Options
Title: DCF77 Re... Modulation
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Output Language: Python
Generate Options: QT GUI

Complexity: 3.533mbal

Variable
ID: samp_rate
Value: 192k

Import
Import: zmq

Windows needs the import of zmq

Variable
ID: freq_DCF77
Value: 77.5k

Variable
ID: decimation
Value: 12

Import
Import: math

QT GUI Range
ID: hi_thres
Label: upper Threshold
Default Value: 100
Start: 0
Stop: 500
Step: 1

Adapt the upper threshold
so that the one value is provided
each time the signal is high

QT GUI Range
ID: lo_thres
Label: lower Threshold
Default Value: 15
Start: 500m
Stop: 50
Step: 100m

Adapt the lower threshold
so that the one value is provided
each time the signal is low

QT GUI Range
ID: gain1
Label: Gain1
Default Value: 10.5
Start: 1
Stop: 30
Step: 1

default real: 150
default simulation: 1

QT GUI Range
ID: gain2
Label: Gain2
Default Value: 25
Start: 1
Stop: 35
Step: 500m

default real: 290
default simulation: 1

QT GUI Range
ID: chip_size
Label: Chip size
Default Value: 25
Start: 20
Stop: 30
Step: 1

NOTE:
depends on decimation!

osmocom Source
Device Arguments: airspyhf=0
Sync: Unknown PPS
Number Channels: 1
Sample Rate (sps): 192k
Ch0: Frequency (Hz): 77.5k
Ch0: Frequency Correction (ppm): 0
Ch0: DC Offset Mode: 0
Ch0: IQ Balance Mode: 0
Ch0: Gain Mode: False
Ch0: RF Gain (dB): 30
Ch0: IF Gain (dB): 30
Ch0: BB Gain (dB): 0
Ch0: Bandwidth (Hz): 4k

QT GUI Frequency Sink
Name: unfilter...al frequency
FFT Size: 1024
Center Frequency (Hz): 77.5k
Bandwidth (Hz): 2k

Multiply Const
Constant: 150

Frequency Xlating FIR Filter
Decimation: 1
Taps: variable_low_pass_fi...
Center Frequency: 0
Sample Rate: 192k

Multiply Const
Constant: 25

Simple Squelch
Threshold (dB): -60
Alpha: 1

filter out low noise
below given threshold

QT GUI Frequency Sink
Name: filtered...al frequency
FFT Size: 1024
Center Frequency (Hz): 77.5k
Bandwidth (Hz): 2k

QT GUI Time Sink
Name: received...sband signal
Number of Points: 576k
Sample Rate: 192k
Autoscale: No

Rational Resampler
Interpolation: 1
Decimation: 12
Taps:
Fractional BW: 0

Apply downsampling to
reduce computations on
total number of samples

QT GUI Range
ID: pll_bw
Default Value: 1
Start: 1
Stop: 15
Step: 500m

Variable
ID: pll_limit
Value: 1

PLL Carrier Tracking
Loop Bandwidth: 32.7249u
Min Phase/sample: -32.7249u
Max Phase/sample: 32.7249u

phase drift compensation

Multiply Const
Constant: 10.5

Amplify signal

Virtual Sink
Stream ID: 0

Low-pass Filter Taps
ID: variable_...filter_taps_0
Gain: 1
Sample Rate (Hz): 192k
Cutoff Freq (Hz): 1k
Transition Width (Hz): 150
Window: Hamming
Beta: 6.76

TCP Source
Address: 127.0.0.1
Port: 55.554k
Mode: Client

This block takes the DCF77
signal from a simulated
Channel at 77.5 kHz.
(both amplitude and phase
modulated)

Frequency Xlating FIR Filter
Decimation: 1
Taps: variable_low_pass_fi...
Center Frequency: 77.5k
Sample Rate: 192k

Demodulation from 77.5 kHz
down to the base band.

Virtual Source
Stream ID: 0

Complex to Mag^2

Compute real-valued signal

Rational Resampler
Interpolation: 12
Decimation: 1
Taps:
Fractional BW: 0

for correct timing-display
the previous down-sampled
/decimated signal must be
upsampled/interpolated again

Audio Sink
Sample Rate: 48 kHz

Moving Average
Length: 5
Scale: 200m
Max Iter: 100
Length of Vectors: 1

to smooth out
undesired spikes
from the OOK
decider for more
resilience against
interference

Threshold
Low: 2.5
High: 125
Initial State: 1

Decide whether
the received OOK
signal is low
or high

Rational Resampler
Interpolation: 12
Decimation: 1
Taps:
Fractional BW: 0

for correct timing-display
the previous down-sampled
/decimated signal must be
upsampled/interpolated again

Multiply Const
Constant: 200

QT GUI Time Sink
Number of Points: 384k
Sample Rate: 192k
Autoscale: No

view the noisy input signal
to set gain and thresholds properly

Complex to Arg

this exracts the phase
modulated part (PRPSK)
of the DCF77 signal

Multiply

mute signal if
carrier is off

Virtual Sink
Stream ID: 2

phase signal is
muted (to zero)
when carrier is off

Threshold
Low: -200m
High: 200m
Initial State: 0

detect +1 and -1
within phase signal

Add Const
Constant: -500m

down-shift signal
to zero as central
phase value

Multiply

mute signal if
carrier is off
(to avoid 0
being shifted
to -0.5)

Virtual Sink
Stream ID: 4

to detector

Virtual Source
Stream ID: 4

Multiply Const
Constant: 2

normalize chip
sequence to
[-1,+-1]

Virtual Source
Stream ID: 2

DCF77 Phase Detector
Sample_Rate: 16k
Chip_Size: 25

* append tags
  0, -1, +1
* ensure 200ms are
  muted (=0) during
  PSN off-time

QT GUI Time Sink
Name: Drift Co... Phase & PNS
Number of Points: 32k
Sample Rate: 192k
Autoscale: No

Code Sequence Correlator

applied on each
full chip sequence
at each second

ZMQ PUSH Message Sink
Address: tcp://1....0.1:55555
Timeout (msec): 500

provide signal to a ZMQ-server
to further decode the bits
to human-readible
date & time information

Message Debug
PDU Vectors: On

Message Debug
PDU Vectors: On

Note
Note:

The official codeword for symbol 0 from the code-polynomial x^9+x^5+1 is:
000001000110000100111001010101100001101111010011011100100010100001010110100
111111011001001001011011111100100110101001100110000000110001100101000110100
101111111010001011000111010110010110011110001111101101000001101011011011 0
110000010110101111101010101000000101001010111100101110111000000111001110100
100111101011101010001001000#01100111000010111101101100110100001110111100001
111111110000011110111110001011100110010000010010100111011010011110011111100
110110001010100100011100011011010101110001001100010001000000001

The opposite codeword for symbol 1 is its bit-wise inverted version

It has a number of:
* 256 ones
* 256 zeros

Except for the first two bits and the last 2 bits, it can be repoduced with the following python script.
(maybe because the initial state=[0,0,0,0,0,0,0,0,0] is not permitted)