Laboratory of electric drives

KARIM LAITI

0000902683

Project data

Motor Data			
1.1	Nominal voltage	V	12
1.2	No load speed	Rpm	6920
1.3	No load current	mA	241
1.4	Nominal speed	rpm	6370
1.5	Nominal torque	mNm	95
1.6	Nominal current	A	6.000
1.7	Stall torque	mNm	1680
1.8	Starting current	A	102
1.9	Winding resistance	Ohm	0.12
1.10	Winding inductance	mH	0.245
1.11	Torque constant	mNm/A	16.7
1.12	Speed constant	Rpm/V	581
1.13	Rotor inertia	gcm^2	139

LOAD DATA

2.1	torque type		proportional to speed
2.2	load torque slope	Nm.s	6,409E-05
2.3	Load inertia	gcm^2	174

SUPPLY SYSTEM

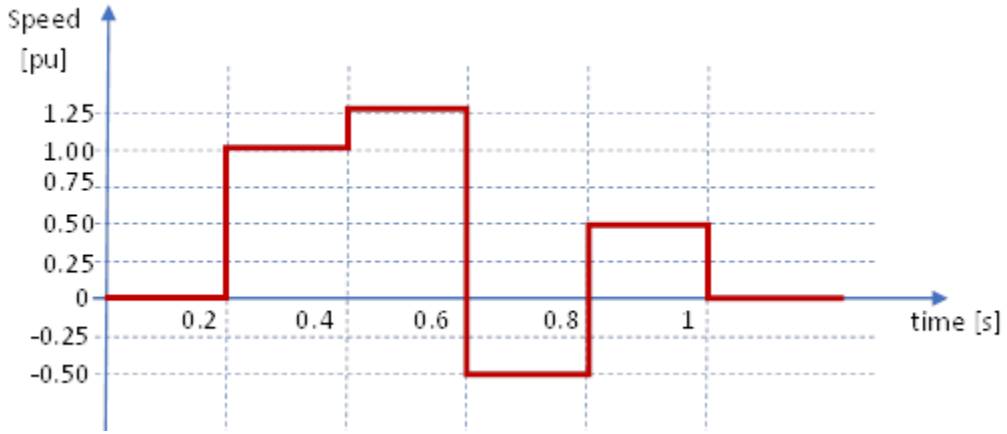
3.1	Type		battery
3.2	Supply voltage	V	18
3.3	source internal resistance	Ohm	0,18
3.4	source internal inductance	mH	0,18

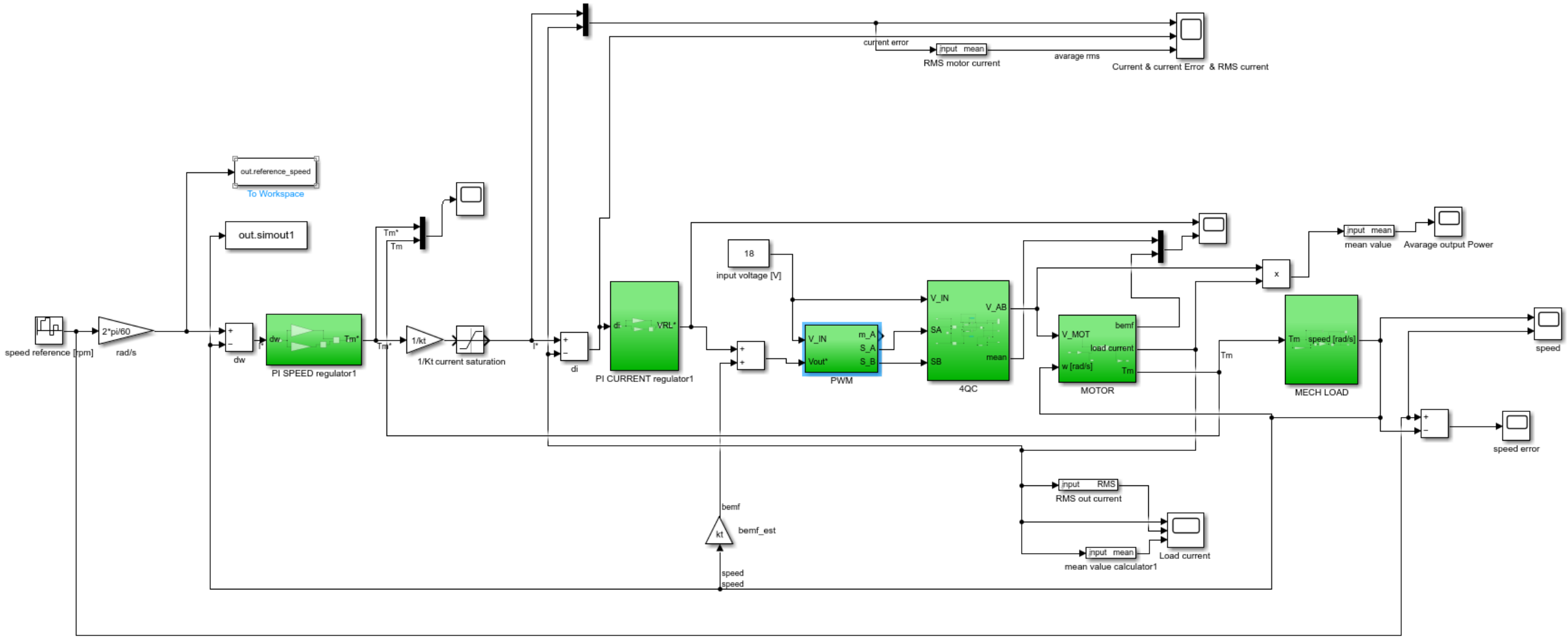
CONVERTER

4.1	Type		4 Quad DC/DC
4.2	max. output current	A	12,0

EXPECTED PERFORMANCE

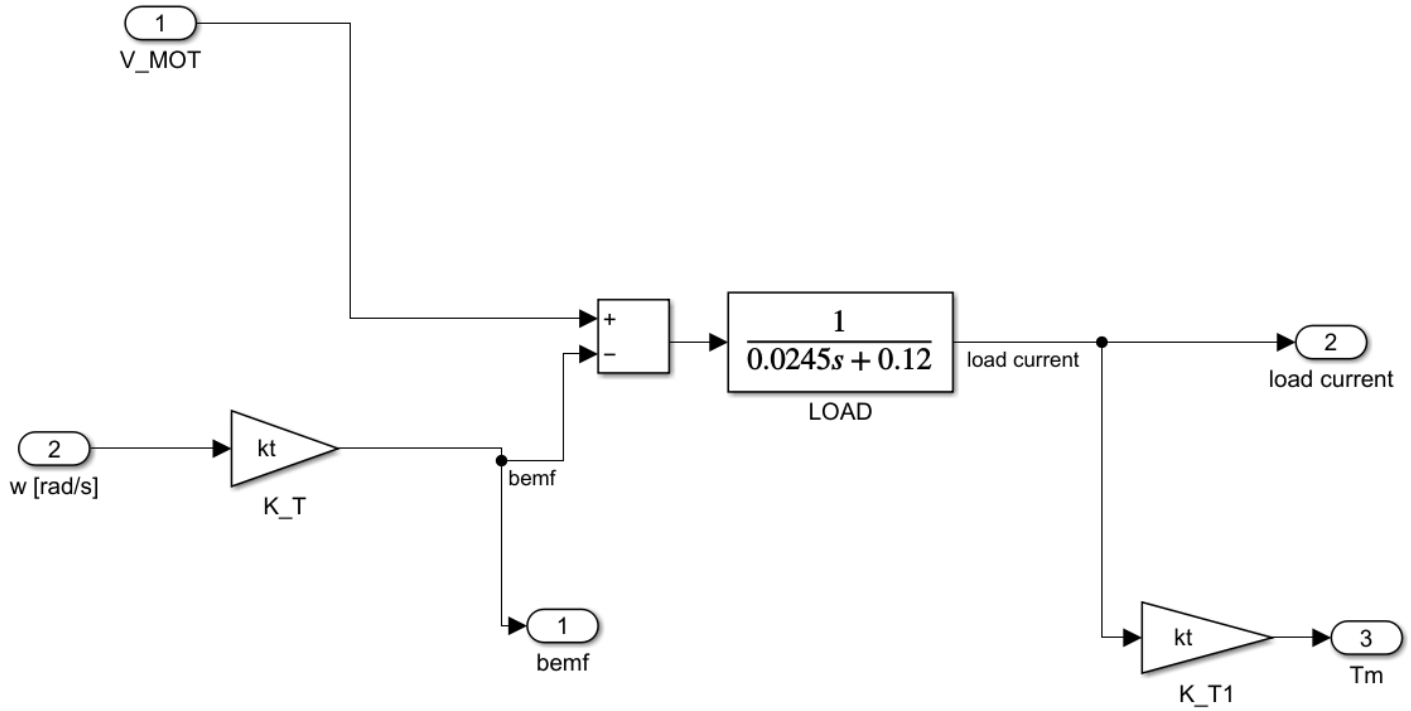
5.1.	Output current ripple at high frequency in steady state operation $I_{pk-pk}/I_{OUT\_nominal}$	<10%
5.2	Input current ripple at high frequency in steady state operation $I_{pk-pk}/I_{SOURCE\_mean}$	<1%
5.3	Speed range of stable operation	-125% to 125% of nominal speed
5.4	Load current lower than the converter max output current in any operating condition	
5.5	Speed overshoot with the step references of Fig.1	< 1%
5.6	Rise time with the step references of Fig. 1	<100ms
5.7	Steady state speed error with the step references of Fig. 1	< 1%




current error
input mean
RMS motor current
avarage rms
Current & current Error & RMS current
out.reference_speed
To Workspace
out.simout1
Tm*
Tm
18
input voltage [V]
input mean
mean value
Avarage output Power
x
speed reference [rpm]
2*pi/60
rad/s
dw
PI SPEED regulator1
1/kt
1/Kt current saturation
di
PI CURRENT regulator1
VRL*
V_IN
V_AB
SA
SB
mean
PWM
m_A
S_A
S_B
4QC
V_MOT
bemf
load current
w [rad/s]
Tm
MOTOR
speed [rad/s]
MECH LOAD
speed
speed error
input RMS
RMS out current
bemf
kt
bemf_est
input mean
mean value calculator1
Load current
speed
speed

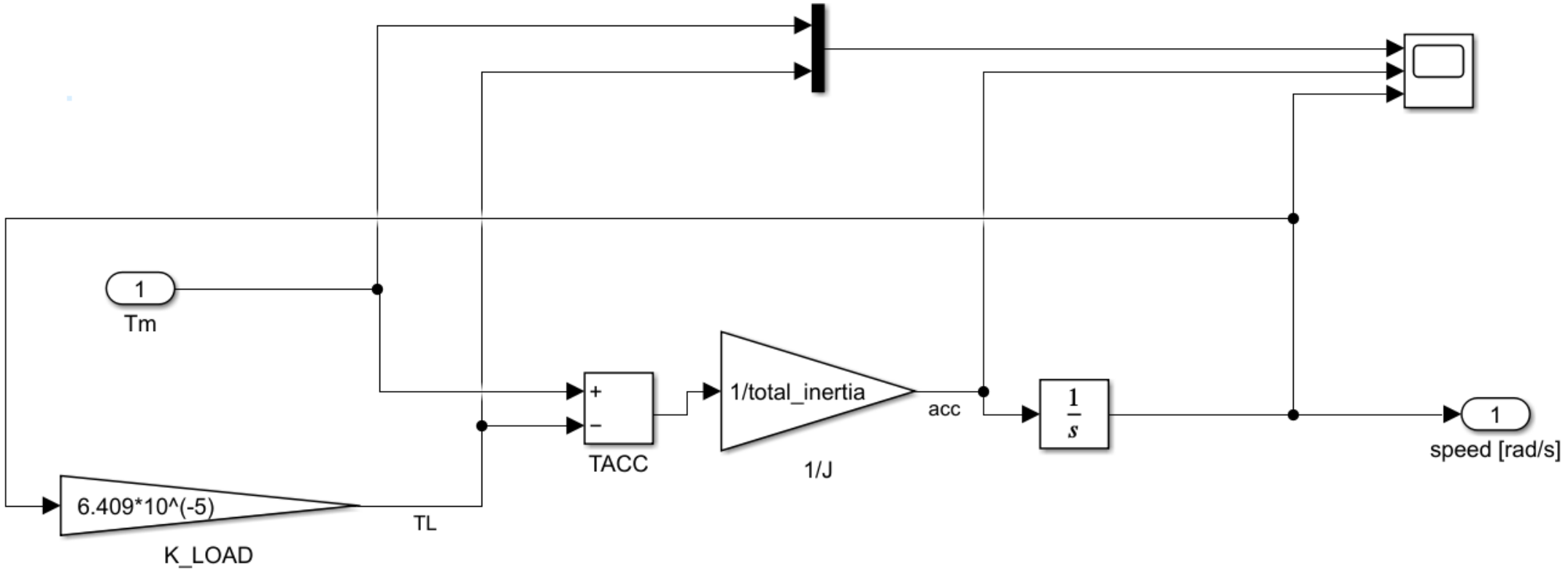
MOTOR

- Kt=16.7*10^(-3)

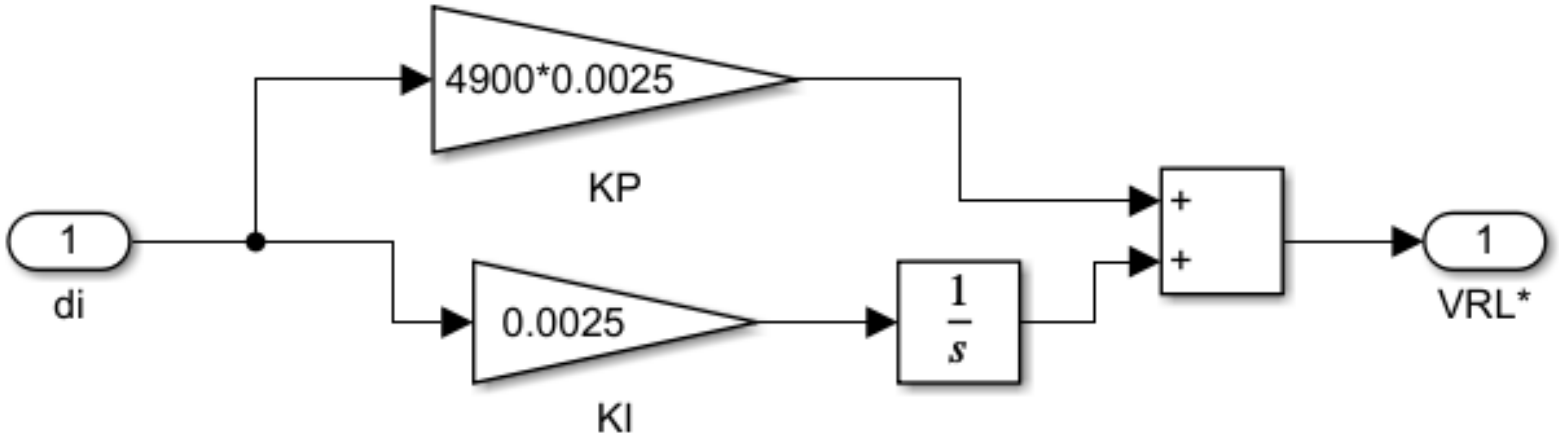


LOAD

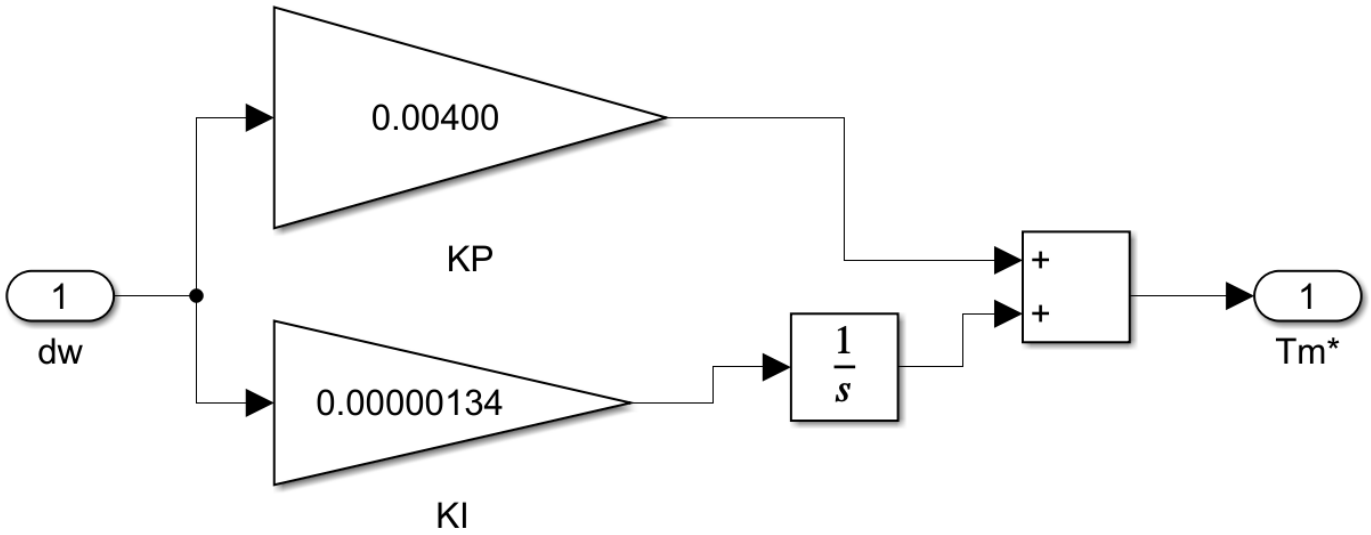
- rotor_inertia = 139; [g·cm2]
- load_inertia = 174; % [g·cm2] %
- total_inertia = (rotor_inertia + load_inertia) * 10^(-7);



PI CURRENT REGULATOR



PI SPEED REGULATOR



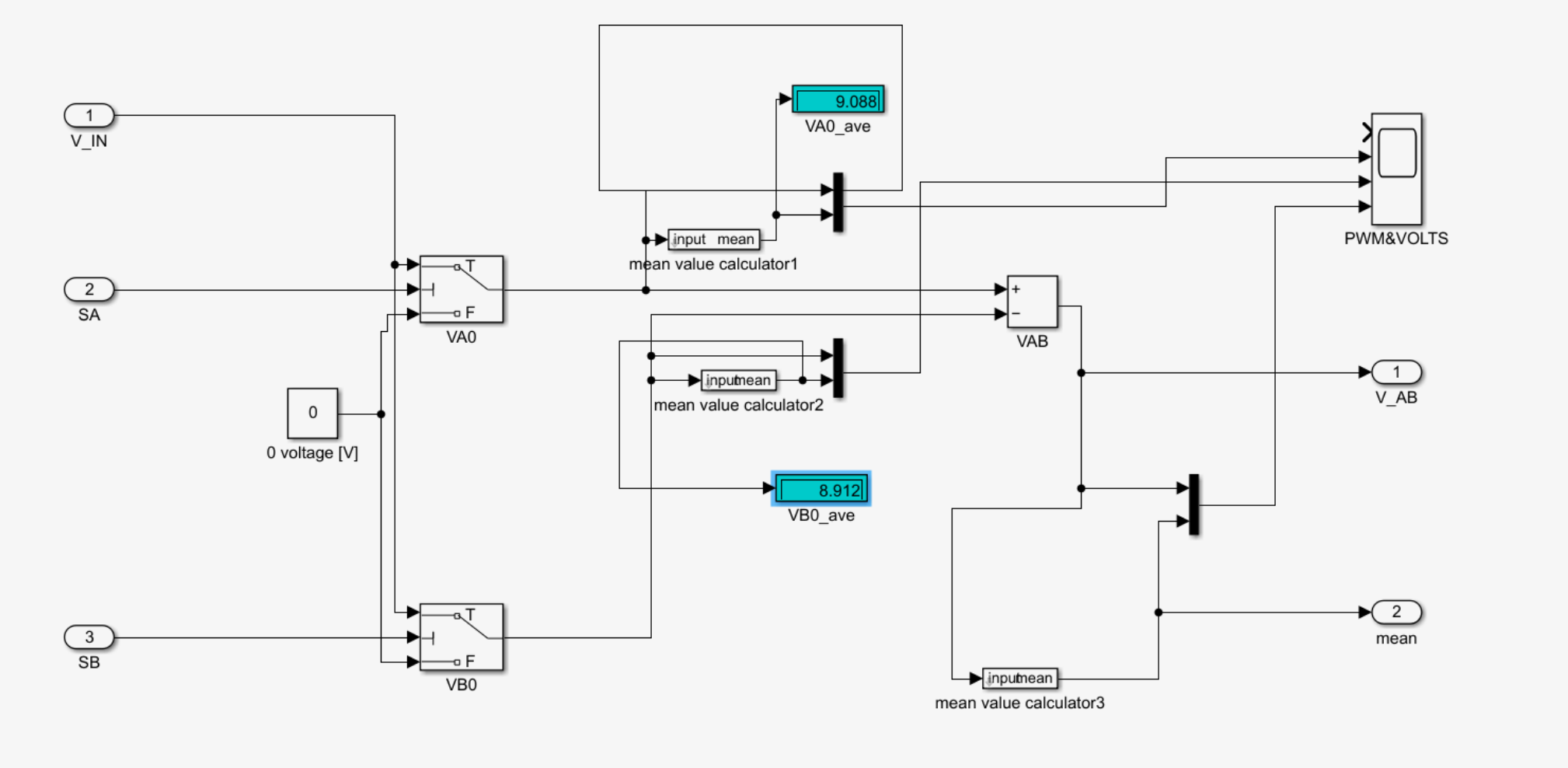
HOW I SETTED THE PI REGULATORS

As PI calibration method I used the experimental **tuning method**

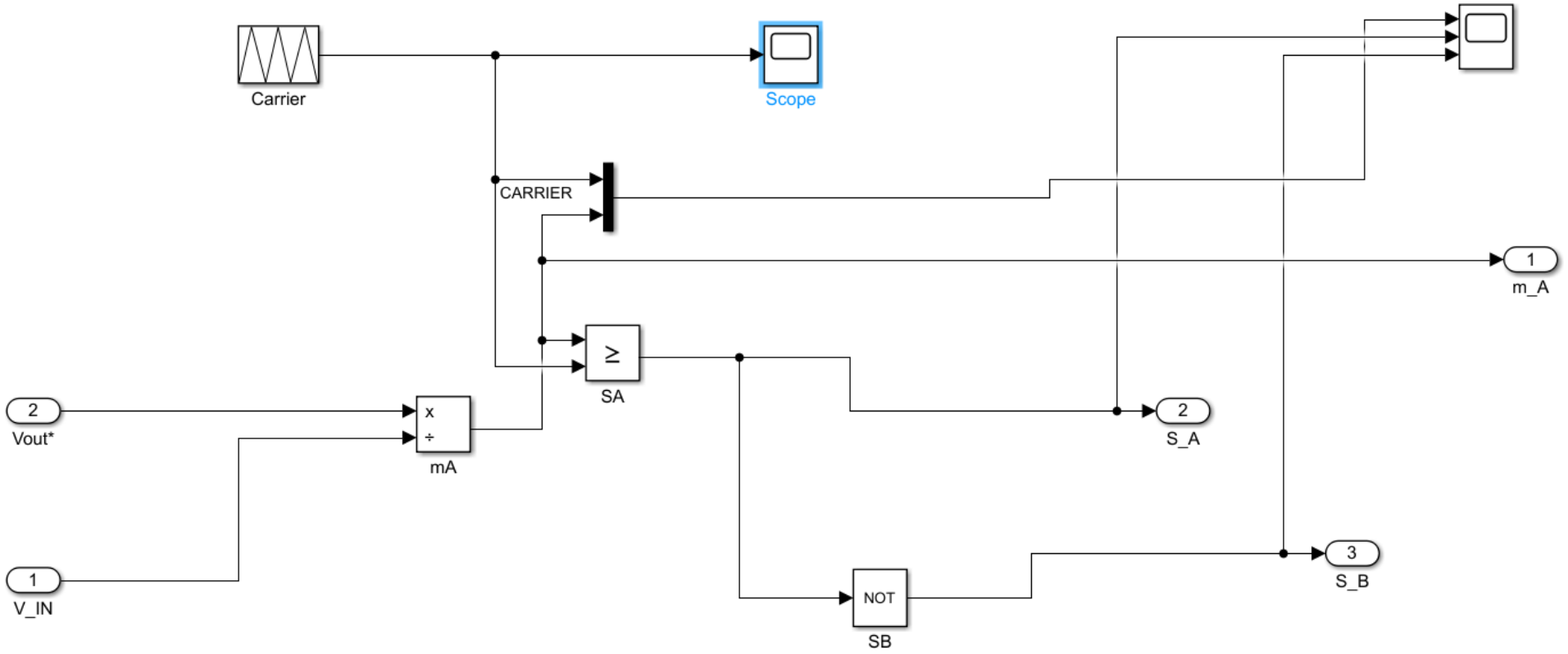
First I calibrated the KP value then I calibrated the KI value

I tried different values until I found the ones that give me a correct response from the system

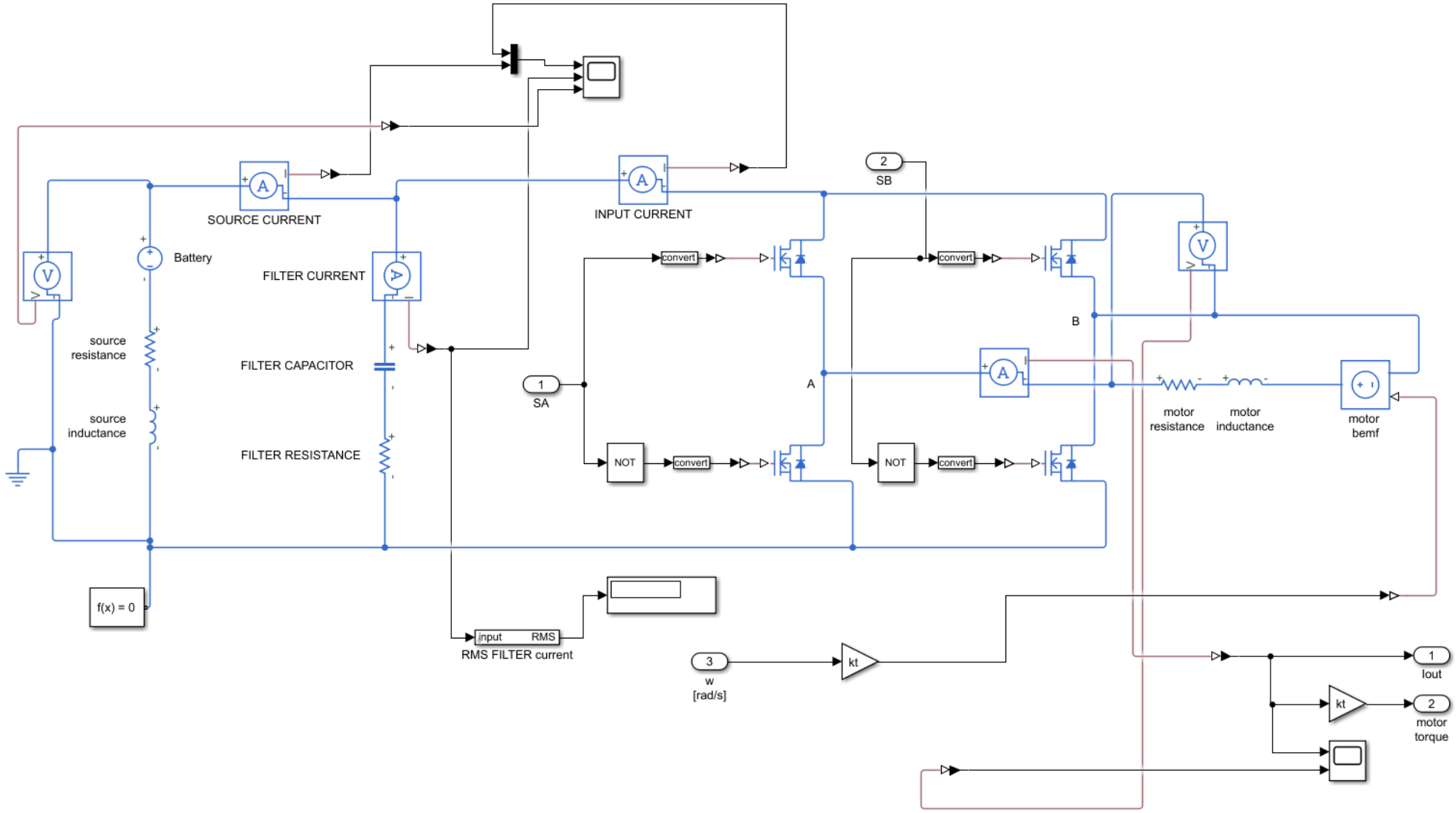
4 QUADRANT CONVERTER



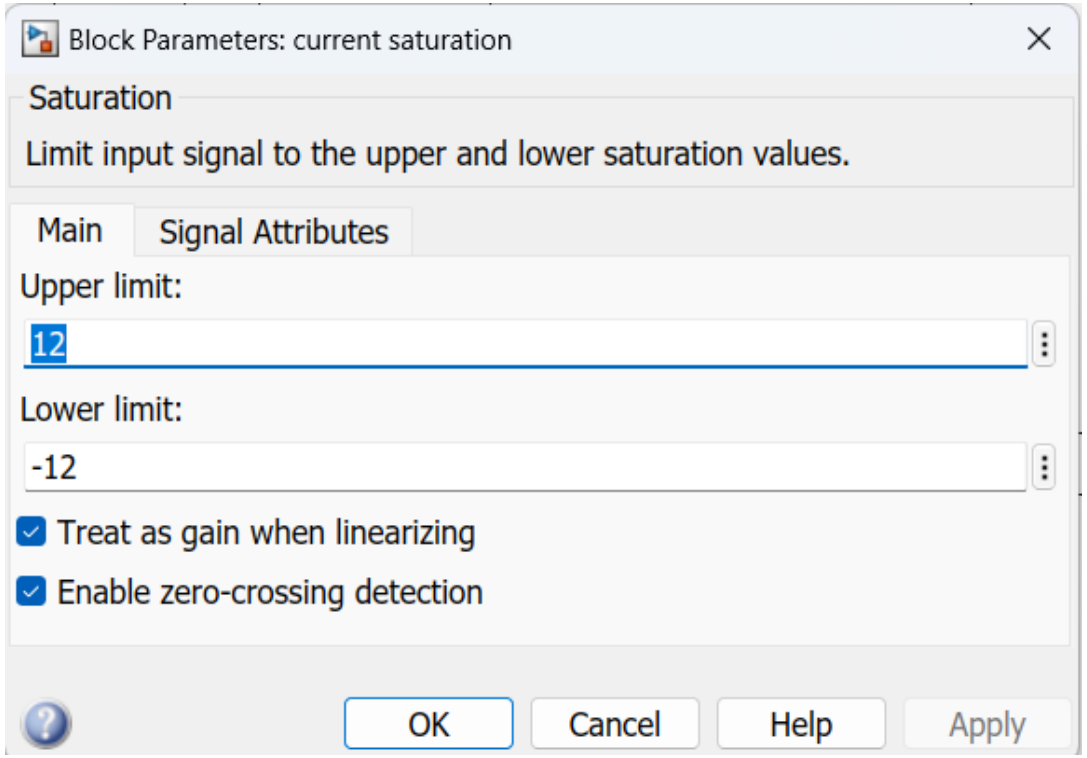
PWM MODULATION

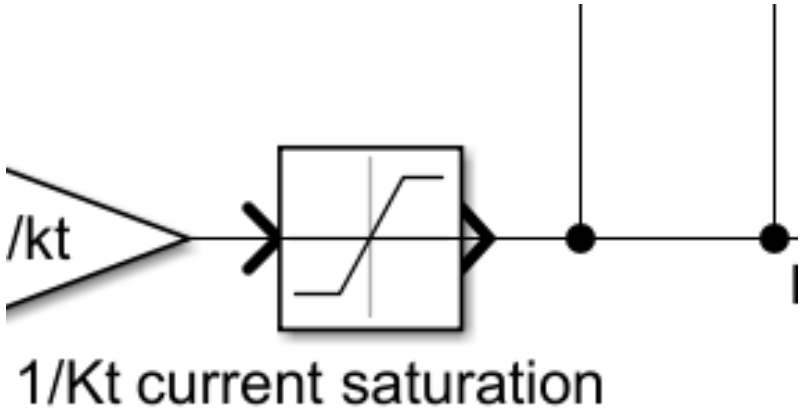


SIMSCAPE


SOURCE CURRENT
INPUT CURRENT
2
SB
Battery
FILTER CURRENT
source resistance
source inductance
FILTER CAPACITOR
FILTER RESISTANCE
convert
convert
B
A
1
SA
NOT
convert
NOT
convert
motor resistance
motor inductance
motor bemf
f(x) = 0
input RMS
RMS FILTER current
3
w
[rad/s]
kt
1
Iout
kt
2
motor torque

SATURATION BLOCK

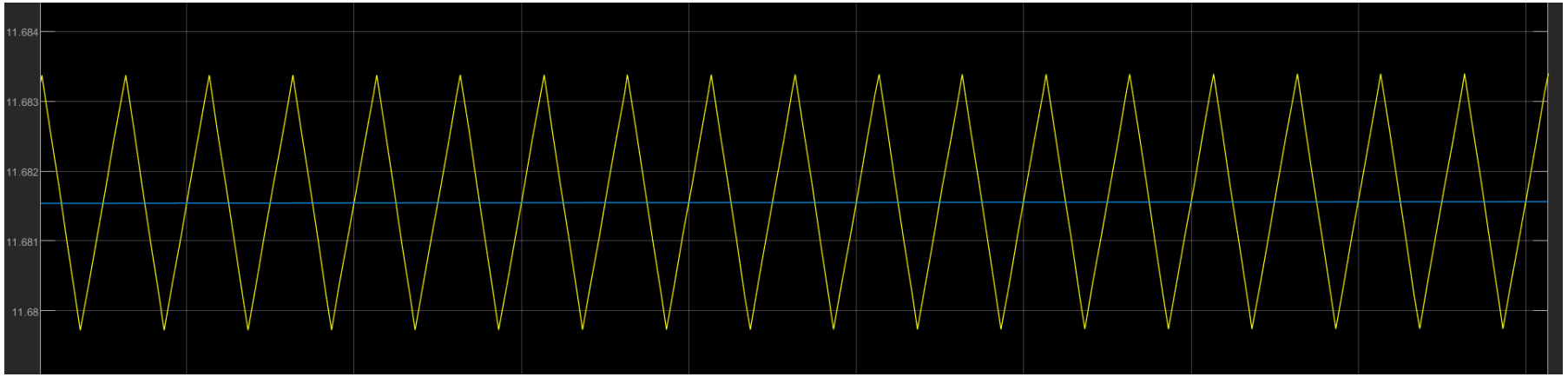


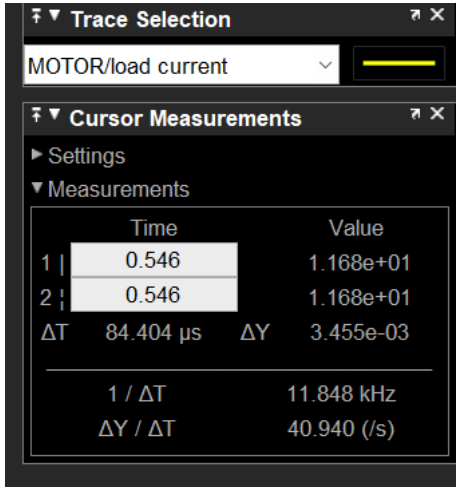


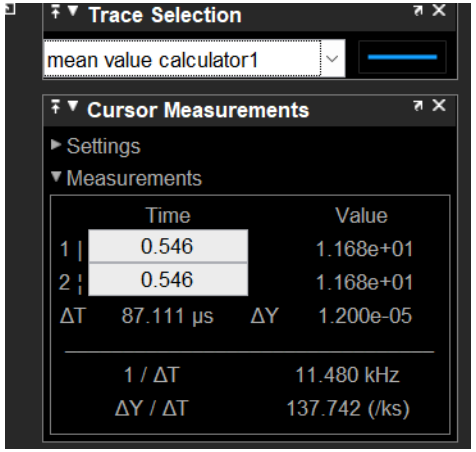
1/Kt current saturation

EXCPECTED PERFORMANCE

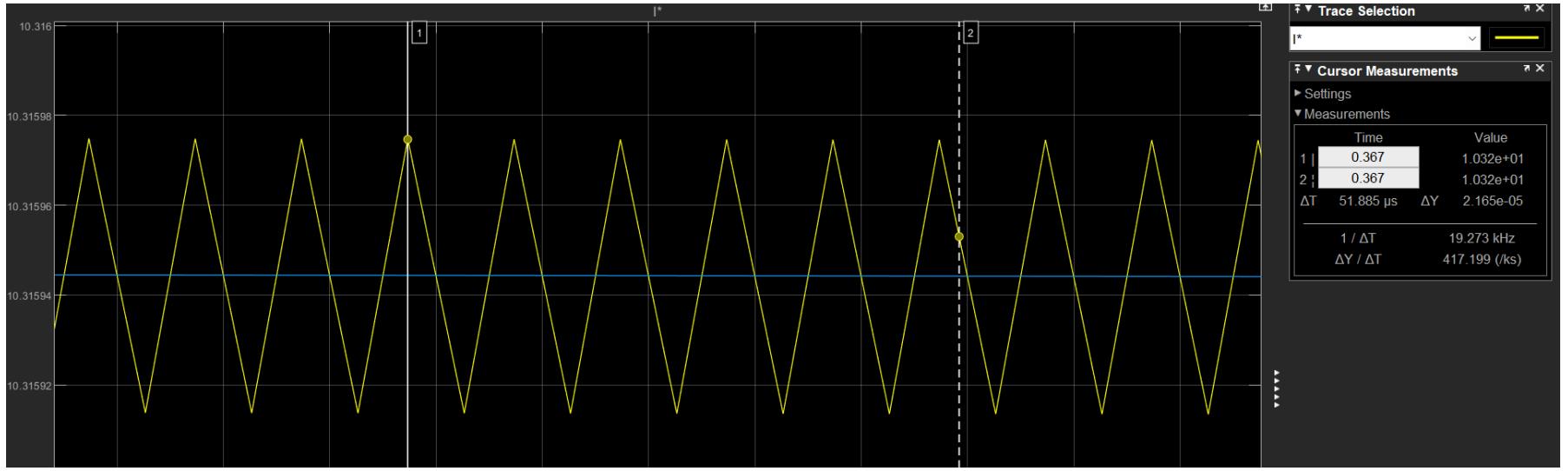
5.1.Output current ripple at high frequency in steady state operation $I_{pkpk}/I_{OUT\_nominal}$ <10%

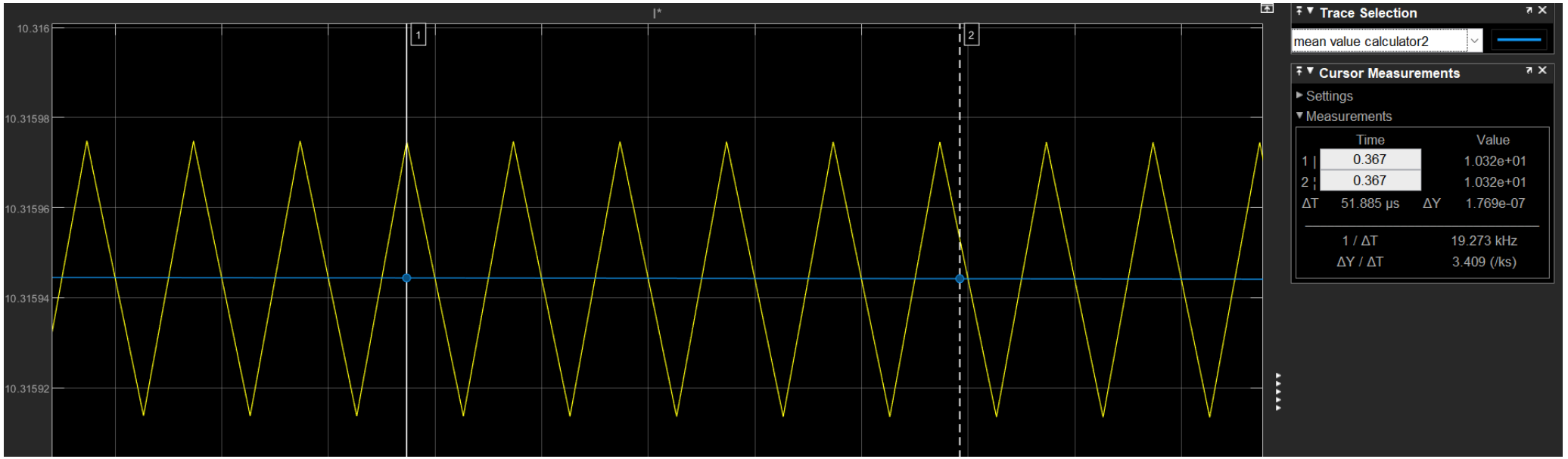




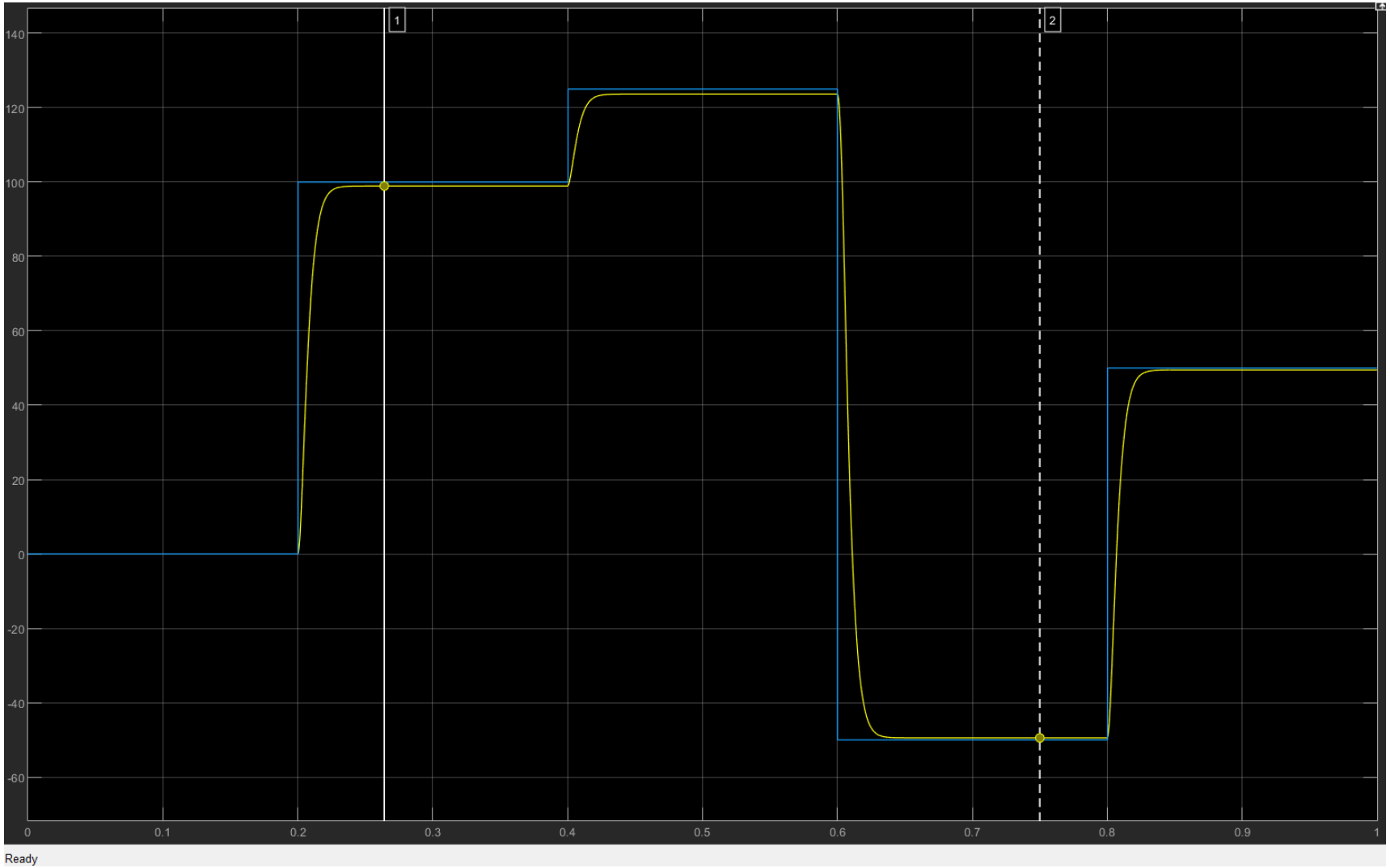


5.2 Input current ripple at high frequency in steady state operation $I_{pk\text{-}pk}/I_{SOURCE\_mean}$ <1

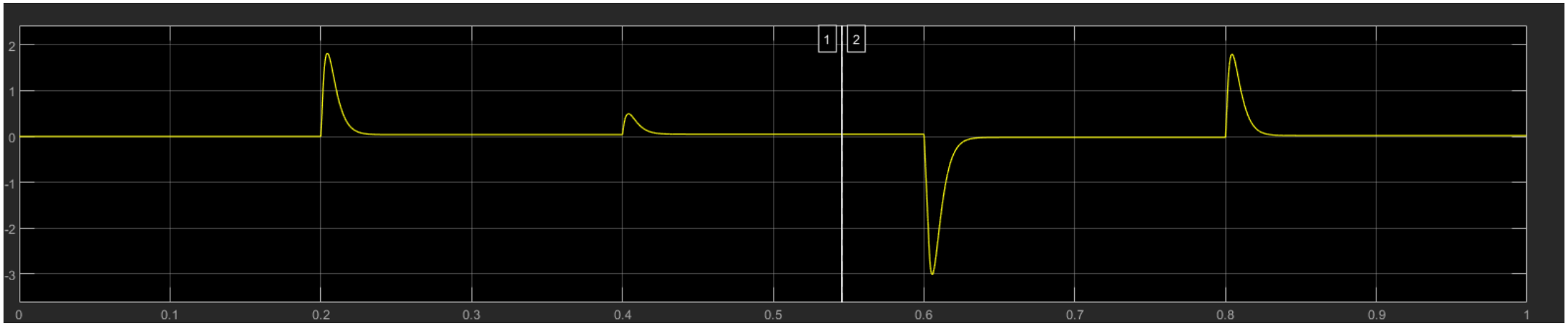




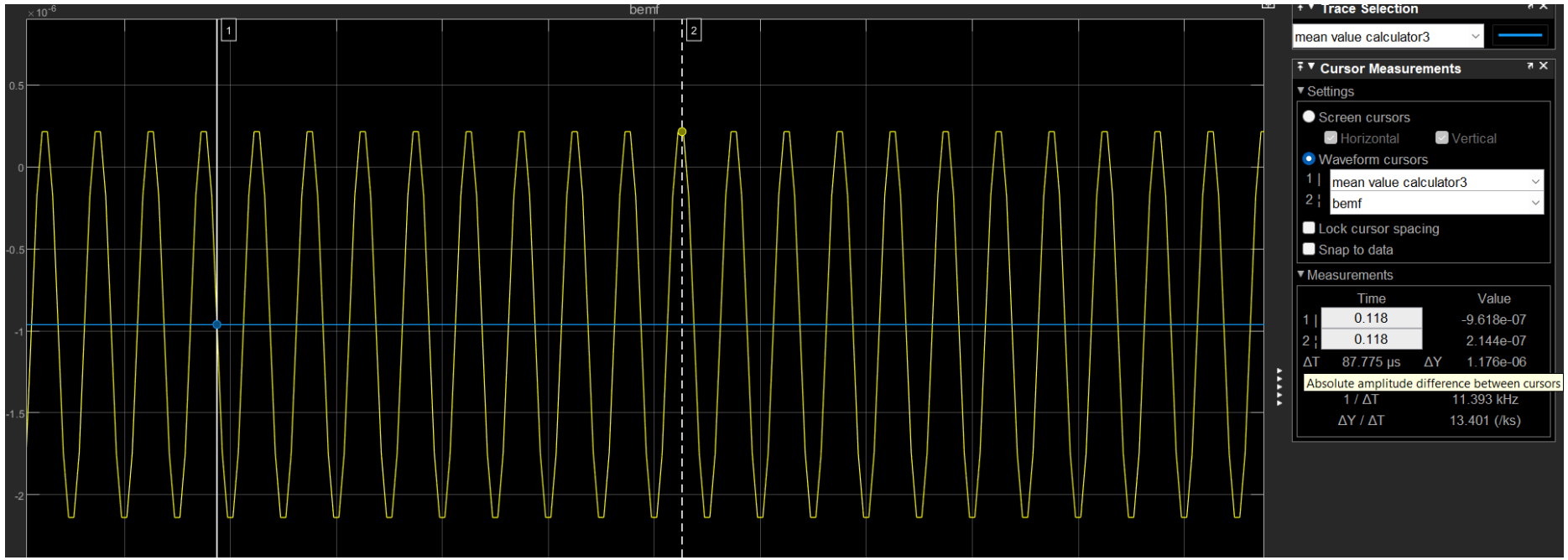
5.3 Speed range of stable operation -125% to 125% of nominal speed



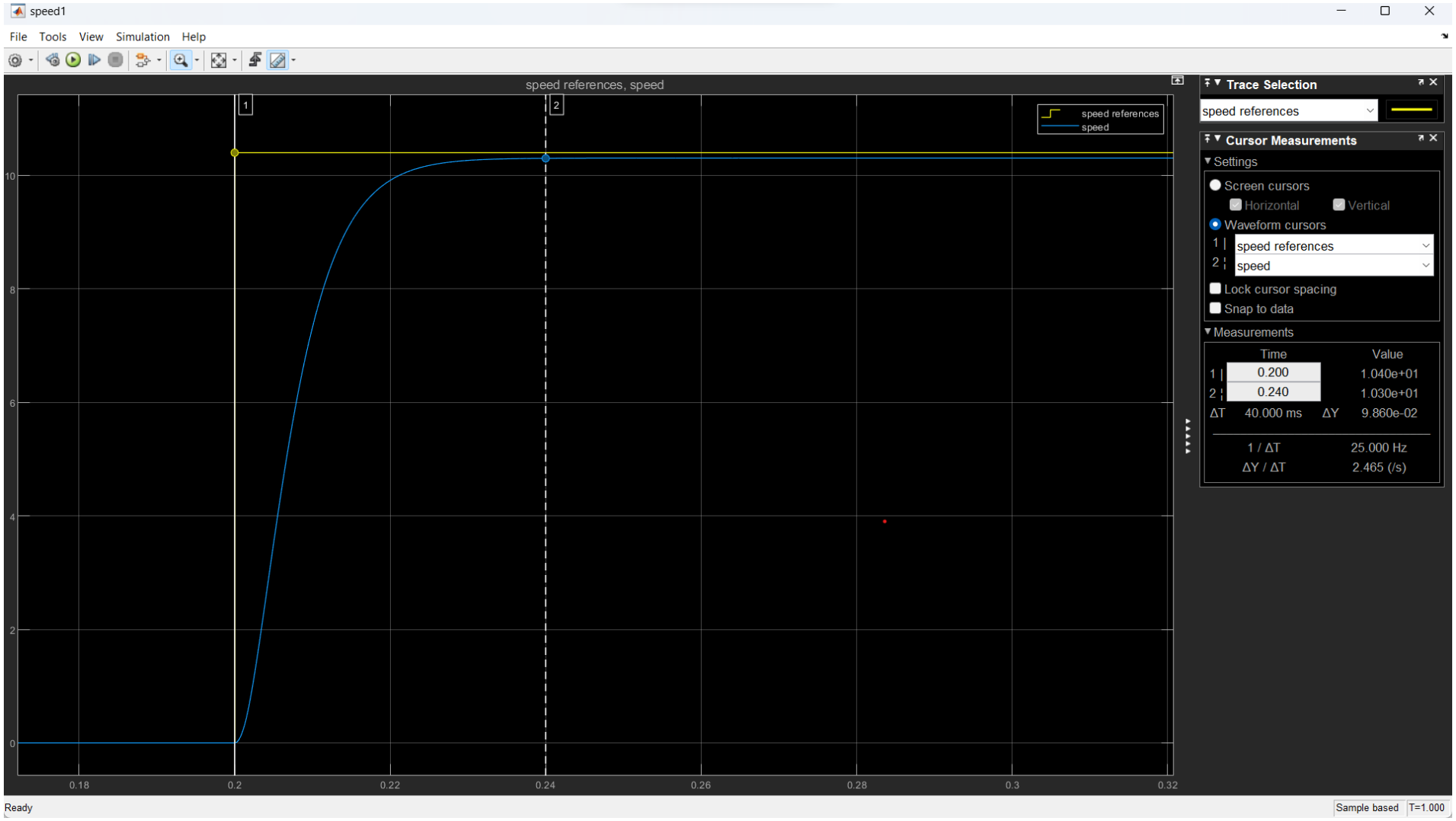
5.4 Load current lower than the converter max output current in any operating condition



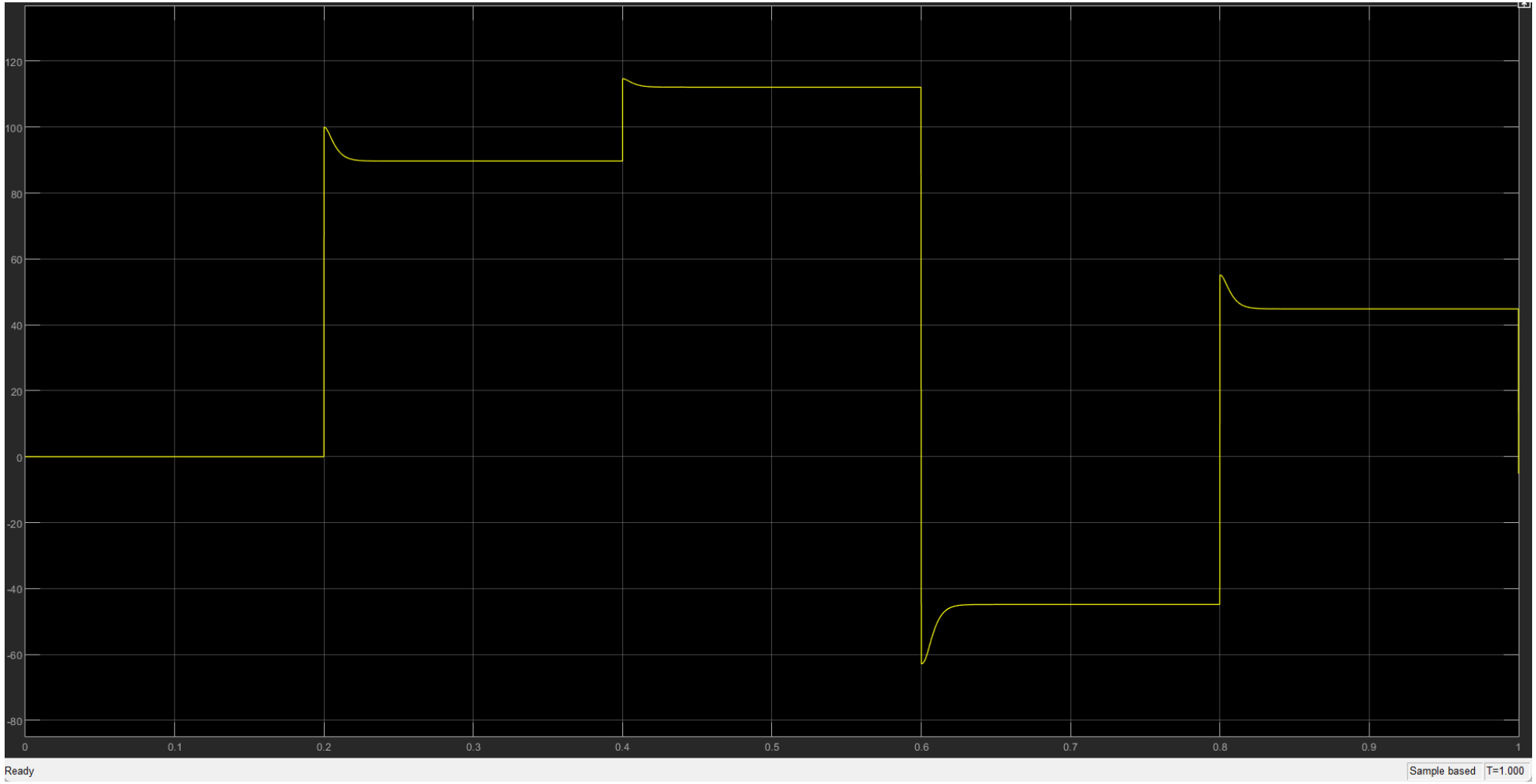
5.5 Speed overshoot with the step references of Fig.1 < 1%



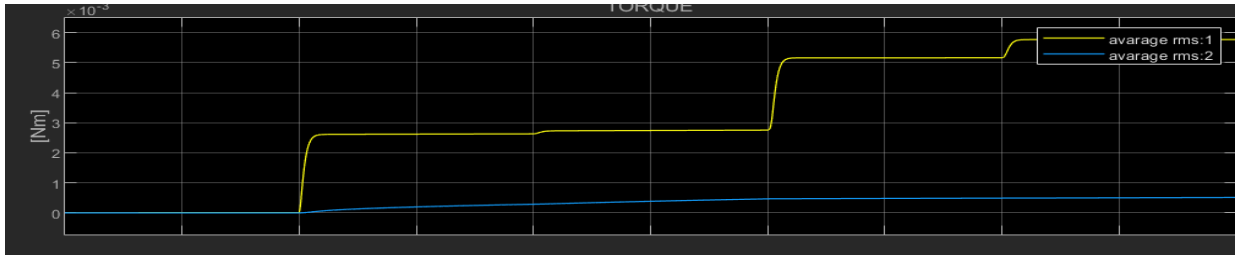
5.6 Rise time with the step references of Fig. 1 <100ms



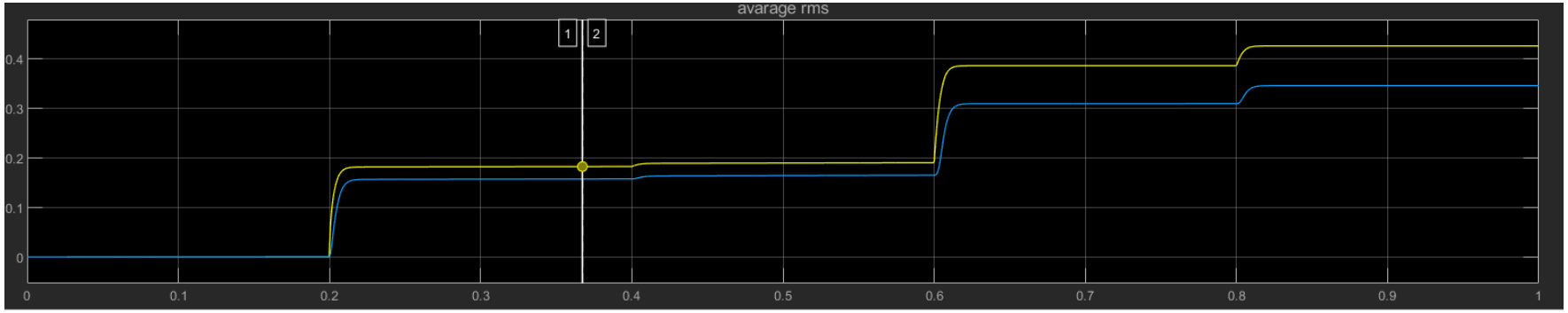
5.7 Steady state speed error with the step references of Fig. 1 < 1%



RMS MOTOR TORQUE



RMS MOTOR CURRENT



AVARAGE OUTPUT POWER