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Selecting the optimal measuring cable.

Dipl. Ing. (FH) Stefan Burger

ABOUT THE AUTHOR

Stefan Burger received his engineering degree (FH) from the University of Applied Science, Offenburg, in 1986. He remained at the university as a research assistant until 1990, when he moved to the research and development department of Endress + Hauser in Maulburg.

There, he was involved in the development of RADAR-based level measuring devices until 2001 and was responsible, among other things, for the support of RADAR modules and the development of antennas and pressure-resistant HF feedthroughs.

From 2001 to 2011, he worked at Panasonic Electronic Devices in Lüneburg on filters and duplexers for base stations and SAW filters, and was responsible for life time and power durability simulation.

In 2012, he founded his own company, Delta Gamma Consultant (www.delta-gamma.com), in Hampton, Australia. Since 2014, he has been working as an exclusive consultant in the field of RF and measurement technology for el-spec GmbH, Geretsried.

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Selecting the optimal measuring cable

Ask the right questions BEFORE you buy.
Useful information from measurement engineer Stefan Burger, Dipl. Ing. (FH)

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The optimal measuring cable is not found by chance, but after careful consideration of all relevant criteria:

We have compiled some information for you on how to ask the right questions and whether expensive means good. RF expert Stefan Burger, graduate engineer (FH), helped us with this.

Question: Mr. Burger, is it really that difficult to find the right combination of connector and cable? It's always the same thing: switch on the analyzer, connect the cable, connect the application, and read the values...

Stefan Burger: If only it were that simple. The fact is that every cable is tailored by its manufacturer to have different capabilities and properties. This starts with the very precise selection of the materials used, continues with the well-thought-out processing and arrangement of the various layers, and ends with the exact assembly with the optimal connector. There are already massive differences between the same cable types, because not all manufacturers work with the same dedication and according to the same criteria. But it also depends on the knowledge and experience of the engineers. Sometimes the task is completely uncritical and can be accomplished with simple, inexpensive cables from a discount store. In most cases, however, it comes down to the decimal places, and if the technician takes his profession and his company seriously, he is dependent on a reliable brand-name cable.

Question: But a brand-name cable is usually a more expensive cable. Can we then say that expensive is always the best choice?

Stefan Burger: Well, it's true that the cost of measuring cables from brand-name manufacturers such as Gore, Teledyne Storm (TSM), or Harbour Industries, which generally invest heavily in research and development, is sometimes significantly higher than that of no-name discounters.

But there are also considerable differences between the top manufacturers, and I wouldn't necessarily agree that the sometimes enormous price premiums are really worth itin every case.

Question: Let's get a little more specific. What tips can you give a measurement technician? How can they find the optimal cable for their specific application?

Stefan Burger: During my visits to Germany, I met Thomas Weber, engineer and managing director of el-spec GmbH. He was looking for an impartial evaluation of the products of one of his most important partners, Teledyne Storm Microwave. I therefore focused my attention on this manufacturer, measuring and comparing their products, and discovered a number of things that I'm sure will be helpful to some readers.

Stefan Burger: The most important question that technicians must ask themselves at the very beginning is which criteria are crucial for achieving their goals and in what order of importance. Because, as we all know, there is no such thing as a jack-of-all-trades. Where one cable can withstand extreme temperatures but cannot cope with high pressure, another cannot be used up to 50 GHz or loses its phase stability when moved and bent. Of course, the available budget must not be ignored either.

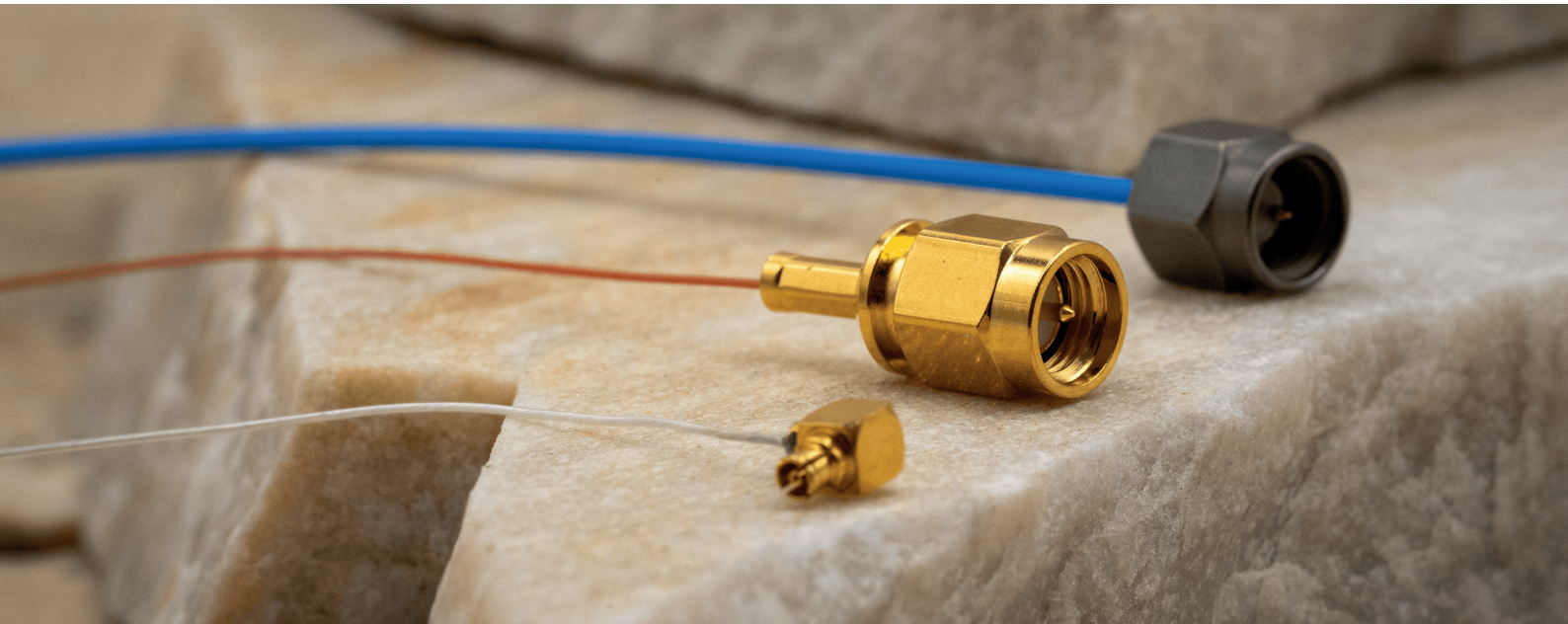
Question: In which areas does the American manufacturer's high-quality cable portfolio that you have examined make more sense than the aforementioned no-name product? In which areas does the American manufacturer's high-quality cable portfolio that you have examined make more sense than the aforementioned no-name product?

Stefan Burger: The use of higher-priced Teledyne cables makes sense there,

- where extreme reliability or durability are important,
- where qualifications according to aerospace, military, or other safety standards are required,
- when extremely accurate RF or measurement parameters are decisive, such as lowest losses, high shielding, very good phase stability, or high repeatability, or a combination of some of these properties is required.

The first point in particular begins where one rarely looks and is a good example of the "subtle" difference: the kink protection. As everyone knows, the most sensitive area of a measuring cable is the transition from the cable to the connector. The mechanical stress here is particularly high and naturally also influences the electrical properties of the connection.

Among the cables I examined, there were brand-name products whose so-called kink protection was only three centimeters long. This is, of course, completely inadequate. On the other hand, there are systems in which the cable kink protection is relatively long and stiff and, at first glance, protects the connection well. But this is not the case, as it only shifts the stress back to the cable and acts as a relatively long lever. Especially with small connectors—such as an SMA—in combination with a stiff kink protection, significant forces can act on the connector, putting it under heavy strain or even damaging it.



Question: In your opinion, what should proper crease protection look like?

Stefan Burger: Good kink protection is firmly connected to the plug so that it transfers the forces exerted when the cable is bent to the plug and keeps them away from the cable-plug connection. Towards its end, it becomes progressively less rigid to allow the cable to form a bend. If it were simply rigid, the cable would kink at the end of the protection.

Good manufacturers achieve this by using at least three layers of heat-shrink tubing, each layer being slightly longer than the previous one. This absorbs and dissipates the shear forces, yet the cable remains uniformly flexible all the way to the connector. In summary, it can be said that a small detail such as a properly constructed kink protection is responsible for how long the cable will last.
To my knowledge, there are very few manufacturers worldwide who are able to dispense with this essential protection, albeit only for certain special types and to achieve specific properties. The StormFlex® cables from TSM that I have examined deliberately do not have any visible kink protection. The cable is designed with the aid of special materials in such a way that you can even do without an angle adapter with a clear conscience. The cable itself can be bent at 90° without losing or changing its electrical and mechanical properties

Question: Another fundamental question is to what extent costs dominate over performance in the procurement of measurement or transmission cables.

Stefan Burger: A good kink protection device is firmly connected to the plug so that it transfers the forces exerted when the cable is bent to the plug and keeps them away from the cable-plug connection. Towards its end, it becomes progressively less rigid to allow the cable to form a bend. If it were simply rigid, the cable would kink at the end of the protection device.

Engineers do not always have a free choice. There are often specifications from the controlling department that make it difficult for technicians to solve the task with the required precision using the means available.
In certain areas, such as the military, aerospace technology, or research, where absolute reliability and accuracy are essential, this question probably arises less frequently than in everyday industrial life, where semi-skilled assembly line workers with no knowledge of measurement technology calibrate the circuit boards. Nevertheless, it is certainly a good idea for the purchasing department to calculate carefully whether a large number of wear-prone no-name products are really cheaper than a durable brand-name cable. There are major differences in the following two areas in particular: namely, bending at 90° without losing or changing its electrical and mechanical properties.

Domain 1:

in the electrical (high-frequency) parameters.

- e.g. Maximum operating frequency (Max Frequency GHz)
- Adjustment of the assembled cable (Return Loss dB)
- Maximum power to be transmitted at the operating frequency (CW Power Handling [W])
- How low is the total attenuation at the desired cable length (Loss [dB])?
- What is the value of the crosstalk attenuation (Isolation [dB])?
- And the repeatability of the measurement after cable movement (repeatability)

Teledyne has done a really good job here and offers excellent solutions for every application and various combinations. For example, the StormFlex® cable is ideal for frequencies above 50 GHz.

Domain 2:

Other important criteria relate to service life and stress:

- For example, are cables exposed to high mechanical or thermal stress? (To be defined with mil specs?)
- What is the tensile load? (tensile load [N])
- Is there even the slightest shock or vibration?
- Just like phase stability after cable movement.
- What phase change occurs as a function of temperature (Phase Change vs. Temperature [ppm])?

In everyday industrial use, the bending frequency (flex lifetime, e.g., due to installation/removal, movement during measurement) is of crucial importance. Therefore, the question must be asked: How often are the cables bent during use? More than 5,000 cycles? More than 10,000 cycles? More than 25,000 cycles? Or even more than 50,000 cycles? If a cable is permanently installed, the number of mating cycles is of course not so important. However, if they are used in production, for example, and connected several times a day, the maximum number of mating cycles can quickly be exceeded.
Another aspect to consider is phase stability during bending. If calibrations are performed and the cables are moved, which is almost always the case, the phase may change. If this is a permanent change after bending, the calibration may be invalid. Even higher demands are placed on the cable if it is also required to be stable during bending. This occurs, for example, with moving phase array antennas.

So we ask ourselves:

- How important is the high bending stability and durability of the connector to cable interface (Stability of strain critical connector / cable interface)?
- What phase change occurs as a function of temperature (phase change vs. temperature [ppm])?

- Do you require abrasion-resistant behavior? (Abrasion resistance)
- Are your cables subject to high external pressure? (Pressure on cable diameter)
- If the cables are subjected to mechanical pressure (crush resistance [kN/m])
- How often can the cable be bent (flex life cycles)?

Every measurement engineer should have researched the answers thoroughly before considering the pure costs. Because, as in all areas of life, you will otherwise have to buy at least twice, and in areas where cables with the above criteria are used, the follow-up costs are often many times higher than if you had opted for a higher-quality product from the outset. And according to Murphy's Law, things go wrong when they absolutely must not go wrong! According to my research, there are only a few manufacturers whose portfolios include cable types that can easily handle the scenarios described above. Without exception, these are not in the lower price categories, that much is clear. But even among high-quality manufacturers, there are significant price differences. The most expensive cable is not necessarily the most suitable one. For me, and this is not just my opinion, the American manufacturer ***TSM Teledyne Storm Microwave,*** for example, would be a good choice in terms of performance, selection, and service life at an excellent price.

Mr. Burger, thank you very much for talking to us!

DO YOU HAVE A QUESTION?

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Learn more about the vast world of high frequency on YouTube.

Legal notice

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