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CONTRIBUTIONS REGARDING MONITORING OF UNIVERSAL FRACTIONAL-HORSEPOWER COMMUTATOR MOTORS

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Abstract: This paper aims at highlighting the behaviour of universal fractional-horsepower commutation motor in different operating situations, by using modern means of investigation. For this purpose, a series of direct current and alternating current experimental tests were carried out, with and without compensation winding. The paper presents partial photos of the test stand, the circuit schemes used and the figures obtained from the experiments. From this last category, there are emphasized the phasor representations obtained and the harmonic analyses of the monitored currents. The paper ends with conclusions and references.
Keywords: universal fractional-horsepower motor, monitoring, data acquisition, harmonic analyser

1. INTRODUCTION

The problem of the experimental tests of low-power electrical motors is widely approached in specialty papers [5], [6], [8]. This problem is more important when it comes to tests carried out with a motor having special constructive and functional particularities.

This category also includes universal fractional-horsepower commutator motor [1], [2], [7].

This motor operates, without constructive modifications, both in direct current and in alternating current. Moreover, this motor can be endowed, if necessary, with a compensation winding.

The interest in such a motor has been amplified by a large number of household applications which use it as an execution element.

This paper aims at emphasizing the behaviour of universal fractional-horsepower commutator in different operation states, by means of some modern investigation means.

Figure 1. The test stand

2. TEST STAND

The experimental tests have been carried out on a test stand detailed in [3]. For the analyzed case there has been used a universal fractional-horsepower commutator motor rated at 170 W. It was mechanically connected with a dynamometer, used for modifying the resistant torque at the motor shaft (Figure 1).

Figure 2. Detail on the stand

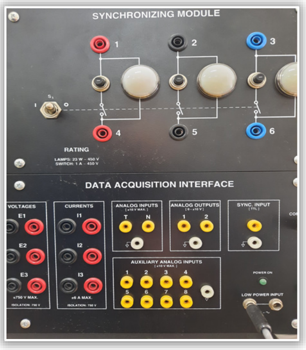


Figure 3. The specialized modules

The stand was supplied by a direct current source, respectively alternating current source [9], of adjustable value (Figure 2). The values of the monitored quantities (currents, voltages, torques) can be acquired by means of a specialized module (Figure 3). These values will be then viewed, by using a soft which is partly developed by the authors.

It enables, among others, to view the phasors of the voltages and currents (with phase shifts) and the harmonic analysis of the analyzed electrical quantities (voltages or currents).

3. CIRCUIT SCHEMAS

Three categories of tests have been carried out:

- wavy current tests (schema from Figure 4 [10]);
- alternating current tests with compensation winding (schema from Figure 5 [10]);
- alternating current tests with shunt winding (schema from Figure 6 [10]).

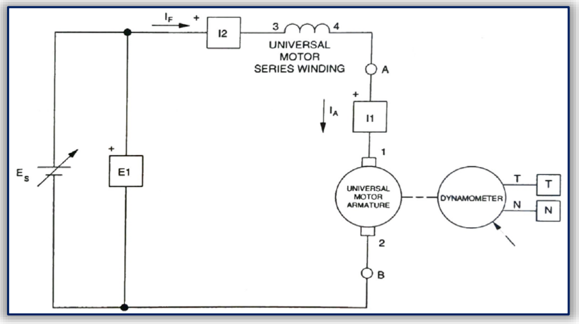


Figure 4. The wavy current tests [10]

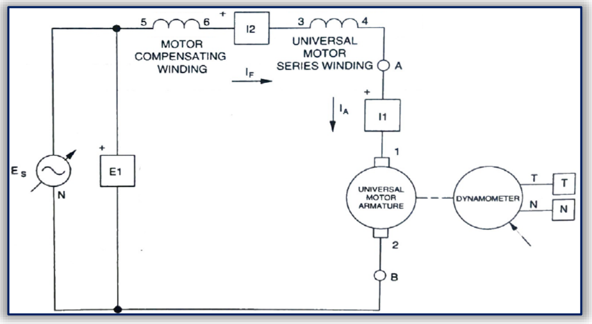


Figure 5. The alternating current tests with compensation winding [10]

4. EXPERIMENTAL DETERMINATIONS

The results obtained in the three situations will be presented further on. For each case, the values of the main monitored quantities and the associated phasor diagram will be detailed. For the case of alternating current operation, there will be presented the module of harmonic analysis, made by the authors.

— Wavy current tests

There are presented three situations for three different values of the resistant torque: 0 Nm, 1 Nm and 2 Nm (the phasor diagrams are determined by the use of the ordered rectifier).

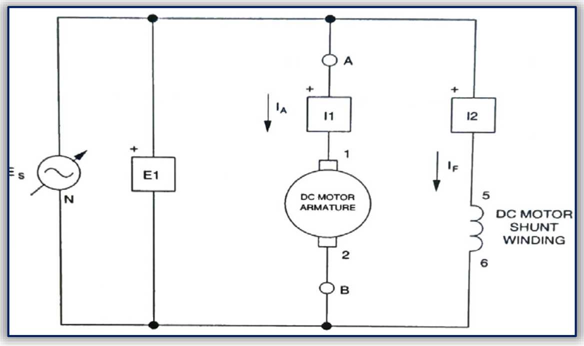
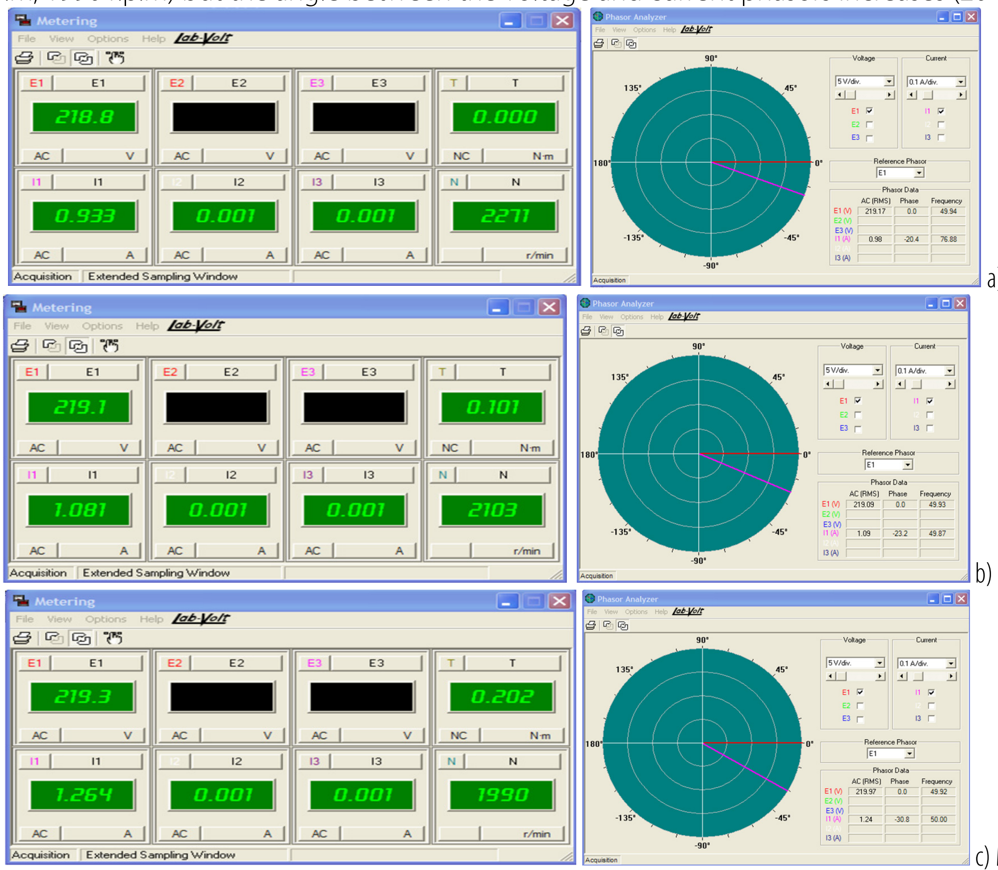


Figure 6. The alternating current tests with shunt winding [10]

It is noticed that the speed obviously decreases when the value of the resistant torque increases (2271 r.p.m, 2103 r.p.m, 1990 r.p.m) but the angle between the voltage and current phasors increases (20°, 23°, 30°).



a) Mr=0 Nm.

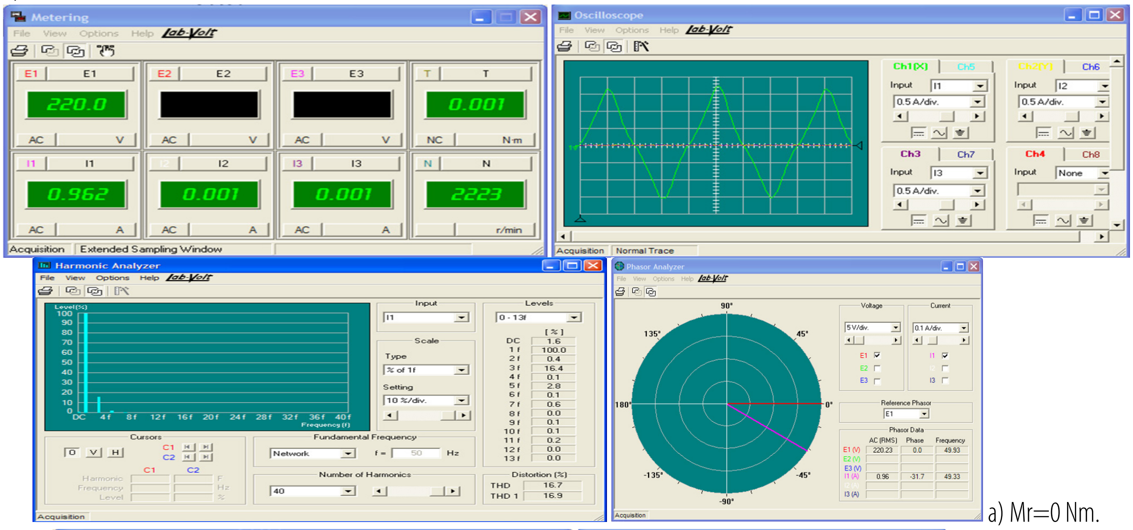
b) Mr=0,1 Nm.

c) Mr=0,2 Nm.

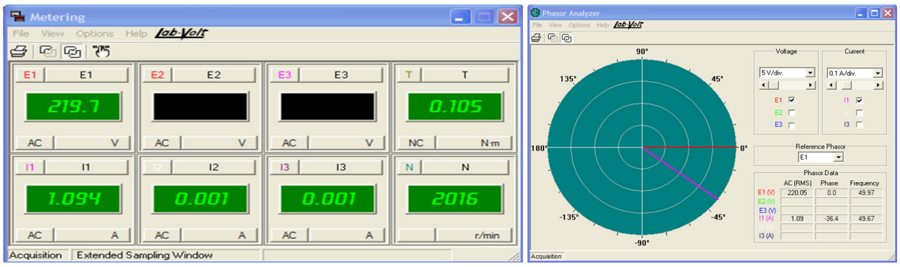
Figure 7. Graphics obtained in case of direct current operation

— Alternating current tests without compensation winding

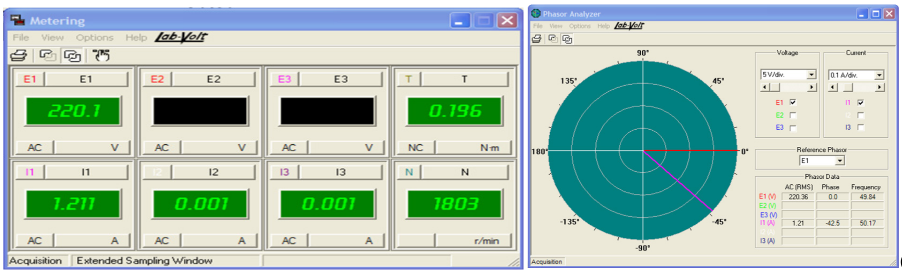
The analysis of these graphics shows that the same conclusions as in the previous case are obtained but the speed values are smaller and close to each other (2223 r.p.m, 2016 r.p.m and 1803 r.p.m) and the phase shift angles are bigger at the same values of the load (31°, 36° and 42°). Moreover, there has been emphasized the non-sinusoidal wave of the current which has important components of the third order harmonics (16,4 %) and 5 (2,8 %).



a) Mr=0 Nm.



b) Mr=0,1 Nm.

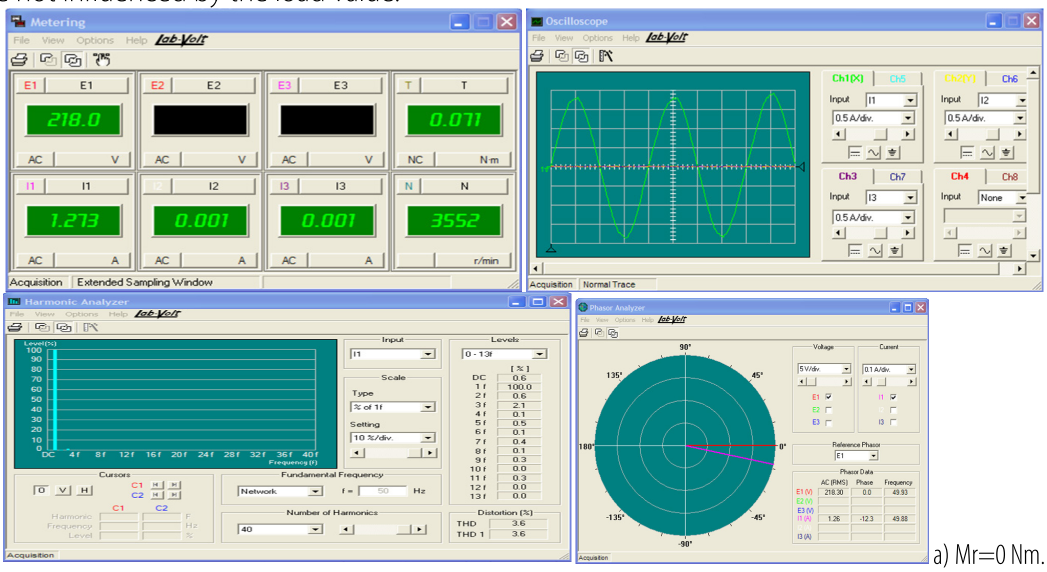


c) Mr=0,2 Nm.

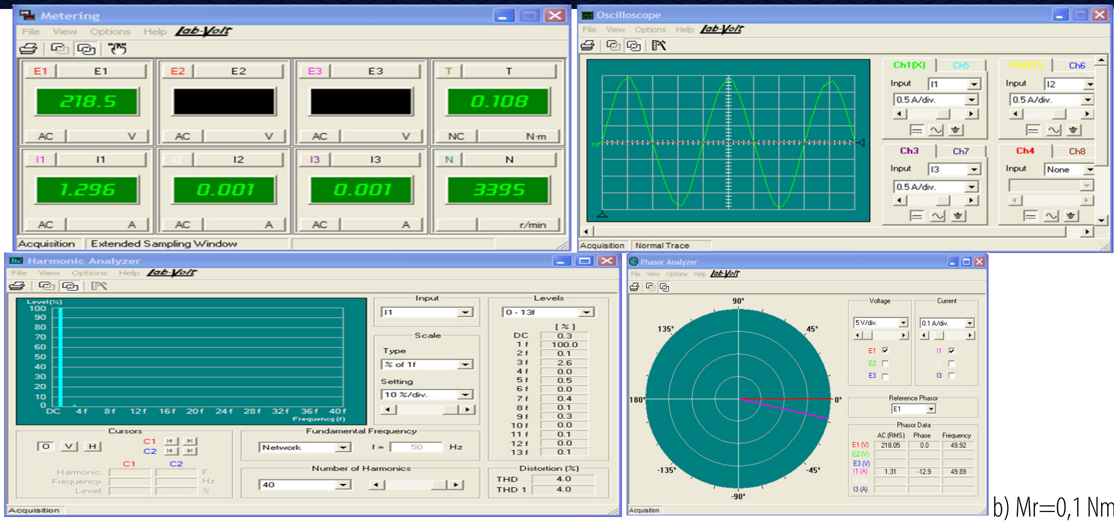
Figure 8. Graphics obtained in case of alternating current operation with compensation winding

— Alternating current tests with shunt circuit

In this case there have been analyzed two situations, for Mr=0 Nm and Mr=0,1 Nm. Higher values of speed were used (3552 r.p.m and 3395 r.p.m). It is noticed that both the phase shift angle and the harmonic content of the current are not influenced by the load value.



a) Mr=0 Nm.



b) Mr=0,1 Nm.

Figure 9. Graphics obtained in case of alternating current operation with shunt circuit.

5. CONCLUSIONS

The following conclusions have been obtained by the analyses carried out:

— this paper is an application of using a data acquisition and viewing program, improved by the authors;
— the contributions brought by the authors consisted in adding some modules of computing and viewing the phasors phase shift angle and of harmonic analysis of non-sinusoidal quantities;
— in case of wavy current supply it is noticed that the speed value obviously decreases when the resistant torque value increases, but the angle between the voltage and current phasors increases;
— in case of alternating current supply with compensation winding the same conclusions as in the previous case are obtained, but the smaller values of the speed are close to the direct current values and the angles are bigger, for the same values of the load;
— in case of alternating current supply with shunt circuit, at bigger values of speed than in the previous cases, both the phase shift angle and the current harmonic content are not influenced by the load value.

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