Input - Automotive Use-cases and Requirements Multi Gigabit

IEEE 802.3 Multi Gigabit Automotive Optical PHY Study Group

Supporters (Volvo Cars):

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Purpose

• Provide initial OEM recommendations / input and use-cases to IEEE 802.3 Multi Gigabit Automotive Optical PHY Study Group.

• Presentation covers
  • Use cases
  • Requirements
Use-Cases

• Backbone

• Integration Interfaces

• ECU sensors
  • E.g. Camera, Lidar & Displays
Use-Cases - Bandwidth

What potentially drives more bandwidth?

• ECU sensors
  • Cameras
    • Today: <= 6Gbps LVDS links
    • Tomorrow: > 6 Gbps?
  • Lidar/radar
    • Today: <= 1 Gbps Ethernet
    • Tomorrow: > 1 Gbps?
• Displays

"Tomorrow: one the day after today"
REQUIREMENTS

• Speed
• Optical Physical Medium & Connectors
• Power Requirements
• Network capabilities
• Settings
• Electromagnetic Compatibility (EMC)
• Lifetime on components
• Other
Speed Requirements

Potential speed grades for future

Important:
- It shall be possible to use the same physical medium.
- PHY (Transceiver) support of multiple speed grades is interesting. However, cost optimization important.
Optical Physical Medium & Connectors

- 4 inline connectors on total length 15m (e.g. SMD FOT with pigtail (internal inlines within ECU) to connector and 2 in lines within vehicle)

- Connectors
  - Sealed (water tight, dust protection, temperature etc.) -> e.g. cameras
  - Unsealed (dust protection, temperature etc.)

- Single connector(s)
- Multi-pin connectors (Multiple Optical connectors AND Optical + UTP harness)

Challenges: connector size
Optical Physical Layer & Transceiver

- Operating temperature (ambient) range challenge -> Optical Physical Medium & PHY (transceiver, FOT):
  - $T_{\text{min}}$ - 40°C
  - $T_{\text{max}}$ +105°C
  
  Note. There are surfaces / areas which might require higher temperatures . $T_{\text{max}}$ +125°C

- Bending attenuation challenge
  - POF -> bending diameter 90° that has 25 mm radius without no rise in attenuation
  - Next Physical medium: Bending diameter 90° bending that has less than 10 mm radius without no rise in attenuation.

- Interesting harnesses
  - Single Optical (full duplex)
  - Full duplex
  - Hybrid cable
Optical Wakeup - Power Requirements

• Support of Optical Wakeup and Sleep
  • Established link ("link up") in less than 100ms

• Transceiver: 35uA in sleep at 12v (Vbat)
Settings

• Auto-Negotiation
  • Keep as optional feature.
  • Default: Disabled to save booting time.

• Speed grade
  • Forced by configuration
    • Symmetric
    • Asymmetric (e.g. configurable speed of backchannel for control data for e.g. a camera.)
Network capabilities

• Interesting capabilities
  • Time Sensitive Networking (TSN)
  • “Tunneling” PCIe
  • Datalink security
Electromagnetic Compatibility (EMC)

• The optical link and components shall be capable to support radiated immunity test

<table>
<thead>
<tr>
<th>Band</th>
<th>Frequency Range [MHz]</th>
<th>Test level [V/m]</th>
<th>Modulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>200 - 800</td>
<td>200</td>
<td>CW, AM 80% Pulsed PRR = 18 Hz, PD = 28 msec</td>
</tr>
<tr>
<td>6</td>
<td>800 - 6000</td>
<td>140</td>
<td>CW, Pulsed PRR = 217 Hz, PD = 0.57 msec</td>
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<tr>
<td>7</td>
<td>1200 - 1400</td>
<td>1200</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>2700 - 3100</td>
<td>1200</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>8500 - 10500</td>
<td>600</td>
<td>Pulsed PRR = 300 Hz, PD = 3 usec, gated by a pulse PRR=1 Hz, PD=200 msec</td>
</tr>
<tr>
<td>10</td>
<td>15700 - 17700</td>
<td>300</td>
<td></td>
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</tbody>
</table>
### Lifetime on components

<table>
<thead>
<tr>
<th>Operation state</th>
<th>Operation condition</th>
<th>Operational time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Life time</td>
<td></td>
<td>≥ 15 years FIC C functions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥ 10 years FIC A/B functions</td>
</tr>
<tr>
<td>Continuous feed or activity</td>
<td>OC1</td>
<td>≥ 131 500h FIC C functions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥ 88 000h FIC A/B functions</td>
</tr>
<tr>
<td>Driving, (In vehicle usage)</td>
<td>OC2</td>
<td>≥ 20,000 h FIC C functions,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥ 13,500 h FIC A/B functions available. Loads may be restricted.</td>
</tr>
<tr>
<td>Preconditioning only</td>
<td>OC3</td>
<td>≥ 6,000 h</td>
</tr>
<tr>
<td>Traction battery vehicles “Plugged in” charging/preconditioning</td>
<td>OC4</td>
<td>≥ 30,000 h</td>
</tr>
<tr>
<td>Connected functionality</td>
<td>OC5</td>
<td>&gt; 1,500 h</td>
</tr>
<tr>
<td>Other functionalities active in non-driving states</td>
<td>Not specified</td>
<td></td>
</tr>
</tbody>
</table>

FIC = Function Important Classification
Level of availability needed of a functionality while driving a vehicle.
Level C is essential to the safe operation and control of the vehicle.
Components other

- EMC Radiated Immunity
- Radiated Emissions
- Bulk Current Injection
- Conducted Immunity
- Conducted Emissions
- Material testing
- Vibration
- Thermal Shock
- Electrical Testing
- Mechanical Testing
- Temperature
- Humidity
- Rain
- Salt Fog/Spray
- Sand & Dust