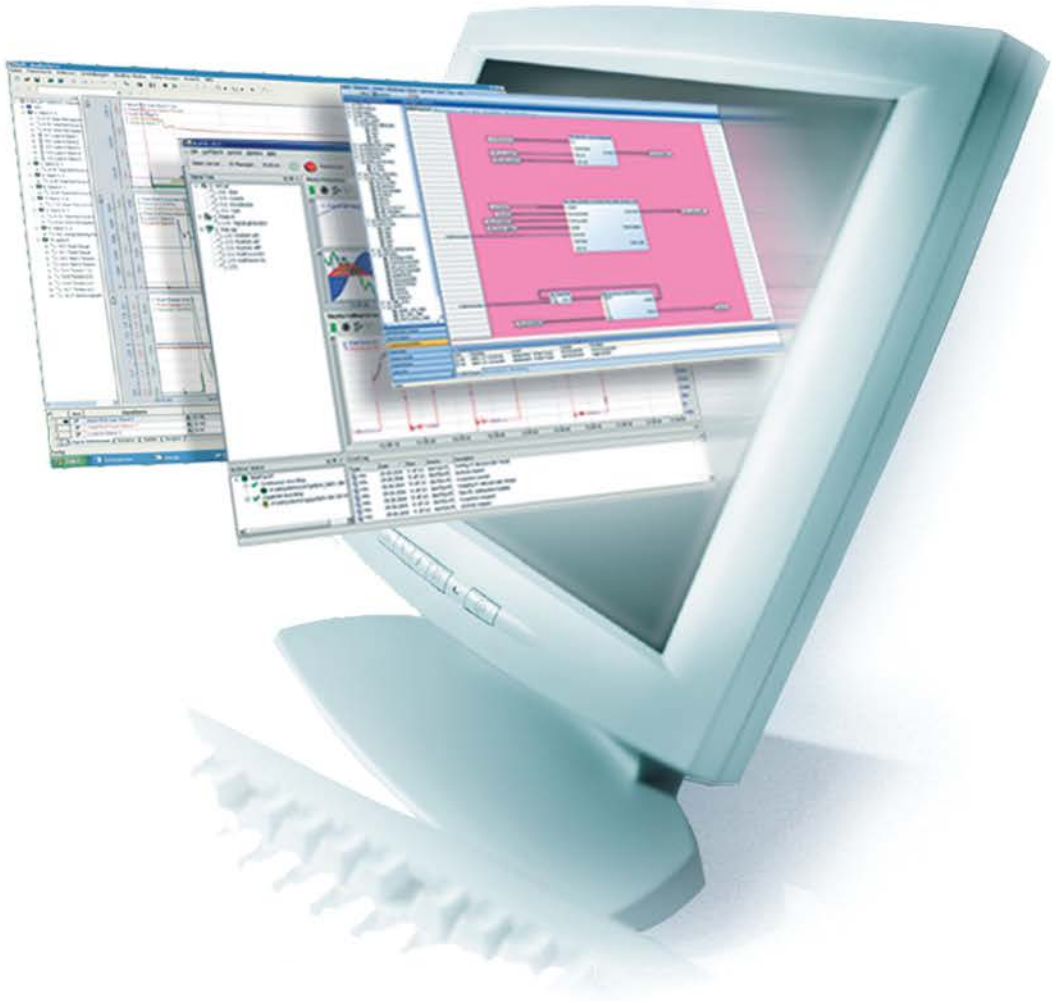
ibaPDA-Multistation

Measure and record synchronously with multiple ibaPDA systems



Manual

Issue 1.0

Measurement and Automation Systems

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The content of this publication has been checked for compliance with the described hardware and software. Nevertheless, deviations cannot be excluded completely so that the full compliance is not guaranteed. However, the information in this publication is updated regularly. Required corrections are contained in the following issues or can be downloaded on the Internet.

The current version is available for download on our web site http://www.iba-ag.com.

Issue	Date	Revision	Author	Version SW
1.0	29.10.2015	First issue	RM	6.34.0

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1 About this manual

This documentation describes the function, the design and the application of the software product *ibaPDA-Multistation*.

1.1 Target group and previous knowledge

This documentation refers to qualified specialists, who are familiar with handling electrical and electronic modules as well as communication and measurement technology. A person is regarded as a specialist if he/she is capable of assessing the work assigned to him/her and recognizing possible risks on the basis of his/her specialist training, knowledge and experience and knowledge of the standard regulations.

This documentation addresses especially persons, who deal with the capturing and storage of measuring data. For the handling of *ibaPDA-Multistation* the following basic knowledge is required and/or useful:

- ❑ Windows® operating system
- ❑ Basic knowledge of *ibaPDA-V6*
- ❑ Basic knowledge of *ibaAnalyzer*

1.2 Notations

In this manual the following notations are used:

Action	Notation
Menu command	Menu *Logic diagram*
Calling the menu command	*Step 1 – Step 2 – Step 3 – Step x* Example: Select the menu *Logic diagram - Add - New function block*.
Keys	<Key name> Example: <Alt>; <F1>
Press the keys simultaneously	<Key name> + <Key name> Example: <Alt> + <Ctrl>
Buttons	<Key name> Example: <OK>; <Cancel>
File names, paths	"Filename", "Path" Example: "Test.doc"

1.3 Used symbols

If safety instructions or other notes are used in this manual, they mean:

⚠ DANGER

The non-observance of this safety information may result in an imminent risk of death or severe injury:

- ❑ From an electric shock!
- ❑ Due to the improper handling of software products which are coupled to input and output procedures with control function!

⚠ WARNING

The non-observance of this safety information may result in a potential risk of death or severe injury!

⚠ CAUTION

The non-observance of this safety information may result in a potential risk of injury or material damage!

Note

A note specifies special requirements or actions to be observed.

Important note

Note if some special features must be observed, for example exceptions from the rule.

Tip

Tip or example as a helpful note or insider tip to make the work a little bit easier.

Other documentation

Reference to additional documentation or further reading.

Example

Configuration and application examples for a better understanding

2 Introduction

The multistation operation is an extension of the *ibaPDA* function, providing for precisely synchronized data acquisition on multiple *ibaPDA* computers.

The multistation operation is used in such cases when the number of the necessary measuring signals exceeds the input card capacity of a computer or if a spatially separated, but synchronized acquisition shall be carried out.

This situation especially occurs when measurement of many signals with a high sampling rate via *ibaFOB* cards is required, as e.g. in the energy measurement technology.

If a computer has not enough slots for input cards to acquire all measuring channels of a plant, there is only the possibility to install further *ibaPDA* computers and allocate the inputs to the systems.

Basically, the systems can be temporally synchronized by means of NTP, PTP, DCF77 or other methods. However, a sample-accurate synchronous acquisition on all systems is not feasible that way.

Furthermore, the different *ibaPDA* systems work independently from each other, and they can start and stop their acquisition at different times. Also, the start time of the data files on the systems may differ. When viewing the data files in *ibaAnalyzer* it would be difficult to align the files accurately.

The multistation operation ensures that all participating *ibaPDA* systems can acquire and store the signals absolutely synchronously with a synchronization accuracy of less than one sample.

A comprehensive trigger management throughout the multistation network enables the systems to exchange trigger events amongst each other in order to control a synchronous data recording. The trigger signals are transferred with a high precision. The occurrence of a trigger on one *ibaPDA* system can be used to start or stop a data recording on any other *ibaPDA* system at the same time. The possibility to configure individual pre- or posttrigger time for recording is also given hereby.

This function is especially useful when the involved *ibaPDA* systems are widely separated and the connected plants are technically related, e.g. as it is the case at energy transmission systems. Thereby, interactions or subsequent events on connected plants can be proven.

Later, when the data files from different *ibaPDA* systems are opened with *ibaAnalyzer* for evaluation, then it is like the signals having been recorded with a single system.

A pleasant side effect is a minimal wiring effort, as signals that are matter of particular interest for multiple *ibaPDA* systems must be wired only once.

3 System requirements

3.1 Hardware

- ❑ *ibaPDA* computer according to the currently valid minimum requirements (see *ibaPDA* manual)
- ❑ *ibaFOB-D* input card for the measuring signals in every involved computer Firmware version D3
- ❑ For the so-called multistation master computer:
  Min. 1 / max. 8 *ibaFOB-4i-D* (or *-Dexp*) + *ibaFOB-4o-D*
  The module *ibaFOB-4o-D* must be connected at the socket for the mirror mode (white socket on the card board).
  The cards *ibaFOB-io-D/Dexp* and *ibaFOB-2io-D/Dexp* apply as well. The module *ibaFOB-4o-D* can also be attached to these cards.
- ❑ For the so-called multistation slave computer:
  Min. 1 free *ibaFOB-D* input channel for the synchronization
- ❑ 2 separate network interfaces on all involved computers

3.2 Software

- ❑ ibaPDA-V6.34.0 or higher
- ❑ License for multistation operation must be enabled in the dongle.

License information

Order no.	Product name	Description
30.001930	ibaPDA Multistation License	Extension license for ibaPDA-V6 by the multistation operation function The license is necessary for every computer, which should take part in a multistation network.

4 Functional principle

The multistation operation enables the synchronized data acquisition of multiple *ibaPDA* systems and the mutual control of the data storage.

A multistation configuration can comprise 2 to 33 *ibaPDA* systems.

Note

Typical and by now (state 09/2015) realized configurations comprise 3 to 5 *ibaPDA* systems. More than 5 systems (1 master + 4 slaves) are not released yet. Tests are planned for a configuration with up to 9 systems (1 master + 8 slaves).

One system is designated multistation master, the other systems are multistation slaves.

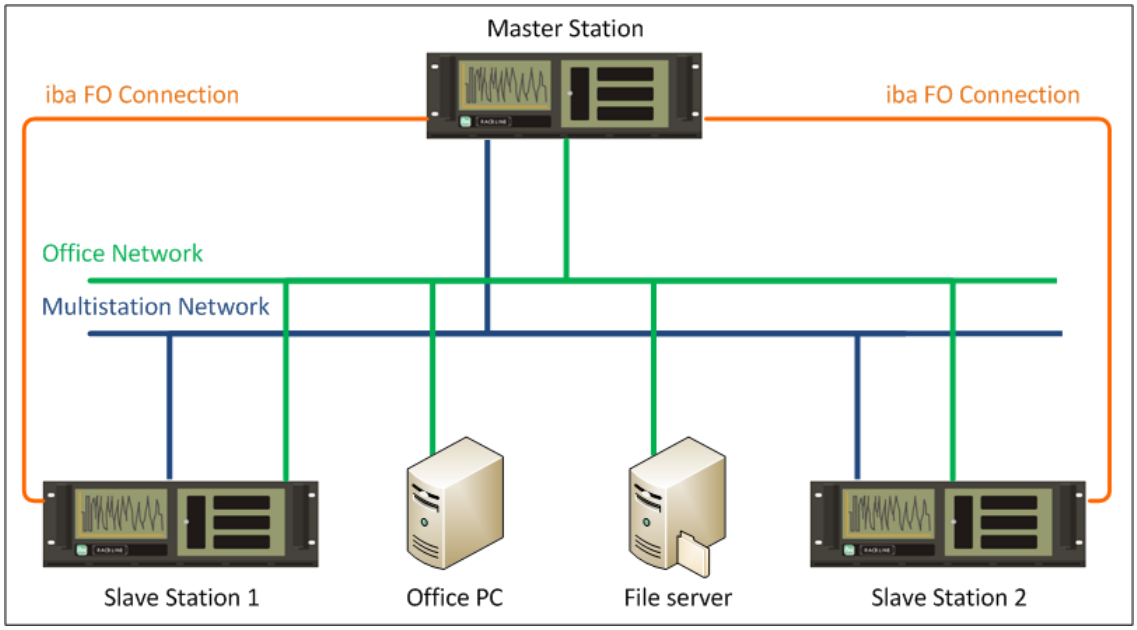


Figure 1: Sample-topology for multistation operation

There are 2 connections between master and slave:

- Network connection for the transmission of control signals between master and slave (start, stop, watchdog, trigger, etc.)
- Fiber-optic connection between *ibaFOB-D* cards for the transfer of the sampling clock

In the overall system, 2 separate networks must be installed, to which the involved *ibaPDA* computers are connected:

- Multistation network which only connects the *ibaPDA* computers and serves to transfer the multistation communication
- Network for the general access to the *ibaPDA* computers also from outside, e.g. to open or copy data files (“office network” in the figure above)

5 Configuration

The configuration of the multistation operation is made in the I/O manager of *ibaPDA*. You can find the setup dialog in the I/O manager on the node *General* sub-node-*Multistation.*

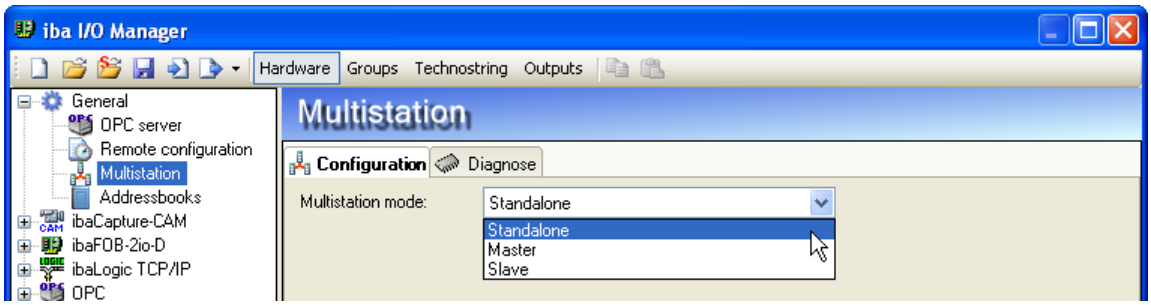
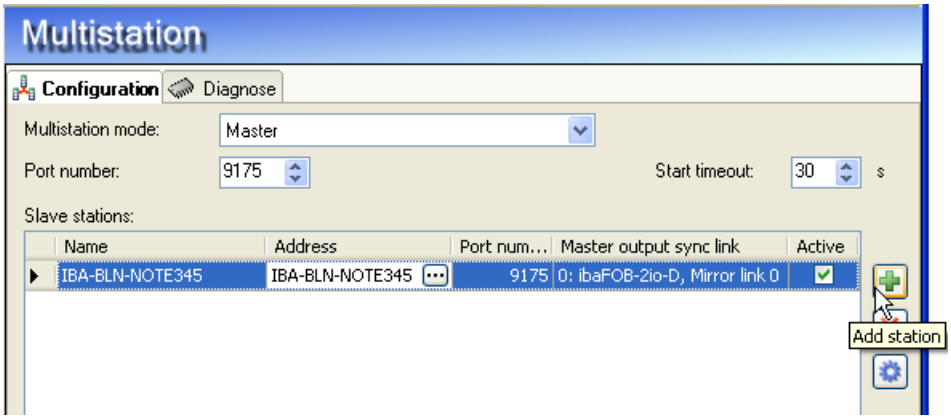


Figure 2: Configuration dialog for Multistation

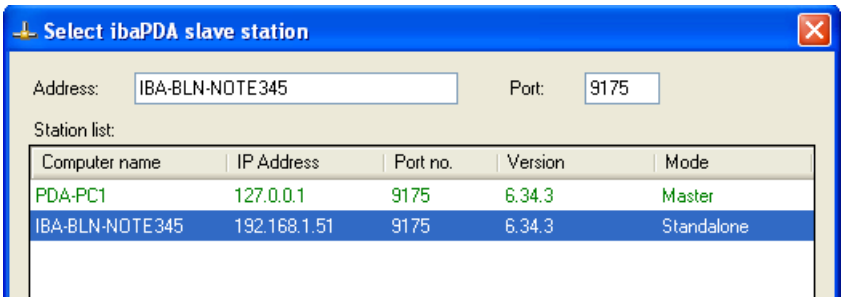
Default setting is always the so-called “Standalone” mode. In the stand-alone mode, the *ibaPDA* system works independently even if it is located in a multistation network.

5.1 Configuration as multistation master

1. To configure a system as multistation master, click on “Master”.
   Further elements will appear in the dialog.



2. At first, all of the involved slave systems must be entered into the table. For this purpose, click on the button with the plus-symbol.
   A station browser is opened, where all *ibaPDA* servers that are active in the network are listed.

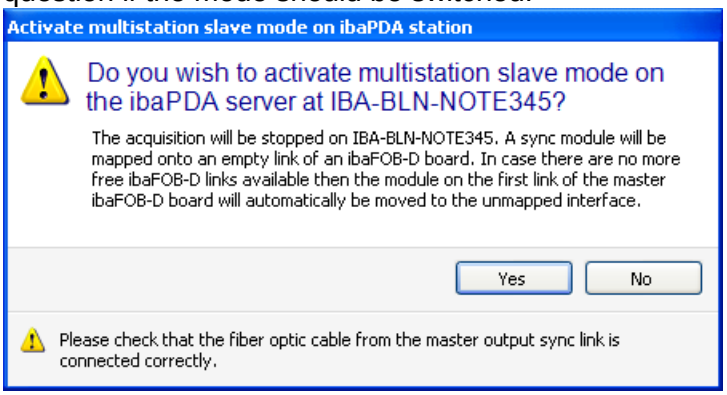


The mode of the *ibaPDA* systems is displayed along with the computer name, IP address, port number and *ibaPDA* version.

The color of the lines has the following meaning:

- Green: This station supports multistation operation and the computer is already in the slave mode.
- Orange: This station supports multistation operation and the computer is not in the right mode.
- Red: This station does not support multistation operation (software upgrade necessary).

3. Select a computer that should be run as multistation slave.
If the respective computer is in the stand-alone mode, a note will appear with the question if the mode should be switched.



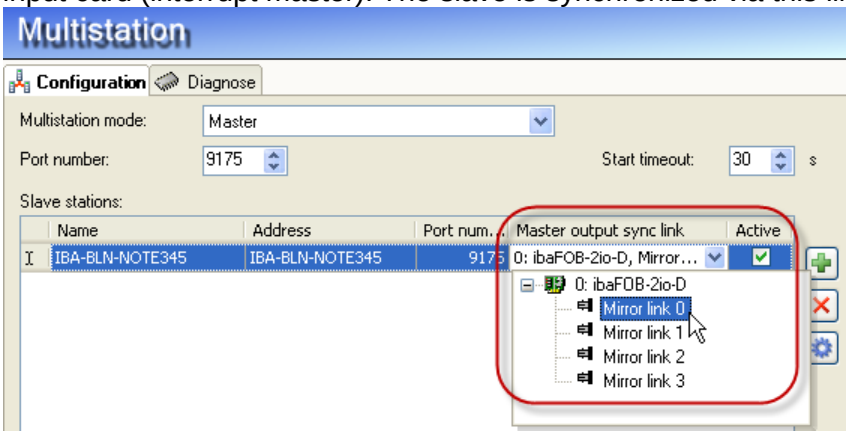
4. Confirm with <Yes>. The acquisition on the slave system is then stopped, the system is set into the multistation slave mode and is then ready to be started together with the master system.

5. If requested, you can name the slave computer (“Name” column). When using the station browser, the name of the computer is applied by default.

6. In the “Address” column, enter the IP address or the computer name if it has not been entered by the station browser yet.

7. The same applies to the port number. Please note, that all involved computers in the multistation network use the same port number.

8. Select finally the link of an *ibaFOB-4o-D* output card (mirror module) of the master, which is connected to the according slave computer with an input of the *ibaFOB-D* input card (interrupt master). The slave is synchronized via this link.



9. Repeat the steps 2 to 8, until all slave stations are connected.

The "Start timeout" parameter defines the waiting time of the system, until it has established a connection with the other stations for the start of the acquisition. If the acquisition must be started on a slave system, e.g. after a change of the I/O configuration, the system waits for a feedback of the master for this time. If the connection to the master is not achieved in this time, the systems starts in the stand-alone mode.

5.2 Configuration as multistation slave

Usually, every system can be configured as multistation slave already at the configuration of the multistation master (see above, step 3 and 4).

If you want to configure a system as multistation slave in its own I/O manager, click on “Slave” in the drop-down menu “Multistation mode”.
Further elements appear in the dialog.

Only the port number and the value for the start timeout can be set in a slave.

The connection setup is always carried out from master to slave, so that the slave does not need to know the name or the address of the master.

As soon as a station has been switched to slave mode, a „Multistation sync module“ will be added on the first free link of the *ibaFOB-D*-card (interrupt master) in the I/O manager of the respective station.

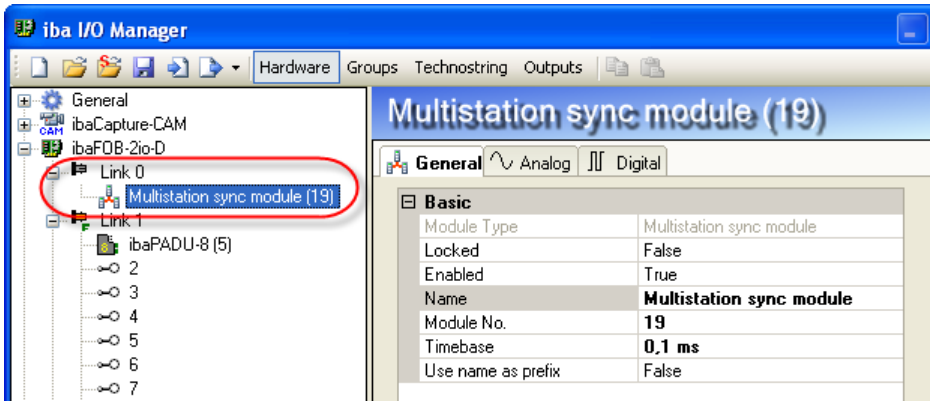


Figure 3: Multistation sync module am Synchronisationseingang bei einem Multistation Slave

This module has – like other modules – the registers *General*, *Analog* and *Digital*. However, the settings and values rather provide for internal management and debugging. They have no practical use for the user.

Do not change the timebase setting, as this is already preset properly.

The module supplies two signals:

- Analog value „Sync counter“, a 24 bit sync-message counter
- Digital signal „Clock“, a digital pulse signal running in 1 ms clock (interrupt)

These signals are also available in the signal tree for display and in the signal selection of the data stores.

5.3 Trigger configuration

In a multistation network, a trigger can be used by one station to start or stop the data storage on another station. For this purpose there are so-called “global triggers”. Global trigger is a property of the trigger modules, which can be enabled or disabled in the general module settings. If this property is set to *True*, all trigger signals on this module are considered as global triggers and can be used for the control of the data storage on other stations.

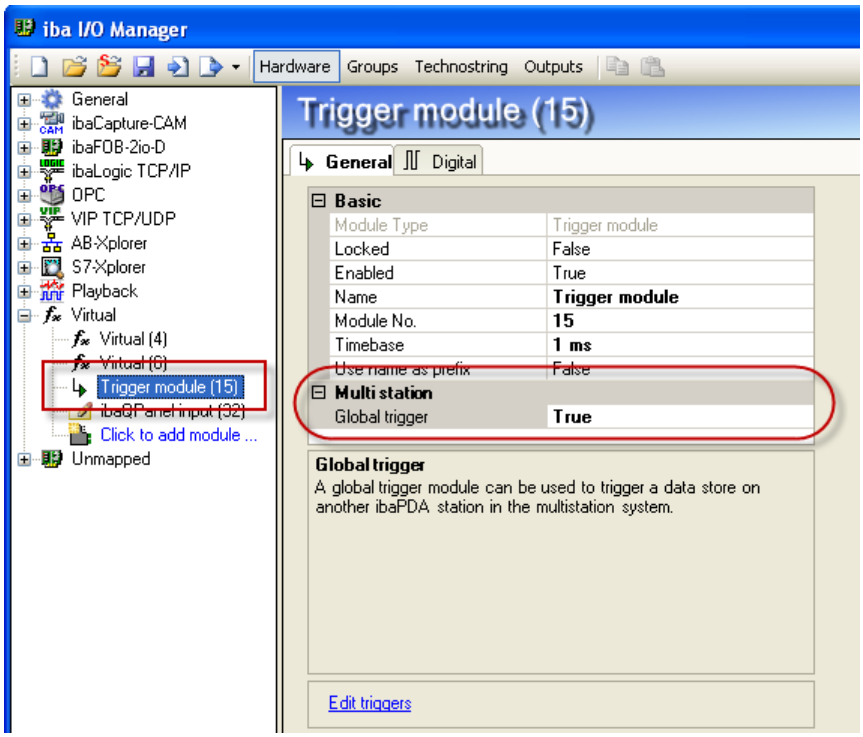


Figure 4: Configuration of a trigger module for global triggers

The global trigger module is then available in the data storage configuration of all of the other stations in the multistation network and can e.g. be enabled in the start or stop trigger pool.

The global trigger module is listed in the trigger pool with one line and a reference to the original station. It can only be enabled entirely, the access to particular global trigger signals is not possible. In terms of a logical OR operation a trigger is fired, if one of the global trigger signals (on the source station) trips.

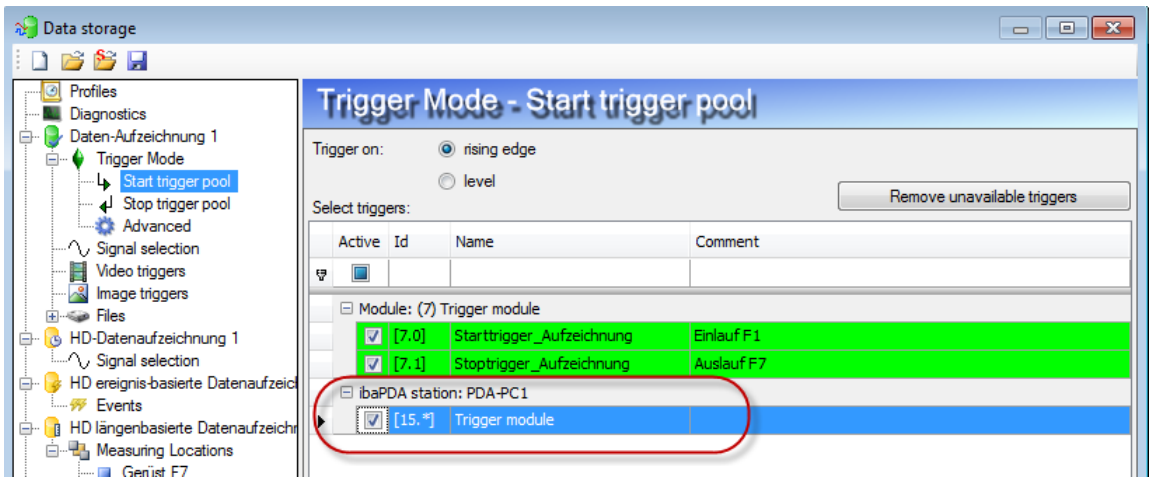


Figure 5: Use of the global trigger module in the start trigger pool

If a global trigger occurs, a telegram is sent from the concerned station to all other stations over the data connections (network). This telegram contains, amongst others, the following information:

- Sample number
- Name of the occurred trigger

The transmission of the sample number ensures, that the trigger event is inserted in any data file at the same sample number. As all systems count completely synchronously, a clear assignment is on hand. Only by different pre- and post-trigger times at the storage configuration, different intervals, e.g. from the starting point of the data file to the trigger event, can be present in the data file.

The transmission of the trigger name provides for the information which event tripped the trigger. As the trigger name can be used for the generation of a data file name, data files are created that can be clearly assigned to a trigger event.

To include the trigger name into the file name you must enable the option “Add trigger name” in the configuration dialog of the data storage, file node.

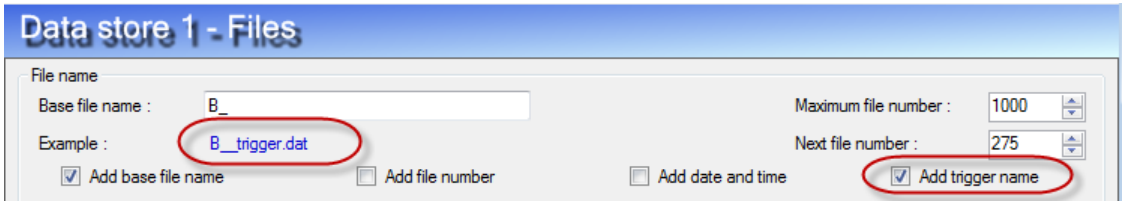
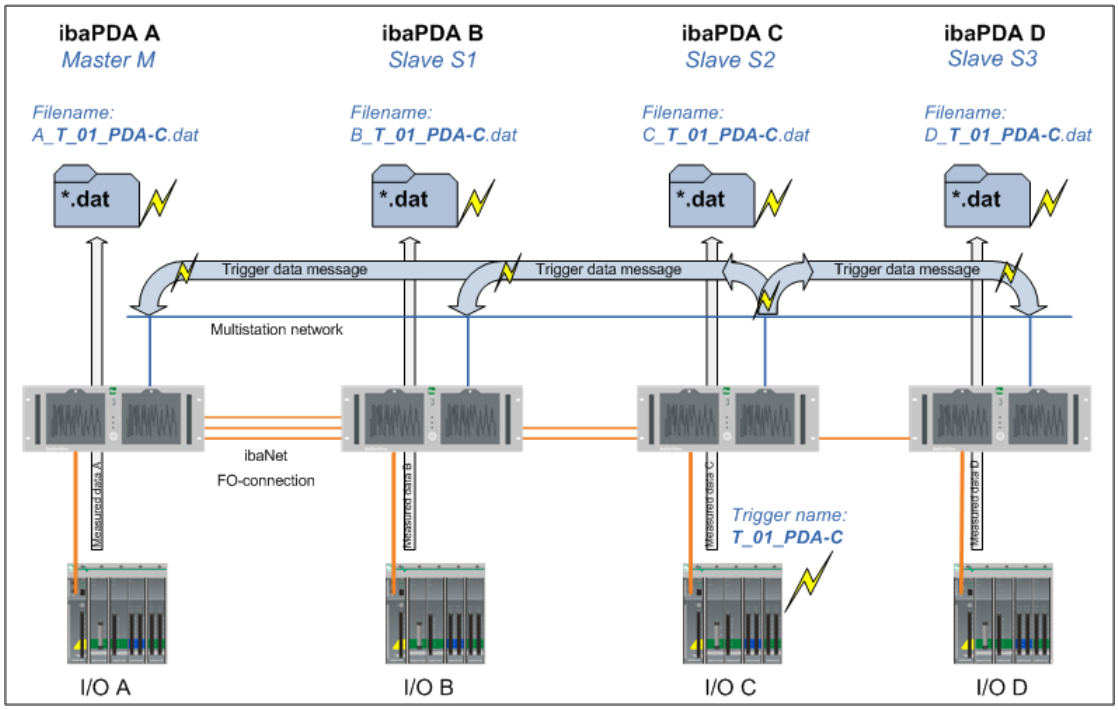


Figure 6: Settings for the use of the trigger name in the data file name

This option is only available, if the trigger settings of the storage “Use the start trigger pool” or “Use the stop trigger pool” was selected as trigger type.

Example



The figure shows a configuration consisting of 4 *ibaPDA* systems.

In the “ibaPDA C” system, a trigger named T_01_PDA-C is defined, that belongs to the group of global triggers. When the trigger in the “ibaPDA C” system occurs, a telegram comprising the trigger event is sent to all of the other stations via the data connection.

If data stores are configured in other stations with the global trigger e.g. in the start trigger pool, storages are started there at the same time. If storages are stopped or started by a trigger pool, the triggering events are written as info fields into the data files. The following info fields for a start trigger can be found in the info node of the data file:

- „start_event", followed by the signal and/or trigger name
- „start_event_expression", followed by an expression which evaluates the signal

Accordingly, the info fields “stop_event” and “stop_event_expression” exist for the stop trigger.

To easily associate the created data files with the trigger event, the option “add trigger name” was selected in the data storage configuration on all systems. The data files of the respective systems then carry the trigger name T_01_PDA-C in the file name.

To be able to identify the data files in *ibaAnalyzer* later, the file names start with the name of the respective *ibaPDA* system, as in this example B_T-01_PDA-C.dat for the system “B”.

5.4 Connections in detail

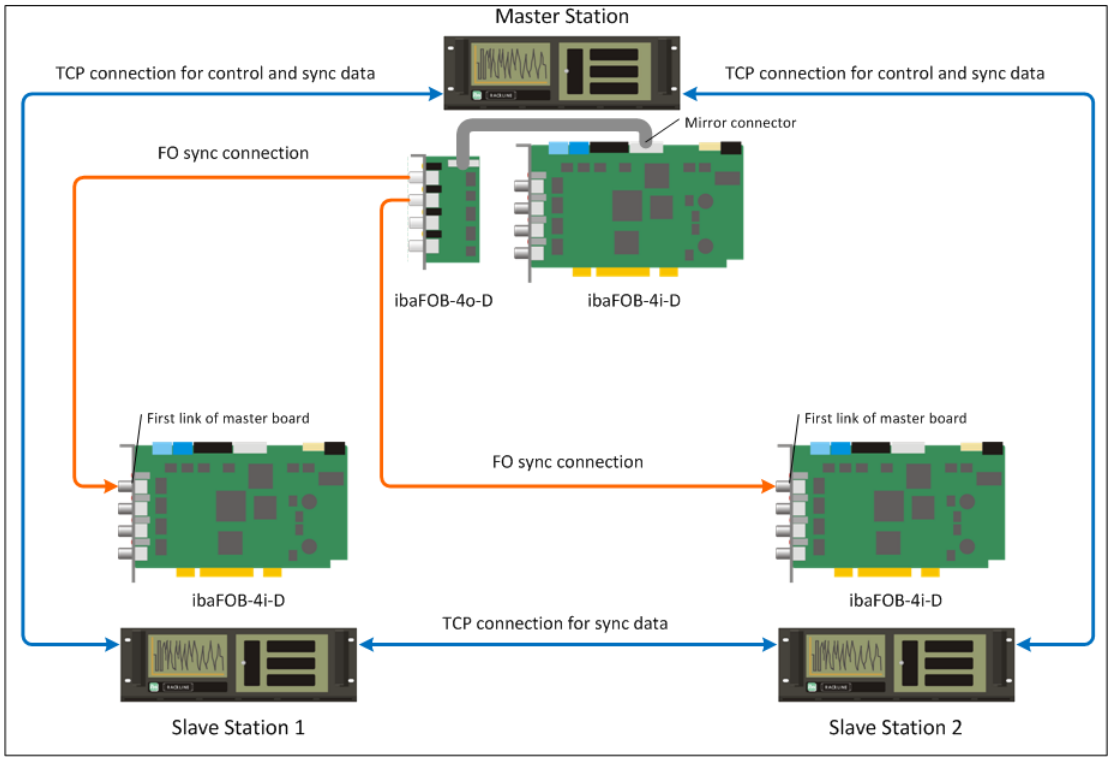


Figure 7: Multistation connections in detail

FO sync connection

The master station is connected with every slave station via a fiber optic cable, which leads from an output of an *ibaFOB-4o-D* card in the master to an input of an *ibaFOB-4i-D* card in the slave.

The *ibaFOB-4o-D* module must be connected to the mirror socket of an *ibaFOB-4i-D* card (white connector on the card).

The *ibaFOB* card in the slave must be configured as interrupt master (internal), as it clocks possible other cards in the slave computer.

The master sends a clock signal via the fiber optic cable, which allows the other stations to sample the measuring data at the exactly same time. Furthermore, this clock signal is transmitted to the connected signal sources of the slaves (e.g. *ibaPADU-M, ibaPADU-S-CM*, *ibaPADU-S-IT*, *ibaLink-VME* etc.), so that these devices can measure in the exact same clock.

ibaPDA knows and compensates the protocol-related time delays during the transmission and such enables a perfect synchronization of the signals, which are sent with different fiber optic protocols from different devices.

TCP connection

Besides the fiber optic synchronization connection, an Ethernet network is used between all stations. This way, two different kinds of network connections are created:

- Control connections, with the functions...
  - Transmission of start and stop commands
  - Monitoring (Watchdog)
  - Negotiation of the timing between the stations in the starting phase
  - Check for validation errors
  - Control of the exactly synchronal start of the acquisition
  - Ensuring synchronized data processing on all stations
  - Trigger configuration
- Data connections, with the functions...
  - Transmission of trigger events

The control and data connections are established during the starting phase between master and slave(s). If more than 1 slave is in the network, data connections are established between the slaves, so that every station has a data connection to all other stations. Via the control connection, specific telegrams are exchanged between the stations, which contain the system time of the master and furthermore information regarding the defined trigger events, which have been calculated based on the data volume to be processed.

The acquisition does not start before every station has received a data telegram by all of the other stations.

An exact synchronization of the system times of the particular stations is not necessary, because all stations use the system time of the master for the data files.

6 Operation

6.1 Start of the acquisition

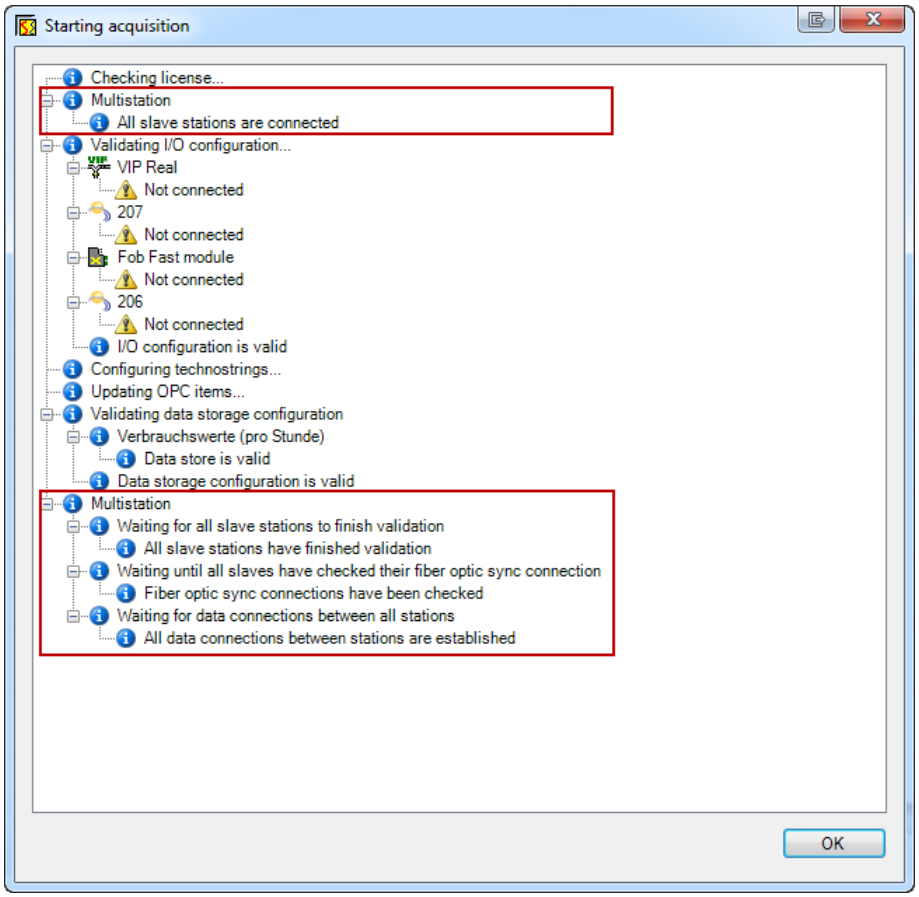


Figure 8: Validation of the systems for the start of the acquisition

In a multistation system, the acquisition is started and stopped on all stations at the same time. If the acquisition is started on a station - no matter if it is a master or a slave - then the acquisition will also start on any other station in the network. This applies accordingly for stopping the acquisition. Thereby, the following cases are differentiated:

Start of the acquisition on the multistation master

If the acquisition is started on the master, it will initially establish the connections to the slaves. If a slave cannot be connected within the preset start timeout, then this slave will be disabled and the acquisition starts on the master and all connected slaves. If no slave can be connected, the master will start in the stand-alone mode.

Start of the acquisition on a multistation slave

If the acquisition is started on a slave, it will wait until a connection to the master is established. If this does not work within the preset start timeout, the slave will start in the stand-alone mode.

Start of the acquisition in case of a configuration error

If it turns out during the validation after the start of the acquisition, that the configuration of a station is invalid, then this station will be excluded from the multistation network. If the respective station is the master, all slaves will start in the stand-alone mode. If the respective station is a slave, it is excluded from the network until the next start of the acquisition.

6.2 Behavior at connection problems

Multiple scenarios are possible during the operation of a multistation network. Here follows a description of the system behavior in some typical situations:

- If a master station has started the acquisition despite one or more missing slaves, then it will restart the acquisition automatically as soon as a missing slave reconnects.
- If the network connection between two random stations is interrupted during the acquisition, then the acquisition will be restarted after a timeout of 5 s. The same applies for the FO synchronization connection between the master and the slave.
- If a slave could not start in the multistation mode because the FO connection was interrupted at the start of the acquisition, then it monitors the FO connection constantly. If the FO connection has been re-established and is active for more than 2 s, the slave station will automatically restart the acquisition and is included into the multistation network again.
- If the ibaPDA service will be stopped on a station during an ongoing acquisition, e.g. because the computer shuts down, then the acquisition is stopped on every station and is restarted without the respective station. If the respective station is a slave, then the master and the remaining slaves will restart together. If this concerns the master, the slaves will restart independently. The exchange of the trigger signals among each other is nevertheless performed for the slaves.
- If the master fails, the central time synchronization of the systems is missing. Because the slaves restart the acquisition in case of a master failure and work individually, the system time of the slaves is used for the data files. As the clocks of the computers normally do not spread too quickly, deviations are first very low.
  To ensure a high-precision synchronization of the systems in such a case, the time synchronization via a radio and/or GPS clock (e.g. *ibaClock*) of every involved computer is recommended.

7 Diagnostics

7.1 Diagnose register

In the register *Diagnose* of the multistation node in the I/O manager you get information about the connections between particular stations.

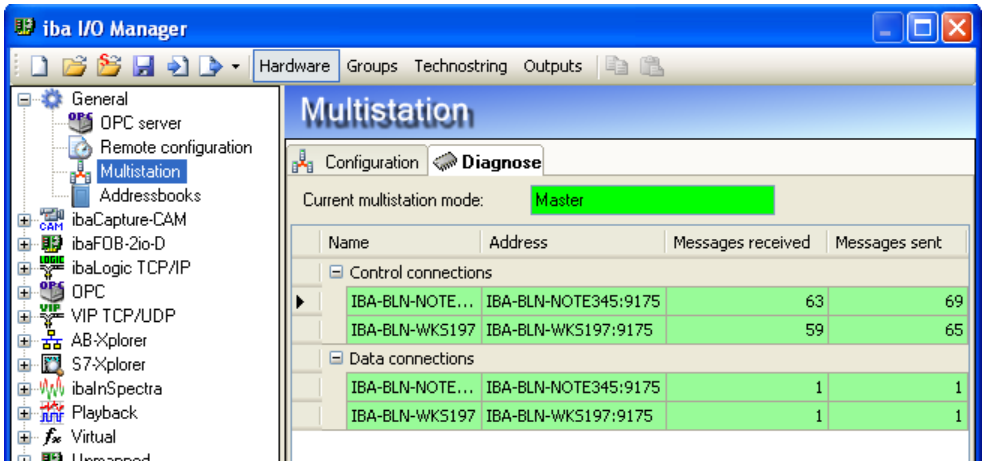


Figure 9: Diagnostics on the multistation master

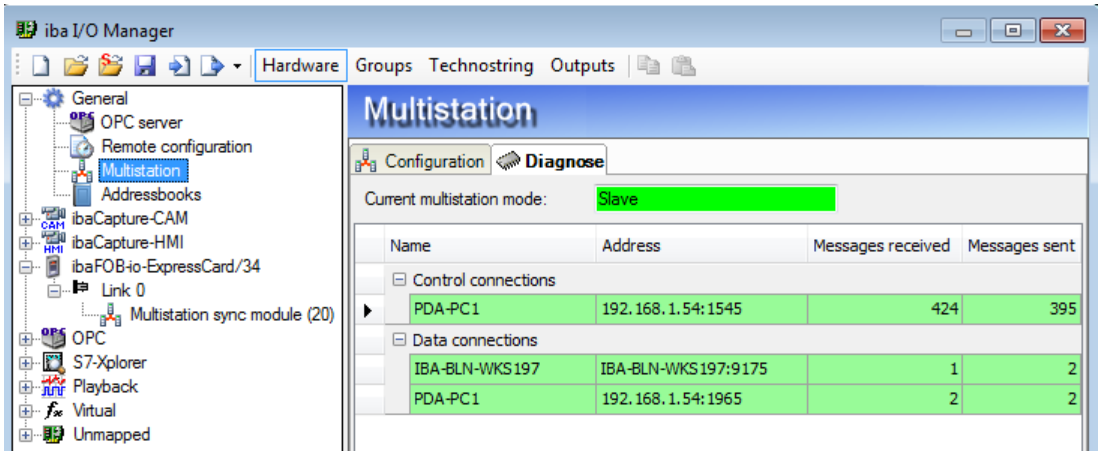


Figure 10: Diagnostics on a multistation slave

❑ Current multistation mode

Here, the mode of the station is indicated. Master, slave or stand-alone are possible.

❑ Table

In the table, the network connections between the stations (control and data connections) are displayed.

The example in both figures above shows a system, consisting of 3 stations. The master station has a control and data connection each to both slaves. The slave station has a control connection to the master as well as a data connection to the master and to the other slave.

7.2 Data storage status

The current multistation mode of a station is also displayed in the “Data storage status” window.

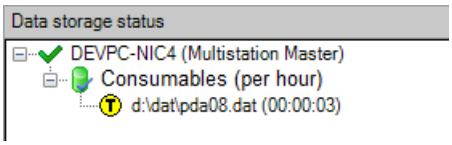


Figure 11: Data storage status with multistation mode.

7.3 Function MultiStationStatus()

In the expression editor there is a function MultiStationStatus() which detects and returns the current multistation mode.

The possible return values are:

0	Stand-alone
1	Slave
2	Master

With this, you can e.g. create a virtual signal to visualize the status in *ibaQPanel* or to make it available to other systems as output signal.

8 Support and contact

Support

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Note

If you require support, indicate the serial number (iba-S/N) of the product.

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