TEMPS to digitize waveforms
Demonstration of measurement equipment, data capture and analysis software

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Objectives

Capturing real-world waveforms

- Software to perform on-site captures
- Measure and visualize data in real-time
- Providing live information to the field measurement team
- Store and tag waveforms
- Apply advanced triggering techniques

Waveform analysis

- Develop advanced triggering
- Time-frequency transforms and wavelets
- Statistical characterization of Waveform
- Identify on-the-flight critic waveforms
Content

- TEMPS description
- Advantages of using TEMPS
- Advanced Triggering
- DEMO
- Examples: data capture, visualization and analysis
TEMPS: Time Domain EMI Measurements and Processing System – TEMPS*

- Full Time Domain measurement systems
- EMI measurements
- PicoScope 5444B/D
- Standard laptop
  - Executable .exe
  - Windows, Matlab runtime
- Triggering and storing capabilities
- Advanced Processing Triggering

* TEMPS means TIME in Catalan language

Excellent for on-site characterization of EMI and waveforms
TEMPS Full Time Domain EMI measurements system: *Overview*

- **Oscilloscope instantaneous acquisition**
- Obtain **Full spectrum** measurements with a single measurement (bandwidth OSC)
- **FFT** post-processing
- Deal with time-variant, low repetition and duration interferences
- Reduced cost (HW and time) vs EMI receiver
**Time Domain systems compliance with CISPR 16-1-1**

CISPR Requirements

Full time domain system Hardware + Software

Evaluation procedure according to standard

1. Sine wave voltage accuracy
2. Bandwidth (Overall selectivity)
3. Response to pulses
4. Voltage standing wave ratio (VSWR)

CISPR 16-1-1 follows a black box approach regarding the implementation of the receivers. It also does not define the reference calibration methods for ensuring the receivers compliance. 16-1-1
TEMPS implementation (I)

Step by step

Acquisition
- EMI Sampling
- Oversampled waveform
- Memory
- Resolution bits
- Channels
- Observation time for detectors

Spectral estimation
- STFT
- Windowing
- Resolution bandwidth
- Overlapping
- Welch’s method

Detectors emulation
- Spectrum Amplitude calculated
- Weighted spectrum

Display
- Corrections
- Compliance check
- Data display
- Real-time evaluation

Novel Post-Processing techniques for MeterEMI research Project

Store on-site critical waveforms for Meters
Novel post-processing techniques

- Spectrogram available for low frequency
- Include other functionalities like Probe factor (time factor like scope)
- Live post-processing with the capability to store the measurement at any point
- Real time computation of statistical detectors (APD)
- Computation of Wavelet Transform
- Employing Advanced trigger (Post-processing)
- Set multiple triggers at the same time
- New viewer to evaluate the stored data
- Capability to use the AWG integrated at the scope with previous captured data
TEMPS advantages for MeterEMI

waveform on-site characterization

Capabilities

• **Full Spectrum** acquisitions
• **Multiple** synchronous inputs
• **Amplitude and phase**

Advantages for MeterEMI

• Employ of general purpose scopes
• Sufficient dynamic range, resolution and deep memory to store waveform
• Robust for **on-site measurements**
• Instantaneous Multiple phase measurement
• Use synchronously multiple probes
• Statistical detectors
• Wavelets
On-site measurements

- Robust input stage compared with EMI
- Employed before, for EMI measurements
- View in real time and define triggers
- Run measurements during several days
- Flag events according to triggering events
- Easy to use and possibility to reevaluate data
EMC assessment: Multichannel measurements

- **Multiple channel – Several lines measured simultaneously**

- **Multiple channel – Different Probes** (different frequency ranges)
Advanced triggering functions

To identify and store potential harmful waveforms for Electricity Meters

- Statistical approach (APD)
- Wavelets
- Frequency Mask
- Others: time, external inputs (file)
Amplitude Probability Distribution (APD) triggering

- Impulsive current **shape according to EMI**
- APD successfully **applied** before to detect and evaluate **disturbances and characterize interferences**
- **Apply** APD measurements in **MeterEMI** to trigger TEMPS measurement system
Frequency domain mask triggering

- Apply a frequency mask to start the capture
- Waveforms with high harmonics contribution
- Including the frequency range between 2 kHz and 150 kHz
Wavelets triggering

- Applying wavelets transforms
- Capable of adjusting parameters at the software
- Threshold
- All post-processing
- User friendly
- Coefficient of the wavelets
- Apply the algorithms developed by NPL
Other Advanced triggering options

- **Timeouts**
  - Free run to record waveforms

- **Read File to synchronize with other software**
  - To measure when a certain device is activated
  - Experiment with UT to run measurements at after certain consumption
Viewer

- Specific interface to evaluate captured data
- Flag all events
- Matlab Runtime (Free to download)
- See the stored information
  - Several days
  - Several channels
- Short DEMO, using previous captured data
DEMO
TEMPS Meter EMI
TEMPS tool to identify and trigger current measurements

- AWG

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TEMPS

MeterEMI functional mode
Support
AWG Agilent, BAT signal -> AWG

- OUT 1 AWG -> CH1 PS
- OUT 2 AWG -> CH2 PS

- CH1 AWG: F = 50 Hz; Amp = 1,5 Vpp; Off = 0 V; Delay = 0 s
- CH2 AWG: F = 50 Hz; Amp = 1,5 Vpp; Off = 0 V; Delay = “Añadir”
AWG Agilent, BAT signal -> TEMPS
AWG Agilent, BAT signal -> TEMPS

**BAT 1:**
- APD: 1
- WL: 1
- FD: 0

**BAT 2:**
- APD: 0
- WL: 0
- FD: 0
AWG Agilent, BAT signal -> TDV

**BAT 1:**
- APD: 1
- WL: 1
- FD: 0

**BAT 2:**
- APD: 0
- WL: 0
- FD: 0
AWG Agilent, BAT signal -> TDV

**BAT 1:**
- APD: 1
- WL: 1
- FD: 0

**BAT 2:**
- APD: 0
- WL: 0
- FD: 0
VSL, CFL
VSL, CFL 0%

**CFL 0%:**
- APD: 0
- WL: 0
- FD: 1

**CFL 75%:**
- APD: 1
- WL: 1
- FD: 1
CFL 0%:
• APD: 0
• WL: 0
• FD: 1

CFL 75%:
• APD: 1
• WL: 1
• FD: 1
VSL, CFL 0%

**CFL 0%:**
- APD: 0
- WL: 0
- FD: 1

**CFL 75%:**
- APD: 1
- WL: 1
- FD: 1
VSL, CFL 75%

CFL 0%:
- APD: 0
- WL: 0
- FD: 1

CFL 75%:
- APD: 1
- WL: 1
- FD: 1
VSL, CFL 0%

CFL 0%:
- APD: 0
- WL: 0
- FD: 1

CFL 75%:
- APD: 1
- WL: 1
- FD: 1
VSL, CFL 75%

CFL 0%:
- APD: 0
- WL: 0
- FD: 1

CFL 75%:
- APD: 1
- WL: 1
- FD: 1