
PIMag® Controller

This document describes the C-413.1G PIMag® controller.

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Symbols and Typographic Conventions

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

NOTICE



Dangerous situation

If not avoided, the dangerous situation will result in damage to the equipment.

- Actions to take to avoid the situation.

INFORMATION

Information for easier handling, tricks, tips, etc.

Symbol/Label	Meaning
1.	Action consisting of several steps whose sequential order must be observed
2.	
➤	Action consisting of one or several steps whose sequential order is irrelevant
•	List item
p. 5	Cross-reference to page 5
Motor	Labeling of an operating element on the product (example: socket on the C-413.1G for connection for the voice coil drive)

Other Applicable Documents

The latest versions of the user manuals are available for download (p. 3) on our website.

Description	Document
C-413.2xx PIMag® controllers	MS224E User Manual See the user manual for the following: <ul style="list-style-type: none"> ▪ Descriptions of the commands that can be sent via the TCP/IP interface ▪ Parameter descriptions ▪ Descriptions of control algorithms and other functional principles ▪ Software overview ▪ Details concerning start-up and operation
C-413 GCS driver library for use with NI LabVIEW software	MS225E Software Manual
PI GCS 2.0 DLL	SM151E Software Manual
GCS array data format description	SM146E Software Manual
PIMikroMove	SM148E Software Manual

Description	Document
PI Update Finder: Search and download updates	A000T0028 Technical Note
PI Update Finder: Updating PC without Internet connection	A000T0032 Technical Note

Downloading Manuals

INFORMATION

If a manual is missing or problems occur with downloading:

- Contact our customer service department (p. 16).

INFORMATION

For products that are supplied with software (CD in the scope of delivery), access to the manuals is protected by a password. Protected manuals are only displayed on the website after entering the access data.

You need the product CD to get the access data.

For products with CD: Get access data

- 1) Insert the product CD into the PC drive.
- 2) Switch to the Manuals directory on the CD.
- 3) In the Manuals directory, open the Release News (file including releasenews in the file name).
- 4) Get the access data for downloading protected content in the "User login for software download" section of the Release News. Possible methods for getting:
 - Link to a page for registering and requesting the access data
 - Direct input of user name and password
- 5) If the access data needs to be requested via a registration page:
 - a. Follow the link in the Release News.
 - b. Enter the required information in the browser window.
 - c. Click **Show login data** in the browser window.
 - d. Note the user name and password shown in the browser window.

Downloading manuals

If you have requested access data for protected contents via a registration page (see above):

- Click the links in the browser window to change to the content for your product and login in using the access data that you received.

General procedure:

- 1) Open the website www.pi.ws.
- 2) If access to the manuals is protected by a password:
 - a. Click **Login**.

- b. Log in with the user name and password.
- 3) Click **Search**.
- 4) Enter the product number up to the period (e.g., P-882) or the product family (e.g., PICMA® Bender) into the search field.
- 5) Click **Start search** or press the Enter key.
- 6) Open the corresponding product detail page in the list of search results:
 - a. If necessary: Scroll down the list.
 - b. If necessary: Click **Load more results** at the end of the list.
 - c. Click the corresponding product in the list.
- 7) Click the **Downloads** tab on the product detail page.
The manuals are displayed under **Documentation**.
- 8) Click the desired manual and save it to the hard disk of your PC or to a data storage medium.

Intended Use

The C-413.1G is a laboratory device as defined by DIN EN 61010-1. It is intended to be used in interior spaces and in an environment which is free of dirt, oil and lubricants.

According to its design, the C-413.1G is intended for operating stages with voice coil drives.

The C-413.1G is intended for closed-loop operation. For closed-loop operation, sensor signals must be provided. Furthermore, the C-413.1G can read the reference switch signals of the connected stages and process them further.

The C-413.1G may only be used in compliance with the technical specifications and instructions in this document and the C-413 standard user manual (MS224E). The user is responsible for process validation.

Safety Precautions

NOTICE



Supply voltage incorrectly connected!

Incorrect connection of the supply voltage can cause damage to the C-413.1G.

- Only operate the C-413.1G when the supply voltage is properly connected; see "Pin Assignment" (p. 21).

Scope of Delivery

Item number	Components
C-413.1G	PIMag® motion controller, 1 channel, benchtop device, optional force control
3763	Power cord
K050B0003	Adapter for the power supply connection; barrel connector to M8 4-pin connector
C-663.PS	Wide-range-input power supply 24 V / 42 W

Item number	Components
C-413.CD	Product CD with software and user manuals for the C-413
C-815.563	Cross-over network cable
C-815.553	Straight-through network cable
C413T0008	User manual for C-413.1G, this document

Product Description

C-413.1G Front Panel



Labeling	Type	Function
Motor	Sub-D 9 (f) (p. 19)	Connection for the voice coil drive
Sensor	Sub-D 25 (f) (p. 20)	Connection for position sensor and force sensor: <ul style="list-style-type: none"> ▪ Sensor and ID chip data (via SPI) ▪ Reference switch signals
I/O	Sub-D 15 (f) (p. 19)	Digital lines (see p. 11 for details): <ul style="list-style-type: none"> ▪ Outputs: Show the current state ▪ Inputs: Command target positions and forces Analog output lines: <ul style="list-style-type: none"> ▪ Analog output 1 shows the axis position ▪ Analog output 2 shows the axis force
Ethernet	RJ45 socket	Network connection via TCP/IP
Status	LED green/red/off	State: <ul style="list-style-type: none"> ▪ Green: C-413.1G is ready for operation. ▪ Red: Error (error code \neq 0). The error code can be queried with the ERR? command. The query resets the error code to zero and the LED is deactivated. ▪ Alternating green/red: C-413.1G is changing its IP address ▪ Off: C-413.1G is not ready or no power supply is connected.
24 V DC	M8 panel plug, 4-pin (p. 21)	Connection for the supply voltage

C-413.1G Side Panel

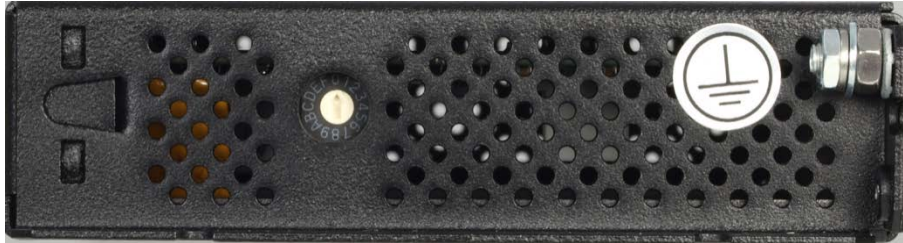




Figure 1: Side panel of the C-413.1G with rotary coding switch and functional earth connection

Labeling	Type	Function
	Rotary coding switch	IP address setting for communication via TCP/IP, see p. 10
	M4 threaded pin	Functional earth connection

Commandable Items

The following table contains the items that can be accessed with commands of the PI General Command Set (GCS).

Item	Number	Identifier	Description
Logical axis	1	1	<p>The logical axis represents the motion of the stage in the firmware of the C-413.1G. It corresponds to the axis of a linear coordinate system.</p> <p>All commands for the motion of a stage refer to logical axes.</p> <p>The value of the Number Of System Axes parameter (ID 0x0E000B02) specifies the number of axes.</p> <p>The input and output signal channels of the C-413 can be flexibly allocated to the axis.</p>
Input signal channels	2	1, 2	<p>Channels that are intended for sensors; inputs via the Sensor socket (p. 20). The number can be queried via the Number Of Sensor Channels parameter (ID 0x0E000B03).</p> <p>The total number of input signal channels can be queried via the Number Of Input Channels parameter (ID 0x0E000B00).</p>

Item	Number	Identifier	Description
Output signal channels	3	1 to 3	<p>1: Channel of the motor driver output of the C-413; output via the Motor socket (p. 19). The number can be queried via the Number Of Driver Channels parameter (ID 0x0E000B04).</p> <p>2 and 3: Channels of the analog outputs; output via the I/O socket (p. 19). Each analog output can be used to monitor the position, force or velocity of an axis or to control an external motor driver.</p> <p>The total number of output signal channels can be queried via the Number Of Output Channels parameter (ID 0x0E000B01).</p>
Digital outputs	5	1 to 5	<p>1 to 5 identify digital output lines 1 to 5 of the I/O socket (p. 19). Digital output 6 (pin 13 of the I/O socket) is not accessible for commands. It can be used to read out the servo cycles.</p> <p>Further information, see "Using the Customized DIO Interface of the C-413.1G" (p. 11) and "Digital Output Signals" in the C-413 user manual.</p>
Digital inputs	4	1 to 4	<p>1 to 4 identify digital input lines 1 to 4 of the I/O socket (p. 19). Further information, see "Using the Customized DIO Interface of the C-413.1G" (p. 11) and "Digital Input Signals" in the C-413 user manual.</p>
Wave generator	1	1	The number of wave generators corresponds to the number of logical axes.
Wave table	8	1 to 8	<p>The wave tables contain the saved data (a total of 4096 points) for the waveforms that are output by the wave generator.</p> <p>The value of the Number Of Waves parameter (ID 0x1300010A) indicates the number of wave tables.</p>
Data recorder table	≤8	1, 2, ...	<p>The data recorder tables contain the recorded data (a total of 4096 points). The number of data recorder tables can be set with the Data Recorder Channel Number parameter (ID 0x16000300). The Max Number Of Data Recorder Channels parameter (ID 0x16000100) indicates the maximum number of data recorder tables.</p>
Overall system	1	1	C-413 as an overall system.

Installation

Connecting the C-413.1G to the Functional Earth Conductor

INFORMATION

If the C-413.1G is not connected to the functional earth conductor, interferences may occur which can affect measurements.

- Connect the C-413.1G to the functional earth conductor before conducting measurements.

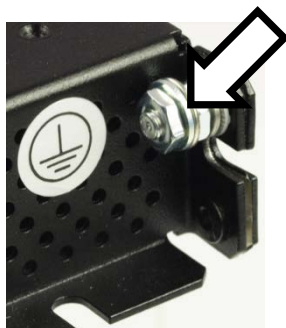


Figure 2: Functional earth connection of the C-413.1G

- Connect the threaded pin (see arrow) on the case of the C-413.1G to the functional earth conductor.

Interconnecting the System

- 1) Make sure that the C-413.1G is switched off (i.e. C-413.1G is **not** connected to the power supply).
- 2) Interconnect stage and C-413.1G using suitable motor and sensor cables (see “Motor”, p. 19, and “Sensor”, p. 20). Do **not** exceed a maximum cable length of 3 m.
- 3) Connect the C-413.1G to the network (via the RJ45 socket) and to the necessary I/O signals (see “I/O on C-413.1G”, p. 19) using suitable cables.
- 4) Secure the connections against being accidentally pulled out, e.g. using integrated screws.

Operation

For details concerning start-up and operation, see the MS224 user manual for C-413.2xx PIMag® controllers.

INFORMATION

Optional with stages that are equipped with a return mechanism: If you want to keep the motion caused by the return mechanism of the stage as small as possible when you switch off the C-413.1G, proceed as follows:

1. Switch to the Pos_vel closed-loop control mode (ID 7) using the CMO command.
 2. Command a motion to the minimum possible position (depends on the application).
 3. Switch off the servo mode for the axis using the SVO command.
 4. Switch off the C-413.1G.
-

INFORMATION

When the C-413.1G is switched on but the servo mode for the axis is switched off, the weight force of the moving mass is compensated for by the C-413.1G (see “AutoZero Procedure for Weight Force Compensation” in the C-413 user manual (MS224E)).

Default Configuration

The C-413.1G comes preconfigured for the stage with which it was ordered. Other important settings:

- Default closed-loop control mode: Position control with subordinate velocity control (Pos_vel; ID 7)
- TCP/IP properties: IP address selection via rotary coding switch in combination with parameter settings, see “Configuration of IP Address for Communication via TCP/IP” below for details.
- Command interface for motions: TCP/IP (see p. 11 for how to use the customized DIO interface)

Configuration of IP Address for Communication via TCP/IP

The IP address used by the C-413.1G for communication via TCP/IP results from the setting of the rotary coding switch. With some settings of the rotary coding switch, the IP address in addition is influenced by parameter settings of the C-413.1G. See the table below for details.

Rotary switch setting	Resulting IP address of the C-413.1G
0 (default)	IP address is obtained via DHCP or automatically configured using AutoIP. When the C-413.1G is switched on or rebooted, the value of the Ethernet IP-Address parameter (ID 0x11000600) is set to 0.0.0.0:50000, and the value of the IP-Configuration parameter (ID 0x11000800) is set to 1 (= DHCP or Auto-IP is used to obtain IP address) in volatile and nonvolatile memory.
1	Offset = 1*
2	Offset = 2*
3	Offset = 3*
4	Offset = 4*
5	Offset = 5*
6	Offset = 6*
7	Offset = 7*
8	Offset = 8*
9	Offset = 9*
A	Offset = 10*
B	Offset = 11*
C	Offset = 12*
D	Offset = 13*
E	Offset = 14*
F	Static IP address to be used = value of the Ethernet Fixed IP-Address parameter (ID 0x11000602) When the C-413.1G is switched on or rebooted, the value of the Ethernet IP-Address parameter (ID 0x11000600) is set to the value of the Ethernet Fixed IP-Address parameter (ID 0x11000602), and the value of the IP-Configuration parameter (ID 0x11000800) is set to 0 (= Static-IP is used) in volatile and nonvolatile memory.

Static IP address to be used = offset given by the rotary switch setting + value of the **Ethernet Base IP-Address** parameter (ID 0x11000601)
The offset given by the rotary switch setting depends on the value of the **Ethernet IP-Address Increment** parameter (ID 0x11000603).

When the C-413.1G is switched on or rebooted, the value of the **Ethernet IP-Address** parameter (ID 0x11000600) is set to the resulting static IP address, and the value of the **IP-Configuration** parameter (ID 0x11000800) is set to 0 (= Static-IP is used) in volatile and nonvolatile memory.

Example:
 Value of **Ethernet Base IP-Address** (ID 0x11000601) = 192.168.1.1:50000 (default)
 Value of **Ethernet IP-Address Increment** (ID 0x11000603) = 1 (default)
 Rotary coding switch is set to 7
 → Resulting IP address is 192.168.1.8:50000

* Offset value with the default value (1) of the **Ethernet IP-Address Increment** parameter (ID 0x11000603).

Default values of the parameters relevant for communication via TCP/IP:

Parameter	Default value
Ethernet IP-Address (ID 0x11000600)	0.0.0.0:50000
Ethernet Base IP-Address (ID 0x11000601)	192.168.1.1:50000
Ethernet Fixed IP-Address (ID 0x11000602)	192.168.1.99:50000
Ethernet IP-Address Increment (ID 0x11000603)	1
IP-Netmask (ID 0x11000700)	255.255.0.0
IP-Configuration (ID 0x11000800)	1 = DHCP or Auto-IP is used to obtain IP address

INFORMATION

A changed setting of the rotary coding switch becomes effective after the C-413.1G is switched on or rebooted.

- If you have changed the setting of the rotary coding switch while the C-413.1G was switched on, reboot the C-413.1G or switch it off and back on again to activate the new setting.

Behaviour after switching on or rebooting the C-413.1G:

The C-413.1G reads the setting of the rotary switch and compares the resulting IP address (“new address”) with the current valid IP address (given by the **Ethernet IP-Address** parameter (ID 0x11000600)). If the values are identical, communication can be established. If the values differ, the C-413.1G changes the value of the **Ethernet IP-Address** parameter to the new address. In addition, the C-413.1G may change the value of the **IP-Configuration** parameter (ID 0x11000800). The changes are made in volatile and nonvolatile memory. During the change procedure, the color of the **Status** LED on the C-413.1G front panel is alternately switching between red and green. The change procedure takes a few seconds.

- Do **not** switch off the C-413.1G during the change procedure.
- Make sure that the change procedure is finished before you establish communication via TCP/IP.

Using the Customized DIO Interface of the C-413.1G

On the **I/O** socket, the C-413.1G provides digital input and output lines for use as a customized DIO interface, for pinout see p. 19. Functionality of the customized DIO interface:

- Digital input lines can be used to command motions of the stage.
- Digital output lines can be used to read the current state of the stage.

To use the customized DIO interface, set the **Command Interface Selection** parameter (ID 0x15001A00) to the corresponding value. Possible values:

- 0 = TCP/IP (default); customized DIO interface is not used
- 1 = Customized DIO interface is used

Notes:

- Start up the system as described on p. 10 before you use the customized DIO interface.
- To have write access to the parameters mentioned in this section, you have to switch to command level 1 by sending `CCL 1 advanced`. You can use the SPA or SEP commands to change parameter values (see the C-413 user manual for details).
- When working with the customized DIO interface, it is **not** recommended to use the functionality which is described in the C-413 user manual for the digital input and output lines.
- When the customized DIO interface is used, the TCP/IP interface can still be used to send commands to the C-413.1G, e.g. to configure settings or to query values.

Using the Digital Input Lines to Command Motion

If the customized DIO interface is used, motions of the stage are determined by the states of the four digital input lines and by parameter settings as follows:

State of the digital input lines				Action and corresponding parameter	Default value of the parameter*
Line 4 (pin 8)	Line 3 (pin 15)	Line 2 (pin 7)	Line 1 (pin 14)		
0	0	0	0	Move to the target position which is given by the value of the Home-Position Value parameter (ID 0x15001A01)	0.0 mm
0	0	0	1	Move to the target position which is given by the value of the Pre-Position Value parameter (ID 0x15001A02)	1.0 mm
0	0	1	0	Apply the target force which is given by the value of the Target Force Value 1 parameter (ID 0x15001B00)	0.1 N
0	0	1	1	Apply the target force which is given by the value of the Target Force Value 2 parameter (ID 0x15001B01)	0.2 N
0	1	0	0	Apply the target force which is given by the value of the Target Force Value 3 parameter (ID 0x15001B02)	0.5 N
0	1	0	1	Apply the target force which is given by the value of the Target Force Value 4 parameter (ID 0x15001B03)	1.0 N
0	1	1	0	Apply the target force which is given by the value of the Target Force Value 5 parameter (ID 0x15001B04)	1.5 N
0	1	1	1	Apply the target force which is given by the value of the Target Force Value 6 parameter (ID 0x15001B05)	2.0 N
1	0	0	0	Apply the target force which is given by the value of the Target Force Value 7 parameter (ID 0x15001B06)	3.0 N
1	0	0	1	Apply the target force which is given by the value of the Target Force Value 8 parameter (ID 0x15001B07)	4.0 N
1	0	1	0	Apply the target force which is given by the value of the Target Force Value 9 parameter (ID 0x15001B08)	5.0 N
1	0	1	1	Apply the target force which is given by the value of the Target Force Value 10 parameter (ID 0x15001B09)	6.0 N
1	1	0	0	Apply the target force which is given by the value of the Target Force Value 11 parameter (ID 0x15001B0A)	7.0 N
1	1	0	1	Apply the target force which is given by the value of the Target Force Value 12 parameter (ID 0x15001B0B)	8.0 N
1	1	1	0	Apply the target force which is given by the value of the Target Force Value 13 parameter (ID 0x15001B0C)	9.0 N
1	1	1	1	Apply the target force which is given by the value of the Target Force Value 14 parameter (ID 0x15001B0D)	10.0 N

* Exemplary values; value may vary depending on the stage model used.

Using the Digital Output Lines to Read the Current State

If the customized DIO interface is used, the current motion state of the stage can be read via the states of the digital output lines 1 and 2. The settings for settling window and delay time are used to determine if the target is reached, see "On-Target State" in the C-413 user manual for details. Default values with C-413.1G:

- Settling window for position: ± 0.005 mm
- Settling window for force: ± 0.02 N
- Delay time: 10 ms

State of the digital output lines		Motion state of the V900B042x
Line 2 (pin 11)	Line 1 (pin 3)	
0	0	Home position is reached (target given by the value of the Home-Position Value parameter)
0	1	Pre-position is reached (target given by the value of the Pre-Position Value parameter)
1	0	The target force is reached (given by one of the Target Force Value parameters)
1	1	Stage is moving, i.e. the target is not reached.

The state of the digital output line 5 (pin 5) indicates the current error state of the customized DIO interface (low = no error, high = error). The current error code can be read using the STA? command (over the TCP/IP interface).

STA? (Get DIO Command Interface Error Code)

Description: Gets error code <int> of the customized DIO interface of the C-413.1G.
When the customized DIO interface is **not** used (parameter 0x15001A00 has the value 0), the response to STA? is always 0 (no error).
Digital output line 5 indicates if an error is present on the customized DIO interface. Use STA? to query the error code. If the error code in the response to STA? is 7, use the ERR? command to query error details.

STA? does not reset the error state and the error code of the customized DIO interface.

Format: STA?

Arguments: None

Response: <int> is the current error code of the customized DIO interface of the C-413.1G. Possible values:

0 = No error

1 = End of position travel range

2 = End of force travel range

3, 4, 5, 6, = reserved

7 = Other error (at present, the errors of the PI GCS are indicated here, can also be queried using the ERR? command)

Troubleshooting: Communication breakdown

Force Control— Find-Surface Procedure

The C-413.1G supports a find-surface procedure.

FSF (Start Find-Surface Procedure)

Description: Starts a find-surface procedure.

A find-surface procedure is recommended for axes that are to be operated in a force control mode.

The find-surface procedure detects the surface position and saves the result as the Pre-Position Value (parameter ID 0x15001A02). The pre-position value is the sum of the found surface position and the <PositionOffset> distance specified with the FSF command.

If the force is scaled to gF and the position is scaled to mm: Optionally, an automatic adaptation of feedforward settings for force control can be included in the find-surface procedure. The automatic adaptation can be enabled via the Auto Adaption parameter (ID 0x1D000000; 0 = disabled, 1 = enabled). If automatic adaptation is enabled, the following parameters are adapted during the find-surface procedure: FFC Jerk On Subordinate Velocity Control (ID 0x07000316), FFC Jounce On Control Output (ID 0x07000317), and the coefficient of the axis in the output matrix (Driving Factor 1, IDs 0x09000000).

During the find-surface procedure, all parameters are changed in volatile memory only. If the results of the find-surface procedure are to be preserved when the C-413 is switched off or rebooted, they have to be saved with the WPA command.

Procedure details:

- 1) The closed-loop control mode of the axis is set to position control, and the servo mode is switched on.
- 2) The axis is moved to the position specified by the Auto Zero Low Value parameter (ID 0x07000A00).
- 3) When the axis is on target, the closed-loop control mode is set to force control.
- 4) The axis moves to the surface and exerts <Force 1> that has been specified with the FSF command.
- 5) When the axis is on target: The axis exerts the force specified by the Force Sensor Surface Detection Level parameter (0x07000401; gives the force threshold for the contact detection).
- 6) When the axis is on target: The current position is detected, and the sum of current position and <PositionOffset> is saved to the Pre-Position Value parameter (ID 0x15001A02).
- 7) The enable state of the automatic adaptation is checked:
 - Automatic adaptation is enabled: The procedure continues with step 8.
 - Automatic adaptation is disabled: The procedure continues with step 9.
- 8) If automatic adaptation is enabled:
 - a. The axis exerts <Force 1>.
 - b. When the axis is on target: Force, control output and current position of the axis are internally saved.

- c. The axis exerts <Force 2> that has been specified with the FSF command.
 - d. When the axis is on target: Force, control output and current position of the axis are internally saved.
- 9) When the axis is on target: The closed-loop control mode of the axis is set to position control.
 - 10) The axis is moved to the position specified by the Auto Zero Low Value parameter (ID 0x07000A00).
 - 11) If automatic adaptation is enabled: The feedforward settings and the matrix coefficient of the axis are adapted according to the values saved in step 8.
 - 12) If servo mode was off at the start of the find-surface procedure, it is switched off again.

The find-surface procedure can be stopped with #24.

Use the FSR? command (p. 15) to check if the find-surface procedure has finished successfully. Starting a find-surface procedure first resets the FSR? response to 0.

Format: FSF <AxisID> <Force1> <PositionOffset> [<Force2>]

Arguments: <AxisID> is one axis of the controller, as string
 <Force1> is a force value as float. Unit: N (or gF).
 <PositionOffset> distance to be added to the found surface position, as float.
 <Force2> is a force value as float. Unit: N (or gF).

Response: none

FSF? (Get Settings Of Find-Surface Procedure)

Description: Gets the settings made with FSF.

Format: FSF? [<AxisID>]

Arguments: <AxisID> is one axis of the controller, as string

Response: {<AxisID>="<Force1> <PositionOffset> <Force2> LF}
 See FSF for descriptions.

FSR? (Get Result Of Find-Surface Procedure)

Description: Gets the result of the find-surface procedure.

Format: FSR? [<AxisID>]

Arguments: <AxisID> is one axis of the controller, as string

Response: {<AxisID>="<uint> LF}
 where
 <uint> indicates the result: 1 = successfull, 0 = procedure failed / still running

Maintenance

The C-413.1G controller is maintenance-free.

Cleaning

NOTICE



Short circuits or flashovers!

The C-413.1G controller contains electrostatic sensitive devices that can be damaged by short circuits or flashovers when cleaning fluids penetrate the controller case.

- Before cleaning, remove the C-413.1G controller from the power source by pulling the power plug.
- Prevent cleaning fluid from penetrating the controller case.

- Before cleaning, make sure that you have removed the C-413.1G controller from the power source.
- When necessary, clean the surfaces of the C-413.1G case with a cloth lightly dampened with a mild cleanser or disinfectant.

Customer Service

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

- If you have questions concerning your system, have the following information ready:
 - Product and serial numbers of all products in the system
 - Firmware version of the controller (if present)
 - Version of the driver or the software (if present)
 - Operating system on the PC (if present)
- 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 (p. 3) on our website.

Technical Data

Specifications

Preliminary data	C-413.1G controller	Unit
Function	PIMag® motion controller for voice coil drives	
Motor channels	1	
Sensor channels	2	
Motion and control		
Servo characteristics	PID controller for force, position and velocity; parameter change during operation; including feed-forward control	
Servo cycle time	100 µs to 200 µs, selectable in 4 steps, 100 µs is default	
Profile generator	Trapezoidal velocity profile, setting of maximum velocity and acceleration	
Encoder input	Differential SPI sensor interfaces	
Reference point switches	2 x differential (RS-422)	
Electrical properties		
Max. output voltage	24	V
Max. output current	±1.5	A, regulated
Interface and operation		
Communication interfaces	TCP/IP Digital input and output lines on I/O port	
Connection to actuator	Motor: Sub-D 9-pin (f) Sensors: Sub-D 25-pin (f)	
I/O port	6 x digital outputs; output 6 shows the servo cycle 4 x digital input 2 x analog output	
Command set	PI General Command Set (GCS)	
User software	PIMikroMove	
Software drivers	API for C / C++ / C# / VB.NET / MATLAB / Python, drivers for use with NI LabVIEW	
Supported functionality	Point-to-point motion, data recorder, wave generator, auto zero, ID chip detection	
Miscellaneous		
Operating voltage	24	V
Max. operating current	2	A
Operating temperature range	5 to 50	°C
Max. mass	0.35	kg
Dimensions	210 x 105 x 28	mm




Ambient Conditions and Classifications

The following ambient conditions and classifications must be observed for the C-413.1G controller:

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
Storage temperature	0 °C to 70 °C
Transport temperature	-25 °C to +85 °C
Overvoltage category	II
Protection class	I
Degree of pollution	2
Measurement category	I
Degree of protection according to IEC 60529	IP20

Maximum Ratings

The C-413.1G is designed for the following maximum ratings:

Input on:	Maximum Operating Voltage	Maximum Operating Frequency	Maximum Current Consumption
			
M8 panel plug, 4-pin (m)	24 V	==	2 A

Pin Assignment

I/O

Sub-D socket, 15-pin, female

Pin	Signal	Direction
1	AOUT1	Output
2	GND	-
3	Digital output 1	Output
4	Digital output 3	Output
5	Digital output 5	Output
6	GND	-
7	Digital input 2	Input
8	Digital input 4	Input
9	AOUT2	Output
10	5 V (Maximum output power 500 mW)	Output
11	Digital output 2	Output
12	Digital output 4	Output
13	Digital output 6*	Output
14	Digital input 1	Input
15	Digital input 3	Input

Recommendations for cable assembly:

- The lines on pins 1, 2 and 9 (AOUT1, GND and AOUT2) should be shielded together, and should be separated from the digital input and output lines.
- The cable should have a total shield. This shield should be connected to the connector shells (this way, it will be connected to functional earth when connected to the I/O socket of the C-413.1G).

Analog outputs: -10 to 10 V, 17 bit, 1 kHz

Digital outputs: 24 V driver outputs (drives EN 61131-2, type 3 inputs)

Digital inputs: EN 61131-2, type 3 inputs, 11 V to 30 V, 6 mA max. input current

* Digital output 6 outputs a square wave signal based on the servo cycle (frequency = servo frequency/10).

Motor

Sub-D socket, 9-pin, female

Pin	Signal*
1	Motor P1
2	Motor N1
3	GND
4	NC**
5	NC**
6	Motor P1
7	Motor N1
8	NC**
9	NC**

Recommendations for cable assembly:

- Maximum cable length: 3 m
- The lines on pins 1, 2, 6 and 7 (Motor P1 und Motor N1) should be twisted and shielded together.

* Motor output on C-413.1G: ± 1.5 A, regulated; 24 V max.

** NC: not connected

Sensor

Sub-D socket, 25-pin, female.

Pin	Signal	Direction on C-413.1G
1	SPI_CLK+	Output
2	GND	-
3	SPI_MOSI-	Output
4	SPI_MISO+	Input
5	GND	-
6	SPI_CS_Sensor1-	Output
7	SPI_CS_Sensor2+	Output
8	GND	-
9	SPI_CS_Memory1-	Output
10	SPI_CS_Memory2-	Output
11	Reference1-	Input
12	Reference2-	Input
13	5 V Sensor Supply	Output
14	SPI_CLK-	Output
15	SPI_MOSI+	Output
16	GND	-
17	SPI_MISO-	Input
18	SPI_CS_Sensor1+	Output
19	GND	-
20	SPI_CS_Sensor2-	Output
21	SPI_CS_Memory1+	Output
22	SPI_CS_Memory2+	Output
23	Reference1+	Input
24	Reference2+	Input
25	5 V Sensor Supply	Output

Recommendations for cable assembly:

- Maximum cable length: 3 m
- The lines on the following pins should be implemented as twisted pairs:
 - 1 with 14
 - 3 with 15
 - 4 with 17
 - 6 with 18
 - 7 with 20
 - 9 with 21
 - 10 with 22
 - 11 with 23
 - 12 with 24
- The cable should have a total shield. This shield should be connected to the connector shells (this way, it will be connected to functional earth when connected to the sensor socket of the C-413.1G).

Power Supply Connection 24 V DC

Phoenix M8 panel plug, 4-pin, male



Pin	Function
1	GND (power)
2	GND (power)
3	Input: 24 V DC
4	Input: 24 V DC

Recommendations for cable assembly:

- All lines should be twisted and shielded together.
- The GND lines should be completely separated from functional earth. Otherwise, interferences may occur which can affect measurements.
- The shield should be connected to the connector shells (this way, it will be connected to functional earth when connected to the 24 V DC socket of the C-413.1G).