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Exercises with the maxon Selection Program

http://www.maxongroup.com/maxon/view/msp

Purposes and Goals

The participants…
- learn how to use the main parts of the maxon selection program.
- select motor-gearhead combinations for continuous and cyclic operation.
- select complete drive solutions for a positioning application.

Part 1: SEARCH - Easy drive specification with only a few parameters

The simple SEARCH functionality offers a fast way to find motor gearhead combinations for a fixed operation point. All you need to specify is a speed, a torque and a supply voltage. Additionally, you can limit the maximum diameter and opt for a sensor (encoder or tacho).

Exercise 1: Selection for continuous operation

Goal: Learn how the MSP works.
- Using the simple SEARCH function.
- Selecting solutions in the result list.
- Watching details of a specific solution.

Scanning device application

For a medical scanning device, the motor gearhead combination typically must run at 200 rpm at a torque of 150 mNm. The maximum power supply voltage is 18 VDC.
There is a restriction on the diameter of 24 mm and for speed control the motor needs to have an encoder.

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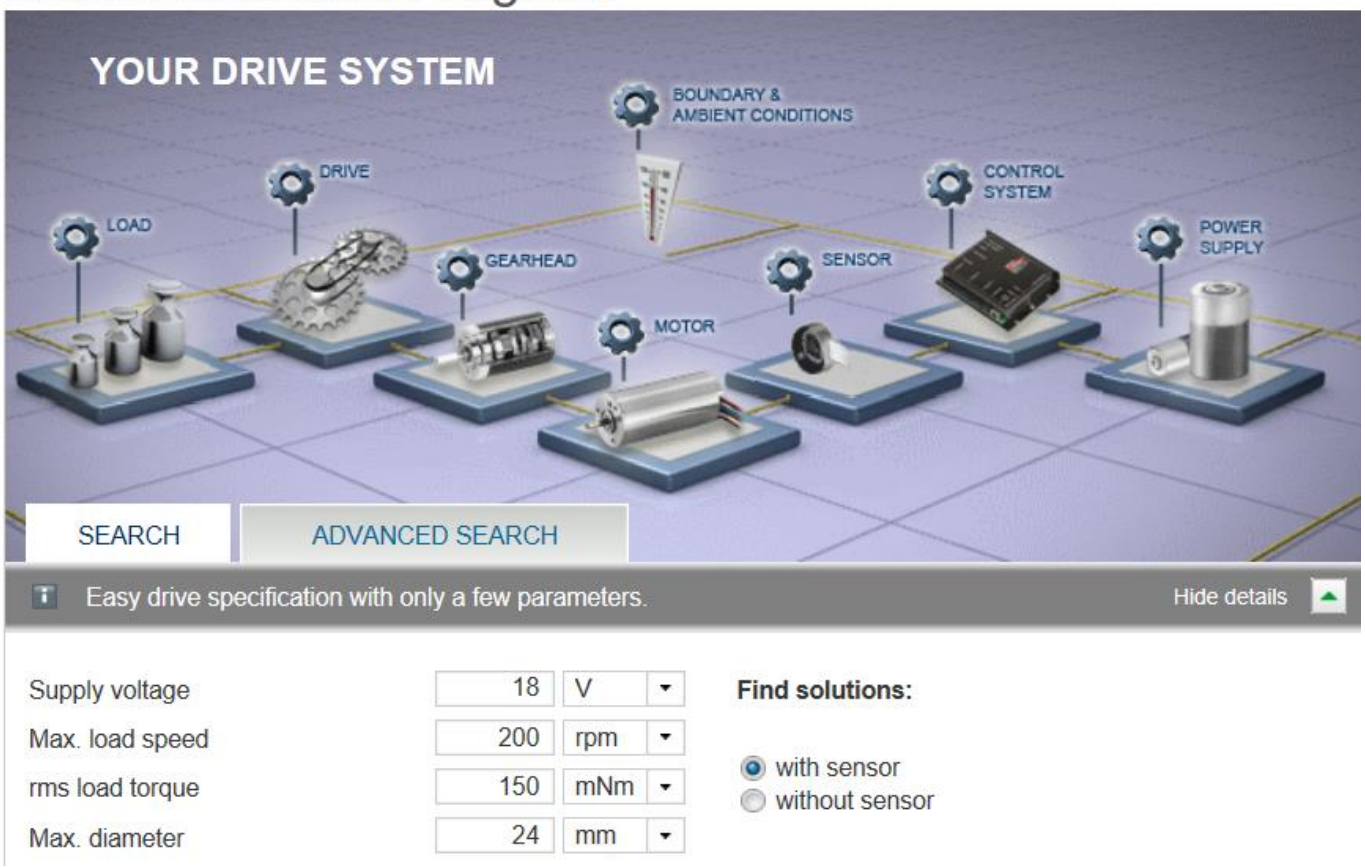
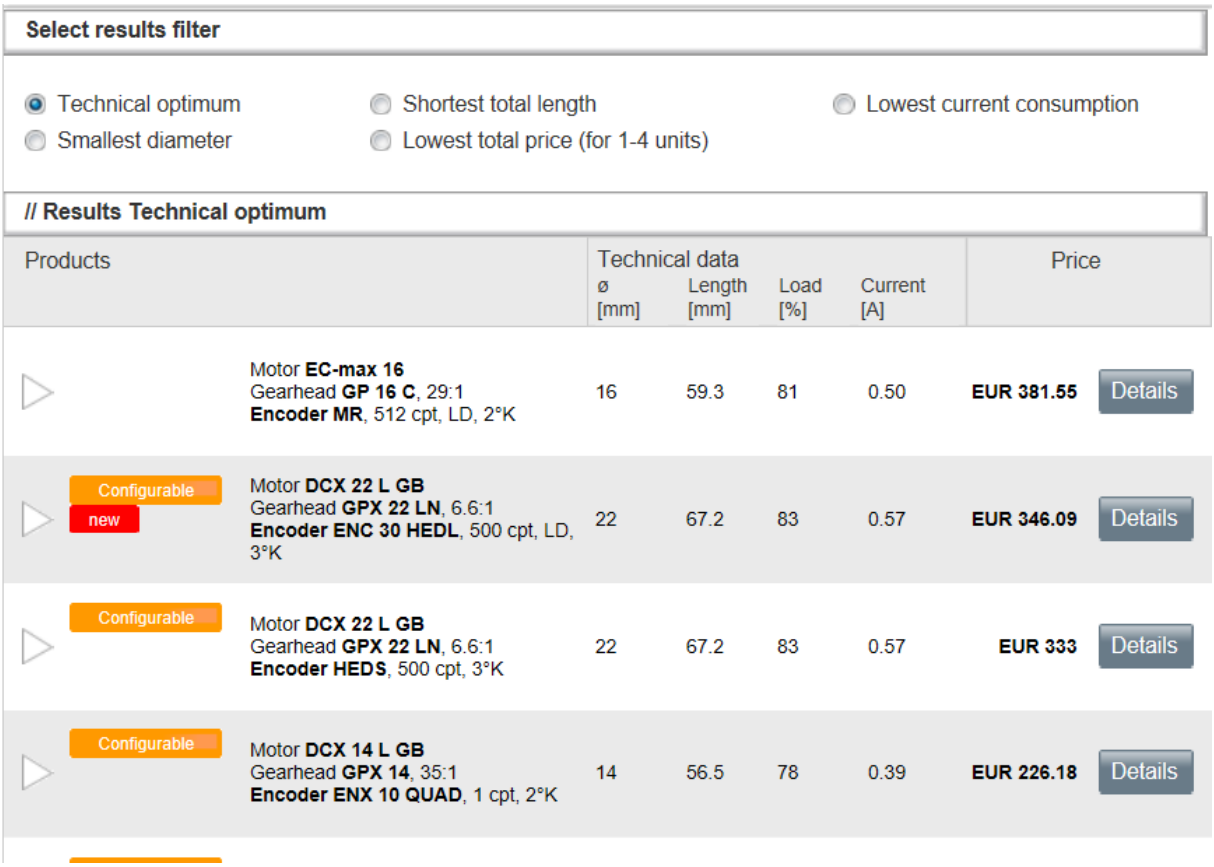
1. Select the SEARCH tab.
   Enter the parameters according to the application requirements. Since an encoder is needed, don't forget to select *with sensor*.

Maxon Selection Program

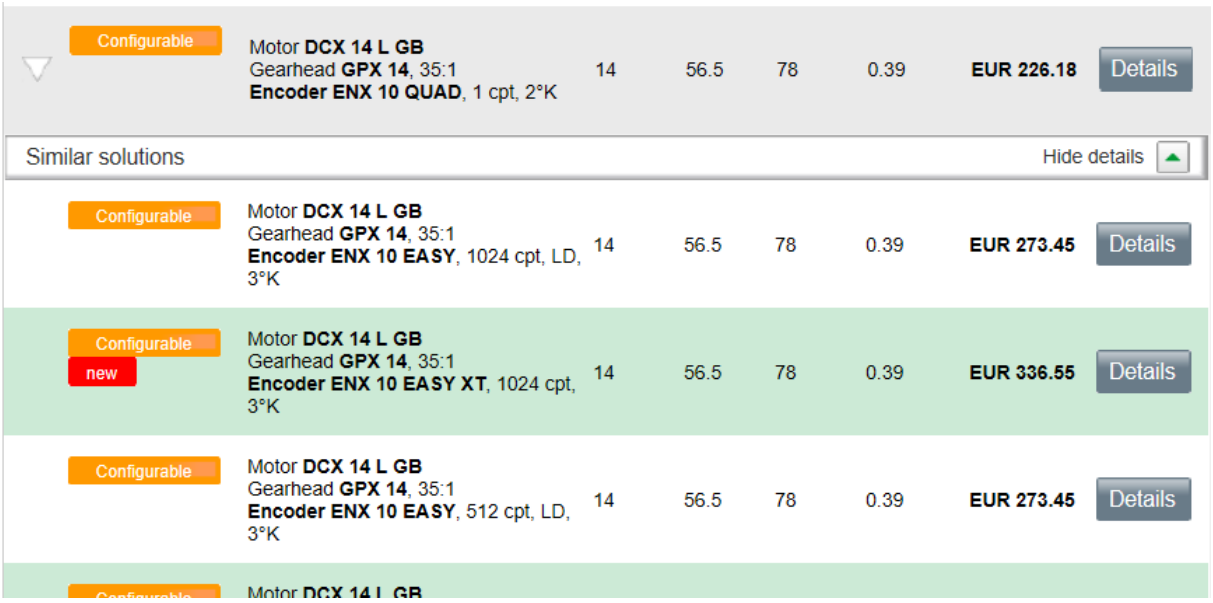


Hint: The parameter inputs work as unit converters. A parameter value will be converted if the unit is changed. Therefore, for entering a specific value with a given unit select the unit first, and then enter the parameter value.

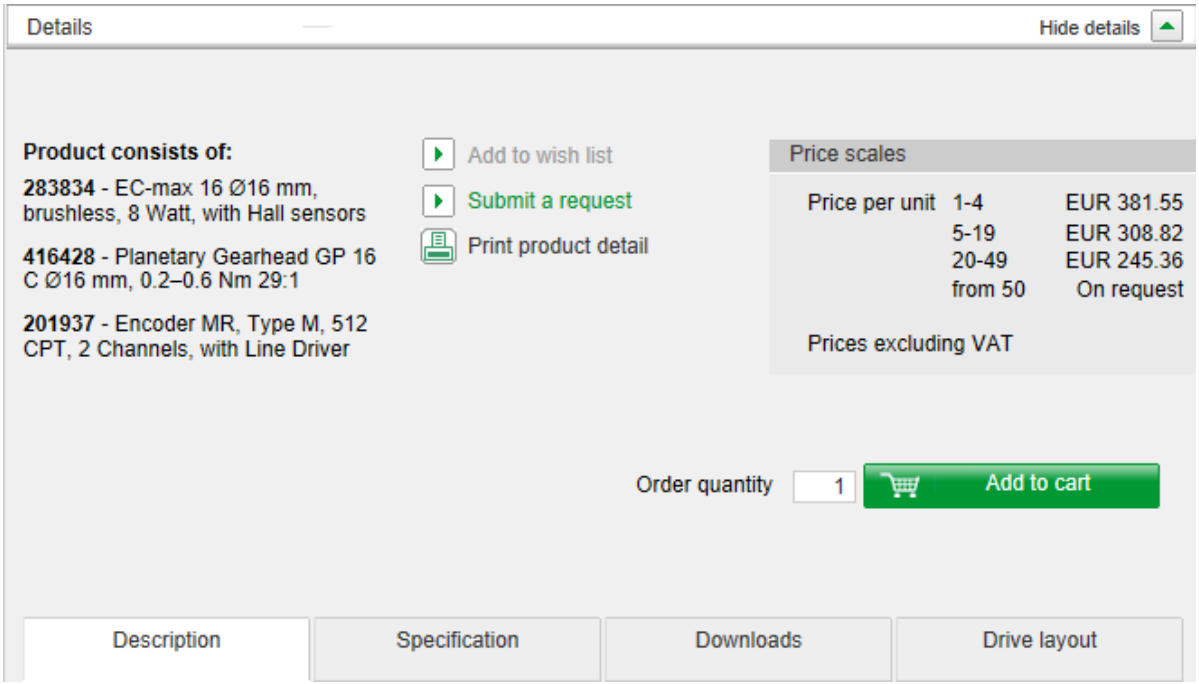
2. Result list.
   Click on the *Show results* button on the lower right.
   You will get a list of 10 propositions, each of them shortly described by the components it contains: Motor type, gearhead type and sensor type.
   The default sorting of the list is according to the *Technical optimum*, i.e. solutions are preferred that make good use of the available voltage and torque (but still with some reserve power) and encoder with 500 counts per turn. It is instructive to set other priorities to your solution, such as smallest diameter, shortest length or lowest price. Setting other filters can be helpful in exploring all kind of other solutions. It's always the 10 best in class that are shown.



3. Similar solutions
   Often, there are very similar solutions (e.g. made of the same motor type and gearhead type). In such cases only the best one is shown. You can make the alternative solutions visible by clicking on the triangle/arrow on the left. Typically, the *Similar solutions* contain units with different motor windings, different gearhead reductions, different current uptake or encoder counts.



4. *Details* button.
   Select a solution and explore what's behind the *Details* button.
   - Use the button *Print product detail*.
   - Compare to the tab *Specification* (at the bottom).
   - Look at the *Operating Range Diagram* of the combination in the corresponding tab.
   - Explore the tab *Downloads*.



Hint: The green "*Add to cart"* button allows entering directly the shop area of the maxon website**.**

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Part 2: ADVANCED SEARCH - Drive specification with high precision.

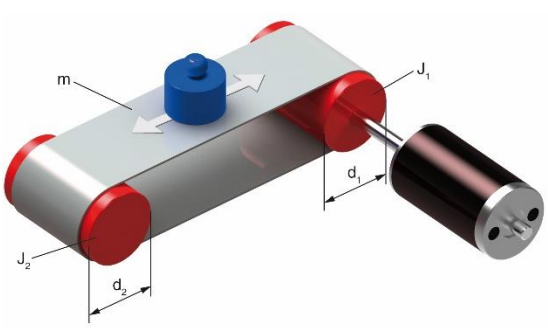
The ADVANCED SEARCH functionality allows to precisely specify your application. You can define a mechanical transmission and enter the load speed and torque requirements in a more sophisticated matter. In addition, the required control mode and accuracy can be stated.
At the same time, you can set filters on the product types you would like to have included in the search.

Exercise 2: Selection for continuous operation

Goal: Learn how the ADVANCED SEARCH works

- Defining a mechanical transmission.
- Entering a continuous load.
- Selecting speed control with encoder

Conveyor belt application



A motor gearhead combination is needed for a conveyor belt application running with a power supply of 24 VDC and 5 A.
In a first approximation the conveyor belt is assumed to run continuously at a maximum speed of 0.5 m/s.
The friction of the empty belt is 40 N. Additional friction due to the load (max. 3 kg) amounts to 9 N. Hence, we have a total load of 49 N.
The belt is speed controlled, but the accuracy of speed control need not be very high.
The required life is quite high (several 10'000 hours), thus a brushless motor should be used.

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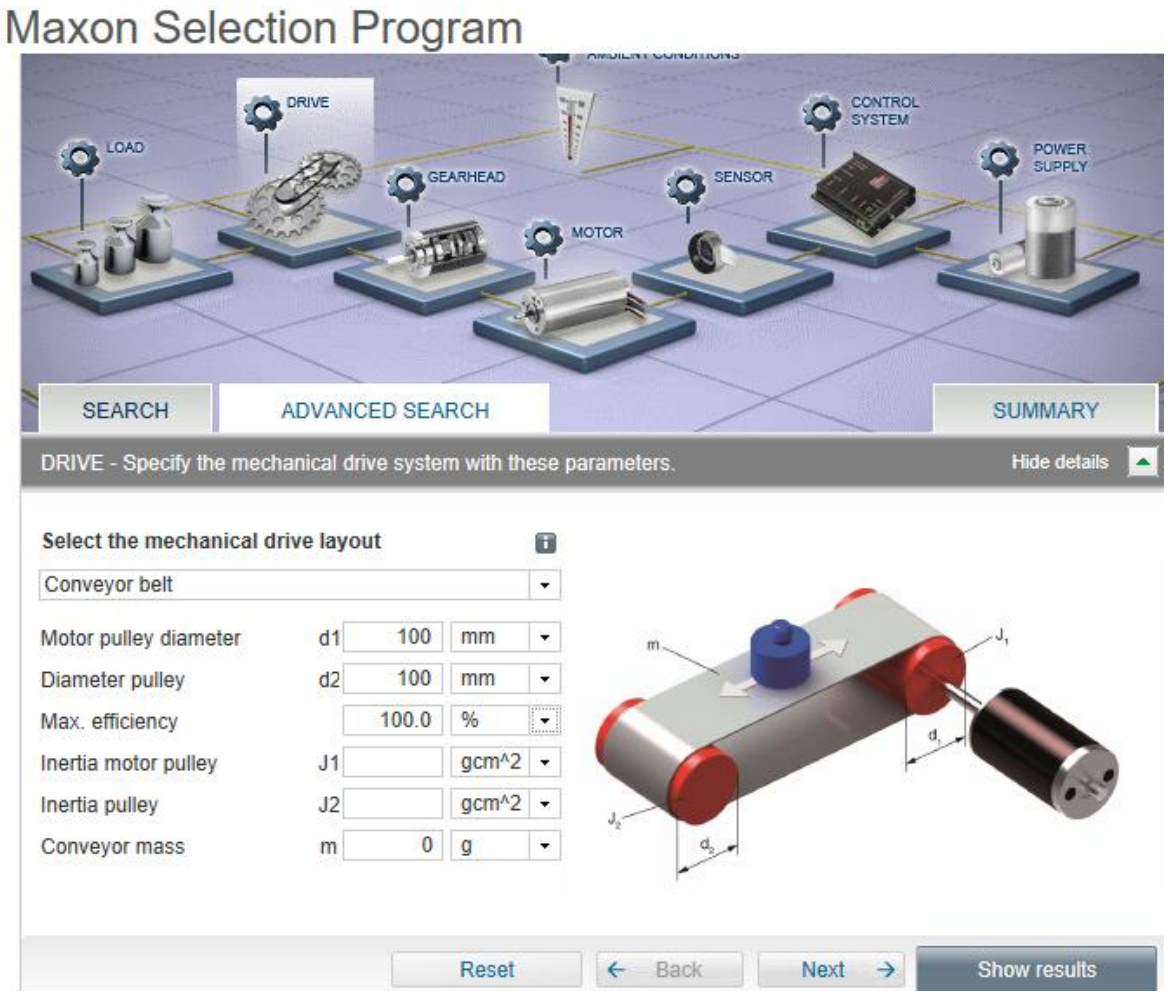
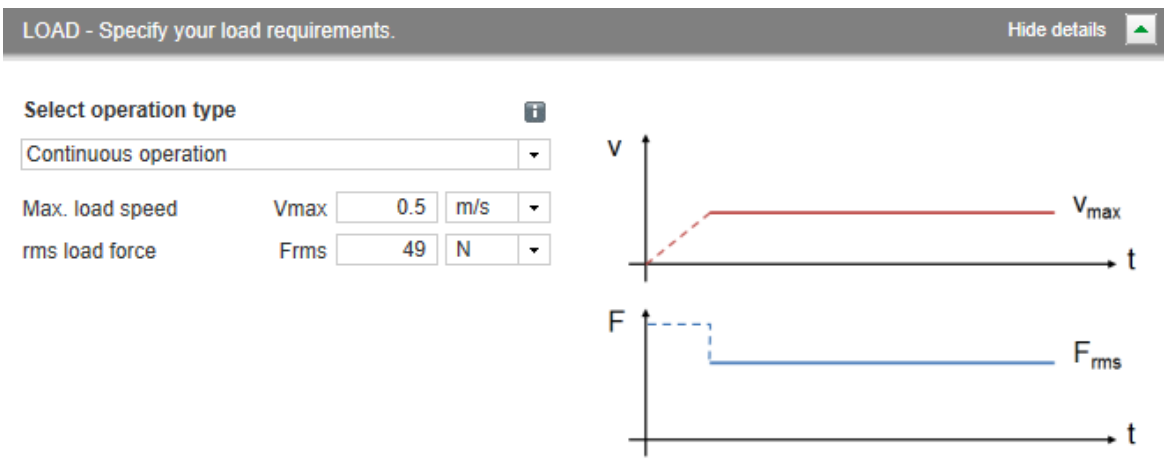
1. Select the ADVANCED SEARCH tab
   The MSP will guide you through the different inputs and filters (buttons *Next* and *Back* at the bottom). We recommend that you use this input sequence.
   Option: For direct access to the different settings in the drive specification, you can always click on the symbols in the drive system layout diagram at the top. The corresponding component is highlighted in the diagram.

2. Mechanical transmission
   The definition of the application requirements starts with the mechanical drive. From the drop-down menu select *Conveyor belt* as the mechanical transmission.
   For simplicity reasons we consider just the continuous operation and ignore the starting process. Therefore, we just need to enter the diameter of the pulleys and can neglect all the mass inertias.
   Let's assume that the driving pulley has a diameter of 10 cm.
   Knowing the friction explicitly, we can add it to the load thrust force and can set efficiency to 100%.



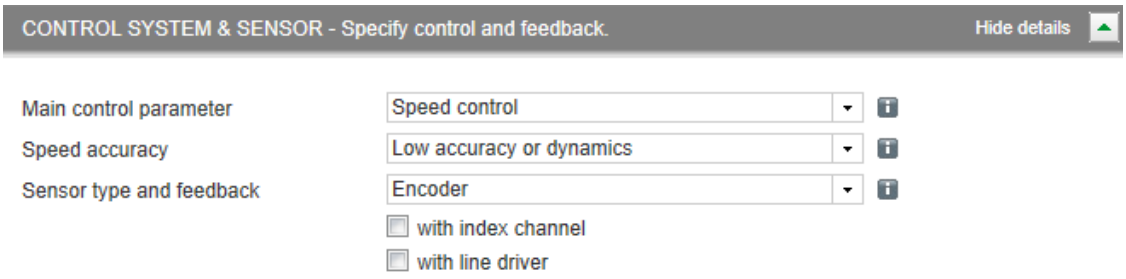
3. Load definition
   Click on the Next button. The load specification window opens.
   For continuous operation the inputs are straight forward. Enter the required load velocity and the load force (for our example 0.5 m/s and 49 N). (More sophisticated load situations will be treated in a later exercise).



4. Gearhead and motor filter
   Click on the *Next* button. Specify whether the solution can or should contain a maxon gearhead or not.
   For our application we don't put any limits and leave the selection on *with or without gearhead*.
   Click on the *Next* button. Specify whether the solution should contain a brushed maxon DC motor or a brushless maxon EC motor. Since we need a high operating life we select *with brushless motor (= maxon EC)*.

5. Boundary conditions
   Click on the *Next* button. There is no boundary and ambient conditions to be specified in our case. So, just click on the *Next* button again.

6. Control system
   Select Speed control as the Main control parameter, since the conveyer should run at constant speed. There is only a low speed accuracy and dynamics required, and we would like to use the encoder as a speed feedback device.



7. Power supply
   Click on the *Next* button. The available power supply just gives the 24 VDC and 5 A electrical power that are the default values in the MSP. So, there is nothing to change.

8. Result list
   Click on the *Show results* button on the lower right.
   The suggested drive solutions contain now the controller as well. Analyze the solutions and check the details as before in exercise 1.
   Observe how the result list reacts if one of the inputs is changed: e.g. brushed motors instead of brushless motors, or high accuracy speed control.

   Remark: The *Similar Solutions* list contains now mainly alternative controllers and feedback sensors matching the required control. Motor and gearhead alternatives are not shown anymore.

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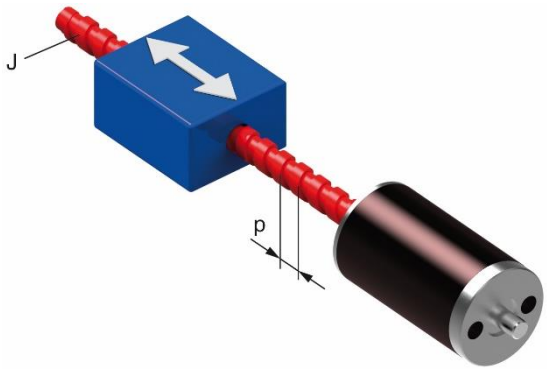
Exercise 3: Selection for working cycles with positioning

Goal: Learn how *Cyclic or intermittent operation* works.

- Defining a mechanical transmission by lead screw.
- Entering a load cycle.
- Selecting position control with encoder.

Positioning with lead screw



A high precision lead screw with 2mm lead per revolution is used to position back and forth a device in a production plant with short dwell times in between the moves.
The rms average of the force needed (including dwell) is 23 N. The peak force is 44 N acting during 0.3 s acceleration.
The maximum velocity is 100 mm/s.
There is a power supply of 48 VDC available that can deliver 1 A permanently and up to 2 A for about 1s.
For life time reasons a brushless motor is required with a position controller. There is no gearhead (backlash!) allowed in order to achieve the position accuracy (repeatability) of 0.01 mm.

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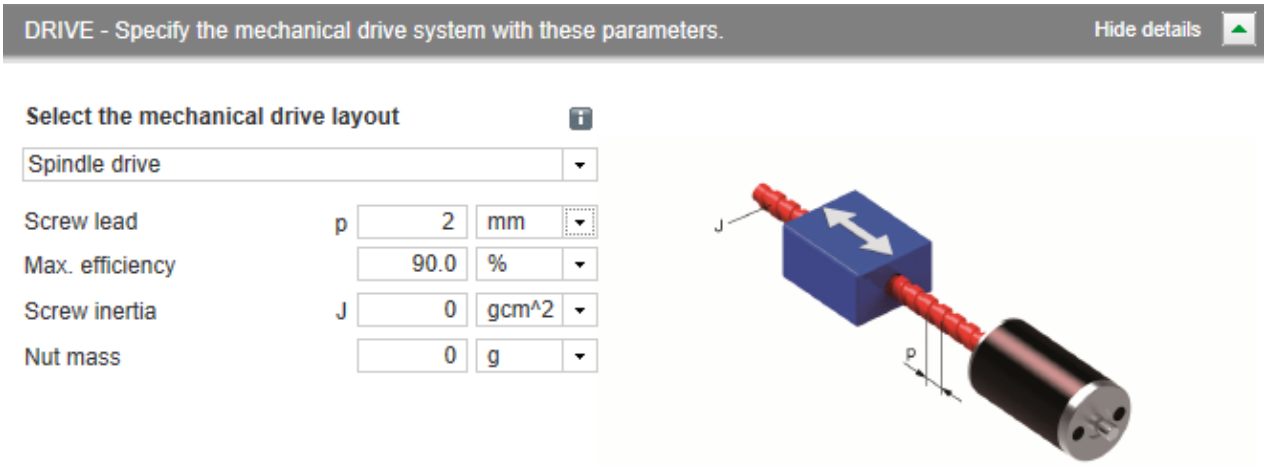
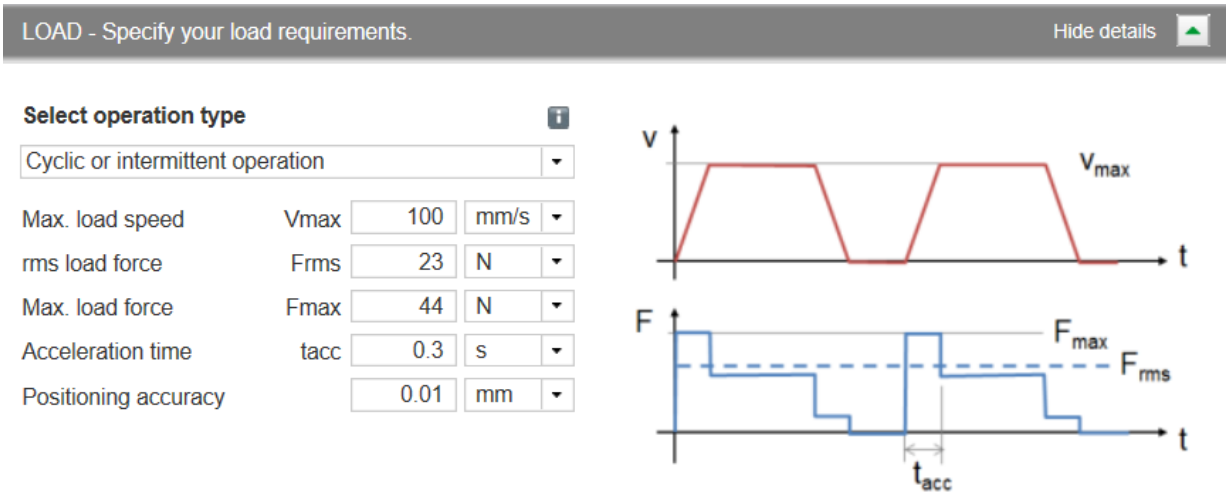
1. Select the ADVANCED SEARCH tab. Press the Reset button at the bottom.

2. Mechanical transmission
   From the dropdown menu select *Spindle drive* as the mechanical transmission.
   Define the lead to be 2 mm and enter the efficiency. Ball screws typically have an efficiency around 90% or higher.
   For a first selection we neglect all the mass inertias of the screw and the nut.
   Click on the *Next* button.



3. Load definition
   From the dropdown menu select Cyclic and intermittent operation. Then fill in the input fields according to the requirements of the application.

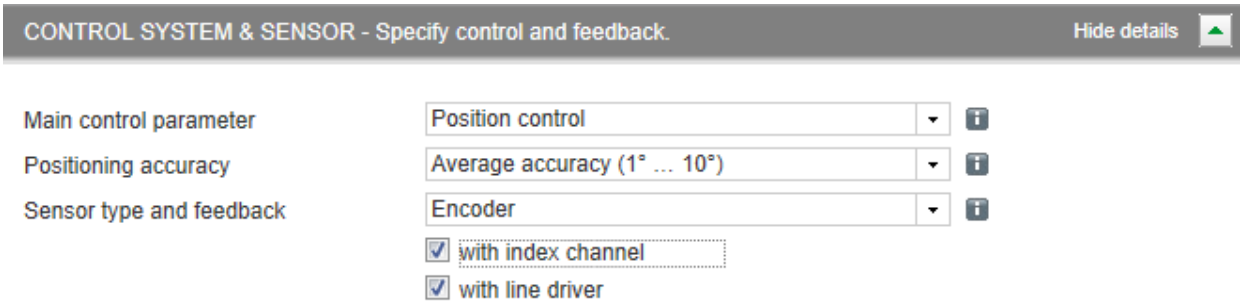


   Click on the *Next* button.

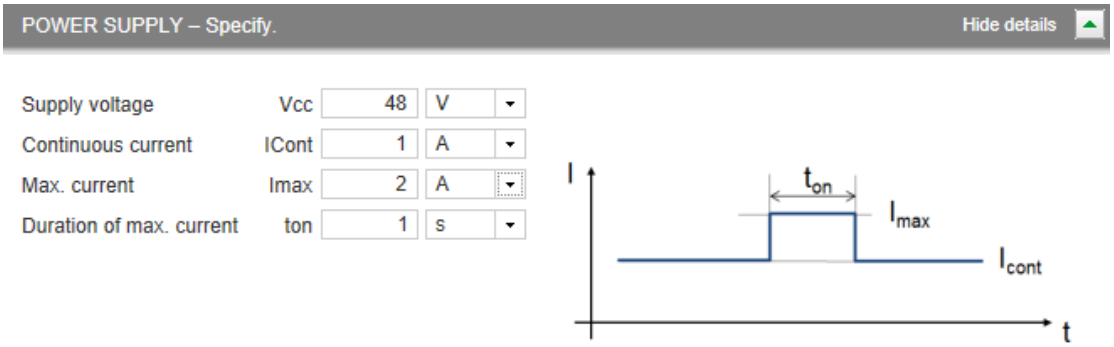
4. Gearhead and motor filter
   Specify now that you are only interested in solutions without gearheads and motors without brushes.
   Click on the *Next* button.

5. Boundary conditions
   There is no boundary and ambient conditions to be specified in our case. So, just click on the *Next* button again.

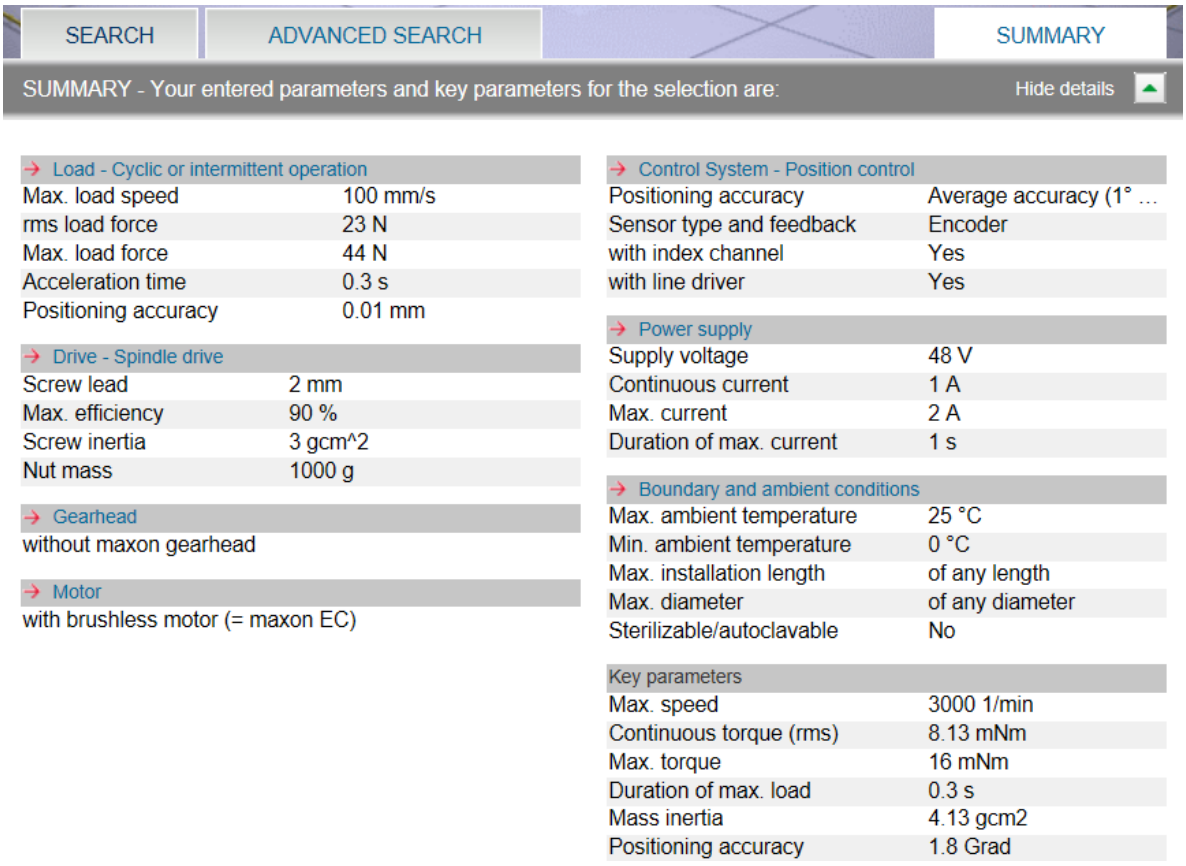
6. Control system
   Select Position control as the control parameter.
   The accuracy required is about 0.01mm/2mm = 1/200 motor turn (or 1.8°). Hence, we need a position sensor (encoder) that has at least 200 counts per turn. This is still average accuracy. The encoder should exhibit a Line Driver for reliable position signals and an Index channel to get a precise position reference.



7. Power supply
   Click the Next button. Adjust the parameters according to the power supply capabilities at hand.



8. Summary
   Click on the SUMMARY tab on the right and check your inputs. In the *Key parameters* section, you can find the requirements for the drive to be selected.
   Look at the torque values and the moment of inertia. Now, click on the DRIVE symbol in the diagram and change the mass inertia of the screw to 3 gcm^2 and the nut mass to 1000 g (here including load mass). Observe in the SUMMARY tab how the torque and inertia values have changed.



9. Result list
   Click on the *Show results* button on the lower right.
   The suggested drive solutions contain now position controller. Analyze the solutions and check the details as before in exercise 1 and 2.

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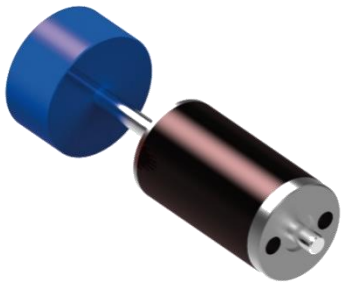
Exercise 4: Selection for Short-term operation

Goal: Learn how Short-term operation works.

- Defining a direct drive
- Entering a “once in a while” load
- Selecting speed control with encoder

Flywheel acceleration



A flywheel needs to be accelerated in 7 s to a speed of 17’000 rpm. This requires a torque of about 60 mNm. The available voltage is 24V.
Space is limited: The maximum diameter is 1 inch and the length should not be as short as possible (max. 2 inches).
Drive components needed: Motor with feedback and speed controller.

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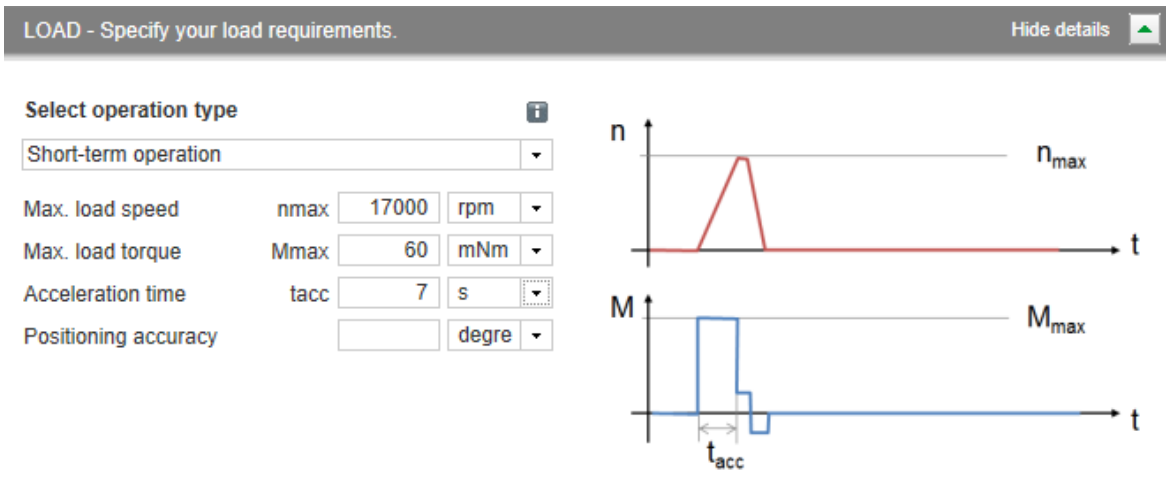
1. Select the ADVANCED SEARCH tab
   Press the *Reset* button at the bottom.
   There is no mechanical transmission to be selected.

2. Load definition
   From the dropdown menu select *Short-term operation*. Fill in the input fields according to the requirements of the application. Click on the *Next* button.



3. Specify the gearhead and motor filters
   Note: The high speed makes it highly improbable that any gearheads or brushed motors are selected.

4. Boundary conditions
   Limit the maximum diameter to 2 inches and the maximum length to 3 inches.

5. Power supply
   Select *Speed control* with high dynamics.

6. Power supply
   Try the default power supply values. The electrical power capabilities might be a little low as can be seen from a power comparison:
   - Required mechanical power: approx. 100 W ($= \pi/30 * 17\ krpm * 60\ mNm$)
   - Available electrical power (> 7 s): approx. 120 W ($= 24\ V * 5\ A$)

7. Result list
   As almost expected, the power is too low and there are no solutions found. Hence, click on the *POWER SUPPLY* in the diagram and allow for higher continuous current or more supply voltage. Recommendation: Double the voltage (In this case this is the strongest restriction).

   Analyze the solutions and check the details as in the exercises before.