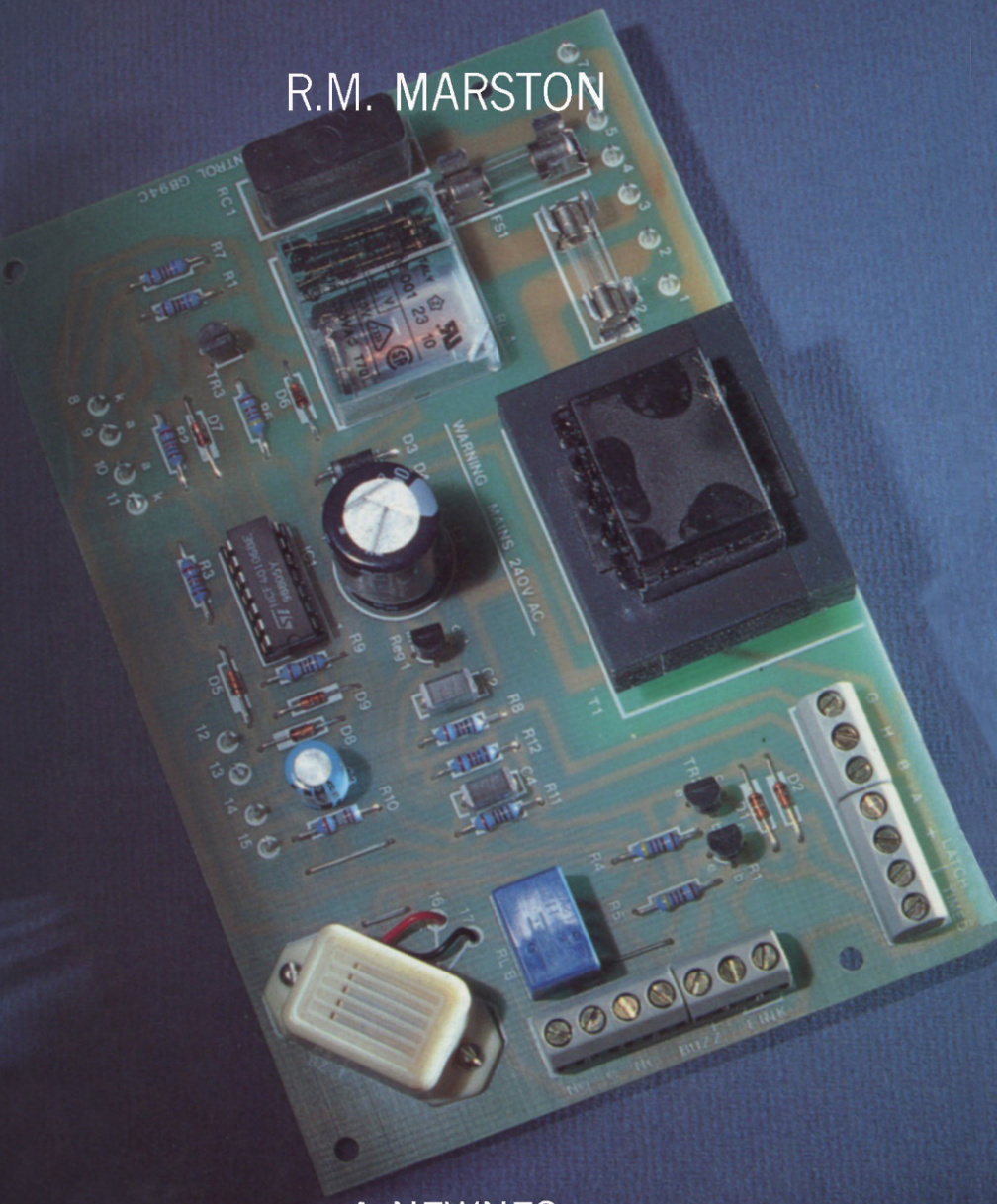
# POWER CONTROL CIRCUITS MANUAL

R.M. MARSTON

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# Power Control Circuits Manual

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Heinemann Newnes

*To Brenda, the true power in the Marston household*

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# Preface

Electronic power control circuits can be used to manually or automatically control the brilliance of lamps, the speed of motors, the temperature of heating devices such as electric fires or radiators, or the loudness of audio signals, etc. This control can be achieved using electromechanical switches or relays, or electronic components such as transistors, SCRs, TRIACs, or power ICs, etc. This book takes an in-depth look at the whole subject of electronic power control, and in the process presents the reader with a vast range of useful circuits and diagrams.

The book is specifically aimed at the practical design engineer, technician, and experimenter, as well as the electronics student and amateur, and deals with its subject in an easy-to-read, down-to-earth, non-mathematical but very comprehensive manner. Each chapter deals with a specific aspect of power control, and starts off by explaining the basic principles of its subject and then goes on to present the reader with a wide range of practical application circuits.

The book is split into eight distinct chapters. Chapter 1 explains the basic principles of electrical-electronic power control, and Chapter 2 shows practical control circuits using conventional switches and relays. Chapter 3 describes ways of using CMOS devices as low-power electronic switches, and Chapters 4 and 5 deal with AC and DC power control systems and present sixty-eight practical application circuits.

One of the most important sections of the book is Chapter 6, which takes a close look at ways of controlling DC motors, including those of the 'stepper' and servo type, and presents forty-two practical circuits. The final two chapters deal with audio power

control and DC power supply systems, and present a further total of sixty-two circuits.

Throughout the volume, great emphasis is placed on practical 'user' information and circuitry, and the book abounds with useful circuits and graphs; a total of 283 diagrams are included. Most of the solid state devices used in the practical circuits are modestly priced and readily available types, with universally recognized type numbers.

# 1 Basic principles

An electrical or electronic power control circuit can be defined as any circuit that is used to control the distribution or the levels of AC or DC power sources. Such circuits can be used to control (either manually or automatically) the brilliance of lamps, the speed of motors, the temperature of heating devices such as electric fires or radiators, or the loudness of audio signals, etc., or they can be used to manually switch power to these or other devices, or to switch power automatically when parameters such as temperature or light intensity, etc., go beyond pre-set limits.

A variety of devices can be used in power control applications. These range from simple switches and electromechanical devices such as relays and solenoids, which can be used as low-speed power switches, to solid-state devices such as transistors, FETs, CMOS multiplexers, SCRs or TRIACs, or power ICs, etc., which can be used as high-speed power switches or magnitude controllers. This opening chapter describes basic electronic power control principles, and shows how the above devices can be used in power control applications at levels ranging from a fraction of a milliwatt to several kilowatts.

## Power switching circuits

All electric power controllers fit into either of the two basic categories: power switchers (such as a lamp on/off switch); and power level controllers (such as a lamp dimmer). *Figure 1.1* shows examples of three basic types of power switching circuit, and *Figures 1.2* to *1.5* illustrate the operating principles of four different types of power level control circuit.

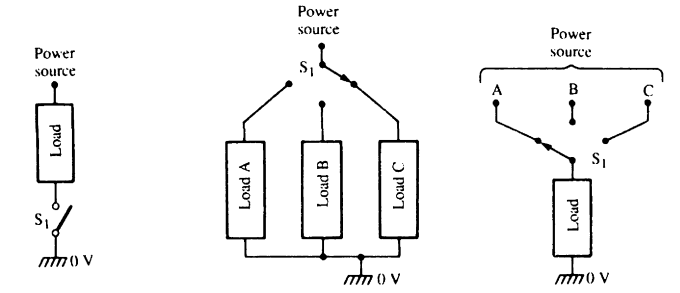


Figure 1.1 *Three basic types of power switching circuit*

The three basic switching circuit types are the on/off controller (*Figure 1.1(a)*), which is used to switch power to a single load, the power distributor (*Figure 1.1(b)*), which switches power to one or other of several different loads, and the power selector (*Figure 1.1(c)*), which feeds one or other of several different power sources to a single load.

Note in *Figure 1.1* that power switching is shown via ordinary electric switches, but in practice these can easily be replaced by sets of relay contacts or by any of a variety of types of solid-state switch.

## DC power control

*Figure 1.2* shows the basic circuit of a simple DC power level controller in which 0 to 12 V is available on $RV_1$ slider and is fed to the load via a current-boosting voltage follower buffer stage. Note that this type of circuit is not very efficient, since all unwanted power is 'lost' across the buffer stage. If, for example, the load is

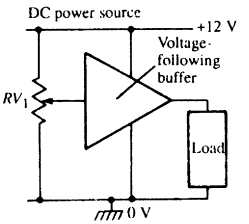


Figure 1.2 *Simple DC power level controller*