APPENDIX-A

Theoretical Analysis for Multiple Interference Scenario

Let input signal voltage to receiver in case of two adjacent channel interference is

\[ v_{\text{in}}(t) = v_{RF}(t) + v_{a1}(t) + v_{a2}(t) \]

where,
\[ v_{RF}(t) = I(t) \cos \omega_{RF}(t) - Q(t) \sin \omega_{RF}(t), \]
\[ v_{a1}(t) = I_{a1}(t) \cos \omega_{a1}(t) - Q_{a1}(t) \sin \omega_{a1}(t), \]
\[ v_{a2}(t) = I_{a2}(t) \cos \omega_{a2}(t) - Q_{a2}(t) \sin \omega_{a2}(t). \]

Let , local oscillator signal to mixer-1 is

\[ v_{\text{LO}}(t) = \cos \omega_{LO}(t) \]

where, \( \omega_{LO}(t) = \omega_{RF}(t) \)

Output voltage of Mixer-1 is

\[ v_{m1}(t) = v_{\text{in}}(t)v_{\text{LO}}(t) + \gamma_1 \{ v_{\text{in}}(t)v_{\text{LO}}(t) \}^2 \]

\[ v_{m1}(t) = v_{RF}(t)v_{\text{LO}}(t) + v_{a1}(t)v_{\text{LO}}(t) + v_{a2}(t)v_{\text{LO}}(t) + \gamma_1 \{ v_{RF}(t)v_{\text{LO}}(t) + (v_{a1}(t)+v_{a2}(t))v_{\text{LO}}(t) \}^2 \]

\[ v_{m1}(t) = v_{RF}(t)v_{\text{LO}}(t) + v_{a1}(t)v_{\text{LO}}(t) + v_{a2}(t)v_{\text{LO}}(t) + \gamma_1 \{ v_{RF}(t)v_{\text{LO}}(t) + \left[ v_{a1}(t)v_{\text{LO}}(t) + v_{a2}(t)v_{\text{LO}}(t) \right]^2 + 2v_{RF}(t)[v_{a1}(t)+v_{a2}(t)]v_{\text{LO}}(t) \}^2 \]

\[ v_{m1}(t) = v_{RF}(t)v_{\text{LO}}(t) + v_{a1}(t)v_{\text{LO}}(t) + v_{a2}(t)v_{\text{LO}}(t) + \gamma_1 \left\{ v_{RF}(t)v_{\text{LO}}(t) + v_{a1}(t)v_{\text{LO}}(t) + v_{a2}(t)v_{\text{LO}}(t) + 2v_{RF}(t)v_{a1}(t)v_{\text{LO}}(t) + 2v_{RF}(t)v_{a2}(t)v_{\text{LO}}(t) \right\}^2 \]
The output of low pass filter \(-1\) (LPF-1) is

\[ v_1(t) = LPF\{v_{m1}(t)\} \]

where, \(LPF[x] = \) low pass filtering of signal \(x\).

\[
\therefore v_1(t) = LPF\{v_{RF}(t)v_{LO}(t)\} + LPF\{v_{a1}(t)v_{LO}(t)\} + LPF\{v_{a2}(t)v_{LO}(t)\} + \\
\left[ LPF\{v_{RF}^2(t)v_{LO}^2(t)\} + LPF\{v_{a1}^2(t)v_{LO}^2(t)\} + LPF\{v_{a2}^2(t)v_{LO}^2(t)\} + \\
LPF\{2v_{a1}(t)v_{a2}(t)v_{LO}(t)\} + LPF\{2v_{RF}(t)v_{a2}(t)v_{LO}^2(t)\} + LPF\{2v_{RF}(t)v_{a1}(t)v_{LO}^2(t)\} + LPF\{2v_{a1}(t)v_{a2}(t)v_{LO}^2(t)\} \right]
\]

Now we analyze each term separately,

\(LPF\{v_{RF}(t)v_{LO}(t)\} = I(t),\)

\(LPF\{v_{a1}(t)v_{LO}(t)\} = 0,\)

\(LPF\{v_{a2}(t)v_{LO}(t)\} = 0,\)

\(LPF\{v_{RF}^2(t)v_{LO}^2(t)\} = I(t)^2 + Q(t)^2 = \text{power or component of desired signal},\)

\(LPF\{v_{a1}^2(t)v_{LO}^2(t)\} = I_{a1}(t)^2 + Q_{a1}(t)^2 = \text{power or component of adjacent channel signal},\)

\(LPF\{v_{a2}^2(t)v_{LO}^2(t)\} = I_{a2}(t)^2 + Q_{a2}(t)^2 = \text{power or component of adjacent channel signal},\)

\[LPF\{2v_{a1}(t)v_{a2}(t)v_{LO}(t)\} = LPF\left\{ \frac{2[Q_{a2}(t)I_{a1}(t)\cos\omega_{a1}(t) - Q_{a1}(t)\cos\omega_{a1}(t)\sin\omega_{a1}(t)]}{I_{a2}(t)\cos\omega_{a2}(t) - Q_{a2}(t)\sin\omega_{a2}(t)[\cos\omega_{LO}(t)]^2} \right\} \]

\[LPF\{2v_{a1}(t)v_{a2}(t)v_{LO}^2(t)\} = \\
LPF\left\{ \frac{[I_{a1}(t)I_{a2}(t)\cos\omega_{a1}(t)\cos\omega_{a2}(t) - I_{a1}(t)Q_{a2}(t)\cos\omega_{a1}(t)\sin\omega_{a2}(t) - \\
Q_{a1}(t)I_{a2}(t)\sin\omega_{a1}(t)\cos\omega_{a2}(t) + Q_{a1}(t)Q_{a2}(t)\sin\omega_{a1}(t)\sin\omega_{a2}(t)][1 + \cos 2\omega_{LO}(t)]}{[I_{a2}(t)\cos\omega_{a2}(t) - Q_{a2}(t)\sin\omega_{a2}(t)[\cos\omega_{LO}(t)]^2]} \right\} \]

\[LPF\{2v_{a1}(t)v_{a2}(t)v_{LO}^2(t)\} = 0 \]

Similarly,
\[ LPF\{2v_{RF}(t)v_{a1}(t)v^{2}_{LO}(t)\} = 0 \]

\[ LPF\{2v_{RF}(t)v_{a2}(t)v^{2}_{LO}(t)\} = 0 \]

Let,

\[ LPF\{v^{2}_{RF}(t)v^{2}_{LO}(t)\} = I(t)^2 + Q(t)^2 = x_{RF}(t) \text{ and} \]
\[ LPF\{v^{2}_{a1}(t)v^{2}_{LO}(t)\} + LPF\{v^{2}_{a2}(t)v^{2}_{LO}(t)\} = I_{a1}(t)^2 + Q_{a1}(t)^2 + I_{a2}(t)^2 + Q_{a2}(t)^2 = x_{adj}(t) \]

Therefore,

\[ v_{1}(t) = LPF\{v_{m1}(t)\} = I(t) + \gamma_{1}\{x_{RF}(t) + x_{adj}(t)\} \]

This equation is same as the equation [eq. no (35)] of output of LPF-1 in the presence of single interference. Thus for n number of interference the output of LPF-1 would be of the above structure and therefore the proposed method is able to deal with multiple interferences.