

# Innovative multifrequency, multimode, modulated (MMM) sonic & ultrasonic vibrations for food-processing applications

## MMM - Wideband Sonic and Ultrasonic Technology

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# ***Presentation overview***

- Part #1
- MMM Fundamental Concepts
- (M. Prokic)
- Part #2
- Breakthroughs in signal processing techniques with their potential applications to “MMM technology
- (J.-P. Sandoz)
- Part #3
- Different novel and effective applications with an emphasis on food industry applications
- (M. Prokic)

# ***Part #1: MMM Fundamental Concepts***

Traditional high intensity and fixed-frequency  
ultrasound

## Typical applications:

- Cleaning
- Plastic welding
- Mixing and homogenization
- .....

# **Part #1:**      *MMM Fundamental Concepts; -Continued*

***Fixed-frequency*** traditional ultrasonic systems are showing certain ***limitations*** related to new industrial ultrasound-related applications, such as:

- Sonochemistry
- Extractions
- Waste water treatment
- Cutting, Sieving, Atomizing
- .....

# ***Part #1: MMM Fundamental Concepts; -Continued***

## **Basic requirements of ultrasonic applications based on fixed frequency:**

- well-tuned ultrasonic sources and tools
- a large number of design and matching parameters must be respected

These basic requirements significantly limit large scale and practical applications of the findings realized in laboratory-scale testing.

# **Part #1:** *MMM Fundamental Concepts; -Continued*

- **Real world:**

Most industrial ultrasound systems work inherently in ***non-stationary*** and evolving-load conditions. Industrial loads usually have number of resonant frequencies.

- **Consequences:**

***Continuous adaptation*** to the load is required in order to maximize the efficiency. *This is often difficult to achieve with the fixed-frequency units.*

# **Part #1:      *MMM* Fundamental Concepts; -Continued**

*To meet this challenge,  
novel “MMM” signal  
processing techniques  
have been developed.*

## ***MMM:***

- ***Multi-Frequency***
- ***Multi-Mode***
- ***Modulated Technology***

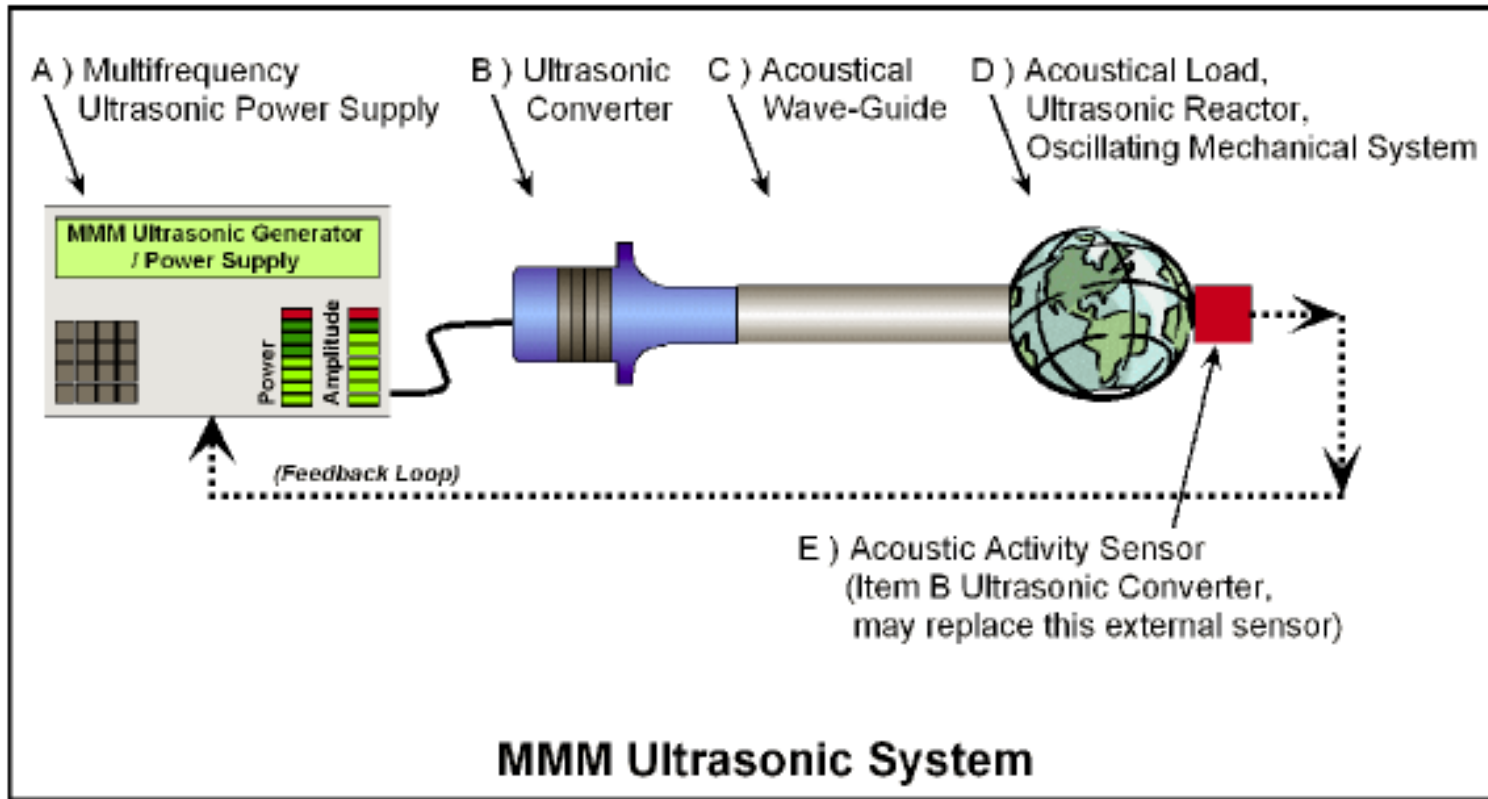
# ***Part #1: MMM Fundamental Concepts; -Continued***

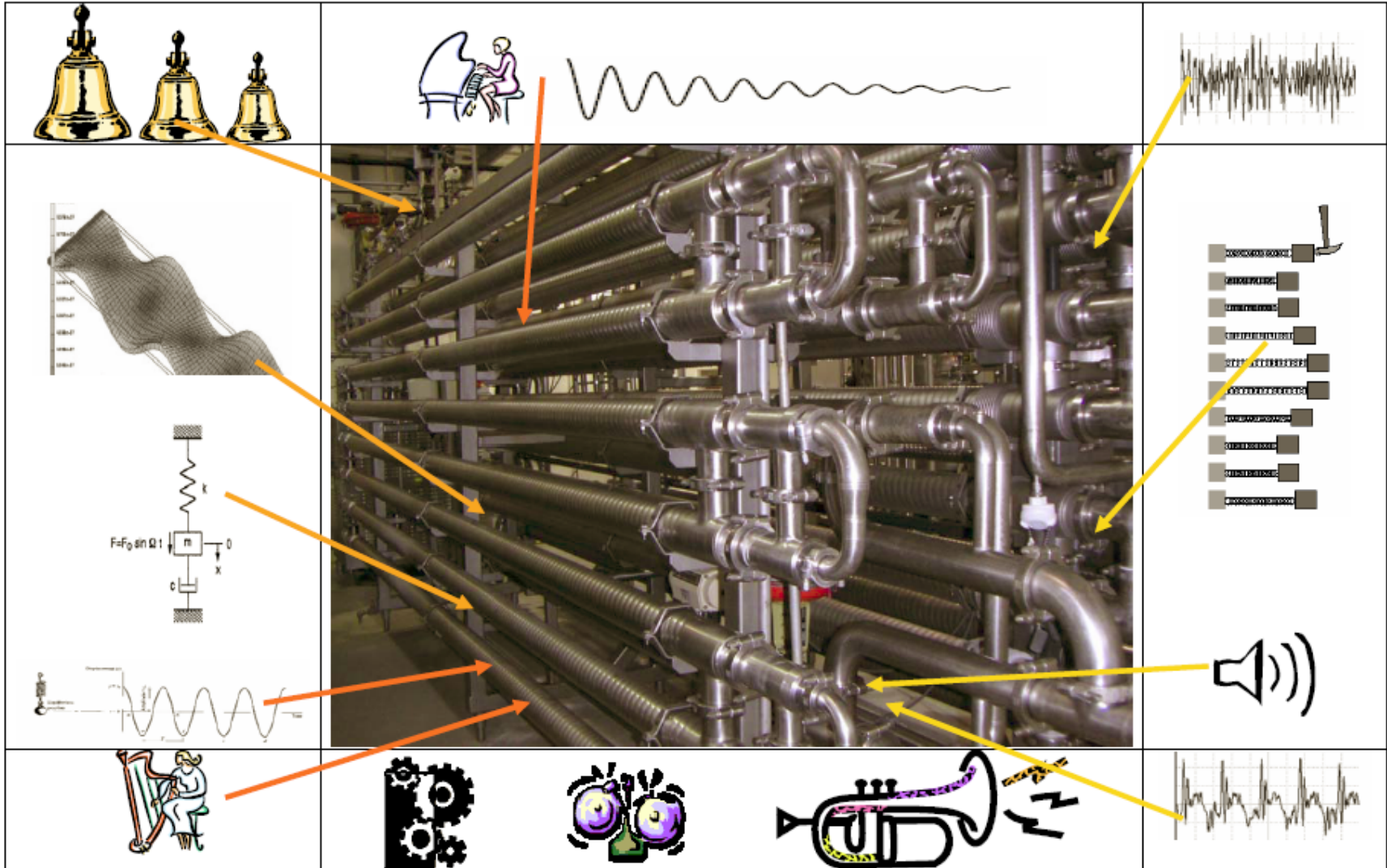
## ***Benefits:***

- Success in applying “wideband-frequency high-power ultrasonic agitation”
- Adaptable to almost any existing process equipment, regardless of its mass, load size and particular operating conditions
- Implementable without involving significant design modifications of existing industrial processing systems

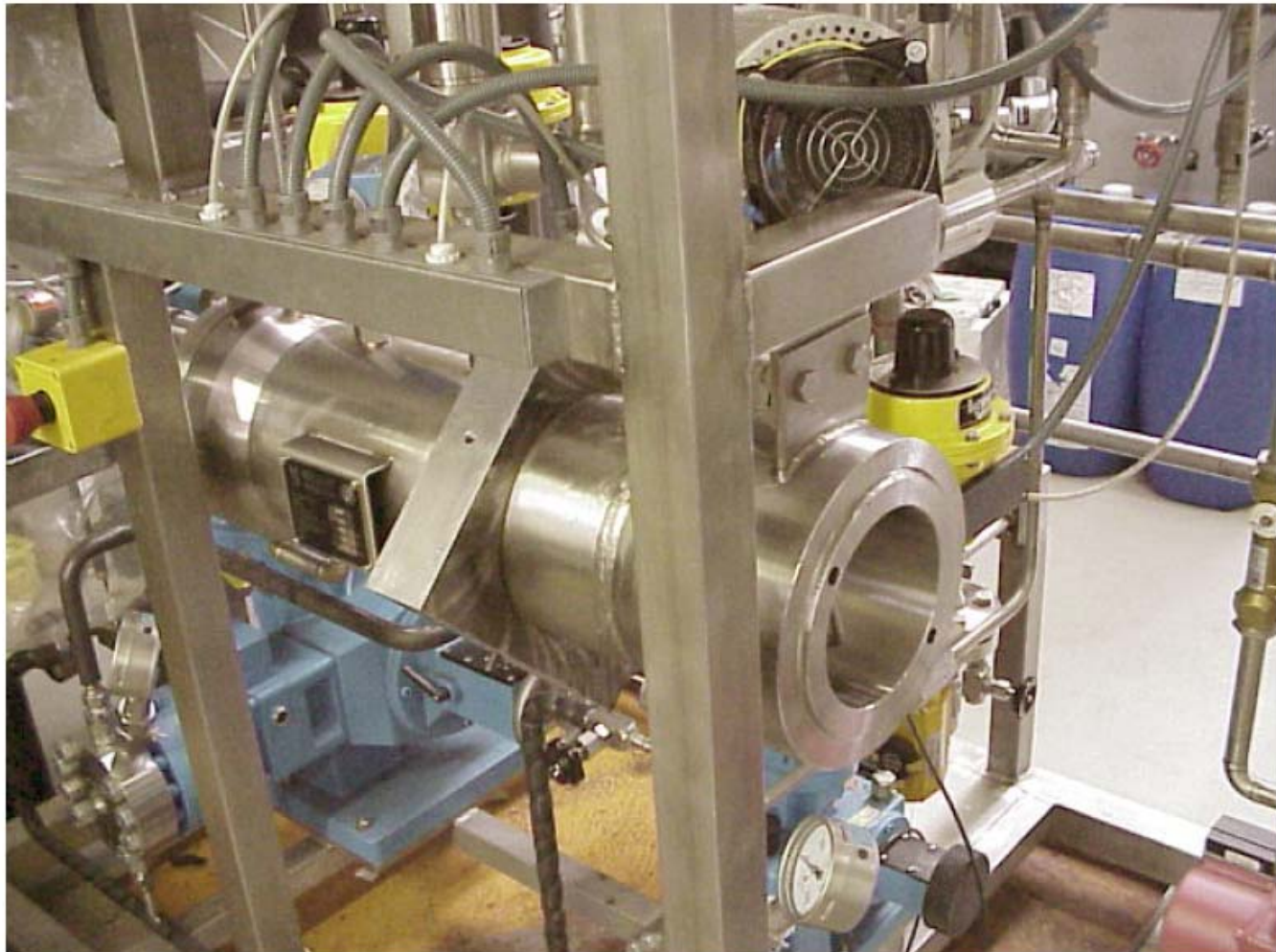


# Part #1: *Block diagram of MMM ultrasonic System*



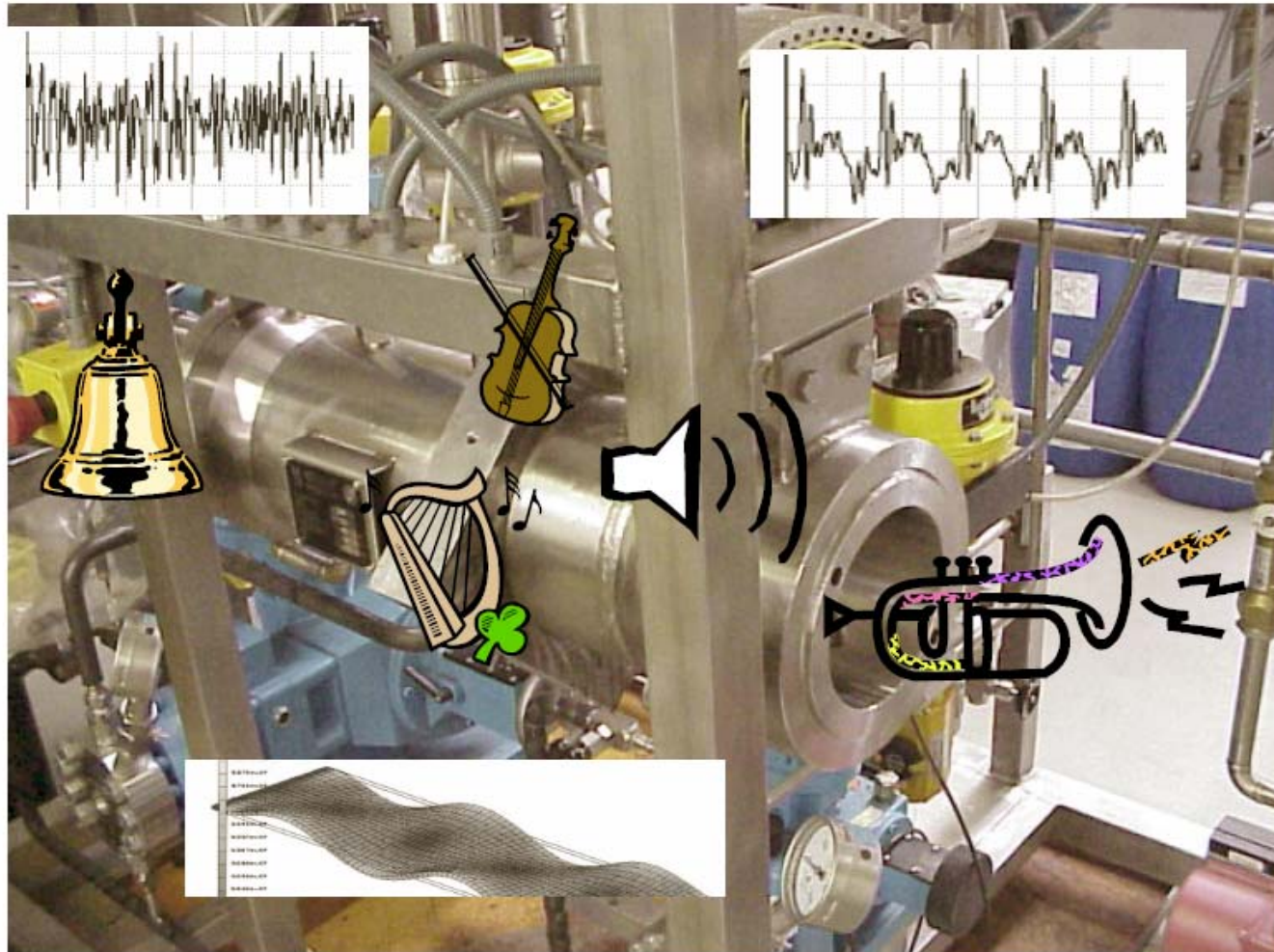


**ILLUSTRATION OF DIFFERENT OSCILLATING MODES OF A COMPLEX MECHANICAL SYSTEM**

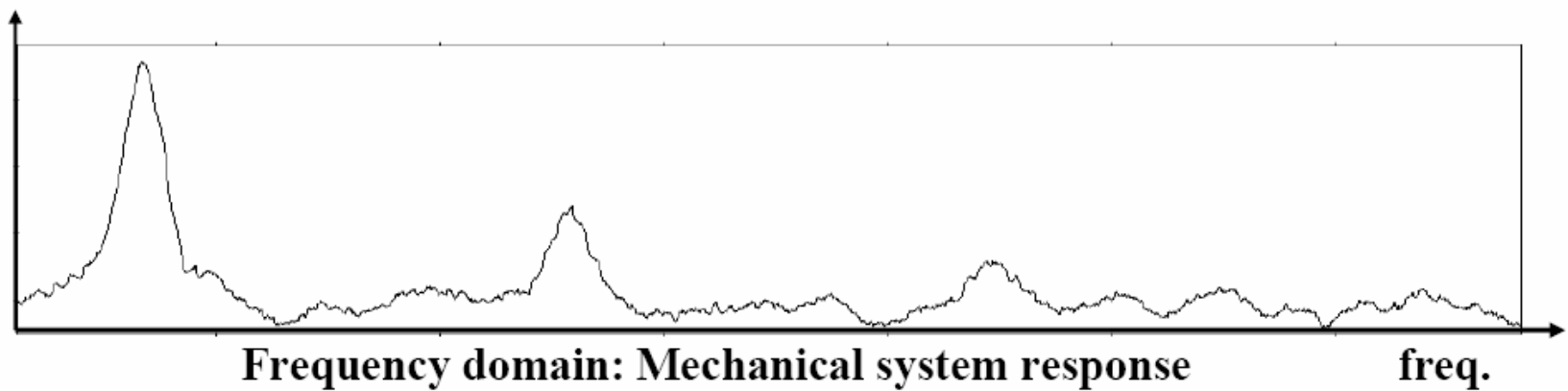
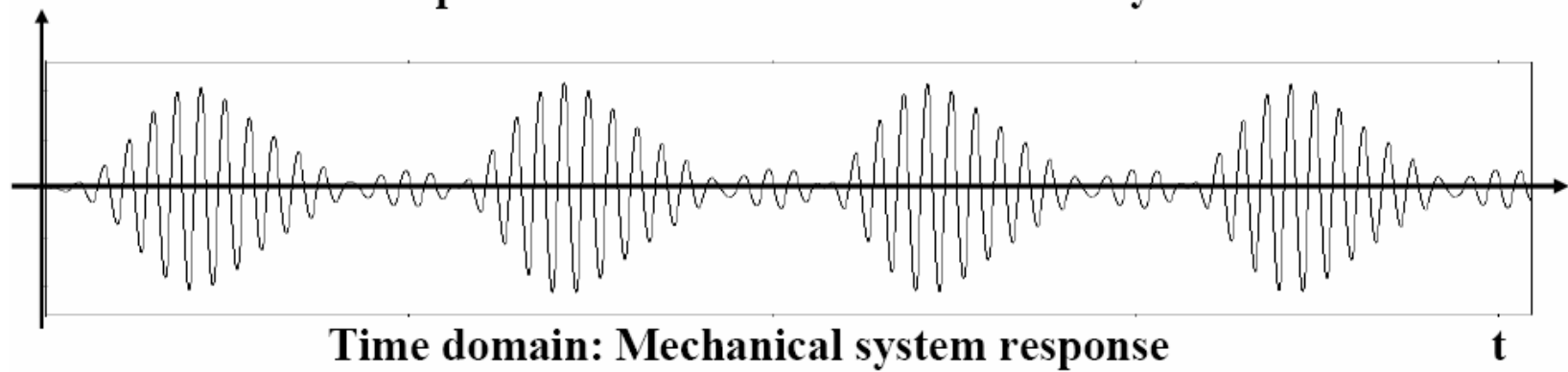
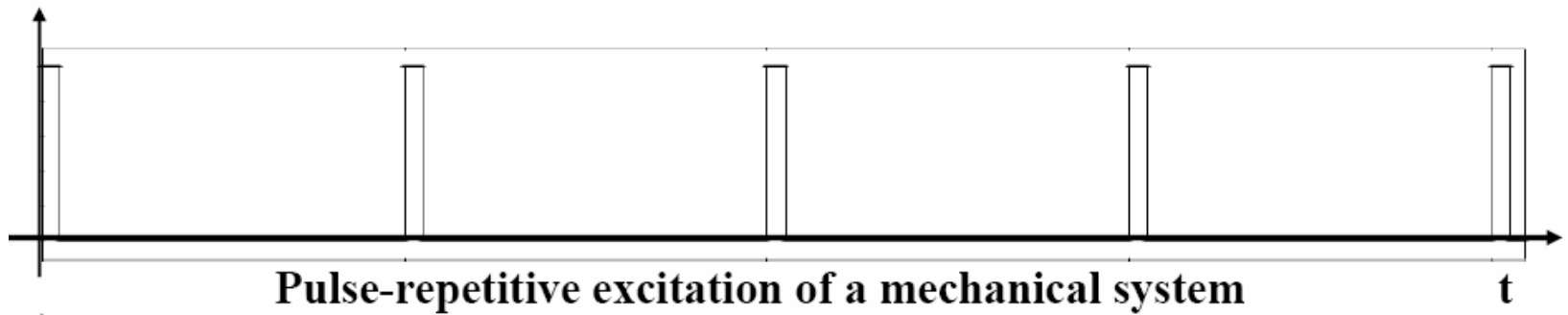


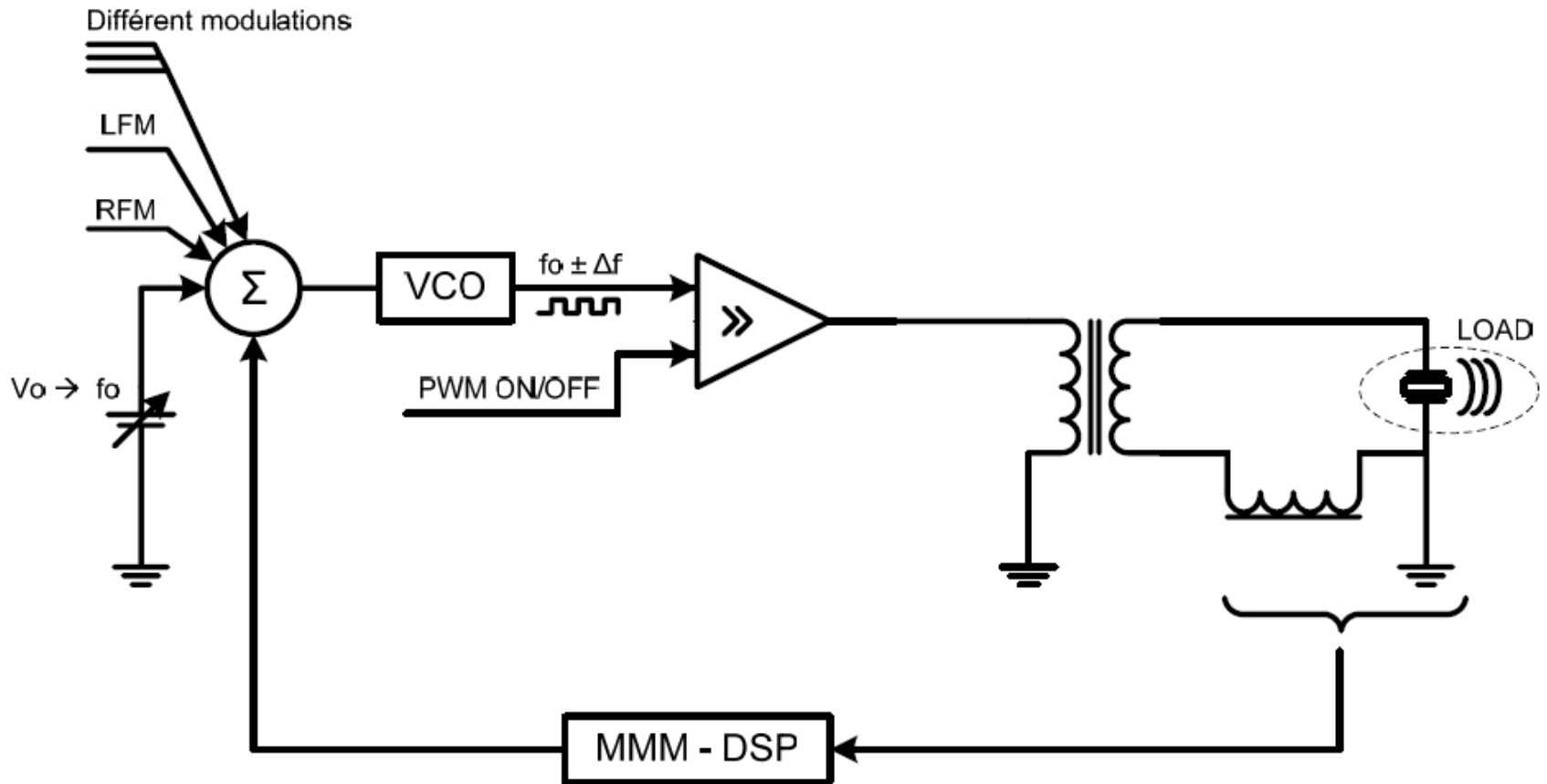
**Complex mechanical system before MMM agitation**





**Complex mechanical system during MMM agitation**





## MMM Power Supply Block Diagram

With dynamic, load-dependent frequency modulation

**Part #2:**

**J. -P. SANDOZ**

***Breakthroughs in signal  
processing techniques with their  
potential applications to  
“MMM technology”***

## ***Part #3: Different novel and effective applications with an emphasis on food industry applications***

- **MMM Ultrasonic Cutting:** Cheese, chocolate, cakes, fruits and vegetables, meat... (obviously, there are many other industrial products).
- **MMM Ultrasonic Sieving:** Different food industry powders, Sticky powders... (obviously, there are many other industrial powders).
- **Powders agitation, vibrating transport lines, removing powders build-ups.**
- **Ultrasonically stimulated extrusion:** Pasta products, cakes... (of course plastics, metals).
- **Atomizing:** Liquid food products, chocolate, paraffin, water, micro encapsulation, coating... (of course many other industrial products).



## ***Part #3: MMM applications; -continued***

- **MMM Cleaning: Food products, fruits, vegetables, machinery parts, meat... (of course, other domains of industry and life).**
- **MMM Extractions from plants and minerals (sonoreactors).**
- **Pipelines fluid-flow acceleration, internal tubes cleaning, removing build-ups...**
- **Mixing and homogenizations.**
- **Seeds treatment before planting.**
- **Ultrasonically stimulated water sterilization.**
- **Heat exchangers**