International Journal of Innovative Computing, Information and Control
Volume **6**, Number **2**, February **2010**

ICIC International ©2010 ISSN 1349-4198
pp. **423–438**

DEVELOP A DE-BOUNCE AND ENERGY-SAVING CHARACTERISTIC AC PM CONTACTOR AND ITS MICROCONTROLLER-BASED ELECTRONIC CONTROL UNIT

Chieh-Tsung Chi

Department of Electrical Engineering
Chienkuo Technology University
No. 1, Chieh Shou N. Rd., Changhua, Taiwan
jih@cc.ctu.edu.tw

Received August 2008; revised December 2008

Abstract. *A new type of an ac permanent magnet (PM) actuator and its electronic control circuit (ECU) based on a microcontroller will be presented in this paper. When one wants to switch the ac PM contactor on or off, a power on or off signal is then first sensed by the ECU. Shortly, the ECU immediately commands the actuator to execute the making or breaking courses at a purposely selected closing phase angle of the ac voltage source and then the actuator drives contactor closed or opened. In particular, the ac voltage source applied to the actuator is completely cut off once when the contactor has entered into the holding process. Significant improvements, such as little energy dissipation, noise-free pollution and no voltage-sag events, are achieved. The feasibility of the actuator was validated by comparing the simulation results with the experimental results. The function and its benefits offered by the proposed ac PM actuator were verified and illustrated through simulation and experimental tests as well.*
Keywords: Electronic control unit (ECU), AC permanent magnet (PM) actuator, Contact bounce, AC electromagnetic (PM) actuator, Closing phase angle

1. **Introduction.** As we know, contactors are simple and inexpensive devices. They have been extensively used in all low-voltage apparatus. The trend is that contactors are increasingly applied in the development of the industry. So that more and more engineers concern about the contactor's using lifespan, energy dissipation and operating reliability. When contactors and the other switching devices perform the closing operation, arcs are often produced. The amount of arc during operation is deeply determined by the particular operating and loading conditions. For certain loads, such as induction motors, the direct on-line starting current is perhaps ten times the rated current of the load. Contact bounces are generally produced after the mechanical contacts closing. If the bouncing problem of contacts is integrated with the starting current of motors, arcs are produced between the contacts, not only related to contact erosion and possible contact welding, but also since it causes electromagnetic interference (EMI), which leads to problems with electronic control circuits [1,2].

Significant disadvantages are often found in the applications of the ac electromagnetic (EM) actuator. For example, those ac EM actuator produces noise pollution at lower voltage, consumes much more energy to hold the armature during the holding process, their coils are easy to be burnt due to frequent working state and the abnormal dropouts are resulted from the power line disturbances like voltage sag events. To overcome the these drawbacks produced by ac EM actuators, a variety of the permanent magnet (PM) actuators are designed for the development of the ac PM contactor.