OptiSystem

Optical Communication System and Amplifier Design Suite

12.2

New Features

Created to address the needs of research scientists, optical telecom engineers, professors and students, OptiSystem satisfies the demand of users who are searching for a powerful yet easy to use optical communication system design tool.

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Key Features for OptiSystem 12.2

OptiSystem 12.2 includes several important component and feature enhancements that improve the design and analysis capabilities of higher order modulation system designs (notably for 16-QAM and QPSK, single or dual polarization channel, coherent systems).

- New capabilities have been added to the ***DSP for 16-QAM*** component (formally known as ***DSP for DP-16-QAM***) and ***DSP for QPSK*** component (formally known as ***DSP for DP-QPSK***) including DC blocking, normalization, resampling, quadrature imbalance compensation, timing recovery & frequency offset estimation.
- Enhancements have also been made to the chromatic dispersion compensation, adaptive equalization, and carrier phase estimation algorithms.
- A new ***Decision*** component has been added to the Receivers/Demodulators library to allow for the automated setting and optimization of decision settings for QPSK and 16-QAM signal formats.
- Differential encoding has been added to the ***QPSK*** and ***QAM sequence generators*** and ***decoders*** (to resolve phase ambiguity problems with 16-QAM and QPSK modulation formats) thus providing improved distance performance for these types of coherent-based systems.
- The ***BER Test Set*** component has been enhanced to provide more effective measurement tools for the analysis of impairments in higher order modulation systems including bit error rate (BER) direct counts per sequence iteration and the running average of the BER results. Separate BER data is also provided for X, Y and X+Y polarization channels.
- The ***WDM Analyzer*** component has been updated to allow for the calculation of SNR or OSNR depending on the designer's test configuration requirements.
- New "Symbol rate" and "Guard Bits" parameters have been added to the *Global Parameters* window to better align system settings for higher modulation systems.

New library components

<u>Receivers/Demodulators</u>: Decision

The new ***Decision*** component processes the I & Q electrical signal channels received from the DSP stage, normalizes the electrical amplitudes of each I and Q channel to the respective QPSK or 16-QAM grid, and performs a decision on each received symbol based on normalized threshold settings for QPSK or 16-QAM. The Decision component also supports single or dual polarization (SP/DP) multiplexing schemes.

The Decision component performs the following functions:

- DC blocking
- Normalization
- Error Vector Magnitude (EVM) calculation
- Decision (including optimization procedures for constellation rotation, timing alignment and polarization rotation)
- Calculate Symbol Error Rate (SER)

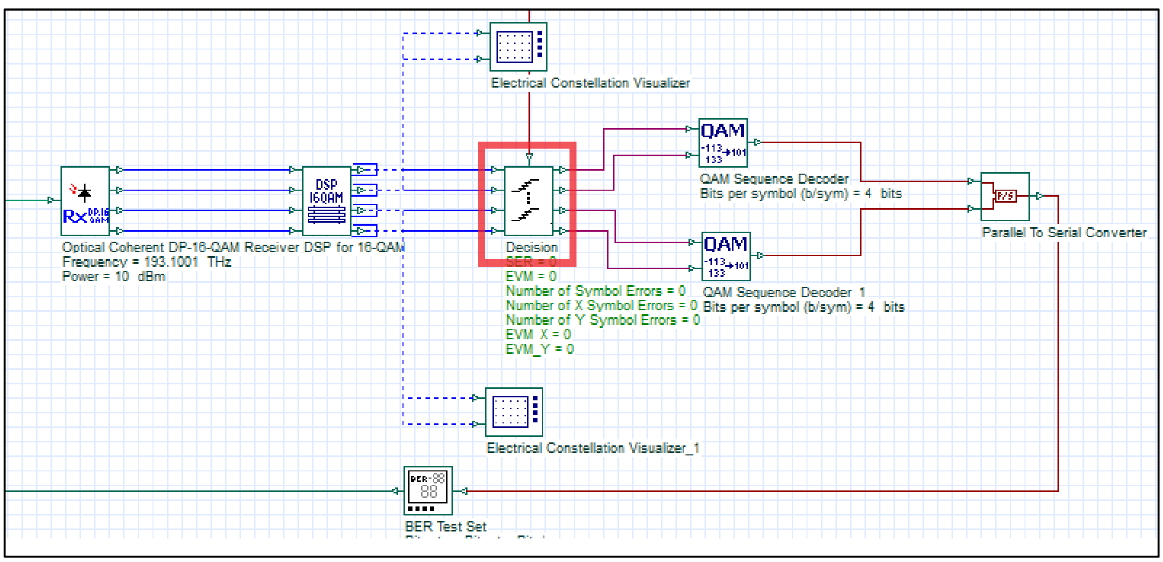

__Fig 1__: __Decision component__ - The decision component automatically normalizes the electrical amplitudes of each I and Q channel to the respective QPSK or 16-QAM grid and performs an optimized decision on each received symbol based on normalized threshold settings for QPSK or 16-QAM.

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Library Component Enhancements

<u>Receivers/Digital Signal Processing</u>: DSP for 16-QAM

The ***DSP for 16-QAM*** component (formerly ***DSP for DP-16-QAM***) performs several important functions to aid in recovering the incoming transmission channel(s) after coherent detection. It can be used with coherent system designs that utilize 16-QAM modulation with single polarization (X channel) or dual polarization (X and Y channel) multiplexing. This component has undergone several important updates, including:

<u>Pre-processing</u>

- Noise (from noise bins) is now automatically added to the sampled signal data.
- DC blocking is now performed to deal with imperfectly biased voltage settings in modulators.
- Normalization is now automatically performed to set the received symbols to the [-3, -1, 1, 3] 16-QAM constellation grid.

<u>DSP algorithms</u>

- A Bessel filter has been integrated into the ***DSP for 16-QAM*** component (thus eliminating the requirement to use an external filter).
- Quadrature Imbalance (QI) compensation is now performed to mitigate the amplitude and phase imbalances of the in-phase and quadrature signals.
- The chromatic dispersion (CD) compensation algorithm has been enhanced to include a frequency domain transfer function (complementing the existing time-domain FIR filter).
- Timing recovery is now performed to ensure that received symbols are synchronized.
- The Adaptive Equalizer (AE) algorithm has been improved and now uses the two stage constant modulus and radius-directed (CMA-RD) method.
- Frequency Offset Estimation (FOE) is now performed to deal with frequency and phase mismatching between the received carrier and local oscillator.
- The Carrier Phase Estimation (CPE) algorithm has been improved and now uses the blind phase search method.

<u>Component flexibility</u>

- All stages of the DSP algorithms can be separately activated or deactivated thus allowing for DSP component cascading. Designers can also easily integrate external DSP algorithms (such as MATLAB-based algorithms) into a DSP component cascade.
- The ***DSP for 16-QAM*** component can be optionally setup to support single or dual polarization system configurations (16-QAM, DP-16-QAM)

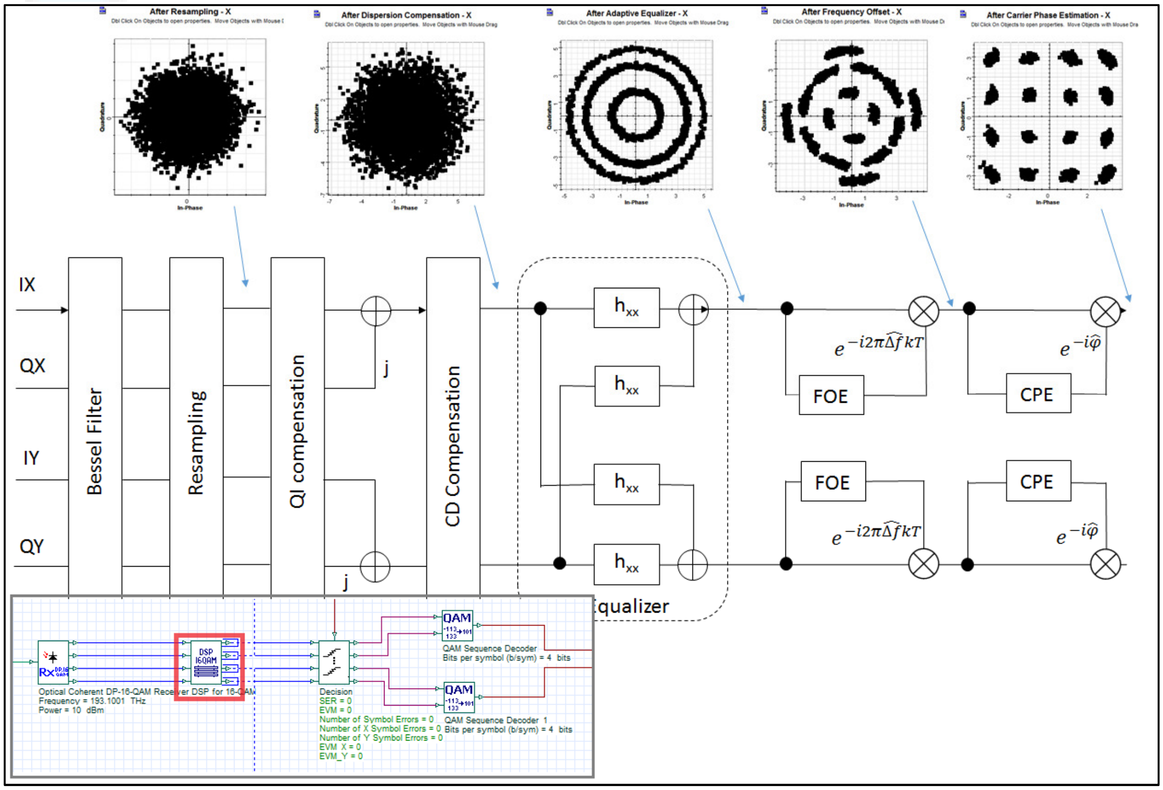


Fig 2: DSP for 16-QAM *– New features include DC blocking, normalization, resampling, quadrature imbalance compensation, timing recovery & frequency offset estimation.*

<u>Receivers/Digital Signal Processing</u>: DSP for QPSK

The ***DSP for QPSK*** component (formerly ***DSP for DP-QPSK***) performs several important functions to aid in recovering the incoming transmission channel(s) after coherent detection. It can be used with coherent system designs that utilize QPSK modulation with single polarization (X channel) or dual polarization (X and Y channel) multiplexing. This component has undergone several important updates, including:

<u>Pre-processing</u>

- Noise (from noise bins) is now automatically added to the sampled signal data.
- DC blocking is now performed to deal with imperfectly biased voltage settings in modulators.
- Normalization is now automatically performed to set the received symbols to the [-1, 1] QPSK constellation grid.

<u>DSP algorithms</u>

- A Bessel filter has been integrated into the ***DSP for QPSK*** component (thus eliminating the requirement to use an external filter).
- Quadrature Imbalance (QI) compensation is now performed to mitigate the amplitude and phase imbalances of the in-phase and quadrature signals.

- The chromatic dispersion (CD) compensation algorithm has been enhanced to include a frequency domain transfer function (complementing the existing time-domain FIR filter).
- Timing recovery is now performed to ensure that received symbols are synchronized.
- The functionality of the existing CMA algorithm (within the Adaptive Equalizer (AE) algorithm) has been improved for more accuracy and robustness.
- Frequency Offset Estimation (FOE) is now performed to deal with frequency and phase mismatching between the received carrier and local oscillator.
- The functionality of the existing 4th power method (within the Carrier Phase Estimation (CPE) algorithm) has been improved for more accuracy and robustness.

<u>Component flexibility</u>

- All stages of the DSP algorithms can be separately activated or deactivated thus allowing for DSP component cascading. Designers can also easily integrate external DSP algorithms (such as MATLAB-based algorithms) into a DSP component cascade.
- The ***DSP for QPSK*** component can be optionally setup to support single or dual polarization system configurations (QPSK, DP-QPSK).

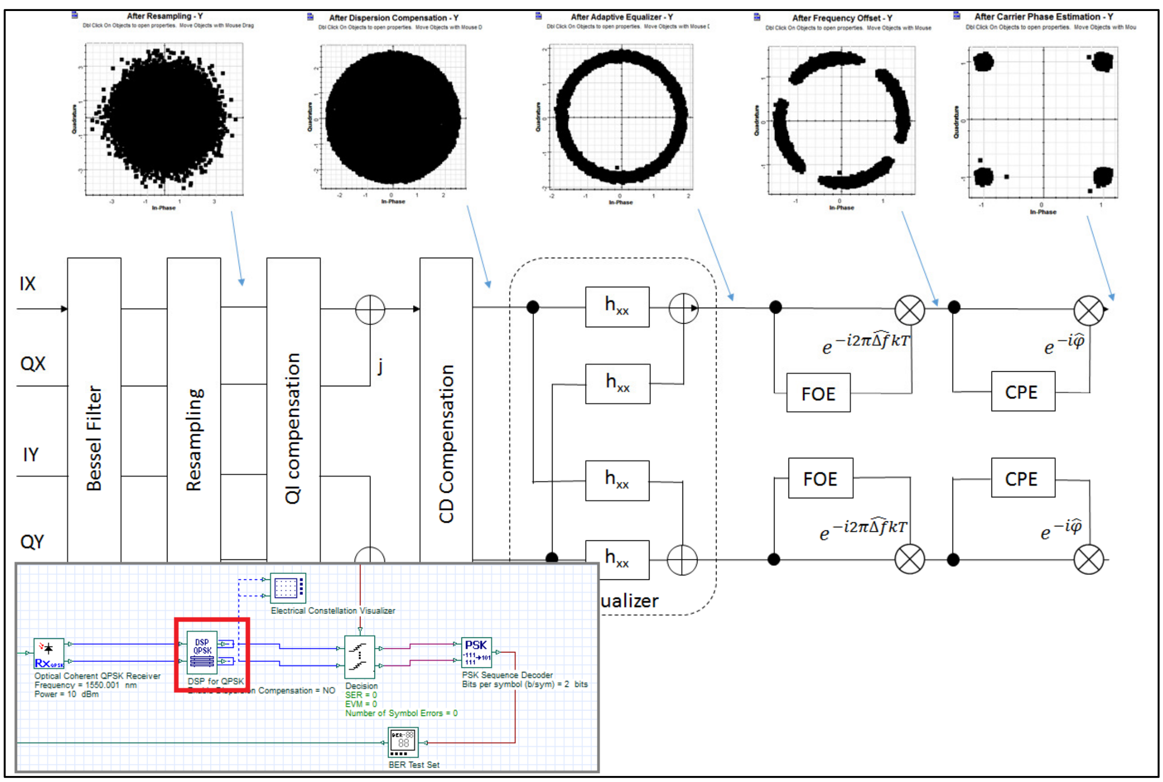


Fig 3: DSP for QPSK *- New features include DC blocking, normalization, resampling, quadrature imbalance compensation, timing recovery & frequency offset estimation.*

Visualizers: BER Test Set

The ***BER Test Set*** component has been enhanced to provide more effective measurement tools for the analysis of impairments in higher order modulation systems. Direct error counting is now provided for one or more sweep iterations based on a defined sequence length of bits. From this data it is possible to determine the bit error rate (BER) per iteration and also the running average of the BER results. BER data is also provided for X, Y and X+Y polarization channels.

Using the OptiSystem nested sweep feature, BER graphs are now automatically created as a function of a defined impairment parameter (such as OSNR) – see Fig. 4.

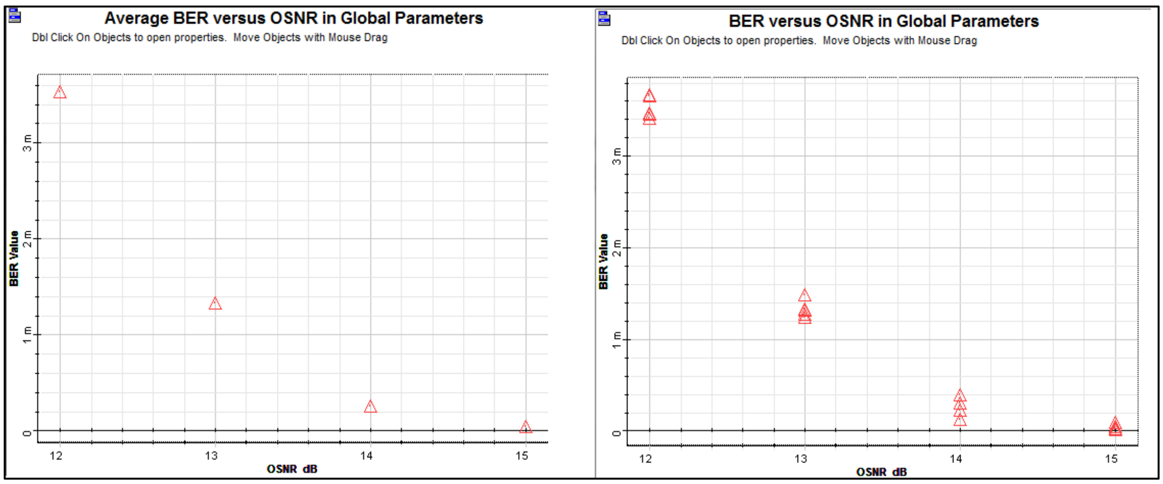
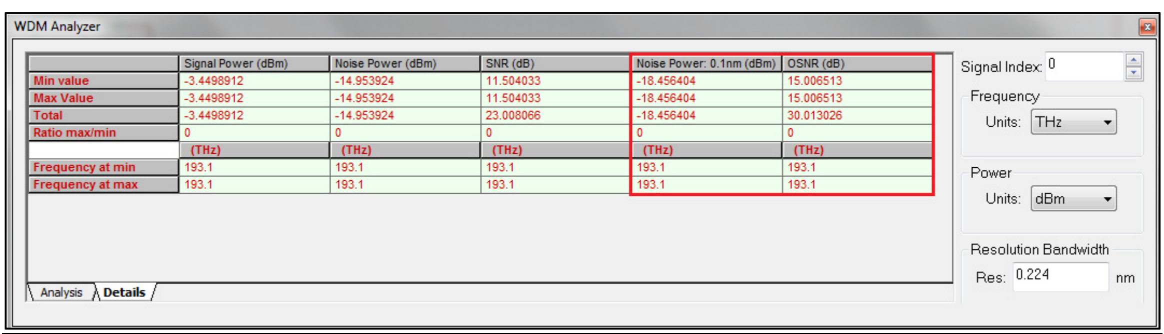


Fig 4: *BER Test Set – BER and average BER results for multiple bit sequences as a function of varying OSNR values*

Visualizers: WDM Analyzer

The ***WDM Analyzer*** component has been enhanced to provide users with both signal to noise (SNR) and optical signal to noise (OSNR) measurements for single and multiple wavelength systems.



	Signal Power (dBm)	Noise Power (dBm)	SNR (dB)	Noise Power: 0.1nm (dBm)	OSNR (dB)
Min value	-3.4498912	-14.953924	11.504033	-18.456404	15.006513
Max Value	-3.4498912	-14.953924	11.504033	-18.456404	15.006513
Total	-3.4498912	-14.953924	23.008066	-18.456404	30.013026
Ratio max/min	0	0	0	0	0
	(THz)	(THz)	(THz)	(THz)	(THz)
Frequency at min	193.1	193.1	193.1	193.1	193.1
Frequency at max	193.1	193.1	193.1	193.1	193.1

Fig 5: *WDM Analyzer – New measurement parameters have been added for "Noise Power @ 0.1 nm" and "OSNR".*

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Global parameters: Symbol rate and Guard bits

Two new parameters have been added to the *Global Parameters* window to simplify the setup and analysis of higher order modulation systems. The new “Symbol rate” parameter can be used, for example, to define the Cutoff frequency of the electrical filters. The new “Guard bits” parameter allows designers to specify the number of bits to ignore (for example by the BER Test Set) at the beginning and end of each bit sequence. For example, when performing the analysis of coherent systems, the DSP algorithm requires a certain number of bits to train the compensation system. Guard bits are thus useful as we do not want to count “training” errors as part of the overall BER system performance.

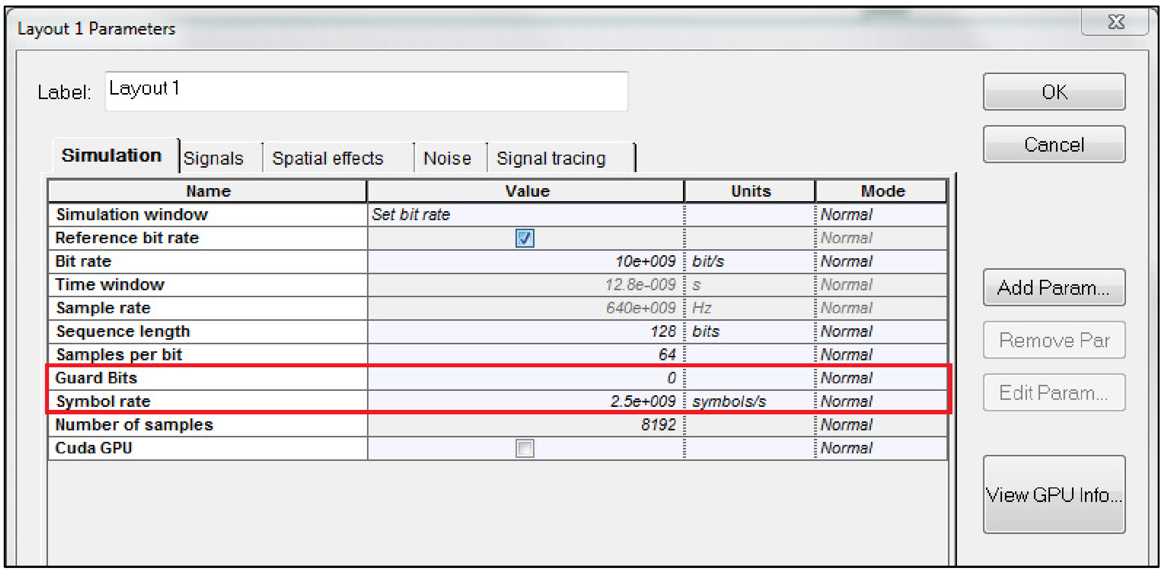

Fig 6: *Global parameters – New parameters have been added for “Guard bits” and “Symbol rate”*

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