ICMU-Y2 programming and Swerve drive wheel-tuning guide

Swerve-Drive V1.1

commutation over ssi for controlling the swerve-drive platform

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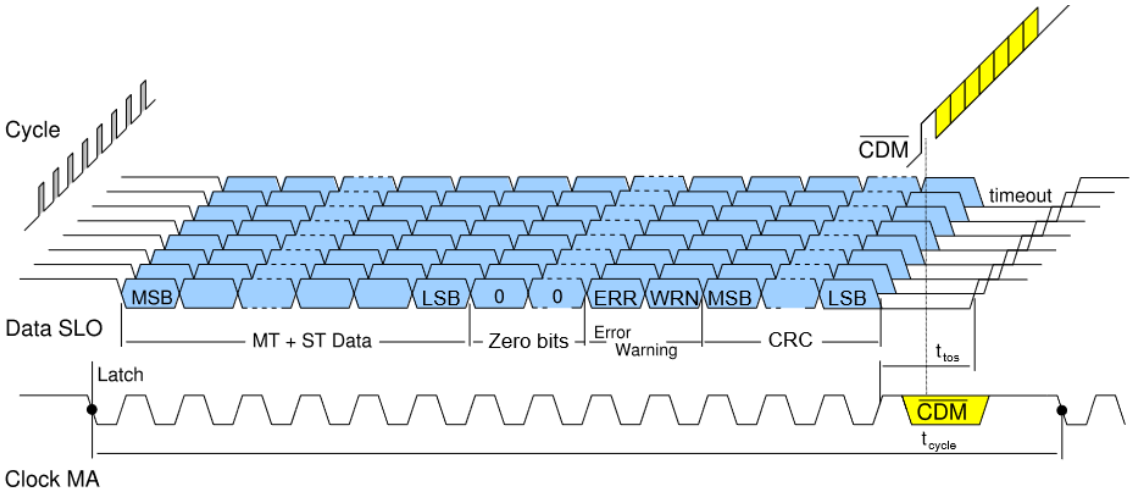
Jan 2023



Preface

The Swerve-Drive wheels are equipped with dedicated for this goal designed encoder PCB,s with ICMU brand programmable encoder chips. These encoder chips are freely programmable and can be used as both absolute and incremental encoders with various protocols.

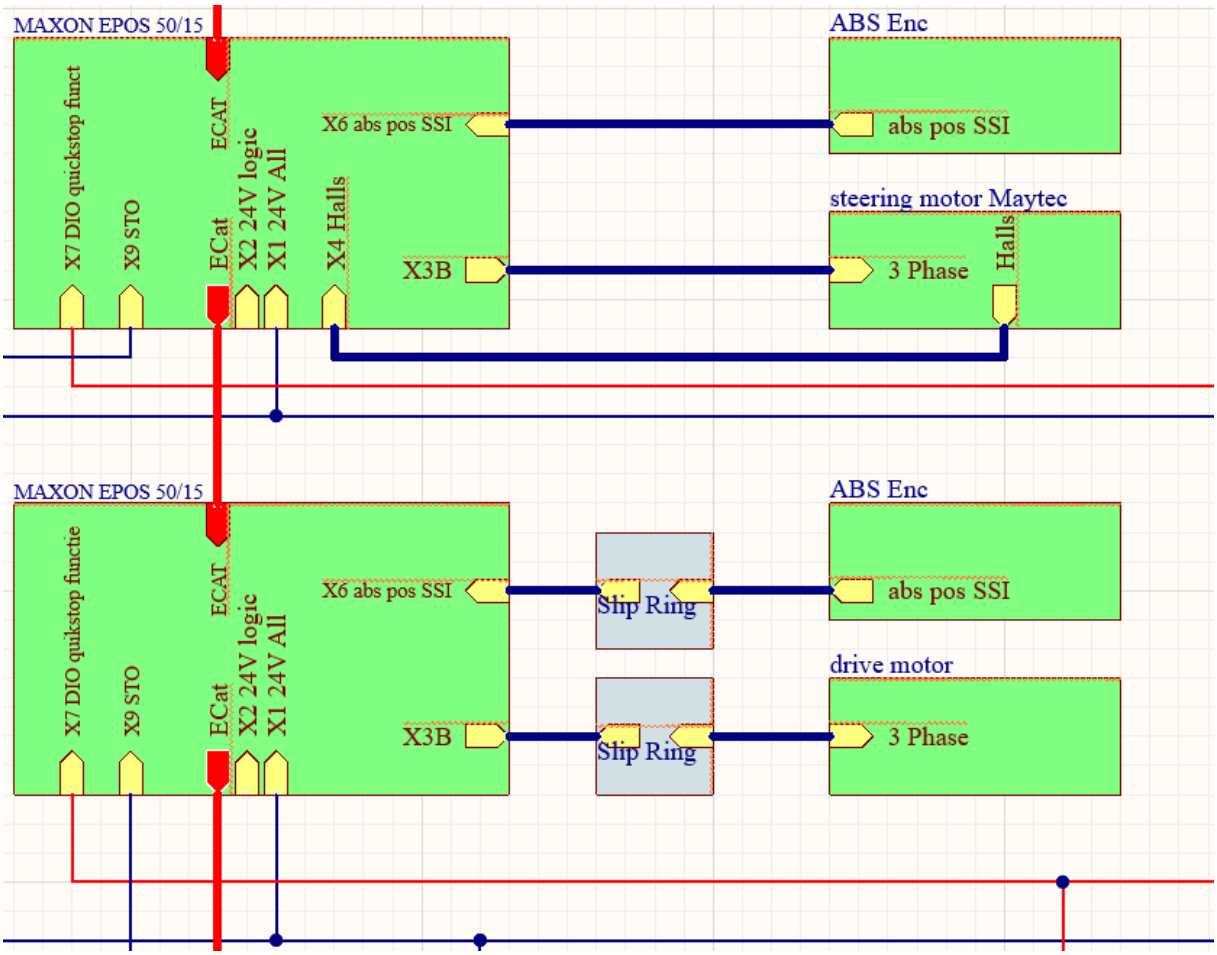
The original ICMU based wheel encoder PCB's are not equipped with an EEPROM. EEPROM makes the PCB more multi-functional for our goal and programmable other software. We have extended the original PCB with this feature. Because this redesign had to have the same form factor, it became a four-layer PCB. The EEPROM is externally programmable via the BISSC protocol over an USB adapter.

For the Swerve drive V1 we used Maxon EtherCAT amplifiers

The texts in blue are links to relevant web documents and software downloads for the tuning procedure.

Contents:

1. Hardware



Hardware design wheelsets

1.1 Abs Enc hardware.

PCB V1.0 A KD2207001 (open source hardware by Ketels with EEPROM extension)

Specs components

iCMU Y2 –(0x07) IC-MU DFN16-5X5

https://www.ichaus.de/upload/pdf/MU_datasheet_F2en.pdf

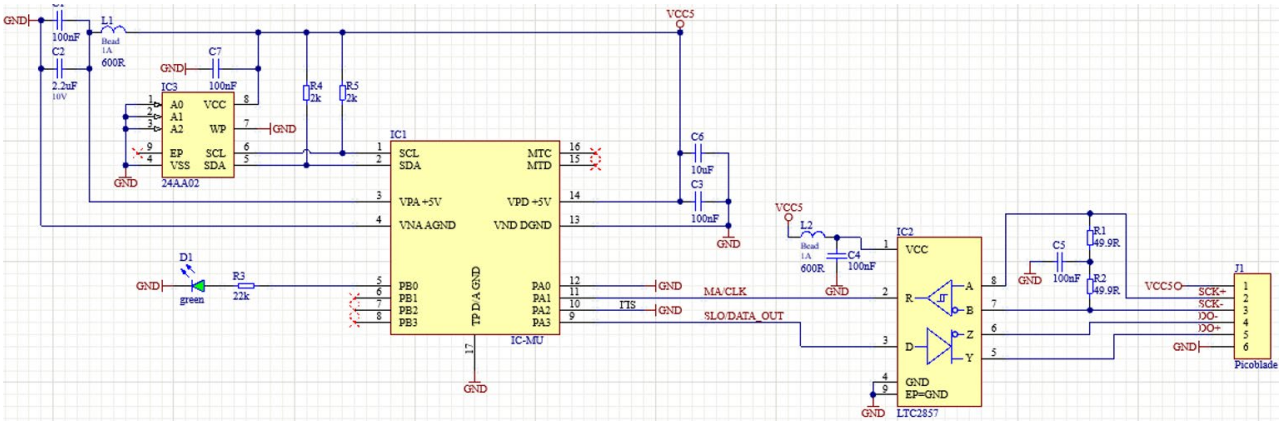
Distributor https://ave-nl.com/

24AA02 Microchip EEPROM. Compatible 24LC16BHT-I/MNY.

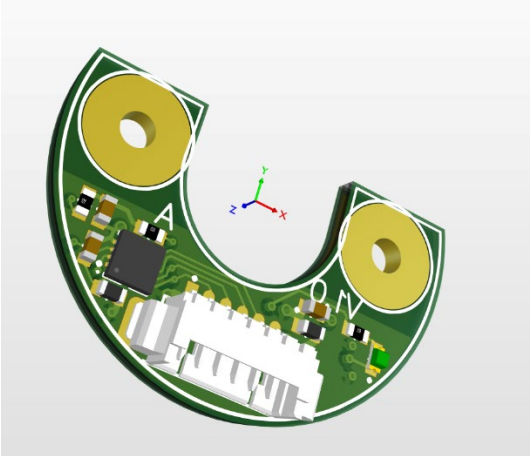
Distributor Mouser

LCT2857IDD-1#PBF RS-422/RS-485 interface chip .

Distributor Mouser



Schematic encoder hardware

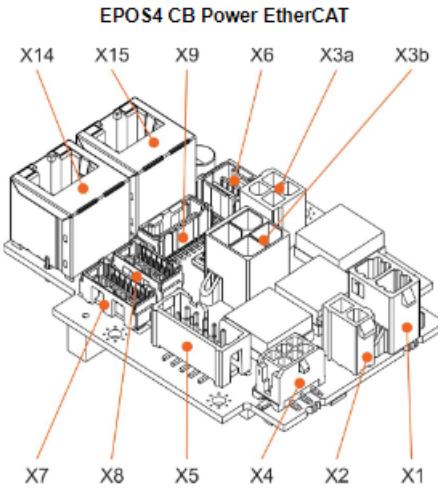


PCB Layout

Track nonius encoder disc bipolar magnetized

https://www.ichaus.de/upload/pdf/MU18S_30-32N_codedata_B1en.pdf

1.2 Maxon Epos



Maxon Epos 50/15 EtherCat

(https://www.maxongroup.com/medias/sys_master/8825356681246.pdf)

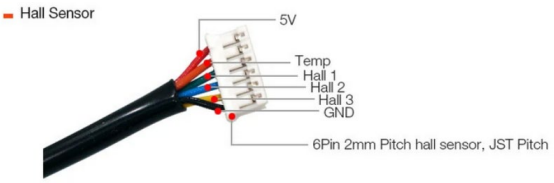
1.3 Drive motor, Brand unknown

10 poles pares,

0.1ohm flux-linkage

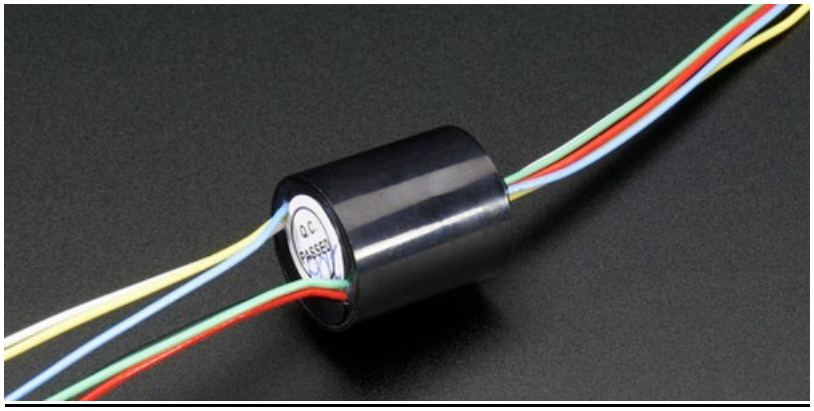
Induction 150uH

1.4 Steering (rotation) e-scooter motor, brand Maytec



https://www.alibaba.com/product-detail/Maytech-5065-170KV-brushless-outrunner-motor_60732555864.html

1.5 Slip rings

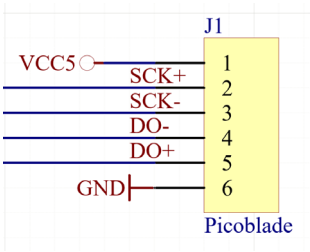


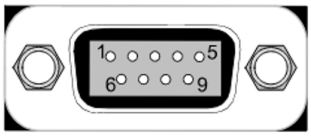
http://adafru.it/775

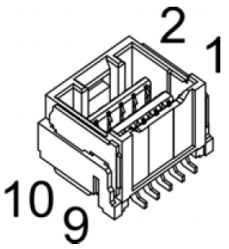
1.6 Programming hardware

https://www.ichaus.de/upload/pdf/MB5U_datasheet_D1en.pdf

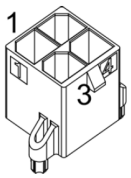
3 Connections

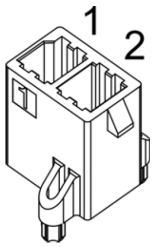






PCB	MB5U BISS	Maxon EPOS	slipring
1 VCC	4 VDD	10 V-aux	violet red
2 SCK+	2 MA+	5 Clock SSI	grey green
3 SCK-	3 MA-	6 Clock\ SSI	pink violet
4 DO-	8 SL-	7 Data SSI	blue grey
5 DO+	7 SL+	8 Data\ SSI	red yellow
6 GND	6 GND	9 GND	black black



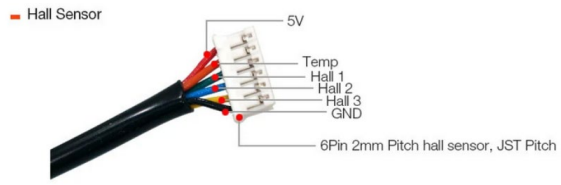


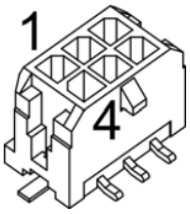
X3b Motor

Drive motor	EPOS
U1 Yellow	1
U2 Green	2
U3 Blue	3

X1 Power Supply

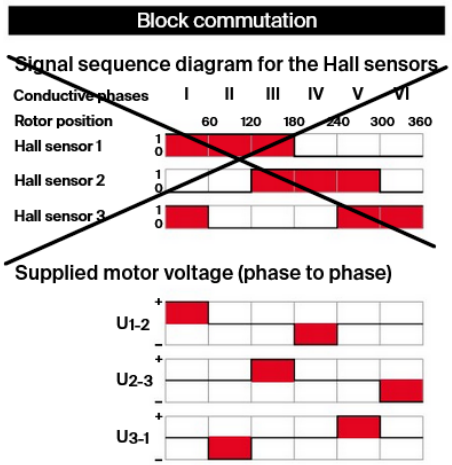
Power Supp	EPOS
black-	1 GND
black+	2 VCC 24V (+10- 50VDC)





Hall Sensor (only rotation motor)	EPOS
Hal 1	1 Green
Hal 2	2 Brown
Hal3	3 White
5V	4 Grey
GND	5 Yellow
	6 Black (shield)

Determination of the direction of rotation. Use this scheme to figure out the right connection. It is possible to use a battery to connect the motors



Wheelset 1 Drive

EPOS	Motor-connection cable
1	Black
2	Brown
3	Red

Wheelset 2 Drive

EPOS	Motor-connection cable
1	Black
2	Red
3	Brown

Wheelset 3 Drive

EPOS	Motor-connection cable
1	Red
2	Brown
3	Black

Rotation motors: because the commutation is controlled via hall sensors, the order of the motor does not matter.

3. Software & Tuning

3.1 Relevant software & documents:

-Drivers for IC-Haus adapters

(https://www.ichaus.de/adapter_drivers)

-ICMU gui software with RTE

(www.ichaus.de/MU_gui_rte)

-Maxon Epos Studio IDX

https://www.maxongroup.nl/medias/sys_master/root/8994700001310/EPOS-2-4-IDX-Setup.zip

3.2 Settings ICMU Software:

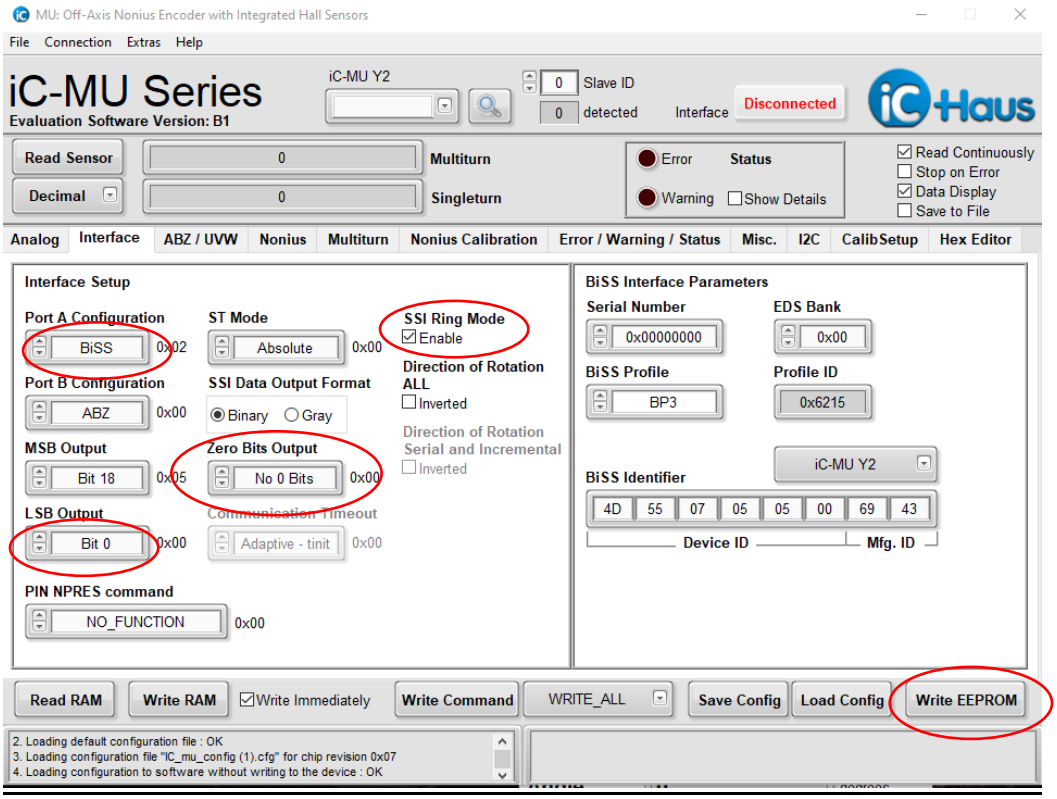
Connect the ICMU PCB to the MB5U BISS. Port A BISS,

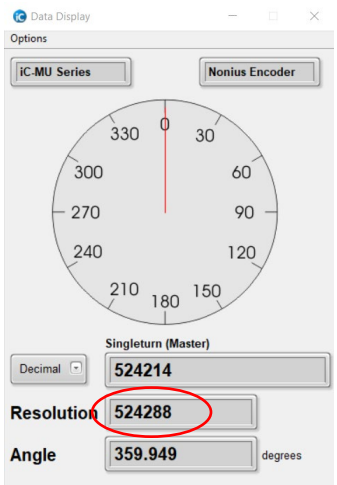
MSB output 18-bit,

SSI Ring Mode Enable.

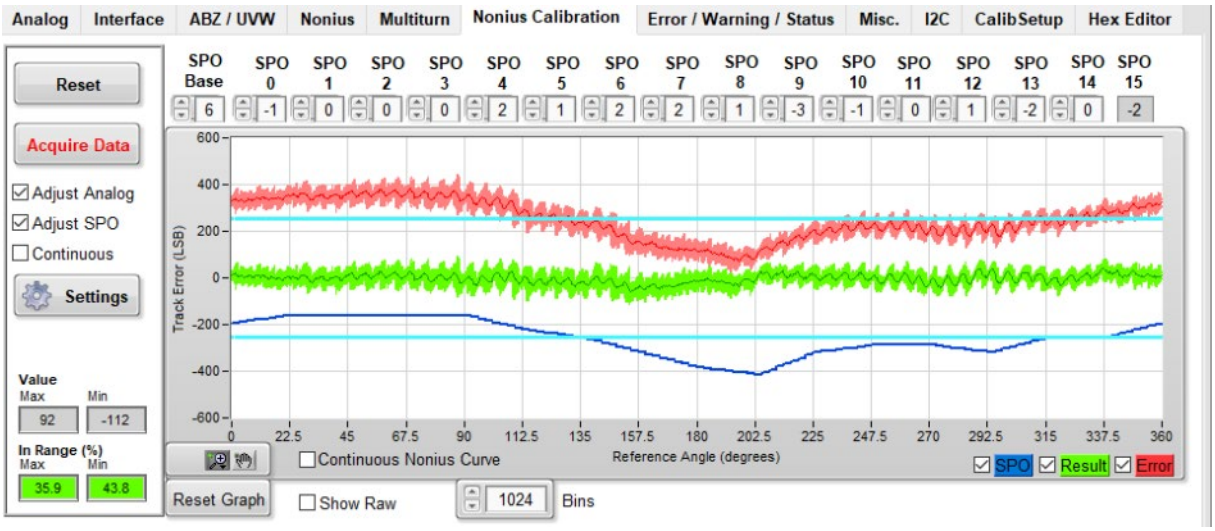
No zero bits =0.

Make sure the resolution is 19 bit = 524288 bits





3.3 Nonius Calibration

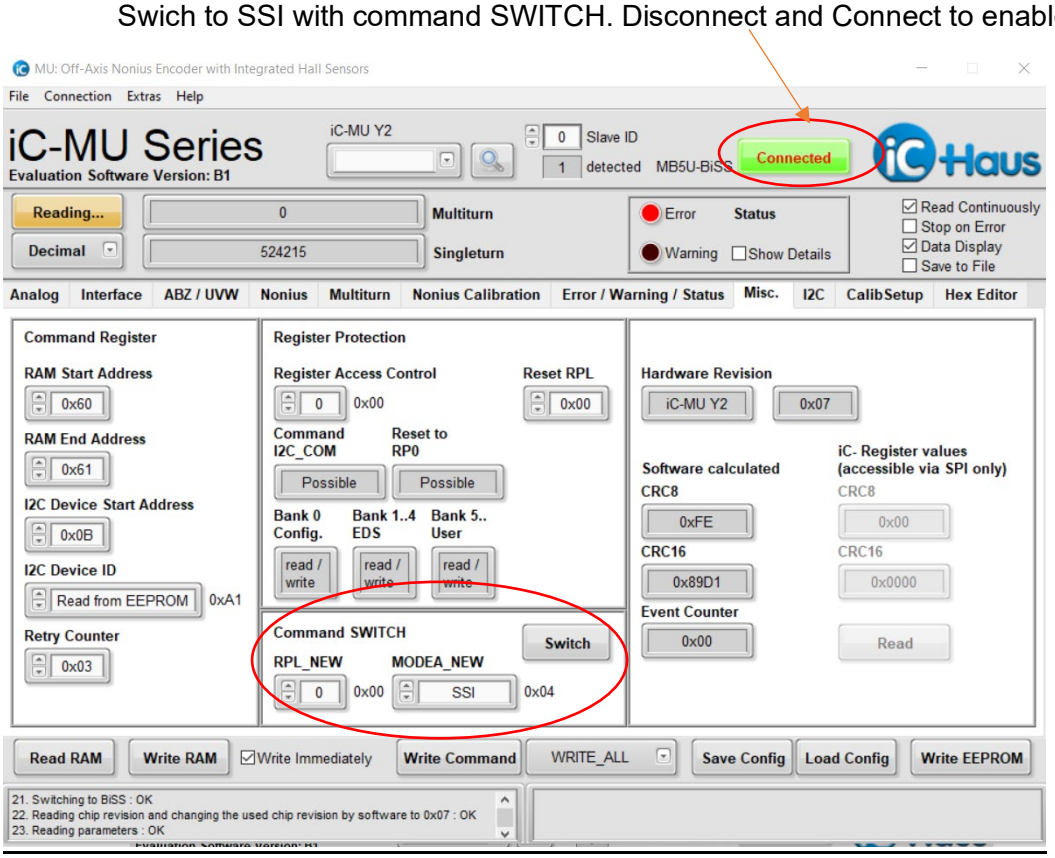


Calibrate the ICMU using the AN3 appnote calibration and programming step by step:

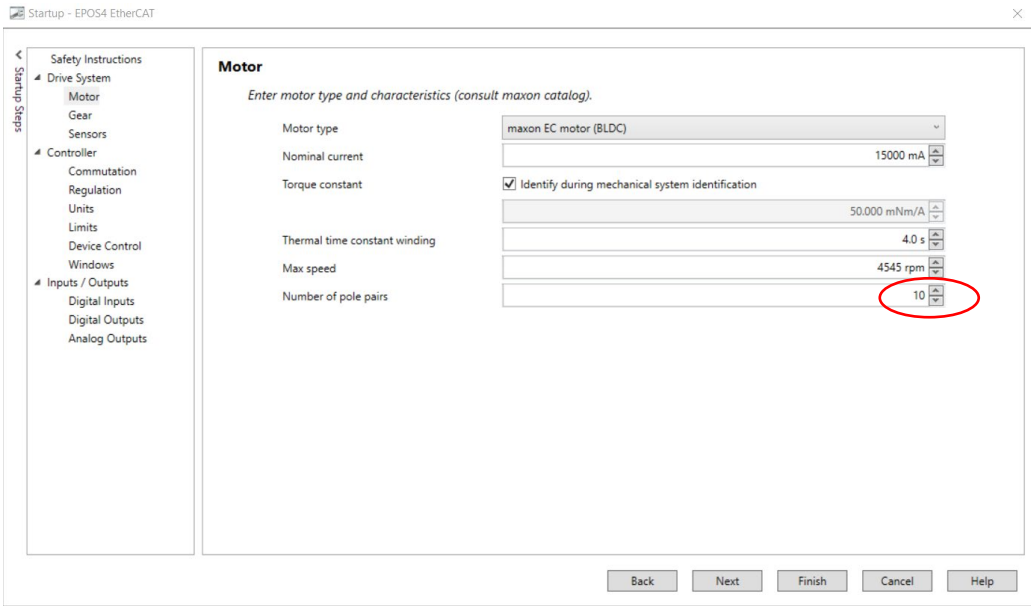
https://www.ichaus.de/upload/pdf/MU_AN3_appnote_Rotary_calibration_and_programming_D1en.pdf

3.4 Switch to SSI

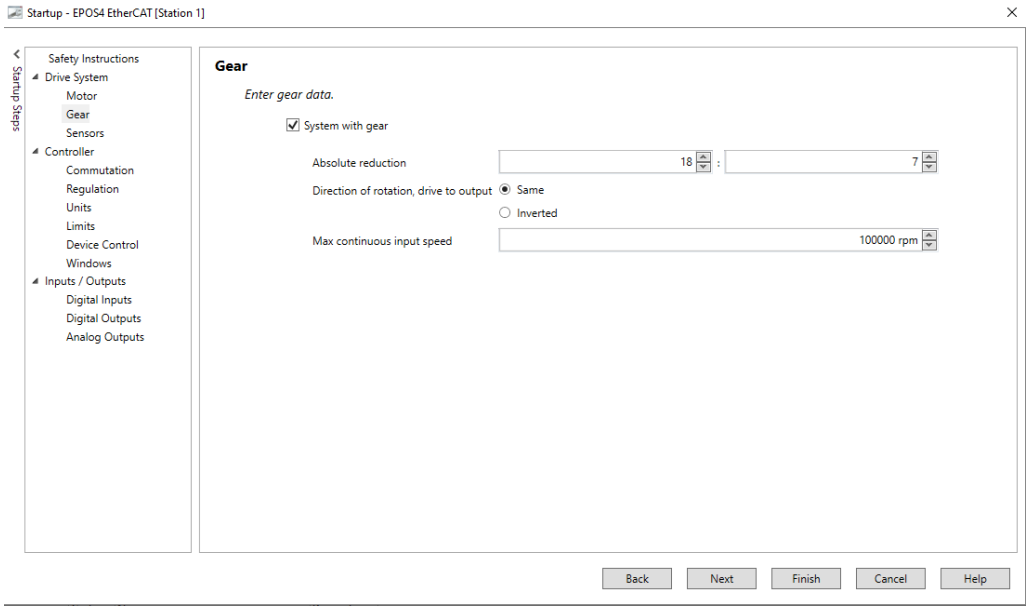
Swich to SSI with command SWITCH. Disconnect and Connect to enable SSI



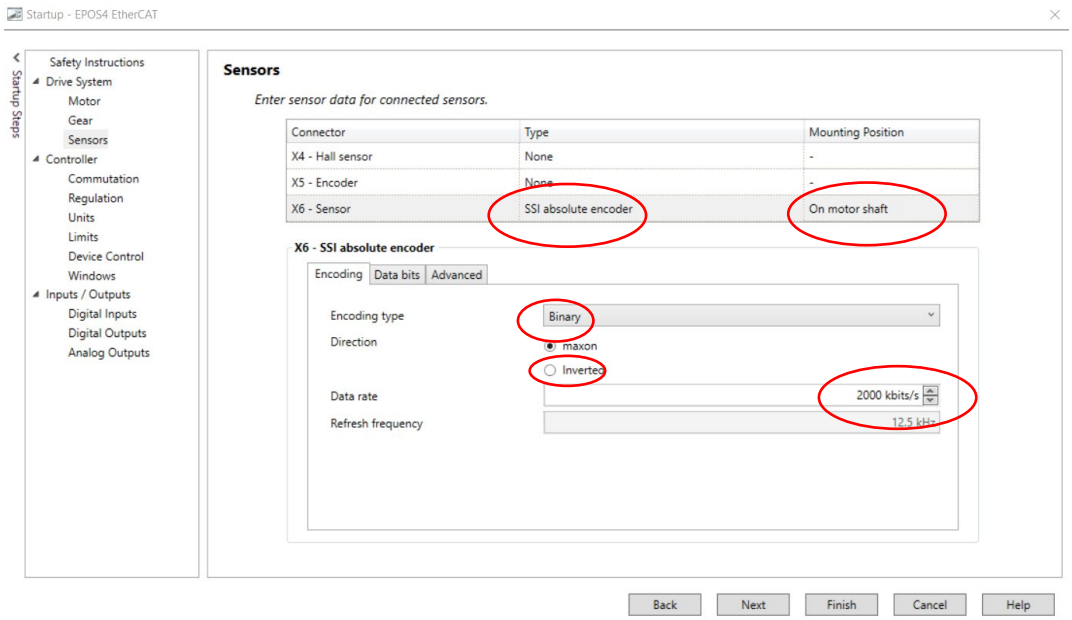
3.4 Pole pares drive motor: 10, pole pares rotation motor: 7



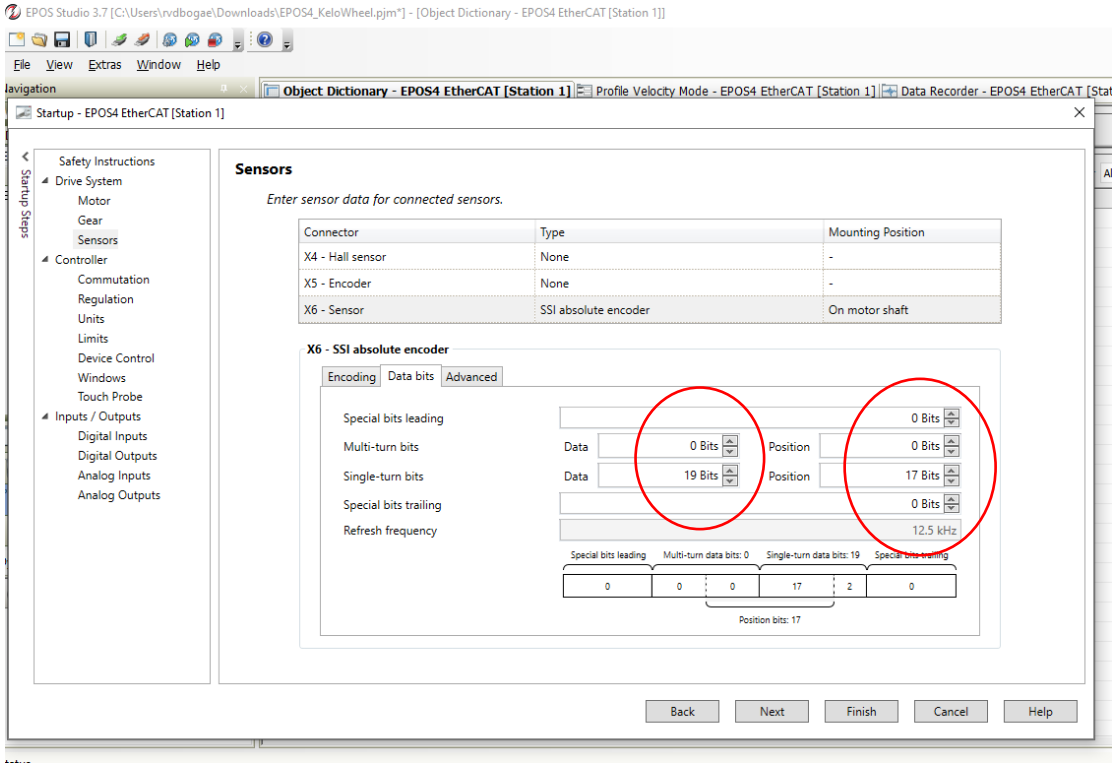
Drive motor : no gear, rotation motor reduction 18 :7



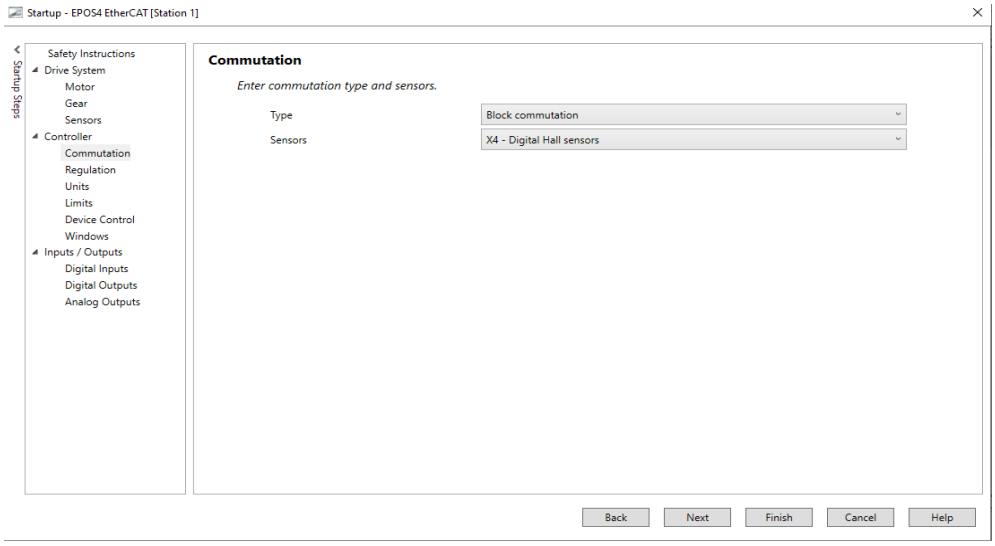
3.5 Encoder settings drive motor. rotation motor + hallsensor -> mounting on shaft

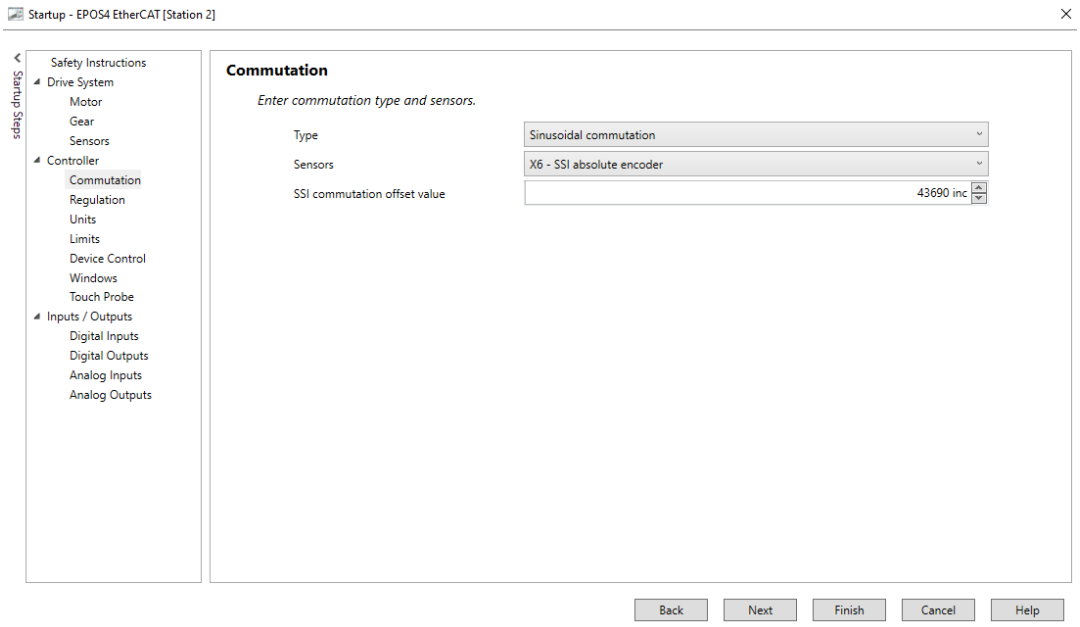


3.6 Encoder settings: Data Bits 19



Commutation rotation:




Startup - EPOS4 EtherCAT [Station 2]
Startup Steps
Safety Instructions
Drive System
Motor
Gear
Sensors
Controller
Commutation
Regulation
Units
Limits
Device Control
Windows
Touch Probe
Inputs / Outputs
Digital Inputs
Digital Outputs
Analog Inputs
Analog Outputs
Commutation
Enter commutation type and sensors.
Type
Sinusoidal commutation
Sensors
X6 - SSI absolute encoder
SSI commutation offset value
43690 inc
Back
Next
Finish
Cancel
Help

3.7 Calculation of SSI commutation offset value:

Application notes collection, follow the steps chapter 8 page 131-135:

Calculation offset flow chart:

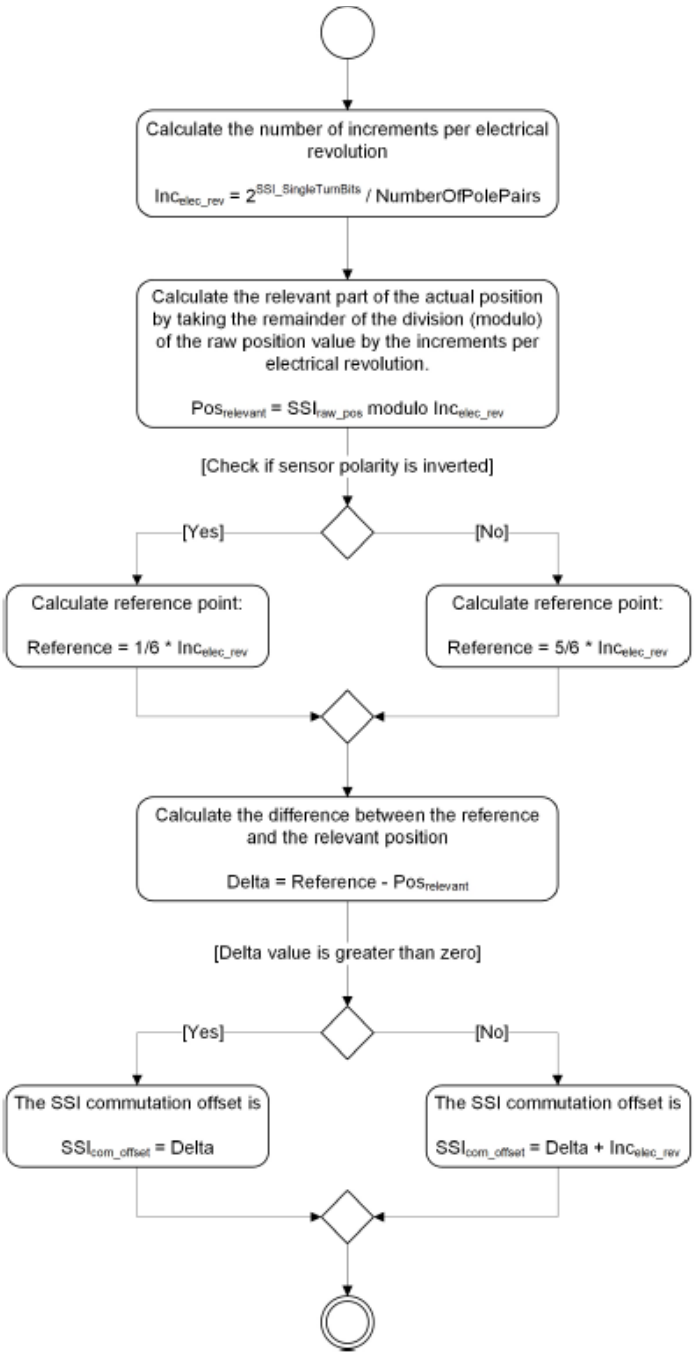


Figure 8-133 Adjustment of SSI commutation offset value | Determine SSI commutation offset value

Go to startup, put the motor temporarily in dc modus

Go to Tools Cyclic torque mode

Enable.

Activate Synchronous torque.

Type a toque e.g. 30%

Apply torque.

Go to Tools object dictionary 0x3012 SSI position raw value.

Copy this value to *Enc Pos* in the Excel calculation sheet(yellow).

Delta non inverted (Maxon) is the value that has to be used.

Put the motor back in BLDC modus

3.8 Exel calculation sheet

Enc res	524288				Inverted	**Non Inverted (Maxon)**				**Bits**	**Enc cnt**	
N Pole Pairs	10			n incs per electrc. Rev	52428,8	52428,8				1	2	
Enc pos test	1956			pos-relevant	1956	1956				2	4	
				reference-point	8738,133333	43690,66667				3	8	
				Delta	6782,133333	41734,66667				4	16	
				Delta + 1N	59210,93333	94163,46667				5	32	
										6	64	
										7	128	
										8	256	
										9	512	
										10	1024	
										11	2048	
										12	4096	
										13	8192	
										14	16384	
										15	32768	
										16	65536	
										17	131072	
										18	262144	
										19	524288	
												1456,356

3.9 Offset calculation results

Wheelset 1 drive wheel

SSI commutation offset value : **43690**

Wheelset 2 drive wheel

SSI commutation offset value : **866**

Wheelset 3

SSI commutation offset value : **14895**