STP cable
in automotive environment

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Agenda

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 ℃
  - Low temp. atmos. -40 ℃
  - High humidity atmos.
  - Life time

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

  etc.

Figure 1: Jig board

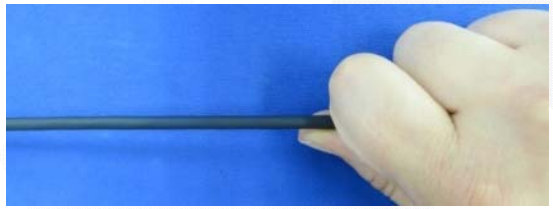

Figure 2: Tensile

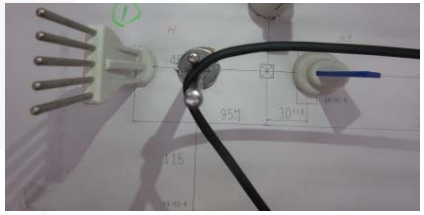

Figure 3: Bending on Jig board

Figure 4: Bending in-vehicle

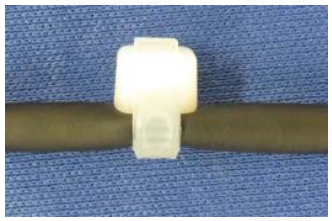

Figure 5: Wire band

Vehicle environment, W/H assembling and vehicles installation affect to transmission characteristics

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2. NGAUTO current situation

- **Initial data of components such as connector and cable are used.**

- **Link segment configuration**

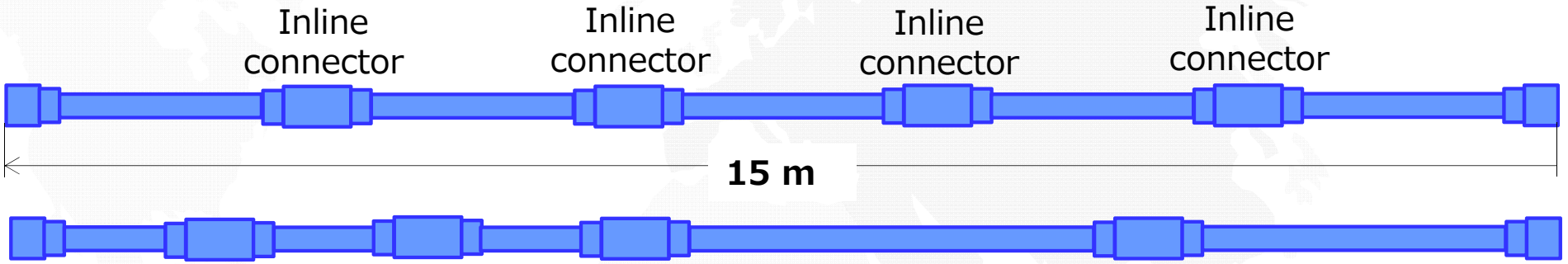
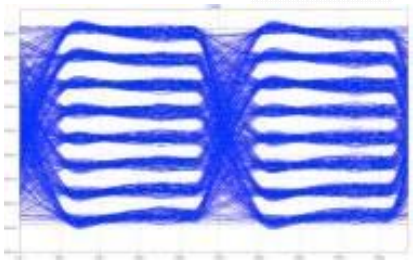


Figure 6: Link segment image

- **PHY makers run simulation to decide what modulation should be used?**



PAM-8 or PAM-16

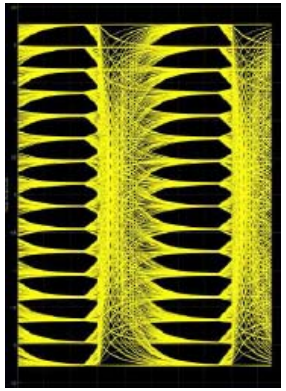


Figure 7: PAM-8 eye pattern image

Figure 8: PAM-16 eye pattern image

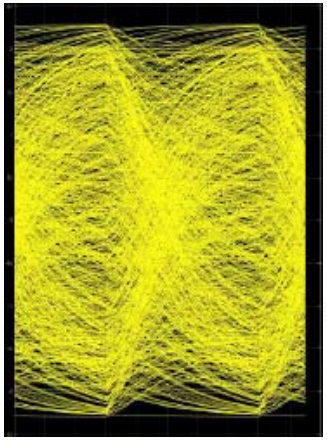
2. NGAUTO current situation

- **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**

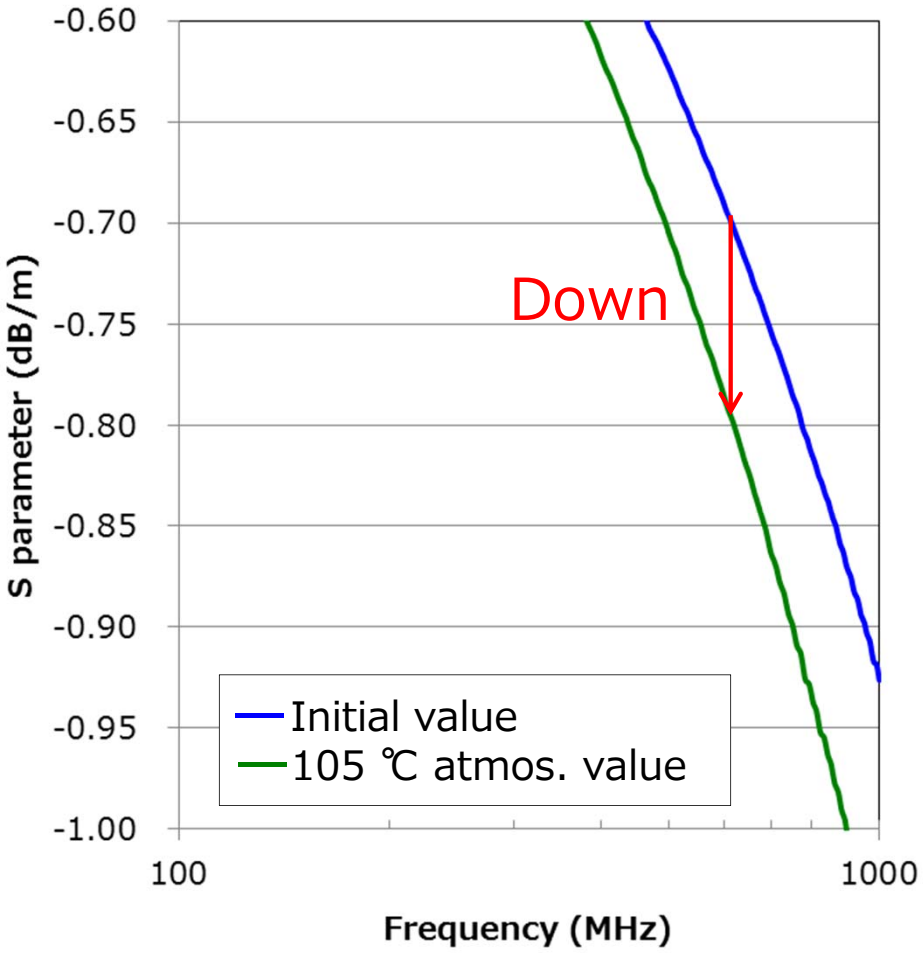


As the result of simulation,
eye pattern doesn’t open

Figure 9: PAM-16 eye pattern image

3. STP cable
◆ In-vehicle influence

Insertion loss



Graph 1: Insertion loss

In-vehicle influence test

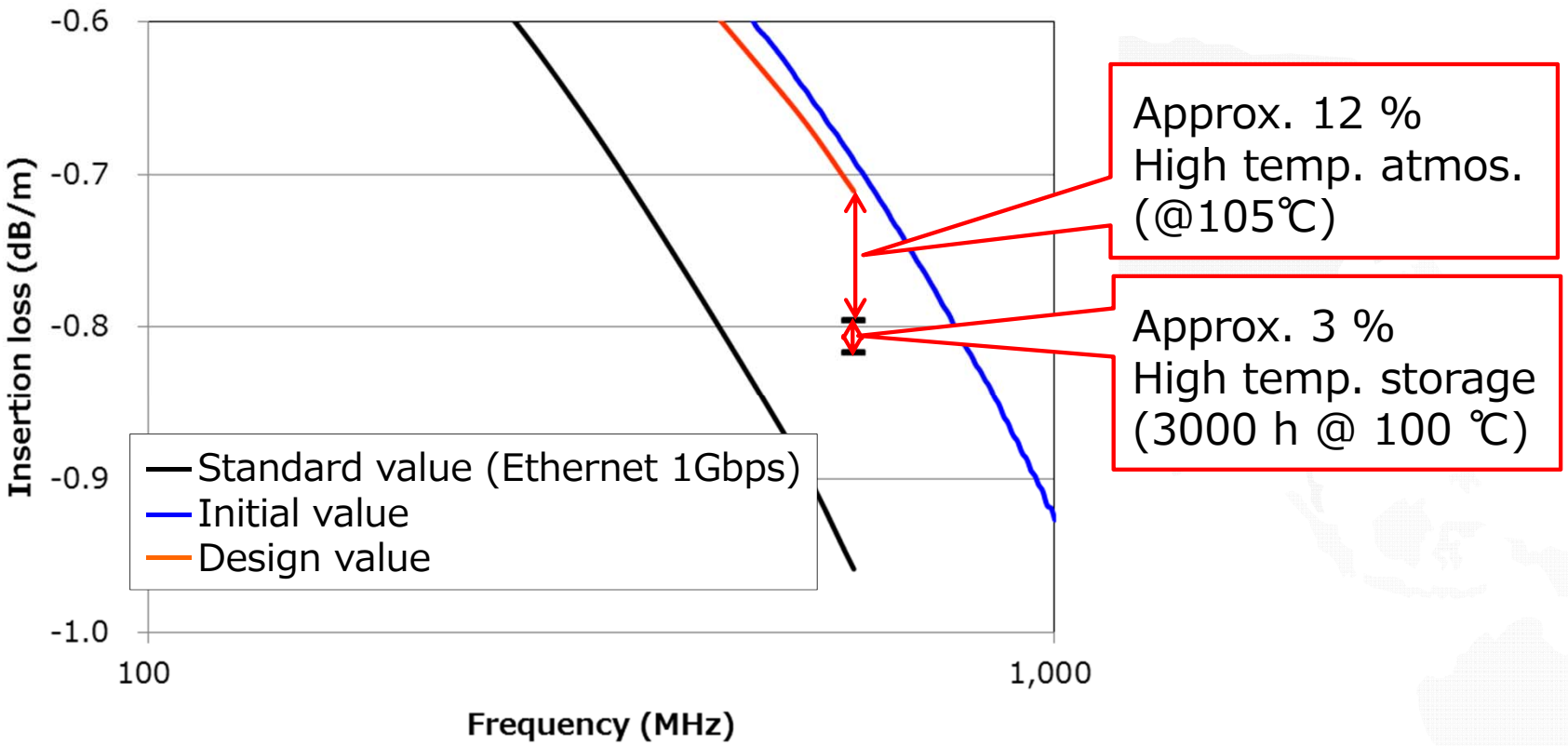
Test item	Test description	Tough level
High temp. atmos.	Measurement of transmission characteristic **in 105 ℃ atmos.**	✓✓
Low temp. atmos.	Measurement transmission characteristic **in -40 ℃ atmos.**	
High temp. and high humidity atmos.	Measurement transmission characteristic **in 85 ℃, 85 %**	
High temp. storage	Measurement transmission characteristic **After 100℃, 3000 h aging**	✓
Tensile	Measure transmission characteristic **with 100 N pulled**	
Bending	Measurement transmission characteristic **with R = 5 times of wire diameter**	
Wire band	Measurement transmission characteristic **with wire band**	

✓✓ 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



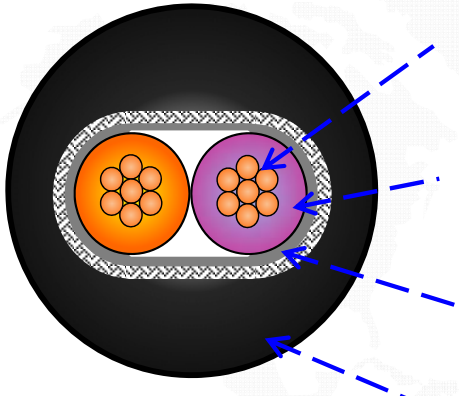
Graph 2: Insertion loss

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.

3. STP cable

◆ Structure and transmission characteristics more than 1GHz

Cable structure



0.13sq Pure copper

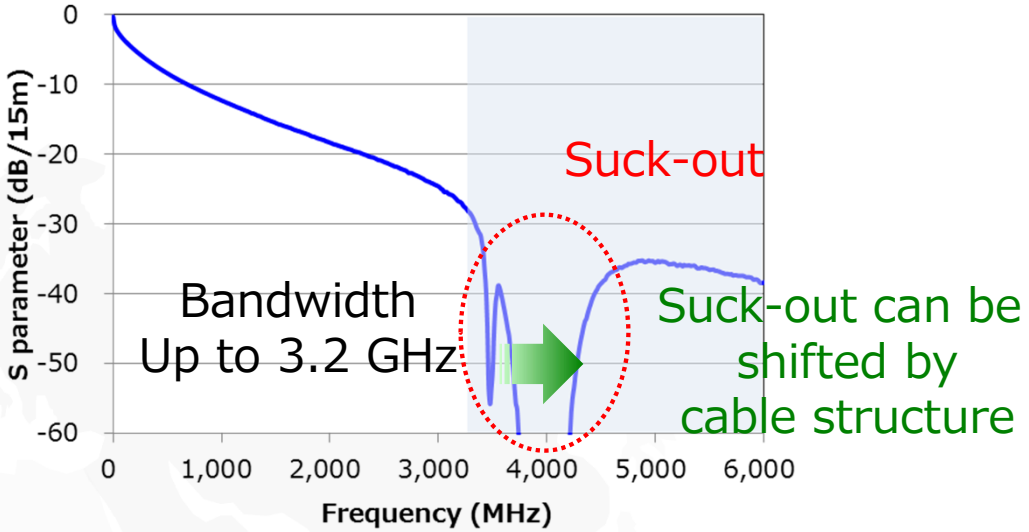
Cross-linked polyethylene

Metal foil + Braided shield

PVC

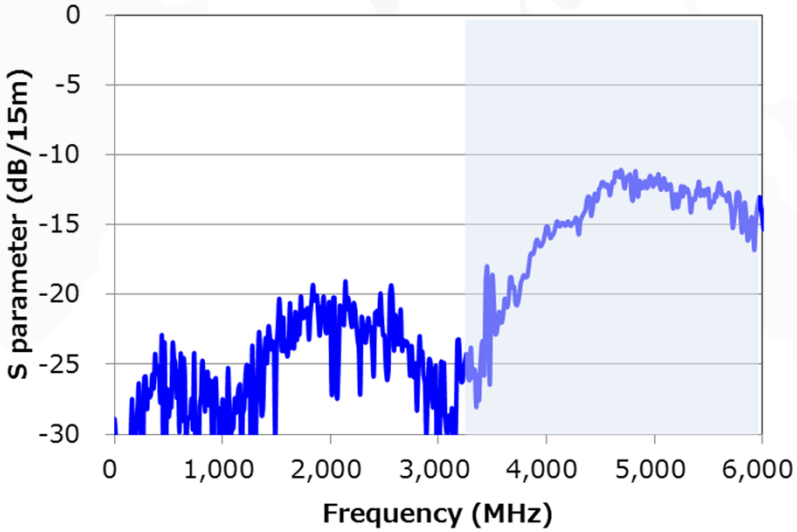
Figure 10: Cable structure

Insertion loss



Graph 3: Insertion loss

Return loss



Graph 4: Return loss

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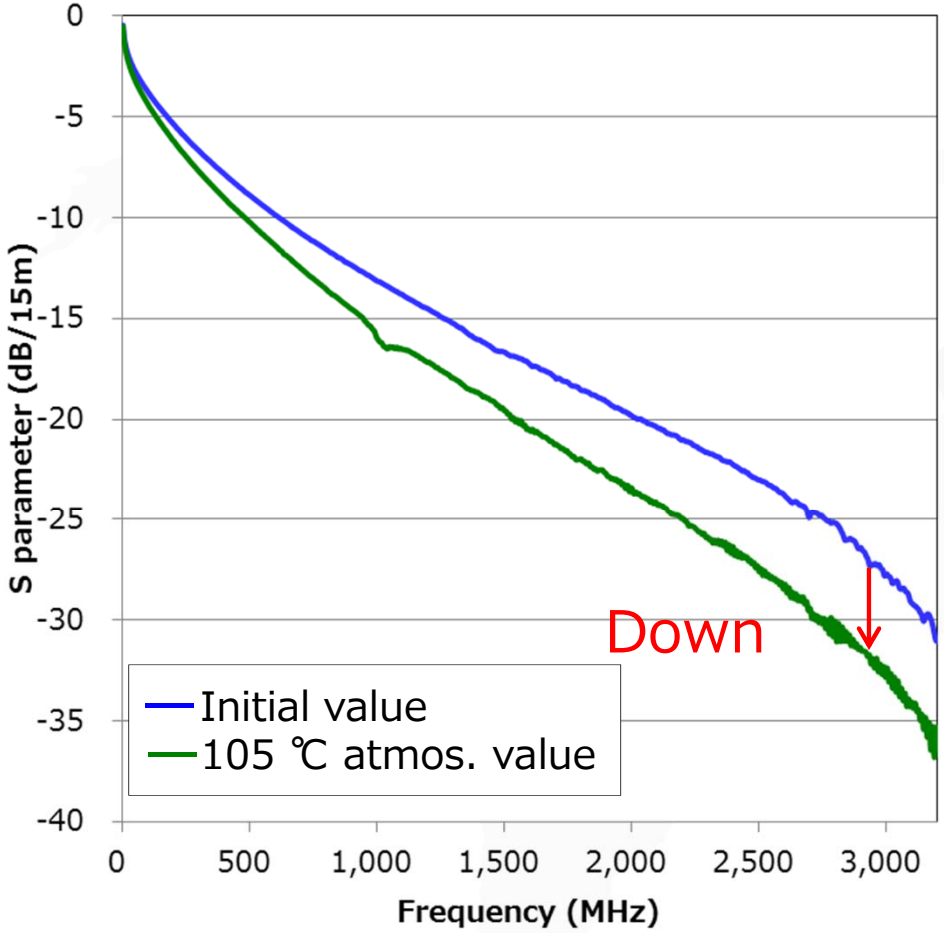
3. STP cable

◆ Structure and transmission characteristics more than 1GHz

Insertion loss



Graph 5: Insertion loss

Frequency	Initial value	105 ℃ atmos.	
	IL	IL	Change rate
MHz	dB / 15m	dB / 15m	%
10	-1.46	-1.63	11.2
100	-3.95	-4.39	11.1
1000	-13.5	-16.0	18.5
2000	-19.8	-23.4	18.0
3000	-28.5	-32.7	14.4
3200	-29.1	-36.1	24.0

$$Change\ rate = \frac{(IL_{105\,℃\ atmos.} - IL_{Initial\ value})}{IL_{Initial\ value}}$$

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

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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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