Ethernet over Plastic Optical Fibre

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Plastic Optical Fibre, or POF as it is commonly referred to, has emerged as a low cost alternative to traditional copper cabling in office, home and automotive networks. Continued growth for POF is estimated to be worth in excess of $1 Billion/year by the end of 2008.

POF offers many benefits to the user. It is lightweight, robust, cheap and easy to install. A simple sharp blade can be used to cut POF, without the need for polishing afterwards. The use of 650nm red light (LED) makes it completely safe. This safety feature brings additional benefits to the installer, as red light can be easily seen by the human eye to diagnose if the link is good. Perhaps though one of the biggest advantages in today's complex and congested world of networking is the fact that being fibre it is totally immune to electro-magnetic noise and just as important itself emits no radiation. Just think of all the wireless networks that are present today in the home and office. This is extremely important for video and voice streaming, where such noise can affect picture or service quality. Installation is simplified further as existing mains cable ducting can be used to route the fibre without any impact from noise interference.

Industrial networks have been slower to adopt POF compared to automotive manufacturers who have been keen to exploit such technology to connect car infotainments systems and even some safety-critical applications like the airbag. Today's high-end cars are processor intensive, supporting devices such as Radio, CD, DVD, Navigation systems, Bluetooth, Telephones, TV tuners and Gaming, to name the most common. In fact next generation car specifications can be easily predicted by observing trends in home networking. For the '24/7' world we live in the user demands the same services at the office, home and now the car.

A bus protocol called Media Oriented Systems Transport (MOST) led by car manufacturers Damlier Chrysler, BMW and Audi was devised in the late 90's to meet the rapidly increasing in-car data bandwidth. MOST25 offers 25Mbps and more recently MOST50 up to 50Mbps data bandwidth using POF as the physical media.

Differences between Plastic and Glass Fibre

POF differs from traditional optical fibre in material and the core / cladding dimensions.

The core is the highly refractive centre of the fibre which acts as a 'light guide'. For standard telecommunication Single-Mode Fibre (SMF) the core diameter is around 9um and cladding diameter 125um. SMF is utilised in long haul applications with transmission distances of up to 100km, without the need for any repeater. Multi-Mode Fibre (MMF) uses a core / cladding diameter of typically 50um / 125um, providing

less reach, up to approximately 2km, due to increased dispersion as a consequence of the larger diameter core. POF has a much larger core diameter compared to both SMF and MMF, commonly 980um / 1000um. Although this results in lower data rates (100's of Mbps) and reach, the big advantage is cost. The large core means the accuracy of alignment between the LED driver and fibre is less critical, to a point where even slightly damaged fibre is acceptable. Most of the expense in fibre systems today is not in the BOM (Bill of Materials) but production set up and alignment costs. The core / cladding diameters of Single-Mode, Multi-Mode and POF fibre are depicted in Figure 1 below.

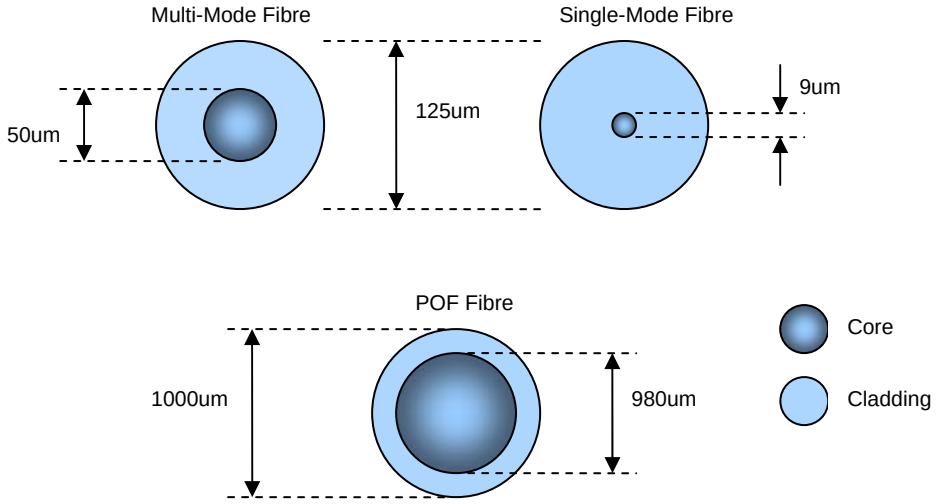

Figure 1.Single-Mode, Multi-mode and POF Fibre Core / Cladding Diameters

Standard fibre-optic cables have a glass quartz core and cladding, where impurities are added to the core to produce the desired refractive index to act a guide for the light. Glass fibre-optic cable offers lower attenuation than it's plastic counter part. POF typically consists of a polymethylmethacrylate (PMMA) core and a fluoropolymer cladding. The plastic nature of POF provides a more rugged cable, capable of withstanding tighter bend radius than glass fibre-optic cable.

POF over Ethernet

Today POF has generally been utilised in more niche applications where the fore mentioned advantages have outweighed the need for high data bandwidth. Advances in LED and VCSEL (Vertical Cavity Surface Emitting Laser) technology have now enabled POF to support data rates of 3Gbps and above. Such bandwidth capability should open the doors to more mainstream applications.

For POF to become a real serious alternative to copper cable networks it must be able to support Ethernet. Why? Because Ethernet is almost exclusively used as the lower layers in any office network and is fast beginning to dominate factory and home networks. So why 'reinvent the wheel' by devising unique application specific protocols, when you can benefit from today's mass market deployment of Ethernet. Ethernet is a low cost proven open standard, providing the bandwidth capability and Quality of Service (QoS) to support today's triple play (voice, video and data) services.

It is naive to assume that wireless will always be the answer for home triple play networking. Although highly desirable to connect a broadband modem or router to IPTV or IP SetTop Box (STB) without the added expense and complication of wiring, it is not always feasible. Each home is totally unique in its structure and layout and already congested with wireless signals from mobiles, DECT phones, microwaves, wireless PCs, printers and gaming. Telcos predict that the necessary quality of service required for a wireless video link between router and STB/TV, cannot be delivered in possibly up to 30% of homes. In these cases a wired alternative solution is required.

There are some obvious candidates for this wired link. Coaxial cable may be common in US households but not in Europe. Laying relatively thick coaxial or CAT5 cable in the home is awkward at best and 'ugly' at worst. HomePlug offers a solution using existing powerline cabling in the home, but this too has disadvantages of security and doubts over the quality of delivering video and voice. POF's 'home friendly' characteristics provides an ideal solution. Thin, flexible plastic optical fibre can be inconspicuously laid along skirting boards and door frames, cut to the desired length and safely self terminated. It's immunity to electro-mechanical noise allows the provider to offer a guaranteed QoS for video and voice services.

If you search the market you will find a number of different manufacturer Fibre-Optic Transceivers (FOTs) designed to provide Fast Ethernet (100Mbps) over POF. However, unlike traditional FOTs, such transceivers lack a common interface standard, both electrically and physically. So will this hold back the introduction of Ethernet over POF? Not necessary, as it depends on the flexibility of existing Ethernet device specifications. Micrel Semiconductor, for example, offers an Ethernet family of multi-port switches and PHYs ideal for POF transceivers. 'Any' differential input can be interfaced to the receiver due to the wide range common mode and voltage swing input specification (50mV pk-pk to Vdd).

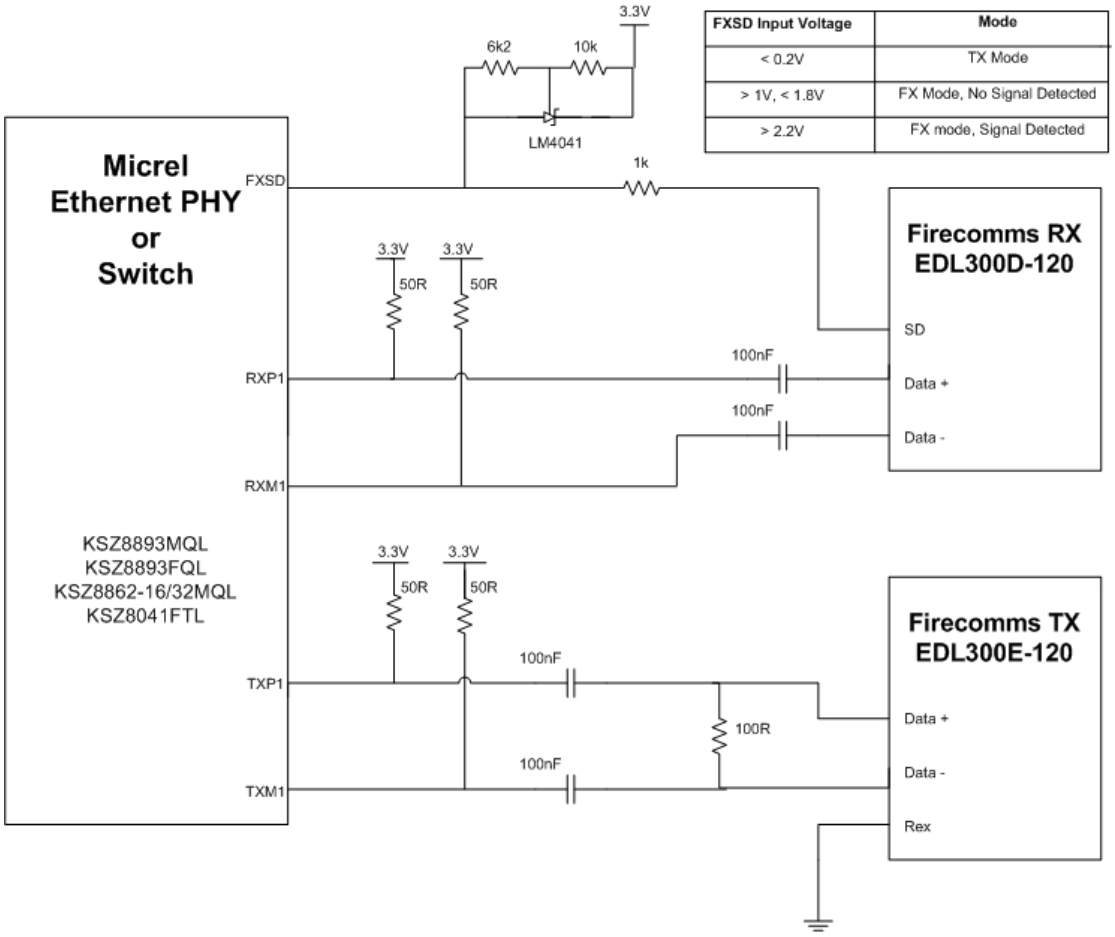

Figure 2. Example Ethernet-to-POF Interface Circuit Schematic

Figure 2 shows an example for interfacing one of Micrel's Ethernet devices to the Firecomms EDL300E POF transmitter and EDL300D receiver. This implementation provides a Fast Ethernet link over POF with a typical reach of 100 metres, comparable to a standard CAT5 solution. Any differences in the signals common mode voltage are removed by AC coupling the interfaces. An adjustable voltage reference LM4041 is used to ensure input FXSD is in the correct FX mode when a signal is detected (greater than 2.2V) and loss of signal (between 1V and 1.8V). The 10K and 6K resistors are used to adjust the reference voltage across the LM4041 to around 2V. This acts to clamp the FXSD input at 1.3V (Vcc–Vref) when the EDL300D Signal Detect Pin (SD) is low (LVCMOS < 0.4V). When a signal is present the SD pin is high (> 2.4V), thus no current will flow through the reference voltage diode and FXSD will follow the SD pin voltage (>2.4V).

Conclusion

POF technology offers an attractive alternative to traditional glass optical fibre as well as copper for industrial, office, home and automotive networks. It is low cost, weighs little, easy and safe to install and EMC immune. However, to become a mainstream alternative to copper cabling in such networks, POF needs to support Ethernet. We have hopefully shown that despite a lack of standards, interfacing POF to Ethernet can be a straightforward task.

Micrel Semiconductor offers a variety of different media converter Ethernet solutions to support today's 100Base-FX networks as well as legacy 10Base-FL or 100Base-SX applications. For more details visit www.micrel.com

* 100Mbps Data rate, 125Mbps Baud Rate