STP cable

Analysis of insertion loss degradation in high temperature atmosphere

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Agenda

IL :Insertion Loss

1 Contents of indications at the last meeting

2 Degradation factors

3 Comparison of calculated value and measured value

4 Calculation of IL

5 Comparison of IL between 23℃ and 105℃

6 IL up to 7.5GHz in 23℃ and 105℃

1 Contents of indications at the last meeting

IL :Insertion Loss

- Cable structure

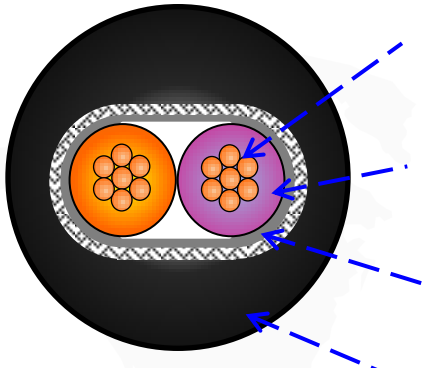
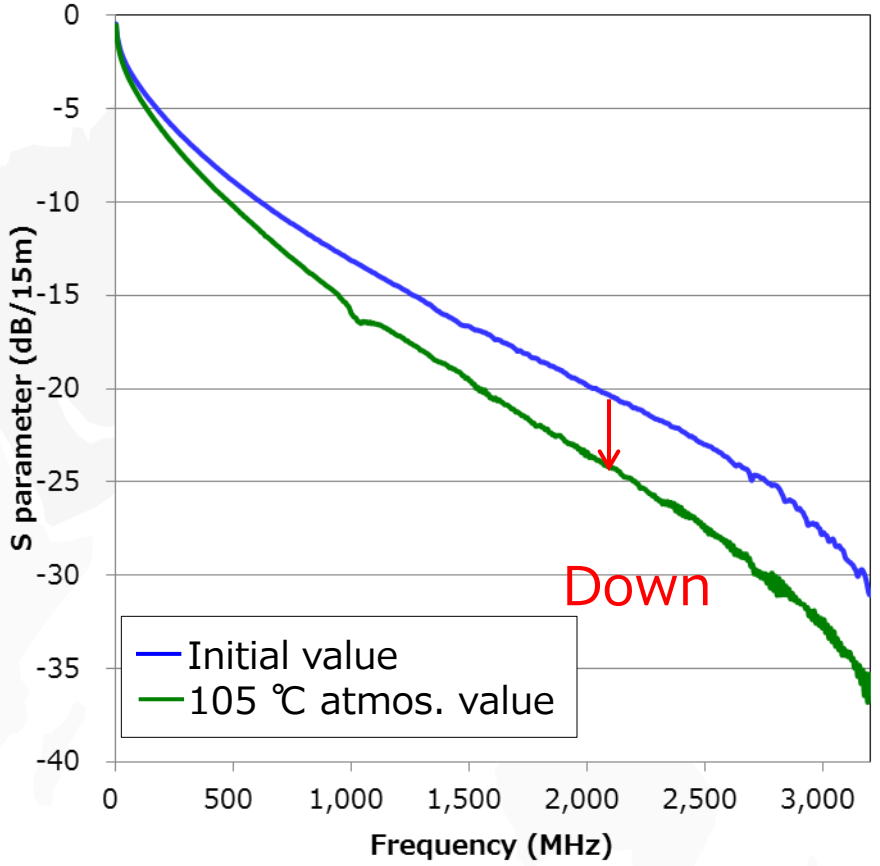


Figure 10: Cable structure

- Insertion loss



- Contents of indications

To explain the reason why the IL remarkably decreases in 105℃ atmosphere.

⇒ Based on theoretical formula, the results of actual measurements were verified at this time

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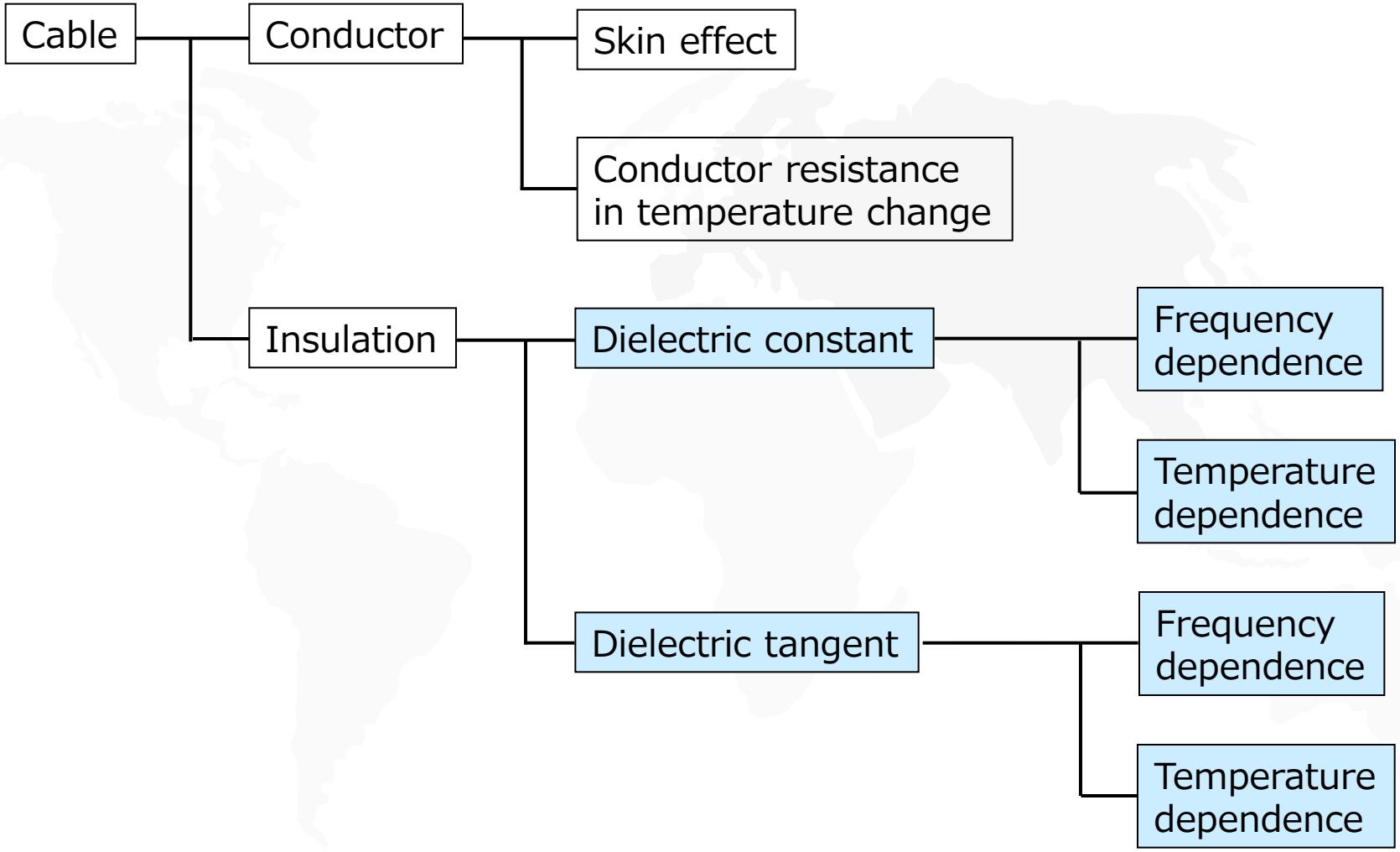
Main factors



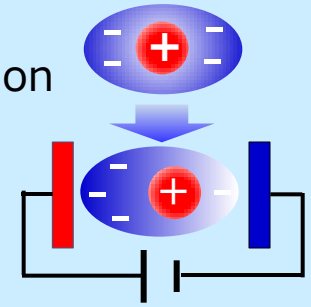
2 Degradation factors

- Dielectric constant : The ease of dielectric polarization of a medium filled between electrodes

Types of polarization

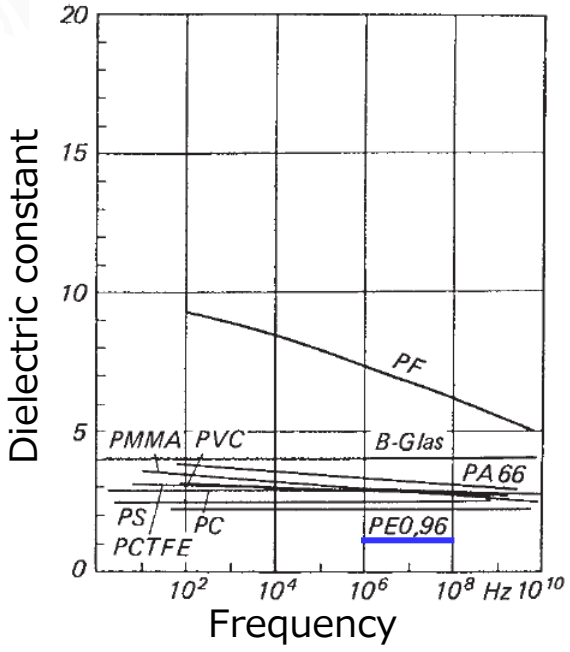
- Electronic polarization
- Ion polarization
- Orientation polarization

Ex)
Ion polarization

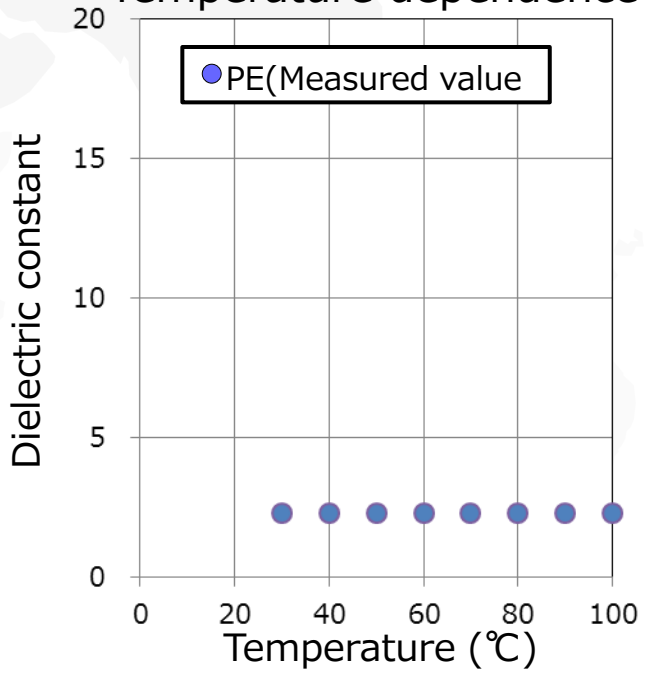


If polarization is large, the bias of electricity in material is large

Frequency dependence



Temperature dependence

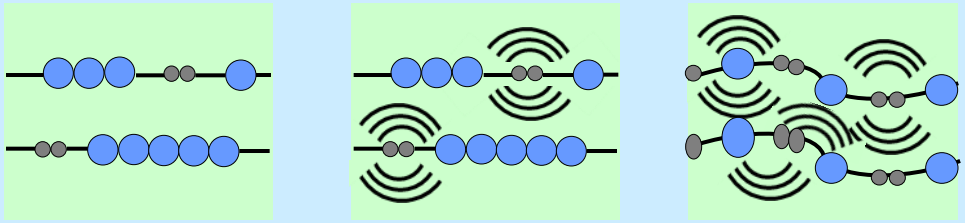


2 Degradation factors

- Dielectric tangent : Electric energy causes molecular motion, it is lost as thermal energy

Basic idea

:Crystal part
:Amorphous part



Temperature

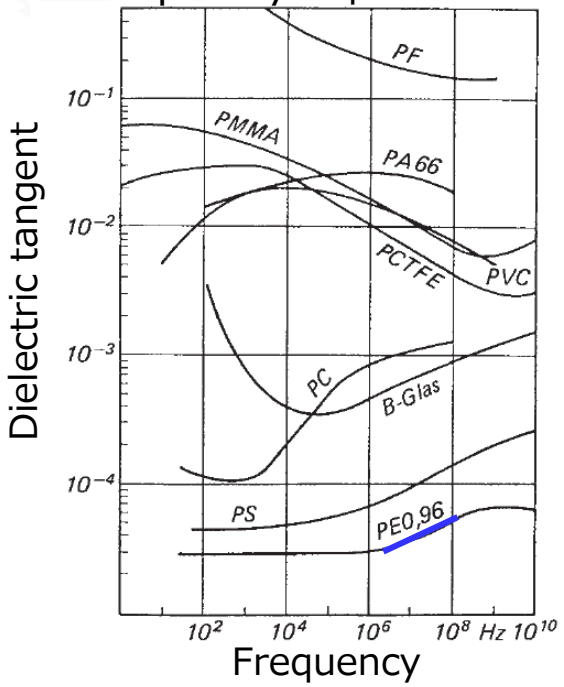
Tg or less

Tg :Glass transition point

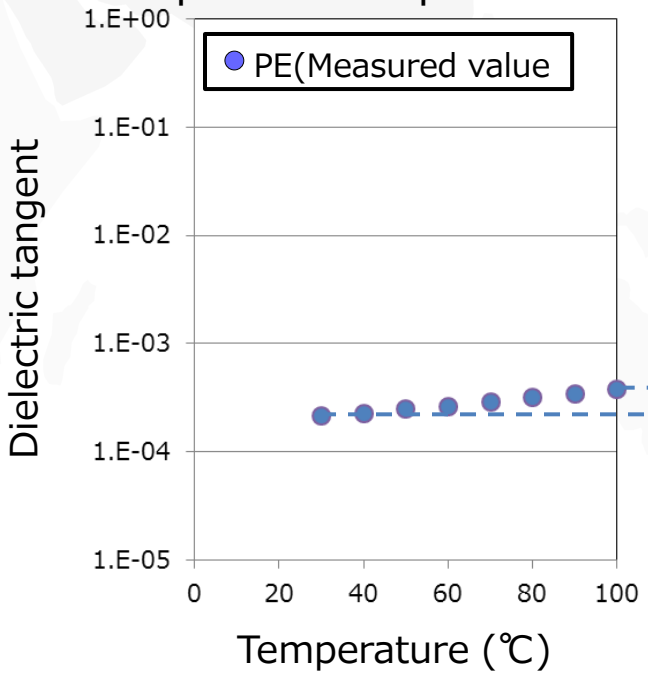
Tg or more

Structure and material which are easy to move in the molecule increase the dielectric tangent

Frequency dependence



Temperature dependence



Approx.
1.76 times

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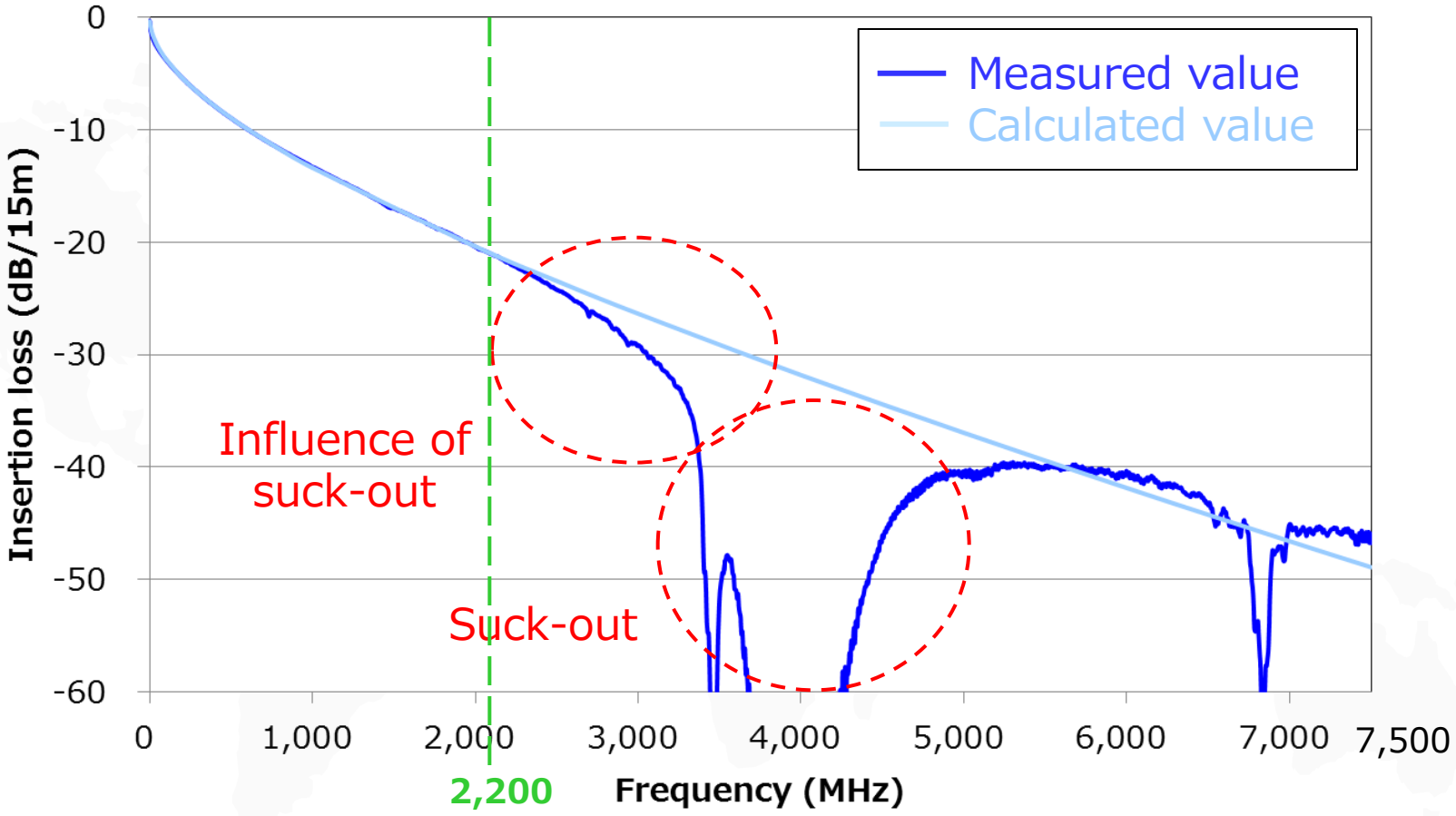
3 Comparison of calculated value and measured value

@ 23℃ atmosphere



- More than 2.2GHz are affected by suck-out
- Measured value and calculated value match up to 2.2GHz

4 Calculate IL

- Formula of Insertion loss

Insertion loss(IL) = Conductor loss(CL) + Dielectric loss(DL)

$$CL=10\times\log\left(\frac{Z_0}{Z_0+\frac{l}{2\times r\times\sqrt{\frac{\pi\times\sigma}{f\times\mu}}}}\right)$$

Deformation of formula

$$\sqrt{\pi^2\times\sigma^2\left(\frac{\rho}{\pi f\mu}\right)}$$

$$=d$$

Skin effect

$$DL=91\times\tan\delta\times\sqrt{\varepsilon_r}\times f$$

Z_0	:Characteristic impedance
l	:Conductor length
r	:Conductor radius
σ	:Electric conductivity of conductor
f	:Frequency
μ	:Magnetic permeability of conductor
Tanδ	:Dielectric constant tangent
$\rho=\frac{1}{\sigma}$	:Electric resistivity of conductor

i.e. Skin effect is taken into account in CL

4 Calculation of IL

Calculation at 105℃ atmosphere

- Conductor resistance in temperature change

$$R = R_0|1 + \alpha(T - 20)|$$

$R_{23℃}$: Conductor resistance at 23℃

$$R_{23℃} = R_0|1 + 0.00393 \times (23 - 20)|$$

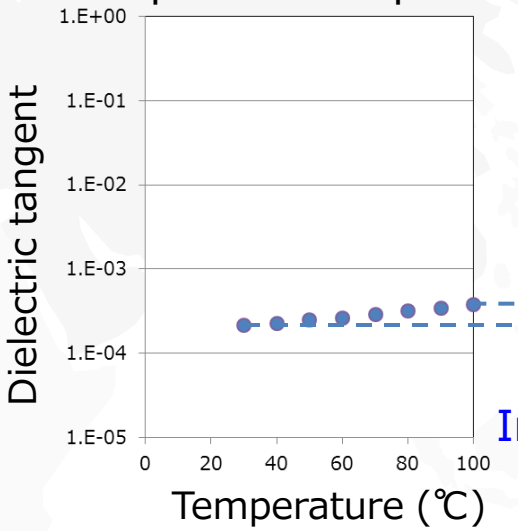
$R_{105℃}$: Conductor resistance at 105℃

$$R_{105℃} = R_0|1 + 0.00393 \times (105 - 20)|$$

$$\frac{R_{105℃}}{R_{23℃}} = 1.318 = \beta_{23℃⇒105℃}$$

- Temperature dependence of dielectric tangent

Temperature dependence



Approx.
1.76 times
+
Influence of structure
=γ

- Formula of Insertion loss

Insertion loss(IL) = Conductor loss(CL) + Dielectric loss(DL)

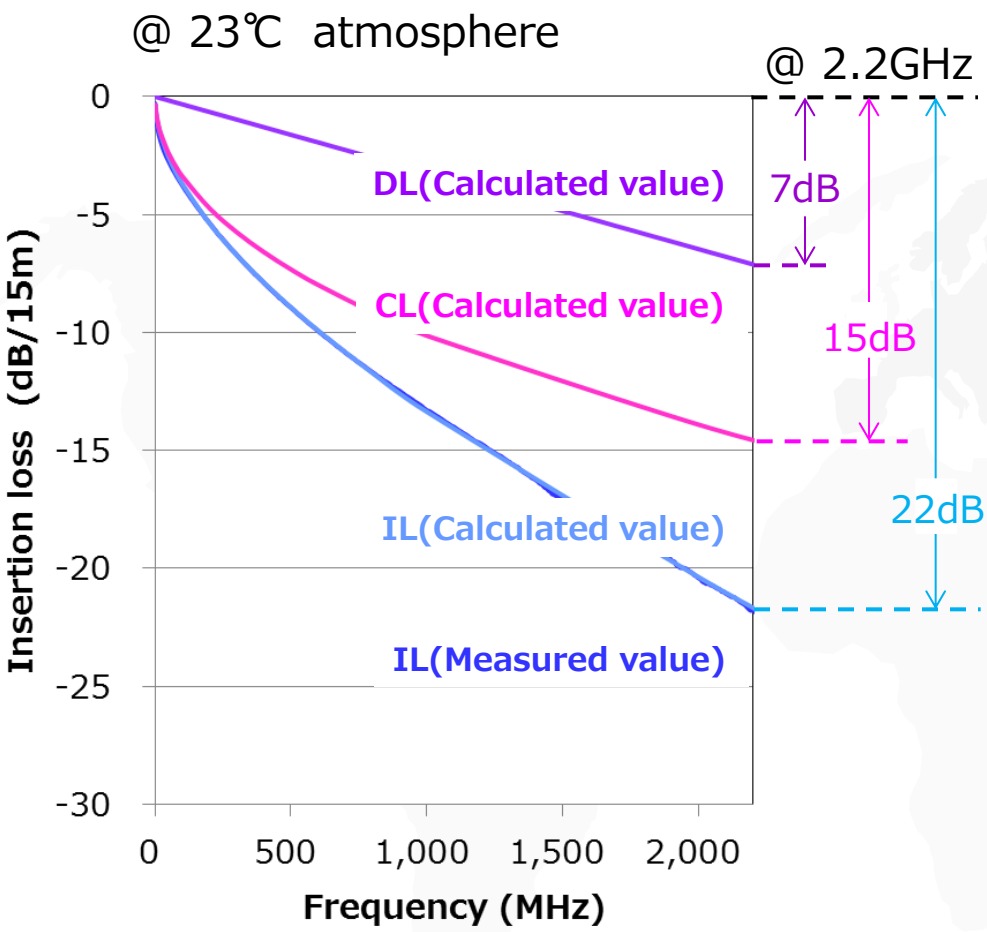
$$CL = 10 \times \log\left(\frac{\frac{Z_0}{i}}{Z_0 + \frac{}{2 \times r \times \sqrt{\frac{\pi \times \sigma / \beta_{23℃⇒105℃}}{f \times \mu}}}}\right)$$

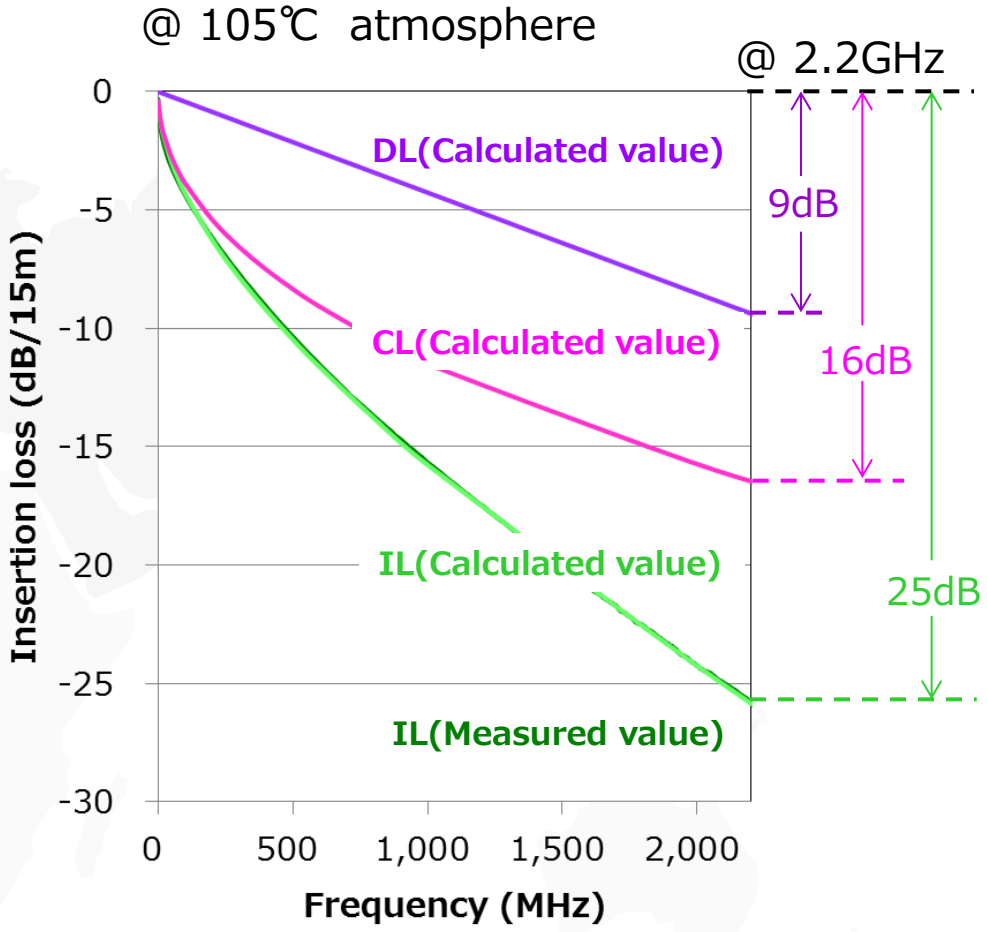
$$DL = 91 \times \tan\delta \times \sqrt{\varepsilon_r \times \gamma} \times f$$

However, the theoretical formula of IL used in this study does not consider the twist of the conductor, shielding layer or the frequency dependence of the dielectric tangent, etc.

5 Comparison of IL between 23℃ and 105℃

IL :Insertion Loss
CL :Conductor Loss
DL :Dielectric Loss

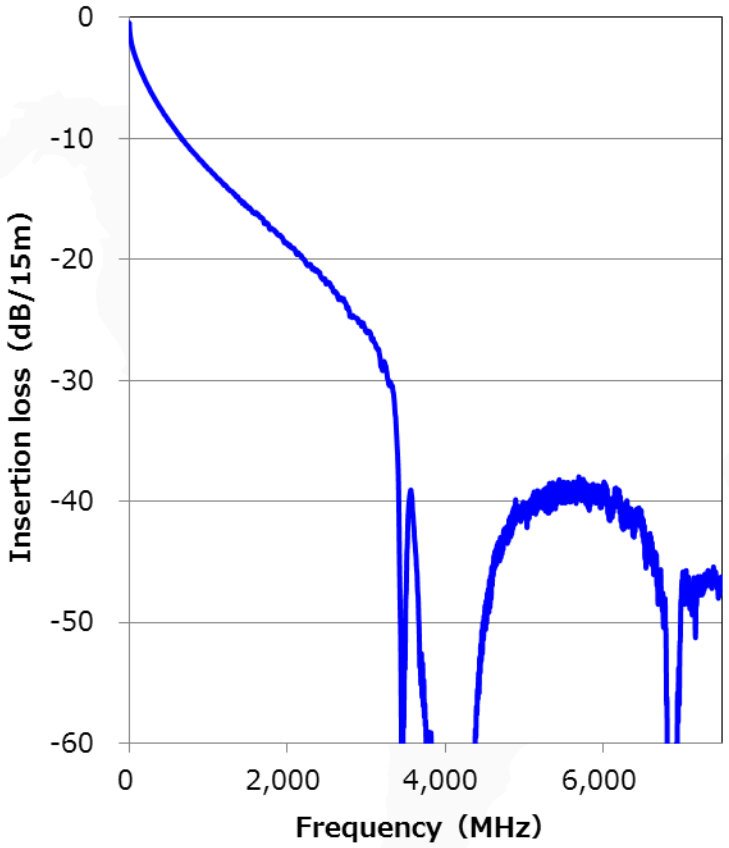




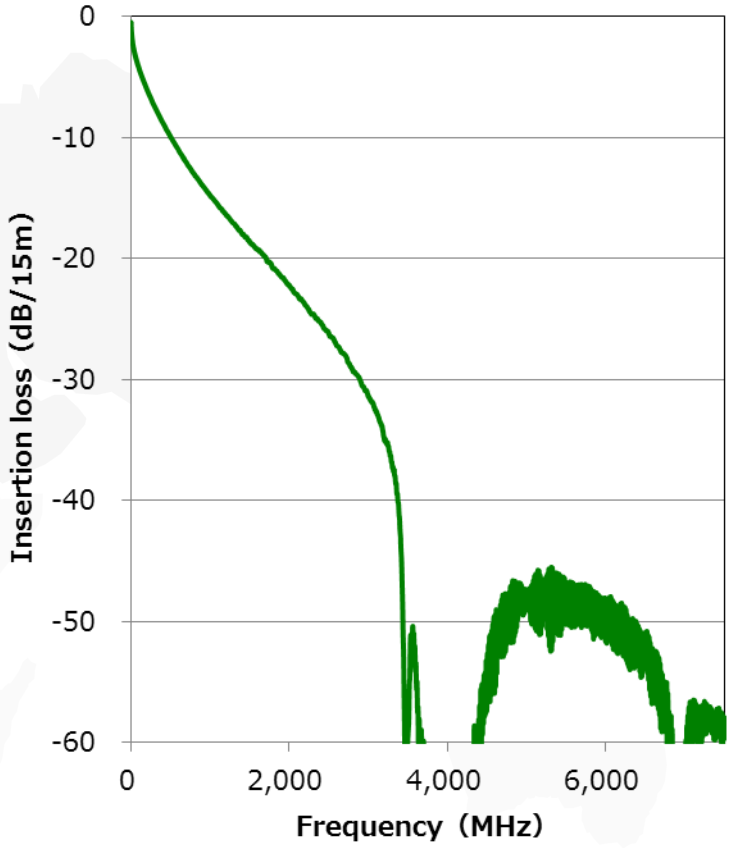
In the case of 105℃ atmosphere, the influence of DL tends to be large particularly in high frequency band. Therefore the influence of the temperature dependence of the dielectric tangent was also found to be large.

6 IL up to 7.5GHz in 23℃ and 105℃

@ 23℃ atmosphere



@ 105℃ atmosphere



The above data is downloaded in the private area

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Thank you for your attention

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