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1 About

This Application Note describes how the servo drives of the smartServo BL 4000-C/-M/-D device series can be integrated into a Powerlink network. The physical connection, the activation of the fieldbus protocol and the integration into the network are described.

It is intended for persons who are already familiar with the respective servo drive family and have read and understood the corresponding product manual. The product manual contains instructions for the proper and professional transport, storage, assembly, installation, project planning and correct and safe operation of the servo drive. The product manual contains safety instructions which must be strictly observed. The product manuals are available for download on our homepage (www.metronix.de).

⚠ DANGER ⚠ Life-threatening hazards

Handling the servo drive involves numerous hazards that can be avoided by following the correct procedure. Therefore, always read the product manual first and observe the safety instructions contained therein!

2 Introduction

Ethernet Powerlink is a real-time Ethernet based fieldbus system developed and supported by the Ethernet Powerlink Standardization Group (EPSG).

<https://www.ethernet-powerlink.org/>

An Ethernet Powerlink network always consists of exactly 1 Managing Node (MN - Master) and several Controlled Nodes (CN - Slaves). All communication is always initiated by the MN. No CN is allowed to send any data via the network, if not asked by the MN to do so (except of Basic Ethernet Mode where no EPL communication is taking place).

Single participants inside the network are identified by the Powerlink Node ID (1 to 255 – with 240 reserved for the MN and 255 being the broadcast Node ID).

The object dictionary of the EPL system is based on the CANopen Object Dictionary, defined inside the CANopen DS402 specification for use in servo drives in context of industrial automation applications. Refer to the Metronix CANopen manual for a detailed description of the available CANopen objects and operation modes:

www.metronix.de/manuals

As with CANopen and EtherCAT, there is a hardware description file that is used to easily implement a new CN into a PLC control program. In EPL these files are called XDD file.

3 Terms and abbreviations

EPL	Ethernet Powerlink (short term)
MN	Managing Node The Master inside the EPL network. Responsible to initiate all communications. In our example the B&R X20 PLC.
CN	Controlled Node The Slaves inside the EPL network. In our example the Metronix smartServo BL 4XXX drives.
NRT	Non Real Time (communication) As part of the EPL communication, legacy UDP/IP packets may be exchanged, e.g. if accessing the drives from Metronix ServoComander software via the EPL network.
CANopen	A fieldbus communication protocol based on CAN messages, using a protocol stack to implement communication inside industrial automation systems.
SDO	Service Data Objects Used in CANopen compliant communication systems to exchange acyclic data between single participants
PDO	Process Data Objects Used in CANopen compliant communication systems to exchange cyclic data (e.g. position actual valid and setpoint data) between participants, here mostly between Master and Slave.
KO	Communication Object Used to access single parameters inside the Metronix drives, e.g. EPL Node ID via the drives configuration interface.

4 Features

The Metronix smartServo BL 4000 servo drives offer the following functionalities if used in Ethernet Powerlink networks:

- Cyclic Synchronous Controlled Node (CN) with fieldbus cycle times $\leq 1\text{ms}$
- Cyclic and Non Cyclic operation modes using PDOs:
 - Profile Torque Mode
 - Profile Velocity Mode
 - Profile Position Mode
 - Cyclic Synchronous Velocity Mode
 - Cyclic Synchronous Position Mode
- Asynchronous communication using SDOs via ASnd
- Asynchronous communication via UDP/IP
- Basic Ethernet Mode

5 Hardware

5.1 Setup



The single smartServo BL 4000 drives are connected in a line with the B&R X20 PLC. The Laptop, using B&R Automation Studio is connected to the connector IF2 of the X20 PLC. The first drive is connected to the IF3 connector (Powerlink) of the PLC via connector RTE0 of the drive.

All following drives are bridged from connector RTE1 of the prior drive to RTE0 of the next following drive.

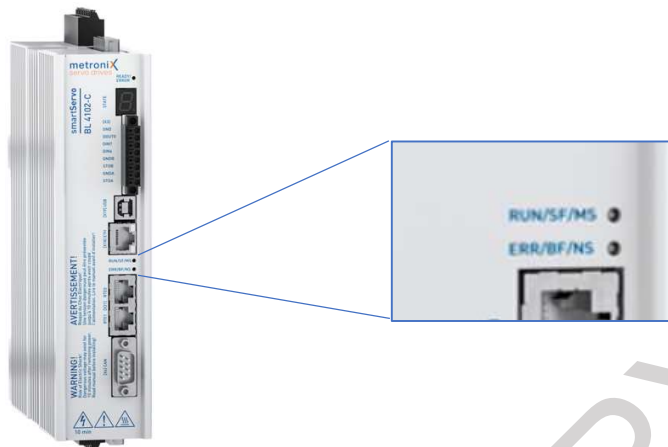
INFORMATION Commissioning via the Metronix ServoCommander

Note that the Standard Ethernet connector ETH [X18] is disabled on smartServo BL 4000 drives, if Ethernet Powerlink is active. Hence this interface cannot be used e.g. for commissioning via ServoCommander as long as Ethernet Powerlink is active.

Instead, either the non-real Time (NRT) communication via the X20 PLC, or the Basic Ethernet Mode, if no PLC is connected, can be used via connectors RTE0 and RTE1 [X21].

5.2 Status LEDs

The Metronix smartServo BL 4000 drive provides 2 status LEDs to show the current state of the Ethernet Powerlink communication.



“RUN/FS/MS”-LED:

Signal	Meaning
Constant off	Not Active: No communication is active.
Single flash	Preoperational 1: MN is communicating with the CN and e.g. configuring the cyclic data exchange (PDOs). Only acyclic data is taking place.
Double flash	Preoperational 2: See Preoperational 1, except that now cyclic telegrams are transmitted via the EPL interface, except PDO data.
Triple flash	Ready To Operate: Full cyclic communication, including exchange of cyclic data objects (PDO) is taking place BUT PDO data is not yet evaluated in MN and CN.
Constant on	Operational: MN and CN are in full operation. All cyclically exchanged data is evaluated. This is the final stage when running up the EPL fieldbus.
Blinking	Stopped: MN stopped a CN from taking part in EPL communication. The CN behaves passive inside the network.
Flickering	Basic Ethernet Mode: The CN switches to Basic Ethernet Mode if no EPL telegrams have been received for a longer time than set in CANopen object 1F99 _h (default is 5s). In Basic Ethernet Mode normal UDP/IP and TCP/IP telegrams can be exchanged directly with the drive without the need for an special EPL switch or MN in between. Basic Ethernet Mode is left as soon as at least 1 EPL telegram has been received.

“ERR/BF/NS”-LED:

Signal	Meaning
Constant off	No error
Constant on	Fieldbus error: More detailed information can be read out with the parameterization software Metronix ServoCommander.

6 Activation

Up to now, Powerlink communication can only be activated by direct access to the corresponding parameterization objects. The following parameters are available for this purpose:

Number	Description
0850	Enable / Disable Powerlink communication of the BL 4000. 0: Powerlink communication ON 1: Powerlink communication OFF
0851	Set the drives Powerlink Node ID (1 to 239)

INFORMATION Changing the Node ID

To make a new Node ID become active, the Powerlink communication must be deactivated and activated again.

The writing of the communication objects can be done via the "Transfer" windows of the Metronix ServoCommander:



See Application Note 38 “RS232 command set” for a detailed description of the use of KOs to configure the drives:

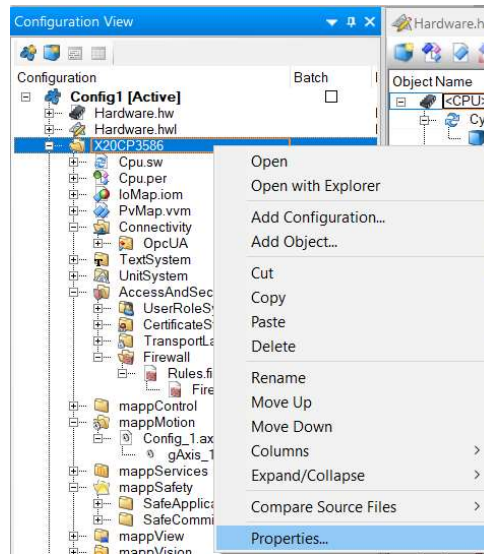
[APPL38 ARS2000 RS232 Command Set EN](#)

Dies ist ein Beispiel für eine Tabelle ohne Überschrift:

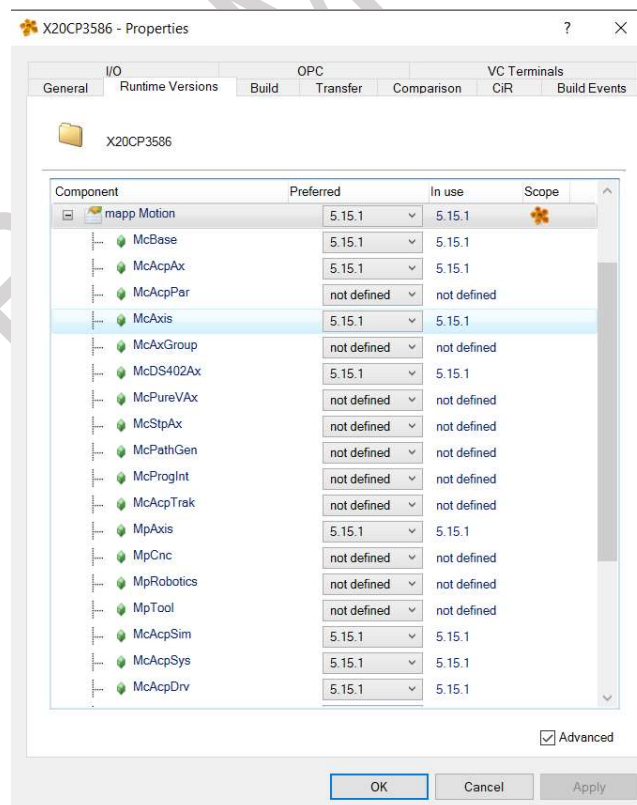
Dokumentenname	Montageanleitung "BL 4000-C"
Dateiname	MI_BL 4000-C_1p4_DE.pdf
Version	1.4
Jahr	2022

7 Automation Studio integration

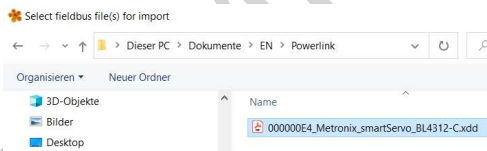
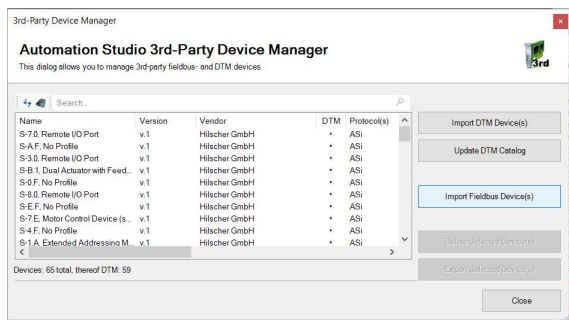
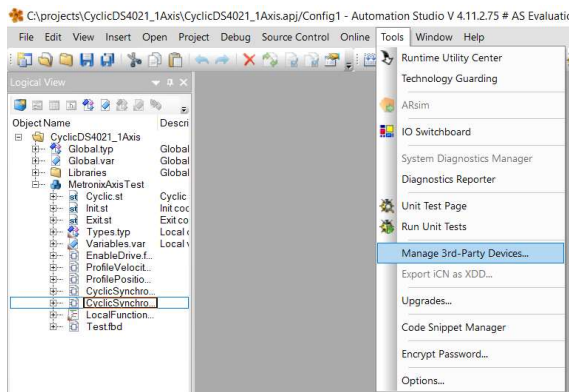
The following section describes the use of the smartServo BL 4000 with a B&R X20 controller as MN. The configuration is done via B&R Automation Studio. In B&R controllers, the smartServo BL 4000 is used as a "DS402 compliant drive". Therefore some special libraries have to be activated within the controller. To do this, right-click on the X20 entry in the "Configuration View" and then click on "Properties":



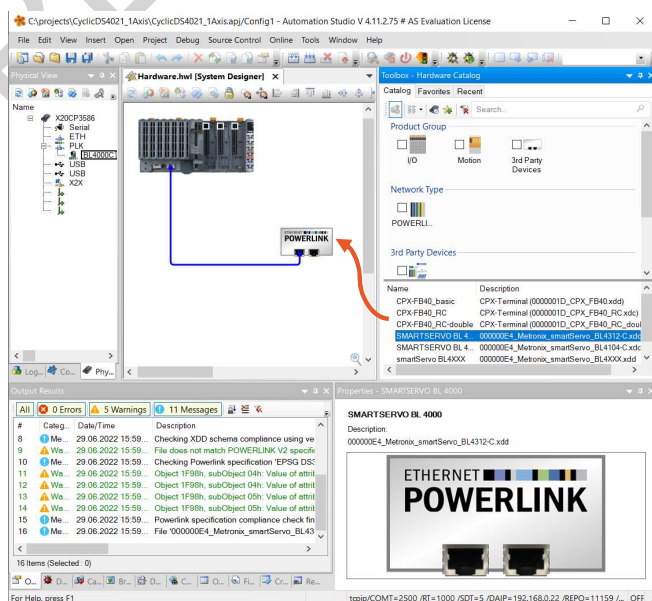
The following library options **MUST** be activated for the "mapMotion" library:



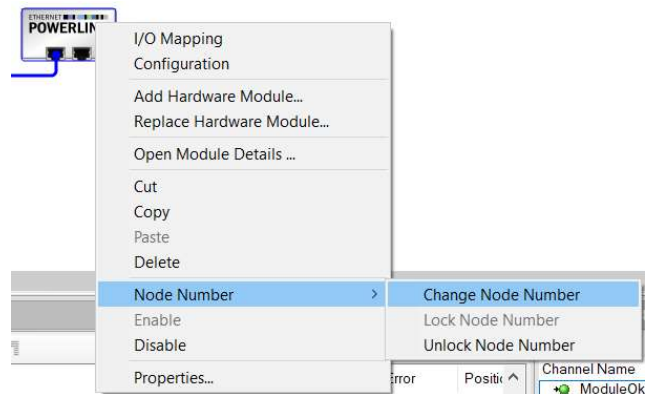
The first step is to import the drives XDD hardware description file that you downloaded from Metronix Homepage into the Automation Studio project to make the drive being available in the Automation Studio hardware catalogue:



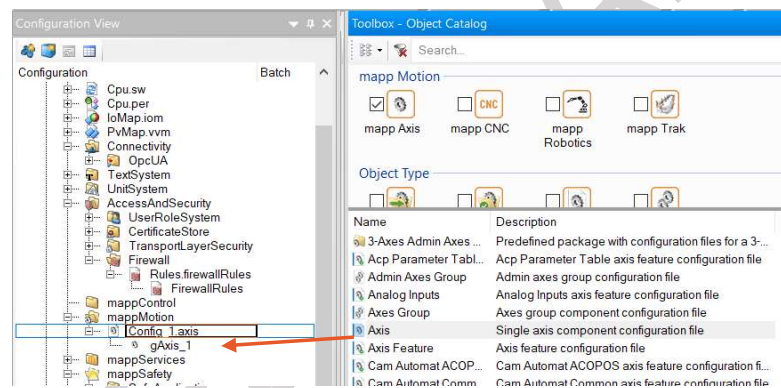
Afterwards the smartServo BL 4000 appears in the hardware catalogue of the Automation Studio and can be added to the hardware configuration of the project:



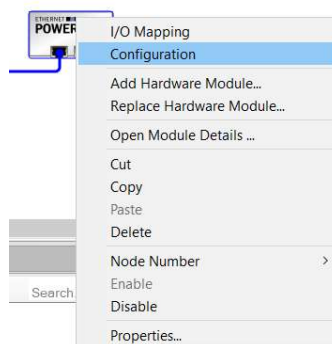
The drive must now be connected to the X20 PLC via IF3. By default, Automation Studio assigns the Node IDs in consecutive order. If the added drive uses another Node ID, this one must be updated via the drive properties. For this purpose, right-click on the drives icon in Automation Studio and choose "Node Number / Change Node Number".



Afterwards an Axis Instance must be added to make the drive available inside the PLC code and connect it to the PLC function blocks. This is done by adding an instance of "Axis" from the hardware catalogue to the "mappMotion" part of the "Configuration View":



Finally, the smartServo BL 4000 must be configured as a "DS402-compliant drive" in Automation Studio. To do this, right-click on the drive icon in the physical view and open the "Configuration" dialog:



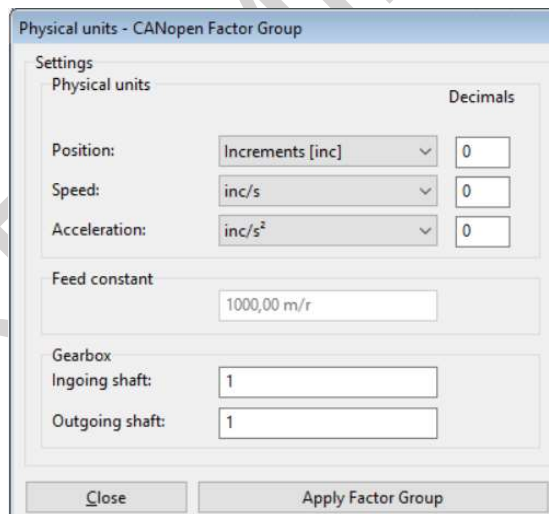
The configuration should be done as follows:

Name	Value	Unit
BL4000C1		
General		
Module supervised	on	
POWERLINK parameters		
Mode	controlled node	
Response timeout	20	µs
Advanced		
Verify Device Type	off	
Verify VendorID	off	
Verify RevisionNumber	off	
Verify ProductCode	off	
Optimization	data throughput	
Enable DS402 Axis Driver Library	on	
DS402 axis		
Axis reference	gAxis_1	
Mechanical elements		
Encoder settings		
Increments per revolution	65536	
Position actual value range	Default	
Cyclic set value modes		
Cyclic position mode	Cyclic synchronous position	
Cyclic velocity mode	Cyclic synchronous velocity	
Axis features		
Feature reference 1		
Channels		
ErrorCode_AU16_1603F	Read	
Cyclic transmission	UINT	
Datatype		

Especially the option “Enable DS402 Axis Driver Library” must be activated. Inside that option now the drive must be linked to the Axis instance that we just added in the “Configuration View” (in this example gAxis_1). Encoder Settings should be set to 65536 increments per revolution.

Important:

The CANopen display units MUST be set accordingly inside the drive via Metronix ServoCommander:



Finally the “Cyclic set values mode” should be set to “Cyclic Synchronous Position” and “Cyclic Synchronous Velocity”.

Using these settings the smartServo BL 4000 can now be used by B&R PLC projects.

INFORMATION Commissioning via the Metronix ServoCommander

If using the DS402 driver in Automation Studio, the PDO mapping is configured automatically by the PLC. Cyclically exchanged PDOs in this case should contain:

- 6040_00 control word
- 6041_00 status word
- 6064_00 position actual value
- 607A_00 target position
- 606C_00 velocity actual
- 60FF_00 target velocity

8 Operating the servo drive

To illustrate the use of a smartServo BL 4000 on a B&R X20 controller, a small sample application is used that operates a single axis in all available operation modes. For this purpose it contains several function blocks:

File Name	Description
Cyclic.st	Cyclic code
Init.st	Init code
Exit.st	Exit code
Types.typ	Local data types
Variables.var	Local variables
EnableDrive.fbd	
ProfileVelocity.fbd	
ProfilePosition.fbd	
CyclicSynchronou...	
CyclicSynchronou...	
LocalFunctions.fun	
Test.fbd	

CAUTION Use PLC program only for test purposes

This PLC program is intended for test purposes only. It must never be used directly as a customer application. It only serves as an example for the use of the drive within the B&R X20 PLC programs and its function blocks.

8.1 Main Program: Cyclic.st

The main program calls the EnableDrive.fbd function block to enable the power stage of the drive. Additionally, it retrieves the address of the Axis instance. Afterwards it calls the single function blocks to test the drive in the different operation modes, using the B&R PLC internal function blocks:

```

PROGRAM _CYCLIC
(* Insert code here *)

// enable drive
EnableDrive;

// test: profile velocity mode
ProfileVelocity;

// test: profile position mode
//ProfilePosition;

// test: cyclic synchronous velocity
//CyclicSynchronousVelocity;

// test: cyclic synchronous position
//CyclicSynchronousPosition;

// compute new cyclic speed setpoint
rSpeedSetpointCounter := rSpeedSetpointCounter + 0.01;
rSpeedSetpoint        := SIN (rSpeedSetpointCounter) * 20.0;

// compute new cyclic position setpoint
IF (bAtZeroPos = FALSE) THEN
  rPosSetpointCounter := 0.0;
ELSE
  rPosSetpointCounter := rPosSetpointCounter + 0.008;
  rPosSetpoint        := SIN (rPosSetpointCounter) * 2.0;
END_IF

END_PROGRAM

```

The single function blocks implement the following functionality:

Name	Description
EnableDrive	Enables the power stage of the drive at Node ID 1. Additionally gets the address of the drives Axis instance. That address is used as reference on all function blocks.
ProfileVelocity	Moves the drive at 20 rps in acyclic Profile Velocity Mode
ProfilePosition	Moves the drive cyclically between +10 r and -10 r with a profile velocity of 20 rps in acyclic Profile Position Mode
CyclicSynchronousVelocity	Moves the drive in Cyclic Synchronous Velocity Mode. A sine profile is used in this case as the velocity setpoint. Note: The difference to ProfileVelocity in this case is that the PLC transfers one new velocity setpoint value in every bus cycle (hence in our example every 1ms), which is directly accepted by the drive as new setpoint.
CyclicSynchronousPosition	Moves the drive in Cyclic Synchronous Position Mode. A sine profile is used in this case as the position setpoint. Note: Same as in CyclicSynchronousVelocity a new setpoint value is transferred to the drive in every bus cycle, which is directly accepted by the drive as new setpoint. Before starting synchronous movements, the drive is moved to position 0 to avoid a large step between cyclic movement and sine profile at the start of the movement.
Homing	Executes a Homing procedure. The Homing is completely controlled by the drive itself. The PLC only sets the mode (e.g. limit switch, sample switch, ...) and starts it.

9 Communication with the Metronix ServoCommander via Powerlink network

If the Powerlink cabling is not only to be used for Powerlink communication, but also to transmit normal Ethernet protocols (TCP/IP, UDP, etc.), the following must be observed:

› Powerlink active

If the Powerlink fieldbus is active, non-Powerlink communication (NRT, Non-Realtime) can only take place **via** the B&R X20 PLC, since it is strongly forbidden to include a non-Powerlink participant into the network.

In this case, the setup would look as follows:



The X20 PLC operates as a Gateway between the standard Ethernet side (Laptop and IF2 on X20 PLC) and the Powerlink side (IF3 on X20 PLC and all drives). This enables the Metronix ServoCommander running on the laptop to reach the servo drives.

For this purpose, a route must be set on the Laptop that defines the X20 PLC as a Gateway to access the servo drives, e.g. via Windows Command Prompt.

```
Administrator: Eingabeaufforderung
Microsoft Windows [Version 10.0.19044.1766]
(c) Microsoft Corporation. Alle Rechte vorbehalten.

C:\WINDOWS\system32>route add 192.168.100.0 mask 255.255.255.0 192.168.0.22
OK!

C:\WINDOWS\system32>
```

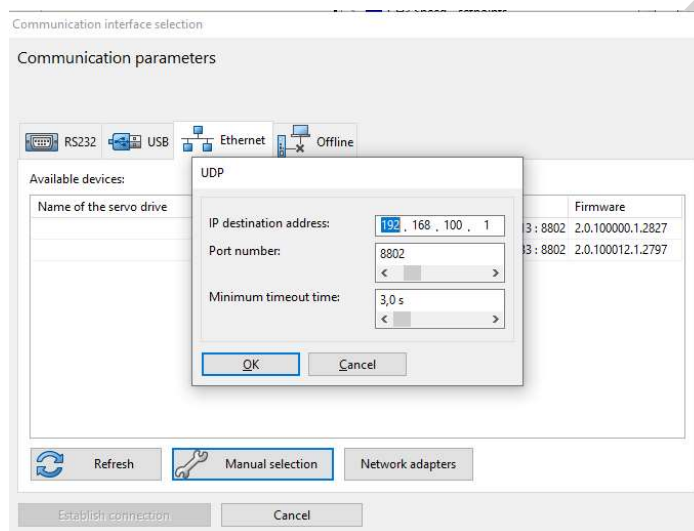
To open a Windows command prompt, press [Windows]-R, type `cmd.exe` and then press [ENTER]. Then you must add a route:

```
route add 192.168.100.0 mask 255.255.255.0 192.168.0.22
```

This command is composed as follows:

<code>route add</code>	<code>192.168.100.0 mask 255.255.255.0</code>	<code>192.168.0.22</code>
command	Destination IP address and netmask of Powerlink Network	IP address of X20 (Gateway)

In the ServoCommander the connection can now be established using the IP address of the servo drive as follows:



Press the "Manual selection" button in the "Communication interface selection" window to enter the desired IP address. The IP addresses of the individual nodes are composed of the fixed first 3 octets 192.168.100 and the node ID as the last octet. For example, the IP address for a CN with node ID 2 is 192.168.100.2.

> Basic Ethernet Mode

In case the drive is **NOT** connected to a Powerlink control and hence no Powerlink communication is taking place, it will switch to Basic Ethernet Mode after the time defined in object 1F99_00 (CNBasicEthernetTimeout / default is 5s) if no Powerlink telegrams are received.

If this mode is entered the RUN/SF/MS LED will start to flicker. After the mode has been entered, the drive can be connected **DIRECTLY** to a laptop, without the need to use a PLC as a gateway between Ethernet and Powerlink network:



Connecting the drive via ServoComander works the same way as in NRT mode.

INFORMATION Commissioning via the Metronix ServoComander

In Basic Ethernet Mode you

- Do not need to set a route on your laptop
- MUST configure an IP address for your laptop's ethernet interface that is inside the same network segment as the drive, e.g. 192.168.100.254.
Any IP address of the type 192.168.100.XXX can be used, whereby XXX must not correspond to the node ID of one of the connected servo drives and must be less than 255.

As soon as any Powerlink telegram is received by the drive, e.g. because a PLC has been connected, the Basic Ethernet Mode is left and the drive will returns to normal Powerlink operation. Therefore, direct communication with the drive from the laptop (without PLC as gateway) will no longer work until drive is reset.

Original Application Note

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