



AEROSPACE STANDARD

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Aerospace Analog Fiber Optic Link

RATIONALE

The aerospace industry requires precise standards for avionics system design. This document identifies and defines a common set of parameters necessary to describe an analog link over an optical fiber interconnect system. This common set of parameters will allow a consistent measure of analog fiber optic links between vendors and techniques.

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1. SCOPE

This SAE Aerospace Standard (AS) defines the parameters that describe the performance of an analog link transported over an optical fiber interconnect system suitable for aerospace applications.

2. REFERENCES

There are no referenced publications specified herein.

3. INTRODUCTION

This document details parameter definitions for an analog optical interconnect system. The general block diagram is shown in Figure 1.

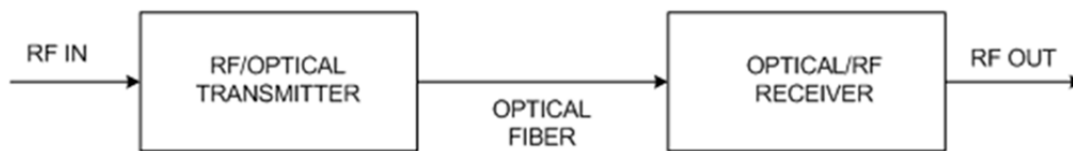


FIGURE 1 - BLOCK DIAGRAM OF ANALOG OPTICAL INTERCONNECT SYSTEM

As shown in Figure 1 the RF electrical signal is input into a RF/optical transmitter where it is modulated onto an optical signal. This modulated signal is then guided through an optical fiber. The benefit of converting into an optical signal is that it offers low loss and low crosstalk even in harsh environments. The modulated optical signal is then received at the optical/RF receiver where the optical signal is converted back to an RF electrical signal. The desired RF electrical signal is then output.

4. MEASURED ANALOG PARAMETERS

4.1 Gain

Gain is defined as the ratio of the output power to the input power in the linear operating region of the device such that compression is not a factor. The input power is the power into the RF optical link. Similarly, the output power is the power at the output of the RF optical link. Gain is typically frequency dependent, so it should be measured and plotted versus frequency.

4.2 Operating Frequency Range

The frequency range of the operating device is the frequencies contained within the 3 dB bandwidth relative to the peak value of the gain curve.

4.3 Maximum Survivable Input Power

The maximum survivable input power is the maximum power that can be injected into the device for any duration without causing permanent damage. The RF optical link shall return to its normal operating state upon decreasing the power from the maximum survivable input power.

4.4 Noise Figure

Noise figure is a figure of merit that describes how the output signal to noise ratio (SNR_o) compares to the input signal to noise ratio (SNR_i). For all practical devices the SNR_o will be less than the SNR_i . Noise figure is defined as shown in Equation 1.

$$F = \frac{SNR_i}{SNR_o} \quad (\text{Eq. 1})$$

The input signal to noise ratio used in Equation 1 is defined in Equation 2.

$$SNR_i = \frac{S_i}{N_i} = \frac{S_i}{kTB} \quad (\text{Eq. 2})$$

S_i and N_i are the input signal power and noise power to the RF optical link, respectively. In Equation 2, k is Boltzmann's constant, T is device temperature in Kelvin, and B is bandwidth of the RF optical link. The output signal to noise ratio is shown in Equation 3. The output noise of the link is the combination of amplified noise power injected into the device and the noise power of the device. The output signal power is the input signal power multiplied by the gain.

$$SNR_o = \frac{S_o}{N_o} = \frac{G \cdot S_i}{G \cdot (N_{device} + N_i)} \quad (\text{Eq. 3})$$

Taking the ratio of Equation 2 and Equation 3 yields the noise factor given in Equation 4.

$$F = 1 + \frac{N_{device}}{N_i} \quad (\text{Eq. 4})$$

From Equation 4 noise factor is calculated by taking one plus the ratio of noise power created by the link to the device temperature noise power. This quantity will always be greater than or equal to one. Noise factor is converted to noise figure (NF) in dB by $10 \log(F)$.

4.5 Group Delay

Group delay is defined as the negative rate of change of the phase shift with respect to frequency. It quantifies the variation in propagation delay for different frequencies. This parameter is important to describe the integrity of a received pulse. If the various frequency components that make up the pulse propagate at different rates the received pulse will be distorted. This is the case if the group delay is large. Figure 2 shows an example of ideal and non-ideal group delays.

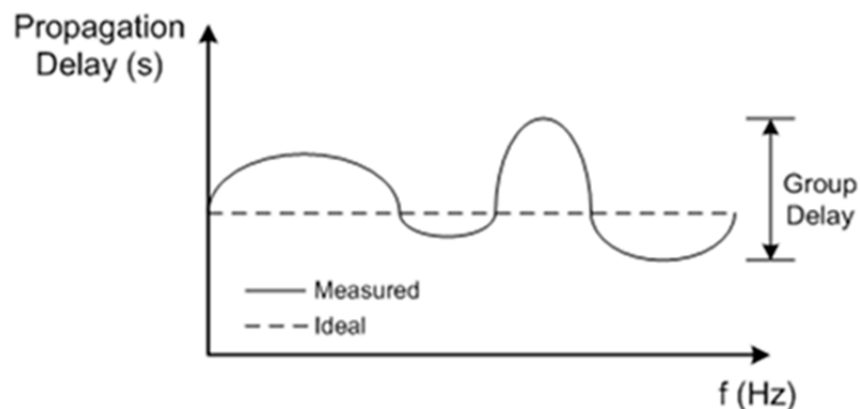


FIGURE 2 - PROPAGATION DELAY VERSUS FREQUENCY IS PLOTTED WITH THE IDEAL SCENARIO RESULTING IN AN UNDISTORTED RECEIVED PULSE SHOWN BY THE DASHED LINE. MEASURED GROUP DELAY IS THE PEAK-TO-PEAK CHANGE IN PROPAGATION.