Conventional digital feedback for sinusoidal induction waveform

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As part of the project, a conventional digital feedback loop for imposing a sinusoidal induction waveform was implemented. A portion of the developed software interface is shown in Figs. 1 and 2, while an example of captured waveforms displayed on the oscilloscope screen is presented in Fig. 3.

The waveforms $H(t)$ and $J(t)$ are treated as parametric representations of the hysteresis loop. The iterative feedback process begins with the measurement of the initial excitation waveform (e.g., sinusoidal $H(t)$). Although the corresponding $J(t)$ waveform may initially be distorted, it provides sufficient information to construct a refined $H(t)$ waveform that yields the desired $J(t)$. The excitation signal $e(t)$ applied to the arbitrary waveform generator is derived from the primary circuit equation. Assuming negligible air flux, this relationship is expressed as:

$$Ge(t) = u_R(t) + u_L(t) = (R_\mathrm{s} + R_H) i_H(t) + N_1 A \frac{\mathrm{d}J}{\mathrm{d}t}, \qquad (1)$$

where G is the gain of the power amplifier, $R_\mathrm{s} + R_H$ denotes the total resistance of the primary circuit, and A is the cross-sectional area of the sample.

In cases where the air flux is not negligible, the inductive voltage term $u_L(t)$ in Eq. (1) must be modified as:

$$u_L(t) = N_1 \left(A \frac{\mathrm{d}J}{\mathrm{d}t} + A_\mathrm{tot} \mu_0 \frac{\mathrm{d}H}{\mathrm{d}t} \right), \qquad (2)$$

where A_tot represents the total area enclosed by the primary winding.

This procedure is iterated to refine both $H(t)$ and $e(t)$ until the resulting $J(t)$ waveform conforms closely to the desired waveform. As a convergence criterion, the deviation in waveform form factor is employed.

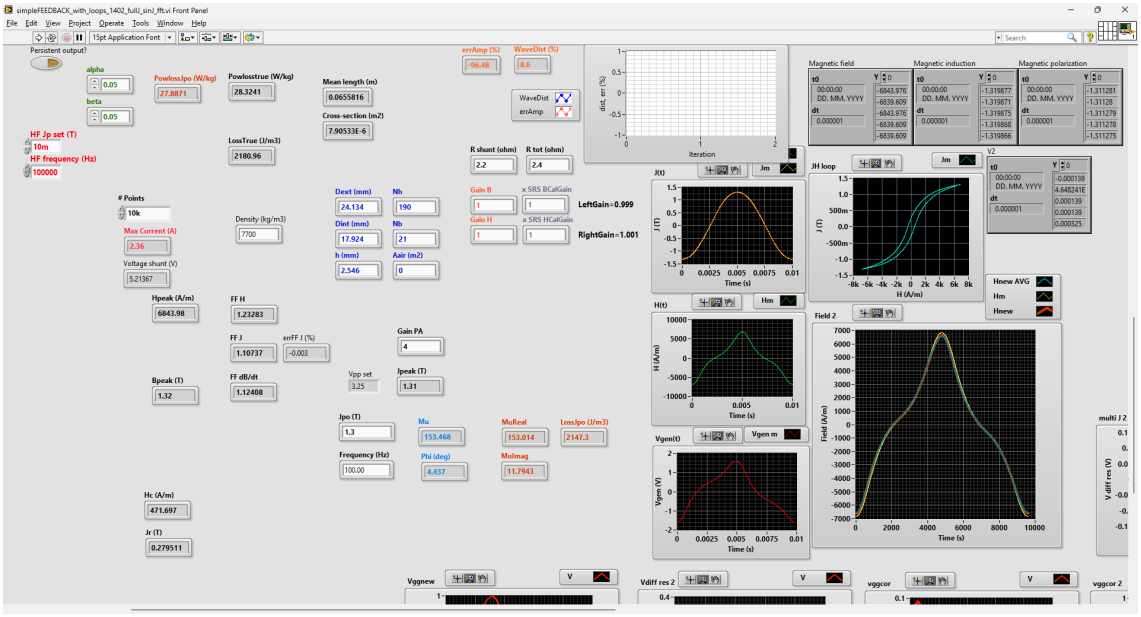

FIG. 1. Segment of the LabVIEW front panel developed for controlling the induction waveform in sinusoidal form.

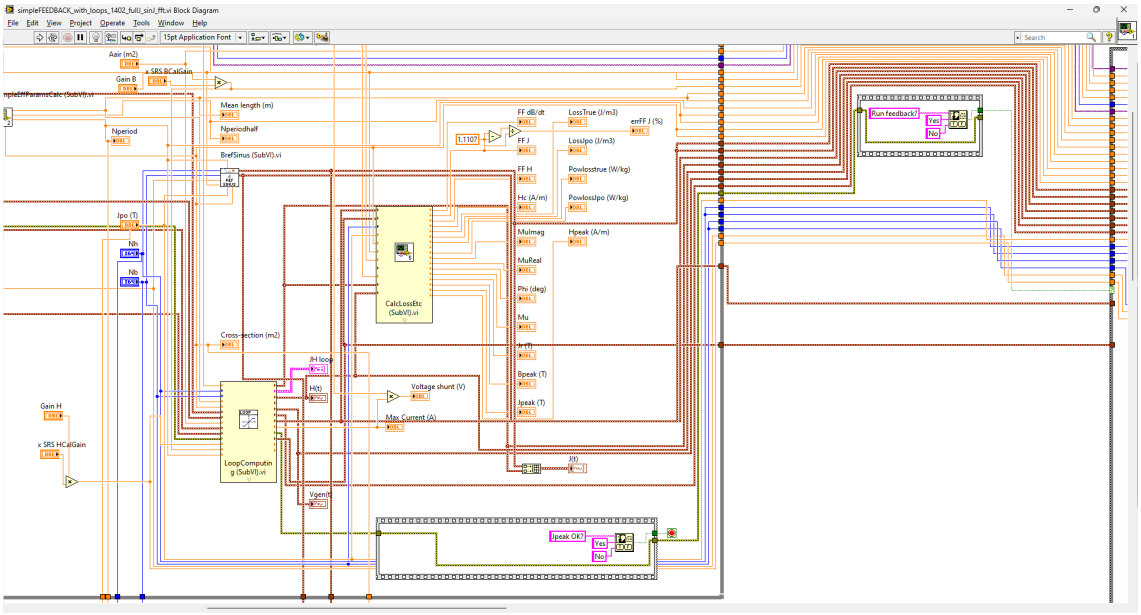

FIG. 2. Segment of the LabVIEW block diagram developed for controlling the induction waveform in sinusoidal form.

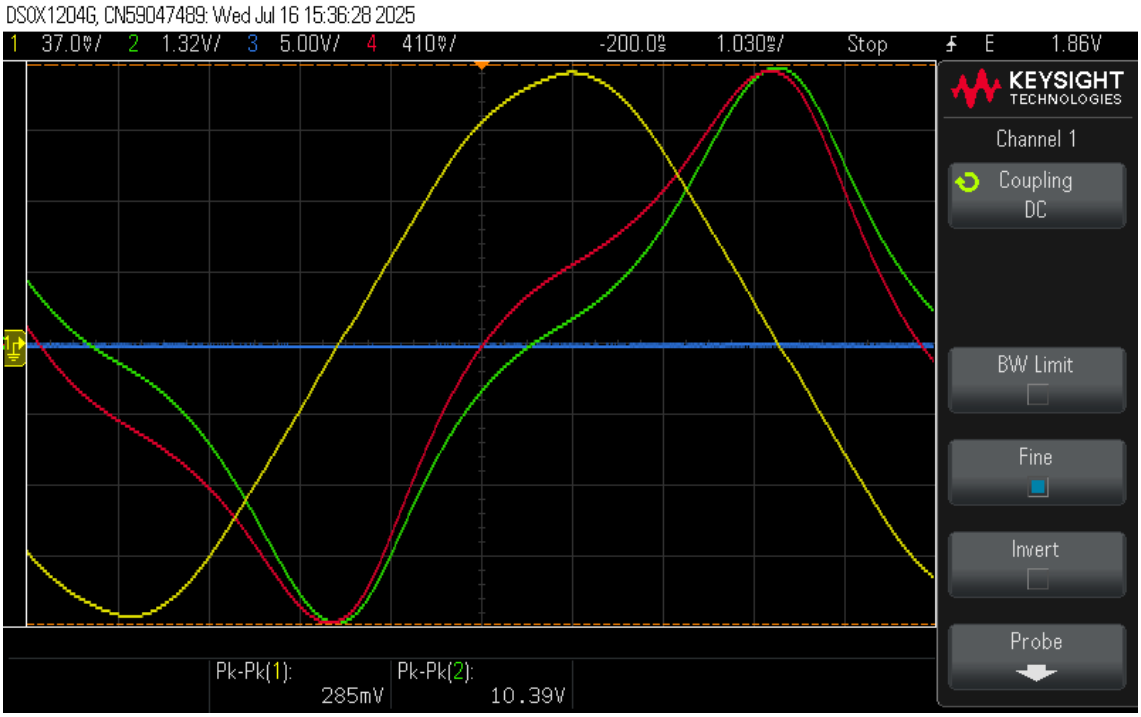

FIG. 3. Oscilloscope screen showing: voltage corresponding to the generated waveform in the arbitrary waveform generator (red), voltage across the calibrated resistor in the primary circuit (green), and the induced sinusoidal voltage in the secondary coil (yellow).