MPD MICROWAVE PRODUCT DIGEST
February 2006

MDL Integrates Components for Front End SAR Application

by Microwave Development Labs

Microwave Development Labs (MDL) has been supplying an array of precision manufactured passive waveguide components for over 50 years. MDL's business has always centered around components, most destined for final assembly within advanced communications, defense and space systems. Recently, however, MDL supplied an integrated subassembly to a UAV (unmanned aerial vehicle) defense contractor working with the U.S. Army. MDL's Integrated Transmit-Receive Assembly, now in production at the company's Needham Heights, MA production facility, demonstrates how the company that patented the Riblet Coupler back in the early 1950s continues to provide innovative waveguide solutions for some of the most demanding customers in the world.

MDL's integrated Transmit-Receive Assembly (**Figure 1**) is an all-aluminum front-end assembly consisting of seven individual components for use in a very high resolution, all weather Synthetic Aperture Radar (SAR) airborne system employed in a UAV (in this case an unmanned helicopter). The SAR system tracks moving ground targets by seeing through clouds, rain or fog, day and night. Within the SAR system assembly the MDL integrated subassembly is positioned after the transmitter and before the antenna, and transmits a pulse between 16 and 17 GHz through its transmit port.

The overall assembly consists of seven integrated components. In the past MDL would have supplied the individual components to the subassembly – couplers, band pass filters and circulators – and the defense contractor would have assembled them together within the SAR. In this case, MDL agreed to provide an integrated assembly because in doing so it could best meet, and even exceed, the customer's demanding specifications. In doing so, MDL reduced the total number of components and removed some unneeded flanges, which helped achieve one of the most important customer requirements: keeping the subassembly as compact and lightweight as possible while minimizing the insertion loss.

The assembly's configuration is seen in **Figure 2**. The transmit signal passes through a coaxial TNC coupler to waveguide adapter, then enters a 30 DB

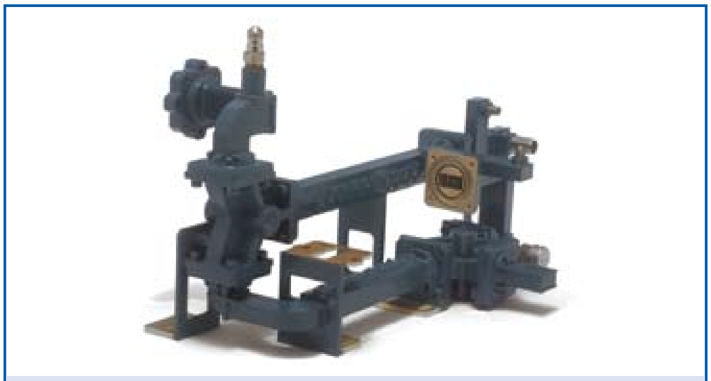

Figure 1

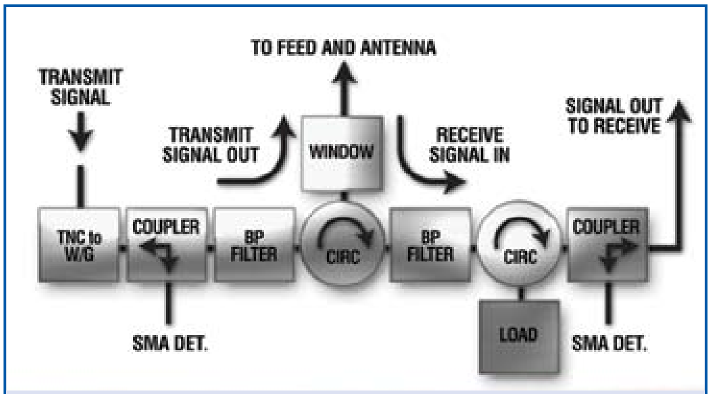

Figure 2: Integrated Front End

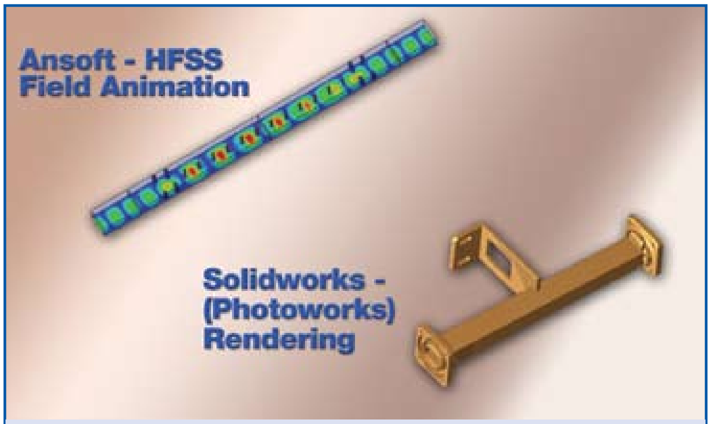

Figure 3

Frequency	16.0 - 17.0 GHz
Waveguide	WR62
Transmit VSWR	1.50 Max
Transmit Loss	(0.7 dB @ 16.5)
Receive VSWR	1.50 Max
Receive Loss	(0.7 dB @ 16.5)
Power (CW)	150 W
Power (Peak)	300 W
Pressure	15 PSIG
Material	Aluminum/Iridite
Weight	1.5 LBS
Size	12" x 6.5" x 6.5"

Figure 5: Typical Specifications

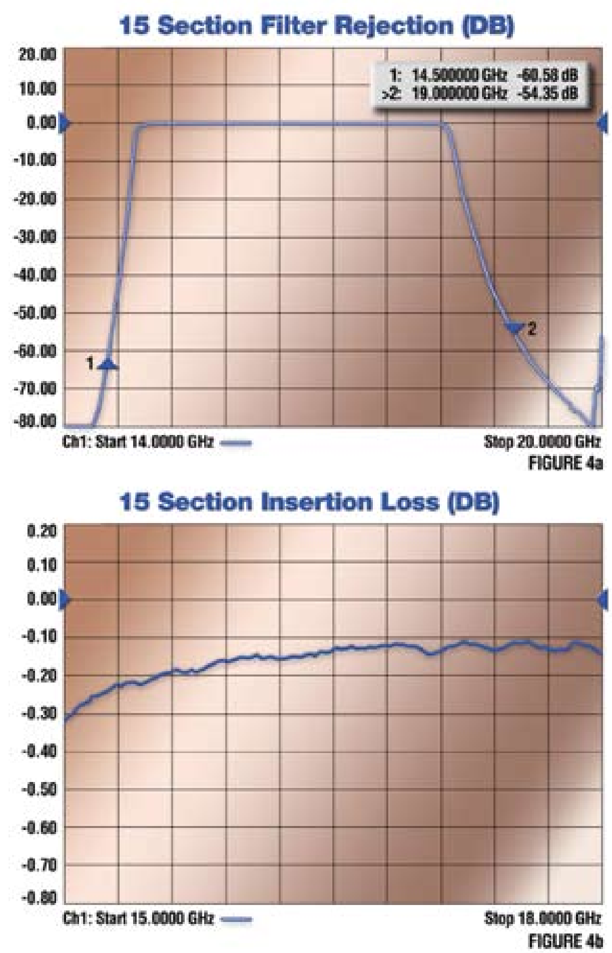

Figure 4A & 4B

cross guide coupler equipped with a SMA adaptor in the unit's auxiliary arm. The signal then goes into a 15-cavity band pass filter (**Figure 3**), through a circulator into a bend assembly. The bend assembly is made of cast components and a section of flex guide. The flex guide aids in bolting the system into the final SAR assembly. On the end of the flex guide's flange is a pressure window.

The receive signal returns from the antenna into the pressure window through the flex guide assembly into the circulator. From the circulator the signal passes through a series of bends into a second band pass filter consisting of 11 sections. Another circulator on the receive line serves as an isolator with one port terminated with a load. From there the receive signal goes into another combination bend cross guide coupler and then out to the receiver.

Based on a three GHz bandwidth within the KU range, the MDL assembly's center frequency is between 16 and 17 GHz. The defense contractor customer provided a detailed specification on the two filters to minimize possible signal interference with satellite communications bands. MDL was able to meet both filter rejection requirements in those two bands. For the 15-section transmit filter (**Figure 4, pg 52**) the customer required greater than 50 DB rejection from the 14-14.5 GHz (common satellite communications band) and 19-20 GHz. In a similar fashion, the 11-section receive filter had a requirement of greater than 50 DB rejection from 14 to 14.5 GHz.

Weight, as cited above, is a critical consideration in any airborne radar system. MDL's Transmit-Receive Assembly weighs less than 2 pounds. This weight was achieved not only by integrating the components into a single assembly - thereby reducing the number of components from 10 down to seven – but also by milling out most of the aluminum in the assembly's two circulators.

Another critical factor was the "shake, rattle and roll" vibration factor, especially pertinent considering the assembly's ultimate placement within an unmanned rotary aircraft to be employed in a combat zone. On any helicopter platform there's a considerable amount of vibration that has to be compensated for to achieve a stable signal. To accomplish this MDL worked closely with the customer and adjusted the placement of the two filters to optimize the center of gravity.

In passive component systems insertion loss is another major consideration because insertion loss directly affects the signal range and detection sensitivity. MDL worked diligently to reduce the amount of power that is naturally dissipated in the assembly itself. The solution, again, was in providing an integrated assembly and not simply individual components. Purchasing individual components requires the end user to both individually inspect and assemble the components. By doing so, the customer almost guarantees a higher insertion loss than if his subcontractor matched them together for him. That's the advantage of having an integrated assembly with specifications applied strictly between the input and the output as opposed to having specifications on several different components. With an integrated assembly the customer is guaranteed the specifications on the entire assembly (see **Figure 5**) as opposed to receiving individual components to be assembled without knowing beforehand how the whole assembly will perform.

MDL believes that providing its customers with subassemblies is a trend for the future. Buying a single assembly, wherever possible, is to the customer's advantage. The VSWR, Insertion loss and other R.F. specifications along with the weight and other mechanical parameters can be optimized as an assembly. In the case of MDL's Integrated Transmit-Receive Assembly, if provided as individual components the parts count could have been as high as ten separate components. Customers typically could purchase these parts from various suppliers, but components of differing quality and cost can make the final product assembly problematic. While they may be able to be married together, they may not function optimally or even adequately.

Having multiple in-house capabilities assists in meeting customer objectives. MDL engineers use the very latest in SolidWorks, Ansoft HFSS and their own proprietary design software to accomplish 3-D modeling. Furthermore, MDL designed all the components in the assembly and has the necessary test equipment to make all the RF tests along with the chemical filming, painting and finishing. While not a requirement even for the U.S. defense industry, all components were made in the United States – in fact, in this case, all were made at MDL in Needham Heights, Massachusetts.

MDL has been involved with the Transmit-Receive Assembly for over two years now. They have provided about 16 separate assemblies in two initial orders and expect to provide many more during the next five years. The company also has provided Raytheon with another integrated assembly recently, and expects subassembly work to grow to between 15-20 percent of total business in the years ahead.

Information supplied by Microwave Development Laboratories, Needham Heights, MA. www.mdllab.com

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