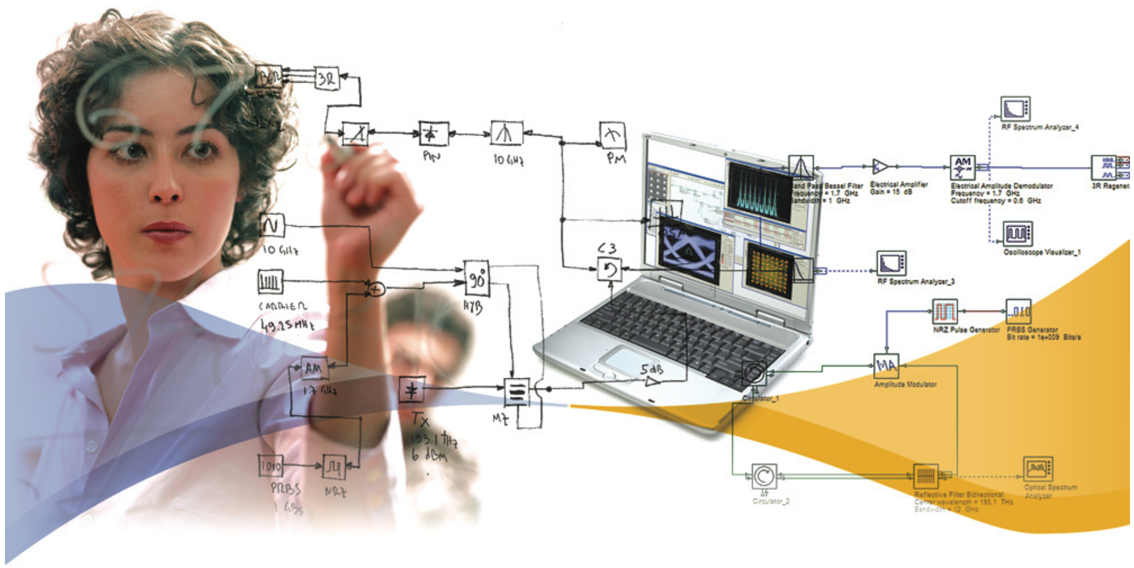

OptiSystem applications:
Digital modulation analysis (PSK)

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Introduction

PSK modulation

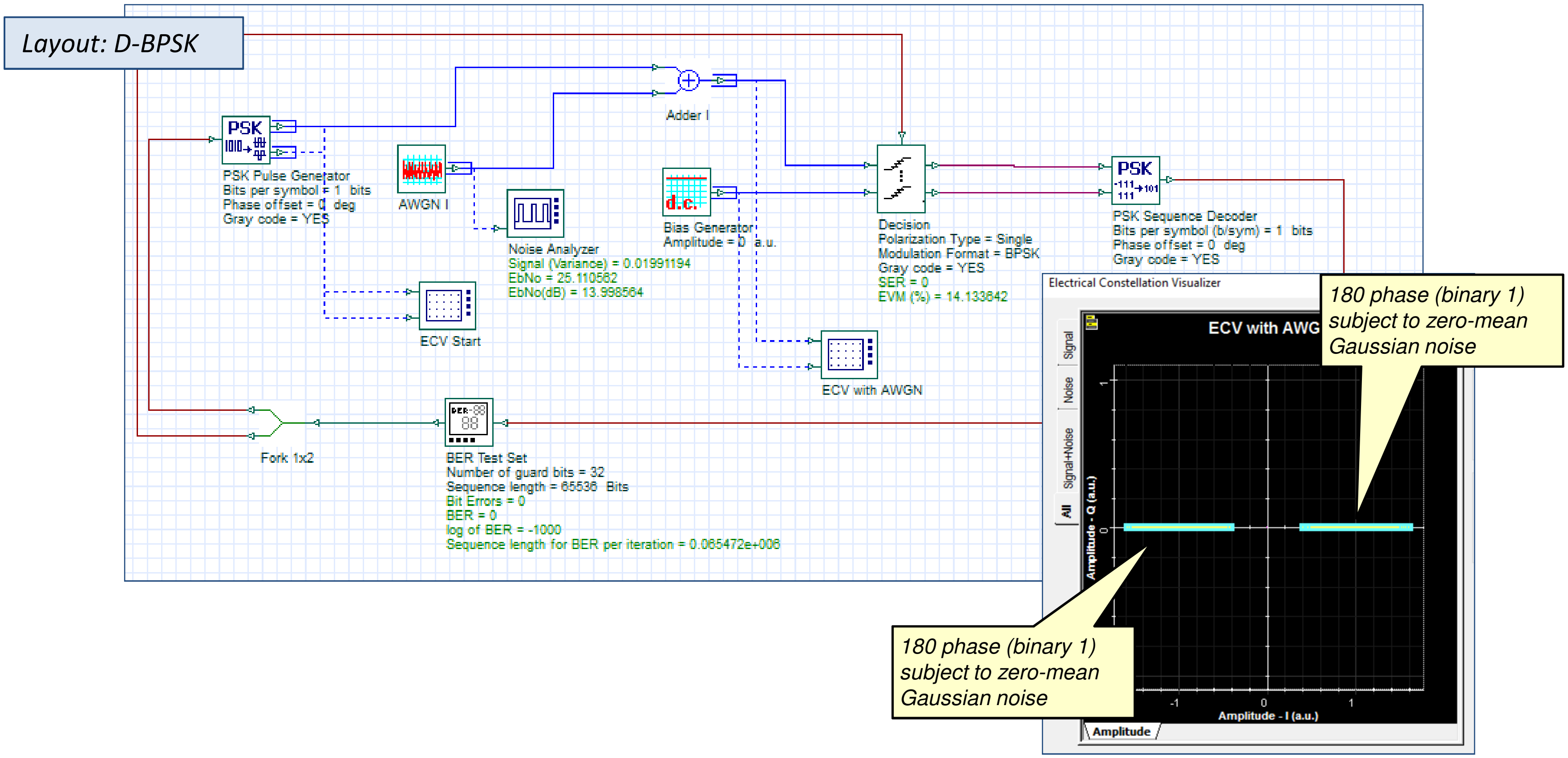
- Digital modulation systems are used to transmit digital (quantized) information over a medium such as air or optical fiber. Transmission is achieved by mapping the information (baseband) channel onto an analog carrier channel, propagating over the medium, and then recovering the baseband channel at the receiver[1]. Several techniques can be used to carry the information channel and involve changing the characteristics of its analog carrier (periodic) signal. These include[2]:
  - Amplitude shift keying (**ASK**), also called pulse amplitude modulation (**PAM**), where different amplitudes of the carrier are used to represent the digital signal
  - Phase shift keying (**PSK**), where different phase settings of the carrier are used to represent the digital signal
  - Quadrature amplitude modulation (**QAM**) – a combination of PAM and PSK
  - Frequency shift keying (**FSK**), where different relative frequency settings (relative to the carrier frequency) are used to represent the digital signal
- This application note reviews common implementations for **PSK** modulation and includes the following models:
  - Binary phase shift keying (Layout: BPSK)
  - Differential binary phase shift keying (Layout: D-BPSK)
  - Quadrature phase shift keying (Layout: QPSK)
  - Offset quadrature phase shift keying (Layout: O-QPSK)
  - Pi/4 quadrature phase shift keying (Layout: Pi/4-QPSK)
  - Differential quadrature phase shift keying (Layout: D-BPSK)
  - BPSK over analog carrier (Layout: BPSK (with Carrier))
  - QPSK over analog carrier (Layout: QPSK (with Carrier))

REF 1: All About Modulation Part 1, Intuitive Guide to Principles of Communications, Charan Langton (2002, revised Dec 2005). Retrieved 16 Mar 17 from http://complextoreal.com/tutorials/tutorial-8-all-about-modulation-part-1/#.WMrlRn_nLTY

REF 2: Link budget analysis: Digital Modulation Part 1, Atlanta RF (Bob Garvey, Chief Engineer), July. Retrieved (16 Mar 17) from http://www.atlantarf.com/Downloads.php

Binary phase shift keying (BPSK)

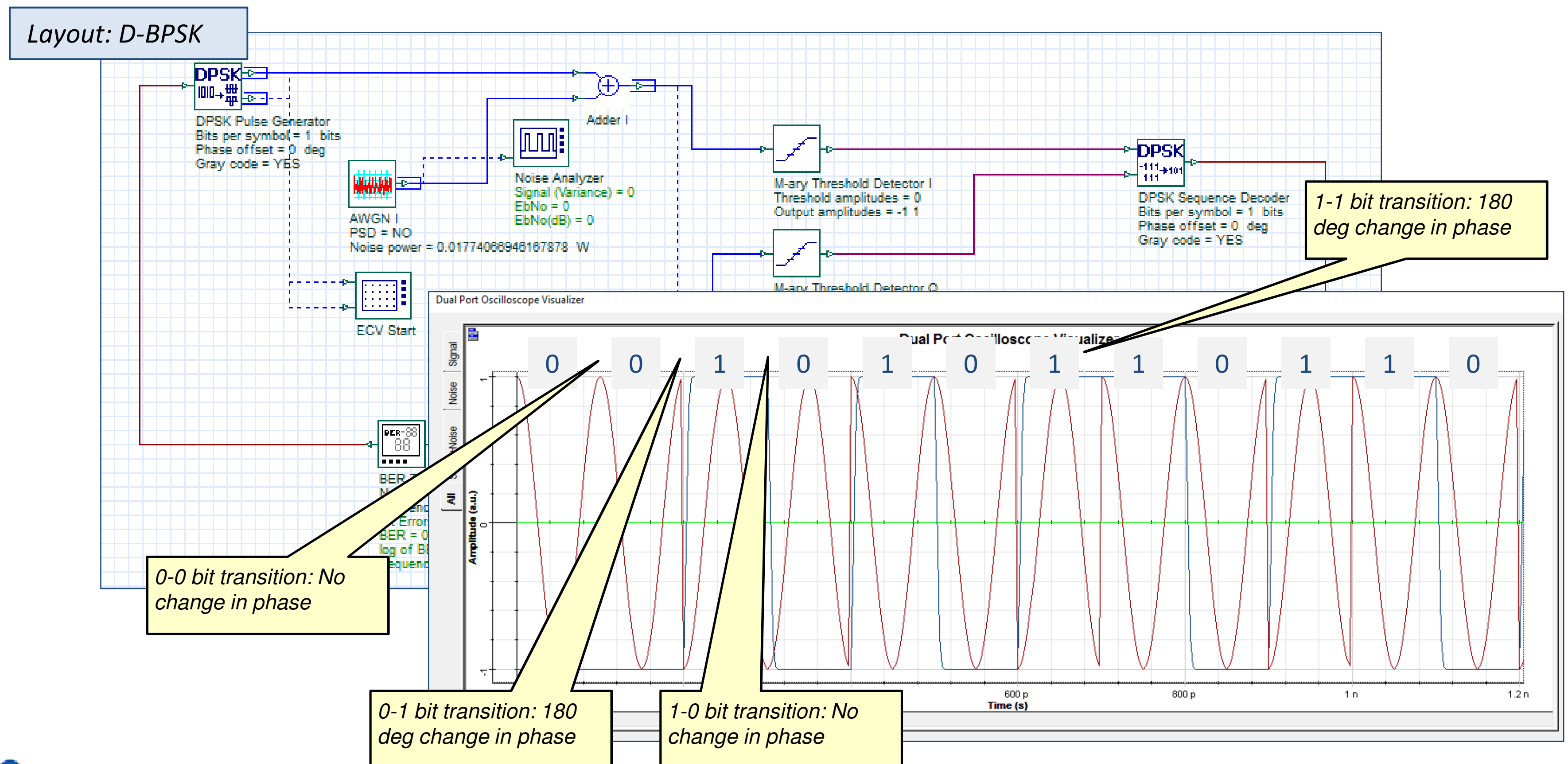
- This example demonstrates binary phase shift keying (BPSK) using the PSK Pulse Generator, Decision and PSK Sequence Decoder components. It is a two-level modulation technique where the antipodal signals are represented by phases of 0 and 180 degrees (binary “0” and binary “1”, respectively). As only phase is being changed, the amplitude of the modulation envelope is constant.



Differential binary phase shift keying (D-BPSK)

- This example demonstrates differential binary phase shift keying (D-BPSK) using the DPSK Pulse Generator, M-ary Threshold and DPSK Sequence Decoder (with no analog carrier). When differential encoding is used, the phase transitions change by 180 deg compared to the previous bit if a **binary 1** is transmitted and does not change if a **binary 0** is transmitted

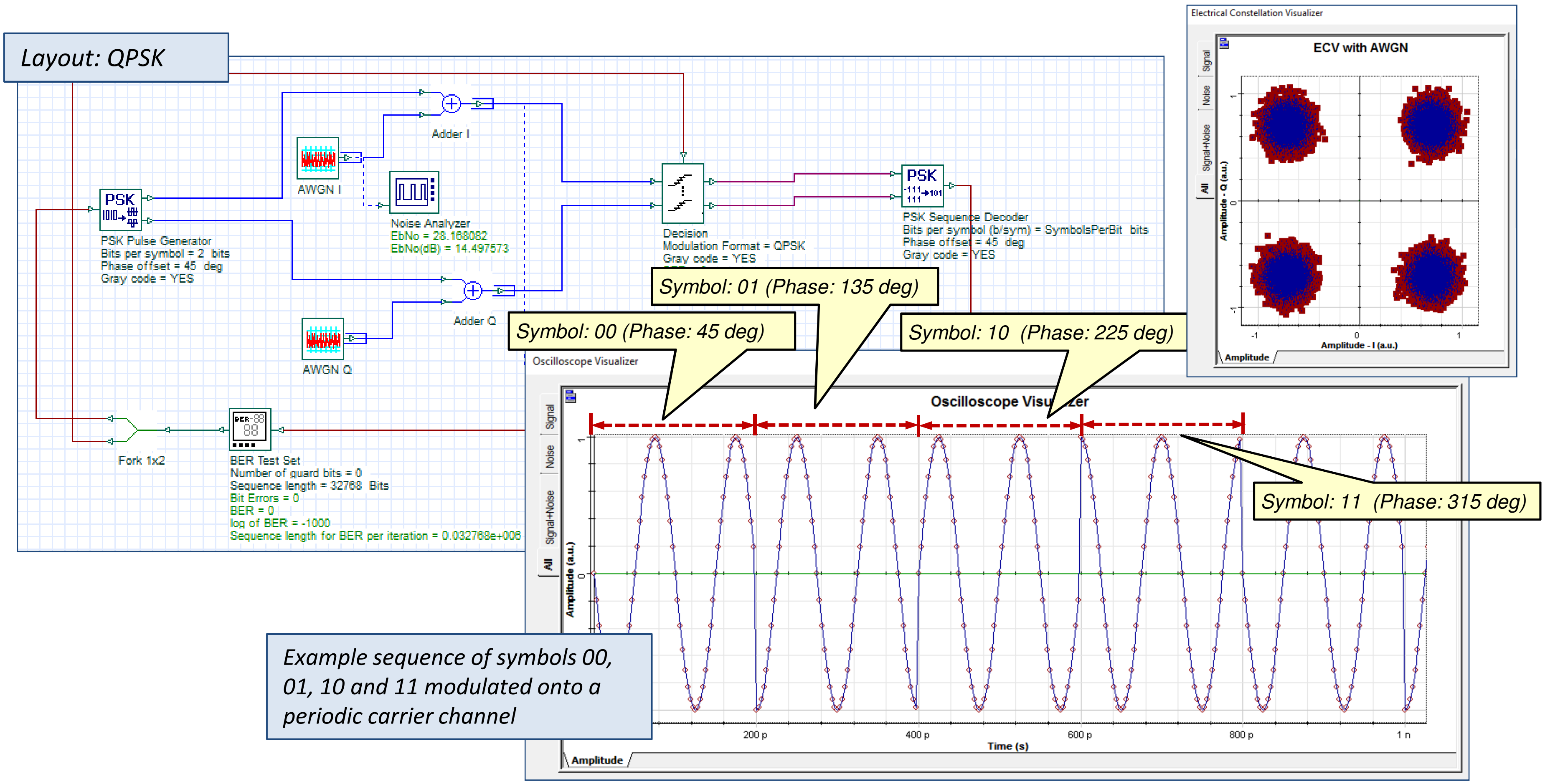
REF: Phase-shift keying. (2017, January 26). In Wikipedia, The Free Encyclopedia. Retrieved 17:53, March 16, 2017, from https://en.wikipedia.org/w/index.php?title=Phase-shift_keying&oldid=762095019



Quadrature phase shift keying (QPSK)

- This example demonstrates quadrature phase shift keying (QPSK) using the PSK Pulse Generator, Decision and PSK Sequence Decoder (with no analog carrier). See layout "QPSK (with carrier)" for an example with includes an analog transmission channel.

REF: L. Kazovsky, S. Benedetto, A. Willner, Optical Fiber Communication Systems, Artech House (1996), pp. 199-200

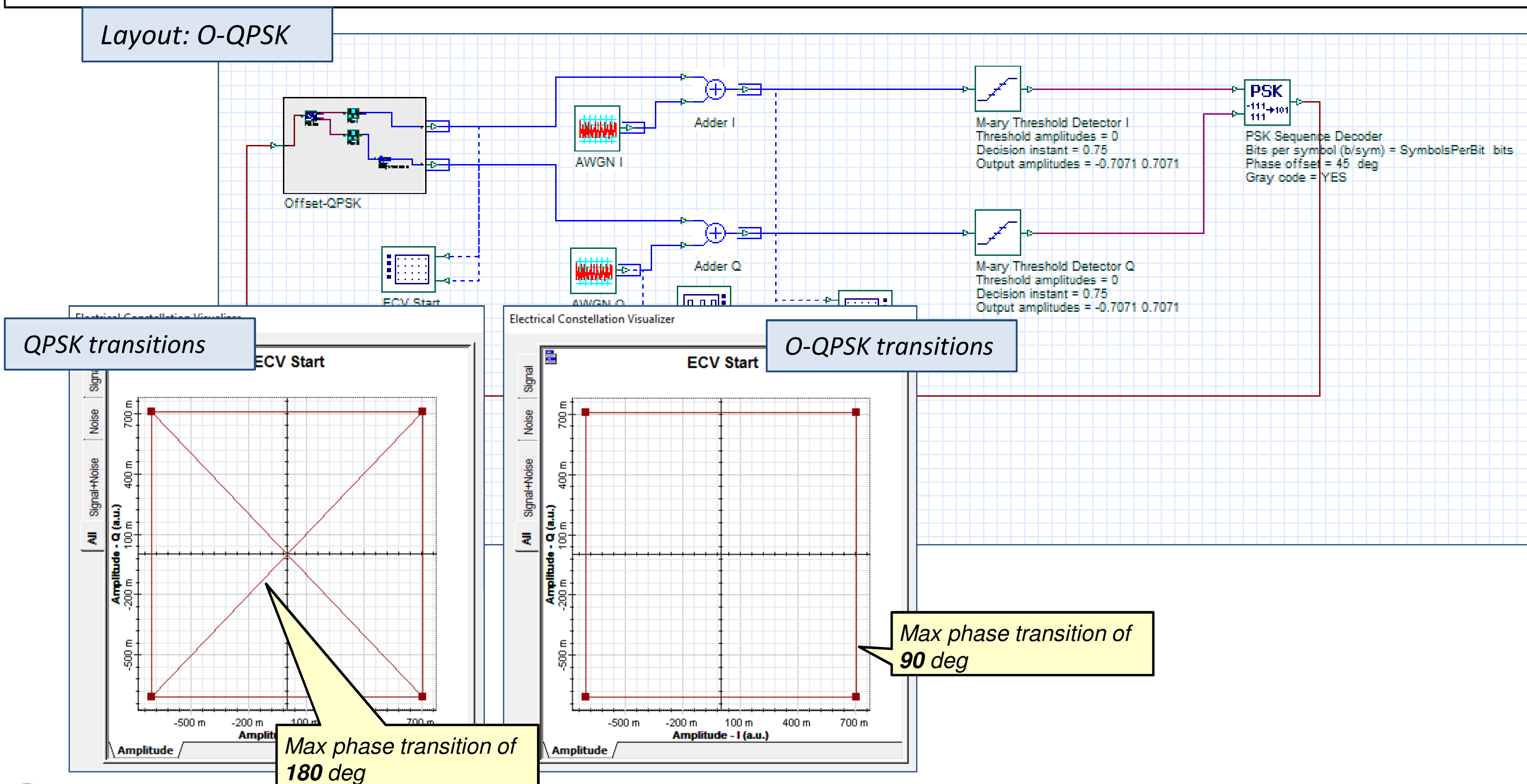


Offset quadrature phase shift keying (O-QPSK)

- This example demonstrates off-set quadrature phase shift keying (O-QPSK) using the PSK Pulse Generator, Threshold and PSK Sequence Decoder components. The O-QPSK modulator applies a one bit (half-symbol) period time delay to the Q channel thus creating a staggered constellation (this ensures that the maximum phase shift between symbol transitions is 90 deg – compared to 180 deg for QPSK)

REF 1: Phase-shift keying. (2017, January 26). In Wikipedia, The Free Encyclopedia. Retrieved 17:53, March 16, 2017, from https://en.wikipedia.org/w/index.php?title=Phase-shift_keying&oldid=762095019

REF 2: Link budget analysis: Digital Modulation Part 3, Atlanta RF (Bob Garvey, Chief Engineer), July. Retrieved (16 Mar 17) from http://www.atlantarf.com/Downloads.php

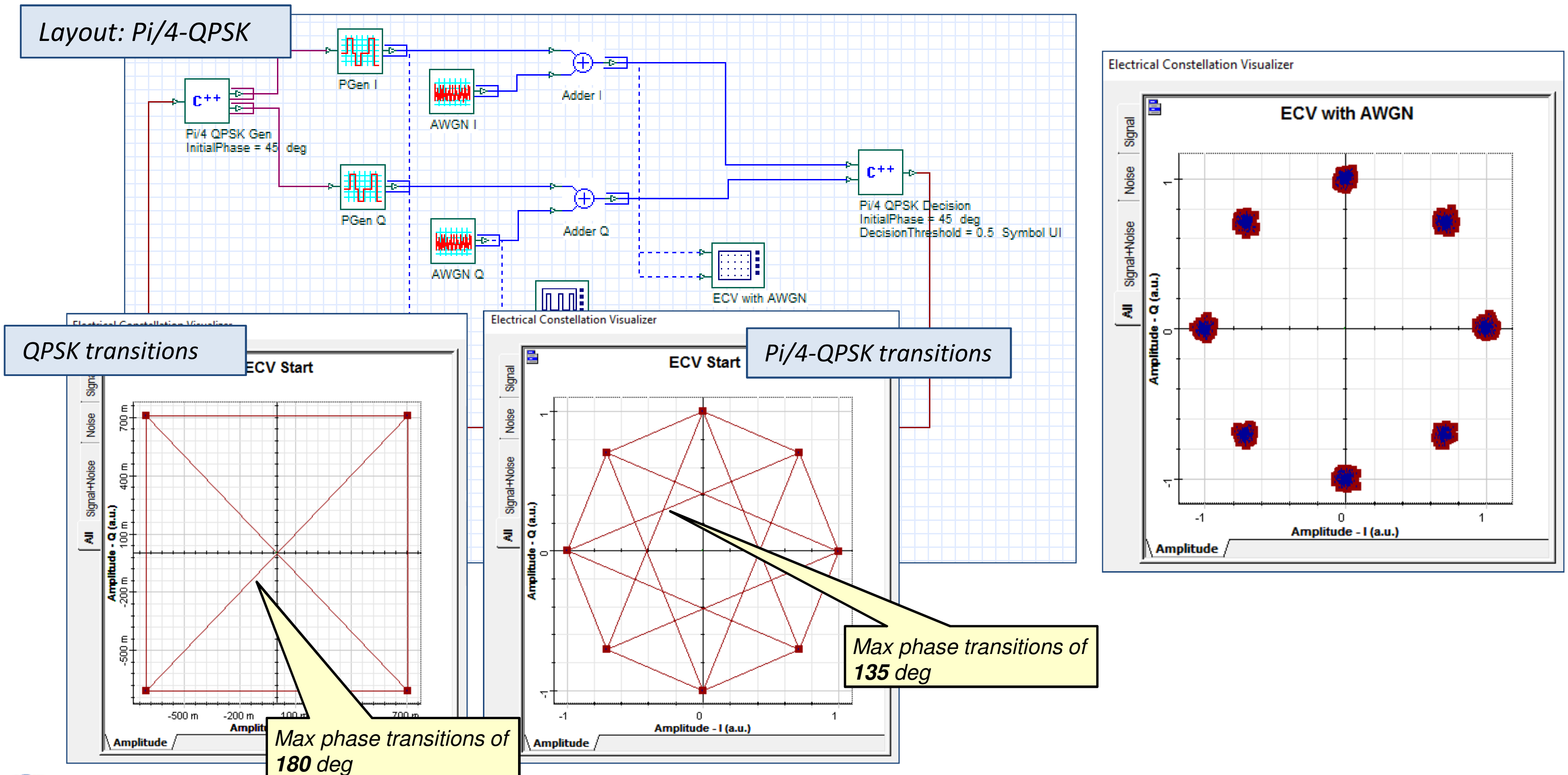


Pi/4 quadrature phase shift keying (Pi/4-QPSK)

- This example demonstrates Pi/4 quadrature phase shift keying (Pi/4 QPSK) using the Cpp Component. The Pi/4-QPSK modulator uses two separate QPSK constellations. For even numbered symbols the standard QPSK constellation is used; for odd numbered constellations a 45 deg rotated version of the QPSK constellation is used.

REF 1: Phase-shift keying. (2017, January 26). In Wikipedia, The Free Encyclopedia. Retrieved 17:53, March 16, 2017, from https://en.wikipedia.org/w/index.php?title=Phase-shift_keying&oldid=762095019

REF 2: Link budget analysis: Digital Modulation Part 3, Atlanta RF (Bob Garvey, Chief Engineer), July. Retrieved (16 Mar 17) from http://www.atlantarf.com/Downloads.php

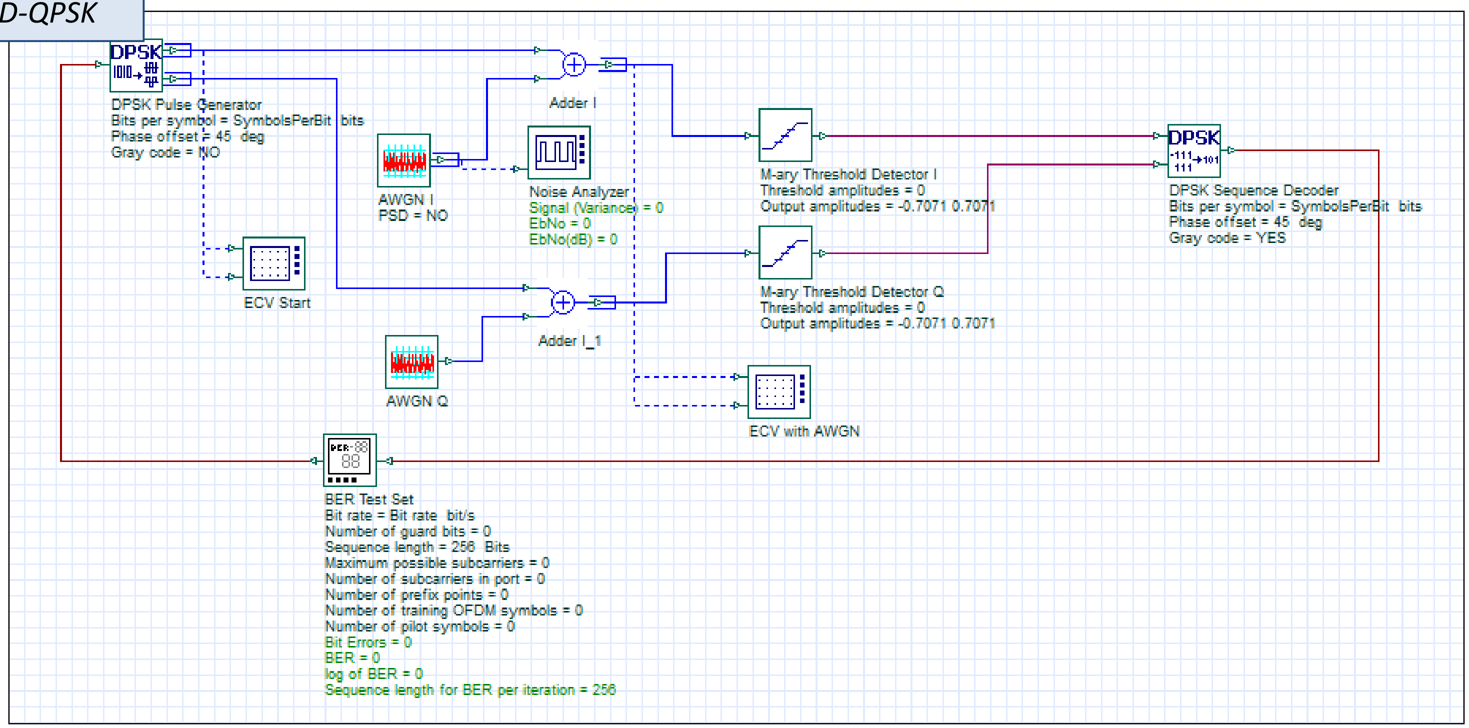


Differential quadrature phase shift keying (D-QPSK)

- This example demonstrates differential quadrature phase shift keying (D-BPSK) using the DPSK Pulse Generator, M-ary Threshold and DPSK Sequence Decoder (with no analog carrier). Similar to BPSK differential encoding, the phase transitions change by a defined value compared to the previous symbol based on the transmitted symbol (00, 01, 10, 11).

REF: Phase-shift keying. (2017, January 26). In Wikipedia, The Free Encyclopedia. Retrieved 17:53, March 16, 2017, from https://en.wikipedia.org/w/index.php?title=Phase-shift_keying&oldid=762095019

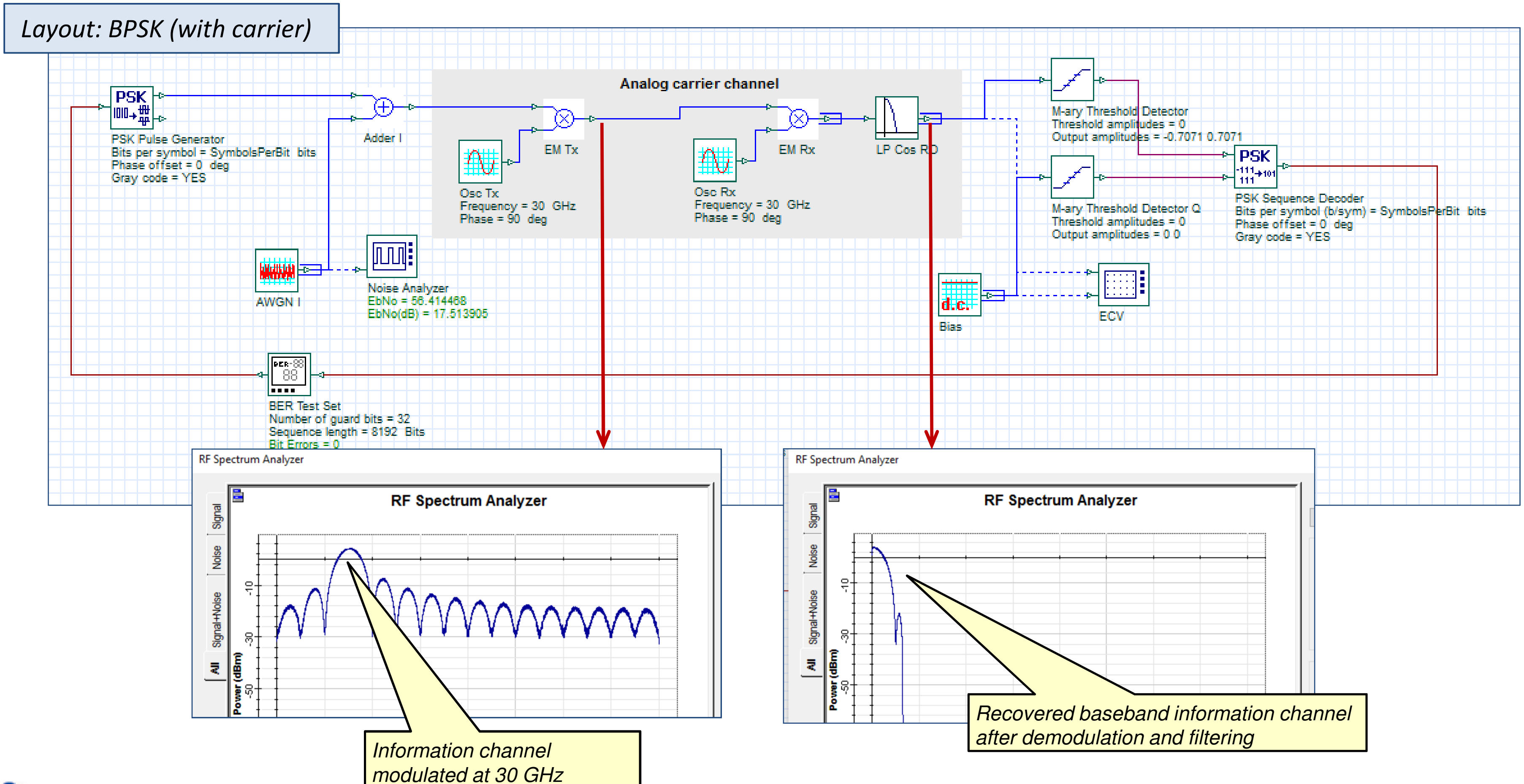
Layout: D-QPSK



BPSK with carrier channel

- This example demonstrates binary phase shift keying (BPSK) using the PSK Pulse Generator, Decision and PSK Sequence Decoder with transmission over an analog carrier. Modulation is achieved by mixing the information (baseband) channel with an RF oscillator (30 GHz). At the receiver, the transmitted channel is mixed with a local oscillator at the same carrier frequency and low pass filtered (10 GHz) to remove the double frequency component

Layout: BPSK (with carrier)



QPSK with carrier channel

- This example demonstrates quadrature phase shift keying (QPSK) using the PSK Pulse Generator, Threshold and PSK Sequence Decoder with transmission over an analog carrier. Modulation is achieved by mixing the information (baseband) channel with an RF quadrature modulator (30 GHz). At the receiver, the transmitted channel is demodulated with a Quadrature demodulator with a local oscillator at the same carrier frequency and low pass filtered (10 GHz) to remove the double frequency component

REF: Link budget analysis: Digital Modulation Part 3, Atlanta RF (Bob Garvey, Chief Engineer), July. Retrieved (16 Mar 17) from http://www.atlantarf.com/Downloads.php

Layout: QPSK (with carrier)