

## How to configure an ESCON controller

maxon's ESCON controller manages the speed and torque of brushed or brushless DC motors.



## Contents

Software Installation.....	3
Wiring.....	3
Connecting the Controller.....	4
Startup Wizard .....	5
Motor Type .....	6
Motor Data.....	6
System Data .....	7
Rotor Position .....	8
Speed Sensor.....	8
Mode of Operation .....	9
Enable Function .....	10
Set Value .....	10
Current Limit .....	11
Speed Ramp .....	12
Minimal Speed .....	13
Offset .....	13
Digital Inputs & Outputs .....	14
Analog Inputs & Outputs .....	16
Final Steps .....	17
Further Information .....	18

The ESCON is a 4-quadrant PWM servo controller that controls permanent magnet motors, providing highly precise speed and/or torque control. The compact design and various form factors are suitable for various functionalities and used in applications such as AGVs, pumps and grippers.

Please find an overview of all maxon product types at <http://escon.maxongroup.com>.

## Software Installation

Install the latest version of [ESCON Studio Software](#). ESCON Studio is the same for any ESCON product type. The "ESCON Setup" package is available by the "Downloads" tab of any ESCON product site, e.g., ...

→ ["ESCON 50/5", P/N: 409510](#)

A brief overview of all ESCON product types is available on this website:

<http://escon.maxongroup.com>

There is also a button "Download ESCON Setup" present at the bottom of the website.

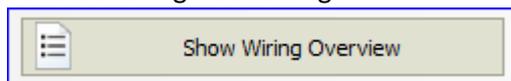
## Wiring

The wiring is set up according to the ESCON Hardware Reference (model specific). Once the ESCON Studio software download is complete, the hardware reference is in the subfolder matching your exact ESCON product type:

→ [C:\Program Files \(x86\)\maxon motor ag\ESCON Servo Controller](#)

It is possible to connect the USB initially to the ESCON without any additional wiring or power supply (or even using a "virtual" ESCON). ESCON Studio's Startup wizard will configure the required usage of ESCON's analog and digital inputs and outputs according to the needs of the final device.

After all configuration steps have been processed by ESCON Studio's "Startup wizard" (as described in this document), the wizard offers to print a PDF showing the required wiring based on the selected configured settings



The resulting automatically generated PDF can be used as a guideline to connect all required power, motor, and signal lines to the specified ESCON connector pins.

Launch "ESCON Studio".

Please read and confirm the "Safety Instructions" initially:

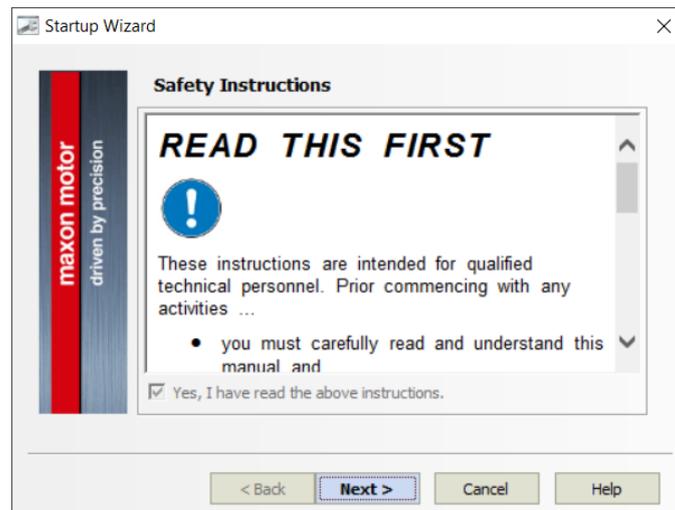


Figure 1 – Safety Instructions

## Connecting the Controller

Ensure the controller is connected via USB; this will be available from the Active Controller drop-down below in Figure 2. It will show the ESCON's product type and USBX interface (e.g., USB0, USB1, ...) beside it, indicating a successful connection (and not a virtual controller identified by IPC instead of USB).

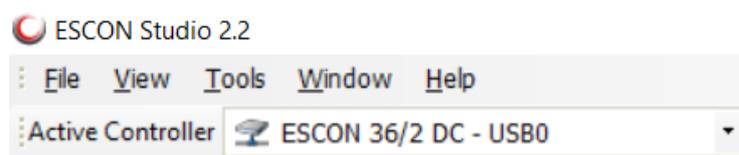


Figure 2 – Active Controller / Connected via USB

*Hint:*

*If your controller seems not to be present by the pull-down list, press the "Binoculars" icon. ESCON Studio checks then again for all connected controllers.*

## Startup Wizard

Launch Startup Wizard from the Tools menu on the left in ESCON Studio; this is where all parameters are entered for the motor data, system data and I/O implementation.

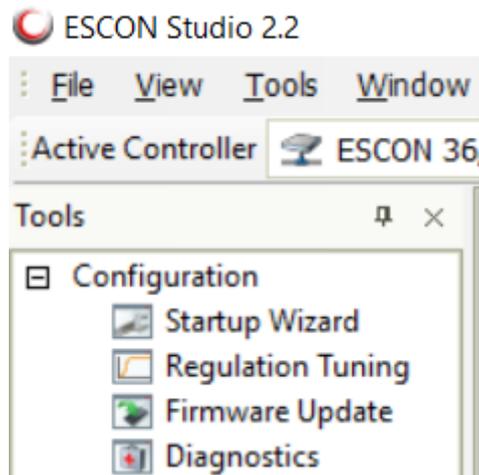


Figure 3 – Startup Wizard

The Startup Wizard will bring up the Safety Instruction again as in Figure 1, ticking 'Yes, I have read the above instruction.' The following window is shown below in Figure 4. In the example below is the ESCON 50/5. This confirms which controller is connected.

Also, the 'Help Contents' button on this window will open up the relevant Hardware Reference for this specific controller if required.



Figure 4 – Controller Confirmation

## Motor Type

Select the correct type of motor in use; maxon EC or DC motor, i.e., Brushless or Brushed DC commutation.

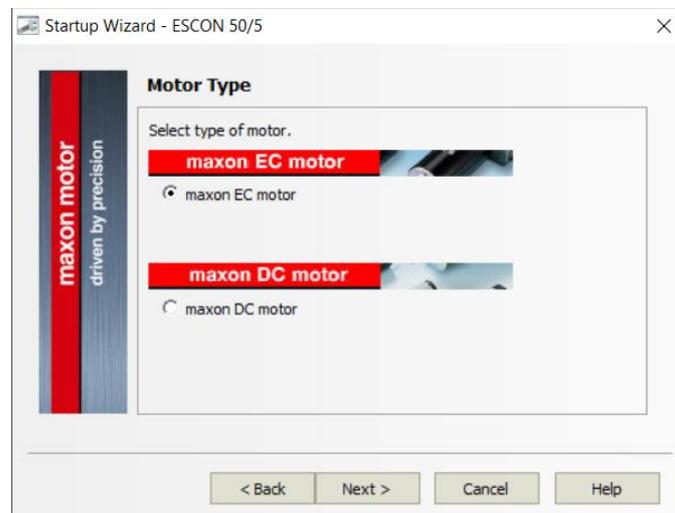


Figure 5 – Motor Type

This document mainly shows the configuration of an EC (= brushless) motor. In the case of a DC motor, some configuration dialogues (e.g., Hall sensors) or parameters (e.g., number of pole pairs) might not be present.

## Motor Data

Enter the motor characteristics such as speed constant, thermal time constant of the winding and the number of pole pairs.

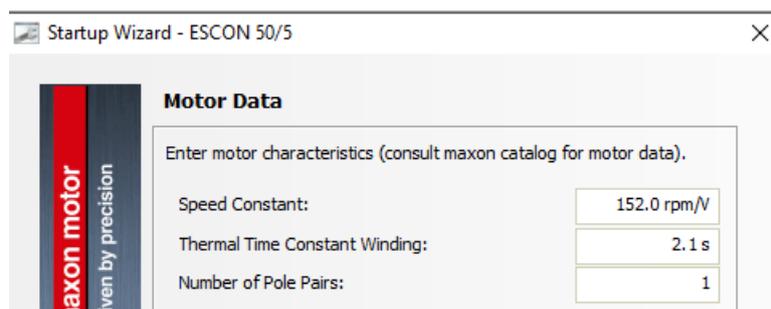


Figure 6 – Motor Data

The required data is in the maxon catalogue datasheets, on lines 13, 19 and 29.

Although the stated speed constant value is entered manually, this is re-determined during the regulation tuning process in case of a closed-loop configuration, i.e., a feedback sensor like a tacho, encoder, or hall sensors are present.

*Note - Important to keep in mind:*

- *In a DC motor without any sensors (i.e., no tacho and no encoder configured), the "Speed constant" must be configured manually based on the motor's datasheet. Otherwise, the*

motor will operate at the wrong Speed afterwards.

- Ensure that the correct "Thermal Time Constant Winding" is configured. This value is important for overload protection of the motor winding by the ESCON.
- The "Number of Pole Pairs" must be configured as stated on the motor's datasheet. The number of pole pairs is just present in the case of an EC (= brushless) motor. A high pole pair number limits the maximum Speed, which can be finally configured and driven by the ESCON.

## System Data

The overall system data can now be configured. The Maximum Permissible Speed, the Nominal Current, and the Maximum Output Current Limit, determine the maximum torque achievable.

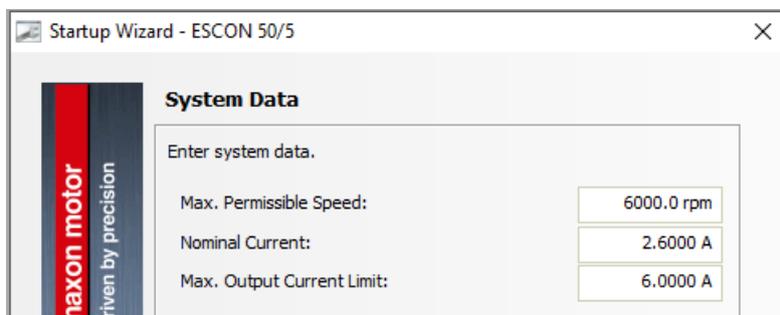


Figure 7 – System Data

Several factors can limit the maximum permission speed, such as:

- Maximum controller speed
- Number of pole pairs
- Maximum permissible speed of the motor
- Maximum continuous input speed of the gearhead
- Maximum speed of the load
- Speed constant of the motor
- Available voltage from the power supply.

The Nominal Current application to the motor is in line 6 of the motor data in the maxon catalogue.

The factors that limit maximum output current are as follows:

- Nominal torque of the motor
- Maximum output torque of the gearhead
- Available current from the power supply
- Maximum torque of the overall system
- Ambient temperature
- Current required for acceleration/deceleration.

A maximum output current of twice the nominal current is typically recommended. This is to account for the acceleration current, which can be adjusted later if required.

## Rotor Position

Hall sensors detect the positioning of the rotor to energise the correct winding phase at the correct time. Hall sensors are required when using the ESCON controller with a brushless DC motor, unless the sensorless ESCON is used. When using maxon motors, the polarity of the hall sensors will always be set to maxon standard, but other third-party motors may be inverted.

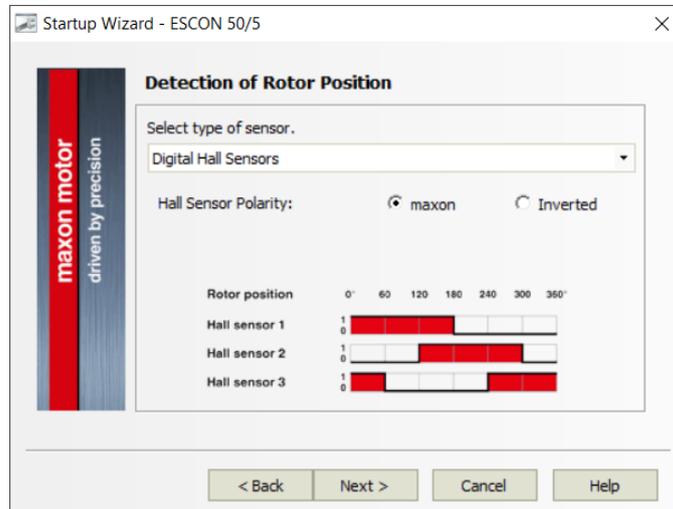


Figure 8 – Rotor Position

## Speed Sensor

Various configurations are available for the speed sensors, whether a DC motor or EC motor from maxon's range. There are as follows:

- Digital Incremental Encoder
- DC Tacho
- Hall Sensors
- No Sensors

For applications with low speed and fluctuating loads, it is advised to use an incremental digital encoder for feedback. The encoder must have a minimum of 16 counts per turn, resulting in 64 quad counts. If a maxon sensor is used, it will be set to maxon standard, but other third-party sensors maybe be inverted.

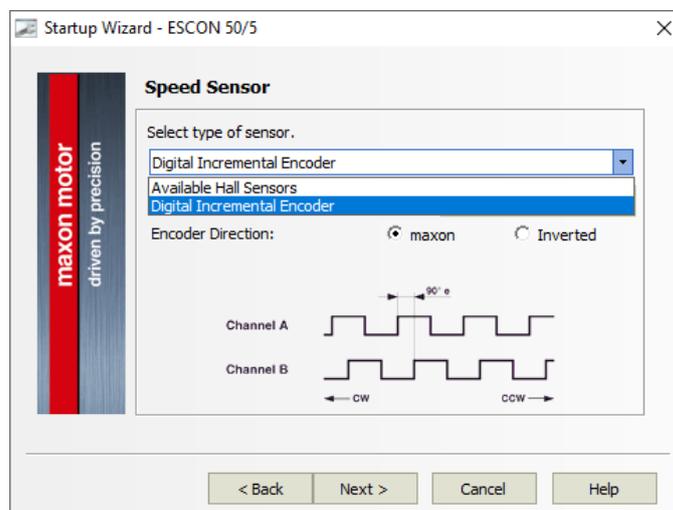


Figure 9 – Speed Sensor

## Mode of Operation

The ESCON offers both Speed and torque control, and depending on the sensor, the following modes are available:

- Current Controller
- Speed Controller (Closed Loop)
- Speed Controller (Open Loop)
  - ❖ Static IxR Compensation
  - ❖ Adaptive IxR Compensation

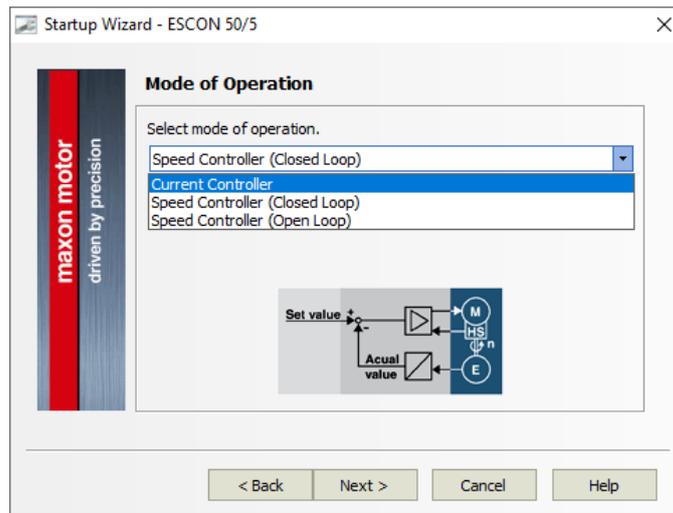


Figure 10 – Mode of Operation

When the ESCON is used for speed control, a closed-loop operation is preferred if the motor has an encoder or hall sensors. Open-loop control can be utilised for a less complex application, such as in pumps or fans where the load and Speed remain consistent.

Open-loop operation requires IxR compensation to control the system. The speed controller provides the motor with a voltage corresponding to the set value speed based on the Speed constant. With increasing load, the Speed decreases. IxR compensation accounts for this by observing the terminal resistance of the motor and the current draw.

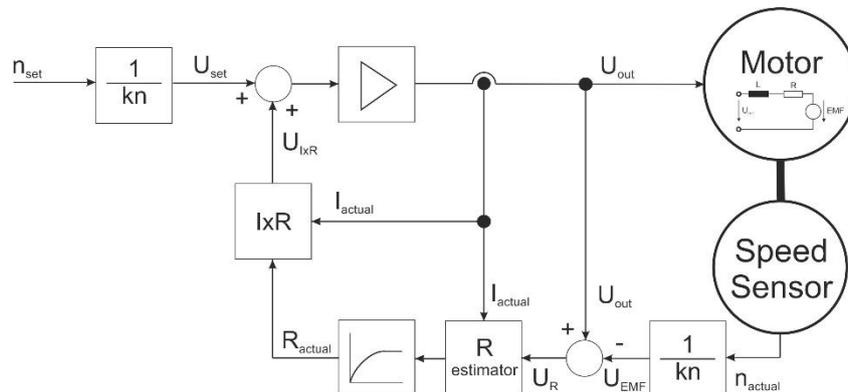


Figure 11 – IxR Compensation Block Diagram

Current control allows the user to adjust and maintain required torque, depending on the application. As current and torque are proportional, increasing the current results in higher torque.

## Enable Function

An Enable signal voltage is required to activate the power stage of the ESCON controller. This is provided by the 5V auxiliary voltage output of the controller, or typically, there will be an external 24V I/O supply voltage connected to the configured Enable input(s) by switches or relays.

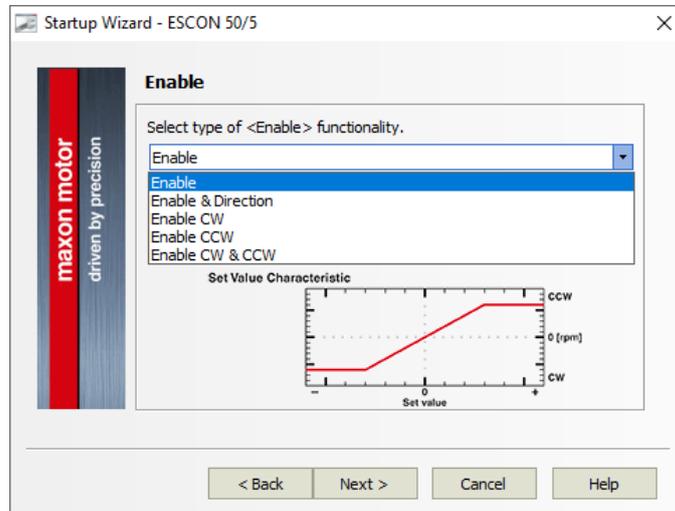


Figure 12 – Enable Function

In addition to the Enable function, additional options are available to configure the direction of rotation suitable for the application.

Up to 4 Digital Inputs are available, depending on the number of Digital Output being utilised, allowing the Enable function to be triggered using one of four Digital Inputs.

*Note:*

*Digital Input 1 has a higher frequency capability, so if a PWM set value is used, it should be allocated to Digital Input 1 and Enable to any other Input.*

## Set Value

The ESCON has both Digital and Analog Inputs.

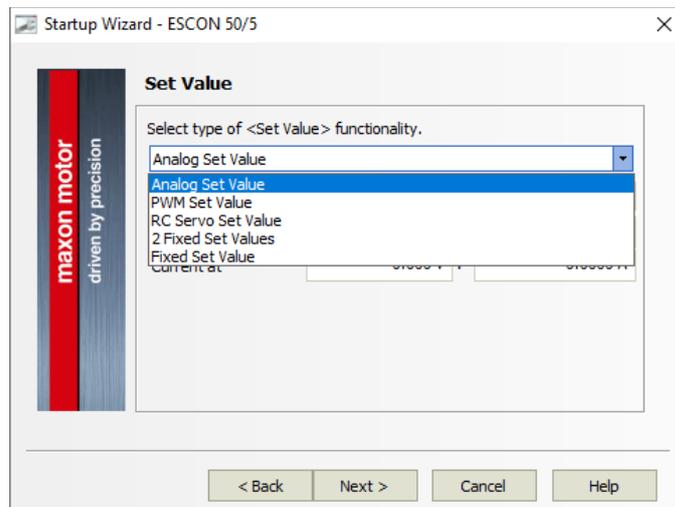


Figure 13 – Set Value

Analog Set Value allows a variation of either the current or speed over a -10V to +10V (or 0% - 100%) range, providing adjustability via a PLC or potentiometer.

PWM Set Value is in use if the Speed or current must be commanded by a pulse width of a PWM signal. Please find the ESCON's PWM input specification of "Digital input 1" by its "Hardware Reference". The required PWM frequency is between 10 Hz ... 5 kHz. "PWM set value" is typically used by the microcontroller (without an analog output) commanding the ESCON.

RC Set Value is a type of command used by remote control systems based on differing pulse lengths of 1 up to 2ms.

2 Fixed Set Values allows the user to set two fixed current or speed values, allocated to a digital input and enabled via the input's High or Low active states.

Fixed Set Value is selected if only one fixed current or speed value is required, this is active when the configured "Enable" is activated.

## Current Limit

The ESCON can implement a current limit, in effect, a maximum torque limitation. This option is only possible in Speed Control mode, and a Digital or Analog input can be assigned for this action.

The drop-down menu below shows the current limiting options for Speed Control mode. If Current Control mode is selected in Mode of Operation, this window would be skipped as these limits have already been set.

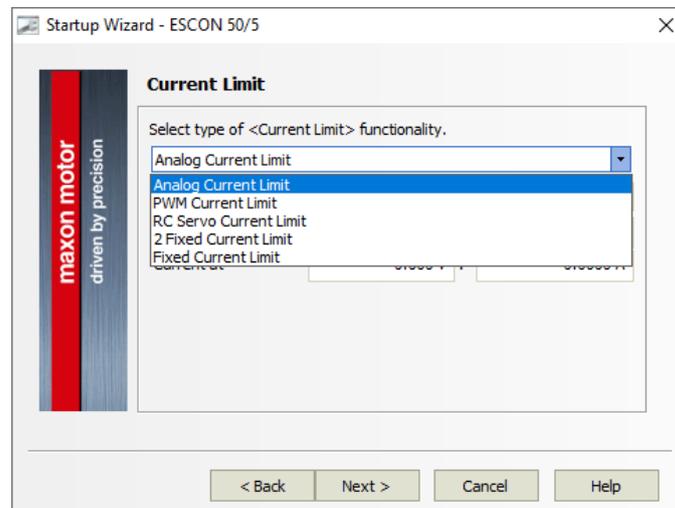


Figure 14 – Current Limit

A current limit is typically set as protection for the motor, gearhead, or drive load. These are set in the same method as when the Set Values were configured.

*Note:*

*Once a Digital or Analog Input is allocated to a function, it is no longer available in the following windows.*

## Speed Ramp

The ESCON controller is a 4-Quadrant controller, meaning torque can be applied in the opposite direction of motion.

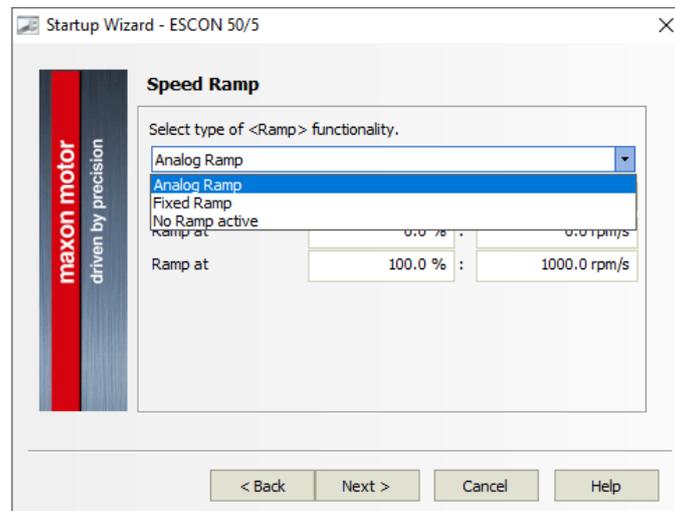


Figure 15 – Speed Ramp

The acceleration/deceleration can be defined for a final speed to be achieved within the desired time frame. Typical values are in the range of 1000 ... 100000 rpm/s.

**Note:**

*Factors such as the available current and the inertia of the load should be considered when defining the acceleration ramp. Rapid acceleration of high loads will draw higher currents, and if the power supply cannot provide this, or the controller reaches its current limit, the motor will not be able to follow the commanded motion. If the power supply is overloaded and partly shuts down, an error state is reported, or the system processes a restart.*

**Note:**

*The potential reversed energy that goes back into the controller, or power supply, during deceleration should be considered. If the controller, or power supply, does not have sufficient capacitance to absorb the energy, the supply voltage level will increase, and the ESCON will report an "Overvoltage" error state, or the power supply will trip.*

## Minimal Speed

The Minimal speed configuration might not be available depending on the configured operating mode and feedback sensor.

The minimal speed configuration is useful when a low-resolution speed sensor is used in the operation Speed Controller (Closed Loop) mode. Low-speed set values can cause jerking movements of the motor or look like a stop and go motion in the case of Hall sensors only or a low-resolution encoder. If required, a minimal speed value can be set here to block low-speed operation. But in most cases, this is not necessary if an encoder with more than 100cpt. (= counts per turn) or even 500cpt. as a common standard is mounted on the motor shaft as part of a motor combination.

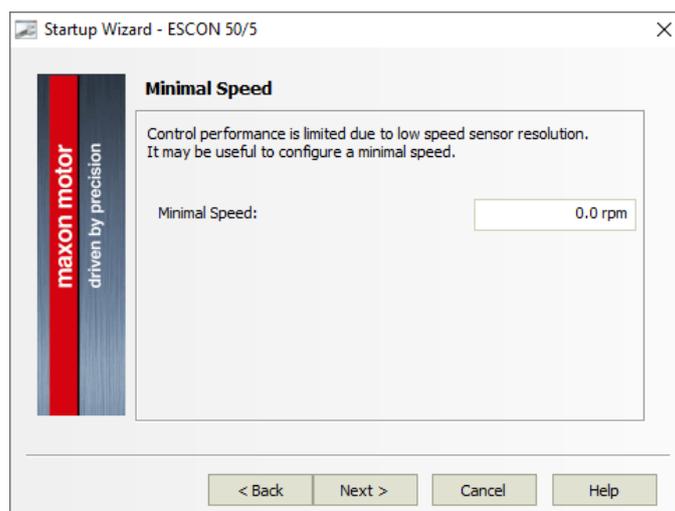


Figure 16 – Minimal Speed

## Offset

When the output differs from the pre-defined set value, the following offset configurations can be utilised:

- Analog Offset
- PWM Offset
- RC Servo Offset
- Fixed Offset

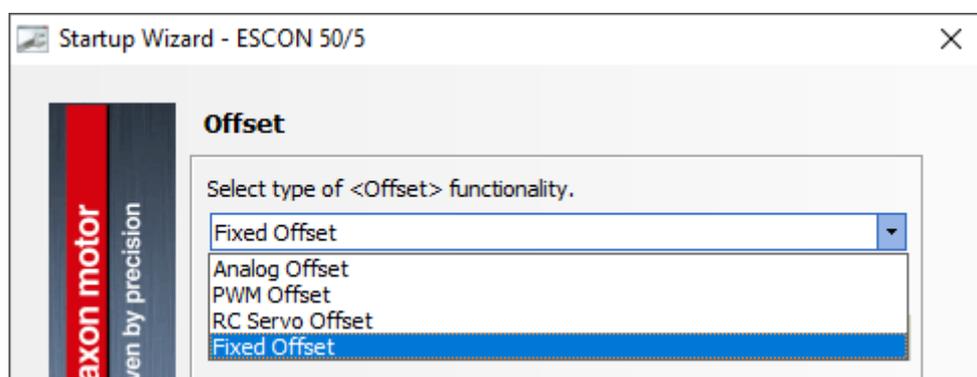


Figure 17 – Offset

## Digital Inputs & Outputs

Commutation Frequency Input or output signal with two voltage levels; Logic 0 (Low) and Logic 1 (High)

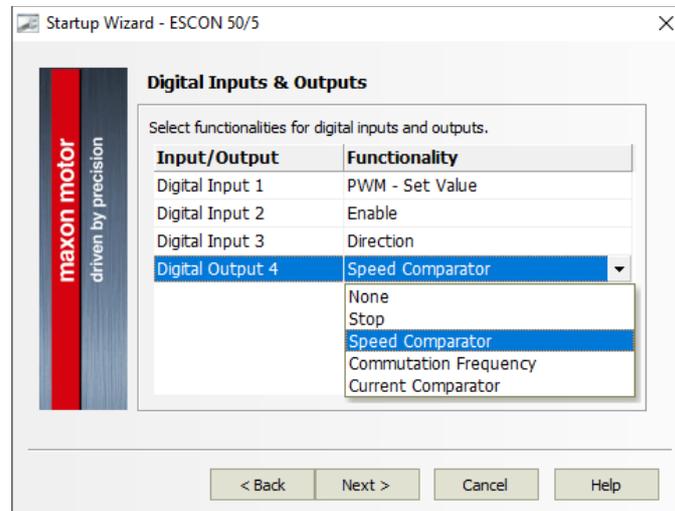


Figure 18 – Digital Inputs & Outputs

Additionally, to the Enable and/or Direction Inputs, the following digital inputs are available:

### Inputs

- Stop

Motor shaft decelerates with pre-set speed ramp until standstill.

- PWM Set Value

The fixed frequency and amplitude define the set value. The change in set value is achieved by adjusting the duty cycle variation of 10-90%.

## Outputs

- Ready

The signal is used to transmit the status or fault of the operation to a superior control.

- Speed Comparator / Current Comparator

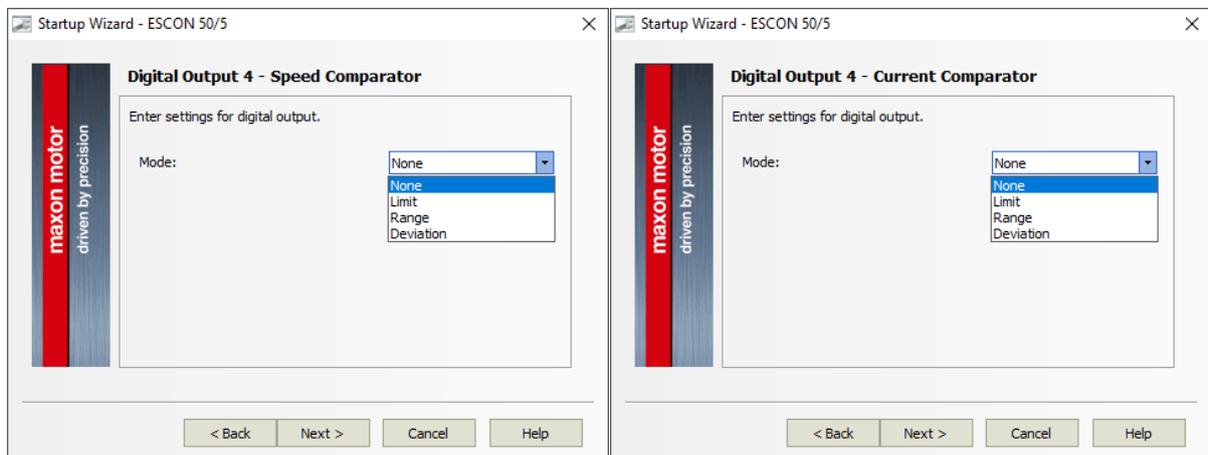


Figure 19 – Digital Output Speed/Current Comparator

Digital output is set as soon as the Actual Speed Averaged reaches the pre-set for comparison

- Limit: Digital output is set when pre-set value is reached and continues if over limit remains.
- Range: Digital output is set when the pre-set range is reached and continues if within a pre-set range.
- Deviation: Digital output is set when pre-set variation is reached (based on the set value)

- Commutation Frequency

The actual speed is available as a digital frequency signal. Its frequency corresponds to the electrical frequency of the motor. This is for brushless DC motors only.

## Analog Inputs & Outputs

### Input

Depending on the controller, it will have 2 Analog Inputs and up to 2 Potentiometer Inputs. The following are available:

- Current Gain: Adjustment of the current controller gain.
- Speed Gain: Adjustment of the speed controller gain.
- IxR Factor: The voltage drop caused by terminal resistance in the range of:
  - 0 – not compensated
  - 1'000 – fully compensated
  - 2'000 – overcompensated

### Output

There are two analog outputs available, with a resolution of 12 bits, a range of -4V to 4V and a current rating of up to 1mA.

The following functions are available and are often used as a monitoring measure:

- Fixed Value: Output voltage is fixed to a pre-set value.
- Actual Current: Measured motor winding current.
- Actual Current Averaged: Measured motor winding current filtered by a first-order digital low-pass filter with a cut-off frequency of 5Hz.
- Actual Speed: Measured motor speed.
- Actual Speed Averaged: Measured motor speed filtered by a first-order digital low-pass filter with a cut-off frequency of 5Hz.
- Demand Current: Demanded motor winding current.
- Demand Speed: Demanded motor speed.
- Temperature Power Stage: Measured power stage temperature.

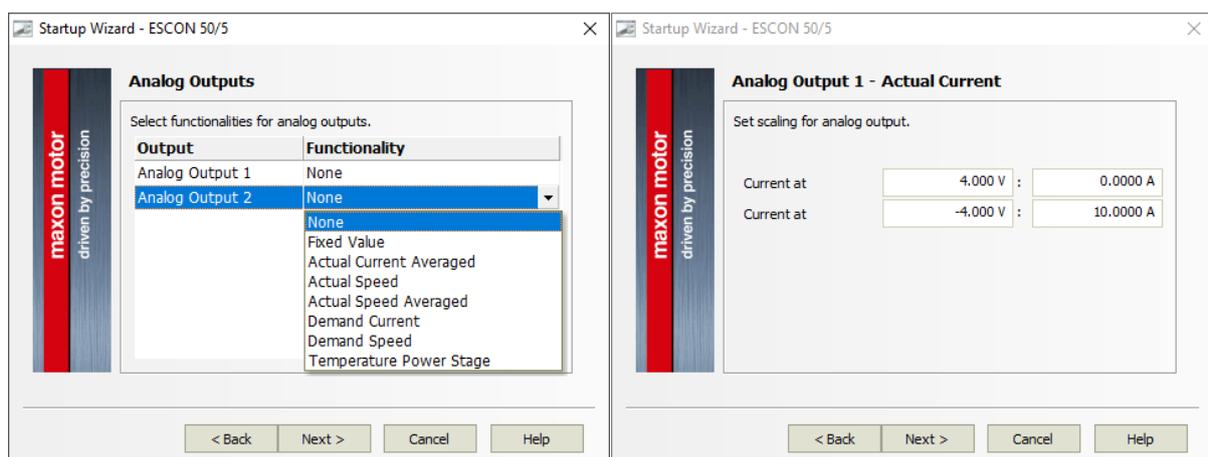


Figure 20 – Analog Outputs / Settings

\* When configuring the ESCON, it is important to consider the overall drive system instead of just the motor, as there may be a weaker component within the overall system that may need accounting for from a safety point of view.

## Final Steps

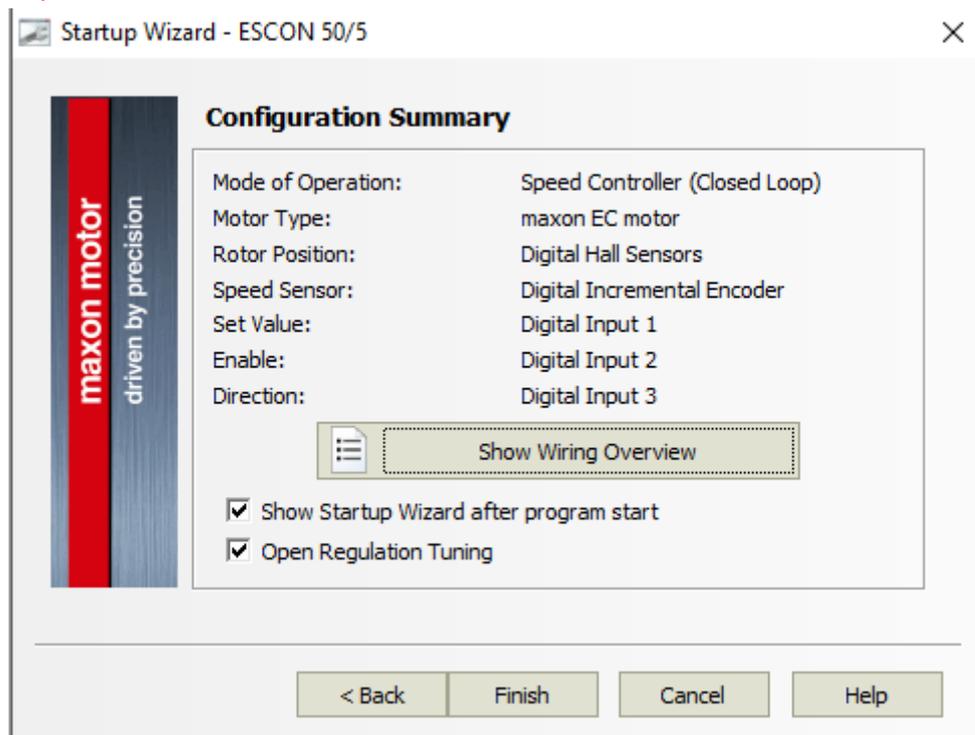


Figure 21 – Configuration Overview

- **Show Wiring Overview**  
Please note that the Configuration summary presents a button Show Wiring Overview as the last step of the Startup wizard. If you press this button, you get a wiring list based on the DC or EC motor type selection and configured I/O features. It can be saved or printed as a PDF.
- **Regulation tuning**  
Regulation tuning is mandatory after the configuration and wiring are completed, and the system with the motor is powered on for the first time. Please find some guidance about automatic or manual regulation tuning in the following video tutorials:
  - ESCON Studio: [Regulation Tuning \(Auto Tuning Mode\)](#)
  - ESCON Studio: [Regulation Tuning \(Expert Tuning Mode\)](#)
- **Finish**  
Press the Finish button to save all selected configuration details in the controller internally so that these are still present after power off/on.

## Further Information

Please note: there are many different maxon video tutorials focused on the different configuration, tuning, and test features of ESCON Studio. These videos are by the Video tab of each ESCON product site (e.g., "[ESCON 50/5](#)" ):

- ESCON Studio: [Startup Wizard \(DC motor\)](#)
- ESCON Studio: [Startup Wizard \(EC motor\)](#)
- ESCON Studio: [Diagnostics Tool](#)
- ESCON Studio: [Regulation Tuning \(Auto Tuning Mode\)](#)
- ESCON Studio: [Regulation Tuning \(Expert Tuning Mode\)](#)
- ESCON Studio: [Data Recorder Tool](#)
- ESCON Studio: [Help Topics](#)
- ESCON Studio: [Firmware Update Tool](#)

Are you learning about ESCON's configuration even without having an actual controller already present?

Please find some information on how ESCON Studio's 'virtual' controllers can be activated for checking all configuration settings by the following linked Support Center document:

- "[ESCON Studio: Activation of Virtual Controller](#)"

Such a configuration processed by a virtual controller can be even uploaded to a file and downloaded later again to "real" ESCON:

- "[Export / Upload of the configuration in an \\*.edc file](#)"

Additional documents from [maxon's global Support Center](#) dealing with specific topics concerning I/O wiring, e.g.

- [ESCON: Digital output wiring](#)
- [ESCON: Using an external potentiometer for set value commanding](#)
- [ESCON: Analog I/O properties](#)
- [ESCON: RC Servo Set Value?](#)

Processing Regulation tuning is mandatory to be processed after all configuration and wiring are correctly done, and the system with the motor is powered on the first time.