Measurement Systems

Tadeusz Stepinski, Signaler och system

- Elements of measurement systems II
  - Switched capacitor filters
  - Analog digital converters
  - Sample and hold
  - Digital analog converters

Switched Capacitor Filters - principle

- Replacing resistor with a switch

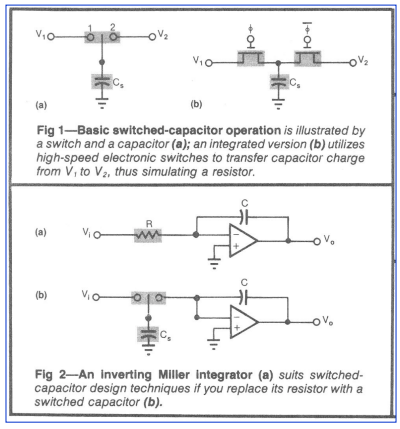


Fig 1—Basic switched-capacitor operation *is illustrated by a switch and a capacitor* ***(a)****; an integrated version* ***(b)*** *utilizes high-speed electronic switches to transfer capacitor charge from* V_1 *to* V_2*, thus simulating a resistor.*

Fig 2—An inverting Miller integrator (a) *suits switched-capacitor design techniques if you replace its resistor with a switched capacitor* ***(b)****.*

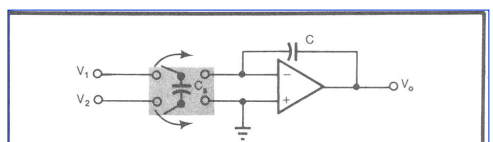


Fig 3—A differential integrator *is easy to construct using switched-capacitor methods. The arrows indicate switch phasing.*

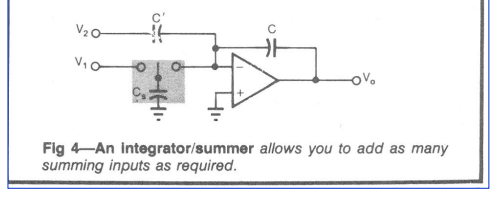


Fig 4—An integrator/summer *allows you to add as many summing inputs as required.*

Switched Capacitor Filters - principle

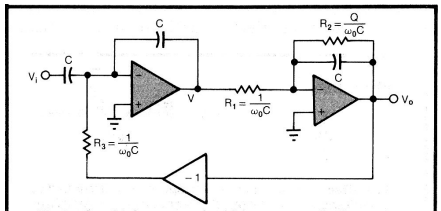


Fig 8—Combining a standard integrator and a lossy one *creates a viable switched-capacitor circuit when resistance values are stated in terms of capacitance and switching speed.*

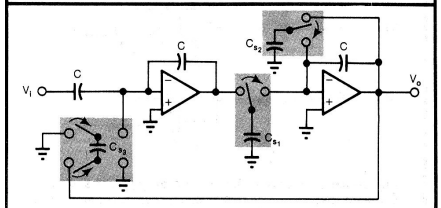
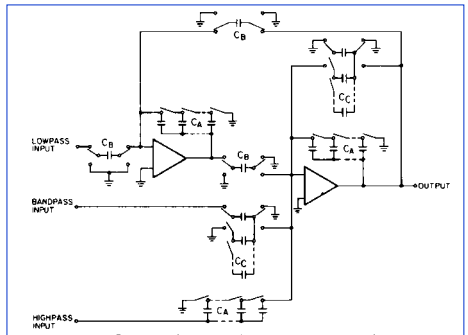


Fig 9—Substituting switched capacitors for resistors *in* ***Fig 8****'s integrator circuit produces a precise, easily integrated filter.*

- Second order universal active filter



Schematic of the switched-capacitor universal active filter.

Switched Capacitor Filters - implementations

- Integrated switched capacitor filter

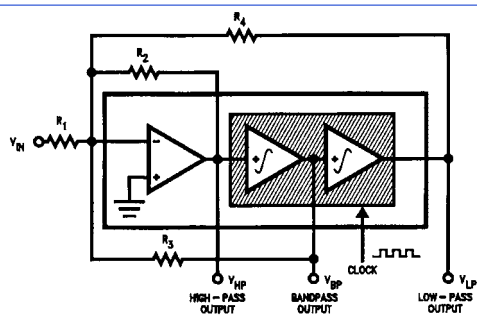


FIGURE 33. Block diagram of a second-order universal switched-capacitor filter, including external resistors connected to provide High-Pass, Bandpass, and Low-Pass outputs. Notch and All-Pass responses can be obtained with different external resistor connections. The center frequency of this filter is proportional to the clock frequency. Two second-order filters are included on the LMF100 or MF10.

Switched Capacitor Filters - implementations

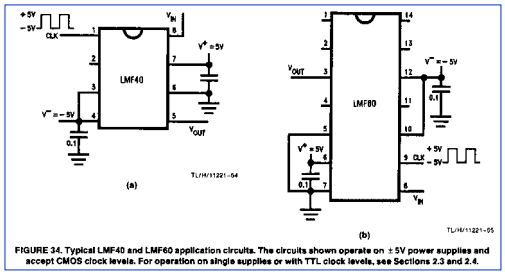


FIGURE 34. Typical LMF40 and LMF60 application circuits. The circuits shown operate on ±5V power supplies and accept CMOS clock levels. For operation on single supplies or with TTL clock levels, see Sections 2.3 and 2.4.

- Integrated switched capacitor filters

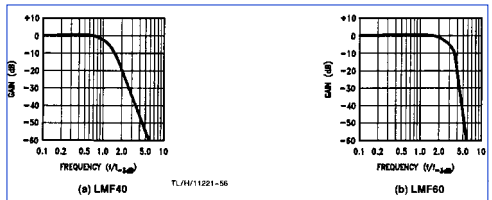


FIGURE 35. Typical LMF40 and LMF60 amplitude response curves. The cutoff frequency has been normalized to 1 in each case.

Switched Capacitor Filters - implementations

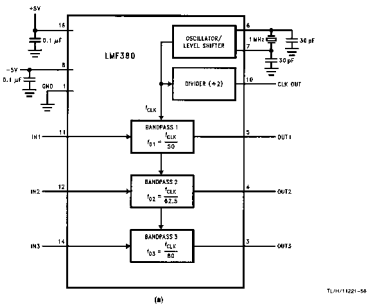


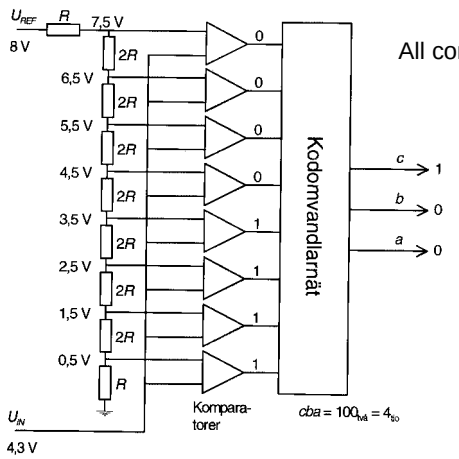
FIGURE 36. LMF380 one-third octave filter array. (a) Typical application circuit for the top audio octave. The clock is generated with the aid of the external crystal and two 30 pF capacitors. (b) Response curves for the three filters.

- Integrated switched capacitor filters

A/D converters

- Most common A/D types
  - Flash
  - Integrating dual slope
  - Delta pulse modulation
  - Successive approximation
  - Voltage frequency converter

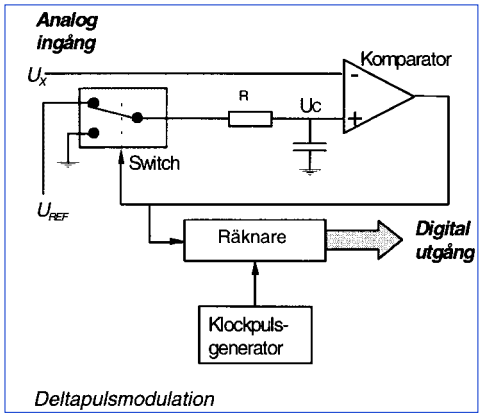
A/D converters - flash



Parallellomvandling (Flash ADC)

All comparators operate simultaneously

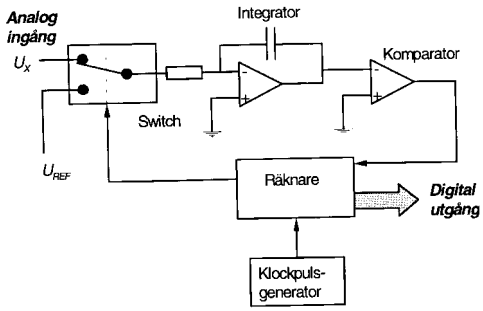
A/D converters - delta pulse modulation



Deltapulsmodulation

- One ramp
  - counter counts time required for loading the capacitor C
  - accuracy depends on the time constant RC

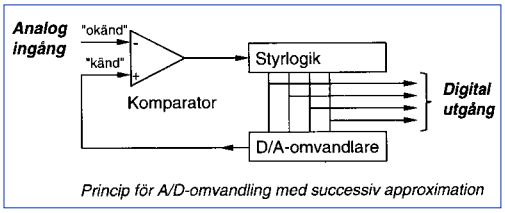
A/D converters - integrating dual slope



Integrerande A/D-omvandling (Dual Slope)

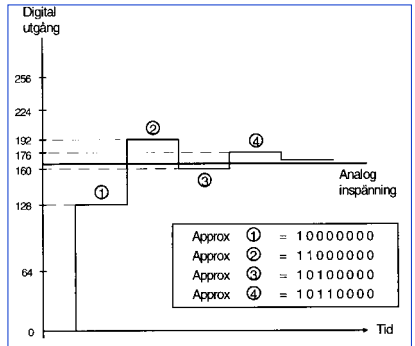
- Two ramps:
  - up with reference voltage
  - down with U_x
- Counter counts time
  - independent from the integrator time constant
- Example: dual slope inetegrator

A/D converters - successive approximation



Princip för A/D-omvandling med successiv approximation

- Successive interval decimation



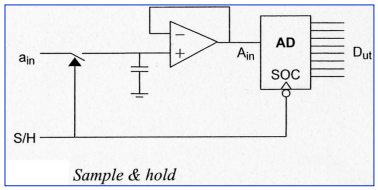
Exempel på intervallhalvering med successiv approximation

A/D converters - comparison

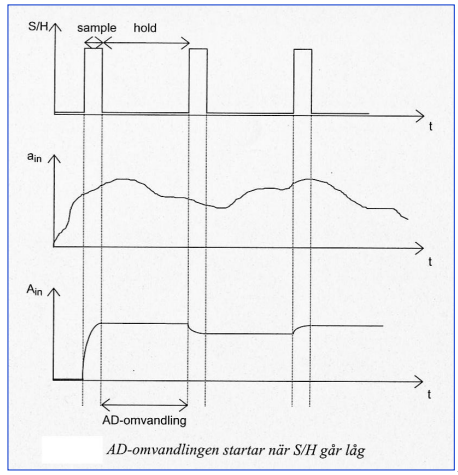
Method	Speed	Resolution
Flash	*very high*	*low*
Dual slope	*slow*	*very high*
Delta modulation	*medium*	*high*
Successiv approximation	*high*	*medium*
Voltage frequency	*slow*	*very high*

Sample & hold

Signal must be frozen during A/D conversion

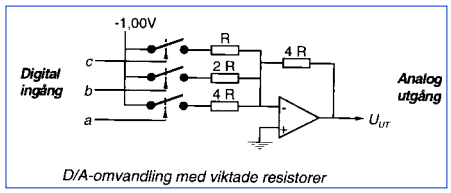


Sample & hold

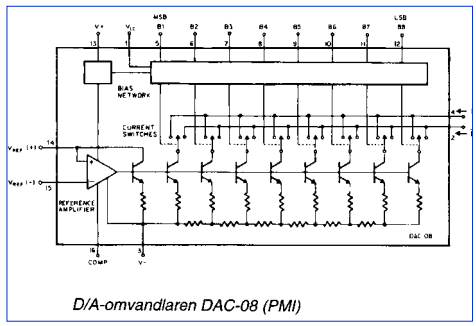


AD-omvandlingen startar när S/H går låg

D/A converters



D/A-omvandling med viktade resistorer



D/A-omvandlaren DAC-08 (PMI)