Lab2: Single-phase Induction Motors

Introduction

Single phase induction motors have cage rotors and a single-phase distributed stator winding. Such a motor does not develop self-starting torque and therefore will not start to rotate if the stator winding is connected to an ac supply. However, if the rotor is given a spin or started by auxiliary means, it will continue to run. These motors need a starting method, and they are classified according to the methods used to start them and are referred to by names descriptive of these methods. Some common types are resistance-start (split-phase), capacitor-start, capacitor-run, two-capacitor, and shaded-pole motors. The split-phase motor has an additional auxiliary winding which possess a higher resistance-to-reactance ratio than the main winding. The auxiliary winding will be in the circuit only during the starting period, then disconnected using a centrifugal switch. The capacitor start motor has a large capacitor (ac electrolytic type) connected in series with the auxiliary winding. This gives higher starting torque. Also, the auxiliary winding is disconnected after starting using a centrifugal switch. In case of capacitor-run motors, the capacitor that is connected in series with the auxiliary winding is not cut out after starting. This decreases the cost and improves the running performance.

Objectives

The purpose of the tests is to investigate and determine the starting performance characteristics as well as the running performance characteristics of single-phase induction motors.

Instruments and components

-Ac metering module.
-Wattmeter module.
-Power supply module.
-Split-phase/capacitor start motor module.
-Capacitor-run motor module.
-Electro-dynamometer module.
-Connection leads.

Procedure

1. Starting Performance

a) Investigate and examine the power supply module, the induction motors and their auxiliary equipment, and the electrodynamometer.
b) Set up the circuit as shown for the capacitor start motor.
c) With the capacitor out of the circuit, adjust the dynamometer field current to a quit high value. Starting from zero voltage applied to the motor, raise the voltage until a starting torque value enough to drive the motor at very low speed is reached. Record the starting torque (dynamometer reading), main current, auxiliary current and supply current.
d) Repeat the above test with the capacitor included in the motor circuit.
e) Repeat the test for the capacitor run motor.
f) Correct the starting variables for the rated voltage.

2. Running Performance

- For each of the capacitor start motor and the capacitor run motor, start the motor at no-load.
- Increase the load torque in steps and measure the input power, current and speed. The load torque is varied from zero up to a value at which the input current reaches 1.1 times the rated value.

3. Determination of the Equivalent Circuit Parameters

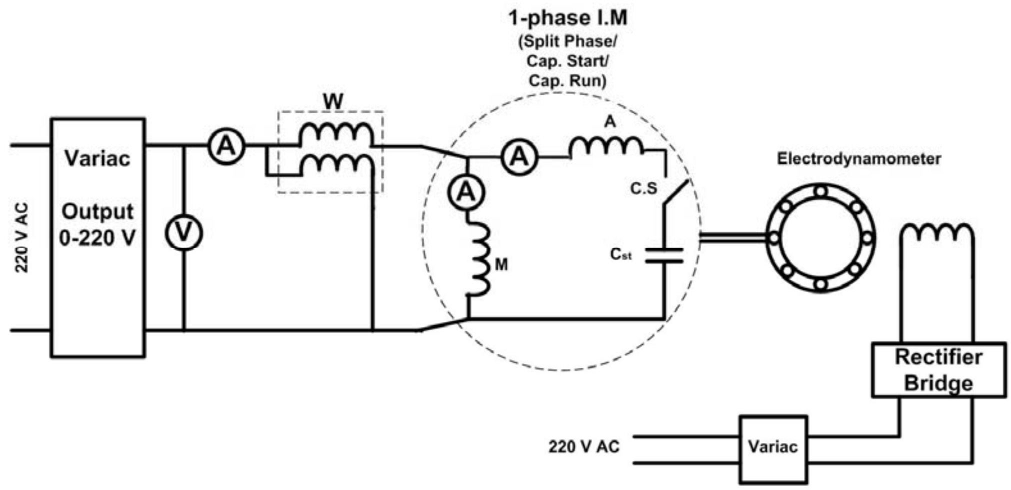
To determine the parameters of the single-phase induction motor when operates without the auxiliary winding two tests are performed; the no-load test and the standstill (short-circuit) test.

- The no-load test readings are obtained from the running test when the dynamometer torque is zero.
- The standstill test is carried out by disconnecting the auxiliary winding and applying a reduced voltage on the main winding such that the input current is the rated current. Then, the voltage and input power are recorded.

Report

The report should contain

a) Nameplate data of the motors and equipment.
b) Results.
c) Comments on starting and running performance.
d) Running performance characteristics (speed/torque, current/torque, input power/torque, Pf/torque and efficiency/torque curves) from the obtained results.
e) Calculate the parameters of the motor equivalent circuit and draw this circuit.



Connection Diagram

M: Main winding
A: Auxiliary winding
C. S.: Centrifugal switch (exists in case of split phase and capacitor-start motor only)
C: Capacitor (large capacitor in case of capacitor start motor and small capacitor in case of capacitor run motor)

Lab2:
Single-phase Induction Motors

Report

Name: ……………………………………………

Number: ……………………………………………

Lab results

1. Starting Performance

	Split-phase	Capacitor-Start	Capacitor-Run
I (A)			
I_M (A)			
I_A (A)			
V (V)			
T (N.m)			
T_{rated} (N.m)			

$$T_{rated} = \left(\frac{V_{rated}}{V}\right)^2 T_{measured}$$

Comments:

2. Running Performance

Motor I

T (N.m)	0	0.2	0.4	0.5	0.6	0.8	1
I (A)							
P_{in} (W)							
n (rpm)							
P_{out}							
η							
pf							

Motor II (Capacitor-Run)

T (N.m)	0	0.2	0.4	0.5	0.6	0.8	1
I (A)							
P_{in} (W)							
n (rpm)							
P_{out}							
η							
pf							

$P_{in} = V I_s \cos\varphi$

$P_{out} = T\omega$ $\quad \omega = \frac{2\pi n}{60}$ $\quad \eta = \frac{P_{out}}{P_{in}}$

Comments:

3. Determining the equivalent circuit parameters

Motor I

DC Test

V_{DC}=	I_{DC} =

$R_1 = \frac{V_{DC}}{I_{DC}} =$

R_1 =

Standstill test (locked rotor test)

V_{sc} =	I_{sc} =	P_{sc} =

$Z_{sc} = \frac{V_{sc}}{I_{sc}} =$ $\qquad R_{sc} = \frac{P_{sc}}{I_{sc}^2} =$

$X_{sc} = \sqrt{Z_{sc}^2 - R_{sc}^2} =$

$R_{sc} = R_1 + R_2'$

$X_{sc} = X_1 + X_2'$ $\qquad$ *Assuming that*

R_2' =
$X_1 = X_2'$ =

No-load test

V_{nl} =	I_{nl} =	P_{nl} =

$P_{nl} = I_{nl}^2 \left(R_1 + \frac{R'_2}{4}\right) + P_{rot}$

P_{rot} =

$Z_{nl} = \frac{V_{nl}}{I_{nl}} =$ $\qquad R_{nl} = \frac{P_{nl}}{I_{nl}^2} =$

$X_{nl} = \sqrt{Z_{nl}^2 - R_{nl}^2} =$

$= X_1 + \frac{X'_2}{2} + \frac{X_m}{2}$

X_m =

Motor II

DC Test

V_{DC}=	I_{DC} =
V_{DC}=	I_{DC} =

R_{1m} =
R_{1a} =

Standstill test

Main:

V_{sc} =	I_{sc} =	P_{sc} =

$Z_{sc} = \frac{V_{sc}}{I_{sc}} =$ $\qquad R_M = \frac{P_{sc}}{I_{sc}^2} =$ $\qquad R_2'$=

Z_M = +*j*

$X_M = \sqrt{Z_{sc}^2 - R_M^2} =$

Auxiliary:

V_{sc} =	I_{sc} =	P_{sc} =

$Z_{sc} = \frac{V_{sc}}{I_{sc}} =$ $\qquad R_A = \frac{P_{sc}}{I_{sc}^2} =$

Z_A = +*j*

$X_A = \sqrt{Z_{sc}^2 - R_A^2} =$

$R_A = R_{1a} + a^2 R_2'$

a =

Draw the equivalent circuit:

Nameplate Values
