



OptiSystem

Optical Communication System
and Amplifier Design Suite

16.0

New Features

New features are created in OptiSystem 16.0 to address the needs of researchers, scientists, photonic engineers, professors and students. OptiSystem software satisfies the demands of users who are searching for a powerful yet easy to use photonic systems design tool.





Key Features for OptiSystem 16.0

OptiSystem 16.0 includes the creation of several new components and enhancement of many existing components.

New components include:

- Compliance Test Patterns
- FBG Sensor
- Phi-OTDR
- Phi-OTDR Interrogator

Enhancements include:

- Allowing users to enter a **“User defined IQ-map”** for the QAM Sequence Generator, QAM Sequence Decoder, and the Decision components.
- Adding a new parameter to the **“Decision”** component called **“Decision Error Accuracy”**, which controls the EVM value.
- Adding an approximate number of guided modes to the results of the **“Parabolic-Index Multimode fiber”** and **“Measured-Index Multimode Fiber”** components
- Adding a **time domain representation** of the Rayleigh backscattering (RBS). The randomly produced RBS noise power level is measured accurately at the input port of the fiber. The RBS is also represented as parametric signal in the frequency domain
- Creating a new subdirectory called **“M-ary”** in the **“Visualizer Library”** and the location of the components in the **“Visualizer Library”** are reorganized to better display them. Also, **“Compare”** subdirectories are created in the Optical, Electrical, Binary and M-ary directories, where the relevant compare visualizers are now found.
- Adding a new tab to the **“View Signal Visualizer”** component to allow exporting of all samples/iterations when either the **“Convert To Optical individual Samples”** component or sweeping feature is used. Typically, one sample is displayed and can be exported as xxxxx.txt or an Excel file. The new tab is called **“Export All Signal Indices”** to xxxxx.txt or excel file
- Adding a data file that represents the used data in the absorption and phase profiles of **“Single Drive MZ Modulator Absorption-Phase”** and **“Dual Drive MZ Absorption-Phase”** components in the Example Library to allow users load/edit it.

New library components and major enhancements

Phi-OTDR:

The Phi-OTDR and Phi-OTDR Interrogator components are added to OptiSystem 16.0 Sensors Library. These components can be used to sense multiple vibrations and interrogate measured the Rayleigh back-reflected signal of a fiber experiencing single or multiple vibrations at different locations. Fig. 1 illustrates a project layout of the Phi-OTDR and Phi-OTDR Interrogator used to measure three vibrations (100Hz, 400Hz, and 600Hz) located at different positions (20m, 40m, and 60m) of a 100m single mode fiber (SMF). The Phi-OTDR interrogator analyzes the collected Rayleigh backreflected signal of the SMF and displays the frequency of the vibration(s) and location of each vibration as shown in figures 2 and 3.

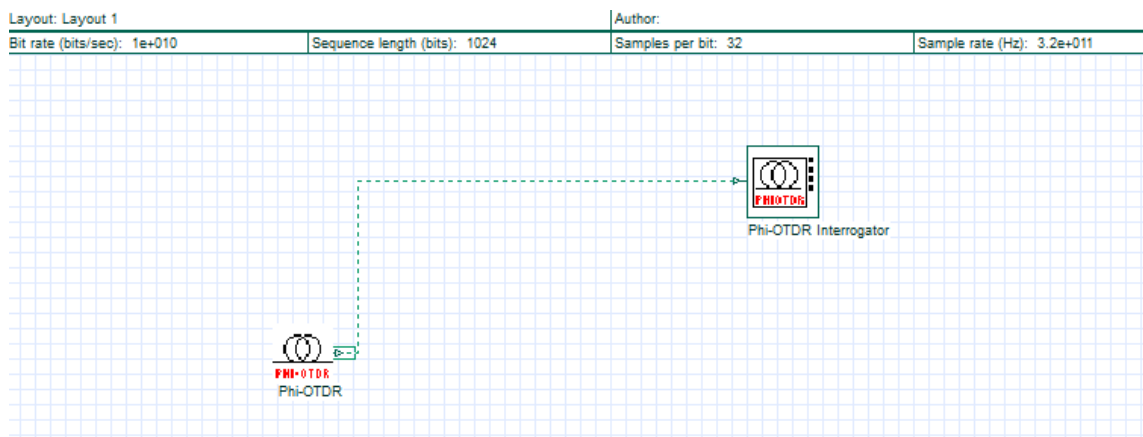


Fig 1: Project layout concept of an optical vibration sensor using Phi-OTDR.

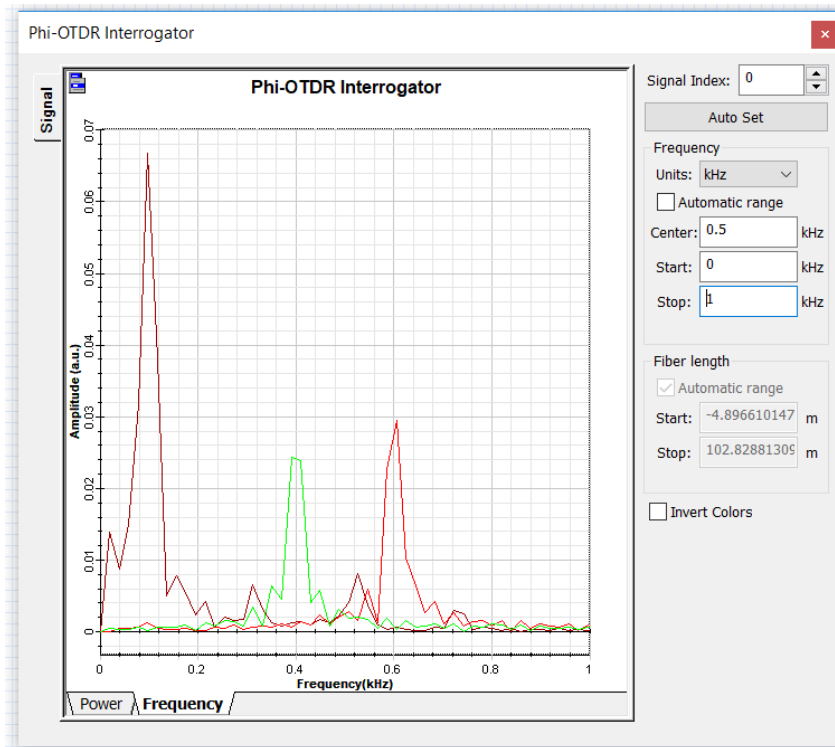


Fig 2: Calculated vibration frequencies in a 100m SMF

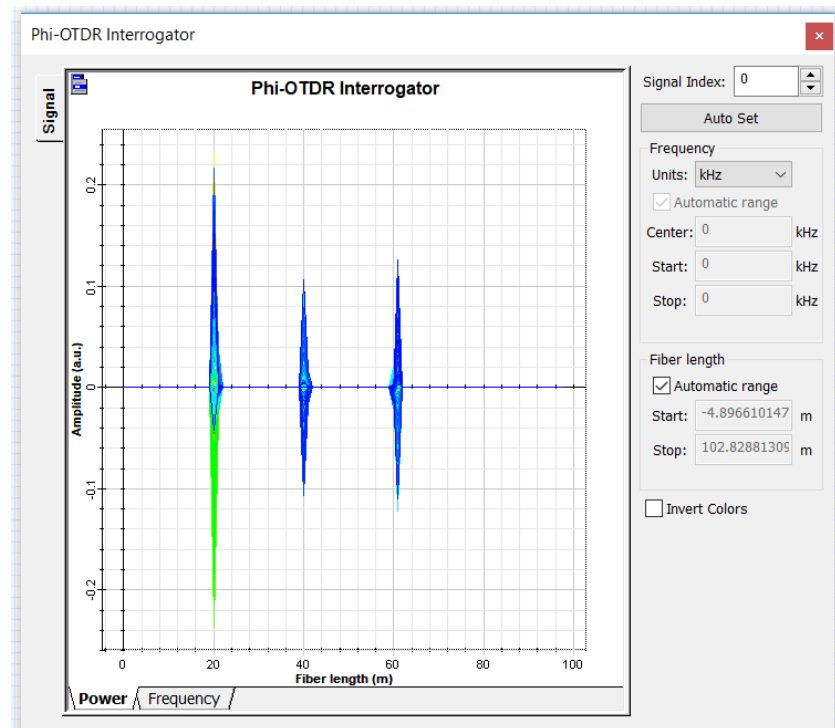


Fig 3: Locations of the vibrations in a 100m SMF

FBG Sensor:

The **FBG Sensor** allows users to design the fiber Bragg grating (FBG), according to the actual physical parameters provided by the vendor, to perform temperature, stress and strain sensing. The component can also be used for synthesizing measured data of an FBG in the field to find its physical parameters. Fig. 4 shows the schematic diagram used to sense the temperature variation of an FBG Sensor component. Fig. 5 illustrates the transmission and reflection spectra of the FBG sensor when changing temperature between 10°C and 50°C.

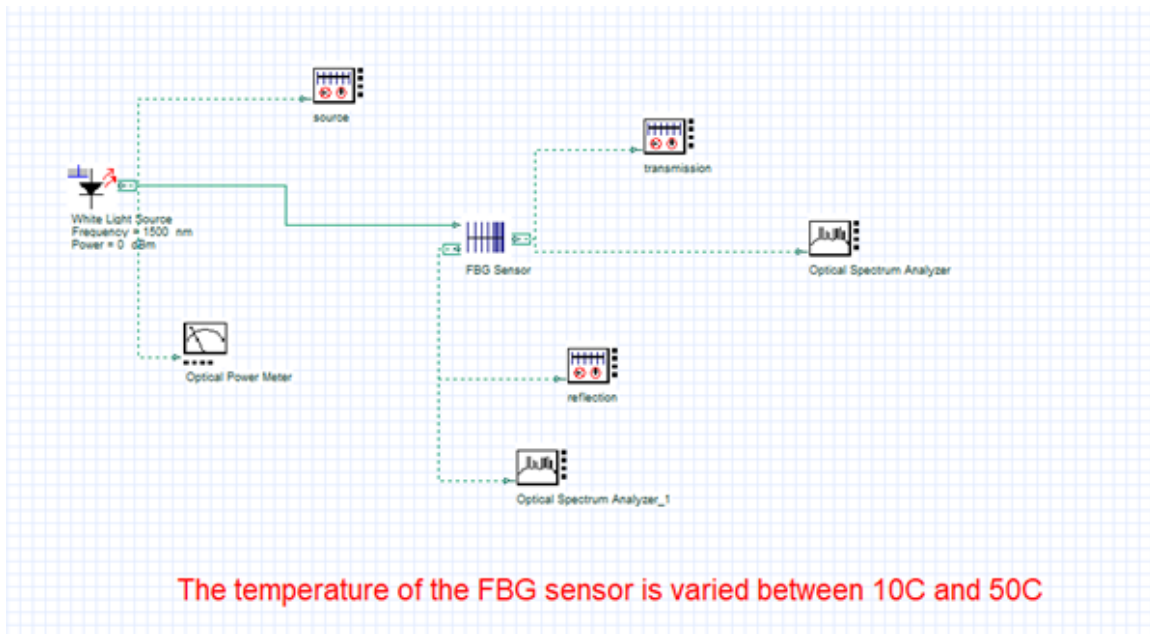


Fig 4: Schematic layout used for temperature sensing of FBG Sensor component.

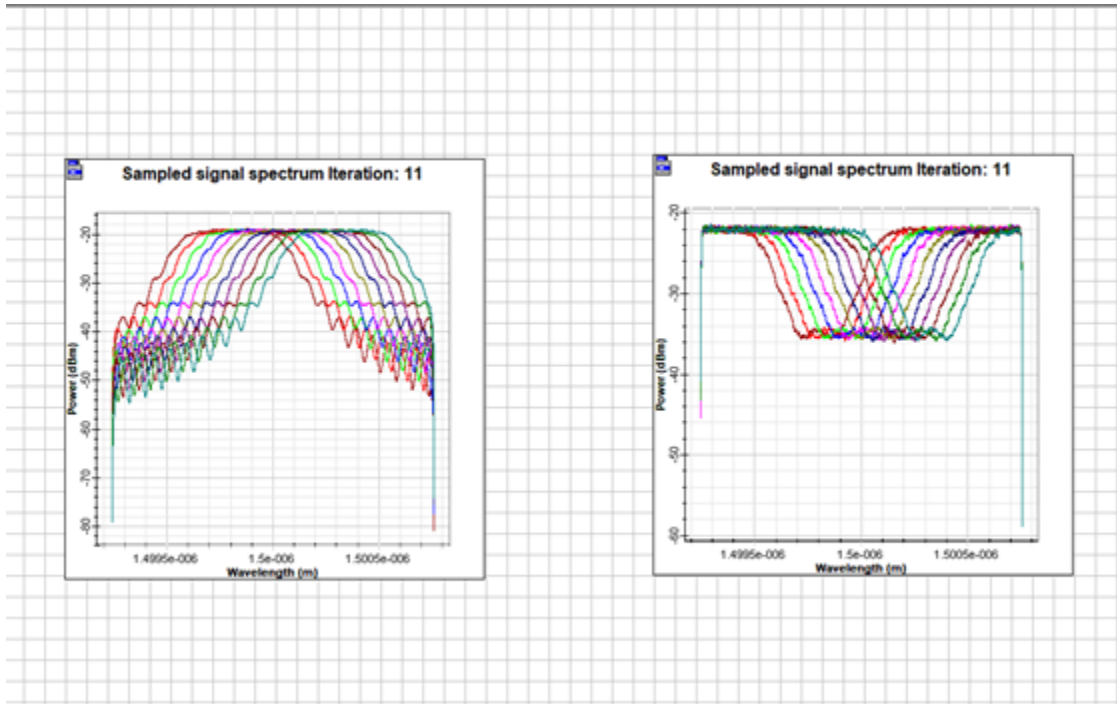


Fig 5: Transmission and reflection spectral characteristic of the FBG Sensor component used to sense temperature variation.

Compliance Test Patterns:

The **Compliance Test Patterns** component can be used to create standard compliance jitter patterns for testing tolerances of different photonic devices. The default patterns implemented in the component are the CJTPAT, CRPAT, and CSPAT as shown in Fig. 6. The component also allows users to edit these patterns by adding different bytes and the number of times each sequence is repeated as shown in Fig. 7. Users have the ability to load their own patterns in this component.

CRPAT	
Sequence	Repetition
BC 95 B5 B5	6
BC B5 36 36	1
BE D7 23 47 6B 8F B3 14 5E FB 35 59	16
EE 23 55 16	1
BC B5 D5 D5	1
CJTPAT	
Sequence	Repetition
BC 95 B5 B5	6
BC B5 36 36	1
7E 7E 7E 7E	41
7E 7E 7E 74	1
7E AB B5 B5	1
B5 B5 B5 B5	12
B5 5E 4A 7E	1
7E 7E 7E FE	1
F5 2E F6 DD	1
BC B5 D5 D5	1
CSPAT	
Sequence	Repetition
BC 95 B5 B5	6
BC B5 36 36	1
7F 7F 7F 7F	512
F1 96 DB 97	1
BC 95 D5 D5	1

Fig 6: The strings of an implemented compliance jitter pattern in the Compliance Test Patterns Component

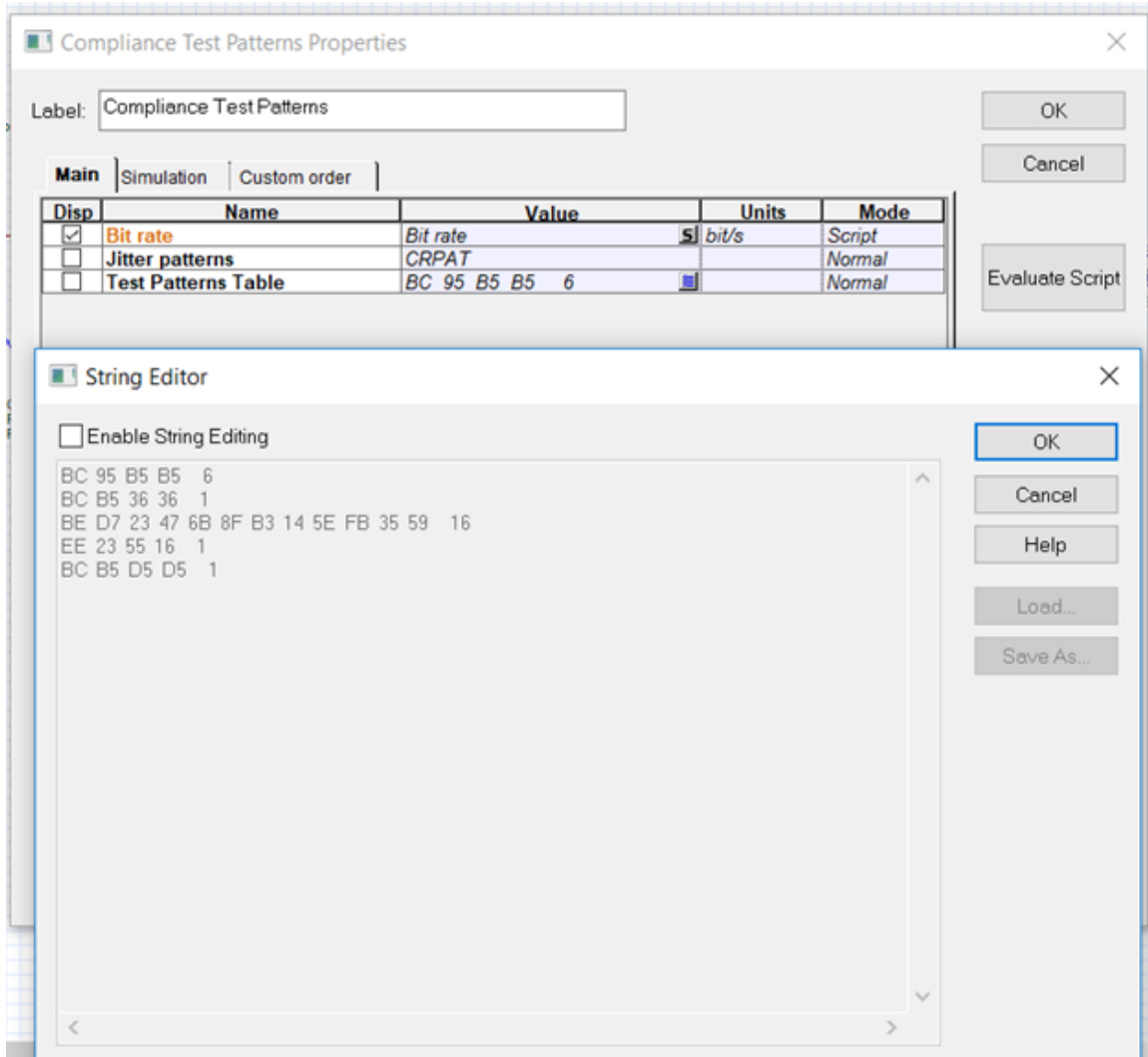


Fig 7: Pattern String Editor used to edit the jitter patterns and the number of sequence sweeps.



Other product improvements and fixes

User defined IQ-map

Users can enter a user defined IQ-map in the **QAM Sequence Generator**, **QAM Sequence Decoder**, and the **Decision** components.

EVM accuracy

A new parameter has been added to the **Decision** component called "**Decision Error Accuracy**", which will control the calculated EVM value.

Guided modes number

An approximate number of guided modes has been added to the results of the "**Parabolic-Index Multimode fiber**" and "**Measured-Index Multimode Fiber**" components.

Rayleigh backscattering

A time domain representation of the **Rayleigh backscattering signal (RBS)** in OptiSystem 16.0 has been added to relevant fiber components. The randomly produced RBS noise power level is measured accurately at the input port of the fiber. The RBS is also represented as a parametric signal in the frequency domain.

Visualizers relocation

A new subdirectory called "**M-ary**" is created in the "**Visualizer Library**" and the location of the different components in the "**Visualizer Library**" are reorganized for easier access. Also, "**Compare**" subdirectories were created in the Optical, Electrical, Binary and M-ary directories, where the relevant compare visualizers are now found.

View Signal Visualizer data download

A new tab has been added to the "**View Signal Visualizer**" component to allow exporting all samples/iterations when either the "**Convert To Optical individual Samples**" component or **sweeping feature** is used. Typically, one sample is displayed and can be exported as xxxxx.txt or Excel file. The new tab is called "**Export All Signal Indices**" to xxxxx.txt or excel file.



Modulators absorption and phase data file

A data file that represents the used data in the absorption and phase profiles of **“Single Drive MZ Modulator Absorption-Phase”** and **“Dual Drive MZ Absorption-Phase”** components has been added to the **Example Library** to allow users load/edit it

Applications updates

The Samples folder (OptiSystem 16.0 Samples) has been updated as follows:

- a. New example has been added to explain the operation of the “Compliance test Patterns” component. The “Compliance Test Patterns for pin jitter testing.osd” example is located at C:\Users\USERNAME\Documents\OptiSystem 16.0 Samples\Optical receiver design and analysis\Jitter analysis\
- b. The original example “8B 10B sequence Generator.osd” is improved by adding new visualizers to enable better understanding the results. A “View Signal Visualizer” and “Dual Port Binary Sequence Visualizer” are added to allow viewing the input and output bit sequences and their relevant pulses. The modified example is located at C:\Users\USERNAME\Documents\OptiSystem 16.0 Samples\Component sample files\Transmitters Library\Coders\
- c. New example showing the transmission of 8B/10B encoded signal has been added. The file name is “8B10B Sequence Generator-Decoder.osd”. The new example is located at C:\Users\USERNAME\Documents\OptiSystem 16.0 Samples\Component sample files\Transmitters Library\Coders\
- d. Three examples for DP-256QAM modulated signal at 160gbps are added to OptiSystem 16. The transmitted signal is evaluated for back-to-back, amplified and transmitted over 160km of SMF fiber cases. The new examples are located at C:\Users\USERNAME\Documents\OptiSystem 16.0 Samples\Advanced modulation systems\QAM systems\256 QAM\. Note that the sequence length and the number of samples per bit affect the accuracy of the calculation.
- e. A new example using OFDM 256-QAM modulated signal RoF transmission has been added to OptiSystem 16 Example Library. The new example is located at C:\Users\USERNAME\Documents\OptiSystem 16.0 Samples\Advanced modulation systems\OFDM systems\
- f. A new example on 16APSK “120 Gbps Nyquist DP-16APSK circular (1 2) 100km no-repeater system.osd” has been added at the following location. C:\Users\USERNAME\Documents\OptiSystem 16.0 Samples\Advanced modulation systems\



- g. An example on active mode-locked laser using intensity modulator inside a ring cavity has been added to OptiSystem 16. The example "Active Mode Locked Fiber Laser with IM.osd" is located at the location
C:\Users\USERNAME\Documents\OptiSystem 16.0 Samples\Optical amplifiers\Fiber lasers and amplifiers. The laser generated pulses are compressed from 0.5ms to 11ns.
- h. New example describing the operation of the "Optical Hard Limiter" component has been added to the Example Library. The example "Optical Hard Limiter_Cascaded.osd" uses cascaded hard limiter components. It is located at
C:\Users\USERNAME\Documents\OptiSystem 16.0 Samples\Component sample files\Signal Processing Library\Arithmetic\Optical
- i. The example "Spatial-Mode-Demultiplexing-Amplification.osd" has been renamed to "Spatial Division Multiplexing (two modes) Amplified Transmission.osd" to reflect its application.
- j. An example on the newly introduced FBG sensor component has been added to OptiSystem 16. The example "FBG Sensor.osd" is located at
C:\Users\USERNAME\Documents\OptiSystem 16.0 Samples\Sensor systems\FBG Sensor
- k. A new set of examples on the "Phi-OTDR" and "Phi-OTDR Interrogator" components have been added to the Example Library. Four examples to sense single, two, three and four vibrations are included. Also, one example showing the capability of loading an external experimentally measured vibration file has been added. This feature can be used to analyze experimentally measured data. The location of these examples are at
C:\Users\USERNAME\Documents\OptiSystem 16.0 Samples\Sensor systems\Phi-OTDR\
- l. New example "112Gbps DP-16QAM_OSNR Control_ Transmission System with DSP.osd" has been added to 16QAM example library located at
C:\Users\USERNAME\Documents\OptiSystem 16.0 Samples\Advanced modulation systems\QAM systems\16 QAM
- m. The example "Optical Frequency Comb Generation Using Stimulated Brillouin Scattering Recycling.osd" is used for generating comb laser using SBS nonlinear effect. The example is located at C:\Users\USERNAME\Documents\OptiSystem 16.0 Samples\Fiber analysis and design\Optical Fiber Nonlinearity\SBS
- n. A new example "Rayleigh Backscattering-Time Domain Representation.osd" has been added to OptiSystem 16.0 showing the time representation of Rayleigh scattering signal. The example is located at
C:\Users\USERNAME\Documents\OptiSystem 16.0 Samples\Fiber analysis and design\RayleighScattering\



- o. A new example "OptiGrating component.osd" allowing users to edit and load FBG transmission and reflection data file (FBG.txt) has been added to the Example Library. The example is located at
C:\Users\USERNAMEDocuments\OptiSystem 16.0 Samples\Software
interworking\OptiGrating

Documentation updates

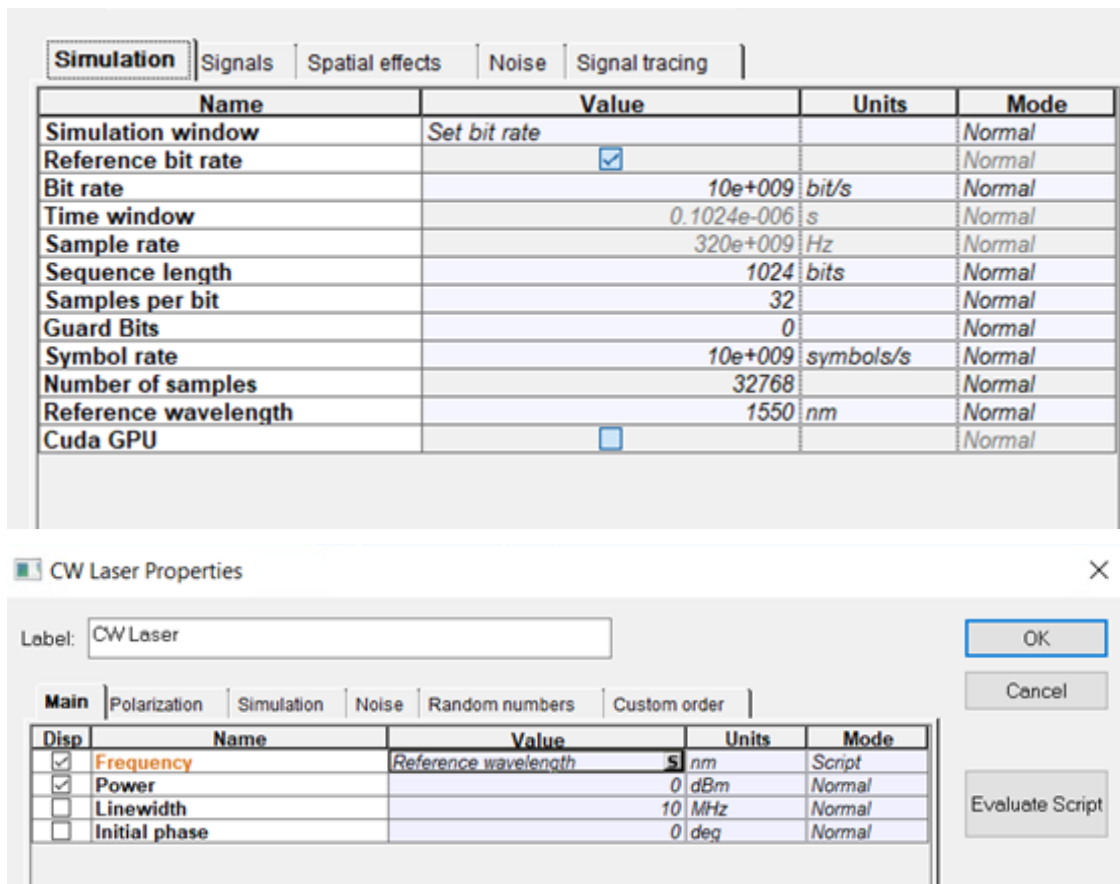
OptiSystem Component Library

New data sheets are created for the Compliance Test Patterns, Phi-OTDR, Phi-OTDR Interrogator, and FBG Sensor components. Also, the following datasheets are edited or corrected:

- a. The equation that describes the operation of the "Optical Hard Limiter" Component has been corrected.
- b. The data sheet of saturable absorber is edited to fix the unit of saturation power. A new reference by H. A. Haus, "Theory of mode locking with a fast-saturable absorber", Journal of Applied Physics, Vol. 46, No. 7, July 1975 has been added to the data sheet.
- c. New equations describing Fried parameter are added to the data sheet of the "FSO Channel" component. Also, a new reference has been added to the list of references.
- d. The data sheet of the "Optical DP-QPSK Transmitter" component has been edited to describe the process that allows using external laser and external PRBS for the component.
- e. The data sheets of the "Single Drive MZ modulator Absorption-Phase", "Dual Drive MZ Absorption-Phase" and "Dual Port Dual Drive MZ Absorption-Phase" components have been edited to show the structure of the absorption and phase data file. Thus, users can load/edit their own data files.
- f. The data sheet of the "Parabolic-Index Multimode Fiber" component is modified to show the method used to approximately calculate the number of modes propagating in the fiber.
- g. The FBG length unit has been fixed in the data sheets for the "Uniform FBG Sensor", "Fiber Bragg Grating (FBG)", "Empirical Laser Measured" and "Saturable Absorber" by changing it from nm to mm

OptiSystem Global Parameters

The Global Parameters Reference Guide document is edited to better explain some of the “**Layout Parameters**” especially the **Reference wavelength**. This parameter is only used in the **Phi-OTDR** component. However, it can be used to set a global **Reference wavelength** parameter that can be scripted to many different components in the project layout. For example, the user can set the value of the wavelength parameter used for these components to equal the “**Reference wavelength**” as shown below for a CW laser component as shown in Fig. 8.



The image shows two screenshots from the OptiSystem software. The top screenshot is the 'Simulation' tab of the Global Parameters dialog, showing a table of parameters. The bottom screenshot is the 'CW Laser Properties' dialog, showing the 'Main' tab with a table of parameters where the 'Frequency' is set to 'Reference wavelength'.

Global Parameters - Simulation Tab

Name	Value	Units	Mode
Simulation window	Set bit rate		Normal
Reference bit rate	<input checked="" type="checkbox"/>		Normal
Bit rate	10e+009	bit/s	Normal
Time window	0.1024e-006	s	Normal
Sample rate	320e+009	Hz	Normal
Sequence length	1024	bits	Normal
Samples per bit	32		Normal
Guard Bits	0		Normal
Symbol rate	10e+009	symbols/s	Normal
Number of samples	32768		Normal
Reference wavelength	1550	nm	Normal
Cuda GPU	<input type="checkbox"/>		Normal

CW Laser Properties - Main Tab

Label: CW Laser

Disp	Name	Value	Units	Mode
<input checked="" type="checkbox"/>	Frequency	Reference wavelength	nm	Script
<input checked="" type="checkbox"/>	Power	0	dBm	Normal
<input type="checkbox"/>	Linewidth	10	MHz	Normal
<input type="checkbox"/>	Initial phase	0	deg	Normal

Fig 8: Scripting the Frequency parameter of the CW Laser with a value equal to the Reference wavelength.