

DC POWER CONTROL OF SWITCHING DEVICES

FIELD OF THE INVENTION

This invention relates to a system for controlling actuation of mains powered electrical devices, using a low voltage, direct current control circuit to command and effect switching of power to the devices. The invention has been developed and is hereinafter described by way of example in the context of a system that utilises a central processor which is arranged to act on command signals and issue actuating signals for the purpose of switching power to devices in a domestic residence or other building.

BACKGROUND OF THE INVENTION

In a system to which the invention relates, common control circuit wiring is employed to carry command signals, actuating signals and current at a level sufficient to effect actuation of switching relays. This approach minimises the amount of wiring required for a given system installation but it does impose a requirement for voltage regulation in order that reliable operation will occur with changing circuit conditions, including changes to the size of the installation. The inclusion of a voltage regulated, direct current power supply as such does not present any difficulties, but a problem occurs when attempting to modulate the otherwise constant control circuit voltage with command and/or actuating signals. That is, a conventional regulated power supply will present zero impedance to an alternating signal and, thus, effectively absorb the command and actuating signals.

One attempt has been made to avoid this problem by arranging for the response time of voltage regulation to be slow relative to the frequency of modulation used by both the command and the actuating signals. However, this solution requires the introduction of R.C time constant circuit components, resulting in consequential power loss and imposing limits on the number of load devices that may be connected to a given installation.

DESCRIPTION OF THE INVENTION

The present invention seeks to avoid this problem, without increasing the amount of control circuit wiring, by arranging for the control circuit voltage to be regulated between two levels at the modulation rate of the control and actuating signals.

Thus, the present invention may be defined broadly as providing a system for controlling the connection of power to electrical devices by way of switching devices and which comprises a low voltage, direct current power supply, an electrical connection between the power supply and the switching devices, and means for generating and feeding to the electrical connection pulse-form control signals. The system is characterised in that the power supply includes means for detecting the presence of the pulse-form control signals and means for modulating the output voltage of the power supply between two discrete levels responsive to and at a rate corresponding with that of the pulse-form control signals.

The invention in a more specific, preferred form may be defined as providing a system for controlling the connection of power to electrical devices by way of switching devices and which comprises a low voltage, direct current power supply, a plurality of command units connected to and powered from the power supply by way of an electrical connection, and a plurality of switching devices connected to and powered from the power supply by way of the electrical connection. Respective ones of the command units are arranged to generate uniquely coded pulse-form command signals and to feed the command signals to a central processing unit by way of the electrical connection, and the central processing unit is arranged to generate pulse-form actuating signals having codes determined by respective command signals and to feed the actuating signals to the switching devices by way of the electrical connection. The system is characterised in that the power supply incorporates a voltage regulator which includes means for detecting the

presence of the pulse-form signals and means for modulating the output voltage of the power supply between two discrete levels responsive to and at a rate corresponding with that of the pulse-form signals.

5 The two discrete output voltage levels of the power supply comprise an upper level which corresponds to the unmodulated voltage level of the supply and a lower level corresponding to the minimum voltage level required for the command and/or actuating signals. The upper voltage
10 level will typically be in the order of 15 to 30 volts, and the difference between the upper and lower voltage levels will typically be in the order of one to five volts.

 In use of the above defined system (when in its
15 preferred form) the switching devices are arranged to effect connection of power to associated ones of the electrical devices responsive to detection by the switching devices of appropriately coded actuating signals.

20 PREFERRED FEATURES OF THE INVENTION

 The command units preferably comprise signal generators that produce digital form coded signals when operated. Operation may be effected manually, for
25 example by operation of a push-button type switch, or remotely from a further signal generator such as an infra-red signal radiating device.

 The switching devices preferably comprise electromagnetic relays having contacts which are either normally open or normally closed, depending upon the electrical
30 devices to which the relays are required to switch power. Alternatively, the switching devices may comprise bistable relay units. In either case, each of the switching relays includes circuitry which is arranged to detect for the existence of an appropriately coded
35 actuating signal from the central processing unit and to initiate a switching operation upon detection of the appropriate actuating signal.

The central processing unit may comprise any conventional type of stand-alone processor or computer and it preferably incorporates a keyboard or other mechanism to permit data entry and, possibly, programming
5 of the system to meet specific operational requirements.

The system may be operated at various levels of complexity, and at the simplest level the system may be employed to control energisation of predetermined room lighting responsive to manual activation of one or more
10 switch-operated command units. Again at a simple level, the system may be programmed to control energisation of predetermined internal and/or external lighting and to arm an intruder alarm in the event that a mobile target is detected to be present by command units in the form of
15 proximity detectors. As a further example, the system may be programmed to effect energisation of lighting and other electrical devices at predetermined times, either for the purpose of readying a dwelling for intending occupancy or to give the impression of residential
20 occupation to would-be intruders. Override controls may be programmed into the system, for example to prevent energisation of lighting under high ambient light conditions or to bar actuation of selected electrical devices.

25 The invention will be more fully understood from the following description of a preferred embodiment of a system for controlling the actuation of mains powered electrical devices in a domestic residence. The description is provided with reference to the
30 accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings -

Figure 1 shows a schematic representation of the complete system,

35 Figure 2 shows a circuit diagram of a power supply that is incorporated in the system of Figure 1,

Figure 2A is a graphical representation of an example output voltage of the power supply, and

Figure 3 shows a diagrammatic representation of a signal generator which is incorporated in a command unit— in the system of Figure 1.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT OF THE
5 INVENTION

As illustrated, the complete control system comprises a power supply 10 which is connected to a single phase, alternating current mains supply 11. The power supply incorporates a transformer/bridge rectifier
10 circuit 12, as shown in Figure 2, and it provides a direct current output to a voltage regulator 13. The output from the voltage regulator is maintained at a nominal potential of 20 volts and is connected to two-wire control circuit wiring 14.

15 Three command units 15A, B and C are shown connected to the control circuit wiring 14, although a typical system would normally employ a significantly greater number of command units. Each command unit 15 incorporates a manually operable push-button type switch
20 16 and a signal generator 17. The signal generator associated with each command unit 15 is shown in Figure 3, is powered by way of the control circuit wiring 14 and is arranged to generate a unique command signal composed of a digital modulation of the control circuit voltage.

25 The command signals from the command units 15 are detected by a central processing unit 18 which is connected to the control circuit wiring 14 and powered from the main supply 11. The central processing unit 18 is programmed to translate detected command signals into
30 actuating signals which are fed to the control circuit wiring for detection by actuator relay units 19A, B and C. The central processing unit is programmed to preclude simultaneous superimposition of two or more command and/or actuating signals on the control circuit
35 wiring.

Also, the central processing unit 18 includes programming facilities which permit local programming or

reprogramming of the system, using a keyboard (not shown), to effect extension of the system and/or to modify the translating functions of the central processing unit.

5 The actuator relay units 19 each incorporate a bistable relay 20 and detector/signal processing circuitry 21, the latter of which is arranged to detect for an appropriately coded actuation signal from the central processing unit 18 and to apply a relay operating
10 signal to the associated relay 20 upon receipt of the actuating signal. Having been actuated to a closed condition, each relay 20 functions to connect an associated load 22 to the mains supply 11.

 As an example of one possible operating condition of
15 the system, operation of the switch 16 in command unit 15A may produce a command signal having a code which is recognised by the central processing unit 18 as one which should be translated into an actuating signal which is detectable by relay unit 19C. Then, having detected
20 the actuating signal, the relay unit 19C causes its relay 20 to close in order that mains power will be connected to load 22C.

 The power supply shown in Figure 2 functions to maintain the 20 volt supply to the control circuit wiring
25 14 in the absence of any command or actuating signal on the control circuit wiring 14. For this purpose the power supply circuit incorporates a voltage regulator 22. To protect against "absorption" of the command or actuating signals, as a consequence of normal voltage
30 regulation performed by the power supply, the power supply as shown in Figure 2 is arranged to regulate or, expressed in an alternative way, modulate the output voltage to the control circuit wiring 14 between two levels at a rate which corresponds with that of the coded
35 command and actuating signals that appear at any one time on the control circuit wiring. Thus, the power supply functions to detect for the presence of pulse-form signals generated by the command units 15 or by the

central processing unit 18 and to modulate the supply voltage applied to the same control circuit wiring 14 on which the signals appear. Modulation of the supply voltage occurs responsive to the existence of a command or actuating signal and at a rate corresponding with that of the coded command or actuating signal. Thus, the supply voltage is modulated between the two (upper and lower) levels and in a manner which emulates the codes of the command or actuating signals. The upper level of the power supply voltage is +20 volts, as stated above, and the lower level is typically +17 volts as shown in the voltage signal that is graphed in Figure 2A.

The voltage regulator 22 comprises an LM350 adjustable linear voltage regulator and its output level is determined by the value of the resistance ratio R_2/R_1 or, when a comparator 23 is controlled effectively to place resistance R_2 and R_3 in parallel, by the resistance ratio $R_2 \cdot R_3 / R_1 (R_2 + R_3)$.

With the specific circuit configuration shown in Figure 3 and with the value of the output voltage being determined by the resistance ratio R_2/R_1 , the output voltage is maintained at a level of 20 volts with no command or actuator signals on the control circuit wiring 14.

The comparator 23 comprises an operational amplifier having a small offset, determined by the ratio R_4/R_5 and, because of the small offset, a separate regulated voltage source 24 is provided to ensure a constant voltage supply to the comparator circuit 23. The regulator 24 comprises a 78L12 constant voltage supply integrated circuit device.

When the system is operating without command or actuator signals on the control circuit wiring 14, the non-inverting input of the comparator 23 remains high and the output voltage level of the regulator 22 (determined by the resistance ratio R_2/R_1) is maintained high at 20 volts. However, if one of the command units as shown in Figure 3 is actuated, current flow through the collector

resistor R_6 in the signal generator 17 will be detected as current flow through resistor R_7 in the power supply circuit of Figure 2. As a consequence and as a result of the low offset established by the value of resistors R_4 and R_5 , the inverting input to the comparator 23 will go high relative to the non-inverting input, cause the output of the comparator to go low and effectively place resistor R_3 in parallel with resistor R_2 . The output of the regulator 22 will then go low, with the circuit component values indicated to a level of approximately 17 volts.

The regulator output voltage will stay low until current flow through resistors R_6 and R_7 ceases, whereupon the regulator output will return to the high level. The same circuit operation will occur with generation of an actuator signal in the system.

THE CLAIMS

1. A system for controlling the connection of power to electrical devices by way of switching devices and which comprises a low voltage, direct current power supply, an electrical connection between the power supply and the switching devices, and means for generating and feeding to the electrical connection pulse-form control signals; characterised in that the power supply includes means for detecting the presence of the pulse-form control signals and means for modulating the output voltage of the power supply between two discrete levels responsive to and at a rate corresponding with that of the pulse-form control signals.

2. The system as claimed in claim 1 further characterised in that the means for generating the pulse-form control signals comprise actuatable command units which are arranged when actuated to generate digitally coded command signals.

3. The system as claimed in claim 1 further characterised in that the means for generating the pulse-form control signals comprise actuatable command units and a central processing unit, in that respective ones of the command units are arranged when actuated to generate unique digitally coded command signals, in that the central processing unit is arranged to detect the digitally coded command signals and to generate digitally coded actuating signals which are predetermined by the respective digitally coded command signals, and in that respective ones of the switching devices are arranged to effect switching operations responsive to detection of the presence of predetermined ones of the digitally coded actuating signals.

4. The system as claimed in claim 3 further characterised in that the central processing unit is programmed to translate respective ones of detected said command signals into predetermined said actuating signals.



5. The system as claimed in claim 3 further characterised in that the central processing unit is programmed to preclude simultaneous superimposition of two or more command and/or actuating signals on the electrical connection between the power supply and the switching devices.

6. The system as claimed in claim 2 or claim 3 further characterised in that each of the command units comprises a manually operable switch and means for generating the digitally coded command signal responsive to actuation of the switch.

7. The system as claimed in any one of claims 1 to 4 further characterised in that the switching devices comprise electromagnetic relays which are arranged to connect a mains supply to the electrical devices.

8. The system as claimed in any one of the preceding claims further characterised in that the power supply is arranged to provide an output having an upper voltage level in the absence of any said pulse-form control signal on the electrical connection between the power supply and the switching devices, and in that the power supply is arranged to effect a reduction in the voltage level of the output responsive to and at the rate of any said pulse-form control signal that is detected to exist on the electrical connection.

9. The system as claimed in any one of the preceding claims further characterised in that the power supply includes a voltage regulator circuit which provides an output having an upper voltage level in the absence of any said pulse-form control signal on the electrical connection between the power supply and the switching devices, in that the power supply includes means for detecting changes in current flow through the power supply due to the presence of any said pulse-form control signal on the electrical connection, and in that means are provided for effecting a reduction in the voltage level of the output of the regulator circuit



responsive to and at the rate of change detected in said current flow.

10. A system for controlling the connection of power to electrical devices by way of switching devices and
5 which comprises a low voltage, direct current power supply, a plurality of command units connected to and powered from the power supply by way of an electrical connection, and a plurality of switching devices
10 connected to and powered from the power supply by way of the electrical connection, respective ones of the command units being arranged to generate uniquely coded pulse-form command signals and to feed the command signals to a central processing unit by way of the electrical
15 connection, and the central processing unit being arranged to generate pulse-form actuating signals having codes determined by respective said command signals and to feed the actuating signals to the switching devices by way of the electrical connection; characterised in that
20 the power supply includes means for detecting the presence of the pulse-form signals and means for modulating the output voltage of the power supply between two discrete levels responsive to and at a rate corresponding with that of the pulse-form signals.

11. A system for controlling the connection of power
25 to electrical devices by way of switching devices, substantially as shown in the accompanying drawings and substantially as hereinbefore described with reference thereto.