# BRUSHLESS PUMP CONTROL INSTRUCTIONS

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# 1 SCOPE

This document details general instructions to control pump configurations that include a brushless motor using a Maxon ESCON controller.

## 2 REFERENCE DOCUMENTS

#### 2.1 CONTROLLER MANUAL DOWNLOADS

#### 2.1.1 ESCON 36/6:

https://www.maxongroup.com/medias/sys\_master/root/8834332721182/414533-ESCON-36-3-EC-Hardware-Reference-En.pdf

#### 2.1.2 ESCON 50/5:

https://www.maxongroup.com/medias/sys\_master/root/8834332262430/409510-ESCON-50-5-Hardware-Reference-En.pdf

#### 2.1.3 ESCON 70/10:

https://www.maxongroup.com/medias/sys\_master/root/8834333179934/422969-ESCON-70-10-Hardware-Reference-En.pdf

NOTE: References in this document are of the following released manual versions:

ESCON 36/3 ... November 2018 Edition

ESCON 50/5 ... November 2018 Edition

ESCON 70/10 ... November 2018 Edition

# **3** SAFETY

- Installation, integration, and modification of the electrical components of supplied pumps and controllers should be performed by experienced, skilled personnel only.
- Ensure that the supply voltage to any controller apparatus, as well as to any pump, does not exceed the max rated voltage for that component. Consult the controller manual or Flight Works for clarification and/or specs.
- If any errors or issues are experienced (error light on the controller, inoperable pump, etc.) consult the included controller manual or Flight Works immediately.
- Repairs to damaged components should not be attempted by the customer. Please contact Flight Works in case of damage.
- Ensure that no controller apparatus is connected to an electrical supply during pump connection/installation. After switching on, do not touch any live electrical parts or any moving parts such as exposed motor shaft.
- Ensure a clean environment for both pump and controller, free from excessive dust, debris, etc. Keep controllers and non-wetted pump parts (such as the rear shaft) protected from fluids or other objects like towels or wires. Note that the controllers are electrostatic-sensitive devices
- If necessary, contact Flight Works Technical Support (949-387-9502) for any comments / questions.



# 4 MOTOR WIRING

### 4.1 STANDARD (8-WIRE W/ CONNECTOR)

See Table 1 for use with all X-Series pumps using standard motors (X01-X07).

Wire Color Pin Description Brown 1 Motor Winding 1 Red 2 Motor Winding 2 Orange 3 Motor Winding 3 Yellow 4 V<sub>Hall</sub> 3...24 VDC PIN 1 PIN 8 Green 5 GND Blue 6 Hall Sensor 1 7 Hall Sensor 2 Wire Gauge AWG 24 Violet 8 Hall Sensor 3 Grey

Table 1 Standard Motor Wiring

# 4.2 INDIVIDUAL WIRES

See **Table 2** for use with X-Series pumps using individual-wire motors (X09 or higher and some custom configurations).

#### **Table 2 Individual Wires**

Wire Color	Description	Wire Gauge X09/X10/X11	Wire Gauge X34
Red	Motor Winding 1		
Black	Motor Winding 2	AWG 20	AWG 18
White	Motor Winding 3		
Red & Grey	Hall Sensor 1		
Black & Grey	Hall Sensor 2		
White & Grey	Hall Sensor 3	AWG 26	AWG 26
Green	V <sub>Hall</sub> 324 VDC		
Blue	GND		

#### 4.3 OTHER/CUSTOM WIRES/CONNNECTORS

For other connections not referenced in Section 4.1 or Section 4.2, contact Flight Works.



# 5 CONTROLLER INTERFACE/SETUP (ESCON 36/3, ESCON 50/5 AND 70/10)

- If the controller was supplied directly by Flight Works, it has been likely set up to the specific motor configuration purchased with the controller. If the Analog and Digital I/O's need to be modified for the setup and/or if the controller needs to be setup up entirely, please follow the instructions below.
- 1. Download the ESCON Studio software from the Maxon website at:
  - a. <u>https://www.maxongroup.com/medias/sys\_master/root/8843037835294/ESCO</u> <u>N-Setup.zip</u>
- 2. Connect the controller to a PC via micro-USB cable and open the ESCON Studio software. The startup wizard will open, read carefully, and follow the safety instructions.



3. If the controller is plugged into the PC, the software should recognize the controller, alternatively a virtual controller can be chosen to get familiar with the setup. (In the following example, an X34 Motor will be setup to run on an ESCON 70/10 controller.

🗾 Startup Wiz	ard - ESCON 70/10	Х
maxon motor driven by precision	Introduction The ESCON 70/10 is a small-sized, powerful 4-quadrant PWM serve control of permanent magnet-activated brushed DC motors or brushless EC motors up to approximately 700 Watts.	
	< Back Next > Cancel Help	



4. Select EC Motor (for brushless) and click Next:

😹 Startup Wiz	rard - ESCON 70/10	×
maxon motor driven by precision	Motor Type Select type of motor. maxon EC motor maxon EC motor maxon DC motor C maxon DC motor	
	< Back Next > Cancel Help	>

5. Follow the steps in the setup wizard to setup the controller referring to the Appendix for the motor/controller specifications. If the controller was purchased directly from Flight Works, it has been likely set up to the specific motor configuration purchased with the controller. These parameters are for setup purposes ONLY and are not necessarily standard operational pump / system parameters. Contact Flight Works with any questions or concerns. The following parameters shown are for an X34 Motor setup to run on an ESCON 70/10 controller. Refer to the Appendix Section 7.1 for the motor parameters and Section 7.2 for MAX current limits

😹 Startup Wiz	ard - ESCON 70/10		X 🔀 Startup Wize	ard - ESCON 70/10	×
	Motor Data			System Data	
	Enter motor characteristics (consult maxon catal	og for motor data).	<b>.</b> .	Enter system data.	
<mark>ocisio</mark>	Speed Constant:	697.0 rpm/V	<mark>ioto</mark> ecisio	Max. Permissible Speed:	24000.0 rpm
u u	Thermal Time Constant Winding:	2.1s		Nominal Current:	10.0000 A
ve p	Number of Pole Pairs:	2	axo Menta	Max. Output Current Limit:	15.0000 A
Εŧ			εā		
	< Back Next > C	ancel Help		< Back Next >	Cancel Help

6. For "Detection of Rotor Position" select Digital Hall Sensors and Maxon (polarity).

	Detection of Rotor Position	
	Select type of sensor.	
sion to	Digital Hall Sensors	
axon mo	Hall Sensor Polarity: 🕫 maxon C Inve	erted
Ëŝ	Rotor position 0' 60 120 180 240 300 366	
	Hall sensor 1 0	
	Hall sensor 2 0	
	Hall sensor 3	



7. For "Speed Sensor" select Available Hall Sensors.

	~
Speed Sensor	
Select type of sensor.	
Available Hall Sensors	•
< Back Next > Cancel	Help
	Speed Sensor Select type of sensor. Available Hall Sensors <a href="https://www.sensors.org">www.sensors</a>

The following steps use the controller's Digital and Analog I/O's and are based on how the pump will be operated for the application/setup. The values set below can be changed by the operator to interface directly with the system.

8. For "Mode of Operation" select preferred method of control. Flight Works recommends Speed Controller (Closed Loop), which allows for direct setting of the pump RPM.

🜌 Startup Wiza	ard - ESCON 70/10	×
	Mode of Operation	
otor cision	Speed Controller (Closed Loop)	3
maxon mo driven by pres	Set value \$2- Actual value to	
	< Back Next > Cancel Help	

The controller requires an ON/OFF signal to enable and disable the motor. For "Enable", Select Enable CW (clockwise), select preferred digital input and select preferred enable mode "High active". A 5-24V signal can be used from a separate source or a bridge to the +5V terminal of the J5 Digital I/O connector on the controller (terminal 6) can be used.

	Enable	Enable > functionality	•
sion <b>to</b>	Enable CW	Enable > functionality.	•
iven by pred	Enable CW:	Digital Input 1   High activ	ve •



10. The method for controlling Motor RPM can be controlled in the "Set Value" screen. It is recommended using the analog set value with a 0-10V signal with the RPM needed for the application. For simple speed control the onboard potentiometer option can be used as well. (do not exceed max speed per motor parameters). Recommended max speed is approximately 50-60% of the max speed of the motor.

ጆ Startup Wiz	ard - ESCON 70/10				>
	Set Value				
	Select type of <set td="" va<=""><td>lue&gt; functionality.</td><td></td><td></td><td></td></set>	lue> functionality.			
ision	Analog Set Value			•	
prec m	Input:		Ana	log Input 1 🔹 🔻	
<b>o</b> Aq	Speed at	0.000 V	:	0.0 rpm	
<b>ma)</b> drive	Speed at	10.000 V	:	24000.0 rpm	
	< Back	Next >	Cance	I Help	

11. For "Current Limit" select Fixed Current Limit and enter the max output current of the controller/system.

📈 Startup Wiza	ard - ESCON 70/10		×
	Current Limit		
	Select type of <current limit=""> f</current>	functionality.	
ision	Fixed Current Limit	•	
<mark>xon mo</mark> n by prec	Current Limit:	15.0000 A	
<b>ma)</b> drive			
	< Back Ne:	xt > Cancel Help	

12. For "Speed Ramp" select preferred ramping method and speed. 12000 RPM/s is recommended for typical operations.

	Select type of <ramp> functionalit</ramp>	у.
notor scision	Fixed Ramp	•
<b>ton IT</b> n by pre	Acceleration:	12000.0 rpm/s
drive	Deceleration:	12000.0 rpm/s



13. For "Minimal Speed", 100 RPM is recommended for typical operations.

🜌 Startup Wiza	ard - ESCON 70/10	$\times$
maxon motor driven by precision	Minimal Speed           Control performance is limited due to low speed sensor resolution.           It may be useful to configure a minimal speed.           Minimal Speed:         100.0 rpm	
	< Back Next > Cancel Help	

14. For the "Offset" parameter, 0.0 rpm is default.

ጆ Startup Wiz	ard - ESCON 70/10	:	×				
	Offset						
	Select type of <offset> functionality.</offset>						
ision	Fixed Offset	•					
maxon mo driven by prec	Offset:	0.0 rpm					
	< Back Next >	Cancel Help					

15. Once all the parameters have been set, the setup wizard summarizes the input/output setups as shown below:

🗾 Startup W	izard - ESCON 70/10		🗙 🔀 Startup Wiz	zard - ESCON 70/10	>
	Digital Inputs & Ou	itputs		Analog Inputs	
	Select functionalities for	digital inputs and outputs.		Select functionalities for	analog inputs.
sion to	Input/Output	Functionality	sion to	Input	Functionality
reci S	Digital Input 1	Enable CW		Analog Input 1	Set Value
L d K	Digital Input 2	None		Analog Input 2	None
e f	Digital I/O 3	None	x 5	Potentiometer 1	None
driv	Digital I/O 4	None	driv 🖁	Potentiometer 2	None
	< Back	Next > Cancel Help		< Back	Next > Cancel Help



16. The "Analog Outputs" can be set on the following screens. These can be set up to interface with a separate control and data acquisition device. Below are examples of how values could be set:

	Select functionalities for	analog outputs.
sion of	Output	Functionality
reci 3	Analog Output 1	Actual Speed Averaged
L d Ko	Analog Output 2	Actual Current Averaged
drive		

📈 Startup Wiza	ard - ESCON 70/10			×	🗾 Startup Wiza	ard - ESCON 70/10			×
	Analog Output 1 - A	ctual Speed Average	ed			Analog Output 2	- Actual Current /	Averaged	
ion to	Set scaling for analog output	ut.			ion <b>D</b>	Set scaling for analog o	output.		
precis	Speed at	0.000 V :	0.0 rpm		n mo	Current at	0.000 V	: 0.00	A 00
<mark>axor</mark> ven by	Speed at	4.000 V :	24000.0 rpm		axor ven by	Current at	4.000 V	: 10.00	A 00
Ê Ê					Ē				
	< Back	Next > Cancel	Help			< Back	Next >	Cancel	Help

- 17. Use the wiring overview in **Table 1** or **Table 2** to connect the pump to the controller.
  - a. Uncheck "Open Regulation Tuning" and click "Finish."

🗾 Startup Wiza	ard - ESCON 70/10	×
	Configuration Summary	
maxon motor driven by precision	Mode of Operation:       Speed Controller (Closed Loop)         Motor Type:       maxon EC motor         Rotor Position:       Digital Hall Sensors         Speed Sensor:       Available Hall Sensors         Set Value:       Analog Input 1         Enable CW:       Digital Input 1	
	Show Wiring Overview  Show Startup Wizard after program start  Open Regulation Tuning  UNCHECK	
	< Back Finish Cancel Help	



#### 5.1 ADDITIONAL NOTES

- a) Ensure the pump is installed into fluid system to allow for priming when powered on.
- b) Connect the controller to a power supply (recommended voltage of approximately 125-150% nominal pump voltage). Note that the pump will immediately power on if there is no switch (set to OFF) on the enable terminal.



- c) If there are any issues with the control, the ESCON Studio should indicate the error such as hall sensors not connected, no voltage provided, etc.
- d) Consult the controller manual for further control options (including uploading parameters into the controller).

#### 6 TROUBLESHOOTING

#### 6.1 OPERATING STATUS LIGHT

- a) The controller operating status light should be a steady green when operating the pump.
- b) For any unusual operating status light behavior (blinking, color change, no light) refer to the Operating Status Display section of the appropriate controller manual.
- c) If failure mode references "Motor shaft is blocked", "Load too great" or a similar issue, the failure may be related to the pump head. In this case, it is recommended that Flight Works be contacted immediately.
- d) Only skilled/experienced personnel should attempt to troubleshoot control issues. If necessary, contact Flight Works Technical Support (949-387-9502) for troubleshooting help.

#### 6.2 FAILURES DURING OPERATION

- a) If there any control issues at any time, **DO NOT** continue operating the pump until the issues have been resolved
- b) Disconnect power to the controller before any checking all wiring, and ensure safe, sturdy connections at all solder joints or terminals.
- c) Ensure that no debris have come in contact with the controller or exposed motor components (wires, rear shaft).
- d) If necessary, contact Flight Works Technical Support (949-387-9502) for troubleshooting help.



# 7 APPENDIX

#### 7.1 MOTOR INPUT PARAMETERS FOR ESCON SETUP WIZARD\*\*\*

Pump P/N	Nominal Voltage (V)	Speed Constant (rpm/V)	Thermal Time Constant Winding (seconds)	Pole Pairs	Max Speed (rpm)	Nominal Current (Amps)*	Max Output Current Limit (Amps)**
X01	12	1050	1.99	1	18000	2.71	5.42
X03	24	549	1.99	1	18000	1.4	2.8
X04	48	274	1.99	1	18000	0.716	1.43
X05	6	2070	1.85	1	18000	2.61	5.22
X06	12	1060	1.85	1	18000	1.25	2.5
X07	24	526	1.85	1	18000	0.657	1.314
X09	18	907	5.12	2	25000	4.32	8.64
XS09	18	970	5.12	2	25000	4.24	8.48
XS09A	18	970	5.12	2	25000	4.24	8.48
X10	24	680	5.12	2	25000	3.34	6.68
X11	48	340	5.12	2	25000	0.679	1.358
X12	24	705	4.66	2	25000	4.21	8.42
X34	24	697	2.11	2	25000	7.61	15.22

\*Maximum Continuous Current

#### \*\*Maximum Output Current Limit is based on a factor of 2x Nominal Current recommended by factory

\*\*\*These parameters are for setup purposes and are not necessarily standard operational pump parameters. Contact Flight Works Technical Support (949-387-9502) for any questions or concerns.

#### 7.2 CONTROLLER TECHNICAL DATA

Controller	Voltage Range (VDC)	Continuous Current (A)	Maximum Current (A)
ESCON 36/3	10-36	2.7	9 (< 4 seconds max)
ESCON 50/5	10-50	5	15 (< 20 seconds max)
ESCON 70/10	10-70	10	30 (< 20 seconds max)