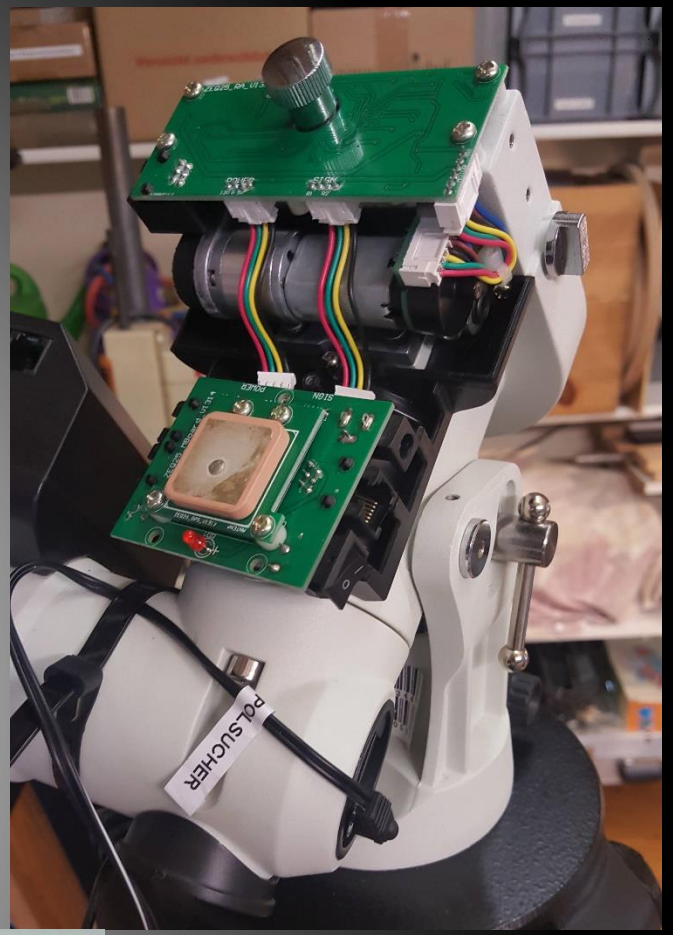
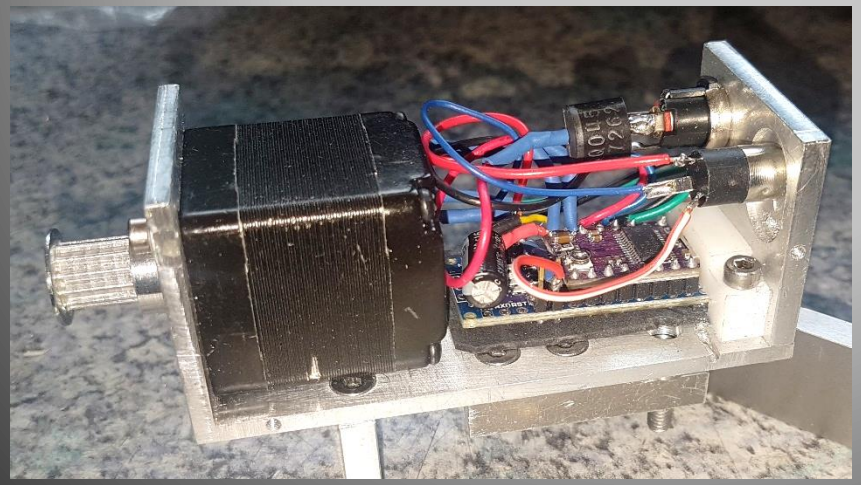
Schrittmotoren in der Astropraxis

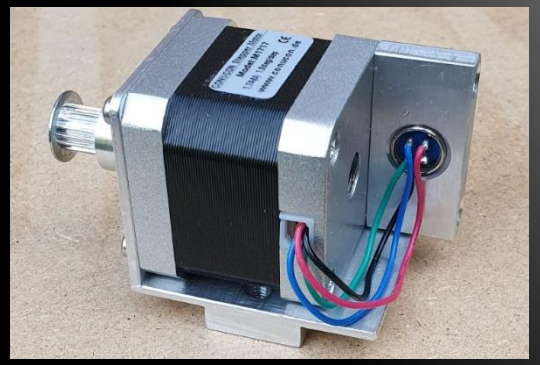
- häufig anzutreffen
- enorm „praktisches Bauteil“
- Verständnis kann helfen Problem zu vermeiden

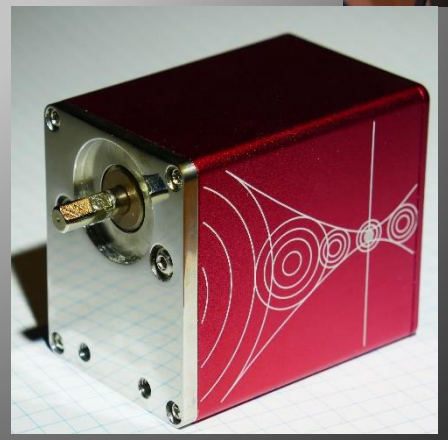
Kai Wicker, Bremen, kai@photonenfangen.de

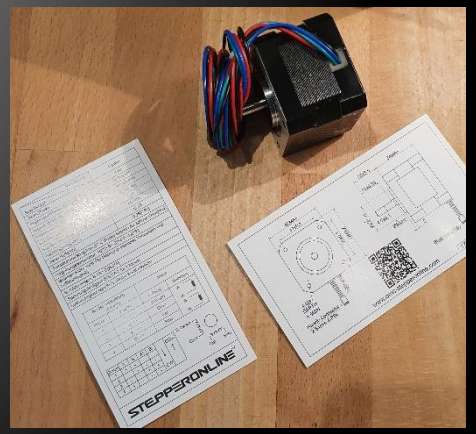
Schrittmotore
Beispiele





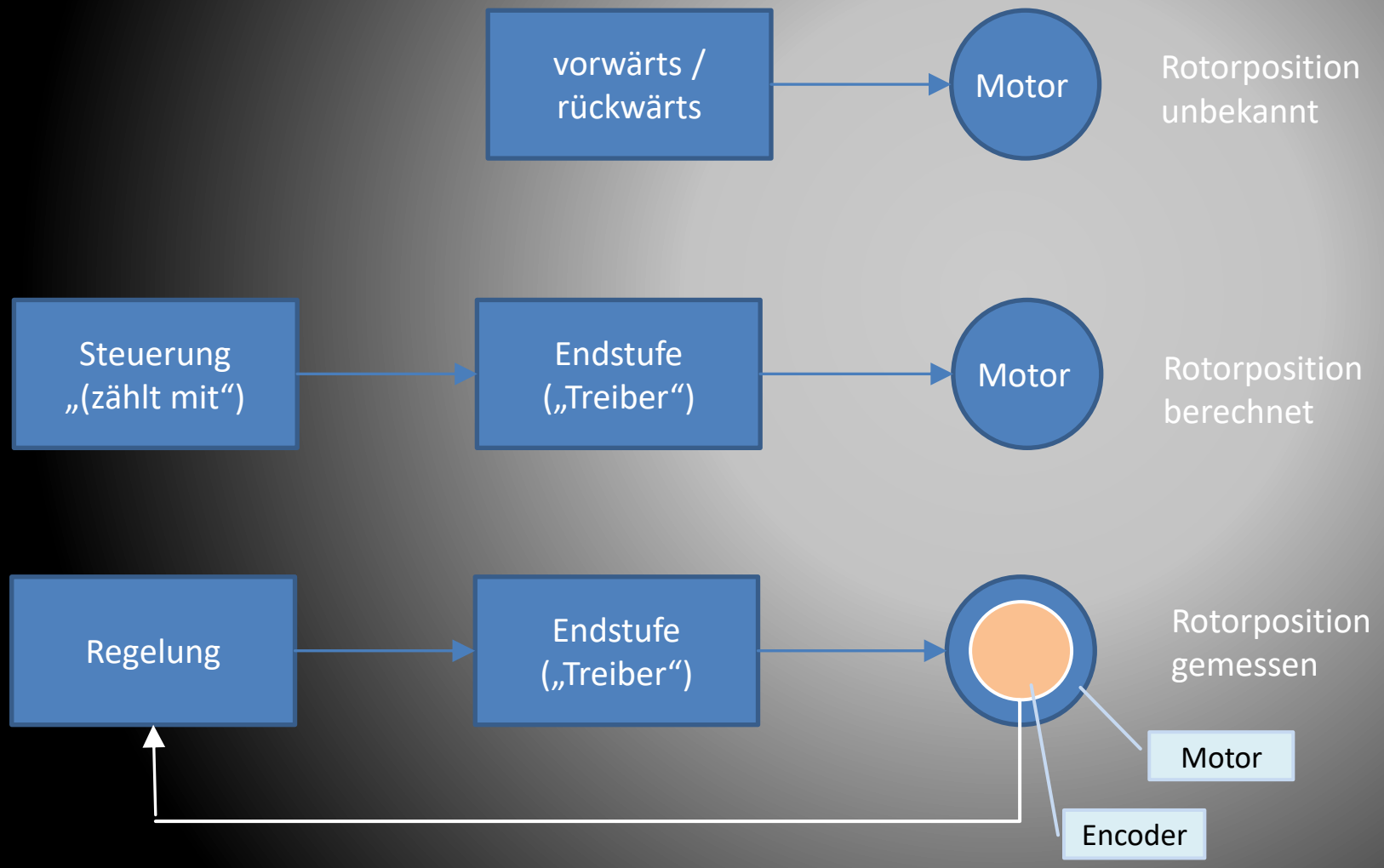






Schrittmotoren

Steuerung – Regelung



www.teleskop-express.de

Nanotec

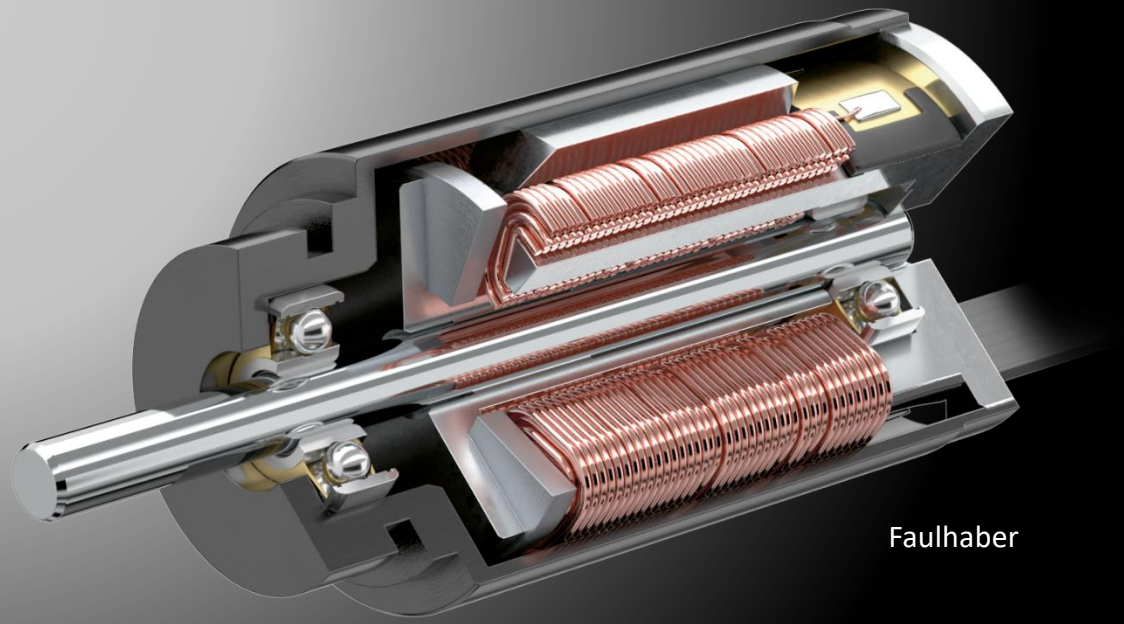
Schrittmotoren

Vorteile:

- einfach aufgebaut und zuverlässig, wartungsarm
- im Stillstand hat der Motor das volle Drehmoment
- kostengünstig
- gutes Anlauf-, Stopp- und Rückwärtsverhalten

Nachteile:

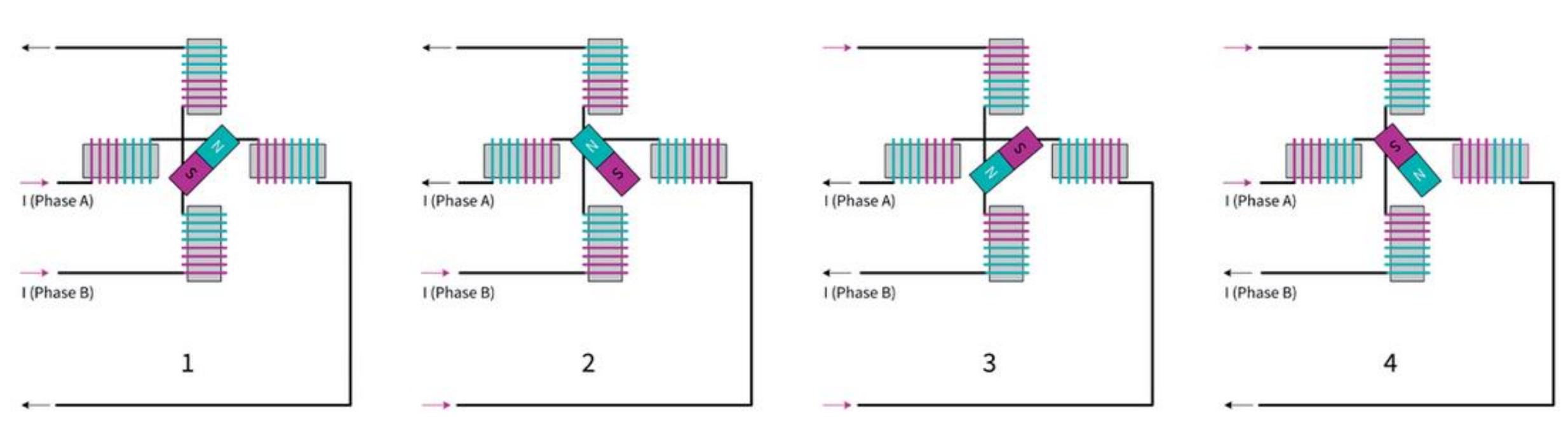
- höherer Strombedarf als der Gleichstrommotor
- Drehmoment fällt mit steigender Drehzahl
- geringere Effizienz
- Resonanzneigung



Faulhaber

Schrittmotoren

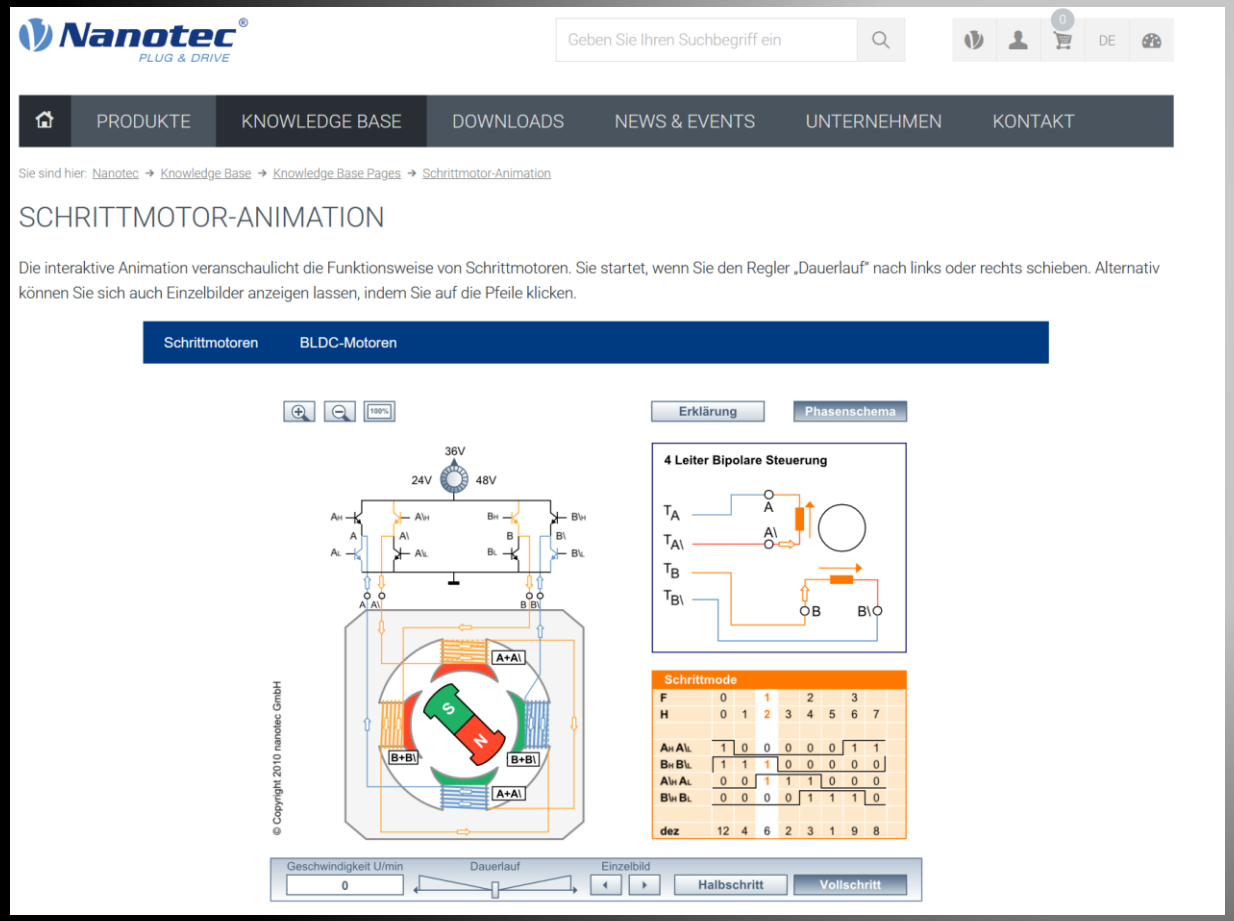
Funktionsprinzip – Vollschritt



Schrittmotoren

Nanotec Knowledge Base

https://de.nanotec.com/knowledge-base/schrittmotor-animation

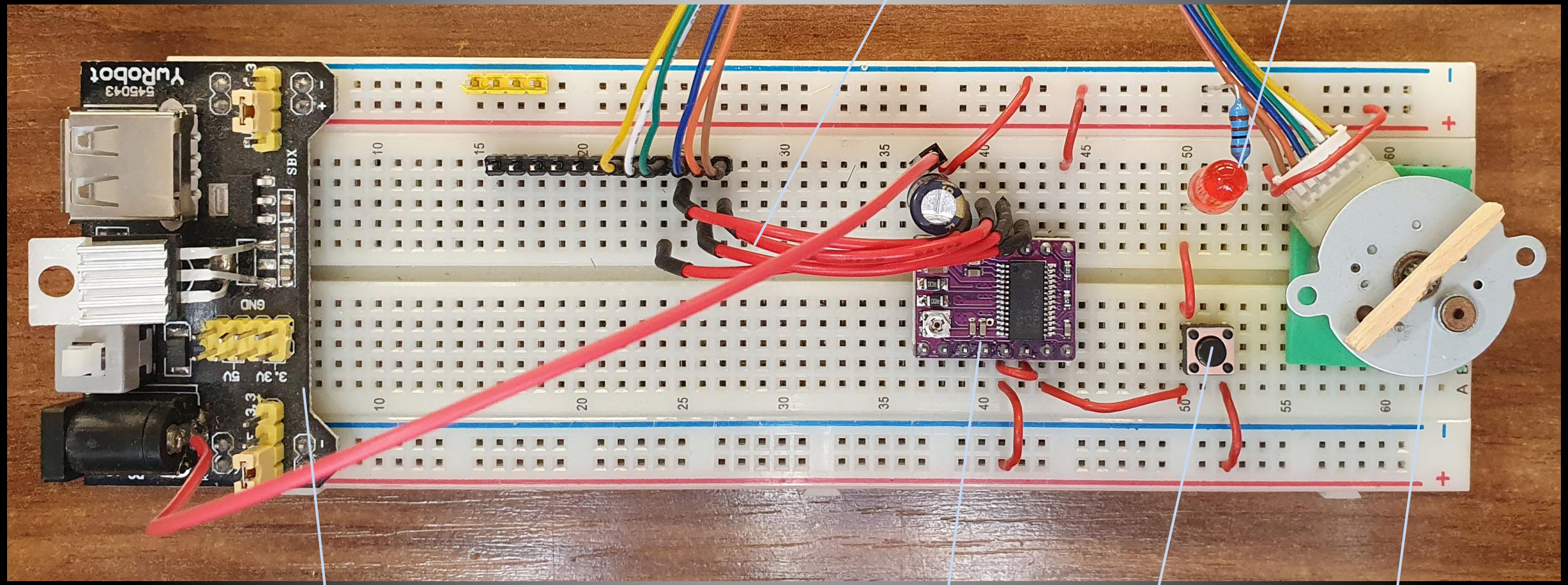


Auswahl / Bedienung der Seite:

- *bipolar / 4 lead*
- *Phasenschema*
- *Vollschritt*

Schrittmotoren

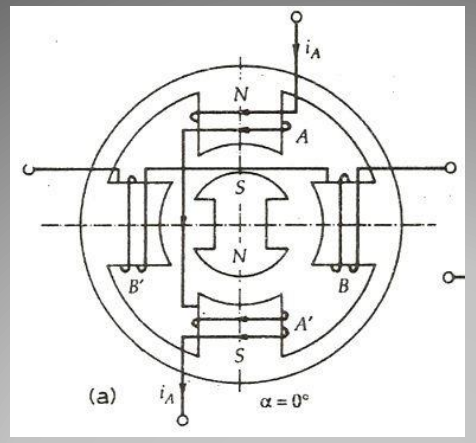
Vollschritt – ein Experiment



Schrittmotoren
häufigste Typen

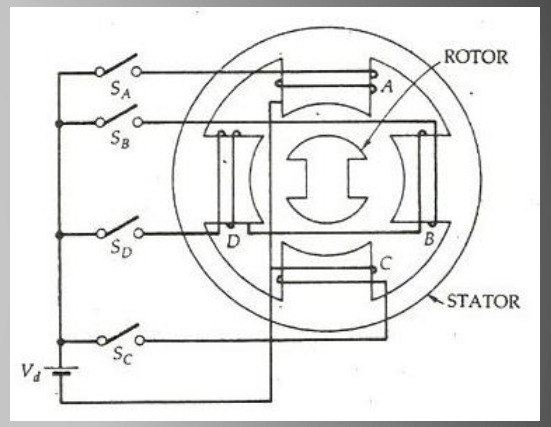
- Permanentmagnetschrittmotor

https://illustrationprize.com

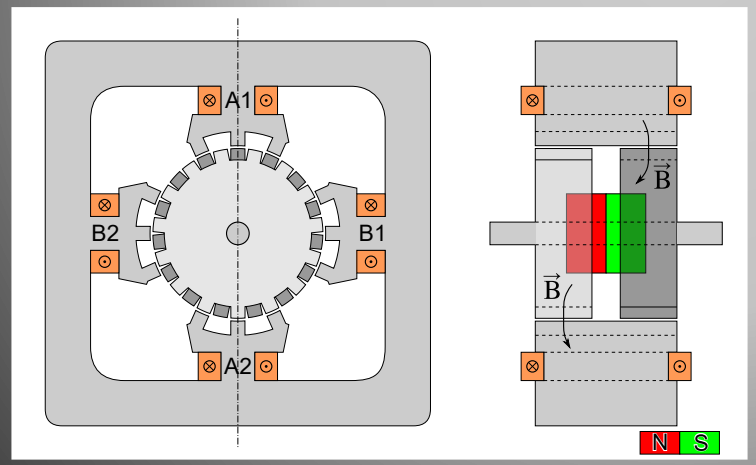


- Reluktanzschrittmotor

https://illustrationprize.com



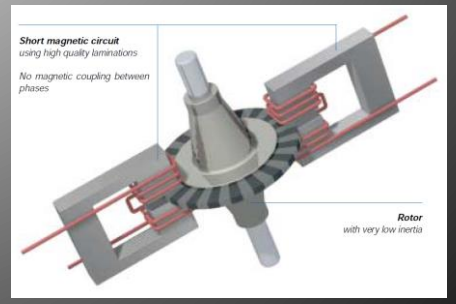
- Hybridschrittmotor



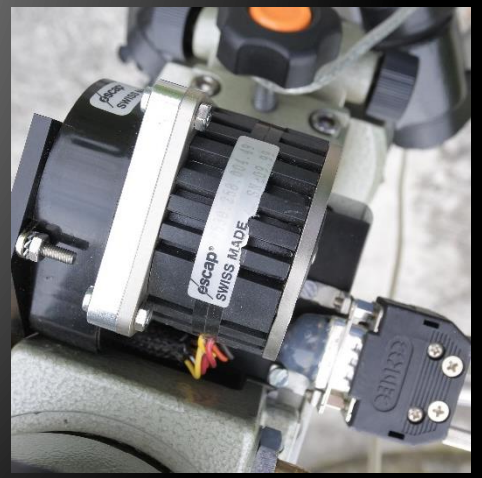
Von Stündle - Eigenes Werk, Gemeinfrei,
https://commons.wikimedia.org/w/index.php?curid=11545846

- Scheibenmagnet-Schrittmotoren

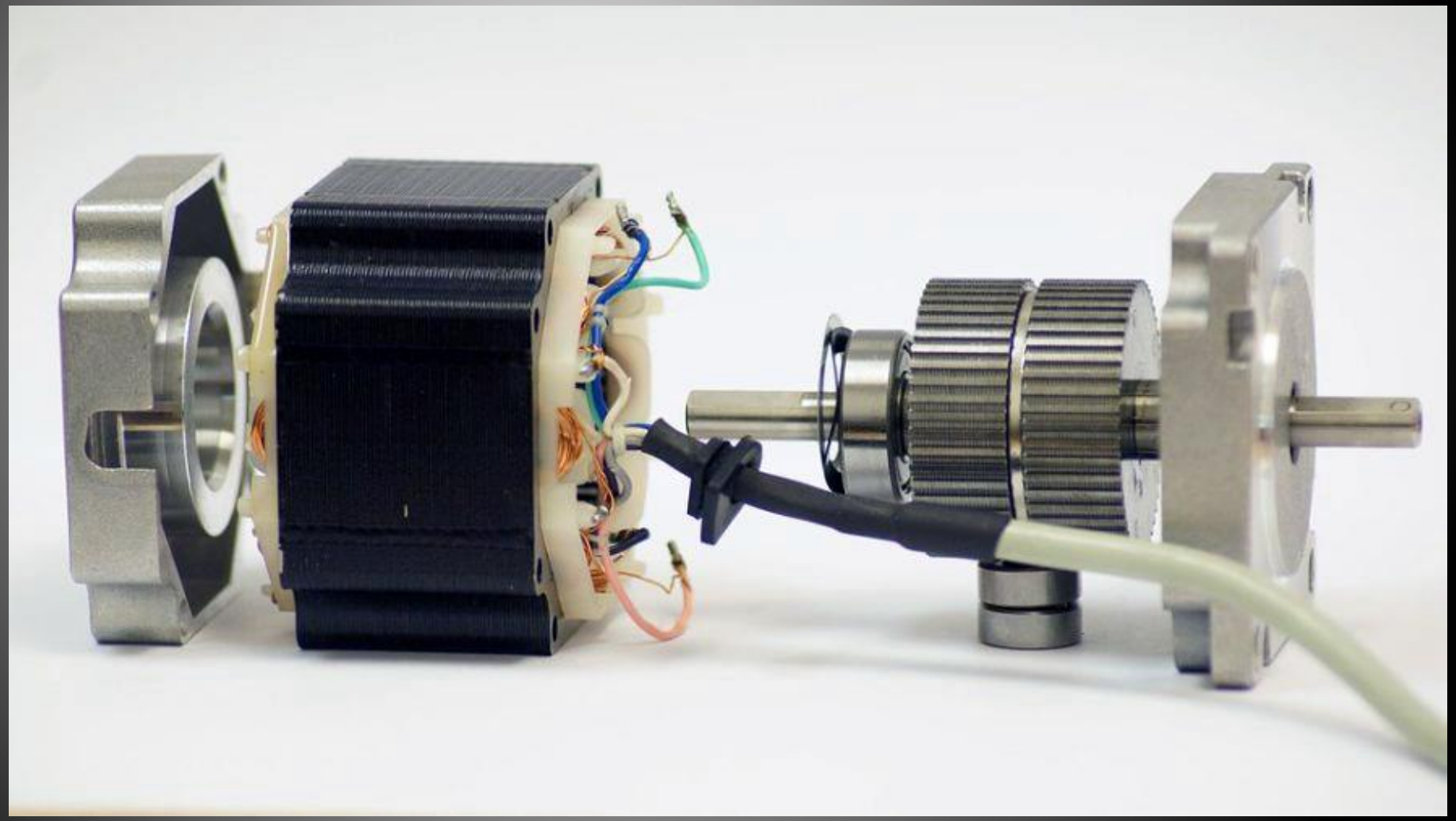
Portescap



Ruddeck



Beispiel Hybridschrittmotor
nicht nachmachen!

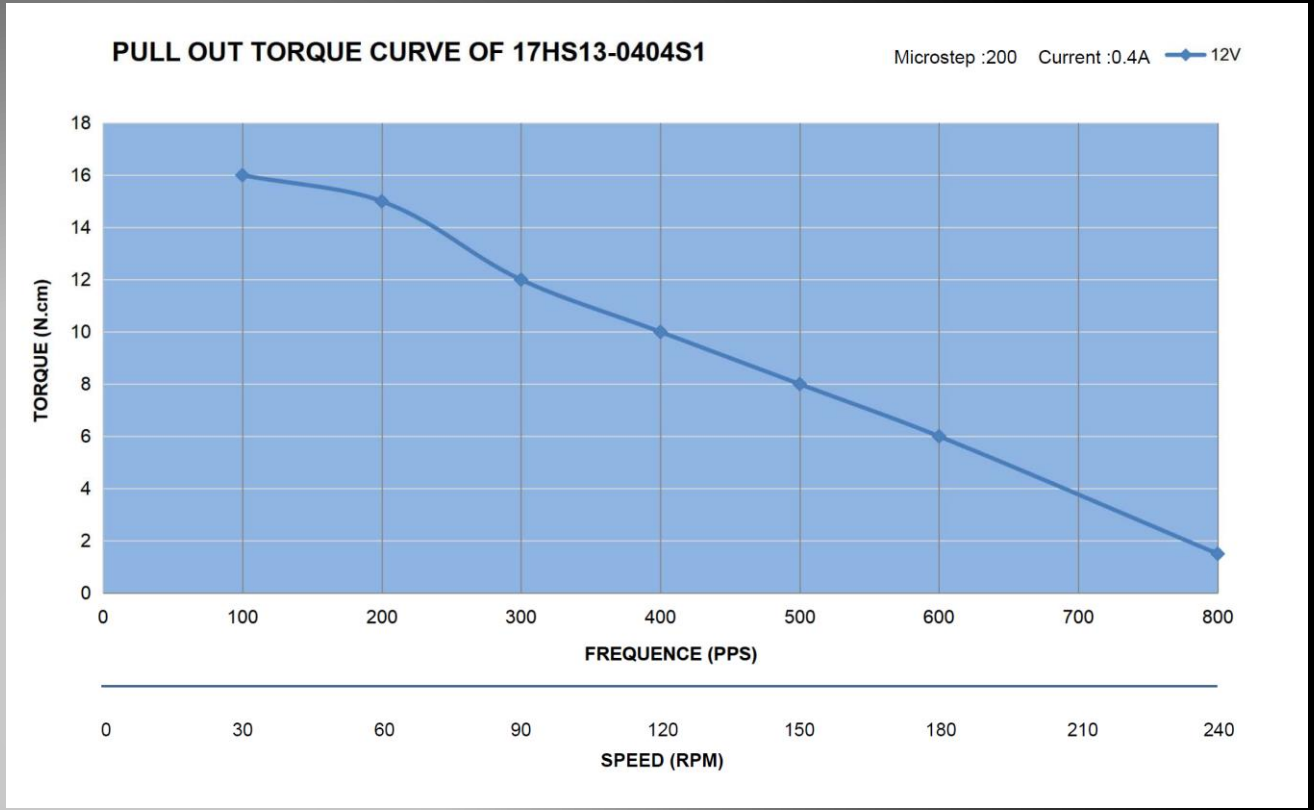


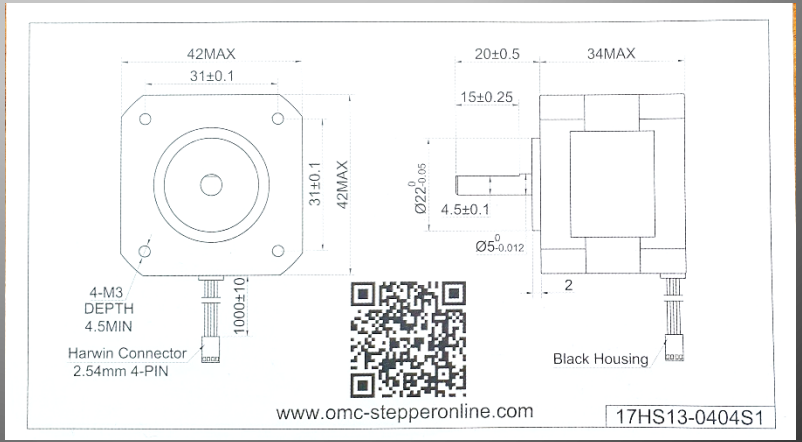
https://www.deviceplus.com/arduino/how-to-control-a-step-motor-with-an-arduino

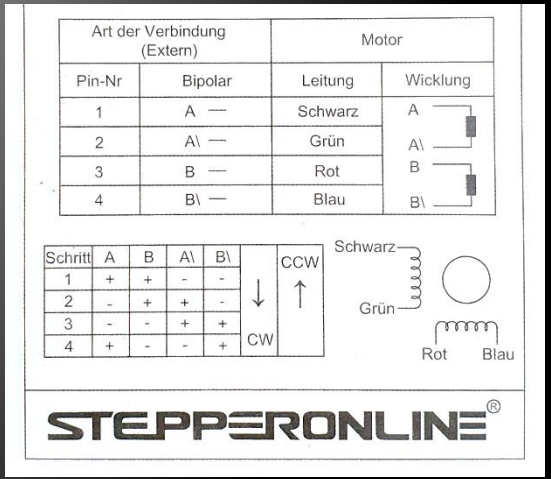
Schrittmotor - Kenngrößen

Beispiel: GP-DX kleine Kuppel

Phasenzahl, Wicklungstypen	**2**
Schrittwinkel	**1,8°**
Phasenstrom	**0,4 A**
Rastmoment	
Haltemoment	0,26 Nm
Drehmoment	
Wicklungswiderstand	**30 Ohm**
Wicklungsinduktivität	37mH @1kHz
Nennspannung	12 V
Rotorträgheitsmoment	38 g cm^2
Temperatur	Delta: 80°
Mechanische Parameter	0,28 kg
Bauform	NEMA14

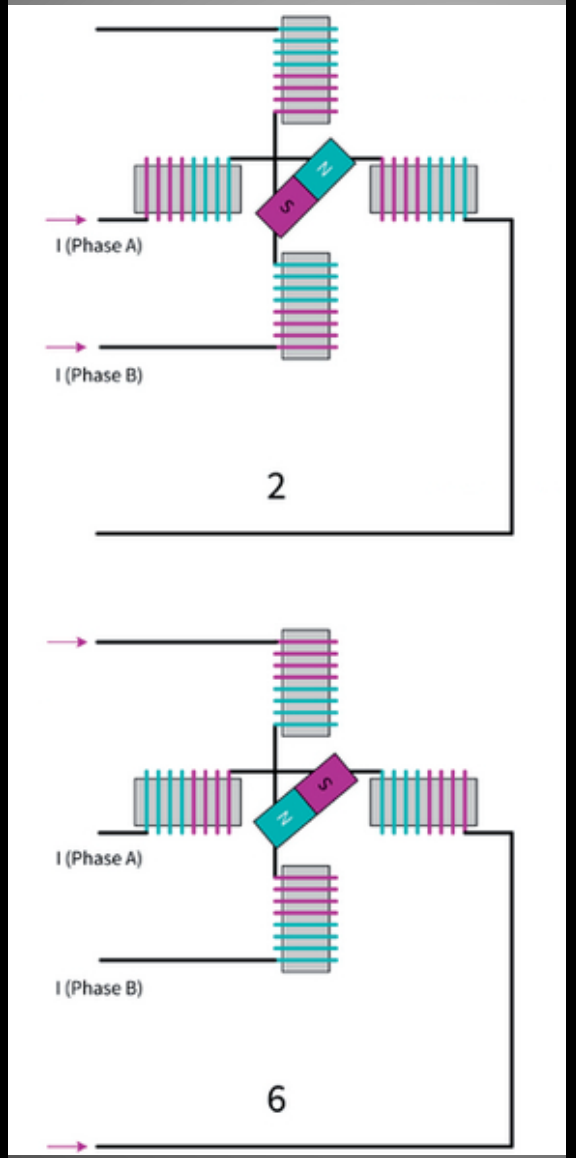




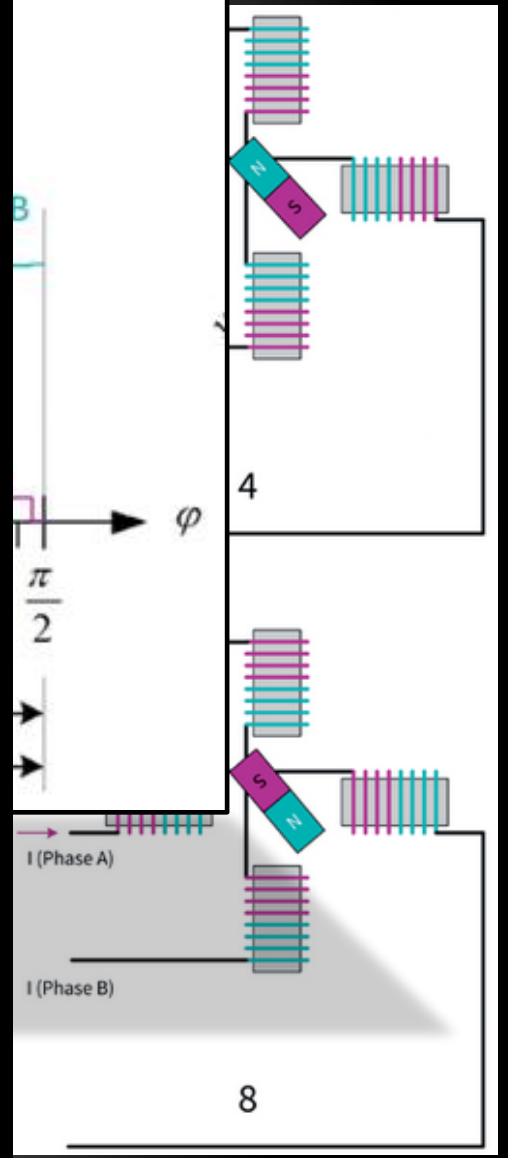


Schrittmotoren

Funktionsprinzip – Vollschritt



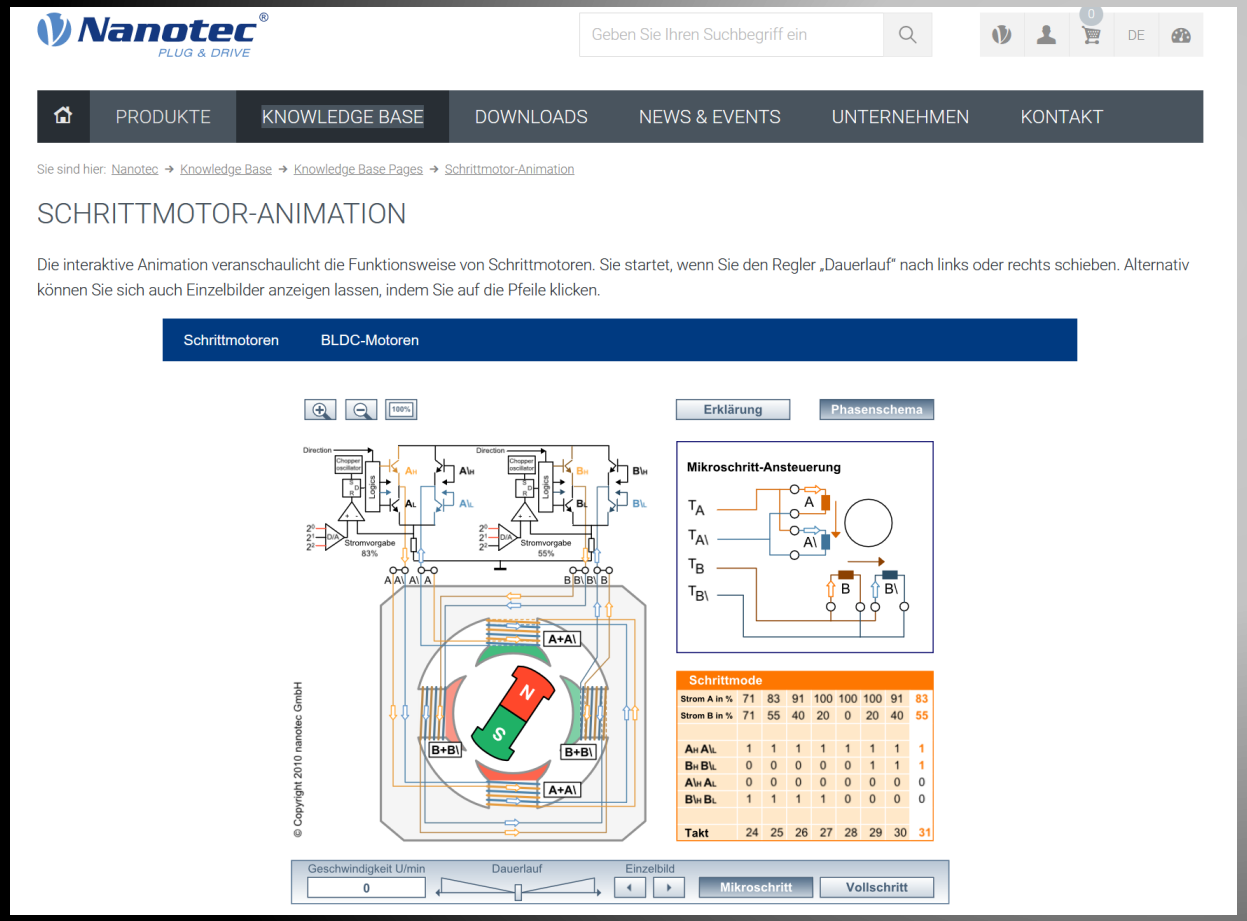
Mikroschritt



Schrittmotoren

Nanotec Knowledge Base

https://de.nanotec.com/knowledge-base/schrittmotor-animation



Auswahl / Bedienung der Seite:

- *Mikroschritt*
- *Phasenschema*
- *erst Vollschritt*
- *dann Mikroschritt*

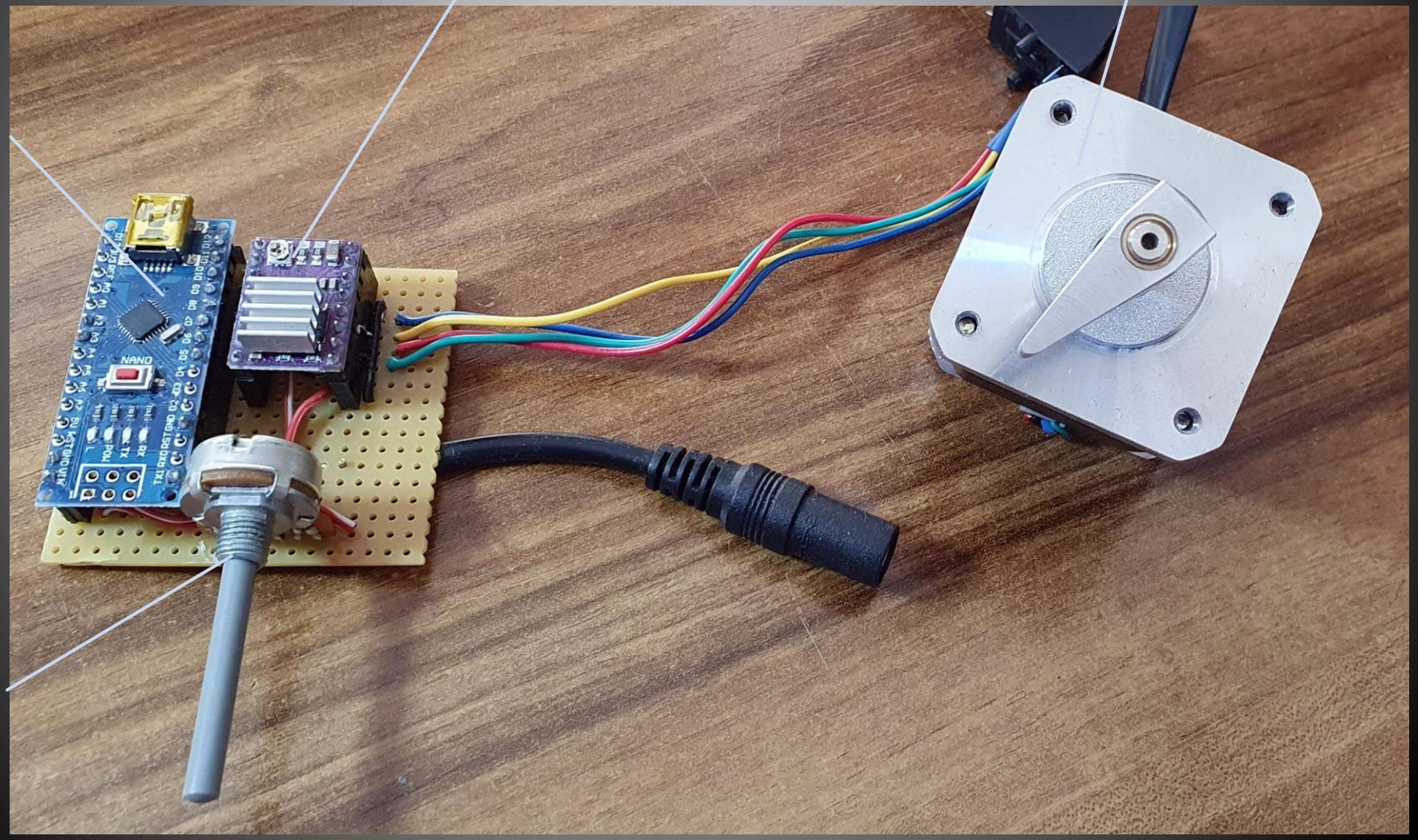
Schrittmotoren

Demonstration Mikroschrittbetrieb

Treiber
(DRV8825)

unipolarer NEMA 17 Hybridmotor
1.8° pro Step
1.7 A

Steuerung:
- Arduino nano
- Testprogramm
- Mikroschrittbetrieb über Interface steuerbar



Potentiometer zur Einstellung der Taktfrequenz (Drehzahl)

Schrittmotoren
Schrittwinkel im Schrittmotor

Der Schrittwinkel ist der Winkel, um den sich der Rotor eines Schrittmotors bewegt, wenn *ein Impuls an den Eingang der Steuerung* angelegt wird.

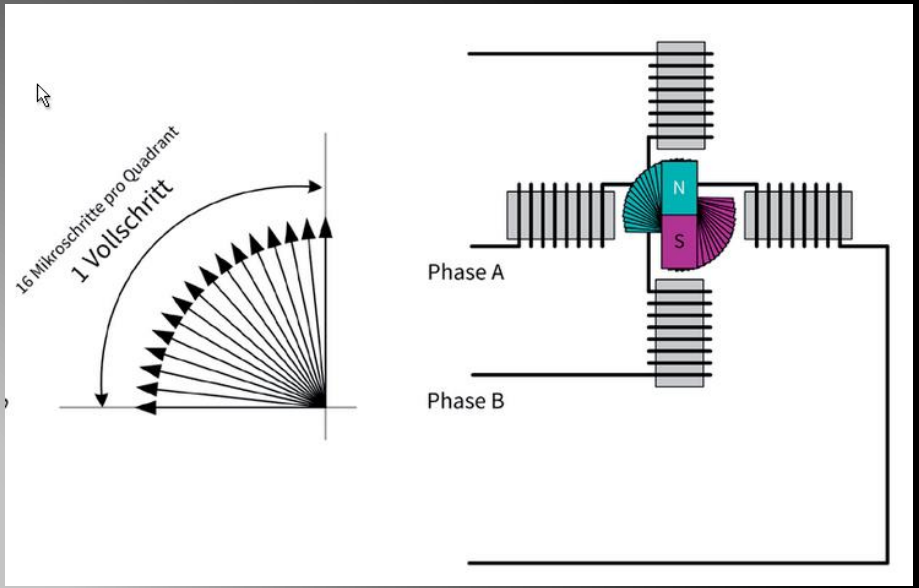
Die Genauigkeit der Positionierung des Rotors durch den Motor hängt von der Auflösung ab.

Es gilt aber nicht: Je höher die Auflösung, desto höher ist die Genauigkeit.

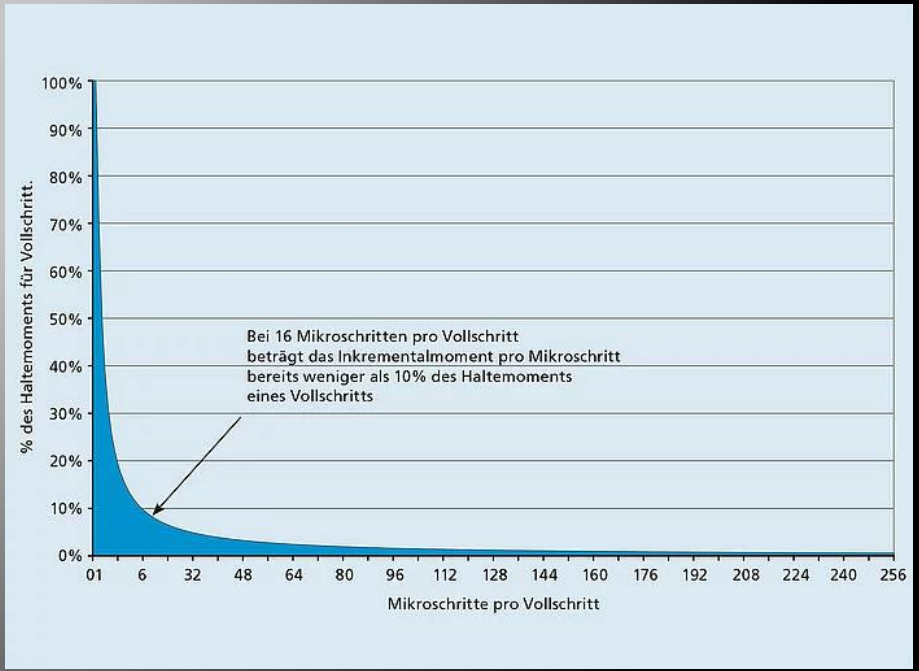
Schrittverlust:
Der Motor folgt einem oder mehreren Schritten nicht mit dem Rotor.

Demonstrationen:

- *„Schrittverlust“*
- *Rampensteuerung*

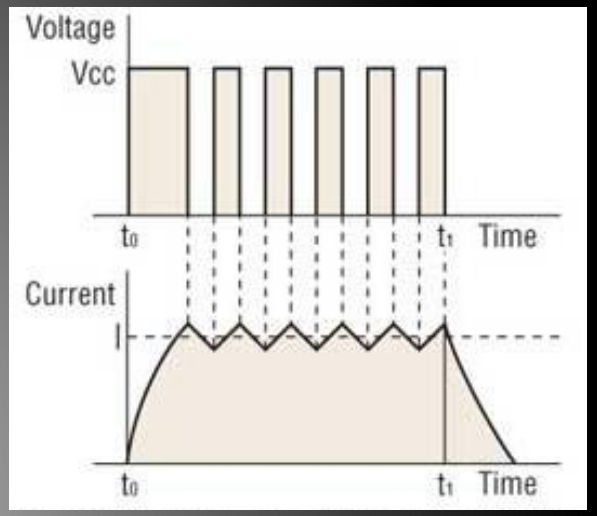


www.trinamic.com

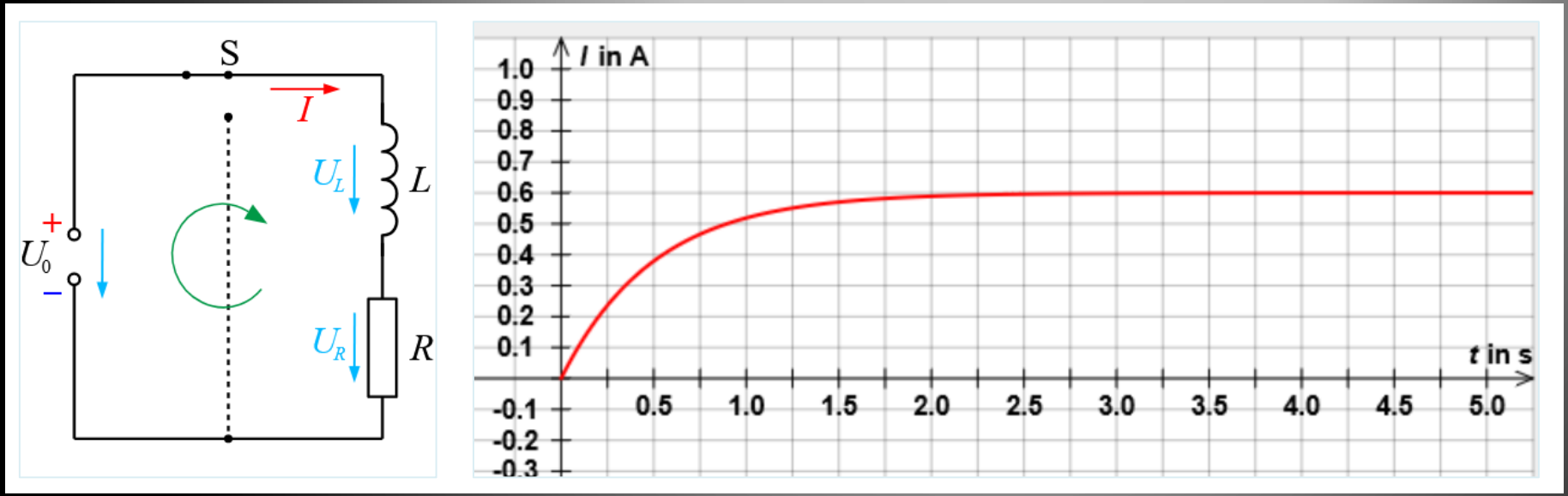


www.faulhaber.com

Schrittmotoren
Spannung und Strom



fab.cba.mit.edu/classes/865.21/topics/power_electronics/architectures



www.leifiphysik.de/elektrizitaetslehre/elektromagnetische-induktion/grundwissen/ein-und-ausschalten-von-rl-kreisen

Schrittmotoren
Designbeispiel

Enter your values in the green areas, results which are outlined have equivalents in OnStep's Config.h file.
Hard limits are in red, OnStep won't function properly if they aren't adhered too. Other limits are recommendations. Note that "µs" = micro-seconds.

Axis1 is for Right Ascension or Azimuth
Axis2 is for Declination or Altitude

		Stepper-Steps	**AXIS1_DRIVER_ MICROSTEPS**	Gear Reduction GR1 (Other stages)	GR2 (Final stage)
AXIS1_STEPS_PER_DEGREE	**51200,00000**	400	128	2,5	144
AXIS2_STEPS_PER_DEGREE	**51200,00000**	400	128	2,5	144
	<= 61200		**AXIS2_DRIVER_ MICROSTEPS**	*A planetary gear-box for example.*	*A worm/wheel for example.*
AXIS1_STEPS_PER_WORMROT	**128000**				

Stepper Motor shaft speeds
Axis1 (RA/Azm)
300,0 RPM
5,0 RPS
2,0 kHz (full step)
Axis2 (Dec/Alt)
300,0 RPM
5,0 RPS
2,0 kHz (full step)

				Tracking resolution (in arc-sec) Calculated	Estimate	
SLEW_RATE_BASE_DESIRED	5,00	°/s	Axis1	0,07	0,44	<= 1.25
	1200		Axis2	0,07	0,44	<= 1.25
	↓			(servo, etc.)	(stepper drive)	

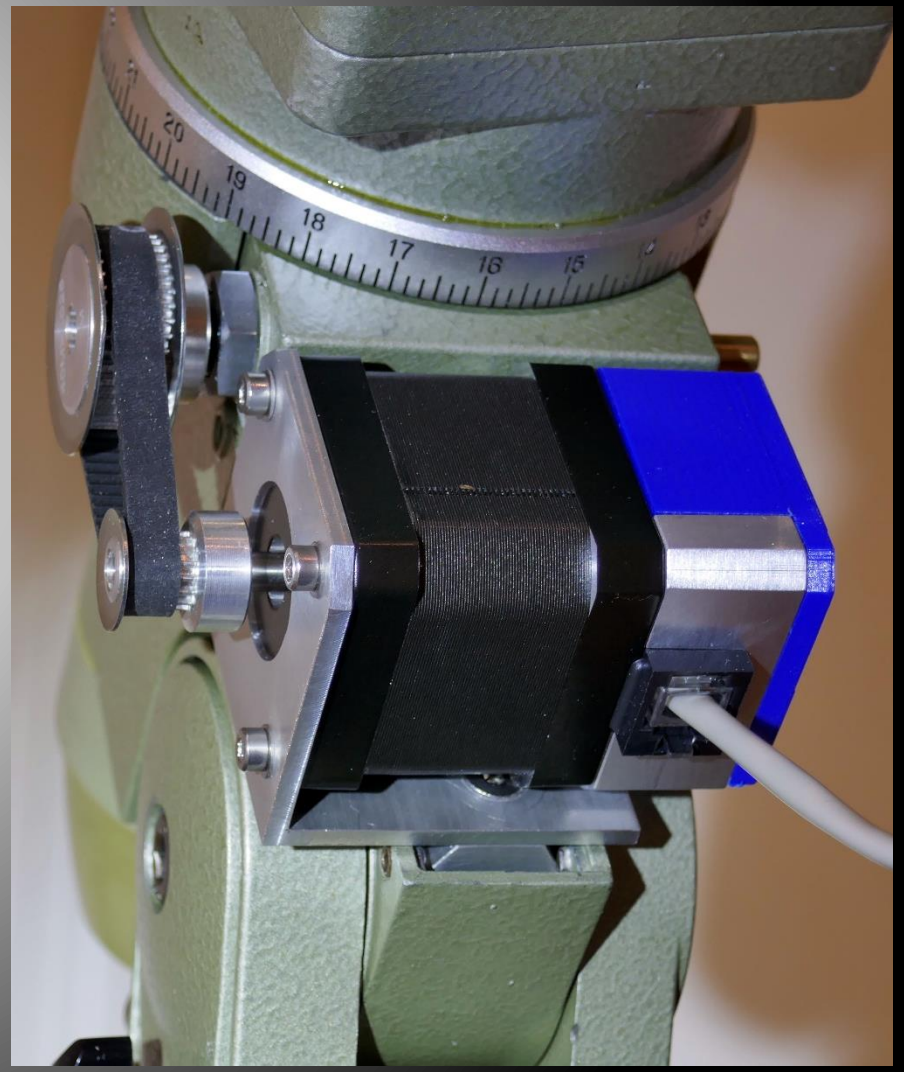
Slowest rate w/run-time adjustment	7,8	µs/step → 2,5°/s slew rate
Fastest rate w/run-time adjustment	2,0	µs/step → 10°/s slew rate

General rate limit* recommendations (in µs/step):
Mega2560 >= 48, STM32 >= 20, ESP32 >= 16,
Teensy3.2 >= 14, T3.5 >= 12, T3.6 >= 2.6, T4.0 >= 1.5
(smaller values are faster, larger values are slower)

* = General rate limits are a basis, other factors can *effectively* allow higher step rates.
if micro-step mode switching can be used, configuring **AXISn_DRIVER_MICROSTEPS_GOTO** allows step rates 2 to 32 times faster, typically (2 to 32 times lower µs/step.)
Step signaling defaults to **STEP_WAVE_FORM SQUARE** for best compatability with s/d drivers.
Using **STEP_WAVE_FORM PULSE** allows step rates 1.6 times faster (1.6 times lower µs/step.)

OnStep will limit slew rates automatically if they exceed your platform's capabilities.

OnStep Configurator Calculator V 1.19



Schluss

Folien dieses Vortrages als Download:

www.photonenfangen.de

Kai Wicker, Bremen, kai@photonenfangen.de