Electronic starter for single phase induction motor

PROJECT NO: 104
SUPERVISOR: DR. WEKESA
EXAMINER: PROF MANG’OLI
Prepared by: GITONGA HILDA WANJIKU- F17/39921/2011
PROJECT OUTLINE

1. Project Objective
2. Introduction
3. Methodology
4. Results
5. Conclusion
6. Recommendation
PROJECT OBJECTIVE

To build an electronic starter for a single phase induction motor, rated 370 watts, that incorporates short circuit and overload protection.
INTRODUCTION-STARTER

- A starter is a device that controls the use of electric power to an equipment usually, a motor.
- As the name implies, starters ‘start’ motors. They can also stop them, reverse them, accelerate them and protect them. Starters are made from two building blocks, **contactors** and **overload protection**.
- Contactors control the electric current to the motor by repeatedly establish and interrupt an electric power circuit.
- Types of Contactors- Knife blade switch, Manual contactor, Magnetic contactor
OVERLOAD PROTECTION

- Overload refers to when too many devices are connected to a circuit or when electrical equipment is made to work beyond its rated capabilities.
- They protect the motor by sensing current going to the motor.
- Types of Overload relays:
  1. Thermal overload relays
    - Eutectic Relay
    - Bimetallic Relay
  2. Magnetic Overload Relay
Overload devices must be sized based on the motor nameplate current rating in accordance with 430.31.

Overload Protection [430.32(A)(1)]

Motors with a nameplate service factor rating of 1.15 or more must have their overload protection device, sized no more than 125% of the motor nameplate current rating.

Motors with a temperature rise not over 40°C must have overload protection device sized no more than 125% of the motor nameplate current rating.

Motors that do not have a service factor rating must have the overload protection devices sized at no more than 115% of motor nameplate ampere rating.
Service Factor means the motor has been designed to operate at 115% of rated hp rating continuously.

Means that the motor is designed to operate so that it will not heat up more than 40 degrees above its rating.
SHORT CIRCUIT

- A short circuit occurs when bare conductors touch and the resistance between them drops to almost zero. This reduction in resistance causes current to rise rapidly, usually to many times the normal circuit current.

- In the case of motors, at starting, voltage induced in the induction motor rotor is maximum \((s=1)\). Since the rotor impedance is low, the rotor current is excessively high. This large rotor current is reflected in the stator. This results in high starting current in the stator.

- This will adversely affect operation of other electrical equipment connected to the motor.
NEC Article 430.52(C) requires that motor short circuit protection to be sized from 150% to 300% of motor FLC.

Conductors are sized at 125% of motor FLC [430.22(A)].
MOTOR FULL-LOAD CURRENT/AMPERES

Motor nameplate full load amperes is the current the motor is expected to draw at rated horsepower, voltage, efficiency and power factor.

FLC is used to determine conductor ampacity or short circuit overcurrent protection.

The NEC codebook provides a worst case scenario of full load amperes rating otherwise known as full-load current as shown in the table.

<table>
<thead>
<tr>
<th>HP</th>
<th>115 V</th>
<th>230 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/6</td>
<td>4.4</td>
<td>2.2</td>
</tr>
<tr>
<td>1/4</td>
<td>5.8</td>
<td>2.9</td>
</tr>
<tr>
<td>1/3</td>
<td>7.2</td>
<td>3.6</td>
</tr>
<tr>
<td>1/2</td>
<td>9.8</td>
<td>4.9</td>
</tr>
<tr>
<td>3/4</td>
<td>13.8</td>
<td>6.9</td>
</tr>
<tr>
<td>1</td>
<td>16</td>
<td>8</td>
</tr>
<tr>
<td>1 1/2</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>24</td>
<td>12</td>
</tr>
<tr>
<td>3</td>
<td>34</td>
<td>17</td>
</tr>
<tr>
<td>5</td>
<td>56</td>
<td>28</td>
</tr>
<tr>
<td>7 1/2</td>
<td>80</td>
<td>40</td>
</tr>
<tr>
<td>10</td>
<td>100</td>
<td>50</td>
</tr>
</tbody>
</table>

Reprinted with permission from NFPA 70-1984, National Electrical Code®, Copyright © 1983, National Fire Protection Association, Quincy, Massachusetts 02269. This reprinted material is not the complete and official position of the NFPA on the referenced subject which is represented only by the standard in its entirety.
Starter circuitry

Motor Starter has two circuitry:

1. Power Circuit
2. Control Circuit
METHODOLOGY

Å To switch on the supply to the motor, switch S1 is pressed momentarily, which causes the supply path to the primary of transformer X1 to be completed via N/C contacts of relay RL1.

Å Relay RL2 gets energized due to the DC voltage developed across capacitor C2 via the bridge rectifier.
RESULTS

- Once the relay energizes, its N/O contacts RL2(a) provides a short across switch S1 and supply to the primary of transformer X1 becomes continuous, hence RL2 latches even if S1 is opened.

- The other N/O contacts RL2(b) on energization, connect the voltage developed across capacitor C2 to RL3, which thus energizes and completes the circuit to the motor, as long as current is within limit for 0.5HP.

- When the current developed by the motor exceed 5A, RL1 is energized and trips the supply to relays RL2 and RL3, which was passing via the N/C contacts of RL1.
ELECTRONIC STARTER

- As a result, the supply to the motor trips.
- The red on pushbutton is a N/O while the green off pushbutton is a N/C type.
- Capacitor C1 is used to provide necessary delay during energization and de-energization and provide smoothing of the rectified output.
- Diodes across the relays are used for protection as free wheeling diodes.
- Starters for 0.5HP are not easily available in the market.
- Parts used in this circuit are easily available in most of the local markets.
ELECTRONIC STARTER
OVERLOAD PROTECTION CIRCUIT
CONCLUSION

- Overload Relays are inexpensive, however the result of selecting the wrong one for the application can be catastrophic for your motor.
- The set objectives were achieved:
  - Design of an electronic starter that provided both short circuit and overload protection.
RECOMMENDATION

The areas of improvement in the project include:

1. Implementing an alternative electronic starter that is current sensitive and accurate to ensure protection of both the motor and equipment connected to it.
2. Design of a less bulky system, preferably program based that works instantly in the case of an overload.
3. Implementing an automatic reset electronic starter.
THANK YOU.