1. Application description

This application note describes the available start modes. The start modes are special procedures required to align the magnetic fields in the motor.

2. Start modes description

The preferred start mode can be selected during the setup phase, trough the "Drive Setup" dialogue.

ive Setup							
Guideline assistant Previous Next Step 1. In the < <control mode="">group box, select what do you want to control position, speed or torque. In the <<commutation method="">> group box, choose sinusoidal or transcripted mode. The transcripted mode in the series.</commutation></control>	Control mode Position C Speed C Torque	External re	ference gue natically a on metho		sSetup emental lafter Power On		OK ancel Help
CANbus V Baud rate F/W default CANopen settings	Advanced	⊂ Trape Axis ID se I⊽ Set /	zoidal ection change a	Sini xis ID	usoidal		otoi tun
Current controller	Drive operation para	ameters			1		cap
Kp 4.4227	Power supply	24	V	-	Detect		
Ki 0.91437	Current limit	4	A	-			
	Load speed limit	675.719	rad/s	-			
Tune & Test Position controller Kp [49.566] Integral limit [10]	 ✓ Control error Position error > ✓ Control error Speed error > ✓ Motor over tem 	0.59998	rot	✓ fo	r more than 3 r more than 3	8	2
Ki 2.3236 Feedforward 835.43 (Acceleration)	12t over current	6.77	A	Ŧ	for 15	\$	
Kd filter [0.4046 Modify] Gein sched DFF Tune & Test	External chopping running Connected	esistor	Activat	e if pow	er supply > 49.99	9 V	7
Motion complete settings Band 0.5 rot Time 0.001 s	Active high (Connec Active low (Open/N	cted to +Vlog lo connectio) 1)	Limit swi (• (-	ntch+ Limit switch- ເຈົ (^	Type Sink Source	(PNP) ce(NPN
#IT POS LP2 400Hz Q=0.707 Filter 6 Filter 2 Filter 7 Filter 3 Filter 8 Filter 4 Filter 9	Software limits - r Negative limit -2621 Positive limit 2621	estrict mover 144 rot 44 rot	nent + +	F	Position range limits Minimum 0 Maximum 0	rot	y y

Figure 1. Start mode selection

Depending on the system configuration (drive model, motor type and feedback sensors) the available start modes varies from a project to another. A complete list with the available start modes is presented below.

- 1) Move till aligned with phase A;
- 2) BLDC with Hall sensors;
- 3) PMSM with Hall sensors;
- 4) Direct start, using the absolute position sensor;
- 5) Motionless start (encoder only).

The start mode selection will be done function on the application requirements and on the system configuration. For example, in case of a gravitational system (vertical axis) that is not equipped with an absolute position sensor, the recommended start modes are "BLDC / PMSM with Hall sensors" (if the motor is equipped with digital Hall sensors) or to "Motionless start (encoder only)".

The "Move till aligned with phase A" start method is not recommend because the load might be in a mechanical limit and this will not allow the motor to perform the needed alignment movements.

2.1. "Move till aligned with phase A" start mode

This start method assume a small motor movement that has the purpose to align the magnetic field from rotor with phase "A" of motor. For this, the motor is energized to align first with phase B, then with phase A. This has the purpose to avoid the situation when the initial electrical angle between the magnetic field from the rotor and the phase "A" of the motor is 180 degrees.

<u>Remark</u>: If the electrical angle between the magnetic field from the rotor and the phase "A" of the motor is 180 degrees, then the rotor will not move if the phase "A" of the motor is energized. That is why this start mode energizes first the phase "B" of the motor.

When the "Move till aligned with phase A" start mode is selected, the "Settings" button will appear in the "Start mode" section.

Move till aligned with phase A 🗾 🚽 Settings	Start mode			
		Move till aligned with phase A	-	Settings

Figure 2. "Move till aligned with phase A" start mode settings button

Clicking on this button the following dialog will open.

Move till aligned with phase A - Settings				×
Current used during start mode Time to apply on phases	48	% • s •	of nominal current	OK
Trigger failed start protection if motor moves less than	0	% 🔻	of expected movement	
				Cancel

Figure 3. "Move till aligned with phase A" start mode settings

This dialog allows setting the current that will be used during the alignment procedure (as percentages from the motor nominal current, defined in the "Motor Setup" dialog) and the "time to apply on phase". The used current value depends on the mechanical system inertia. To avoid a start method failing the used current value can be set to 90% or 100% from the motor nominal current.

<u>Remark</u>: If the mechanical system has sticktion or a very high inertia, the alignment current can be also set to 110% or 120% from the motor nominal current.

The "Move till aligned with phase A – Settings" dialog allows also to enable/disable a protection that detects if the start mode failed. If the respective parameter is set to 0 %, the protection is disabled. Any other value will activate the protection and set its level to the respective value. For example, 70% means that the protection is active and set to 70% from the expected movement (70% from 120 electrical degrees).

Move till aligned with phase A - Settings						Х
Current used during start mode	90	%	•	of nominal current	OK	
Time to apply on phases	1	s	•			
Trigger failed start protection if motor moves less than	70	%	•	of expected movement		
					Cancel	

Figure 4. "Move till aligned with phase A" start mode protection setting

This start method can be used for all applications with horizontal loads, using motors without Hall sensors and where the motor can move freely.

2.2. "BLDC and PMSM with Hall sensors" start modes

These start modes are available only in case of motors equipped with digital Hall sensors.

Compared with the "Move till aligned with phase A" start mode, the start methods based on the digital Hall sensors have the advantage that does not involve an initial movement of the motor. The command is adjusted based on the first read Hall combination.

In order for this start modes to work correctly, is very important to detect the Hall configuration. This can be done during the setup phase through the "Motor Setup" dialog.

Motor sensors Type	Incremental Enc	oder 💌	·	Connector	Feedback	.1		•
	No. of lines/rev	500	line	s 🔻	Test Co	nnections	Det	tect Number of Lines
🔽 Digital Hal	ls	Hall configuration	8	•	Test Co	nnections	Dete	ect Hall Configuration
	– Sensor h	ne						
Temperati	re 💿 NTC	C PTC	▼ F	ilter encoder	nputs to	1/24	_	of maximum bandwidth
, remported			F	leverse enco	der counting	,		

Figure 5. Detect the digital Hall sensors configuration

The "**BLDC with Hall sensors**" method starts the motor using the trapezoidal commutation method and commutes to sinusoidal after the first Hall sensors transition is detected.

The **"PMSM with Hall sensors**" method starts the motor directly in the sinusoidal mode and adjusts the electrical angle after the first transition of the Hall sensors. Due to this, it is smoother than the "BLDC with Hall sensors" method.

These start modes are recommended for applications where an uncontrolled movement of the motor is not allowed or where mechanical limits might be involved.

2.3. "Direct start using the absolute position sensor" method

To control the motor using a FOC method, the drive needs to know the rotor position. In case of the absolute position sensors, the rotor position is always known, so the drive can start the motor directly.

If this start mode is selected, a mandatory step is to detect the absolute sensor offset. This test is available in the "Motor Setup" dialog and has the purpose to check the absolute sensor indication, when the rotor is aligned with the phase "A" of the motor.

– Motor sensors– Type	SSI	▼ Conn	ector Feedback 2	•
 Binary Gray 	C Single turn 13 Multi turn 12 Frequency 2000 kH	bits bits	resolution resolution Offset 571 Reverse counting	Test Connections Detect offset (Mandatory) (from motor phase A)
🗌 Temperatu				



2.4. "Motionless start (encoder only)" method

In absence of an absolute position sensor / digital Hall sensors, the drive needs to align the motor with a known position. This alignment is mandatory for an optimal vector control, where the internal angle of the motor is kept at 90 degrees, to ensure maximal torque generation with minimum current consumption.

This alignment is usually done using the "Move till aligned with phase A" start mode but as was explained above, there are some cases where this start method cannot be used. The "Motionless start" method was developed to alleviate this drawback.

To do the initial alignment, the "Motionless start" method uses an angle controller and the notions of "stator" and "rotor" are reversed. Instead of physically moving the rotor, to align it with the stator, the drive moves the electromagnetic field, generated on the stator to "find" the actual position of the rotor. For that, a small movement is still needed but compared to the maximum travel of 240 electrical degrees, in case of the "Move till aligned with phase A" start mode, here the movement has only few electrical degrees.

To avoid rotor movement the information from the encoder is read and to react automatically on the rotor position change an angle controller is used.

The angle controller is PI type and can be accessed from the "Drive Setup" dialog.



Figure 7. Angle controller tuning

The "Motionless start" method is slightly more complex in setup than any of the other available methods and sometimes it may require a manual tuning. For more details check <u>Motionless-start-up-method-description</u> article in our Knowledge base.