

Why You Need to Measure Both BER and MER on QAM Digital Signals

Presented by:

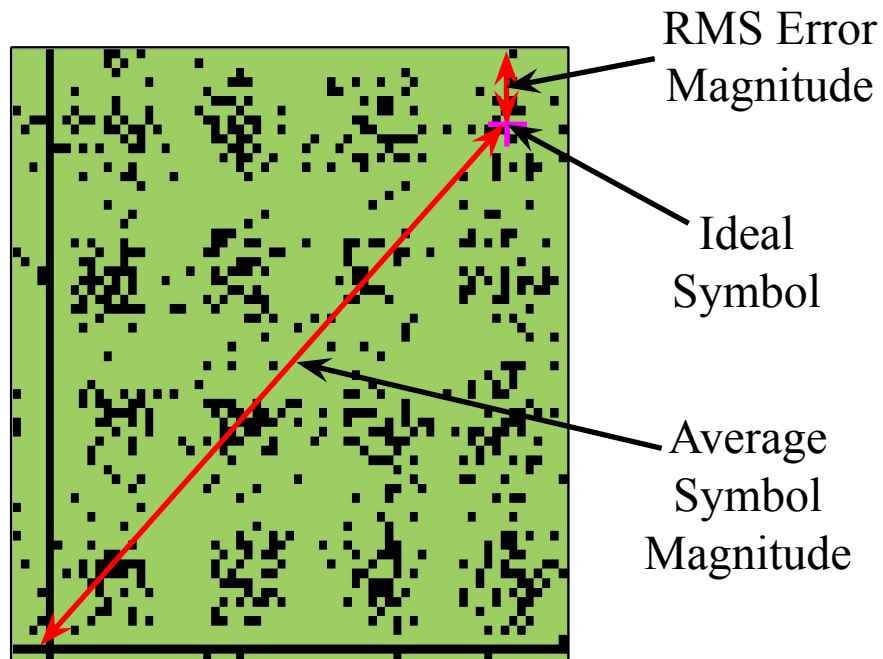
Sunrise Telecom Broadband *...a step
ahead*

- Most Digital Analyzers measure Modulation Error Ratio (MER) and Bit Error Rate (BER)
- MER and BER each have their limitations
- This seminar explains why it is important to measure both MER and BER and what types of impairments that will be missed if you only measure one or the other.
- Viewing of the Constellations Demystified Seminar and the Modulation Error Ratio Demystified Seminar is recommended prior to viewing this seminar.

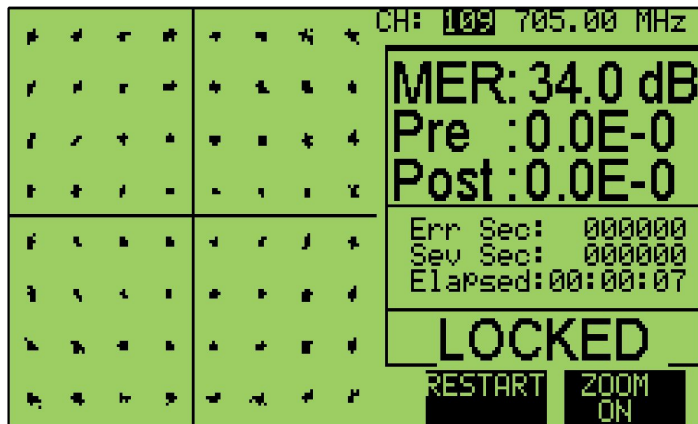
Modulation Error Ratio

- MER is defined as follows:
- MER is expressed in dB.

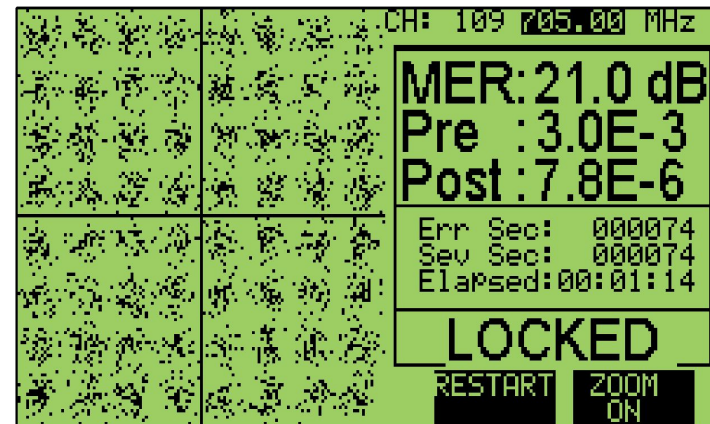
$$10 \log \frac{\text{RMS error magnitude}}{\text{average symbol magnitude}}$$



- MER effectively assigns a value to the fuzziness of the symbol cluster.
- The larger or fuzzier the cluster, the poorer the MER.
- The further from the ideal locations, the poorer the MER.



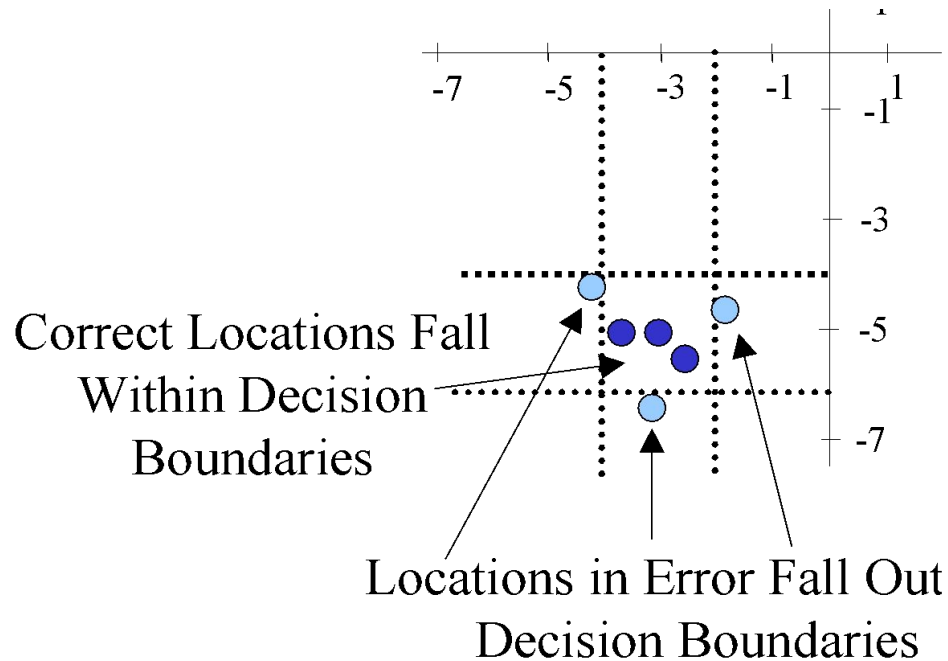
Constellation With
“Good” MER



Constellation With
“Poor” MER

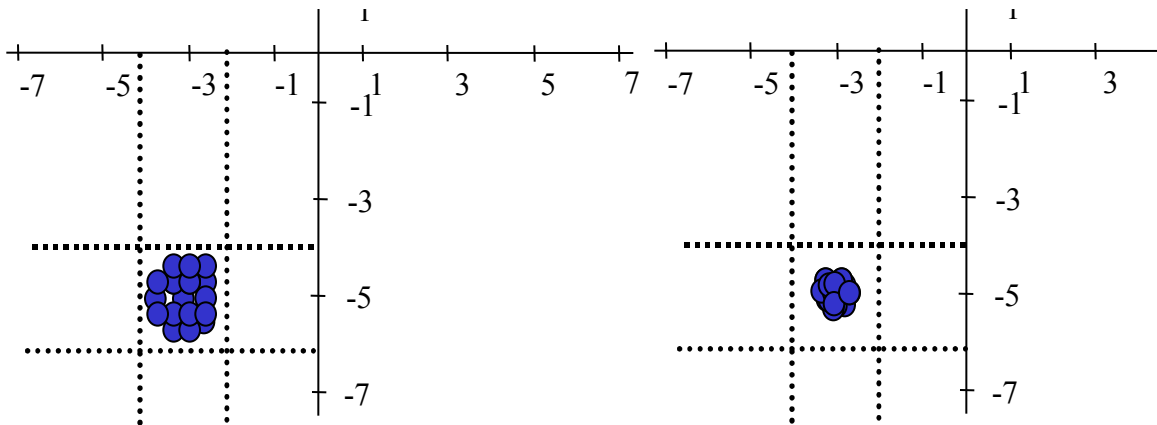
How Errors Occur

- Each symbol on the constellation is framed by decision boundaries
- When the carrier falls inside the decision boundaries the information is transmitted error free.

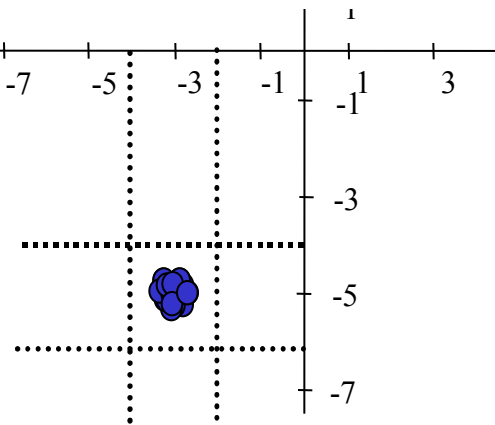


Comparison Between Three Error Free Constellations

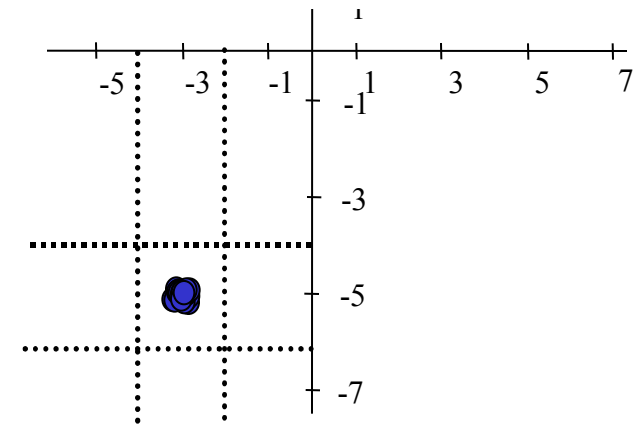
- All constellations below have a perfect BER with no errors, because the carrier always falls within the decision boundaries.
- The constellations to the right have significantly better MER with less noise.
- When the cluster falls within the decision boundaries, BER is not an effective measurement of quality because the BER is perfect.



Poor MER
Perfect BER



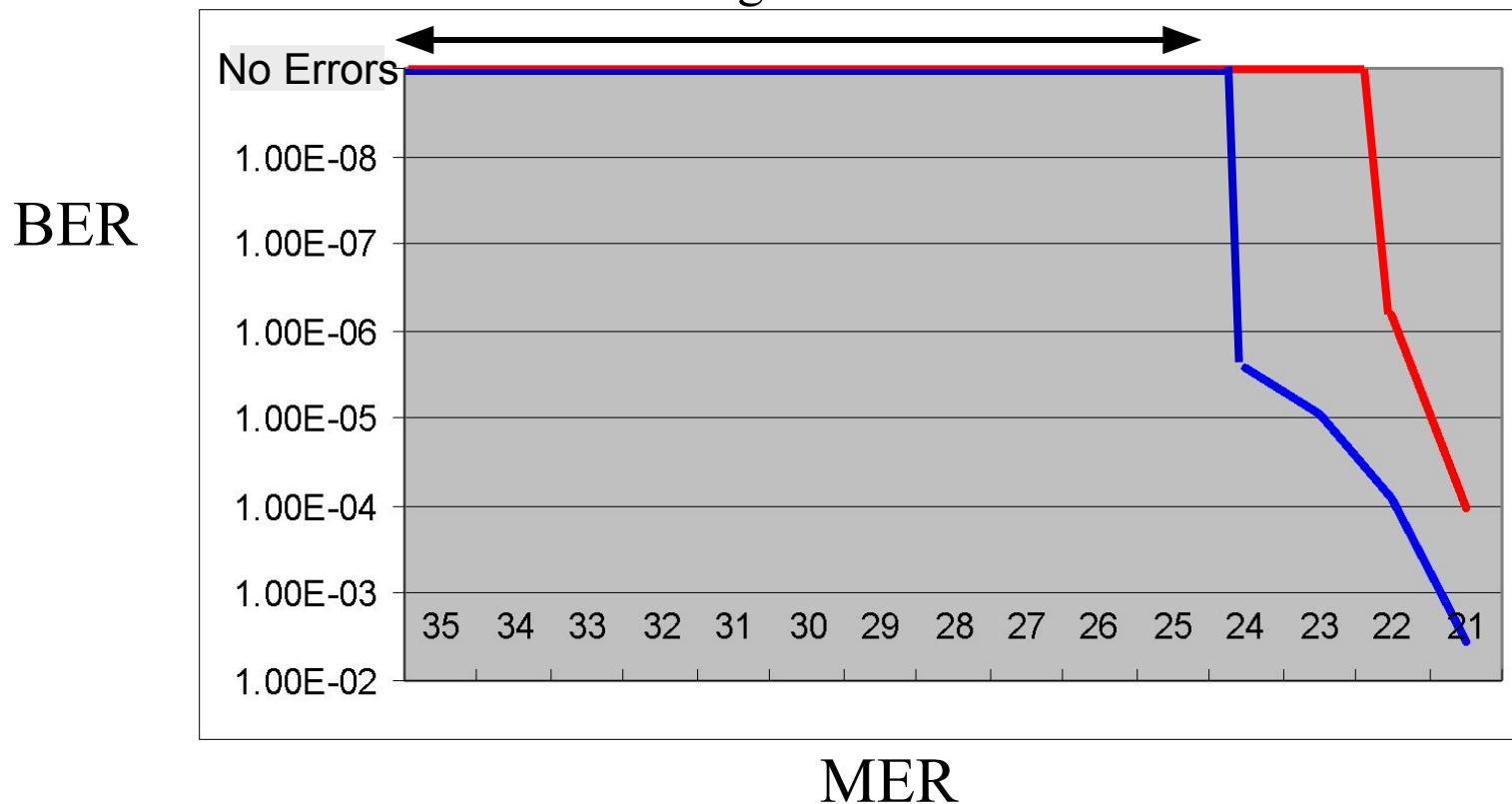
Good MER
Perfect BER



Best MER
Perfect BER

MER vs BER With Only Gaussian Noise Impairing the 64 QAM Signal

Note there are no errors in
this range of MER.



In practice errors will tend to occur at higher MERs due to other forms of impairments besides Gaussian Noise.

Why Measure BER?

- Since MER can quantify signal quality when no errors exist the question can be raised, why measure BER at all if MER will do?
- The major limitation of MER is the inability of the measurement to capture fast intermittent transients.
- A signal can have a very good MER, but poor BER due to intermittent interference.

Examples of Intermittent Interference That Cause Poor BER But Good MER

- Laser Clipping
 - Occasional overload of the laser due to analog sync pulses lining up.
- Loose Connections
 - Corroded or loose connections.
- Sweep System Interference
 - Sweep pulses from a sweep system set up to sweep empty spectrum.
- Microphonics
 - Vibration of digital origination equipment can cause intermittent errors.

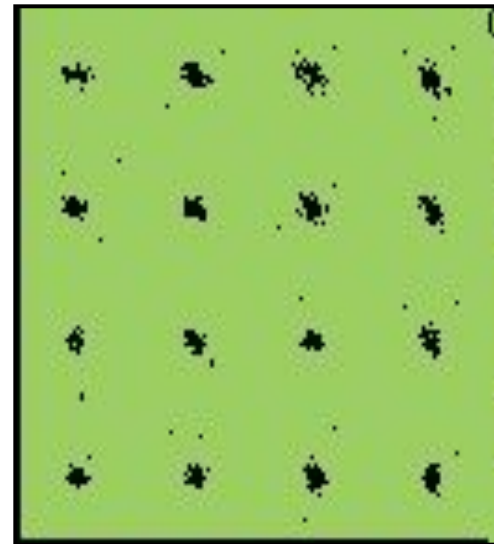
Troubleshooting By Measuring Both MER and BER



- One way to determine if you have intermittent problems is to measure both MER and BER.
- If the MER is high, but you still see errors, then the errors are probably caused by a intermittent problem.

Intermittent Errors on a Constellation Display

- Intermittent errors will show up on a constellation display as lone dots away from the main cluster.



Zoomed Constellation
with Intermittent
Interference

Conclusions

- In order to see the effects of all types of impairments on a QAM signal you need to measure both MER and BER.
- MER can quantify the quality of a digital signal that doesn't have any errors.
- MER has the limitation of not being able to see intermittent errors so a signal can have a good MER but a poor bit error rate.
- The most common type of intermittent errors are caused by laser clipping.



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