

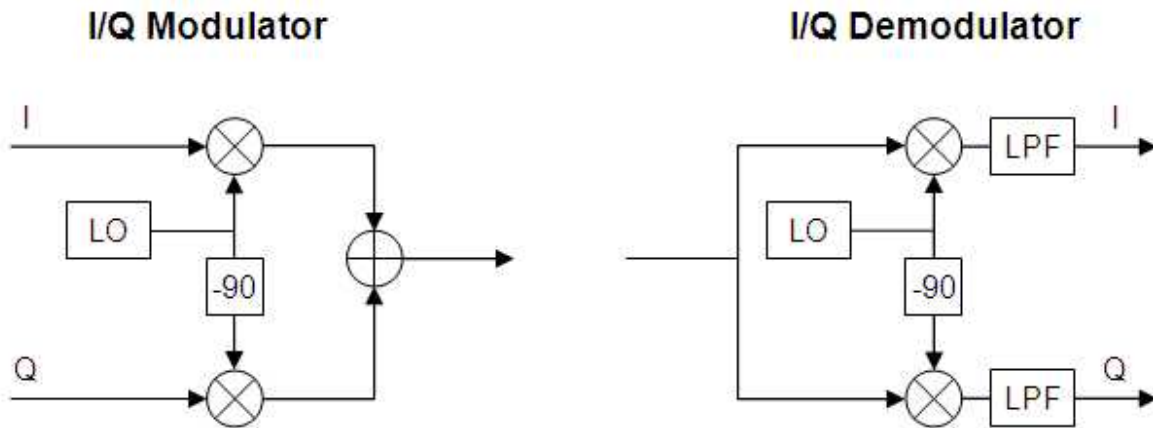
# LO Phase Shift for IQ Modulator-Demodulator

## Problem

Why, when assembling an I/Q modulator or demodulator using MIXER\_B/MIXER\_F, is a phase shift of +90 degrees applied to the LO signal rather than -90 degrees?

## Solution

In an ideal I/Q modulator or demodulator, the I channel is mixed with  $\cos(2f_{LO}t)$ , while the Q channel is mixed with  $-\sin(2f_{LO}t)$ :



Using the identity:

$$\cos(f_{LO}) = \cos(s) \hat{A} \cdot \cos(t) - \sin(s) \hat{A} \cdot \sin(t)$$

We can relate  $-\sin(2f_{LO}t)$  to  $\cos(2f_{LO}t)$  by:

$$\cos(f_{LO} + \pi/2) = \cos(f_{LO}) \hat{A} \cdot \cos(\pi/2) - \sin(f_{LO}) \hat{A} \cdot \sin(\pi/2) = -\sin(f_{LO})$$

Therefore, applying a 90 degree phase shift to  $\cos(2f_{LO}t)$  is identical to  $-\sin(2f_{LO}t)$ .