User Manual

C885T0002, valid for C-885 PIMotionMaster, C-885.Mx, C-885.Rx, C-885.iD
CBo, BRo, ASt, 2023-08-17

C-885 PIMotionMaster

Modular Multi-Axis Controller with Card Slots

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About this Document

This document describes the C-885 PIMotionMaster which is a customizable, modular multi-axis controller with card slots. See "Product Description" (p. 9) for detailed information on the system.

Symbols and Typographic Conventions

The following symbols and typographic conventions are used in this document:

CAUTION

Dangerous situation
Failure to comply could lead to minor injury.

➢ Precautionary measures for avoiding the risk.

NOTICE

Dangerous situation
Failure to comply could lead to damage to equipment.

➢ Precautionary measures for avoiding the risk.

INFORMATION

Information for easier handling, tricks, tips, etc.

Typographic Conventions	Meaning
1.	Action consisting of several steps with strict sequential order
2.	
➢	Action consisting of one or more steps without relevant sequential order
▪	Bullets
p. 5	Cross-reference to page 5
`SVO?`	Command line or a command from PI's General Command Set (GCS) (example: command to get the servo mode).
RS-232	Labeling of the control elements on the product (Example: RS-232 interface socket)

Typographic Conventions	Meaning
Device S/N	Parameter name (example: parameter where the serial number is stored)
Start > Settings	Menu path in the PC software (example: To open the menu, the *Start* and *Settings* buttons must be selected successively.)
5	Value that must be entered or selected via the PC software

Other Applicable Documents

The devices and software tools mentioned in this document are described in separate manuals.

Product	Document
C-663.12C885 Motion Controller Module	C663T0004 User Manual
C-863.20C885 Motion Controller Module	C863T0005 User Manual
C-867.10C885 Motion Controller Module	C867T0017 User Manual
C-891.11C885 Motion Controller Module	C891T0005 User Manual
E-861.11C885 Motion Controller Module	E861T0012 User Manual
E-873.10C885 Motion Controller Module	E873T0002 User Manual
PIUpdateFinder	A000T0028 User Manual
PIMikroMove	SM148E Software Manual
Downloading manuals from PI: PDF file with links to the manuals for digital electronics and software from Supplied with the PI software.	A000T0081 Technical Note

The latest versions of the user manuals are available for download on our website (p. 6).

Downloading Manuals

INFORMATION

If a manual is missing or there are problems with downloading:

➢ Contact our customer service department (p. 70).

Downloading manuals

1. Open the website www.pi.ws.
2. Search the website for the product number (e.g., C-885).
3. Select the corresponding product to open the product detail page.
4. Activate the ***Downloads*** tab.

   The manuals are shown under ***Documentation***. Software manuals are shown under ***General Software Documentation***.
5. Select the ***ADD TO LIST*** button for the desired manual and then select ***REQUEST***.
6. Fill out the request form and select ***SEND REQUEST***.

   The download link will then be sent to the email address entered.

Safety

Intended Use

The C-885 PIMotionMaster is a laboratory device according to DIN EN 61010. It is intended to be used in interior spaces and in an environment which is free of dirt, oil and lubricants.

In accordance with its design, the C-885 PIMotionMaster is for operating suitable controller modules provided by PI (p. 9). The operator is responsible for electrical safety according to EN 61010-1:2010 and electromagnetic compatibility according to EN 61326-1:2013 when integrating the plug-in cards (C-885.M1/C-885.M2 and controller modules) in the overall system.

The C-885 PIMotionMaster may only be used in compliance with the technical specifications and instructions in this user manual. The operator is responsible for validating the process.

General Safety Instructions

The C-885 PIMotionMaster is built according to state-of-the-art technology and recognized safety standards. Improper use can result in personal injury and/or damage to the C-885 PIMotionMaster.

- Use the C-885 PIMotionMaster only for its intended purpose, and only when it is in perfect technical condition.
- Read the documentation.
- Eliminate any malfunctions that may affect safety immediately.

The operator is responsible for installing and operating the C-885 PIMotionMaster correctly.

Organizational Measures

Documentation

- Keep the user manual together with the C-885 PIMotionMaster always.
- Add all information from the manufacturer to the documentation, for example supplements or technical notes.
- If you give the C-885 PIMotionMaster to other users, include this document as well as other relevant information provided by the manufacturer.
- Use the C-885 PIMotionMaster only if the documentation is complete. Missing information due to an incomplete documentation can result in minor injury and damage to equipment.
- Install and operate the C-885 PIMotionMaster only after you have read and understood this user manual.

Personnel qualification

The C-885 PIMotionMaster may only be installed, started, operated, maintained, and cleaned by authorized and appropriately qualified personnel.

Safety Precautions

In addition to the safety information contained in the documentation of the controller modules (p. 18), take the following safety precautions:

CAUTION

Risk of electric shock if the protective earth conductor is not connected!
If the protective earth conductor is missing or not properly connected, dangerous touch voltages could occur on the C-885 PIMotionMaster in the event of malfunction or failure of the system. If touch voltages occur, touching the C-885 PIMotionMaster could result in minor injury from electric shock.

- Connect the C-885 PIMotionMaster to a protective earth conductor (p. 20) before startup.
- Do **not** remove the protective earth conductor during operation.
- If the protective earth conductor has to be removed temporarily (e.g., for modifications), reconnect the C-885 PIMotionMaster to the protective earth conductor before restarting and operating.

CAUTION

Risk of electric shock and electromagnetic radiation when operating with open chassis!
If the C-885 PIMotionMaster is operated when modules and/or cover plates are missing, live parts will be accessible and electromagnetic radiation is possible. Touching live parts can result in minor injuries from electric shock.

- Make sure that all slots in the chassis are either equipped with a suitable module or closed with a suitable cover. If necessary, order suitable covers (p. 10).
- Operate the C-885 PIMotionMaster only when all slots of the chassis are occupied or covered.

NOTICE

Electrostatic hazard!
The plug-in cards (C-885.M1/.M2 and controller modules, adapter boards) of the C-885 PIMotionMaster contain electrostatic-sensitive devices (ESD) and can be damaged if handled improperly.

- Avoid touching assemblies, pins, and PCB traces.
- Discharge yourself before touching the plug-in cards. For example, wear an antistatic wrist strap.
- Only handle and store the plug-in cards in environments that dissipate any static charges to earth in a controlled way and prevent electrostatic charges (ESD workplace or electrostatically protected area, abbreviated to EPA).

Product Description

C-885 PIMotionMaster Components

The C-885 PIMotionMaster is a customizable, modular multi-axis controller with card slots. In order to be functional, the C-885 PIMotionMaster requires a chassis (C-885.Rx) with one digital processor and interface module (C-885.Mx) and at least one controller module. The available components are listed in the following tables.

C-885 chassis
One chassis module (C-885.Rx) required for each PIMotionMaster.

Order number	Description
C-885.R1	9.5" chassis for PIMotionMaster This chassis provides card slots for up to 4 controller modules to be operated with 24 V DC input voltage.
C-885.R2	19" chassis for PIMotionMaster This chassis provides card slots for up to 20 controller modules to be operated with 24 V DC input voltage.
C-885.R3	19" chassis for PIMotionMaster This chassis provides card slots for up to 19 controller modules to be operated with 24 V DC input voltage, with the option of operating controller modules with 24 V DC and 48 V DC.
C-885.R4	9.5" chassis for PIMotionMaster This chassis provides card slots for up to 8 controller modules to be operated with 24 V DC input voltage.

C-885 processor and interface modules
One processor and interface module (C-885.Mx, p. 17) is required per C-885 PIMotionMaster.

The C-885.Mx module controls up to 20 controller modules in conjunction with the largest chassis.

Order number	Description
C-885.M1	C-885.M1 is equipped with Ethernet and USB interfaces for external communication. GCS commands can be used to operate the module.
C-885.M2	C-885.M2 is equipped with Ethernet and USB interfaces for external communication. GCS commands can be used to operate the module.

Controller modules
At least one controller module is required for each PIMotionMaster.

Order number	Item
C-663.12C885	Motion controller module for **stepper motors**, 1 axis, HD D-sub 26, for PIMotionMaster
C-863.20C885	Motion controller module for **DC motors**, 2 axes, for PIMotionMaster
C-867.10C885	Motion controller module for **PILine® piezo motor systems** with D-sub plug connector, 1 axis, for PIMotionMaster
C-891.11C885	**PIMag®** controller module for the C-885 PIMotionMaster
E-861.11C885	Motion controller module for **NEXACT® piezo motor systems**, 1 axis, for PIMotionMaster
E-873.10C885	Motion controller module for **Q-Motion® systems with piezoelectric inertia drive**, 1 axis, for PIMotionMaster

Scope of Delivery

C-885.R1, .R2, .R3, and .R4 chassis for C-885 PIMotionMaster:

Item number	Description
C-885.Rx	Chassis for C-885 PIMotionMaster, according to order
000058055	Adapter for the Optional C-885.PS Power Adapter
C885T0002	User manual for C-885 PIMotionMaster (this document)

C-885.M1 and .M2 processor and interface modules:

Item number	Description
C-885.Mx	Digital processor and interface module for C-885 PIMotionMaster, according to order
C-815.553	Straight-through network cable for connecting to the PC via a TCP/IP network
000036360	USB cable (type A to mini B) for connecting to the PC, 3 m
C-990.CD1	Data storage device with PC software from PI
C885T0002	User manual for C-885 PIMotionMaster (this document)

Refer to the documentation of the respective controller modules for the scope of delivery of the controller modules (p. 5).

Optional Accessories

Item number	Item
C-885.iD	Digital interface module for PIMotionMaster (p. 18)
C-885.AA01	Adapter board from C-891.11C885 to C-885.iD in PIMotionMaster

Item number	Item
C-885.PS	Wide input range power supply for C-885 PIMotionMaster, 24 V DC, 10 A, including power cord
C-885.AP1	Cover plate for C-885 PIMotionMaster, 4HP
C-885.AP2	Cover plate for C-885 PIMotionMaster, 8HP
C-885.AP4	Cover plate for C-885 PIMotionMaster, 16HP
C-885.AP8	Cover plate for C-885 PIMotionMaster, 32HP

Product View

Front Panel

C-885.R1 front panel

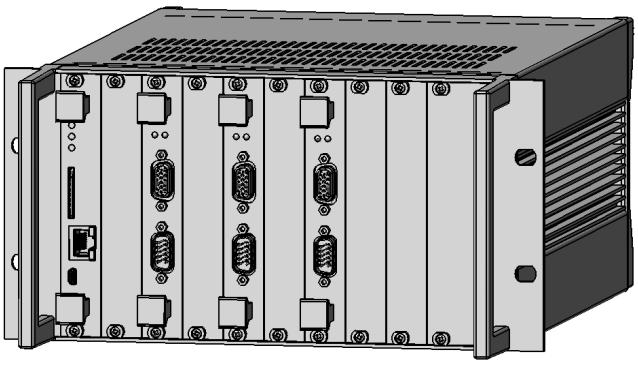


Figure 1: C-885 PIMotionMaster (example view of .R1 9.5" chassis)

C-885.R2 front panel

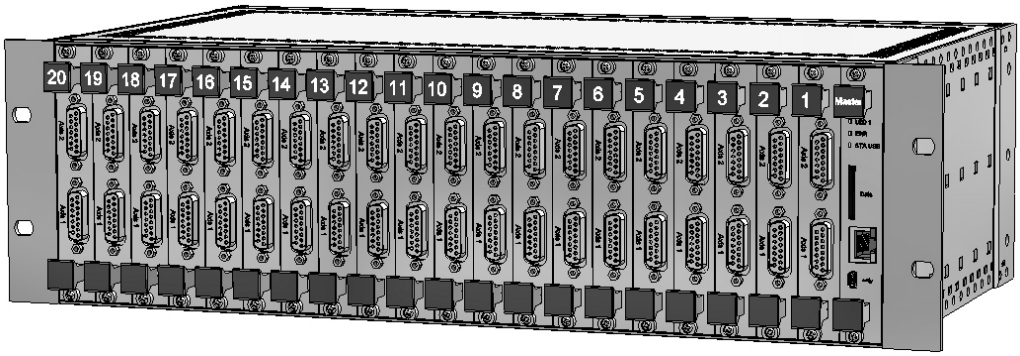


Figure 2: C-885 PIMotionMaster (example view of .R2 19" chassis)

C-885.R3 front panel

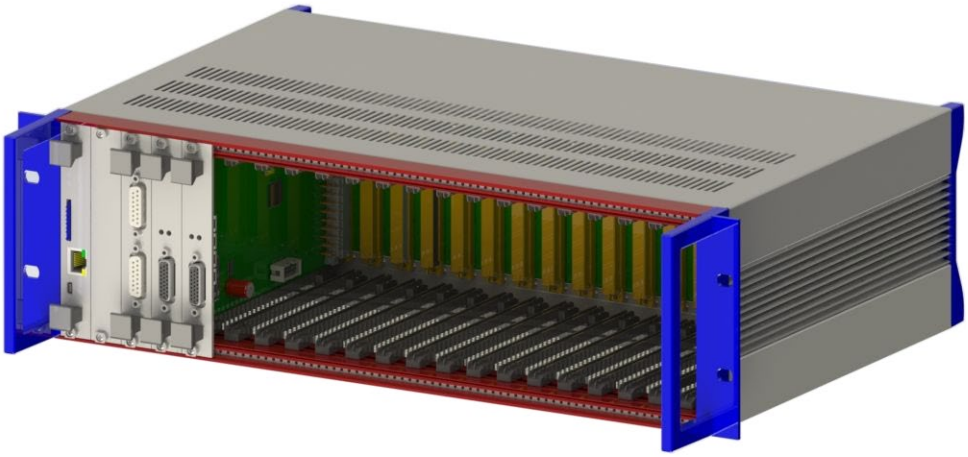


Figure 3: C-885 PIMotionMaster (example view of .R3 19" chassis)

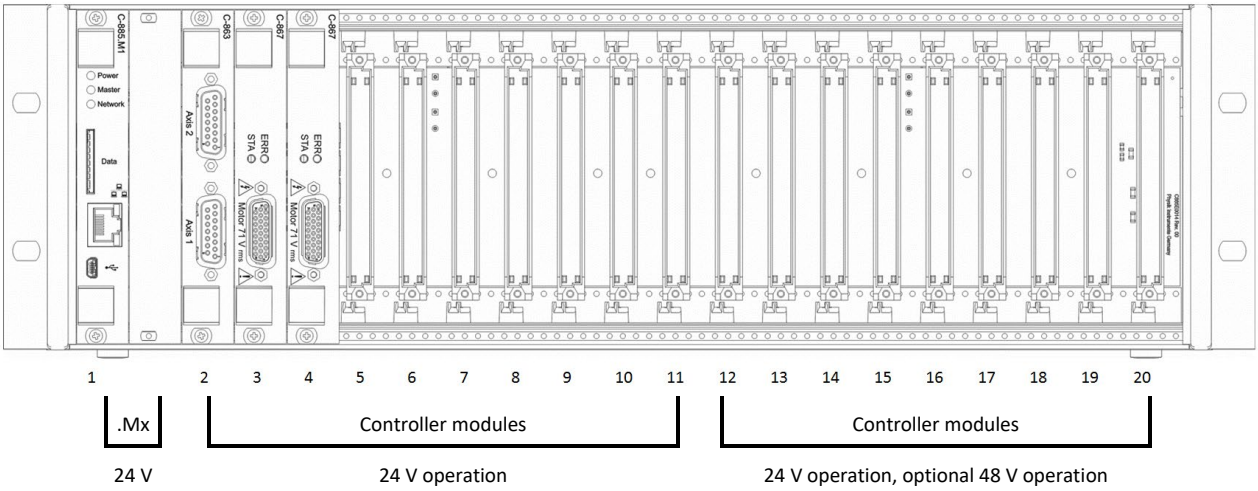


Figure 4: C-885.R3 - power supply at the slots

C-885.R4 front panel

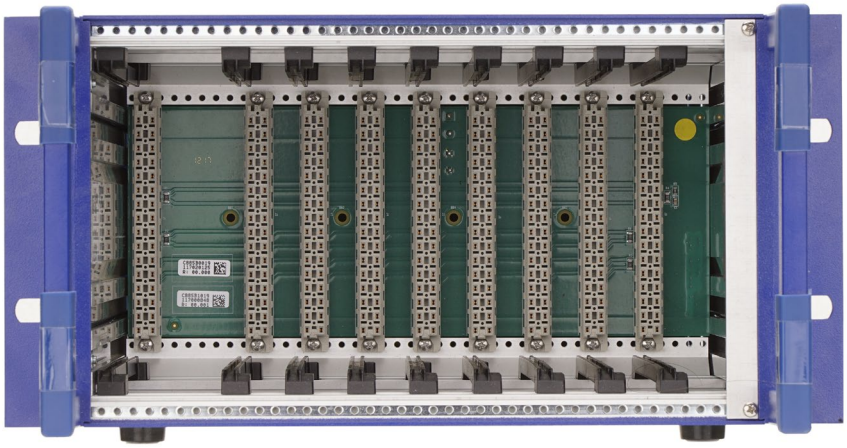


Figure 5: C-885 PIMotionMaster (example view of .R4 9.5" chassis)

Rear Panel

Rear panel of the .R1, .R2, and .R4 chassis

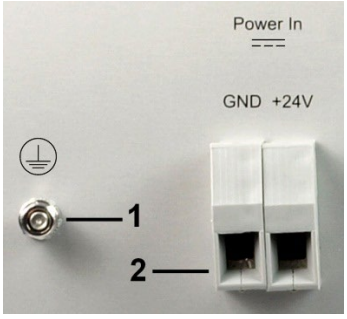


Figure 6: Protective earth connector (1) and power connector (2) of the C-885.R1 and C-885.R2 chassis

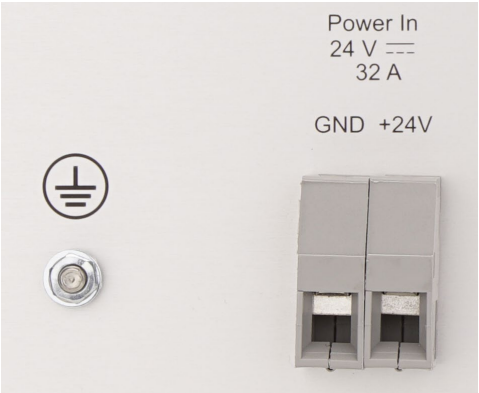


Figure 7: Protective earth connector and power connector of the C-885.R4 chassis

Labeling	Description
⏚	Symbol for the protective earth conductor, indicates the C-885 PIMotionMaster's protective earth connector
GND +24V	Connector for the supply voltage: 24 V DC. Max. input current: 32 A Pin assignment indicated by **GND** and **+24V**

Rear panel of the .R3 chassis

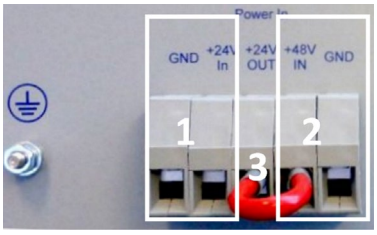


Figure 8: Protective earth connector and power connector of the C-885.R3 chassis on delivery

1 24 V DC supply voltage connector for card slots 1 to 11

2 48 V DC supply voltage connector for card slots 12 to 20

*3 Pin **+24V OUT** connected to Pin **+48V IN**, via a cable bridge for supplying card slots 12 to 20 with 24 V DC (input at **+24V IN**)*

Labeling	Description
⏚	Symbol for the protective earth conductor, indicates the C-885 PIMotionMaster's protective earth connector
GND +24V IN	Connector for 24 V DC supply voltage. Max. input current: 32 A Pin assignment indicated by **GND** and **+24V IN**
+24V OUT	24 V DC output (coupled to **+24V IN** input)
+48V IN GND	Connector for 48 V DC supply voltage. Max. input current: 32 A Pin assignment indicated by **GND** and **+48V IN**

Adapter for the Optional C-885.PS Power Adapter

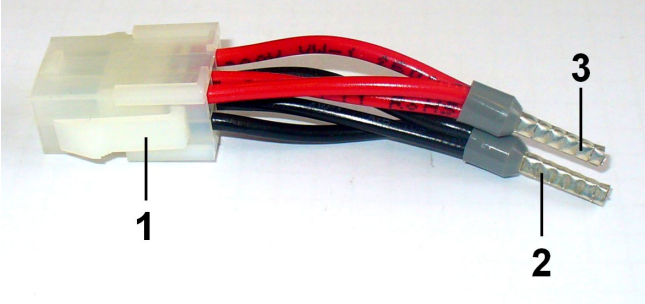
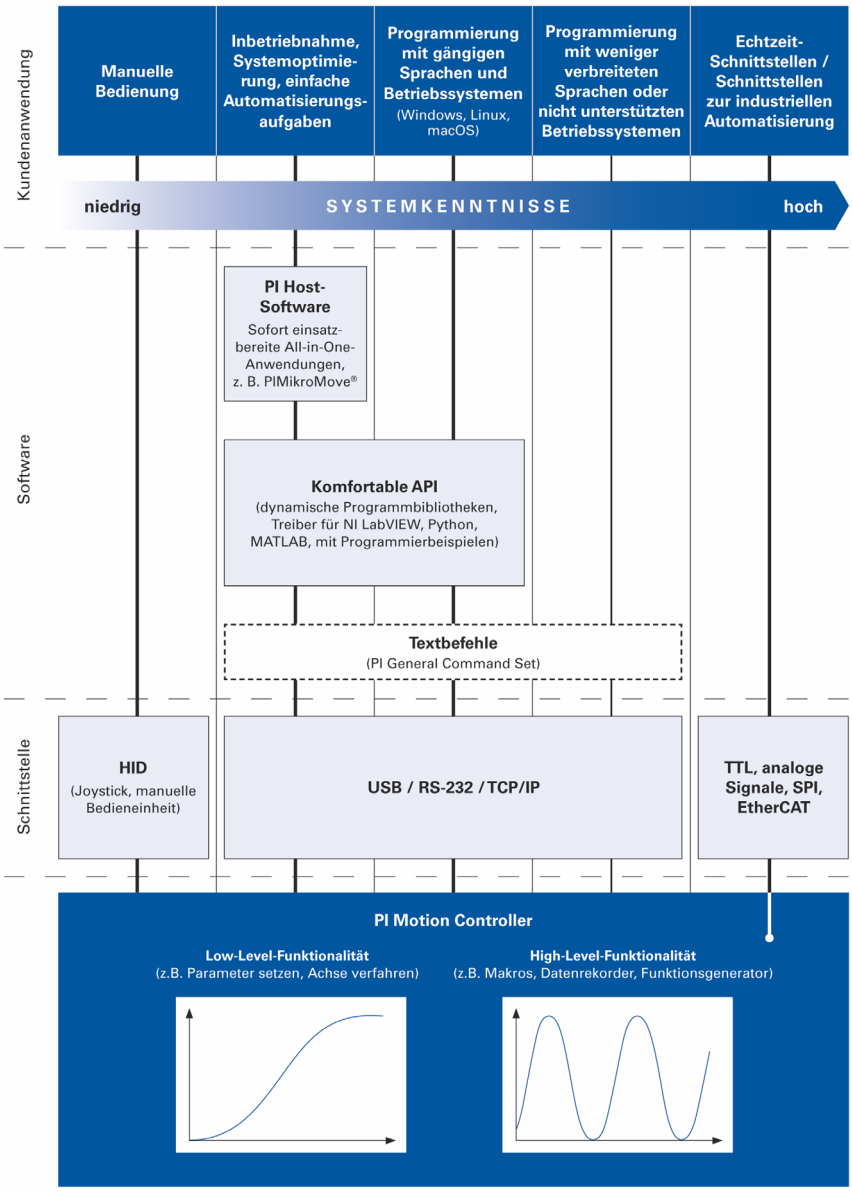


Figure 9: 000058055 adapter for connecting the optional C-885.PS power adapter to pins (screw terminals) on the rear panel of the C-885 PIMotionMaster's chassis

1: Connector for the C-885.PS power adapter
2: GND contact pin at the cable end
3: +24 V contact pin at the cable end

Controlling PI Systems

Basically, PI systems can be controlled as follows:



Operating Concept

The C-885.Mx digital processing and interface module is the central element of the C-885 PIMotionMaster. Every type of communication is done via the C-885.Mx module. As a communication interface, the C-885.Mx ensures both external communication with a PC and internal communication with the controller modules installed.

The C-885 PIMotionMaster provides two types of external communication:

- Communication with the C-885 as a "conventional" multi-axis controller
- Direct communication with the individual controller modules (slave devices)

Different axis identifiers must be used according to the type of communication and it may be necessary to specify module IDs in commands. Refer to "Module Addresses and Axis Identifiers" for details (p. 44).

Communication with the C-885 as a "conventional" multi-axis controller
This is the standard way of communicating when operating the system. The C-885.Mx module controls all available axes with a limited number of GCS commands (p. 45). The user sends commands to the C-885.Mx (e.g., motion commands and status queries) that passes them on to the controller modules automatically. The C-885.Mx communicates with the subordinate controller modules internally. This communication principle allows fast response times as well as synchronous motion.

Direct communication with the controller modules (slave devices)
This type of communication is necessary to configure the controller modules and access their special functions (e.g., parameter settings and module-specific GCS commands). If the user addresses a controller module directly, the C-885.Mx module provides access to the controller module via an internal daisy-chain network.

See their documentation for detailed information on the special functions of the controller modules (p. 5).

C-885.Mx Digital Processor and Interface Module

The C-885.Mx module is the central element of the C-885 PIMotionMaster. It ensures both internal and external communication.

The C-885.M1 and .M2 are capable of external communication via TCP/IP (Ethernet) and USB.

The C-885.Mx can be operated with the help of GCS commands (p. 42).

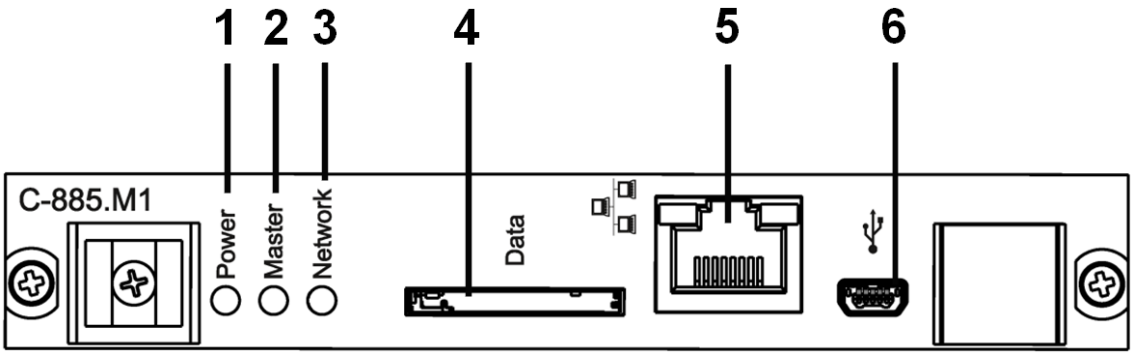


Figure 10: Front view of C-885.Mx processor and interface module (example: C-885.M1)

No.	Element/connector	Description
1	Power LED	Flashes while the C-885.Mx is booting and lights up green after the C-885.Mx has successfully booted.
2	Master LED	Flashes red when there is an error in the C-885.Mx and is switched off after querying with the `ERR?` command.
3	Network LED	Flashes red if there is an error in any of the controller modules (p. 18). If applicable, the ERR LED on the affected controller module lights up red simultaneously to indicate the same error. The LEDs are only switched off when the error is queried by the `ERR?` command.
4	Slot for SD card	The SD card slot is for future use and currently has no function.
5	RJ45 socket	Ethernet interface for communication via TCP/IP
6	USB socket	Universal serial bus for connecting to the PC

Controller Modules

See the documentation of the controller modules for a view of the controller modules (p. 5).

C-885.iD Digital Interface Module

The digital interface module makes a controller module's input and output lines available.

INFORMATION

Commands for using I/O lines are only available on the controller modules, but not with the C-885.Mx. Therefore, using the input and output lines requires direct communication with the controller modules.

- See "Configuring Controller Modules" (p. 30) to establish direct communication with the controller modules in PIMikroMove.
- Refer to "Module Addresses and Axis Identifiers" for general information on direct communication (p. 44).

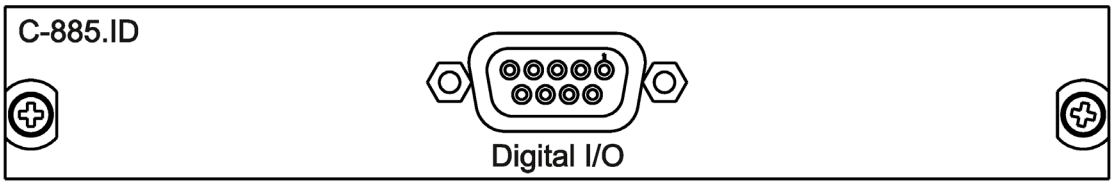


Figure 11: C-885.iD digital interface module (front view)

Chassis	Number of .iD modules	Remarks

Chassis	Number of .iD modules	Remarks
C-885.R1 9.5'' chassis	4 (max.)	All controller modules can be equipped with a digital interface module.
C-885.R2 19" chassis	10 (max.)	Each digital interface module occupies a card slot that is no longer available for controller modules.
C-885.R3 19" chassis	9 (max.)	Each digital interface module occupies a card slot that is no longer available for controller modules.
C-885.R4 9.5'' chassis	8 (max.)	Each digital interface module occupies a card slot that is no longer available for controller modules.

You will find further information on the digital interface module under "Installing the C-885.iD Digital Interface module" (p. 24) and "Pin Assignment" (p. 78).

Installation

Connecting the C-885 PIMotionMaster to the Protective Earth Conductor

INFORMATION

➢ Pay attention to the applicable standards for the protective earth conductor connection.

There is an M4 threaded bolt on the rear panel (p. 13) of the C-885 PIMotionMaster's chassis for attaching the protective earth conductor. This M4 threaded bolt is indicated by the protective earth conductor symbol⏚.

Requirements

✓ You have read and understood the safety precautions (p. 8).

✓ The chassis of the C-885 PIMotionMaster is not connected to the power supply.

Tools and accessories

- Suitable protective earth conductor:
  - Cable cross section ≥ 0.75 mm2
  - Contact resistance <0.1 Ω at 25 A at all points relevant for attaching the protective earth conductor
- Mounting hardware for the protective earth conductor, preassembled on the protective earth connector (threaded bolt) in the following order on delivery of the C-885 PIMotionMaster, starting from the chassis:
  - Lock washer
  - Nut
  - Flat washer
  - Toothed washer
  - Nut
- Suitable wrench

Connecting the C-885 to the protective earth conductor

1. If necessary, attach a suitable cable lug to the protective earth conductor.
2. Remove the outer nut from the protective earth connector (p. 13) on the rear panel of the C-885 PIMotionMaster.
3. Connect the protective earth conductor:
   a) Push the cable lug of the protective earth conductor onto the threaded bolt.
   b) Screw the nut onto the threaded bolt. In this way, the cable lug attached to the protective earth conductor is wedged between the toothed washer and the nut.
   c) Tighten the nut with at least three turns and a torque of 1.2 Nm to 1.5 Nm.

Installing the Modules

The modules can be plugged into the chassis of the C-885 PIMotionMaster. The mounting direction of the modules depends on the type of chassis. Note that the position of the C-885.Mx digital processor and interface module must be either far left or far right, depending on the chassis.

Requirements

- ✓ You have read and understood the safety precautions (p. 8).
- ✓ The chassis of the C-885 PIMotionMaster is not connected to the power supply.

Tools and accessories

- Suitable chassis from PI (p. 9)
- C-885.M1/C-885.M2 digital processor and interface module (p. 10)
- Controller modules (p. 10)
- Suitable cover plates for all slots that will not be occupied by controller modules (p. 10)
- Optional: C-885.iD digital interface modules (p. 18)
- Suitable screwdriver

Installing the modules into the C-885.R1 / C-885.R4 chassis (9.5'')

1. Plug the C-885.M1/C-885.M2 into the first card slot (slot 1) on the left-hand side of the chassis.
2. Plug the controller modules into the vacant card slots on the chassis. The recommended mounting direction is from left to right.
3. If additional C-885.iD digital interface modules are to be installed: Follow the instructions in "Installing the C-885.iD Digital Interface Module" (p. 24).
4. Fix the modules to the chassis using the two captive screws on the front of each module.

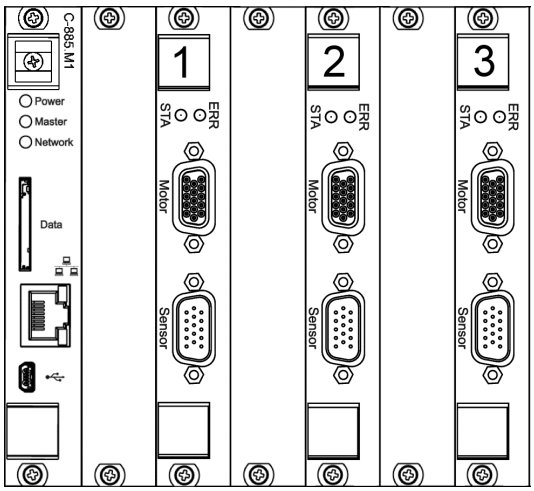


Figure 12: .R1 chassis (front view): Mounting from left to right

Installing the modules into the C-885.R2 chassis (19'')

1. Plug the C-885.M1/C-885.M2 into the first card slot (slot 1) on the right-hand side of the chassis.
2. Plug the controller modules into the vacant card slots on the chassis. The recommended mounting direction is from right to left.
3. If additional C-885.iD digital interface modules are to be installed: Follow the instructions in "Installing the C-885.iD Digital Interface Module" (p. 24).
4. Fix the modules to the chassis using the two captive screws on the front of each module.

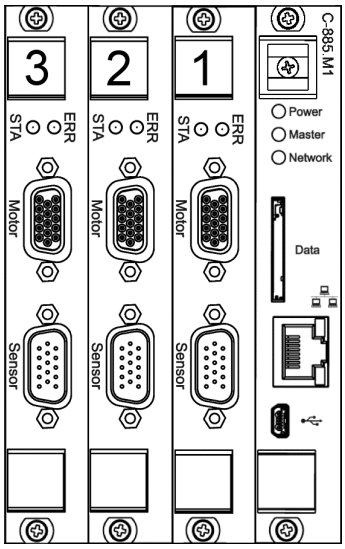


Figure 13: .R2 chassis (front view): Mounting from right to left

Installing the modules into the C-885.R3 chassis (19'')

NOTICE

Damage to the controller module as a result of excessive operating voltage!

As an option, slots 12 to 20 can be operated at 48 V DC.

If you want to operate slots 12 to 20 at 48 V DC (refer to "Connecting the C-885 PIMotionMaster to the Power Adapter" for details p. 25):

➢ Make sure that all controller modules in slots 12 to 20 are suitable for operating at 48 V DC.

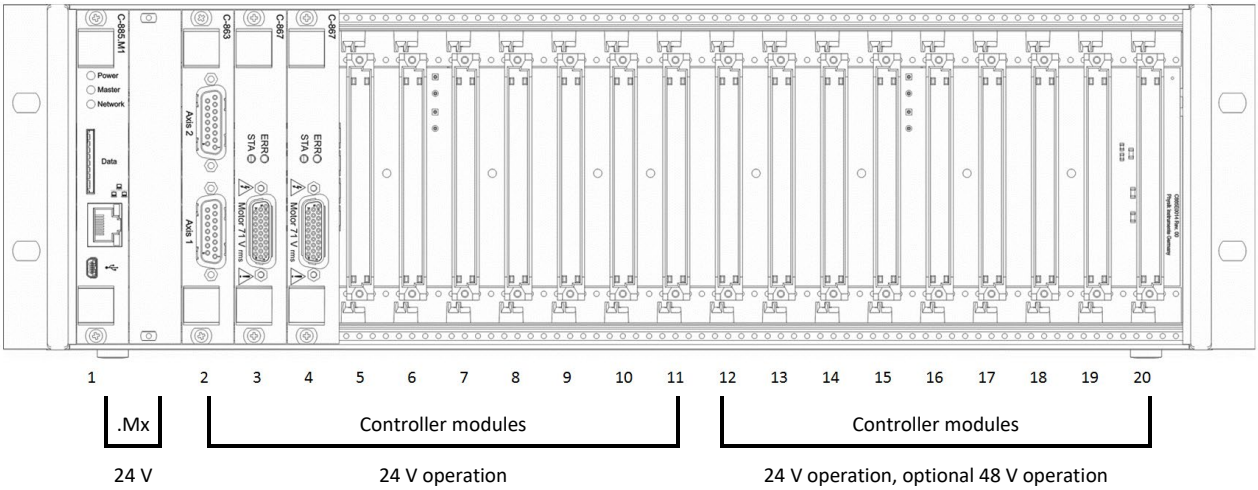


Figure 14: .R3 chassis (front view): Voltage supply to the slots

1. Plug the C-885.M1/C-885.M2 into the first card slot (slot 1) on the left-hand side of the chassis.
2. Plug the controller modules into the vacant card slots on the chassis. The recommended mounting direction is from left to right.
   - If you want to operate slots 12 to 20 at 48 V DC (refer to "Connecting the C-885 PIMotionMaster to the Power Adapter" for details p. 25), do **not** install controller modules into those slots that are only designed for an operating voltage of 24 V DC.
3. If additional C-885.iD digital interface modules are to be installed: Follow the instructions in "Installing the C-885.iD Digital Interface Module" (p. 24).
4. Fix the modules to the chassis using the two captive screws on the front of each module.

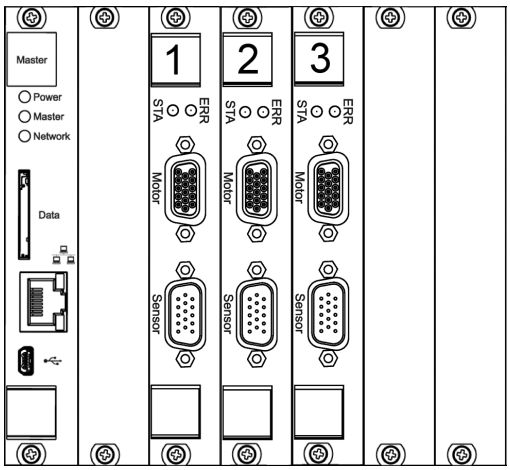


Figure 15: .R3 chassis (front view): Mounting from left to right

Installing the C-885.iD Digital Interface Module

The digital interface module (p. 18) must be installed to the **right** of the controller module that it is connected to (front view).

Requirements

- ✓ You have read and understood the safety precautions (p. 8).
- ✓ The chassis of the C-885 PIMotionMaster is not connected to the power supply.
- ✓ If the digital interface module is used with a C-891.11C885 controller module: You have installed a C-885.AA01 adapter board onto the controller module. You will find the installation instructions in the controller module's user manual (C891T0005).

Tools and accessories

- C-885.iD digital interface module (p. 18)
- Suitable screwdriver

Installing the C-885.iD digital interface module

1. Make sure that the space in the chassis on the right of the controller module to be connected to the digital interface module is empty.
   - If necessary, remove the cover plate or controller module that covers the space.
2. If the controller module to be connected to the digital interface module is installed in the chassis, remove it from the chassis.
3. Connect the connector of the ribbon cable of the digital interface module to the corresponding 10-pin socket of the controller module or the adapter board.
4. Plug in the controller module that the digital interface module is connected to.
5. Install the digital interface module to the right of the controller module that it is connected to.
6. Fix the modules to the chassis using the two captive screws on the front of each module.

Connecting the C-885.Mx to the PC

Connecting the C-885.Mx via the TCP/IP Interface

Requirements

- ✓ If the C-885.Mx is to be connected directly to the PC:
  The PC has a vacant RJ45 Ethernet connection socket.
- ✓ If the C-885.Mx and a PC are to be operated together in a network:
  A free access point to the network is available for the C-885.Mx; a suitable hub or switch is connected to the network for this purpose if necessary.

Tools and accessories

- If the C-885.Mx is to be connected directly to the PC: Crossover network cable (not included in the scope of delivery)
- If the C-885.Mx is to be connected to a network access point: Straight-through network cable (p. 10)

Connecting the C-885.Mx directly to the PC

➢ Connect the RJ45 socket on the front panel of the C-885.Mx to the RJ45 Ethernet connection socket of the PC using a suitable crossover network cable.

Connecting the C-885.Mx to the network where the PC also is

➢ Connect the RJ45 socket on the front panel of the C-885.Mx to the network access point using the straight-through network cable.

Connecting the C-885.Mx to the PC via the USB Interface

Requirements

✓ The PC has a vacant USB socket.

Tools and accessories

- USB cable, type A to mini B (p. 10)

Connecting the C-885.Mx to the PC via the USB interface

➢ Connect the mini USB socket (type B) of the C-885.Mx to the USB socket of the PC using the USB cable.

Connecting the C-885 PIMotionMaster to the Power Adapter

Requirements

✓ The C-885 PIMotionMaster is installed near to the power supply so that the power plug can be quickly and easily disconnected from the mains.

✓ If your power adapter has an on/off switch: The power adapter is **switched off**.

✓ The power cord is **not** connected to the power socket.

Tools and accessories

- Sufficiently rated 24 V power adapter with stranded wires:
  - The output current to be delivered by the power adapter depends on the configuration of the C-885 PIMotionMaster, refer to "C-885 PIMotionMaster Maximum Ratings" for details (p. 72).

- If suitable for your configuration, you can order a 24 V DC wide input range power supply with 10 A output current as optional accessory (p. 10).

- Only if you are using the C-885.PS wide input range power supply from PI: 000058055 Adapter for the C-885.PS power adapter (included in the scope of delivery of the chassis (p. 10))
- Only if you are operating the modules in slots 12 to 20 in the C-885.R3 with 48 V: Sufficiently sized 48 V power adapter with stranded wires.
- Slot screwdriver

Connecting the C-885 PIMotionMaster to the power supply

For C-885.R1, C-885.R2, and C-885.R4 chassis:

1. Only if you are using the C-885.PS power adapter from PI:
   Connect the 000058055 adapter (p. 15) to the C-885.PS power adapter.
2. Connect the power adapter to the power connector (screw terminals) on the rear panel of the C-885 PIMotionMaster's chassis (see figure):

   a) Connect the end of the power adapter's ground cable (-) to the **GND** socket.
   b) Connect the end of the power adapter's power cable (+) to the **+24V** socket.
   c) Use the integrated screws to secure the connections against accidental disconnection.
3. Connect the power cord to the power adapter.

For the C-885.R3 chassis:

NOTICE

Excessively high operating voltage for slots 12 to 20!
On delivery of the C-885.R3 chassis, pins **+24V OUT** and **+48V IN** on the power connector are connected to each other via a cable bridge so that **all** card slots are operated at 24 V DC.

If you want to operate slots 12 to 20 at 48 V DC:

➢ Make sure that all controller modules in slots 12 to 20 are suitable for operating at 48 V DC.

1. Only if you are using the C-885.PS power adapter from PI:
   Connect the 000058055 adapter (p. 15) to the C-885.PS power adapter.
2. Connect the 24 V power adapter to the power connector (screw terminals) on the rear

panel of the C-885 PIMotionMaster's chassis (see figure):

a) Connect the end of the 24 V power adapter's ground cable (-) to the **GND** socket on the **left-hand** side.

b) Connect the end of the 24 V power adapter's power cable (+) to the **+24V IN** socket.

c) Use the integrated screws to secure the connections against accidental disconnection.

3. Only if you want to operate slots 12 to 20 at 48 V DC:

   a) Remove the cable bridge that connects pin **+24V OUT** to pin **+48V IN**.

   b) Connect the end of the 48 V power adapter's ground cable (-) to the **GND** socket on the **right-hand** side.

   c) Connect the end of the 48 V power adapter's power cable (+) to the **+48V IN** socket.

   d) Use the integrated screws to secure the connections against accidental disconnection.

4. Connect the power cord(s) to the power adapter(s).

Installing the PC Software

Accessories

- Software from PI: On the storage device supplied or available for download from our website www.pi.ws.

Installing the PC Software

1. Insert the data storage device into the PC or go to the directory where you saved the downloaded software to.
2. Start the install wizard by calling **PISoftwareSuite.exe**.

   The ***InstallShield Wizard*** window opens for installing the PC software from PI.

3. Follow the instructions on the screen.

Updating the PC Software

Use the PIUpdateFinder to search for software updates.

For detailed information, see the PIUpdateFinder's user manual A000T0028 (p. 5).

Starting and Operating

General Notes on Starting and Operating

➢ Before you start and operate the C-885 PIMotionMaster, carefully read and pay attention to the safety precautions for all components of your PIMotionMaster system. See p. 8 and the "Safety" chapter in the documentation for all controller modules (p. 5) that can be integrated into your PIMotionMaster system.

Starting and operating the C-885 PIMotionMaster for the first time involves the following steps:

1. Establishing communication between the C-885 PIMotionMaster and the PC (p. 28)
2. Configuring the controller modules for the connected positioners (p. 30)

The C-885 PIMotionMaster is normally operated as follows:

1. Establishing communication between the C-885 PIMotionMaster and the PC (p. 28)
2. Starting positioner motion (p. 35)

The instructions in this chapter explain the use of the PIMikroMove PC software for starting and operating the C-885 PIMotionMaster.

INFORMATION

The controller modules may be referred to as "slave devices" in the PC software.

Establishing Communication

Requirements

✓ The C-885 PIMotionMaster is installed properly (p. 20).
✓ PIMikroMove is correctly installed on your PC (p. 27).
✓ Any mechanics are properly connected to the relevant controller modules.

If a TCP/IP connection is used:

✓ The C-885.Mx is connected to the network or directly to the PC (p. 24) via the RJ45 Ethernet socket.
✓ If the C-885.Mx is connected to a network: The PC to be used for communicating with the C-885.Mx is appropriately connected to the same network as the C-885.Mx.
✓ If the network does **not** have a DHCP server or if the C-885.Mx is **directly** connected to the PC's Ethernet socket: By adapting the interface parameters, you have set the correct startup behavior for configuring the IP address of the C-885.Mx and adapted the IP addresses and subnet masks of the C-885.Mx and PC to each other. See "Preparing the C-885.Mx when a DHCP Server is not Available" (p. 63).

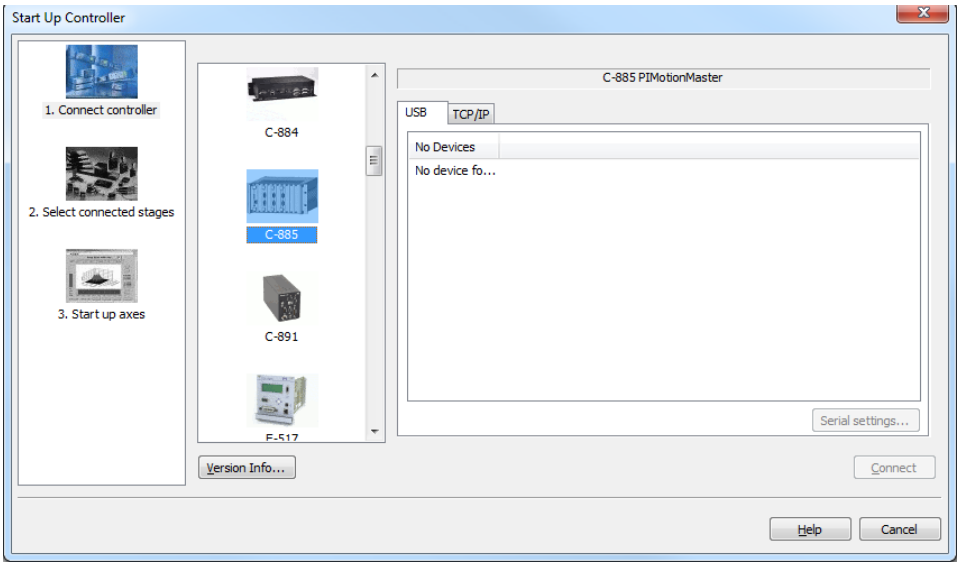
If a USB connection is used:

✓ The C-885.Mx is connected to the PC via the USB cable (p. 10).

Establishing communication with the C-885 PIMotionMaster

1. Switch the C-885 PIMotionMaster on:
   - Connect the power adapter to the power socket with the power cord.
   - If your power adapter has an ON/OFF switch: Switch the power on.
2. Start PIMikroMove. The **Start Up *Controller*** window opens.

   If the ***Start Up Controller*** window does not open automatically, select ***Connections > New…*** from the main menu.
3. Select ***C-885*** from the list of controllers.



4. Establish connection to the C-885.Mx via USB **or** TCP/IP:

   To establish a USB connection, proceed as follows:

   a) Activate the ***USB*** tab. If several devices were found, select the ***C-885.XX*** to be connected from the list.

   b) Select ***Connect***.
   The ***Start Up Controller*** window changes to the ***Start up axes*** step.

   To establish a TCP/IP connection, proceed as follows:

   a) Activate the ***TCP/IP*** tab.

   b) Select the **Search for controllers** button.

   The C-885.XX (e.g., *PI C-885.XX SN 0*) is displayed in a list.

   c) Select the C-885.XX that is to be connected to.

   d) Select ***Connect***.
   The ***Start Up Controller*** window changes to the ***Start up axes*** step.

5. Depending on the configuration state of the C-885 PIMotionMaster, proceed as follows:
   - If the controller modules of the C-885 PIMotionMaster are not configured for the positioners yet: Configure the controller modules for the connected positioners, see (p. 30).
   - If the C-885 PIMotionMaster is already configured for the connected positioners: Start normal operation of the positioners (p. 35).

Configuring the Controller Modules

When starting and operating the C-885 PIMotionMaster for the first time, its controller modules must be configured for the connected positioners. This section describes the following configuration steps:

- Loading the parameters for the positioner from the positioner database
- Testing the function of the positioner with the loaded parameters
- Saving the parameter values to the nonvolatile memory of the controller module

You will find further information on adjusting parameters in the documentation for the controller modules, for example, tuning the servo control parameters.

Once all controller modules present in a C-885 PIMotionMaster have been configured, further configuration is necessary only in the following cases:

- The positioners have been replaced.
- Additional controller modules have been added to the C-885 PIMotionMaster.
- Some parameter values need to be adjusted (example: Changes to load make tuning the servo control parameters necessary).

Configuring the controller modules requires direct communication with the controller modules.

INFORMATION

Several parallel direct connections to the controller modules of the C-885 PIMotionMaster are possible but could increase the response time of the C-885 PIMotionMaster.

➢ Configure the controller modules of the C-885 PIMotionMaster successively, whereby there is only one direct connection to a controller module at any one time.

Requirements

✓ You have read and understood the general notes on starting and operating (p. 28).

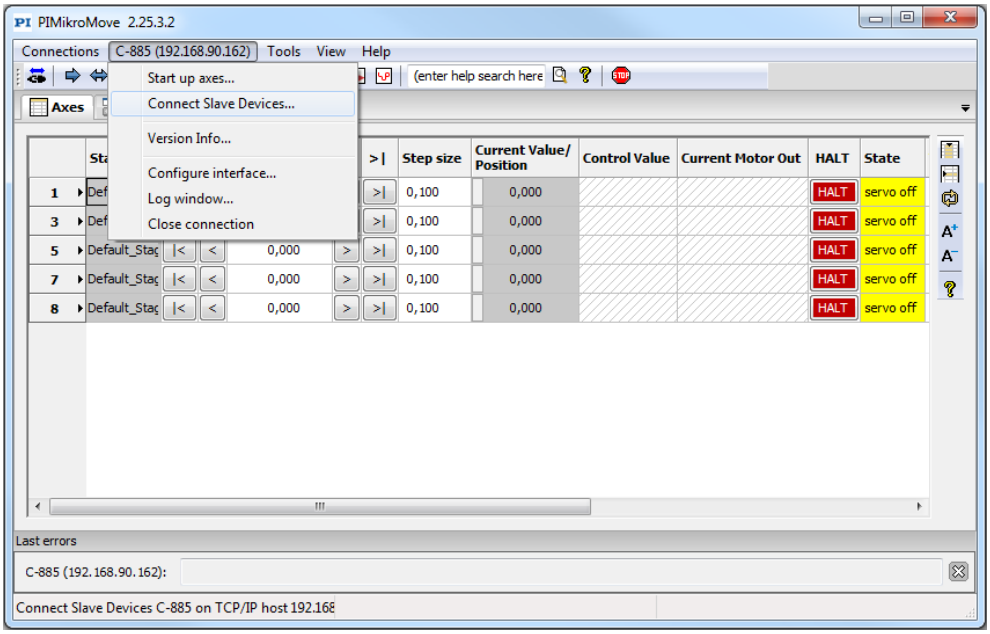
✓ You have established communication between the C-885 PIMotionMaster and the PC with PIMikroMove via TCP/IP or USB (p. 28).

Configuring the controller modules for the connected positioners

In the example instruction below, configuration is described for the C-863.20C885 controller module installed in card slot 2.

1. After you have established communication between PC and C-885 PIMotionMaster (see p. 29), close the ***Start Up Controller*** window with ***Close***.
2. Establish direct connection to the controller modules to be configured:
   a) Open the C-885 menu and select ***Connect Slave Devices....***in the main window of

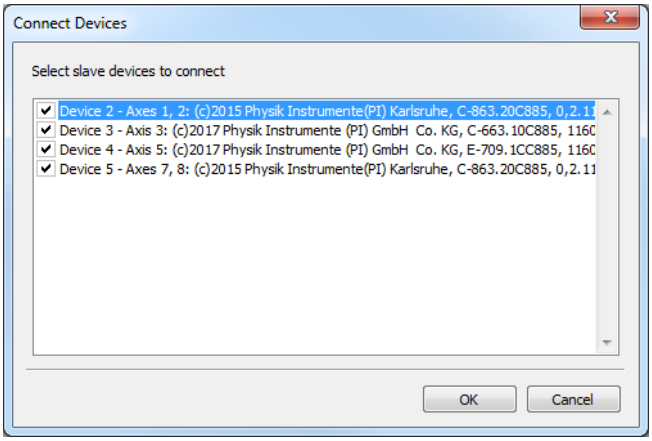
PIMikroMove.



The ***Connect Devices*** window opens.

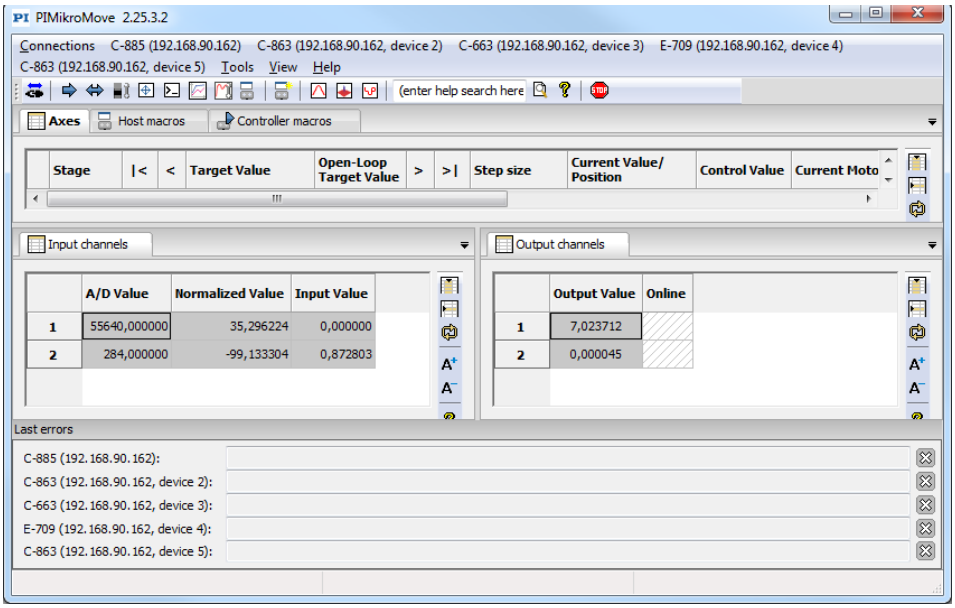
b) Activate the checkboxes for the controller modules (slave devices) to be connected in the ***Connect Devices*** window.

The device number corresponds to the card slot where the controller module is installed.



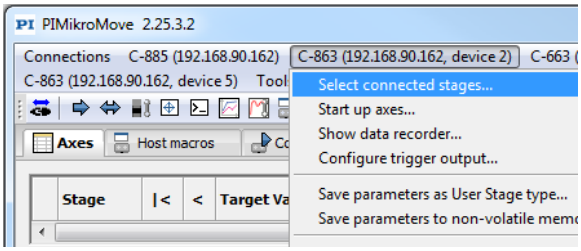
c) Confirm your selection with ***OK***.

The ***Connect Devices*** window is closed and you are back in the main window of PIMikroMove. The menu bar now contains a separate menu for each connected controller module that gives access to the module configuration.



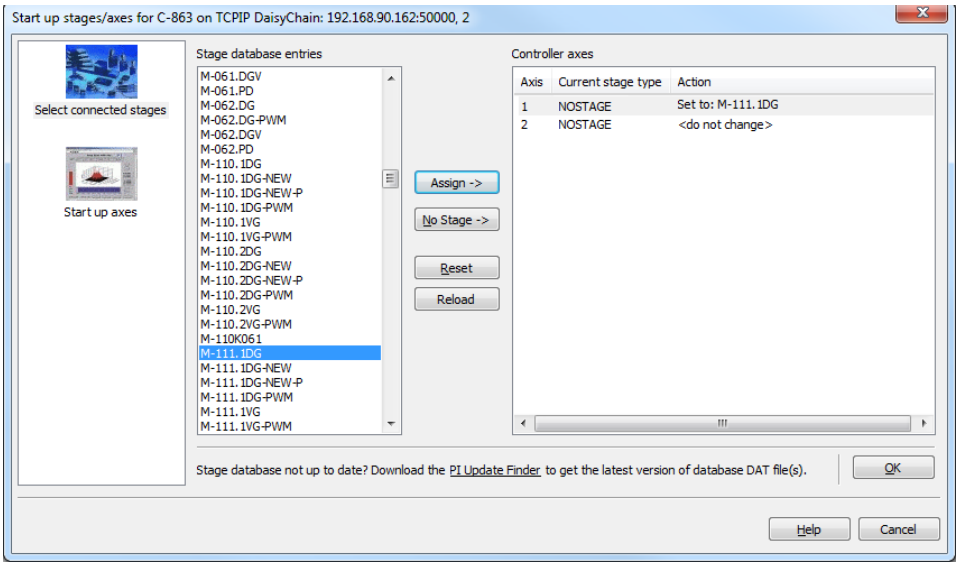
3. Load the positioner parameters of the connected positioner(s) for the controller module to be configured. Proceed as follows:

   a) Open the ***Start up stages/axes*** window for the controller module via the ***Select connected stages...***. item in the controller module's menu, e.g., ***C-863 (<IP address>, device 2) > Select connected stages ...***



   b) In the ***Start up stages/axes*** window for the controller module, select the positioner type in the ***Stage database entries*** list, select the axis in the ***Controller axes*** list, and select ***Assign ->***.

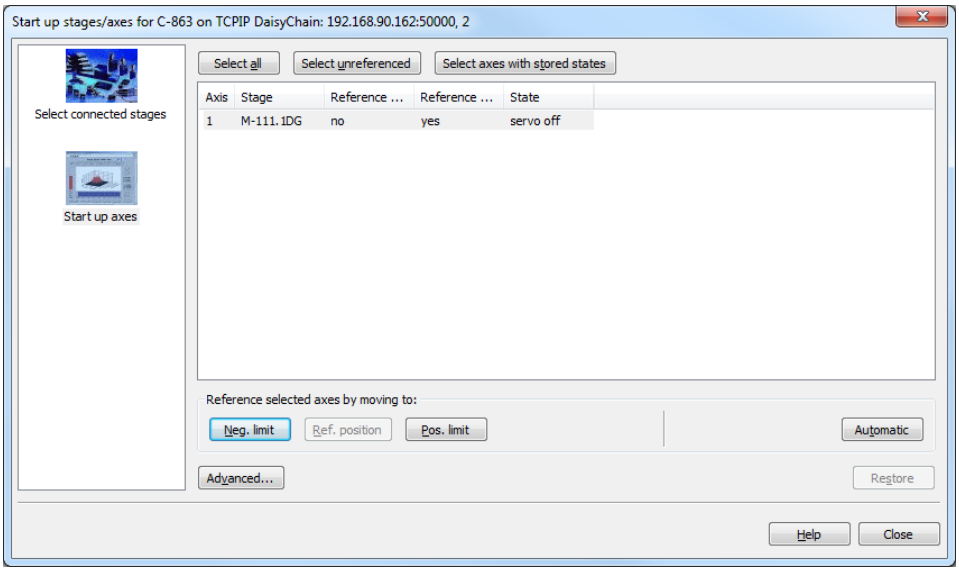
      The positioner assignment is displayed in the ***Action*** column of the ***Controller axes*** list.



Repeat this step if there is more than one axis to be assigned.

c) Confirm selection with ***OK*** to load the parameter settings for the selected positioner type from the positioner database. The ***Save all changes permanently?*** dialog opens.

In the ***Save all changes permanently?*** dialog select the option ***Keep the changes temporarily*** to load the parameter settings into the volatile memory of the controller module. The dialog closes and the ***Start up stages/axes window*** of the controller module changes to the ***Start up axes*** step.



4. Test the function of the positioner(s) with the loaded parameter settings:

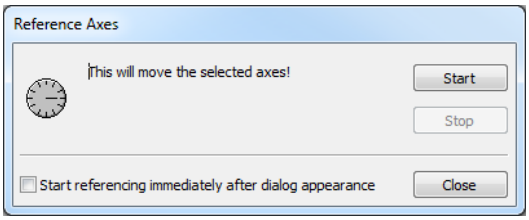
a) Do the reference move for the axis/axes in the ***Start up stages/axes window***.

The reference move moves the axis to a defined point, e.g., to the reference switch or to a limit switch.

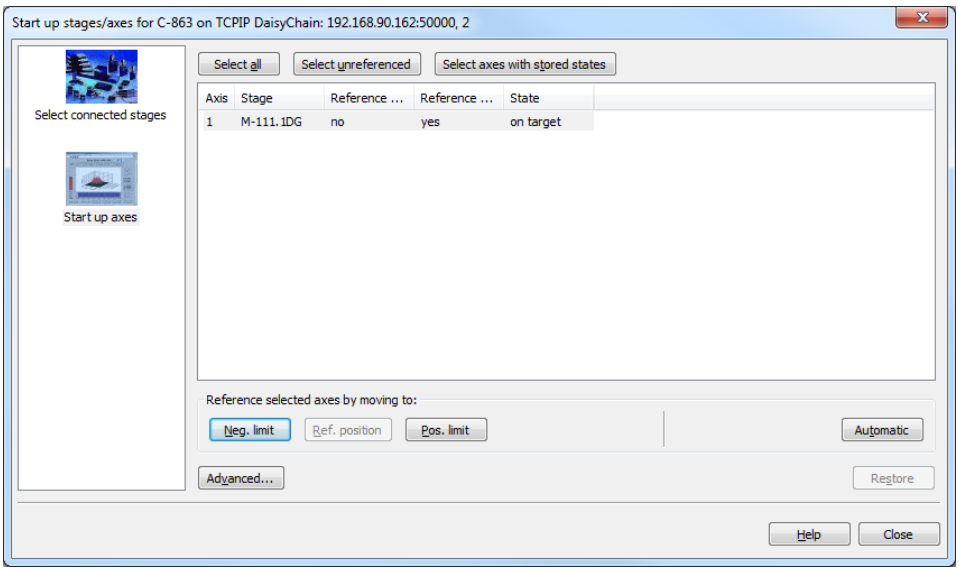
Proceed as follows to do the reference move:

- Select ***Ref. position*** for a reference move to the reference switch.
- Select ***Neg. limit*** for a reference move to the negative limit switch.
- Select ***Pos. limit*** for a reference move to the positive limit switch.

b) Select the ***Ref. switch*** or ***Automatic*** button. If necessary, confirm that servo mode is switched on. The ***Reference Axes*** dialog opens.

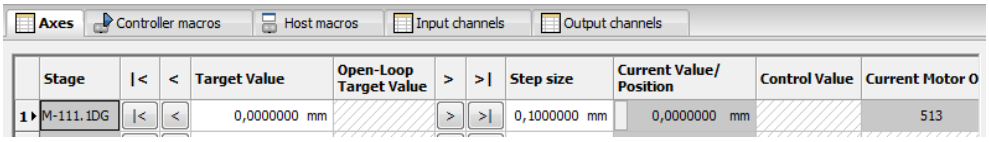


c) Select ***Start*** in the ***Reference Axes*** dialog.
The axis/axes do the reference move and the result is shown in the ***Start up stages/axes*** window.



d) Select ***Close*** after a successful reference move.
The ***Start up stages/axes*** is closed and you are back in the main window of PIMikroMove.

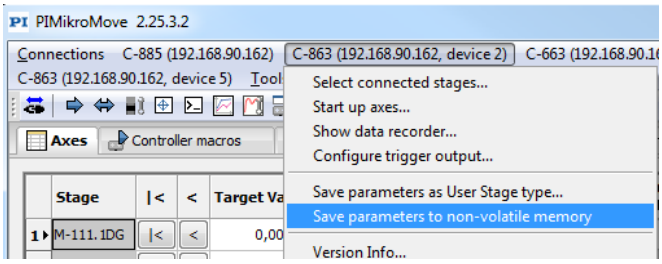
Run a few motion tests for the axis/axes by selecting the corresponding arrow buttons (|<, <, >, >|) in the main window of PIMikroMove.



5. Save the current values of the parameter settings to the nonvolatile memory of the controller module:

   a) Open the ***Save Parameters to Non-Volatile Memory*** dialog for the controller

module in the main window of PIMikroMove via the ***Save parameters to non-volatile memory*** entry in the controller module's menu, e.g., ***C-863 (<IP address, device 2) > Save parameters to non-volatile memory***.



The ***Save Parameters to Non-Volatile Memory*** dialog opens.

b) Enter 100 into the selection box of the ***Save Parameters to Non-Volatile Memory*** or select the *all parameters, settings of HDT, HIA, HIT (100)* entry.

c) Select ***OK*** to save and to close the dialog.

6. Repeat steps 3 to 5 for every controller module to be configured.
7. Terminate the direct connection to the controller modules:
   - Open the ***Connect Devices*** window via the ***C-885*** menu (e.g., ***C-885 (<IP address) > Connect Slave Devices...***. Uncheck the boxes for the controller modules in the ***Connect Devices*** window and confirm with ***OK.***

   You can also proceed as follows:
   - Terminate the connection via the ***Close connection*** entry in the menus of the individual controller modules, e.g., ***C-863 (<IP address, device 2) > Close connection***.
     or
   - Use the corresponding entry for each controller module in the ***Connections*** menu, e.g., select ***Connections > Close > C-863 (<IP address, device 2)***.

Starting Motion For Normal Operation

The C-885 PIMotionMaster behaves like a "conventional" multi-axis controller during normal operation.

The parameter settings for the axes cannot be changed during normal operation. If parameter settings have to be adapted, refer to "Configuring the Controller Modules" (p. 30).

Requirements

✓ You have read and understood the general notes on starting and operating (p. 28).

✓ You have established communication between the C-885 PIMotionMaster and the PC with PIMikroMove via TCP/IP or USB (p. 28).

✓ You have configured the controller modules for the connected positioners (p. 30).

Starting motion for normal operation of the C-885 PIMotionMaster

In the following instructions, it is assumed that the reference move can be done for all axes in one concurrent step. If the reference move for your system configuration is not possible in one concurrent step, additional steps will be necessary . Follow the instructions in "Example: Start motion with separate reference move" (p. 36).

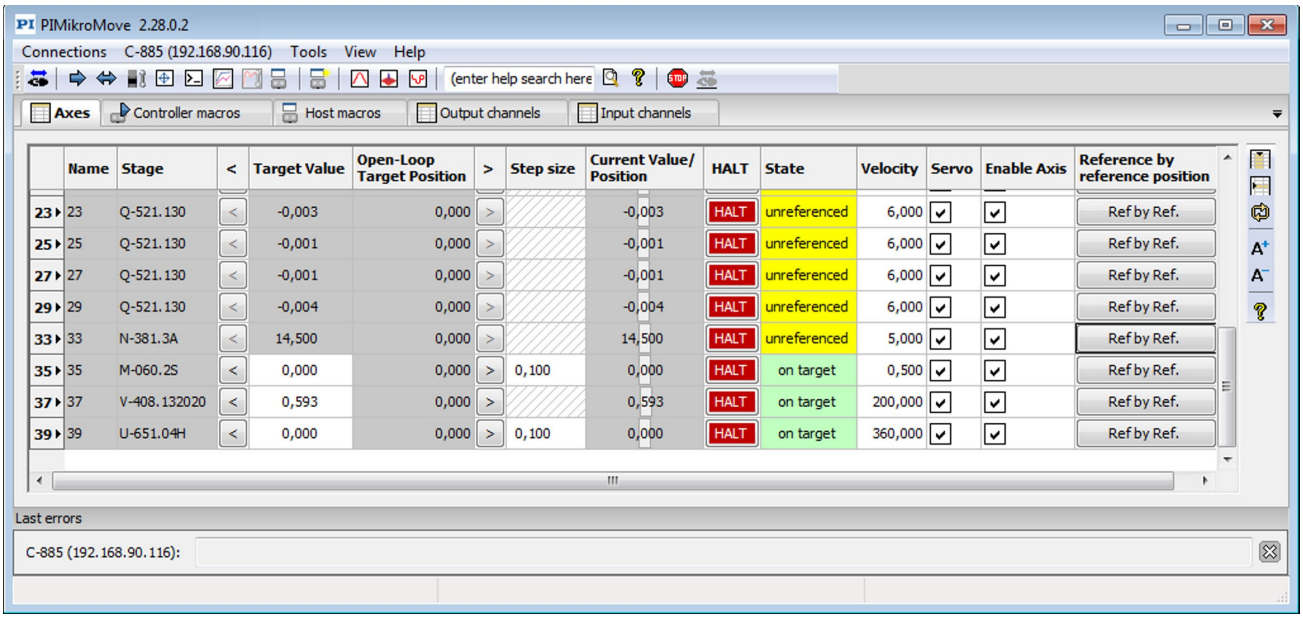
1. Do the reference move for the connected axes in the ***Start Up Controller*** window so that the C-885 PIMotionMaster knows the absolute axis positions.

   If the **Start Up Controller** window does not open automatically, select the **C-885 > Start up axes** menu item in the main window.

   Proceed as follows to do the reference move:

   - Select ***Ref. position*** for a reference move to the reference switch.
   - Select ***Neg. limit*** for a reference move to the negative limit switch.
   - Select ***Pos. limit*** for a reference move to the positive limit switch.

   If necessary, confirm that servo mode is switched on. In the ***Reference Axes*** dialog select ***Start***.
2. Select ***OK > Close*** after a successful reference move. The main window of PIMikroMove opens.
3. Test the motion of the axes several times. For example, you can select the corresponding arrow buttons in the main window of PIMikroMove (***|<***, ***>|***) to start motion to the travel range limits. You can also enter new target values in the ***Target Value*** fields for the axes.



Example: Start motion with separate reference move

The following system configuration is used in the example:

Controller module	Axis identifiers in the C-885 PIMotionMaster	Connected positioner
C-863.20C885	1	M-122.2DD1

	(nothing is connected to axis 2 of the module)	
C-867.10C885	3	U-651.03
C-891.11C885	5	V-408.232020
C-891.11C885	7	V-408.232020

The controller modules behave differently with respect to the reference move that is necessary for axes with incremental sensors:

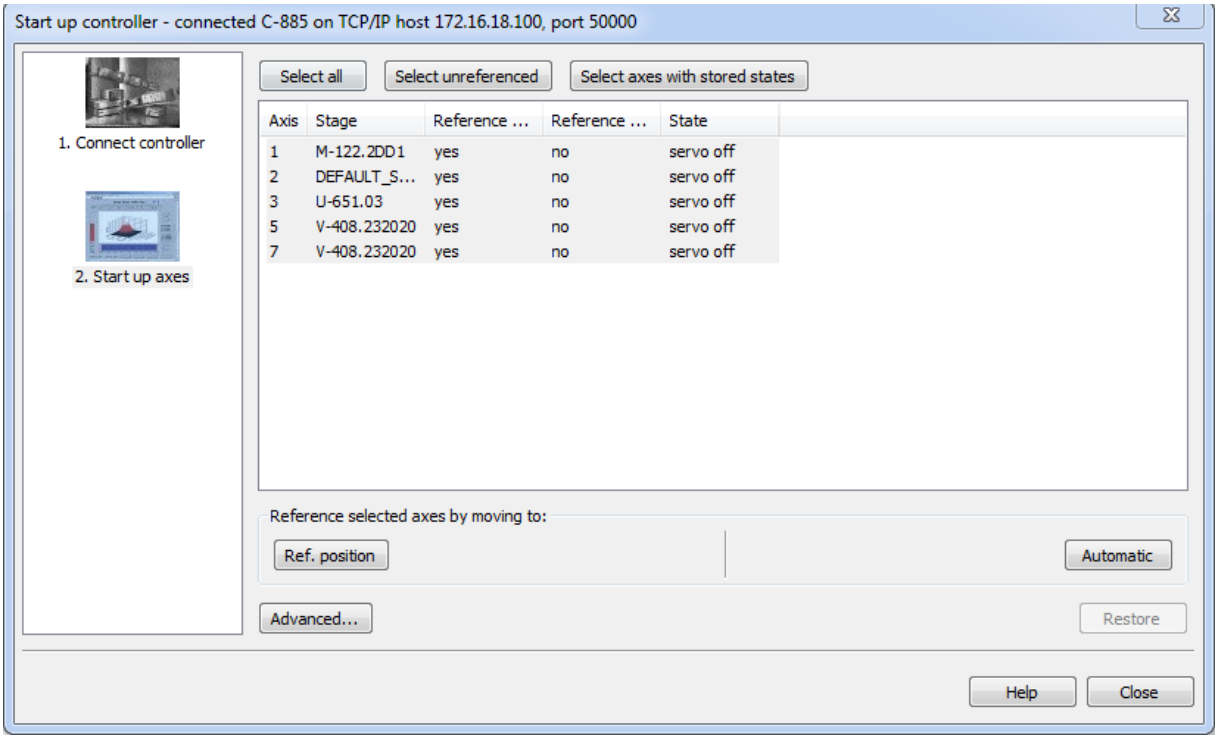
- C-863.20C885, C-867.10C885: Servo mode must be switched on **before** the reference move.
- C-891.11C885: Servo mode may only be switched on **after** the reference move.

The reference move for the specified system configuration can therefore **not** be done in a concurrent step in the ***Start up controller*** window but must be started in the main window of PIMikroMove®.

Proceed as follows:

1. Establish connection to the C-885 PIMotionMaster in PIMikroMove, refer to "Establishing Communication" (p. 28).

   The ***Start up controller*** window changes to the ***Start up axes*** step.

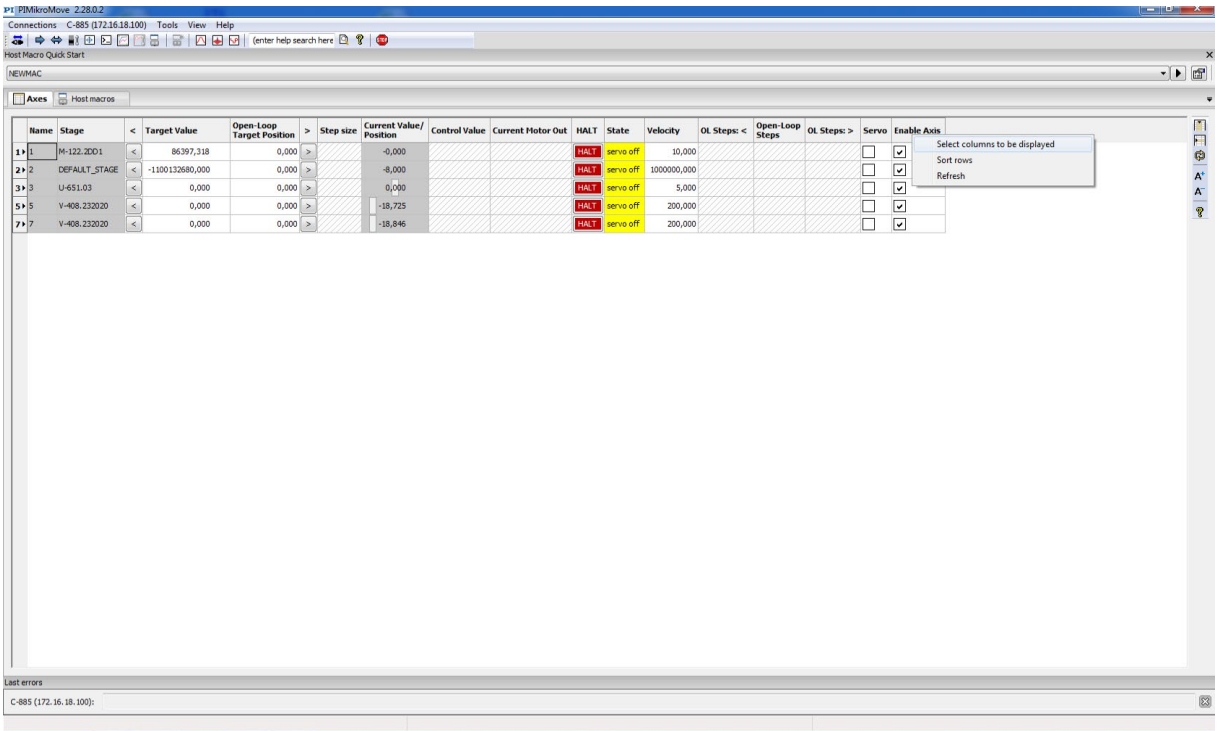


2. Close the ***Start up controller*** window with ***Close***.

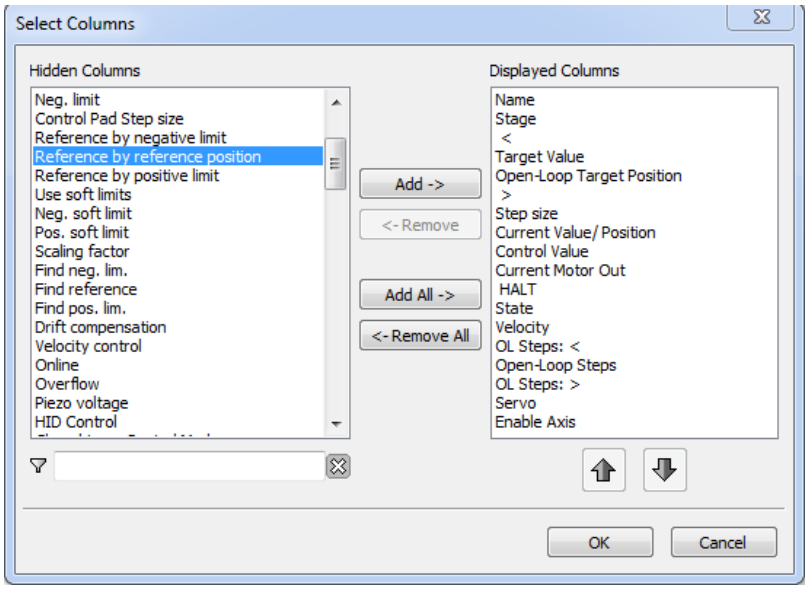
   The main window of PIMikroMove opens.

3. Show the following additional columns in the main window:
   - ***Enable Axis***
   - ***Reference by reference position***

For this purpose, open the separate ***Select Columns*** window via the context menu for the axis table.

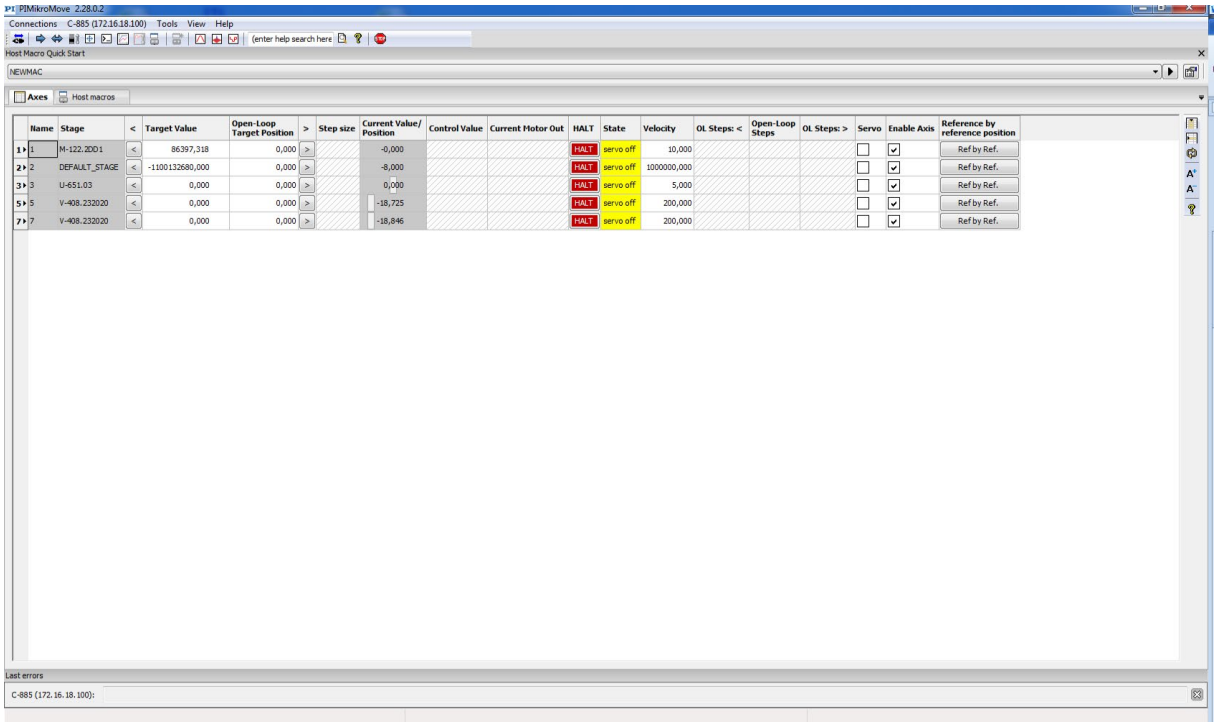


Select the desired entry from the ***Hidden Columns*** list the ***Select Columns*** window and confirm with ***Add ->***

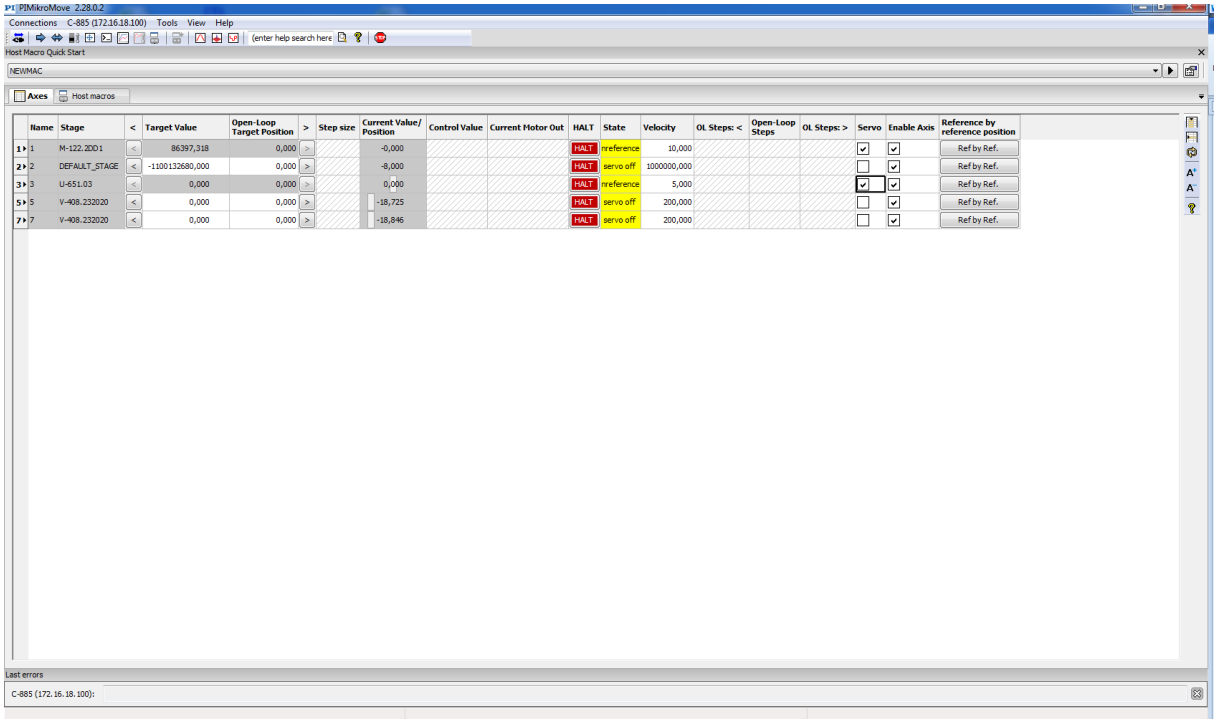


Close the ***Select Columns*** window with ***OK***.

The selected columns are shown in the main window.

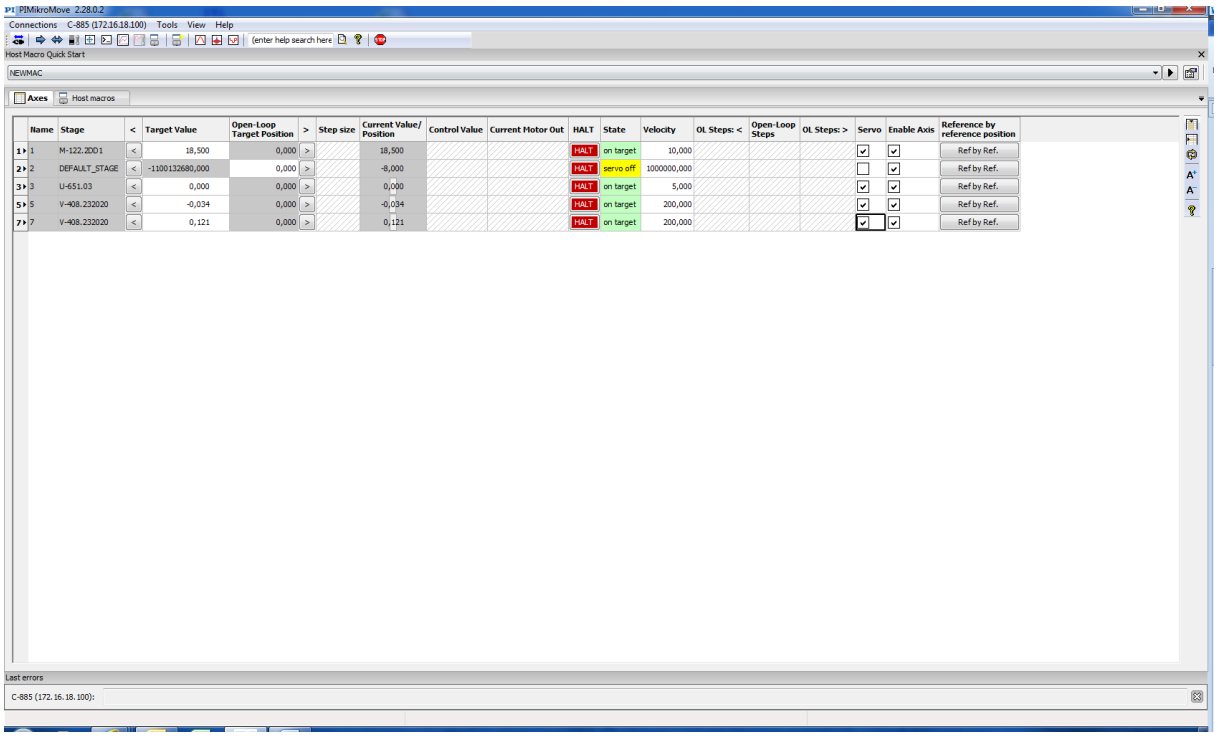


4. Switch servo mode on for axes 1 and 3 by activating in the corresponding checkboxes in the Servo column.



5. Start the reference move for axes 1, 3, 5, and 7 by selecting the corresponding buttons in the ***Reference by reference position*** column.

6. Switch servo mode on for axes 5 and 7 by activating the corresponding checkboxes in the ***Servo*** column.



You can test the motion of the axes for example, by selecting the arrow buttons for the individual axes or entering a new target position into the ***Target Value*** fields.

Protective Functions of the C-885 PIMotionMaster

Motion Errors

Motion errors can be caused for example, by malfunctions of the drive or the position sensor of the positioner.

A motion error occurs, when the position error (i.e., the absolute value of the difference between the current position and the commanded position) exceeds the maximum specified value in closed-loop operation. The maximum value for the deviation is specified by the parameter ***Maximum Position Error (Phys. Unit)*** (0x8) on the controller modules.

If motion error occurs, the controller modules of the C-885 PIMotionMaster react as follows to protect the system from damage:

- The servo mode is switched off for the axis in question.
- If applicable, the brake is activated for the axis in question.
- All motion is stopped.
- Error code -1024 is set on the controller module in question.

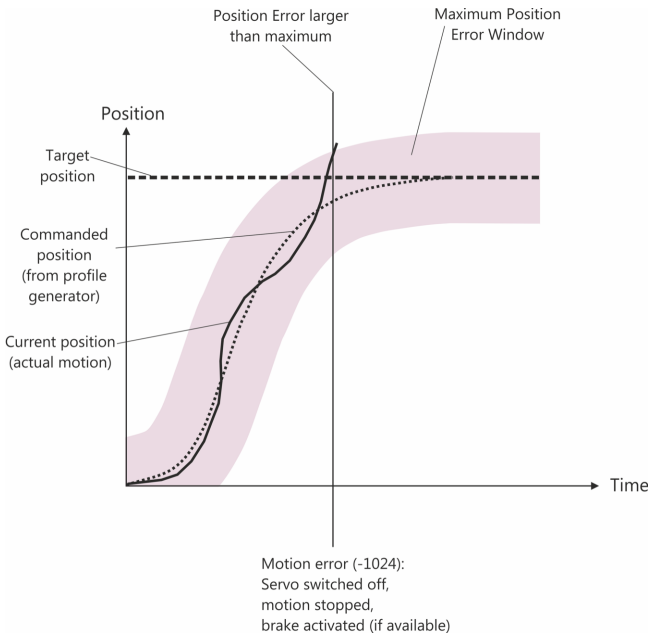


Figure 16: Behavior in case of motion errors

Re-Establishing Operational Readiness

1. Send the `ERR?` command to read out the error code.
2. If a motion error occurred, error code -1024 is output. `ERR?` resets the error code to zero during the query.
3. Check your system and make sure that all axes can be moved safely.
4. Switch servo mode on for the axis in question with the SVO command (p. 60).

   When servo mode is switched on, the target position is set to the current axis position and the brake is deactivated if applicable. Now the axis can move again and you can command a new target position.

GCS Commands

INFORMATION

Available GCS commands

This section describes the GCS commands that are available on the C-885.M1 and C-885.M2 for communicating as a "conventional" multi-axis controller. Additional GCS commands are available on the controller modules. Read the user manual specified in the documentation of the respective controller module (p. 5).

Notation

The following notation is used to define the GCS syntax and to describe the commands:

<...>	Angle brackets indicate an argument of a command, can be an element identifier or a command-specific parameter.
[...]	Square brackets indicate an optional entry
{...}	Curly brackets indicate a repetition of entries, i.e., it is possible to access more than one item (e.g., several axes) in one command line.
LF	LineFeed (ASCII char #10), is the default termination character (character at the end of a command line)
SP	Space (ASCII char #32) indicates a space.
"..."	Quotation marks indicate that the characters enclosed are returned or to be entered.

GCS Syntax for Syntax Version 2.0

A GCS command consists of 3 characters, e.g. CMD. The corresponding query command has a question mark added to the end, e.g. CMD?.

Command mnemonic:

CMD ::= character1 character2 character3 [?]

Exceptions:

- Single-character commands, e.g., fast query commands, consist only of one ASCII character. The ASCII character is written as a combination of # and the character code in decimal format, e.g., as #24.
- *IDN? (for GPIB compatibility)

The command mnemonic is not case sensitive. The command mnemonic and all arguments (e.g., axis identifiers, channel identifiers, parameters, etc.) must be separated from each other by a space (SP). The command line ends with the termination character (LF).

CMD[{{SP}<Argument>}]LF

CMD?[{{SP}<Argument>}]LF

Exception:

- Single-character commands are not followed by a termination character. However, the response to a single-character command is followed by a termination character.

The argument <AxisID> is used for the logical axes of the controller. Depending on the controller, an axis identifier can consist up to 16 characters. All alphanumeric characters and the underscore are allowed.

Example 1:

Axis 5 is to be moved to position 10.0. The unit depends on the controller (e.g., µm or mm).

Send: `MOV`SP`5`SP`10.0`LF

More than one command mnemonic per line is not permitted. Several groups of arguments following a command mnemonic are allowed.

Example 2:

Axis 1 and axis 3 are to be moved:

Send: `MOV`SP`1`SP`17.3`SP`3`SP`2.05`LF

When a part of a command line cannot be executed, the line is not executed at all.

When all arguments are optional and not specified, the command is executed for all possible argument values.

Example 3:

The position of all axes is to be queried.

Send: `POS?`LF

The response syntax is as follows:

[<Argument>[{SP<Argument>}]"="]<Value>LF

The space preceding the termination character is left out in the last line of multiline responses:

{[<Argument>[{SP<Argument>}]"="]<Value>SP LF}

[<Argument>[{SP<Argument>}]"="]<Value>LF for the last line!

The arguments are listed in the response in the same order as in the query command.

Query command:

CMD?SP<Arg3>SP<Arg1>SP<Arg2>LF

Response to this command:

<Arg3>"="<Val3>SP LF

<Arg1>"="<Val1>SP LF

<Arg2>"="<Val2>LF

Module Addresses and Axis Identifiers

INFORMATION

If you are using the PIMikroMove PC software: PIMikroMove handles module addressing. Therefore, all module addresses must be left out of the ***Command entry*** window.

The axis identifiers and module addresses to be used depend on the following factors:

- Counting the modules and axes in the chassis
- Type of communication

Counting the modules and axes in the chassis

In order to facilitate the operation of a system with a flexible number of controller modules, the C-885.Mx module assigns fixed module addresses and axis identifiers to the card slots of the chassis. Therefore, modules and axes are always counted in a row even if the corresponding card slot is empty, and the addresses and identifiers will remain unchanged when a controller module is removed.

Note that two axes are counted for each card slot to allow for flexibility in the use of single-axis and two-axis controller modules.

Counting the card slots begins with the slot for the C-885.Mx digital processing and interface module. The position of the C-885.Mx and the direction of counting depend on the chassis, refer to p. 21 for details.

Type of communication

The C-885 PIMotionMaster provides two types of external communication:

- Communication with the C-885 as a "conventional" multi-axis controller
- Direct communication with the individual controller modules (slave devices)

Different axis identifiers must be used according to the type of communication and module addresses can be left out of commands:

Card slot where the controller module is*	**Communication with the C-885 as a "conventional" multi-axis controller:** Consecutive axis identifier to be used**	**Direct communication with controller modules:**	
		Module addresses to be used***	Module-specific axis identifier to be used
2	1, 2	2	1, 2
3	3, 4	3	1, 2
4	5, 6	4	1, 2
[...]	[...]	[...]	[...]

*Card slot 1 is always used by the C-885.Mx digital processor and interface module.

**Module addresses not required. The axis identifiers are assigned consecutively in the same way as a "conventional" multi-axis controller. The consecutive axis identifiers must be used with the commands described in this chapter (referred to as "C-885 PIMotionMaster axis“).

***Commands without module address or with module address 1 are sent to the C-885.Mx digital processor and interface module.

Example

The MOV command has to be sent from a terminal program that does not execute module addressing (e.g., PITerminal) as shown in the list below:

Comparable Commands		Description
Communication with the C-885 as a "conventional" multi-axis controller:	**Direct communication with controller modules:**	
`MOV 5 7`	`4 MOV 1 7`	Both commands will move axis 5 (= axis 1 of the controller module installed in card slot 4) to position 7.
`MOV 8 9`	`5 MOV 2 9`	Both commands will move axis 8 (= axis 2 of the controller module installed in card slot 5) to position 9.

INFORMATION

Refer to "Target and Sender Address" in the user manual belonging to the documentation of the appropriate controller module for further information.

Command Overview

The following table lists the commands made available by the C-885.M1 and C-885.M2 for communicating as a "conventional" multi-axis controller. You will find an exact description of the commands under "Command Descriptions" (p. 47).

Command	Format	Description	See page
#4	#4	Request Status Register	47
#5	#5	Request Motion Status	47
#7	#7	Request Controller Ready Status	48
#24	#24	Stop All Axes	48
*IDN?	*IDN?	Get Device Identification	49
CST?	CST? [{<AxisID>}]	Get Assignment Of Stages To Axes	49
CSV?	CSV?	Get Current Syntax Version	49
EAX	EAX {<AxisID> <MotorEnableState>}	Set Motor Enable State	49
EAX?	EAX? [{<AxisID>}]	Get Motor Enable State	50
ERR?	ERR?	Get Error Number	50
FRF	FRF [{<AxisID>}]	Fast Reference Move To Reference Switch	51
FRF?	FRF? [{<AxisID>}]	Get Referencing Result	51

Command	Format	Description	See page
HLP?	HLP?	Get List Of Available Commands	52
HLT	HLT [{<AxisID>}]	Halt Motion Smoothly	52
IFC	IFC {<InterfacePam> <PamValue>}	Set Interface Parameters Temporarily	52
IFC?	IFC? [{<InterfacePam>}]	Get Current Interface Parameters	53
IFS	IFS <Pswd> {<InterfacePam> <PamValue>}	Set Interface Parameters As Default Values	53
IFS?	IFS? [{<InterfacePam>}]	Get Interface Parameters As Default Values	54
INI	INI	Initialize axes	54
MAN?	MAN? <CMD>	Get Help String For Command	54
MOV	MOV {<AxisID> <Position>}	Set Target Position (start absolute motion)	54
MOV?	MOV? [{<AxisID>}]	Get Target Position	55
OMA	OMA {<AxisID> <Position>}	Absolute Open-Loop Motion	56
OMA?	OMA? [{<AxisID>}]	Get Open-Loop Target Position	57
ONT?	ONT? [{<AxisID>}]	Get On-Target State	56
POS	POS {<AxisID> <Position>}	Set Real Position (does not cause motion)	57
POS?	POS? [{<AxisID>}]	Get Real Position	58
RBT	RBT	Reboot System	58
RON	RON {<AxisID> <ReferenceOn>}	Set Reference Mode	58
RON?	RON? [{<AxisID>}]	Get Reference Mode	59
SAI?	SAI? [ALL]	Get List Of Current Axis Identifiers	59
SRG?	SRG? {<AxisID> <RegisterID>}	Query Status Register Value	59
STP	STP	Stop All Axes	60
SVO	SVO {<AxisID> <ServoState>}	Set Servo Mode	60
SVO?	SVO? [{<AxisID>}]	Get Servo Mode	61
TMN?	TMN? [{<AxisID>}]	Get Minimum Commandable Position	61
TMX?	TMX? [{<AxisID>}]	Get Maximum Commandable Position	61
VEL	VEL {<AxisID> <Velocity>}	Set Closed-Loop Velocity	62
VEL?	VEL? [{<AxisID>}]	Get Closed-Loop Velocity	62
VER?	VER?	Get Versions Of Firmware And Drivers	62

Command Descriptions

#4 (Request Status Register)

Description: Queries system status information.

Format: #4

Arguments: None

Response: The response is bit-mapped. See below for the individual codes.

Notes: This command is identical in function to SRG? except that only one character is sent via the interface.

The response is the sum of the following codes, in hexadecimal format:

Bit	15	14	13	12	11	10	9	8
Descript-ion	On-target Status	Is referencing	In motion	Servo mode on	-	-	-	Error flag
Bit	7	6	5	4	3	2	1	0
Descript-ion	Digital input line 4	Digital input line 3	Digital input line 2	Digital input line 1	Axis is referenced	Positive limit switch	Reference switch	Negative limit switch

Example: Send: #4

Receive: `0x900A`

Note: The response is in hexadecimal format. It means that the axis is on target (on-target state =true), servo mode is on, there is no error, the states of the digital input lines 1 to 4 are low, the axis has been referenced and the positioner is on the positive side of the reference switch (limit switches are not active).

If there are several axes, the responses are listed one after the other.

Example: If there are four axes, the response may look like this: 0x900E9008900A900A

#5 (Request Motion Status)

Description: Queries motion status of the axes.

Format: #5

Arguments: None

Response: The response <uint> is bit-mapped and returned as the hexadecimal sum of the following codes:

1=First axis is moving

2=Second axis is moving

4=Third axis is moving

...

Examples: 0 indicates motion of all axes complete.

3 indicates that the first and the second axis are moving.

#7 (Request Controller Ready Status)

Description: Queries the controller for ready state (tests if controller is ready to do a new command).

Note: Use #5 instead of #7 to verify if motion has finished.

Format: #7

Arguments: None

Response: B1h (ASCII character 177 = "±" in Windows) if controller is ready

B0h (ASCII character 176 = "°" in Windows) if controller is not ready

(e.g., doing a reference move)

Troubleshooting: The response characters may be displayed differently in non-Western character sets or other operating systems.

#24 (Stop All Axes)

Description: Stops all axes abruptly. Refer to the following the notes for details.

Sets error code to 10.

This function of this command is identical to STP except only one character is sent via the interface.

Format: #24

Arguments: None

Response: none

Notes: #24 stops all motion triggered by motion commands (e.g., MOV) as well as commands for referencing (e.g., FRF).

After the axes are stopped, their target positions are set to their current positions.

HLT in contrast to #24 stops motion with given deceleration with regard to system inertia.

***IDN? (Get Device Identification)**

Description: Queries the device identification string.

Format: *IDN?

Arguments: None

Response: Single-line text terminated with a termination character (line feed) with controller name, serial number, and firmware version

Notes: In the case of the C-885.M1, the *IDN? query responds something like this:

```
©2015 Physik Instrumente(PI) Karlsruhe, C-885.M1 TCP-IP Master,115027410,0.0.3.5
```

CST? (Get Assignment Of Stages To Axes)

Description: Queries the name of the positioner type connected to the specified axis.

Format: CST? [{<AxisID>}]

Arguments: <AxisID> is a C-885 PIMotionMaster axis.

Response: {<AxisID>"="<string> LF}

where

<string> is the name of the positioner type assigned to the axis.

Note: The name of the positioner is read out of the *Stage Name* parameter (0x3C) of the controller module when the C-885.Mx is switched on or rebooted (see RBT command, p. 58). Reading out can be repeated with the INI command (p. 54).

CSV? (Get Current Syntax Version)

Description: Queries the GCS syntax version used in the firmware.

Format: CSV?

Arguments: None

Response: The current GCS syntax version (e.g., "2.0" for GCS 2.0).

EAX (Set Motor Enable State)

Description: Sets the motor enable state the of the given axis (motor on/off switch).

Format: EAX {<AxisID> <MotorEnableState>}

Arguments: <AxisID> is a C-885 PIMotionMaster axis.

<MotorEnableState> can have the following values:

0 = motor off (axis motion disabled)

1 = motor on (axis motion enabled)

Response: None

Troubleshooting: Illegal axis identifier

Notes: Switching off the motor also switches off the servo mode and – if present – activates the brake.

EAX? (Get Motor Enable State)

Description: Gets the motor enable state (motor on/off state) for the axis specified.

If all arguments are omitted, gets the state of all axes.

Format: EAX? [{<AxisID>}]

Arguments: <AxisID> is a C-885 PIMotionMaster axis.

Response: {<AxisID>"="<MotorEnableState> LF}

where

<MotorEnableState> is the current motor enable state for the axis:

0 = motor off (axis motion disabled)

1 = motor on (axis motion enabled)

Troubleshooting: Illegal axis identifier

ERR? (Get Error Number)

Description: Queries the error code <int> of the last error and resets the error to 0.

Only the last error is buffered. You should therefore call ERR? after each command.

You can find error codes and their descriptions in the user manual named in the documentation for the corresponding controller module (p. 5).

Format: ERR?

Arguments: None

Response: The code for the last error (integer).

Troubleshooting: Communication breakdown

Notes: ERR? takes all C-885 PIMotionMaster errors into account irrespective of whether they occurred on the C-885.Mx or on a controller module.

If there are errors in more than one controller module, the query will return the code of the last error but reset all error codes to 0.

If there are errors in the C-885.Mx and at least one controller module, the query will return the code for the error in the C-885.Mx but reset all error codes to 0.

In the case of simultaneous access to the controller by several instances, the error code is only returned to the first instance that sent the ERR? command. Because the error is reset to 0 by the query, the error is not visible for any further querying instance.

- If possible, access the controller with one instance only.
- If incorrect system behavior does not cause the controller to send an error code, check whether the error code is queried regularly in the

background by a macro, script or the PC software (e.g., PIMikroMove).

FRF (Fast Reference Move To Reference Switch)

Description:	Starts a reference move. Moves the specified axis to the reference switch and sets the current position to a defined value. See below for details. If multiple axes are specified in the command, they are moved synchronously.
Format:	FRF [{<AxisID>}]
Arguments:	<AxisID> is a C-885 PIMotionMaster axis, if the identifier is left out, all axes are addressed.
Response:	none
Troubleshooting:	Illegal axis identifier
Notes:	Depending on the controller module, the servo mode must be switched on with SVO for the commanded axis before using this command (closed-loop operation). If the reference move was successful, absolute motion will then be possible in closed-loop operation. The value of the parameter 0x16 of the controller module is set as the current position when the axis is at the reference switch. The motion can be stopped by #24, STP, and HLT. Use FRF? to check whether the reference move was successful. To achieve the best repeatability, referencing must always be done in the same way. The FRF command always approaches the reference switch from the same side, no matter where the axis is when the command is called.

FRF? (Get Referencing Result)

Description:	Queries whether the specified axis is referenced or not.
Format:	FRF? [{<AxisID>}]
Arguments:	<AxisID> is a C-885 PIMotionMaster axis.
Response:	{<AxisID>"="<uint> LF} where <uint> indicates whether the axis was successfully referenced (=1) or not (=0).
Troubleshooting:	Illegal axis identifier
Notes:	An axis is considered as "referenced" when the current position value is set to a known position. This is the case when a reference move was successfully done with FRF or when the position was set directly with POS (depending on the referencing method set with RON).

HLP? (Get List Of Available Commands)

Description:	Lists a help string containing all commands available in the C-885.Mx.
Format:	HLP?
Arguments:	None
Response:	List of available commands
Troubleshooting:	Communication failure

HLT (Halt Motion Smoothly)

Description:	Stops motion of the specified axes gently. Refer to the notes below for details. Error code 10 is set. #24 and STP in contrast abort current motion as fast as possible for the controller without taking care of maximum velocity and acceleration.
Format:	HLT [{<AxisID>}]
Arguments:	<AxisID> is a C-885 PIMotionMaster axis, if the identifier is left out, all axes are stopped.
Response:	none
Troubleshooting:	Illegal axis identifier
Notes:	HLT stops motion with specified system deceleration with regard to system inertia. HLT stops all motion triggered by motion commands (e.g., MOV) as well as commands for referencing (e.g., FRF). After the axes are stopped, their target positions are set to their current positions.

IFC (Set Interface Parameters Temporarily)

Description:	Configures the communication interface.
Format:	IFC {<InterfacePam> <PamValue>}
Arguments:	<InterfacePam> is the interface parameter to be changed; can be IPADR, IPMASK or IPSTART (see below). <PamValue> specifies the value of the interface parameter (see below).
Notes:	The following interface parameters can be set: IPADR <PamValue> specifies the IP address for TCP/IP communication (e.g., 192.168.0.10:50000). The first four parts of <PamValue> specify the IP address, the last part specifies the port to be used. Port 50000 cannot be changed. IPMASK <PamValue> specifies the IP mask to be used for TCP/IP communication, in the form uint.uint.uint.uint, e. g. 255.255.255.0.

IPSTART

<PamValue> defines the startup behavior for configuring the IP address for TCP/IP communication.

0 = The address is used that is defined by IPADR

1 = DHCP is used to get the IP address (default).

Response: none

IFC? (Get Current Interface Parameters)

Description: Queries the current values of the interface parameters for communication from the volatile memory.

Format: IFC? [{<InterfacePam>}]

Arguments: <InterfacePam> is the interface parameter to be queried; can be IPADR, IPMASK or IPSTART (see the above-mentioned description of the IFC command).

Response: {<InterfacePam>"="<PamValue> LF}

where

<PamValue> specifies the value of the interface parameter from volatile memory

IFS (Set Interface Parameters As Default Values)

Description: Stores interface parameters.

The default parameters for the interface are changed in the nonvolatile memory. Note that the currently active parameters remain unchanged until the settings made with IFS become active with the next power-on or reboot.

To change the interface parameters immediately (but temporarily) use IFC.

Format: IFS <Pswd> {<InterfacePam> <PamValue>}

Arguments: <Pswd> is the password for writing to nonvolatile memory, default is "100".

<InterfacePam> is the interface parameter to be changed; can be IPADR, IPMASK or IPSTART (see the above-mentioned description of the IFC command).

<PamValue> specifies the value of the interface parameter (see the above description of the IFC command).

Response: none

IFS? (Get Interface Parameters As Default Values)

Description: Queries the parameter values of the interface configuration stored in the nonvolatile memory (i.e. default settings).

Format: IFS? [{<InterfacePam>}]

Arguments: <InterfacePam> is the interface parameter to be queried; can be IPADR, IPMASK or IPSTART (see the above-mentioned description of the IFC command).

Response: {<InterfacePam>"="<PamValue> LF}

where

<PamValue> is the value of the interface parameter in the nonvolatile memory.

INI (Initialize Axes)

Description: Initializes the C-885.Mx digital processor and interface module.

Format: INI

Response: none

Notes: During initialization, the C-885.Mx module determines the controller modules available in the C-885 PIMotionMaster and reads the values of the *Numerator/Denominator Of The Counts-Per-Physical-Unit Factor* parameters (0xE and 0xF) and the value of the *Stage Name* parameter (0x3C) from the controller modules.

Initialization is also done after switching the C-885 PIMotionMaster on or after rebooting the C-885.Mx (see RBT command, p. 58).

MAN? (Get Help String For Command)

Description: Shows a description of the corresponding command.

Format: MAN? <command>

MOV (Set Target Position (start absolute motion))

Description: Sets a new absolute target position for the specified axis.

Servo mode must be switched on for the commanded axis prior to using this command (closed-loop operation).

Format: MOV {<AxisID> <Position>}

Arguments: <AxisID> is a C-885 PIMotionMaster axis.

<Position> is the new absolute target position in physical units.

Response: none

Notes: The target position must be inside the soft limits. Use TMN? and TMX? to query the current valid soft limits.

The motion can be stopped by #24, STP, and HLT.

During motion, a new motion command resets the target to a new value and the old one may never be reached.

Example 1: Send: MOV 1 10

Note: Axis 1 moves to 10 (target position in mm)

Example 2: Send: MOV 1 243

Send: `ERR?`

Receive: 7

Note: The axis does not move. Error code "7" in the response to the ERR? command indicates that the target position specified in the motion command is out of limits.

MOV? (Get Target Position)

Description: Queries the last valid commanded target position.

Format: MOV? [{<AxisID>}]

Arguments: <AxisID> is a C-885 PIMotionMaster axis.

Response: {<AxisID>"="<float> LF}

where

<float> is the last commanded target position in physical units

Troubleshooting: Illegal axis identifier

Notes: The target position can be changed by commands that trigger motion (e.g., MOV).

MOV? gets the commanded positions. Use POS? to get the current positions.

ONT? (Get On-Target State)

Description:	Queries the on-target state of the specified axis. If no arguments are specified, gets state of all axes.
Format:	ONT? [{<AxisID>}]
Arguments:	<AxisID> is a C-885 PIMotionMaster axis.
Response:	{<AxisID>"="<uint> LF} where <uint> = "1" when the specified axis is on target, "0" otherwise.
Troubleshooting:	Illegal axis identifier
Notes:	Detecting the on-target state is only possible in closed-loop operation (servo mode ON).

OMA (Absolute Open-Loop Motion)

Description:	Moves the specified axis to the specified absolute position. The motion is performed in open-loop mode.
Format:	OMA {<AxisID> <Position>}
Arguments:	<AxisID> is a C-885 PIMotionMaster axis. <Position> is the absolute target position in physical units.
Response:	None
Troubleshooting:	Illegal axis identifier, servo mode active (SVO returns 1)
Notes:	Servo mode must be switched off for the specified axis (axes) (open-loop operation). Position control is not done with OMA (i.e., the target position is not held in the servo loop). Overshooting the axis is possible depending on the type of drive connected to the axis(axes). The controller compensates this by moving the axis back the corresponding number of steps.

OMA? (Get Open-Loop Target Position)

Description:	Queries the last valid commanded target position for open-loop operation. If no arguments are specified, the query is done for all axes.
Format:	OMA? [{<AxisID>}]
Arguments:	<AxisID> is a C-885 PIMotionMaster axis.
Response:	{<AxisID>"="<float> LF} where <float> = the last valid commanded target position for open-loop operation in physical units.
Troubleshooting:	Illegal axis identifier

POS (Set Real Position (does not trigger motion))

Description:	Sets the current position (does not trigger motion).
Format:	POS { <AxisID> <Position>}
Arguments:	<AxisID> is a C-885 PIMotionMaster axis. <Position> is the new current position in physical units.
Response:	none
Troubleshooting:	Illegal axis identifier
Notes:	It is only possible to set the current position with POS when the referencing method is set to "0", see RON. If a position is set with POS, the axis is considered to be "referenced". The minimum and maximum commandable positions (TMN?, TMX?) are not adapted when a position is set with POS. This can lead to target positions that are allowed by the controller but cannot be reached by the mechanics. It is possible to enter target positions that could be reached by the mechanics but would be refused by the controller. Furthermore, the zero position can be outside of the physical travel range after using POS.

POS? (Get Real Position)

Description:	Queries the current axis position.
	If no arguments are specified, the current position of all axes is queried.
Format:	POS? [{<AxisID>}]
Arguments:	<AxisID> is a C-885 PIMotionMaster axis.
Response:	{<AxisID>"="<float> LF}
	where
	<float> is the current axis position in physical units.
Troubleshooting:	Illegal axis identifier

RBT (Reboot System)

Description:	Reboots the C-885.Mx digital processor and interface module.
Format:	RBT
Arguments:	None
Response:	none
Notes:	Rebooting includes initializing the C-885.Mx, see INI command (p. 54).
	In order to restart a controller module of the C-885 PIMotionMaster, it is necessary to communicate with the controller module directly. For example, the module address must precede the RBT command in PITerminal, e.g., `4 RBT` for the controller module in card slot 4.

RON (Set Reference Mode)

Description:	Selects referencing method for the specified axes.
Format:	RON {<AxisID> <ReferenceOn>}
Arguments:	<AxisID> is a C-885 PIMotionMaster axis.
	<ReferenceOn> can be 0 or 1. 1 is default. See below for details.
Response:	none
Troubleshooting:	Illegal axis identifier
Notes:	<ReferenceOn> = 0: An absolute position value can be assigned with POS or a reference move can be started with FRF.
	<ReferenceOn> = 1: A reference move must be started with FRF. Using POS is not permitted.
	Motion in closed-loop operation is only possible when the axis has been referenced.

RON? (Get Reference Mode)

Description:	Queries the referencing method of the specified axes.
Format:	RON? [{ <AxisID>}]
Arguments:	<AxisID> is a C-885 PIMotionMaster axis.
Response:	{<AxisID>"="<ReferenceOn> LF} where <ReferenceOn> is the currently selected referencing method for the axis
Troubleshooting:	Illegal axis identifier
Note:	You will find more information in the description of the RON command.

SAI? (Get List Of Current Axis Identifiers)

Description:	Queries the axis identifiers.
Format:	SAI? [ALL]
Arguments:	[ALL] is optional. For controllers that allow axes to be deactivated, [ALL] ensures that the response also includes the axes that are "deactivated".
Response:	{<AxisID> LF} <AxisID> is a C-885 PIMotionMaster axis.

SRG? (Query Status Register Value)

Description:	Returns register values for the queried axes and registers.
Format:	SRG? {<AxisID> <RegisterID>}
Arguments:	<AxisID> is a C-885 PIMotionMaster axis. <RegisterID> is the ID of the specified register; see below for available registers.
Response:	{<AxisID><RegisterID>"="<Value> LF} where <Value> is the value of the register; see below for details.
Note:	This command is identical in function to #4 that should be preferred when the C-885 PIMotionMaster is doing time-consuming tasks. Possible register IDs and response values: <RegisterID> can be 1. <Value> is the bit-mapped response and returned as the sum of the individual codes, in hexadecimal format:

Bit	15	14	13	12	11	10	9	8
Descript-ion	On-target Status	Is referencing	In motion	Servo mode on	-	-	-	Error flag
Bit	7	6	5	4	3	2	1	0
Descript-ion	Digital input line 4	Digital input line 3	Digital input line 2	Digital input line 1	Positioner is referenced	Positive limit switch	Reference switch	Negative limit switch

Example: Send: `SRG? 1 1`

Receive: `1 1=0x900A`

Note: The response is in hexadecimal format. It means that axis 1 is on target, the servo mode is ON for that axis, no error occurred, the states of the digital input lines 1 to 4 are low, axis 1 has been referenced and axis 1 is on the positive side of the reference switch.

STP (Stop All Axes)

Description: Stops all axes abruptly. Refer to the notes below for details.

Sets error code to 10.

This command is identical in function to #24.

Format: STP

Arguments: None

Response: none

Troubleshooting: Communication breakdown

Notes: STP stops all motion triggered by motion commands (e.g., MOV) as well as commands for referencing (e.g., FRF).

After the axes are stopped, their target positions are set to their current positions.

In contrast to STP, HLT stops motion with specified deceleration with respect to system inertia.

SVO (Set Servo Mode)

Description: Sets the servo mode for specified axes (open-loop or closed-loop operation).

Format: SVO {<AxisID> <ServoState>}

Arguments: <AxisID> is a C-885 PIMotionMaster axis.

<ServoState> can have the following values:

0 = servo mode off (open-loop operation)

1 = servo mode on (closed-loop operation)

Response: none

Troubleshooting: Illegal axis identifier

Notes: When switching from open-loop to closed-loop operation, the target is set to the current position to prevent the mechanics from jumping.

When the servo mode is switched off while the axis is moving, the axis stops.

SVO? (Get Servo Mode)

Description: Queries the servo mode for the specified axes.

If no arguments are specified, gets the servo mode of all axes.

Format: SVO? [{<AxisID>}]

Arguments: <AxisID> is a C-885 PIMotionMaster axis.

Response: {<AxisID>"="<ServoState> LF}

where

<ServoState> the current servo mode of the axis is:

0 = servo mode off (open-loop operation)

1 = servo mode on (closed-loop operation)

Troubleshooting: Illegal axis identifier

TMN? (Get Minimum Commandable Position)

Description: Queries the minimum commandable position in physical units.

Format: TMN? [{ <AxisID>}]

Arguments: <AxisID> is a C-885 PIMotionMaster axis.

Response {<AxisID>"="<float> LF}

where

<float> is the minimum commandable position in physical units.

Note: The minimum commandable position of an axis is defined by parameter 0x30 of the corresponding controller module.

TMX? (Get Maximum Commandable Position)

Description: Queries the maximum commandable position in physical units.

Format: TMX? [{ <AxisID>}]

Arguments: <AxisID> is a C-885 PIMotionMaster axis.

Response {<AxisID>"="<float> LF}

where

<float> is the maximum commandable position in physical units.

Note: The maximum commandable position of an axis is defined by parameter 0x15 of the corresponding controller module.

VEL (Set Closed-Loop Velocity)

Description:	Sets the velocity of the specified axes. The velocity can be changed with VEL while the axis is moving.
Format:	VEL {<AxisID> <Velocity>}
Arguments:	<AxisID> is a C-885 PIMotionMaster axis. <Velocity> is the velocity value in physical units/s.
Response:	none
Troubleshooting:	Illegal axis identifiers
Notes:	The VEL setting only takes effect when the specified axis is in closed-loop operation (servo mode ON). The lowest possible value for <Velocity> is 0.

VEL? (Get Closed-Loop Velocity)

Description:	Queries the velocity value commanded with VEL. If no arguments are specified, the value of all axes commanded with VEL is queried.
Format:	VEL? [{<AxisID>}]
Arguments:	<AxisID> is a C-885 PIMotionMaster axis.
Response:	{<AxisID>"="<float> LF} where <float> is the velocity value commanded with VEL in physical units per second.
Notes:	VEL? queries the velocity value for closed-loop operation.

VER? (Get Versions Of Firmware And Drivers)

Description:	Queries of versions for: ▪ Firmware of the C-885.Mx digital processor and interface module ▪ Firmware of all controller modules present in the C-885 PIMotionMaster ▪ Further components such as for example, drivers and libraries.
Format:	VER?
Arguments:	None
Response	{<string1>":" <string2> [<string3>]LF} where <string1> is the name of the component; <string2> is the version information of the component <string1>; <string3> is an optional specification.

Configuring the C-885.Mx for TCP/IP Communication

Overview of the Interface Settings of the C-885.Mx

Before communication is established, it can be necessary to adapt the interface settings once, depending on the type of networking.

- **Network with DHCP server**: No adjustment of the C-885.Mx factory interface settings is necessary.
- **Network without DHCP server or direct connection** (C-885.Mx directly connected to the Ethernet connection socket of the PC):
  - The startup behavior of the C-885.Mx for configuring the IP address must be changed so that it uses a static IP address.
  - The IP address and the subnet mask of the C-885.Mx must be adapted to the PC and the other network devices.

INFORMATION

The following commands are available for configuring the interface settings of the C-885.Mx:

- Values in the nonvolatile memory:
  - Get with IFS? (p. 54)
  - Set with IFS (p. 53)
- Values in the volatile memory:
  - Get with IFC? (p. 53)
  - Set with IFC (p. 52)
  - Get possible settings with `MAN? IFC`

For querying and configuring the interface settings, it is recommended to use the ***Configure Interface*** window in PIMikroMove. Refer to the PIMikroMove manual for details.

Preparing the C-885.Mx when a DHCP Server is not Available

If the network used does not have a DHCP server, or if the C-885.Mx is connected directly to the Ethernet connection socket of the PC (direct connection), it is necessary to adapt the factory default interface settings of the C-885.Mx.

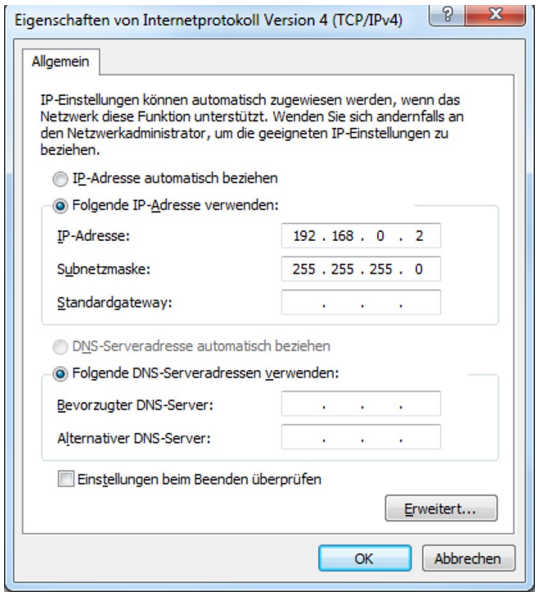
Requirements

✓ You have established communication between the C-885.Mx and the PC via USB with PIMikroMove (p. 28) in order to change the settings for the C-885.Mx.

Determining the PC's IP address and subnet mask

1. Open the window on your PC appropriately so that the TCP/IP Internet protocol properties can be displayed and set. If your operating system distinguishes between Internet Protocol

version 4 (TCP/IPv4) and version 6 (TCP/IPv6), open the window for version 4.

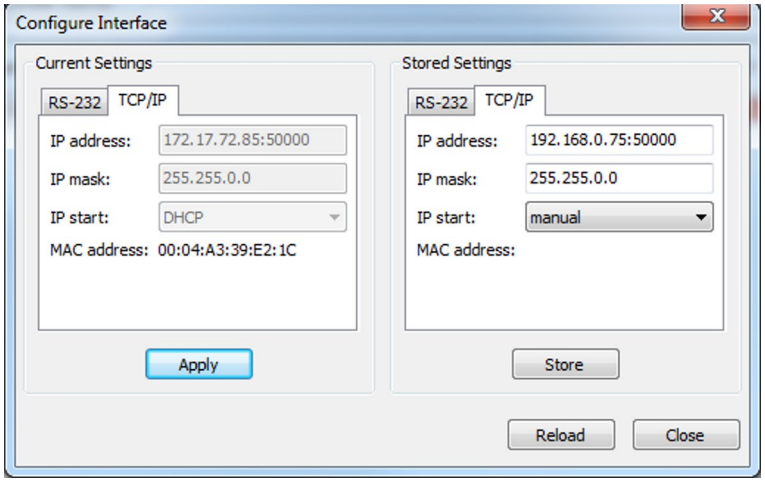


The figure shows example settings that may not apply to your system.

2. Write down the settings for the IP address and the subnet mask.

Adapting the interface settings of the C-885.Mx

1. Open the ***Configure Interface*** window in PIMikroMove by selecting the ***C-885 > Configure interface*** menu item in the main window.
2. Select the ***TCP/IP*** tab in the ***Stored Settings*** area in the ***Configure Interface*** window.



The figure shows example settings that may not apply to your system.

3. Adapt the C-885.Mx's settings in the ***TCP/IP*** tab to those of the PC (refer to "Determining the IP Address and Subnet Mask of the PC" (p. 63)):
   a) Select the value *manual* in the ***IP start*** field. This changes the C-885.Mx's startup

behavior so that it uses a static IP address.

b) Change the subnet mask in the ***IP mask*** field to the subnet mask of the PC.

c) Change the IP address (format: *xxx.xxx.xxx.yyy*) in the ***IP address*** field, whereby the following applies:

- xxx.xxx.xxx. matches the first three sections of the IP address of the PC.
- yyy differs from the last section of the IP address of the PC and every other device in the same network.
- yyy is not "255" and not "0" and is in the address range which is specified by the last section of the subnet mask.
- The port address "50000" must not be changed.

Example:
If the IP address of the PC is 192.168.0.2 and no other device has IP address 192.168.0.3, set 192.168.0.3:50000 as IP address.

4. Save the changed settings in the nonvolatile memory of the C-885.Mx:
   a) In the ***Stored Settings*** area select the ***Store*** button. The ***Store interface settings*** dialog opens.
   b) In the ***Store interface settings*** dialog select ***Store settings***. The dialog closes.
5. Close the ***Configure Interface*** window with ***Close***.
6. Terminate the USB connection of the C-885.Mx by selecting the ***Connections > Close > C-885*** menu item in the main window of PIMikroMove.
7. Switch the C-885 PIMotionMaster off.
8. Test the TCP/IP communication:
   a) Make sure that the C-885.Mx module is connected to the network or PC via the TCP/IP interface (p. 24).
   b) Switch the C-885 PIMotionMaster on.
   c) Establish communication between the C-885.Mx and the PC via TCP/IP, e.g., in PIMikroMove (p. 28).

Firmware Updates

Updating the C-885.M1 / C-885.M2 Firmware

INFORMATION

The `*IDN?` command reads the device identification string of the C-885.Mx that also includes the firmware version.

Example: (c)2015 Physik Instrumente(PI) Karlsruhe, C-885.M1 TCP-IP Master,115027410,0.0.3.5

- C-885.M1 TCP-IP Master device name
- 0.0.3.5 version of the firmware

INFORMATION

To update the firmware, communication between the C-885.Mx and the PC must be established via the TCP/IP interface.

Requirements

- ✓ The C-885 PIMotionMaster is installed properly (p. 20).
- ✓ You have made all necessary preparations for communication via the TCP/IP interface, refer to "Establishing Communication" (p. 28).
- ✓ The PIFirmwareManager program from the data storage device with PC software from PI (p. 10) is installed on the PC.
- ✓ The current firmware file that you received from our customer service department (file type: IPK) is in a directory on the PC.

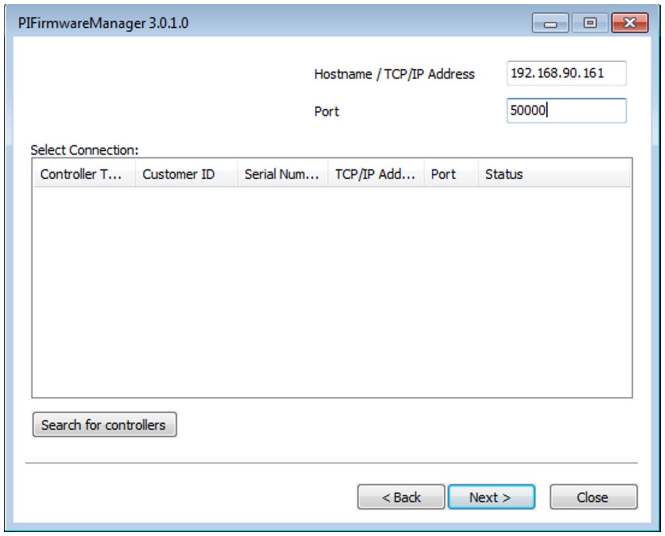
Updating the C-885.Mx firmware

1. Start the PIFirmwareManager program on the PC via the ***All Programs > PI > PIFirmwareManager*** start menu item.

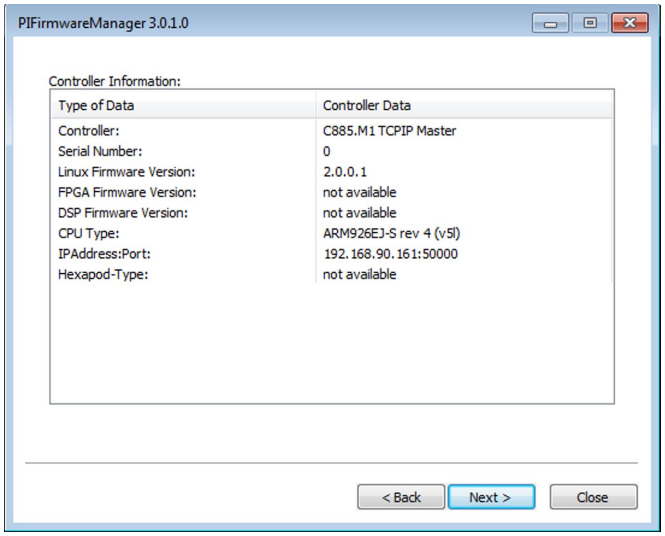
The ***PIFirmwareManager*** window opens.

– Select the ***Next >*** button.

2. Establish communication between the C-885.Mx and the PC.
   a) Select the ***Search for controllers*** button.
   b) If your C-885.Mx is shown in the ***Select Connection***: field, mark the corresponding line in the list.
   c) If your C-885.Mx is not displayed in the ***Select Connection:*** field but its current IP address is known, enter the address into the ***Hostname / TCP/IP Address*** field and 50000 into the ***Port*** field.
   d) Select the ***Next >*** button.

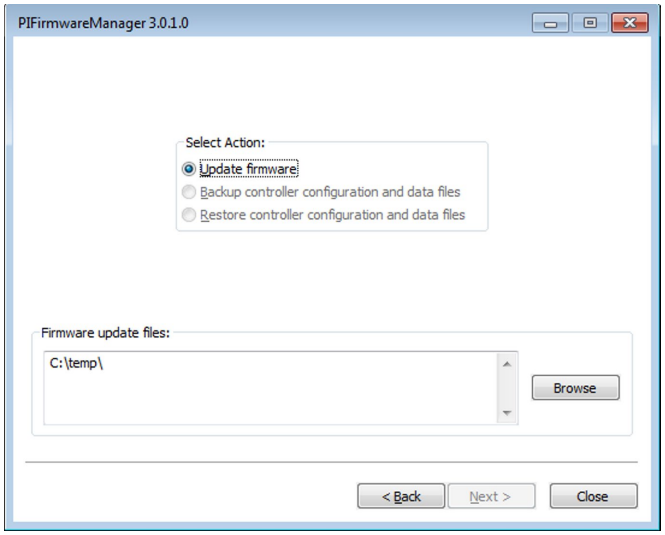


3. Check whether the displayed information matches the information that you have received with the new firmware from our customer service department.



– Select the ***Next >*** button.

4. Select the ***Update firmware*** option in the ***Select Action:*** field.



5. Select the current firmware file.

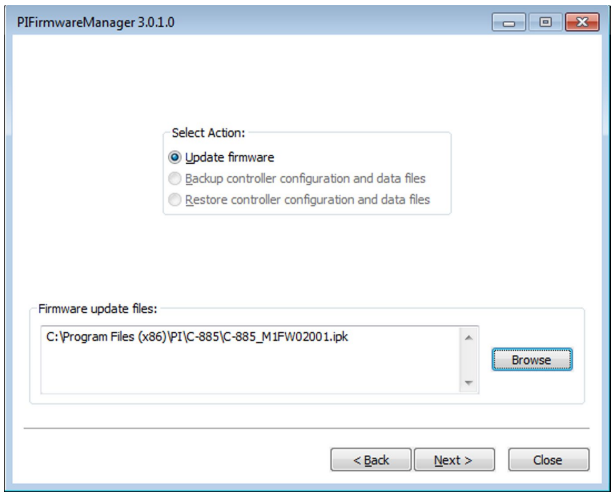
   a) Select the ***Browse*** button. A file selection window opens.

   b) Go to the directory in the file selection window that has the file that you received from the customer service department.

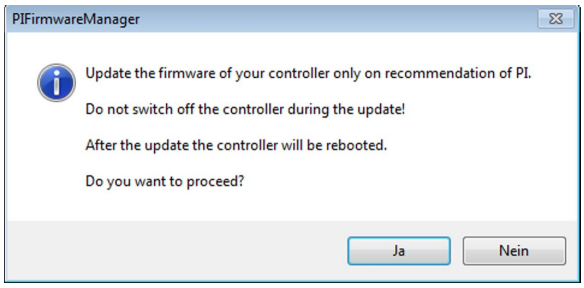
   c) Select the firmware file in the file selection window, e.g., C-885_M1FW02001.ipk.

   d) Select the ***Open*** button in the file selection window to confirm the selection. The file is shown in the ***Firmware update files:*** field in the PIFirmwareManager.

6. Start the transfer of the firmware to the C-885.Mx.



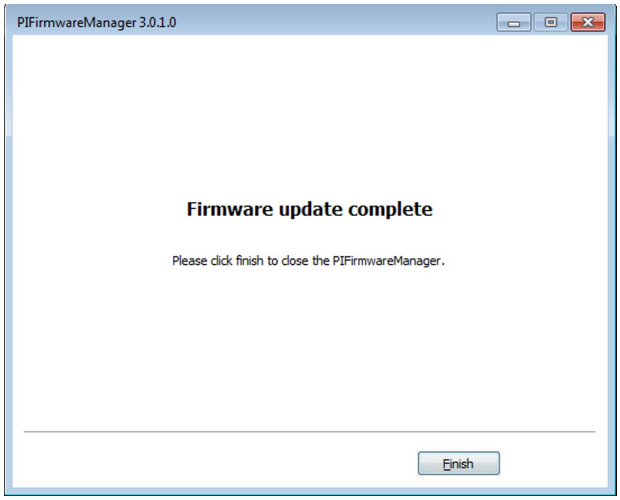
a) Select the ***Next >*** button. A dialog containing notes opens.



b) Select ***Yes*** in the dialog to start transferring the firmware to the C-885.Mx.

The update progress is displayed. The update finishes when the C-885.Mx reboots.

7. Select the ***Finish*** button.



The PIFirmwareManager closes.

Updating the Controller Module Firmware

- Contact our customer service department for information on updating the firmware in controller modules (p. 70).

Customer Service Department

For inquiries and orders, contact your PI sales representative or send us an email (info@pi.ws).

- If you have questions concerning your system, provide the following information:
  - Product codes and serial numbers of all products in the system
  - Firmware version of the controller (if applicable)
  - Version of the driver or the software (if applicable)
  - PC operating system (if applicable)
- If possible: Take photographs or make videos of your system that can be sent to our customer service department if requested.

The latest versions of the user manuals are available for download on our website (p. 6).

Technical Data

Specifications

C-885.R1, C-885.R4 9.5" Chassis

	C-885.R1	C-885.R4
Function	9.5" Chassis for C-885 PIMotionMaster	9.5" Chassis for C-885 PIMotionMaster
Number of card slots	1 C-885.Mx module (required) 4 controller modules (max.)	1 C-885.Mx module (required) 8 controller modules (max.)
Dimensions	269.04 mm × 133.14 mm × 349.5 mm (including handles)	269.04 mm × 133.14 mm × 349.5 mm (including handles)
Operating voltage	24 V DC from external power adapter	24 V DC from external power adapter
Current consumption, max.	32 A	32 A
Mass without modules	3.2 kg	3.5 kg
Operating temperature range	10 to 40 °C	10 to 40 °C

C-885.R2, C-885.R3 19" Chassis

	C-885.R2	C-885.R3
Function	19" chassis for C-885 PIMotionMaster	19" chassis for C-885 PIMotionMaster
Number of card slots	1 C-885.Mx module (required) 20 controller modules (max.)	1 C-885.Mx module (required) 19 controller modules (max.)
Dimensions	Without modules: 482.6 mm × 132.55 mm × 265.3 mm With modules: 482.6 mm × 132.55 mm × 278.55 mm	Without modules: 482.6 mm × 132.55 mm × 265.3 mm With modules: 482.6 mm × 132.55 mm × 278.55 mm
Operating voltage	24 V DC from external power adapter	24 V DC / 48 V DC from external power adapter
Current consumption, max.	32 A	32 A
Mass without modules	2.9 kg	5.08 kg
Operating temperature range	10 to 40 °C	10 to 40 °C

C-885.M1, C-885.M2 Digital Processor, and Interface Module

	C-885.M1 / C-885.M2
Function	Digital processor and interface module for C-885 PIMotionMaster
Interface and operation	
Interface / communication	Ethernet, USB
Command set	PI General Command Set (GCS)
User software	PIMikroMove
Application programming interfaces	API for C / C++ / C# / VB.NET / MATLAB / python, drivers for NI LabVIEW
Display	LEDs for Power, Error
Miscellaneous	
Operating temperature range	10 to 40 °C
Mass	C-885.M1: 132 g, C-885.M2: 270 g
Dimensions	186.42 mm × 128.4 mm (3 RU) × 19.98 mm (4 HP)

C-885 PIMotionMaster Maximum Ratings

The C-885 PIMotionMaster was designed for the following operating data:

For C-885.R1, C-885.R2, and C-885.R4 chassis:

Maximum operating voltage ⚠	**Operating frequency** ⚠	**Maximum current consumption** ⚠
24 V DC	⎓	32 A

For the C-885.R3 chassis:

Maximum operating voltage ⚠	**Operating frequency** ⚠	**Maximum current consumption** ⚠
48 V DC	⎓	32 A

* The maximum current consumption of the C-885 PIMotionMaster depends on the following:
- Module type (plug-in card)
- Number of modules
- Connected motor
- Motion parameters (e.g., acceleration and velocity)

The current consumption of the C-885 PIMotionMaster at rest is approximately 100 mA per module (including C-885.M1/.M2).

Refer to the documentation (p. 5) for the respective controller module for information on the output data.

Ambient Conditions and Classifications

Pay attention to the following ambient conditions and classifications for the C-885 PIMotionMaster:

Area of application	For indoor use only
Maximum altitude	2000 m
Relative humidity	Highest relative humidity 80 % for temperatures up to 31 °C Decreasing linearly to 50 % relative humidity at 40 °C
Operating temperature	10 °C to 40 °C
Storage temperature	–20 °C to 75 °C
Transport temperature	–20 °C to 75 °C
Overvoltage category	II
Protection class	I
Degree of pollution	2
Measurement category	I
Degree of protection according to IEC 60529	IP20

Dimensions

Dimensions in mm. Note that the decimal places are separated by a comma in the drawings

C-885.R1

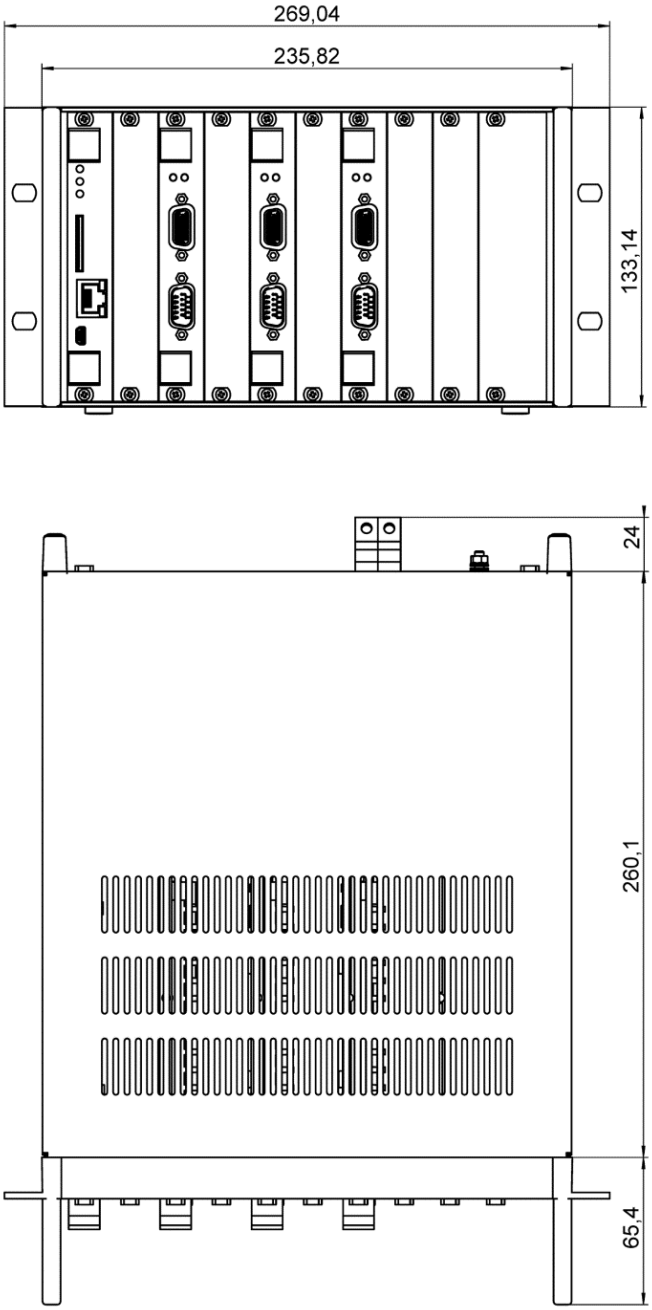


Figure 17: C-885.R1 9.5-inch chassis of the C-885 PIMotionMaster

C-885.R2

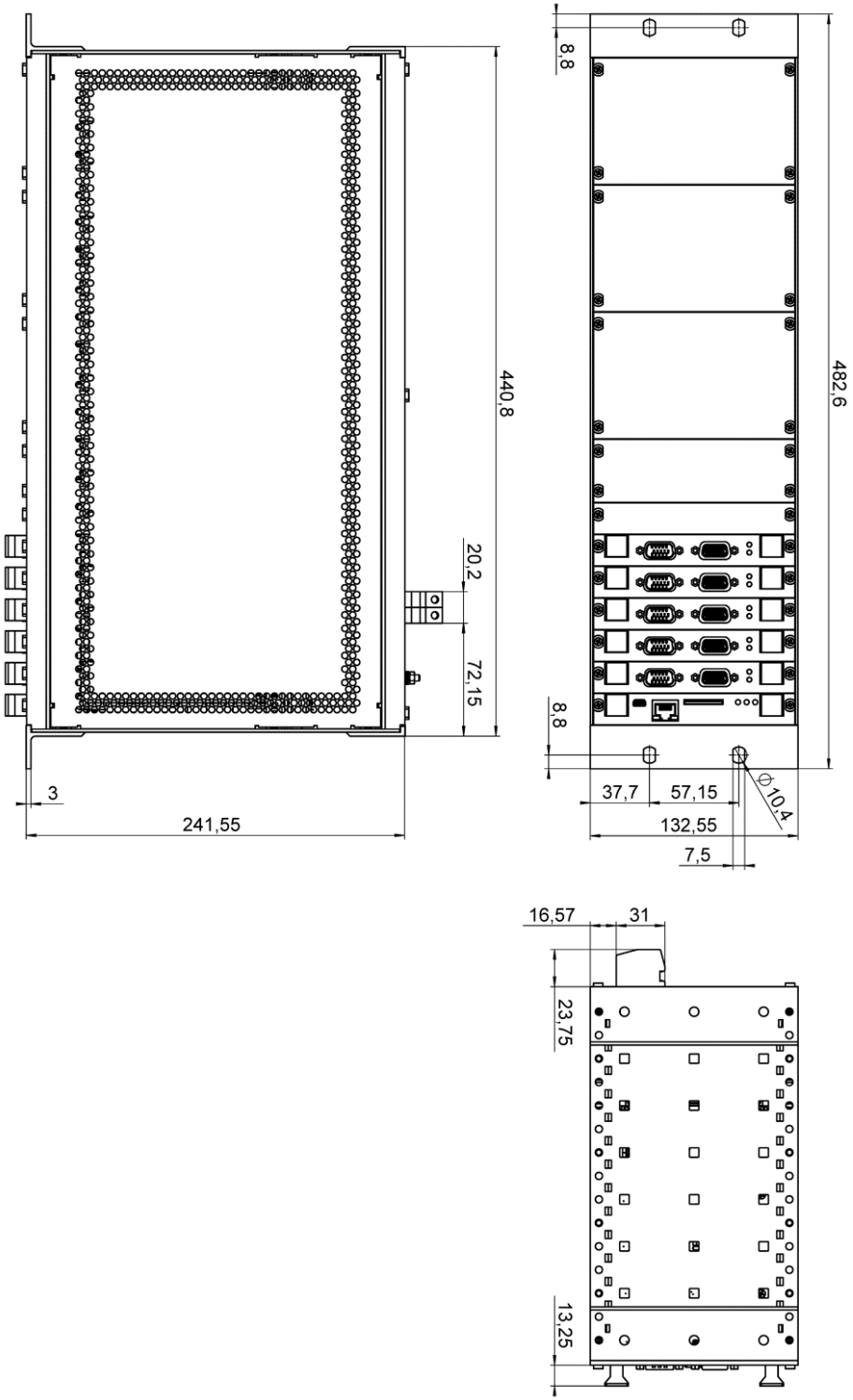


Figure 18: C-885.R2 19-inch chassis of the C-885 PIMotionMaster

C-885.R3

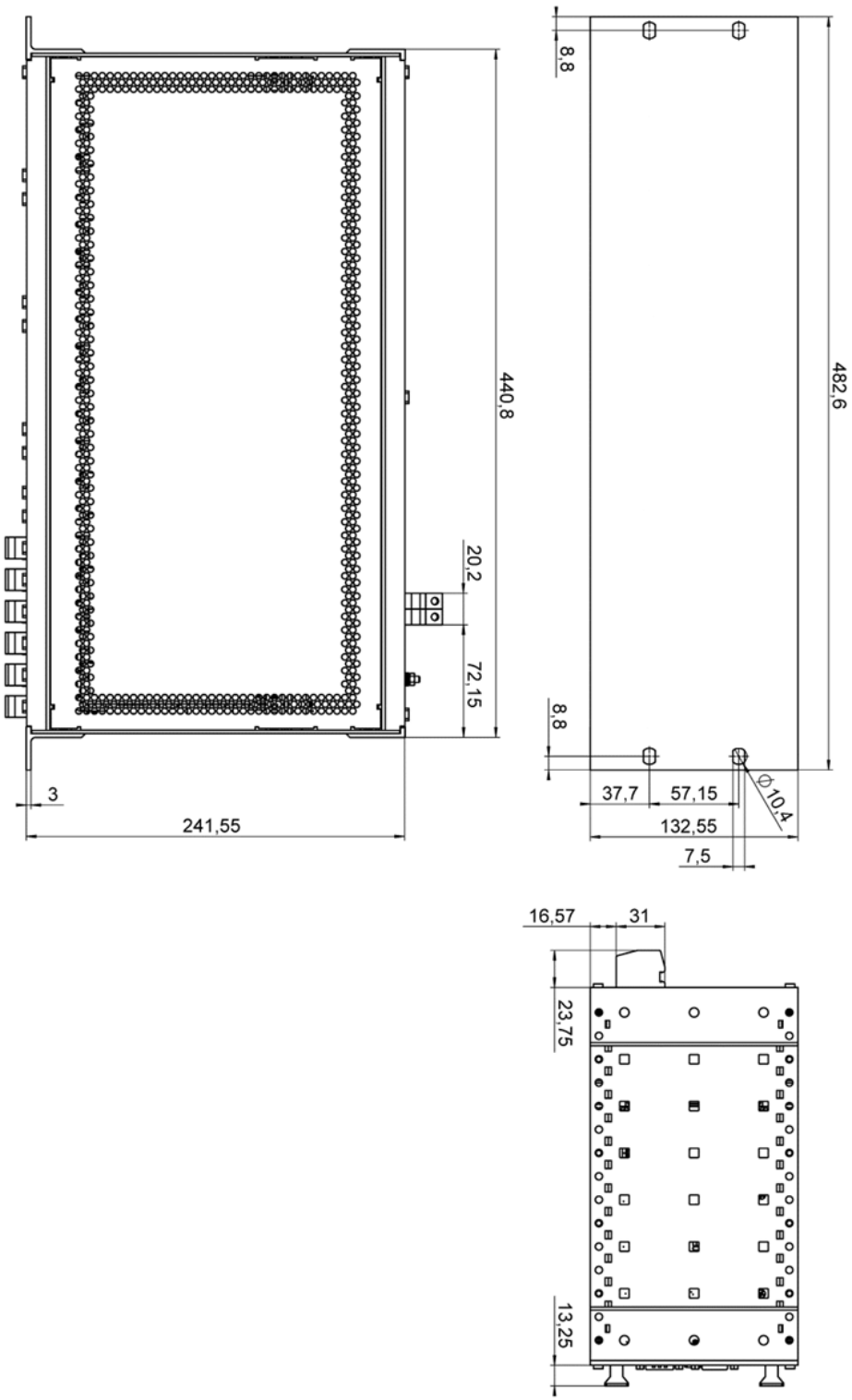


Figure 19: C-885.R3 19-inch chassis of the C-885 PIMotionMaster

C-885.R4

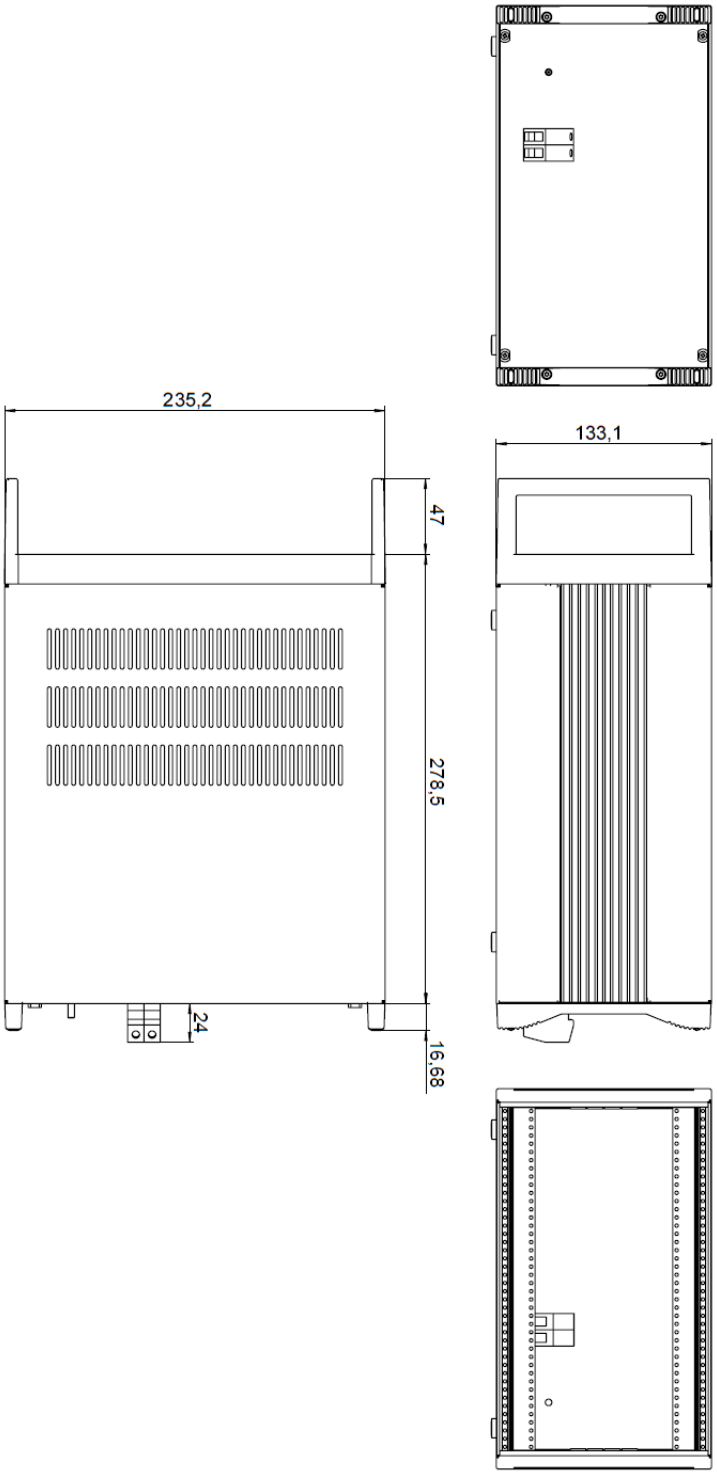


Figure 20: C-885.R4 19-inch chassis of the C-885 PIMotionMaster

C-885.iD Digital Interface Module Pin Assignment

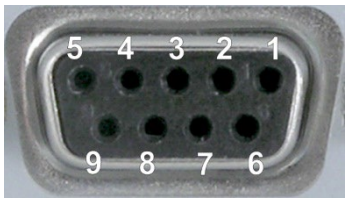


Figure 21: C-885.iD digital interface module: D-sub 9 (female)

Connector strip	D-sub 9 socket		Function
1	1		Input 1 (analog: 0 to 5V / digital: TTL)
2		6	Input 2 (analog: 0 to 5V / digital: TTL)
3	2		Input 3 (analog: 0 to 5V / digital: TTL)
4		7	Input 4 (analog: 0 to 5V / digital: TTL)
5	3		Digital output 1 (TTL)
6		8	Digital output 2 (TTL)
7	4		Digital output 3 (TTL)
8		9	Digital output 4 (TTL)
9	5		GND
10			n.a.

Old Equipment Disposal

In accordance with the applicable EU law, electrical and electronic equipment may not be disposed of with unsorted municipal waste in the member states of the EU.

Dispose of your old equipment according to international, national, and local rules and regulations.

In order to fulfill the responsibility as the product manufacturer, Physik Instrumente (PI) GmbH & Co. KG undertakes environmentally correct disposal of all old PI equipment made available on the market after 13 August 2005 without charge.

Any old PI equipment can be sent free of charge to the following address:

Physik Instrumente (PI) GmbH & Co. KG

Auf der Roemerstr. 1

D-76228 Karlsruhe, Germany

Appendix: Error Codes

The error codes listed here are part of the PI General Command Set. Some of the error codes may not necessarily be relevant for your controller and will never be output.

Controller Errors

0	PI_CNTR_NO_ERROR	No error
1	PI_CNTR_PARAM_SYNTAX	Parameter syntax error
2	PI_CNTR_UNKNOWN_COMMAND	Unknown command
3	PI_CNTR_COMMAND_TOO_LONG	Command length out of limits or command buffer overrun
4	PI_CNTR_SCAN_ERROR	Error while scanning
5	PI_CNTR_MOVE_WITHOUT_REF_OR_NO_SERVO	Unallowable move attempted on unreferenced axis, or move attempted with servo off
6	PI_CNTR_INVALID_SGA_PARAM	Parameter for SGA not valid
7	PI_CNTR_POS_OUT_OF_LIMITS	Position out of limits
8	PI_CNTR_VEL_OUT_OF_LIMITS	Velocity out of limits
9	PI_CNTR_SET_PIVOT_NOT_POSSIBLE	Attempt to set pivot point while U, V, and W not all 0
10	PI_CNTR_STOP	Controller was stopped by command
11	PI_CNTR_SST_OR_SCAN_RANGE	Parameter for SST or for one of the embedded scan algorithms out of range
12	PI_CNTR_INVALID_SCAN_AXES	Invalid axis combination for fast scan
13	PI_CNTR_INVALID_NAV_PARAM	Parameter for NAV out of range
14	PI_CNTR_INVALID_ANALOG_INPUT	Invalid analog channel
15	PI_CNTR_INVALID_AXIS_IDENTIFIER	Invalid axis identifier
16	PI_CNTR_INVALID_STAGE_NAME	Unknown stage name
17	PI_CNTR_PARAM_OUT_OF_RANGE	Parameter out of range
18	PI_CNTR_INVALID_MACRO_NAME	Invalid macro name
19	PI_CNTR_MACRO_RECORD	Error while recording macro
20	PI_CNTR_MACRO_NOT_FOUND	Macro not found
21	PI_CNTR_AXIS_HAS_NO_BRAKE	Axis has no brake
22	PI_CNTR_DOUBLE_AXIS	Axis identifier specified more than once
23	PI_CNTR_ILLEGAL_AXIS	Illegal axis
24	PI_CNTR_PARAM_NR	Incorrect number of parameters
25	PI_CNTR_INVALID_REAL_NR	Invalid floating point number
26	PI_CNTR_MISSING_PARAM	Parameter missing
27	PI_CNTR_SOFT_LIMIT_OUT_OF_RANGE	Soft limit out of range
28	PI_CNTR_NO_MANUAL_PAD	No manual pad found
29	PI_CNTR_NO_JUMP	No more step-response values
30	PI_CNTR_INVALID_JUMP	No step-response values recorded
31	PI_CNTR_AXIS_HAS_NO_REFERENCE	Axis has no reference sensor
32	PI_CNTR_STAGE_HAS_NO_LIM_SWITCH	Axis has no limit switch
33	PI_CNTR_NO_RELAY_CARD	No relay card installed

34	PI_CNTR_CMD_NOT_ALLOWED_FOR_STAGE	Command not permitted for selected stage(s)
35	PI_CNTR_NO_DIGITAL_INPUT	No digital input installed
36	PI_CNTR_NO_DIGITAL_OUTPUT	No digital output configured
37	PI_CNTR_NO_MCM	No more MCM responses
38	PI_CNTR_INVALID_MCM	No MCM values recorded
39	PI_CNTR_INVALID_CNTR_NUMBER	Controller number invalid
40	PI_CNTR_NO_JOYSTICK_CONNECTED	No joystick configured
41	PI_CNTR_INVALID_EGE_AXIS	Invalid axis for electronic gearing, axis cannot be slave
42	PI_CNTR_SLAVE_POSITION_OUT_OF_RANGE	Position of slave axis is out of range
43	PI_CNTR_COMMAND_EGE_SLAVE	Slave axis cannot be commanded directly when electronic gearing is enabled
44	PI_CNTR_JOYSTICK_CALIBRATION_FAILED	Calibration of joystick failed
45	PI_CNTR_REFERENCING_FAILED	Referencing failed
46	PI_CNTR_OPM_MISSING	OPM (Optical Power Meter) missing
47	PI_CNTR_OPM_NOT_INITIALIZED	OPM (Optical Power Meter) not initialized or cannot be initialized
48	PI_CNTR_OPM_COM_ERROR	OPM (Optical Power Meter) communication error
49	PI_CNTR_MOVE_TO_LIMIT_SWITCH_FAILED	Move to limit switch failed
50	PI_CNTR_REF_WITH_REF_DISABLED	Attempt to reference axis with referencing disabled
51	PI_CNTR_AXIS_UNDER_JOYSTICK_CONTROL	Selected axis is controlled by joystick
52	PI_CNTR_COMMUNICATION_ERROR	Controller detected communication error
53	PI_CNTR_DYNAMIC_MOVE_IN_PROCESS	MOV! motion still in progress
54	PI_CNTR_UNKNOWN_PARAMETER	Unknown parameter
55	PI_CNTR_NO_REP_RECORDED	No commands were recorded with REP
56	PI_CNTR_INVALID_PASSWORD	Password invalid
57	PI_CNTR_INVALID_RECORDER_CHAN	Data record table does not exist
58	PI_CNTR_INVALID_RECORDER_SRC_OPT	Source does not exist; number too low or too high
59	PI_CNTR_INVALID_RECORDER_SRC_CHAN	Source record table number too low or too high
60	PI_CNTR_PARAM_PROTECTION	Protected Param: Current Command Level (CCL) too low
61	PI_CNTR_AUTOZERO_RUNNING	Command execution not possible while autozero is running
62	PI_CNTR_NO_LINEAR_AXIS	Autozero requires at least one linear axis
63	PI_CNTR_INIT_RUNNING	Initialization still in progress
64	PI_CNTR_READ_ONLY_PARAMETER	Parameter is read-only
65	PI_CNTR_PAM_NOT_FOUND	Parameter not found in nonvolatile memory
66	PI_CNTR_VOL_OUT_OF_LIMITS	Voltage out of limits
67	PI_CNTR_WAVE_TOO_LARGE	Not enough memory available for requested wave curve

68	PI_CNTR_NOT_ENOUGH_DDL_MEMORY	Not enough memory available for DDL table; DDL cannot be started
69	PI_CNTR_DDL_TIME_DELAY_TOO_LARGE	Time delay larger than DDL table; DDL cannot be started
70	PI_CNTR_DIFFERENT_ARRAY_LENGTH	The requested arrays have different lengths; query them separately
71	PI_CNTR_GEN_SINGLE_MODE_RESTART	Attempt to restart the generator while it is running in single step mode
72	PI_CNTR_ANALOG_TARGET_ACTIVE	Motion commands and wave generator activation are not permitted when analog target is active
73	PI_CNTR_WAVE_GENERATOR_ACTIVE	Motion commands are not permitted when wave generator is active
74	PI_CNTR_AUTOZERO_DISABLED	No sensor channel or no piezo channel connected to selected axis (sensor and piezo matrix)
75	PI_CNTR_NO_WAVE_SELECTED	Generator started (WGO) without having selected a wave table (WSL).
76	PI_CNTR_IF_BUFFER_OVERRUN	Interface buffer overran and command couldn't be received correctly
77	PI_CNTR_NOT_ENOUGH_RECORDED_DATA	Data record table does not hold enough recorded data
78	PI_CNTR_TABLE_DEACTIVATED	Data record table is not configured for recording
79	PI_CNTR_OPENLOOP_VALUE_SET_WHEN_SERVO_ON	Open-loop commands (SVA, SVR) are not permitted when servo is on
80	PI_CNTR_RAM_ERROR	Hardware error affecting RAM
81	PI_CNTR_MACRO_UNKNOWN_COMMAND	Not macro command
82	PI_CNTR_MACRO_PC_ERROR	Macro counter out of range
83	PI_CNTR_JOYSTICK_ACTIVE	Joystick is active
84	PI_CNTR_MOTOR_IS_OFF	Motor is off
85	PI_CNTR_ONLY_IN_MACRO	Macro-only command
86	PI_CNTR_JOYSTICK_UNKNOWN_AXIS	Invalid joystick axis
87	PI_CNTR_JOYSTICK_UNKNOWN_ID	Joystick unknown
88	PI_CNTR_REF_MODE_IS_ON	Move without referenced stage
89	PI_CNTR_NOT_ALLOWED_IN_CURRENT_MOTION_MODE	Command not permitted in current motion mode
90	PI_CNTR_DIO_AND_TRACING_NOT_POSSIBLE	No tracing possible while digital IOs are used on this HW revision. Reconnect to switch operation mode.
91	PI_CNTR_COLLISION	Move not possible, would cause collision
92	PI_CNTR_SLAVE_NOT_FAST_ENOUGH	Stage is not capable of following the master. Check the gear ratio.
93	PI_CNTR_CMD_NOT_ALLOWED_WHILE_AXIS_IN_MOTION	This command is not permitted while the affected axis or its master is in motion.
94	PI_CNTR_OPEN_LOOP_JOYSTICK_ENABLED	Servo cannot be switched on when open-loop joystick control is enabled.
95	PI_CNTR_INVALID_SERVO_STATE_FOR_PARAMETER	This parameter cannot be changed in current servo mode.
96	PI_CNTR_UNKNOWN_STAGE_NAME	Unknown stage name
97	PI_CNTR_INVALID_VALUE_LENGTH	Invalid length of value (too much

		characters)
98	PI_CNTR_AUTOZERO_FAILED	Autozero procedure was not successful
99	PI_CNTR_SENSOR_VOLTAGE_OFF	Sensor voltage is off
100	PI_LABVIEW_ERROR	PI driver for use with NI LabVIEW reports error. See source control for details.
200	PI_CNTR_NO_AXIS	No stage connected to axis
201	PI_CNTR_NO_AXIS_PARAM_FILE	File with axis parameters not found
202	PI_CNTR_INVALID_AXIS_PARAM_FILE	Invalid axis parameter file
203	PI_CNTR_NO_AXIS_PARAM_BACKUP	Backup file with axis parameters not found
204	PI_CNTR_RESERVED_204	PI internal error code 204
205	PI_CNTR_SMO_WITH_SERVO_ON	SMO with servo on
206	PI_CNTR_UUDECODE_INCOMPLETE_HEADER	uudecode: incomplete header
207	PI_CNTR_UUDECODE_NOTHING_TO_DECODE	uudecode: nothing to decode
208	PI_CNTR_UUDECODE_ILLEGAL_FORMAT	uudecode: illegal UUE format
209	PI_CNTR_CRC32_ERROR	CRC32 error
210	PI_CNTR_ILLEGAL_FILENAME	Illegal file name (must be 8-0 format)
211	PI_CNTR_FILE_NOT_FOUND	File not found on controller
212	PI_CNTR_FILE_WRITE_ERROR	Error writing file on controller
213	PI_CNTR_DTR_HINDERS_VELOCITY_CHANGE	VEL command not allowed in DTR command mode
214	PI_CNTR_POSITION_UNKNOWN	Position calculations failed
215	PI_CNTR_CONN_POSSIBLY_BROKEN	The connection between controller and stage may be broken
216	PI_CNTR_ON_LIMIT_SWITCH	The connected stage has driven into a limit switch, some controllers need CLR to resume operation
217	PI_CNTR_UNEXPECTED_STRUT_STOP	Strut test command failed because of an unexpected strut stop
218	PI_CNTR_POSITION_BASED_ON_ESTIMATION	While MOV! is running position can only be estimated!
219	PI_CNTR_POSITION_BASED_ON_INTERPOLATION	Position was calculated during MOV motion
220	PI_CNTR_INTERPOLATION_FIFO_UNDERRUN	FIFO buffer underrun during interpolation
221	PI_CNTR_INTERPOLATION_FIFO_OVERFLOW	FIFO buffer underrun during interpolation
230	PI_CNTR_INVALID_HANDLE	Invalid handle
231	PI_CNTR_NO_BIOS_FOUND	No bios found
232	PI_CNTR_SAVE_SYS_CFG_FAILED	Save system configuration failed
233	PI_CNTR_LOAD_SYS_CFG_FAILED	Load system configuration failed
301	PI_CNTR_SEND_BUFFER_OVERFLOW	Send buffer overflow
302	PI_CNTR_VOLTAGE_OUT_OF_LIMITS	Voltage out of limits
303	PI_CNTR_OPEN_LOOP_MOTION_SET_WHEN_SERVO_ON	Open-loop motion attempted when servo ON
304	PI_CNTR_RECEIVING_BUFFER_OVERFLOW	Received command is too long
305	PI_CNTR_EEPROM_ERROR	Error while reading/writing EEPROM
306	PI_CNTR_I2C_ERROR	Error on I2C bus
307	PI_CNTR_RECEIVING_TIMEOUT	Timeout while receiving command
308	PI_CNTR_TIMEOUT	A lengthy operation has not finished in

		the expected time
309	PI_CNTR_MACRO_OUT_OF_SPACE	Insufficient space to store macro
310	PI_CNTR_EUI_OLDVERSION_CFGDATA	Configuration data has old version number
311	PI_CNTR_EUI_INVALID_CFGDATA	Invalid configuration data
333	PI_CNTR_HARDWARE_ERROR	Internal hardware error
400	PI_CNTR_WAV_INDEX_ERROR	Wave generator index error
401	PI_CNTR_WAV_NOT_DEFINED	Wave table not defined
402	PI_CNTR_WAV_TYPE_NOT_SUPPORTED	Wave type not supported
403	PI_CNTR_WAV_LENGTH_EXCEEDS_LIMIT	Wave length exceeds limit
404	PI_CNTR_WAV_PARAMETER_NR	Wave parameter number error
405	PI_CNTR_WAV_PARAMETER_OUT_OF_LIMIT	Wave parameter out of range
406	PI_CNTR_WGO_BIT_NOT_SUPPORTED	WGO command bit not supported
500	PI_CNTR_EMERGENCY_STOP_BUTTON_ACTIVATED	The \"red knob\" is still set and disables system
501	PI_CNTR_EMERGENCY_STOP_BUTTON_WAS_ACTIVATED	The \"red knob\" was activated and still disables system - reanimation required
502	PI_CNTR_REDUNDANCY_LIMIT_EXCEEDED	Position consistency check failed
503	PI_CNTR_COLLISION_SWITCH_ACTIVATED	Hardware collision sensor(s) are activated
504	PI_CNTR_FOLLOWING_ERROR	Strut following error occurred, e.g., caused by overload or encoder failure
505	PI_CNTR_SENSOR_SIGNAL_INVALID	One sensor signal is not valid
506	PI_CNTR_SERVO_LOOP_UNSTABLE	Servo loop was unstable due to wrong parameter setting and switched off to avoid damage.
507	PI_CNTR_LOST_SPI_SLAVE_CONNECTION	Digital connection to external SPI slave device is lost
508	PI_CNTR_MOVE_ATTEMPT_NOT_PERMITTED	Move attempt not permitted due to customer or limit settings
509	PI_CNTR_TRIGGER_EMERGENCY_STOP	Emergency stop caused by trigger input
530	PI_CNTR_NODE_DOES_NOT_EXIST	A command refers to a node that does not exist
531	PI_CNTR_PARENT_NODE_DOES_NOT_EXIST	A command refers to a node that has no parent node
532	PI_CNTR_NODE_IN_USE	Attempt to delete a node that is in use
533	PI_CNTR_NODE_DEFINITION_IS_CYCLIC	Definition of a node is cyclic
536	PI_CNTR_HEXAPOD_IN_MOTION	Transformation cannot be defined as long as Hexapod is in motion
537	PI_CNTR_TRANSFORMATION_TYPE_NOT_SUPPORTED	Transformation node cannot be activated
539	PI_CNTR_NODE_PARENT_IDENTICAL_TO_CHILD	A node cannot be linked to itself
540	PI_CNTR_NODE_DEFINITION_INCONSISTENT	Node definition is erroneous or not complete (replace or delete it)
542	PI_CNTR_NODES_NOT_IN_SAME_CHAIN	The nodes are not part of the same chain
543	PI_CNTR_NODE_MEMORY_FULL	Unused nodes must be deleted before new nodes can be stored
544	PI_CNTR_PIVOT_POINT_FEATURE_NOT_SUPPORTED	With some transformations pivot point usage is not supported
545	PI_CNTR_SOFTLIMITS_INVALID	Soft limits invalid due to changes in coordinate system

546	PI_CNTR_CS_WRITE_PROTECTED	Coordinate system is write protected
547	PI_CNTR_CS_CONTENT_FROM_CONFIG_FILE	Coordinate system cannot be changed because its content is loaded from a configuration file
548	PI_CNTR_CS_CANNOT_BE_LINKED	Coordinate system may not be linked
549	PI_CNTR_KSB_CS_ROTATION_ONLY	A KSB-type coordinate system can only be rotated by multiples of 90 degrees
551	PI_CNTR_CS_DATA_CANNOT_BE_QUERIED	This query is not supported for this coordinate system type
552	PI_CNTR_CS_COMBINATION_DOES_NOT_EXIST	This combination of work-and-tool coordinate systems does not exist
553	PI_CNTR_CS_COMBINATION_INVALID	The combination must consist of one work and one tool coordinate system
554	PI_CNTR_CS_TYPE_DOES_NOT_EXIST	This coordinate system type does not exist
555	PI_CNTR_UNKNOWN_ERROR	BasMac: unknown controller error
556	PI_CNTR_CS_TYPE_NOT_ACTIVATED	No coordinate system of this type is activated
557	PI_CNTR_CS_NAME_INVALID	Name of coordinate system is invalid
558	PI_CNTR_CS_GENERAL_FILE_MISSING	File with stored CS systems is missing or erroneous
559	PI_CNTR_CS_LEVELING_FILE_MISSING	File with leveling CS is missing or erroneous
601	PI_CNTR_NOT_ENOUGH_MEMORY	Not enough memory
602	PI_CNTR_HW_VOLTAGE_ERROR	Hardware voltage error
603	PI_CNTR_HW_TEMPERATURE_ERROR	Hardware temperature out of range
604	PI_CNTR_POSITION_ERROR_TOO_HIGH	Position error of any axis in the system is too high
606	PI_CNTR_INPUT_OUT_OF_RANGE	Maximum value of input signal has been exceeded
607	PI_CNTR_NO_INTEGER	Value is not integer
608	PI_CNTR_FAST_ALIGNMENT_PROCESS_IS_NOT_RUNNING	Fast alignment process cannot be paused because it is not running
609	PI_CNTR_FAST_ALIGNMENT_PROCESS_IS_NOT_PAUSED	Fast alignment process cannot be restarted/resumed because it is not paused
650	PI_CNTR_UNABLE_TO_SET_PARAM_WITH_SPA	Parameter could not be set with SPA - SEP needed?
651	PI_CNTR_PHASE_FINDING_ERROR	Phase finding error
652	PI_CNTR_SENSOR_SETUP_ERROR	Sensor setup error
653	PI_CNTR_SENSOR_COMM_ERROR	Sensor communication error
654	PI_CNTR_MOTOR_AMPLIFIER_ERROR	Motor amplifier error
655	PI_CNTR_OVER_CURR_PROTEC_TRIGGERED_BY_I2T	Overcurrent protection triggered by I2T-module
656	PI_CNTR_OVER_CURR_PROTEC_TRIGGERED_BY_AMP_MODULE	Overcurrent protection triggered by amplifier module
657	PI_CNTR_SAFETY_STOP_TRIGGERED	Safety stop triggered
658	PI_SENSOR_OFF	Sensor off?
700	PI_CNTR_COMMAND_NOT_ALLOWED_IN_EXTERNAL_MODE	Command not permitted in external mode

710	PI_CNTR_EXTERNAL_MODE_ERROR	External mode communication error
715	PI_CNTR_INVALID_MODE_OF_OPERATION	Invalid mode of operation
716	PI_CNTR_FIRMWARE_STOPPED_BY_CMD	Firmware stopped by command (#27)
717	PI_CNTR_EXTERNAL_MODE_DRIVER_MISSING	External mode driver missing
718	PI_CNTR_CONFIGURATION_FAILURE_EXTERNAL_MODE	Missing or incorrect configuration of external mode
719	PI_CNTR_EXTERNAL_MODE_CYCLETIME_INVALID	External mode cycle time invalid
720	PI_CNTR_BRAKE_ACTIVATED	Brake is activated
731	PI_CNTR_SURFACEDETECTION_RUNNING	Command not permitted while surface detection is running
732	PI_CNTR_SURFACEDETECTION_FAILED	Last surface detection failed
733	PI_CNTR_FIELDBUS_IS_ACTIVE	Fieldbus is active and is blocking GCS control commands
1000	PI_CNTR_TOO_MANY_NESTED_MACROS	Too many nested macros
1001	PI_CNTR_MACRO_ALREADY_DEFINED	Macro already defined
1002	PI_CNTR_NO_MACRO_RECORDING	Macro recording not activated
1003	PI_CNTR_INVALID_MAC_PARAM	Invalid parameter for MAC
1004	PI_CNTR_RESERVED_1004	PI internal error code 1004
1005	PI_CNTR_CONTROLLER_BUSY	Controller is busy with some lengthy operation (e.g., reference move, fast scan algorithm)
1006	PI_CNTR_INVALID_IDENTIFIER	Invalid identifier (invalid special characters, ...)
1007	PI_CNTR_UNKNOWN_VARIABLE_OR_ARGUMENT	Variable or argument not defined
1008	PI_CNTR_RUNNING_MACRO	Controller is (already) running a macro
1009	PI_CNTR_MACRO_INVALID_OPERATOR	Invalid or missing operator for condition. Check necessary spaces around operator.
1010	PI_CNTR_MACRO_NO_ANSWER	No response was received while executing WAC/MEX/JRC/...
1011	PI_CMD_NOT_VALID_IN_MACRO_MODE	Command not valid during macro execution
1024	PI_CNTR_MOTION_ERROR	Motion error: position error too large, servo is switched off automatically
1025	PI_CNTR_MAX_MOTOR_OUTPUT_REACHED	Maximum motor output reached
1063	PI_CNTR_EXT_PROFILE_UNALLOWED_CMD	User profile mode: command is not allowed, check for required preparatory commands
1064	PI_CNTR_EXT_PROFILE_EXPECTING_MOTION_ERROR	User profile mode: first target position in user profile is too far from current position
1065	PI_CNTR_PROFILE_ACTIVE	Controller is (already) in user profile mode
1066	PI_CNTR_PROFILE_INDEX_OUT_OF_RANGE	User profile mode: block or data set index out of allowed range
1071	PI_CNTR_PROFILE_OUT_OF_MEMORY	User profile mode: out of memory
1072	PI_CNTR_PROFILE_WRONG_CLUSTER	User profile mode: cluster is not assigned to this axis
1073	PI_CNTR_PROFILE_UNKNOWN_CLUSTER_IDENTIFIER	Unknown cluster identifier
1090	PI_CNTR_TOO_MANY_TCP_CONNECTIONS_OPEN	There are too many open tcpip connections

2000	PI_CNTR_ALREADY_HAS_SERIAL_NUMBER	Controller already has a serial number
4000	PI_CNTR_SECTOR_ERASE_FAILED	Sector erase failed
4001	PI_CNTR_FLASH_PROGRAM_FAILED	Flash program failed
4002	PI_CNTR_FLASH_READ_FAILED	Flash read failed
4003	PI_CNTR_HW_MATCHCODE_ERROR	HW match code missing/invalid
4004	PI_CNTR_FW_MATCHCODE_ERROR	FW match code missing/invalid
4005	PI_CNTR_HW_VERSION_ERROR	HW version missing/invalid
4006	PI_CNTR_FW_VERSION_ERROR	FW version missing/invalid
4007	PI_CNTR_FW_UPDATE_ERROR	FW update failed
4008	PI_CNTR_FW_CRC_PAR_ERROR	FW Parameter CRC wrong
4009	PI_CNTR_FW_CRC_FW_ERROR	FW CRC wrong
5000	PI_CNTR_INVALID_PCC_SCAN_DATA	PicoCompensation scan data is not valid
5001	PI_CNTR_PCC_SCAN_RUNNING	PicoCompensation is running, some actions cannot be performed during scanning/recording
5002	PI_CNTR_INVALID_PCC_AXIS	Given axis cannot be defined as PPC axis
5003	PI_CNTR_PCC_SCAN_OUT_OF_RANGE	Defined scan area is larger than the travel range
5004	PI_CNTR_PCC_TYPE_NOT_EXISTING	Given PicoCompensation type is not defined
5005	PI_CNTR_PCC_PAM_ERROR	PicoCompensation parameter error
5006	PI_CNTR_PCC_TABLE_ARRAY_TOO_LARGE	PicoCompensation table is larger than maximum table length
5100	PI_CNTR_NEXLINE_ERROR	Common error in NEXLINE® firmware module
5101	PI_CNTR_CHANNEL_ALREADY_USED	Output channel for NEXLINE® cannot be redefined for other usage
5102	PI_CNTR_NEXLINE_TABLE_TOO_SMALL	Memory for NEXLINE® signals is too small
5103	PI_CNTR_RNP_WITH_SERVO_ON	RNP cannot be executed if axis is in closed loop
5104	PI_CNTR_RNP_NEEDED	Relax procedure (RNP) needed
5200	PI_CNTR_AXIS_NOT_CONFIGURED	Axis must be configured for this action
5300	PI_CNTR_FREQU_ANALYSIS_FAILED	Frequency analysis failed
5301	PI_CNTR_FREQU_ANALYSIS_RUNNING	Another frequency analysis is running
6000	PI_CNTR_SENSOR_ABS_INVALID_VALUE	Invalid preset value of absolute sensor
6001	PI_CNTR_SENSOR_ABS_WRITE_ERROR	Error while writing to sensor
6002	PI_CNTR_SENSOR_ABS_READ_ERROR	Error while reading from sensor
6003	PI_CNTR_SENSOR_ABS_CRC_ERROR	Checksum error of absolute sensor
6004	PI_CNTR_SENSOR_ABS_ERROR	General error of absolute sensor
6005	PI_CNTR_SENSOR_ABS_OVERFLOW	Overflow of absolute sensor position

Interface Errors

0	COM_NO_ERROR	No error occurred during function call
-1	COM_ERROR	Error during com operation (could not be specified)
-2	SEND_ERROR	Error while sending data
-3	REC_ERROR	Error while receiving data

-4	NOT_CONNECTED_ERROR	Not connected (no port with given ID open)
-5	COM_BUFFER_OVERFLOW	Buffer overflow
-6	CONNECTION_FAILED	Error while opening port
-7	COM_TIMEOUT	Timeout error
-8	COM_MULTILINE_RESPONSE	There are more lines waiting in buffer
-9	COM_INVALID_ID	There is no interface or DLL handle with the given ID
-10	COM_NOTIFY_EVENT_ERROR	Event/message for notification could not be opened
-11	COM_NOT_IMPLEMENTED	Function not supported by this interface type
-12	COM_ECHO_ERROR	Error while sending "echoed" data
-13	COM_GPIB_EDVR	IEEE488: System error
-14	COM_GPIB_ECIC	IEEE488: Function requires GPIB board to be CIC
-15	COM_GPIB_ENOL	IEEE488: Write function detected no listeners
-16	COM_GPIB_EADR	IEEE488: Interface board not addressed correctly
-17	COM_GPIB_EARG	IEEE488: Invalid argument to function call
-18	COM_GPIB_ESAC	IEEE488: Function requires GPIB board to be SAC
-19	COM_GPIB_EABO	IEEE488: I/O operation aborted
-20	COM_GPIB_ENEB	IEEE488: Interface board not found
-21	COM_GPIB_EDMA	IEEE488: Error performing DMA
-22	COM_GPIB_EOIP	IEEE488: I/O operation started before previous operation completed
-23	COM_GPIB_ECAP	IEEE488: No capability for intended operation
-24	COM_GPIB_EFSO	IEEE488: File system operation error
-25	COM_GPIB_EBUS	IEEE488: Command error during device call
-26	COM_GPIB_ESTB	IEEE488: Serial poll-status byte lost
-27	COM_GPIB_ESRQ	IEEE488: SRQ remains asserted
-28	COM_GPIB_ETAB	IEEE488: Return buffer full
-29	COM_GPIB_ELCK	IEEE488: Address or board locked
-30	COM_RS_INVALID_DATA_BITS	RS-232: 5 data bits with 2 stop bits is an invalid combination, as is 6, 7, or 8 data bits with 1.5 stop bits
-31	COM_ERROR_RS_SETTINGS	RS-232: Error configuring the COM port
-32	COM_INTERNAL_RESOURCES_ERROR	Error dealing with internal system resources (events, threads, ...)
-33	COM_DLL_FUNC_ERROR	A DLL or one of the required functions could not be loaded
-34	COM_FTDIUSB_INVALID_HANDLE	FTDIUSB: invalid handle
-35	COM_FTDIUSB_DEVICE_NOT_FOUND	FTDIUSB: device not found
-36	COM_FTDIUSB_DEVICE_NOT_OPENED	FTDIUSB: device not opened
-37	COM_FTDIUSB_IO_ERROR	FTDIUSB: IO error

-38	COM_FTDIUSB_INSUFFICIENT_RESOURCES	FTDIUSB: insufficient resources
-39	COM_FTDIUSB_INVALID_PARAMETER	FTDIUSB: invalid parameter
-40	COM_FTDIUSB_INVALID_BAUD_RATE	FTDIUSB: invalid baud rate
-41	COM_FTDIUSB_DEVICE_NOT_OPENED_FOR_ERASE	FTDIUSB: device not opened for erase
-42	COM_FTDIUSB_DEVICE_NOT_OPENED_FOR_WRITE	FTDIUSB: device not opened for write
-43	COM_FTDIUSB_FAILED_TO_WRITE_DEVICE	FTDIUSB: failed to write device
-44	COM_FTDIUSB_EEPROM_READ_FAILED	FTDIUSB: EEPROM read failed
-45	COM_FTDIUSB_EEPROM_WRITE_FAILED	FTDIUSB: EEPROM write failed
-46	COM_FTDIUSB_EEPROM_ERASE_FAILED	FTDIUSB: EEPROM erase failed
-47	COM_FTDIUSB_EEPROM_NOT_PRESENT	FTDIUSB: EEPROM not present
-48	COM_FTDIUSB_EEPROM_NOT_PROGRAMMED	FTDIUSB: EEPROM not programmed
-49	COM_FTDIUSB_INVALID_ARGS	FTDIUSB: invalid arguments
-50	COM_FTDIUSB_NOT_SUPPORTED	FTDIUSB: not supported
-51	COM_FTDIUSB_OTHER_ERROR	FTDIUSB: other error
-52	COM_PORT_ALREADY_OPEN	Error while opening the COM port: was already open
-53	COM_PORT_CHECKSUM_ERROR	Checksum error in received data from COM port
-54	COM_SOCKET_NOT_READY	Socket not ready, you should call the function again
-55	COM_SOCKET_PORT_IN_USE	Port is used by another socket
-56	COM_SOCKET_NOT_CONNECTED	Socket not connected (or not valid)
-57	COM_SOCKET_TERMINATED	Connection terminated (by peer)
-58	COM_SOCKET_NO_RESPONSE	Can't connect to peer
-59	COM_SOCKET_INTERRUPTED	Operation was interrupted by a nonblocked signal
-60	COM_PCI_INVALID_ID	No device with this ID is present
-61	COM_PCI_ACCESS_DENIED	Driver could not be opened (on Vista: run as administrator!)
-62	COM_SOCKET_HOST_NOT_FOUND	Host not found
-63	COM_DEVICE_CONNECTED	Device already connected

DLL Errors

-1001	PI_UNKNOWN_AXIS_IDENTIFIER	Unknown axis identifier
-1002	PI_NR_NAV_OUT_OF_RANGE	Number for NAV out of range--must be in [1.10000]
-1003	PI_INVALID_SGA	Invalid value for SGA--must be one of 1, 10, 100, 1000
-1004	PI_UNEXPECTED_RESPONSE	Controller sent unexpected response
-1005	PI_NO_MANUAL_PAD	No manual control pad installed, calls to SMA and related commands are not permitted
-1006	PI_INVALID_MANUAL_PAD_KNOB	Invalid number for manual control pad knob
-1007	PI_INVALID_MANUAL_PAD_AXIS	Axis not currently controlled by a manual control pad
-1008	PI_CONTROLLER_BUSY	Controller is busy with some lengthy operation (e.g., reference move, fast scan

		algorithm)
-1009	PI_THREAD_ERROR	Internal error--could not start thread
-1010	PI_IN_MACRO_MODE	Controller is (already) in macro mode--command not valid in macro mode
-1011	PI_NOT_IN_MACRO_MODE	Controller not in macro mode--command not valid unless macro mode active
-1012	PI_MACRO_FILE_ERROR	Could not open file to write or read macro
-1013	PI_NO_MACRO_OR_EMPTY	No macro with specified name on controller, or macro is empty
-1014	PI_MACRO_EDITOR_ERROR	Internal error in macro editor
-1015	PI_INVALID_ARGUMENT	One or more arguments given to function is invalid (empty string, index out of range, ...)
-1016	PI_AXIS_ALREADY_EXISTS	Axis identifier is already in use by a connected stage
-1017	PI_INVALID_AXIS_IDENTIFIER	Invalid axis identifier
-1018	PI_COM_ARRAY_ERROR	Could not access array data in COM server
-1019	PI_COM_ARRAY_RANGE_ERROR	Range of array does not fit the number of parameters
-1020	PI_INVALID_SPA_CMD_ID	Invalid parameter ID given to SPA or SPA?
-1021	PI_NR_AVG_OUT_OF_RANGE	Number for AVG out of range--must be >0
-1022	PI_WAV_SAMPLES_OUT_OF_RANGE	Incorrect number of samples given to WAV
-1023	PI_WAV_FAILED	Generation of wave failed
-1024	PI_MOTION_ERROR	Motion error: position error too large, servo is switched off automatically
-1025	PI_RUNNING_MACRO	Controller is (already) running a macro
-1026	PI_PZT_CONFIG_FAILED	Configuration of PZT stage or amplifier failed
-1027	PI_PZT_CONFIG_INVALID_PARAMS	Current settings are not valid for desired configuration
-1028	PI_UNKNOWN_CHANNEL_IDENTIFIER	Unknown channel identifier
-1029	PI_WAVE_PARAM_FILE_ERROR	Error while reading/writing wave generator parameter file
-1030	PI_UNKNOWN_WAVE_SET	Could not find description of wave form. Maybe WG.INI is missing?
-1031	PI_WAVE_EDITOR_FUNC_NOT_LOADED	The WGWaveEditor DLL function was not found at startup
-1032	PI_USER_CANCELLED	The user cancelled a dialog
-1033	PI_C844_ERROR	Error from C-844 Controller
-1034	PI_DLL_NOT_LOADED	DLL necessary to call function not loaded, or function not found in DLL
-1035	PI_PARAMETER_FILE_PROTECTED	The open parameter file is protected and cannot be edited
-1036	PI_NO_PARAMETER_FILE_OPENED	There is no parameter file open
-1037	PI_STAGE_DOES_NOT_EXIST	Selected stage does not exist
-1038	PI_PARAMETER_FILE_ALREADY_OPENED	There is already a parameter file open. Close it before opening a new file

-1039	PI_PARAMETER_FILE_OPEN_ERROR	Could not open parameter file
-1040	PI_INVALID_CONTROLLER_VERSION	The version of the connected controller is invalid
-1041	PI_PARAM_SET_ERROR	Parameter could not be set with SPA--parameter not defined for this controller!
-1042	PI_NUMBER_OF_POSSIBLE_WAVES_EXCEEDED	The maximum number of wave definitions has been exceeded
-1043	PI_NUMBER_OF_POSSIBLE_GENERATORS_EXCEEDED	The maximum number of wave generators has been exceeded
-1044	PI_NO_WAVE_FOR_AXIS_DEFINED	No wave defined for specified axis
-1045	PI_CANT_STOP_OR_START_WAV	Wave output to axis already stopped/started
-1046	PI_REFERENCE_ERROR	Not all axes could be referenced
-1047	PI_REQUIRED_WAVE_NOT_FOUND	Could not find parameter set required by frequency relation
-1048	PI_INVALID_SPP_CMD_ID	Command ID given to SPP or SPP? is not valid
-1049	PI_STAGE_NAME_ISNT_UNIQUE	A stage name given to CST is not unique
-1050	PI_FILE_TRANSFER_BEGIN_MISSING	A uuencoded file transferred did not start with "begin" followed by the proper filename
-1051	PI_FILE_TRANSFER_ERROR_TEMP_FILE	Could not create/read file on host PC
-1052	PI_FILE_TRANSFER_CRC_ERROR	Checksum error when transferring a file to/from the controller
-1053	PI_COULDNT_FIND_PISTAGES_DAT	The PiStages.dat database could not be found. This file is required to connect a stage with the CST command
-1054	PI_NO_WAVE_RUNNING	No wave being output to specified axis
-1055	PI_INVALID_PASSWORD	Invalid password
-1056	PI_OPM_COM_ERROR	Error during communication with OPM (Optical Power Meter), maybe no OPM connected
-1057	PI_WAVE_EDITOR_WRONG_PARAMNUM	WaveEditor: Error during wave creation, incorrect number of parameters
-1058	PI_WAVE_EDITOR_FREQUENCY_OUT_OF_RANGE	WaveEditor: Frequency out of range
-1059	PI_WAVE_EDITOR_WRONG_IP_VALUE	WaveEditor: Error during wave creation, incorrect index for integer parameter
-1060	PI_WAVE_EDITOR_WRONG_DP_VALUE	WaveEditor: Error during wave creation, incorrect index for floating point parameter
-1061	PI_WAVE_EDITOR_WRONG_ITEM_VALUE	WaveEditor: Error during wave creation, could not calculate value
-1062	PI_WAVE_EDITOR_MISSING_GRAPH_COMPONENT	WaveEditor: Graph display component not installed
-1063	PI_EXT_PROFILE_UNALLOWED_CMD	User profile mode: command is not allowed, check for required preparatory commands
-1064	PI_EXT_PROFILE_EXPECTING_MOTION_ERROR	User profile mode: first target position in user profile is too far from current position
-1065	PI_EXT_PROFILE_ACTIVE	Controller is (already) in user profile mode

-1066	PI_EXT_PROFILE_INDEX_OUT_OF_RANGE	User profile mode: block or data set index out of allowed range
-1067	PI_PROFILE_GENERATOR_NO_PROFILE	ProfileGenerator: No profile has been created yet
-1068	PI_PROFILE_GENERATOR_OUT_OF_LIMITS	ProfileGenerator: Generated profile exceeds limits of one or both axes
-1069	PI_PROFILE_GENERATOR_UNKNOWN_PARAMETER	ProfileGenerator: Unknown parameter ID in Set/Get Parameter command
-1070	PI_PROFILE_GENERATOR_PAR_OUT_OF_RANGE	ProfileGenerator: Parameter out of allowed range
-1071	PI_EXT_PROFILE_OUT_OF_MEMORY	User profile mode: out of memory
-1072	PI_EXT_PROFILE_WRONG_CLUSTER	User profile mode: cluster is not assigned to this axis
-1073	PI_UNKNOWN_CLUSTER_IDENTIFIER	Unknown cluster identifier
-1074	PI_INVALID_DEVICE_DRIVER_VERSION	The installed device driver doesn't match the required version. Please see the documentation to determine the required device driver version.
-1075	PI_INVALID_LIBRARY_VERSION	The library used doesn't match the required version. Please see the documentation to determine the required library version.
-1076	PI_INTERFACE_LOCKED	The interface is currently locked by another function. Please try again later.
-1077	PI_PARAM_DAT_FILE_INVALID_VERSION	Version of parameter DAT file does not match the required version. Current files are available at www.pi.ws.
-1078	PI_CANNOT_WRITE_TO_PARAM_DAT_FILE	Cannot write to parameter DAT file to store user defined stage type.
-1079	PI_CANNOT_CREATE_PARAM_DAT_FILE	Cannot create parameter DAT file to store user defined stage type.
-1080	PI_PARAM_DAT_FILE_INVALID_REVISION	Parameter DAT file does not have correct revision.
-1081	PI_USERSTAGES_DAT_FILE_INVALID_REVISION	User stages DAT file does not have correct revision.
-1082	PI_SOFTWARE_TIMEOUT	Timeout Error. Some lengthy operation did not finish within expected time.
-1083	PI_WRONG_DATA_TYPE	A function argument has an unexpected data type.
-1084	PI_DIFFERENT_ARRAY_SIZES	Length of data arrays is different.
-1085	PI_PARAM_NOT_FOUND_IN_PARAM_DAT_FILE	Parameter value not found in parameter DAT file.
-1086	PI_MACRO_RECORDING_NOT_ALLOWED_IN_THIS_MODE	Macro recording is not permitted in this mode of operation.
-1087	PI_USER_CANCELLED_COMMAND	Command cancelled by user input.
-1088	PI_TOO_FEW_GCS_DATA	Controller sent too few GCS data sets
-1089	PI_TOO_MANY_GCS_DATA	Controller sent too many GCS data sets
-1090	PI_GCS_DATA_READ_ERROR	Communication error while reading GCS data
-1091	PI_WRONG_NUMBER_OF_INPUT_ARGUMENTS	Wrong number of input arguments.
-1092	PI_FAILED_TO_CHANGE_CCL_LEVEL	Change of command level has failed.
-1093	PI_FAILED_TO_SWITCH_OFF_SERVO	Switching servo mode off has failed.

-1094	PI_FAILED_TO_SET_SINGLE_PARAMETER_WHILE_PERFORMING_CST	A parameter could not be set while performing CST: CST was not performed (parameters remain unchanged).
-1095	PI_ERROR_CONTROLLER_REBOOT	Connection could not be reestablished after reboot.
-1096	PI_ERROR_AT_QHPA	Sending HPA? or receiving the response has failed.
-1097	PI_QHPA_NONCOMPLIANT_WITH_GCS	HPA? response does not comply with GCS2 syntax.
-1098	PI_FAILED_TO_READ_QSPA	Response to SPA? could not be received.Response to SPA? could not be received.
-1099	PI_PAM_FILE_WRONG_VERSION	Version of PAM file cannot be handled (too old or too new)
-1100	PI_PAM_FILE_INVALID_FORMAT	PAM file does not contain required data in PAM-file format
-1101	PI_INCOMPLETE_INFORMATION	Information does not contain all required data
-1102	PI_NO_VALUE_AVAILABLE	No value for parameter available
-1103	PI_NO_PAM_FILE_OPEN	No PAM file is open
-1104	PI_INVALID_VALUE	Invalid value
-1105	PI_UNKNOWN_PARAMETER	Unknown parameter
-1106	PI_RESPONSE_TO_QSEP_FAILED	Response to SEP? could not be received.
-1107	PI_RESPONSE_TO_QSPA_FAILED	Response to SPA? could not be received.Response to SPA? could not be received.
-1108	PI_ERROR_IN_CST_VALIDATION	Error while performing CST: One or more parameters were not set correctly.
-1109	PI_ERROR_PAM_FILE_HAS_DUPLICATE_ENTRY_WITH_DIFFERENT_VALUES	PAM file has duplicate entry with different values.
-1110	PI_ERROR_FILE_NO_SIGNATURE	File has no signature
-1111	PI_ERROR_FILE_INVALID_SIGNATURE	File has invalid signature
-10000	PI_PARAMETER_DB_INVALID_STAGE_TYPE_FORMAT	PI stage database: String containing stage type and description has invalid format.
-10001	PI_PARAMETER_DB_SYSTEM_NOT_AVAILABLE	PI stage database: Database does not contain the selected stage type for the connected controller.
-10002	PI_PARAMETER_DB_FAILED_TO_ESTABLISH_CONNECTION	PI stage database: Establishing the connection has failed.
-10003	PI_PARAMETER_DB_COMMUNICATION_ERROR	PI stage database: Communication was interrupted (e.g. because database was deleted).
-10004	PI_PARAMETER_DB_ERROR_WHILE_QUERYING_PARAMETERS	PI stage database: Querying data failed.
-10005	PI_PARAMETER_DB_SYSTEM_ALREADY_EXISTS	PI stage database: System already exists. Rename stage and try again.
-10006	PI_PARAMETER_DB_QHPA_CONTANS_UNKNOWN_PAM_IDS	PI stage database: Response to HPA? contains unknown parameter IDs.
-10007	PI_PARAMETER_DB_AND_QHPA_ARE_INCONSISTENT	PI stage database: Inconsistency between database and response to HPA?.
-10008	PI_PARAMETER_DB_SYSTEM_COULD_NOT_BE_ADDED	PI stage database: Stage has not been added.

-10009	PI_PARAMETER_DB_SYSTEM_COULD_NOT_BE_REMOVED	PI stage database: Stage has not been removed.
-10010	PI_PARAMETER_DB_CONTROLLER_DB_PARAMETERS_MISMATCH	Controller does not support all stage parameters stored in PI stage database. No parameters were set.
-10011	PI_PARAMETER_DB_DATABASE_IS_OUTDATED	The version of PISTAGES3.DB stage database is out of date. Please update via PIUpdateFinder. No parameters were set.
-10012	PI_PARAMETER_DB_AND_HPA_MISMATCH_STRICT	Mismatch between number of parameters present in stage database and available in controller interface. No parameters were set.
-10013	PI_PARAMETER_DB_AND_HPA_MISMATCH_LOOSE	Mismatch between number of parameters present in stage database and available in controller interface. Some parameters were ignored.
-10014	PI_PARAMETER_DB_FAILED_TO_SET_PARAMETERS_CORRECTLY	One or more parameters could not be set correctly on the controller.
-10015	PI_PARAMETER_DB_MISSING_PARAMETER_DEFINITIONS_IN_DATABASE	One or more parameter definitions are not present in stage database. Please update PISTAGES3.DB via PIUpdateFinder. Missing parameters were ignored.