STP cable in automotive environment

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1. About in-vehicle influence

2. NGAUTO current situation

3. STP cable
   - In-vehicle influence
   - Degradation of the transmission characteristics
   - Structure and transmission characteristics more than 1 GHz

4. Summery

STP : Shielded Twisted Pair
1. About in-vehicle influence

- **Vehicle environment**
  - High temp. atmos. 105 °C
  - Low temp. atmos. -40 °C
  - High humidity atmos.
  - Life time
  - etc.

- **W/H assembling and vehicle installation**
  - Tensile
  - Bending
  - Wire band
  - etc.

Vehicle environment, W/H assembling and vehicles installation affect to transmission characteristics
2. NGAUTO current situation

- Initial data of components such as connector and cable are used.
- Link segment configuration
  
  ![Link segment image](image)

  Figure 6: Link segment image

- PHY makers run simulation to decide what modulation should be used?
  
  ![PAM-8 eye pattern image](image)  
  ![PAM-16 eye pattern image](image)

  Figure 7: PAM-8 eye pattern image  
  Figure 8: PAM-16 eye pattern image
2. NGAUTO current situation

- Running simulation using the initial data of components
  - Considering the in-vehicle influence below
    - Vehicle environment
    - W/H assembling and vehicle installation

- Investigated link segment may not work in automotive environment
  - As the result of simulation, eye pattern doesn’t open

Figure 9: PAM-16 eye pattern image
### 3. STP cable

◆ In-vehicle influence

#### Insertion loss

Graph 1: Insertion loss

<table>
<thead>
<tr>
<th>Test item</th>
<th>Test description</th>
<th>Tough level</th>
</tr>
</thead>
<tbody>
<tr>
<td>High temp. atmos.</td>
<td>Measurement of transmission characteristic in 105 °C atmos.</td>
<td>✔ ✔</td>
</tr>
<tr>
<td>Low temp. atmos.</td>
<td>Measurement transmission characteristic in -40 °C atmos.</td>
<td></td>
</tr>
<tr>
<td>High temp. and high humidity atmos.</td>
<td>Measurement transmission characteristic in 85 °C, 85 %</td>
<td></td>
</tr>
<tr>
<td>High temp. storage</td>
<td>Measurement transmission characteristic After 100°C, 3000 h aging</td>
<td>✔</td>
</tr>
<tr>
<td>Tensile</td>
<td>Measure transmission characteristic with 100 N pulled</td>
<td></td>
</tr>
<tr>
<td>Bending</td>
<td>Measurement transmission characteristic with R = 5 times of wire diameter</td>
<td></td>
</tr>
<tr>
<td>Wire band</td>
<td>Measurement transmission characteristic with wire band</td>
<td></td>
</tr>
</tbody>
</table>

Tough level:
- ✔ ✔ Toughest
- ✔ Second Toughest
3. STP cable

◆ Degradation of transmission characteristics

STP cable is designed taking into consideration the degradation of transmission characteristics due to the influence of in-vehicle conditions. The degradation of the transmission characteristics is assumed in the actual vehicles. Therefore, it is necessary to use cable data in consideration of the degradation in the simulation.

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3. STP cable
◆ Structure and transmission characteristics more than 1GHz

Cable structure

0.13sq Pure copper
Cross-linked polyethylene
Metal foil + Braided shield
PVC

Figure 10: Cable structure

Graph 3: Insertion loss
- Suck-out
- Bandwidth: Up to 3.2 GHz

Graph 4: Return loss
- Suck-out can be shifted by cable structure
3. STP cable

◆ Structure and transmission characteristics more than 1GHz

**Insertion loss**

<table>
<thead>
<tr>
<th>Frequency (MHz)</th>
<th>Initial value</th>
<th>105 °C atmos.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IL dB / 15m</td>
<td>IL dB / 15m</td>
</tr>
<tr>
<td>10</td>
<td>-1.46</td>
<td>-1.63</td>
</tr>
<tr>
<td>100</td>
<td>-3.95</td>
<td>-4.39</td>
</tr>
<tr>
<td>1000</td>
<td>-13.5</td>
<td>-16.0</td>
</tr>
<tr>
<td>2000</td>
<td>-19.8</td>
<td>-23.4</td>
</tr>
<tr>
<td>3000</td>
<td>-28.5</td>
<td>-32.7</td>
</tr>
<tr>
<td>3200</td>
<td>-29.1</td>
<td>-36.1</td>
</tr>
</tbody>
</table>

- The change rate of insertion loss increases according to frequency
- The maximum change rate is 24 %
4. Summary

- With regard to the simulation for deciding the modulation method, it is necessary to consider degradation of the transmission characteristics of the cable due to the influence on the vehicle.

- The STP cable is designed with consideration of degradation of the transmission characteristics at the standard value of Ethernet 1 Gbps.

- The STP cable can secure bandwidth up to 3.2 GHz. Also it can shift bandwidth to high frequency band by cable structure.

- The change rate of insertion loss increase according to frequency. And the maximum change rate is 24%.
END

Thank you for your attention

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