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Condition Monitoring And Fault Diagnosis Of AC Machine Using Labview Through Serial Communication

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***Abstract*:**

AC machines are a vital component of many industrial processes . Monitoring the condition of those machinery can significantly reduce the cost of maintenance and the risk of unexpected failures by allowing the early detection of faults and also the range of safe operation of that particular machine. In condition-based maintenance, one does not schedule maintenance or machine replacement based on previous records or statistical estimates of machine failure. Thus the key for the success of condition-based maintenance is having an accurate means of condition assessment and fault diagnosis. It can be implemented in the motor control center remotely from the motors being monitored.

1. INTRODUCTION:

It is estimated that more than 50% of the world electric energy generated is consumed by electric machines. Condition monitoring of those machines have been a challenging task for the engineers and researchers mainly in industries. There are many condition monitoring methods. In this project we utilize the serial communication port of PIC micro controller to carry out the monitoring of the AC machine (here Universal motor). Here Universal motor is used for the condition monitoring purpose due to its simple construction and wide use of it in domestic appliances. Mostky these motors are used in Electric trains as traction motor so before dispatch the motor it should be monitored for any faults and this setup can be used for other AC machines also like Induction motor etc.. Thus monitoring the performance of this AC machines may help in reduction of breakdowns in industry as well as wherever it is used.

In the proposed setup Electrical quantities like Stator current, stator voltage, reverse current, modulation index, power factor and temperature are monitored and faults like high staring current introduction to the circuit/motor , reverse current flowing to the mains are diagnosed using relay operations.

2. MODELLING OF UNIVERSAL MOTOR IN GENERAL FORM:

The lumped-parameter equivalent circuit of the universal motor is developed in the following manner. The field and armature quantities are represented with f and a subscript:

$$V_a = r_a.i_a + p\,\lambda_a \quad (1)$$

$$V_f = r_f.i_f + p\,\lambda_f \quad (2)$$

$$\lambda_a = L_{aa}.i_a + L_{af}.i_f \quad (3)$$

$$\lambda_f = L_{fa}.i_a + L_{ff}.i_f \quad (4)$$

where ,

p= derivative operator

v_f = stator voltage (volt)

r_a= total rotorresistance including brushes (ohm)

r_f =total ststor resistance (ohm)

i_a= rotor current (ampere)

i_f = stator current (ampere)

L_{aa} =rotor self inductance (henry)

L_{af}=L_{fa}

Mutual inductance between satator and rotor (henry),
L_{ff} stator self inductance (henry)

Inductances vary with rotor position θ as

$$L_{aa} = \frac{(Lmax+Lmin)+(Lmax-Lmin)}{2} . \cos(2\theta) \quad (5)$$

$$L_{af} = L_{fa} = -L.\cos(\theta_r) \quad (6)$$

$$L = \frac{Na.Nf}{Raf} \quad (7)$$

L_{max} and L_{min} reflect the maximum and minimum values of rotor self inductance, respectively. N_a and N_f are the rotor and stator number of turns. The reluctance is represented by R.

Since stator self inductance does not depend upon the rotor position,

$$L_{ff} = \frac{N_f^2}{R_f} \quad (8)$$

α is the angle of brush shift if there is any

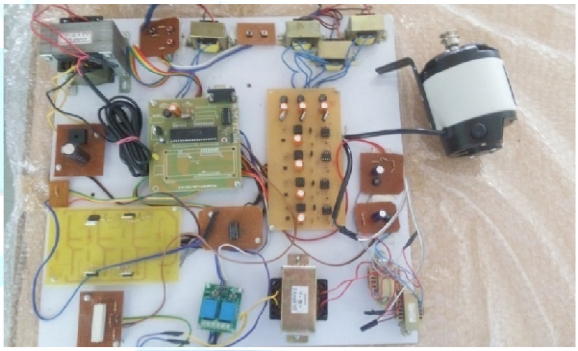
$$L_{aa2} = \frac{(Lmax+Lmin)+(Lmax-Lmin)}{2} . \cos(2\alpha) \quad (9)$$

$$L_{aa1} = (L_{min} - L_{max}) . \sin(2\alpha) \quad (10)$$

$$L_{af1} = L.\cos(\alpha) \quad (11)$$

$$L_{af2} = L.\sin(\alpha) \quad (12)$$

$$V_a = r_a.i_a - w_r.L_{aa1} . i_a + L_{aa2}.\frac{dia}{dt} + w_r . L_{af1} .i_f + L_{af2} . \frac{dif}{dt} \quad (13)$$



$$V_f = r_f .i_f + L_{fa} . \frac{dia}{dt} + L_{ff} . \frac{dif}{dt} \quad (14)$$

Considering (13) and (14)

$$V_t = V_a + V_f \quad (15)$$

The generalized equivalent circuit of the Univwersal Motor is shown figure1

The following well-known electromechanical equations are used in simulation package

$$T_e = K.\varphi.i_a \quad (16)$$

$$K = \frac{Z.p}{2\pi a} = \frac{Na}{\pi} \quad (17)$$

$$T_e = J.\frac{dw}{dt} + B.w + T_L \quad (18)$$

Where,

J = inertia (Nms^2)

B = friction coefficient (Nms)

K = torque coefficient

T_L = Load torque (Nm)

3. HARDWARE DESCRIPTION:

- Here in this project universal motorIs choosed for monitoring purpose.
- Two supplies are taken one for motor and other for controller
- MOSFET is used as switching device / inverter Current and voltage transformers are used for monitoring stator current and voltage respectively.
- Two relay circuit used for performing the required fault diagnosis operations
- Here PIC micro controller is used as controller of the project.
- For communication purpose PIC's Serial communication port is used to interface the hardware with LABVIEW.

4. SERIAL COMMUNICATION:

4.1 Serial Communication

There are several serial communication standards RS232, SPI, I2C etc. In which RS232 is an asynchronous method. It does NOT have a synchronizing clock line. One way data requires only one conductor line. It is a two way communication, two lines between the two device. One for sending data called the **Tx** and one for receiving data called the **Rx**.

Here data can be sent at the same time can be received, it is known as duplex.Other serial communication like SPI and I2C are generally used for short range communication like between two IC's. RS232 is based on serial communication and is used for short range as well as long range communication.

4.2 PC's Serial Port

Modern computers don't have serial communication port as of the older one. For utilizing serial communication from the PIC micro controller we use USB to SERIAL Converter.

FIG 2. USB TO SERIAL CABLE

Serial port connecter has 9 pin d type male/female connecter, among the 9 pins three pins are used for serial communication.

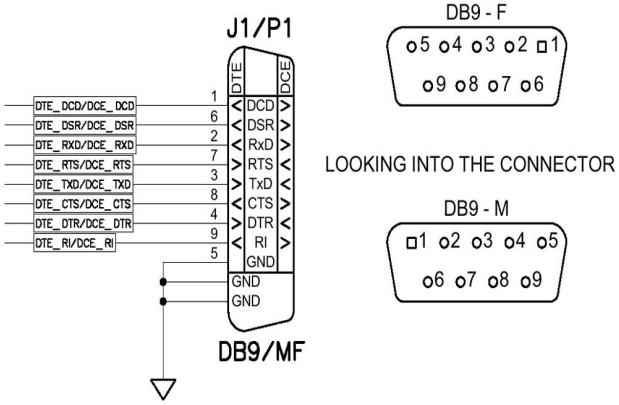


FIG 3. DB9 MALE-FEMALE CONNECTOR

4.3 Level Conversion

Voltagee level on RS232 is differ from voltage used in microcontrollers Interfacing of the above needs to convert the voltage level using a level converter. A level converter will convert RS232 level signals -12V & +12V from PC to TTL level signal +5V & 0V.

The above said operation can be performed by MAX32 IC which is developed for the level controlling purpose. ter

4.4 PIC16F877A's Serial Port

The serial communication pins of PIC16F877A is shown in the image below.

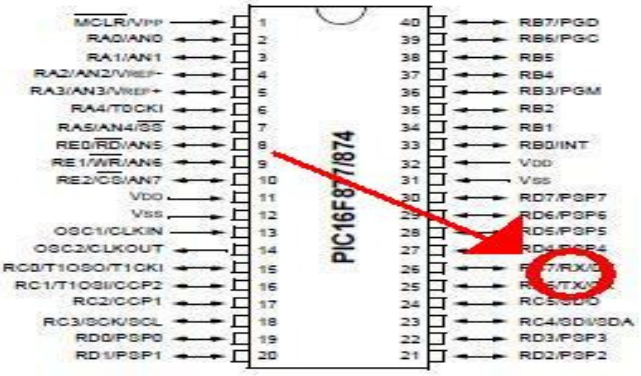


FIG 4. PIC SERIAL PORT

5. CONCLUSION :

Thus in this project basic and needful parameters such as stator current , stator voltage , power factor at which the motor runs , temperature of the motor, response of motor to the over modulation and the amount of reverse current that come toward the mains at the time of switching off of the motor are monitored.

Faults such as high starting current entering the circuit is diagnosed by the operation of relay, reverse current coming towards mains may cause damage to the inverter from which the circuit is energized this fault is diagnosed with the help of relay working and diverting that reverse current to the load resistor connected to it.

Condition monitoring of AC machine and fault diagnosis are made in this project. A detail literature survey is presented to summarize the state of art techniques that are applicable to the

methods proposed in this project. The motor may have small abnormality from the time of manufacture and it has some of the fault frequency components. Hence, in all condition monitoring methods, base measurements are taken for a healthy motor at the time of commissioning. A significant change in the amplitudes indicates a developing fault.The NI LabVIEW software is used to study these effects.

6. SCOPE FOR FUURE WORK :

This project may be further expanded to use for high range AC machines.

Further apart from electrical faults mechanical faults also can be monitored and diagnosed.

This can be expanded by introducing multiple stator and rotor fault types into a motor.

Rather than using serial communication for interfacing hardware with LABVIEW few signal processing techniques such as FFT , Wavelet analysis etc.

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