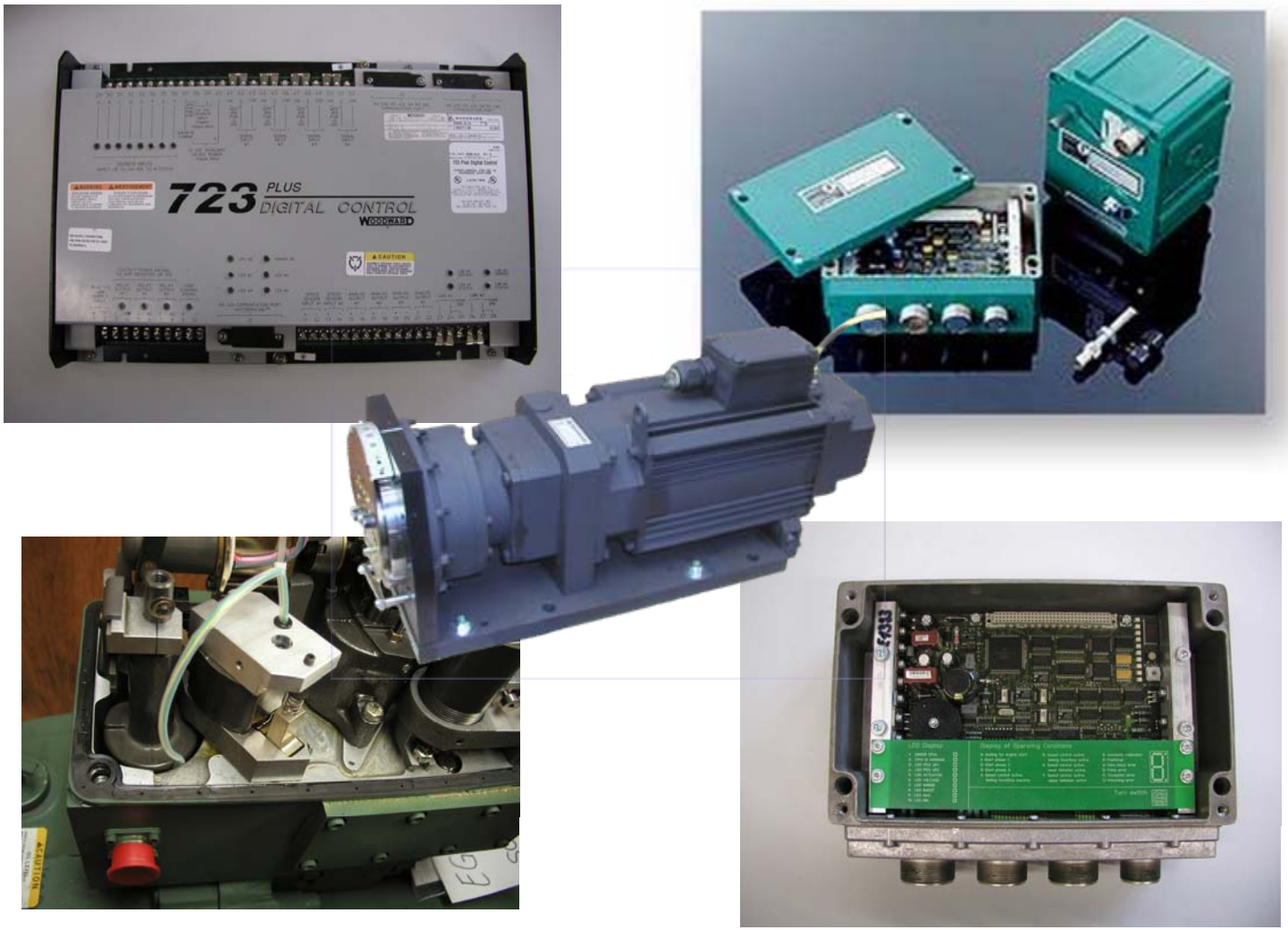
Basics electronic speed Governor



Why do we need Governors?

- Power sources must be controlled to be converted to useful work.
- Uncontrolled prime movers, not operating at desired speed or load are examples of why governors are needed.

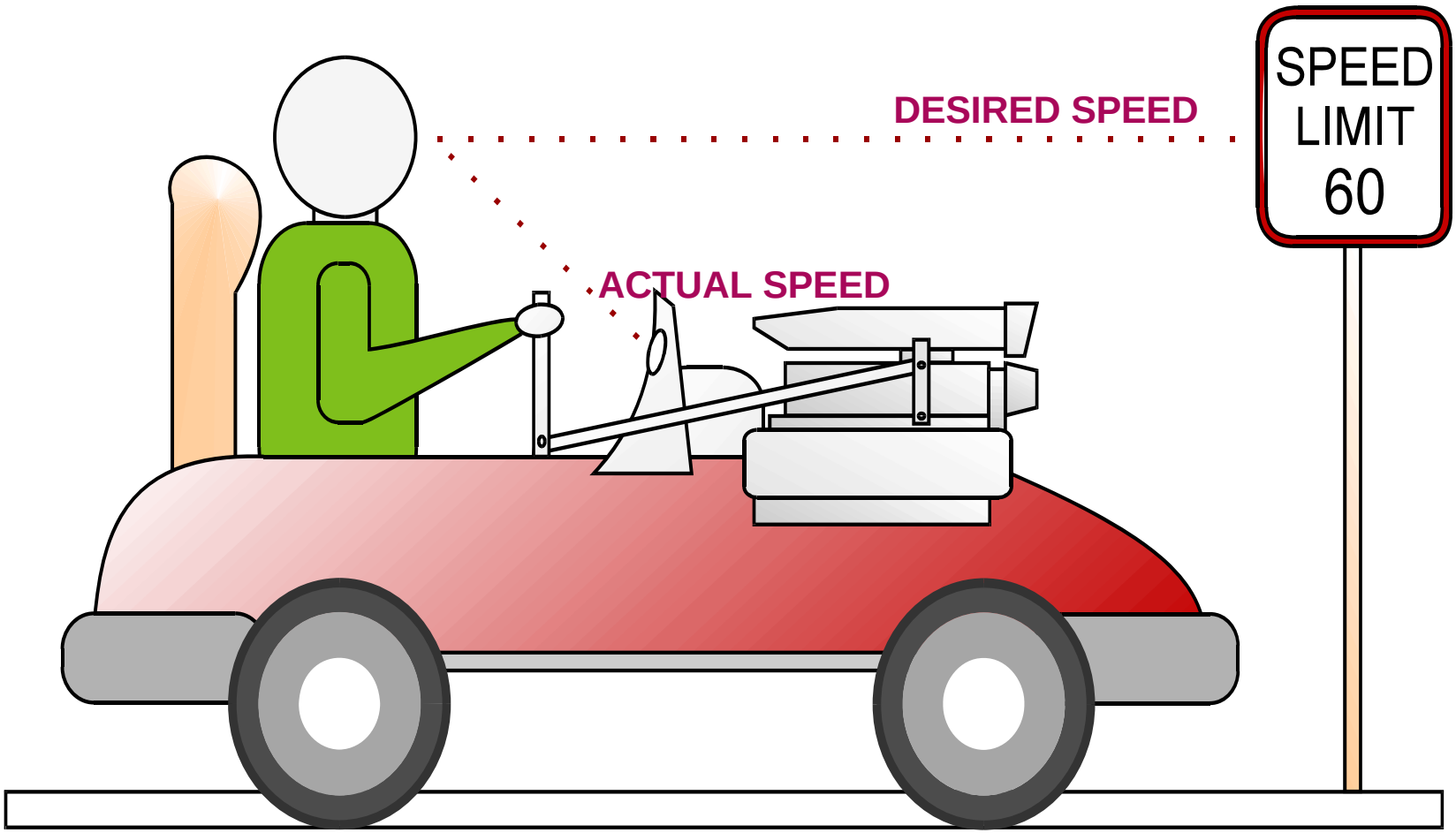
What is a Governor?

- Governor Definition: a: An attachment to a machine for automatic control or limitation of speed. b: A device giving automatic control (as of pressure or temperature).
- A Governor is a device which controls the energy source to a prime mover to control its power for a specific purpose.
- Basic governors sense speed and sometimes load of a prime mover and adjust the energy source to maintain the desired level.
- Advanced governors are often referred to as **Control Systems**.

Simple explanation of governing

Imagine you are driving a car. The speed limit on the road is 60 km/h and you want always to go that fast it is allowed. In that case you have to “control” the accelerator depending of driving up- or downhill.

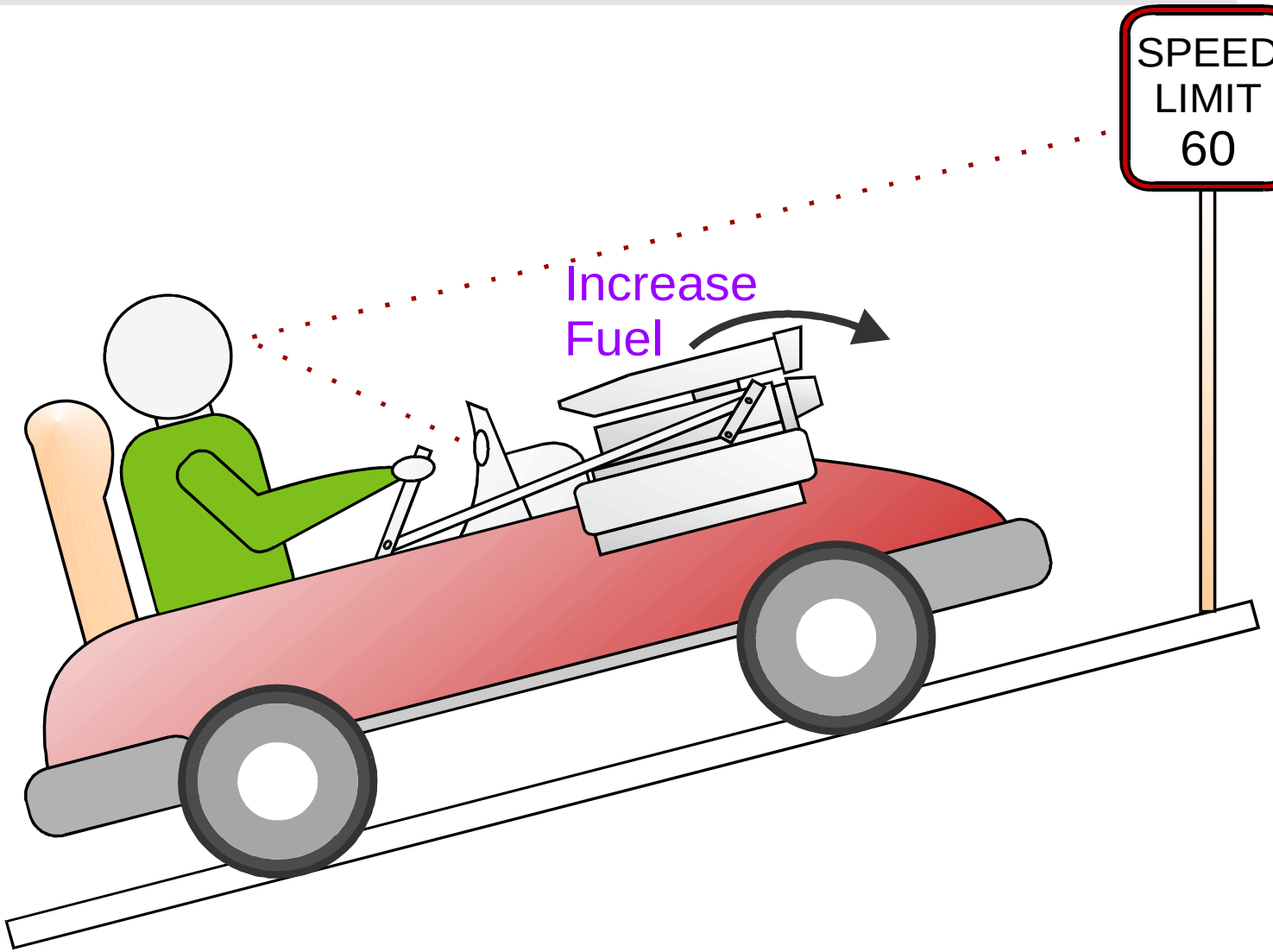
Constant Load



Constant Load

- The driver of the car is the control or governor.
- The speed limit sign is the desired speed setting.
- The speedometer senses actual speed.
- The driver compares desired speed to actual speed, If they are the same, fuel is held steady.
- If desired speed and actual speed are different, the fuel setting is adjusted by the driver to make actual speed equal desired speed.
- Fuel is held steady until a speed or load change occurs.

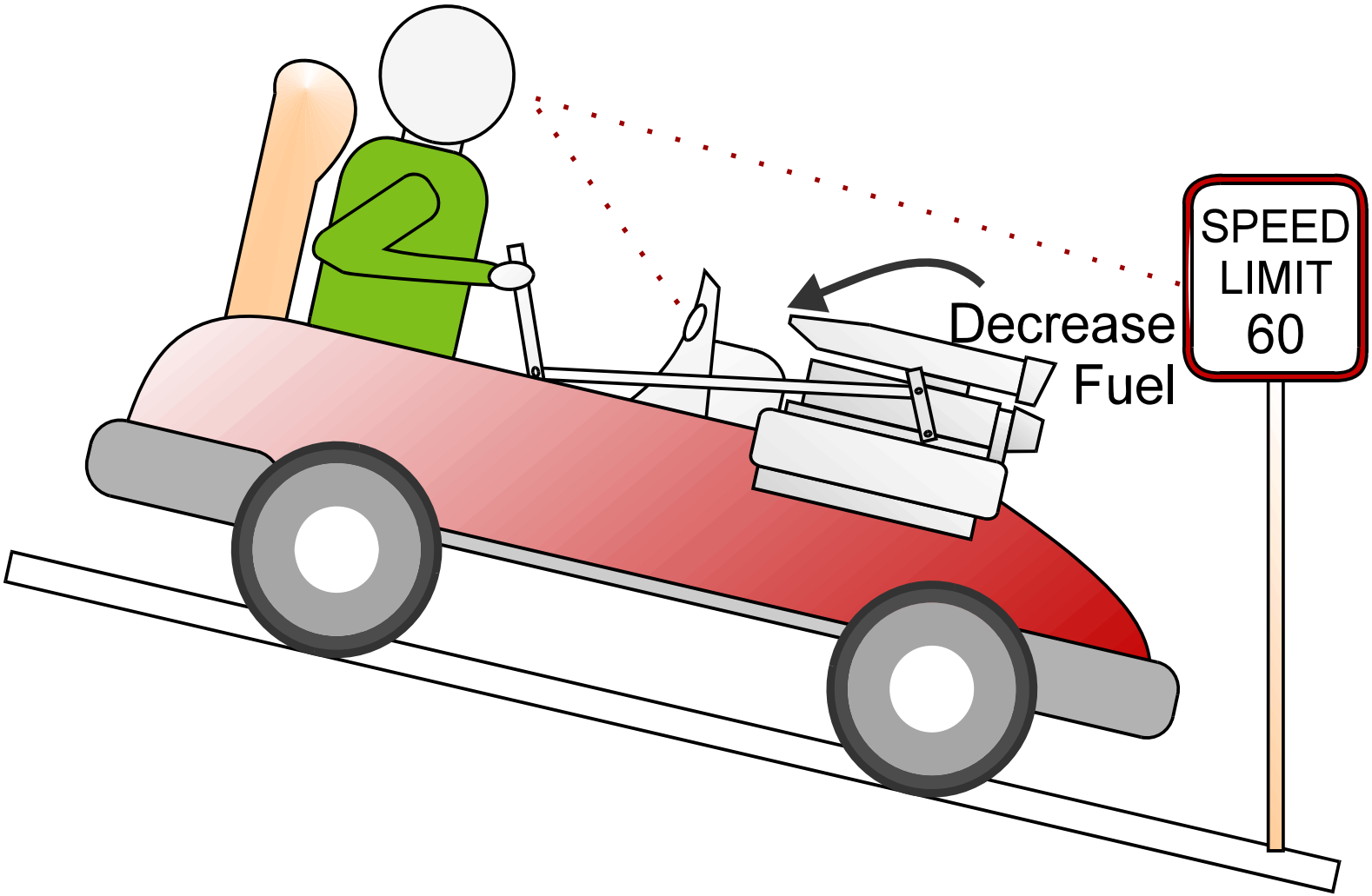
Increased Load



Increased Load

- The car starts up the hill, load increases, speed decreases.
- The actual speed is less than desired speed.
- Driver increases the fuel to increase the speed, which returns the actual speed to the desired speed.
- Before the actual speed reaches the desired speed, the driver reduces the fuel to prevent overshoot of speed. This is called Compensation and is adjusted to match the response time of the prime mover.
- It takes more fuel to pick up load than to maintain load.

Decreased Load

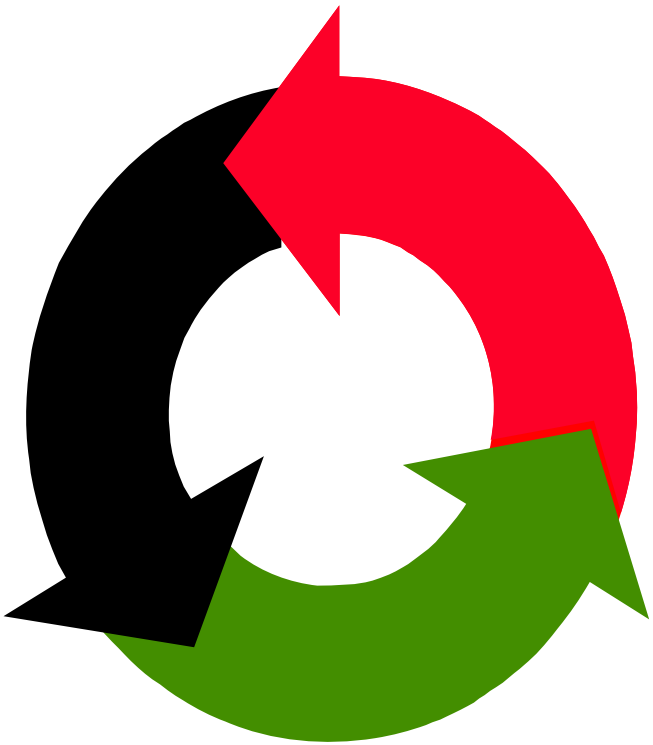


Decreased Load

- The car starts down the hill, load decreases, speed increases.
- Actual speed is greater than desired speed.
- Driver decreases fuel to decrease speed, which returns the actual speed to desired speed.
- Before the actual speed reaches the desired speed, the driver increases the fuel to prevent overshoot of speed. This is called Compensation and is adjusted to match the response time of the prime mover.

Control Loop

Actual Speed or Load



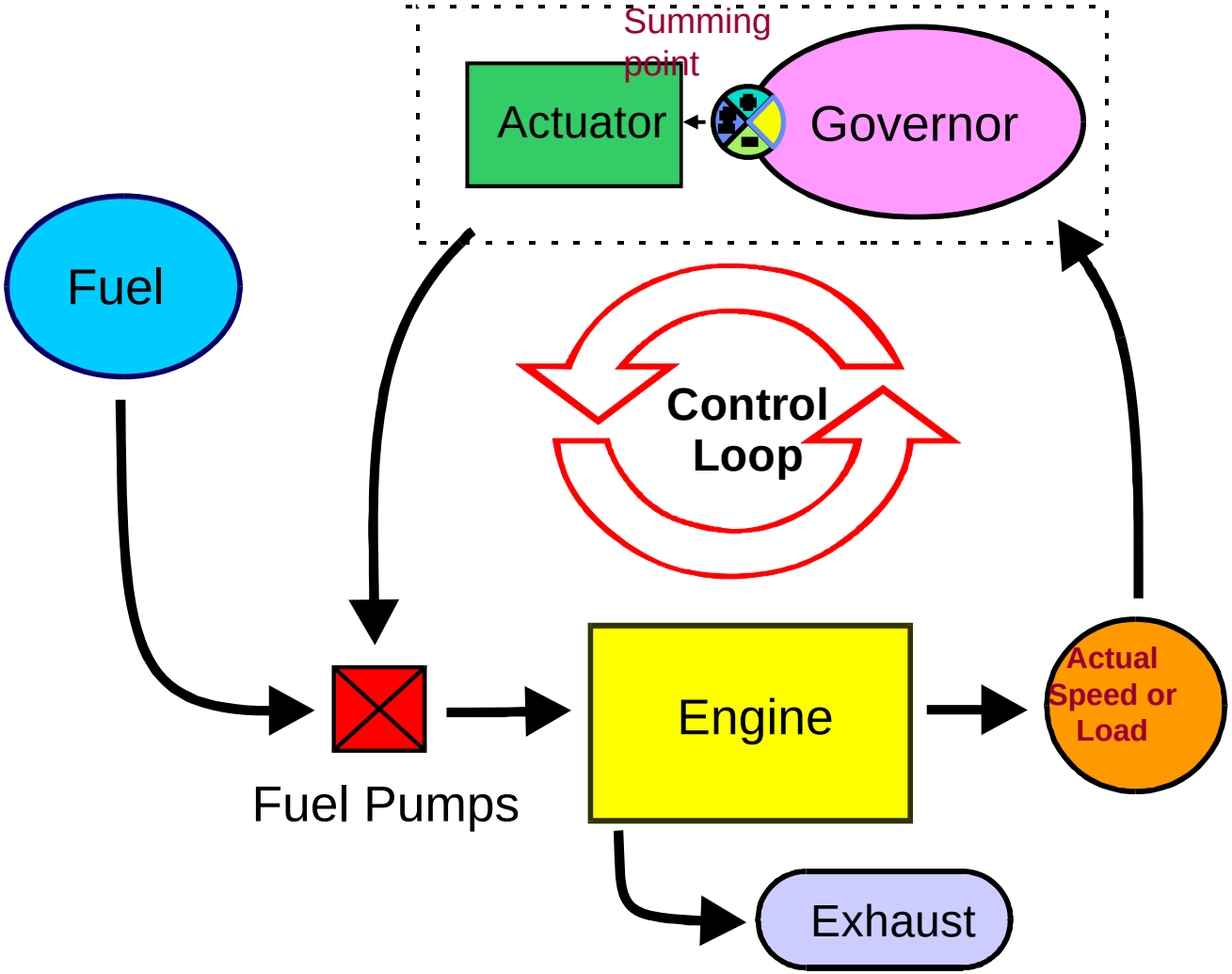
Control of the Energie

Desired Speed or Load Reference

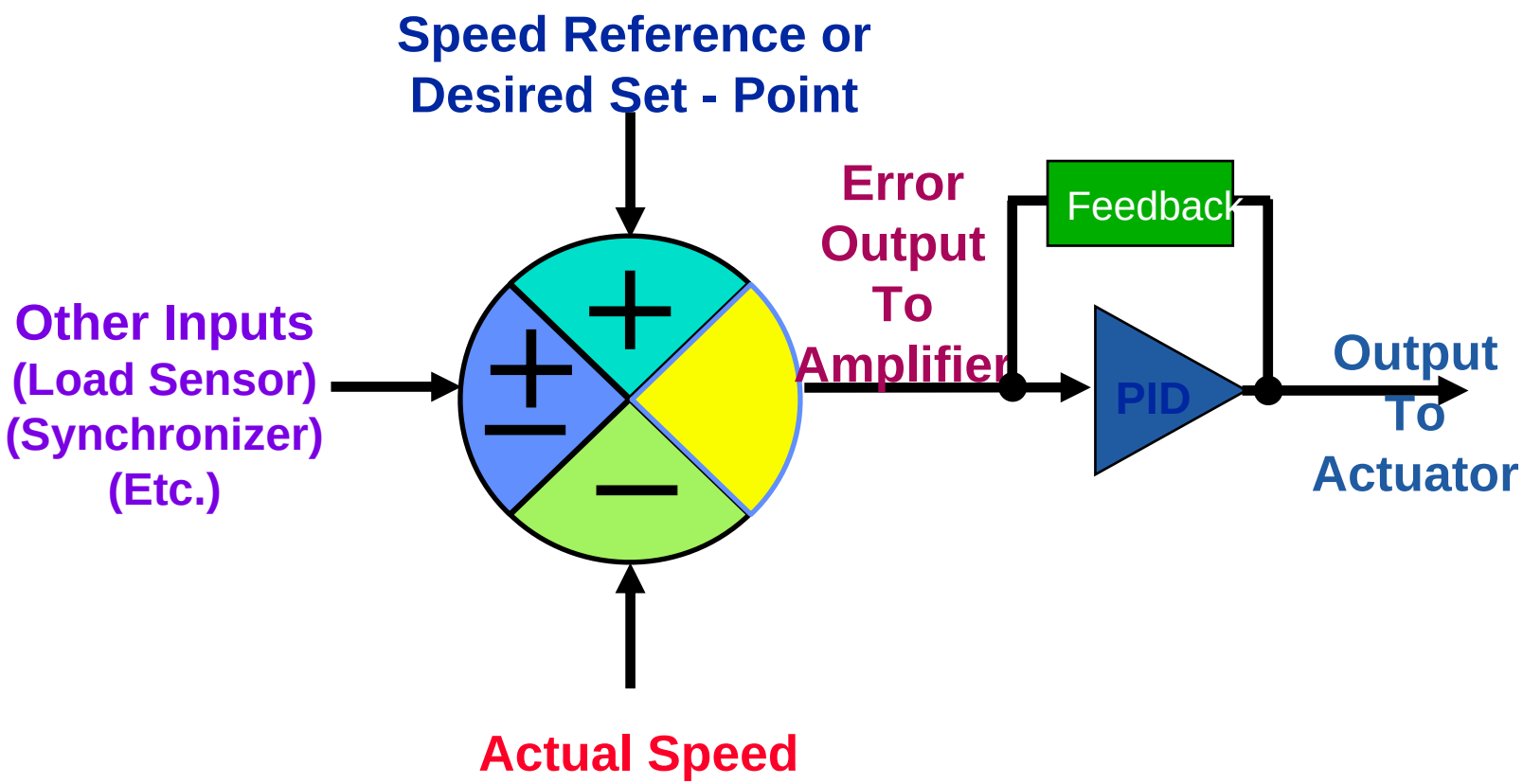
Closing the Loop

- The governor functions the same as the car driver.
- It automatically changes the Fuel Flow to maintain the desired speed or load.
- Closed Loop Definition: When used as an automatic control system for operation or process in which feedback in a closed path or group of paths to maintain output at a desired level.
- If parameter(s) of the loop change, it will effect the entire loop and fuel will automatically be corrected to maintain the desired setpoint.

Control Loop at a Diesel engine



Summing point

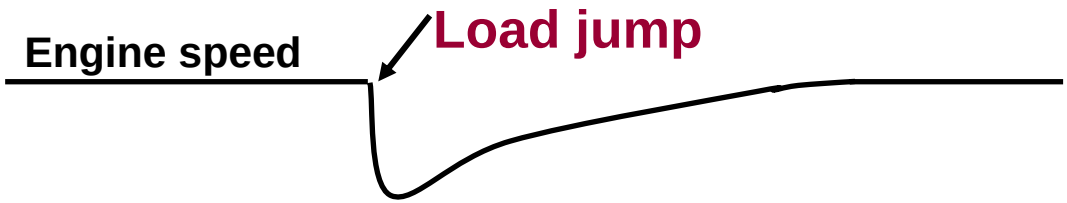


Elements of the Control Loop

- The Proportional Part
- The Integrator Part
- The Derivative Part

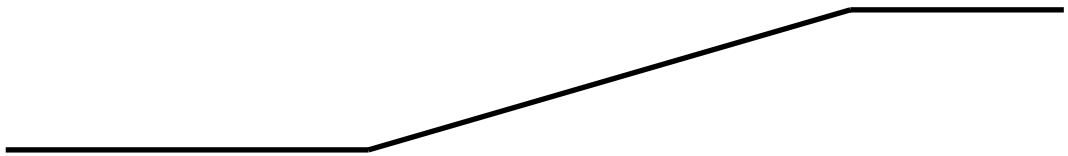
➢ PID - Governor

Characteristics of PID



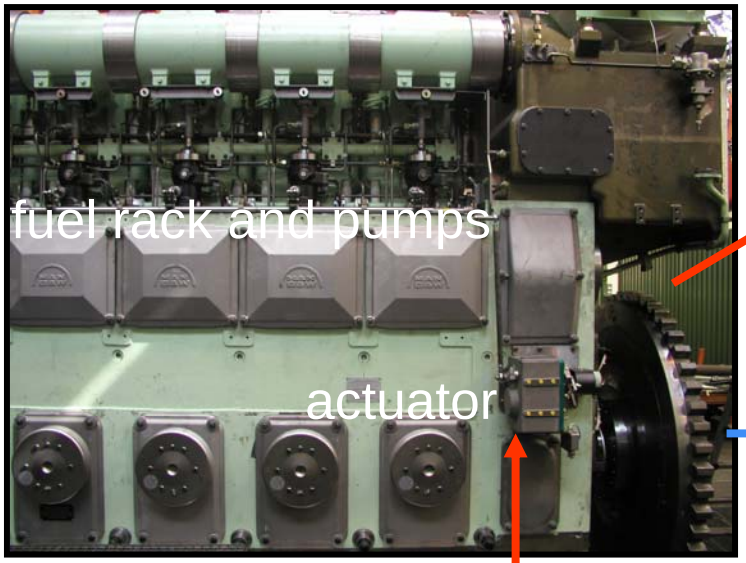
- reaction of the proportional Part:

- reaction of the integrator Part:

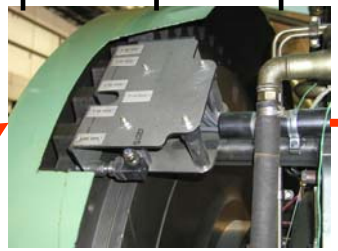


- reaction of the derivative Part:

Layout of the electronic speed governor



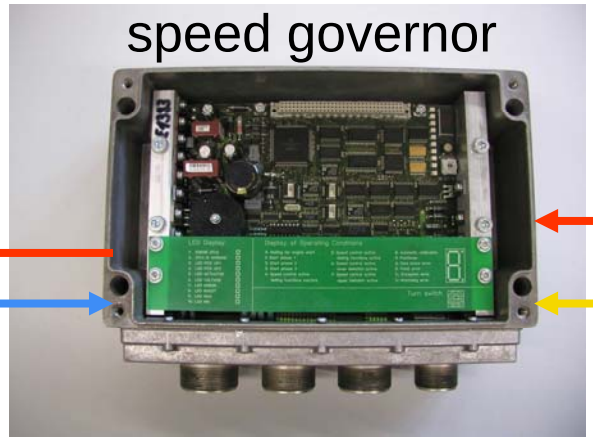
speed pickups



speed signal

controlled
engine speed

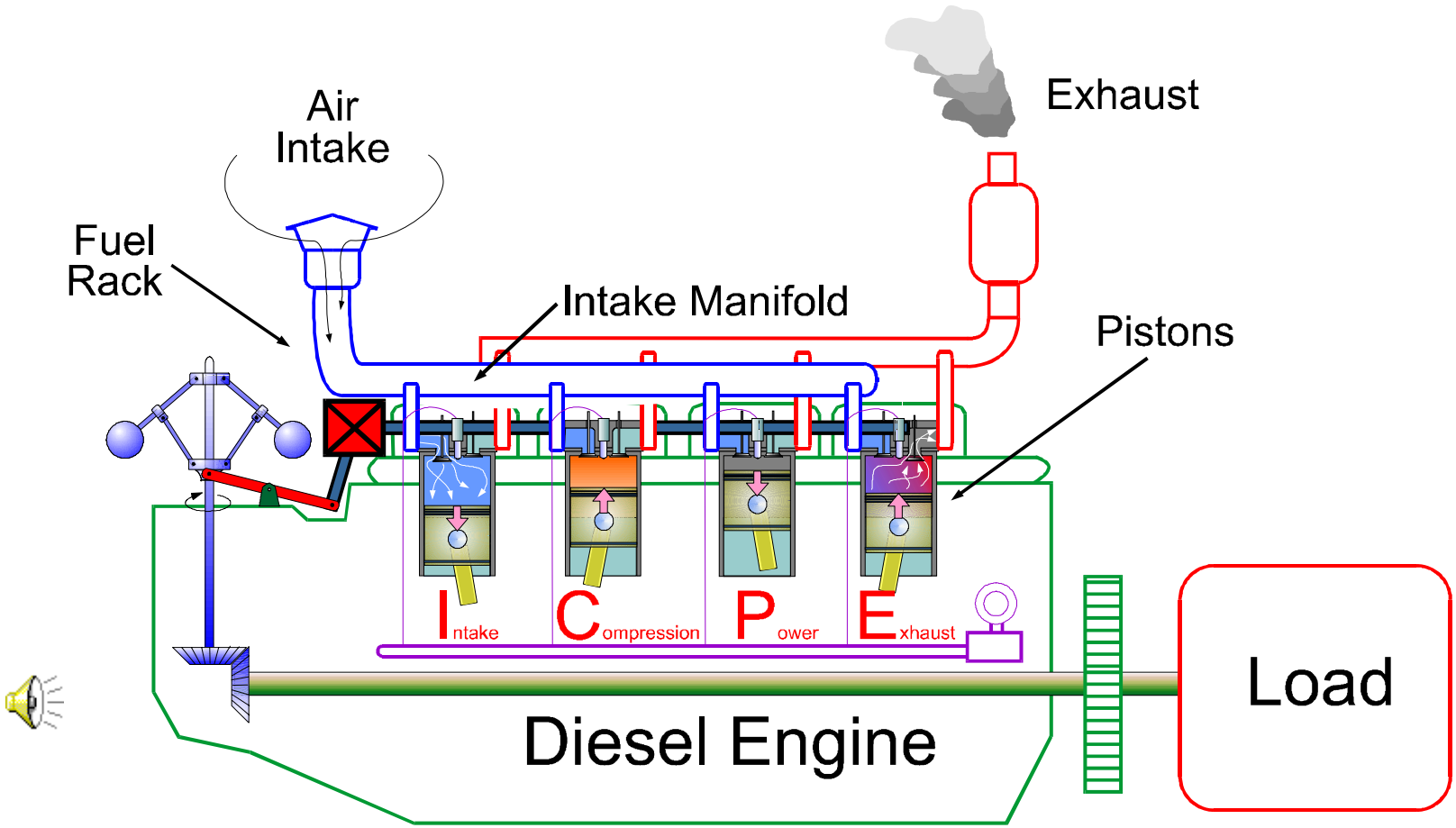
calculated
fuel setpoint



speed setpoint

Power
supply

running 4 stroke Diesel engine



Possible operating modes

- **Speed droop**
  especially used at infinite grid parallel operation
- **Isochronous load sharing**
  especially used at island operated plants
- **Master / Slave load sharing**
  especially used at ships propulsion plants, running two engines on one shaft

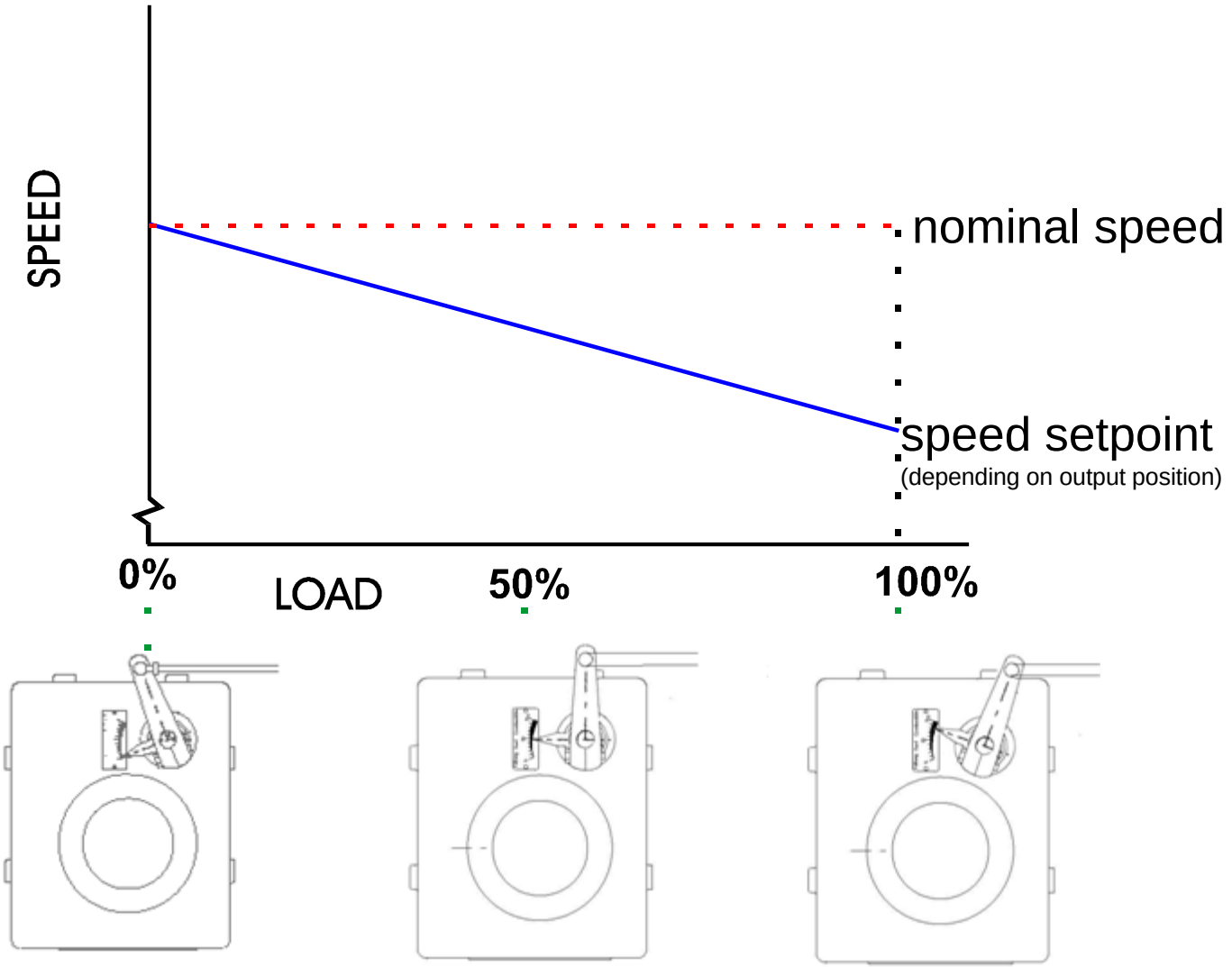
Speed droop

Droop is simply a decrease of the speed setting value with governor power piston (output shaft) movement in the increase fuel direction.

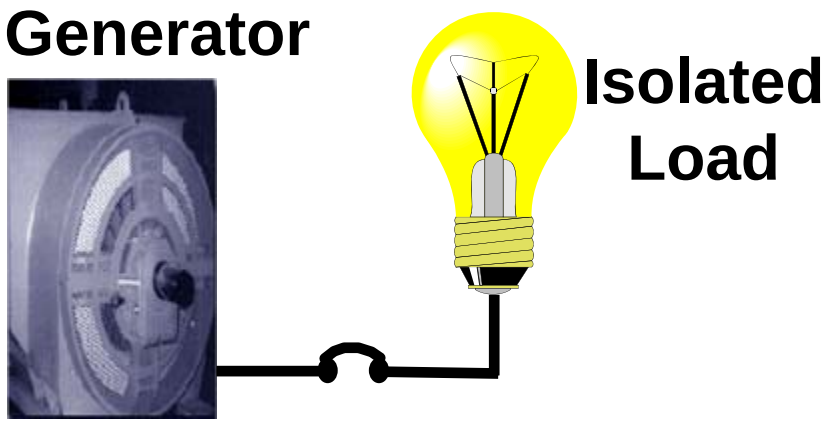
Applications:

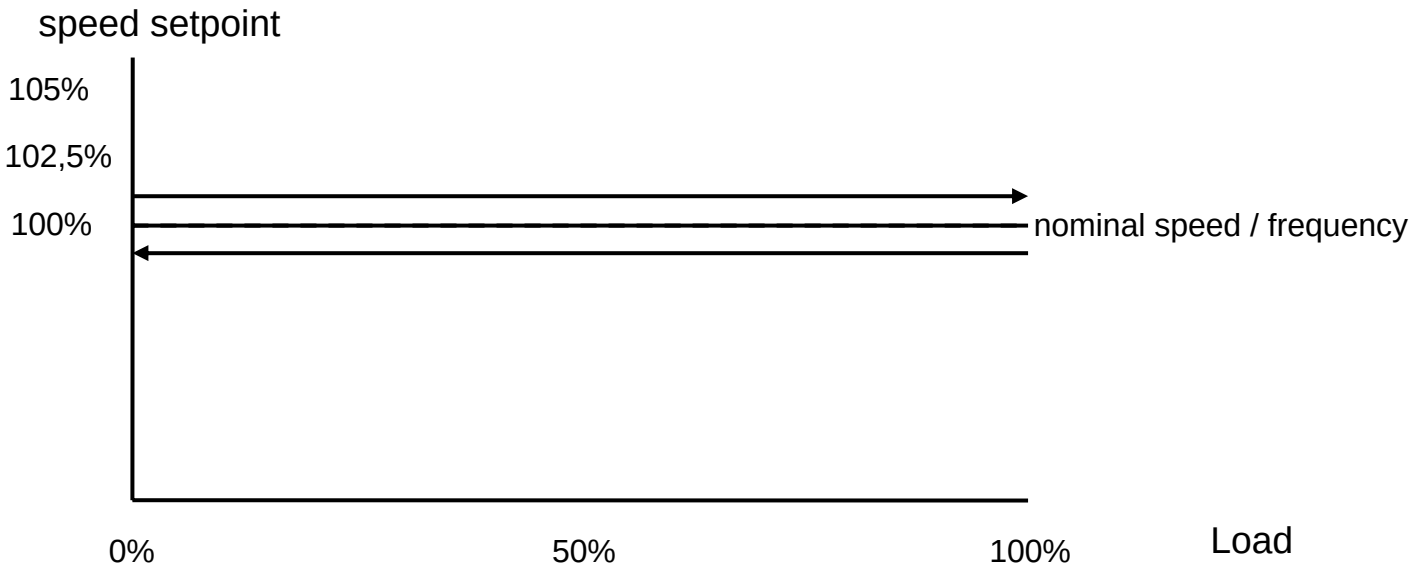
- Grid parallel operation
- Loadsharing between two ships main engines running on one shaft (old desingn, today: Master/Slave)
- Loadsharing at Diesel electric plants on ships

Speed droop Curve

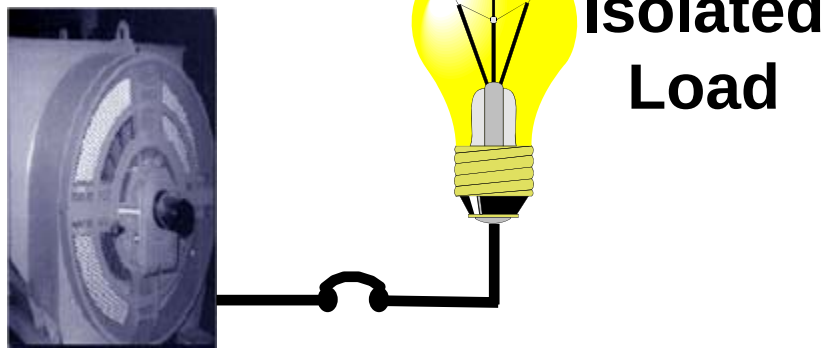


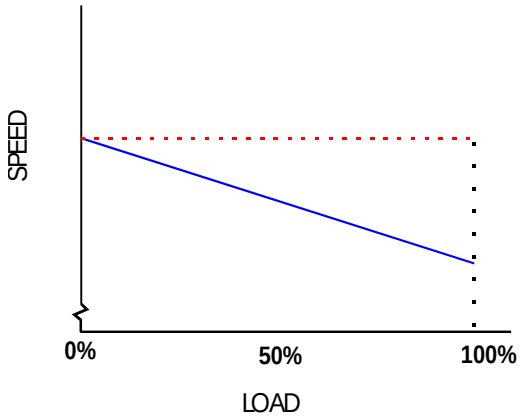
What happens without speed droop

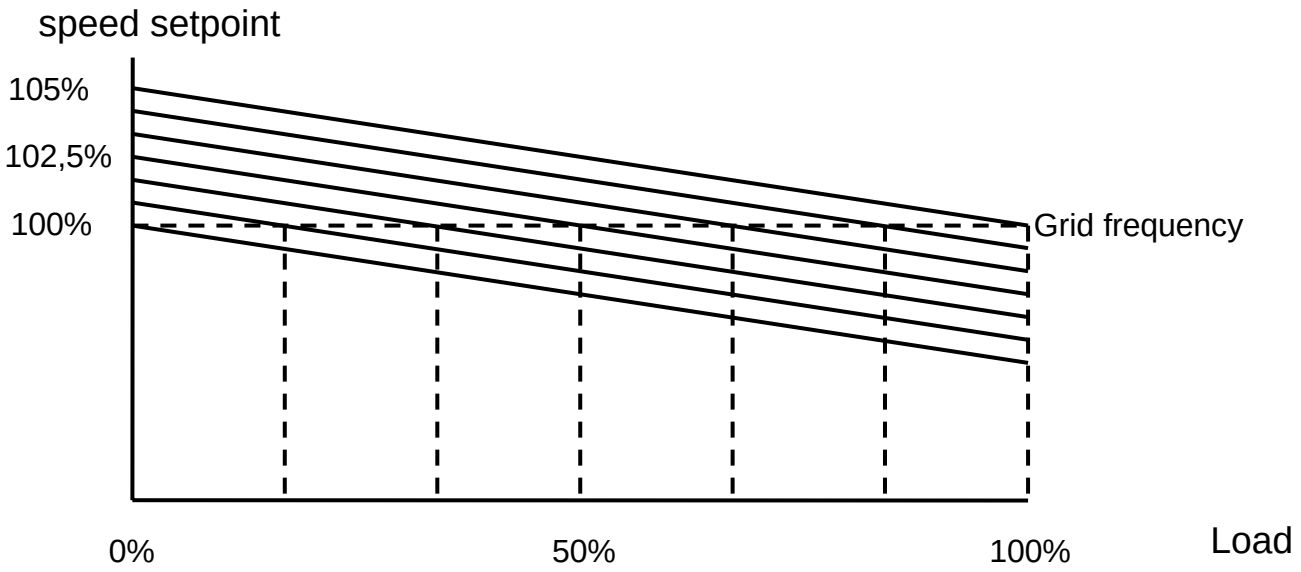




Grid parallel with speed droop







Definition of Isochronous

ISOCHRONOUS

(ISO+CHRONOS = SAME +TIME)

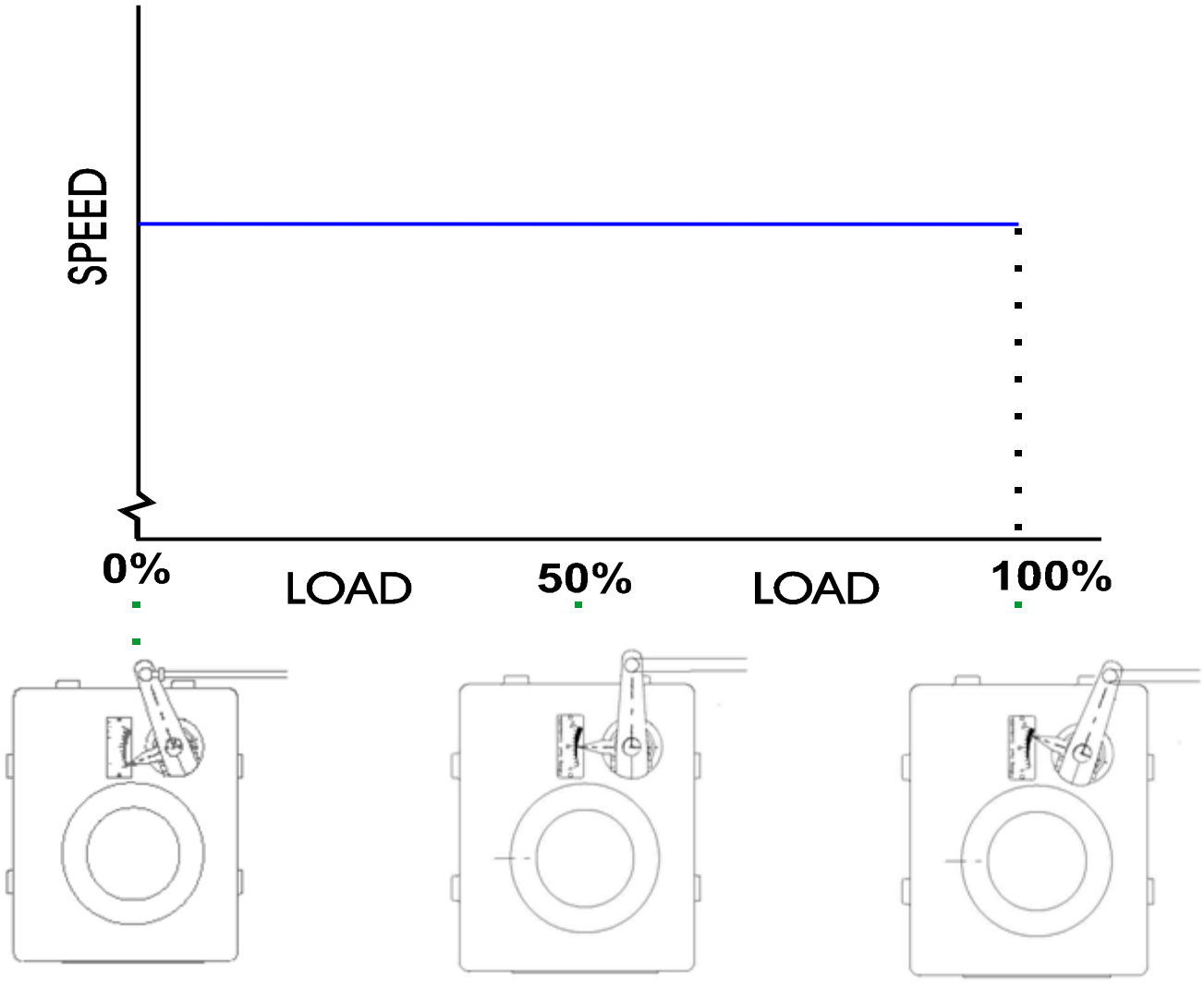
CONSTANT SPEED

No change in speed setting
with an change in load

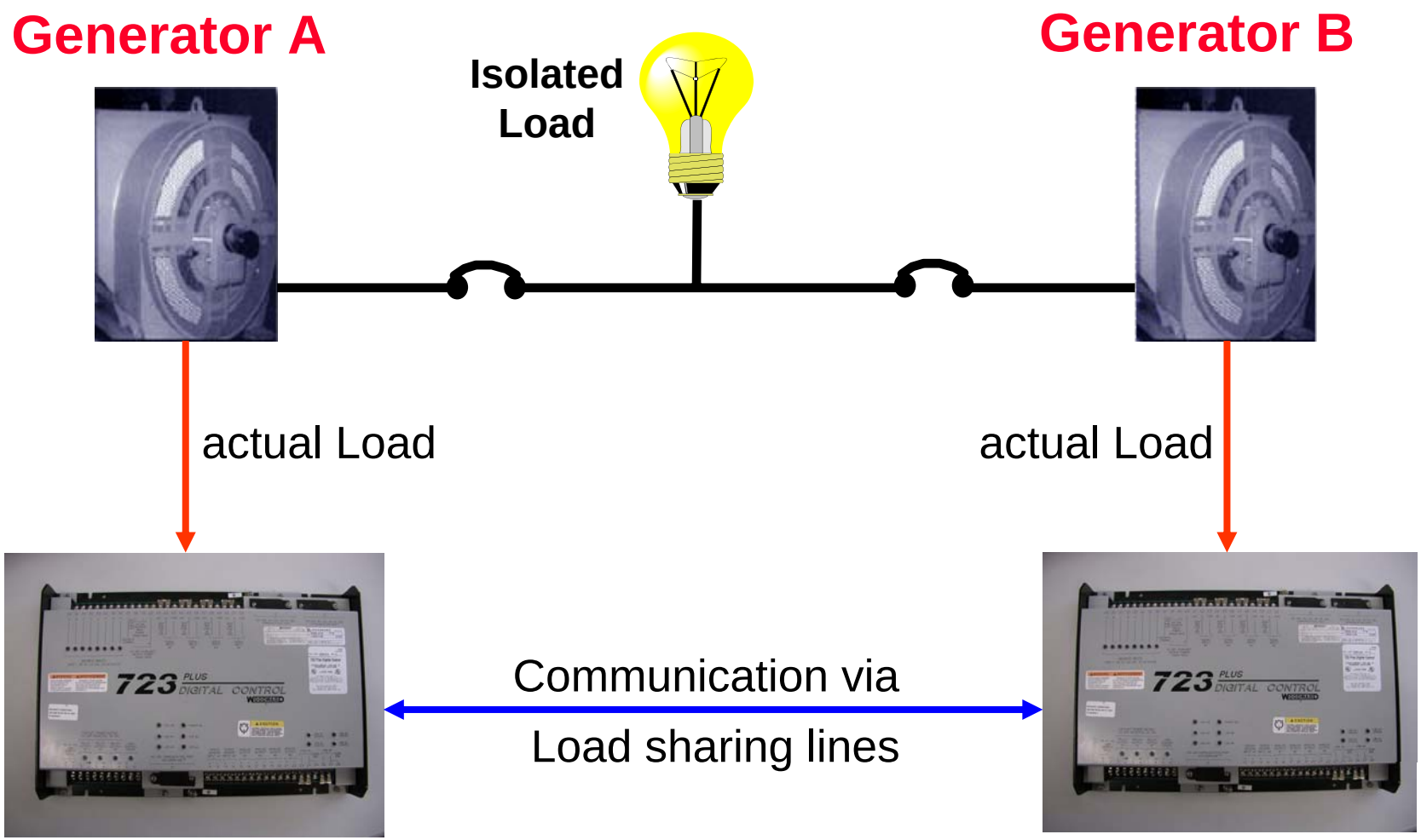
Applications:

- Grid parallel operation for frequency stabilisation
- Loadsharing at Diesel electric plants on ships
- Loadsharing at Island Power Stations

Isochronous Curve



Layout Isochronous Load sharing



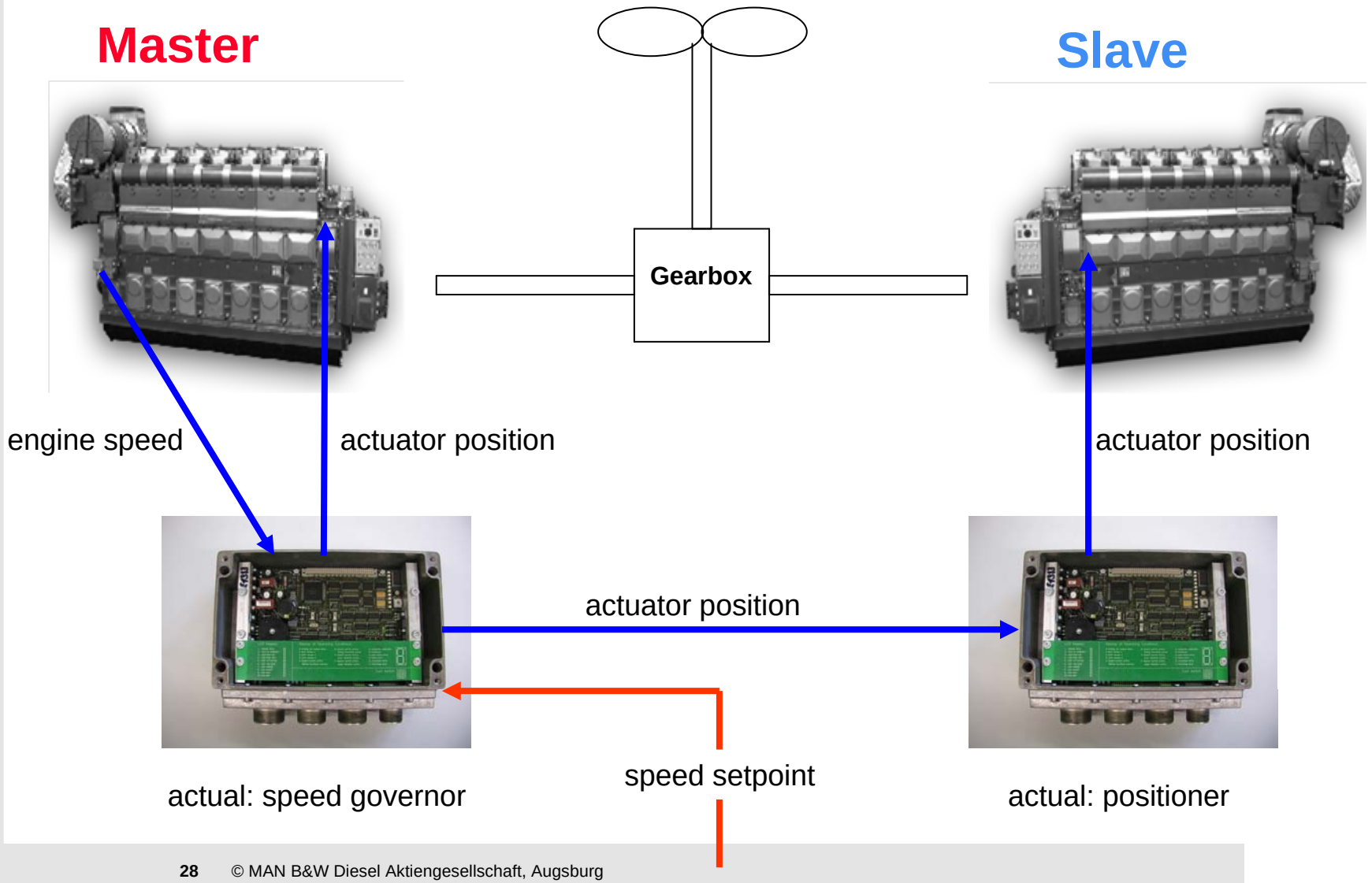
Master / Slave

For operation with two or more engines on one mech. load (twin engine operation) load sharing is achieved on the basis of equal fuel rack position. The speed control is taken over by the master governor. The second governor gets from the master an equal actuator setpoint. The Slave is operating as a positioner.

Applications:

- Loadsharing between two ships main engines running on one gearbox / shaft.

Layout Master /Slave operation



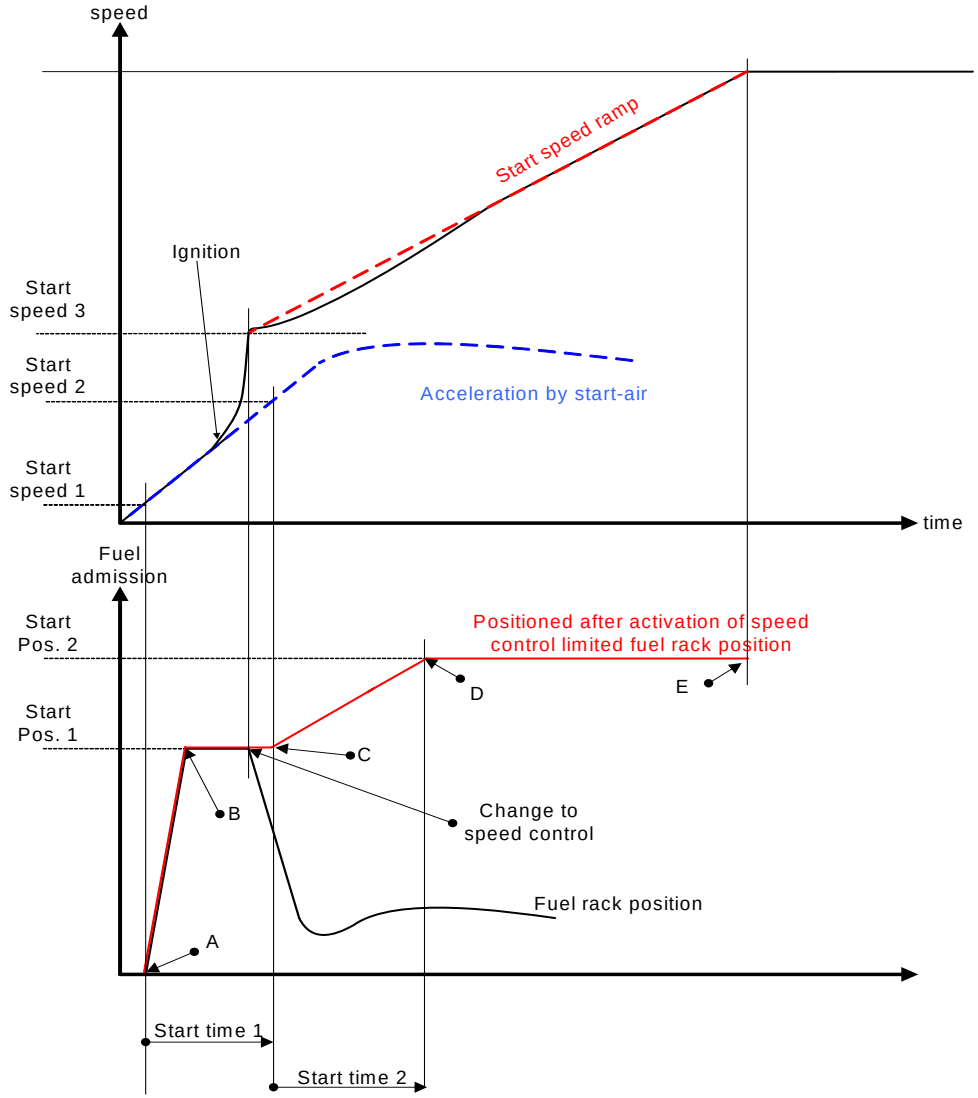
New starting procedure

Advantages :

- Reliable engine start up
- No smoke at engine start
- Less air consumption during engine start up
- Start behavior independent of fuel quality

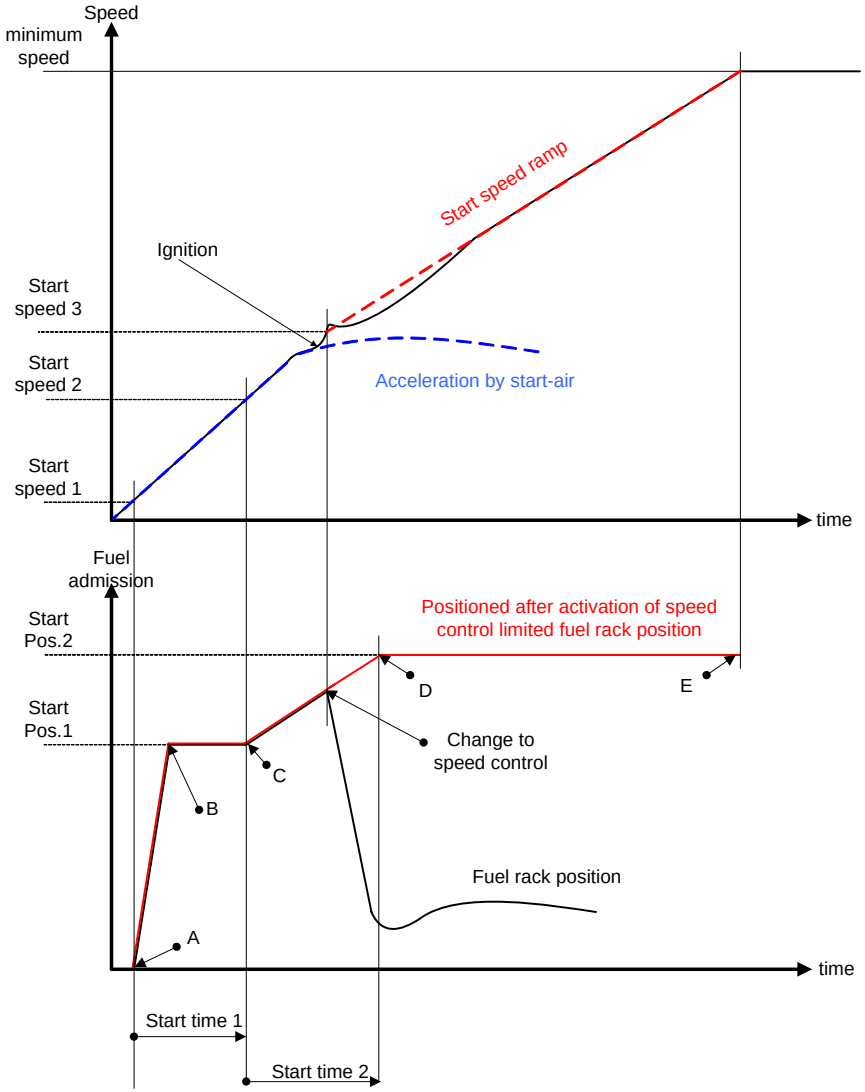
Very good engine start

engine needs little fuel for ignition



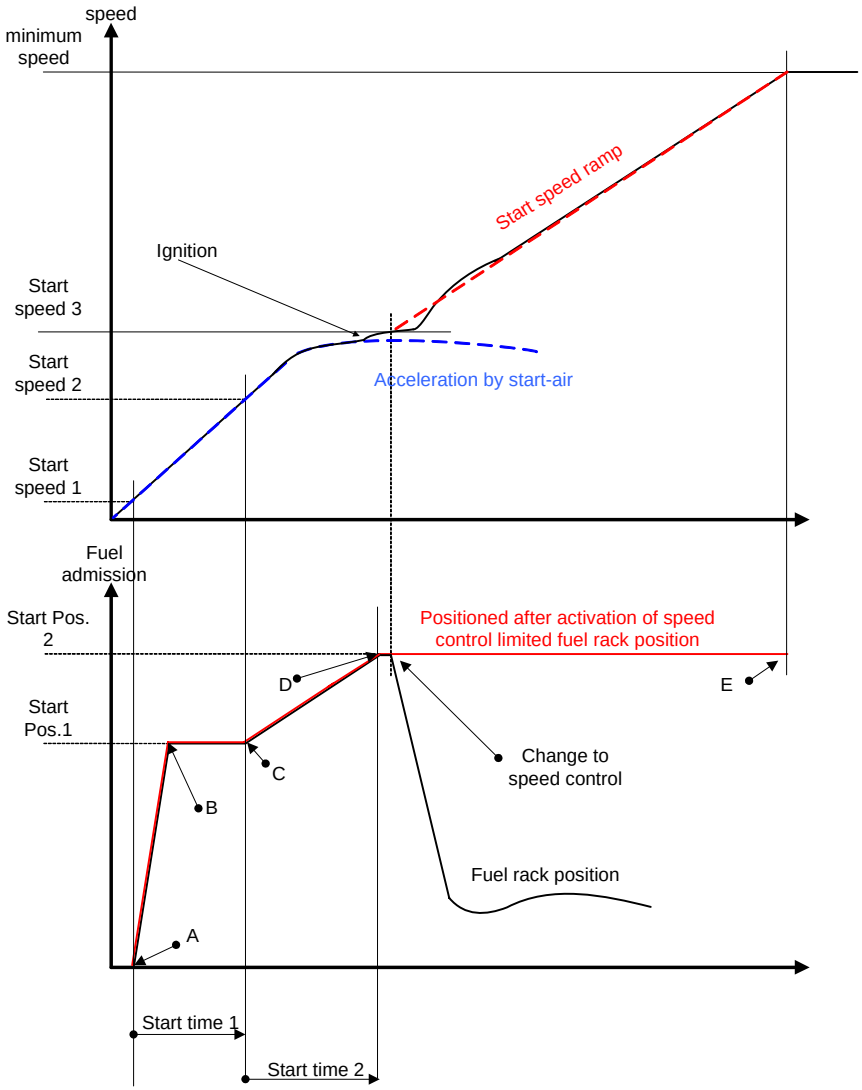
Medium engine start

engine needs more fuel for ignition

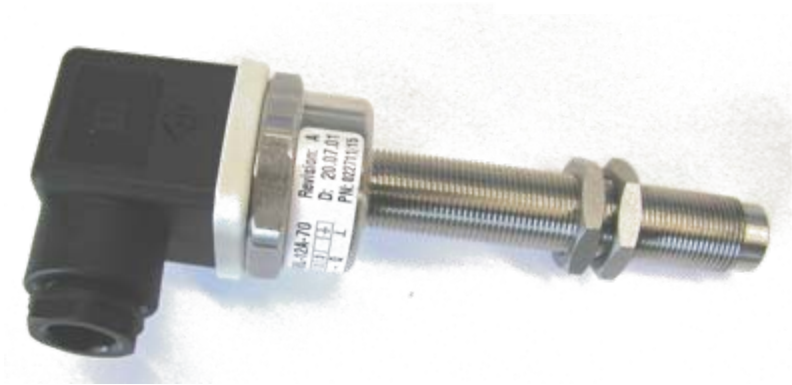


Bad engine start

engine needs a lot of fuel for ignition



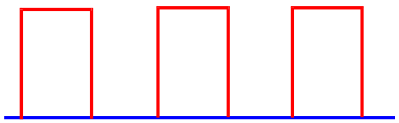
Speed Sensors

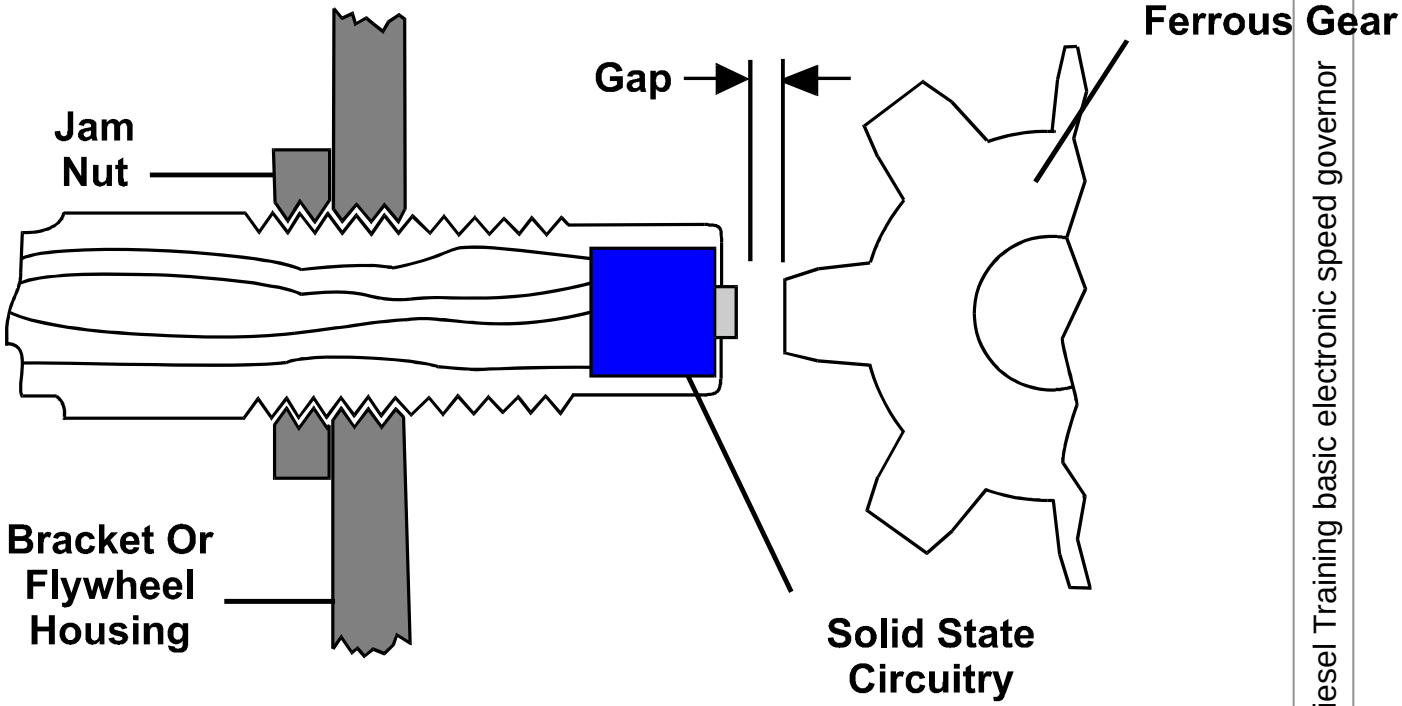


Proximity Probes

- Proximity Probes or Proximity Switches are active devices usually used where slow rpm or a large air gap is required. This is necessary due to the large runout of the monitored gear and the slow speeds of large engines or turning gears on turbines. These have a slower surface speed which a MPU cannot detect.
- Proximity probes require an external power supply, usually 24 Vdc to operate.

Demo Proximity Probe



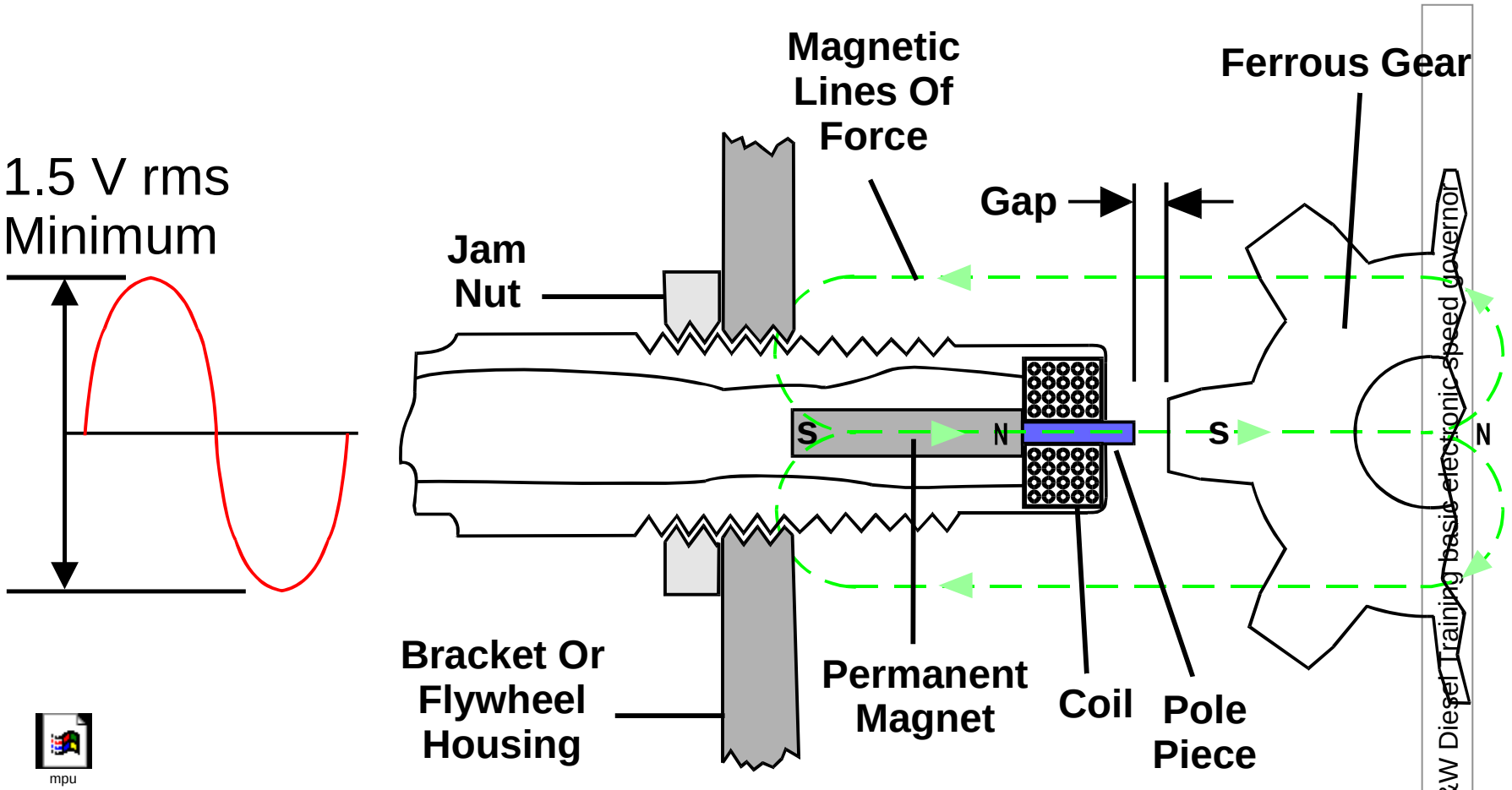


mpu

Magnetic Probes

- Single pole, alternating current, electric generator.
- Single magnet, attached to a pole piece which is wrapped with multiple layers of copper wire.
- The ferrous gear teeth and the magnet creates a path for the magnetic lines of force.
- Making and breaking of the Flux Lines induces an alternating voltage into the coil around the pole piece.
- Each pulse is represented by a gear tooth passing by the Magnetic Pick-up.
- The Impedance of a Magnetic Pick-up is approximately 220 ohms.

Demo Magnetic Probes



Frequency calculation

$$\text{MPU Hertz} = \frac{\text{No. Teeth x Gear RPM}}{60}$$

Example:

$$\text{MPU Hertz} = \frac{\text{30 Teeth x 500 RPM}}{60}$$

→ MPU Hertz = 250 Hertz

