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PROPOSAL OF THE POWER SUPPLY FOR DC AND AC ELECTRIC MOTORS

NÁVRH NAPÁJENÍ PRO STEJNOSMĚRNÉ A STŘÍDAVÉ ELEKTROMOTORY

Abstract

The article deals with measuring system by Steiger Mohilo. The unit serves for measuring rotations of low power electric motors without contact specially intended for laboratories. There is available to measure AC motors and also DC motors using mostly in white appliances. The contribution also deals with finding suitable power supplies for these motors and their continual regulation provided on our markets.

Abstract

Tento článek se zabývá měřením systémem Steiger Mohilo. Přístroj slouží k měření rotace nízkoenergetických motorů bez potřeby speciálních laboratoří. Je vhodný pro měření střídavých motorů a také stejnosměrných motorů používajících se většinou v bílých spotřebičích. Příspěvek se zabývá také hledáním vhodného zdroje pro tyto motory a jejich vzájemnou regulací, dostupnou na našich trzích.

1 INTRODUCTION

Research institutions in the engine respectively, white appliances need to test their product before they put it into the markets. One of the most important attribute is lifetime of power trains. However, these reason it was developed universal measuring system for testing electric motors used in white industry. Company Steiger Mohilo found in Germany developed with co-operations with their partners' universal measuring system, which one was donated to the Technical University of Košice by firm B/S/H Drivers and Pumps Michalovce. In fact of this measuring system is necessary to design or find universal power supply for testing motors on that device.

2 MEASURING STATION STEIGER MOHILO

Measuring system is determined for testing of AC and DC highspeed electric motors of low electrical power by using station Steiger mohilo (Fig. 1).

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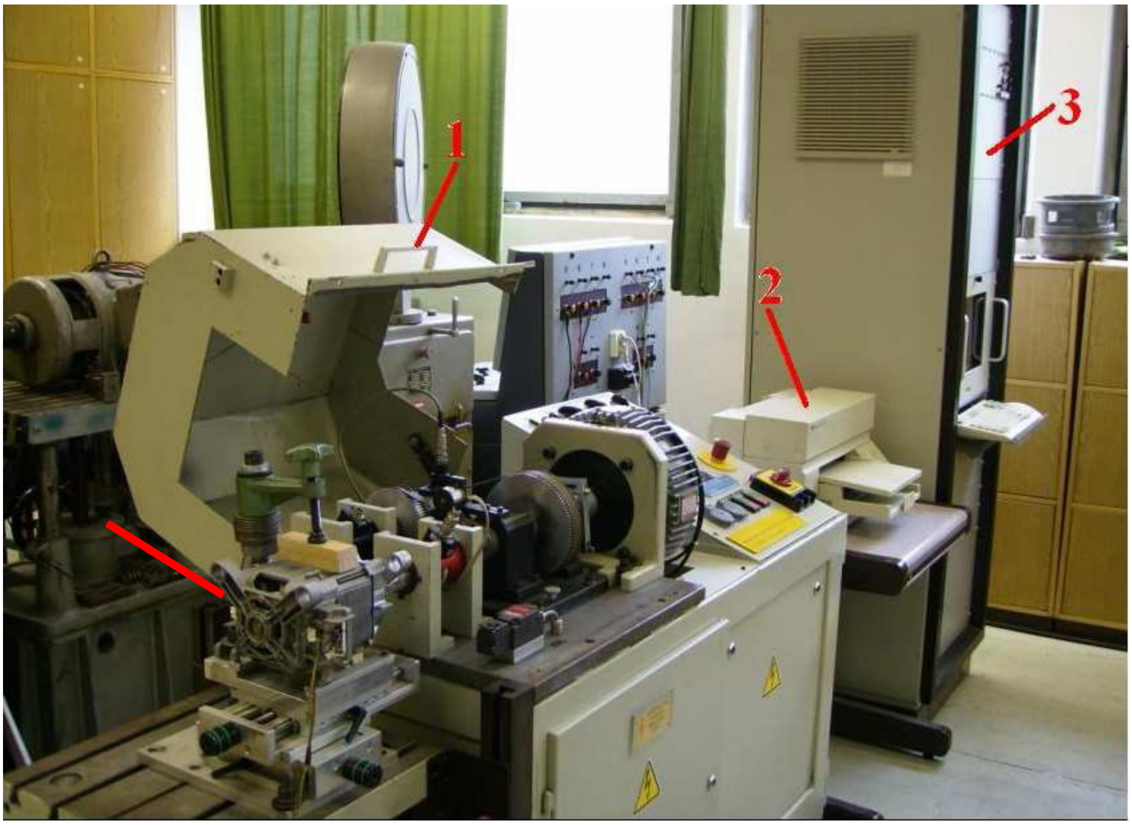


Fig. 1. Measuring system Steiger mohilo.
1.Measuring stool
2. Printer HP DeskJet 1200C or plotter
3. Meracia skriňa ďalší popis
4. Testovaný motor

Analysis made by measuring station are used for finding information about mechanical and electrical function characteristic, heating characteristic, overload and detection of technical information about testing electrical rotary motors, where we determinate total efficiency and torque factor of measured motor by inducitve senzor of torque.

3 POSSIBILITIES OF CONTROLLING ROTATION SPEED OF ELECTRIC MOTORS

This part is devoted to speed controlling of motor devices. For the station is necessary to propose universal power supply that is identical to voltage, current, DC and AC sources in their mutual ineteraction. Sources can be devided into two main groups:

1. DC source - dynamo
   - rectifier
2. AC source - autotransformer
   - inductive generator
   - frequency converter

3.1 DC sources

In general these types of sources are powered by the mains voltage with nominal sinus voltage 230V and frequency 50Hz. On the exterminations are used semiconductors components. In the regulation of DC motors and rotor windings supllying of large synchronous machines is the possibility of using dynamo. Dynamo with extraneous winding is supllied from an external power suplly. Voltage of the dynamo is controled by changing excitation current or directly modifies the excitation voltage. The advantage of these dynamos is that it´s appear as a hard voltage power source.

Dynamo with parallel extraneous does not need external source of current. Excitation winding is powered directly from source of dynamos. There is possibility to connect into series compensation windings and windings of main poles. The first winding limiting dependence of voltage and load ability and the second one suppress magnetic effect of windings on main poles.

Semiconductor rectifiers can operate in two modes depended on used rectifier unit. First mode is by using classic rectifier diode, which reacts on positive polarity of voltage on the cathode, when we talk about opening PN junction above the diffuse current. When the opposite polarity get to cathode of PN junction it´s became non conductive and current is consist of minority particles, which is negligible. In this case when we can’t control statuary voltage we talk about non controlled rectifier. This type of rectifying can be used as a one phase (Fig.2) or with modification in three phase rectifier.

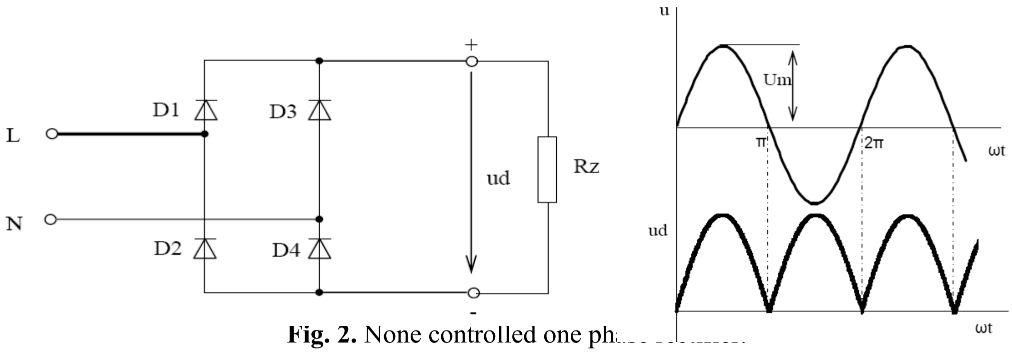


Fig. 2. None controlled one ph…

$$u_D = \frac{1}{\pi}\int_0^{\pi} U_M.\sin\omega.t(d.\omega.t) = \frac{2.\sqrt{2}}{\pi}\left[-\cos\omega.t\right]_0^{\pi} = \frac{2.\sqrt{2}}{\pi}U_{EF} \cong 0{,}9.U_{EF} \quad [V] \quad (1)$$

In case that are used thyristor instead of diodes we have a choice to control rectifier by impulses to the gates of thyristors. Impulses are supplied to the gate with shift versus sinus signal which open junction (fig. 3).

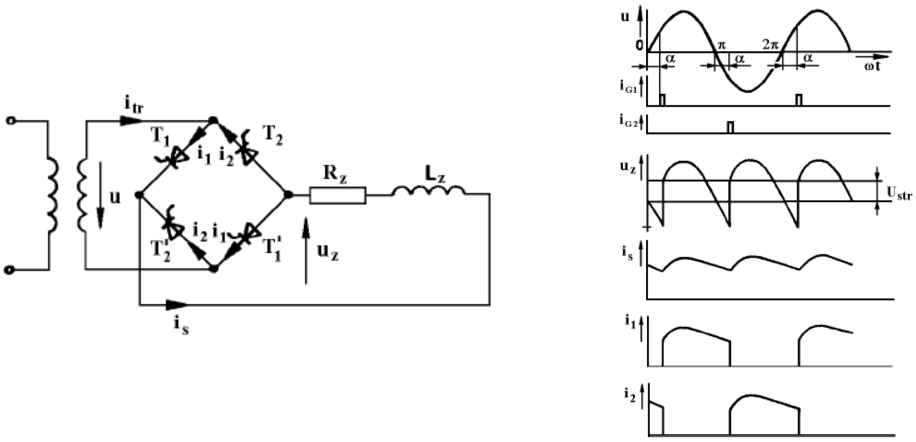


Fig. 3. Controlled one phase rectifier by using thyristors.

3.2 AC sources

The simplest way how to control one phase motor is using autotransformer (Fig. 4). The principle is based on the windings with conductive runner. Primary voltage U1 is on the inputs clamps with treads N1, and secondary windings with treads N2 and voltage U2. Decreasing transformer has transfer N2 < N1 and for raising N1 < N2.

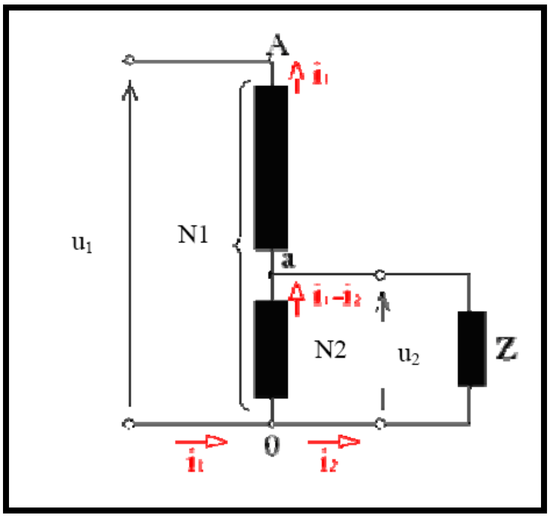


Fig. 4. Autotransformer.

Transfer of the transformer is located in the interval $p_a \in (1{,}2;2)$.

$$p_a = \frac{N_1}{N_2} \text{ [-]} \tag{2}$$

Inductive regulator is the example of three phase source, which is consist of one slip-ring asynchrony motor with regulation of voltage from 0V to 400V. Their main disadvantage is offset input voltage against output voltage as is shown in phasor diagram (Fig. 5).

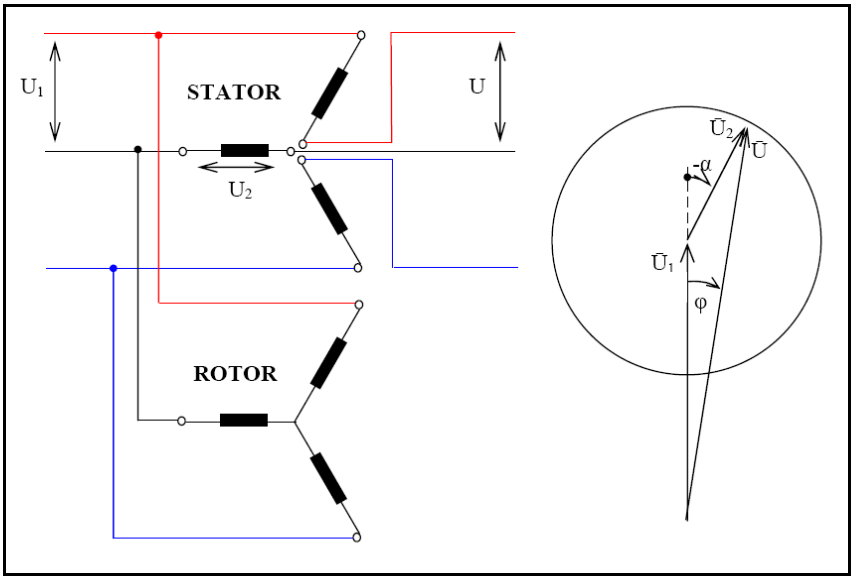


Fig. 5. Phasor diagram of inductive regulator.

In the fact of offset voltage was connected to the series three phase asynchrony motor, where rotor of second motor change phase sequence what in affect output voltage Ū is in phase with input voltage $\bar{U}_1$ (Fig.6). Regulating range is unchanged from 0V to 400V.

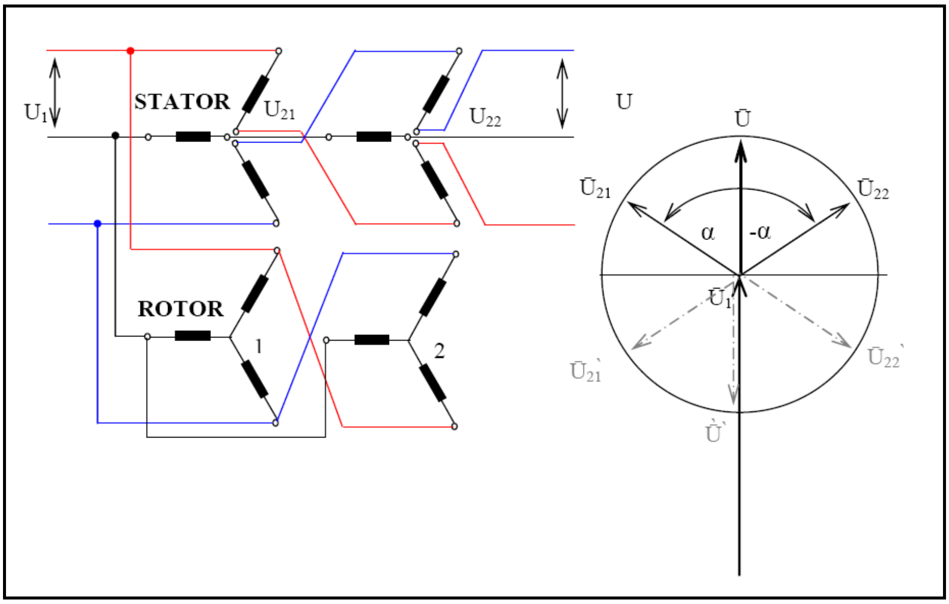
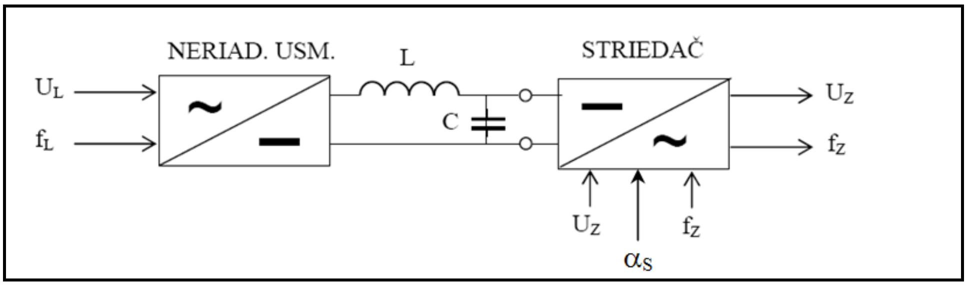


Fig. 6. Phasor diagram of inductive regulator with serial asynchrony motor.

3.2 Frequency converters

In the area of industry automation frequency convertors reach high dynamics. Industry applications are represented by drivers for pumps, compressors, conveyors, ventilators, intelligent drives of robots, positioning, packaging and polytrophic machining and high voltage drivers of high speed wind power plants, testing motors, centrifuge in sugar industry or shipping industry. These drivers are powered from frequency converter. They can be used on the orders of 100kW, where sizes are relatively small. Diodes, transistors, thyristors, IGBT transistors and so on are the most commonly used in the industry.

Alternating frequency converters (Fig. 7) are in fact used for controlling speed and torque moment of inductive electric motors. Their internal technique has in fact possibilities to exceed their nominal values without any destruction.



None controlled rectifier   Inverter

Fig. 7. Principal schema of frequency convertor .

Nowadays is used specially controlled rectifier, where gate impulse α change average value of input voltage for semi-filter circuit L-C and secondary effective output voltage of frequency converter. Power inverter is controlled by control angel α conduction times of thyristors. The main conditions of frequency regulation is constant U/f, when is also magnetic flow as a constant.

$$U_i = 4{,}44.f.N_V.k_V.\Phi \cong U \quad \text{[V]} \tag{3}$$

$$\Phi = \frac{1}{4{,}44.N_V.k_V}.\frac{U}{f} = K.\frac{U}{f} \quad \text{[Wb]} \tag{4}$$

3.3 Applications in manufacturing Technologies

In all devices using electric motors is problematic about controlling their speed an important part of creating system. Their secondary parameter is in general regulation any move in the production, where is used electric actuators.

Their applications in the manufacturing technologies have wide range of function especially in full automotive producing. This way of producing is characteristic of high level of flexibility on in and out puts conditions, which are also influenced by movement of drivers. Very often we can find in producing robotic arms, manipulators, conveyors and their systems, feeding devices, and so on, which have to be regulated. In many cases frequency converter is an internal part of whole device, which appear as a feed rate or a distance to the coordinate system. In fact it´s regulating the rotation speed of motors, which secondary effect are mentioned variables.

Frequency converter Micromaster is specialized for regulation of rotation speed of motors with power outputs from 100W to 11kW. Frequency converter Micromaster is produces in three main modifications as is indicated in table below (Tab. 1).

Tab. 1. Modifications of frequency converter by SIEMENS Micromaster.

Nominal value of power	0.12 - 3 kW	0.12 – 5.5 kW	0.37 - 11 kW
Input voltage	1 x 200 - 240V	200 - 240V 3AC	380 - 480V 3AC
Output voltage	1x 0 - 240V	1(3) x 0 - 240 V	3 x 0- 480 V
Frequency interval	0 - 650 Hz		
Step	0.01 Hz		
Overload	150% - 60s		
Type of regulation	vector without feedback		
Internal control modules	FCC , U/f		
Working temeprature	- 10 °C - +50 °C		
Type of motors	reluctance, asynchronous, step, synchronous, ...		
Using	pumps, ventilators, conveyors,...		

Micromaster 420 is suitable for applications of drivers system to control and regulation rotation speed for pumps, ventilators, transport techniques, and so on.

Modern electric drivers must work in all four quadrants of moment-rotation characteristic. Frequency converter working in four quadrants allows very simple regulate DC motors by using Pulse width modulation, which change effective value of output voltage.

In the table below is financial compare (Tab.2) about frequency converter offered in our markets. Prices are given without extra accessories.

Tab. 2. Overview of frequency converter on our market.

S. n.	Type	Input voltage	Output voltage	Power
1.	MITSUBISHI - FR-E740-095-EC	3 x 380 - 400 V	3 x 380-400 V	3.7 kW
2.	MITSUBISHI - FR-D720S-100-EC	1 x 200 - 240 V	1 x 200 - 240 V	2.5 kW
3.	PW motors - VACON-0010-3L-0012	3 x 380 - 400 V	3 x 380 - 400 V	5.5 kW
4.	Control Techniques - SKCD200300	1 x 230 V	1x 200V	3 kW
5.	Control Techniques - SKC3400300	3 x 400 V	3 x 400 V	3 kW
6.	Siemens - Micromaster 420	3 x 200 - 240 V	3 x 200 - 240 V	5.5 kW

4 CONCLUSION

The selected configuration of frequency convertor SIEMENS Micromaster 420 combined with Siemes Simoreg represents the high quality, which guaranty required parameters for high power AC and DC motors. This ensures long-term stable operation of the whole system for high-speed measurements.

REFERENCES

[1] MIHAĽOV, Peter: Meracie zariadenie pre vysokootáčkové motory malého výkonu Diplomová práca Košice: TU-FEI, 2008
[2] Dr. Staiger, Mohilo: Bedienungsanleitung fur DC und AC – 4 Phasen Motorenprufstand
[3] SIEMENS: Simoreg DC master Catalog DA 21.1: 2009
[4] SIEMENS: Frekvenčný menič MICROMASTER 420 :2009
[5] TIMKO, Jaroslav – FEDÁK, Viliam: Elektrické pohony Košice: TU-FEI, 1998.
ISBN 85-637-88

[6] VASILE, Nasui - RADU, Cotetiu – NICOLAE, Ungureanu: Studies of the Performances of Dynamic Regimen for Electro Mechanic Actuators, 2010, p 70-71, Mannufacturing engineering, vol. 2, ISSN1335-7972
[7] PITEĽ, Ján: Trends in actuators of manipulators for automation of manufacturing technologies, 2008, p71-73, Mannufacturing engineering, vol. 4, ISSN1335-7972
[8] VUKELIČ, Djordje – HODOLIČ, Janko – AGARSKI, Boris: Handling automation of fixture and fixture elements in flexible technological structure, 2008, p86-90, Mannufacturing engineering, vol. 4, ISSN1335-7972