pump (CP) are clocked at the reference frequency (fref).

Spurs from these sources can be seen in the PLL's output spectrum, offset from the PLL's output spectrum. The spurs are caused by non-idealities in the PLL component such as mismatched propagation delay in the PFD and CP, charge injection and current mismatches in the CP. So modelling of spurs is required. As we are analyzing the frequency synthesizer in the x band and ku band we calculate and compare the spurs in that particular bands.

$$\text{Spur in dBc} = 20 \cdot \log_{10}\left(\frac{KVCO \cdot vn}{2 \cdot fn}\right) \qquad (2)$$

where, vn is the peak voltage measured at the fn, KVCO is the gain of VCO.

Lock time should be less for a better frequency synthesizer. The above factors cause the lock time to increase. The lock time is effected with the change in bandwidth.

$$Lt \approx (400/F_c) \,.\, (1-\log_{10} \Delta F) \qquad (3)$$

where, Lt is lock time in micro seconds and F_c is the loop bandwidth in KHz. ΔF is the ratio of frequency tolerance to frequency jump.

3. Simulation tool and results

The matlab is used as the tool simulation tool for comparative study of the performance factors of the PLL based frequency synthesizer. Using equation (1) the graph that is Figure 1 is plotted between the phase noise and the offset frequency.

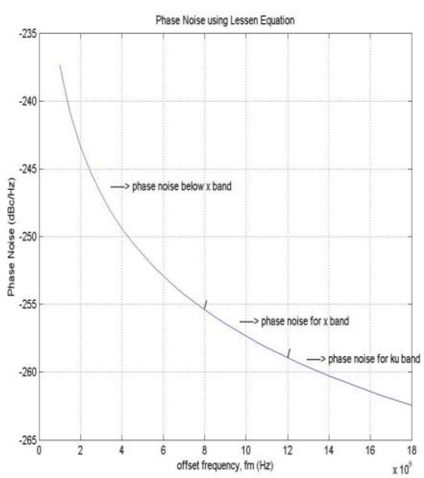

Fig. 1 Plot for offset frequency Vs phase noise

The range of frequencies are below x band, in x band and in ku band. The phase noise is measured in dBc/Hz. The frequency is taken in Hz. The figure shows that the graph decreases from the below x band to ku band. The phase noise plot has the break points to indicate the below x band region, x band region and ku band region. The phase noise is more in below x band region, less in x band region and very less in the ku band region.

Using equation (2) the graph that is Figure 2 is plotted between the spur and the offset frequency. The range of frequencies are below x band, in x band and in ku band. The spur is measured in dBc/Hz. The frequency is taken in Hz. The Figure 2 shows that the graph decreases from the below x band to ku band.

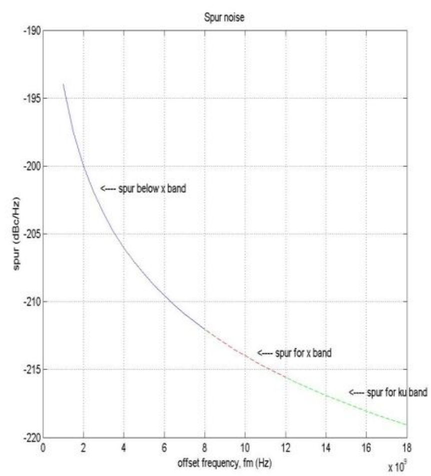

Fig. 2 Plot for offset frequency Vs Spur

The spur plot has the different colours used to indicate the blue for below x band region, red for x band region and green for ku band region. The spur is more in below x band region, less in x band region and very less in the ku band region. Using equation (3) the graph that is Figure 3 plotted between the frequency and lock time.

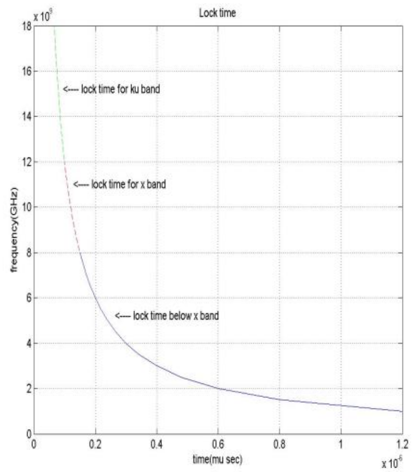

Fig. 3 Plot for offset frequency Vs Lock time

The range of frequencies are below x band, in x band and in ku band. The lock time is measured in micro seconds. The frequency is taken in GHz. The figure 3 shows that the graph decreases which mean that the lock time decreases as the frequency increases. It implies that the lock time is less in ku band when compared to x band. The lock time plot has the different colours used to indicate the blue for below x band region, red for x band region and green for ku band region. The lock time required by the frequency synthesizer is more in x band region when compared to the ku band region.

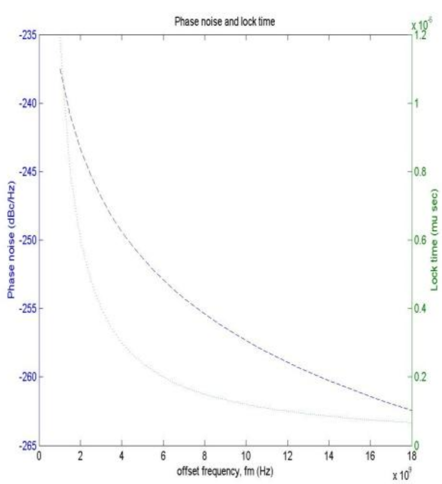

Fig. 4 Plot for offset frequency Vs Phase noise, Lock time

The graph in figure 4 is plotted among phase noise on left y axis, lock time on right y axis and offset frequency on x axis. The green dotted lines indicate the lock time in micro seconds and the blue dashed lines indicate the phase noise in dBc/Hz with respective to the offset frequency in GHz.

4. Comparative study

The values obtained from the matlab simulation are shown in the table 1. The comparison for the parameters phase noise, spur and lock time is done among below x band region, in x band region and ku band region. The phase noise measured in dBc/Hz ranges from -237.5 to -263.5 which mean that the phase noise decreases from below x band, in x band and in ku band.

The spur measured in dBc/Hz ranges from -194 to -219 which mean that the spur decreases from below x band, in x band and in ku band. The lock time measured in micro seconds 0.175musec to 0.1musec which mean that the lock time decreases from below x band, in x band and in ku band.

	Below X band (1-8 GHz)	X band (8-12 GHz)	Ku band (12-18 GHz)
Phase noise	-237.5 dBc/Hz to -255.5 dBc/Hz	-255.5 dBc/Hz to -259 dBc/Hz	-259 dBc/Hz to -263.5 dBc/Hz
Spur	-194 dBc/Hz to -212 dBc/Hz	-212 dBc/Hz to -216 dBc/Hz	-216 dBc/Hz to -219 dBc/Hz
Lock time	0.175 musec to 1.2 musec	0.1 musec to 0.175 musec	0.75 musec to 0.1 musec

Table 1 Simulation results table

5. Conclusion

The performance factors that mainly affect the functioning of the frequency synthesizer are phase noise, spur and lock time. The following are some of the observations.

- The phase noise is a linearly decreasing graph in both x band and ku band.
- The phase noise is less in ku band when compared to x band.
- Spur is less in ku band when compared to the x band and can be reduced by using proper loop filter.
- Lock time is less in ku band with respective to the bandwidth when compared to the x band and can be reduced by taking the reference frequency nearer to the fed back frequency.

The performance factors of PLL based frequency synthesizers namely phase noise, spur and lock time are modelled and simulated in x band and ku band. The results of matlab simulations are analysed.

6. References

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