OPTOELECTRONIC LINK FOR HARNESING SUBSTITUTION IN SPACE

SPACEWIRE APPLICATION

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OPTOELECTRONIC LINK FOR SPACE HARNESSING SUBSTITUTION
OPTOELECTRONIC CONVERSION MODULE “SIOS”

- SIOS Optical Transceiver is a subsystem of optical interconnections to substitute copper data cables by optical fibre data links

- This substitution of copper harness will not require current equipment requalification
- It will reduce the harness mass in the S/C without impacting the terminal connectors of the equipments, the equipments manufacturing and simplify the S/C AIT process

Total mass saving in harness’ is around 25%.
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OPTOELECTRONIC CONVERSION MODULE
“SIOS”

• Provide symmetrical, bi-directional connection

• Handle data rates 1Mb/s-400Mb/s and support variable signalling rates (with capability for higher data rates)

• Compatible with electrical levels and bit rates of current satellite buses (1553, RS-422) and SpaceWire

• Applicable for:
  • SPACEWIRE
  • CONTROL BUSES: 1553 / CAN BUS
  • RS-422 (CALIBRATION, CLOCK)
  • AOCS TMTC
  • Serial TM & Bilevel TM

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Many limitations because the use of copper wires in traditional harness:
- Mass cost
- Volume cost
- Limited data rate and distance
- No EMI immunity between channels
- Increment mass due to isolating wires

Optic fibre has become a potentially copper harness replacement:
- Low mass and volume compared with copper wires (2-4 g/m)
- Allow longer distances and data rate
- Immunity to EMI without external jackets
- Optical fibres for Space Applications already in use
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OPTIC FIBRE HARNESS APPLICATIONS

- ESA and many satellite integrators are interested in the use of optical fibre as a potentially copper harness replacement
- SpaceFibre has become an important activity in order to evolve SpaceWire standard
  - High-speed serial data-link standard intended for use in data-handling networks for high data-rate payload (2,5 Gbps and higher)
  - Not targeted for bus substitution (MIL-1553 or CAN)

- How to take advantage of the use of fibre links in the short term?
- SIOS is an alternative approach to substitute most copper harness including low speed communications
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SIOS MODULES DESIGN

DESIGN CRITERIA

- Modular design with selectable number of TX & RX channels per module.
- Adaptable to a range of connectors. DB-9, DB-15, DB-25, DB-37, μD-9
- Selected components from qualified parts, when available
- Dedicated components space assessment and thermo-mechanical analysis to assure that the final mechanical design is suitable for the environment
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ASSESSMENT OF OPTOELECTRONICS MODULE FOR SPACEWIRE

• **The module is fully compliant with SpW link** and can be used to replace all point-to-point SpW cable.

• The modules will be developed in different versions according most used space connectors (SubD9, SubD15…). The connectors for SpW version will be compatible with SpW connectors (**μminiature D connectors, ESCC 3401/071, 9 contact type**).

• The SpW transceiver version will be fully compliant with LVDS standards, including its differential voltages and DC value.

• **Data and Strobe jitter/skew has been estimated less than 1200 ps**, typical value in copper cable @400 Mbps. These values are compliant with maximum values defined in SpW standard.

• To assure pin-to-pin compatibility power supply must be provided through an external cable.

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QUALIFICATION APPROACH

• Space qualified components used when available

• When not feasible (simply not existing): VCSELs, Photodiode and its drivers
  ➔ Highest quality level for commercial off-the-shelf opto-electronic components
  ➔ Full space assessment @ components level: Constractional Analysis, Residual Gas Analysis, Outgassing, Thermal Vacuum cycles, COD threshold & fiber pull.

• Full qualification campaign for the units
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QUALIFICATION APPROACH

• **Functional electrical:**
  - BER and eye diagram (BER<10E-12)
  - Power consumption
  - Mechanical properties (mass, dimensions)

• **Vibration:**
  - 6.4G peak, 3 axes, sine
  - 23.73g RMS, 3 axes, random

• **Shock**
  - 1500G at 10kHz, 3 axes

• **Thermal vacuum cycling**
  - 8 cycles (-60,85) °C @ 1E-8mbar, system level
  - 300 cycles (-40,85)°C @ 1E-8mbar, component level

• **Radiation total dose (TID)**
  - 150 Krad @ 50Krad/h
  - 1 unit without aluminum package
  - 150 Krad @ 360 rad/h

• **Proton radiation**
  - Total dose of 3E10 p/cm2 with a flux of 5E7 p/cm2/s with energy of 60 MeV
  - Total dose of 1E11p/cm2 with energies of 200/100/60 MeV
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SUMMARY AND CONCLUSIONS

- Concept has been demonstrated and a complete set of modules covering the wide range of applications (e.g. 1553 and TM/TC) is ready.
- Comparing the “active optical cables” based on these modules with passive copper harness significant advantages proven:

  - **SAVING OF MASS:**
    Study for real cases have been done (GAIA and LISA Pathfinder) based on real mass of fabricated modules
    
    |                       | Replaceable copper mass | 18640 g |
    |-----------------------|-------------------------|---------|
    | Fibre mass            |                         | 4660 g  |
    | Mass reduction (over 50kg harness) |             | 25%     |

  - **25% mass would have been saved for GAIA and 27% for LISA**

  - **LONG LINK DISTANCES, HIGH SPEED RATES and EMI:**
    EMI and Low losses are inherent advantages, it simplify testing tasks used as GSE

  - An In-orbit demonstration experiment to obtain real performances in-orbit and reliability data will be done in AlphaSat (TDP8)