BIDIRECTIONAL VIDEO TRANSMISSION FOR AVIONICS APPLICATIONS

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Introduction

As the cost of fuel increase and the grooving consciousness of technological impact on the environment, industries and avionic companies are looking for less consuming aircraft. The weight saving become one of the main aircraft today challenges. The successful introduction of optical links in civilian avionic applications within the A380 and B787, allows system architects and designers to explore intrinsic advantages of optics and optical communications. Among all the theoretical advantages of optical fibre, insensitivity to EMI and fiber weight are one of the most relevant for avionics systems. The possibility of “contra propagating” the photons doubles the impact of the weight saving as a single fibre can be use for a bidirectional link. A Single wavelength bi-directional and full-duplex optical links implemented on a full-duplex video multiplexing transmission is presented hereafter. The system, main performances and limitations are described and compared with avionics requirements and standards.

System Description

The video transmission demonstrator allows the transmission of three analog video signals and a 200Mbps PRBS pattern in real-time over a single fibre. Both ends of the links are identical: the three analog video signals are sampled at 20MHz over 10 bits providing 200Mbps digital video flux. A fourth 200Mpbs is generated with a PRBS pattern to provide a Bit Error Rate (BER) measurement channel. A multiplexer is used to provide a single 16 bits bus clocked at 80Mbps. A low power consumption Serdes (serialiser/deserialiser) generate a single 8B/10B encoded aggregate signal with a throughput of 1.6Gbps. The signal is transmitted to a full-duplex single wavelength bidir. optical transceiver.

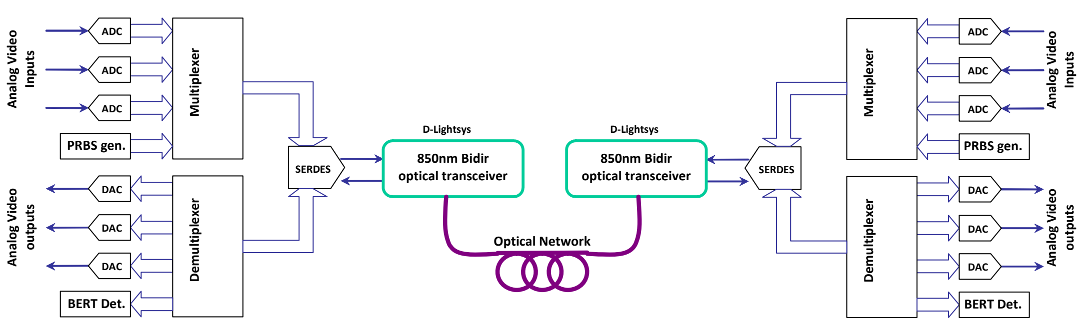

Figure 1. Schematic block diagram of the full-duplex link

The optical signal propagates over the optical network (62.5/125µm avionic multimode fibre) to the receiving part that retrieves the electrical signal to the Serdes and then the original analog video signals.

Optical transceiver performances

In this section, we describe the performance of the bidirectional optical transceivers. Modules are pigtailed with a 62.5/125µm avionic cable and terminated with ST connectors. The output power of the transceivers #1 and 2 are measured at typical *-7dBm*. Their sensitivities at BER 10^{-12} are *-17 dBm* when receiving only and *–15 dBm* when the transmitter part is operating. Connector return losses are expected between *15* to *18 dB.*

The link budget is limited by the optical crosstalk which could be decomposed in two parts: the connector return loss and the optical subassembly optical crosstalk.

The receiver photo current (index 1) is given by $I_{PhD}^{1\leftarrow 2} = R_{PhD}^{1} \times \left[P_{opt}^{2} - P_{TX}^{2} - \alpha - P_{RX}^{1}\right] - I_{PhD}^{1\leftarrow 1}$, where R^1_{PhD} is the receiver responsivity, P^x_y are different optical incident power (from the transmitting part x=1, or from the adjacent laser x=2). We had demonstrated that the electrical crosstalk could be kept below the optical crosstalk with an appropriated electrical design and therefore ignored. We plot here after the overall crosstalk (OSA and Connector RL) influence on the link budget.

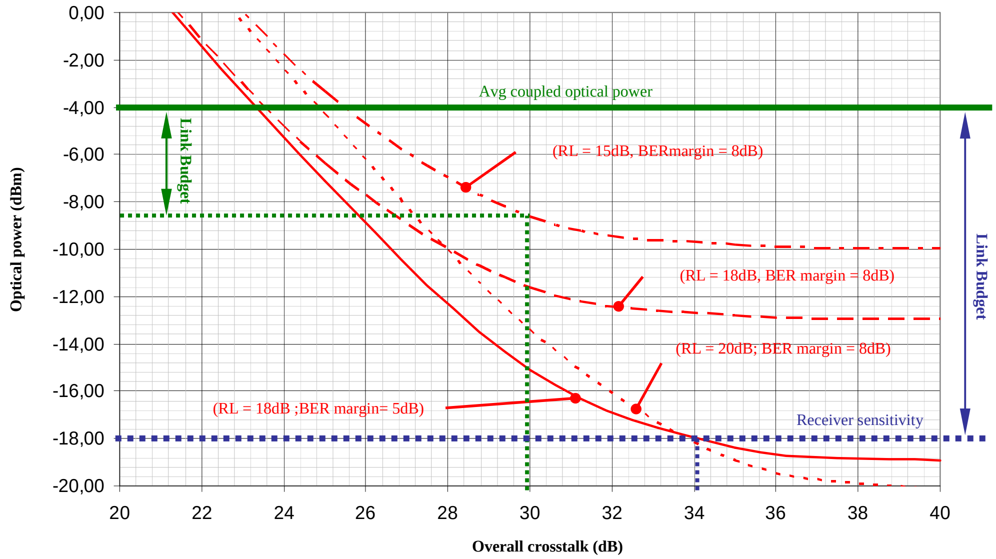

Figure 2. Link budget vs. Overall optical crosstalk and connector return losses

From this graph we note that the main limiting factor for bidir. optical communication using the same wavelength is the connector return loss: with a RL of *15 dB*, the link budget is limited to *5 dB*. A gain of *5 dB* on the RL (at a given BER margin) improves the link budget of *4 dB*.

Bidir Video transmission demonstrator

The video transmission demonstrator uses two video sources (one camera and one laptop) and two monitors, each source and monitors are attached to both end of the link, demonstrating a full duplex transmission.

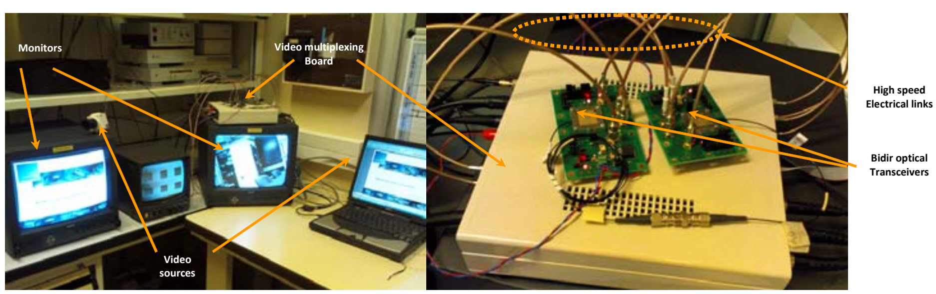

Figure 3. Birdir video transmission demonstrator

Video are transmitted in both direction on a single fibre. Both transceivers are operating at 850nm. The estimated link losses are *3 dB*.

Conclusion

The demonstration in this paper was taken at room temperature but module performances are suitable for the [-40:+85°C] range. Simulations and experimental results, validated through the presented demonstration show that the control of a good connector and the overall link return losses are predominant to achieve large link budget bir optical transmission. Avionic standards, namely ARINC 800 requirements, shall finally be taken into account in link specification in adding requirements on the Connector RL.