Method to measure wire oscillation of a wire scanner (G. Ferioli)

The method consists of moving the wire through a gap between two permanent magnets. The extremities of the wires are connected to an oscilloscope with differential inputs. The obtained voltage is a measure of the vibration. To simplify the problem, the magnetic field is assumed to be homogeneous in the gap and zero outside this gap. Also the wire is considered to be of infinite length. The height of the gap should be small compared to the expected length of the oscillation period.

\[ \Phi = B.A \Rightarrow d\Phi = B.l.ds , \]

\[ e_i = \frac{d\Phi}{dt} = B.l.ds / dt = B.l.V \]

The induced voltage on the wire, measured on the oscilloscope, \( V \) being the speed of the wire.

\[ \Delta e_i = \Delta V / V , \]

\[ \Delta V = \Delta X.\omega = \Delta X.2\pi f , \] with \( f \) being the measured oscillation frequency.

The peak to peak amplitude of the wire oscillation \( \Delta X \) equals: \( \Delta X = \Delta e_i / e_i \cdot V / 2\pi f . \)

The next figures have been found during a measurement campaign in the 1980's:

<table>
<thead>
<tr>
<th>scanner</th>
<th>Rotary</th>
<th>Linear</th>
<th>Linear</th>
<th>Linear</th>
<th>Linear</th>
</tr>
</thead>
<tbody>
<tr>
<td>wire</td>
<td>C 30 ( \mu )m</td>
<td>C 30 ( \mu )m</td>
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<td>C 30 ( \mu )m</td>
</tr>
<tr>
<td>( V )</td>
<td>4 m/s</td>
<td>0.15 m/s</td>
<td>0.31 m/s</td>
<td>0.47 m/s</td>
<td>0.62 m/s</td>
</tr>
<tr>
<td>( \Delta e_{i,pp} )</td>
<td>250 ( \mu )V</td>
<td>40 ( \mu )V</td>
<td>80 ( \mu )V</td>
<td>100 ( \mu )V</td>
<td>130 ( \mu )V</td>
</tr>
<tr>
<td>( e_i )</td>
<td>10 mV</td>
<td>290 ( \mu )V</td>
<td>575 ( \mu )V</td>
<td>870 ( \mu )V</td>
<td>1150 ( \mu )V</td>
</tr>
<tr>
<td>( f )</td>
<td>400 Hz</td>
<td>4 kHz</td>
<td>4 kHz</td>
<td>4 kHz</td>
<td>4 kHz</td>
</tr>
<tr>
<td>( \Delta X_{pp} )</td>
<td>40 ( \mu )m</td>
<td>0.82 ( \mu )m</td>
<td>1.7 ( \mu )m</td>
<td>2.1 ( \mu )m</td>
<td>2.8 ( \mu )m</td>
</tr>
<tr>
<td>( \Delta V_{pp} )</td>
<td>0.1 m/s</td>
<td>0.02 m/s</td>
<td>0.043 m/s</td>
<td>0.052 m/s</td>
<td>0.07 m/s</td>
</tr>
</tbody>
</table>
TEST LABO
BWS - 11974

FIL: 30μm "C"

H

V = 4 m/V

-10 mV
-10 mV

±250μV

F~900Hz

±200 μV

±2500 μV

±200 μV

±100 μV
Fig. 3

V_in: 0.455 m/s
S = 2.90 µV
Osc = 40 µV (60 µV)
F = 4 kHz
Err. Osc. 5 kHz = ±0.4 µm
Err. Osc. 8 kHz = ±0.65 µm

Fig. 10

V_in: 0.31 m/s
S = 5.75 µV
Osc = 180 µV (120 µV)
F = 4 kHz
Err. Osc. 5 kHz = ±0.85 µm
Err. Osc. 8 kHz = ±1.2 µm

Fig. 11

V_in: 0.466 m/s
S = 8.20 µV
Osc = 80 µV (180 µV)
F = 4 kHz
Err. Osc. 5 kHz = ±0.85 µm
Err. Osc. 8 kHz = ±1.4 µm

Fig. 12

V_in: 0.62 m/s
S = 1.150 µV
Osc = 130 µV (200 µV)
F = 4 kHz
Err. Osc. 5 kHz = ±1.4 µm
Err. Osc. 8 kHz = ±1.2 µm