MindMotion Ceiling Fan Control Board
User Guide
BLDC FOC Sensor less

Version:1.02

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1. Introduction

This user guide introduces the MindMotion ceiling fan control board operation methdology which not only present the hardware structure but also provides the ceiling fan tuning procedure that is based on MindMotion BLDC driving methodology and algorithm.

1.1. Overview

The system block diagram shown as Figure 1 which includes main controller MM32SPIN160C(BLDC control MCU), related circuit, drivers and power supply。

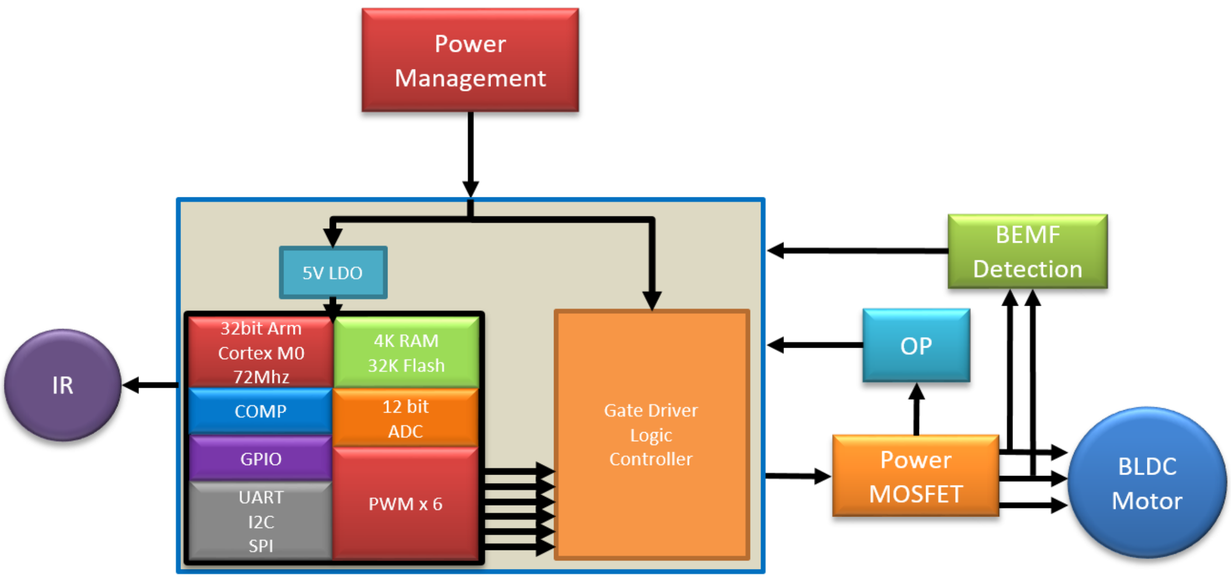


Figure 1. Block Diagram

1.2. Features

The control system has the following features:

- Bulit-in AC-DC Rectifier
- Bulit-in DC-DC Rectifier
- FOC Sensorless
- Programmable Over-Current Protection
- Programmable Over-Voltage Protection
- Firmware Example

1.3. Specifications

Symbol	Description	Value	Comments
AC_{IN}	AC Input Voltage	90V~320 V	50Hz/60Hz
DC_{24V}	24 V Voltage	24V	
DC_{12V}	12 V Voltage	12V	
DC_{5V}	5 V Voltage	5 V	
PWM_{Freq}	PWM Frequency	16 kHz	
AC $input_{OVP}$	AC Input Voltage Over-Voltage Protection	350 V	
$Motor_{OVP}$	Motor Drive Over-Voltage Protection	30 V	Programmable
OCP_{SHORT}	Short-Circuit Current Protection	5 A	
	Maximum Input Power	35 W	

2. Introduction of Functions

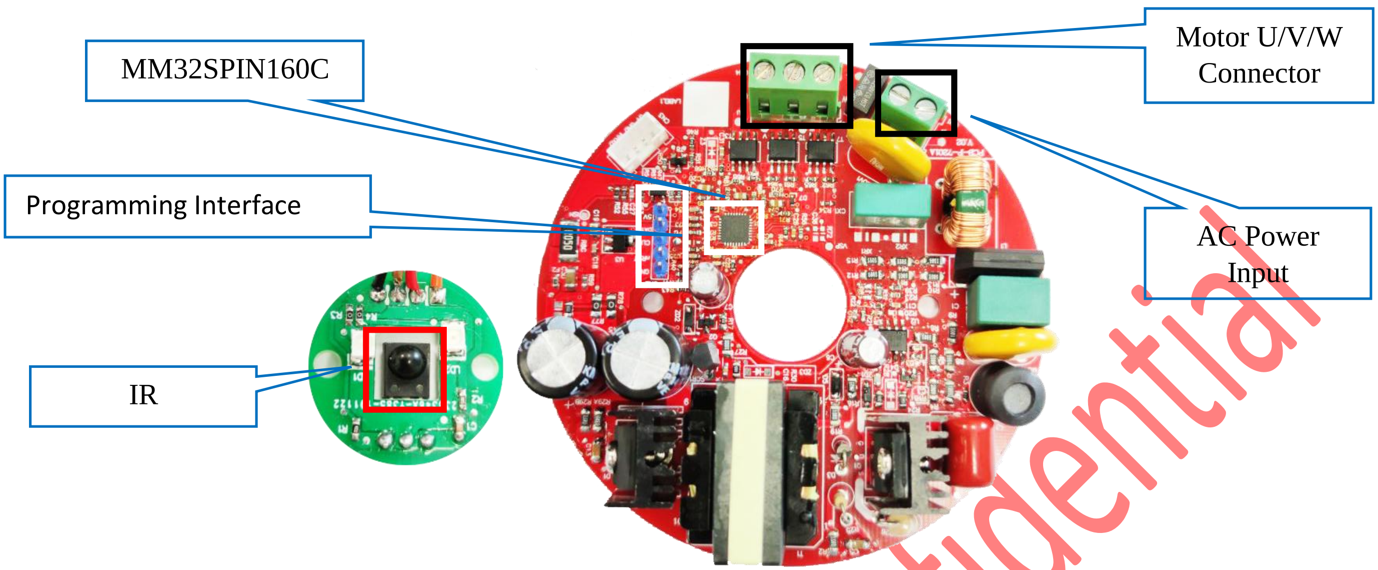


Figure 2. **Top view of PCBA**

2.1. Power supply

The AC input power is 220V, then generates three DC voltages:

1) 24V for motors
2) 12V system voltage
3) 5V system voltage

2.2. Firmware programming

User can update the firmware through SWD interface as shown in Figure 3. MindMotion provides more detail information about programming tool MM32-LINK which can found by following link: [MM32-Link Application Note]

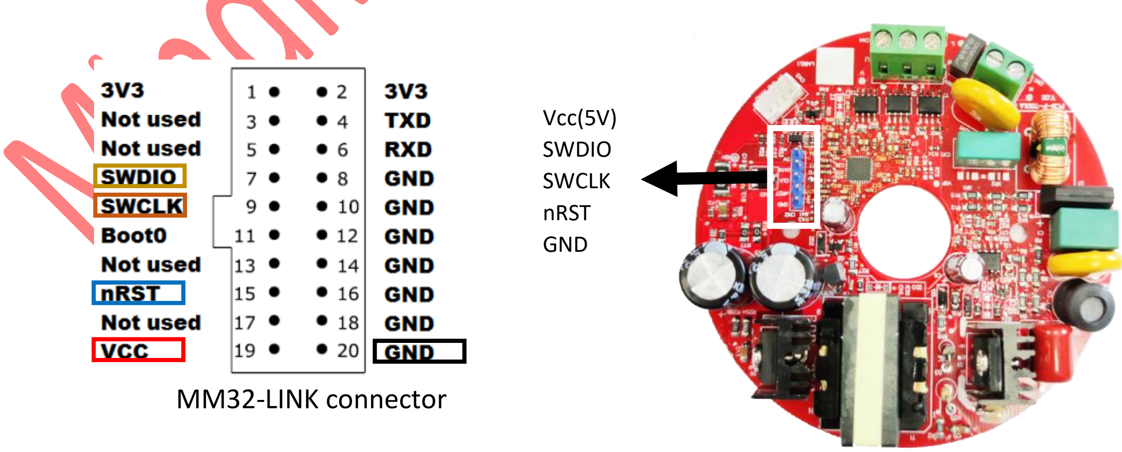


Figure 3. **Programming Interface**

3. Remote controller

Figure 4. Remote control

3.1. Switch ON/OFF

Turn on/off the ceiling fan and the target speed will be the first stage when the fan starts.

3.2. Speed control

The Fan speed control button configures seven stages for choice .

3.3. Reverse control

Reverse the Fan rotation.

3.4. LED

LED will blink when system error is encountered. Please refer to Ch.6.1 for the Error Code description.

4. Motor Phase Current Measurement

4.1. Required Equipments and Tools

Figure 5. shows recommended tools that user needs to prepare for emulation and verification which are Power supply to supply DC 310V or AC 220V, Current probe to measure the phase current of motor and Oscilloscope to display the phase current waveform.

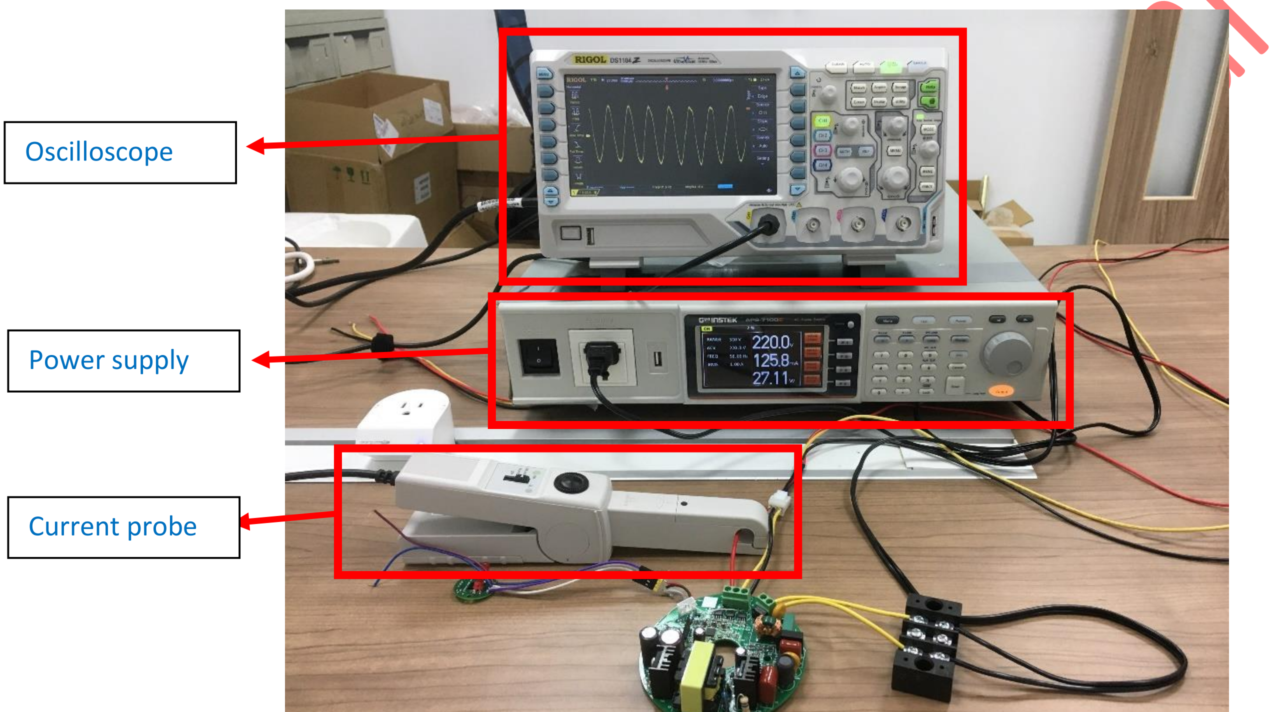


Figure 5. Operating environment and testing equipment

The user uses Current probe to connect each one of U, V, W signal of motor for the phase current waveform measuring which is shown in Figure 6.

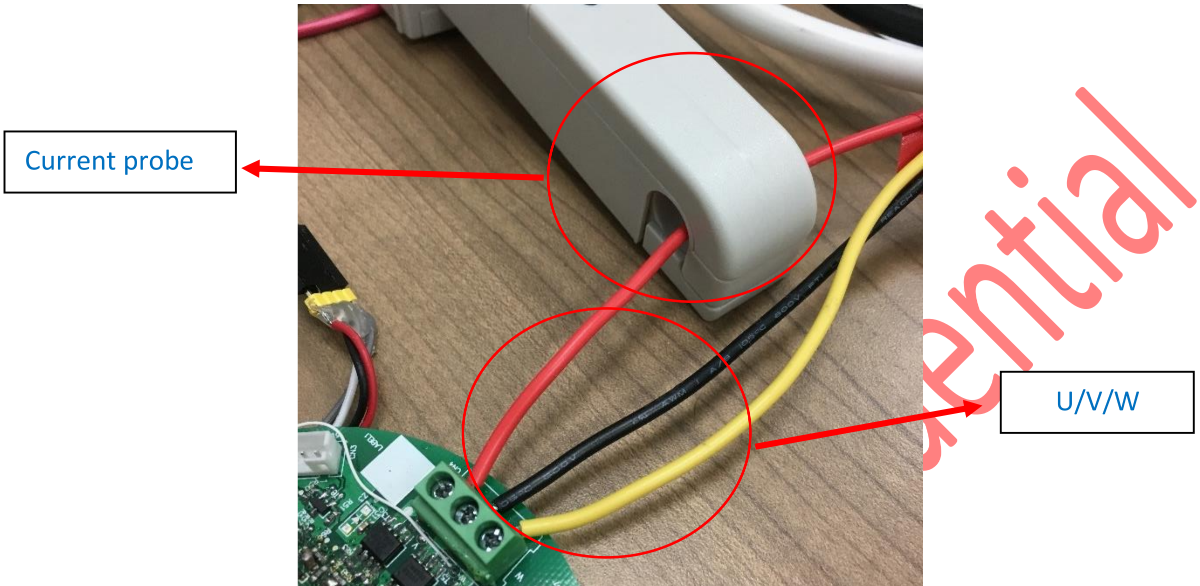


Figure 6. Phase current measurement

4.2. Motor phase current waveform

Figure 7 shows the phase current waveform of motor start from standstill. IPD procedure will capture the rotor initial position then speed up the motor in open loop stage and enter the close loop control stage.

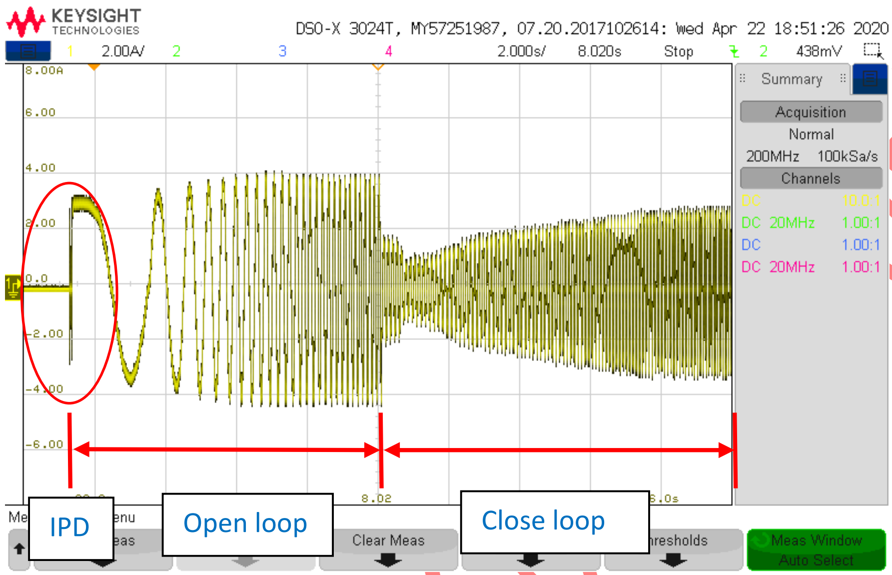


Figure 7. Motor standstill startup phase current waveform

User can calculate the phase current frequency by following fomula which can help to identify the motor speed reach to the assigned speed.

Motor speed(RPM) = Phase current frequency(Hz) * 60 / (motor pole number/2)

For example, user set 320rpm rotation speed with 16 poles motor, then measure the waveform and found the exact speed is 43.1(Hz) x 60 / (16 / 2) = 323(RPM).

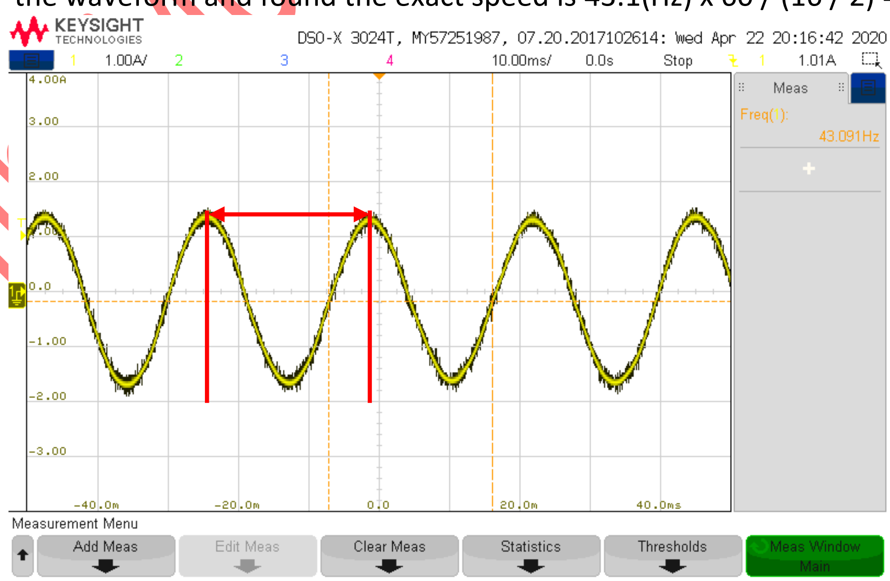


Figure 8. Phase current waveform when motor speed = 320RPM

5. Parameters tuning procedure

The ceiling fan work flow is shown in Figure 9 that describes system initialized after power on, then the program monitor the motor status and rotating speed by measuring the BEMF voltage. Enter the standstill startup procedure when motor still or downwind startup if motor spin as same as direction, otherwise startup procedure will enter the against wind startup.

User can follow the steps for the optimization like setting initial parameter, then setup the BEMF detection parameter to identify the initial status and speed of motor. Third stage will be the Standstill startup parameter adjustment and make the motor rotating stable at the target speed. In the last, user can try to power on the motor in Downwind and Against wind condition to find if motor spins smoothly.

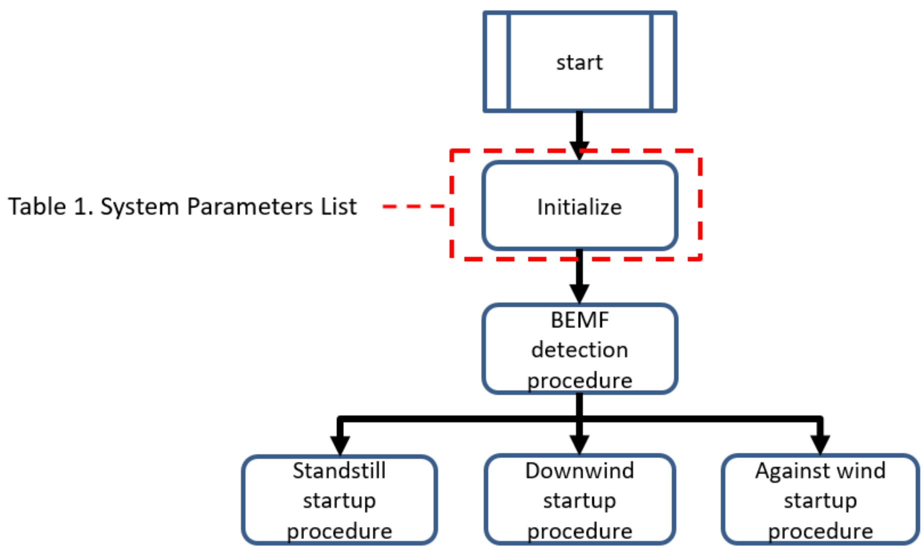


Figure 9. Motor startup flow

5.1. Initialize procedure

User have to input the motor poles and PWM frequency specs in this stage for system initialization.

Table 1. System Parameters List

Parameter name	Parameter Description	Recommend value
PWM_FREQUENCY	Unit: Hz. Set the frequency of PWM output. Setting range: 10K~20KHz	16000
POLE_NUMBER	The pole number of motor	14

5.2. BEMF detection procedure

When startup command is issued, the procedure will calculate BEMF voltage and recognize the motor is still or not. Then enter the Standstill startup procedure if motor is still. If not, program will measure the initial speed and rotation direction of motor. If speed is less than the value of BEMF_SPEED_AS_STILL, then treat it like standstill. Enter the Downwind startup procedure when the speed is higher than BEMF_SPEED_AS_STILL and motor rotate as same direction, otherwise start with Against wind startup procedure.

Generally, the detection time needs longer for the lower speed capturing but the BEMF_SPEED_AS_STILL value and BEMF detection duration still can be adjusted based on user’s demand. If user would like to curtail the reaction in startup procedure, then the detected lowest speed must increase. Refer to Table 2 for the relative parameter and adjustment.

User can rotate the fan smoothly with higher efficiency by enabling the low brake function when initial failed in very low rotating speed. Table 3 shows the relative parameter and how to modify it.

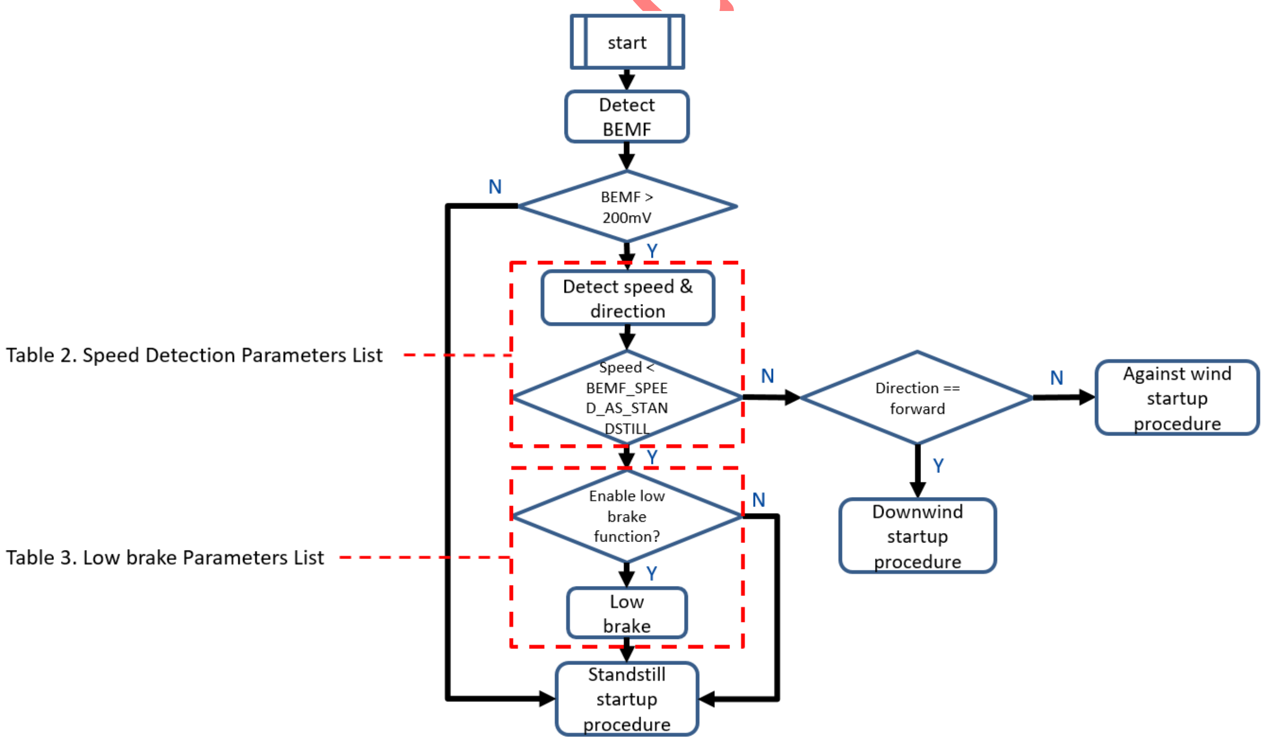


Figure 10. **BEMF detection flow**

Table 2. Speed Detection Parameters List

Parameter name	Parameter Description	Recommend value
BEMF_DETECT_LIMIT_ TIME	Motor speed and direction detection time. If user would like motor response faster after receive command, then user can curtail detection time. Reference configuration for these two parameters: BEMF_DETECT_LIMIT_TIME: 600 / 1000 / 2000 (Unit: ms) BEMF_SPEED_AS_STANDSTILL: 30 / 24 / 12 (Unit: RPM)	2000
BEMF_SPEED_AS_ STANDSTILL	Unit: RPM. Motor will be treated like standstill if the motor initial speed lower than this value. User set this value as low as possible to prevent the motor startup failed in low speed status, but BEMF_DETECT_LIMIT_TIME have to increase. Reference configuration for these two parameters: BEMF_DETECT_LIMIT_TIME: 600 / 1000 / 2000 (Unit: ms) BEMF_SPEED_AS_STANDSTILL: 30 / 24 / 12 (Unit: RPM)	12

Table 3. Low brake Parameters List

Parameter name	Parameter Description	Recommend value
ENABLE_LOWER_3_ ARM_UL_VL_WL_ON_ BRAKE_VERY_LOW_ SPEED	Motor will brake before startup when this function enables. User can switch on this function when motor start failed in low speed status.	
K_PARAMETER_OF_UL_ VL_WL_BRAKE_VERY_ LOW_SPEED	Brake time = 10ms * (LOWER_3_ARM_BRAKE_MIN_TIME + (BEMF_SPEED * K_PARAMETER_OF_UL_VL_WL_BRAKE_ VERY_LOW_SPEED)) **DO NOT MODIFY THIS PARAMETER.**	10
LOWER_3_ARM_ BRAKE_MIN_TIME_ VERY_LOW_SPEED	The motor brake minimum time. The brake time should longer than motor stop time, otherwise, the startup will fail due to motor still not stop. Setting range: 1~5000 (Unit: 10 ms)	600

5.3. Standstill startup procedure

Figure 11 shows the motor Standstill startup flow. We have to detect the rotor position first which is based on IPD detection and then enter the motor running procedure. Chapter 5.3.1 will introduce the IPD function and 5.3.2 will show the motor running procedure.

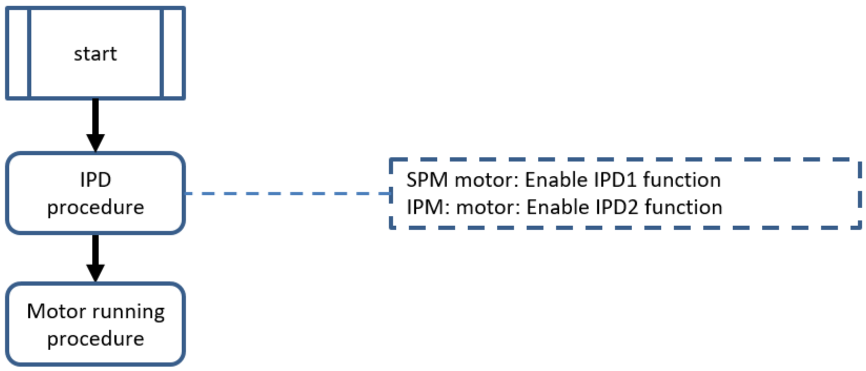


Figure 11. Standstill startup flow

5.3.1. IPD procedure

Initial Position Detection (IPD) methdology is used for the rotor position when motor startup in FOC sensorless structure. There are two IPD methods provided to user for different motor manufacture. IPD1 used for the SPM motor and IPD2 for IPM. Using IPD1 will cause the fan reverse a little bit but not in IPD2.

- IPD1: IPD by BEMF detection (good at SPM, IPM motor)
- IPD2: IPD by inductance saturation theory (good at IPM motor)

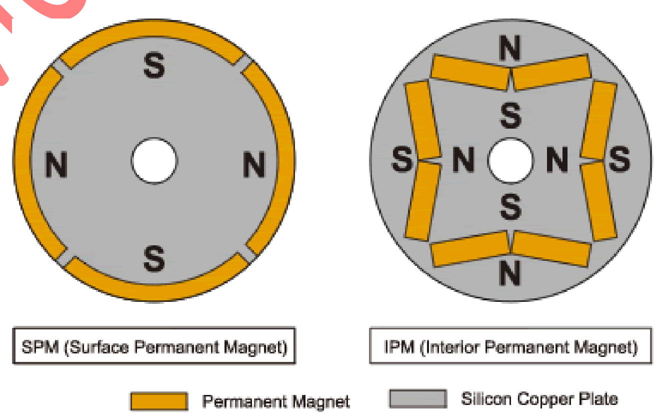


Figure 12. SPM/IPM motor construction

(1) **IPD1 procedure**

Following Figure 13 shows the IPD1 flow. IPD1 calculates the rotor position by the BEMF value which is generated by injecting the phase currents with different angles and cause the fan shake lightly.

Injection start from zero degree and capture the BEMF value. Increase 60 degree for 2nd injection if last injection can not capture enough BEMF value for algorithm calculation. Repeat this procedure until the injection phase current cause the fan shaking and generate enough BEMF valuse for calculation. If IPD1 still can not detect the rotor position after six times, then program will force the motor startup with open loop but it will cause the motor not to rotate smoothly. For more detail parameter and adjustment method, can refer to Table 4.

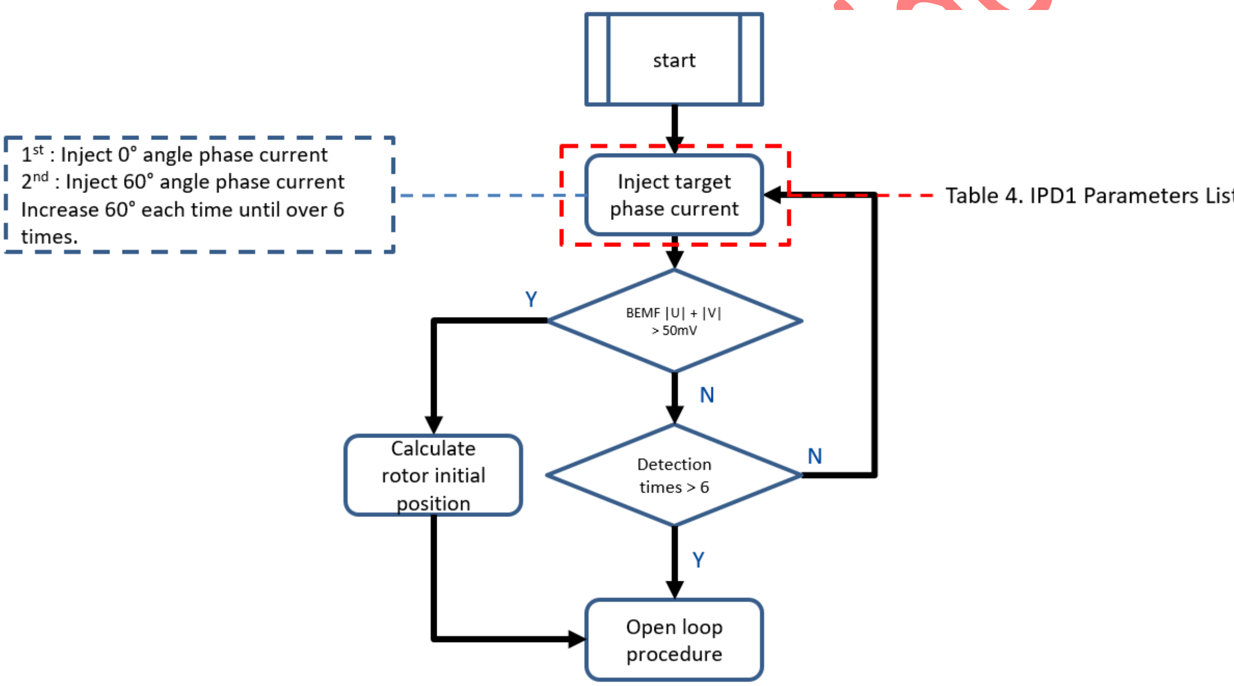


Figure 13. IPD1 flow

Figure 14 is the waveform that IPD1 found the rotor position detected successfully within six times. The Target current and Swing time stands for phase current injection scale and duration. Detection time shows both duration and times. User can capture the rotor position with the BEMF value by configuring the inject current and times. It is recommended to adjust the fan position to verify if we can find the rotor position by every different angle.

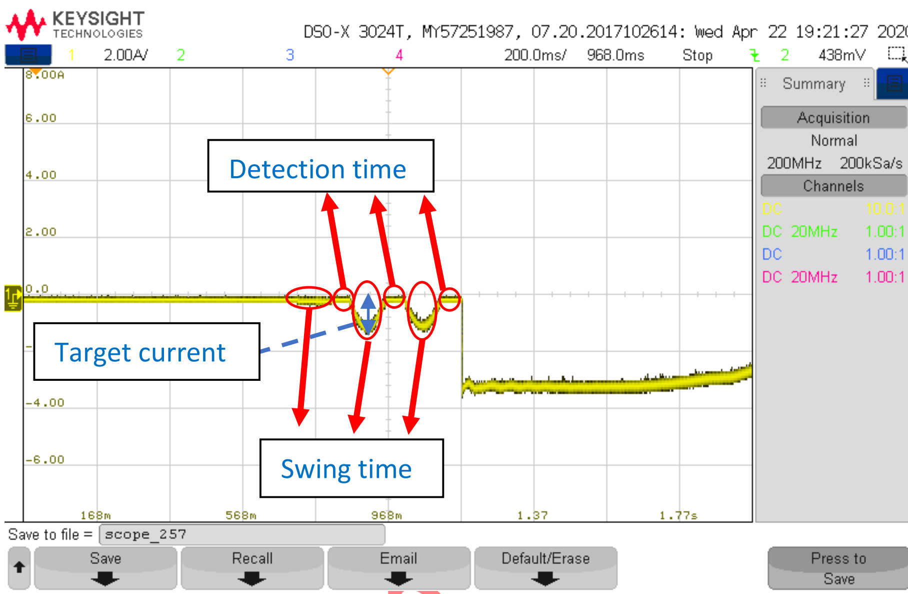


Figure 14. IPD1 phase current waveform

The phase current inject time related to the different type setting methods for different kinds ceiling fan which is shown in following figure 15. Bell type ceiling have solid structure for installation, so phase current injection time will be longer to make sure the fan shaking cause enough BEMF value for rotor detection in IPD1. Hook type just needs less time for current injection than Bell type.

Figure 15. Ceiling fan fix method

Figure 16 tells the IPD1 detection failed waveform. Motor startup by open loop procedure if IPD1 failed the rotor detection after six times which causes rotation not smooth. In this case, user might increase the phase current and injection duration as recommended, to make more shaking to raise the BEMF value. If fan shakes too much, then user can deduct the phase current and injection duration to make motor start smoothly once IPD1 captured the rotor position.

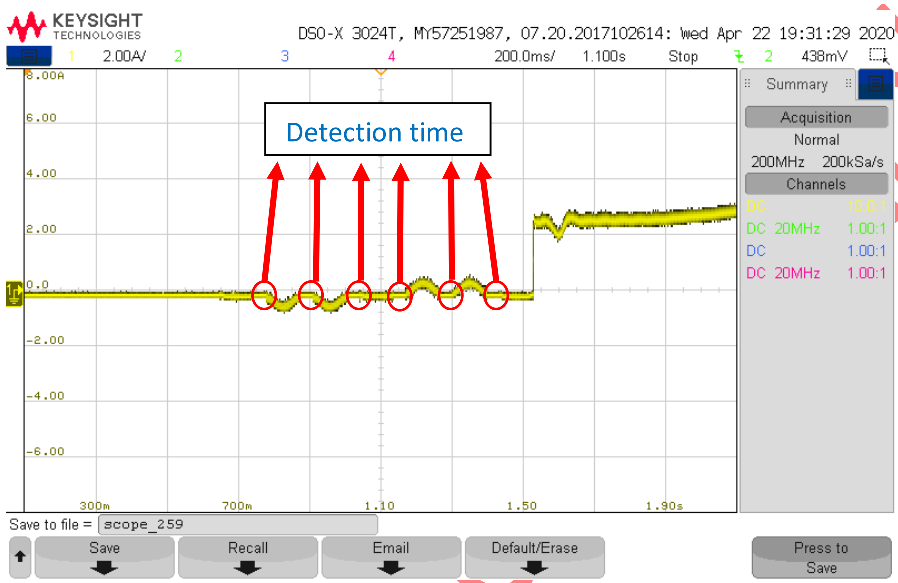


Figure 16. IPD1 failed phase current waveform

Table 4. IPD1 Parameters List

Parameter name	Parameter Description	Recommend value
ENABLE_ROTOR_ IPD1_FUNCTION	Enable: enable IPD1 function Disable: disable IPD1 function	Enable
ROTOR_IPD1_ TARGET_CURRENT	Configure the inject phase current pulse in IPD1. To generate enough BEMF value to calculate rotor position. The maximum must less than 2A Setting range: 10 ~ 20 (Unit: 0.1A)	15
ROTOR_SMALL_ SWING_TIME	Phase current injection duration setting. For hook type ceiling fan, inject duration around 100ms; bell type need increase to 400ms. More solid installation structure needs longer injection time to generate enough BEMF value. Setting range: 60 ~ 500 (Unit: 1 ms)	100
ROTOR_IPD1_ DETECT_TIME	Detection duration after phase current injected. User can keep the default without modification. Setting range: 40 ~ 100 (Unit: 1 ms)	60

(2) IPD2 procedure

Here we are going to introduce IPD2 detection for the IPM motor and procedure flow as Figure 17. IPD2 use Inductance Saturation Methodology to capture the rotor position by inputting twelve angles d-axis voltage to measure the feedback current which has fastest rising time and most close to saturation. The feature of IPD2 is the motor won't reverse in startup if rotor position found correct.

User charge the inductance by input Vd voltage and duration then stop it when you receive the feedback current to discharge the inductance. User can adjust the value of feedback current by the Vd voltage input duration and duty cycle. To avoid the angle detection failed, we can set the value of feedback current as 70% open loop target current value.

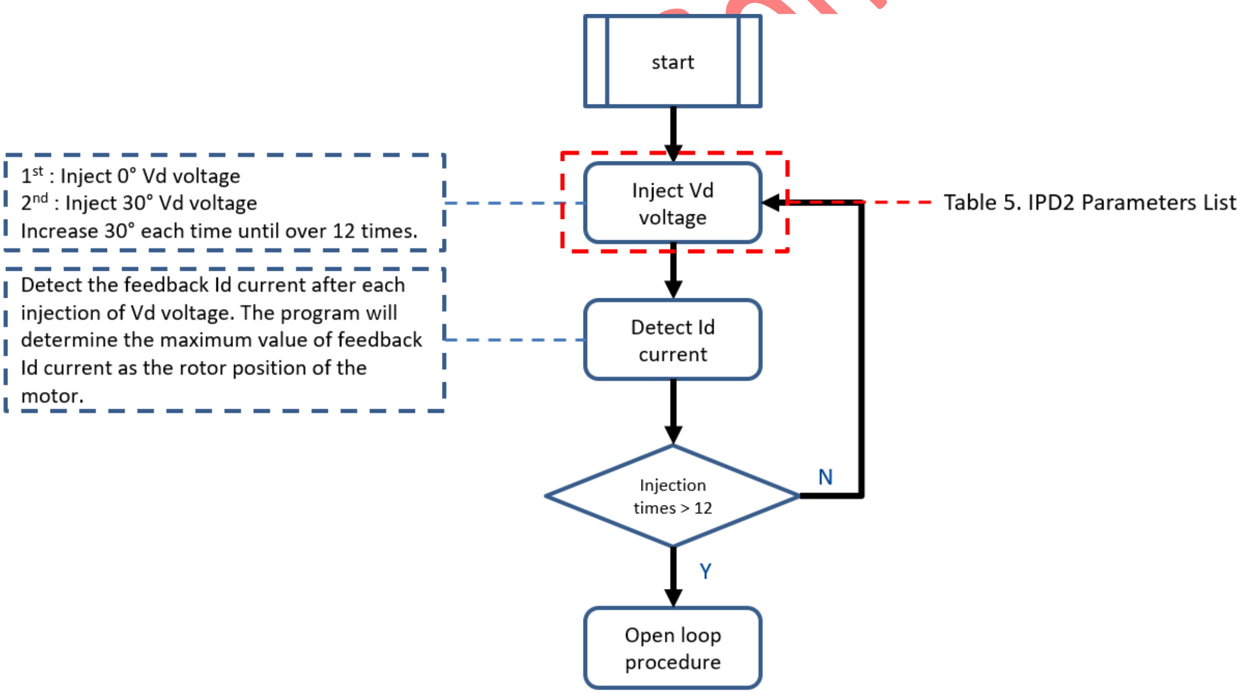


Figure 17. IPD2 flow

In the right side of Figure 18, the waveform shows IPD2 successfully capture the rotor position. The Vd voltage input duration and duty cycle have to match well to make sure the rotor position can be found precisely, otherwise user cannot find the rotor position when Vd voltage input time is too long or duty cycle is too big. We can pick shorter input time and duty cycle to approach the 70% open loop target current by increasing IPD2 current step by step.

The zoomed figure (left-hand side) shows inductance recharge from rising current and discharge when current drop. User can set the 1:4 arrangement for recharge and discharge duration first, then adjust that base on exact duration shown on oscilloscope.

Table 5 will introduce the parameters in IPD2 function. The Fan won't occur reverse rotation in any angles when IPD2 capture correct position.

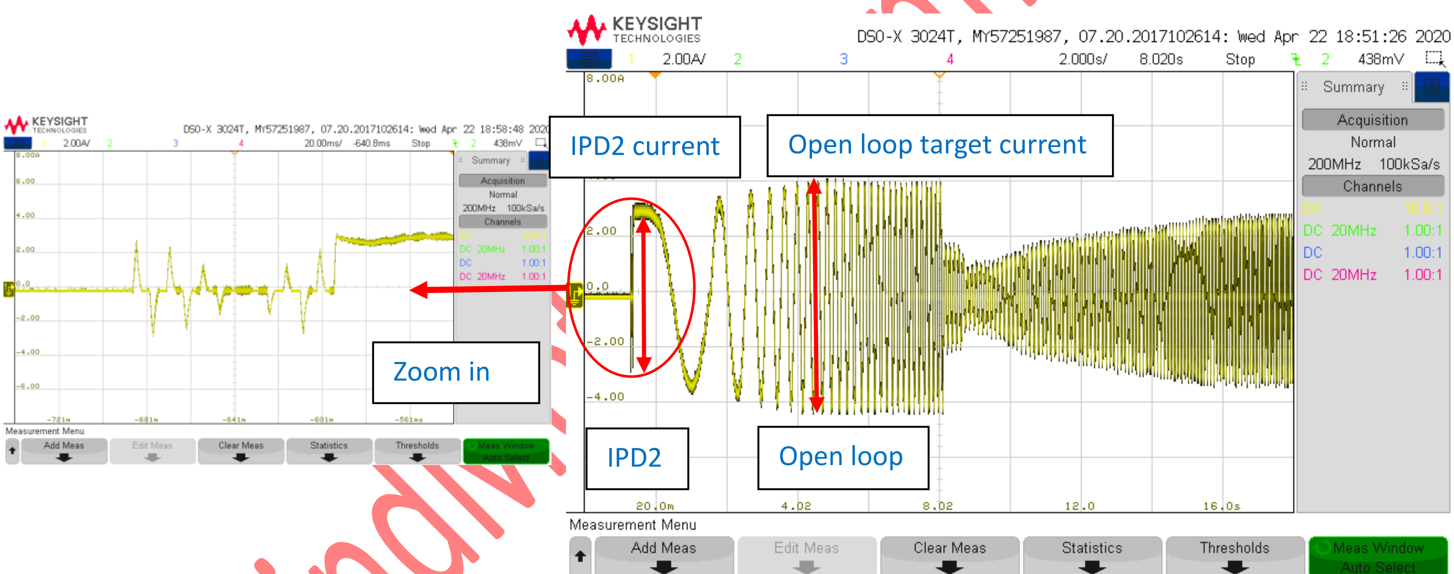


Figure 18. IPD2 phase current waveform

Table 5. IPD2 Parameters List

Parameter name	Parameter Description	Recommend value
ENABLE_ROTOR_ IPD2_FUNCTION	Enable: enable IPD2 function Disable: disable IPD2 function	Enable
PWM_NUM_FOR_ INJECT_VOLT	Numbers of Vd voltage injection PWM cycles, higher value stands for longer injection duration. Setting minimum value and increase step by step to make the feedback approaching to saturation. The injection time = PWM_NUM_FOR_INJECT_VOLT * PWM period (24 * 62.5us = 1.5ms) Setting range: 8 ~ 30 (Unit: PWM number)	24
PWM_NUM_FOR_ NON_INJECT_VOLT	Numbers of Vd voltage Non-injection PWM cycles, to discharge inductance. User can set the value as four times of PWM_NUM_FOR_INJECT_VOLT then adjust that base on exactly duration shown on oscilloscope. The non-injection time = PWM_NUM_FOR_NON_INJECT_VOLT * PWM period (96 * 62.5us = 6ms) Setting range: 8 ~ 120 (Unit: PWM number)	96
INJECT_VOLT_ PULSE_AMPLITUDE	Vd voltage injection duty cycle value. Might cause over current if this value is too large. Recommend the default value as 10, then adjust it to fulfill the feedback current achieve the 70% open loop target current. Setting range: 1 ~ 99 (Unit: %)	20
PHASE_LEAD_ ANGLE_FOR_IPD2	Phase lead angle parameter. 360 degree scale to 1024 steps, so 85 = 30 degree, phase lead angle setup. User can just follow the default value. Setting range: 0 ~ 1024	85

5.3.2. Motor running procedure

Motor running procedure have two major status, open loop and close loop that is shown as in Figure 19. In the open loop status motor is forced to spin based on assigned acceleration slope and current command by user. Then enter the close loop when rotatation speed reaches the rotor position and can be found by SMO. Table 6 provides the relative parameter in open loop and close loop as shown in Table 7 to 10.

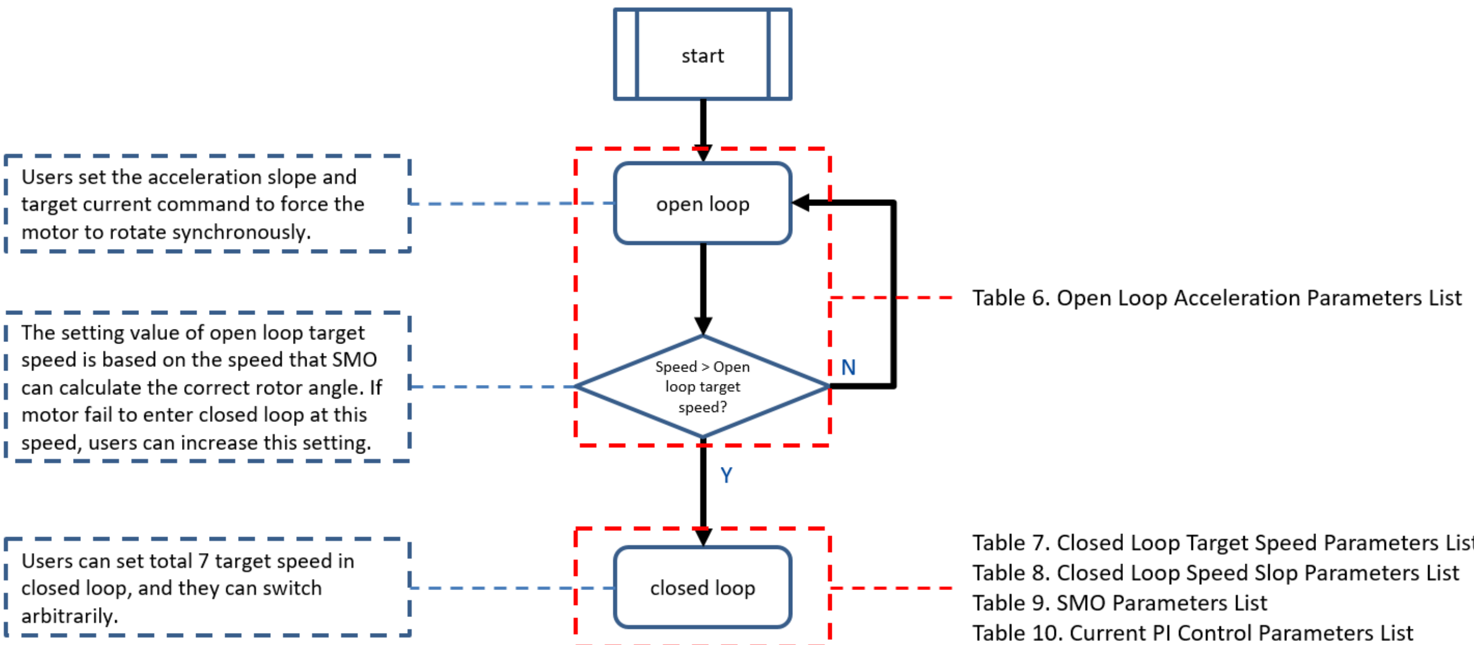


Figure 19. Motor running flow

(1) Open loop procedure

User have to setup the acceleration slope and current command in open loop mode. Motor rotation speed might not catchup the assigned speed if acceleration slope setting is too high which might cause vibration and noise, even failed to enter close loop. Following figure 20 introduces the phase current waveform occur the vibration noise.

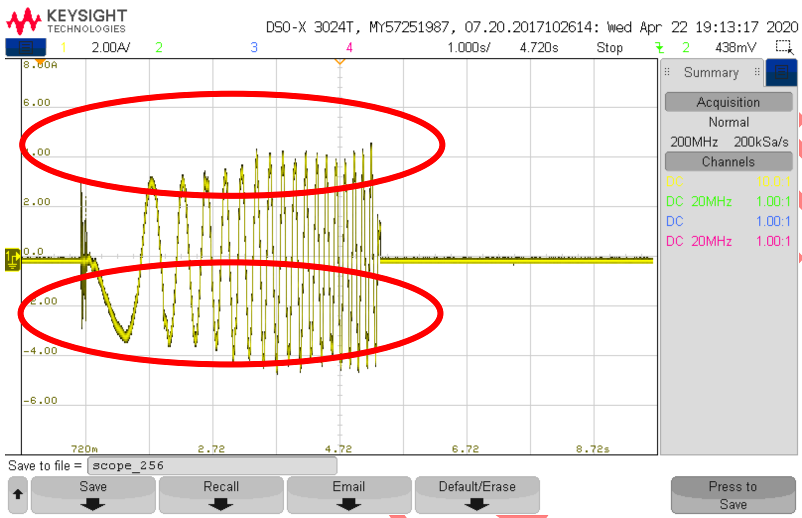


Figure 20. Original open loop phase current waveform

We can drop the acceleration slope or increase the command current to avoid this vibration situation. Found in Following figure 21 that improved phase current is more flat and no noise appear.

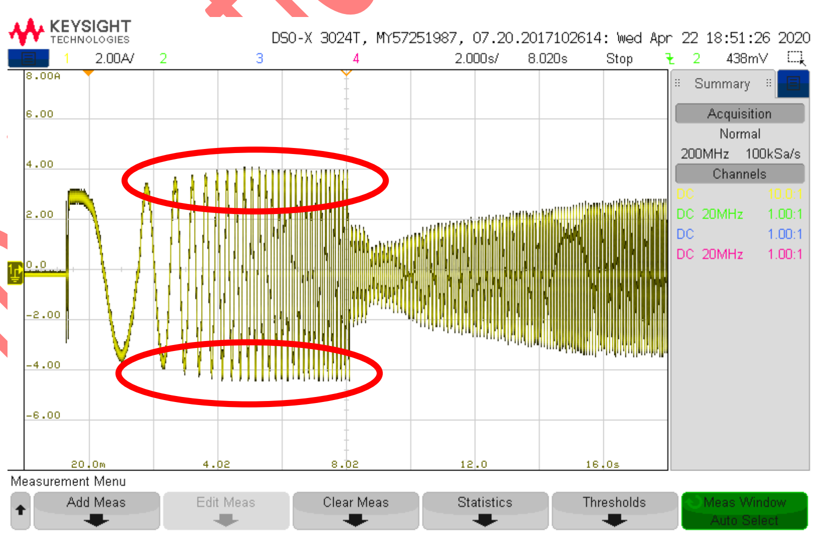
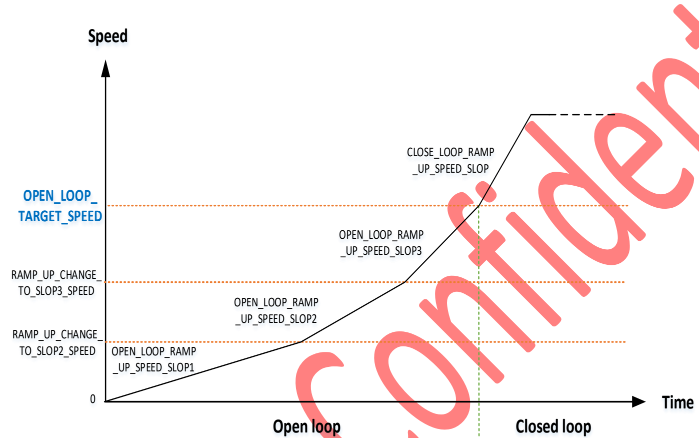
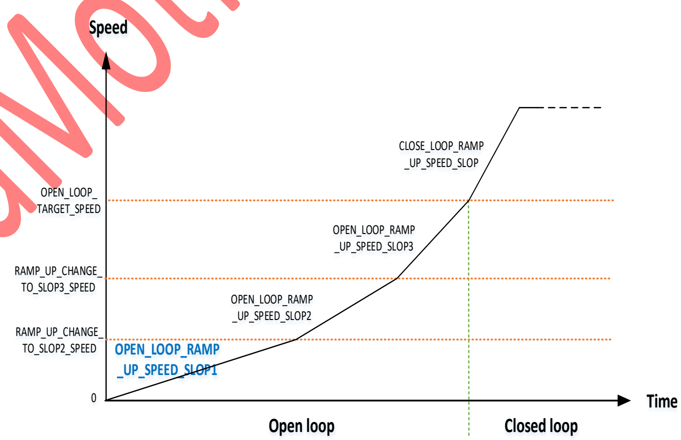
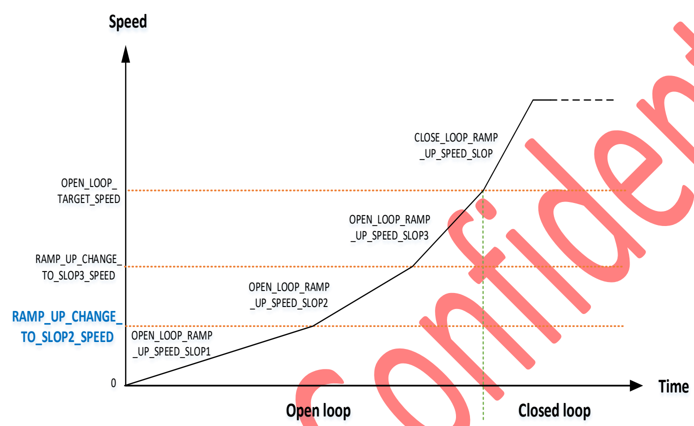


Figure 21. Improved open loop phase current waveform

Table 6. Open Loop Acceleration Parameters List

Parameter name	Parameter Description	Recommend value
OPEN_LOOP_ TARGET_ SPEED	Target speed in open loop configuration. Motor will enter the close loop when rotate speed reached. User can increase open loop target speed by once 5rpm when failed to enter the close loop and SMO can't capture the rotor position. Setting range: 1 ~ 200 (Unit: RPM) 	80
OPEN_LOOP_ RAMP_UP_ SPEED_SLOP1	Stage one slope in open loop configuration. User can drop this value to avoid the motor startup unstable Setting range: 1 ~ 50 (Unit: RPM/ sec) 	4
OPEN_LOOP_ RAMP_UP_ SPEED_SLOP2	Stage two slope in open loop configuration. User can drop this value to avoid motor speed and target speed mismatch. Suggest to set the same value as OPEN_LOOP_RAMP_UP_SPEED_SLOP3 Setting range: 1 ~ 50 (Unit: RPM/ sec)	10

OPEN_LOOP_ RAMP_UP_ SPEED_SLOP3	Stage three slope in open loop configuration. Drop this value can avoid motor speed behind target speed and cause mismatch. Setting range: 1 ~ 50 (Unit: RPM/ sec)	10
RAMP_UP_CHANGE_ TO_SLOP2_SPEED	The switching slope one and two target speed. Recommended set three times slope one value. Means motor will enter slope two stage after three seconds accelerate. Setting range: 1 ~ 200 (Unit: RPM) 	12
RAMP_UP_CHANGE_ TO_SLOP3_SPEED	he switching slope two and three target speed. User don't need to adjust this parameter if slope two as same as slope three. Setting range: 1 ~ 200 (Unit: RPM)	30
OPEN_LOOP_ TARGET_ CURRENT	Target current configuration in open loop. Higher value can provide more driving power. User must to configure it carefully and do not over 4A which might cause motor speed can't catchup the assigned acceleration slope. Setting range: 10 ~ 40 (Unit: 0.1A)	40
OPEN_LOOP_ INITIAL_ CURRENT	Target current default setting, user do not need to adjust it. Setting range: 10 ~ 40 (Unit: 0.1A)	20

(2) Closed loop

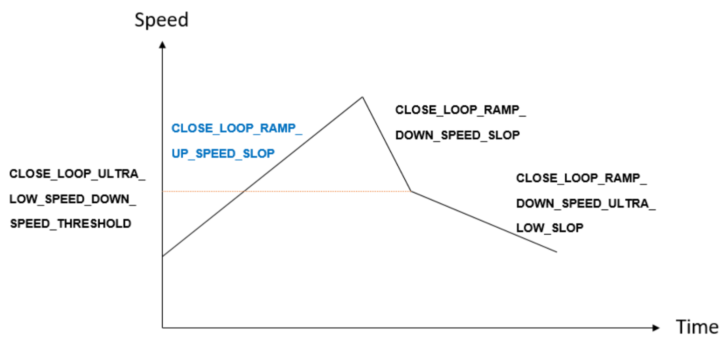
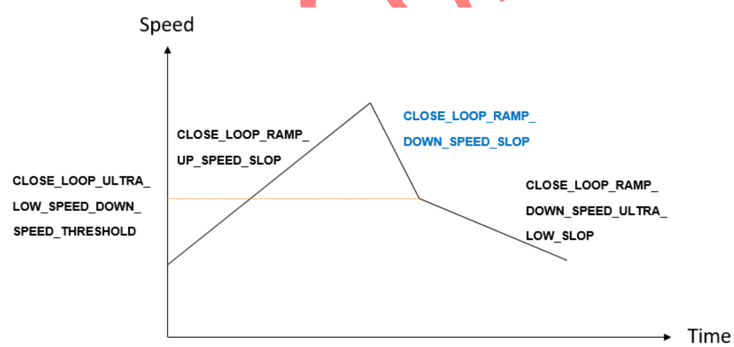
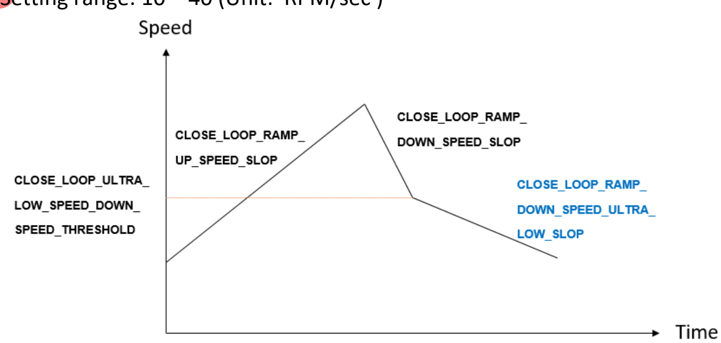
MindMotion offers seven stage target speed for user configuration which shown in table 7, but the maximum speed should not higher than this control board driving capability which specified for maximum input power at 35W. User can raise or fall the slope to avoid motor lossing control, and refer to table 8 for detial parameters.

SMO and current PI control portion are not recommand to modify it, so we don't introduce it but just list the parameters for reference.

Table 7. Closed Loop Target Speed Parameters List

Parameter name	**Parameter Description**	**Recommend value**
TARGET_ SPEED_1	Unit: RPM. The first target speed Setting range: 60 ~ 400 (Unit: RPM)	120
TARGET_ SPEED_2	Unit: RPM. The second target speed Setting range: 60 ~ 400 (Unit: RPM)	150
TARGET_ SPEED_3	Unit: RPM. The third target speed Setting range: 60 ~ 400 (Unit: RPM)	180
TARGET_ SPEED_4	Unit: RPM. The 4th target speed Setting range: 60 ~ 400 (Unit: RPM)	210
TARGET_ SPEED_5	Unit: RPM. The 5th target speed Setting range: 60 ~ 400 (Unit: RPM)	240
TARGET_ SPEED_6	Unit: RPM. The 6th target speed Setting range: 60 ~ 400 (Unit: RPM)	270
TARGET_ SPEED_7	Unit: RPM. The 7th target speed Setting range suggestion: 60 ~ 400 (Unit: RPM)	300

Table 8. Closed Loop Speed Slope Parameters List

Parameter name	Parameter Description	Recommend value
CLOSE_LOOP_RAMP_ UP_SPEED_SLOPE	The close loop acceleration slope setting. User can drop this value to avoid motor out of control or stop when accelerate too fast. Setting range: 10 ~ 40 (Unit: RPM/sec)  	30
CLOSE_LOOP_RAMP_ DOWN_SPEED_SLOPE	Reduce slope configuration, user can drop the value to avoid the motor out of control or stop when speed falling to fast. Setting range: 10 ~ 40 (Unit: RPM/sec)  	30
CLOSE_LOOP_RAMP_ DOWN_SPEED_ULTRA_ LOW_SLOPE	Set this parameter to reduce motor speed when motor rotate speed lower than CLOSE_LOOP_ULTRA_LOW_SPEED_DOWN_SPEED_THRESHOLD Setting range: 10 ~ 40 (Unit: RPM/sec)  	10

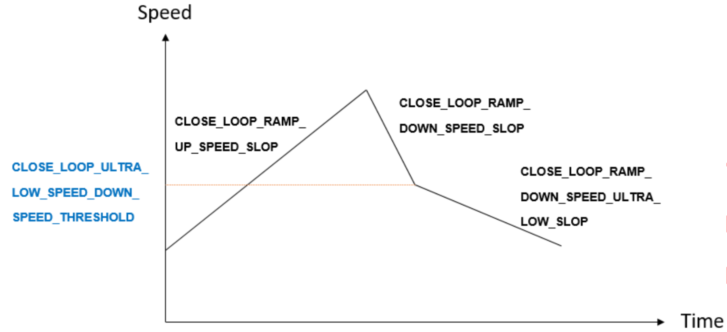
CLOSE_LOOP_ULTRA_ LOW_SPEED_DOWN_ SPEED_THRESHOLD	When motor rotating speed lower than this value, motor will reduce speed by ultra-low slope. To avoid motor out of control when speed switch from high speed to low speed, user can increase this value once 10rpm. Setting range: 1 ~ 400 (Unit: RPM) 	140

Table 9. SMO Parameters List

Parameter name	Parameter Description	Recommend value
SMO_Kslf_MAX_VALUE	SMO filter maximum value. Do not modify Setting range: 100 ~ 3000	800
SMO_Kslf_MIN_VALUE	SMO filter minimum value. Do not modify Setting range: 100 ~ 1500	200

Table 10. Current PI Control Parameters List

Parameter name	Parameter Description	Recommend value
PI_CURRENT_Kp_ VALUE	PI current controller Kp parameter. Do not modify	24000
PI_CURRENT_Ki_MAX_ VALUE	PI current controller Ki maximum parameter. Do not modify Setting range: 2800 ~ 10000	2800
PI_CURRENT_Ki_MIN_ VALUE	PI current controller Ki minimum parameter. Do not modify Setting range: 100 ~ 1000	280

5.4. Downwind startup procedure

Figure 22 highlight the startup procedure in downwind status. When motor startup speed reach the target speed, then enter close loop directly, otherswise, startup in open loop. Usually, user can ignore the adjustment in this case but still need modify it when accelerating not smoothly in open loop or failed to enter close loop. The modification methods can refer to Table 11.

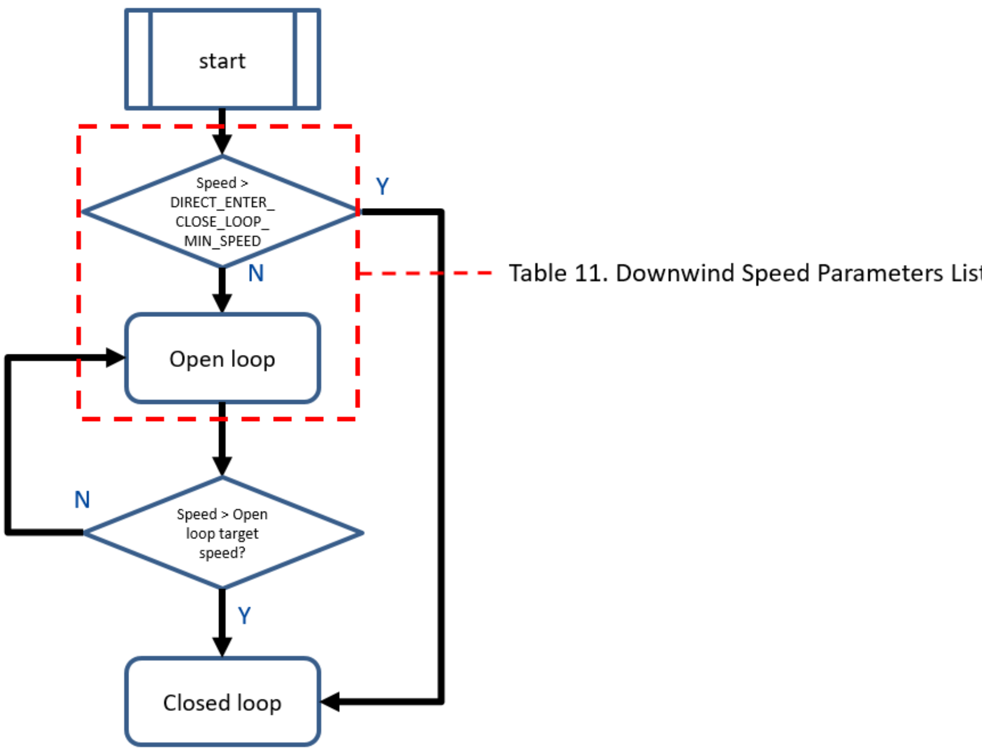
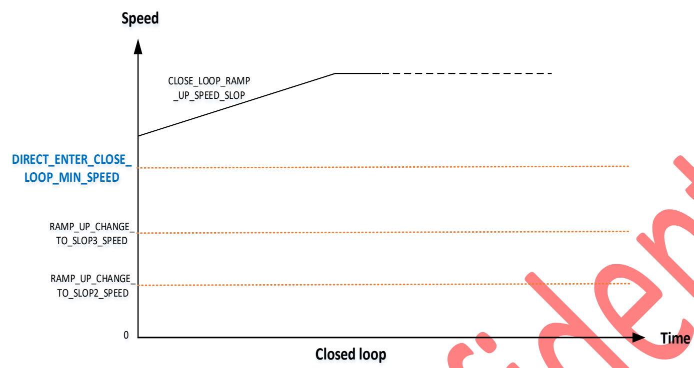


Figure 22. Downwind startup flow

Table 11. Downwind Speed Parameters List

Parameter name	Parameter Description	Recommend value
DIRECT_ENTER_ CLOSE_LOOP_MIN_ SPEED	Configure the speed that motor can enter close loop directly. Suggest to set the value as same as OPEN_LOOP_TARGET_SPEED 	80
DOWN_WIND_ RESTART_RAMP_UP_ SLOP_DIVIDE_PARA	Open loop acceleration slope control in open loop. User don't need to modify. Eg. Setting 2 stand for acceleration slope become to one half times to original slope in open loop. Setting range: 1~3	2

5.5. Against wind startup procedure

Following figure shows against wind startup procedure. If reverse rotation speed higher than close loop target speed, then motor will reduce the speed in close loop, otherwise motor reduce the speed until standstill then start in the direction.

In open loop reducing speed mode, motor might have vibration and noise if user cannot adjust the speed slope and current command well. The modification methods can be checked from Table 12. User can use brake function to replace the open loop reduce speed function if motor can't stop smoothly. The table 13 will guide user how to adjust it when motor restart but still can not rotate smoothly or failed to enter close loop which is caused by environment. Modification shown in table 14.

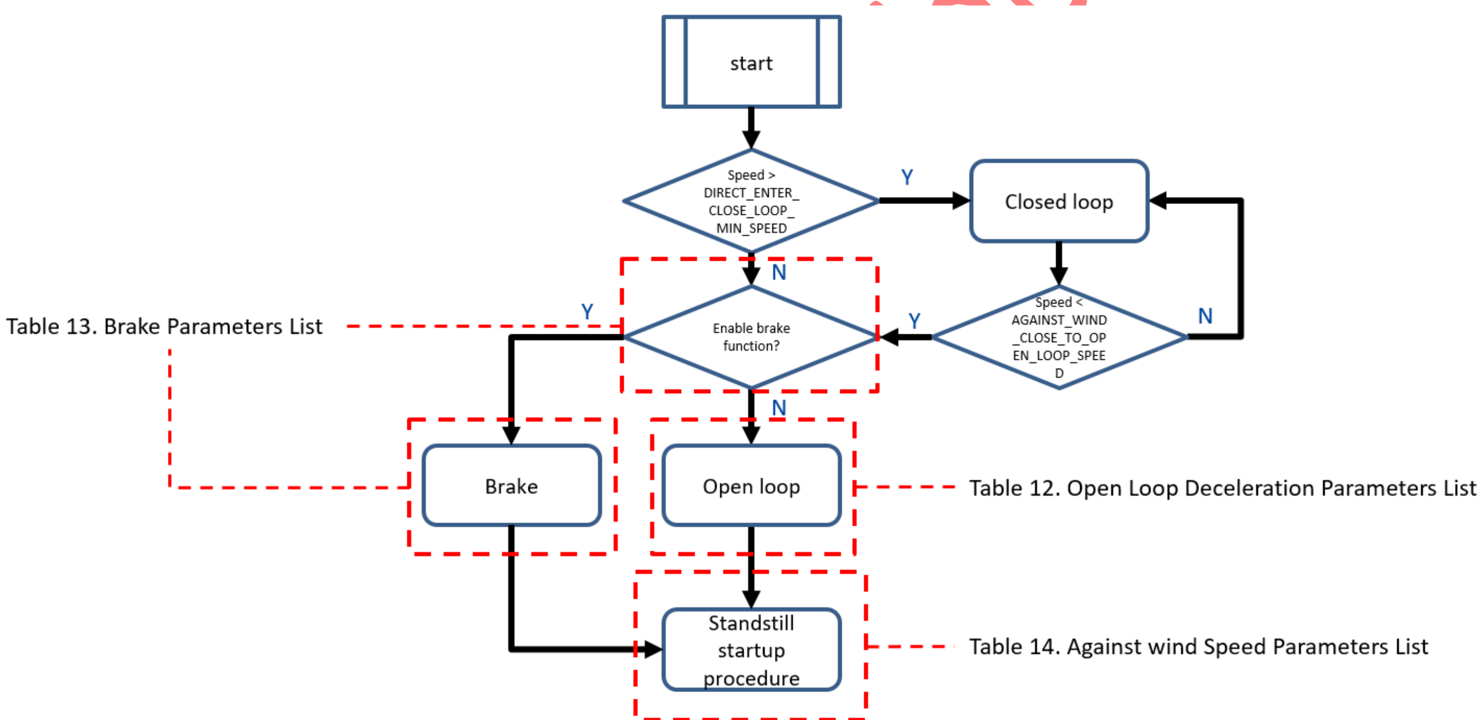
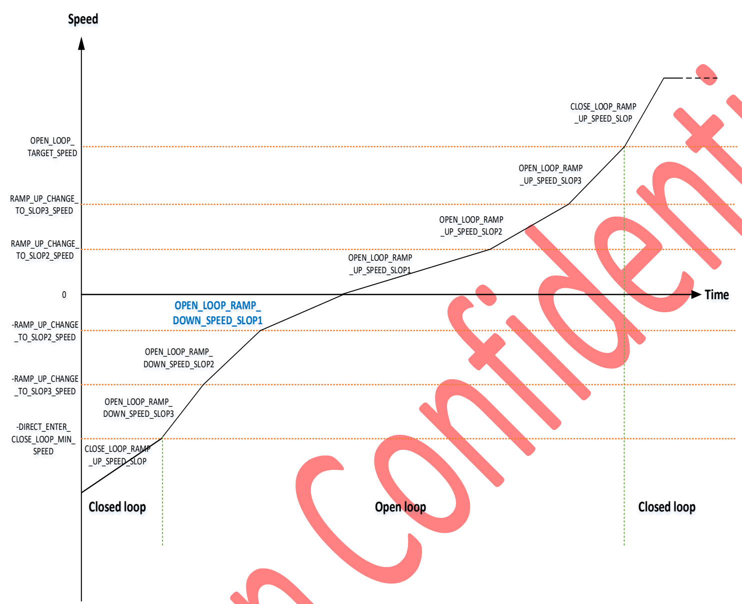


Figure 23. Against wind startup flow

Table 12. Open Loop Deceleration Parameters List

Parameter name	Parameter Description	Recommend value
OPEN_LOOP_RAMP_ DOWN_SPEED_SLOPE1	Motor reduce speed slope in open loop. Suggest to start the tuning in lower value then revise it if motor can't stop smoothly. Setting range: 1 ~ 10 (Unit: RPM/sec) 	2
OPEN_LOOP_RAMP_ DOWN_SPEED_SLOPE2	Motor reduce speed slope stage two in open loop. Suggest to set the middle value between stage one and three. Setting range: 1 ~ 20 (Unit: RPM/sec)	3
OPEN_LOOP_RAMP_ DOWN_SPEED_SLOPE3	Motor reduce speed slope stage three in open loop. Motor reduce the speed from close loop to open loop. Raise this value to make motor reduce speed faster but might appear vibration and noise if slope is too high. Setting range: 1 ~ 50 (Unit: RPM/sec)	5
RAMP_UP_CHANGE_ TO_SLOPE2_SPEED	Target speed for slope one and two. Setting range: 1 ~ 200 (Unit: RPM)	12

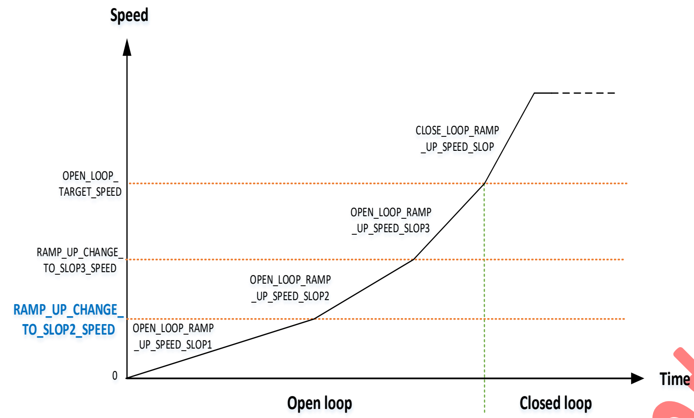
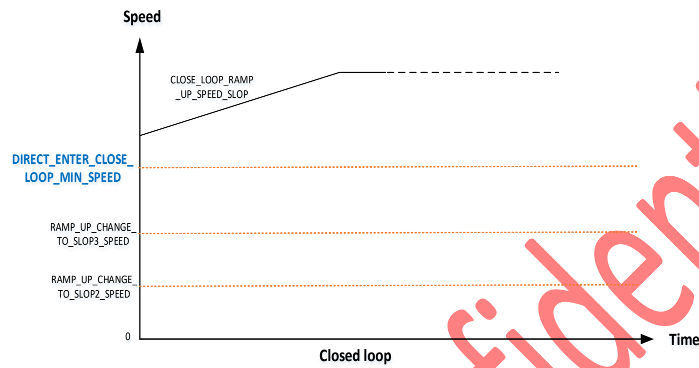
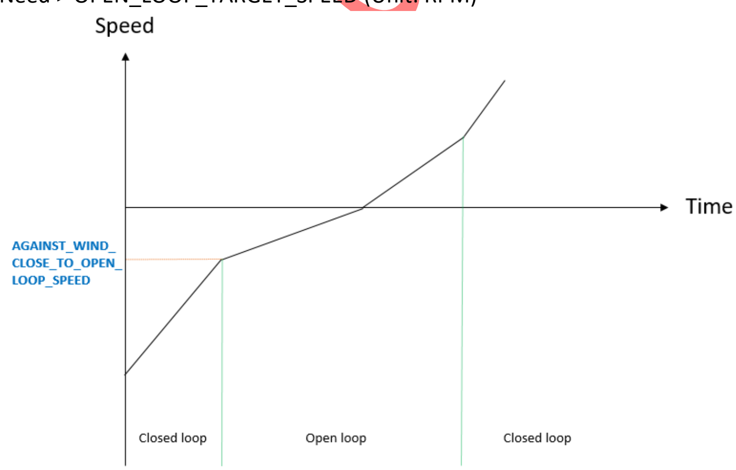
		
RAMP_UP_CHANGE_ TO_SLOPE3_SPEED	Switching to slope two and three target speed. Setting range: 1 ~ 200 (Unit: RPM)	30
OPEN_LOOP_RAMP_ DOWN_CURRENT	Target speed in open loop reducing speed. User do not modify it. Unit: 0.1A, define the torque current in open loop ramp down stage.	30

Table 13. Brake Parameters List

Parameter name	**Parameter Description**	**Recommend value**
ENABLE_LOWER_3_ ARM_UL_VL_WL_ON_ BRAKE_AGAINST_ WIND	Enable: open loop reduce speed function replace by break function.	
K_PARAMETER_OF_UL_ VL_WL_BRAKE_ AGAINST_WIND	Brake time = 10ms * (LOWER_3_ARM_BRAKE_MIN_TIME + (BEMF_SPEED * K_PARAMETER_OF_UL_VL_WL_BRAKE))	20
LOWER_3_ARM_ BRAKE_MIN_TIME_ AGAINST_WIND	Shortest break duration. This values must higher than motor stop time, otherwise, motor will fail to startup. Setting range: 1~5000 (Unit: 10 ms)	500

Table 14. Against wind Speed Parameters List

Parameter name	Parameter Description	Recommend value
DIRECT_ENTER_ CLOSE_LOOP_MIN_ SPEED	Configure the speed that motor can enter close loop directly. Suggest to set the value as same as OPEN_LOOP_TARGET_SPEED Setting range: 1~200 (Unit: RPM)  	80
AGAINST_WIND_ CLOSE_TO_OPEN_ LOOP_SPEED	Target speed from close loop enter open loop in against wind startup mode. Suggest to set the value as OPEN_LOOP_TARGET_SPEED+10 Setting range: Need > OPEN_LOOP_TARGET_SPEED (Unit: RPM)  	90
AGAINST_WIND_ RESTART_RAMP_UP_ SLOPE_DIVIDE_PARA	Acceleration slope control configuration when motor reduce speed to standstill then accelerate in open loop. Eg. Setting 2 means acceleration slope will become one half as original. User can increase this value to slow down the acceleration in open loop to deal with the stronger against wind. Setting range: 1~3	1

6. Troubleshooting

6.1. Error code

Table 15 is the error code description, motor will stop to protect the system when following error code detected. LED lighting will appear different blinking methods to tell user which error occurred:

Table 15. Error Code List

Parameter name	Parameter Description	Default value
MAX_ERROR_ ACCUMULATIVE_TOTAL	Maximum error accumulative times. When error times over ten, then motor won't reboot.	10
ERROR_RESTART_WAIT_TIME	Motor rebooting duration after error appeared. Unit: 100ms	5
MOTOR_SPEED_ERROR	LED blinking one time to identify the motor speed offset is too high or too low and cause motor stop.	1
MOTOR_PHASE_ CURRENT_ERROR	LED blinking twice if program detected the phase current over 5A.	2
MOTOR_OVER_CURRENT	LED blinking three times if phase current over 5A and motor have been stop.	3
MOTOR_ROTATION_ INVERSE_ERROR	LED blinking four times if reverse rotating in close loop.	4
MOTOR_OVER_UNDER_ VOLTAGE_ERROR	LED blinking five times if supply power abnormal. (over 30V or less than 12V).	5
NEW_STARTUP_MODE_ OVER_TIME_ERROR	LED blinking six times if motor startup failed in zero speed mode.	6
MOTOR_DCBUS_OVER_ CURRENT_ERROR	LED blinking seven times when DC bus appear over current error.	7
MOTOR_LACK_PHASE_ ERROR	LED blinking eight times when U/V/W phase lost and cause motor stop.	8

7. Revision History

Rev.	Date	Description
1.00	2020/4/13	Initial Release
1.01	2020/6/10	Revised P.10 error.
1.02	2020/6/25	Translate to English version