OptiSystem

Optical Communication System
and Amplifier Design Suite

17.0

New Features

New features are created in OptiSystem 17.0 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.

Optiwave

Key Features of OptiSystem 17.0

OptiSystem 17.0 version includes the creation of several new components and enhancement of many existing components.

New components include:

- GN Model
- LiFi Channel
- Multicore Fiber
- MCF XT-Bending Radius
- MCF XT-Core Pitch
- OTDR

Enhancements include:

- A check box is added to enable users saving the calculated data of the **Phi-OTDR** component to a file and allow them to define their desired path for storing the file.
- The datasheet of the **Linear Multimode Fiber** component is edited to show the format of the CamMMFi data file. A PDF file that describes the data structure is added to the example library at C:\ Users\user name\Documents\OptiSystem 17.0 samples\Component sample files\Multimode Library\Optical Fibers.
- An equation to calculate the peak to average power ratio (PAPR) parameter for the **OFDM Modulation** component is added to the component datasheet. The PAPR parameter could be viewed through the “Component Results...”.
- Appendix (3) is added to the **Optical Fiber** component data sheet to explain how to load the Optical Fiber data files located at C:\Program Files\Optiwave Software\OptiSystem 17\components\Optical Fiber\... to the component properties popup window.

New Components and Major Enhancements

GN-Model:

The **GN-Model** component is used to simulate long-haul single span and multi-span DWDM transmission systems. The DWDM channels can be modulated using mQAM or mPSK modulation schemes. The GN-Model allows ultra-fast calculation of the optical transmission systems compared to those methods that use traditional way of solving the nonlinear Schrödinger equation. The component can be used to calculated the System OSNR versus transmitted power as shown in Fig. 1, System BER versus received or transmitted power as shown in Fig. 2, and System maximum reach versus transmitted power as shown in Fig.3. The different graphs captured below are obtained using the default setting of the component. The graphs can be viewed by right-click on the component and select "**Component View…**", then choose 2D Graphs to display the results. The results can be also accessed through the "**Project Browser**" docker, where the graph and its data can be viewed and saved. A webinar was offered on this component and can be accessed on Optiwave's website: https://optiwave.com/category/resources/webinars/

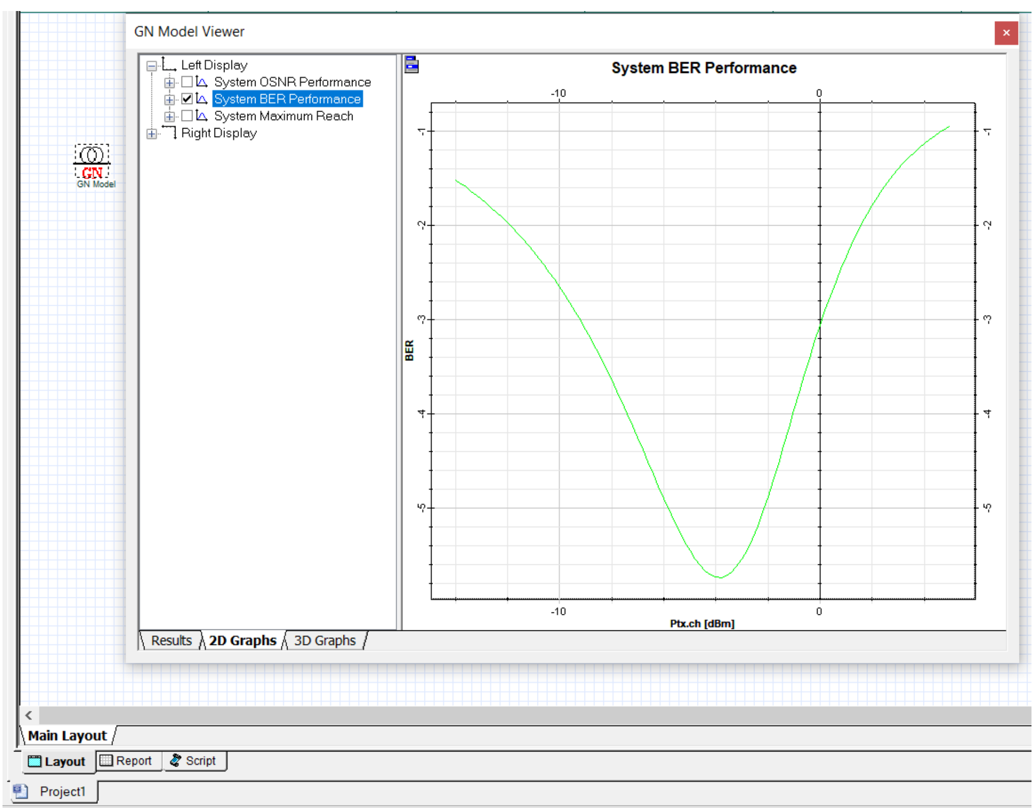


Fig 1: System BER versus channel transmitted power.

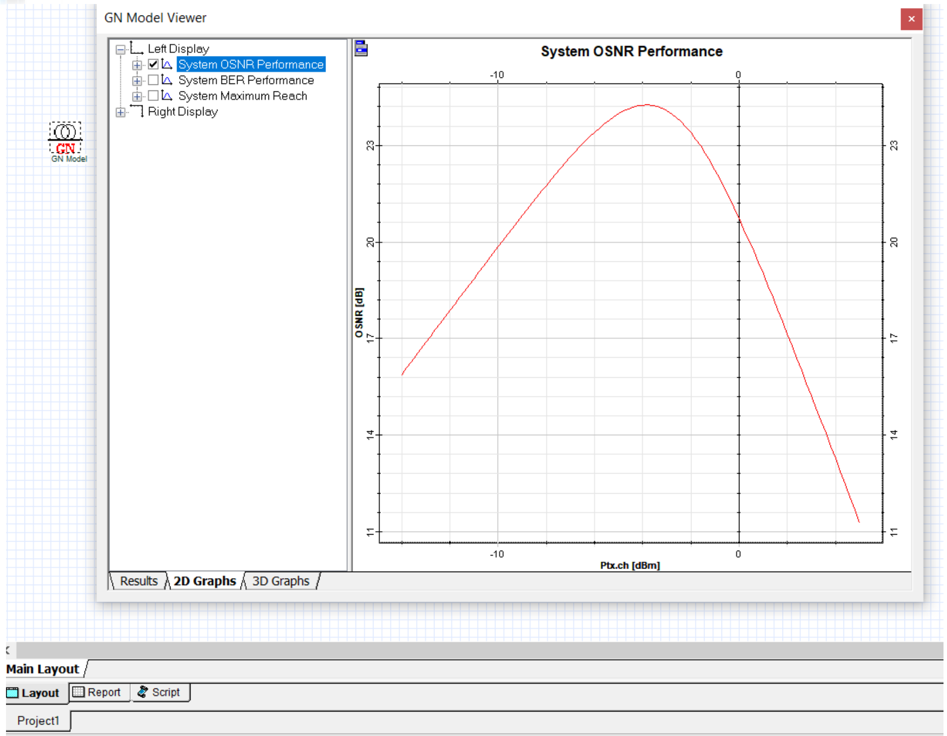


Fig 2: System OSNR versus transmitted power

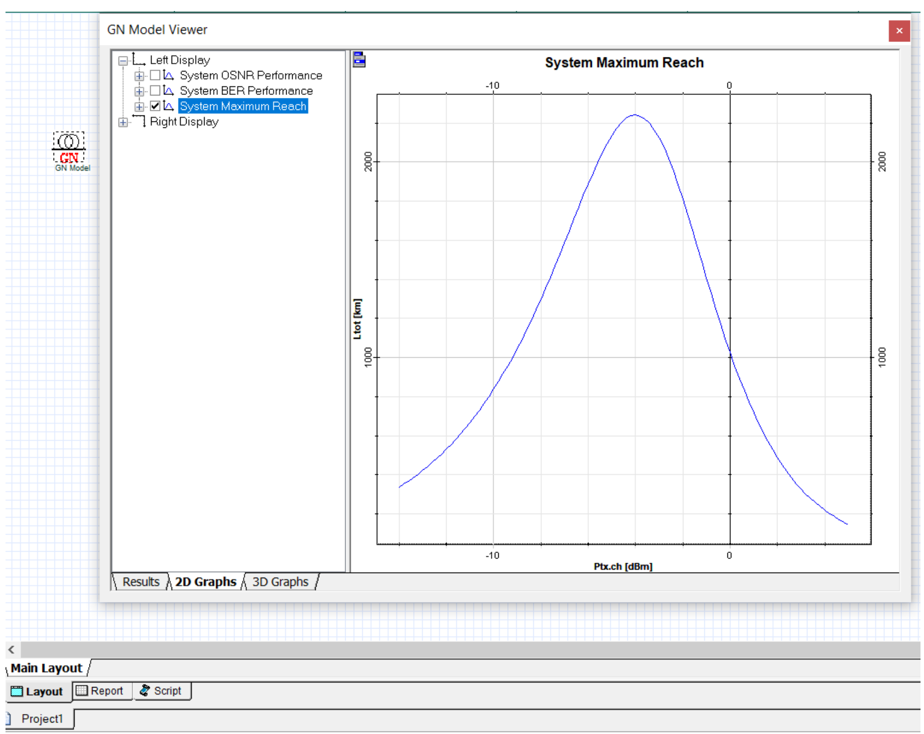


Fig 3: System maximum reach versus transmitted power

LiFi Channel:

The **LiFi Channel** component allows users to design LiFi system and investigate the power distribution of different transmitters located at different positions in a room as shown in Fig. 4. As well as, it calculates the impulse response and frequency response of the LiFi channel as illustrated in Fig. 5. Finally, the channel BER versus SNR performance can be simulated using this component for a non-return-to-zero on-off keying (NRZ-OOK) transmission systems as depicted in Fig. 6. The graphs captured for the default setting of the component can be viewed by right-click on the component and select "**Component View**…", then choose 2D Graphs to display the results. The results can be also accessed through the "**Project Browser**" docker, where the graph and its data can be viewed and saved. A webinar was offered on this component and can be accessed on Optiwave's website: https://optiwave.com/category/resources/webinars/

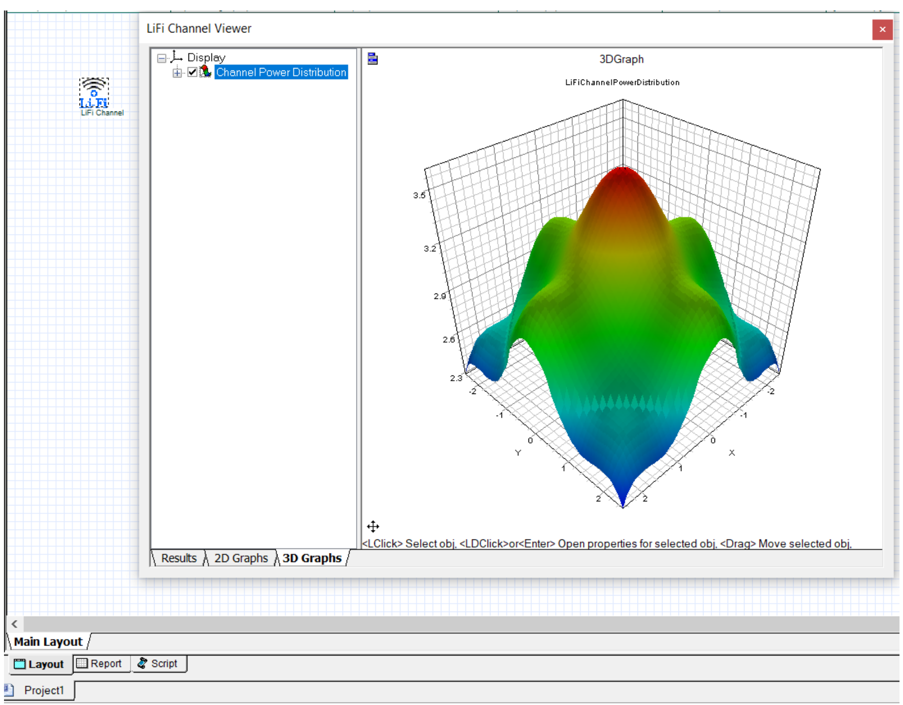
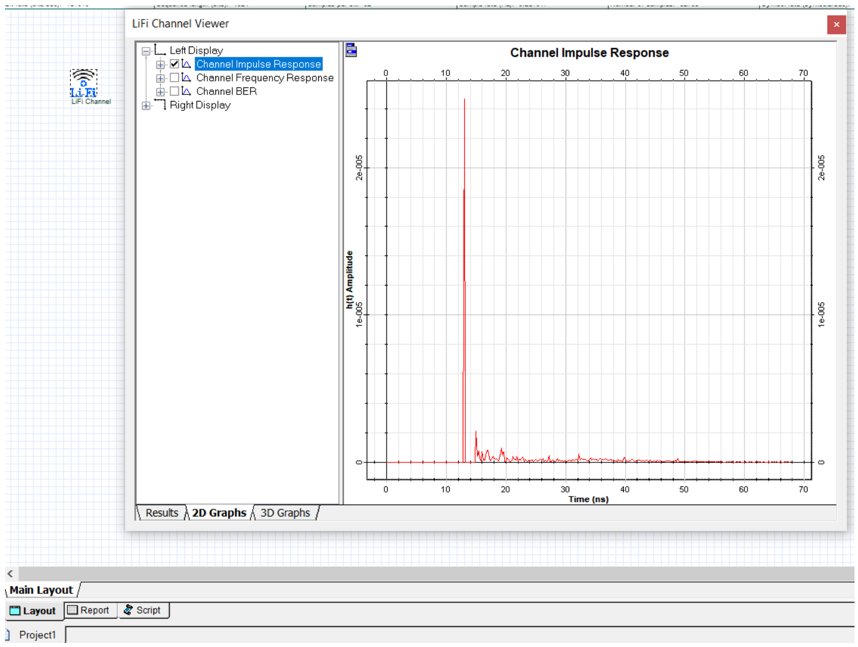
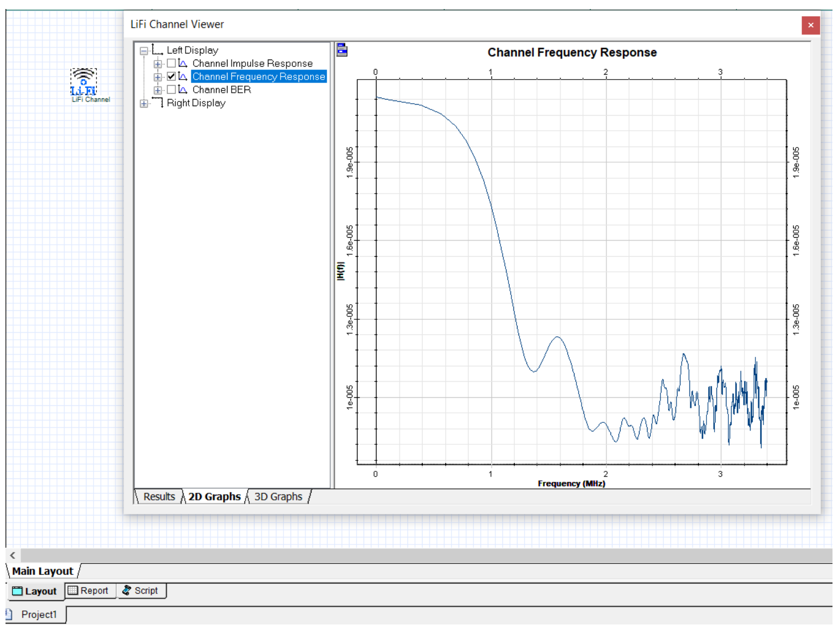


Fig 4: Power distribution 3D graph for a LiFi Channel component.



(a)



(b)

Fig 5: LiFi Channel Impulse response (a) and frequency response (b).

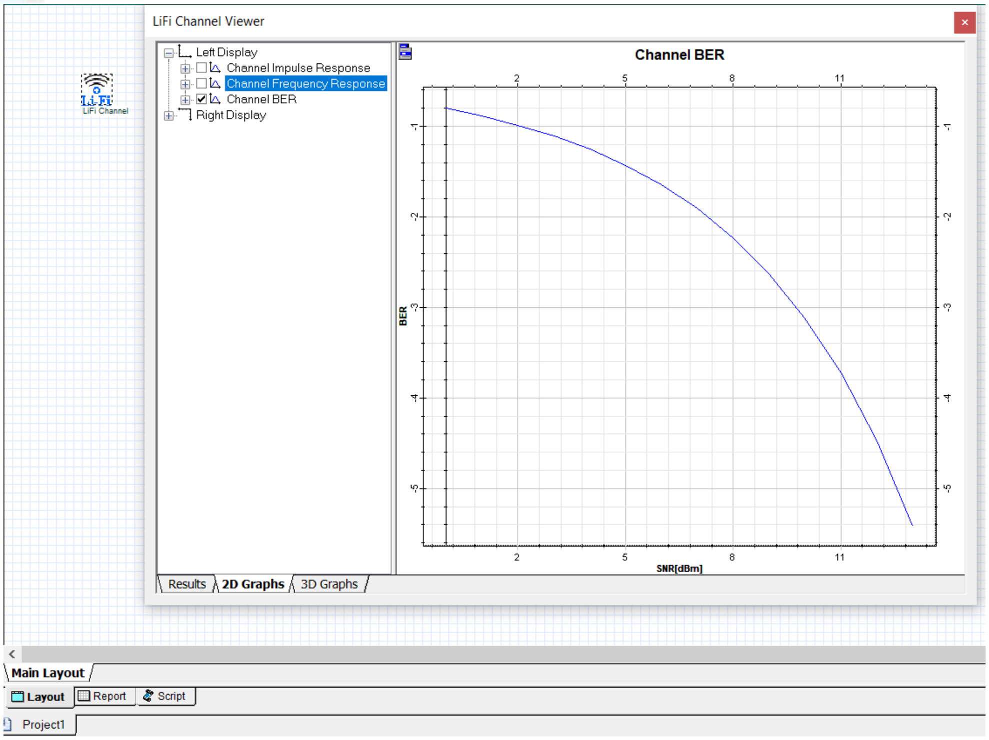


Fig 6: BER versus SNR for a NRZ-OOK LiFi Channel.

<u>Multicore Fiber</u>:

The **Multicore Fiber** component calculates core-to-core crosstalk and the total crosstalk for each core of a multicore fiber (MCF) cable. Users need to enter the MCF parameters then select a path for a .csv file used to save the results shown in Fig. 7. The default XTdBsumeachcore.csv file has the total crosstalk results for each core contributed by all other cores. Also, the file shows pass/fail messages about some crucial parameters that are calculated in the component and affect the overall simulation. These messages are related to bending radius loss, MCF fiber design choice, and coupling coefficient. When the value is 0, the calculation is a pass, while it is a fail when the value is -1. There are five different MCF structures that can be designed in this component. These structures are:

1. Homogeneous MCF without trench
2. Homogeneous MCF with trench
3. Heterogeneous MCF without trench
4. Heterogeneous MCF with trench
5. Homogeneous and heterogeneous MCF with one core with trench and the neighboring core without trench

XTdB sum of each core:			
-44.0838	-41.2378	-44.4188	
XTdB summarize:			
-1.#INF	-44.0838	-119.121	
-44.0838	-1.#INF	-44.4188	
-119.121	-44.4188	-1.#INF	
Bending loss error summarize:			
0	0	0	
CC error summarize:			
0	0	0	
0	0	0	
0	0	0	
Choice error summarize:			
0	0	0	
0	0	0	
0	0	0	

Fig 7: Results stored in the CSV file of the Multicore Fiber Component with default settings.

MCF XT-Bending Radius:

This component calculates the effect of bending radius on the crosstalk between two cores in a multi-core fiber cable. Users need to enter the MCF parameters then select the desired range of the MCF bending radius and its step size. The results of the simulation can be accessed by right-click on the component and select Component View. Then choose 2D Graphs to display the results as shown in Fig. 8. The results can be also accessed through the **Project Browser** docker, where the graph and its data can be viewed and saved.

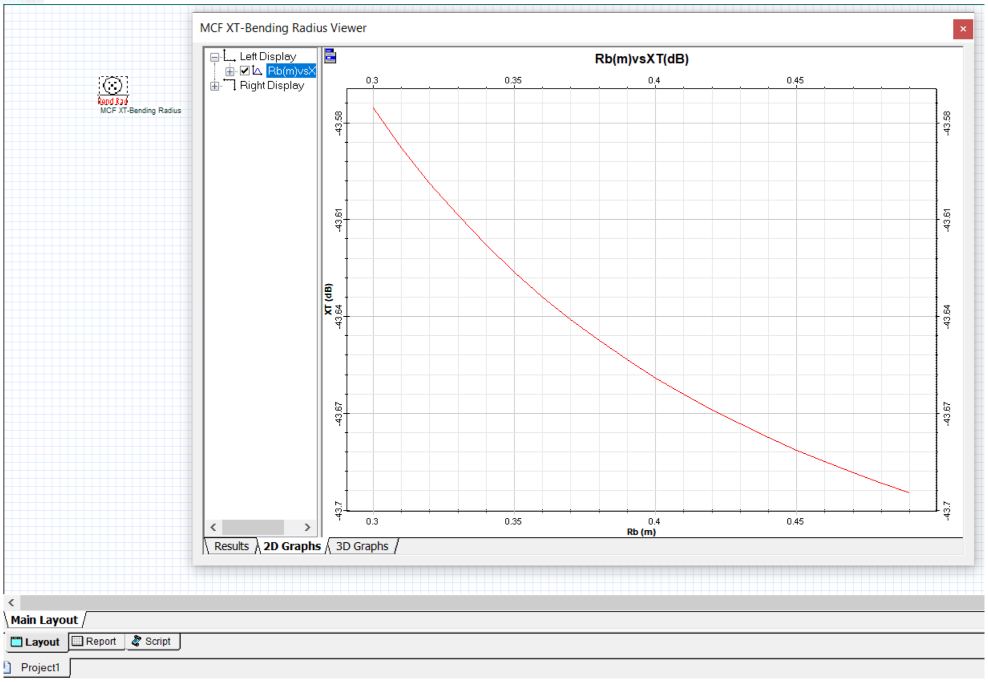


Fig 8: Crosstalk between neighboring cores of a MCF cable when changing the cable bending radius. The results are displayed for the component with default settings.

<u>MCF XT-Core Pitch</u>:

The **MCF XT-Core Pitch** component is used to calculate core-to-core crosstalk due to changes in their core pitch. neighboring cores of a multicore single-mode fiber (MCF) due to changes in their core pitch. Users need to enter the MCF parameters then select the desired range of the MCF core pitch and its step size. The results of the simulation can be accessed by right-click on the component and select **Component View**…. Then choose 2D Graphs to display the results. The results can be also accessed through **Project Browser** docker, where the graph and its data can be viewed and saved.

<u>OTDR</u>:

The **OTDR** component allows users to design and investigate OTDR performance of a multi-section fibers with different kinds of connection such as APC/APC, PC/PC, APC/PC and splice. Users control the pulses launching conditions and set the fiber cable physical characteristic. The parameters of each fiber attenuation, numerical aperture (NA), and length can be different. Fig.10 shows a trace of the **OTDR** component with default settings. The results can be viewed by right-click of the mouse on the component and select "**Component View...**". Then select the "2D Graphs" and expand either the Left Display or Right Display and select "Normalized Intensity R1" graph. The figure can also be accessed through the “**Project Browser**” by double clicking on the graph of the **OTDR** component or drag it to the “Report” page. The graph’s image and data can be saved.

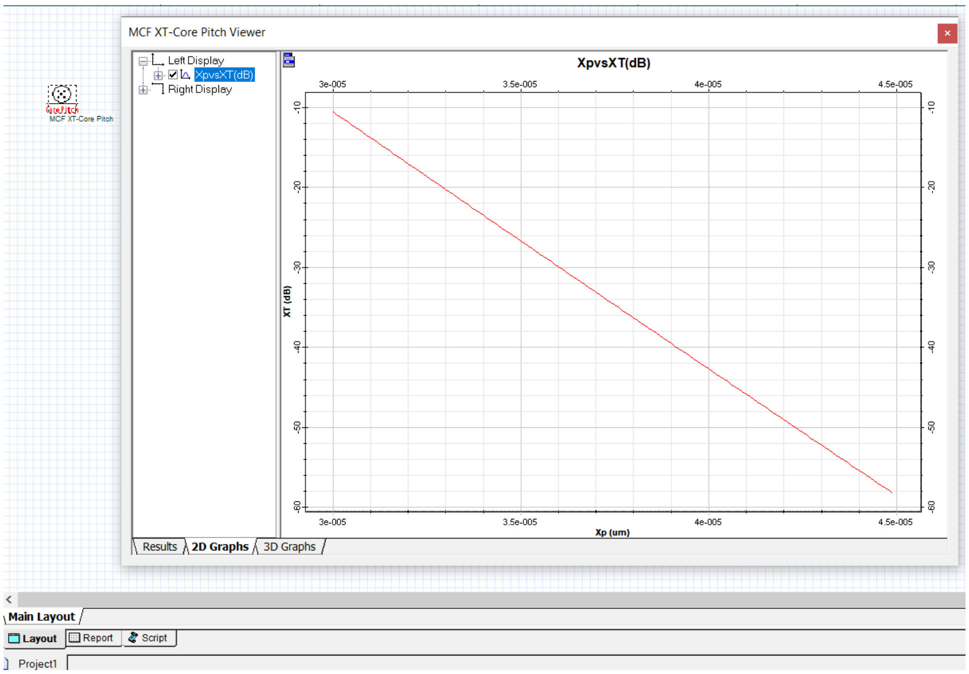


Fig 9: Crosstalk between neighboring cores of a MCF cable when changing their core pitch. The results are displayed for the component with default settings.

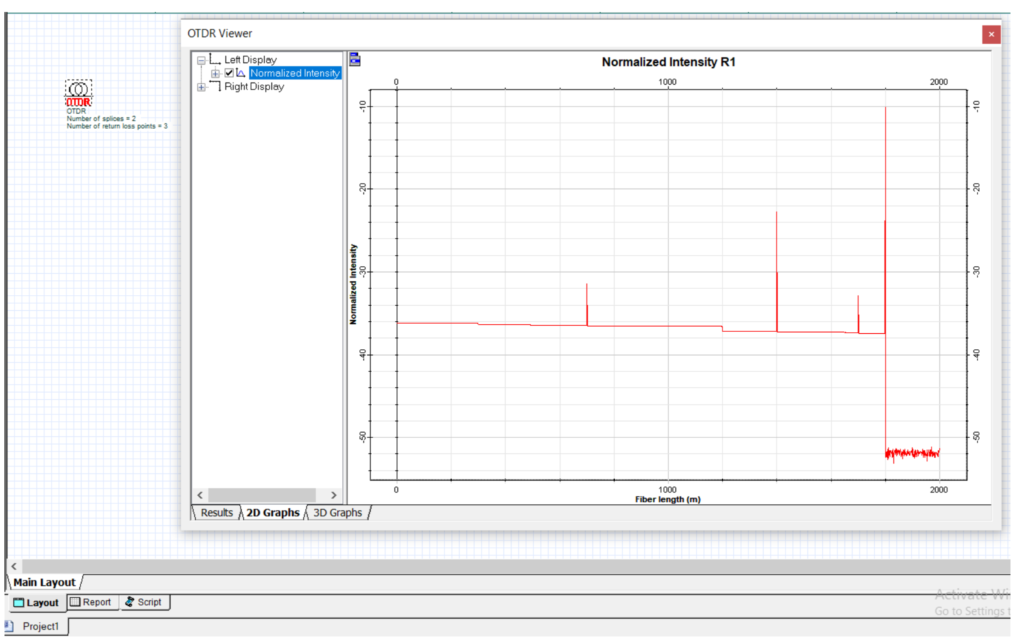


Fig 10: OTDR trace for six cables connected through a splice, APC/APC, splice, APC/PC, APC/APC, and terminated with flat surface.

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Product Improvements and Fixes

Python Component

The name of some libraries provided by Python software/Anaconda could change upon updates, which would cause OptiSystem to fail calculating the Python component examples provided in OptiSystem Example Library due to mismatch in the file names. Please make sure that python specific version (Python 3.7) is used with the proper release of OptiSystem.

Getting Started Guide and User Reference Guide Access

The issue of accessing the "**Getting Started Guide**" and "**User Reference Guide**" from the "**Help**" filed in OptiSystem GUI tool bar is fixed in OptiSystem version 17.0.

Optical Spectrum Analyzer Visualizer & Dual Port Optical Spectrum Analyzer Visualizer

OptiSystem software crashes when signals with optical spectrum has values of 0 Hz, while the setting of the **Optical Spectrum Analyzer** visualizer or the **Dual Port Optical Spectrum Analyzer** visualizer is in "m". The software does not crash if the setting is "Hz". The issue has been fixed in OptiSystem 17.0.

3D Graph

The results displayed using the **3D Graph** feature when dragged from the "**Graphs**" field of the component in the "**Project Browser**" docker into the "**Report**" page are not correct. This issue has been fixed in OptiSystem 17.0

View Signal Visualizer

When changing the number of samples in the project layout and go from higher number of samples to a lower number of samples, the change is not reflected on the captured number of samples in the "**View Signal Visualizer**" component. This issue is resolved in OptiSystem 17.0.

Applications Updates

OptiSystem 17.0 Samples folder has been updated with the following:

a. The example (RA Optimizing pump power and frequencies - Average model.osd) is edited to allow convergence of the optimization of the Raman amplifier gain for the used lasers wavelength and pump power. The example is located at C:\Users\user name\Documents\OptiSystem 17.0 Samples\Optical amplifiers\Raman amplifiers

b. A new example (VCSEL Laser Measured Impulse response.osd) is created to simulate the frequency response of the "**VCSEL Laser Measured**" component. The file is located at C:\Users\user name\Documents\OptiSystem 17.0 Samples\Component sample files\Transmitters Library\Optical Sources

c. An example (polarization control in VCSEL Laser.osd) is created to control the polarization of the VCSEL laser output. The file is located at C:\Users\user name\Documents\OptiSystem 17.0 Samples\Optical transmitter design and analysis\VCSEL models

d. A new example (VCSEL Harmonic Distortion suppression.osd) is created to demonstrate the suppression of nonlinearity in VCSEL using feedback technique. The example file is located at C:\Users\user name\Documents\OptiSystem 17.0 Samples\Component sample files\Transmitters Library\Optical Sources

e. The example (Coexisting GPON and NG-PON1.osd) is created for upgrading GPON and coexisting with NG-PON1. The file is located at C:\Users\user name\Documents\OptiSystem 17.0 Samples\Metro and access systems\PON and CDMA systems

f. The text file CamMMFI.txt and its description in a pdf file are added to the example library directory at C:\Users\user name\Documents\OptiSystem 17.0 Samples\Component sample files\Multimode Library\Optical Fibers. The CamMMFI.txt file is used in the "Linear Multimode Fiber" component.

g. A new example (supercontinuum in PCF.osd) is created for generating supercontinuum in photonic crystal fiber (PCF). It is placed in the example library at C:\Users\user name\Documents\OptiSystem 17.0 Samples\Fiber analysis and design\PCF. The parameters of the PCF are generated using OptiMode software. The files used in OptiMode can be found in the same directory.

h. The BER calculation in the example (LiFi Model.osd) located in C:\Users\user name\Documents\OptiSystem 17.0 Samples\Optical wireless\Indoor optical link\... is fixed.

i. A new example (Raman self-frequency shift_Soliton.osd) is created and placed at the location C:\Users\user name\Documents\OptiSystem 17.0 Samples\Fiber analysis and design\Optical Fiber Nonlinearity\SRS. The effect of the pulse width on the Raman self-frequency shit and the propagated distance is demonstrated in this example.

j. A new example (Phase Modulator and detection.osd) located at C:\Users\user name\Documents\OptiSystem 17.0 Samples\Component sample files\Transmitters Library\Modulators\Optical\... is created.

k. The example (PAM fiber link w PAM Decision.osd) located at the C:\Users\user name\Documents\OptiSystem 17.0 Samples\Advanced modulation systems\PAM systems\... is edited for better visualization by adding "**Eye Diagram Analyzer**" visualizer at different locations.

l. An optical not signal example (Optical Not.osd) is created. It is located at C:\Users\user name\Documents\OptiSystem 17.0 Samples\Component sample files\Signal Processing Library\Logic\Optical.

m. A microwave photonic filter example (Microwave photonic filter.osd) is created. The example is located in the directory C:\Users\user name\Documents\OptiSystem 17.0 Samples\Microwave and RF optical systems.

n. A new example on satellite communication (inter satelite Design.osd) is added at the location C:\Users\user name\Documents\OptiSystem 17.0 Samples\Optical wireless\Earth-satellite design.

o. A new FBG sensor example (FBG temp sensing.osd) is created and placed in the directory C:\Users\user name\Documents\OptiSystem 17.0 Samples\Sensor systems\FBG Sensor.

p. A new example on double pass EDFA using reflective mirror and grating (double pass EDFA.osd) is added. The example is located at C:\Users\user name\Documents\OptiSystem 17.0 Samples\Optical amplifiers\EDFA models and analysis.

q. New example on using VCSELs in OFDM QAM modulated signals (Direct Detection OFDM 4 QAM_VCSEL direct modulation.osd) is created. It is located at C:\Users\user name\Documents\OptiSystem 17.0 Samples\Advanced modulation systems\OFDM systems.

r. The OFDM QAM direct detection example (Direct Detection OFDM 4 QAM.osd) is edited to allow best performance. The example is located at C:\Users\User name\Documents\OptiSystem 17.0 Samples\Advanced modulation systems\OFDM systems.

s. New example on PON (PON Co-existing.osd) is added. The file is located at C:\Users\user name\Documents\OptiSystem 17.0 Samples\Metro and access systems\PON and CDMA systems.

t. A new example (112Gbps SP-16QAM_B2B_subsystem with DSP_Investigating Power level calculation.osd) is added to validate the calculation of power levels of QAM modulated using postprocessing of modulated signal data in an excel sheet. The example and excel files are located at C:\Users\user name\Documents\OptiSystem 17.0 Samples\Advanced modulation systems\QAM systems\16 QAM.

u. A new single polarization 16QAM transmission example (112Gbps SP-16QAM_B2B_subsystem with DSP.osd) is added and located at C:\Users\user name\Documents\OptiSystem 17.0 Samples\Advanced modulation systems\QAM systems\16 QAM.

v. New 64QAM OFDM ROF example (64QAM-OFDM Signal ROF transmission.osd) is created and located at C:\Users\user name\Documents\OptiSystem 17.0 Samples\Advanced modulation systems\OFDM systems.

w. A new example (4 PAM - VCSEL MMF Fiber Link.osd) is created to generate a 4PAM signal using multimode VCSEL over multimode fiber. The example is located at C:\Users\user name\Documents\OptiSystem 17.0 Samples\Multimode systems.

x. New example (2D-SWZCC_spectral-spatial OCDMA system.osd) on two-dimensional spectral/spatial OCDMA system is added and located at C:\Users\user name\Documents\OptiSystem 17.0 Samples\Metro and access systems\PON and CDMA systems.

y. A new example (5 fiber cables with 2 splices and 2 connectors-OTDR example.osd) is created to characterize 5 pieces of fiber with 2 splices and 2 connectors. The example is located at C:\Users\user name\Documents\OptiSystem 17.0 Samples\Sensor systems\OTDR.

z. New example (6 fiber cables with 2 splices and 2 connectors-OTDR example.osd) is created to characterize 6 pieces of fiber with 2 splices and 3 connectors. The example is located at C:\Users\user name\Documents\OptiSystem 17.0 Samples\Sensor systems\OTDR.

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Documentation Updates

New data sheets are created for the **GN-Model**, **LiFi Channel**, **Multicore Fiber**, **MCF XT-Bending Radius**, **MCF XT-Core Pitch** and **OTDR** components.

VCSEL Laser Component

The Measured LI and LV data files for the 683nm VCSEL Laser are copied from C:\Users\user name\Documents\OptiSystem 16.1 Samples\Optical transmitter design and analysis\VCSEL models and placed in C:\Users\user name\Documents\OptiSystem 17.0 Samples\Component sample files\Transmitters Library\Optical Sources. This allows easier access to the files.

Linear Multimode Fiber Component

The datasheet of the component is edited to show the format of the CamMMFi data file. A description PDF file is added to the example library at C:\......\OptiSystem 17.0\samples\Component sample files\Multimode Library\Optical Fibers.

OFDM Modulation Component

An equation that is used to calculate the peak to average power ratio (PAPR) parameter of the **OFDM Modulation** component is added to the datasheet. The PAPR parameter could be viewed through the “Component Results...”.

Optical Fiber Component

Appendix (3) is added to the **Optical Fiber** component data sheet to explain how to load the Optical Fiber data files located at C:\Program Files\Optiwave Software\OptiSystem 17\components\Optical Fiber\... into the component properties popup window.

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Document revised: Mar 10-2020