

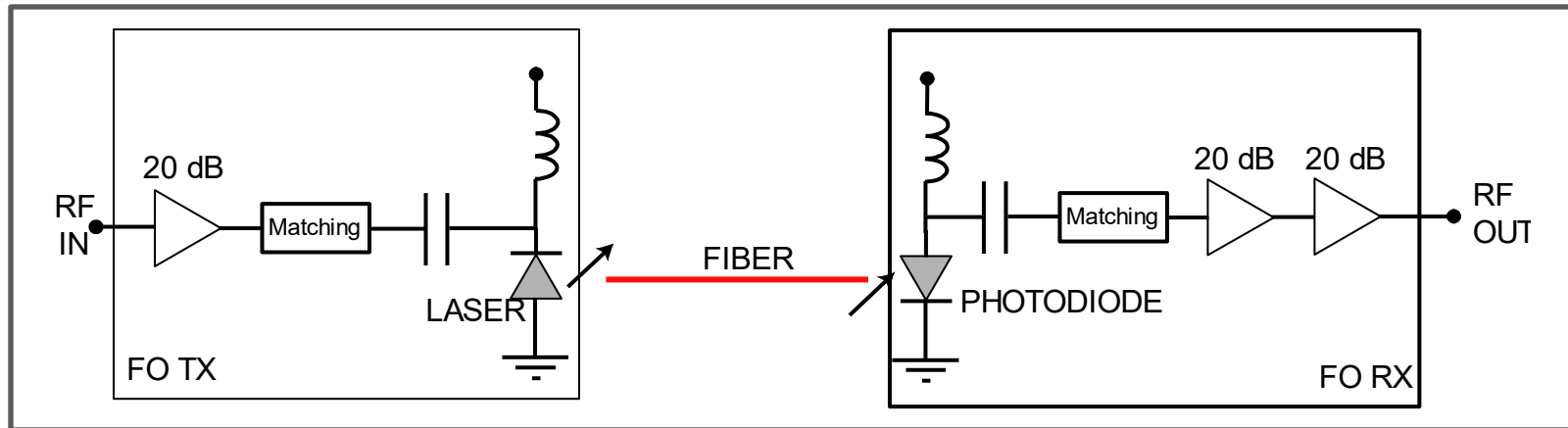


RFOF DATASHEET
FUNDAMENTALS
FOR THE NEW WEBSITE 2024

RF-Over-Fiber Equivalent Circuit

Fiber Transport is Analog RF-Over-Fiber

- RF Signal Amplitude Modulates Laser Light Output – Fiber Optic Transmitter (direct or external modulation)
- Photodiode Receiver detects modulated light and outputs RF Signal
- Fiber Optic Link – Laser Transmitter + Fiber + Photodiode Receiver
 - Standard RF specifications: Noise, Gain, Linearity
- Optimize Noise Figure, Gain, Output Power for Specific Applications with pre- and post amplifiers

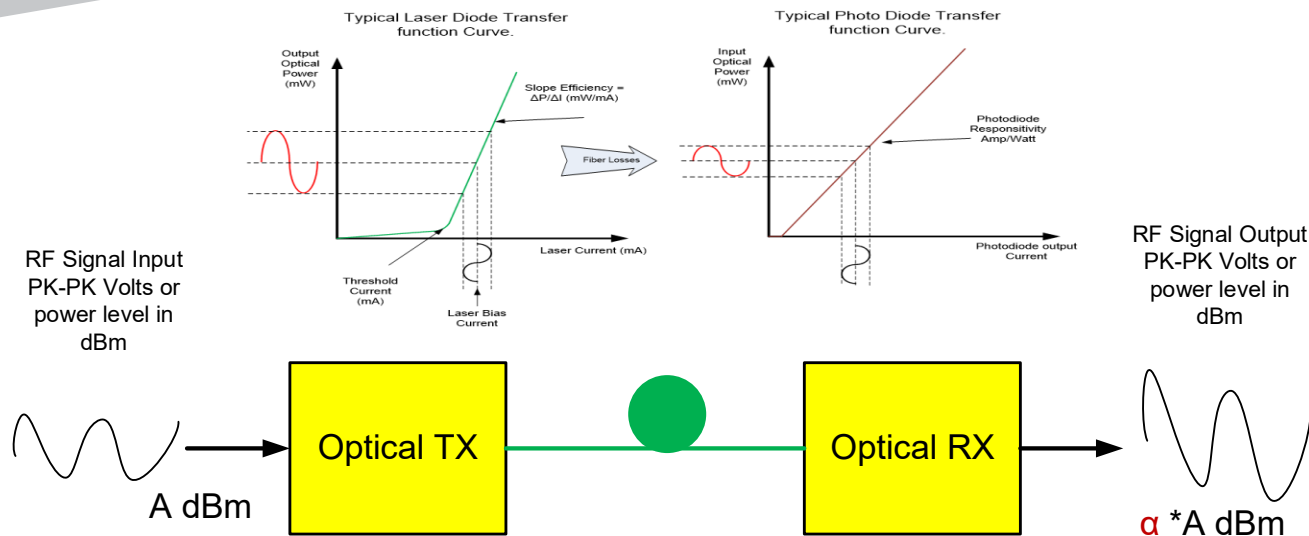


OZ510 or any Other



Spur Free Dynamic Range	SFDR		110		(dB/Hz) ^{2/3}
Spur Free Dynamic Range (with LNA)	SFDR		109		(dB/Hz) ^{2/3}
RF Link Gain		-1	+1	+3	dB
RF Link Gain (with LNA)		19	20	22	dB
Input Noise Floor Density @ 1 GHz	EIN		-134	-130	dBm-Hz
Input Noise Density @ 1 GHz (with LNA)	EIN		-154	-150	dBm-Hz
Input Third Order Intercept @ 1 GHz	IIP3	29	31		dBm
Input Third Order Intercept @ 1 GHz (with LNA)	IIP3	8	10		dBm
Group Delay TX/RX Link (electronics only)	GD		0.5	1	nS

Gain

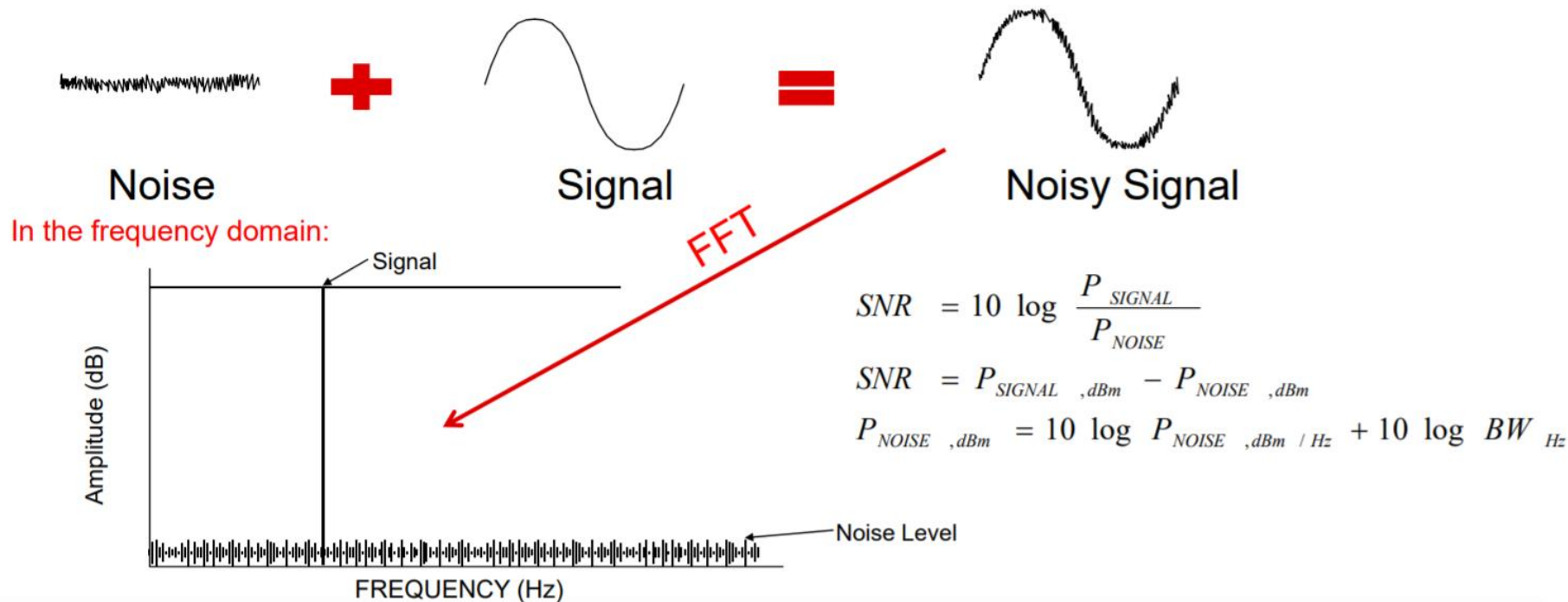


$$\text{Gain (linear)} = \frac{\alpha * A \text{ dBm}}{A \text{ dBm}} = \alpha$$

$$\text{Gain (Log scale)} = 10 * \text{LOG}(\alpha) \text{ in dB}$$

Signal to Noise Ratio

SNR is the ratio of the signal power to the noise power that corrupts the signal.



Input Noise Density

Equivalent Link Input Noise Density (dBm-Hz), EIN is the amount of Noise at the input of the RFoF link measured in 1Hz bandwidth that produces output Noise Density (EON) measured in 1Hz bandwidth at the receiver end if the total link itself were Noiseless.

Minimum Noise In electronics is thermal Noise (KT) measured at Room Temperature approximately **-173.8 dBm-Hz**

Input Noise Density Relationship to **Noise Figure (NF)**. Next Slide.

Input Noise Density = -173.8-NF dBm-Hz



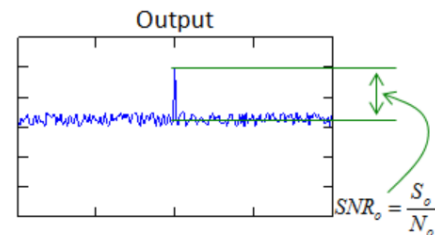
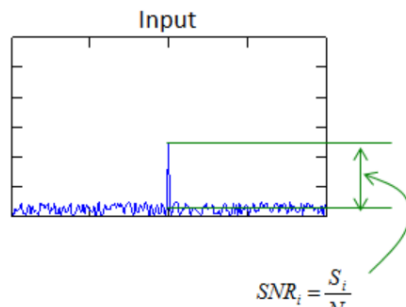
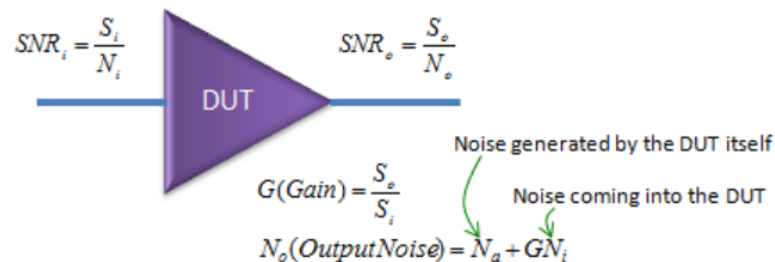
Noise Figure (NF)

Noise Figure is the measure of degradation of the signal to noise ratio in a device. It is the ratio of the Signal to Noise Ratio at the input to the Signal to Noise Ratio at the output. Since the signal to noise ratio at the output will always be lower than the Signal to Noise ratio at the input, the Noise Factor is always more than 1. The Lower Noise Factors results in better performance of a devices.

$$NF \text{ (linear)} = \frac{(\text{SNR input})}{(\text{SNR output})} > 1$$

$$NF \text{ (Log scale)} = 10 * \text{LOG}(NF) \text{ in dB}$$

No Device is perfect, Signal to Noise ratio will degrade as signal pass through a Device, by added Noise..

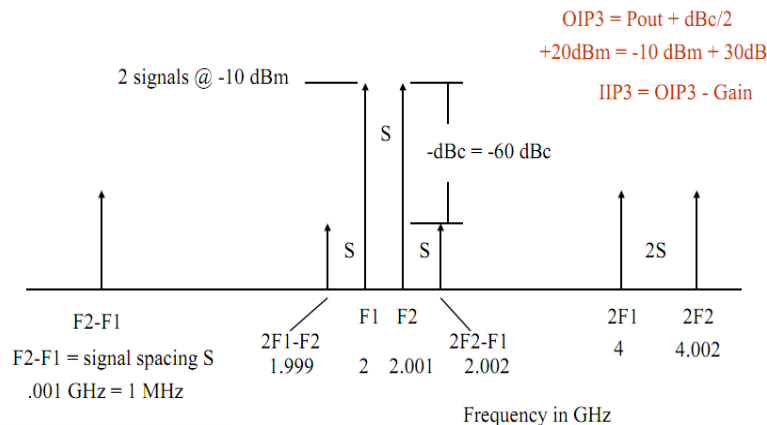
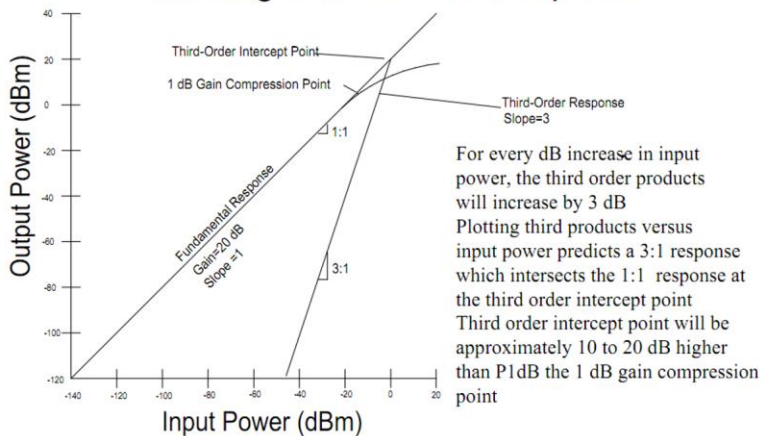


Input Intercept Point 3rd order (IIP3)

A Input third-order intercept point (IIP3) is a measure of nonlinearity of the RFoF link and where the 3rd order distortion power becomes equal to the main fundamental signal power. Although it's a extrapolated but critical parameter to calculate the overall Intermodulation distortion produced by the RFoF link.

$$\text{IIP3} = \text{OIP3} - \text{Link Gain}$$

Plotting Third Order Response

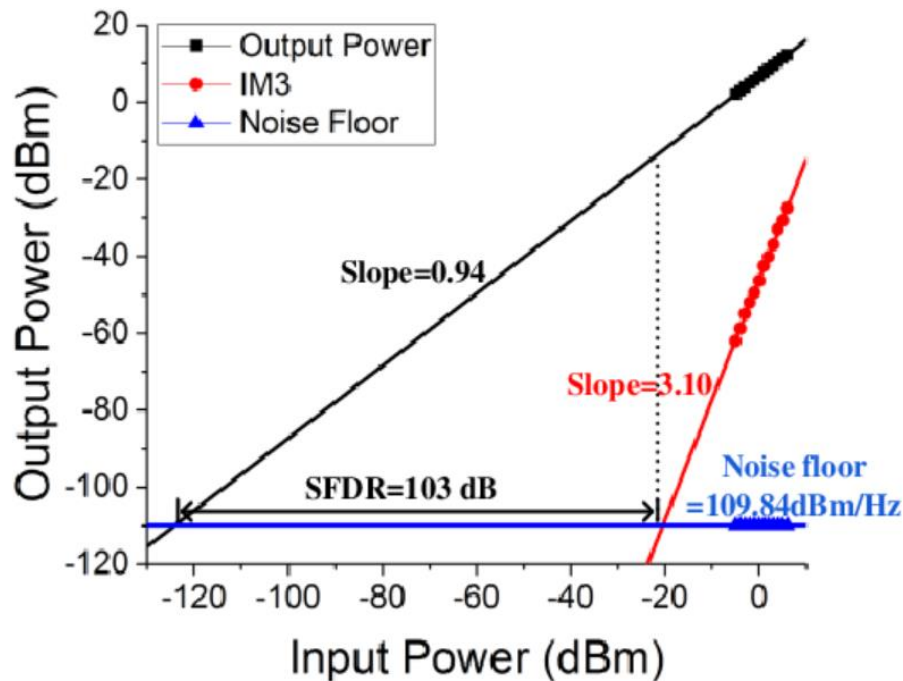


SFDR Spurious Free Dynamic Range

Spurious Free Dynamic Range (SFDR), is defined as the power level range of a pair of two input signals in which the two signals are above the noise floor and the 3rd order Intermodulation distortion products are below the noise floor. This is the range of RFoF Link Able to detect the smallest signal (*a signal just above the noise level*), and the **largest signal** that can be introduced into a system without **creating detectable distortions** in the bandwidth of concern. The larger SFDR becomes the higher dynamic range, the RFoF link possesses

$$\text{SFDR} = 2/3 \times (\text{IIP3} - \text{EIN})$$

The 2/3 rate, is the difference between the slope of the output signal and distortion curves.



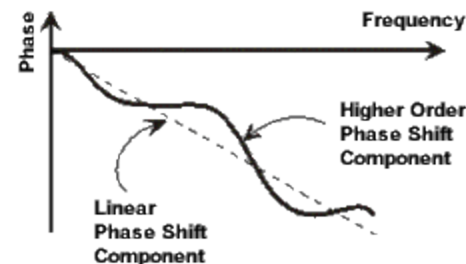
Signal Delay & Group Delay

Signal delay is:

- A measure of time delay of signal propagation.
- The transit time of a signal through a device, free-space, cable, fiber link, etc..

Group delay is:

- A measure of device phase distortion.
- The transit time of a signal through a device versus frequency.
- The derivative of the device's phase characteristic with respect to frequency.



$$\begin{aligned} \text{Group Delay} = t_g &= \frac{-d\phi}{d\omega} && \phi \text{ in Radians} \\ &&& \omega \text{ in Radians/Sec} \\ &= \frac{-1}{360^\circ} \cdot \frac{d\Theta}{df} && \Theta \text{ in Degrees} \\ &&& f \text{ in Hz } (\omega = 2\pi f) \end{aligned}$$

Group Delay

Gain

[https://en.wikipedia.org/wiki/Gain_\(electronics\)](https://en.wikipedia.org/wiki/Gain_(electronics))

Input Intercept Point 3rd order or IIP3

https://en.wikipedia.org/wiki/Third-order_intercept_point

Input Noise Density

https://en.wikipedia.org/wiki/Input_noise_density

Noise Figure or NF

https://en.wikipedia.org/wiki/Noise_figure

Signal to Noise Ratio

https://en.wikipedia.org/wiki/Signal-to-noise_ratio

Spurious Free Dynamic Range or SFDR

https://en.wikipedia.org/wiki/Spurious-free_dynamic_range

Group Delay

https://helpfiles.keysight.com/csg/pxivna/Tutorials/Group_Delay6_5.htm

https://en.wikipedia.org/wiki/Group_delay_and_phase_delay

Thank You!