Patria

Status of Space Fibre Link Module development

Taisto Tuominen
Patria Aviation Oy

SpW-WG mtg#18
ESTEC

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Introduction

- ESA Contract for development of SpaceFibre EM-level modules, work started 09/2008
  - Prime Contractor: Patria, Finland
  - Modules: VTT, Finland and D-Lightsys, France
  - Fibre cables with connector mounting: Fibrepulse; Ireland
  - Environmental testing: Alter Technology, Spain
  - End user requirements: ThalesAlenia Space, France
- Previous work 2004-2006
  - SpaceFibre prototype modules
  - VTT, INO, Fibrepulse, Gore
  - Final Summary Report 08/2007

Optical Modules

- Background

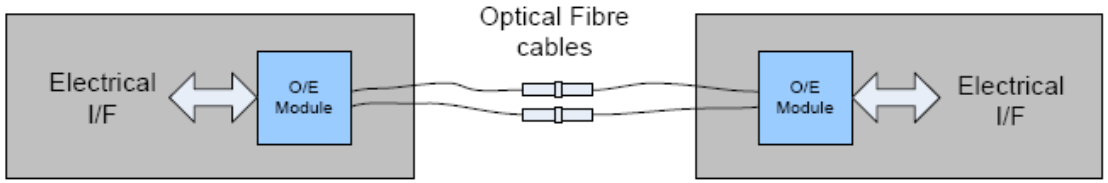
  A High Speed extension to SpaceWire link is needed to meet the growing need for high data rate payloads

- Goal

  To provide EM-level design with production process documentation

- Main features

  SpaceFibre modules are physical layer components meant to establish a bi-directional optical link between two nodes at 10 Gbps speed



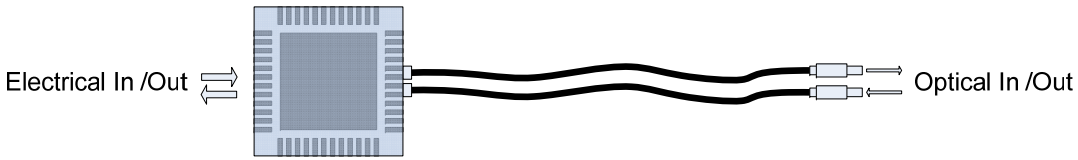
Specifications

- Main Specifications
  - Data rate goal 10 Gbps, 6.25 Gbps specified
    - 12 dB link budget over temperature range
  - Module dimensions 17 mm x 17 mm x 5 mm
  - Fibre pigtail cable length > 1 m
  - 3.3 V operating voltage, CML electrical interface
  - Power consumption < 400 mW
  - Temperature range
    - Operational -40 °C to +85 °C
    - Storage -55 °C to +125 °C
  - Typical space project environmental requirements
    - Hermeticity and outgassing
    - Shock and vibration tolerance
    - Radiation tolerance

One Specification – Two solutions

- Two types of optical modules with common specifications and interfaces
  - → Two interchangeable solutions: VTT & D-Lightsys

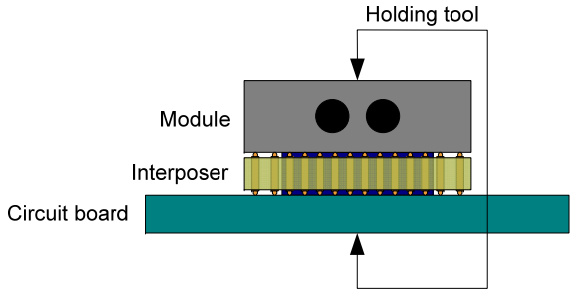
- Common features
  - Mounting pad pattern and pin function
    - 48-pin QFN type footprint



  - Fibre pigtails and connectors
    - 50/125 µm graded-index radiation resistant fibre
    - 1.2 mm cable
    - Radiall LuxCis (alternative: Diamond AVIM)

One Specification – Two solutions

- Solderless mounting using an interposer or socket



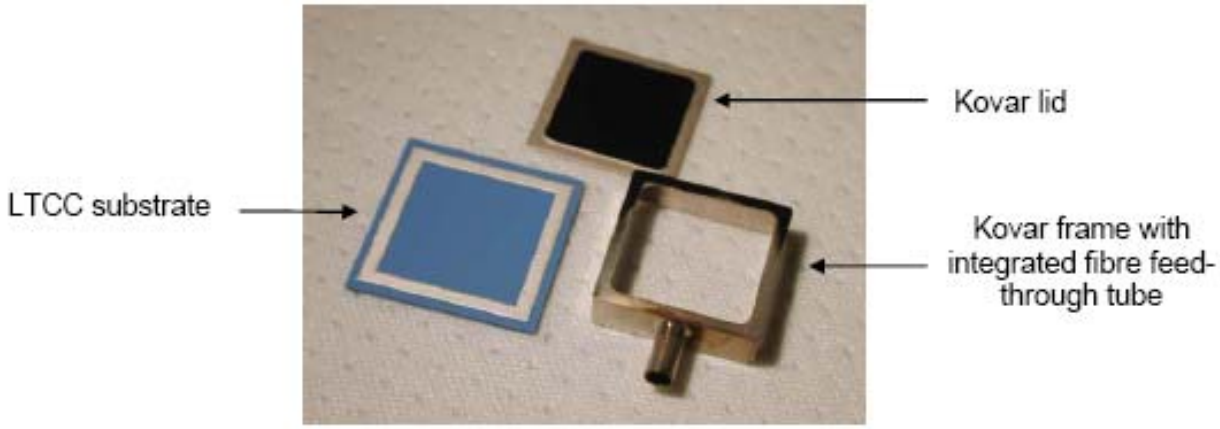
- 850 nm GaAs VCSEL and transmitter chips
- GaAs PIN diode chip

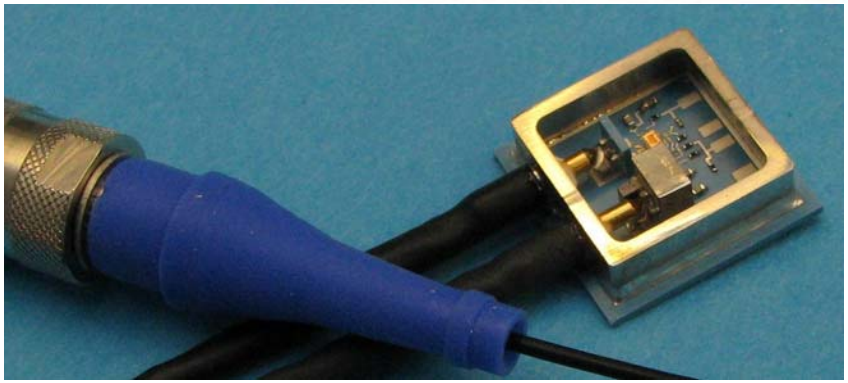
➢ Differences

- Internal structure and fibre-electronics connection
- Package type and materials
- Receiver-amplifier chips
- VCSEL temperature compensation in type 2
- Some different status & control pins

Module Type 1: VTT

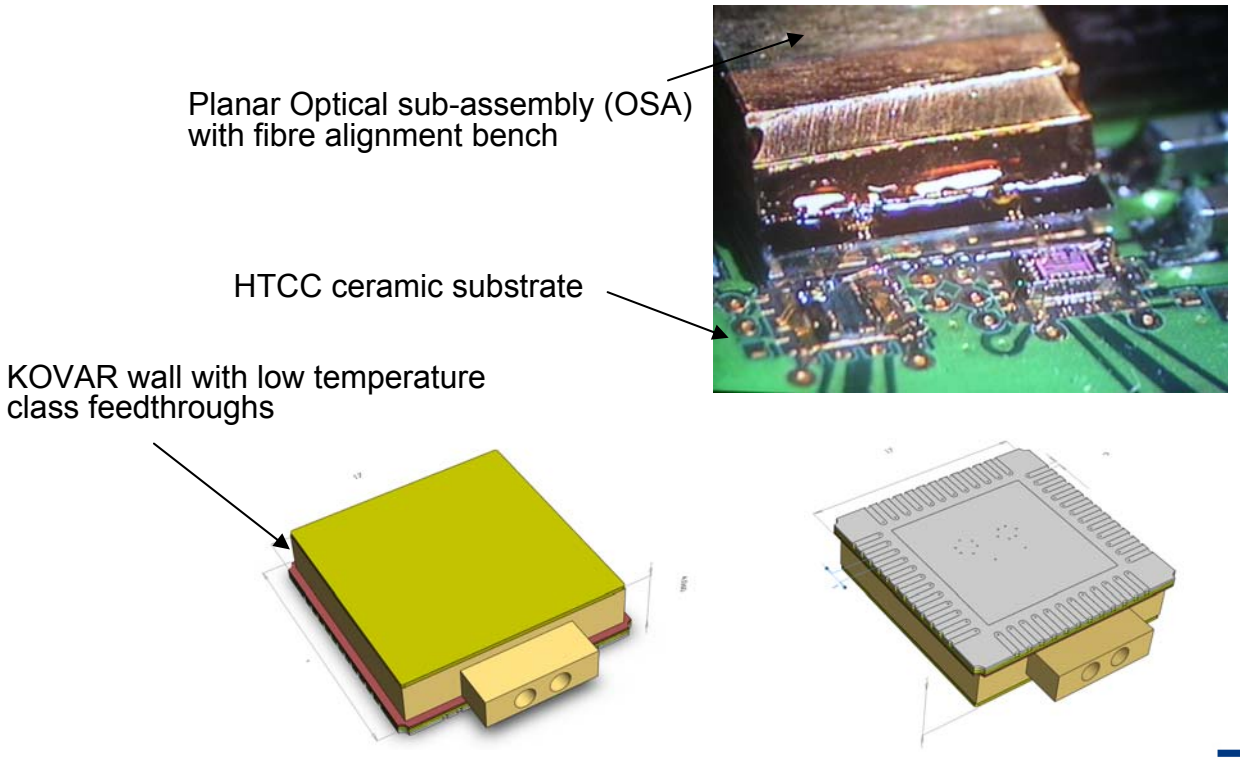
- Electronics mounted on LTCC substrate
- Kovar frame with hermetic feed through
- Kovar lid





Module Type 2: D-Lightsys

- Electronics mounted on HTCC substrate
- Kovar frame with hermetic feed through
- Kovar lid



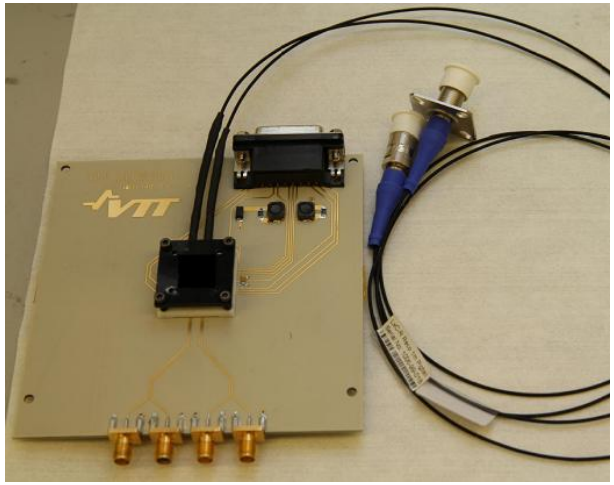
Component Test Results

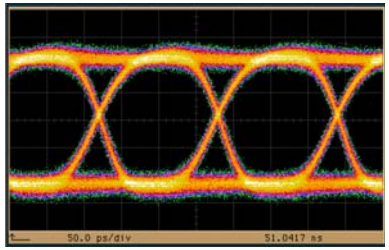
- Package Hermeticity test
  - Fibre cable absorption test
    - This was needed to confirm package test method
  - Package sealing test
    - Type 1: pass
    - Type 2: pass
- Radiation Tests
  - Total dose 100 krad: pass
  - Heavy ions LET_{th} up to 70 MeV cm^2/mg: partial pass
    - VCSEL driver was sensitive to latch-up
    - Reasons / solution to be discussed with manufacturer
  - Proton fluence up to 10^{12} p/cm^2 @ 60 MeV: pass
    - **Note:** number of samples was small; additional radiation testing is needed for full confidence

Performance Test Results

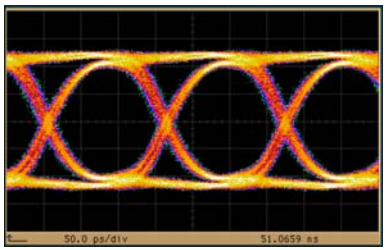
- Type 1: VTT

- Electrical power consumption: 250 mW
- Optical output power: 800 µW
- Receiver sensitivity: –13 dBm (6.25 Gbps, 10^{-12} BER)
- Mass without pigtail: 3 g





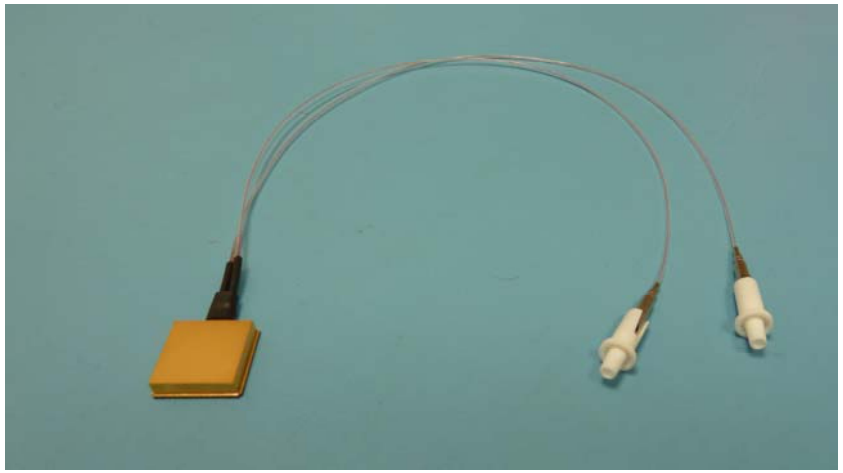
Transmitter eye diagram
at 6.25 Gbps

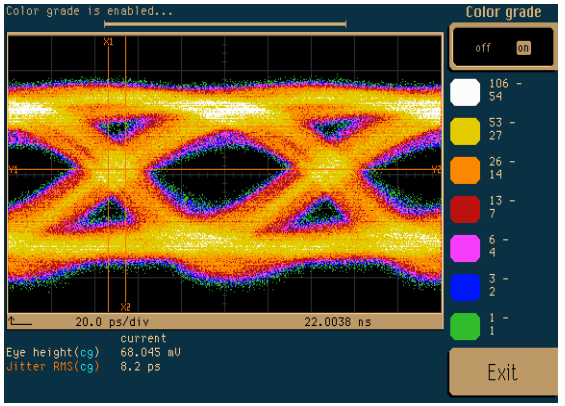


Receiver eye diagram at
6.25 Gbps

Performance Test Results

- Type 2: D-Lightsys
  - Electrical power consumption: typ. 250 mW
  - Optical output power: ~ -3 dBm
  - Mass without pigtail: ~ 5 g





Transmitter eye diagram at 10 Gbps (Using D-Lightsys OI2-project module)

On-going and Future Work

- On-going work April – August 2012
  - Environmental testing (Alter)
  - End-User test (ThalesAlenia)
  - SpaceWire interface test (Patria)
  - Final Report

- Issues to be solved outside of this contract
  - Latch-up sensitivity of VCSEL driver
  - Interposer development is in progress by a connector manufacturer (Hypertac)
  - Holding tool; to be solved after interposer solution