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Manual

for

Controller FCU 3.0 / FCU 3.0-S

For the operation of Turntables TT,

Turn Device TD

and Antenna Masts

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2 Safety instructions, general instructions, decommissioning

2.1 Operator responsibility

- Make sure that the system is operated only by personnel who have been authorized and instructed by the operator!
- Define an area of risk, which must not be entered while operating the system!
- Affix the instructed person's signature, that the operating instructions have been read and understood!
- Ensure that a copy of the entire operating manual is permanently ready to hand at the system!
- Determine the responsibility in accordance with the different fields of duty exactly (Maintenance, upkeep, etc.)!

2.2 Danger caused by energy

2.2.1 Danger from electrical energy





The device may only be connected to a power supply, where the protective conductor has a proper grounding.
Any damage or interruption of the protective conductor inside or outside of the device, or interruptions of the protective earth terminal can result in injury.
The electrical commissioning of this device may only be performed by authorized personnel. The legal local rules and safety regulations must be adhered to.
Even when the device is turned off, there remains residual electrical energy in conduits!
Working at electrical components may only be performed by qualified electricians, before that the system must be disconnected from the mains.

2.2.2 Danger from mechanical energy

Caused by the movements of parts of the system, there is a risk of crushing as well as drawing-in hazard during operation. The defined area of risk must not be entered. While the system is stationary, there is a risk of impact as well as tripping hazard.

2.3 Residual hazards

Despite all precautions taken, there may occur unobvious residual hazards.
These can be reduced by considering the safety advises, the intended use and the operating instructions.

2.3.1 Risk of injury by malfunctions

Malfunctions or operating conditions which may affect the safety, force the shutdown of the system by separating the power supply.
Before re-commissioning of the system, proper restoring of the intended condition is required.

2.3.2 Risk of impact, tripping falling

After removal of panels or plates, as required e.g., for maintenance, there is a danger to stumble against or to trip over parts of the system, or to fall in maintenance hatches.

2.3.3 Danger of slipping

During the operation or caused by malfunctions of the system there may form contamination or leak on ground near the system.

2.3.4 Explosion hazard through flammable detergents

During the maintenance there is a risk of explosion if highly flammable detergents are used for cleaning the system.

2.3.5 Risk of injury from irritant, health-damaging or caustic substances





There are dangers when handling consumable supplies like oils, detergents, etc. While working with these, the currently valid operating and work instructions or safety data sheets for handling of the respective substances must be observed.

2.3.6 No entry for unauthorized persons


There is risk of injury if unauthorized persons enter the pre-defined are of risk of the system. The operator must ensure that unauthorized persons, as visitors, customers, etc. have no access to the risk of area of the system.

2.3.7 Risk of death by falling loads


In the defined danger zone there is risk of death caused by human error or insufficient secured loads.

During installation, repair or maintenance of the system, appropriate lifting devices must be used, and the personal protective equipment must be used.

2.3.8 Risk of injury from hot surfaces

Especially motors are heating up during operation and cause risk of burning. Before maintenance and repair it is necessary to ensure that all components are cooled down.

2.3.9 Risk of injury from use by unauthorized persons or third parties

There are risks if unauthorized persons or third parties operate the system via the control unit while personnel are staying unauthorized in the area of risk.

2.3.10 Danger from laser beams


During setup operation of the device laser systems are used. Never look into the laser beam! Wear safety glasses!

2.4 General instructions

Before carrying out any repairs, always contact maturo GmbH previously.
Independent repairs or modifications to the equipment may cause warranty to expire.

Before any repairs the electrical power supply must be interrupted. At many points of the individual component's voltages appear that can cause injuries when touching.

Only trained staff may carry out settings and / or repairs to the devices. At the capacitors inside the device can still be voltage even if the device is powered off.

Regularly inspect and maintenance all devices in accordance with the provided instructions
Only use spare parts that are ordered or recommended by the manufacturer.

The devices must be clean and free of dust. A dirty or dusty environment may cause electrostatic interference.

To prevent electromagnetic interference, we use filters with a high leakage.

These filters are installed in each phase and the neutral conductor. The filters are principally used in products which are grounded to the floor, for example AM, CAM, TAM, EAS, TD, WPTC, MVCF. The filters are also installed into turn tables with higher loads, starting at TT2.0-1t. In most EMC chambers no Residual Current protective device (RCD) is installed. This is legit when sockets are built for a specific item of electrical equipment. In this case, the high leakage current has no effect.
If you are planning to install an RCD in the EMC chamber, then a 30mA RCD is too small!
You must use a 300mA RCD!

2.5 Decommissioning

2.5.1 Switch of the system

Stop all remote controls by external software!
Move the devices to their parking positions (see instructions for the control unit)!
Turn off the respective control unit and devices with their power switches and disconnect the equipment from the power supply!

2.5.2 Storage of the system

Turn off the system, disconnect all data connections between control units and devices!
The storage area must be cool and dry to avoid corrosion on the individual devices of the system. The room temperature of the storage area must be constantly between 5°C and 25°C, the humidity must not be more than 50%.

- Prepare the individual parts of the system to avoid any external damaging influences during storage!
- If necessary, use cardboard, wooden boxes, and other packaging material!
- Secure all components against accidental tilting and instability!

2.5.3 Dispose of the system

This device must be disposed according to the applicable regulations and legislation from domestic waste. By collecting and recycling of recyclable materials the natural resources are conserved, and it is ensured, that all the applicable regulations for the protection of health and the environment are considered.

3 General Instructions and Precautions

Before this device is applied with power:
Ground it properly through the protective conductor of the power cable to a power source provided with protective earth contact. Any interruption of the protective (grounding) conductor, inside or outside the device, or disconnection of the protective earth terminal could result in personal injury.

The electrical installation of this product must be accomplished by an individual who is authorized to so do by the appropriate local authority. The installation must follow local electrical safety codes.

Only qualified personnel are allowed to operate or service this equipment.

Before making service, contact maturo GmbH
Service or modifications of the device by yourself may void your warranty.
If you attempt to service the unit by yourself, disconnect all electrical power before starting. There are voltages at many points in the components which could, if contacted, cause personal injury. Only trained service personnel are allowed to perform adjustments and/or service procedures upon this device. Capacitors inside this instrument may still be charged even when instrument is disconnected from its power source.

Stay clear of moving components during the operation of the device.
Do not operate the device while somebody is close to moving parts.

The protection of the area of risk at site is part of the operator.

Read this manual completely before starting installation. This equipment must be installed and operated only by qualified personnel.

Regularly inspect all equipment and conduct scheduled maintenance in accordance with the factory recommendations provided. Only use replacement parts and fasteners ordered directly from the factory.

Information presented enclosed is subject to change as product enhancements are made regularly.
Every effort has been made to ensure that the information in this manual is accurate. However, no liability or guarantee is assumed for the up-to-dateness, correctness and completeness of the information provided herein.
Pictures included are for illustration purposes only and do not represent all possible configurations.

4 Technical data of Controller FCU 3.0

The Controller FCU 3.0 is suited for the operation of up to four devices with multiple axes of motion. Those devices can be any combinations of antenna masts, turntables, cable guide rails or any other positioning equipment.
This controller FCU 3.0 permits the operation in manual, semi-automatic and remote-control mode via TCP/IP (LAN) of multiple devices simultaneously.

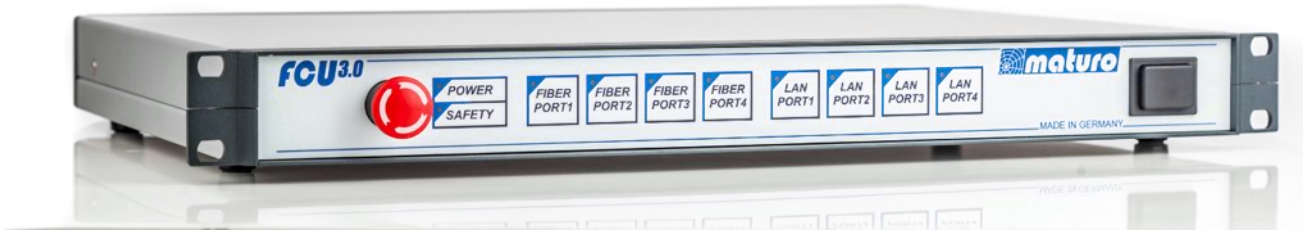

Figure 1: FCU 3.0

Technical data

ports	4x LAN / RJ45, 4x Fibre optics / FSMA
transfer rate	100 Mbit/s
voltage	100 V – 240 V / 50 Hz – 60 Hz
current consumption	max. 20 W
fuse	2x T1,6 A
size in mm (W x D)	19“ Rack mount (427 x 300)
height	1 HE (44 mm)
temperature range	5°C – 40°C
total weight	3 kg
accessories	mcApp HSU$^{3.0}$ handheld service unit Maturo dongle USB – network adapter

Requirements for existing PC

- Windows 7 32/64bit or better
- .NET Framework (included with mcApp software)
- 1 GB RAM
- 1 GHz Processor
- 5.5 GB disk space

5 Technical data of the Controller FCU 3.0 – S

The Controller FCU 3.0 – S is suited for the operation of one device with multiple axis of motion. That device can be any of antenna masts, turntables, cable guide rails or any other positioning equipment. This controller FCU 3.0 - S permits the operation in manual, semi-automatic and remote-control mode via TCP/IP (LAN), of the connected device.

Figure 2: FCU 3.0 - S

Technical data

ports	2x LAN / RJ45, 1x Fibre optic / FSMA
transfer rate	100 Mbit/s
voltage	100 V – 240 V / 50 Hz – 60 Hz
current consumption	max. 20 W
size in mm (W x D x H)	100 x 105 x 40
temperature range	5°C – 40°C
total weight	600 g
accessories	mcApp HSU$^{3.0}$ handheld service unit Maturo dongle USB – network adapter

Requirements for existing PC

- Windows 7 32/64bit or better
- .NET Framework (included with mcApp software)
- 1 GB RAM
- 1 GHz Processor
- 5.5 GB disk space

6 Brief description of the FCU 3.0 / FCU 3.0 - S

The FCU 3.0 / FCU 3.0 – S remote interface is fully compatible to the previous controller NCD and therefore works with KeySight (former Agilent), Rohde & Schwarz, Teseq, Toyo, DARE!, TDK and other measurement software with minimal implementation effort.
With the help of various available coding templates, for example for C++, C#, Python or Matlab, it is also easy to implement a self-made automation solution.

Highlights:

- Easy error analysis based on error codes
- Integration of emergency stop switches combinable
- Easy integration in the company network
- Control via existing PC
- Software included
- TCP/IP into the drive system
- Automation via LAN up to 100 Mbit/s
- Highest flexibility due to decentralisation of drive intelligence
- Unlimited combination of various positioners independent of the controller version 3.0
- Extended interface for development of own automation solutions

Note:
With the Maturo Dongle Lite, only up to one positioning device with up to one axis is supported.
The Standard Maturo Dongle can support an unlimited number of devices and/or axes.

7 Commissioning FCU 3.0 / FCU 3.0 – S

Bus Connection

The connection between the Controller FCU 3.0 / FCU 3.0 - S and the positioner is performed by the included fibre optic cable. The green lights on the front and on the back of the controller indicate if there is a physical connection (LED lighting up) or if there is a data transfer (LED flashing).

Figure 3: Green lights highlighted on the front of the FCU 3.0

Figure 4: Green lights are highlighted on the back of the FCU 3.0

Take care that the colours of cables match with the stickers at the backside of the controller and the drive units.

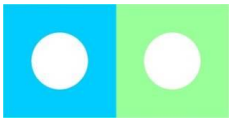

Figure 5: Colours around the FOC ports on the drive unit

"Hot connect" allows all positioners to be controlled immediately without a restart of the controller.

Power Supply

The power supply of all devices must be 110-240 VAC / 47-63Hz unless stated otherwise in the device description or on the device rating plate.

Switch On

Switch on power switch of the Positioners, if existing.
Switch on power switch at front of the controller (FCU3.0), check if emergency circuit is all right (LED "Safety" is green).
Connect power adapter (FCU3.0-S).
Use the included mcApp Control Application as described later.

Attention: The fibre optic cables of FCU 3.0 / FCU 3.0 - S are highly sensitive, ensure that it is not bent too much or gets damaged any otherwise!
If cables or ports are not in use, the included dust protection covers must be used!
Even a minor, hardly visible dirtying of cable ends or feedthroughs (FSMA) harms the connection, up to complete communication malfunction!
Therefore, please have a look at the Chapter Troubleshooting.

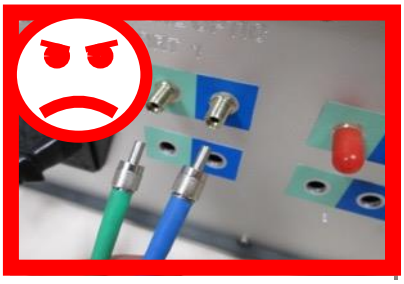

Figure 7: Wrong handling of ports and cables

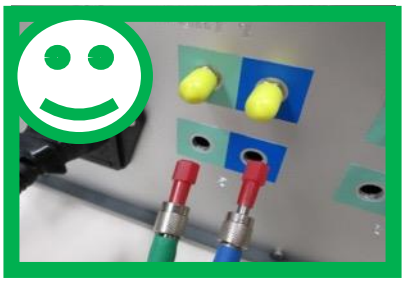

Figure 6: Proper handling of ports and cables

7.1 Emergency system

Safety connections overview

For safety there is an emergency switch at the front side of the FCU3.0. Triggering this switch immediately stops all connected devices.
Furthermore, the safety connectors at the backside of the FCU3.0 can be used to implement additional emergency switches, combine the emergency switches of two FCU3.0 units, or fully integrate an existing emergency circuit together with the FCU3.0 controller for an even higher level of safety.

Figure 8: Safety connectors at backside

Safety connector pin alignment

1.1 Optional safety feedback break contact (max. 250V, 0.5A)
1.2 Optional safety feedback break contact (max. 250V, 0.5A)

2.1 External safety input, necessary for working internal emergency circuit
2.2 24VDC supply contact
2.3 24VDC supply contact
2.4 0VDC supply contact
2.5 0VDC supply contact

By default, pins 2.1 and 2.2 are bridged with a jumper. Interrupting the circuit between those pins has the same effect as pushing the emergency switch on the front, therefore this can be used for an optional additional emergency switch (e.g., chamber door switch).
Only use the 24VDC supply provided at pin 2.2 or 2.3, do not use any external power sources!

Pins 1.1 and 1.2 provide an output signal that can be used as feedback for an already existing emergency circuit. The contacts are electrically isolated; therefore, the usage of an external power source is supported.

Integrating FCU3.0 into existing emergency circuit

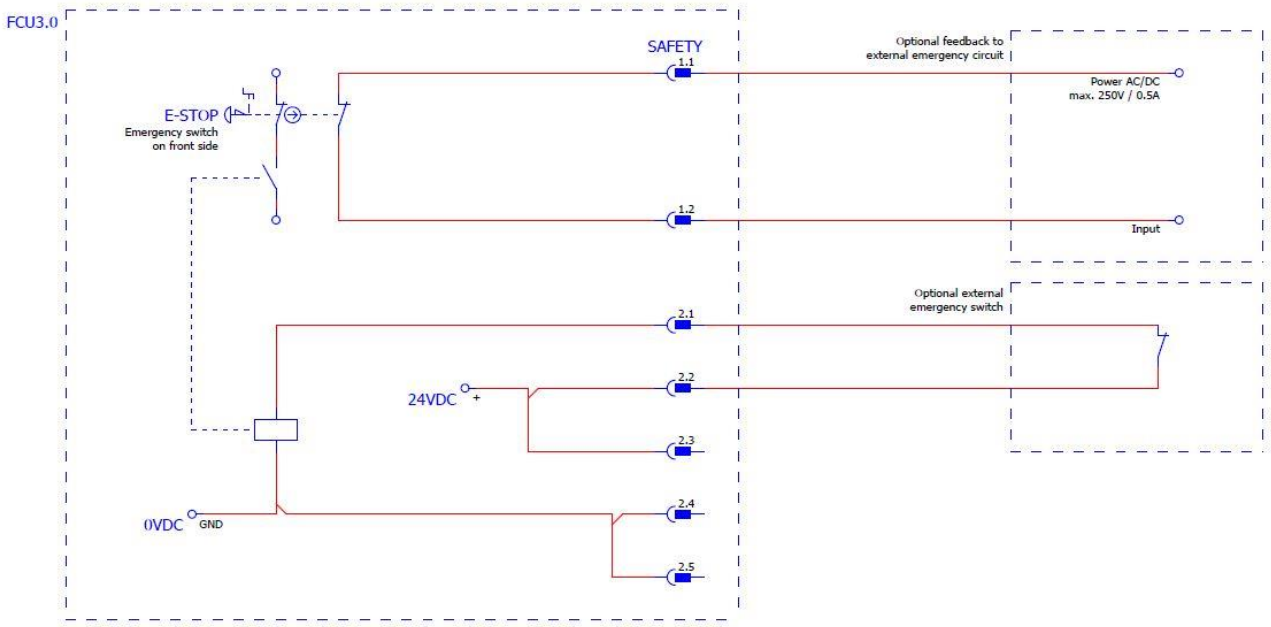

Figure 9: Example wiring diagram for external feedback and additional emergency switch

Combining emergency functions of two FCU3.0 controllers

When controlling five or more positioners, a second FCU3.0 controller is necessary to provide a sufficient amount of optical ports. In this case it is heavily advised to combine the two emergency circuits of the controllers to avoid uncertainty about which emergency switch powers off which positioners.

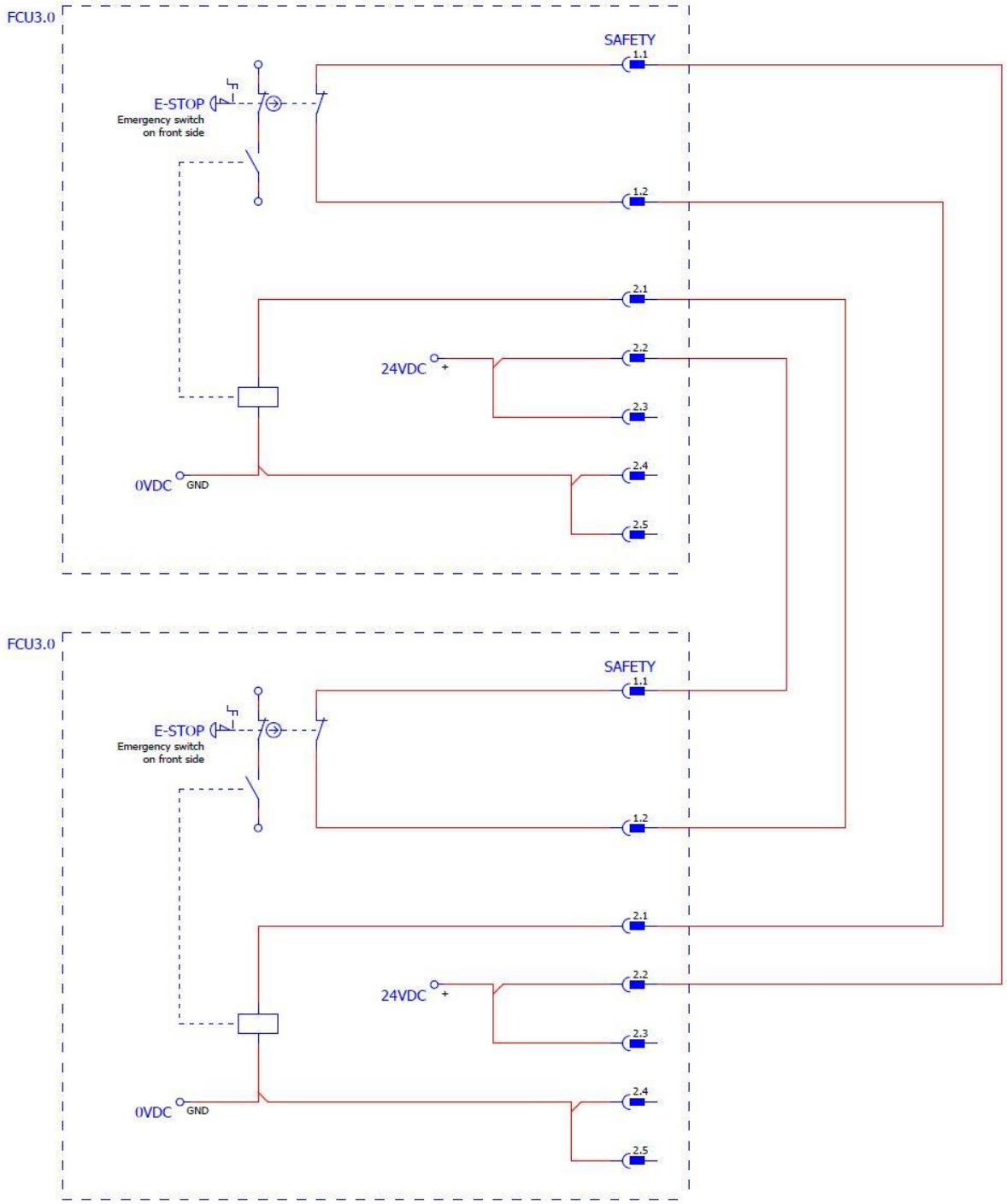

Figure 10: Combining emergency circuit of two FCU3.0 controllers

8 maturo mcApp and maturo dongle

8.1 Installation and setting of the IP - address

The first step is to install the maturo mcApp on your PC. The needed setup is provided together with the positioners on a USB flash drive. The installation routine will guide you through the steps required. In general, it is recommended to have a second unused Network card available at your PC, because it is needed to connect to the devices, and this way it is not necessarily needed to integrate the devices to the company network. Therefore, the USB – network adapter from maturo is included. Just plug that adapter in your computer and connect it on the other side via LAN with the FCU 3.0 / FCU3.0–S.

It is recommended to use a LAN cable with certification CAT5 or higher.

Example: changing the IP – address on a WIN 10 PC

- Open the network and internet settings

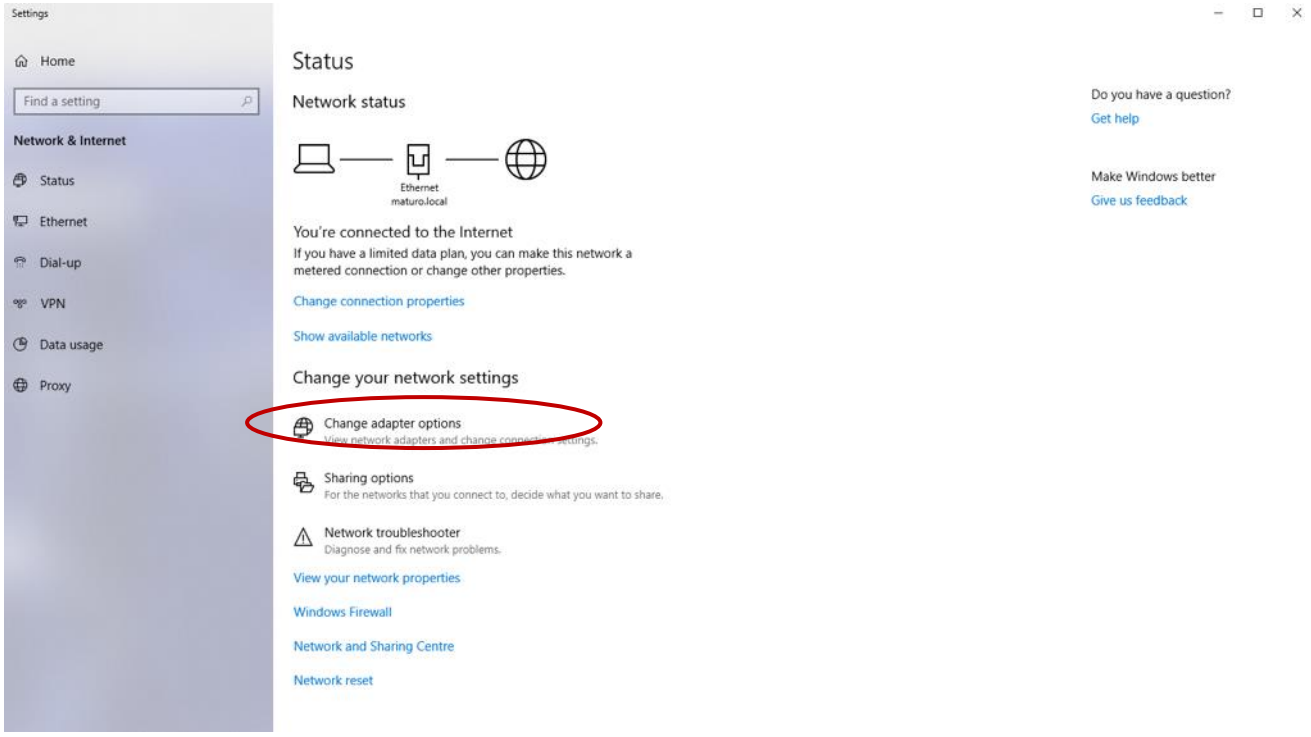

Figure 11: Internet and network settings

- Change adapter options

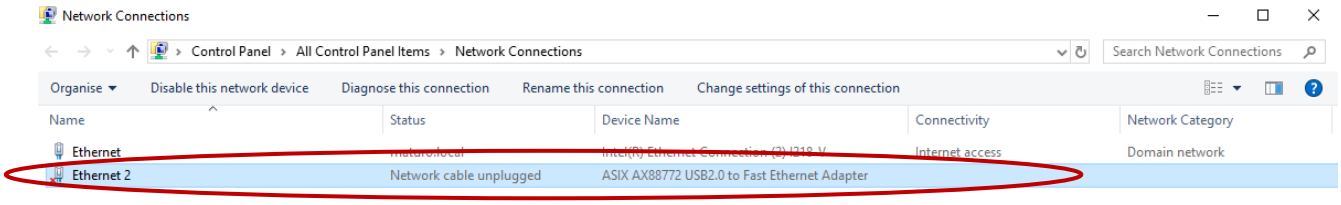

Figure 12: Network connections

- Right click on the correct USB - Ethernet adapter ⟶ choose Properties

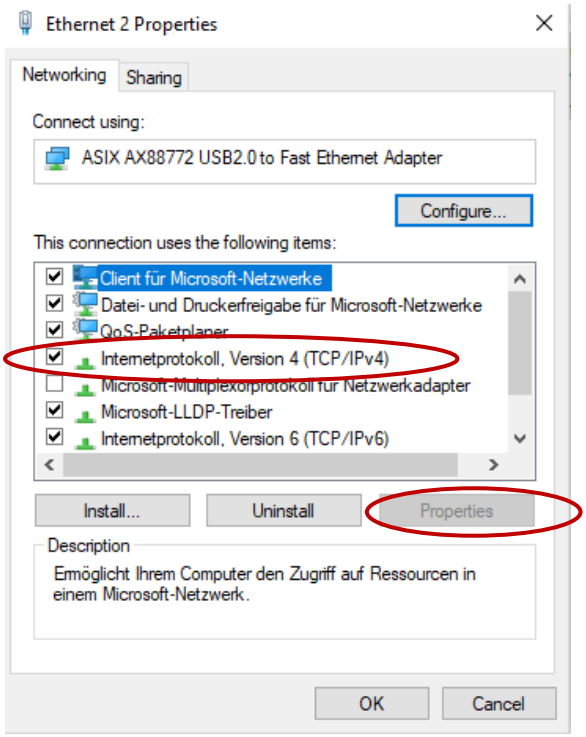

Figure 13: Properties of the chosen connection

- Choose Internet protocol, Version 4 (TCP/IPv4) and click on Properties

- Set the IP address and the subnet mask as follows (Be aware of the use of the IP-address, every IP-address must be unique)

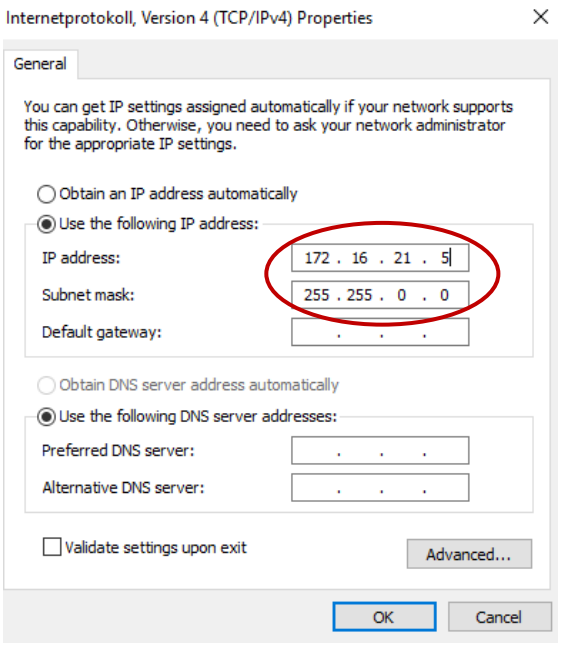

Figure 14: Setting the IP address and the Subnet mask

After that, your PC is able to find the devices connected via fiber optic to the FCU 3.0 / FCU 3.0 - S. You can find the device's default IP-Address on a sticker at the drive unit, next to the power outlet. The factory-set IP-Addresses are usually in the following range:

Antenna masts 172.16.0.1 – 172.16.0.255
Turntables 172.16.1.1 – 172.16.1.255
Turn devices 172.16.3.1 – 172.16.3.255
Others 172.16.4.1 – 172.16.4.255

Therefore, it is required to have a subnet mask of 255.255.0.0 in order to be able to connect to all necessary address ranges.

8.2 maturo dongle

For controlling the devices, the maturo dongle is also required. If it is not plugged in the control PC, the mcApp Control Application cannot be started and the devices will not respond to any command.

Figure 15: maturo dongle

8.3 Menu guidance

To open the maturo mcApp, just double-click on the shortcut that is on your desktop after installation.

8.3.1 Home screen

After opening the mcApp, the home screen will appear like shown below.

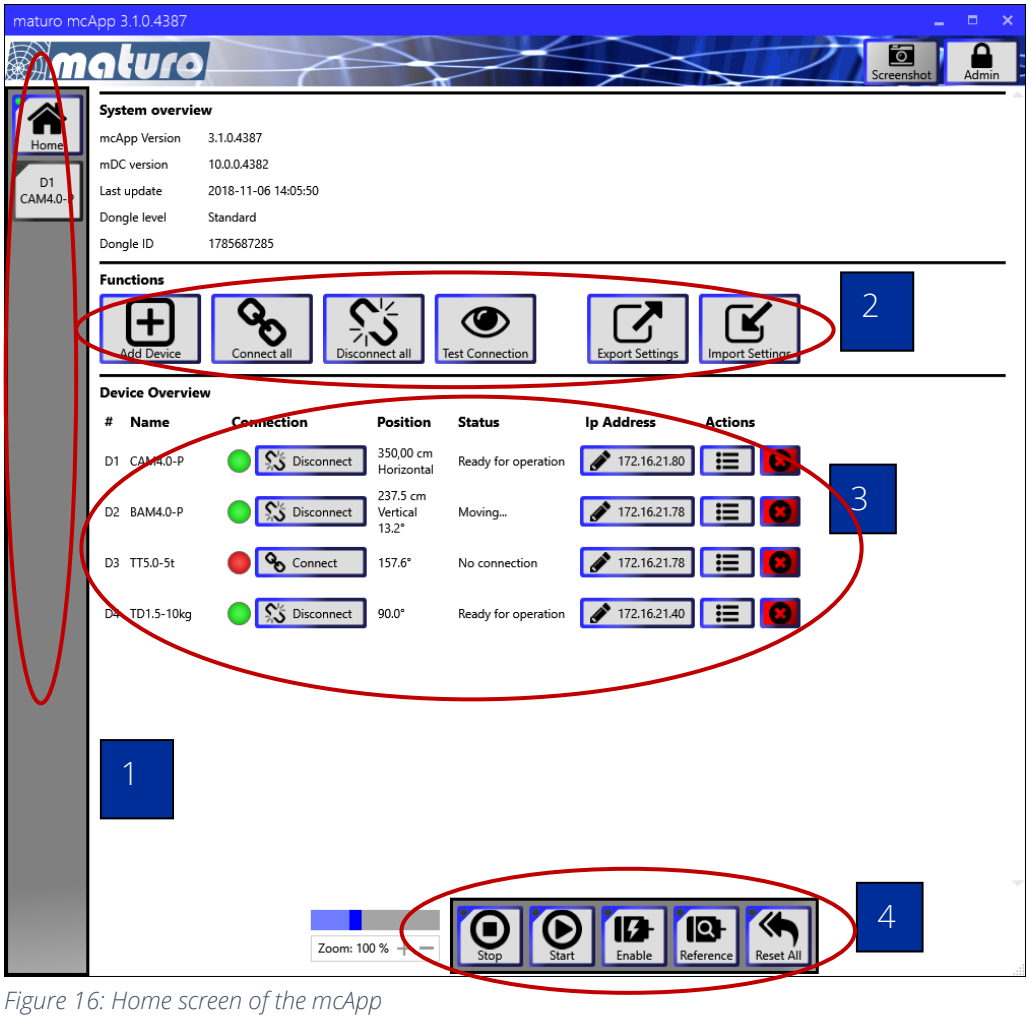

Figure 16: Home screen of the mcApp

1 → On the top there is the home-screen button. Clicking it will always get you into the home-screen. Below the home-screen button, buttons of all connected devices will appear. These will get you into the menu of the respective device.

2 → Function buttons:

Add Device:	Adding a new device
Connect all:	Connecting all added devices
Disconnect all:	Disconnecting all added devices
Test Connection:	Testing added devices whether they are connected
Export Settings:	Export the added devices as a file
Import Settings:	Import an existing file with already configured devices

3 → Device Overview: Here are all added devices are shown with some short information

4 → Control buttons:

Stop button:	Stops the chosen device
Start button:	Starts the actual chosen device to target position
Enable button:	Enables the chosen device
Reference button:	References the actual chosen device
Reset all button:	Resets all added devices

8.3.2 Adding a new device

Click on the Add Device button for adding a new device.

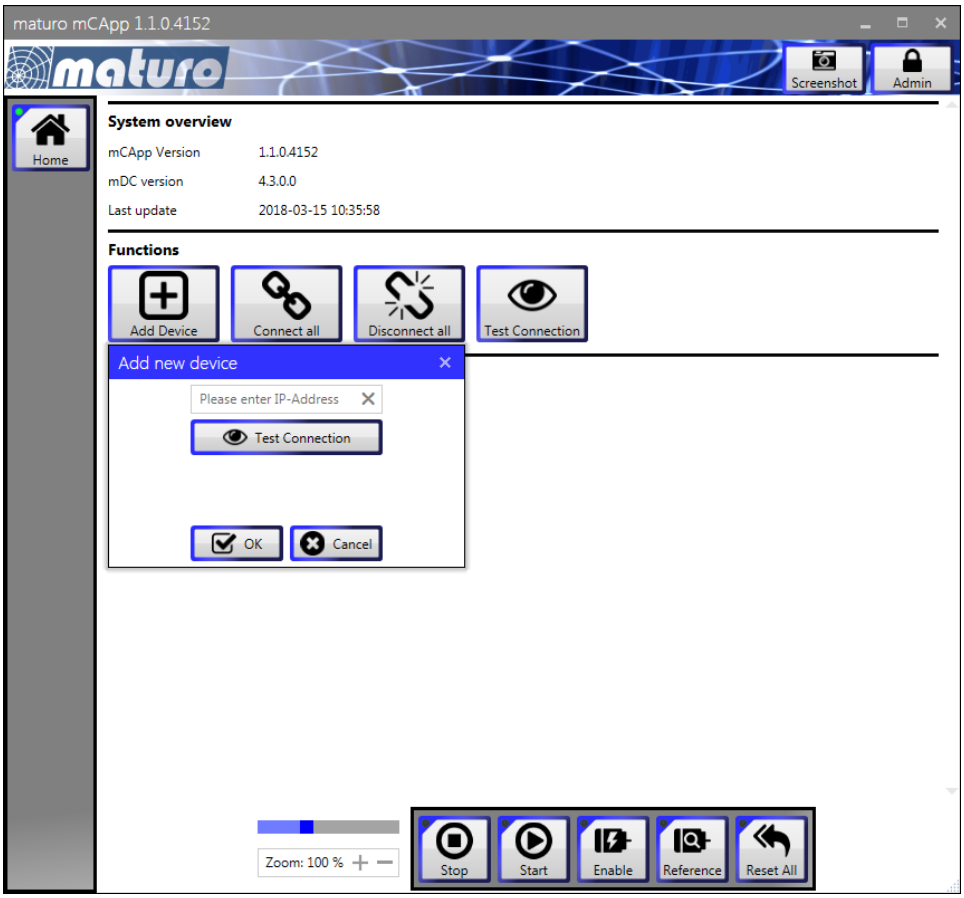

Figure 17: Adding a new device

The IP – Address of the device must be entered. The default IP – Address of the device can be found on a sticker on the drive unit. Optionally the connection can be tested and by clicking OK the device is added.

Figure 18: Entering the IP address

The home screen appears after adding devices like that (please note: The home-screen of your system may look different):

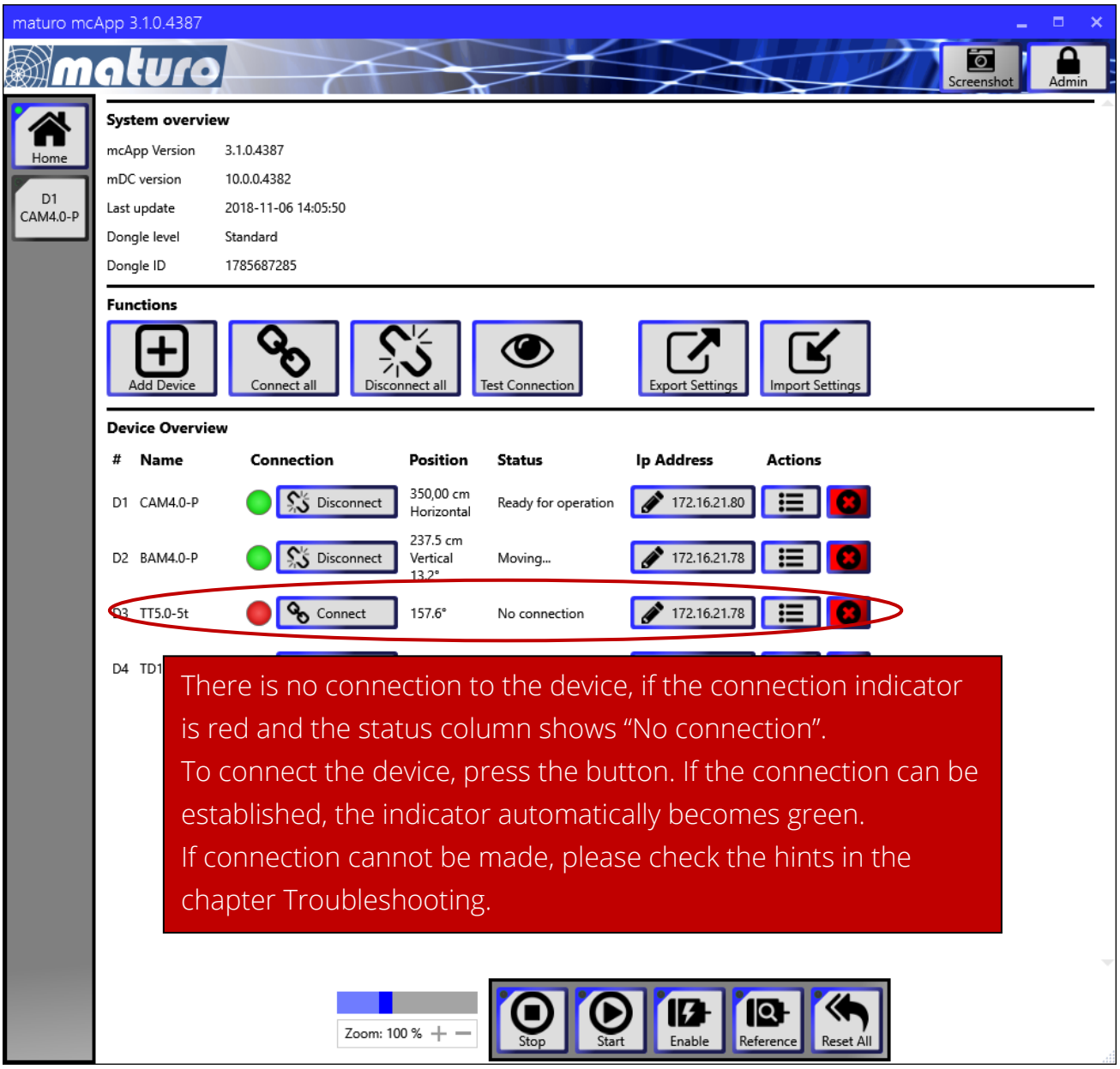

Figure 19: Home screen showing connected and non-connected devices

After connection there is already some short information about device number, device name, connection, actual position, state of the device and the IP – Address shown.
For remote control via separate measurement software, maturo mcApp must be up and running in the background and the respective positioner must be “Ready for operation”.
There is no need to connect device D1 to the first port. Each device can be connected to any free port of the FCU 3.0.

8.3.3 Brief description of Standard – Positioners

Note: The following brief descriptions are examples, but the controlling of most positioners is similar. Possibly your Device does not have all described functions.

General Setup

In short, the following steps are required once:

1. Set your PC and all devices to the same IP Range
2. Install maturo mcApp
3. Connect the devices and your PC physically to FCU controller
4. Add the devices to maturo mcApp

The following steps are required during daily routine:

1. Power on PC, FCU controller and positioners
2. Start maturo mcApp
3. Connect to all devices
4. Set Enable of each device
5. Carry out device referencing, if required
6. Optionally: Automation via separate Measurement software

Turntable TT, Turn Device TD

Most turntables do not require referencing. The displayed value of “Actual Position” is stored by an absolute encoder, even after power off. In the device screen (shown below) it is possible to enter a new position or alternatively move manually by clicking the Jog-Min and Jog-Max buttons.

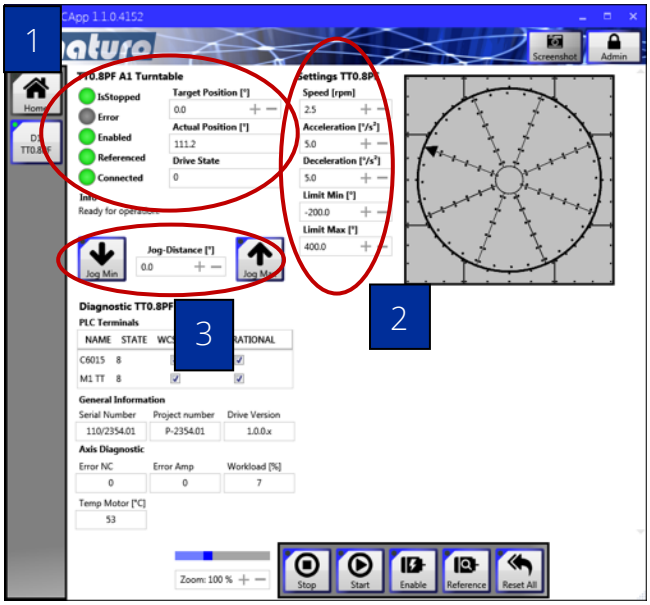

Figure 21: Device screen TT

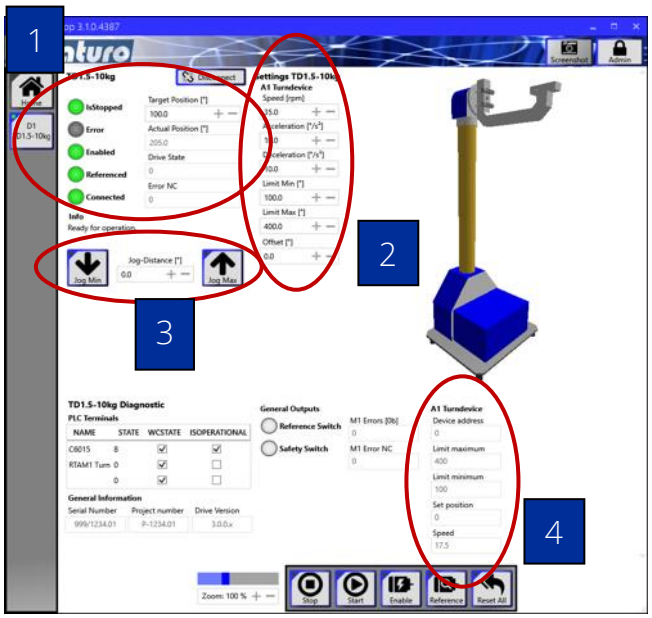

Figure 20: Device Screen TD

1 The target position within the limits can be entered and by clicking the start button the TT will start to turn until that position is reached.

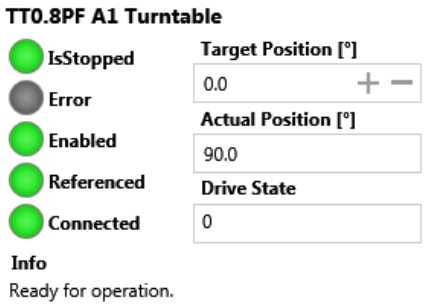

Figure 22: Status information of the device

2 Some settings can be changed within the default limits, e.g., the speed, acceleration, and deceleration.

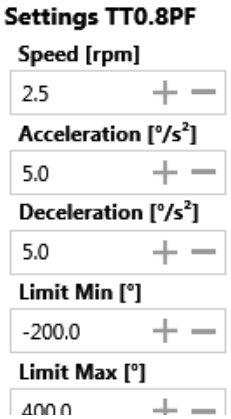

Figure 23: Settings of the device

3 The TT and the TD can also be turned manually by clicking on the Jog-Min and Jog-Max buttons. While Jog-Distance is 0.0, the device will move for as long as the Jog button is pressed. If for example 20.0 is entered as Jog-Distance, the device will move incrementally by 20.0 Degree once the corresponding Jog button is pressed.

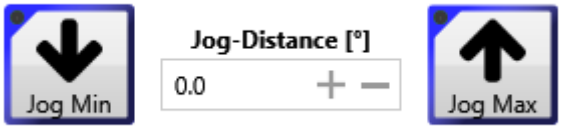

Figure 24: Jog Min and Jog Max buttons for moving the devices relatively

Antenna mast, Antenna stand

Masts must be referenced before positioning is enabled.

There are the same settings as shown above and additionally the polarization axis can be controlled. For tilt masts, there are also settings and actual angle of the tilt axis shown.

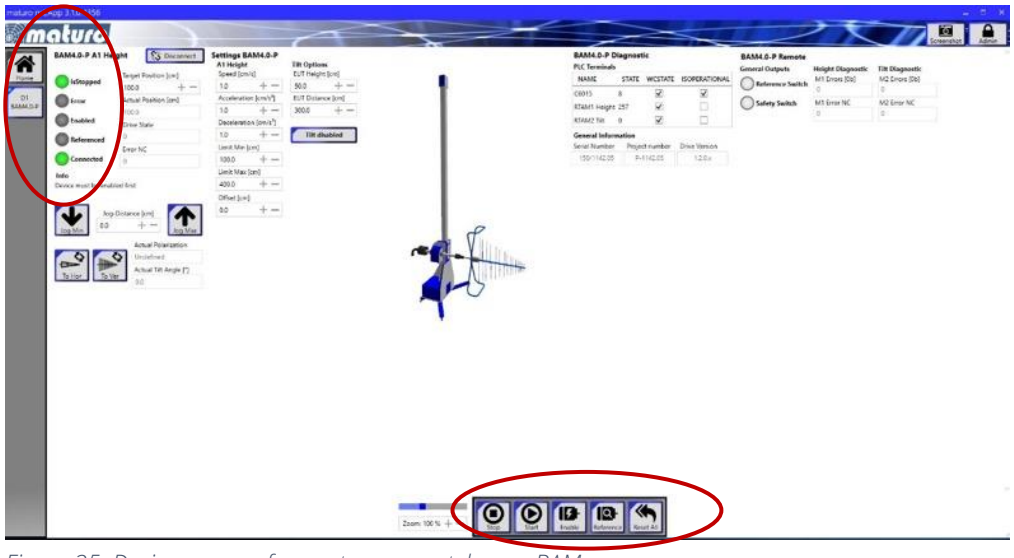

Figure 25: Device screen of an antenna mast, here a BAM

8.3.4 Referencing

Before moving the antenna masts, they must be referenced. As shown in Figure 25, the “Enabled” and “Referenced” indicators are grey. Therefore, the device cannot move. In case of TAM or BAM device, first the carriage must be adjusted considering the bubble level (see Figure 28). This have to be done either by the “Tilt Up” and “Tilt Down” buttons located on the side of the drive box of TAM or BAM (see Figure 27 right circle) or by the “Tilt Min” and “Tilt Max” buttons in the mcApp (see Figure 29: Reference Tilt mast via the mcAppFigure 29) which appear, when the “Reference” button (see Figure 26) was pressed. When the carriage is horizontal, the “Save Tilt” button must be pressed either on the drive box (see Figure 27 left circle) or in the mcApp (see Figure 29). This saves the actual Tilt angle as 0°.

Figure 27: "Tilt up", "Tilt down" and "Save Tilt" button on the drive box

Figure 28: Bubble level on the carriage of the antenna mast

Figure 26: Circle on the bottom of Figure 25, controlling buttons

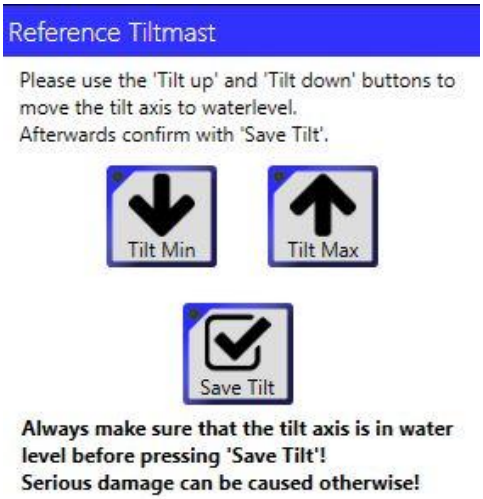

Figure 29: Reference Tilt mast via the mcApp

Figure 31: Left circle of Figure 25 enabled mast

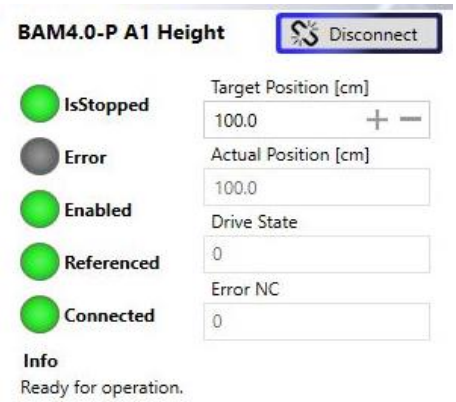

Figure 30: Referenced mast

First, set Enable, afterwards, press the “Reference” button (see Figure 26) on the bottom of the device screen.

In case of all other masts the adjustment of the carriage is omitted. Just the “Reference” - button must be pressed. Then the “Referenced” indicator becomes green (see Figure 30).

8.3.5 Positioning

By pushing any "JOG" key (see Figure 24) the Positioner moves in the respective direction. The movement stops either by releasing the "JOG" key or when a limit is reached.
"JOG Min" means Down for Masts and CCW for Turntables.
"JOG Max" means Up for Masts and CW for Turntables.
By entering a "JOG-Distance," an incremental stepwise positioning is activated. The respectively axis moves by the indicated distance pressing the "JOG" key. This stepwise positioning can be repeated any number of times if no limit is reached.

This function can be deactivated by entering "0.0" in the JOG- Distance input.

The polarisation can be changed by pressing "To Hor" or "To Ver" buttons (see Figure 32).

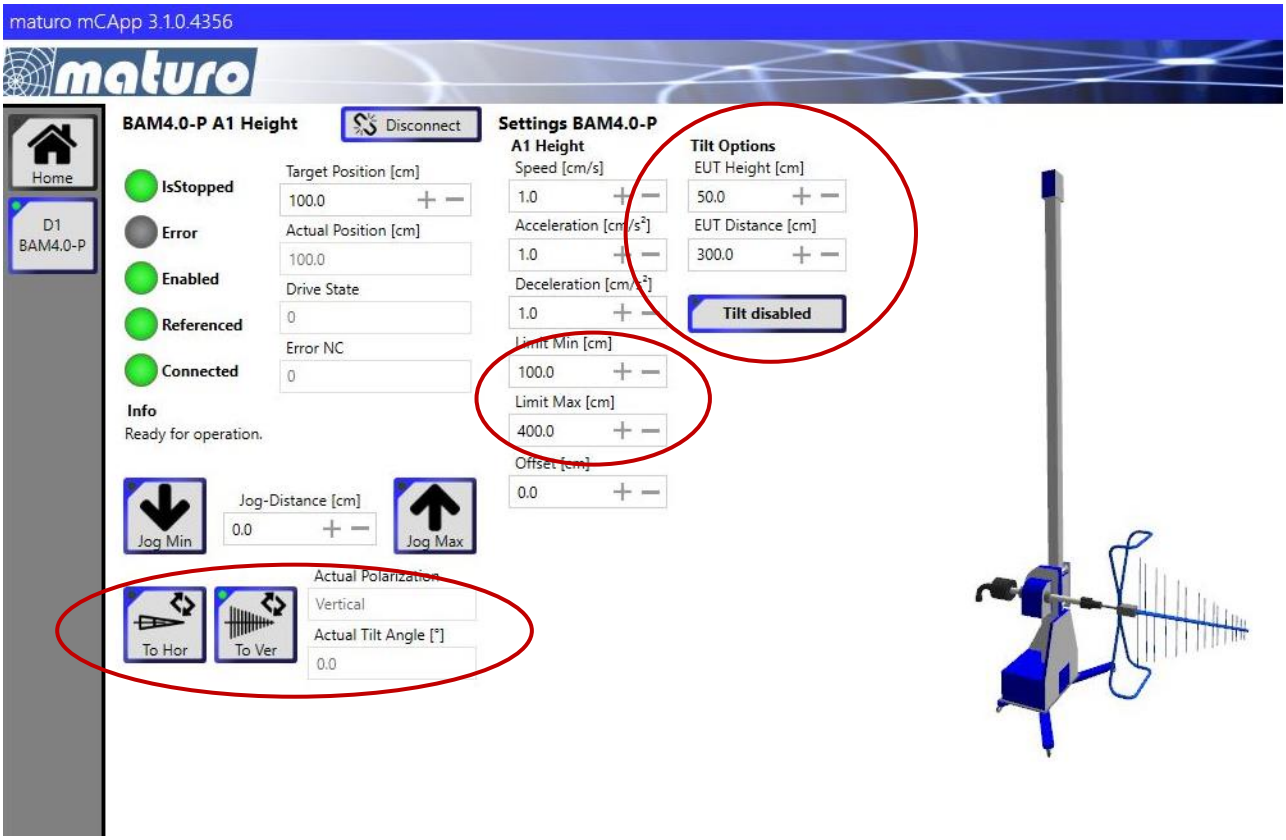

Figure 32: Highlighted polarization buttons, "Limit Min" and "Limit Max" values, Tilt Options

8.3.6 Actual and Target Position

The actual position is indicated in the respective box “Actual Position” (Figure 30).
Any target position can be entered in the box “Target Position” (see Figure 30, of course between the “Limit Min” and “Limit Max” values as highlighted in Figure 32) and afterwards the positioning can be activated with the “START” button (see Figure 26). If the input is higher/lower than the limits, the maximum/minimum limit will be used as new position automatically. During the movement, the positioning can be stopped with the “STOP” key and activated again with the “START” key.

8.3.7 Settings

The speed, acceleration and deceleration for all axes can be changed entering new values (within the indicated limits) in the boxes below the respective name (see Figure 23).
Also, for remote control the values of speed and acceleration can be adjusted separately by the software (see Figure 34). If no other values are chosen, the default values are selected automatically.

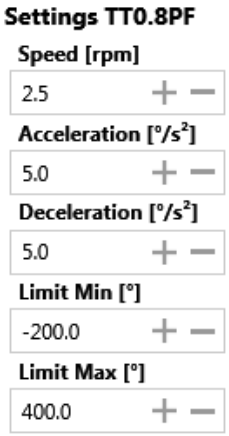

Figure 35: Settings of the device

Figure 34: Enlargement of Figure 20: Device Screen TDPos.4: set remote limits and device address are indicated

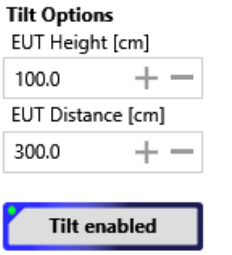

Figure 33: Tilt Options

Furthermore, settings for the Tilt – function and measurement distance and EUT height can be changed (see Figure 32). See Figure 36 for the right EUT settings.
EUT height:

- Before referencing, balance the antenna with the levels.
- After referencing or if the EUT height has changed, the new EUT height must first entered in the box “EUT height” and confirmed by pressing the “Start” button and moving to the new height.
- The movement of the antenna mast is now possible again.

Switching on or off tilt function or changing the tilt settings is only possible while the mast is at the lowest position limit.
With these settings the required tilt angle depending on the distance is calculated automatically.

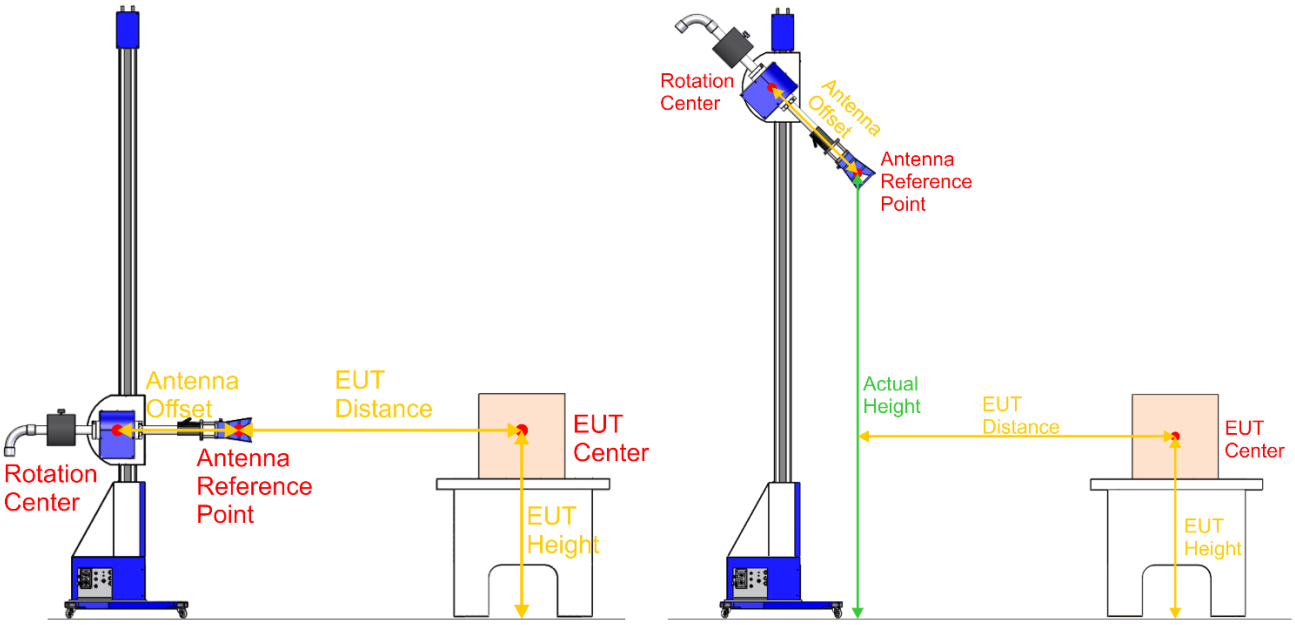

Figure 36: Sketch for input the correct EUT settings

8.3.8 Error Diagnostics

If an error occurs, the error indicator device screen changes to red (see Figure 37, 1).
To reset the error, press the “Reset All” button (see Figure 37, 2).

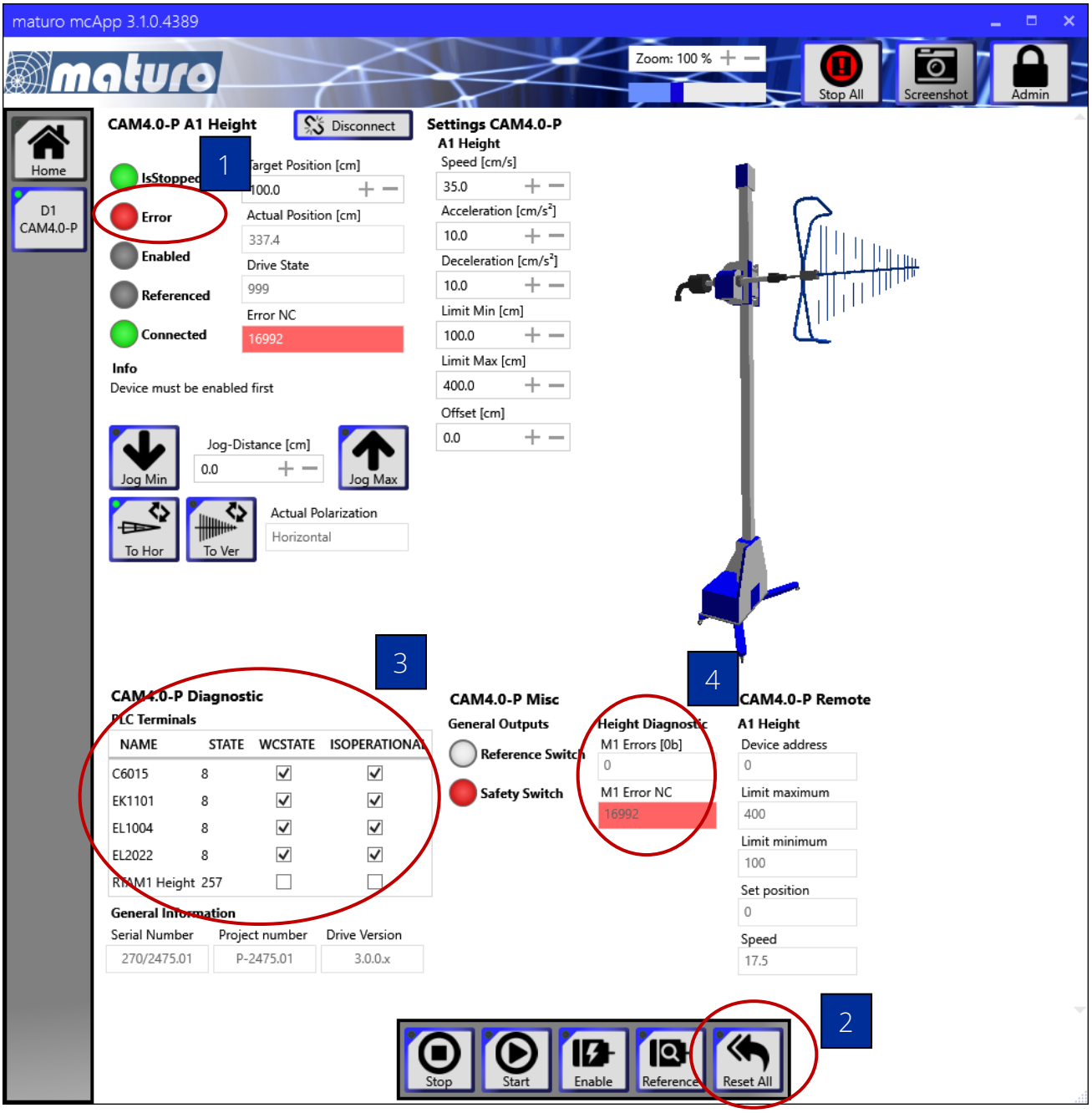

Figure 37: Error of a device

The state of each single component inside the drive unit is monitored (see Figure 37, 3).
In normal case, each indicator should be colored in white (see Figure 37, 4). If this is not the case, there is an error in the bus. For diagnosis and troubleshooting from maturo, a screenshot of this view is very helpful in order to give a quick solution.

If you need support, please always note the serial number of your device and the error numbers before contacting maturo.

Please contact our service department by:
Phone: +49 9606 9239130
Email: service@maturo-gmbh.de

9 Trouble Shooting Controller FCU 3.0 / FCU 3.0 – S

If there are problems with the controller, please always carry out the following first:

1. Check power supply – must be between 100V and 240V if not stated otherwise
2. Check fuses at the backside of the controller
3. Check fuse at the Positioner
4. Check if positioner is switched on (if power switch is existing)
5. Disconnect the power supply of the device and the controller for at least one minute. Reconnect the power supply and carry out referencing
6. Check fibre optic cables and connections (if possible, change cables from a different device and check), clean cables (see next page)
7. Use a short cable for connection directly to the device in the chamber

Please contact our service department by phone or by e-mail, please always provide the serial number of the products:
Phone: +49 9606 9239130
E-mail: service@maturo-gmbh.de

Cable cleaning

If you have connectivity malfunction, the cables, or the feedthroughs (FSMA) may be dirty.
Even if the cables never where disconnected, some dirt can get inside over time.
The cables may even not look dirty and still the attenuation loss can be too high!

Tools are shown in Figure 38 for best cleaning result:

- At least 90% pure cleaning alcohol (1)
  (other detergents can make it even worse!)
- Compressed air spray (optionally) (2)
- Small cotton sticks (3)
- Microfiber cloth (4)

Figure 38: Cleaning tools

Figure 41 and Figure 40 show how to clean the cables and the feedthroughs.

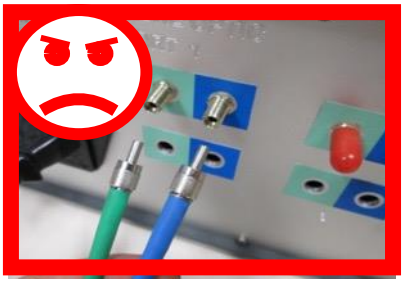

Figure 39: Use the provided dust protection caps, while cables are not in use.

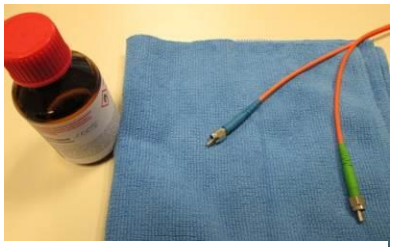

Figure 41: Use the microfiber cloth to clean all cable ends

Figure 40: Cotton sticks and compressed air to clean all feed-throughs (FSMA)

Warranty Statement

Maturo GmbH, hereinafter referred as maturo, warrants that our standard products are free from defect in materials and workmanship for a period of two years from date of shipment if maintenances are done regularly. Standard maturo products include the following:

- Antenna Masts and Stands
- Turntables and Turn Devices
- Cable Guide Rails
- Controllers
- Dynamometers for the automotive industry

If the Buyer notifies the Seller of a defect within the warranty period, the Seller will at the Seller's option, either repair and/or replace those products that prove to be defective.
There will be no charge for warranty services performed at the location maturo designates. The customer must, however, prepay inbound shipping costs and any duties or taxes. Maturo will pay outbound shipping cost for a carrier of maturo's choice, exclusive of any duties and taxes. If maturo determines that warranty service can only be performed at the customer's location, the customer will not be charged for maturo's travel related costs.

This warranty does not apply for:

- Improper storage of our products outside our area of influence
- Errors during installation, commissioning, or operation
- Wear and tear during normal operations
- Unqualified maintenance works
- The application of unsuitable equipment and materials
- The results of repair work or other activities undertaken on our products, which have not been expressly approved by us.
- Consumable items such as fuses, batteries, etc.
- Products which have been operated outside the specifications

Note: Please always contact maturo before shipping equipment to us.

Einbauerklärung

im Sinne der EG-Richtlinie Maschinen 2006/42/EG, Anhang II, Nr. 1 B

Declaration of Incorporation

in accordance with EC -Machinery Directive 2006/42/EC, appendix II, No. 1 B

Hiermit wird erklärt, dass das Positioniersystem, bestehend aus:
We hereby declare that the positioning system, consisting of:

Produktbezeichnung: *Product:*	Controller FCU$^{3.0}$
Seriennummer: *Serial number:*	FCU$^{3.0}$/525/3792.01
Baujahr: *Year:*	2023
Hersteller: *Manufacturer:*	maturo GmbH, Am Kalvarienberg 24, 92536 Pfreimd

mit den Vorschriften folgender Europäischer Richtlinien übereinstimmt:
has been manufactured according to the regulations of the following European directives:

- 2014/30/EU — Elektromagnetische Verträglichkeit – EMV-Richtlinie
- *2014/30/EU — Electromagnetic compatibility – EMC directive*

- 2014/35/EU — Elektrische Betriebsmittelrichtlinie
- *2014/35/EU — Electrical equipment directive*

Grundlagen dafür sind folgende harmonisierte Normen:
Basis for that are the following harmonized standards:

- DIN EN 55032:2022-08 — Class B
- DIN EN 61000-4-2:2009-12 — Level 2/3
- DIN EN 61000-4-3:2021-11 — Level 2
- DIN EN 61000-4-4:2013-04 — Level 2
- DIN EN 61010-1:2020-03 — Safety requirements for electrical equipment for measurement, control, and laboratory use.

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Pfreimd, den 30.08.2023

Gerhard Strehl, Managing Director

Firmenstempel *Company stamp*	Ort und Datum der Ausstellung Place and date of issue	rechtsverbindliche Unterschrift Name and signature of authorised person

EU-Konformitätserklärung

im Sinne der EU-Richtlinie RoHS 2011/65/EU
und EU 2015/863

EC declaration of conformity

in accordance with EC Directive RoHS 2011/65/EU
and EU 2015/863

Unsere Produkte erfüllen die Vorschriften der Richtlinie 2011/65/EU des Europäischen Parlaments und des Rates vom 08.06.2011 zur Beschränkung der Verwendung bestimmter gefährlicher Stoffe in Elektro- und Elektronikgeräten, sowie der Einhaltung der Höchstkonzentration in homogenen Werkstoffen in Gewichtsprozent von Cadmium < 0,01%, sowie Blei, Quecksilber, sechswertiges Chrom (Cr6+), Polybromierte Biphenyle (PBB), Polybromierte Diphenylether (PBDE), Bis(2-ethylhexyl) phthalat ((DEHP), Benzylbutylphthalat (BBP), Dibutylphthalat (DBP) und Diisobutylphthalat (DIBP) < 0,1% gemäß Anhang II der Richtlinie. Wir erklären hiermit, dass alle unsere Produkte RoHS-konform produziert werden.

Our products comply with the regulation of Directive 2011/65/EU of the European Parliament and the Council dated 08.06.2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment and the observance of the maximum concentration in homogeneous materials by weight Cadmium < 0,01%, and lead, mercury, hexavalent chromium (Cr6 +), polybrominated biphenyls (PBB), polybrominated diphenyl ethers (PBDE), Bis(2-ethylhexyl) phthalate (DEHP), Butyl benzyl (BBP), Dibutyl phthalate (DBP) and Diisobutyl phthalate (DIBP) < 0,1% according to Annex II of the Directive. We hereby declare that all our products are produced RoHS compliant.

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eMail: info@maturo-gmbh.de
Web: www.maturo-gmbh.de

Remote command API for all maturo controllers

For remote control of Antenna Mast AM and Stands AS, Turntable TT &Turn Devices TD

General Information

Information presented enclosed is subject to change as product enhancements are made regularly. Every effort has been made to ensure that the information in this manual is accurate. However, no liability or guarantee is assumed for the up-to-dateness, correctness and completeness of the information provided herein. Pictures included are for illustration purposes only and do not represent all possible configurations. Newer devices may have additional features or functions, there is no entitlement for any updates.

Manual version 2.1.3

Information for all maturo controllers

- All values are transferred in centimeter or degree if not specified otherwise.
- Commands, values, and units must be transferred in capital letters and separated by spaces.
- Both negative and positive values within the device limit are allowed.
- If not stated otherwise, decimal values are allowed. As decimal separator a dot must be used. Thousands of separators are not allowed, neither comma nor space.
- The basic command set is identical for all maturo controllers, however newer controllers may have additional commands.
- Additional non-standard commands or overridden standard commands, if existing, are described in the corresponding device manual.
- Settings made by remote control commands are generally not saved and must be resent after every device or controller power restart.
- Any axis can only accept new commands once it is in standstill (BU command returns '0')

Information for GPIB remote control only (supported by MCU, SCU and NCD)

- All outputs through the bus are followed by Linefeed (0AH).
- Line feed or EOI must be used as an end character (CR will be ignored).

Information for LAN remote control only (supported by NCD, FCU3.0 and FCU3.0-S)

- All strings are null terminated, so null (`'\0'`) must be used as termination character.

Information for FCU3.0 and FCU3.0-S

- For safety reasons the maturo control application mcApp must be connected to the device in the background permanently while using remote control.

Addressing multiple devices or axes

Each device that is connected to the maturo controller needs to be addressed separately before it accepts other commands.
For devices with multiple axes, the device address is also used to target specific axes.
The standard device addresses are as follows:

Device address	Device
0	Antenna Mast, Field Probe Positioner FPP axis 1, EAS-90, Height axis
1	Turntable 1, rotation axis
2	Cable Guide Rail, Linear axis
3	Turn Device, EAS-365, rotation axis
4	Second Antenna Mast, Field Probe Positioner axis 2
5	Second Turntable, rotation axis
6	Second Cable Guide Rail
7	Second Turn Device
8	Third Antenna Mast
9	Third Turntable
...	

Example setup with an antenna mast and a turntable:
`"LD 0 DV"` for addressing the Antenna Mast
`"LD 1 DV"` for addressing the Turntable.
This command must be used one time before the other device or axis specific commands can be used.
All following commands are valid for the device that was addressed last.

Example setup with a multi-axis device with a height, linear and rotation axis:
`“LD 0 DV”` for addressing the height axis.
`“LD 1 DV”` for addressing the rotation axis.
`“LD 2 DV”` for addressing the linear axis.

Global commands for all maturo controllers

`*IDN?` Returns the device identification string, e.g. `'maturo,NCD_999'`
The return value is different for the various maturo controllers:
MCU: `'maturo,MCU_nnn'` where nnn is the serial number
NCD: `'maturo,NCD_nnn'` where nnn is the serial number
The FCU3.0 does return the positioning device serial number (nnn) and firmware version (v.v.v.vvvv):
`'maturo,BAM4.0-P/nnn,v.v.v.vvvv'` or `'maturo,TT2.0SI/nnn,v.v.v.vvvv'`

Global commands (FCU3.0, FCU3.0-S)

`CHR n` Remote control check counter for debugging
Can be used to ensure that all commands are received by the device.
If commands are sent too fast, some may be lost eventually.

If the return value does not match the number of write operations, the timeout between write operations must be increased to make sure all are received safely.

`CHR 1`	Increment counter by 1 (write only)
`CHR 2`	Increment counter by 1 and get current count (query only)
`CHR 3`	Get current count (query only)
`CHR 0`	Reset counter to 0

`VR?` Query the remote-control API version

`VD?` Query the device version

`RE` Reset eventual errors

`E?` Query eventual error numbers, `'0'` means no errors
If the device has multiple axes, error numbers will be separated by semicolon.
Example string with 2 axes: `'0;422D;'`

`BUS?` Query the state of each single device terminal. Each terminal state is a 4 char hexadecimal string, separated by semicolon.
Example string with 3 device terminals: `'0008;0008;0114;'`

`S?` Query the device state overview, return value is a 32bit hexadecimal string Example: `'1234FFFF'`. Each single bit contains a Boolean state feedback. The description describes the true condition:

Bit 0	Always true
Bit 1	One or more fuses in drive box down
Bit 2	Any error on any axis
Bit 3	Any device terminal not operational
Bit 4	All axes enabled (=ready for movement)
Bit 5	All axes referenced
Bit 6	All axes stopped
Bit 7	Any axis is moving
Bit 8-31	reserved

`Sn?` n has to be replaced by axis number, example: `'S1?'`
Query the device axis state return value is a 32bit hexadecimal string.
Example: `'1234FFFF'`. Each single bit contains a Boolean state feedback.
The description describes the true condition:

Bit 0	Always true
Bit 1	reserved
Bit 2	Axis error
Bit 3	reserved
Bit 4	Axis is enabled (=ready for movement)
Bit 5	Axis is referenced
Bit 6	Axis is stopped
Bit 7	Axis is moving
Bit 8	Axis is in constant velocity
Bit 9	Axis is at minimum position
Bit 10	Axis is at maximum position
Bit 11-31	reserved

General commands (Controllers SCU, MCU, NCD, FCU3.0, FCU3.0-S)

`LD x DV`	Set axis with address x as active device (needed for the following commands)
`DV`	Query the currently set device
`LD x SP`	Set speed of active device to a value between 1 and 8
`SP`	Query the currently set speed (returns 1 to 8)
`LD x SF`	Set speed of active device to a single precision (32bit) floating number
`SF`	Query the currently set speed (return value is rounded to 2 decimal places)
`CP`	Query the current position (16bit integer)
`RP`	Query the current position (32bit floating number), rounded to 2 decimal places
`BU`	Query the busy state, returns **`'0'`** for standstill and **`'1'`** for busy
`ST`	Stops any movement of the currently set device

Linear axes (Controllers SCU, MCU, NCD, FCU3.0, FCU3.0-S)

`LD x CM UL`	Set positive limit of active device to a single precision (32bit) floating number within the hardware limits (Upper limit)
`LD x CM LL`	Set negative limit of active device to a single precision (32bit) floating number within the hardware limits (Lower limit)

`UL`
`UV`
`LL`
	Query the currently set limit (return value rounded to 2 decimal places)

`LD x CM NP GO`	Set new position to a single precision (32bit) floating number within the Hardware limits and start positioning
`LD x CM NP`	Set new position to a single precision (32bit) floating number within the Hardware limits
`GO`	Start the positioning to the previously set value
`NP`	Query the currently set new position (return value rounded to 2 decimal places)
`UP`	Jog positive direction (up) until Jog-Distance value or maximum position is reached
`DN`	Jog negative direction (down) until Jog-Distance value or minimum position is reached

Antenna mast specific commands (Controllers SCU, MCU, NCD, FCU3.0, FCU3.0-S)

`LD x CM UV`	Set positive limit of active mast to a single precision (32bit) floating number within the hardware limits. Limit is valid while polarization is vertical. (Upper Vertical limit)
`PV`	Start moving to vertical polarization
`PH`	Start moving to vertical polarization
`P?`	Queries the actual polarization. Returns `'0'` for horizontal and `'1'` for vertical

Tilt mast specific commands (Controllers FCU3.0 and FCU3.0-S)

`LD x TD`	Set tilt axis distance of active device to a single precision (32bit) floating number
`LD x TH`	Set tilt axis height of active device to a single precision (32bit) floating number
`TD` `TH`	Query the currently set values for tilt distance or height
`LD x TL`	Enable (x = 1) or disable (x = 0) tilt function, mast position must be at lower limit
`LD x AD`	Set antenna offset of active device to a single precision (32bit) floating number. mast position must be at lower limit
`TL`	Query tilt status information, returns an info byte with the following true conditions: Bit 0: Tilt is on Bit 1: Changing tilt settings is allowed Bit 2: Tilt settings have changed, start has to be sent to apply settings
`T?`	Query the current tilt angle as a single precision (32bit) floating number

Note: After changing tilt settings, 'GO' must be sent to confirm the new values.
Consider that when using an antenna offset, the limits will eventually change dynamically.

Example to change Tilt settings via Remote:

`LD 100 CM NP GO`	Move the mast to minimum position
`LD 300 CM TD`	Set EUT distance 300.0cm
`LD 80.5 CM TH`	Set EUT Height to 80.5cm
`LD 10.33 CM AD`	Set antenna offset to 10.33cm
`LD 1 TL`	Switch on tilt
`GO`	Send start, tilt axis will move to new angle

Rotation axes (Controllers SCU, MCU, NCD, FCU3.0, FCU3.0-S)

`LD x DG WL`	Set positive limit of active device to a single precision (32bit) floating number within the hardware limits (clockwise limit)
`LD x DG CL`	Set negative limit of active device to a single precision (32bit) floating number within the hardware limits (counter clockwise limit)
`WL` `CL`	Query the currently set limit (return value rounded to 2 decimals places)
`LD x DG NP GO`	Set new position to a single precision (32bit) floating number within the Hardware limits and start positioning
`LD x DG NP`	Set new position to a single precision (32bit) floating number within the Hardware limits
`GO`	Start the positioning to the previously set value
`NP`	Query the currently set new position (return value rounded to 2 decimal places)
`CW`	Jog positive direction (clockwise) until Jog-Distance value or maximum position is reached
`CC`	Jog negative direction (counter clockwise) until Jog-Distance value or minimum position is reached

Generic axis commands (Controllers FCU3.0 and FCU3.0-)

`LD x PL`	Set positive limit of active device to a single precision (32bit) floating number within the hardware limits (e.g. clockwise for tables or upwards for masts)
`LD x NL`	Set negative limit of active device to a single precision (32bit) floating number within the hardware limits (e.g. counter clockwise for tables or downwards for masts)
`PL`	Query the currently set limit (return value rounded to 2 decimals places)
`NL`	
`LD x NP GO`	Set new position to a single precision (32bit) floating number within the Hardware limits and start positioning
`LD x NP`	Set new position to a single precision (32bit) floating number within the Hardware limits
`GO`	Start the positioning to the previously loaded value
`NP`	Query the currently set new position (return value rounded to 2 decimal places)
`JP`	Jog positive direction until Jog-Distance value or maximum position is reached
`JN`	Jog negative direction until Jog-Distance value or minimum position is reached
`LD x AF`	Set acceleration of active device to a single precision (32bit) floating number
`AF`	Query the currently set acceleration (return value is rounded to 2 decimal places)
`LD x DF`	Set deceleration of active device to a single precision (32bit) floating number
`DF`	Query the currently set deceleration (return value is rounded to 2 decimal places)

Quick examples

Set the speed

You can set speed 1 to 8 with the SP command. To change the speed of a turntable, make the following two steps:
Select the Turntable by sending **“LD 1 DV”**
Write **"LD 5 SP"** sets the speed to five. The speed depends on the maximum speed of the device.
For example, the maximum speed of the turntable is 2.0 rpm (12°/s)
(2.0 ÷ 8) * 5 = 1.25 U/min is the new speed.
Alternatively, the speed can be set to a floating number with the SF command.
Select an antenna mast by sending **“LD 0 DV”**.
Optionally query **“SF”** to readout the maximum speed (e.g. 20.0 cm/s).
Write **“LD 10.45 SF”** to select 10.45 cm/s as the new speed.
Note: Querying **“SF”** will now also return **“10.45”** until next power cycle.

Go to a new position

For setting a new position of the turntable make the following two steps:
Select the Turntable with the command **“LD 1 DV”**
Write the command **"LD 180.0 DG NP GO"** (the turntable moves to 180 degree)

With the commands **"CC"** and **"CW"** it is possible to move the turntable to minimum and maximum limit.
“CC” – Turntable moves to minimum limit (default: -200 degree)
“CW” – Turntable moves to maximum limit (default: +400 degree)

For stopping the turntable make the following two steps:
Select the turntable **“LD 1 DV”**
Write the command **"ST"**

For setting a new position of the antenna mast follow the same steps:
Except: Select the antenna mast with writing **"LD 0 DV"**
Write the command **"LD 300.0 CM NP GO"** (the antenna mast moves to 3.0 meter)
For polarization of the antenna mast write **"PV"** and **"PH"**.

Before starting with the next position command, it is advised to wait until **“BU”** returns **“0”.**
(Device is not busy)

Readout the actual position of the device:

Select the device by writing **"LD x DV"**. (x = 0 => Antenna Mast and x = 1 => Turntable)
Write **"CP"** for integer or **“RP”** for floating value.
Readout returns the position e.g. **“201”** for CP or **“200.96”** for RP
(Applies to antenna mast and turntable)

For polarization readout select the antenna mast
Write **"P?"**, then readout returns **“0”** for horizontal and **“1”** for vertical.

Setting up LAN remote control for controller NCD, FCU3.0, FCU3.0-S or PC – CU

The following example shows how a functional LAN communication is set up to the controller NCD principally.
In the example, the Measurement & Automation Explorer from National Instruments is used.

The NCD controller must be in LAN mode (see chapter “Changing GPIB/LAN-Address”).
In the example, the following default addresses are set in the NCD:
LanPort: 200
IP-Address: 172.16.21.50
Subnet mask: 255.255.0.0
Termination character: \0 (Null)
The remote address of FCU3.0 devices can be found on a small sticker on its drive unit.

The address of the remote PC must be in the same area, for example 172.16.21.49.
The Subnet mask must be identical.
After every command block, the termination character “\0” (Null) must be sent.

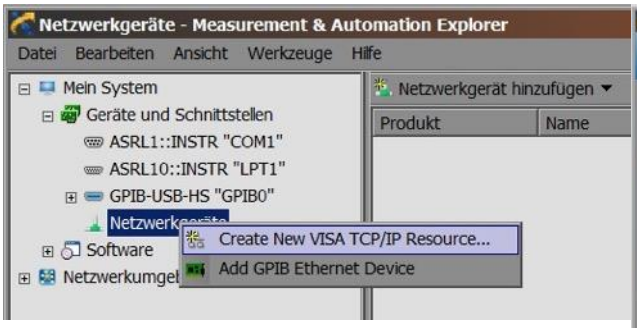

Figure 44: Create a new resource at network devices

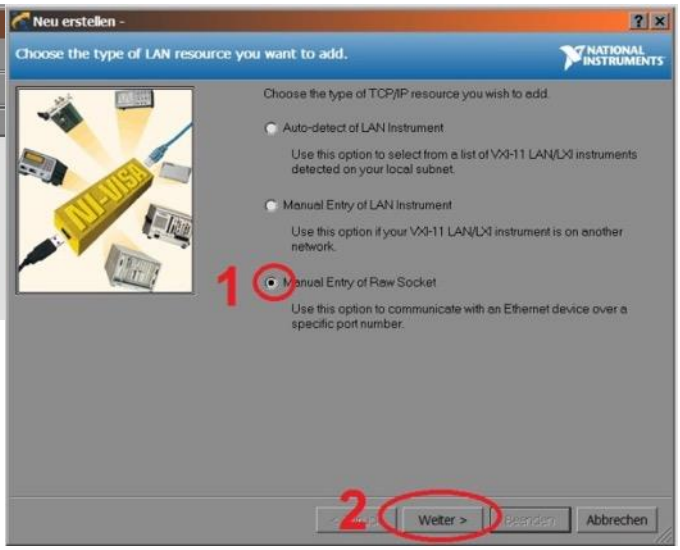

Figure 44: Chose the third option

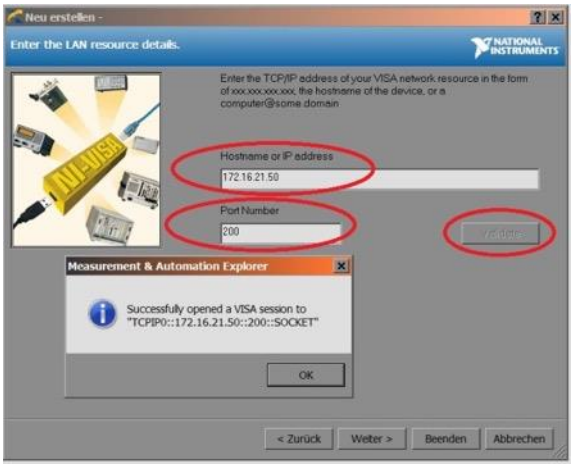

Figure 42: Enter the NCD's IP-Address and port number. By pressing "Validate" the communication can be checked.

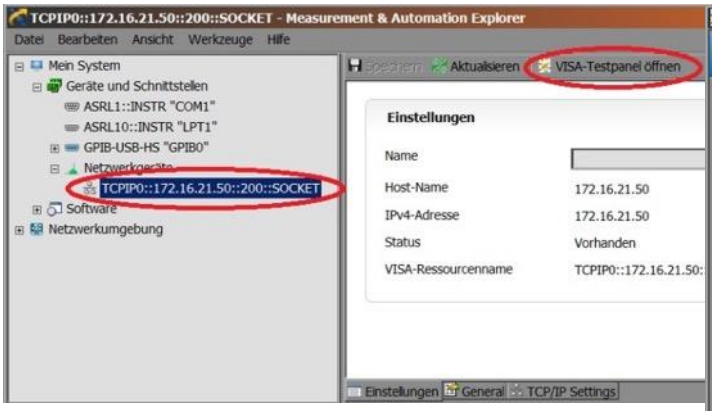

Figure 46: Chose the device

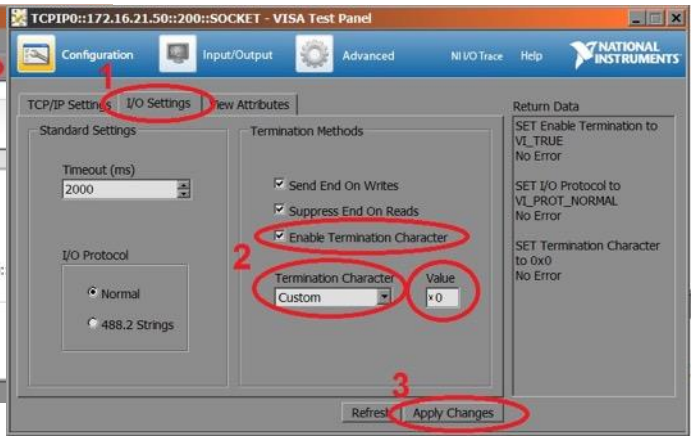

Figure 46: VISA - Testpanel

Open the VISA-Testpanel.
At "I/O Settings" the shown settings must be adjusted.

It is important, that "Enable Termination Character" is checked, and the Termination Character must be set to „Custom" and the Value to „0" (Zero).

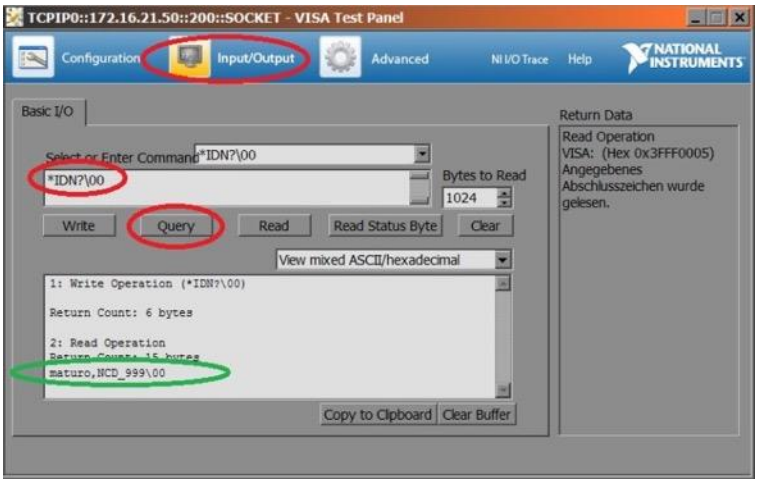

*Figure 47: Go to "Input/Output", enter "*IDN?\0", press query. Now the serial number of the NCD must be shown.*

The other remote commands can be found in the NCD controller remote description.
It is important that these commands are also followed by „\0" (Null)!

Example:
„LD 1 DV\0"
„LD 180.0 DG NP GO\0"

The first command loads the turntable with the device address 1.
The second command sets the new position to 180.0 degree and starts the positioning.

Example LAN Remote control application in Visual C# .NET4.6.1

```
namespace RemoteControlSample
{
    using System;
    using System.Net;
    using System.Net.NetworkInformation;
    using System.Net.Sockets;
    using System.Threading;

    /// <summary>
    /// Example implementation of <see cref="Lan"/>
    /// </summary>
    public static class ImplementationExample
    {
        public static void Example()
        {
            // Create instance of Lan class
            Lan = new Lan() {IpAddress = "172.16.21.50", PortNumber = "200",
                                CommandTimeout = 100};

            // Check ping (optional)
            Console.WriteLine("Checking ping...");
            if (lan.CheckPing())
            {
                Console.WriteLine("Ping check successful");
            }
            else
            {
                Console.WriteLine("Ping check failed");
            }

            // Check socket (optional)
            Console.WriteLine("Checking socket...");
            if (lan.CheckSocket())
            {
                Console.WriteLine("Socket check successful");
            }
            else
            {
                Console.WriteLine("Socket check failed");
            }

            // Query device identification string
            lan.WriteString("*IDN?");

            // Print the response
            Console.WriteLine(lan.ReadString());

            // Set DV 1 (Turntable) as active device
            lan.WriteString("LD 1 DV");

            // Set speed to 50% (4/8)
            lan.WriteString("LD 4 SP");

            // Query current position
            lan.WriteString("RP");
            Console.WriteLine(lan.ReadString());

            // Ask the user to input a new position
            Console.WriteLine("Enter new target position:");
            string s = Console.ReadLine();
```

```
            // Move to new position
            string command = "LD " + s + " DG NP GO";
            lan.WriteString(command);

            // Wait until the device has started moving (BU returns 1)
            string busy = string.Empty;
            while (busy != "1")
            {
                lan.WriteString("BU");
                busy = lan.ReadString();
            }

            // Wait until the device has finished moving (BU returns 0)
            while (busy != "0")
            {
                lan.WriteString("BU");
                busy = lan.ReadString();

                // Also print current position
                lan.WriteString("RP");
                Console.WriteLine(lan.ReadString());
            }

            Console.ReadKey();
        }
    }

    /// <summary>
    /// Lan interface to maturo device
    /// </summary>
    public class Lan
    {
        private const string TerminationChar = "\0"; // Maturo device use null-terminated strings
        private TcpClient _tcpC;

        /// <summary>
        /// IpAddress of maturo device
        /// </summary>
        public string IpAddress { get; set; } = "172.16.21.50";

        /// <summary>
        /// Port number of maturo device
        /// </summary>
        public string PortNumber { get; set; } = "200";

        /// <summary>
        /// Command Timeout, 100ms is recommended
        /// </summary>
        public int CommandTimeout { get; set; } = 100;

        /// <summary>
        /// Send ping to device and return true on success
        /// </summary>
        /// <param name="timeout"></param>
        /// <returns></returns>
        public bool CheckPing(int timeout = 3000)
        {
            Ping p = new Ping();
            PingReply result = p.Send(IpAddress, timeout);
            return result != null && result.Status == IPStatus.Success;
        }
```

```
/// <summary>
/// Try opening the device socket and return true on success
/// </summary>
/// <param name="timeout"></param>
/// <returns></returns>
public bool CheckSocket(int timeout = 3000)
{
    Socket soc = new Socket(AddressFamily.InterNetwork,
        SocketType.Stream, ProtocolType.Tcp);
    IPAddress ipAdd = IPAddress.Parse(IpAddress);

    // Check for valid port number
    int port = Convert.ToInt32(PortNumber);
    IPEndPoint remoteEp = new IPEndPoint(ipAdd, port);
    try
    {
        // Connect async to prevent UI blocking
        IAsyncResult result = soc.BeginConnect(remoteEp, null, null);
        result.AsyncWaitHandle.WaitOne(timeout, true);

        // Check socket
        if (soc.Connected)
        {
            soc.EndConnect(result);
            return true;
        }
        else
        {
            soc.EndConnect(result);
            return false;
        }
    }
    finally
    {
        soc.Close();
    }

}
```

```
/// <summary>
/// Read via TCP/IP Socket
/// </summary>
public string ReadString()
{
    NetworkStream ns = _tcpC.GetStream();
    ns.ReadTimeout = 3000;

    int iRx = 0;
    int iAvailable = _tcpC.Available;
    byte[] bytes = new byte[1024];

    // Wait until data available
    while (iAvailable <= 0)
    {
        iAvailable = _tcpC.Available;
    }

    // Wait until all available data received
    while (iRx < iAvailable)
    {
        iRx = ns.Read(bytes, 0, iAvailable);
    }

    // Decode
    char[] chars = new char[iRx];
    System.Text.Decoder d = System.Text.Encoding.UTF8.GetDecoder();
    d.GetChars(bytes, 0, iRx, chars, 0);
    string result = new string(chars);

    // Close Socket
    DisconnectClient();

    // Cut termination chars
    result = result.Substring(0, result.Length - 1);

    // Wait before using the next command
    Thread.Sleep(CommandTimeout);
    return result;

}

/// <summary>
/// Write a string via TCPIP Socket
/// </summary>
/// <param name="cmd">Command string</param>
public void WriteString(string cmd)
{
    // Connect Client
    ConnectClient();

    // Start Send
    string send = cmd + TerminationChar;
    byte[] data = System.Text.Encoding.ASCII.GetBytes(send);
    NetworkStream ns = _tcpC.GetStream();

    // Send data
    ns.Write(data, 0, data.Length);

    // Wait before using the next command
    Thread.Sleep(CommandTimeout);
}
```

```
        /// <summary>
        /// Connect the TCP client
        /// </summary>
        private void ConnectClient()
        {
            // Check if instance of Client already exists
            if (_tcpC == null)
            {
                _tcpC = new TcpClient { ReceiveBufferSize = 1024, NoDelay = true };
            }

            // Start the Client
            if (!_tcpC.Connected && _tcpC != null)
            {

                IAsyncResult result = _tcpC.BeginConnect(IpAddress,
                    Convert.ToInt32(PortNumber), null, null);

                bool success = result.AsyncWaitHandle.WaitOne(TimeSpan.FromMilliseconds(3000));

                if (!success)
                {
                    throw new Exception("Connection Timeout");
                }
                _tcpC.EndConnect(result);
            }
        }

        /// <summary>
        /// Disconnect the TCP client and cleanup used resources.
        /// </summary>
        private void DisconnectClient()
        {
            // Check if instance exists
            if (_tcpC != null)
            {
                // Disconnect and dispose
                if(_tcpC.Connected)
                {
                    _tcpC.Dispose();
                    _tcpC = null;
                }
            }
        }

    }
}
```

Example LAN Remote control application in Python 3.6 32-bit

```
import socket
import time
import datetime

def Write(cmd):
    """Send the input cmd string via TCPIP Socket"""
    s = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
    s.connect((TCP_IP, TCP_PORT))

    s.send(cmd.encode())
    print(datetime.datetime.now().time(), "Sent: ", cmd)

    time.sleep(TCP_CMDDELAY); # Commands may be lost when writing too fast

    s.close()


def Query(cmd):
    """Send the input cmd string via TCPIP Socket and return the reply string"""
    s = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
    s.connect((TCP_IP, TCP_PORT))

    s.send(cmd.encode())
    data = s.recv(TCP_BUFFER);
    value = data.decode("utf-8")
    # Cut the last character as the device returns a null terminated string
    value = value[:-1]
    print(datetime.datetime.now().time(), "Sent: ", cmd)
    print(datetime.datetime.now().time(), "Recv: ", value)

    s.close()

    return value;


# Initialize Constants
TCP_IP = "172.16.21.50"
TCP_PORT = 200
TCP_BUFFER = 128
TCP_CMDDELAY = 0.1
```

```
# Query device identification string
Query("*IDN?")

# Set DV 1 (Turntable) as active device
Write("LD 1 DV")

# Preset the speed to 3.0 °/s
Write("LD 3 SF")

# Query current position
Query("RP")

# Ask the user for a new position
pos = input("Enter new target position: ")

# Concat the command for new position
cmd = "LD " + pos + " DG NP GO"

# Go to set new position
Write(cmd)

# Wait until the device starts moving (BU returns 1)
while True:
    bu = Query("BU")
    if bu == "1":
        break;

# Wait until the device finished moving (BU returns 0)
while True:
    bu = Query("BU")
    Query("RP") # Also display current position
    if bu == "0":
        break;
```

Example LAN Remote control application in MatLab R2018a

```
% Query device identification string
Query("*IDN?");

% Set DV 1 (Turntable) as active device
Write("LD 1 DV");

% Preset the speed to 3.0 °/s
Write("LD 3 SF");

% Query current position
Query("RP");

% Ask the user for a new position
prompt = 'Enter new target position: ';
str = input(prompt, 's');

% Concat the command for new position
str = strcat("LD ", str, " DG NP GO");

% Go to set new position
Write(str);

% Wait until the device starts moving (BU returns 1)
while 1
    bu = str2num(Query("BU"));
    if bu == 1
        break
    end
end

% Wait until the device finished moving (BU returns 0)
while 1
    bu = str2num(Query("BU"));
    Query("RP"); % Also display current position
    if bu == 0
        break
    end
end

fprintf("\n") % NewLine for logger overview only

function Write(cmd)
    t = tcpip("172.16.21.50", 200);
    t.Terminator = 0;
    fopen(t);
    fprintf(t, cmd);
    fprintf(strcat(datestr(now, "HH:MM:SS.FFF"), " Sent: ", cmd, "\n"));
    fclose(t);
    pause(0.01);
end
```

```
function y = Query(cmd)
    t = tcpip("172.16.21.50", 200);
    t.Terminator = 0;
    fopen(t);
    fprintf(t, cmd);
    fprintf(strcat(datestr(now, 'HH:MM:SS.FFF'), " Sent: ", cmd, "\n"));
    pause(0.01);
    recv = fscanf(t);
    fclose(t);
    fprintf(strcat(datestr(now, 'HH:MM:SS.FFF'), " Recv: ", recv, "\n"));
    y = native2unicode(recv);
end
```

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Notes