Application Note

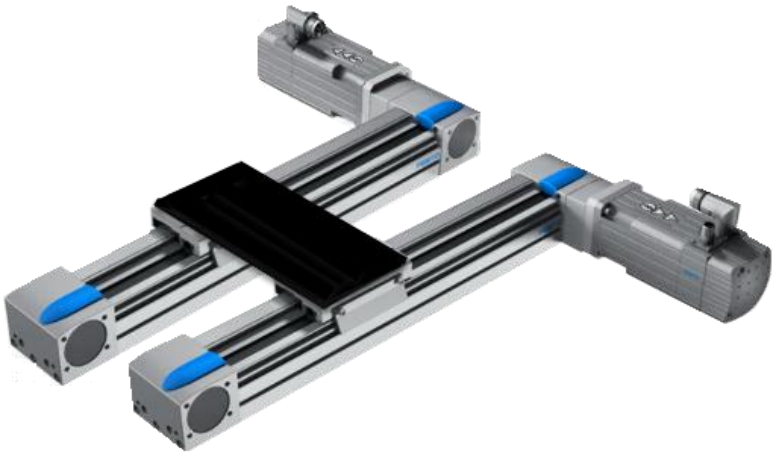
FESTO

CMMT-AS Parallel Axis
Synchronous Position Absolute

CMMT-AS-xx

When 2 physical axes are rigidly coupled together by the load or other means (examples: gantry system X/X' coupled by a Y-Axis or 2 x ESBF rods attached), then it is necessary to synchronise/Gear these axes with an electronic alignment (Master to Slave).

This application note discusses the required settings to control the 2 x parallel linear axes in Synchronous Position Absolute mode using CMMT-AS-xx controllers.



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Document no. 100453
Original .....en
Author .....Festo
Last saved 27.01.2025

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Table of contents

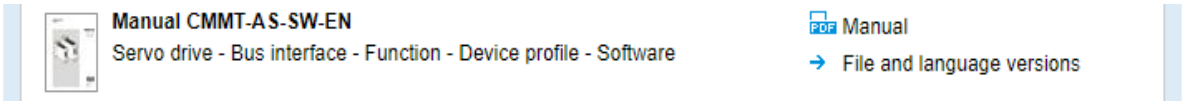
1 Components/Software/Firmware used

Type/ Name	Version Software/ Firmware	Description
CMMT-AS-C4-3A-MP-S1 (Master)	V31.0.7.10	Firmware
CMMT-AS-C4-3A-MP-S1 (Slave)	V31.0.7.10	Firmware
Festo Automation Suite	V2.4.0.442	Software
CMMT-AS Plug-in	V2.4.1.23	Software
RSLogix 5000/ Logix Designer 5000	V20.04	Rockwell Programming Software
1769-L30ERM	V20.019	CompactLogix 5370 Controller
CMMT_EIP_MotionLib.zip	V2.4	Rockwell RSLogix 5000/LogixDesign AOI (Add-On Instruction) Software Library

Table 1.1: 1 Components/Software used

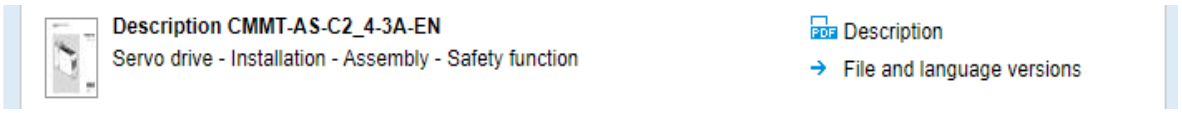
1.1 Recommended Website Downloads

A) CMMT-AS Software/Function/Fieldbus/Device Profile Manual



Reference:
https://www.festo.com/net/en_ca/SupportPortal/Downloads/648237/725657/CMMT-AS-SW_manual_2022-04i_8173126g1.pdf

B) CMMT-AS Wiring & Installation Manual

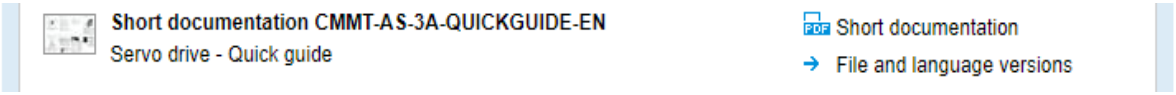


Reference:
https://www.festo.com/net/en_ca/SupportPortal/Downloads/648246/720730/CMMT-AS-C2_4-3A-_manual_2022-03e_8173941g1.pdf

C) CMMT-AS Wiring & Installation Safety Function Manual

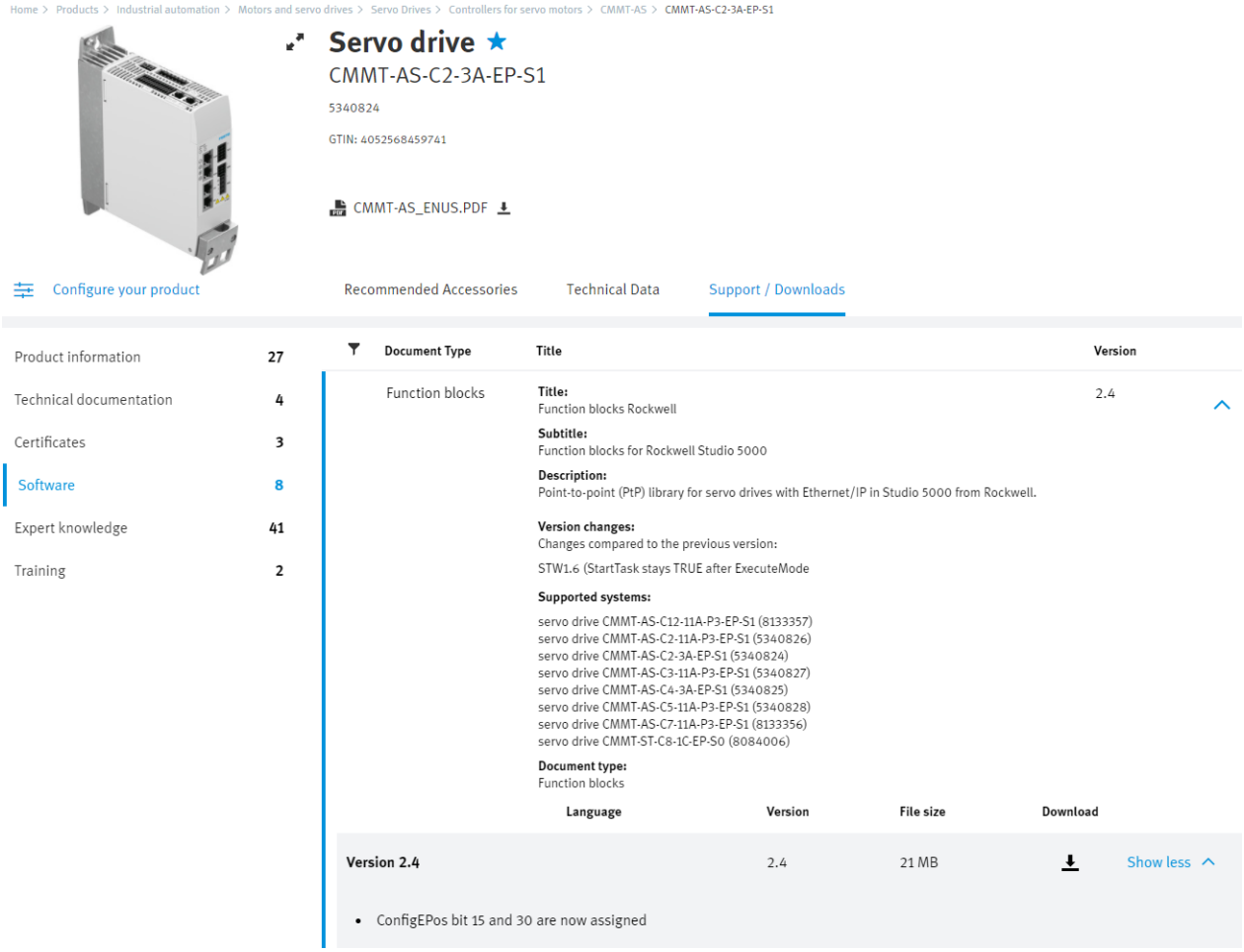
Reference:
https://www.festo.com/net/en_ca/SupportPortal/Downloads/648247/720882/CMMT-AS-_-S1_manual_2022-03e_8173923g1.pdf

D) CMMT-AS Short Documentation/Quick Guide Manual



Reference:
https://www.festo.com/net/en-gb_gb/SupportPortal/Downloads/629760/696705/CMMT-AS-3A-QUICKGUIDE_2019-05_8100291g1.pdf

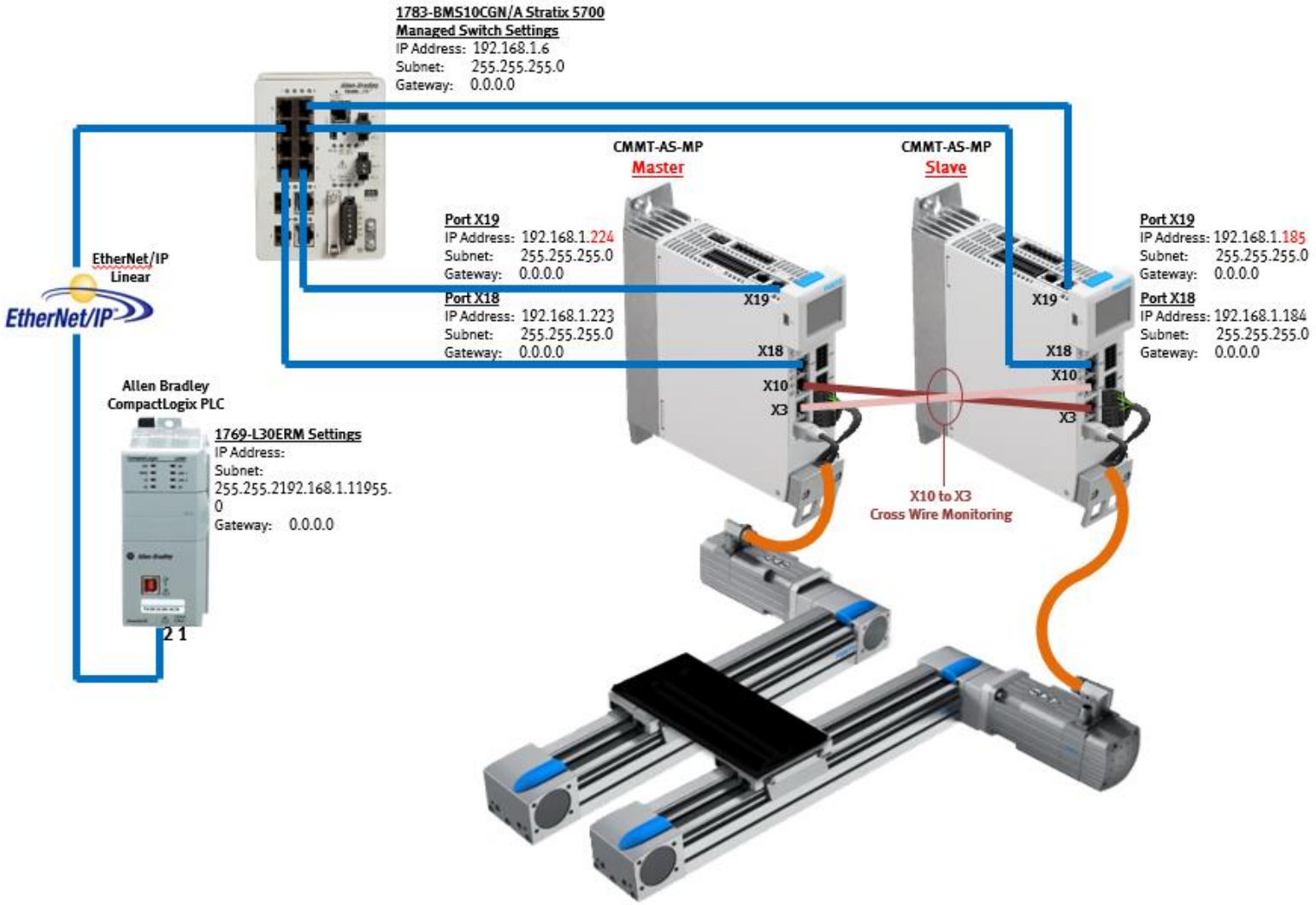
E) Rockwell RSLogix 5000/LogixDesign AOI (Add-On Instruction) Software Library



https://www.festo.com/net/en-ca_ca/SupportPortal/Downloads/654836/724629/CMMT_EIP_MotionLib%20v2.4.zip

1.2 Network Topology of the tested system

Please refer to the picture below and make sure all wires are correctly placed and connected. The user manuals (reference provided in section 1.1 Recommended Manuals) will need to be referenced for other wiring not shown here.



2 Overview of Required Steps

1. Both the **Master and Slave axis must use a multi-turn absolute encoder**.
2. Master and Slave axis must be mechanically aligned.
3. Reference both axis so they have the same absolute position value (perfect electronic alignment) and the user is not to execute additional references after the initial commissioning (Exception for motor/controller replacement when needing to re-establish this alignment)
4. After E-Stop or Control Enable are removed or Supply power is lost or Encoder signal failure is detected, the axes need to be re-synchronised/Geared In (electronic alignment).
5. This application guide discusses ways to implement monitoring of Slave faults and Encoder Emulation cable monitoring. Although it is described in this guide how to configure and monitor certain adverse conditions, it is up to the user to program the PLC to monitor these and other fault conditions/status for both Master and Slave and then react according to their design.

Up synchronisation, "synchronous position, absolute" mode

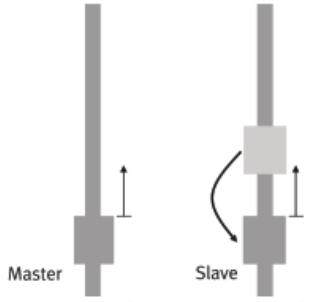


Fig. 115: Synchronous position, absolute (example)

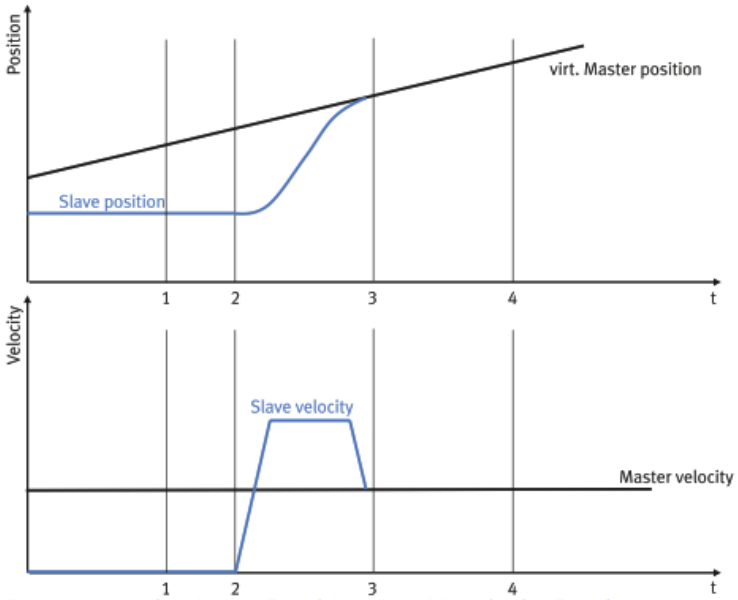


Fig. 116: Up synchronisation, "synchronous position, absolute" mode

Caption	
1	"Synchronous position, absolute" mode is executed.
2	Start Sync Pos (start of up synchronisation)
3	Master Sync Pos (target at which up synchronisation must be competed.)
4	End Sync Pos (start of down synchronisation)

Tab. 669: Legend for up synchronisation, "synchronous position, absolute" mode

The synchronisation mode is executed at the position (1). The virtual master position is not changed.
If the virtual master position reaches the position (2) "Start Sync Pos", it is up synchronised to the virtual master position. If up synchronisation is completed, the slave reports the status "Slave synchronous". Up synchronisation must be completed before "Master Sync Pos".
Between positions (3) and (4) the slave reports the status "Slave synchronous".
If the virtual master position exceeds the position (4) "End Sync Pos", the down synchronisation is initiated.

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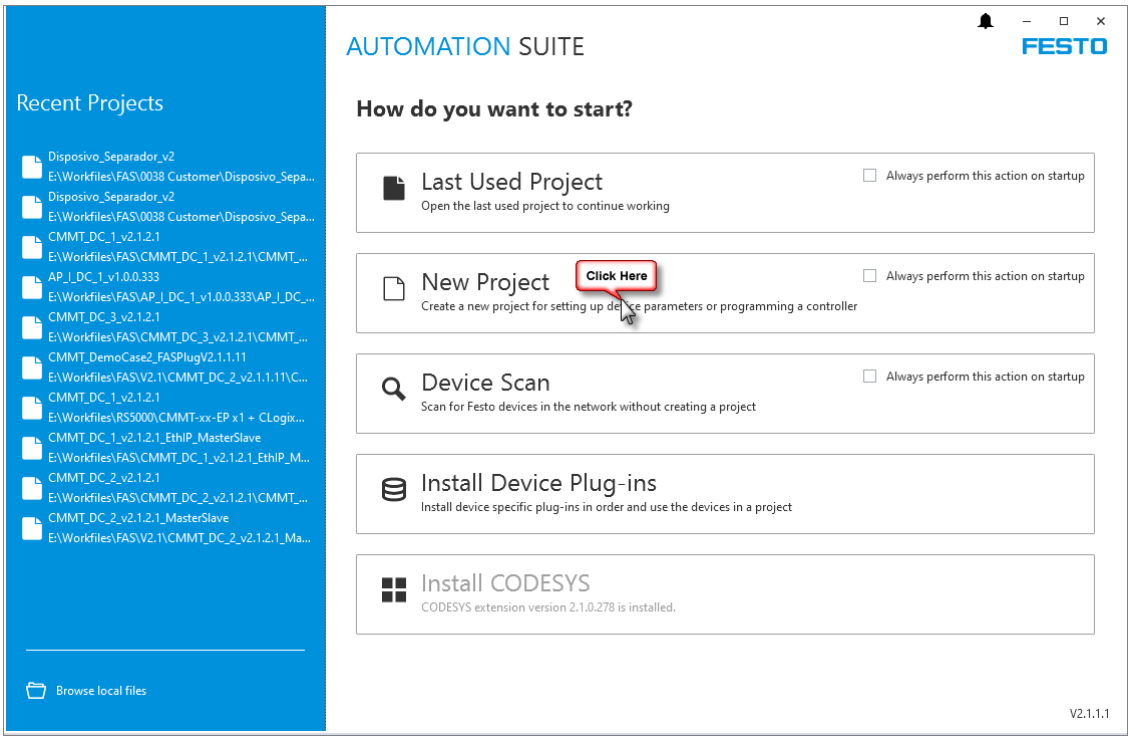
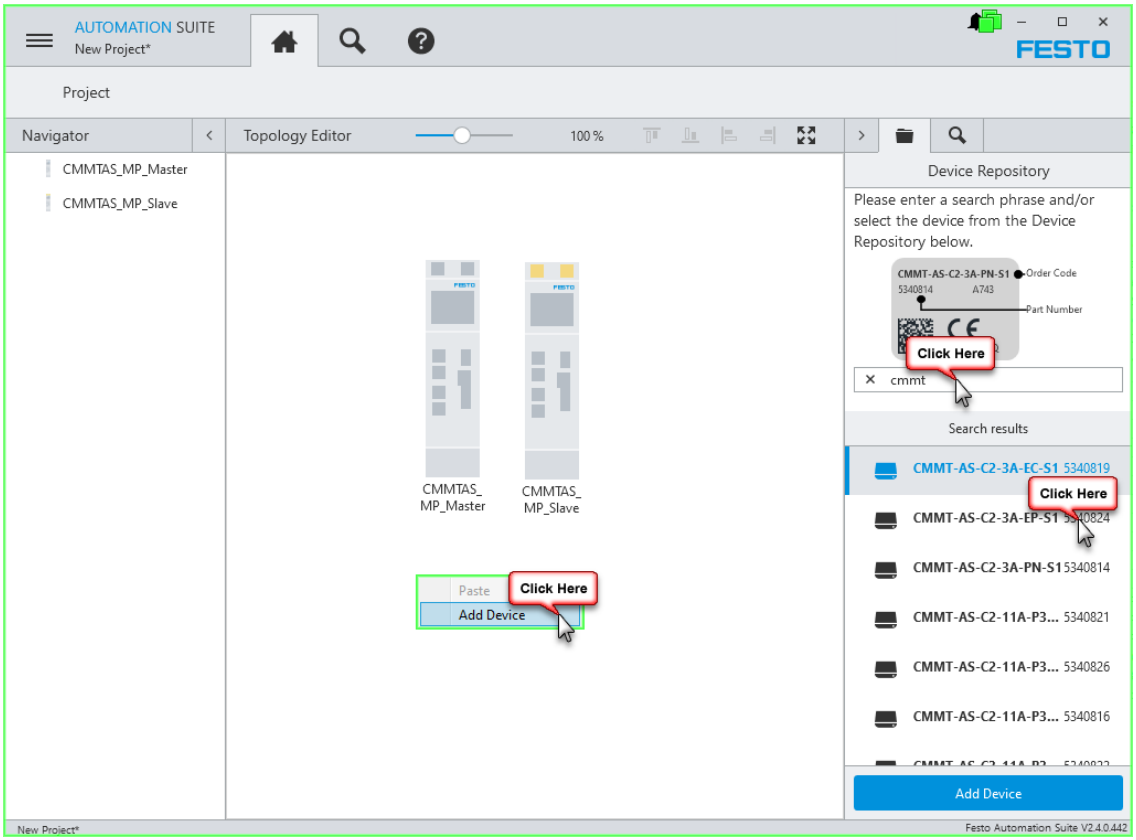
3 Project Configuration

3.1 Create New Project

Start a new project

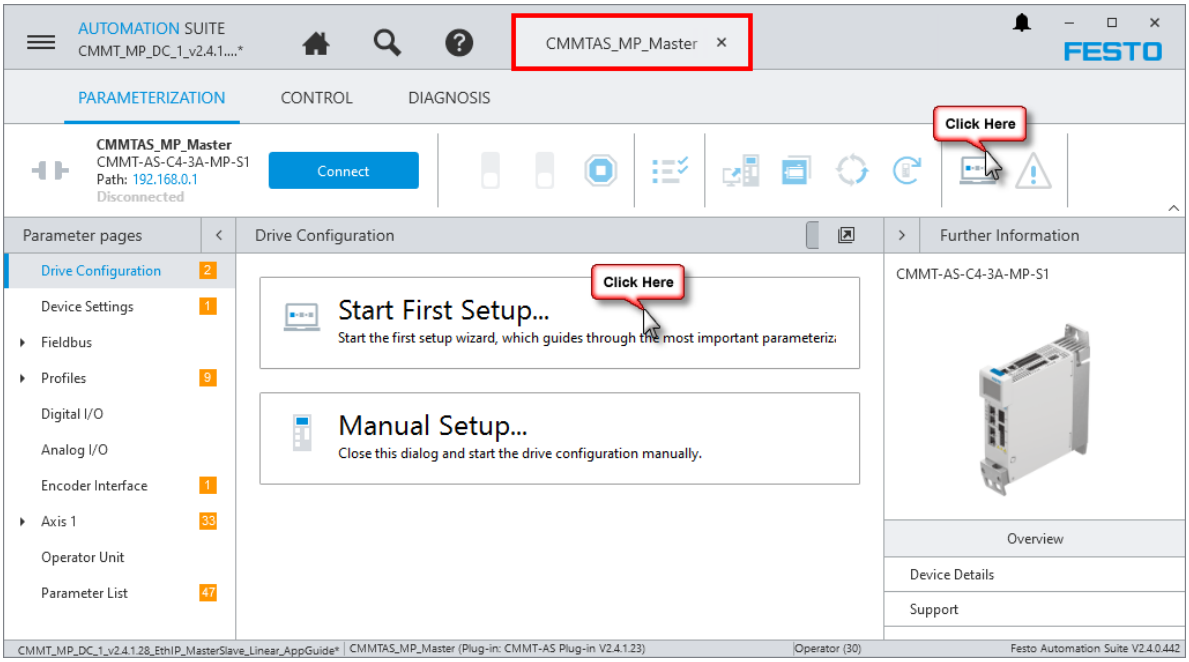


Add the 2 x CMMT-AS-xx-xx-MP controllers you have purchased for the application and name them accordingly



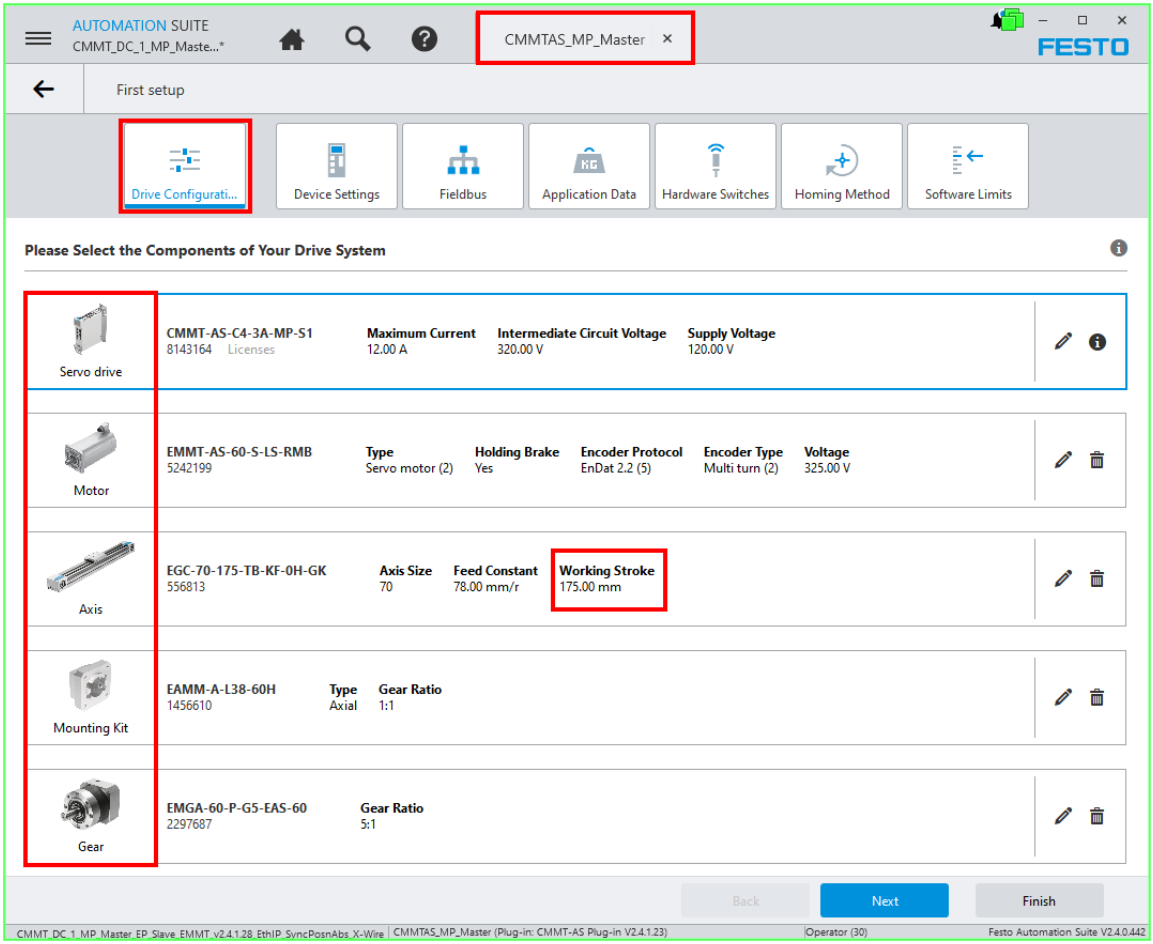
4 Master Axis General Setup

4.1 First setup - Start Wizard



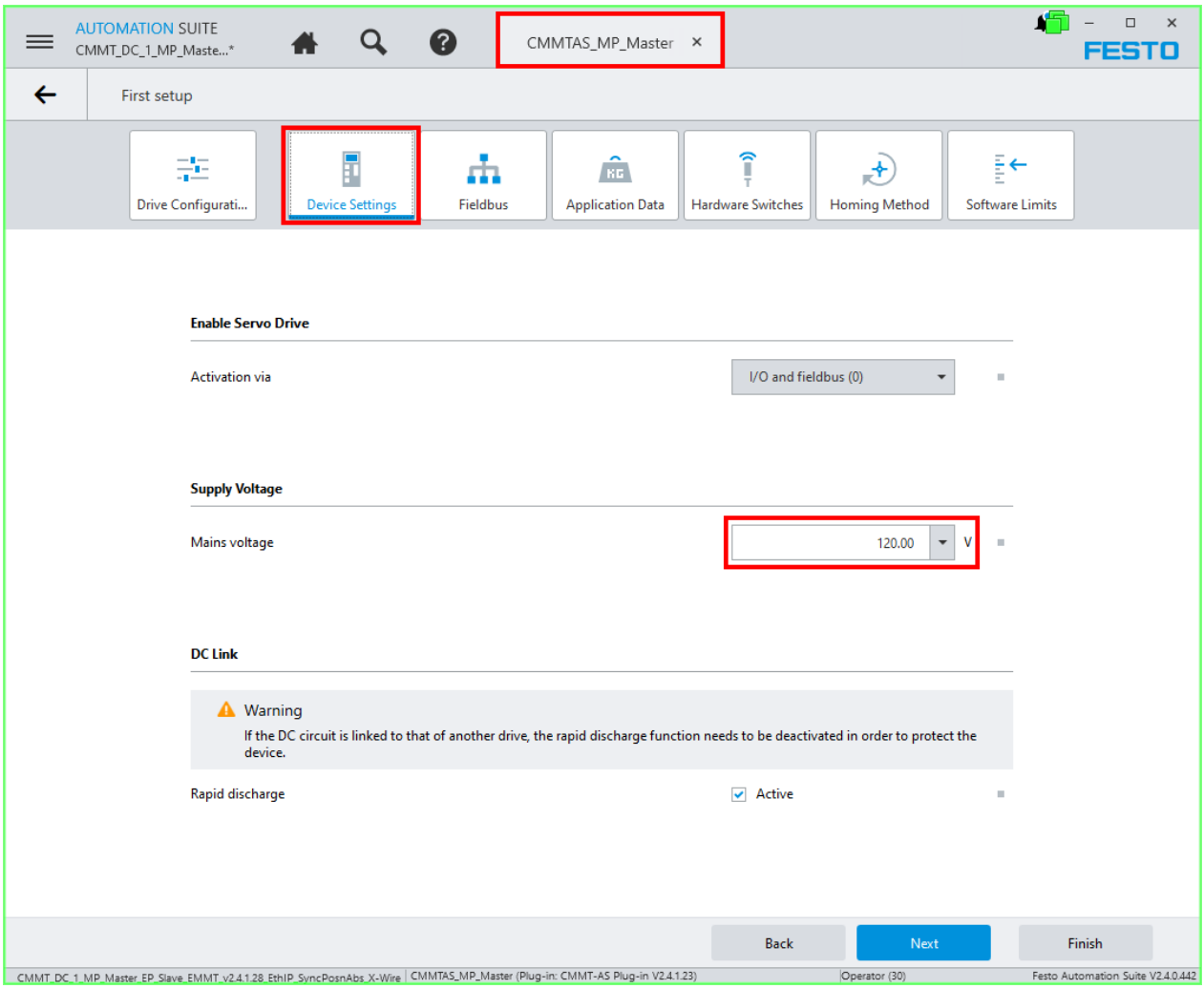
4.2 First setup - Drive Configuration

This application considers the maximum range of 175 mm.



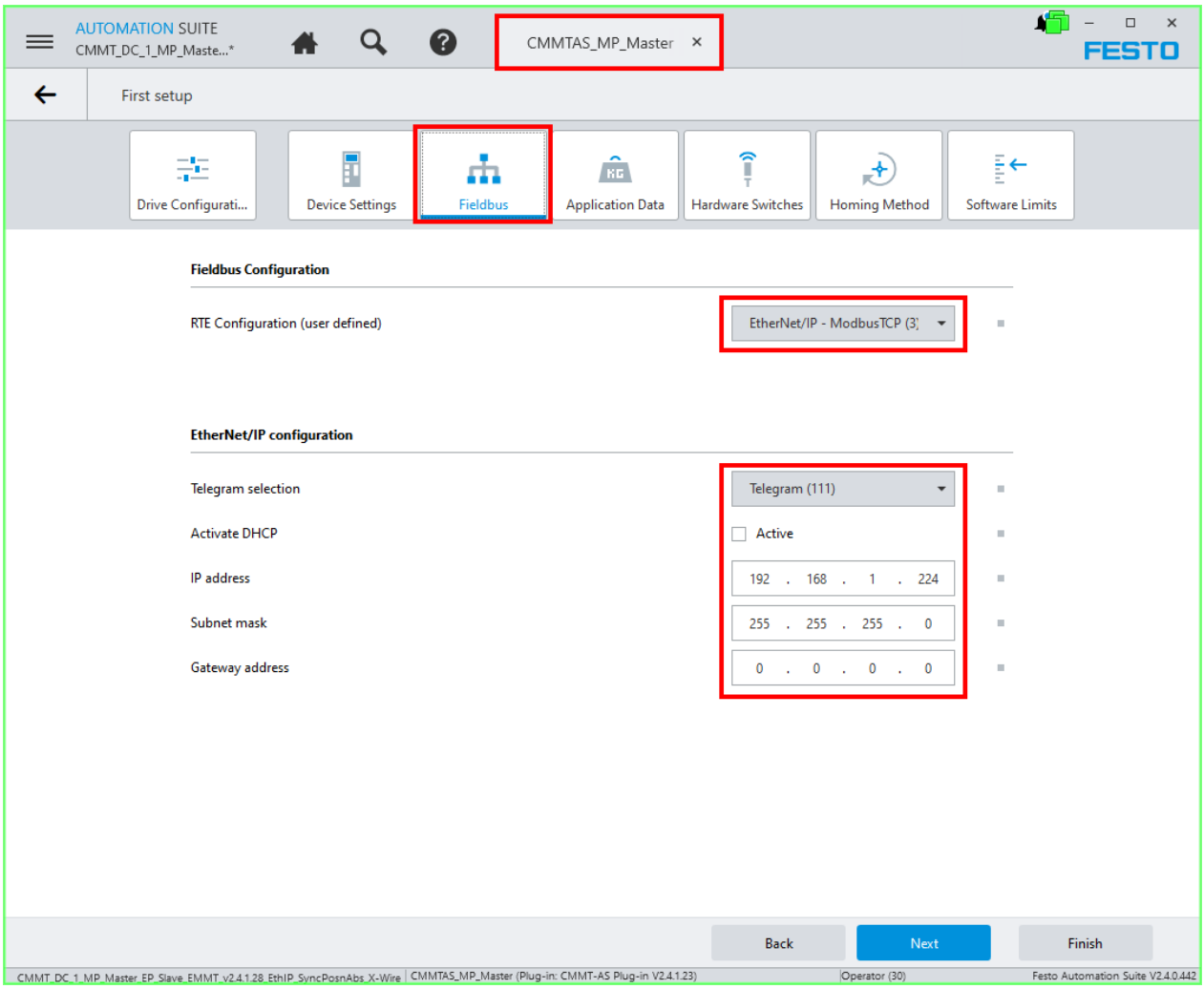
4.3 First setup - Device Settings

Consider the application Supply Voltage and modify from default if needed.



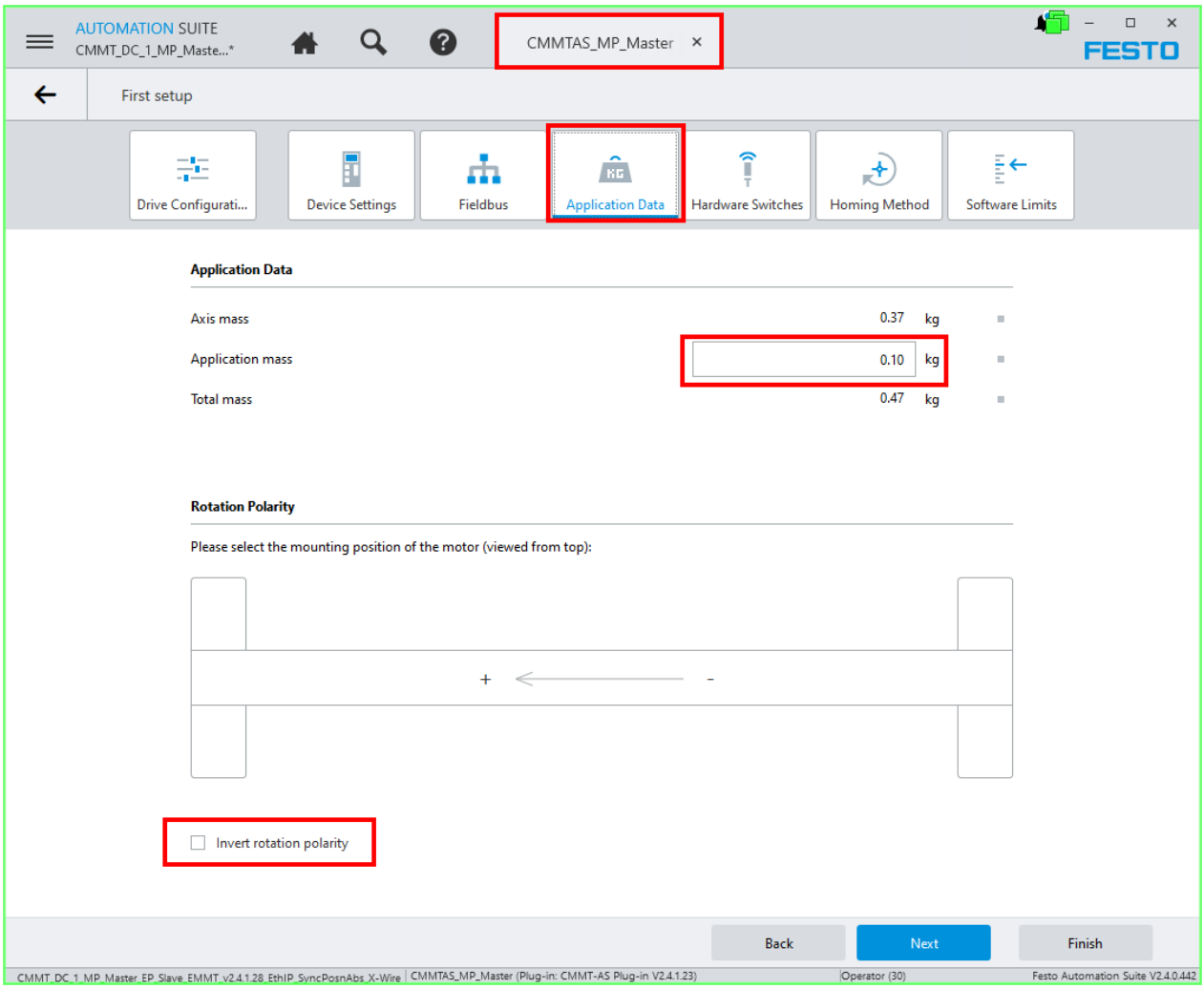
4.4 First setup - Fieldbus

Select EtherNet/IP – Modbus (3) for the RTE ethernet ports and Telegram 111, then modify the IP Address.

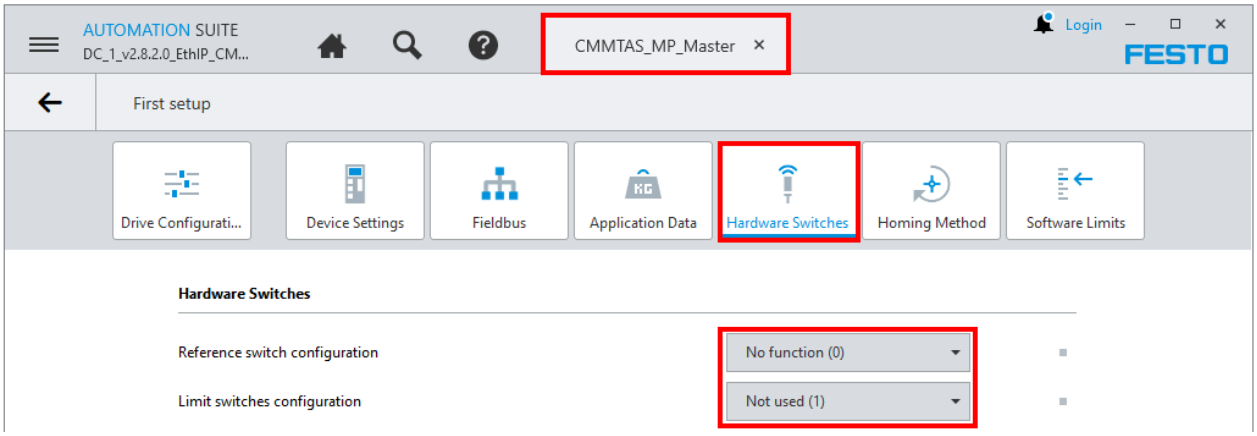


4.5 First setup - Application Data

Consider the application design

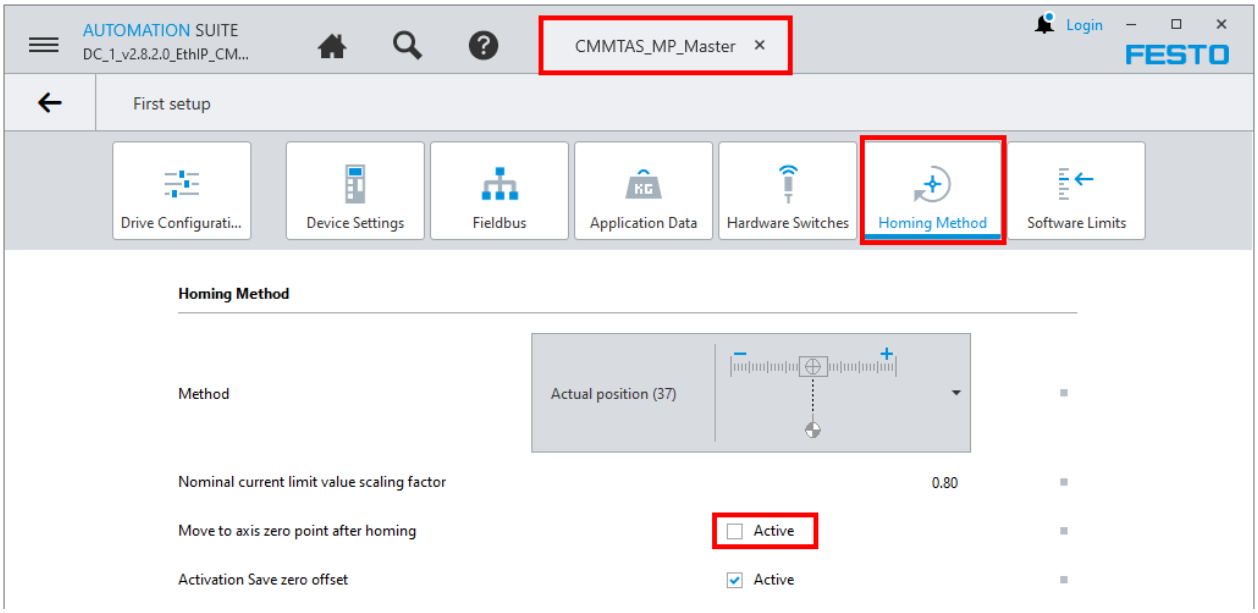


4.6 First setup - Hardware switches



4.7 First setup - Homing Method

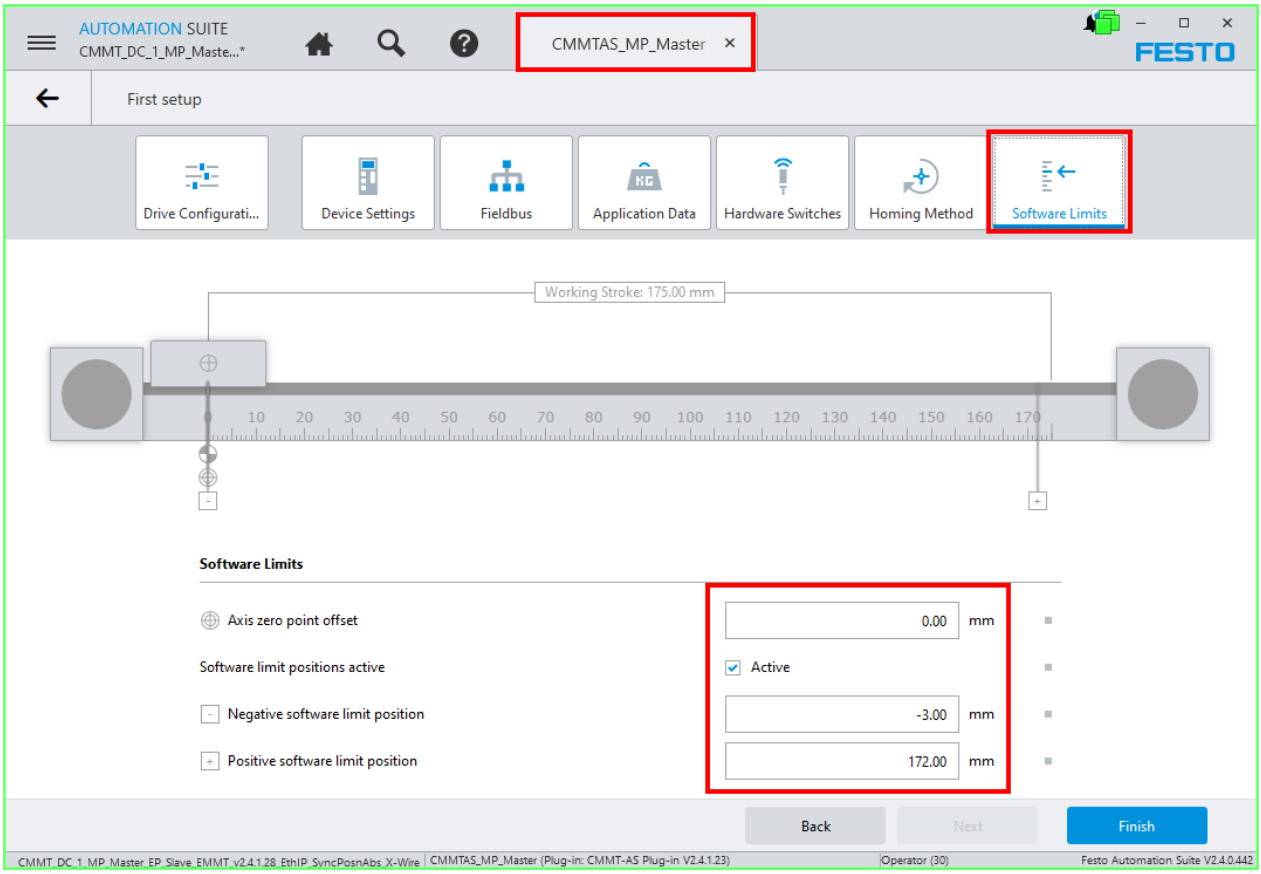
The simplest Homing method is Actual position (37) with no movement. This is because after the mechanical alignment, this allows the axis to reference and store the offset in the existing position without any movement.



4.8 First setup - Software Limits

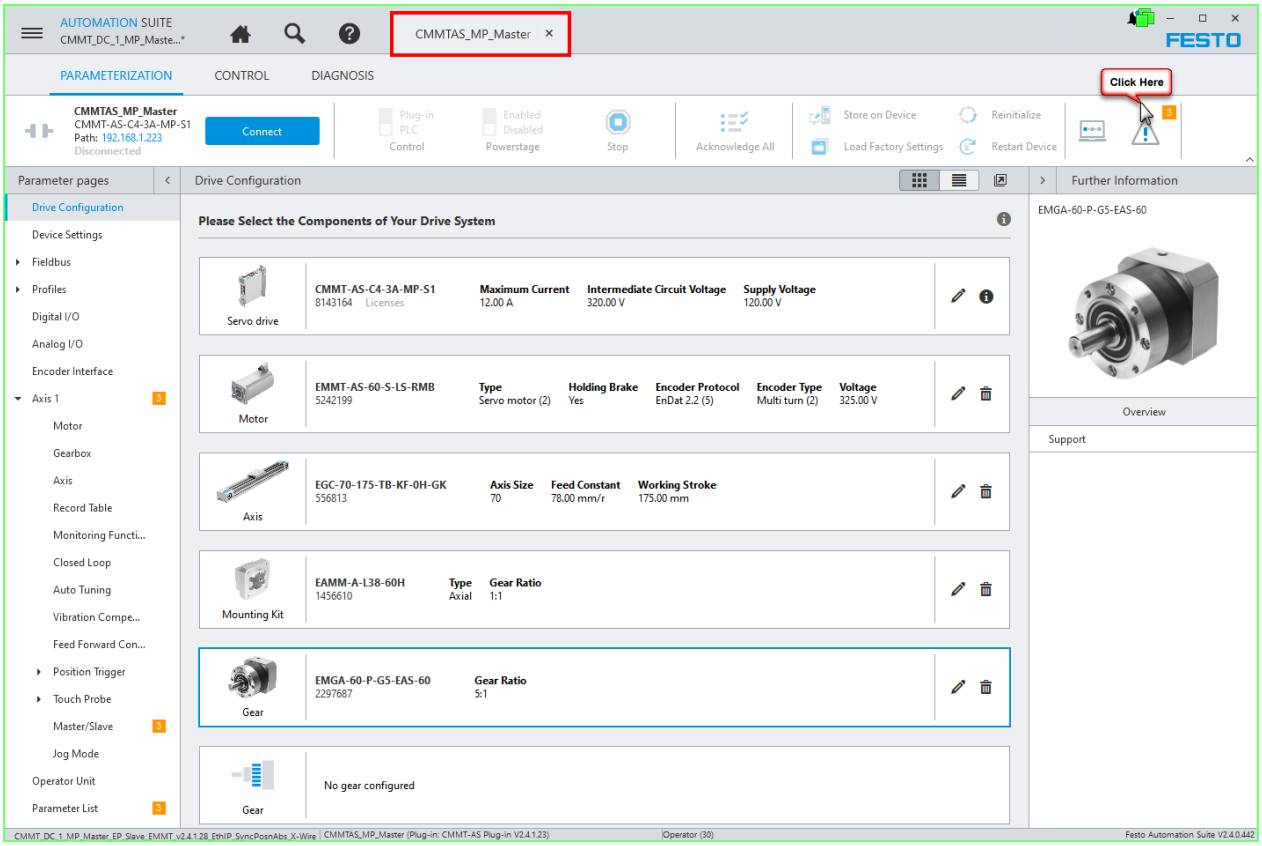
The Axis zero point offset should be configured as 0.00mm because once the axis is physically in place, we don't want to change the zero point.

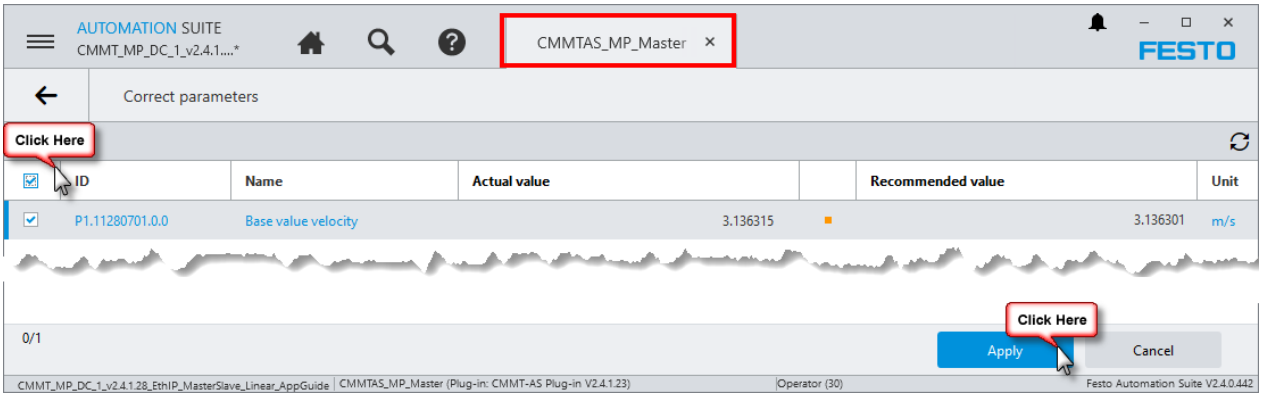
The Software Limits should be observed however, this depends on your application. A software limit larger than that of -3.00mm may be required to avoid mechanical limitations with the Slave alignment.



4.9 Correct Parameters

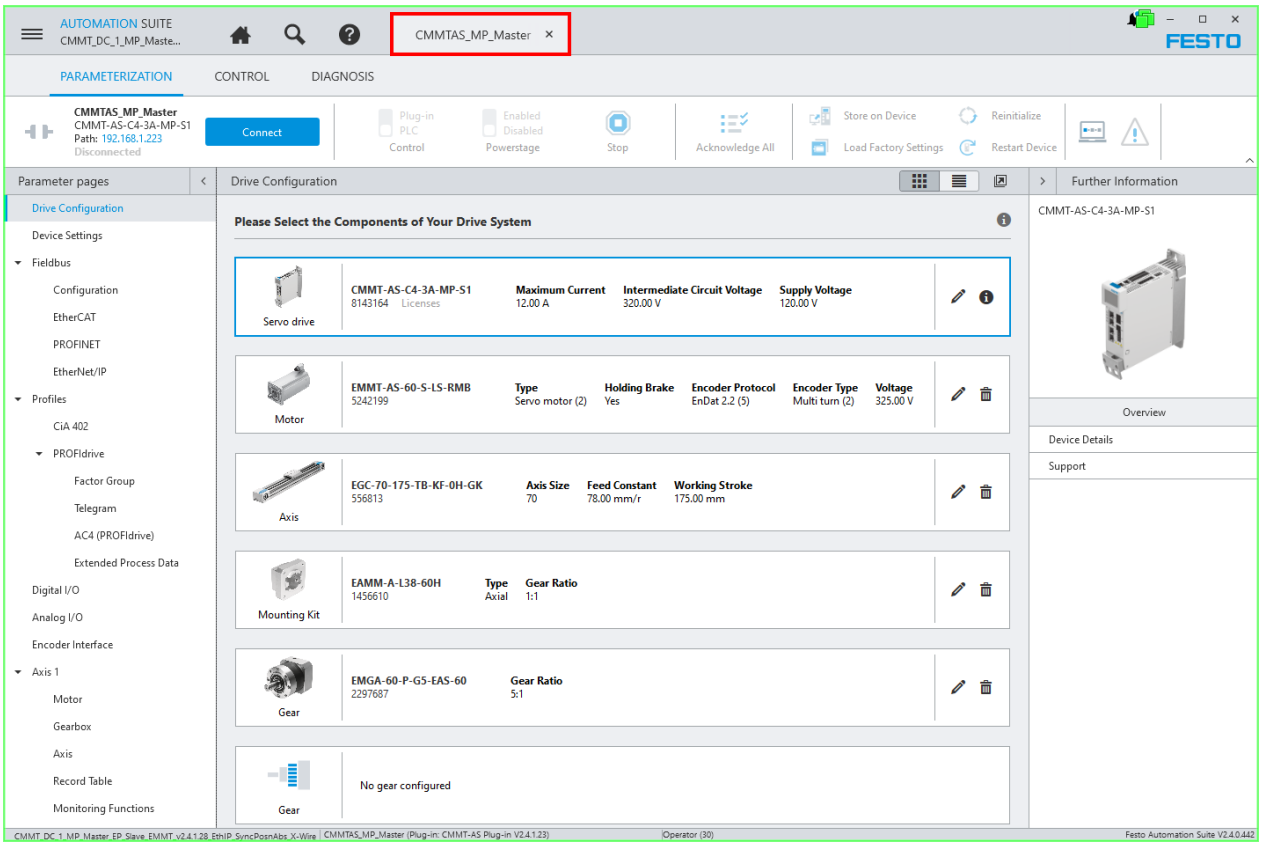
If you find orange adorners/indicators, these are warning to indicate unfavorable or inconsistent values and these may need to be modified. It is recommended to use the “Correct Parameters” function to modify the parameters with recommended values as shown below.





4.10 Setup Complete

Master axis general configuration is now complete.

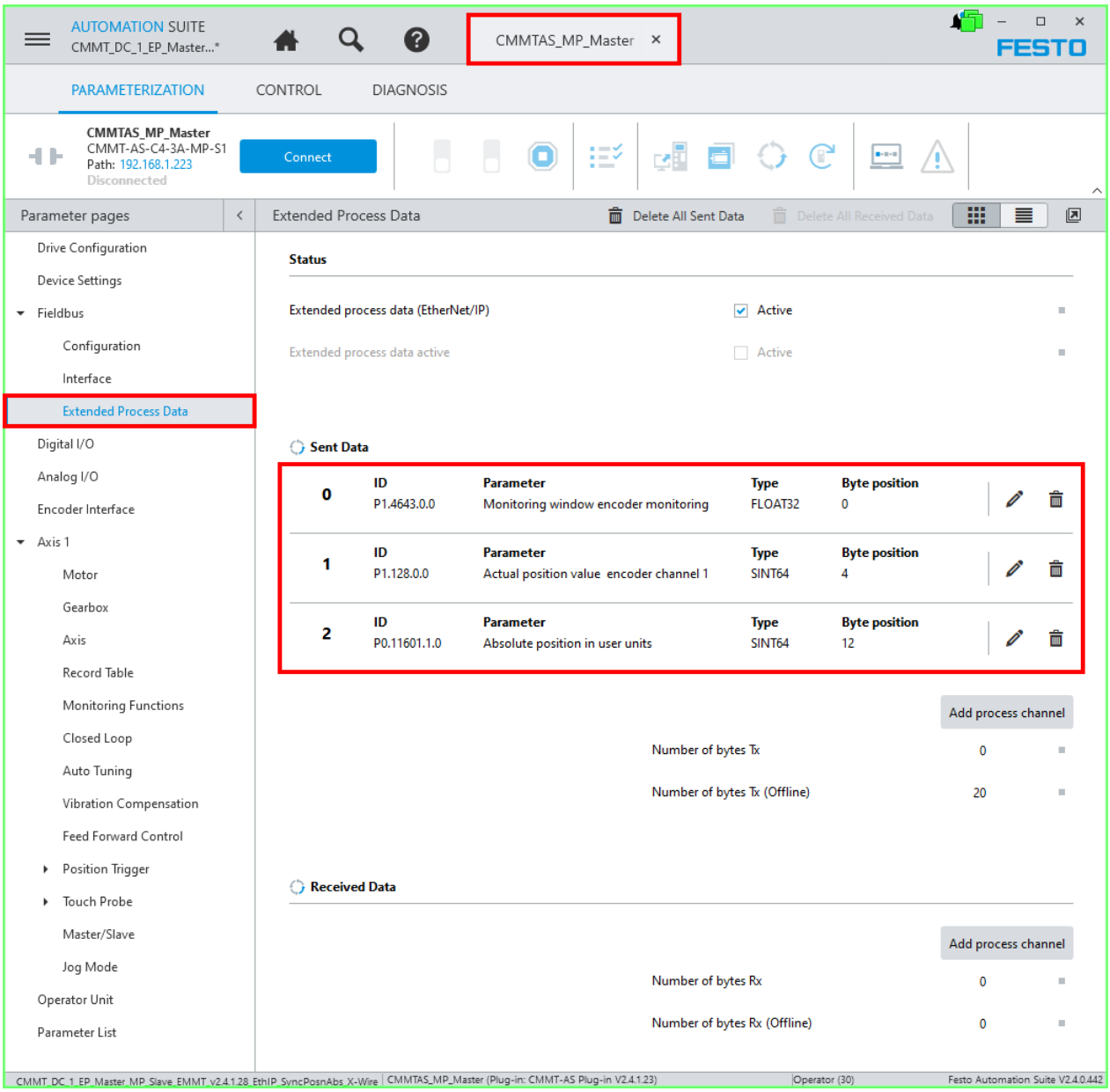


5 Master Axis Changes Required for Synchronous Position Absolute

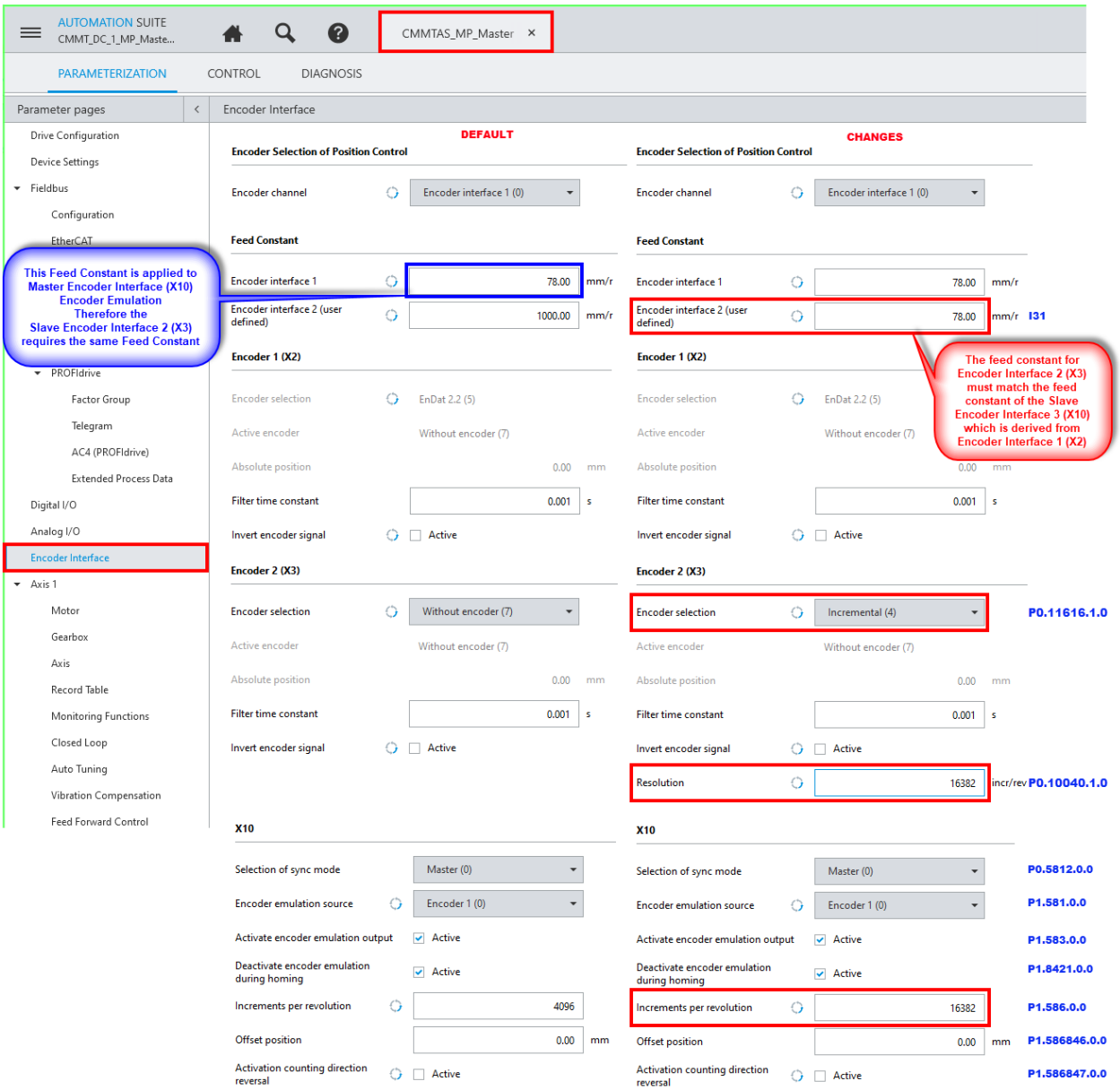
5.1 Extended Process Data (EPD)

Configure all Sent/Received data as shown here in the **EXACT** order shown (Do NOT use editor to modify order):

Sent Data	P1.4643.0.0 P1.128.0.0 P0.11601.1.0
Received Data	Not Used



5.2 Encoder Interface



See section 8.4 (Master and Slave X10 to X3 physical connections) for an overview about Encoder interfaces.

I31 Encoder Interface 2
In Festo Automation Suite (FAS) and in general for this application, the encoder interfaces have the following meaning:
Encoder 1[X2] = Actual Position of Motor Encoder
Encoder 2[X3] = Actual Position Emulated by opposite Controller
Encoder 3[X10] = Encoder 1[X2] Actual Position Emulation
The feed constant for Master Encoder Interface 2 (X3) must match the feed constant of the Slave Encoder Interface 3 (X10) which is derived from Slave Encoder Interface 1 (X2)

P0.11616.1.0 Encoder Selection
Set Encoder 2 [X3] encoder selection to incremental (4) which is used for X10 and X3 cross wiring monitoring. The Slave axis interface X10 will be configured to emulate differential A,B,N signals which will be received by this Encoder 2 [X3] interface for the purpose of position difference monitoring.

P0.10040.1.0 Resolution
The Slave axis Encoder 3[X10] will be set as 16382 so the Master Encoder 2[X3] should be set to the same value. See the caution note 2 on this page.

P0.5812.0.0 Selection of Sync Mode
Here we configure as Master(0) so Encoder 3[X10] will emulate/transmit Encoder 1[X2] Actual Position in the form of differential A,B,N signals. The Slave axis will be synchronised/Geared to this Master Position.

P1.581.0.0 Encoder Emulation Source
Encoder 1 (0) refers to the Primary Motor Encoder at connection X2
Encoder 2 (1) refers to a secondary Encoder at connection X3
Setpoint position (2) will transmit setpoint position signal (normally less noise is observed), however when the Master is disabled, no setpoint is changed and therefore if the shaft changes, the Slave will not observe this.

Caution 1

If actual values are transmitted to the slave as position signals (P1.581 Encoder Emulation Source = Encoder 1 or Encoder 2), increased noise may occur due to the torque feed forward control in the synchronous phase. The torque feed forward control is switched off by setting parameter Px.968 to 0.

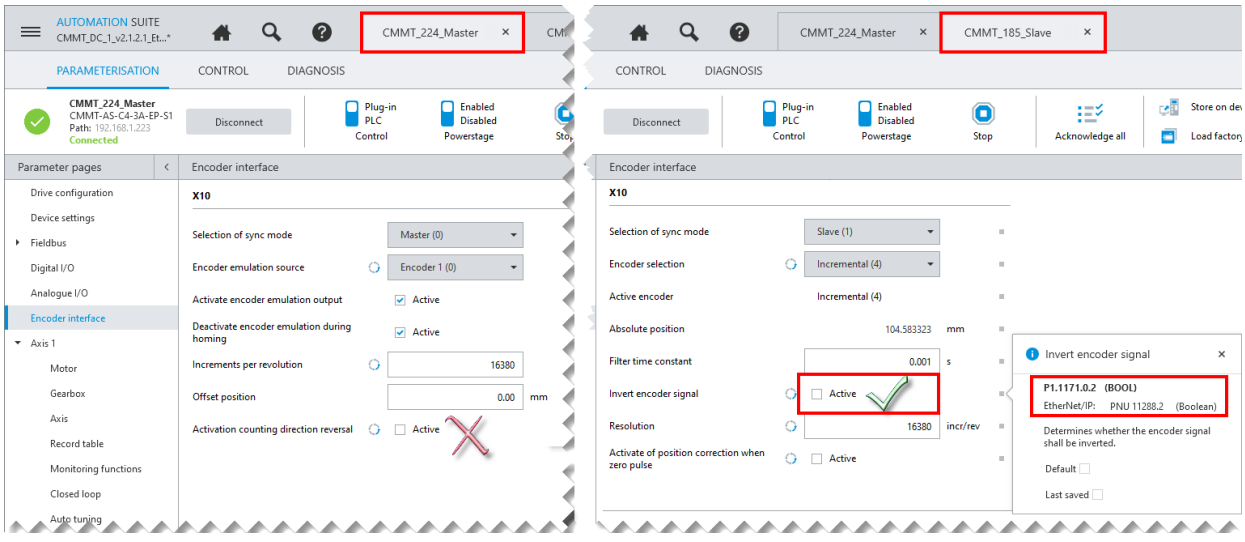
P1.8421.0.0 Deactivate Encoder Emulation During Homing
If enabled, whilst a reference/home routine is executed, X10 Encoder Emulation will be inhibited.
With this application, it is expected the axis are referenced/homed only once during commissioning and are NOT to be not referenced/homed repeatedly. Among many reasons, it is expected the Master and Slave axis both have Multi-Turn Absolute Encoders. Due to the fact this application has Master and Slave axes rigidly coupled and due to the encoder difference monitoring, it should be decided by the user if encoder signals are always transmitted even during a home routine.

P1.586.0.0 Increments per revolution
The Slave axis Encoder 3[X10] will be set as 16382 so the Master Encoder 2 [X3] should be set to the same value. 16382 Increments per revolution also allows for better tuning when in Synchronisation. (The greater the selected value the lower the resulting noise on the connected slave axes).

Caution 2

- **The same increments per revolution should be set on the opposing encoder connections of the Master and Slave drives.**
- **DO NOT USE THE VALUE "16384" for Increments per revolution.**
  This will result with an exception in the firmware when re-initializing the drive (div/0) and the hardware will need to be replaced (cannot be fixed onsite).
  The firmware release V19.0.4.72 is supposed to address this issue.

When it is necessary to adjust the direction of rotation in an application, the Px.1171 direction reversal should be used in the slave drive.



5.3 Record Table

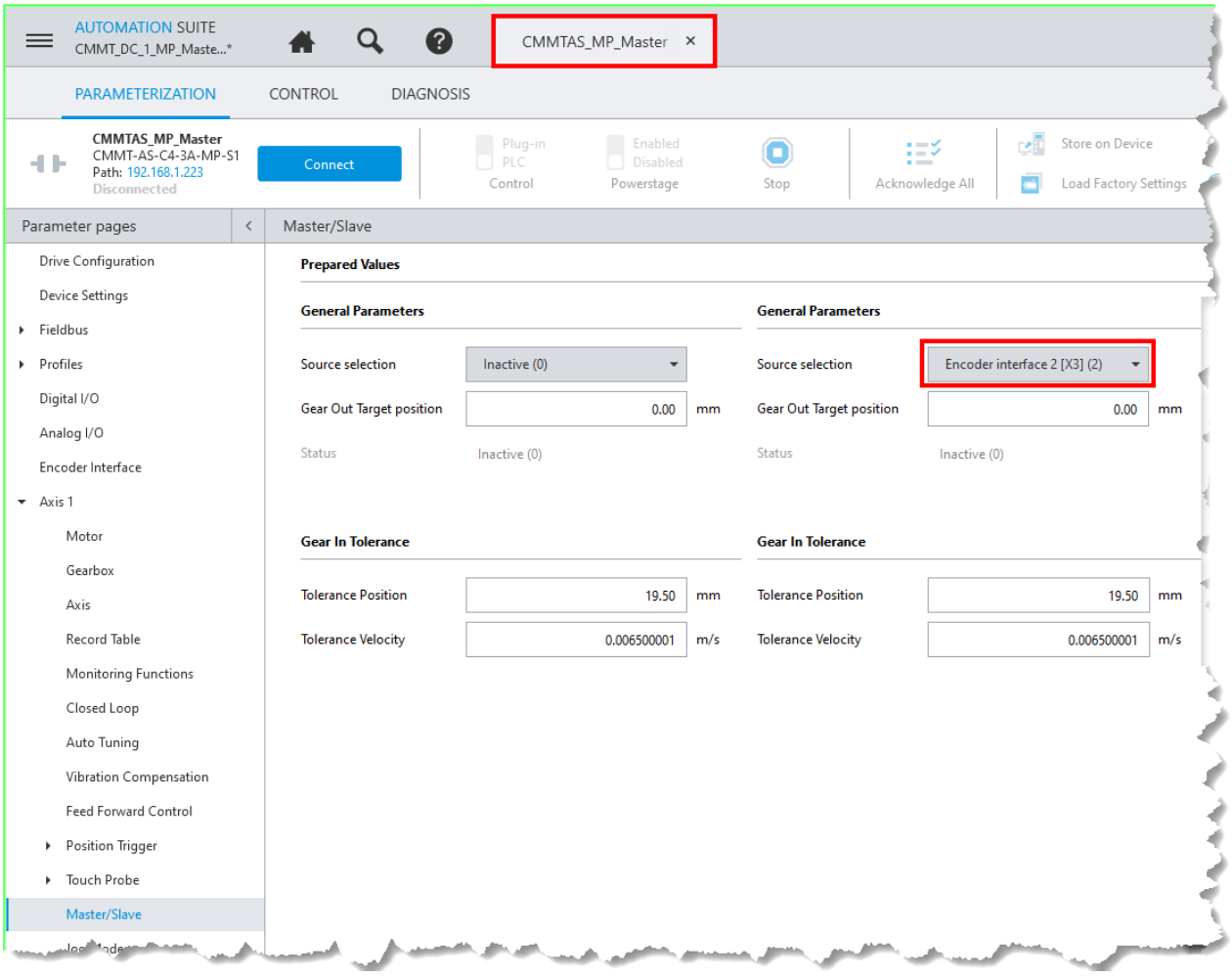
There are no records configured, however, please consider the important facts.

NOTE:

Within the required PLC program, a "Method" is used to Set Master Gear In Position instead of using a record. This is because before a record table task can be executed, the controller MUST BE ENABLED WITHOUT FAULTS and so, for error recovery, the "Method" is much more convenient with this application.

5.4 Master/Slave

Choose Encoder interface 2 [X3] (2) as source selection because this will be used for the encoder emulation cross-wire cable monitoring.



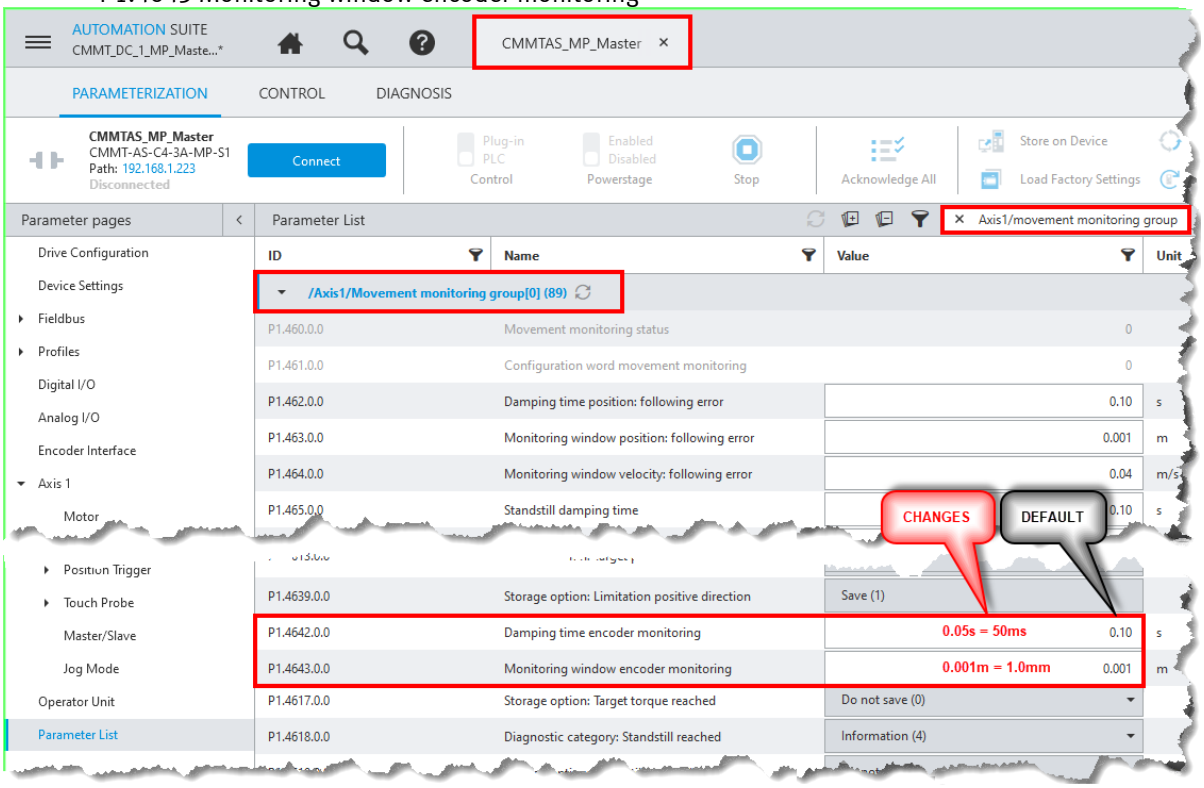
5.5 Parameter List

5.5.1 P1.4643.0.0 Monitoring Window Encoder Monitoring

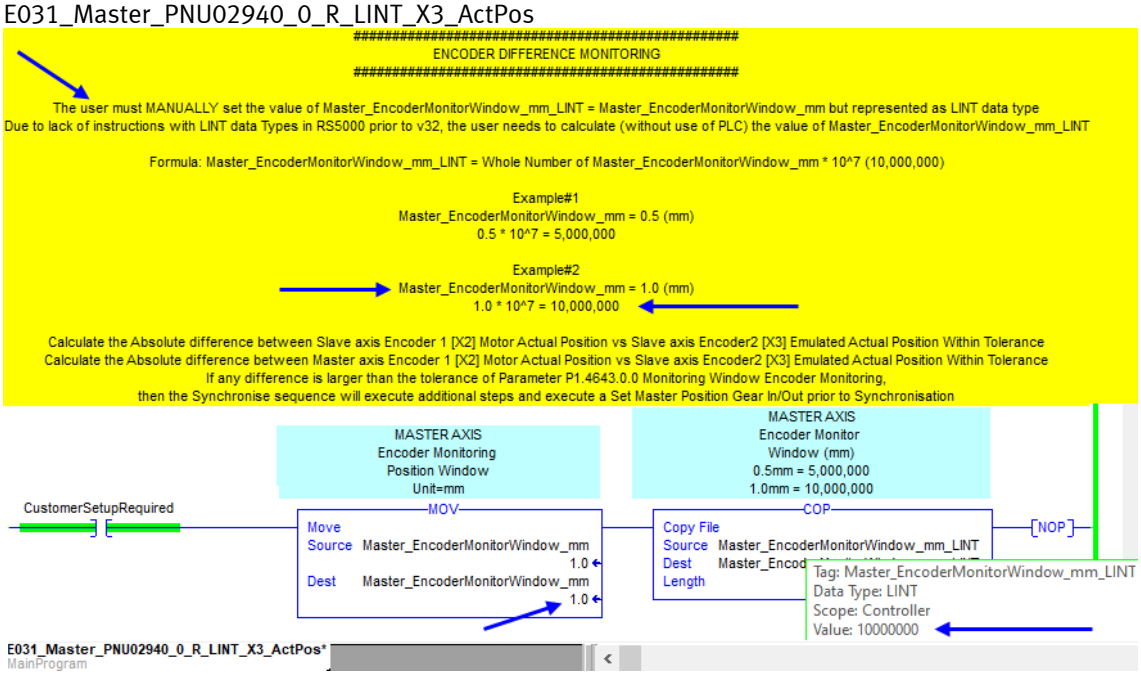
In Festo Automation Suite (FAS) and in general for this application, the encoder interfaces have the following meaning:
Encoder 1[X2] = Actual Position of Motor Encoder
Encoder 2[X3] = Actual Position Emulated by opposite Controller
Encoder 3[X10] = Encoder 1[X2] Actual Position Emulation

In order for Encoder 1 [X2] and Encoder 2 [X3] position difference monitoring to function, configure these group parameters (Axis1/movement monitoring group):

- P1.4642 Damping time encoder monitoring
- P1.4643 Monitoring window encoder monitoring



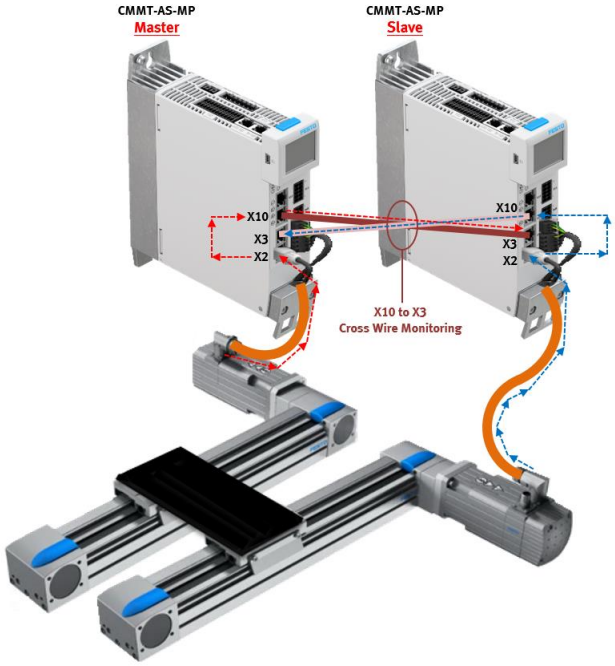
PLC (Programmable Logic Controller) Code will also need to be modified in the following Routine:
E031_Master_PNU02940_0_R_LINT_X3_ActPos



5.6 Error Classification

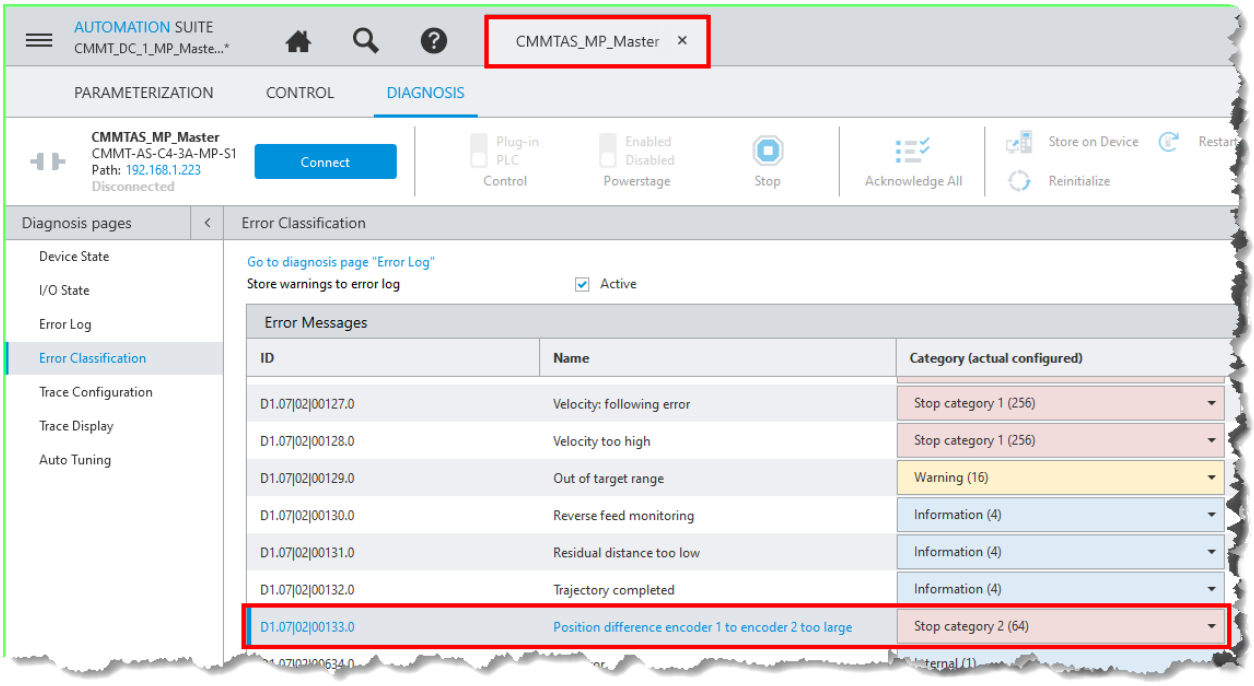
5.6.1 D1.07|02|00133.0 Position Difference Encoder 1 to Encoder 2 too Large

In Festo Automation Suite (FAS) and in general for this application, the encoder interfaces have the following meaning:
Encoder 1[X2] = Actual Position of Motor Encoder
Encoder 2[X3] = Actual Position Emulated by opposite Controller
Encoder 3[X10] = Encoder 1[X2] Actual Position Emulation



Both the Master and Slave will provide an emulated encoder signal (differential A,B,N signals) from Encoder 3[X10] to the opposite controller at Encoder 2[X3]. The Master and Slave use the Encoder 2[X3] emulated encoder signal for the purpose of position difference monitoring.

In the Error Classification, change the error "D1.07|02|00133.0 Position Difference Encoder 1 to Encoder 2 too Large" category from Ignore (2) to Stop Category 2 (64). This setting will demand a Stop Category 2 (detail shown below) by the Master axis during a position deviation larger than parameter P1.4643. The Slave reaction for error 133 will be set to warning so that it will remain following the master in this situation.



Error Stop Level definition:

Tab. 411: Error level, stop category 2

Classification (level)	Reactions
Error, stop category 2	Stop category 2 General error response ▪ Generation of the message and entry in the message directory ▪ The device switches to the error status. ▪ Status LED indicates the error (flashing red). ▪ The normally open contact RDY-C1/2 is opened (ready = open). ▪ Depending on the configuration, an entry is added to the error memory Specific error response of category 2 ▪ The drive is decelerated using the parameterised stop ramp as soon as the error occurs. ▪ When the drive has reached speed 0, the closed-loop controller maintains the drive at the position achieved upon completion of the stop ramp.

ID	Name	Value	Unit
/Axis1/Stop mode group[0] (3)			
P1.12101.0.0	Deceleration Stop ramp	20.00	m/s²
P1.12111.0.0	Jerk Stop ramp	1000.00	m/s³
P1.12112.0.0	Stop ramp velocity	0.05	m/s

Stop ramp velocity
P1.12112.0.0 (FLOAT32)
EtherNet/IP: CIP 11836.0 (REAL)

Jerk Stop ramp
P1.12111.0.0 (FLOAT32)
EtherNet/IP: CIP 11835.0 (REAL)

Stop ramp velocity
P1.12112.0.0 (FLOAT32)
EtherNet/IP: CIP 11836.0 (REAL)

1. Parameterised Decel
2. Closed-Loop remains enabled
4. Output Stage remains enabled

Tab. 412: Error level, stop category 1

Classification (level)	Reactions
Error, stop category 1	Stop category 1 General error response ▪ The same as with stop category 2 Specific error response of category 1 ▪ The drive is decelerated using the defined stop ramp as soon as the error occurs. When the drive is at a standstill, the brake engages and the closed-loop controller is switched off upon expiry of the deceleration delay. If there is no brake, the drive is deactivated directly when at a standstill.

1. Parameterised Decel
2. Physical Brake Engaged
3. Closed-Loop disabled
4. Output Stage Disabled

Tab. 413: Error level, stop category 0

Classification (level)	Reactions
Error, stop category 0	Stop category 0 General response ▪ The same as with stop category 2 Specific error response of category 0 ▪ The output stage is switched off immediately after the error has occurred. The brake is engaged on drives with a brake. The drive runs down if there is no brake.

1. Output Stage Disabled (Run-away)
2. Physical Brake Engaged

5.7 Trace Configuration

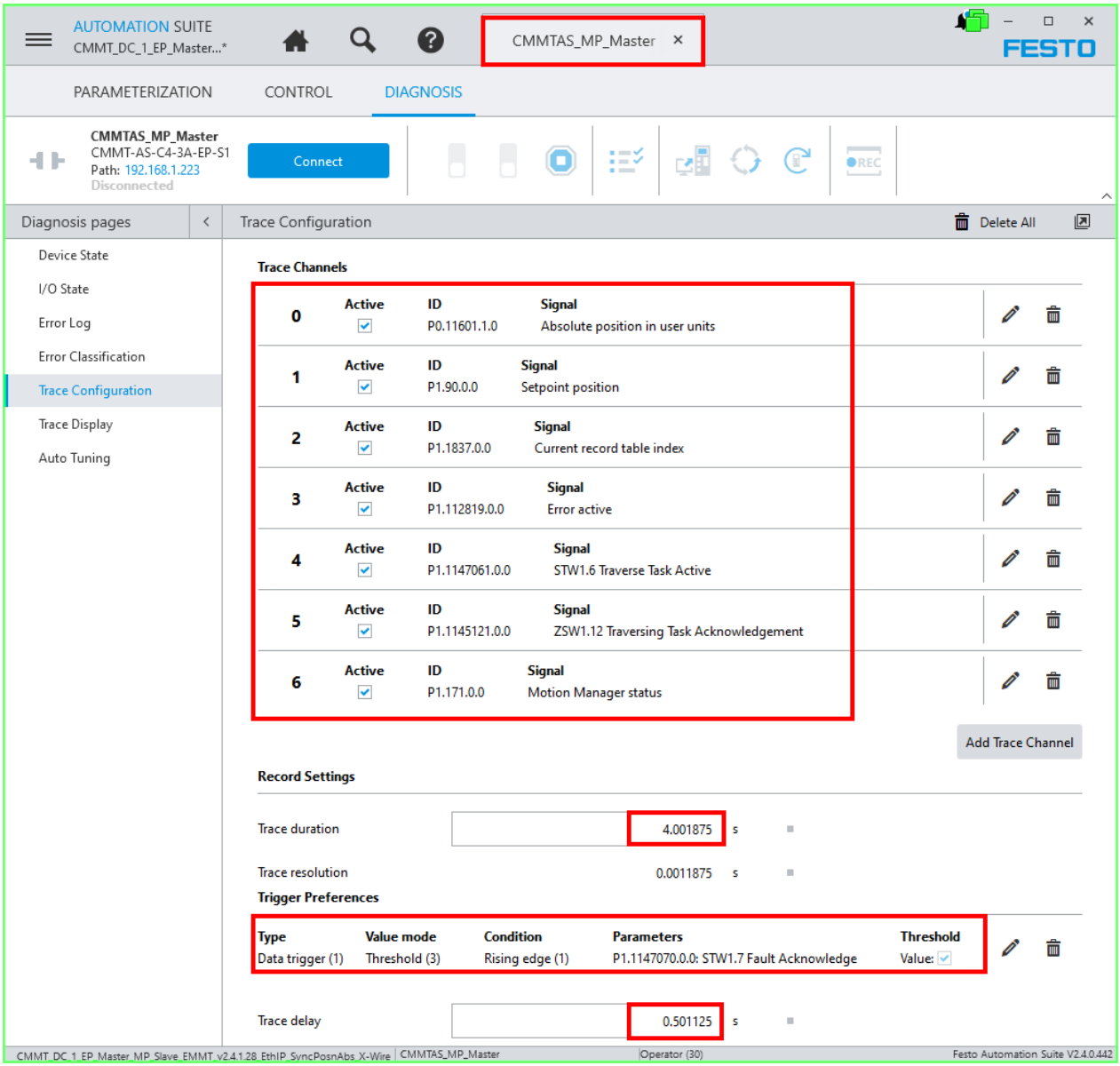
The following are suggestions for troubleshooting/monitoring of Gear In Functions

Channel Data:

P0.11601.1.0
P1.90.0.0
P1.1837.0.0
P1.112819.0.0
P1.1147061.0.0
P1.1145121.0.0
P1.171.0.0

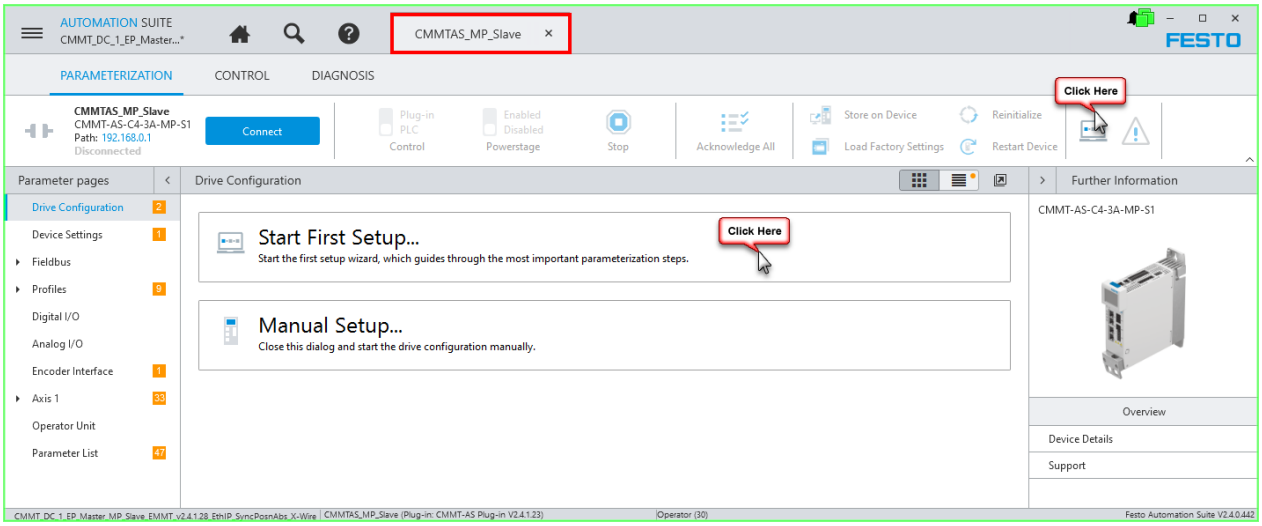
Trigger

P1.1147070.0.0



6 Slave Axis General Setup

6.1 First setup - Start Wizard



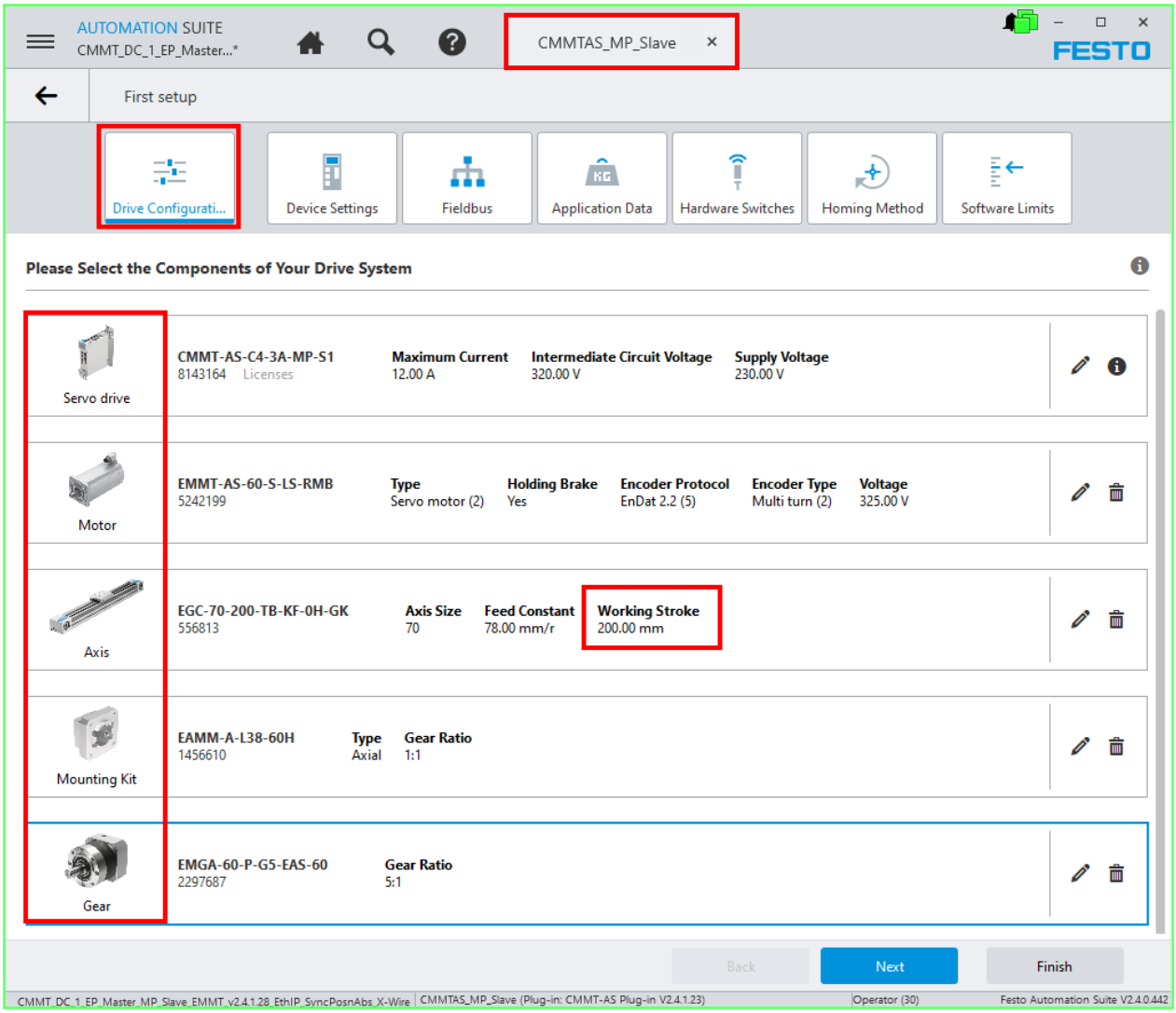
6.2 First setup - Drive Configuration

Configure the hardware selected for the application.

NOTE: Working Stroke -> In this example, the Master and Slave physical axis stroke are both 175mm, however, it is recommended to configure the value of the Slave Working Stroke slightly larger (200mm which provides a physical 15mm buffer). This concept is to avoid the Slave from entering an software overtravel status and losing the synchronisation at any time.

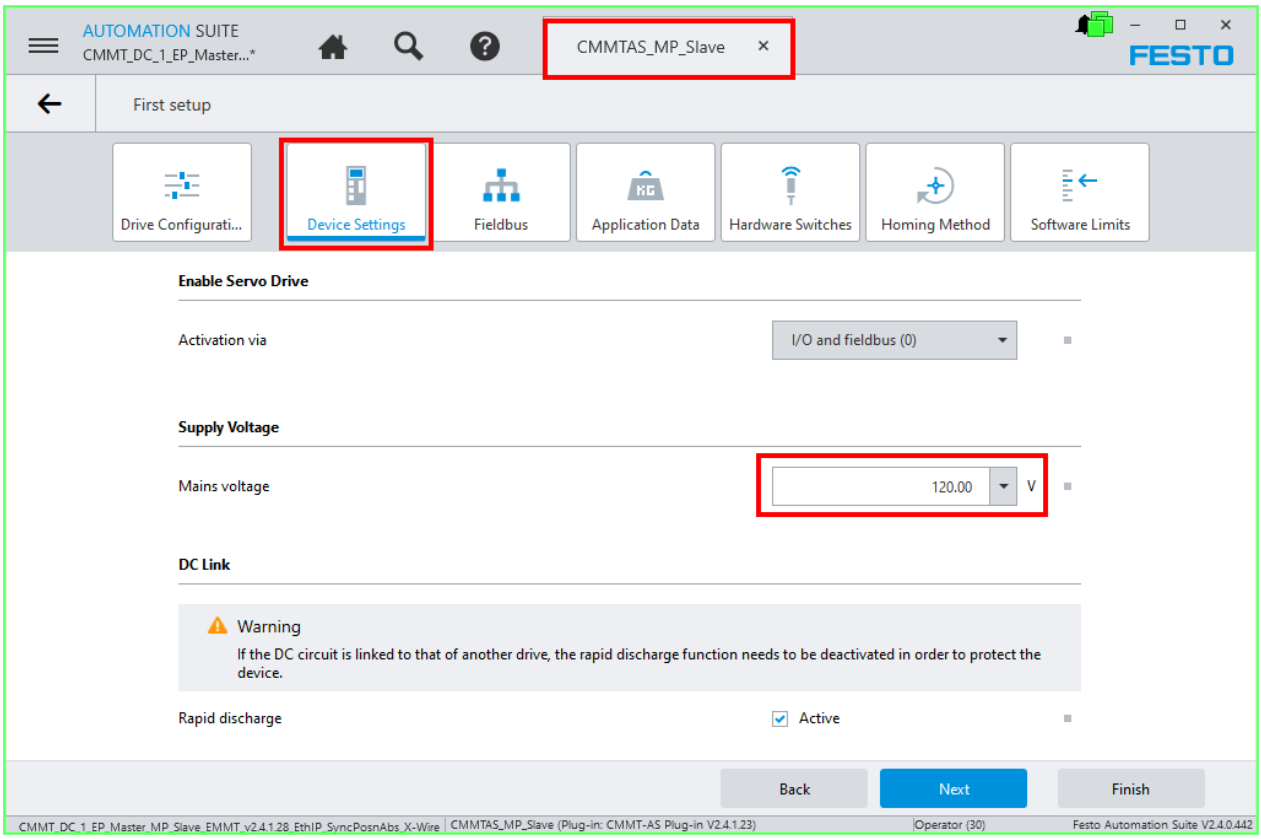
Caution

The Slave axis should not be able to encounter a software or hardware limit otherwise it can lose synchronisation which could cause an issue depending on the monitoring and reaction of the higher order PLC (Programmable Logic Controller).



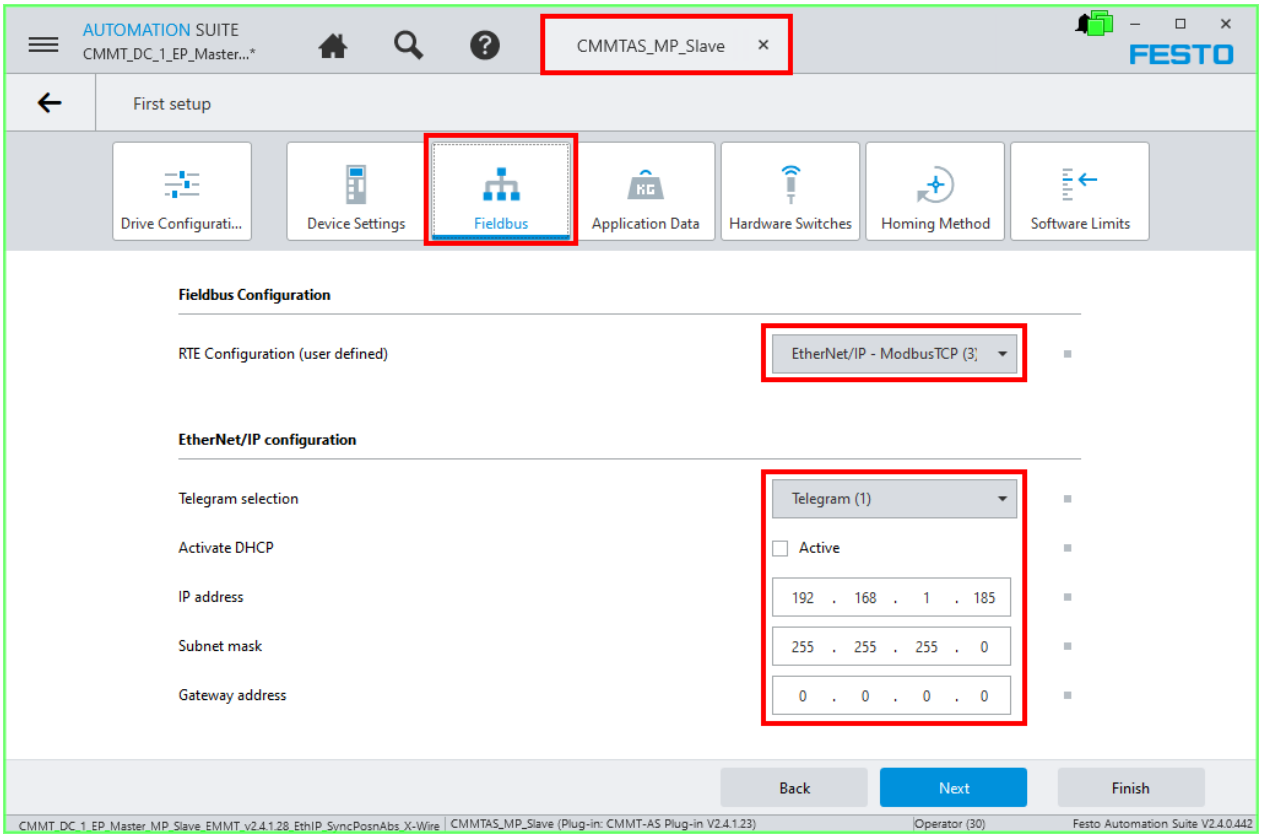
6.3 First setup - Device Settings

Consider the application Supply Voltage and modify from default if needed.



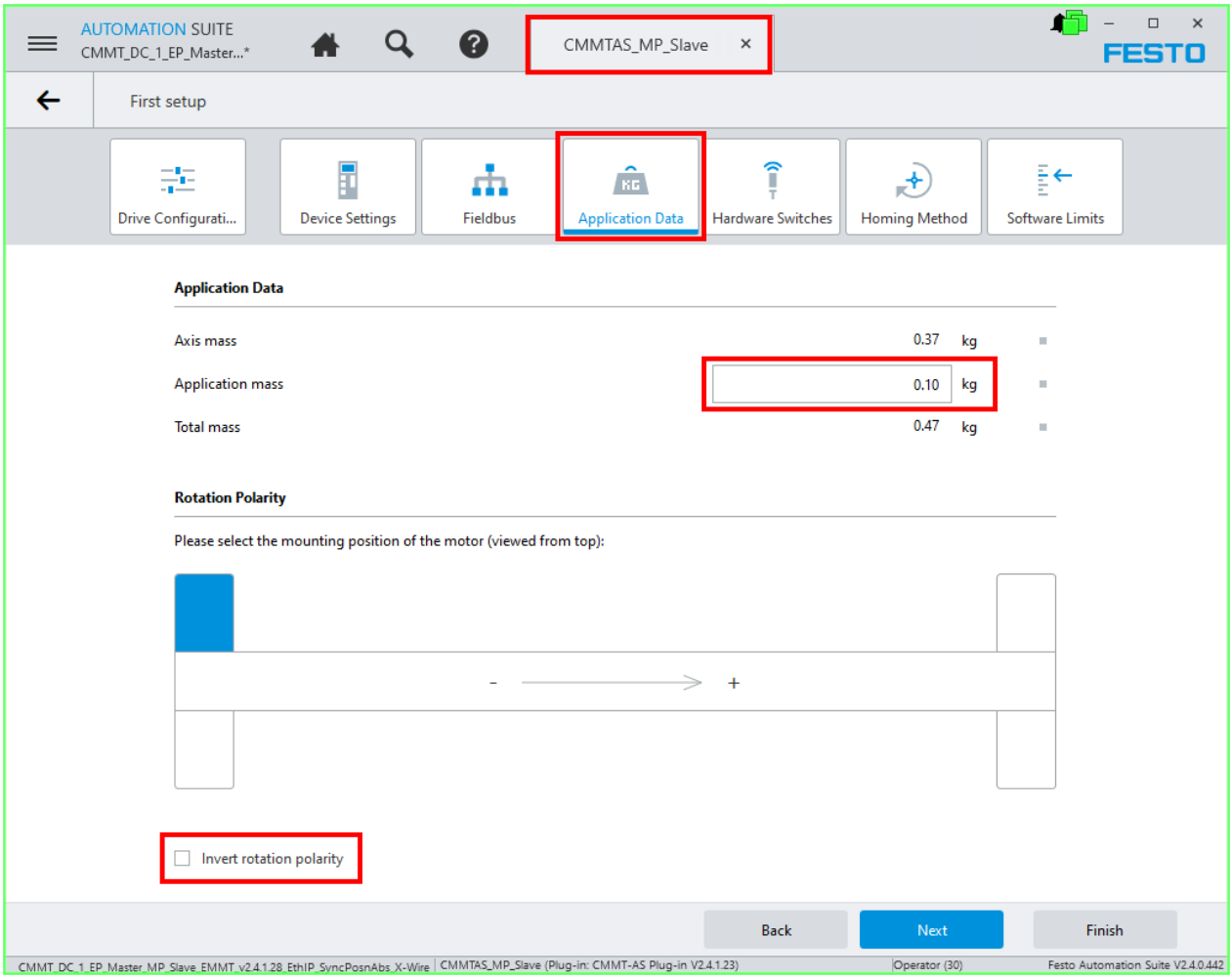
6.4 First setup - Fieldbus

Select EtherNet/IP – Modbus (3) for the RTE ethernet ports and Telegram 111, then modify the IP Address

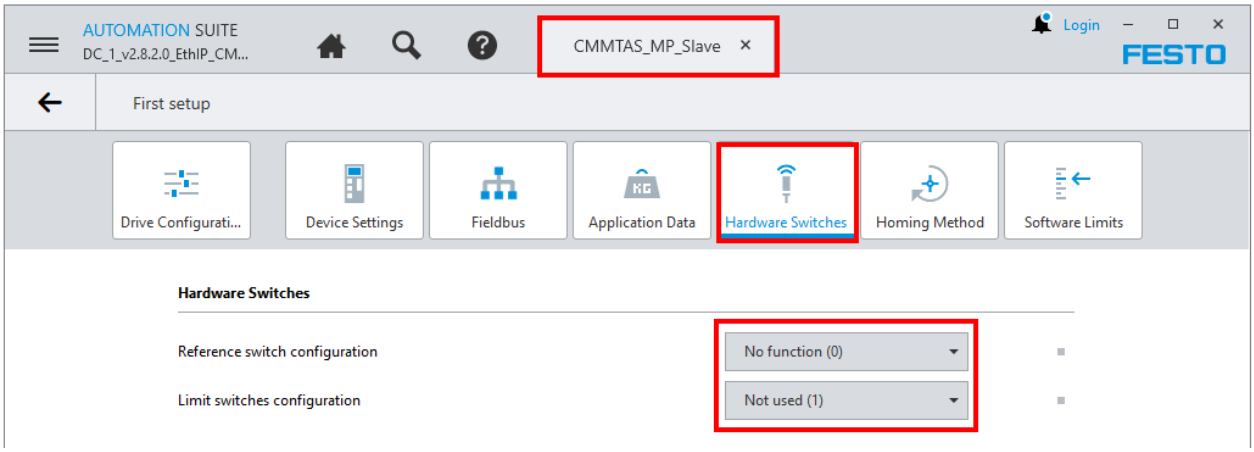


6.5 First setup - Application Data

Consider the application design.

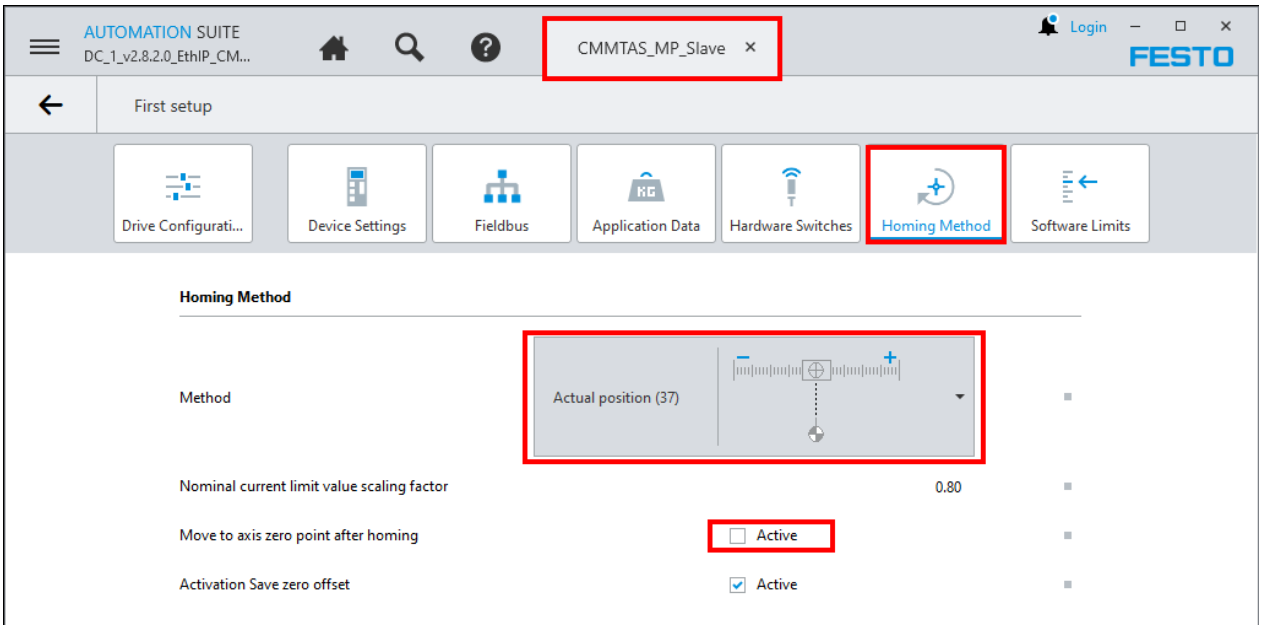


6.6 First setup - Hardware switches



6.7 First setup - Homing Method

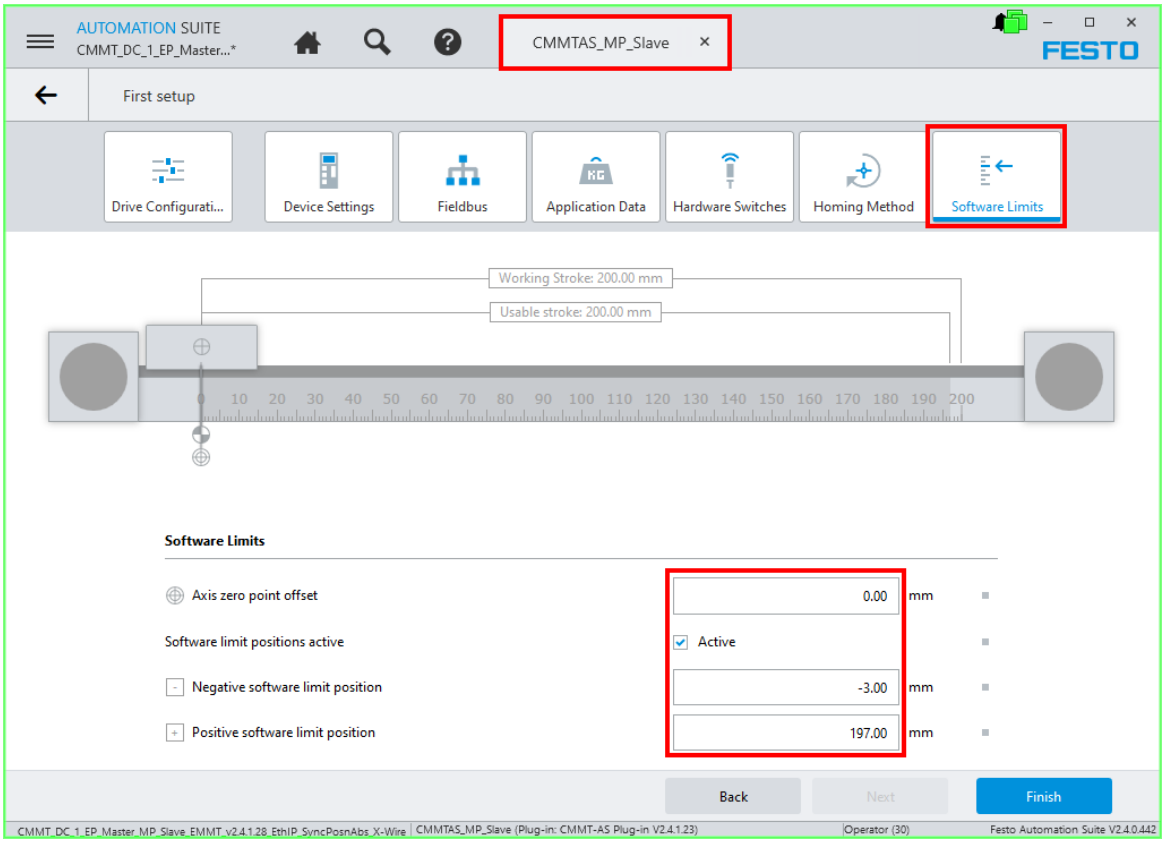
The simplest Homing method is Actual position (37) with no movement. This is because after the mechanical alignment, this allows the axis to reference and store the offset in the existing position without any movement.



6.8 First setup - Software Limits

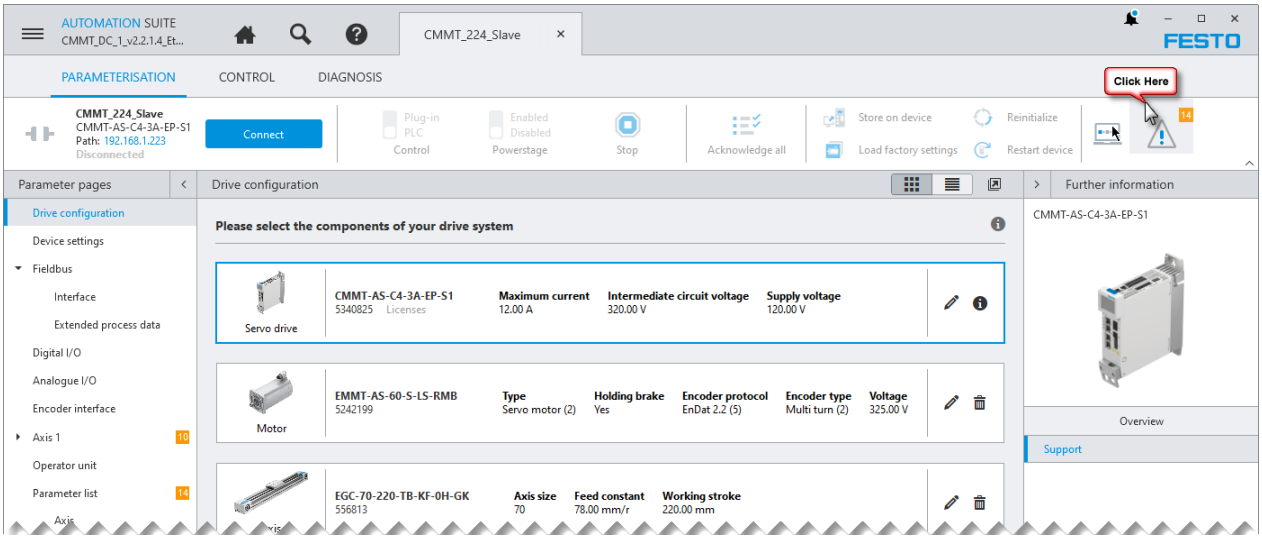
The Axis zero point offset should be configured as 0.00mm because during the execution of reference/homing, The Master position will already be at 0.00mm and the slave needs to match this position.

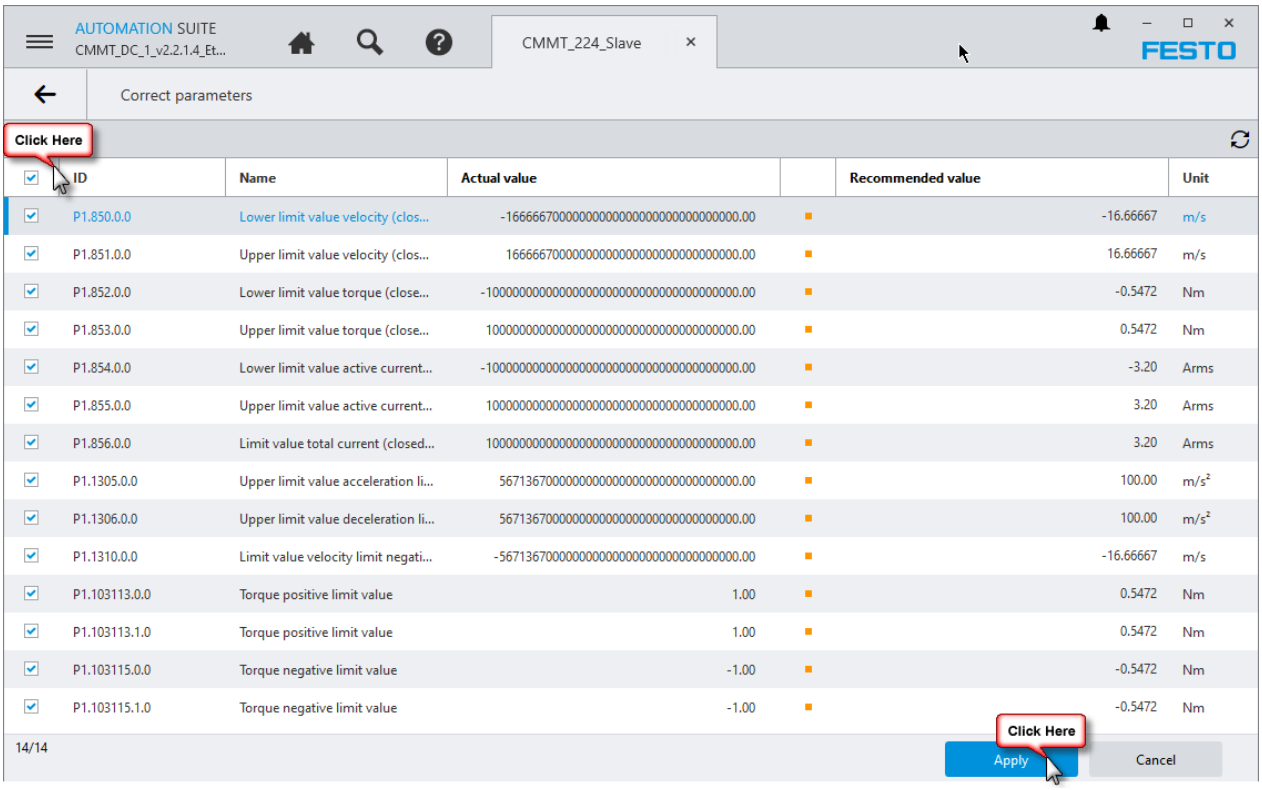
The Software Limits should be observed however, this depends on your application. The default values for negative/positive position limits should be adequate because the values of the slave should be beyond the physical stroke at either end of the axis (this was discussed earlier in section “First setup - Drive Configuration”).



6.9 Correct Parameters

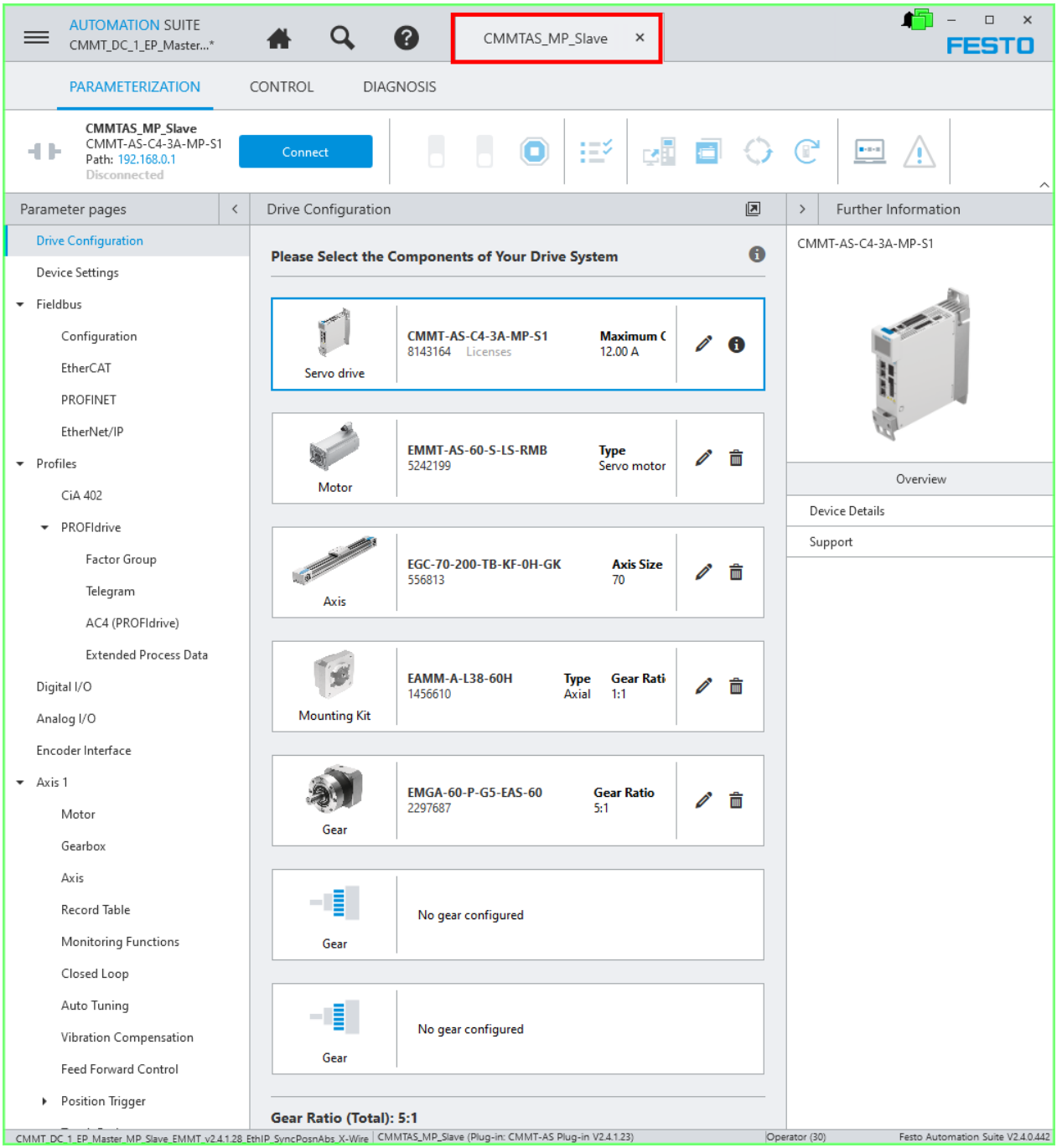
If you find orange adorners/indicators (example shown here), these are warning to indicate unfavorable or inconsistent values and these may need to be modified. It is recommended to use the “Correct Parameters” function to modify the parameters with recommended values as shown below.





6.10 Setup Complete

Slave axis general configuration is now complete.

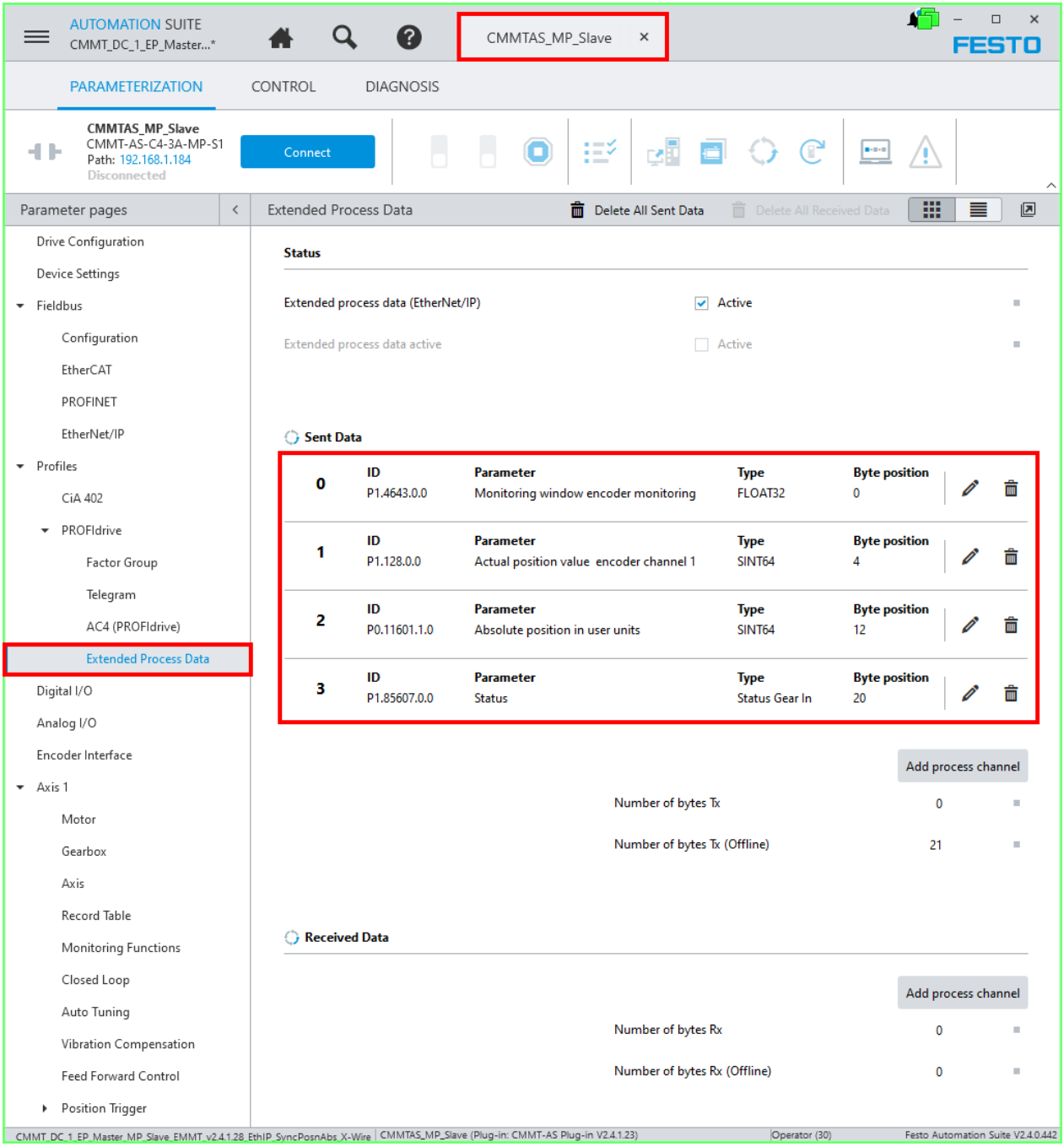


7 Slave Axis Changes Required for Synchronous Position Absolute

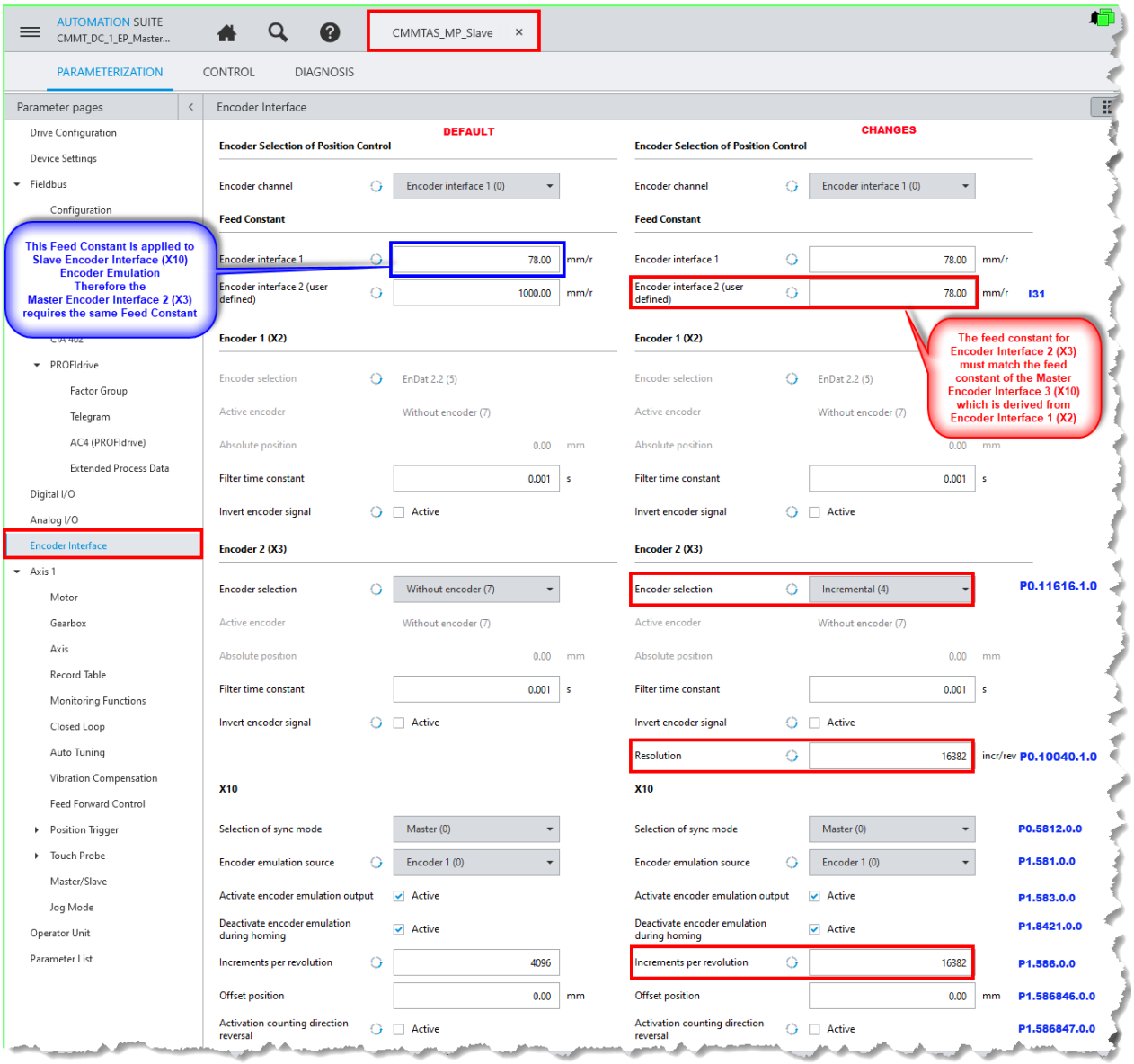
7.1 Extended Process Data (EPD)

Configure all Sent/Received data as shown here in the **EXACT** order shown (Do NOT use editor to modify order):

Sent Data	P1.4643.0.0 P1.128.0.0 P0.11601.1.0 P1.85607.0.0
Received Data	Not Used



7.2 Encoder Interface



See section 8.4 (Master and Slave X10 to X3 physical connections) for an overview about Encoder interfaces.

I31 Encoder Interface 2
In Festo Automation Suite (FAS) and in general for this application, the encoder interfaces have the following meaning:
Encoder 1[X2] = Actual Position of Motor Encoder
Encoder 2[X3] = Actual Position Emulated by opposite Controller
Encoder 3[X10] = Encoder 1[X2] Actual Position Emulation
The feed constant for Slave Encoder Interface 2 (X3) must match the feed constant of the Master Encoder Interface 3 (X10) which is derived from Master Encoder Interface 1 (X2)

P0.11616.1.0 Encoder Selection
Set Encoder 2 [X3] encoder selection to incremental (4) which is used for X10 and X3 cross wiring monitoring. The Slave axis interface X10 will be configured to emulate differential A,B,N signals which will be received by this Encoder 2 [X3] interface for the purpose of position difference monitoring as well as Virtual Master Position.

P0.10040.1.0 Resolution
The Master axis Encoder 3[X10] will be set as 16382 so the Slave Encoder 2 [X3] should be set to the same value. See the caution note on this page.

P0.5812.0.0 Selection of Sync Mode
Here we configure as Master(0) so Encoder 3[X10] will emulate/transmit Encoder 1[X2] Actual Position in the form of differential A,B,N signals. The Master axis will use this signal for encoder difference monitoring.

P1.581.0.0 Encoder Emulation Source
Encoder 1 (0) refers to the Primary Motor Encoder at connection X2
Encoder 2 (1) refers to a secondary Encoder at connection X3
Setpoint position (2) will transmit setpoint position signal (normally less noise is observed), however when the Master is disabled, no setpoint is changed and therefore is the shaft changes, the Slave will not observe this.

Caution 1

If actual values are transmitted to the slave as position signals (P1.581 Encoder Emulation Source = Encoder 1 or Encoder 2), increased noise may occur due to the torque feed forward control in the synchronous phase. The torque feed forward control is switched off by setting parameter Px.968 to 0.

P1.8421.0.0 Deactivate Encoder Emulation During Homing
If enabled, whilst a reference/home routine is executed, Encoder 3[X10] emulation will be inhibited.
With this application, it is expected the axis are referenced/homed only once during commissioning and NOT to be not referenced/homed repeatedly. Among many reasons, it is expected the Master and Slave axis both have Multi-Turn Absolute Encoders. Due to the fact this application has Master and Slave axes rigidly coupled and due to the encoder difference monitoring, it should be decided by the user if encoder signals are always transmitted even during a home routine.

P1.586.0.0 Increments per revolution
The Master axis Encoder 3[X10] will be set as 16382 so the Slave Encoder 2 [X3] should be set to the same value. 16382 Increments per revolution also allows for better tuning when in Synchronisation. (The greater the selected value the lower the resulting noise on the connected slave axes).

Caution 2

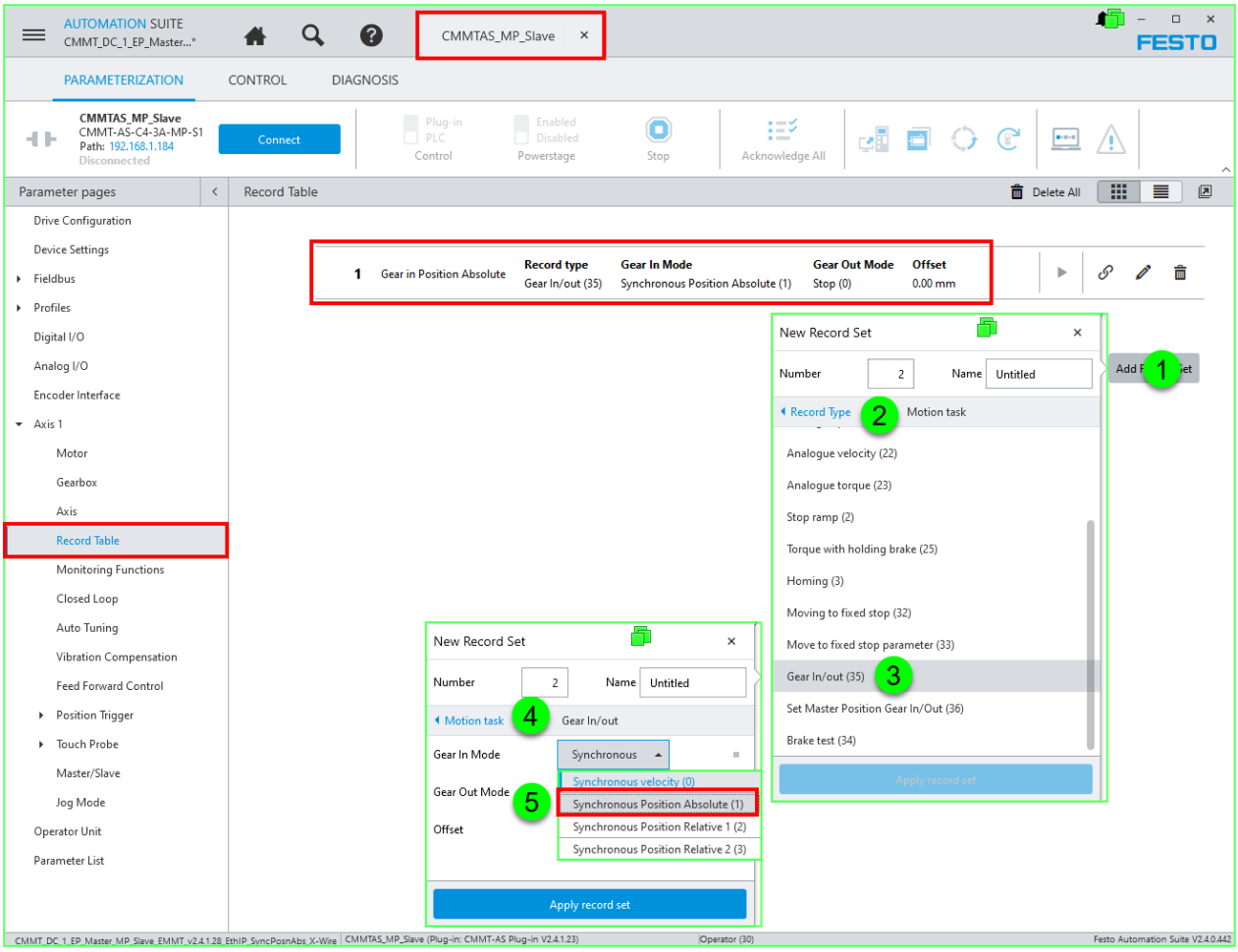
- **The same increments per revolution should be set on the opposing encoder connections of the Master and Slave drives.**
- **DO NOT USE THE VALUE "16384" for Increments per revolution.**
  This will result with an exception in the firmware when re-initializing the drive (div/0) and the hardware will need to be replaced (cannot be fixed onsite).
  The firmware release V19.0.4.72 is supposed to address this issue.

7.3 Record Table

The Record Table needs to have the associated Gear In record as shown here and this will be used to activate the Slave axis synchronisation.

NOTE:

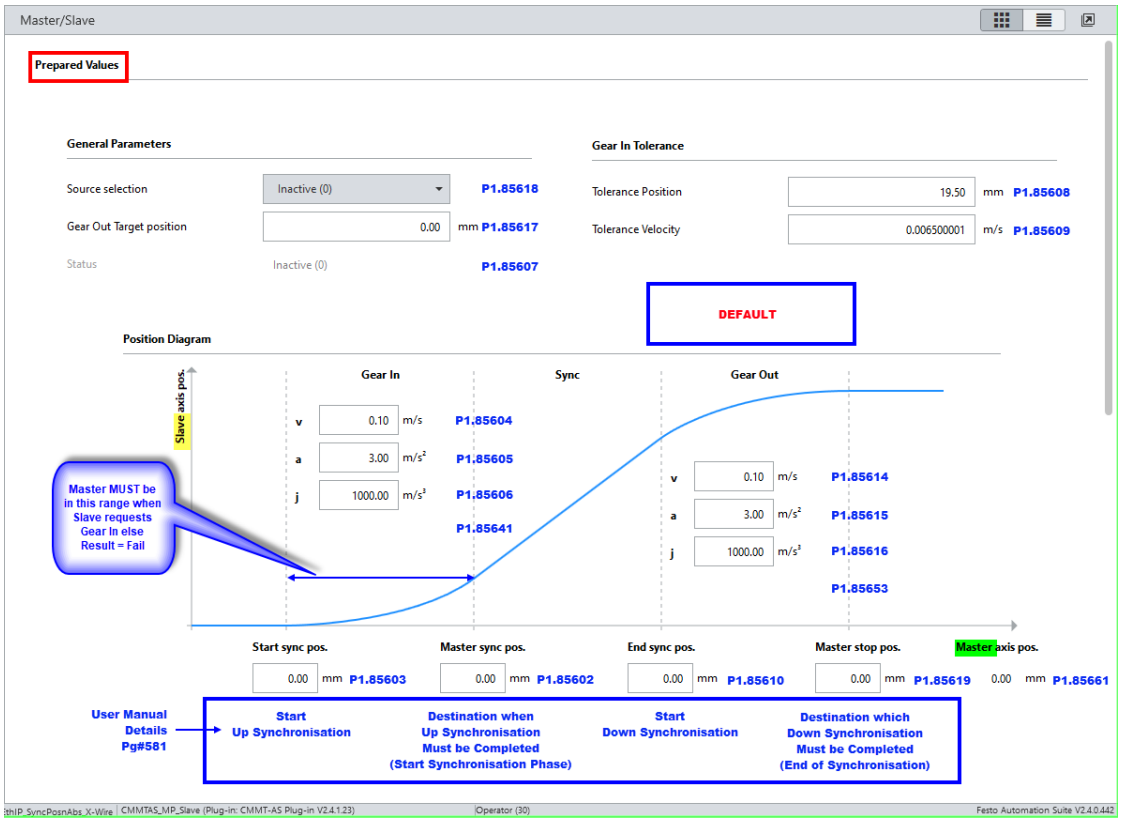
Within the required PLC program, a "Method" is used to Set Master Gear In Position instead of using a record. This is because before a record table task can be executed, the controller MUST BE ENABLED WITHOUT FAULTS and so, for error recovery, the "Method" is much more convenient with this application.

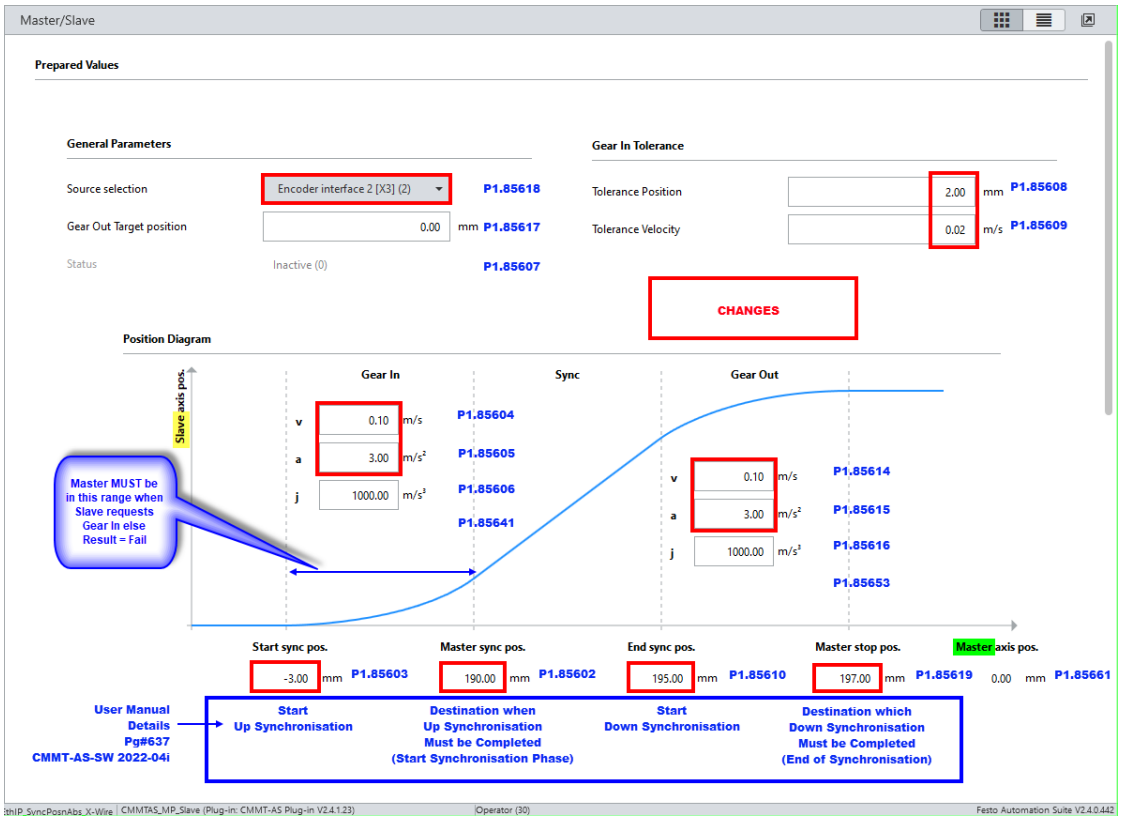


7.4 Master/Slave

The Slave axis Master/Slave page needs to be configured based on the Device Configuration Axis Working Stroke. In this example, the Master and Slave physical axis stroke are both 175mm. The Slave is configured with 200mm (197mm Software Limit) to avoid loss of synchronisation. In order to correlate with the Slave Software limit and avoid losing synchronisation, the Master Sync Pos./End Sync Pos. and Master Stop Pos. are all configured with values greater than the Master axis physical stroke up to the unachievable Slave Stroke including the positive software limit.

The Encoder Interface 2[X3] (2) needs to be selected so the Slave considers this as the Virtual Master Position.

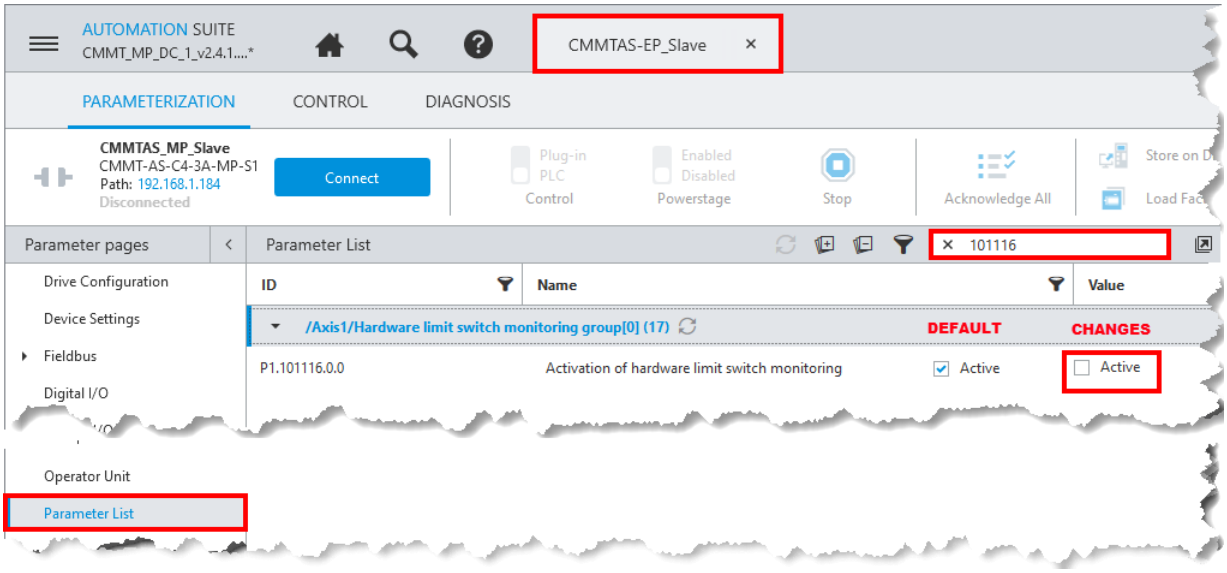




7.5 Parameter List

7.5.1 P1.101116.0.0 Hardware Limits Disabled

This option should be disabled to prevent undesirable behavior while in sync.



Caution

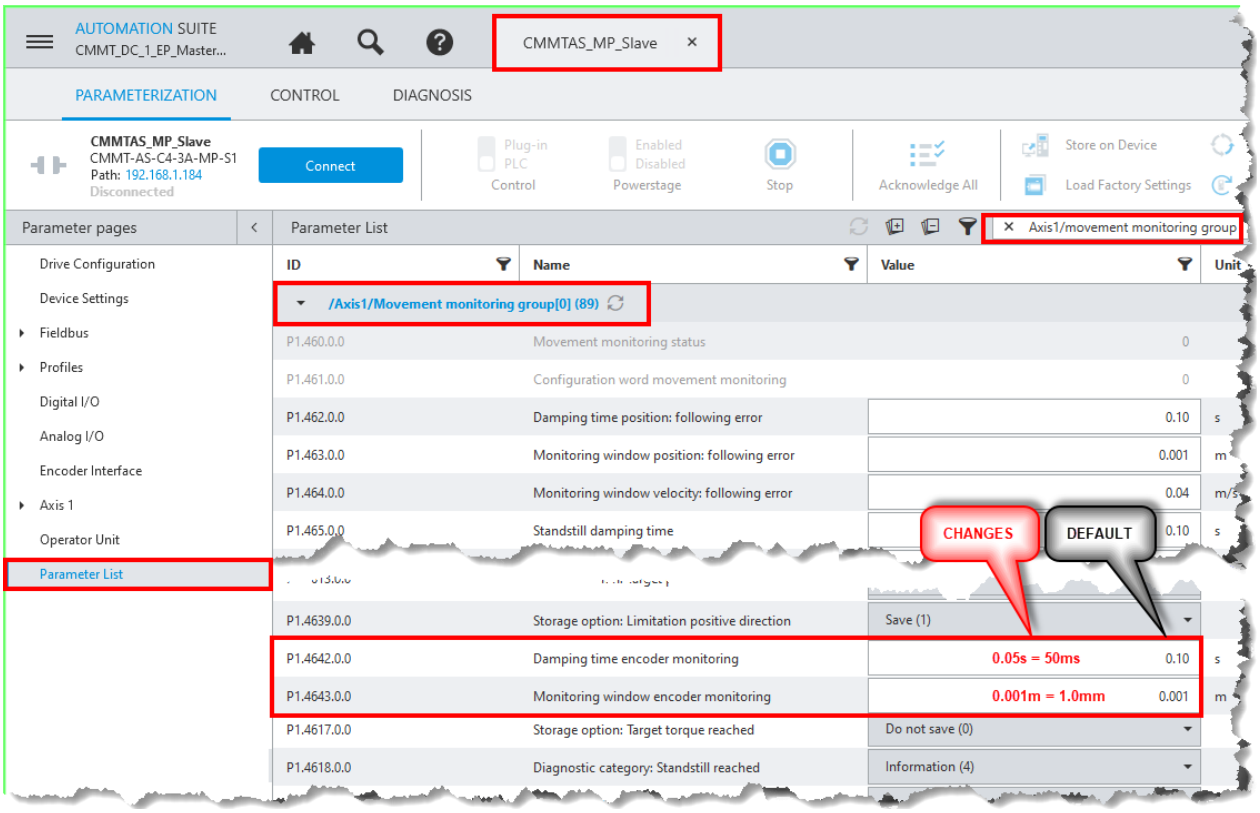
If the Slave axis is in synchronisation to the Master and a Hardware limit is encountered, the slave will be inhibited by the limit and will NOT follow the Master.

7.5.2 P1.4643.0.0 Monitoring Window Encoder Monitoring

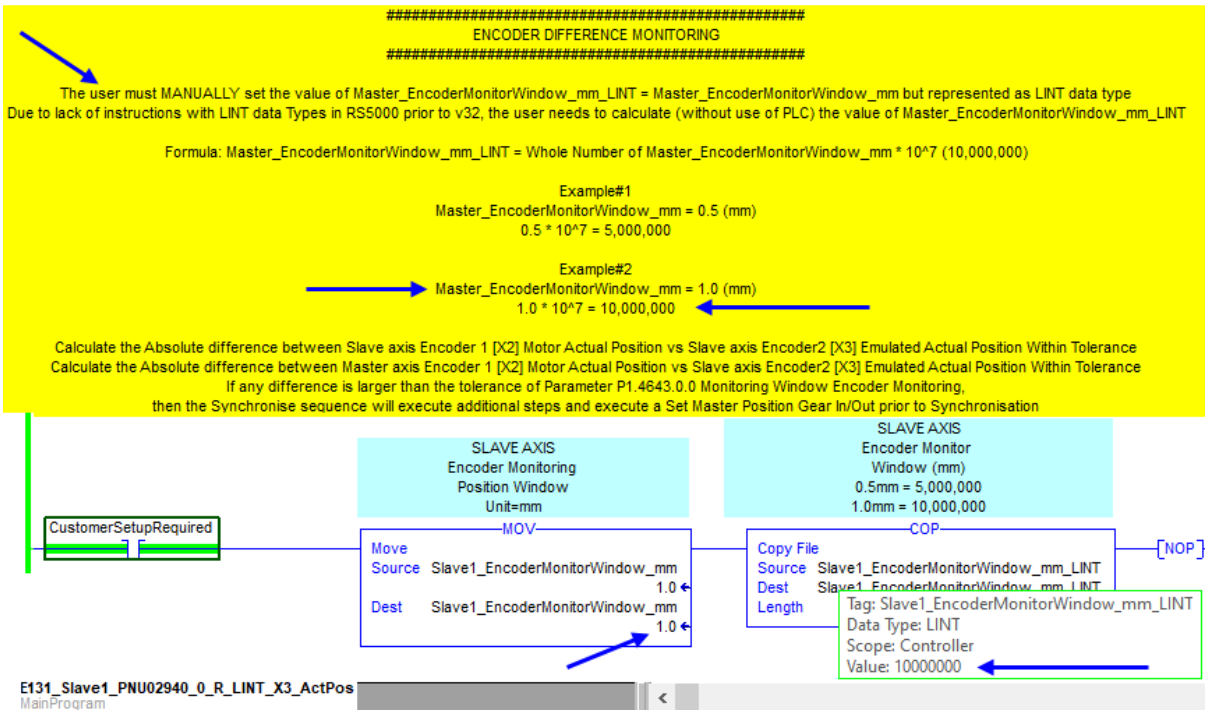
In Festo Automation Suite (FAS) and in general for this application, the encoder interfaces have the following meaning:
Encoder 1[X2] = Actual Position of Motor Encoder
Encoder 2[X3] = Actual Position Emulated by opposite Controller
Encoder 3[X10] = Encoder 1[X2] Actual Position Emulation

In order for Encoder 1 [X2] and Encoder 2 [X3] position difference monitoring to function, configure these group parameters (Axis1/movement monitoring group):

- P1.4642 Damping time encoder monitoring
- P1.4643 Monitoring window encoder monitoring



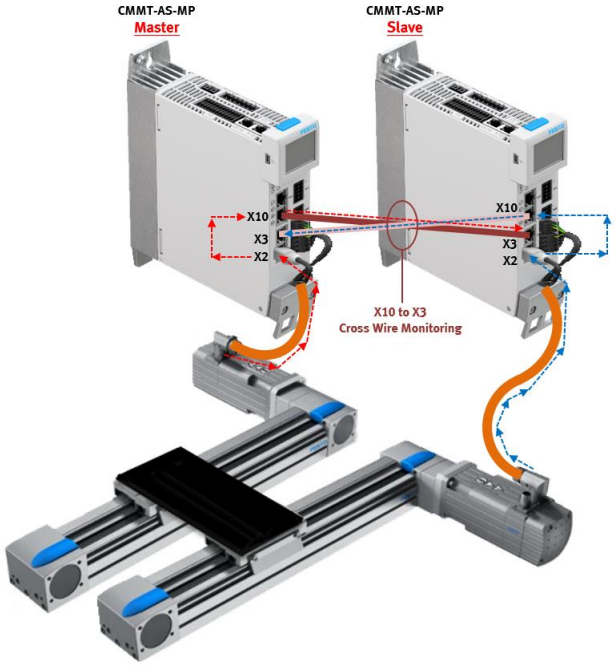
PLC (Programmable Logic Controller) Code will also need to be modified in the following Routine:
E031_Master_PNU02940_0_R_LINT_X3_ActPos



7.6 Error Classification

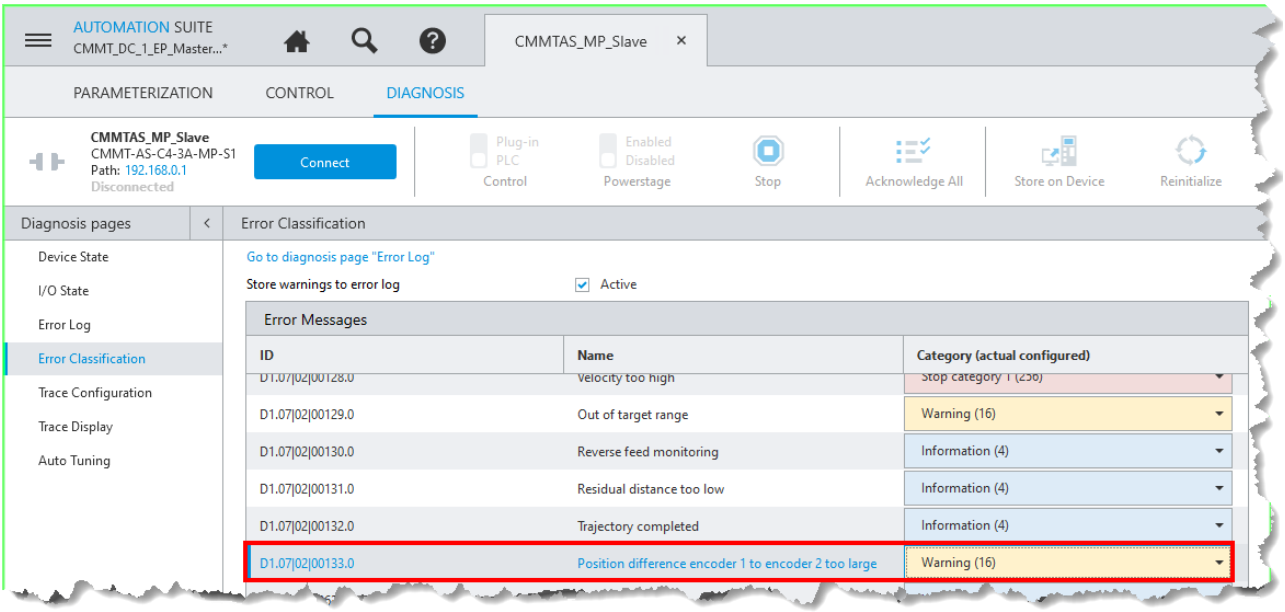
7.6.1 D1.07|02|00133.0 Position Difference Encoder 1 to Encoder 2 too Large

In Festo Automation Suite (FAS) and in general for this application, the encoder interfaces have the following meaning:
Encoder 1[X2] = Actual Position of Motor Encoder
Encoder 2[X3] = Actual Position Emulated by opposite Controller
Encoder 3[X10] = Encoder 1[X2] Actual Position Emulation



Both the Master and Slave will provide an emulated encoder signal (differential A,B,N signals) from Encoder 3[X10] to the opposite controller at Encoder 2[X3].
The Master and Slave use the Encoder 2[X3] emulated encoder signal for the purpose of position difference monitoring.

In the Error Classification, change the error "D1.07|02|00133.0 Position Difference Encoder 1 to Encoder 2 too Large" category from Ignore (2) to Warning (16). This setting allows the Slave axis to remain in synchronisation and provide a warning during a position deviation larger than parameter P1.4643.



7.7 Trace Configuration

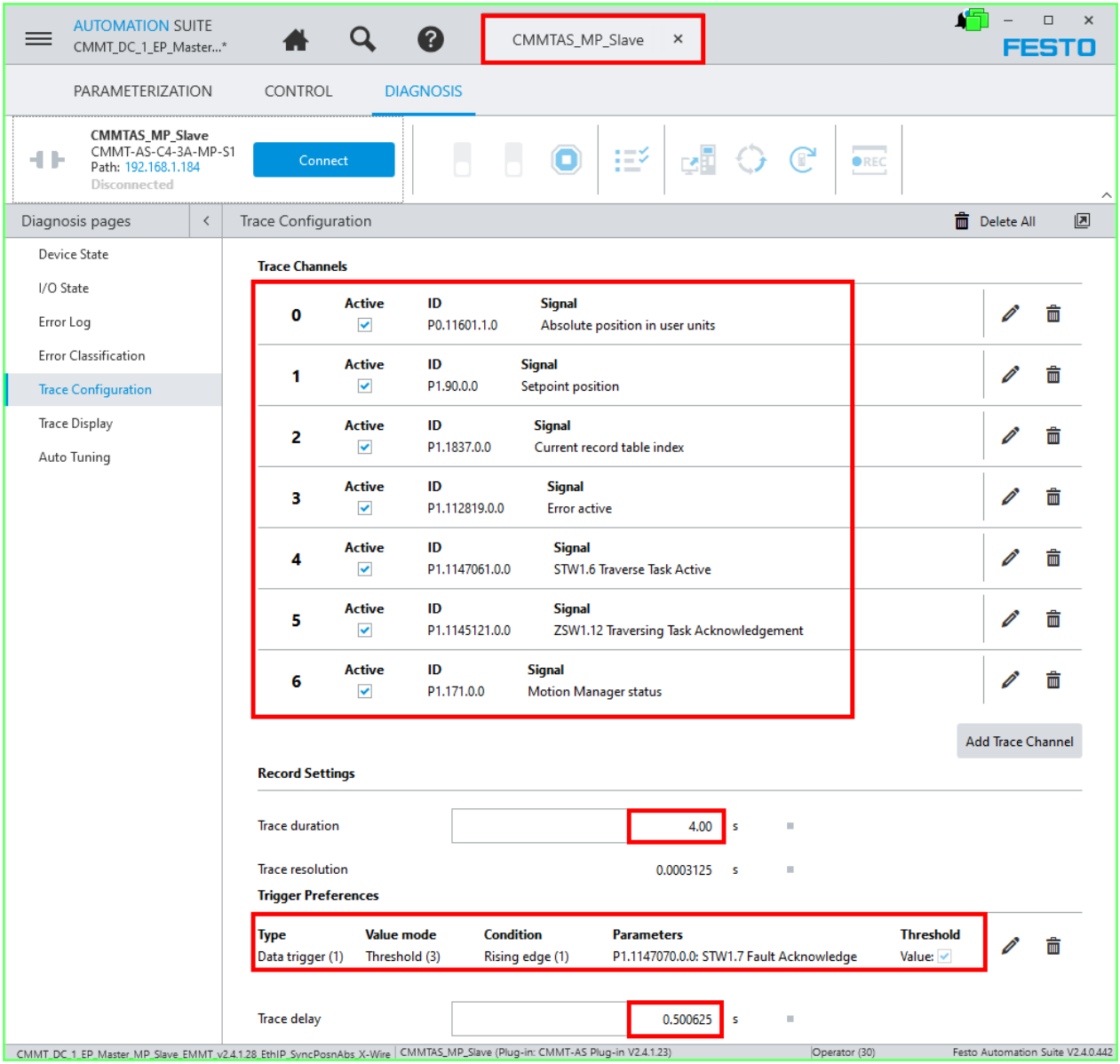
The following are suggestions for troubleshooting/monitoring of Gear In Functions

Channel Data:

P0.11601.1.0
P1.90.0.0
P1.1837.0.0
P1.112819.0.0
P1.1147061.0.0
P1.1145121.0.0
P1.171.0.0

Trigger

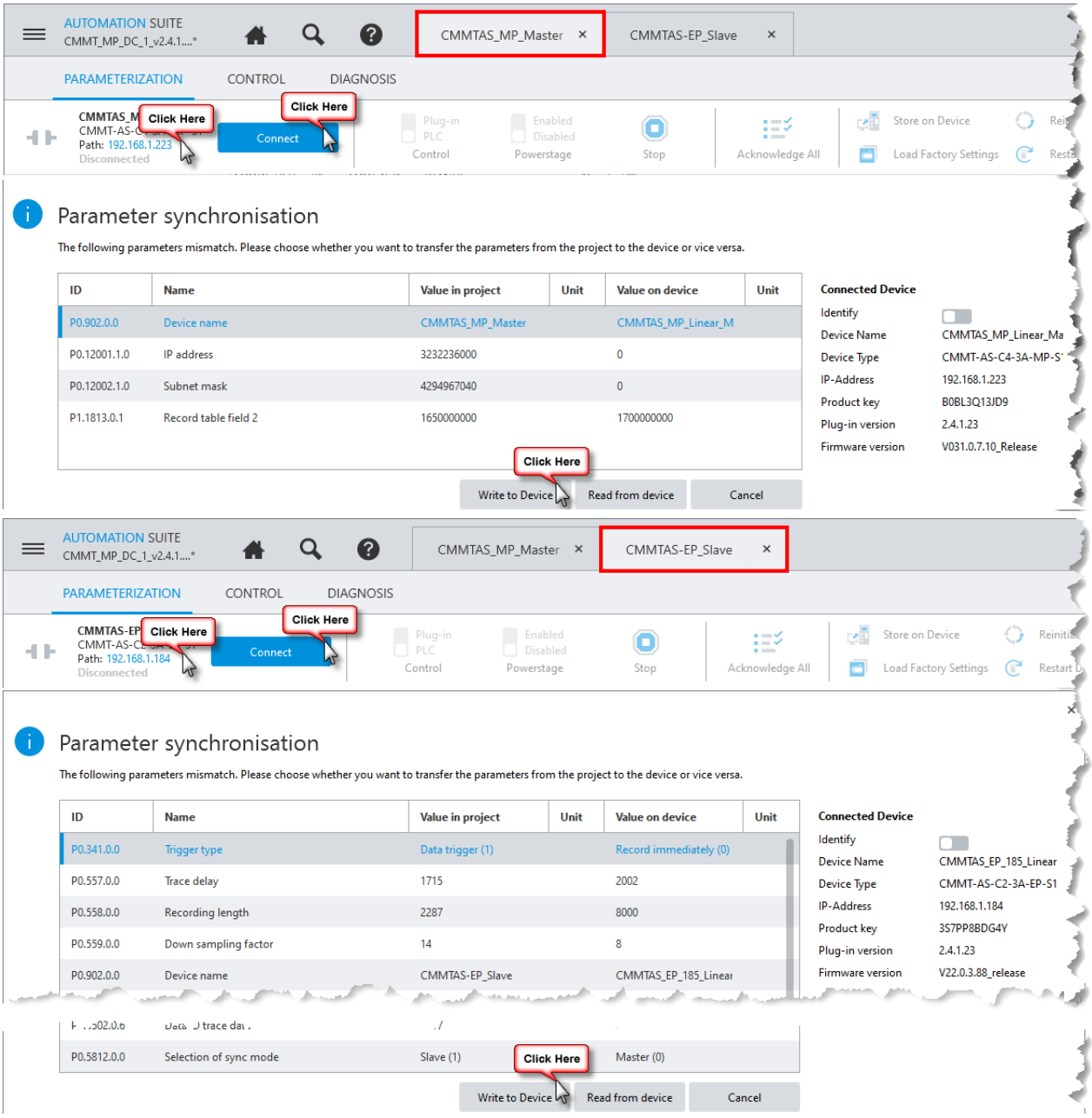
P1.1147070.0.0



8 Commissioning Steps

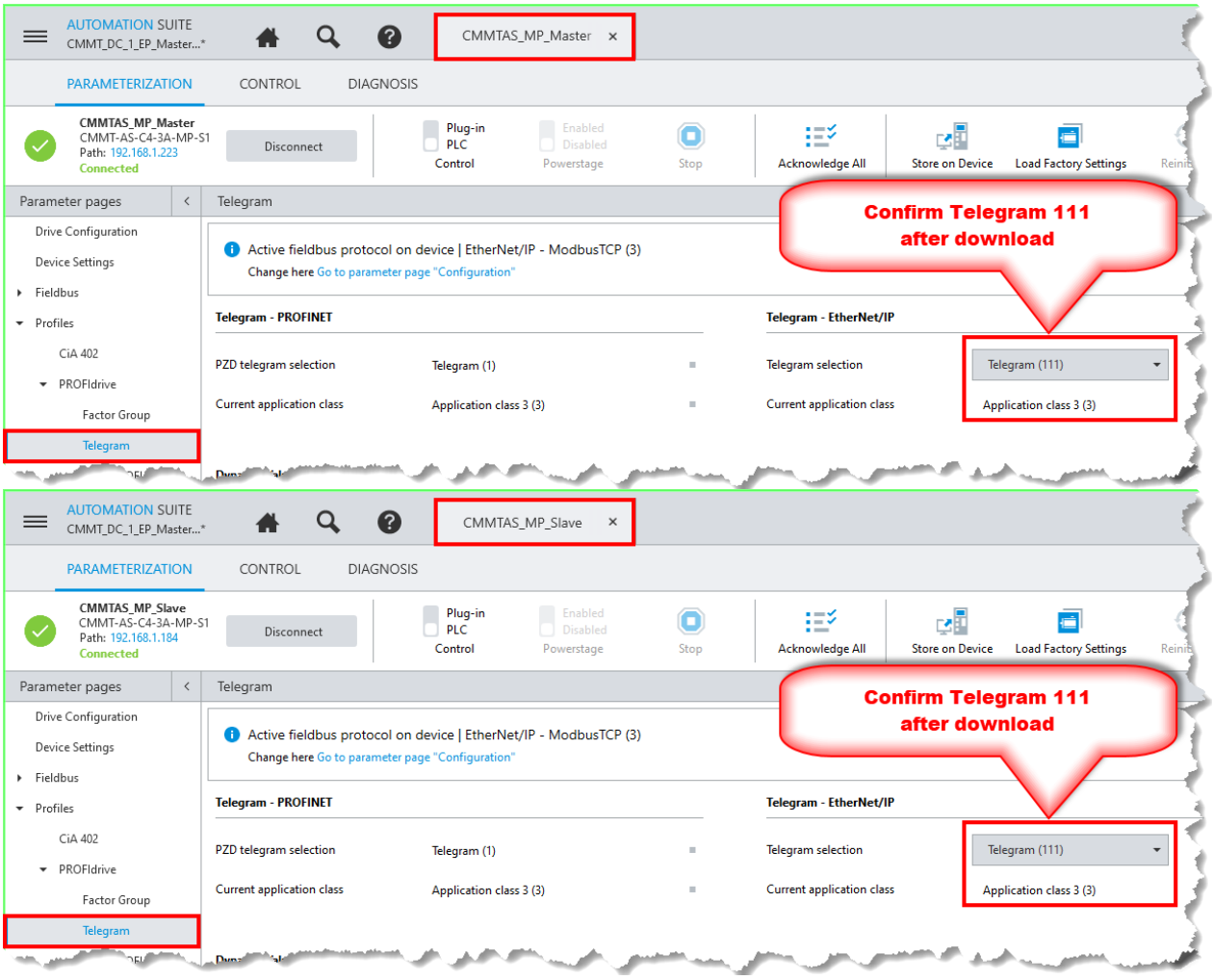
8.1 Download both axis configurations

The motor controller should have factory defaults, however, if a parameter synchronisation window appears, make certain to select “Write to Device”

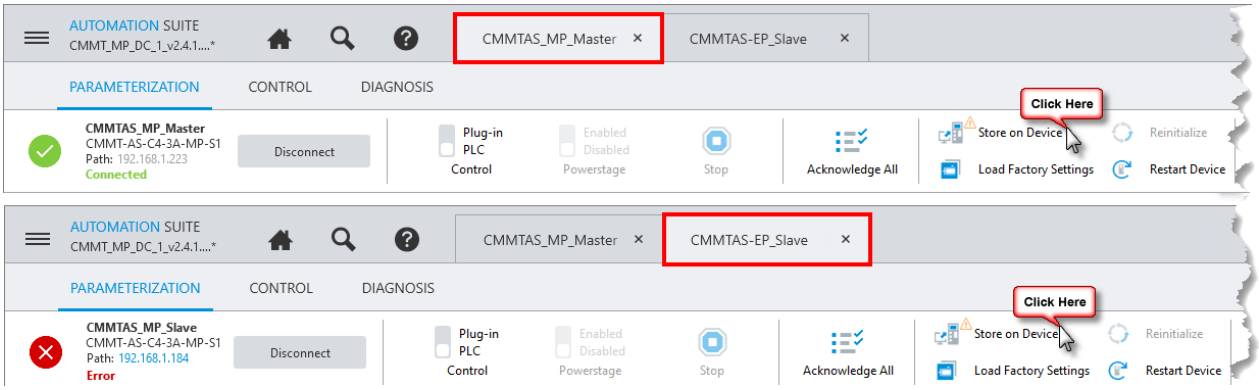


8.2 Telegram

Please be certain that after download, the Telegram selection is set correct with Telegram (111)



8.3 Store both axis configurations

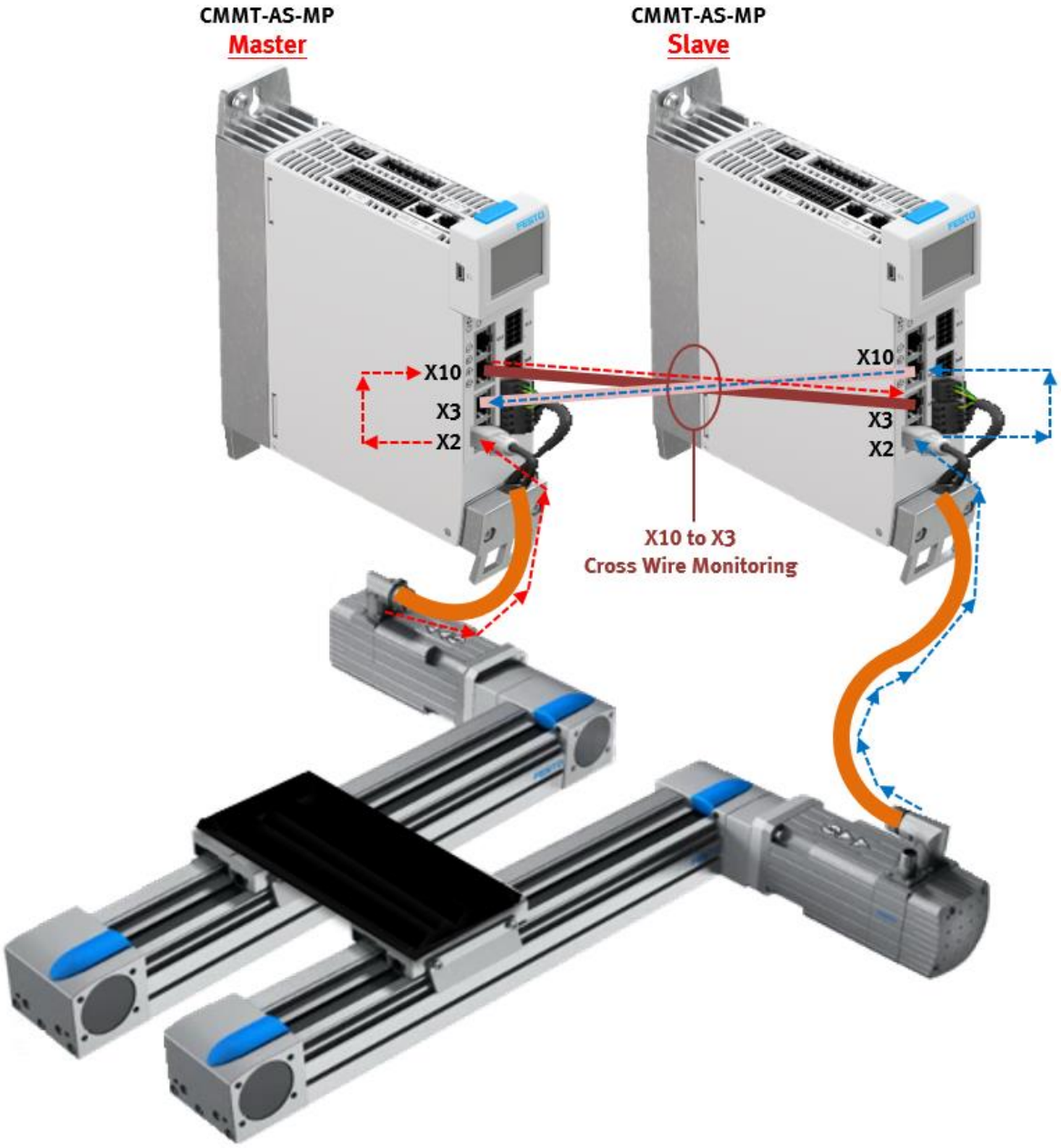


8.4 Cross-Wiring Encoder Emulation X10 to X3

In Festo Automation Suite (FAS) and in general for this application, the encoder interfaces have the following meaning:
Encoder 1[X2] = Actual Position of Motor Encoder
Encoder 2[X3] = Actual Position Emulated by opposite Controller
Encoder 3[X10] = Encoder 1[X2] Actual Position Emulation

Cables must be installed between the controller Encoder 3[X10] and Encoder 2[X3] interfaces as shown here. It is recommended to use a RJ45 patch cable of ethernet category 5e with a maximum length of 25 cm. Festo cables can be purchased (Part: 8082383, Type: NEBC-R3G8-KS-0.2-N-S-R3G8-ET).

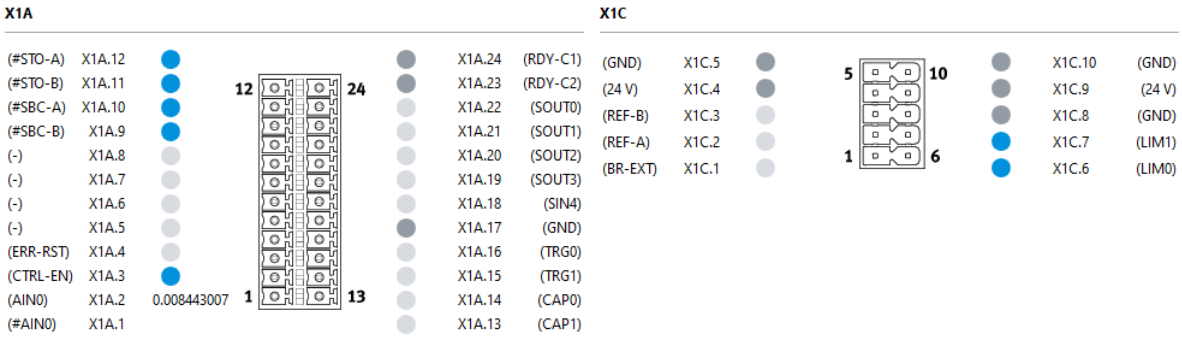
The dashed lines shown here represent actual encoder signal or emulated encoder signal between the servo controllers. Both the Master and Slave will provide an emulated encoder signal (differential A,B,N signals) from Encoder 3[X10] to the opposite controller at Encoder 2[X3].
The Master uses the Encoder 2[X3] emulated encoder signal for the purpose of position difference monitoring.
The Slave uses the Encoder 2[X3] emulated encoder signal for the purpose of position difference monitoring as well as Virtual Master Position.



8.5 Cross-Wiring Control Enable

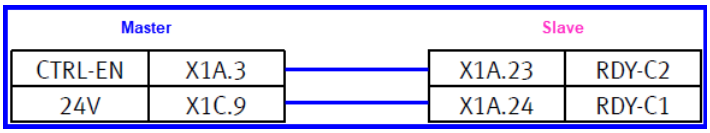
- In applications with rigid mechanical coupling, an offset between master and slave can lead to distortion, even mechanical destruction of the system. To avoid such risk, a reliable solution must be deployed.
- In the event of an error of the Slave, the Master should stop as soon as possible, in the best case with the delay dynamics of the Slave. Such a shutdown via the higher-level controller is usually subject to the update time of the fieldbus system and the cycle time of the controller. Therefore, hardware control enable cross-wiring is recommended in this case. The Master can be enabled by a ready signal, physically via the potential-free contact RDY-C1/C2 of the Slave. If the Slave now goes into error state, the CNTRL-EN of the Master will be removed, which leads to a stop ramp and following stop. The Master can also be enabled again only if there is no more error in the Slave. If the hardware cross-wiring shown here conflicts with the safety circuit of the Master (CTRL-EN), the Master can also be disabled in the event of an error via a digital input and using the event table.
- In case of error to the Master, the Slave still will follow the Master's position. It must be ensured that Slave drive can follow the dynamics of the Master's stop ramp.

8.5.1 Wiring IO (Inputs/Outputs) Connector Function



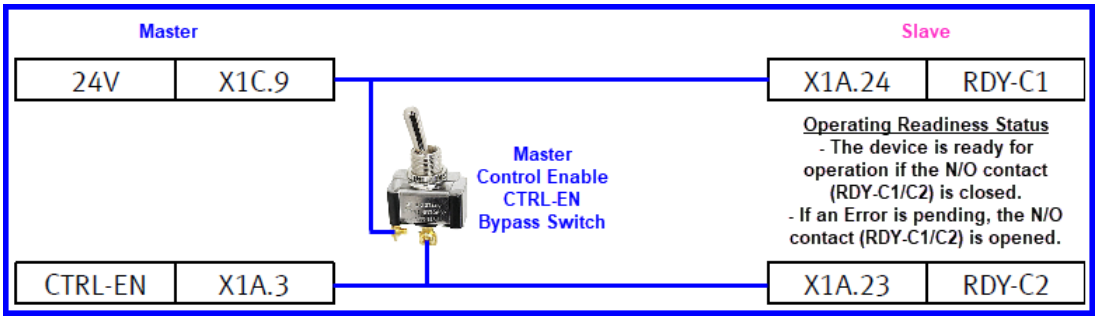
8.5.2 Wiring Example

The wiring shown here is very simple and will react very fast to an error on the Slave. It is also common that the 24V (X1C.9) is replaced by a voltage supply from a safety relay. The idea is application dependent (up to designer) and the idea is the RDY-C1/C2 contact is simply in series with any other conditions required to disable the controller.



8.5.3 Wiring Example With Bypass

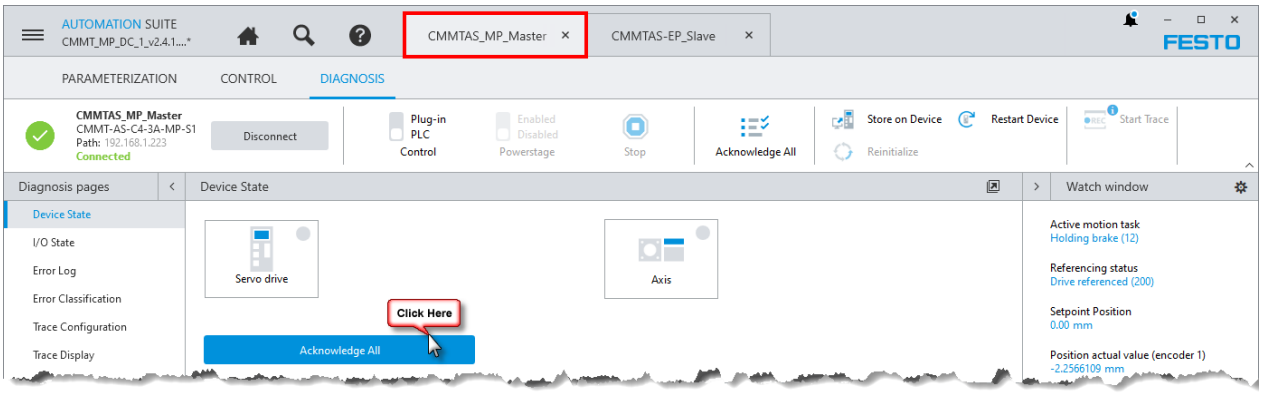
If the user feels they will need to bypass this condition in certain circumstances, they could wire as follows:



8.6 Master and Slave cycle power

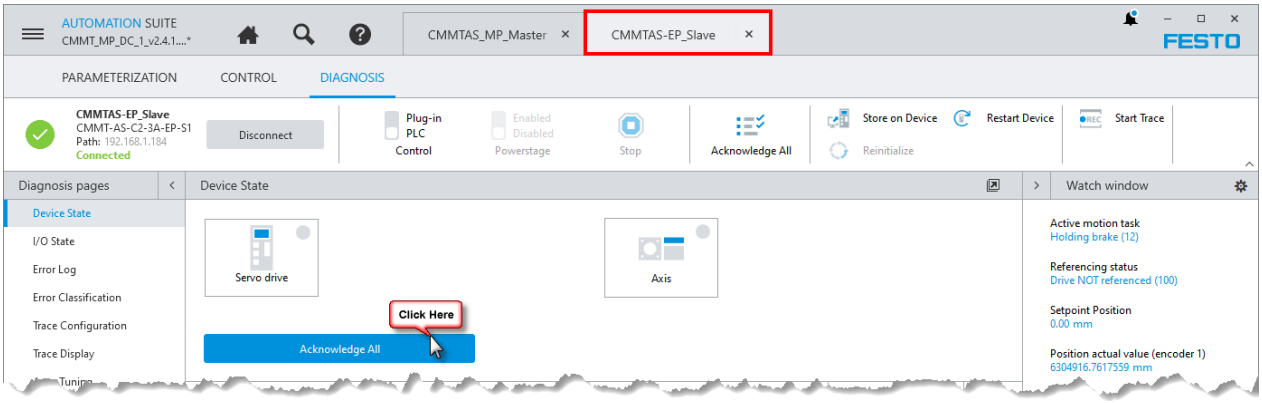
8.7 Master axis Acknowledge Faults

Go online with the CMMT Master axis and acknowledge any faults



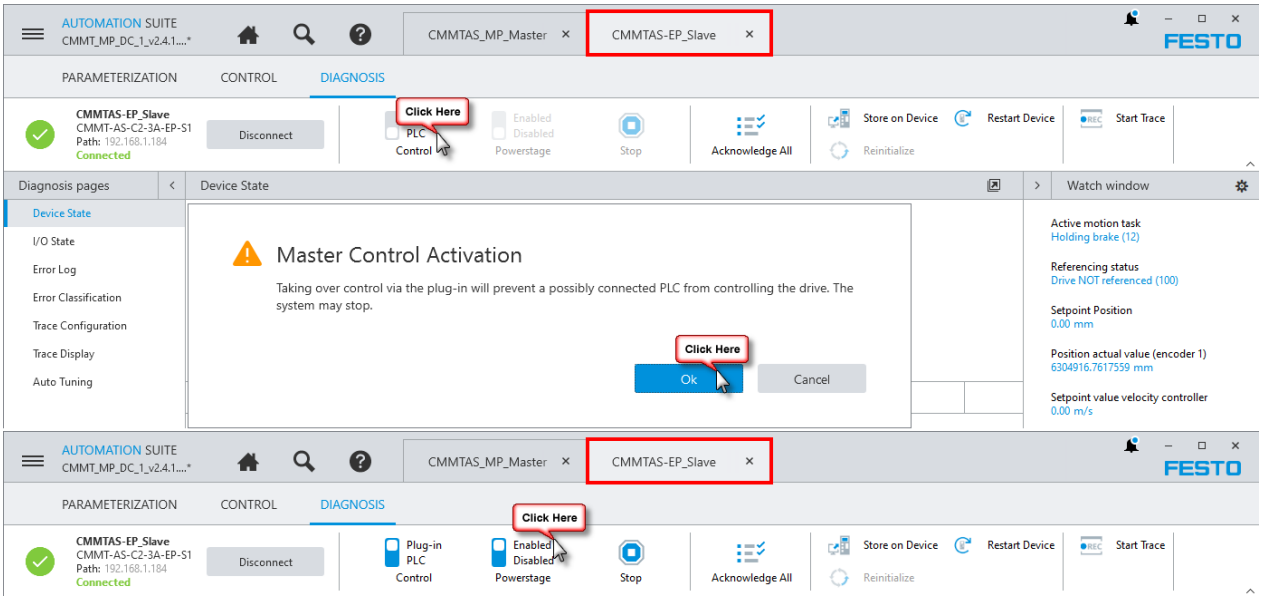
8.8 Slave axis Acknowledge Faults

Go online with the CMMT Slave axis and acknowledge any faults



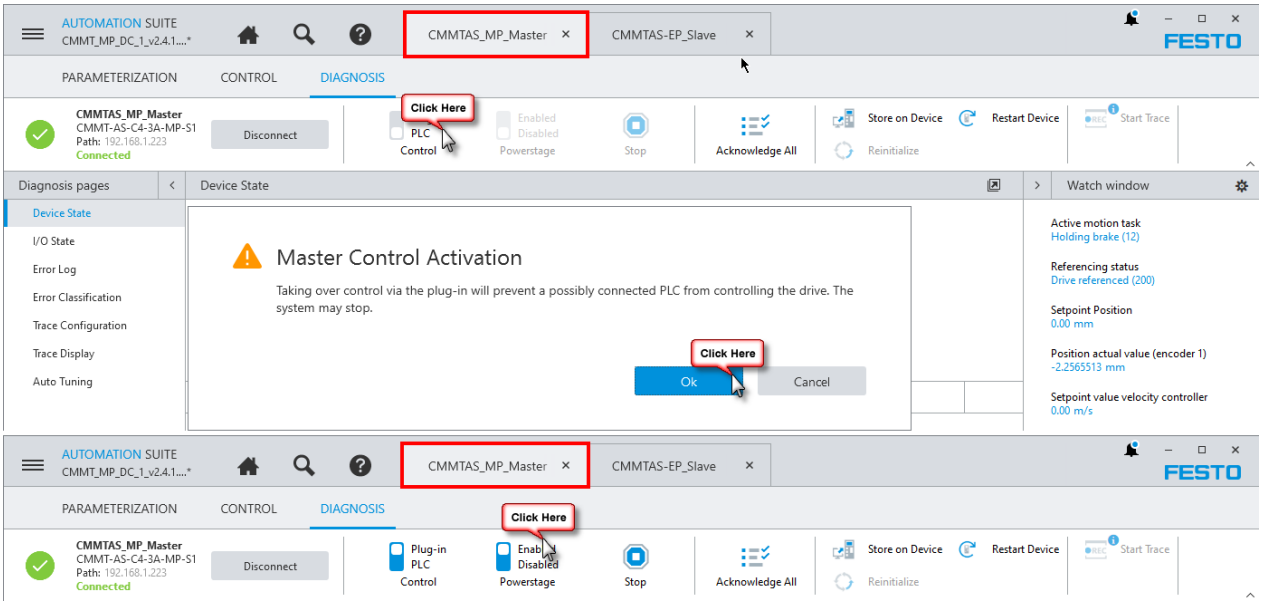
8.9 Slave Enable Plug-in PLC Control and Powerstage

The Slave Axis must be enabled and clear of faults prior to enable of the Master due to the Cross-Wiring Control Enable.



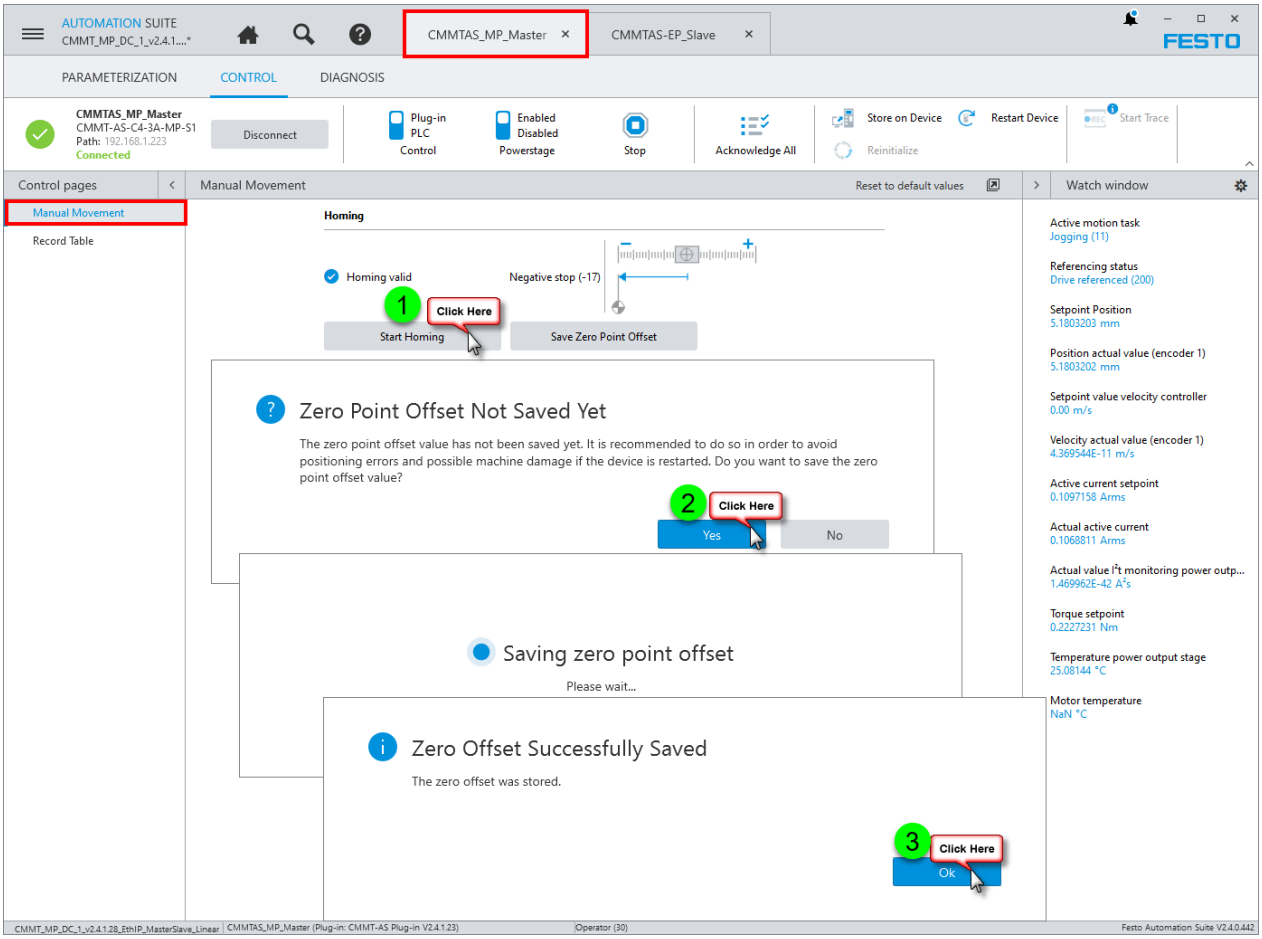
8.10 Master Enable Plug-in PLC Control and Powerstage

The Slave Axis must be enabled and clear of faults prior to enable of the Master due to the Cross-Wiring Control Enable.



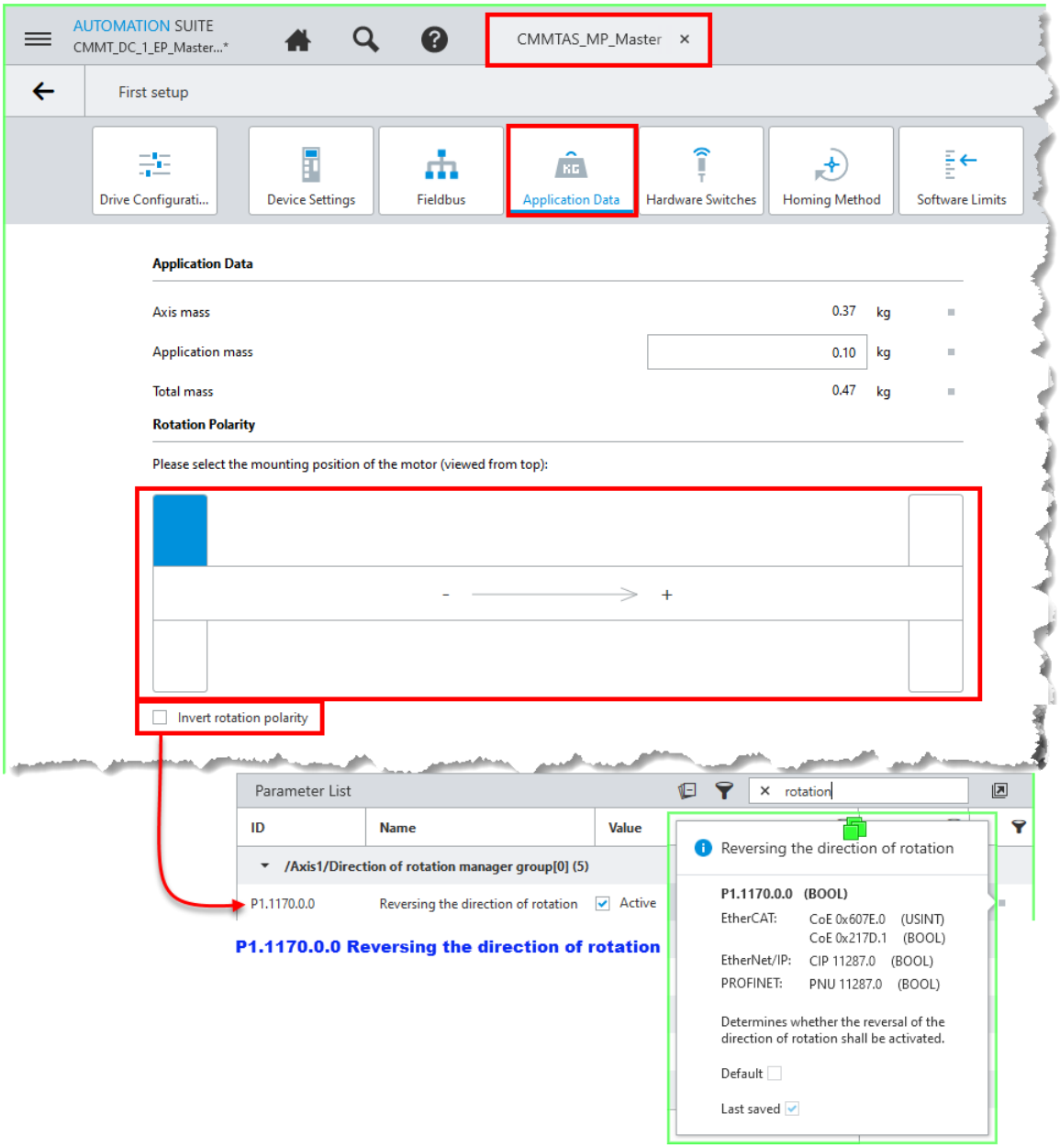
8.11 Master Homing

As mentioned earlier, a different reference method may be required for the application.



8.12 Master Rotation Polarity

Check if the axis is moving in the desired/correct direction as a standalone axis. This can be modified via the Start First Setup –› Application Data – Rotation Polarity as shown here



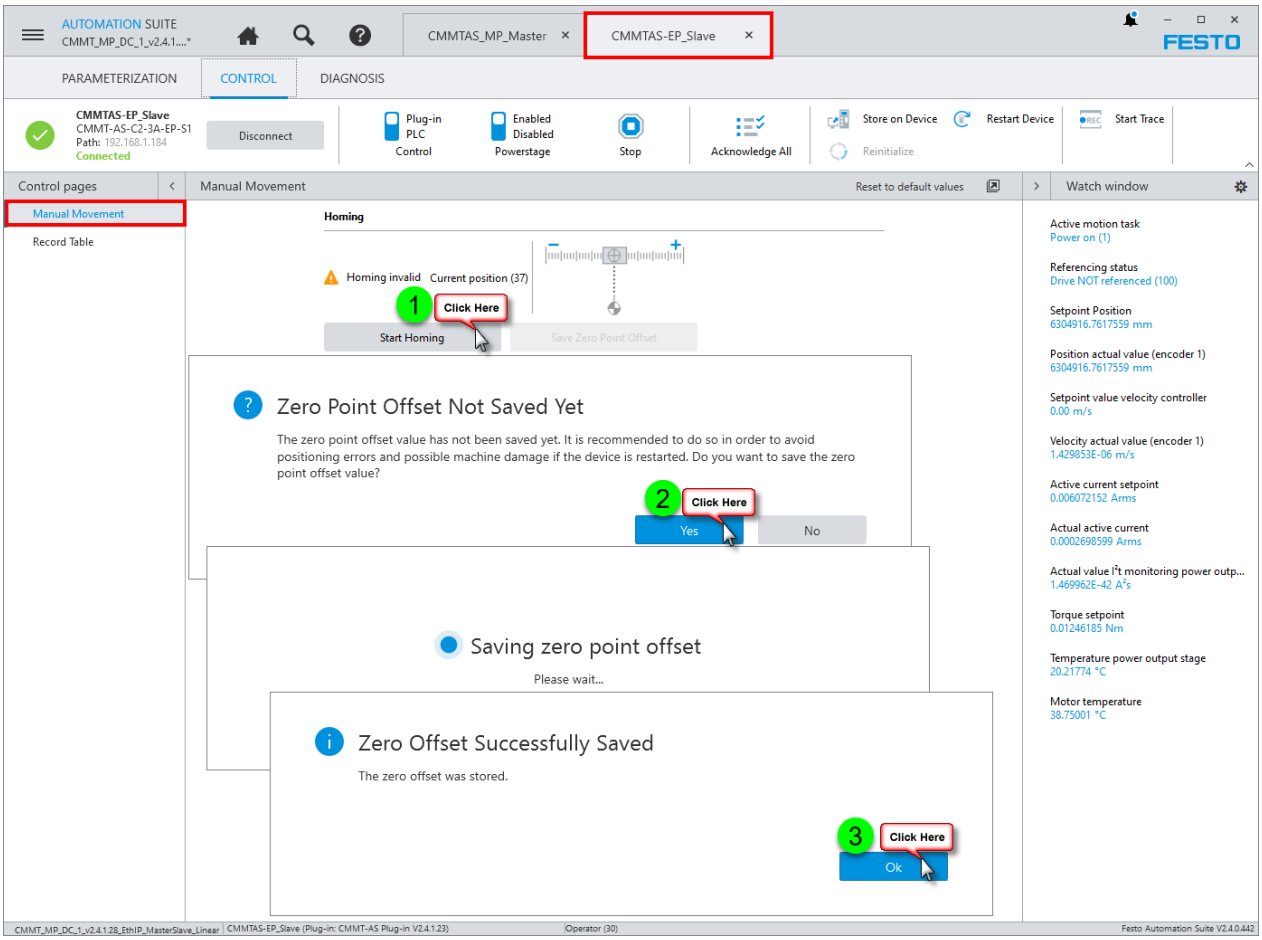
8.13 Master Slave Mechanical Alignment

Caution

- At this point, the mechanical alignment between the Master and Slave axis should be carried out. Depending on the application, this may include moving the Master and Slave axes before or after they are enabled.
- Only after the Slave axes has been aligned perfectly to the Master should the Slave axis now be referenced/homed and have the encoder position offset stored at their existing aligned positions!

8.14 Slave Homing

As mentioned earlier, a different reference method may be required for the application.



8.15 System Ready for Synchronisation

Once the previous steps of commissioning are completed, the system configuration is ready for Synchronisation/Gear In.

At this point the following implementations are active with the application:

- Cross-Wiring Hardware Control Enable (section 8.5) and
- Cross-Wiring Encoder X10 to X3 (section 8.4) and
- Master axis Active Error of Position Difference Encoder 1 to Encoder 2 too Large (section 5.5.1) and
- Slave axis Active Warning of Position Difference Encoder 1 to Encoder 2 too Large (section 7.5.2)

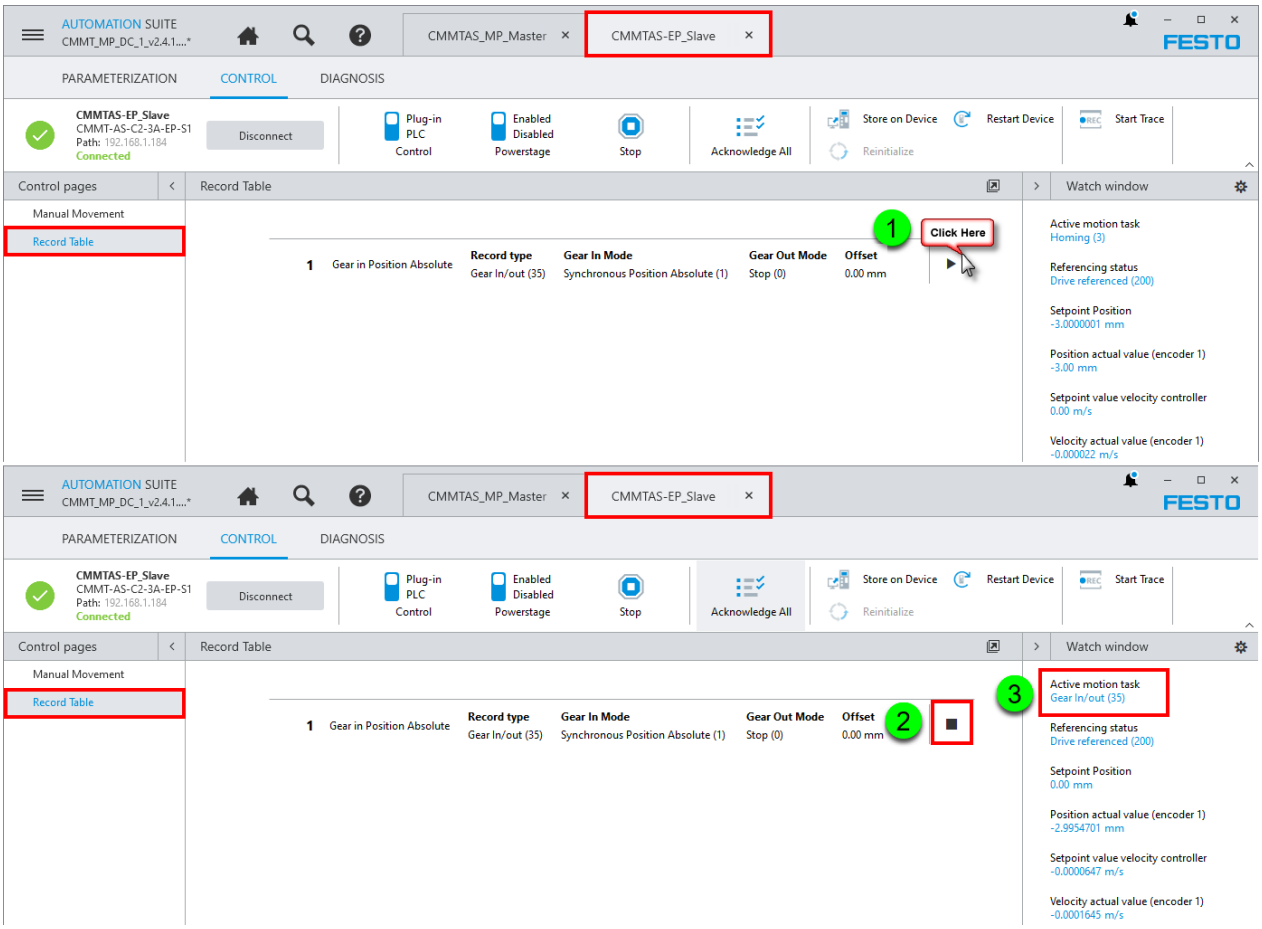
These implementations need to be considered prior to achieving a Gear In and during Gear In to avoid experiencing issues.

For example, incorrect tuning or high move velocity can effect and could nuisance trigger the error of " Position Difference Encoder 1 to Encoder 2 too Large". Testing needs to be completed in order to understand the limits of the application design and the configuration may need to change
In other words, in order to achieve the smallest position error and quickest response time, the following group parameters (Axis1/movement monitoring group) may need to be adjusted on both Master/Slave axis:

- P1.4642 Damping time encoder monitoring
- P1.4643 Monitoring window encoder monitoring

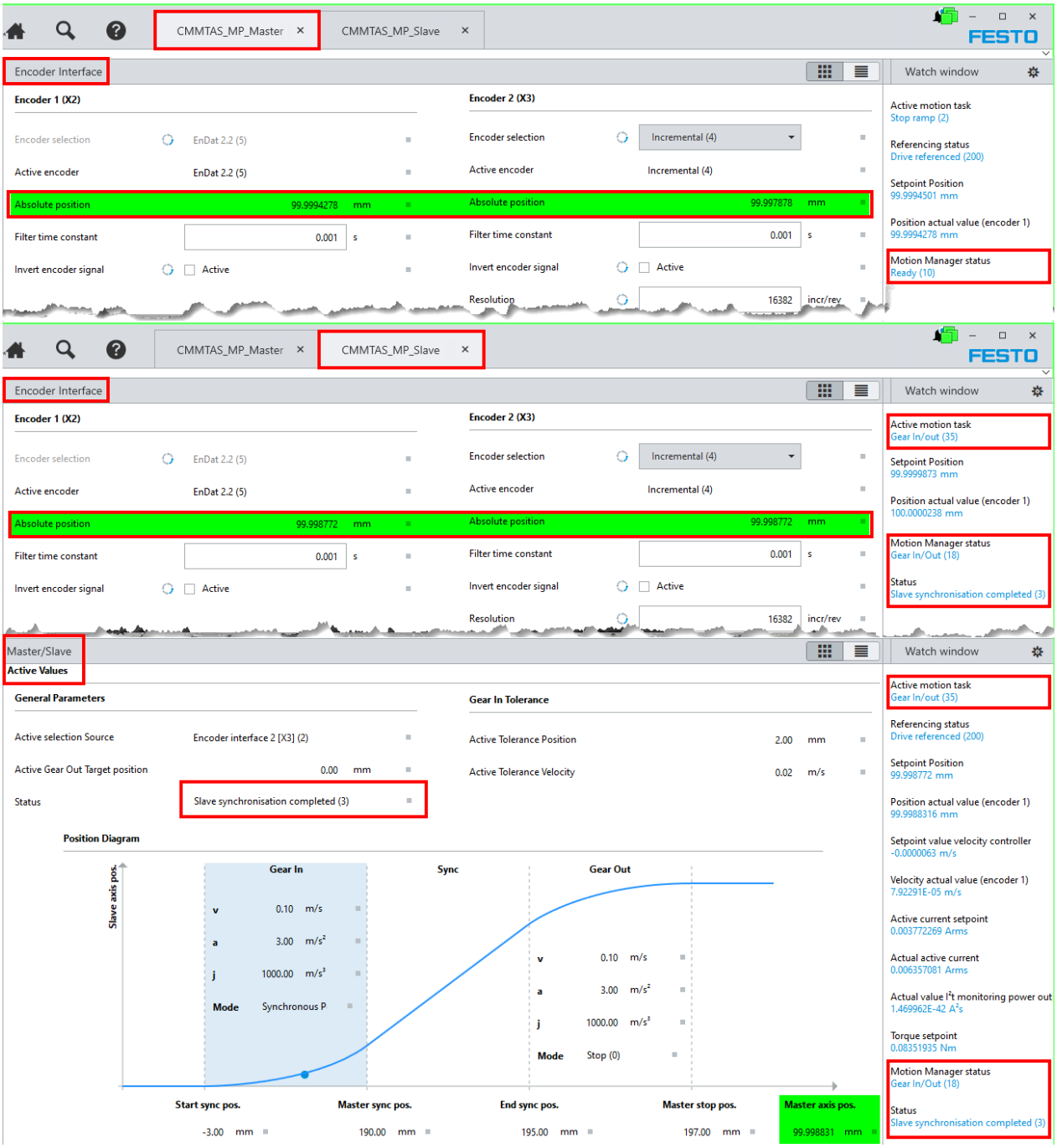
8.16 Slave Record Table Gear In Synchronous Position Absolute

Execute the Record Table Record "Gear In Synchronous Position Absolute (1)" that was previously programmed.



8.17 Slave Synchronisation is now Complete

While Gear In/Synchronisation is active/complete, the Encoder Interface page of both Master and Slave axes, Encoder 1[X2] Actual Position of Motor Encoder & Encoder 2[X3] Actual Position Emulated by opposite controller should always show the same value (within a tolerance) for both Master and Slave axes as shown here.



As described in section 8.14, now the axis is Geared in, testing should be done to determine system limits and configuration changes. This can be done using the features of Festo Automation Suite (FAS), or you can use PLC (Programmable Logic Controller) programming code to execute all Gear In functions along with the monitoring features of Festo Automation Suite (FAS).

9 PLC (Programmable Logic Controller)

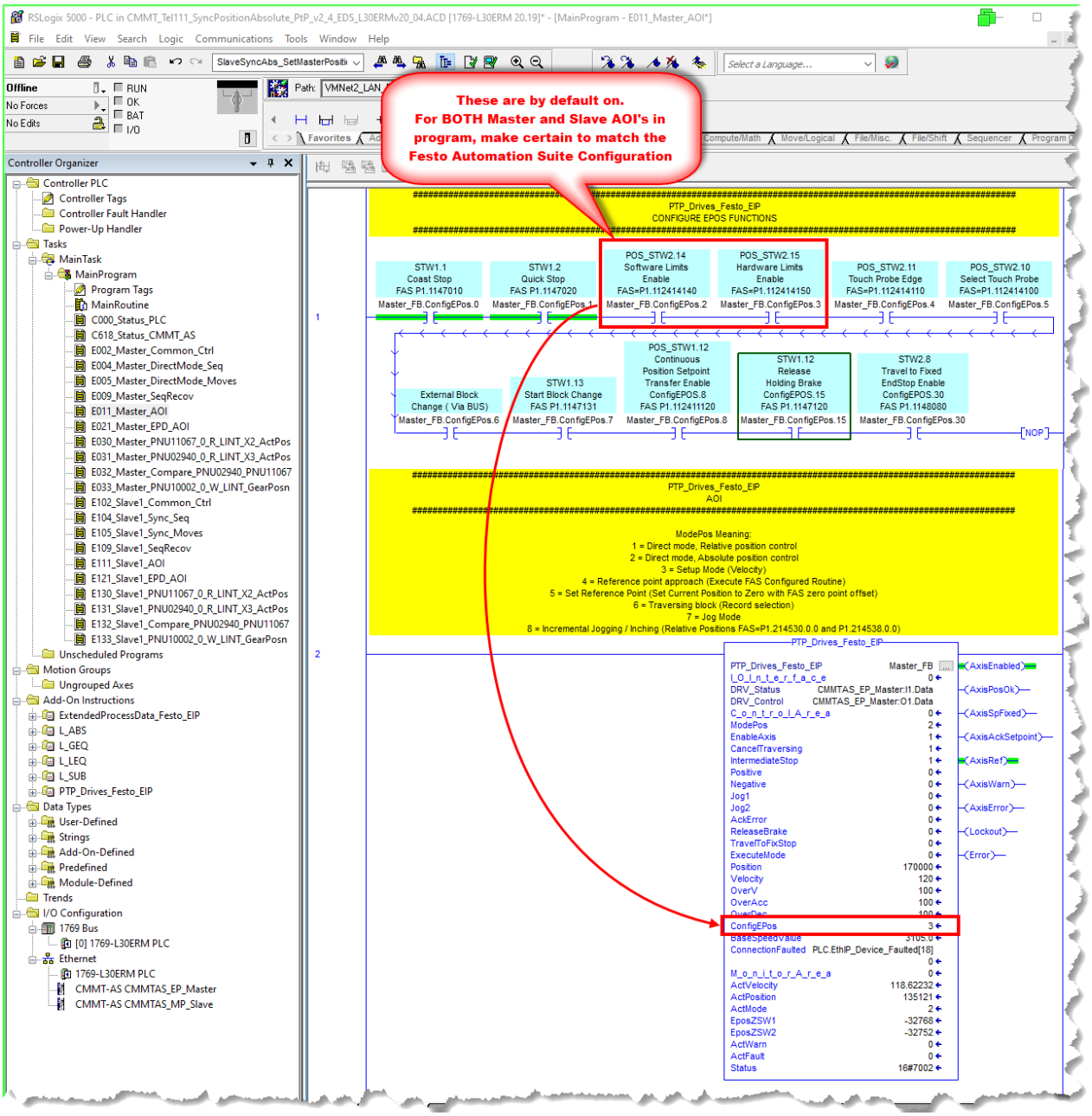
The use of a higher order PLC (Programmable Logic Controller) to monitor and control the Master Slave Synchronisation/Gear In will have configuration bits/words that can activate/deactivate Software and hardware limits. These PLC tags need to be considered during the configuration of the system. The next sections 9.x Show an example of what to consider in a Rockwell software environment and similar tags can be found in other PLC types.

9.1 Rockwell AOI (Add-On Instruction) Software Library

If the end user plans to use an Allen Bradley as higher order PLC, section 1.1 (Recommended Website Downloads) describes a download of the Rockwell RSLogix 5000/LogixDesign AOI Software Library. This library would/should be used in this situation along with this application guide.

9.2 Rockwell AOI (Add-On Instruction) ConfigEPos

As discussed previously in this application guide, the Software Limits should be observed however, this depends on your application. Depending on the decisions of the user, make certain the settings previously made within the Festo Automation Suite (FAS) project MATCH the configuration bits shown here in the PLC code for each axis because the PLC will take priority and will override the Software or Hardware limits in the controllers.



10 Error Recovery

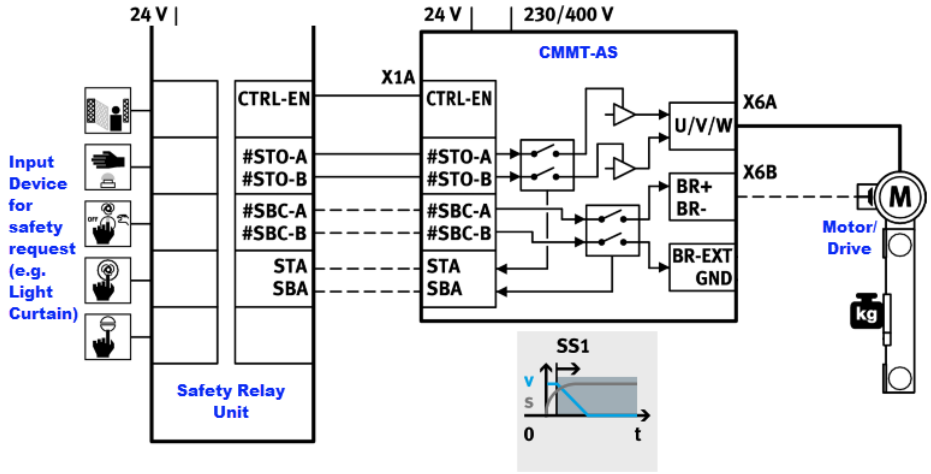
Gear In Synchronous Position Absolute mode will be considered the normal working state of this application.

Error Recovery is the term used in this guide to describe situations this application can encounter and methods to recover to a normal working state afterward.

With the application of Gear In Synchronous Position Absolute mode, there can be many error recovery situations and a some common situations are detailed in this guide.

10.1 E-Stop or Control Enable

Shown here is sub-function SS1 safety wiring (This is an example only and not an actual certified design).



The normal working state of Gear In Synchronous Position Absolute mode can be compromised by some of the following causes:

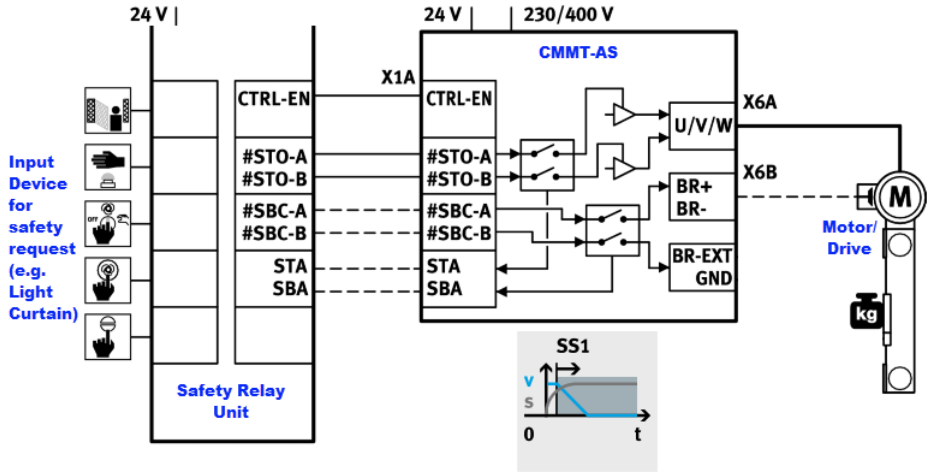
- CMMT-AS Slave axis STO-A or STO-B disconnected
- CMMT-AS Slave axis SBC-A or SBC-B disconnected
- CMMT-AS Slave axis CTRL-EN disconnected from 24Vdc source

The error recovery and re-synchronisation/Gear In (electronic alignment) for these causes are accomplished as follows:

1. The normal working state of Gear In Synchronous Position Absolute mode is active
2. Synchronisation/Gear In is lost due to one of the causes described in this section
3. Synchronisation/Gear In is now required
4. All safeties and any other cause for the loss of synchronisation are restored
5. Slave axis reset faults
6. Slave axis enable
7. Slave axis execute Record#1 "Gear In with Synchronous Position Absolute"
8. Master axis reset faults
9. Master axis enable. NOTE: the Slave Axis Synchronisation must be active prior to enable
10. Synchronisation/Gear In Sequence now Complete

10.2 Supply Power

Shown here is sub-function SS1 safety wiring (This is an example only and not an actual certified design).



The normal working state of Gear In Synchronous Position Absolute mode can be compromised by some of the following causes:

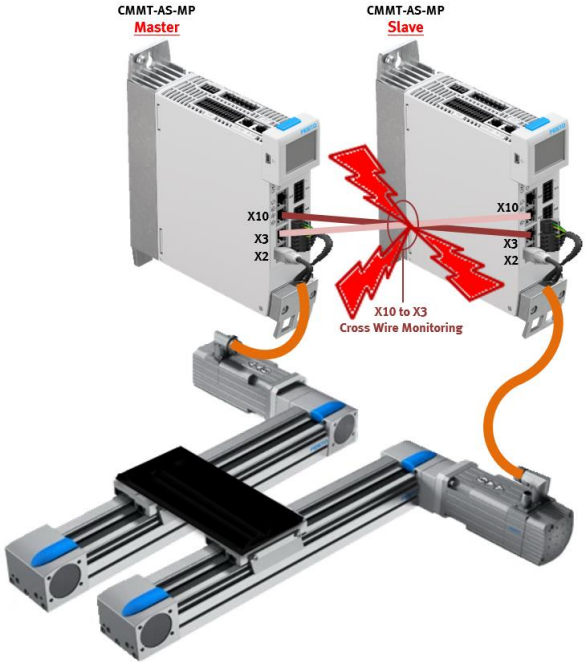
- CMMT-AS Master or Slave axis 24Vdc disconnected
- CMMT-AS Master or Slave axis 230/400Vac disconnected
- CMMT-AS Master or Slave axis other unforeseen circumstances

The error recovery and re-synchronisation/Gear In (electronic alignment) for these causes are accomplished as follows:

1. The normal working state of Gear In Synchronous Position Absolute mode is active
2. Synchronisation/Gear In is lost due to one of the causes described in this section
3. Synchronisation/Gear In is now required
4. All supply voltages previously removed are restored
5. All safeties are restored
6. It has been determined that "Set Master Position Gear In" is required by a compare of the following:
   - Master axis Encoder 1[X2] vs Master axis Encoder2 [X3] is within Tolerance
   - Slave axis Encoder 1[X2] vs Slave axis Encoder2 [X3] is within Tolerance
   - Master axis Encoder 1 [X2] vs Slave Axis Encoder2 [X3] is Within Tolerance
7. Slave axis reset faults
8. Slave axis set Gear In Master Position Value = Master axis actual position (to perform this function, use the METHOD [e.g. PNU 10002] as described in user manual)
9. Slave axis enable
10. Slave axis execute Record#1 "Gear In with Synchronous Position Absolute"
11. Master axis reset faults
12. Master axis set Gear In Master Position Value = Master axis actual position (to perform this function, use the METHOD [e.g. PNU 10002] as described in user manual)
13. Master axis enable. NOTE: the Slave Axis Synchronisation must be active prior to enable
14. Synchronisation/Gear In Sequence now Complete

10.3 Encoder Emulation Cable X10 to X3 Failure

Encoder signal loss between X10 to X3 (sections 5.5.1 and 5.6.1 and 7.5.2 and 7.6.1 and 8.4) is implemented in this application. Shown here is an example of a cable failure.



The normal working state of Gear In Synchronous Position Absolute mode can be compromised by the following cause:

- CMMT-AS Master axis D1.07|02|00133.0 Position Difference Encoder 1 to Encoder 2 too Large

The error recovery and re-synchronisation/Gear In (electronic alignment) for these causes are accomplished as follows:

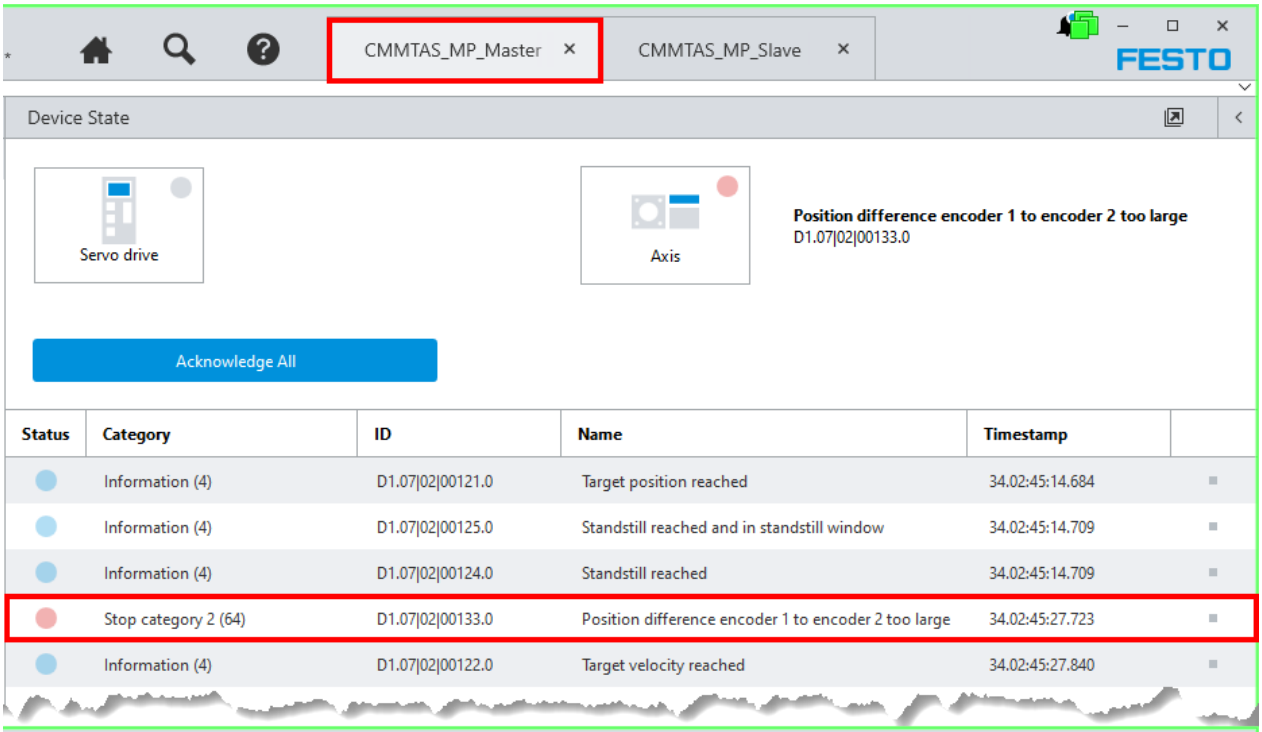
1. The normal working state of Gear In Synchronous Position Absolute mode is active
2. Master axis detects a error Position Difference between Encoder 1 vs Encoder 2
3. Synchronisation/Gear In is lost due the Stop Category 2 reaction (category reaction details in section 5.6.1)
4. Synchronisation/Gear In is now required
5. All safeties are restored (This step and remaining steps are identical to Supply Power section 10.2 Step 5)
6. It has been determined that "Set Master Position Gear In" is required by a compare of the following:
   - Master axis Encoder 1[X2] vs Master axis Encoder2 [X3] is within Tolerance
   - Slave axis Encoder 1[X2] vs Slave axis Encoder2 [X3] is within Tolerance
   - Master axis Encoder 1 [X2] vs Slave Axis Encoder2 [X3] is Within Tolerance
7. Slave axis reset faults
8. Slave axis set Gear In Master Position Value = Master axis actual position (to perform this function, use the METHOD [e.g. PNU 10002] as described in user manual)
9. Slave axis enable
10. Slave axis execute Record#1 "Gear In with Synchronous Position Absolute"
11. Master axis reset faults
12. Master axis set Gear In Master Position Value = Master axis actual position (to perform this function, use the METHOD [e.g. PNU 10002] as described in user manual)
13. Master axis enable. NOTE: the Slave Axis Synchronisation must be active prior to enable
14. Synchronisation/Gear In Sequence now Complete

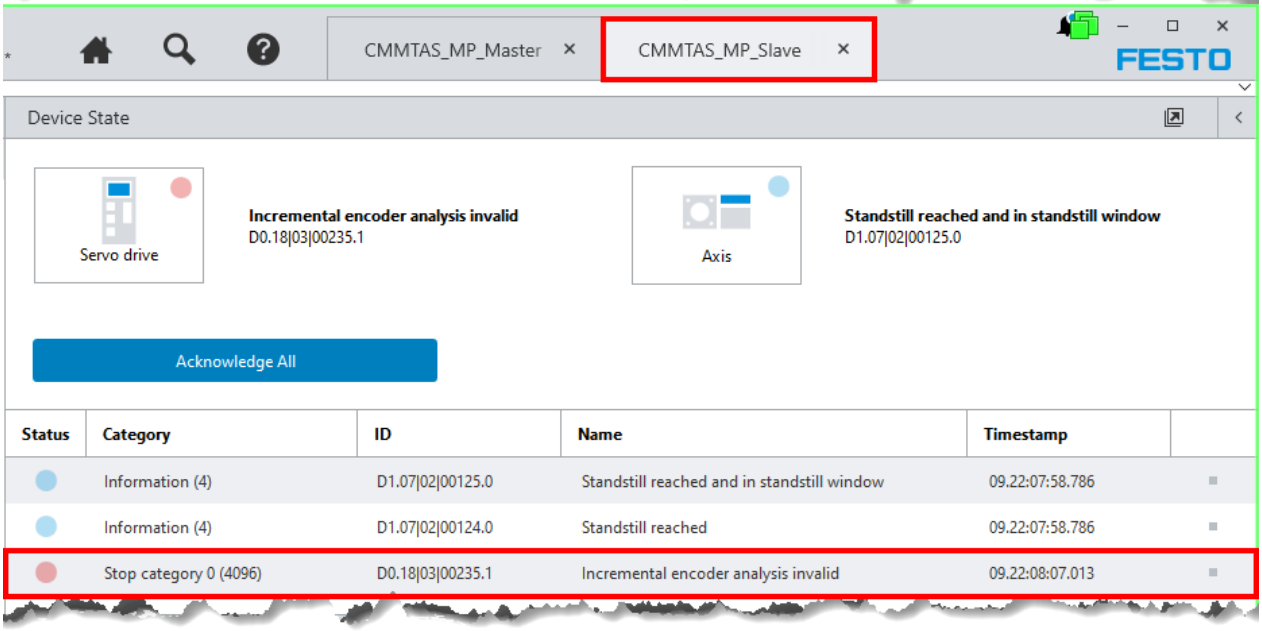
10.3.1 Slave Encoder 2[X3] Cable Failure Errors

Slave Encoder 2[X3] cable provides the Actual Position Emulated by Master.

Typical errors observed when the Slave Encoder 2[X3] cable fails are as follows:

- Error 00133 Position difference encoder 1 to encoder 2 too large
- Error 00235 Incremental encoder analysis invalid





10.3.2 Master Encoder 2[X3] Cable Failure Errors

Master Encoder 2[X3] cable provides the Actual Position Emulated by Slave.

Typical errors observed when the Master Encoder 2[X3] cable fails are as follows:

- Error 00133 Position difference encoder 1 to encoder 2 too large
- Error 00235 Incremental encoder analysis invalid