PMSM Lab

Name:Li Xin
ITMO ID:375334
HDU ID:22320404

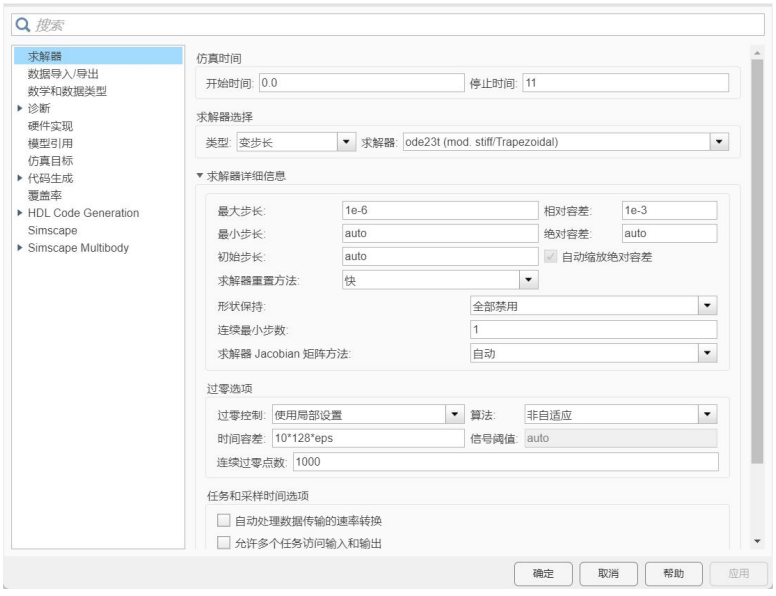
TASK 1.BUILD THE MECHANICAL PART OF THE MODEL BASED ON DIFFERENTIAL EQUATIONS

1.DATA INITIAL

Variant	L	R	flux	pole pairs	J	n_rated	t_startup
4	0.0002700	0.600	0.0043319	7	0.00000600	3500	10

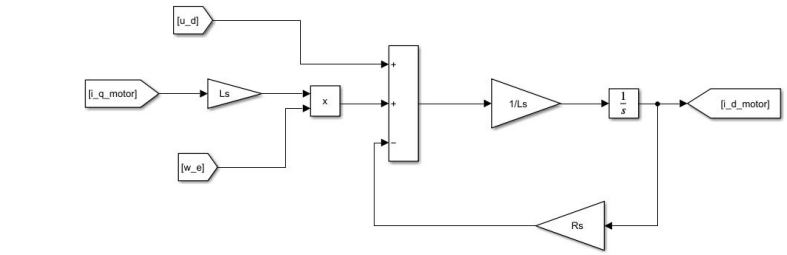
```
Rs = 0.600;
Ls = 0.0002700;
zp = 7;
psi = 0.0043319;
J = 0.00000600;
n_rated = 3500;
t_startup = 10;

f = n_rated/60*zp;
eps_startup = f/t_startup;
```

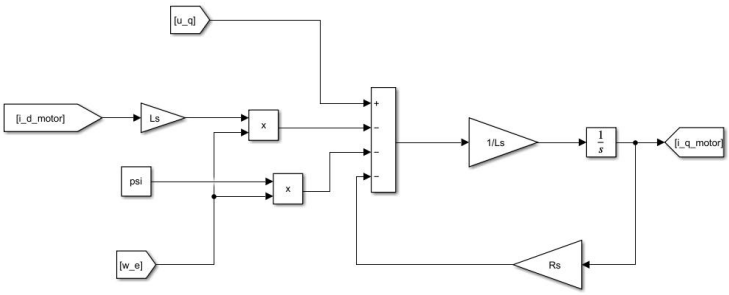
2.MODEL CONFIGURATION



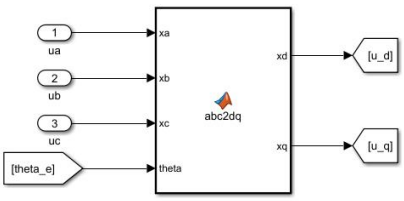
3. The model of SPMSM based on differential equations

Block diagram of d-q equations



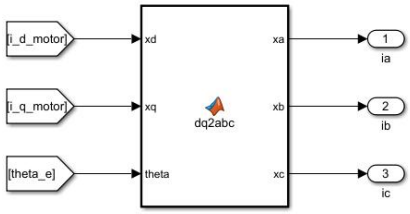


Input Clark & Park transformation:



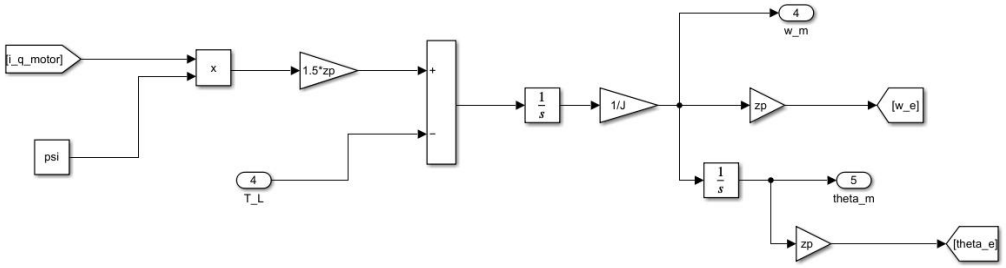

```
function [xd, xq] = abc2dq(xa, xb, xc, theta)
    sin_t = sin(theta);
    cos_t = cos(theta);
    x2 = [2/3 -(1/3) -(1/3); 0 1/sqrt(3) -1/sqrt(3)] * [xa xb xc]';
    x_alpha = x2(1);
    x_beta = x2(2);
    xd = x_alpha * cos_t + x_beta * sin_t;
    xq = -x_alpha * sin_t + x_beta * cos_t;
end
```

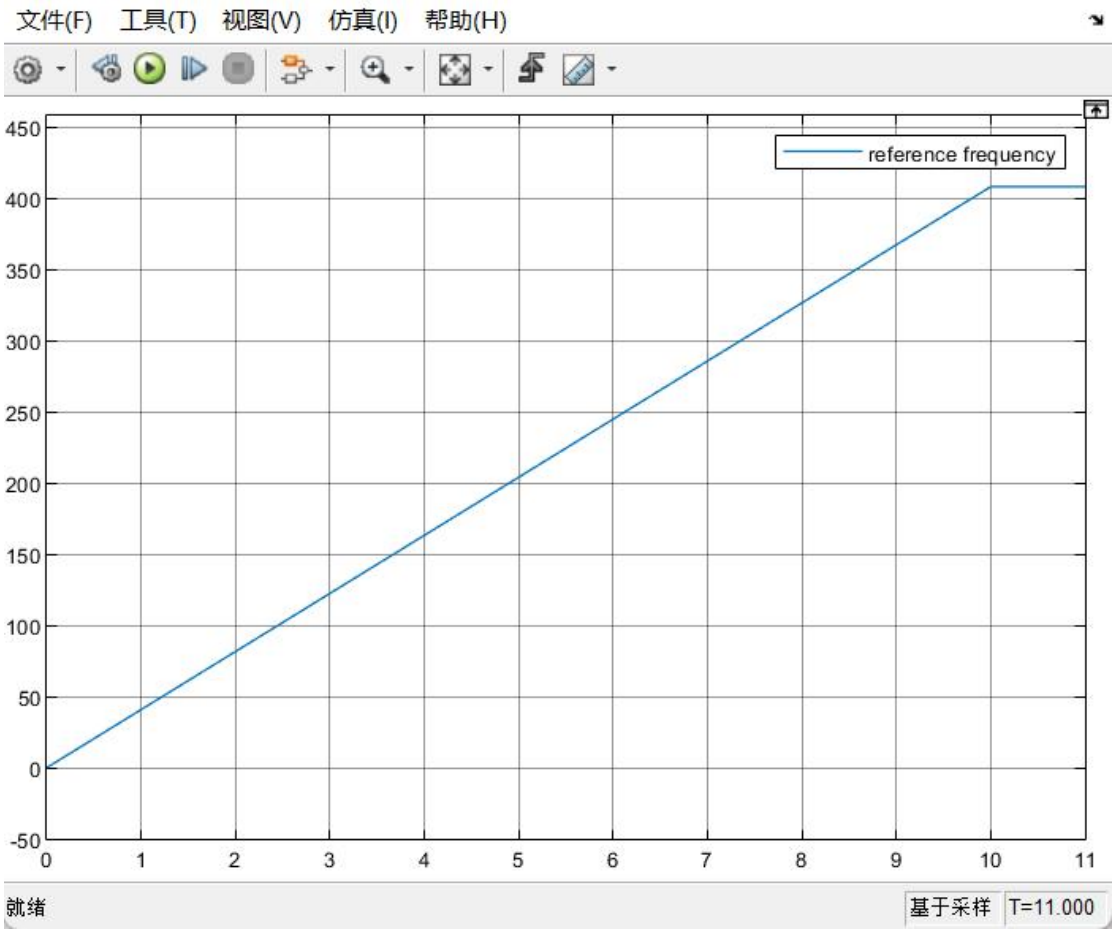
Output inverse Park & Clark transformation:



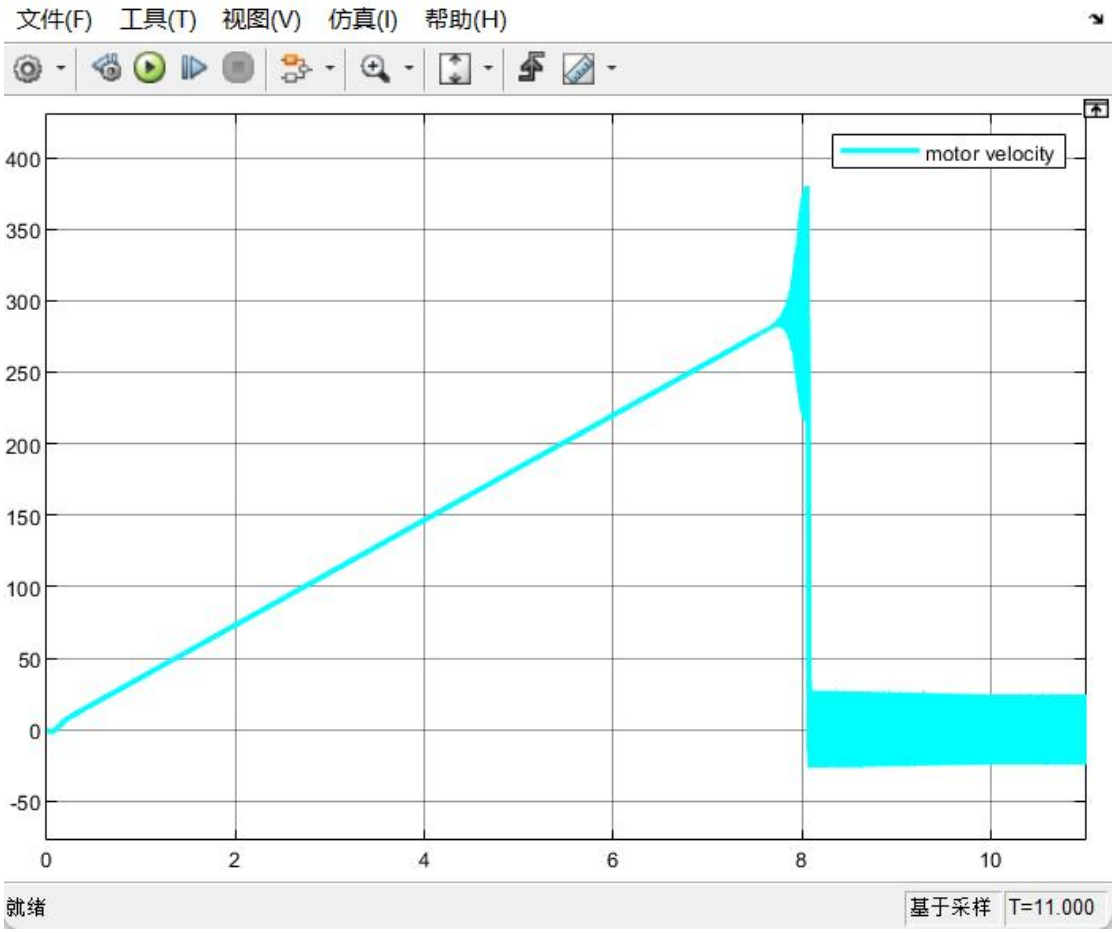

```
function [xa, xb, xc] = dq2abc(xd, xq, theta)
    sin_t = sin(theta);
    cos_t = cos(theta);
    x_alpha = xd * cos_t - xq * sin_t;
    x_beta = xd * sin_t + xq * cos_t;
    xa = x_alpha;
    xb = (-0.5) * x_alpha + sqrt(3) / 2 * x_beta;
    xc = (-0.5) * x_alpha - sqrt(3) / 2 * x_beta;
end
```

Mechanical part:

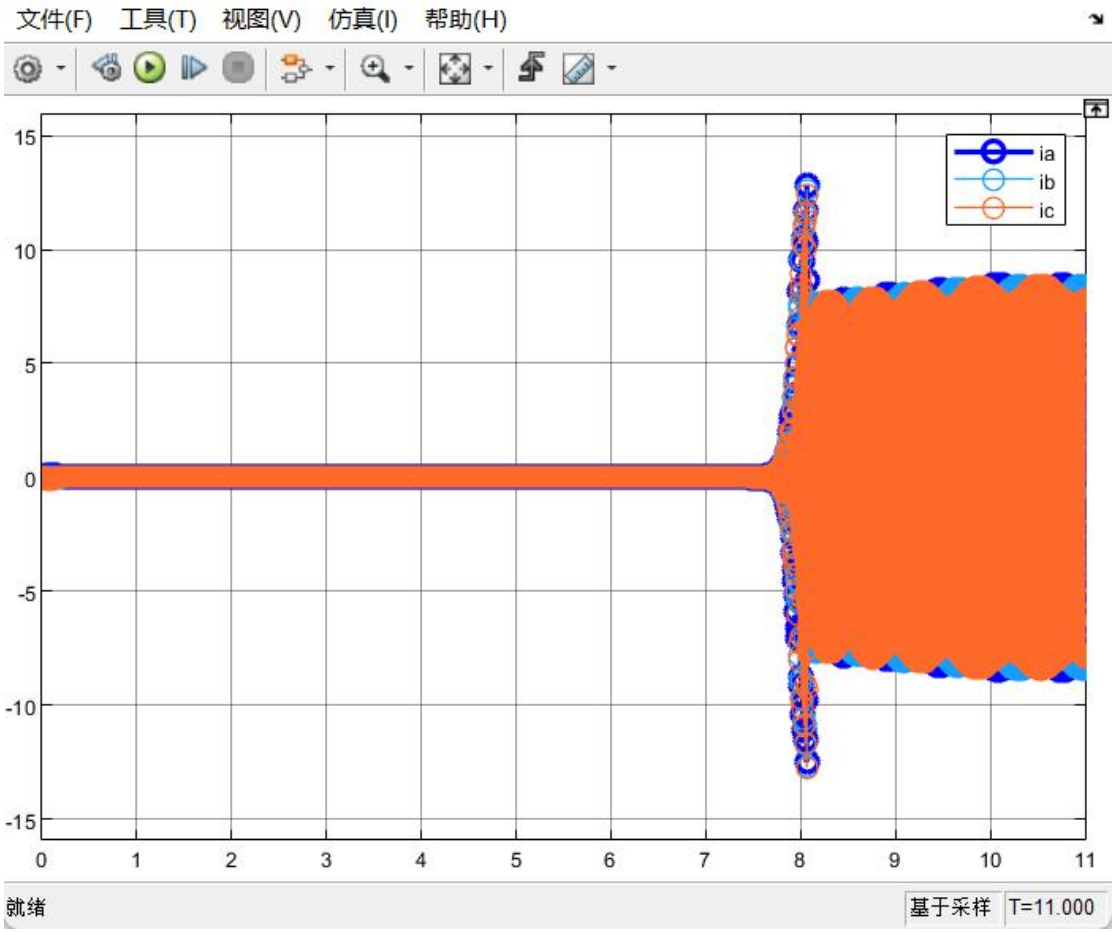




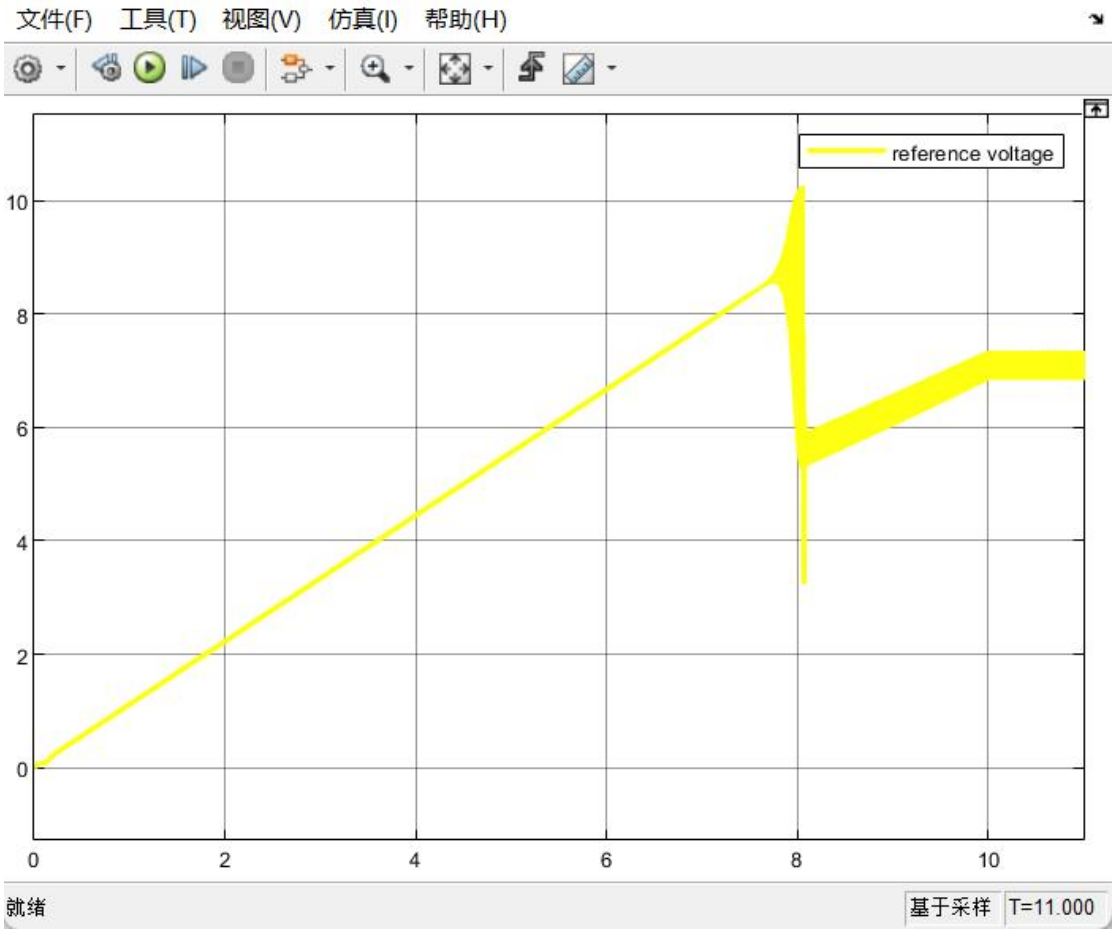
1-reference frequency



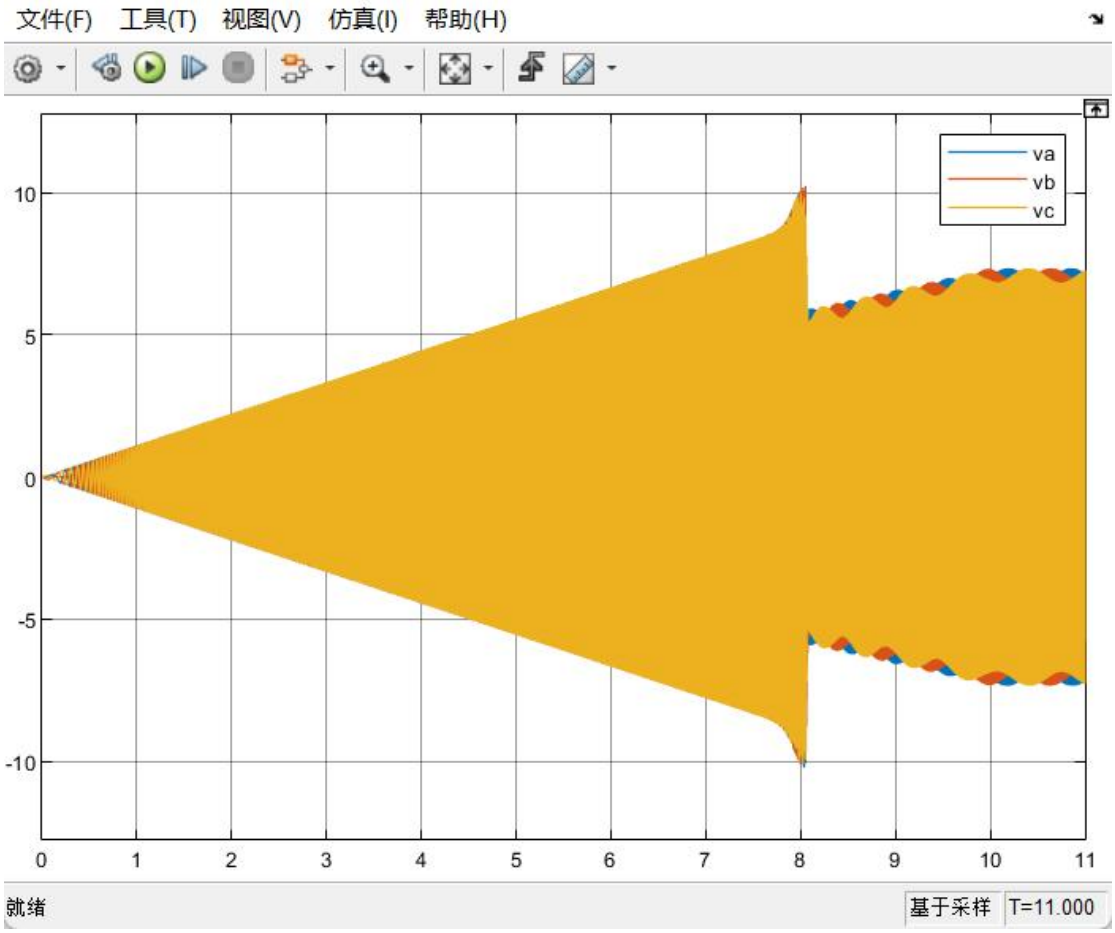
2- motor velocity in rev/min



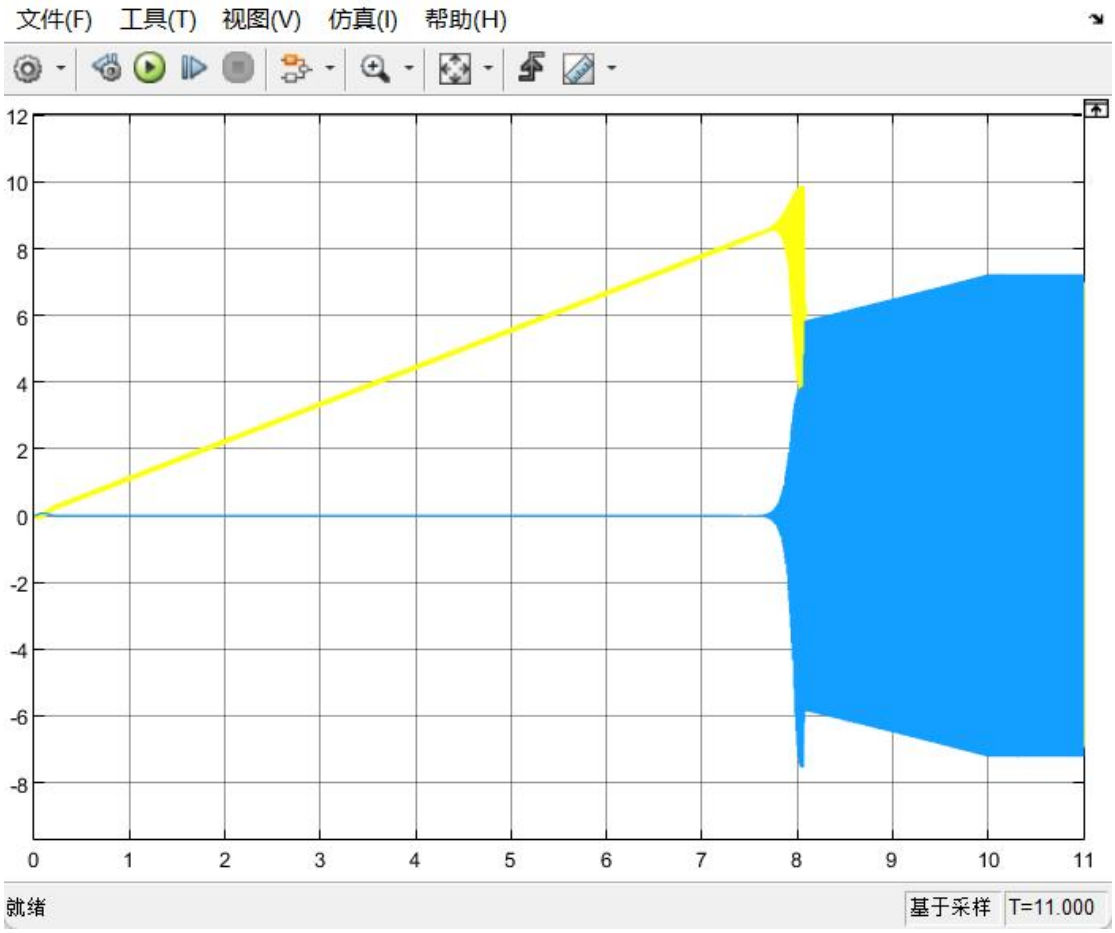
3-phase currents ia, ib, ic,



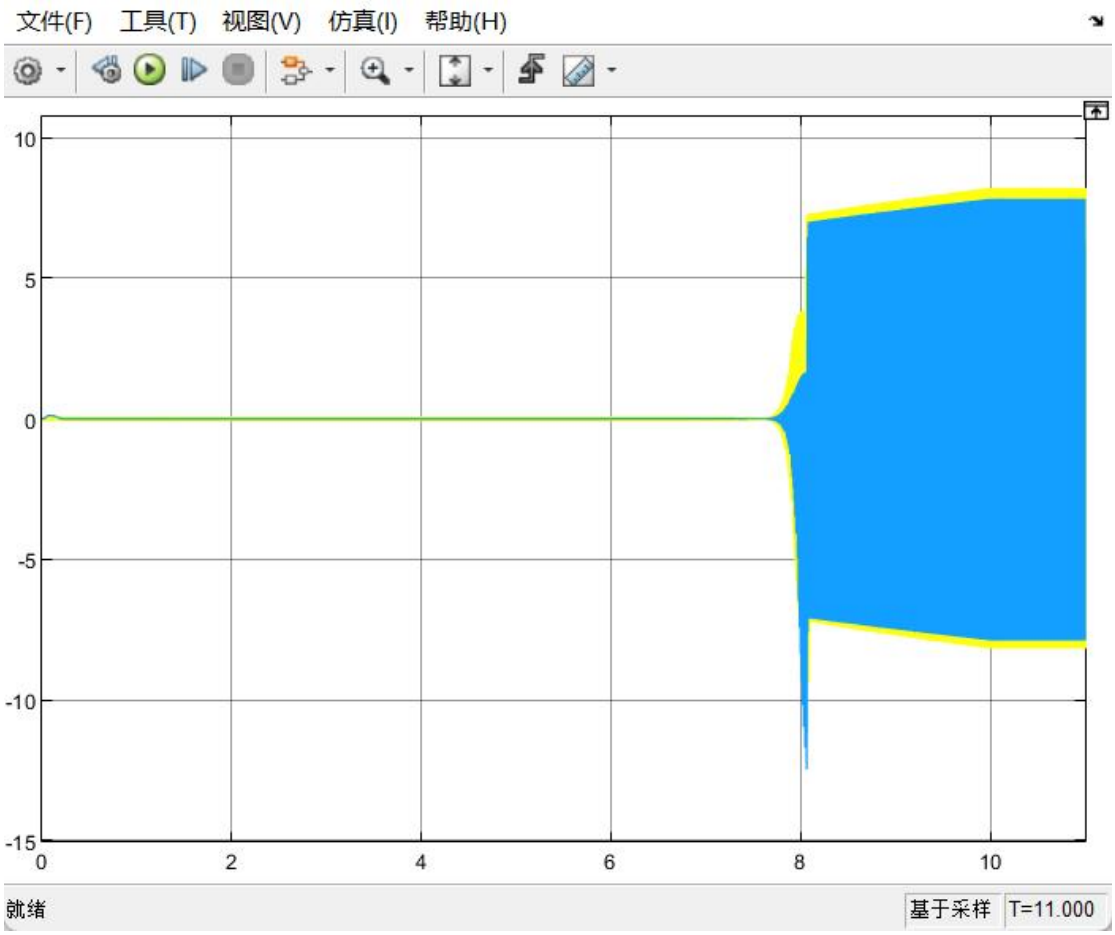
4-reference voltage vs*, V



5-phase voltages va, vb, vc, V

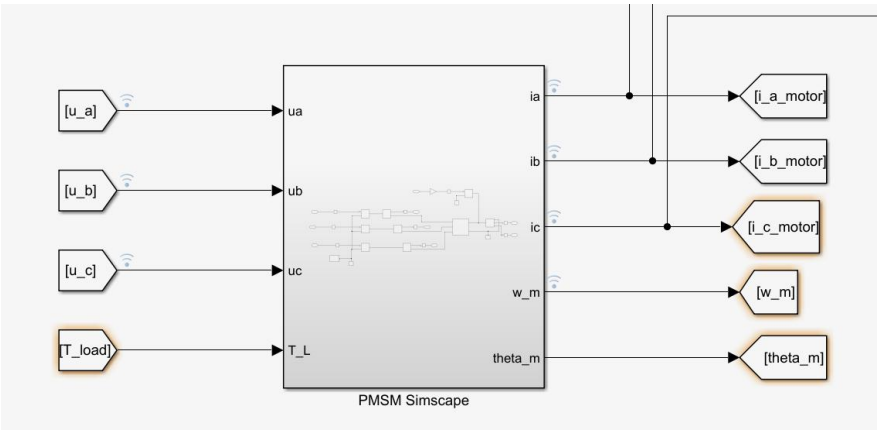


6-dq-voltages, V

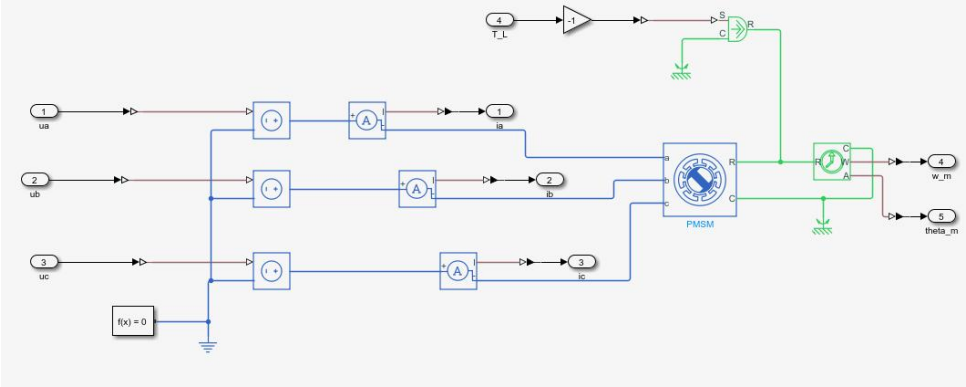


7-dq-currents, A

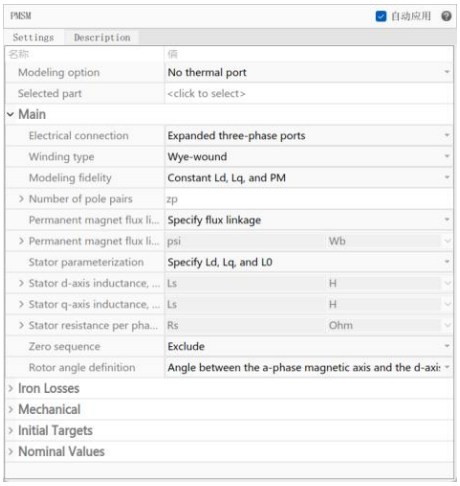
TASK 2.BUILD THE MECHANICAL PART OF THE MODEL BASED ON SIMSCAPE MODEL

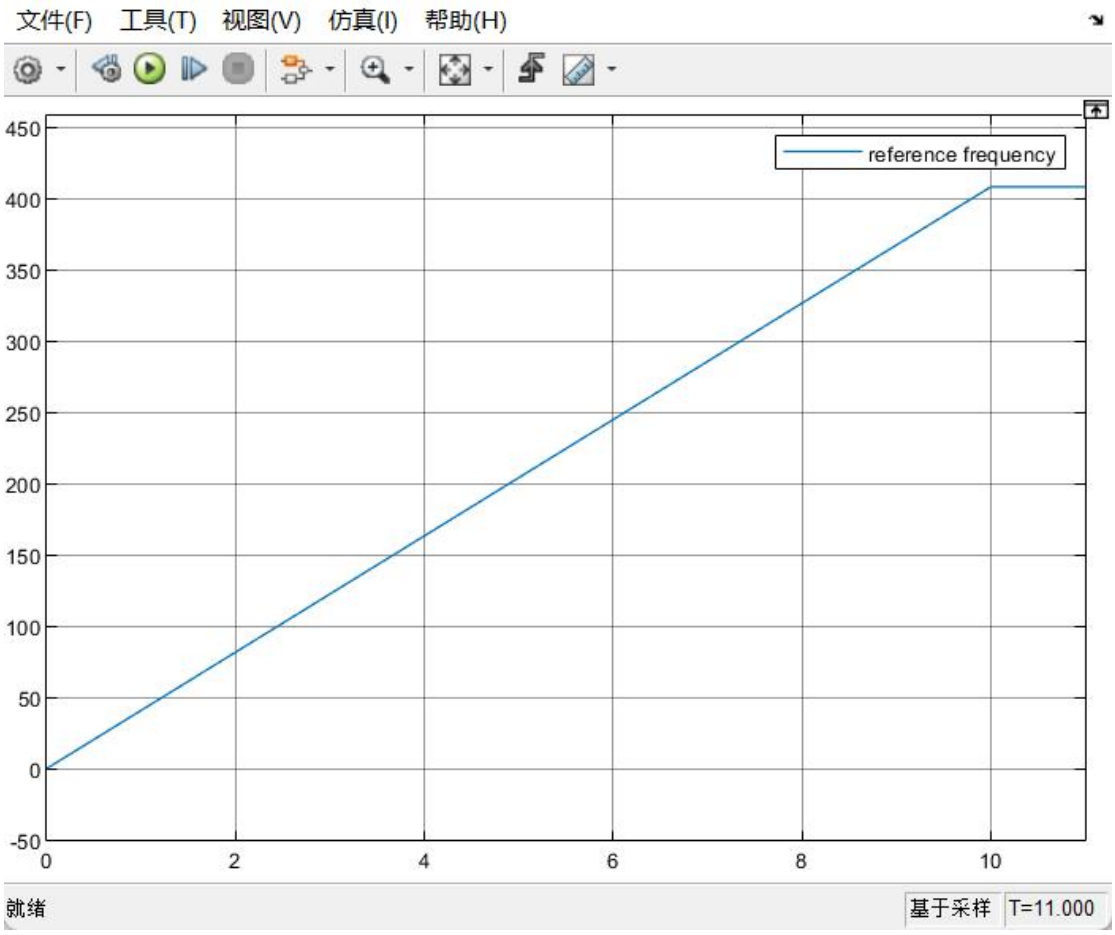


1.Model build

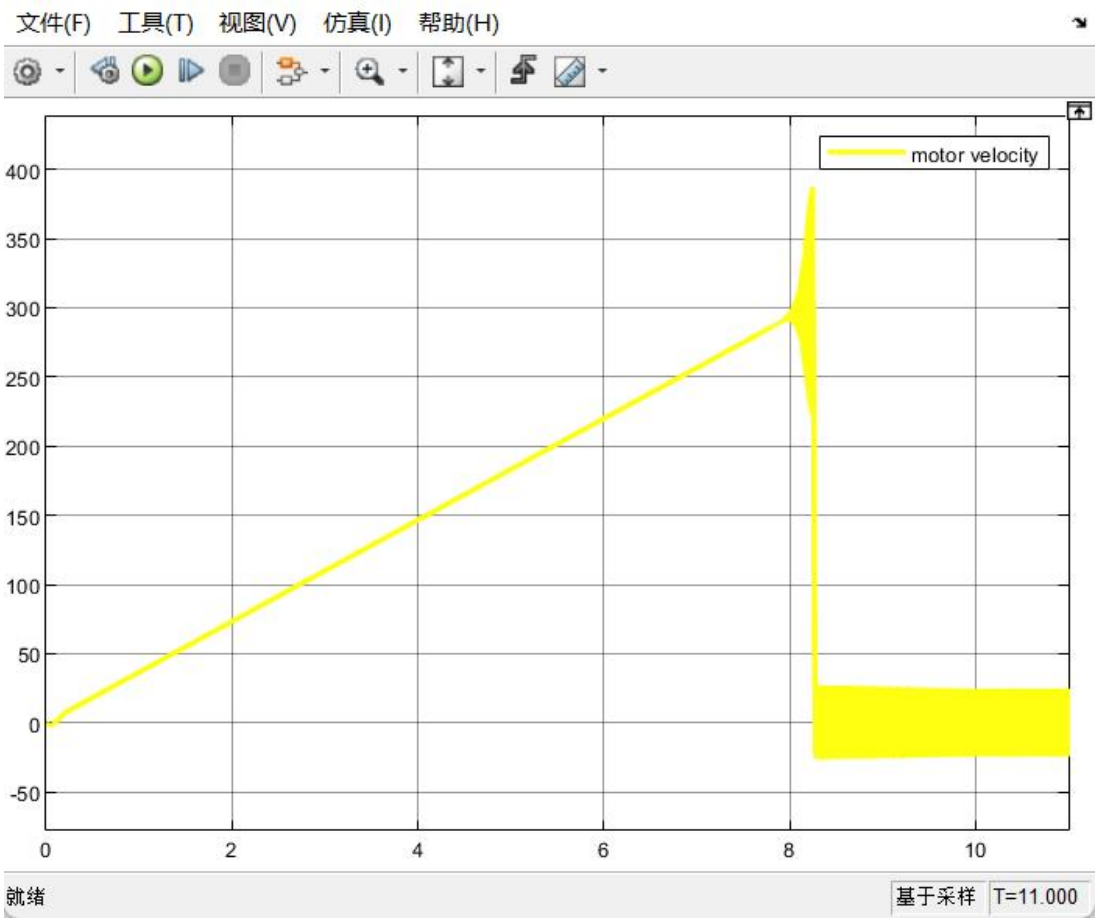


2.Motor parameters setting

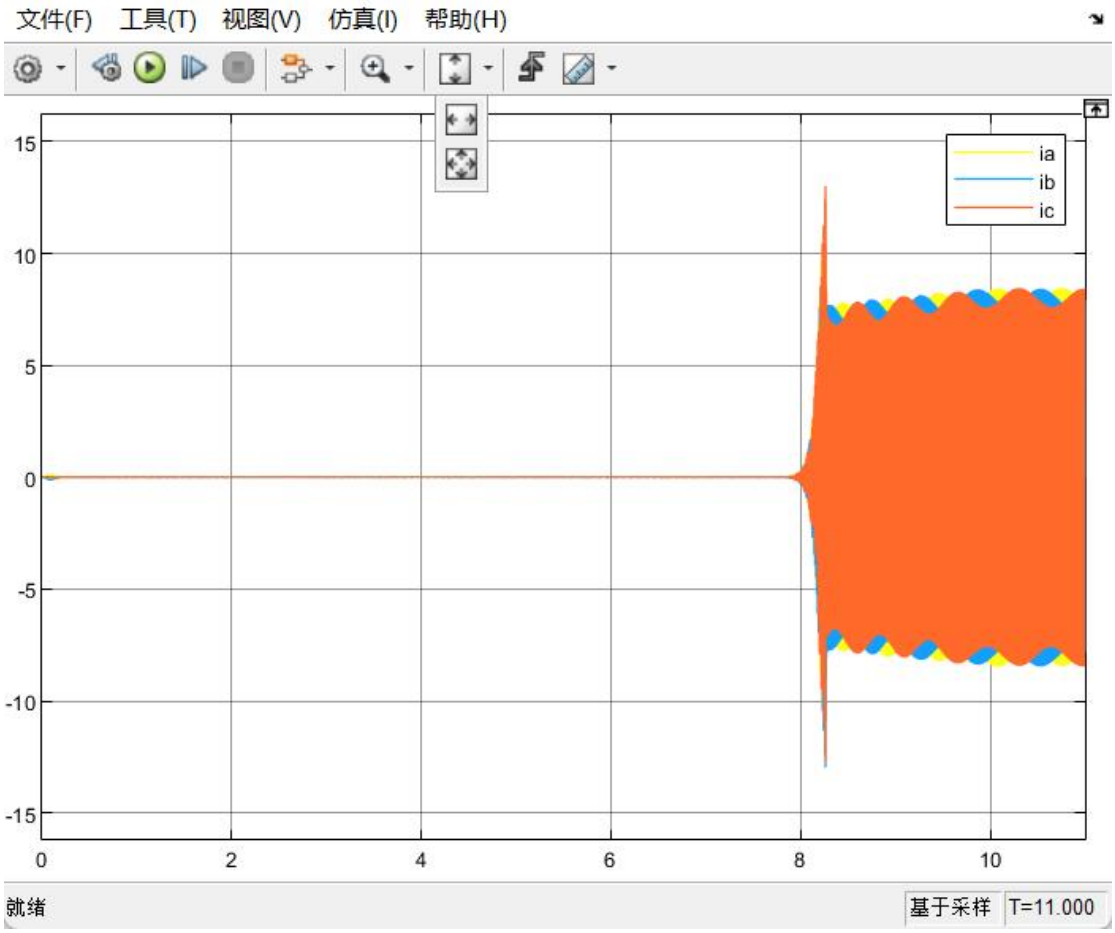




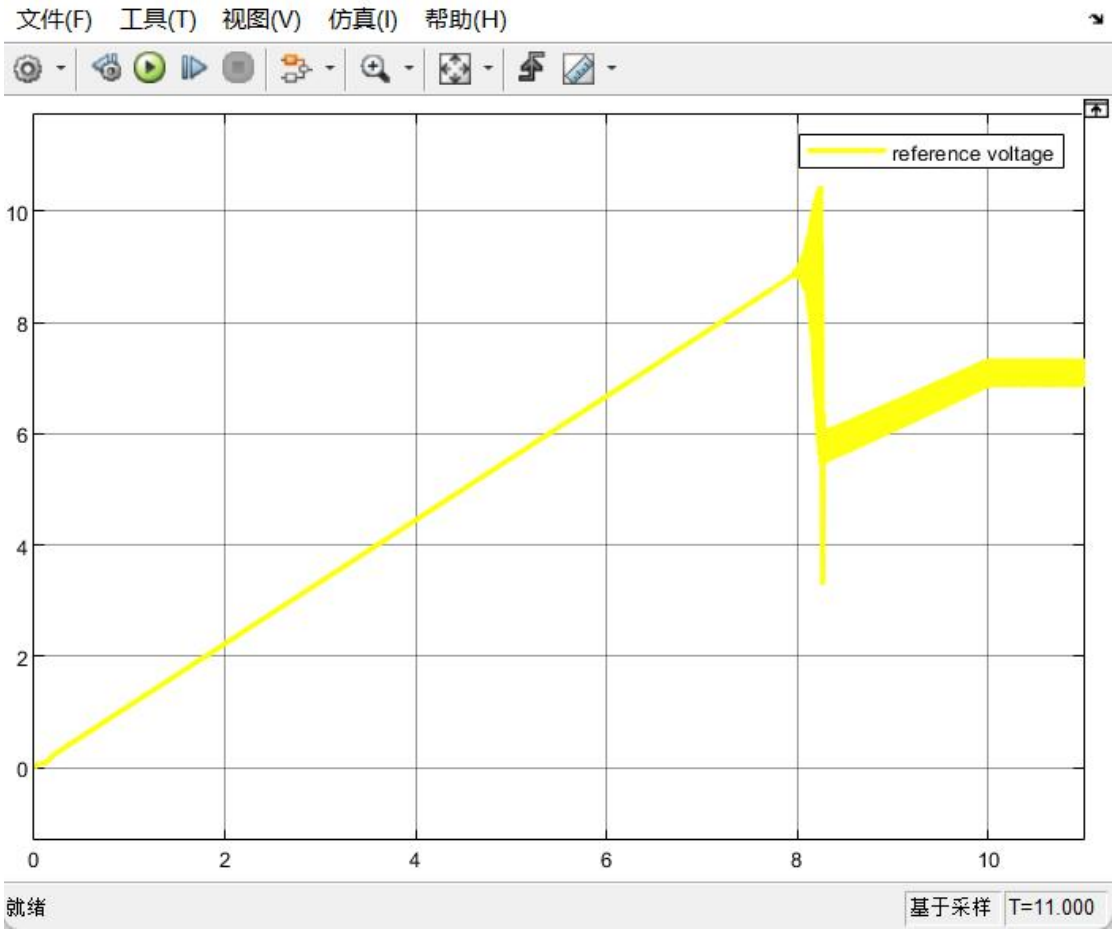
1-reference frequency



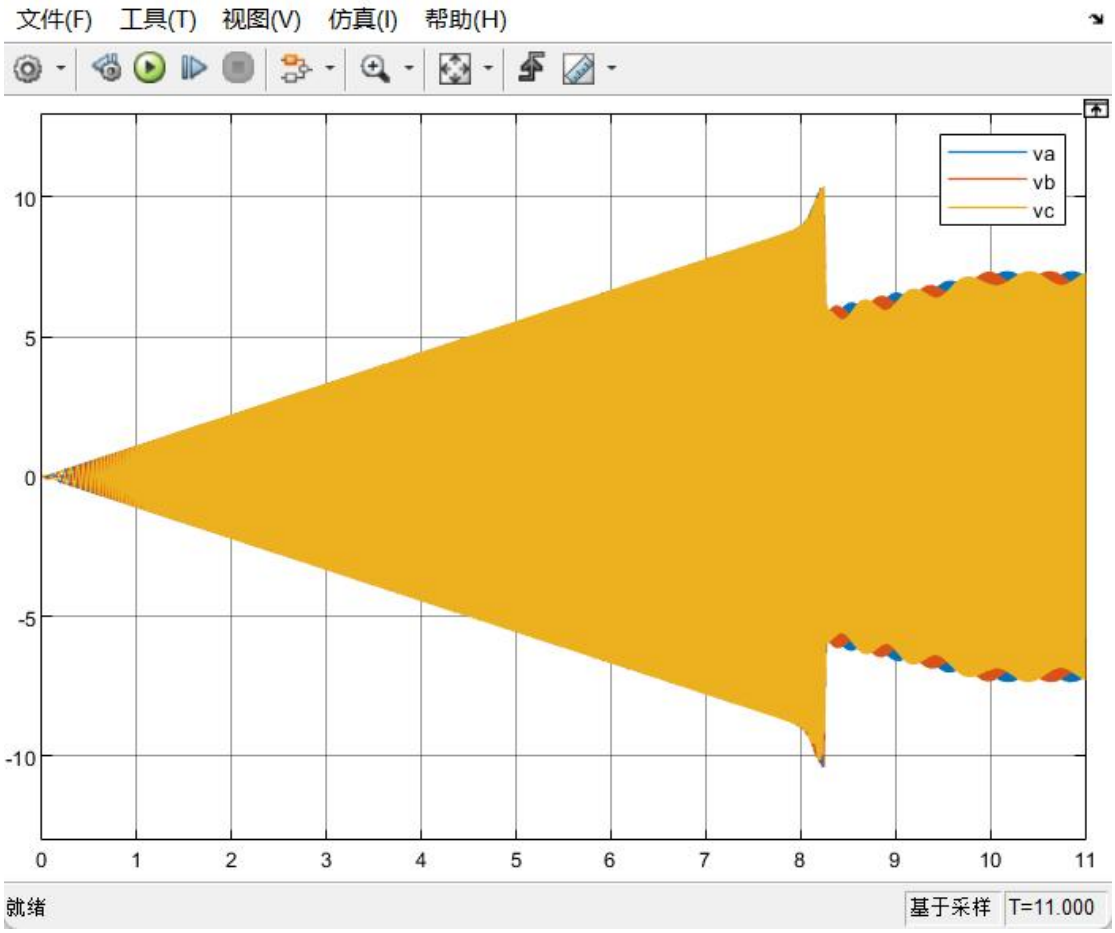
2-motor velocity in rev/min



3--phase currents ia, ib, ic, A



4-reference voltage vs*,V



5-phase voltages va, vb, vc, V

Conclusion:

The lab examined two distinct methods for modeling motor behavior: one using differential equations in the d/q reference frame and the other utilizing Simscape.

Both approaches considered the motor's electrical and mechanical dynamics to evaluate its performance. The experiment concluded with a voltage control strategy, specifically the V/f startup method, to regulate motor speed. Simulations of no-load startup were run for both models, and the results showed similar behavior. However, the V/f controller was unable to drive the motor to its rated speed. After about 8 seconds, oscillations appeared in both the reference voltage and motor speed, signaling a loss of synchronization. As the slip increased, the motor speed dropped toward zero and continued oscillating, never achieving the rated rotational speed.