How do gain blocks perform at low frequencies?

I would like to use a high dynamic range gain block amplifier for an application in the 1 to 50 MHz range, but most published specifications do not include data below 100 MHz. How do these devices perform at lower frequencies—in terms of noise figure, gain flatness and third order intercept point—for the various available technologies (Si, SiGe, GaAs)?"

T. S. Williams
Consultant

An RFIC manufacturer provides an answer:

With properly selected bias components, Darlington gain block amplifiers based on SiGe and GaAs technology, such as the Sirenza Microdevices SGA and NGA product families, work very well down to frequencies as low as 1 MHz. Because of the IC's internal resistive matching, it can be expected that return loss, gain flatness, and linearity (IP3) will be slightly better in the 1 to 50 MHz range as compared to >100 MHz performance. At frequencies below 500 kHz, noise figure might degrade in GaAs devices as 1/f or "flicker noise" becomes dominant.

All of Sirenza Microdevices' datasheets show detailed performance at the "most popular" frequencies. Lower frequency data is collected and added to datasheets as requested by our customers.

Todd Fariss
Applications Engineering Manager
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What is the relationship between BER and MDS?

What is the relationship between the Bit Error Rate (BER) and the Minimum Detectable Signal (MDS) of a PM receiver.

[This question is commonly asked in the Wireless System Design Fundamentals course]

The instructor answers:

To understand the relationship between the MDS and the BER of a PM receiver we must first define these two terms:

The minimum detectable signal (MDS) is a measure of responsiveness to a weak signal in the presence of noise. It is a measure of sensitivity within a limited bandwidth.

The bit error rate (BER) rate of a receiver is the ratio of errors to nonerrors that are received on a bit-by-bit basis. It is the probability of a detectable bit being corrupted by noise.

The MDS of a receiver can be calculated by the following equation:

$$MDS = 10\log(kT) + 10\log Bw + NF + S/N\ min$$

where k = Boltzmann's constant, T = temperature in kelvins, Bw = channel bandwidth, NF = noise figure, and S/N = RF signal-to-noise ratio

However, in a digital receiver the BER is function of the digital signal-to-noise ratio (Eb/No.).

The theoretical probability of bit error in additive white gaussian noise (AWGN) can be expressed as $BER = 1/2\,[1 - \mathrm{erf}\sqrt{(Eb/No)}]$. There are many published curves that give you the BER for a given Eb/No.

We can relate the Eb/No to the S/N by the following equation:

$$S/N = Eb/No + 10\log Rb/Bw$$

where Rb = the data rate, Bw = channel bandwidth

If we know the BER requirement we can calculate the Minimum Detectable Signal (MDS) by converting the Eb/No to S/N and using the above equations.

A basic rule of thumb used by RF design engineers states that, "A 1-dB decrease in MDS can cause a tenfold increase in BER."

Richard Fornes
Vice President of Technical Sales and Marketing
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How do I submit a question to the "Ask the Experts" column?

The Editorial Director answers:

The best way to submit questions is by e-mail to: *editor@highfrequencyelectronics.com*. We will locate the right person among our many volunteer experts to provide the answer you need.

Our "Ask the Experts" column is a great place to ask any question related to the job of high frequency engineering. No matter what the question, we will find someone to provide an answer.

One of your follow-up questions might be, "Do I need to wait to see my answer in print?" No! First, we'll send you the answer as soon as we receive it. Also, we'll include it in our online edition at: *www.highfrequencyelectronics.com*

We will pick the most interesting questions and answers for publication in our print edition.

Gary Breed
Editorial Director
High Frequency Electronics