The O series cable assemblies offer excellent phase stability against temperature fluctuation sand bending.

They are ideal for connecting to vector network analyzers for precision measurement.

(Continuous operating temperature range : from -30 to +85 °C)

Cables are offered in wide range of the frequencies of 26.5, 50, 67, 70, 110, 120 and 145 GHz with various connectors.

88								
	Center Conductor	Dielectric	1st Outer Conductor	2nd Outer Conductor	Sheath	Armored	Braid	Sheath
	Silver Plated Copper	Low Density PTFE	Silver Plated Copper Tape	Silver Plated Copper Braid	Fluoropolymer	SUS Spiral Tube	Silver Plated Copper Braid	Polyester Fiber

#### 0 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.				

# **Power Rating**

The diagram to the right shows the relationship between frequency and power rating.

The values are calculated at 25 °C and at sea level.

The power rating will need to be corrected for different ambient temperatures and altitude.

Power ratings may decrease, depending on the connector selected .

\* The above figures are measured values for reference only.

#### Power Rating of 0 Series at Sea Level







# 021 Phase Change vs. Temperature



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6

The cable was wrapped 360° around φ60mm mandrel. \* Guaranteed value within ±5.7° at 26.5GHz (In shipping value)

The cable was measured in chamber every 20 °C from -30 to 90 °C, 1 hour after the temperature changed.





# **O** Series

Placing orders



Armored-Type cables will have a " /B" appended to the connector combination code. No appended to the connector combination code when cables are not armored type.

• The order of Connector | and Connector II is determined by the alphabetical order of the first letter of the Connector Code. In the case of DMS (3.5mm(m) and AMS (SMA(m), Connector I: AMS, Connector II: DMS

• The order of Connector I and Connector II when the first letter of the Connector Code is the same depends on the alphabetical order of the second and subsequent letters.

In the case of DMS (3.5mm(m) and DFS (3.5mm(f), Connector I: DFS, Connector II: DMS

# **Delivery time**

O series will be shipped within 11 business days after received order. \* Leadtime may be effected by larger order volume.

# **Connector Codes**

Connector		0 Series								
Connec	021/B	051/B	051	061/B	061	071/B	001/B	002/B	004/B	
Туре	Maximum Operating Frequency	26.5 GHz	50.0	) GHz	67.0	GHz	70.0 GHz	110.0 GHz	120.0 GHz	145.0 GHz
N (m) Straight	18.0 GHz	NMS								
SMA (m) Straight	18.5 GHz	AMS								
SMA (f) Straight	18.5 GHz	AFS								
3.5 mm (m) Straight	26.5 GHz	DMS		DMS						
3.5 mm (m) Multi-Lock	26.5 GHz	DMP								
3.5 mm (m) Swept	26.5 GHz			DMW						
3.5 mm (f) Straight	26.5 GHz	DFS								
2.92 mm (m) Straight	40.0 GHz		KMS	KMS						
2.92 mm (m) Swept	40.0 GHz			KMW						
2.92 mm (f) Straight	40.0 GHz		KFS	KFS						
2.4 mm (m) Straight	50.0 GHz		LMS	LMS						
2.4 mm (m) Swept	50.0 GHz			LMW						
2.4 mm (f) Straight	50.0 GHz		LFS	LFS						
2.4 mm (f) NMD	50.0 GHz		LFD							
1.85 mm (m) Straight	67.0 GHz				VMS	VMS				
1.85 mm (m) Swept	67.0 GHz					VMW				
1.85 mm (f) Straight	67.0 GHz				VFS	VFS				
1.85 mm (f) NMD	67.0 GHz				VFD					
1.85 mm (m) Straight	70.0 GHz						VMS			
1.85 mm (f) Straight	70.0 GHz						VFD			
1.0 mm (m) Safety-Lock	110.0 GHz							WMT		
1.0 mm (f) Straight	110.0 GHz							WFS		
1.0 mm (m) Straight	110.0 GHz								WMS1	
1.0 mm (f) Straight	110.0 GHz								WFS1	
1.0 mm (m) Safety-Lock	120.0 GHz								WMT	
1.0 mm (m) Straight	120.0 GHz								WMS	
1.0 mm (f) Straight	120.0 GHz								WFS	
1.0 mm (m) Safety-Lock	130.0 GHz									WMT
1.0 mm (f) Straight	130.0 GHz									WFS
0.8 mm (m) Safety-Lock	145.0 GHz									MMT
0.8 mm (f) Straight	145.0 GHz									MFS

• The smallest frequency among the maximum operating frequencies of the connectors and cables to be used is the maximum operating frequency of the assembly. • Please inquire separately for products with connector symbols in gray, as they require a longer delivery time.

• The lowest frequency among the maximum operating frequencies of the connectors and cables to be used is the maximum operating frequency of the assembly. • For products with Connector Code in gray, please inquire separately as it takes time for delivery.



shown at the figure to the left.





# 021

- Features
- Phase Stability: Static Bending
- Phase Stability: Temperature Change
- Maximum Operating Frequency: 26.5 GHz
- Temperature Range: -30 to 85°C • Days to Ship: 11 Business Days RoHS Compliant



# Property

#### **Electrical Properties**

Maximum Operating Frequency	26.5 GHz
Characteristic Impedance	50±1 Ω
Capacitance (Typical)	85 pF/m
Propagation Delay (Typical)	4.21 ns/m
Velocity of Propagation (Typical)	79 %
Higher Mode Frequency (Typical)	28 GHz
VSWR (Typical)	1.33
Maximum Frequency Insertion Loss (26.5 Ghz)	2.0 dB/m

#### **Mechanical Properties**

Cable Outer Diameter	8.5 mm
Minimum Bending Radius (Inner Side)	30 mm
Cable Mass (Typical)	122 g/m
Continuous Operating Temperature Range	-30~+85 °C
Armored Side Pressure	196 N/cm
Assembly Length	700~1,500 mm

### Order Form Example Please provide the following information when placing an order.

#### Example MWX021

Assembly Length : 1000mm Connector I: 3.5 mm (f) Straight Connector II: 3.5 mm (m) Straight

Catalog No. MWX021-01000DFSDMS/B a L d a. Cable Type

\* See P. 0-4 "Connector Codes"

- b. Assembly Length
- c. Connector
- d. Armored

# **Technical Data**



# $\textbf{Typical Insertion Loss} (0.67 \times (0.038 \times f [GHz] + 0.371 \times \sqrt{f} [GHz]) + 0.07) \times L [m] \quad \textbf{Maximum Insertion Loss} (0.67 \times (0.038 \times f [GHz] + 0.371 \times \sqrt{f} [GHz]) + 0.07) \times 1.12 \times L [m]$



# Connector

18g

43g

Technology

Partner



N (m) Straight (Code : NMS)





#### 3.5mm Connector "Multi-Lock Type" 3 Ways for Coupling

24g

2



Insert the cable connector and slide the coupling nut forward. It helps to reduce workload for insertion and extraction, such as production and testing line.

С

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

\* The above figures are measured values for reference only.

Hand Screw Coupling

After snap-on coupling, becomes stable. screw the coupling nut, then the connection This connector made the work-load 1/3 compared to the conventional ones.



# Torque Wrench Coupling

Torque wrench management for more accurate measureis available at the HEX part with standard tightening, ment, such as calibration.







#### **Electrical Properties**

Maximum Operating Frequency	50.0 GHz
Characteristic Impedance	50±1 Ω
Capacitance (Typical)	85 pF/m
Propagation Delay (Typical)	4.19 ns/m
Velocity of Propagation (Typical)	79 %
Higher Mode Frequency (Typical)	61 GHz
VSWR (Typical)	1.46
Maximum Frequency Insertion Loss (50.0 GHz)	4.6 dB/m

#### **Mechanical Properties**

Cable Outer Diameter	6.6 mm
Minimum Bending Radius (Inner Side)	30 mm
Cable Mass (Typical)	76 g/m
Continuous Operating Temperature Range	-30~+85 °C
Armored Side Pressure	196 N/cm
Assembly Length	700~1,500 mm

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6

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Order Form Example Please provide the following information when placing an order.

Example MWX051

Catalog No.

Assembly Length: 1000mm

Connector I: 2.4 mm (f) Straight Connector II: 2.4 mm (m) Straight

MWX051-01000LFSLMS/B

d

С

\* See P. 0-4 "Connector Codes"

a. Cable b. Assembly Length c. Connector d. Armored







# Connector



NMD 2.4 mm (f) Straight (Code : LFD)



Mass : 60g

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



Non-armored type (2.4 mm and 2.92 mm connector) can be used for 051. Please contact us.

\* The above figures are measured values for reference only.

0-7

a b

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 $\textbf{Typical Insertion Loss} (0.0095 \times f[GHz] + 0.587 \times \sqrt{f[GHz] + 0.02}) \times L[m] \quad \textbf{Maximum Insertion Loss} (0.0095 \times f[GHz] + 0.587 \times \sqrt{f[GHz] + 0.02}) \times 1.12 \times L[m]$ 



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6



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- Features
- Phase Stability: Static Bending
- Phase Stability: Temperature Change
- Maximum Operating Frequency: 67.0 GHz
- Temperature Range: -30 to 85°C • Days to Ship: 11 Business Days RoHS Compliant



# Property

#### **Electrical Properties**

Maximum Operating Frequency	67.0 GHz
Characteristic Impedance (Typical)	50±1 Ω
Capacitance (Typical)	90 pF/m
Propagation Delay (Typical)	4.35 ns/m
Velocity of Propagation (Typical)	77 %
Higher Mode Frequency (Typical)	70 GHz
VSWR (Typical)	1.46
Maximum Frequency Insertion Loss (67.0 GHz)	7.3 dB/m

#### **Mechanical Properties**

Cable Outer Diameter	6.6 mm
Minimum Bending Radius (Inner Side)	30 mm
Cable Mass (Typical)	73 g/m
Continuous Operating Temperature Range	-30~+85 °C
Armored Side Pressure	196 N/cm
Assembly Length	700~1,500 mm

## Order Form Example Please provide the following information when placing an order.

Example MWX061
Assembly Length: 700 mm Connector I : 1.85 mm (f) Straight Connector II : 1.85 mm (m) Straight
Catalog No. MWX061-00700VFSVMS/B

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a. Cable b. Assembly Length c. Connector d. Armored

\* See P. 0-4 "Connector Codes"

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# **Technical Data**





## Connector



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

#### Option

Non-armored type (1.85mm connector) can be used for 061. Please contact us.

Technology

Partner

 $\textbf{Typical Insertion Loss} (0.0232 \times f [GHz] + 0.702 \times \sqrt{f} [GHz] + 0.02) \times L [m] \quad \textbf{Maximum Insertion Loss} (0.0232 \times f [GHz] + 0.702 \times \sqrt{f} [GHz] + 0.02) \times 1.12 \times L [m]$ 

#### NMD 1.85 mm (f) Straight (Code : VFD)





\* The above figures are measured values for reference only. 0-10



6

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071

- Features
- Phase Stability: Static Bending
- Phase Stability: Temperature Change
- Maximum Operating Frequency: 70.0 GHz
- Temperature Range: -30 to 85°C • Days to Ship: 11 Business Days RoHS Compliant



# Property

#### **Electrical Properties**

Maximum Operating Frequency	70.0 GHz
Characteristic Impedance (Typical)	50±1 Ω
Capacitance (Typical)	90 pF/m
Propagation Delay (Typical)	4.35 ns∕m
Velocity of Propagation (Typical)	77 %
Higher Mode Frequency (Typical)	70 GHz
VSWR (Typical)	1.46
Maximum Frequency Insertion Loss (70.0 GHz)	7.5 dB/m

#### **Mechanical Properties**

Cable Outer Diameter	6.6 mm
Minimum Bending Radius (Inner Side)	30 mm
Cable Mass (Typical)	73 g/m
Continuous Operating Temperature Range	-30~+85 °C
Armored Side Pressure	196 N/cm
Assembly Length	700~1,500 mm

## Order Form Example Please provide the following information when placing an order.

Example MWX071
Assembly Length: 700 mm Connector I:1.85 mm (f) Straight Connector II:1.85 mm (m) Straight
Catalog No. MWX071-00700VFSVMS/B

a. Cable b. Assembly Length c. Connector d. Armored

\* See P. 0-4 "Connector Codes"

6

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**Technical Data** 

Cable Typical Insertion Loss

\_\_\_\_\_0.7m - 1 m - 1.5m

10

30

Frequency [GHz]

40 50 60

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

10 20

Connector

HEX 8 -É

1.85 mm (m) Straight (Code : VMS)

Maximum Operating Frequency : 70.0 GHz / Mass : 11g

20

⊆

-10

-15 L

0

1.85 mm (f) Straight (Code : VFS)

Maximum Operating Frequency : 70.0 GHz / Mass : 14g

Before Test

- During Test

After Test

Before Test - During Test

After Test

12

Щ

0.0



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0-11



 $\textbf{Typical ilnsertion Loss} (0.0232 \times f[GHz] + 0.702 \sqrt{f[GHz] + 0.02}) \times L[m] \quad \textbf{Maximum Insertion Loss} (0.0232 \times f[GHz] + 0.702 \sqrt{f[GHz] + 0.02})) \times 1.12 \times L[m]$ 



\* The above figures are measured values for reference only. 0-12



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# 001

- Features
- Phase Stability: Static Bending
- Phase Stability: Temperature Change
- Maximum Operating Frequency: 110.0 GHz
- Temperature Range: -30 to 85°C • Days to Ship: 15 Business Days
  - RoHS Compliant

# **Technical Data**



#### Static Bending Data (Insertion Loss, Phase) Bending Radius : 15 mm



\* The cable was wrapped 90° around ø30mm mandrel.

# Property

#### **Electrical Properties**

Maximum Operating Frequency	110.0 GHz
Characteristic Impedance	50 Ω
Capacitance (Typical)	88 pF/m
Propagation Delay (Typical)	4.2 ns/m
Velocity of Propagation (Typical)	79 %
Higher Mode Frequency (Typical)	110 GHz
VSWR (Typical)	1.43
Maximum Frequency Insertion Loss (110.0 GHz)	11.8 dB/m

### **Mechanical Properties**

Cable Outer Diameter	4.0 mm
Minimum Bending Radius (Inner Side)	15 mm
Cable Mass (Typical)	50 g/m
Continuous Operating Temperature Range	-30~+85 °C
Armored Side Pressure	157 N/cm
Assembly Length	100~200 mm

## Order Form Example Please provide the following information when placing an order.

#### Example MWX001

Assembly Length: 100 mm Connector I: 1.0 mm (f) Straight Connector II: 1.0 mm (m) Straight Catalog No. MWX001-00100WFSWMT/B

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a. Cable b. Assembly Length c. Connector

\* See P. 0-4 "Connector Codes"

d. Armored



# Connector



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

#### How to Use "Safety Lock Mechanism" of 1.0mm (m) Connector



the knurled screw thread. Central pin is located back side, seeing from







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0 Series

Same as the normal 1.0mm(m) connectors, it the coupling nut with female connector. They will be fixed under the condition that both connector's central axis is matched. Central pin has not connected yet.





Rotate the knurled parts, then let the cable side central pin forward, and insert to female connector's socket. With the help of fixed coupling nut, central axis is matched. This helps not to happen pin's slanting.



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# 002

- Features
- Phase Stability: Static Bending
- Phase Stability: Temperature Change

- Maximum Operating Frequency: 120.0 GHz
   RoHS Compliant
- Temperature Range: -30 to 85°C • Days to Ship: 15 Business Days

# Property

#### **Electrical Properties**

Maximum Operating Frequency	120.0 GHz
Characteristic Impedance	50 Ω
Capacitance (Typical)	88 pF/m
Propagation Delay (Typical)	4.2 ns/m
Velocity of Propagation (Typical)	79 %
Higher Mode Frequency (Typical)	120 GHz
VSWR (Typical)	1.43
Maximum Frequency Insertion Loss (67.0 GHz) 120.0 GHz)	14.5 dB/m

#### **Mechanical Properties**

Cable Outer Diameter	4.0 mm
Minimum Bending Radius (Inner Side)	15 mm
Cable Mass (Typical)	50 g/m
Continuous Operating Temperature Range	-30~+85 ℃
Armored Side Pressure	157 N/cm
Assembly Length	100~200 mm

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## Order Form Example Please provide the following information when placing an order.

#### Example MWX002

Assembly Length: 100 mm Connector I: 1.0 mm (f) Straight Connector II: 1.0 mm (m) Straight Catalog No. MWX002-00100WFSWMT/B

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a. Cable b. Assembly Length c. Connector d. Armored

\* See P. 0-4 "Connector Codes"

# **Technical Data**





#### $\label{eq:constraint} \textbf{Typical Insertion Loss} (0.035 \times f[\text{GHz}] + 0.9 \times \sqrt{f[\text{GHz}] + 0.4} \times \text{L[m]} \quad \textbf{Maximum Insertion Loss} (0.035 \times f[\text{GHz}] + 0.9 \times \sqrt{f[\text{GHz}] + 0.4} \times 1.12 \times \text{L[m]} \times 1.12 \times 1.12 \times \text{L[m]} \times 1.12 \times 1.1$

#### Static Bending Data (Insertion Loss, Phase) Bending Radius



# Connector



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

Knurled Screw Thread

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### How to Use "Safety Lock Mechanism" of 1.0mm (m) Connector



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0 Series

\* The above figures are measured values for reference only.

Mass: 2g

Same as the normal 1.0mm(m) connectors, it the coupling nut with female connector. They will be fixed under the condition that both connector's central axis is matched. Central pin has not connected yet.

1.0 mm (m) Straigh (Code : WMS1)

Maximum Operating Frequency : 110GHz /

HEX6

Mass : 3g



Rotate the knurled parts, then let the cable side central pin forward, and insert to female connector's socket. With the help of fixed coupling nut, central axis is matched. This helps not to happen pin's slanting.

1.0 mm (f) Straigh (Code :WFS1)

Maximum Operating Frequency : 110GHz /

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- Phase Stability: Static Bending
- Phase Stability: Temperature Change
- Maximum Operating Frequency: 145.0 GHz
   RoHS Compliant
- Temperature Range: -30 to 85°C • Days to Ship: 15 Business Days

# Property

004

#### **Electrical Properties**

Maximum Operating Frequency	145.0 GHz
Characteristic Impedance (Typical)	50 Ω
Capacitance (Typical)	90 pF/m
Propagation Delay (Typical)	4.5 ns/m
Velocity of Propagation (Typical)	74 %
Higher Mode Frequency (Typical)	145 GHz
VSWR (Typical)	1.5
Maximum Frequency Insertion Loss (145.0 GHz)	28.1 dB/m

#### **Mechanical Properties**

Cable Outer Diameter	4.0 mm
Minimum Bending Radius (Inner Side)	20 mm
Cable Mass (Typical)	50 g/m
Continuous Operating Temperature Range	-30~+85 °C
Armored Side Pressure	157 N/cm
Assembly Length	100~200 mm

# Order Form Example Please provide the following information when placing an order.

Example MWX004	* See P. 0-4 "Connector Codes"
Assembly Length: 100 mm Connector I : 1.0 mm (f) Straight Connector II : 1.0 mm (m) Straight	a. Cable
Catalog No. MWX004-00100MFSMMT/B	<ul><li>b. Assembly Length</li><li>c. Connector</li><li>d. Armored</li></ul>

a. Cable	
b. Assembly Length	
c. Connector	
d. Armored	

# **Technical Data**



#### $\label{eq:constraint} \textbf{Typical Insertion Loss} (0.1 \times f[\text{GHz}] + 1.1 \times \sqrt{f[\text{GHz}] + 0.4}) \times L[m] \quad \textbf{Maximum Insertion Loss} (0.1 \times f[\text{GHz}] + 1.1 \times \sqrt{f[\text{GHz}] + 0.4}) \times 1.12 \times L[m]$

#### Static Bending Data (Insertion Loss, Phase) Bending Radius: 15mm



\* The cable was wrapped 90° around ø30mm mandrel.

# Connector



# How to Use "Safety Lock Mechanism" of 1.0mm / 0.8mm (m) Connector



# Knurled Screw Thread



Bichardson <u>Electronics</u>







Same as the normal 1.0 / 0.8mm(m) connectors, it the coupling nut with female connector. They will be fixed under the condition that both connector's central axis is matched. Central pin has not connected yet.



Rotate the knurled parts, then let the cable side central pin forward, and insert to female connector's socket. With the help of fixed coupling nut, central axis is matched. This helps not to happen pin's slanting.



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# Series Common Properties

### Connector Insertion Loss [dB/connector]

Connector Type	Connector	Frequency [GHz]						
Connector Type	Insertion Loss	1.0 GHz	10.0 GHz	18.5 GHz	26.5 GHz	40.0 GHz	50.0 GHz	67.0 GHz
SSMA (m) Straight	0.03√f	0.03	0.09	0.13	-	-	-	-
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	-	-	-	-
SMA (m) Swept	0.04√f	0.04	0.13	0.17	-	-	-	-
TNC (m) Straight	0.07√f	0.07	0.22	0.3	-	-	-	-
N (m) Straight	0.05√f	0.05	0.16	0.22	-	-	-	-
N (f) Straight	0.05√f	0.05	0.16	0.22	-	-	-	-
N (m) Swept	0.06√f	0.06	0.19	0.26	-	-	-	-
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
3.5mm (m) Straight	0.03√f	0.03	0.09	0.13	0.15	-	-	-
3.5mm (f) Straight	0.03√f	0.03	0.09	0.13	0.15	-	-	-
3.5mm (m) Swept	0.04√f	0.04	0.13	0.17	0.21	-	-	-
2.92mm (m) Straight	0.03√f	0.03	0.09	0.13	0.15	0.19	-	-
2.92mm (f) Straight	0.03√f	0.03	0.09	0.13	0.15	0.19	-	-
2.92mm (m) Swept	0.04√f	0.04	0.13	0.17	0.21	0.25	-	-
2.4mm (m) Straight	0.042√f	0.04	0.13	0.18	0.22	0.27	0.3	-
2.4mm (f) Straight	0.042√f	0.04	0.13	0.18	0.22	0.27	0.3	-
1.85mm (m) Straight	0.065√f	0.065	0.206	0.28	0.33	0.41	0.46	0.53
1.85mm (f) 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
1.0mm (f) Straight	0.065√f	0.065	0.206	0.28	0.33	0.41	0.46	0.53

### **Tolerances for Assembly Length**

Tolerance values of 0, 1, 2 and 3 series are shown below. Please contact us if your tolerance requirements for phase matching are more stringent.

Assembly Length [mm]	Tolerance [mm]
L≦1000	±10
1000 <l≦2000< td=""><td>±20</td></l≦2000<>	±20
2000 <l≦5000< td=""><td>±50</td></l≦5000<>	±50
5000 <l< th=""><th>±100</th></l<>	±100

### About Customer-Specified Swept and Right-Angle Connectors



0-19

Connector I is assumed to be at 0° (as viewed from the direction of Connector I ) is indicated by three digits following the catalog number. (The indication is omitted if the angle is 0°.) Example : If Connector II is at an angle of 90° when viewed from the direction of Connector I : MWX312-01000AMRAMR-090

6

The angle of Connector II relative to Connector I when

# **Technical Data**

Return Loss dB         Voltage Standing Wave Ratio VSWR         Reflection Coefficient         Voltage Standing Coefficient         Return Loss dB         Reflection Coefficient         Pro Ld           60         1.002         0.001         1.01         46.1         0.005         0           50         1.006         0.003         1.02         40.1         0.010         0           40         1.020         0.010         1.03         36.6         0.015         0           35         1.036         0.032         1.05         32.3         0.024         0           29         1.074         0.035         1.06         30.7         0.029         0           28         1.083         0.040         1.07         29.4         0.034         0           27         1.094         0.050         1.08         28.3         0.038         0           25         1.119         0.056         1.10         26.4         0.048         0           24         1.135         0.063         1.15         23.1         0.070         0	
60         1.002         0.001         1.01         46.1         0.005         0           50         1.006         0.003         1.02         40.1         0.010         0           40         1.020         0.010         1.03         36.6         0.015         0           35         1.036         0.018         1.04         34.2         0.020         0           30         1.065         0.032         1.05         32.3         0.024         0           29         1.074         0.035         1.06         30.7         0.029         0           28         1.083         0.040         1.07         29.4         0.034         0           27         1.094         0.045         1.08         28.3         0.038         0           26         1.106         0.050         1.09         27.3         0.043         0           25         1.119         0.056         1.10         26.4         0.048         0           24         1.135         0.063         1.15         23.1         0.070         0	pagatio oss dB
50         1.006         0.003         1.02         40.1         0.010         0           40         1.020         0.010         1.03         36.6         0.015         0           35         1.036         0.018         1.04         34.2         0.020         0           30         1.065         0.032         1.05         32.3         0.024         0           29         1.074         0.035         1.06         30.7         0.029         0           28         1.083         0.040         1.07         29.4         0.034         0           27         1.094         0.045         1.08         28.3         0.038         0           26         1.106         0.050         1.09         27.3         0.043         0           25         1.119         0.056         1.10         26.4         0.048         0           24         1.135         0.063         1.15         23.1         0.070         0	.0001
40         1.020         0.010         1.03         36.6         0.015         0           35         1.036         0.018         1.04         34.2         0.020         0           30         1.065         0.032         1.05         32.3         0.024         0           29         1.074         0.035         1.06         30.7         0.029         0           28         1.083         0.040         1.07         29.4         0.034         0           27         1.094         0.045         1.08         28.3         0.038         0           26         1.106         0.050         1.09         27.3         0.043         0           25         1.119         0.056         1.10         26.4         0.048         0           24         1.135         0.063         1.15         23.1         0.070         0	.0004
35         1.036         0.018         1.04         34.2         0.020         0           30         1.065         0.032         1.05         32.3         0.024         0           29         1.074         0.035         1.06         30.7         0.029         0           28         1.083         0.040         1.07         29.4         0.034         0           27         1.094         0.045         1.08         28.3         0.038         0           26         1.106         0.050         1.09         27.3         0.043         0           25         1.119         0.056         1.10         26.4         0.048         0           24         1.135         0.063         1.15         23.1         0.070         0	.0010
30         1.065         0.032         1.05         32.3         0.024         0           29         1.074         0.035         1.06         30.7         0.029         0           28         1.083         0.040         1.07         29.4         0.034         0           27         1.094         0.045         1.08         28.3         0.038         0           26         1.106         0.050         1.09         27.3         0.043         0           25         1.119         0.056         1.10         26.4         0.048         0           24         1.135         0.063         1.15         23.1         0.070         0           23         1.152         0.071         1.20         20.8         0.091         0	.0017
29         1.074         0.035         1.06         30.7         0.029         0           28         1.083         0.040         1.07         29.4         0.034         0           27         1.094         0.045         1.08         28.3         0.038         0           26         1.106         0.050         1.09         27.3         0.043         0           25         1.119         0.056         1.10         26.4         0.048         0           24         1.135         0.063         1.15         23.1         0.070         0	.0025
28         1.083         0.040         1.07         29.4         0.034         0           27         1.094         0.045         1.08         28.3         0.038         0           26         1.106         0.050         1.09         27.3         0.043         0           25         1.119         0.056         1.10         26.4         0.048         0           24         1.135         0.063         1.15         23.1         0.070         0	.0037
27         1.094         0.045         1.08         28.3         0.038         0           26         1.106         0.050         1.09         27.3         0.043         0           25         1.119         0.056         1.10         26.4         0.048         0           24         1.135         0.063         1.15         23.1         0.070         0	.0050
26         1.106         0.050         1.09         27.3         0.043         0           25         1.119         0.056         1.10         26.4         0.048         0           24         1.135         0.063         1.15         23.1         0.070         0           23         1.152         0.071         1.20         20.8         0.091         0	.0063
25         1.119         0.056         1.10         26.4         0.048         0           24         1.135         0.063         1.15         23.1         0.070         0           23         1.152         0.071         1.20         208         0.091         0	.0080
24         1.135         0.063         1.15         23.1         0.070         0           23         1.152         0.071         1.20         20.8         0.091         0	.0100
23 1 152 0.071 1 20 20.8 0.091 0	.0213
	.0361
22 1.173 0.079 1.25 19.1 0.111 0	.0538
21 1.196 0.089 1.30 17.7 0.130 0	.0740
20 1.222 0.100 1.35 16.5 0.149 0	.0975
19 1.253 0.112 1.40 15.6 0.167 0	.1228
18 1.288 0.126 1.45 14.7 0.184 0	.1496
17 1.329 0.141 1.50 14.0 0.200 0	.1773
16 1.377 0.158 1.60 12.7 0.231 0	.2382
15 1.433 0.178 1.70 11.7 0.259 0	.3016
14 1.499 0.200 1.80 10.9 0.286 0	.3706
13 1.577 0.224 1.90 10.2 0.310 0	4388
12 1.671 0.251 2.00 9.5 0.333 0	.5104
11 1.785 0.282 3.00 6.0 0.500 1	2494
10 1.925 0.316 4.00 4.4 0.600 1	

### Frequency Band Name and Code

Frequency [GHz]	Wavelength [cm]	Conventional frequency band (radar)	Current frequency band (ECM)	Freque [GHz]
0.15 0.2	200 150	VHF	A	- 0.1 - 0.2
0.3 · 0.4 ·			В	- 0.3 - 0.4
0.6 0.75	50 40	UHF	С	- 0.6
1.5	20	L	D	- 1.5
2	15	ç	E	$T^{2}$
3 -	10	5	F	+ 3
5	6	С	G	- 5
8.	375		Н	
10 .	3	х	1	- 10
15	2	Ku	J	- 15
20	1.5	К		+ 20
30 ·	1	Ka	К	- 30
40 · 50 ·			L	- 50
60 · 75 ·		MILLIMETER	М	- 60 - 75
100	0.3			L 100

# db Table

Power Ratio P2/P1	dB Dp	Current Ratio/ Voltage Ratio	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
×З	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

Power : Dp =  $10\log_{10} \frac{P_2}{P}[dB]$ 

Current : Di =  $20\log_{10} \frac{l_2}{l_1} [dB]$ 

Voltage :  $Dv = 20 \log_{10} \frac{V_2}{V_2} [dB]$ 

• Power level "dBm" represents the absolute value with respect to the standard 0[dBm] for 1[m/W]. P[mW] is given by 10log10P[dBm].

1. VSWR =  $\frac{1+\rho}{1-\rho} = \frac{1+10^{-\frac{BL}{20}}}{1-10^{-\frac{BL}{20}}}$ 

2. Return Loss RL (dB) =-20logp =-20log VSWR-1 VSWR+1

3. Reflection Coefficient  $\rho = (VSWR-1) /$  $(VSWR+1) = 10^{-\frac{RL}{20}}$ 

4. Propagation Loss  $\alpha$  (dB) = -10log (1- $\rho^2$ )  $=-10\log\left(1-\left(\frac{VSWR-1}{VSWR+1}\right)^{2}\right)$ 

Relationship between frequency and wavelength  $f = \frac{c}{\lambda}$  where c=2.998 × 10<sup>s</sup> [m/s] Relationship between phase change  $\theta$ [°], frequency f [GHz], cable length L[mm]and propagation delay T[nsec] L=0.8328× $\theta$ ÷ $\sqrt{\epsilon_r}$ ÷f  $\theta = 1.201 \times L \times \sqrt{\epsilon_r} \times f$  $\theta = 360 \times f \times \tau$ where  $\epsilon r$  is the specific dielectric constant of the cable insulator. Air : εr=1, Dense PTFE : εr ≒ 2.1

quency Hz]

).15 ).2

0.3

).4

).5

).6

0.75

.5





1 Series Cable Assemblies with Wide Temperature Range & High Durability for Measuring Instruments

# Cable Assemblies with Wide Temperature and High Durability for Measuring Instruments 1 Series

We line up 121 of the heat-resistant type that can be used under a wide range of temperatures (-65 - +125°C) in the microwave measurement. And 122 of the high-durability type (that can be used under the temperature range from -35°C to +85°C) of which the mechanical life is drastically extended by applying a cabling structure that we developed in the robot cable.

21					
Center Conductor	Dielectric	1st Outer Conductor	2nd Outer Conductor	Sheath	Sheath
Silver Plated Copper	Low Density PTFE	Silver Plated Copper Tape	Silver Plated Copper Braid	Fluoropolymer	Aramid Fibe

100						
	Center Conductor	Dielectric	1st Outer Conductor	2nd Outer Conductor	Sheath	Sheath
	Silver Plated Copper	Low Density PTFE	Silver Plated Copper Tape	Special braid	Fluoropolymer	PVC

161				-	and the the the the		
Center Conductor	Dielectric	1st Outer Conductor	2nd Outer Conductor	Sheath	Armored	Braid	Sheath
Silver Plated Copper	Low Density PTFE	Silver Plated Copper Tape	Silver Plated Copper Braid	Fluoropolymer	SUS Spiral Tube	SUS Wire	Aramid Fiber

#### 1 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.					
<b>Flexibility</b> The smaller the cable, the better the flexibility.						
Mass	The smaller the cable, the lighter the cable.					

# **Power Rating**

The diagram to the right shows the relationship between frequency and power rating.

The values are calculated at 25 °C and at sea level.

The power rating will need to be corrected for different ambient temperatures and altitude.

Power ratings may decrease, depending on the connector selected.

\* The above figures are measured values for reference only.

#### Power Rating of 1 Series at Sea Leve



# Heat Cycle Test for 121





# Composite Durability Test for 122



# Slimness Comparison of Maximum Outer Diameter

·Cable assemblies with a small diameter at the neck, making it the most suitable for a Multiport VNA •Torque Driver is available to mount on narrow pitch connector arrangement board



Cable	161	061	261
Maximum Outer Diameter [mm]	7.9	13	9.7

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The cycle indicated above chart was repeated 30 times. We measured the insertion and return loss of the specimen that was taken out from the tester after the 30 cycles.





Exzmple of Commection to a Murti-Pert VNA





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#### semblies with Wide Temperature Range & bility for Measuring Instrument 1 Series Cable As High Dura

# 1Series

# **Placing Orders**



#### **Connector Codes**

Quanta	Cable			
Connector	121	122	161	
Туре	Maximum Operating Frequency	26.5 GHz	26.5 GHz	67.0 GHz
N (m) Straight	18.0 GHz	NMS	NMS	
N (m) Torque Canceller	18.0 GHz		NMC	
SMA (m) Straight	18.5 GHz	AMS	AMS	
SMA (m) Torque Canceller	18.5 GHz		AMC	
3.5mm (m) Straight	26.5 GHz	DMS	DMS	DMS
3.5mm (m) Torque Canceller	26.5 GHz		DMC	
3.5mm (f) Straight	26.5 GHz	DFS	DFS	
3.5mm (f) Torque Canceller	26.5 GHz		DFC	
2.92mm (m) Straight	40.0 GHz			KMS
2.4mm (m) Straight	50.0 GHz			LMS
1.85mm (m) Straight	67.0 GHz			VMS

m : male (plug) f : female (jack)

• The smallest frequency among the maximum operating frequencies of the connectors and cables to be used is the maximum operating frequency of the assembly. • Please inquire separately for products with connector symbols in gray, as they require a longer delivery time.

• The order of Connector | and Connector II is determined by the alphabetical order of the first letter of the Connector Code. In the case of DMS (3.5mm(m) and AMS (SMA(m), Connector I: AMS, Connector II: DMS

• The order of Connector I and Connector II when the first letter of the Connector Code is the same depends on the alphabetical order of the second and subsequent letters.

In the case of DMS (3.5mm(m) and DFS (3.5mm(f), Connector I: DFS, Connector II: DMS

# **Delivery time**

1 series will be shipped within 11 business days after received order.

\* Leadtime may be effected by larger order volume.

1-3



Please provide a catalog number when placing an order.





#### emblies with Wide Temperature Range & bility for Measuring Instruments 1 Series Cable Ass High Dura





- Phase Stability: Static Bending
- ¥ Maximum Operating Frequency: 26.5 GHz

- Temperature Operating Frequency: -65 to 125°C





# Property

#### **Electrical Properties**

Maximum Operating Frequency	26.5 GHz
Characteristic Impedance (Typical)	50±1 Ω
Capacitance (Typical)	88 pF/m
Propagation Delay (Typical)	4.28 ns/m
Velocity of Propagation (Typical)	78 %
Higher Mode Frequency (Typical)	27.0 GHz
VSWR (Typical)	1.33
Maximum Frequency Insertion loss (26.5 GHz)	1.3 dB/m

#### **Mechanical Properties**

Cable Outer Diameter	6.6 mm
Minimum Bending Radius (Inner Side)	30 mm
Cable Mass (Typical)	80 g/m
Continuous Operating Temperature Range	-65~+125 ℃
Assembly Length	200~5,000 mm

# **Technical Data**





# Connector



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

Order Form Example Please provide the following information when placing an order.

\* See P. 1-4 "Connector Codes"

Assembly Length: 1000mm Connector I: 3.5 mm (f) Straight Connector II: 3.5 mm (m) Straight Catalog No.

MWX121-01000DFSDMS

a. Cable b. Assembly Length c. Connector

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Bichardson <u>Electronics</u> R & MIC

1-5 Technology

Partner







Maximum Operating Frequency : 26.5 GHz / Mass : 12g

## N (m) Straight (Code : NMS)







#### semblies with Wide Temperature Range & ability for Measuring Instruments 1 Series Cable Asse

# 122

- Features
- Phase Stability: Static Bending

• Temperature Range: -30 to 85°C

Maximum Operating Frequency: 26.5 GHz

- Cable Flexibility
- Bending Resistant Cable
- Torque Canceller
- Days to Ship: 11 Business Days
- RoHS Compliant



# Property

#### **Electrical Properties**

Maximum Operating Frequency	26.5 GHz
Characteristic Impedance (Typical)	50±1Ω
Capacitance (Typical)	89 pF/m
Propagation Delay (Typical)	4.39 ns/m
Velocity of Propagation (Typical)	76 %
Higher Mode Frequency (Typical)	27.0 GHz
VSWR (Typical)	1.33
Maximum Frequency Insertion loss (26.5 GHz)	1.9 dB/m

#### **Mechanical Properties**

Cable Outer Diameter	6.5 mm
Minimum Bending Radius (Inner Side)	30 mm
Cable Mass (Typical)	79 g/m
Continuous Operating Temperature Range	-30~+85 °C
Assembly Length	300~3,000 mm

## Order Form Example Please provide the following information when placing an order.

#### Example MWX122

# \* See P. 1-4 "Connector Codes"

Assembly Length: 1000 mm Connector I : 3.5 mm (f) Straight Torque Canceller Connector II : 3.5 mm (m) Straight Torque Canceller

Catalog No. MWX122-01000DFCDMC

a. Cable b. Assembly Length c. Connector

**Technical Data** 



#### **Typical Insertion Loss** (0.022f [GHz]+0.25√f [GHz]+0.025)×L [m] **Maximum Insertion Loss** (0.022f [GHz]+0.25√f [GHz]+0.025)×1.12×L [m]



# Connector



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



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Maximum Operating Frequency : 26.5 GHz / Mass : 15g

#### N (m) Straight (Code : NMS)



Maximum Operating Frequency : 18.0 GHz / Mass : 41g

Serie







### • Temperature Range: -65 to 125°C • Days to Ship: 11 Business Days RoHS Compliant



# Property

#### **Electrical Properties**

Maximum Operating Frequency	67.0 GHz
Characteristic Impedance (Typical)	50±1 Ω
Capacitance (Typical)	90 pF/m
Propagation Delay (Typical)	4.35 ns/m
Velocity of Propagation (Typical)	77 %
Higher Mode Frequency (Typical)	70.0 GHz
VSWR (Typical)	1.43
Maximum Frequency Insertion loss (67.0 GHz)	7.3 dB/m

#### **Mechanical Properties**

Maximum Outer Diameter	7.9 mm
Cable Outer Diameter	6.5 mm
Minimum Bending Radius (Inner Side)	30 mm
Cable Mass (Typical)	79 g/m
Continuous Operating Temperature Range	-65~+125 °C
Armored Side Pressure	196 N/cm
Assembly Length	600~1,500 mm

800.348.5580

630.208.2200

## Order Form Example Please provide the following information when placing an order.

Example MWX161
Assembly Length: 610 mm Connector I:2.4 mm (m) Straight Connector II:1.85 mm (m) Straight
Catalog No. MWX161-00610LMSVMS/B

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R & MIC

a. Cable b. Assembly Length c. Connector d. Armored

\* See P. 1-4 "Connector Codes"

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R & MIC

# **Technical Data**





# Connector



1-9

Technology

Partner









Series





# Series Common Properties

### Connector Insertion Loss [dB/connector]

Connector Type	Connector	Frequency [GHz]						
Connector type	Insertion Loss	1.0 GHz	10.0 GHz	18.5 GHz	26.5 GHz	40.0 GHz	50.0 GHz	67.0 GHz
SSMA (m) Straight	0.03√f	0.03	0.09	0.13	-	-	-	-
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	-	-	-	-
SMA (m) Swept	0.04√f	0.04	0.13	0.17	-	-	-	-
TNC (m) Straight	0.07√f	0.07	0.22	0.3	-	-	-	-
N (m) Straight	0.05√f	0.05	0.16	0.22	-	-	-	-
N (f) Straight	0.05√f	0.05	0.16	0.22	-	-	-	-
N (m) Swept	0.06√f	0.06	0.19	0.26	-	-	-	-
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
3.5mm (m) Straight	0.03√f	0.03	0.09	0.13	0.15	-	-	-
3.5mm (f) Straight	0.03√f	0.03	0.09	0.13	0.15	-	-	-
3.5mm (m) Swept	0.04√f	0.04	0.13	0.17	0.21	-	-	-
2.92mm (m) Straight	0.03√f	0.03	0.09	0.13	0.15	0.19	-	-
2.92mm (f) Straight	0.03√f	0.03	0.09	0.13	0.15	0.19	-	-
2.92mm (m) Swept	0.04√f	0.04	0.13	0.17	0.21	0.25	-	-
2.4mm (m) Straight	0.042√f	0.04	0.13	0.18	0.22	0.27	0.3	-
2.4mm (f) Straight	0.042√f	0.04	0.13	0.18	0.22	0.27	0.3	-
1.85mm (m) Straight	0.065√f	0.065	0.206	0.28	0.33	0.41	0.46	0.53
1.85mm (f) 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
1.0mm (f) Straight	0.065√f	0.065	0.206	0.28	0.33	0.41	0.46	0.53

### **Tolerances for Assembly Length**

Tolerance values of 0, 1, 2 and 3 series are shown below. Please contact us if your tolerance requirements for phase matching are more stringent.

Assembly Length [mm]	Tolerance [mm]
L≦1000	±10
1000 <l≦2000< th=""><th>±20</th></l≦2000<>	±20
2000 <l≦5000< td=""><td>±50</td></l≦5000<>	±50
5000 <l< th=""><th>±100</th></l<>	±100

### About Customer-Specified Swept and Right-Angle Connectors



1-11



The angle of Connector II relative to Connector I when

Connector I is assumed to be at 0° (as viewed from the

direction of Connector I ) is indicated by three digits

Example : If Connector II is at an angle of 90° when

viewed from the direction of Connector I : MWX312-01000AMRAMR-090

(The indication is omitted if the angle is 0°.)

following the catalog number.

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# **Technical Data**

Return Loss	<ul> <li>VSWR Conve</li> </ul>	rsion Table	VSWR – Re	9
Return Loss dB	Voltage Standing Wave Ratio VSWR	Reflection Coefficient	Voltage Standing Wave Ratio VSWR	
60	1.002	0.001	1.01	
50	1.006	0.003	1.02	
40	1.020	0.010	1.03	
35	1.036	0.018	1.04	
30	1.065	0.032	1.05	
29	1.074	0.035	1.06	
28	1.083	0.040	1.07	
27	1.094	0.045	1.08	
26	1.106	0.050	1.09	
25	1.119	0.056	1.10	
24	1.135	0.063	1.15	
23	1.152	0.071	1.20	
22	1.173	0.079	1.25	
21	1.196	0.089	1.30	
20	1.222	0.100	1.35	
19	1.253	0.112	1.40	
18	1.288	0.126	1.45	
17	1.329	0.141	1.50	
16	1.377	0.158	1.60	
15	1.433	0.178	1.70	
14	1.499	0.200	1.80	
13	1.577	0.224	1.90	
12	1.671	0.251	2.00	
11	1.785	0.282	3.00	
10	1 9 2 5	0.316	4 00	

### Frequency Band Name and Code

Frequency [GHz] 0.1	Wavelength [cm]	Conventional frequency band (radar)	Current frequency band (ECM)	Frequency [GHz]
0.15 0.2	200 150	VHF	A	- 0.15 - 0.2
0.3 0.4 0.5			В	- 0.3 - 0.4
0.6 0.75 1	50 40 30	UHF	С	- 0.6 - 0.75
1.5	20	L	D	- 1.5
2	10	S	E	
3	75	Ū į	F	
5	6	С	G	- 5
8	375		н	
10		х		- 10
15	2	Ku	J	- 15
20		к		- 20
30		Ka	K	- 30
40 50	0.75		L	- 50
60 75		MILLIMETER	М	- 60
100	0.3			100

## Conversion Table

eflection pefficient	Propagation Loss dB
0.005	0.0001
0.010	0.0004
0.015	0.0010
0.020	0.0017
0.024	0.0025
0.029	0.0037
0.034	0.0050
0.038	0.0063
0.043	0.0080
0.048	0.0100
0.070	0.0213
0.091	0.0361
0.111	0.0538
0.130	0.0740
0.149	0.0975
0.167	0.1228
0.184	0.1496
0.200	0.1773
0.231	0.2382
0.259	0.3016
0.286	0.3706
0.310	0.4388
0.333	0.5104
0.500	1.2494
0.600	1.9382

## db Table

Power Ratio P2/P1	dB Dp	Current Ratio/ Voltage Ratio	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
×З	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

Power : Dp =  $10\log_{10} \frac{P_2}{P}[dB]$ 

Current : Di =  $20\log_{10} \frac{I_2}{I_1}$  [dB]

Voltage :  $Dv = 20 \log_{10} \frac{V_2}{V_2} [dB]$ 

• Power level "dBm" represents the absolute value with respect to the standard 0[dBm] for 1[m/W]. P[mW] is given by 10log10P[dBm].

1. VSWR =  $\frac{1+\rho}{1-\rho} = \frac{1+10^{-\frac{BL}{20}}}{1-10^{-\frac{BL}{20}}}$ 

2. Return Loss RL (dB) =-20logp =-20log VSWR-1 VSWR+1

3. Reflection Coefficient  $\rho = (VSWR-1) /$  $(VSWR+1) = 10^{-\frac{RL}{20}}$ 

4. Propagation Loss  $\alpha$  (dB) = -10log (1- $\rho^2$ )  $=-10\log\left(1-\left(\frac{VSWR-1}{VSWR+1}\right)^{2}\right)$ 

Relationship between frequency and wavelength  $f = \frac{c}{\lambda}$  where c=2.998 × 10<sup>e</sup> [ m/s] Relationship between phase change  $\theta$ [°], frequency f [GHz], cable length L[mm]and propagation delay T[nsec] L=0.8328× $\theta$ ÷ $\sqrt{\epsilon_r}$ ÷f  $\theta = 1.201 \times L \times \sqrt{\epsilon_r} \times f$  $\theta = 360 \times f \times \tau$ where  $\epsilon r$  is the specific dielectric constant of the cable insulator. Air : εr=1, Dense PTFE : εr ≒ 2.1



2 Series Flexible Cable Assemblies for Measuring Instruments

# Flexible Cable Assemblies for Measuring Instruments 2 Series

The 2 series offer flexibility and low repulsion to reduce stress loads to the device umder test objects with excellent phase stability against bending in intensive use of microwave measurement.

Non-Armored Type				
Center Conductor	Dielectric	1st Outer Conductor	2nd Outer Conductor	Sheath
Silver Plated Copper	Low Density PTFE	Silver Plated Copper Tape	Silver Plated Copper Braid	PVC

Armored Type			1				
Center Conductor	Dielectric	1st Outer Conductor	2nd Outer Conductor	Sheath	Armored	Braid	Sheath
Silver Plated Copper	Low Density PTFE	Silver Plated Copper Tape	Silver Plated Copper Braid	PVC	SUS Spiral Tube	SUS Wire	PVC

I	Lightweight Armore	ed Type (for Fixed V	Viring)			A MANA	
	Center Conductor	Dielectric	1st Outer Conductor	2nd Outer Conductor	Sheath	Armored	Sheath
	Silver Plated Copper	Low Density PTFE	Silver Plated Copper Tape	Silver Plated Copper Braid	PVC	SUS Spiral Tube	PVC

#### 2 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.				

# **Power Rating**

The diagram to the right shows the relationship between frequency and power rating. The values are calculated at 25°C and at sea level. The power rating will need to be corrected for different ambient temperatures and altitude. Power ratings may decrease, depending on the connector selected. \* The above figures are measured values for reference only.

# **Flexibility Data**

#### Test cable : 221, 021, 121

Test Condition Temperature : 24°C Test load : 454g Diameter of bar : ¢16mm Test Method A test cable measuring 1,000 mm in length was formed into a circle with an internal diameter of 300mm. Both ends were overlapped andsecured with tape measuring 50 mm in width. The circularly formed test cable was then suspended, with the overlapping end section at the top and a weight positioned at the bottom. Circularity was measured after five seconds. (Circularity is expressed as the ratio a/b.)

### **Test Result**

Test Cable	Sample 1	Sample 2
221	1,887	2,049
021	1,532	1,404
121	1,552	1,564

2-1



()	(
221	

Sample 3

2,011

1,482

1,595

ple 2

<u>1</u>	
021	

1	
Ā	121

Average

1,982

1,473

1,570

2 Se







# 2 Series

# **Placing Orders**



In the case of DMS (3.5mm(m) and AMS (SMA(m), Connector I: AMS, Connector II: DMS

• The order of Connector I and Connector II when the first letter of the Connector Code is the same depends on the alphabetical order of the second and subsequent letters.

In the case of DMS (3.5mm(m) and DFS (3.5mm(f), Connector I: DFS, Connector II: DMS

# Delivery

2 series will be shipped within 10 business days after received order.

\* Leadtime may be effected by larger order volume.



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### **Connector Codes**

Corrector		2 Series												
		Connector		221	221/B	221/A	241/B	241/A	241	251/B	251	261/B	261/A	261
		Туре	Maximum Operating		26.5 GHz			40.0 GHz		50.0	GHz		67.0 GHz	
			Frequency											
SMA	(m)	Right Angle	10.0 GHz											
SMP	(f)	Right Angle	12.0 GHz											
SMP	(f)	Straight	12.0 GHz											
4.3-10	(m)	Straight	12.0 GHz	FMS	FMS	FMS								
TNC	(m)	Straight	15.0 GHz											
N	(m)	Straight	18.0 GHz	NMS	NMS	NMS	NMS	NMS	NMS					
N	(m)	Lightweight	18.0 GHz											
N	(m)	Torque Canceller	18.0 GHz											
N	(m)	Swept	18.0 GHz	NMW										
N	(f)	Straight	18.0 GHz	NFS	NFS	NFS								
SMA	(m)	Right Angle H	18.0 GHz	AMH										
SMA	(m)	Straight	18.5 GHz	AMS	AMS	AMS	AMS	AMS	AMS					
SMA	(m)	Lightweight	18.5 GHz											
SMA	(m)	Torque Canceller	18.5 GHz											
SMA	(m)	Swept	18.5 GHz	AMW										
SMA	(f)	Straight	18.5 GHz											
SSMA	(m)	Straight	18.5 GHz											
3.5 mm	(m)	Straight	26.5 GHz	DMS	DMS	DMS								DMS
3.5 mm	(m)	Torque Canceller	26.5 GHz											
3.5 mm	(m)	Multi-Lock	26.5 GHz											
3.5 mm	(m)	Swept	26.5 GHz	DMW										
3.5 mm	(f)	Straight	26.5 GHz	DFS	DFS	DFS								
3.5 mm	(f)	Torque Canceller	26.5 GHz											
2.92 mm	(m)	Straight	40.0 GHz				KMS	KMS	KMS	KMS	KMS			KMS
2.92 mm	(m)	Swept	40.0 GHz						KMW*					
2.92 mm	(f)	Straight	40.0 GHz				KFS	KFS	KFS	KFS	KFS			
SMPM	(f)	Right Angle	40.0 GHz											
2.4 mm	(m)	Straight	50.0 GHz							LMS	LMS			LMS
2.4 mm	(m)	Swept	50.0 GHz											
2.4 mm	(†)	Straight	50.0 GHz							LFS	LFS			
2.4 mm	(†)	NMD	50.0 GHz									1.4.40		
1.85 mm	(m)	Straight	67.0 GHz									VMS	VMS	VMS
1.85 mm	(m)	Swept	67.0 GHz									1/50		1/50
1.85 mm	(†)	Straight	67.0 GHz									VF5	VFS	VFS
1.85 mm	(†)	NMD	67.0 GHz											
SIMPIN	(†)	Straight	67.0 GHz											
1.85 mm	(m)	Straight	70.0 GHz											
	(1)	Straight	70.0 GHz											
SIMPS	(1)	Straight	100.0 GHz											
1.0 mm	(m)	Safety-Lock	110.0 GHz											
1.0 mm	(1)	Straight	110.0 GHz											
1.0 mm	(m) (A)	Straight	110.0 GHz											
1.0 mm	(1)	Straight Sefetual cele	100.0 GHz											
1.0 mm	(m) ()	Stroight	120.0 GHz											
1.0 mm	(m) (f)	Straight	120.0 GHz											
1.0 mm	(I) (m)	Safaty-Look	120.0 GHz											
1.0 mm	(III) (f)	Straight	130.0 GHz											
0.8 mm	(I) (m)	Safaty-Lock	145.0 GHz											
0.0 mm	(III) (f)	Straight	145.0 GHZ											
0.8 mm	(1)	Straight	145.0 GHz	i										

m : male (plug) f : female (jack)

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• The smallest frequency among the maximum operating frequencies of the connectors and cables to be used is the maximum operating frequency of the assembly • Please inquire separately for products with connector symbols in gray, as they require a longer delivery time.

Please provide a catalog number when placing an order.



# 2 Series Flexible Cable Assemblies for Measuring Instruments

## Features

- Phase Stability: Static Bending
- Cable Flexibility
- Maximum Operating Frequency: 26.5 GHz
- Temperature Range: -30 to 85°C
- Days to Ship: 11 Business Days

\* See P. 2-4 "Connector Codes"

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RoHS Compliant



# Property

Maximum Frequency

sertion Loss (26.5 GHz)

221

Electrical Properties		Mechanical Properties	Standard Type	Armored Type	Lightweight Armored Type (for Fixed Wiring)
Maximum Operating Frequency	26.5 GHz	Cable Outer Diameter	6.0 mm	12.5 mm	11 mm
Characteristic Impedance (Typical)	50±1 Ω	Minimum Bending Radius (Inner Side)	20 mm	20 mm	30 mm
Capacitance (Typical)	88 pF/m	Cable Mass (Typical)	64 g/m	212 g/m	160 g/m
Propagation Delay (Typical)	4.4 ns/m	Continuous Operating Temperature Range	-30~+85 °C	-30~+85 °C	-30~+85 °C
Velocity of Propagation (Typical)	76 %	Armored Side Pressure	-	196 N/cm	196 N/cm
Higher mode frequency (Typical)	27.5 GHz	Assembly Length	200~5,000 mm	700~5,000 mm	500~5,000 mm
VSWR (Typical)	1.33				

### Order Form Example Please provide the following information when placing an order.

1.4 dB/m

Example 1 Example 2 Example 3 **MWX221** MWX221 Armored type MWX221 Lightweight Armored Type Assembly Length: 1000mm Assembly Length: 1500mm Assembly Length: 1000mm Connector I : SMA (m) Straight Connector I : N (m) Straight Connector I : SMA (m) Straight a. Cable Connector II: 3.5mm (m) Straight Connector II : N (m) Straight Connector II: SMA (m) Straight b. Assembly Length Catalog No. Catalog No. Catalog No. MWX221-01500NMSNMS/B MWX221-01000AMSDMS MWX221-01000AMSAMS/A . Connector С d. Armored Option

• We can deliver products with matched phases for customers who require this characteristic.

# **Technical Data**







## Connector

Reference Plane

Mass : 10g

Mass : 38g

Mass : 26g

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\* Please see P.2-13 about "customer-specified swept and right angle



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2 S€

2 Series Flexible Cable Assemblies for Measuring Instruments





- Cable Flexibility
- Maximum Operating Frequency: 40.0 GHz
   RoHS Compliant
- Temperature Range: -30 to 85°C • Days to Ship: 11 Business Days



# Property

VSWR (Typ

2-7

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Maximum frequency

sertion Loss (40.0 GHz)

Electrical Properties		Mechanical Properties	Standard Type	Non-Armored Type Custom-Made	Lightweight Armored Type (for Fixed Wiring)
Maximum Operating Frequency	40.0 GHz	Cable Outer Diameter	9.5 mm	4.1 mm	8 mm
Characteristic Impedance (Typical)	50±1 Ω	Minimum Bending Radius (Inner Side)	20 mm	20 mm	20 mm
Capacitance (Typical)	88 pF/m	Cable Mass (Typical)	137 g/m	35 g/m	98 g/m
Propagation Delay (Typical)	4.35 ns/m	Continuous Operating Temperature Range	-30~+85 °C	-30~+85 °C	-30~+85 °C
Velocity of Propagation (Typical)	77 %	Armored Side Pressure	196 N/cm	-	196N/cm
Higher Mode Frequency (Typical)	40.5 GHz	Assembly Length	700~5,000 mm	200~5,000 mm	500~5,000 mm
VSWR (Typical)	1.43	* Take care when handling the	non-armored type produc	t because its outer diamet	er of the cable is thin.

Order Form Example Please provide the following information when placing an order.

Example 1 MWX241 Armored Type (Standard)	Example 2 MWX241 Non-Armored Type	Example 3 MWX241 Lightweight Armored Type	
Assembly Length: 1000mm Connector I : 2.92mm (m) Straight Connector II : 2.92mm (m) Straight		Assembly Length: 1000mm Connector I : 2.92mm (m) Straight Connector II : 2.92mm (m) Straight	a. Cable b. Assembly
Catalog No. MWX241-01000KMSKMS/B	* The individual specification is required.	Catalog No. MWX241-01000KMSKMS/A	Length c. Connector d. Armored

• We can deliver products with matched phases for customers who require this characteristic. Optio



 $\textbf{Typical Insertion Loss} (0.0095 \times f [GHz] + 0.41 \times \sqrt{f} [GHz] + 0.02) \times L [m] \quad \textbf{Maximum Insertion Loss} (0.0095 \times f [GHz] + 0.41 \times \sqrt{f} [GHz] + 0.02) \times 1.12 \times L [m]$ 



Connector

ÉE





Maximum Operating Frequency : 40.0 GHz / Mass : 10g

Maximum Operating Frequency : 40.0 GHz / Mass : 10g





3.0 dB/m

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Mass : 17g

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\* See P. 2-4 "Connector Codes"







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

\* Swept and right angle are not available to armored type.

\* Please see P.2-13 about "customer-specified swept and right angle connectors". \* []: Non-armored type size.









Electrical Properties				
Maximum Operating Frequency	50.0 GHz			
Characteristic Impedance (Typical)	50±1 Ω			
Capacitance (Typical)	88 pF/m			
Propagation Delay (Typical)	4.36 ns/m			
Velocity of Propagation (Typical)	77 %			
Higher Mode Frequency (Typical)	50.3 GHz			
VSWR (Typical)	1.43			
Maximum Frequency Insertion Loss (50.0 GHz)	3.8 dB/m			

Mechanical Properties	Standard Type	Non-Armored Type Custom-Made			
Cable Outer Diameter	9.5 mm	3.7 mm			
Minimum Bending Radius (Inner Side)	20 mm	6 mm			
Cable Mass (Typical)	129 g/m	29 g/m			
Continuous Operating Temperature Range	-30~+85 °C	-30~+85 °C			
Armored Side Pressure	196 N/cm	-			
Assembly Length	700~1,500 mm	200~1,500 mm			
* Take care when handling the non-armored type product because its outer diameter of the cable is thin.					

# Order Form Example Please provide the following information when placing an order.

Example 1 MWX251 Armored Type (Standard)	Example 2 MWX251 Non-Armored Type	* See P. 2-4 "Connector Codes"
Assembly Length: 1000mm Connector I : 2.4mm (m) Straight Connector II : 2.4mm (m) Straight		a. Cable
Catalog No. MWX251-01000LMSLMS/B	* The individual specification is required.	<ul><li>b. Assembly Length</li><li>c. Connector</li><li>d. Armored type</li></ul>

Option

# 2.0 3.0

**Technical Data** 

10

Cable Typical Insertion Loss

#### 4.0 50 - 0.7m 1 m 6.0 1.5m 7.0 L 10 20 Frequency [GHz]



# Connector



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

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 $\textbf{Typical Insertion Loss} (0.0095 \times f[\text{GHz}] + 0.47 \times \sqrt{f[\text{GHz}]} + 0.02) \times L[\text{m}] \quad \textbf{Maximum Insertion Loss} (0.0095 \times f[\text{GHz}] + 0.47 \times \sqrt{f[\text{GHz}]} + 0.02) \times 1.12 \times L[\text{m}]$ 

2.92mm (m) Straight (Code : KMS)



Maximum Operating Frequency : 40.0 GHz / Mass : 13g

2.92mm (f) Straight (Code : KFS)



Maximum Operating Frequency : 40.0 GHz / Mass : 13g

\* []: Non-armored type size.





# 2 Series Flexible Cable Assemblies for Measuring Instruments Features 261 Phase Stability: Static Bending • Temperature Range: -30 to 85°C Cable Flexibility • Days to Ship: 11 Business Days Maximum Operating Frequency: 67.0 GHz RoHS Compliant

# Property

Electrical Properties					
Maximum Operating Frequency	67.0 GHz				
Characteristic Impedance (Typical)	50±1 Ω				
Capacitance (Typical)	90 pF/m				
Propagation Delay (Typical)	4.38 ns/m				
Velocity of Propagation (Typical)	76 %				
Higher Mode Frequency (Typical)	67.0 GHz				
VSWR (Typical)	1.43				
Maximum Frequency Insertion Loss (67.0 GHz)	5.6 dB/m				

Mechanical Properties	Standard Type	Non-Armored Type Custom-Made			
Cable Outer Diameter	7.7 mm	2.6 mm			
Minimum Bending Radius (Inner Side)	20 mm	6 mm			
Cable Mass (Typical)	90 g/m	17 g/m			
Continuous Operating Temperature Range	-30~+85 °C	-30~+85 °C			
Armored Side Pressure	196 N/cm	-			
Assembly Length	700~1,500 mm	200~1,500 mm			
* Take care when handling the non-armored type product because its outer diameter					

of the cable is thin.

# Order Form Example Please provide the following information when placing an order.

Example 1 MWX261 Armored Type (Standard)	Example 2 MWX261 Non-Armored Type	* See P. 2-4 "Connector Codes"
Assembly Length: 1000mm Connector I:1.85 mm (m) Straight Connector II:1.85 mm (m) Straight		a. Cable
Catalog No. MWX261-01000VMSVMS/B	* The individual specification is required.	<ul><li>b. Assembly Length</li><li>c. Connector</li><li>d. Armored type</li></ul>

Optio

# **Technical Data**



 $\textbf{Typical Insertion Loss} (0.0095 \times \text{f} [\text{GHz}] + 0.6148 \times \sqrt{\text{f} [\text{GHz}] + 0.02}) \times \text{L} [\text{m}] \quad \textbf{Maximum Insertion Loss} (0.0095 \times \text{f} [\text{GHz}] + 0.6148 \times \sqrt{\text{f} [\text{GHz}] + 0.02}) \times 1.12 \times \text{L} [\text{m}]$ 



# Connector



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

• We can deliver products with matched phases for customers who require this characteristic.

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\* []: Non-armored type size.





# Series Common Properties

### Connector Insertion Loss [dB/connector]

Connector Type	Connector	Frequency [GHz]						
	Insertion Loss	1.0 GHz	10.0 GHz	18.5 GHz	26.5 GHz	40.0 GHz	50.0 GHz	67.0 GHz
SSMA (m) Straight	0.03√f	0.03	0.09	0.13	-	-	-	-
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	-	-	-	-
SMA (m) Swept	0.04√f	0.04	0.13	0.17	-	-	-	-
TNC (m) Straight	0.07√f	0.07	0.22	0.3	-	-	-	-
N (m) Straight	0.05√f	0.05	0.16	0.22	-	-	-	-
N (f) Straight	0.05√f	0.05	0.16	0.22	-	-	-	-
N (m) Swept	0.06√f	0.06	0.19	0.26	-	-	-	-
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
3.5mm (m) Straight	0.03√f	0.03	0.09	0.13	0.15	-	-	-
3.5mm (f) Straight	0.03√f	0.03	0.09	0.13	0.15	-	-	-
3.5mm (m) Swept	0.04√f	0.04	0.13	0.17	0.21	-	-	-
2.92mm (m) Straight	0.03√f	0.03	0.09	0.13	0.15	0.19	-	-
2.92mm (f) Straight	0.03√f	0.03	0.09	0.13	0.15	0.19	-	-
2.92mm (m) Swept	0.04√f	0.04	0.13	0.17	0.21	0.25	-	-
2.4mm (m) Straight	0.042√f	0.04	0.13	0.18	0.22	0.27	0.3	-
2.4mm (f) Straight	0.042√f	0.04	0.13	0.18	0.22	0.27	0.3	-
1.85mm (m) Straight	0.065√f	0.065	0.206	0.28	0.33	0.41	0.46	0.53
1.85mm (f) 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
1.0mm (f) Straight	0.065√f	0.065	0.206	0.28	0.33	0.41	0.46	0.53

#### **Tolerances for Assembly Length**

Tolerance values of 0, 1, 2 and 3 series are shown below. Please contact us if your tolerance requirements for phase matching are more stringent.

Assembly Length [mm]	Tolerance [mm]
L≦1000	±10
1000 <l≦2000< td=""><td>±20</td></l≦2000<>	±20
2000 <l≦5000< td=""><td>±50</td></l≦5000<>	±50
5000 <l< th=""><th>±100</th></l<>	±100

### About Customer-Specified Swept and Right-Angle Connectors



2-13

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The angle of Connector II relative to Connector I when

# **Technical Data**

Return Loss	<ul> <li>VSWR Conve</li> </ul>	rsion Table	VSWR – Re	eturn Loss	Convers	ion Table
Return Loss dB	Voltage Standing Wave Ratio VSWR	Reflection Coefficient	Voltage Standing Wave Ratio VSWR	Return Loss dB	Reflection Coefficient	Propagation Loss dB
60	1.002	0.001	1.01	46.1	0.005	0.0001
50	1.006	0.003	1.02	40.1	0.010	0.0004
40	1.020	0.010	1.03	36.6	0.015	0.0010
35	1.036	0.018	1.04	34.2	0.020	0.0017
30	1.065	0.032	1.05	32.3	0.024	0.0025
29	1.074	0.035	1.06	30.7	0.029	0.0037
28	1.083	0.040	1.07	29.4	0.034	0.0050
27	1.094	0.045	1.08	28.3	0.038	0.0063
26	1.106	0.050	1.09	27.3	0.043	0.0080
25	1.119	0.056	1.10	26.4	0.048	0.0100
24	1.135	0.063	1.15	23.1	0.070	0.0213
23	1.152	0.071	1.20	20.8	0.091	0.0361
22	1.173	0.079	1.25	19.1	0.111	0.0538
21	1.196	0.089	1.30	17.7	0.130	0.0740
20	1.222	0.100	1.35	16.5	0.149	0.0975
19	1.253	0.112	1.40	15.6	0.167	0.1228
18	1.288	0.126	1.45	14.7	0.184	0.1496
17	1.329	0.141	1.50	14.0	0.200	0.1773
16	1.377	0.158	1.60	12.7	0.231	0.2382
15	1.433	0.178	1.70	11.7	0.259	0.3016
14	1.499	0.200	1.80	10.9	0.286	0.3706
13	1.577	0.224	1.90	10.2	0.310	0.4388
12	1.671	0.251	2.00	9.5	0.333	0.5104
11	1.785	0.282	3.00	6.0	0.500	1.2494
10	1.925	0.316	4.00	4.4	0.600	1.9382

### Frequency Band Name and Code

ioquoi	bana nama			
Frequency [GHz]	Wavelength [cm]	Conventional frequency band (radar)	Current frequency band (ECM)	Frequency [GHz]
0.15 0.2	200	VHF	A	- 0.15 - 0.2
0.3 · 0.4 ·			В	- 0.3 - 0.4
0.6 0.75	50 40	UHF	с	- 0.6 - 0.75
1 · · · · · · · · · · · · · · · · · · ·		L	D	— 1 — 1.5
2 ·		6	E	2
3 ·		5	F	3
5	6	С	G	- 5
0 .	0.75		Н	
10 .	3.75	х		10
15	2	Ku	J	- 15
20	1.5	K		20
30 ·	1	Ka	K	- 30
40 · 50 ·	0.75		L	40 - 50
60 75	0.50.4	MILLIMETER	М	- 75
100 -	0.3		1	

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# db Table

Power Ratio P2/P1	dB Dp	Current Ratio/ Voltage Ratio	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
×З	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

Power : Dp =  $10\log_{10} \frac{P_2}{P}[dB]$ 

Current : Di =20log<sup>10</sup> |\_[dB]

Voltage :  $Dv = 20 \log_{10} \frac{V_2}{V_2} [dB]$ 

• Power level "dBm" represents the absolute value with respect to the standard 0[dBm] for 1[m/W]. P[mW] is given by 10log10P[dBm].

1. VSWR =  $\frac{1+\rho}{1-\rho} = \frac{1+10^{-\frac{BL}{20}}}{1-10^{-\frac{BL}{20}}}$ 

2. Return Loss RL (dB) =-20logp =-20log VSWR-1 VSWR+1

3. Reflection Coefficient  $\rho = (VSWR-1) /$  $(VSWR+1) = 10^{-\frac{RL}{20}}$ 

4. Propagation Loss  $\alpha$  (dB) = -10log (1- $\rho^2$ )  $=-10\log\left(1-\left(\frac{VSWR-1}{VSWR+1}\right)^{2}\right)$ 

Relationship between frequency and wavelength  $f = \frac{c}{\lambda}$  where c=2.998 × 10<sup>s</sup> [m/s] Relationship between phase change  $\theta$ [°], frequency f [GHz], cable length L[mm]and propagation delay T[nsec] L=0.8328× $\theta$ ÷ $\sqrt{\epsilon_r}$ ÷f  $\theta = 1.201 \times L \times \sqrt{\epsilon_r} \times f$  $\theta = 360 \times f \times \tau$ where  $\epsilon r$  is the specific dielectric constant of the cable insulator. Air : εr=1, Dense PTFE : εr ≒ 2.1







# 3 Series Cable Assemblies for Equipment Wiring

The 3 series cable assemblies use a Low Density PTFE dielectric material to ensure excellent phase stability against temperature fluctuations. (Continuous operating temperature range : -65 °C to 125 °C (-30 °C to 85 °C for 315))

Non-Armored Type				
Center Conductor	Dielectric	1st Outer Conductor	2nd Outer Conductor	Sheath
Silver Plated Copper	Low Density PTFE	Silver Plated Copper Tape	Silver Plated Copper Braid	Fluoropolymer (PVC for MWX315)

Armored type									
Center Conductor	Dielectric	1st Outer Conductor	2nd Outer Conductor	Sheath	Armored	Braid	Sheath		
Silver Plated Copper	Low Density PTFE	Silver Plated Copper Tape	Silver Plated Copper Braid	Fluoropolymer (PVC for 315)	SUS Spiral Tube	SUS Wire	PVC		

Lightweight Armore	ed Type (for Fixed V	Viring)		MINIMINI	and the file of th	
Center Conductor	Dielectric	1st Outer Conductor	2nd Outer Conductor	Sheath	Armored	Sheath
Silver Plated Copper	Low Density PTFE	Silver Plated Copper Tape	Silver Plated Copper Braid	Fluoropolymer (PVC for 315)	SUS Spiral Tube	PVC

#### 3 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.						

# **Power Rating**

The diagram to the right shows the relationship between frequency and power rating.

The values are calculated at 25 °C and at sea level.

The power rating will need to be corrected for different ambient temperatures and altitude.

Power ratings may decrease, depending on the connector selected.

 $^{\star}$  The above figures are measured values for reference only.

#### Power Rating of 3 Series at Sea Level



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# Bending Test Data of 312 (Camparison)

### Test Method

The connector on one end of test cable (MWX312-00500AMSAMS, measuring 500 mm in length and with SMA (m) connectors on both ends) was fixed in place. The connector on the other end was moved in the sequence  $a \rightarrow b \rightarrow c$ , after which initial insertion loss and return loss values were compared to those after the test.

### MWX312-00500AMSAMS



# 3-1







3 Series







# **3** Series

# **Placing Orders**



Connector II : 2.92mm (m) Straight

Armored : Light Weight Armored Type

• The order of Connector I and Connector II is determined by the alphabetical order of the first letter of the Connector Code. In the case of DMS (3.5mm(m) and AMS (SMA(m), Connector I: AMS, Connector II: DMS

• The order of Connector I and Connector II when the first letter of the Connector Code is the same depends on the alphabetical order of the second and subsequent letters.

In the case of DMS (3.5mm(m) and DFS (3.5mm(f), Connector I: DFS, Connector II: DMS

### **Connector Codes**

Connector		3 Series														
			311	312	313	314	315	315/A	321	322	322/B	322/A	341	342	342/B	342/A
	Туре	Maximum Operating Frequency	18.5 GHz	18.5 GHz	18.5 GHz	18.5 GHz	18.0	) GHz	26.5 GHz		26.5 GH	Z		40.0 GH	Z	40.0 GHz
SMA	(m) Right Angle	10.0 GHz	AMR	AMR	AMR				AMR							
TNC	(m) Straight	15.0 GHz		CMS	CMS	CMS	CMS		CMS	CMS	CMS	CMS				
Ν	(m) Straight	18.0 GHz		NMS*	NMS*	NMS*	NMS	NMS	NMS	NMS	NMS	NMS				
Ν	(m) Lightweight	18.0 GHz					NMS1	NMS1								
N	(m) Swept	18.0 GHz								NMW						
Ν	(f) Straight	18.0 GHz								NFS	NFS	NFS				
SMA	(m) Right Angle H	18.0 GHz		AMH						AMH						
SMA	(m) Straight	18.5 GHz	AMS	AMS	AMS	AMS	AMS	AMS	AMS	AMS	AMS	AMS	AMS*			
SMA	(m) Lightweight	18.5 GHz					AMS	AMS								
SMA	(m) Swept	18.5 GHz								AMW						
SMA	(f) Straight	18.5 GHz	AFS	AFS	AFS				AFS							
SSMA	(m) Straight	18.5 GHz	SMS						AFS							
3.5 mm	(m) Straight	26.5 GHz			DMS				DMS	DMS	DMS	DMS				
3.5 mm	(m) Swept	26.5 GHz								DMW						
3.5 mm	(f) Straight	26.5 GHz								DFS	DFS	DFS				
2.92 mm	(m) Straight	40.0 GHz												KMS	KMS	KMS
2.92 mm	(f) Straight	40.0 GHz												KFS	KFS	KFS
2.4 mm	(m) Straight	50.0 GHz												LMS	LMS	LMS
2.4 mm	(f) Straight	50.0 GHz												LFS	LFS	LFS

• The smallest frequency among the maximum operating frequencies of the connectors and cables to be used is the maximum operating frequency of the assembly. · Please inquire separately for products with connector symbols in gray, as they require a longer delivery time.

• The maximum operating frequency of the 312, 313, and 314 N(m) Straight connectors is 18.5 GHz.

• The SMA(m) connector on the 341 supports 40.0 GHz.

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

• For products with Connector Code in gray, please inquire separately as it takes time for delivery.

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#### **Electrical Properties**

Maximum Operating Frequency	18.5 GHz
Characteristic Impedance (Typical)	50±1 Ω
Capacitance (Typical)	86 pF/m
Propagation Delay (Typical)	4.25 ns/m
Velocity of Propagation (Typical)	79 %
Higher Mode Frequency (Typical)	75.0 GHz
VSWR (Typical)	1.40
Maximum Frequency Insertion Loss (18.5 GHz)	3.4 dB∕m

#### **Mechanical Properties**

Cable Outer Diameter	2.7 mm
Minimum Bending Radius (Inner Side)	10 mm
Maximum Tensile Strength	29.4 N (3kgf)
Cable Mass (Typical)	18.5 g/m
Continuous Operating Temperature Range	-65~+125 °C
Assembly Length	100~10,000 mm

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# Order Form Example Please provide the following information when placing an order.

Example 1 MWX311	Example 2 MWX311	* See P. 3-4 "Connector Codes"
Assembly Length: 1000mm Connector I:SMA (m) Straight Connector II:SMA (m) Straight	Assembly Length: 1500 mm Connector I:SMA (f) Straight Connector II:SMA (m) Right Angle	
Catalog No. MWX311-01000AMSAMS	Catalog No. MWX311-01500AFSAMR	a. Cable b. Assembly Length c. Connector

Option • We can deliver products with matched phases for customers who require this characteristic.

# Technical Data



 $\textbf{Typical Insertion Loss } 1.55 \times (0.0297 \times f[\text{GHz}] + 0.371 \times \sqrt{f[\text{GHz}] + 0.07}) \times L[\text{m}] \textbf{Maximum Insertion Loss } 1.55 \times (0.0297 \times f[\text{GHz}] + 0.371 \times \sqrt{f[\text{GHz}] + 0.07}) \times 1.12 \times L[\text{m}]$ 



-40 °C, 1 hour after the temperature changed.

## Connector



\* Please see P.3-23 about "customer-specified swept and right angle connectors".

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

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SMA (m) Right Angle (Code : AMR)



Maximum Operating Frequency : 10.0 GHz / Mass : 5g





Maximum Operating Frequency : 18.5 GHz /	
Mass : 3g	







#### **Electrical Properties**

Maximum Operating Frequency	18.5 GHz
Characteristic Impedance (Typical)	50±1 Ω
Capacitance (Typical)	82 pF/m
Propagation Delay (Typical)	4.10 ns/m
Velocity of Propagation (Typical)	81 %
Higher Mode Frequency (Typical)	44.0 GHz
VSWR (Typical)	1.40
Maximum Frequency Insertion Loss (18.5 GHz)	2.2 dB/m

#### **Mechanical Properties**

Cable Outer Diameter	4.1 mm
Minimum Bending Radius (Inner Side)	20 mm
Maximum Tensile Strength	98 N (10 kgf)
Cable Mass (Typical)	42 g/m
Continuous Operating Temperature Range	-65~+125 °C
Assembly Length	100~20,000 mm

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# Order Form Example Please provide the following information when placing an order.







 $\textbf{Typical Insertion Loss} (0.0297 \times f [GHz] + 0.371 \times \sqrt{f} [GHz] + 0.07) \times L [m] \quad \textbf{Maximum Insertion Loss} (0.0297 \times f [GHz] + 0.371 \times \sqrt{f} [GHz] + 0.07) \times 1.12 \times L [m]$ 



**Technical Data** 

-40 °C, 1 hour after the temperature changed.

# Connector



\* Please see P.3-23 about "customer-specified swept and right angle connectors".

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

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#### 3-7

SMA (m) Right Angle (Code : AMR)



Maximum Operating Frequency : 10.0 GHz / Mass : 5g





Maximum Operating Frequency : 18.0 GHz / Mass : 12g







# 3 Series Cable Assemblies for Equipment Wiring

313

- Features
  - Phase Stability: Temperature Change
  - Maximum Operating Frequency: 18.5 GHz
  - Temperature Range: -65 to 125°C
- Equipment Wiring • Days to Ship: 11 Business Days RoHS Compliant



# Property

#### **Electrical Properties**

Maximum Operating Frequency	18.5 GHz
Characteristic Impedance (Typical)	50±1 Ω
Capacitance (Typical)	80 pF/m
Propagation Delay (Typical)	4.05 ns∕m
Velocity of Propagation (Typical)	82 %
Higher Mode Frequency (Typical)	37 GHz
VSWR (Typical)	1.40
Maximum Frequency Insertion Loss (18.5 GHz)	1.9 dB/m

#### **Mechanical Properties**

Cable Outer Diameter	4.7 mm
Minimum Bending Radius (Inner Side)	30 mm
Maximum Tensile Strength	98 N (10 kgf)
Cable Mass (Typical)	52 g/m
Continuous Operating Temperature Range	-65~+125 ℃
Assembly Length	100~20,000 mm

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## Order Form Example Please provide the following information when placing an order.

Example 1 MWX313	Example 2 MWX313	* See P. 3-4 "Connector Codes"
Assembly Length: 1000 mm Connector I : SMA (m) Straight Connector II : SMA (m) Straight	Assembly Length: 1500 mm Connector I:SMA (f) Straight Connector II:SMA (m) Right Angle	
Catalog No. MWX313-01000AMSAMS	Catalog No. MWX313-01500AFSAMR	a. Cable b. Assembly Length c. Connector

• We can deliver products with matched phases for customers who require this characteristic. Opt

# **Technical Data** Cable Typical Insertion Loss 2. 4. 8. 100 1 1 1 12.0



— 5m

14.0

The cable was measured in chamber every 20 °C from -40 °C, 1 hour after the temperature changed.

# Connector



\* Please see P.3-23 about "customer-specified swept and right angle connectors".

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

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 $\textbf{Typical Insertion Loss } 0.88 \times (0.0297 \times f[\text{GHz}] + 0.371 \times \sqrt{f[\text{GHz}] + 0.07}) \times L[\text{m}] \quad \textbf{Maximum Insertion Loss } 0.88 \times (0.0297 \times f[\text{GHz}] + 0.371 \times \sqrt{f[\text{GHz}] + 0.07}) \times 1.12 \times L[\text{m}]$ 

SMA (m) Right Angle (Code : AMR)



Maximum Operating Frequency : 10.0 GHz / Mass : 5g

# N (m) Straight (Code : NMS)



Maximum Operating Frequency : 18.5 GHz / Mass : 39g





# 3 Series Cable Assemblies for Equipment Wiring Features • Phase Stability: Temperature Change 314 Maximum Operating Frequency: 18.5 GHz • Temperature Range: -65 to 125°C Equipment Wiring • Days to Ship: 11 Business Days RoHS Compliant

# Property

#### **Electrical Properties**

Maximum Operating Frequency	18.5 GHz
Characteristic Impedance (Typical)	50±1Ω
Capacitance (Typical)	78 pF∕m
Propagation Delay (Typical)	3.95 ns/m
Velocity of Propagation (Typical)	84 %
Higher Mode Frequency (Typical)	19.0 GHz
VSWR (Typical)	1.40
Maximum Frequency Insertion Loss (18.5 GHz)	0.8 dB/m

### **Mechanical Properties**

Cable Outer Diameter	7.7 mm
Minimum Bending Radius (Inner Side)	40 mm
Maximum Tensile Strength	294 N (30 kgf)
Cable Mass (Typical)	125 g/m
Continuous Operating Temperature Range	-65~+125 °C
Assembly Length	200~20,000 mm

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# **Technical Data**





-40 °C, 1 hour after the temperature changed.

# Connector



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

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# Order Form Example Please provide the following information when placing an order.

Assembly Length: 1000 mm       Assembly Length: 1500mm         Connector I : SMA (m) Straight       Connector I : N (m) Straight         Connector II : SMA (m) Straight       Connector II : N (m) Straight         Catalog No.       Catalog No.         MWX314-01000AMSAMS       Catalog No.         a       b         c       c         a       b         c       c	Example 1 MWX314	Example 2 MWX314	* See P. 3-4 "Connector Codes"
Catalog No. MWX314-01000AMSAMS bc Catalog No. MWX314-01500NMSNMS bc A. Cable b. Assembly Length c. Connector	Assembly Length: 1000 mm Connector I : SMA (m) Straight Connector II : SMA (m) Straight	Assembly Length: 1500mm Connector I : N (m) Straight Connector II : N (m) Straight	
	Catalog No. MWX314-01000AMSAMS	Catalog No. MWX314-01500NMSNMS	a. Cable b. Assembly Length c. Connector

• We can deliver products with matched phases for customers who require this characteristic.

 $\textbf{Typical Insertion Loss } 0.36 \times (0.0297 \times f[\text{GHz}] + 0.371 \times \sqrt{f[\text{GHz}] + 0.07)} \times L[\text{m}] \quad \textbf{Maximum Insertion Loss } 0.36 \times (0.0297 \times f[\text{GHz}] + 0.371 \times \sqrt{f[\text{GHz}] + 0.07)} \times 1.12 \times L[\text{m}]$ 

TNC (m) Straight (Code : CMS)



Maximum Operating Frequency : 18.5 GHz / Mass : 42g







Electrical Properties		Mechanical Properties	Standard Type	Lightweight Armored Type (for Fixed Wiring)
Maximum Operating Frequency	18.0 GHz	Cable Outer Diameter	8.6 mm	17 mm
Characteristic Impedance (Typical)	50±1 Ω	Minimum Bending Radius (Inner Side)	30 mm	40 mm
Capacitance (Typical)	88 pF/m	Cable Mass (Typical)	155 g/m	313 g/m
Propagation Delay (Typical)	4.3 ns/m	Continuous Operating Temperature Range	-30~+85 °C	-30~+85 °C
Velocity of Propagation (Typical)	77 %	Armored Side Pressure	-	196 N/cm
Higher Mode Frequency (Typical)	18.5 GHz	Assembly Length	500~5,000 mm	500~5,000 mm
VSWR (Typical)	1.40			
Maximum Frequency Insertion Loss (18.0 GHz)	0.76 dB/m			

## Order Form Example Please provide the following information when placing an order.

Example 1 MWX315	Example 2 MWX315 Lightweight Armored Type	* See P. 3-4 "Connector Codes"
Assembly Length: 1000mm Connector I : SMA (m) Straight Connector II : SMA (m) Straight	Assembly Length: 1000mm Connector I:SMA (m) Straight Connector II:SMA (m) Straight	a. Cable
Catalog No. MWX315-01000AMSAMS	Catalog No. MWX315-01000AMSAMS/A	<ul><li>b. Assembly Length</li><li>c. Connector</li><li>d. Armored type</li></ul>

• We can deliver products with matched phases for customers who require this characteristic. Optio





#### $\textbf{Typical Insertion Loss } 0.35 \times (0.0297 \times f + 0.371 \times \sqrt{f} + 0.07) \times L \ [m] \quad \textbf{Maximum Insertion Loss } 0.35 \times (0.0297 \times f + 0.371 \times \sqrt{f} + 0.07) \times L \ [m] \times 1.12 \times$



-40 °C, 1 hour after the temperature changed.

# Connector



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



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#### N (m) Straight (Code : NMS)



Maximum Operating Frequency : 18.0 GHz / Mass : 61g

Lightweight TypeN (m) Straight (Code : NMS1)



Maximum Operating Frequency : 18.0 GHz / Mass : 50g

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#### **Electrical Properties**

Maximum Operating Frequency	26.5 GHz
Characteristic Impedance (Typical)	50±1Ω
Capacitance (Typical)	80 pF/m
Propagation Delay (Typical)	4.05 ns∕m
Velocity of Propagation (Typical)	82 %
Higher Mode Frequency (Typical)	37.0 GHz
VSWR (Typical)	1.44
Maximum Frequency Insertion loss (26.5 GHz)	2.4 dB/m

#### **Mechanical Properties**

Cable Outer Diameter	4.7 mm
Minimum Bending Radius (Inner Side)	30 mm
Maximum Tensile Strength	98 N (10 kgf)
Cable Mass (Typical)	52 g/m
Continuous Operating Temperature Range	-65~+125 ℃
Assembly Length	100~20,000 mm

# **Technical Data**





-40 °C, 1 hour after the temperature changed.

# Connector



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

# Order Form Example Please provide the following information when placing an order.

MWX321	MWX321	* See P. 3-4 "Connector Codes"
Assembly Length: 1100 mm Connector I : SMA (m) Straight Connector II : SMA (m) Straight	Assembly Length: 1500mm Connector I:SMA (m) Straight Connector II:3.5mm (m) Straight	
Catalog No. MWX321-01100AMSAMS	Catalog No. MWX321-01500AMSDMS	a. Cable b. Assembly Length c. Connector

• We can deliver products with matched phases for customers who require this characteristic. Opti



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rellpower.com rellpower@rell.com  $\textbf{Typical Insertion Loss } 0.88 \times (0.0297 \times f[\text{GHz}] + 0.371 \times \sqrt{f[\text{GHz}] + 0.07}) \times L[\text{m}] \quad \textbf{Maximum Insertion Loss } 0.88 \times (0.0297 \times f[\text{GHz}] + 0.371 \times \sqrt{f[\text{GHz}] + 0.07}) \times 1.12 \times L[\text{m}]$ 











Electrical Properties		Mechanical Properties	Standard Type	Armored Type	Lightweight Armored Type (for Fixed Wiring)
Maximum Operating Frequency	26.5 GHz	Cable Outer Diameter	5.2 mm	12.5 mm	11.0 mm
Characteristic Impedance (Typical)	50±1 Ω	Minimum Bending Radius (Inner Side)	25 mm	25 mm	25 mm
Capacitance (Typical)	88 pF/m	Maximum Tensile Strength	98 N (10 kgf)	98 N (10 kgf)	98 N (10kgf)
Propagation Delay (Typical)	4.38 ns/m	Cable Mass (Typical)	60 g/m	208 g/m	155 g/m
Velocity of Propagation (Typical)	76 %	Continuous Operating Temperature Range	-65~+125 °C	-30~+85 °C	-30~+85 °C
Higher Mode Frequency (Typical)	27.5 GHz	Armored Side Pressure	-	196 N/cm	196 N/cm
VSWR (Typical)	1.33	Assembly Length	200~20,000 mm	700~5,000 mm	500~20,000 mm
Maximum Frequency	1.3 dB/m				

## Order Form Example Please provide the following information when placing an order.

Example 1 MWX322	Example 2 MWX322 Armored Type	Example 3 MWX322 Lightweight Armored Type	
Assembly Length: 1000 mm Connector I : SMA (m) Straight Connector II : N (m) Straight	Assembly Length: 1000 mm Connector I : 3.5mm (f) Straight Connector II : 3.5mm (m) Straight	Assembly Length: 1000mm Connector I : SMA (m) Straight Connector II : SMA (m) Straight	a. Cable b. Assembly
Catalog No. MWX322-01000AMSNMS	Catalog No. MWX322-01000DFSDMS/B	Catalog No. MWX321-01000AMSAMS/A	Length c. Connector d. Armored

• We can deliver products with matched phases for customers who require this characteristic.



## $\textbf{Typical Insertion Loss} (0.214 \times \sqrt{f} [\text{GHz}] + 0.007 \times f [\text{GHz}] + 0.01) \times L [\text{m}] \quad \textbf{Maximum Insertion Loss} (0.214 \times \sqrt{f} [\text{GHz}] + 0.007 \times f [\text{GHz}] + 0.01) \times 1.12 \times L [\text{m}] = 0.007 \times f [\text{GHz}] + 0.007 \times$



**Technical Data** 

The cable was measured in chamber every 20 °C from -40 °C, 1 hour after the temperature changed.

# Connector



3.5mm (f) Straight (Code : DFS)



Maximum Operating Frequency : 26.5 GHz / Mass : 10g

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sertion Loss (26.5 GHz)

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\* See P. 3-4 "Connector Codes"



Maximum Operating Frequency : 26.5 GHz / Mass : 18g

# N (f) Straight (Code : NFS)



Maximum Operating Frequency : 18.0 GHz / Mass : 26g

# 3.5mm (m) Straight (Code : DMS)



\* Please see P.3-23 about "customer-specified swept and right angle connectors". \* []: Armored type size.

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





## 3 Series Cable Assemblies for Equipment Wiring

341

- Features
- Phase Stability: Temperature Change
- Maximum Operating Frequency: 40.0 GHz
- Temperature Range: -65 to 125°C
- Equnipment Wiring Days to Ship: 11 Business Days RoHS Compliant



# Property

#### **Electrical Properties**

Maximum Operating Frequency	40.0 GHz
Characteristic Impedance (Typical)	50±1 Ω
Capacitance (Typical)	80 pF/m
Propagation Delay (Typical)	4.05 ns/m
Velocity of Propagation (Typical)	82 %
Higher Mode Frequency (Typical)	46.0 GHz
VSWR (Typical)	1.44
Maximum Frequency Insertion Loss (40.0 GHz)	3.3 dB/m

#### **Mechanical Properties**

Cable Outer Diameter	4.0 mm
Minimum Bending Radius (Inner Side)	20 mm
Maximum Tensile Strength	98 N (10 kgf)
Cable Mass (Typical)	40 g/m
Continuous Operating Temperature Range	-65~+125 °C
Assembly Length	100~10,000 mm

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# **Technical Data**





The cable was measured in chamber every 20 °C from -40 °C, 1 hour after the temperature changed.

# Connector

#### SMA (m) Straight (Code : AMS)



Maximum Operating Frequency : 40.0 GHz / Mass : 3g

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

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# Order Form Example Please provide the following information when placing an order.

MWX341
Assembly Length: 1200 mm Connector   : SMA (m) Straight
Connector II : SMA (m) Straight
Catalog No. a. Cable
MWX341-01200AMSAMS b. Assembly Length
a b c c. Connector

• We can deliver products with matched phases for customers who require this characteristic.

 $\textbf{Typical Insertion Loss } 1.04 \times (0.0297 \times f[\text{GHz}] + 0.371 \times \sqrt{f[\text{GHz}] + 0.07)} \times L[\text{m}] \quad \textbf{Maximum Insertion Loss } 1.04 \times (0.0297 \times f[\text{GHz}] + 0.371 \times \sqrt{f[\text{GHz}] + 0.07)} \times 1.12 \times L[\text{m}]$ 





# 3 Series Cable Assemblies for Equipment Wiring Features Phase Stability: Temperature Change 342 Maximum Operating Frequency: 40.0 GHz • Temperature Range: -65 to 125°C Equnipment Wiring • Days to Ship: 11 Business Days RoHS Compliant Low Insertion Loss

# Property

Electrical Properties		Mechanical Properties	Standard Type	Armored Type	Lightweight Armored Type (for Fixed Wiring)
Maximum Operating Frequency	40.0 GHz	Cable Outer Diameter	3.9 mm	9.5 mm	8.0 mm
Characteristic Impedance (Typical)	50±1 Ω	Minimum Bending Radius (Inner Side)	20 mm	20 mm	20 mm
Capacitance (Typical)	87 pF/m	Maximum Tensile Strength	98 N (10 kgf)	98 N (10 kgf)	98 N (10kgf)
Propagation Delay (Typical)	4.35 ns/m	Cable Mass (Typical)	35 g/m	137 g/m	98 g/m
Velocity of Propagation (Typical)	76 %	Continuous Operating Temperature Range	-65~+125 °C	-30~+85 °C	-30~+85 °C
Higher Mode Frequency (Typical)	40.5 GHz	Armored Side Pressure	-	196 N/cm	196 N/cm
VSWR (Typical)	1.43	Assembly Length	200~10,000 mm	700~10,000 mm	500~10,000 mm
Maximum Frequency	2.4 dB/m				

Order Form Example Please provide the following information when placing an order.

Example 1	Example 2	Example 3	
VWX342	MWX342 Armored type	MWX342 Lightweight Armored type	
Assembly Length: 1000 mm	Assembly Length: 1000mm	Assembly Length: 1000mm	a. Cable
Connector I:2.92mm (f) Straight	Connector I : 2.4mm (f) Straight	Connector I : 2.92mm (m) Straight	
Connector II:2.92mm (m) Straight	Connector II : 2.4mm (m) Straight	Connector II : 2.92mm (m) Straight	
Catalog No.	Catalog No.	Catalog No.	c. Connector
MWX342-01000KFSKMS	MWX342-01000LFSLMS/B	MWX342-01000KMSKMS/A	d. Armored
Option We can deliver produc	cts with matched phases for customers w	the require this characteristic	

# **Technical Data**



 $\textbf{Typical Insertion Loss} (0.315 \times \sqrt{f} [\text{GHz}] + 0.009 \times f [\text{GHz}] + 0.02) \times L [\text{m}] \quad \textbf{Maximum Insertion Loss} (0.315 \times \sqrt{f} [\text{GHz}] + 0.009 \times f [\text{GHz}] + 0.02) \times 1.12 \times L [\text{m}]$ 

### 342 Phase Change vs. Temperature



-40 °C, 1 hour after the temperature changed.

# Connector



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

# \* See P. 3-4 "Connector Codes"

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sertion Loss (40.0 GHz)

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2.4mm (m) Straight (Code : LMS) Reference Plane HEX 8 8 2



Maximum Operating Frequency : 40.0 GHz / Mass : 6g





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# Series Common Properties

### Connector Insertion Loss [dB/connector]

Connector Type	Connector	Frequency [GHz]							
Connector Type	Insertion Loss	1.0 GHz	10.0 GHz	18.5 GHz	26.5 GHz	40.0 GHz	50.0 GHz	67.0 GHz	
SSMA (m) Straight	0.03√f	0.03	0.09	0.13	-	-	-	-	
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	-	-	-	-	
SMA (m) Swept	0.04√f	0.04	0.13	0.17	-	-	-	-	
TNC (m) Straight	0.07√f	0.07	0.22	0.3	-	-	-	-	
N (m) Straight	0.05√f	0.05	0.16	0.22	-	-	-	-	
N (f) Straight	0.05√f	0.05	0.16	0.22	-	-	-	-	
N (m) Swept	0.06√f	0.06	0.19	0.26	-	-	-	-	
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	
3.5mm (m) Straight	0.03√f	0.03	0.09	0.13	0.15	-	-	-	
3.5mm (f) Straight	0.03√f	0.03	0.09	0.13	0.15	-	-	-	
3.5mm (m) Swept	0.04√f	0.04	0.13	0.17	0.21	-	-	-	
2.92mm (m) Straight	0.03√f	0.03	0.09	0.13	0.15	0.19	-	-	
2.92mm (f) Straight	0.03√f	0.03	0.09	0.13	0.15	0.19	-	-	
2.92mm (m) Swept	0.04√f	0.04	0.13	0.17	0.21	0.25	-	-	
2.4mm (m) Straight	0.042√f	0.04	0.13	0.18	0.22	0.27	0.3	-	
2.4mm (f) Straight	0.042√f	0.04	0.13	0.18	0.22	0.27	0.3	-	
1.85mm (m) Straight	0.065√f	0.065	0.206	0.28	0.33	0.41	0.46	0.53	
1.85mm (f) 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	
1.0mm (f) Straight	0.065√f	0.065	0.206	0.28	0.33	0.41	0.46	0.53	

### **Tolerances for Assembly Length**

Tolerance values of 0, 1, 2 and 3 series are shown below. Please contact us if your tolerance requirements for phase matching are more stringent.

Assembly Length [mm]	Tolerance [mm]
L≦1000	±10
1000 <l≦2000< td=""><td>±20</td></l≦2000<>	±20
2000 <l≦5000< td=""><td>±50</td></l≦5000<>	±50
5000 <l< th=""><th>±100</th></l<>	±100

### About Customer-Specified Swept and Right-Angle Connectors



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direction of Connector I ) is indicated by three digits following the catalog number. (The indication is omitted if the angle is 0°.) Example : If Connector II is at an angle of 90° when viewed from the direction of Connector I : MWX312-01000AMRAMR-090

The angle of Connector II relative to Connector I when

Connector I is assumed to be at 0° (as viewed from the

# **Technical Data**

Return Loss	- VSWR Conve	rsion Table	VSWR – Re	eturn Loss	Convers	ion Tab
Return Loss dB	Voltage Standing Wave Ratio VSWR	Reflection Coefficient	Voltage Standing Wave Ratio VSWR	Return Loss dB	Reflection Coefficient	Propagati Loss de
60	1.002	0.001	1.01	46.1	0.005	0.000
50	1.006	0.003	1.02	40.1	0.010	0.0004
40	1.020	0.010	1.03	36.6	0.015	0.0010
35	1.036	0.018	1.04	34.2	0.020	0.0017
30	1.065	0.032	1.05	32.3	0.024	0.002
29	1.074	0.035	1.06	30.7	0.029	0.003
28	1.083	0.040	1.07	29.4	0.034	0.005
27	1.094	0.045	1.08	28.3	0.038	0.006
26	1.106	0.050	1.09	27.3	0.043	0.008
25	1.119	0.056	1.10	26.4	0.048	0.0100
24	1.135	0.063	1.15	23.1	0.070	0.0213
23	1.152	0.071	1.20	20.8	0.091	0.036
22	1.173	0.079	1.25	19.1	0.111	0.053
21	1.196	0.089	1.30	17.7	0.130	0.0740
20	1.222	0.100	1.35	16.5	0.149	0.097
19	1.253	0.112	1.40	15.6	0.167	0.1228
18	1.288	0.126	1.45	14.7	0.184	0.1496
17	1.329	0.141	1.50	14.0	0.200	0.1773
16	1.377	0.158	1.60	12.7	0.231	0.238
15	1.433	0.178	1.70	11.7	0.259	0.3016
14	1.499	0.200	1.80	10.9	0.286	0.370
13	1.577	0.224	1.90	10.2	0.310	0.4388
12	1.671	0.251	2.00	9.5	0.333	0.5104
11	1.785	0.282	3.00	6.0	0.500	1.249
10	1.925	0.316	4.00	4.4	0.600	1.9383

### Frequency Band Name and Code

ioquoi	bana nama			
Frequency [GHz]	Wavelength [cm]	Conventional frequency band (radar)	Current frequency band (ECM)	Frequency [GHz]
0.15 0.2	200	VHF	A	- 0.15 - 0.2
0.3 · 0.4 ·			В	- 0.3 - 0.4
0.6 0.75	50 40	UHF	с	- 0.6 - 0.75
1 · · · · · · · · · · · · · · · · · · ·		L	D	— 1 — 1.5
2 ·		6	E	2
3 ·		5	F	3
5	6	С	G	- 5
0 .	0.75		Н	
10 .	3.75	х		10
15	2	Ku	J	- 15
20	1.5	K		20
30 ·	1	Ka	K	- 30
40 · 50 ·	0.75		L	40 - 50
60 75	0.50.4	MILLIMETER	М	- 75
100 -	0.3		1	

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# db Table

Power Ratio P2/P1	dB Dp	Current Ratio/ Voltage Ratio	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
×З	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

Power : Dp =  $10\log_{10} \frac{P_2}{P}[dB]$ 

Current : Di =  $20\log_{10} \frac{l_2}{l_1} [dB]$ 

Voltage :  $Dv = 20log_{10} \frac{V_2}{V_2} [dB]$ 

• Power level "dBm" represents the absolute value with respect to the standard 0[dBm] for 1[m/W]. P[mW] is given by 10log10P[dBm].

1. VSWR =  $\frac{1+\rho}{1-\rho} = \frac{1+10^{-\frac{BL}{20}}}{1-10^{-\frac{BL}{20}}}$ 

2. Return Loss RL (dB) =-20logp =-20log VSWR-1 VSWR+1

3. Reflection Coefficient  $\rho = (VSWR-1) /$  $(VSWR+1) = 10^{-\frac{RL}{20}}$ 

4. Propagation Loss  $\alpha$  (dB) = -10log (1- $\rho^2$ )  $=-10\log\left(1-\left(\frac{VSWR-1}{VSWR+1}\right)^{2}\right)$ 

Relationship between frequency and wavelength  $f = \frac{c}{\lambda}$  where c=2.998 × 10<sup>s</sup> [m/s] Relationship between phase change  $\theta$ [°], frequency f [GHz], cable length L[mm]and propagation delay T[nsec] L=0.8328× $\theta$ ÷ $\sqrt{\epsilon_r}$ ÷f  $\theta = 1.201 \times L \times \sqrt{\epsilon_r} \times f$  $\theta = 360 \times f \times \tau$ where  $\epsilon r$  is the specific dielectric constant of the cable insulator.

Air : εr=1, Dense PTFE : εr ≒ 2.1

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4. 5 Series Formable Interconnect

# 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.

- MWX511 - MWX512

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#### 4 Series Typical Insertion Loss

**5** 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.			

# **Placing orders**



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).

 $^{\star}$  2) Assembly length is measured from the end of one connector to the end of the other connector.

Connector Codes							
Connecto	_	4 Series				5 Series	
Connecto		411	412	441	461	511	512
Туре	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

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# Delivery

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

Frequency [GHz]





\* The above figures are measured values for reference only. 4.5-2



rellpower.com rellpower@rell.com 4. 5 Series Formable Interconnect

# 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



#### **5** 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.			

# **Placing orders**



ex.	Catalog No. MWX511 - AF	
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).  $^{\star}$  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."

### **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	

## Delivery

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



\* 2) Assembly Length is measured from the end of one connector to the end of the other connector.

Please provide a catalog number when placing an order.



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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	Semi-Rigid Cable  \$\phi\$3.6 Equivalent	Semi-Rigid Cable p2.2 Equivalent	Semi-Rigid Cable

Order Form Example Please provide the following information when placing an order.

### Example MWX441

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. Cable b. Assembly Length c. Connector

\* See P.4.5-2 "Connectol Codes"

# **Technical Data**

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



 $\label{eq:constraint} \textbf{Typical Insertion Loss} (0.002 \times f[\text{GHz}] + 0.336 \times \sqrt{f[\text{GHz}]} \times L[\text{m}] \qquad \textbf{Maximum Insertion Loss} (0.004 \times f[\text{GHz}] + 0.517 \times \sqrt{f[\text{GHz}]} \times L[\text{m}] \times 1.12 \times$ 411 Typical Insertion Loss ( $0.004 \times f[GHz] + 0.517 \times \sqrt{f[GHz]} \times L[m]$ Maximum Insertion Loss (0.004×f [GHz] +0.517×√f [GHz] ) ×L [m] ×1.12 412 **Typical Insertion Loss** (0.008×f [GHz] +0.604× $\sqrt{f}$  [GHz])×L [m] **Maximum Insertion Losss** (0.008×f [GHz] +0.604× $\sqrt{f}$  [GHz])×L [m] ×1.12 441

## 461 Typical Insertion Loss (L=1000mm)



# Connector



Mass : 3g

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

6.2

12

SMP (J) Straight (Code : S1FJ)

Reference Plane

6.2

. 12

Mass : 1g

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Maximum Operating Frequency : 67.0 GHz /



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

HEX 7.9

19

Mass : 3g

Maximum Operating Frequency : 18.0 GHz /



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



Maximum Operating Frequency : 12.0 GHz / lass : XXg

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Maximum Operating Frequency : 100.0 GHz /

4.5-5

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461 Typical Insertion Loss  $(0.01 \times f[GHz] + 1.1 \times \sqrt{f[GHz]} \times L[m]$  Maximum Insertion Loss  $(0.01 \times f[GHz] + 1.1 \times \sqrt{f[GHz]} \times L[m] \times 1.12$ 



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

\* The above figures are measured values for reference only. 4.5-6

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# 4, 5 Series Formable Interconnect Features 5 Series Formable Cable Fixed Wiring Low Insertion Loss than Semi-Rigid Cables • Days to Ship: 11 Business Days RoHS Compliant

# Property

Electrical Properties	511	512	Ν
Maximum Operating Frequency	18.0 GHz	18.0 GHz	0
Characteristic Impedance (Typical)	50 Ω	50 Ω	N (
Capacitance (Typical)	97 pF/m	95 pF/m	0
Propagation Delay (Typical)	4.7 ns/m	4.7 ns/m	1
Velocity of Propagation (Typical)	71 %	71 %	ŀ
Higher mode frequency (Typical)	63.0 GHz	34.0 GHz	F
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 °C	-30~+85 °C
Assembly Length	100~5,000 mm	100~5,000 mm
Remark	Semi-Flexible Cable φ2.1 Equivalent	Semi-Flexible Cable

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## Order Form Example Please provide the following information when placing an order.

### Example MWX511

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

Catalog No. MWX511-AP-APL=200mm

a. Cable b. Assembly Length c. Connector

\* See P.4.5-2 "Connrctor Codes"

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Uarthor I	

# **Technical Data**



# Connector



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

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

**512 Typical Insertion Loss (**0.018×f [GHz] +0.42×√f [GHz] )×L [m] **Maximum Insertion Loss (**0.018×f [GHz] +0.42×√f [GHz] )×L [m] ×1.12

\* The above figures are measured values for reference only. 4.5-8



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# **Technical Date**

# Formable (4, 5 Series) Technical Data 1

Static Bending Data (Insertion Loss)













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

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## Static Bending Data (Phase)

461 Static Bending Data 1



#### 461 Static Bending Data 2



#### **Test Method**



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

4.5-9

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#### Semi-Flexible Coaxial Cable Corresponding to UT47



#### Semi-Flexible Coaxial Cable Corresponding to UT47





<sup>\*</sup> The above figures are measured values for reference only. 4.5-10

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General Assemb

# **Technical Date**

### Temperature Characteristics (Insertion Loss) Test Cable: 2 m



#### Semi-Flexible Cable ø2.1



### Semi-Flexible Cable ø3.45



#### Semi-Rigid Cable ø2.2



#### Semi-Rigid Cable ø3.6



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# Series Common Properties

### Connector Insertion Loss [dB/connector]

Connector Type		Connector	Frequency [GHz]						
		Insertion Loss	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 Conve	rsion Table	VSWR – Re	turn L
Return loss dB	Voltage Standing Wave Ratio VSWR	Reflection Coefficient	Voltage Standing Wave Ratio VSWR	Return L dB
60	1.002	0.001	1.01	46.1
50	1.006	0.003	1.02	40.1
40	1.020	0.010	1.03	36.6
35	1.036	0.018	1.04	34.2
30	1.065	0.032	1.05	32.3
29	1.074	0.035	1.06	30.7
28	1.083	0.040	1.07	29.4
27	1.094	0.045	1.08	28.3
26	1.106	0.050	1.09	27.3
25	1.119	0.056	1.10	26.4
24	1.135	0.063	1.15	23.1
23	1.152	0.071	1.20	20.8
22	1.173	0.079	1.25	19.1
21	1.196	0.089	1.30	17.7
20	1.222	0.100	1.35	16.5
19	1.253	0.112	1.40	15.6
18	1.288	0.126	1.45	14.7
17	1.329	0.141	1.50	14.0
16	1.377	0.158	1.60	12.7
15	1.433	0.178	1.70	11.7
14	1.499	0.200	1.80	10.9
13	1.577	0.224	1.90	10.2
12	1.671	0.251	2.00	9.5
11	1.785	0.282	3.00	6.0
10	1.925	0.316	4.00	4.4

Initial

-40°C

-20°C



#### **Conversion Table**

eflection pefficient	Propagation Loss dB
0.005	0.0001
0.010	0.0004
0.015	0.0010
0.020	0.0017
0.024	0.0025
0.029	0.0037
0.034	0.0050
0.038	0.0063
0.043	0.0080
0.048	0.0100
0.070	0.0213
0.091	0.0361
0.111	0.0538
0.130	0.0740
0.149	0.0975
0.167	0.1228
0.184	0.1496
0.200	0.1773
0.231	0.2382
0.259	0.3016
0.286	0.3706
0.310	0.4388
0.333	0.5104
0.500	1.2494
0.600	1.9382

## db Table

P	ower Ratio P2/P1	dB Dp	Current Ratio/ Voltage Ratio I2/I1·V2/V1	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
	×З	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. 4.5-12



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# 6 Series Highly Precise Skew Match Type

Highly precise skew match cable assembly with less than 1psec skew between the two cabls for measurement of digital transmission. (Continuous operating temperature range : -30 to +85°C) Low insertion loss, suitable for measurement of the high-precision differential transmission signal. 4 type cables are available depends on maximum frequency (26.5GHz, 40GHz, 50GHz and 67GHz).

### 6 Series Typical Insertion Loss



Simple Criteria for Cable Selection					
Insertion Loss	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.				

Maximum Insertion Loss (0.0095×f [GHz] +0.41×√f [GHz] +0.02) ×1.12×L [m]

Maximum Insertion Loss (0.0095×f [GHz] +0.47×√f [GHz] +0.02) ×1.12×L [m]

5.6 dB/m

# 621 Typical Insertion Loss (0.0077×f [GHz] +0.2304×√f [GHz] +0.02)×L [m] Maximum Insertion Loss (0.0077×f [GHz] +0.2304×√f [GHz] +0.02)×1.12×L [m] 641 Typical Insertion Loss (0.0095×f [GHz] +0.41×√f [GHz] +0.02) ×L [m]

**651 Typical Insertion Loss (**0.0095×f [GHz] +0.47×√f [GHz] +0.02)×L [m]

661 Typical Insertion Loss (0.0095×f [GHz] +0.6148×√f [GHz] +0.02)×L [m] Maximum Insertion Loss (0.0095×f [GHz] +0.6148×√f [GHz] +0.02)×1.12×L [m]

1.4 dB/m

621 661 18.5 GHz 1.2 dB/m 1.8 dB/m 2.1 dB/m 2.9 dB/m

3.8 dB/m

3.0 dB/m

# Power rating

The diagram to the right shows the relationship between frequency and power rating.

The values are calculated at 25 °C and at sea level.

The power rating will need to be corrected for different ambient temperatures and altitude.

Power ratings may decrease, depending on the connector selected.

\* The above figures are measured values for reference only.

#### Power Rating of 6 Series at Sea Level



6

# **Connection Example of 6 Series**



# **Major Applications**

• Complince and evaluation of the USB, HDMI etc. • BERT measurement, Jitter measurement.

# (Reference) Eye Pattern and Junkosha's Method of Calculating Degree of Eye Pattern

To measure pulse wave transmission characteristics, an experimental tool called "eye pattern" is observed. Upon balanced transmission, skew (variability of propagation delay time) between the signal cables will become one of the cause of deterioration of the jitter. Taking above into consideration, 6 series are designed and manufactured.



6 Series



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## **Conventional Product**









## 6 Series Highly Precise Skew Match Type

# 6 Series

# **Placing Orders**



Example 1					
	MVVX621 - 010	000 DI	-S DI	VIS / P/	AIR
Cable: MWX621					
Assembly Length: 1000 mm					
Connector I : 3.5 mm (f) Straight					
Connector II : 3.5 mm (m) Straight					
Pair Product					

Note 1) The unit of Assembly Length is mm. Shown as a five-digit number. If the number consists of fewer than five digits, remember to add zero (s) to the left of the first digit to make it five digits. The Assembly Length is measured based on the reference planes, not on the connector ends, shown at the figure to the left. Note 2) We supply MWX6 series one pair of two cables. Upon ordering, you are requested to inform us the catalogue number and set quantity.

# Delivery

6 Series will be shipped within 11 business days after receiving your order. \*L/T might be changed on your order Qty.

# Option

In the event that you would like to change quantity of one set, please feel free to contact us.

# Remarks

Skew of 6 series between the two cables is standardized less than 1 psec upon shipment. Bending or pulling the cable with strong force or other impact may cause the skew to go out of alignment Please be careful upon handling them with great care.

6-3



**Connector Codes** 

Туре

3.5 mm (f) Straight 2.92 mm (m) Straight

2.92 mm (f) Straight

2.4 mm (f) Straight 1.85 mm (m) Straight

1.85 mm (f) Straight

SMA

3.5 mm

(m) Straight

(f) Straight

(m) Straight

(m) Straight

Connector

Maximum Operatin Frequency

18.5 GHz

26.5 GHz

40.0 GHz 40.0 GHz

50.0 GHz 50.0 GHz 26.5 GHz

NMS

NFS

AMS

DMS

DFS

Ca	ble	
641	651	661
40.0 GHz	50.0 GHz	67.0 GHz
NMS		
AMS		
		DMS
KMS	KMS	KMS
KFS	KFS	
	LMS	LMS
	LFS	
		VMS
		VFS

The smallest frequency among the maximum operating frequencies of the connectors and cables to be used is the maximum operating frequency of the assembly. •Please inquire separately for products with connector symbols in gray, as they require a longer delivery time.





### 6 Series Highly Precise Skew Match Type

# 6 Series

Features

- High Precise Skew Matching
- Days to Ship: 11 Business Days RoHS Compliant

# Property

	621	641	651	661
Maximum Operating Frequency	26.5 GHz	40.0 GHz	50.0 GHz	67.0 GHz
Characteristic Impedance (Typical)	50 ±1Ω	50 ±1Ω	50 ±1Ω	50 ±1Ω
Propagation Delay (Typical)	4.4 ns/m	4.35 ns/m	4.36 ns/m	4.38 ns/m
VSWR ((Typical)	1.33	1.43	1.43	1.43
Typical Insertion Loss	1.4 dB/m(26.5GHz)	3.0 dB/m(40.0GHz)	3.8 dB/m(50.0GHz)	5.6 dB/m(67.0GHz)
Skew (Between Pair Cables)	1 ps	1 ps	1 ps	1 ps
Phase Deviation (Between Pair Cables : @1 GHz)	0.3°	0.3°	0.3°	0.3°
Cable Outer Diameter	6.0 mm	4.1 mm	3.7 mm	2.6 mm
Cable Mass (Typical)	64 g/m	35 g/m	29 g/m	17 g/m
Continuous Operating Temperature Range	-30~+85 °C	-30~+85 °C	-30~+85 °C	-30~+85 °C
	SMA(m)	2.92 mm(m),	2.4 mm(m), 2.4 mm(f)	1.85 mm(m),
	3.5 mm(m), 3.5 mm(f)	2.92 mm(f)	2.92 mm(m), 2.92 mm(f)	1.85 mm(f)
Assembly Length	200~1,500 mm	200~1,500 mm	200~1,500 mm	200~1,500 mm
Typical Insertion Loss	1.4 dB/m (26.5 GHz)	3.0 dB/m (40.0 GHz)	3.8 dB/m (50.0 GHz)	5.6 dB/m (67.0 GHz)

# Order Form Example Please provide the following information when placing an order.

Examp	le l	MW	/X621
-------	------	----	-------

Assembly Length : 1000mm Connector I: 3.5 mm (f) Straight Connector II: 3.5 mm (m) Straight

Catalog No. MWX621-01000DFSDMS/PAIR a. Cable b. Assembly Length

\* See P.6-4 "Connector Codes"

\* We supply 6 series one pair of two cables.

c. Connector d. Armored

# **Technical Data**

6 Series Typical Insertion Loss



# Connector 621

Mass : 6g

Technology

Partner

Richardson <u>Electronics</u>

SMA (m) Straight (Code : AMS) Reference Plane 10.5	3.5 mm (m) Straight (Code : DMS) Reference Plane + HEX 8 10.5 
2.92 mm (m) Straight (Code : KMS) Reference Plane +EX 8 19.5 10.0 Maximum Operating Frequency : 40.0 GHz / Mass : 8g 651	2.92 mm (f) Straight (Code : KFS) Reference Plane 9.5 1.7 Maximum Operating Frequency : 40.0 GHz / Mass : 8g
2.4 mm (m) Straight (Code : LMS) Reference Plane	2.4 mm (f) Straight (Code : LFS) Reference Plane 75 72 Maximum Operating Frequency : 50.0 GHz / Mass : 5g
1.85 mm (m) Straight (Code : VMS)	1.85 mm (f) Straight (Code : VFS) Reference Plane 75 72 Maximum Operating Frequency : 67.0 GHz /
Mass 6g	Mass : 6g

6-5

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			621
			- 641 - 651
			- 661
1	I		
40	50	60	61
Jency [GHz]			

Maximum Insertion Loss (0.0095×f [GHz] +0.41×√f [GHz] +0.02) ×1.12×L [m] Maximum Insertion Loss (0.0095×f [GHz] +0.47×√f [GHz] +0.02) ×1.12×L [m]



Mass : 10g







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# Series Common Properties

### Connector Insertion Loss [dB/connector]

Connector Type	Connector	Frequency [GHz]						
Connector Type	Insertion Loss	1.0 GHz	10.0 GHz	18.5 GHz	26.5 GHz	40.0 GHz	50.0 GHz	67.0 GHz
SSMA (m) Straight	0.03√f	0.03	0.09	0.13	-	-	-	-
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	-	-	-	-
SMA (m) Swept	0.04√f	0.04	0.13	0.17	-	-	-	-
TNC (m) Straight	0.07√f	0.07	0.22	0.3	-	-	-	-
N (m) Straight	0.05√f	0.05	0.16	0.22	-	-	-	-
N (f) Straight	0.05√f	0.05	0.16	0.22	-	-	-	-
N (m) Swept	0.06√f	0.06	0.19	0.26	-	-	-	-
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
3.5mm (m) Straight	0.03√f	0.03	0.09	0.13	0.15	-	-	-
3.5mm (f) Straight	0.03√f	0.03	0.09	0.13	0.15	-	-	-
3.5mm (m) Swept	0.04√f	0.04	0.13	0.17	0.21	-	-	-
2.92mm (m) Straight	0.03√f	0.03	0.09	0.13	0.15	0.19	-	-
2.92mm (f) Straight	0.03√f	0.03	0.09	0.13	0.15	0.19	-	-
2.92mm (m) Swept	0.04√f	0.04	0.13	0.17	0.21	0.25	-	-
2.4mm (m) Straight	0.042√f	0.04	0.13	0.18	0.22	0.27	0.3	-
2.4mm (f) Straight	0.042√f	0.04	0.13	0.18	0.22	0.27	0.3	-
1.85mm (m) Straight	0.065√f	0.065	0.206	0.28	0.33	0.41	0.46	0.53
1.85mm (f) 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
1.0mm (f) Straight	0.065√f	0.065	0.206	0.28	0.33	0.41	0.46	0.53

### **Tolerances for Assembly Length**

Tolerance values of 0, 1, 2 and 3 series are shown below. Please contact us if your tolerance requirements for phase matching are more stringent.

Assembly Length [mm]	Tolerance [mm]
L≦1000	±10
1000 <l≦2000< td=""><td>±20</td></l≦2000<>	±20
2000 <l≦5000< td=""><td>±50</td></l≦5000<>	±50
5000 <l< th=""><th>±100</th></l<>	±100

### About Customer-Specified Swept and Right-Angle Connectors



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The angle of Connector II relative to Connector I when Connector I is assumed to be at 0° (as viewed from the direction of Connector I ) is indicated by three digits following the catalog number. (The indication is omitted if the angle is 0°.) Example : If Connector II is at an angle of 90° when viewed from the direction of Connector I : MWX312-01000AMRAMR-090

# **Technical Data**

Return Loss	<ul> <li>VSWR Conve</li> </ul>	ersion Table	VSWR – Re	eturn Loss	Convers	ion Table
Return Loss dB	Voltage Standing Wave Ratio VSWR	Reflection Coefficient	Voltage Standing Wave Ratio VSWR	Return Loss dB	Reflection Coefficient	Propagation Loss dB
60	1.002	0.001	1.01	46.1	0.005	0.0001
50	1.006	0.003	1.02	40.1	0.010	0.0004
40	1.020	0.010	1.03	36.6	0.015	0.0010
35	1.036	0.018	1.04	34.2	0.020	0.0017
30	1.065	0.032	1.05	32.3	0.024	0.0025
29	1.074	0.035	1.06	30.7	0.029	0.0037
28	1.083	0.040	1.07	29.4	0.034	0.0050
27	1.094	0.045	1.08	28.3	0.038	0.0063
26	1.106	0.050	1.09	27.3	0.043	0.0080
25	1.119	0.056	1.10	26.4	0.048	0.0100
24	1.135	0.063	1.15	23.1	0.070	0.0213
23	1.152	0.071	1.20	20.8	0.091	0.0361
22	1.173	0.079	1.25	19.1	0.111	0.0538
21	1.196	0.089	1.30	17.7	0.130	0.0740
20	1.222	0.100	1.35	16.5	0.149	0.0975
19	1.253	0.112	1.40	15.6	0.167	0.1228
18	1.288	0.126	1.45	14.7	0.184	0.1496
17	1.329	0.141	1.50	14.0	0.200	0.1773
16	1.377	0.158	1.60	12.7	0.231	0.2382
15	1.433	0.178	1.70	11.7	0.259	0.3016
14	1.499	0.200	1.80	10.9	0.286	0.3706
13	1.577	0.224	1.90	10.2	0.310	0.4388
12	1.671	0.251	2.00	9.5	0.333	0.5104
11	1.785	0.282	3.00	6.0	0.500	1.2494
10	1.925	0.316	4.00	4.4	0.600	1.9382

### Frequency Band Name and Code

ioquoi	bana nama			
Frequency [GHz]	Wavelength [cm]	Conventional frequency band (radar)	Current frequency band (ECM)	Frequency [GHz]
0.15 0.2	200	VHF	A	- 0.15 - 0.2
0.3 · 0.4 ·			В	- 0.3 - 0.4
0.6 0.75	50 40	UHF	с	- 0.6 - 0.75
1 · · · · · · · · · · · · · · · · · · ·		L	D	— 1 — 1.5
2 ·		6	E	2
3 ·		5	F	3
5	6	С	G	- 5
0 .	0.75		Н	
10 .	3.75	х		10
15	2	Ku	J	- 15
20	1.5	K		20
30 ·	1	Ka	K	- 30
40 · 50 ·	0.75		L	40 - 50
60 75	0.50.4	MILLIMETER	М	- 75
100 -	0.3		1	

6

Richardson <u>Electronics</u> Technology Partner

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		Iau	ᇆ

# db Table

Power Ratio P2/P1	dB Dp	Current Ratio/ Voltage Ratio	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
×З	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

Power : Dp =  $10\log_{10} \frac{P_2}{P}[dB]$ 

Current : Di =  $20\log_{10} \frac{l_2}{l_1} [dB]$ 

Voltage :  $Dv = 20log_{10} \frac{V_2}{V_2} [dB]$ 

• Power level "dBm" represents the absolute value with respect to the standard 0[dBm] for 1[m/W]. P[mW] is given by 10log10P[dBm].

1. VSWR =  $\frac{1+\rho}{1-\rho} = \frac{1+10^{-\frac{BL}{20}}}{1-10^{-\frac{BL}{20}}}$ 

2. Return Loss RL (dB) =-20logp =-20log VSWR-1 VSWR+1

3. Reflection Coefficient  $\rho = (VSWR-1) /$  $(VSWR+1) = 10^{-\frac{RL}{20}}$ 

4. Propagation Loss  $\alpha$  (dB) = -10log (1- $\rho^2$ )  $=-10\log\left(1-\left(\frac{VSWR-1}{VSWR+1}\right)^{2}\right)$ 

Relationship between frequency and wavelength  $f = \frac{c}{\lambda}$  where c=2.998 × 10<sup>s</sup> [m/s] Relationship between phase change  $\theta$ [°], frequency f [GHz], cable length L[mm]and propagation delay T[nsec] L=0.8328× $\theta$ ÷ $\sqrt{\epsilon_r}$ ÷f  $\theta = 1.201 \times L \times \sqrt{\epsilon_r} \times f$  $\theta = 360 \times f \times \tau$ where  $\epsilon r$  is the specific dielectric constant of the cable insulator. Air : εr=1, Dense PTFE : εr ≒ 2.1



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