FLEXIBLE COAXIAL CABLE ASSEMBLIES
for microwave
Wavemolle
Highly Flexible

We released flexible cable assembly supporting 110 GHz first in the world.

Mating Flexibility
(It supports
・Plug ⇔ jack conversion
・Connector type conversion
・Different type connector plug ⇔ jack conversion, etc.)

Lower Attenuation characteristics

Low Reflection characteristics

Solid Phase Stability over Temperature and Bending

It can use for ultra high speed digital signal transmission.
(For differential transmission, it is possible to
・adjust the phase between two or more cables
・absolute phase adjustment.)
Attenuation of cable

Cable Attenuation (at 25°C)

- TCF119
- TCF219
- TCF280
- TCF358
- TCF500
Cable Lineup (and connector lineup)

Cable Structure

1: Inner conductor
   - Solid silver plated copper (Solid or Stranded)
2: Insulation
   - Porous PTFE
3: Outer conductor
   - a. Silver plated copper tape
   - b. Silver plated copper braid
4: Jacket (Inner sheath)
   - FEP (blue) , ETFE (TCF280S(-HS))
5: Armor jacket
   - a. Stainless steel coil (flat wire)
   - b. Stainless steel wire braid
6: Outer sheath
   - PVC (blue)
■ Cable specification

Structure details

<table>
<thead>
<tr>
<th>Material</th>
<th>Dielectric</th>
<th>Outer Conductor</th>
<th>Inner Sheath</th>
<th>H Armor Outer Sheath</th>
<th>HS Armor Outer Sheath</th>
<th>SJ type (soft jacket)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCF119</td>
<td>Solid SPC</td>
<td>Silver plated</td>
<td>FEP (blue)</td>
<td>1.7</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>TCF219(S)HS</td>
<td>Solid SPC</td>
<td>Tape &amp; Braid</td>
<td>FEP (blue)</td>
<td>2.7</td>
<td>Olefin</td>
<td>PVC 7.1</td>
</tr>
<tr>
<td>TCF280(S)HS</td>
<td>Solid SPC</td>
<td>Sharod SPC</td>
<td>FEP (blue)</td>
<td>3.3</td>
<td>Olefin</td>
<td>PVC 7.1</td>
</tr>
<tr>
<td>TCF358(SJ)</td>
<td>Solid SPC</td>
<td>Porous PTFE</td>
<td>ETFE(gray)</td>
<td>4.1</td>
<td>Olefin</td>
<td>8.6 PVC 7.7 Olefin</td>
</tr>
<tr>
<td>TCF500(SJ)</td>
<td>Solid SPC</td>
<td>Strang SPC</td>
<td>FEP (blue)</td>
<td>5.6</td>
<td>Olefin</td>
<td>10.2 PVC 9.2 Olefin</td>
</tr>
</tbody>
</table>

Electrical, Mechanical characteristics

<table>
<thead>
<tr>
<th>Characteristic impedance</th>
<th>Capacitance</th>
<th>Time Delay</th>
<th>Transmission rate</th>
<th>Moding frequency</th>
<th>Min. Bending radius (static)</th>
<th>Temp range</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ohm]</td>
<td>[pF/m]</td>
<td>[ns/m]</td>
<td>[% of c]</td>
<td>[GHz]</td>
<td>[mm]</td>
<td>without armor</td>
</tr>
<tr>
<td>TCF119</td>
<td>50</td>
<td>85</td>
<td>4.3</td>
<td>78</td>
<td>134</td>
<td>10</td>
</tr>
<tr>
<td>TCF219(S)HS</td>
<td>50</td>
<td>85</td>
<td>4.3</td>
<td>78</td>
<td>75</td>
<td>15</td>
</tr>
<tr>
<td>TCF280(S)HS</td>
<td>50</td>
<td>85</td>
<td>4.3</td>
<td>78</td>
<td>52</td>
<td>20</td>
</tr>
<tr>
<td>TCF358(SJ)</td>
<td>50</td>
<td>85</td>
<td>4.3</td>
<td>78</td>
<td>48</td>
<td>20</td>
</tr>
<tr>
<td>TCF500(SJ)</td>
<td>50</td>
<td>85</td>
<td>4.3</td>
<td>78</td>
<td>27</td>
<td>25</td>
</tr>
</tbody>
</table>

■ Cable attenuation (Nominal)

Cable Attenuation (at 25℃)

up to 110GHz

※ SPC: Silver plated copper

※ Attenuation of TCF119...Please see next page
### Cable attenuation

Cable attenuation (25°C) [dB/m] = Conductor loss coefficient × √f [GHz] + Dielectric loss coefficient × f [GHz] + 0.0117 (typical) × f [GHz]

1.300 (typical) × √ f [GHz] + 0.0117 (typical) ∗ f [GHz]

### Assembly insertion loss

Assembly insertion loss (25°C) = Cable attenuation (25°C) ∗ assembly length + 0.06 ∗ √ f [GHz]
- **Cable attenuation**

  Cable attenuation (25°C) \( [\text{dB/m}] \) = Conductor loss coefficient \( \times \sqrt{f \ [\text{GHz}]} \) + Dielectric loss coefficient \( \times f \ [\text{GHz}] \)

  \[ 0.610 \text{ (typical)} \times \sqrt{f \ [\text{GHz}]} + 0.0123 \text{ (typical)} \times f \ [\text{GHz}] \]

- **Assembly insertion loss**

  Assembly insertion loss (25°C) = Cable attenuation (25°C) \( \times \text{assembly length} \) + 0.06 \( \times \sqrt{f \ [\text{GHz}]} \)
■ Cable attenuation

\[
\text{Cable attenuation (25°C) [dB/m]} = \text{Conductor loss coefficient} \times \sqrt{f \text{ [GHz]}} + \text{Dielectric loss coefficient} \times f \text{ [GHz]}
\]
\[
0.395 \text{ (typical)} \times \sqrt{f \text{ [GHz]}} + 0.0140 \text{ (typical)} \times f \text{ [GHz]}
\]

■ Assembly insertion loss

\[
\text{Assembly insertion loss (25°C)} = \text{Cable attenuation (25°C) \times assembly length} + 0.06 \times \sqrt{f \text{ [GHz]}}
\]
### Cable attenuation

Cable attenuation (25°C) [dB/m] = Conductor loss coefficient * $\sqrt{f \text{ [GHz]}}$ + Dielectric loss coefficient * $f \text{ [GHz]}$

- $0.420 \text{ (typical)} \times \sqrt{f \text{ [GHz]}}$
- $0.0140 \text{ (typical)} \times f \text{ [GHz]}$

![Graph of cable attenuation](image)

### Assembly insertion loss

Assembly insertion loss (25°C) = Cable attenuation (25°C) * assembly length + $0.06 \times \sqrt{f \text{ [GHz]}}$
- **Cable attenuation**

  Cable attenuation \( (25^\circ \text{C}) \) \([\text{dB/m}]\) = Conductor loss coefficient \( \times \sqrt{f \ [\text{GHz}]} \) + Dielectric loss coefficient \( \times f \ [\text{GHz}] \)

  \[
  0.297 \text{ (typical)} \times \sqrt{f \ [\text{GHz}]} + 0.0123 \text{ (typical)} \times f \ [\text{GHz}]
  \]

- **Assembly insertion loss**

  Assembly insertion loss \( (25^\circ \text{C}) \) = Cable attenuation \( (25^\circ \text{C}) \) \( \times \) assembly length + 0.06 \( \times \sqrt{f \ [\text{GHz}]} \)
■ Cable attenuation

Cable attenuation (25°C) [dB/m] = Conductor loss coefficient * √f [GHz] + Dielectric loss coefficient * f [GHz]

0.165 (typical) × √f [GHz] + 0.0129 (typical) × f [GHz]

![Graph of Attenuation of TCF500 (at 25°C)]

■ Assembly insertion loss

Assembly insertion loss (25°C) = Cable attenuation (25°C) * assembly length + 0.06 × √f [GHz]

![Graph of Assembly insertion loss (at 25°C)]
**VSWR Spec**

- Frequency [GHz]: 18, 20, 26.5, 40, 50, 70, 110
- VSWR Spec:
  - SMA: 1.1
  - PC3.5: 1.2
  - PC2.92: 1.3
  - PC2.4: 1.4
  - PC1.85: 1.5
  - PC1.0: 1.6

- VSWR values:
  - 1.1: (-15.6 dB)
  - 1.2: (-17 dB)
  - 1.3: (-17 dB)
  - 1.4: (-15 dB)
  - 1.5: (-15 dB)

- PC1.85:
  - Frequency [GHz]: 50
  - VSWR: 1.4

- PC1.0:
  - Frequency [GHz]: 110
  - VSWR: 1.5
Phase matching assemblies technology

Phase matching in two or more cable assemblies is available before delivery. An additional work is done by the method of connecting the cable and the connector of original TOTOKU after a strict phase is measured, and the adjustment to the electrical length of hope and two or more phase matching are done.

There is no uselessness of the cable and the connector depending on an original connection method, and the offer by the low price is possible.

Relative phase matching

Phase matching in two or more cable assemblies

Phase (Electrical length) matching of 51 assemblies is enumerated as an example.

51 assemblies Assembly length: 1m Measure frequency: 18GHz

BEFORE phase matching ±5ps / 51assemblies

AFTER phase matching ±1ps / 51assemblies

Absolute phase matching

Appoint the electrical length.
Phase variation for temperature change

Phase variation for temperature change of Wavemolle (TCF Cable Assembly).

Phase change After bending

【Test method】

① before the test
② during the test 
③ after the test

① before the test
② during the test (φ 100° bending)
③ after the test
② during the test (Φ 60° bending)
③ after the test
② during the test (φ 40 or φ 30° bending)
③ after the test

Measured each phase change.
Reference date for Phase change is measured values, not guarantee values.
Reference date for Phase change is measured values, not guarantee values.

**TCF358**

- **φ 100**
  - Frequency [GHz]: 0.0 to 40.0
  - Phase change [°]: -20.0 to 20.0
  - Graphs show Phase change after bending versus frequency.

- **φ 60**
  - Frequency [GHz]: 0.0 to 40.0
  - Phase change [°]: -20.0 to 20.0
  - Graphs show Phase change after bending versus frequency.

- **φ 40**
  - Frequency [GHz]: 0.0 to 40.0
  - Phase change [°]: -20.0 to 20.0
  - Graphs show Phase change after bending versus frequency.

**TCF500**

- **φ 100**
  - Frequency [GHz]: 0.0 to 25.0
  - Phase change [°]: -20.0 to 20.0
  - Graphs show Phase change after bending versus frequency.

- **φ 60**
  - Frequency [GHz]: 0.0 to 25.0
  - Phase change [°]: -20.0 to 20.0
  - Graphs show Phase change after bending versus frequency.

- **φ 50**
  - Frequency [GHz]: 0.0 to 25.0
  - Phase change [°]: -20.0 to 20.0
  - Graphs show Phase change after bending versus frequency.
Reference date for Phase change is measured values, not guarantee values.
### Lateral pressure performance

<table>
<thead>
<tr>
<th>TOTOKU cable type</th>
<th>Armor type</th>
<th>Lateral pressure performance typical (N/cm) *1,2</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCF358</td>
<td>Normal</td>
<td>47</td>
</tr>
<tr>
<td>TCF500</td>
<td>Normal</td>
<td>65</td>
</tr>
<tr>
<td>TCF280</td>
<td>Normal</td>
<td>36</td>
</tr>
<tr>
<td>TCF219</td>
<td>Normal</td>
<td>29</td>
</tr>
<tr>
<td>TCF358H</td>
<td>Standard armor</td>
<td>770</td>
</tr>
<tr>
<td>TCF500H</td>
<td>Standard armor</td>
<td>690</td>
</tr>
<tr>
<td>TCF358HS</td>
<td>Soft armor</td>
<td>500</td>
</tr>
<tr>
<td>TCF500HS</td>
<td>Soft armor</td>
<td>370</td>
</tr>
<tr>
<td>TCF280HS</td>
<td>Soft armor</td>
<td>400</td>
</tr>
<tr>
<td>TCF219HS</td>
<td>Soft armor</td>
<td>430</td>
</tr>
<tr>
<td>TCF119</td>
<td>Soft armor</td>
<td>330</td>
</tr>
</tbody>
</table>

*1 Data shows typical values, not guaranteed values.

*2 It is the force that the electrical characteristic can secure.

It is in a condition that the cable or armor was crushed a little.
Terminal shape correspondence

Standard: $\theta = 90$ degrees

Special terminal shape correspondence

We cope as well as 90 degrees (standard) in forming of terminal part.

Please feel free to contact our sales department.
### ケーブルタイプ/Cable type

<table>
<thead>
<tr>
<th>コネクタタイプ/Connector type</th>
<th>ケーブル適用可能最大長 (m) Assembly maximum length (m)</th>
<th>ケーブル標準最大長 (m) Standard maximum length (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>営業</td>
<td>50</td>
<td>21</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ケーブル適用可能最大長 (m) Assembly maximum length (m)</th>
<th>50</th>
<th>21</th>
<th>16</th>
<th>9</th>
<th>0.7</th>
<th>10</th>
<th>3</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>ケーブル標準最大長 (m) Standard maximum length (m)</td>
<td>20</td>
<td>21</td>
<td>5</td>
<td>2</td>
<td>0.3</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

ケーブル適用可能最大長 (m)を超える長さのアセンブリについては弊社営業までご相談ください。
When you need an assembly of length more than cable standard maximum length, please inquire to our sales department at each time.

※70G：次ページの"品番"の項をご確認ください。※70G: Please confirm an item of "model number" of following page.
**TCF219 cable 1000mm length assembly**

1. 85mm straight male connector and 1.85mm straight female connector (DC ~ 70GHz)

**TCF219 cable 1000mm length assembly reinforced by HS armor**

1. 85mm straight male connector and 1.85mm straight female connector (DC ~ 70GHz)

**TCF219 cable 1200mm length assembly**

1. 85mm angle type male connector and 1.85mm straight female connector.

**TCF358 cable 500mm length assembly**

SMA straight male connector and SMA straight female connector.

**TCF280 cable 700mm length assembly**

PC2.4mm straight female connector and 2.92mm straight male connector.

**TCF358 cable 300mm length assembly**

PC3.5mm straight male connector both side, added phase matching option.

※ Model number of 1.85mm connector assembly for 70GHz

**TCF219TU70Q1000**

TCF219 cable 1000mm length assembly. 1.85mm straight male connector and 1.85mm straight female connector (DC ~ 70GHz)

**TCF219HSTU70Q1000**

TCF219 cable 1000mm length assembly reinforced by HS armor. 1.85mm straight male connector and 1.85mm straight female connector (DC ~ 70GHz)
Feature

Cable
Expanding frequency range up to 70GHz by improved outer conductor

Precision connector
Expanding frequency range up to 70GHz by improved inner structure

Corresponds also to
- Flexible armor ("HS" armor) type
- Right angle type.

Reference data
TCF219HSTT70G1220 (L=1220mm) (Assembly for 70GHz)
TCF128 flexible coaxial cable assembly for 110GHz with 1.0mm connector

Feature
- World largest broadband area: DC~110GHz
- Easy handling, easy fixing by without armor
- Low-reflection and Low-attenuation realized by means of dedicated connector and unique fixing
- Corresponding to arbitrary length
- Excellent mating reproducibility

Application
- Millimeter wave radar
- High-frequency device wiring material
- Measuring instruments lead wire
- Optical device
- Semiconductor tester
- Metal and optical Info-communications device

Terminal structure

Reference data
Data of TCF128XY254 (L=254mm)