

CIMPS-fit

Fast Intensity Transients



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1. Introduction

It is often advantageous, when linear dynamic measurements under frequency variation, like IMPS and IMVS can be put in relation to measurements of transient behaviour in the time domain. Slower photo-electrochemical systems, like DSSC or inorganic photo-catalytic systems can be evaluated successfully with the standard CIMPS function "Intensity Transients" described in Chapter 4.4 of the general [CIMPS manual](#). For faster processes happening for instance in silicon based or other monolithic types of semiconductor solar cells, and, due to their thin layer structure also in organic solar cells, the time resolution of the standard CIMPS "Intensity Transients" is not sufficient. Photo-charge diffusion and migration time constants in such objects may occur at timescales in the upper region or even beyond that, what can be covered by CIMPS. As a solution, Zahner offers a fast intensity transients option, which extends the timescale resolution some orders of magnitudes down to 50ns. CIMPS-fit uses the fast two-channel transient recorder TR8M plug-in from Zahner, which can be taken in general applications using its external inputs. Besides, the TR8M can communicate with the internal potentiostat of the Zennium/IM6 and with slave potentiostats connected externally via an EPC40 in an optimal manner by automatic, software controlled signal routing. This feature is the base for CIMPS-fit: the slave potentiostat, active in CIMPS controlling the lightsource intensity is set to perform fast transients, while the main potentiostat controls the cell and acquires cell voltage respectively cell current. The signals are internally routed to the TR8M. By this, light switching time constants of typically 400ns (off-transient) respectively 1µs (on transient) can be achieved. If necessary, CIMPS-fit may be extended optionally by a special external potentiostat-front-end and a fast light-off circuit, enabling switch-off transients with a time constant of typically less than 80ns.

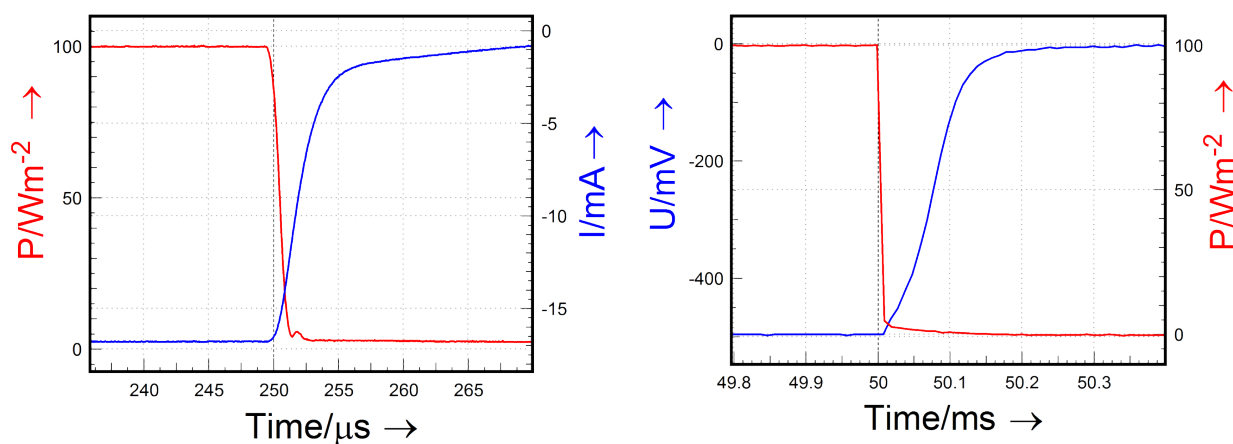


Fig. 1 Photocurrent transient of a monolithic silicon solar cell (left hand side) and photo voltage transient of an organic solar cell built up from Cr-Al-Cr-P3HT-PCBM-PEDOT-Cr-Au

2. Hardware and Installation

CIMPS-fit uses the LDA, light sources and cell carrier of standard CIMPS. Additionally the transient recording module TR8M is necessary to record fast transients.

The probe E/I connectors of the light source are connected to the slave potentiostat (PP211 or XPOT) using the cable supplied with CIMPS-fit. The BNC-plug of the probe E cable is connected to the external trigger input TREXT of the TR8M.

The photo sensor located in front of the cell is connected to the BNC socket of the LDA.

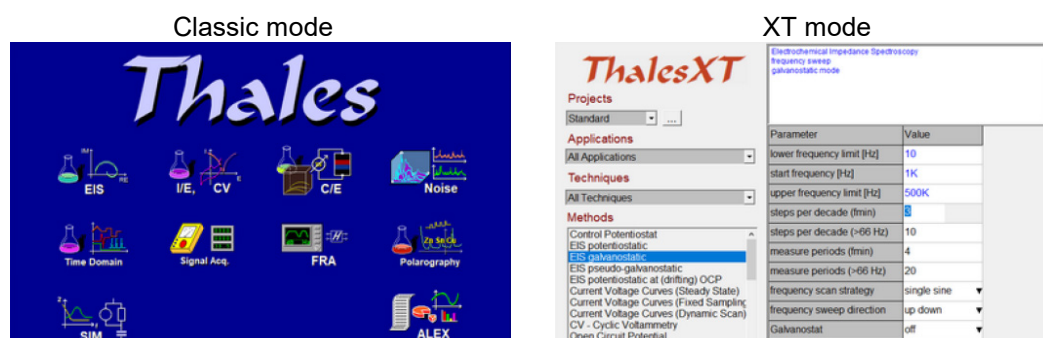
! An enclosure covering the complete optical bench is necessary to avoid detrimental effects caused by ambient light during the whole measurement time.

2.1. TR8M Calibration for Zennium pro/X

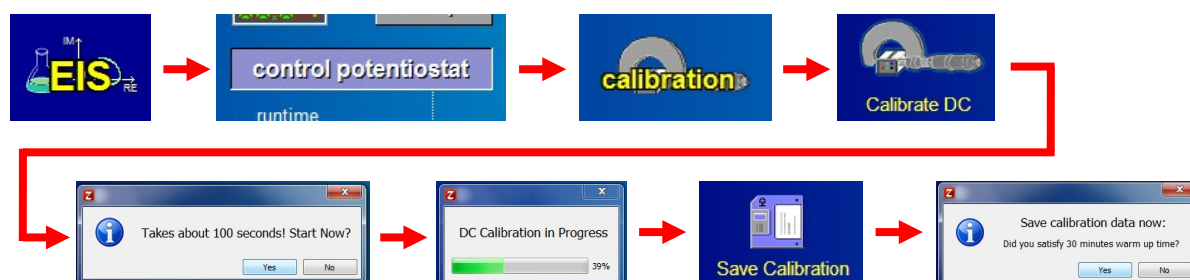
This is only necessary when upgrading a TR8M to a CIMPS system based on a Zennium-pro or Zennium-X electrochemical workstation (HDP Technology logo at the left frontpanel).

When installing a TR8M add-on card to a Zennium pro/X system the DC calibration has to be performed after a warmup time of about 30 minutes.

Ensure that classic mode is enabled for calibration procedures:



When using the Thales XT mode please change to the Thales classic mode (refer to manual Installation & Getting Started, chapter 6).




After performing and saving the DC calibration close Thales software package, turn off the electrochemical workstation and restart the system.

! When upgrading a Zennium or IM6 CIMPS system with a transient recorder TR8M there is no need of addition calibration tasks.

3. CIMPS-fit Software

3.1. Startup

CIMPS-fit is easily activated by using the pull down menu as shown in Fig. 2. To open the pull down menu click onto the Z-icon  in the title bar of the Thales window.

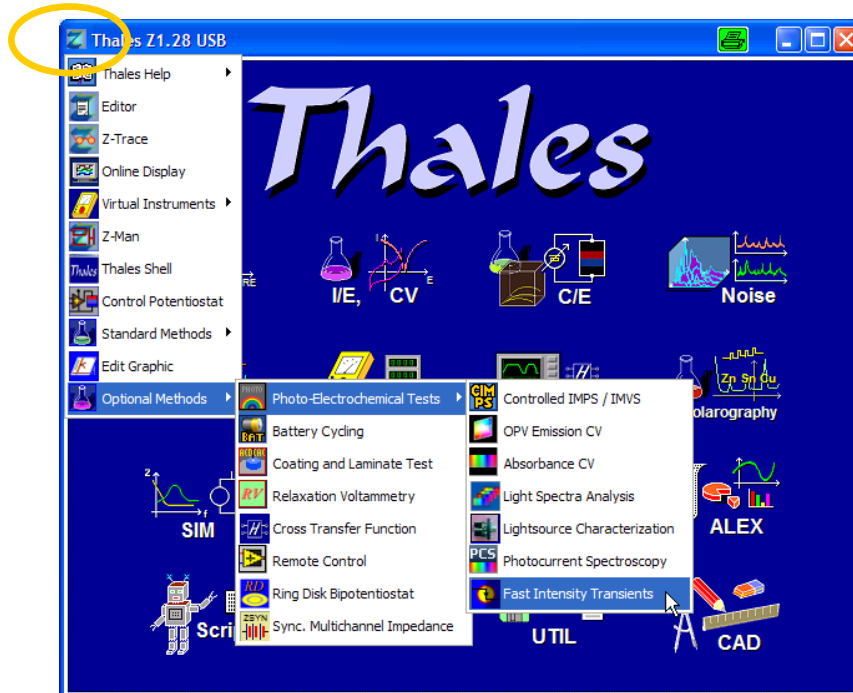


Fig. 2 Start of CIMPS-fit using the pull down menu

After initialization of the potentiostats, the main window of CIMPS-fit is displayed (see Fig. 3).



Fig. 3 Main window of CIMPS-fit after startup

It is similar to the regular CIMPS main window regarding source and cell control so chapters 3.1.2 and 4.1 of the [CIMPS manual](#) also apply.

3.2. Light Source Calibration

Light sources delivered by Zahner come with a calibration file allowing the direct input of light intensity in W/m^2 .

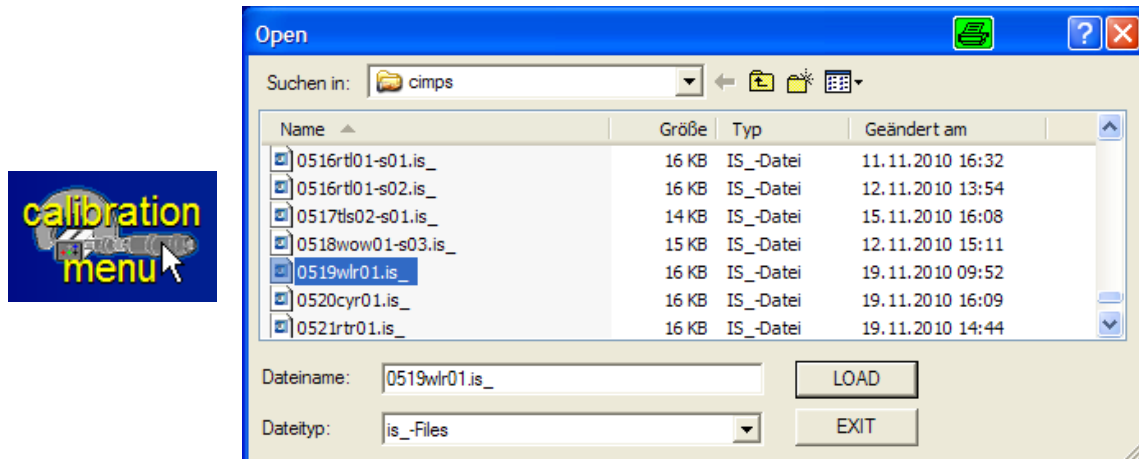


Fig. 4 Loading light source calibration data.

Click the calibration menu icon (Fig. 4, left hand side) to open the file dialog for choosing the light source calibration file (Fig. 4, right hand side). In the file dialog select the file corresponding to the light source. After installation of the calibration data CD light source calibration files are located in `c:\thales\cimps`. The name of the calibration file consists of the serial number and the ordering code of the light source, e.g. 0519wlr01 for the white light source with serial number 519.

3.3. Light Source Control



Fig. 5 Setting the DC current of the light source

Here the state of the light source in default (idle) state (i.e. no measurement running) is set. If set to on-state, this intensity setting is also used as on-phase intensity during the following measurements. If the default intensity is set to off-state, setting up the intensity during a transient measurement is described in chapter 3.8 Intensity Course and Light On Phase Intensity.

3.4. Transient Time

The radio buttons in Fig. 6 are used to set the rise time of the light source potentiostat. Setting a low transient time reduces rise time of the potentiostat but may lead to ringing. In this case increasing the transient time may be useful.

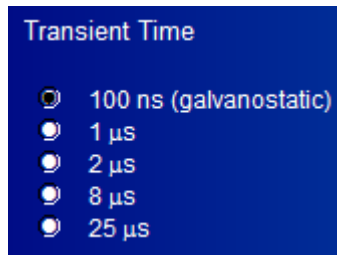


Fig. 6 Setting the transient time of the light source potentiostat

3.5. Cell Control

Cell control is located in the middle of the main screen. As in standard CIMPS the cell control icon is used to enter the control menu of the cell potentiostat (main potentiostat of the Zennium/IM6) as shown in Fig. 7.



Fig. 7 Active cell control icon and control potentiostat window

The set up of the cell configured here is used both for the measurement and the idle state of CIMPS-fit. The cell state (ON/OFF) determines, which transient is recorded. With the cell switched off, the voltage transient at open circuit is measured. With the cell switched on the current transient is recorded.

3.6. Cell Potentiostat Settling Time

The rise time of the cell potentiostat can be set by using the radio buttons as shown in Fig. 8. The smaller the settling time the more is the potentiostat prone to ringing, if the cell exhibits excessive capacitive contribution. In this case increasing the settling time may be useful.

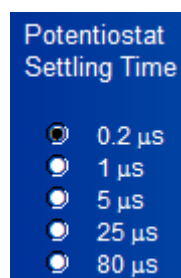


Fig. 8 Setting the settling time of the cell potentiostat

3.7. Recording Parameters

The configuration of the TR8M is done in the recording settings shown in Fig. 9 and automatically passed to the transient recording program.

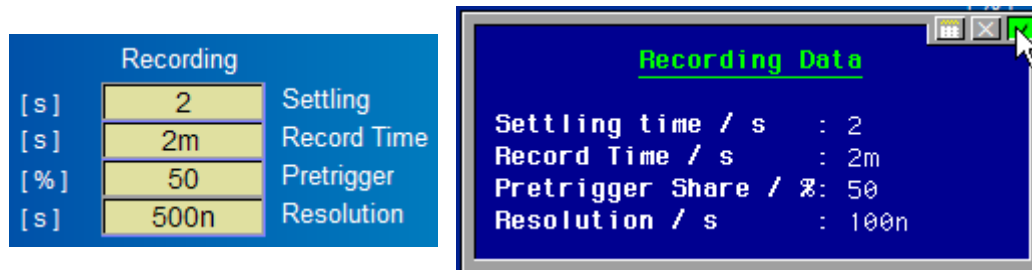


Fig. 9 Setting the recording parameters

Settling time sets the time span, the light source is kept in the initial state in order to equilibrate the system investigated. In case of switch-off measurements the light source is set to the on-phase intensity, in case of switch-on measurements the light source is set to 1% of the on-phase intensity for the settling time. No data is recorded during the settling time so it can be set to prolonged time spans (maximum 3600 s) without drawbacks.

Record time sets the complete time span in which the transient is recorded.

Pretrigger Share is the percentage of the total record time before the trigger event (i.e. the light transient) occurs. In case of a pretrigger share of 25% and a record time of 100 ms, 25 ms before and 75 ms after the trigger event are recorded.

Resolution sets the sampling time of the data points, i.e. the inverse of the sampling frequency. Range: 50 ns (20 MHz) to 0.1 ms (10 kHz).

Record Time / Resolution yields the number of data points recorded. The TR8M is capable of recording up to 8 Mega-words of data, but this huge amount of data is seldom of use for evaluation. Try to keep record time short and resolution just small enough to get a good resolution of the transient in order to avoid excessive data processing and data export time.

3.8. Intensity Course and Light On Phase Intensity

Using the radio buttons in Fig. 10 the intensity course can be set for switch-off measurements (on-off) and for switch-on measurements (off-on).

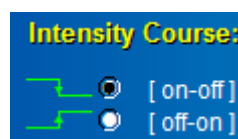


Fig. 10 Selection of switch-off and switch-on measurements

In the case of zero default intensity, the intensity of the on-phase during measurement is set with the input box shown in Fig. 11. This setting is necessary, if the actual default intensity described in chapter 3.3 Light Source Control is switched off.

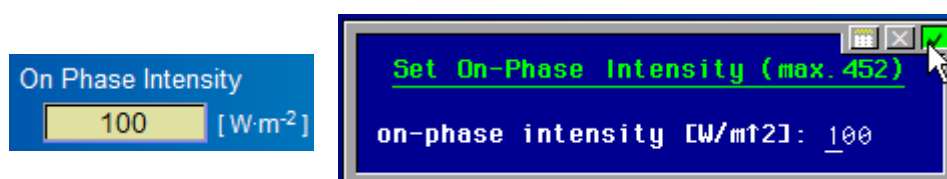


Fig. 11 Setting the intensity of the on-phase

3.9. Transient Recorder Panel

CIMPS-fit makes use of the transient recording program which is automatically configured and opened during a measurement. For reviewing and exporting recorded data the transient recording software can be accessed any time using the icon shown in Fig. 12. A more detailed description of the transient recording software is given in chapter 4.

Press the ESC key of the keyboard or the middle mouse button while in the transient recorder panel to return to CIMPS-fit.



Fig. 12 Access to the Transient Recorder Panel

3.10. Starting Measurements

After the parameters have been set, the measurement can be started with the button shown in Fig. 13.



Fig. 13 Button for starting a measurement

If current transients are recorded, CIMPS-fit determines the suited current range of the cell potentiostat automatically before starting the settling phase. In the next step the initial intensity is set for the preset settling time. In case of switch-off transients this is the on-phase intensity (Fig. 14, left hand side). In case of switch-on transients the light source is set to 1% of the on-phase intensity (Fig. 14, right hand side). While 1% of the nominal intensity has no significant effect on the cell it improves transient response of the light source potentiostat compared to a light source switched completely off.

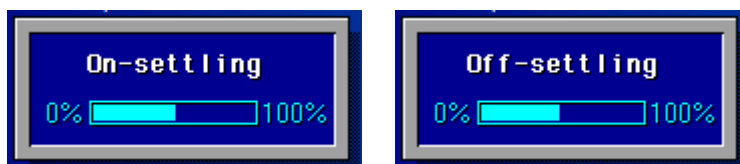


Fig. 14 Progress bar displayed during the settling phase

The settling phase can be interrupted by pressing the middle mouse button at any time. In this case CIMPS-fit does not record a transient but returns to the idle state.

After the settling time is elapsed the data acquisition of the transient recorder starts with the recording of the pretrigger phase, which defaults to 50% of the total measurement time. A message like in Fig. 15 is displayed in this state.

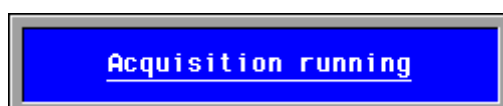


Fig. 15 Status message during the pretrigger time data acquisition

After the pretrigger time is elapsed the light transient is initiated and the transient recorder waits for the completion of the transient. A message like in Fig. 16 is displayed in this state normally lasting the rest of the measurement time after the pretrigger phase.

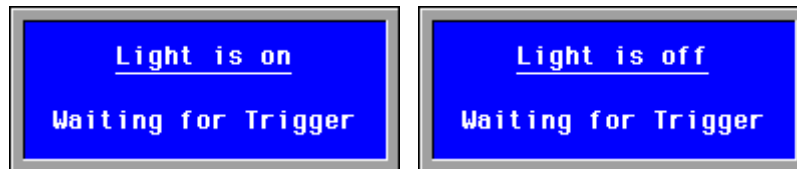


Fig. 16 Status message while waiting for completion after the trigger event

. In case no trigger event is detected, the measurement can be interrupted manually using the escape key or the middle mouse button. As soon as data acquisition is completed, the transient recording screen is displayed automatically.

4. Transient Recording Software

4.1. Initial Display of Recorded Data

After a transient was recorded it is displayed automatically in the transient recording software like shown in Fig. 17.

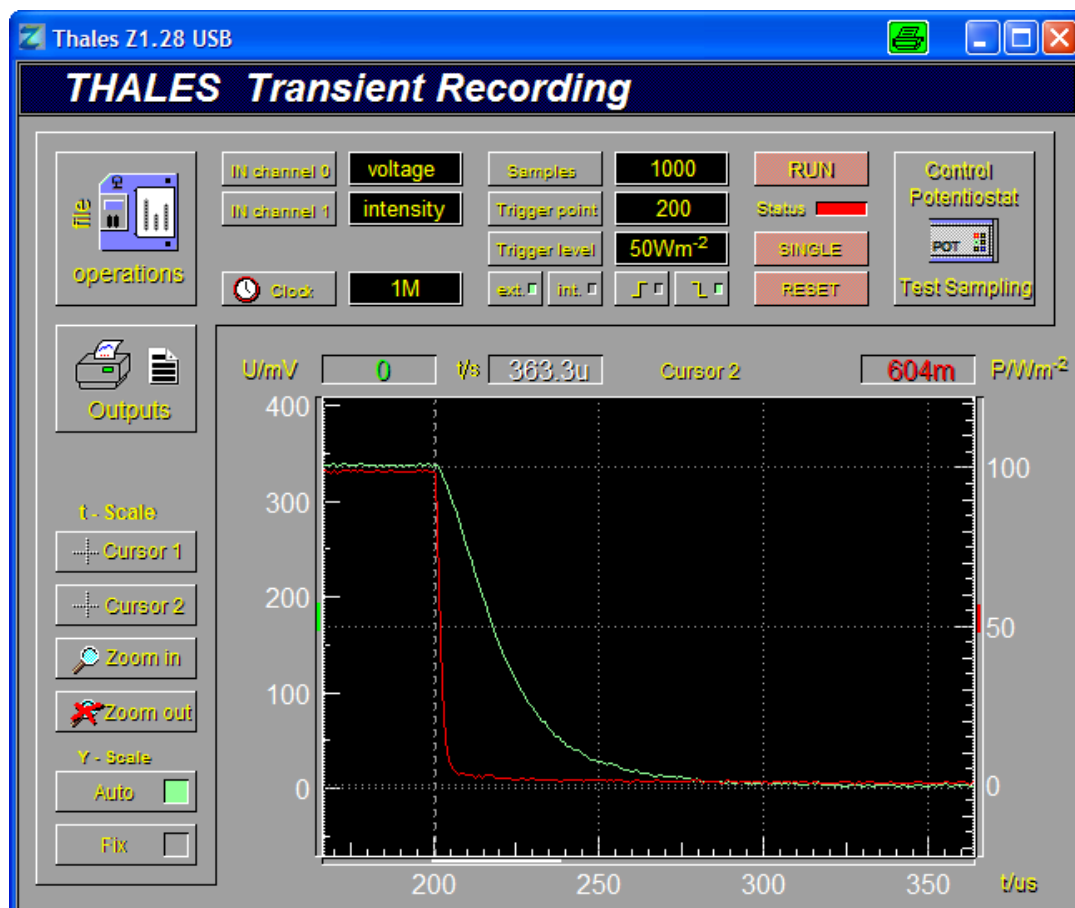


Fig. 17 Transient Recording Software

The colour of the graphs are green for the first channel "IN channel 0" and red for the second channel "IN channel 1". Please note, that the sequence of the channel meaning changes due to different internal signal routing, if the photovoltage- or the photocurrent transient was measured. Photovoltage is displayed in green colour at channel 0 together with the intensity in red colour at channel 1. Different from that, photocurrent is displayed in red colour at channel 1 together with the intensity in green colour at channel 0.

4.2. Scaling of Graphs

The scaling of the display may be set to auto scale, automatically expanding the graphs to fit the display size in Y-direction, or it can be set manually (see Fig. 18).

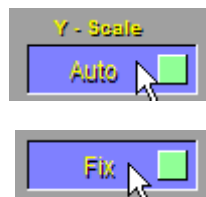


Fig. 18 Y-scaling buttons

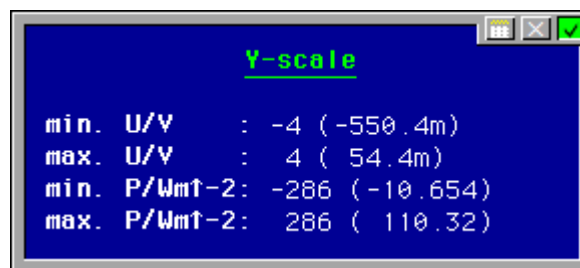


Fig. 19 Inputting the scale factors for manual (fixed) Y-scaling

Pressing the fixed scale button opens the input box for inputting in the scale factors for manual (fixed) Y-scaling (see Fig. 19). Suggested values in brackets are calculated from auto scaling. The default values are set to the maximum dynamic range of the according channel.

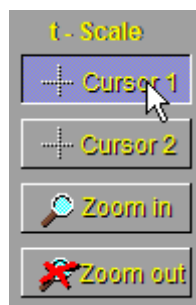


Fig. 20 Setting cursor marks and selecting a time section

Two cursor positions can be set and moved by moving the mouse, when selected (Fig. 20). The time at cursor position and the according signal values are displayed on top of the graphic display window. By means of the zoom-in button one may select an arbitrary section of the time course dependent on the cursor positions to be displayed. The zoom-out function will switch back to the display of the total record. If you are in active cursor mode, clicking the alternate mouse button will open the cursor help panel (Fig. 21) for extended cursor functionality. Here "define as reference" causes the actual cursor position to be used as zero reference for following cursor positions. In this mode, the differences (marked by a "Δ" in the display line) between the actual and the reference position are displayed. One may use this for instance for estimating transition times or measuring peak amplitudes. Using "take zero reference" switches back to absolute reference. With "take free reference" the time - respectively signal differences relative to an arbitrary Y-T-value may be chosen. "export values" copies the actual values to a text line in the internal Thales text editor panel.

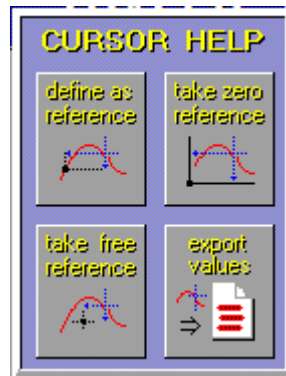


Fig. 21 Help panel for extended cursor functionality

4.3. Export of Data

Data may be put out in different ways. Use the button “outputs” to open the output data panel.



Fig. 22 Entering the output data panel (right hand side) by clicking the output button

The output functions “Export Data”, “Hardcopy” and “Export Drawing” can be used orthogonal in the way like anywhere in the Thales program environment. The export is “WYSWYG” – you may shorten the data list for instance, if only a section of the record was selected by the “zoom in” function.

4.4. Settings

You should not change the settings of the trigger functions. Trigger source, sign and level are overwritten automatically with the optimal values by the CIMPS-fit program on the next measurement. The count of data samples, the position of the trigger in the time course of the record and the sampling time may be changed here, and are taken for the next measurement. Please note, that the pretrigger phase is set here in an absolute count share of the total samples, and not in percentage, like done in the CIMPS-fit panel. Similar, the sample rate is defined as sampling frequency instead of a sampling time and the record length is defined as a sample count.