Manual
Time Tagger 2.10.6

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THATec Innovation
www.thatec-innovation.com

Contents

1 Introduction and working principle

The software module *Time Tagger 2.10.6* is a driver module for the Time Tagger from Swabian Instruments which allows to perform time-resolved Brillouin light scattering measurements using a Tandem Fabry-Pérot interferometer in combination with the THATec Innovation *TFPDAS5* or *TFPDAS6* software.

The measurement method is a time-of-flight method using a CW laser. Thus, in order to get a time-resolved signal, a time-dependent external excitation source for the investigated system (magnons, phonons, etc.) is inevitable. The time-dependent signal is then given by the time between the start signal and a stop signal from the photons arriving at the detector. A more detailed description of the underlying principle can be found in Section 5 of the following article:
https://www.frontiersin.org/articles/10.3389/fphy.2015.00035/full

1.1 System Requirements

All software modules are compatible to 64-bit Windows 7 and later.

2 Software installation

The download of the driver module is done using thaTEC:Core in analogy to the download of any other thaTEC:driver modules. For the installation of thaTEC:Core and how to download driver modules, please refer to the Quick start guide available on our homepage.

For the Time Tagger module, in the device list in *thaTEC:Core*, there are different versions available for the Time Tagger module. This manual is for version *Time Tagger 2.10.6* but widely also corresponds to other versions.

Before installation, always check the changelog of the software module which is available via the right-click menu in thaTEC:Core or in the software module itself via the menu bar under File → Open Changelog.

In the changelog, the download link for the corresponding driver software from Swabian Instruments can be found which also needs to be installed in the system.

In case of problems that occur during the installation or operation, please contact us under contact@thatec-innovation.com.
More contact details can be found in Sec. 5.

3 Hardware connections

For the time- and frequency-resolution for the Brillouin measurements, several signals have to be provided to the Time Tagger and connected to the input channels. In total 5 channels will be used: Start, Stop, Counter, Reset, Gate. All signals except for the start signal are provided by the THATec Innovation breakout box which is also required by the thaTEC:TFPDAS software to control the interferometer. The BNC connectors are located at the front of the breakout box in the *TimeTagger* section. For the connection, BNC cables and BNC-SMA adapters are needed. Any input channel on the Time Tagger might be used for any connection and the individual channels will be assigned in the software later on.

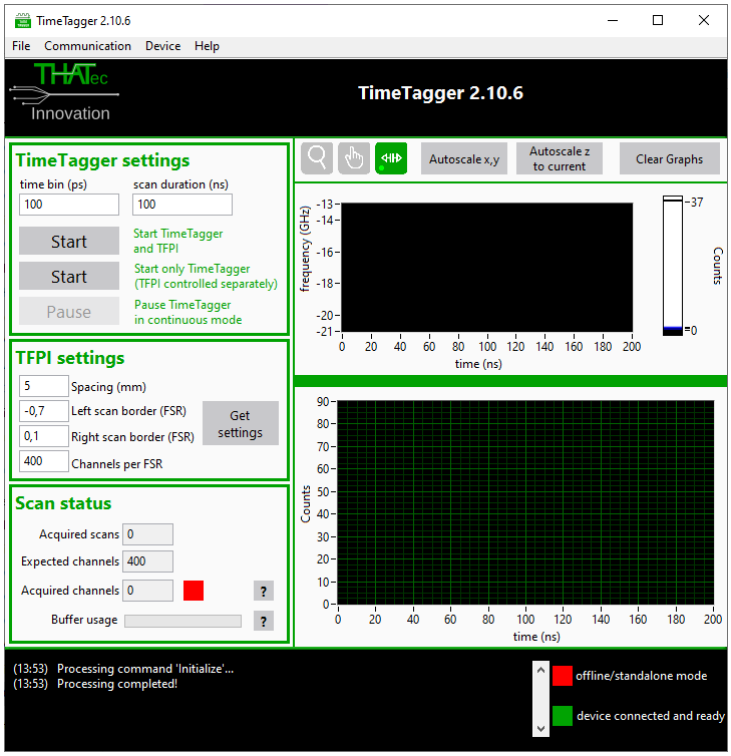
As mentioned in the Sec. 1, a time dependent external excitation is required. Thus, to synchronize the time-resolution to the excitation, a start signal must be provided to an input channel of the Time Tagger. This signal can be, e.g., the trigger output of a RF generator. For the input specifications of the Time Tagger, please check the manual of your hardware.

4 Software settings

In the following, only the settings specific to the *Time Tagger 2.10.6* software will be discussed. Basic settings which are available in all thaTEC:driver modules like, e.g., the communication settings to thaTEC:OS are not discussed. For this, please refer to the Quick start guide available on our homepage.

4.1 Initializing the hardware

After starting the *Time Tagger 2.10.6* software via thaTEC:Core, the software will automatically try to connect to the Time Tagger hardware. If the connection was successful, the status bar at the bottom of the front panel will display that the initialization process was completed and the indicator on the lower right turns green indicating *device connected and ready* as shown in the image below:



4.2 Troubleshooting hardware initialization

If the initialization process fails, the according error message will be displayed in the status bar. Please check the error message which might give you some hints on why the connection has failed. Below, some typical issues as well as the solutions are listed:

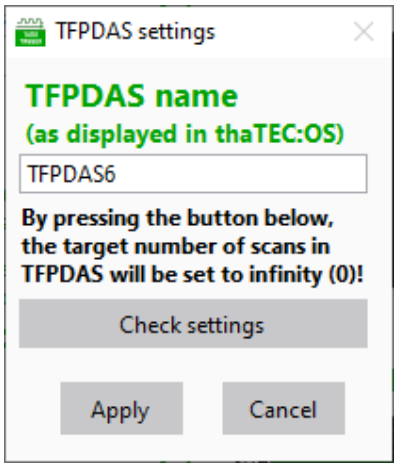
- The versions of software module and the installed Swabian Instruments software does not match → **Uninstall** the Swabian Instruments software and install the correct version

- The Time Tagger software from Swabian Instruments is still running → Close the Swabian Instruments software completely
- The Time Tagger is connected to a USB hub → Connect the Time Tagger directly to the PC using the included USB cable
- The Time Tagger is not connected to the PC via a low quality USB cable → Use the original cable provided with the Time Tagger
- Sometimes, switching USB ports might also resolve connection issues

4.3 Communication to TFPDAS

The most convenient way for the operation is when the *Time Tagger 2.10.6* software as well as the thaTEC:TFPDAS software are connection to thaTEC:OS. In this case, both software modules can communicate and exchange their settings for an easy use of the software.

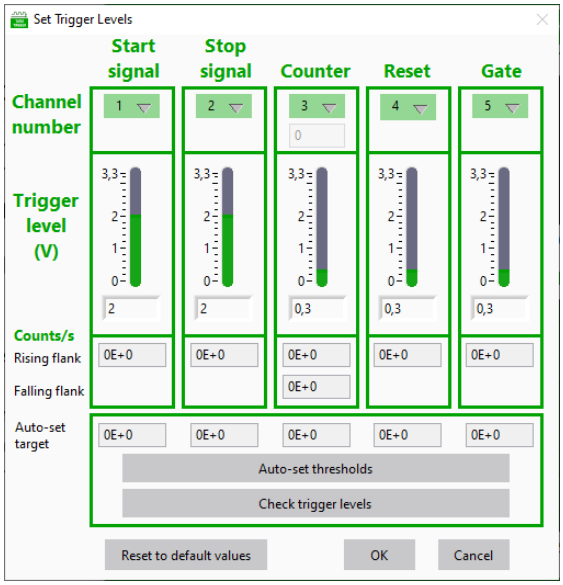
For the communication, the according name of the installed TFPDAS software must be set correctly. For this, connect the TFPDAS software as well as the *Time Tagger 2.10.6* software to thaTEC:OS and open the settings window via the menu bar → Device → TFPDAS settings. Please make sure that the name is exactly as displayed in thaTEC:OS!



By pressing the *Check settings* button, the communication will be tested and, in case all settings are correct, the new settings can be applied.

4.4 Hardware settings / Trigger levels

Open the hardware settings window via the menu bar → Device → Hardware settings. As mentioned in Sec. 3, for time-resolved Brillouin measurements, 5 input channels at the Time Tagger are required. Each channel is represented by a column in the hardware settings window:



4.4.1 Setting the channel numbers

In the upper row, the input channel numbers must be set according to the hardware connection described in Sec. 3. Simply select the according input channel from the dropdown menu.

4.4.2 Trigger levels

In the hardware settings window, the trigger levels for the individual channels must be set that all signals are recognized correctly. To help with the correct settings, there is an auto-set method (only available with the latest versions of TFPDAS**6**!) or the current count rates of the individual channels can be displayed while adjusting the trigger levels.

Auto-set trigger levels

As mentioned above, this feature is only available with the latest versions of TFPDAS**6**!

Before starting the auto-setting, make sure that the TFPDAS name is correctly set as described in Sec. 4.3. Furthermore, both, the TFPDAS6 software as well as the *Time Tagger 2.10.6* software must be connected to thaTEC:OS.

If this is the case, the auto-set can be started. After pressing the button, a popup will appear asking for the target countrate of the start signal. Since the start signal is provided separately, please make sure that the start signal is enabled an enter the correct count rate.

Now the trigger level indicators should be set to the maximum value and decrease stepwise while updating the count rate indicators. In case of any errors, a popup will display the errors after finishing the auto setting. In this case, the trigger level for the according channels has to be set manually.

Manual setting of the trigger levels

To help with the manual setting of the trigger levels, press the *Check trigger levels* button which will active the readout of the current count rates in counts/s for the individual channels. To get any counts on the Counter/Reset/Gate channels, it is required that the TFPDAS software is acquiring a spectrum since these signals are not output in transmission- or reflection mode.

Adjust the trigger levels that each channel shows a reasonable countrate as described in more detail below. Please note that the count rates may show some fluctuations but the range with reasonable values should very easily be recognizable.

Target count rates

Start: The count rate is given by the repetition rate of the external excitation

Stop: Counts per second at the detector. Depending on the current signal in TFPDAS, this will fluctuate the most with large count rates when the reference peak is scanned. However, the trigger level range is typically very broad.

Counter: TFPDAS arranges each spectrum in frequency channels. Whenever the frequency channel is changed, the Counter signal is toggled causing either a rising flank or a falling flank (note the two indicators in the according column in the hardware settings window). Thus, the expected count rate strongly depends on the scan settings. Assuming the following TFPDAS settings: scan borders -0.7 FSR to +0.7 FSR and 200 channels per FSR, this would correspond to 280 channels in the scan. When the average time a scan takes is in the order of 1 s, the expected count rate for the rising/falling flank should be around 140 counts/s.

Reset: The reset channel will register a count whenever a new scan in TFPDAS is started. Thus, again assuming the above parameters, only 1 count/s is expected.

Gate: The gate channel will register a count whenever a ROI is scanned. Thus, with the above parameters, when only 1 ROI is defined, the Gate channel should yield 1 count/s. With 2 ROIs, the Gate channel should yield 2 counts/s.

4.5 Scan settings

4.5.1 TFPI settings

For the frequency resolution, it is necessary that the current scan settings of the TFPDAS software are correctly set in the *Time Tagger 2.10.6* software which are displayed on the left hand side of the front panel (spacing, left-/right scan border, channels per FSR) need to be set. This can either be done manually by entering the values on the front panel or the settings can automatically be set. For this, make sure that the TFPDAS name is correctly set as described in Sec. 4.3. Furthermore, both, the TFPDAS6 software as well as the *Time Tagger 2.10.6* software must be connected to thaTEC:OS.

4.5.2 TimeTagger settings

On the upper left on the front panel, the time binning as well as the scan duration can be set.

Time binning: In analogy to the Brillouin spectrum which is split into frequency channels, the time-dependent signal will be split into time channels. The time binning setting defines the size of these channels. Please note that a smaller binning will result in the obtained signal being spread over more channels, thus, the overall signal will be lower and the acquisition time might drastically increase. Also note that the typical time resolution given by the interferometer is in the range of a few nanoseconds. Thus, a too small binning won't necessarily yield an increased time resolution. Typical values are in the range of 100 ps to 500 ps.

Scan duration: This value basically describes the maximum time over which the time-resolved signal will be acquired. Please note that whenever a new start signal is detected, the Time Tagger will reset the internal timer. Thus, when the external excitation source will trigger every 200 ns, and value larger than 200 ns for the time duration will only cause an increased memory usage while signals which arrive after 200 ns will be treated as if they arrived only after the next excitation pulse.

4.5.3 Starting a measurement

Since the acquisition of a time-resolved measurement also always includes the TFPDAS software controlling the interferometer, both must be running during an acquisition. Thus, the *Time Tagger 2.10.6* software offers a start button (the upper button on the front panel) to start both, the acquisition in the TFPDAS software as well as the acquisition of the time-resolved signal. For this, make sure that the TFPDAS name is correctly set as described in Sec. 4.3. Furthermore, both, the TFPDAS6 software as well as the *Time Tagger 2.10.6* software must be connected to thaTEC:OS.

However, also only the time-resolution can be started separately via the lower start button on the front panel.

4.5.4 Scan status indicators

Using the indicators at the bottom of the front panel indicate, the status of the measurement can be checked and potential mismatches in the settings between the *Time Tagger 2.10.6* software and the TFPDAS software can be identified.

The upper indicator *Acquired scans* indicates the number of scans acquired in the *Time Tagger 2.10.6* software. When starting the *Time Tagger 2.10.6* software and TFPDAS together using the upper start button (see also the previous section), the number of scans in both software modules should be identical. If the *Time Tagger 2.10.6* software is started independently from the TFPDAS software, the numbers might not be identical since both software modules are not synchronized.

Troubleshooting: In case the number of scans in the *Time Tagger 2.10.6* software shows a different behavior to the number of scans in the TFPDAS software (e.g. not every scan

is recognized), check the hardware connections and adjust the trigger level of the *Reset* channel.

The indicators *Expected channels* and *Acquired channels* indicate the frequency channels per scan given by the TFPI settings. If both numbers don't match, the colored indicator on the right will turn red indicating that the acquisition is not correct.

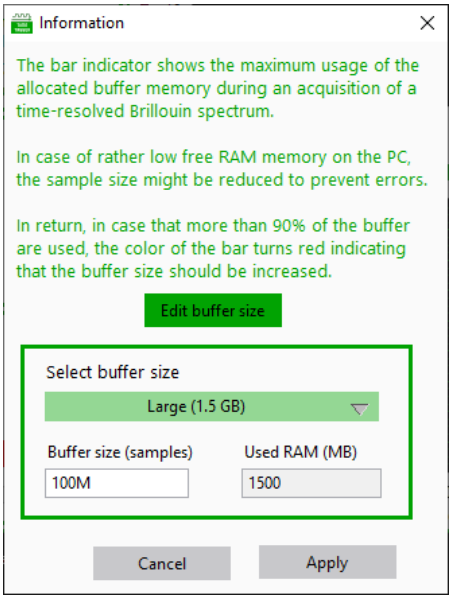
Troubleshooting: TFPDAS must be in acquisition mode (measurement mode) in order to obtain a time-resolved measurement. If this is not the case, the *Time Tagger 2.10.6* software will be in idle mode until a measurement is started in TFPDAS and the number of acquired channels will be 0. If the numbers mismatch, try the following:

- Check if the TFPI settings in the *Time Tagger 2.10.6* software are identical to the scan settings in TFPDAS (see also Sec. 4.5.1)
- Check the hardware connections
- Adjust the trigger level of the *Counter* channel

4.5.5 Buffer usage and buffer size

The bar indicator at the bottom of the user interface shows the maximum usage of the allocated buffer memory during an acquisition of a time-resolved Brillouin spectrum. In case that more than 90% of the allocated buffer is used, the color of the bar turns red indicating that the buffer size should be increased.

Adjust the buffer size In case of rather low free RAM memory on the PC, the buffer size might be reduced to prevent errors. For this, click on the *?* button next to the bar indicator and select *Edit buffer size*. In the menu (see image below), the buffer size can be adjusted. Three presets (small, medium, large) can be set or the buffer size can also be adjusted manually. For this, adjust the desired number of samples for the buffer size until the calculated buffer size in MB is reached and apply the settings.



5 Contact

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