Receiver Testing Using Interference Tolerance Measurements

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IMPORTANT

Preliminary Presentation

- **This is a preliminary presentation designed to begin discussion on receiver testing using interference tolerance measurements.**
- **As a result, many details have been intentionally omitted.**

System Components

The three components of a system are:

- Transmitter
- Channel
- Receiver

A system needs specifications:

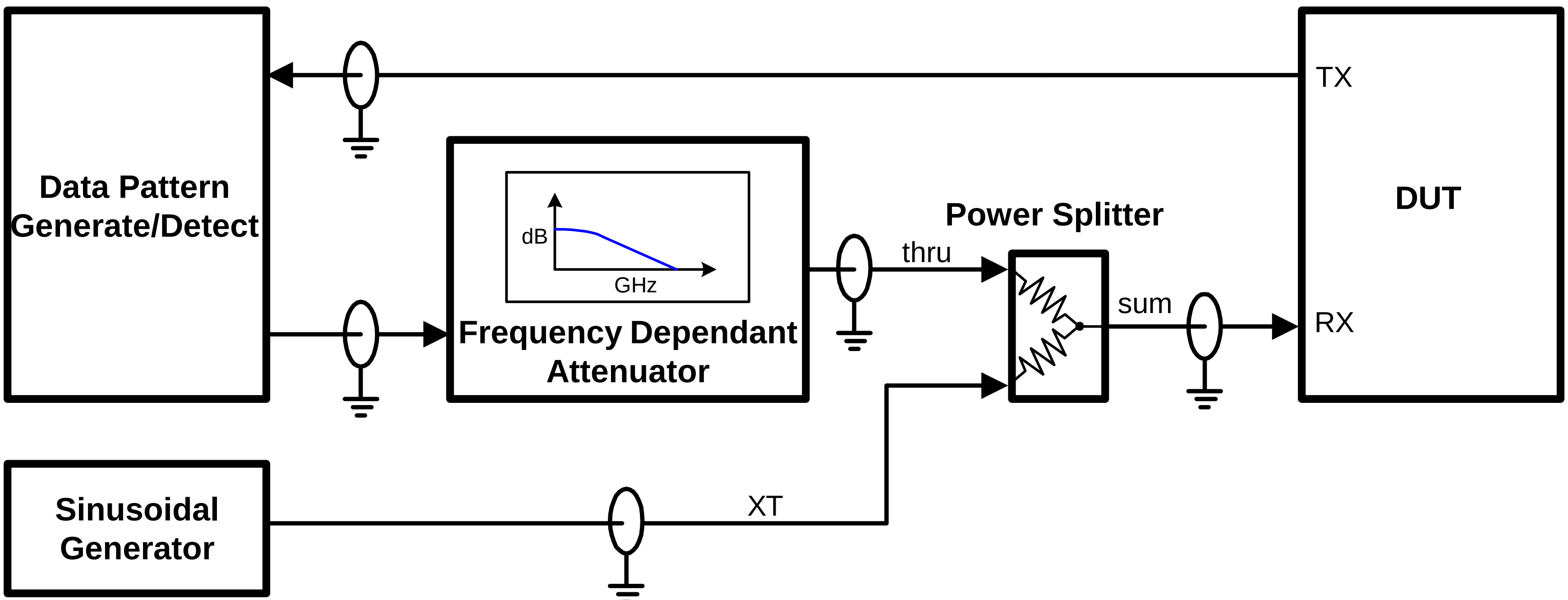
- That are testable.
- Guarantee system performance if all the specification are met.

Specifying the Components

- **We believe we know how to specify the transmitters.**
- **We are actively pursuing channel specifications.**
- **How do you specify the receiver in a testable method?**
  - **By the way, how do you show BER much less than 1e-12 in a reasonable amount of time?**

Receiver Specification Solution

Interference Tolerance Measurement

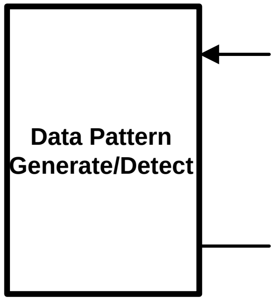


Receiver Interference Tolerance Measurement

This test is based on the following premises:

1. **Primary problems faced are:**
   - **High attenuation at high frequency**
   - **High cross-talk levels**
2. **By using calibrated over stress on the receiver, we can provide margins that reliably predict BERs well below what can be economically measured.**

Data Pattern Generator

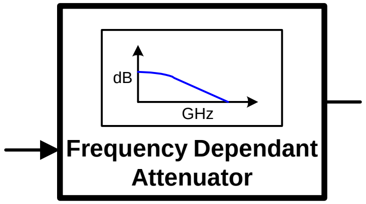


The data pattern generator may be a BERT, a digital pattern generator, or a "Golden Transmitter."

It should have:

- Equalization to the the specification
- RJ to the specification (this may be replaced with PJ)
- It is recommended the data pattern be a 23 bit PRBS (8388607 bit repeating)

Frequency Dependent Attenuator



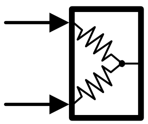
The frequency dependent attenuator is a "Golden Channel" probably constructed of precision PC boards and connectors. To avoid "designing around the specification," the receiver should be tested against several different channels.

Frequency Dependent Attenuator (cont.)

The channels could include:

- A long path with attenuation characteristics at the IEEE802.3ap channel limit.
- A medium path with generally better high-speed characteristics, with reflections that put bumps into the impulse response and ripples in the frequency response.
- A short path with generally low attenuation but perhaps with some reflections.

Summing Block



The summing block produces a linear, weighted sum of the "thru" signal and the "XT" signal to produce the "sum" signal. This signal should have gain near 1 for the "thru: data, and may have much lower gain for the "XT" data.

This block may consist of either:

- A resistor network
- Coupled transmission lines

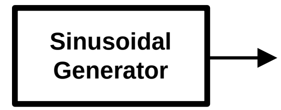
Summing Block (cont.)

This block may consist of:

- **A resistor network**
- **Coupled transmission lines**

This is a linear summation, just like the cross talk path in BACKPLANE channels. It does not directly produce AM or PM, but the resulting sum may have some aspects of a AM and PM.

Sinusoidal Generator

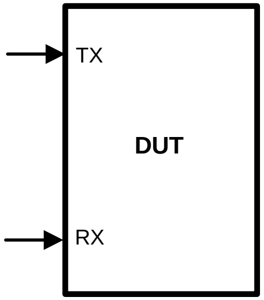


The sinusoidal generator produces an interfering signal. It may be either a single frequency or swept over a range. Its amplitude is the sum of the following two components:

- **A frequency dependent interference tolerance**
- **A margin term to allow extrapolation from an easily measured BER to a much lower specified BER. Determining the size of a margin is described later.**

The amplitude must be corrected for the gain of the summing block.

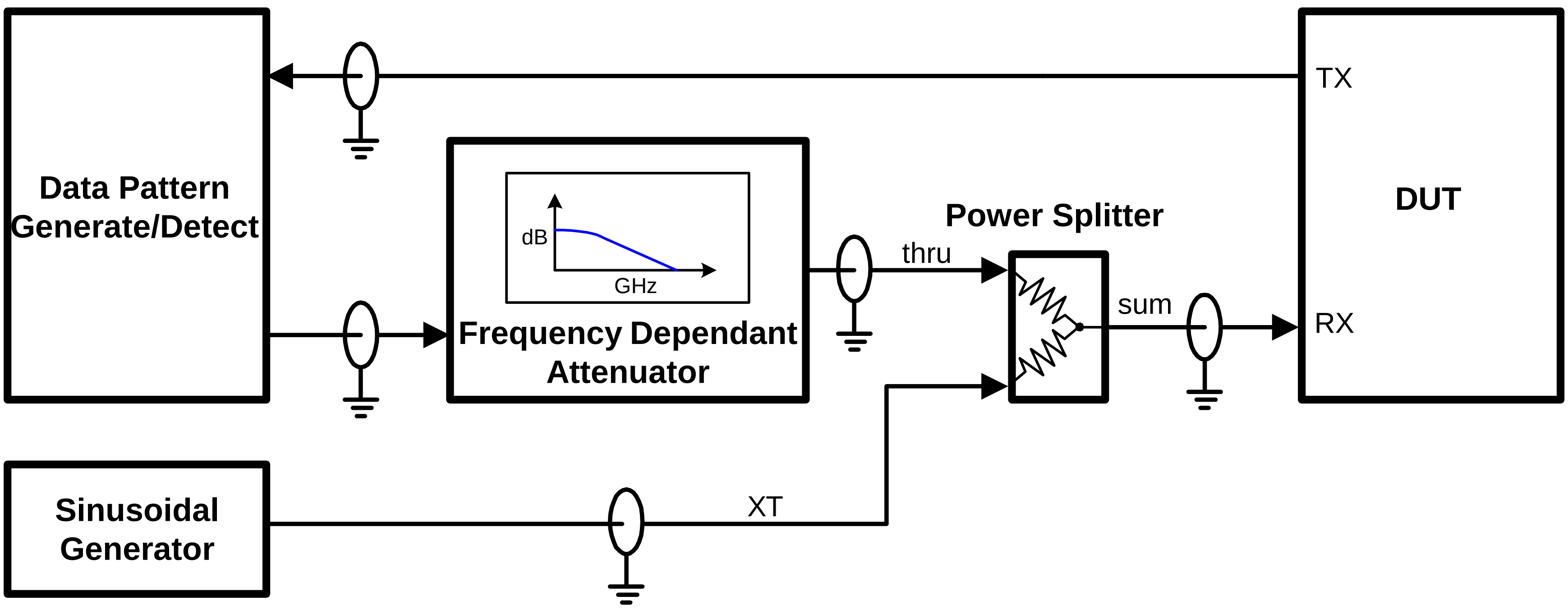
Device Under Test (DUT)



This is the device under test (DUT). It is shown acting as a repeater and using external BERT. However, if a common pattern is used for the test and the DUT can measure BER for that pattern, no external BERT is necessary.

Determining Amount of Margin

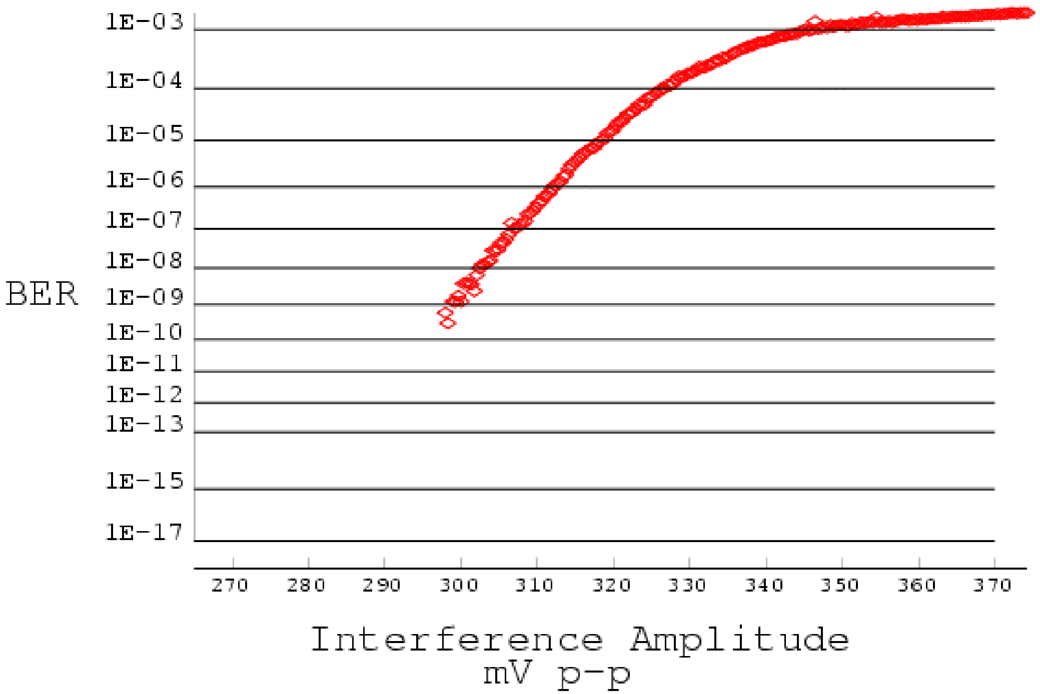
To determine the amount of margin needed to achieve some BERs, use the same setup as the main measurement.



Determining Amount of Margin (cont.)

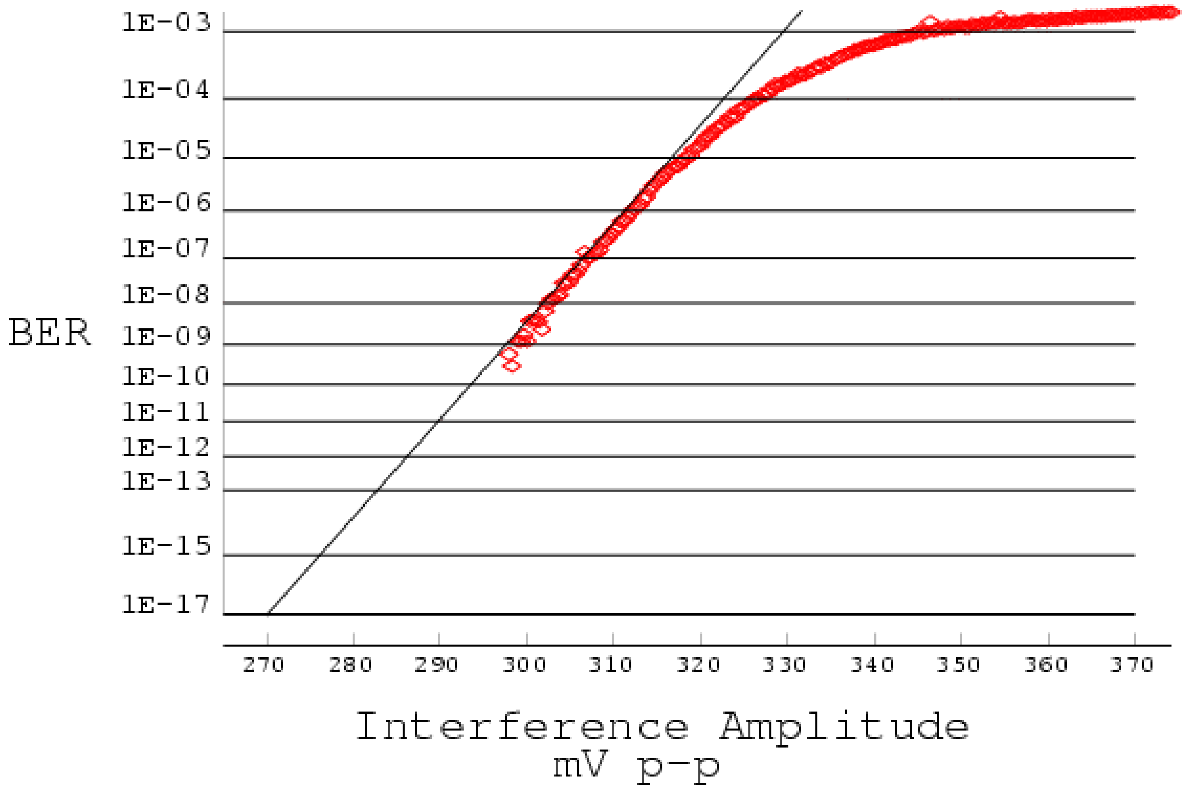
1. Starting a fairly low value, increase the amplitude of the sinusoidal generator in small steps.
2. At each interference amplitude, record any non-zero BER.
3. Plot BER on an error function scale vs. amplitude on a linear scale.
4. Fit a trend-line to the low BER linear portion of the curve.
5. Extrapolate to the desired BER.
6. Find the difference in the interference amplitude between the point on the trend-line where it is at the BER that will be measured; and where it is at the BER that the specification states.
7. The result is the margin needed.

BER vs. Interference Amplitude



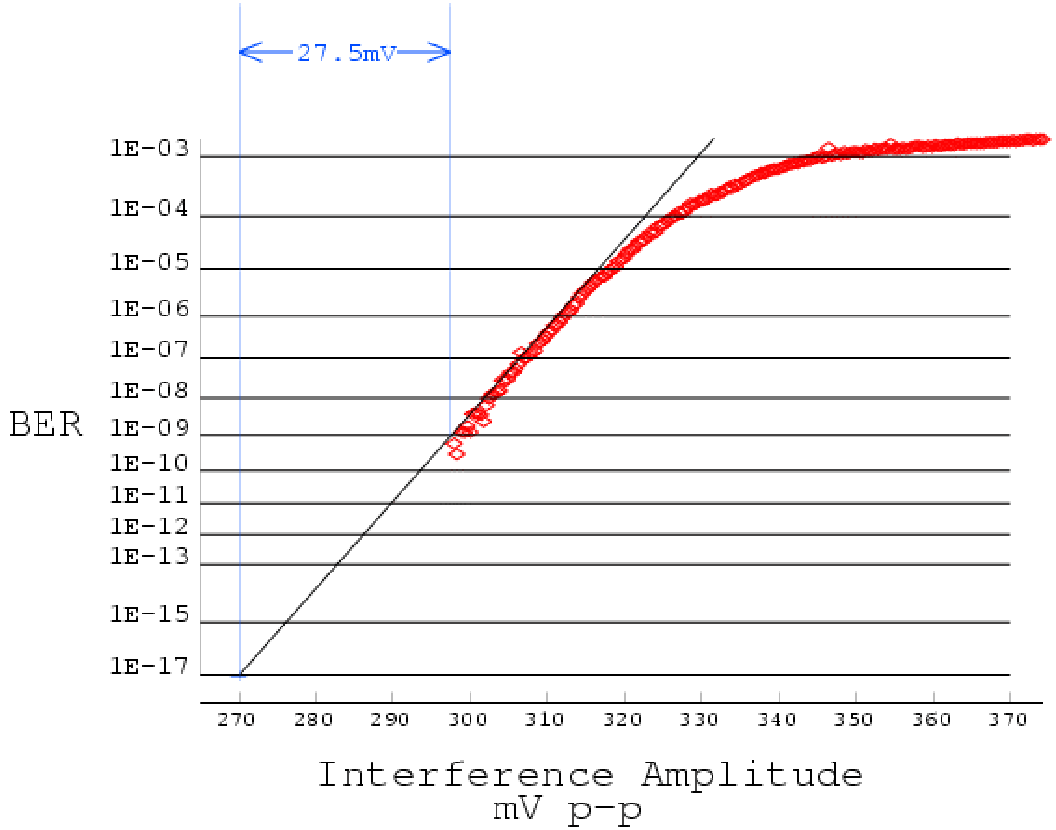
BER vs. Interference Amplitude Plot

Extrapolation



Extrapolate down to 1e-17 BER

Extrapolation (cont.)



Measure margin to get from an easily measured BER of 1e-9 to a desired BER of 1E-17

Summary

A method of testing receivers has been demonstrated that:

- **Is reasonably representative of actual operation and impairment.**
- **Is easy to perform.**
- **Is repeatable.**
- **By over-stress, allows reasonable interference of BER that is desirable to have but impractical measure.**