

Integrated Ferrite Film Inductor for Power Systems-on-a-chip (PowerSoC) Smart Phone Applications

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The integrated inductor is an essential passive component in an on-chip power system for smart phone applications. For high efficiency of power conversion, high quality factor and high rated current of inductor are needed. In order to achieve the aforementioned characteristics, ferrite film has been used due to its low eddy current loss. Furthermore, the parasitic capacitance and the leakage current, which lead to electric energy loss, can be significantly reduced by the use of ferrite [1]. In this paper, sputtered $\text{Ni}_{0.5}\text{Zn}_{0.3}\text{Cu}_{0.2}\text{Fe}_2\text{O}_4$ ferrite film inductors were fabricated on 4 inch silicon wafer by photolithographic process and copper electroplating. Electroplated $65\ \mu\text{m}$ thick copper spiral coil was used for the ferrite inductor with $5 \times 5\ \text{mm}^2$ outer coil area. Figure 1 shows the fabricated array of ferrite inductors.

Maximum inductance (L_{max}), Q-factor (Q_{max}), and rated DC current of the fabricated inductors are given in Table I. The L_{max} and Q_{max} were measured to be 50 and 58.9 at 2.87 MHz for the $2.5\ \mu\text{m}$ thick ferrite inductor. It is noted that Q_{max} of the $1\ \mu\text{m}$ and $2.5\ \mu\text{m}$ thick ferrite inductors increased by factors of 2.1 and 2.5, respectively, compared to those of air-core inductor. This is attributed to the low parasitic capacitance and small leakage current. The ferrite inductors also have higher rated current compared to the air-core inductor. The rated DC current of $1\ \mu\text{m}$ and $2.5\ \mu\text{m}$ thick ferrite inductors was measured to be 2.15 A and 2.5 A, respectively. In summary, the ferrite inductors were fabricated on 4 inch silicon wafer. The $2.5\ \mu\text{m}$ ferrite inductor showed an increase in L and Q by 22.5 % and 154 %, respectively, compared to the air-core inductor.

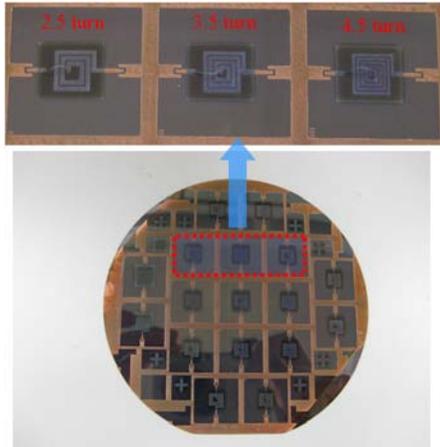


Fig. 1. Fabricated array of ferrite Inductors.

Table I. Maximum inductance, Q-factor, and superimposed DC current of air-core and ferrite inductors.

Inductors	L_{max} [nH]	Q_{max}	Rated DC current [A]
Air-core	40.8	23.2 at 1.56 MHz	-
$1\ \mu\text{m}$ thick ferrite	45.5	49.3 at 2.26 MHz	2.15
$2.5\ \mu\text{m}$ thick ferrite	50.0	59.0 at 2.87 MHz	2.5

[1] S. Bae, Y. K. Hong, J. J. Lee, G. S. Abo, J. Jalli, A. Lyle, B. C. Choi, and G. W. Donohoe, "High Q NiZnCu ferrite inductor on-chip power module," *IEEE Transactions on Magnetics*, Vol. 45, No. 10, 4773, October (2009).