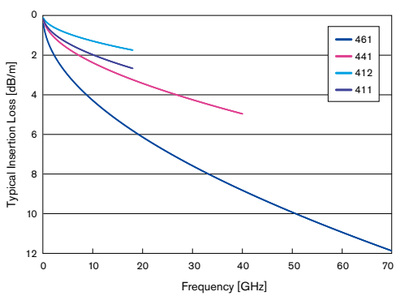
4, 5 Series Formable Interconnect

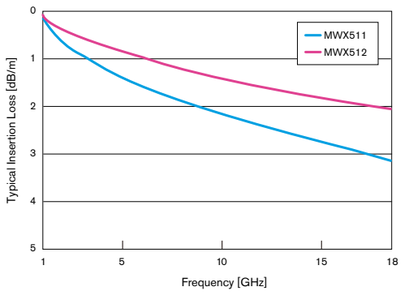
Coaxial cable assembly suitable for fixed wiring inside and between equipment used in the microwave band up to 100 GHz (continuous operating temperature range: -30 to +85°C).
These cables have excellent formability (shape-retention capability) that make wiring work easy and exhibit superior loss characteristics compared to semi-rigid cables.
Standard connectors are SMA (m) straight connectors, although other connectors can be used as required.

4 Series Typical Insertion Loss



Simple Criteria for Cable Selection	
Insertion Loss	The larger the cable outer diameter, the lower the insertion loss.
Frequency Range	The smaller the cable, the higher mode frequency.
Power Rating	The larger the cable outer diameter, the higher the power rating.
Flexibility	The smaller the cable, the better the flexibility.
Mass	The smaller the cable, the lighter the cable.

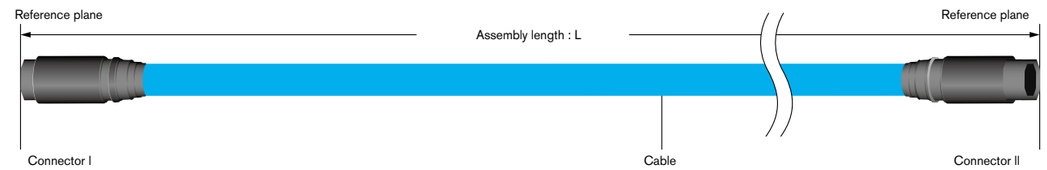
5 Series Typical Insertion Loss



Delivery

4 and 5 series will be shipped within 11 business days after received order.
* Leadtime may be effected by larger order volume.

Placing orders



Catalog No.

ex. MWX461 - 01000 S1FR S1FS

Cable : MWX461
Assembly Length : 1000 mm
Connector I : SMP (f) Right Angle
Connector II : : SMP (f) Straight

* 1) The minimum order quantity is 5 for MWX4 and 10 for MWX5 respectively (for MWX461, the minimum order quantity is 100).
* 2) Assembly length is measured from the end of one connector to the end of the other connector.

Connector Codes

Connector		4 Series				5 Series	
		411	412	441	461	511	512
Type	Maximum Operating Frequency	18.0 GHz	18.0 GHz	40.0 GHz	67.0 GHz	18.0 GHz	18.0 GHz
SMA (m) Right Angle	10.0 GHz	AMR	AMR	AMR		AMR	AMR
SMP (f) Right Angle	12.0 GHz			S1FR	S1FR		
SMP (f) Straight	12.0 GHz			S1FS	S1FS		
N (m) Straight	18.0 GHz						NMS
SMA (m) Straight	18.5 GHz	AMS	AMS	AMS	AMS	AMS	AMS
SMA (f) Straight	18.5 GHz			AFS		AFS	AFS
2.92 mm (m) Straight	40.0 GHz			KMS			
SMPM (f) Right Angle	40.0 GHz				S2FR		
1.85 mm (m) Straight	67.0 GHz			VMS	VMS		
SMPM (f) Straight	67.0 GHz			S2FS	S2FS		
SMPS (f) Straight	100.0 GHz				S3FS*		
1.0 mm (m) Straight	100.0 GHz				WMS1*		

• The smallest frequency among the maximum operating frequencies of the connectors and cables to be used is the maximum operating frequency of the assembly.

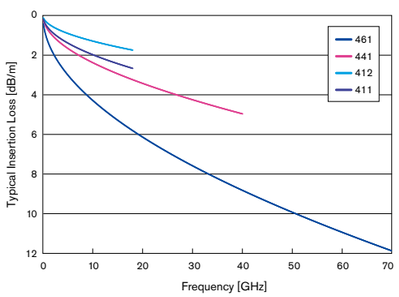
[Exception]
SMPS(f) or 1.0mm(m) assembled with 461: Maximum operating frequency 100.0 GHz

* The above figures are measured values for reference only.

4, 5 Series Formable Interconnect

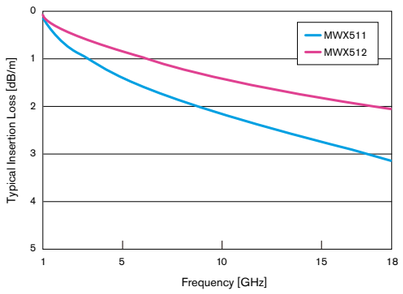
Coaxial cable assembly suitable for fixed wiring inside and between equipment used in the microwave band up to 100 GHz (continuous operating temperature range: -30 to +85°C).
These cables have excellent formability (shape-retention capability) that make wiring work easy and exhibit superior loss characteristics compared to semi-rigid cables.
Standard connectors are SMA (m) straight connectors, although other connectors can be used as required.

4 Series Typical Insertion Loss



Simple Criteria for Cable Selection	
Insertion Loss	The larger the cable outer diameter, the lower the insertion loss.
Frequency Range	The smaller the cable, the higher mode frequency.
Power Rating	The larger the cable outer diameter, the higher the power rating.
Flexibility	The smaller the cable, the better the flexibility.
Mass	The smaller the cable, the lighter the cable.

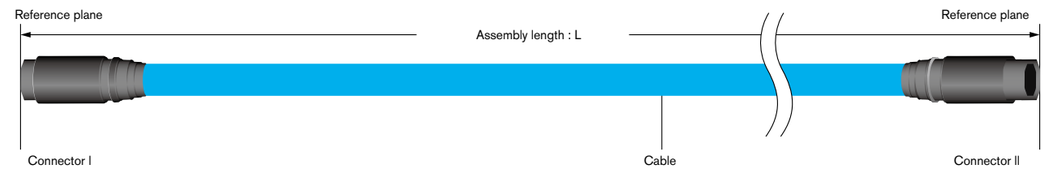
5 Series Typical Insertion Loss



Delivery

4 and 5 series will be shipped within 11 business days after received order.
* Leadtime may be effected by larger order volume.

Placing orders



Catalog No.

ex. MWX511 - AP - AP L=1000mm

Cable : MWX511 type
Connector I : SMA (m) Straight
Connector II : SMA (m) Straight
Assembly Length : 1000 mm

The minimum order quantity is 5 for MWX4 and 10 for MWX5 respectively (for MWX461, the minimum order quantity is 100).
* 1) MWX411, 412, 511, and 512 come with the standard SMA (m) connector.
The product code for the connector is "AP." The standard connector for MWX411 is a 2.92 mm (m) Straight type.
The product code for this connector is "KP." For MWV461, the product code for the SMP (f) Straight connector is "SJ." The product code for the SMPM (f) Straight connector is "MJ."
* 2) Assembly Length is measured from the end of one connector to the end of the other connector.

Connector Codes

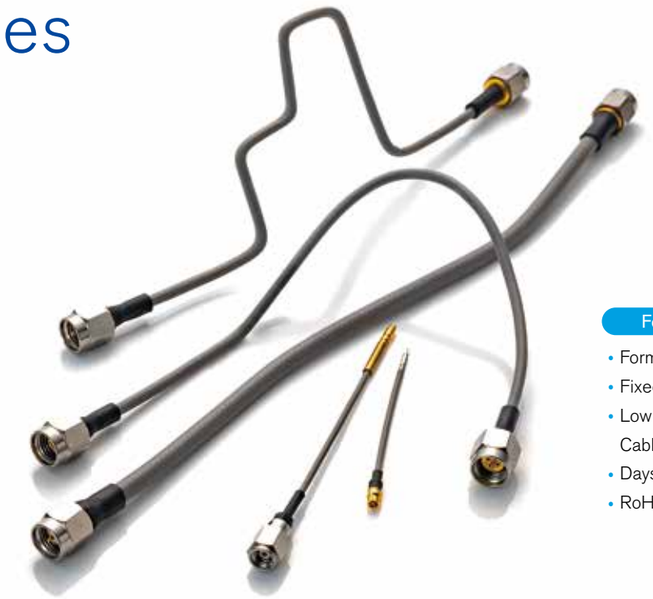
Connector		Cable			
		411	412	441	461
XXX	XXX Frequency	18.0 GHz	18.0 GHz	40.0 GHz	67.0 GHz
SMP (f) Straight	12.0 GHz				SJ
SMA (m) Straight	18.0 GHz	AP	AP		AP
2.92mm (m) Straight	40.0 GHz			KP	
SMPM (f) Straight	67.0 GHz				MJ
1.85mm (P) Straight	67.0 GHz				VP
1.0mm (P) Straight	100.0 GHz				WP
SMPS (f) (G3PO) Straight	100.0 GHz				QJ

Please provide a catalog number when placing an order.

* The above figures are measured values for reference only.

4, 5 Series Formable Interconnect

4 Series



Features

- Formable Cable
- Fixed Wiring
- Low Insertion Loss than Semi-Rigid Cables
- Days to Ship: 15 Business Days
- RoHS Compliant

Property

Electrical Properties	411	412	441	461
Maximum Operating Frequency	18.0 GHz	18.0 GHz	40.0 GHz	67.0 GHz
Characteristic Impedance (Typical)	50 Ω	50 Ω	50 Ω	50 Ω
Capacitance (Typical)	85 pF/m	85 pF/m	90 pF/m	95 pF/m
Propagation Delay (Typical)	4.3 ns/m	4.4 ns/m	4.3 ns/m	4.7 ns/m
Velocity of Propagation (Typical)	78 %	76 %	78 %	70 %
Higher Mode Frequency (Typical)	64.0 GHz	36.0 GHz	76.0 GHz	108 GHz
VSWR (Typical)	1.40	1.40	1.50	3.0
Maximum Frequency Insertion Loss	2.2 dB/m (18.0 GHz)	1.4 dB/m (18.0 GHz)	4.3 dB/m (40.0 GHz)	12 dB/m (67.0 GHz)

Mechanical Properties	411	412	441	461
Cable Outer Diameter	2.5 mm	4.0 mm	2.4 mm	1.33 mm
Minimum Bending Radius (Inner Side)	15 mm	20 mm	15 mm	5 mm
Cable Mass (Typical)	19 g/m	41 g/m	17 g/m	4.6 g/m
Continuous Operating Temperature Range	-30~+85 °C	-30~+85 °C	-30~+85 °C	-65~+125 °C
Assembly Length	100~5,000 mm	100~5,000 mm	100~5,000 mm	40~2,000 mm
Remark	Semi-Rigid Cable ϕ2.2 Equivalent	Semi-Rigid Cable ϕ3.6 Equivalent	Semi-Rigid Cable ϕ2.2 Equivalent	Semi-Rigid Cable ϕ1.2 Equivalent

Order Form Example

Please provide the following information when placing an order.

Example MWX441

* See P.4.5-2 "Connectol Codes"

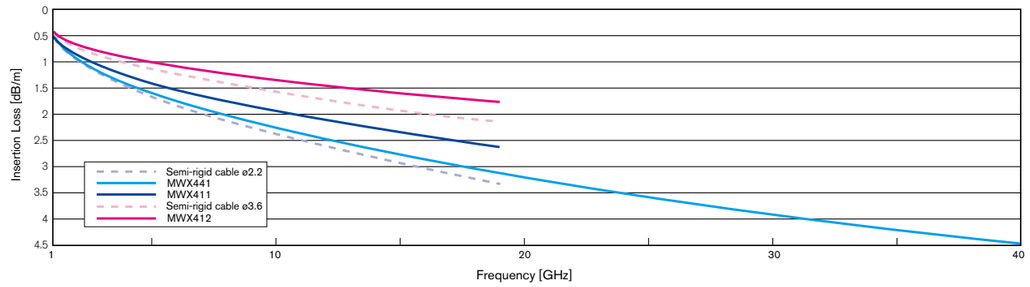
Assembly Length: 100 mm
Connector Ⅰ : 2.92 mm (m) Straight
Connector Ⅱ : 2.92 mm (m) Straight

Catalog No.
MWX441-KP-KPL=200mm
a c b

a. Cable
b. Assembly Length
c. Connector

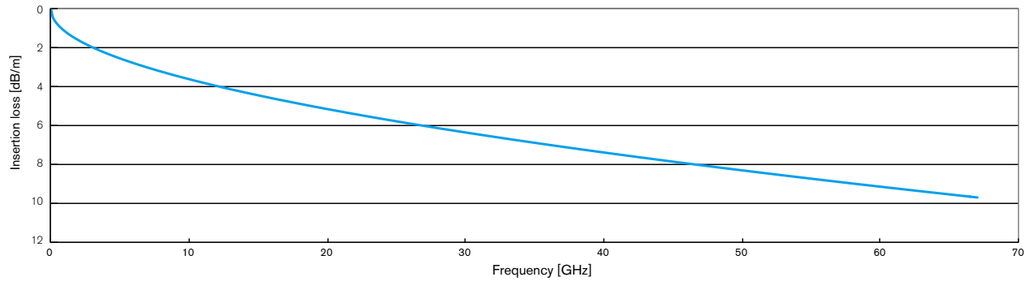
Technical Data

Comparison of Typical Insertion Loss (4 Series vs. Ssemi-Rigid cable L=1000mm)



411	**Typical Insertion Loss** (0.002×f [GHz] +0.336×√f [GHz]) ×L [m]	**Maximum Insertion Loss** (0.004×f [GHz] +0.517×√f [GHz]) ×L [m] ×1.12
412	**Typical Insertion Loss** (0.004×f [GHz] +0.517×√f [GHz]) ×L[m]	**Maximum Insertion Loss** (0.004×f [GHz] +0.517×√f [GHz]) ×L [m] ×1.12
441	**Typical Insertion Loss** (0.008×f [GHz] +0.604×√f [GHz]) ×L [m]	**Maximum Insertion Losss** (0.008×f [GHz] +0.604×√f [GHz]) ×L [m] ×1.12

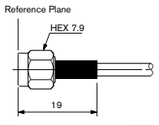
461 Typical Insertion Loss (L=1000mm)



461	**Typical Insertion Loss** (0.01×f [GHz] +1.1×√f [GHz]) ×L [m]	**Maximum Insertion Loss** (0.01×f [GHz] +1.1×√f [GHz]) ×L [m] ×1.12

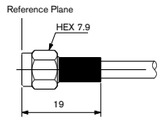
Connector

SMA (m) Straight (Code : 411-AMS)



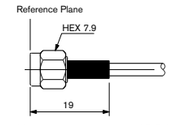
Maximum Operating Frequency : 18.0 GHz / Mass : 3g

SMA (m) Straight (Code : 412-AMS)



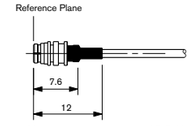
Maximum Operating Frequency : 18.0 GHz / Mass : 3g

2.92 mm (m) Straight (Code : 441-KMS)



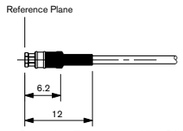
Maximum Operating Frequency : 40.0 GHz / Mass : 5g

SMP (f) Straight (Code : 461-S1FS)



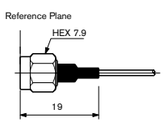
Maximum Operating Frequency : 12.0 GHz / Mass : 1g

SMPM (f) Straight (Code : 461-S2FS)



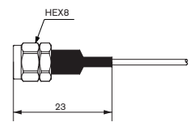
Maximum Operating Frequency : 67.0 GHz / Mass : 1g

SMA (m) Straight (Code : 461-AMS)



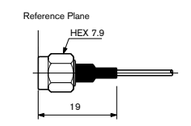
Maximum Operating Frequency : 18.0 GHz / Mass : 3g

1.85mm (P) Straight (Code : VMS)



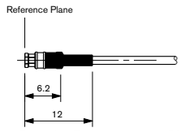
Maximum Operating Frequency : 67.0 GHz / Mass : XXg

1.0mm (P) Straight (Code : WMS1)



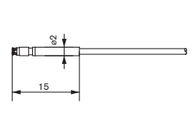
Maximum Operating Frequency : 100.0 GHz / Mass : XXg

SMP (J) Straight (Code : S1FJ)



Maximum Operating Frequency : 12.0 GHz / Mass : XXg

SMPS (G3PO) (J) Straight (Code :S3FS)



Maximum Operating Frequency : 100.0 GHz / Mass : XXg

*Refer to P0-4 Connector Code Table for othrer applicable connectors.

* The above figures are measured values for reference only.

4, 5 Series Formable Interconnect

5 Series

Features

- Formable Cable
- Fixed Wiring
- Low Insertion Loss than Semi-Rigid Cables
- Days to Ship: 11 Business Days
- RoHS Compliant

Property

Electrical Properties	511	512
Maximum Operating Frequency	18.0 GHz	18.0 GHz
Characteristic Impedance (Typical)	50 Ω	50 Ω
Capacitance (Typical)	97 pF/m	95 pF/m
Propagation Delay (Typical)	4.7 ns/m	4.7 ns/m
Velocity of Propagation (Typical)	71 %	71 %
Higher mode frequency (Typical)	63.0 GHz	34.0 GHz
VSWR (Typical)	1.40	1.40
Maximum Frequency Insertion Loss	3.1 dB/m (18.0 GHz)	2.0 dB/m (18.0 GHz)

Mechanical Properties	511	512
Cable Outer Diameter	3.0 mm	4.4 mm
Minimum Bending Radius (Inner Side)	10 mm	15 mm
Cable Mass (Typical)	19 g/m	41 g/m
Continuous Operating Temperature Range	-30~+85 ℃	-30~+85 ℃
Assembly Length	100~5,000 mm	100~5,000 mm
Remark	Semi-Flexible Cable ϕ2.1 Equivalent	Semi-Flexible Cable ϕ3.45 Equivalent

Order Form Example

Please provide the following information when placing an order.

Example MWX511

* See P.4.5-2 "Connrctor Codes"

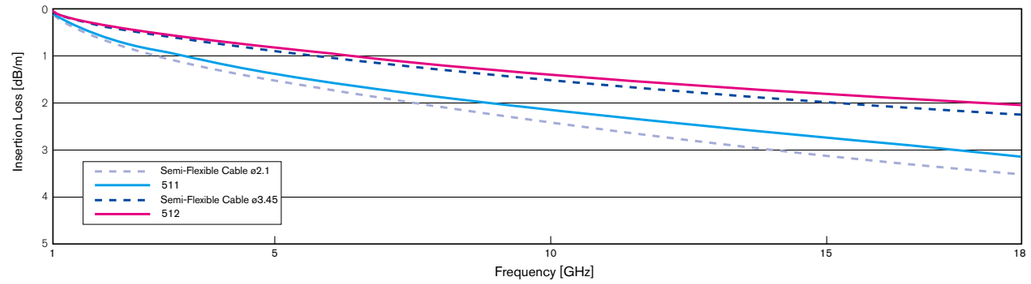
Assembly Length: 100 mm
Connector Ⅰ : SMA (m) Straight
Connector Ⅱ : SMA (m) Straight

Catalog No.
MWX511-AP-APL=200mm
a c b

a. Cable
b. Assembly Length
c. Connector

Technical Data

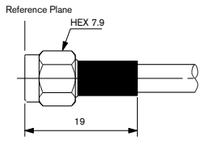
Comparison of Typical Insertion Loss (5 Series vs. Semi-Flexible Cable L=1000mm)



511	**Typical Insertion Loss** (0.015×f [GHz] +0.693×$\sqrt{f}$ [GHz]) ×L [m]	**Maximum Insertion Loss** (0.015×f [GHz] +0.693×$\sqrt{f}$ [GHz]) ×L [m] ×1.12
512	**Typical Insertion Loss** (0.018×f [GHz] +0.42×$\sqrt{f}$ [GHz]) ×L [m]	**Maximum Insertion Loss** (0.018×f [GHz] +0.42×$\sqrt{f}$ [GHz]) ×L [m] ×1.12

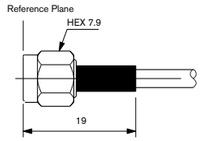
Connector

SMA (m) Straight (Code : 511-AP)



Maximum Operating Frequency : 18.0 GHz /
Mass : 3g

SMA (m) Straight (Code : 512-AP)



Maximum Operating Frequency : 18.0 GHz /
Mass : 3g

*Refer to P0-4 Connector Code Table for othrer applicable connectors.

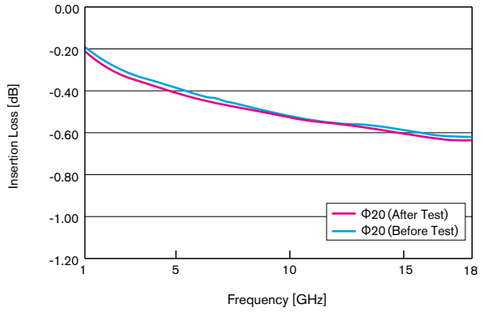
* The above figures are measured values for reference only.

Technical Date

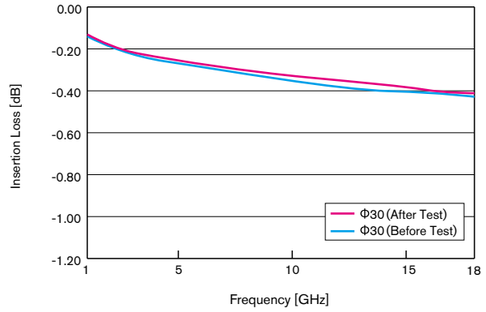
Formable (4, 5 Series) Technical Data 1

Static Bending Data (Insertion Loss)

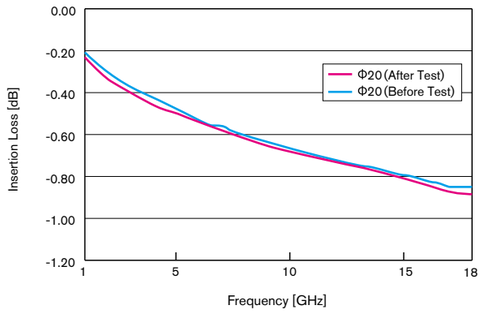
411



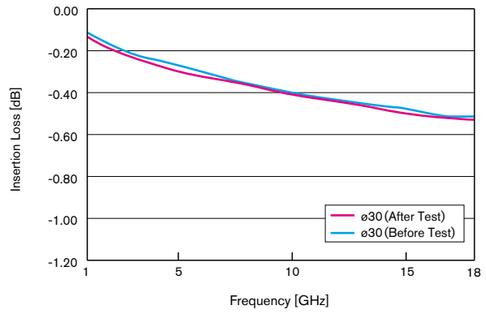
412



511



512



Measurement Method

The initial value was measured with the test cable connected to the measuring instrument. The after-test value was measured with the cable wrapped 360 °around a mandrel at a position approximately 50 mm from the measuring instrument.

Test Conditions

Mandrel diameter
411, 511 **20 mm** 412, 512 **30 mm**
Test cable length **300 mm**

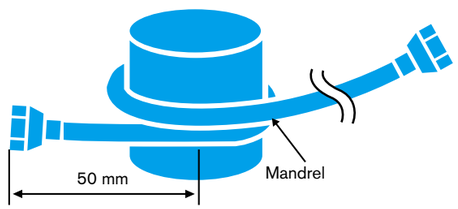
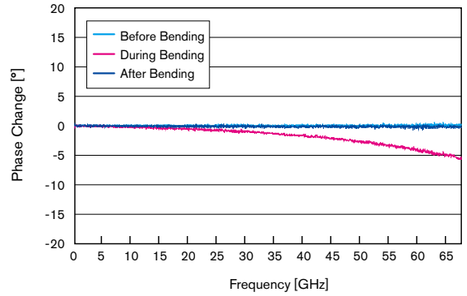


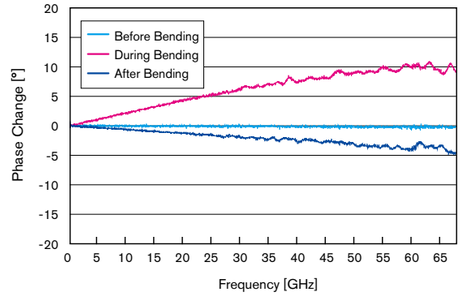
Fig.1 Schematic Description of the Static Bending Test

Static Bending Data (Phase)

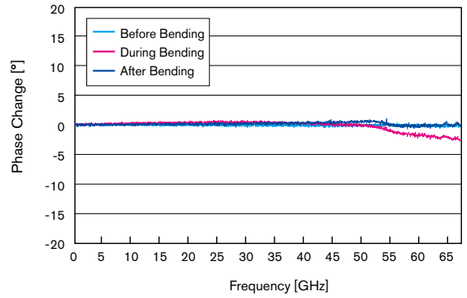
461 Static Bending Data 1



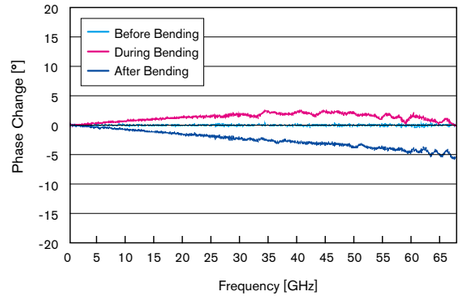
Semi-Flexible Coaxial Cable Corresponding to UT47



461 Static Bending Data 2



Semi-Flexible Coaxial Cable Corresponding to UT47

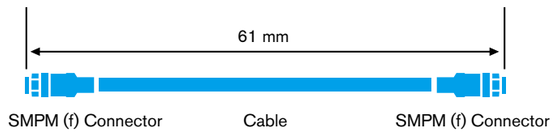


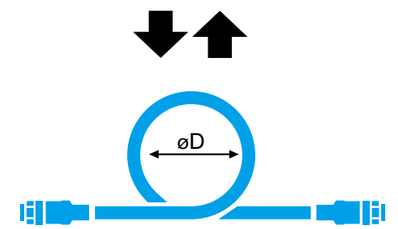
Test Method

(1)The Straight cable is connected to the vector network analyzer to record the initial phase waveform. (Waveform before the test)
(2)The phase waveform is recorded while the cable is wrapped on a mandrel of ø8mm (R = 4mm). (Waveform during the test)
(3)The phase waveform is recorded after Straightening the cable. (Waveform after the test)

Test Cables

• 2 type cables are tested as the right figures.
① 461 formable coaxial cable assembly
② Semi-flexible coaxial cable corresponding to UT47





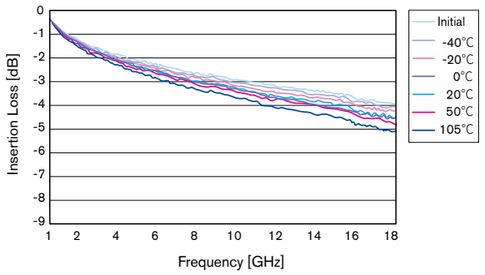
The cable was wrapped 360°around ø8mm mandrel.
(During bending)

* The above figures are measured values for reference only.

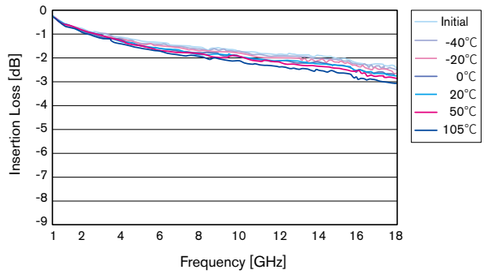
Technical Date

Temperature Characteristics (Insertion Loss) Test Cable: 2 m

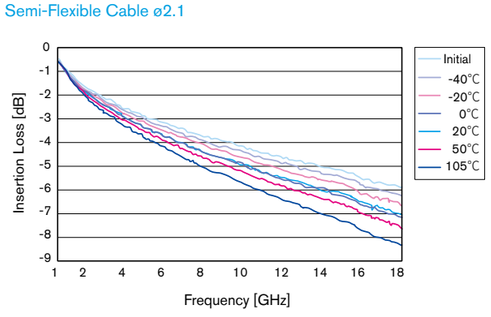
411



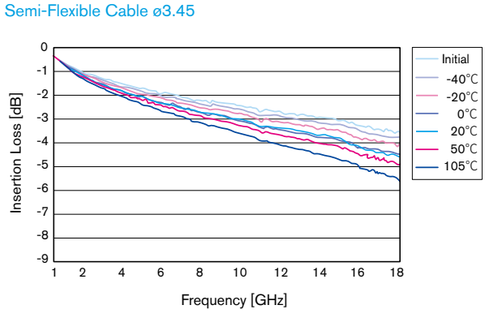
412



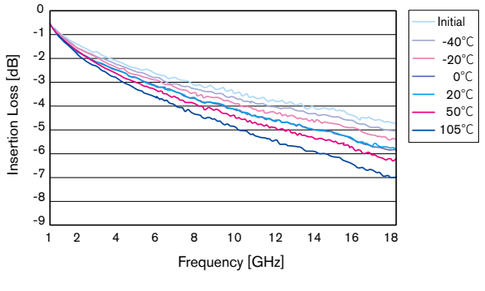
Semi-Flexible Cable ø2.1



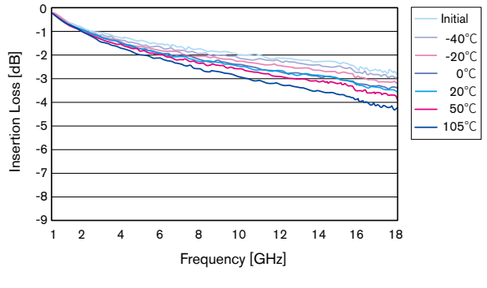
Semi-Flexible Cable ø3.45



Semi-Rigid Cable ø2.2



Semi-Rigid Cable ø3.6



Series Common Properties

Connector Insertion Loss [dB/connector]

Connector Type	Connector Insertion Loss	Frequency [GHz]						
		1.0 GHz	10.0 GHz	18.5 GHz	26.5 GHz	40.0 GHz	50.0 GHz	67.0 GHz
SMA (m) Straight	0.03√f	0.03	0.09	0.13	0.15	0.19	-	-
SMA (f) Straight	0.03√f	0.03	0.09	0.13	-	-	-	-
SMA (m) Right Angle	0.07√f	0.07	0.22	0.3	-	-	-	-
N (m) Straight	0.05√f	0.05	0.16	0.22	-	-	-	-
SMP (f) Straight	0.12√f	0.12	0.38	0.52	-	-	-	-
SMPM (f) Straight	0.12√f	0.12	0.38	0.52	0.62	0.76	0.85	0.98
2.92mm (m) Straight	0.03√f	0.03	0.09	0.13	0.15	0.19	-	-
1.85mm (m) Straight	0.065√f	0.065	0.206	0.28	0.33	0.41	0.46	0.53
1.0mm (m) Straight	0.065√f	0.065	0.206	0.28	0.33	0.41	0.46	0.53

Technical Data

Return Loss – VSWR Conversion Table

Return loss dB	Voltage Standing Wave Ratio VSWR	Reflection Coefficient
60	1.002	0.001
50	1.006	0.003
40	1.020	0.010
35	1.036	0.018
30	1.065	0.032
29	1.074	0.035
28	1.083	0.040
27	1.094	0.045
26	1.106	0.050
25	1.119	0.056
24	1.135	0.063
23	1.152	0.071
22	1.173	0.079
21	1.196	0.089
20	1.222	0.100
19	1.253	0.112
18	1.288	0.126
17	1.329	0.141
16	1.377	0.158
15	1.433	0.178
14	1.499	0.200
13	1.577	0.224
12	1.671	0.251
11	1.785	0.282
10	1.925	0.316

VSWR – Return Loss Conversion Table

Voltage Standing Wave Ratio VSWR	Return Loss dB	Reflection Coefficient	Propagation Loss dB
1.01	46.1	0.005	0.0001
1.02	40.1	0.010	0.0004
1.03	36.6	0.015	0.0010
1.04	34.2	0.020	0.0017
1.05	32.3	0.024	0.0025
1.06	30.7	0.029	0.0037
1.07	29.4	0.034	0.0050
1.08	28.3	0.038	0.0063
1.09	27.3	0.043	0.0080
1.10	26.4	0.048	0.0100
1.15	23.1	0.070	0.0213
1.20	20.8	0.091	0.0361
1.25	19.1	0.111	0.0538
1.30	17.7	0.130	0.0740
1.35	16.5	0.149	0.0975
1.40	15.6	0.167	0.1228
1.45	14.7	0.184	0.1496
1.50	14.0	0.200	0.1773
1.60	12.7	0.231	0.2382
1.70	11.7	0.259	0.3016
1.80	10.9	0.286	0.3706
1.90	10.2	0.310	0.4388
2.00	9.5	0.333	0.5104
3.00	6.0	0.500	1.2494
4.00	4.4	0.600	1.9382

db Table

Power Ratio P2/P1	dB Dp	Current Ratio/ Voltage Ratio $I_2/I_1 \cdot V_2/V_1$	dB Di·Dv
×0.01	-20dB	×0.01	-40dB
×0.1	-10dB	×0.1	-20dB
×1	0dB	×1	0dB
×2	3.0dB	×2	6.0dB
×3	4.8dB	×3	9.5dB
×4	6.0dB	×4	12.0dB
×5	7.0dB	×5	14.0dB
×6	7.8dB	×6	15.6dB
×7	8.5dB	×7	16.9dB
×8	9.0dB	×8	18.1dB
×9	9.5dB	×9	19.1dB
×10	10dB	×10	20dB
×100	20dB	×100	40dB
×1000	30dB	×1000	60dB

* The above figures are measured values for reference only.