BOSA

User Guide

[2017, Rev.2]

by

ARAGON PHOTONICS

Welcome to BOSA.

Contents

0 Safety Considerations

0.1 Safety Symbols

The following signs will be used in this guide and must be followed by the user to ensure safe operation and maintain the product in a safe condition.

The warning sign denotes a hazard. It calls attention to a procedure which, if not correctly performed, could result in injury or loss of life. Do not proceed beyond a caution or warning sign until the indicated conditions are fully understood and met.

The caution sign indicates a hazard. It calls attention to a procedure which, if not correctly performed, could result in damage to or destruction of the product. Do not proceed beyond a caution or warning sign until the indicated conditions are fully understood and met.

The instrument will be marked with the following symbols:

Power button of the unit.

It indicates the front USB 2.0 port.

It indicates that laser radiation may be output from the connector (option X10 and X20).

~

The AC symbol is used to indicate the required nature of the line module input power.

0.2 General Considerations

The BOSA is a Safety Class 1 instrument, that is, an instrument with a metal chassis directly connected to earth via power supply cable. The main plug shall only be inserted in a socket outlet provided with a protective earth contact. Any interruption of the protective conductor inside or outside of the product is likely to make the product dangerous. Intentional interruption is prohibited.

Before operation, check the instrument and this manual for safety considerations. This section describes general safety precautions that must be observed during the operation of this instrument and to maintain the instrument in safe condition.

If this product is not used as specified, the protection provided by the equipment could be impaired. This product must be used in a normal condition (in which all means for protections are intact) only.

No operator serviceable parts inside. Refer servicing to qualified service personnel. To prevent electrical shock do not remove covers.

Ventilation requirements: the device should be located so that the convection into and out of the product must not be restricted.

The instrument must not be positioned on its rear part; the connectors on the back panel could be damaged.

0.3 Specific Considerations for BOSA Option X10 and X20

The BOSA Option X10 and X20 has an optical output connector for the internal laser source in the front panel indicated as “AUX Output”.

Please pay attention to the following laser safety warnings:

Under no circumstances look into the end of an optical cable attached to the optical laser output when the device is operational. The laser radiation can seriously damage your eyesight.

Do not activate the laser output when there is no fiber attached to the optical output connector.

The laser output is enabled by pressing the "Switch On" button in the Tunable Laser application (option X10) or performing a measurement in the component Analyzer application (option X20). The laser is on when the green LED on the front panel of the instrument is lit.

The use of other optical instruments with this product will increase the hazard to your eyes.

0.4 Initial Inspection

Inspect the shipping package for damage. If there is any damage to the container, please keep it until you have checked the contents of the shipment for completeness and verified the external aspect of the instrument. If there are no signs of damage, verify the instrument performance.

If there are any signs of damage to any part of the outer enclosure, do not perform any electrical testing. Please, contact to Aragon Photonics Labs service.

For repair and calibration the device must be returned to APL service.

0.5 Line Power Requirements and Connections

The instrument has a three wire power cable. This cable is connected directly in the appliance coupler located at the rear of the instrument and to the mains.

Do not remove instrument covers under any circumstances. Components replacement and internal adjustment must be made only by qualified service in APL.

Do not connect AC power until you have verified the line voltage above indicated. Damage to the equipment could result.

To operate with the instrument it is necessary to switch on the power button located in the front panel of the device. Then a green LED on the button is lit.

To switch off the instrument press the power button located in the front panel of the device. Then the green LED on the button will not light. Please, note that the power button on the front panel of the instrument does not stop the flow of power to the instrument.

If you need to turn off the power, unplug the instrument at the mains or remove the power cable connector from the appliance coupler at the rear of the device.

The instrument BOSA (complies with overvoltage category II) can operate from the single-phase AC power source that supplies between 100 V and 240 at a frequency range of 50 to 60Hz. The maximum power consumption is 140 W.

0.6 Operation Environment

The BOSA instrument has been designed for indoor use only.

The device should be protected from temperature extremes and changes in temperature that might cause condensation within it.

The specified operation temperature range for this device is +15°C to 35°C.

To prevent potential fire or shock hazard do not expose the instrument to rain or other excessive moisture.

To prevent electrical shock, disconnect the instrument from mains before cleaning. Use a dry cloth to clean the external case parts. Do not attempt to clean internally.

0.7 Input/Output Connectors

The electrical ports located in the rear of the instrument are showed in the figure 0.1. A brief description of each one is indicated.

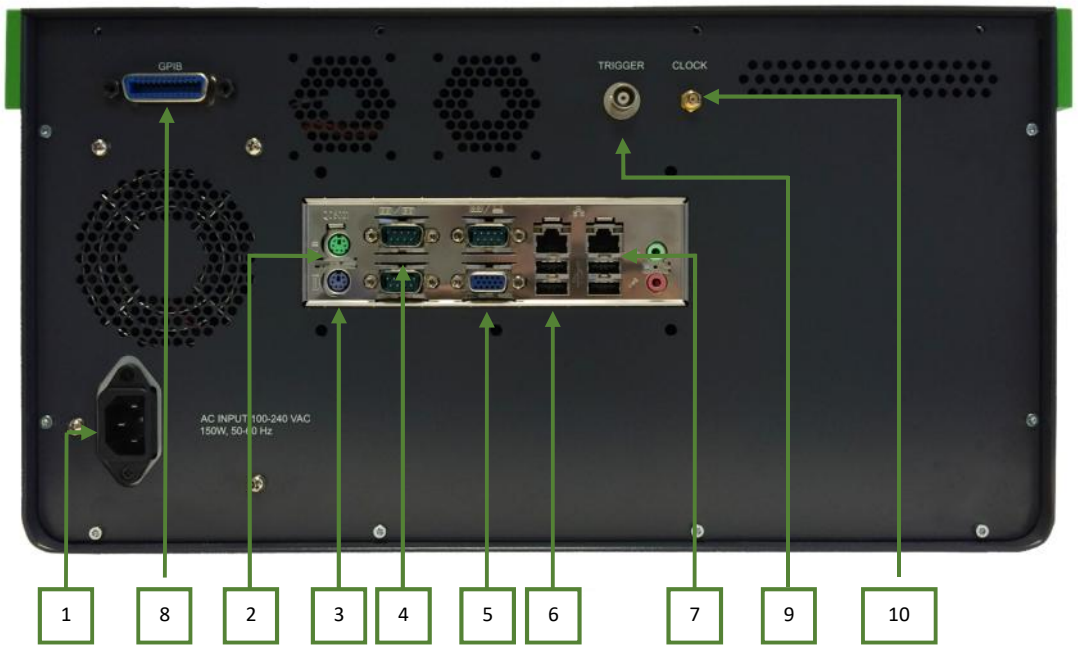


Fig. 0.1 BOSA rear panel.

1. Power Cable connector.
2. Mouse connector: standard PS/2 connector.
3. Keyboard connector: standard PS/2 connector.
4. Serial Port.

CAUTION This port is not available.

5. VGA connector (VGA OUT)
6. USB out ports: a memory stick can be used to export data.

STOP Controller devices must not be connected to these USB ports.

7. RJ 45 connector (Ethernet port): connector 10/100 base-T. Available port for remote control.
8. GPIB: Available for remote control with SCPI commands.

a. BOSA 100 series: port used for communication with the external tunable laser source.
b. On other options is available under request.

9 BNC TRIGGER

a. Trigger IN (BOSA 100 series): trigger synchronization with the external tunable laser.
b. Trigger OUT (BOSA Option X10 and X20): output trigger for the internal tunable laser (for trigger configuration please refer to section 4 “Tunable Laser Source Application)

10 SMA RF Clock (Option X40)

a. Synchronization feed required for the phase measurement.

The optical connectors located in the front panel are showed in figure 0.2. They may change depending on the BOSA option. Unless requested otherwise, all the optical connectors are FC/APC

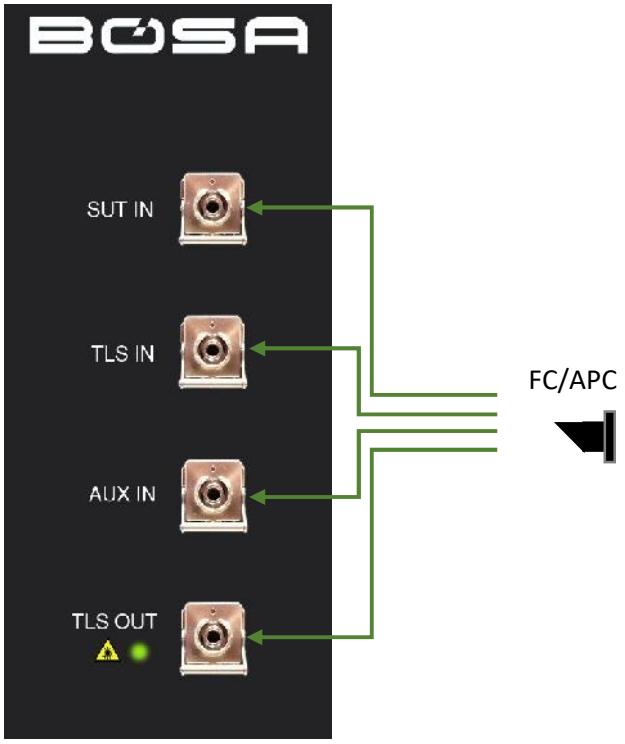


Fig. 0.2 BOSA front panel.

Following the optical connectors located in the front panel are listed.

1 *SUT IN:* optical input for the signal under test.

The maximum optical power of the signal under test must not exceed the value of +20 dBm.

2 *TLS IN (BOSA 100 series):* the external tunable laser is connected here.

3 *TLS OUT (option X10 and X20)*: optical output for the internal tunable laser source. A green LED is activated when there is power being output through this connector.

Invisible laser radiation. Do not view directly with optical instruments. Class 1 laser product. Refer to section 0.3 for specific considerations.

4 *AUX IN (option X20)*: Input optical connector for the Component Analyzer application.

1 What is a BOSA?

The BOSA is a high resolution optical spectrum analyzer, which measures in real time the optical spectrum of a signal under test (SUT) in the available wavelength ranges (see section 11) with the main following characteristics:

- Very high optical resolution: 10MHz.
- High Sensitivity: -70dBm/0.1pm.
- Wide dynamic range: >80 dB. All Spurious-free.
- Real time measurement, fast speed.

1.1 BOSA Technology

The BOSA technology utilizing Stimulated Brillouin Scattering (SBS), relies on a pure optical analysis of the SUT transmitted through a nonlinear medium stimulated by a counter-propagating probe laser (TLS) (see fig. 1.1). This process creates the equivalent of an optical filter of Gaussian profile that allows reaching high resolution optical measurements at any span range inside C band. This optical signal is directly detected in a photo detector, processed and displayed on the screen under the control of an internal computer.

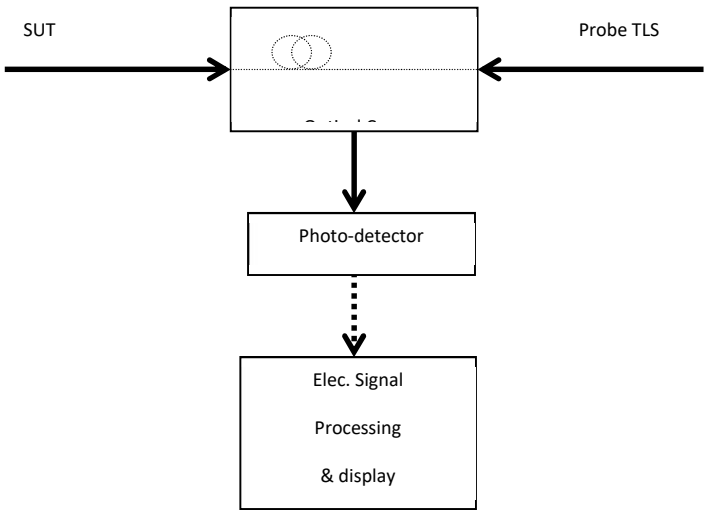


Fig. 1.1 BOSA principle.

1.2 Applications

In real time, and keeping at the same time high resolution and high dynamic range, it is possible to quickly and easily measure optical spectra of:

- Laser sources
- Direct modulation laser
- External modulated laser
- PRBS signals
- DWDM signals
- Pulsed laser fiber
- RF Photonics

Where it is possible:

- Identify laser lines
- Identify frequency chirp effects
- Identify lindewidth
- Show laser drift (wavelength)
- Show modulations effects

The BOSA has a built-in Macro Tool function that allows you to automate measurements process and control via GPIB interface other instruments in your measurement set-up. Alternatively, the BOSA can be remotely controlled over both GPIB bus and the communication network through the Ethernet interface.

NOTE: Signals under test at modulation frequency lower than 25 kHz can derive in optical measurements with optical artefacts appearing in the noise floor.

1.3 Some practical considerations

When measuring the optical power spectrum with a very narrow resolution such as the one used in the BOSA, some differences compared with the use of traditional OSAs must be considered:

- In OSAs, signal power corresponds to the peak power for those signals that are narrow compared with the resolution bandwidth. With BOSA even carrier line widths can be of the order of the resolution bandwidth, and of course channels are much wider. In order to avoid underestimation of the total power, the **power integral** of the frequency region should be taken instead of the peak power.
- When the line shape is the target of the measurement and averaging is desired to improve the signal to noise ratio of the measurement, measurement repeatability can be critical. For this purpose, a feature called **trace locking** has been implemented in BOSA application. Trace locking performs a correlation of the actual measured trace with the previous averaged trace and displaces the measured trace so that the correlation is maximum before computing it to obtain the averaged signal.

2 Setting up the BOSA

2.1 Items Included in the shipment

The following items are included in the BOSA shipment:

1. BOSA

The default configuration includes angled FC/APC connectors. The unit may have other type of connectors.

2. Power Cord
3. GPIB Cable (BOSA 100 series)
4. BNC Cable (BOSA 100 series)
5. Polarization Maintaining Fiber patch cord (BOSA 100 series)
6. User Guide
7. Programming Guide

2.2 Connecting the BOSA

When operating, the BOSA should be located whith a clearance of at least 75 mm in each side and at the rear of the instrument.

Follow the steps described below to properly start up the unit.

1. In case of using an external monitor it may be connected to the computer VGA connector.
2. The front panel LCD is a touch sensitive screen. In addition an optical mouse can be connected at the real panel using the PS2 or USB ports.
3. Connect the BOSA to the electric line using the supplied power cord.
4. In case of using an external monitor connect it to the electric line using the proper power cord or adaptor of your country.
5. Turn on the BOSA pressing the power button located in the front panel.

Fig. 2.1 BOSA setup.

2.2.1 Connecting an external tunable laser (BOSA 100 series)

BOSA 100 series requires the following additional steps in order to properly connect an external tunable laser to the BOSA. Check section 14 in this manual for a list of compatible external tunable lasers.

- **GPIB Laser**

If the external tunable laser uses the GPIB bus to communicate with the BOSA please follow the next connection procedure:

1. Turn off the BOSA and use the GPIB cable to connect the BOSA unit to the external laser source.
2. Use the BNC cable included in the shipment to connect the "Trigger Input" connector on the rear panel of the BOSA to the "Trigger Output" connector on the laser.
3. Use the polarization maintaining fiber included in the shipment to connect the external laser optical output to the "TLS Input" on the front panel of the BOSA.
4. Turn on the BOSA.

- **USB Laser (Luna)**

The installation of a USB laser must be carried out with the BOSA unit turned on. Please refer to section 2.4 and then continue with the following steps. The installation process is basically the same one described in the Phoenix laser manual but substituting the default installation directory by "C:\Program Files\APL\Luna". The detailed installation process is described:

1. Turn on the BOSA unit without making any connection between the laser and the unit.
2. Go to the "Application Selector Screen" (see section 2.4). Go to help->Software Update and click on "USB TLS Installation". A warning message will appear indicating that the BOSA application will be closed.

Once the BOSA application is closed the user has full access to the operating system ONLY for TLS installation purposes. Do not perform any other operation apart from the ones described in this manual. Aragon Photonics is not responsible of any malfunction derived from additional actions performed in the operating system.

3. Copy the laser drivers in a USB stick from the CD of the manufacturer. Plug the USB stick in a USB port of the rear panel of the BOSA. Open the Phoenix 1400 folder, run setup.exe and follow on-screen instructions. **When asked for an installation directory use "Program Files\APL\Luna".**

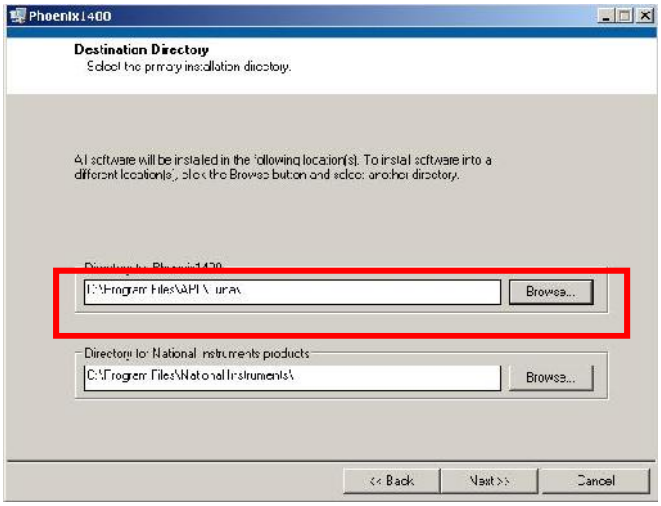


Fig. 2.2 *Directory for Luna drivers installation.*

4. After finishing the installation, connect the laser and the BOSA using a USB cable and turn on the laser.
5. After a few moments the BOSA will automatically detect the device and display the "Found New Hardware Wizard".
6. Select "No, not this time" option and click the "Next" button to continue.
7. Select the "Install from a list or specific location (Advance)" option and click the "Next" button.
8. Select the "Search for the best driver in these locations" option and check the "Include this location in the search" checkbox. Click the "Browse" button and select the folder **"C:\Program Files\APL\Luna\USB_Drivers"**. Click "Next".
9. Another dialog box will alert the user to wait while the Wizard searches.
10. An alert dialog will be display. Click "Continue Anyway" button to proceed.

11 If any other file is required select the driver installation directory (**C:\Program Files\APL\Luna\USB_Drivers**) using the "browse" button.

12 In the last window click "Finish" button to complete installation of the driver.

13 Turn off the BOSA. Remove the USB stick previously plugged in step 3.

14 Use the BNC cable included in the shipment to connect the "Trigger Input" connector on the rear panel of the BOSA to the "Trigger Output" connector on the laser.

15 Use the polarization maintaining fiber included in the shipment to connect the external laser optical output to the "TLS Input" on the front panel of the BOSA.

16 Turn on the BOSA.

This installation procedure must be repeated for different TLS units. If only one TLS unit is used the installation process needs to be carried out just once, even if different USB ports of the BOSA are used.

2.3 Turning on the BOSA

When the BOSA unit starts an OS based in Windows 7 is launched. After a few seconds a User Account selector screen appears with two options:

- **APL Support**: password protected account for remote support and administration purposes. Not accessible by the user.

- **User**: password protected account for the use of the BOSA application. By default the password is 1234, it can be changed afterwards in the application selector screen, see section 2.4.

2.4 Application selector screen

Once the BOSA unit is started an application selector screen appears. It is possible to select between several applications depending on the BOSA option.

Fig. 2.3 *Application Selector Screen.*

1. BOSA: runs the High Resolution Optical Spectrum Analyzer application (see section 3).
2. Tunable laser: runs the internal tunable laser application (see section 4).

Invisible laser radiation. Do not view directly with optical instruments. Class 1 laser product. Refer to section 0.3 for specific considerations.

3. Component analyzer: runs the Component Analyzer application (see section 5).

Invisible laser radiation. Do not view directly with optical instruments. Class 1 laser product. Refer to section 0.3 for specific considerations.

4. BOSA PHASE: runs the phase measurement application (see section 7).

The application selector screen is always accessible from any of the applications through the Exit to App Selector button located in the System menu.

2.4.1 Application by default

It is possible to configure a specific application to automatically run on BOSA start up. The "Configure" dialog box is accessible through the set up menu.

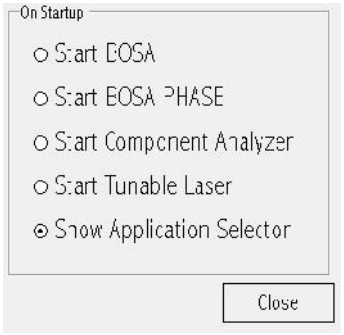


Fig. 2.4 Configure default application dialog box.

2.4.2 Change user password

It is possible to change the default User account password in the BOSA. Click in *SetUp->Change User Password* and introduce the required information.

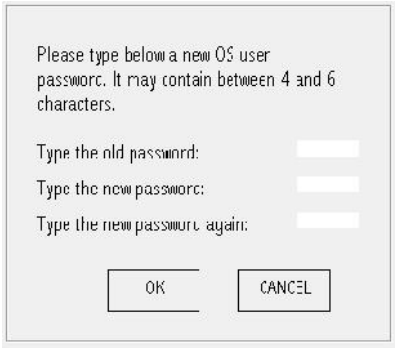


Fig. 2.5. Change or set the password of the User account.

2.4.3 Updates and Installation

See section 10.5.

3 BOSA: High resolution optical spectrum analyzer

3.1 Graphical User Interface

In this chapter, the user interface of the BOSA is presented. All menu options and user keys are summarized. Next, a brief description of each feature is made for the ease of understanding.

3.1.1 Interface Keys Overview

The interface is composed of two main areas, as shown in Figure 3.1. These are: *Button Bar* and *Measurement Area*. The measurement area includes the measurement representation, context menu, current measurement settings and markers information.

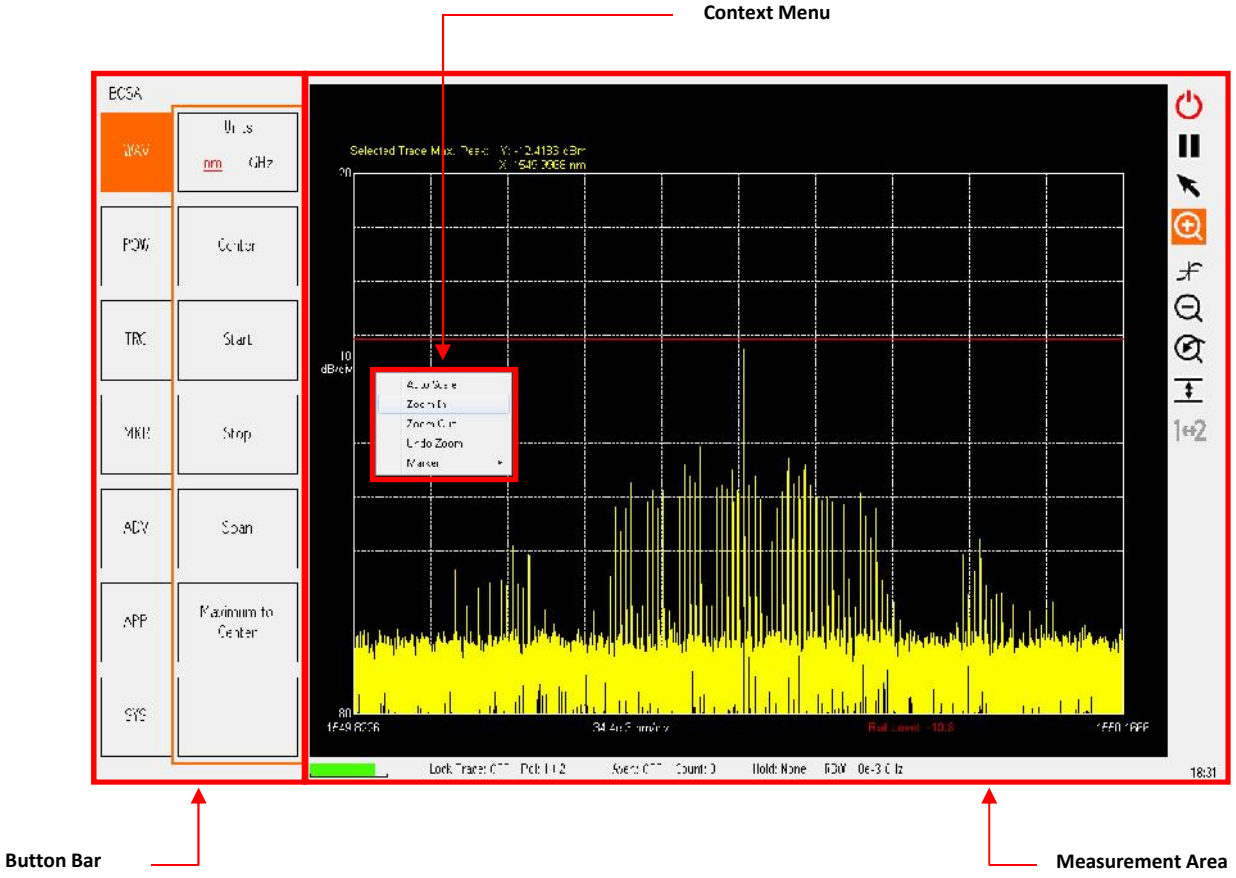


Fig. 3.1 BOSA user interface.

3.1.1.1 The measurement area

The *measurement area* shows the optical spectrum of the current Signal Under Test (SUT). Results are offered via traces and numerical data. In Figure 3.2 the trace plotting area is represented.

The *measurement area* can be further divided into a *graphical representation area*, *data collection area*, *operation parameters area* and quick function bar.

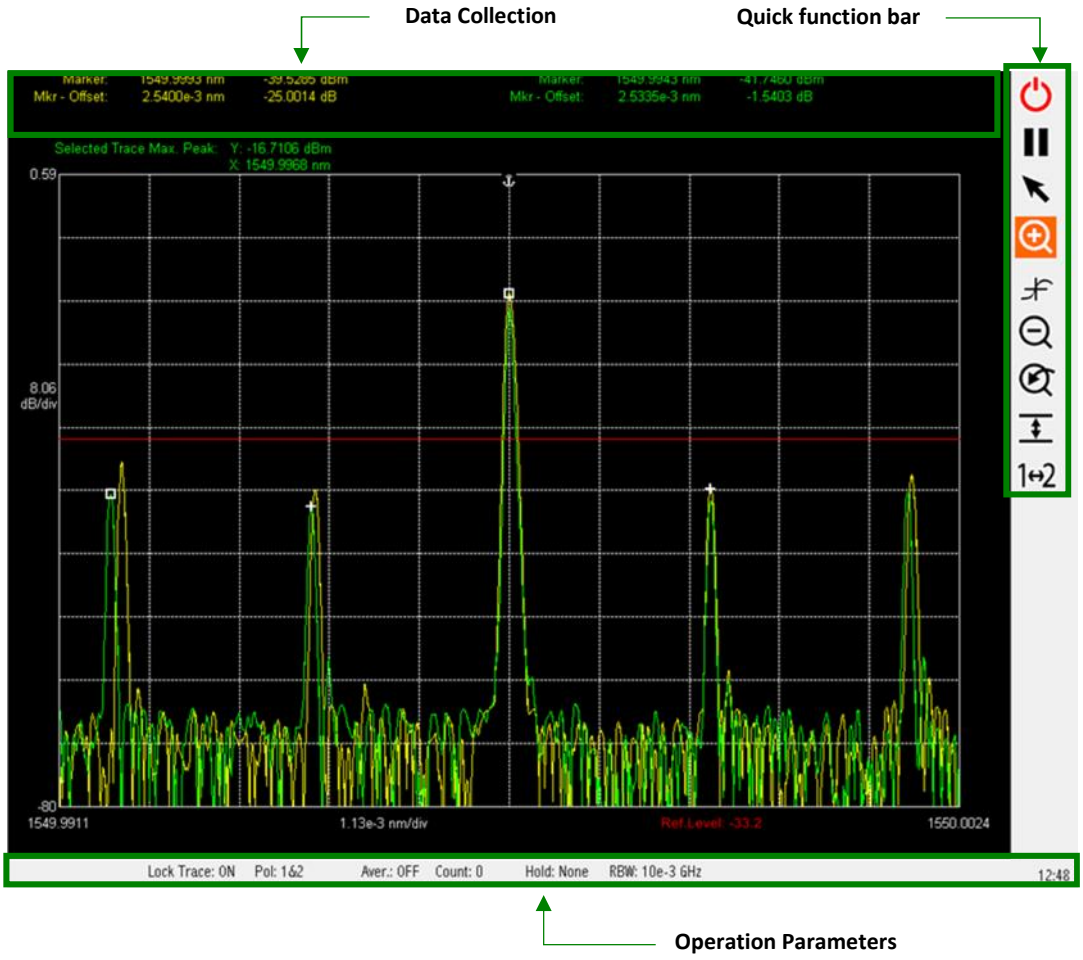


Fig. 3.2 BOSA Measurement area.

- **Data collection area** in the top side of the *measurement area* shows markers information (optical power and wavelength) for traces.

- **Operation parameters area** the lower part of the measurement area shows information about the operation conditions of the system such as resolution bandwidth, polarization control, average state and hold function stage (refers to Figure 4.11). A power bar indicates the optical power level of the SUT. Any internal error will be output at the right in this area (please refer to *13.2 Error Messages* for details).

- **Quick function bar** at the top right of the *measurement area* which allows the user to perform commonly used actions in an easy way.

Quick bar description

	No mode is selected
	Sets the zoom-in mode. The representation area on a chart can be amplified by a click and drag operation.
	Places a marker on the trace.
	Extends the wavelength representation range by a factor of two.
	Undoes up to three zooming actions.
	Fits the vertical axis to the displayed data.
	Switches among active traces in the chart.
	Freezes the current measurement on the screen. The unit is fully working in second plane but the data is not displayed.
 	Allows the user to start or stop the current measurement at any time. Even when stopped, the configuration parameters of the BOSA can be modified; if the measurement is later initialized, the new parameter values will be used.

- **Graphical representation area** where the current SUT spectrum is plotted. Attached to the graph the following measurement conditions are indicated:

  1 *Reference Level* information
  2 Scales per division for both power and wavelength

When the *Total Power* is selected, the power Integral value and the integration width is indicated in the top left corner of the grid in orange color.

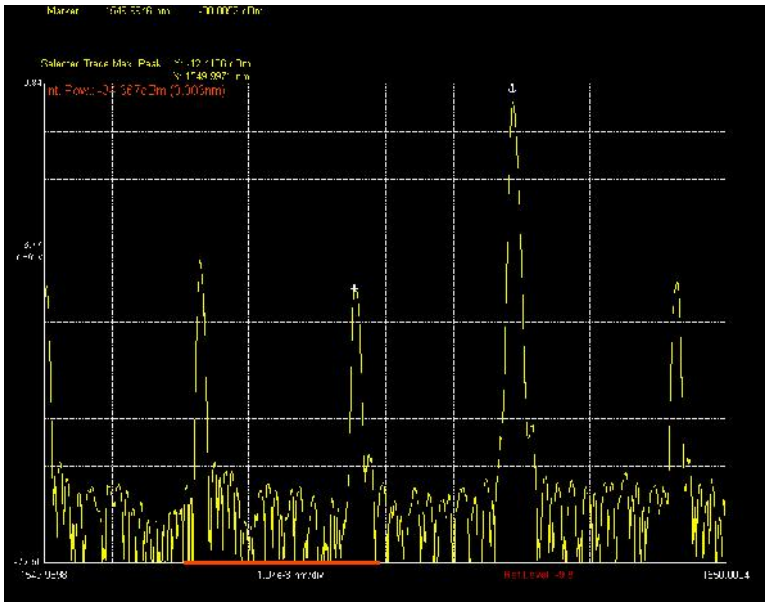


Fig. 3.3 BOSA Graphical representation area.

It is possible to view several traces simultaneously, a live trace (*Trace A*) and loaded traces identified as *Trace M1 to Trace M4*. Markers can also be added to active traces and can be shifted just by clicking and dragging the mouse pointer over them.

In the *operation parameters area* some related parameters are shown. These include:

1. Device Status (i.e. starting, calibrating,...)
2. Power bar for optical power level of the SUT.
3. Resolution bandwidth.
4. Polarization control information, averaging information and holding function state.
5. Time.

Fig. 3.4 BOSA operation parameters area.

3.1.1.2 The button bar

The *Button Bar* encompass user keys related to Wavelength, Optical Power, Markers, Traces, Advanced and System issues, respectively. Following figures show the button tree diagram of the BOSA.

Button Bar description

The button bar contains all user keys related to the measurement options. From the main bar the user can set all the operation parameters of the BOSA by means of the touch sensitive screen or using a mouse.

Those options which require data to be typed in, display an emerging keyboard. This allows the use of the system without the need of an external keyboard. Changes can be confirmed with the "*Apply*" button, or dismissed by clicking "*Cancel*" button or clicking outside the keyboard. Note that it is always possible to type the data using an external keyboard.

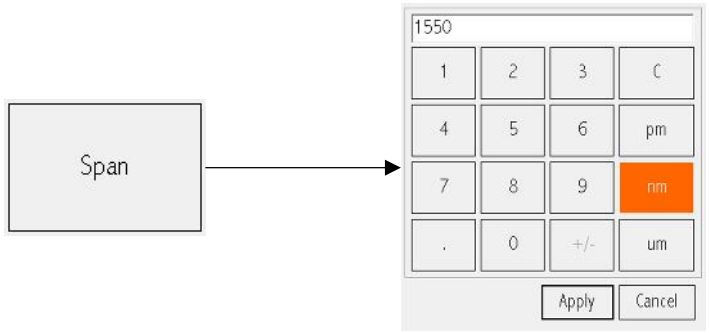


Fig. 3.5 Keyboard.

Some buttons allow the user to choose between different options. By pressing the button, all the options are consecutively activated. These are called *Option Buttons*.

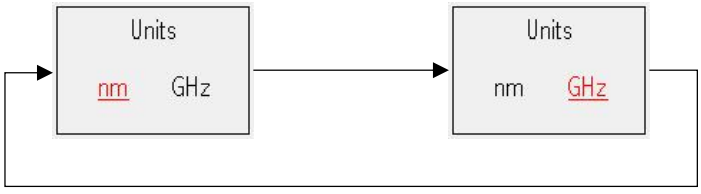


Fig. 3.6 Example of option button.

3.1.1.2.1. Wavelength button

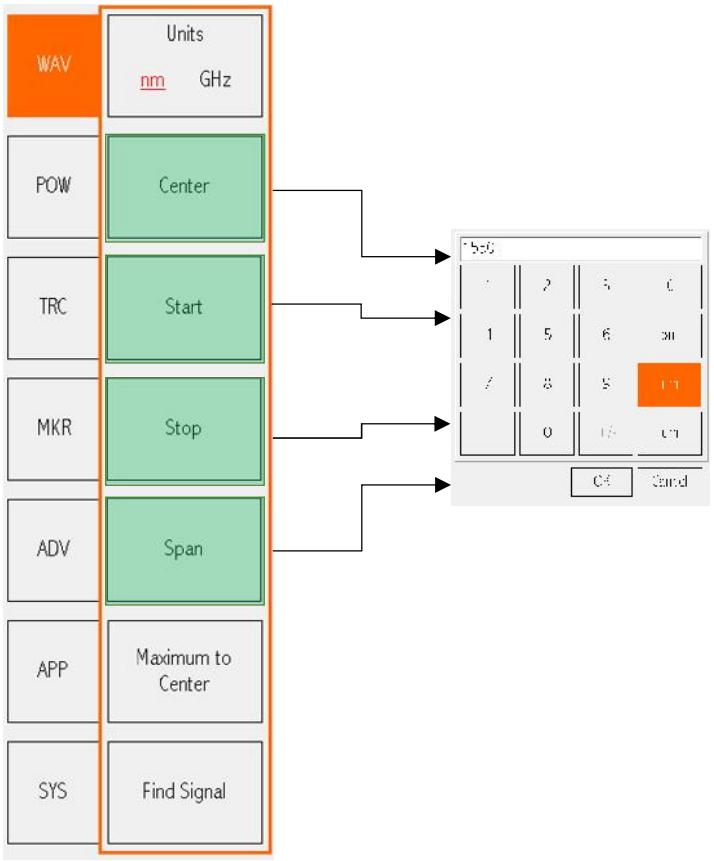


Fig. 3.7 BOSA *Wavelength* button bar tree diagram.

Wavelength submenu

	This is an option button. Changes the units of the horizontal axis from nm to GHz or vice versa. All the information in the *button bar* or *data collection area* related to the horizontal axis is properly switched to the current scale units.
	Sets the central value for the wavelength or frequency to be represented.
	Sets the initial wavelength or frequency value for the measurement range.
	Sets the final wavelength or frequency value for the measurement range.
	Sets the total measurement range.
	Shifts the wavelength or frequency range in order to represent the maximum power peak of the current trace at the center of the plotting area.
	Performs a sweep of the maximum span and automatically centers the wavelength of the signal.

3.1.1.2.2. Power button

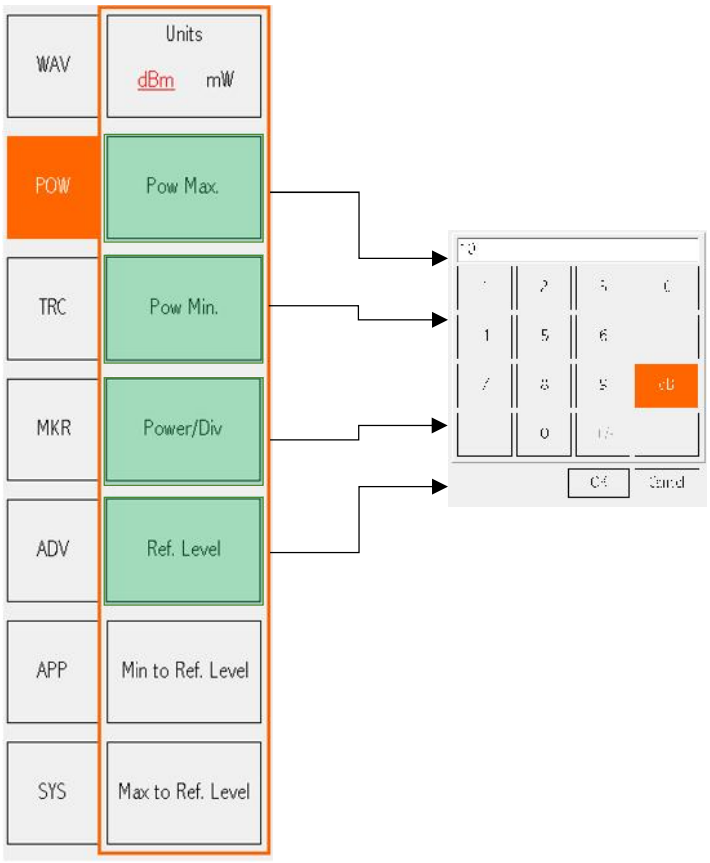
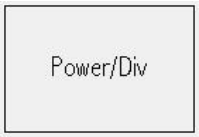


Fig. 3.8 BOSA *Power* button bar tree diagram.

Optical Power submenu

	This is an *option button*. It changes the units of the vertical axis from dBm to mW or vice versa. **NOTE:** The grid is always divided into 10 parts. Besides, when measuring in dBm the maximum does not change and when measuring in mW the minimum does not change either.
	Sets the scale factor of the vertical axis. Power axis is rescaled with the indicated power per division.
	"Pow Max" sets the maximum value of the power axis.
	"Pow Min" sets the minimum value of the power axis.
	Sets the power value of the reference level.
	Makes the minimum vertical axis value equal to the reference level.
	Makes the maximum vertical axis value equal to the reference level.

3.1.1.2.3. Traces button

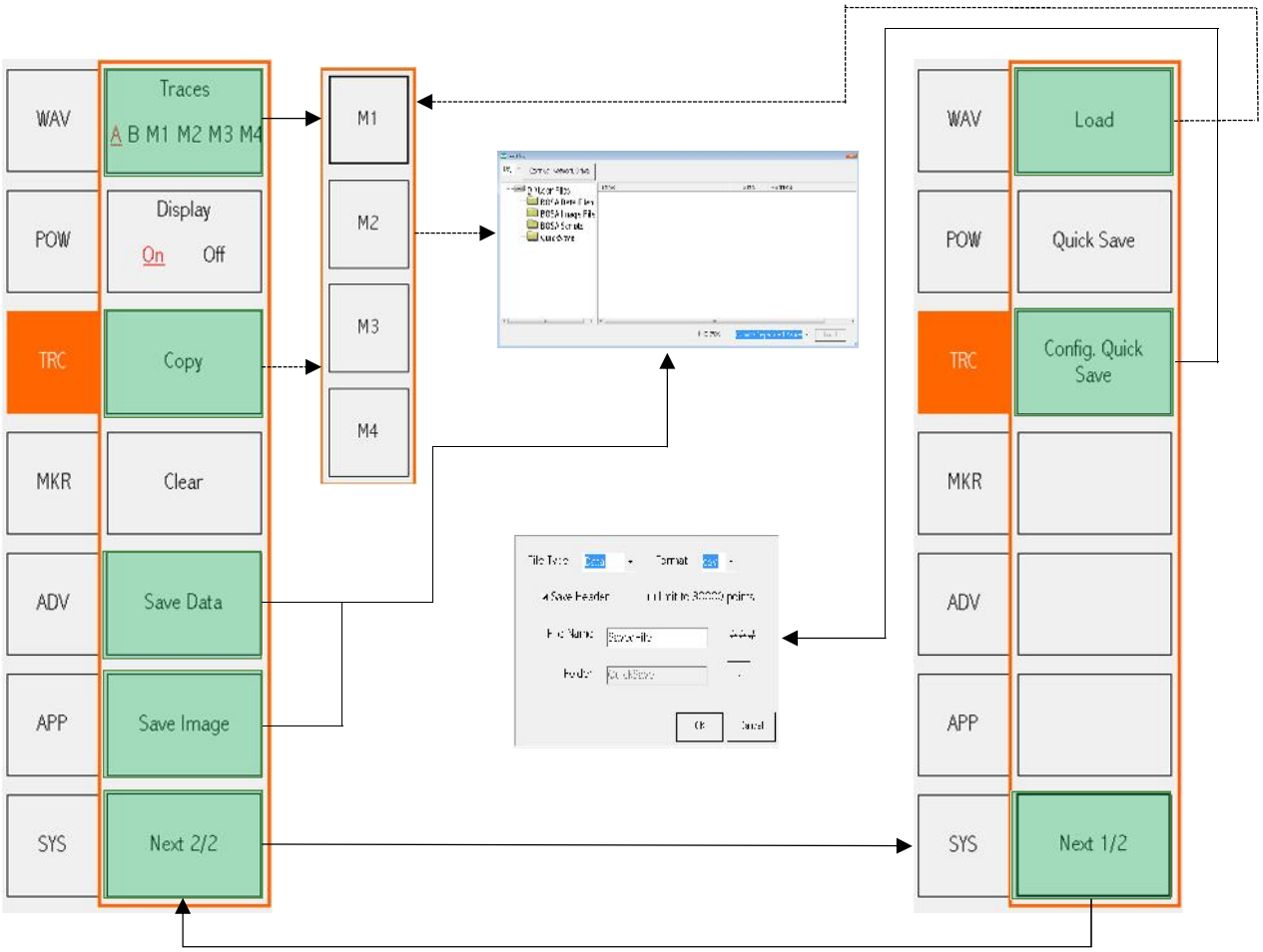
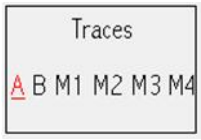
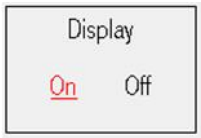


Fig. 3.9 BOSA *Traces* button bar tree diagram.

Traces submenu

The spectra of the current measured SUT will be displayed in yellow.

	Changes the active trace among the measured traces, A and B, and the stored memories, M1 M2 M3 M4 when used. The application reserves the trace A and B for the polarization
	Enables or disables the display of the current memory trace.
	Performs a copy of the active trace A or B to the trace selected through the displayed menu.
	Loads a data file, previously saved by the user (in local or external disc), in the trace selected through the displayed menu.
	Clears the active trace.
	Opens a new windows form to save the active trace. Available formats are: .bdf, .txt, csv. More information in section 3.2.4.
	Opens a new windows form to save the image displayed in the measurement area. Available formats are jpeg, bitmap, gif or tiff image formats.
	Performs a Quick Save operation in one click in the conditions set in Config. Quick Save button.
	Displays a dialog box to set the way in which the Quick Save operation is performed: File type, format, name, folder.

3.1.1.2.4. Markers button

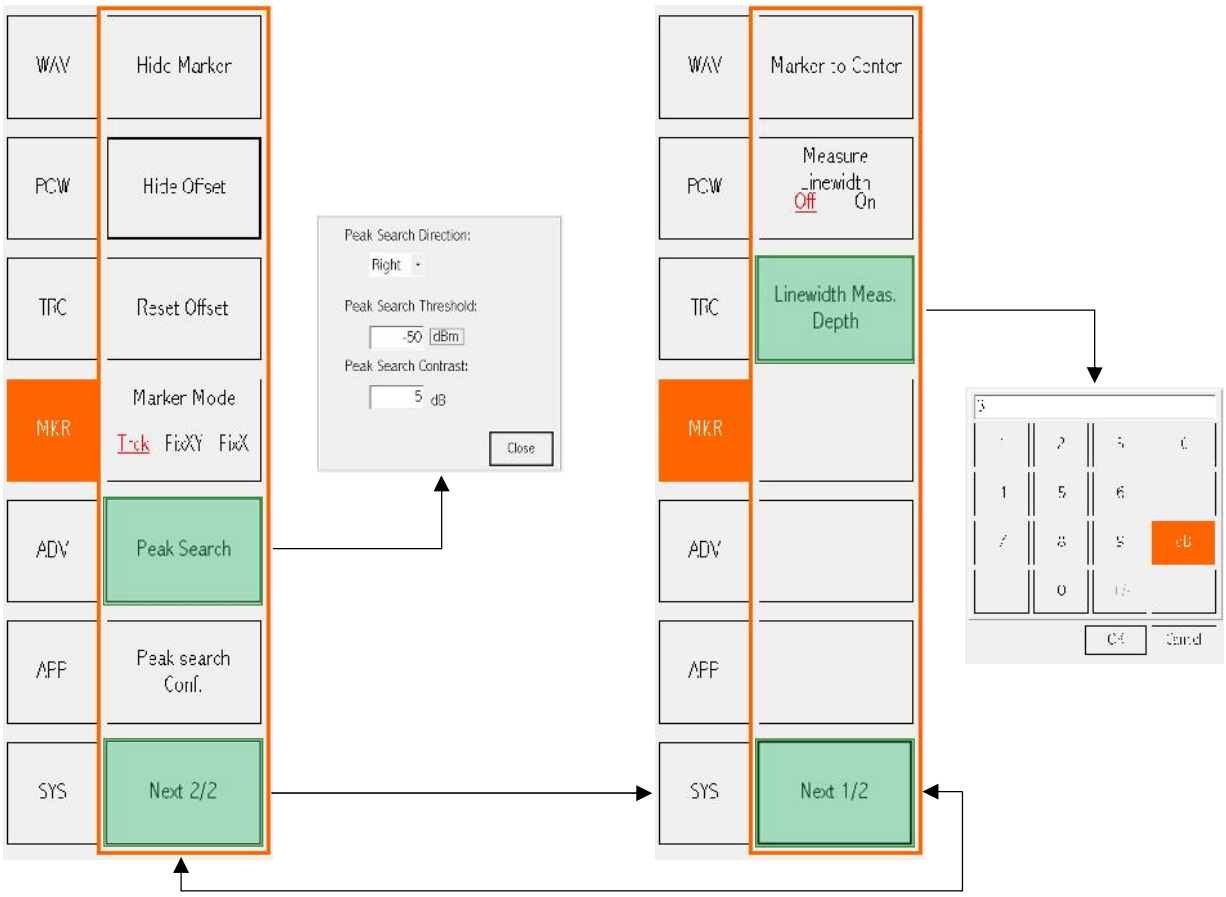
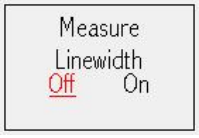
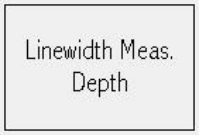


Fig. 3.10 BOSA *Markers* button bar tree diagram.

Markers submenu

One marker and its offset can be placed on any of the two traces.

	Shows or hides a marker on the active trace. It is represented on the chart with a cross. Automatically the data appears on the data section on top of chart.
	Shows or hides the offset of a marker. It is represented on the chart with a square. Data appears on the data section on top of chart together with marker-offset information.
	Sets the offset to cero and the square is placed at the same position of the marker
	This is an *option button*. Three options are allowed: o Trck: the marker tracks the peak. o *Fix XY*: the marker is fixed in the screen. o *Fix X*: marker is fixed in X axis and updates Y value.
	Moves the active marker to the next peak. The criteria of peak searching are defined through *Peak Search Configuration* button.
	Opens a new window that allows user to configure the peak searching criteria. Detailed description available at 3.3.1.4.
	Moves the center of the screen to the position of the active marker.
	This is an *option button.* When ON, the linewidth of the peak selected with the marker is displayed above the measurement area after a "LW XdB:" label, where X is the value configured with the "linewidth measurement depth" window.
	Opens a new window that allows configuration of the depth level at which linewidth value is calculated.

3.1.1.2.5. Advanced button

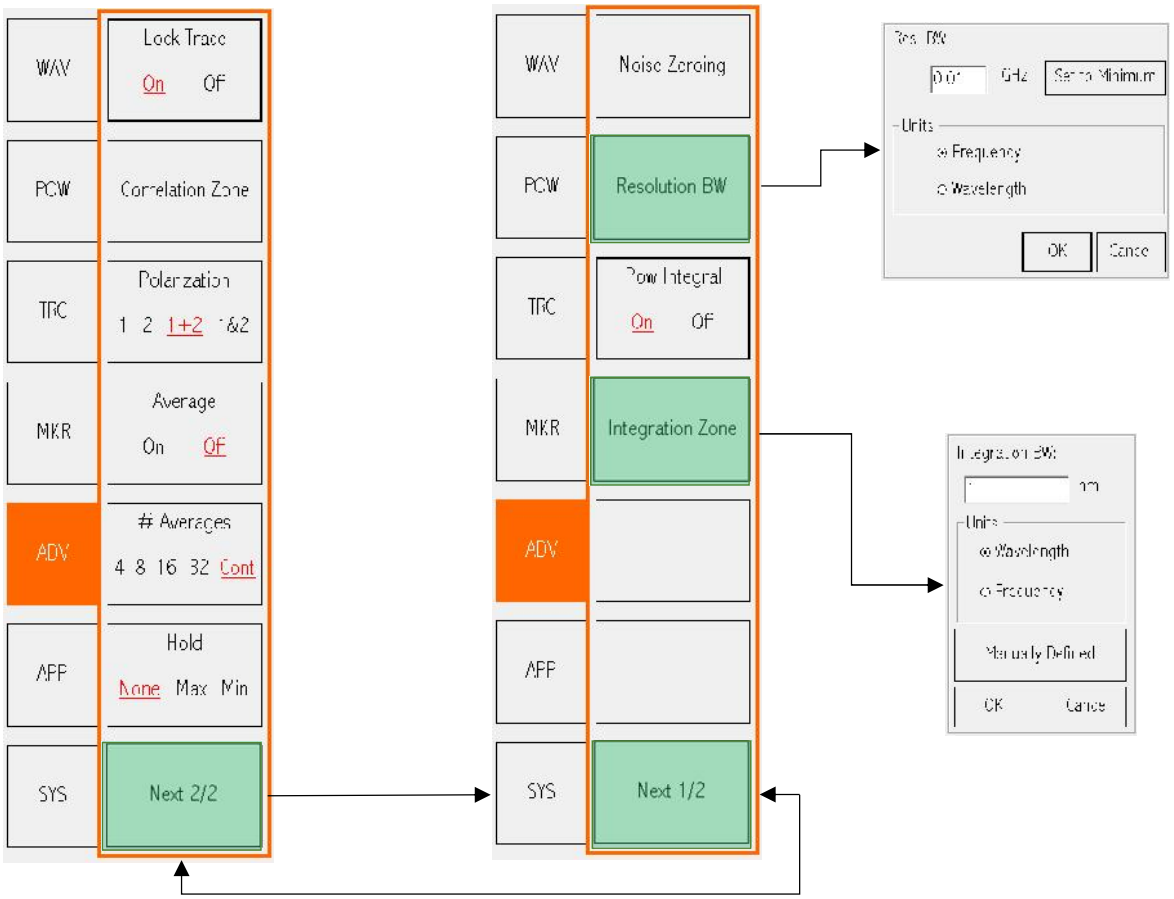
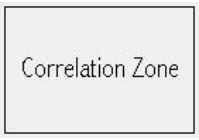
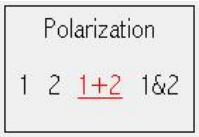
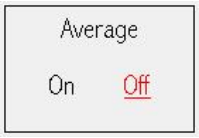
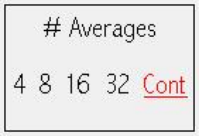
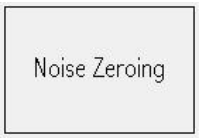
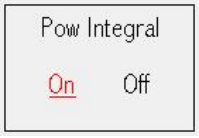


Fig. 3.11 BOSA *Advanced* button bar tree diagram.

Advanced submenu

	This is an *option button*. It provides a procedure to avoid trace fading when averaging. This is done defining a *correlation zone*.
	This button changes the mouse mode to "click and drag" mode. By clicking the measurement area, the center of the correlation zone is defined.
	This is an *option button*. 1, 2 or 1&2 show the two orthogonal polarization measurements separately or together. 1+2 provides highest power accuracy.
	This is an *option button*. It performs trace averaging for noise reduction purposes.
	This is an *option button*. Five averaging modes are available: 4, 8, 16, 32 traces averaging and continuous averaging.
	Takes an instantaneous update of the noise floor pattern measurement performing a noise correction in the current measurement.
	This is an option button. It compares consecutive sweeps and shows the maximum or minimum for each point of the trace.
	Only for representation purposes the video bandwidth resolution of the measurement can be changed. Note that the optical resolution of the unit is not changed.
	This is an option button. It integrates the optical power of the active trace under a spectral region defined as integration zone.
	Refers to the spectral region where the Total Power function is performed. This zone is selected manually after drag operation with the mouse, or typing the desired value.

3.1.1.2.6. Applications button

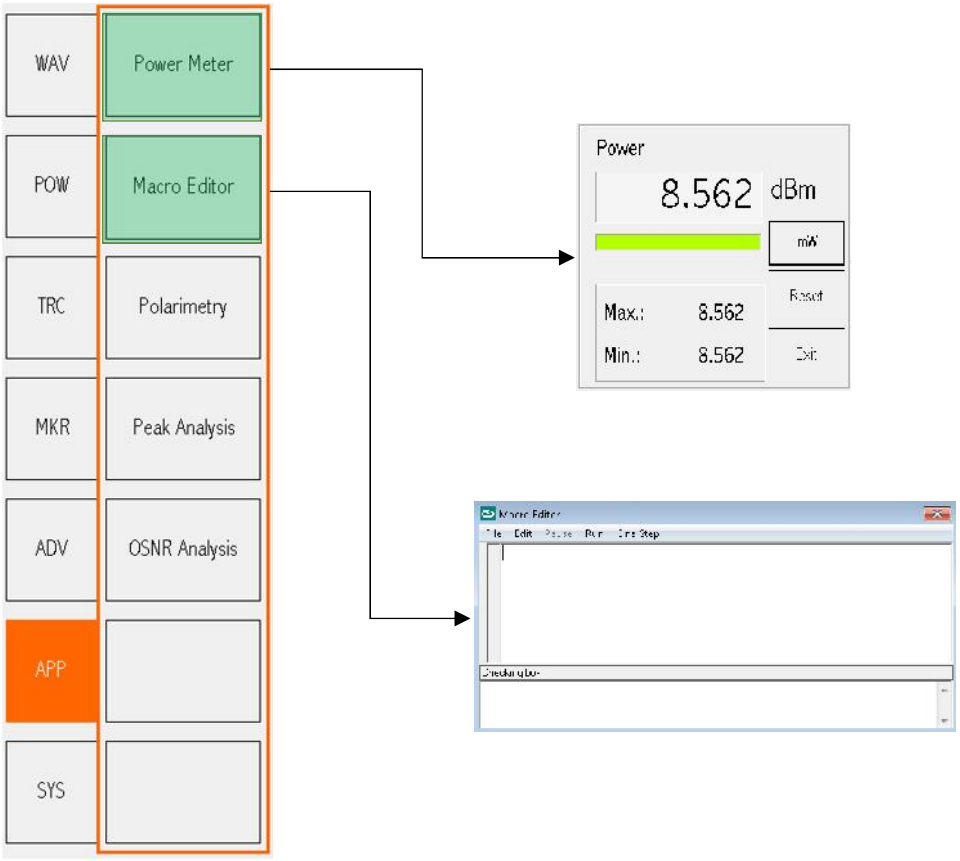
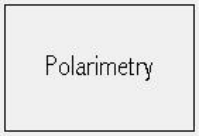


Fig. 3.12 BOSA *Applications* button bar tree diagram.

Applications submenu

	Displays the *power meter* application which measures the optical power value of the SUT. Only available while RUN/STOP button displays "RUN" (BOSA stopped).
	This application allows the user to perform automatic measurements and procedures in the BOSA. Moreover, the unit can control other external devices through GPIB protocol. Please, refer to section 8.1 of this guide and "BOSA Programming Guide" for more details.
	Only in BOSA option X30. This applications allows the user to perform polarimetry measurements. For more details go to section 6.
	Displays the Peak Analysis application for the identification and analysis of multiple peaks in the active measurement. Detail description in section 3.3.1.
	Displays the OSNR Analysis application for the signal characterization. Detail description and information in section 3.3.2.

3.1.1.2.7. System button

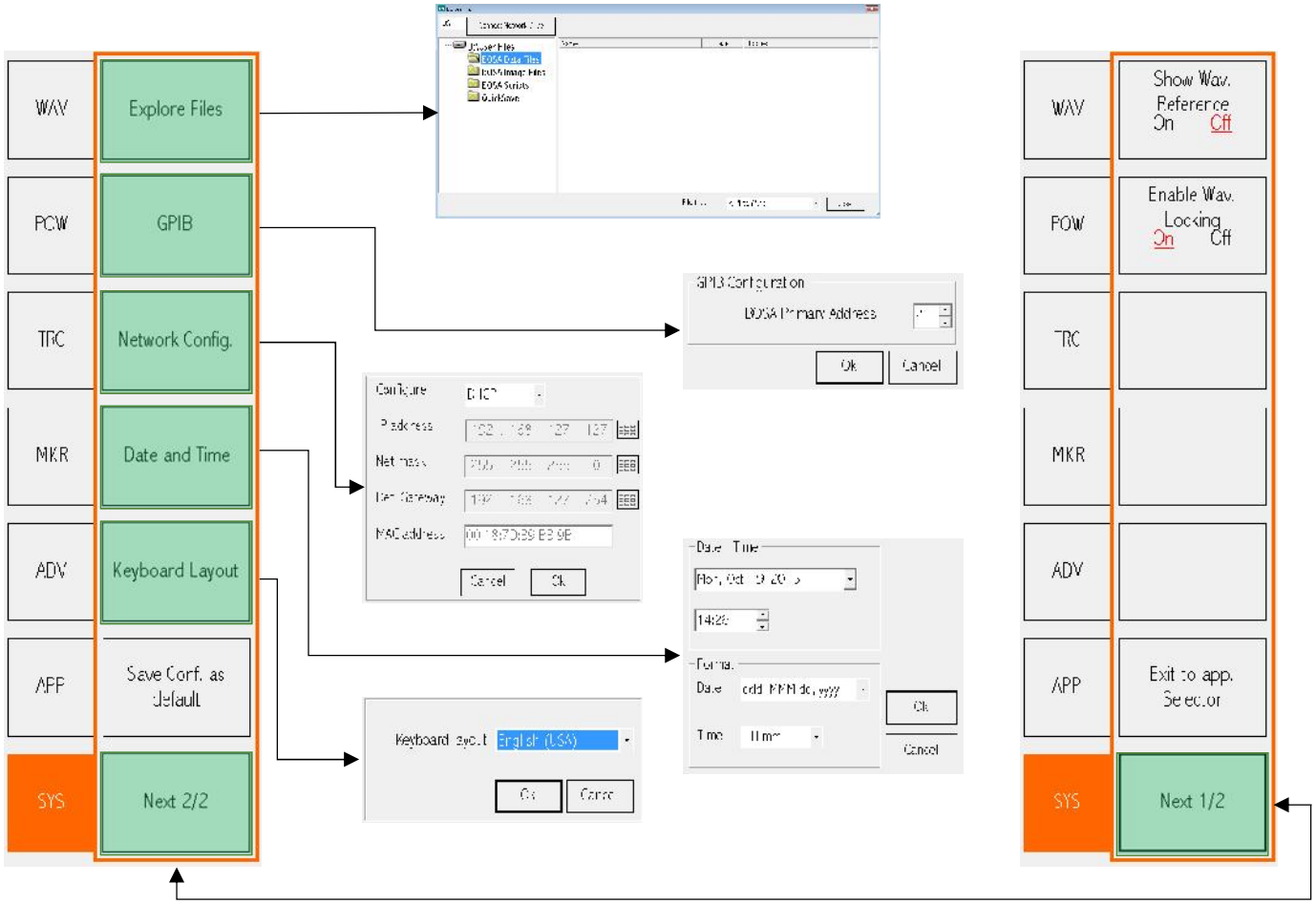
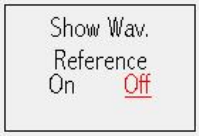
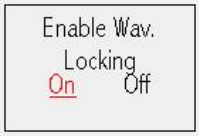


Fig. 3.13 BOSA *System* button bar tree diagram.

System submenu

	Manages the user files. Allows user to delete files, create new folders, rename files or move them to USB stick. It also allows to connect to a network drive (see section XXX)
	Saves the current measurement configuration (X axis, Y axis) to be set up the next time the BOSA is started.
	Displays a dialog box to configure the network allowing remote access to the BOSA.
	Pops up a dialog box to configure the GPIB properties.
	Shows data and time information.
	Allows the user to select the keyboard layout.
	Displays the absorption spectrum of the internal gas cell. See Appendix I for details.
	Enables continuous wavelength correction based on the internal gas cell. For small spans, less than absorption lines separation, this function may not work properly. See Appendix I for details.
	Exits to the application selector screen.

3.1.1.3 The Context Menu

The *Context Menu* appears when right-clicking on the graphical representation area, and comprises some important user keys related to the representation itself and is only accessible when using an external mouse.

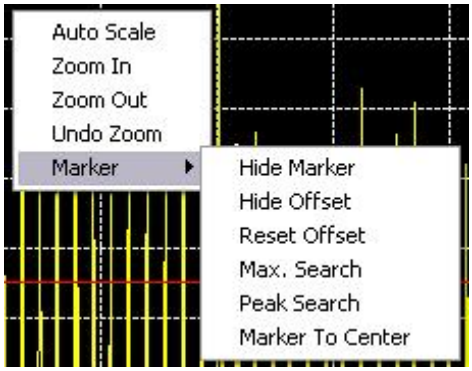


Fig. 3.14 BOSA *Context Menu.*

Context menu description

The context menu contains interface keys related to the graphical representation itself.

Auto Scale	Performs an auto scale operation in the vertical axis of the chart
Zoom In	Enables the zoom mode to perform a zoom-in operation
Zoom Out	Performs a zoom-out operation on the chart
Undo Zoom	Retrieves the previous axis configuration on the chart
Marker-> Show Marker	Shows or hides a marker on the active trace
Marker-> Show Offset	Shows a marker offset to obtain relative measurements
Marker-> Reset Offset	Sets the offset to cero and moves the square symbol of the offset to the marker position
Marker-> Max Search	Moves the marker to the maximum value of the display data
Marker-> Peak Search	Moves the marker to the position of the next peak
Marker-> Marker to Center	Changes the horizontal axis configuration to set the marker in the center of the representation area

3.1.1.4 Interface shortcuts

Some of the configuration parameters can be easily changed through the active zones of the graphical interface. By double clicking in these zones, marked in Fig.4.14, the application opens the corresponding menu to set the value of the related parameter.

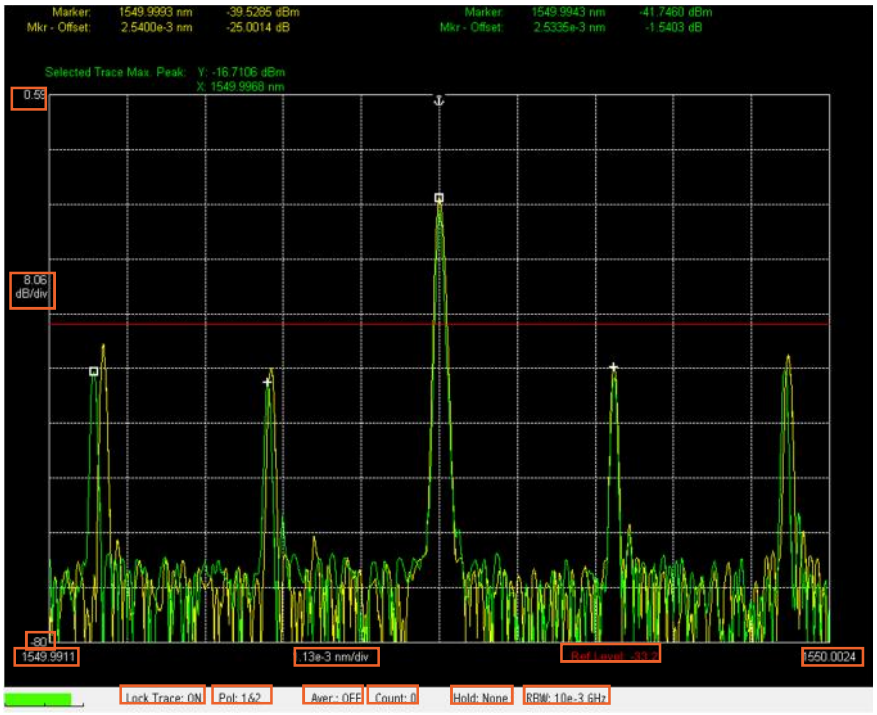


Fig. 3.15 BOSA Graphical Interface shortcuts.

3.2 Taking measurements

3.2.1 Hooking Up the Signal Under Test (SUT)

Using a single mode fiber optic patchcord, connect the signal under test to the optical front panel input connector, identified as *SUT IN*. Make sure that the connectors are clean and undamaged. In the *operation parameters area* a bar indicates the optical power level of the SUT.

If the power level of the SUT is higher than +13 dBm the power meter will be saturated. On the contrary, if the power level of the SUT is too low the label *SUT signal input loss* appears close to the power bar.

Check the connector type for SUT before connecting it. Unless requested otherwise, the input connector type of the BOSA is FC/APC.

Fig. 3.16 SUT Power Meter.

3.2.2 Viewing the SUT Trace

Prepare the instrument to make measurements as explained in section 2 "Setting up the BOSA". Measurements require to press the Run button placed on the top right corner to start.

If the optical spectrum is not viewed set the start and stop wavelength accordingly in the wavelength tab.

NOTE: *Noise Zeroing* in the *Advanced sub*menu is a function that allows user to update instantly the noise pattern. In the next sweep a new noise background will be taken improving the noise pattern.

NOTE*:* The current measurement can be stopped at any time by pressing the *OFF* button, which is located at the right top corner of the screen. Later, the measurement can be continued by pressing the *ON* button.

3.2.3 Making measurements with Averaging function

It is possible to reduce the noise in the spectrum using the *Averaging* function.

1. Select the *Advanced* submenu.
2. Choose the average count (4, 8, 16, 32 or Continuous) pressing *#Averages* button.
3. Activate the average process pressing *Average* button.

It is possible to see some trace fading when averaging. In this case, it is recommendable to lock the trace before averaging. There are two options.

Option 1:

1. Select the *Advanced* submenu.
2. Set Lock Trace button On. The main visible peak is locked and this will avoid trace fading when averaging.
3. *Choose the average count (4, 8, 16, 32 or Continuous) pressing #Averages button.*
4. Activate the average process pressing *Average* button.

Option 2:

1. *Select the* Advanced *submenu.*
2. Press the *Correlation Zone* button. This option allows the user to select the region to be locked through a click and drag operation.
3. Set Lock trace button On.
4. Choose the average count to make (4, 8, 16, 32 or *Continuous*).
5. Activate the average process pressing *Average* button

This option is recommendable when you wish to get definitive results.

3.2.4 Saving and loading measurements

3.2.4.1 Save

1. Select *Traces submenu and press Save button*.
2. Select *Save Data or Image button*.
3. Choose the format you wish to use for saving the measurement.
4. Enter a filename and choose the destination for the saved measurement.
5. Press *OK* button.

Save data:

Opens a new windows form to save the active trace. Available formats are:

- .bdf : it is the BOSA Data File format (binary format). Only a BOSA can open this type of file.
- .txt: it is a text file witch can be opened by any text editor.
- .csv: comma separated values file. Wavelength and power values are saved in each row separated by a comma.

The total number of points in the current view will be saved. Note that some widely used applications present limitations on the number of points to be managed. A downsampling to 44000 points can be set in the Save window.

Save image:

Opens a new windows form to save the image displayed in the *measurement area.* Available formats are jpeg, bitmap, gif or tiff image formats. Please take into account that jpeg format will not preserve the level of quality displayed in the screen.

3.2.4.2 Quick save

Before performing a quick save, it is possible to configure it.

1. *Select Traces submenu.*
2. Select the *Configure Quick Save* option.
3. Select the *File Type and Format.*
4. Write the *File name.*
5. Select the *Folder.*
6. Press *OK* button.

To perform a Quick Save, proceed as below:

1. *Select* Traces *submenu.*
2. Select the *Quick Save* option.

The measurement is automatically saved with the configuration defined in *Configure Quick Save*.

3.2.4.3 Load

In order to load data, follow the next steps:

1. Select *Traces* in the main button bar.
2. Select the *Load* option.
3. Select the drive.
4. Select the file you wish to load and press *OK* button.

3.3 Applications

3.3.1 Peak Analysis

The peak analysis application provides fast and dynamic measurement of multiple peaks in a live signal. Based on the threshold level set by the user, the system locates all the peaks in the span and displays their information.

3.3.1.1 Interface Description

The application presents all the identified peaks by setting individual markers in all of them. In the right side of the display, all the information is sorted and presented in a table according to the units set by the user.

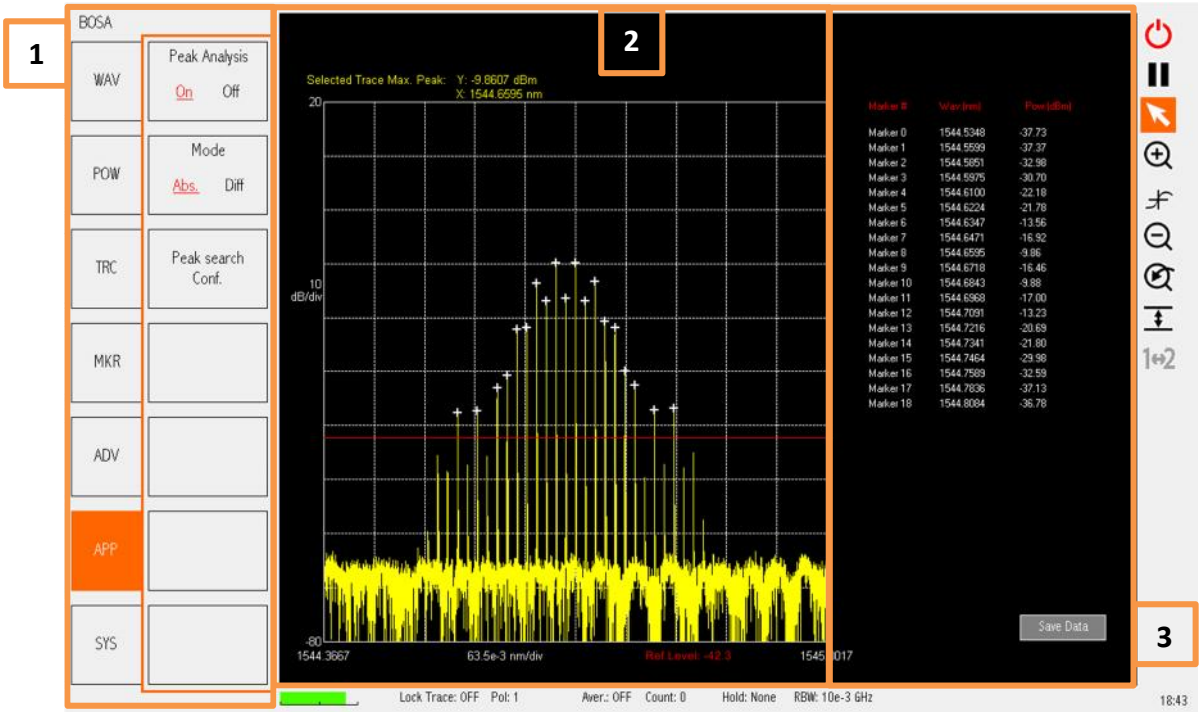
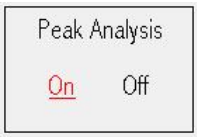


Fig. 3.16 Peak Analysis application graphical user interface.

3.3.1.2 GUI Area Description

1	Specific buttons for the peak analysis application are located here. See below interface keys description for more details.
2	Spectrum measurement area. All the identified peaks will be marked in this area based on the threshold level set by the user. All BOSA tabs and functionalities can be used to set the most suitable spectrum measurement for peak analysis.
3	Data display area. It presents all the information of each of the detected peaks according to the selected mode and units.

3.3.1.3 *Interface Keys description*

	Activate or deactivate the Peak Analysis application.
	Switch between the two modes for the peak analysis. The "*Abs.*" mode shows the absolute value for the parameters, while the "Diff" mode shows the values relative to a spectral component defined by the marker.
	It is used to define the configuration parameters for the peak identification.

3.3.1.4 *Peak Search Configuration*

In order to change the threshold level for the peak identification the user has two options. The first one is to manually change the reference level by dragging the red line with the mouse in the arrow cursor mode. The second option is to manually set the level by clicking in the "*Peak Search Conf*" menu and type the desired level in the emerged menu. In this menu the user can also define the contrast level for the peak identification.

3.3.1.5 *Display Mode*

The application also compares the power and wavelength/frequency with respect to any desired point of the spectrum. For that purpose, the user can place the marker in any point of the spectra, including any of the already identified peaks, and select the "*Differential Mode*". In this mode the table shows the absolute information of the marked point in the spectra, and its difference with each of the identified peaks.

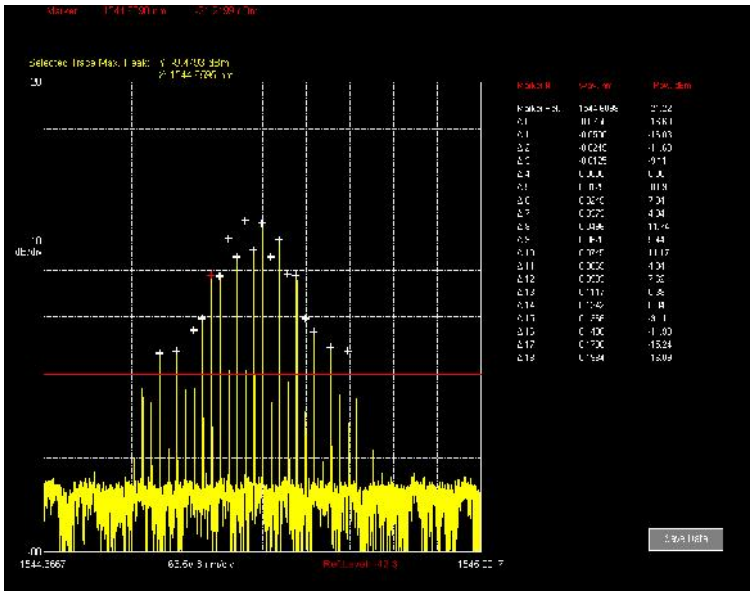


Fig. 3.17 Peak Analysis graphical user interface in differential mode.

3.3.1.6 Save and Export

All the displayed information in the table can be saved at any time by clicking the "Save Data" in the lower part of the data display area. Data can be saved in both modes along with an optional header with all the measurement configuration parameters.

3.3.2 OSNR Analysis

The OSNR analysis application evaluates the value of the Optical Signal-to-Noise ratio of the signal under test. The application measures the signal power and, based on the user defined parameters, interpolates the value of the noise to display the value of the OSNR according to the IEC 61280-2-9:2009 standard.

3.3.2.1 Interface Description

The application presents an advanced marker mode that allows the visualization of the different configuration parameters. In the top right side of the display, the final value of the OSNR is displayed according to all the set parameters. In the extended info mode the displays shows also the value of the signal and the interpolated noise power.

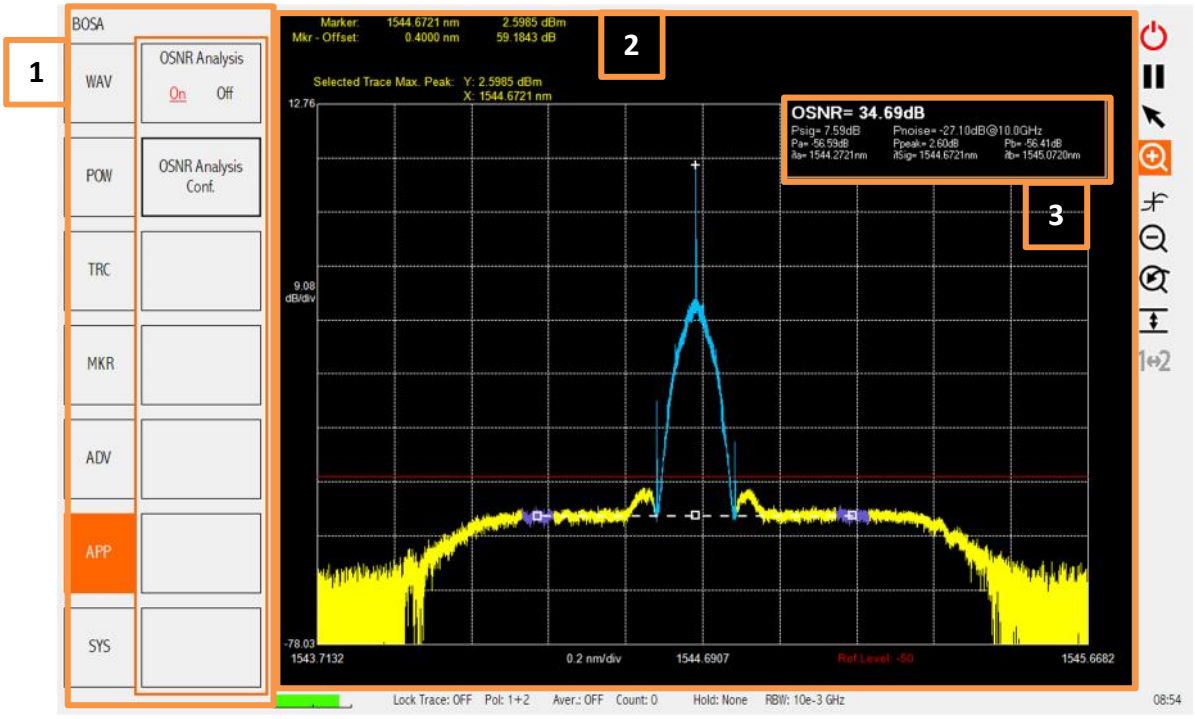


Fig. 3.18 OSNR Analysis application graphical user interface.

3.3.2.2 *GUI Area Description*

1	Specific buttons for the OSNR analysis application are located here. See below interface keys description for more details.
2	Spectrum measurement area. All BOSA tabs and functionalities can be used to set the most suitable spectrum measurement for the OSNR analysis.
3	Data display area. It presents all the information of the measured components and displays the final OSNR value.

3.3.2.3 *Interface Key Description*

OSNR Analysis On Off	Activates or deactivates the OSNR Analysis application.
OSNR Analysis Conf.	Shows the OSNR configuration menu where the user can set the different parameters for the measurement.

3.3.2.4 OSNR Configuration Parameters

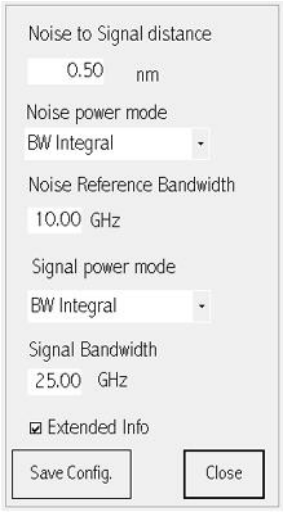


Fig. 3.19 OSNR Configuration menu.

3.3.2.4.1. Noise to Signal distance

This value set the measuring point for the noise value. By placing this point in the out-of-channel area the user ensures that the measured power corresponds to noise only.

3.3.2.4.2. Noise power mode

This option defines how the noise power is measured, either peak power mode, where the value of the noise is measured through the value at a single point, or the bandwidth integral mode, where the value of the noise is measured through the average value in the region defined by the noise reference bandwidth, plotted in purple.

3.3.2.4.3. Noise reference bandwidth

It defines the spectral region for the noise average when the noise power is set to bandwidth integral. Provides better stability than the peak power mode.

3.3.2.4.4. Signal power mode

This option defines how the signal power is measured, either peak power mode, where the value of the signal is measured through the value at one point, or the bandwidth integral mode, where the value of the signal is the integrated value in the region defined by the signal reference bandwidth, plotted in light blue.

3.3.2.4.5. Signal Bandwidth

It defines the spectral region for the signal when the signal power is set to bandwidth integral. This value provides more accurate OSNR values as it considers the whole signal power instead of the peak power of the signal.

3.3.2.5 OSNR Extended Info

In the Extended Info mode the user can find the following information:

- **P_{sig}**: Power of the signal based on the central position of the marker and the signal power mode.
- **P_{noise}**: Power of the noise interpolated in the central position of the marker and measured with a 10GHz reference bandwidth as stated in the IEC standard.
- **P_a and P_b**: Power of the noise value measured in the two spectral region λ_a and λ_b.
- **P_{peak}**: Peak value of the signal defined by the marker position.
- $^a_{sig}$: Spectral position of the center of the signal defined by the marker.
- ^a_a **and** ^a_b.: Spectral position of the measured values for the noise. It is set by the noise to signal distance.

4 Tunable laser source (option X10)

4.1 Description

The BOSA option X10 allows the user to access the internal tunable laser and use it as a standalone laser. The optical output connector is located in the front panel. There is a green LED placed close to the optical connector which is lit any time there is optical power being output.

Invisible laser radiation. Do not view directly with optical instruments. Class 1 laser product. Refer to section 0.3 for specific considerations.

4.2 Graphical User Interface

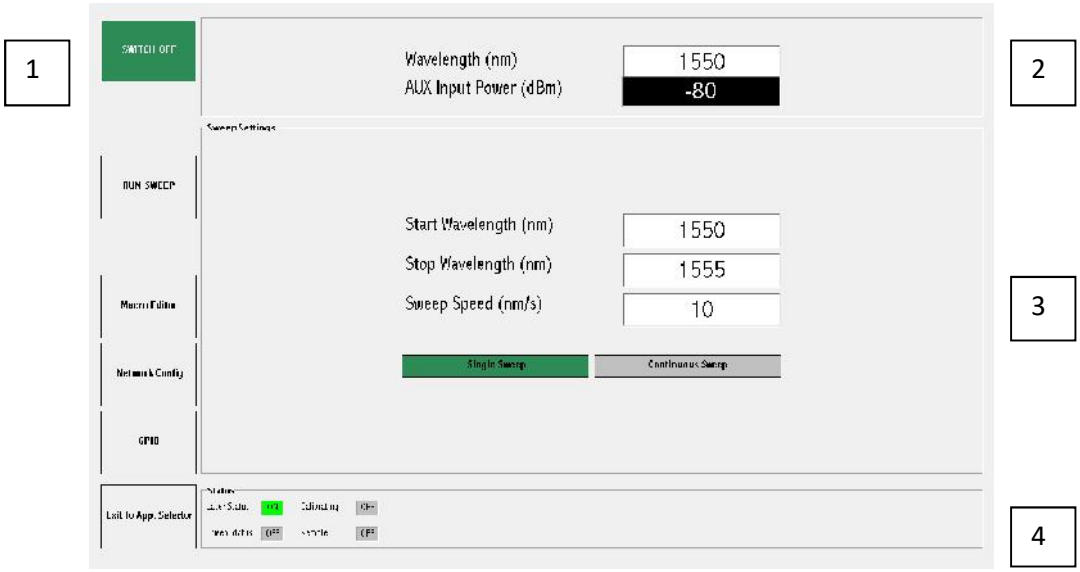


Fig. 4.1 TLS application interface.

1. General configuration

- SWICTH ON/OFF: the laser is switched on and off. The laser needs to be switch on before any other parameter is available.

- RUN SWEEP: the laser perform a sweep under the conditions configured in the “Sweep Settings” box.
- MACRO EDITOR: shows the macro editor tool to perform automatic measurements and procedures with the TLS (section 8)
- NETWORK CONFIG: a dialog box is displayed in order to configure an Ethernet remote communication.
- GPIB: a dialog box is displayed in order to configure a remote GPIB communication.

2. Static laser configuration
   - WAVELENGTH: current laser wavelength in nm.
   - AUX INPUT POWER: current optical input power in of the Aux Input in dBm.
3. Dynamic laser configuration
   - START WAVELENGTH: starting wavelength for the sweep in nm.
   - STOP WAVELENGTH: stopping wavelength for the sweep in nm.
   - SWEEP SPEED: speed for the sweep.
   - SINGLE/CONTINUOUS SWEEP: *single sweep* performs just one scan while *continuous sweep* maintain the laser sweeping until the user stops it.
4. Status Area. Actual status of the laser is indicated here as well as any error in the configuration parameters.

4.3 Remote Control

See section 8.

5 Component analyzer (option X20)

5.1 Description

With option X20 the Insertion and Return Loss of optical passive devices can be measured. The interface can display the maximum and minimum transmission values across the required spectral width. It can also show the Polarization Dependent Loss for both IL and RL (Option X30).

5.2 Graphical User Interface

The Component Analyzer application, accessible from the App selector, uses a very similar graphical user interface as the BOSA application. In this section the specific functions of the Component Analyzer mode of those whose behavior is different to BOSA mode are described. For the rest of the functions please refer to section 3.1.

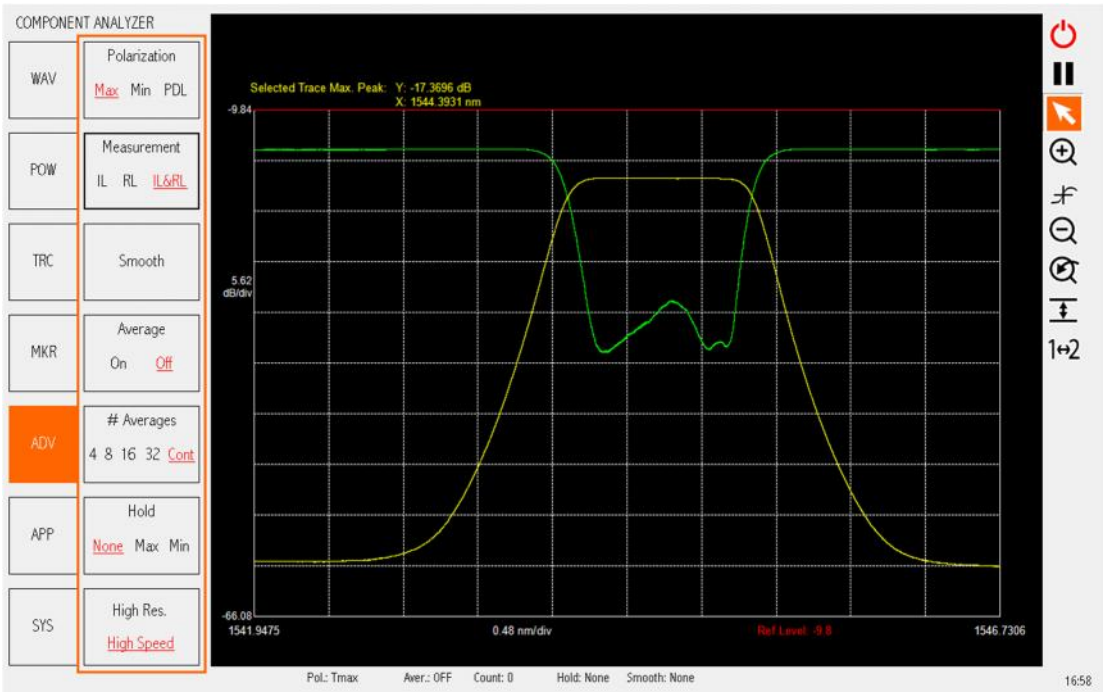
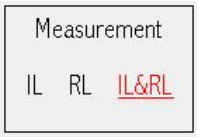


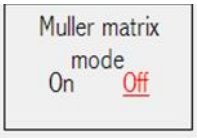
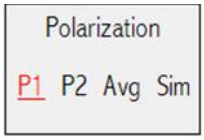
Fig. 5.1. Component analyzer graphical User Interface.

5.2.1 Interface Keys description

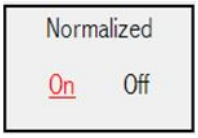
5.2.1.1 Advanced submenu

	This is an *option button*. It allows the user to switch between Insertion Loss and Return Loss measurement.
	Refers to the maximum and minimum transmission of the device for a polarized input. The ratio between both values is the PDL that can be represented directly.
	Performs a moving average on the active trace. The width of the average is set in a dialog box.
	Switches between measurement modes prioritizing the speed or the resolution.

5.2.1.2 System submenu (next 2/2)

	This is an *option button*. It allows the user to disable the standard Polarization (in Advanced submenu) measurement. Then the following Polarization button is displayed:
	This is an *option button*. P1 or P2 doesn´t change the polarization state, so measurements is faster. If PDL is not required we recommend P1 measurement (after having deselected the Muller Matrix mode). Average or Simultaneous P1 and P2 can be also performed.

5.2.1.3 Power submenu

	This is an *option button*. It allows the user to normalize the losses from 0dB.

5.3 Taking Measurements

5.3.1 Hooking up the Device Under Test (DUT)

Using a single mode fiber, connect an optical patchcord from the AUX Output port on the front panel of the BOSA to the input fiber of the device under test. Connect then the output fiber of the device under test to the AUX Input port on the front panel of the BOSA. Now the BOSA is ready to start measuring the DUT.

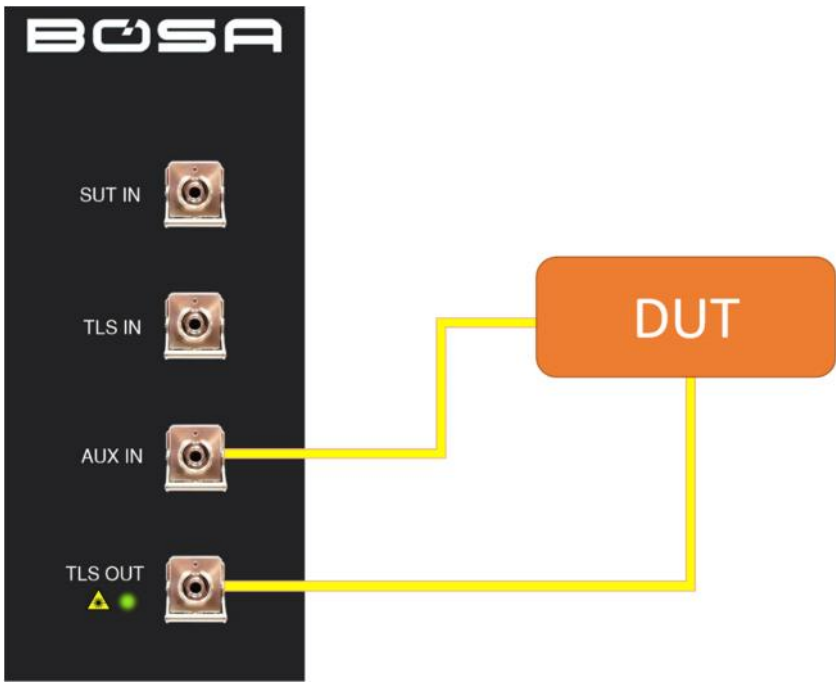


Fig. 5.2. Diagram of the connections for the component analyzer measurement.

Check the connector type for DUT before connect it.

Invisible laser radiation. Do not view directly with optical instruments. Class 1 laser product. Refer to section 0.3 for specific considerations.

6 Spectral polarimetry (option X30)

6.1 Description

With option X30 the spectrally-resolved state of polarization (SOP) can be measured. Markers can be used to measure polarization differences between different light sources or different spectral components. Polarization changes under different testing conditions can also be checked.

6.2 Graphical User Interface

The polarimetry extension can be found in the *Applications* tab of the BOSA. An overview of the GUI is shown.

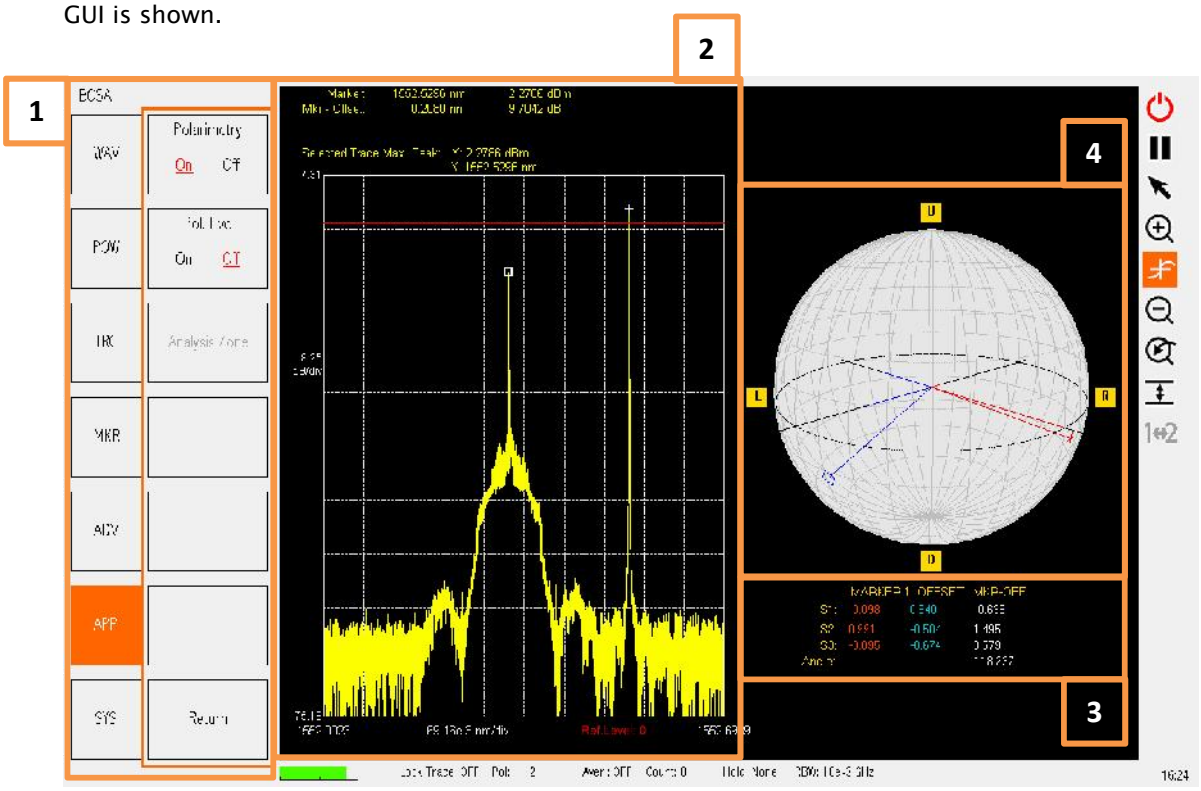
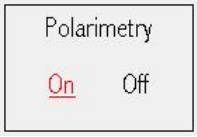
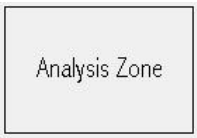


Fig. 6.1 Polarimetry Extension graphical user interface.

6.2.1 GUI Area Description

1	Specific buttons for the polarimetry extension are located here. See interface keys description for more details. All the other buttons and tabs of the BOSA user interface are still accessible even if the polarimetry option is activated.
2	Spectrum measurement area. Polarimetry measurements will be performed over the optical spectrum shown here. All BOSA tabs and functionalities can be used to set the most suitable spectrum measurement for polarization analysis.
3	Data display area. Cartesian values for the SOP in the Poincare Sphere are shown here.
4	SOP representation. The Poincare sphere is used to represent the measured SOP of the point selected with the marker. The sphere is normalized.

6.2.2 Interface Keys description

	Activate or deactivate the polarization analysis function.
	Activate or deactivate the polarization evolution analysis. When this function is activated it is possible to define a spectral region in which the SOP is continuously measured. The SOP measured of the all spectral components inside the defined region is simultaneously plotted over the Poincare sphere.
	It is used to define the spectral region in which the SOP is measured.

6.1 How to perform measurements

6.1.1 Polarization measurement using markers

The SOP of a selected spectral component is measured using markers. The measured polarization corresponding to the marker and the offset marker positions are plotted in the Poincare Sphere as a vector pointing to certain position in the sphere surface. The polarization difference angle between marker and offset is also displayed.

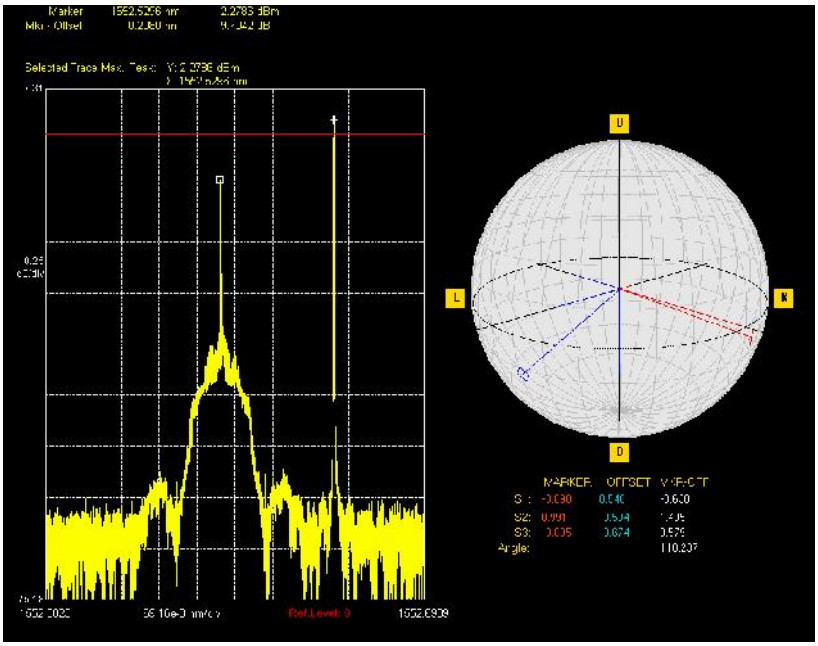


Fig. 6.2. Polarization interface using markers.

6.1.2 Polarization evolution measurement

It is possible to measure the continuous polarization evolution over a certain spectral region. To do that it is necessary to activate the Pol. Evo. Option in the polarization tab and define an analysis region. A solid violet bar appears at the bottom of the spectral measurement indicating the measured region.

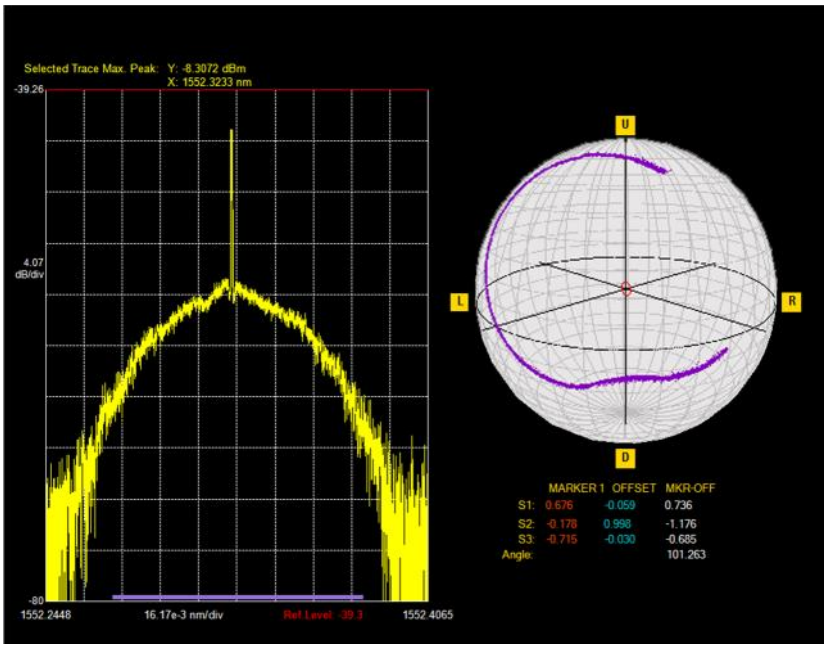


Fig. 6.3. Polarization interface using polarization evolution.

The set of SOP measurements are simultaneously plotted in the Poincare Sphere so the polarization evolution across the defined spectral region is displayed.

7 Complex spectrum analyzer (option X40)

7.1 Description

With option X40, the Complex Spectrum of the signal under test can be measured. By performing an IFFT, the application recovers the temporal trace. Based on this reconstruction the interface can plot the temporal and frequency data in four different modes: Oscilloscope, Eye Diagram, Constellation and Complex OSA.

7.2 Graphical User Interface

In this chapter, the user interface of the BOSA Phase is presented. First, all menu options and user keys are summarized. Next, a brief description of each feature is made for the ease of understanding.

The interface is composed by two main areas, as shown in Figure 8.1. These are: *Button Bar* and *Measurement Area*. The measurement area includes the measurement representation, context menu, current measurement settings and markers information.

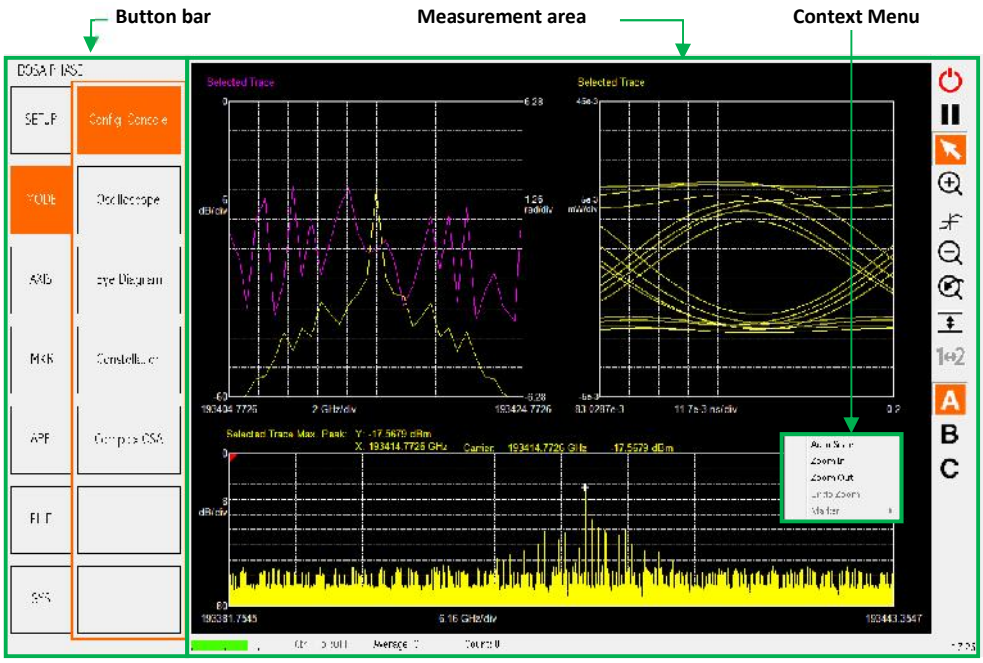


Fig. 7.1 BOSA Phase graphical user interface.

7.2.1 Measurement area description

The measurement area contains the measurement charts and information about the measurement conditions.

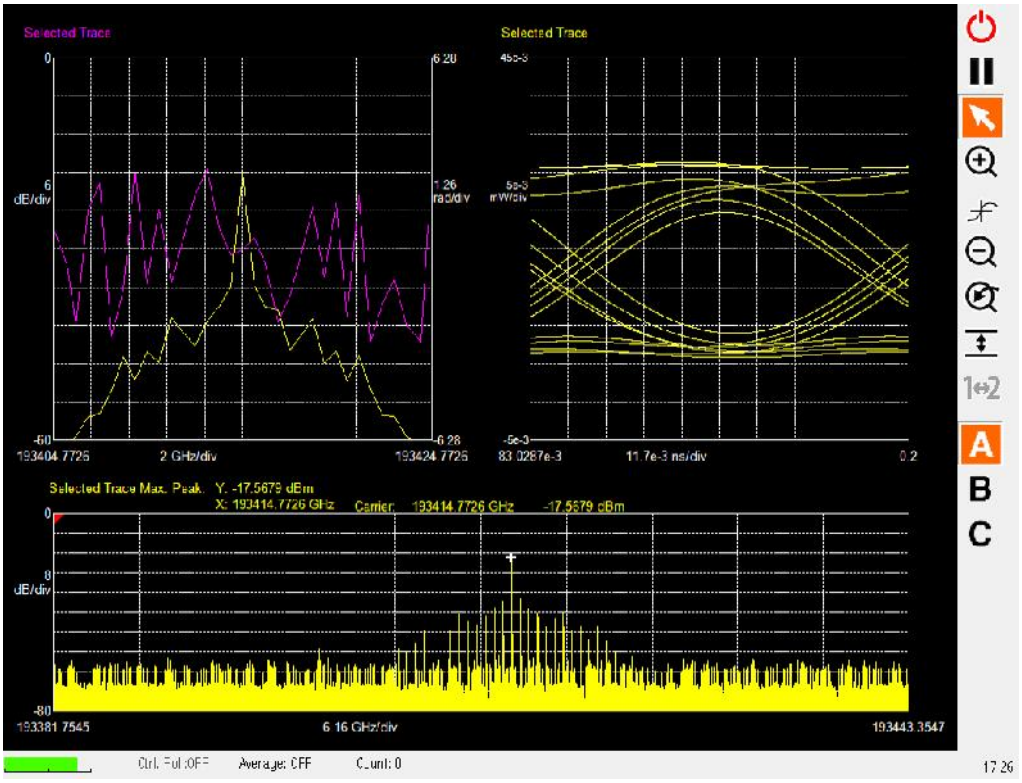


Fig. 7.2 BOSA Phase Measurement area description.

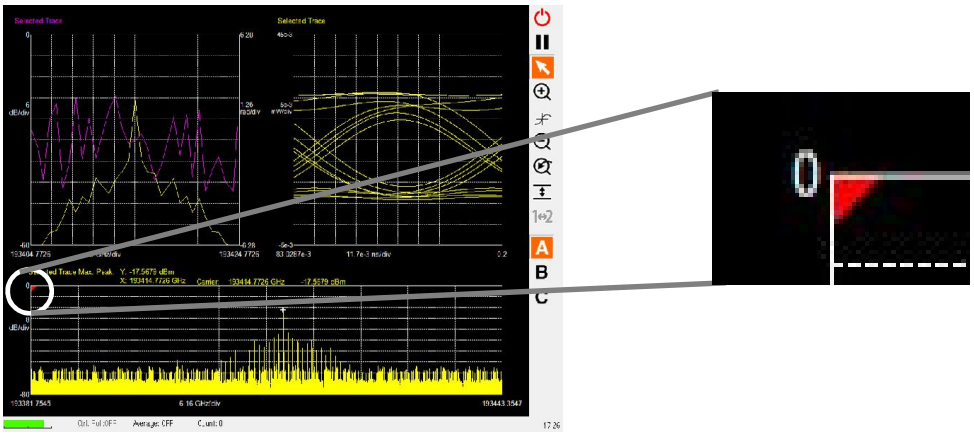


Fig. 7.3 BOSA Phase Active chart identification.

The bottom area is used to display general measurement conditions, system warnings and a visual indicator for the optical power of the signal under test:

In addition a quick function button bar is placed at the right of the *measurement area* which allows the user to perform common actions in an easy way.

	Selects the active chart.
	Sets the zoom-in mode. The representation area on a chart can be amplified by a click and drag operation.
	Places a marker on the trace. It is also used to select the carrier in the chart A.
	Extends the wavelength representation range by a factor of two.
	Undoes up to three zooming actions.
	Fits the vertical axis to the displayed data.
	Switches between active traces in the active chart.
	Sets the A chart as the active chart.
	Sets the B chart as the active chart.
	Sets the C chart as the active chart.
	Freezes the current measurement on the screen. The unit is fully working in second plane but the data is not displayed.
	Allows the user to start or stop the current measurement at any time. Although stopped, the configuration parameters of the unit can be modified; if the measurement is later initialized, the new parameter values will be used.

7.2.2 The Button bar

The *Button Bar* encompasses non specific function keys. The following figures show the button bar tree diagram of the BOSA Phase.

7.2.2.1 Set Up Button

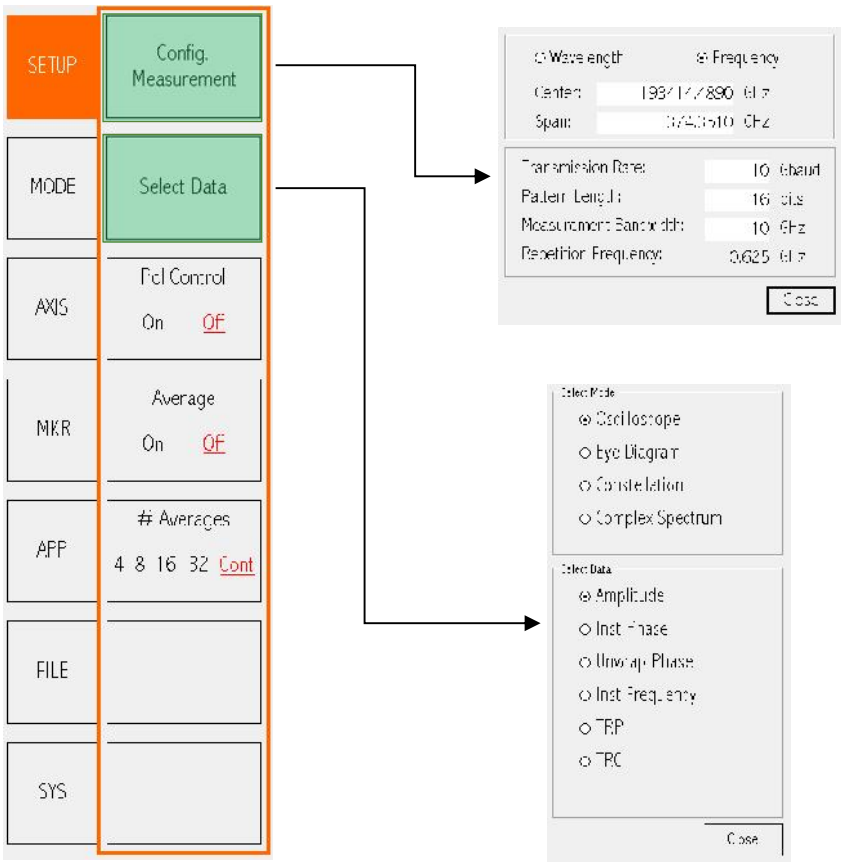
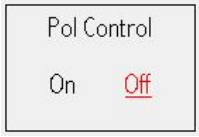
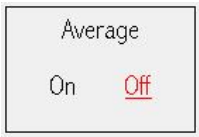
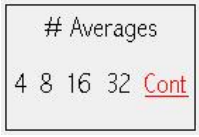


Fig. 7.4 BOSA Phase Set Up button tree diagram.

Set Up submenu

	Displays the "Configure Measurement" dialog box to configure the measurement parameters of the signal under test.
	Displays the "Select Data" dialago box to change the data plot depending on the current mode.
	This is an *option button*. It allows the user to make more precise power measurements by means of controlling the polarization of the SUT. The unit internally performs two consecutives sweeps with polarization control and shows the result independent of the polarization. When the *polarization control* is active the floor noise pattern is automatically controlled.
	This is an *option button*. It performs trace averaging for noise reduction purposes.
	This is an *option button*. Five averaging modes are available: 4, 8, 16, 32 traces averaging and continuous averaging. The first four modes perform the averaging of the most recent traces (4, 8, 16 or 32). The continuous mode performs averaging with an accumulative number of traces. When the continuous mode is selected, the floor noise pattern is automatically controlled.

7.2.2.2 Mode Button

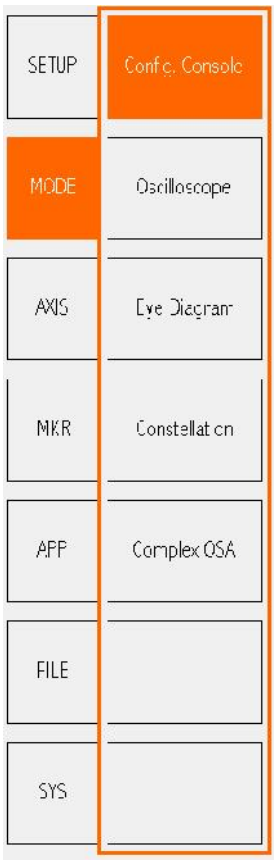


Fig. 7.5 BOSA Phase Mode button tree diagram.

Mode submenu

	Display the default display where the carrier can be selected.
	Runs the oscilloscope mode.
	Runs the eye analysis mode.
	Runs the constellation mode.
	Runs the complex spectrum analyzer mode.

Particular button of the Eye Analysis mode

	Displays on the chart specific markers to perform specific measurements on the Eye representation. You can move them with click and drag operations.

7.2.2.3 Axis Button

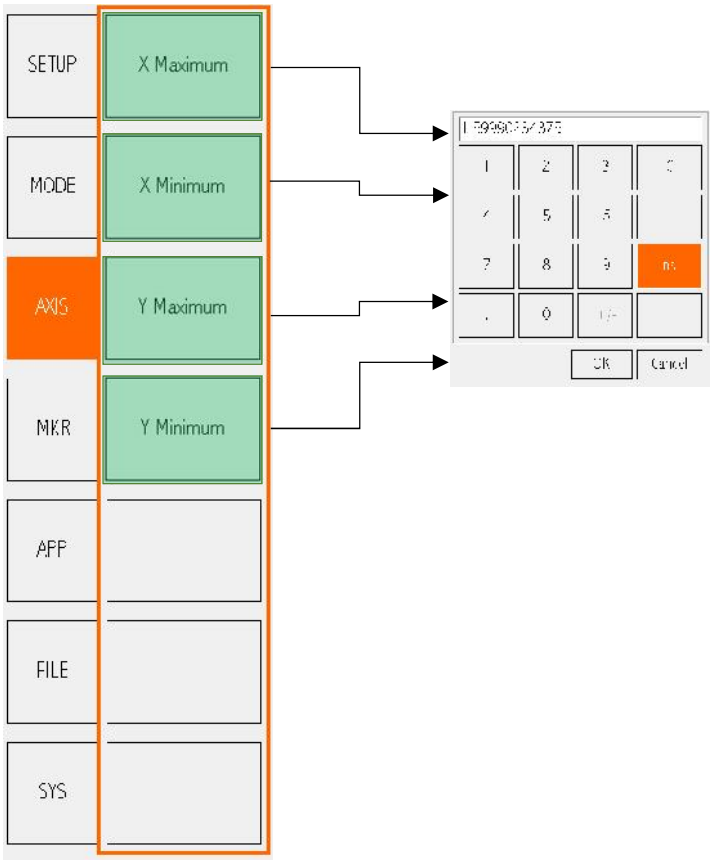
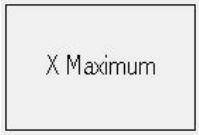


Fig. 7.6 BOSA Phase Axis button tree diagram.

Axis submenu

	Allows the user to set the maximum value of the horizontal axis in the active chart.
	Allows the user to set the minimum value of the horizontal axis in the active chart.
	Allows the user to set the maximum value of the vertical axis in the active chart.
	Allows the user to set the minimum value of the vertical axis in the active chart.

7.2.2.4 Marker Button

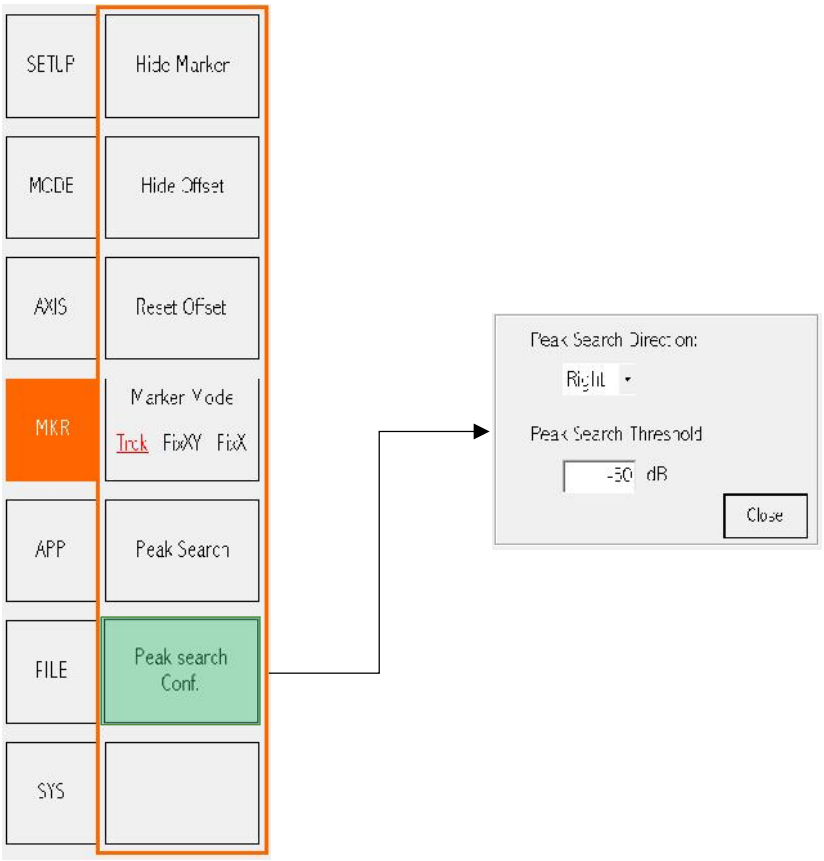


Fig. 7.7 BOSA Phase Marker button tree diagram.

Marker submenu

	Shows or hides a marker on the active trace. It is represented on the chart with a cross.
	Shows or hides the offset of a marker. It's represented on the chart with a square.
	Sets the offset to cero and the square is placed at the same position of the marker.
	This is an *option button*. Three options are allowed: *Tracking, Fix XY and Fix X*. This functions allows to change the marker's behavior. o **Tracking**: the marker will update its X and Y value to track the closest peak of the signal. o ***Fix XY***: The X and Y positions of the marker will remain fixed unless the user manually moves it with the mouse or peak search function. o ***Fix X***: The X position of the marker is fixed and updates its Y value to that of the SUT.
	Moves the active marker to the next peak. The criteria of peak searching are defined through *Peak Search Configuration* button.
	Opens a new window that allows user to configure the peak searching criteria. Detailed description available at 3.3.1.4.

7.2.2.5 Applications Button

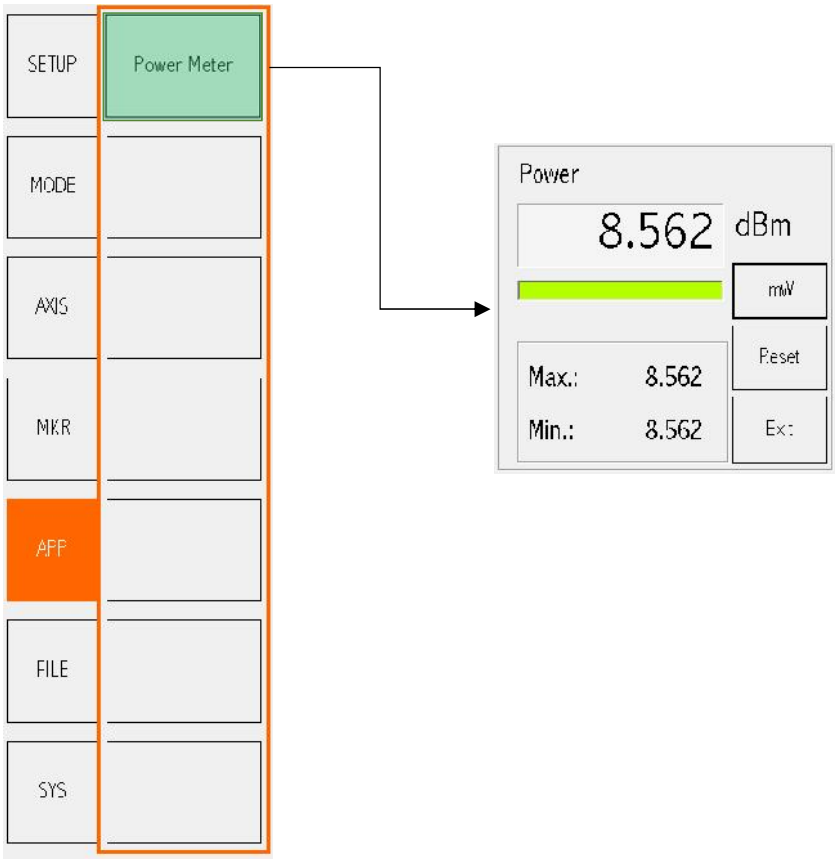


Fig. 7.8 BOSA Phase Application button tree diagram

Applications submenu

Power Meter	Runs the “Power Meter” application which measures the total optical power being input on the front panel optical connector.

7.2.2.6 System Button

Fig. 7.9 BOSA Phase System button tree diagram.

System submenu

The *System submenu* shares all the features of the BOSA's *System submenu*, 0, and there is an extra button:

Calibration	Performs a calibration.

7.2.2.7 File Button

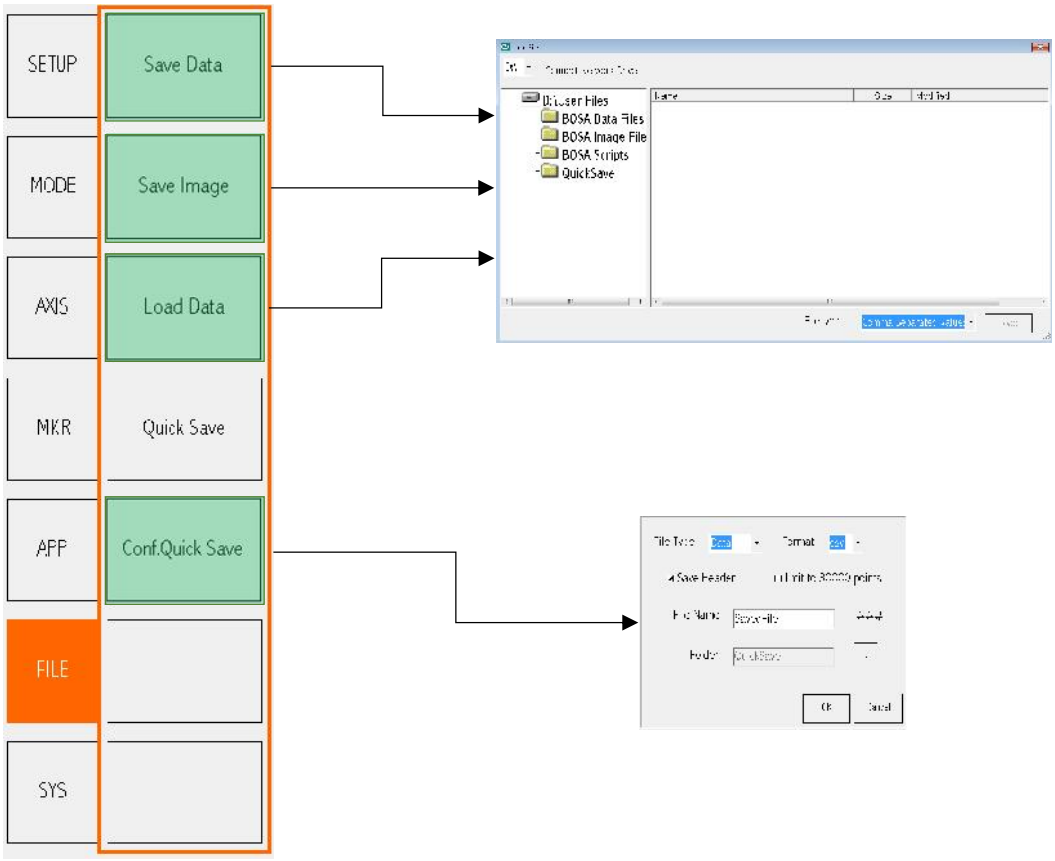


Fig. 7.10 BOSA Phase File button tree diagram.

File submenu

	Opens a new windows form to save the active trace. Available formats are: o .txt: it is a text file witch can be opened by any text editor. o .csv: comma separated values file. Wavelength and power values are saved in each row separated by a comma.
	Displays the "Save Files" dialog box to save the current measurement as an image file.
	Displays the "Load File" dialaog box to load Complex Spectrum data previously saved.
	Performs a quick save operation of the current measurement. The features of this saving are set in the "Config. Quick Save" button.
	Shows the "Quick Save Configuration" dialog box to configure the way in which the "Quick Save" button will proceed.

7.2.4 Context menu description

The context menu contains interface keys related to the graphical representation itself.

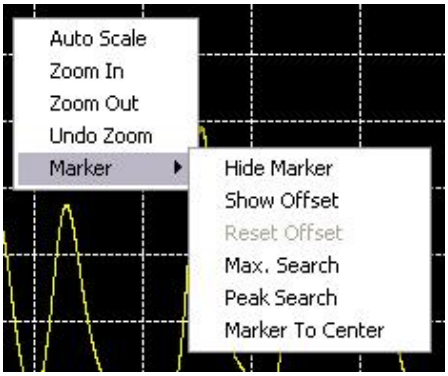


Fig. 7.11 BOSA Phase context menu.

Auto Scale	Performs an auto scale operation in the vertical axis of the active chart.
Zoom In	Enables the zoom mode to perform a zoom-in on any of the three charts.
Zoom Out	Performs a zoom-out operation on the active chart.
Undo Zoom	Retrieves the previous axis configuration on the active chart.
Marker -> Show Marker	Only available in the analysis modes. Shows or hides a marker on the active trace.
Marker -> Show Offset	Only available in the analysis modes. Shows a marker offset to obtain relative measurements.
Marker -> Reset Offset	Only available in the analysis modes. Sets the offset to cero and moves the square symbol of the offset to the marker position.
Marker -> Max Search	Moves the marker to the maximum value of the display data.
Marker -> Peak Search	Moves the marker to the position of the next peak.
Marker -> Marker to Center	Changes the horizontal axis configuration to set the marker in the center of the representation area.

7.3 Taking measurements

7.3.1 Hooking Up the Signal Under Test (SUT)

Follow the next steps to properly connect the signal under test to the unit:

1. Use a single mode optical patchcord to connect the signal under test to the optical front panel input connector, identified as *SUT IN*. Please check the connectors are clean and undamaged as well as the connector type.

Check the connector type for SUT before connect it.

2. Connect the clock signal coming from the pattern generator to the rear SMA connector in the *BOSA Phase* unit. This electrical signal must have a fundamental frequency equal to the pattern repetition frequency of the optical signal.
3. If necessary, run the *BOSA Phase* application in the *Application Selector Screen* and then check that optical power is being input in the system by using the Power Meter application in the Application submenu.

If the power level of the SUT is higher than +10 dBm the power meter will be saturated. On the contrary, if the power level of the SUT is too low the label *SUT signal input loss* appears close to the power bar.

7.3.2 Performing a complex measurement

Follow the next steps to perform a complex measurement:

1. In the *BOSA Phase* application click *RUN* button on the top right of the screen to start the measurement.
2. Press *Set Up* button on the left tab. On the *Measurement* section configure the signal under test properties. Then press *Close* button.
3. Select chart A, by just clicking on it, and locate the signal under test spectrum using zoom-in, zoom-out and autoscale functionalities.
4. Use the marker mode to select the carrier. The marker will automatically be placed at the maximum of the spectral component.
5. Press *Set Up* button on left tab. On the *Trace* section select the desired representation for the C chart.
6. For further analysis press on the *Mode* button on the left tab.

7.3.3 Saving a measurement

For save a measurement follow the next steps:

1. Press *Mode* button on the left tab and select the desired analysis mode to save the measurement.
2. Press *File* and *Save to File*.
3. If the current measurement consist of just one trace only the *Save Active Trace* button will be enabled. Press it to pop up the *Save Files* dialog box. Select the type of file to be saved and type a name. Press *Save* button to finish the process.
   If two traces are represented in the current analysis mode the *Save Data* button will be also enabled. It is used to save both traces in just one file. It is also possible to save only the active trace in a single file using the *Save Active Trace* button. Use 1↔2 to switch between traces.

7.3.4 Configuring a measurement

7.3.4.1 The SET UP dialog

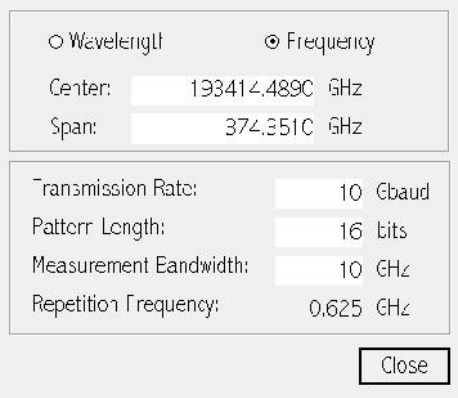


Fig. 7.12. BOSA Phase Set Up dialog.

This dialog set all the measurement parameters required for the proper synchronization of the phase measurement.

7.3.4.2 The Select Data dialog

This dialog is used to change the data displayed in the interface.

In the "Configuration Console" mode, this dialog allows users to change the mode and data of the upper right graph without exiting this mode.

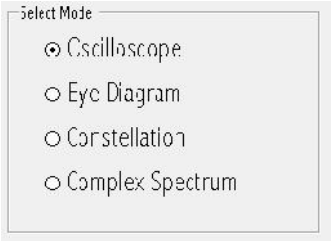


Fig. 7.13. BOSA Phase Select Data dialog in configure console mode.

In the Oscilloscope mode the interface can show:

- Amplitude: It shows the temporal evolution of the amplitude trace
- Inst Phase: It shows the temporal evolution of the phase with its value constrained between $-\pi$ and $+\pi$.
- Unwrap Phase: It shows the continuous value of the temporal evolution of the phase.
- Inst Frequency: It shows the temporal derivative of the phase values.
- TRP: It shows simultaneously the amplitude and phase evolution of the signal under test.
- TRC: It shows simultaneously the amplitude evolution and frequency of the signal under test.

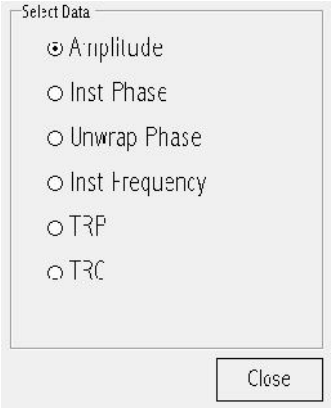


Fig. 7.14. BOSA Phase Select Data dialog in Oscilloscope mode.

In the Eye Diagram mode the interface can show:

- Amplitude Eye Diagram: It shows the conventional Eye Pattern based on the amplitude values of the incoming data.
- I Eye Diagram: It displays the eye diagram based on the In-phase data recovered.
- Q Eye Diagram: It displays the eye diagram based on the Quadrature data recovered.
- Phase Eye Diagram: It shows the Eye Pattern based on the phase values of the incoming data.

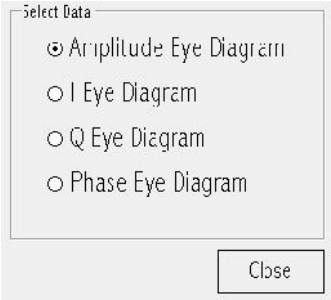


Fig. 7.15. BOSA Phase Select Data dialog in Eye Diagram mode.

In the Constellation mode the interface can show:

- I-Q: It plots the constellation diagram of the symbol recovered from the data.

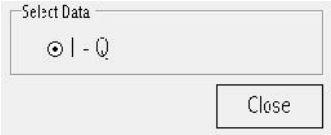


Fig. 7.16. BOSA Phase Select Data dialog in Constellation mode.

In the Complex Spectrum mode the interface can show:

- Complex Spectrum: It shows the amplitude and phase measured values of the spectral components.

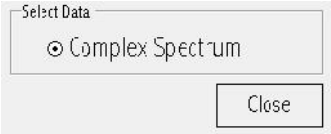


Fig. 7.17. BOSA Phase Select Data dialog in Complex Spectrum mode.

8 Remote control

There are several ways to automate measurement processes in the system.

The build in *Macro Editor Tool* allows the user to automate measurements as well as remotely control other devices through simple code scripts written directly in the unit. The BOSA can also be controlled remotely by using both the GPIB (if available) and Ethernet interface (all options).

8.1 Using the Macro Editor Tool

The Macro Editor Tool is a built-in function which allows control and program the BOSA, Tunable Laser and Component Analyzer apps. In each operation the instrument can also remotely control other instruments through GPIB interface (if available). These applications require the use of an external keyboard connected to the BOSA.

In case you need to control external devices, a standard GPIB cable (if interface available) must be used to connect the instrument and any other laboratory unit. The device addresses should be assigned from the programming language (see the Programming Guide).

- **To operate the BOSA or Component Analyzer through the built-in Macro editor function:**

1. Select *Applications* in the main button bar
2. Press *Macro Editor* button. The interface of the *Macro Editor* will appear (fig 8.1)
3. You can choose between creating a new macro or load one previously saved.

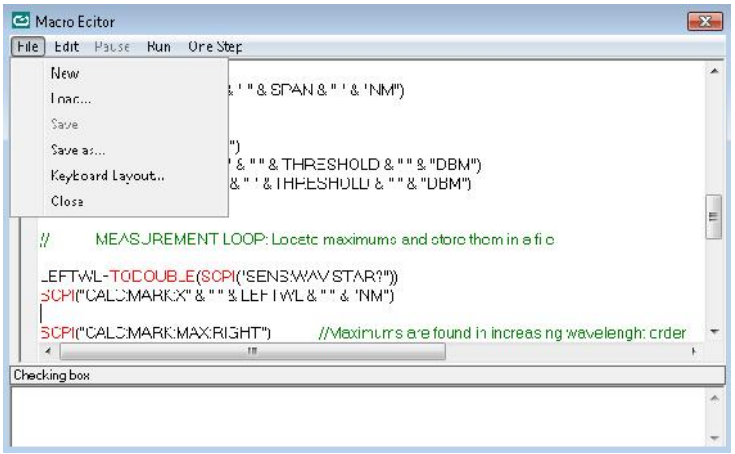


Fig. 8.1 Macro Editor.

- **To operate the Tunable Laser application through the built-in Macro editor function click on the Macro Editor button.**

Create a Macro:

1. Choose the *New* option on *File* menu.
2. Click on the *Keyboard Layout* option to select one.
3. Refer to Programming Guide for more information about commands to create the macro.
4. Click on Run to start the macro. Information of the stage of the macro will appear in the Checking box section.
5. Click on One step if you wish to check the performance of each order of the program, Information will be shown in the Checking box.

Load a Macro:

1. Choose the *Load* option in *File* menu and load the desired macro.
2. Click on Run to start the macro. Information of the stage of the macro will appear in the Checking box section.
3. Click on One step if you wish to check the performance of each order of the program, Information will be shown in the Checking box.

8.2 Using the GPIB Interface (if available)

The GPIB (General Purpose Interface Bus) is an interface used for communication between personal computers and laboratory instruments, such as the BOSA. The IEEE-488 connector on the back of the unit allows for remote operation through a standard GPIB cable. The connector is a standard female 24-pin IEEE-488 connector to use with a standard shielded IEEE-488 cable.

Before you can operate BOSA through GPIB interface you must assign a device address that is unique from the other equipment attached to the bus.

- **Setting the Device Address in BOSA and Component Analyzer:**

1. Under the System menu, select GPIB. The GPIB Configuration window appears.
2. Select a GPIB primary address for the BOSA different from the controller computer or the other instruments' addresses.

- **Setting the Device Address in Tunable Laser:**

1. Click GPIB button. GPIB Configuration window appears.

2 Select a GPIB primary address for the BOSA different from the controller computer or the other instruments' addresses.

The default GPIB address of the BOSA is 4.

- **Returning to Local Control:**

When the BOSA or Component Analyzer application is in remote control, the Stop/Run button in the main screen will change to Local and all the main interface of the will be disabled. Press Local button if you wish to return the instrument to local control.

NOTE: When the Laser application is in remote mode all the button in the main window are disabled. Press EXIT REMOTE MODE button if you wish to return the instrument to local control.

8.3 Using the Ethernet Interface

In order to use the Ethernet interface in the BOSA, it must be connected to a LAN through its 10/100/1000 base-T connector, located on the back of the instrument, and a standard network cable. To operate the instrument remotely through Ethernet interface, see the Programming Guide.

Before you can operate the BOSA through the Ethernet interface you might need to configure it. The IP address of the instrument is set by default using DHCP (Dynamic Host Configuration Protocol). If your network does not support DHCP, a manual configuration will be required. Use the following steps to configure the Ethernet interface.

- **Automated configuration:**

1 Open system/configuration screen:
   - In BOSA or Component Analyzer:
     - Select the *System* option on the Menu bar.
     - Choose the *Network Configuration* option. A dialog box will appear on the screen (fig.7.2)
   - In Tunable Laser app:
     - Click Network Config. button.

2 Choose DHCP in the Configure combo box

3 Press *OK* button to automatically configure the IP address.

4 It is necessary to wait a few seconds until the new configuration takes effect.

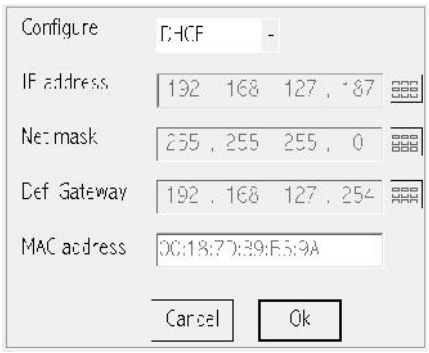


Fig. 8.2 Automated Network Configuration.

- **Manual configuration:**

1. Same as above.
2. Same as above.
3. Choose Manual in Configure combo box.
4. IP Address, subnet mask and the default gateway will be enabled. The MAC address of the device is displayed at the bottom. Press the button at the right of the IP address and the keypad appears. See figure 7.3
5. Enter the IP address, the subnet mask and the default gateway using the keypad
6. Press *OK* button on the message box IP Address
7. Press *OK* button on the message box Network configuration to finish.
8. It is necessary to wait a few second until the new configuration take effect.

Now the BOSA is ready to be operated through Ethernet interface. See Programming Guide for more information.

Upon receiving a command over the Ethernet interface, the instrument will set in remote mode and the functions on the screen are locked out. To return the system to local, press the *LOCAL* button located in the right top corner on the screen.

Fig. 8.3 Manual Network Configuration.

9 Maintenance

For the maintenance of the device, please follow the safety considerations described in 'Safety considerations' at the beginning of this guide (section 0) and the cleaning information provided in the following points. These cleaning instructions mainly concern both optical connectors located at the front of the equipment and the external optical connectors that are being inserted.

9.1 Cleaning Optical Connections. General Considerations

It is important that every fiber connector and adapter is inspected and cleaned prior to mating.

Cleaning the fiber optic connections is one of the most basic and important procedures for maintaining fiber optic systems.

Any contamination in the fiber connection can cause failure of the component or failure of the whole system. A particle that partially or completely blocks the core generates strong back reflections, which can cause instability in the laser system.

In addition to dust, other types of contamination must also be cleaned off the endface. Such materials include:

- Oils (frequently from human hands)
- Film residues (condensed from vapours in the air)
- Powdery coatings (left after water or other solvents evaporate away)

These contaminants can also cause damage to the equipment if not removed.

When cleaning fiber connections, always follow the procedures carefully. The aim is to eliminate any dust or contamination and to provide a clean environment for the fiber- optic connection. Remember that inspection, cleaning and re-inspection are critical steps which must be done before making any fiber-optic connection.

Before inspecting and cleaning your fiber-optic connections, review the following reminders:

- Always turn off any laser sources before you inspect fiber connectors or bulkheads.

Laser light can damage your eyes.

- Always inspect the connectors or adapters before you clean.

- Always inspect and clean the connectors before you make a connection.
- Always use the connector housing to plug or unplug a fiber.
- Always keep a protective cap on unplugged fiber connectors.
- Never clean bulkheads or receptacle devices without a way to inspecting them.
- Never touch the end face of the fiber connectors.
- Never allow cleaning alcohol to evaporate slowly off the ferrule.

Wet cleaning is not recommended for mounted bulkheads and receptacles. Damage to equipment can occur.

9.2 Clean Bulkheads

The fiber optic bulkheads of BOSA equipment are designed to be easily disassembled and cleaned.

Swabs for the cleaning of bulkheads is not always very effective even for experienced operators.

Wet cleaning is not recommended for mounted bulkheads and receptacles. Damage to equipment can occur.

Any bulkhead placed in the front panel of the BOSA is formed by one adapter and one APC polished connector and is designed to be disassembled with facility before being cleaned.

The **disassembling procedure** is as follows:

1. Make sure that the lasers are turned off before beginning the inspection.

Invisible laser radiation may be emitted from disconnected fibers or connectors. Do not stare into beams or view directly with optical instruments.

2. Remove the protective end cap from the adapter.
3. Remove the optical adapter pushing upwards the horizontal metal bar below the connector. With special care pull out the adapter to extract it from the front panel. Please, refer to figure 8.1

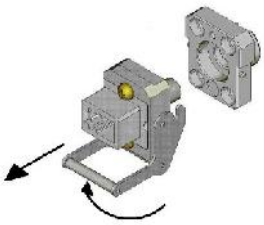


Fig. 9.1 Removable Front Adapter (connector type might be different).

4 The internal connector ferrule is now accessible to be cleaned (see following chapters).

5 Reinsert the adapter applying horizontal soft pressure.

6 Push downwards the horizontal metal bar. A “click” sound confirms that the adapter is in its proper position.

9.3 Connector Cleaning Procedure

1 Inspect the fiber connector, component, or bulkhead with a fiberscope. If the connector is dirty, clean it with a dry cleaning technique.

2 Inspect the connector.

3 If the connector is still dirty, repeat the dry cleaning technique.

4 Inspect the fiber connector.

5 If the connector is still dirty, clean it with a wet cleaning technique followed immediately with a dry clean to ensure no residue is left on the endface.

6 Inspect the connector again.

7 If the contaminate still cannot be removed, repeat the cleaning procedure until the end face is clean.

Wet cleaning is not recommended for mounted bulkheads and receptacles. Damage to equipment can occur.

Never use wet cleaning without to insuring that it does not leave residue on the end face. It can cause equipment damage.

9.3.1 Dry Cleaning Technique

This section describes dry cleaning techniques using lint-free wipes.

1 Make sure that the lasers are turned off before beginning the inspection.

Invisible laser radiation may be emitted from disconnected fibers or connectors. Do not stare into beams or view directly with optical instruments.

2 Remove the protective endcap and store it in a small resealable container.

3 Inspect the connector with a fiberscope.

4 If the connector is dirty, clean it with a lint-free wipe.

5 Fold the wipe into a square (about 4 to 8 layers thick).

Be careful not to contaminate the cleaning area of the wipe with your hands or on a surface during folding.

6 Fold the wipe into a square (about 4 to 8 layers thick).

Do not scrub the fiber against the wipe; doing so could cause more contamination.

7 Fold the wipe into a square (about 4 to 8 layers thick) using another clean section of the wipe.

8 Properly dispose of the wipe and lightly wipe the ferrule tip with the central portion of the wipe.

9 Inspect the connector again with the fiberscope.

10 Repeat this process if necessary.

9.3.2 Wet Cleaning Technique

If a 'dry' cleaning procedure does not remove the dirt from the fiber endface, then try the wet cleaning method.

Improper cleaning can cause damage to the equipment. The primary concern with using isopropyl alcohol is that it be removed completely from the connector or adapter. Residual liquid alcohol will act as a transport mechanism for loose dirt on the endface. If the alcohol is allowed to evaporate slowly off the ferrule, it can leave residual material on the cladding and fiber core. This is extremely difficult to clean off without another wet cleaning and usually more difficult to remove than the original contaminant. Liquid alcohol can also remain in small crevices or cavities where it can re-emerge during fiber connection.

1 Make sure that the lasers are turned off before beginning the inspection.

Invisible laser radiation may be emitted from disconnected fibers or connectors. Do not stare into beams or view directly with optical instruments.

2 Remove the protective endcap and store it in a small resealable container.

3 Inspect the connector with a fiberscope.

4 Fold two wipes into a square (about 4 to 8 layers thick).

5 Moisten one of the wipes with one drop of 99% alcohol. Be sure the other wipe remains dry.

6 Lightly wipe the ferrule tip in the alcohol moistened wipe.

7 Immediately repeat the action on the dry wipe to remove any residual alcohol.

8 Inspect the connector again with a fiberscope.

9 Repeat the process as necessary.

9.4 Adapters Cleaning Procedure

Dry cleaning techniques are recommended for adapters using lint-free swabs. Please, apply the following steps:

1 Remove the protective endcap and store it in a small resealable container.

2 Inspect the adapter.

3 If the adapter is dirty, clean it with a lint-free swab.

4 Turn the swab to clean the sleeve face.

5 Inspect the adapter again.

6 Repeat this process as necessary.

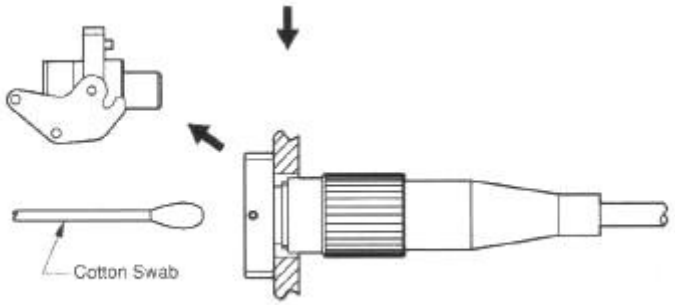


Fig. 9.2 Adapter Cleaning.

10 Technical Service

10.1 Aragón Photonics Labs Services and Sales Office

Any repair, maintenance or adjustment of this instrument must be performed by qualified personnel. Before returning an instrument for service, please contact our assistant engineer at APL support office by internet, phone or fax.

Phone number +34 976 359972
Fax number: +34 976 402022
Email address: support@aragonphotonics.com
Internet: www.aragonphotonics.com
Box mail: Prado 5, local. 50009. Zaragoza. Spain

Also, if you need assistance with your test and measurement needs, we will be very pleased to support you.

10.2 Warranty

The BOSA instrument is warranted against defects in material under normal use conditions for a period of one year from the date of shipment. For warranty service the product must be returned to APL Office. Contact support@aragonphotonics.com for any question on warranty.

10.3 Calibration

The calibration of the instrument affects to the optical power and wavelength scales and this should be done in APL offices. A two-year calibration period is recommended unless indicated otherwise in your Calibration Certificate.

10.4 Returning the Device for Service

If the initial inspection of the device fails, the instrument does not meet the specifications or the device is not working correctly, notify the APL service office. If the instrument is to be shipped to APL service, APL will send the document 'Return Material Agreement request form' to be completed by you. This document should be attached to the device.

The original carton and packaging material must be used when shipping the BOSA to APL Service. Mark with FRAGILE labels the outer side of the packaging to encourage careful handling.

10.5 Firmware updates

You may need to upgrade the firmware of the instrument to enhance the usability and functionality of your instrument. New features may be available with new firmware revisions.

APL will provide the latest firmware versions. Load the corresponding file on a USB memory stick. Once the USB stick is connected to your BOSA you may carry out the firmware update directly through the *Help* Menu, selecting the *Software Update* option.

11 Specifications

There are different series, models (bands) and options of BOSA.

BOSA 400

- Standalone: built-in TLS
- *10MHz, 20nm/s*
- C, L & O bands
- All options for upgrade

BOSA 100

- Cost effective: external TLS
- *10MHz, 20nm/s*
- C, L & O bands
- All options for upgrade

BOSA Lite

- Affordable & compact
- *20MHz, 2.5nm/s*
- Only C band HR-OSA

BOSA Lite+

- Affordable & standalone
- *20MHz, 2.5nm/s*
- C & L bands
- Some options for upgrade

The main options for upgrade are:

	BOSA 400	BOSA 100	BOSA Lite	BOSA Lite+
Tunable Laser Source	Option 410	Option 110	-	Option 010
Component Analyzer	Option 420	Option 120	-	Option 020
Spectral polarimetry	Option 430	Option 130	-	Option 030
Phase measurement	Option 440	Option 140	-	-

The following tables show the BOSA technical specifications:

BOSA 400[1] series	C band	C+L band	O band
Mainframe			
Operating Temperature	+15°C to +35°C		
Power Requirement	100/110/220 V, 50/60 Hz		
Power consumption	Máx. 150W		
Dimmensions & Mass	430 x 230 x 470 (mm). Máx. 25Kg		
Model Parameters			
Wavelength Range	1525 – 1565 nm	1525 – 1607 nm	1265 – 1345 nm
Optical Resolution[2]	10 MHz		
Wavelength Accuracy	±0.5 pm	±2 pm	±2 pm
Spurious free Dynamic Range[2]	>80 dB		
Calibrated Input Power Range	+13 to -70 dBm		
Close-in Dynamic range	>40 dB @ ±0.3 pm >60 dB @ ±0.6 pm		
Max. Safe Input Power	+20 dBm		
Sensitivity[2]	-70 dBm / 0.1 pm		
Power accuracy[2]	±0.5 dB		
Polarization Measurement	Two orthogonal polarization channels. (+Option 430) Full state-of-polarization.		
Measurement time	1 sec. for 20 nm		
Internal Wavelength Calibrator	Yes		
Communication Interface			
Optical connectors	FC/APC		
Interfaces Available	Ethernet. USB. GPIB		

[1]BOSA100 specs may depend on TLS model used with BOSA.
[2]Typical values, measured at 0 dBm @ 1550 nm, 1590 nm and 1310 nm.

Options available for BOSA 400:

Option 410	**C band**	**C+L band**	**O band**
Wavelength Range	1516 – 1565 nm	1521 – 1630 nm	1266 - 1345 nm
Wavelength repeatability	± 1.5 pm	± 2 pm	± 2 pm
Tunning Speed	1-100 nm/s		2-1000 nm/s
Output power	> 1 mW		
SSE	>43 dB	>45 dB	>40 dB
RIN	<-145 dB/Hz	<-140 dB/Hz	<-135 dB/Hz
Linewidth	<1 MHz		
Trigger input	BNC (other on request)		

Option 420	**C band**	**C+L band**	**O band**
Wavelength Range	1516 – 1565 nm	1521 – 1630 nm	1266 - 1345 nm
Wavelength accuracy	± 1 pm	± 2 pm	± 2 pm
Power accuracy	± 0.2 dB		
Polarization measurement	2 orthogonal polarization states. PDL with option 130		
Output power	>0 dBm		
Sensitivity	-70 dBm (IL), -45 dBm (RL)		
Calibrated input range	+10 to -70 dBm		
Spurious-free dynamic	>80 dB		
Measurement time	1s for 100 nm		

Option 430	**C band**	**C+L band**	**O band**
Polarization repeatability	± 5°		
Temperature dependence	0.2°/°C		
Measurement time	6 scans at 20 nm/s		
Sensitivity for pol. meas.	-40 dBm		
Polarization crosstalk	<20 dB		

Option 440	**C band**	**C+L band**	**O band**
Wavelength Range	1525 nm – 1565 nm	1525 nm – 1607 nm	N.A.
Bandwidth	80 MHz to full span		
Pattern Frequency range	Continuous from 88 MHz to 2GHz		
Phase Accuracy	± 1°		
Electrical Ref. Input power	-15 to +5 dBm		
Sensitivity	-60 dBm		
Measurement time	1s for 10 nm		

BOSA 100[1] series	C band	L band	O band
Mainframe			
Operating Temperature	+15°C to +35°C		
Power Requirement	100/110/220 V, 50/60 Hz		
Power consumption	Máx. 150W		
Dimmensions & Mass	430 x 230 x 470 (mm). Máx. 25Kg		
Model Parameters			
Wavelength Range	1525 – 1565 nm	1565 – 1607 nm	1265 – 1355 nm
Optical Resolution[2]	10 MHz		
Yenista lasers[3,4]	T100S-HP/CL/M, T100S-HP/SCL/M, T100S-HP/CLU/M		T100S-HP/O/M, T100S-HP/O+/M
Wavelength Accuracy	Typ. ±2 pm		
Spurious free Dynamic Range[2]	>80 dB		
Calibrated Input Power Range	+13 to -70 dBm		
Close-in Dynamic range	>40 dB @ ±0.3 pm >60 dB @ ±0.6 pm		
Max. Safe Input Power	+20 dBm		
Sensitivity[2]	-70 dBm / 0.1 pm		
Power accuracy[2]	±0.5 dB		
Polarization Measurement	Two orthogonal polarization channels. (+Option 130) Full state-of-polarization		
Measurement time	1 sec. for 20 nm		1 sec. for 10 nm
Internal Wavelength Calibrator	Yes		
Communication Interface			
Optical connectors	FC/APC		
Interfaces Available	Ethernet. USB. GPIB		

[1]BOSA100 specs may depend on TLS model used with BOSA.
[2]Typical values, measured at 0 dBm @ 1550 nm, 1590 nm and 1310 nm.
[3]If customer already owns a laser with SMF, please contact us.
[4]Full specs of Yenista lasers available in Yenista datasheet.

Options available for BOSA 100:

Option 110	**C band**	**L band**	**O band**
Wavelength Range	1502 nm – 1630 nm Yenista T100S-HP/CL 1442 nm – 1640 nm Yenista T100S-HP/SCL 1502 nm – 1680 nm Yenista T100S-HP/CLU		1262 - 1360 nm Yenista T100S-HP/O 1242 - 1380 nm Yenista T100S-HP/O+
Wavelength repeatability	Typ. 5 pm with Yenista T100S models		
Tunning Speed	Typ. 1 – 100 nm/s with Yenista T100S models		
Output power	> 1 mW with Yenista T100S models		
SSE	>90 dB with Yenista T100S models		
RIN	Typ. -145 dB/Hz with Yenista T100S models		
Linewidth	Typ. 400 KHz with Yenista TLS models (coherence control off)		
Trigger input	BNC (other on request)		

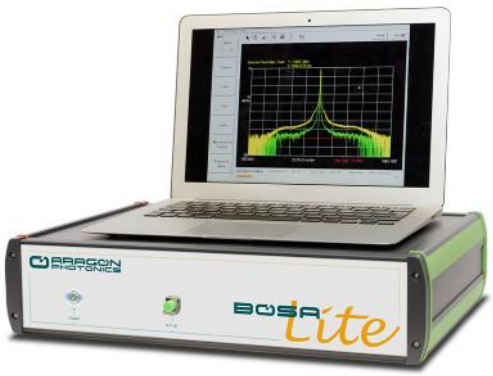
Option 120	**C band**	**L band**	**O band**
Wavelength Range	1502 nm – 1630 nm Yenista T100S-HP/CL 1442 nm – 1640 nm Yenista T100S-HP/SCL 1502 nm – 1680 nm Yenista T100S-HP/CLU		1262 - 1360 nm with Yenista T100S-HP/O 1242 - 1380 nm Yenista T100S-HP/O+
Wavelength accuracy	±2 pm		
Power accuracy	± 0.2 dB		
Polarization measurement	2 orthogonal polarization states. PDL with option 130		
Output power	>0 dBm		
Sensitivity	-70 dBm (IL), -45 dBm (RL)		
Calibrated input range	+10 to -70 dBm		
Spurious-free dynamic	>80 dB		
Measurement time	1s for 100 nm		

Option 130	**C band**	**L band**	**O band**
Polarization repeatability	± 5°		
Temperature dependence	0.2°/°C		
Measurement time	6 scans at 20 nm/s		6 scans at 10 nm/s
Sensitivity for pol. meas.	-40 dBm		
Polarization crosstalk	<20 dB		

Option 140	**C band**	**L band**	**O band**
Wavelength Range	1525 nm – 1565 nm	1565 nm – 1607 nm	N.A.
Bandwidth	80 MHz to full span		
Pattern Frequency range	Continuous from 88 MHz to 2GHz		
Phase Accuracy	± 1°		
Electrical Ref. Input power	-15 to +5 dBm		
Sensitivity	-60 dBm		
Measurement time	1s for 10 nm		

BOSA Lite & Lite+	C band	C+L band*
Mainframe		
Operating Temperature	+15°C to +35°C	
Power Requirement	100/110/220 V, 50/60 Hz	
Power consumption	Máx. 100W. BOSA Lite Máx. 150W. BOSA Lite+	
Dimmensions & Mass	420 x 310 x 100 (mm). Máx. 7Kg. BOSA Lite 430 x 230 x470 (mm). Max. 20Kg. BOSA Lite+	
Model Parameters		
Wavelength Range	1525 nm – 1565 nm	1525 nm – 1607 nm
Optical Resolution[1]	0.16 pm (20 MHz)	
Wavelength Accuracy	± 2 pm	
Spurious free Dynamic Range[1]	>80 dB	
Calibrated Input Power Range	+13 to -70 dBm	
Close-in Dynamic range	>40 dB @ ±0.8 pm >60 dB @ ±2.0 pm	
Max. Safe Input Power	+20 dBm	
Sensitivity[1]	*-70 dBm / 0.16 pm*	
Power accuracy[1]	±0.5 dB	
Polarization Measurement	Two orthogonal polarization channels	
Measurement time	1 sec. for 2.5 nm	
Internal Wavelength Calibrator	Yes	
Communication Interface		
Optical connectors	FC/APC	
Interfaces Available	USB. Ethernet.	

*Only available in BOSA Lite+ standalone box.
[1]Typical values, measured at 0dBm @1550nm and @1590nm.



BOSA Lite

BOSA Lite+

Options included in BOSA Lite+:

Option 010	C band model	C+L band model
Wavelength Range	1525 nm – 1565 nm	1525 nm – 1607 nm
Absolute Accuracy	± 2 pm	
Tuning Speed	1-2.5 nm/s	
Output power	>0 dBm	
Side-mode suppression	>43 dB	
RIN	<-145 dB/Hz	
Linewidth	<1 MHz	

Option 020	C band model	C+L band model
Wavelength Range	1525 nm – 1565 nm	1525 nm – 1607 nm
Wavelength repeatability	± 2 pm	
Power accuracy	± 0.2 dB	
Polarization measurement	2 orthogonal polarization states. PDL with option 030	
Output power	>0 dBm	
Sensitivity	-70 dBm (IL), -45 dBm (RL)	
Calibrated input range	+10 to -70 dBm	
Spurious-free dynamic range	>70 dB	
Measurement time	1s for 2.5 nm	

Options available for BOSA Lite+:

Option 030	C band model	C+L band model
Polarization repeatability	± 5°	
Temperature dependence	0.2°/°C	
Measurement time	6 scans at 2.5 nm/s	
Sensitivity for polarization meas.	-40 dBm	
Polarization crosstalk	<20 dB	

12 Glossary

The definitions of the terms used in the BOSA specification are the following:

Close-in dynamic range	Height, in a logarithmic scale, of the spectral filtering function[1] applied to input signals.
Dynamic range	Ratio between maximum and minimum optical powers that can be detected in a single measurement process in conditions for maximum sensitivity (averaging over 32 scans with *Lock Trace* on).
Maximum Safe Total Input Power	Specify the maximum total input power that can be applied as input signal.
Optical resolution	Width of the spectral filtering function FWHM* applied to input signals.
Power accuracy	The uncertainty of an optical power measurement in absolute terms. It is the maximum deviation from a known reference source power level where the polarization dependence is not included.
Sensitivity	Minimum detectable optical power spectral density.
Wavelength Accuracy	The uncertainty of the wavelength axis measured by the BOSA in absolute terms.

1 The spectral filtering function represents the effective response of measuring system to a purely monochromatic input signal. It is a nearly Gaussian function with spectral widths of 0.08 pm, 0.66 pm and 0.88 pm at levels of 3 dB, 40 dB and 60 dB below the function peak. See: A. Villafranca, J. A. Lázaro, Í. Salinas, and I. Garcés, 'Stimulated Brillouin scattering gain profile characterization by interaction between two narrow-linewidth optical sources', Opt. Express ***13,*** *7336-7341(2005), http://www.opticsexpress.org/abstract.cfm?URI=OPEX-13-19-7336.*

13 Troubleshooting

13.1 Error Messages

There is a list of possible system errors identified by an error code.

The Code Errors 100X, 200X, 440X, 800X and 900X are related to optical hardware errors and the Code errors 500X and 700X are related to communication hardware errors. All the error messages are shown above the operation parameters area. If any of the following error appears restart the system. If the error persists, please contact Aragon Photonics for further support.

Code Error	Error Message
7001 7002	'An internal module error has occurred, please take note on Error Code and contact Aragon Photonics for Technical Support. Error Code: 700x'
5001 5002 5005 5008 5009	'500x: Internal device communication error'
5004	'5004: Internal device read error'
5007	'5007: Internal device write error'
8001 8002 8003	'System error: 800X'
9001 9002 9003	'System error: 900X'

14 Compatible external TLS (BOSA 100 series)

BOSA 100 requires and external tunable laser to work. In order to offer the maximum measurement performance only few models are fully compatible with the BOSA.

14.1 Compatible lasers

The next list summarizes the TLS models and manufactures:

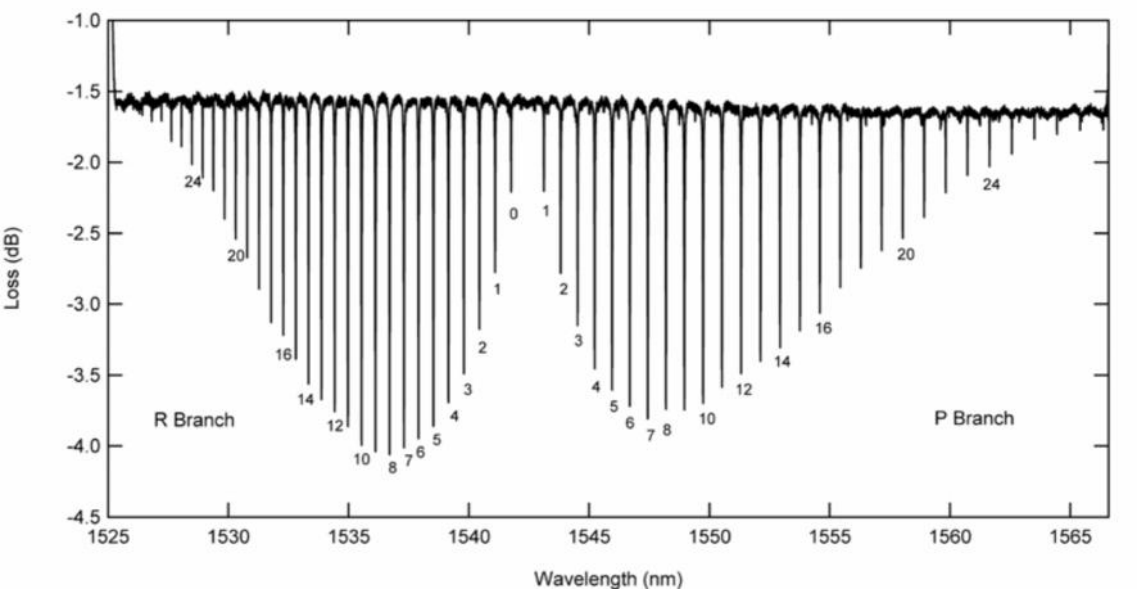
- Keysight (Agilent)
  - 81600 family (Agilent Technologies, GPIB communication interface)
  - 81640A/B
  - 81680A/B
  - 81600B #200
- Luna Innovations:
  - Phoenix 1400
- Yenista Optics:
  - Tunics T100S
  - Tunics T100R
  - Tunics Reference

14.2 Lasers requirements

- Wavelength range
  - 1525-1565 nm for the C band model
  - 1525-1615 nm for the C+L band model.
- PMF output APC (FC preferred)
- Linewidth <1MHz
- Modehop free in the complete tunning range
- Continuous sweep
- Sweeping speed: 5 to 20nm/s
- Trigger output at begin of sweep
- Output power of at least 0dBm across complete range
- GPIB (or USB)

APPENDIX I : Gas Cell Absorption Lines

[1] C band model:



R Branch	Wavelength (nm)	P Branch	Wavelength (nm)
25	1528.0541	1	1543.1148
24	1528.4862	2	1543.8094
23	1528.9271	3	1544.5147
22	1529.3762	4	1545.2314
21	1529.8376	5	1545.9563
20	1530.3061	6	1546.6902
19	1530.7856	7	1547.4354
18	1531.2764	8	1548.1904
17	1531.7738	9	1548.9554
16	1532.2825	10	1549.7302
15	1532.8024	11	1550.5149
14	1533.3291	12	1551.3106
13	1533.8671	13	1552.1157
12	1534.4159	14	1552.9308
11	1534.9723	15	1553.7560
10	1535.5401	16	1554.5892
9	1536.1170	17	1555.4346
8	1536.7034	18	1556.2919
7	1537.2997	19	1557.1573
6	1537.9069	20	1558.0329
5	1538.5224	21	1558.9185
4	1539.1494	22	1559.8143
3	1539.7855	23	1560.7185
2	1540.4314	24	1561.6344
1	1541.0872	25	1562.5625

[2] C+L band model:

Band	C12 HCN	C12 CO	C13 CO
L26	1519.007585		
L25	1519.421573		
L24	1519.845905		
L23	1520.28055		
L22	1520.725527		
L21	1521.180877	1560.5025	1595.3772
L20	1521.646548	1560.868	1595.7554
L19	1522.122606	1561.26	1596.1595
L18	1522.609023	1561.6786	1596.5895
L17	1523.10582	1562.1237	1597.0454
L16	1523.613015	1562.5953	1597.5271
L15	1524.130607	1563.0935	1598.0349
L14	1524.658593	1563.6183	1598.5686
L13	1525.197017	1564.1697	1599.1284
L12	1525.745855	1564.7477	1599.7141
L11	1526.305129	1565.3523	1600.3258
L10	1526.874837	1565.9835	1600.9636
L9	1527.455003	1566.6414	1601.6274
L8	1528.045651	1567.3261	1602.3174
L7	1528.646756	1568.0375	1603.0334
L6	1529.258344	1568.7756	1603.7756
L5	1529.880439	1569.5405	1604.5439
L4	1530.513043	1570.3323	1605.3385
L3	1531.156133	1571.1509	1606.1593
L2	1531.809784	1571.9965	1607.0064
L1	1532.473951	1572.8691	1607.8799
L0	1533.148683	1573.7687	1608.7799
R1	1534.529837	1575.6498	1610.6596
R2	1535.23629	1576.6311	1611.6393
R3	1535.953327	1577.6397	1612.6457
R4	1536.680951	1578.6758	1613.6788
R5	1537.419216	1579.7392	1614.7388
R6	1538.168127	1580.83	1615.8255
R7	1538.927668	1581.9485	1616.9392
R8	1539.697845	1583.0945	1618.0797
R9	1540.478712	1584.2683	1619.2473
R10	1541.270255	1585.4698	1620.442
R11	1542.072479	1586.6993	1621.6641
R12	1542.885418	1587.9567	1622.9132
R13	1543.709081	1589.2422	1624.1898
R14	1544.543475	1590.5559	1625.494
R15	1545.388588	1591.8978	1626.8257
R16	1546.244477	1593.2681	1628.1851
R17	1547.111151	1594.6669	1629.5723
R18	1547.988599	1596.0942	1630.9873
R19	1548.87683	1597.5502	1632.4303
R20	1549.775904		
R21	1550.685785		
R22	1551.60651		
R23	1552.538091		
R24	1553.480541		
R25	1554.433873		
R26	1555.398101		
R27	1556.373239		