

# SOFTWARE DEFINED RADIO

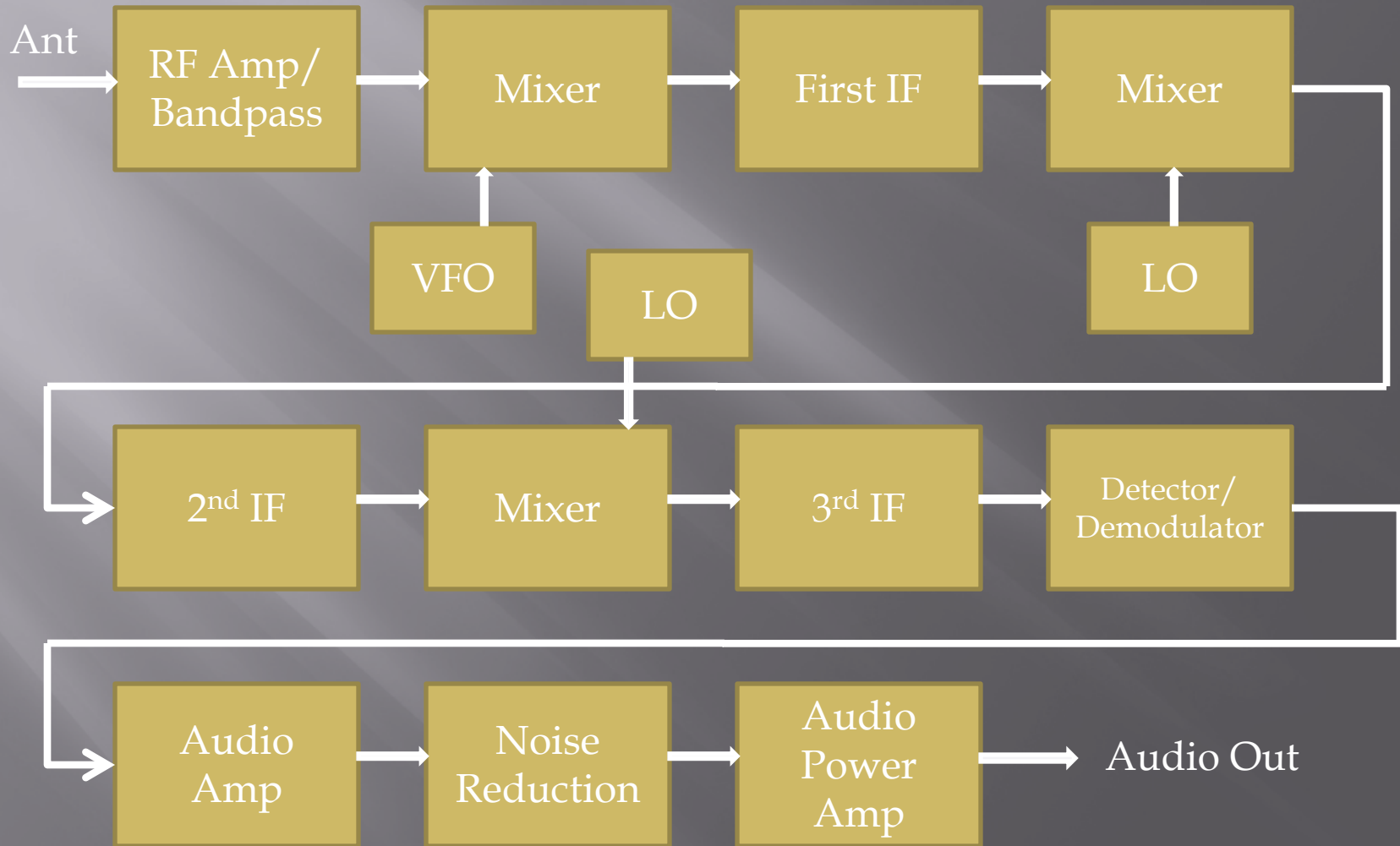
## SDR

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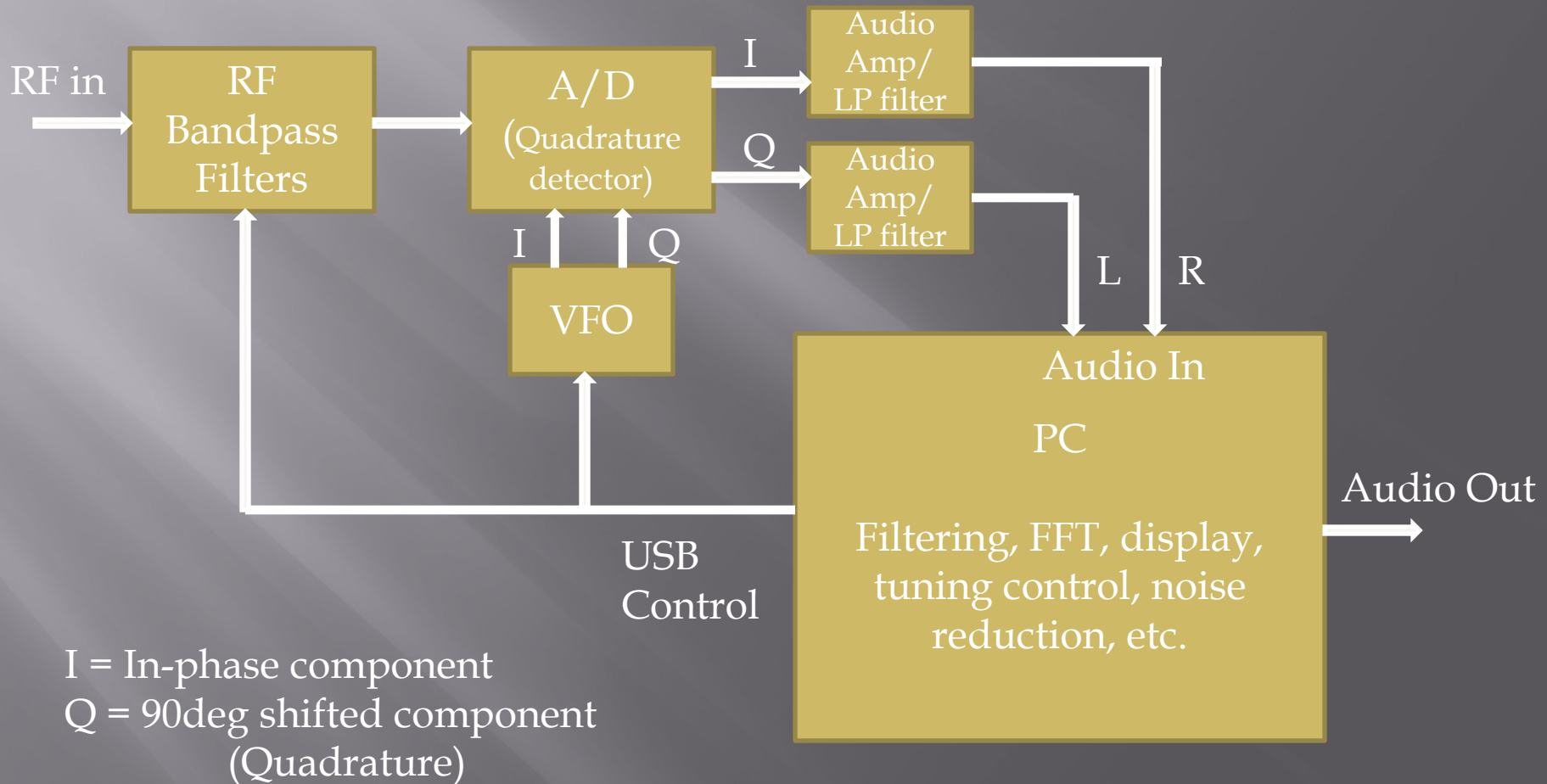
# SDR Definition

- ▣ *Software-defined* not *software-controlled* radio
- ▣ Most of the complex signal handling uses DSP
- ▣ User interface through the computer
- ▣ Usually some form of direct conversion
  - RF to baseband with no IF
  - RF band pass filtering is required to avoid images and birdies
- ▣ IF bandpass filtering equivalent, demodulation, amplification, detectors, noise reduction, noise blanking, etc. all done in software
- ▣ Usually requires a PC to run software and control the “receiver/transmitter”

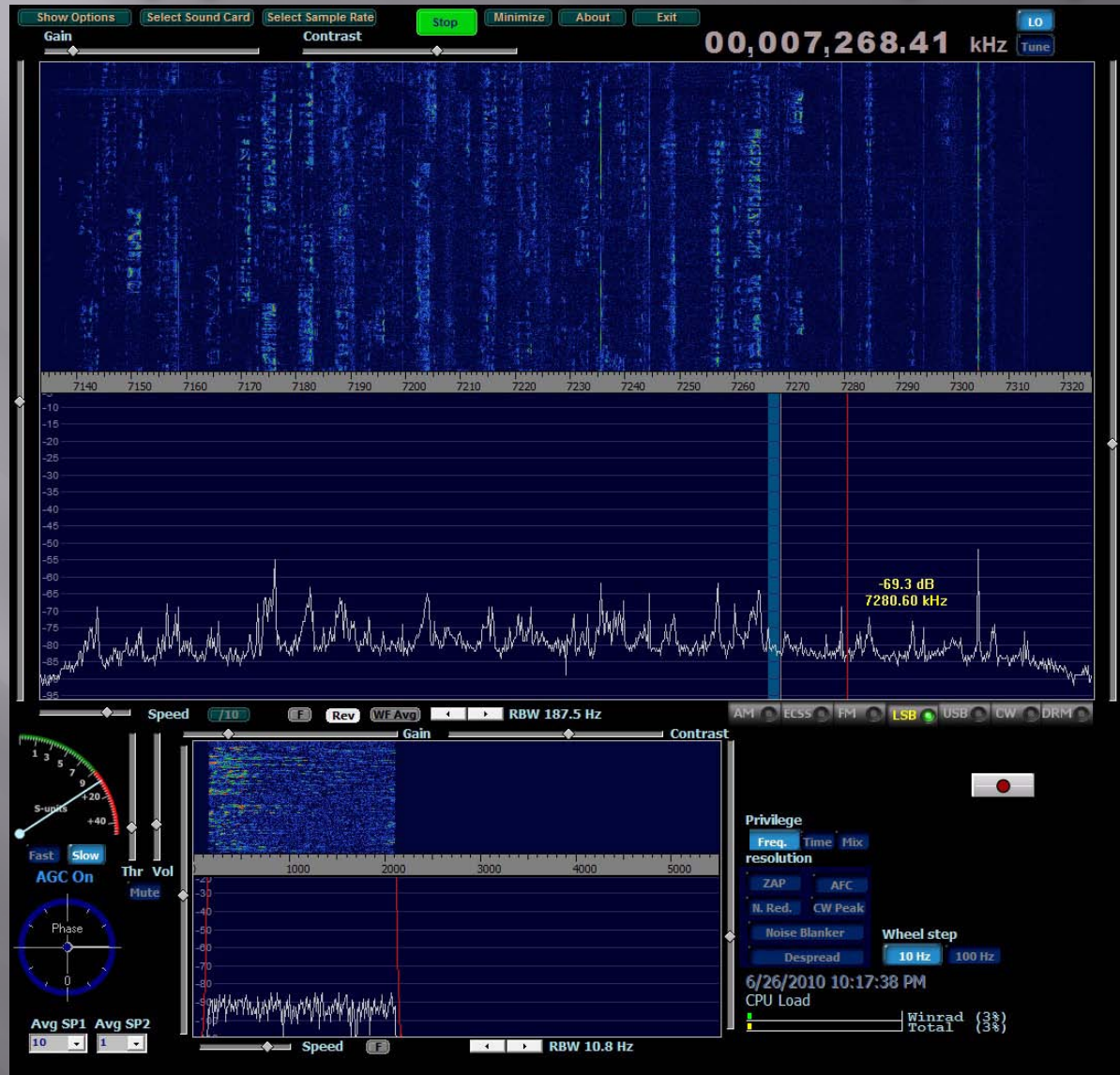
# Typical HF Receiver



# Simplified SDR Receiver



# Typical SDR Display



# SDR Advantages

- ▣ Very Flexible
  - Software and UI easily customized
  - New functions easy to implement
- ▣ Wide spectrum display
  - 48KHZ to several MHz
- ▣ Software filters
  - Very sharp cutoff
  - Easily tuned
  - Audio band shaping easy to implement
- ▣ DSP functions such as noise reduction, etc
- ▣ Various detection modes in software
  - AM, SSB, CW, ECSS
  - RTTY, PSK31 and all other data modes
- ▣ Simple design for modest performance
- ▣ RX and TX readily implemented

# Disadvantages

- ▣ Simple designs have
  - Lower sensitivity
  - Reduced/only adequate image rejection
  - Higher noise
  - Lower Dynamic Range
- ▣ High performance designs more complex and costly
  - High speed A/D 100-200MHz required
  - Dedicated DSP processor
  - Cost similar to mid to higher-end receivers

# Some Currently Available Receivers / Transceivers

- ▣ Softrock series
  - RX Ensemble II Receiver Kit \$56
  - RX/TX Transceiver Kit (1W) \$74
- ▣ Elektor \$140
- ▣ LP-Pan Panadapter \$225
- ▣ Winradio WR-G303i \$500
- ▣ RFSpace SDR-IQ, SDR-14, SDR-IP \$500-\$2999+
- ▣ Flexradio \$649-\$2,699+
- ▣ Perseus \$1200

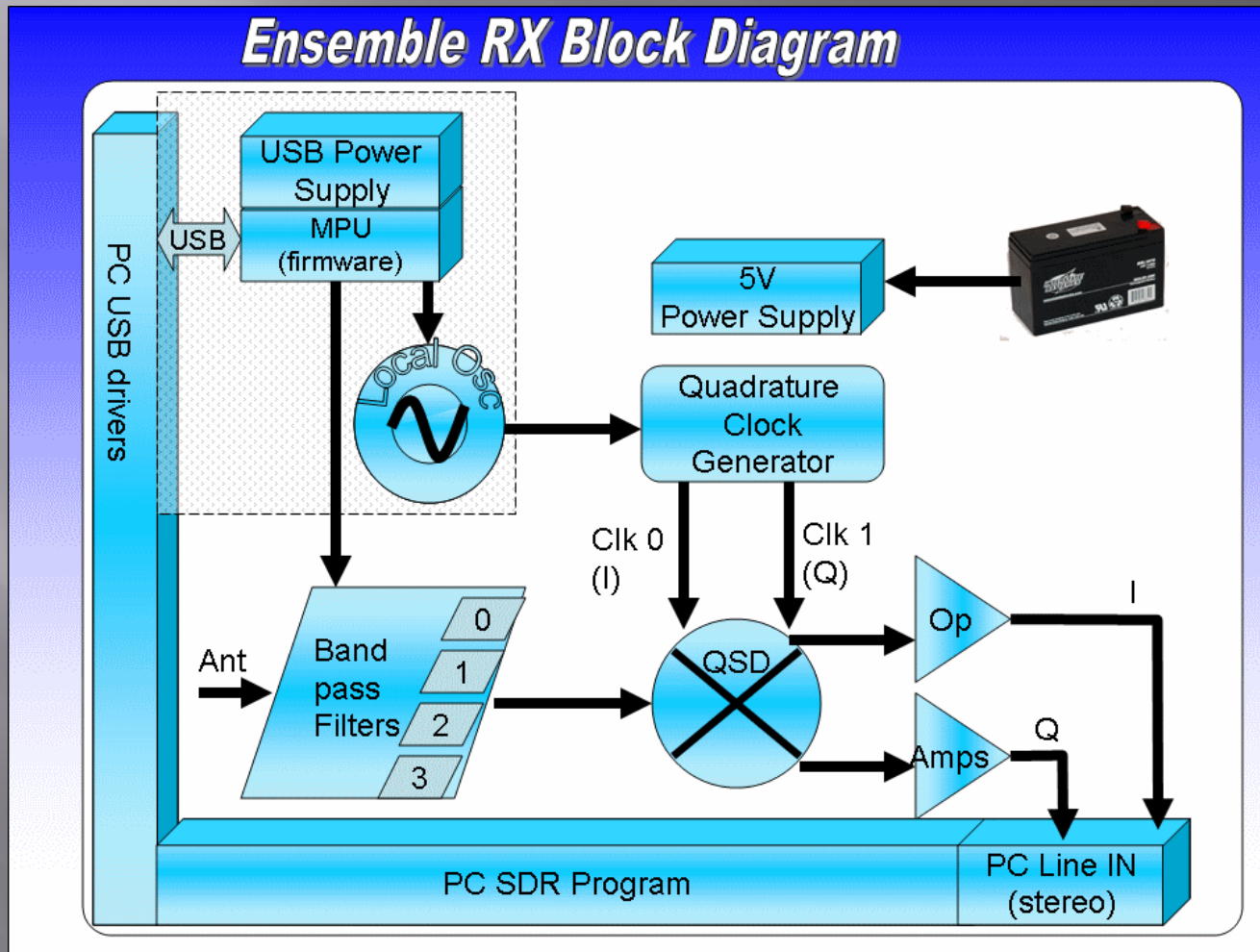
# Softrock Ensemble

- ▣ 1.8 – 30MHz and 180KHZ to 3 MHZ
- ▣ RX and RXTX
- ▣ Inexpensive kits - \$56 to \$74
- ▣ Requires computer with USB2 and soundcard
  - Full capability needs high-end sound card
  - 24bit, up to 192KHZ sampling, no channel imbalance
- ▣ Sensitivity OK for most HF bands (~110-120dBm)
- ▣ Dynamic range only about 75 to 80db
- ▣ Strong signal image rejection only about 50db
  - Suitable for most amateur SSB and CW
  - Dependent upon sound card used (some high-end sound cards ~ 70db)
- ▣ Software from several sources
  - Winrad (serveral versions)
  - SRD-Radio
  - PowerSDR

# Softrock RX Ensemble

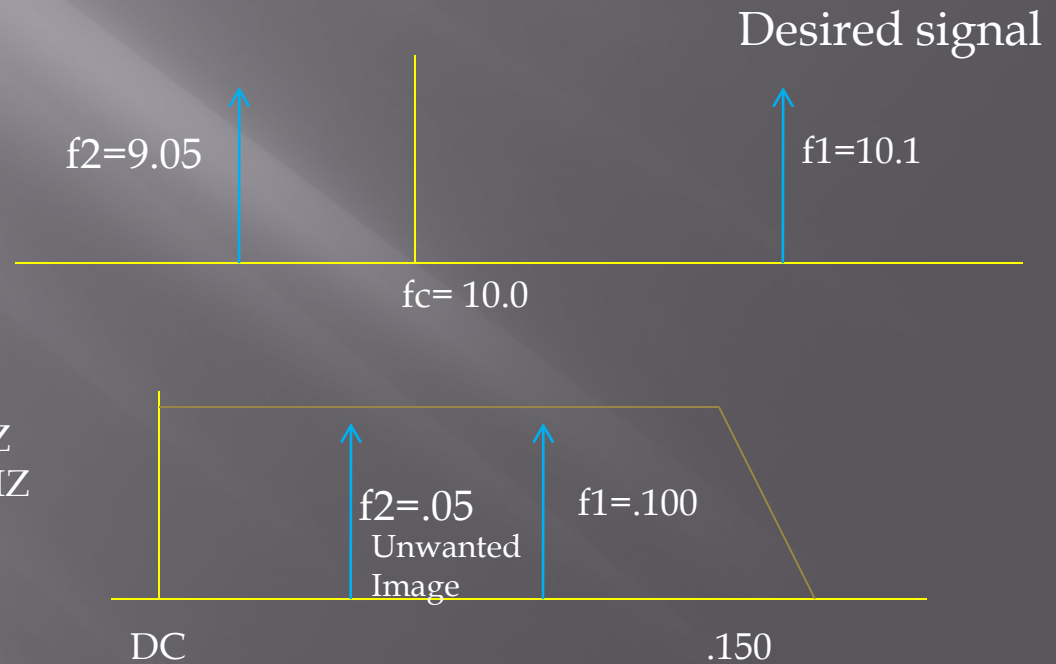
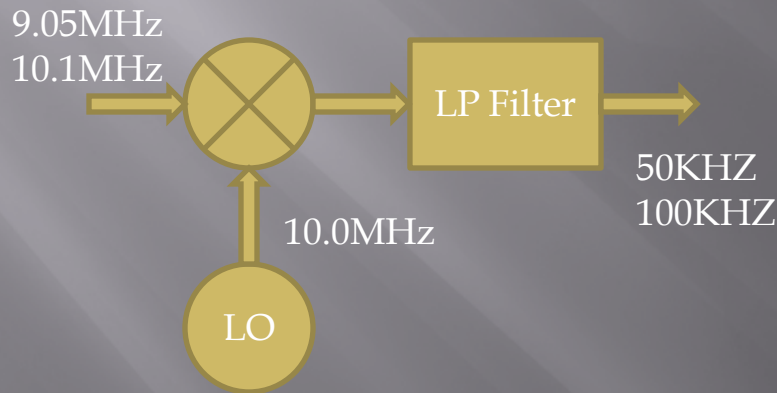


# Softrock RX Block Diagram



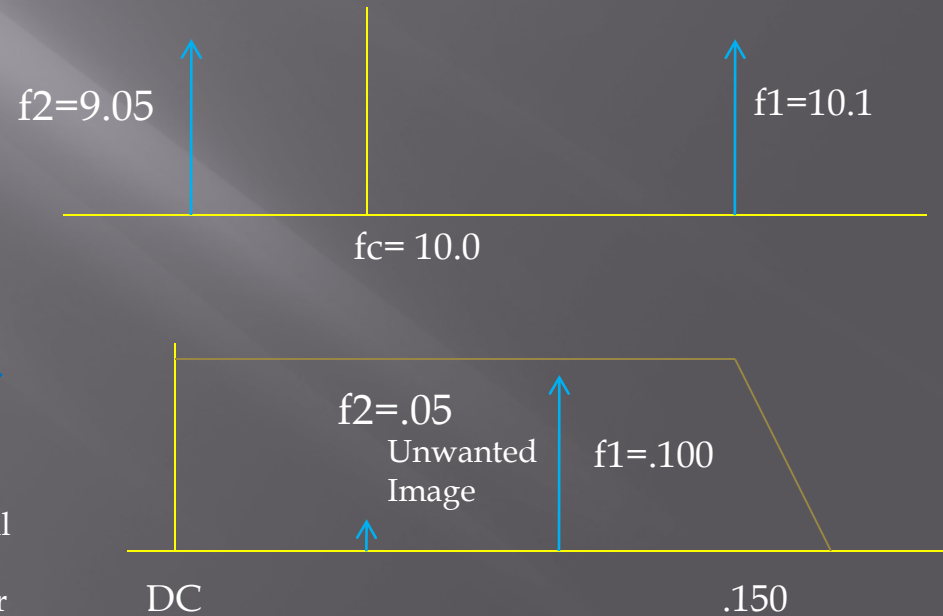
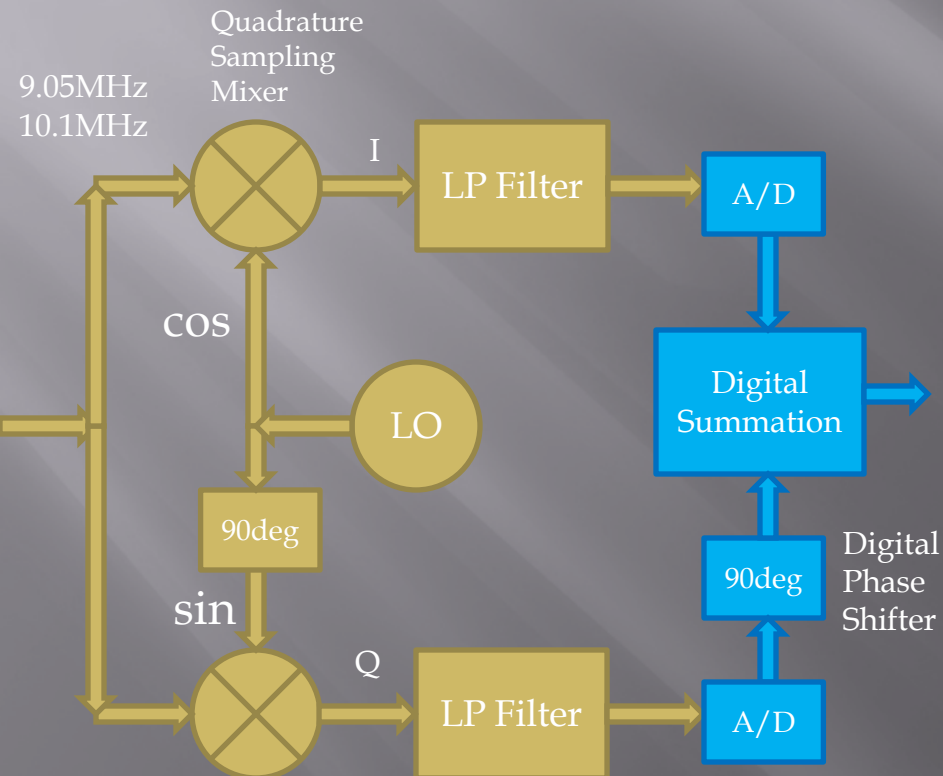
# So how does SDR Work?

- Analog direct conversion suffers from severe image problems:



# So how does SDR Work?

- Quadrature sampling and digital signal processing reduces image by 40 to 70dB, while increasing desired signals by nearly 6dB compared to conventional mixers



# Limitations of Softrock

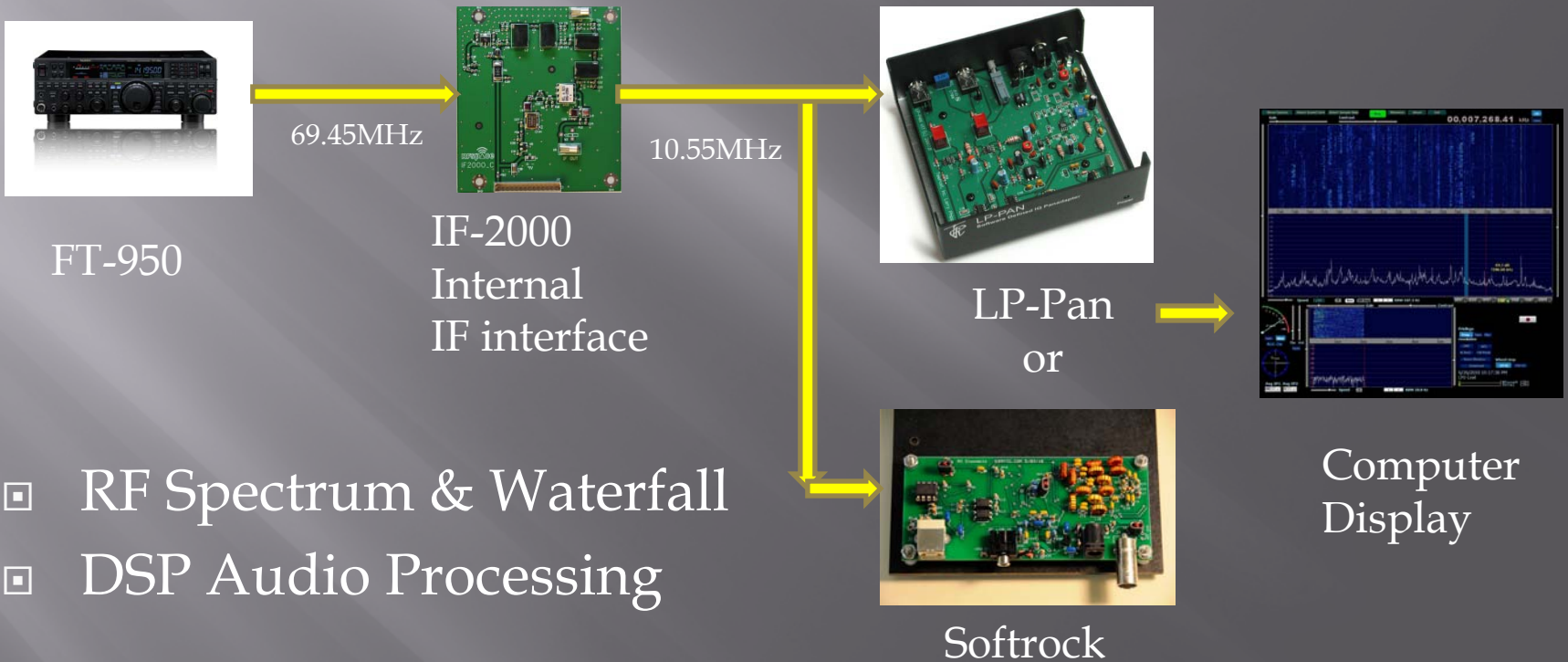
- ❑ PC sound cards are not designed for the precision required for high performance
  - 40dB of image rejection requires 1deg and 0.1 dB match between channels
  - 60dB requires 0.1 deg and 0.01db
- ❑ Sampling bit depth limits dynamic range
  - 16bit yields a max of 96dB
  - 24bit yield a max of 144dB
  - Real world A/D is less than this, typically no more than 130dB – still pretty good
  - Actual dynamic range well below modern analog receiver, on order of 75 to 80db
- ❑ Spurious outputs near 0Hz
  - Imbalance between channels also produces false signals at the center of the display band.
  - For spectrum display and pan-adapters this is less important

# SDR as Panadapter

- ▣ Simple SDR radios like Softrock can be a great addition to an existing radio
  - Second receiver
  - Panaramic RF spectrum display
  - Access to DSP for analog receivers
- ▣ Requires only a first IF output prior to any roofing filters
- ▣ Some radios require modification to bring out the IF or translate the IF to  $<30\text{MHz}$

# SDR Panadapter

- ▣ Typical setup – Yaesu FT-950



# FT-950 with Panadapter



# Conclusions

- ▣ SDR has some refinement to go before replacing conventional analog receivers
- ▣ RF Spectrum and waterfall displays greatly enhance rapid signal finding
- ▣ Current top of the line receivers from ICOM and Yaesu, etc. already incorporate some of the digital processing technologies
- ▣ Simple SDR radio can serve as a second receiver or as a QRP transceiver

Experimenting with SDR is lots of fun!

# References

- ▣ All about Softrocks - [www.wb5rvz.com/sdr/ensemble](http://www.wb5rvz.com/sdr/ensemble)
- ▣ All about Softrocks - [www.wb5rvz.com](http://www.wb5rvz.com)
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