



- 5) Now let's change the LO clock duty cycle from 50% to 25% as shown above, and all the other conditions are same as 1) and no image signal. Calculate **rms** output signal power ( $S_o$ ) and output noise power ( $N_o$ ) and noise factor  $F$  (15 pt).  
 (Note: non-50% duty cycle also generates RF leakage to IF output node due to DC component of LO waveforms.)

Fundamental tone

$$50\% \rightarrow \frac{2}{\pi}$$

$$25\% \rightarrow \frac{2}{\pi} \sin\left(\pi \cdot \frac{1}{4}\right) = \frac{2}{\pi} \cdot \frac{1}{\sqrt{2}}$$

$$\therefore S_{o, \text{new}} = S_{o, \text{old}} \times \left(\sin \frac{\pi}{4}\right)^2 = 117.13 \text{ nW} \times \frac{1}{2} = 58.565 \text{ nW}$$

Noise power will be the same as into 50% duty-cycle

$$\therefore F_{\text{new}} = F_{\text{old}} \times \frac{1}{\left(\sin \frac{\pi}{4}\right)^2} = \frac{5.057}{1/2} = 10.114$$

$$\Rightarrow 10.049 \text{ dB}$$