

Cogging compensation with PPAC-28 servo drives

1 – Introduction

The cogging torque in brushless permanent magnet rotating motors or the cogging force in brushless permanent magnet linear motors results from the interaction between the rotor magnets and the stator slots. This disturbance is due to the difference of reluctance between the copper of the windings and the iron of the stator teeth. For a given motor, the cogging can be easily evaluated by simply moving the motor manually when the amplifier is disabled. The Cogging compensation option available in the XtrapulsPac servo drive range allows to cancel the motor cogging effects for specific applications where torque accuracy or force accuracy better than 1 % is required.

The XtrapulsPac servo drive must be equipped by the factory for getting the cogging compensation option (reference PPAC-28). Only XtrapulsPac servo drive with SN greather than 11302000 can support the cogging compensation option.



For a brushless motor equipped with an incremental encoder (incremental encoder + HES and incremental encoder with CD tracks are also concerned), the Cogging torque compensation is only available if the encoder is providing one marker pulse per motor revolution.

The “Cogging torque compensation” window is available in GemDriveStudio software from 5.8 version.

2 – Cogging compensation commissioning

The XtrapulsPac servo drive setup and commissioning is first executed as indicated in the XtrapulsPac installation manual and XtrapulsPac user manual.



The High bandwidth selection is recommended for the current loops adjustment in order to get the best cogging compensation performances.



For a motor equipped with an incremental encoder (incremental encoder + HES and incremental encoder with CD tracks are also concerned), it is recommended to activate the Zero Mark Pitch monitoring function in order to check the marker pulse signal.

The motor cogging torque acquisition procedure must be performed before the cogging torque compensation activation. For this operation, the motor must be uncoupled from the load and shaft movement free.

Start first the Auto-tuning procedure with following selections:

- Operation mode = Profile velocity,
- Speed measurement select = Auto,
- Filter = Max. Stiffness,
- Bandwidth = High.

Start the cogging torque acquisition procedure in the “Cogging torque compensation” window. The acquisition procedure duration is about 1 minute. The motor shaft must not be disturbed during the acquisition procedure execution.

When the cogging torque acquisition procedure is over, enable the motor cogging torque compensation in the “Cogging torque compensation” window.

Select Operation mode = Profile torque, then move the motor manually when the drive is disabled and when it is enabled in order to feel the cogging compensation effect.

Execute “Store cogging torque file to flash memory” command in the “Cogging torque compensation” window for the cogging compensation table to be saved into the drive.

Execute “Backup cogging torque file to PC file” command for the cogging compensation file (COGGINGC.BIN) to be transferred to the GemDriveStudio project on the PC.

The motor can then be mounted on the machine and the servo drive setup and commissioning is continued as indicated in the XtrapulsPac user manual.

If the drive initial parameter setting must be restored after the cogging acquisition procedure has been executed, proceed as described below:

- Restore the initial parameter file (DRIVEPAR.TXT) from the PC,
- Enable the motor cogging torque compensation in the “Cogging torque compensation” window,
- Store the drive parameters into the flash memory,
- Backup the new parameter file (DRIVEPAR.TXT) to the PC.

3 – Troubleshooting

If the “WARNING 9: Cogging compensation is not OK” message is continuously displayed after the drive power up, check the following points:

- Disable the motor cogging torque compensation in the “Cogging torque compensation” window. If the Warning 9 disappears, the cogging compensation file (COGGINGC.BIN) is not into the drive or it is corrupted. Restore the cogging compensation file from the PC or execute the cogging torque acquisition procedure.
- read the object 0x51E0,8 and check that bit 13 is set. If bit 13 is reset to 0, the drive is not equipped with the cogging compensation option (PPAC-28).

If the cogging torque acquisition procedure is not starting on the “Start” command activation in the “Cogging torque compensation” window:

- check that the drive is not enabled,
- check that the speed loop gains are not set to 0.

If the “ERROR 64: Procedure error” message is continuously displayed after the starting of the cogging torque acquisition procedure, the procedure has failed because of an external cause and the cogging torque acquisition is not valid, check the following points:

- check that a drive fault is not released,
- check that drive Quick Stop is not activated,
- check that drive Limit Swith is not activated,
- check that drive STO is not activated,
- check that encoder is providing one marker pulse per motor revolution if the motor is equipped with an incremental encoder,
- check that the motor shaft has not been disturbed during the cogging torque acquisition procedure execution,
- check that the motor shaft movement is free before starting again the cogging torque acquisition procedure.

If the “WARNING 9: Cogging compensation is not OK” message is continuously displayed after the starting of the cogging torque acquisition procedure, the procedure has failed because of an external cause and the cogging torque acquisition is not valid, check the following points:

- check that drive STO is not activated,
- check that drive Enable is not deactivated.

Remark:



For a motor equipped with an incremental encoder (incremental encoder + HES and incremental encoder with CD tracks are also concerned), in case of a feedback sensor fault, the Cogging torque compensation becomes active again when the sensor fault has been cleared and the marker pulse signal detected again by the drive.

4 – Maintenance

Restore the application parameter file (DRIVEPAR.TXT) from the PC into the new drive.

Execute “Restore cogging torque file from PC file” command for the cogging compensation file (COGGINGC.BIN) to be transferred from the PC to the drive.

Remarks:



For a motor equipped with an incremental encoder (incremental encoder + HES and incremental encoder with CD tracks are also concerned), the Cogging torque compensation only becomes active when the marker pulse signal has been detected by the drive.



When exchanging a drive, if the new drive current rating is different, the cogging torque acquisition procedure must be renewed.



When exchanging the motor or when disassembling the position sensor, the cogging torque acquisition procedure must be renewed.

5 – Parameters

5.1) Object 3492h: Cogging torque acquisition procedure

Index	3492h
Name	Cogging torque acquisition procedure
Object Code	VAR
Data Type	Unsigned32
Object Class	-
Access	wo
PDO Mapping	No

In order to avoid running the cogging torque acquisition procedure by mistake, the cogging torque acquisition is only executed when a specific signature is written to the this object. This signature is 'coga'.

Signature	MSB			LSB
ASCII	a	g	o	c
hex	61h	67h	6Fh	63h

5.2) Object 3491h: Enable / Disable Cogging Torque Compensation

Index	3491h
Name	Enable / Disable Cogging Torque Compensation
Object Code	VAR
Data Type	Unsigned16
Object Class	all
Access	rw
PDO Mapping	No
Default Value	eprom

Bit Number	Description
0	0 => Cogging Torque Compensation disabled 1 => Cogging Torque Compensation enabled

5.3) Object 1010h: parameters saving

Index	0x1010
Name	Store parameters
Object Code	RECORD
Number of Elements	

This command saves the parameters from the drive volatile memory (ram), in a file located in an internal flash memory.

Value Description

Sub Index	1
Description	Save all parameter
Data Type	Unsigned32
Access	rw
PDO Mapping	No
Value	writing signature: 0x65766173 save drive parameters

Signature for various operations:

Operation	Signature	Ascii
Saving of the drive parameters saves drive parameters into flash memory (DRIVEPAR.TXT file).	0x65766173	"save"
Saving of the cogging compensation saves cogging compensation table from cogging compensation memory into flash memory (COGGINGC.BIN file).	0x676F6373	"scog"

While operation is running, busy bit in status word ([0x6041](#)) is set.

If the Hiperface® encoder is selected when saving drive parameters, the encoder reference (0x312D,5 and 0x3125,6) and homing offset (0x3128,0) are also stored into the Hiperface® encoder non-volatile memory.

5.4) Object 1011h: parameters restoring

Index	0x1011
Name	Restore parameters
Object Code	RECORD
Number of Elements	

Value Description

Sub Index	1
Description	Load all parameters
Data Type	Unsigned32
Access	rw
PDO Mapping	No
Value	writing signature: 0x64616F6C load drive parameters

Signature for various operations:

Operation	Signature	Ascii
Loading of the drive parameters (DRIVEPAR.TXT)	0x64616F6C	"load"
Loading of the USER_PAR.TXT file loads parameters from USER_PAR.TXT file into memory.	0x7273756C	"lusr"
Loading of the COGGINGC.BIN file loads parameters from COGGINGC.BIN file into cogging compensation memory	0x676F636C	"lcog"

While operation is running, busy bit in status word ([0x6041](#)) is set.

If the Hiperface® encoder is selected when loading drive parameters, the encoder reference (0x312D,5 and 0x3125,6) and homing offset (0x3128,0) are also loaded from the Hiperface® Encoder non volatile memory. After a reset of the Hiperface® error, these objects are also reloaded.