Overview

Teledyne Lincoln Microwave has seen a growing demand from customers to supply integrated assemblies which provide the functionality normally delivered by multiple discreet components with the benefit of higher system performance overall. A recent example was an X-Band radar receiver sub-system assembly for use in a ground-based surveillance radar.

Teledyne Lincoln Microwave was approached by a customer to design a waveguide limiter component for a radar application. The performance specified for the limiter was unusually demanding and therefore costly for an application of this kind.

Working in conjunction with the customer’s engineering group, Teledyne Lincoln Microwave’s low noise amplifier, circulator/Isolator and coupler designers were brought together with systems engineering expertise in a joint technical team. By re-balancing the contribution made by each component to the sub-system noise figure, the team was able to create the headroom necessary to introduce additional functionality and improve the sub-system’s overall performance.

Background

Our customer had been awarded a contract to upgrade an outmoded surveillance radar installation. The existing radar’s transmitter and receiver were located in an air conditioned cabin remote from the antenna. The noise and attenuation losses introduced by the transmission lines between the cabin and antenna meant that the overall level of performance targeted for the new radar could not be achieved.

Teledyne’s new design relocated the radar’s receiver sub-assembly from the air-conditioned cabin to the antenna. Enabling the receiver to be positioned on the antenna demanded that the sub-assembly meet a constrained and complex space envelope as well as a challenging weight budget.

Reliability was recognized as a critical issue to address. When operational, the radar installation would be unmanned with planned maintenance activity minimized. Any unplanned maintenance would be costly, with an unacceptable impact on system availability.

Other design considerations included:

- The control of heat dissipation
- Environmental durability
- Waveguide pressurization
- Minimisation of loss attributable to cable interconnects and waveguide interfaces.

Approach

Our customer initially approached Teledyne Lincoln Microwave with a requirement for a limiter function. The requested level of performance for the limiter was on the edge of viability and unusually demanding for an application of this type.

Working in conjunction with the customer’s engineering group, Teledyne Lincoln Microwave’s team performed a review of the receiver sub-system component line-up (cascaded noise figure analysis) which identified a number of opportunities to optimise component selections. These design modifications promised an overall higher performing sub-system.
The Solution

The improved performance was made possible by first identifying a number of small reductions in the sub-system’s insertion losses. A significant contribution to this was made by exchanging an off-the-shelf, connectorized LNA for a Teledyne Lincoln Microwave LNA with waveguide input. This eliminated the requirement for a waveguide to coaxial adapter. The LNA waveguide interface was later customized to enable the component to be located in the available space envelope.

This afforded the design margin necessary to enable the inclusion of an isolator at the output of the limiter; the isolator stabilised the low noise amplifier performance and thereby made it possible for the specification of the limiter to be eased.

Once the cascaded noise figure analysis was complete and the line-up defined, other sub-system issues were addressed. Foremost amongst these was the design of a mechanical layout to meet the dual constraints of a complex space envelope and a challenging weight budget.

The solution was found in adding customized interfaces to our standard components, including the LNA. This resulted in the unique structure seen in the image which remained within the available weight budget.

Other mechanical considerations included locating the limiter’s field replaceable gas switch in an accessible position, thereby facilitating in-service, in-situ maintenance to maximise system availability.

During acceptance testing the resultant sub-system solution outperformed the target specification, validating the customer’s decision to enhance its system engineering capability by utilizing the specialized component expertise of the Teledyne Lincoln Microwave team.
Subsystem solution successfully employed in surveillance radar application

Summary

Through intimate knowledge of each component, combined with a rigorous system engineering approach, Teledyne Lincoln Microwave was able to improve the size, weight and RF performance of the microwave subsystem. This allowed relocation of the X-band surveillance radar front end to the antenna, while improving maintainability and closing the overall system link budget.

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