Software Manual

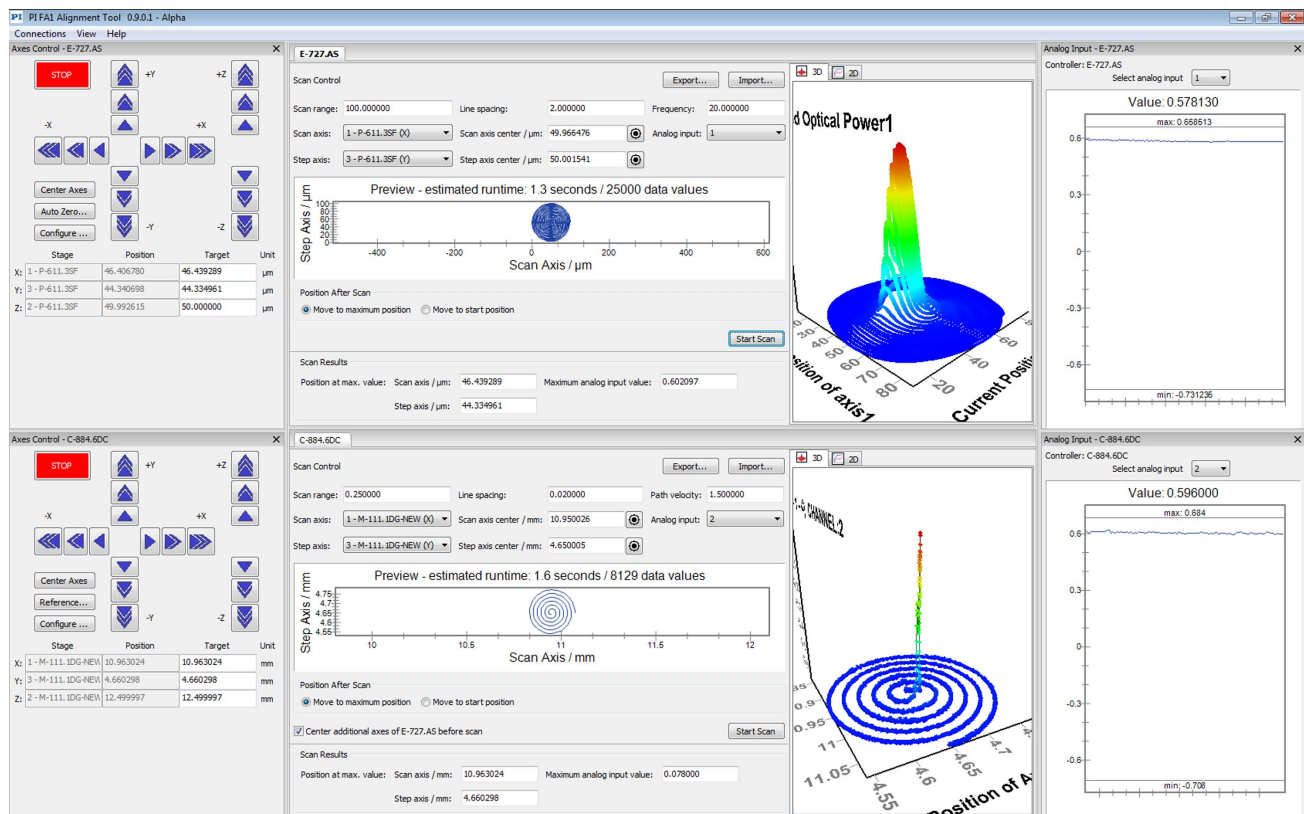C990T0001, valid for C-990.FA1

BRo, 6/5/2024

C-990.FA1 PI FA1 Alignment Tool

Software for aligning optoelectronic components; for use with C-884 controller for motorized axes and E-727.AS controller with fast alignment routines (spiraled area scan) for piezo axes with strain gauge sensors.

Contents

Physik Instrumente (PI) GmbH & Co. KG, Auf der Roemerstrasse 1, 76228 Karlsruhe, Germany
Phone +49 721 4846-0, Fax +49 721 4846-1019, Email info@pi.ws, www.pi.ws

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Subject to change. This manual is superseded by any new release. The latest respective release is available for download on our website (http://www.pi.ws).

The devices and software tools that are mentioned in this documentation are described in their own manuals.

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Definition of Terms

F-131.3SD1 system	Photonics alignment system available from PI. Consists of three stacked M-111 linear stages, one three-axis P-611 NanoCube® nanopositioner, one C-884.4DC controller for DC motors, and one E-727.AS controller. E-727.AS controls the axes of the P-611 NanoCube® nanopositioner, and C-884.4DC controls the stacked M-111 linear stages.

Photonics Alignment	The goal of photonics alignment is to align optical components— transmitter or receiver— so that the maximum optical power is measured on the receiver side. During the alignment of transmitter or receiver in axes x, y and z, the power of the optical signal (light) is measured on the receiver side with a power meter. The power meter converts the optical power into an analog signal that is fed into the controllers.
PI FA1 Alignment Tool	Program name. Note that the product code for purchase orders is "C-990.FA1".
Spiraled area scan	An area scan is performed during photonics alignment to find the position of the global intensity maximum of the measured signal in a given area. With a spiraled scan, the motion of scan axis and step axis results in a spiral that covers the scan area. The start position is the center of the (square) scan area.

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Function Reference

The PI FA1 Alignment Tool allows the user to operate the F-131.3SD1 photonics alignment system and similar PI systems in scanning applications easily. The program makes it possible to configure and execute spiraled area scans. The user can choose to go to the position of the maximum intensity that was found or go back to the start position.
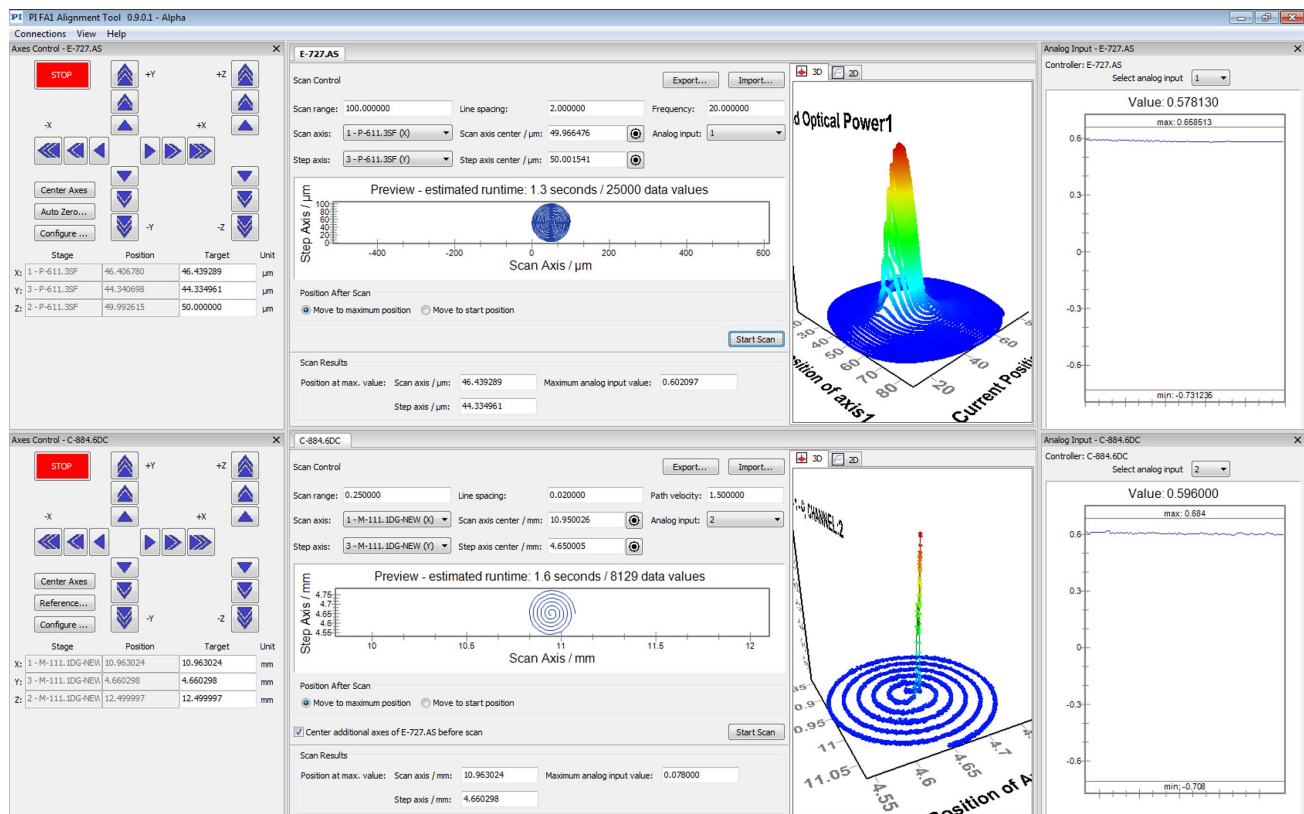

Figure 1: PI FA1 Alignment Tool, main window

The scan configurations can be saved to and imported from files on the PC.

The scan results can be saved as data file or image.

The program configuration is saved in a configuration file on the PC so that the last configuration is immediately available at the next start of the program.

Menu Bar

- *Connections*: You can close all connections, and clear the *Last Connections* list in the *Connect Devices* window.

- *View*: You can show the following:

    - *Connect Devices* window (p. 6)

    - *Advanced* pane in the *Scan Control* tab cards; gives you access to data recorder and timing settings for the scan (p. 13)

    - *Command Entry* windows for the connected controllers (p. 9)

    - *Axes Control* windows for the connected controllers (p. 7)

    - *Analog Input* windows for the connected controller (p. 9)

- *Help*: You can import licenses for controllers (p. 11), show this manual and program version information.

Connect Devices
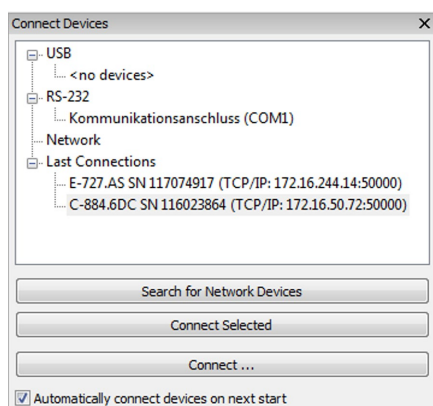
In the *Connect Devices* window, you can establish the communication between the PC and the controllers.

- When you try to establish the connection to a controller for which the license has not yet been imported, you will obtain an "*Invalid license*" message. Import the license for the controller (p. 11).

The *Connect Devices* window automatically opens at program start. You can open it again using the *View > Show Connect Devices window* menu item.

If the controller to be connected is listed in the window, double-click its line, or mark it and click *Connect Selected*.

- The *Last Connections* item lists all connections that were successfully established in the past. In this way, you can easily establish a previous connection again. You can clear the list using the *Connections > Clear last connections* menu item.

If you want to use the TCP/IP interface and the controller is not listed in the window, click *Search for Network Devices* to add it to the list.

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If the controller is not found using **Search for Network Devices**, but you know its IP address and port, click **Connect …** to open the **Connect** dialog. In the **Connect** dialog, go to the **TCP/IP** tab, enter IP address and port and click **OK**.

If you want to reconnect the currently connected controllers at the next start of the PI FA1 Alignment Tool, tick the **Automatically connect devices on next start** box.

Axes Control
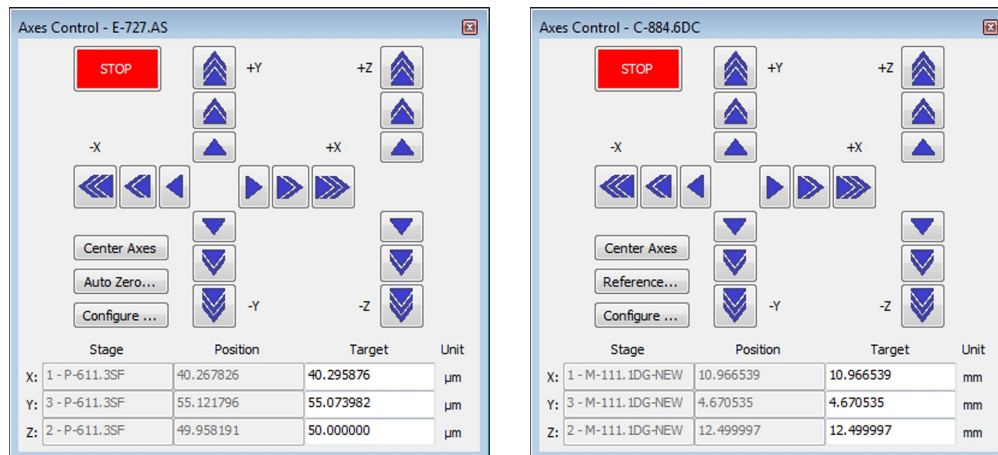
The PI FA1 Alignment Tool provides an **Axes Control** window for each controller connected.

The **Axes Control** windows by default open docked to the left-hand border of the main window. You can undock and dock them again by dragging them with the left-hand mouse button pressed.

You can open an **Axes Control** window again using the **View > E-727 > Show Axes Control** or **View > C-884 > Show Axes Control** menu item.

The **Axes Control** window is intended for the following tasks:

- If necessary, start a reference move (axes with incremental sensors) or an AutoZero procedure (axes with piezo actuators): **Reference…** button / **Auto Zero…** button
- Move the axes to their center position: **Center Axes**
- Execute motion of a particular step size by clicking the arrow buttons. The step sizes can be configured in the **Axes Control Options** window. Click **Configure…** to open this window.
- Execute motion to a certain target position by entering the target in the **Target** column of the axes table. Confirm the entry with the Enter button.

- Assign the axes of the mechanics to the directions of motion (X, Y, Z; invert axes) as defined in your application: Click **Configure…** to open the **Axes Control Options** window. The assignment applies to motion started in the **Axes Control** window. The X, Y, and Z assignment is also shown in the **Scan axis** and **Step axis** selection boxes of the **Scan Control** panel.
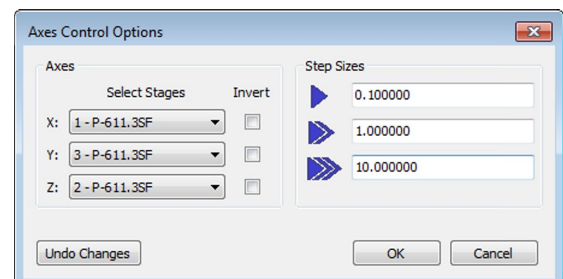
Scan Control
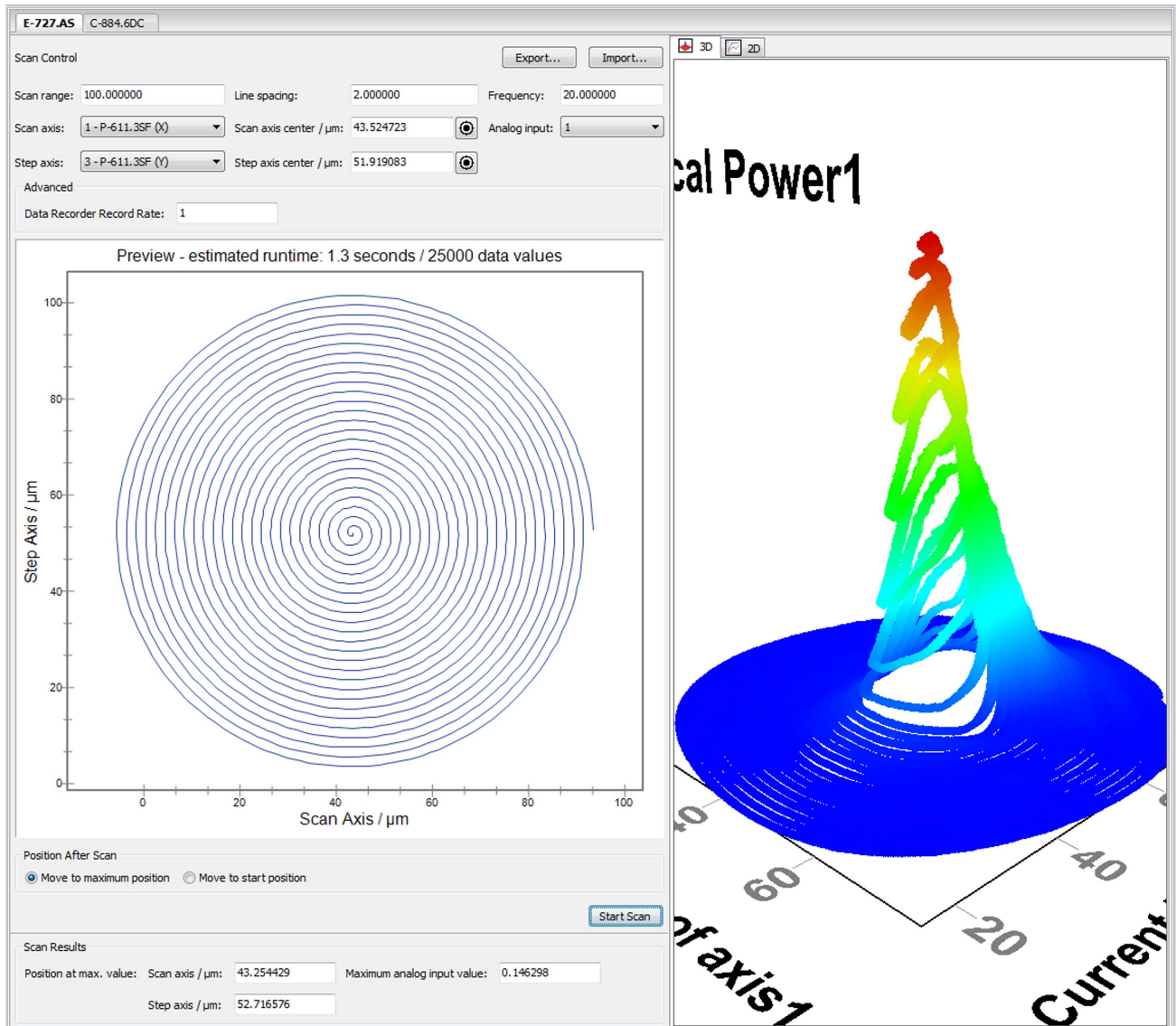
The PI FA1 Alignment Tool provides a *Scan Control* panel for each controller connected. Each panel has its own tab.

You can arrange the *Scan Control* tabs in the main window of the PI FA1 Alignment Tool by dragging them with the left-hand mouse button pressed.

Contents of the *Scan Control* panel:

- Controls for configuration and start of scans, for details, see "Scanning for the Maximum Intensity" (p. 13)
- Preview of the last configured scan
- Tabs with 3-D and 2-D graphic representations of the scan results, for further details, see "Handling of Scan Results" (p. 18)
- Panel with scan results

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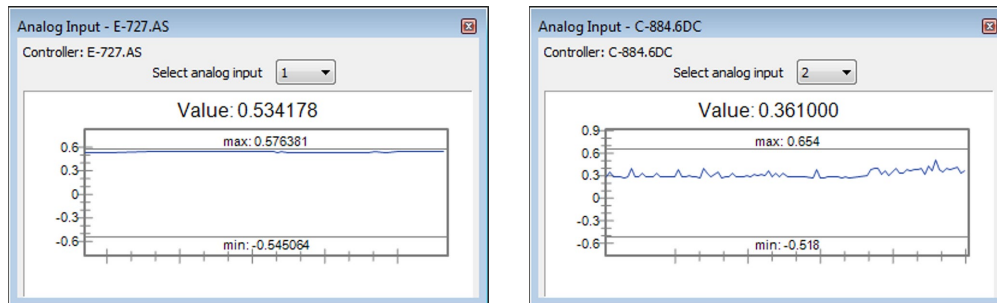
Analog Input

The PI FA1 Alignment Tool provides an *Analog Input* window for each controller connected.

The *Analog Input* windows by default open docked to the right-hand border of the main window. You can undock and dock them again by dragging them with the left-hand mouse button pressed.

You can open an *Analog Input* window again using the *View > E-727 > Show Analog Input* or *View > C-884 > Show Analog Input* menu item.

The *Analog Input* windows display the input signal as live chart, which allows the user to monitor the measured intensity permanently.

You can select the input channel to be displayed. The selection has no effect on the scan settings in the *Scan Control* panel.

Command Entry
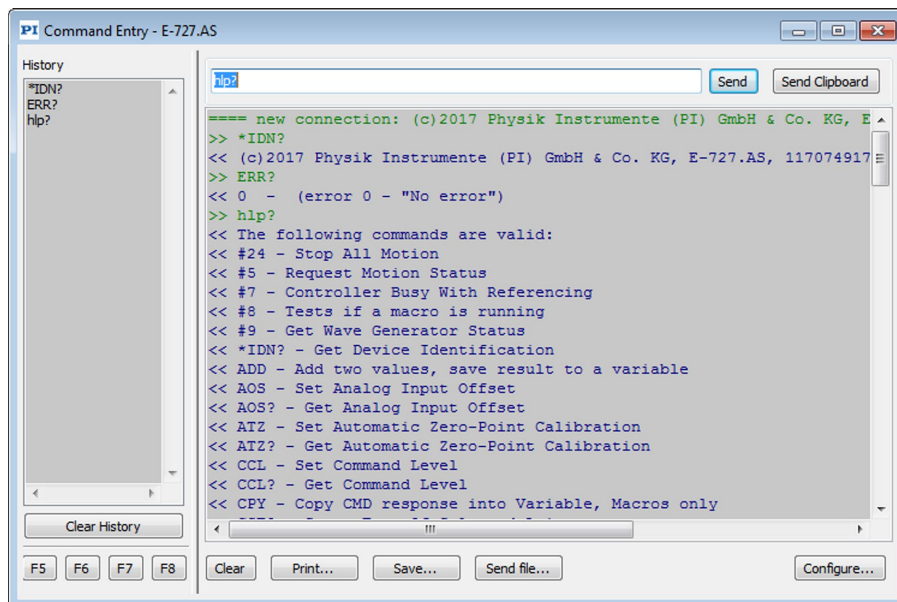
The PI FA1 Alignment Tool provides a *Command Entry* window for each controller connected.

You can open a *Command Entry* window using the *View > E-727 > Show Command Entry* or *View > C-884 > Show Command Entry* menu item.

In the **Command Entry** window, you can address GCS commands to the controller. See the response to the HLP? command for a list of all commands supported by the controller. For detailed descriptions of the commands, see the user manual or commands manual of the controller.

Configuration File

The following settings of the PI FA1 Alignment Tool are automatically saved in a configuration file:

- Connection settings (p. 6)
- **Axes Control** window (p. 7): Axis assignment, step size for the arrow buttons
- **Scan Control** panel (p. 8): Scan configuration, selection of the analog input channel

Working with the PI FA1 Alignment Tool

Requirements

To work with the PI FA1 Alignment Tool, the following requirements have to be fulfilled.

Program and Licence

You have purchased the PI FA1 Alignment Tool from PI.

PI has provided you with the program setup, and with a license file for each controller which is to be used with the program.

PC and Communication Interface

PC with Windows operating system (For information on the compatibility of the software with PC operating systems see the C-990.CD1 Release News in the root directory of the data storage device provided with the controller.)

You have installed the software provided on the data carrier with PI software (e.g., dynamic program library for GCS, PIMikroMove).

One of the following communication interfaces is available:

- COM port on the PC

- Ethernet connection in the PC or an access point in the network connected to the PC

- USB interface on the PC

Photonics Alignment System available from PI

The photonics alignment system (e.g., F-131.3SD1, p. 4) functions properly. To ensure this, start a few motion tests of the axes in PIMikroMove. Note that for motorized axes (e.g., axes connected to C-884), this includes loading the parameter settings for the connected stages from a stage database. See the E727T0005 user manual and the user manual of the C-884 controller for instructions.

Note that a new adjustment of the closed-loop performance is absolutely necessary whenever you change the load on the nanopositioner (which is, for example, the P-611 NanoCube®), e.g., by attaching, removing or replacing a fiber holder.

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The PIMikroMove software and the user manuals are provided on the data carrier with PI software which is in the scope of delivery of the controllers.

Analog Input

The measured optical power is fed as an analog input signal into the controllers of the photonics alignment system. The analog signal can be in the range from -10 V to +10 V.

Installing the PI FA1 Alignment Tool

You can install the PI FA1 Alignment Tool on any number of computers.

1. Start the installation wizard by double-clicking the **Setup.exe** file in the installation directory (root directory of the installation medium).

   The **InstallShield Wizard** window opens.

2. Follow the instructions on the screen to install the program and import the licenses for the controllers (for details on license import, see p. 11).

Starting the PI FA1 Alignment Tool

1. Start the PI FA1 Alignment Tool on the PC.
2. Establish communication with the controllers. For details, see "Connect Devices" (p. 6).
3. If necessary, import the licenses for the controllers. For details, see "Importing Licenses".

Importing Licences

You need a license for each controller which is to be used with the PI FA1 Alignment Tool.

If the product codes and the serial numbers of the controllers are known to PI at the time of purchase of the PI FA1 Alignment Tool, the license files are available on the installation medium and can be imported immediately after the program installation has finished.

If you want to get a licence file for another controller:

➢ Contact your PI sales engineer or our customer service department (p. 21). Have the product code and the serial number of the controller ready.

Import the license file (*serialnumber_productcode*.pilic) for the controller as follows:

1. Open the **Import PI license file** window:

   – Use the **Help > Import License …** menu item at any time.

   – When you establish a connection to the controller for the first time in the PI FA1 Alignment Tool: Confirm the "*Invalid license*" message with **OK**.

2. In the **Import PI license file** window, go to the directory where the license file (file extension .pilic) for the controller is located.

3. Double-click the file, or mark it and click **Open**.

   The PI FA1 Alignment Tool imports the license.

You can import an unrestricted number of licenses into the program, but only one E-727.AS

controller and one C-884 controller can be used at a time. If you have more controllers, use multiple instances of the program.

Configuring Axes and Analog Input

The configuration settings for axes and analog input are automatically saved in the configuration file (p. 10) so that they are immediately available at the next start of the PI FA1 Alignment Tool.

1. Click *Configure…* in the *Axes Control* windows (p. 7) to open the *Axes Control Options* window.

   a) Assign the axes of the mechanics to the directions of motion (X, Y, Z) as defined in your application. Note that the settings in the *Invert* boxes apply only to motion started using the controls in the *Axes Control* windows.

   b) Set the step sizes for motion that is triggered with the arrow buttons in the *Axes Control* windows.

2. For each controller, select the analog input channel to be used via the *Analog input* selection button in the *Scan Control* panel. The selection also applies to the *Analog Input* windows (p. 9).

Optional: Starting Motion Manually

NOTICE

Collisions between optical components and surroundings

Collisions can damage the optical components to be aligned, and the surroundings.

➢ When using the controls in the *Axes Control* windows to move the axes, watch the axis motion to avoid collisions.

➢ Keep in mind that the axes use different units of length for position values (target, current position):

  – Piezo-driven nanopositioners, e.g., P-611 NanoCube® (E-727.AS): µm

  – Motorized positioners, e.g., stacked M-111 linear stages (C-884): mm

Proceed as follows if you want to move the axes manually, for example, before or instead of using scans:

1. If necessary, start a reference move (axes with incremental sensors) or an AutoZero procedure (axes with piezo actuators) using the *Reference…* button / *Auto Zero…* button in the *Axes Control* windows.

2. Move the axes using the controls in the *Axes Control* windows (p. 7) towards the position where you expect the maximum intensity of the optical power and hence the maximum value of the analog input signal. When moving, watch the live charts in the *Analog Input* windows. The greater the voltage values, the greater the measured intensity. You have the following options for motion:

   – Move the axes to their center positions: *Center Axes*

   – Execute motion of a particular step size by clicking the arrow buttons

‒ Execute motion to a certain target position by entering the target in the *Target* column of the axes table. Confirm the entry with the Enter button.

Scanning for the Maximum Intensity

NOTICE

Collisions between optical components and surroundings

Collisions can damage the optical components to be aligned, and the surroundings.

With a spiral scan, the motion of scan axis and step axis results in a spiral that covers the square scan area. The start position is the center of the scan area.

➢ Configure the scans so that collisions are not possible. In particular, enter suitable values for
  ‒ Scan range
  ‒ Center position of the scan
➢ Keep in mind that the axes use different units of length for position values (target, current position):
  ‒ Piezo-driven nanopositioners, e.g., P-611 NanoCube® (E-727.AS): μm
  ‒ Motorized positioners, e.g., stacked M-111 linear stages (C-884): mm

Configuring and Running Scans

Configure and run scans as follows:

1. If necessary, start a reference move (axes with incremental sensors) or an AutoZero procedure (axes with piezo actuators) using the *Reference…* button / *Auto Zero…* button in the *Axes Control* windows.

2. Configure the spiraled area scans in the *Scan Control* panels (figure, see p. 8):

    a) Select the axes involved in the scan: *Scan axis*, *Step axis*

    b) Make sure that the proper analog input channel is selected: *Analog input*

    c) Specify the side length of the square scan area: *Scan range*

    d) Specify the start position of the scan (= center of the scan area): *Scan axis center*, *Step axis center*
    Click the ⊚ buttons if you want to use the current positions of the axes.

    e) Specify the separation distance between the successive turns of the spiral: *Line spacing*

    f) Specify the velocity for the scan.

        □ E-727: The velocity is the product of separation distance and frequency. Specify the *Frequency* in Hz.

□ C-884: *Path velocity*

The figures show the default settings of the PI FA1 Alignment Tool that are present when you run the program for the first time.

The configuration settings for the scans are automatically saved in the configuration file (p. 10) so that the last used settings are immediately available at the next start of the PI FA1 Alignment Tool.

You can also export scan configurations to files on the PC and import them later (p. 17).

3. Optional: Check the settings for data recorder and trajectory timing (C-884 only).

   a) Show the **Advanced** pane in the **Scan Control** panels using the **View > Show advanced features** menu item.

   b) Check the **Data Recorder Record Rate** entry in the **Advanced** pane. The value specifies the number of servo cycles before the recording of one data point. The PI FA1 Alignment Tool automatically optimizes the value when you configure a scan. You can change the value, but keep in mind that with a too high record table rate the maximum may not be precisely found, while with a too low record table rate the data recorder may be full before the axes have covered the scan area completely.

   c) In the **Scan Control** panel of C-884, click **Estimate** in the **Advanced** pane to check the trajectory timing for the scan.

4. Start the scan.

   a) In the **Position After Scan** pane, select the position to be approached by scan axis and step axis when the scan has been completed. Default and recommended: **Move to maximum position**.

   b) C-884 only, recommended: Tick the **Center axes of E-727.AS before scan** box.

c) Click the *Start Scan* button to start the scan.
While a scan is running, it is not possible to start a second scan.

5. Check the scan results.

The *Scan Results* pane displays the position and the value of the found maximum.

The *3D* and *2D* tabs show graphic representations of the scan results.

You can change the display properties and export the scan results to an image or data file using the toolbar buttons on the *2D* tab; for details, see p. 18.

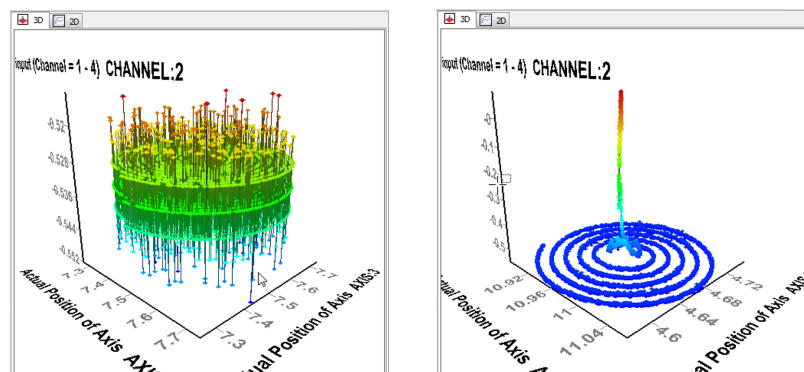The following figures show examples for scan results.

Figure 2: Scans performed by the stacked M-111 linear stages connected to the C-884 controller; maximum was not found (left-hand figure) / maximum was found (right-hand figure)
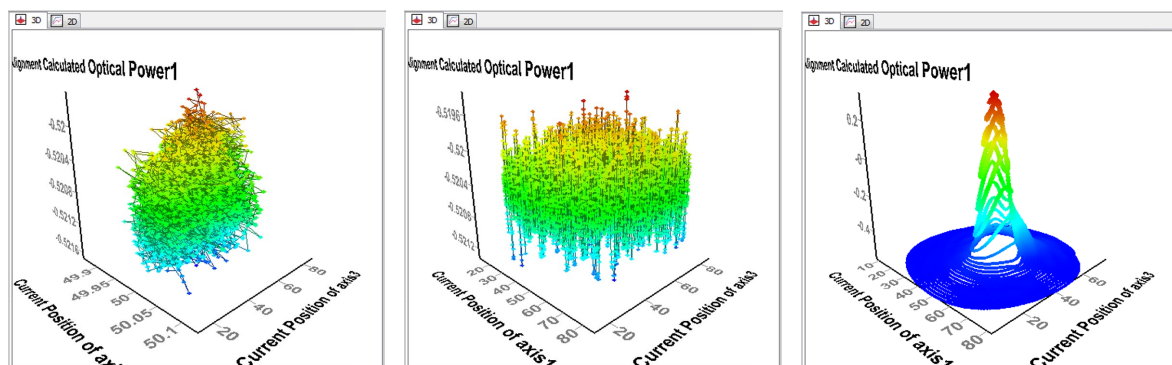

Figure 3: Scans performed by the P-611 NanoCube® nanopositioner connected to the E-727.AS controller; maximum not found, and slew rate too low (left-hand figure) / maximum not found, and slew rate ok (middle figure) / maximum was found

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(right-hand figure)

Optimizing the Scan Procedures

There is no universal 'best' approach to aligning an arbitrary device. There is, however, a best practice: exploratory experimentation. Here are some tips.

Iterative process

Finding the global intensity maximum is an iterative process. It is more likely to capture the global maximum precisely with the next scan when it starts at the maximum found with the previous scan.

1. Perform a scan with **Move to maximum position** selected so that the axes are at the position of the found maximum afterwards.
2. Use the ⊙ buttons to specify the current position as the start position (center) of the next scan.
3. Start a new scan.

E-727.AS: Slew rate setting

With E-727.AS, the velocity required for a spiraled scan is the product of the specified separation distance in µm (**Line spacing**) and frequency in Hz (**Frequency**). The maximum permissible velocity for the axes is given in µm/s by the **Servo Loop Slew-Rate** parameter (ID 0x07000200) of the E-727.AS. Make sure that the slew rate is set high enough for the axes involved in the scan.

1. Open the **Command Entry** window (p. 9) using the **View > E-727 > Show Command Entry**.
2. Query the slew rate settings for axes 1, 2 and 3 with the following commands:
   ```
   SPA? 1 0x07000200
   SPA? 2 0x07000200
   SPA? 3 0x07000200
   ```
3. If the response shows that the slew rate is too low, increase it with the following commands (settings are made in volatile memory), where `slewrate` specifies the new slew rate setting:
   ```
   CCL 1 advanced
   SPA 1 0x07000200 slewrate
   SPA 2 0x07000200 slewrate
   SPA 3 0x07000200 slewrate
   ```

Considering the Mechanics Lifetime

In terms of the mechanics lifetime (and, of course, also in terms of the scan optimization), you should consider some general recommendations:

You should solve the alignment tasks as far as possible using the axes of a piezo-driven nanopositioner (e.g., P-611 NanoCube®). With the nanopositioner, in contrast to motorized drives, there are no rotating parts or friction. The piezo actuators are therefore free of backlash, maintenance, and wear. In addition, the flexure guides of a nanopositioner are maintenance and wear free.

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Use motorized stages (e.g., M-111 linear stages) only for the rough optimization. Keep in mind that with motorized axes, frequent motions over a limited travel range can cause the lubricant to be unevenly distributed in the drive train:

➢ For motorized axes, carry out a maintenance run over the entire travel range at regular intervals (see documentation of the mechanics). The more often motions are carried out over a limited travel range, the shorter the time between the maintenance runs has to be.

Export / Import of Scan Configurations

You can export scan configurations to files on the PC and import them later at any time.

The exported data can also be imported on the **Area Routines** tab in PIMikroMove, and area routine configurations exported from PIMikroMove can be imported in the PI FA1 Alignment Tool.

Export the Current Scan Configuration

➢ Click the **Export …** button on the **Scan Control** panel, enter a name for the scan and save the scan configuration to a .dat file.

   − Make sure to use unique names for the scans, especially if you want to save multiple scan configurations to the same file.

Note that the PI FA1 Alignment Tool automatically adds fixed values for the following settings to every scan configuration:

   − Minimum intensity threshold of the analog input signal

   − Target type of the scan

   − Estimation method for the position of the global intensity maximum

   − Minimum and maximum intensity to be used for estimation

Import a Scan Configuration

➢ Click the **Import …** button on the **Scan Control** panel, select a .dat file and the scan to be imported.

Note that when importing a scan configuration created in PIMikroMove, the PI FA1 Alignment Tool ignores the values for the following settings:

   − Minimum intensity threshold of the analog input signal

   − Target type of the scan

   − Estimation method for the position of the global intensity maximum

   − Minimum and maximum intensity to be used for estimation

Handling of Scan Results

The *Scan Control* panels contains *3D* and *2D* tabs for the scan results.

The *3D* tab simply shows a 3-D graphic representations of the results. Rotate the view by dragging the mouse pointer across the tab with the left-hand mouse button pressed. Zoom in or out on the view by dragging the mouse pointer across the tab with the right mouse button pressed.

The *2D* tab offers various functions via its toolbar.
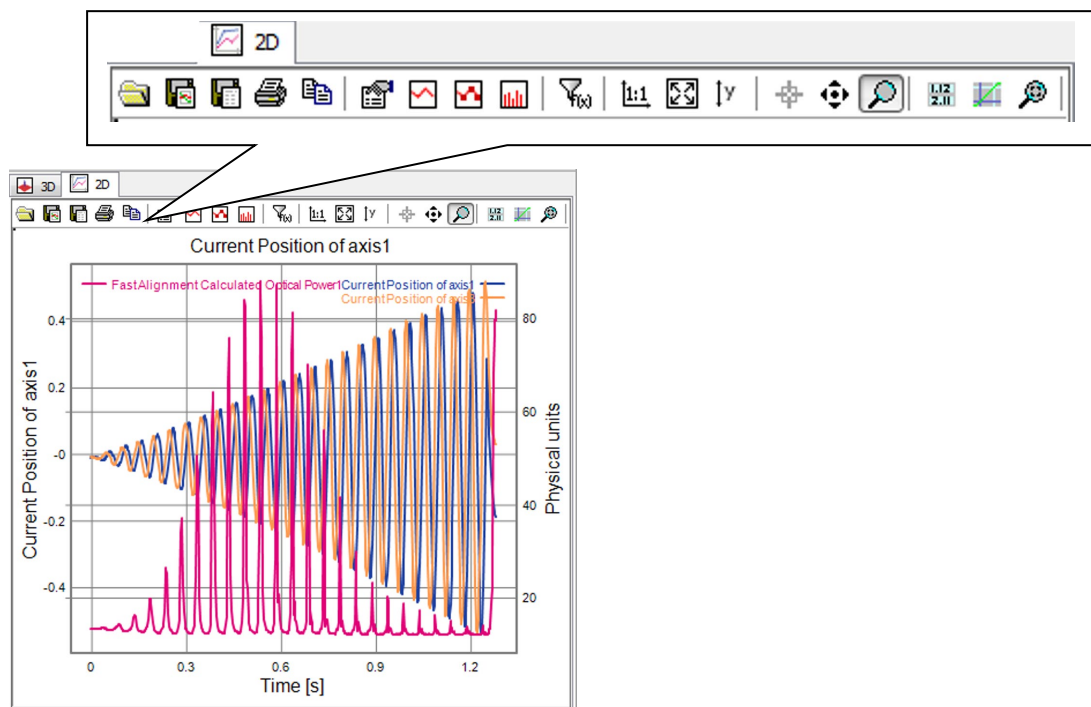
Read the tooltips for short descriptions of the tools.

This manual describes the tools for configuration of the display properties (p. 19) and export/import of scan results (p. 20).

You can find detailed descriptions of the other tools in the "Configure Graphics Pane" section of the PIMikroMove manual (SM148E).

Configure Display Properties of the 2D Tab

Open the **Display Properties** window with the [icon] toolbar button of the **2D** tab.

In the **Display Properties** window, you can define the curves to be displayed on the **2D** tab.

The upper pane of the window shows lists of the recorded data. The table below contains the curve definitions.
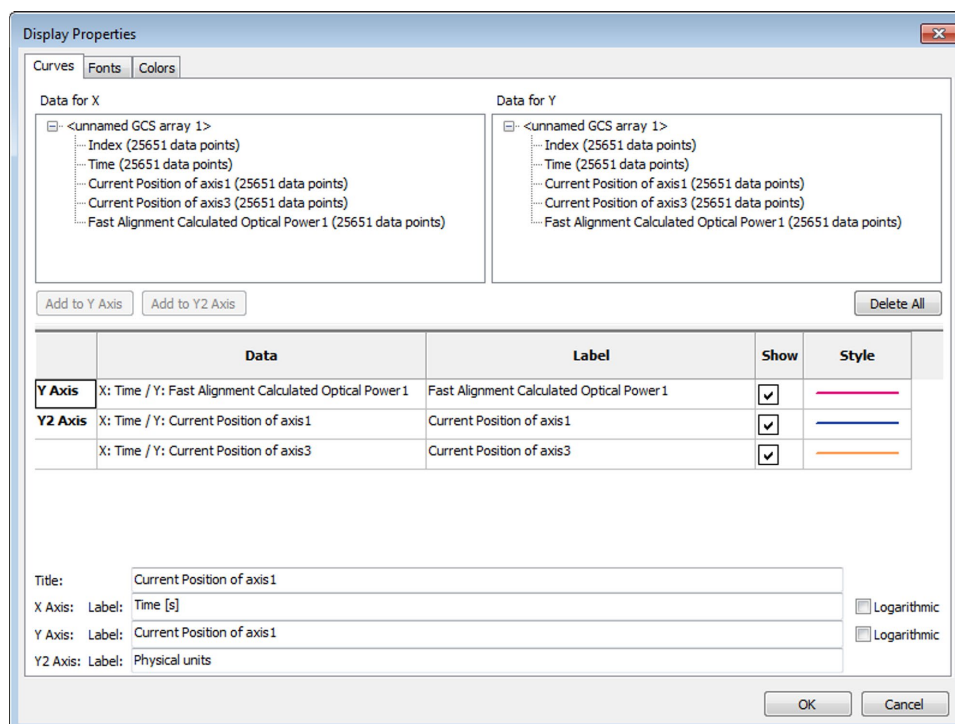
You can add curves to the display:

1. Select the desired data in the **Data for X** list.
2. Select the desired data in the **Data for Y** list.
3. Click the **Add to Y Axis** or **Add to Y2 Axis** button to add the curce to the curve table and therefore to the display. It is recommended to assign any data whose range is greatly different from that of other data to the second Y-axis in the graphics pane.

You can remove curves from the display:

➢ Hide a curve by removing the check from its **Show** box in the curve table.
➢ Delete a curve using the **Delete** entry of its context menu in the curve table.

Furthermore you can set the color and the appearance of data points and lines in the display for every single curve.

You can enter title and labels for the display at the bottom of the **Display Properties** window.

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Export the Scan Result

The scan result can be saved on the PC using the toolbar buttons of the *2D* tab:

➢ Click "Export data as data file": Save the scan result by exporting the recorded data as "comma separated values" (.csv format, e.g. for MS Excel) or in GCS Array format (see GCS Array manual, SM146E). If you want to load the data to the *2D* tab later, you must save it in GCS Array format.

➢ Click "Save image as graph": Save the graphic representation of the scan result as .png or .bmp file.

Import Scan Results

You can load data to the display using a toolbar button of the *2D* tab:

➢ Click "Import data": Import data from GCS Array .dat files on the PC.

Troubleshooting

Fault: Communication with the controller does not work	
Possible Causes	**Remedial measures**
The wrong communication cable is used or it is defective	➢ If necessary, check whether the cable works on a fault-free system.
The power-on/reboot sequence had not finished	➢ Wait until the starting procedure of the controllers has finished before you try to establish communication.
The interface is not configured correctly	➢ With the RS-232 interface, check port and baud rate. When using the TCP/IP connection: ➢ Connect the controller to the network **before** you switch it on. Otherwise, you will have to switch the controller off and on again. ➢ Check the network settings (for details, see the user manual of the controller). ➢ Make sure that the network is not blocked for unknown devices. ➢ Make sure that several PC software applications cannot access a controller at the same time. ➢ Make sure that you have selected the correct controller when establishing communication. ➢ If you cannot solve the problems, consult your network administrator if necessary.
Another program is accessing the interface.	➢ Close the other program.
Problems with the PI FA1 Alignment Tool	➢ Check whether the system works with other software, such as a terminal program or a PIMikroMove. ➢ Test the communication by sending the `*IDN?` or `HLP?` command.

Fault: "Invalid license" message appears when you try to establish a connection to the controller	
Possible Causes	**Remedial measures**
License for the controller is missing	➢ Import the license file for the controller, for details, see p. 11.

Fault: The scan result is not satisfactory.	
Possible Causes	**Remedial measures**
Input signal faulty or not available	➢ Check the light source. ➢ Check the cables and connections. ➢ Check if the proper input channel is selected in the PI FA1 Alignment Tool. ➢ Check if the analog signal is in the range from -10 V to +10 V.
Unsuitable settings for the scan	➢ Check if **Line spacing** is appropriate to your signal width. ➢ Check if the velocity fits to the mechanics performance.
Unsuitable settings of the notch filter and the servo-control parameters	➢ A new adjustment of the closed-loop performance is absolutely necessary whenever you change the load on the P-611 NanoCube® nanopositioner, e.g., by attaching, removing or replacing a fiber holder. See the E727T0005 user manual and the user manual of the C-884 controller for instructions.
E-727.AS: Slew rate too low	Spiral is deformed / whole scan range is not reached: ➢ Increase the slew rate of the axes, for details, see p. 16.
E-727: Sensor zero point is not set correctly	Changes in temperature or changes in the mechanical load can cause small deviations of the sensor zero point. When the sensor zero point is not set correctly, the complete output voltage range of the amplifier cannot be used in closed-loop operation. ➢ Start an AutoZero procedure in the **Axes Control** window for E-727.AS.
Unsuitable data recorder record rate	1. Show the **Advanced** pane in the **Scan Control** panels using the **View > Show advanced features** menu item. 2. Check the **Data Recorder Record Rate** entry in the **Advanced** pane. The value specifies the number of servo cycles before the recording of one data point. The PI FA1 Alignment Tool automatically optimizes the value when you configure a scan. You can change the value, but keep in mind that with a too high record table rate the maximum may not be precisely found, while with a too low record table rate the data recorder may be full before the axes have covered the scan area completely.

Fault: No motion of the axes.	
Possible Causes	**Remedial measures**
The F-131.3SD1 system does not function properly.	➢ Start a few motion tests of the axes in PIMikroMove. ➢ C-884: Make sure that you have loaded the proper parameter settings for the motorized axes from a stage database in PIMikroMove.
C-884: Reference move required	For axes with incremental position sensor, absolute target positions can be commanded only if the reference point for the axis has been defined beforehand. ➢ Start the reference moves in the **Axes Control** window for C-884.

Customer Service

For inquiries and orders, contact your PI sales engineer or send us an email (mailto:service@pi.de).

➢ 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 available)

    – Version of the driver or the software (if available)

    – Operating system on the PC (if available)

➢ 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 (http://www.pi.ws) on our website.