DC OFFSET

• Analog circuits often add DC offsets to signals which may be undesirable

• Suppose we want to detect a signal by summing magnitude over some period

• Example: detection circuit
  – No signal → 0
  – Signal → 1
  – No signal + DC bias → 1

\[ \sum_{t=t_0}^{t_f} |x| \]
DC Offset

• Not usually a problem for high frequency signals
  – Filter out DC component with a high-pass filter
  – Analog or digital domain

DC Offset

• Can be a problem for signals with important components near DC, however
  – Still need a high-pass filter
  – Need a sharp frequency response to keep important low-frequency parts of signal
  – Digital processing may be best (or required)
DC Offset Cancellation Architectures

- A) Signal passes through high-pass filter
  - Filter must not distort signal
    - Phase response likely important
- B) Low pass filter estimates DC offset, which is then subtracted from the signal
  - Filter need only estimate DC magnitude
    - Phase response likely unimportant

DC Offset Estimation

- FIR filters
  - Have desirable characteristic of linear phase
  - Require higher-order filter typically
- IIR filters
  - Generally lower-order for same filtering requirements
- IIR filters can be best choice here since sharp-response low-pass magnitude-only output is typically required
DC Offset Estimation

- Analog
  - Faster response
- Digital
  - Opportunities to use sophisticated algorithms. Can adapt estimator based on:
    - System mode (e.g., rapid changes or steady state)
    - Signal characteristics (e.g., make estimations more accurate)
    - Knowledge about circuit characteristics (e.g., self calibration)

DC Offset Cancellation Architectures

- 1) Feed-forward
  - DC offset estimator circuit receives the input signal
  - Generally faster responding

- 2) Feed-back
  - DC offset estimator circuit receives corrected signal
  - Generally more accurate as it can compensate for DC offsets introduced by the subtractor
DC Offset Cancellation

- Many techniques to estimate DC offset of a varying signal
- Helpful to know characteristics of signal

DC Offset Cancellation

- Can use more sophisticated DC offset algorithms with digital design
- Likely includes a low-pass filter
DC Offset

- Example input signal with no DC bias

DC Offset

- Example input signal with positive DC bias
DC Offset Estimation

- Biased signal low-pass filtered with a 16-tap FIR filter

- Biased signal low-pass filtered with a 36-tap FIR filter
DC Offset Correction

- Corrected signal with little DC bias