

# World's first GaN HEMT T/R module operating in the C-Ku band

June 6 2011

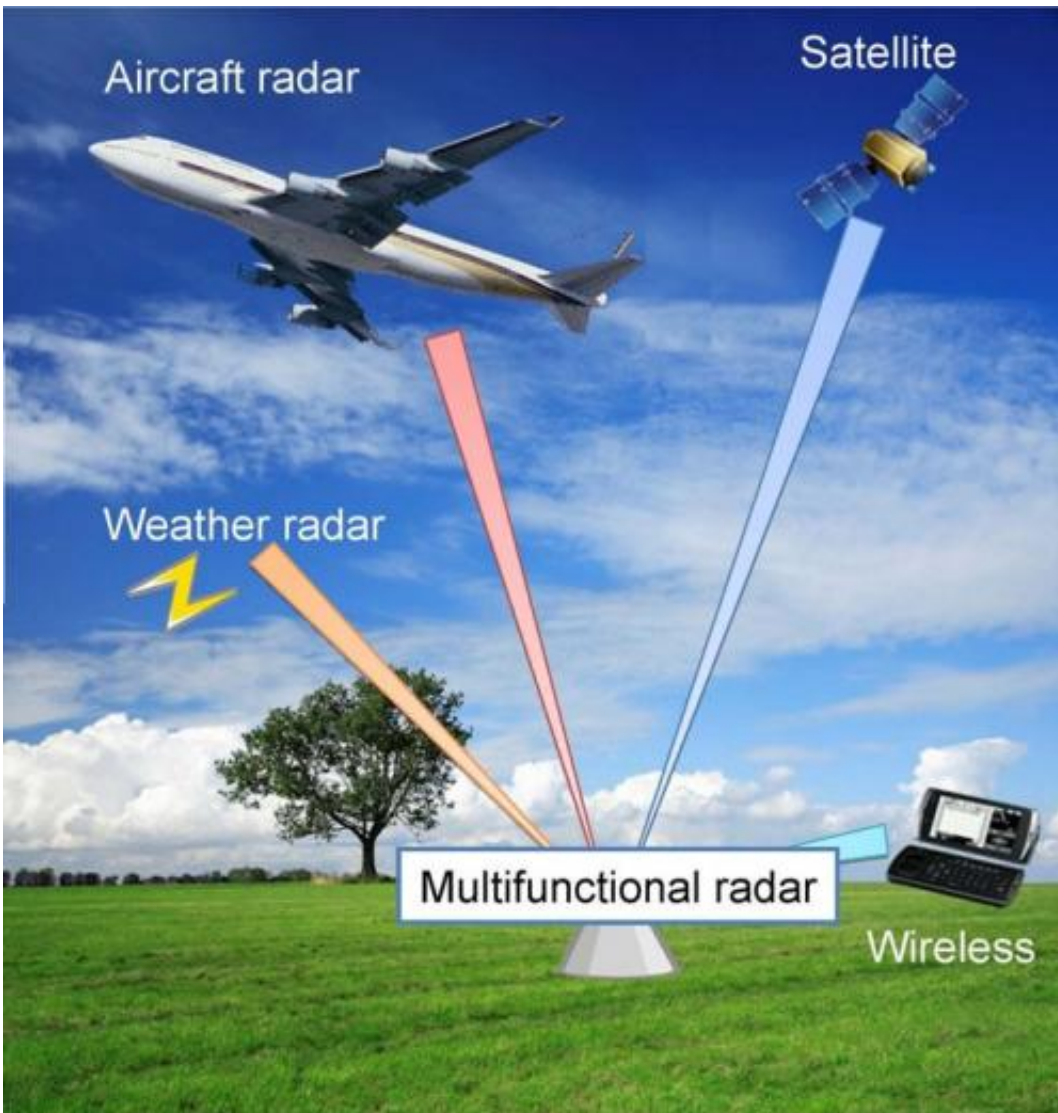


Figure 1: Usage scenarios for multifunctional radars operating across C-Ku bands

Fujitsu Laboratories today announced that it has successfully developed the world's first transmitter/receiver (T/R) module using gallium-nitride (GaN) high electron mobility transistor (HEMT) technology that features an output of 10 W and that operates in a wide bandwidth range of C-band, X-band, and Ku-band (C-Ku band) radio frequencies over 6-18 GHz. By combining the world's best performing GaN power amplifier (PA) developed last year with the newly developed GaN low-noise amplifier (LNA), the researchers achieved a compact T/R module that generates a high-output.

This technology makes possible the integration of multiple types of communications equipment—each currently operated at a different frequency range—into a single module, making for the development of smaller, lighter radar equipment and wireless communication systems.

Details of this technology will be presented at the IEEE MTT International Microwave Symposium (IMS 2011) held in Baltimore, Maryland, starting June 5.

[Gallium-nitride](#) (GaN) is used as a blue-LED in traffic signal lights, and compared to the conventional semiconductor materials of silicon (Si) and gallium-arsenide (GaAs), it features a high saturation carrier velocity and relative resistance to the breakdown caused by voltage. Given these characteristics, GaN HEMTs—or [transistors](#) that use GaN—show promise for high-output and exceptionally efficient operations.

In line with the advance of a network-based society, radio wave demand in a variety of wireless systems is expected to increase even further. For example, aircraft radar typically switches between the C-band, which can detect distant objects and works well in rain, and the X- and Ku-bands which are able to measure physical objects with high-precision.

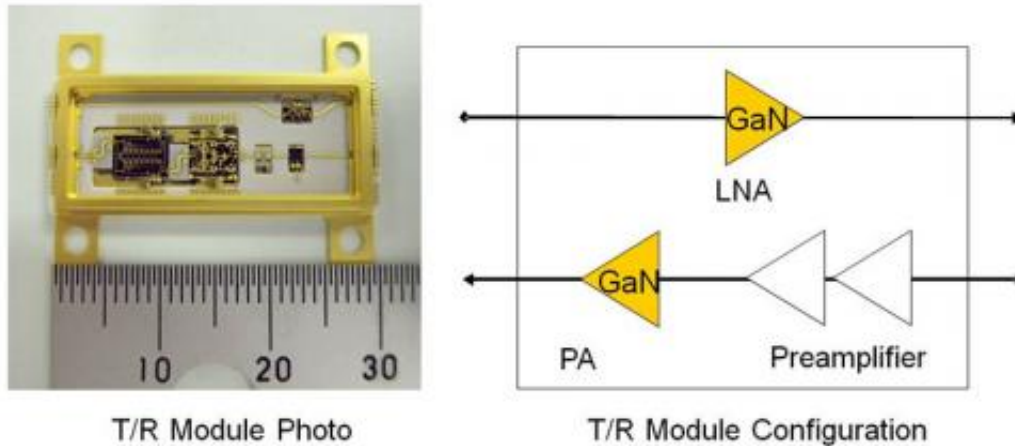


Figure 2: Photo and structure of GaN wide broadband T/R module

Currently, this demand for multiple frequency ranges requires different [communications equipment](#) each suited to their respective frequency band. However, a single T/R module capable of covering the entire C-Ku band range would meet a variety of needs, allowing systems to become more compact.

T/R modules are essential to operate multifunctional radar over a broad spectrum. Users therefore demand that T/R modules possess wideband features capable of operating across multiple frequency ranges, and high output performance so as to cover a wide area. To develop a T/R module with 10 W-class high output power over a wide broadband range, such as the C-Ku band, not only is a wideband PA and LNA required, but it is also critical to improve the T/R module's heat dissipation characteristics as heat generation intensifies in tandem with higher output levels.

In addition, it is also necessary to reduce signal losses in the input/output terminal to maintain frequencies up to 18 GHz. This is because at higher frequency ranges input/output signal losses increase in the terminal portion of the T/R module.

By adopting a GaN HEMT, [Fujitsu](#) Laboratories developed a compact, high-output GaN HEMT T/R module that covers the ultra-broadband C-Ku spectrum (6-18 GHz).

Key features of the new technology are as follows:

- Improved heat dissipation with heat sink

Fujitsu Laboratories developed an embedded heat sink structure that efficiently dissipates the heat generated at high output levels. The heat sink is built into the T/R module's multilayer alumina ceramic substrate. Compared to previous designs, heat dissipation improved by a factor of five times, enabling high output levels of 10 W.

- Lower signal losses in the signal input/output terminal portion

Fujitsu Laboratories devised an ultra-broadband terminal structure that reduces the input/output terminal signal loss that occurs at higher frequencies. With the new terminal structure, high frequency signals passing through the module can be transmitted at up to 40 GHz, three times the frequency levels of previous designs.

- Development of a world-class, compact LNA

In addition to the GaN HEMT PA featuring the world's highest output performance developed last year by Fujitsu Laboratories, the researchers have now developed a new LNA that uses GaN [HEMT](#). Being a compact  $2.7 \times 1.2$  mm, the LNA achieves a gain of 16 dB across 3-20 GHz, and noise figures of 2.3-3.7 dB, representing the world's best performance levels.

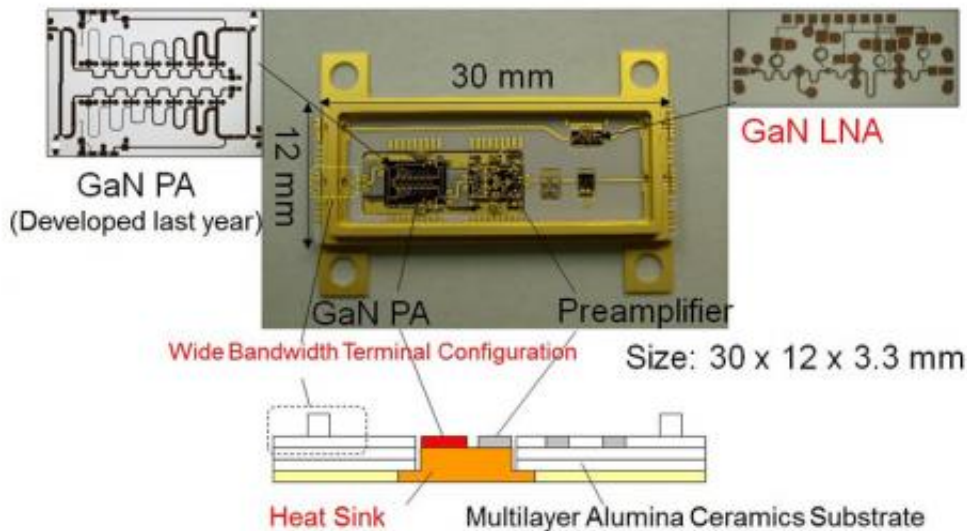


Figure 3: Photo and cross-sectional diagram of GaN wide broadband T/R module

The new technology has enabled Fujitsu Laboratories to develop a compact T/R module measuring only 12 × 30 mm that operates across an ultra-wide broadband 6-18 GHz, with output power of 10 W.

This new technology will make it possible for a single T/R module to operate at multiple frequencies, paving the way for further system integration in broadband communications and radar systems that utilize various frequencies, meaning more compact and lighter equipment.

Source: Fujitsu

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