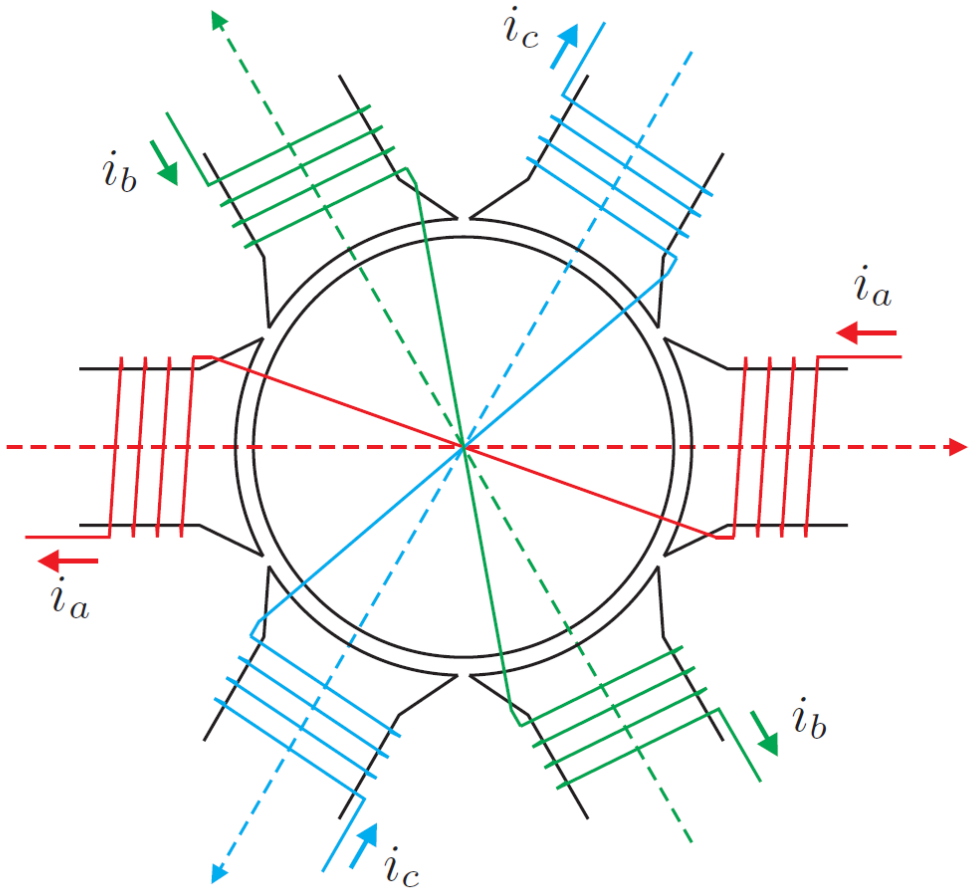
Mechatronic Actuators

Lecture 5b

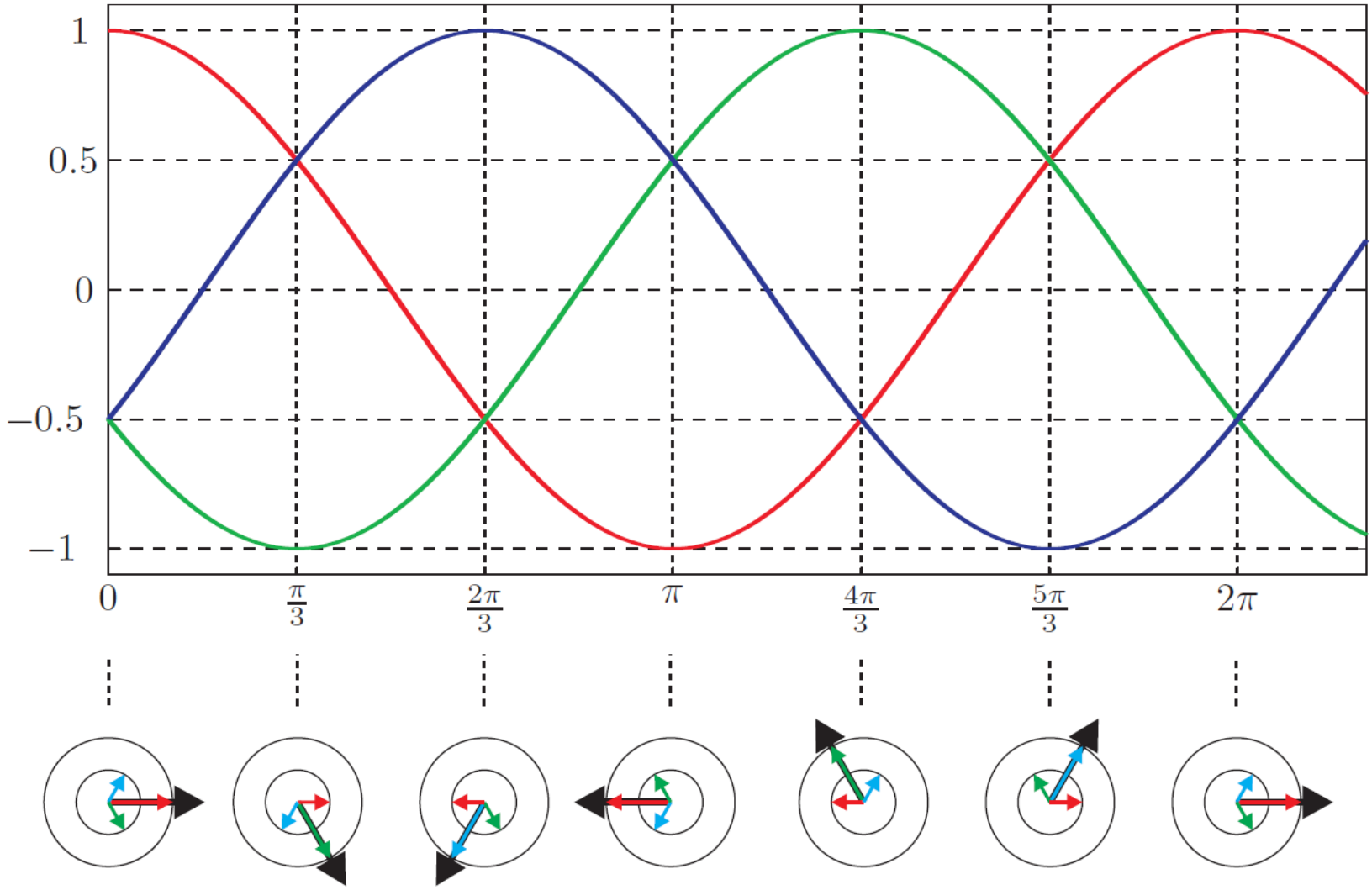
Asynchronous motors

Asynchronous electric motor

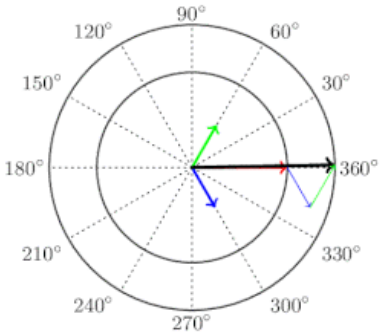
Rotating magnetic field 1

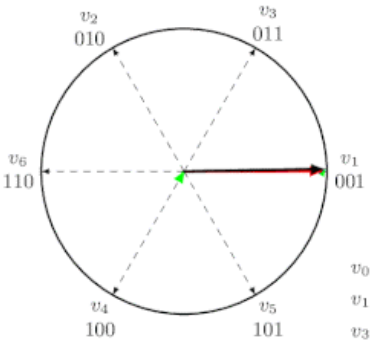


Rotating magnetic field 2



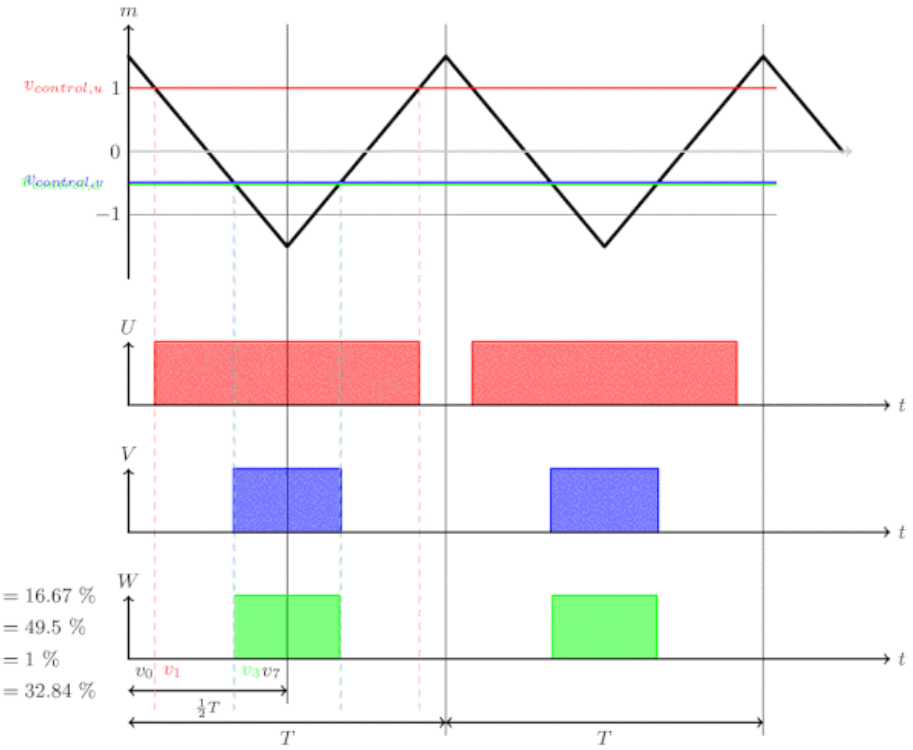
Operation

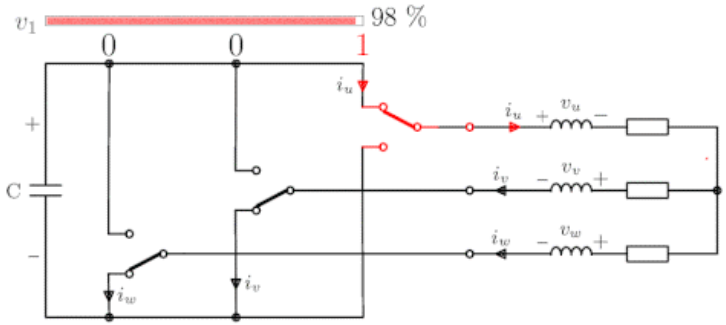


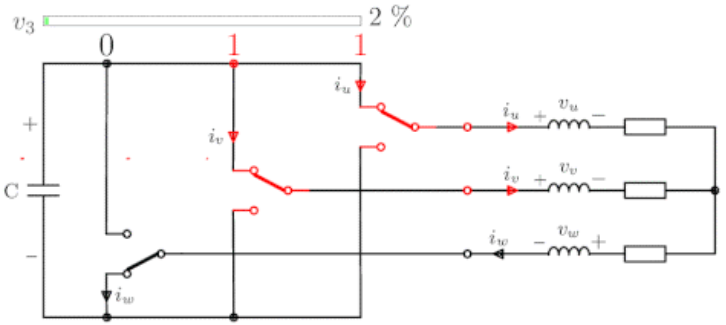


$s = 1$
$\phi = 1°$
$x = 0.98007$
$y = 0.01993$

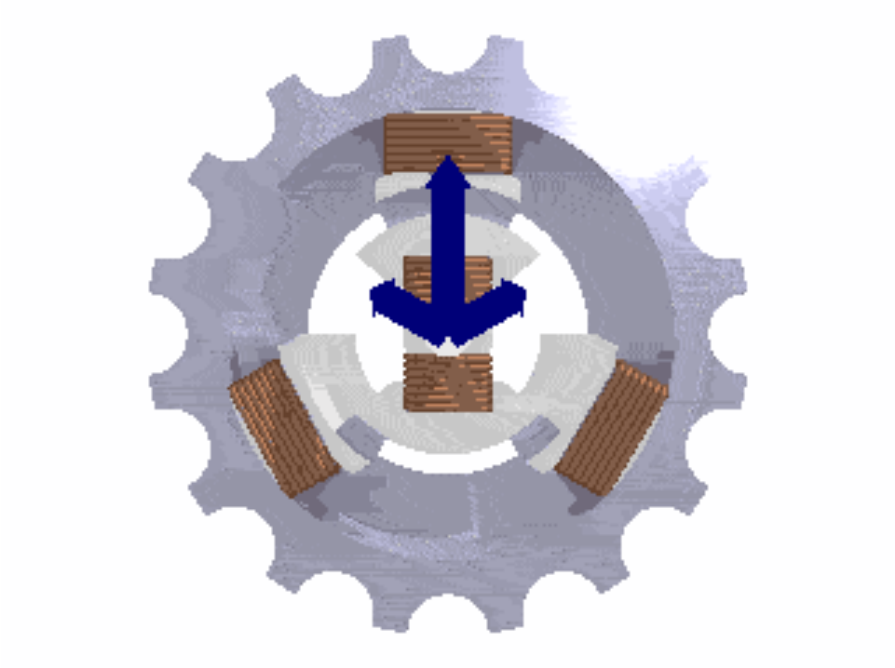
$v_0 = 16.67\ \%$
$v_1 = 49.5\ \%$
$v_3 = 1\ \%$
$v_7 = 32.84\ \%$



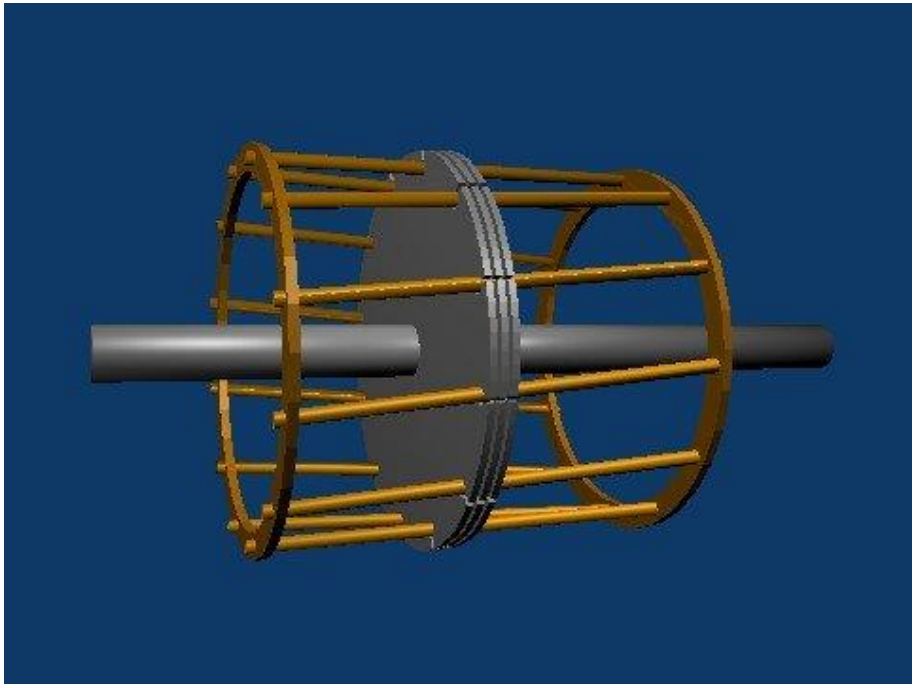


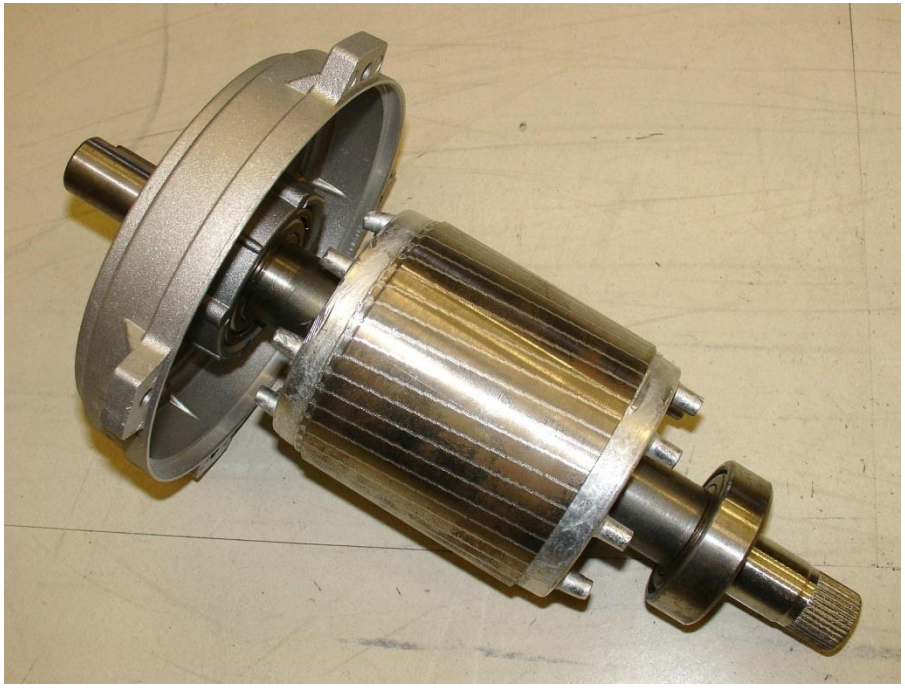


Operation

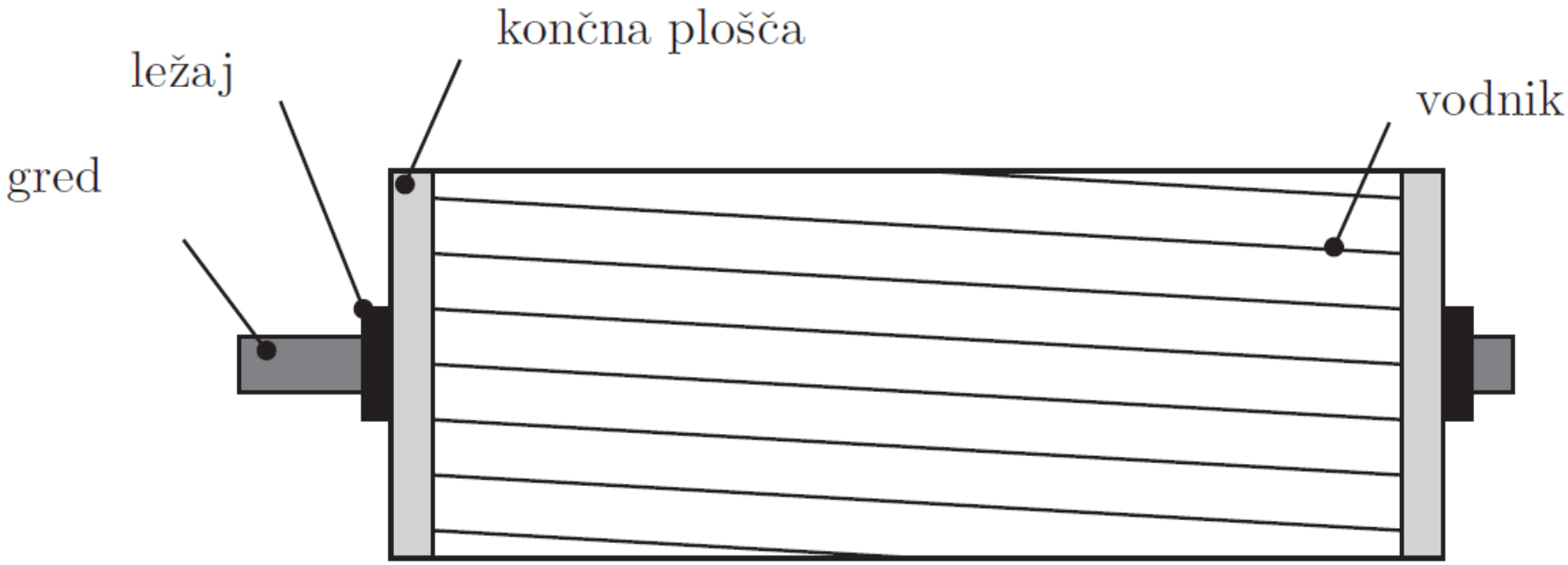


Squirrel cage

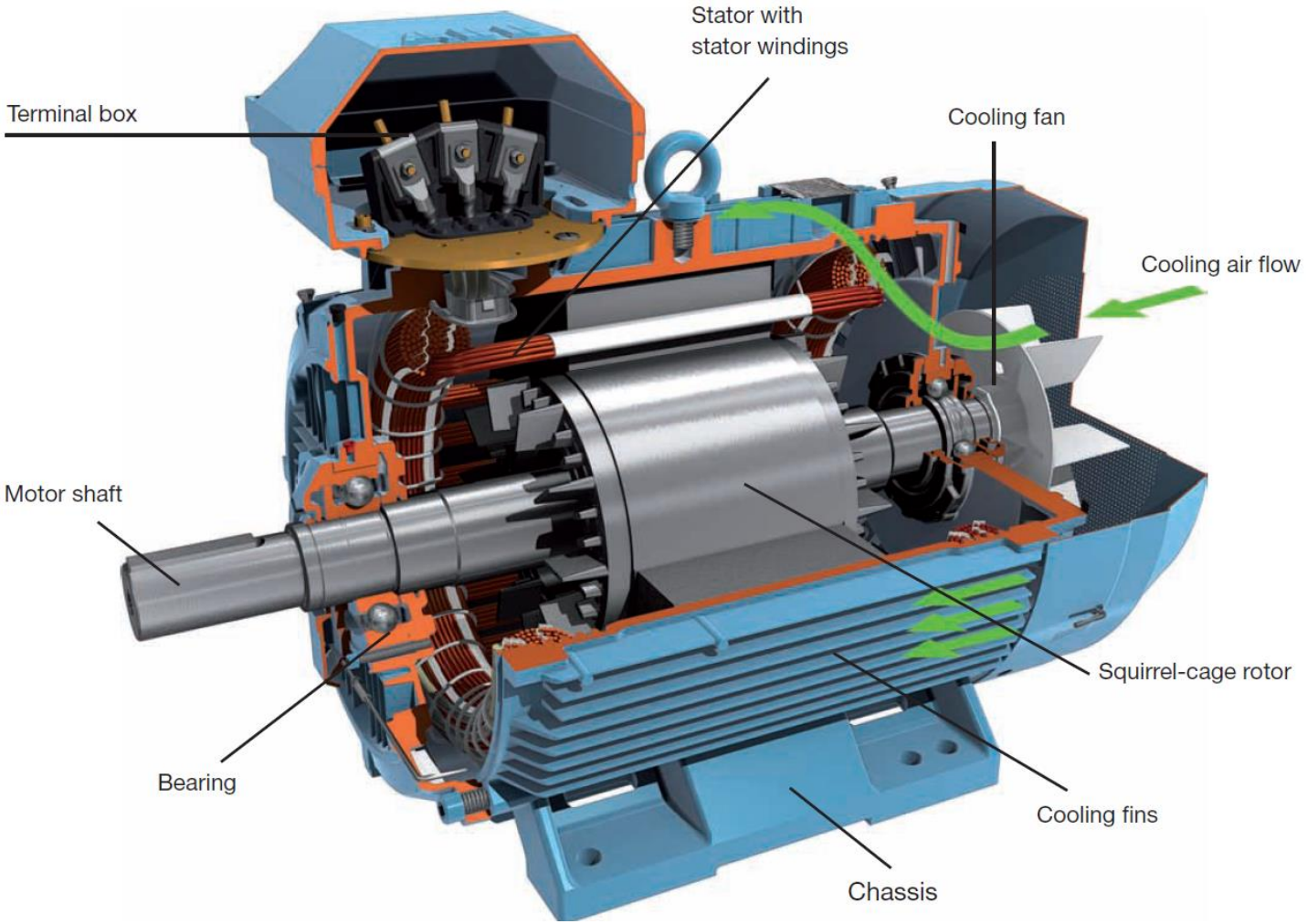




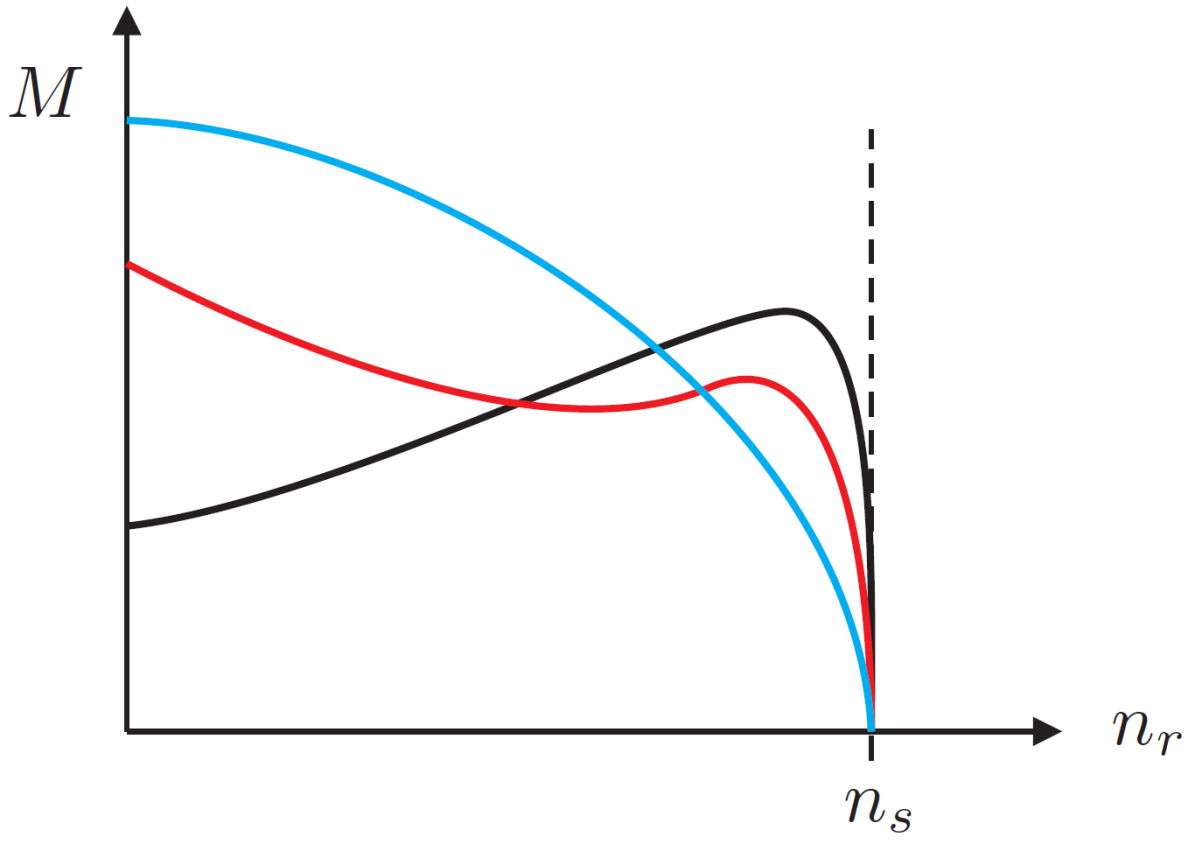
Squirrel cage (schematic)



Detailed composition

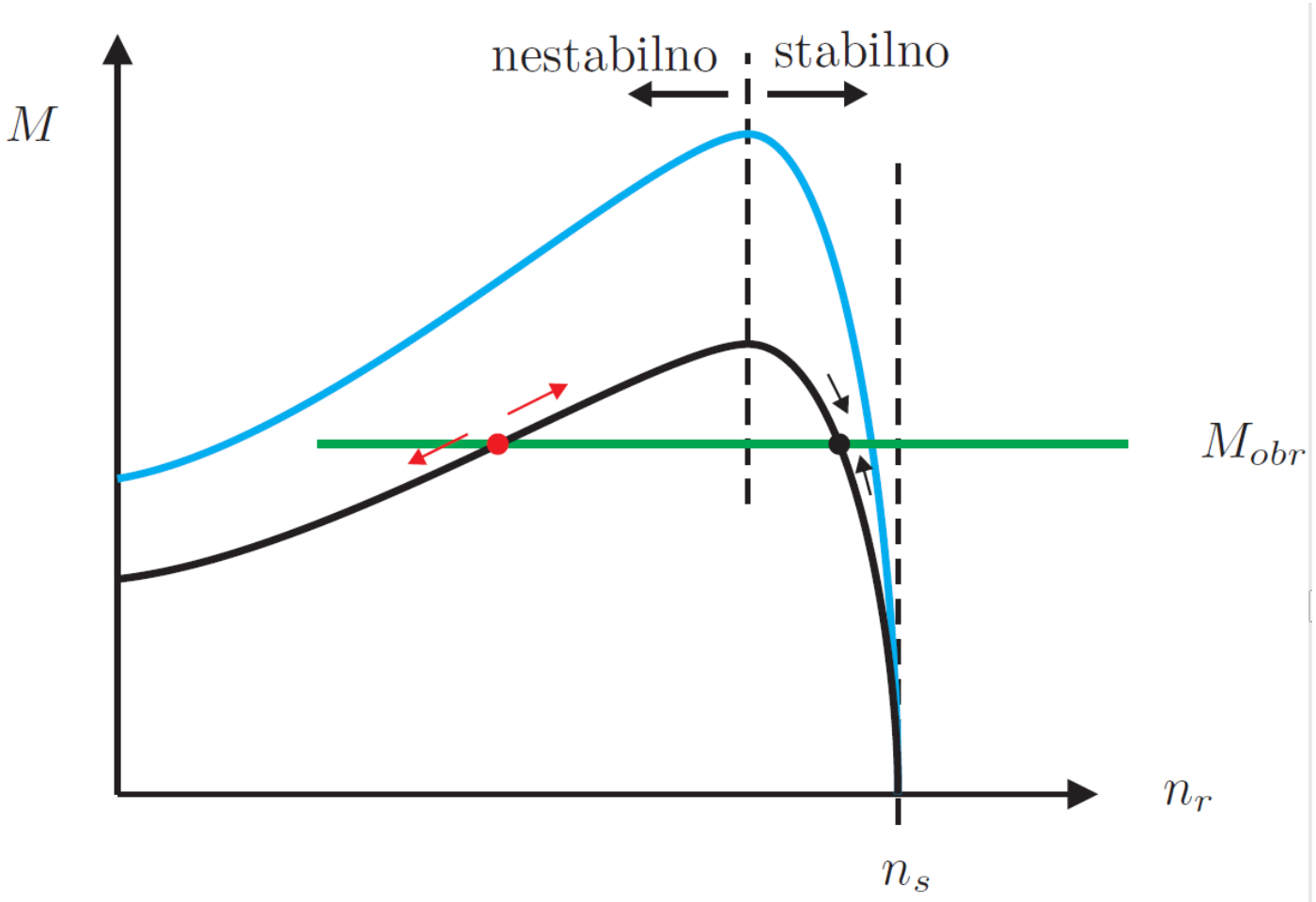


Moment characteristic

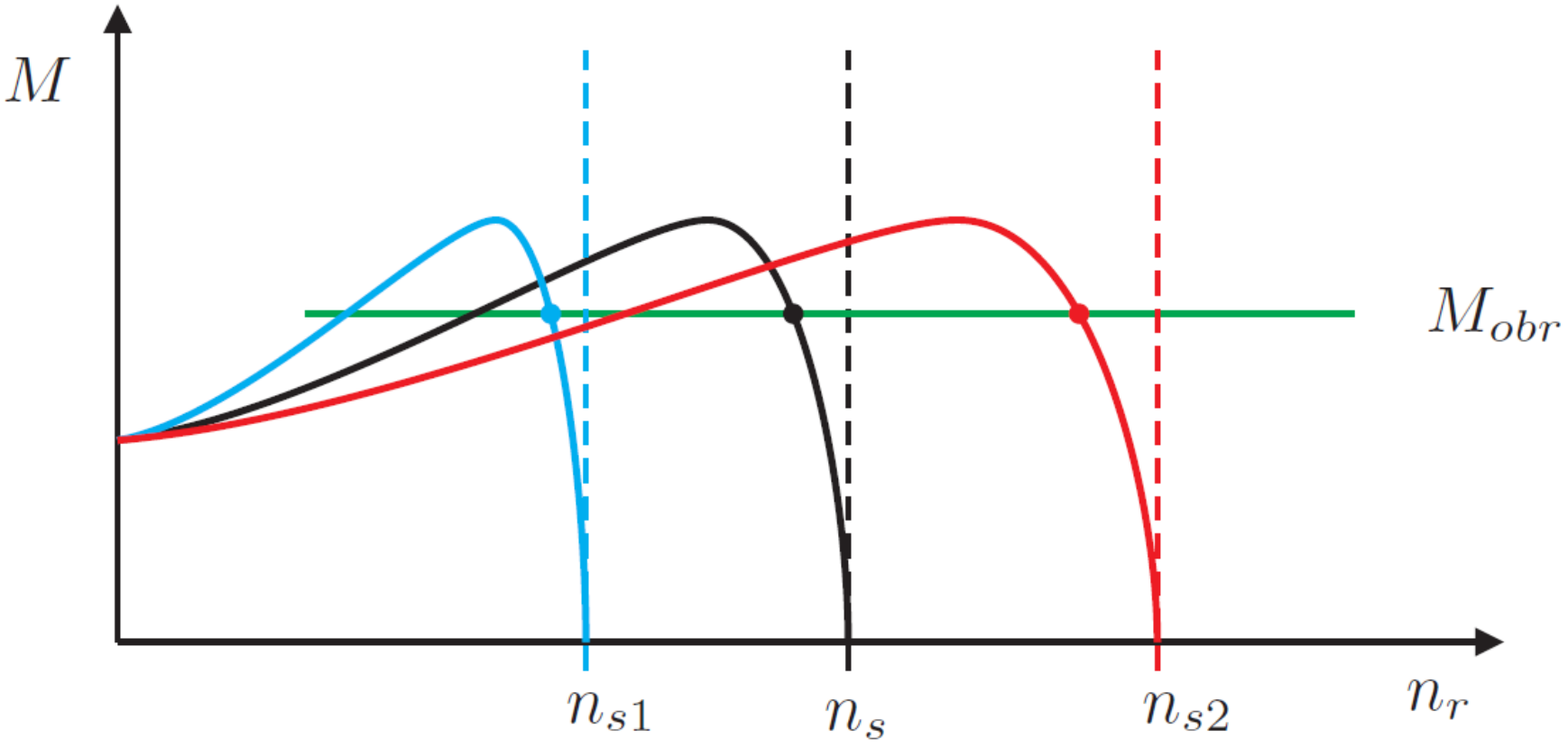


$$s = \frac{n_s - n_r}{n_s} \cdot 100\%$$

Control options (1)

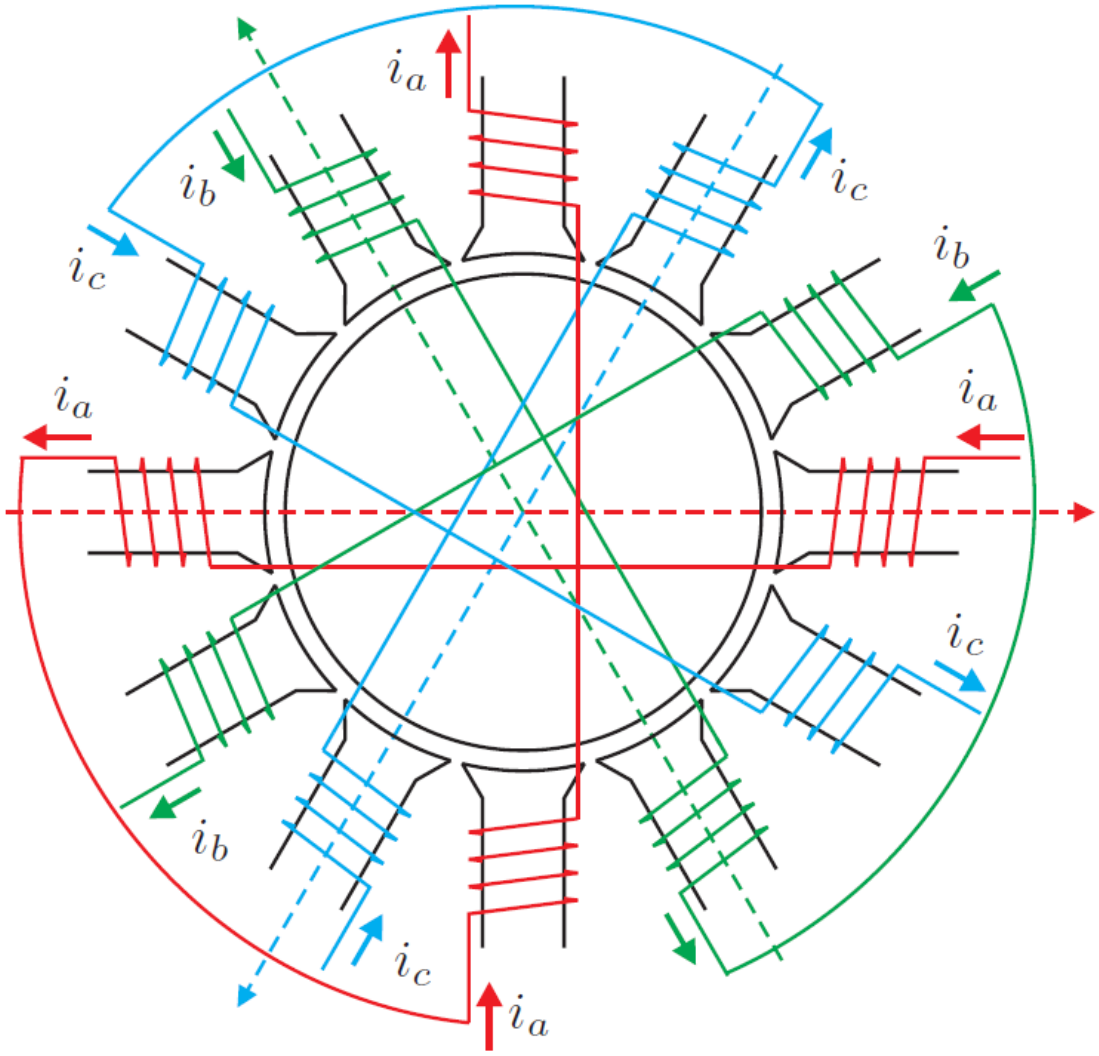


Control options (2)

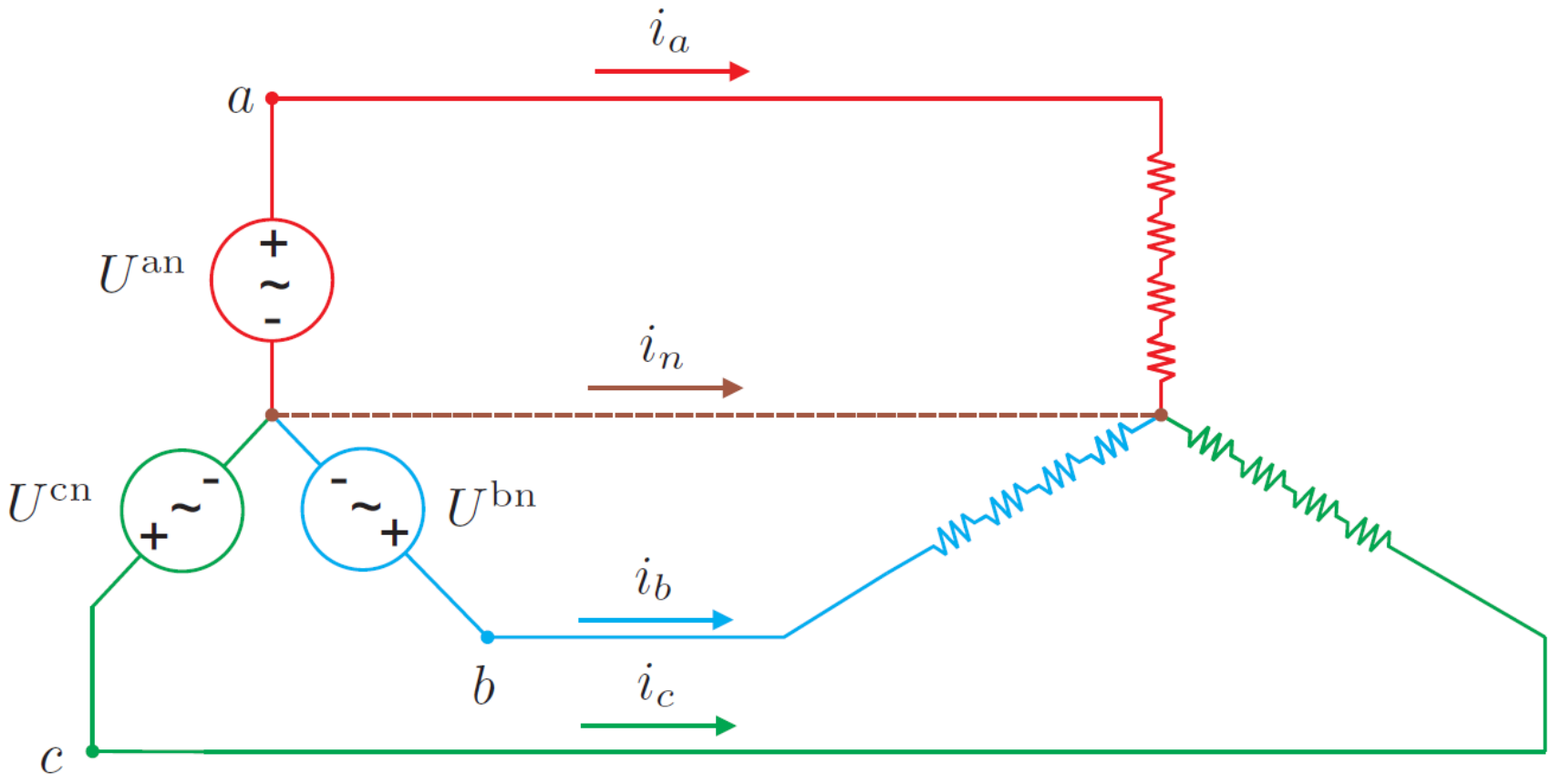


$$n_s = 50 \frac{60 \text{ vrt. na min.}}{1\text{Hz}} = 3000 \text{ vrt. na min.}$$

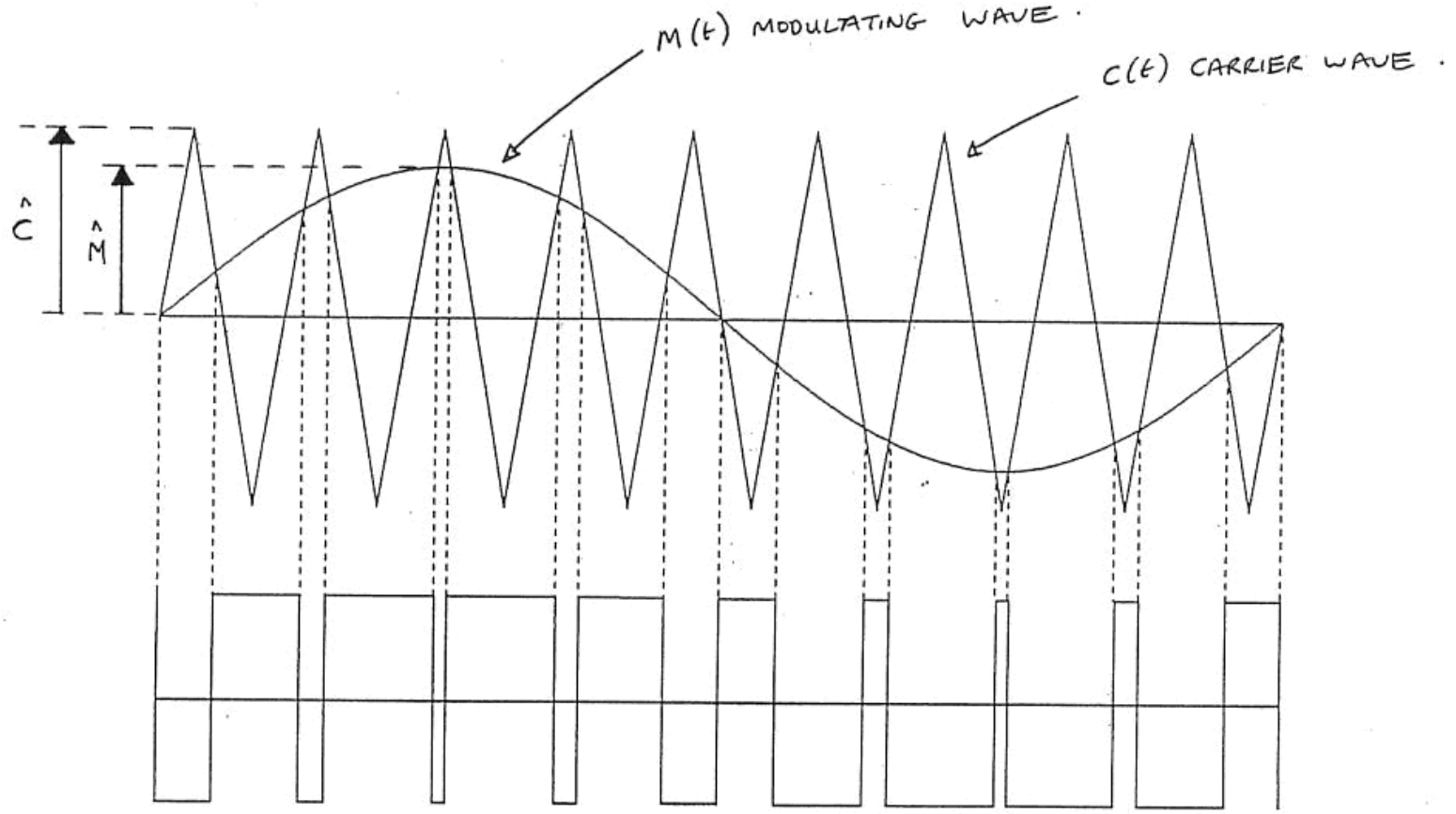
Control options (3)



Control options (4)

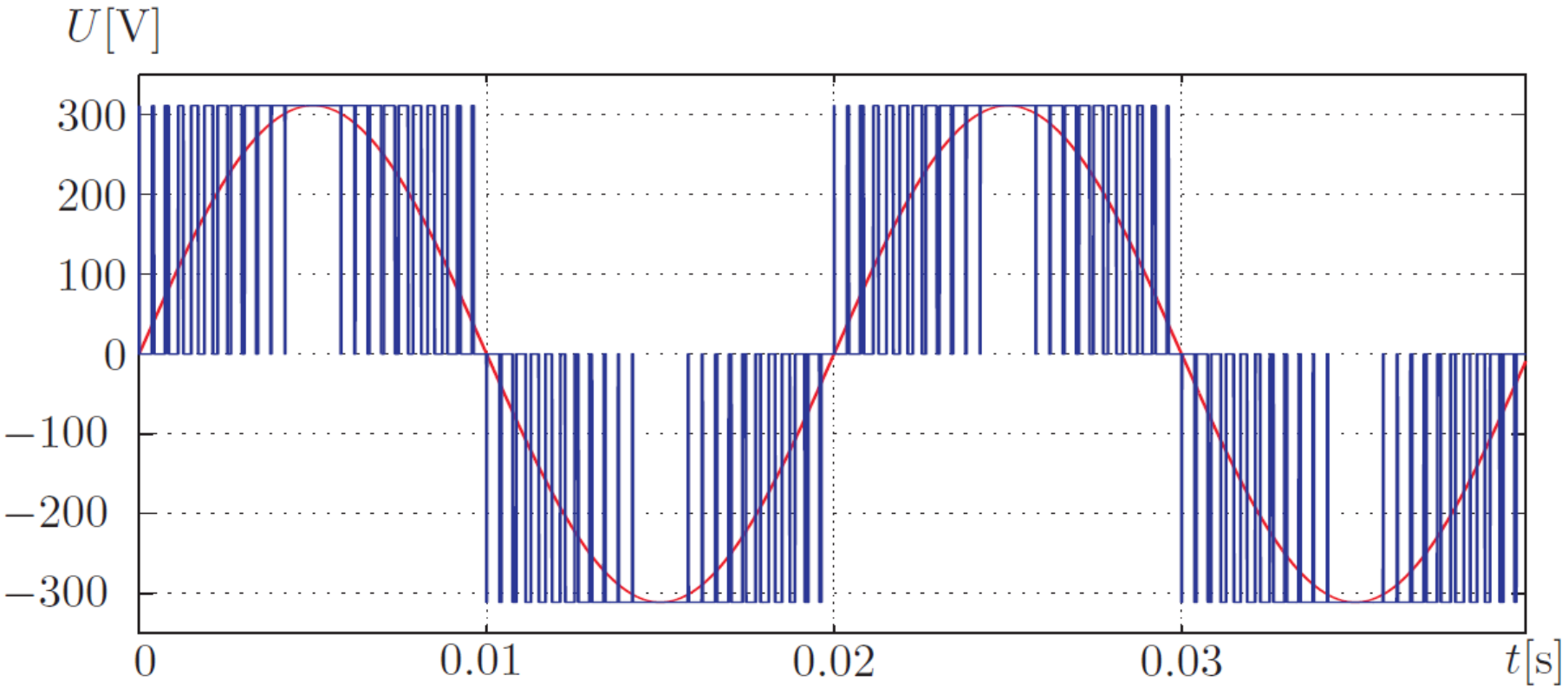


Principle of pulse width modulation

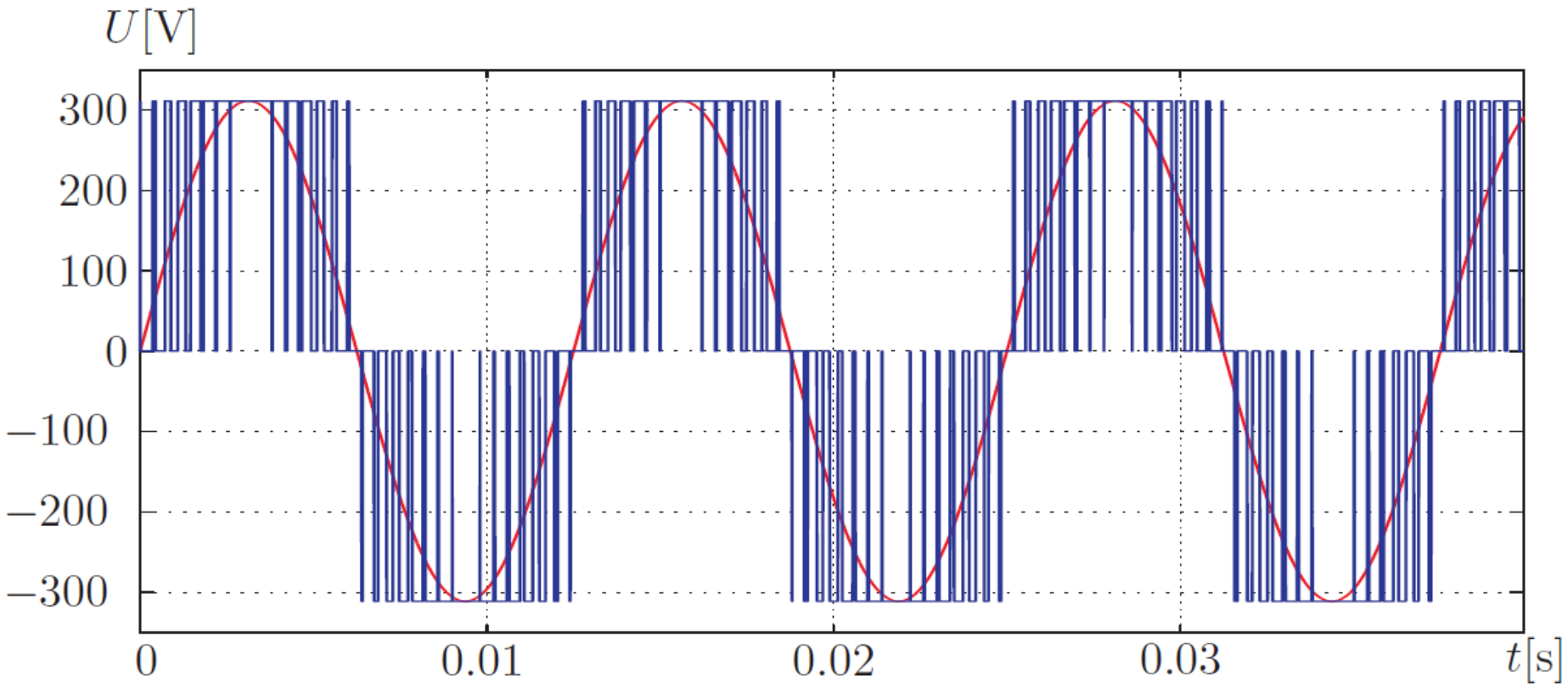


Generation of Pulse Width Modulation using natural sampling
Frequency ratio = 9, Modulation depth = 0.8 $(\hat{M}/\hat{C})$

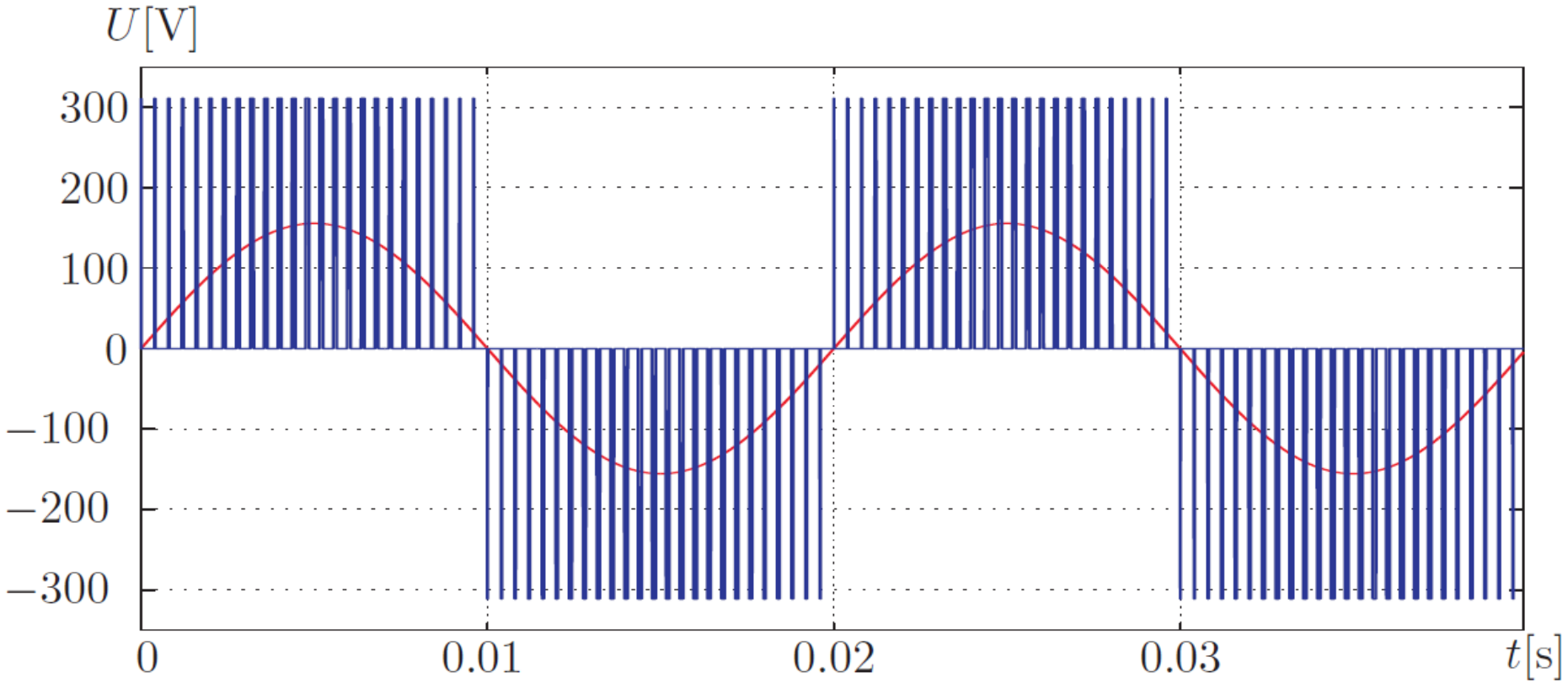
Pulse width modulation (1)
220V, 50Hz



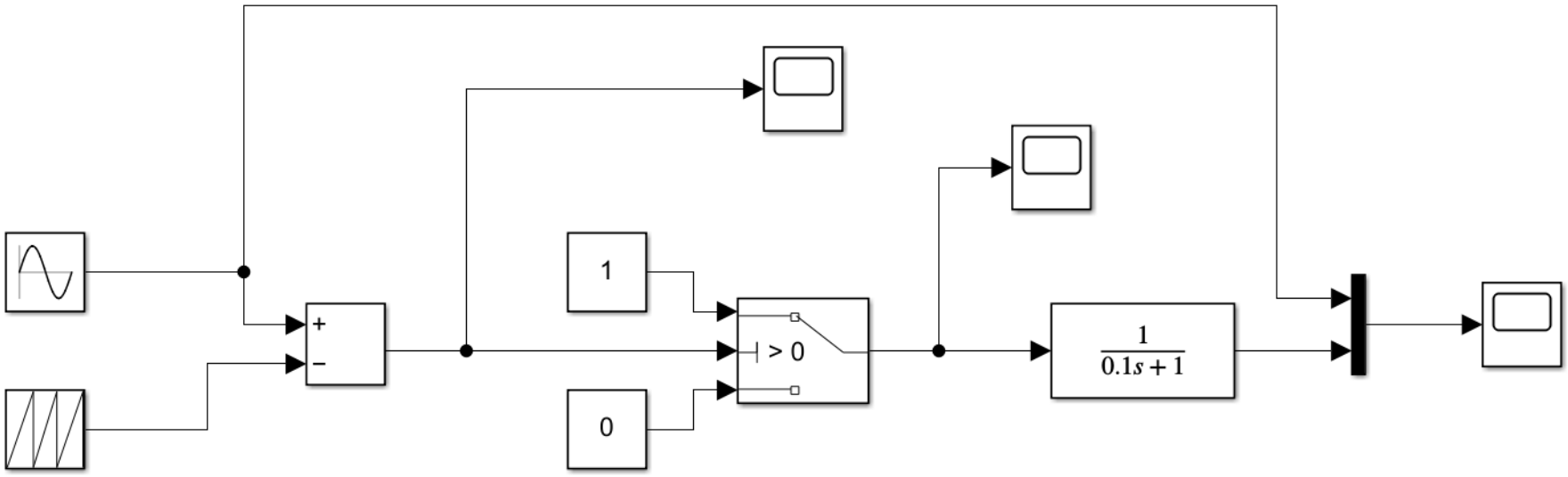
Pulse width modulation (2)
220V, 80Hz



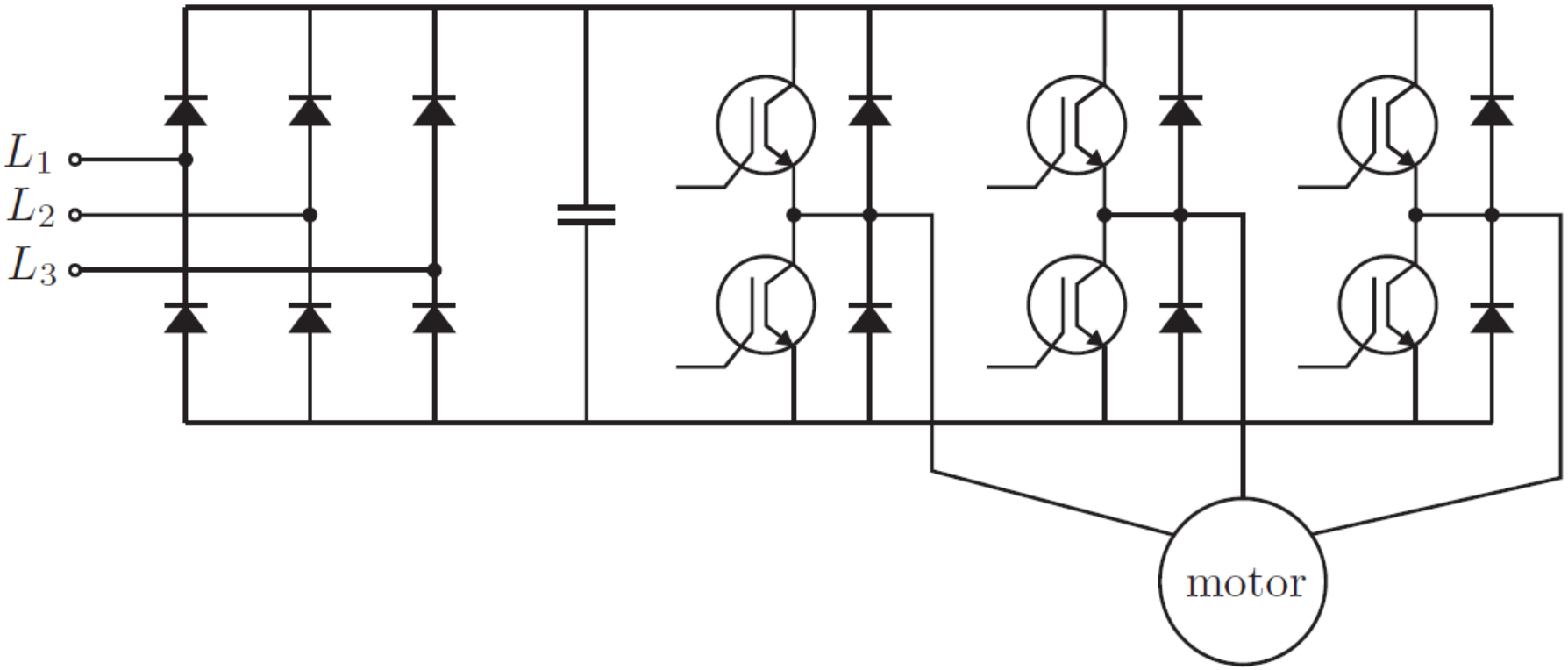
Pulse width modulation (3)
110V, 50Hz



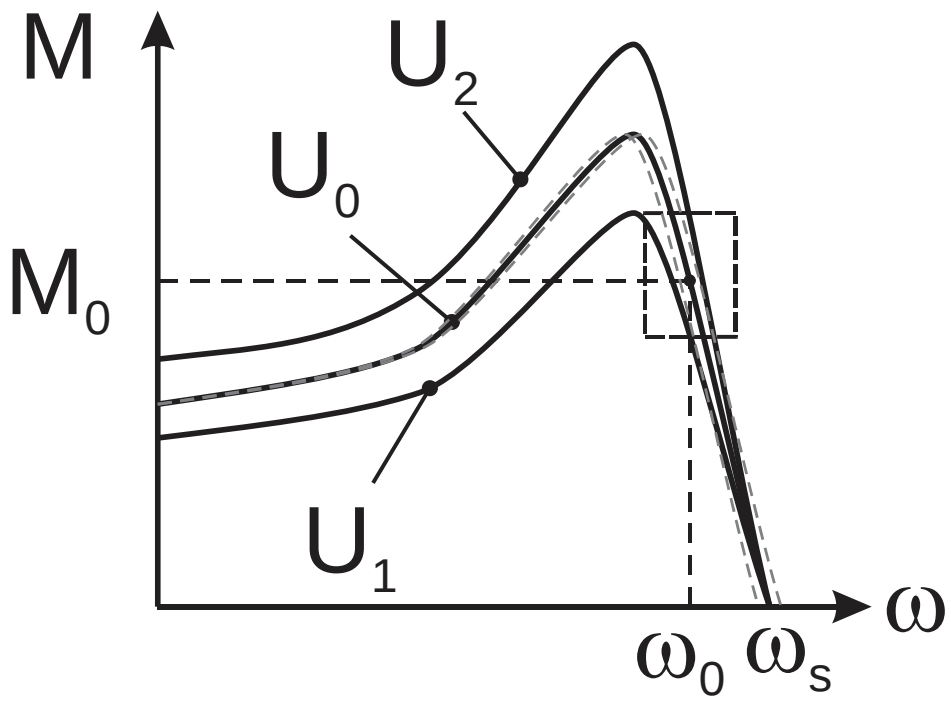
Realization in Simulink



Frequency regulator

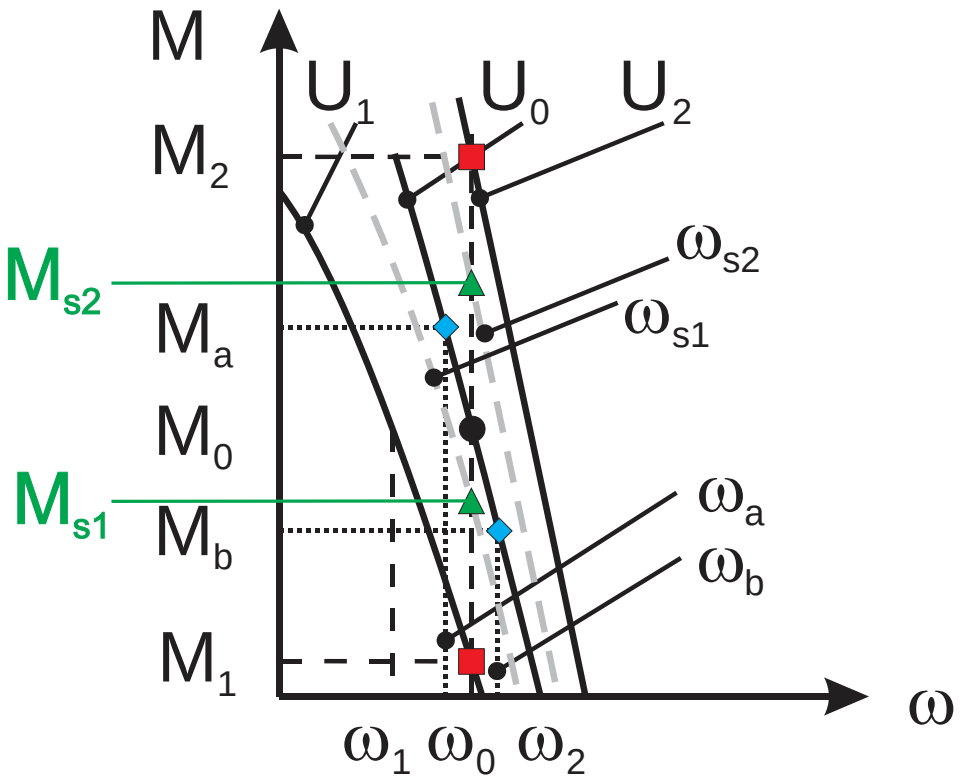


A model of an asynchronous electric motor



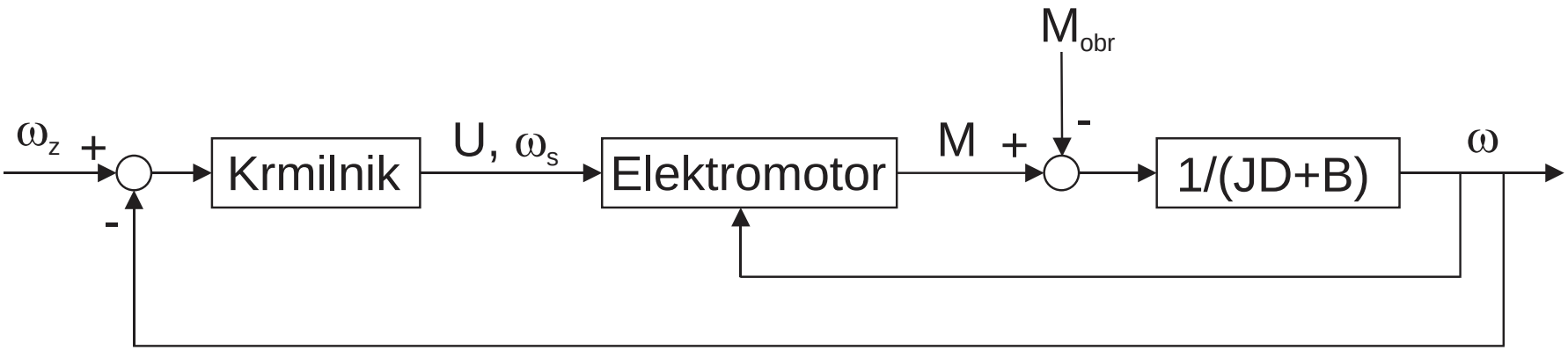
Linearization

$$M = F(\omega, U, \omega_s)$$

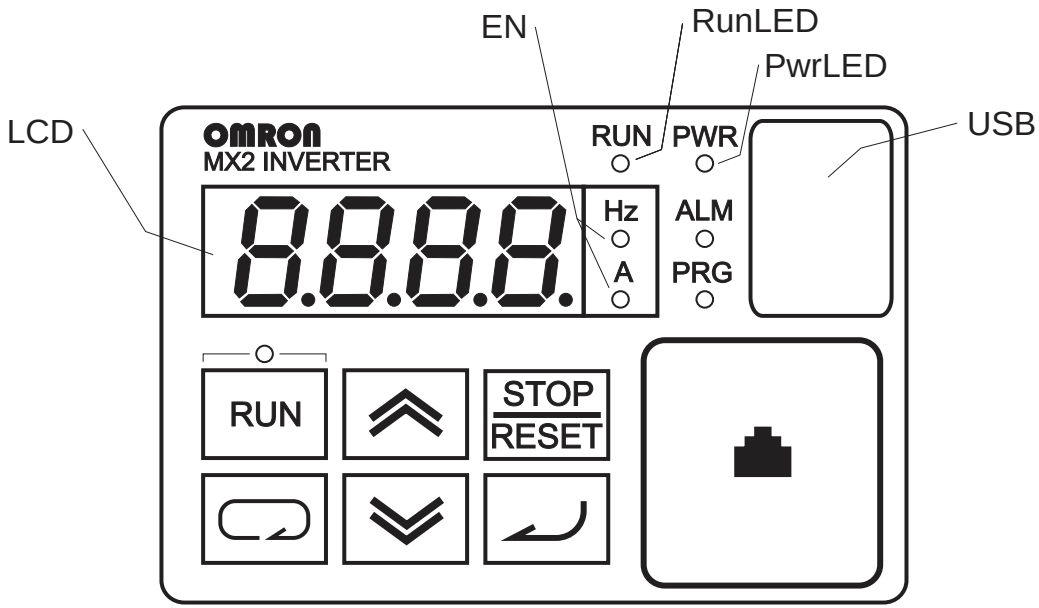


$$\Delta M = \frac{\partial f}{\partial \omega} \cdot \Delta\omega + \frac{\partial f}{\partial U} \cdot \Delta U + \frac{\partial f}{\partial \omega_s} \cdot \Delta\omega_s$$

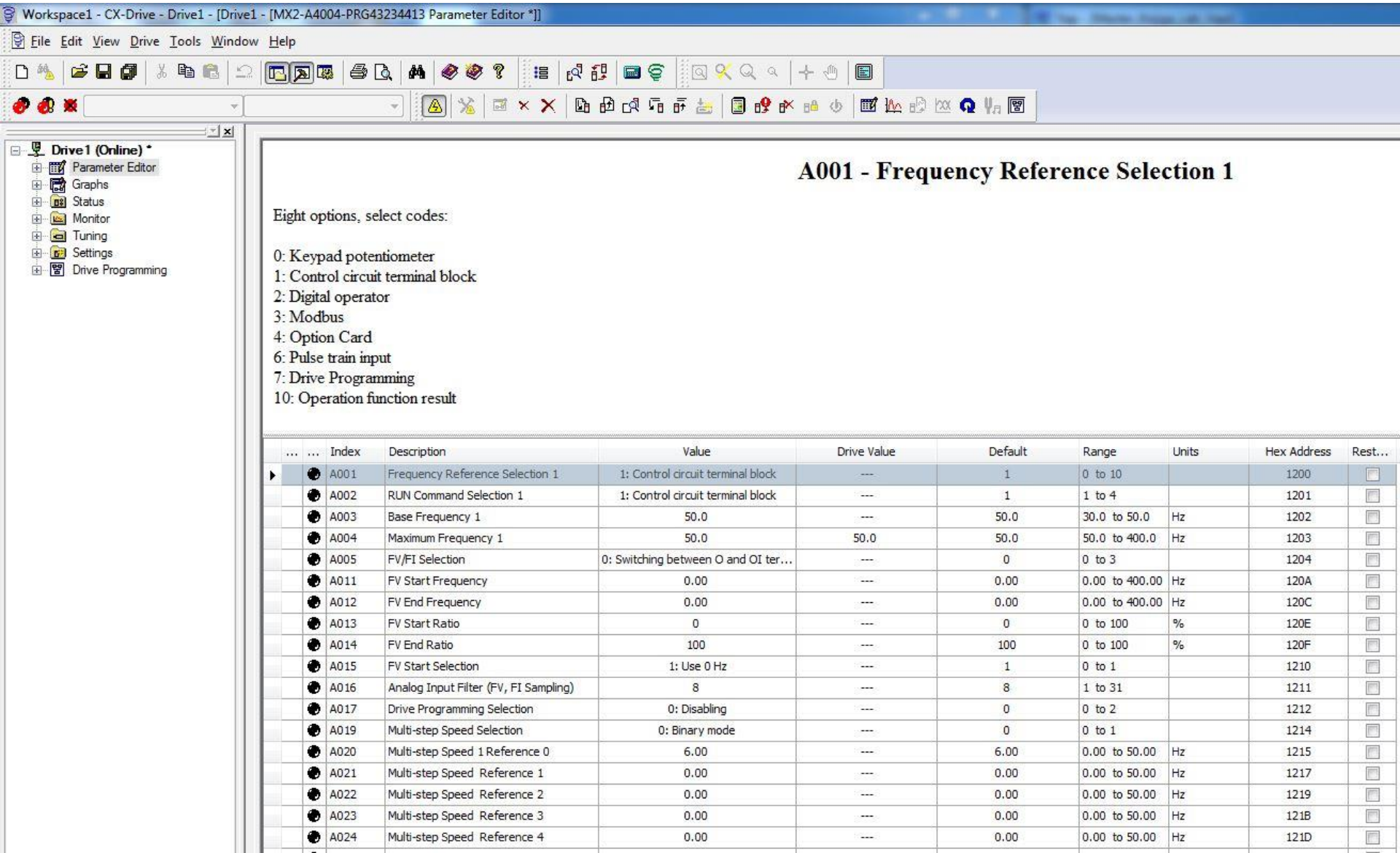
Asynchronous motor as an element in the control system



Frequency controller

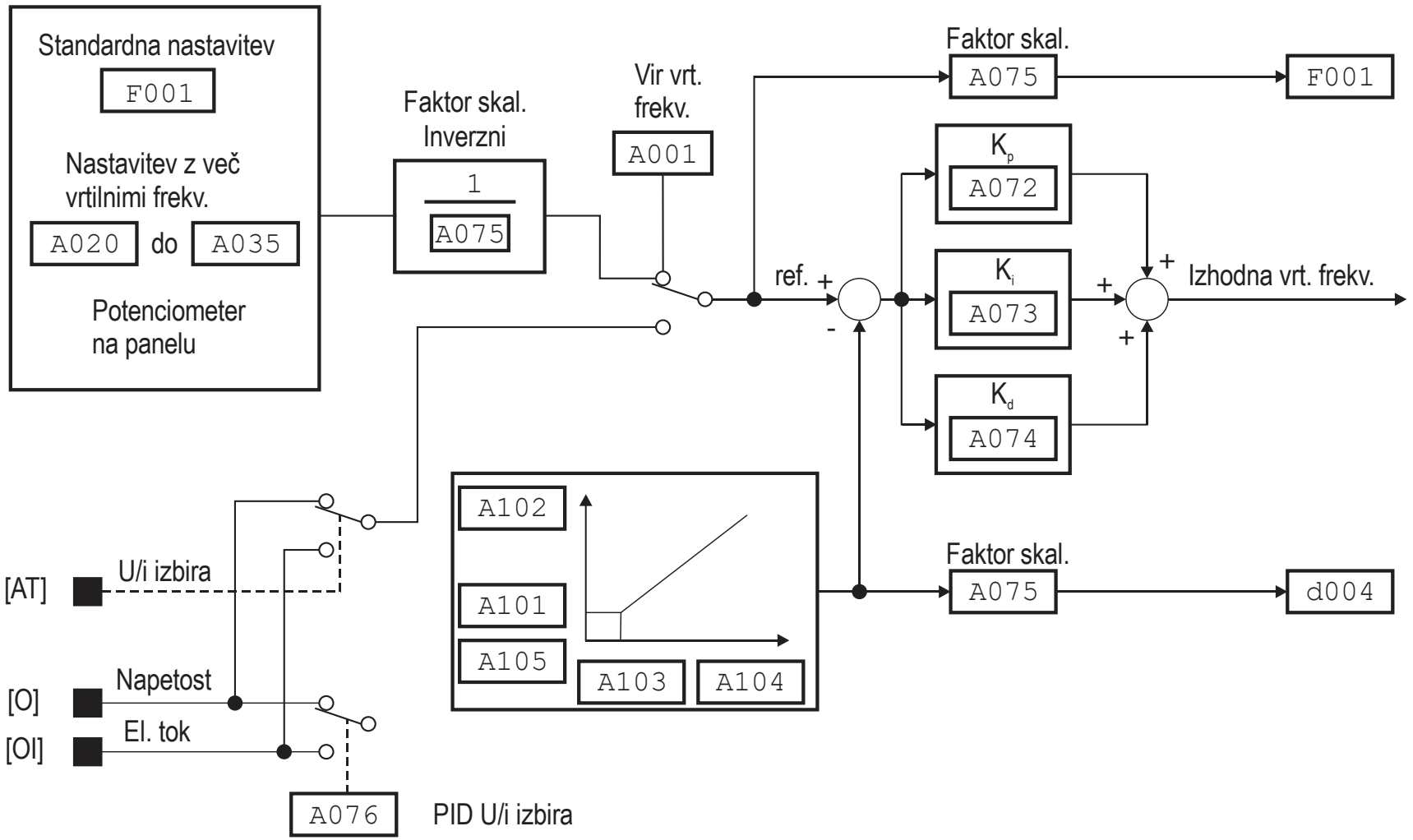


Frequency controller

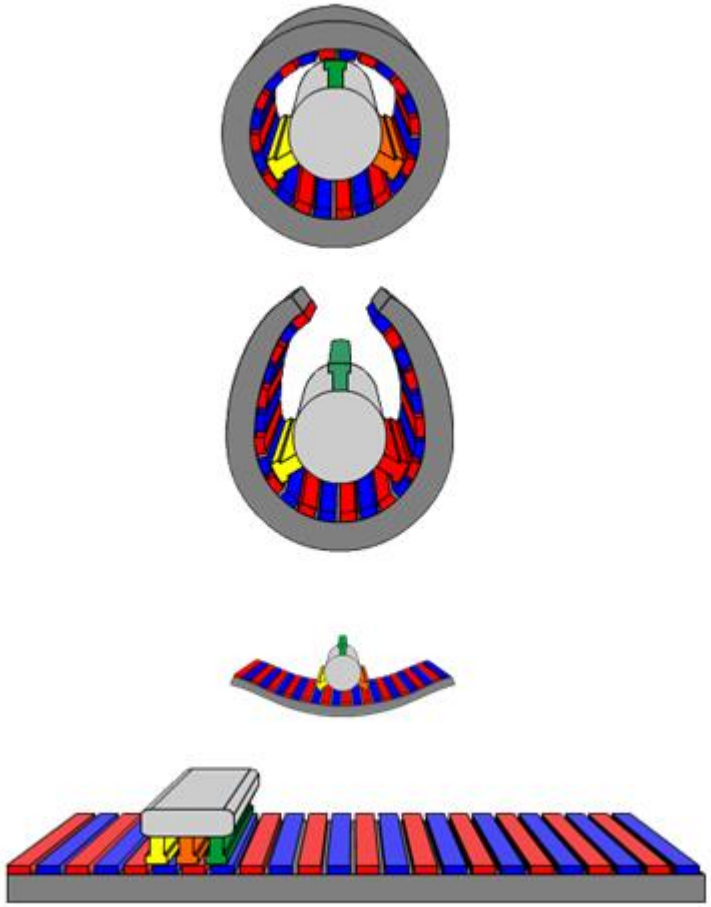


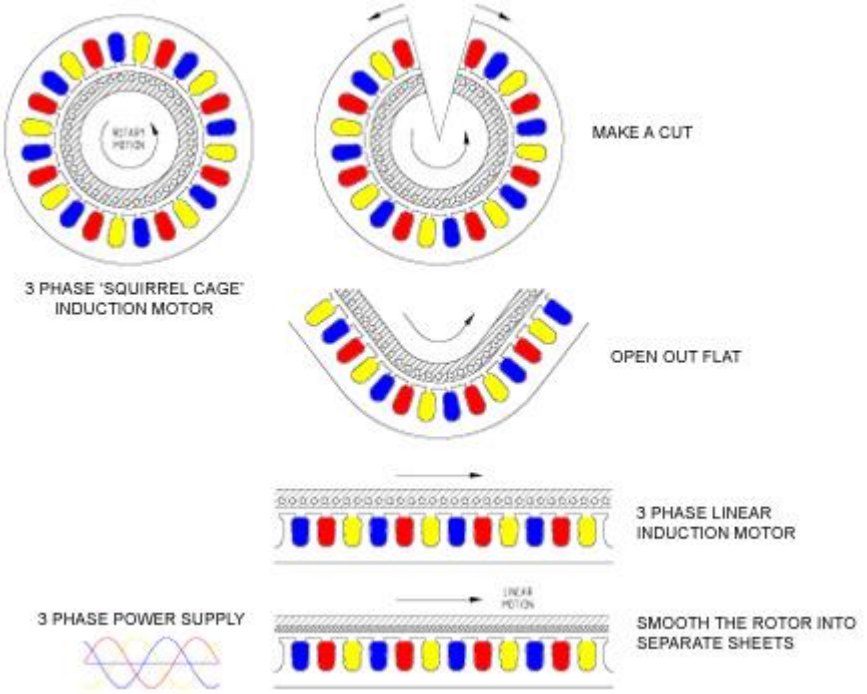
Index	Description	Value	Drive Value	Default	Range	Units	Hex Address	Rest...
A001	Frequency Reference Selection 1	1: Control circuit terminal block	---	1	0 to 10		1200	
A002	RUN Command Selection 1	1: Control circuit terminal block	---	1	1 to 4		1201	
A003	Base Frequency 1	50.0	---	50.0	30.0 to 50.0	Hz	1202	
A004	Maximum Frequency 1	50.0	50.0	50.0	50.0 to 400.0	Hz	1203	
A005	FV/FI Selection	0: Switching between O and OI ter...	---	0	0 to 3		1204	
A011	FV Start Frequency	0.00	---	0.00	0.00 to 400.00	Hz	120A	
A012	FV End Frequency	0.00	---	0.00	0.00 to 400.00	Hz	120C	
A013	FV Start Ratio	0	---	0	0 to 100	%	120E	
A014	FV End Ratio	100	---	100	0 to 100	%	120F	
A015	FV Start Selection	1: Use 0 Hz	---	1	0 to 1		1210	
A016	Analog Input Filter (FV, FI Sampling)	8	---	8	1 to 31		1211	
A017	Drive Programming Selection	0: Disabling	---	0	0 to 2		1212	
A019	Multi-step Speed Selection	0: Binary mode	---	0	0 to 1		1214	
A020	Multi-step Speed 1 Reference 0	6.00	---	6.00	0.00 to 50.00	Hz	1215	
A021	Multi-step Speed Reference 1	0.00	---	0.00	0.00 to 50.00	Hz	1217	
A022	Multi-step Speed Reference 2	0.00	---	0.00	0.00 to 50.00	Hz	1219	
A023	Multi-step Speed Reference 3	0.00	---	0.00	0.00 to 50.00	Hz	121B	
A024	Multi-step Speed Reference 4	0.00	---	0.00	0.00 to 50.00	Hz	121D	

Frequency controller

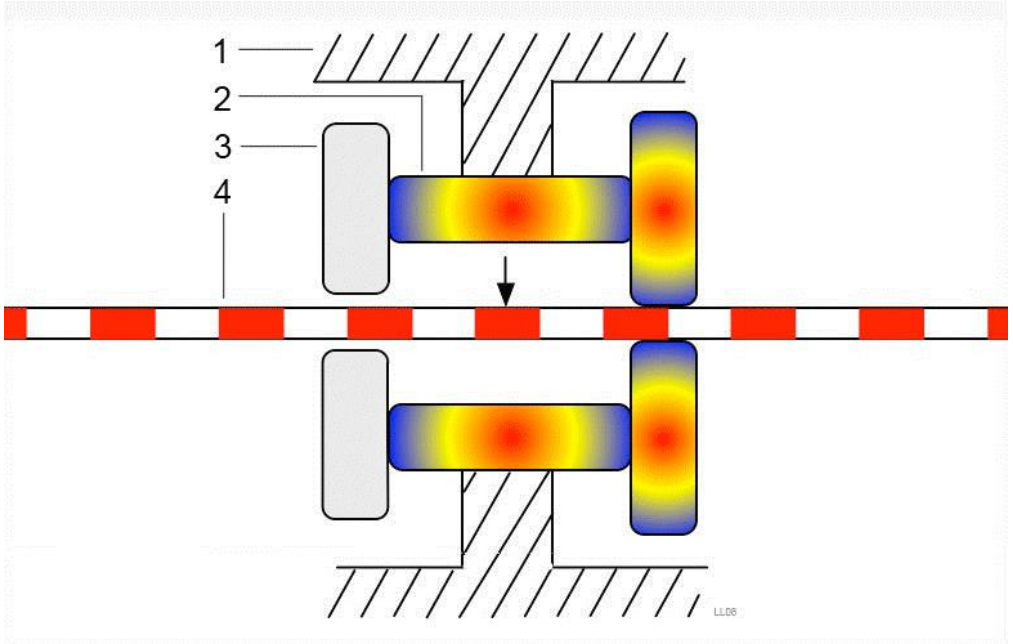


Linear motor





Piezoelectric motor (USM)



Synhronous motor