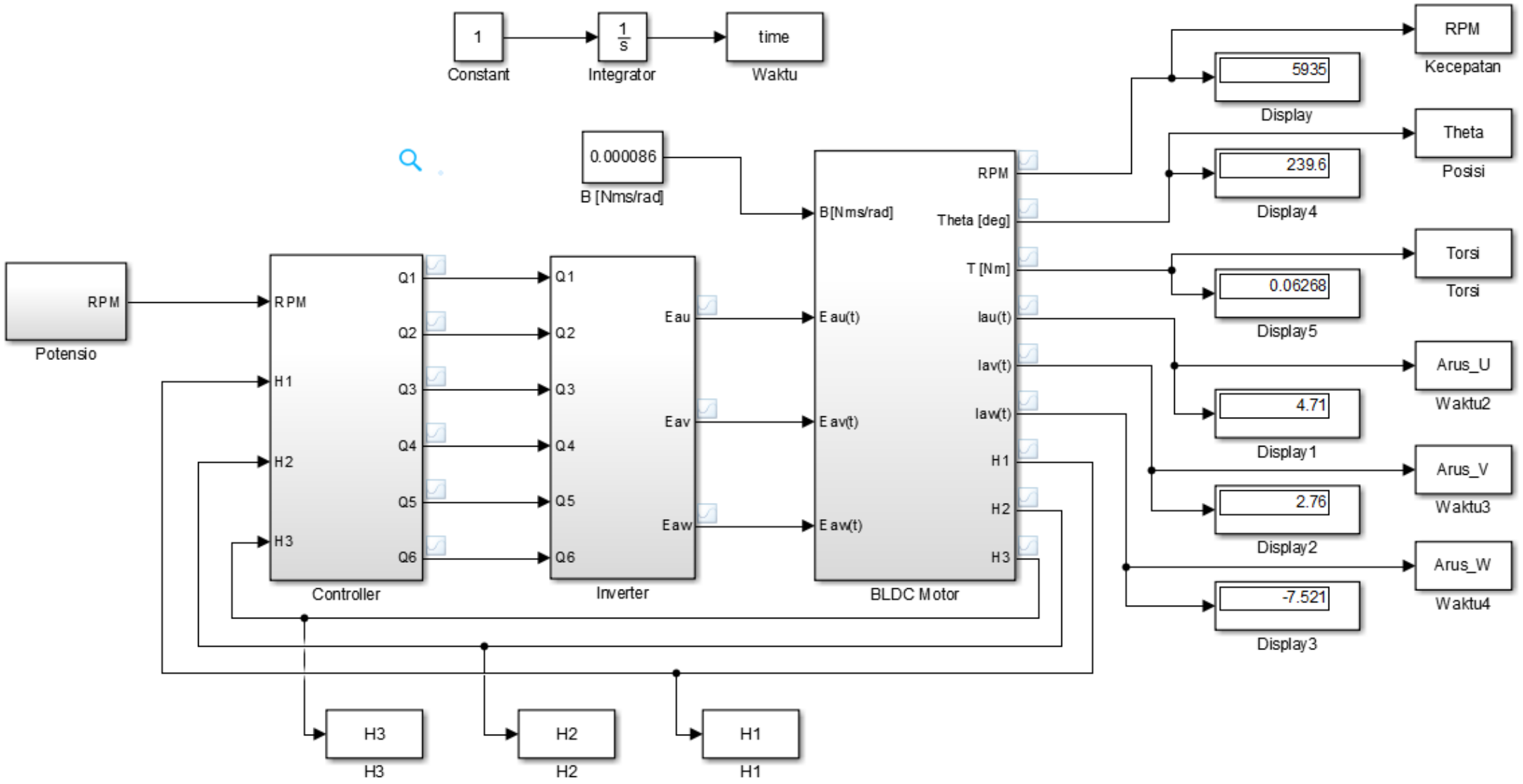
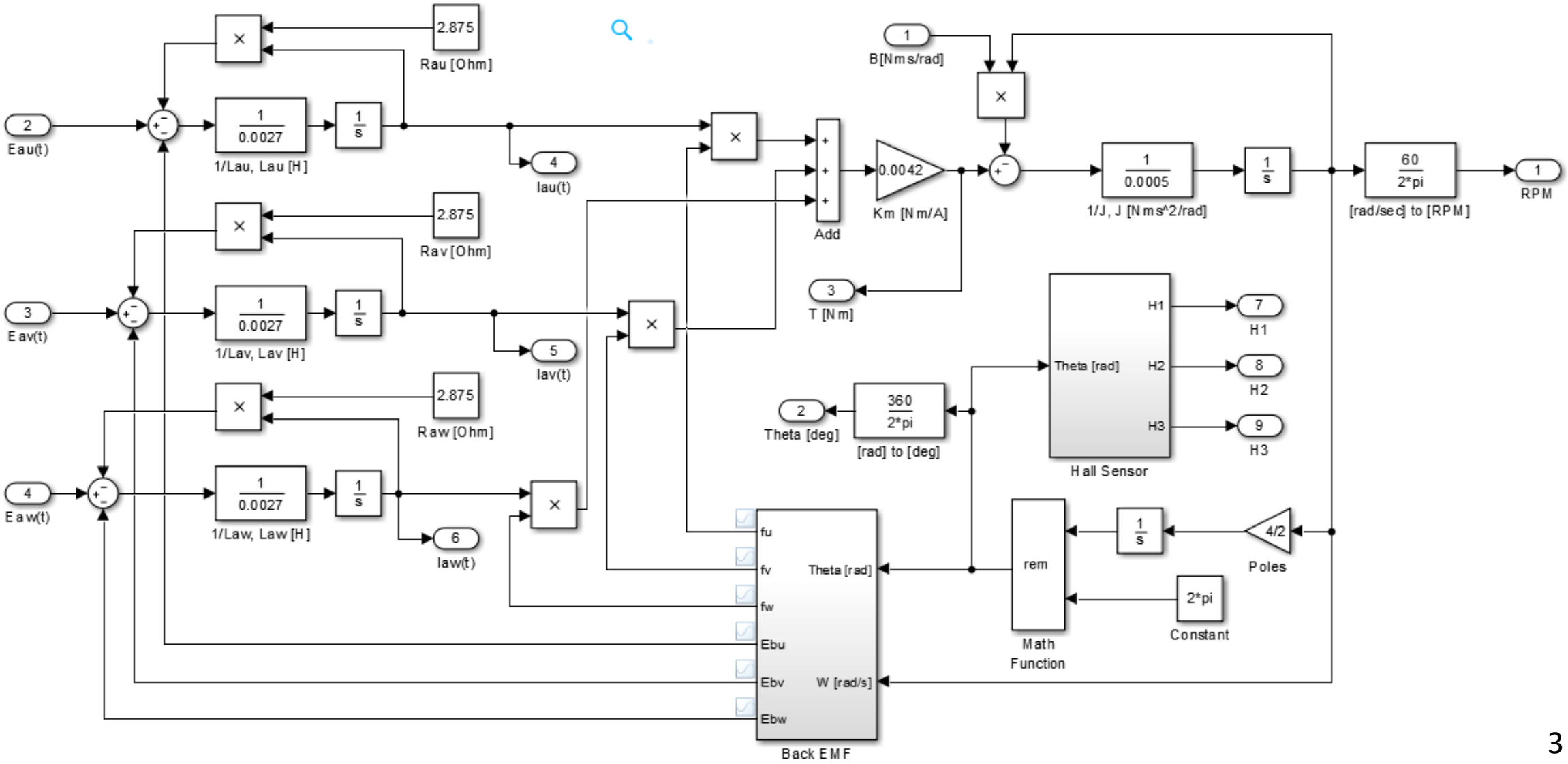
MODEL MOTOR BLDC

Andi Fauzan Alim

Model Utama


1
Constant
1/s
Integrator
time
Waktu
0.000086
B [Nms/rad]
RPM
Potensio
RPM
H1
H2
H3
Q1
Q2
Q3
Q4
Q5
Q6
Controller
Q1
Q2
Q3
Q4
Q5
Q6
Eau
Eav
Eaw
Inverter
B[Nms/rad]
Eau(t)
Eav(t)
Eaw(t)
RPM
Theta [deg]
T [Nm]
Iau(t)
Iav(t)
Iaw(t)
H1
H2
H3
BLDC Motor
5935
Display
RPM
Kecepatan
239.6
Display4
Theta
Posisi
0.06268
Display5
Torsi
Torsi
4.71
Display1
Arus_U
Waktu2
2.76
Display2
Arus_V
Waktu3
-7.521
Display3
Arus_W
Waktu4
H3
H3
H2
H2
H1
H1

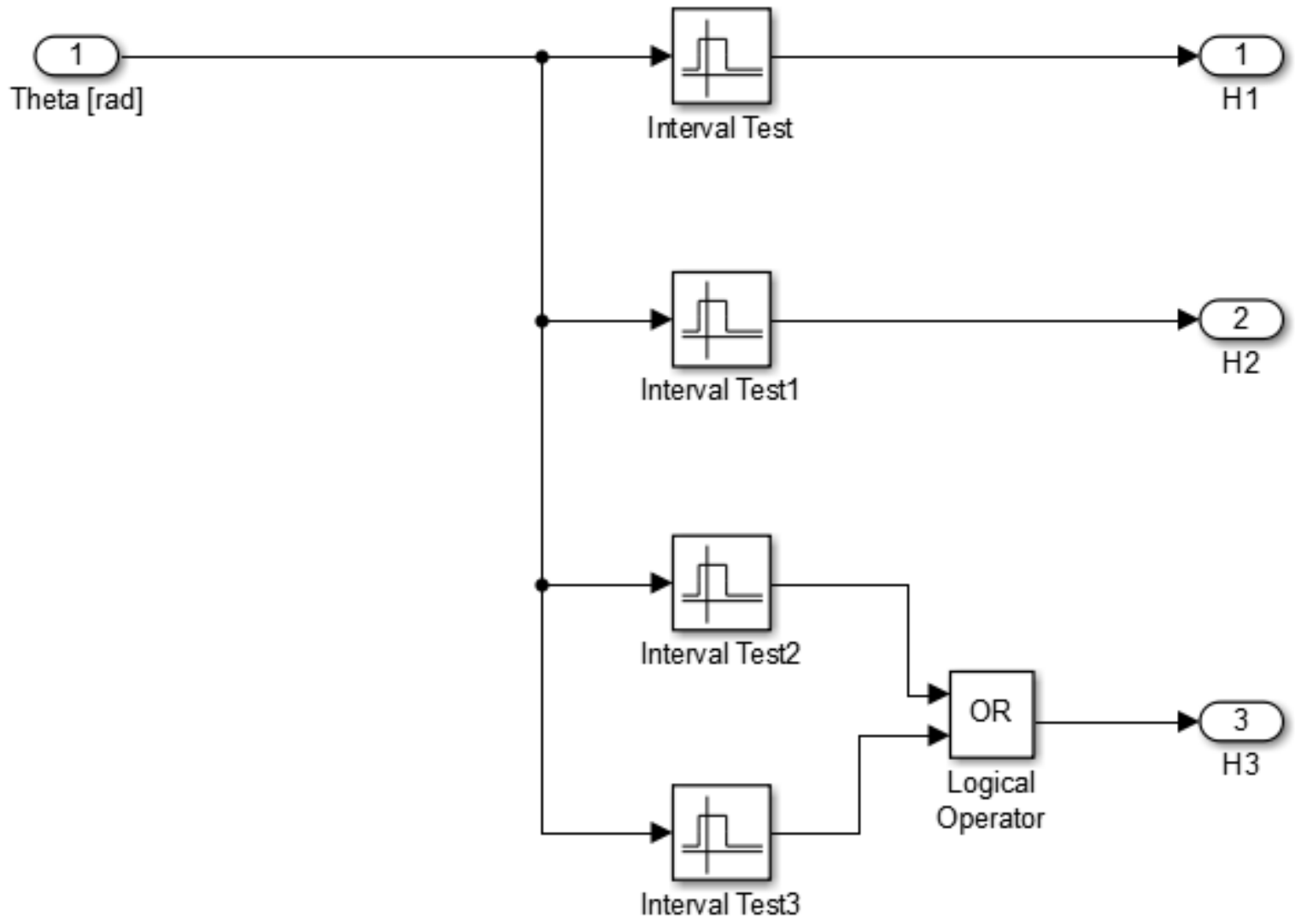
Motor BLDC


2
Eau(t)
3
Eav(t)
4
Eaw(t)
2.875
Rau [Ohm]
2.875
Rav [Ohm]
2.875
Raw [Ohm]
1
0.0027
1/Lau, Lau [H]
1/Lav, Lav [H]
1/Law, Law [H]
4
Iau(t)
5
Iav(t)
6
Iaw(t)
Add
1
B[Nms/rad]
0.0042
Km [Nm/A]
3
T [Nm]
1
0.0005
1/J, J [Nms^2/rad]
60
2*pi
[rad/sec] to [RPM]
RPM
H1
H2
H3
Theta [rad]
Hall Sensor
7
8
9
360
2*pi
[rad] to [deg]
Theta [deg]
fu
fv
fw
Ebu
Ebv
Ebw
Theta [rad]
W [rad/s]
Back EMF
rem
Math Function
2*pi
Constant
4/2
Poles

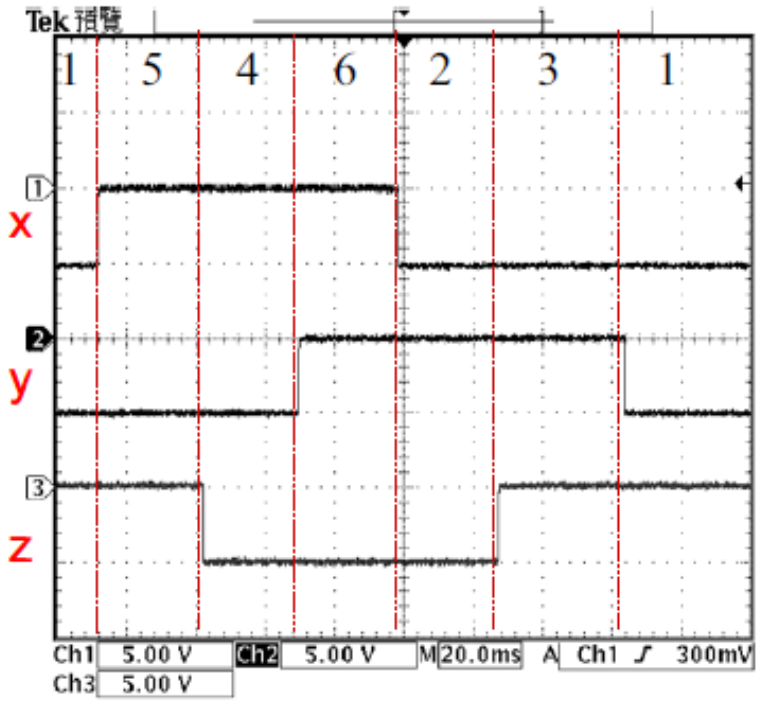
Parameter Motor yang Digunakan

Parameter	*Symbol*	*Value*	*Units*
Resistance	R	2.875	Ohms
Inductance	L	2.7	mH
Back-emf constant	k_e	0.0042	V/rad/s
Torque constant	k_t	0.0042	N-m/A
Viscous damping	B	0.000089	N-m/(rad/s)
Rotor inertia	J	0.0005	Kg-m^2
Number of pole	P	4	poles

Motor BLDC → Hall sensor

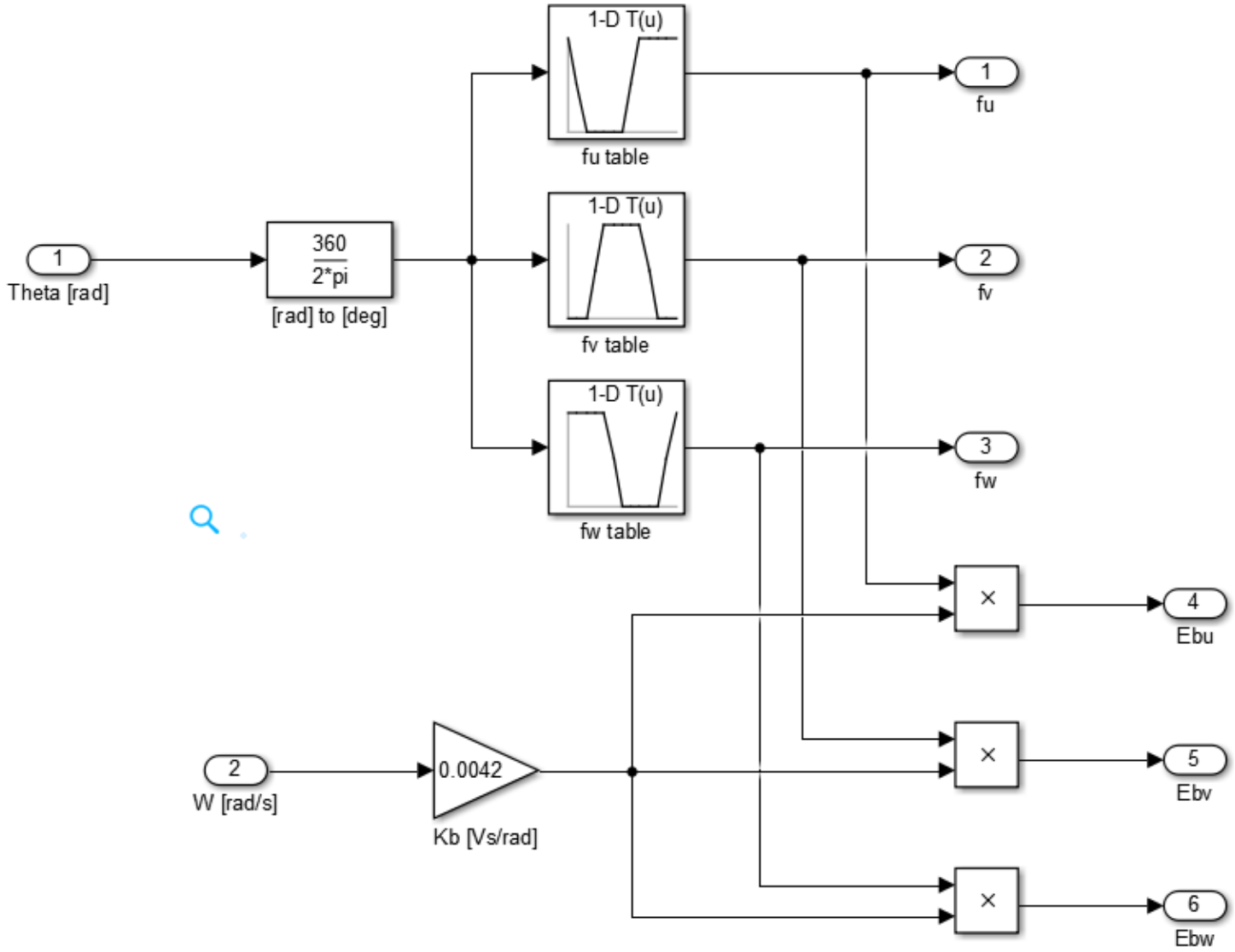


Hall Sensor Signal

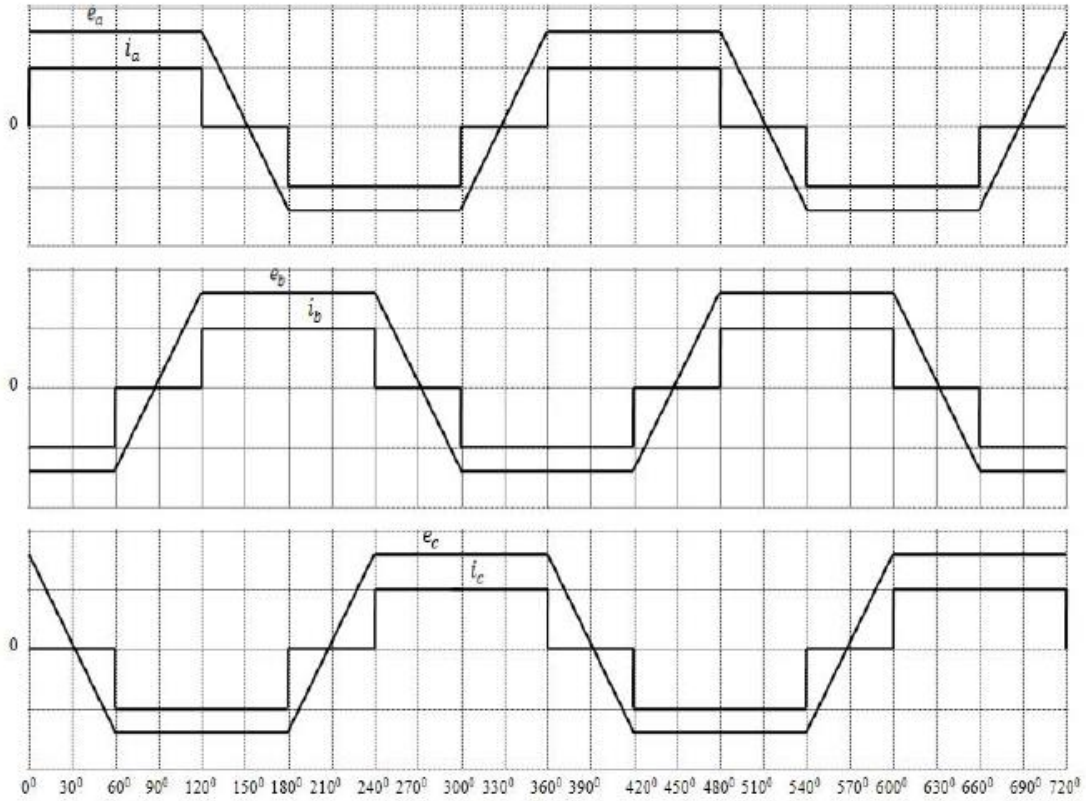


Theta_elec (θ_r)	x	y	z	State
0^0 - 60^0	1	0	1	5
60^0 - 120^0	1	0	0	4
120^0 - 180^0	1	1	0	6
180^0 - 240^0	0	1	0	2
240^0 - 300^0	0	1	1	3
300^0 - 360^0	0	0	1	1

Motor BLDC → Back EMF

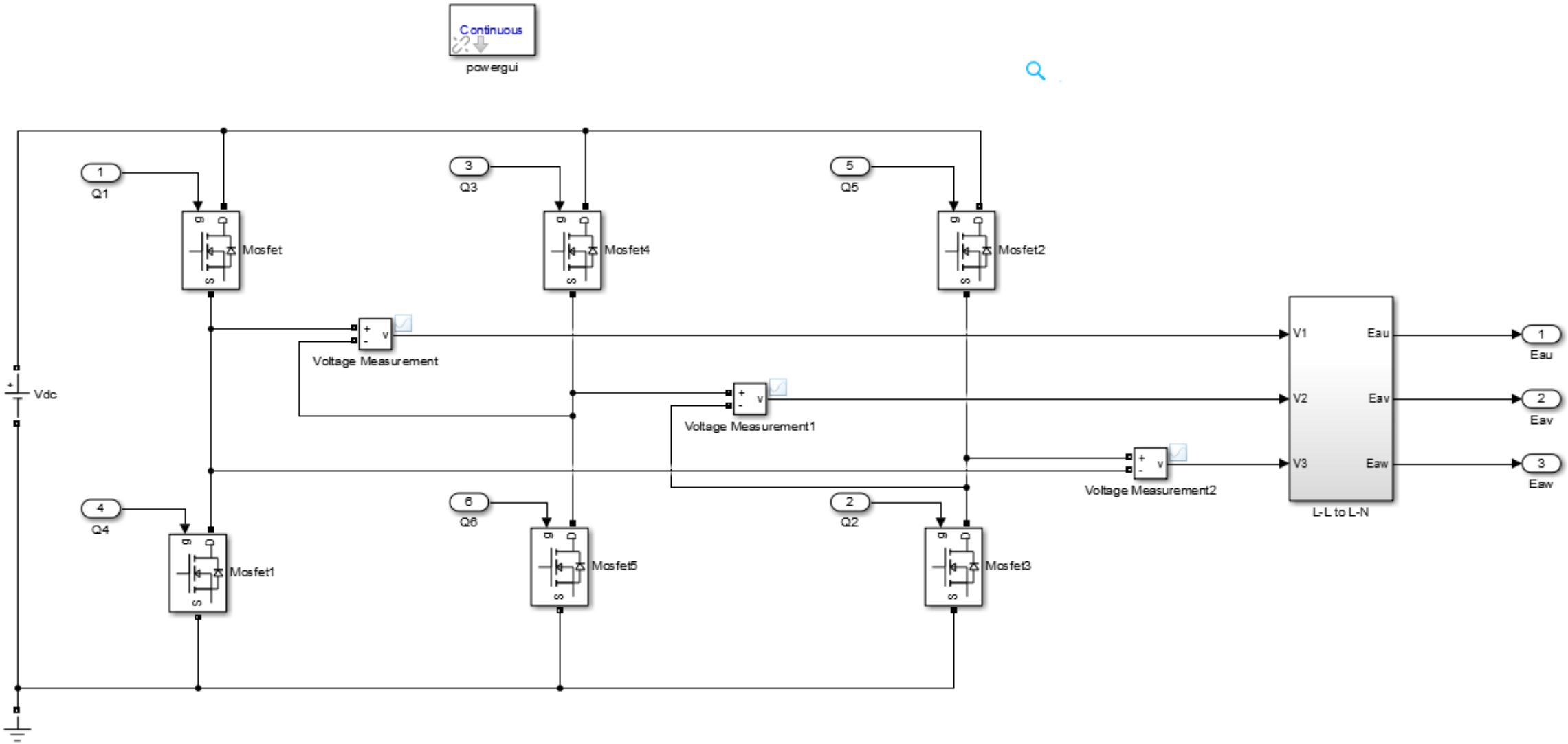


Back EMF Signal

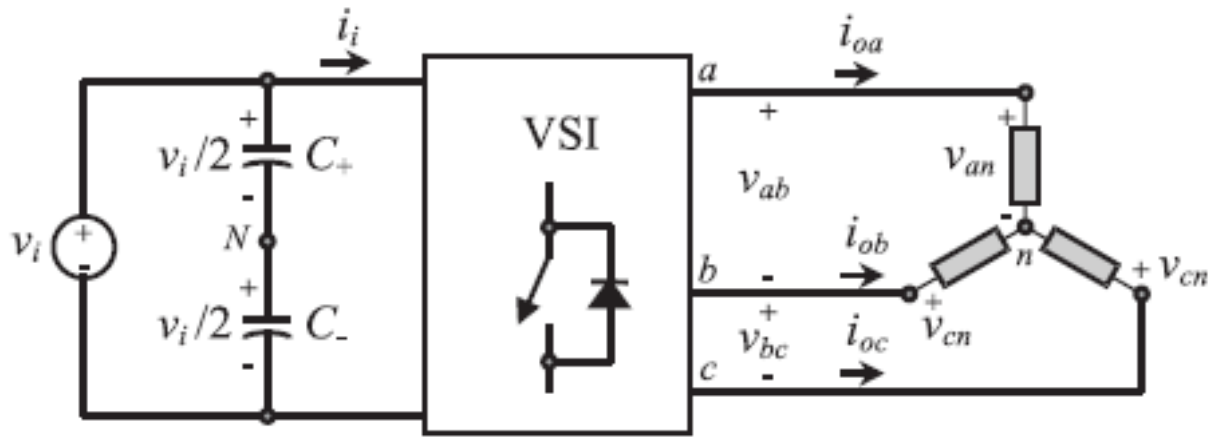


Theta_elec (θ_r)	$f_a(\theta_r)$	$f_b(\theta_r)$	$f_c(\theta_r)$
0^0 - 60^0	1	-1	$1-\frac{6\theta_r}{\pi}$
60^0 - 120^0	1	$\frac{6\theta_r}{\pi}-3$	-1
120^0 - 180^0	$5-\frac{6\theta_r}{\pi}$	1	-1
180^0 - 240^0	-1	1	$\frac{6\theta_r}{\pi}-7$
240^0 - 300^0	-1	$9-\frac{6\theta_r}{\pi}$	1
300^0 - 360^0	$\frac{6\theta_r}{\pi}-11$	-1	1

Inverter

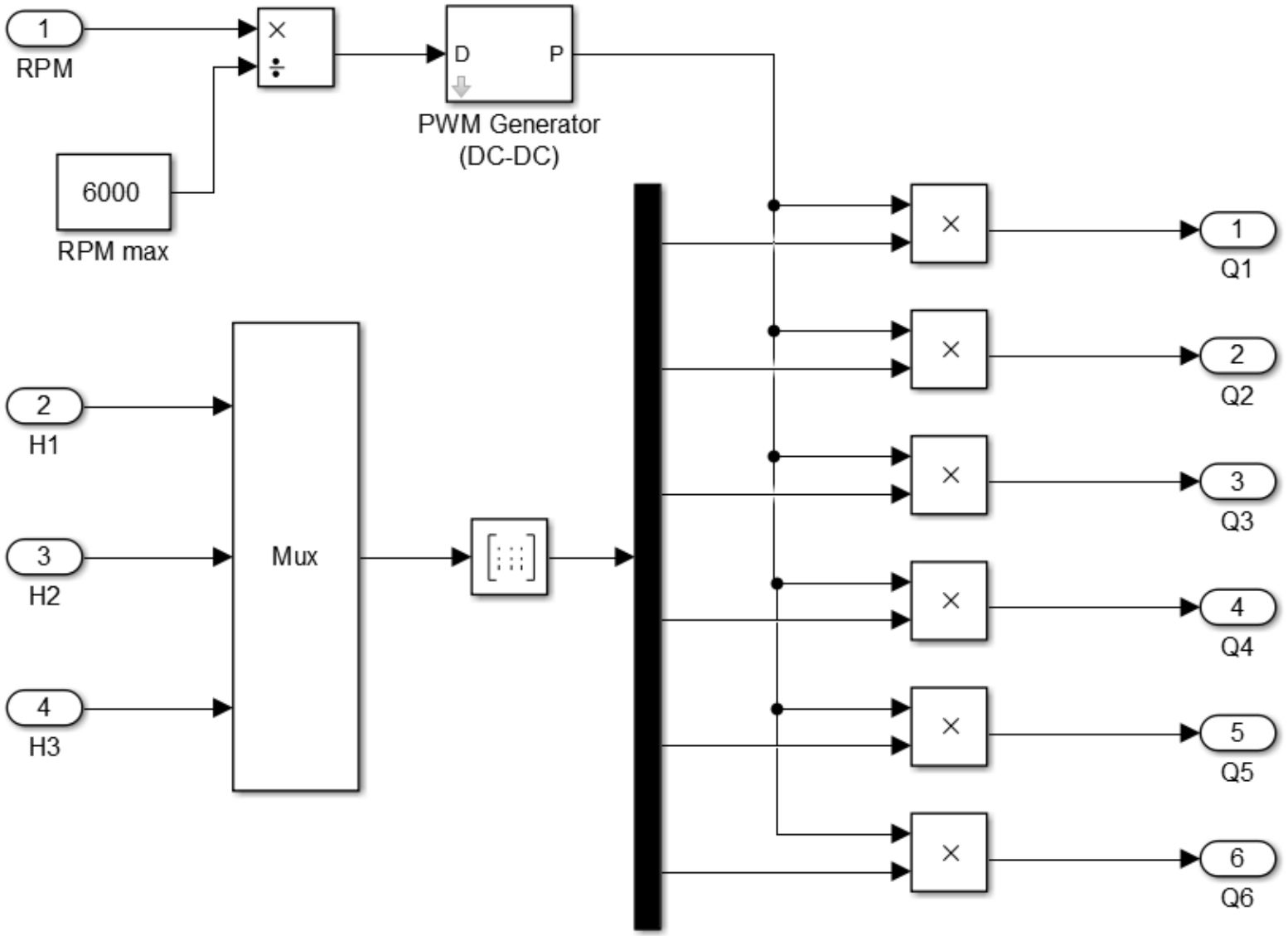

Continuous
powergui
1
Q1
3
Q3
5
Q5
Mosfet
Mosfet4
Mosfet2
Voltage Measurement
Voltage Measurement1
Voltage Measurement2
Vdc
V1
V2
V3
Eau
Eav
Eaw
L-L to L-N
1
Eau
2
Eav
3
Eaw
4
Q4
6
Q6
2
Q2
Mosfet1
Mosfet5
Mosfet3

Inverter : LL →LN



$$\begin{bmatrix} v_{an} \\ v_{bn} \\ v_{cn} \end{bmatrix} = \frac{1}{3} \begin{bmatrix} 2 & 1 \\ -1 & 1 \\ -1 & -2 \end{bmatrix} \begin{bmatrix} v_{ab} \\ v_{bc} \end{bmatrix}$$

Controller


1
RPM
6000
RPM max
D
P
PWM Generator
(DC-DC)
2
H1
3
H2
4
H3
Mux
1
Q1
2
Q2
3
Q3
4
Q4
5
Q5
6
Q6

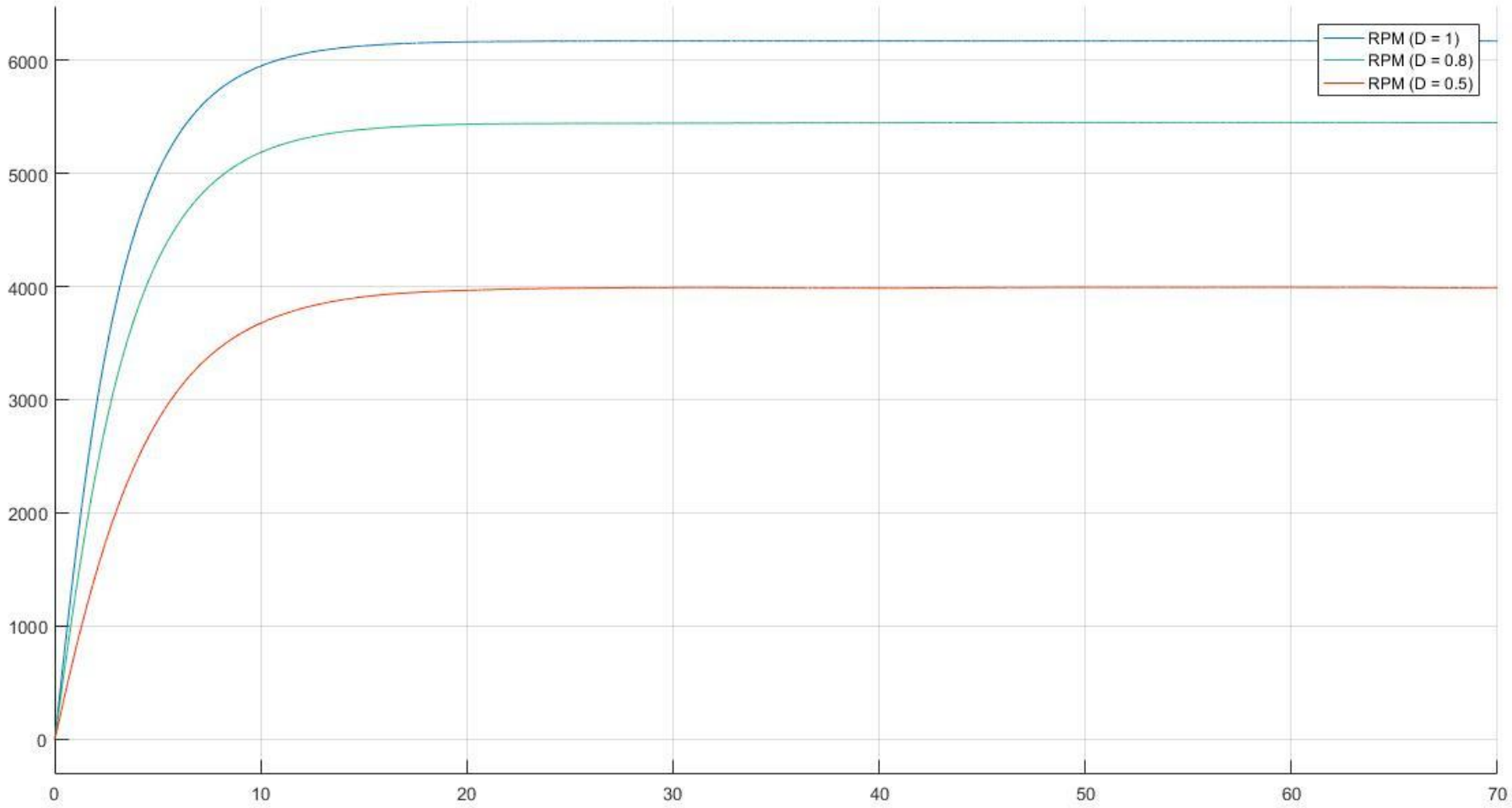
Controller : Commutation Logic

Hall Signal			Controller Output*					
H1	**H2**	**H3**	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**
1	0	1	0	0	0	1	1	1
1	0	0	0	0	1	1	1	0
1	1	0	0	1	1	1	0	0
0	1	0	1	1	1	0	0	0
0	1	1	1	1	0	0	0	1
0	0	1	1	0	0	0	1	1

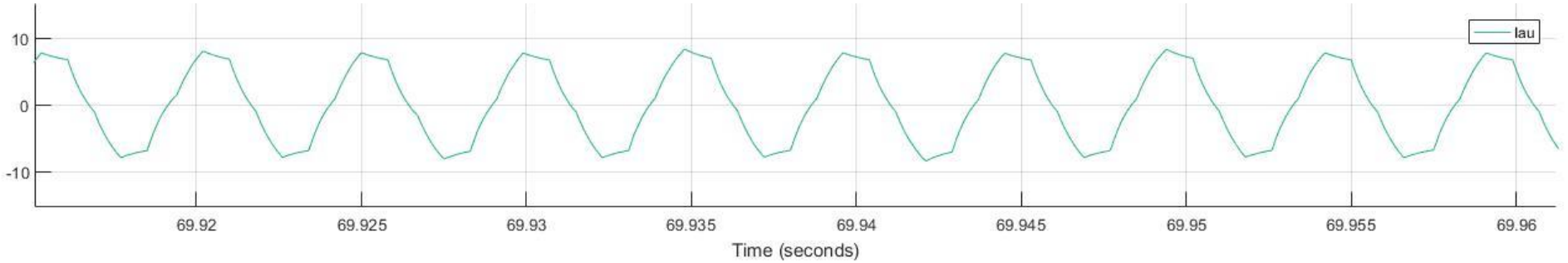
*180° mode of operation

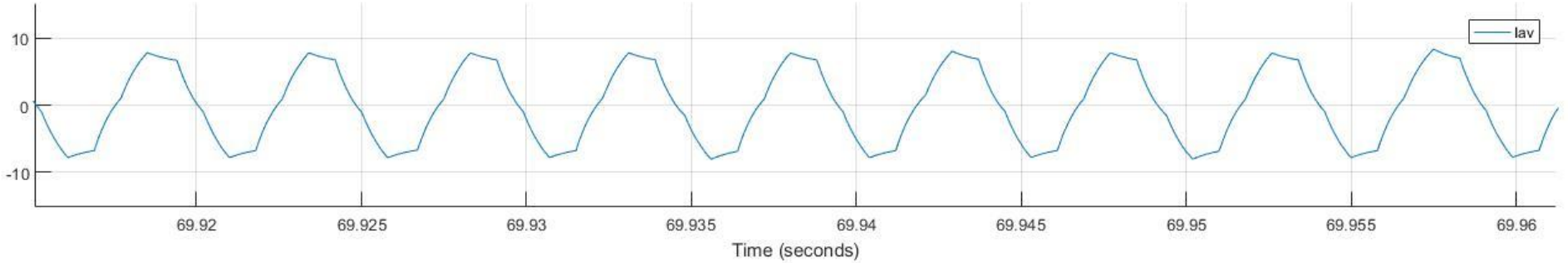
Hasil Simulasi

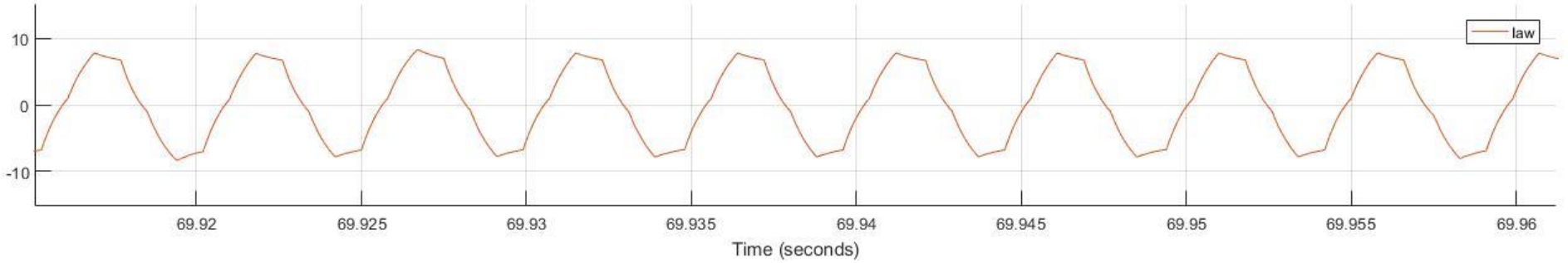
RPM


RPM (D = 1)
RPM (D = 0.8)
RPM (D = 0.5)
6000
5000
4000
3000
2000
1000
0
0
10
20
30
40
50
60
70

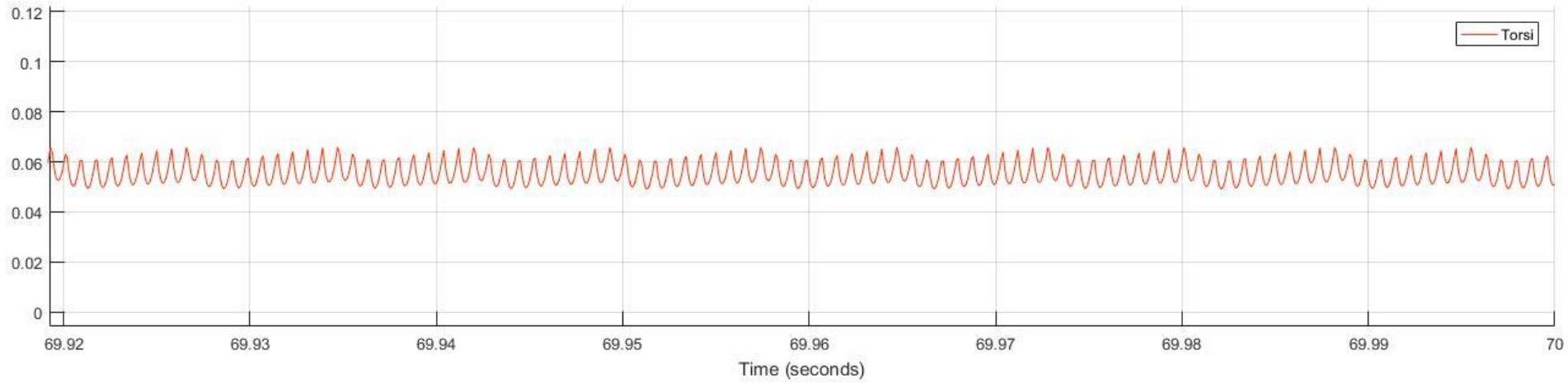
Arus Jangkar (D=1)

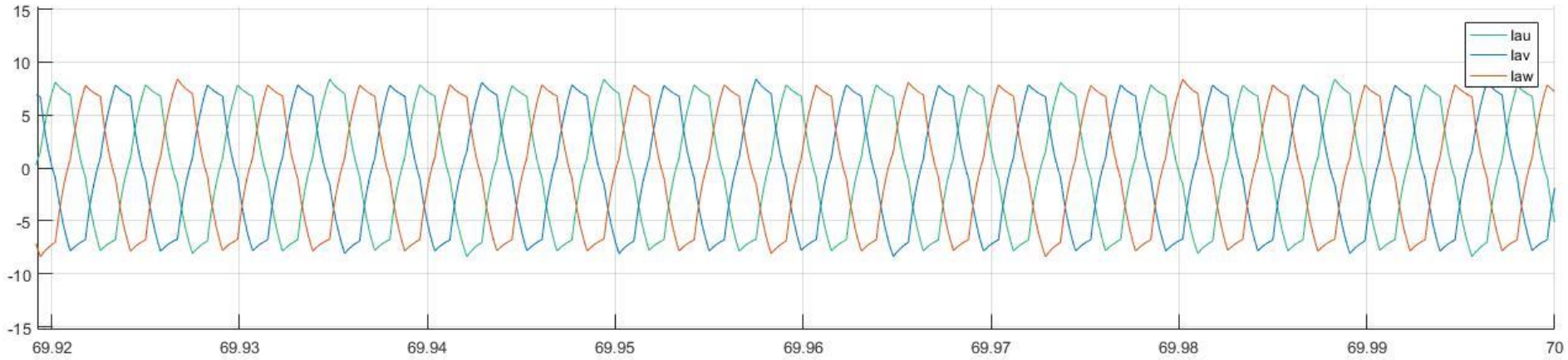




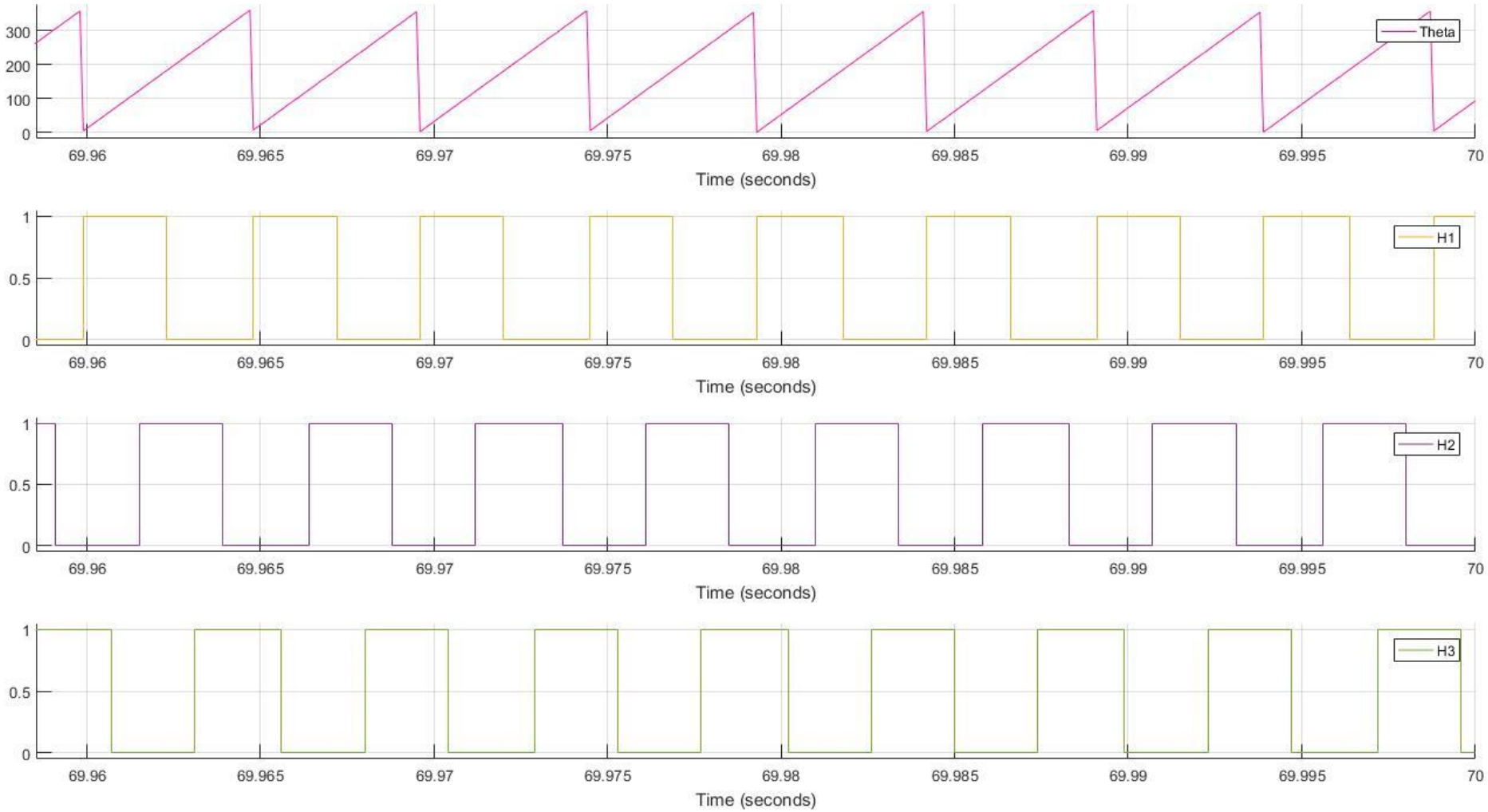


Torsi (D=1)

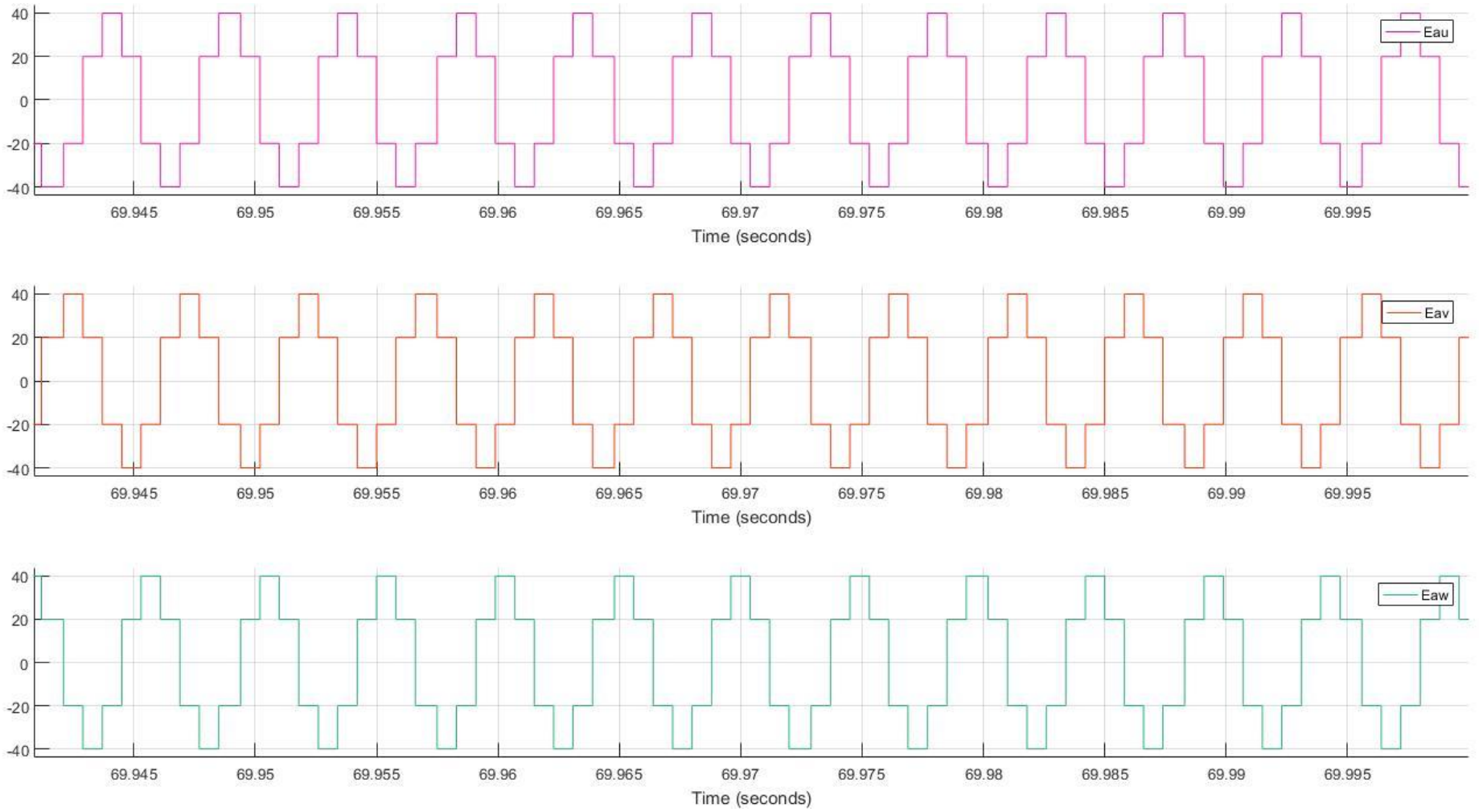

0.12
0.1
0.08
0.06
0.04
0.02
0
69.92
69.93
69.94
69.95
69.96
69.97
69.98
69.99
70
Time (seconds)
Torsi


15
10
5
0
-5
-10
-15
69.92
69.93
69.94
69.95
69.96
69.97
69.98
69.99
70
Iau
Iav
Iaw

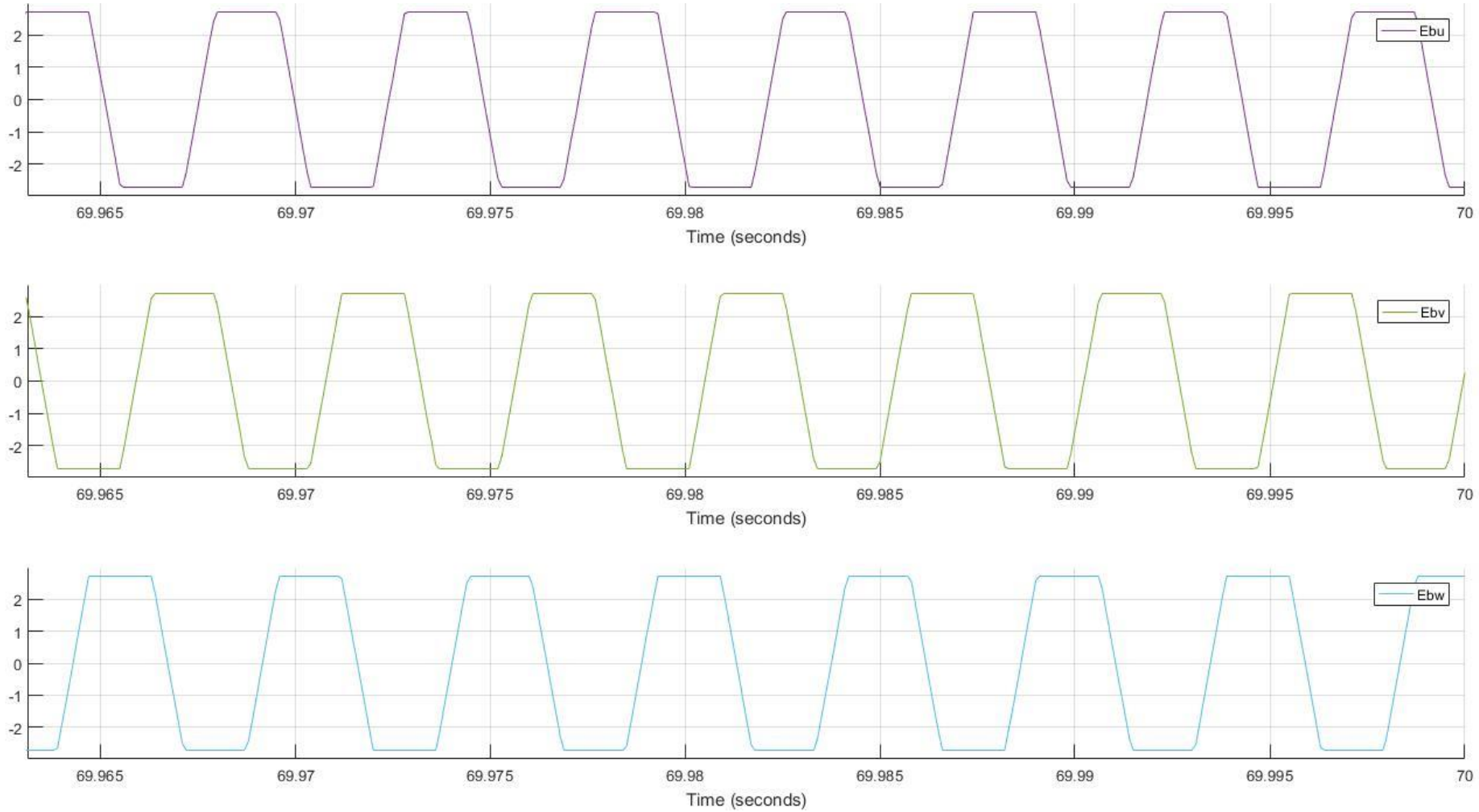
Theta


Theta
300
200
100
0
69.96
69.965
69.97
69.975
69.98
69.985
69.99
69.995
70
Time (seconds)
H1
1
0.5
0
Time (seconds)
H2
Time (seconds)
H3
Time (seconds)

Tegangan Input (D=1)



Back EMF (D=1)


Ebu
Ebv
Ebw
2
1
0
-1
-2
69.965
69.97
69.975
69.98
69.985
69.99
69.995
70
Time (seconds)

Hall Sensor


Hall Sensor 1
Hall Sensor 2
Hall Sensor 3
1
0.8
0.6
0.4
0.2
0
69.965
69.97
69.975
69.98
69.985
69.99
69.995
70
Time (seconds)

Controller (D=1)