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A Gold Rush to D-Band and Beyond

Covering 60GHz to 90GHz, the E-band is a well-established high-capacity frequency band capable of accommodating numerous different mmWave applications. With radio links that can reach up to 20Gbps data rates, it has been an attractive and cost-effective area for design engineers to make use of. However, ever-increasing demand for greater data transmission volumes at accelerated speeds means that migration up to higher frequencies, such as those in D-band, is now being called for. ***Micro Harmonics Corporation's COO*** *Diane Kees tells us more.*

Though the D-band (which occupies the 110GHz to 170GHz range and offers 100Gbps speeds) is very appealing - particularly in military, defence, space and avionics related applications - currently there is simply not enough infrastructure in place to support such a move. The real question is - can that infrastructure be deployed within the next 5 to 10 years? Otherwise, there will be problems - as by that time the push up the spectrum will be a necessity rather than optional.

A lack of available mmWave components is creating a two-pronged problem. First, system designers making active electronics above 100GHz are going to need mmWave components as well as cost-effective and high-performance equipment for testing. However, those companies that manufacture the test and measurement equipment will also need those high-frequency components to improve their systems. So, the industry is constantly battling those two forces. While not exactly a catch-22, these dependent conditions can slow development activities down significantly.

Bridging the gap

The issue extends beyond just the dearth of test and measurement equipment for mmWave and THz frequencies. The problem is also cost and mobility. System designers are going to require high-performance test instrumentation. Then, when transitioning from the design phase to the production phase, there will be a need to deploy a greater number of these systems, so they will also need to be smaller and less expensive.

As any system designer knows, it can be quite difficult to move the sensitive and bulky testing equipment normally used in research labs around a production facility. In response to this, vector network analyser (VNA) manufacturers have started to adopt a more streamlined approach, with USB-based units that are smaller, portable and cost much less than traditional benchtop models. The only issue is that these are unfortunately restricted to operation at microwave frequencies (from 26.5GHz to 75GHz).

In order to make these small, low-cost VNAs suitable for higher frequency usage, some companies are now releasing custom modules that pair performance-enhanced extender analysers with the new VNAs.

As an example, Virginia Diodes manufactures extenders for traditional VNAs that can reach in excess of 1,100GHz.

Figure 1: VNA extenders can now be used with new streamlined USB VNA devices that are smaller, portable and cost much less than the benchtop models - extending test capabilities up to 400GHz

For the new compact USB-based VNAs previously mentioned, the company is able to extend measurement capabilities up to 400GHz, thereby bridging the gap between low cost and strong performance.

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This extender analyser technology was recently tested on a patent-pending mmWave hybrid circulator developed by Micro Harmonics. The tests showed that, by using the extender, it was theoretically possible to cover entire waveguide bands with relatively low insertion loss and more than 20dB of isolation. Consequently, designers will be able to transmit greater volumes of data through systems operating in the upper regions of the mmWave spectrum.

The combination of a cost-effective VNA and accompanying extender technology represents a real game-changer. Thanks to it, Micro Harmonics has already been awarded a contract from NASA. This will see the company develop a complete line of hybrid circulators, operating in every standard waveguide band from 50GHz to 250GHz, over the course of the next 2 years.

By providing a major boost to existing equipment, extenders like those just described are enabling engineers to undertake new activities with their VNA. This is, in turn, allowing much more innovation to be witnessed within the mmWave spectrum.

Incremental steps

Another huge benefit of utilising new VNAs at higher frequencies is the ability to generate multiport measurements. Typically, companies have only been able to get either a one-port measurement or a two-port measurement at a time when working in mmWave frequencies. Now there are VNAs that can test up to 8 measurements at once. For companies looking to ramp up production, this gives them the ability to greatly increase their testing throughput. That is something which is especially important to companies that fully RF test each component using over 1200 data points across the band.

Having a cost-effective VNA option, used in conjunction with a mmWave extender analyser, will allow manufacturers to move the equipment around the production floor much more easily. Additionally, due to the small USB form factor, they can also be deployed in the field.

The next frontier

There are a number of issues facing system designers looking at pushing the performance and functional boundaries of radar and communication systems. Building components at frequencies above 100GHz becomes increasingly difficult, because of the associated physics involved. Moving up the electromagnetic spectrum, as we all know, the wavelengths will get shorter. Upon reaching a frequency of 300GHz, the wavelength shrinks down to just a single mm. At higher frequencies like this, the constituent parts are tiny and even small alignment errors can significantly degrade the performance derived.

When dealing with things at such a small-scale, available power and device power handling become a big challenge too. Therefore, components at these frequencies must operate with exceptionally low insertion loss and extremely high performance to allow engineers to develop effective signal chains.

In addition to sufficient device power handling, high isolation between active components becomes of critical importance - in order to minimise signal degradation and potential device destruction from signal reflections between components. While these hurdles are high, the ability to transmit a billion Bytes of data in a single second (which is possible within the D-band) is a powerful incentive. Everyone is looking for ways to make it happen sooner, rather than later.

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