Moderne Messempfängertechnologien

und

deren Anwendung und Vorteile in der Laborpraxis

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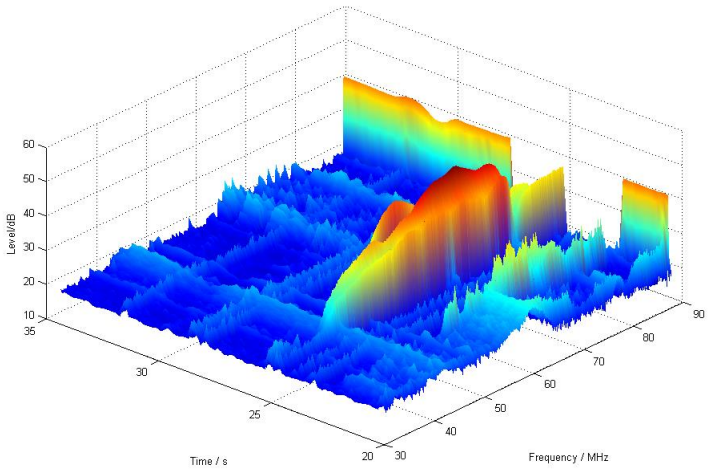
GAUSS INSTRUMENTS

Outline

- Motivation
- Concept & Architecture of the "FFT based Measuring Instrument"
- Comparison/Parallelization
- Test Procedures without Pre-scans
- Measurement Examples
- Demo

Motivation

various emissions changing over time…



Motivation

- More complex electronics => time-consuming emission measurements
- Non-stationary emission
- Intermittent disturbances
- Transients or single events, e.g. starter engine of a car
- Increasing number of operation modes of DUTs
- Ensure capturing the worst case (not only ON and OFF state)
- Changing load and emissions of the DUT
- Fast moving DUTs -> open area, very short possible observation time

Motivation

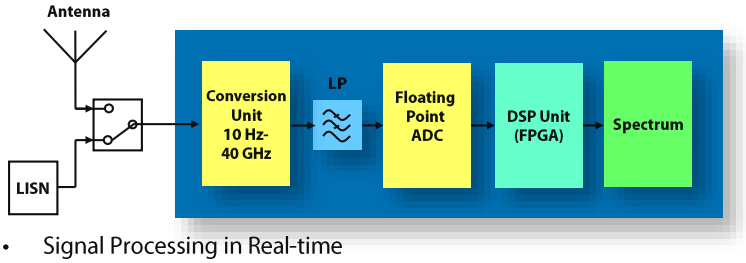
- Additional measurement uncertainty by "pre-scan/final scan" procedure between the two measurements carried out at different times
- Updates in communication and EMC standards, e.g. CISPR 16-1-1, new detector types, wider frequency test ranges
- Longer observation times (=> means higher accuracy)
- Overcome very long sweep times for narrowband resolution bandwidths
- Easy investigation of intermittent disturbances
- Recording of highly fluctuating emissions
- Ensure capturing everything

➡ **New instrument making all drawbacks history ?!**

"FFT-based Measuring Instrument"

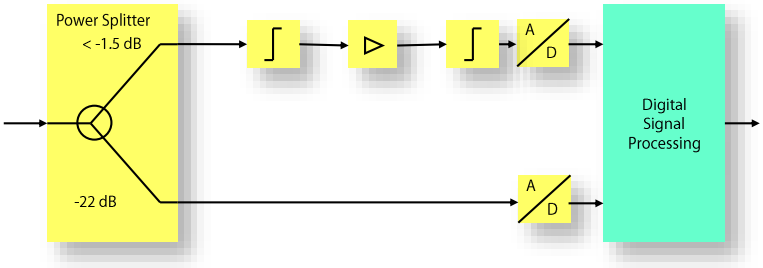
- Digitized signal contains all information
- Digitization of measurement equipment
- Speeding up by huge computational power and massively parallel implementation
- **Full conformance** with CISPR, ANSI, MIL, DO, FCC, and other standards
- Parallel measurement at several thousands of frequencies
- Huge DSP resources allow to implement a set of digital Spectrum Analyzers
- Increased overall measurement quality

Concept & Architecture – Basic Block Diagram



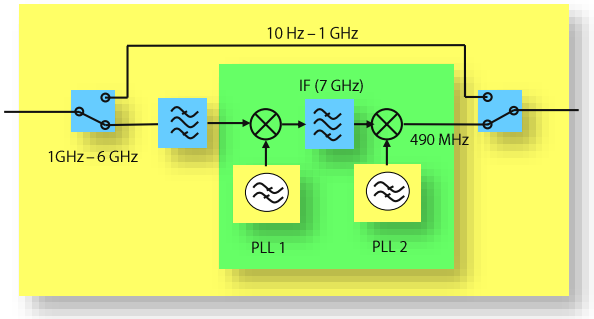
- Signal Processing in Real-time
- Real-time Analysis Bandwidth of up to 645 MHz (Quasi-Peak)
- CISPR Bandwidth 200Hz, 9 kHz, 120 kHz, 1 MHz
- MIL/DO Bandwidth 10Hz,100 Hz, 1kHz, 10 kHz, 100 kHz, 1 MHz
- Peak, Average, CISPR-AVG, RMS, CRMS, and Quasi-Peak Detector, APD
- Weighted Spectrogram, i.e. Real-time EMI Receiver
- Time-domain Analysis Bandwidth 1 GHz

High Resolution 2.6 GS/s 12 Bit ADCs (2013)



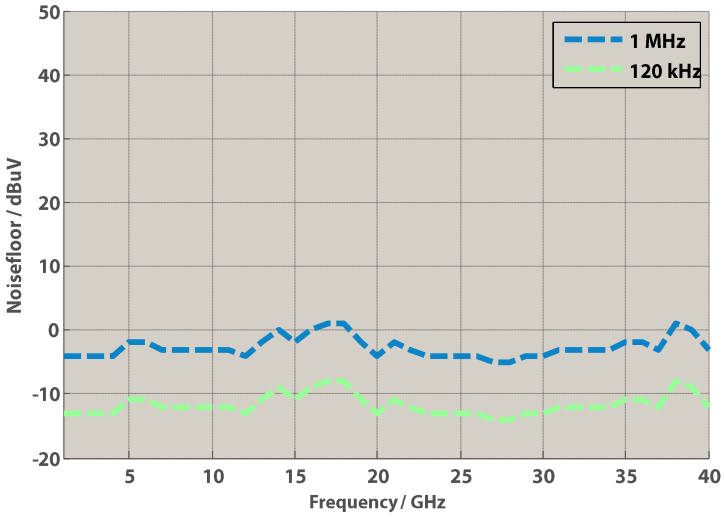
- 2.6 GS/s ADCs
- Limiter and amplifier
- 100 dB dynamic (without preselection, without attenuator)

Broadband Conversion Unit 1 GHz to 6 GHz



- Frequency band upconversion to IF above 7 GHz
- Broadband IF Filter with several 100 MHz
- Conversion to ADCs baseband
- Improved suppression of image frequencies and other mixing products (Rejection of image frequencys and unrequested frequency conversion product by optimum selection of PLL and filter)

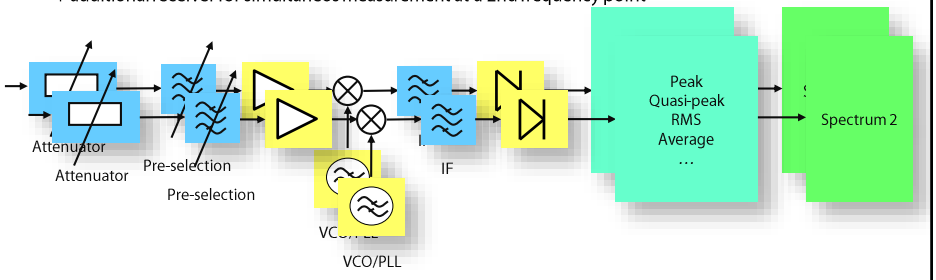
Typical Noise Floor 1 GHz – 40 GHz

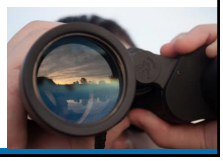


Conventional analog EMI Receiver

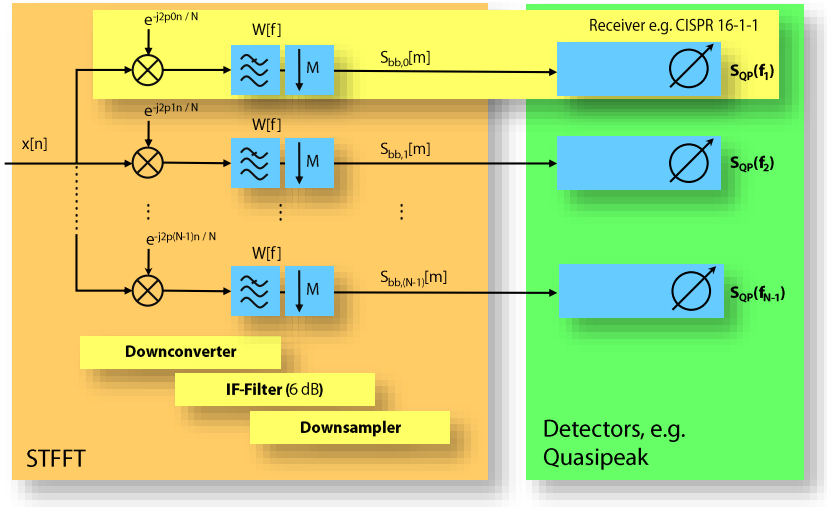
EMI receiver based on heterodyne receiver technique:

+ additional receiver for simultaneos measurement at a 2nd frequency point

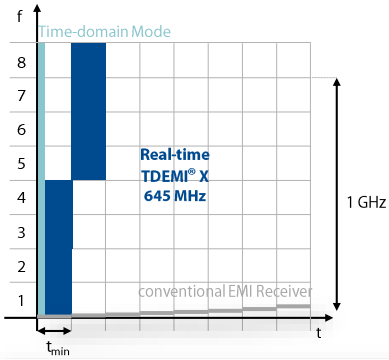




Short-term Fast Fourier Transform => Bank of several thousands parallel Receivers



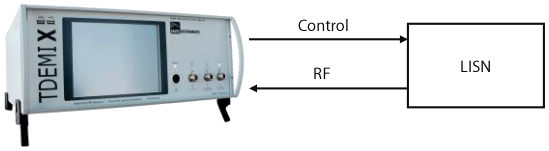
Short-time Fast Fourier Transform => Ultra high-speed Measurements



Traditional EMI Receiver / Spectrum Analyzer	Real-time TDEMI®
• Sequential Measurement • Preselection (Option)	• dwell time unlimited • Ultra-fast measurement • 2-7 frequency Bands (DC - 1 GHz) • Several ADCs • GS/s ADCs

IF bandwidth	Frequency points	Dwell time	Conv. EMI receiver	Real-time TDEMI® X
9 kHz	4096	200 ms	20 min	**< 1 s**
120 kHz	1024	100 ms	33 min	**2 s**
120 kHz	1024	3 s (QP)	9 h	**< 9 s**
1kHz DO160	4096	10ms	10 min	**< 1 s**

Test Setup: Conducted Emission Measurements – 4 Phases



Automatic Measurement of L1 ,L2 ,L3 and N

Extraction of Maxima

Report Generator

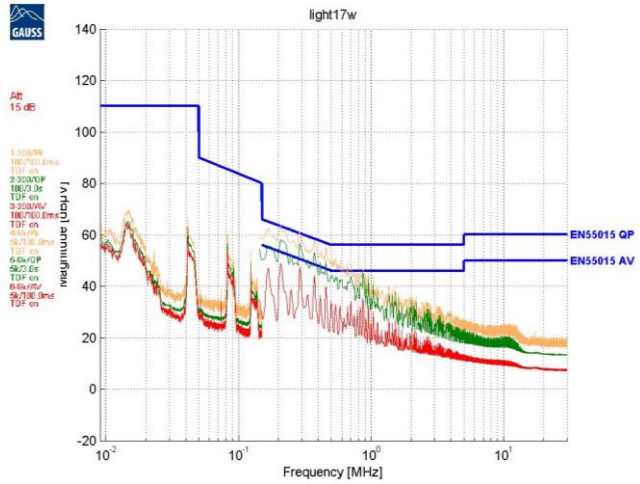
Approx. 2 sec. per Phase (Band A,B)
Approx. 1sec. per Phase (Band B)

Extraction of Maxima

➡ ~ 8 seconds for full measurement Band A+B

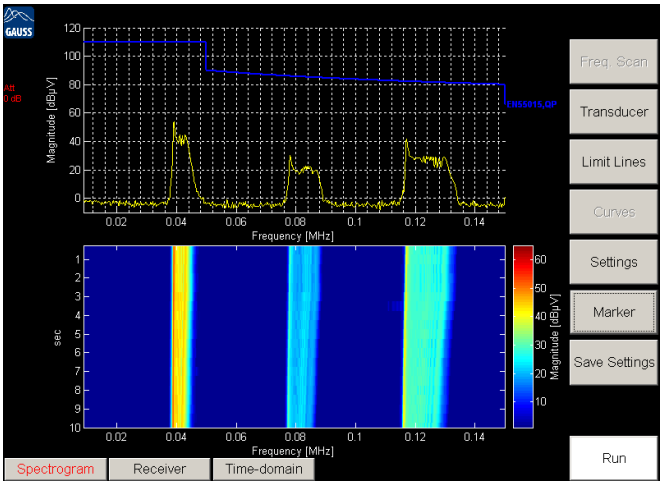
Application Field Electrical Lighting

Conducted (final QP!) Measurement up to 30 MHz



Application Field Electrical Lighting

Measurement of an energy saving lamp with drifting emissions



Test Setup: Measurement of Disturbance Power

RF

Positioner

continuously moving clamp along the slideway/ cabletrack:

Moving continuously instead of a high number of positions & pre- and final measurements

Continuous Measurement of 300MHz Spectrogram

↓

MaxHold of Quasi-Peak and Average

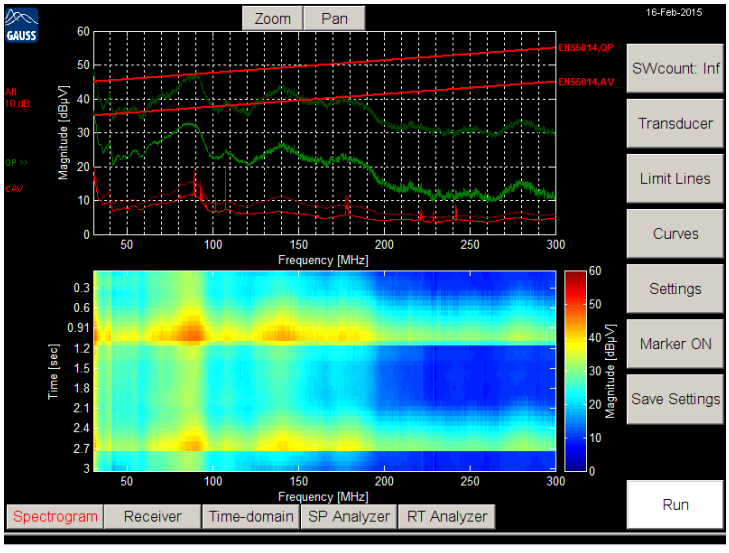
↓

Report

Fully Automated Report Generation & Full Characterization!

➡ **~ 10 seconds for FULL QP characterization**

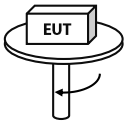
Disturbance Power Measurement 30 MHz – 300 MHz in Real-time



Test Setup: Radiated Emissions up to 1 GHz

Antenna

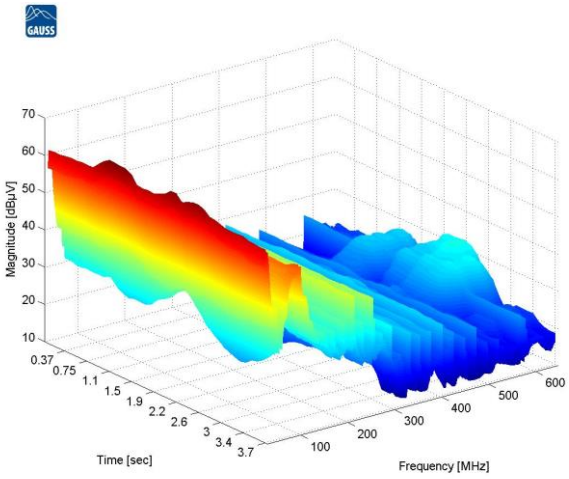
f < 1GHz



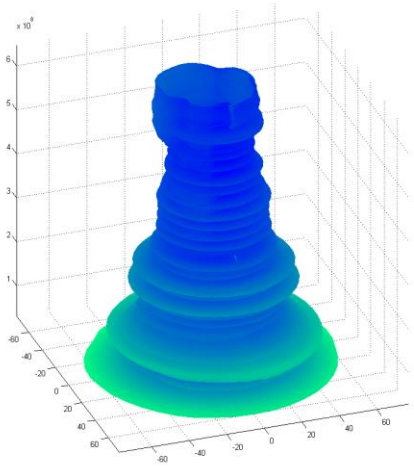
- Quasi-Peak Spectrogram 30 MHz – 645 MHz
- 1. full rotation of Turntable
- Quasi-Peak Spectrogram 645 MHz – 1000 MHz
- 2. full rotation of Turntable
- Final Report

FULL QUASI-PEAK characterization in real-time

Continuous 3D Spectrogram of Measurement of E-Field Strength



Measurement of E-Field Strength of a Motor



Test Setup: Radiated Emissions above 1 GHz

Antenna

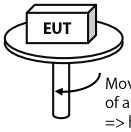
Multi-GHz Real-time Scanning

1. full rotation of Turntable @ hor. Pol

2. full rotation of Turntable @ vert. Pol.

Final Report

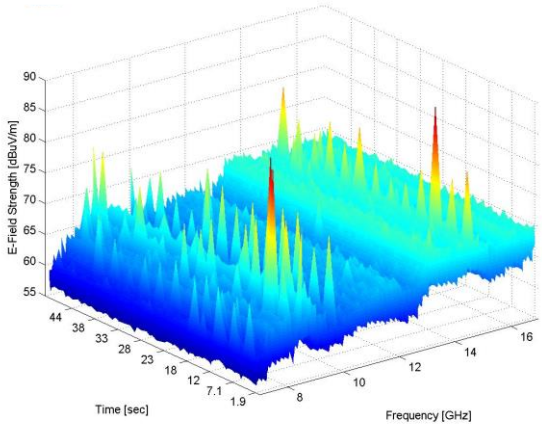
f > 1GHz



Moving continuously instead of a high number of positions => higher pos. resolution

Full characterization & Final Maximization in real-time

Radiated Emission Measurement of a Magnetron's Harmonics



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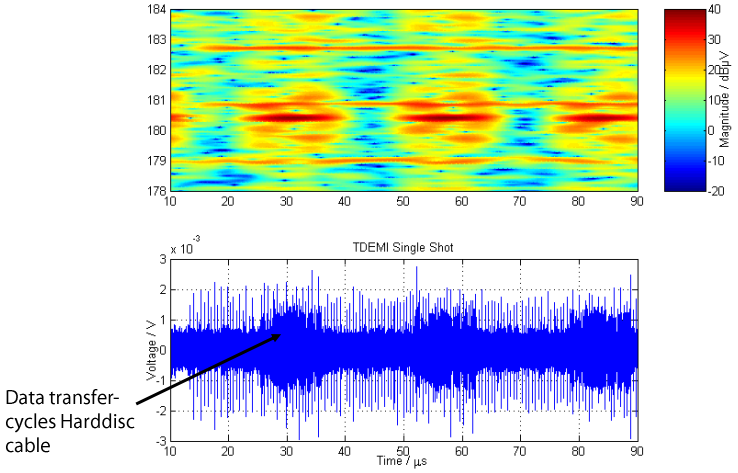
- **Measurement Examples**
- Demo

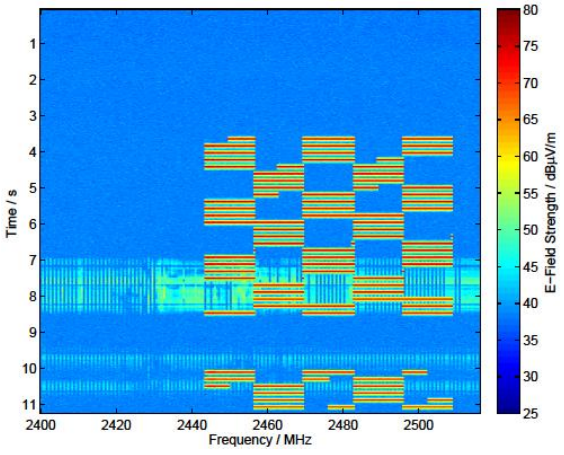
Application Field IT Equipment: Radiated Emission of a Notebook

-Analyzing the Emissions in Spectrogram Mode (real-time)



Data transfer-cycles Harddisc cable

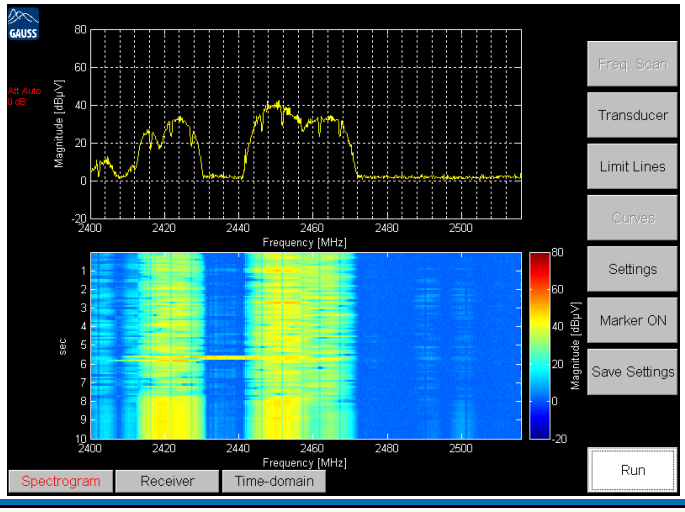
Radiated Emissions: Bluetooth communication between two smartphones



- Bluetooth communication between two modern mobile phones were measured
- Real-time spectrogram shows the bluetooth inquiry process, as the phones scan the bluetooth bands around 2480 MHz

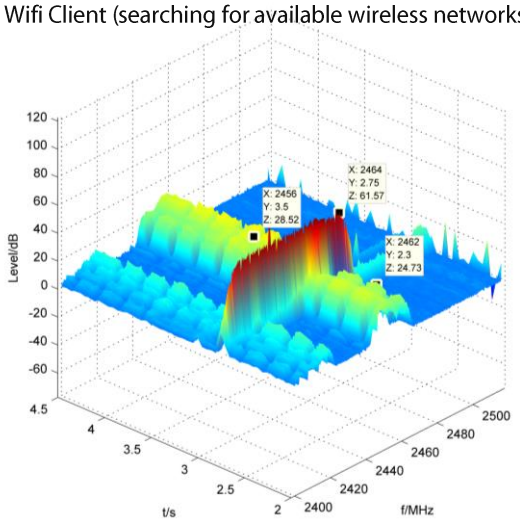
Application Field IT Equipment: Radiated Emission of a Wifi Adapter

-Radiated emission of a Wifi Adapter above 2.4 GHz

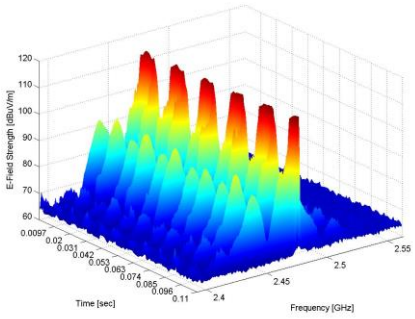


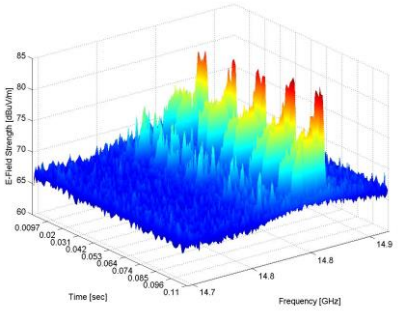
Application Field IT Equipment: Radiated Emission of a Wifi Adapter

-Emissions of a Wifi Client (searching for available wireless networks at 3s)
-3D Plot



Radiated Emission of a Microwave oven





Fundamental frequency (ISM Band) Harmonics

Real-time spectrogram allows the characterization of the magnetron ‘s frequency e.g. the 50Hz Pulse Modulation

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- **Live demo**