



# **Application Note**

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## **EtherCAT Servo Drive Quick Start Guide**

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### **Applicable Products:**

Yaskawa Servodrives with CANopen over EtherCAT



<b>Product:</b> Yaskawa Servodrives with CANopen over EtherCAT	<b>Doc#:</b> AN.MTN.03
<b>Title:</b> EtherCAT Servo Drive Quick Start Guide	

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## 1. About This Document

This document contains the minimum hardware and software setup required to operate Yaskawa CANopen over EtherCAT Servo Drives with the Beckhoff TwinCAT EtherCAT master.

Users who are developing a customized EtherCAT master should consider testing with an EtherCAT master that is known to be compatible with Yaskawa EtherCAT drives for the following reasons:

- Proof of concept
- Comparison of functionality
- Comparison of performance
- Troubleshooting a custom master that's under development

Beckhoff TwinCAT version 2.11 R3, Build 2220 is known to be compatible with Yaskawa EtherCAT servo drives.

For additional setup options to perform basic operation of Yaskawa EtherCAT drives with Beckhoff TwinCAT, refer to Yaskawa.com document number "ENG.09.126.MTN".

### Abbreviations

- **CoE** - CANopen over EtherCAT - *Profile for motion control*
- **ESI** - EtherCAT Slave Information - *File with slave device descriptions, utilized by masters*
- **GUI** - Graphical User Interface - *Screen that allows interaction*
- **IPC** - Industrial PC - *Computer designed for industrial use*
- **NIC** - Network Interface Card - *(EtherCAT) Ethernet PC card*
- **OS** - Operating System - *Examples: Windows 7, Linux, Mac OS X*
- **RAM** - Random-Access Memory - *PC Hardware for computer data storage*
- **USB** - Universal Serial Bus - *PC Hardware communication interface*



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## 2. Prerequisites

### 2.1. Hardware

- Yaskawa CANopen over EtherCAT Servo Drive
  - SGDV with SGDV-OCA01A
- USB Communications Cable
  - Use Yaskawa USB Communications cable to avoid communication issues
    - Yaskawa part number JZSP-CVS06-02-E
  - Connects Yaskawa drive to host PC running SigmaWin, which features:
    - Verification of Target Position each EtherCAT cycle
    - Setting drive parameters
    - Issuing drive functions
- Ethernet cable
  - Cat5e Shielded Twisted-Pair is recommended
  - Unshielded Ethernet cables may result in A.A12 or A.A11 alarms due to noise interference
- Windows PC
  - TwinCAT-compatible NIC from the following list is required:  
[http://infosys.beckhoff.com/english.php?content=content/1033/tcsystemmanager/reference/ethercat/html/ethercat\\_supnetworkcontroller.htm](http://infosys.beckhoff.com/english.php?content=content/1033/tcsystemmanager/reference/ethercat/html/ethercat_supnetworkcontroller.htm)
  - CPU and RAM
    - In general, the required CPU performance and amount of RAM depend on the following factors:
      - Number of axes (more axes requires faster CPU)
      - Cycle time (faster cycle time requires faster CPU)
      - Load on processor from other programs
    - CPU performance can be verified by checking “TwinCAT Real Time Usage.”
      - See “Appendix G: TwinCAT Real Time Usage”.



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- Suggested PC hardware:
  - Beckhoff IPC
    - Guaranteed to run TwinCAT
  - Other IPC or Desktop PC
    - Compatible NIC and sufficient CPU and RAM are required

## 2.2. Software

- ESI files for Yaskawa CANopen over EtherCAT Servo Drive
  - Available on Yaskawa.com (document number: **Yaskawa\_CoE\_ESI\_Files**)
  - Example: **Yaskawa SGD-V-E1\_CoE rev5.00.xml**
  - Files can co-exist, so the recommendation is to download them all.
  - See “Appendix A: Yaskawa ESI Files” for details about individual ESI files.
- Microsoft Windows
  - 32-bit Windows XP or 32-bit Windows 7 required for the configuration described in this quick start guide.
  - Virtual machines cannot be used. Windows must be installed on the physical PC hardware.
- Beckhoff TwinCAT
  - This quick start guide assumes the use of TwinCAT version TwinCAT 2.11 R3, Build 2220.



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## 3. Software Configuration

### 3.1. Install TwinCAT

- For the TwinCAT Installation Level, select “TwinCAT NC I - Interpolation”
- For the Components, select “TwinCAT Scope View”
  - Other components may be included if desired

### 3.2. ESI File Installation

- Close the TwinCAT System Manager application if it is running.
- Place all ESI files into the TwinCAT directory.
  - The default ESI file installation location is: C:\TwinCAT\Io\EtherCAT

### 3.3. TwinCAT Ethernet Adapter Setup

- This step is only required one time.
- See “Appendix C: TwinCAT Ethernet Adapter Setup” for step-by-step instructions.



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## 4. Hardware Configuration

### 4.1. Clear Drive Alarms and Warnings

Clear all alarms and warnings on the Yaskawa Drive before connecting with EtherCAT.

- The most common alarms are addressed in this section.
- For alarms not addressed in this document, refer to the product's user's manuals for corrective actions.
  - For Sigma-5 user's manuals, refer to "Appendix B: User's Manuals".
- Alarms are indicated in SigmaWin (refer to SigmaWin's user's manuals for instructions)
  - If the drive has a 7-segment status display, the alarms/warnings flash on the display.

#### 4.1.1. Parameter Reset

- The parameters should be reset to start with the default parameters.
- Execute Parameter Initialize using SigmaWin.

#### 4.1.2. Absolute Encoder Setup

- Clears alarm "Encoder backup error" (A.081)
- Possible solutions:
  - Configure absolute encoder for incremental operation.
    - Set Pn002.2 = 1 through SigmaWin.
  - Use SigmaWin to reset the absolute encoder.
    - Example for SGDv: "Appendix D: Reset Absolute Encoder Using SigmaWin"





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#### 4.1.3. Overtravel Setup

- Clears “Forward/reverse run prohibited”
  - If the drive has a 7-segment LED status display, “Forward/reverse run prohibited” is indicated by flashing “P”/“n”
  - “Forward/reverse run prohibited” is also indicated in SigmaWin.
- Possible solutions:
  - Make appropriate electrical connections the positive/negative overtravel inputs on the drive’s CN1 connector
    - Refer to the user’s manual for example I/O electrical connections.
  - Use SigmaWin to disable the inputs.
    - Example for SGDv: “Appendix E: Disable Overtravels Using SigmaWin”

#### 4.2. Configure Motor and Drive

- For the first trial, start with just a single drive on the EtherCAT network.
- Secure the motor body so that it cannot move.
- Detach all load from motor shaft
- Execute motor jog through SigmaWin, forward and backwards 10 times, which:
  - Checks motor wiring
  - Is required for tuningless mode to detect tuning and set gains

#### 4.3. Configure EtherCAT Network

- Topology: Connect a single Ethernet cable between Master Ethernet port and Slave “IN” port.
  - No other devices (e.g. no network hubs) should be present in the EtherCAT network.

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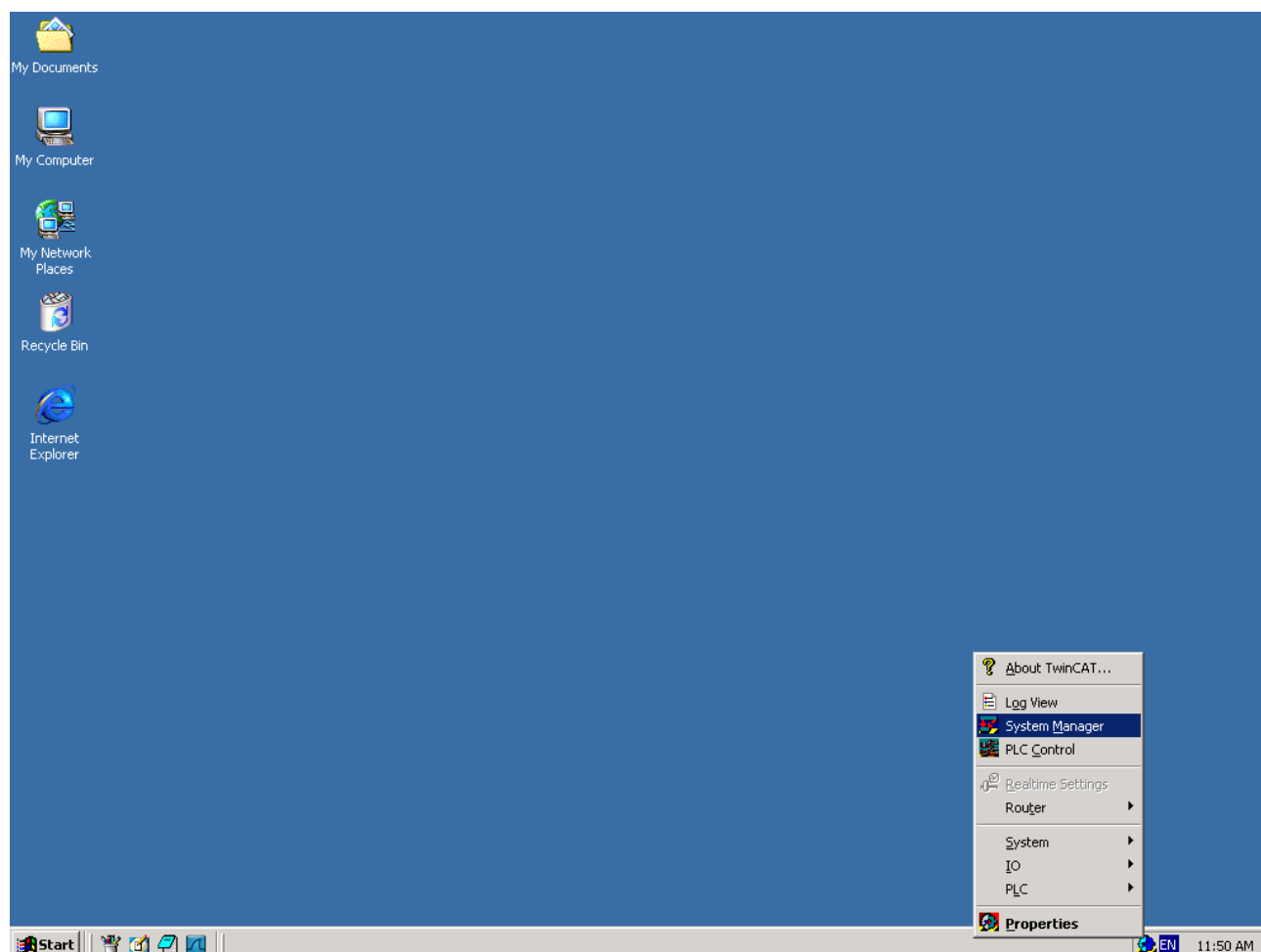
## 5. Trial Motion Operation Using TwinCAT

A step-by-step guide is shown here, which is similar to the eLearning module (eLM.Sigma5.01.CoE).

A video is also available at: <http://youtu.be/NgHKjHeHxOw>

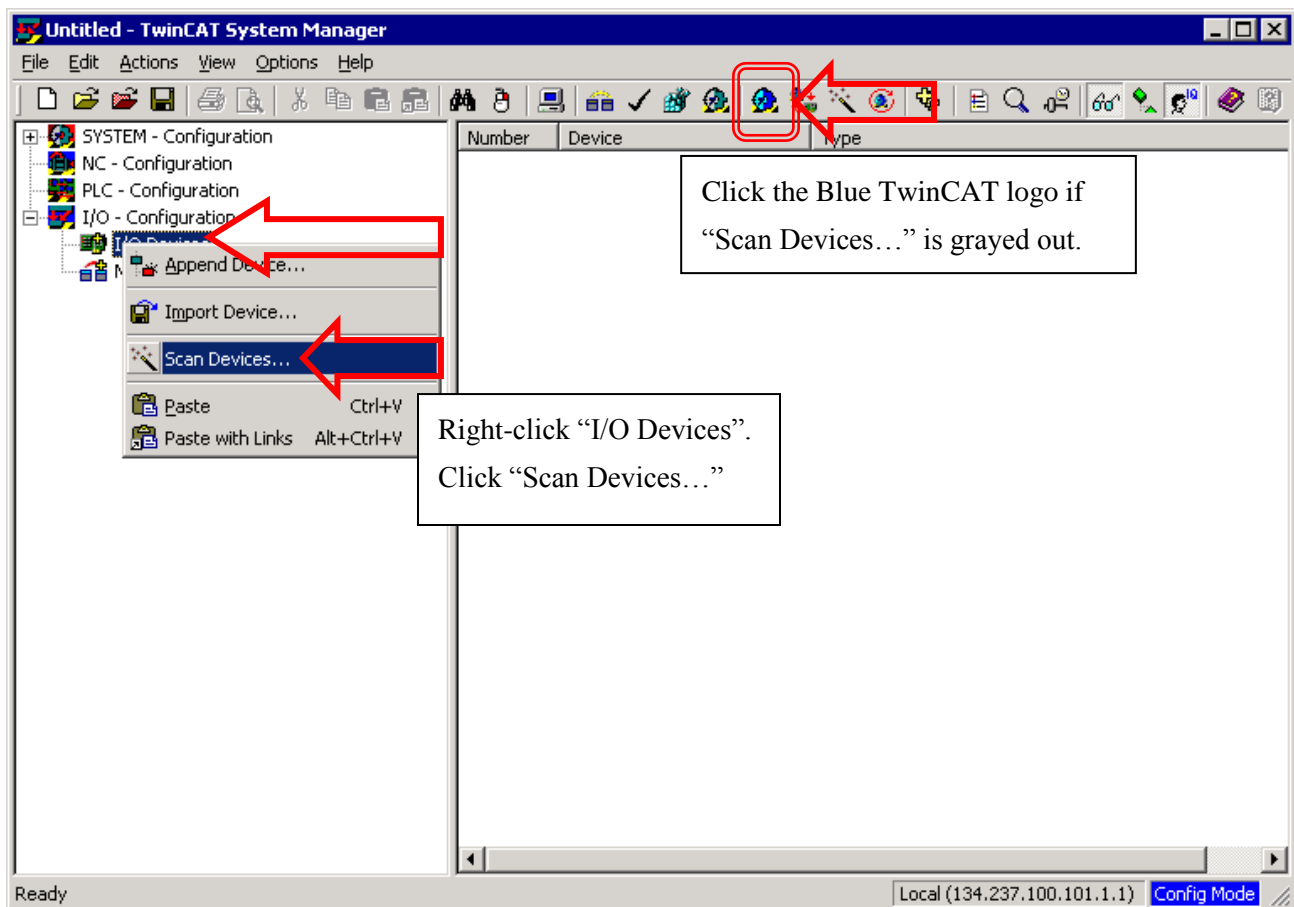
### 5.1. Start TwinCAT System Manager

- Right-click the TwinCAT icon in the Windows System Tray.
- Select “System Manager”



## 5.2. Scan PC For EtherCAT Master Devices

- Right-click “I/O Devices”
- Click “Scan Devices...”
  - If “Scan Devices...” is grayed out:
    - Click the Blue TwinCAT logo to put TwinCAT into Config Mode

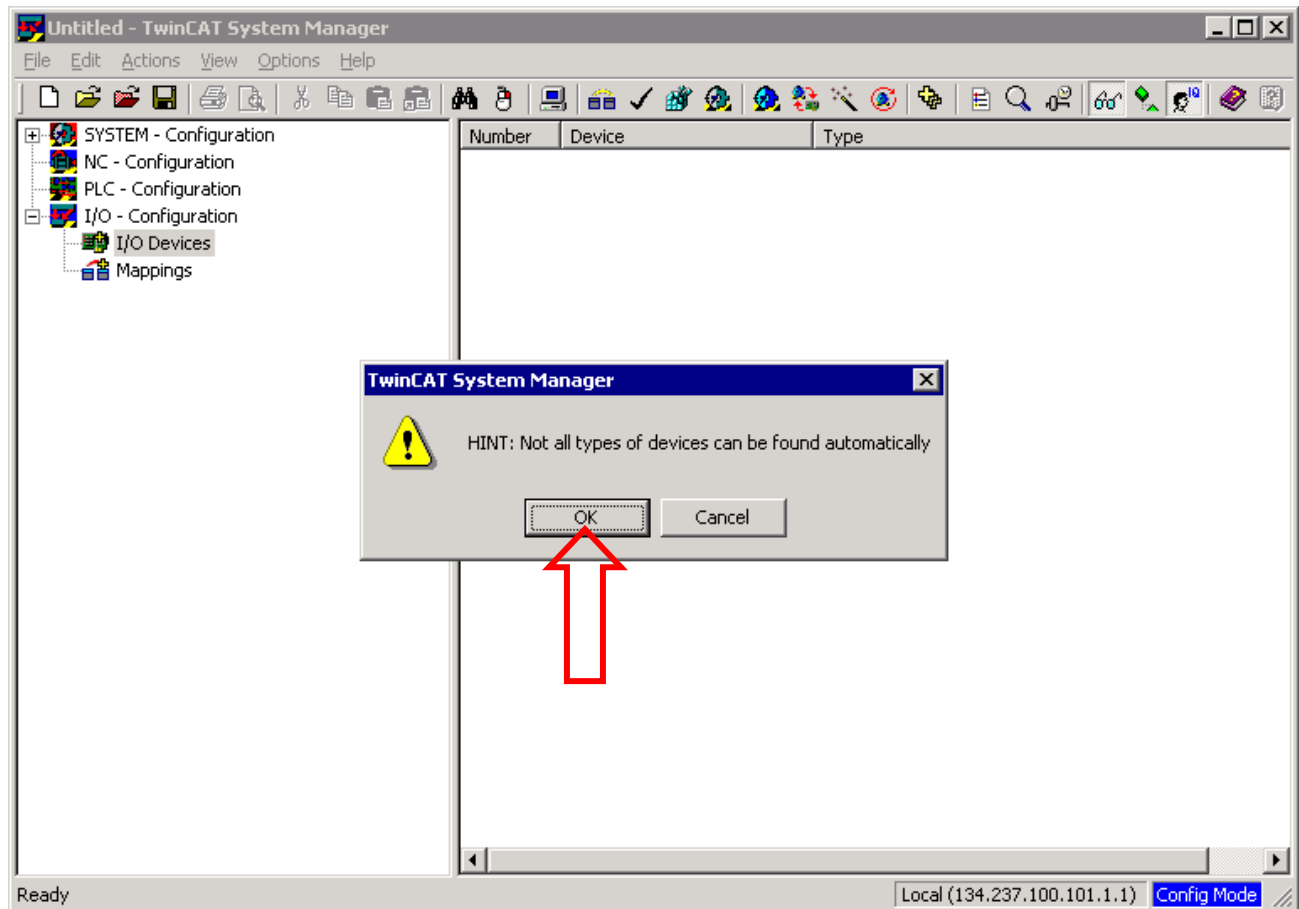


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- Click “OK”

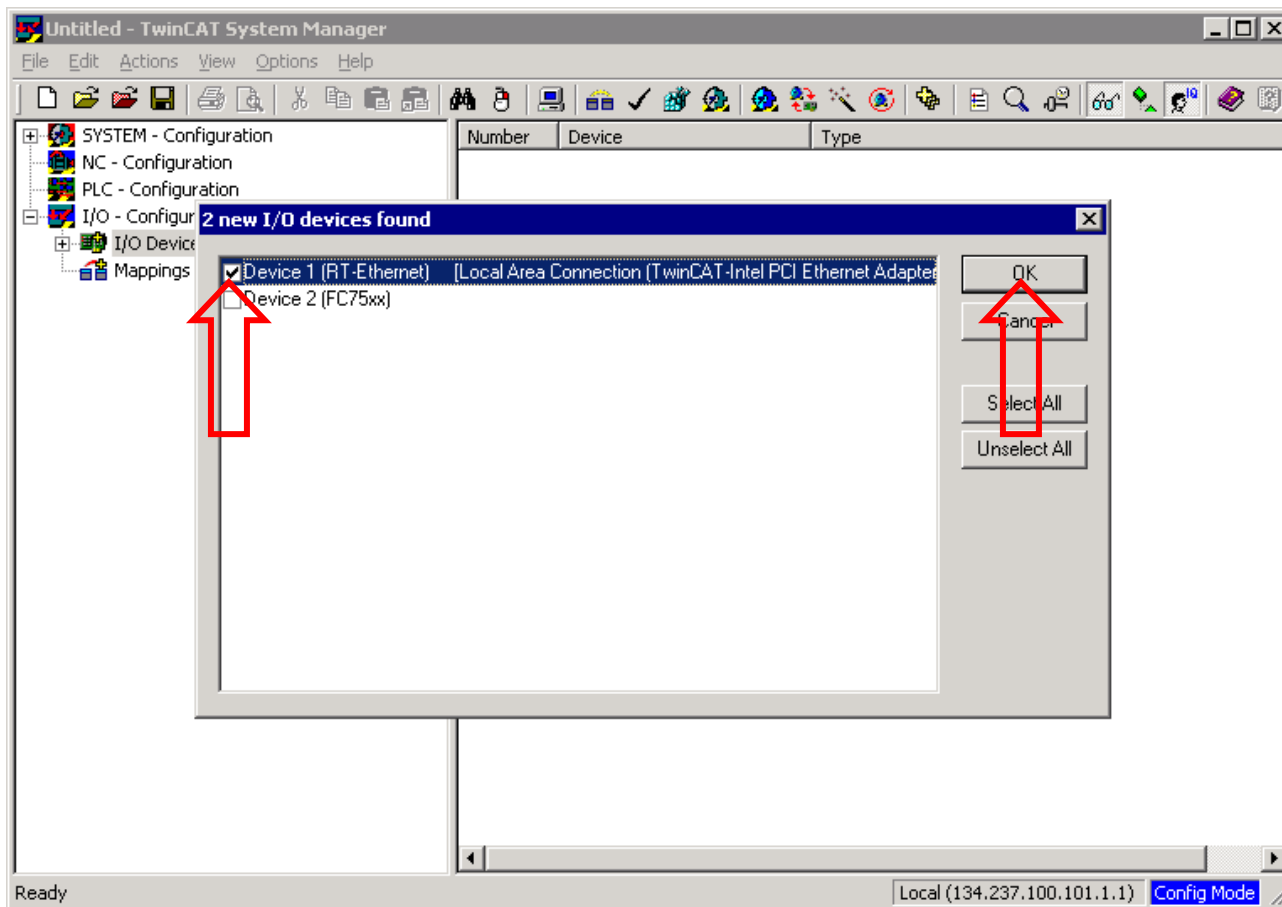


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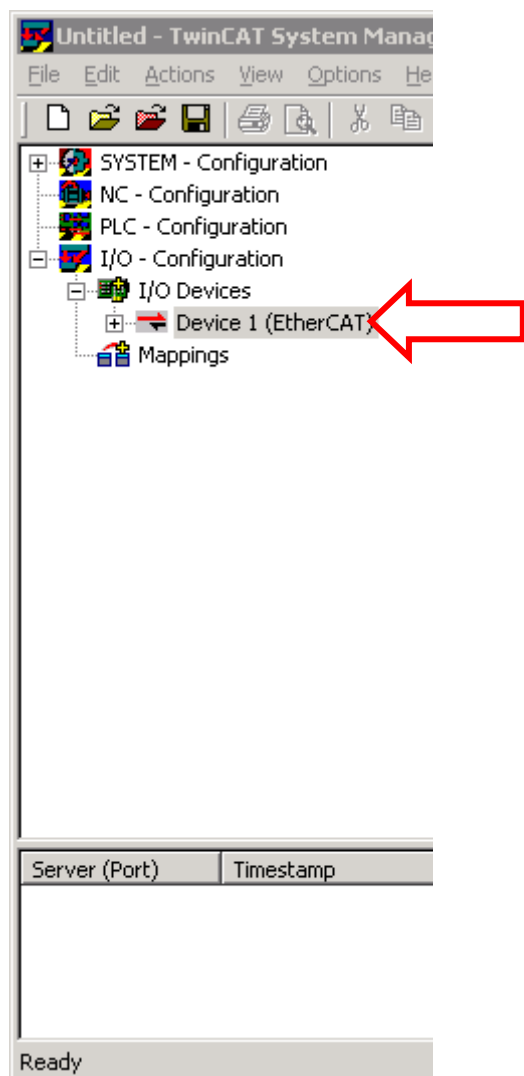
- Deselect all items except the Ethernet adapter, then click “OK”
  - If an Ethernet adapter does not appear here, the Ethernet adapter must be set up.
    - See section 3.3. TwinCAT Ethernet Adapter Setup above





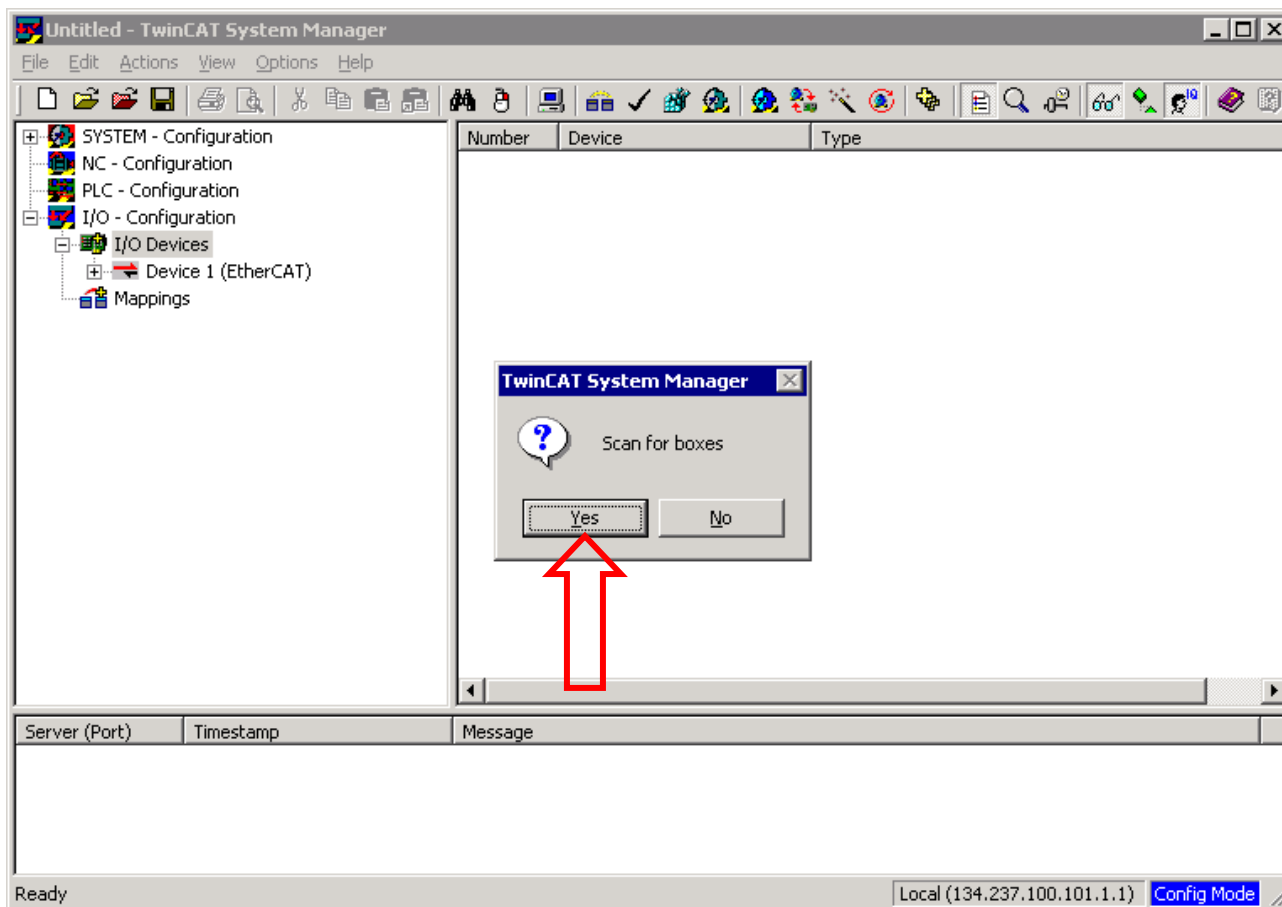
<b>Product:</b> Yaskawa Servodrives with CANopen over EtherCAT	<b>Doc#:</b> AN.MTN.03
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- The EtherCAT adapter should now appear on the left side of TwinCAT System Manager (below).
  - If the EtherCAT adapter does not appear as shown in the image (Example: “RT Ethernet” appears instead), either of the following might be true:
    - Slave device not connected to Master
      - Check cabling and that slave is powered on
    - Autoscan could not find the EtherCAT adapter, so it must be added manually
      - See “Appendix F: Adding EtherCAT Adapter Manually”



### 5.3. Scan Network For EtherCAT Slave Devices

- Click “Yes”
  - If the EtherCAT adapter was added manually, right click on “Device 1 (EtherCAT)”
    - Select “Scan Boxes...” (not pictured)
    - Then proceed to click “Yes”.

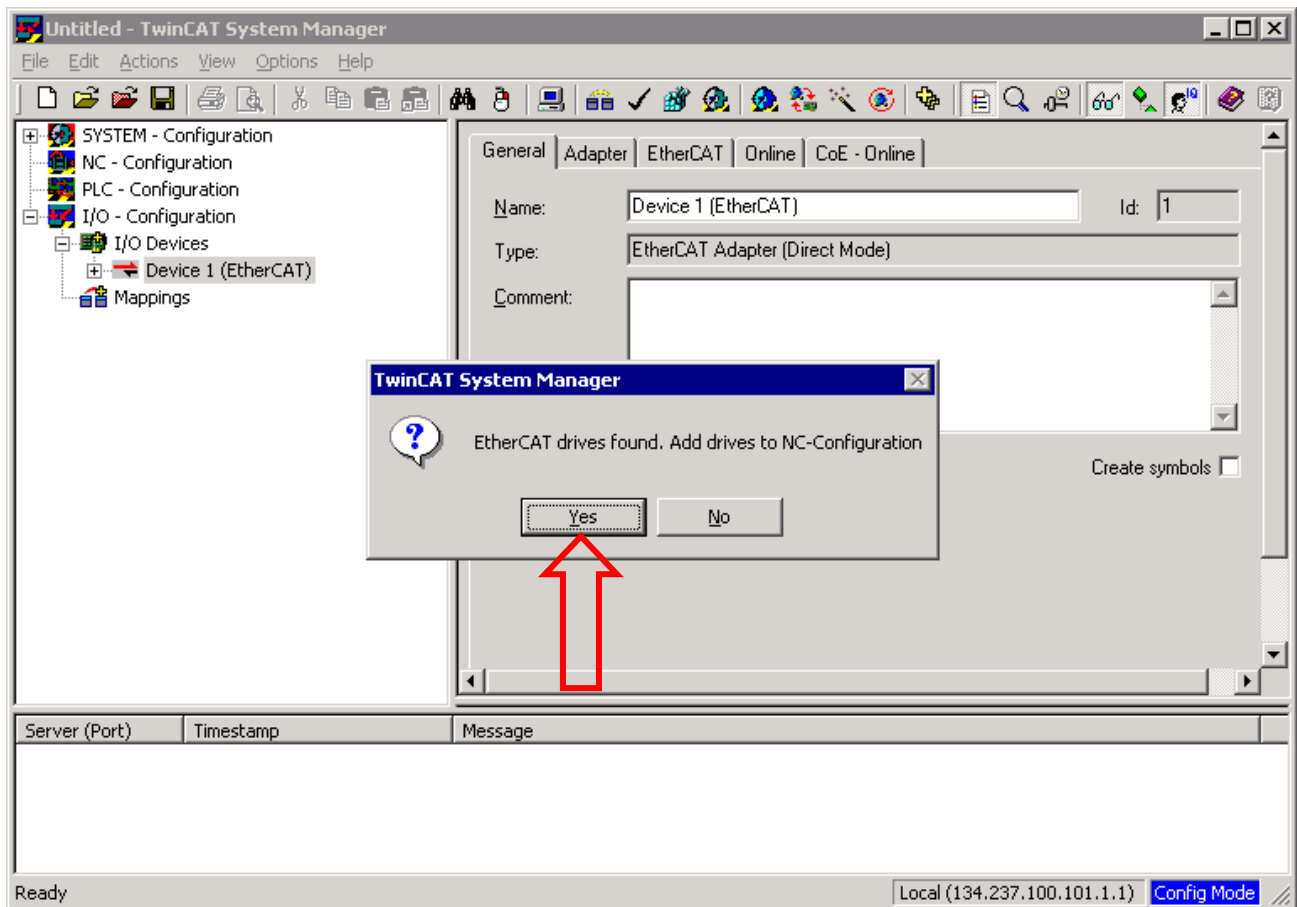


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- Click “Yes”
  - NC-Configuration is the “Numeric Control” function of TwinCAT.
  - This allows basic drive functions using the TwinCAT GUI like Jog.



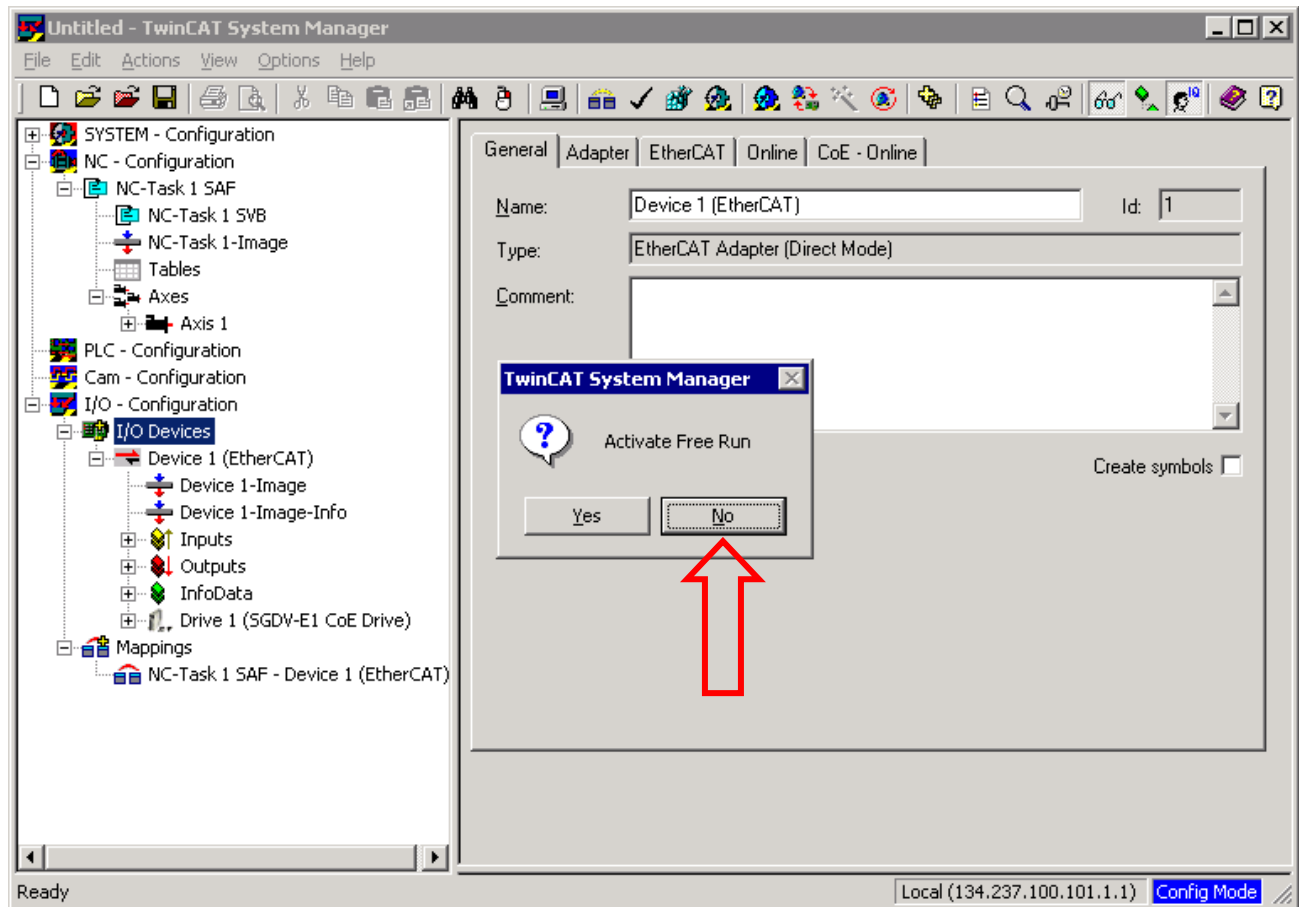


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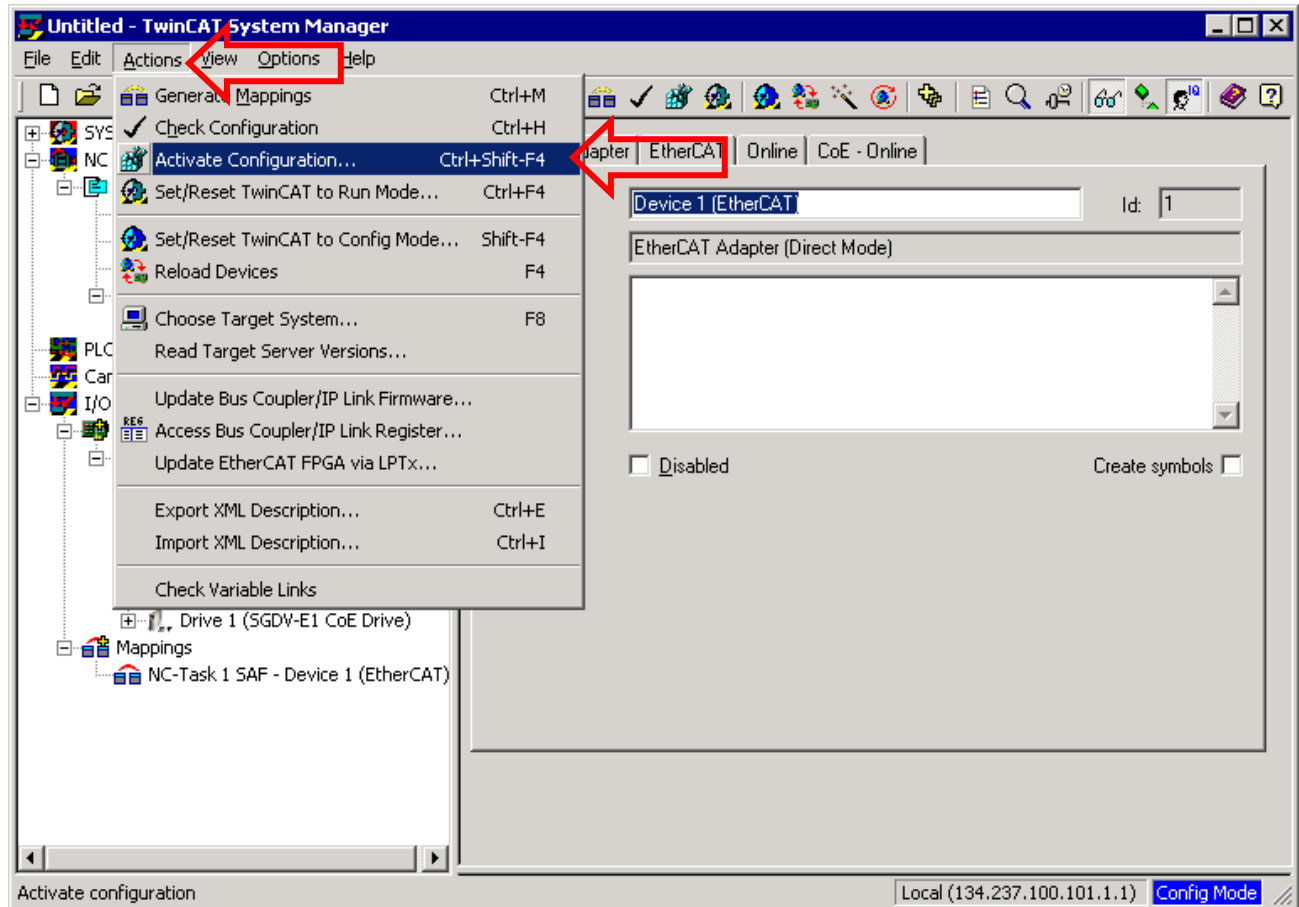
**Title:** EtherCAT Servo Drive Quick Start Guide

- Click “No”
  - Clicking “Yes” will not cause any problems, but the program performs additional unnecessary functions (delay occurs) for motion control.
  - Free Run is a mode that is used to control I/O, which is not necessary for motion control.



## 5.4. Start Communications

- From the Actions menu, select “Activate Configuration...”
  - This step must be performed every time after the configuration is modified.

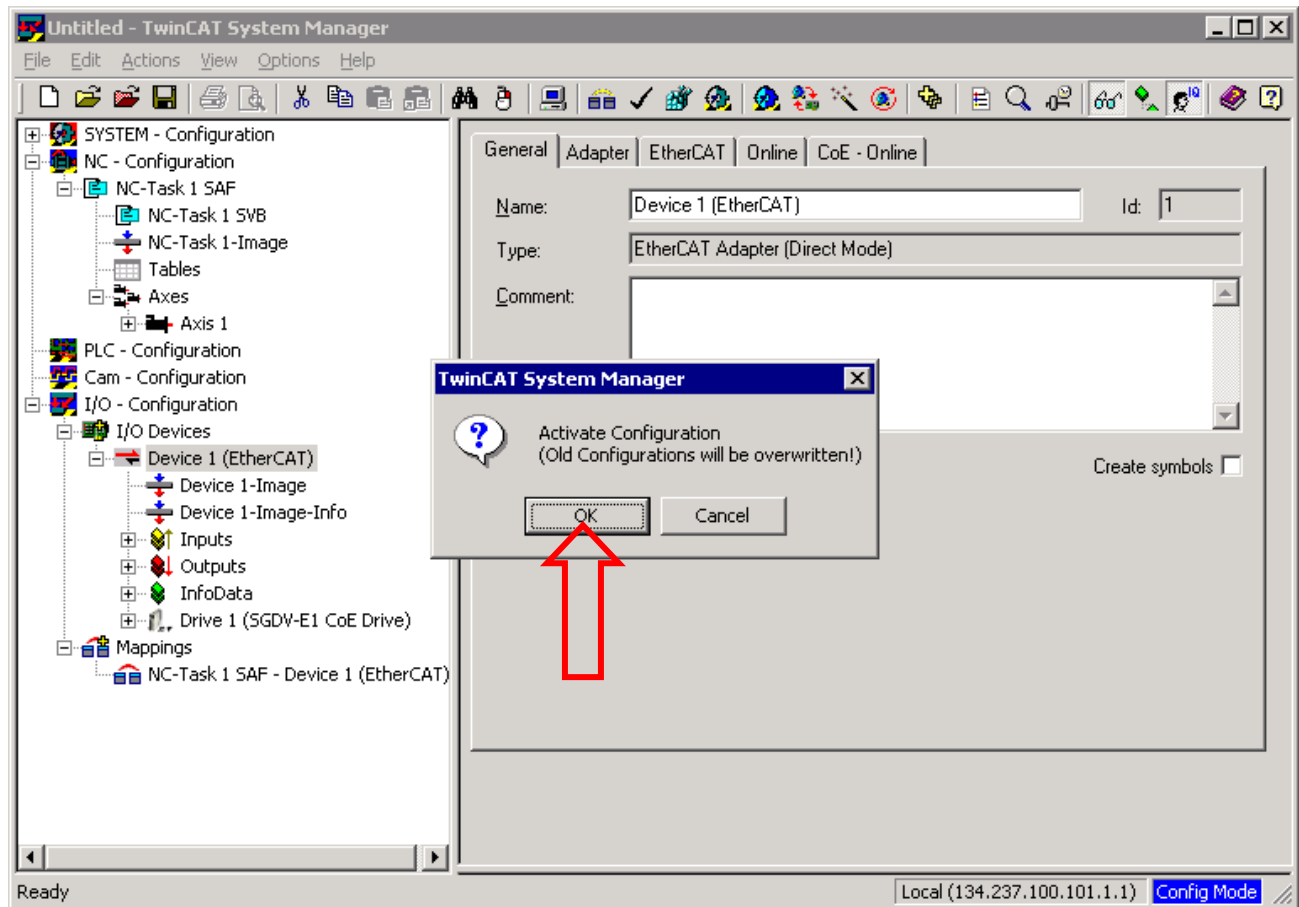


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- Click “OK”

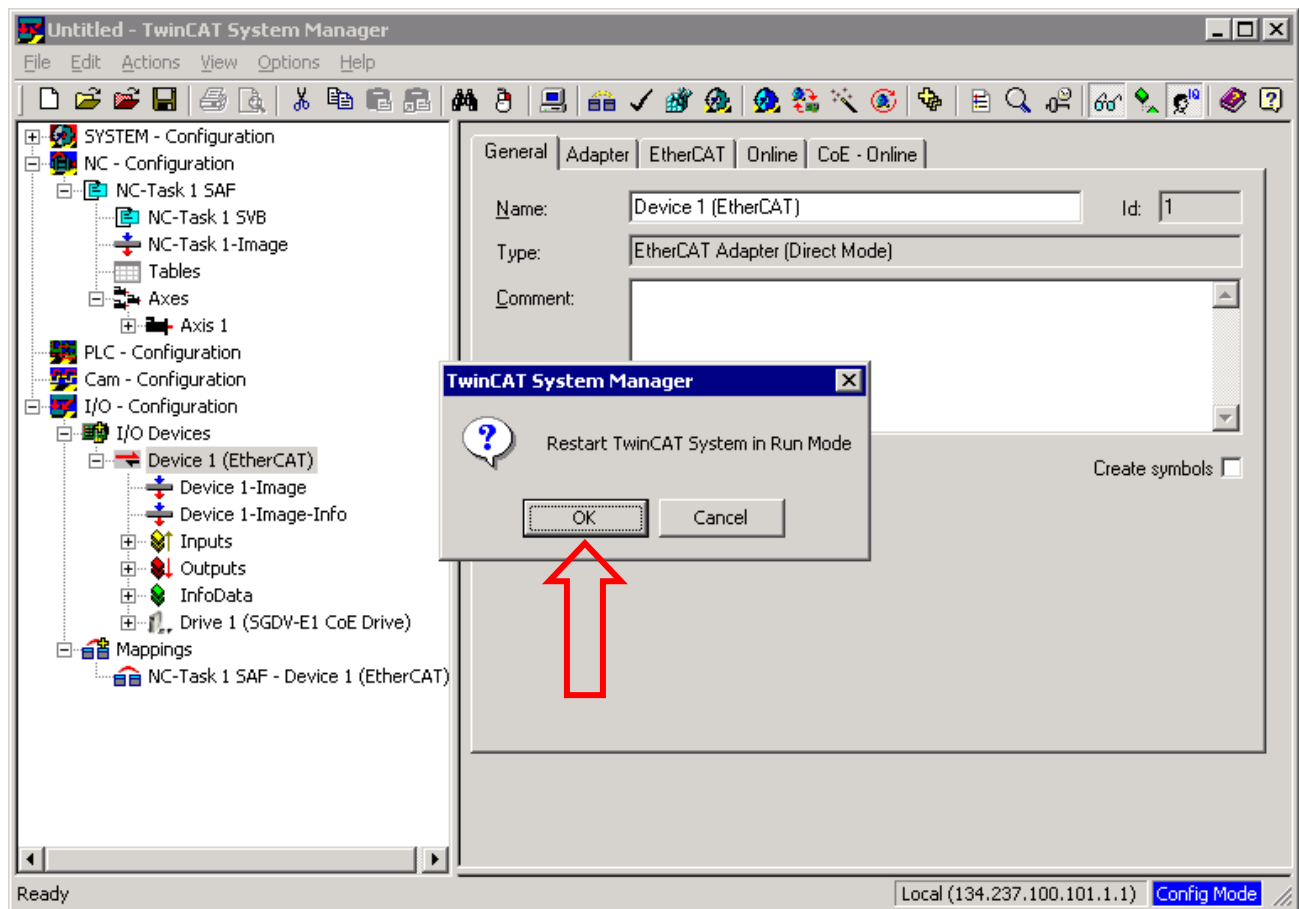


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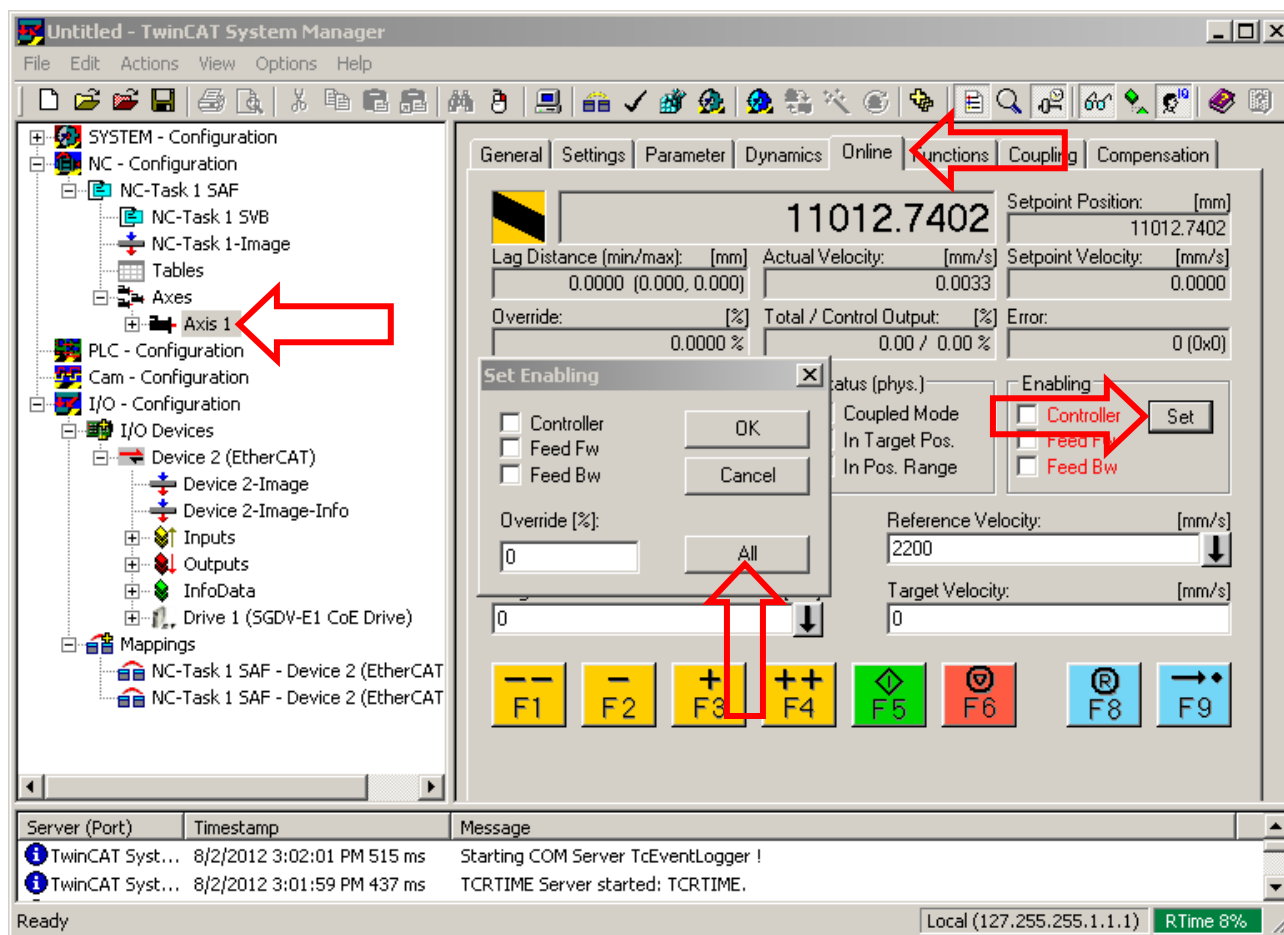
**Title:** EtherCAT Servo Drive Quick Start Guide

- Click “OK”
  - This will start the realtime communications.

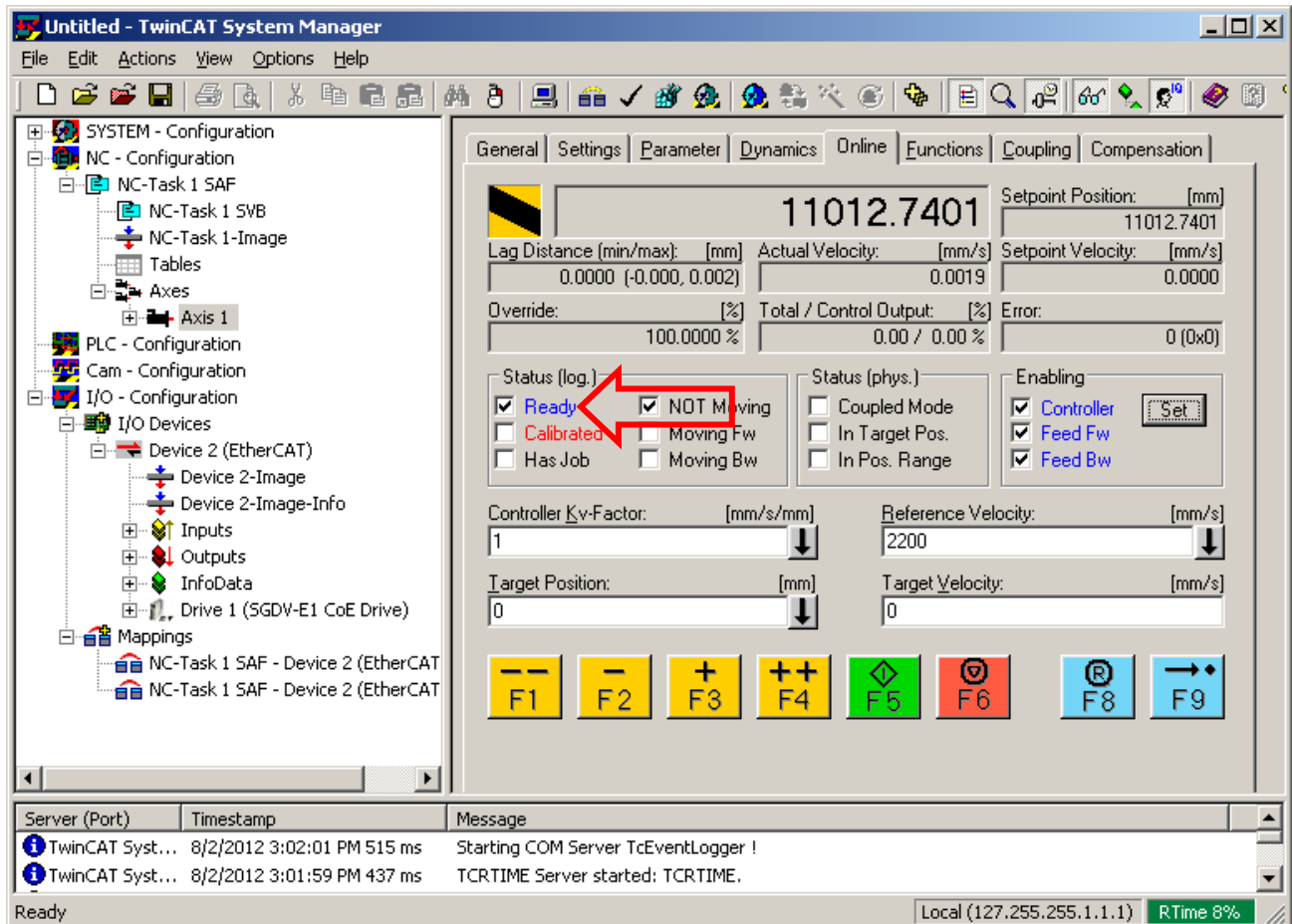


## 5.5. Test Motion

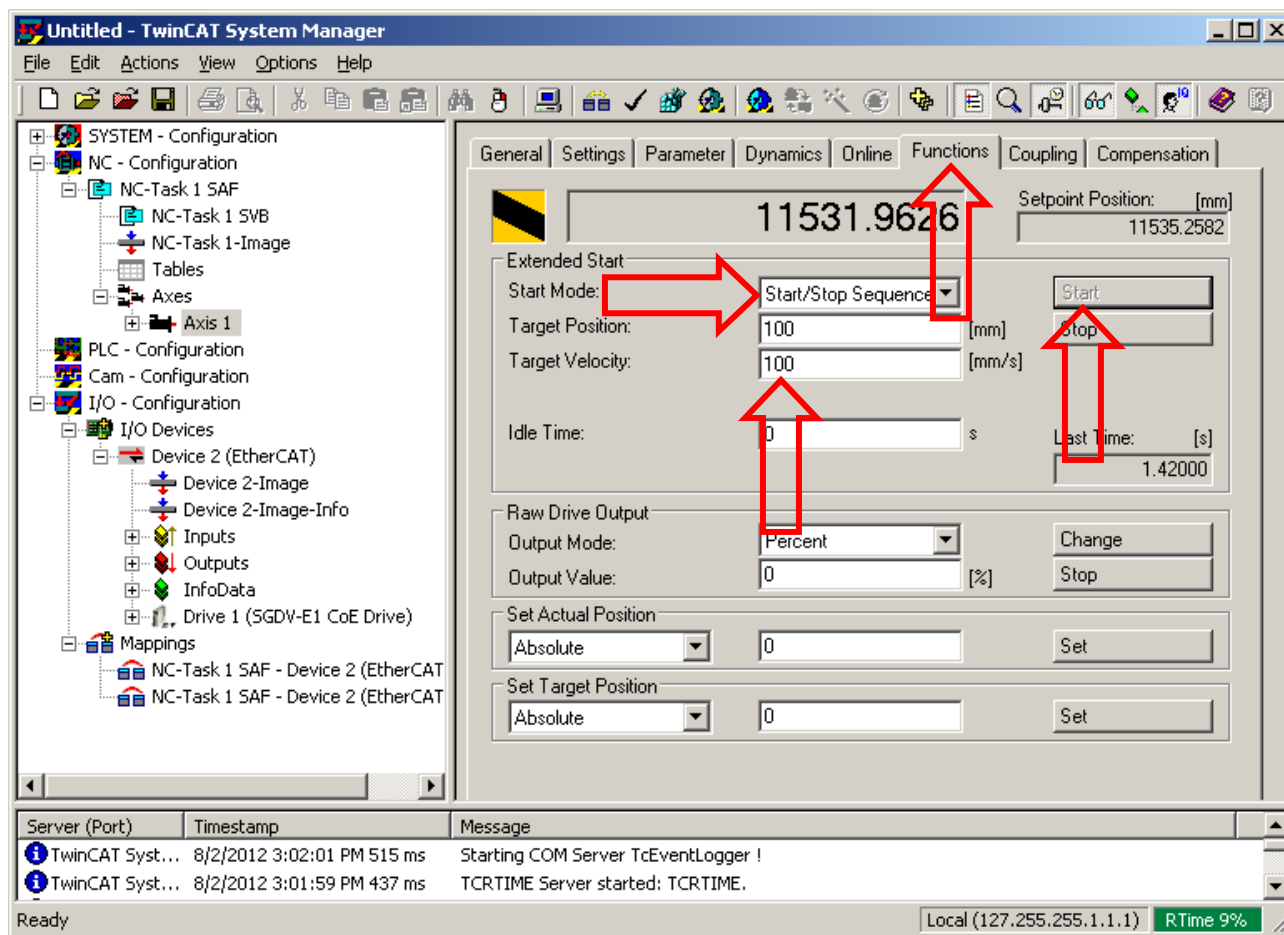
- In “NC – Configuration”, select “Axis 1”.
- Select the “Online” tab.
- Press the “Set” button.
- Press the “All” button.



- The “Ready” box will automatically change to a checked box, and the servo enables.

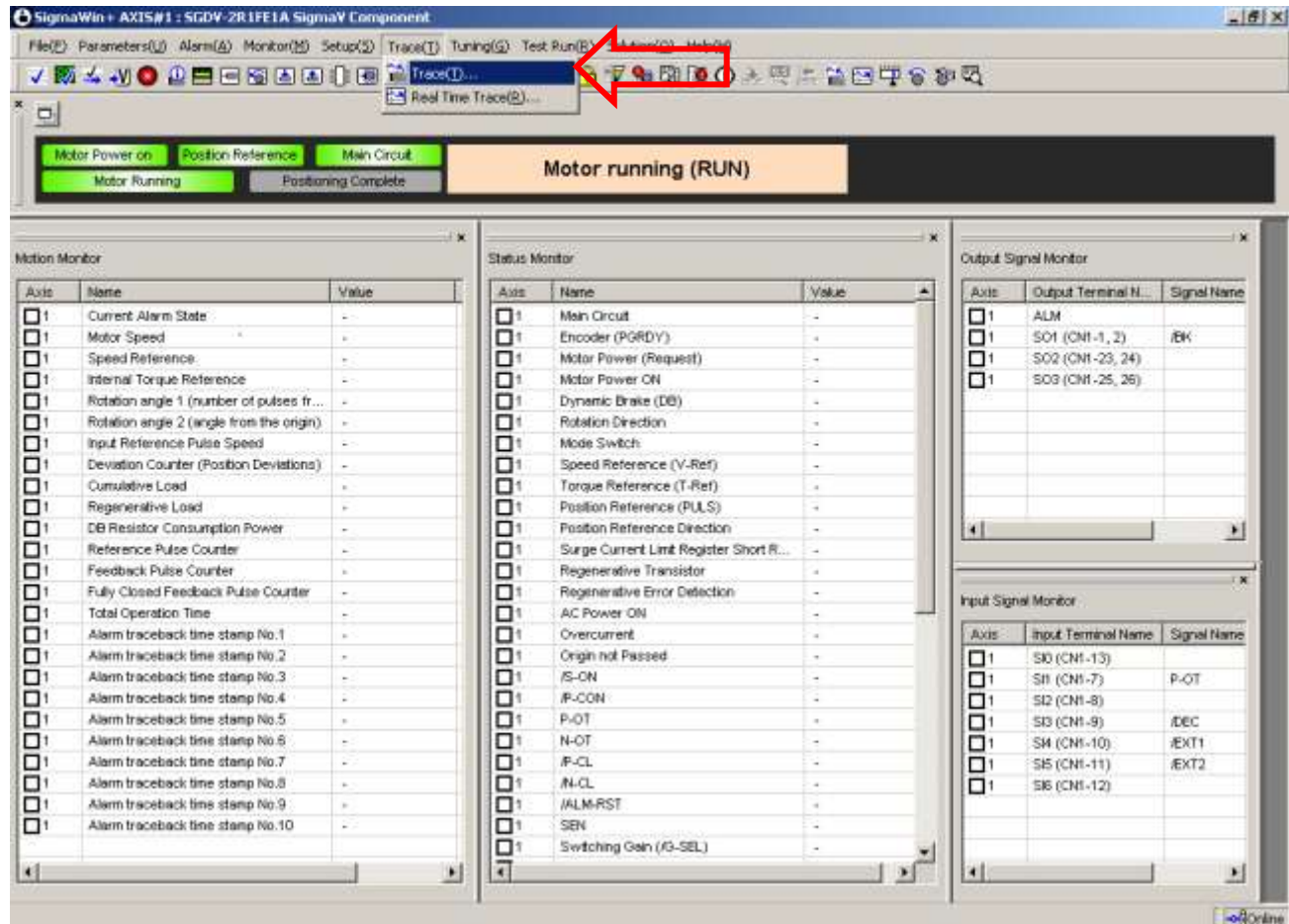


- Select the “Functions” tab.
- Select the “Start/Stop Sequence” Start Mode.
- Enter “100” for “Target Position” and “Target Velocity”.
- Press the “Start” button.
  - The motor will move, stop, repeat.



## 5.6. Verify Motion

- Connect to the Yaskawa Drive with SigmaWin
- Select “Trace(T)...” from the “Trace(T)” menu option



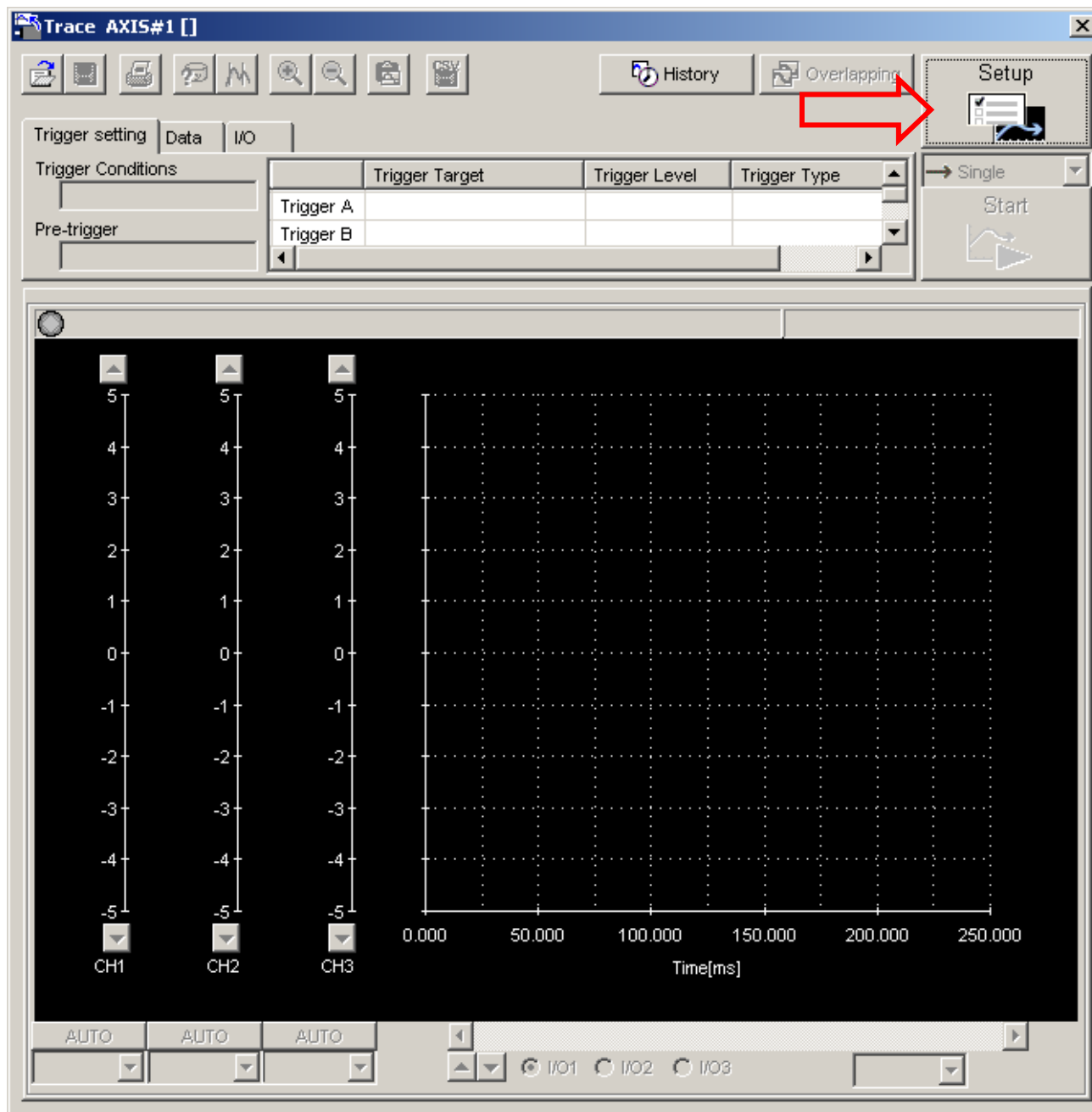


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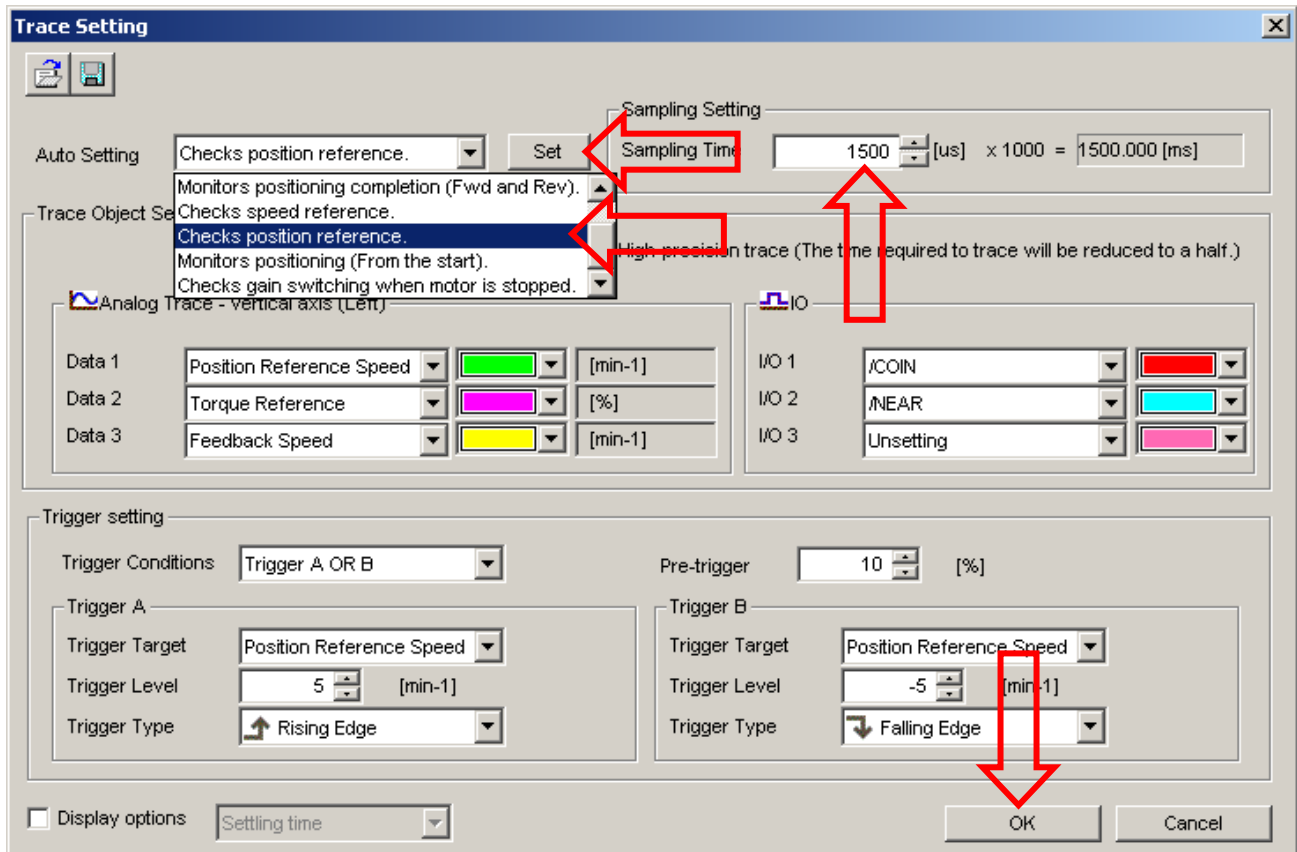
**Doc#:** AN.MTN.03

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- Press “Setup”



- From the “Auto Setting” dropdown, select “Checks position reference.”
- Press the “Set” button.
- Change “Sampling Time” to 1500.
- Check other items as seen in the image below.
- Press “OK”.



**Trace Setting**

Auto Setting: Checks position reference. [Set]

Trace Object Set: Checks positioning completion (Fwd and Rev).  
Checks speed reference.  
Checks position reference.  
Monitors positioning (From the start).  
Checks gain switching when motor is stopped.

High-precision trace (The time required to trace will be reduced to a half.)

Sampling Setting: Sampling Time: 1500 [us] × 1000 = 1500.000 [ms]

IO: I/O 1: /COIN, I/O 2: /NEAR, I/O 3: Unsetting

Trigger setting: Trigger Conditions: Trigger A OR B

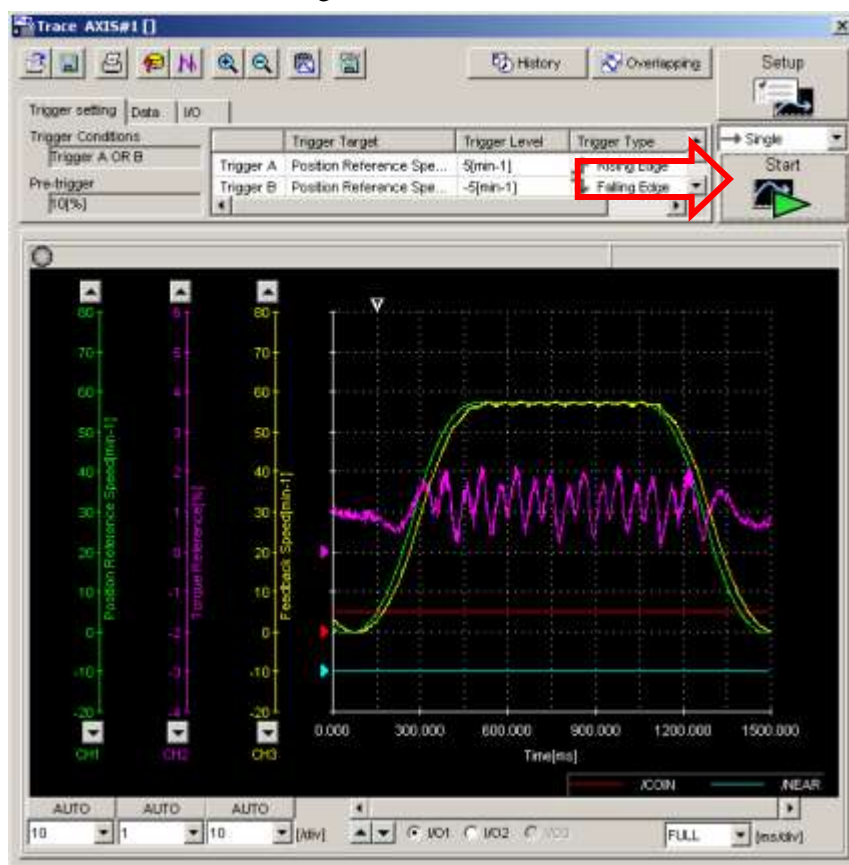
Trigger A: Trigger Target: Position Reference Speed, Trigger Level: 5 [min-1], Trigger Type: Rising Edge

Trigger B: Trigger Target: Position Reference Speed, Trigger Level: -5 [min-1], Trigger Type: Falling Edge

Display options: Settling time

OK Cancel

- Press “Start”
- Wait for acquisition to complete.
  - If acquisition does not complete after 10 seconds, change trigger conditions.
- Check “Position Reference Speed” (green line) for discontinuities.
  - “Position Reference Speed” is the difference between 2 position commands received by the Yaskawa Drive.
  - This will be updated every 2ms.
    - 2ms is the default TwinCAT EtherCAT communication cycle.
  - A discontinuity would appear as:
    - Position Reference Speed dropping from a non-zero value to zero for a 2ms duration
    - Torque Reference spiking not related to accel/decel, for a 2ms duration
  - If discontinuities are apparent, see “Appendix K: Discontinuities During Motion” for troubleshooting.





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## 5.7. Conclusion

If interrupted motion is suspected due to audible noise, verify by capturing additional SigmaWin traces.

- If interrupted motion is captured, see “Appendix K: Discontinuities During Motion” for troubleshooting.

If discontinuities are not apparent in the SigmaWin trace, quick start procedure is complete.



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## Appendix A: **Yaskawa ESI Files**

- ESI files for Yaskawa EtherCAT servos are available for download from Yaskawa.com.
  - For Sigma-5 SGDVB, the document number is: **Yaskawa\_CoE\_ESI\_Files**
- ESI files can contain device descriptions of many different versions or one version.
  - SGDVB-OCA01A
    - **Yaskawa SGDVB-E1\_CoE rev5.00.xml & Yaskawa SGDVB-E5\_CoE rev5.00.xml**  
contain device descriptions for:
      - FW 1.00
      - FW 2.00
      - FW 3.01
      - FW 3.05
      - FW 4.00
      - FW 5.00
    - **Yaskawa\_SGDVB-E1\_CoE\_rev5.04.xml & Yaskawa\_SGDVB-E1\_CoE\_rev5.04.xml**  
contain the device description for:
      - FW 5.04



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## Appendix B: User's Manuals

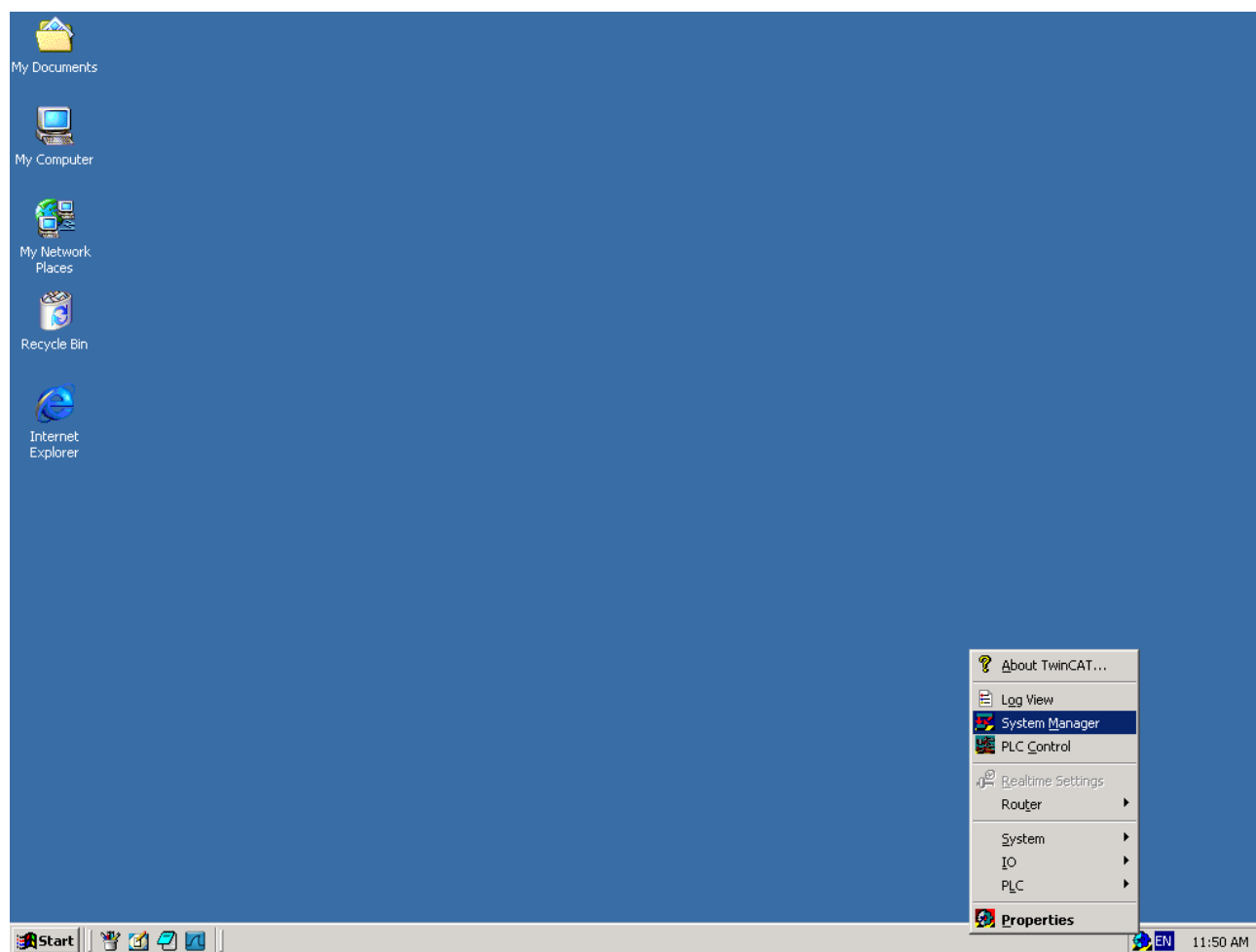
Sigma-5:

- $\Sigma$ -V Series User's Manual Design and Maintenance Command Option Attachable Type
  - Yaskawa.com document number: SIEPS80000060
- $\Sigma$ -V Series User's Manual EtherCAT (CoE) Network Module
  - Yaskawa.com document number: SIEPC72082904
- SigmaWin+  $\Sigma$ -V Component Online Manual
  - Installed with SigmaWin (Yaskawa.com document number: JZSP-WP002)
  - File name: SigmaWinFV.pdf

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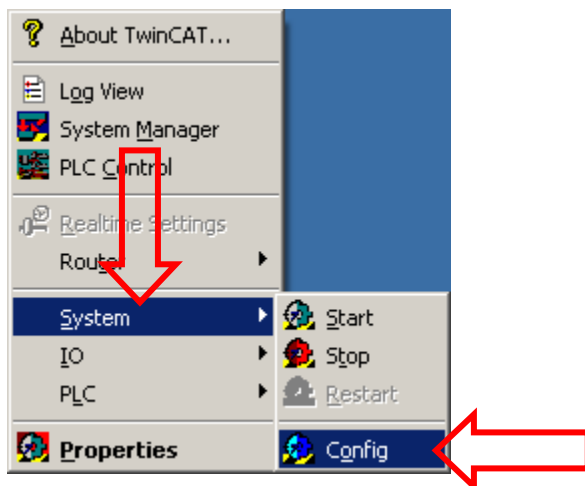
## Appendix C: TwinCAT Ethernet Adapter Setup

- Start TwinCAT System Manager
  - Right-click the TwinCAT icon in the Windows System Tray.
  - Select “System Manager”



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- If the icon is not blue, change TwinCAT to Config mode:
  - Select “System”
  - Select “Config mode”



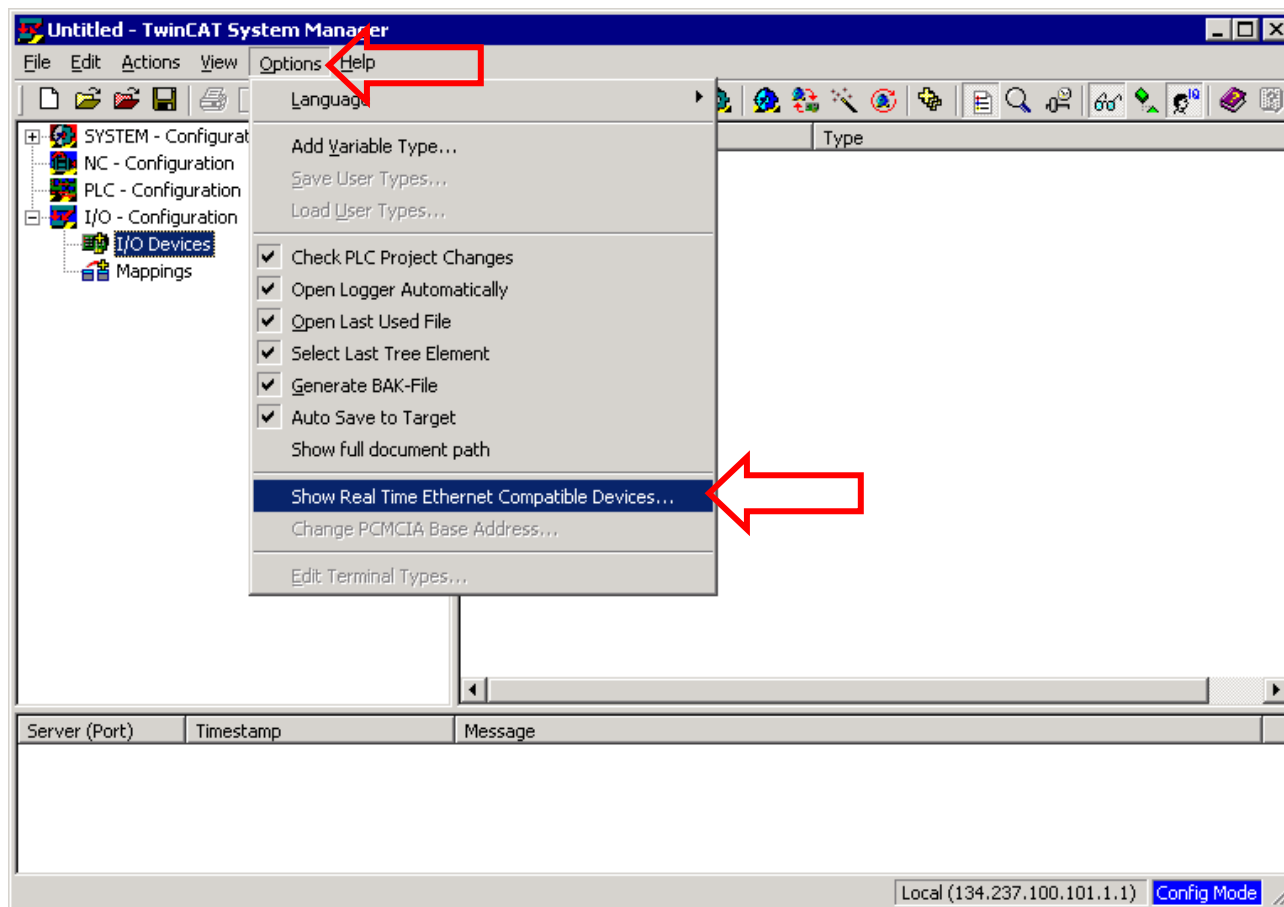


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- Select “Options”
- Select “Show Real Time Ethernet Compatible Devices...”

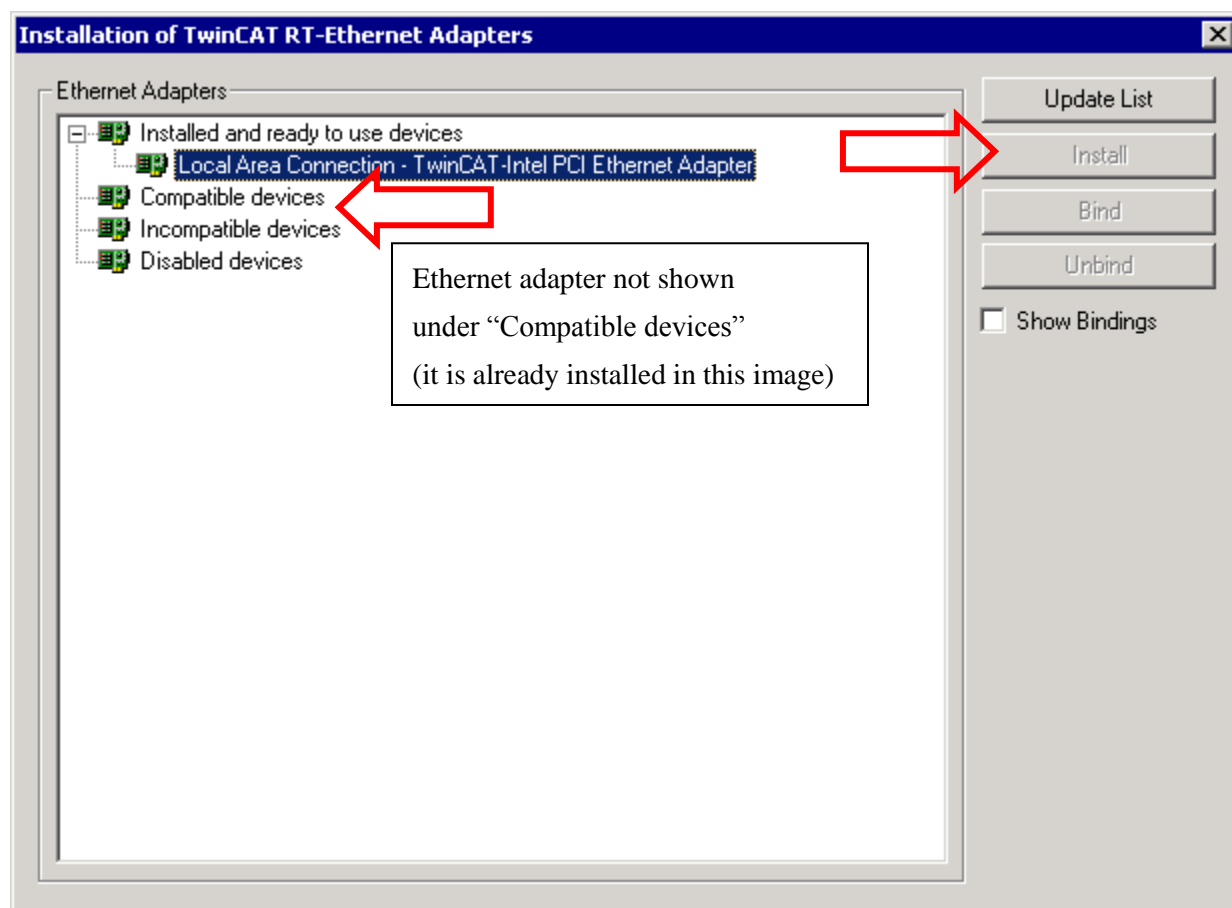


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- Select the Ethernet adapter listed under “Compatible devices”
  - Incompatible devices may be selected, but likely results in undesired performance such as motion that is not smooth.
- Press the “Install” button.
  - When installation is complete, the Ethernet adapter will appear under “Installed and ready to use devices” as shown below.




## Appendix D: Reset Absolute Encoder Using SigmaWin

The below information is in:

- SigmaWin  $\Sigma$ -V Component Online Manual
  - File name: SigmaWinFV.pdf
  - This is installed with SigmaWin
  - Section 4.4.2

### 4.4.2 Setting the Absolute Encoder

#### ■ Initializing the Absolute Encoder

 **WARNING**

The absolute encoder setup function resets the multi-turn counter and the encoder alarms for a connected serial absolute encoder.

If the absolute encoder's multi-turn counter is reset to zero, the previously defined mechanical system will change to a different coordinate system.

Operating the machine in this state is extremely dangerous. Failure to observe this warning may result in personal injury and/or damage to the machine. Be sure to reset the zero point for the mechanical system after the encoder has been successfully set up.

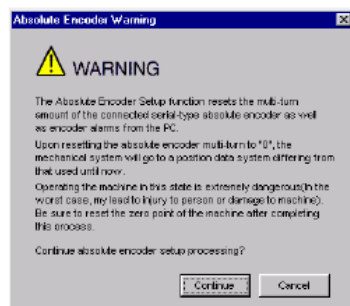
Set up the absolute encoder in the following cases:

- At initial machine startup
- When an "Encoder Backup Alarm" has occurred
- When the SERVOPACK power has been turned off, and the encoder cable removed.

The absolute encoder can only be set up while the servo is off. Turn the power back on after the encoder has been successfully set up.

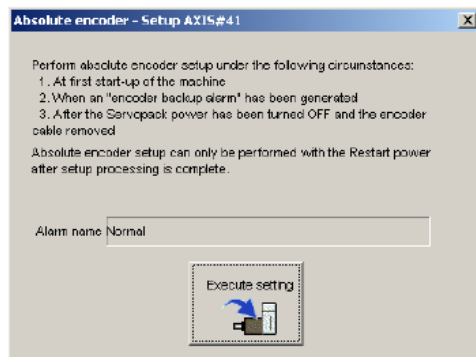
Set up the absolute encoder using the following procedure.

1. In the SigmaWin+  $\Sigma$ -V component main window, click **Setup**, point to **Set Absolute Encoder** and click **Reset Absolute Encoder**. A warning message appears confirming if you want to continue the processing.



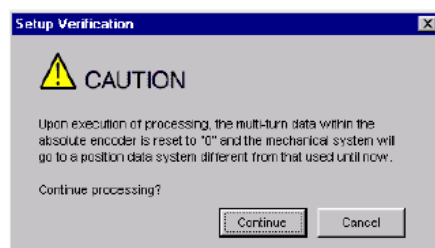
Click **Cancel** to return to the main window without resetting the absolute encoder.

- Click **Continue**, and the Absolute encoder Setup box appears.



The Alarm Name box displays the code and name of the alarm that is occurring now.

- Click **Execute setting**, and a verification message appears confirming if you want to continue although the coordinate system will change.



Click **Cancel** to return to the previous window without resetting the absolute encoder.

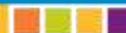
- Click **Continue** to set up the encoder.

#### <If Setup is Unsuccessful>

If setting up is attempted with the servo ON, a reset conditions error occurs, and the processing is aborted.



Click **OK** to return to the main window.



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## Appendix E: Disable Overtravels Using SigmaWin

The information below contains resources to assist in changing Pn50A = 8xxx, and Pn50B = xxx8.

The below information is in multiple sources:

- Σ-V Series User's Manual Design and Maintenance Command Option Attachable Type
  - Yaskawa.com document number: SIEPS80000060
  - Section 4.2.3 Part (2)
- SigmaWin Σ-V Component Online Manual
  - File name: SigmaWinFV.pdf
  - This is installed with SigmaWin
  - Section 4.1.2

### (2) Overtravel Function Setting

Parameters Pn50A and Pn50B can be set to enable or disable the overtravel function.

If the overtravel function is not used, no wiring for overtravel input signals will be required.

Parameter		Meaning	When Enabled	Classification
<b>Pn50A</b>	n.1□□□ [Factory setting]	Inputs the Forward Run Prohibited (P-OT) signal from CN1-7.	After restart	Setup
	n.8□□□	Disables the Forward Run Prohibited (P-OT) signal. Allows constant forward rotation.		
<b>Pn50B</b>	n.□□□2 [Factory setting]	Inputs the Reverse Run Prohibited (N-OT) signal from CN1-8.		
	n.□□□8	Disables the Reverse Run Prohibited (N-OT) signal. Allows constant reverse rotation.		

A parameter can be used to re-allocate input connector number for the P-OT and N-OT signals. Refer to 3.3.1 *Input Signal Allocations* for details.



## 4.1.2 Editing Parameters Online

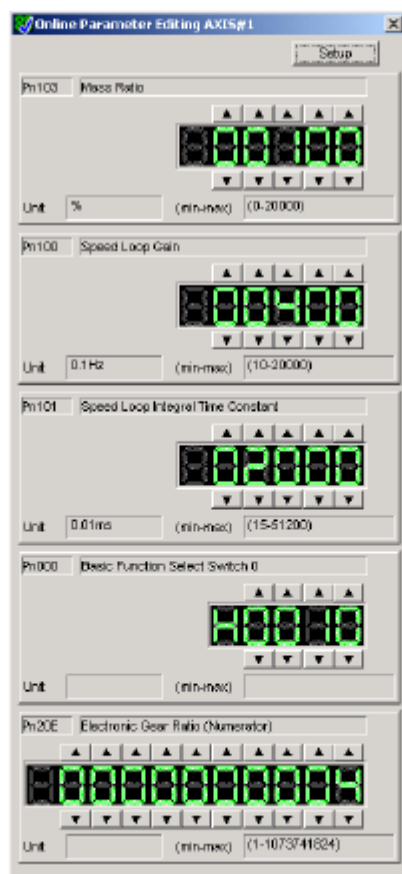
Parameters can be viewed or edited in the Online Parameter Editing window.

### NOTE

- Values edited in the Online Parameter Editing box are also immediately changed in the SERVOPACK.
- If the power to the SERVOPACK is turned off or the communication between the SERVOPACK and the SigmaWin+ is interrupted while editing parameters online, the edited values will not be saved in the SERVOPACK.
- Safety Module parameters (Pcxx) cannot be set or edited in the Online Parameter Editing box.

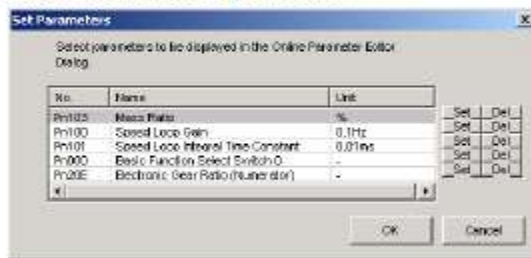
Edit parameters online using the following procedure.

1. In the SigmaWin+  $\Sigma$ -V component main window, click **Parameters** and then click **Edit Online Parameters**. The Online Parameter Editing box appears. The previously saved parameter settings will be displayed.



Online Parameter Editing Box

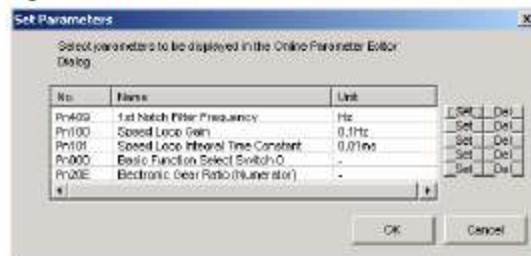
- To change the values of the settings, click the setting arrows to raise or lower the value. If an upper or lower limit is displayed, make sure that the setting is within the limit. Modified values are also immediately changed in the SERVOPACK. Click Setup to view different parameters.



- Click Set to view a parameter other than the "Moment of Inertia Ratio."



- Select the parameter to be edited, and click OK.



- If there are still parameters to be edited, click Set for the parameter to be edited and set these in the same manner as the first parameter.



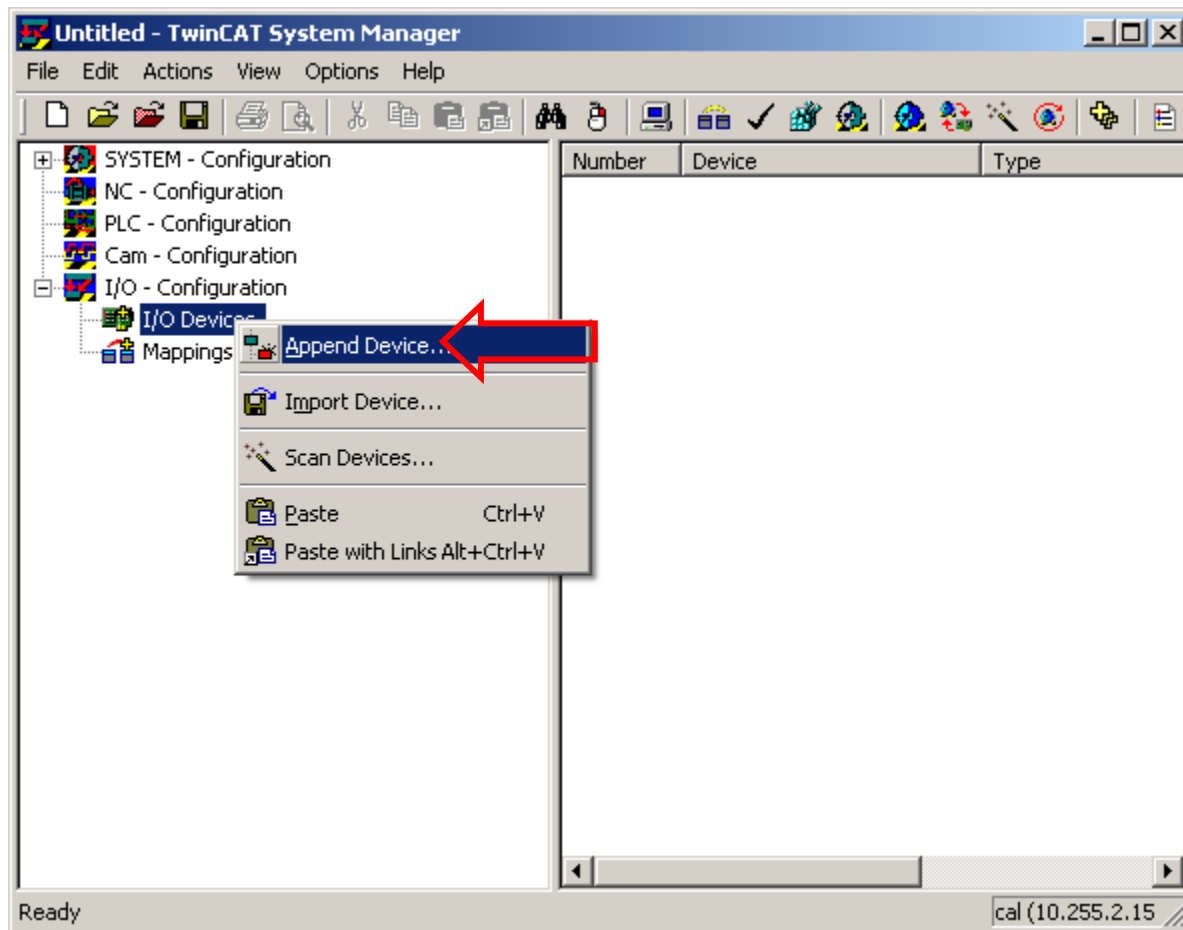






## Appendix F: Adding EtherCAT Adapter Manually

- In TwinCAT System Manager, right click “I/O Devices” under “I/O Configuration”.
- Select “Append Device...”

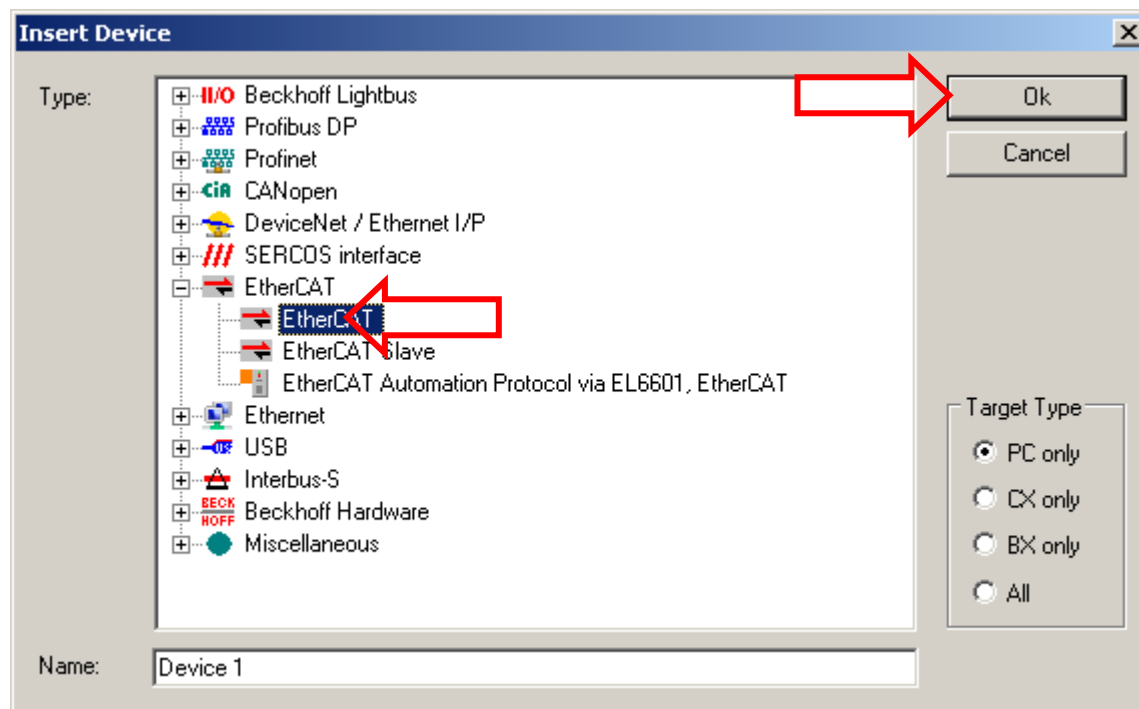


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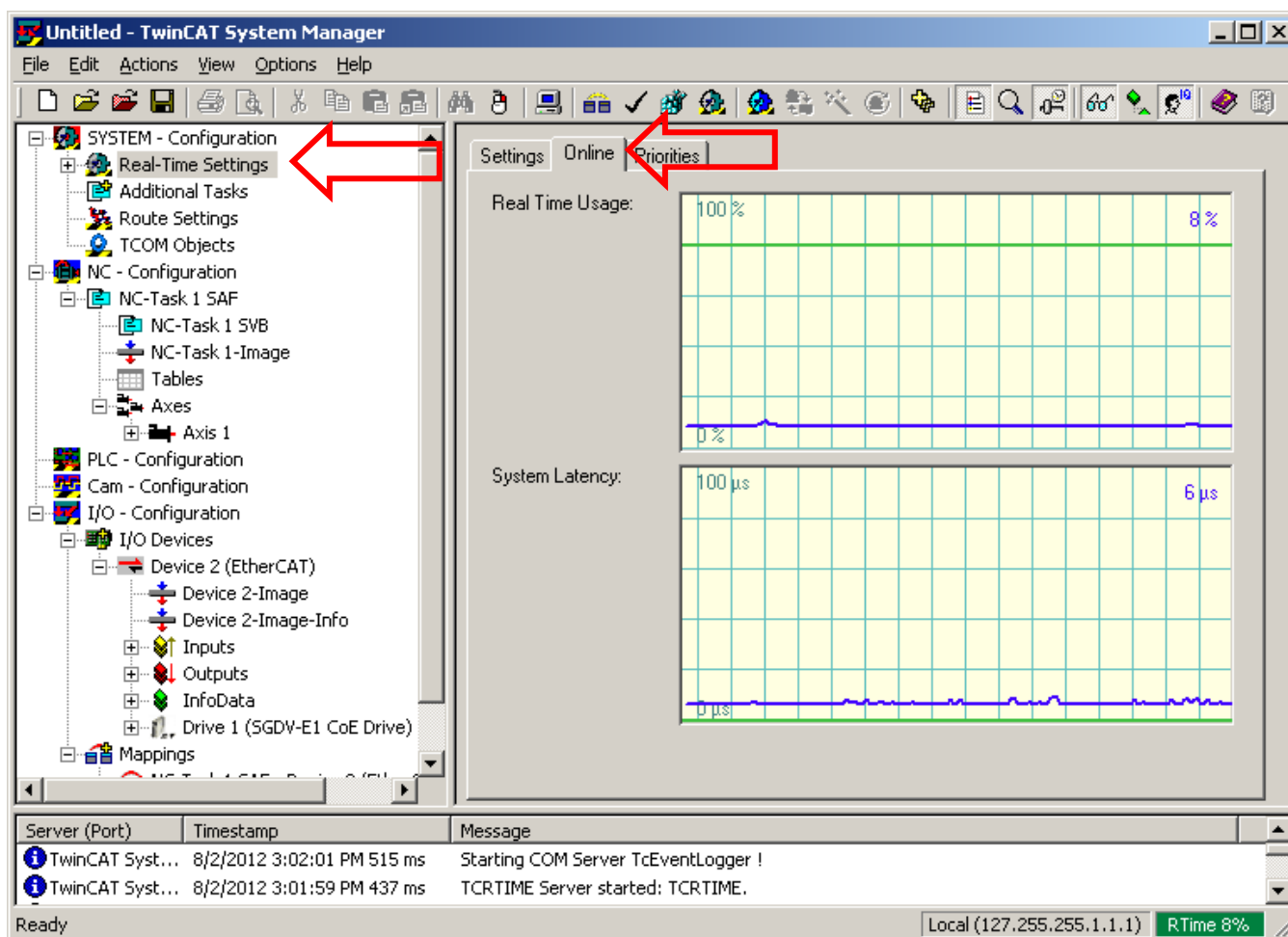
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- Select “EtherCAT” under the “EtherCAT” category.
- Press “Ok”.



## Appendix G: TwinCAT Real Time Usage

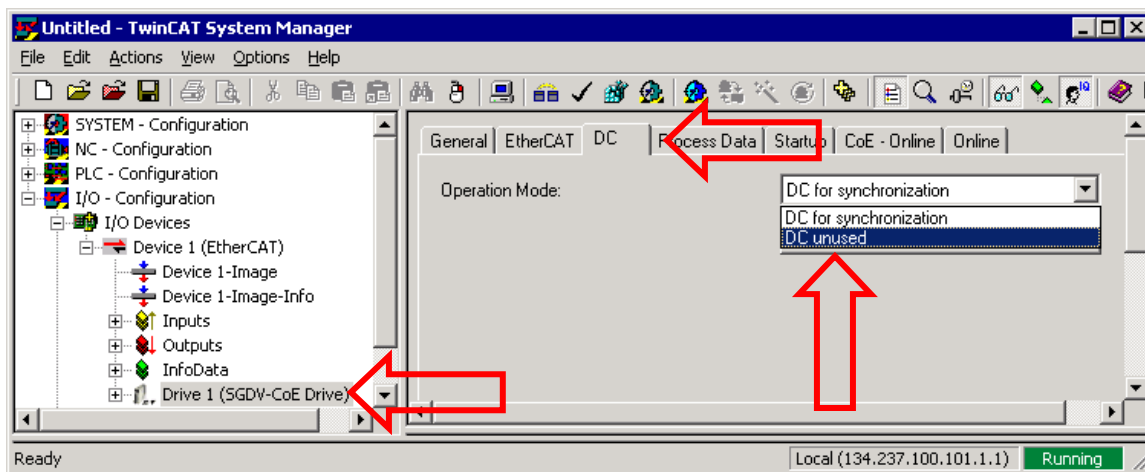
- To determine if the IPC's CPU is insufficient, view the Real Time Usage in TwinCAT
  - Under “SYSTEM – Configuration”, select “Real-Time Settings”.
  - Select the “Online” tab.
  - Real Time Usage is displayed on the plot.
    - A Real Time Usage that exceeds 80% at any time indicates that the IPC's CPU is insufficient.



## Appendix H: Checking Distributed Clocks

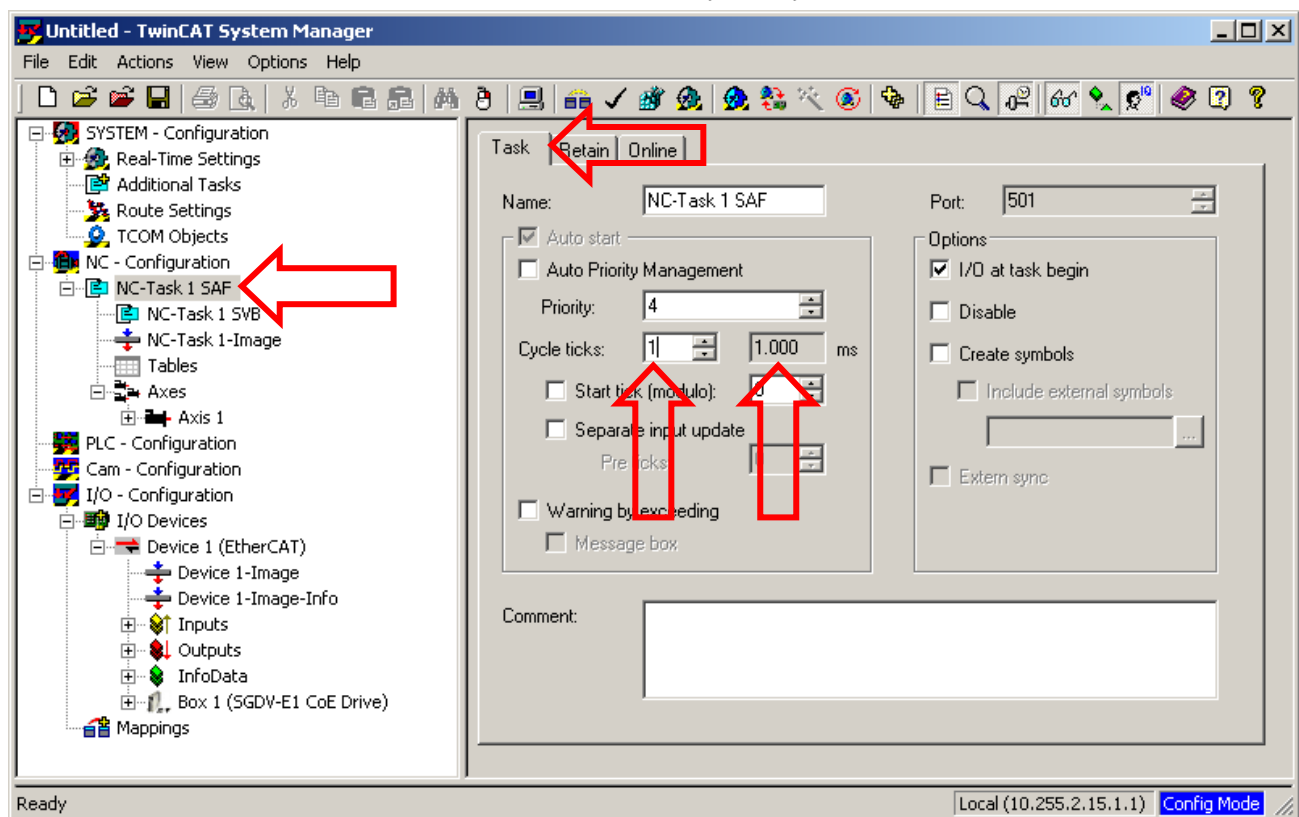
The settings for the Distributed Clock on the Yaskawa Drive can be modified.

- Select the Yaskawa Drive in TwinCAT System Manager
- Select the “DC” tab.
- Select the DC method from the “Operation Mode:” dropdown.
- For the Sigma-5 SGD V, the default setting is “DC for synchronization” (DC is enabled)



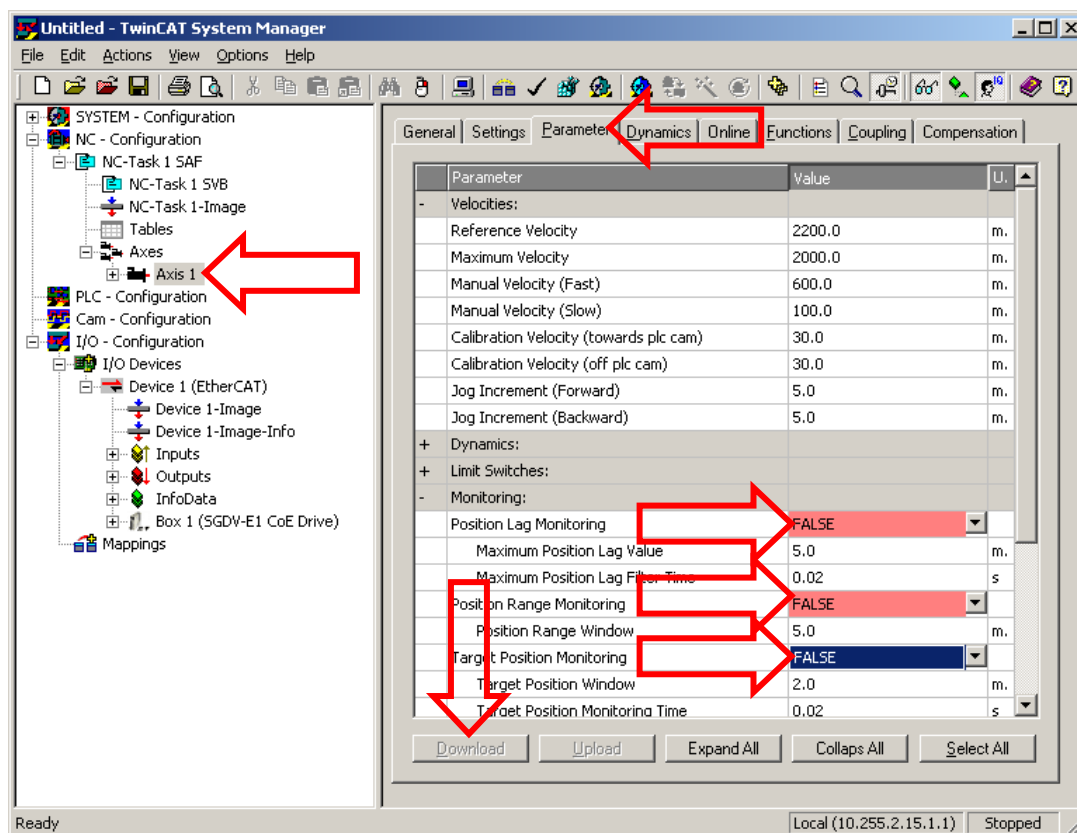
## Appendix I: Checking Cycle Time

- To check the EtherCAT communication cycle time:
  - Select “NC-Task 1 SAF”
  - Select the “Task” tab
  - Check that the non-editable field after “Cycle ticks:” reads as “2.000 ms”
    - If the value is not 2.000 ms, then modify the Cycle ticks.

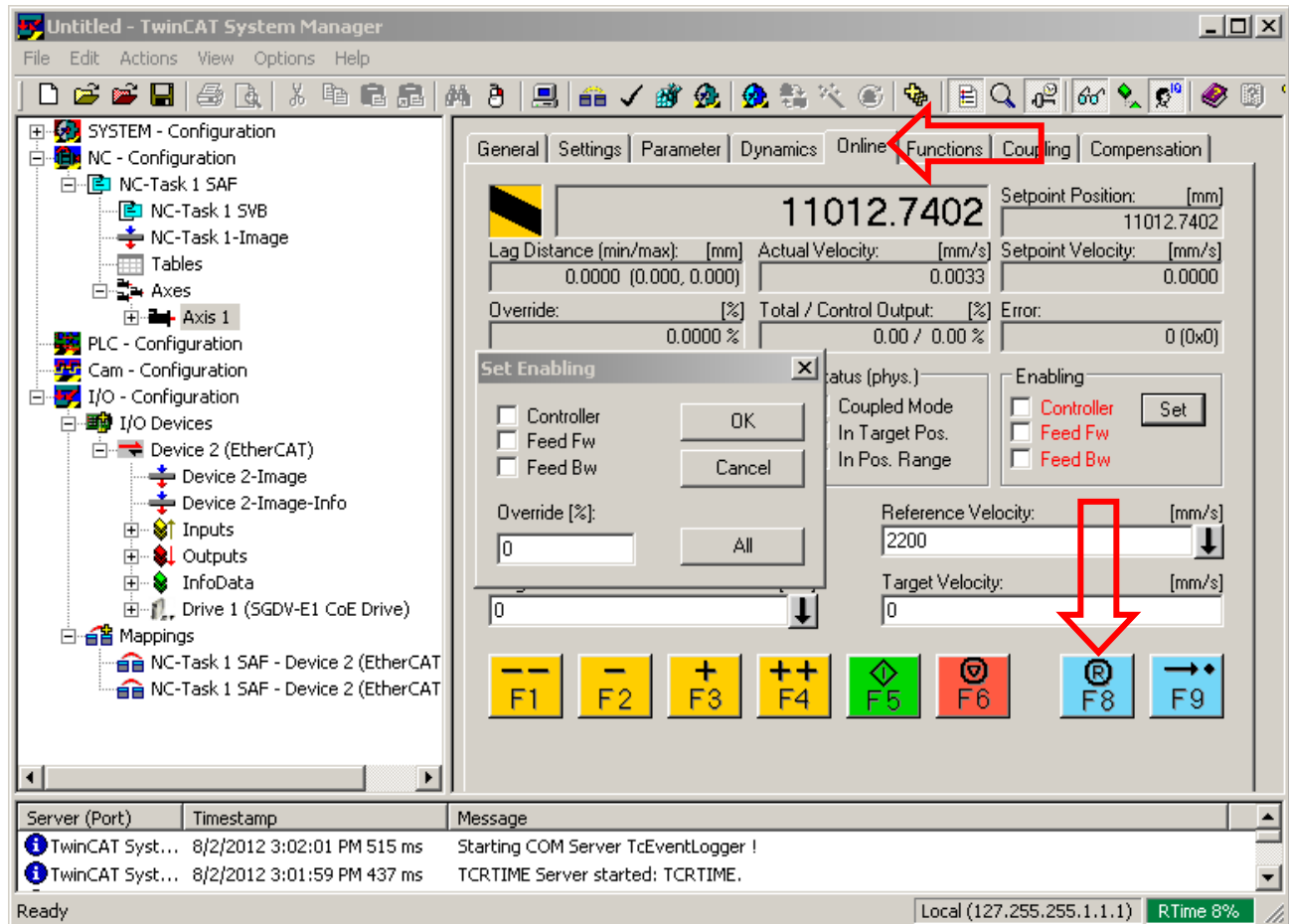


## Appendix J: Disabling TwinCAT Position Monitoring

- TwinCAT's default position monitoring is designed for low resolution encoders.
  - TwinCAT position errors occur during normal testing operation for Yaskawa drives
- Disable TwinCAT's position monitoring for test operation.
  - Set TwinCAT into Run mode
  - Select "Axis 1" from the "NC – Configuration"
  - Select the "Parameter" tab
  - Select "False" from the dropdown menus for:
    - Position Lag Monitoring
    - Position Range Monitoring
    - Target Position Monitoring
  - Highlight each "False" selection (control-click the 3 items until they are highlighted)
  - Press the "Download" button



- Reset the error caused by position monitoring
  - Select the “Online” tab
  - Press the “F8” button



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## Appendix K: Discontinuities During Motion

If the following **Symptoms** are apparent, investigate the items in the “**Investigative Items**” list below.

### Symptoms:

- Discontinuities are apparent during motion
- Alarm A.A11 or A.A12 occurs
- A TwinCAT error occurs

### Investigative Items:

- Disable TwinCAT position monitoring
  - See “Appendix J: Disabling TwinCAT Position Monitoring”
- The NIC might be incompatible.
  - See “2.1 Hardware”
- Try a different Ethernet port on the IPC.
- Try a different IPC.
- Check that Distributed Clocks are enabled.
  - See “Appendix H: Checking Distributed Clocks”
- Check for Shielded Ethernet cable used for communications.
- Check for Line Topology (remove any devices between Master and Slave).
- Check that SigmaWin or Digital Operator Jog function with no load is OK.
- Set EtherCAT cycle time to 2ms (TwinCAT SAF timing default).
  - See “Appendix I: Checking Cycle Time” for details on how to set cycle time.
- Increase Task priority in TwinCAT.
- Try using 3 meter to 10 meter Shielded Ethernet cable.
- Try using latest firmware for EtherCAT slave.
- Check that the cable is plugged into the IN port of the slave.