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Converter Fed DC Motor Speed Control Open Loop and Closed Loop Control

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Abstract: ***Single phase uncontrolled rectifiers are extensively used in a number of power electronic based converters. In most cases they are used to provide an intermediate unregulated dc voltage source which is further processed to obtain a regulated dc or ac output. Thyristors are semi controlled devices which can be turned ON by applying a current pulse at its gate terminal at a desired instance. However, they cannot be turned off from the gate terminals. Therefore, the fully controlled converter continues to exhibit load dependent output voltage / current waveforms as in the case of their uncontrolled counterpart. Working principle of thyristors based single phase fully controlled converters will be explained first in the case of a single thyristor halfwave rectifier circuit supplying an R or R-L load. However, such converters are rarely used in practice. Full bridge is the most popular configuration used with single phase fully controlled rectifiers.***
Index Terms – DC motor, speed, converter, open loop, close loop.

I. INTRODUCTION

Semiconductor converters may be grouped into three main categories, According to their functions.

A. Transfer of power from an alternating current (ac) supply to direct current (dc) form. This type of converter is usually called a rectifier.
B. Transfer of power from a direct current supply to alternating current form. This type of converter is usually called an inverter.
C. Transfer of power from an ac supply directly into an ac load of different frequency. This type of converter is called a cyclo-converter or a matrix converter.
D. Transfer of power from a direct current supply directly into a direct current load of different voltage level. This type of converter is called a chopper converter or a switch-mode converter.

II. RECTIFIERS

The process of changing AC into DC is called *rectification.* Where the application requires fixed voltage DC., the switching element is a diode. Where the application requires variable voltage DC., controlled rectifiers are used. These are generally classified in to

1) Single phase controlled converter /Single phase Rectifier
2) Three phase controlled converter / three phase rectifier

Single phase ac-to-dc converters are generally limited to a few kilowatts, and for higher levels of d.c. power output three-phase line commuted converters are used owing to restrictions on unbalanced loading, line harmonics, current surge and voltage dips. Increase in ripple frequency also reduces the filter size. converter which can be operated both in rectifying and inverter modes are called fully controlled converters. When power flow can only occur from ac-to-dc, the converter is known as semi converter, or half controlled converter. Fully controlled converters find applications in high voltage dc power (HVDC) transmission, d.c. and a.c. motor drives with regenerative breaking capabilities.

The major components of the SINGLE PHASE CONVERTR fed dc motor drive is (1) 1Ø SCR Power module (2) Digital PWM Controller (3) Motor.

A. 1Ø SCR Power Module

The SCR has two states, On and Off, and allows current to flow in only one direction. An SCR unit is composed of two SCRs arranged to control AC power. SCRs can remain in the off state even though the applied potential may be several thousand volts; in the on state, they can pass several thousand amperes. When a small signal is applied the SCR will turn on in 10-100 microseconds. Once turned on it will remain on until the current through it is reduced below a very low value called the holding current.

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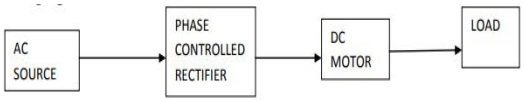
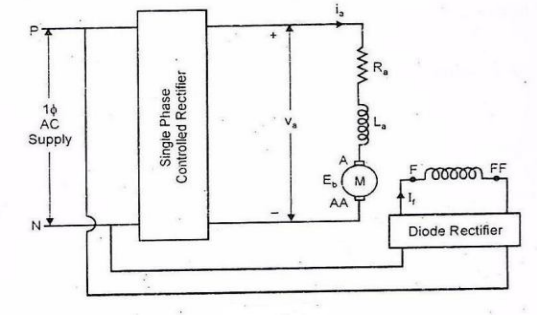
III. SINGLE PHASE CONTROLLED RECTIFIER FED DC DRIVES:



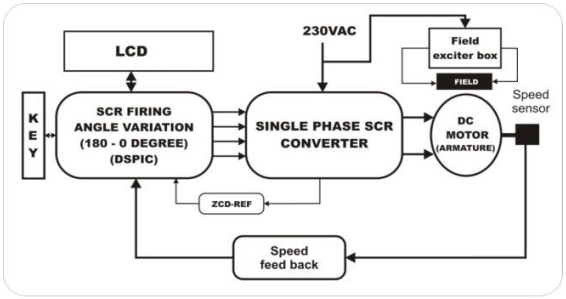
Here AC supply is fed to the phase controlled rectifier circuit.AC supply may be single phase or three phase. Phase controlled rectifier converts fixed AC voltage into variable DC voltage. Here the circuit consists of SCR's .By varying the SCR firing angle the output voltage can be controlled. This variable output voltage is fed to the DC motor. By varying the motor input voltage, the motor speed can be controlled.



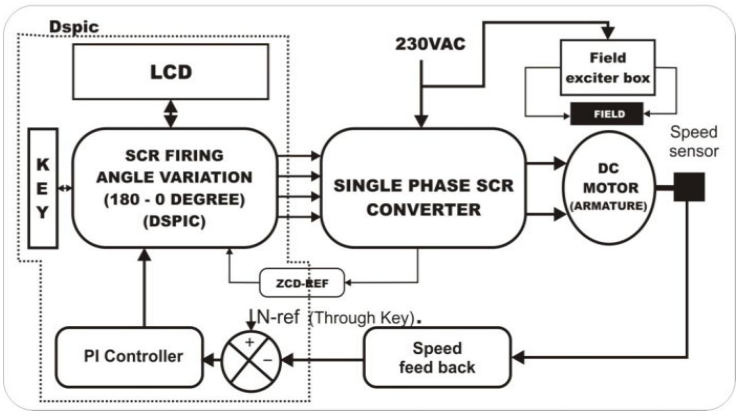
The armature voltage is controlled by means of a half wave controlled or half controlled or full convener. l¢ AC supply is fed to the single phase controlled rectifier. This controlled rectifier converts fixed AC voltage into variable DC voltage. By varying the firing angle of this converter, we can get variable DC voltage. The field winding is fed from the AC supply through a diode bridge rectifier.

IV. BLOCK DIAGRAM

A. Open Loop Control



B. Closed Loop Control



V. SPECIFICATIONS

Power circuit input :1Ø (0-230VAC)
Output : 0- 200V DC (for 1Ø SCR Converter)
Capacity : 5A (output)
Power Device : SCR (SEMIKRON Make /Model SKKT 57B16E) & Diode (SEMIKRON Make /Model MD7LU5512)

A. PWM Inputs (From External Controller)

1) Maximum numbers of input : 4 Numbers
2) Maximum PWM Voltage : 5V
3) Firing angle variation : 180-0degree

B. PWM Inputs (From External Controller)

1) Maximum numbers of input : 4 Numbers
2) Maximum PWM Voltage : 5V
3) Firing angle variation : 180-0degree

VI. DC MOTOR

A. A DC motor is any of a class of rotary electrical machines that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current flow in part of the motor.

B. DC motors were the first type widely used, since they could be powered from existing direct-current lighting power distribution systems. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances. The universal motor can operate on direct current but is a lightweight brushed motor used for portable power tools and appliances. Larger DC motors are used in propulsion of electric vehicles, elevator and hoists, or in drives for steel rolling mills. The advent of power electronics has made replacement of DC motors with AC motors possible in many applications like Lathe Machines, Centrifugal Pumps, Fans, Blowers, Conveyors, Lifts, Weaving Machine, Spinning machines.

VII. OTHER FEATURES

A. Pulse transformer is provided for SCR Gate pulse isolation in all SCRS

B. RC Snubber Circuit is provided for all SCR's.

VIII. ADVANTAGES

A. SCR power controllers provide a relatively economical means of power control. SCR power controllers cost less and are more efficient than satiable core reactors and

B. Extremely fast response: The SCR controller can switch load power on and off extremely fast providing the means to respond rapidly to command changes, load changes and power supply changes. This feature allows the control of fast responding loads and eliminates the negative effects of variations in load or supply voltages that can occur with other types of control.

C. Selectable control parameters: The SCR power controller can control the average load voltage, the RMS value of the load voltage, the RMS or the average load current or load power. It can also provide useful features such as current and voltage limiting. The ability to control the desired parameter as a function of a command signal and to incorporate limiting features is not normally available with other types of control.

D. Minimum maintenance: Because they are solid state there are no moving parts to wear out or replace. Therefore, the routine replacement required in some forms of control is eliminated.

E. SCR power controllers over other forms of control include,

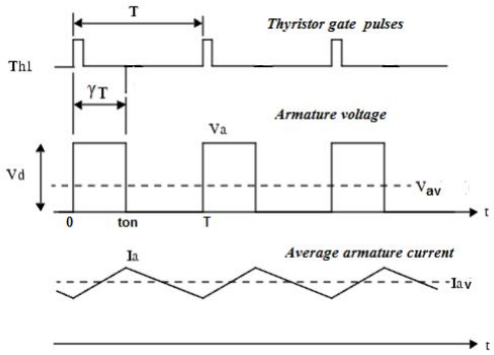
F. Problems of mechanical devices. Features and benefits of High reliability: Because the SCR power controller is a solid-state device, there are no inherent wear-out modes. Thus, they provide virtually limitless and trouble free operation.

G. core reactors and variable transformers. Compared to contactors, SCR power controllers offer a much finer degree of control and do not suffer from the maintenance Infinite resolution : Power, current or voltage can be controlled from zero to 100% with infinite resolution. This capability allows extremely accurate, stepless control of the process.

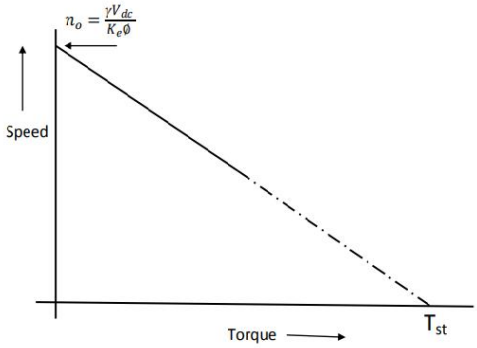
H. variable transformers. Compared to contactors, SCR power controllers offer a much finer degree of control and do not suffer from the maintenance Infinite resolution: Power, current or voltage can be controlled from zero to 100% with infinite resolution. This capability allows extremely accurate, stepless control of the process.

I. SCR power controllers provide a relatively economical means of power control. SCR power controllers cost less and are more efficient than satiable core reactors and

Output Waveforms



Speed Torque Characteristics



IX. CONCULSION

This paper presents a novel neural network (NN)-based model reference adaptive control (MRAC) to improve the trajectory tracking performance of a DC motor. The controller is used to change the duty cycle of the converter and, thereby, the voltage fed to the armature of the separately excited motor to regulate the speed. Finally, simulated and experimental results show that on the one hand the proposed controller provides high-performance dynamic characteristics, and on the other hand that this scheme is robust with respect to load disturbances.

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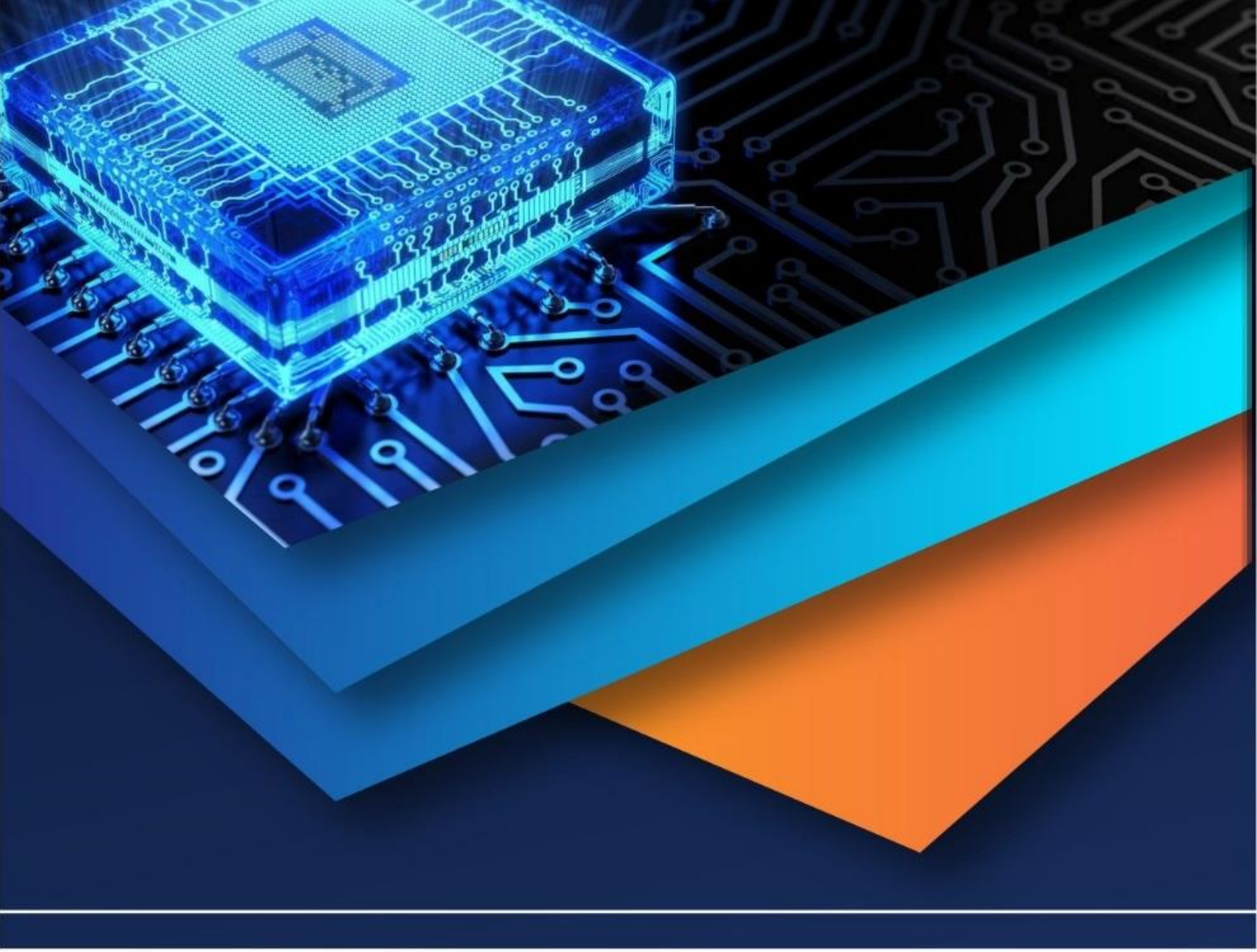

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