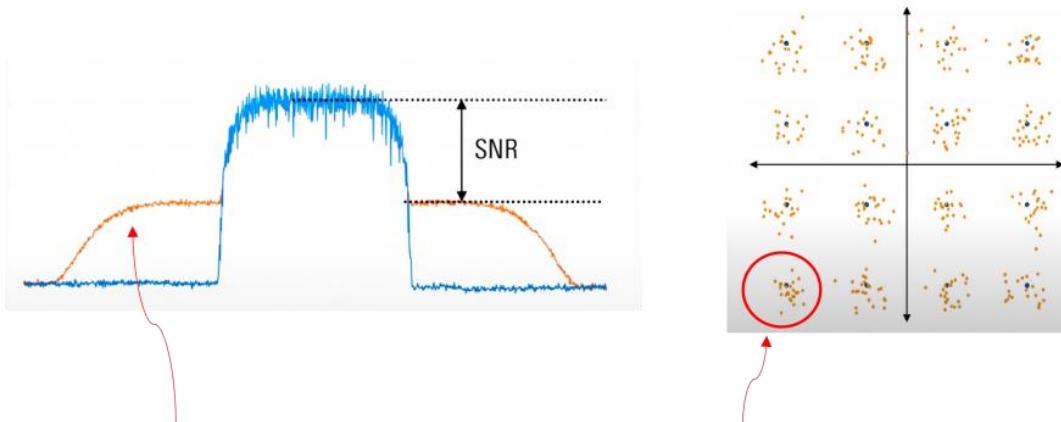
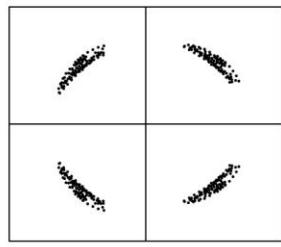


Digital RF impairment types



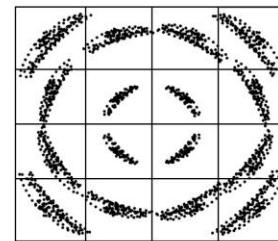
Wideband noise reduces SNR and Low SNR causes random spread of constellation points

Simpler modulation schemes may be able to tolerate phase noise



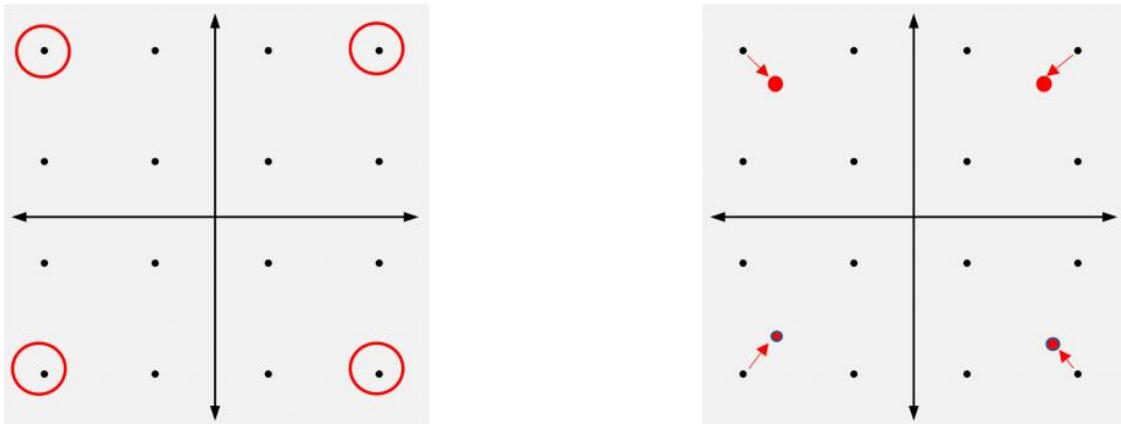
QPSK

Higher-order modulation schemes are more susceptible to error due to phase noise



16-QAM

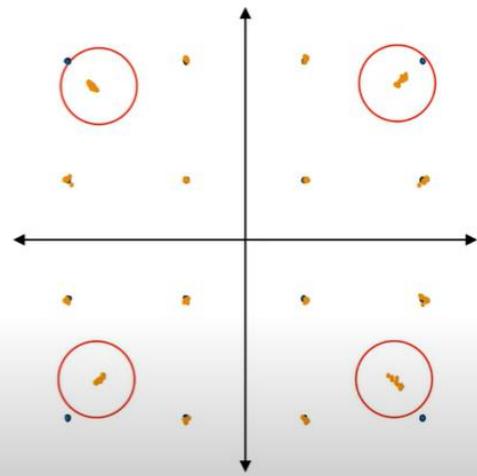
Same phase noise on 16-QAM system causes symbol errors

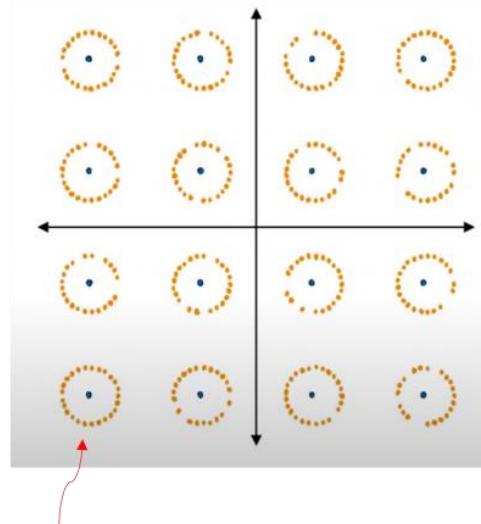
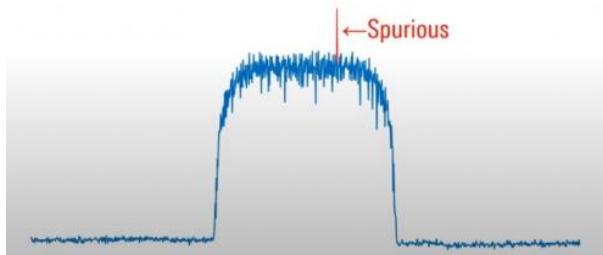


High-Amplitude constellation points move ‘inwards’ due to gain reduction at compression

Compression

- ▶ Compression is a characteristic of amplifiers
- ▶ Amplifiers do not provide the same amount of amplification (gain) at all input levels
 - Typically lower gain for higher input powers
 - Referred to as “compression”
- ▶ Points furthest away from the origin have the highest amplitude
 - Compression reduces the amplitude of these outer points relative to other points
 - Outer points are “pulled in”
- ▶ Can be a transmitter or a receiver issue

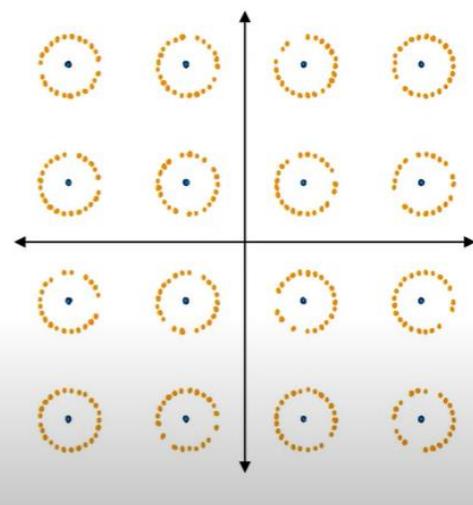
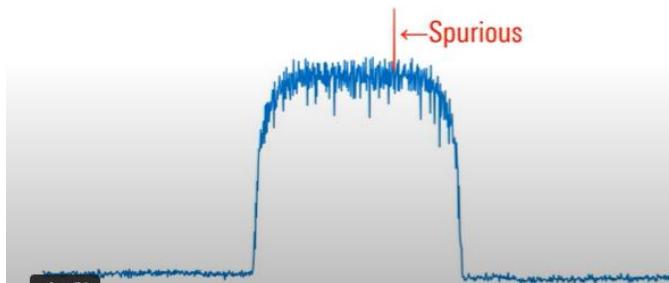




In-band interference creates circles around reference constellation points

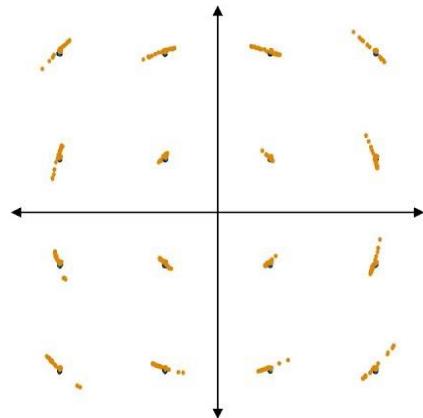
In-band spurious

- ▶ Narrow interferers within the signal bandwidth
- ▶ Creates circles around the reference points
- ▶ Radius depends on the spurious signal level
 - Higher level spurs produce larger circles



Phase errors / phase noise

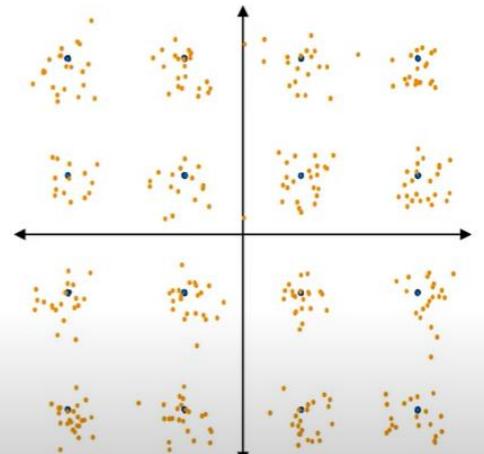
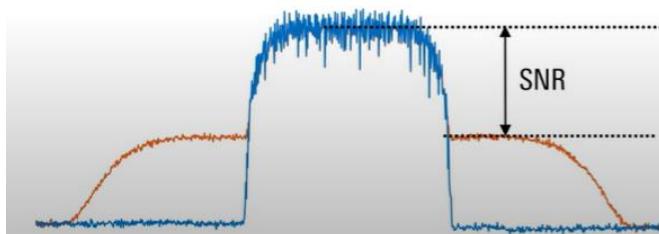
- ▶ Phase noise is undesired variation in the phase of the transmitted carrier
 - Vector signals use phase to transfer information
- ▶ Causes points to rotate around the origin
- ▶ Increasing levels of phase noise creates higher amounts of rotation (longer arcs)

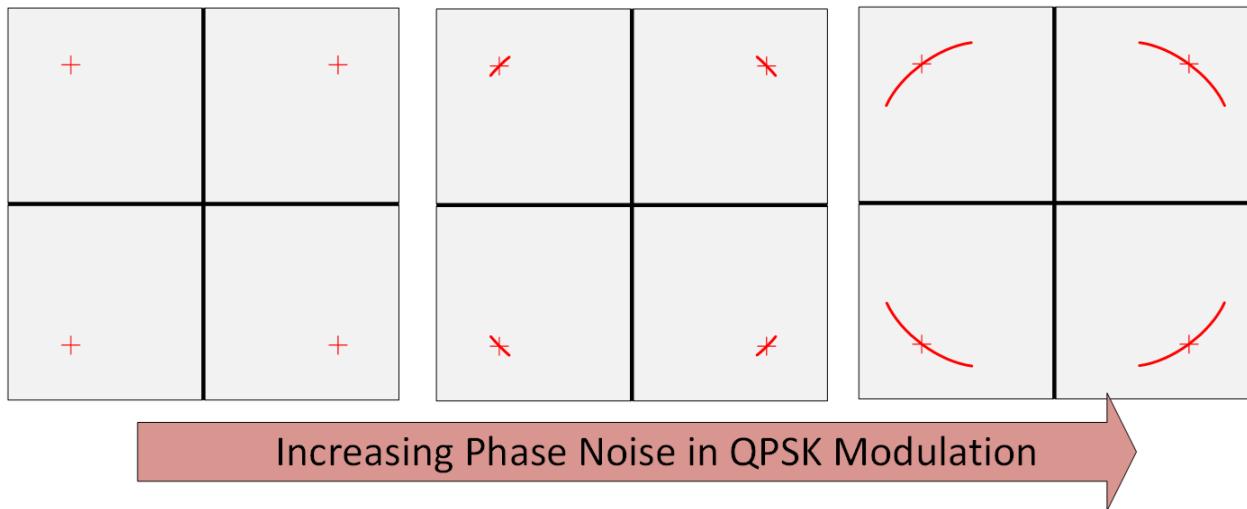


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Noise

- ▶ Noise is another type of amplitude issue
- ▶ Low signal to noise ratio (SNR) causes the points to spread out
 - Lower SNR → more spread out
- ▶ If the noise is wideband / uncorrelated, the points are randomly distributed around the ideal points





IQ Imbalance

