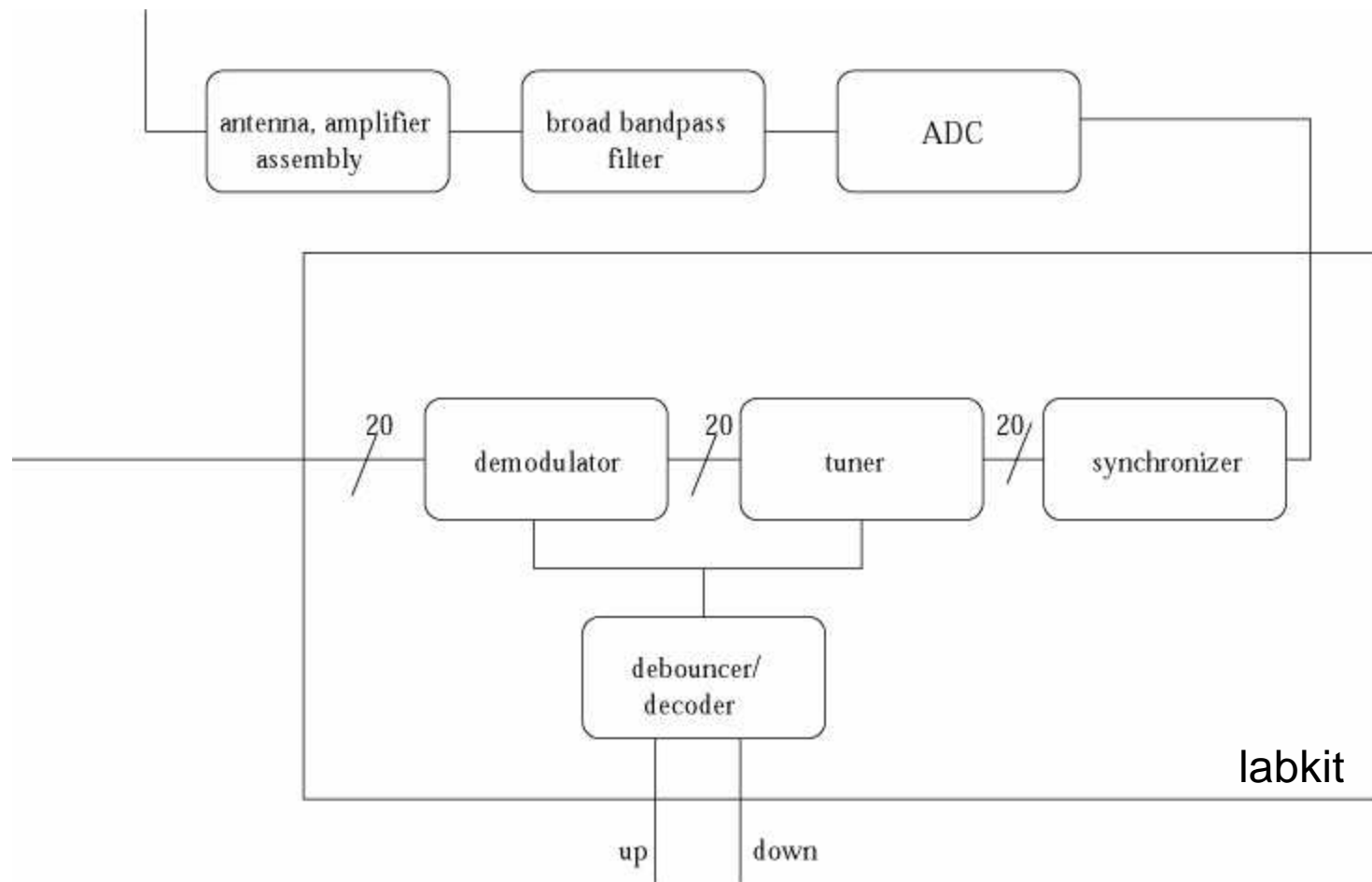
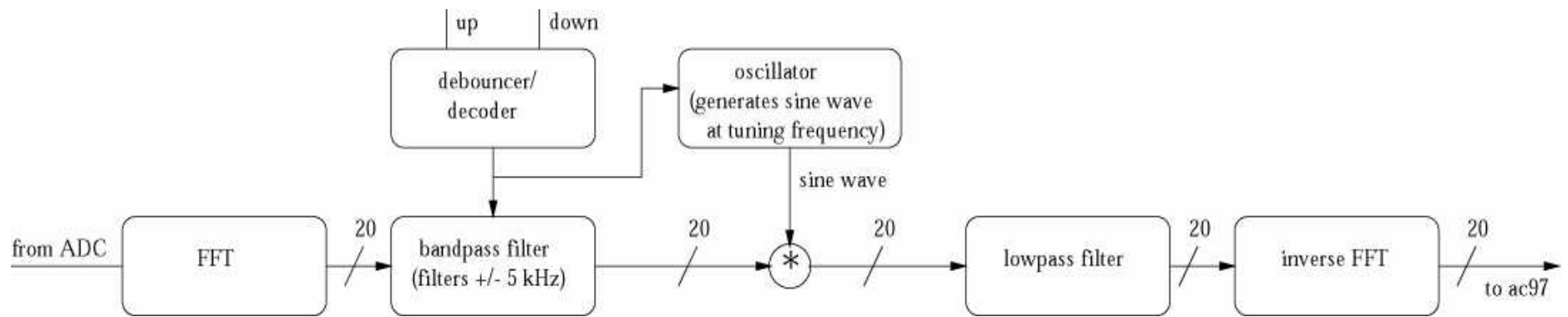


# Radio 6.111

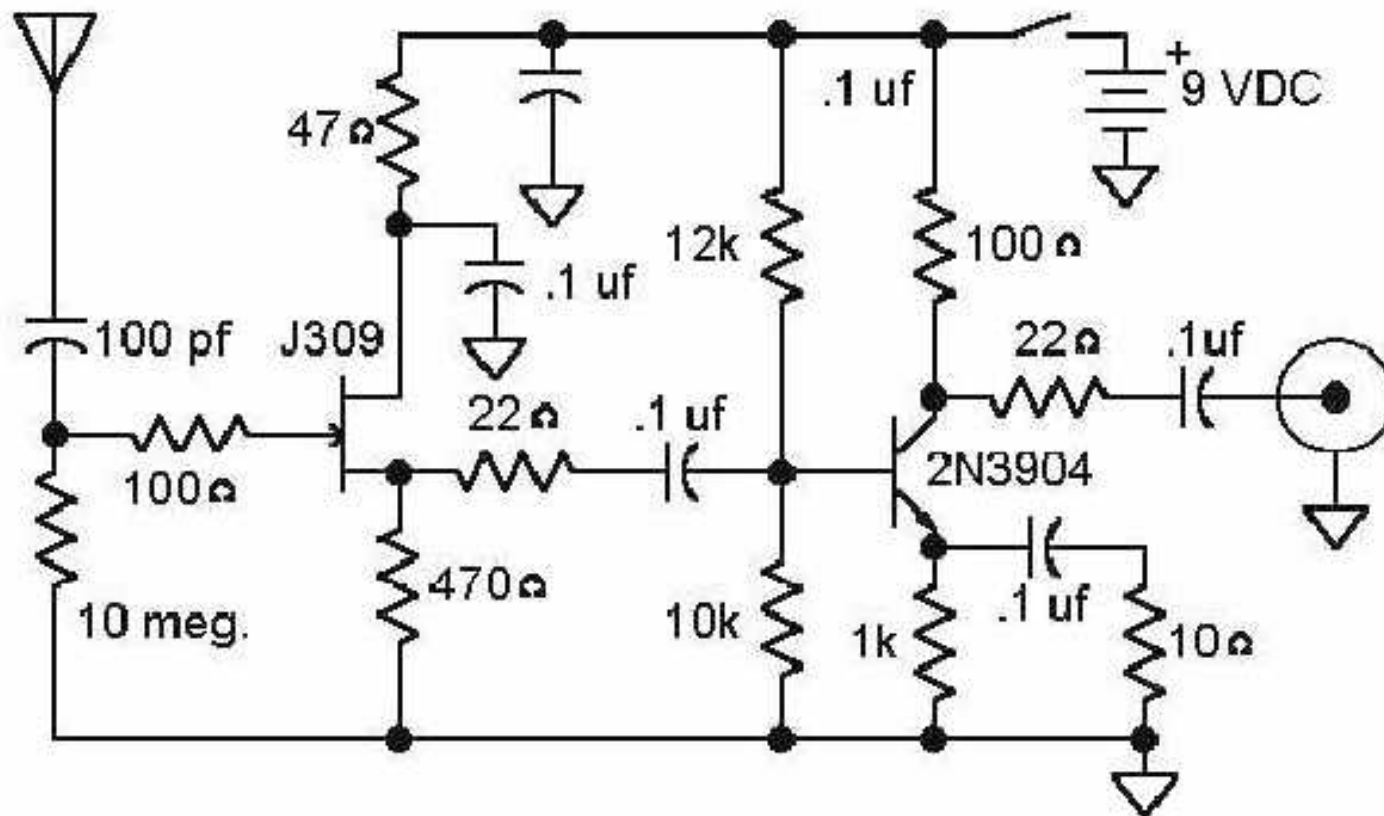
## Dexter Chan



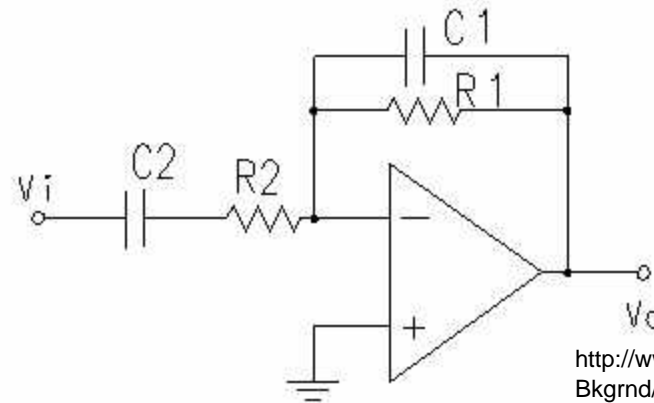


# Analog Modules

- Antenna, amplifier
  - Schematic from techlib.com



# Bandpass Filter



<http://www.swarthmore.edu/NatSci/echeeve1/Ref/FilterBkgnd/Filters.html>

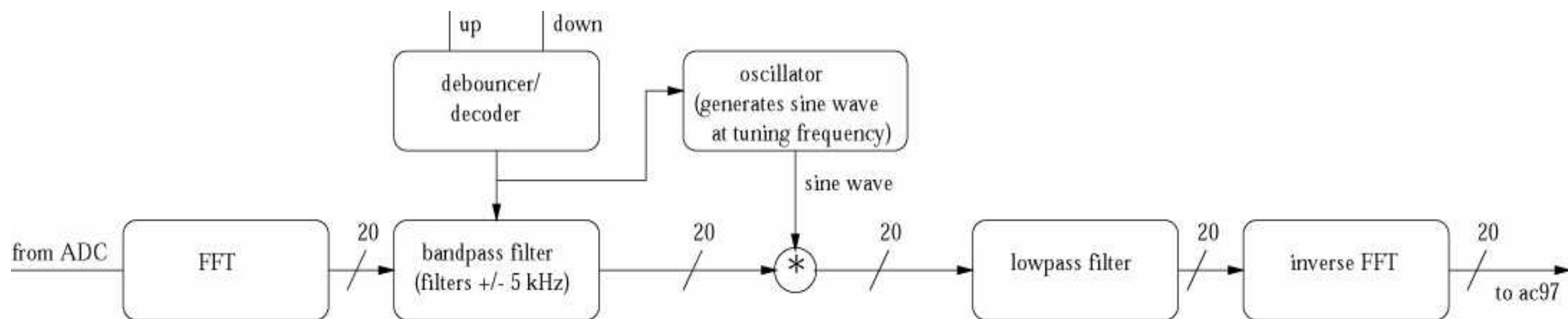
- Built from one op-amp
- Tune resistors, capacitors as appropriate

$$R_1 * C_1 \gg 5.8 * 10^{-7}$$

$$R_2 * C_2 \ll 1.8 * 10^{-3}$$

# Analog to Digital Converter

- Requirements:
  - At least 4 MSPS, preferably 8 to 10
  - Ideally 20-bit resolution—quantization noise
  - Architectures? Can this be done on FPGA?
- Options:
  - AD7621: \$29.95, 3 MSPS, 16-bit
  - AD7760: \$34.95, 2.5 MSPS, 24-bit
  - LTC2202: \$30.00, 25 MSPS, 16-bit



# Digital Components

- Synchronizer
  - Sequential bits arrive on sequential cycles from ADC
  - Depends on ADC architecture
- FFT/Inverse FFT
  - Modules exist in Verilog

# The Hard Part

- Tuning and Modulation
- Theory:
  - AM transmission—carrier wave multiplied by signal

Then,  $y(t) = x(t) \cdot \cos(\omega_o t)$

$$\Rightarrow Y(\omega) = X(\omega) \cdot [\delta(\omega + \omega_o) + \delta(\omega - \omega_o)] / 2$$

Generally, demodulate by multiplying by cosine,  
lowpass filtering

# Tuning

- Need to recover main band, sidebands
- To recover spectrum at given frequency, use a bandpass filter
- Bandpass filter needs to be 10 kHz wide, to recover sidebands and prevent aliasing

# Adjusting Stations

- Inputs to tuner: up, down
- Works like volume dial—UP shifts center of bandpass filter up by 10 kHz, DOWN shifts center down 10 kHz
- Decoder sends control signal to oscillator

# Oscillator

- Generates  $\cos(\omega_0 t)$  to recover signal
- $\omega_0$  controlled by user inputs—UP, DOWN
- Multiply, lowpass filter with bandwidth equal to 2x bandwidth of original signal

# Expected Issues

- Spectral noise
- ADC interface
  - Quantization noise—more resolution, sigma-delta architecture
  - Sigma-delta ADCs can't sample fast enough
  - Power supply noise
- Radio reception in the lab

# Proposed Solutions

- Spectral Noise
  - Prefilter, preamplify stages
  - Small compared to quantization noise; can probably be ignored
- Radio Reception in Lab
  - Test analog front end elsewhere—artificially generate AM signals to test digital hardware
- ADC Issues
  - ...

# Milestones

- Tuner system testable by 11/28
- Signal demodulation testable by 12/1
- Analog Front End testable by 12/5