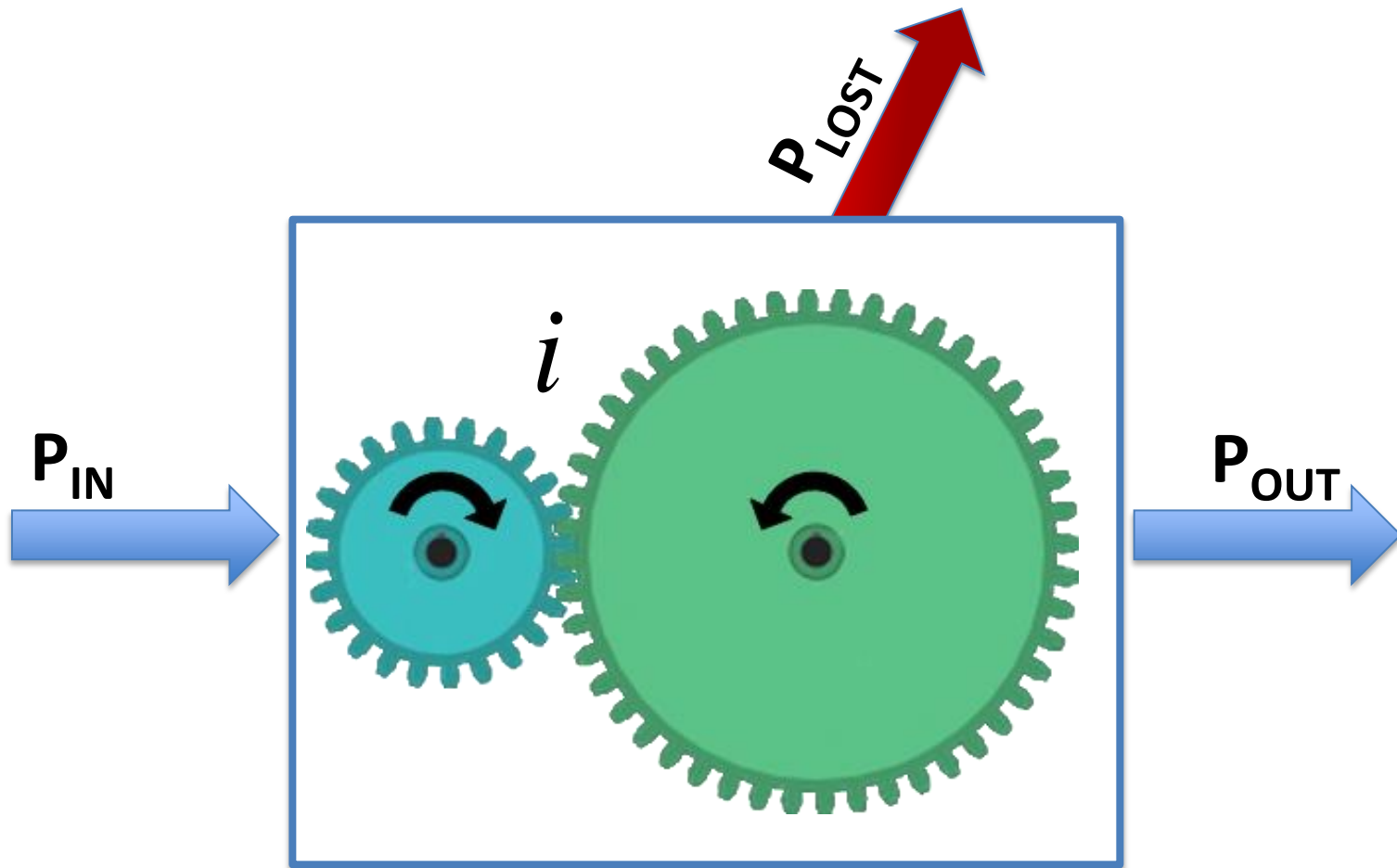


Trasmissione di potenza: i Riduttori

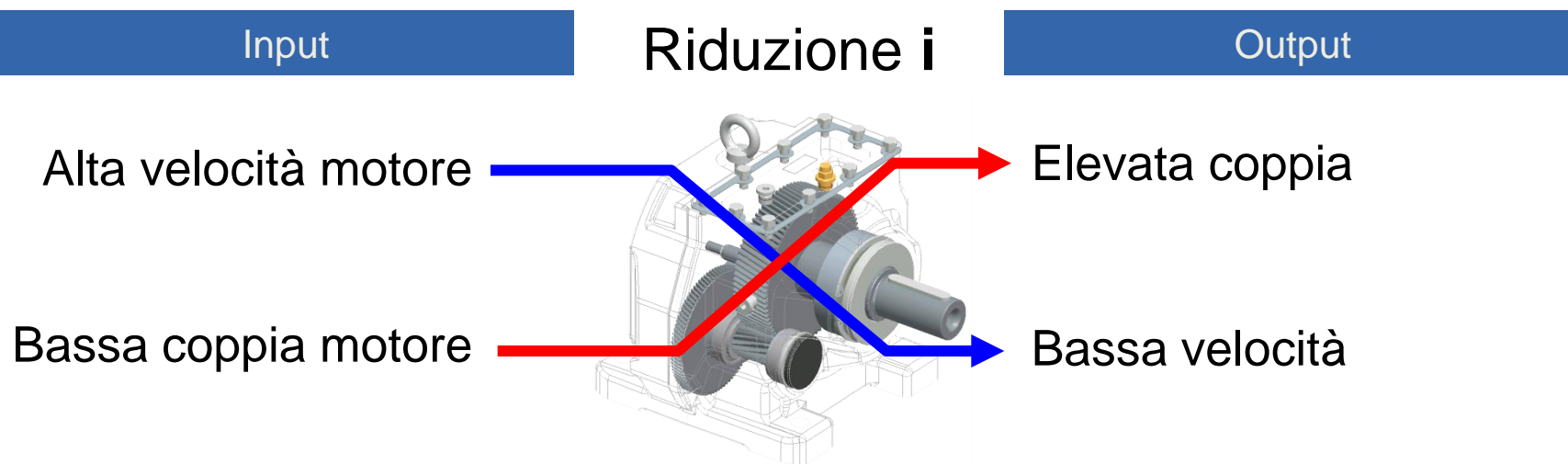
ing. Fabio Gallerani

Siemens

Che cos'è un riduttore?



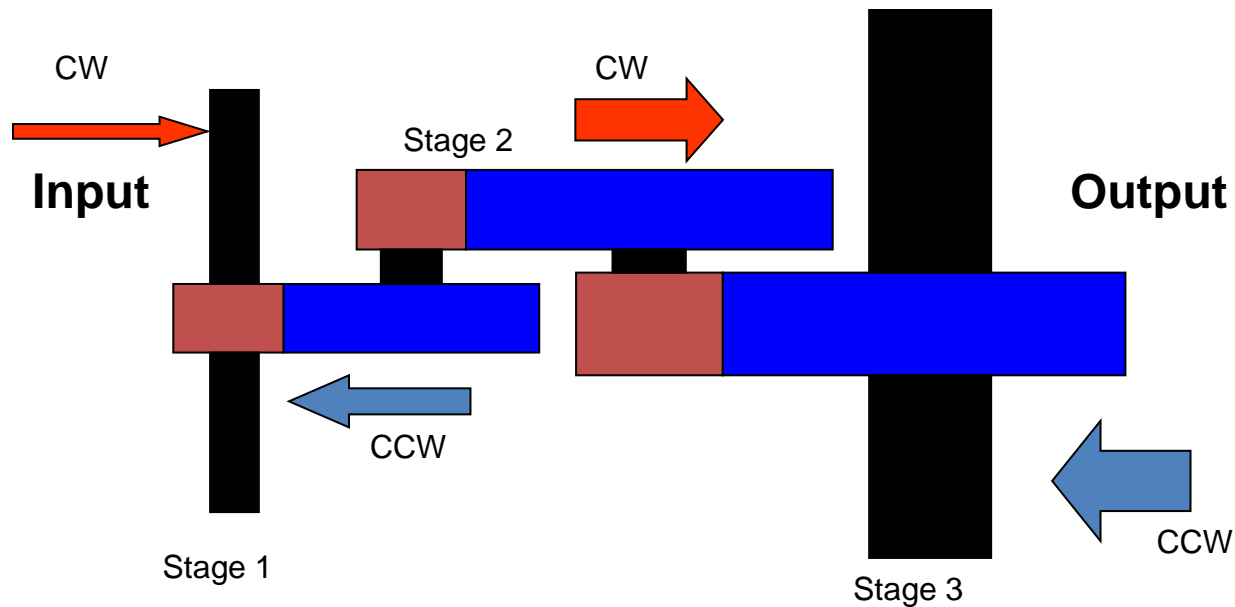
Rapporto di riduzione



$$i = \frac{n_{input}}{n_{output}} = \frac{n_1}{n_2}$$

$$i = \frac{\# \text{ of teeth}_{wheel}}{\# \text{ of teeth}_{pinion}} = \frac{z_2}{z_1} = \frac{48}{24} = 2$$

Rapporto di riduzione

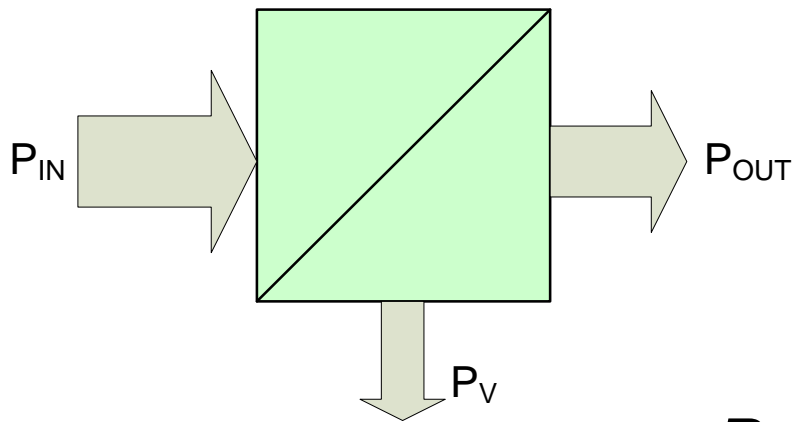


$$i_{tot} = i_1 \cdot i_2 \cdot i_3 \cdot \dots \cdot i_n$$

CW clockwise

CCW counterclockwise

Rendimento e Coppia trasmessa



$$\eta = \frac{P_2}{P_1}$$



Typical efficiency values

Motor	el. \leftrightarrow mech.	70...95%
Gearbox	mech. \leftrightarrow mech.	40...98%
Converter	el. \leftrightarrow el.	90...97%

Rendimento e Coppia trasmessa

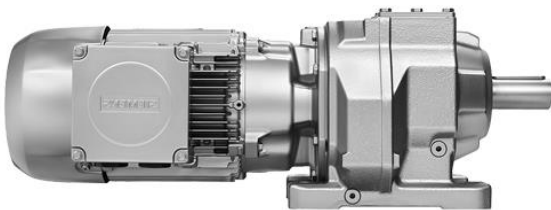
$$P = T \cdot \omega$$

$$P = T \cdot \omega = \frac{T \cdot n}{\frac{60}{2\pi} \cdot 1000}$$

Con l'efficienza:

Motor side
index 1

Load side
index 2

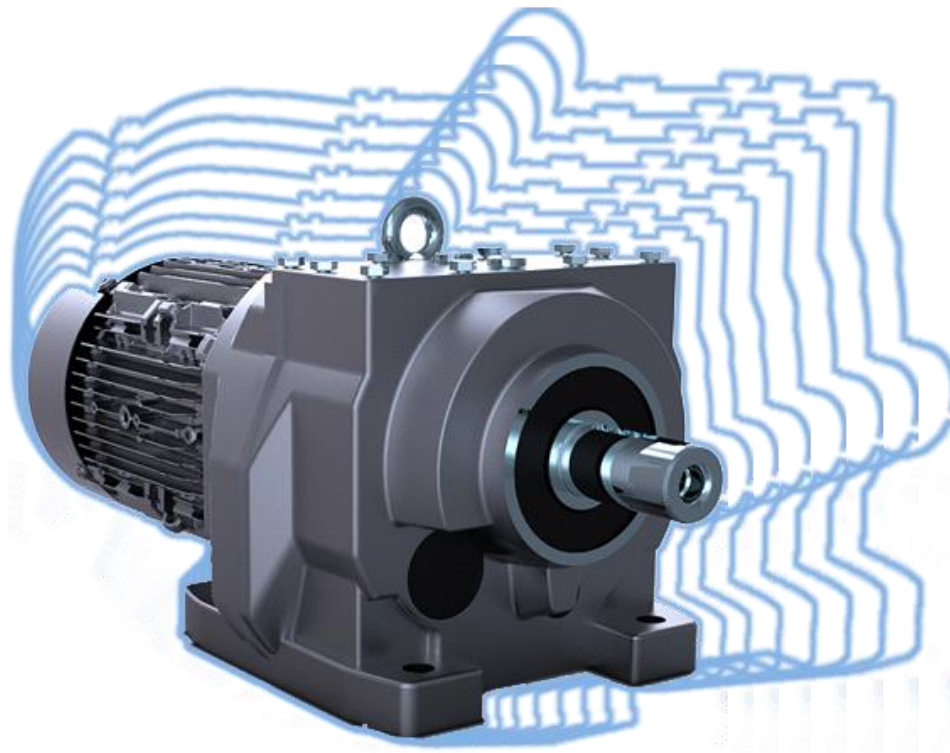


$$P_1 = T_1 \cdot 2\pi n_1 = \frac{P_2}{\eta_{Gearbox}} = \frac{T_2 \cdot 2\pi n_2}{\eta_{Gearbox}}$$

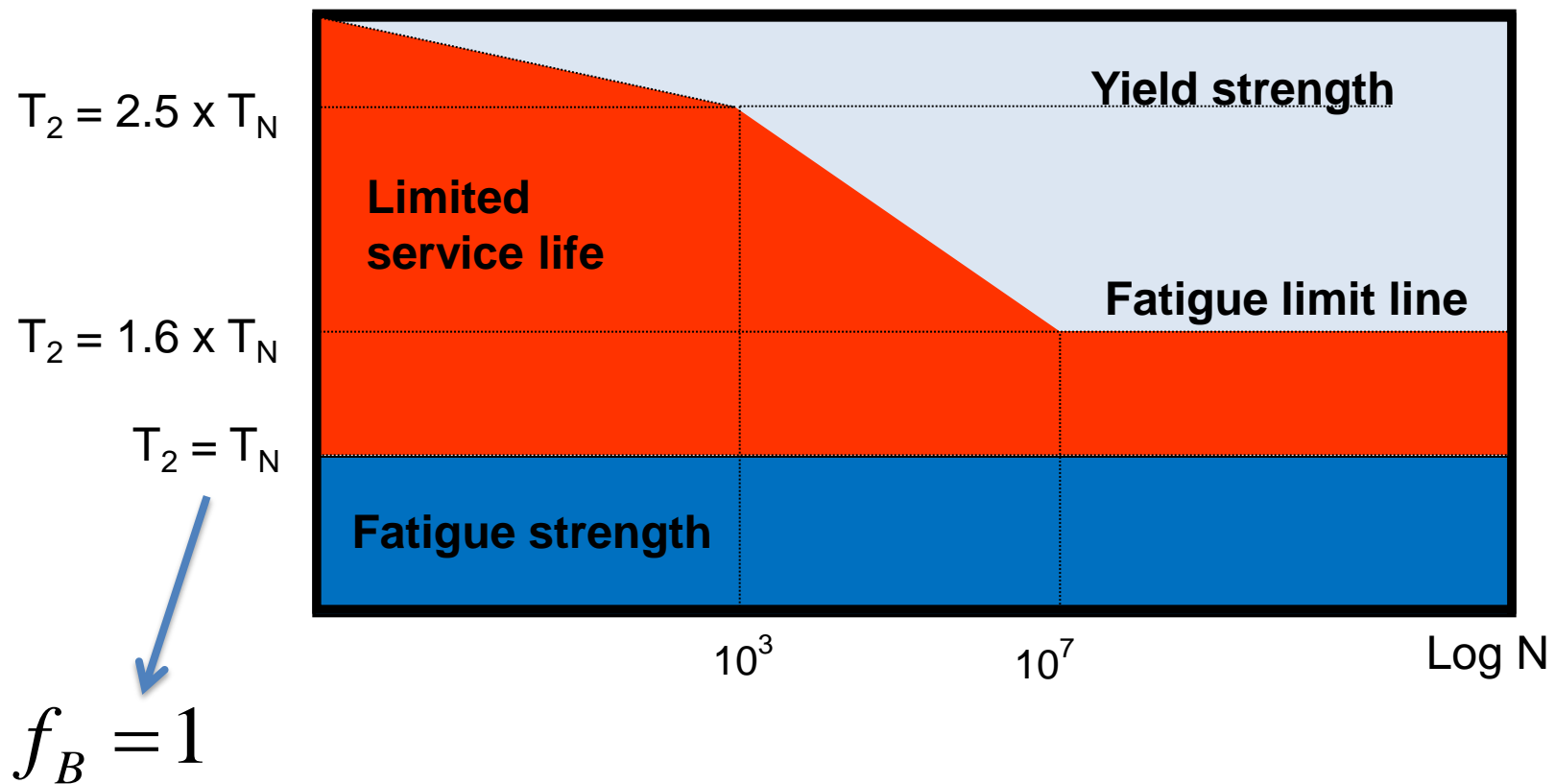
$$i = \frac{n_1}{n_2} \quad \rightarrow \quad T_2 = T_1 \cdot \eta_{Gearbox} \cdot i$$

Taglia del riduttore – Coppia nominale

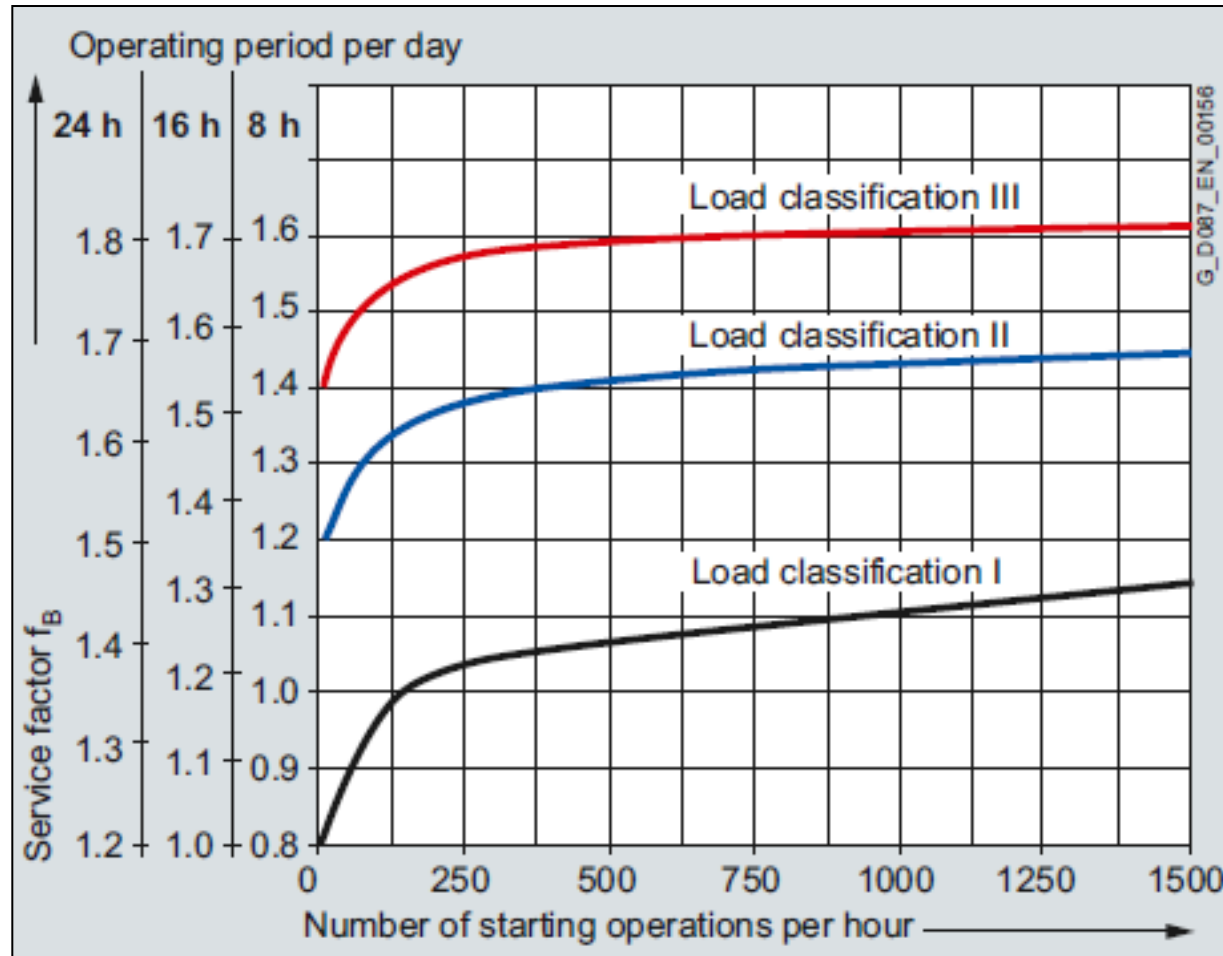
$$f_B = \frac{T_{nom, gearbox}}{T_1 \cdot i \cdot \eta} = \frac{T_N}{T_2}$$



Taglia del riduttore – Coppia nominale



Taglia del riduttore – Coppia nominale



Inerzia e rapporto inerziale

La classificazione del tipo di carico dipende dal rapporto inerziale:

$$\text{Mass acceleration factor} = \frac{\text{all external mass of inertia (reduced)}}{\text{mass of inertia on motor side}} = \frac{J_{Load_red}}{(J_M + J_B + J_R + J_{M+})}$$

$$J_{Load_red} = J_{Load} \cdot \left(\frac{n_2}{n_1} \right)^2 = \frac{J_{Load}}{i^2}$$

J_{Load_red} All external moments of inertia based on the motor shaft

J_M Motor moment of inertia

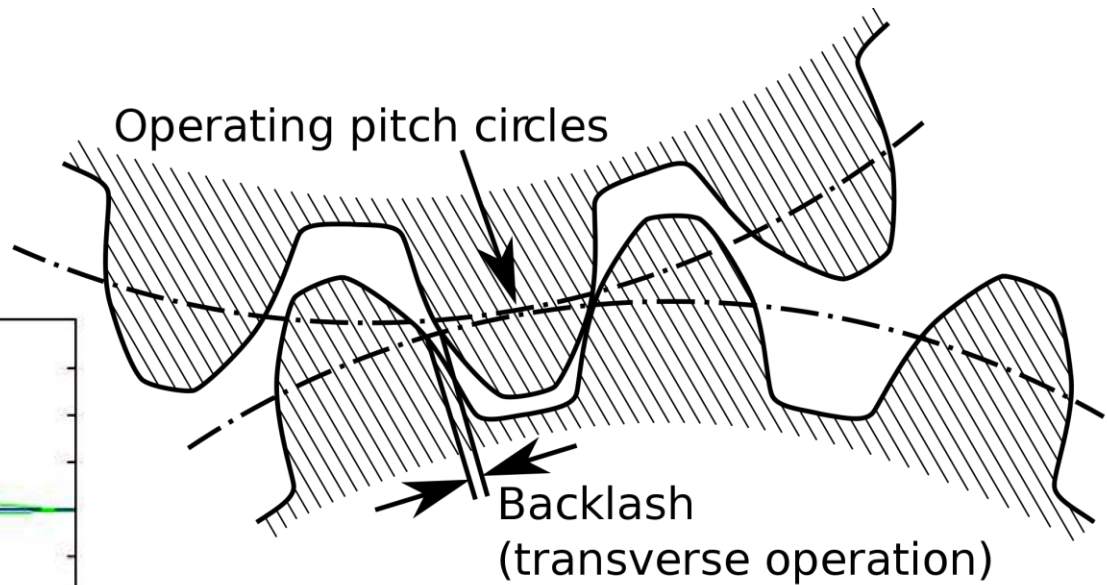
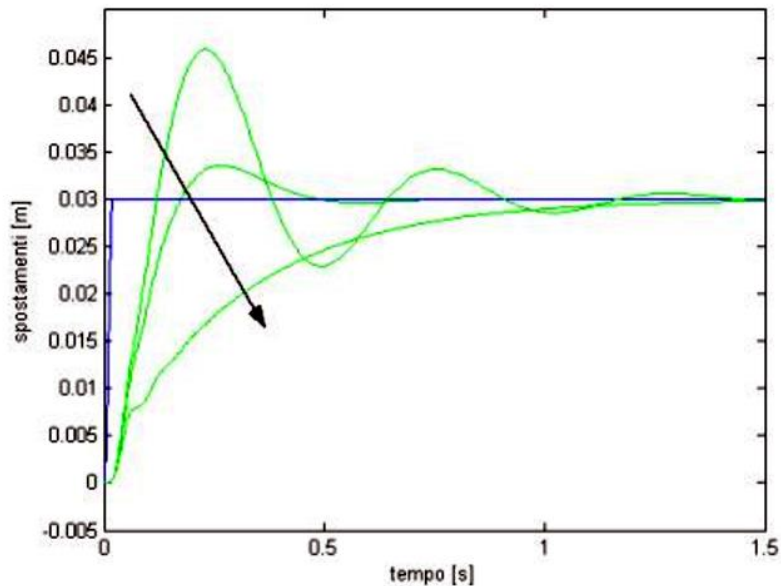
J_B Brake moment of inertia

J_R Gearbox moment of inertia

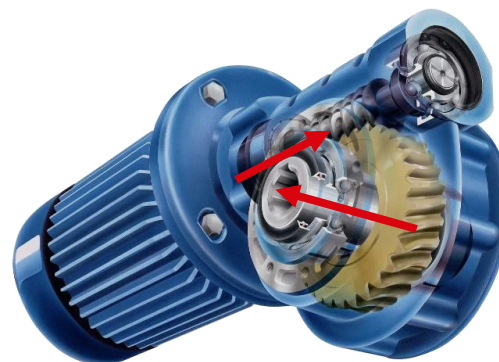
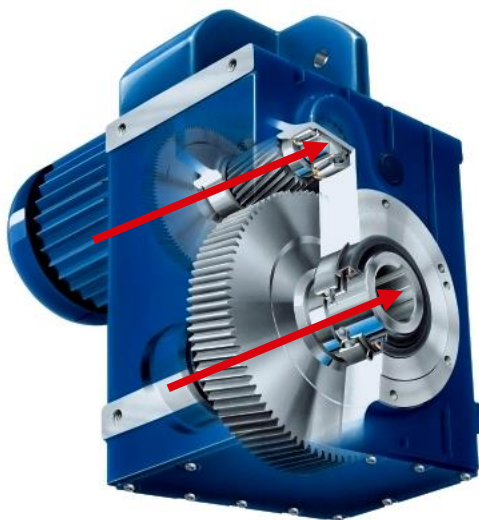
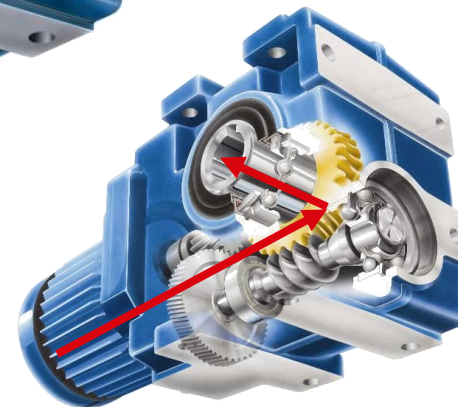
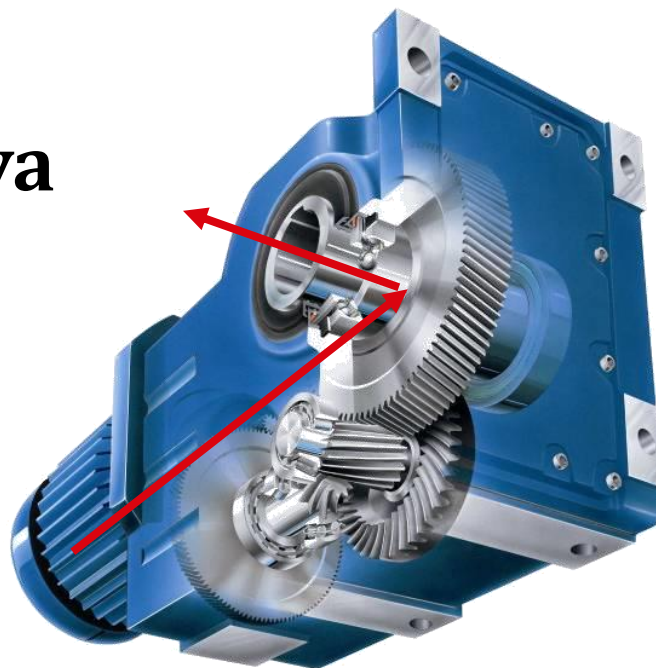
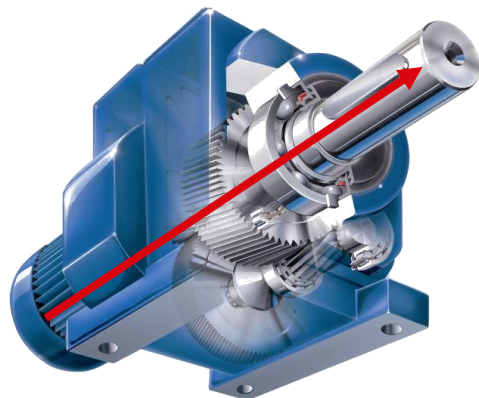
J_{M+} Additional moment of inertia

Gioco ed “elasticità”

Il gioco è sinonimo di elasticità → difficoltà nel controllo

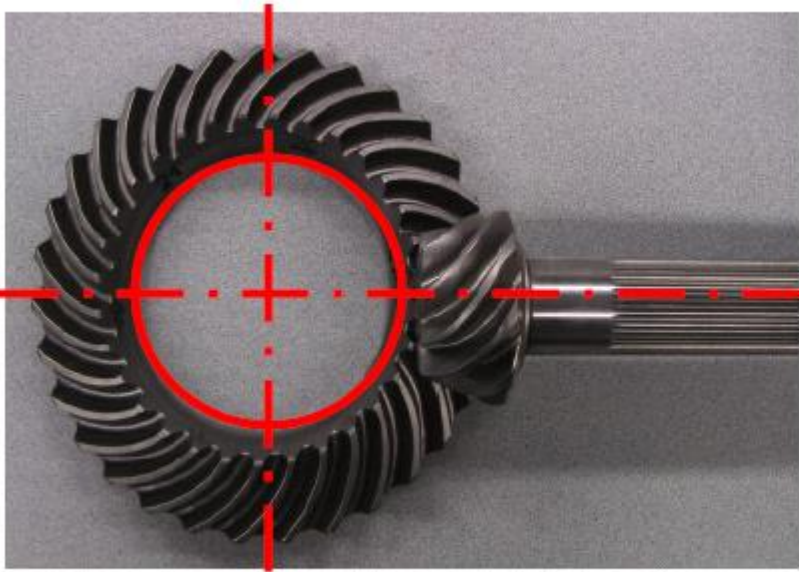


Forma costruttiva



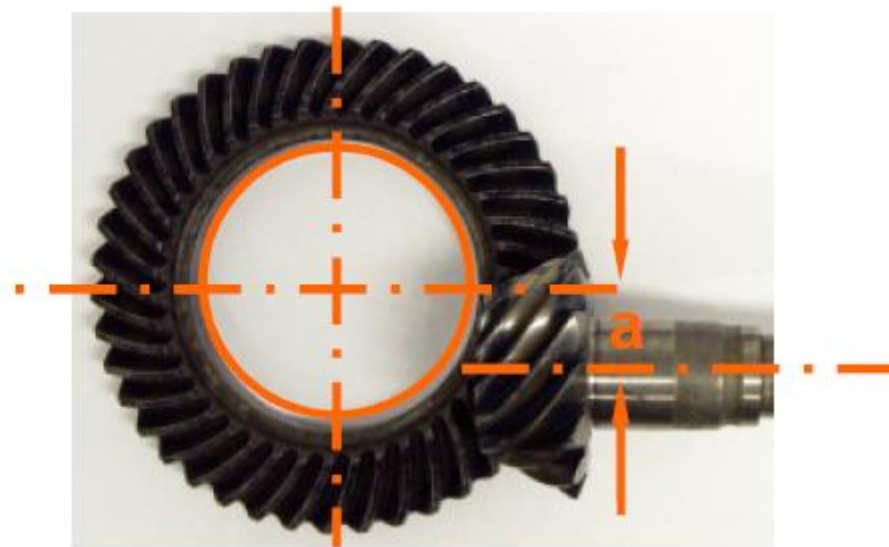
Forma costruttiva

Riduttori ortogonali



Coppia conica

nessun offset tra vite e corona

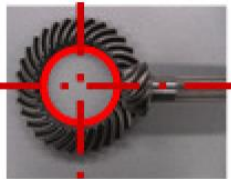



Coppia ipoide

presenza di offset tra vite e corona

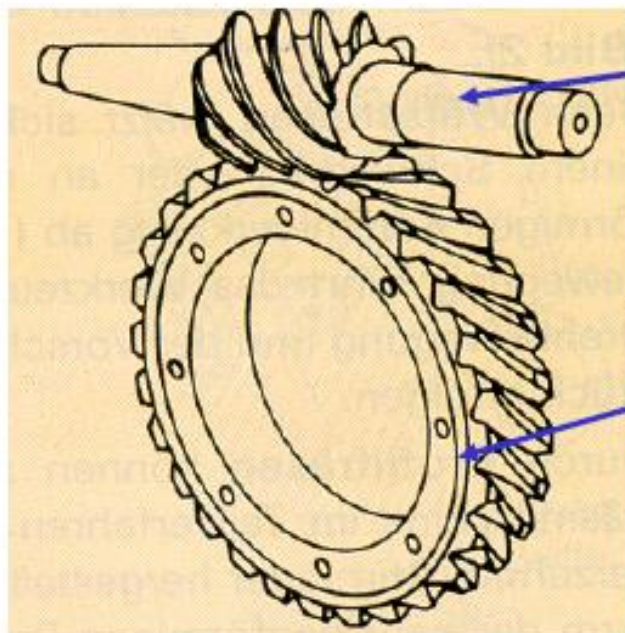
Forma costruttiva

Riduttori ortogonali

Tipo	<p>Coppia conica</p> 	<p>Coppia Ipoidale</p> 
Pro	<ul style="list-style-type: none"> • Possibili bassi rapporti di riduzione • Basse forze assiali • Elevate efficienza all'avvio 	<ul style="list-style-type: none"> • Rapporti di riduzione elevati in uno stadio • Morbidezza di funzionamento • Elevata capacità di trasmissione di coppia
Contro	<ul style="list-style-type: none"> • Rumorosità • Alti rapporti di riduzione non possibili 	<ul style="list-style-type: none"> • Forze assiali aggiuntive • Maggiori frizioni

Forma costruttiva

Riduttori vite senza fine



Worm
(input)

Worm wheel
(output)



Limiti di velocità

