# Software Defined Radio and receiver (Softrock) demo

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# What is Software Defined Radio?

My ‘SupaDupa DX5000’ has lots of DSP, isn’t that SDR?

American National Standard, *Telecom Glossary 2000*.

An SDR consists of a receiver and/or transmitter with the following properties:

(a) the received signal is digitized and then processed using software-programmable digital signal processing techniques (digitization may occur at the RF, IF, or baseband); and

(b) the modulated signal to be transmitted is generated as a digital signal using software-programmable digital signal processing techniques. The digital signal is then converted to an analog signal for transmission (the conversion to analog may occur at baseband, IF, or RF).

# What is Software Defined Radio?

There are two main features that seem to define amateur radio SDR ;

- As defined previously software is used for modulation/demodulation.
- The software can be ‘field’ upgraded by the user.

# Why Software Defined Radio-general?

Flexible

- New modes
- New features

Less RF hardware

- Lower cost (up to 70%)
- Increased reliability

Improved performance

- Use ideal ‘component’ values

Reduced Obsolescence

# Why Software Defined Radio- for amateur radio (1/2)?

Totally configurable

- Potentially tweak every aspect of performance
- Numerous options / functions

When open source software used

- Potentially huge pool of programmers
- Download free updates & extras
- Experiment with software
- Assist with evaluations

# Why Software Defined Radio- for amateur radio (2/2)?

New possibilities for experimentation

- Network radios
- Simultaneous voice, data, and video – D-Star is an exception

# SDR – how does it work?

Magic!

- The magic of mathematics!
- Any signal can be described mathematically, e.g SSB =

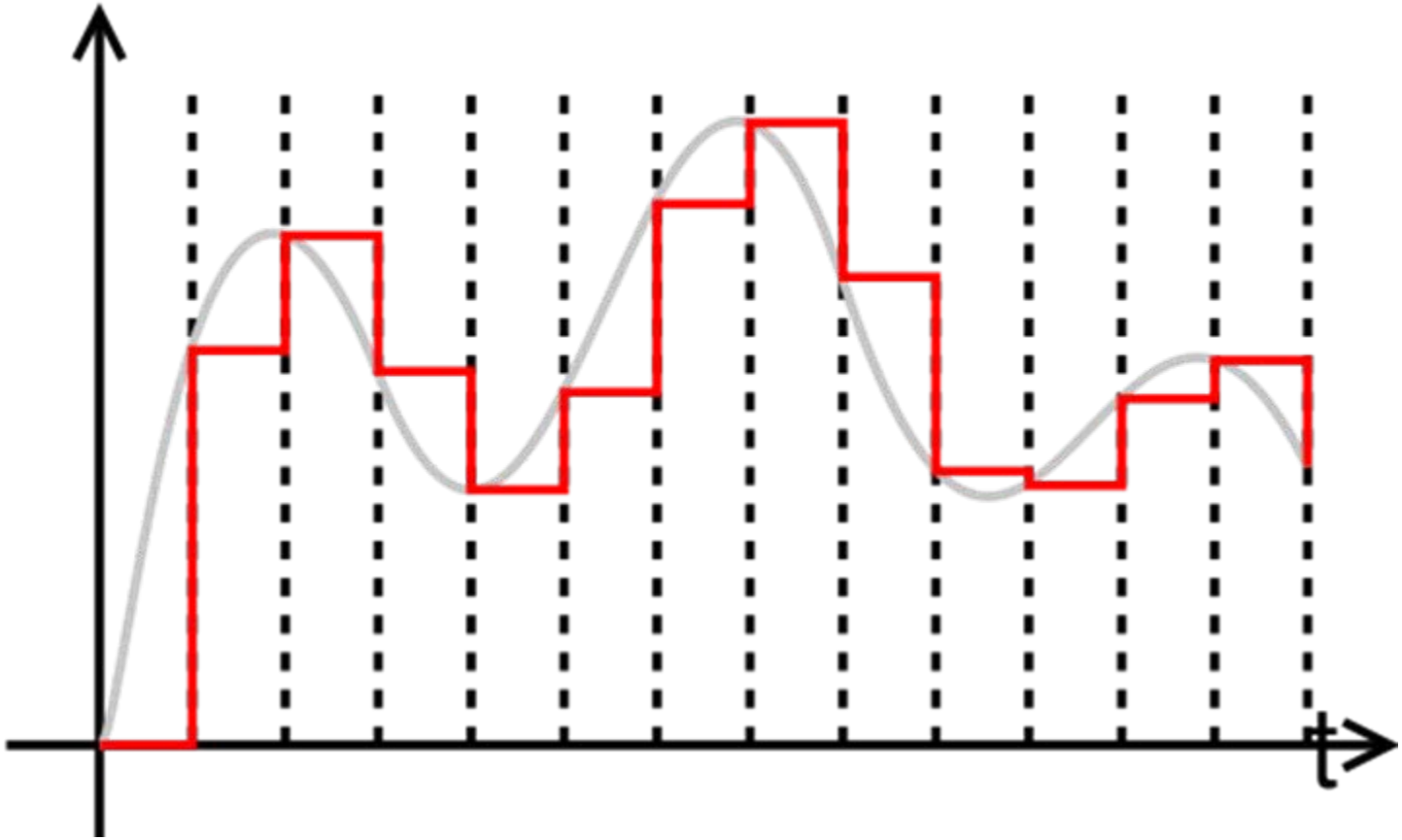
$$e^{j\omega_0 t}(I_t + jQ_t) = (\cos\omega_0 t + j\sin\omega_0 t)(I_t + jQ_t)$$
$$= (I_t\cos\omega_0 t - Q_t\sin\omega_0 t) + j(I_t\sin\omega_0 t + Q_t\cos\omega_0 t)$$

- Convert an analogue signal into a digital representation (A to D converter)
- Generate an analogue signal from a digital representation (D to A converter)

# SDR – how does it work?

## Digital generation of a sine wave

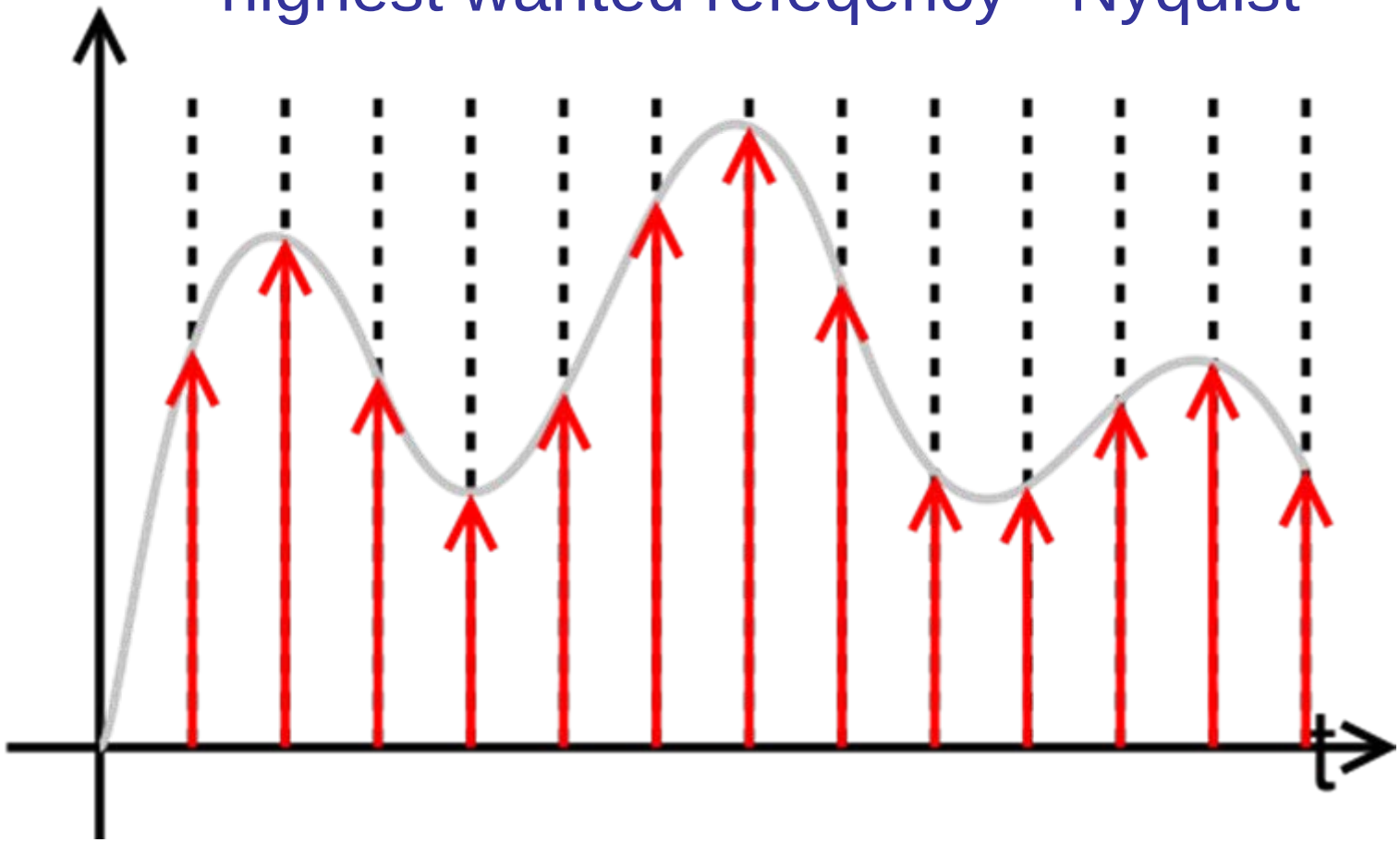
### Sampling rate/frequency



# SDR – how does it work?

## Sine wave conversion to digital

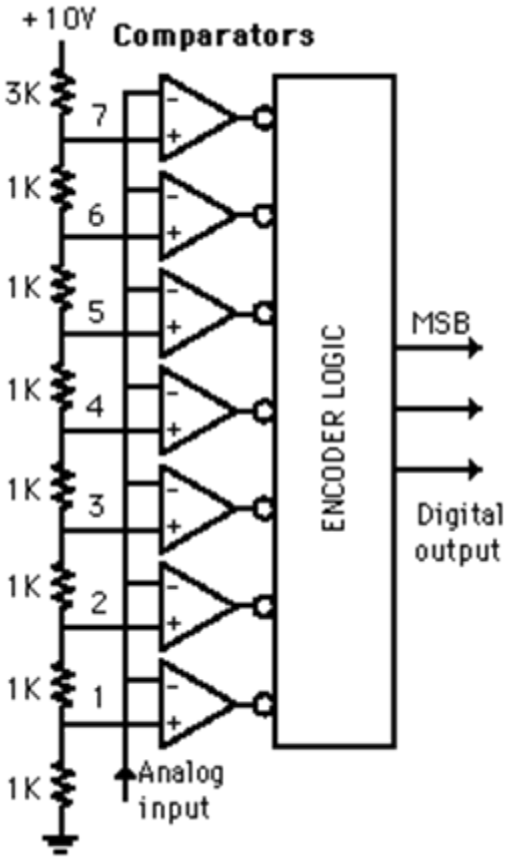
### Sampling rate/frequency – must be twice the highest wanted refeqency - Nyquist



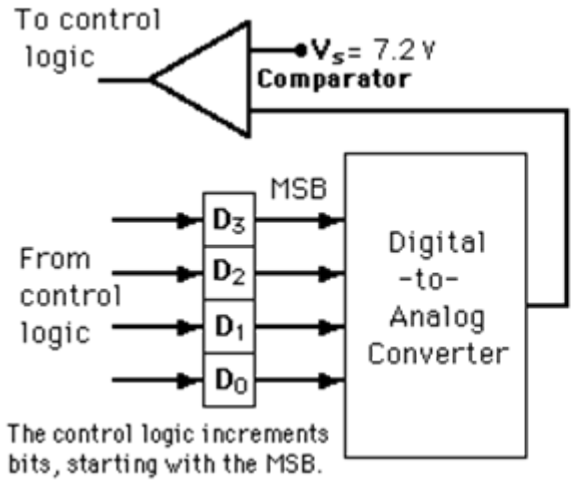
# SDR – how does it work?

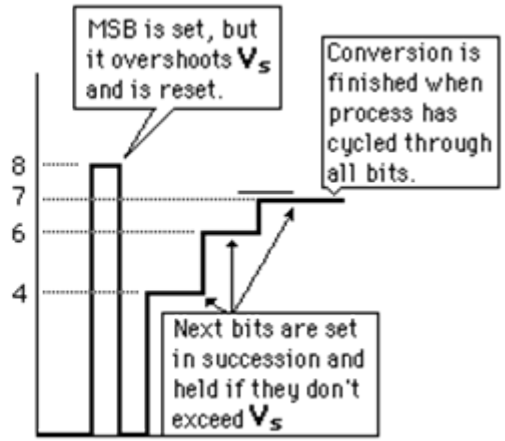
## A/D conversion

Flash – comparator for each O/P value (e.g. 255 for 8 bit)




Successive approximation



# SDR – how does it work?

## A/D conversion

### Delta-Sigma

Used in soundcards

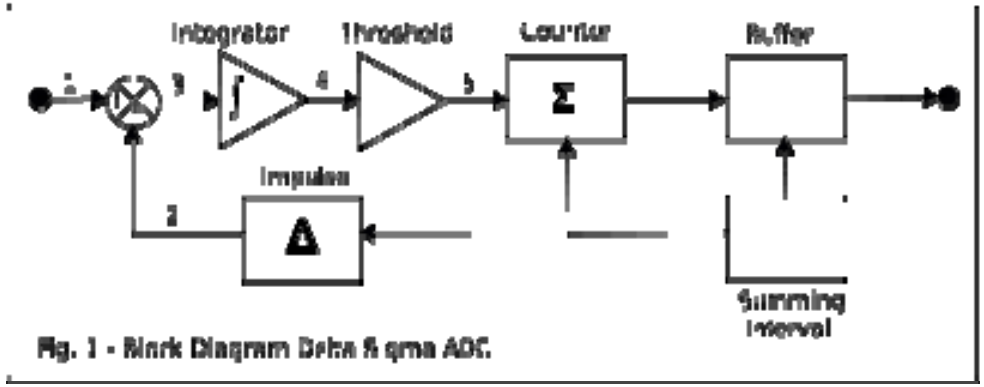
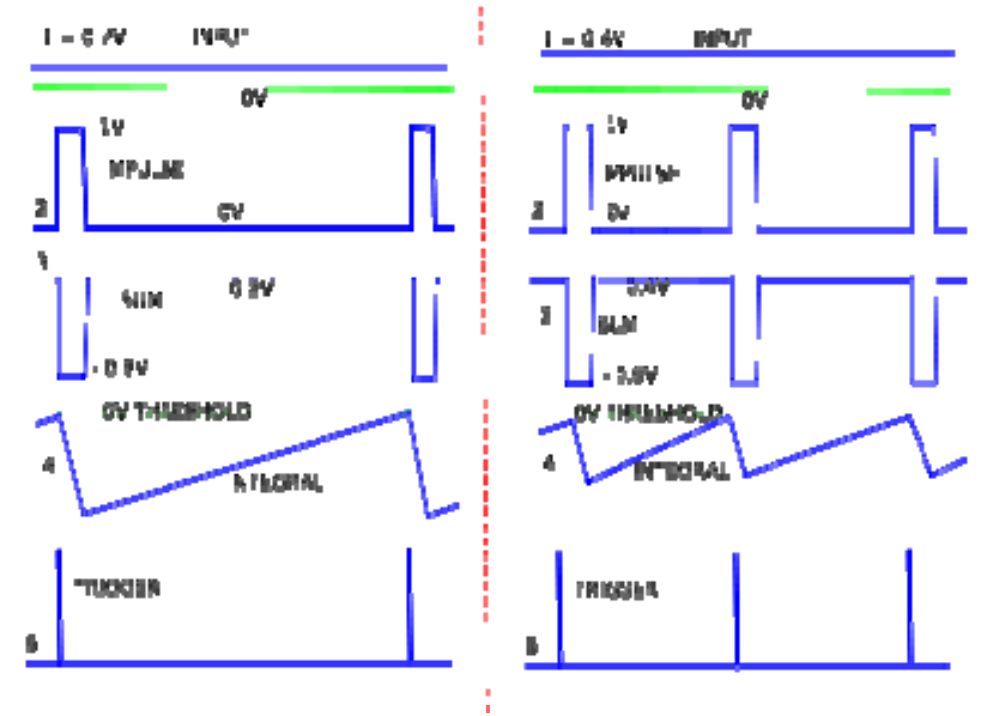


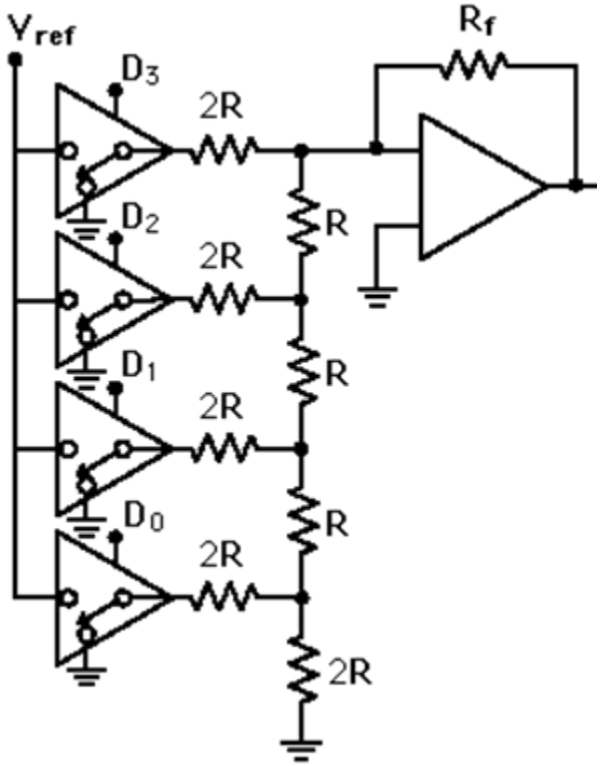
Fig. 1 - Block Diagram Delta Sigma ADC



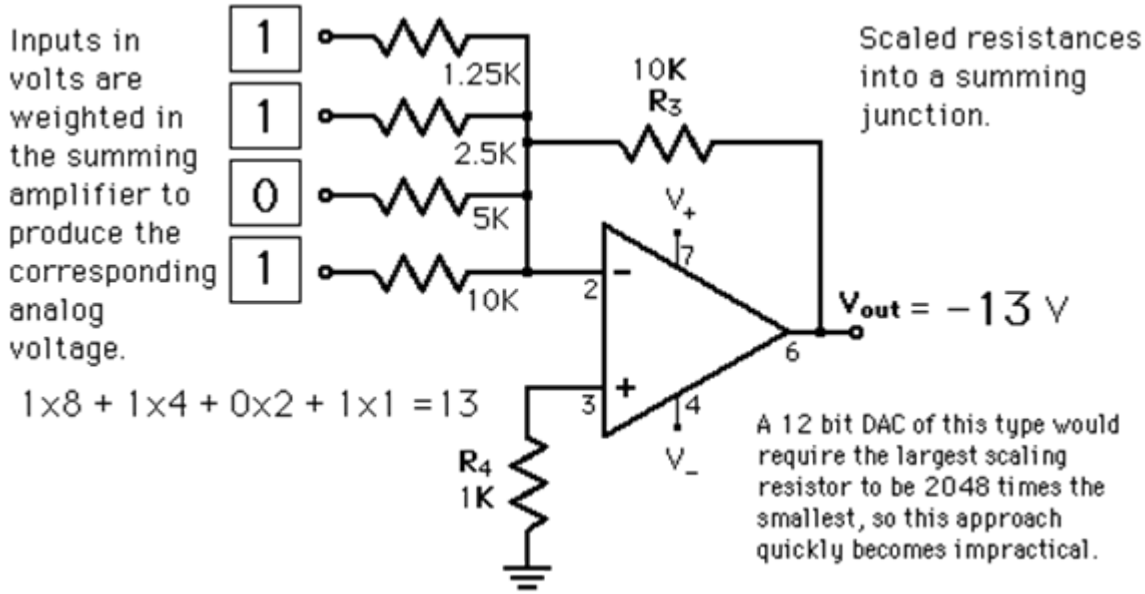
# SDR – how does it work?

## D/A conversion

### R – 2R ladder




### Weighted summing amp



# SDR – why now? (1/2)

SDR has been around for some years but hasn't taken off until relatively recently

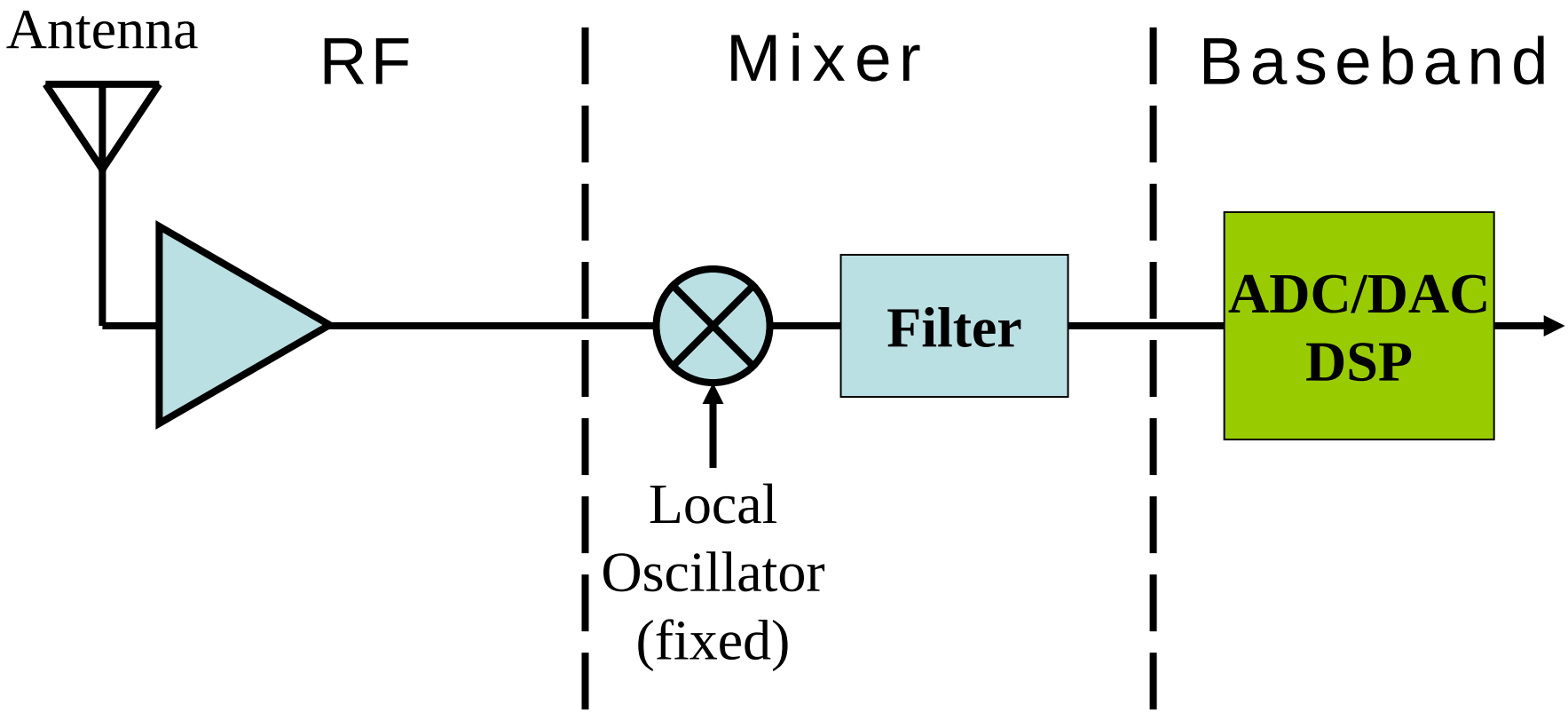
- Dedicated hardware was required, A/D & D/A converters plus microprocessor
- Build it yourself or buy  evaluation kit
- Limited scope to exchange software

# SDR – why now? (2/2)

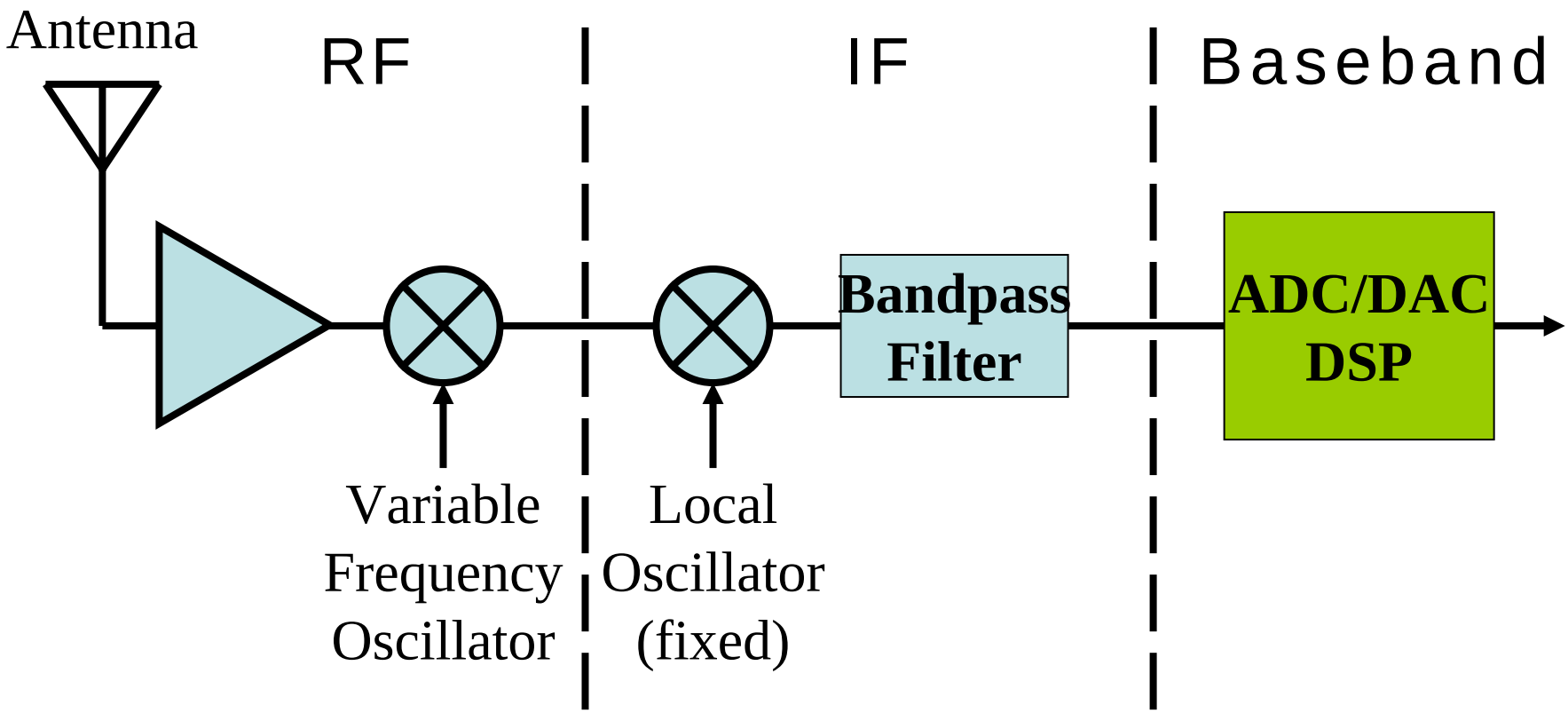
The relentless march of computing power & the web has made SDR more accessible

- Modern PC quite capable of processing
- Soundcards have two channel A/D & D/A converters
- But beware many laptops only have mono microphone inputs – USB soundcards
- Easy access to other interested amateurs and software

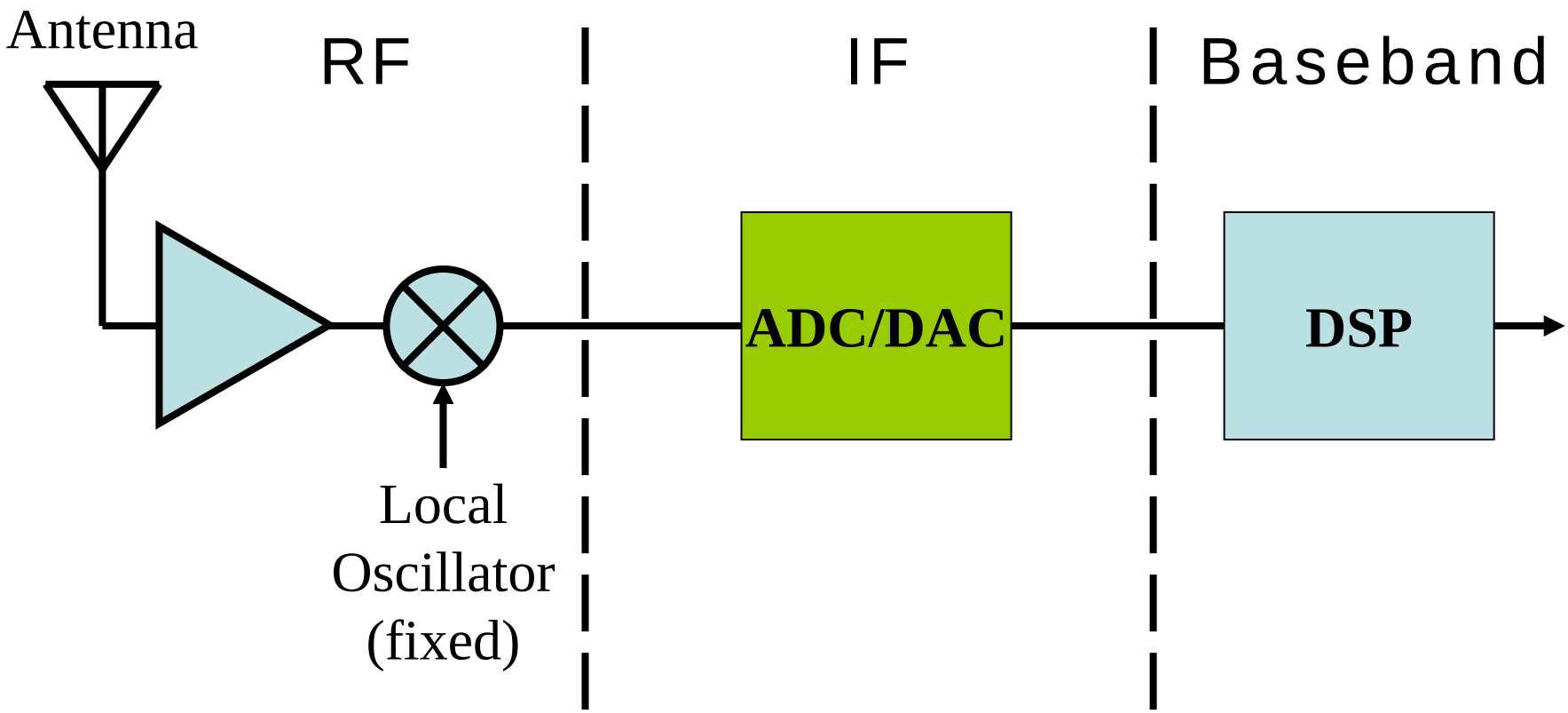
# Block Diagram
# SDR (simplified) – basic direct conversion RX, e.g. Softrock series



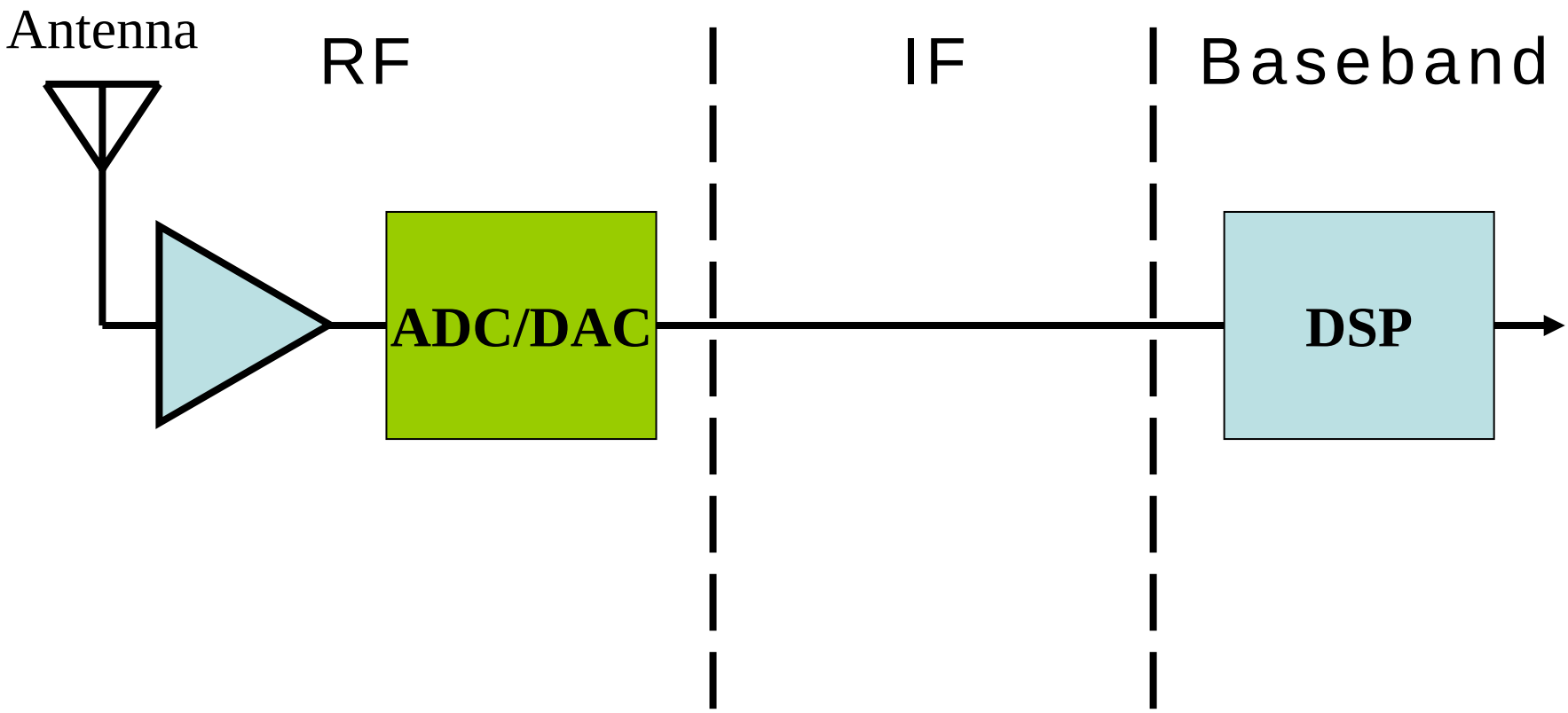
# Block Diagram
# SDR – basic with IF



# Block Diagram
# SDR – digital IF



# Block Diagram
# Software Radio – ultimate?



# SDR – software

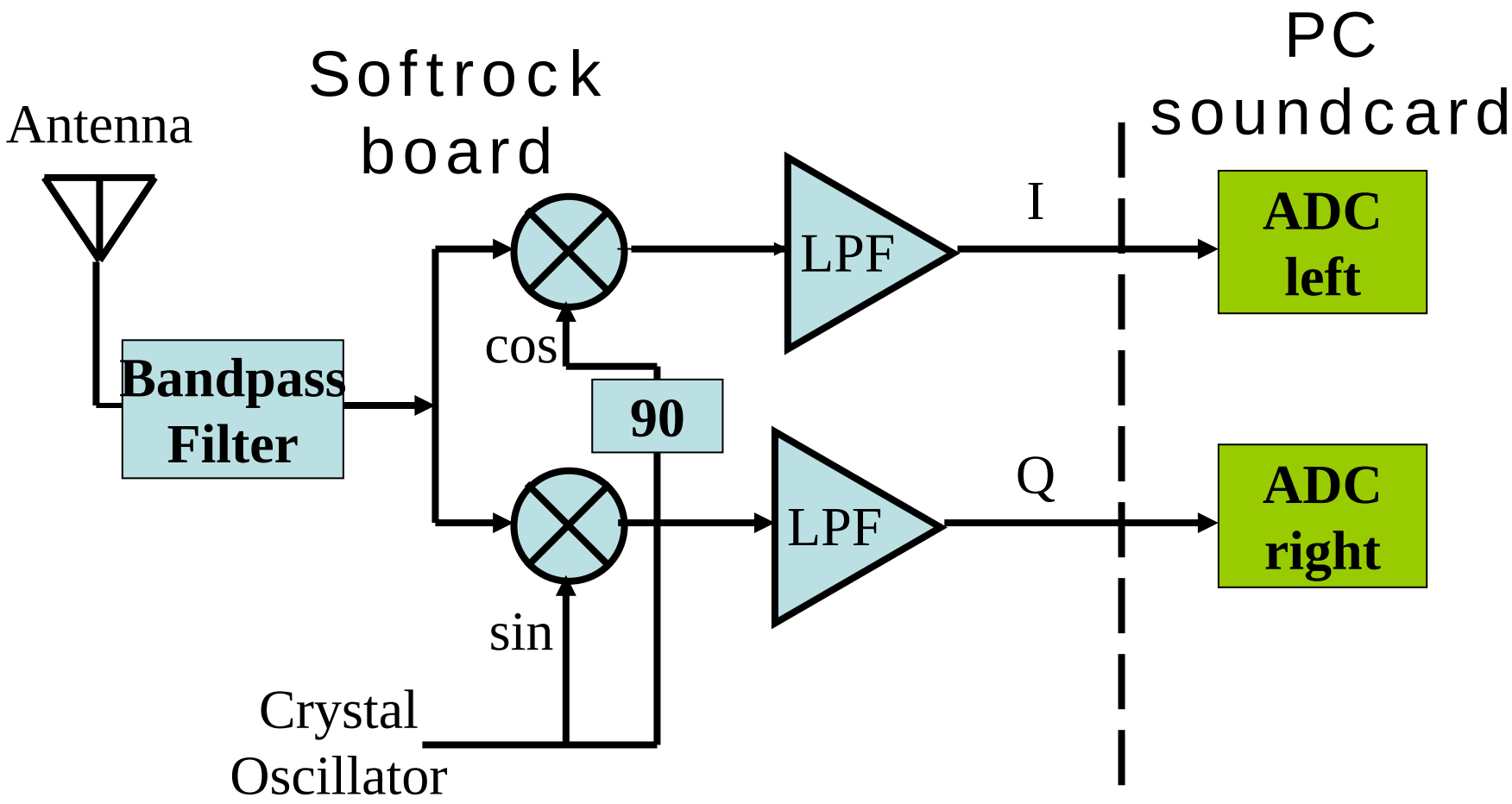
Several DC RX soundcard programmes available

- Power SDR – Flex Radio Systems, makers of SDR-1000 & latest FLEX-5000
- Rocky by Alex, VE3NEA
- KGKSDR by Duncan, M0KGK
- SAQRX by Johan SM6LKM- DC-22kHz RX mono input direct to soundcard (nothing else!) or Spectrum Lab
- Others

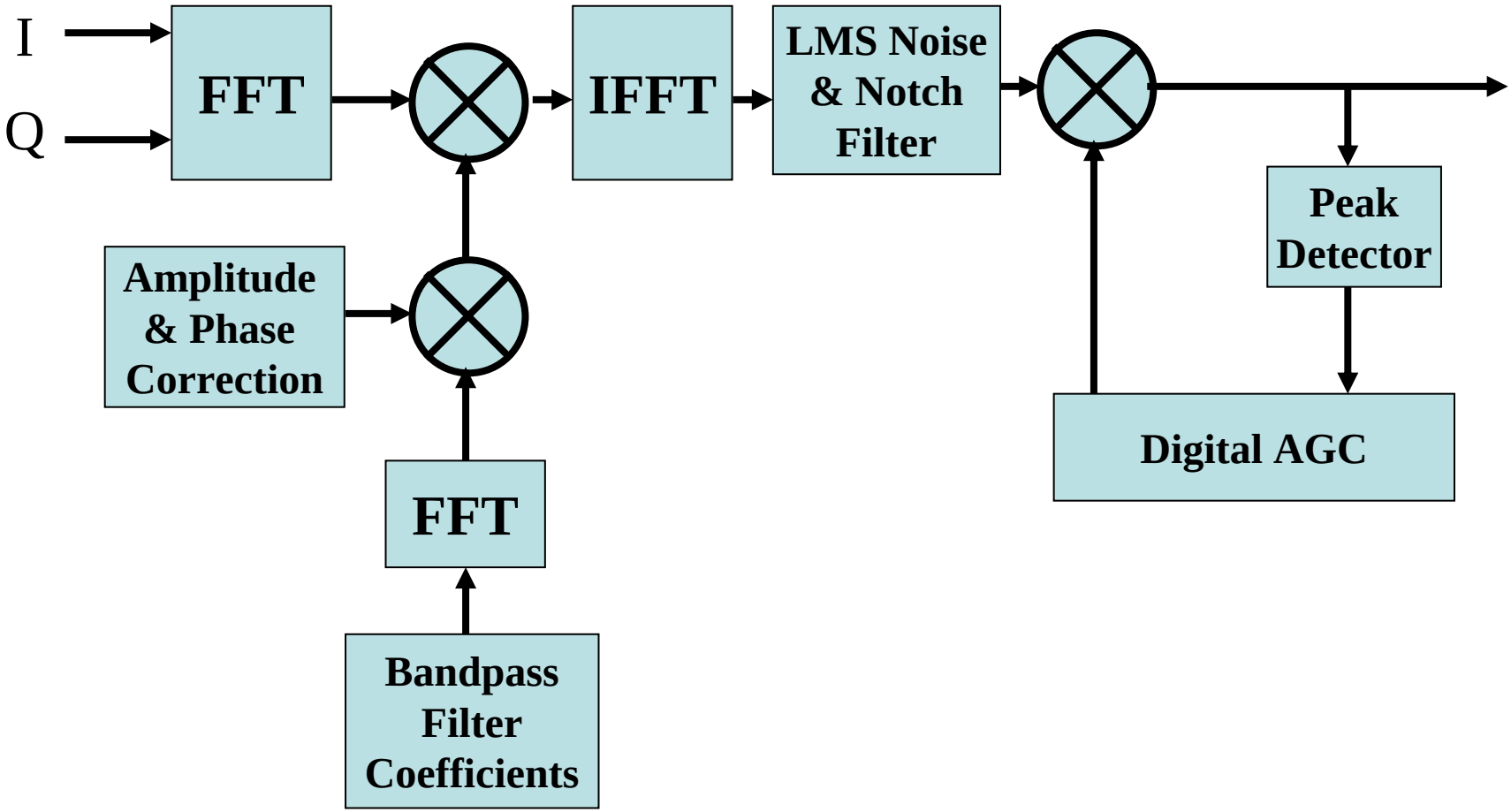
# SDR – hardware

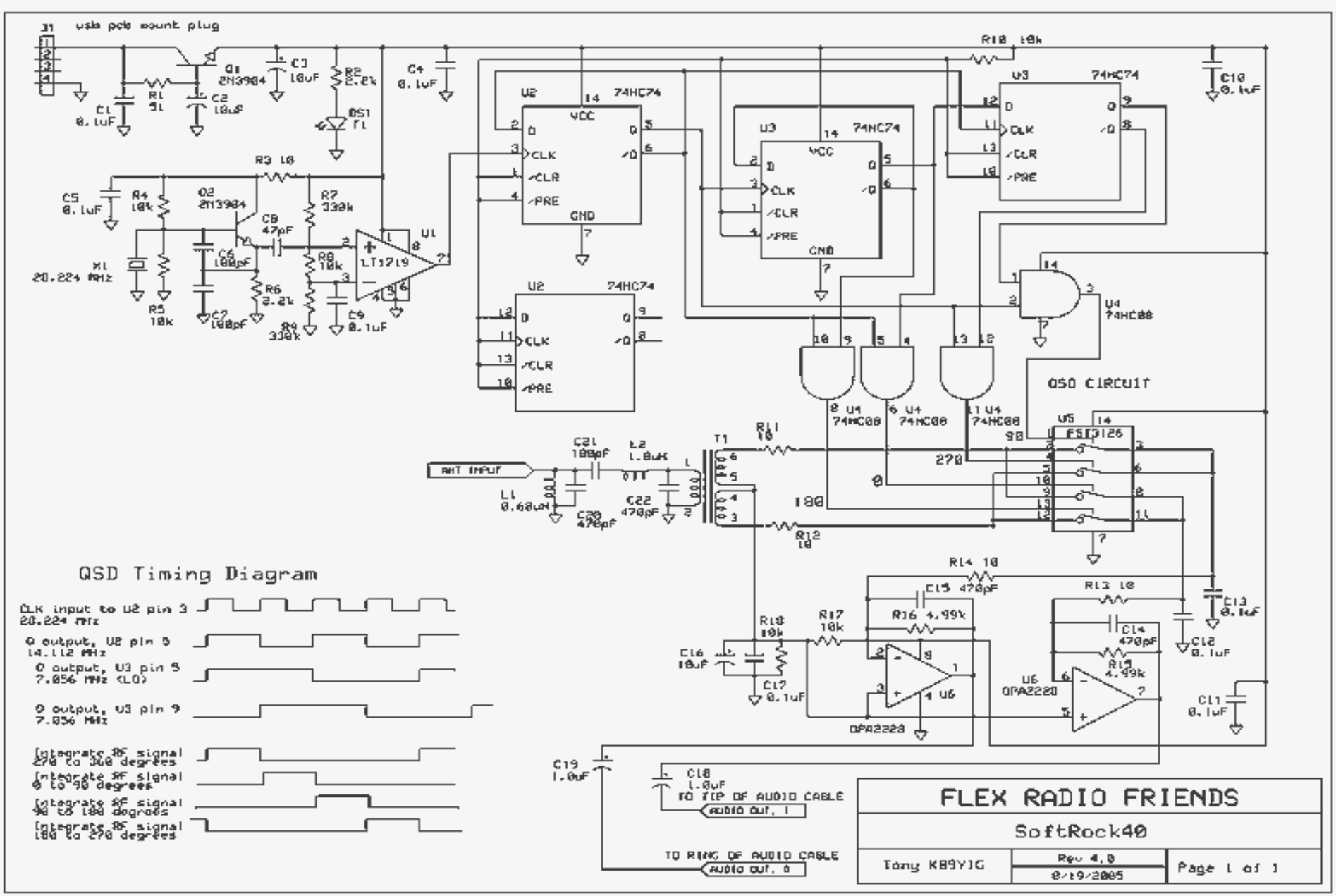
- Flex Radio Systems - SDR-1000 (soundcard) & latest FLEX-5000 (Firewire I/F)
- Softrock series
- TinySDR
- Elektor
- HPSDR
- others

# Block Diagram Softrock



# Block Diagram
# Software




QSD Timing Diagram
CLK input to U2 pin 3
20.224 MHz
Q output, U2 pin 5
14.112 MHz
Q output, U3 pin 5
7.056 MHz (LO)
Q output, U3 pin 9
7.056 MHz
Integrate RF signal
270 to 360 degrees
Integrate RF signal
0 to 90 degrees
Integrate RF signal
90 to 180 degrees
Integrate RF signal
180 to 270 degrees
QSD CIRCUIT
FLEX RADIO FRIENDS
SoftRock40
Tony KB9YIG
Rev 4.0
8/19/2005
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# SDR – internet links (1/2)

- http://www.arrl.org/tis/info/sdr.html - ARRL SDR page, inc. link to “A Software-Defined Radio for the Masses” articles – good intro to SDR

- http://f4dan.free.fr/sdr_eng.html - Christophe, F4DAN - comprehensive list of amateur SDR projects

- http://web.flex-radio.com/ - PowerSDR
- http://www.dxatlas.com/Rocky/ - Rocky
- http://www.m0kgk.co.uk/sdr/index.php - KGKSDR

# SDR – internet links (2/2)

- http://www.alexander.n.se/ - Grimeton SAQ VLF (17.2kHz) transmitter – Sun 29th June, 0900 & 1300 UTC.
- http://web.telia.com/~u33233109/saqrx/saqrx.html - SAQRX
- http://freenet-homepage.de/dl4yhf/spectra1.html - Spectrum Lab (has SAQ mode)