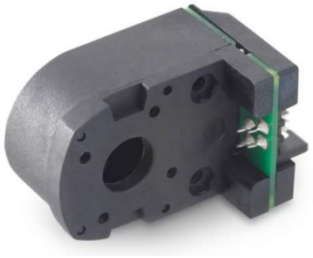
UNIVERSITY OF BRITISH COLUMBIA
MECH 423 – Mechatronic Product Design 2022W
Final Project – Handout #2/3
Component Library

Overview

The following components are available for students teams to borrow for their projects. Student teams must first obtain permission from the TAs before borrow components. Borrowed components must be returned at the end of the semester in usable condition.

- DC motor
- Encoder for DC motor
- Stepper motor (NEMA 17)
- Peristatic pump
- Web cam
- XBee wireless UART link

DC Motor



DC motors are versatile, easy to use and control. The motor displayed above is a Maxon 12V brushed DC motor **(PN: 2322.980 – 52.235 – 200)**, coupled with a gearbox providing a gear reduction of 14:1. The motor has the following specifications:

	Motor Data		
	Values at nominal voltage		
1	Nominal voltage	V	12
2	No load speed	rpm	7010
3	No load current	mA	42.2
4	Nominal speed	rpm	4300
5	Nominal torque (max. continuous torque)	mNm	11.8
6	Nominal current (max. continuous current)	A	0.807
7	Stall torque	mNm	32.9
8	Starting current	A	2.14
9	Max. efficiency	%	70
	Characteristics		
10	Terminal resistance	Ω	5.61
11	Terminal inductance	mH	0.492
12	Torque constant	mNm/A	15.4
13	Speed constant	rpm/V	622
14	Speed/torque gradient	rpm/mNm	227
15	Mechanical time constant	ms	13.9
16	Rotor inertia	gcm²	5.84

It has a 4 mm shaft with a machined flat for convenient interfacing with other mechanical components. It also has a 2 mm rear shaft, compatible with a Maxon 2-channel, 100 counts per turn encoder **(PN: 103937)**.

Encoder for DC Motor

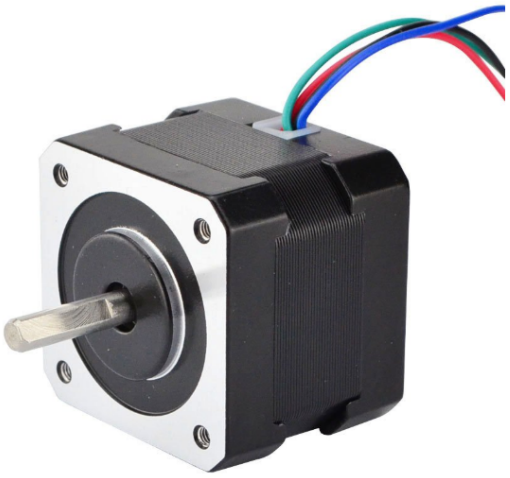
The encoder specifications are as follows:

General information		
	Counts per turn	100
	Number of channels	2
	Line Driver	No
	Max. mechanical speed	12000 rpm
	Shaft diameter	2 mm
Technical Data		
	Supply voltage V_{CC}	5.0V ± 10.0%
	Driver used logic	TTL
	Max. angular acceleration	-1 rad / s²
	Output current per channel	-1...5 mA
	Signal rise time	200 ns
	Measurement condition for signal rise time	CL=25pF, RL=11kOhm,
	Signal fall time	50 ns
	Measurement condition for signal fall time	CL=25pF, RL=11kOhm,
	Phase shift	90 °e
	Phase shift, inaccuracy	45 °e
	Max. moment of inertia of code wheel	0.05 gcm²
	Operating temperature	-20...+85 °C
	Orientation of encoder output to motor flange	-1 °

For a complete list of technical specifications, please see:

https://www.maxongroup.com/medias/sys_master/root/8807091437598/13-365-EN.pdf
https://www.maxongroup.com/medias/sys_master/root/8831079317534/2018EN-426.pdf

Stepper Motor

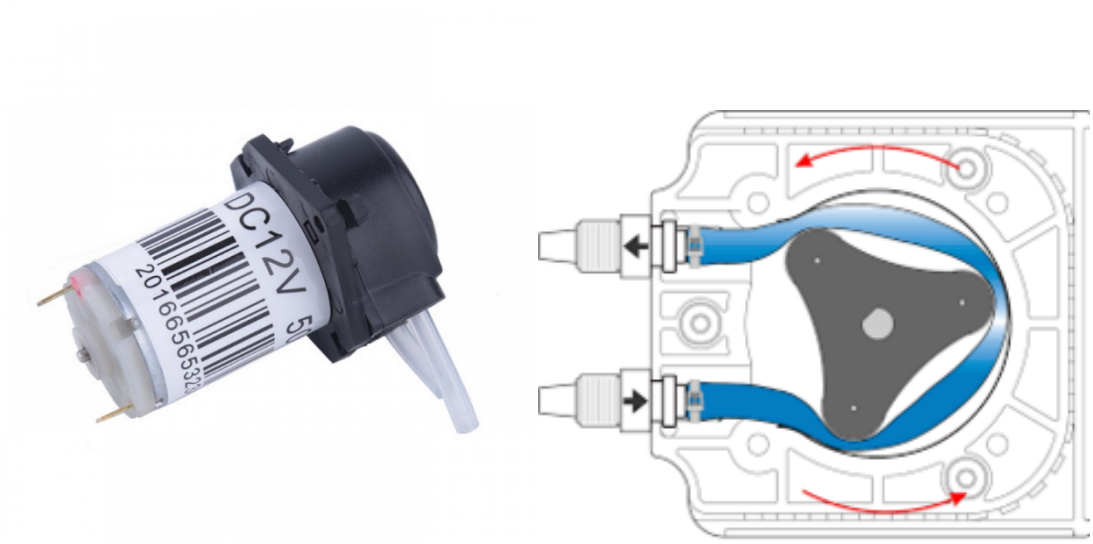


Stepper motors are commonly used for applications that require high precision position control. They can be found in printers, CNC machines, 3D printers, etc. The stepper motor displayed above is a **12 V NEMA 17, bipolar motor with a 1.8 degree step angle** (200 steps per revolution) and can be driven using a dual H-bridge stepper motor driver. The electrical and mechanical specifications can be found below.

Step Angle	1.8 degrees
Holding Torque	26 N-cm (36.8 oz-in)
Rated Current per Phase	0.4 A
Phase Resistance	30 Ohms
Inductance	37 mH
Connection (Black, Green, Red, Blue)	Phase A+ (Black) Phase B+ (Red) Phase A- (Green) Phase B- (Blue)

Frame Size	42 x 42 mm
Body Length	34 mm
Shaft Diameter	5 mm
Shaft Length	20 mm
Machined Flat Length	15 mm

Peristaltic Pumps



A peristaltic pump can be the ideal, and cost effective, solution for moving around low to high viscosity fluids. The pump moves the fluid forward by pinching and pushing the tube inside of the pump. Peristaltic pumps are easy to sanitize as the pump never comes in contact with the working fluid. One thing to keep in mind is that these pumps come with a small piece of tubing (with connectors) which is very flexible. If you wish to replace the tubing/connectors, ensure the correct diameter/toughness of tubing is used. The pumping apparatus is connected to a 12V DC motor, making control very simple. The pump can be powered in forward or reverse polarity. When the pump is not powered there is a low chance of backflow as there is a significant amount of friction in the pump.

Webcam – Logitech C270 HD

Webcam's are an easy way to record video data. This model has both audio and video capabilities. It can capture at 1280x720 px resolution at up to 30 frames per second. There is no setup required, as most modern PCs should be able to automatically detect and install drivers for it. Most Machine Learning libraries will be able to extract data directly from the camera.

In case you are defining your own network, Accord.NET's implementation of DirectShow can be used to directly extract frames from the camera in C#. Windows 7 SDK also includes DirectShow that is useable with C++. DirectShow is Window's native solution for interfacing with video devices. OpenCV should also have video interface libraries. These libraries are needed for communication as the size of raw image data is quite large.

It is not feasible to use serial COMM ports for IO. At 20FPS, 8 seconds of footage generates 160 bitmap frames, taking 150MB of space.

If basic image capture is needed:

Refer to demo camera stream project using Accord.Video.DirectShow.

If fine control needed:

Here is some documentation on DirectShow as a starting point:

http://www.aforgenet.com/framework/features/directshow_video.html

https://csharp.hotexamples.com/site/file?hash=0x1f0400659d2c8deb732fac3a5bfd3c74cab2f4026f7b6501dafeb19052e323c5

DirectShow Examples from SDK available

OpenCvSharp is also an option, and may have a lighter learning curve:

https://github.com/shimat/opencvsharp/wiki/Capturing-Video