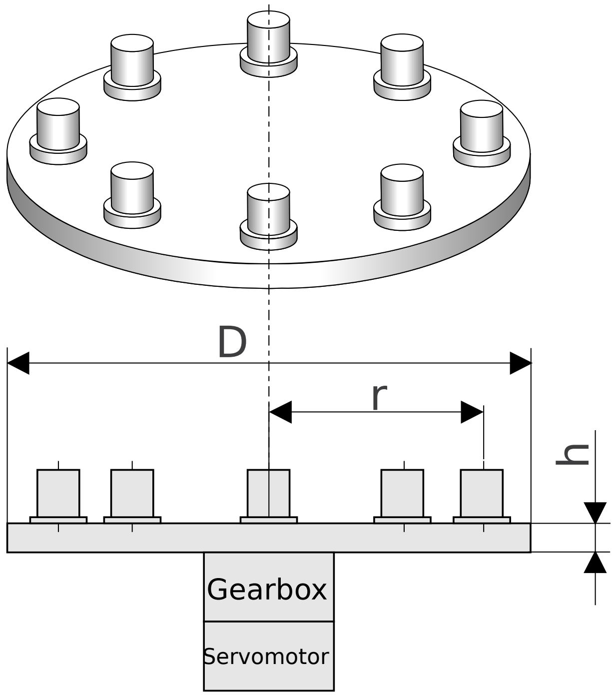
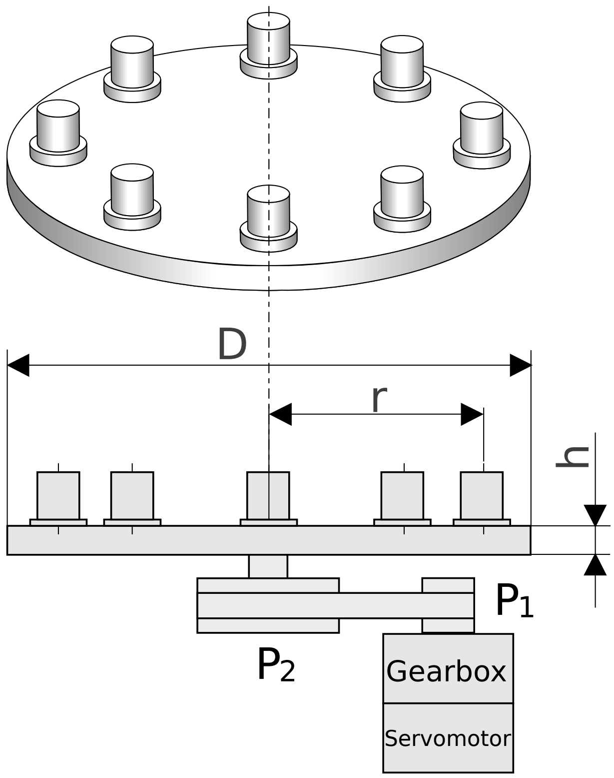
Rotary Table



Direct Drive Rotary Table



Indirect Drive Rotary Table

Multiple stop rotary tables are used in component assembly processes, dosing and filling machines, labeling machines, packaging machines, robotics, etc. They can be directly driven or use an intermediate reduction stage, composed of either gear wheels or a timing belt and two pulleys. This later arrangement allows for smaller gearboxes and higher precision.

Disclaimer

This tool has been created to assist engineers with the sizing of the different parts of the system. Calculations might not cover all corner cases. and results should always be checked by a qualified engineer. Under no circumstances shall we beheld responsible to any damages to persons or property due to correct or incorrect use of this tool, or to errors in it.

Time per Division

$$t_{on}=t_a+t_{cs}+t_d \quad [s]$$

Cycle Duration

$$t_{cycle}=t_a+t_{cs}+t_d+t_{off} \quad [s]$$

Cycles per Minute

$$Z=\frac{60}{t_{cycle}}$$

System Efficiency (Direct Drive)

$$\eta=\eta_g$$

System Efficiency (Indirect Drive)

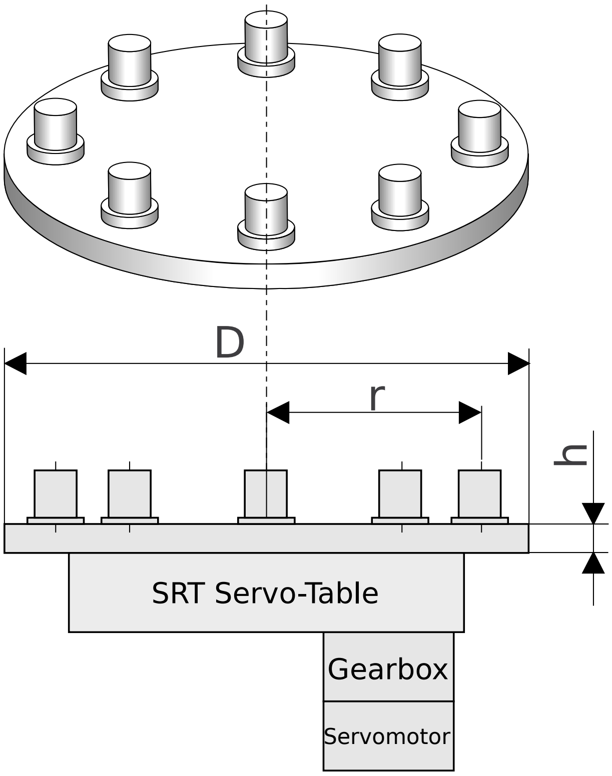
$$\eta=\eta_{pu}\cdot\eta_g$$

System Efficiency (SRT Servo-Table)

$$\eta=\eta_{SRT}\cdot\eta_g$$

Plate Mass

$$m_{pla}=\pi\cdot\left(\frac{D}{2000}\right)^2\cdot\frac{h}{1000}\cdot\rho \quad [kg]$$



SRT Servo Rotary Table

Total Workstation Mass

$$m_{aws} = no_{ws} \cdot m_{ws} \quad [kg]$$

Total Load Mass

$$m_{load} = m_{pla} + m_{aws} \quad [kg]$$

Pulley Ratio

$$i_P = \frac{D_{P2}}{D_{P1}}$$

Total Transmission Ratio (Direct Drive)

$$i = i_g$$

Total Transmission Ratio (Indirect Drive)

$$i = i_g \cdot i_{pu}$$

Total Transmission Ratio (SRT Servo-Table)

$$i = i_g \cdot i_{SRT}$$

Required Acceleration Torque

$$T_{acc} = J_T \cdot \alpha_a \quad [N \cdot m]$$

Required Deceleration Torque

$$T_{dec} = J_T \cdot \alpha_d \quad [N \cdot m]$$

Plate Inertia

$$J_{pla} = \frac{1}{2} \cdot m_{pla} \cdot \left(\frac{D}{2000}\right)^2 \quad [kg \cdot m^2]$$

Single Work Station Inertia

$$J_{ws} = m_{ws} \cdot \left(\frac{r}{1000}\right)^2 \quad [kg \cdot m^2]$$

Total Work Station Inertia

$$J_{aws} = J_{ws} \cdot m_{ws} \quad [kg \cdot m^2]$$

Plate and Workstations Inertia

$$J_T = J_{pla} + J_{aws} \quad [kg \cdot m^2]$$

Constants

Pi	$\pi \simeq 3.141592654$

Inputs

Acceleration Time	t_a $[s]$
Deceleration Time	t_d $[s]$
Constant Speed Time	t_{cs} $[s]$
Dwell Time	t_{off} $[s]$
Plate Diameter	D $[mm]$
Plate Thickness	h $[mm]$
Plate Density	ρ $\left[\frac{kg}{m^3}\right]$
No of Work Stations	no_{ws}
Work Station Mass	m_{ws} $[kg]$
Work Stations at Radius	r $[mm]$
P_1 Pulley Pitch Diameter	D_{P1} $[mm]$
P_2 Pulley Pitch Diameter	D_{P2} $[mm]$
SRT Internal Ratio	i_{SRT}
Pulleys' Efficiency	η_{pu}
SRT Efficiency	η_{SRT}
Gearbox Efficiency	η_g
Service Factor	K_A
Max. Motor Speed During Cycle	n_1 $[rpm]$
Positioning Accuracy	Δ_p $[mm]$
Gearbox Inertia	J_g $[kg \cdot cm^2]$
SRT Inertia	J_{SRT} $[kg \cdot cm^2]$
Motor Inertia	J_M $[kg \cdot cm^2]$
Motor Encoder/Resolver Resolution	PPR_i $[PPR]$ PPR: Pulses per Revolution

Total Inertia as Seen by the Motor (Direct Drive)

$$J_{T1} = \frac{10000 \cdot J_T}{i^2} + J_g \quad [kg \cdot cm^2]$$

Total Inertia as Seen by the Motor (SRT Servo-Table)

$$J_{T1} = \frac{10000 \cdot (J_T + J_{SRT})}{i^2} + J_g \quad [kg \cdot cm^2]$$

Load to Motor Inertia Ratio

$$\Lambda = \frac{J_{T1}}{J_M + J_g}$$

Angular Acceleration

$$\alpha_a = \frac{\omega_{max}}{t_a} \quad \left[\frac{rad}{s^2}\right]$$

Angular deceleration

$$\alpha_d = \frac{\omega_{max}}{t_d} \quad \left[\frac{rad}{s^2}\right]$$

Maximum Rotational Speed

$$n_{2\,max} = \omega_{max} \cdot \frac{30}{\pi} \quad [rpm]$$

Maximum Rotational Speed

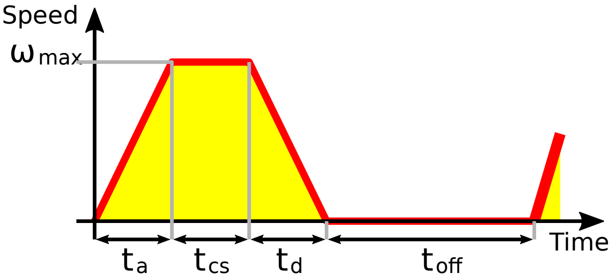
$$\omega_{max} = \frac{2 \cdot \pi}{no_{ws} \cdot \left(t_{ws} + \frac{t_a}{2} + \frac{t_d}{2}\right)} \quad \left[\frac{rad}{s}\right]$$

Minimum Recommended Motor Inertia

$$J_{M\,min} = \frac{J_{T1}}{5} - J_g \quad [kg \cdot m^2]$$

Motor Power during Acceleration

$$P_{acc\,1} = \frac{T_{acc} \cdot n_2}{9550 \cdot \eta} \quad [kW]$$



Sample duty cycle

Motor Power during Deceleration

$$P_{dec1}=\frac{T_{dec}\cdot n_2}{9550\cdot \eta}\ [kW]$$

Ideal Gearbox Ratio (Direct Drive)

$$i_g=\frac{n_1}{n_2}$$

Ideal Gearbox Ratio (Indirect Drive)

$$i_g=\frac{\frac{n_1}{n_2}}{i_P}$$

Ideal Gearbox Ratio (SRT Servo-Table)

$$i_g=\frac{\frac{n_1}{n_2}}{i_{SRT}}$$

Ideal Gearbox Backlash (Direct Drive)

$$\Delta\phi=\frac{60\cdot 180\cdot \Delta_p}{r\cdot\pi}\ [arcmin]$$

Ideal Gearbox Backlash (Indirect Drive)

$$\Delta\phi=\frac{60\cdot 180\cdot \Delta_p\cdot i_P}{r\cdot\pi}\ [arcmin]$$

Ideal Gearbox Backlash (SRT Servo-Table)

$$\Delta\phi=\frac{60\cdot 180\cdot \Delta_p\cdot i_{SRT}}{r\cdot\pi}\ [arcmin]$$

Required Gearbox Output Torque (Direct Drive)

$$T_{2max}=max(T_{acc},T_{dec})\ [N\cdot m]$$

Required Gearbox Output Torque (Indirect Drive)

$$T_{2max}=\frac{max(T_{acc},T_{dec})}{i_P\cdot\eta_{pu}}\ [N\cdot m]$$

Required Gearbox Output Torque (SRT Servo-Table)

$$T_{2max} = \frac{max(T_{acc}, T_{dec})}{i_{SRT} \cdot \eta_{SRT}} \quad [N \cdot m]$$

Required Gearbox Output Torque, Adjusted for Service Factor

$$T_{2KA} = T_{2max} \cdot K_a \quad [N \cdot m]$$

Required Motor Torque

$$T_m = \frac{T_{2max}}{i_g} \quad [N \cdot m]$$

Outer Ring Resolution

$$PPR_o = PPR_i \cdot i_g \cdot i_{SRT} \quad [PPR]$$

Pulses/Degree

$$PPD_o = \frac{PPR_o}{360} \quad [PPR]$$

Pulses/Workstation

$$PPW_o = \frac{PPR_o}{no_{ws}} \quad [PPR]$$