TOPAS (ORPHEUS) CONTROL SOFTWARE

"WinTOPAS" version 3.x

Start Guide

ver. 1.05

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NOTES

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PREFACE

TOPAS (ORPHEUS) is a series of BBO or LBO crystal based optical ultra short pulse parametric amplifiers (OPA or NOPA) equipped with optional frequency converters providing generation of pulses continuously tunable over wide wavelength range. TOPAS (ORPHEUS) operating system consists of I/O interface board installed in TOPAS (ORPHEUS) module and Windows compatible software package "WinTOPAS". The main function of "WinTOPAS", is the control of TOPAS (ORPHEUS) hardware when wavelength tuning is performed. It also provides the user with numerous menu options for easy program installation, setting of TOPAS (ORPHEUS) configuration, access to calibration and service procedures.

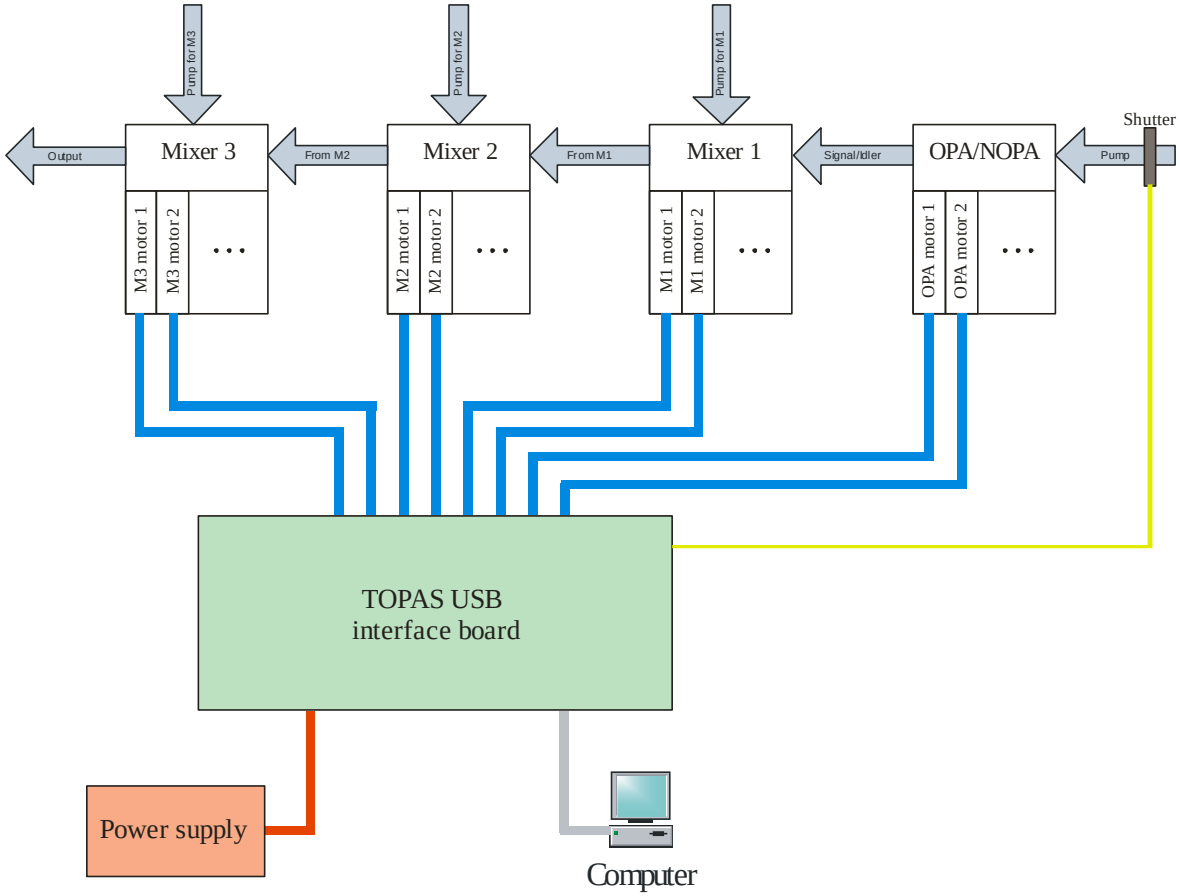

Figure 1. Structure of TOPAS (ORPHEUS) system.

Functional structure of the system is presented in Figure 1. The whole TOPAS (ORPHEUS) optical scheme can be represented as a sequence of wavelength converters (OPA/NOPA, Mixer 1, Mixer 2 and Mixer 3). In OPA/NOPA module signal and idler waves are generated from the incoming pump beam. Mixer 1 uses OPA/NOPA signal or idler waves for further wavelength transformations. Additional pump can be supplied to Mixer 1 for sum or difference frequency generations. In the same manner Mixer 2 uses output from Mixer 1, and Mixer 3 output from Mixer 2. Every wavelength changing unit has dedicated motors. Up to 12 motors can be implemented in every unit. All motors are connected to TOPAS (ORPHEUS) I/O board and controlled via USB bus from "WinTOPAS" application. When asked for a particular wavelength value, "WinTOPAS" drives

the motors to the positions calculated accordingly to formulas and tables of positions (tuning curves).

Single software package provides parallel operation of up to five I/O boards (situated in five different TOPAS (ORPHEUS) devices) each of whom can drive up to 12 stepper motors. "WinTOPAS" has an intuitive graphical user interface that makes the control of TOPAS (ORPHEUS) systems simple and straightforward. Being the fourth generation of software for computer controlled optical parametrical amplifiers "WinTOPAS" is built and designed to meet the demands of researchers working in the fields of nonlinear optics, spectroscopy, biomedicine, etc.

This Start Guide provides the user with information on "WinTOPAS" main features and installation; it also contains an overview of TOPAS (ORPHEUS) system settings and control options accessible from control computer screen. In the last chapter a description of basic "WinTOPAS" operating procedures is presented.

1. SYSTEM REQUIREMENTS AND GENERAL FEATURES

1.1. System requirements

System requirements for operation of "WinTOPAS" are following:

- Computer with Pentium II or better processor.
- 128 Mbytes RAM (512 Mbytes recommended).
- 16 Mbytes of hard disk space.
- SVGA color adapter (16-bits or more colors depth recommended).
- USB 1.1 or USB2 port.
- Windows XP, Windows Vista, Windows 7 (both 32 and 64 bits editions).

1.2. General features

The list below describes the general features of "WinTOPAS".

- Fully computer controlled wavelength tuning in whole range from 180 nm to 20 μm.
- Support for TOPAS (ORPHEUS) USB and legacy LPT interface cards (LPT cards are supported on 32-bit operating systems only).
- Up to 12 motors controlled with one interface card and up to five cards can be connected simultaneously.
- 32 and 64 bits applications for Microsoft Windows, compatible with Windows XP, Windows Vista and Windows 7. (Older versions support Windows 2000, Windows 98, Windows 95, MS-DOS).
- "WinTOPAS Software Development Kit" provides simple .dll based interface to control TOPAS (ORPHEUS) devices from external applications.
- Integrated serial port and TCP/IP network servers allow accepting control commands from remote computers via serial cable or local area network.
- Examples how to control TOPAS (ORPHEUS) over TopasAPI functions from LabView, MatLab, Visual Basic and Visual C++.
- Context sensitive HTML help system.

2. DEVICE INSTALLATION

1. Connect external power supply to the TOPAS (ORPHEUS) interface board.
2. Connect external power supply to the mains.
3. Install "WinTOPAS" software. "WinTOPAS" is stored in USB memory stick provided. Run Setup.exe file and installation process will copy all necessary files (executables, dynamic link libraries, help system and "WinTOPAS SDK") to the default (C:\Program Files\WinTOPAS3) or user defined folder. "WinTOPAS" shortcut will also be created on your desktop.

Windows 7 users are not advised to install "WinTOPAS" to the default folder (C:\Program Files\WinTOPAS3) as the operating system prevents file modification in "Program files" folder. Therefor it is recommended to create a custom folder for "WinTOPAS" (for example: C:\TOPAS\WinTOPAS3).

4. Copy device configuration file "*serial_number*.ini" from USB memory stick folder "Configuration files" to any folder on local computer ("WinTOPAS" default directory is recommended).
5. Connect USB cable to the TOPAS (ORPHEUS) interface board and computer.

After plugging USB cable to computer, operating system will detect a new device and ask for a driver.

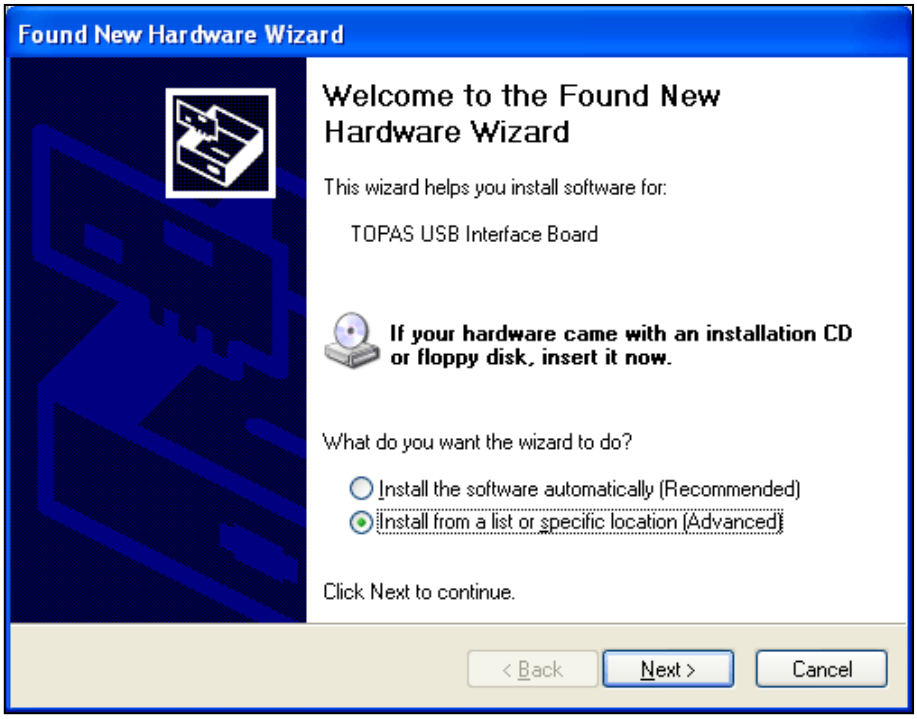

Figure 2. USB driver installation, step 1.

Select "Install from a list or specific location (Advanced)" and press "Next" button. Windows will ask for a path to driver.

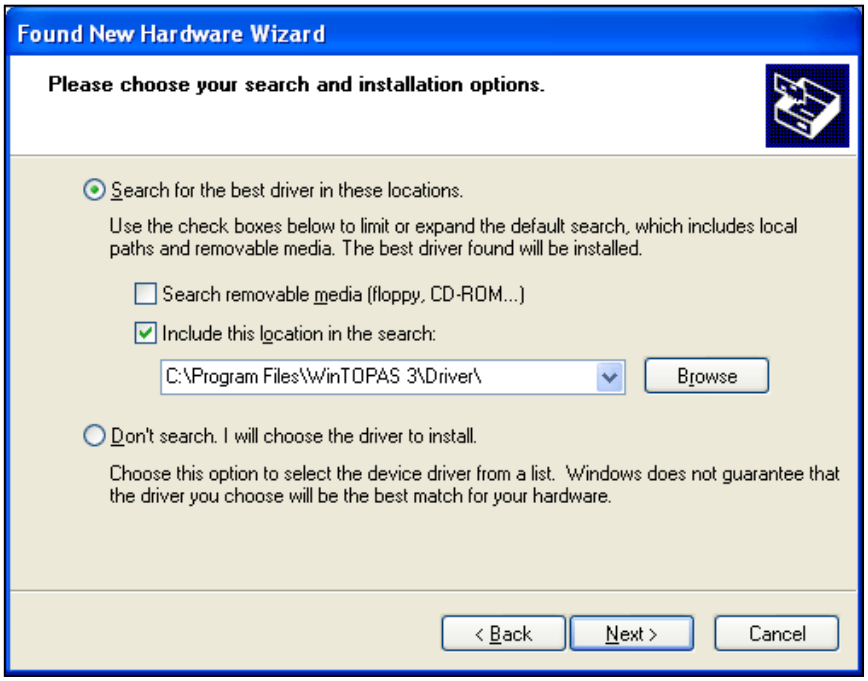

Figure 3. USB driver installation, step 2.

Press "Browse" button and select "...\WinTOPAS 3 \Driver" directory. Press "Next" button. System will copy all necessary files.

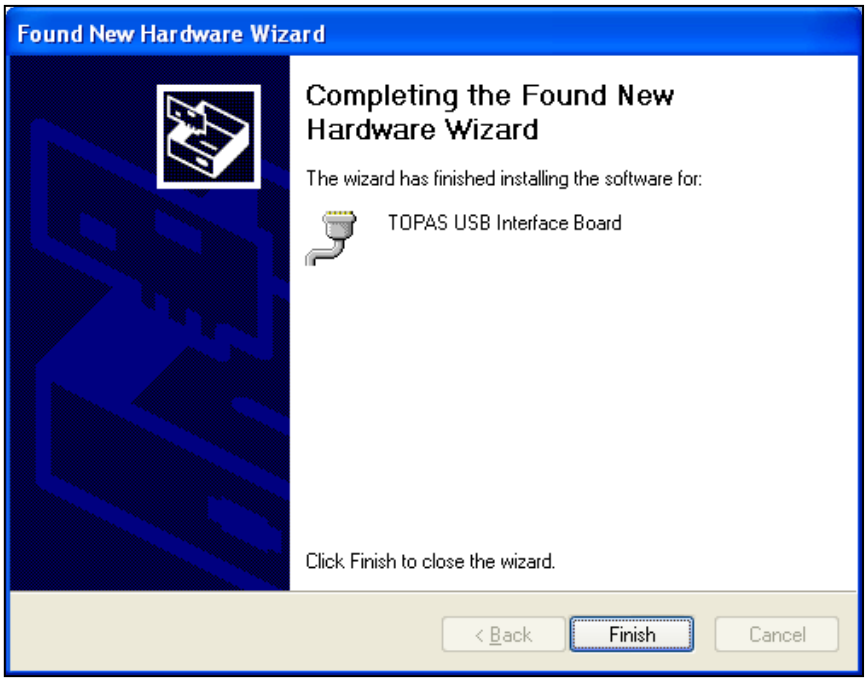

Figure 4. USB driver installation, step 3.

Press "Finish" button to complete installation.

3. DEVICE CONFIGURATION

Typically device configuration is performed by authorized service engineer. User has to complete this operation only if software is moved to another computer.

- Select device configuration file/s.
  - Select "Service"->"Access level" menu option and switch access level to "advanced user" or "service engineer" (see Appendix 4 for "advanced user" password).
  - Select "Load/Unload Devices Configurations" option in "Devices" menu.

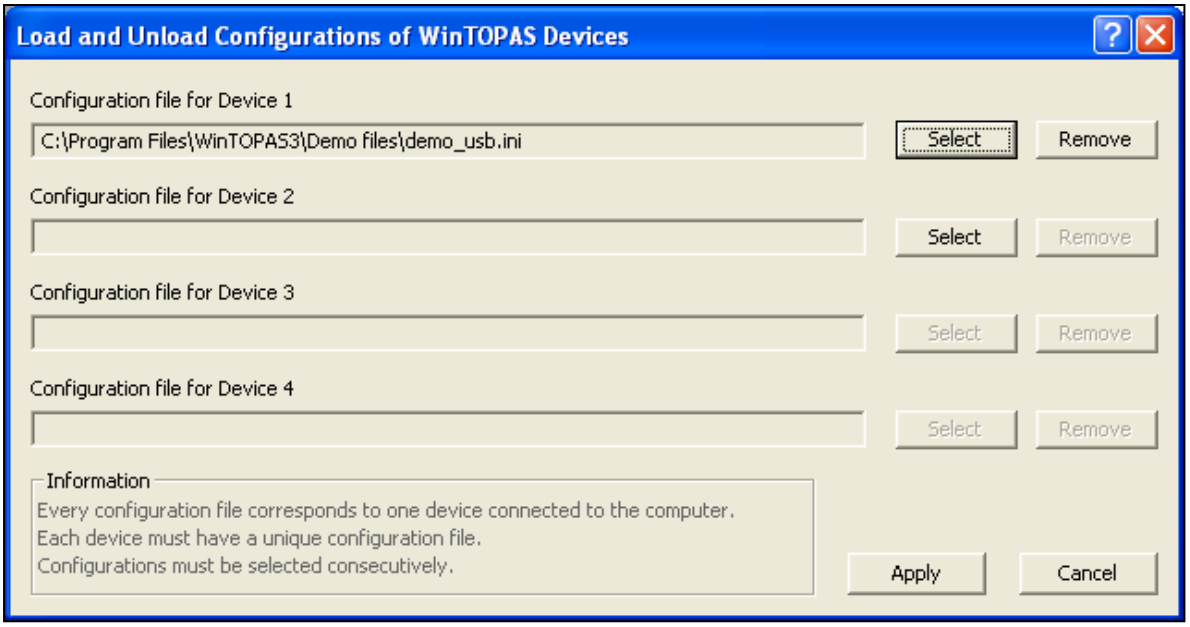

Figure 5. Selecting device configuration file.

  - Press button "Select" and browse to device configuration file (typically configuration file resides in "/Configuration files" directory on "WinTOPAS" installation USB stick and must be manually copied to any location on computer's hard disc. Configuration file contains all physical TOPAS (ORPHEUS) system configuration parameters, information about used tuning curves and current TOPAS (ORPHEUS) state, user's preferences and customization settings. Repeat the last step again if more than one TOPAS (ORPHEUS) system is connected.
  - Press "Apply" button to load configurations files..
  - Restart "WinTOPAS".
- Select tuning curves files.
  - Select "Load/Unload Curves" option in "Curves" menu.
  - Press button "Load" of corresponding tuning curve (OPA/NOPA, Mixer I, Mixer II or Mixer III) and browse to tuning curve file. At the bottom of "Open" window short summary of currently selected tuning curve is displayed. Select the tuning curve and press "Open" to load it. Repeat this procedure for all tuning curves.

After this reset operation for motors must be performed before "WinTOPAS" is ready to use (for more information on "Reset" function see Chapter **5.2.**).

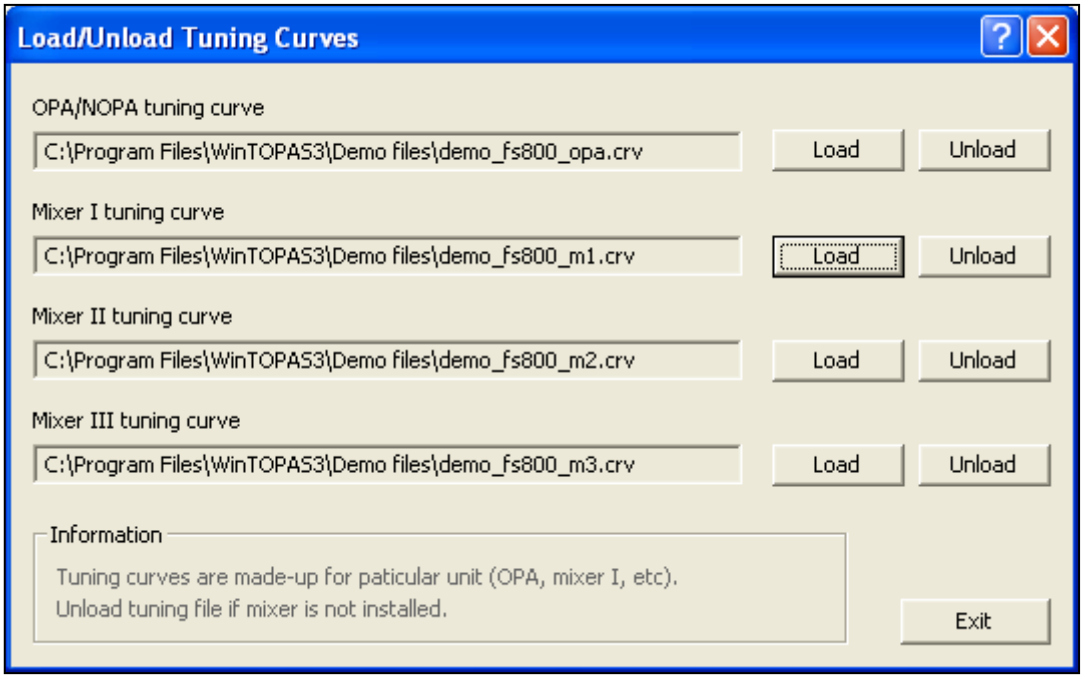

Figure 6. Loading tuning curves.

4. USER INTERFACE

4.1. Main application window

By default program is installed to "C:\Program Files\WinTOPAS3" directory. WinTOPAS3.exe file runs TOPAS (ORPHEUS) control program. Just one "WinTOPAS" application can be started on the computer at a time. It can control up to 5 TOPAS (ORPHEUS) series devices but only one device (called "active") can be accessed at once.

When the program is started, **Main application window** is displayed. It contains **Menu bar** at the top, **Info** area in the center and **Status line** with **Toolbar** and function keys at the bottom.

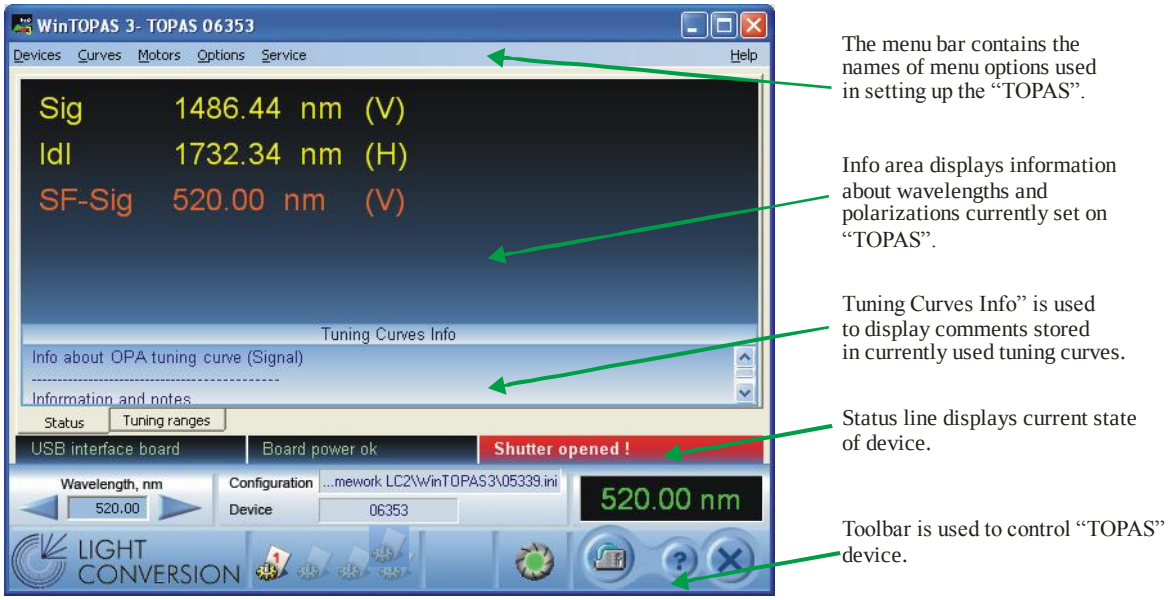

Figure 7. Main "WinTOPAS" application window.

4.2. Info window

The **Info** window contains tab control with several pages.

Status page shows you the current state of TOPAS (ORPHEUS) operation - wavelengths and polarizations of radiation generated by the device. First two lines show the currently set wavelengths for Signal and Idler. If frequency mixers are used for accessing additional wavelength regions, extra line(s) appear in the **Status** page. They contain the information about interaction types used in mixers, wavelengths and polarizations of the output pulses. The list of abbreviation for different types of interaction is presented in Appendix1.

Wavelength can be displayed in nm or reciprocal centimeters accordingly to selected display mode. If position of any motor was changed from program using "Direct access" window the message "WAVELENGTH IS NOT SET" will appear at the top of **Info** window. "Tuning Curve Info" area at the bottom of the page displays description of all interactions used to produce output wavelength. These free-form descriptions are stored in tuning curves files and can be edited in "Tuning Curves Properties" window. Descriptions for OPA/NOPA and mixers are separated with dashed lines.

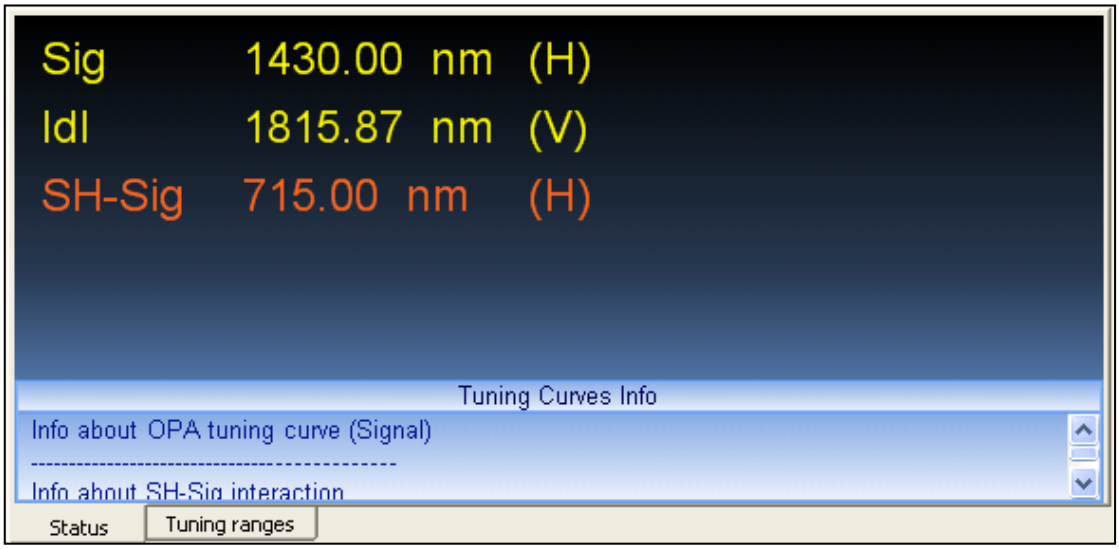

Figure 8. "Status" window.

Tuning ranges page contains graphical representation of TOPAS (ORPHEUS) tuning ranges provided by installed tuning curves. Every installed interaction type is displayed as colored box on the wavelength axe. Vertical or horizontal lines inside every box stand for the polarization of output wave. White horizontal dashed lines separate OPA/NOPA and mixers tuning curves.

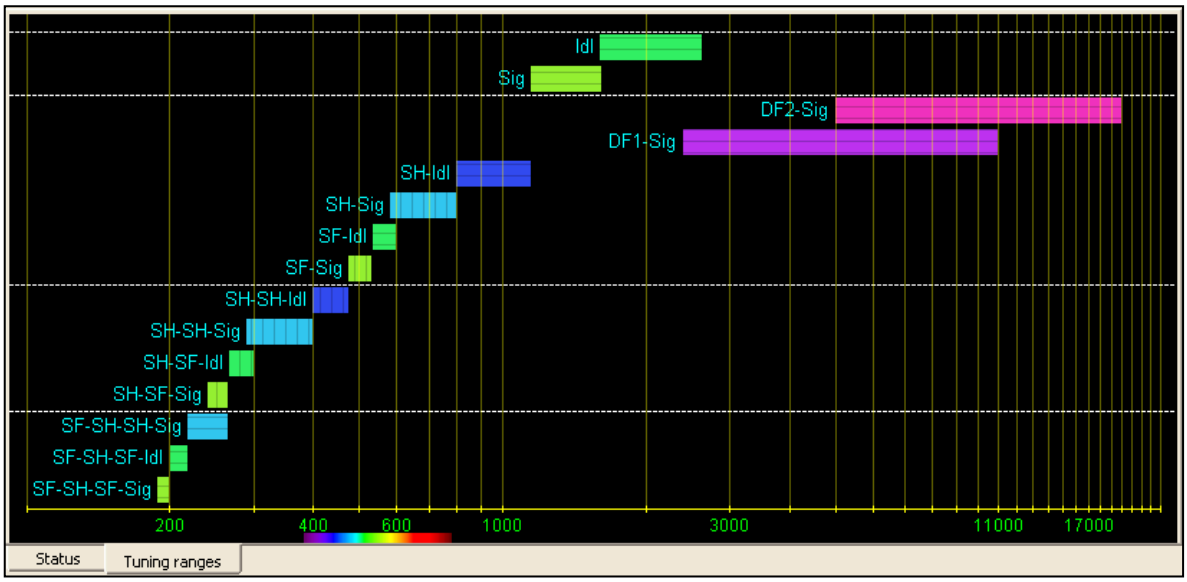

Figure 9. "Tuning ranges" window.

4.3. Status line

The Status line displays current status of active device.

Figure 10. TOPAS (ORPHEUS) Status line.

The first section of **Status line** displays type of interface board.

Table 1. Status line messages part 1.

Message	Explanation
USB interface board	Currently selected device is equipped with USB interface board.
LPT interface board	Currently selected device is equipped with LPT interface board. (True for older TOPAS (ORPHEUS) models)

If USB board is connected, the second section displays warnings about interface board power failure and short connections in stepper motor circuits.

Table 2. Status line messages part 2.

Message	Explanation
5V voltage failure !	USB interface board detected that 5V power supply voltage is out of range.
24V voltage failure !	USB interface board detected that 24V power supply voltage is out of range.
5V and 24V voltages failure !	USB interface board detected that 5V and 24V power supply voltages are out of range.

If USB board is connected, the third section displays current state of shutter and board flash memory status.

Table 3. Status line messages part 3.

Message	Explanation
Shutter opened !	TOPAS (ORPHEUS) device input shutter is opened.
Shutter closed !	TOPAS (ORPHEUS) device input shutter is closed; no radiation is transmitted into the TOPAS (ORPHEUS).

Cover open	Cover of the TOPAS (ORPHEUS) is opened without interlock defeat.
...Flash empty	Flash memory on USB interface card contains no data about last device state. Typically this message can be displayed after first powering of the interface board and disappears after restarting "WinTOPAS" program ("WinTOPAS" saves device state to flash on exit.)
...Not synchronized with PC	Device data stored in USB interface board differs from data stored in computers memory. This message can be shortly displayed after connecting to TOPAS (ORPHEUS) devices and before data is transferred to interface board.

4.4. Menu bar

All the necessary functions used for TOPAS (ORPHEUS) control are stored in pull-down menus situated in the **Menu bar**. The access to menu selections depends on currently selected access level (see Appendix 2 for more information about "WinTOPAS" access levels). Some menu options will not be displayed if appropriate access level is not selected. Here is the list of all pull-down menus and selections:

- **Devices**
  - **Connect/Disconnect Devices.** Opens the window to load and unload configuration files to connect or disconnect TOPAS (ORPHEUS) devices. Up to 5 different TOPAS (ORPHEUS) series devices can be connected simultaneously.
  - **Save Configuration.** Saves current parameters of "active" TOPAS (ORPHEUS)device to configuration file.
  - **Save Configuration As.** Saves current parameters of "active" TOPAS (ORPHEUS)device to a new configuration file prompting user for a new file name.
  - **Save All Configurations.** Saves current parameters of all connected TOPAS (ORPHEUS) devices.
  - **Exit WinTOPAS 3.** Saves current parameters of all connected TOPAS (ORPHEUS) devices and closes application.
- **Curves**
  - **Load/Unload Curves.** Opens the window to load and unload tuning curves for "active" TOPAS (ORPHEUS) device. After tuning curves are loaded program tries to locate license for every interaction type. If license for particular interaction type is not located in device configuration file, the tuning curve corresponding to that interaction is removed from memory. See Appendix 3 for more details about licensing in "WinTOPAS".
  - **Priorities.** Calls the window that give a possibility to select between "Interactive" and "Priority" operation modes (for more information see Chapter **5.3.**)

- **Curves Properties.** Displays the window with properties of loaded tuning curves (interaction types, tuning ranges, offsets, pump wavelength, polarizations).
- **Offsets**
  - **OPA/NOPA Offsets.** Shows OPA/NOPA calibration dialog.
  - **Mixer I Offsets.** Shows mixer I calibration dialog.
  - **Mixer II Offsets**. Shows mixer II calibration dialog.
  - **Mixer III Offsets**. Shows mixer III calibration dialog.
- **Modify.** Allows modification of separate points in tuning curves.
- **Create Tuning Curve**. Calls series of windows that serve as a guide when measuring new tuning curves for OPA/NOPA and mixers.

- **Motors**
  - **Direct Access**. Calls the "Direct access" window. This window allows direct control of all stepper motors used in TOPAS (ORPHEUS) system.
  - **Motors Properties**. Displays the window with properties of installed motors. All parameters (except of Affix values) are read only in "user" and "advanced user" access levels.
  - **Swing tool.** A tool for fast wavelength scanning. Can be used to increase the effective (average) bandwidth of the TOPAS output.

- **Options**
  - **Windows**
    - **External commands window.** Displays window to display commands received by "WinTOPAS" via COM port or via TCP/IP network.
  - **Preferences**. Opens window with global options of "WinTOPAS" (wavelength or wave number display mode, wavelength step, shutter, backlash compensation and external commands server options).
  - **Customize**. Calls "Customize" window to change info window colors and font.

- **Service**
  - **Access Level**. Opens "Access Level" selection dialog to switch to different access level (see Appendix 2 for more information about "WinTOPAS" access levels).
  - **Install licenses**. Opens "Install licenses" window. See Appendix 3 for more details about licensing in "WinTOPAS".
  - **USB Board Diagnostics.** Active only when USB interface board is connected. Displays diagnostics window used to troubleshoot hardware problems.

- **Help**
  - **Contents**. Shows contents of "WinTOPAS" help file.
  - **About WinTOPAS 3**. Presents the information on current "WinTOPAS" version.

4.5. Preferences window

Preferences window (Options->Preferences) helps to manage global options of "WinTOPAS". Here is a brief description of submenus available (see Figure 11.):

- **Wavelength display.** Helps choosing wavelength measurement units as well as a number of precision digits displayed in **Info** window.

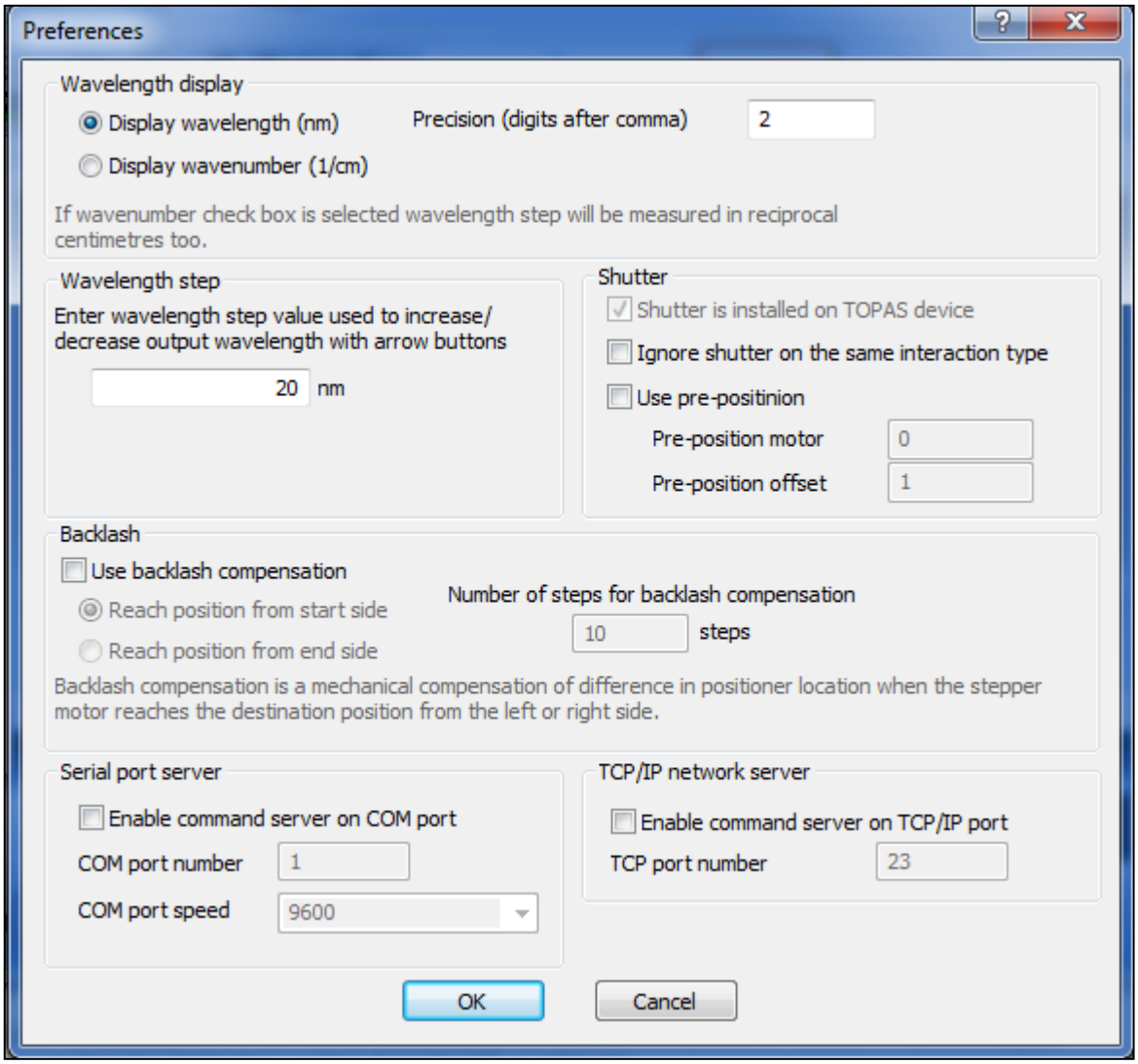

Figure 11. Preferences window.

- **Wavelenth step.** User can enter step value used to increase/decrease output wavelength with arrow buttons (situated in **Toolbar**).

- **Shutter.**
    - **Ignore shutter...** As the shutter is automatically closed while "WinTOPAS" changes the output wavelength, there is an option to keep the shutter opened while changing the wavelength within the same interaction.
    - **Use-preposition.** This function is used to detune one of the OPA motors from its optimal position before the shutter is closed. This may be necessary to protect internal components of the OPA or the external user's components from dangerous diffraction peaks that occur while the shutter is being closed.
        - **Pre-position motor.** The number of the stage which should be detuned (Counting from 0 in the Direct access menu),
        - **Pre-position offset**. The amount by which the stage should be moved, in physical units. In ORPHEUS, this would correspond to motor number 5 (SHG crystal) and offset of around 1 degrees.
- **Backlash.** Backlash compensation is a mechanical compensation of difference in positioned location when the stepper motor reaches the destination position from the left or the right. User can choose a compensation direction as well as a value of compensation in motor steps.
- **Serial port server. TCP/IP network server.** These options allow accepting control commands from remote computers via serial cable or local area network (for more information see "**Wintopas 3 External Interfaces**" manual).

4.6. Toolbar

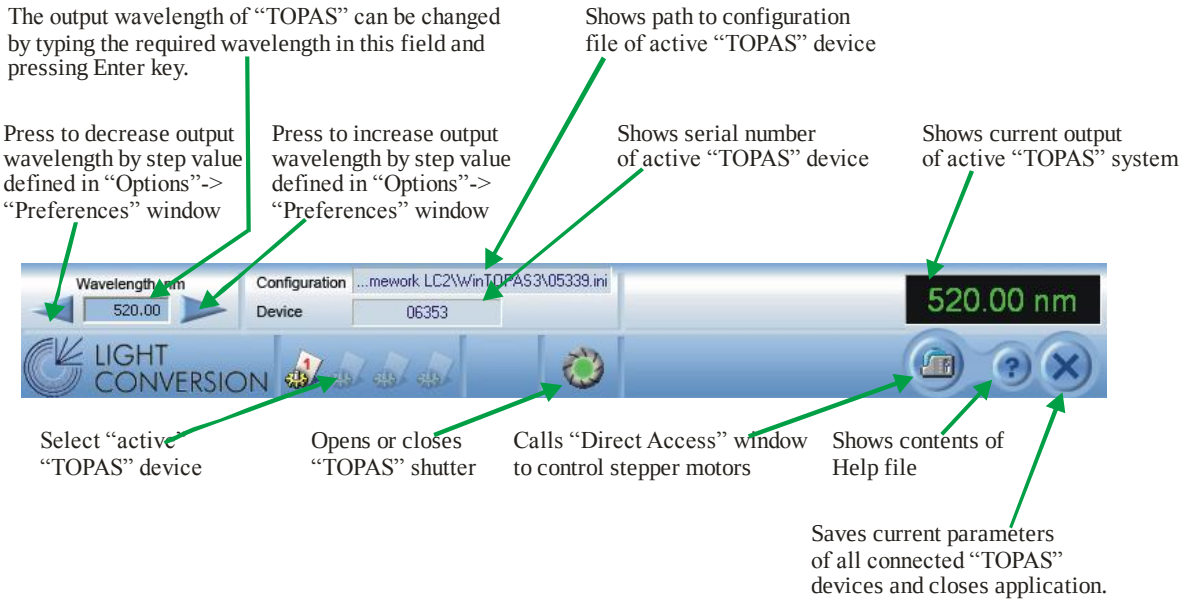

Figure 12. "WinTOPAS" main window toolbar.

5. BASIC OPERATIONS

The complete TOPAS (ORPHEUS) system configuration is set up by service personnel during initial system installation. For daily operation usually just few procedures are required when setting up the particular wavelength(s) of TOPAS (ORPHEUS) output.

5.1. Starting the program

- Connect the 24V DC power supply cable to "DC/24V" socket located on the front panel of I/O interface board (s). Switch on the power.

On the regular usage of system it is recommended to keep TOPAS (ORPHEUS) system powered permanently thus avoiding the need of motors position recalibration.

- Connect TOPAS (ORPHEUS) device to computer via USB cable.
- Run "WinTopas3.exe" file or the corresponding icon on the desktop of control computer. The **Main application window** with **Menu bar** at the top, **Info window** in the center, **Status line** and **Toolbar** will be displayed (see Chapter **4.1.**). The system configuration and the settings are restored from current TOPAS (ORPHEUS) configuration file, which is updated every time you exit the program.
- Select the "active" device by clicking the proper icon on the **Toolbar** of **Main application window.**

5.2. Reset of stepper motors

TOPAS (ORPHEUS) output energy, space-time quality and wavelength value depend on the orientation and positions of optical elements installed on the rotation/translation stages inside TOPAS (ORPHEUS). These stages are driven by computer controlled stepper motors, and their positions are loaded from the tuning file(s) when setting TOPAS (ORPHEUS) operation at the defined wavelength. The motor reset procedure relates the true position of motor to the numerical motor position set by software.

If power for interface board was switched off between software working sessions, you should run the stepper motor reset procedure. The procedure should performed also in case when computer controlled stages were adjusted manually during or in between of working sessions.

To reset stepper motors:

- Select **"**Direct access" option from "Motors**"** menu.

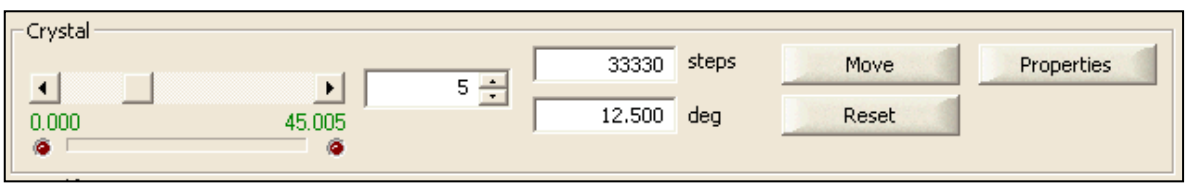

Figure 13. Reset of stepper motors.

- Press "Reset" buttons of the motors which you are going to reset. The motor moves the stage to the minimum position at which the end-microswitch is activated. After microswitch activation the program relates minimum mechanical stage position to "zero" numerical position. Finally the stage will be moved to initial numerical position.
- Repeat the reset procedure for other motors if needed.

You can reset all the motors by clicking the button "Reset all" located at the left bottom corner of the window.

When reset procedure is finished set the desired output wavelength from the **Main application window.**

5.3. Setting the output wavelength

The tuning range of each TOPAS (ORPHEUS) device is determined by the set of tuning curves included in the device configuration file. By clicking the **"Tuning ranges"** option in **Info** window you can activate the page containing graphical representation of TOPAS (ORPHEUS) subunits tuning range provided by current configuration of the device. More detailed information on TOPAS (ORPHEUS) tuning can be accessed through "Curves Properties" option of "Curves" menu.

When setting the required wavelength you can express it both in nanometers (nm) and wave numbers (cm^{-1}). To do so:

- Select the **Preferences** option from the "Options" menu.
- Select a desirable format (in "nm" or in "cm^{-1}") for wavelength setting. In the same window you can set the number of significant digits with which the wavelength is expressed.

Figure 14. Wavelength display in Preferences window.

TOPAS (ORPHEUS) output wavelength is set using the input field named "Wavelength, nm" (or "Wavenumber, cm^{-1}"), it is located on the left side of the **Toolbar.** To set a wavelength:

- Type the wavelength in the field and press "Enter". The new window with a progress bar will appear displaying the status of procedure execution. Afterwards all information regarding interaction type(s) will appear in the **Info** window. Do not forget to open the shutter after starting "WinTOPAS". Once the shutter is opened, it will automatically close during wavelength change procedure.

The output wavelength can be changed by fixed value when clicking  or  buttons located on the both sides of the wavelength input field. The value of the wavelength shift is set using option "**Preferences**" from the "Options" menu.

Certain wavelengths of output radiation can be obtained using different interaction types, i.e. the tuning curves for different subunits overlap at certain range of wavelengths. To solve these cases "WinTOPAS" provides two operation modes for interaction type priority setting:

- Select the "Priorities" option from "Curves" menu. "Set priorities for interaction types" window will appear.

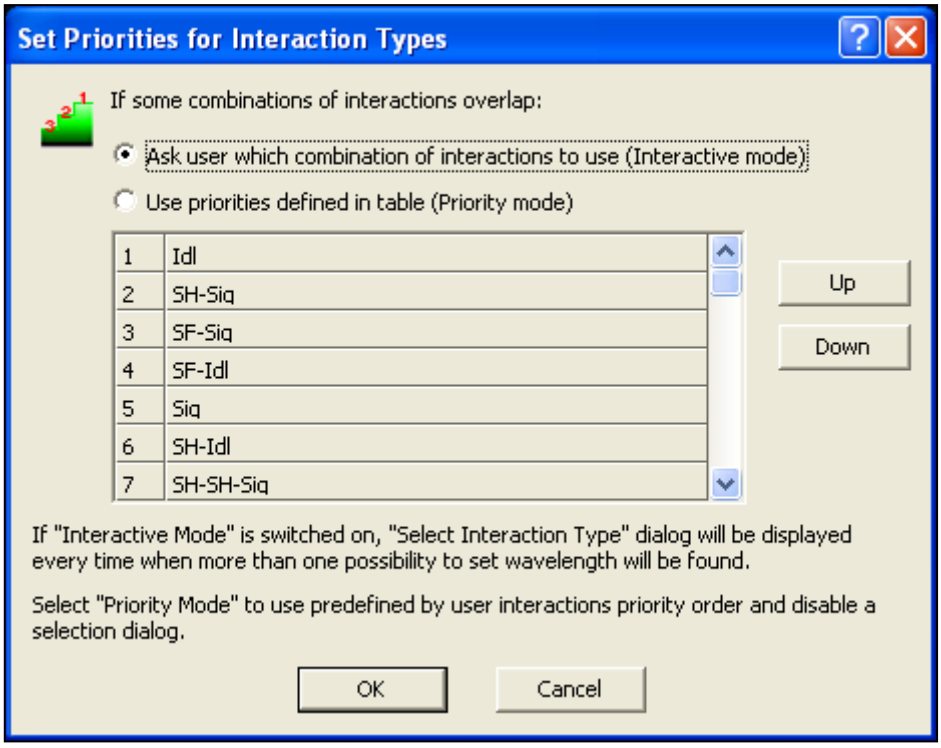

Figure 15. Priority mode selection dialog.

- Select the "Interactive mode" or "Priority mode" by checking the corresponding field.

When working in the "Interactive mode", the user will be asked to choose the preferable interaction type each time a wavelength setting overlap occurs. When working in the "Priority mode" the program will choose automatically the needed interaction type from the user predefined priority list. This list is presented in the window "Set priorities for interaction types". You can modify the priority order by selecting the certain interaction type and clicking the buttons "Up" or "Down".

Appendix 1

Abbreviations used in "WinTOPAS"

Table 3. Abreviations.

Sig	Signal wave
Idl	Idler wave
SH	Second harmonic
SF	Sum frequency with additional pump
DF, DF1, DF2	Difference frequency of signal and idler waves
DFP	Difference frequency of pump and idler waves
NON	Mixer is not used

Every combination of interaction types in TOPAS (ORPHEUS) devices is described as a line of abbreviations. Interactions in different units (OPA/NOPA, Mixer I, II, and III) are separated with symbol "-". For example:

SH-Sig (second harmonic of signal wave): Mixer I generates second harmonic of signal wave from OPA output,

SF-SH-Idl (sum frequency of second harmonic of idler wave): Mixer II generates sum frequency of additional pump and output from Mixer I, Mixer I generates second harmonic of idler wave from OPA output).

DFG-NON-NON-SIG (difference frequency of signal and idler) Mixer III generates difference frequency of signal and idler from OPA output. Mixers I and II are not used.

Appendix 2

"WinTOPAS" access levels

To protect sensitive device related information there is three access levels introduced in "WinTOPAS":

- user level,
- advanced user level,
- service engineer level.

Access level can be changed from the main program menu ("Service"->"Access level"). Two higher access levels are password protected. Summary of rights is presented in a table below.

Table 4. Summary of user rights.

Operation	User	Advanced user	Service engineer
Change wavelength	yes	yes	yes
Switch between TOPAS devices	yes	yes	yes
Move and reset motors	yes	yes	yes
Load/ unload device configuration files	no	yes	yes
Save configuration files	yes	yes	yes
Load/ unload tuning files for selected device	yes	yes	yes
Change priority order of interaction types	yes	yes	yes
Change parameters of tuning curves	no	yes	yes
Calibrate tuning curves	no	yes	yes
Measure new tuning curves	no	yes	yes
Install licenses for interaction types	yes	yes	yes
Change motors parameters	no	no	yes

Appendix 3

"WinTOPAS" licensing model

"WinTOPAS" ver.3.x introduces licensing for different combinations of interactions. Every license is issued for particular TOPAS (ORPHEUS) device (accordingly to it's serial number) and for particular combination of interactions used in OPA/NOPA and mixers. For example there will be different licenses for interactions combinations Sig, SH-Sig, SF-SH-Idl, etc. License is represented by string of 16 hexadecimal symbols and can be preinstalled with "WinTOPAS" software or bought and installed later by user. To install a new license:

- Open "Install Licenses" dialog (menu option "Service"->"Install Licenses").
- Copy license string to edit box or load the string from the license file provided.
- Press "Install" button.

Check if a new license appeared in "Installed licenses" list.

Licenses are checked when tuning curves are loaded. Software try to locate license in device configuration file for every interaction type loaded from tuning curve file. Interaction is deleted from memory if there is no license found.

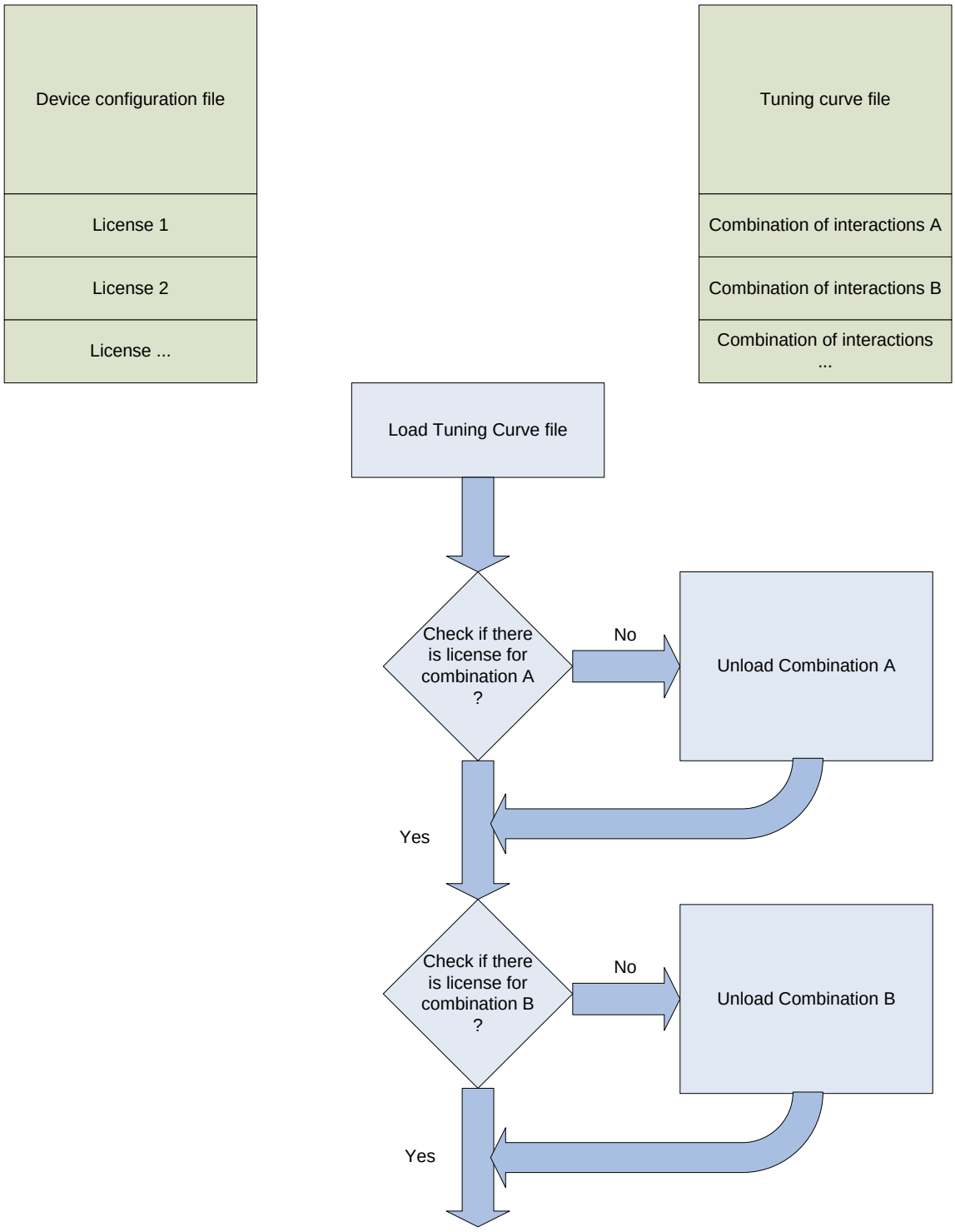

Figure16. "WinTOPAS" license model.

Appendix 4

"WinTOPAS" advanced user password

NOTE

Setting incorrect or incomplete parameters may stop system from functioning or damage some electrical componets.

Advanced User Password

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