μSFP

Ultra miniature 10 Gbps optical transceiver

institute MIHAILO PUPIN

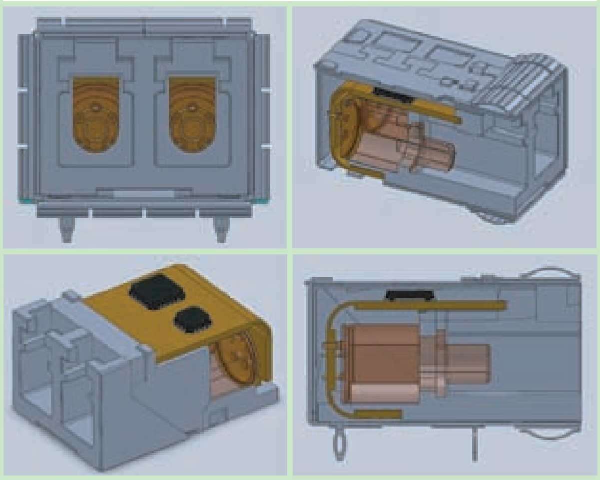
Original Design Manufacturing (ODM) Project

Customer: TagOn, Halstead, UK

Project completed in 2010

IMP-Telecommunications is a prominent Serbian embedded systems design house. It was established in 1997 as a fully owned spin-off company of the Michael Pupin Institute (IMP), the leading ICT research and development center in Southeast Europe. The company is oriented towards international market, focusing on helping product manufacturers and vendors to develop customized hardware, firmware and products. IMP-Telecommunications` experienced and vibrant embedded systems development team utilizes latest technologies, complex hardware and software concepts, and field proven know-how to develop prototypes based on customer's product ideas.

Ultra miniature 10 Gbps optical transceiver module (μSFP) is the state-of-the-art device designed for TagOn based in Halstead, England. TagOn is a start-up engineering innovations company, whose engineering solutions are based on strong scientific foundations and advanced best practice manufacturing processes. The company is acknowledged for Sockeye connector solutions based on high performance expanded beam technology.



With the idea to broaden the range of their products with the 10 Gbps miniature optical transceiver, TagOn started search for a design house capable of providing the solution. Finally, it recognized IMP Telecommunications as a reliable and competent partner. Following the discussion about the target market and on initial device specifications, an ODM product development project was launched in the last quarter of the year 2009. It was agreed that IMP-Telecommunications would be responsible for the design and manufacturing, while TagOn would hold the rights for product trademark, distribution and sales.

The initial μSFP optical transceiver module requirements included the following:

- Duplex LC connector interface
- 1x/2x/4x/8x Fibre Channel and 10G Ethernet protocols
- Small physical volume – to occupy no more than 40% of the industry standard SFP optical transceiver's volume (2.8 cm^3)
- Full electrical compatibility with MSA Small Form-factor Pluggable (SFP) industry standard
- Hot swap capability
- Extended temperature range

All of these requirements were to be fulfilled with having target price constraint in mind.

The product required robustness, very small form factor and extremely precise mechanical design, making mechanics the biggest design challenge. Initial solution was composed of two parts, the transceiver itself and its cage. Additionally, the special tool for removing the transceiver from the cage was designed, making μSFP easy unpluggable. The transceiver holds electronic and optoelectronic parts, and provides mechanical connection to optical cables. The cage is mounted on the host board, providing mechanical stiffness, precise positioning and good electrical connection between the board and the transceiver.

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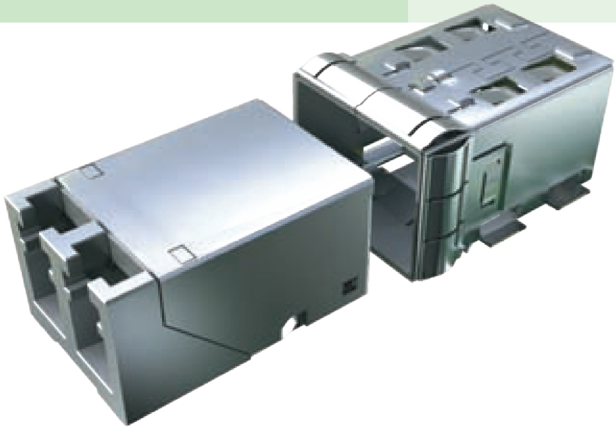
When plugged into the cage, the transceiver makes electrical contacts with the customized connector, enabling signal and power connections to the host board. For this connector part we selected technology which utilizes PCB processing techniques for producing high density, extremely low profile connectors with controlled impedance. The connector is soldered directly to the host board, by employing standard pick-and-place assembly and lead-free reflow soldering processes. Only after assembling this connector the transceiver cage is mounted and soldered.

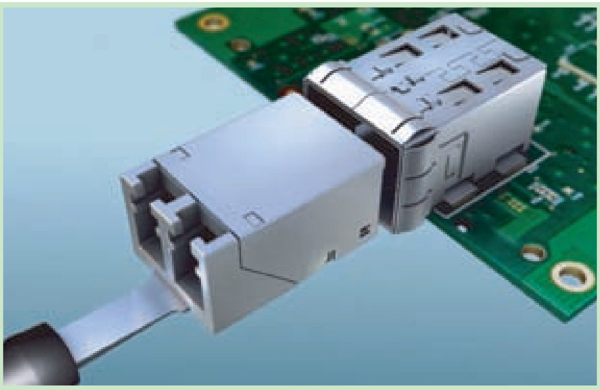
High speed PCB design was the big challenge. To achieve the communication speed as high as 10 Gbps, it was crucial to do a proper PCB laminate selection, routing strategy, impedance control, component placement and high speed traces routing. Since the board had to be very small and at the same time easy to put inside the transceiver casing, the smallest components available on the market and rigid-flex PCB technology were used. Rigid-flex technology combines rigid and flex materials, enabling the PCB to be flexible in the bending zones while stiff in the zones where electronic components are placed. To assure constant impedance of high speed traces and low dispersion at high frequencies, the top-notch flexible laminate had to be selected. Detailed 2D and 3D simulations using EM simulation software packages for RF and Microwave applications were performed and brought first-pass design success.



The lack of available space inside the transceiver casing significantly dictated the electronic components selection process. Most passive components had to be in 0201 package. For VCSEL driver and limiting amplifier, we selected miniature 5x5 mm single-chip integrated solution. For other active components smallest packages available on the market were selected, some as small as 1x1.5 mm.

For verification of hardware and mechanical designs, separate host boards and accompanying software were designed. The host board enabled plugging and unplugging of transceiver for checking mechanical parts and hot swap capability, as well as capturing of high speed signal waveforms and verifying communication with the transceiver. This board was crucial for proving the design concept and realization.

In just four months, μSFP ultra miniature 10 Gbps optical transceiver was developed, prototype manufactured and successfully verified in the house. This design proved once again IMP-Telecommunications' outstanding know-how in embedded systems design.



Contact person at IMP-Telecommunications:
Nikola Nenadic, CTO
tel.: +381 (0) 11 2772 953
mobile: +381 (0) 62 369 796
e-mail: nikola.nenadic@institutepupin.com

For contact at TagOn please refer to their web site:
http://www.tagon.co.uk

institute MIHAILO PUPIN
IMP-TELECOMMUNICATIONS
EMBEDDED SYSTEMS DESIGN HOUSE

Institute Mihailo Pupin
Telecommunications Ltd.
Volgina 15,
11060 Belgrade, Serbia

phone: +381 11 2774 959
fax: +381 11 2772 755
www.imptelecom.com
telecom@institutepupin.com

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