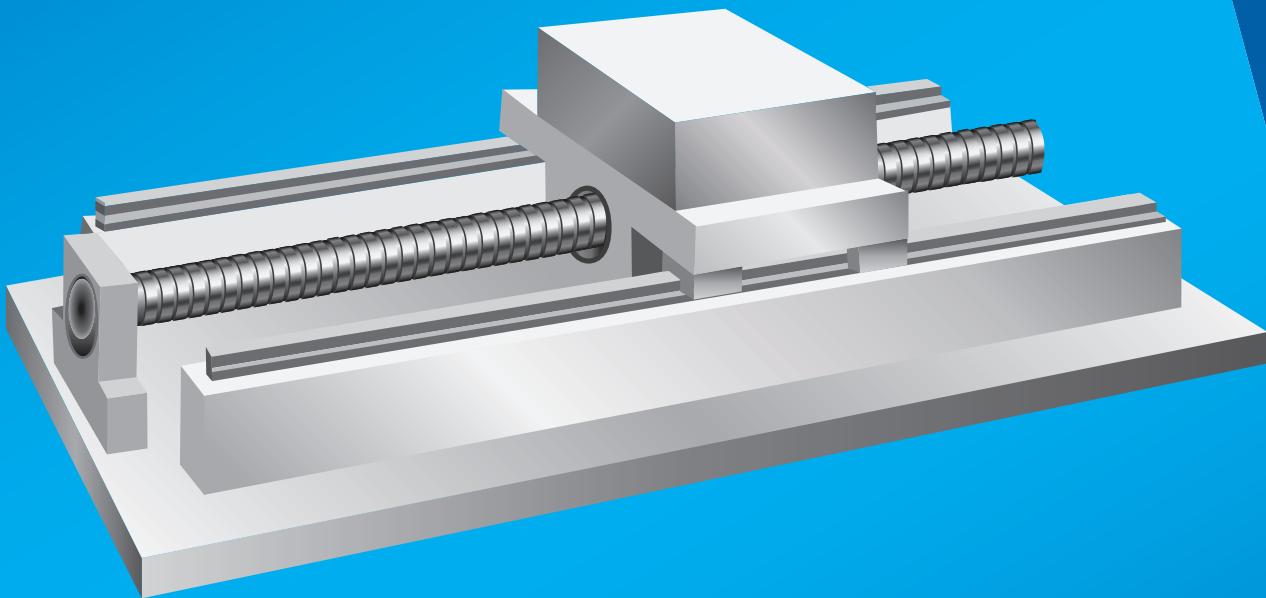


## SigmaSelect™ Sizing Software

Overview of Servo Sizing for a Ballscrew Application



## Overview

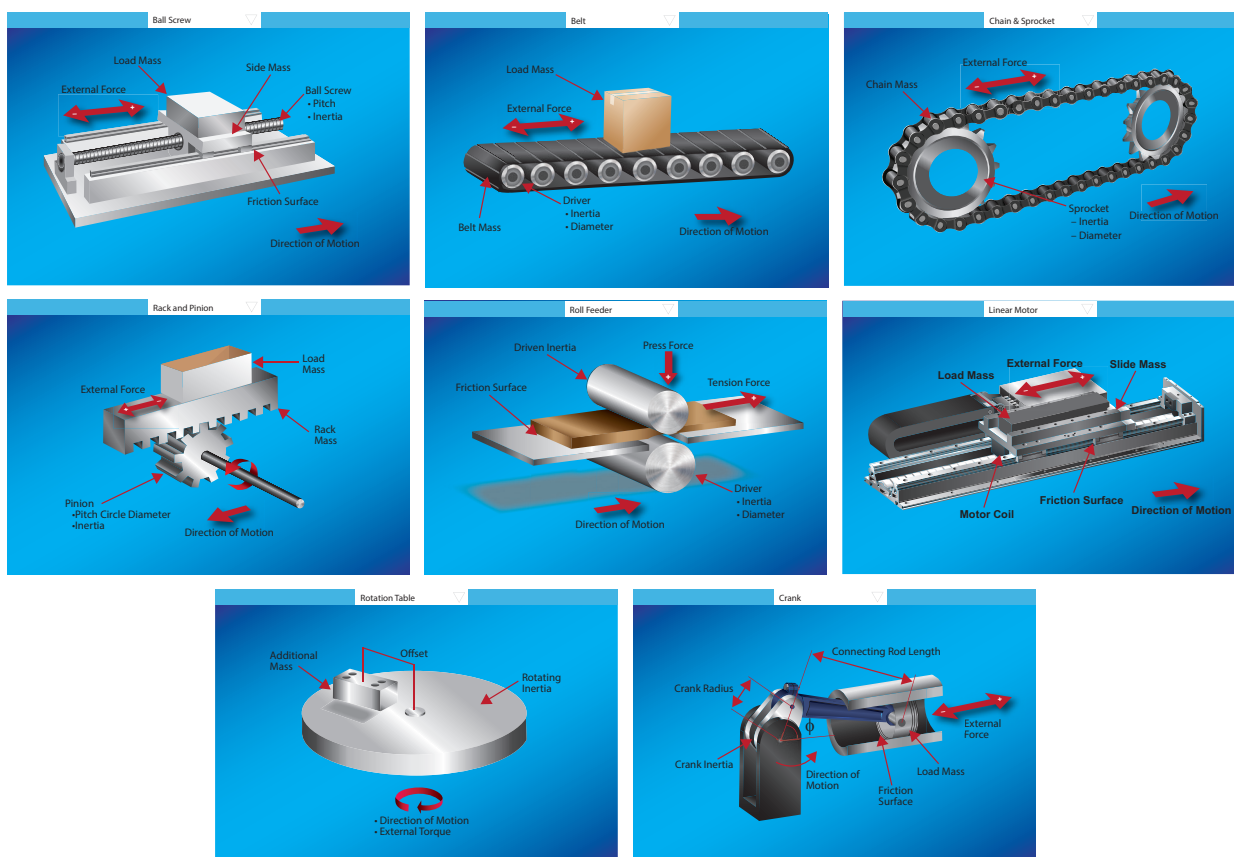
There are lots of servo motors on the market that do various applications. The art of properly selecting a servo motor for a specific task based on speed, torque and inertia has become so automated that users need only enter a small amount of data to select the most appropriate product. This white paper shows how to use Yaskawa's SigmaSelect™ sizing software to properly select a servo system for a common application.



Yaskawa SigmaSelect™ Sizing Software

## Point 1: Mechanical Selection

Most applications can be simplified into a basic mechanism. A typical setup for linear motion is the ballscrew. Using a rotary servo motor that is coupled to the ballscrew by an aluminum coupling, will move a load carriage that slides on linear rails to move a payload back and forth. Let's use this example through the remainder of this article



SigmaSelect™ allows you to size a servo system for various types of applications

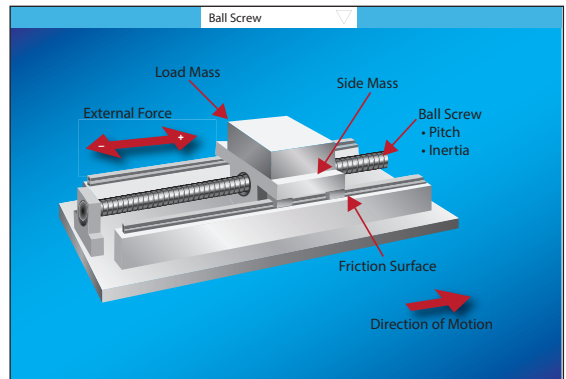
## Point 2: Gathering and Entering Data

Getting information from a customer or potential customer can sometimes be haggling. However, Yaskawa's SigmaSelect software gives the user the ability to visually see and enter data. The software will choose which servo motor is most appropriate for the application given the following parameters:

### 1. Total Load and Slide Mass

This is usually a combined number, but can be made up of various numbers like:

- Load Mass
- Slide Mass



### 3. Lead of the Ballscrew

The number of units (inches, millimeters, etc.) the ballscrew travels in one revolution of the ballscrew

#### Mechanism

Lead (unit/rev)

0.5

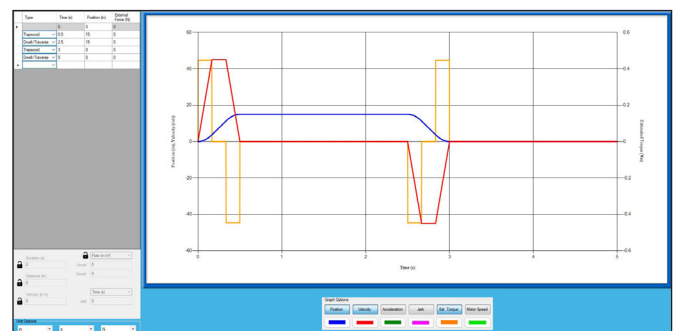
in

### 2. Inertia of the Ballscrew

If this isn't given by the customer or manufacturer, use the Ball Screw Inertia Calculator to determine the inertia of the ballscrew:

### 4. Move Profile

- Enter the distance to move and in the amount of time
- Enter dwells or pauses
- It is good practice to enter a return move



## Point 3: Selecting a Motor

With all the information entered, sometimes a huge list of servo motors will display that can work for the application

Model	<input checked="" type="checkbox"/> Torque FOS (Min - Max)	<input type="checkbox"/> Max Inertia Ratio	<input checked="" type="checkbox"/> Filter by Speed	<input checked="" type="checkbox"/> Display Required Values
All motors	1	100	10	<input checked="" type="checkbox"/> Torque FOS (Min - Max)
Motor Voltage				
200VAC				
Brake				
Oil Seal				
Series				
<input checked="" type="checkbox"/> Sigma-7				
<input checked="" type="checkbox"/> Sigma-5				
<input type="checkbox"/> Direct Drive				
<input type="checkbox"/> Sigma II				
<input type="checkbox"/> Sigma III				
<input type="checkbox"/> Junma				

Part No.	Rated Torque (Nm)	Factor of Safety	Required Rated Torque (Nm)	Peak Torque (Nm)	Factor of Safety	Required Peak Torque (Nm)	Rated Speed (RPM)	% Rated Speed	Required Rated Speed (RPM)	Peak Speed (RPM)	% Peak Speed	Required Peak Speed (RPM)
SGM7J-02D*F	0.637	3.38	0.189	2.23	6.25	0.519	3000	50%	1800	6000	90%	5400
SGM7J-04D*F	1.27	5.88	0.216	4.46	7.5	0.595	3000	50%	1800	6000	90%	5400
SGM7J-08D*F	2.39	5.53	0.366	8.36	8.3	1.01	3000	50%	1800	6000	90%	5400
SGM7J-15D*F	4.77	5.35	0.752	14.3	8.91	2.07	3000	50%	1800	6000	90%	5400
SGM7A-02D*F	0.637	8.67	0.173	2.23	8.67	0.477	3000	50%	1800	6000	90%	5400
SGM7A-04D*F	1.27	5.95	0.183	4.46	8.86	0.503	3000	50%	1800	6000	90%	5400
SGM7A-08D*F	2.39	9.01	0.265	8.36	11.4	0.73	3000	50%	1800	6000	90%	5400
SGM7A-10D*F	3.18	11	0.289	11.1	13.9	0.797	3000	50%	1800	6000	90%	5400
SGM7A-15D*F	4.9	11.5	0.425	14.7	12.6	1.17	3000	50%	1800	6000	90%	5400
SGM7A-20D*F	6.36	12.2	0.483	19.1	14.4	1.33	3000	50%	1800	6000	90%	5400
SGM7A-25D*F	7.96	13.9	0.572	23.9	15.2	1.57	3000	50%	1800	6000	90%	5400
SGM7A-30D*F	9.8	7.65	1.28	29.4	8.33	3.53	3000	50%	1800	6000	90%	5400
SGM7A-40D*F	12.6	7.86	1.6	37.8	8.57	4.41	3000	50%	1800	6000	90%	5400
SGM7A-50D*F	15.8	8.17	1.94	47.6	8.94	5.33	3000	50%	1800	6000	90%	5400
SGM7A-70D*F	22.3	11.5	1.94	54	10.1	5.33	3000	50%	1800	6000	90%	5400
SGMAV-A5A*A	0.159	1.05	0.151	0.477	1.14	0.417	3000	50%	1800	6000	90%	5400
SGMAV-01A*A	0.318	2.08	0.153	0.955	2.26	0.422	3000	50%	1800	6000	90%	5400
SGMAV-C2A*A	0.477	3.08	0.155	1.43	3.35	0.427	3000	50%	1800	6000	90%	5400
SGMAV-02A*A	0.637	3.75	0.17	1.91	3.09	0.467	3000	50%	1800	6000	90%	5400
SGMAV-04A*A	1.27	7.1	0.179	3.82	7.25	0.493	3000	50%	1800	6000	90%	5400
SGMAV-06A*A	1.75	8.94	0.196	5.25	9.75	0.539	3000	50%	1800	6000	90%	5400
SGMAV-08A*A	2.39	9.07	0.263	7.16	9.87	0.725	3000	50%	1800	6000	90%	5400
SGMAV-10A*A	3.18	9.84	0.323	9.55	10.7	0.89	3000	50%	1800	6000	90%	5400
SGMJV-A5A*A	0.159	1.03	0.154	0.557	1.32	0.423	3000	50%	1800	6000	90%	5400
SGMJV-01A*A	0.318	2.03	0.157	1.11	2.57	0.431	3000	50%	1800	6000	90%	5400
SGMJV-02A*A	0.637	3.4	0.187	2.23	3.32	0.516	3000	50%	1800	6000	90%	5400
SGMMV-A1E*A	1.27	6.58	0.21	4.46	8.73	0.678	3000	50%	1800	6000	90%	5400

If cost is an issue, and it usually is, sort the selection by the Cost Factor to find the lowest initial cost servo motor that will do the application. Something else to highlight is the ability to use the Cost Factor in relation to the Factor of Safety by highlighting that for only 10% more on the initial investment, the application could gain an additional 20% of Factor of Safety. Thus, allowing for future 'scope creep', as is often the case.

Part No.	Rated Torque (Nm)	Factor of Safety	Required Rated Torque (Nm)	Peak Torque (Nm)	Factor of Safety	Cost Factor
SGMMV-A1E*A	0.0318	0.215	0.148	0.0955	0.234	1
SGMMV-A2E*A	0.0637	0.429	0.148	0.191	0.468	1.02
SGM7J-A5A*A	0.159	1.04	0.153	0.557	1.32	1.03
SGM7A-A5A*A	0.159	1.05	0.151	0.557	1.34	1.03
SGMMV-A3E*A	0.0955	0.643	0.149	0.286	0.699	1.04
SGM7J-01A*A	0.318	2.03	0.157	1.11	2.57	1.06

Sometimes, selecting a motor with only 6% cost difference can provide over twice the performance.

Next, verify that the inertia ratio is at or below the allowable inertia ratio number. This will be highlighted in green in the allowable inertia ratio column.

Part No.	% of Allowable Inertia Ratio	Application Inertia Ratio	Cost Factor
SGMMV-A1E*A	932%	279	1
SGMMV-A2E*A	630%	189	1.02
SGM7J-A5A*A	68%	23.9	1.03
SGM7A-A5A*A	96%	38.3	1.03
SGMMV-A3E*A	472%	141	1.04
SGM7J-01A*A	44%	15.4	1.06
SGM7A-01A*A	68%	27.3	1.06

In this case, the application load inertia ratio divided by the servo motor's motor inertia is 44%, which is great for the application.

Third, verify the speed and torque of the application is at or under the motor's characteristics. There are different series of servo motor for different applications.

Part No.	Rated Torque (Nm)	Factor of Safety	Peak Torque (Nm)	Factor of Safety	Rated Speed (RPM)	% Rated Speed	Peak Speed (RPM)	% Peak Speed
SGMMV-A1E*A	0.0318	0.215	0.0955	0.234	3000	60%	6000	90%
SGMMV-A2E*A	0.0637	0.429	0.191	0.468	3000	60%	6000	90%
SGM7J-A5A*A	0.159	1.04	0.557	1.32	3000	60%	6000	90%
SGM7A-A5A*A	0.159	1.05	0.557	1.34	3000	60%	6000	90%
SGMMV-A3E*A	0.0955	0.643	0.286	0.699	3000	60%	6000	90%
SGM7J-01A*A	0.318	2.03	1.11	2.57	3000	60%	6000	90%
SGM7A-01A*A	0.318	2.08	1.11	2.64	3000	60%	6000	90%

Required speed and torque are less than the ratings of the selected motor.

If the application requires more speed, but not a lot of torque, use the SGM7J or SGM7A series. Conversely, if the application requires more torque and not a lot of speed, use the SGM7G series. Some applications can have dimensional constraints and in that case, use the SGM7P series. For a full list of servo motors, please see [www.yaskawa.com/Sigma-7/servomotors](http://www.yaskawa.com/Sigma-7/servomotors)



## Point 4: Ease of Use

Let's say the motor chosen is an expensive servo motor. Remember the sizing was done as a servo motor directly coupled to the ballscrew. What if the application could use a 5 to 1 gearbox? No worries, as the software is flexible by allowing the user to reenter data within the Load Editor Tab. Enter the following for the gearbox characteristics:

### Ratio

- Input to Output: For 5 to 1 gear ratio, enter 5

### Inertia

- Example can be in the units in lb-sec<sup>2</sup>, kg-m<sup>2</sup>, etc

### Efficiency

- Typically between 95% to 97%

**Transmission**

Gear Ratio: 5

Reflected Inertia of Transmission: 0 kg·m<sup>2</sup>

Additional Torque: 0 N·m

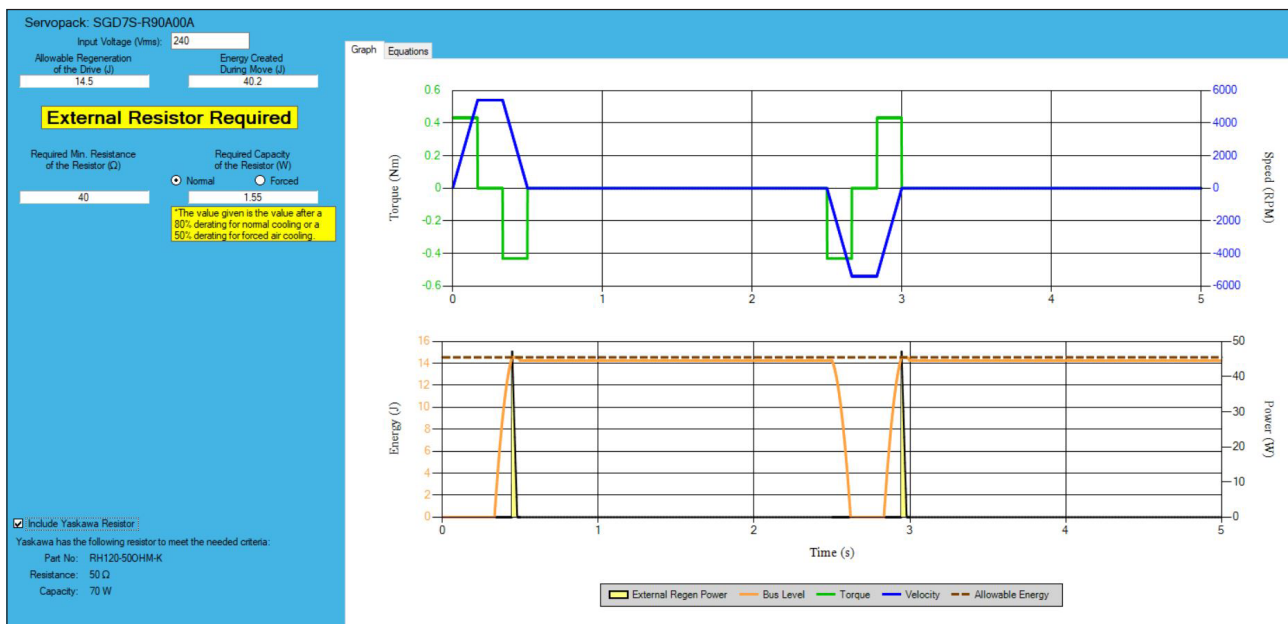
Efficiency: 0.95

Then, go back to the motor selection to choose a different servo motor, often a smaller servo motor since the gearbox:

- Multiplies the torque by the ratio number
- Reduces the inertia by the square of the ratio number
- Fits within the constraints of speed

## Point 5: Regeneration

Yaskawa's SigmaSelect software will indicate if a regenerative resistor is required and what capacity should be selected.

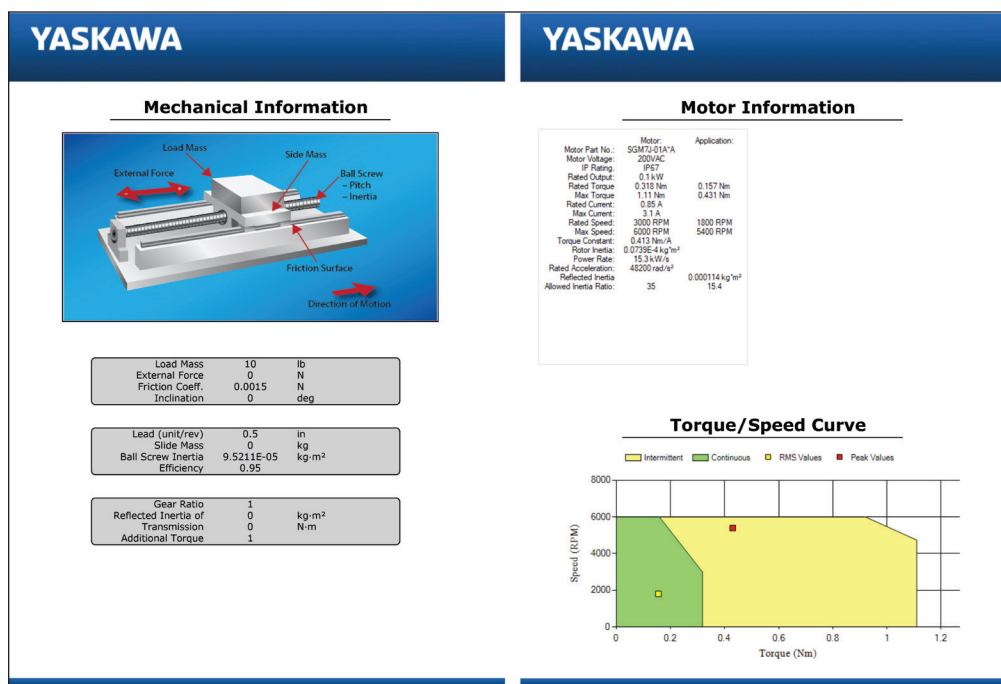


## Point 6: SERVOPACK Selection

Select the power input and type of SERVOPACK for the application. Analog/Pulse, EtherCAT or Mechatrolink-III.

## Point 7: Reports

Creating a report in Yaskawa's SigmaSelect software is a very nice feature that highlights the software's capabilities. Use the PDF Icon to generate a 6 page report to share with clients so all data can be verified.



## Wrapping it Up

Choosing a servo motor for an application doesn't have to be tedious or a myth. In fact, using Yaskawa's SigmaSelect software, it is as easy as entering in some data, selecting a servo motor for the application and sharing this information with a customer.