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Estun Servo Motor Selection Principle

Estun overseas department 2010.11

Factors for choosing Servo Motor

➢**Factors for choosing servo motor**

1. Load framework
2. Movement mode
3. Load speed
4. Positioning precision
5. Usage environment

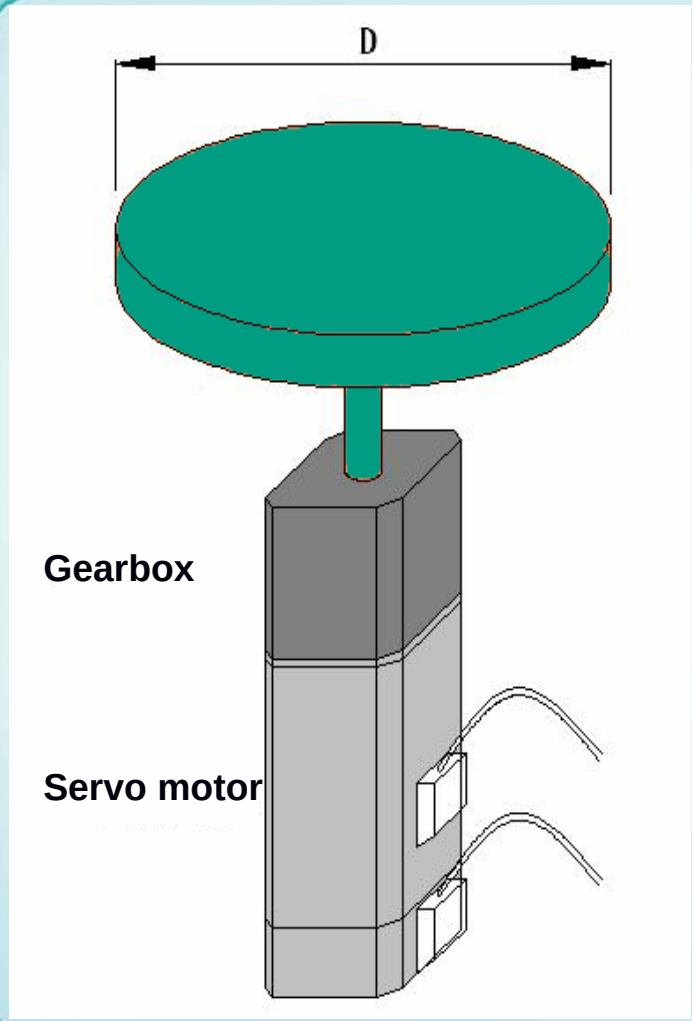
➢**Specification for choosing servo motor**

1. Motor power (W)
2. Motor rated speed (rpm)
3. Rated torque and maximum torque (N.m)
4. Rotor inertia (kg • ㎡)
5. Brake
6. Volume, weight, dimension

Servo Motor Selection Principle

- Continuous work torque < Servo motor rated torque
- Instantaneous peak torque < Servo motor maximum torque (When acceleration)
- Load inertia < 6 times motor rotor inertia(20 times for EMJ series)
- Continuous work speed < Motor rated speed

Example I



➢Say:

Circular plate Mess (M)=50kg,
Circular diameter (D)=500mm,
Circular plate top rotation speed= 80rpm,

please select suitable servo motor and gearbox.

Example I

➢Calculate circular plate rotation inertia

JL = MD^2/ 8 = 50 * 2500 / 8 = 15625 $kg.cm^2$

Suppose gearbox Geared-down ratio= 1:R, therefore, the inertia on the motor load shaft is 15625 / R^2 .

➢Selection principle 'Load inertia < 6 times motor rotor JM inertia' (20 times for EMJ series)

If select EMJ-04(400W), JM = 0.31$kg.cm^2$,

Therefore,15625 / R^2 < 20*0.31, R^2 > 2520, R > 50

Output speed=3000/50=60 rpm, It cannot match the requirement.

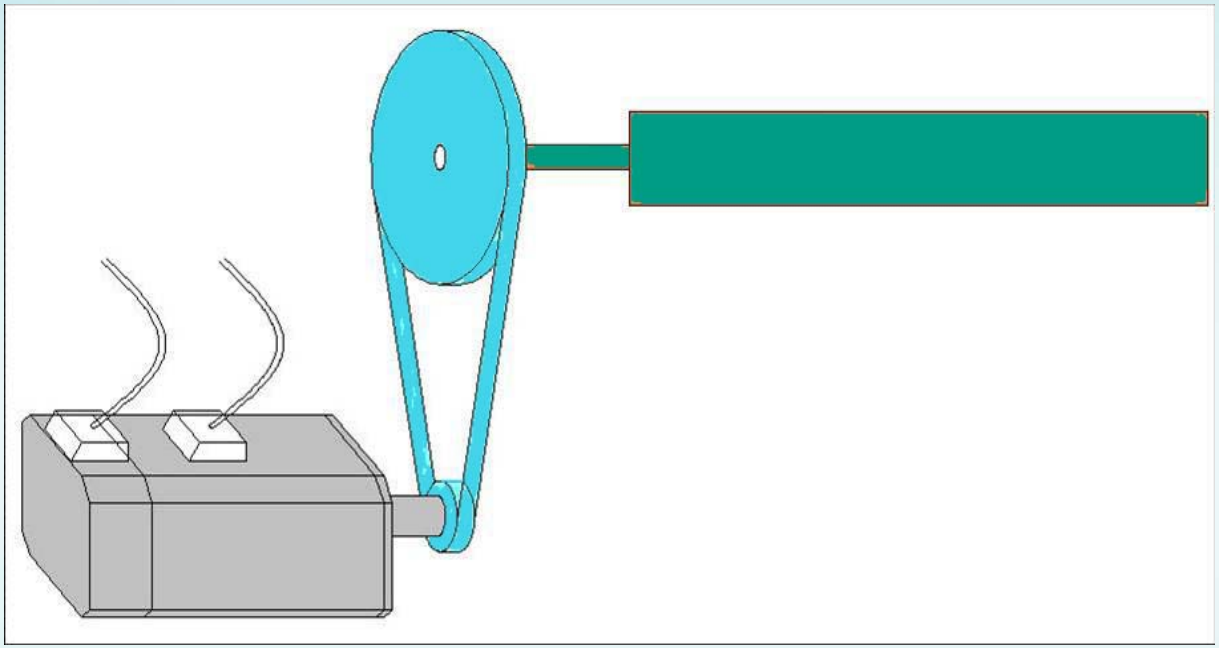
If select EMJ-08(750w), JM = 1.35$kg.cm^2$,

Therefore, 15625 / R^2 < 20*1.35, R^2 > 578, R > 24

Output speed=3000/24=125 rpm, it can match the requirement.

Note: Torque calculation is omitted, for resistance for this kind of driving method is small.

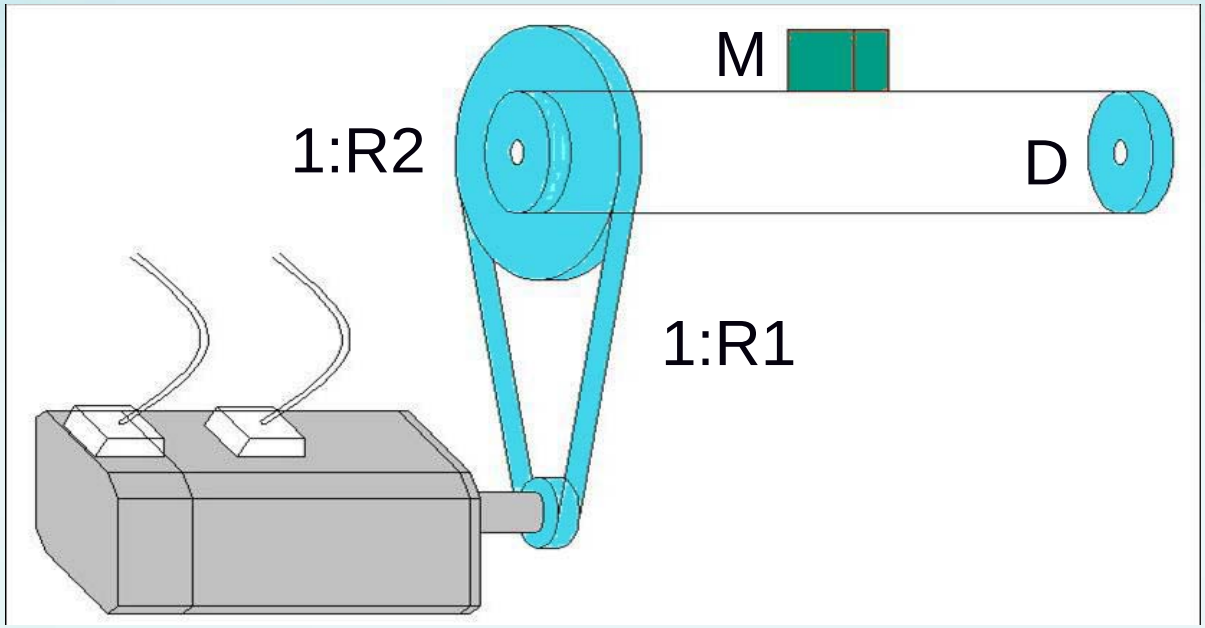
Example II



This kind of driving type is the same as Example I, while selection, it is mainly considering load inertia. Calculation formula is the same as Example I.

Conclusion: Rotation load type is mainly considering inertia calculation.

Example III



- Say: Load mess (M)=50kg, Synchronous belt pulley diameter (D)=120mm, gearbox Geared-down ratio R1=10,R2=2, Friction factor between load and table (μ)=0.6, Load tope movement speed = 30m/min, Acceleration time for load from static to top speed =200ms, neglect all the weight of belt pulley.
- What is the suitable motor?

Example III

➢Calculate load inertia on motor shaft

JL = M * D^2 / 4 / $R1^2$ = 50 * 144 / 4 / 100 = 18 kg.cm2

According to principle: load inertia < 20 times motor rotor inertia JM

JM > 0.9 kg.cm2

➢Calculate the torque for motor to drive the load

Torque for overcoming friction (Tf） = M * g * μ * (D / 2) / R2 / R1

= 50 * 9.8 * 0.6 * 0.06 / 2 / 10

= 0.882 N.m

Torque for acceleration (Ta) = M * a * (D / 2) / R2 / R1

= 50 * (30 / 60 / 0.2) * 0.06 / 2 / 10

= 0.375 N.m

Servo motor rated torque > Tf , Maximum torque > Tf + Ta

Example III

➢Calculate motor rotation speed

$N = v / (\pi D) * R1$

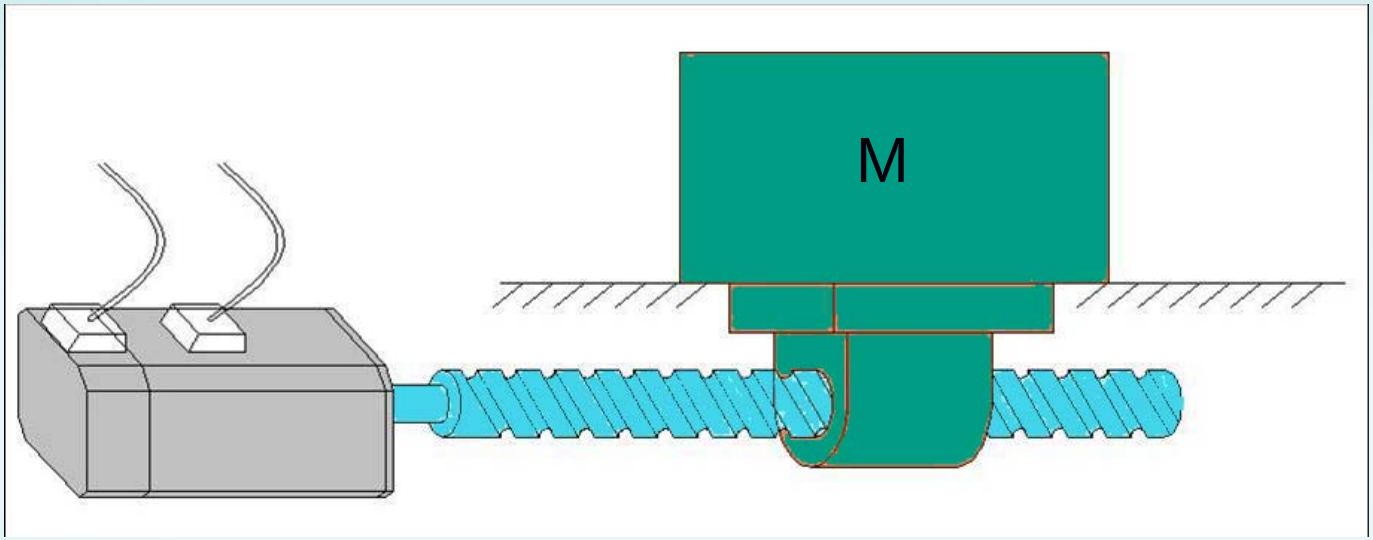
$= 30 / (3.14 * 0.12) * 10$

$= 796$ rpm

➢Choose suitable motor

Choose EMJ-08

Example IV



Say: Load mess (M)=200kg, Ball screw pitch (PB)=20mm, Ball screw diameter (DB)=50mm, Ball Screw mess (MB)=40kg, friction factor (μ)=0.2, Mechanical efficiency (η)=0.9, Load moving speed (V)=30m/min, Full-distance moving time (t)=1.4s, Acceleration time (t1=t3)=0.2s, Static time(t4) =0.3s. Please select suitable servo motor.

Example IV

➢**Calculate load inertia on motor shaft**

Load inertia on motor shaft

$$JW = M * (PB / 2\pi)^2$$
$$= 200 * (2 / 6.28)^2$$
$$= 20.29\ kg.cm^2$$

Ball screw rotation inertia

$$JB = MB * DB^2 / 8$$
$$= 40 * 25 / 8$$
$$= 125\ kg.cm^2$$

Total load inertia

$$JL = JW + JB = 145.29\ kg.cm^2$$

➢**Calculate motor speed**

$$N = V / PB$$
$$= 30 / 0.02$$
$$= 1500\ rpm$$

Example IV

➢**Calculate torque for motor to drive the load**

Torque to overcome friction

$$Tf = M * g * \mu * PB / 2\pi / \eta$$
$$= 200 * 9.8 * 0.2 * 0.02 / 2\pi / 0.9$$
$$= 1.387 \text{ N.m}$$

Torque for work piece acceleration

$$TA1 = M * a * PB / 2\pi / \eta$$
$$= 200 * (30 / 60 / 0.2) * 0.02 / 2\pi / 0.9$$
$$= 1.769 \text{ N.m}$$

Torque for ball screw acceleration

$$TA2 = JB * \alpha / \eta = JB * (N * 2\pi / 60 / t1) / \eta$$
$$= 0.0125 * (1500 * 6.28 / 60 / 0.2) / 0.9$$
$$= 10.903 \text{ N.m}$$

Total torque for acceleration $TA = TA1 + TA2 = 12.672$ N.m

Example IV

- Calculate torque for motor to drive the load

Calculate instantaneous peak torque:

Acceleration torque Ta = TA + Tf = 14.059 N.m

Uniform torque Tb = Tf = 1.387 N.m

Deceleration torque Tc = TA – Tf = 11.285 N.m

Actual torque

$$Trms = sqrt[(Ta^2*t1 + Tb^2*t2 + Tc^2*t3) / (t1+t2+t3)]$$

$$= sqrt[(14.059^2*0.2 + 1.387^2*1 + 11.285^2*0.2)/(0.2+1+0.2)]$$

$$= sqrt[(39.531+1.924+25.47)/1.4]$$

$$= 6.914 \text{ N.m}$$

Example IV

➢**Select suitable servo motor**

Servo motor rated torque　　T > Tf　and　T > Trms

Servo motor maximum torque　　Tmax > Tf + TA

Therefore, choose EMG-15.

Drive comparison form

Function / Series	Control	RS232	RS485	Canopen	Erthercat	Profibus	Encoder
EDC Series	Position control	√	×	√	×	×	2500P/R
EDB series	Position control	√	√	×	×	×	2500P/R
EDB series ‘M’ type	Position, torque and speed control	√	√	×	×	×	2500P/R
ProNet series	Position, torque and speed control	×	√	√	√	√	17 bits 131072P/R

Motor and drive match form							EDC/EDB series Servo Drives		ProNet series Servo Drives	
Motor		Capacity	Flange size (mm)	Rated torque (NM)	Rated/top speed (r/min)	Model	Single phase 200VAC	Three phase 200VAC	Three-phase 200VAC	Three-phase 400VAC
	EMJ Series	200w	60	0.64	3000/4500	EMJ-02APA	EDC-02A			
		400w	60	1.27	3000/4500	EMJ-04APA	EDC-04A			
		750w	80	2.39	3000/4500	EMJ-08APA	EDC-08A EDB-08A	EDB-08A		
		1000W	80	3.18	3000/4500	EMJ-10APA	EDB-10A	EDB-10A		
	EMG Series	1.0kW	130	4.78	2000/3000	EMG-10A□A	EDB-10A PRONET-10	EDB-10A	PRONET-10	
		1.5kW	130	7.16	2000/3000	EMG-15A□A	EDB-15A PRONET-15A	EDB-15A	PRONET-15A	
		2.0kW	130	9.55	2000/3000	EMG-20A□A		EDB-20A	PRONET-20A	
		3.0kW	180	14.3	2000/3000	EMG-30A□A		EDB-30A	PRONET-30A	
		5.0kW	180	23.9	2000/3000	EMG-50A□A		EDB-50A	PRONET-50A	
	EML Series	1.0kW	130	9.55	1000/1500	EML-10A□A		EDB-10A	PRONET-10A	
		2.0kW	180	19.1	1000/1500	EML-20A□A		EDB-20A	PRONET-20A	
		3.0kW	180	28.7	1000/1500	EML-30A□A		EDB-30A	PRONET-30A	
		4.0kW	180	38.2	1000/1500	EML-40A□A		EDB-50A	PRONET-50A	
	EMB Series	7.5kW	220	47.80	1500/2000	EMB-75D□A				PRONET-75D
		11kW	220	70.00	1500/2000	EMB-1AD□A				PRONET-1AD
		15kW	220	95.50	1500/2000	EMB-1ED□A				PRONET-1ED

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