400 W GaN HEMT Power Amplifier for X-Band Shipboard Radar

1. Outline

Shipboard radar is used for navigation, collision avoidance, and weather monitoring, with operating frequencies varying according to application, including X-band and S-band. In recent years, there has been an expected increase in radar demand due to a growing emphasis on safety aimed at automated navigation. Among this trend, there is a shift from vacuum tube components, such as magnetrons, to solid-state components like Gallium Nitride High Electron Mobility Transistors (GaN HEMTs). This shift is driven by the fact that vacuum tube components have a relatively short replacement cycle of 1 to 2 years due to their limited lifespan, which contributes to rising operational costs. In contrast, solid-state components offer long-term reliability of over 10 years, eliminating the need for regular replacements like those required for magnetrons. Additionally, technologies such as pulse compression enable solid-state components to achieve radar performance equal to or exceeding that of magnetrons with lower power consumption, leading to expectations of continued demand growth.

This report presents the development of a 400 W GaN HEMT for X-band shipboard radar to meet the market needs for high output.

2. Development of 400 W GaN HEMT for X-Band

2-1 Product development

We have previously commercialized 200 W and 300 W GaN HEMTs for shipboard radar applications. The product we have developed this time is expected to contribute to the miniaturization of shipboard radar modules. In shipboard radar modules, high output is achieved by paralleling multiple 200 W units.

By developing the 400 W GaN HEMT product for X-band with high output capabilities, we can achieve output power with fewer parallel units, enabling the miniaturization and cost reduction of shipboard radar modules. Photo 1 shows the internal circuit. The circuit configuration is designed to perform tournament-type in-phase distribution and combining. Additionally, Photo 2 shows the evaluation fixture, which has a λ/4 open stub designed for the bias circuit.

2-2 Device performance

Figure 1 shows the electrical characteristics of the product. The operating conditions are a drain voltage of 50 V, with pulse conditions of a pulse period of 1 ms and a pulse width of 100 µs. The frequency range corresponds to the X-band frequency for shipboard radar, specifically 9.3–9.5 GHz. At an input power of 48 dBm, the output power achieved was 56.5 dBm, with a power added efficiency of 38%. Orders for the product have been accepted since April 2025.

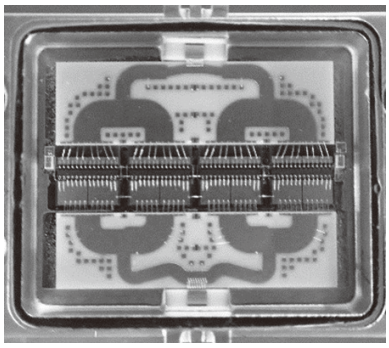

Photo 1. Internal circuit of the 400 W GaN HEMT for X-Band

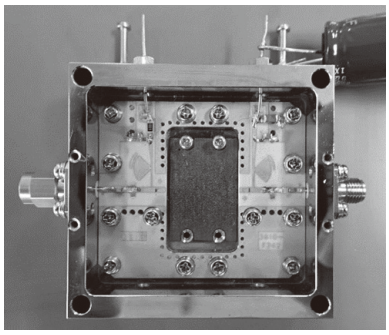

Photo 2. Evaluation fixture for the 400 W GaN HEMT for X-band

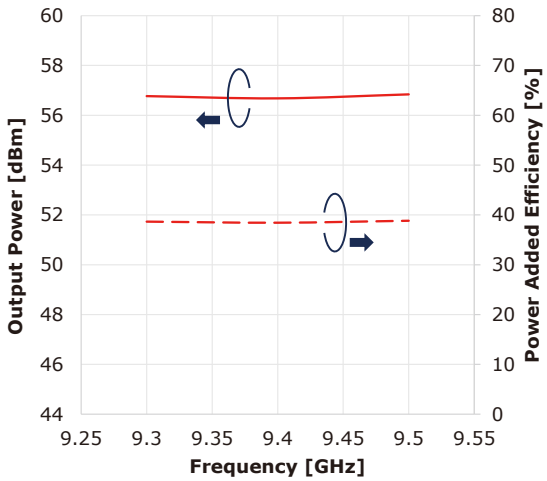

Fig. 1. Electrical characteristics of the 400 W GaN HEMT for X-band