Technical Reference for RF Interconnects

Product Care & Handling

Connector Interfaces

Interface Cleanliness

Clean Interfaces prolong connector life and produce more accurate, repeatable measurements. The use of connector end-caps to protect test cables and adapters when not in use is recommended.

Interface Cleaning Procedure

1. Solvents: Connector insulators, support beads, and seals are susceptible to solvent damage. Solvents can produce permanent physical and electrical damage. Isopropyl alcohol is recommended for cleaning interfaces. It should be noted that connector interfaces should not be immersed in solvents of any kind because solvents can become trapped within the connectorized assembly. Trapped fluids can cause SWR, Phase, and Insertion Loss problems.
2. Applicators: Fibrous or abrasive applicators can contaminate and even damage interface surfaces. Clean lint free swabs should be used. They need to be sharp enough and hard enough to remove dirt and debris without damaging surfaces and/or dislodging center pins.
3. Method: Dip a clean lint free swab in clean isopropyl alcohol. Press excess alcohol out of swab on a clean lint free towel. Wipe the interface components as required to clean the interface. Blow-dry the interface with clean compressed air. Re-inspect the connector to verify that the interface is clean and ready for additional inspection procedures and interface gauging prior to use.

Interface Gauging

Incorrect center pin depths can produce inaccurate measurements and in the case of protruding center pins can damage test devices, adapters, and test ports. Frequent interface gauging can detect gauging problems before they ruin mating devices (see Table I).

Table I: Connector Interface Pin Depths

Connector Interface	Contact Location wrt Reference Plane (in.)	Specification
7 mm	-0.002 / -0.002	IEEE STD 287
N Male	0.210 / -0.230	MIL-STD-348
N Female	+0.187 / +0.207	MIL-STD-348
3.5 mm	0 / -0.003	IEEE STD 287
2.92 mm	0 / -0.003	IEEE STD 287
2.4 mm	0 / -0.002	IEEE STD 287
1.85 mm	0 / -0.002	IEEE STD 287
SMA	0 / -0.010	MIL-STD-348
TNC / BNC	-0.210 / -0.230	MIL-STD-348
TNC / BNC	+0.186 / +0.206	MIL-STD-348
7-16 Male	+0.0579 / +0.0697	IEC 169-4
7-16 Female	-0.0697 in. / -0.0815	IEC 169-4

Recommended Coupling Torque

Incorrect coupling torque can produce inaccurate measurements and over-torque coupling can damage test devices, adapters, and test ports. Torque wrenches should be utilized to for all mate/de-mate processes (see Table II).

Table II: Recommended Coupling Torque

Interface Type	Coupling Torque (in.-lbs.)
7 mm, N	12
3.5 mm, 2.92 mm, K®, 2.4 mm, 1.85 mm	8
SMA, TNC	5

Cable Routing

Bend Radius

Care should be taken to avoid over-bending test cables beyond minimum bend radius guidelines. Over-bending can force cable center conductor off-center, and can force the outer conductor out of round even to the point of kinking and fracture. Over bending results in degraded IL and SWR performance. It should also be noted that coiling cables at small diameters could force connector center-pins to protrude beyond required interface dimensions.

Twisting

Twisting test cables should be avoided at all times. Excessive twist can damage cable assembly at the cable/connector junction or even mid-cable depending on how the twist is applied. Lower level twist can cause measurement problems as well. Induced stresses on test ports and device ports can damage the ports.

Cable Assembly Mate/De-Mate Process

Interface Alignment

Contact Pins and Dielectrics can be damaged if misaligned connectors are mated. Make sure that mating interfaces are parallel and on center during mate/de-mate cycle.

Interface Rotation

Plating and surface finish of outer and inner contacts can be damaged it connector bodies are allowed to rotate during mate/de-mate cycle. Use wrench flats on connector bodies to keep them rotationally stationary while rotating coupling nut during the mate/de-mate process.

Minimized Load Configuration

Allow test cable to assume natural bend configuration route between test port and device port. Loosen test port connection when test configuration is largely different than test configuration. Route the cable, connect device port loosely then tighten both port connections to recommended coupling torque (see Table II). This method will minimize most bend and twist loading issues.

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Technical Reference for RF Interconnects (cont'd)

MegaPhase Materials Temperature Ratings

Description	Comments	Operating Temperature
Core Types		
Teflon Core		-103 to 392ºF (-75 to 200ºC)
Polyethylene Core		-103 to 176ºF (-75 to 80ºC)
Cable Protection Types		
No Jacket	Standard strength, heat dissipation	See Core Type
Braid Only	Modest strength, heat dissipation	See Core Type
Polyolefin Jacket	System use, standard strength	-67 to 275ºF (-55 to 135ºC)
Polyolefin Jacket over Braid	TM Series standard, Test and System use, modest strength	-67 to 275ºF (-55 to 135ºC)
Neoprene Jacket	Outdoor use, environmental protection	-94 to 250ºF (-70 to 121ºC)
Neoprene Jacket over Braid	Modest strength, environmental protection	-94 to 250ºF (-70 to 121ºC)
FEP Jacket	Space, low outgassing	-103 to 392ºF (-75 to 200ºC)
FEP Jacket over Braid	Modest strength, low outgassing	-103 to 392ºF (-75 to 200ºC)
Polyethylene	Tower 7 Series standard	-103 to 176ºF (-75 to 80ºC)
Nomex Braid	Airborne or Plenum use	-103 to 392ºF (-75 to 200ºC)
Nomex over Metallic Braid	Modest strength, Airborne or Plenum use	-103 to 392ºF (-75 to 200ºC)
Viton Jacket	Space, radiation protection, NBC	-40 to 392ºF (-40 to 200ºC)
Viton Jacket over Metallic Braid	Modest strength, radiation resistant, NBC	-40 to 392ºF (-40 to 200ºC)
Teflon Tape Wrap Jacket	High flexibility	-103 to 392ºF (-75 to 200ºC)
Polyurethane Jacket	Exterior UV and high abrasion resistance	-103 to 257ºF (-75 to 125ºC)
Other Armor	Crush resistant, extra strength	Dependant on Armor Type
Marker and Strain Relief Types		
Semi-Flexible Dual Wall Polyolefin (DWP)	General purpose, flexible adhesive for environmental seal	-67 to 230ºF (-55 to 110ºC)
Semi-Rigid Dual Wall Polyolefin (SCL)	General purpose, rigid adhesive	-67 to 230ºF (-55 to 110ºC)
Polyolefin	General purpose, flexible, no adhesive	-67 to 275ºF (-55 to 135ºC)
Viton	Space, radiation protection, no adhesive	-40 to 392ºF (-40 to 200ºC)
Kynar	Space, no adhesive	-67 to 347ºF (-55 to 175ºC)
Metal	Indoor use, no adhesive	-103 to 392ºF (-75 to 200ºC)

Cable Attenuation

For attenuation at any frequency, use the following formula: (K1 x √freq GHz) + (K2 x freq GHz)

Cable Type	Part Number	K1	K2
Phase3™ C Series	C08	0.19043	0.00957
	C12	0.10265	0.00127
	C19	0.07122	0.00164
	C29	0.04687	0.00173
JumpShot™ B Series	B08	0.22097	0.00903
	B14	0.12357	0.00643
ClearPath™ A Series	A06	0.38370	0.00360
	A08	0.22620	0.00630
Semi-rigid Cable	SR034	0.59248	0.00752
	SR047	0.39284	0.00716
	SR086	0.20608	0.01392
	SR141	0.10948	0.01052
	SR250	0.06569	0.00931
TowerFlex Cable	D19	0.11285	0.00470
	D24	0.07660	0.00330
	D30	0.06070	0.00330
	D40	0.03870	0.00260
	D60	0.02390	0.00260
	D90	0.01640	0.00160
TowerFeed Cable	725	0.05232	0.00558
	738	0.03574	0.00486
	748	0.02883	0.00323

Frequency Stops

Frequency (GHz)	IEEE (USA)
0.250	VHF
0.300	
0.500	UHF
1.000	L
3.000	S
6.000	C
8.000	
12.000	X
18.000	Ku
20.000	K
27.000	
30.000	Ka
35.000	
40.000	
45.000	V
50.000	
60.000	
70.000	

SWR/Return Loss Conversion

SWR	Return Loss (dB)
1.00:1	∞
1.01:1	46.02
1.02:1	40.06
1.03:1	36.60
1.04:1	34.15
1.05:1	32.25
1.06:1	30.72
1.07:1	29.42
1.08:1	28.29
1.09:1	27.31
1.10:1	26.45
1.12:1	24.94
1.14:1	23.69
1.15:1	23.12
1.18:1	21.66
1.20:1	20.83
1.22:1	20.08
1.25:1	19.09
1.30:1	17.70
1.35:1	16.54
1.40:1	15.56
1.45:1	14.72
1.50:1	13.98
1.55:1	13.32
1.60:1	12.74
1.65:1	12.21
1.70:1	11.73
1.75:1	11.29
1.80:1	10.88
1.85:1	10.51
1.90:1	10.16
1.95:1	9.84
2.00:1	9.54
2.10:1	8.98
2.20:1	8.52
2.30:1	8.09
2.40:1	7.71
2.50:1	7.36
2.60:1	7.04
2.70:1	6.76
2.80:1	6.49
2.90:1	6.25
3.00:1	6.02
3.20:1	5.62
3.40:1	5.26
3.60:1	4.96
3.80:1	4.68
4.00:1	4.44
5.00:1	3.52
6.00:1	2.92
7.00:1	2.50
8.00:1	2.18
9.00:1	1.94
10.00:1	1.74
15.00:1	1.16
20.00:1	0.87
25.00:1	0.70
30.00:1	0.58
35.00:1	0.50
∞	0.00

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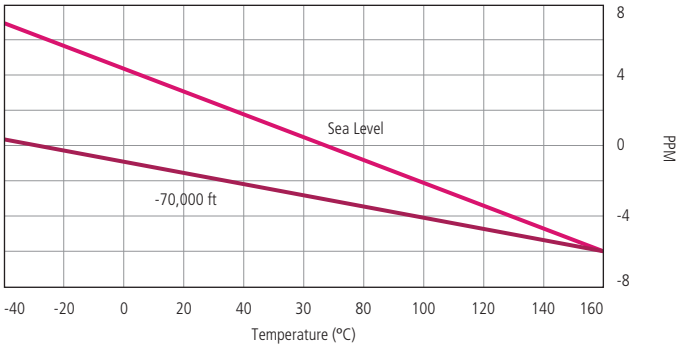
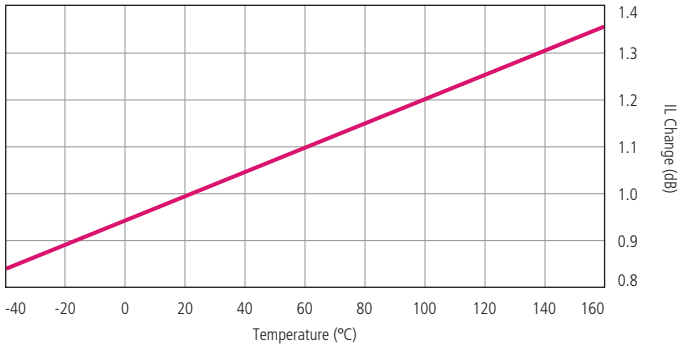
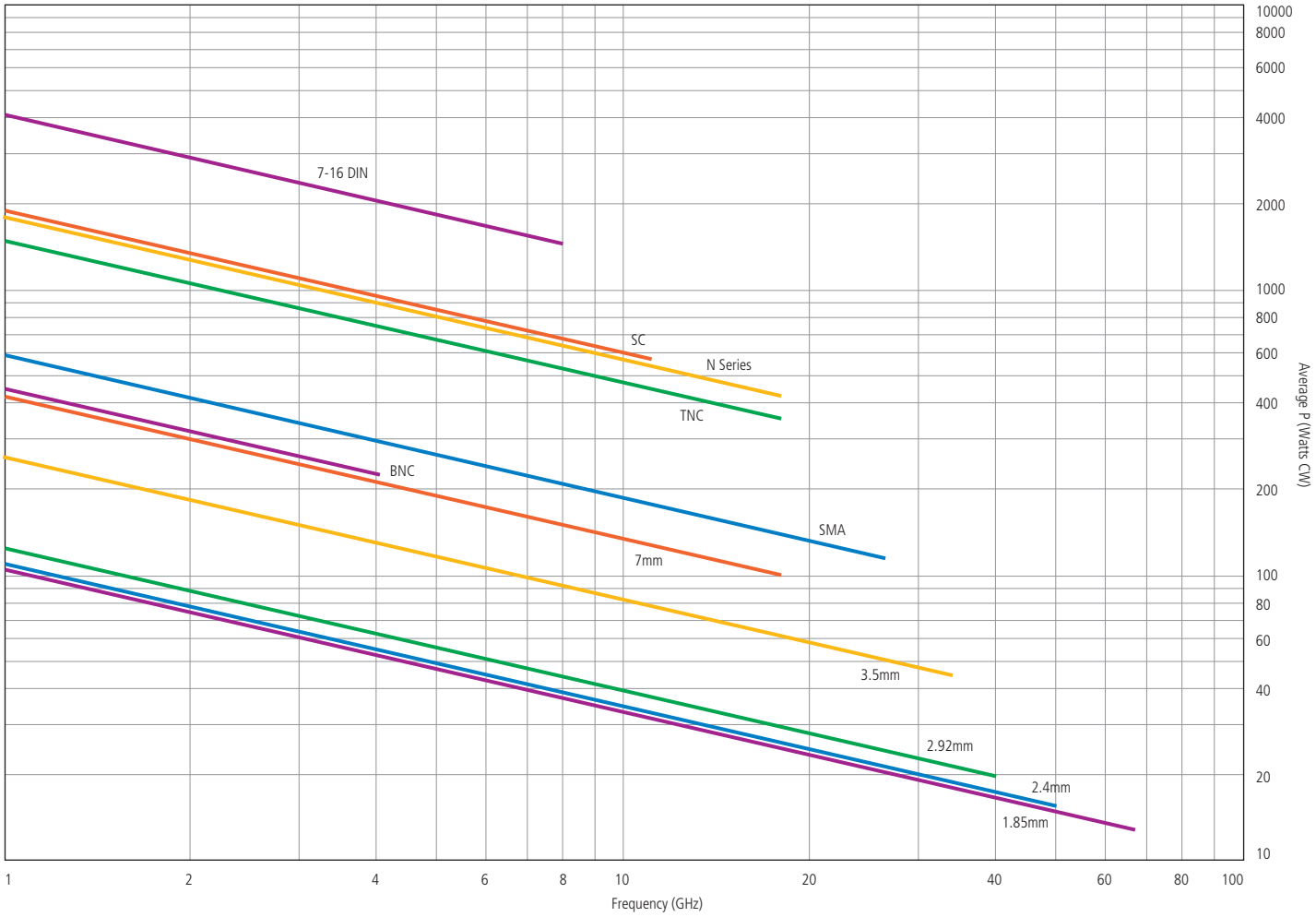
Power Derating over Temperature and Altitude



Attenuation Derating over Temperature



Connector CW Power Handling



Note: Data at ambient temperature and sea level.

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RF Connector Interface Specifications

Interface	Specification	Comments
7mm (APC-7)[1]	IEEE STD 287	
	IEC STD 457-2	
N 50 ohm	IEEE STD 287	
	MIL-STD-348A	Excellent information.
	IEC STD 169-16	Excellent information.
N 75 ohm	IEC STD 169-16	Appendix describes 75 ohm center conductors.
3.5mm	IEEE STD 287	
	IEC STD 169-23	Contains interface dimensions only.
	IEC STD 457-5	Describes beaded airline dimensions with no interface information.
2.92mm (K)[2]	IEEE STD 287	Compatible with Anritsu K Connector®.
2.4mm	IEEE STD 287	Compatible with Anritsu V Connector® and 1.85mm.
1.85mm	IEEE STD 287	Compatible with Anritsu V Connector® and 2.4mm.
1.0mm	IEEE STD 287	Compatible with Anritsu W1 Connector®.
SMA	MIL-STD-348A	
	MIL-C-39012	
	IEC STD 169-15	Specifies SMA performance up to 24 GHz.
TNC	MIL-STD-348A	
	MIL-C-39012	
	IEC STD 169-17	Specifies TNC performance up to 3 GHz.
	IEC STD 169-26	Specifies TNC performance up to 18 GHz.
BNC	MIL-STD-348A	
	MIL-C-39012	
	IEC STD 169-8	Specifies BNC performance up to 3 GHz.
SMC	MIL-STD-348A	
	MIL-C-39012	
	IEC STD 169-9	Specifies SMC performance up to 3 GHz.
SMB	MIL-STD-348A	
	MIL-C-39012	
	IEC STD 169-10	Specifies SMB performance up to 3 GHz.
F 75 ohm	IEC STD 169-24	Allows male pin to range in diameter from 0.51mm to 1.63mm.
	IPS-SP-400	F female.
	IPS-SP-401	F male. Male pin ranges from 0.56mm to 1.07mm.
	IPS-SP-402	F female push on connector.
	IPS-SP-600	F male push on connector. Male pin ranges from 0.56mm to 1.067mm.
FD	ANSI/EIA-550	F male pin ranges from 0.76mm to 0.86mm. Specified up to 1.5 GHz.
7-16	IEC 169-4	Specifies 7-16 performance up to 7.5 GHz.
	CECC 22190	

RF Connector Interface Information

Interface	Min. Upper Operating Freq. (GHz)	Coupling Torque		Metrology Grade	Instrument Grade	Production Grade
		in/lb	N/cm			
7mm (APC-7)[1]	18	12	135	•	•	•
N 50 ohm	18	12	135	•	•	•
N 75 ohm	18[6]	12	135	•[8]	•	•
3.5mm	33	8	90	•	•	•[9]
2.92mm (K)[2]	40	8	90		•	•
2.4mm	50	8	90	•	•	•
1.85mm[7]	65	8	90	•[8]	•	•
1.0mm	110	4[9]	45[9]		•	•
SMA	18[10]	5	56	•[11]	•[11]	•
TNC	11[12]	5	56		•	•
BNC	3	-	-			•
SMC	4	3-4	34-45			•
F 75 ohm	1	15	168			•
FD	3[13]	15	168	•[8]	•	•
7-16	7.5	20[14]	226[14]		•	•

1. APC-7 is a registered trademark of Amphenol Corporation.
2. Anritsu K Connector®.
3. Precision slotless contacts with the tightest tolerances to achieve best performance.
4. Slotted female center conductors (except 7mm) with tight tolerances and very good performance.
5. Lower cost connectors with moderate performance.
6. Theoretically doesn't mode until 18 GHz, but the Anritsu 85036B 75 ohm N Calibration Kit is specified to 3 GHz.
7. Fully mateable with the Anritsu V Connector®.
8. Components for these styles have been developed by Hewlett-Packard (Anritsu) for internal test purposes, but are not readily available.
9. Spec may still call out 34 N/cm, but we found we needed 45 N/cm for adequate repeatability.
10. Many have maximum frequency of 18 GHz, but some manufacturers specify performance of some of their SMA product line up to 27 GHz.
11. Considered the Production Grade version of the 3.5mm, just as the 3.5mm provides the Instrument and Metrology Grades for the SMA.
12. IEC 169-17 describes TNCs with 11 GHz or 16 GHz maximum frequency, but expectation for many connectors is only up to 3 GHz. IEC 169-26 specifies a TNC with 18 GHz maximum frequency.
13. EIA-550 Standard specifies 1.5 GHz maximum frequency, but the Anritsu 85039A F Calibration Kit is specified to 3 GHz.
14. Used for precision measurements. CECC 22190 specifies torque at 250-300 N/cm (approx. 20 ft/lb) in the field.

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