Efficient tone recognition and digital modulation with a low-cost Signal Controllers

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DSP algorithms

- Where necessary?
  - ✓ In full digital solutions;
  - ✓ Mixed, analogue and digital solutions too.
- Main requirements
  - ✓ Stability;
  - ✓ Efficient executability – low computational requirements;
- Which algorithm can be considered efficient?
- Stable;
- Low resource;
- Fast running;
- Low parameter sensitivity.

Tone generation

- DSP or DSC with low computational capacity is not prepared to compute trigonometric functions.

Aspects:

- real-time
- low resource requirements

Efficient solution: using Look-up table

The table contains samples of a harmonic full period (could be a half period as well).

Tone generation

Example from the look-up table declaration:

```
Sine_table:
        .word
0x0,0x2e0,0x5c0,0x89e,0xb7c,0xe58,0x1131,0x1408,0x16dc,0x
19ad,0x1c79,0x1f41,0x2204,0x24c2,0x277a,0x2a2c

…
```

Tone generation

Reading from look-up table

From „N” element table,

Every „T” samplig time,

Read the „k” sample, so, the harmonic signal frekvency is:

$$f_{jel} = \frac{f_s \cdot k}{N}$$

An example: fs=8000Hz, N=256 (elements in the table)

k=32 step size generates the 1000Hz harmonic signal.

FSK modulator

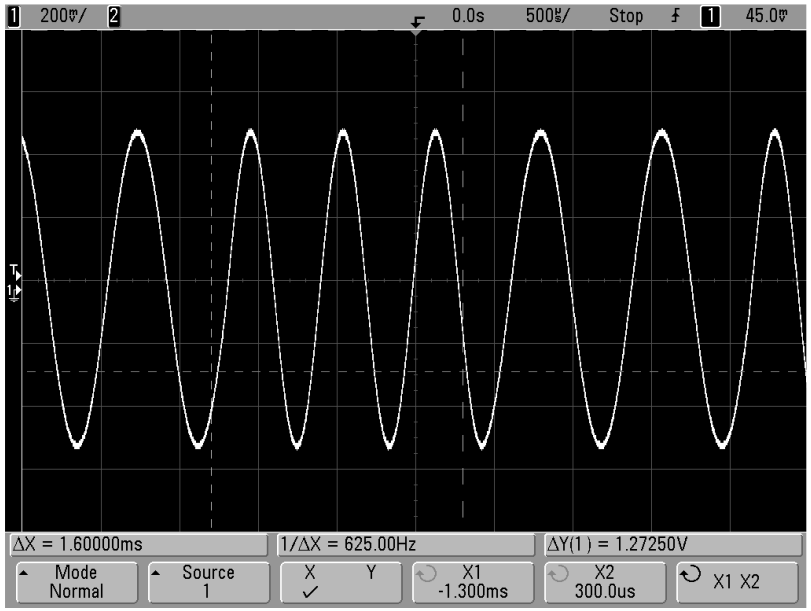
We use the signal generation bases described above!

Important aspect: spectral purity

- Unwanted spectral components can be removed by DSP filtration;
- Symbol change, symbol transition continuity.

FSK modulator

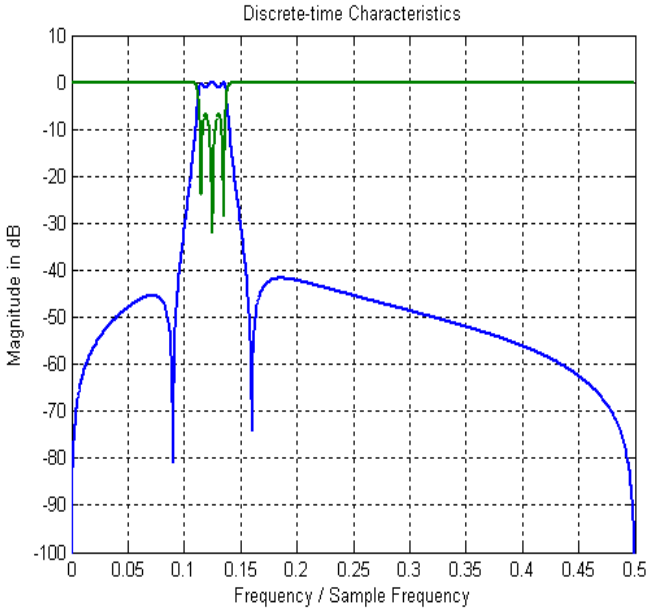
An output signal example:

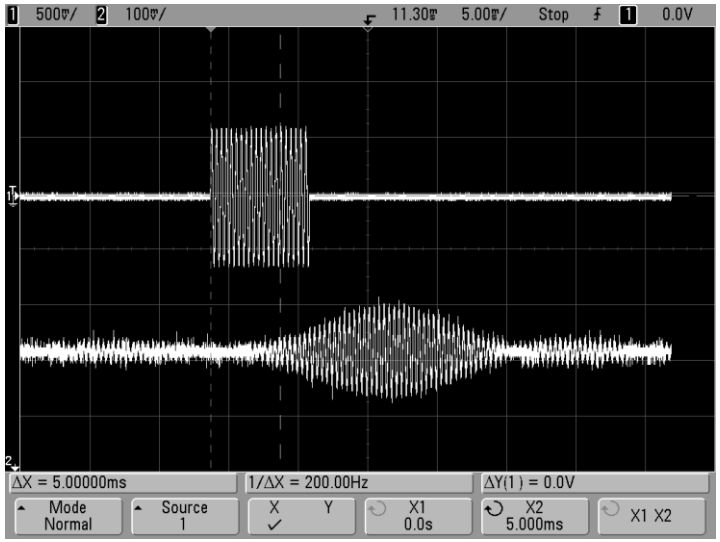


Tone recognition

Main steps of algorithm:

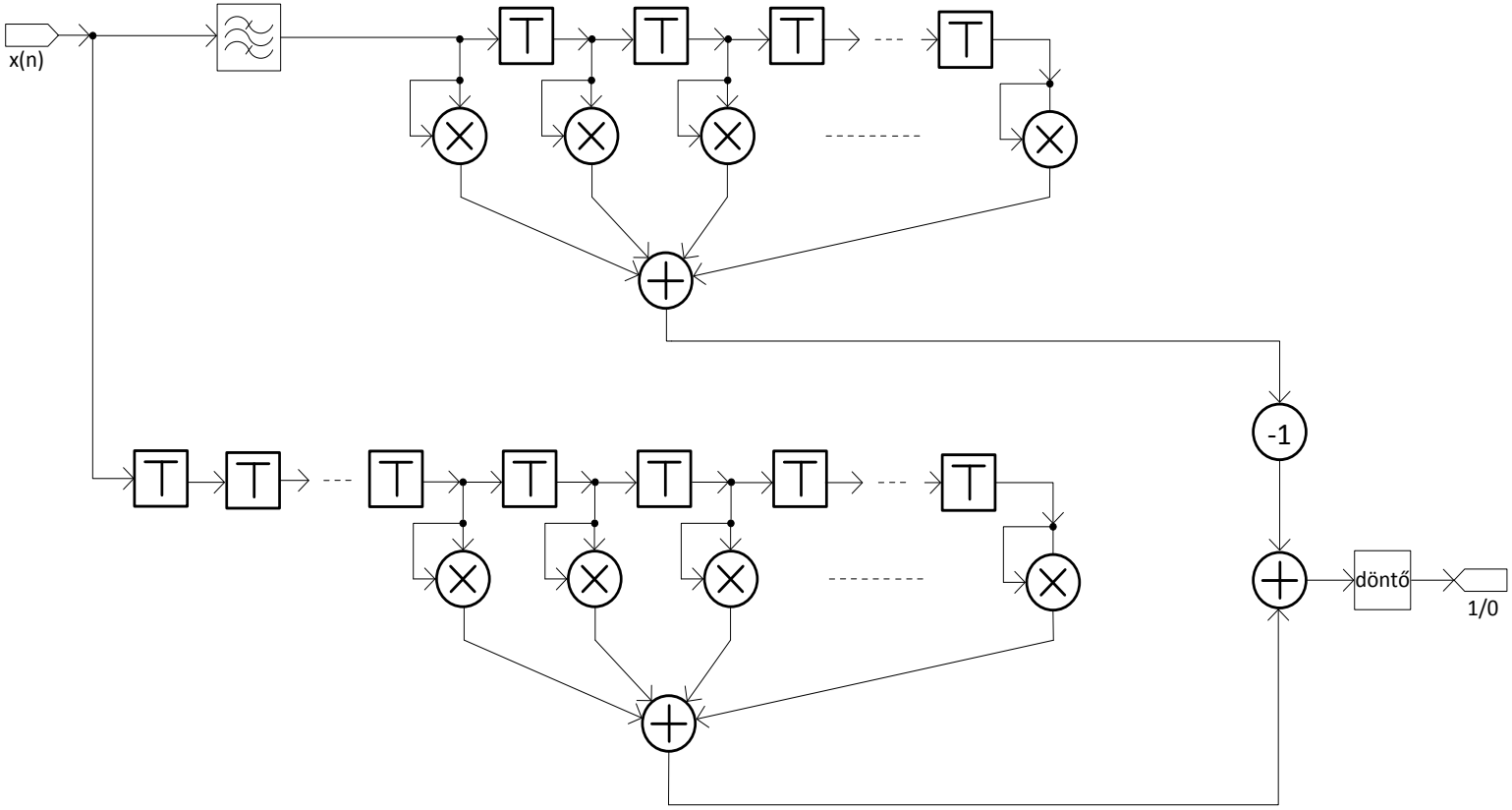
- Filtering;
- Signal energy calculation (in fixed sliding window);
- Energy comparison.





Tone recognition

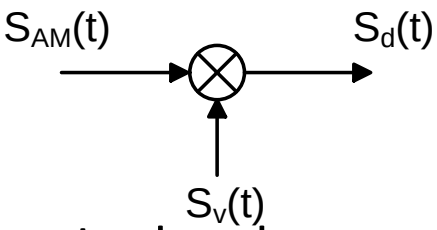
DSP flow diagram:



Digital demodulator example

Basis of demodulation:

The tone recognition algorithm would be obvious, but it is inoperable!



$$S_d(t) = S_{AM}(t) \cdot \cos(\omega_v t + \varphi) = a(t)\cos(\omega_v t) \cdot \cos(\omega_v t + \varphi) =$$

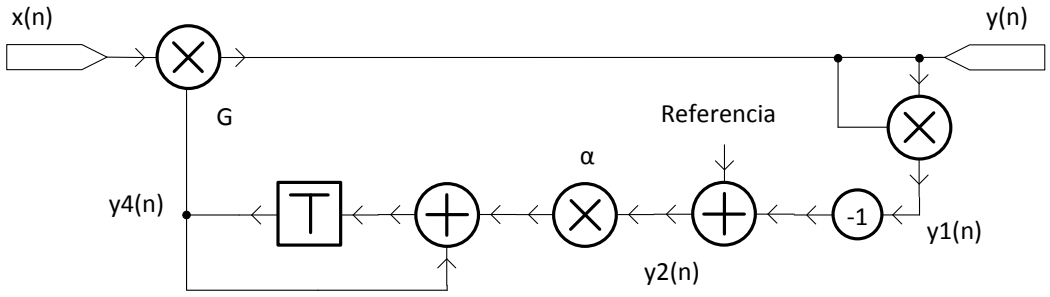
$$= \frac{a(t)}{2} \cdot \cos\varphi + \frac{a(t)}{2} \cdot \cos(2\omega_v t + \varphi)$$

In the above context, a(t) is modulating signal, and "ϕ" is the phase difference between the modulated and demodulated carrier signals.

Automatic Gain Control

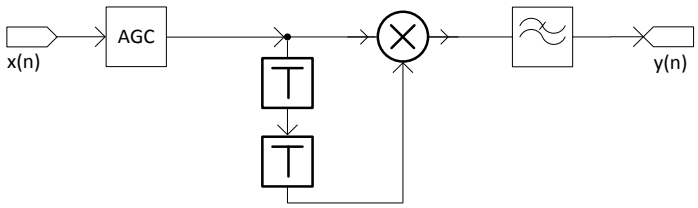
AGC scheme:

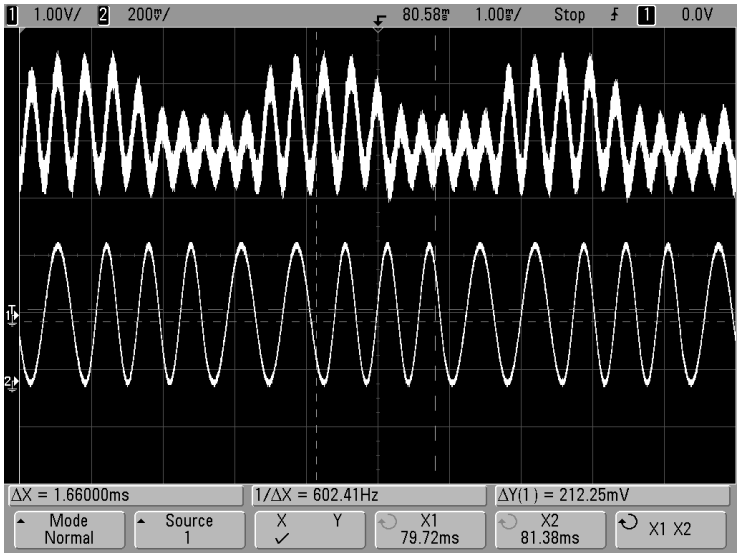
Eliminates the amplitude fluctuations of signal

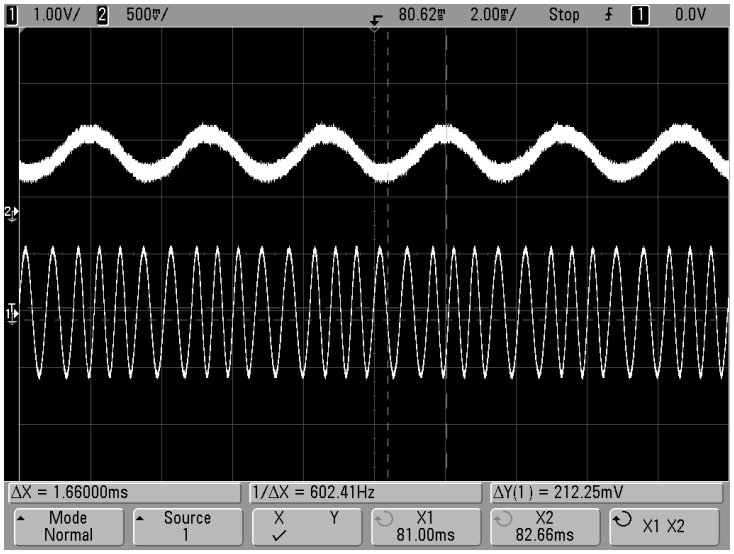


FSK demodulator

Basic scheme of FSK demodulator

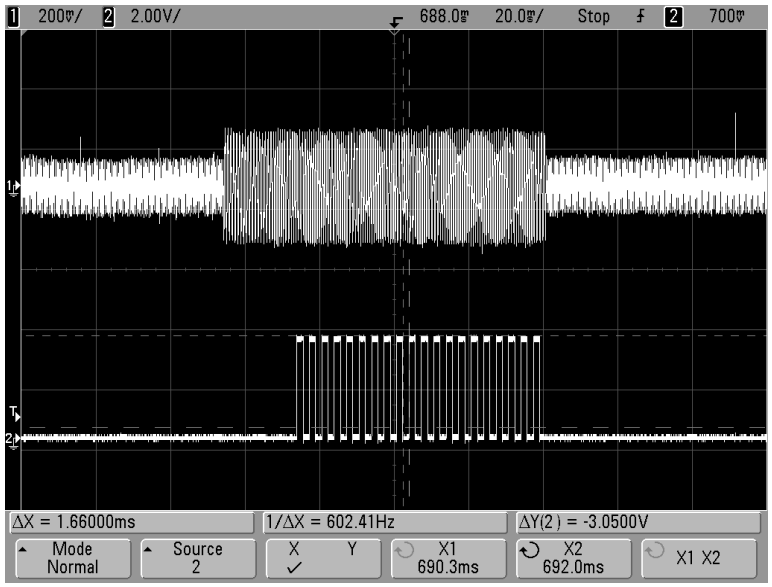


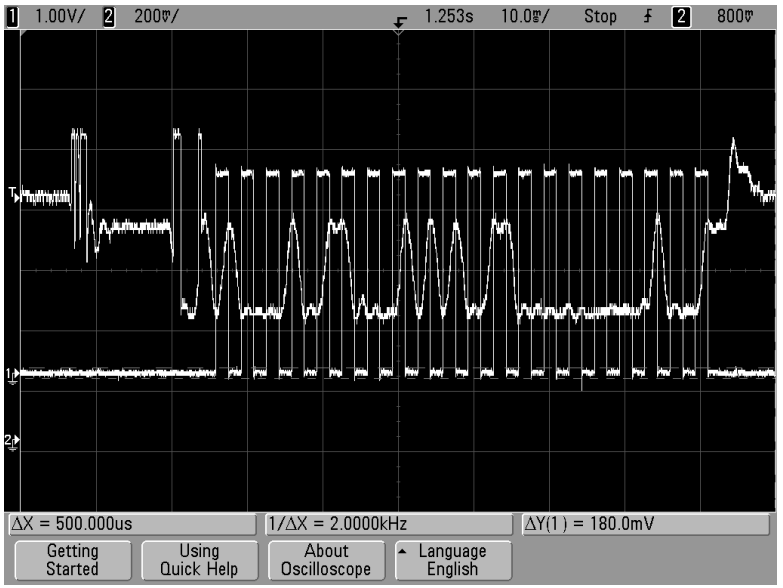




FSK message demodulation

Clock signal recovery – synchronisation and demodulation





Thank You for Your Attentions!

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