

Measurement signals

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Today's goal:

Use a sound card (or an acquisition device) to measure FRF and IR

Code in `python` the design, excitation, acquisition and post-processing of

- sine-wave signal
- multitone signal
- MLS (maximum-length sequence) signal

Codes developed during the lecture will be available on *umtice*.

Python module:

sounddevice <https://python-sounddevice.readthedocs.io/>

```
# import the module
import sounddevice as sd

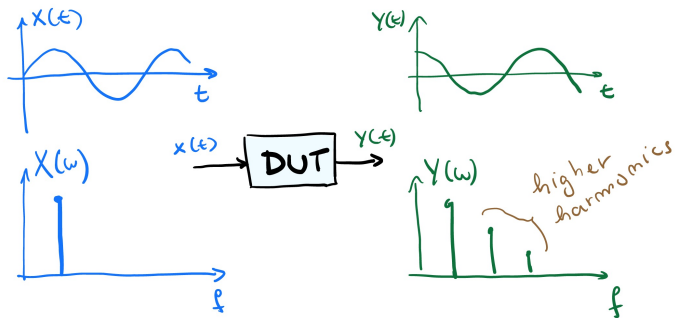
# show list of devices
print(sd.query_devices())

# set the device numbers (input, output)
sd.default.device = (5, 5)

# play and record simultaneously
y = sd.playrec(x, # x is the signal to play
               samplerate=48000,
               channels=2,
               input_mapping=(7, 8), # input channels 7 and 8
               blocking=True # wait until playback is finished
               )
```

1. Sine-wave measurement

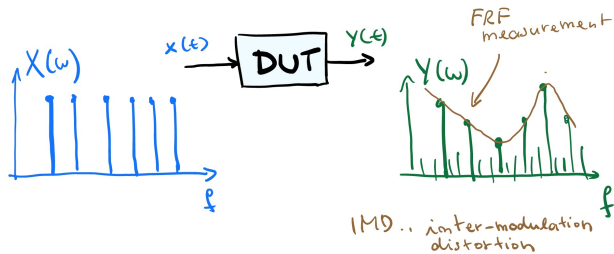
Sine-wave measurement



DUT... device under test

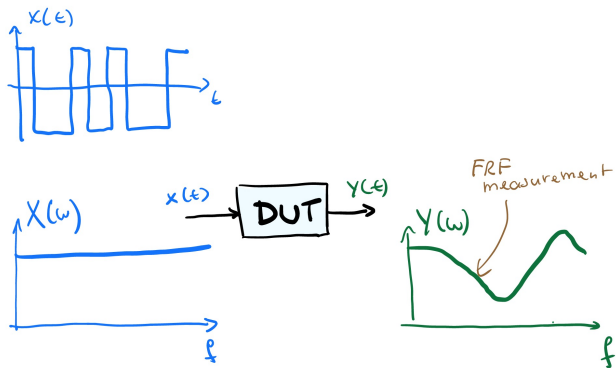
2. Multitone measurement

Multitone measurement

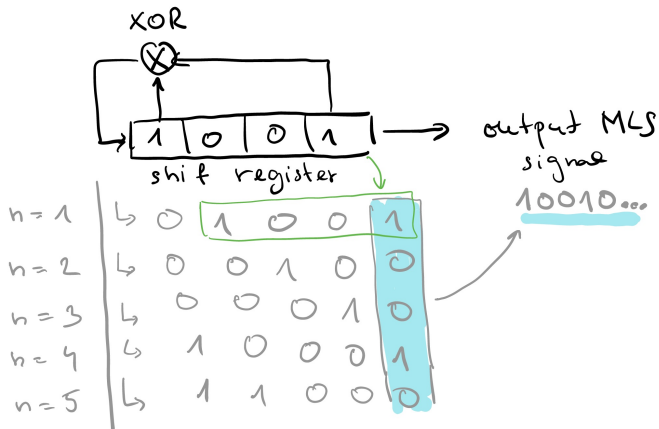


3. MLS (maximum length sequence) measurement

MLS measurement



MLS signal generation (4th order example)



MLS signal generation

List of shift register configurations:

- [1] Vanderkooy, John. "Aspects of MLS measuring systems." Journal of the Audio Engineering Society 42.4 (1994): 219-231.

Python function:

```
# import max_len_seq function
from scipy.signal import max_len_seq

# M ... order of the MLS signal
M = 17

# generate MLS signal
output_signal = max_len_seq(M)[0]
```

Conclusion

Sine-wave measurement

- energy focused on one frequency
- THD (total harmonic distortion)

Multitone measurement

- energy spread over the selected frequencies
- FRF measurement (incomplete)
- IMD (intermodulation distortion)

MLS measurement

- energy spread over all the frequencies
- great for IR (impulse response) measurement