Application Note 036 – Why Use a Fibre Optic Link

This document describes the benefits that lead to fibre optic links becoming essential in many applications.

Introduction

Fibre optic links have many advantages over conventional galvanic conducting cable such as coaxial and triaxial cables. RF engineers are 'crossing-over' to fibre deployment where transport performance issues concerning bandwidth and signal integrity are critical. This document examines these two signal transport platforms and discusses the performance enhancements realised by network designers in migrating to optical fibre.

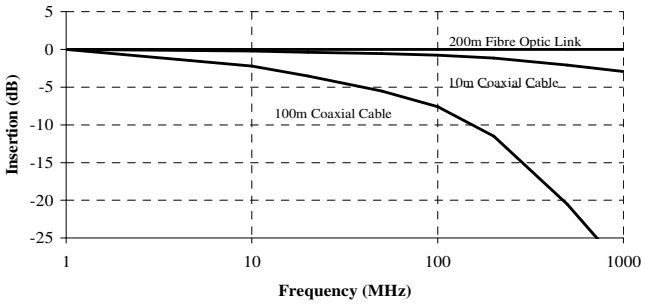
Minimal Signal Distortion

A signal propagated along conventional copper cable is attenuated due to parasitic elements inherent in this type of transmission line. The amount of attenuation is directly proportional to the frequency of the signal and the length and quality of the cable. As the parasitic elements are reactive, the transmitted signal is attenuated as a function of frequency, and the phase response is non-linear against frequency.

Such losses are negligible when transporting signals through optical fibre. This allows link lengths of several tens of kilometres without any noticeable signal loss or phase distortion. Figure 1 shows the insertion characteristics of a typical coaxial cable (RG214) and compares it to a 200m single mode fibre optic link.

Figure 1

Insertion Loss in Copper compared with Optical Fibre



Non-linear insertion characteristics found in coaxial cable can seriously distort the transmitted signal and will also reduce the overall performance of the system. The distortion is derived from the fact that different frequencies are attenuated by different amounts and their relative phases are altered. Although this can be compensated for, it is an added complication and can be extremely difficult to implement for broadband signals.

Sensitivity is reduced because the system needs to be configured so that low frequency signals do not cause saturation. However, reducing the sensitivity means the higher frequencies will have been attenuated. The reduction in sensitivity is directly equal to the amount of attenuation.

A flat frequency response, which is characteristic of PPM's fibre optic links, avoids both of these problems. This is illustrated by the typical test data taken from a L-band transmitter and receiver shown in figures 2 and 3 respectively.

Figure 2

Spectral response for a typical L-band transmitter

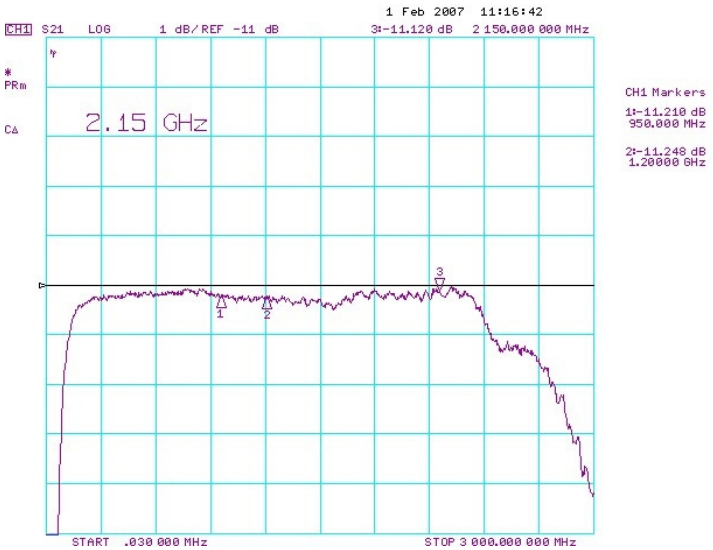
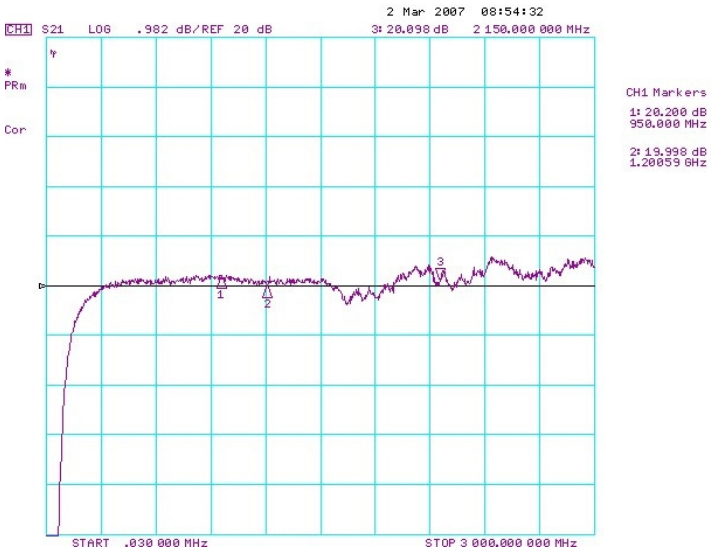


Figure 3

Spectral response for a typical L-band receiver

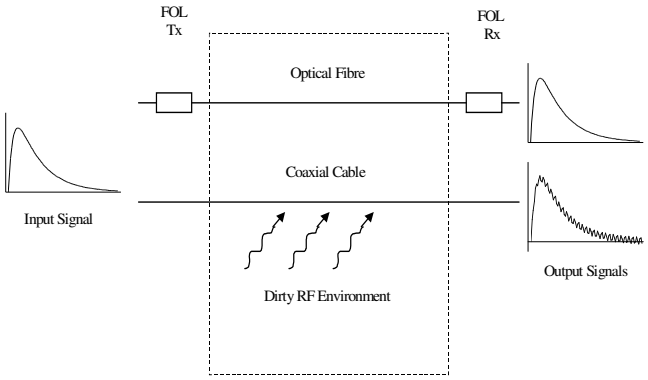


Immunity to Electromagnetic Interference

Unlike conventional copper cables, optical fibre is immune to electromagnetic interference and is therefore considered an excellent alternative to coaxial cables when routing through noisy RF environments. Figure 4 illustrates the effect that electromagnetic interference has on signals being transmitted through noisy RF environment using either coaxial cable or fibre.

Figure 4

EMI Impact on Signal Integrity During Transmission Over Coax and Fibre



Interference will reduce the signal to noise ratio of a system and this in turn will reduce the dynamic range and system sensitivity. However, by using a fibre optic link it is possible to maximise the potential signal to noise ratio and sensitivity of any system.

Electrical Isolation – Safety

There are many circumstances where electrical isolation from a high voltage strike area is essential in protecting valuable control room equipment. In these cases a fibre optic link provides a simple and effective isolation solution. Figure 4 shows a typical fibre deployment used to effectively isolate the basement receiver equipment from the off-air antenna feeds during a lightening strike.

Figure 4

Optical fibre being used to isolate an equipment room from lightening strike on roof-top antenna

Summary of benefits when deploying optical fibre instead of copper:

- Minimum signal distortion
- Minimum signal loss (typically <0.4dB/km), enabling very long haul transport with minimal degradation to carrier-to-noise
- Minimum effect on signal phase
- Non- conductive, provides electrical Isolation
- Extended transit span
- EMF / EMI immunity, service signal is not corrupted by radiation interference
- Light weight, small cable diameter, flexible
- Ease of installation
- Wide dynamic range, frequency response is independent of path length
- Excellent noise figure and frequency/ phase response

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