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(56) Documents Cited
US 4223395 A US 3982141 A

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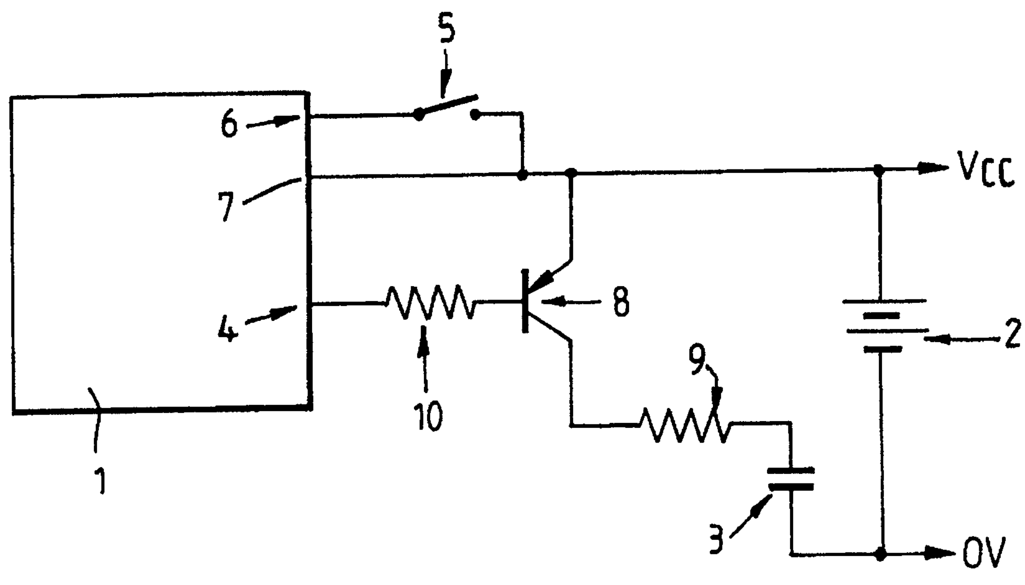
(54) Back-up Arrangement of a Battery Power Supply for an Appliance

(57) A capacitor 3 is operable as a back-up for a battery 2 which powers an appliance,but the capacitor 3 is only charged up from the battery 2 in response to sensing an imminent loss of power output from the battery 2, thereby avoiding the power wastage that would occur due to capacitor leakage current if the capacitor 3 was always connected across the battery 2. The appliance may be telecommunications, refrigeration, air-conditioning, medical or monitoring equipment, or particularly a programmable domestic heating system controller having a microprocessor 1. Imminent loss of battery power may be detected by monitoring for power output to fall below a predetermined limit, or by means of a switch 5 which opens when a hinged cover is opened to allow exchange of battery 2. In response to opening of switch 5, microprocessor 1 turns on a transistor 8 so that capacitor 3 then charges from battery 2, the microprocessor 1 is put into "STOP" mode, and when the battery 2 has been removed capacitor 3 discharges via transistor 8 and resistor 9 to return the RAM contents of microprocessor 1.



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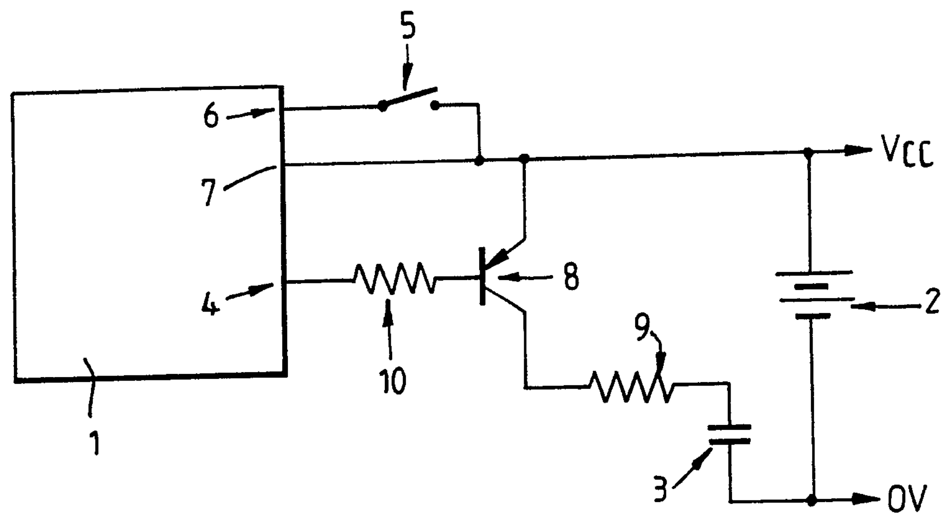
At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.


5
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APPLIANCE

The present invention relates to the back-up of a battery power supply for an appliance.

Programmable domestic heating system controllers with solid-state data stores conventionally have a battery to operate and/or retain permanently programming data which is required for operation of the controller. The battery needs to be renewed every few years, certainly a number of times during the intended lifetime of an average programmer, and therefore it is necessary to ensure that the battery can be changed without risking corruption or loss of the data.

One possible solution might be to provide a capacitor in parallel with the battery such that when the battery is removed, the capacitor will discharge retaining the data uncorrupted for a while. However, the type of capacitor which is most suited to this application is the electrolytic capacitor which has an inherent D.C. leakage current typically of 3 uA; this is an appreciable fraction of the normal operating current drawn from the battery by the solid-state device, and therefore the capacitor will significantly affect the length of the battery's life.

The present invention provides back-up to a battery power supply in an appliance, the apparatus comprising:

means to determine an imminent occurrence of loss of power output from a battery power supply in an appliance,

means to effect charging up of capacitative means when the determining means notes a said occurrence, and means to electrically connect the charged capacitative means to circuitry of the appliance.

In this way, the capacitative means is only charged up once loss of power output (e.g. changing of the battery) is imminent, thereby avoiding power wastage from the leakage current and so maintaining the battery life.

In one form, the determining means monitors for disassembly of parts of the appliance, preferably monitoring for relative separation of two parts of the appliance from their relative position during normal operation of the appliance, for example by watching for an electrical disconnection caused by the separation of the two parts.

In another form, the determining means monitors for the power output to fall below a predetermined limit.

The energy stored in the capacitative means may be used to power that component of the appliance which is normally powered by the battery power supply, and/or it may be used to power a different component in the appliance, for example a warning light or indicator. Typically, a component for powering by the battery power supply and by the charged capacitative means is a solid-state store for data, but it can be any other appropriate component, not necessarily solid-state stores or other microprocessor devices. The invention is applicable to a wide variety of appliances, including programmable heating system control units and general domestic appliances.

The invention is also applicable to appliances other than general domestic appliances; for example, by upgrading of the batteries and the capacitative means, the invention could be used for industrial or military use, for example changing back-up batteries in telecommunications, refridgeration, air-conditioning, medical or monitoring equipment.

Preferably the charging means comprises means to connect electrically the capacitative means across the battery power supply. Also, preferably, there is means to disconnect the battery power supply from the appliance upon connection of the charged capacitative means to the appliance circuitry.

In order that the invention may more readily be understood, a description is given by way of example only, reference being made to the accompanying sole figure which is a circuit diagram of apparatus embodying the present invention.

Figure 1 shows an electric circuit of a battery back-up unit in a programmable heating system controller which incorporates a microprocessor 1 powered by two AA-size batteries 2 to retain program data in the memory store of microprocessor 1. There is provided a capacitor 3 of 400 uF in parallel with batteries 2, capacitor 3 being maintained uncharged during normal operation of the controller by virtue of output port 4 being held HIGH, in this way, there is no leakage current from capacitor 3 which would reduce the life of batteries 2.

The controller has a hinged cover (shown diagrammatically as a switch 5) which in normal operation of the controller, is closed such that it completes an electrical loop between input port 6 of microprocessor 1 and the power line 7 at voltage Vcc. In order to replace batteries 2, the cover is opened to expose the batteries in their compartment, thereby breaking the electrical loop by making switch 5 open circuit, thereby sending a signal 6 to microprocessor 1 that loss of the power supply is imminent. Thus when microprocessor 1 detects that the batteries are about to be changed, output port 4 is set LOW (and microprocessor 1 put into "stop" mode) to allow capacitor 3 to charge through transistor 8 and 1 KOhm resistor 9 . Capacitor 3 is charged to Vcc voltage level in about 5 time constants (RC) e.g.:-

charge time = 5 x 1K x 400 uF = 2s

Thus, by the time batteries 2 are removed, capacitor 3 has been fully charged; their removal causes capacitor 3 to discharge through resistor 9 and transistor 8 thereby maintaining microprocessor 1 at voltage Vr and hence retaining the RAM contents of microprocessor 1 while in the "stop" (low current) mode.

Thus, taking:-

Microprocessor 1 represented as a load of 1M.

Vcc = 2.5V (near the end of 2 AA cells life)

Vr = 2V (RAM retention voltage)

C = 400uF

Hold-up time th = - RC In (Vr/Vcc) (assume transistor 8 Vce(sat) = OV)

th = - (1M + 1K) x (400uF) x In (2/2.5) = 89.3s

When microprocessor 1 detects that the batteries have been changed successfully i.e. the cover is hinged closed so that switch 5 is closed again output port 4 is set HIGH to save the capacitor leakage until the next battery change.

Electrolytic capacitors have an inherent D.C. leakage current that is typically quoted as "0.01CV or 3 uA whichever is greater". Batteries 2 output typically an average current of 30uA sourced from two 1120 mAhrs batteries; thus batteries 2 would have a life as follows:-

Life (years) = 1.12 / ($30 \times 10^{-6} \times 24 \times 365$) = 4.26 years.

If capacitor 3 was continually charged throughout operation of the controller, and the leakage current was 3 uA (i.e. 10% of average current), then

Life (years) = 1.12 / ($33 \times 10^{-6} \times 24 \times 365$) = 3.87 years.

i.e. a difference of nearly 5 months.

Resistor 9 stops the magnitude of the initial charging current to capacitor 3 in case it causes a spike on Vcc that may affect the microprocessor. Resistor 10 is a base resistor picked to ensure that transistor 8 is saturated . Transistor 8 is a high gain device (Hfe = 215 - 500) chosen so that only a small base current is required dictated by resistor 10.

Thus, in the invention, the circuit allows batteries to be changed, without loss of the controllers' program, at minimum cost, size and weight penalty, and there being no significant degradation of the lifetime of the batteries.

CLAIMS

1. Apparatus for providing back-up to a battery power supply in an appliance, the apparatus comprising:

means to determine an imminent occurrence of loss of power output from a battery power supply in an appliance,

means to effect charging up of capacitative means when the determining means notes a said occurrence, and

means to electrically connect the charged capacitative means to circuitry of the appliance.

2. Apparatus according to Claim 1 wherein the determining means monitors for disassembly of parts of the appliance.

3. Apparatus according to Claim 2, wherein the determining means monitors for relative separation of two parts of the appliance from their relative position during normal operation of the appliance.

4. Apparatus according to Claim 3, wherein the determining means monitors for an electrical disconnection caused by the separation of two parts of the appliance.

5. Apparatus according to any preceding Claim, wherein the determining means monitors for the power output below a predetermined limit.

6. Apparatus according to any preceding Claim, wherein the charging means comprises means to connect electrically the capacitative means across the battery power supply.

7. Apparatus for providing back-up to a battery power supply substantially as hereinbefore described with reference to and/or as illustrated in the accompanying drawings.

'atents Act 1977 -8-
Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number GB 9221451.9

Relevant Technical fields

(i) UK Cl (Edition K) H2H HAJ

(ii) Int Cl (Edition 5) G06F 1/26, 1/28, 1/30; G11C 5/14; H02J 9/00, 9/02, 9/04, 9/06

Databases (see over)

(i) UK Patent Office

(ii) ONLINE DATABASE: WPI

Search Examiner

M J BILLING

Date of Search

31 DECEMBER 1992

Documents considered relevant following a search in respect of claims 1-6

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
A	US 4223395 A (OMRON) eg. See capacitor 23 in Figure 2	1
A	US 3982141 A (BELL) eg. See capacitor 13 in Figure 2	1

to claim(s).

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family, corresponding document.

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