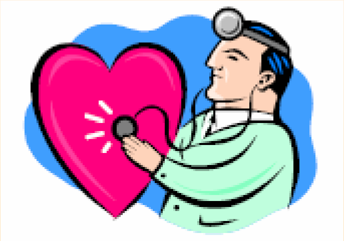
Wireless Musical Electrocardiogram



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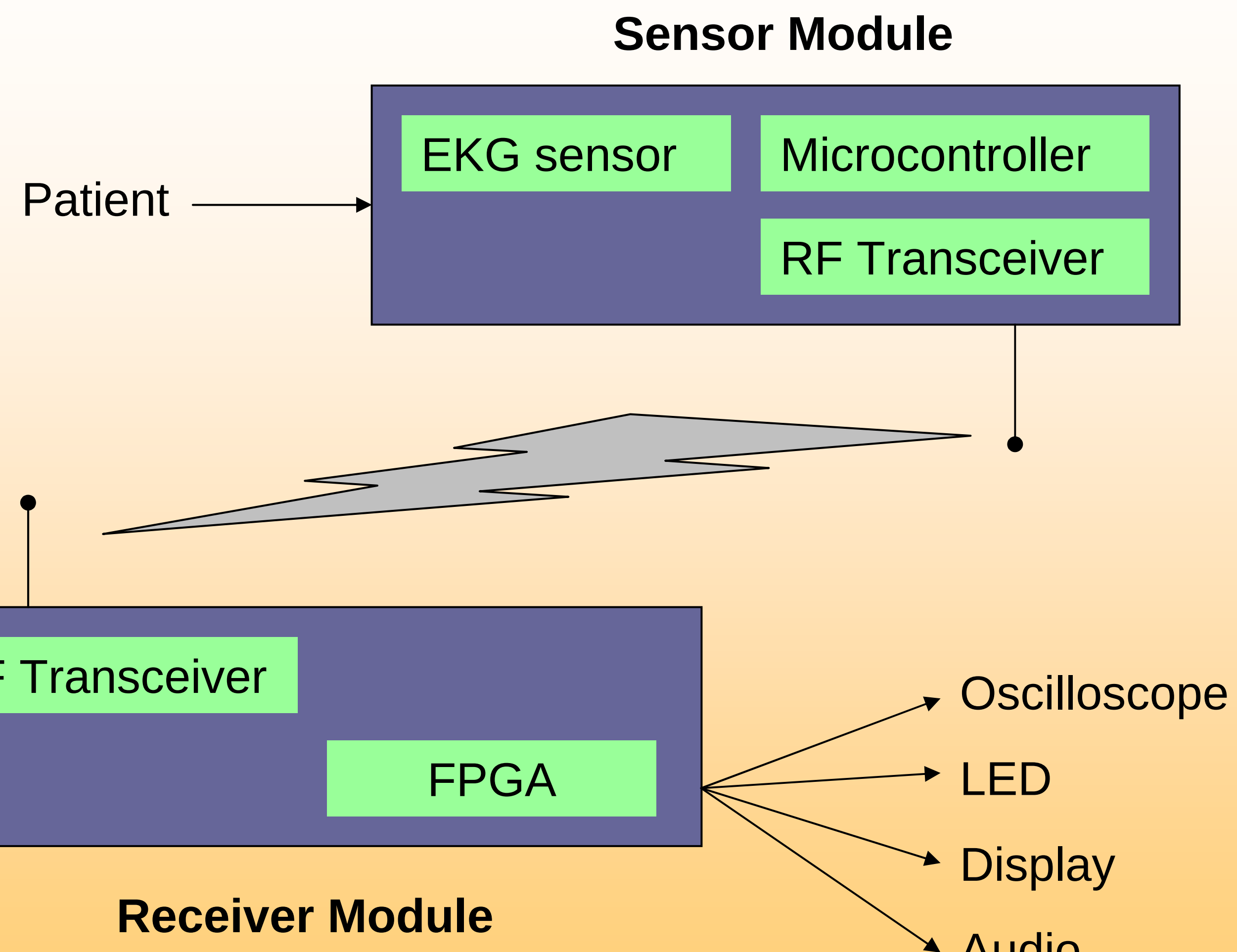
Motivation

- Wireless communication for medical applications is able to solve clinical needs and risks, while providing the patient with the freedom of movement.

Objectives

- Obtain EKG from patient
- Intelligently analyze, store, and transfer data to end user
- Ability to detect varying conditions of patient.


Sensor Module
EKG sensor
Microcontroller
RF Transceiver
Patient
RF Transceiver
FPGA
Receiver Module
Oscilloscope
LED
Display
Audio

Modes of Operation

Mode 1:

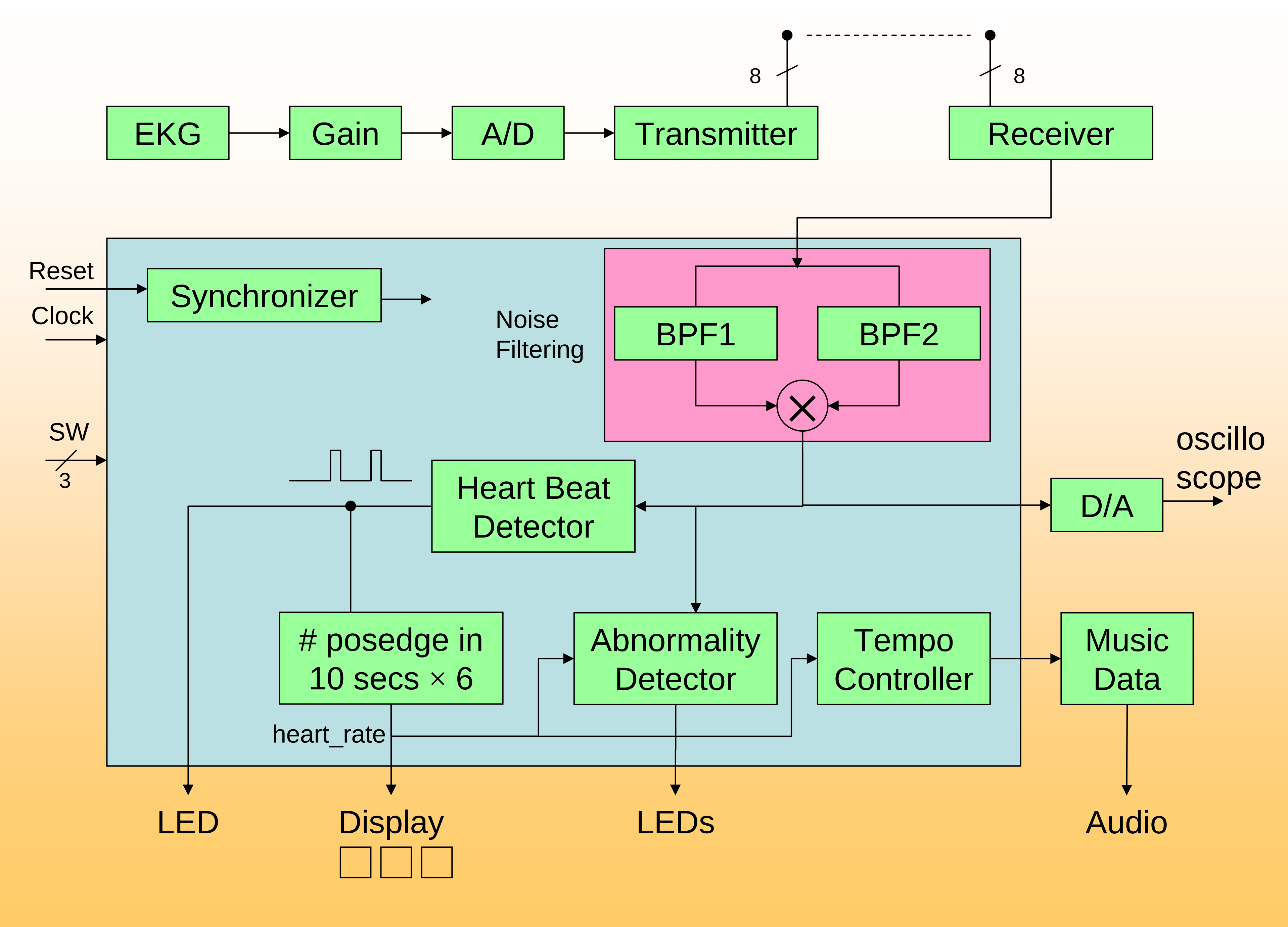
- EKG Wireless Monitor
- Bright LED “Beat” Indicator
- Digital Heart Rate Display

Mode 2:

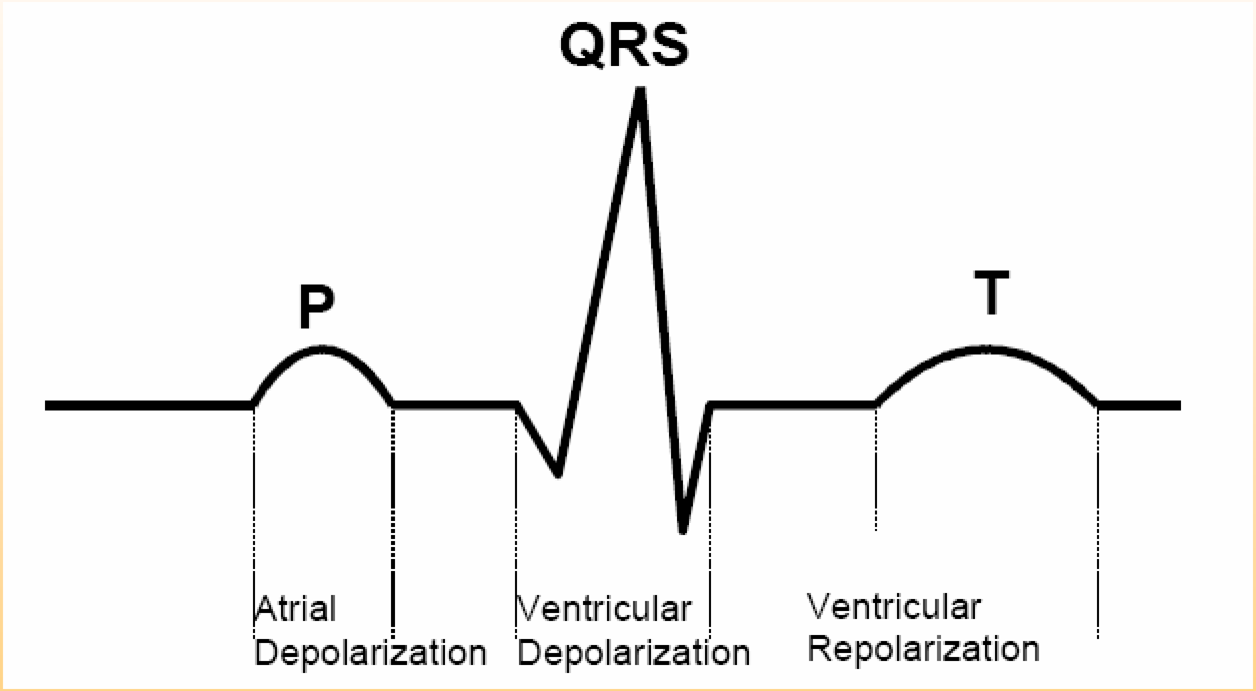
- Detecting Abnormality from Heart Rate
- Detecting Abnormality from EKG

Mode 3:

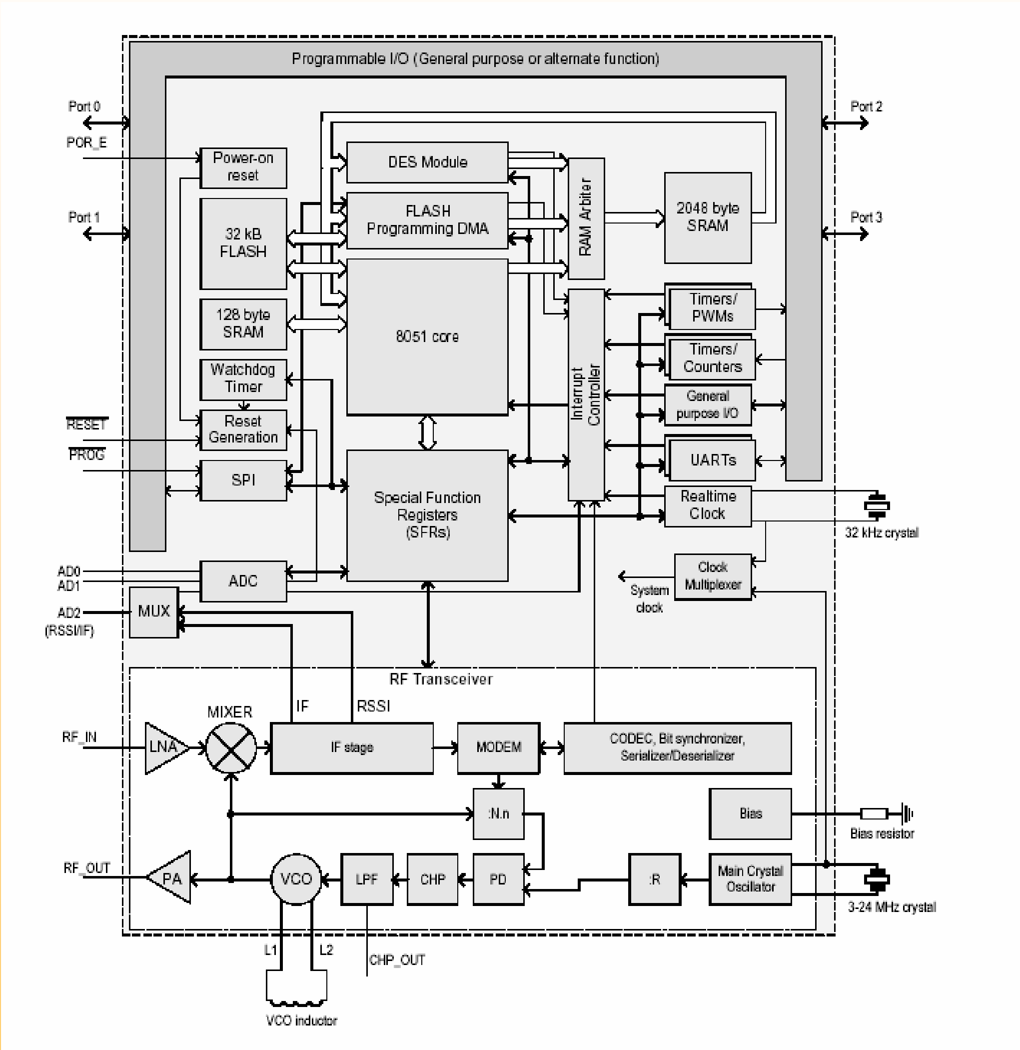
- Heart-Rate-Controlled Music


8
8
EKG
Gain
A/D
Transmitter
Receiver
Reset
Clock
Synchronizer
Noise
Filtering
BPF1
BPF2
SW
3
oscillo
scope
Heart Beat
Detector
D/A
posedge in
10 secs × 6
Abnormality
Detector
Tempo
Controller
Music
Data
heart_rate
LED
Display
LEDs
Audio

Typical EKG Waveform



Wireless Transceiver



CC1010 (ChipCon)

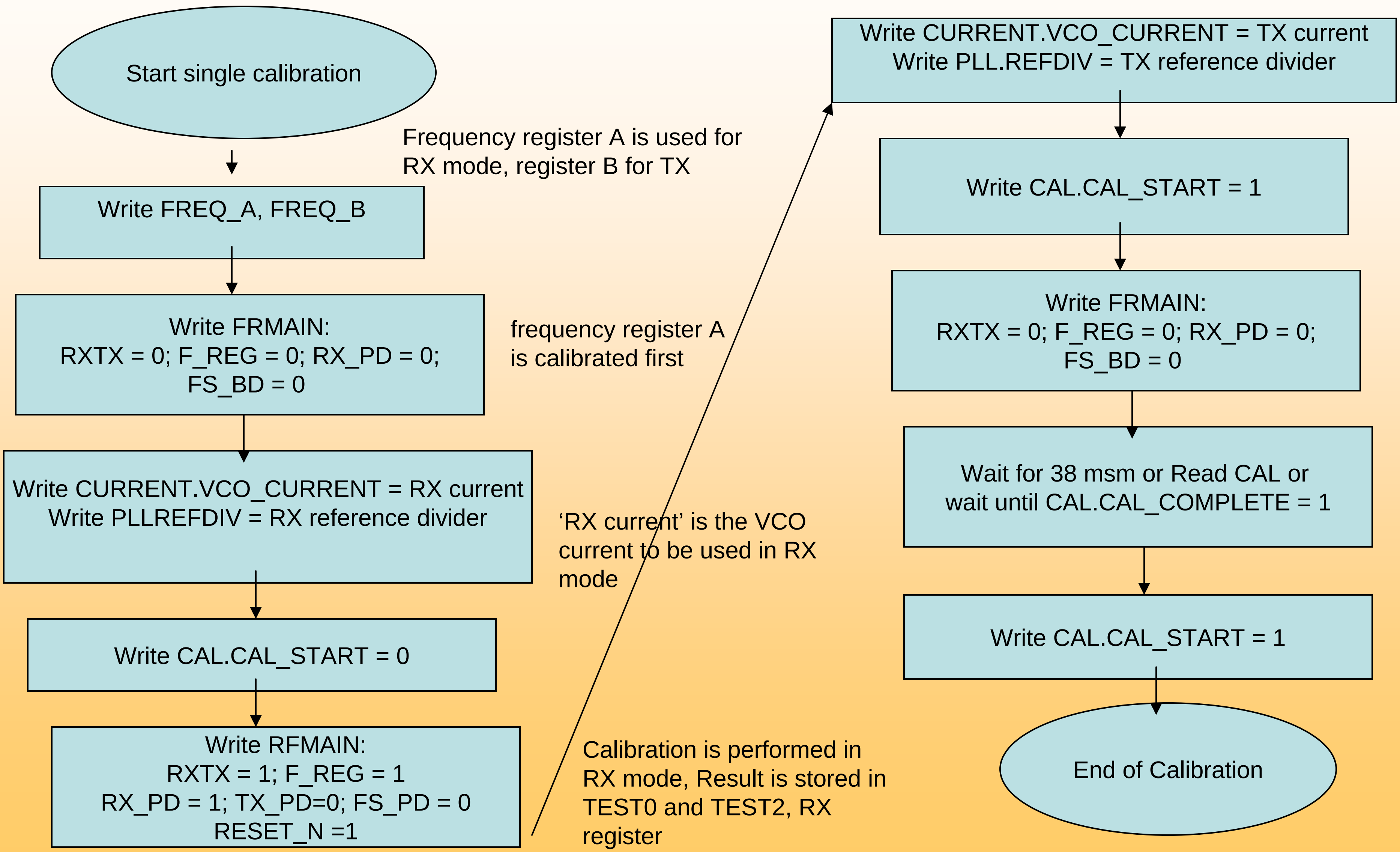
-8051 Compatible Microcontroller

-300-1000 MHz RF Transmission

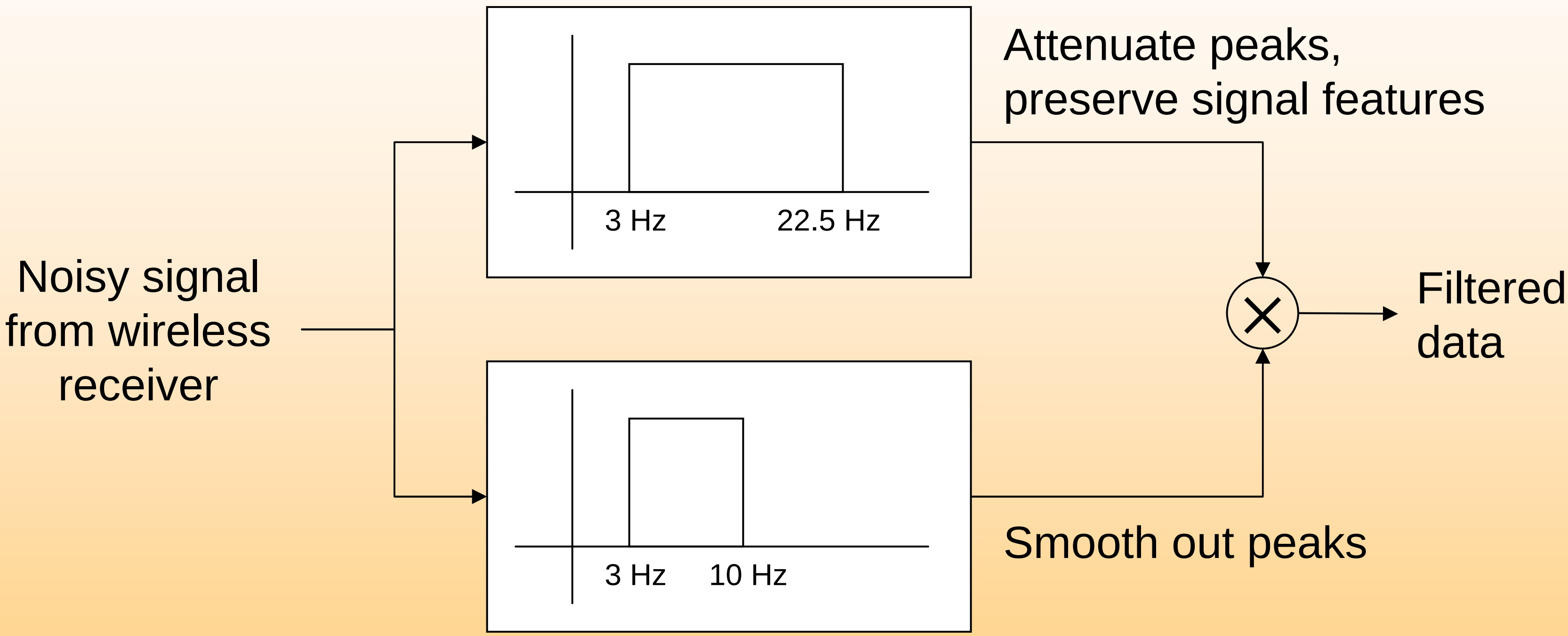
-32 kB Flash Memory

-A/D Converter (10 bit)

Wireless – Calibration Algorithm

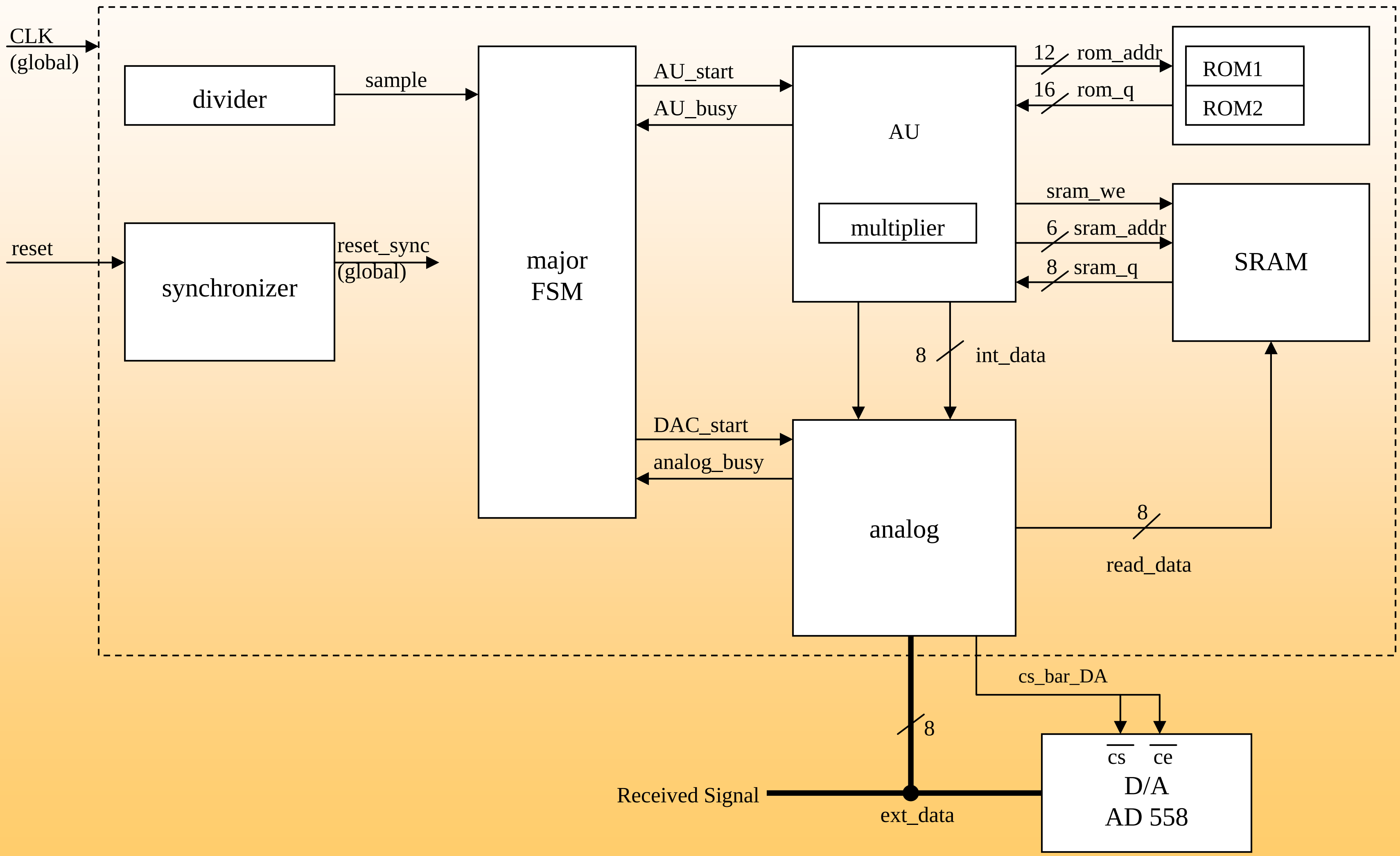


Mode 1: Noise Filtering

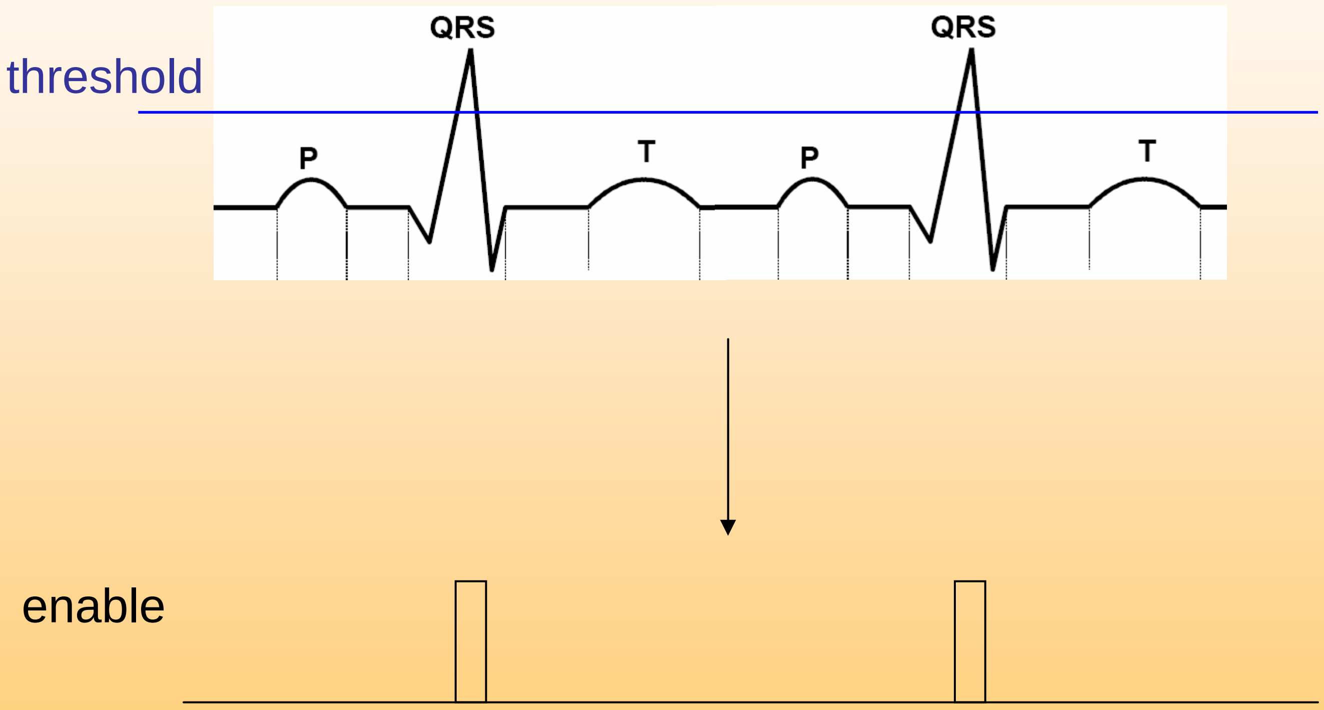


Use Matlab to determine the
impulse response for each filter

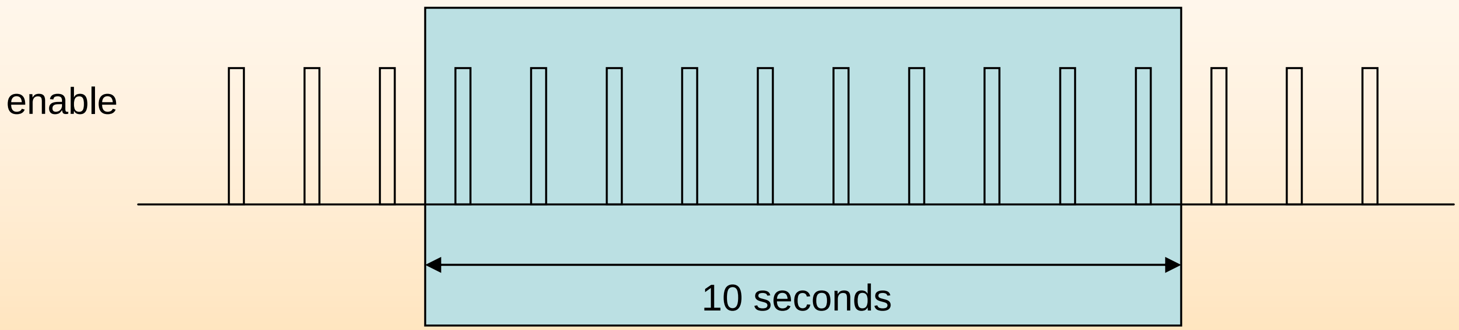
Mode 1: Noise Filtering



Mode 1: Heart Beat Detector



Mode 1: Heart Rate

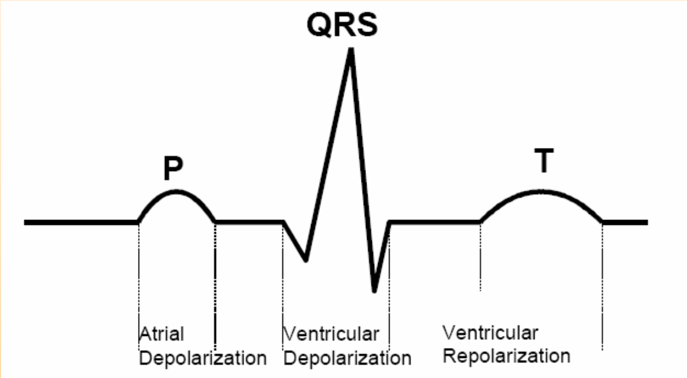


- Count number of positive edges in 10 seconds
- Heart rate = # count × 6

Mode 2: Detecting Abnormality

- Normal heart rate range = [50, 200]
- If heart rate is out of this range, the LED will illuminate.

- Normally, T > P
- Compare the two peaks from stored data in SRAM
- If T < P, the LED will illuminate.



Mode 3: Music from the Heart

- Music tempo is controlled by the heart rate
- Change tempo without changing pitch

Location 1
Location 2
Location 3
Location 4
Location 5
Location 6
Location 7
Location 8
Location 9
Location 10

Mode 3: Algorithm

```
function output = timescale(sig, compression, maxfreq)
% takes in a signal in the time domain and scales its length, thus increasing its tempo.
% It scales the signal by compression, where compression is less than 1.
% It takes in maxfreq in order to compute how often to remove samples.

if nargin < 3, maxfreq = 4096; end
n = length(sig);
% Computes how often to remove samples
Timediv = floor(.08*maxfreq*2)
% Computes how many samples to remove
remove = floor((1-compression)*timediv)
output = 0;

% Remove samples, and recombine signals
for i = remove+1:(timediv±remove):(n-timediv)
   output = [output; sig((i-remove):(i+timediv-remove))];
end
```

+ faster

- slower

Mode 3: Music of the Heart

Heart Rate Range

- 51-80
- 81-110
- 111-140
- 141-170
- 171-200