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ANAMET Connector Guide  
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# ANAMET REPORT

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# ***GUIDANCE ON USING COAXIAL CONNECTORS IN MEASUREMENT***



*Covers DC, Low Frequency, Radio Frequency,  
Microwave and Millimetre-wave frequencies.*

**Compiled by: Doug Skinner**

*Every effort has been made to ensure that this guide contains accurate information obtained from many sources that are acknowledged where possible. However the NPL, ANAMET and the Compiler cannot accept liability for any errors, omissions or misleading statements in the information. The compiler would like to thank all those who have supplied information, comment and advice on the preparation of this document.*

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## GUIDANCE ON USING COAXIAL CONNECTORS IN MEASUREMENT

### 1. INTRODUCTION

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The importance of the correct use of coaxial connectors not only applies at radio and microwave frequencies but also at DC and low frequency. The requirement for 'Traceability to National Standards' for measurements throughout industry may depend on several different calibration systems 'seeing' the same values for the parameters presented by a device at its coaxial terminals. It is not possible to include all the many different types of connectors in this guide and the selection has been made on those connectors used on measuring instruments and for metrology use.

It is of vital importance to note that mechanical damage can be inflicted on a connector when a connection and disconnection is made at any time during its use.

The common types of general-purpose coaxial connectors that are in volume use worldwide are the type N, 7/16, TNC, BNC, and SMA connectors. These connectors are employed for interconnection of components and cables in military, space, industrial and domestic applications.

The simple concept of a coaxial connector comprises an outer conductor contact, an inner conductor contact, and means for mechanical coupling to a cable and/or to another connector. Most connectors, in particular the general purpose types, comprise of plugs (male) and sockets (female).

There are basically two grades of coaxial connectors in use and they are known as precision grade or general purpose grade connectors.

Some connectors are hermaphroditic (non-sexed), particularly some of the precision types, and any two connectors may be joined together. They have planar butt contacts and are principally employed for use on measurement standards and on equipment and calibration systems where the best possible uncertainty of measurement is essential. Most of the non-sexed connectors have a reference plane that is common to both the outer and inner conductors. The mechanical and electrical reference planes coincide and, in the case of the precision connectors, a physically realised reference plane is clearly defined.

Some of the precision grade connectors are of the plug and socket construction and look similar to the general-purpose grade but the materials used in the construction are more robust and the mechanical tolerances are more precise. It is important to be clear on the particular grade of connector being used. Other precision connector types in common use are the GPC14mm, GPC7mm, Type N7mm, GPC3.5mm, Type K2.92mm, GPC2.4mm and Type V 1.85mm.

The choice of connectors, from the range of established designs, must be appropriate to the proposed function and specification of the device or measurement system; repeatability of the connection is generally one of the most important parameters.

## 2. CONNECTOR REPEATABILITY

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Connectors in use on test apparatus and measuring instruments at all levels need to be maintained in pristine condition in order to retain the performance of the test apparatus. The connector repeatability is a key contribution to the performance of a measurement system.

Connector repeatability can be greatly impaired because of careless assembly, misalignment, over-tightening, inappropriate handling, poor storage, and unclean working conditions. In extreme cases, permanent damage can be caused to the connectors concerned and possibly to other originally sound connectors to which they are coupled.

Connectors should never be rotated relative to one another when being connected and disconnected. Special care should be taken to avoid rotating the mating plane surfaces against one another.

### **Handling of airlines**

When handling or using airlines and similar devices used in automatic network analyser, calibration and verification kits it is extremely important to avoid contamination of the component parts due to moisture and finger marks on the lines. Protective lint free cotton gloves should always be worn. The failure to follow this advice may significantly reduce performance and useful life of the airlines.

### **Assessment of connector repeatability**

In a particular calibration or measurement system, repeatability of the coaxial interconnections can be assessed from measurements made after repeatedly disconnecting and reconnecting the device. It is clearly necessary to ensure that all the other conditions likely to influence the alignment are maintained as constant as possible.

In some measurement situations it is important that the number of repeat connections made uses the same alignment of the connectors.

In other situations it is best to rotate one connector relative to the other between connections and reconnections. For example, when calibrating or using devices fitted with Type N connectors (e.g. power sensors or attenuator pads) three rotations (approximately 120°) or five rotations (approximately 72°) are made. However, it is important to remember to make the rotation before making the contact.

The repeatability determination will normally be carried out when trying to achieve the best measurement capability on a particular device, or when initially calibrating a measuring system. The number of reconnections and rotations can then be recommended in the measurement procedure.

Repeatability of the insertion loss of coaxial connectors introduces a major contribution to the Type A component of uncertainty in a measurement process. If a measurement involving connectors is repeated several times, the Type A uncertainty contribution deduced from the results will include that arising from the connector repeatability provided that the connection concerned is broken and remade at each repetition.

It should be remembered that a connection has to be made at least once when connecting an item under test to the test equipment and this gives rise to a contribution to the Type A associated with the connector repeatability.

Experience has shown that there is little difference in performance between precision and ordinary connectors (when new) so far as the repeatability of connection is concerned, but with many connections and disconnections the ordinary connector performance will become progressively inferior when compared with the precision connector.

### 3. COAXIAL CONNECTOR SPECIFICATIONS

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The following specifications are some of those that provide information and define the parameters of established designs of coaxial connectors and they should be consulted for full information on electrical performance, mechanical dimensions and mechanical tolerances.

IEEE 287- 1968  
IEC Publication 457  
MIL-C-39012 C dated 11<sup>th</sup> August 1982  
IEC Publication 169  
CECC 22000  
British Standard 9210

Users of coaxial connectors should also take in to account any manufacturer's performance specifications relating to a particular connector in use.

### 4. INTERFACE DIMENSIONS AND GAUGING

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It is of the utmost importance that connectors do not damage the test equipment interfaces to which they are offered for calibration. Poor performance of many coaxial devices and cable assemblies can often be traced to non-compliance with the mechanical specification.

#### **When to gauge connectors**

A connector should be gauged before it is used for the very first time or if someone else has used the device on which it is fitted.

If the connector is to be used on another item of equipment, the connector on the equipment to be tested should also be gauged.

Connectors should never be forced together when making a connection since forcing often indicates incorrectness and incompatibility. Many connector screw coupling mechanisms, for instance, rarely need to be more than hand tight for electrical calibration purposes; most coaxial connectors usually function satisfactorily, giving adequately repeatable results, unless damaged. There are some dimensions that are critical for the mechanical integrity, non-destructive mating and electrical performance of the connector.

This means that all coaxial connectors fitted on all equipment, cables and terminations etc. should be gauged on a routine basis in order to detect any out of tolerance conditions that may impair the electrical performance.

Connector gauge kits are available for many connector types but it is also easy to manufacture simple low cost test pieces for use with a micrometer depth gauge or other device to ensure that the important dimensions can be measured or verified.

The mechanical gauging of coaxial connectors will detect and prevent the following problems:

**a. Inner conductor protrusion**

This may result in buckling of the female contacts or damage to the internal structure of a device due to the axial forces generated.

**b. Inner conductor recession**

This will result in poor voltage reflection coefficient, possibly unreliable contact and could even cause breakdown under peak power conditions.

Appendix A shows a list of the most common types of coaxial connector in use.

Appendix B gives information on the connector types including the critical mechanical dimensions that need to be measured for the selected connector types.

## 5. CONNECTOR CLEANING

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To ensure a long and reliable connector life, careful and regular inspection of connectors is necessary and cleaning of connectors is essential to maintaining good performance.

Connectors should be inspected initially for dents, raised edges, and scratches on the mating surfaces. Connectors that have dents on the mating surfaces will usually also have raised edges around them and will make less than perfect contact; further to this, raised edges on mating interfaces will make dents in other connectors to which they are mated. Connectors should be replaced unless the damage is very slight.

Awareness of the advantage of ensuring good connector repeatability and its effect on the overall uncertainty of a measurement procedure should encourage careful inspection, interface gauging and handling of coaxial connectors.

Prior to use, a visual examination should be made of a connector or adaptor, particularly for concentricity of the centre contacts and for dirt on the PTFE dielectric. It is essential that the axial position of the centre contact of all items offered for calibration should be gauged because the butting surfaces of mated centre contacts must not touch. If the centre contacts do touch, there could be damage to the connector or possibly to other parts of the device to which the connector is fitted. For precision hermaphroditic connectors the two centre conductor petals do butt up and the dimensions are critical for safe connections.

Small particles, usually of metal, are often found on the inside connector mating planes, threads, and on the dielectric. They should be removed to prevent damage to the connector surfaces. The items required for cleaning connectors and the procedure to be followed is described below

Items required

- a. Low pressure compressed air (solvent free).
- b. Cotton swabs (special swabs can be obtained for this purpose).
- c. Lint free cleaning cloth.
- d. Isopropanol.
- e. Illuminated magnifier.

**Note:**

Isopropanol that contains additives should not be used for cleaning connectors as it may cause damage to plastic dielectric support beads in coaxial and microwave connectors. It is important to take any necessary safety precautions when using chemicals or solvents.

### **Cleaning procedure**

#### **First Step**

Remove loose particles on the mating surfaces and threads etc. using low-pressure compressed air.

#### **Second Step**

Clean surfaces using Isopropanol on cotton swabs or lint free cloth. Use only sufficient solvent to clean the surface. When using swabs or lint free cloth, use the least possible pressure to avoid damaging connector surfaces. Do not spray solvents directly on to connector surfaces or use contaminated solvents.

#### **Third Step**

Use the low-pressure compressed air once again to remove any remaining small particles and to dry the surfaces of the connector to complete the cleaning process before using the connector.

### **Cleaning connectors on static sensitive devices**

Special care is required when cleaning connectors on test equipment containing static sensitive devices. When cleaning such connectors always wear a grounded wrist strap and observe correct procedures. The cleaning should be carried out in a special handling area. These precautions will prevent electrostatic discharge (ESD) and possible damage to circuits.

## **6. CONNECTOR LIFE**

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The number of times that a connector can be used is very difficult to predict and it is quite clear that the number of connections and disconnections that can be achieved is dependent on the environmental conditions and the care taken when making a connection. Some connector bodies such as those used on the Type N connector are made using stainless steel and are generally more rugged, have a superior mechanical performance and a longer useable life. The inner connections are often gold plated to give improved electrical performance.

For many connector types the manufacturer's specification will quote the number of connections and disconnections that can be made. The figure quoted may be as high as >5000 times but this figure assumes that the connectors are maintained in pristine condition and correctly used. The type SMA connector, for example, was originally designed to be used within equipment in order to join two items together and its connector life is therefore relatively short in repetitive use situations.

However, by following the guidance given in this document it should be possible to maximise the lifetime of a connector used in the laboratory.

### 7. ADAPTORS

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Buffer adaptors or ‘connector savers’ can be made use of in order to reduce possible damage to output connectors on signal sources and other similar devices. It should be remembered that the use of buffer adaptors and connector savers may have an adverse effect on the performance of a measurement system and may result in significant contributions to uncertainty budgets. Adaptors are often used for the following reasons:

1. To reduce wear on expensive or difficult to replace connectors on measuring instruments where the reduction in performance can be tolerated.
2. When measuring a coaxial device that is fitted with an SMA connector.

#### **Connector recession**

The ideal connector pair would be constructed in such a way in order to eliminate any discontinuities in the transmission line system into which the connector pair is connected. In practice, due to the mechanical tolerances there will almost always be a small gap between the mated plug and socket connectors. This small gap is often referred to as “recession”.

It may be that both of the connectors will have some recession because of the mechanical tolerances and the combined effect of the recession is to produce a very small section of line that will have a different characteristic impedance than the remainder of the line causing a discontinuity.

The effect of the recession could be calculated but there are a number of other effects present in the mechanical construction of connectors that could make the result unreliable. Some practical experimental work has been carried out at Agilent Technologies on the effect of recession. For more information a reference is given in Appendix F to an ANAMET article paper where the results of some practical measurements have been published.

The connector specifications give limit values for the recession of the plug and socket connectors when joined (see, for example, Appendix B for the Type N connector). The effects on the electrical performance caused by recession in connectors is a subject of special interest to users of network analysers and more experimental work needs to be carried out.

### 8. CONCLUSIONS

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The importance of the interconnections in measurement work should never be underestimated and the replacement of a connector may enable the Type A uncertainty contribution in a measurement process to be reduced significantly. Careful consideration must be given, when choosing a connector, to select the correct connector for the measurement task. In modern measuring instruments, such as power meters, spectrum analyzers and signal generators, the coaxial connector socket on the front panel is often an integral part of a complex subassembly and any damage to this connector may result in a very expensive repair.

It is particularly important when using coaxial cables, with connectors that are locally fitted or repaired that they are tested before use to ensure that the connector complies with the relevant mechanical specification limits. All cables, even those obtained from specialist manufacturers, should be tested before use. Any connector that does not pass the relevant mechanical tests should be rejected and replaced.

Further information on coaxial connectors can be obtained direct from manufacturers. Many connector manufacturers have a web site and there are other manufacturers, documents and specifications that can be found by using a search engine such as [www.google.com](http://www.google.com) and searching by connector type.

## Appendix A

### Frequency range of some common coaxial connectors

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The tables below list common types of coaxial connectors used on measurement systems showing the frequency range over which they are often used and the approximate upper frequency limit for the various line sizes.

Title	Line Size	Impedance	Upper Frequency Range (for normal use)	Upper Frequency Limit (approximate value)
GPC14	14.2875mm	50Ω	8.5GHz	9GHz
GPC14	14.2875mm	75Ω	3.0GHz*	8.5GHz
GPC7	7.0mm	50Ω	18GHz	18GHz

**Table A.1. PRECISION Non-sexed connectors**

Title	Line Size	Impedance	Upper Frequency Range (for normal use)	Upper Frequency Limit (approximate value)
Type N	7.0 mm	50Ω	18GHz	22GHz
GPC 3.5	3.5mm	50Ω	26.5GHz	34GHz
Type K	2.92mm	50Ω	40GHz	46GHz
Type Q	2.4mm	50Ω	60GHz	60GHz
Type V	1.85mm	50Ω	75GHz	75GHz
Type W	1.0mm	50Ω	110GHz	110GHz

**Table A 2. Precision sexed connectors**

Title	Line Size	Impedance	Upper Frequency Range for normal use	Upper Frequency Limit (approximate value)
Type N	7.0mm	50Ω	18GHz	22GHz
Type N	7.0mm	75Ω	3GHz*	22GHz
7/16	16.0mm	50Ω	7.5GHz	9GHz
SMA	3.5mm	50Ω	26.5GHz	34GHz

**Table A.3. General purpose connectors**

*\* Measurements made in 75Ω impedance are normally restricted to an upper frequency limit of 3GHz*

## Appendix B

### B.1. The 14 mm precision connector

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The 14mm precision connector was developed in the early 1960s by the General Radio Company and is known as the GR900 connector. It has seen limited usage and is mainly used in primary standards laboratories and in military metrology. It is probably the best coaxial connector ever built in terms of its performance and it has low insertion loss, low reflection and extremely good repeatability. However, it is bulky and expensive.

The interface dimensions for the GPC 14mm connector are given in IEEE Standard 287 and IEC Publication 457.

Before use, a visual examination, particularly of the centre contacts, should be made. Contact in the centre is made through sprung inserts and these should be examined carefully. A flat smooth disc pressed against the interface can be used to verify correct functioning of the centre contact. The disc must fit inside the castellated coupling ring that protects the end surface of the outer connector and ensures correct alignment of the two connectors when mated. The inner connector should be gauged with the collet removed. There is a special tool kit that can be used for use with GR900 connectors.

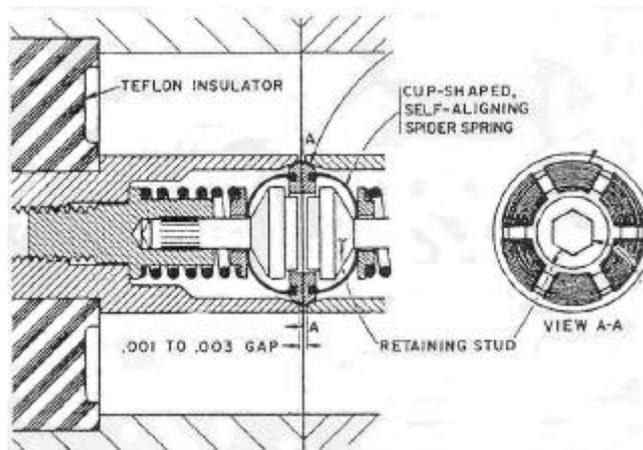
There are 50Ω and 75Ω versions of the GR900 connector available

The GR900 14mm connector is made in two types

<b>LPC</b>	<b>Laboratory precision connector</b>	<b>Air dielectric</b>
<b>GPC</b>	<b>General precision connector</b>	<b>Dielectric support</b>

The LPC version is usually fitted to devices such as precision airlines for use in calibration and verification kits for automatic network analysers and reflectometers.

There is also a lower performance version of the GR900 connector designated the GR890. The GR890 connector can be identified by the marking on the locking ring and it has a much reduced frequency range of operation e.g. 3GHz approx.



**Fig. 1 The GR 900 14mm connector**

## **B.2. The 7 mm precision connector**

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This connector series was developed to meet the need for precision connectors for use in laboratory measurements over the frequency range DC to 18GHz. This connector is known as the Type GPC 7 connector and it is designed as a hermaphroditic connector with an elaborate coupling mechanism. The connector interface features a butt co-planar contact for the inner and outer contacts, with both the mechanical and electrical interfaces at the same location. A feature of the GPC7 connector is its ruggedness and good repeatability over multiple matings in a laboratory environment.

The connector is made in two types.

<b>GPC</b>	<b>General precision connector</b>	<b>Dielectric support</b>
<b>LPC</b>	<b>Laboratory precision connector</b>	<b>Air dielectric</b>

The LPC version is usually fitted to devices such as precision airlines for use in calibration and verification kits for automatic network analysers and reflectometers.

The interface dimensions for the GPC7 connector are given in IEEE Standard No. 287 and IEC 457. The most common connector of this type in the UK has a centre contact comprising a slotted resilient insert within a fixed centre conductor. The solid part of the centre conductor must not protrude beyond the planar connector reference plane, although the resilient inserts must protrude beyond the reference plane. However, the inserts must be capable of taking up co-planar position under pressure. A flat, smooth plate or disc, pressed against the interfaces can verify correct functioning of the centre contact.

There are two versions of the collet for this connector one that has 4 slots and the other has 6 slots. For best performance it is good practice to replace the 4-slot version with the 6-slot type.

### **Connection and disconnection of GPC7 connectors**

It is important to use the correct procedure when connecting or disconnecting GPC7 connectors to prevent damage and to ensure a long working life and consistent electrical performance. The following procedure is recommended for GPC7 connectors.

#### **Connection**

1. On one connector, retract the coupling sleeve by turning the coupling nut until the sleeve and the nut become disengaged. The coupling nut can then be spun freely with no motion of the coupling sleeve.
2. On the other connector, the coupling sleeve should be fully extended by turning the coupling nut in the appropriate direction. Once again the coupling nut can be spun freely with no motion of the coupling sleeve.
3. Put the connectors together carefully but firmly, and thread the coupling nut of the connector with the retracted sleeve over the extended sleeve. Finally tighten using a torque spanner set to the correct torque (see appendix D).

### Disconnection

1. Loosen the fixed coupling nut of the connector showing the wide gold band behind the coupling nut. This is the one that had the coupling sleeve fully retracted when connected.
2. Part the connectors carefully to prevent damage to the inner conductor collet.

It is a common but bad practice with hermaphroditic connectors, to screw the second coupling ring against the first in the belief that there should be no loose parts in the coupled pair. This reduces the pressure between the two outer contacts of the connectors, leading to higher contact resistance and less reliable contact.

When connecting terminations or mismatches etc. do not allow the body of the termination to rotate. To avoid damage, connectors with retractable sleeves (e.g. GPC7) should not be placed face down on their reference plane on work surfaces. When not in use withdraw the threaded sleeve from under the coupling nut and fit the plastic protective caps.

### Measurement of the GPC-7 connector with the collet in place

A special gauge is available to measure the pin depth of GPC-7 connectors with the collet in place. It was originally developed by NIST and is now produced by Custom Microwave in the USA.

Most gauges for GPC-7 connectors require the collet to be removed prior to gauging and replaced afterwards. It is difficult to remove the collets and they are easily damaged. The special gauge means that it is not necessary to remove the collet to check the pin depth. The collet is pushed back to the solid inner conductor shoulder by operating the lever on top of the gauge (see the photograph in Figure 2.1). This is a useful tool that enables the user to check the GPC-7 specifications very efficiently.



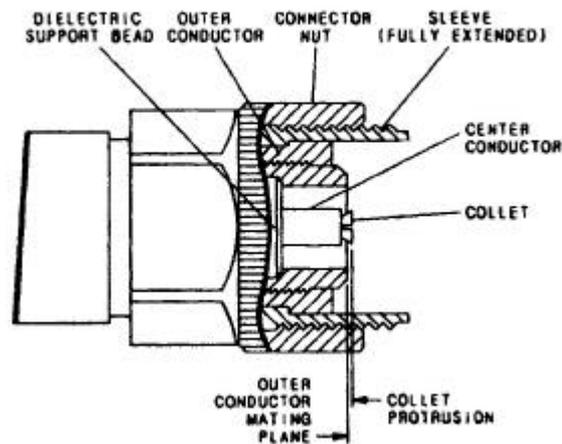
Courtesy of metas

Figure 2.1. Close up of the special jig to measure GPC7 Connectors

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Figure 2.2 shows the construction of the GPC7 Connector



**Fig. 2.2 The GPC 7 connector**

The use of GPC7 connector is normally restricted to making precision measurements in calibration laboratories

### B.3. The Type N 7mm connector

The type N connector is a rugged connector that is often used on portable equipment and military systems because of its large size and robust nature. The design of the connector makes it relatively immune to accidental damage due to misalignment during mating (subject to it being made and aligned correctly). The type N connector is made in both 50Ω and 75Ω versions and both types are in common use. In addition there are four, six finger and slotless types of inner.

For some applications Type N connectors need only be connected fingertight but torque settings are given in appendix D which should be used in metrology applications.

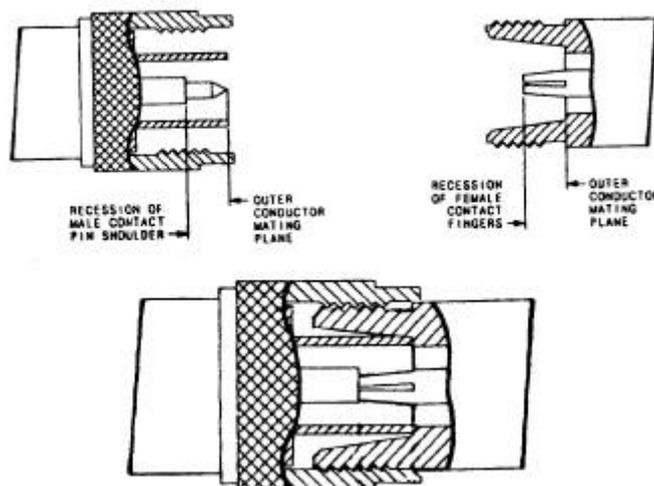
The construction and mechanical gauging requirements for the type N connector are shown in Fig 3 and gauging limits are listed in Table 3 and apply to both 50Ω and 75Ω connector types. For the convenience of users the dimensions are given in Imperial and Metric Units. The metric values are shown in brackets.

**Warning**

**75Ω Type N Connectors**

On the 75Ω connector the centre contact of the socket can be physically destroyed by a 50Ω pin centre contact so that cross coupling of 50Ω and 75Ω connectors is not admissible. Special adaptors can be purchased, which are commonly known as ‘short transitions’; to enable the connection to be made if necessary, but these transitions should be used with caution. If possible it is best to use a minimum loss attenuation pad to transfer from one impedance to another.

The Type N connector is designed to operate up to 18GHz but special versions are available that can operate up to 22GHz and also to 26.5GHz\*.



**Figure 3 The Type N connector**

\* Traceability of measurement is not at present available for devices fitted with 7mm connectors above 18GHz.

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Type N	Dimensions in inches (mm)		Gap between mated centre contacts		
	Female	Male	Min	Nom	Max
MMC Precision also HP Precision	0.000 (0.000) 0.207 (5.2578) -0.003 (- 0.0762)	+ 0.003 (+0.0762) 0.207 (5.2578) 0.000 (0.0000)	0.000 (0.000)	0.000 (0.000)	0.006 (0.1524)
MIL-C-39012 Standard Test	0.000 (0.0000) 0.207 (5.2578) - 0.003 (- 0.0762)	+ 0.003 (+0.0762) 0.208 (5.2832) 0.000 ( 0.0000)	0.001 (0.0254)	0.001 (0.0254)	0.007 (0.1778)
MIL-C-39012 Class 2 Present type N	0.207 max (5.2578)	0.208 min (5.2832)	-	0.001 (0.0254)	-
MMC Type N equivalent to MIL-C-71B	+ 0.005 (+0.1270) 0.197 (5.0038) - 0.005 (- 0.1270)	+ 0.005 (+0.1270) 0.223 (5.6642) - 0.005(- 0.1270)	0.016 (0.4064)	0.026 (0.6604)	0.036 (0.9144)
MIL-C-71B Old type N	+ 0.010 (+0.254) 0.197 (5.0038) - 0.010 (- 0.2540)	+ 0.010 (+0.2540) 0.223 (5.6642) - 0.010 (- 0.2540)	0.006 (.01524)	0.026 (0.6604)	0.046 (1.1684)

**Table 3 Type N connector**

### When gauging a male type N connector

A clockwise deflection of the gauge pointer (a “plus”) indicates that the shoulder of the male contact pin is recessed less than the minimum recession of 0.207 inches behind the outer conductor mating plane. This will cause damage to other connectors to which it is mated.

### When gauging a female type N connector

A clockwise deflection of the gauge pointer (a “plus”) indicates that the tip of the female mating fingers are protruding more than the maximum of 0.207 inches in front of the outer conductor mating plane. This will cause damage to other connectors to which it is mated.

### B.4. The 7/16 connector

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This connector was developed in Germany during the 1960s for high performance military systems and was later developed for commercial applications in analogue cellular systems and GSM base station installations.

This connector is now being widely used in the telecommunications industry and it has a frequency range covering from DC to 7.5 GHz. The “7/16” represents a nominal value of 16mm at the interface for the internal diameter of the external conductor, and a nominal value of 7mm for the external diameter of the internal conductor to achieve 50Ω.

High quality 7/16 connectors are available to be used as standards for the calibration of automatic network analysers, reflection analysers and other similar devices.

A range of push on adaptors is available to eliminate the time consuming need for tightening, and disconnecting using a torque spanner.

It is a repeatable long life connector with a low return loss. It also has a good specification for inter-modulation performance and a high power handling capability.

Terminations, mismatches, open and short circuits are also made and back to back adaptors male to male, female to male and female to female are available.

They are designed to a DIN specification number 47223.

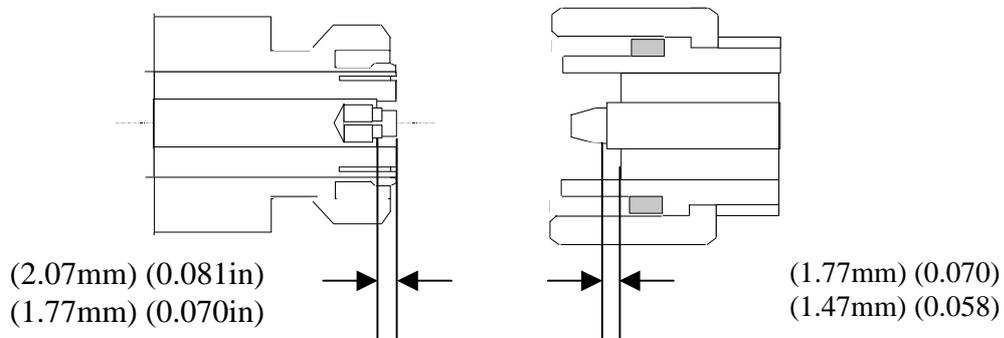


Figure 4.1. The female 7/16 connector

Figure 4.2. The male 7/16 connector

For further information on the 7/16 connector the article by Paynter and Smith is recommended. This article describes the 7/16 connector and discusses whether to use Type N connector technology or to replace it with the 7/16 DIN interface for use in mobile radio GSM base stations.

Jeffery D. Paynter and Richard Smith : **Coaxial Connectors: 7/16 DIN and Type N** Mobile Radio Technology Magazine April 1995 Intertech Publishing Corp A Copy is available on <http://www.andrew.ru/products/article/cmkr0003.asp>

### B.5. The SMA connector

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The interface dimensions for SMA connectors are listed in MIL-C-39012.

BS 9210 N0006 Part 2 published primarily for manufacturers and inspectorates, also gives details for the SMA interface but some of the requirements and specification details differ. For example, wall thickness may be a little thinner and hence a little weaker. However, MIL-C-39012 does not preclude thin walls in connectors meeting this specification although the physical requirements and arrangements will probably ensure that thicker walls are used for both specifications.

The SMA connector is a **semi-precision** connector and should be carefully gauged and inspected before use as the tolerances and quality can vary between manufacturers. The user should be aware of the SMA connector's limitations and look for possible problems with the solid plastic dielectric and any damage to the male pin. In a good quality SMA connector the tolerances are fairly tight. However the SMA connector is not designed for repeated connections and they can wear out quickly, be out of specification, and potentially destructive to other connectors. The SMA connector is widely used in many applications as it is a very cost-effective connector and suitable for many purposes however, precision metrology is not normally possible using SMA connectors?

Connector users are advised that manufacturers' specifications vary in the value of coupling torque needed to make a good connection. Unsatisfactory performance with hand tightening can indicate damage or dirty connector interfaces. It is common but bad practice to use ordinary spanners to tighten SMA connectors however, excessive tightening (>15 lb. in) can easily cause collapse of the tubular portion of the pin connector.

Destructive interference may result if the contacts protrude beyond the outer conductor mating planes; this may cause buckling of the female contact fingers or damage to associated equipment during mating.

The dielectric interface is also critical since protrusion beyond the outer conductor-mating plane may prevent proper electrical contact, whereas an excessively recessed condition can introduce unwanted reflections in a mated pair.

The critical axial interface of SMA type connectors is shown in Figures 5.1, 5.2 and Table 5 where the dimensions are given in inches, with the equivalent in millimetres shown in brackets.

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<i>SMA</i>	Dimensions inches (mm)			
	Female Pin	Female dielectric	Male Pin	Male dielectric
MIL-C-39012 Class 2	+ 0.030 (0.7620) 0.000 (0.000) 0.000 ( 0.000)	*	0.000 (0.000) min	*
MMC Standard	+ 0.015 (0.3810) 0.000 (0.000) 0.000 ( 0.000)	+ 0.002 (0.0508) 0.000 (0.000) - 0.002 (- 0.0508)	+ 0.010 (0.254) 0.000 (0.000) 0.000 ( 0.000)	+ 0.002 (0.0508) 0.000 (0.000) - 0.002 (- 0.0508)
MMC Precision	+ 0.005 (0.1270) 0.000 (0.000) 0.000 ( 0.000)	+ 0.002 (0.0508) 0.000 (0.000) 0.000 ( 0.000)	+ 0.005 (0.1270) 0.000 (0.000) 0.000 ( 0.000)	+ 0.002 (0.0508) 0.000 (0.000) 0.000 ( 0.000)
MIL -C-39012 Standard Test	+ 0.003 (0.0762) 0.000 (0.000) 0.000 ( 0.000)	+ 0.002 (0.0508) 0.000 (0.000) 0.000 ( 0.000)	+ 0.003 (0.0762) 0.000 (0.000) 0.000 ( 0.000)	+ 0.002 (0.0508) 0.000 (0.000) 0.000 ( 0.000)

**Table 5 SMA Connector**

The specification allows dielectric to protrude past the outer conductor-mating plane to 0.002 inches (0.0508mm) max. However, there is some doubt if the SMA standards permit the dielectric to protrude beyond the reference plane. There is a high voltage version that does allow the dielectric to protrude beyond the reference plane, but it does not claim to be compatible with the SMA standard.

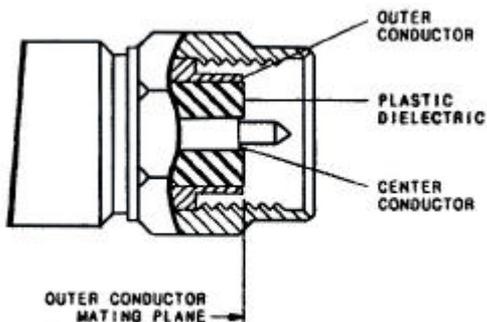


Figure 5.1 SMA male connector.

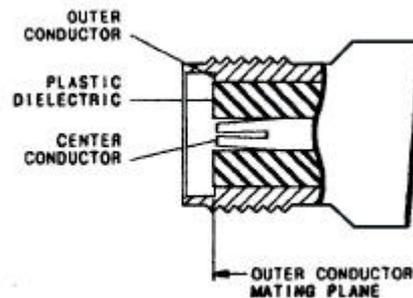


Figure 5.2 SMA female connector.

**B.6. The 3.5 mm connector**

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This connector is physically compatible with the SMA connector and is known as the GPC3.5mm connector. It has an air dielectric interface and closely controlled centre conductor support bead providing mechanical interface tolerances similar to hermaphroditic connectors. However, although in some ways planar, it is not an IEEE 287 precision connector. There is a discontinuity capacitance when coupled with SMA connectors.

A special version of the GPC 3.5mm connector has been designed. The design incorporates a shortened male pin and allows the centre conductors to be pre-aligned before contact thus considerably reducing the likelihood of damage when connecting or disconnecting the 3.5mm connector. Figures 6.1 and 6.2 show the male and female types of GPC 3.5mm connector and Table 6 shows the gauging dimensions.

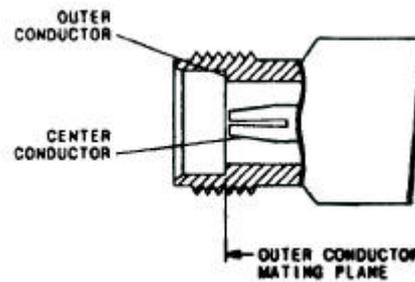
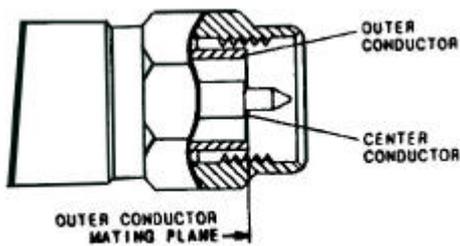


Figure 6.1 GPC 3.5 male connector.

Figure 6.2 GPC 3.5 female connector.

<b>3.5mm</b>	<b>Dimensions inches (mm)</b>	
	<b>Female Pin</b>	<b>Male Pin</b>
<b>LPC</b>	<b>0 to - 0.0005 (- 0.0127)</b>	<b>0 to - 0.0005 (- 0.0127)</b>
<b>GPC</b>	<b>0 to - 0.003 (- 0.0762)</b>	<b>0 to - 0.003 (- 0.0762)</b>

**Table 6 3.5 mm connector**

**B.7. The 2.92 mm connector**

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The 2.92mm connector is a reliable connector that operates up to 46GHz and it is used in measurement systems and on high performance components, calibration and verification standards. It is also known as the Type K™ connector. The K connector interfaces mechanically with 3.5mm and SMA connectors. However, when mated with the 3.5mm or SMA connector the junction creates a discontinuity that must be accounted for in use.

Compared to the 3.5mm and the SMA connector the 2.92mm connector has a shorter pin that allows the outer conductor alignment before the pin encounters the socket contact when mating a connector pair. The type K connector is therefore less prone to damage in industrial use.

Figure 7 shows the diagram of the Type K connector and Table 7 gives the important gauging dimensions.



**Figure 7.1 Type K Female Figure 7.2 Type K Male**

<b>2.92 mm</b>	<b>Dimensions inches (mm)</b>	
<b>Specification</b>	<b>Female Pin</b>	<b>Male Pin</b>
<b>LPC</b>	<b>0 to - 0.0005 (- 0.0127)</b>	<b>0 to - 0.0005 (- 0.0127)</b>
<b>GPC</b>	<b>0 to - 0.0005 (- 0.0127)</b>	<b>0 to - 0.0005 (- 0.0127)</b>
<b>Anritsu</b>	<b>0 to - 0.005 (- 0.127)</b>	<b>0 to - 0.005 (- 0.127)</b>

**Table 7 Type K connector**

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**B.8. The 2.4 mm connector**

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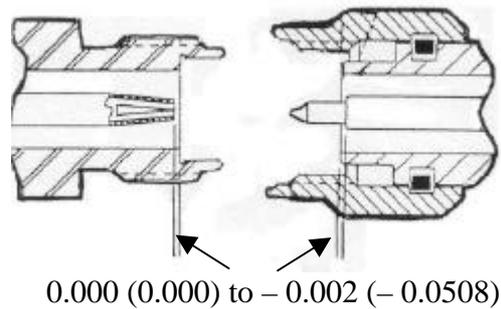
The 2.4mm connector was designed by the Hewlett Packard Company (now Agilent Technologies) and the connector assures mode free operation up to 60GHz. It is also known as the Type Q connector. The 2.4mm connector is a pin and socket type connector that utilises an air dielectric filled interface. The 2.4mm interface is also mechanically compatible with the 1.85mm connector.

**Note**

The manufacturers of small coaxial connectors have agreed the mechanical dimensions so that they can be mated non-destructively. This has lead to the use of the term “mechanically compatible” because both lines are nominally 50Ω it has been assumed that “mechanically compatible” equates to electrical compatibility. The effect of the electrical compatibility of mechanically mateable coaxial lines is discussed in ANAlYse Note No.3 January 1994 included in the list of further reading at the end of this guide.

As for other connectors of this type the coupling engagement of the outer conductors is designed to insure that the outer conductors are coupled before the inner conductors can engage to ensure a damage free fit.

Figure 8 shows the diagram of the 2.4mm connector and Table 8 gives the important gauging dimensions.



**Figure 8. The 2.4mm connector**

<b>2.4 mm</b>	<b>Dimensions inches (mm)</b>	
<b>Specification</b>	<b>Female Pin</b>	<b>Male Pin</b>
<b>LPC</b>	<b>0 to - 0.0005 (- 0.0127)</b>	<b>0 to - 0.0005 (- 0.0127)</b>
<b>GPC</b>	<b>0 to - 0.002.. (- 0.0508)</b>	<b>0 to - 0.002 (- 0.0508)</b>
<b>Agilent Technologies</b>	<b>0 to - 0.002.. (- 0.0508)</b>	<b>0 to - 0.002 (- 0.0508)</b>

**Table 8 Type 2.4mm connector**

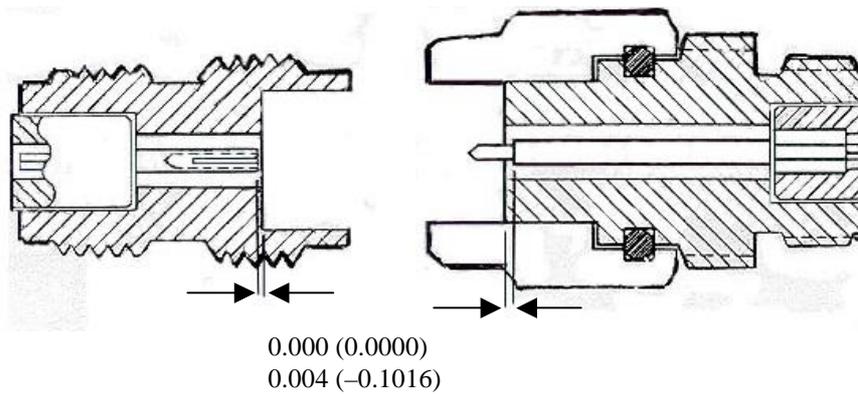
**B.9. The 1.85 mm connector**

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The 1.85mm connector was designed by the Hewlett Packard company (now Agilent Technologies) and the connector assures mode free operation up to 75GHz. It is also known as the Type V™ connector. The 1.85mm connector is a pin and socket type connector which uses an air dielectric filled interface.

The coupling engagement of the outer conductors is designed to insure that the outer conductors are coupled before the inner conductors can engage to ensure a damage free fit.

Figure 9 shows the diagram of the 1.85mm connector and Table 9 shows the important gauging dimensions.



**Figure 9.1 Type V Female.**

**Figure 9.2 Type V Male.**

<i><b>1.85 mm</b></i>	<b>Dimensions inches (mm)</b>	
	<b>Female Pin</b>	<b>Male Pin</b>
<b>LPC</b>	0 to -0.0005 (-0.0127)	0 to -0.0005 (-0.0127)
<b>GPC</b>	0 to -0.002 (-0.0508)	0 to -0.002 (-0.0508)
<b>Anritsu</b>	0 to -0.004 (-0.1016)	0 to -0.004 (-0.1016)

**Table 9 Type 1.85mm connector**

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### B.10. The 1 mm connector

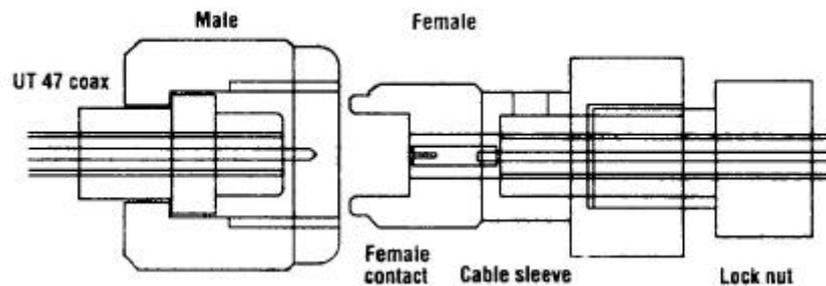
The information included here on the 1 mm connector is provisional and for general guidance only. The manufacturer's specification and advice should be followed where available. There is also a 1.1mm connector available from Anritsu but no details available at present.

The 1mm connector was designed by the Hewlett Packard Company (now Agilent Technologies) and the connector assures mode free operation up to 110GHz. It is also known as the Type W™ connector. The 1mm connector is a pin and socket type connector that utilises an air dielectric filled interface. The coupling diameter and thread size are chosen to maximise strength, and increase durability.

The coupling engagement of the outer conductors is designed to insure the outer conductors are coupled before the inner conductors can engage to ensure a damage free fit.

The W connector can also be used with UT47 semi-rigid cable. A simple sleeve and locking screw assembly allows connection to a waveguide-to-coaxial adaptor and to a type K or V connector.

Figure 10 shows the diagram of the 1.0mm connector and Table 10 shows the important gauging dimensions.



**Figure 10. The W connector**

<i><b>1.00 mm</b></i>	<b>Dimensions inches (mm)</b>	
<b>Specification</b>	<b>Female Pin</b>	<b>Male Pin</b>
<b>LPC</b>	<b>0 to - 0.0005 (- 0.0127)</b>	<b>0 to - 0.0005 (- 0.0127)</b>
<b>GPC</b>	<b>0 to - 0.002 (- 0.0508)</b>	<b>0 to - 0.002 (- 0.0508)</b>
<b>Anritsu</b>	<b>0 to - 0.001 (- 0.0254)</b>	<b>0 to - 0.001 (- 0.0254)</b>

**Table 10 Type W connector**

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## Appendix C

### C. REPEATABILITY OF CONNECTOR-PAIR INSERTION LOSS

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The values shown in Table C1 show some insertion loss repeatability (dB) figures provided that the connector-pairs are in good mechanical condition and clean; further, that in use, they are not subjected to stresses and strains due to misalignment or transverse loads. For any particular measurement process the connector repeatability in the uncertainty budget is calculated in the same units of the final measurements. For example when measuring the Calibration Factor of a power sensor the repeatability is measured in percent. Graph 1 shows a graph of repeatability figures for the calibration factor of a group of microwave power sensors.

These **guidance** figures will serve two purposes:

1. They show limits for connector repeatability for normal use in uncertainty estimates where unknown connectors may be involved;
2. Provide a measure against which a “real” repeatability assessment can be judged.

The Figures in Table C1 are based on practical measurement experience at NPL, SESC, and in UKAS Calibration Laboratories. In practice, connector repeatability is an important contribution to measurement uncertainties and should be carefully determined when verifying measurement systems or calculated for each set of measurements made. In some cases values better than those shown in table C1 can be obtained.

Connector	Connector Insertion loss repeatability dB		
GR900 - 14mm	0.001 (DC to 0.5GHz)	0.002 (0.5 to 8.5GHz)	
GPC7 - 7mm	0.001 (DC to 2GHz)	0.004 (2GHz to 8GHz)	0.006 (8 to 18GHz)
Type N - 7mm	0.001 (DC to 1 GHz)	0.004 (1 to 12GHz)	0.008 (12 to 18GHz)
GPC3.5 - 3.5mm	0.002 (DC to 1GHz)	0.006 (1 to 12GHz)	
SMA 3.5mm	0.002(DC to 1GHz)	0.006 (1 to 12GHz)	

**Table C1 Typical connector insertion loss repeatability.**

#### **Connector repeatability when using Automatic Network Analysers.**

When using Automatic Network Analysers and other similar equipment connector repeatability of the order of those shown in table C2 are typical. The results shown in table C2 give the mean of the ten measurements for a GPC7 connector pair. In addition the standard deviation and standard uncertainty have been calculated, and shown in the table, using the procedure described in the UKAS Guide M3003 Edition 1 to produce a value that can be used in an uncertainty budget. In practice the measurement uncertainty contribution for the connector repeatability should be measured for each measurement procedure.

#### **References for further reading on connector repeatability**

Dietrich Bergfield and Helmut Fischer. **Insertion Loss Repeatability Versus Life of Some Coaxial Connectors.** IEEE Transactions on Instrumentation and Measurement Vol. Im-19, No4, pp 349 – 353 November 1970.

## ANAMET CONNECTOR GUIDE

Freq	Run Number										Mean	Std	Std
GHz	1	2	3	4	5	6	7	8	9	10	Value	Dev	Uncert
1	0.000	-0.001	0.001	-0.001	0.000	-0.001	0.003	-0.002	0.000	0.000	-0.0001	0.0014	0.0004
2	-0.002	-0.001	-0.001	0.000	-0.001	0.000	0.004	-0.001	0.000	0.002	0.0000	0.0018	0.0006
3	-0.001	-0.001	0.001	-0.001	0.000	-0.001	0.004	-0.002	0.000	0.002	0.0001	0.0018	0.0006
4	-0.001	0.000	0.001	-0.001	0.000	0.000	0.005	-0.002	0.000	0.002	0.0004	0.0020	0.0006
5	-0.004	-0.001	0.002	-0.001	-0.001	0.001	0.006	-0.003	0.000	0.003	0.0002	0.0029	0.0009
6	-0.001	-0.001	0.001	-0.001	-0.001	-0.001	0.006	-0.003	0.000	0.004	0.0003	0.0027	0.0009
7	-0.003	-0.002	0.002	-0.003	-0.001	-0.001	0.007	-0.004	0.000	0.004	-0.0001	0.0035	0.0011
8	-0.003	-0.003	0.002	-0.003	-0.001	0.000	0.007	-0.003	-0.001	0.004	-0.0001	0.0034	0.0011
9	-0.001	-0.002	0.002	-0.001	-0.001	0.000	0.007	-0.003	0.000	0.006	0.0007	0.0033	0.0011
10	-0.005	-0.002	0.003	-0.002	-0.002	-0.004	0.008	-0.005	-0.001	0.003	-0.0007	0.0042	0.0013
11	-0.003	-0.003	0.003	-0.001	-0.007	0.003	0.009	-0.005	0.000	0.008	0.0004	0.0053	0.0017
12	-0.001	-0.006	0.003	-0.003	-0.004	0.002	0.005	0.002	0.003	0.007	0.0008	0.0042	0.0013
13	-0.002	0.000	0.004	-0.002	-0.002	-0.002	0.010	-0.005	0.000	0.008	0.0009	0.0049	0.0015
14	-0.003	-0.003	0.004	-0.002	0.001	0.000	0.012	-0.005	0.000	0.008	0.0012	0.0053	0.0017
15	-0.001	-0.003	0.004	-0.002	0.000	-0.001	0.011	-0.003	0.002	0.007	0.0014	0.0046	0.0015
16	-0.004	-0.004	0.003	-0.003	-0.003	-0.004	0.010	-0.004	0.001	0.009	0.0001	0.0055	0.0017
17	-0.002	-0.004	0.005	-0.002	-0.005	0.000	0.012	-0.004	-0.002	0.009	0.0007	0.0059	0.0019
18	0.000	-0.006	0.004	-0.001	-0.004	-0.002	0.012	-0.003	-0.002	0.009	0.0007	0.0058	0.0018

**Table C2 A typical example of GPC7 connector repeatability using an ANA**

Freq	Run Number										Mean	Std	Std
GHz	1	2	3	4	5	6	7	8	9	10	Value	Dev	Uncert
1	0.002	0.001	-0.002	-0.001	0.000	0.000	0.000	-0.001	0.001	-0.002	-0.0002	0.0013	0.0004
2	0.002	0.001	-0.002	-0.001	0.001	0.000	0.001	-0.001	0.002	-0.002	0.0001	0.0015	0.0005
3	0.004	-0.002	-0.005	-0.001	0.001	-0.001	0.001	0.000	0.001	-0.004	-0.0006	0.0026	0.0008
4	0.005	0.000	-0.005	-0.001	0.001	-0.001	0.001	-0.004	0.003	-0.001	-0.0002	0.0030	0.0009
5	0.004	-0.003	-0.007	-0.001	0.002	-0.001	0.001	-0.002	0.004	-0.003	-0.0006	0.0034	0.0011
6	0.006	-0.002	-0.008	-0.001	0.002	-0.001	0.001	-0.003	0.004	-0.004	-0.0006	0.0041	0.0013
7	0.004	-0.003	-0.008	-0.003	0.004	-0.002	0.002	-0.002	0.004	-0.006	-0.0010	0.0043	0.0014
8	0.007	-0.003	-0.010	-0.001	0.003	-0.002	0.003	-0.002	0.004	-0.004	-0.0005	0.0049	0.0015
9	0.005	-0.004	-0.010	-0.001	0.003	-0.003	0.004	-0.004	0.004	-0.004	-0.0010	0.0049	0.0015
10	0.005	-0.005	-0.010	-0.001	0.002	-0.004	0.008	-0.002	0.001	-0.005	-0.0011	0.0053	0.0017
11	0.004	-0.003	-0.010	-0.001	0.001	-0.003	0.006	-0.003	0.002	0.001	-0.0006	0.0045	0.0014
12	0.004	-0.008	-0.012	-0.008	0.009	-0.003	0.011	-0.005	0.001	-0.003	-0.0014	0.0076	0.0024
13	0.006	-0.007	-0.011	-0.001	0.000	-0.003	0.011	-0.006	0.002	-0.002	-0.0011	0.0064	0.0020
14	0.004	-0.007	-0.012	0.001	-0.002	-0.003	0.015	-0.007	0.002	0.003	-0.0006	0.0075	0.0024
15	0.004	-0.005	-0.011	0.001	0.000	-0.004	0.014	-0.006	-0.002	0.001	-0.0008	0.0067	0.0021
16	0.004	-0.008	-0.013	0.001	-0.001	-0.006	0.016	-0.009	0.003	0.003	-0.0010	0.0084	0.0026
17	0.004	-0.008	-0.014	0.001	0.000	-0.006	0.017	-0.008	0.002	0.003	-0.0009	0.0086	0.0027
18	0.001	-0.014	-0.017	0.004	-0.006	-0.008	0.024	-0.011	0.003	0.005	-0.0019	0.0120	0.0038

**Table C3 A typical example of Type N connector repeatability using an ANA**

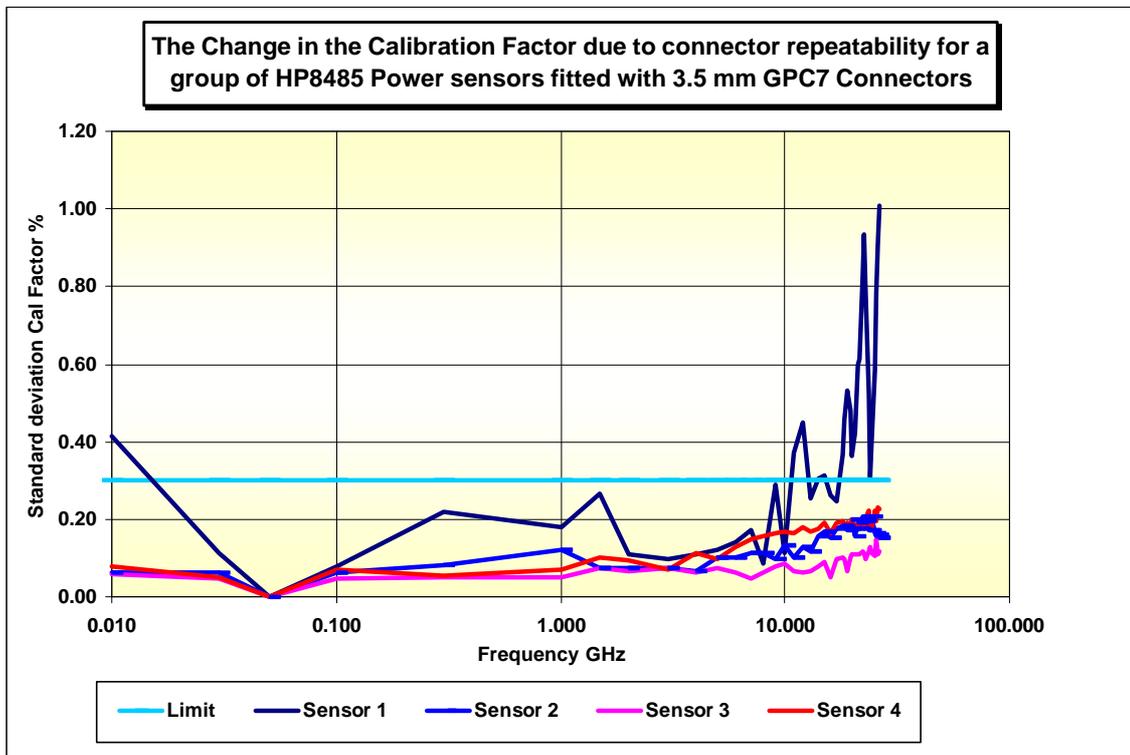
### Connector repeatability for a group of power sensors

The power sensors used in the test are numbered 1 to 4

None of the power sensors used in this test are new devices from production but they are power sensors that are in general use. Power sensor 1 was chosen because it is a well used power sensor that has been in use for a long time. The difference between sensor 1 and the sensors 2,3 and 4 that are fairly new is clear.

The method used to obtain the results was to make ten calibration runs of calibration factor in % for each sensor. The sensor was disconnected and reconnected between each measurement. One reference calibration at 50MHz 1mW was made for each set of measurements. All the connectors were inspected, cleaned and gauged before 'use'.

The graph shows of how a connector can deteriorate with age and use. Also notice that in this case the performance tends to get worse at the high frequencies.



Graph 1. Results of connector repeatability measurement for a group of power sensors

**Appendix D**

**D TORQUE WRENCH SETTING VALUES FOR COAXIAL CONNECTORS**

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Table D1 gives a list of recommended connector tightening torque values to be used for metrology purposes for each connector type.

This list is based on the best available information from various sources and should be used with care. Some manufacturers recommend slightly different values for the torque settings in their published performance data. Where this is the case the manufacturers' data should be used. With all torque spanners, it is possible to get substantially the wrong torque by twisting the handle axially and by a variety of other incorrect methods of using the torque spanner.

There are also some differences on the torque settings used when making a permanent connection (within an instrument) rather than for metrology purposes.

For combinations of GPC3.5/SMA connectors the torque should be set to the lower value e.g. 5 in-lb.

The torque spanners used should be regularly calibrated, and set to the correct torque settings for the connector in use and clearly marked.

On some torque spanners the handles are colour coded to represent the torque value set for ease of identification e.g. 12 in-lb (1.36 N-m) blue and 8 in-lb (0.90 N-m) red. However, for safety, always check the torque setting before use

Connector		Torque	
Type	Size mm	in-lb	N-m
<b>GR900</b>	<b>14</b>	<b>12</b>	<b>1.36</b>
<b>GPC 7</b>	<b>7</b>	<b>12</b>	<b>1.36</b>
<b>N</b>	<b>7</b>	<b>12</b>	<b>1.36</b>
<b>7/16</b>	<b>16.5</b>	<b>20</b>	<b>2.26</b>
<b>GPC 3.5</b>	<b>3.5</b>	<b>8</b>	<b>0.90</b>
<b>SMA</b>	<b>3.5</b>	<b>5</b>	<b>0.56</b>
<b>K</b>	<b>2.92</b>	<b>5 – 8</b>	<b>0.56 – 0.90</b>
<b>Q</b>	<b>2.4</b>	<b>8</b>	<b>0.90</b>
<b>V</b>	<b>1.85</b>	<b>8</b>	<b>0.90</b>
<b>W</b>	<b>1</b>	<b>3</b>	<b>0.34</b>

**Table D1 Torque spanner setting values**

## Appendix E

### E. CALIBRATING DIAL GAUGES AND TEST PIECES

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There are a number of different types of dial gauges and gauge calibration blocks used for gauging connectors. They require regular calibration to ensure that they are performing correctly. There is a British Standard BS 907: "Specification for dial gauges for linear measurement" dated 1965 that covers the procedure for the calibration of dial gauges and this should be used. However, the calibration of the gauge calibration blocks is not covered by a British Standard, but they can be measured in a mechanical metrology laboratory. It is important to use the correct gauge for each connector type to avoid damage to the connector under test. Some gauges have a very strong gauge plunger springs that, if used on the wrong connector, can push the centre block through the connector resulting in damage. Also if gauges are used incorrectly they can compress the centre conductor collet in precision 7mm connectors, during a measurement, resulting in inaccurate readings when measuring the collet protrusion.

#### Types of dial gauges

Dial gauges used for the testing of connectors for correct mechanical compliance are basically of two types:

##### Push on type

The push on type is used for measuring the general-purpose type of connectors. For sexed connectors two gauges are normally used (one male and one female) or a single gauge with male and female adaptor bushings.

##### Screw on type

The screw on type is mainly used (except GR 900) in calibration kits for network analysers and reflectometers. They are used for the GPC7 and sexed connectors and for the latter they are made in both male and female versions. The screw-on type is made in the form of a connector of the opposite sex to one being measured.

When a gauge block is used to initially calibrate the dial gauge a torque spanner should be used to tighten up the connection to the correct torque.

#### Connector gauge measurement resolution

Because of connector gauge measurement resolution uncertainties (one small division on the dial) and variations in measurement technique from user to user connector dimensions may be difficult to measure. Dirt and contamination can cause differences of 0.0001-inch (0.00254 mm) and in addition the way that the gauge is used can result in larger variations. When using a gauge system for mechanical compliance testing of connectors carry out the following procedure each time.

1. Carefully inspect the connector to be tested and clean if necessary.
2. Clean and inspect the dial gauge, and the gauge calibration block.
3. Carefully zero the dial gauge with the gauge calibration block in place.
4. Remove the gauge calibration block.
5. Measure the connector using the dial gauge and note the reading.
6. Repeat the process at least once or more times as necessary.

**Gauge calibration blocks**

Every connector gauge requires a gauge calibration block that is used to zero the gauge to a pre-set value before use.

The photograph in Figure E1 shows a set of dial gauges and gauge calibration blocks for a Type N connector screw on type gauge.

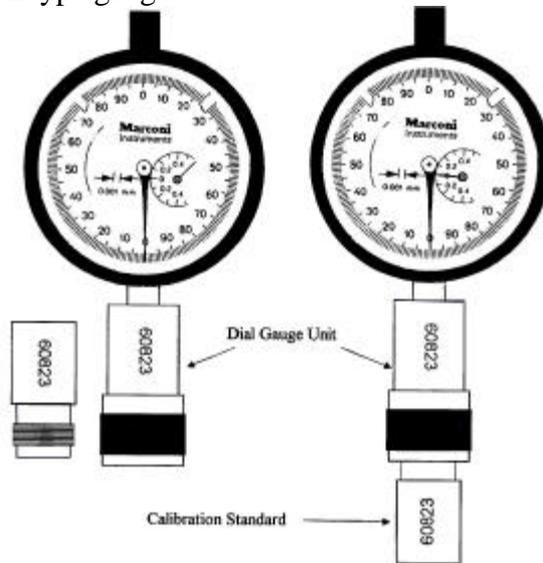


Figure E1. Type N screw-on dial gauge and calibration block

The photograph in Figure E2 shows a SMA dial gauge of the push on type with its gauge calibration block.

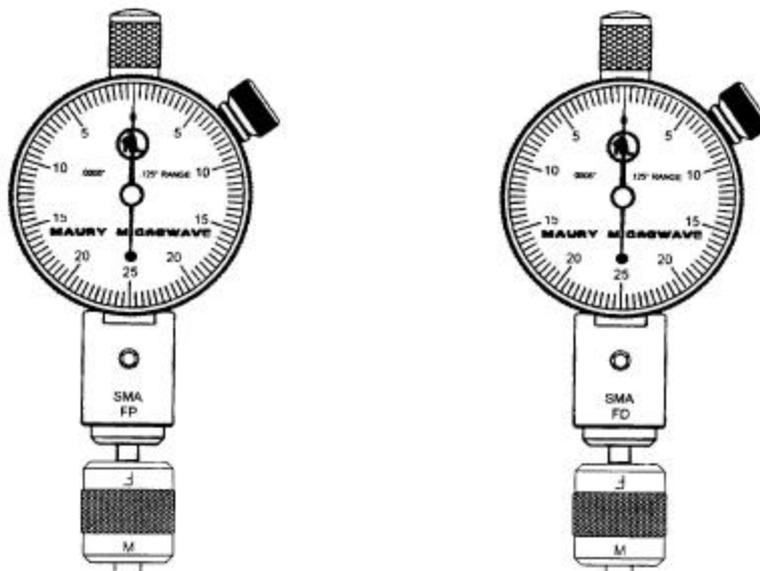


Figure E2. Type SMA push - on type dial gauge for female pin depth (FP) & dielectric FD with calibration block

## Appendix F

### F. COAXIAL CONNECTORS – SOME FURTHER READING.

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#### ANAMET Publications

##### ANALyse Notes

J P Ide “A study of the electrical compatibility of mechanically mateable coaxial lines”,  
ANALyse Note No.3 January 1994.

N M Ridler “ How much variation should we expect from coaxial connector dial gauge  
measurements?” ANALyse Note No. 14, February 1996.

##### ANA Tips

A J A Smith and N M Ridler, “Gauge compatibility for the smaller coaxial line sizes”,  
ANATips No.1, October 1999.

P D Woolliams and N M Ridler, “Tips on using coaxial connector torque spanners”, ANAtips  
No. 2, January 2000.

##### ANAMET Reports

N M Ridler and J C Medley, “Dial gauge comparison exercise” ANAMET  
Report No.001, July 1996.

N M Ridler and J C Medley, “Live dial gauge comparison exercise: ANAMET  
ANAMET Report N0. 007, May 1997.

N M Ridler and C Graham “An investigation into the variation of torque values obtained  
using coaxial connector torque spanners”. ANAMET Report No. 018, September 1998.

G J French “ANAMET –982: Live torque comparison exercise”  
ANAMET Report 022, February 1999.

##### ANAMET News

I Instone. “The effects of port recession on ANA accuracy.” ANAMET News, Issue 11 pages  
4, 5 and 6. Autumn 1998.

##### Uncertainties of Measurement

**UKAS M3003** The expression of uncertainty and confidence in measurement. Edition 1  
December 1997.