GORE® PHASEFLEX®

MICROWAVE/RF TEST ASSEMBLIES

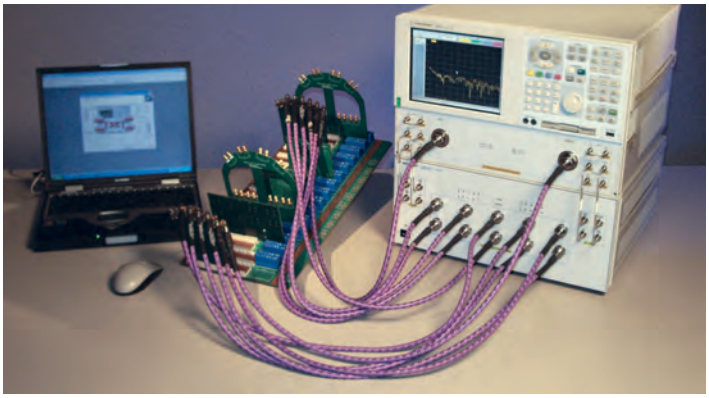
Reduce total cost of test with durable, reliable performance

Reliability is crucial for applications that use microwave/RF cable assemblies to ensure consistent, repeatable measurements and to maintain electrical performance. However, a recent study showed that globally more than 75 percent of microwave/RF cable assemblies are replaced frequently due to damage during installation or operation.

For test applications that require precise, repeatable measurements, GORE® PHASEFLEX® Microwave/RF Test Assemblies provide excellent phase and amplitude stability with flexure. The rugged, lightweight construction of these assemblies delivers reliable performance with longer service life and reduced equipment downtime, which results in lower costs for testing in laboratory, production, and field test environments.

Typical Applications

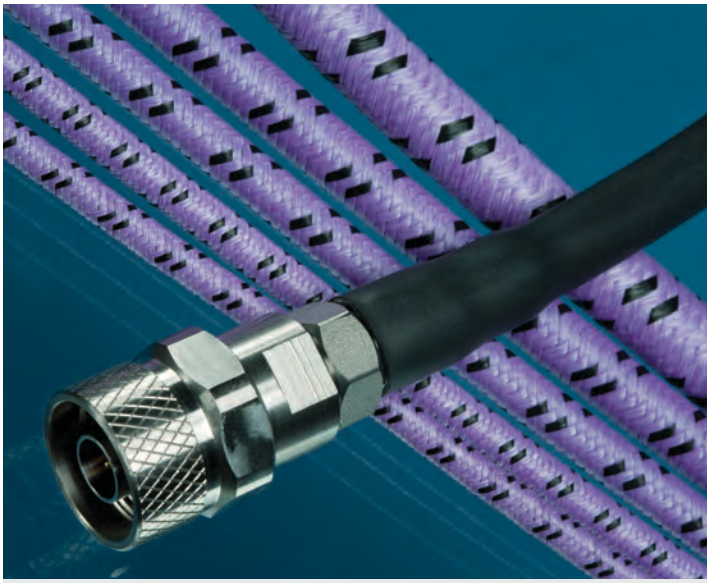
- Bench-top testing
- High throughput RF production testing
- Portable analyzers
- Test rack systems
- Vector network analyzers (VNAs)
- Scalar network analyzers
- Antenna ranges
- Anechoic chambers
- Nearfield scanners
- Wireless telecommunication module testing
- Electromagnetic compliance testing
- Automated test equipment



Courtesy, Agilent Technologies, Inc.

Rugged Construction Delivers Longer Service Life

With an internally ruggedized construction, GORE® PHASEFLEX® Microwave/RF Test Assemblies maintain measurement repeatability while withstanding demanding conditions such as continuous flexing, temperature cycling, broad temperature ranges, and frequent connect and disconnect.



Benefits of GORE® PHASEFLEX® Microwave/RF Test Assemblies

- Consistent, repeatable measurements with stable electrical performance up to 110 GHz
- Longer service life with durable construction that resists crushing, twisting, and kinking
- Enhanced phase and amplitude stability with flexure and temperature
- Increased throughput and reduced downtime with durable and reliable performance

The consistent performance and reliability of these test assemblies increases the interval between time-consuming calibrations of the test system, which in turn increases throughput, and reduces the total cost of test. With a unique construction that is more durable, these cables allow for a small bend radius without affecting performance (Figure 1). Some cables have a minimum bend radius as small as 0.5 inches.

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GORE® PHASEFLEX® Microwave/RF Test Assemblies offer excellent electrical and mechanical performance (Tables 2 and 3). Assemblies are available in 12, 24, 36, 48, and 60 inch lengths. These predetermined lengths correspond to 0.30, 0.61, 0.91, 1.22 and 1.52 meters. Special Purpose Test Assemblies are also available (Tables 4 and 5).

Features for GORE® PHASEFLEX® Microwave/RF Test Assemblies include:

- torque, crush, and kink resistance
- abrasion resistance
- dust/moisture resistance
- performance over a wide temperature range
- chemical resistance
- high connector pull strength

Precise and Repeatable Measurements

The exceptional phase and amplitude stability of GORE® PHASEFLEX® Microwave/RF Test Assemblies ensures accurate and repeatable measurements. Although all of these assemblies exceed specifications for phase and amplitude stability, additional testing is performed on assemblies using cable types 0U, 0T, 0D, 0Z, and 0F to guarantee their phase and amplitude performance with flexure (Table 1). While all other cable types (0Y, 0H, 0X, 0S, 0Q, 0P, 0M, 0W, 0R, 0K, 0G, CX) do not under go this guaranteed stability testing, phase and amplitude stability performance is incorporated by design.

Table 1: Test Assemblies with Guaranteed Phase and Amplitude Stability with Flexure[1]

Gore Cable Type	Phase Stability with Flexure (±°)		Amplitude Stability with Flexure (± dB)	
	Typical Value	Maximum Value	Typical Value	Maximum Value
0U	2.0	4.7	0.05	0.15
0T	3.0	6.6	0.05	0.15
0D	5.0	9.6	0.05	0.15
0Z	6.0	11.8	0.05	0.15
0F	8.0	15.6	0.05	0.10

[1] The maximum value for guaranteed phase and amplitude stability was established using the following test method. The assembly was terminated with a short circuit and tested on a calibrated system. The VNA was normalized. A mandrel of 57 mm (2.25 in) radius was placed adjacent to the left or right side of the assembly, approximately at its midpoint. The assembly was coiled 360° around the mandrel and held in this position for one full sweep. Maximum deviation over the frequency range of analysis was recorded. The assembly was then returned to its initial straight position, and the VNA was normalized again. The mandrel was placed on the opposite side of the assembly and the test was repeated. All of the assemblies above are tested using this test method.

Phase Matching

Upon request, phase or time delay matching can be specified for GORE® PHASEFLEX® Microwave/RF Test Assemblies with frequencies through 67 GHz. Gore can provide absolute and relative time delay matching to sub-picosecond tolerances. According to the performance requirements of the application, cable assemblies may be specified to meet absolute or relative matching values.

- **Absolute match:** One or more assemblies having a specific time delay or phase length target value ± some tolerance value. This type of specification allows replacement or addition of individual cables in a matched set.
- **Relative match:** Two or more assemblies whose time delay or phase length fall within a specified match window. Relative matching ensures consistent matching within a set of cables, but an assembly from one set may not necessarily be matched with cable assemblies in another set.

Figure 1: The anatomy of GORE® PHASEFLEX® Microwave/RF Test Assemblies

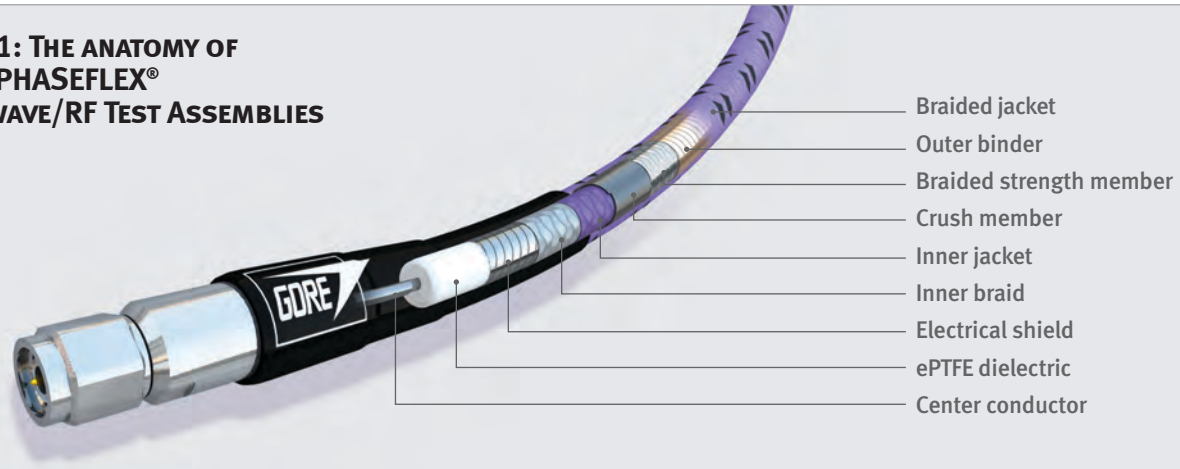

Table 2: Test Assembly Specifications up to 18 GHz[1]

	Gore Cable Type	0Y	0H	0X	0S	0U	0Q	0P	0M
Electrical Properties	Maximum Frequency (GHz)	3	18	18	18	18	18	18	18
	Typical VSWR	1.05:1	1.19:1	1.19:1	1.19:1	1.19:1	1.22:1	1.24:1	1.28:1
	Typical Insertion Loss (dB)	0.48	2.15	1.13	1.36	1.36	0.80	1.00	0.75
	Impedance (Nominal) (Ohms)	75	50						
	Guaranteed Phase and Amplitude Stability	No	No	No	No	Yes	No	No	No
	Typical Phase Stability (degree)[2]	±0.5	±2.0	±2.0	±2.0	±2.0	±8.0	±6.0	±15.0
	Typical Amplitude Stability (dB)[2]	‹ ±0.05							
	Dielectric Constant (Nominal)	1.4							
	Velocity of Propagation (Nominal) (%)	85							
	Shielding Effectiveness (dB through 18 GHz)[3]	› 100							
	Time Delay (Nominal) ns/cm (ns/in)	0.04 (0.103)							
Mech./Env. Properties	Center Conductor	Solid	Stranded	Solid	Stranded	Stranded	Solid	Stranded	Solid
	Overall Diameter mm (in)	7.5 (0.295)	5.3 (0.210)	7.7 (0.305)	7.7 (0.305)	7.7 (0.305)	10.2 (0.400)	10.2 (0.400)	10.7 (0.420)
	Nominal Weight g/m (oz/ft)	144.4 (1.55)	68.9 (0.74)	147.6 (1.6)	147.6 (1.6)	147.6 (1.6)	275.6 (2.96)	275.6 (2.96)	295.3 (3.17)
	Minimum Bend Radius mm (in)	25.4 (1.0)	12.7 (0.5)	25.4 (1.0)	25.4 (1.0)	25.4 (1.0)	38.1 (1.5)	38.1 (1.5)	38.1 (1.5)
	Typical Flex Cycles[4]	50,000	100,000	50,000	100,000	100,000	10,000	15,000	10,000
	Temperature Range (°C)	-55 to 125							
	Crush Resistance kgf/cm (lbf/in)	44.6 (250)	33.5 (187)	44.6 (250)					

Table 3: Test Assembly Specifications up to 67 GHz[1]

	Gore Cable Type	0W	0R	0T	0K	0D	0Z	0F
Electrical Properties	Maximum Frequency (GHz)	26.5	26.5	26.5	40	40	50	67
	Typical VSWR	1.17:1	1.17:1	1.17:1	1.30:1	1.30:1	1.26:1	1.30:1
	Typical Insertion Loss (dB)	1.43	1.71	1.71	2.65	3.35	3.78	5.84
	Impedance (Nominal) (Ohms)	50						
	Guaranteed Phase and Amplitude Stability	No	No	Yes	No	Yes	Yes	Yes
	Typical Phase Stability (degree)[2]	±3.0	±3.0	±3.0	±5.0	±5.0	±6.0	±8.0
	Typical Amplitude Stability (dB)[2]	‹ ±0.05						
	Dielectric Constant (Nominal)	1.4						
	Velocity of Propagation (Nominal) (%)	85						
	Shielding Effectiveness (dB through 18 GHz)[3]	› 100						
	Time Delay (Nominal) ns/cm (ns/in)	0.04 (0.103)						
Mech./Env. Properties	Center Conductor	Solid	Stranded	Stranded	Solid	Solid	Solid	Solid
	Overall Diameter mm (in)	7.7 (0.305)	7.7 (0.305)	8.0 (0.315)	6.1 (0.240)	6.1 (0.240)	6.1 (0.240)	5.8 (0.230)
	Nominal Weight g/m (oz/ft)	147.6 (1.6)	147.6 (1.6)	147.6 (1.6)	98.4 (1.05)	101.7 (1.1)	101.7 (1.1)	88.6 (0.95)
	Minimum Bend Radius mm (in)	25.4 (1.0)						
	Typical Flex Cycles[4]	50,000	100,000	100,000	50,000	20,000	20,000	20,000
	Temperature Range (°C)	-55 to 125				-55 to 75		
	Crush Resistance kgf/cm (lbf/in)	44.6 (250)						

[1] The electrical specifications in this table are based on a 0.91 m (36 in) assembly length and maximum frequency with straight connectors.
[2] When cable is wrapped 360° around a 57 mm (2.25 in) radius mandrel.
[3] Per MIL-STD-1344, method 3008.
[4] When bent ± 90° at a radius that is twice the minimum bend radius, test assembly performs reliably through the stated flex cycles.

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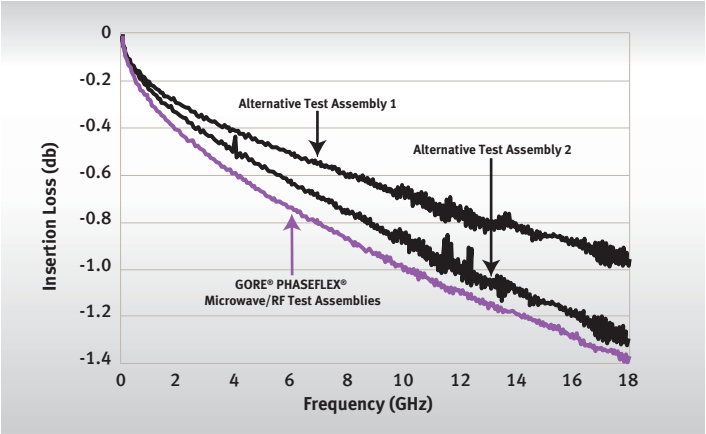
Reliable Performance Now and Over Time

Unlike conventionally designed RF test assemblies, GORE® PHASEFLEX® Microwave/RF Test Assemblies maintain excellent phase and amplitude stability with flexure. When tested right out of the box, the insertion loss traces for these assemblies were smooth indicating stable electrical performance compared to other assemblies that were fairly rough, which may indicate electrical problems in the future (Figure 2).

Figure 2: Insertion Loss of New Cables at 18 GHz



When flexed, the other assemblies experienced significant changes in loss and phase stability compromising their signal integrity (Figures 3 and 4). However, GORE® PHASEFLEX® Microwave/RF Test Assemblies successfully maintained loss and phase stability, indicating their signal integrity remained constant without then need for calibration.

Figure 3: Loss Stability with Flexure of New Cables

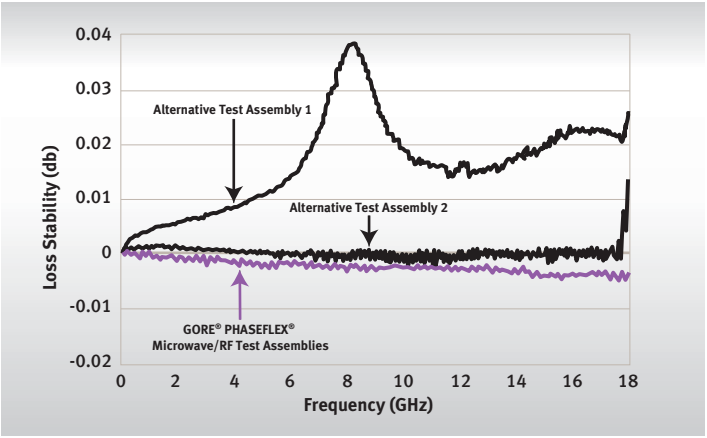
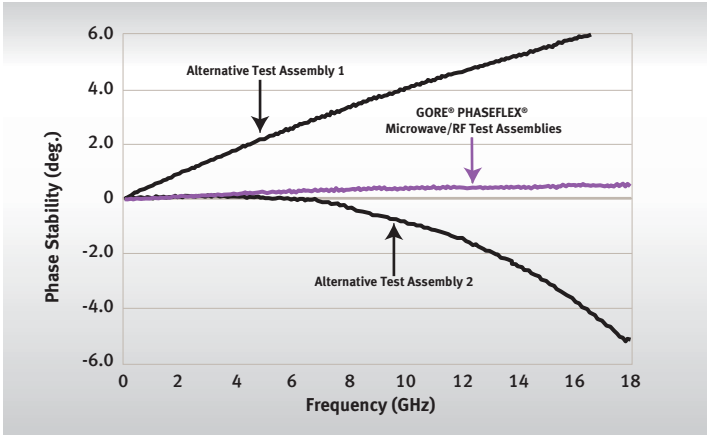


Figure 4: Phase Stability with Flexure of New Cables



During an accelerated life test, GORE® PHASEFLEX® Microwave/RF Test Assemblies showed no change in performance after 10,000 flex cycles compared to other assemblies that experienced a significant change after only 100 and 300 flex cycles (Figures 5 and 6).

Figure 5: Loss Stability Over Time

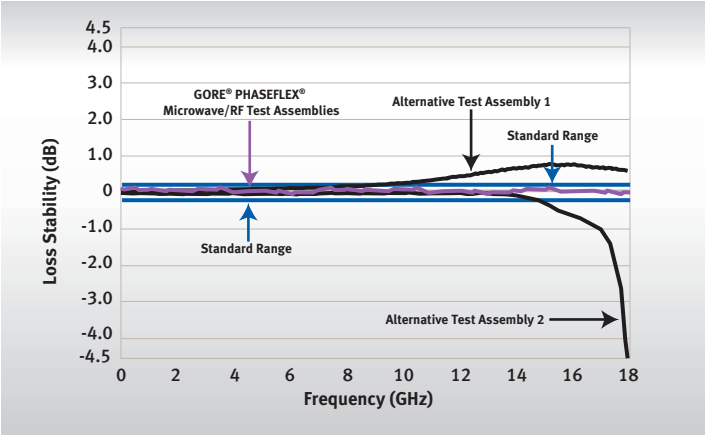
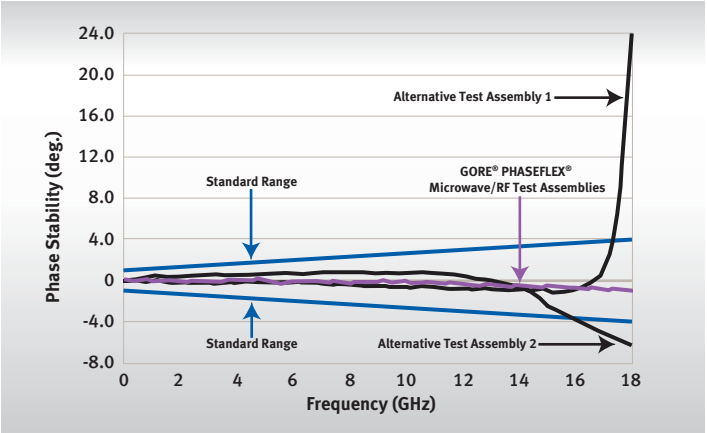


Figure 6: Phase Stability Over Time



110 GHz Test Assemblies

Gore's 110 GHz ruggedized cable assemblies can be flexed, formed, or repositioned without damage while providing excellent stability with flexure and temperature, while maintaining excellent insertion loss and VSWR (Figures 7 and 8). These assemblies provide reliable electrical and mechanical performance (Table 4).

Table 4: 110 GHz Test Assembly Specifications[1]

	Gore Cable Type	CX
Electrical Properties	Maximum Frequency (GHz)	110
	Typical VSWR	1.20:1
	Typical Insertion Loss (dB)	2.14
	Impedance (Nominal) (Ohms)	50
	Typical Phase Stability (degree)[2]	±1.0
	Typical Amplitude Stability (dB)[2]	‹ ±0.05
	Dielectric Constant (Nominal)	1.4
	Velocity of Propagation (Nominal) (%)	85
	Shielding Effectiveness (dB through 18 GHz)[3]	› 100
	Time Delay (Nominal) ns/cm (ns/in)	0.04 (0.103)
Mech./Env. Properties	Center Conductor	Solid
	Overall Diameter mm (in)	4.2 (0.167)
	Nominal Weight g/m (oz/ft)	55.8 (0.60)
	Minimum Bend Radius mm (in)	10.2 (0.40)
	Temperature Range (°C)	-55 to 125
	Crush Resistance kgf/cm (lbf/in)	44.6 (250)

[1] The electrical specifications in this table are based on a 16 cm (6.3 in) assembly length.

[2] When cable is bent 90° around a 25.4 mm (1 in) radius mandrel.

[3] MIL-STD-1344, method 3008.

Figure 7: Typical VSWR[1]

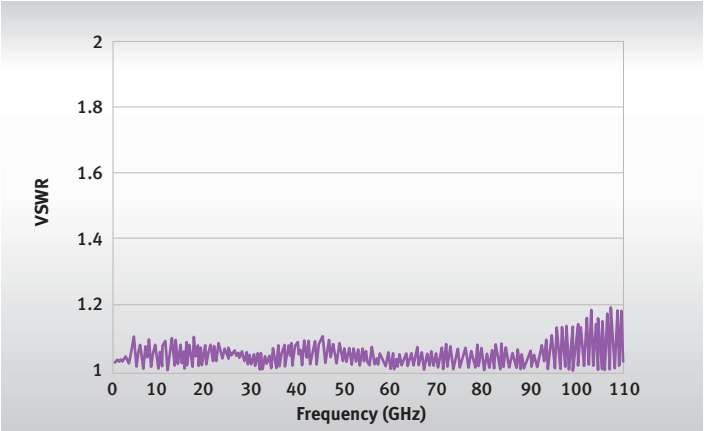
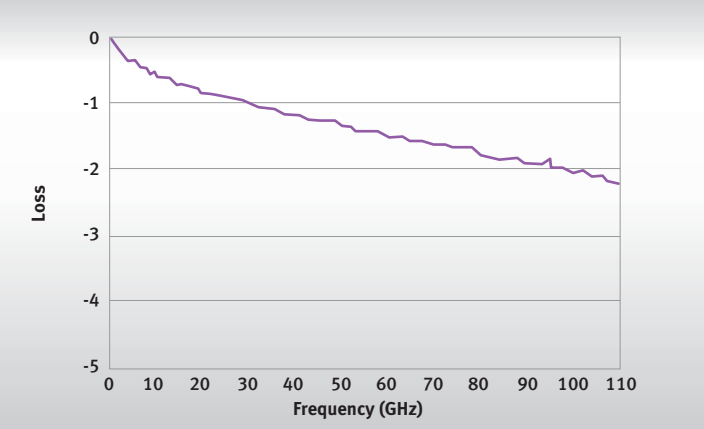


Figure 8: Typical Insertion Loss[1]



Connector Options

Connectors available for GORE® PHASEFLEX® Microwave/RF Test Assemblies are specifically engineered to optimize performance of the assembly. Gore's 601 interface allows the use of field-replaceable connectors on selected 18 GHz cable assemblies (Table 5).

These replaceable connectors thread onto the 601 interface. The replaceable interface cable assembly and the replaceable connectors should be ordered as separate line items (Table 7).

Table 5: Connector Options

		Gore Cable Type															
		0Y	0H	0X	0S	0U	0Q	0P	0M	0W	0R	0T	0K	0D	0Z	0F	CX
Connector Type	Max. Freq. (GHz)[1]	3.0	18	18	18	18	18	18	18	26.5	26.5	26.5	40	40	50	67	110
Type FD Male	3.0	ZLF															
Type FD Female	3.0	ZLX															
7/16 Male	7.0			ZLY	ZLY												
7/16 Female	7.0			ZLZ	ZLZ												
TNC Male	12.4			T01	T01	T01	T01	T01									
Type N Male	12.4	N01		N01	N01		N01	N01	N01								
Type N Female	12.4	N02		N02	N02		N02	N02									
SMA Male[2]	18		R01	R01	R01	R01	R01	R01	R01				R01				
SMA Box Right-Angle Male	18		R71	R71	R71	R71	R71	R71	R71				R71				
SMA Female	18		R02	R02	R02	R02	R02	R02	R02								
TNCA Male	18			C01	C01	C01	C01	C01	C01								
TNCA Box Right-Angle Male	18			C71	C71	C71	C71	C71	C71								
TNCA Female	18			C02	C02	C02	C02		C02								
Precision N Male (Field Grade)[3]	18				ZKU												
Precision N Male (Instrument Grade)	18			Q01	Q01	Q01	Q01	Q01	Q01								
Precision N Right-Angle Male	18			Q71	Q71	Q71	Q71	Q71	Q71								
Precision N Female (Field Grade)	18				ZKV												
Precision N Female (Instrument Grade)	18			Q02	Q02	Q02	Q02	Q02	Q02								
7 mm Hermaphroditic	18			K00	K00	K00		K00									
3.5 mm Male	26.5			D01	D01	D01				D01	D01	D01					
3.5 mm Female	26.5				D02	D02				D02	D02	D02					
3.5 mm Ruggedized Port Female	26.5					0HA						0HA					
3.5 mm Ruggedized DUT Male	26.5					0HB						0HB					
2.92 mm Male	40												0CQ	0CQ	0CQ		
2.92 mm Box Right-Angle Male	40												ZQA				
2.92 mm Female	40												0CP	0CP	0CP		
2.4 mm Male	50												0CJ		0CJ		
2.4 mm Female	50												0CK		0CK		
1.85 mm Male	67															0CB	
1.85 mm Female	67															0CA	
1.0 mm Male	110																0AB
1.0 mm Female	110																0AA
Interface for Replaceable Connectors[4]	18			601	601	601	601	601	601								

[1] The maximum operating frequency of a test assembly is determined as the lowest frequency of either the connectors or the cable.

[2] 0S1 connector code is an easy grip, quick-turn SMA connector.

[3] 0N1 connector code is an easy grip, quick-turn Precision N connector.

[4] Table 6 for compatible connector options that are available separately.

Ordering Information

To order a Special Purpose Test Assembly from Gore, select the part number needed (Table 6).

GORE® PHASEFLEX® Microwave RF/Test Assemblies are identified by a 12-character part number. This number designates the cable type, connector types, and assembly length:

1 2	3 4 5	6 7 8	9 10 11 12
Cable Type	Connector A	Connector B	Assembly Length

Positions 1–2: See Tables 2 and 3 for the two-letter codes representing each cable type.

Positions 3–5 and 6–8: See Table 6 for the list of connectors available for each cable type. Connector codes A and B must be in alphanumeric order. Additionally, Gore offers an interface that can be used with replaceable connectors for 18 GHz cables (Table 7).

Positions 9–12: The length of the assembly is expressed in inches to the nearest tenth, including zeroes to fill positions if the length is less than three digits. For example, the length of a 24-inch test assembly is specified as 0240 in the last four digits of the part number. Cables are available in standard lengths of 12 in (0.30 m), 24 in (0.61 m), 36 in (0.91 m), 48 in (1.22 m), and 60 in (1.52 m).

Gore's Microwave/RF Assembly Builder is a step-by-step tool that allows you to configure and request a quote for a test assembly. For more information, visit **www.gore.com/rfcablebuilder**.

Table 6: Ordering Information for Special Purpose Test Assemblies, continued

Part Number	Gore Cable Type	Connector A	Connector B	Length cm/(in)
CX0AB0ABC10.0	CX	1.0 mm Male	1.0 mm Male	10.0 (3.9)
CX0AA0ABC10.0	CX	1.0 mm Female	1.0 mm Male	10.0 (3.9)
CX0AA0AAC10.0	CX	1.0 mm Female	1.0 mm Female	10.0 (3.9)
CX0AB0ABC13.0	CX	1.0 mm Male	1.0 mm Male	13.0 (5.1)
CX0AA0ABC13.0	CX	1.0 mm Female	1.0 mm Male	13.0 (5.1)
CX0AA0AAC13.0	CX	1.0 mm Female	1.0 mm Female	13.0 (5.1)
CX0AB0ABC16.0	CX	1.0 mm Male	1.0 mm Male	16.0 (6.3)
CX0AA0ABC16.0	CX	1.0 mm Female	1.0 mm Male	16.0 (6.3)
CX0AA0AAC16.0	CX	1.0 mm Female	1.0 mm Female	16.0 (6.3)
CX0AB0ABC20.0	CX	1.0 mm Male	1.0 mm Male	20.0 (7.9)
CX0AA0ABC20.0	CX	1.0 mm Female	1.0 mm Male	20.0 (7.9)
CX0AA0AAC20.0	CX	1.0 mm Female	1.0 mm Female	20.0 (7.9)
CX0AB0ABC24.0	CX	1.0 mm Male	1.0 mm Male	24.0 (9.4)
CX0AA0ABC24.0	CX	1.0 mm Female	1.0 mm Male	24.0 (9.4)
CX0AA0AAC24.0	CX	1.0 mm Female	1.0 mm Female	24.0 (9.4)
CX0AB0ABC30.0	CX	1.0 mm Male	1.0 mm Male	30.0 (11.8)
CX0AA0ABC30.0	CX	1.0 mm Female	1.0 mm Male	30.0 (11.8)
CX0AA0AAC30.0	CX	1.0 mm Female	1.0 mm Female	30.0 (11.8)

Table 7: Ordering Information for Replaceable Connectors

Connector	Part Number
SMA Male	10020014
SMA Female	10028708
TNCA Female	10034080
Precision N Male	10020009
Precision N Female	10032620
7 mm Hermaphroditic	10020012
TNCA Male	10020001
3.5 mm Male	10060062
3.5 mm Ruggedized DUT Male	10292654
3.5 mm Female	10066130

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GORE® PHASEFLEX® Microwave/RF Test Assemblies provide unmatched precision, repeatabiity and durability over time.

Application Notes

NOTICE — USE RESTRICTIONS APPLY
Not for use in food, drug, cosmetic or medical device manufacturing, processing, or packaging operations.

GMCA-0025-R2-DAT-US-NOV15

W. L. Gore & Associates

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