Using the SAW resonator interrogation unit

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March 16, 2011

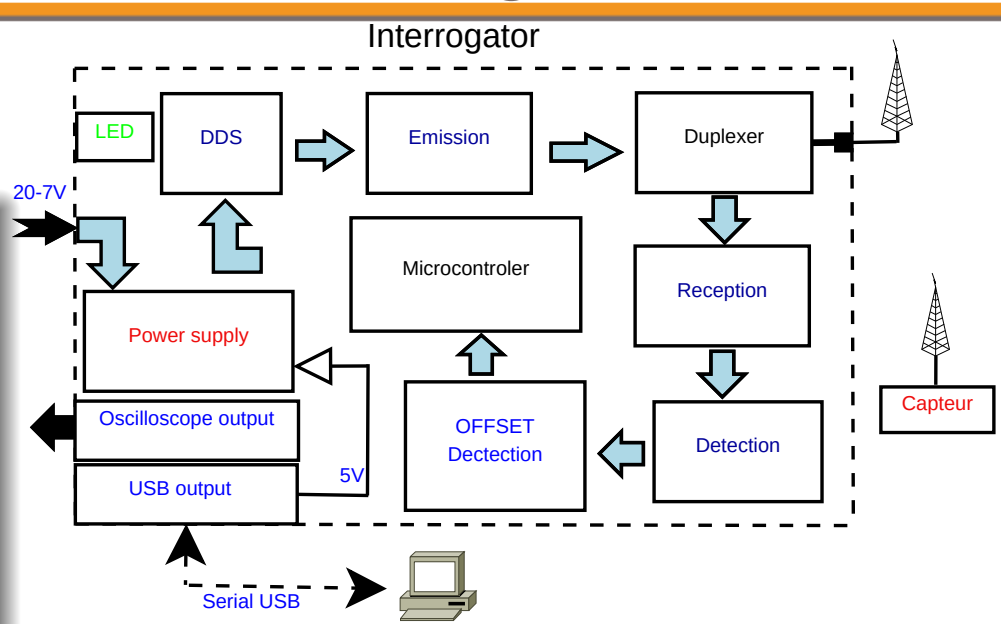
Outline

1. Interrogator information
   - Basic principles
   - Communication protocol
   - Analysis of received frame
2. Parameter adjustement
   - The offset
   - Debugging with oscilloscope
   - Disturbance of received signal
3. Editable parameter
   - Firmware upload
   - Communication parameter
4. Help needed ?

Recall interrogator functioning

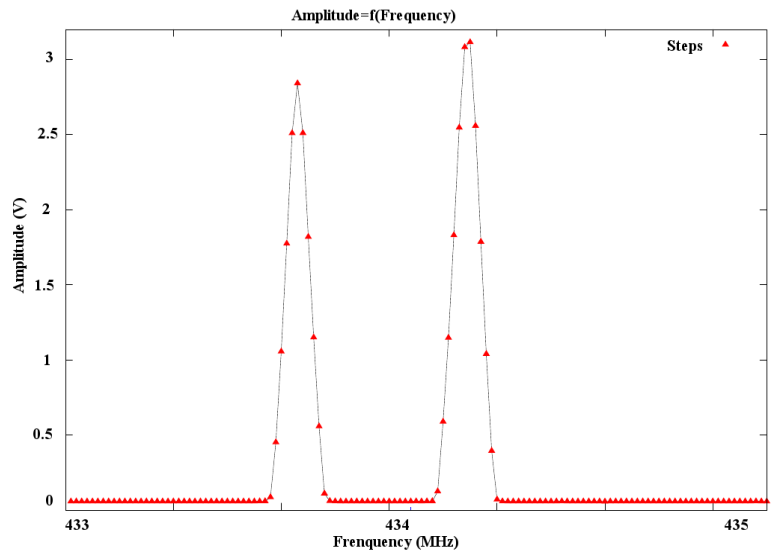
Device Synoptic

- RADAR strategy
- ISM band
  $F \in [433 - 435]$ MHz
- Resonance frequency identification
- Two modes:
  - ISM band mode
  - Loop control mode



Input/output

- USB/RS232
- Oscilloscope Output
- RF Output
- Power supply



Output sentence

Figure: Interrogation unit

Communication protocol

- RS232 compatible asynchronous protocol at 57600 baud (8N1)
- RS232-USB adapter if needed
- ASCII format

1. Number of resonance frequencies

Data repeated

1. The resonance frequency (Hz)
2. The received power $\in 0 \longrightarrow 4095$
3. The emitted power $\in 0 \longrightarrow 31$
4. The measurement variance

Other Data

1. Microprocessor temperature indication
2. Number of measurement information

Structure of sentence:

2	433623972	3069	18	130	434424580	3079	16	31	...	00020591	00116
1	1	2	3	4	1	2	3	4	...	1	2

With space-separated " " and finishes with CRLF "\r\n"

Valid/invalid measurement sentence

To have a good result:

- Received power $\in [1500 \rightarrow 3000]$ (no saturation)
- Variance < 10000
- Number of measurement information
  - If Nb of wanted measure measurement: Result=$100 + NB_{measure}$
  - Else Result=$NB_{measure}$

Valid frame

002 433814401 02316 023 00033 434421281 02439 022 00112 03258 116
002 433815217 03028 015 00025 434421585 02884 014 00014 03302 128

Result found but invalid frame

002 433814497 03058 019 99999 434421009 03044 017 99999 03295 014

Invalid frame

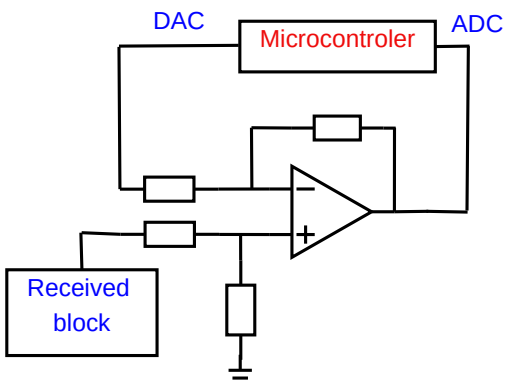
002 000000000 4095 021 99999 000000000 04095 020 99999 03263 000
002 000000000 03987 021 99999 434421937 03926 020 99999 03283 011
002 433819969 00706 031 99999 434427873 00911 031 99999 00301 013

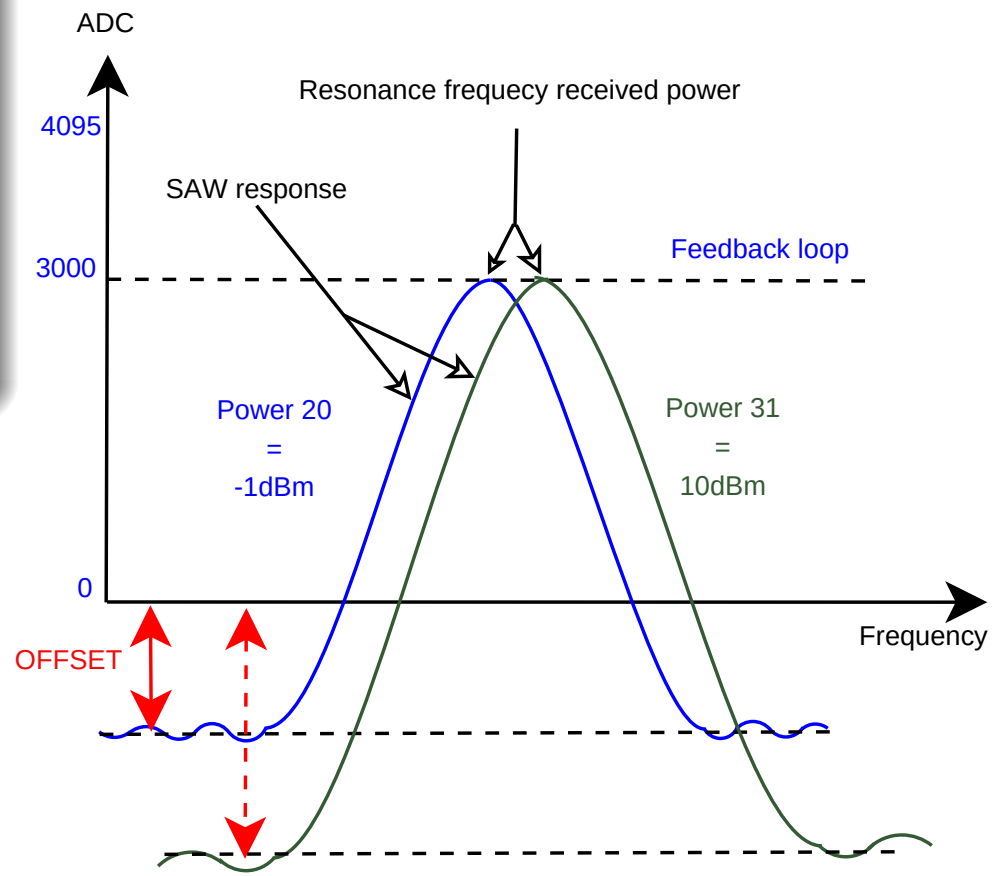
In this case, the sensor is out of range $\Rightarrow$ adjust offset

Offset optimization

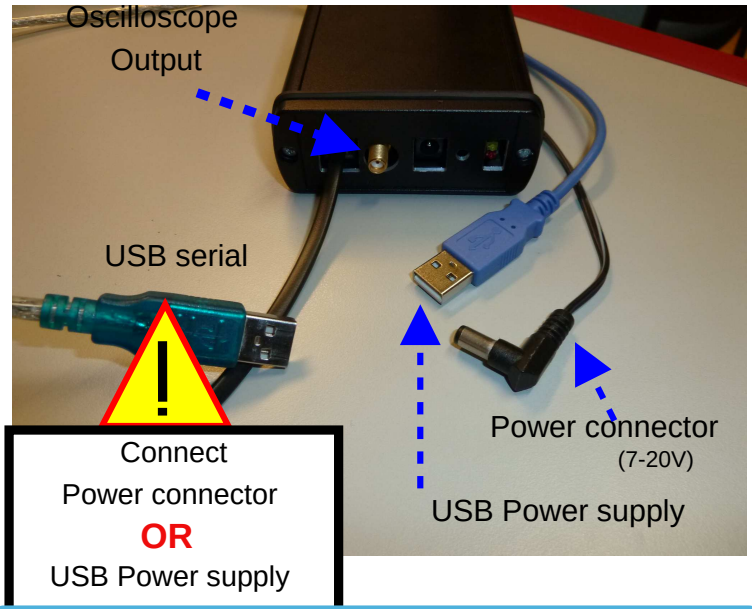
Received power

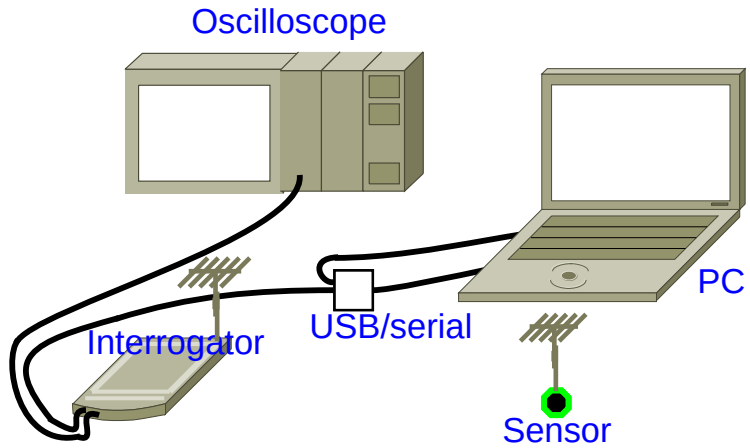
- Avoid saturation of ADC
- Using offset (subtraction circuit)
- The best configuration is with high emitted power (best SNR)
- Optimize the signal to noise ratio





Debug with oscilloscope

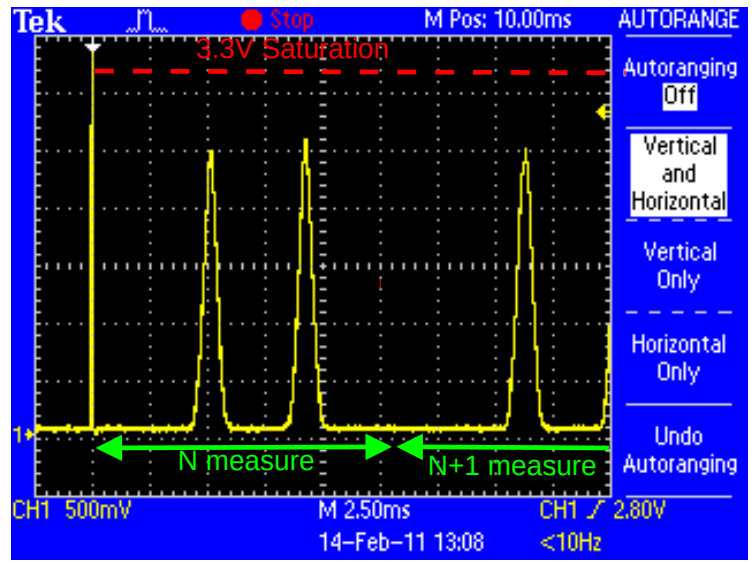




Oscilloscope output

This output is a snapslot of the digital amplitude recorded by the μcontroller, we can see:

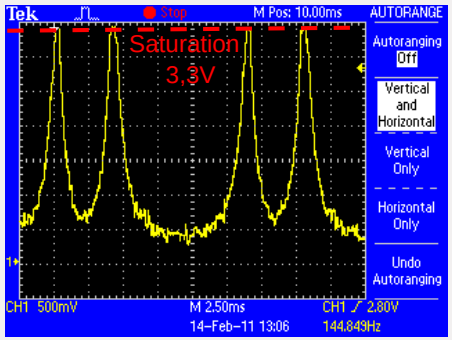
- the number and the lines: number and shape of resonance frequencies,
- the noise level,
- whether the offset is in the best configuration



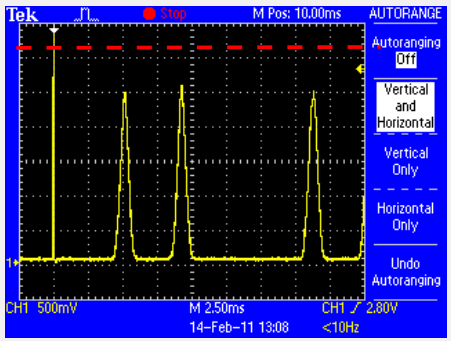
Offset configuration

Case 20dB attenuation

Offset: Ox800



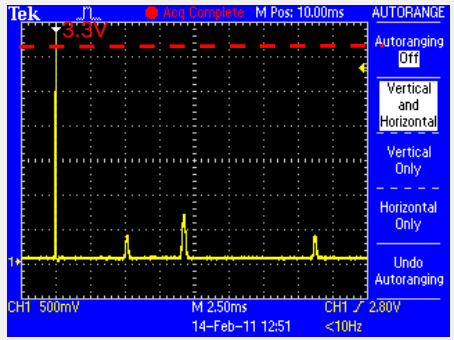
If emitted power is minimal → increase the offset
Offset: OxF00



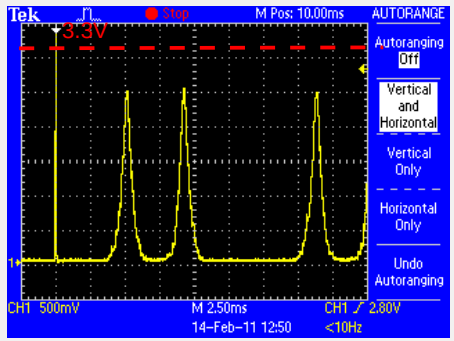
After increase the offset, the best signal dynamics is obtained while bringing the baseline to 0

Case 32dB attenuation

Offset: OxF00



If emitted power is maximal → reduce the offset
Offset: Ox800



This configuration will provide the **best signal to noise ratio**

Disruption signal

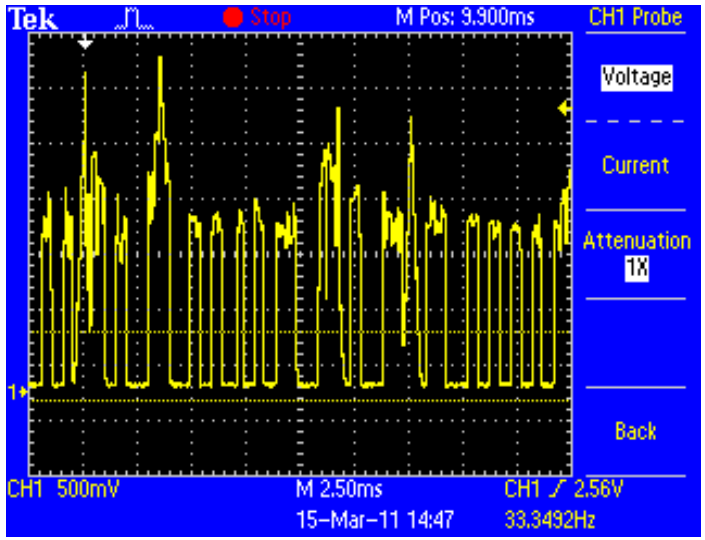
Perturbation by an other device

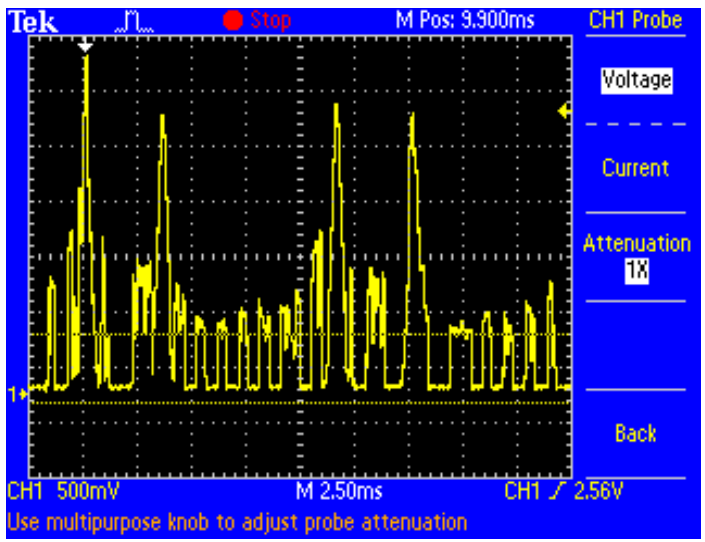
The result of this perturbation:

- high variance
- saturation

Use oscilloscope output to identify the problem: if the perturbation is strong, the measurement is impossible.

In the case of small perturbations, we can improve the measurement yield by increasing the offset





Example

1. car opening emitter
2. 433 MHz radiomodem
3. overhead crane

Antenna and upload program

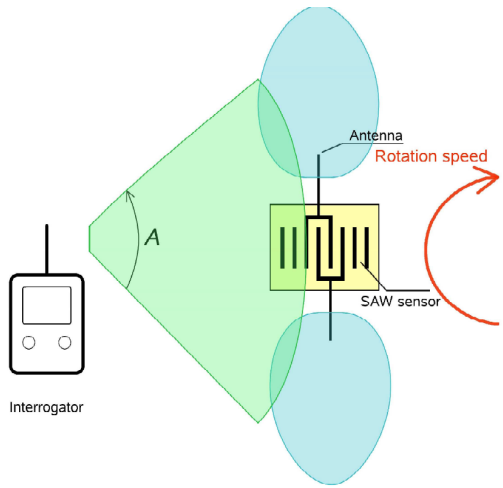
Antenna

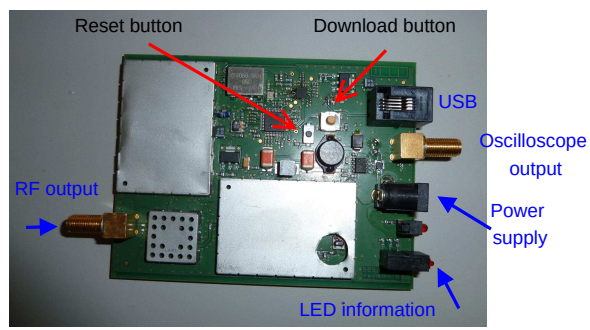
The intersection of those two diagrams along the circular trajectory sketched by the SAW sensor on the moving part results in a vision angle A of the SAW sensor.

- dedicated antenna operating close to 434 MHz (e.g. 17 cm monopole)
- avoid resonance of antenna in the 433-435 MHz range
- take care of polarization (e.g. crossed monopoles)

Upload program

1. Find the file `DDS.hex`
2. Use software `armwsd` `ftp://ftp.analog.com/pub/MicroConverter/ADuC7XXXV0.1/ADuC7XXX_eval_software_v0_1.exe` to upoad to the reader
3. Press and maintain the download button
4. Press and release the reset button

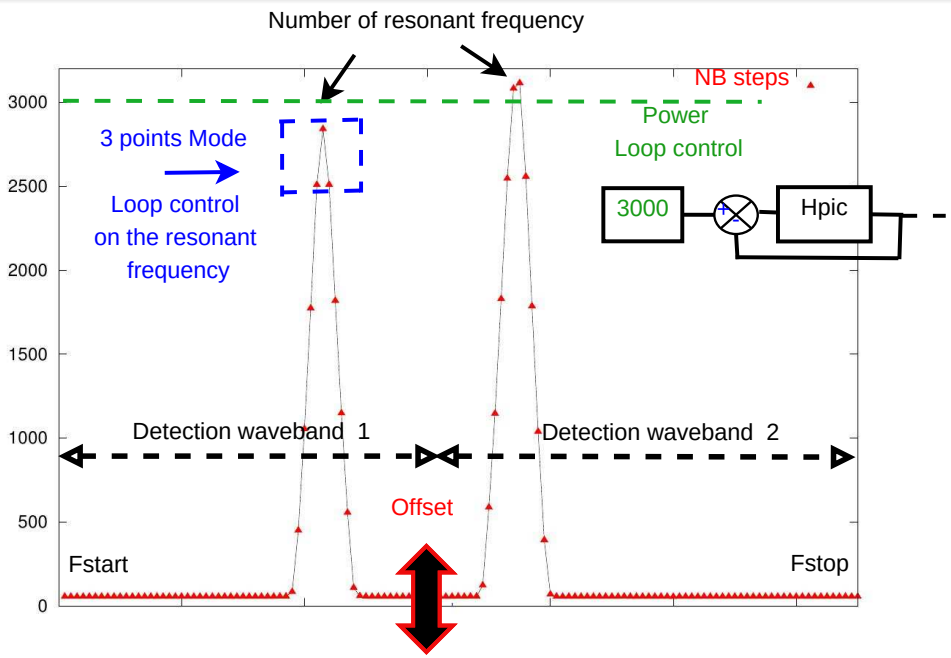


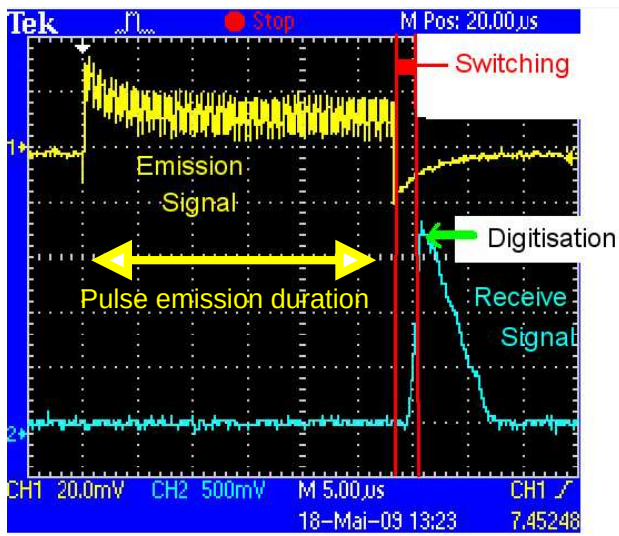


Editable parameter

Most important editable parameters (typing 3 times "+")

1. Number of resonance for each antenna (ATP)
2. Number of averages (default=16) (ATM)
3. Start frequency (ATF)
4. Stop frequency (ATG)
5. Number of points (ATN)
6. Pulse emission duration (ATE)
7. offset (default=FFF, between 000 and FFF) (ATO)
8. Maximum threshold between 000 and FFF (ATB)
9. Minimum threshold between 000 and FFF (ATC)
10. Toggle measurement strategy (fixed comb/3 point) (AT3)
11. Toggle automatic gain control (default=active) (ATZ)
12. For more information see `http://www.senseor.com/images/stories/download/Brochures/SENSeOR_AN_AT_Command_Set.pdf`





Help about interrogation unit

Current default configuration of the interrogation unit

- ISM band $F \in [433 : 435]$ MHz
- 2 resonance frequencies identification, 16 averages

Help documentation

- see SENSeOR application notes `http://www.senseor.com/documentation.html`
- hotline contact: christophe.droit@femto-st.fr or jmfriedt@femto-st.fr
- send raw sentences received from the interrogation unit and a picture of oscilloscope output.

Use fixed frequency comb mode (`+++AT3`): output example

```
002 000000000 00000 012 00000 000000000 00000 012 00000 12033 000
002 433776497 01969 016 00002 434388993 02241 015 00001 12036 116
002 433776433 02986 016 00001 434389089 03085 015 00000 12039 116
002 000000000 04095 000 00000 000000000 04095 000 00000 11908 000
002 000000000 04095 000 00000 000000000 04095 000 00000 11931 000
```