800 W High-Power, High-Efficiency GaN HEMT Amplifier for S-band Radar Applications

1. Outline

In recent years, semiconductor devices for marine and meteorological applications have become more powerful, and solid-state radars are replacing conventional magnetron radars. Long service life is one of the advantages of solid-state devices. Although magnetrons need to be replaced periodically, semiconductors do not require replacement and thus help reduce radar maintenance costs. It is difficult to observe small objects with magnetron radars due to large frequency fluctuations. In contrast, due to their high-frequency stability, solid-state radars improve observation performance by enabling observation of objects that were difficult to observe in the past.

On the other hand, to provide solid-state radars with a detection range equivalent to that of magnetron radars, a plurality of semiconductor devices must be arranged in a row, and their output power needs to be further increased to reduce the required number of devices. We have developed an S-band GaN HEMT with the highest output power of 800 W in the industry. This report describes the features of this new device.

2. Features

2-1 Device technology

In the past, we developed an S-band 600 W device. To develop a device with further high output power, the performance of the transistors, package, and other components was improved.

We improved the conventional transistor technology by improving the single crystal film of GaN and AlGaN on a SiC substrate, and as a result, we could increase the unit output power from 7.5 W/mm to 10 W/mm without loss of quality.

In addition, upsizing the GaN dies was required in response to the increase in output power and for more efficient heat dissipation. A new package was designed because the upsized dies did not fit inside the conventional package.

2-2 Device design

Photo 1 shows a photo of the inside of the newly developed S-band 800 W GaN HEMT, and Photo 2 shows a photo of the evaluation jig. Two GaN dies are installed in the GaN HEMT, and matching ceramic capacitors are mounted on the input and output sides of the GaN HEMT. A Wilkinson-type matching circuit was patterned on the evaluation jig to design a circuit having an impedance of 50 Ω at the connector end.

2-3 Device performance

Figure 1 shows the RF characteristics of the S-band 800 W GaN HEMT. These characteristics were obtained by operating the device at a drain voltage of 50 V under pulse operation conditions of 2 msec in pulse period and 200 µsec in pulse width. The new product achieved an output power of 59.7 dBm and a drain efficiency of 60.5 % in the S-band radar band. This output power is the highest among those of S-band GaN HEMT power amplifiers reported so far.

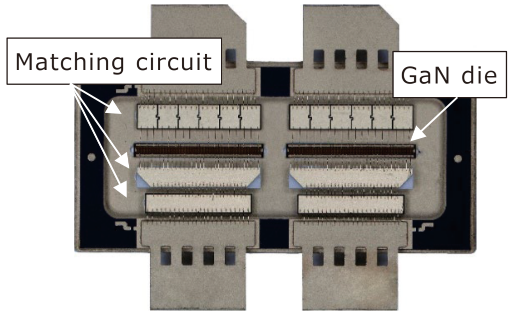

Photo 1 Photo of the inside of S-band 800 W GaN HEMT

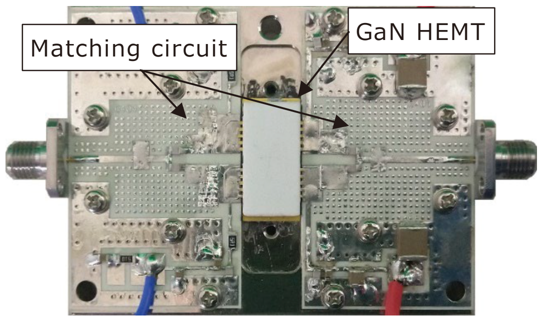

Photo 2 Evaluation jig for S-band 800 W GaN HEMT

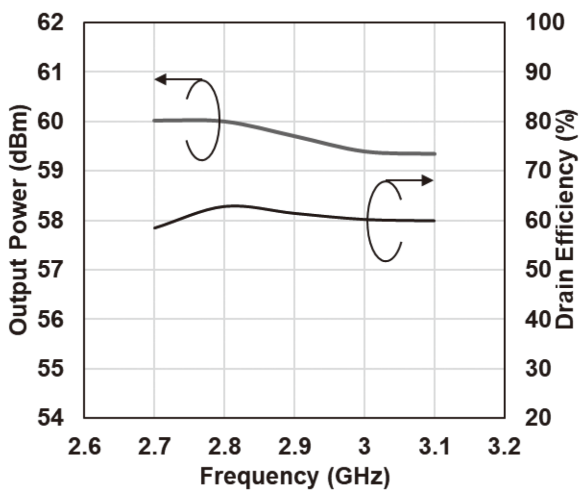

Fig. 1. RF characteristics of S-band 800 W GaN HEMT