

Unconventional digital feedback for non-sinusoidal induction waveform

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(Dated: 20 July 2025)

Funded by the European Union's NextGenerationEU program through the Recovery and Resilience Plan for Slovakia under the Project No. 09I03-03-V04-00008.

As part of the project, an unconventional digital feedback loop for imposing a non-sinusoidal induction waveform was implemented. A portion of the developed software interface is shown in Figs. 1 concerning the superimposed higher harmonics, while an example of captured waveforms displayed on the oscilloscope screen is presented in Fig. 2 regarding the PWM voltage control with the fundamental frequency of 1 kHz, the frequency modulation index of 7 and the amplitude modulation index of 0.5.

In the case of complex induction waveforms—such as those required to emulate application-specific operating conditions resulting in the formation of minor hysteresis loops—the feedback approach described previously becomes insufficient. To

accommodate such conditions, a more general feedback algorithm was implemented. This method involves the iterative computation of a new excitation voltage $e(t)$ for the arbitrary waveform generator at the $(k + 1)$ -th iteration, given by:

$$e_{k+1}(t) = e_k(t) + \alpha [B_{\text{ref}}(t) - B_k(t)] + \beta \left[\frac{dB_{\text{ref}}(t)}{dt} - \frac{dB_k(t)}{dt} \right],$$

where α and β are appropriately small coefficients selected to ensure both sufficient convergence speed and suppression of undesired oscillatory behavior.

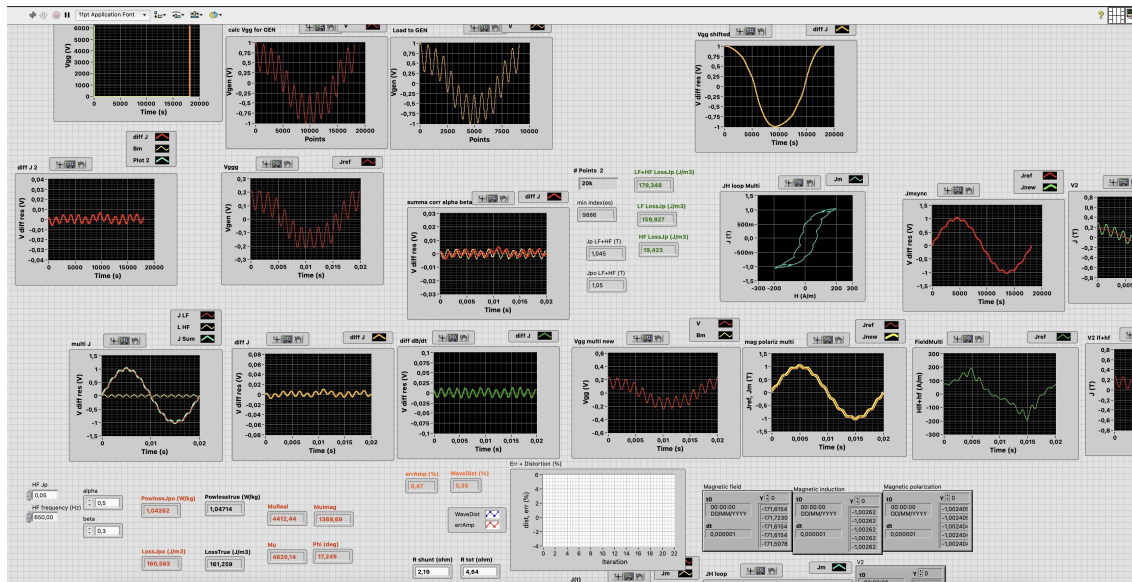


FIG. 1. Segment of the LabVIEW front panel developed for controlling the induction waveform in non-sinusoidal form.

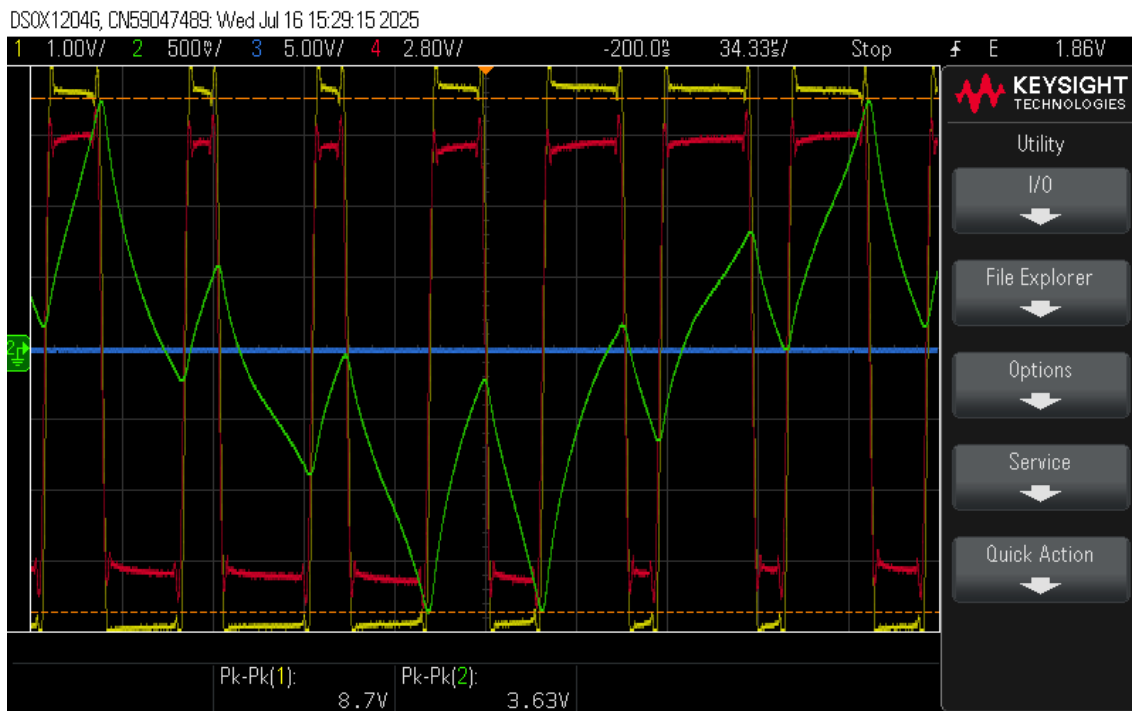


FIG. 2. Oscilloscope screen showing: voltage corresponding to the generated waveform in the arbitrary waveform generator (red), voltage across the calibrated resistor in the primary circuit (green), and the induced rectangular PWM voltage in the secondary coil (yellow).