ATX LABS TECH BRIEF

A Universal Platform for Determining the Interface Compliance of Non-Coplanar Type N Microwave Connectors

A Gaging Technique is Described that is Invariant with Gender and all Commercial, Military & Proprietary Standards

There are three classes of microwave connectors that are commonly used, namely, sexed co-planar, sexed non-coplanar, and hermaphroditic. The second class is the subject of this tech brief.

Coplanar Interface

Briefly, what distinguishes the first two classes is the location of the reference plane – which physically is an extension of the outer conductor of a coaxial cable. The coplanar case will be discussed first.

In the coplanar connector, male or female, the inner conductor plane (either male shoulder or front female socket plane) aligns with the surrounding outer plane, the reference plane. Ideally, they are coplanar, and when a connector's interface is gaged, what is being measured is the difference

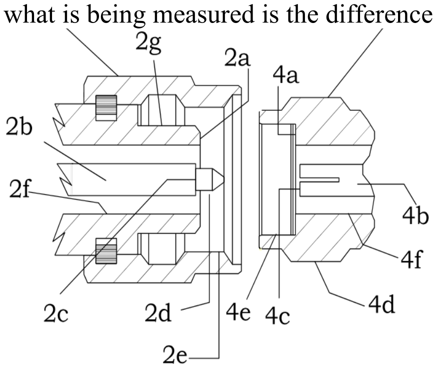


Figure 1

in grade between the two planes or the departure from the ideal coplanar state.

The above cross sectional figure of a generic, coplanar, sexed subminiature connector, taken from an ATX patent, illustrates the two grades, 2a and 2c, whose grade differential a gage is designed to measure.

Still another way of expressing the intent of gaging: what is being determined is whether the recession (of plane 2c relative to plane 2a) falls into a safe zone characterized by standards like IEEE287LPC/GPC, MIL-STD-348B, or even proprietary standards adopted by some manufacturers that represents the manufacturer's target for pin depth. In all coplanar standards, some measure of recession is allowed but procession is always a non-compliant state for the coplanar geometry. That constraint will change with the non-coplanar connector.

Coplanar Gaging Mechanics

When it comes to coplanar connectors, into which SMA, 3.5mm,

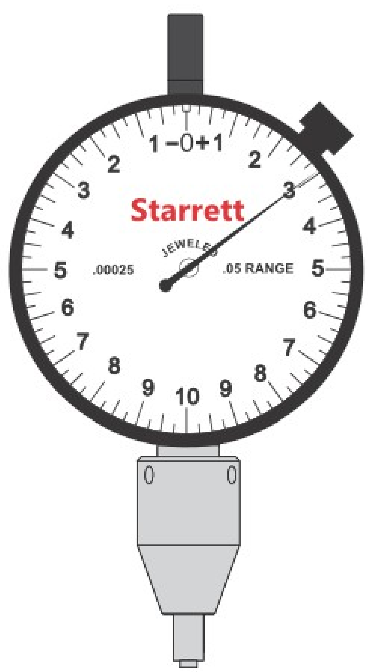


Figure 2

2.92mm, 2.4mm and 1.85mm fall, measuring recession with some kind of conventional dial or digital indicator is relatively simple. This is accomplished by attaching an appropriately shaped fixed bushing and movable contact, the two components shown below the dial face in **figure 2**. This transforms the common dial indicator into a depth indicator not unlike the ones designed to measure tread depth on a tire. In the case of a connector gage, the fixed bushing is made to rest on the outer reference plane of a connector (2a and 4a in **figure 1**) while the movable contact point falls into place under about 2 ounces of force on the pin or socket (2c and 4c in figure 1). The reading on the dial face is a differential grade reading before accounting for uncertainty.

So gaging is naturally with reference to a zero condition since male and female coplanar connectors share ideally common mating planes. Hence traditional microwave interface gages are synergistic with the ordinary ASME dial indicator as pictured in **figure 2**, requiring little change. The “0” on the dial face can be imagined as the grade of the reference plane, while the grade of the male shoulder or the front plane of the female socket falls somewhere clockwise, ideally, between 0 and 2 for general purpose precision connectors. In figure 2, since the indicator has a resolution of 0.00025 inches, all numbers represent an increment of one mil or 0.001 inches. Hence a “2” on the dial would represent 2 mils – which is the IEEE287GPC standard for a general precision 3.5/2.92mm or 2.4/1.85mm connector, male or female.

When a coplanar gage is zeroed, the user only needs a flat surface since the important male and female reference plane and pin features all meet, ideally, in a common plane. That, after all, is the design goal of a perfect coplanar sexed connector; any deviation from that goal represents a flaw to be measured, i.e. gaged.

The Non Coplanar Connector

The non coplanar connector is a different animal, one in which the grade variations – decidedly non-coplanar – might suggest a technique considerably different from the coplanar species of the connector discussed above.

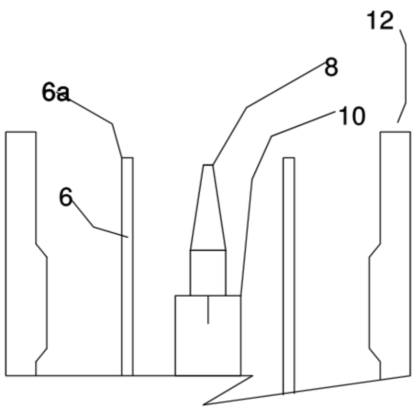


Figure 4

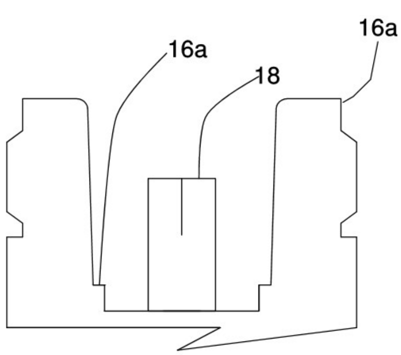


Figure 5

Above, the male N connector is illustrated in figure 4 and the female in figure 5. In these figures, note that the reference plane (6a) for the male in figure 3 is *above* the male pin shoulder (10), whereas for the female in figure 5, the reference plane (16a) is *below* the front plane of socket (18). These grade variations in an airline non-coplanar connector allow a different approach to gaging relative to that used in the coplanar species.

The standards for non-coplanar connectors specify the dimensions of these male and female grade differences in terms of both recession and procession. This leads to a conclusion: the legacy art of mimicking the subminiature conceit of a "0" gage state on an ordinary dial indicator remains possible only by doing something rather unproductive, counter intuitive, and expensive, namely, making a master for every single standard in order to create a zero condition on the conventional dial gage.

Non Coplanar Gaging Mechanics

In practical terms, the above means that for Type N there are at least three master gages, counting only the standards representing military and committee work product. For Type N, the common standards are illustrated in **figure 6** on a custom metal back plate that ATX attaches to its N gages. Observe that the male per standard has three common states of recession: 208, 210, and 207 mils. For the female, on the other hand, the most common condition is for the front plane of the socket to be in procession by 207 mils from the reference.

In practical terms, given the legacy conceit of having to force a zero reading in the gage to represent the

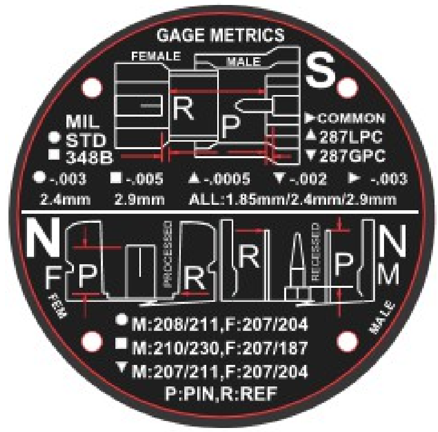


Figure 6

reference plane, the only way to accomplish this is to force the master gage (a small machined artifact) to mimic the physical dimension of the grade difference for *each* standard.

For the male, you would then need a set of three masters with accurately bored holes of 207, 208 and 210 mils, each representing a different standard, as illustrated in **figure 7**.

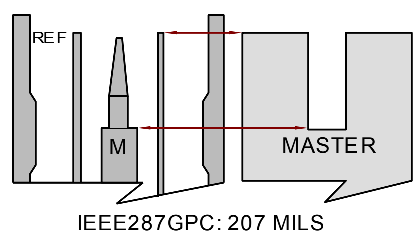


Figure 7

It would also necessitate either two gages, one for each gender, or a single gage with interchangeable components.

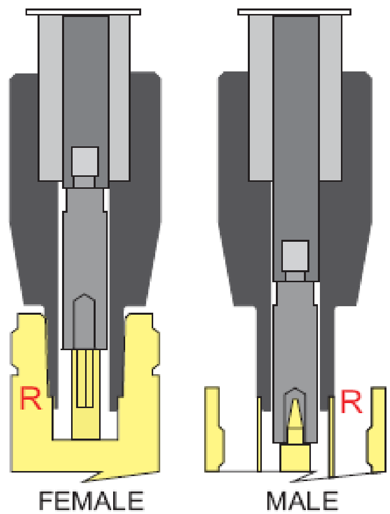
Another condition that results from forcing a zero by mastering relative to the specification in a standard, is that a bored hole will be more difficult to machine than a flat surface used for subminiature gaging: hence it will carry greater uncertainty. Still another downside is that there is added cost and inconvenience with having to maintain an inventory of different masters. In the absence of stamping or etching, it's not always clear which standard matches which master.

The final complication from the legacy conceit of forcing a zero condition to match the traditional dial indicator face is that it is impossible to have a gage that is invariant with standard. So if the male master is cut to 207 mils, then when the user zeroes the gage it is zeroed *only* with reference to this one standard. To achieve a condition that is invariant with standard, one would have to maintain inventory of additional masters with the requisite tracking to keep masters and standard in alignment for use. Which in the end is not a single solution, or an elegant one – as it requires multiple solutions, one for each standard. To put an even finer point on it, to monitor production quality relative to a proprietary standard would require a custom master cut to that internal standard, something not readily available in the market.

It is, though perhaps not obvious at first blush, possible to have true invariant gaging relative to all standards by making a change in the machining of the bushing that affixes to the indicator for the purpose of setting the zero reference. The ubiquitous Type N connector illustrated in the figures above, invented by Paul Neill of Bell Labs in the 1940s, is an excellent candidate for this approach.

A Novel Departure from Legacy N Gage Design

Given the similarity of dimension between the male and female, ATX has designed a bushing for non-coplanar gaging to be geometrically compatible with both male and female reference



planes, as illustrated in **figure 8**.

Figure 8

What this implies, in the practical order, is that the gage can now measure relative to the *same* plane by virtue of a machined step in the bushing that marries to the reference plane of both genders. The further implication is that now all measurements need not be made with reference to an artificial zero that matches a specific standard's specification, like say 207 mils, but may now be a true measurement, thereby matching the specifications of *any* standards.

The benefits that flow from this relatively simple change are additionally: **[i]** there is no longer any confusion regarding the meaning of departure from "0" as exists in the legacy art due to the fact that the male pin is recessed and the female socket is proud relative to the reference plane; **[ii]** there is now only one master, and it is flat, obviating the need for multiple masters matching every standard. This is both cheaper and easier to machine than multiple masters with bored features of specific, tightly toleranced depths; **[iii]** the dial face can be

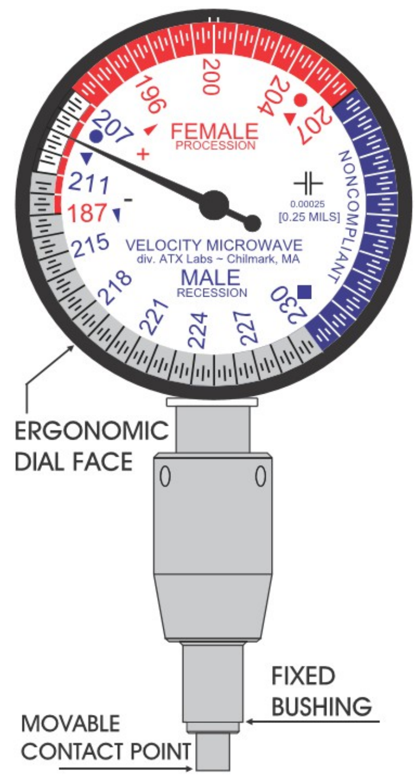


Figure 9

ergonomically enriched by expanding the legacy ASME B89 dial face into something that reflects actual conditions and compliance restraints, as pictured in **figure 9**. Since all standards and both genders can now be gaged, there is an extra degree of freedom: the

ATX LABS TECH BRIEF

A Universal Platform for Determining the Interface Compliance of Non-Coplanar Type N Microwave Connectors

A Gaging Technique is Described that is Invariant with Gender and all Commercial, Military & Proprietary Standards

ability to add a cognitively rich ergonomic interface, using color and icons, for the relatively easy determination of compliance relative to any standard. This can be realized, as the figure illustrates, in the form of embedded tolerance boundaries. A dial fascia so configured quickly shows the interpretation of the female compliance zone - from 207 mils maximum procession to 204 mils minimum procession. Similarly, for the male, there is a well defined tolerance zone of from 207 mils minimum recession to 211 mils maximum recession; **[iv]** there is no longer the added uncertainty relative to the bore's depth tolerance on the master since standard specific machining of multiple masters has been eliminated; **[v]** there is now only a single bushing and single master, for both genders and all standards, making both acquisition cost and carrying cost in terms of calibration and potential service much lower, advantaged by the single instrument solution.

The object of the technique herein described is to circumvent the limitations of legacy art. In general, this now elevates the platform to a true universal gage relative to different standards [including but not limited to MIL-C-39012, MIL-STD-348, and IEEE287 GPC (general precision) or LPC (lab precision]., each specifying different compliance regions relative to different grades between pin or socket and surrounding reference plane. Thus it makes gaging invariant with regard to both gender and standard.

ATX Labs has pioneered the use of ergonomic, user friendly gages for promoting greater clarity and compliance in gaging. In the case of the non-coplanar airline connectors like the Type N, the full value of ergonomic simplicity, as well as simplification and leaner acquisition and carrying costs that flow from leveraging off a single instrument solution for all standards and both genders, becomes manifest.

This work was done by V. R. Spelman and E. Milstein of ATX Labs, Vineyard Haven Massachusetts.