Superheterodyne AM receiver

Problems so far:

Making a tunable receiver is a real pain....

Need a tracking filter.

tracking "BFO"

etc.

It gets worse! (wait for "single sideband")

A good receiver needs good adjacent channel rejection ---

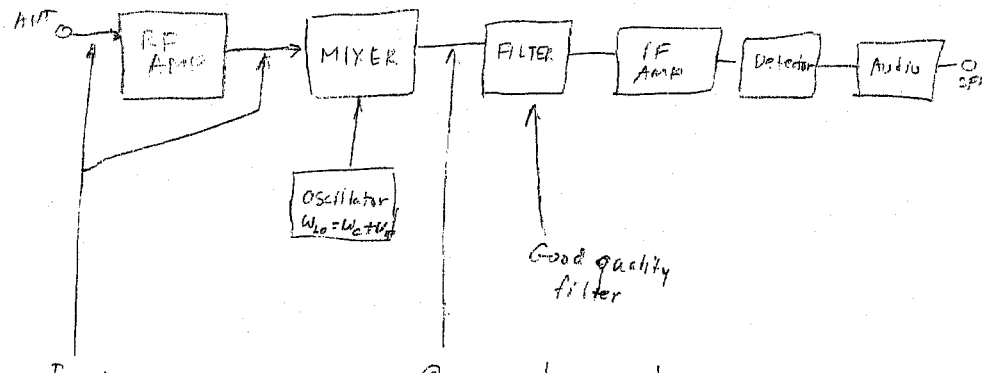
The undesired signal may be a lot stronger than the desired one — and close in frequency.

Solution:

Convert to an "intermediate frequency"

and do filtering, detection there.

block diagram:



Carrier frequency depends on signal chosen.

IF is fixed often 455 KHz.

Pick IF = 455 KHz.

Input freq. (f_c) = 540 KHz ... 1600 KHz
user tuneable

Set local oscillator 455 KHz higher...

995 KHz to 2055 KHz.

To select 1000 KHz, set LO to 1455 KHz.

Alternate design ... "down conversion"

Set LO 455 KHz lower ...

85 KHz to 1145 KHz.

range too wide — bad design

Use the other "up conversion" — only ≈ 2:1 range.

Problem: "image" -- 2 carrier frequencies come in --

Example -- set L.O. to 1005 KHz,

to receive 550 KHz.

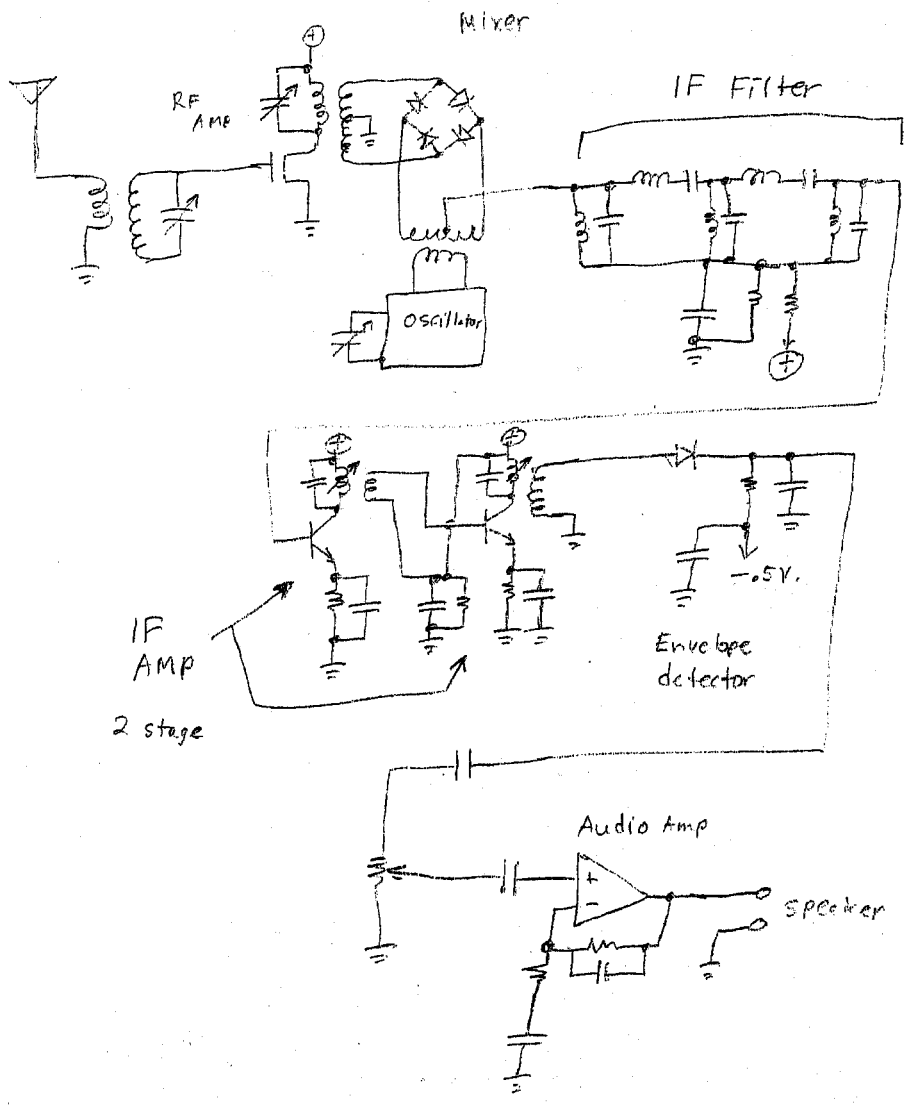
You also get 1460 KHz. (Try it!)

weaker because of RF filter.

So... Put some filtering in RF Amp, to reduce the image.

most filtering at IF.

The RF amp is optional. Mostly, it provides better image rejection.



"Modulator" circuits--

(Mixer, product detector, frequency shifter, ...)

Book shows---

Multiplier modulators —

Analog multiplier actually computes the product,

"It is best to avoid" --
"difficult to maintain linearity"
"rather expensive"

] not true — actually very common.

Nonlinear modulators —

Any nonlinear device will do —

Diodes, transistors, etc.

Often just an imperfect multiplier modulator.

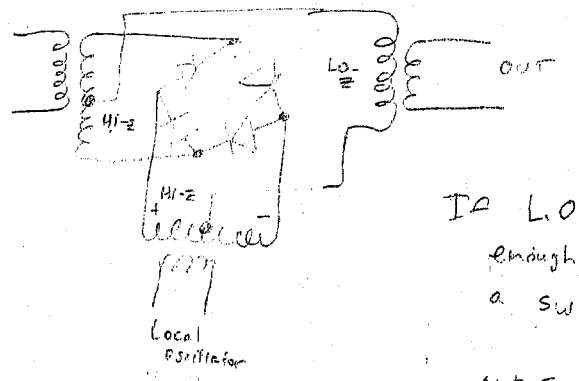
Switching modulators -

Multiplication is replaced by a simple switching operation. —

A multiplier modulator driven to saturation,
or by a square wave.

Not much difference, really.

Diode ring modulator - (review).

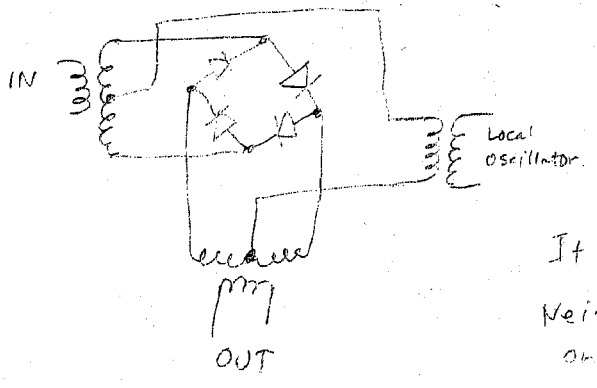


If L.O. level is high enough, it acts like a switching modulator.

Out = IN for + half of L.O.
− IN for − half of L.O.

Alternate configuration

Similar analysis.

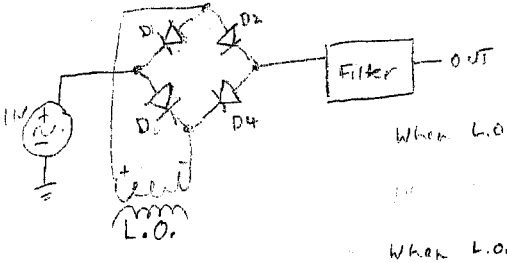


It is "double balanced" -

Neither input appears on output.

Diode bridge modulator

Turn around 2 of the diodes.

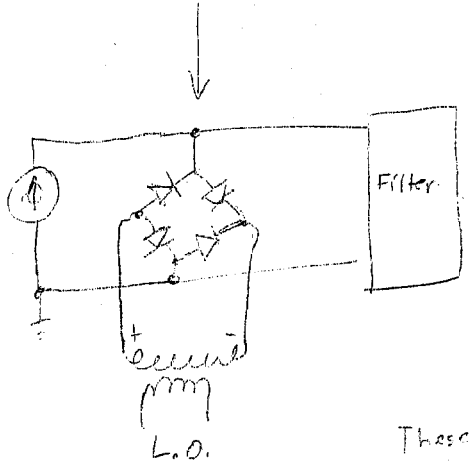


When L.O. is + -- all diodes are on
passing signal

When L.O. is — all diodes are off
blocking signal.

Series bridge — Lo-Z source.

Shunt bridge — Hi-Z source



When L.O. is + --
all diodes are on
shorting signal

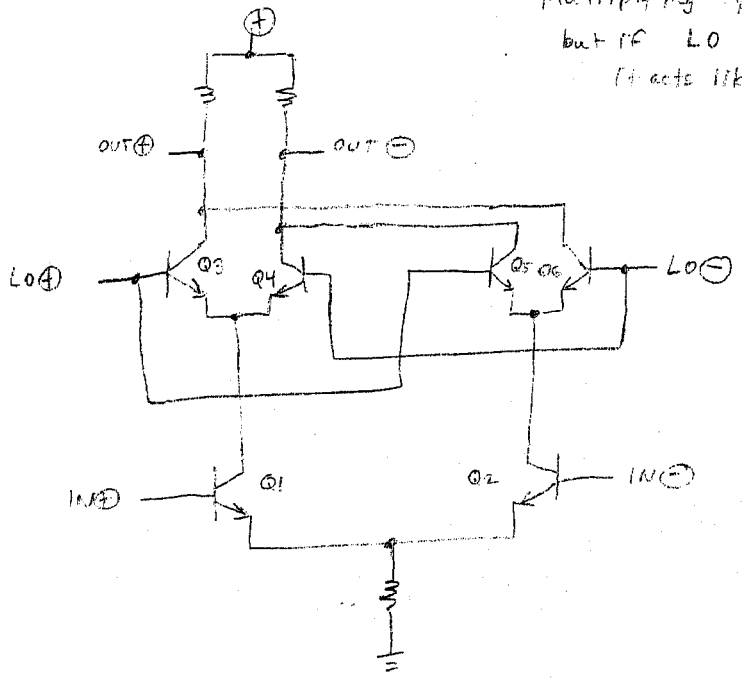
When L.O. is —
all diodes are off
allowing signal to pass.

These are "single balanced" —
L.O. does not appear at output
but IN does.

No input or output transformers.

Gilbert cell — active mixer.

Multiplying type —
but if LO is large,
it acts like a switching type.



Look at half of it -- Q1, Q3, Q4

IN⊕ is amplified by Q1
which changes op. point of Q3, Q4 stiff amp.
changing gain LO to OUT.
IN⊕ does not appear at OUT because of balance.

The other half has outs crossed --
so LO does not appear at out because of balance.

→ double balanced.

Often, only half is used, for a single balanced modulator.