University of Zielona Góra, Poland
Institute of Electrical Engineering

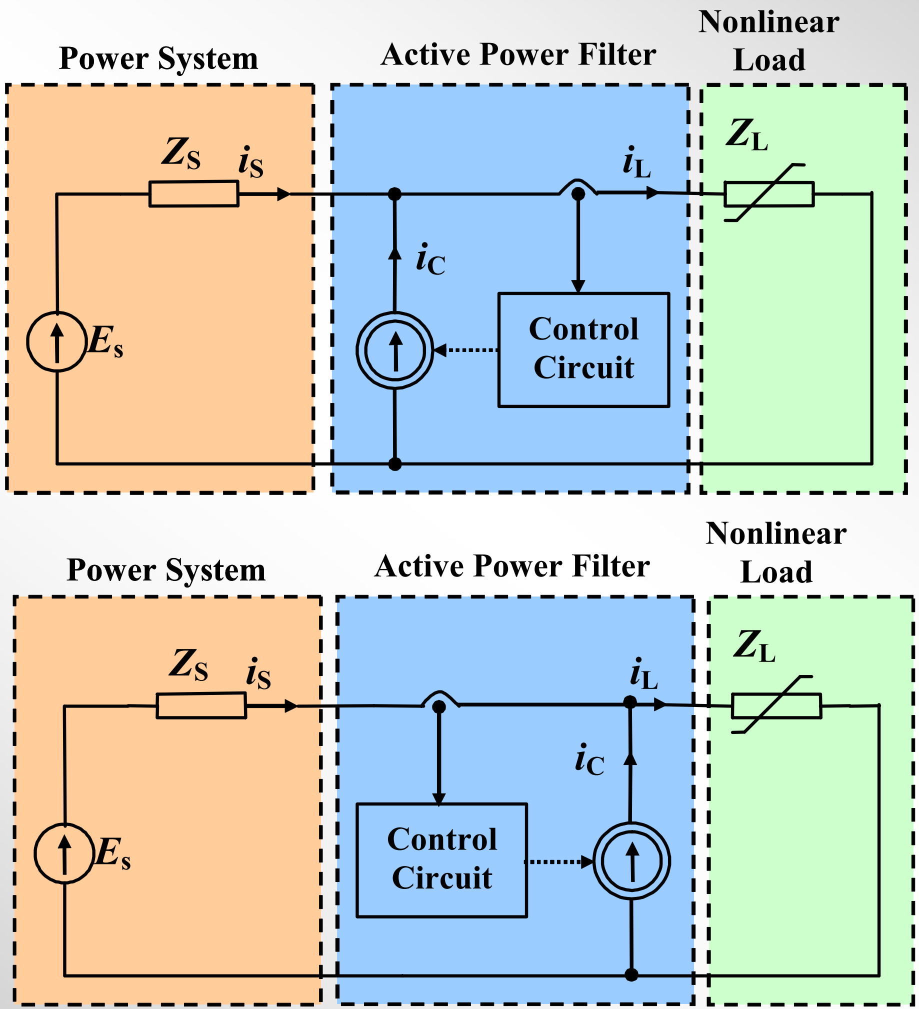
**Krzysztof Sozański, Ryszard Strzelecki,
Adam Kempski**

Digital Control Circuit for Active Power Filter with Modified Instantaneous Reactive Power Control Algorithm

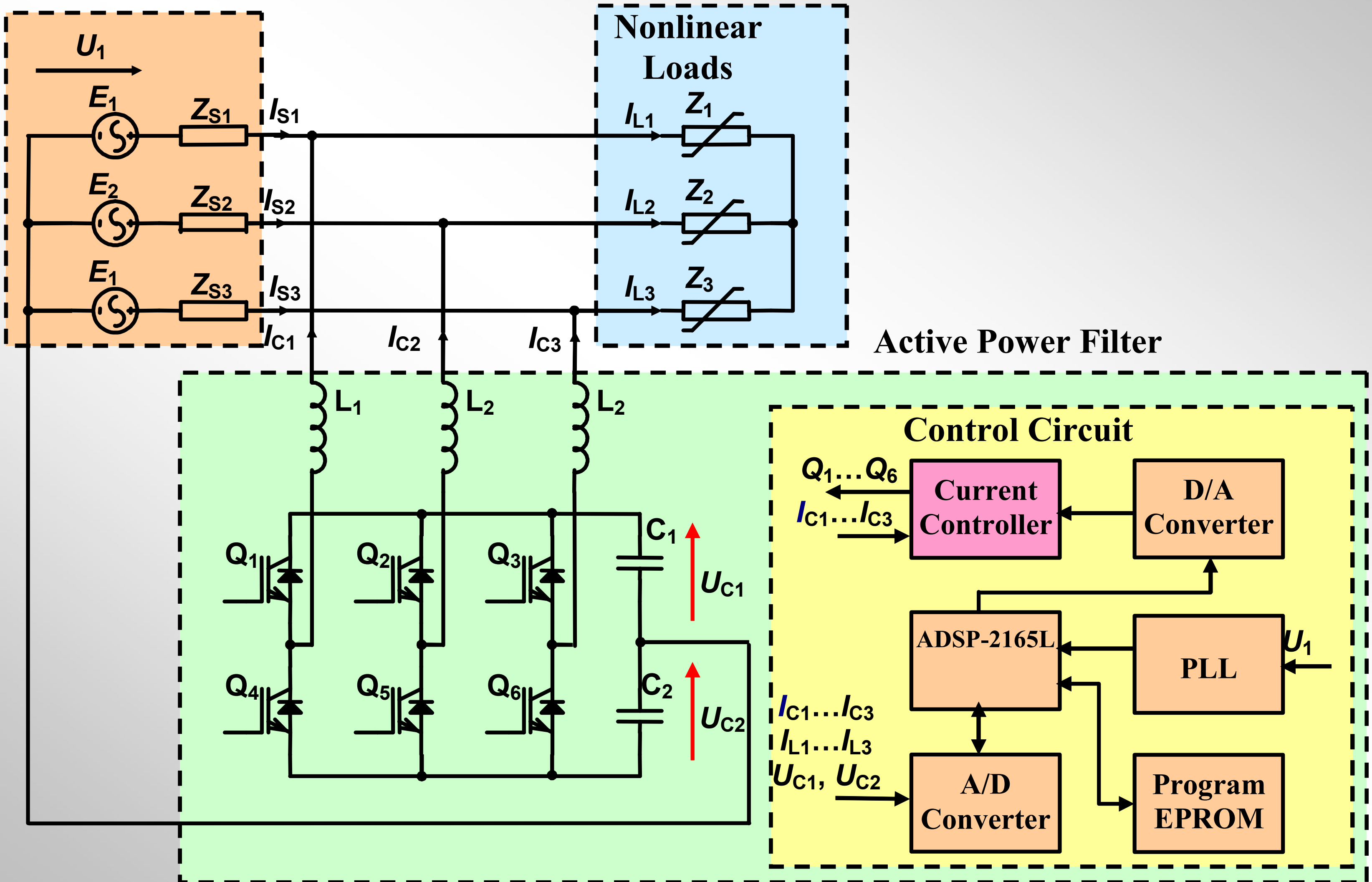
Plan of Presentation

- *Introduction*
- *Control circuit*
- *Current controller*
- *Experimental results*
- *Conclusion*

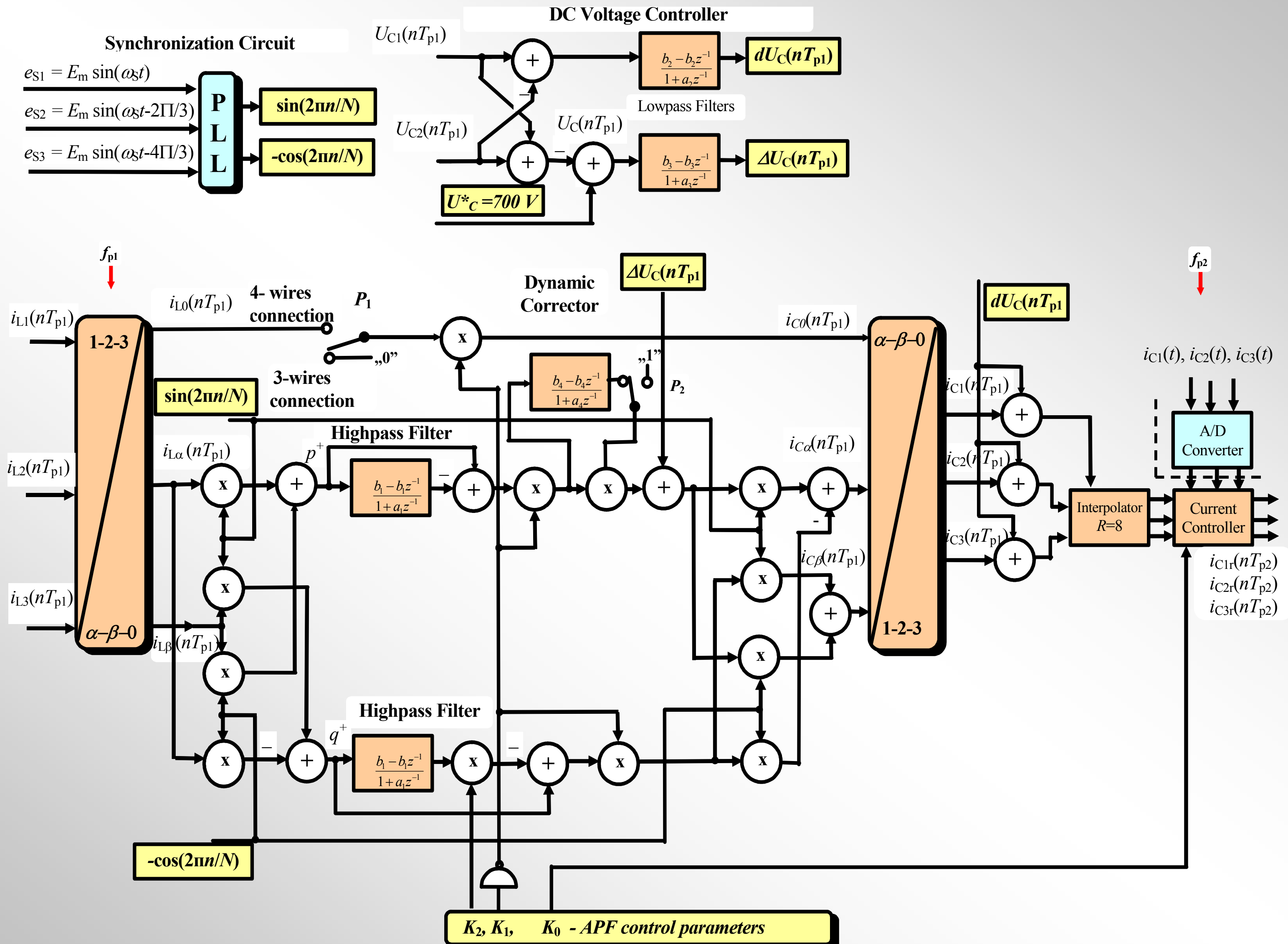
Harmonic Compensation Circuits with Parallel Active Power Filter



Active Power Compensation Circuit



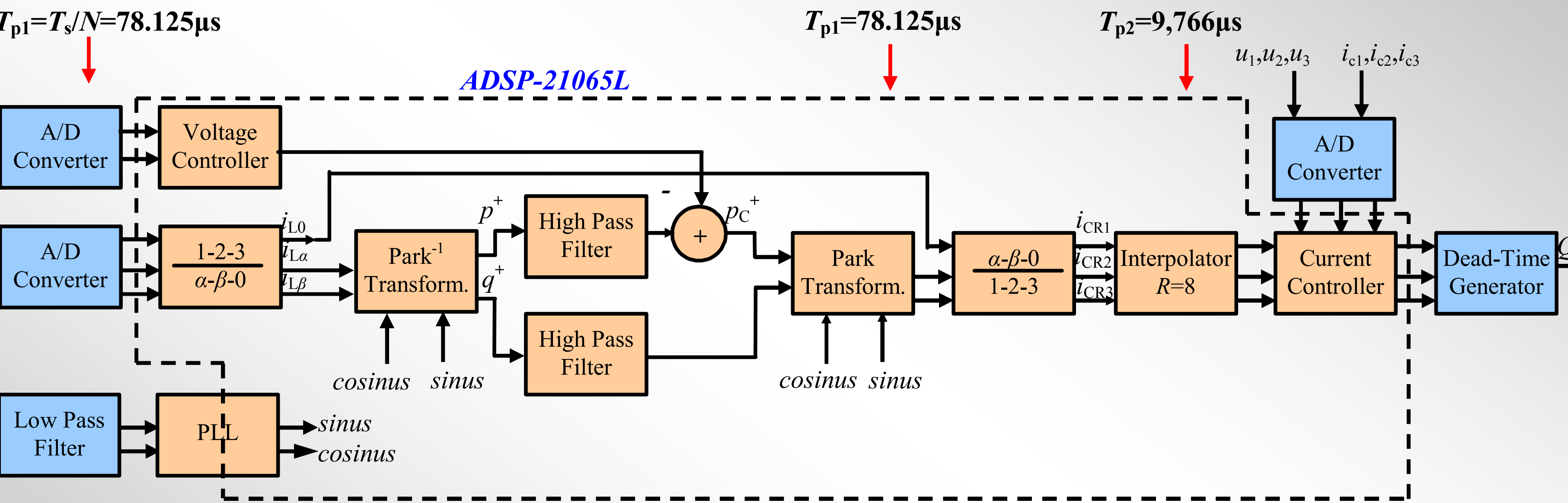
Proposed Digital Speaker System



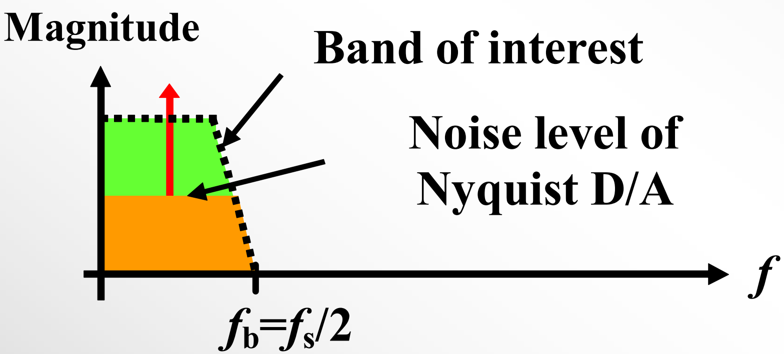
APF Control parameters

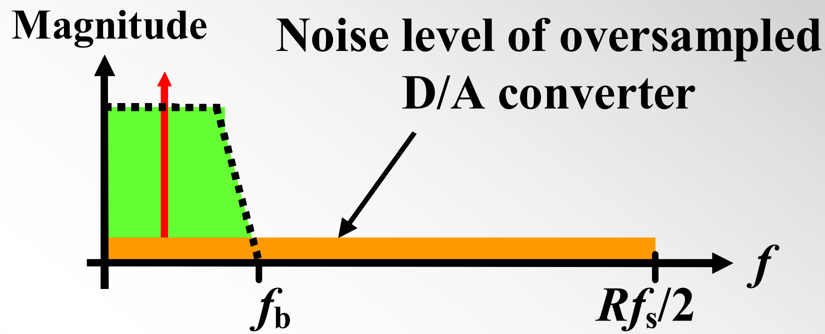
Name	*Value of parameter*
K_0	**1- APF transistors are switch off, capacitors C_1 and $C2$ are charged to initial voltage 510V** **0 – APF transistors are switch on**
K_1	**1- APF compensator is switch off, working only capacitors voltage regulator, capacitors C_1 and C_2 are charged to nominal working voltage 690V** **0 - APF compensator is switch on**
K_2	**Value of parameter varying from 0 to 1** **1- Harmonics and asymmetry are compensated** **0 – Full compensation of reactive power**
P_1	**3 wire or 4-wire circuit**

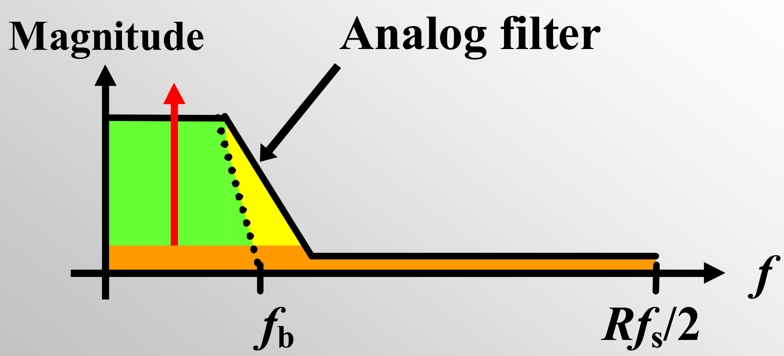
Simplified block diagram of the multirate active power filter control circuit

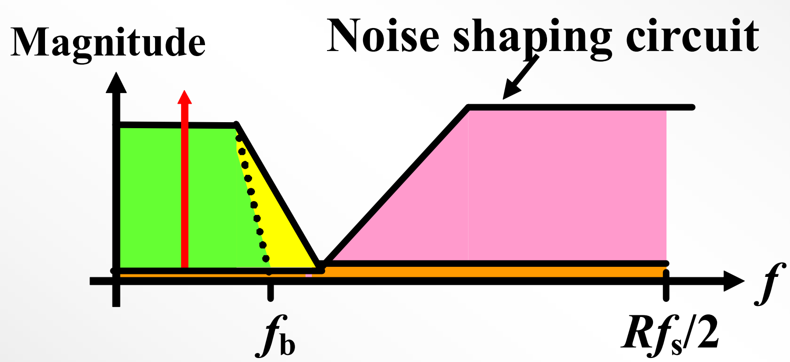


Methods of noise shaping in D/A conversion

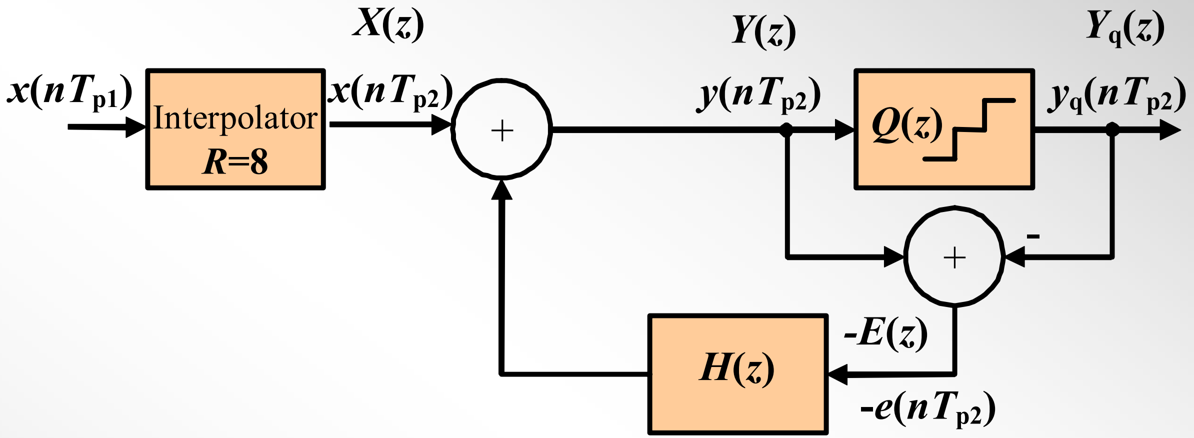








Block diagram of circuit with noise shaping



$$Y_q(z) = X(z) - \overbrace{(1 - H(z))}^{H_n(z)} E(z) = X(z)H_s(z) + E(z)H_n(z) \ .$$

where: $H_n(z)$ – noise transfer function,

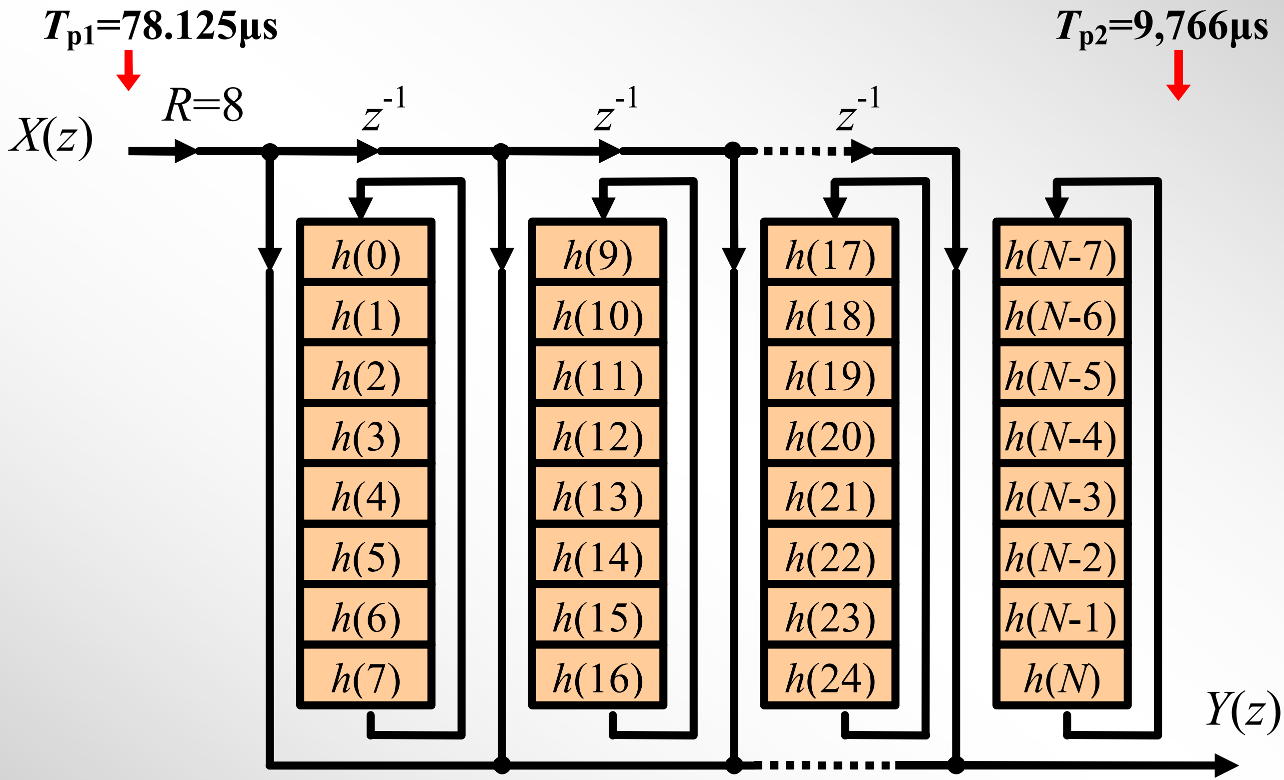
$H_s(z)$ – signal transfer function.

Chosen transfer function

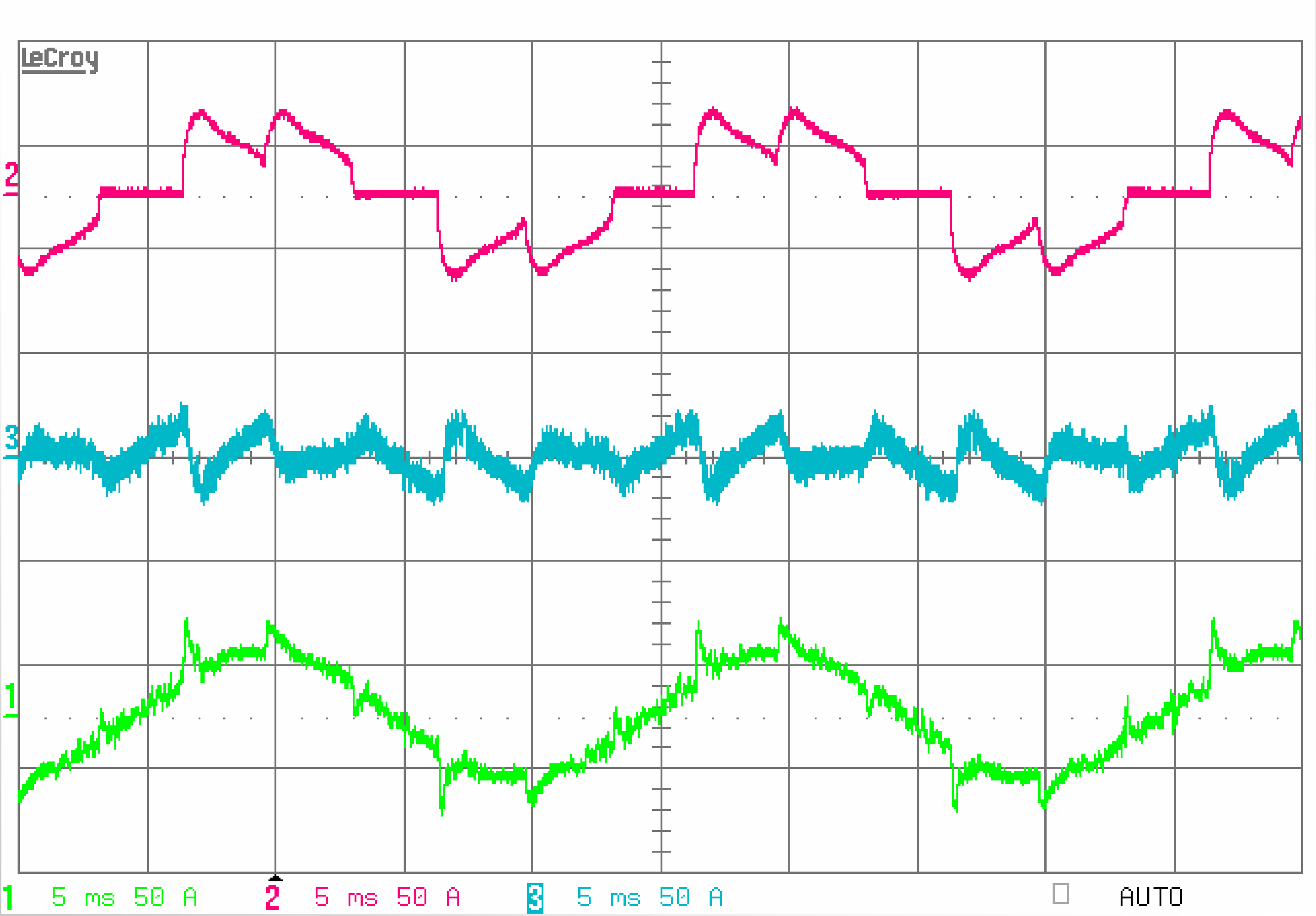
$$H_n(z) = (1 - z^{-1})^2,$$

$$Y_q(z) = X(z) + (1 - z^{-1})^2 E(z) \ .$$

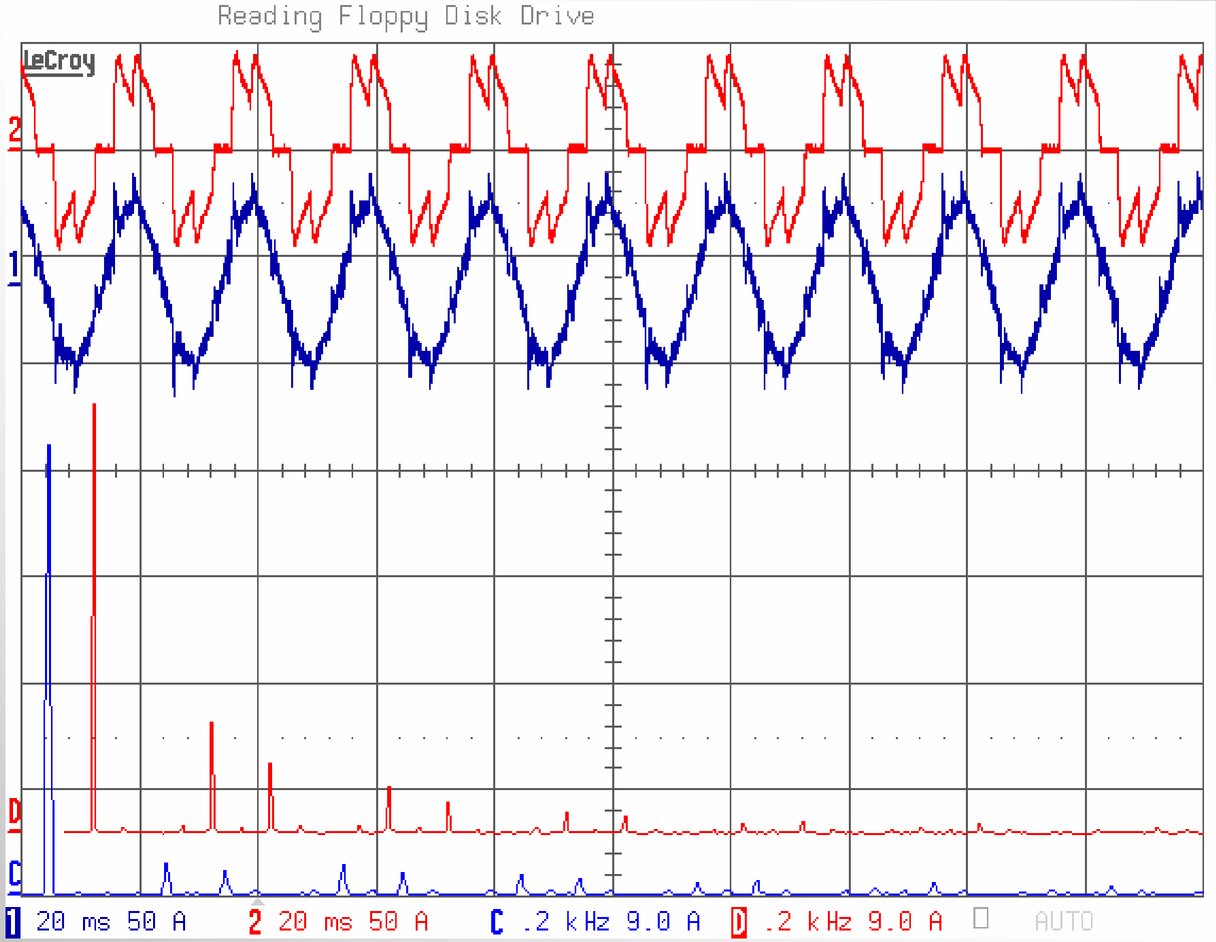
Polyphase interpolator with periodically time-varying coefficients for R=8 based on N-order FIR filter



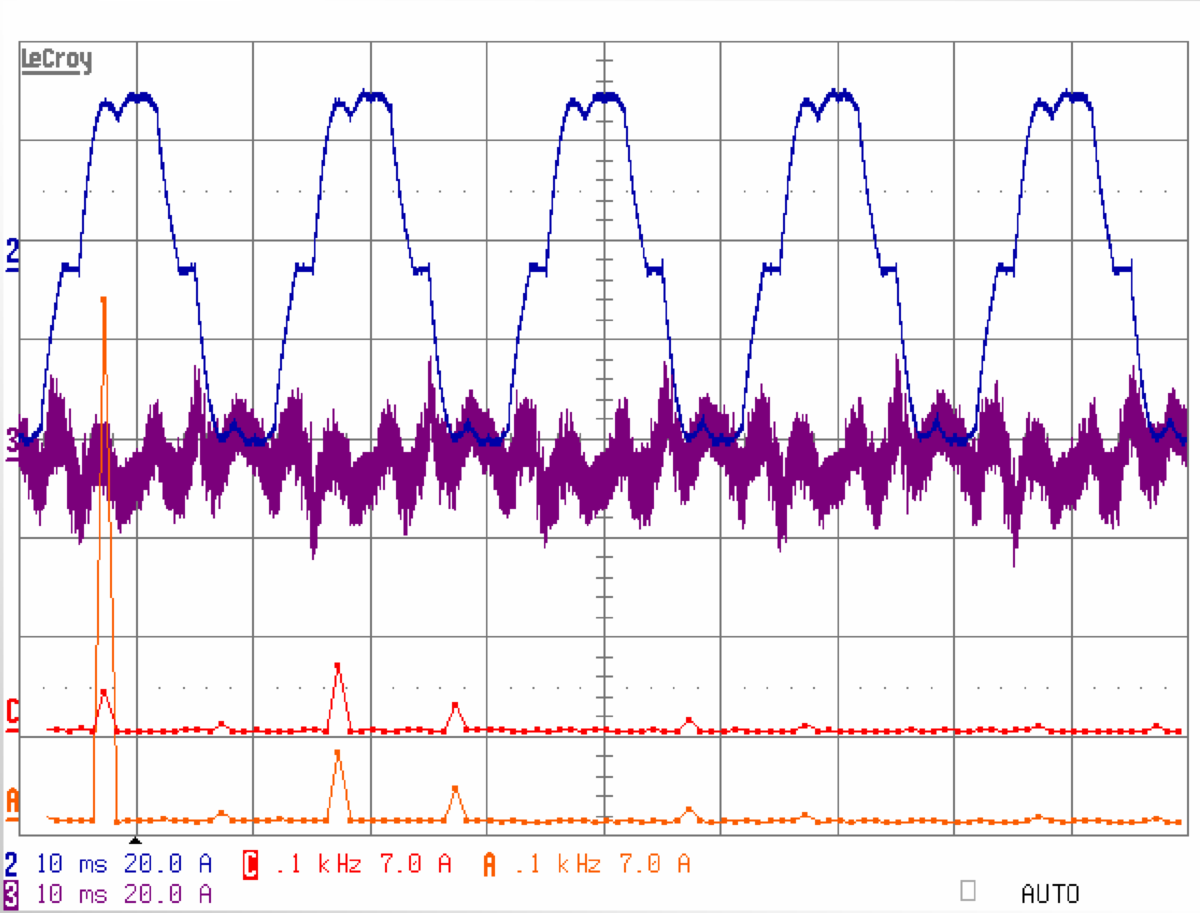
Experimental waveforms of active power filter in steady-state with the resistive load: load current IL1 (red), compensating current IC1 (blue), line current IS1 (green)



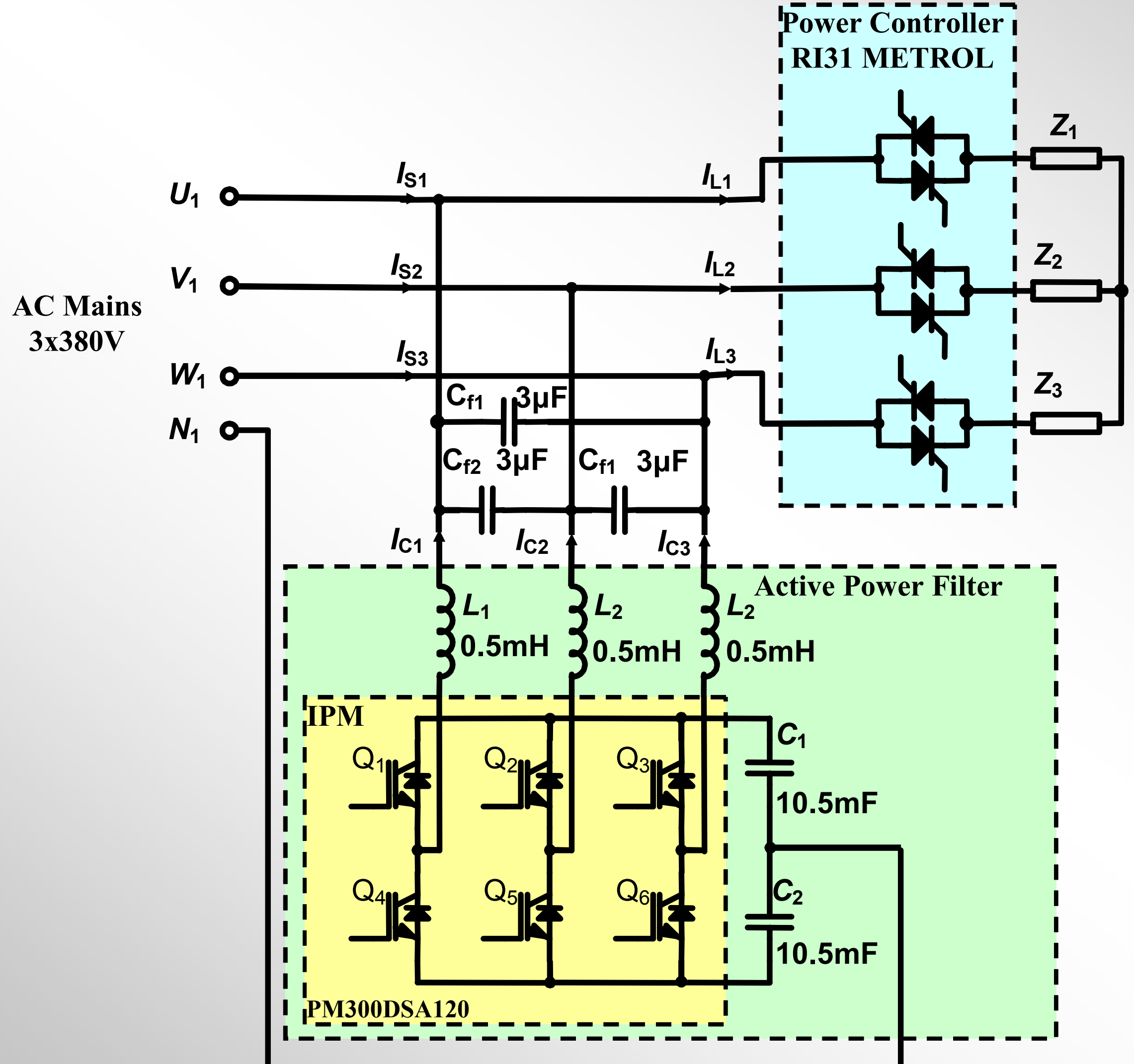
Experimental waveforms of active power filter in steady-state with the resistive load: load current IL1 (red), line current IS1 (blue) and theirs harmonic spectrums



Experimental waveforms of active power filter in steady-state with inductive load: load current IL1 (red), compensating current IS1 (blue) and theirs harmonic spectrums



Three-Phase Active Power Filter Test Circuit



Active power filters EFA1 includes the following standard features and benefits:

- **total harmonics distortion of line current less than 8%,**
- **connection: three or four wires loads,**
- **line voltage 3×230/400V,**
- **typical load power 100kVA,**
- **thermal shutdown protection and indication light,**
- **control panel test switch to verify monitoring circuit integrity,**
- **pulse-by-pulse current limit protection,**
- **stand-alone modular design,**
- **75 amp harmonic cancellation current (output current),**
- **load-independent/active neutral current monitoring.**

Active power filter in our laboratory