# Balancing of a Styrofoam ball (guided example)

Balancing of a Styrofoam ball is performed once as an open-loop control and once as a closed-loop control (=feedback control).

**Open-loop control**

General representation of the **control chain** *[=Steuerkette]*:

control facility

control unit

correcting facility

controlled process

z

disturbing variable

x

controlled variable

y

manipulated variable

SV

set variable

Steuergerät

Stell-einrichtung

Steuer-strecke

Steuereinrichtung

z

Störgrösse

x

Steuergrösse

y

Stell-

grösse

w

Führungs-

grösse

**Task**

Have a look at the general structure of the control chain above and match the devices and values of the balancing system to the terms listed in the table below!

|  |  |
| --- | --- |
| Control facility | Hairdryer |
| Control unit | Switch on/off |
| Correcting facility | Motor |
| Controlled process | Ball |
| Set variable SV | Wanted positon of the ball [mm] |
| Manipulated variable y | Rotational speed of the motor [min-1] or air flow rate [l/s] |
| Controlled variable x | Actual position of the ball [mm] |
| Disturbing variable z | Reduced intake airflow [l/s] |

**Closed-loop control (=feedback control)**

General representation of a **closed-loop control circuit** *[=Regelkreis]*:

controller

x

controlled variable

automatic control device

servo unit

control element

final control element

controlled process

z

disturbance variable

y

manipulated variable

SV

set value

measuring device

PV

process value

summing

point

+

-

actuator

controller output variable

yC

error

(control deviation)

e

x

Regel-grösse

Regeleinrichtung

Stelleinrichtung

Regelglied

Steller

Regel-strecke

z

Störgrösse

Stell-

grösse

y

w

Führungs-

grösse

Messglied

Regler

r

Rückführ-

grösse

Vergleichs-stelle

+

-

Regeldifferenz

e

Regler-ausgangs-grösse

yR

Stell-glied

**Task**

Have a look at the general structure of the control loop above and match the devices and values of the balancing system to the terms listed in the table below!

|  |  |
| --- | --- |
| Controller | Operational amplifier circuit (Op Amp) |
| Control element | Operational amplifier circuit (Op Amp) |
| Final control element | H-bridge |
| Actuator | Motor |
| Controlled process | Ball |
| Measuring device | Ultra sonic sensor |
| Set value SV | Wanted positon of the ball [mm] |
| Error | Differential voltage signal [V] |
| Controller output variable yC | Voltage signal to control the H-bridge [V] |
| Manipulated variable y | Voltage signal to control the motor [V] |
| Controlled variable x | Actual position of the ball [mm] |
| Disturbance variable z | Intake airflow [l/s] inclination [°] speed of the disturbance motor [min-1] |
| Process value PV | Actual position of the ball [V] |