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PPAC21 servo drive for motor control with HES only feedback or in sensorless

Content

1) Introduction

This document gives only specific information for the XtrapulsPac AK PPAC-21 version.

The specific functions of the XtrapulsPac AK PPAC-21 servo drive concern motor control with HES only feedback or in sensorless.

Refer to the XtrapulsPac general manuals for complete information about the XtrapulsPac AK servo drive functionalities:

- **XtrapulsPac Installation Guide** for the hardware installation of the drive (mounting, wiring, …)
- **XtrapulsPac User Guide** for the operation of the drive (commissioning, configuration, ...)
- **XtrapulsPac STO** for the Safe Torque Off function
- **Gem Drive Studio software Quick Start** manual for the drive parameterization.
- **GDPS** manual, for the use of the GDPS power supply unit.

XtrapulsPac AK PPAC-21 specific parameters are displayed in the GemDriveStudio parameter setting software from the 5.9 release.

2) Commissioning for sensorless motor control

If the motor is referenced in the **Gem Drive Studio** motor catalog, it can be simply selected in the proposed motor list.

If the motor is not referenced in the **Gem Drive Studio** motor catalog, the motor parameters can be manually adjusted or calculated by using the drive's built-in procedures. The motor can then be referenced in the **Gem Drive Studio** motor catalog by using the **Add new motor** command (see **Gem Drive Studio** quick start manual). The motor and the position sensor parameter values are manually entered and then saved in the **Gem Drive Studio** motor catalog with a new motor reference.

Remark: From the 5.9 version of **Gem Drive Studio,** by using the **Add new motor** command, the sensorless control parameters are automatically calculated according to the entered motor data. They are then saved in the motor catalog regardless of the sensor selection. So, when the motor is selected in the **Gem Drive Studio** motor list, the sensorless control parameters are initialised with these values.

2.1 - Selection in the motor list for sensorless control

In the motor list, select the motor used in the application. The motor selection will automatically set the following drive parameters: position sensor (resolver or encoder), thermal sensor, current limits, speed

limit, current loop gains, and motor control parameters. Servo loop gains are also calculated according to the motor inertia value (load inertia is not considered).

Check that the thermal sensor calibration is complying with the motor application and modify the threshold values if necessary.

Check that the current limit and the I²t protection adjustment are complying with the motor application, and modify them if necessary.

Check that the motor speed limit is complying with the application and reduce its value if necessary.

If external inductances are serially connected with the motor winding for filtering, renew the current loop gain calculation by using the total value of the phase-to-phase inductance.

Select Fusing mode for the I2t protection operation during the motor commissioning phases.

Disable all the position sensor inputs (resolver and encoder).

Select sensorless control operation in the motor feedback parameter.

Execute the servo loop gains calculation procedure.
-If the Load inertia parameter value cannot be estimated, set its value at 0.
-Select the Profile Velocity operating mode for the gains calculation.

Check the servo loop stability in the Profile velocity mode:
-Small values must be used as a starting point for the Acceleration and Deceleration parameter in order to prevent sharp movements on the mechanical load.
-The stability must be checked at speeds over the Low speed threshold parameter value because at low speed and standstill the speed regulator is not operating.
-If the Load inertia value is high, increase the Gain scaling factor in order to improve the servo loop stability.

2.2 - Manual motor configuration for sensorless control

If the motor configuration must be manually made (motor is not referenced in the **Gem Drive Studio** catalog), proceed as described below.

The required motor data for the manual setup are listed below:
- Motor current limits: rated current and peak current
- Motor speed limit
- Motor pole pairs
- Motor winding inductance
- Motor torque constant
- Motor inertia
- Motor electrical time constant
- Motor winding resistance
- Motor Emf constant

Disable all the position sensor inputs (resolver and encoder).

Select sensorless control operation in the motor feedback parameter.

Enable sensorless control in the sensorless parameter window.

Enter the motor Pole pair value according to the motor catalogue.

Enter the motor Electrical time constant value according to the motor catalogue.

Enter the motor Phase-phase resistance value according to the motor catalogue.

Enter the motor Emf constant value according to the motor catalogue. This parameter corresponds to the rms phase-phase voltage at 1000 rpm. The parameter value is equal to 60,46 x Motor torque constant (Nm/A).

Enter the motor Inductance ratio value. This parameter refers to the motor inductance variation according to the rotor position. If the value is not indicated in the motor catalogue, set the parameter value to 0.

Enter the motor Low speed threshold value. This parameter defines the motor speed value for the commutation between the “sensorless frequency control” (SFC) at low speed and the “sensorless vector control” (SVC) over the threshold value. The parameter is defined as the higher value between (Motor max speed / 8) and (3000 / Motor Pole pair).

Adjust the drive current limits (Maximum current and Rated current) in the motor configuration window according to the motor catalogue.

Calculate current loop gains according to the phase-to-phase inductance value given in the motor catalogue. If external inductances are serially connected with the motor winding for filtering, use the total value of the phase-to-phase inductance.

Select the correct configuration for the motor thermal sensor and adjust the warning and the fault triggering threshold according to the used thermal sensor specifications.

Set the Maximum speed parameter value according to the motor speed limit given in the motor catalogue.

Select Fusing mode for the I2t protection operation during the motor commissioning phases.

Execute the servo loop gains calculation procedure.
-Enter the motor Torque constant value according to the motor catalogue.
-Enter the motor Inertia value according to the motor catalogue.
-If the Load inertia parameter value cannot be estimated, set its value at 0.
-Select the Profile Velocity operating mode for the gains calculation.

Check the servo loop stability in the Profile velocity mode:
-Small values must be used as a starting point for the Acceleration and Deceleration parameter in order to prevent sharp movements on the mechanical load.
-The stability must be checked at speeds over the Low speed threshold parameter value because at low speed and standstill the speed regulator is not operating.
-If the Load inertia value is high, increase the Gain scaling factor in order to improve the servo loop stability.

3) Commissioning for motor control with HES only

If the motor is referenced in the **Gem Drive Studio** motor catalog, it can be simply selected in the proposed motor list.

If the motor is not referenced in the **Gem Drive Studio** motor catalog, the motor parameters can be manually adjusted or calculated by using the drive's built-in procedures: current loop calculation, auto-phasing. The motor can then be referenced in the **Gem Drive Studio** motor catalog by using the **Add new motor** command (see **Gem Drive Studio** quick start manual). The motor and the position sensor parameter values are manually entered and then saved in the **Gem Drive Studio** motor catalog with a new motor reference.

3.1 - Selection in the motor list for HES only motor feedback

In the motor list, select the motor used in the application. The motor selection will automatically set the following drive parameters: position sensor (encoder with HES only configuration), thermal sensor, current limits, speed

Check that the thermal sensor calibration is complying with the motor application and modify the threshold values if necessary.

Check that the current limit and the I²t protection adjustment are complying with the motor application, and modify them if necessary.

Check that the motor speed limit is complying with the application and reduce its value if necessary.

If external inductances are serially connected with the motor winding for filtering, renew the current loop gain calculation by using the total value of the phase-to-phase inductance.

Select Fusing mode for the I2t protection operation during the motor commissioning phases.

Execute the servo loop gains calculation procedure.
-If the Load inertia parameter value cannot be estimated, set its value at 0.
-Select the Profile Velocity operating mode for the gains calculation.

Check the servo loop stability in the Profile velocity mode:
-Small values must be used as a starting point for the Acceleration and Deceleration parameter in order to prevent sharp movements on the mechanical load.
-The speed loop stability must be checked above the motor low speed range. At low speed, the speed regulator is not operating correctly because of the low position resolution (6 increments per motor pole pair). At standstill the speed regulator is disabled (shaft free).
-If the Load inertia value is high, increase the Gain scaling factor in order to improve the servo loop stability.

The drive can be switched in the “sensorless frequency control” (SFC) below a given speed threshold when speed control stability must be increased at low speed or if motor torque is required at standstill. See parameter 0x313D for this feature. In this case, the speed regulator stability must be checked at speeds over the commutation threshold value.

3.2 - Manual motor configuration for HES only motor feedback

If the motor configuration must be manually made (motor is not referenced in the **Gem Drive Studio** catalog), proceed as described below.

The required motor data for the manual setup are listed below:
- Motor current limits: rated current and peak current
- Motor speed limit
- Motor pole pairs
- Motor winding inductance
- Motor torque constant
- Motor inertia

Select encoder 1 operation in the motor feedback parameter.

Check that resolver input is disabled in the resolver parameters.

Enable encoder 1 input in the encoder 1 parameters.

Enter the motor Pole pair value according to the motor catalogue.

Parameters HES type and Reverse HES tracks depends on the HES signal wiring and mechanical mounting. They are automatically calculated when the Auto-phasing procedure is performed.

Adjust the drive current limits (Maximum current and Rated current) in the motor configuration window according to the motor catalogue.

Calculate current loop gains according to the phase-to-phase inductance value given in the motor catalogue. If external inductances are serially connected with the motor winding for filtering, use the total value of the phase-to-phase inductance.

Select the correct configuration for the motor thermal sensor and adjust the warning and the fault triggering threshold according to the used thermal sensor specifications.

Set the Maximum speed parameter value according to the motor speed limit given in the motor catalogue.

Select Fusing mode for the I2t protection operation during the motor commissioning phases.

Execute the Auto-phasing procedure in order to identify the parameters Phase order, Position sensor offset, HES type and Reverse HES tracks. The motor must be uncoupled from the mechanical load and shaft free before the Auto-phasing procedure starting.

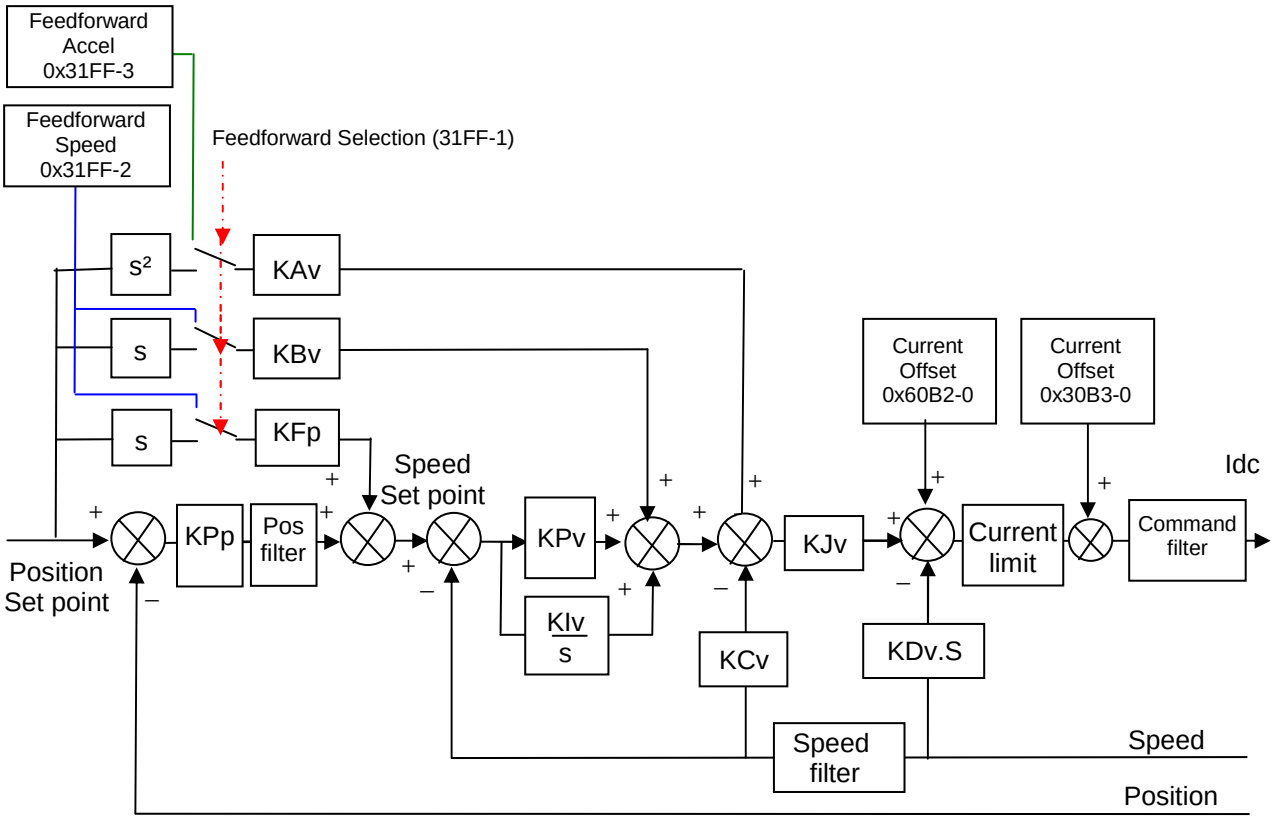
Execute the servo loop gains calculation procedure.
-Enter the motor Torque constant value according to the motor catalogue.
-Enter the motor Inertia value according to the motor catalogue.
-If the Load inertia parameter value cannot be estimated, set its value at 0.
-Select the Profile Velocity operating mode for the gains calculation.

Check the servo loop stability in the Profile velocity mode:
-Small values must be used as a starting point for the Acceleration and Deceleration parameter in order to prevent sharp movements on the mechanical load.
-The speed loop stability must be checked above the motor low speed range. At low speed, the speed regulator is not operating correctly because of the low position resolution (6 increments per motor pole pair). At standstill the speed regulator is disabled (shaft free).
-If the Load inertia value is high, increase the Gain scaling factor in order to improve the servo loop stability.

The drive can be switched in the “sensorless frequency control” (SFC) below a given speed threshold when speed control stability must be increased at low speed or if motor torque is required at standstill. See parameter 0x313D for this feature. In this case, the speed regulator stability must be checked at speeds over the commutation threshold value.

4) Servo loop parameters

SERVO CONTROLLER STRUCTURE



Velocity Control Parameter Set

This object defines the parameters of the speed loop.

Index	**0x60F9**
Name	Velocity Control Parameter Set
Object Code	RECORD
Number of Elements	8

Value Description

Sub Index	1
Description	Regulator Type
Data Type	Unsigned16
Object Class	pp ip hm pv eg
Access	rw
PDO Mapping	No
Value Range	0..65535
Default Value	0

Sub Index	2
Description	Proportional Speed Gain (KPv)
Data Type	Unsigned16
Object Class	pp ip hm pv eg
Access	rw
PDO Mapping	No
Value Range	0..65535
Default Value	256

Sub Index	3
Description	Integral Speed Gain (KIv)
Data Type	Unsigned16
Object Class	pp ip hm pv eg
Access	rw
PDO Mapping	No
Value Range	0.. 65535
Default Value	0

Sub Index	4
Description	Integral Gain Filter
Data Type	Unsigned16
Object Class	pp ip hm pv eg
Access	rw
PDO Mapping	No
Unit	0.1 Hz
Default Value	0

Sub Index	5
Description	Damping Gain (KCv)
Data Type	Unsigned16
Object Class	pp ip hm pv eg
Access	rw
PDO Mapping	No
Value Range	0.. 65535
Default Value	0

Sub Index	6
Description	Derivative Gain (KDv)
Data Type	Unsigned16
Object Class	pp ip hm pv eg
Access	rw
PDO Mapping	No
Value Range	0.. 65535
Default Value	0

Sub Index	7
Description	Derivative Gain Filter
Data Type	Unsigned16
Object Class	pp ip hm pv eg
Access	rw
PDO Mapping	No
Unit	Hz
Default Value	0

Sub Index	8
Description	Gain scaling factor (KJv)
Data Type	Unsigned16
Object Class	pp ip hm pv eg
Access	rw
PDO Mapping	Yes
Value Range	0.. 65535
Default Value	16

Current command Low-pass Filter

Index	**0x30F9**
Name	Speed Loop Low-pass filter Defines the cut-off frequency at -3 dB (Fev) of the first order filter that acts upon the current control. The value of this parameter is depending on the selected bandwidth.
Object Code	ARRAY
Number of Elements	3

Value Description

Sub Index	1
Description	Speed Loop Low-pass filter 1
Data Type	Unsigned16
Object Class	pp ip hm pv eg
Access	rw
PDO Mapping	No
Unit	Hz
Value Range	20..1000 Hz 0 not active
Default Value	0

Sub Index	2
Description	Speed Loop Low-pass filter 2
Data Type	Unsigned16
Object Class	pp ip hm pv eg
Access	rw
PDO Mapping	No
Unit	Hz
Value Range	20..1000 Hz 0 not active
Default Value	0

Sub Index	3
Description	Speed Loop Low-pass filter 3
Data Type	Unsigned16
Object Class	pp ip hm pv eg
Access	rw
PDO Mapping	No
Unit	Hz
Value Range	20..1000Hz 0 not active
Default Value	0

Index	**0x30FA**
Name	Velocity measurement filter
Object Code	VAR
Data Type	Unsigned16
Object Class	all
Access	rw
PDO Mapping	No
Value Range	0 0.5ms 1 1ms 2 2ms

Index	**0x306D**
Name	Speed Following Error
Object Code	VAR
Data Type	Unsigned32
Object Class	pv pp ip hm sq sm se gb cm
Access	rw
PDO Mapping	Yes
Unit	inc/s
Value Range	0..0xFFFFFFFF
Default Value	0xFFFFFFFF

This object defines the tolerance for the speed error value:
If | Speed Demand – Actual Speed | > Speed Following Error → Speed following error is released

If the value of the parameter is FFFF FFFFh, the speed following error control is not operating.

Position Control Parameter Set

This object defines the parameters of the position loop.

Index	**0x60FB**
Name	Position loop Parameter Set
Object Code	RECORD
Number of Elements	9

Value Description

Sub Index	1
Description	Regulator Type
Data Type	Unsigned16
Object Class	pp ip hm eg
Access	rw
PDO Mapping	No
Default Value	0

Sub Index	2
Description	Position loop Proportional Gain (KPp) Defines the proportional gain that acts upon the position loop error.
Data Type	Unsigned16
Object Class	pp ip hm eg
Access	rw
PDO Mapping	No
Value Range	0..65535
Default Value	0

Sub Index	3
Description	Feedforward Speed 1 Gain (KFp) Defines the feedforward term amplitude corresponding to the speed input command (derivation of the position loop input command). This feedforward term allows to reduce the following error during the motor acceleration and deceleration phases.
Data Type	Unsigned16
Object Class	pp ip hm eg
Access	rw
PDO Mapping	No
Value Range	0.. 65535
Default Value	0

Sub Index	4
Description	Feedforward Acceleration Gain (KAv) Defines the feedforward acceleration corresponding to the acceleration input command (second derivation of the position loop input command).This feedforward term allows to reduce the following error during the motor acceleration and deceleration phases.
Data Type	Unsigned16
Object Class	pp ip hm eg
Access	rw
PDO Mapping	No
Value Range	0.. 65535
Default Value	0

Sub Index	5
Description	Feedforward Speed 2 Gain (KBv) This gain value is equal to the damping speed gain value + Feedforward friction gain value. The feedforward friction gain allows to cancel the load viscous friction effect (load viscous friction torque is proportional to axis speed).This feedforward term allows to reduce the following error during the motor acceleration and deceleration phases.
Data Type	Unsigned16
Object Class	pp ip hm eg
Access	rw
PDO Mapping	No
Value Range	0.. 65535
Default Value	0

Sub Index	6
Description	reserved
Default Value	0

Sub Index	7
Description	reserved
Default Value	0xFFFFFFFF

Sub Index	8
Description	reserved
Default Value	0

Sub Index	9
Description	Position loop Error low pass filter (PosErrLF) Defines the low pass filter that acts upon the position loop error.
Data Type	Unsigned16
Object Class	pp ip hm pv eg
Access	rw
PDO Mapping	No
Unit	0.1 Hz
Default Value	0

Position Following error

Index	**0x6065**
Name	Following Error Window
Object Code	VAR
Data Type	Unsigned32
Object Class	pp ip hm sq sm se gb cm
Access	rw
PDO Mapping	Yes
Unit	position unit
Value Range	0..0xFFFFFFFF
Default Value	-

This object defines the tolerance for position value:
If | PosDemand - PosActual | > FollowingErrorWindow → Position following error is released

If the value of the following error window is FFFF FFFFh, the following control shall be switched off.

Index	**0x3065**
Name	Following Error Control This object defines the position error detection mode
Object Code	VAR
Data Type	Unsigned16
Object Class	pp ip hm sq sm se gb cm
Access	rw
PDO Mapping	No
Value Range	Position error detection mode: 0 Absolute value 1 Relative To dynamic model
Default Value	0

Position Deadband

Index	**0x3067**
Description	Position Deadband window
Data Type	Unsigned32
Object Class	pp ip hm
Access	rw
Unit	User unit
PDO Mapping	No
Default Value	0 (Position Deadband window disabled)

When the motor is stopped, if the actual position error is within the “Position Deadband Window”, the position loop is opened.

External Feedforward

Index	**0x31FF**
Name	External Feedforward
Object Code	RECORD
Object Class	pp, ip, hm sq, se, gb
Number of Elements	3

Value Description

Sub Index	1
Description	External Feedforward Selection
Data Type	Unsigned16
Access	rw
PDO Mapping	Yes
Default Value	0

Bit Number	**Function**
0	reserved
1	Select Feedforward Speed 0 Internal feedforward speed 1 External feedforward speed
2	Select Feedforward Acceleration 0 Internal feedforward acceleration 1 External feedforward acceleration
3..15	reserved

Sub Index	2
Description	External Feedforward Speed
Data Type	Integer32
Access	rw
PDO Mapping	Yes
Unit	Velocity unit: User inc / s
Default Value	0

Sub Index	3
Description	External Feedforward Acceleration
Data Type	Integer32
Access	rw
PDO Mapping	Yes
Unit	Acceleration unit: User inc / s^2
Default Value	0

5) Motor feedback parameters

5.1) Sensorless control parameters

Sensorless Parameters

Index	Sub	Name	Description	Type	Attribute
0x3150		Sls_Mon	Sensorless monitoring		
	1	EmfVel	Scaled motor Emf amplitude 0x7FFF → max motor speed (0x6080)	Integer16	ro
	2	EmfErr	Scaled motor Emf error VelRef (0x30F8,1) – EmfVel (0x3150,1) 0x7FFF → max motor speed (0x6080)	Integer16	ro
0x3151		Sls_Setp	Sensorless vector control setup		
	1	Sls_Type	Sensorless Type	Integer16	rw
	2	Sls_Cfg	Sensorless Configuration	Integer16	rw
	3	Sls_NP	Motor pole pairs	Integer16	rw
	4	Sls_Te	Motor electrical time constant	Integer16	rw
	5	Sls_Rm	Motor phase-phase resistance	Integer32	rw
	6	Sls_Ke	Motor emf constant	Integer32	rw
	7	Sls_Ldq	Motor inductance variation ratio	Integer16	rw
	8	SlsSpLim	Motor low speed threshold	Integer16	rw
0x3152		EmfErWin	Motor Emf error threshold (rpm)	Integer16	rw
0x3154		Sls_Adjt	Sensorless frequency control adjust		
	1	Sls_Ired	Motor current reduction at standstill	Integer16	rw
	2	Sls_Tred	Delay for the current reduction at standstill	Integer16	rw
0x315A	0	Sls_spd	Sensorless Velocity (user velocity unit)	Integer32	ro
0x315B	0	Sls_Mod	Sensorless raw position	Integer16	ro

Sensorless vector control (SVC) setup

Index	0x3151
Name	Sensorless vector control setup
Object Code	RECORD
Number of Elements	13

Value Description

Sub Index	1
Description	Sensorless Type
Data Type	Unsigned16
Object Class	all
Access	rw
PDO Mapping	No
Default Value	

Bit Number	Description
0	1 Enabled 0 Disabled

Sub Index	2
Description	Sensorless Configuration
Data Type	Unsigned16
Object Class	all
Access	rw
PDO Mapping	No
Default Value	

Bit Number	**Description**
0	0 Normal direction 1 Reverse direction

Sub Index	3
Description	Motor pole pairs
Data Type	Unsigned16
Object Class	all
Access	rw
PDO Mapping	No
Default Value	Value of object 0x3410-1

Sub Index	4
Description	Motor electrical time constant
Data Type	Unsigned16
Object Class	all
Access	rw
PDO Mapping	No
Unit	0.001 ms
Conversion	1000 x Te (ms)
Default Value	931 (0.931 ms)

Sub Index	5
Description	Motor phase-phase resistance
Data Type	Unsigned32
Object Class	all
Access	rw
PDO Mapping	No
Unit	0.001 Ohms
Conversion	1000 x R (Ohms)
Default Value	5800 (0.58 Ohms)

Sub Index	6
Description	Motor emf constant
Data Type	Unsigned32
Object Class	all
Access	rw
PDO Mapping	No
Unit	0.01 Vrms / Krpm
Conversion	100 x Vrms phase-phase for 1000 rpm
Default Value	2900 (29 Vrms / Krpm)

Sub Index	7
Description	Motor inductance variation ratio
Data Type	Unsigned16
Object Class	all
Access	rw
PDO Mapping	No
Unit	0.1%
Conversion	1000 (Lq – Ld) / Ld
Default Value	0 (Lq = Ld)

Sub Index	8
Description	Motor low speed threshold
Data Type	Unsigned16
Object Class	all
Access	rw
PDO Mapping	No
Unit	rpm
Default Value	1300 rpm

Sub Index	9 to 13
Description	Reserved
PDO Mapping	No

Index	**0x3152**
Name	Motor Emf error threshold
Object Code	VAR
Data Type	Unsigned16
Object Class	pv pp ip hm sq
Access	rw
PDO Mapping	Yes
Unit	rpm
Default Value	0
Remark	The Emf error control is operating only when sensorless control is selected. If the value of this parameter is set at 0, the Emf error control is not operating.

This object defines the tolerance for the scaled Emf error control:
If |Speed Reference – Scaled motor Emf| > Motor Emf error threshold → sensorless error is released

The motor Emf scaling depends on the Motor emf constant parameter (0x3151,6)
The motor Emf error value is displayed in the object 0x3150,2

Sensorless frequency control (SFC) adjust

Index	**0x3154**
Name	Sensorless frequency control adjust
Object Code	RECORD
Number of Elements	6

Value Description

Sub Index	1
Description	Motor current at standstill
Data Type	Unsigned16
Object Class	all
Access	rw
PDO Mapping	No
Unit	per thousand of rated current (0x6075)
Range	100 to 800
Default Value	300 (30 % of rated current value)
Remark	

This parameter defines the motor current value at standstill when the delay for the current reduction (0x3154,2) is over.

Sub Index	2
Description	Delay for the current changing at standstill
Data Type	Unsigned16
Object Class	all
Access	rw
PDO Mapping	No
Unit	ms
Range	0 to 16000
Default Value	4000 (4 seconds)
Remark	

This parameter defines the delay before the motor current changing (0x3154,1) when the motor is at standstill.

Sub Index	3
Description	Motor current in movement
Data Type	Unsigned16
Object Class	all
Access	rw
PDO Mapping	No
Unit	per thousand of rated current (0x6075)
Range	100 to 800
Default Value	800 (80% of rated current value)
Remark	

This parameter defines the motor current value in movement.

Sub Index	4 to 6
Description	Reserved
PDO Mapping	No

5.2) HES only feedback parameters

Hall Effect Sensor configuration

Index	**0x313E**
Name	HES configuration
Data Type	Unsigned16
Object Class	all
Access	rw
PDO Mapping	No
Saved	Yes
Default Value	0

Value Description

Bit Number	**Description**
0-2	HES initial state
3	Direction
4	Type: 0 60° 1 120°

HES control

Index	**0x313D**
Name	HES only control
Object Code	RECORD
Number of Elements	7

Value Description

Sub Index	1 and 2
Description	Reserved
PDO Mapping	No

Sub Index	3
Description	Motor low speed threshold for SFC operation
Data Type	Unsigned16
Object Class	all
Access	rw
PDO Mapping	No
Unit	rpm
Default Value	0

This parameter defines the motor speed value for the commutation between the “sensorless frequency control” (SFC) at low speed and the HES sensor feedback over the threshold value. The drive torque control mode is not concerned.

When this parameter value is set at 0, the SFC operation at low speed is disabled. In this case, the speed loop is switched off when the motor is at standstill (motor shaft is free), and the HES sensor feedback is operating as soon as the motor is moving.

Sub Index	4
Description	Motor current at standstill
Data Type	Unsigned16
Object Class	all
Access	rw
PDO Mapping	No
Unit	per thousand of rated current (0x6075)
Range	100 to 800
Default Value	300 (30% of rated current value)
Remark	When 0x313D, 3 is set at 0, this parameter has no effect.

This parameter defines the motor current value at standstill when the delay for the current changing (0x313D,5) is over.

Sub Index	5
Description	Delay for the current changing at standstill
Data Type	Unsigned16
Object Class	all
Access	rw
PDO Mapping	No
Unit	ms
Range	0 to 16000
Default Value	4000 (4 seconds)
Remark	When 0x313D,3 is set to 0, this parameter has no effect.

This parameter defines the delay before the motor current changing (0x313D,4) when the motor is at standstill.

Sub Index	6
Description	Motor HES error threshold
Object Code	VAR
Data Type	Unsigned16
Object Class	all
Access	rw
PDO Mapping	No
Unit	rpm
Default Value	0
Remark	The HES error control is operating when “HES only” feedback sensor is selected. The HES error control is not operating in Torque mode. If the value of this parameter is set to 0 the HES error control is not operating.

This object defines the tolerance for the HES error control:
If |Speed Reference – Motor Speed| > Motor HES error threshold → HES counting error is released.

Sub Index	7
Description	Motor current in movement
Data Type	Unsigned16
Object Class	all
Access	rw
PDO Mapping	No
Unit	per thousand of rated current (0x6075)
Range	100 to 800
Default Value	800 (80% of rated current value)
Remark	When 0x313D,3 is set at 0, this parameter has no effect.

This parameter defines the motor current value in movement.

6) Troubleshooting

Index	**0x3022**
Name	Error word
Object Code	ARRAY
Number of Elements	3

Value Description
This object contains two 32-bit words in which one bit is assigned to a different error.
The Error code is the value which will be sent as an emergency message (EMCY).

Sub Index	1
Description	Error monitoring
Data Type	Unsigned32
Object Class	all
Access	ro
PDO Mapping	No
Value	See below
Default value	No

Bit	Value	Error Code	Protection	Troubleshooting
0	0x00000001	1	Hardware System 2 Error	- Check that the DNC/PLC-amplifier-motor ground connections and shield answer the Installation manual requirements. - Check the application EMC disturbances level.
1	0x00000002	2	24 Volt Error	- Check that the logic supply voltage value is within the specified range. - Check the logic supply voltage waveform (ripple value, overvoltage spikes, undervoltage spikes, …)
2	0x00000004	3	Undervolt (temporized)	- Check that the power supply is actually on.
3	0x00000008	4	Braking system error	- Check the presence of either the internal resistor jumper (XtrapulsPac) or the external resistor (XtrapulsPac and XtrapulsGem) - Check that the external resistor is not broken (open circuit) If the error cannot be reset, the braking system is out of order (transistor in short-circuit)
4	0x00000010	5	Safety channel 2 Error	- Check the correct STO2 input state with regard to the STO1 input state If the STO fault is released, the drive must be turned off in order to cancel the fault.
5	0x00000020	6	Overvoltage	If the failure occurs when starting the amplifier: - Check the AC supply voltage value. If the failure occurs during the operation: - Check the DC bus voltage during the deceleration phases. - Check the sizing of the braking resistor with regard to the motor deceleration phases.
6	0x00000040	7	Internal Communication 2 Error	- Check that the DNC/PLC-amplifier-motor ground connections and shield answer the Installation manual requirements. - Check the application EMC disturbances level.
7	0x00000080	8	IGBT module	- Check for no short-circuit in the motor wiring and at the motor terminals. - Check for no short-circuit between one motor phase and the ground. - Check the amplifier **Rated current** adjustment with regard to the allowed value in the amplifier specifications. - Check that the amplifier max. temperature specifications are fulfilled. - Check that the amplifier fan is operating correctly.
8	0x00000100	9	Main Phase Error	
9	0x00000200	10	Mains phase loss	
10	0x00000400	11	Power Module over-temperature	- Check the amplifier **Rated current** adjustment with regard to the allowed value in the amplifier specifications. - Check that the amplifier max. temperature specifications are fulfilled. - Check that the amplifier fan is operating correctly.
11				
12	0x00001000	13	Fan	- Available only for some drive models - Check that the fan blades are not blocked by a foreign body - Check that the fan rotor is not locked
13				
14				
15				

16	0x00010000	17	Current measurement offset	- Check that the motor is not driven by the mechanical load If the error cannot be reset, the amplifier current sensors are out of order (wrong current measurement)
17	0x00020000	18	Overcurrent	- Check the current loop adjustment regarding the motor inductance.
18	0x00040000	19	Encoder 1 counting error HES counting error	For operation with encoder feedback: - Check that the encoder max. pulse frequency at the max. motor speed fulfills the encoder specification. - Check that the connections between the encoder and the amplifier are complying with the shield wiring recommendations. Remark: In the incremental encoder configuration without HES, the motor **Phasing** procedure must be executed again after a Counting fault release. For operation with HES only feedback: - Check the correct wiring of the HES signals - Check the correct supply of the HES devices - Check the value of the parameter **Motor Hes error threshold**. If necessary, increase the value of this parameter.
19	0x00080000	20	Resolver tracking error	If the failure occurs when starting the amplifier: - Check for the correct resolver type with regard to the amplifier specifications. If the failure occurs during the operation: - Check that the connections between the resolver and the amplifier are complying with the shield wiring recommendations.
20	0x00100000	21	Resolver (cable interrupted)	- Check the resolver connection on the amplifier connector according to the connector descriptions. - Check for the correct resolver type with regard to the amplifier specifications. - Check the connections between resolver and amplifier (cable wiring).
21	0x00200000	22	Encoder 1 (cable interrupted)	- Check the encoder supply connection on the amplifier connector. - Check the encoder A channel and B channel connections on the amplifier connector. Remark: In the Incremental encoder configuration without HES, the motor **Phasing** procedure must be executed again after an Encoder fault release.
22	0x00400000	23	Encoder 1 (Z marker)	- Check the marker pulse connection on the amplifier connector. If the motor encoder is not providing a marker pulse channel, the amplifier counting protection must be disabled by setting at 0 the **Zero mark pitch** parameter. - Check that the **Motor encoder resolution** and the **Zero mark pitch** parameter values are correct. Remark: In the incremental encoder configuration without HES, the motor **Phasing** procedure must be executed again after a Counting fault release.
23	0x00800000	24	Encoder 2 link	- Check the encoder connection on the amplifier connector.
24	0x01000000	25	Sensorless error	- Check the value of the parameter **Motor Emf error threshold**. Its value mut be greather than the sensorless parameter **Low speed threshold** value. - Check the sensorless parameter **Motor emf constant** value is correct.
25	0x02000000	26	Ambient	- Check that the amplifier operating temperature limit

			Temperature	specification is fulfilled. - Check that the amplifier cooling system is operating correctly. - Check the amplifier **Rated current** adjustment with regard to the allowed value in the amplifier specifications.
26	0x04000000	27	Motor Brake	
27	0x08000000	28	Power Stage Controller Error	- Generic default for the amplifier power stage
28	0x10000000	29	Manufacturer parameters error	- Switch off and on again the 24 V logic supply If the error cannot be reset, the amplifier is out of order.
29	0x20000000	30	Internal Communication 1 error	- Check that the DNC/PLC-amplifier-motor ground connections and shield answer the Install manual requirements. - Check the application EMC disturbances level.
30	0x40000000	31	Configuration error	
31	0x80000000	32	System error	- Switch off and on again the 24 V logic supply If the error cannot be reset, the amplifier is out of order.

Sub Index	2
Description	Error monitoring
Data Type	Unsigned32
Object Class	all
Access	ro
PDO Mapping	No
Value	See below
Default value	No

Bit	Value	Error Code	Protection	Troubleshooting
0				
1	0x00000002	34	Speed following error	- Check that the mechanical load is adjusted to motor and amplifier ratings. - Check that the axis is not on a mechanical limit. - Check the motor voltage limitation regarding the required max speed set point. - Check the accelerations/decelerations values. - Check the speed loop adjustment. - Check that the value of the parameter **Speed following error threshold** is complying with the motion cycle. If necessary, increase the value of this parameter.
2	0x00000004	35	Position following error	- Check that the mechanical load is adjusted to motor and amplifier ratings. - Check that the axis is not on a mechanical limit. - Check the motor voltage limitation regarding the required max speed set point. - Check the accelerations/decelerations values. - Check the position loop adjustment. - Check that the value of the parameter **Following error threshold** is complying with the motion cycle. If necessary, increase the value of this parameter.
3				
4	0x00000010	37	Motor Temperature error	If the failure occurs when starting the amplifier: - Check the selected thermal sensor type (NTC or PTC). - Check the connection between the thermal sensor and the amplifier connector. If the failure occurs during the operation: - Check the motor temperature and look for the reason of this overheating (mechanical shaft overload, duty cycle too high, motor type to small with regard to the machine cycle…).
5	0x00000020	38	I^2t error	Check the amplifier current cycle with regard to the **Rated current** parameter value.
6	0x00000040	39	System Parameters Error	
7	0x00000080	40	Busy/Operation Timeout	
8	0x00000100	41	Calibration parameters file error	If the firmware has been downgraded, reload the correct firmware version. If the error cannot be reset after the amplifier off and on sequence it is out of order.
9	0x00000200	42	Drive parameters file error	If the firmware has been upgraded, execute the procedure “save parameter to Flash memory”, the new parameters will be saved with their default value in the new DRIVEPAR.TXT file. If the firmware has been downgraded, the execution of the procedure “save parameter to Flash memory” will definitely loose some parameters in the new DRIVEPAR.TXT file. In this case, reload the correct firmware version.
10	0x00000400	43	User parameters or template file error	Edit and check the “User parameter file”. Some objects are not compatible with the amplifier firmware version.
11	0x00000800	44	Sequence file error	Check the Sequence file. Some parameters are not compatible with the amplifier firmware version.
12	0x00001000	45	Cam file error	

13	0x00002000	46	Extension Error or Fieldbus watchdog error	
14	0x00004000	47	Extension Error or Fieldbus hardware error	
15	0x00008000	48	Extension Error or Fieldbus hardware error	
16	0x00010000	49	Fieldbus SYNC cycle error	- Check fieldbus cycle period (object 0x1006) - Check fieldbus SYNC signal timing: if great jitter (>=half-period) or period accuracy is not within the tolerance (>=0.4%).
17	0x00020000	50	Fieldbus IP reference underflow/overflow	- Check if IP reference (0x60C1,1) is mapped in a RPDO - If yes, check if this RPDO is sent every bus cycle - To avoid a mix-up, this RPDO must precede the SYNC signal at least of 100 µs
18	0x00040000	51	Fieldbus guarding error	For CANopen: Node guarding error or Heartbeat error.
19				
20	0x00100000	53	SD card error	See details in the SD card chapter.
21	0x00200000	54	File Erase/Write Error	Renew the file transfer.
22	0x00400000	55	Watchdog Error	
23	0x00800000	56	Safety channel 1 Error	- Check the correct STO1 input state regarding STO2 input state If the STO fault is released, the drive must be turned off in order to cancel the fault.
24	0x01000000	57	User Program Error	
25	0x02000000	58	CAN Extension Module communication lost or not found	
26	0x0400000	59	Encoder 2 Absolute Error	
27	0x08000000	60	Stop Operation failed or speed/position monitoring failed.	- Check stop/monitoring parameters.
28	0x10000000	61	Encoder 1 Commutation channel / Incremental channel Error	For the Incremental encoder & HES configuration: - Check for the correct HES supply voltage value. - Check that the HES are correctly wired on the amplifier connector. - Check the parameter **Reverse HES track** and toggle it if not correct. - Check for the correct value of the parameter **Motor encoder resolution**. - Check that the HES-amplifier-motor ground connections and shield answer requirements contained in the Installation manual. For the Absolute encoder (Hiperface®) configuration: - Check the parameter **Reverse incremental track** and toggle it if not correct. - Check that the SinCos channels are correctly wired on the amplifier connector. - Check that the Data communication channel is correctly wired on the amplifier connector. - Check that the encoder-amplifier-motor ground connections and shield answer the requirements contained in the Installation manual.

				For the SinCos encoder with CD tracks configuration: - Check for the correct SinCos encoder supply voltage value. - Check that the encoder CD channels are correctly wired on the amplifier connector. - Check the parameter **Reverse CD track** and toggle it if not correct. - Check that the parameter **Motor encoder resolution** value is correct. - Check for the correct encoder C and D channels signal waveforms. - Check that the encoder-amplifier-motor ground connections and shield answer the requirements contained in the Installation manual.
29	0x20000000	62	Encoder 1 Absolute channel Error	- Check for the correct encoder supply voltage value. - Check that the Data communication channel is correctly wired on the amplifier connector. - Check that the encoder-amplifier-motor ground connections and shield answer the requirements contained in the Installation manual.
30	0x40000000	63	User Program execution error	
31	0x80000000	64	Procedure error (Autotuning, autophasing...)	- If the Procedure fault is continuously displayed after the execution of the **AUTO-PHASING** function, the procedure has failed because of an external cause and the calculated parameters are wrong. Check that the limit switch inputs are not active. Then check that the motor is unloaded and the shaft movement free during the procedure. - If the Procedure fault is continuously displayed after the execution of the **AUTO-TUNING** function, the procedure has failed because of an external cause and the calculated parameters are wrong. Check that the limit switch inputs are not active. Then check that the motor shaft is free during the procedure.