Application Note

C008 Pseudo PMAC Control Set up

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AC30P/D/A V2.16 onwards

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Safety Information

Requirements

Intended Users

This Application Note is to be made available to all persons who are required to install, configure or service equipment described herein, or any other associated operation.

The information given is intended to enable the user to obtain maximum benefit from the equipment.

Application Area

The equipment described is intended for industrial motor speed control utilising AC induction or AC synchronous machines.

Personnel

Installation, operation and maintenance of the equipment should be carried out by qualified personnel. A qualified person is someone who is technically competent and familiar with all safety information and established safety practices; with the installation process, operation and maintenance of this equipment; and with all the hazards involved.

Hazards

Refer to the Safety Information given at the front of the Product Manual supplied with every Parker SSD Drives product.

C008 PSEUDO PMAC CONTROL SET UP

Abstract

This application note gives some advices to set up a PMAC configuration using the Pseudo PMAC control starting method to run a PMAC motor using non absolute encoder type (pulse encoder, sincos encoder, ..).

Pre-Requisite

The pre-requisites are :

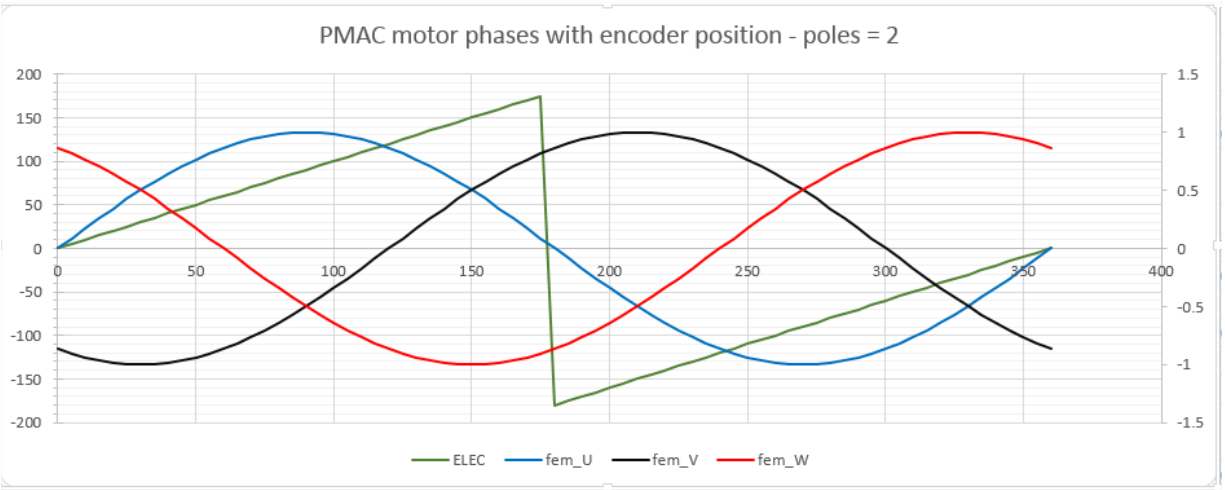
- a AC30P/D/A control boards
- an encoder connected to one of the possible feedback inputs of the drive, and decalred as the feedback in use for the Closed loop control scheme.

Introduction

To make the explanation easier, the motor is a 2 poles motor. 1 motor turn equals 1 encoder turn.

As shown below, the electrical position for the vector control scheme should be synchronized with the motor back EMFs. The electrical position should be absolute.

Electrical Position is the green curve, and the blue is the back EMF on the motor phase U. By definition, the motor Vector Control assumes that the back EMF is crossing the 0V line in a positive direction when the electrical position is also crossing the 0° line in a positive way. Another requirement is to insure a positive encoder rotation with a positive electrical motor rotation (U, V, W).



To make the PMAC control compatible with non absolute encoder type (pulse encoder, sin-cos, etc) which does not give absolute position information (what is the absolute position given by the encoder on a power switch on?), a Virtual Zero Position needs to be determined, creating a position offset which moves the incremental encoder position to an absolute encoder position. After either a drive OFF or a trip condition situation (due to the encoder), this offset is no longer valid and should be extracted again.

Pseudo PMAC Control

Description

The method to align the encoder to the motor back EMF uses the AC30V Sensorless Vector Control motor scheme to start the motor (the meaning of 'to align' is determine the Virtual Zero Position). The absolute motor position is estimated by the sensorless control when the motor is turning.

Requirements

At least, reaching a minimum motor speed is required to calcualte a good estimation of the absolute position.

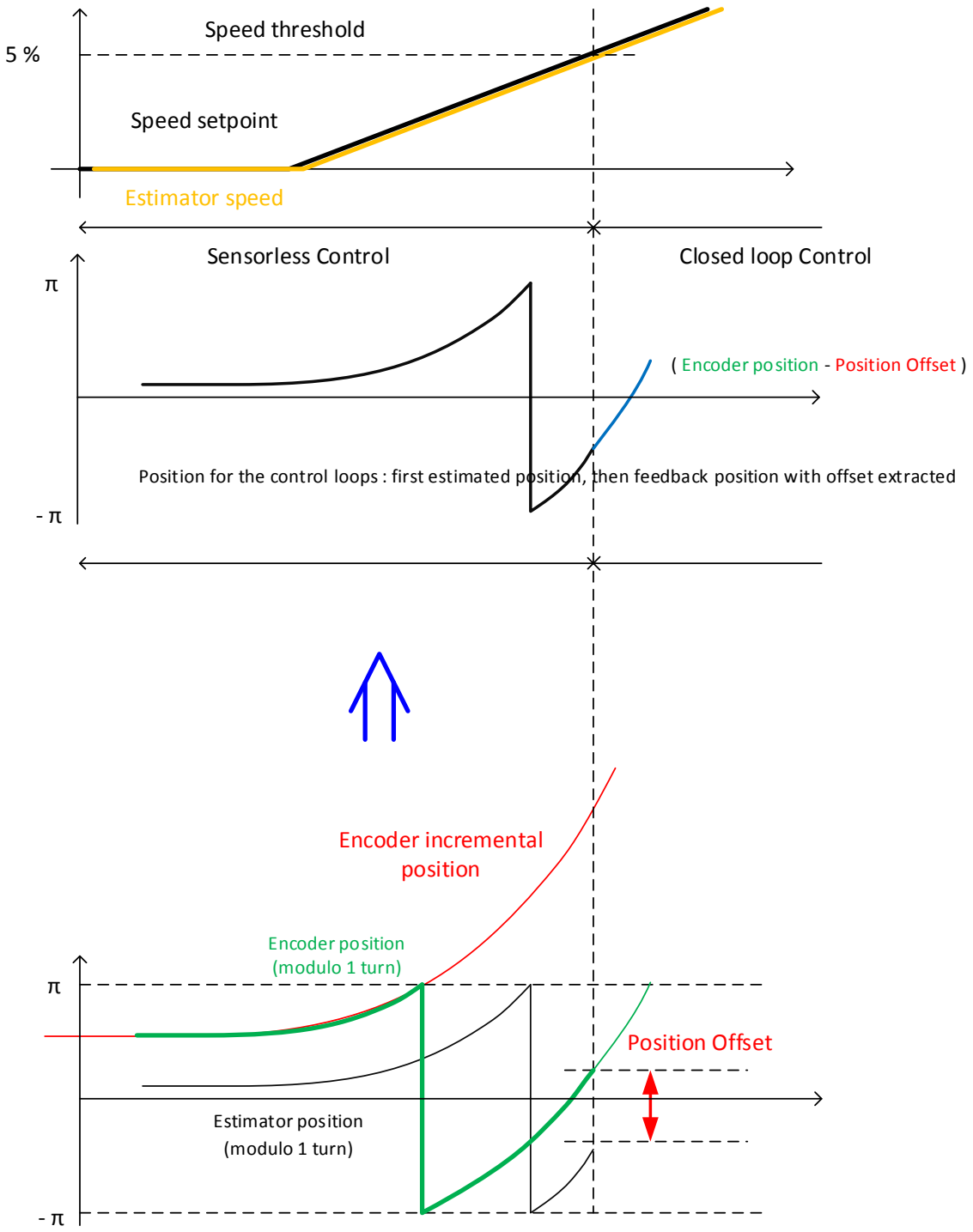
5%(*) is the default (and recommended) threshold value set up in the sensorless control parameters (belonging to PMAC SVC) to move from a VHz motor control to a sensorless closed loop control mode in the actual AC30V sensorless Vector Control mode.

(*) : 5% is related to the motor rated speed, not to the application speed. The value is set up in 0479 PMAC SVC Start Speed

For exemple, 5% a 6000RPM motor rated speed is 300RPM. If the application speed is 1500RPM, then the value to be set up becomes 20%

The drive is started on a non rotating motor (motor at zero speed) with a load level compatible with a sensorless start : no more than 80% of the nominal torque/current + an acceleration also compatible with sensorless control (small acceleration time are forbidden).

Once the motor is rotating at a higher speed than the threshold value, a position offset is calculated. This position offset is then used in real Closed Loop Vector Control. The incremental position from the encoder is now processed as an absolute position.



The method should be enabled if the drive is in speed control mode.

In torque control mode, the method won't give correct and accurate position offset value.

Successful condition

The method is run and is successful :

- if the speed setpoint is set to a higher value than 5% (the speed threshold appearing in the PMAC SVC block). A time out of 5s allows to trip if the estimated speed stays below 5% (whime the speed setpoint is above)

If the speed setpoint is set to a lower value than 5%, then the drive stays in open loop (VHZ) as long as the setpoint is kept below 5%.

- If the speed from the estimator is the same sign as the speed from the encoder feedback. If not, the drive trips. The solution is then to either change 1809 PMAC Wiring or to change the encoder direction count (this is the preferred solution).

- If the speed value from the estimator and the speed from the actual encoder feedback follow the same gradient. Considering a speed error betwen speed estimator an speed feedback of less than 0.5 Hz (Electrical speed) as a target provides a good criterion. If not, a time out of 1s allows the drive to trip. For exemple, that is the case when the number of motor poles is set to a wrong value.

The method will force the pwm to run at 4kHz, no random pattern as long as the starting sequence is in operation.

It is not recommended to set up acceleration time during the startup sequence to low value (low value means value requiring a large amount of the current avaiable to accelerate the motor with its load) , to give a chance to the sensorless algortihm to extract an accurate position information.

Parameters

Parameters belong to "Control Mode" setting.

They will be visible only if the control configuration is set up to PMAC + Encoder Feedback.

The list of parameters is given below :

- Startup Alignment
- Actual Control Type
- Start Align Done

Of course, parameters associated to the Sensorless Control also need to be set up. Keeping most of the default values covers a large panel of application. 0477 PMAC SVC Start Time, 0478 PMAC SVC Start Cur and 0479 PMAC SVC Start speed may need to be adjusted, depending of the application.

Start Up Alignment

DISABLED : No action, for absolute encoder type

ONCE : Start up alignment run once from a cold start state.

At the end of the sequence, the drive is in Full Closed loop Vector control. A position Offset has been calculated and set up in “PMAC Encoder Offset” parameter.

Only a trip condition will reset the system to run again the sequence.

Changing this value will also reset the system and will cause the drive to run again the sequence on the next start.

ALWAYS : At each motor start (Torque OFF to Torque ON condition), the drive goes through the Pseudo PMAC sequence and a new position offset is calculated, which will remain valid until next Torque OFF condition.

Actual Control Type

Diagnostic giving the actual control loop type : ENCODER FEEDBACK or SENSORLESS

Start Align Done

Diagnostics, set to TRUE when the method has been run successfully.

Reset to FALSE after a cold start and/or a trip condition.

Trips condition

Under a trip condition, the following trips will reset the system and restart to a similar state as a cold start :

- TRIP_PMAC_SPEED_ERROR 25
- TRIP_OVERSPEED 26
- TRIP_FEEDBACK_MISSING 28
- TRIP_SPEED_ERROR_FAULT 41
- TRIP_RESOLVER_ERROR 45
- TRIP_PMAC_ALIGN_ERROR 46
- TRIP_AC30A_ENCODER 50

Trip 25 PMAC SPEED ERROR is used as a trip state occurring when something wrong is found during start up alignment. Conditions are :

- Estimator speed is not able to follow speed setpoint.
  - Maybe due to a wrong setting of PMAC motor parameters and/or PMAC svc parameters. Verify parameters.
- Estimator speed and feedback speed are not the same sign. Either a wrong feedback direction or a motor phase wiring are the reason.
  - Change either encoder direction or motor phase wiring.
- Estimator speed and feedback speed are giving different gradient. This is mainly due to a wrong number of motor poles declared, or a wrong encoder setting in term of lines.
  - Change the wrong setting.

How To Set up

Setup Control Mode:

Selection of the control mode (Vector control) and selection of the encoder feedback for the speed loop control.
Selection of the Stating method.

Setup Encoder Feedback :

Depending of the encoder feedback selected :

- if MAIN SPD FEEDBACK Selected, an IO option pulse encoder is required and the settings of the encoder are done in **Setup::Inputs and Outputs::Option**
- if SYSTEM BOARD SLOT 1 or SLOT 2 is selected, a system board is required and the settings of the encoder are done in **Setup::Inputs and Outputs::SB Encoder or Setup::Inputs and Outputs::SB Encoder Slot1** or **Setup::Inputs and Outputs::SB Encoder Slot2**

Motor Nameplate parameters :

Enter the motor parameters (Back EMF, R, L, etc…)

Speed Loop Scaling:

Enter the scaling for the speed loop control. This value represents 100% speed(not necessarily the motor rated speed define in 0555 PMAC Max Speed)

Speed Loop :

By default, speed loop settings gives a safe control of the motor. For a better dynamic and behaviour, it may be better to try to optimize the speed loop settings.

PMAC SVC:

Adapt the parameters to your application:

- 0477 PMAC SVC Start Time : is there a large inertia on the motor? Higher is the inertia, higher the time should be extended
- 0478 PMAC SVC Start Cur : is there a big load on the motor? Do we need to increase the default value (10%)? (This value should be set to a value higher than the current level needed to rotate the motor With its load at constant speed)
- 0479 PMAC SVC Start Speed : This is a percentage of the speed application. For a motor with flux weakening control, the threshold value is 5% of the base speed (not 5% of the maximum speed). Please do not forget to convert this speed value to a % of the speed application defined in 0464 100% Speed in RPM