point. It is also used to configure the SWITCH OFF point, by taking the negative of the value.

So,

SWITCH ON point = controller hysteresis value

SWITCH OFF point = - controller hysteresis value