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Mixers Frequency Conversion and Applications

Ralph J. Pasquinelli

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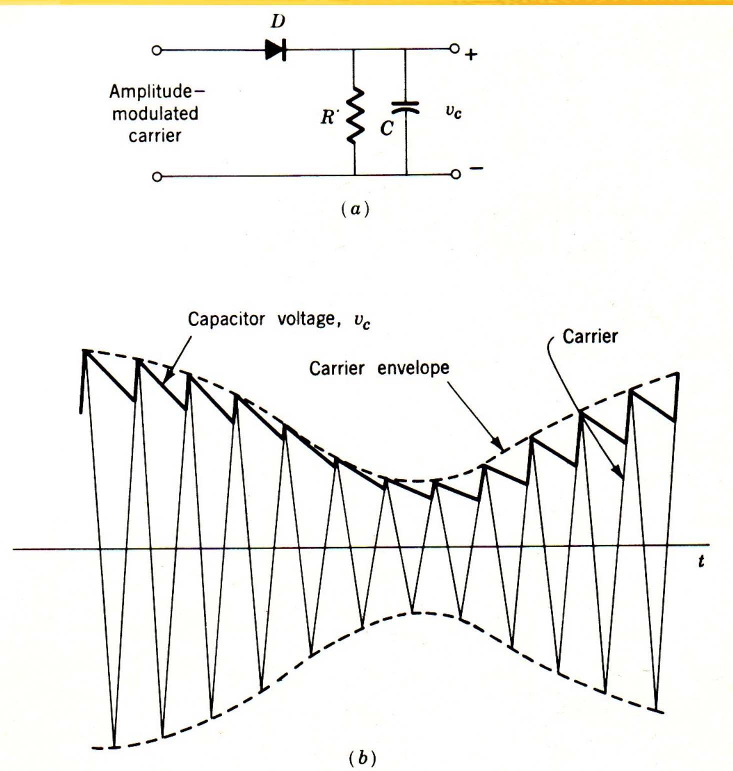
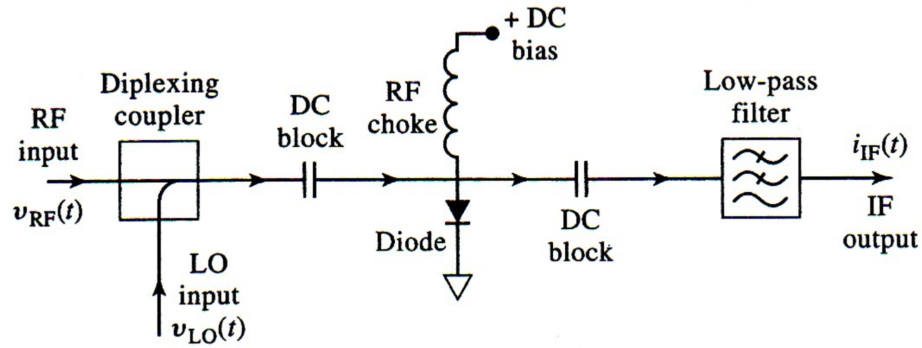
Simple Diode Detector

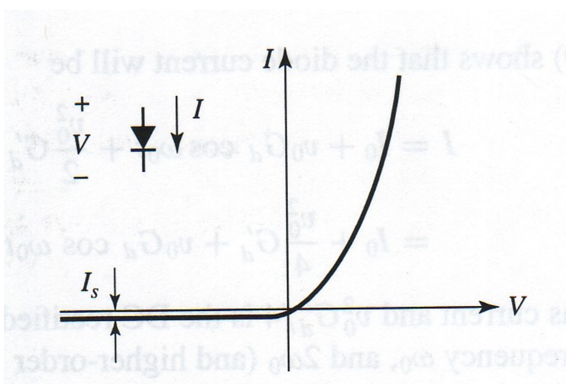


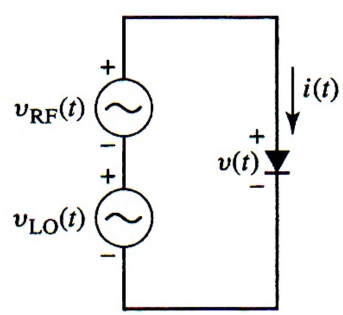
a) Diode demodulator for AM b)input and output waveforms

Simple Diode Mixer



(a)





(b)

a) Basic Diode Mixer b)equivalent circuit

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Frequency Conversion

Let the LO and IF be represented by

$$v_{LO}(t) = \cos 2\pi f_{LO} t$$

$$v_{IF}(t) = \cos 2\pi f_{IF} t$$

the mixer multiplies the two

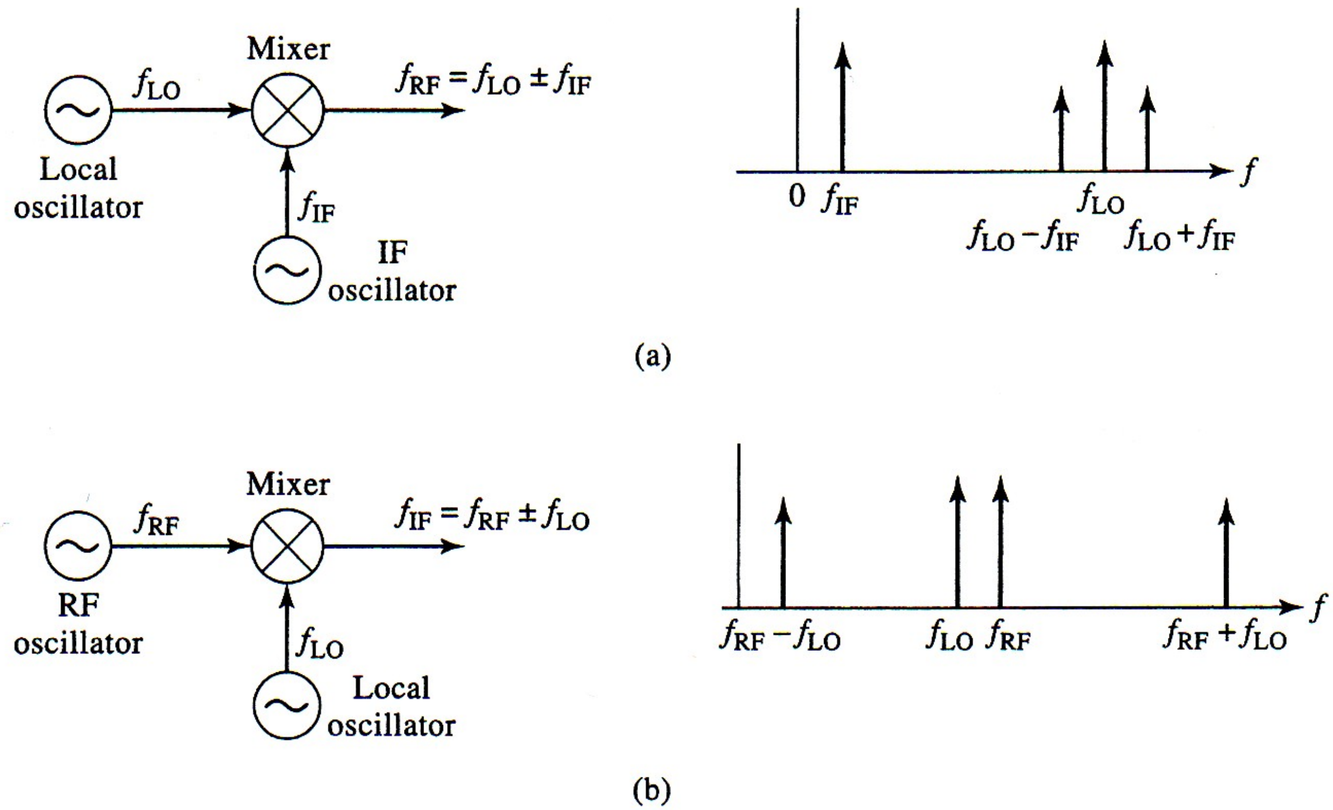
$$v_{RF}(t) = K v_{LO}(t) v_{IF}(t) = K \cos 2\pi f_{LO} t \cos 2\pi f_{IF} t$$

$$v_{RF} = \frac{K}{2}[\cos 2\pi(f_{LO} - f_{IF})t + \cos 2\pi(f_{LO} + f_{IF})t] \text{ UP-Conversion}$$

Likewise

$$v_{IF} = \frac{K}{2}[\cos 2\pi(f_{RF} - f_{LO})t + \cos 2\pi(f_{RF} + f_{LO})t] \text{ Down-Conversion}$$

Frequency Conversion



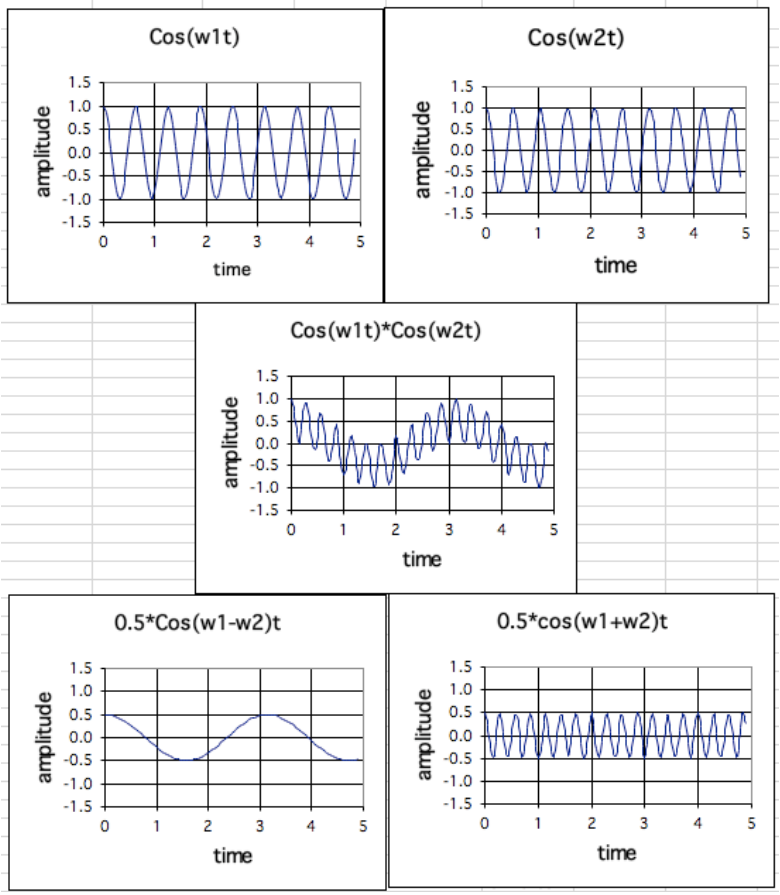
Frequency Conversion. a)Up-conversion b)Down Conversion

Multiplying or Mixing

RJP 1/03/02

Multiplying or "Mixing" signals

Cos(w1t)*Cos(w2t)=0.5*[Cos(w1-w2)t+Cos(w1+w2)t]



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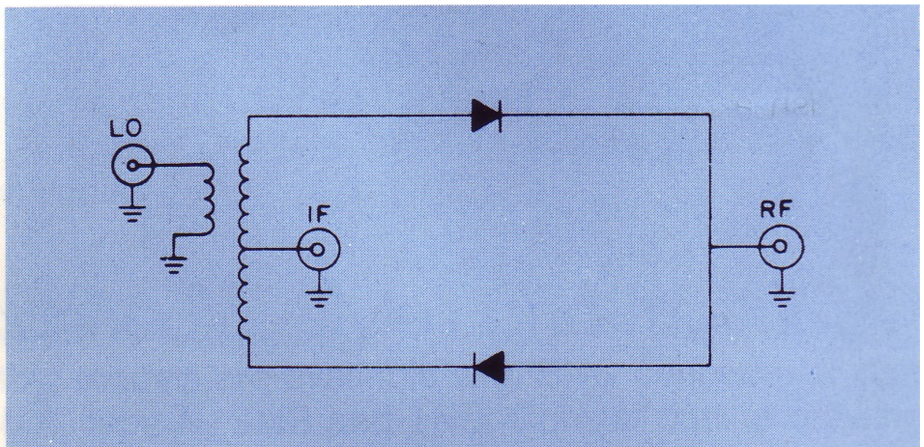
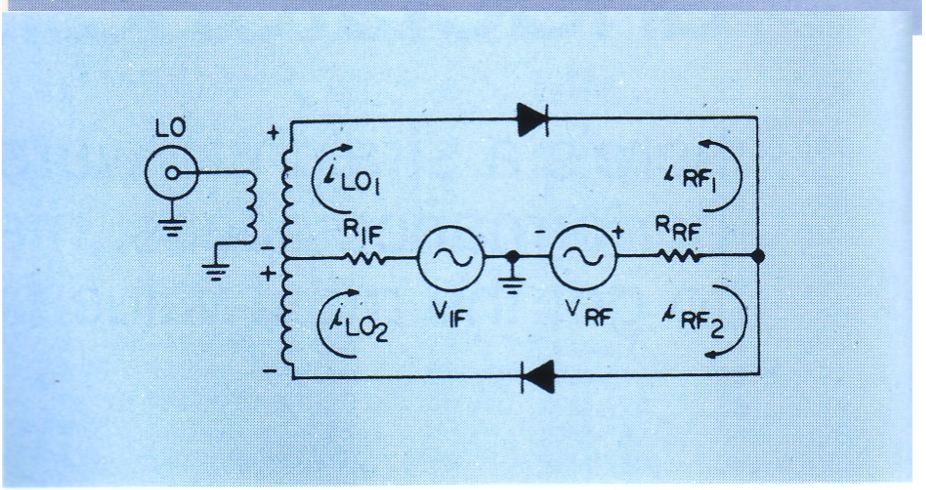
Single Balanced Mixer



Schematic of Single Balanced Mixer

Advantages: Simple circuit

Disadvantage: no isolation between IF and RF ports



Currents in Single Balanced Mixer

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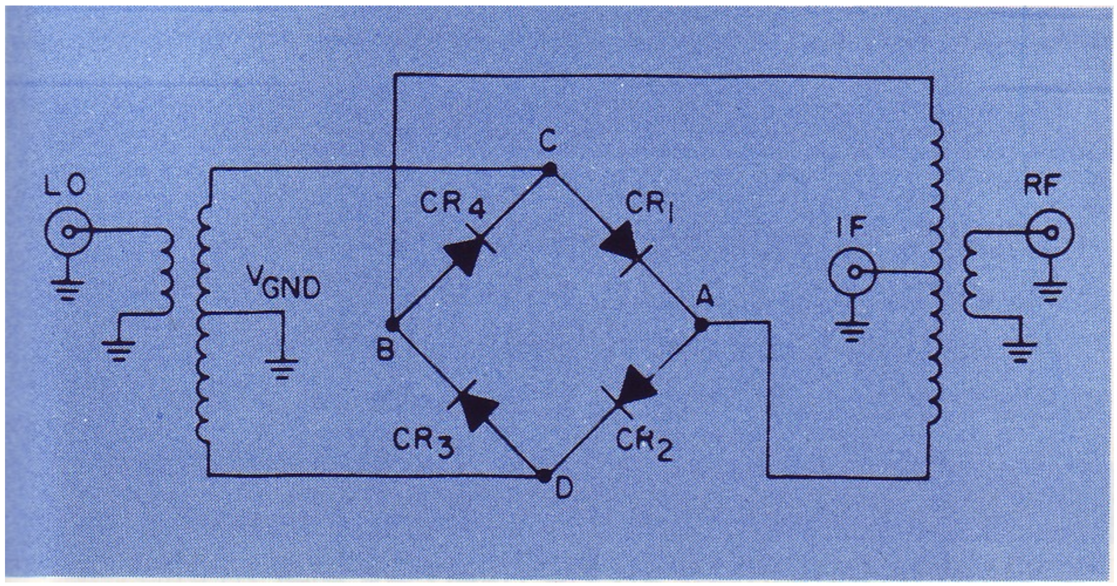
Fermilab Double Balanced Mixer (DBM)

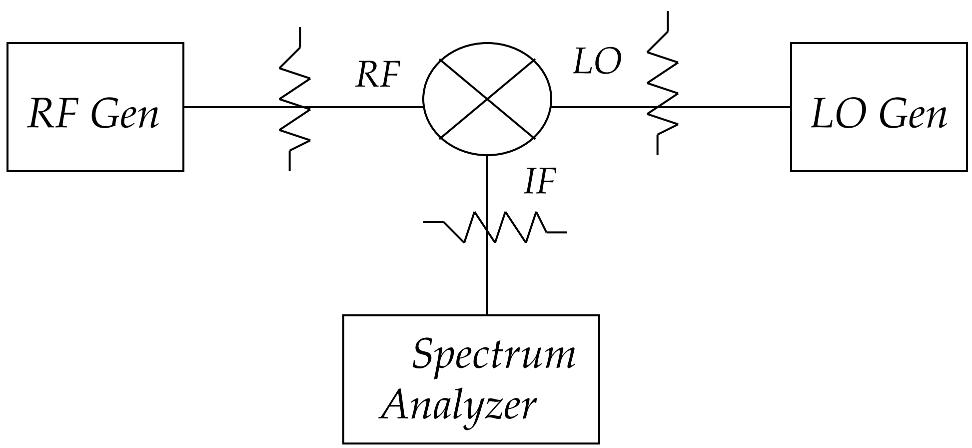


Advantage: good isolation between all ports

Conversion Loss

Conversion Loss is the measure of efficiency of frequency translation, i.e. the factor K mentioned previously expressed in dB

Mixers operate at various power levels ranging mostly between +7 and +23 dBm on the LO port
Pads on Ports insure good match



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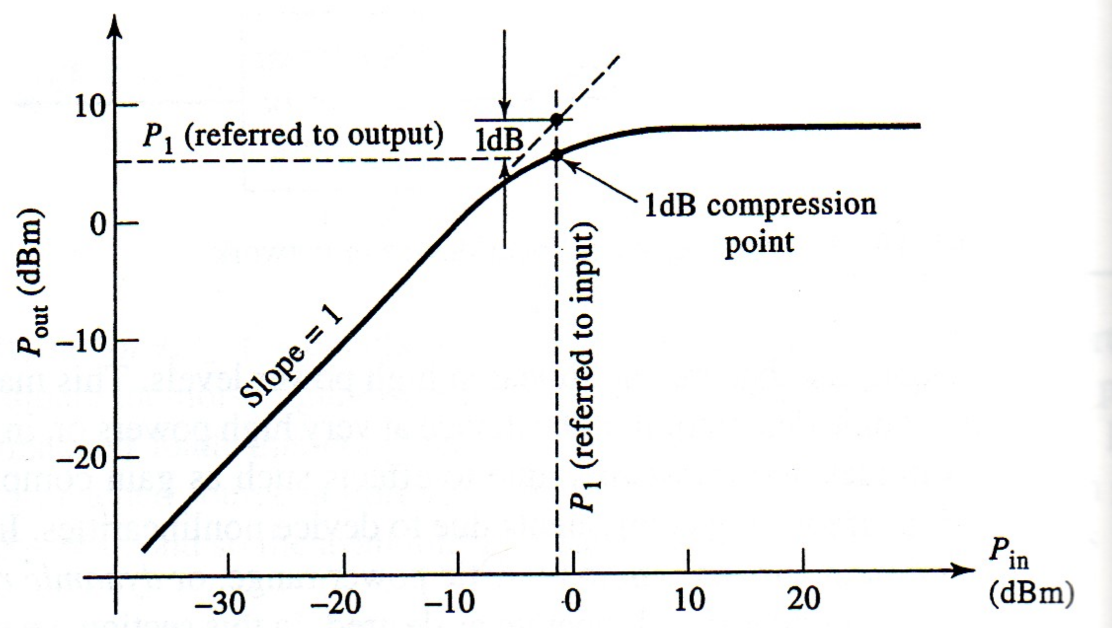
Linearity & 1dB Compression

Linearity is the specification of how closely the input to output translation follows a slope of 1

1 dB compression is point where conversion loss becomes 1 dB greater than a linear response



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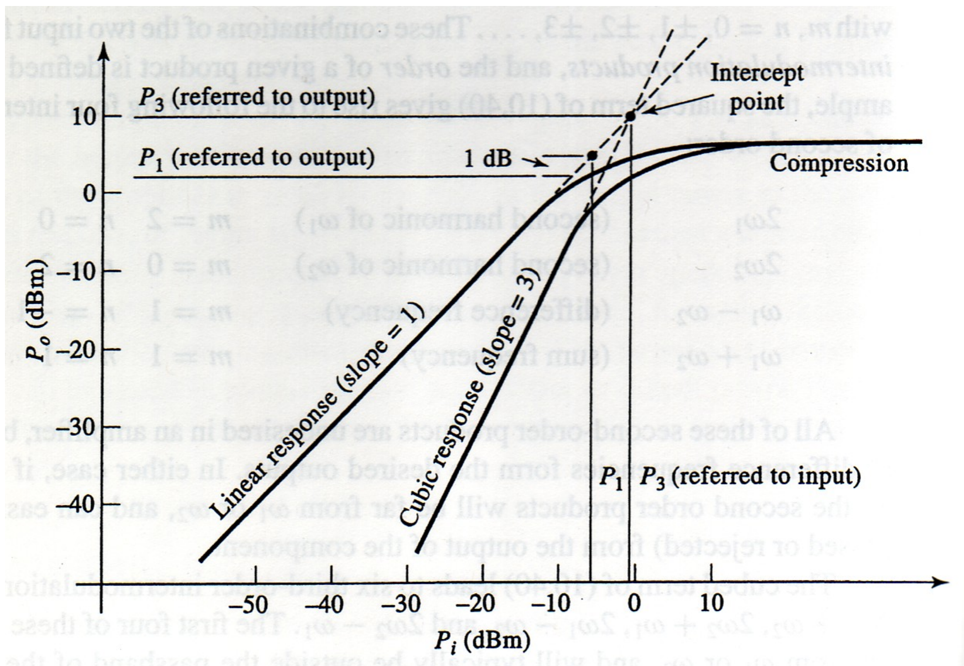
3rd Order Intercept

When 2 signals at the mixer input generate third order products
$(2f_1-f_2)$ or $(2f_2-f_1)$



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3rd Order Intercept

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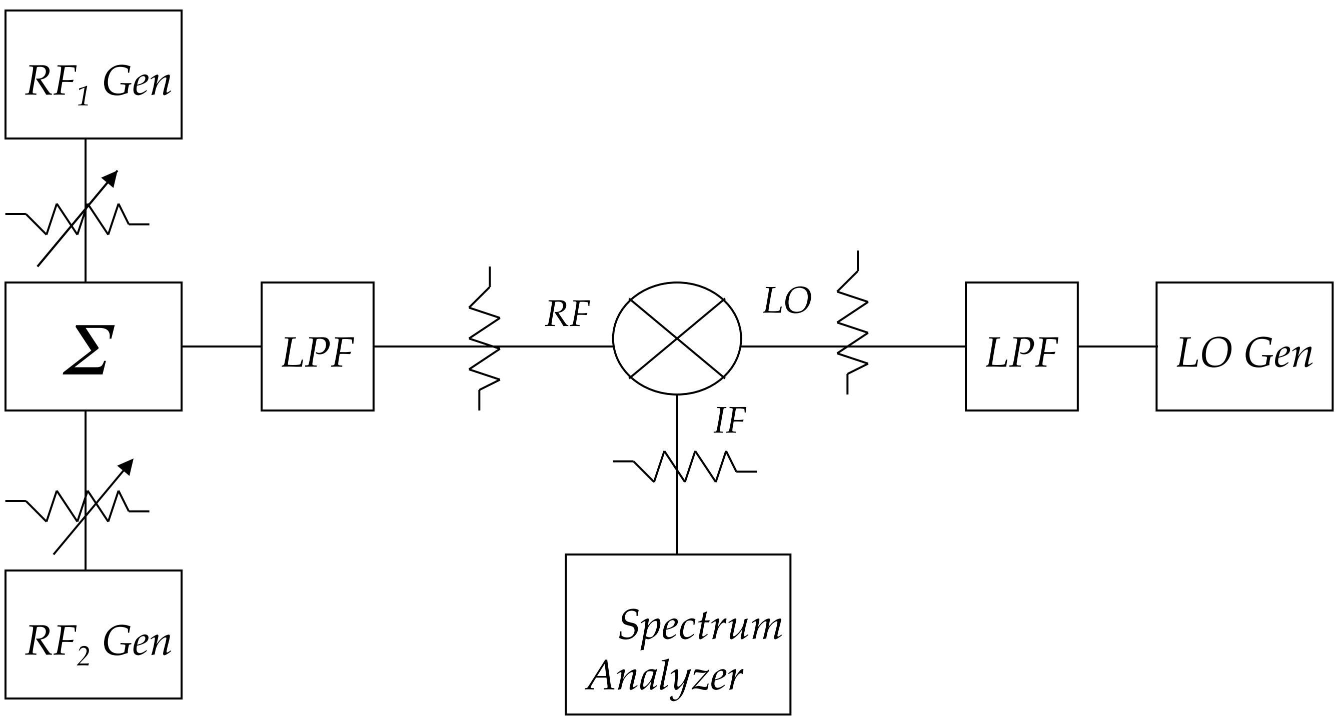
Measurement setup for third order products
$(2f_1\text{-}f_2)$ or $(2f_2\text{-}f_1)$



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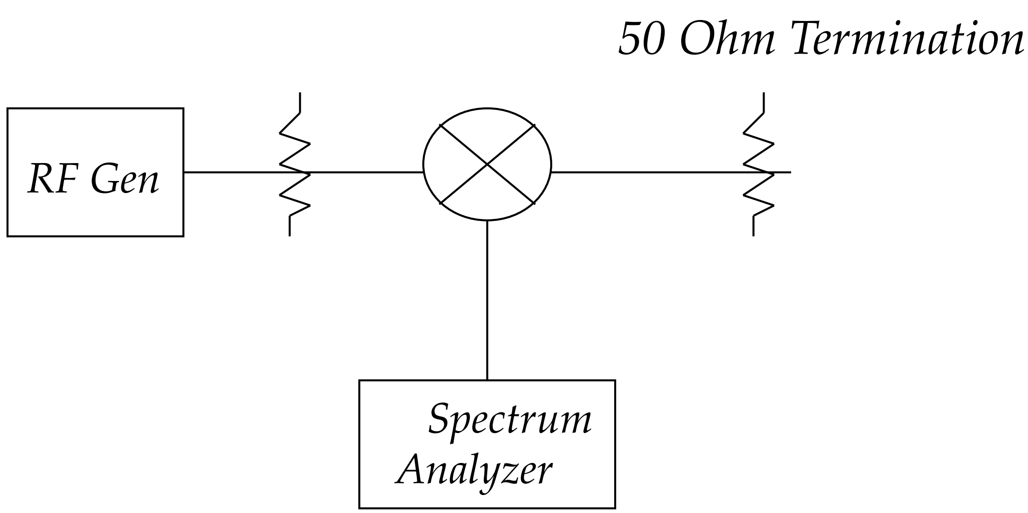
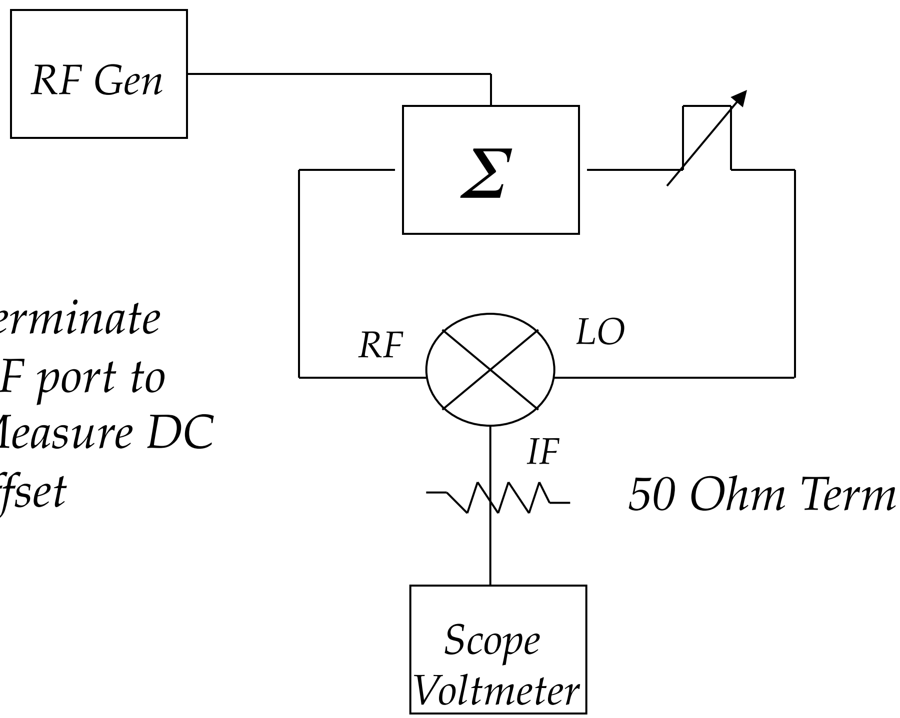
Isolation measurement of DBM



pad on generator insures good match

DBM as phase detector

Measurement setup for phase detector and DC offset



Terminate RF port to Measure DC offset

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DBM as current controlled attenuator

Measurement setup for current controlled attenuator