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CT400

All-Band Optical Component Tester

User Manual

CT400_UM_3.8v1.0

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About This Manual

Subject

This manual explains how to install, set-up and use the CT400 optical component tester, and how to use the CT400 GUI software.

Application

Information in this document applies to the CT400 GUI software version 3.8.x
(with DSP version 1.12).

Intended Readers

Users of this manual must be familiar with fiber optic technology.

Date

8 June 2016

Manual Reference

CT400_UM_3.8v1.0

Typographical Conventions

bold	Identifies interface objects such as menu names, labels, buttons and icons.
italic	Identifies references to other sections or other guides.
`monospace`	Identifies portions of program codes, command lines, or messages displayed in command windows.
IMPORTANT	Identifies important information to which you must pay particular attention.

Symbols

WARNING

Identifies conditions or practices that could result in injury or loss of life.

CAUTION

Identifies conditions or practices that could result in damage to the product or other property.

Abbreviations Used

Abbreviation	Meaning
DUT	Device Under Test
GPIB	General Purpose Interface Bus
IL	Insertion Loss
TF	Transfer Function
TLS	Tunable Laser Source

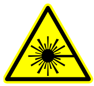
Table of Contents

Safety Information

WARNING

Your safety may be compromised if you do not use the CT400 in accordance with the instructions given in this manual and on the labels located on the product.

Safety Labels and Symbols on the CT400



This label indicates the location of the laser output.This output requires special safety instructions for proper use (see section *Setting up Optical and Electrical Connections of the CT400, p. 21*).

Electrical Safety

WARNING

- Make sure the CT400 power source does not apply more than 265 volts RMS between the supply conductors or between either of the supply conductors and the ground.
- The CT400 has a chassis connected to ground via the power supply cable. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.
- To avoid the possibility of injury, make sure the socket outlet in which the power supply cord will be plugged is equipped with a protective ground contact, and that the electrical installation fulfills the local safety requirements.

WARNING

To avoid personal injury, never remove the protective cover of the chassis to perform servicing or maintenance operations. You must refer to your Yenista Optics service representative.

WARNING

To avoid fire hazard, only use the correct fuse type, voltage and current ratings.

Ventilation

CAUTION

- To ensure proper environment conditions:
  - Make sure the location where the CT400 will be installed meets the environmental characteristics listed in section Technical Specifications, p. 12.
  - Do not expose the CT400 to rain or excessive moisture and do not operate the instrument in the presence of flammable gases or fumes.
- To ensure proper ventilation and cooling, make sure there is sufficient clearance at the sides and on the back of the CT400 in the place where it will be installed. The CT400 is designed so that the feet should leave enough room under the unit to enable proper ventilation.

1. Product Presentation

1.1 Product Features

Presentation

The CT400 is a bench-top instrument designed for fiber-optic device testing. It provides the transmission function of the device under test (DUT) with the help of one or more sweeping laser sources. It covers the specified transmission band in one run by connecting internally up to 4 TLS.

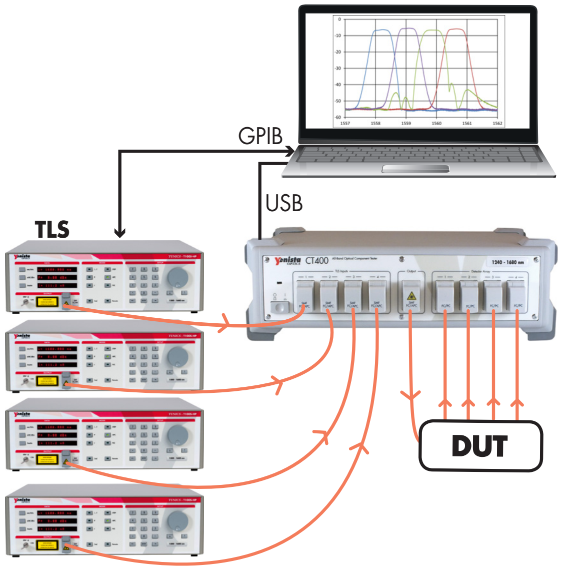


Figure 1: Typical Use of the CT400 (SMF Type)

The CT400 acts in three steps:

- Identifies and switches, from one port to the next, the available laser sources to go through a common output port in order to use a multi TLS source as a unique (usually very wide band) source,
- Takes a part of the source information to identify the source running parameters for wavelength and power referencing,
- Provides between 1 and 4 optical detectors, one electrical input and a synchronization signal to make the direct transfer function of DUTs on 1 to 4 detectors or indirectly using the electrical input or the synchronization signal on remote detectors.

TLS Performances

The CT400 is expected to work with TLS sweeping sources having the following performances:

- No mode hops during the wavelength scan
- Single mode behavior
- 200 pm precision on the definition of the starting wavelength
- Speed between 10 nm/s and 100 nm/s
- Scan span > 5 nm
- Input power between 1 mW and 10 mW

The CT400 checks most of these behaviors and issues a warning in non standard running configurations.

1.2 Technical Specifications

Measurement Specifications

	SMF	PM13	PM15
Wavelength			
Wavelength Range	1240–1680 nm*1	1260–1360 nm	1440–1640 nm
PER	n/a	≥20 dB	
Absolute Wavelength Accuracy*2	±5 pm		
Relative Wavelength Accuracy	±1 pm		
Power			
Detection Range	Minimum Input Power on Detectors: -60 dBm Maximum Input Power on Detectors: 7 dBm		
Transfer Function Accuracy*3*4	±0.2 dB		
Dynamic Range*4*5	65 dB typ. for 1 or 2 laser inputs 60 dB typ. for 3 or 4 laser inputs		
Sampling Characteristics			
Resolution	From 1 to 250 pm		
Points per Scan	Up to 333,333 with 1 detector operation Up to 250,000 with 2 detectors operation Up to 200,000 with 3 detectors operation Up to 166 666 with 4 detectors operation		
Sweep Speed	From 10 to 100 nm/s		

*1: The wavelength range depends on your CT400 hardware version. For more details, see section *Appendix: CT400 Hardware Change, p. 67*.
*2: For wide scan: typical 100 nm.
*3: For incident power on detectors > -30 dBm. Accuracy: +/- 0.5 dB for power between -30 dBm and -60 dBm.
*4: 1260-1640 nm.
*5: If laser output power = 10 mW (dynamic range is proportional to laser output power).

Interfaces & Electrical Specifications

		SMF	PM13	PM15
Optical Connectors				
Laser Inputs	Number of ports	1 to 4	1	1
	Port Type	FC/APC narrow key	FC/APC narrow key (slow axis aligned to connector key)	
Detectors	Number of ports	1 to 4		
	Port Type	FC/PC wide key		
Computer Requirements				
Operating System		From Windows XP to Windows 10		
Interfaces		USB 2.0 port to CT400 and GPIB interface card to lasers		
Electrical Specifications				
Power Supply		AC 100 to 240 V (50 to 60 Hz)		
Fuse Type		2 A, 250V, Time Lag (T) action		

BNC Connectors	
Digital OUT (A port)	TTL levels
Digital IN (B port)	TTL levels
Analog IN (C port)	0 to 2.8 V

Environmental & Physical Specifications

Environmental Specifications	
Equipment Type	Test and Measurement
Equipment Location	Indoor use only
Operating Temperature Range / RH	+15 °C to +30 °C / < 80% (non condensing)
Storage Temperature Range	-10 °C to +60 °C
Physical Specifications	
Dimensions (W x H x D)	335 x 110 x 320 mm
Weight	4 kg

1.3 Product Overview

The CT400 is made of two complementary parts:

- The CT400 instrument, which make the fast measurements during the wavelength scan
- The CT400 software (GUI), which takes the data from the instrument and performs all the analysis

The CT400 is delivered with the following accessories:

- A power supply cord
- A USB-A to USB-B cable
- A USB key containing:
    - The CT400 installation package (GUI software, USB driver and CT400 library for remote control)
    - User documentation

1.3.1 Front Panel

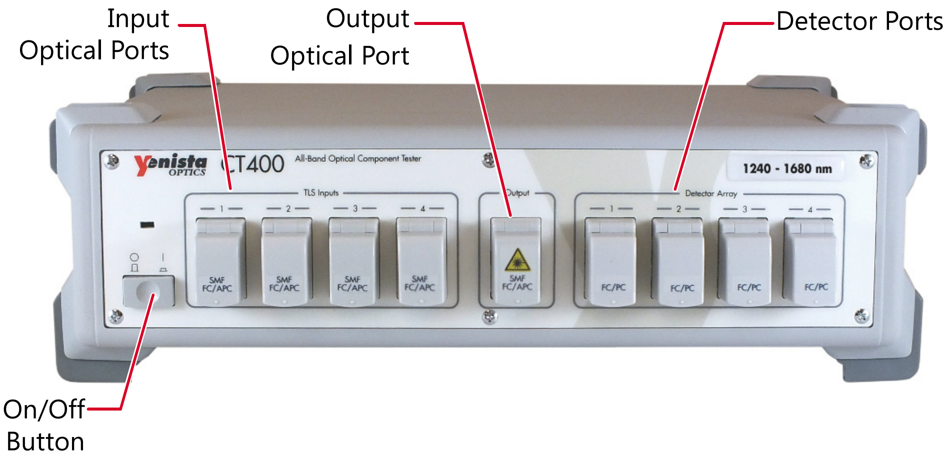


Figure 2: Front Panel (SMF Type)

On/Off Button

The On/Off button turns on/off the CT400 and lights the green LED.

Input Optical Ports

The **TLS Inputs** label identifies the APC connectors used to connect the tunable laser source inputs (up to four connectors, depending on the model). The wavelength range should follow the order of the ports (lower range in port 1)

Output Optical Port

The **Output** label identifies the APC connector providing the signal output to connect the input port of the device under test (DUT).

The  label indicates the location of the laser source. This output requires special safety instructions for proper use (see section *Setting up Optical and Electrical Connections of the CT400, p. 21*).

Detector Ports

The **Detector Array** label identifies the PC connectors used to connect the output ports of the device under test (up to four connectors depending on the model).

1.3.2 Rear Panel

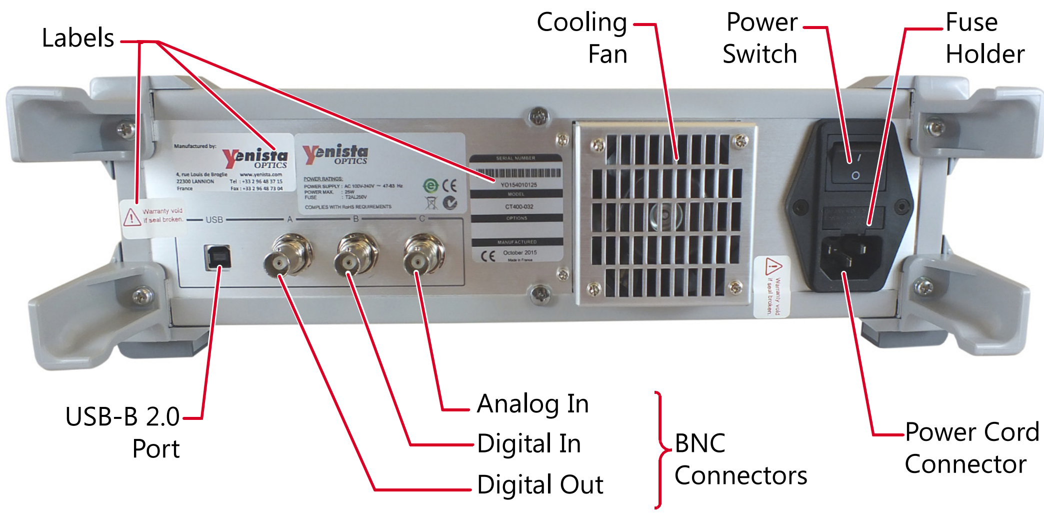


Figure 3: Rear Panel

Cooling Fan

The cooling fan extracts warm air from inside. A cover grid protects it.

Fuse Drawer

The fuse drawer contains a fuse (see section *Technical Specifications, p. 12* for fuse type) to protect the CT400 from overcurrent. For details on how to replace the fuse, see section *Replacing the External Power Fuse, p. 58*).

Power Cord Connector & Power Switch

The CT400 unit is equipped with a self-regulating power supply (for details, see section *Technical Specifications, p. 12*).

USB-B 2.0 Port

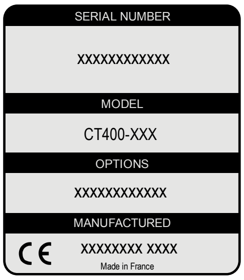
This port enables you to perform remote control operations from a connected computer. For more information, see *CT400 Programming Guide*.

BNC Connectors

- **Connector "A"**: digital output port to perform simultaneous measurements on remote platforms (for more details, see section *Synchronizing the CT400 with External Measurements, p. 33*)
- **Connector "B"**: digital input port to perform triggered scans (for more details, see section *Setting up a Triggered Scan, p. 32*).
- **Connector "C"**: analog input port (**EXT**).

See section *Interfaces & Electrical Specifications, p. 12* for more details on signal levels.

Labels

<table>
<tr><th>Label</th><th>Description</th></tr>
<tr><td>
</td><td>Identification of the Product
Indicates serial number, model, options (if any), and date of manufacture.</td></tr>
<tr><td>
</td><td>Manufacturer Identification
Contact information of the manufacturer.</td></tr>
<tr><td>
</td><td>Information on the Product

Manufacturer logo
Power requirements: input voltage range, frequency range, and power consumption
Fuse type
Compliances (see section Certification and Compliance, p. 65).
</td></tr>
<tr><td>
</td><td>Warranty Seal
The CT400 cover must not be open, otherwise the warranty is not valid anymore.</td></tr>
</table>

2. Installing, Connecting and Starting the CT400

2.1 Unpacking the CT400

Subject

The CT400 is designed for indoor use only, and is not dedicated to wet locations. It must be operated under proper environment conditions, as explained in the following procedure.

Before Starting

CAUTION

- To ensure proper environment conditions:
  - Make sure the location where the CT400 will be installed meets the environmental characteristics listed in section *Technical Specifications, p. 12*.
  - Do not expose the CT400 to rain or excessive moisture and do not operate the instrument in the presence of flammable gases or fumes.
- To ensure proper ventilation and cooling, make sure there is sufficient clearance at the sides and on the back of the CT400 in the place where it will be installed. The CT400 is designed so that the feet should leave enough room under the unit to enable proper ventilation.

WARNING

- Make sure the CT400 power source does not apply more than 265 volts RMS between the supply conductors or between either of the supply conductors and the ground.
- The CT400 has a chassis connected to ground via the power supply cable. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.
- To avoid the possibility of injury, make sure the socket outlet in which the power supply cord will be plugged is equipped with a protective ground contact, and that the electrical installation fulfills the local safety requirements.

Procedure

1. Open the package with care and remove the protective foam.

   IMPORTANT When unpacking, handle the device with care and do not damage the original shipping container in case the CT400 needs to be returned to **Yenista Optics**.

2. Set the CT400 on a flat stable surface free of excessive vibration.
3. Allow the flow of air to be pulled in freely from outside to inside the CT400 through the air inlets located on the two side-faces and be pushed out the instrument through the cooling fan grid.
   Remove any equipment or paper that could block the air-flow.
4. On the rear panel (see *Figure 3, p. 15*), make sure the power switch is set to **O**.
5. Using the proper power cord for your location, connect one end of the power supply cable to the power supply socket on the rear panel of the instrument and plug the other end to the proper voltage supply wall socket.

2.2 Turning On/Off the CT400

Subject

The green LED located on the front panel indicates that the CT400 is turned on.

Procedure

Turning On the CT400

1. On the rear panel (see *Figure 3, p. 15*), set the power switch to **1**.
2. On the front panel (see *Figure 2, p. 14*), press the On/Off button.

   The green LED indicator lights, which means that the CT400 is turned on.

Turning Off the CT400

1. On the front panel (see *Figure 2, p. 14*), press the On/Off button.

   The green LED indicator fades out.
2. On the rear panel (see *Figure 3, p. 15*), set the power switch to **O**.

2.3 Installing the CT400 Software and USB Driver on Your Computer

CAUTION

Before connecting the CT400 to your computer, you must install the CT400 GUI software.

2.3.1 Installing the CT400 Software Package

Subject

The CT400 software installer is available on the USB key delivered with the CT400, or on the **Yenista Optics** website from the download area.

The CT400 Installer installs the following components on your computer:

- CT400 GUI software
- CT400 Library
- CT400 USB driver

If you have already installed the CT400 software and want to update it with the latest version, see section *Updating the CT400 System Version, p. 57*.

Before Starting

- Make sure the computer on which you want to install the CT400 software package matches the requirements specified in section *Technical Specifications, p. 12*.
- Make sure you have writing permission on the folder in which the CT400 software will be installed (the default folder is **C:\Program Files\Yenista Optics** or **C:\Program Files (x86)\Yenista Optics**, depending on your Windows platform).
- If your operating system is Windows 8 or Windows 10, unsigned drivers (such as the USB driver provided by **Yenista Optics**) can only be installed in a specific startup mode. Perform the following steps to start your Windows 8 or Windows 10 system in the appropriate mode:
  a. Make sure you have administrative rights on you computer.
  b. Start Windows.
  c. On the log on screen, click the **Power** button located in the bottom right corner.
  d. Press the **Shift** key while selecting the **Restart** option.
  e. Wait for the **Choose an Option** screen.
  f. On the **Choose an Option** screen, select the following options: **Troubleshooting** > **Advanced Options** > **Startup Settings**
     A page describing all possible restart modes is displayed.
  g. Click the **Restart** button.
  h. After Restart, select the "**Disable Driver Signature Enforcement**" mode.
     The system starts in "Disable Driver Signature Enforcement" Mode.
  i. Log on and follow the installation procedure below.
     When the driver installation is finished, you can restart Windows 8 or Windows 10 to switch it back to "Normal" mode.

Procedure

1. Do one of the following:
   - Connect the CT400 USB key to the USB-A port of your computer.
   - From the **Yenista Optics** website (http://yenista.com/Download-area.html), download the last CT400 software package (**CT400 Installer.zip**) on your computer and unzip it to a temporary folder on your computer.
2. In the **CT400 Installer** folder, double-click the **setup.exe** file.

   The CT400 installation wizard appears.
3. Follow the instructions displayed in the wizard window.

   The CT400 software is now installed on your computer.

2.3.2 Activating the USB Driver

Subject

When you connect a CT400 to your computer, you must select the appropriate USB driver. You may have to install it again in case you connect another CT400 model to your computer.
The CT400 software is fully-compatible with USB 2.0.

Before Starting

- Make sure the CT400 software package is installed (see section *Installing the CT400 Software Package, p. 19*).
- Make sure you have the USB-A to USB-B cable delivered with the product.

Procedure

1. Turn on the CT400 (see section *Turning On/Off the CT400, p. 18*).
2. Using the USB cable, connect the USB-A 2.0 port of your computer to the CT400 USB-B connector located on the rear panel (see *Figure 3, p. 15*).
   - The first time you connect the CT400 to your computer, it prompts you to select the USB driver.
   - If you are not prompted to select the USB driver, do the following:

     In the Windows **Device Manager** (**Control Panel**>**System and Security**>**System**), right-click the **CT400 USB Device** and select **Update driver**. You are prompted to select the appropriate driver.
3. To select the USB driver, browse your computer and select one of the following location, depending on your Windows platform:
   - **C:\Program Files\Yenista Optics\CT400\USB Driver**
   - **C:\Program Files (x86)\Yenista Optics\CT400\USB Driver**

   The CT400 can now communicate with your computer.

2.4 Setting up Optical and Electrical Connections of the CT400

Subject

CAUTION

- Make sure you use the appropriate connector type, corresponding to the one mounted on your CT400 (see section *Technical Specifications, p. 12* for available models).
- Make sure optical connectors are perfectly clean. It is essential to achieve optimum system performance (see section *Cleaning Optical Connectors, p. 59*).
- To prevent premature failure of the CT400 optical connectors due to frequent connections/disconnections, we recommend to use an intermediate jumper CT400 optical port while you use the jumper's free end to connect to other devices. Follow the auto-calibration procedure to take into account the additional insertion loss (see section *Performing Auto Calibration, p. 52*).

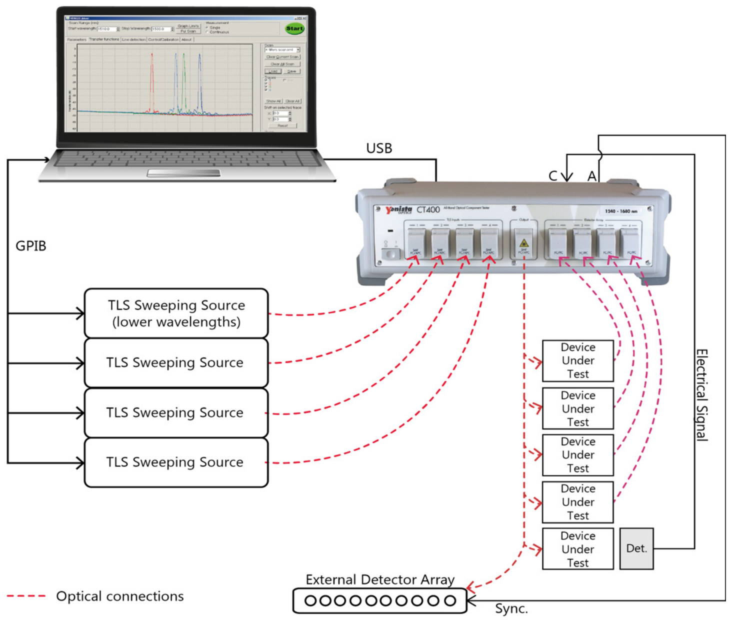


Figure 4: CT400 Connections

Before Starting

- Make sure the CT400 GUI software and USB driver are installed on your computer.
- Make sure you have the following material:
  - One or more tunable laser(s).
  - A GPIB card or GPIB controller.
    For TUNICS lasers, we recommend to use a GPIB card or a GPIB controller (GPIB-USB-HS) from National Instruments .

    If you want to use another vendor's GPIB/ USB adapter, uninstall any existing USB/GPIB driver from your computer before installing the new USB/GPIB driver.

    Make sure the controller driver is installed on your computer according to the manufacturer's guidelines.

- The sufficient number of optical patch cords to connect the CT400 to the tunable laser(s) (the four TLS inputs and the TLS output on the CT400 are narrow key APC type).
- The sufficient number of optical patch cords to connect the CT400 to the device under test (the four detector interfaces are large key PC type).
- The sufficient number of GPIB cables (one GPIB cable per TLS) to connect the computer to the tunable laser(s).
- The USB-A to USB-B cable provided with the CT400.
  The CT400 software is fully-compatible with USB 2.0.

Procedure

1. Set-up the electrical connections:

a. Plug the power cords of the TLS, the CT400 and the computer.

b. Using the GPIB cable, connect your computer to the TLS.

c. Using the USB cable, connect the USB-A 2.0 port of your computer to the CT400 USB-B connector located on the rear panel (see *Figure 3, p. 15*).

d. Turn on the CT400 (see section *Turning On/Off the CT400, p. 18*).

e. Turn on the TLS.

2. Set-up the optical connections:

a. Using a clean APC patch cord, connect one or more TLS to the CT400:

- Connect the TLS with the lowest wavelength range to the TLS Input connector 1 of the CT400.
  The wavelength ranges of the TLS used must follow the CT400's input port order: the source with the lowest wavelength range must always be connected on port 1, and the input port 1 must always be used.
- Connect the TLS with the next lowest starting wavelength to port 2, etc.

Wavelength ranges of multiple TLS don't have to overlap for the system to work. For instance, you can connect an O-band (1260nm-1360nm) TLS to CT400 input port 1 and an CL-band (1500nm-1630nm) TLS to port 2.

b. Connect the input (or common) port of the DUT to the CT400 Output port.

WARNING

Depending on the safety class of the laser(s) you have connected to the CT400 input port(s), the beam coming from the CT400 output port may be dangerous. For safe use of the CT400 output port, please respect the safety guidelines of the laser(s) connected to the CT400 input port(s).

The CT400 Output port is APC type. If the DUT input is PC type, use a clean patch cord APC/PC and an adapter to interface between the CT400 and the DUT.

c. Connect the output port of the DUT to the CT400 detector port.

The detector ports are PC type. If the DUT is APC type, use a clean patch cord APC/PC and an adapter to interface between the CT400 and the DUT.

2.5 Starting the CT400 GUI Software

Subject

The CT400 GUI software allows you to configure the parameters of the TLS and measurement settings, and start optical measurements.

Before Starting

- Make sure the CT400 GUI software is installed on your computer (see section *Installing the CT400 Software and USB Driver on Your Computer, p. 19*).
- Connect optical devices to the CT400 (see section *Setting up Optical and Electrical Connections of the CT400, p. 21*).
- Turn on the CT400 (see section *Turning On/Off the CT400, p. 18*).

Procedure

- To launch the CT400 GUI software, click the CT400 GUI icon located in **Start\All Programs\Yenista Optics\CT400**.

  The CT400 GUI appears. For more details on the interface, see the following *Interface Description* section, *p 23*.

Interface Description

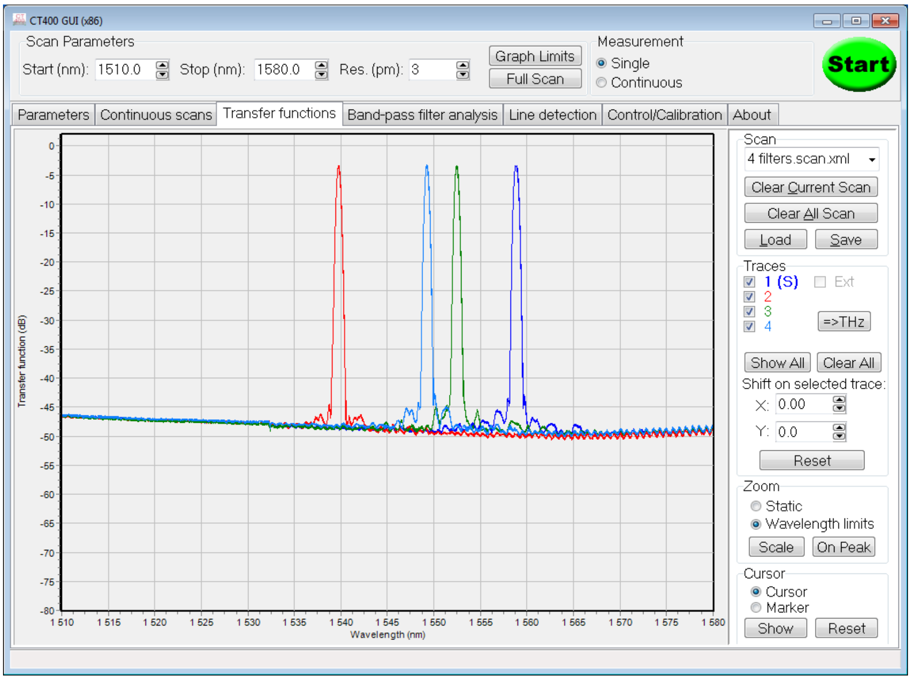


Figure 5: GUI Software – Interface Description

The CT400 GUI provides the following tabs:

Tab	Description
Parameters	This tab enables you to configure the measurement parameters for the devices connected to the CT400. For more details, see section *Setting up Measurements, p. 25*.
Continuous scans	This tab enables you to configure parameters for scans set as continuous. For more details, see section *Configuring Continuous Scans, p. 30*

Tab	Description
Transfer functions	This tab displays the scan results and enables you to manage scans and traces. For more details, see section *Displaying and Managing Scan Results, p. 37*.
Band-pass filter analysis	This tab provides the major characteristics of band-pass filters, mostly dedicated to WDM components. For more details, see section *Performing Band-pass Filter Analysis, p. 45*.
Line Detection	This tab does not appear for CT400 with a single TLS input. It enables you to use the CT400 as a wavemeter. For more details, see section *Performing Line Wavelength Measurements, p. 49*.
Control/Calibration	This tab enables you to check power level on detectors, and perform user power calibration. For more details, see section *Performing User Calibration and Controlling Power on Detectors, p. 51*.
About	This tab provides information about the CT400 instrument: software and DSP versions, type, serial number and available number of TLS inputs and detectors.

3. Setting up Measurements

3.1 Configuring the CT400 for Measurement

Before starting a measurement, you must configure the TLS and detectors used, and the wanted resolution.

3.1.1 Configuring Measurement Parameters

Subject

The **Parameters** tab enables you to set all the necessary parameters to start a measurement.

Procedure

1. Start the CT400 GUI (see section *Starting the CT400 GUI Software, p. 23*).
2. Click the **Parameters** tab and configure the TLS and detector parameters according to the devices you have connected to the CT400.
   For more details, see the following *Parameters Tab Description* section, *p 25*.

Parameters Tab Description

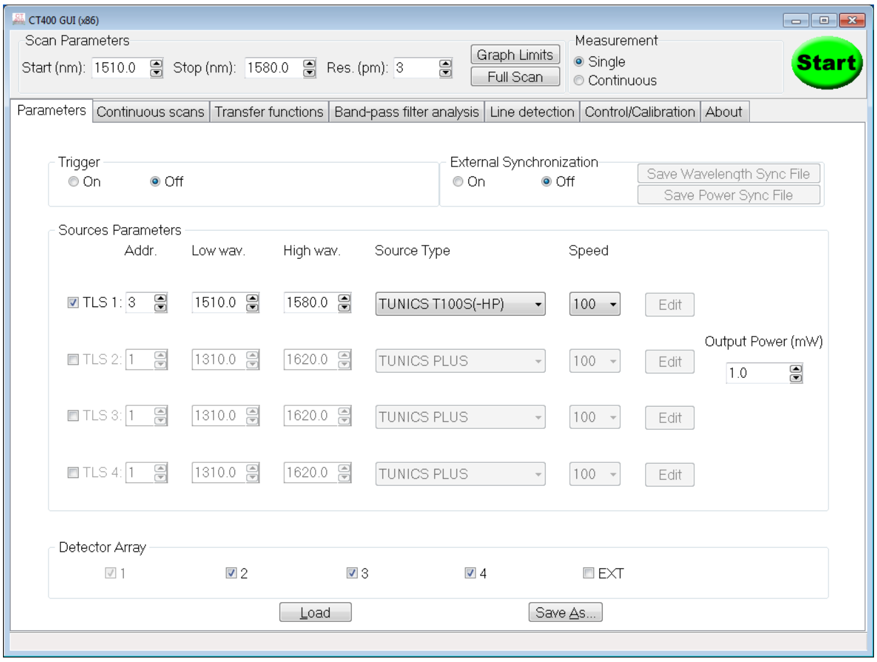


Figure 6: Parameters tab

Trigger

- **On**: (this function is only possible with one TLS) the CT400 waits for an external trigger on the BNC connector labeled **B** to start measurements. For more details, see section *Setting up a Triggered Scan, p. 32*.
- **Off**: The trigger mode is disabled.

External Synchronization

- **On**: the CT400 generates a periodic pulse signal during the scan of the laser. The period of the signal varies in function of the selected resolution. For more details, see section *Synchronizing the CT400 with External Measurements, p. 33*.
- **Off**: the external sync signal is disabled.

Sources Parameters

- :
  Select the check-box to enable the TLS corresponding to the **TLS Input** connector number.
- **Addr.**
  GPIB address of the TLS.
- **Low/High wav.**
  Minimum and maximum wavelength (in nm) that the TLS can provide. You cannot select wavelength values outside the operating wavelength range of the CT400 type connected to your computer (see section *Technical Specifications, p. 12*).
  Each TLS must cover at least 5 nm.
  If you use multiple TLS, make sure an overlap of 10 nm (recommended value) is set between each TLS.
- **Source Type**
  TLS type.
  If the TLS you use is not part of the list, select **Other (IEEE 482.2)** and click the **Edit** button to define the GPIB command for the source (see section *Defining the GPIB Commands for a TLS, p. 27*). The source must implement the *opc? command.
- **Speed**
  Speed of the TLS is nm/s, depending on the laser speed specifications.
- **Output Power (mW)**
  Output power for all TLS: any value between 1 and 10 mW.

Detector Array

Number of detectors to activate, corresponding to the number of connected channels of the DUT.

Detector #1 is always selected.

The **EXT** detector corresponds to the BNC connector **C** on the rear panel. The **EXT** check-box allows you to measure the voltage or the optical power at the BNC connector **C** (see section *Performing a Measurement Using the EXT Detector (BNC C Input Connector), p. 35*).

Load/Save As Buttons

These buttons enable you to save/load the overall configuration set in all tabs of the CT400 GUI: see section *Saving/Loading Configuration Parameters, p. 28*.

3.1.2 Defining the GPIB Commands for a TLS

Subject

If the tunable laser source (TLS) you are using is not part of the **Source** list you must set four specific GPIB commands to it, as explained in the following procedure.
The TLS must be IEEE 482.2 compatible.

Procedure

1. Identify the **TLS Input** port to which your specific TLS is connected.
2. In the **Parameters** tab, in the **Source** list, select **Other (IEEE 482.2)**.
3. Click the **Edit** button.

   The GPIB command definition window appears.
4. Define the necessary GPIB commands as explained in the following *GPIB Commands Window Description* section, *p 27*.
5. Click **Ok**.

GPIB Commands Window Description

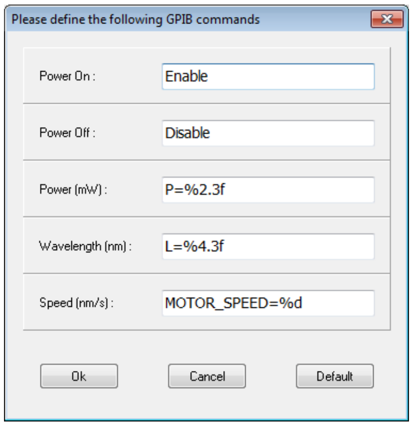


Figure 7: TLS GPIB Commands – Definition Window

To define the appropriate commands in this window, consult your TLS user manual.

Power On

This field defines the command to enable the TLS power.
Example for a TUNICS laser: `Enable`

Power Off

This field defines the command to disable the TLS power.
Example for a TUNICS laser: `Disable`

Power (mW)

This field defines the command to set the output power value in mW.
Example for a TUNICS laser: if the output power defined in the GUI is 1.6 mW, `P=%.2f` sends the following command: `P=1.60`

Wavelength (nm)

This field defines the command to set a wavelength value in nm.
Example for a TUNICS laser: if the wavelength defined in the GUI is 1520.0, `L=%.1f` sends the following command: `L=1520.0`

Speed (nm/s)

This field defines the command to set the speed of the TLS in nm/s (limited to laser speed specifications).

3.1.3 Saving/Loading Configuration Parameters

Subject

The following procedure explains how to save the overall configuration of the CT400 (all parameters set in all tabs of the CT400 GUI) as an XML file.

The default location of the CT400 configuration folder is:

- On Windows XP: C:\Documents and Settings\All Users\Documents\Yenista Optics\CT400\Config
- On Windows Vista and later versions: C:\Users\Public\Documents\Yenista Optics\CT400\Config

Procedure

Saving your Configuration Parameters

1. In the **Parameters** tab, click the **Save As** button.
2. In the Explorer window, select the wanted location and enter a name for the configuration file.
3. Click **Save** to save the configuration.

Loading your Configuration Parameters

1. In the **Parameters** tab, click the **Load** button.
2. In the Explorer window, select the wanted configuration file and click **Open** to load the configuration file.

3.2 Starting Measurements

Subject

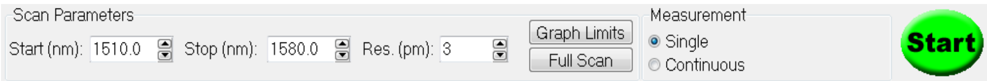
Once you have set all the appropriate parameters, you can set the scanning parameters and start measurements as explained in the following procedure.

Before Starting

- Configure the parameters so that they correspond to your setup (see section *Configuring Measurement Parameters, p. 25*),
- Connect the DUT to the CT400, as explained in section *Setting up Optical and Electrical Connections of the CT400, p. 21*.

Procedure

1. In the top left **Scan Parameters** area, specify the wanted scan parameters:



   - **Start/Stop (nm)**: wavelength range you want to scan according to the wavelength limits of the TLS you have connected in the input port.
   - **Res. (pm)**: sampling resolution of the scan (from 1 to 250 pm).
     The chosen value provides the sampling step.

     The free-spectral range (FSR) of the CT400 is about 100 MHz, which translated into the wavelength domain is of the order of 0.55 pm at 1260 nm; 0.75 pm at 1550 nm. The value varies in function of wavelength, this explains why fractional resolution is not used in the **Transfer Functions** tab.

     In consequence, in this manual:
     - Raw (or not re-sampled) data points refer to measurements done at the fractional resolution.
     - Re-sampled data points refer to raw data sampled at the integer value of the resolution set in the **Res. (pm)** field.

     The best available resolution is 1 pm; in this case the data transfer from the CT400 to the computer takes longer.

     IMPORTANT The number of points depends on the sampling resolution and the wavelength limits. If the current configuration does not allow to store all the points, the sampling resolution is adjusted to the nearest available value when you start the measurement, and a warning window is displayed.

   - **Graph Limits**: automatically sets the scan range to the limits sets on the graph of the **Transfer functions** tab.
   - **Full scan**: maximum range set by the lowest wavelength and the highest wavelength of all connected TLS.

2. In the top right **Measurement** area, select the wanted type of measurement.
   - **Single**: the CT400 performs a single scan of the wavelength range set in the **Start/Stop Wavelength** fields and then stops.
   - **Continuous**: the CT400 performs a continuous series of scans, according to the parameters set in the **Continuous scans** tab. For more details on these parameters, see section *Configuring Continuous Scans, p. 30*.

3. Click the green **Start** button.

In the top right **Measurement** area, "In progress" is displayed as long as the scanning process is not terminated.
The **Transfer functions** tab appears. For more details, see section *Displaying and Managing Scan Results, p. 37*.

In **Continuous** mode, the CT400 waits for the end of all data exchanges and analysis before launching the next scan.

3.3 Configuring Continuous Scans

Subject

If you select **Continuous** in the top right **Measurement** area, the CT400 performs continuous scans according to the parameters set in the **Continuous scans** tab.

Procedure

1. In the **Continuous scans** tab, specify the wanted parameters for continuous scans as described in the following *Continuous scans Parameters* section, *p 30*.
2. In the top right **Measurement** area, select **Continuous**.
3. If you have selected the **Enable number of scans limitation** check box in the **Continuous scans** tab, enter the number of scans you want the CT400 to perform.

Continuous scans Parameters

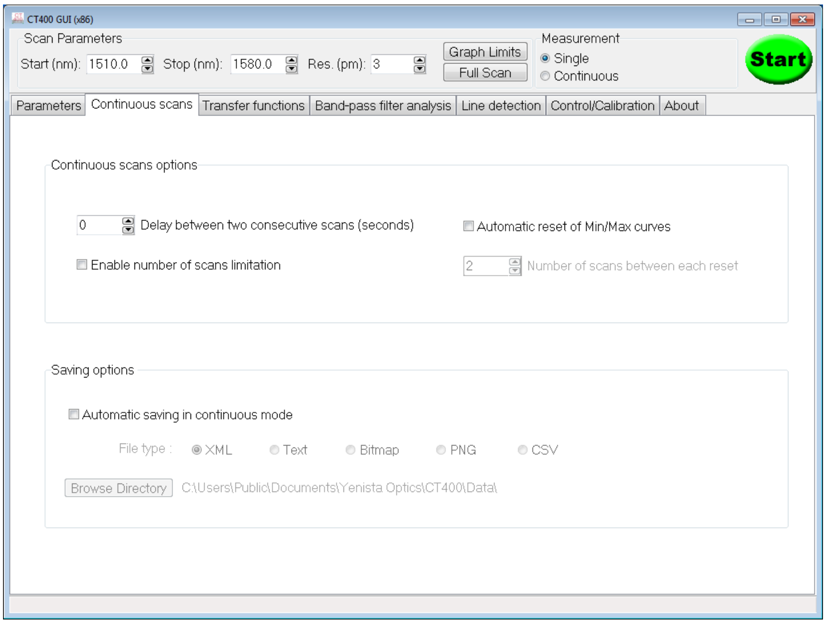


Figure 8: Continuous scans tab

Continuous scans options

- **Delay between two consecutive scans (seconds)** field
  Enter the number of seconds you want the CT400 to idle between consecutive scans.
- **Enable number of scans limitation** check box
  -  : a field appears next to the **Continuous** parameter in the top right **Measurement** area, enabling you to enter the number of scans you want the CT400 to perform.

- : the CT400 performs continuous scans and stops only if you click the **Stop** button.

- **Automatic reset of Min/Max curves** check box
  - : each time the CT400 reaches the number of scans specified in the **Number of scans between each reset** field, the minimum and maximum curves are deleted from the graph.
  - : the CT400 never deletes minimum and maximum curves from the graph.

Saving options

- **Automatic saving in continuous mode** check box
  - : the CT400 creates one separate file by individual scan in the directory specified using the **Browse Directory** button.
    The default location of the CT400 measurement data is:
    - On Windows XP: C:\Documents and Settings\All Users\Documents\Yenista Optics\CT400\Data
    - On Windows Vista and later versions: C:\Users\Public\Documents\Yenista Optics\CT400\Data

    File type:
    - **Bitmap**/**PNG**: for each performed scan, the CT400 creates one .bmp/.png image file representing a screenshot of the curve.
    - **XML**: for each performed scan and for each detector selected in the **Parameters** tab, the CT400 creates one .xml file containing the wavelength and power points of the curves, the min/max values and the scan parameters.
    - **Text**/**CSV**: for each performed scan and for each detector selected in the **Parameters** tab, the CT400 creates one .txt/.csv file containing the wavelength and power points of the curve.
  - : no data is saved during continuous scans.

3.4 Setting up a Triggered Scan

Subject

Although the GPIB control is the only way to run a scan where more than one TLS are required to cover the whole wavelength range, you can also control the measurement with a trigger signal by using the input connector labeled **B**, as explained in this section. No GPIB connection is required if you operate this mode manually.

The following figure illustrates the hardware setup for a triggered scan.

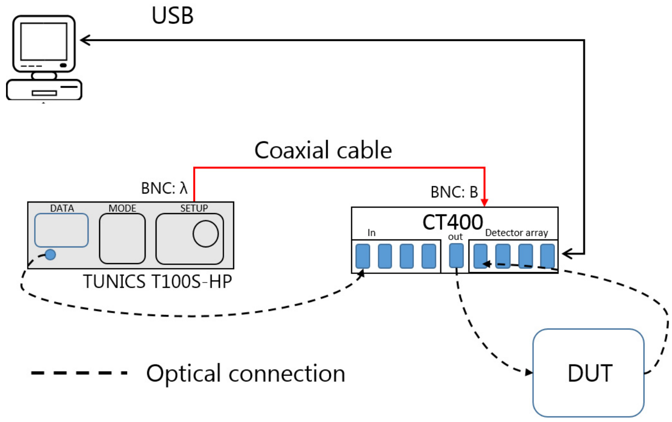


Figure 9: Use of BNC B input for triggered scan

Before Starting

Make sure you have a BNC 50 Ω coaxial cable.

Procedure

1. On the TUNICS T100S-HP laser, configure the **λ** BNC port as a trigger output, as explained in *TUNICS T100S-HP User Manual*.
2. Using the coaxial cable, connect the **λ** port of the TUNICS T100S-HP providing the TTL signal to the input digital BNC connector labeled **B** located on the rear panel of the CT400 (see section *Rear Panel, p. 15*).
3. In the top left **Scan Parameters** area of the CT400 GUI, set the wavelength boundaries of the scan.
4. In the top right **Measurement** area, select the wanted type of measurement.
5. In the **Parameters** tab, in the **Trigger** area, select **On**.
6. Click the green **Start** button.

   The CT400 waits for an external trigger on the BNC connector labeled **B** to start measurements.

   When the TTL signal is emitted, the start/stop of the scan are synchronized as follows:

   - At rising edge (0 to 1) of the input signal, the TLS starts the sweep and the internal analysis is launched.
   - At falling edge (1 to 0) of the input signal, the TLS is expected to have reached its end value and the internal analysis ends.

   IMPORTANT In triggered **Continuous** mode, the CT400 waits for the end of all data exchanges and analysis before starting a new measurement. If data communication or software analysis is not over when the next logic 1 signal arrives, the CT400 ignores the signal and waits for the following logic 1 to start a new measurement.

3.5 Synchronizing the CT400 with External Measurements

Subject

If additional detectors are required for any reason, you can use the synchronization signal (TTL) provided at the BNC connector **A** of the CT400 to perform simultaneous measurements on remote platforms.

Hardware Setup

The following figure illustrates the hardware setup for external measurements

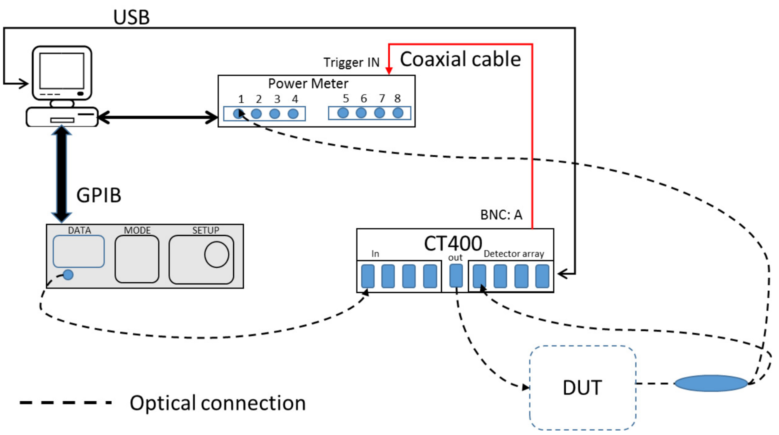


Figure 10: Use of BNC A output for external measurements

CT400 Pulses

During the scan of the laser, the CT400 generates TTL pulses at the BNC connector **A**. The sequence of pulses depends on the resolution (**Res. (pm)**) set in the **Scan Parameters** area: if a resolution of *n* pm is selected, then a trigger pulse over *n* pulses comes out of the CT400.

- The time duration of the generated pulses is around 4 µs.
- The separation between pulses depends on the following settings:
  - the scan speed of the laser
  - the selected resolution in the CT400.

  For example, for a speed of 100nm/s and 1 pm resolution, the time-slot between pulses will be roughly 10 µs ($(100\text{nm/s}/1\text{pm})^{-1}$).

  The CT400 provides a sequence of TTL pulses in the wavelength domain, so separation between pulses is not equidistant as it would be in the frequency domain.

The free-spectral range (FSR) of the CT400 is about 100 MHz, which translated into the wavelength domain (using the following relation $\Delta v = |\frac{c}{\lambda^2}|\Delta\lambda$) is of the order of 0.55 pm at 1260 nm; 0.75 pm at 1550 nm.
The value varies in function of wavelength, this explains why fractional resolution is not used in the **Transfer Functions** tab.
In consequence, in this manual:

- Raw (or not re-sampled) data points refer to measurements done at the fractional resolution.
- Re-sampled data points refer to raw data sampled at the integer value of the resolution set in the **Res. (pm)** field.

Before Starting

Make sure you have a BNC 50 Ω coaxial cable.

Procedure

1. Using the coaxial cable, connect the Trigger In port of the remote instrument receiving the TTL signal to the output BNC connector labeled **A** located on the rear panel of the CT400 (see section *Rear Panel, p. 15*)
2. In the **Parameters** tab, in the **External Synchronization** area, select **On**.
3. In the top right **Measurement** area, select **Single**.
4. Click **Start** to run a single scan.

   The CT400 generates a TTL periodic signal during the measurement acquisition, as explained in the above *CT400 Pulses* section, *p 33*.
5. At the end of the scan, save the measurement files by clicking the following buttons in the **Parameters** tab:
   - **Save Wavelength Sync File**: enables you to save a .txt file containing the wavelength value measured by the CT400 (raw data, not re-sampled) associated with the recorded pulse number. Values are separated by spaces.
     The first column of the file displays the measured pulse number, which indicates the synchronization pulse number starting from the first one emitted after the click on **Start**.
   - **Save Power Sync File**: enables you to save a .txt file containing the output power value registered at the output port (not calibrated) and the transfer function values registered at the detector port(s) associated with the recorded pulse number (recorded values are those measured by the CT400 (not re-sampled)).

     Values are separated by spaces:
     - The first column of the file displays the measured pulse number, which indicates the synchronization pulse number starting from the first one emitted after the click on Start.
     - The second column displays the internal reference of the output port.
     - The following columns display the transfer function values registered at the detector ports (if activated).
       If the **EXT** detector is activated (in the **Detector Array** area), the corresponding column displays the voltage measured at the BNC **C** connector. If the **Optical** check-box is selected in the **BNC input** area, the value displayed corresponds to the optical power (in this case, see section *Performing a Measurement Using the EXT Detector (BNC C Input Connector), p. 35*).

   All the synchronization pulses do not lead to a recorded position.

3.6 Performing a Measurement Using the EXT Detector (BNC C Input Connector)

Subject

The CT400 enables you to measure an electric signal through the BNC C analog port during the scan. The measured signal is plotted along with the transfer function curves with a separated scale (in Volts) on the right axis.

The most common case requiring this kind of measurement happens when the output of the DUT cannot be collected into a fiber or because of unacceptable losses. In such case, free-field photodetectors are currently used, providing an electrical output that feed the BNC C input (voltage input from 0 to 2.8 V) and plotted simultaneously with the results obtained on the detectors of the front panel array.

The voltage information might not be relevant and specific operations on the output recorded files should be done to allow comparisons. For this reason, an internal conversion of the measured data into optical power might be required, which you can set in the **BNC input** area in the **Control/Calibration** tab.

Setup Example

To use the BNC C input port as an external detector, you can build your detection system as illustrated below. We recommend the PDA20C InGaAs transimpedance amplified photodetector from Thorlabs.

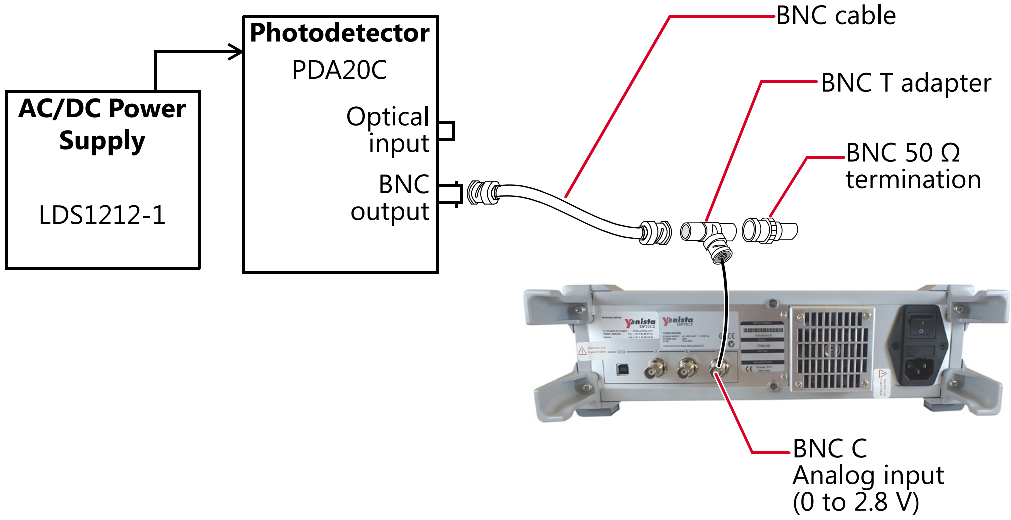


Figure 11: Example of setup using the EXT detector

Procedure

Measuring the Voltage of the Electric Signal

1. In the **Parameters** tab, in the **Detector Array** area, select the **EXT** check-box.
2. Start a measurement (see section *Starting Measurements, p. 29*) and visualize scan results in the **Transfer functions** tab (see section *Displaying and Managing Scan Results, p. 37*).
   The measured signal is plotted along with the transfer function curves with a separated scale (in Volts) on the right axis.
3. To save the measured values: in the **Transfer functions** tab, click the **Save** button (see section *Saving the Current Scan, p. 38*).

Measuring the Optical Power of the Signal

1. In the **Parameters** tab, in the **Detector Array** area, select the **EXT** check-box.

2. In the **Control/Calibration** tab, in the **BNC input** area:
   a. Select the **Optical** check-box.
   b. In the **P=** fields, enter the conversion parameters (from electrical to optical power):
      - **P**:
        - Field 1: optical power (offset) in mW or dBm
        - Field 2: conversion factor (slope) in mW/V or dBm/V
      - **V**: BNC input voltage (Volts)
   c. Select the optical power unit of the conversion (mW or dBm).
3. Start a measurement (see section *Starting Measurements, p. 29*) and visualize scan results in the **Transfer functions** tab (see section *Displaying and Managing Scan Results, p. 37*).
   The insertion loss is displayed on the graph.
4. To save the measured values: in the **Transfer functions** tab, click the **Save** button (see section *Saving the Current Scan, p. 38*).

4. Displaying and Managing Scan Results

The **Transfer functions** tab displays the scan results measured by the CT400 and enables you to manage scans and traces.

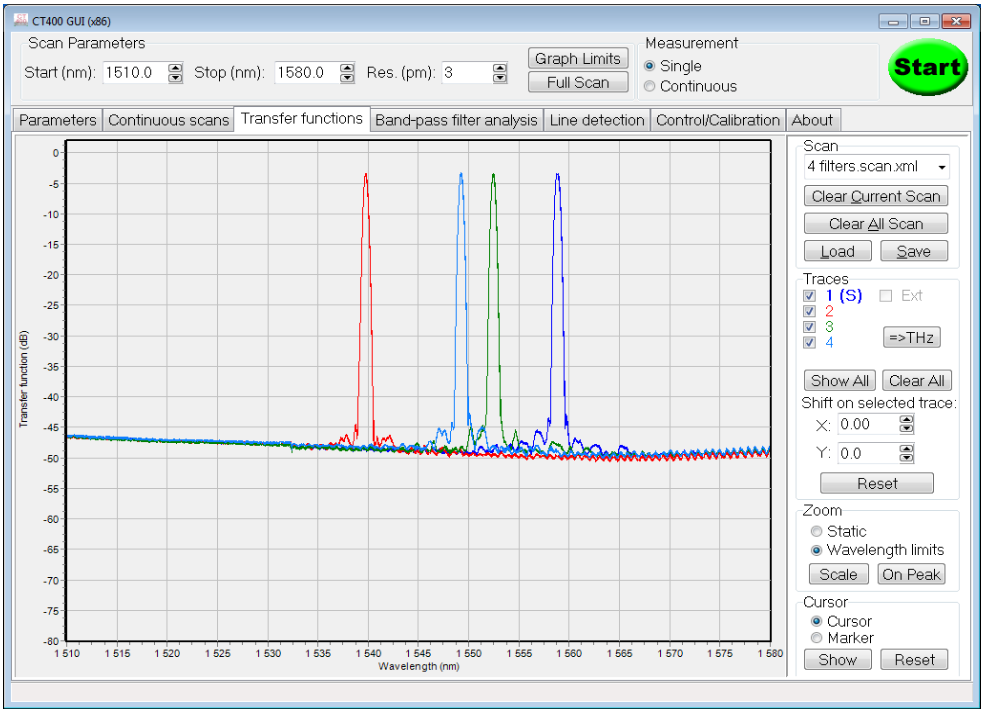


Figure 12: Transfer functions tab

4.1 Handling Scan Files

Subject

A scan gathers traces of all the detectors selected in the **Detector Array** area of the **Parameters** tab).

The **Scan** area of the **Transfer functions** tab enables you to display the wanted scans, and load/save scans (.scan.xml format).

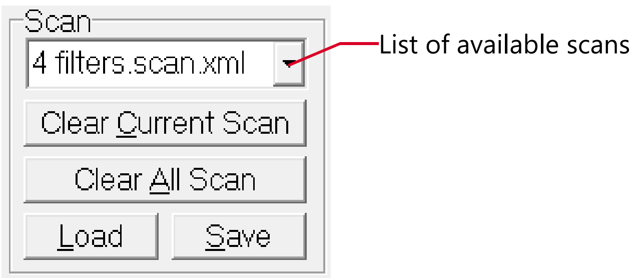


Figure 13: Transfer functions tab – Scan area

4.1.1 Loading and Displaying/Removing a Scan

Procedures

Loading a Scan

Loading a scan displays it on the graph and adds it to the drop-down list of available scan.

1. In the **Scan** area, click the **Load** button.

   A window appears.

2. Select the scan you want to load and click **Open**.

   The selected scan is displayed in color on the graph and appears in the drop-down list.

Displaying a scan

The last scan is referenced as the current scan.

- To display a scan, select it in the drop-down list of available scan.

  The selected scan is displayed in color on the graph, and the other scans are displayed in black on the same graph.

Removing Scans from the List

- To delete the selected scan from the list of available scans, select the scan you want to delete and click the **Clear Current Scan** button.
- To delete all scans of the list of available scans, click the **Clear All Scans** button.

4.1.2 Saving the Current Scan

Subject

You can save the displayed scan in various formats. The following procedure explains how to save the wavelength and power points of the curve of the displayed scan after they have been re-sampled (linear interpolation) so that the step between points corresponds to the selected resolution.

To save the current scan as it has been measured by the CT400 (raw data without re-sampling), you can use the **Save Wavelength Sync File** and **Save Power Sync File** buttons located in the **Parameters** tab: see section *Synchronizing the CT400 with External Measurements, p. 33*.

Procedure

1. To save all traces and parameters set for the current scan: in the **Scan** area, click the **Save** button.

   A saving window appears.

2. Select the wanted folder and type a name for the scan.
3. Select the wanted extension:
   - **.png/.bmp**: saves the image of active traces displayed on graph.
   - **.txt/.csv**: saves the wavelength and power points of the curve of the displayed scan after they have been re-sampled so that the step between points corresponds to the **Res. (pm)** set in the **Scan Parameters** area. In .txt format, values are separated by spaces.

     Values are displayed as follows:

- **L**: lambda
- **O**: internal reference of the output port
- **1**; **2**; **3**; **4**: transfer function on detector 1; 2; 3 and 4, if activated (in the **Parameters** tab, **Detector Array** area).
- **EXT**: if activated in the **Parameters** tab (**Detector Array** area), this column displays the voltage measured at the BNC **C** connector.
  If the **Optical** check-box is selected in the **Parameters** tab (**BNC input** area), this column displays the optical power in mW or dBm (see section *Performing a Measurement Using the EXT Detector (BNC C Input Connector), p. 35*).

- **.xml**: saves the wavelength and power points of the curve (after they have been re-sampled so that the step between points corresponds to the **Res. (pm)** set in the **Scan Parameters** area) and the scan parameters of the displayed scan.

4. Click **Save**.

4.2 Managing Traces

Subject

The **Scan** area of the **Transfer functions** tab enables you to display/hide and shift traces.

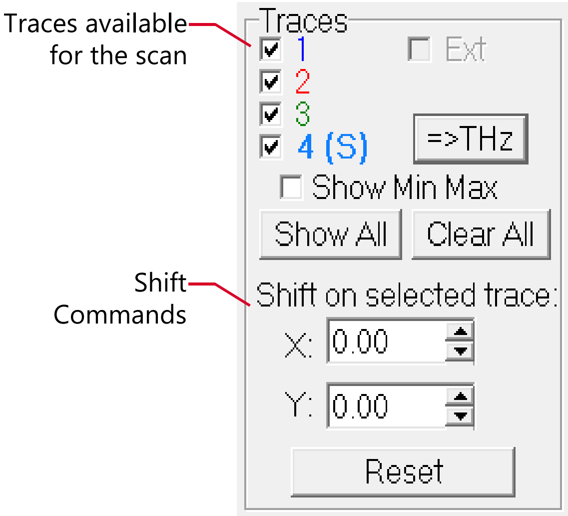


Figure 14: Transfer functions tab – Traces area

4.2.1 Displaying/Hiding Traces

Procedures

- In the **Traces** area, display/hide traces by selecting/clearing the corresponding check-boxes.
- To display/hide all the available traces in the current scan at once, click the **Show All/ Clear All** buttons.
- If the measurement is set as **Continuous**: to display the maximum and minimum scanned values on graph, select the **Show Min/Max** check box.

4.2.2 Shifting Traces

Subject

This section explains how to shift traces in wavelength and power ratio.

Procedure

1. On the graph, click on the trace you want to shift.

   In the **Trace** area, **(S)** appears next to the trace number to indicate the selected trace.
2. Do one of the following to apply a shift:
   - In the **Trace** area, specify a shift value in the **X** and **Y** fields.
     The trace shifts accordingly.
   - On your keyboard, press the **Ctrl** key and drag the trace using your mouse.
     The shift values in X and Y adjusts according to the displacement of the mouse.
3. To remove the shift: in the **Trace** area, click the **Reset** button.

Example

In the following example, Trace 1 has been overlapped on Trace 2, with a shift of 19.9 nm and -0.8 dB, to compare the filter shapes of 2 channels of a CWDM filter.

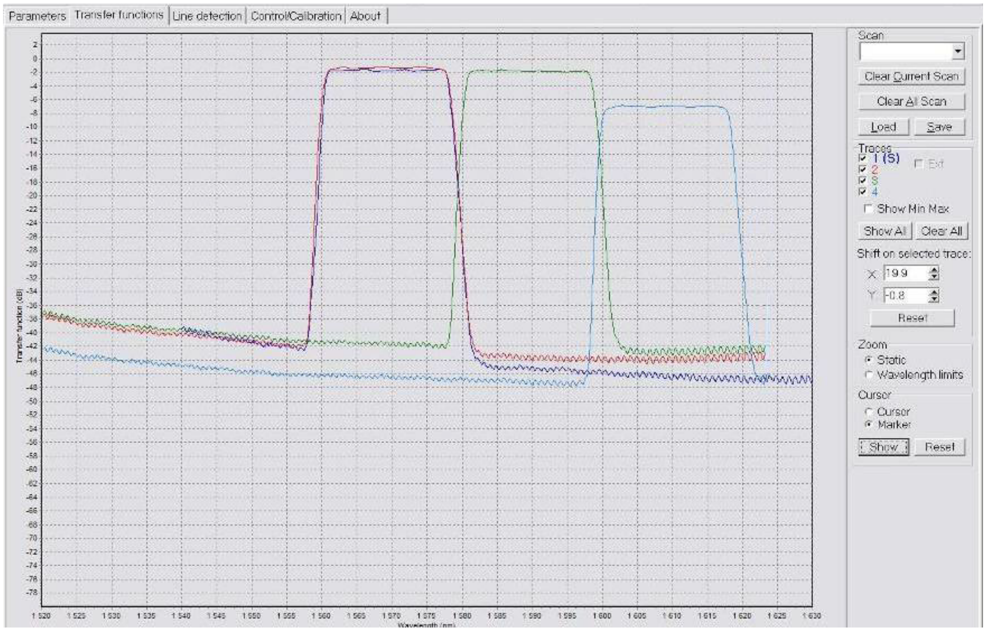


Figure 15: Transfer functions tab – Trace 1 superimposed on Trace 2 with a shift

4.3 Adjusting the Graph Display

Subject

The graph area displays the result of the scan. You can adapt the graph display to your needs by using your mouse and zoom functions located in the **Zoom** area of the tab.

Procedures

Adjusting the Scale of the Displayed Graph

- To modify the minimum and maximum values of the scale displayed on graph, click the **Scale** button and select the values of the X and Y axis.
- To zoom in:
  - To select the exact region of the graph you want to display, click on the graph and draw a rectangle from top left to bottom right by dragging your mouse pointer across the graph on the region you want to zoom in.
  - To zoom on a peak, select the trace on which you want to zoom by clicking on it on the graph, and click the **On Peak** button.
- To zoom out and restore the full original view: click the graph and draw a rectangle from bottom right to top left by dragging your mouse pointer across the graph.
- To move in the graph, right-click the graph and drag your mouse pointer across the graph area to reach the region you want to display.

Configuring the Display of the Next Scan

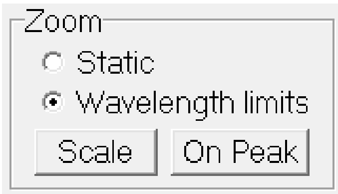


Figure 16: Transfer functions tab – Zoom area

In the **Transfer functions** tab, the **Zoom** area enables you to set zoom options for the next scan:

- **Static**: the single scan will be displayed on the same area as the current zoom.
- **Wavelength limits**: the next scan will be displayed over the full scan range (between the start and stop wavelengths set in the top left **Scan Parameters** area).

4.4 Performing Manual Measurements with Cursors and Markers

4.4.1 Operating Cursors

Subject

Four cursors are available:

- Two cursors dedicated to wavelength measurement.
- Two cursors dedicated to power ratio measurement.

Procedure

1. In the **Cursor** area, select **Cursor**.
2. Click the **Show** button to display the cursors.
    - Values displayed in yellow indicate the cursor positions: wavelength in nm (X axis) and power ratio in dB (Y axis)
    - Values displayed in blue indicate the difference between two cursors
3. To move cursors: click the cursor line and drag it on the graph.

   The corresponding yellow and blue values indicate the cursors' position and cursors' differences, respectively.
4. To place the cursors in the visible area of the graph, click the **Reset** button
5. To hide the cursors, click the **Hide** button.

4.4.2 Using the Marker

Subject

The marker displays the value of a point on a selected curve.

Procedure

1. On the graph, click on the trace you want to read values from.
2. In the **Cursor** area, select **Marker**.
3. Click the **Show** button to display the marker.
4. Move your mouse on the graph to reach the curve value you want to read.

   The marker is locked on the selected trace and follows the mouse. The wavelength (in nm) and power ratio (in dB) values of the selected curve are displayed in yellow.
5. To hide the marker, click the **Hide** button.

5. Performing Band-pass Filter Analysis

The **Band-pass filter analysis** tab provides the major characteristics of band-pass filters, mostly dedicated to WDM components.

For each trace of the transfer functions tab, all peaks above the channel detection threshold and within a selected grid (ITU-T DWDM or CWDM grid) are detected and the following characteristics are automatically computed:

- Channel number
- Central frequency
- Channel center accuracy (relatively to the grid)
- Filter bandwidth at - x dB
- Maximum insertion loss, on a selected passband
- Ripple, on a selected passband
- Adjacent and non-adjacent channel isolations, on a selected passband

5.1 Defining the Analysis Parameters

Subject

In the **Band-pass filter analysis** tab, the **Parameters** panel displays all parameters of the band-pass filter analysis.

Before Starting

Perform an appropriate measurement (see section *Setting up Measurements, p. 25*) and make sure the active scan displayed in the **Transfer Functions** (see section *Displaying and Managing Scan Results, p. 37*) tab is the one you want to analyze.

Procedure

1. Click the **Band-pass filter analysis** tab to display the parameters.

   If the tab displays a table, click the **Parameters** button at the bottom of the tab.

2. Specify the analysis parameters as described in the following *Band-pass Filter Analysis Parameters* section, *p 45*.

3. Start a measurement (see section *Starting Measurements, p. 29*).

Band-pass Filter Analysis Parameters

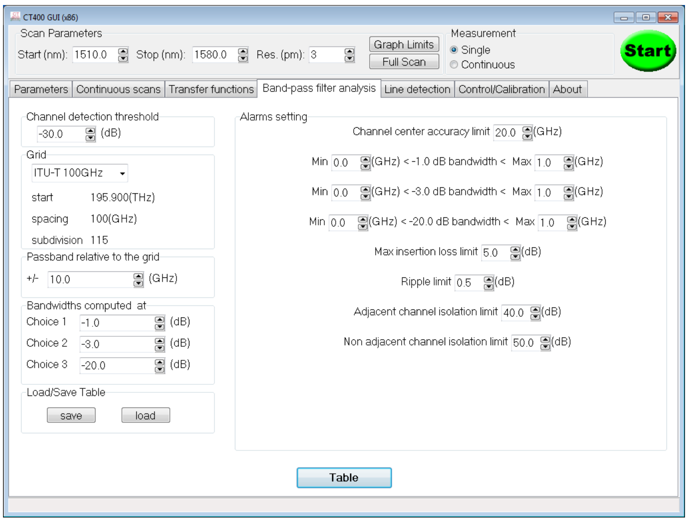


Figure 17: Band-pass filter analysis tab – Parameters

Channel detection threshold

For all traces displayed in the **Transfer functions** tab, only the peaks above this threshold value will be detected. Refer to the traces to determine the appropriate threshold value.

Grid

Select the appropriate ITU-T grid for the device under test among the available grids (the channel number and position is given in the Grid description):

- 4 DWDM grids with channel spacing of 100, 50, 25 and 12.5 GHz.
  The ITU channels are defined in frequency; all results will be in this unit.
- 1 CWDM grid with channel spacing of 20 nm.
  This grid is defined in wavelength; all results will be in this unit.

The channel numbering starts at 1.

Only one peak (the maximum one) is considered by grid interval. If more than one peak are detected within a same grid interval, a warning "*" is displayed after the corresponding channel number.

Passband relative to the grid

The width of the area, centered on the grid, where the maximum insertion loss, the ripple and the channel isolations are computed.

It is a small part of the grid interval where filter characteristics are expected to be optimum. Set here the half width of the passband, in GHz or in nm (depending on the selected grid).

Bandwidths computed at

The three different attenuation values (relative to the maximum value of the filter curve) for which the filter spectral width is computed.

Load/Save Table

These buttons enable you to save/load the configuration and result table of the current band-pass analysis. It does not load/save the transfer function curves, which should be loaded/saved independently if required.

Alarms setting

Definition of the alarms thresholds. If one of the alarm conditions is fulfilled, the relevant parameter becomes red in the **Table** output.

5.2 Displaying the Results of the Band-pass Filter Analysis

Subject

In the **Band-pass filter analysis** tab, the **Table** panel provides the results of the analysis. It is updated at each scan with a different display whether the scan mode is continuous or single.

Before Starting

Make sure you have configured the analysis parameters as explained in section *Defining the Analysis Parameters, p. 45*.

Procedure

- In the **Band-pass filter analysis** tab, display the results by clicking the **Table** button at the bottom of the tab.

  The tab provides the results of the band-pass filter analysis corresponding to the parameters you have set in the Parameters panel (see section *Defining the Analysis Parameters, p. 45*). For a detailed description of the results, see the following *Band-pass Filter Analysis Results* section, *p 47*.

Band-pass Filter Analysis Results

The analysis results are updated at each scan with a different display whether the scan mode is continuous or single:

- Table display in single measurement mode

Channel (Trace)	Central wavelength (nm)	Channel center accuracy (nm)	-1.0dB Bandwidth (nm)	-3.0dB Bandwidth (nm)	-20.0dB Bandwidth (nm)	Max insertion loss (dB)	Ripple (dB)	Adjacent channel isolation (dB)	Non adjacent channel isolation (dB)
1 (1)	1271.004	0.004	15.629	16.136	18.501	11.29	0.11	60.95	0.03
3 (1)	1309.866	-1.134	16.976	17.618	20.498	11.49	0.17	60.51	-0.31

Figure 18: Band-pass filter analysis tab – Results (single mode)

- Table display in continuous measurement mode
  In this mode, the min and max values are shown and continuously updated.

Channel (Trace)	Central frequency (THz)	Channel center accuracy (GHz)	-1db Bandwidth (GHz)	-3db Bandwidth (GHz)	-20db Bandwidth (GHz)	Max insertion loss (dB)	Ripple (dB)	Adjacent channel isolation (dB)	Non adjacent channel isolation (dB)
28(min) 28(1) 28(max)	193.201 193.201 193.201	1.4 1.4 1.4	29.7 29.7 29.7	50.9 50.9 50.9	128.4 128.4 128.4	10.75 10.75 10.75	0.22 0.22 0.22	37.11 37.11 37.11	-0.47 -0.47 -0.47
29(min) 29(2) 29(max)	193.101 193.101 193.101	1.5 1.5 1.5	29.3 29.3 29.3	50.4 50.4 50.4	128.3 128.3 128.3	4.17 4.17 4.17	0.21 0.21 0.21	39.80 39.80 39.80	11.20 11.20 11.20
30(min) 30(1) 30(max)	193.002 193.002 193.002	1.6 1.6 1.6	28.6 28.6 28.6	50.8 50.8 50.8	128.3 128.3 128.3	10.55 10.55 10.55	0.26 0.26 0.26	38.18 38.18 38.18	-0.08 -0.08 -0.08
31(min) 31(2) 31(max)	192.901 192.901 192.901	1.4 1.4 1.4	29.3 29.3 29.3	50.5 50.5 50.5	130.8 130.8 130.8	15.52 15.52 15.52	0.14 0.14 0.14	31.55 31.55 31.55	-11.56 -11.56 -11.56

Figure 19: Band-pass filter analysis tab – Results (continuous mode)

Column Name	Description
Channel (Trace)	Number of the detected channel, followed by the trace number (see section *Managing Traces, p. 40*) in brackets. Only one peak is recorded in each channel. The "*" character means that more than one peak have been found in the channel passband.
Central wavelength/frequency	Central position of the filter. This position is computed as the middle of the -3 dB bandwidth of the filter.

Column Name	Description
Channel center accuracy	The difference in position between the filter center (**Central frequency**) and the expected ITU position.
Bandwidth	The bandwidths for the three choices defined in the **Bandwidths computed at** area (Parameters panel) are computed in three columns.
Max Insertion Loss	Minimal value of the transfer function in the channel passband you defined in the **Passband relative to the grid** area (Parameters panel).
Ripple	Difference between the max and min of the transfer function in the channel passband you defined in the **Passband relative to the grid** area (Parameters panel).
Adjacent channel isolation	Difference between the IL value within the **Passband relative to the grid** area of the channel under interest and the IL value within the passband of the next channels (as illustrated in *Figure 20, p. 48* between channel 1 and 2).
Non adjacent channel isolation	Difference between the IL value within the **Passband relative to the grid** area of the channel under interest and the IL value in the passband of a non-adjacent channel (as illustrated in *Figure 20, p. 48* between channel 1 and 3).

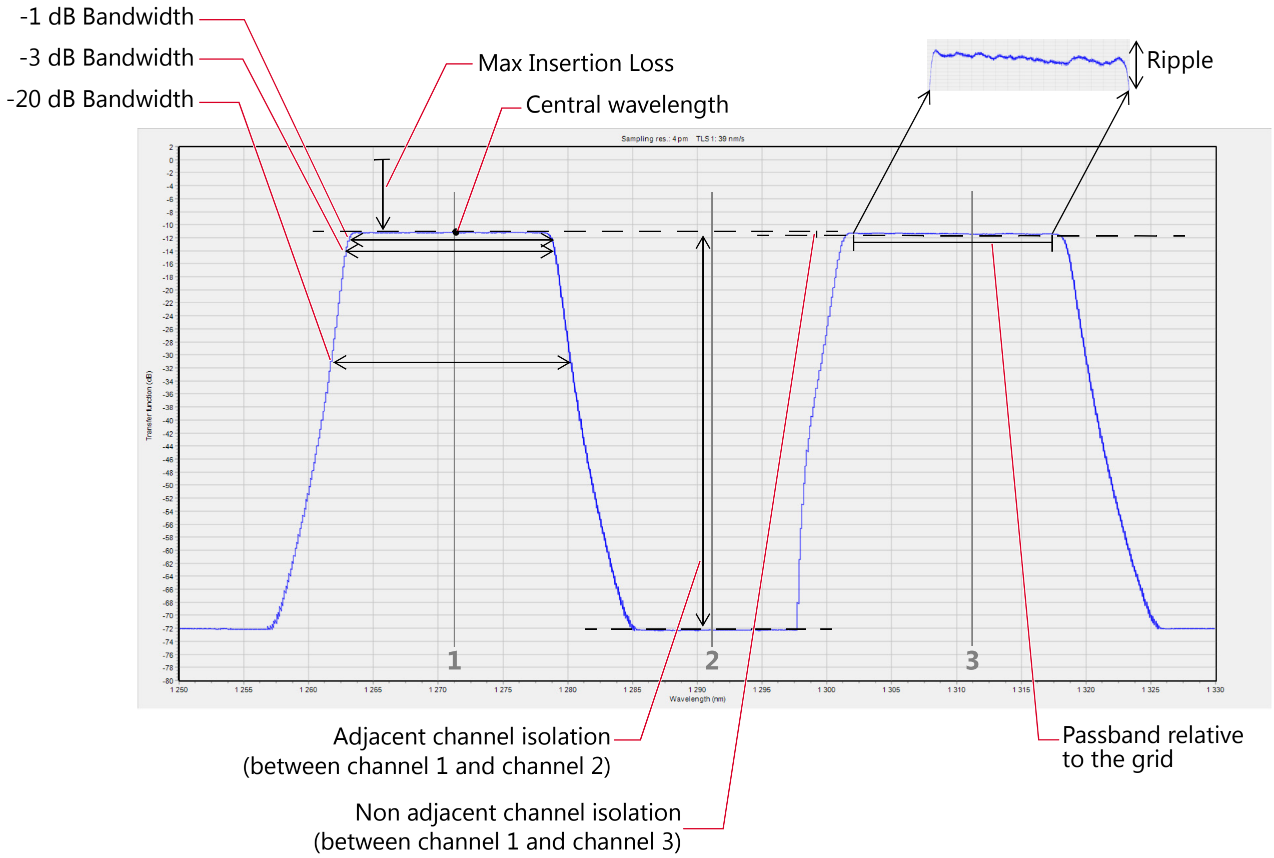


Figure 20: Band-pass filter analysis tab – Result Description (CWDM Grid)

6. Performing Line Wavelength Measurements

Subject

CT400 featuring two or more TLS inputs include a powerful heterodyne detection system that allows detecting when the source of an input port is at the "same" wavelength as the source in the next input.

Multiple Lines Measurement

The CT400 benefits from the heterodyne detector to allow the detection of multiple spectral lines on one port.
The **Line detection** tab provides the list of all spectral lines detected during the scan in a table. This allows you to use the CT400 as a multi-source wavemeter. It is possible to detect up to 16 spectral lines.

Single Line Measurement

The heterodyne detection is useful if more than one TLS is used to perform a scan.
In that case, the sources are connected to two adjacent ports. Both sources are active. While one source is sweeping, the second source waits until the wavelength of the sweeping source coincides with the wavelength of the idle source before taking over the sweeping. At this moment a signal is detected.
It provides a very accurate way to know precisely the wavelength at which a sweeping source crosses the wavelength of the idle source.
This allows to verify how well calibrated the TLS sources are and to correct the measurement if one of the sources does not fulfill the performance specifications.

Limitations

- The heterodyne detection is provided here as a powerful tool to enhance the applications of the CT400. Nevertheless, the input optical ports are not specified here in term of polarization whereas the heterodyne signal comes from the interference pattern of two independent signals from two adjacent input ports. This interference signal is optimal if the two sources arrive in the detector with the same polarization but could be not detected if the two polarizations are orthogonal.
- If the power of both sources (line power) is over 0.2 mW, the detection occurs in most configurations.
- If this tool is strongly required in your application, it is recommended to check first that the spectral lines are well detected at the required power level and then leave the inputs setup unaffected during all the measurement period.

Procedure

1. Connect a TLS to input port 1 and a laser source to input port 2 with an overlapped wavelength.
2. Start a measurement (see section *Starting Measurements, p. 29*).

   All spectral lines present in the source are detected in one scan and displayed in the **Line detection** tab.

7. Performing User Calibration and Controlling Power on Detectors

The **Control/Calibration** tab allows you to perform an auto-calibration and to visualize the power level on all detectors for adjustment purposes of the setup.

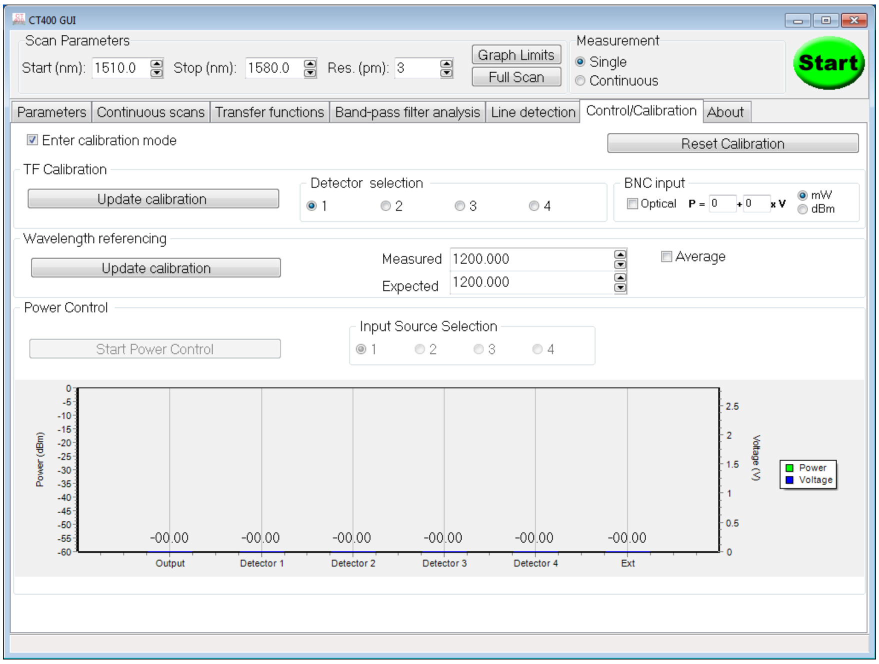


Figure 21: Control/Calibration tab

7.1 Verifying the Power Level on Detectors

Subject

In the **Control/Calibration** tab, the **Power Control** area enables you to monitor:

- Optical power on the selected detectors
- Optical power at the output port of the CT400
- Voltage at the analog BNC input port labeled **C** on the rear panel.

This control panel only provides an indication of the power allowing you to adjust the magnitude of the inputs/outputs of your setup before launching scan measurements. The specifications on the instrument are on the transfer function values, not on the power values that may be calibrated with less accuracy.

The power levels depend on the current wavelength and power output of the TLS, and on the characteristics of the component inserted between the output and the detector array of the instrument. If the current wavelength provided by the TLS is filtered out by the component, there will be no power on the detector array.

Procedure

1. In the **Control/Calibration** tab, in the **Power Control** area, select the wanted input port in the **Input Source Selection** area.

2. Click the **Start Power Control** button.

   The bar graph displays the power level:

   - Green color represents the optical power level on the output port and on the detectors.
   - Blue color represents the voltage level on the analog BNC input (connector **C**) located on the rear panel.
   - Red color indicates that the power and voltage values are out of specification for a proper measurement with the CT400. In this case, verify that your laser injects enough power into the CT400 and that your fiber connectors are clean (see section *Cleaning Optical Connectors, p. 59*).
     User defined calibration may lead to red bar, even in normal conditions.

   If you start any other action (scan, transfer function visualization ...), the power measurement provided here is disabled.

7.2 Performing Auto Calibration

When using the CT400 GUI for the first time, the original factory calibration file is automatically downloaded from the CT400 and stored on the control computer, in the appropriate **Calib** folder:

- On Windows XP: C:\Documents and Settings\All Users\Documents\Yenista Optics\CT400\Calib
- On Windows Vista and later versions: C:\Users\Public\Documents\Yenista Optics\CT400\Calib

The file name is Filexxxxxxxxxxx.dat, where xxxxxxxxxxx is the serial number of the CT400. Performing user calibration updates this file.

7.2.1 Performing User Power Calibration

Subject

In the **Control/Calibration** tab, the **TF Calibration** area enables you to calibrate the offset vs the wavelength for the front panel detectors.

If the DUT is connected to the CT400 via other elements (patchcords, splitters), it may be convenient to eliminate the contribution of these elements from the results, to only display the transfer function of the tested device.

The user calibration of the detector array is very important and must be done frequently to compensate any change in the insertion loss between the CT400 output and the detector inputs, or to accommodate to specific setups and focus only on the DUT properties.

Before starting

To obtain the optimum performance of the system, make sure the optical connectors are perfectly clean (see section *Cleaning Optical Connectors, p. 59*).

Procedure

1. Connect a verified optical jumper between the output port of the CT400 and the detector port you want to calibrate.
2. In the **Control/Calibration** tab, select the **Enter calibration mode** check box to enable the **TF Calibration** area.

3. In the **TF Calibration** area, select the wanted detector port in the **Detector Selection** area.

   You cannot calibrate the BNC C input (EXT) port. For more details on the use of this port, see section *Performing a Measurement Using the EXT Detector (BNC C Input Connector), p. 35*.

4. In the **Parameters** tab, set up the source and select the appropriate detector (see section *Configuring the CT400 for Measurement, p. 25*).
5. In the **Measurement** area, select **Single** and start a scan for the connected detector
6. In the **Transfer functions** tab, verify that the measurement has been performed.
7. In the **Control/Calibration** tab, in the **TF Calibration** area, click the **Update Calibration** button.

   The detector is calibrated, the **(Done)** caption appears next to the calibrated detector number. The undesired contributions will be eliminated in the next scans.

   IMPORTANT User power-calibration-file is stored on the computer on which the CT400 is connected. If you change computer, you must perform the calibration again.

7.2.2 Performing Wavelength Referencing

The CT400 should not encounter any shift in its wavelength accuracy between factory calibrations.
The **Wavelength Referencing** area of the **Control/Calibration** tab enables you to improve the accuracy of the wavelength referencing if needed by adding an offset to the factory calibration.

IMPORTANT User wavelength-calibration-data is stored on the computer on which the CT400 is connected. If you change computer, you must perform the calibration again.

7.2.2.1 Performing Wavelength Referencing Using a Reference Laser

Subject

This procedure uses the heterodyne detection system of the CT400 (see section *Performing Line Wavelength Measurements, p. 49*) and is only available if your CT400 has two or more laser inputs. If not, you must use an acetylene gas cell to perform the wavelength referencing as explained in section *Performing Wavelength Referencing Using an Acetylene Gas Cell, p. 54*.

Before starting

- Make sure you have a second laser with a fixed wavelength and power > 1 mW to use as a reference.
- Accurately measure the fixed wavelength of the laser with an external wavelength meter (accuracy must be better than 1 pm).

Procedure

1. Connect the instruments to the CT400 and specify them as follows:
   - On input port 1, connect a TLS source.
   - On input port 2, connect a stable laser source with a known wavelength.
   - In the **Parameters** tab, specify the parameters of the connected TLS input source.
2. Configure the measurement as follows:

a. In the **Control/Calibration** tab, select the **Enter calibration mode** check box to enable the **Wavelength referencing** area.

b. In the **Wavelength referencing** area, select the **Average** check-box to improve the accuracy.

c. In the **Scan Parameters** area, specify a wavelength range of at least 5 nm that overlaps the wavelength of the stable laser source.

d. In the **Measurement** area, select **Continuous**.

3. Start a scan.

4. In the **Control/Calibration** tab, in the **Wavelength Referencing** area, wait for a complete stabilization of the measured value given in the **Measured** field and stop the scan.

5. In the **Expected** box, enter the known wavelength of the source connected to input port 2.

6. In the **Wavelength Referencing** area, click the **Update Calibration** button.
The software applies the appropriate offset in wavelength to correct the wavelength calibration.

7. Clear the **Enter calibration mode** check box to exit the calibration mode.

7.2.2.2 Performing Wavelength Referencing Using an Acetylene Gas Cell

Subject

This procedure is dedicated to CT400 with one laser input port and is also applicable to CT400 featuring two or more TLS input ports.

This method uses an acetylene gas cell as device-under-test (DUT), which has absorption lines between 1510 and 1545 nm.

Subject

1. Connect the instruments to the CT400 and specify them as follows:

- On input port 1, connect a TLS source.
- Connect an acetylene gas cell as DUT.
- In the **Parameters** tab, specify the parameters of the connected TLS input source.

2. In the **Scan Parameters** area, specify a wavelength range between 1510 and 1545 nm with a resolution setting of 1 pm.

3. Start a scan.

4. In the **Transfer functions** tab, manually measure on the graph the wavelength for a specific absorption line.

5. In the **Control/Calibration** tab, in the **Wavelength Referencing** area, enter the measured value in the **Measured** field (this value is overwritten in case of heterodyne detection).

6. In the **Expected** field, enter the expected value for this absorption line (in nm).

7. In the **Wavelength Referencing** area, click the **Update Calibration** button.

The software applies the appropriate offset in wavelength to correct the wavelength calibration.

8. Clear the **Enter calibration mode** check box to exit the calibration mode.

7.2.3 Resetting Calibration

Subject

You can recover the initial factory calibration at any time. This will definitely erase all calibration modifications done on the wavelength referencing and/or in the Transfer Function calibration.

Procedure

1. In the **Control/Calibration** tab, select the **Enter calibration mode** check box.
2. Click the **Reset Calibration** button.

8. Performing Basic Maintenance Operations

WARNING

To avoid personal injury, never remove the protective cover of the chassis to perform servicing or maintenance operations. You must refer to your **Yenista Optics** service representative.

8.1 Updating the CT400 System Version

Subject

The last version of the CT400 software is available on the **Yenista Optics** website from the download area.

Procedure

1. From the **Yenista Optics** website (http://yenista.com/Download-area.html), download the last CT400 software package and copy it on your computer.
2. Unzip the **CT400 Installer.zip** file to a temporary folder on your computer.
3. Double-click the **setup.exe** file.

   If the new version requires an update of the DSP code of the unit, you are prompted to upgrade the CT400 DSP. In this case, click **Yes** to update the DSP.

   The CT400 Installation wizard appears.
4. Follow the instructions displayed in the wizard window.

   The CT400 GUI software is now updated on your computer.
5. Make sure the folder **C:\Program Files\Yenista\CT400** or **C:\Program Files (x86)\Yenista\CT400** (depending on you Windows platform) has been deleted from you computer.
   If not, it may contain data you want to keep (saved traces or configuration): in this case, save the wanted data in another location and delete the **CT400** folder.

8.2 Replacing the External Power Fuse

Subject

You must verify the power fuse in case you cannot turn on the CT400.


WARNING

To avoid fire hazard, only use the correct fuse type, voltage and current ratings.

Before Starting

Make sure you have the following equipment:

- 1 small flat blade screwdriver.
- Replacement fuse (for fuse type, see section *Technical Specifications, p. 12*).

Procedure

1. Turn the CT400 off (see section *Turning On/Off the CT400, p. 18*) and unplug the power supply cord from the wall socket.
2. Unplug the power cord.
3. Insert a small flat-blade screwdriver into the notch just above the power cord socket (see *Figure 3, p. 15*).

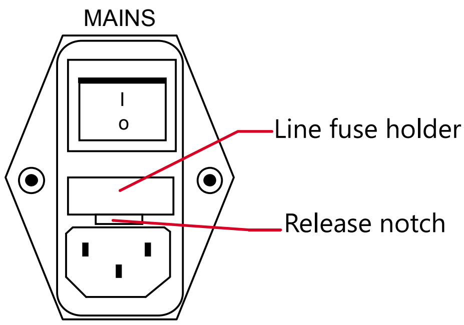


Figure 22: Fuse replacement

4. Use the notch to pull the fuse holder straight out to remove the two fuses.
5. Discard the bad fuse and replace it with a new fuse
6. Replace the fuses in the fuse holder and snap the fuse holder back into its housing.

8.3 Cleaning Optical Connectors

Subject

To ensure measurement accuracy and prevent loss of optical power, you must verify that optical connectors are clean every time you connect a fiber.

Handle optical fiber with appropriate care and preserve the integrity of optical connectors by keeping them free of contamination.

IMPORTANT To reduce the need for cleaning, immediately replace protective caps on the optical connectors when not in use.

Before Starting

Make sure you have the following material:

- Optical grade cleaning cotton swabs
- Clean compressed air
- Isopropyl alcohol
- Fiberscope or similar if available

IMPORTANT Use only high quality cleaning supplies that are non-abrasive and leave no residue.

Procedure

1. Turn the CT400 off (see section *Turning On/Off the CT400, p. 18*) and unplug the power supply cord from the wall socket.
2. Gently clean the connector end, with the following instructions:
   a. Hold the can of compressed air upright and spray the can into the air to purge any propellant.
   b. Spray the clean compressed air on the connector to remove any loose particles or moisture.
   c. Moisten a clean optical swab with isopropyl alcohol and lightly wipe the surfaces of the connector with gentle circular motion.
   d. Spray the clean compressed air on the connector again to remove any loose particles or isopropyl alcohol.
   e. Check that the connector is clean with a fiberscope (or similar).

8.4 Cleaning the CT400

Subject

If the external cover of the CT400 becomes dirty or dusty, clean it by following the instruction below.

CAUTION Do not use chemically active or abrasive materials to clean the CT400.

Before Starting

Material needed:

- Cleaning cloth
- Isopropyl alcohol

Procedure

1. Turn the CT400 off (see section *Turning On/Off the CT400, p. 18*) and unplug the power supply cord from the wall socket.
2. Slightly damp the cloth with an isopropyl alcohol liquid and gently swipe dirt and dust on the external cover of the CT400, without applying excessive force onto it.

8.5 Testing the Wavelength Accuracy

This section provides additional information on how to carry out performance tests on the wavelength accuracy.

The wavelength accuracy could be checked through three different operations:

- **Comparison with a cell etalon**

  The absorption lines of some materials are very stable and precisely known. By using the cell etalon as a DUT, you can precisely see the position of the absorption lines in the transfer function curves (with 1 pm sampling resolution) and their position compared to the tabulated ones. The acetylene cell is currently used for that purpose. The test performed here is usually restricted to a narrow part of the whole telecom spectrum.

- **Comparison with a filter Etalon**

  You can use thin film filter or FP Etalon if the peak positions are tabulated with a good precision, adapted to the environmental conditions of the test, and if the peak finesse is sufficient to check the position at few pm. The interest of the FP Etalon compared to the thin filter is its ability to potentially test the wavelength accuracy on a large bandwidth.

- **Comparison with a stable source**

  By using a sweeping source on port 1 and a stable single mode source on the second port, you can measure the wavelength value of the stable source (see section *Performing Line Wavelength Measurements, p. 49*) accurately and the comparison with the value obtained on a wavemeter will give a direct information on the wavelength accuracy of the CT400. Sources are available (through TLS or DFB) at any wavelength on the telecom band, which allows to check the wavelength accuracy anywhere by this mean.

8.6 Asking for a Factory Recalibration

Subject

Some calibration steps require the adjustment of internal optical components.

The calibration validity period depends on the intensity of use and environmental conditions. You can determine the adequate calibration interval for your CT400 according to your accuracy requirements.

Under normal conditions of use, we recommend to perform a factory recalibration of the CT400 after one year of normal use.

Procedure

Contact the **Yenista Optics** customer support service (see section *Contact Information, p. 4*)

8.7 Packaging for Shipment

If you need to return the CT400 to **Yenista Optics** for servicing or factory calibration, use the original packaging.

For instructions on returning the CT400, please contact **Yenista Optics** (see section *Contact Information, p. 4*).

9. Error and Warning Messages

This section lists all the possible error and warning messages, and how to handle them.

9.1 Warning Messages

Mode hops on the scan

- Cause:
  Mode hopping occurred during the scan on one TLS.
- Possible solution:
  Make sure the source performances meet the requirements detailed in section *Product Features, p. 11*.

Scan speed too low

- Possible causes:
  - The mean sweeping speed of the TLS is too low (< 8nm/s)
  - The calibration file is not located in the correct folder.
- Possible solution:
  - Raise the scan speed.
  - Make sure the calibration file is located in the proper **Calib** folder:
    - On Windows XP:
      C:\Documents and Settings\All Users\Documents\Yenista Optics\CT400\Calib
    - On Windows Vista and later versions:
      C:\Users\Public\Documents\Yenista Optics\CT400\Calib

Scan speed too high

- Cause:
  - The mean scanning speed of the TLS is too high (> 120nm/s).
  - The calibration file is not located in the correct folder.
- Possible solution:
  - Decrease the scan speed.
  - Make sure the calibration file is located in the proper Calib folder:
    - On Windows XP: C:\Documents and Settings\All Users\Documents\Yenista Optics\CT400\Calib
    - On Windows Vista and later versions:
      C:\Users\Public\Documents\Yenista Optics\CT400\Calib

High dynamical changes at low level, reduce scan speed

- Cause:
  The scan speed and input power are not suited for the measurement.
- Possible solution:
  Decrease the scan speed.

Unexpected source behavior, check TLS performance

- Cause:
  The internal wavelength referencing has detected a troubling behavior.
- Possible solution:
  - Make sure the source performances meet the requirements detailed in section *Product Features, p. 11*.
  - Make sure that the input power meet the requirements detailed in section *Technical Specifications, p. 12*.

Low power on one TLS input

- Cause:
  The power in the input port is below -16 dBm.
- Possible solution:
  - Make sure the jumper is clean and properly connected to the optical input of the CT400.
  - Make sure the TLS performances meet the requirements detailed in section *Product Features, p. 11*.

Numerous mode hops or multimoding behavior

- Cause:
  - The TLS is out of specification due to multimode behavior or numerous mode hops.
  - The calibration file is not located in the correct folder or is corrupted.
- Possible solution:
  - Make sure the source performances meet the requirements detailed in section *Product Features, p. 11*.
  - Make sure the calibration file is located in the proper Calib folder:
    - On Windows XP: C:\Documents and Settings\All Users\Documents\Yenista Optics\CT400\Calib
    - On Windows Vista and later versions: C:\Users\Public\Documents\Yenista Optics\CT400\Calib
  - Reset the calibration file as follows: in the **Calib** folder, delete the calibration file *Filexxxxxxxxxxx.dat* file (where *xxxxxxxxxxx* is the serial number of the CT400) and restart the program. The original factory calibration file is automatically downloaded from the CT400.
  - Make sure to perform a wavelength referencing operation in the laser (see the corresponding laser user manual).

High TLS input power variations: check TLS sources

- Cause:
  The power in the input port varies randomly above the specified value.
- Possible solution:
  Make sure the source performances meet the requirements detailed in section *Product Features, p. 11*.

Too high input power during the scan: check input power

- Cause:
  The power in the input port is above the specified value.
- Possible solution:
  Decrease the input power to meet the specifications detailed in section *Technical Specifications, p. 12*.

Power on DET1/DET2/DET3/DET4 too high: check set up

- Cause:
  The power on the detector is above specified value.
- Possible solution:
  Decrease the input power to meet the specifications detailed in section *Technical Specifications, p. 12*.
  Do not use and optical amplifier before the detector.

Spurious input power: check set-up

- Cause:
  Optical power has been detected where it is not supposed to happen.
- Possible solution:
  Verify that the lasers are connected to the correct input ports of the CT400.

Power too low on IN port 1/port 2/port 3/port 4

- Cause:
  The power in the TLS input port is below the specified value.
- Possible solution:
  - Make sure the jumper is clean and properly connected to the corresponding optical inputs
  - Make sure the TLS performances meet the requirements detailed in section *Product Features, p. 11*.

Power too high on IN port 1/port 2/port 3/port 4

- Cause:
  The power in the TLS input port is above the specified value.
- Possible solution:
  Decrease the input power to meet the specifications detailed in section *Technical Specifications, p. 12*.

The current sampling resolution does not allow to memorize all the points. The sampling resolution has been set to x pm.

- Cause:
  The resolution is too high for the running conditions. Scan is performed.
- Possible solution:
  Modify the parameters (wavelength range, number of detectors).

Invalid laser power (x mW)

- Cause:
  - The type of laser used (TUNICS T100R or TUNICS Reference) is not properly selected in the **Parameters** tab, in the **Source Type** list.
  - The wavelength range selected for the scan is not allowed on the laser.
- Possible solution:
  Restart the laser and properly configure the measurement parameters in the **Parameters** tab and in the top right **Measurement** area before starting a scan.

9.2 Error Messages

The measurement has been canceled by the user

This error only occurs if the **Stop** button has been activated by the user.

Failure in data exchange with the DSP

- Cause:
  A failure occurred during the communication between the computer and the internal DSP.
  For example, the number of points expected by the computer does not correspond to the number of points sent by the DSP.
- Possible solution:
  - Check the USB connection.
  - Contact the **Yenista Optics** customer support service (see section *Contact Information, p. 4*).

Error in the wavelength referencing

- Possible cause:
  - The calibration file is not saved in the correct folder.
  - If more than one laser is used, at least one input port is inversed.
- Possible solution:
  - Check the input power of the laser
  - Make sure the calibration file is located in the proper Calib folder:
    - On Windows XP: C:\Documents and Settings\All Users\Documents\Yenista Optics\CT400\Calib
    - On Windows Vista and later versions: C:\Users\Public\Documents\Yenista Optics\CT400\Calib
  - Verify that the lasers are connected to the correct input port of the CT400, so that the wavelength ranges follow the port order.

Switch failure

- Cause:
  Hardware failure on the optical switch.
- Possible solution:
  Contact the **Yenista Optics** customer support service (see section *Contact Information, p. 4*).

Failure in the communication with the DSP

- Cause:
  No communication at all is established between the computer and the internal DSP.
- Possible solution:
  - Check the USB connection.
  - Contact the **Yenista Optics** customer support service (see section *Contact Information, p. 4*).

The DSP version of the CT400 is incompatible with the DLL

- Cause:
  The version of the CT400 library is not compatible with the version of the CT400 DSP.
- Possible solution:
  - Install the last version of the CT400 GUI software on the PC as described in section *Updating the CT400 System Version, p. 57*.

Certification and Compliance

Specifications

The CT400 complies with the following specifications and standards:

- **CE Marking Directive**
- **EMC Directive 89/336/EEC (OJEU 23.05.89 L-139/19)**: Council Directive on the approximation of the laws of the member states relating to electromagnetic compatibility, by reference to the following standards:
  - EN 61326-1 ed.1997
  - EN 61326/A1 ed.1998
  - EN61326/A2 ed.2000
  - EN61326/A3 ed.2003
- **Low Voltage Directive** (as amended by directive 93/68/EEC) 73/23/EEC (OJEU 26.03.73 L-77/29): Council Directive on the harmonization of the laws of Member States relating to electrical equipment designed for use within certain voltage limits.
  - EN 61010-1 ed. 1993 + EN 61010-1/A2 ed. 1995.- UL3111-1 Standard for electrical measuring and test equipment.
  - CAN/CSA 1010-1-92 including MOD: 1997 safety requirements for electrical equipment for measurement, control, and laboratory use.
- **RoHS Directive** and **China RoHS**

Environment

Yenista Optics complies with the Waste Electrical and Electronic Equipment (WEEE) **Directive 2002/96/EC** and honors its obligations under this directive.

The product is marked with the WEEE symbol for recycling.

This means that you must not discard the product with domestic household waste.

At the end of the product's useful life, please contact your local **Yenista Optics** representative to arrange disposal in accordance with your initial contract and the local law.

Additionally, **Yenista Optics** arranges take back and disposal of historical waste as defined by the directives where **Yenista Optics** is supplying a new product or new equivalent product that fulfills the same function and replaces an old product (that is one placed on the market prior to August 2005).

In all cases, should you require **Yenista Optics** to arrange such take back and disposal, please contact your local **Yenista Optics** representative.

This obligation will be met by **Yenista Optics** for any equipment that is sold by **Yenista Optics** in the EU area irrespective of how many times it has been sold on.

Yenista Optics will not be obligated for equipment that was originally sold outside the EU area and subsequently imported unless special conditions have been agreed previously between **Yenista Optics** and the user.

Appendix: CT400 Hardware Change

Yenista Optics has modified the hardware of the CT400 to make it fully compatible with the TUNICS T100S-HP product line (wavelength and power range).

The hardware change is effective from 28 August 2014.

A CT400 with the new hardware as well as a CT400 with the previous hardware can be operated with the GUI version described in the present *CT400 User Manual*.

The main differences between the hardware versions are:

- **Hardware from August 28, 2014:**
  - Wavelength range: 1240 to 1680 nm
  - Available models[1]:
    - Without heterodyning: 1x1; 1x2; 1x3; 1x4
    - With heterodyning: 2x1; 2x2; 2x3; 2x4; 3x1; 3x2; 3x3; 3x4; 4x1; 4x2; 4x3; 4x4
- **Hardware before August 28, 2014**
  - Wavelength range: 1260 to 1650 nm
  - Available models[1]:
    - Without heterodyning: none
    - With heterodyning: 2x2; 2x3; 2x4; 3x2; 3x3; 3x4; 4x2; 4x3; 4x4

If you have a CT400 manufactured before 28 August 2014 and you wish to benefit from the new hardware functions, please contact **Yenista Optics** (see section *Contact Information, p. 4*).

1 Models are defined as <*number of input ports (on per laser)*>x<*number of detectors*>. 1x3 is a CT400 with one laser input port and three detector ports.

List of Figures