08 Sep 2000

WILL THE REAL TNC CONNECTOR PLEASE STAND UP?

The TNC has been, and still is, a very popular connector that is widely used today in many commercial and military applications due to its small size, rugged construction and good power-handling characteristics. Over the years, several changes have been incorporated to improve the connector's performance and extend its frequency range, providing both good and bad news. The good news is that better performance over a wider frequency range has been achieved. The bad news is that many variations in the TNC interface are now being used, creating a compatibility problem that can actually result in very poor performance and possible connector damage if the various TNC connectors are mixed and matched. The purpose of this application note is to describe the various TNC connectors most commonly used today and show the variations in interface dimensions that can cause compatibility problems.

The small size, rugged construction and good power-handling characteristics of the TNC connector are achieved at the expense of a complex, dielectrically loaded interface. A mated pair has no less than six interface dimensions (three on the female and three on the male) that must be tightly controlled. These critical interface dimensions are the contact pin location and the top and bottom faces of the dielectric, all located relative to the outer conductor mating plane, as shown in **Figure 1**.

The TNC connector evolved from the BNC connector, which is basically a bayonet-coupled TNC. The BNC connector is used commonly at lower frequencies. (It is generally not recommended above 2 GHz.) However, in the past, the TNC's screw-coupled design offered many advantages over the BNC in terms of stability, repeatability and environmental protection. Furthermore, the solid mechanical interface of the

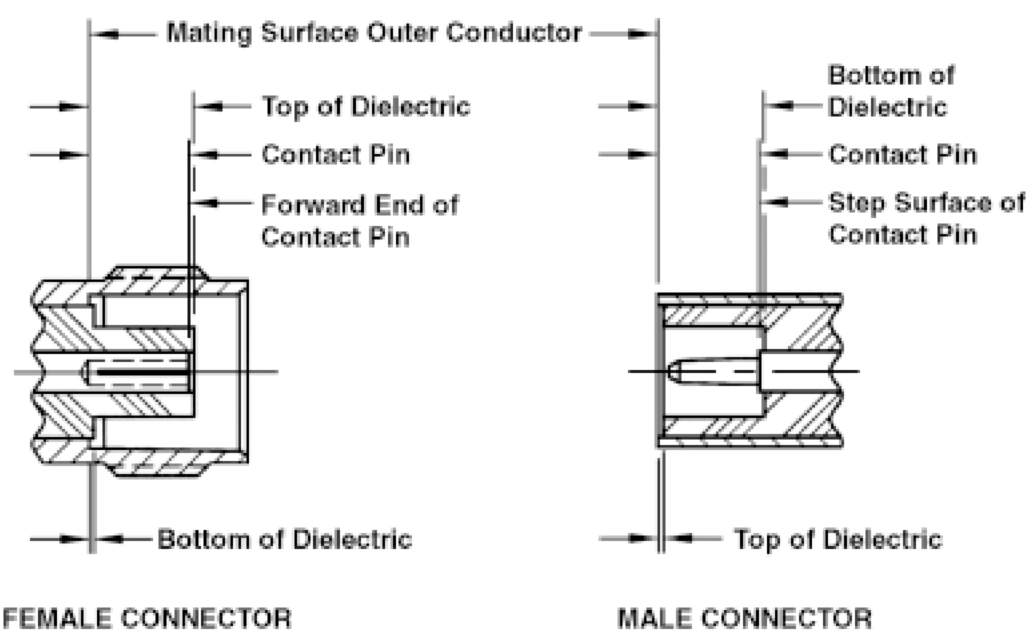

Figure 1: Critical TNC connector dimensions

TABLE 1
TNC Connectors

Specification	Frequency (GHz)	Comments
MIL-C-87104/2 (AFTNC)	DC — 18	AFTNC is a Maury designation for Air Force TNC. The Maury interface is identical to MIL-C-87104/2 except the male outer conductor is solid and the connectors are rated to 20 GHz.
MIL-STD-348A (TNCA) MIL-STD-348A Test Connector MIL-STD-348A Commercial	DC — 18 DC — 16 DC — 16	These connectors are among the most common types used today for military and commercial applications. The test connector is identical to and has replaced the MIL-STD-39012C test connector.
MIL-T-81490 (AS)	DC — 16	This connector is an electronic warfare design used for Naval air systems.
Maury 5E-053A	DC — 18	Originally designed in 1967 as a general purpose test connector, the 5E-053 interface has been improved over the years and is now compatible with all TNC connectors covered in this article.
IEC 169-26 Grade 0 IEC 169-26 Grade 1	DC — 18 DC — 18	European design. Grade 0 is a standard test connector and Grade 1 is a high performance connector.
IEC 169-17 Grade 0 IEC 169-17 Grade 1	DC — 16 DC — 16	European design. Grade 0 is a test connector and Grade 2 is a general purpose connector.

TNC allowed for a design that could operate up to approximately 11 GHz, a major improvement at the time. As a result, the design soon became very popular, especially in military applications where rugged, environmentally sound connectors were in demand.

Over the years, the demand for higher frequency operation caused manufacturers to improve upon the initial TNC design, and reasonably good performance was extended to 16 GHz, which appeared to be the upper limit of mode-free operation. However, during the '60s and '70s there was a great demand for a TNC connector that could operate to 18 GHz (the upper end of WR62 waveguide). This frequency extension was not possible without making some fundamental adjustments to the basic TNC design that had been standardized and controlled by commercial and military requirements. Deviating from the standard TNC design (due to the complexities of the dielectrically loaded interface) would, in essence, mean creating a different connector. However, the need to reach 18 GHz soon became great enough that this change was permitted.

Over the past 20 years, several variations in the basic TNC interface have been made and improved performance to 18 GHz has been achieved. These variations have caused a proliferation of incompatible TNC connectors that now exist in the TNC world. This article covers 10 of the most commonly used TNC-type connectors in use today as well as their mechanical parameters. **Table 1** lists a brief description of these connectors.

Female and male connectors of the same specification type are designed to provide the best-matched condition when mated together. When connectors of different specifications are mated, poor electrical performance and connector damage due to an interface fit can result. Ordinarily, different types of TNC connectors would not be mixed together.

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TABLE 2

TNC Compatibility Chart

			MIL-C-87104/2 (AFTNC)		Maury 5E-053A[1]		IEC 169-26 Grade 1		IEC 169-26 Grade 0		IEC 169-17 Grade 0		IEC 169-17 Grade 2		MIL-STD-348A TNC		MIL-STD-348A Test Conn[3]		MIL-STD-348A TNCA[4]		MIL-T-81490 [5]	
			M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
FREQ RANGE (GHz)			18		18		18		18		16		16		16		16		18		16	
MIL-C-87104/2 (AFTNC)	M	18				OK		OK		OK	6	OK	6	OK	6	OK	6	OK		OK	6	2
	F				1		2		2		OK	6	OK	6	OK	6	OK	6	2		OK	6
Maury 5E-053A[1]	M	18						OK		OK	6	OK	6	OK	6	OK	6	OK		OK	6	OK
	F						OK		OK		OK	6	OK	6	OK	6	OK	6	OK		OK	6
IEC 169-26 Grade 1	M	18								OK	6	2	6	2	6	2	6	2		OK	6	2
	F								OK		OK	6	OK	6	OK	6	OK	6	OK		OK	6
IEC 169-26 Grade 0	M	18									6	2	6	2	6	2	6	2		OK	6	2
	F										OK	6	OK	6	OK	6	OK	6	OK		OK	6
IEC 169-17 Grade 0	M	16												OK		OK		OK	6	OK		2
	F												OK		OK		OK		2	6	OK	
IEC 169-17 Grade 2	M	16														OK		OK	6	OK		2
	F														OK		OK		2	6	OK	
MIL-STD-348A TNC	M	16																OK	6	OK		OK
	F																OK		2	6	OK	
MIL-STD-348A Test Conn[4]	M	16																	6	OK		OK
	F																		2	6	OK	
MIL-STD-348A TNCA[3]	M	18																			6	2
	F																				OK	6

1 Compression fit of mating dielectrics is possible with early designs.

2 Mating will result in noncontacting outer conductors.

3 Maury MIL-STD-348A TNCA interface is fully compliant with the specification. The Maury connector is rated to 19 GHz.

4 MIL-C-39012 test connector has been replaced by the MIL-STD-348A test connector. Both specifications are identical.

5 The male connector interface of this specification is not fully defined.

6 Frequency compatibility problem. These connectors should not be mixed except in cases where one connector has been chosen as a test connector and is characterized on a network analyzer for error corrected measurements.

However, because many of these connectors cannot be identified by visual inspection, there is now a very good chance that unlike connectors will be unknowingly mated together. This problem is an ever-increasing reality as the various new designs proliferate the industry.

The purpose of this application note is not to discourage the use of TNC connectors; the described compatibility problems can be prevented by using caution and the proper inspection techniques. **Table 2** lists connector compatibility results in terms of mechanical compatibility and operating frequency limits when mixing various TNC connectors together.

Although exact electrical performance is unknown when mating unlike designs, less than optimum performance can be expected. For example, if a TNC connector rated to 18 GHz is mated with a design rated to 16 GHz, degraded performance can be expected above 16 GHz and, most likely, at other places in the band.

Table 3 lists various TNC interface dimensions. The connectors can be separated into two groups: American standards and European standards. The International Electrical Commission (IEC) connectors are controlled by European standards. The remaining connector types are American. Some mechanical

TABLE 3

TNC Contact and Dielectric Location Chart

Pin or Dielectric	MIL-C-87104/2	MIL-STD-348A[1]	MIL-T-81490	Maury 5E-053A	IEC 169-17	IEC 169-26
Male	**AFTNC[2]**	**TNCA[3]**				
Male pin	0.2105 ± 0.0015	0.208 minimum				
Top of dielectric	none	none				
Bottom of dielectric	0.2105 ± 0.0015	0.208 minimum				
Female						
Female pin	0.2065 ± 0.0015	0.208/0.198				
Top of dielectric	0.2065 ± 0.0015	0.208/0.198				
Bottom of dielectric	0.0045 ± 0.0015	0.006 maximum				
Male		**Test Connector**		**Test Connector**	**G0[3]**	**G0[3]**
Male pin		0.209 +0.003/-0.000		0.209 +0.005/-0.000	0.209 +0.003/-0.000	0.208
Top of dielectric		0.006 +0.006/-0.000		0.004 +0.004/-0.000	0.006 +0.006/-0.000	none
Bottom of dielectric		0.212 +0.006/-0.000		0.209 +0.005/-0.000	0.212 +0.006/-0.000	0.208 minimum
Female						
Female pin		0.208 +0.000/-0.003		0.208 +0.000/-0.005	0.208 +0.000/-0.003	0.208/0.198
Top of dielectric		0.208 +0.000/-0.008		0.208 +0.000/-0.005	0.206 +0.000/-0.006	0.208/0.204
Bottom of dielectric		0.006 +0.000/-0.006		0.006 +0.000/-0.004	0.006 +0.000/-0.006	0.006 maximum +0.000/-0.006
Male		**Commercial**	**Type 1**		**G2[3] Commercial**	**G1[3] Commercial**
Male Pin		0.210/0.230	0.209/0.212		0.210 minimum	0.208 minimum
Top of dielectric		0.006 minimum	0.006/0.009		0.006 minimum	none
Bottom of dielectric		0.208/0.228	0.209/0.212		0.208 minimum	0.208 minimum
Female						
Female pin		0.206/0.186	0.208/0.205		0.206/0.179	0.208/0.197
Top of dielectric		0.208/0.188	0.208/0.205		0.208 maximum	0.208/0.198
Bottom of dielectric		0.006 maximum	0.006/0.003		0.006 maximum	0.006/0.000

1 MIL-C-39012 has been replaced with MIL-STD-348A.

2 The dimensions for the AFTNC connectors are measured using a polarized technique. The master gage (A012E7) sets the dial indicator to read one end of the tolerance when zeroed.

3 The specifications for some of these connectors list only one dimension.

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Figure 2: The male TNC interface

differences exist that may help identify a few of the designs by visual inspection. For example, male connectors that have no Teflon™ dielectric around the male pin, as shown in **Figure 2**, are either MIL-C-87104/2, MIL-STD-348A (TNCA) or IEC 169-26 (G0 or G1) types. These connectors are rated to 18 GHz. The MIL-C-87104/2 male connector has a 0.0075" counterbore on the mating surface of the outer conductor. This counterbore appears as a small step on the inside diameter when looking at the face of the outer conductor. (Note that type A connectors represent the original design, rated to 16 GHz. Type B connectors, with the Teflon™ dielectric cut back to just below the step in the center conductor, are the newer 18 GHz design.)

The outer conductor on the male TNC connector may be slotted or solid. Some of the standards permit a choice of slotted or solid for a given design. This information can be obtained from the applicable specifications: MIL-C-87104/2; MIL-STD-348A, TNCA, Test and Commercial connectors; MIL-T-81490, Type 1; IEC 169-17, grade 0 and grade 2; IEC 169-26, grade 0 and grade 1; Maury 5E-053A, engineering designs and standards; and MIL-C-39012.

At this point, only a few of the similarities and differences that exist in the various TNC designs have been described. Already it would appear that a TNC expert is required when using these connectors. In reality, only two pieces of information must be obtained to determine the interface specification of a TNC connector. First, a copy of the specifications showing the interface dimensions for the connector should be obtained from the manufacturer. Next, a connector gage should be used to measure the interface dimensions for conformity to specifications. Any out-of-specification condition can degrade performance. Any protrusion of the contact pin can cause severe damage when mated.

Conclusion

The TNC connector is one of the oldest and most widely used connectors in the microwave industry. Several design changes have been made over the past few years to improve performance. Some of the latest designs have extended the operating frequency to 19 GHz and improved the connector's overall quality and performance. The small size, rugged construction and environmentally sound characteristics of the TNC connector have made it a popular choice for many military and commercial applications. However, due to the many design changes, TNC connectors now must be thought of as a series of connectors with a variety of interface designs and performance characteristics. When female and male connectors with different specifications are mated, less than optimum electrical performance can be expected and connector damage is possible. However, if care is taken to avoid mixing and matching the various designs, the improved electrical performance and extended frequency range make the TNC connector a good choice for many applications.

Acknowledgments

The author wishes to thank the late Mario A. Maury, Jr., former president of Maury Microwave Corporation, for his valuable design contributions to improving TNC measurements and for his design of the original connector gages that are now widely used in the microwave industry.

About the Author

Dave White received his AA degree from Mt. San Antonio College and his AS degree from Chaffey College in 1962 and 1976, respectively. In 1980, he attended the UCLA school for professional writers. From 1967 to 1993, White was a test engineer and laboratory manager as well as a technical writer at Maury Microwave Corporation. From 1962 to 1967, he was employed as a microwave specialist with the RF

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This Technical Feature
was Reprinted From
Microwave Journal
May 1999

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