Wideband, low noise and low spurious agile direct frequency synthesis based on combination of SAW Oscillator and high speed DAC

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Electronic warfare sub-systems always need wider frequency band agile synthesizer. This one must show low noise and low spurious levels. Up to recently, Direct Digital Synthesizer (DDS) was not dedicated to this topic because DAC with improved noise performances required working at low frequency. Consequently optimized frequency plans were difficult to define because of non desired frequency mixing products on required large agility bandwidth.

Nowadays, on the first hand, few GHz clock DAC with low spurious and low noise performances are available on commercial market [1]. On the other hand, Ultra Low Noise (ULN) Oven Controlled Surface Acoustic Wave Oscillator (OCSO) [2] shows very low noise floor and can provide the clock to the DAC without any added jitter on the frequency output. In this way, by combining multiplied-frequency OCSO and high frequency DAC, one can achieve state of the art frequency synthesis, outperforming then current established limits. The multiplied-frequency OCSO is used to provide the clock to the DAC and also to up-convert the output frequency DAC in any microwave frequency band of interest.

The frequency plan can be easily designed thanks to high linearity of the DAC. We only have to prevent the frequency mixing between the output second or third harmonics and the clock spurious, because higher harmonic levels are low enough. Furthermore, the DAC output control mode could be chosen, in order to reach the best dynamic performances [3].

Within our experiments operating in high-frequencies (<20 GHz), we obtained a 500 MHz wideband direct frequency synthesis, showing a high Spurious Free Dynamic Range (SFDR) of -70 dBc and -90 dBc respectively for wide (500 MHz) and narrow analog bandwidth ; finally, a phase noise floor level of -135 dBc.Hz^{-1} for offset frequencies above 10 KHz was obtained.

Further developments would allow reaching even better performing direct frequency synthesis in using higher output frequency DAC with lower noise floor and improved near-the-carrier phase noise of OCSO identified as limiting parameters.

[1] http://www.e2v.com/products-and-services/hi-rel-semiconductor-solutions/broadband-data-converters/

[2] http://www.rakon.com/products/families

[3] F.Bore, M. Wigender, A. Glascott-Jones,E. Dumaine, C.Lambert and S. Calais, “3 GS/s 7 GHz BW 12 Bit MuxDAC for direct microwave signal generation over L, S or C bands” , IEEE International Conference on Microwaves, Communications, Antennas and Electronics Systems (COMCAS), 7-9 Nov. 2011