THE FIRST IN A FAMILY OF VERSATILE HIGH POWER GaN TRANSISTORS

RFMD has developed a portfolio of Gallium Nitride (GaN) on Silicon Carbide (SiC) high power amplifiers and just recently released the first product from a family of discrete unmatched power transistors. The RF3931 is a 48 V, 30 W high power discrete transistor that operates in the DC to 3 GHz frequency range and is designed for commercial wireless infrastructure, defense/military, industrial/scientific/medical, test instrumentation and general purpose broadband amplifier applications.

Using an advanced high power density 0.5 µm GaN high electron mobility transistor (HEMT) semiconductor process, these high-performance amplifiers achieve high efficiency and flat gain over a broad frequency range in a single amplifier design. The RF3931 is an unmatched GaN transistor packaged in a hermetic, flanged ceramic package. This package provides excellent thermal stability through the use of advanced heat sink and power dissipation technologies. Ease of integration is accomplished through the incorporation of simple, optimized matching networks external to the package that provide wideband gain and power performance in a single amplifier. This is the first product released from a family of four unmatched power transistors ranging in power levels from 30 to 120 W.

DESIGN

The RF3931 utilizes RFMD's advanced 0.5 µm GaN1 process optimized for high-power and high-efficiency performance with the following process parameters: 28 to 48 V operation, Vbd>200 V, Pd 6-8 W/mm and Ft ~11 GHz. The RFMD GaN1 process is fully qualified and has a predicted Activation Energy E_a=2.3 with Mean Time to Failure (MTTF) of 9.2×10^6 at 200°C channel temperature. The GaN high-voltage process delivers lower output capacitance and higher impedance, enabling device designs that provide wider bandwidth and simpler matching circuits versus incumbent silicon processes.

RFMD's RF3931 is a depletion mode device and therefore requires a typical -5 to -6 V gate pinch-off voltage. The Vgsq to bias the transistor for nominal class AB operation is between -3 to -4 V. Even though the transistor is optimized for 48 V operation, it has been demonstrated to work at drain voltages as low as 28 V and as high as 65 V. The input capacitance is 9.5 pF or 0.3 pF/W; the output capacitance is 5.5 pF or 0.15 pF/W. The RF3931 is optimized for the DC to 3 GHz frequency range and is incorporated into an advanced, high thermal conductivity package that is required to support the higher power density of GaN. The bolt-down, 2-leaded-flange, hermetically sealed solution provides a robust, packaged designed to operate over temperature ranges from -40° to 85°C.

RFMD®
Greensboro, NC

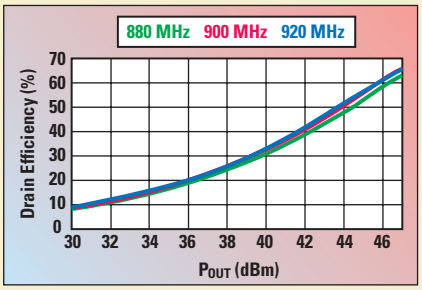

Fig. 1 RF3931 drain efficiency vs. output power at 900 MHz (Vds = 48 V, Idq = 130 mA).

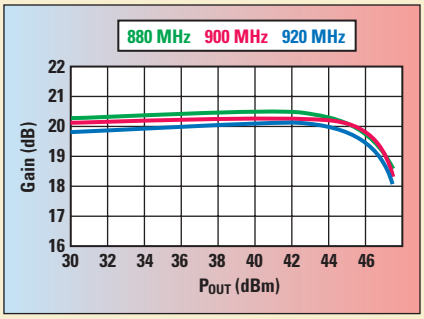

Fig. 2 RF3931 gain vs. output power at 900 MHz (Vds = 48 V, Idq = 130 mA).

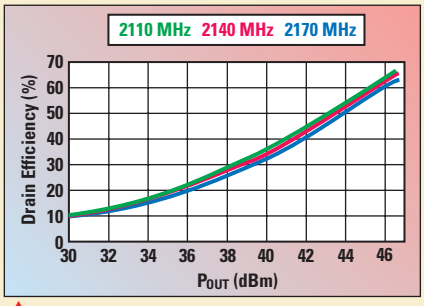

Fig. 3 RF3931 drain efficiency vs. output power at 2.1 GHz (Vds = 48 V, Idq = 130 mA).

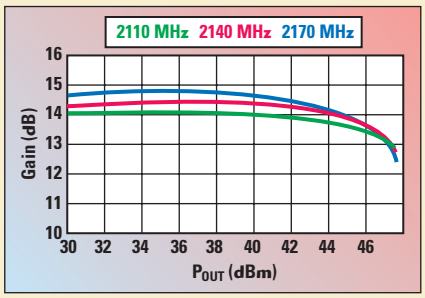

Fig. 4 RF3931 gain vs. output power at 2.1 GHz (Vds = 48 V, Idq = 130 mA).

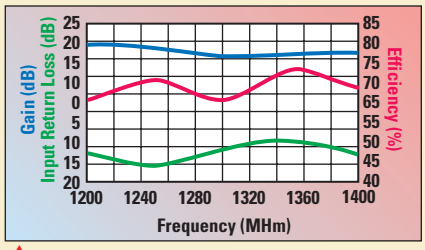

Fig. 5 RF3931 L-band (1200 to 1400 MHz) performance.

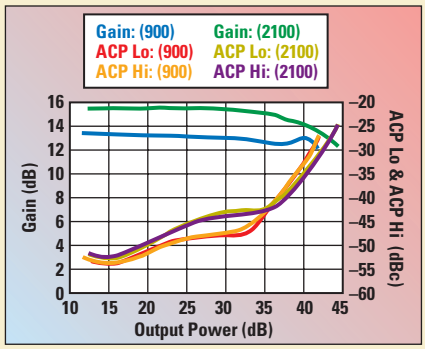

Fig. 6 RF3931 ACP measurements.

A summary of the RF3931's features include: 28 to 48 V operation; DC to 3 GHz broadband tunable frequency range. Performance at 900 MHz (see ***Figures 1*** and ***2***): 50 W typical peak power; 65% power added efficiency; 20 dB linear gain. Performance at 2.1 GHz (see ***Figures 3*** and ***4***): 40 W typical peak power; 62% power added efficiency; 15 dB linear gain. Common to both: 0.012 dB/°C gain variation over temperature; -40° to 85°C operating temperature range; 100 percent RF and DC tested; industry-standard 2-leaded flange ceramic package; RoHS compliant and lead-free; EAR99 export control.

Nonlinear models were developed to enable the design community to predict performance of the RF3931 in both linear and compressed applications. Efforts to improve the model performance over temperature at specific frequencies and power convergence are ongoing. Upgrades to the models will be made available to the market periodically.

NUMEROUS APPLICATIONS

Suitable for both linear and compressed end products, the RF3931 is an ideal solution for a multitude of applications requiring bandwidth, power and efficiency. Such applications include public mobile radios (PMR), military communications, civilian and military radar, military jamming, test instrumentation, commercial/cellular wireless infrastructure, and general purpose broadband amplifiers. End customers incorporating the RF3931 into next-generation systems will benefit from utilizing this advanced technology due to its ability to enable higher efficiency, higher power and wider bandwidth solutions versus the incumbent technology. These enhanced capabilities enable the RF3931 to provide value proposition(s) of reduced components, reduced cooling/thermal requirements, reduced weight/size, and ultimately, reduced installed costs.

The RF3931 performs well for both pulse and CW constant envelope applications. Optimum performance is highlighted by the results of a RF3931 fixture tuned for L-band 1200 to 1400 MHz frequency under pulse conditions. The RF3931, operating at Vdd=48 V and Idsq= 130 mA, provides 45 W output power with ~65 percent drain efficiency and ~17 dB gain over the full 200 MHz bandwidth when a 100 usec pulse width, 10 percent duty cycle waveform, is introduced to the fixture (see ***Figure 5***). The RF3931 L-band results were accomplished through simple, optimized matching networks external to the package.

Linear performance in high power amplifiers is important for applications using complex waveforms with high peak to average ratios (PAR). The RF3931 demonstrates respectable linear performance and can be used in both corrected and un-corrected linear architectures. The linear performance of the RF3931 achieves better than -40 and -45 dBc ACP for 2.1 GHz and 900 MHz, respectively, using 0 percent clipping on a 3G 64-channel test model to 34 dBm (see ***Figure 6***). Both examples demonstrate that the RF3931 is a versatile power amplifier that provides a range of power, efficiency, bandwidth and linearity from a single device. The inherent attributes in RFMD's GaN1 process and end product design allow for ease of implementation and superior performance in end customer applications.

CONCLUSION

RF3931 is the first product released in RFMD's new family of GaN unmatched power transistors ranging in power from 30 to 120 W. The design is incorporated in an advanced, high thermal conductivity flange ceramic package and has been developed to meet the needs of customers requiring optimal power performance for both compressed and linear applications. Based on RFMD's robust GaN1 HEMT process technology, the RF3931 offers customers high power and high efficiency broadband power amplification in a low-cost, green solution.

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VENDORVIEW **RS No. 300**