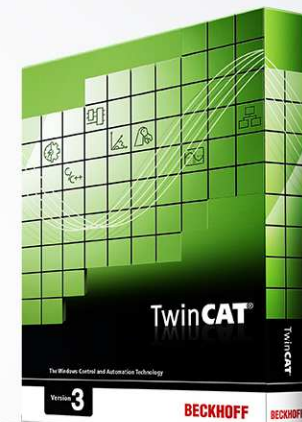
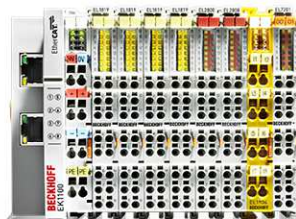


Scoping Main Parameter / Drive Tuning AX5000 2015

BECKHOFF



1. Scoping main parameter
2. The bode plot in AX5000

Scoping Main Parameter

BECKHOFF

- What parameter we like to see? One is current!

The screenshot shows the Beckhoff TwinCAT software interface. On the left is the 'Solution Explorer' showing the project structure for 'Scan_and_run'. The main window displays the 'Parameter' configuration for 'Channel A'. The 'Tree' view on the left of the main window shows the hierarchy: Device > Channel A > Parameter > Process data/Operation mode. The 'Available parameters for Process Data' list on the right contains various parameters, with 'S-0-0084: Torque feedback value' highlighted by a red box and a red arrow pointing to it. The 'Parameters for Process Data' list on the right shows the selected parameters. The bottom status bar displays the current state of the system, including 'Axis State', 'Diag Code', 'Diag Msg', 'Umain OK', 'DcLink OK', 'Ampl: Te...', 'Actual op...', 'v <= v_0', 'Positive c...', and 'N'.

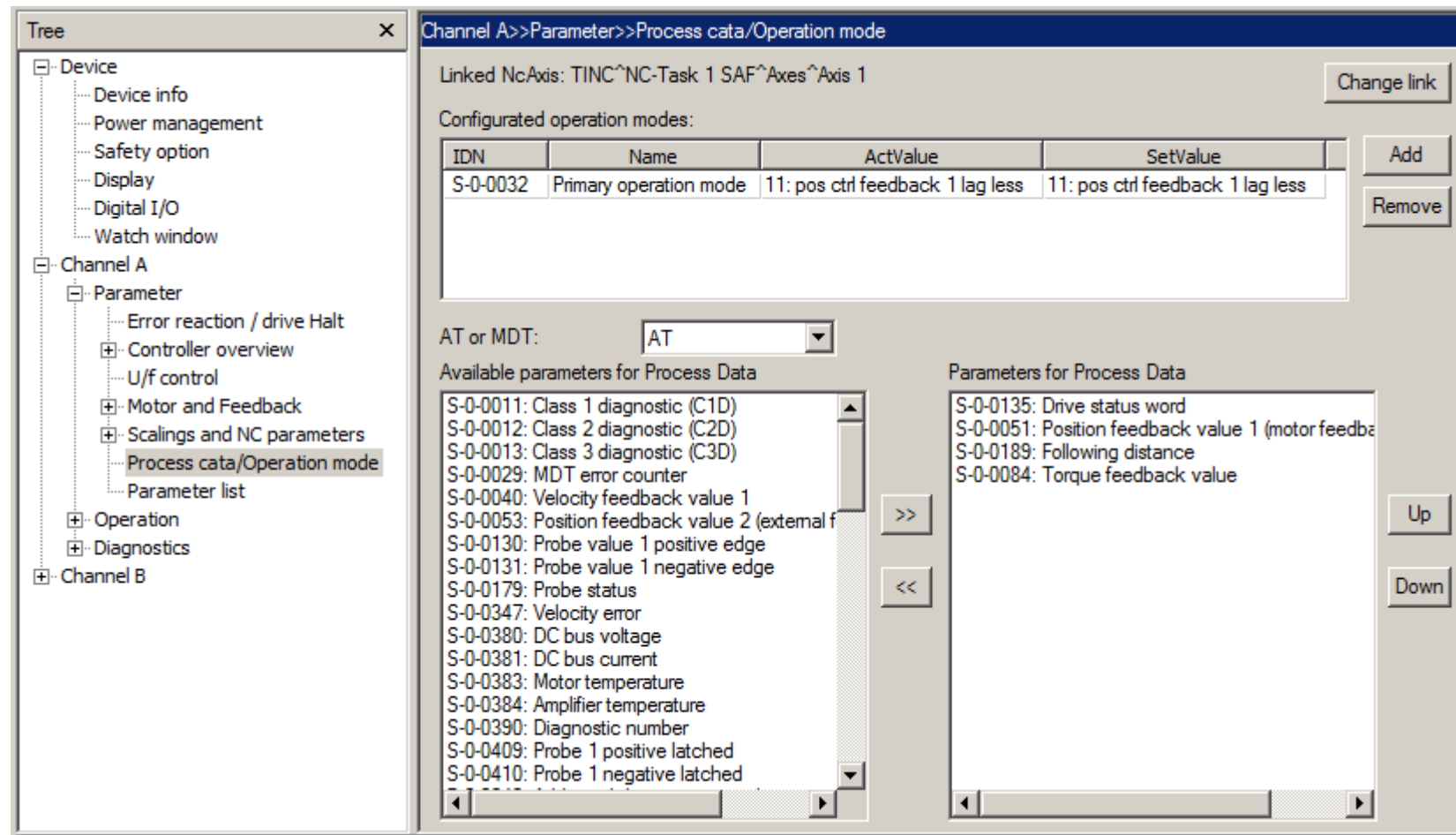
IDN	Name	ActValue	SetValue
S-0-0032	Primary operation mode	11: pos ctrl feedback 1 lag less	11: pos ctrl feedback 1 lag less

Op	AxisState	Diag Code	Diag Msg	Umain OK	DcLink OK	Ampl: Te...	Actual op...	v <= v_0	Positive c...	N
Channel A	Drive Ready	0x0000D012	R Axis state machine: Control and...	●	●	31.0	11: pos ctrl f...	●	●	●
Channel B	Drive Ready	0x0000D012	R Axis state machine: Control and...	●	●	29.7	11: pos ctrl f...	●	●	●

Scoping Main Parameter

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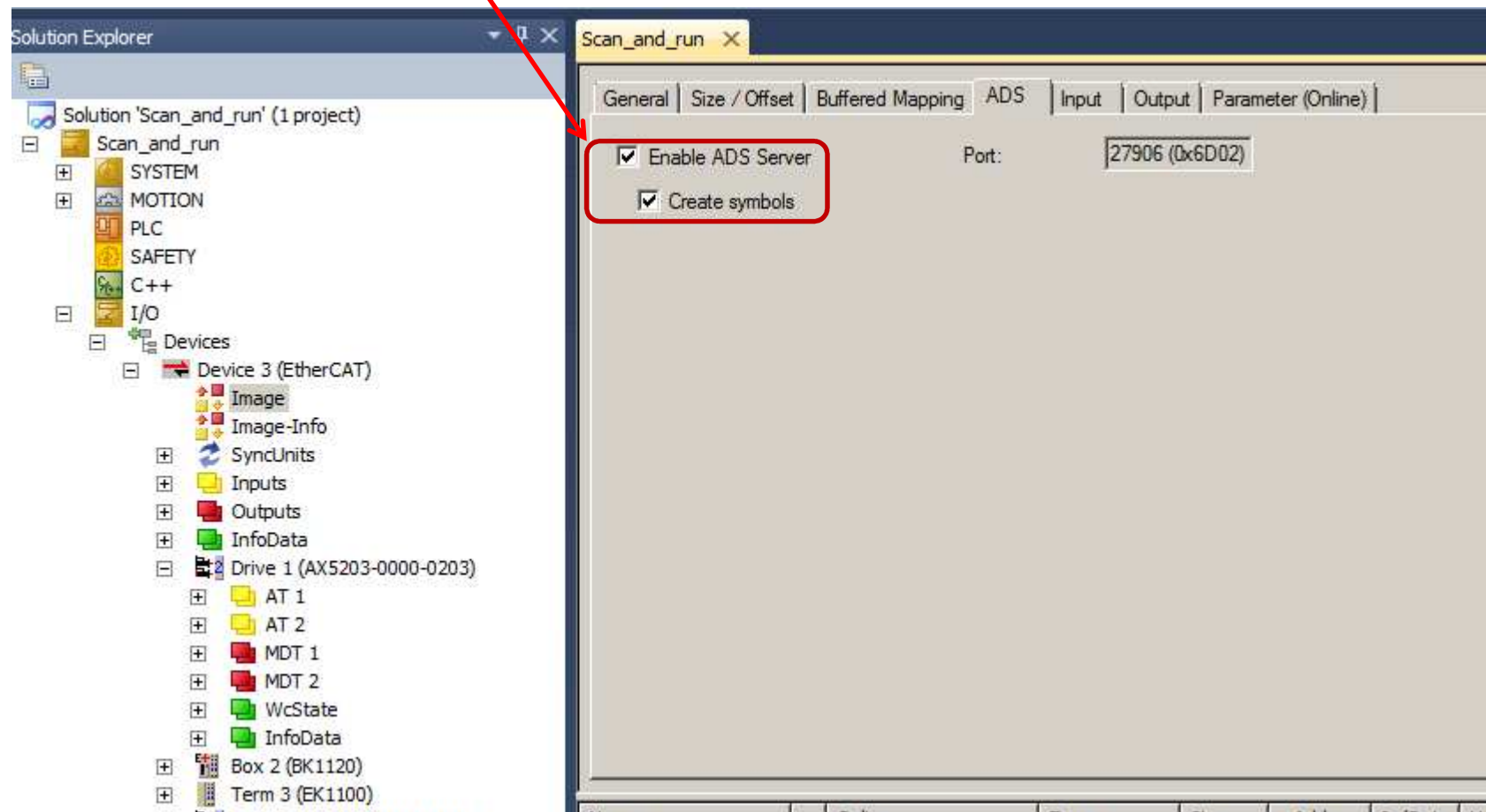
- Add the current into the process data`s



Scoping Main Parameter

BECKHOFF

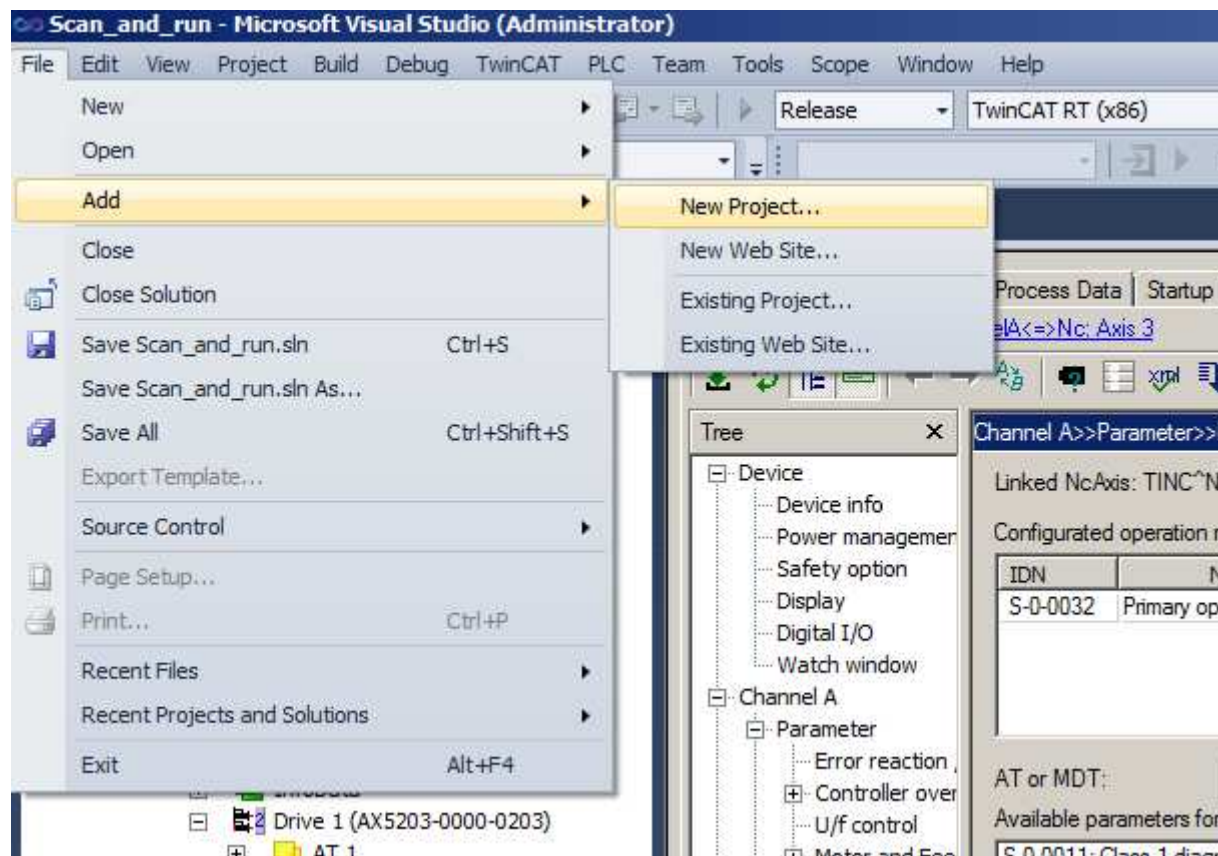
- Make the process data's ready to scope, to get the data direct from the process image of the AX5000



Scoping Main Parameter

BECKHOFF

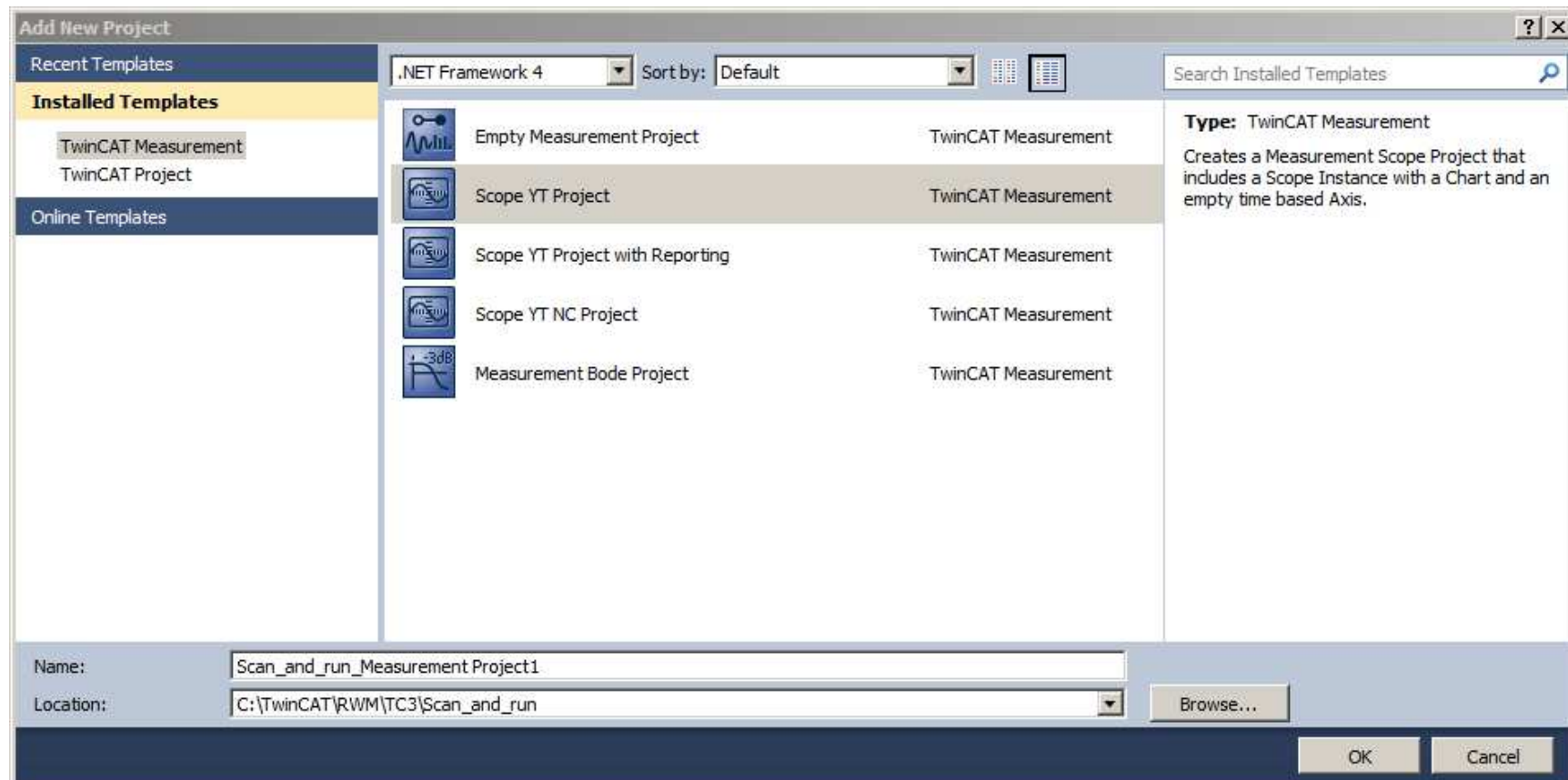
- Create the scope project step 1 -> Add a New Scope Project



Scoping Main Parameter

BECKHOFF

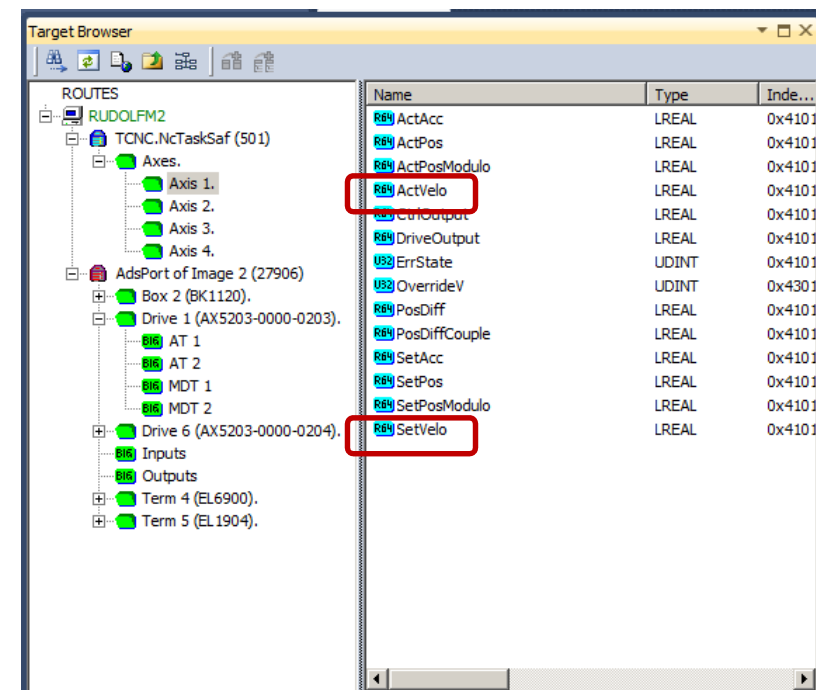
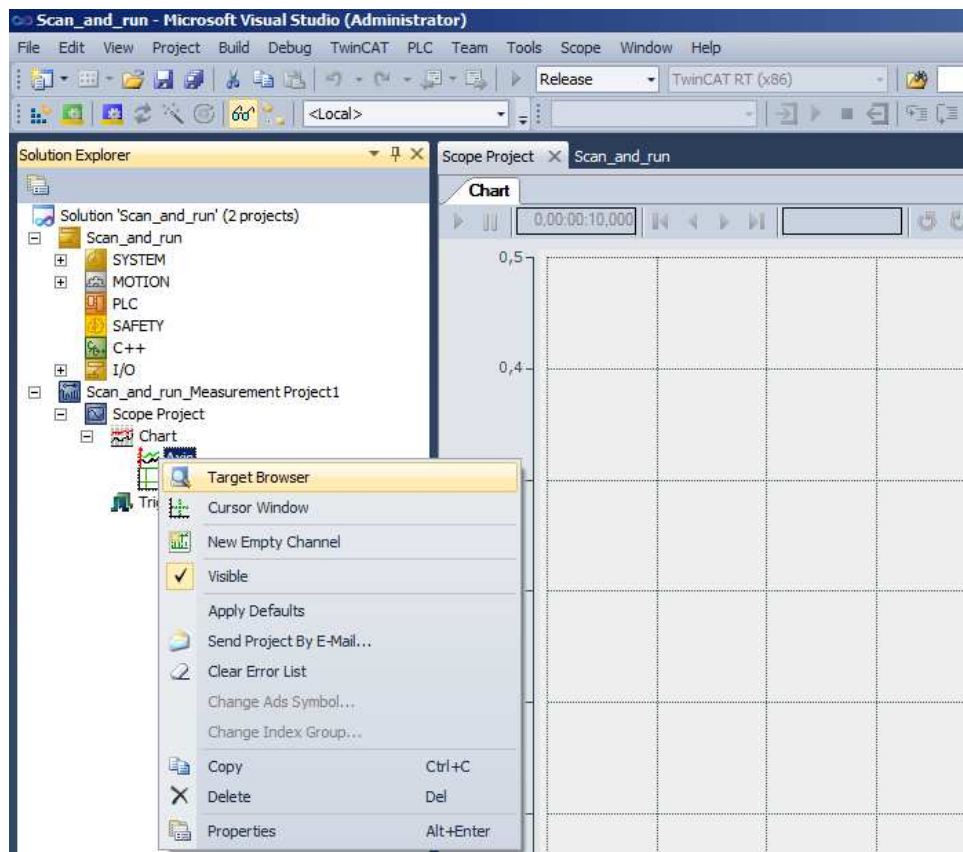
- Create the scope project step 2 -> Choose a YT scope Project



Scoping Main Parameter

BECKHOFF

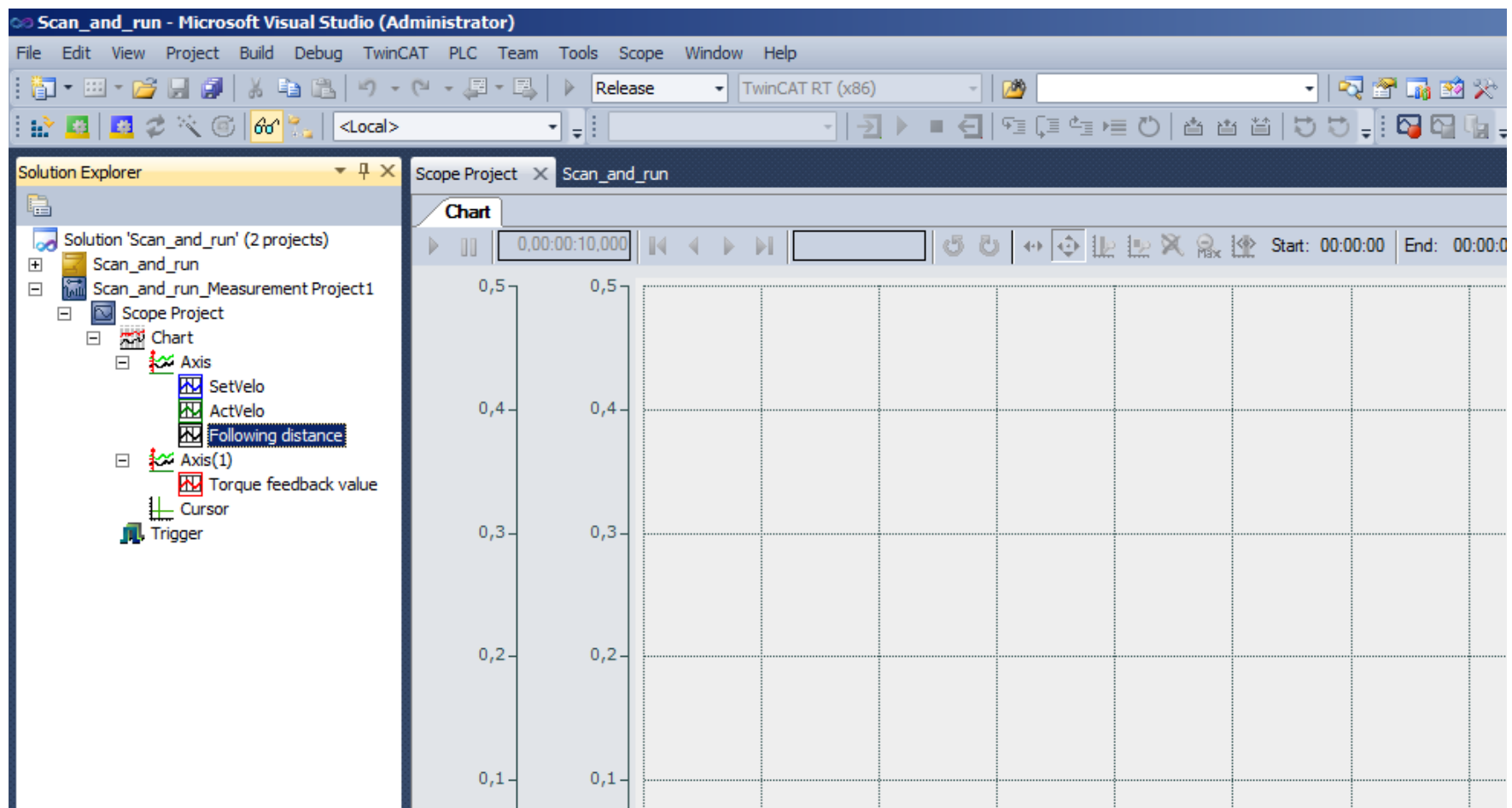
- Create the scope project step 3, select the Axis
 - ActVelo and SetVelo from TCNC.NcTaskSaf
 - Following distance and Torque feedback value from the AdsPort



Scoping Main Parameter

BECKHOFF

- Ready to scope?



Scoping Main Parameter

BECKHOFF

- What is the right scaling? It depends on the application. 60 gives you the speed in rpm.

The screenshot shows the Beckhoff TwinCAT software interface. The 'Solution Explorer' on the left lists the project structure, including 'Scan_and_run' (2 projects) and 'Device 3 (EtherCAT)'. The 'Tree' view in the center shows the configuration tree for 'Channel A', with 'Scalings and NC parameters' selected. The right-hand pane displays the 'Channel A >> Parameters >> Scalings and NC parameters' configuration window. The 'Feed constant' field is set to 60, and the unit is 'mm'. A red arrow points to this field from the text above. The 'NC scaling factor' is set to 5.7220458984375e-005, and the 'NC modulo scale' is 4294967295. The 'Invert NC-Encoder counting direction' and 'Invert NC-Drive motor polarity' checkboxes are unchecked. The 'Default parameter settings for linked Nc-axis. The value can be changed later in Nc-axis configuration.' section contains a table of parameters.

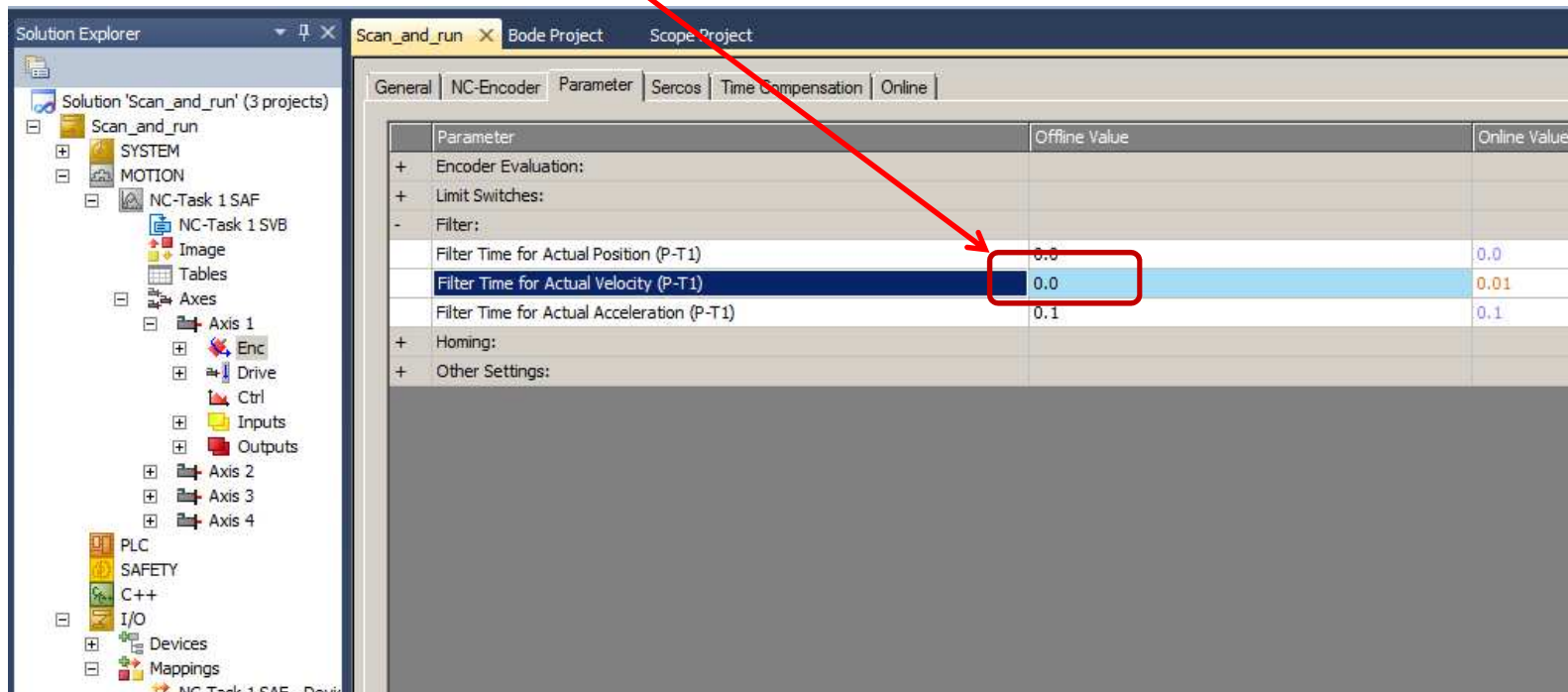
Parameter	Value	Unit
Reference Velocity: 110% of Max motor speed	8358.9	mm/s
Maximum Velocity: 100% of Max motor speed	7599	mm/s
Manual Velocity (Fast): 30% of Max motor speed	2279.7	mm/s
Manual Velocity (Slow): 5% of Max motor speed	379.95	mm/s
Calibration Velocity (towards plc cam): 1% of Max motor speed	75.99	mm/s
Calibration Velocity (off plc cam): 1% of Max motor speed	75.99	mm/s
Acceleration: with an acceleration time of 1s	11398.5	mm/s ²
Deceleration: with an acceleration time of 1s	11398.5	mm/s ²
Jerk: with an acceleration time of 1s	34195.5	mm/s ³

Max motor speed = 7599.000 (mm/s)

Scoping Main Parameter

BECKHOFF

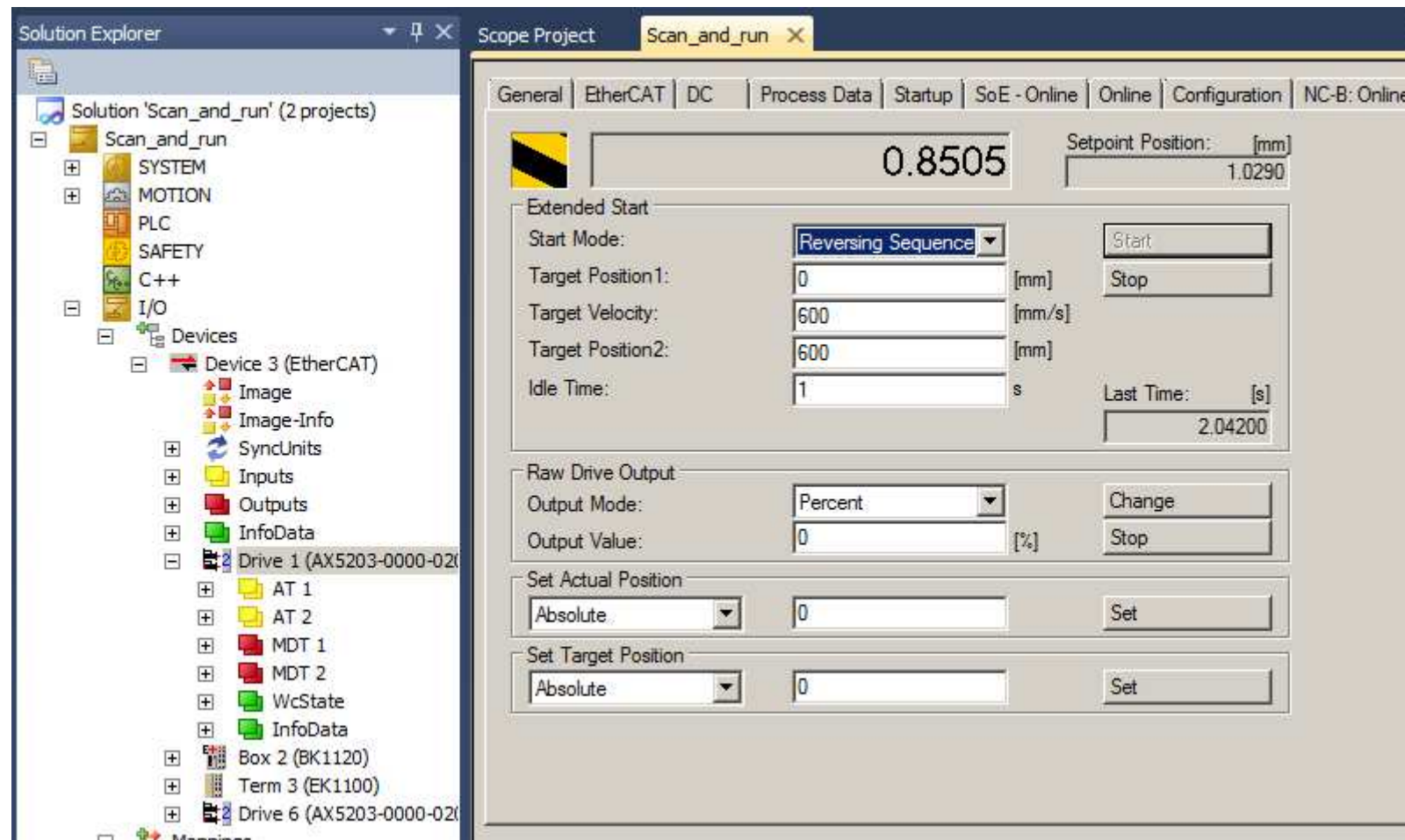
- Set this filter to zero



Scoping Main Parameter

BECKHOFF

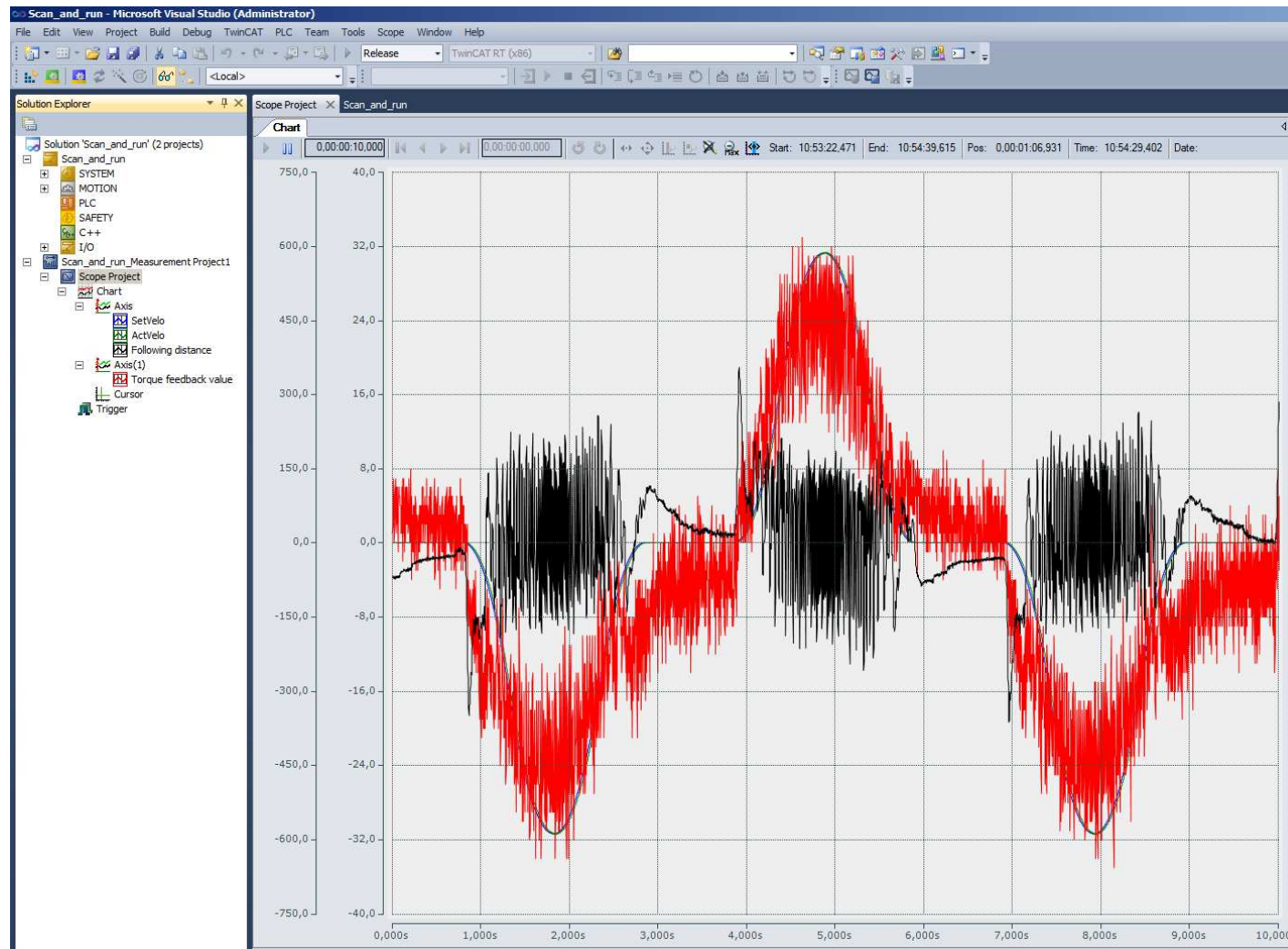
- Start the “Reversing Sequence”. In real application give 1 to 10% of the final speed.



Scoping Main Parameter

BECKHOFF

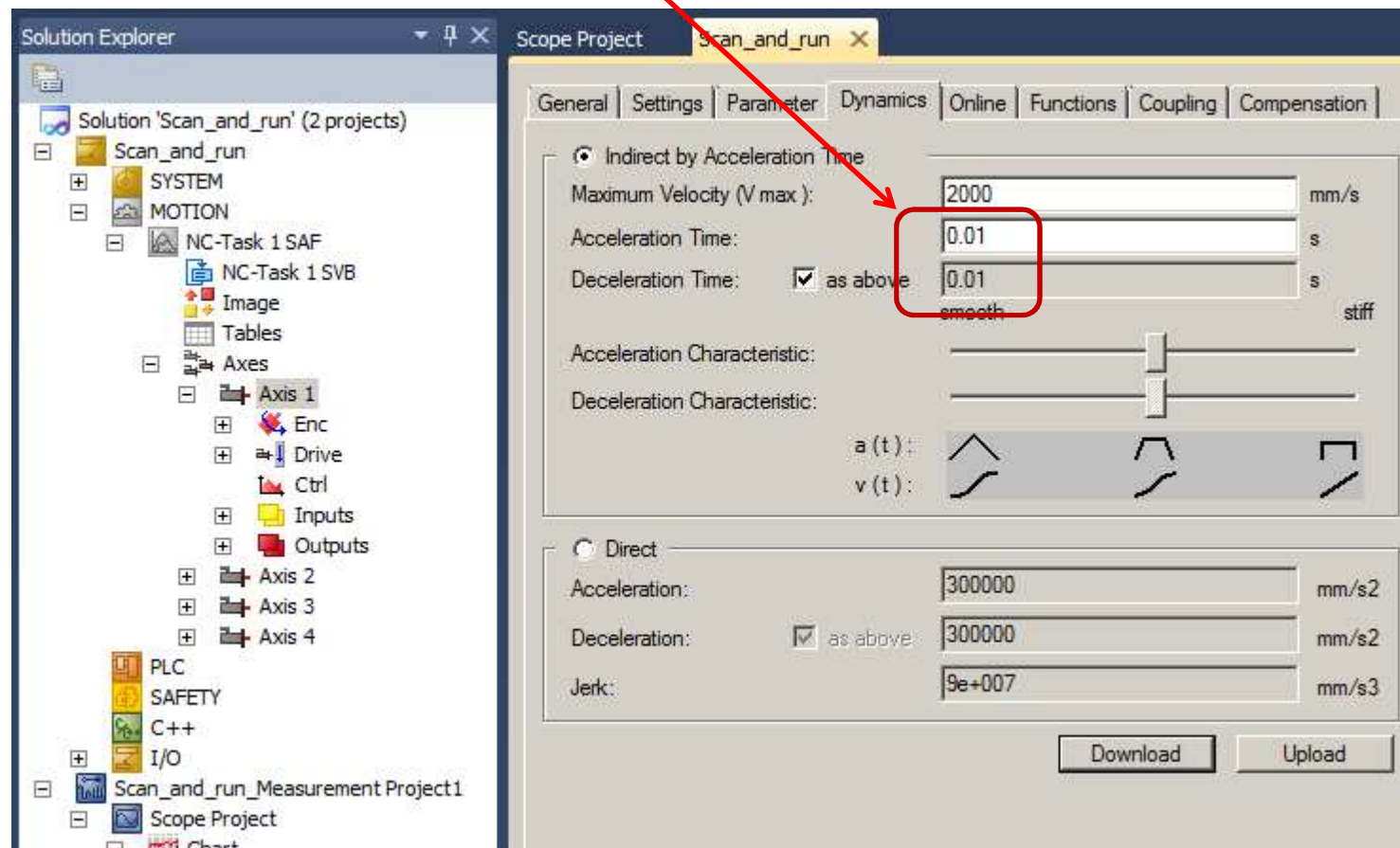
- A step response and no edges?



Scoping Main Parameter

BECKHOFF

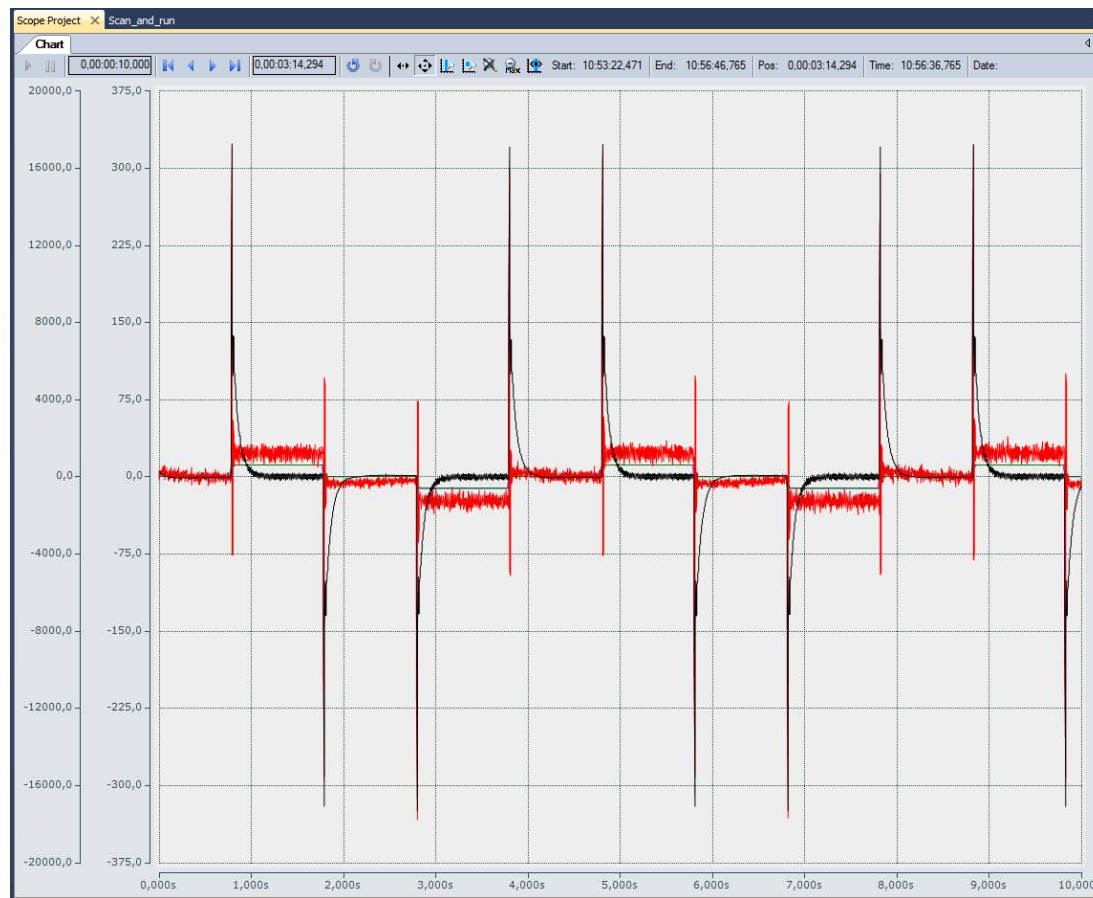
- To see a “real step” take high acceleration



Scoping Main Parameter

BECKHOFF

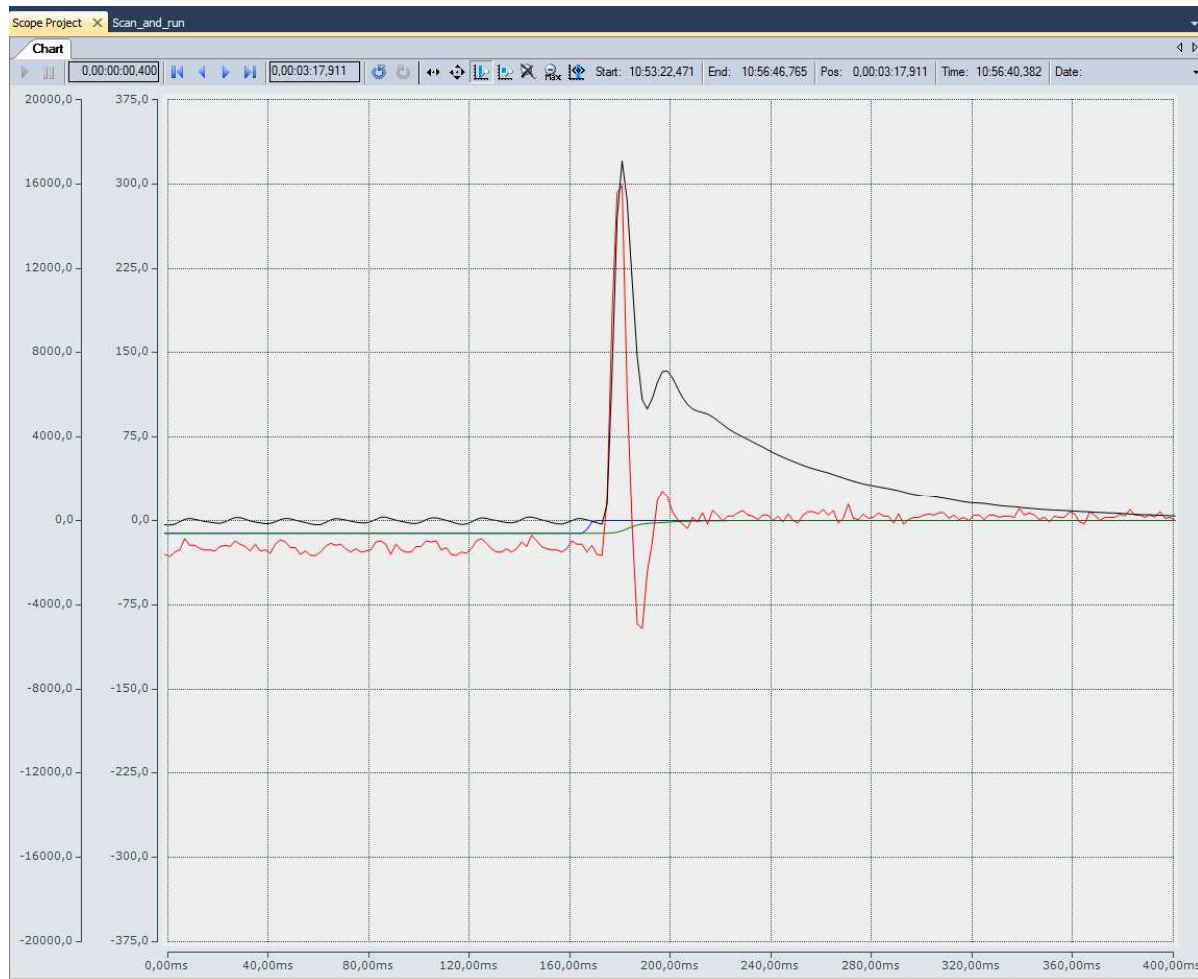
- The step response



Scoping Main Parameter

BECKHOFF

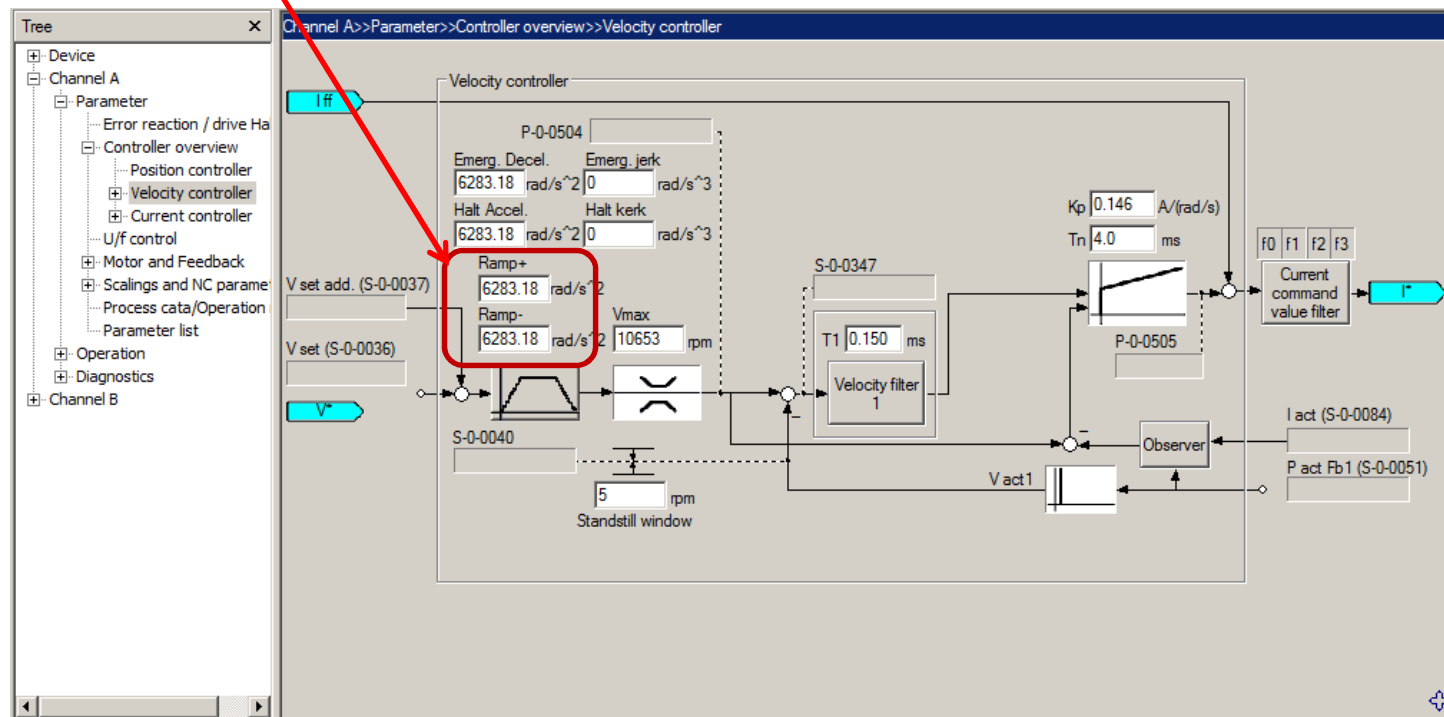
- The step response



Scoping Main Parameter

BECKHOFF

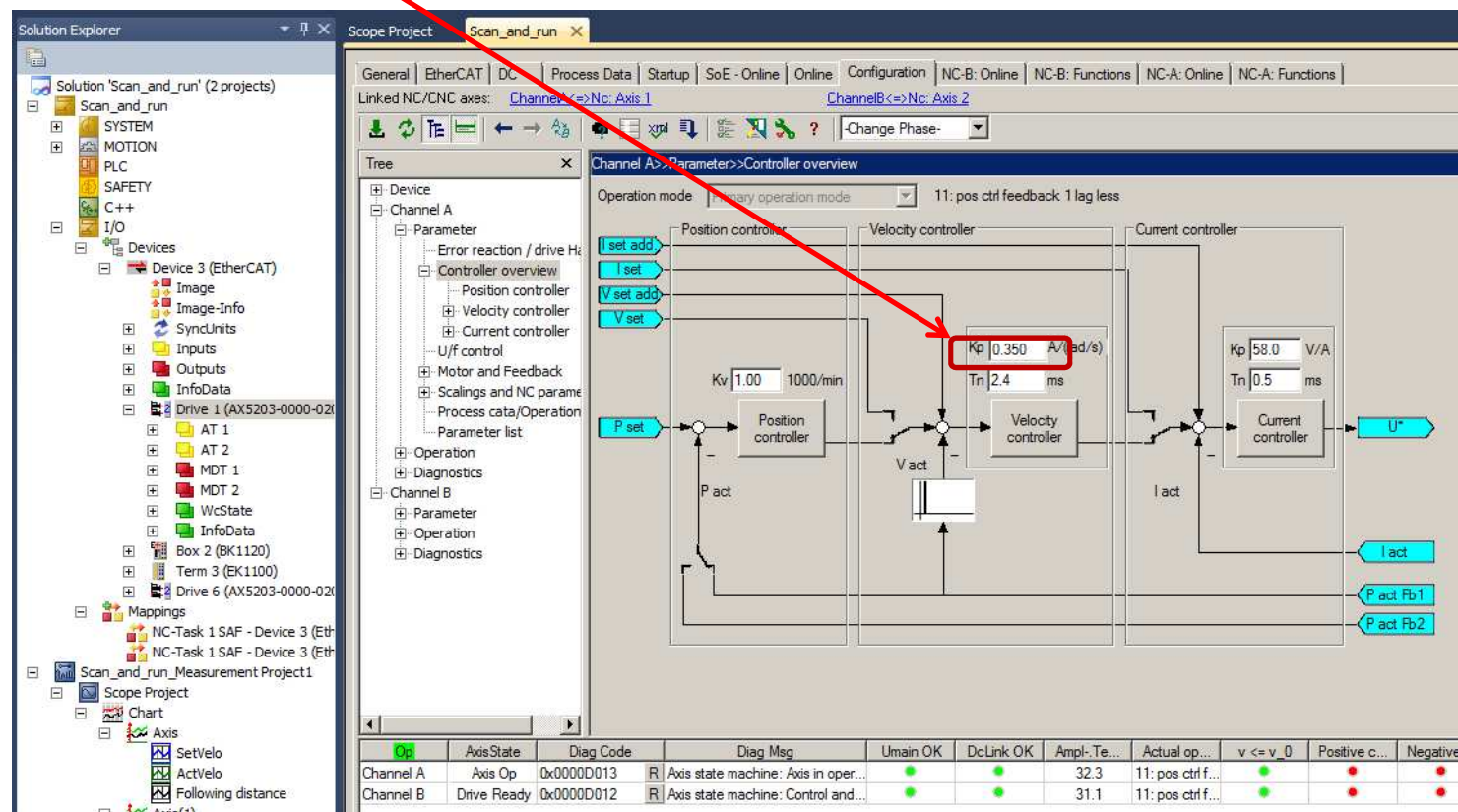
- Some more step limitations?



Scoping Main Parameter

BECKHOFF

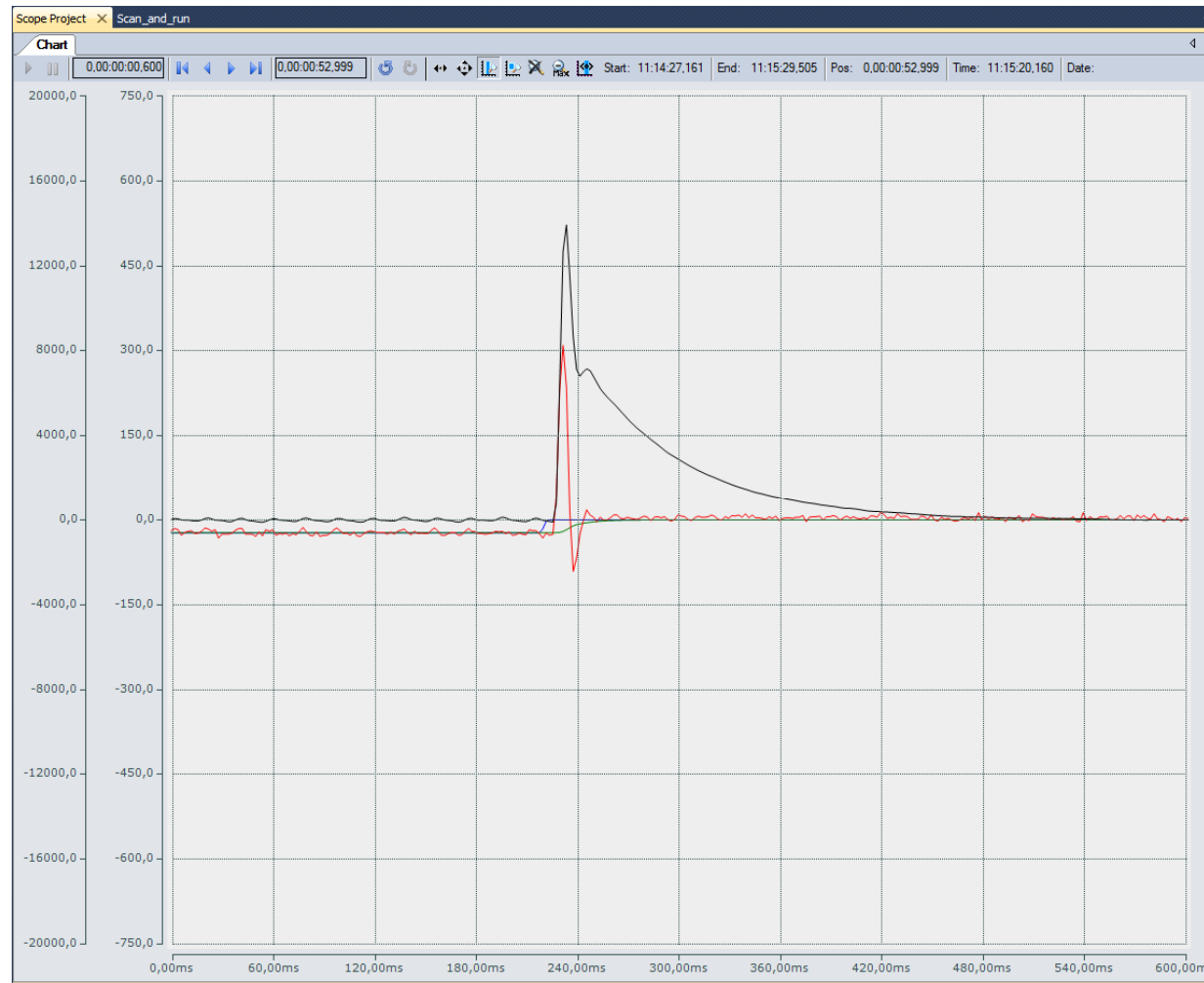
- Increasing velo Kp



Scoping Main Parameter

BECKHOFF

- Increasing velo Kp it gives this affect.

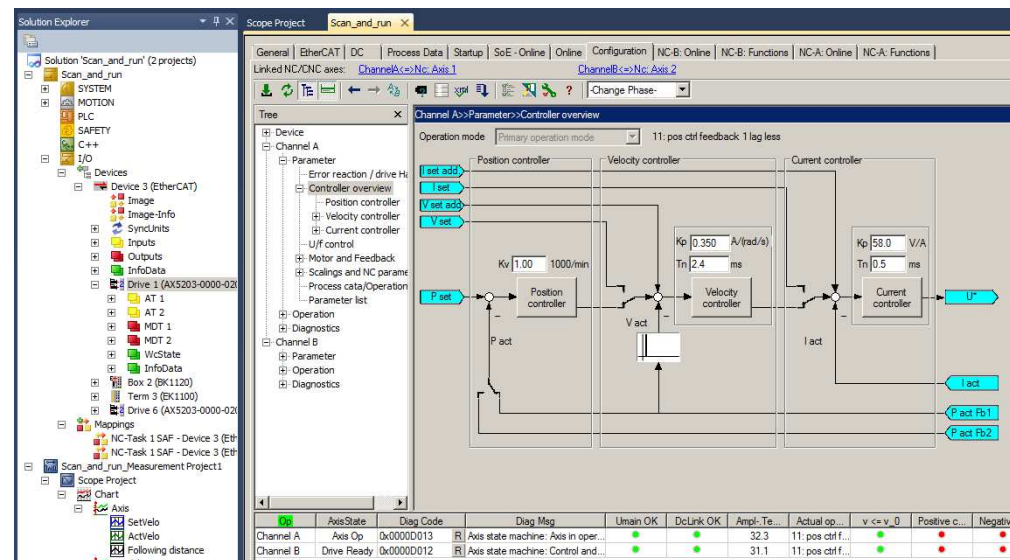


Scoping Main Parameter -> Settings

BECKHOFF

- Possible Strategy for controller setting
 - Set the Kv of the Position controller nearly to 0 -> 0.01 to nearly switch off the Position control
 - Lift up the Tn to switch off the effect of tn (in this case double it)
 - Then try step response and have a look at torque feedback and the following distance
 - Lift up Kp of the velocity controller until torque feedback or velocity feedback start to oscillate
 - Go down with Kp by 5 to 10%
 - Lower Tn of the velocity controller until torque feedback or velocity feedback start to oscillate
 - Go up with Tn until it is stable again
 - Do the same with Kv of the position controller as Kp

– -> Now you made it !!!!

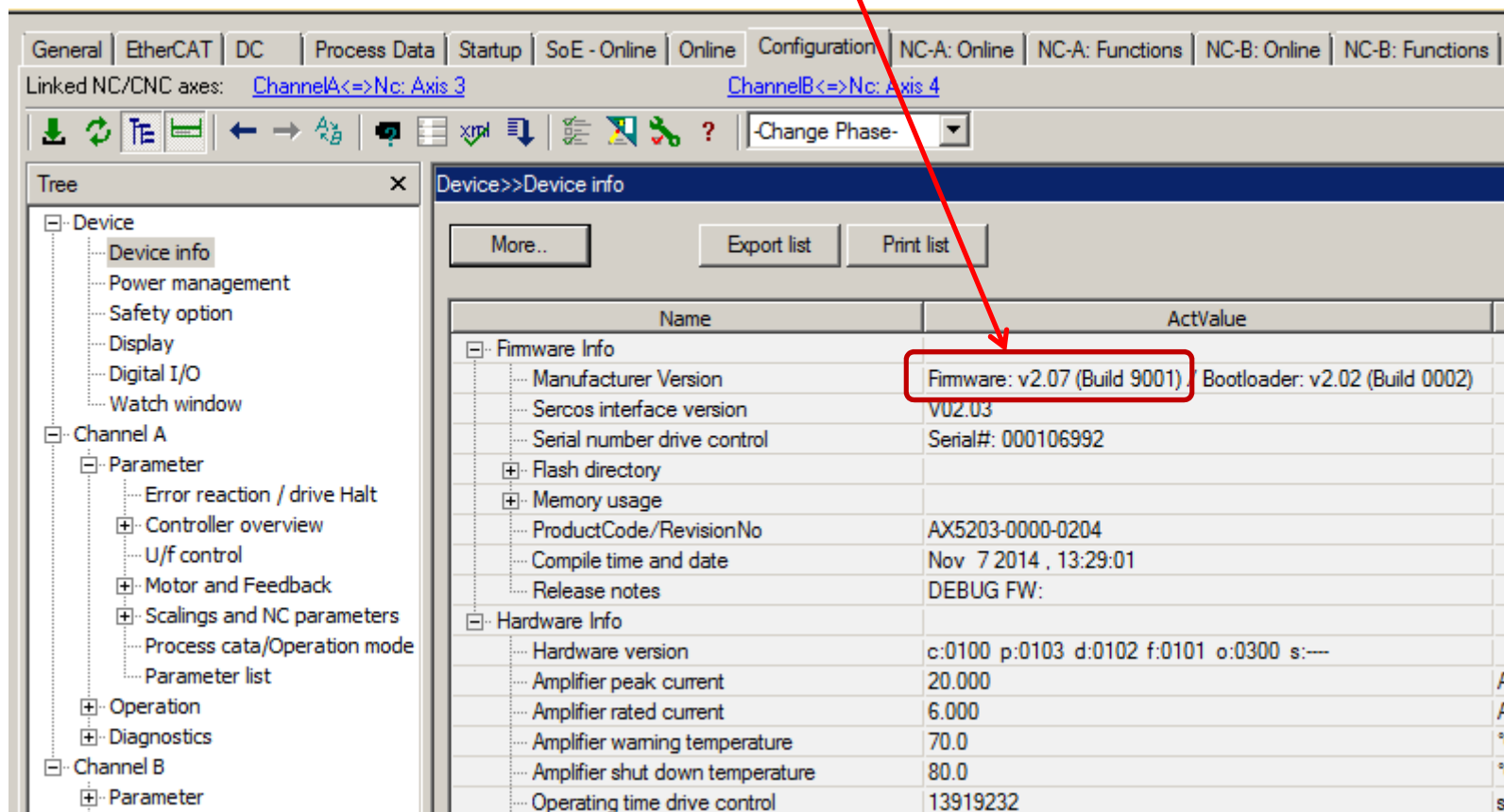


- Just some things to think about
 - A drive system that makes awful noise after tuning has to be checked
 - A drive system where you can feel the oscillation with your hand after tuning has to be checked

The bode plot in AX5000

BECKHOFF

- To create a Bode plot by AX5000 you need a special firmware



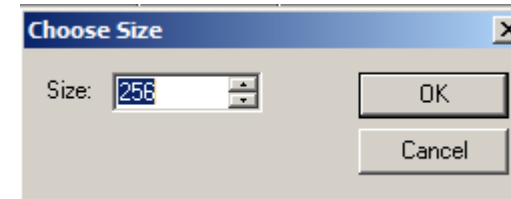
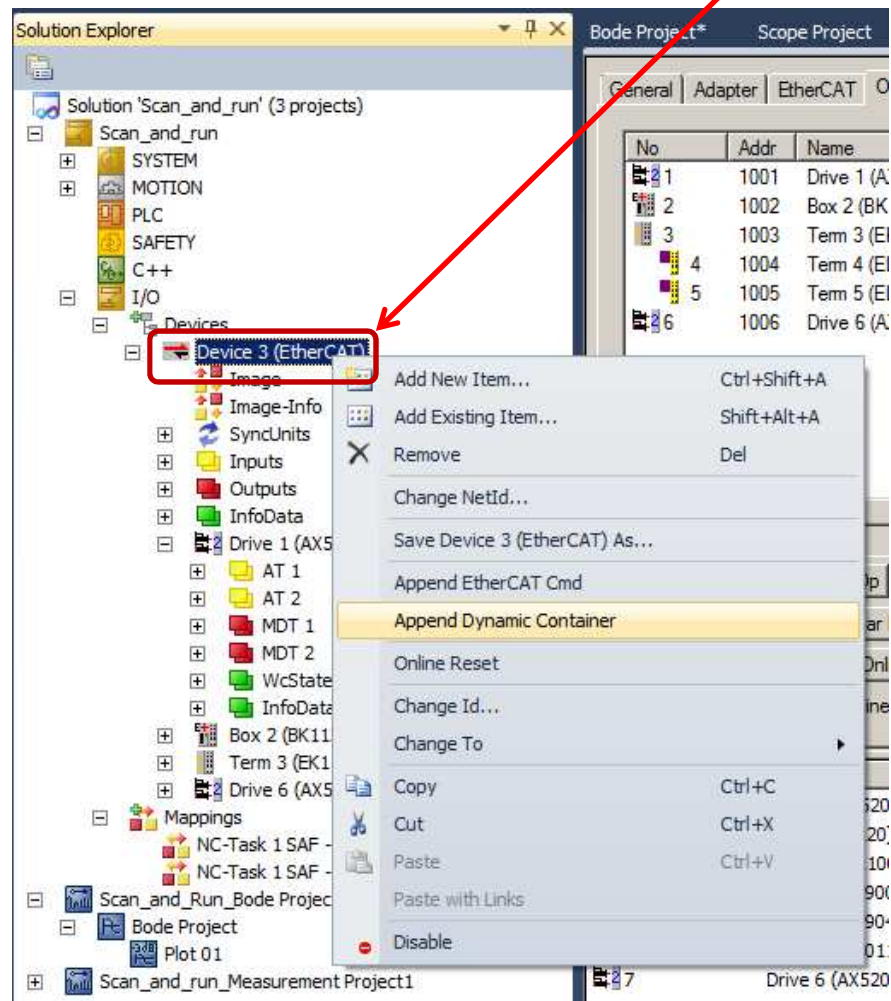
The screenshot shows the Beckhoff AX5000 Configuration Manager interface. The 'Device info' tab is selected, displaying a table of device information. A red arrow points to the 'Firmware Info' section, specifically highlighting the 'Firmware: v2.07 (Build 9001)' entry.

Name	ActValue
Firmware Info	
Manufacturer Version	Firmware: v2.07 (Build 9001) Bootloader: v2.02 (Build 0002)
Sercos interface version	V02.03
Serial number drive control	Serial#: 000106992
Flash directory	
Memory usage	
ProductCode/RevisionNo	AX5203-0000-0204
Compile time and date	Nov 7 2014 , 13:29:01
Release notes	DEBUG FW:
Hardware Info	
Hardware version	c:0100 p:0103 d:0102 f:0101 o:0300 s:---
Amplifier peak current	20.000
Amplifier rated current	6.000
Amplifier warning temperature	70.0
Amplifier shut down temperature	80.0
Operating time drive control	13919232

The bode plot in AX5000

BECKHOFF

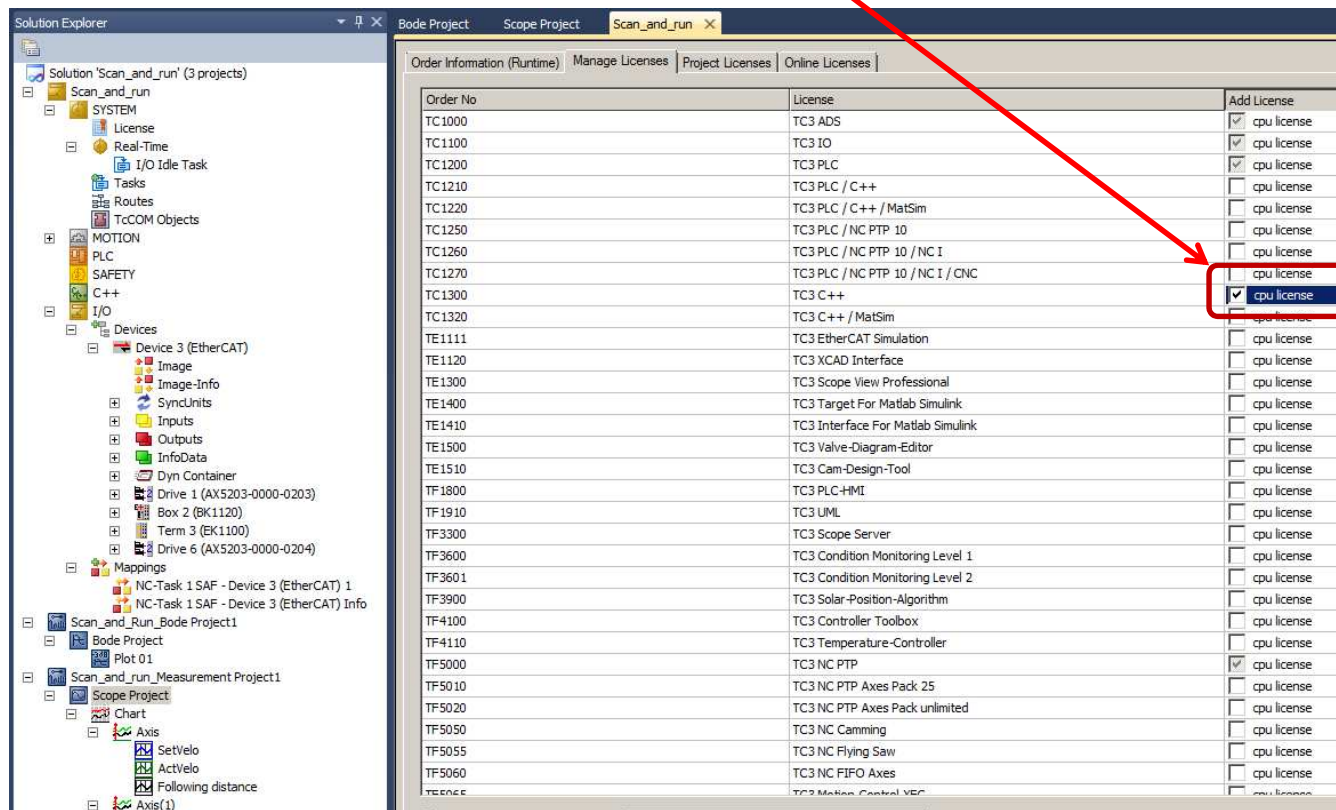
- Preparation to run Bode plot in AX5000, right mouse click here, add the “Dynamic Container”



The bode plot in AX5000

BECKHOFF

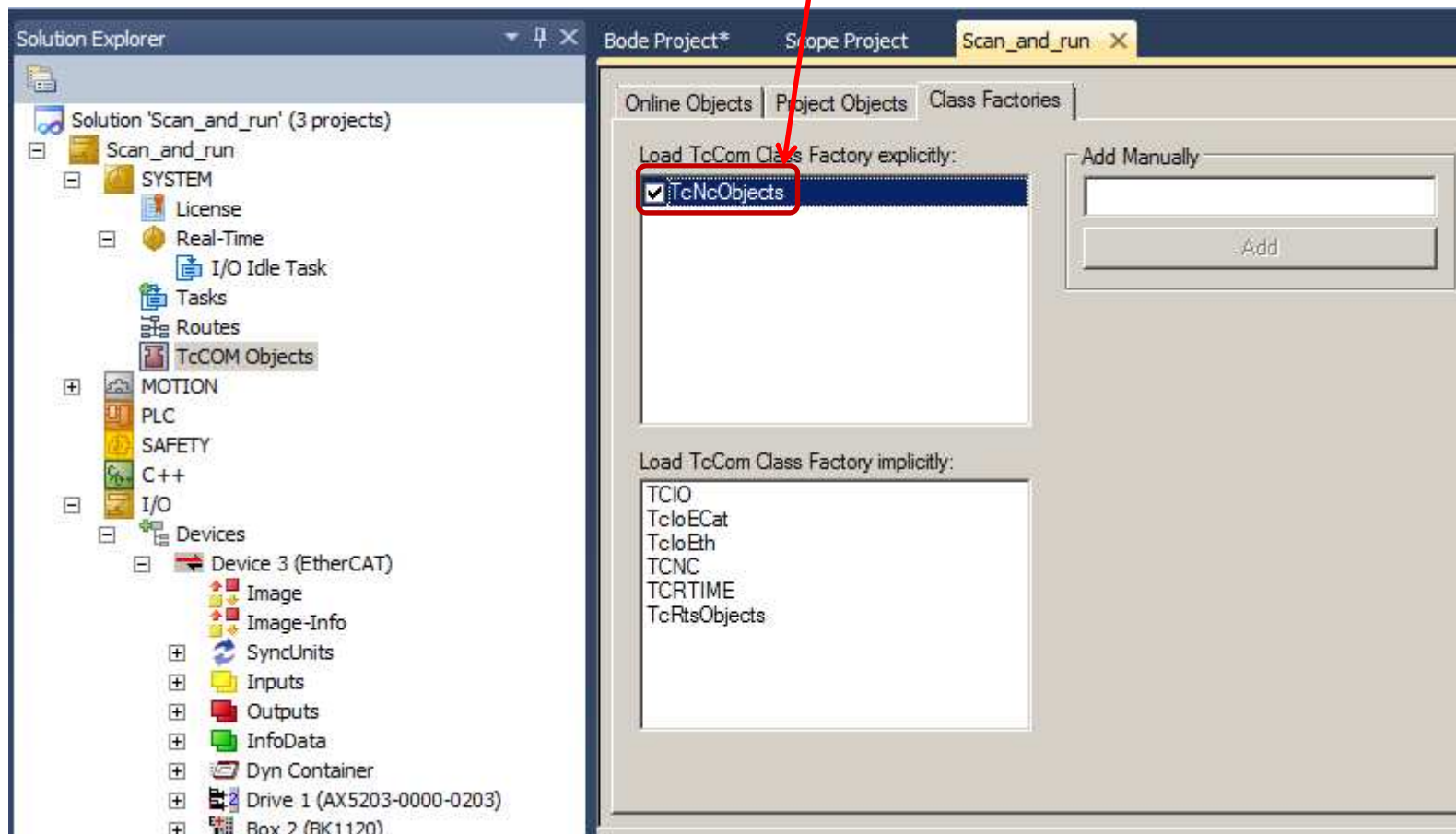
- Preparation to run Bode plot in AX5000 add this C++ License



The bode plot in AX5000

BECKHOFF

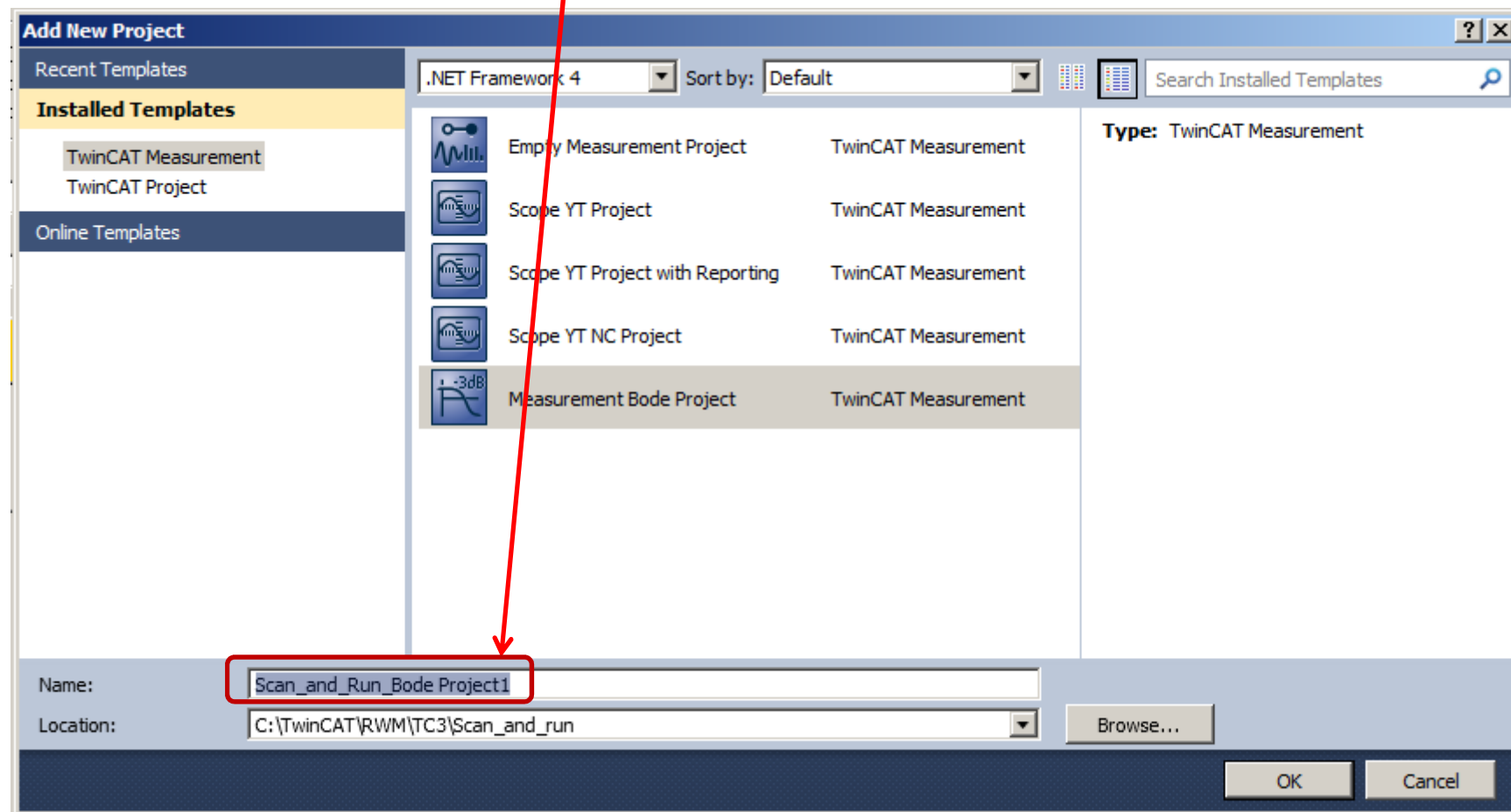
- Preparation to run Bode plot in AX5000, enable the “TcNcObjects”



The bode plot in AX5000

BECKHOFF

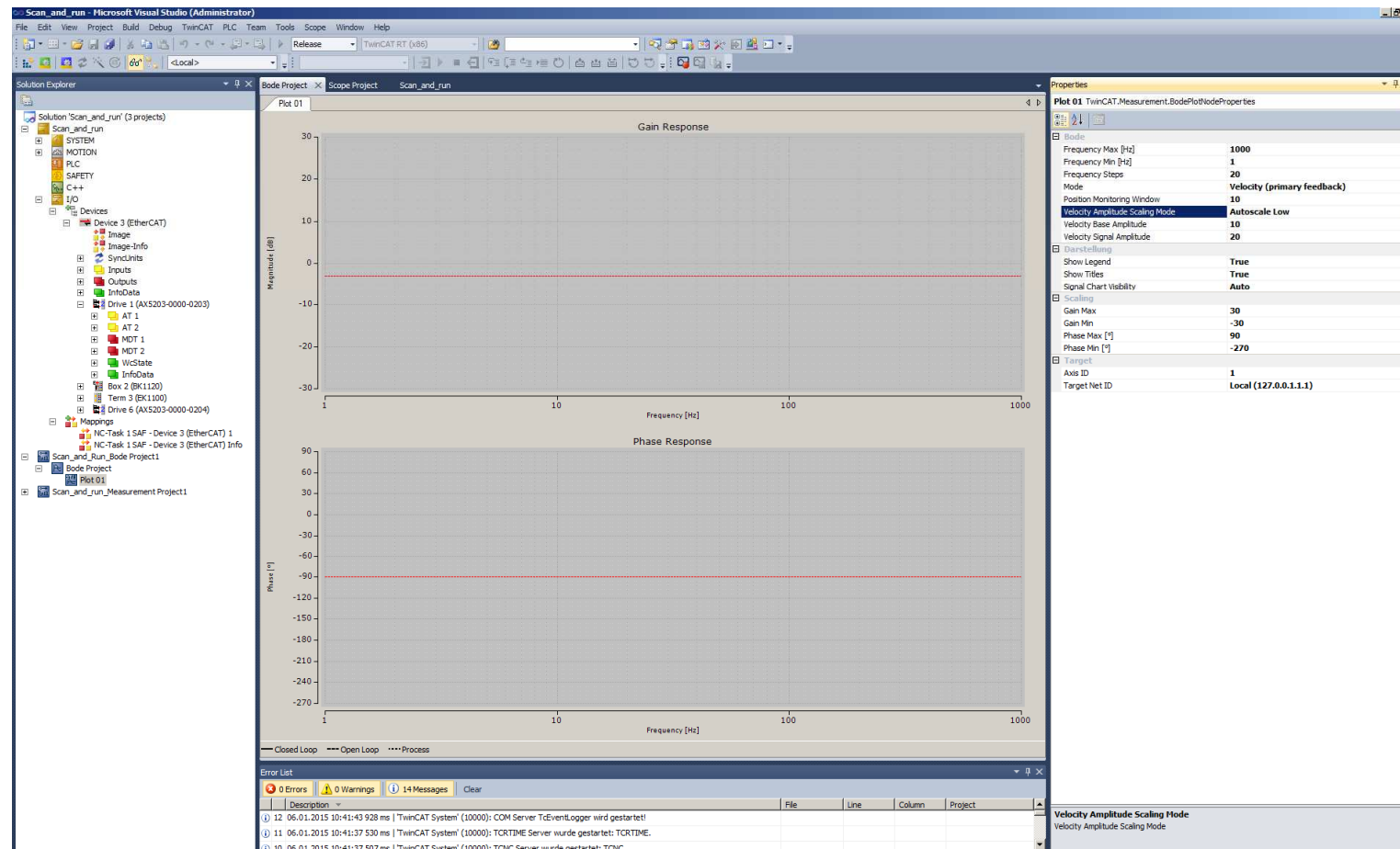
- Create a Bode plot by AX5000 and name it.



The bode plot in AX5000

BECKHOFF

- Bode plot in AX5000, start view.



The bode plot in AX5000

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- Bode plot in AX5000. Give the basic settings.

The image displays two side-by-side screenshots of the TwinCAT Properties window for Plot 01, showing the Bode plot settings. The left screenshot shows the default settings, while the right screenshot shows the settings after modification, with red boxes highlighting the changes.

Left Screenshot (Default Settings):

Property	Value
Bode	
Frequency Max [Hz]	1000
Frequency Min [Hz]	1
Frequency Steps	20
Mode	Velocity (primary feedback)
Position Monitoring Window	10
Velocity Amplitude Scaling Mode	Autoscale Low
Velocity Base Amplitude	10
Velocity Signal Amplitude	20
Darstellung	
Show Legend	True
Show Titles	True
Signal Chart Visibility	Auto
Scaling	
Gain Max	30
Gain Min	-30
Phase Max [°]	90
Phase Min [°]	-270
Target	
Axis ID	1
Target Net ID	Local (127.0.0.1.1.1)

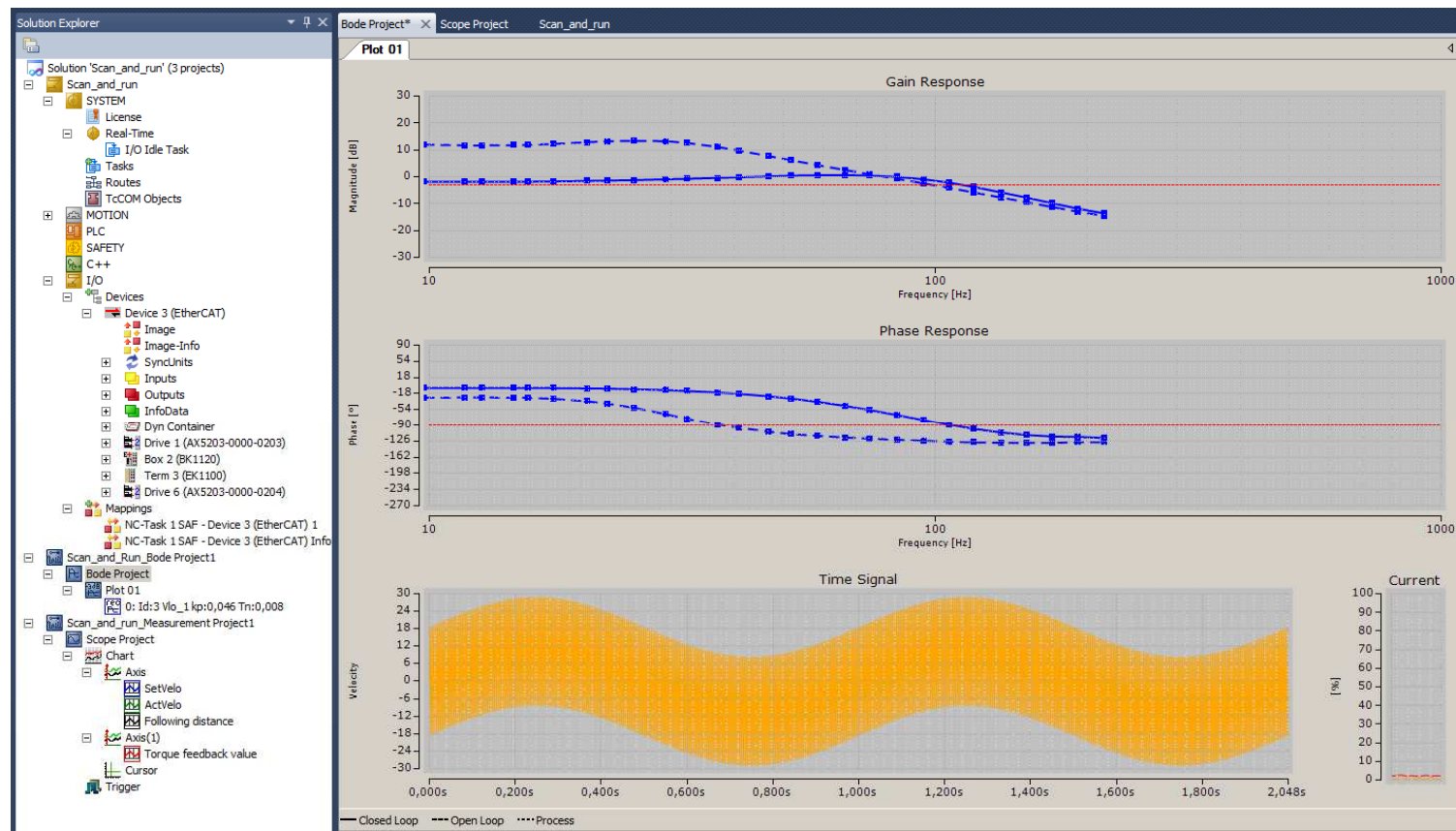
Right Screenshot (Modified Settings):

Property	Value
Bode	
Frequency Max [Hz]	1000
Frequency Min [Hz]	10
Frequency Steps	40
Mode	Velocity (primary feedback)
Position Monitoring Window	10
Velocity Amplitude Scaling Mode	Autoscale Medium
Velocity Base Amplitude	10
Velocity Signal Amplitude	20
Darstellung	
Show Legend	True
Show Titles	True
Signal Chart Visibility	Auto
Scaling	
Gain Max	30
Gain Min	-30
Phase Max [°]	90
Phase Min [°]	-270
Target	
Axis ID	1
Target Net ID	Local (127.0.0.1.1.1)

The bode plot in AX5000

BECKHOFF

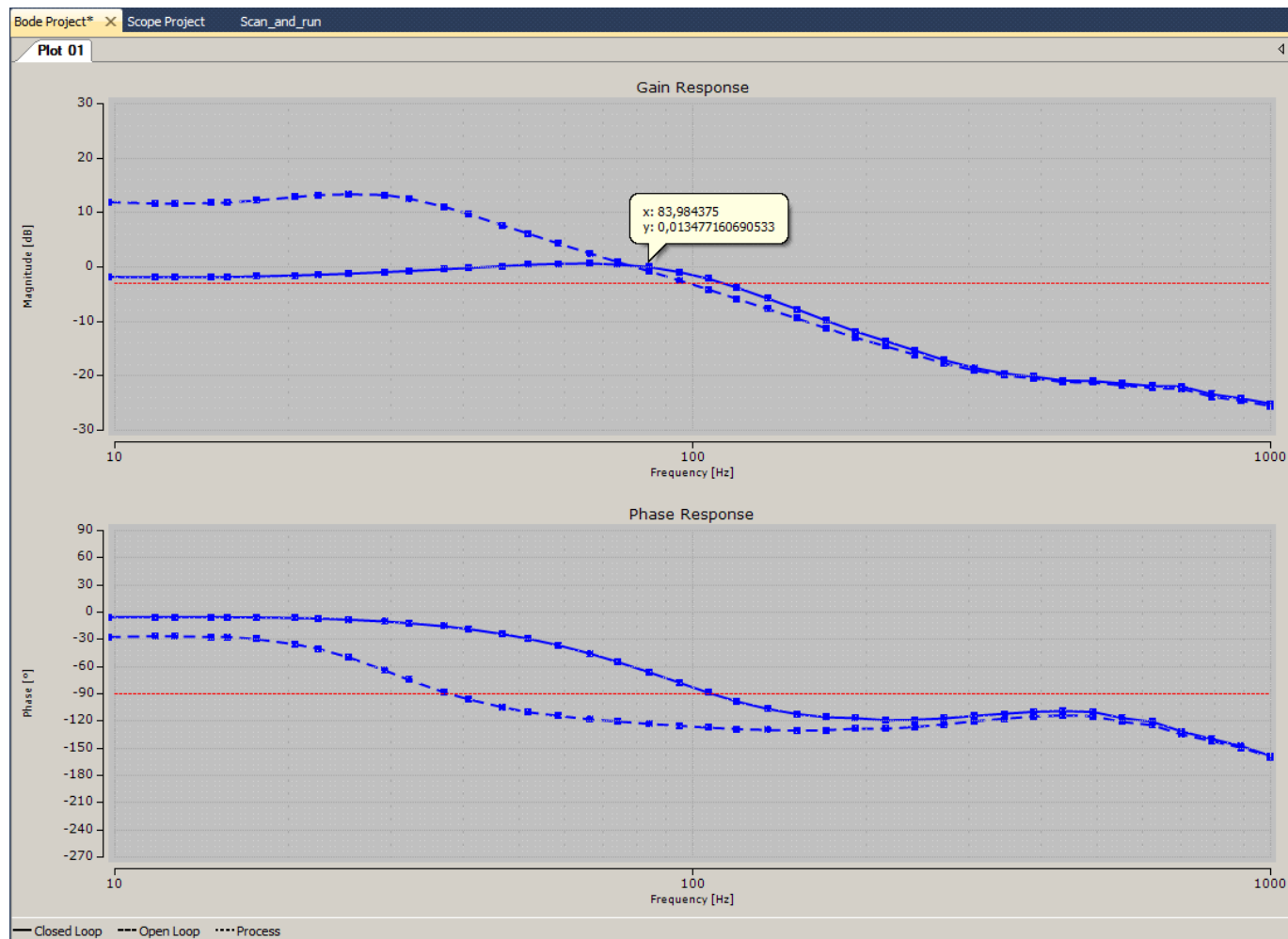
- Bode plot in AX5000 during oscillation



The bode plot in AX5000

BECKHOFF

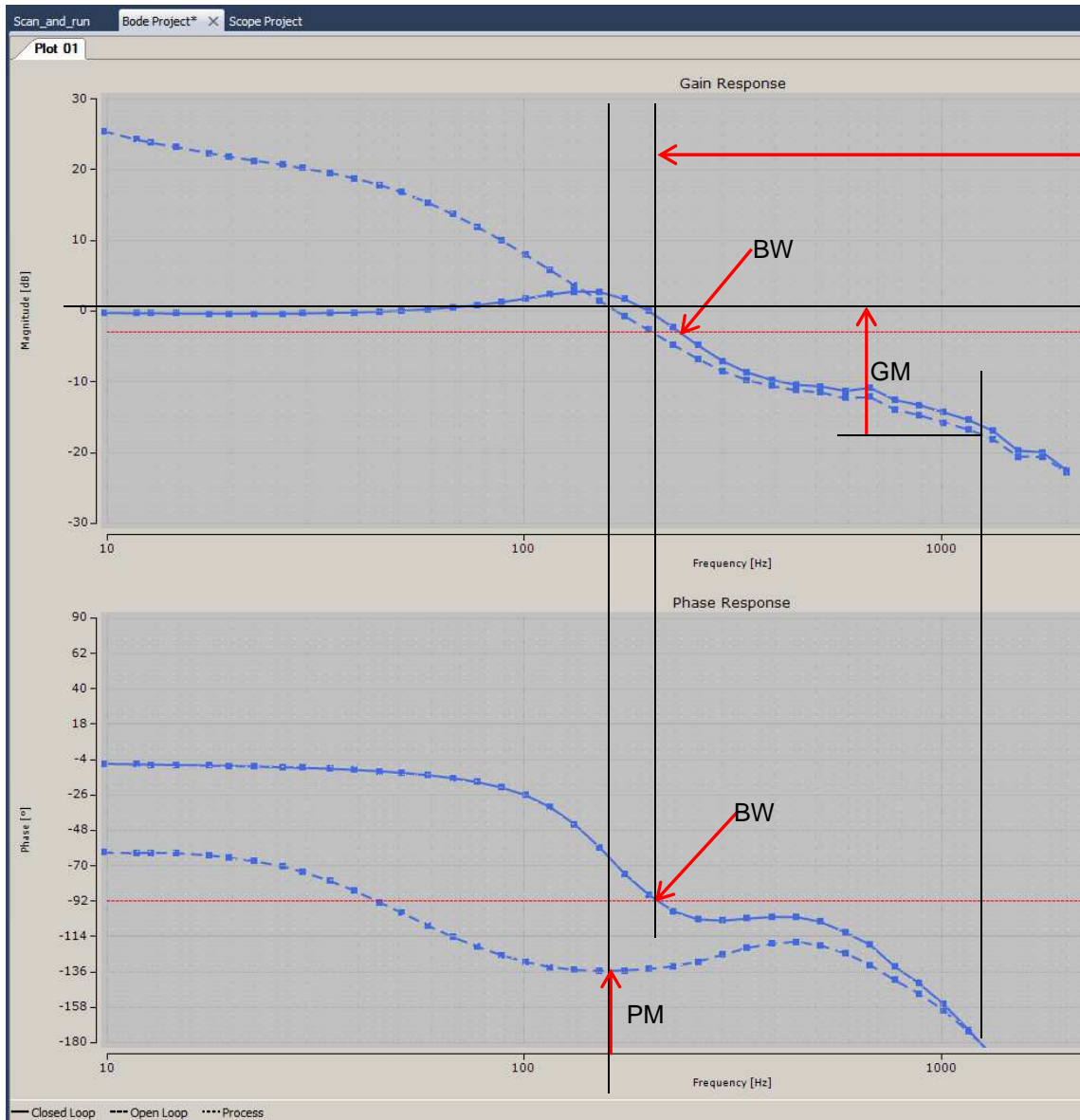
- Bode plot in AX5000, the final result.



- Why using a Bode plot?

The bode plot in AX5000

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The bandwidth BW is taken from the closed loop result.

Bandwidth at -3db or -90deg phase shift, depending what is first. In this case we take the point of -90 deg. It is at 205 Hz.

The phase-margin PM and gain-margin GM measured by open loop.

PM at the point gain reached 0dB.

GM at the point phase reached -180 deg

PM = 180deg – 130deg = 50deg

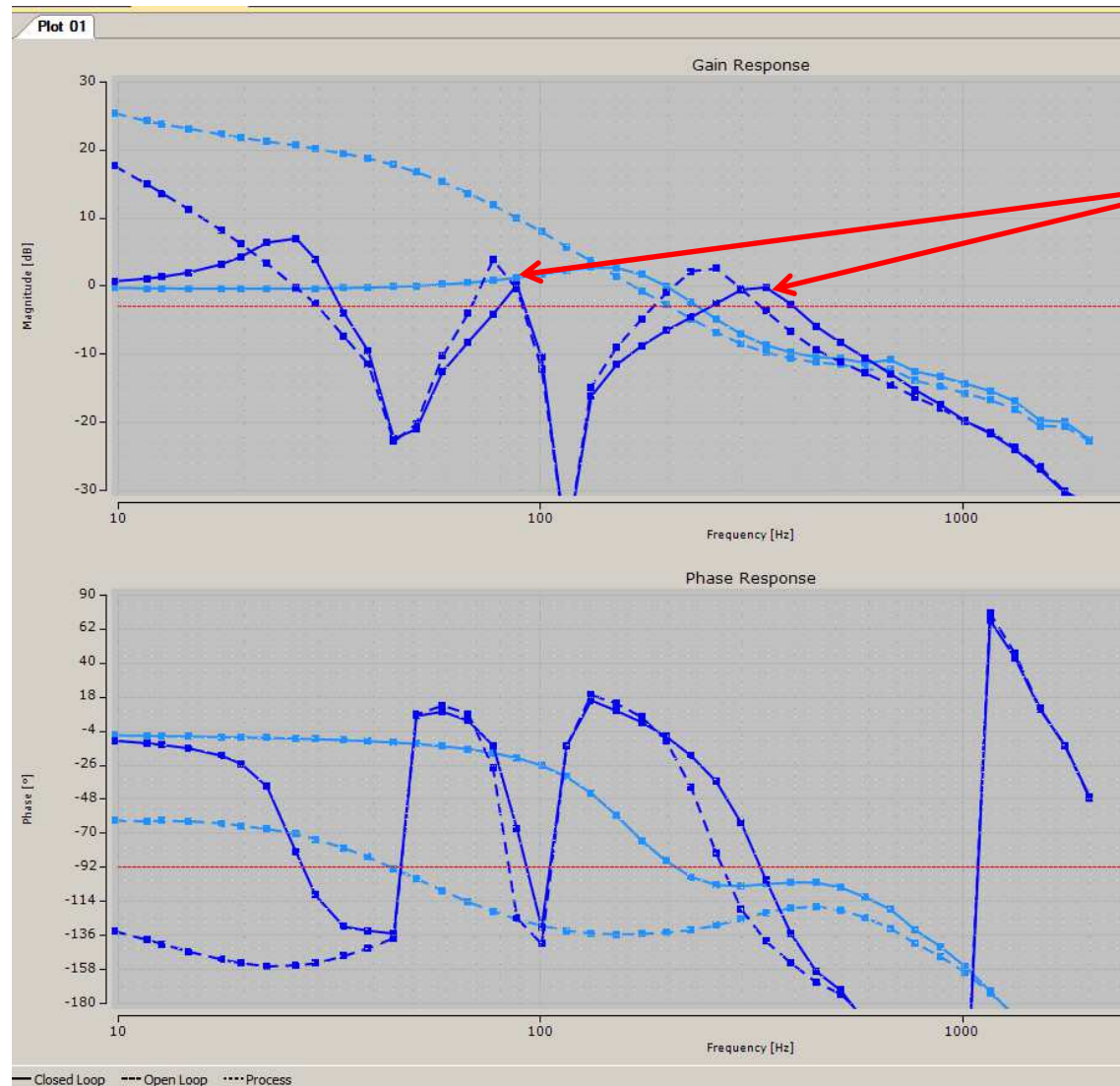
GM = 18 dB

The gain margin GM should be in a range of 10 to 25 dB.

The phase margin PM should be in a range of 35 to 80 deg.

The bode plot in AX5000

BECKHOFF

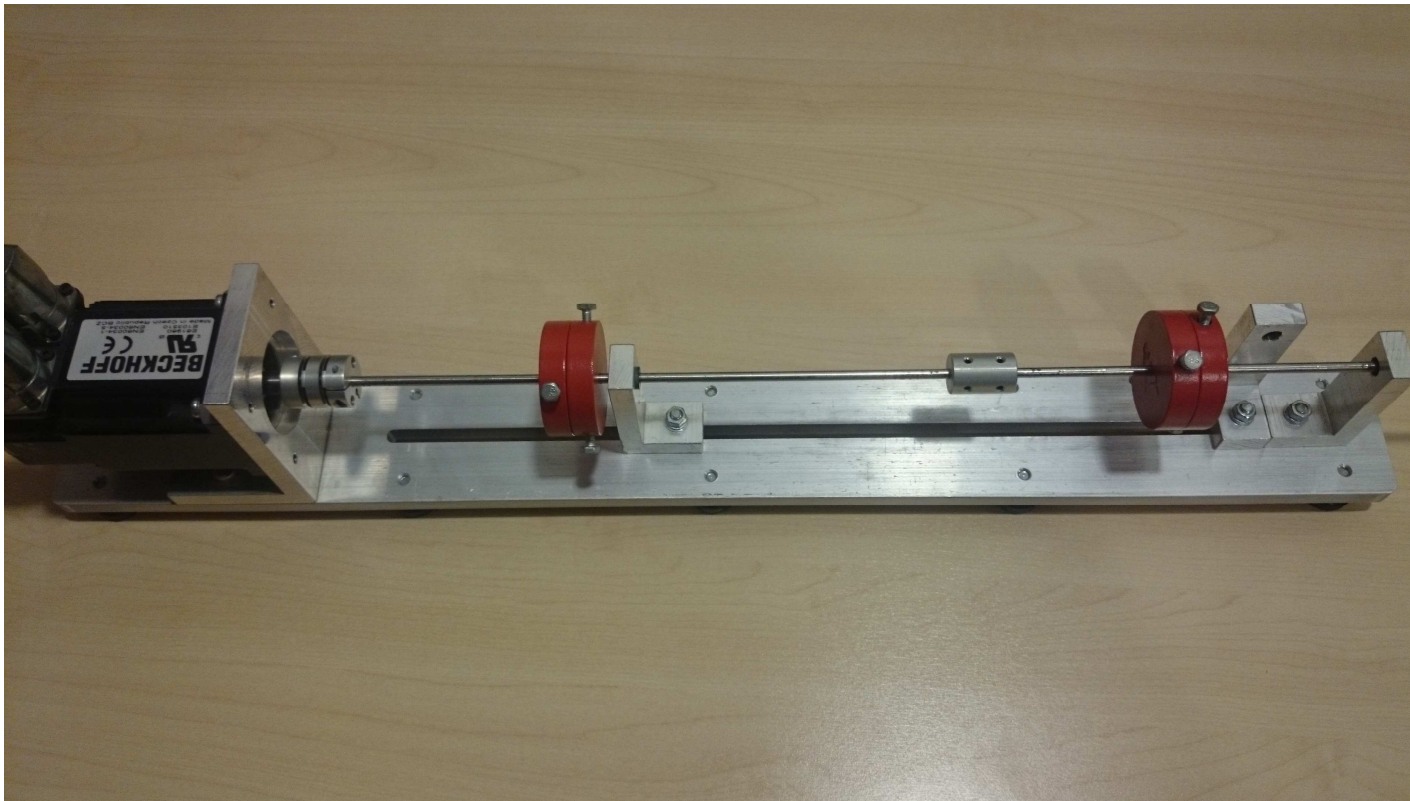


- What is this?
- You can see two resonance points

The bode plot in AX5000

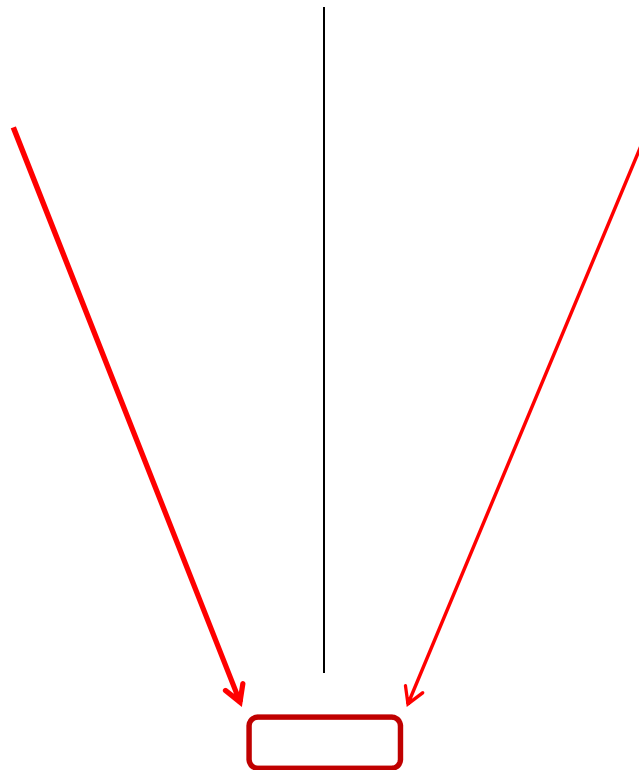
BECKHOFF

- A mechanic like this gives you two resonance points.



Some Questions?

- Hope that you take more as this empty picture?



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