PATENT REQUEST: STANDARD PATENT

I/We, the Applicant(s)/Nominated Person(s) specified below, request I/We be granted a patent for the invention disclosed in the accompanying standard complete specification.

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[54] Invention Title:
Battery Capacity Detector

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NOTICE OF ENTITLEMENT

I, Fraser Patison Old, of Spruson & Ferguson, St Martins Tower, 31 Market Street, Sydney, New South Wales 2000, Australia, being the patent attorney for the Applicant(s)/Nominated Person(s) in respect of Application No 11481/95 state the following:-

The Applicant(s)/Nominated Person(s) has/have entitlement from the actual inventor(s) as follows:-

The Applicant(s)/Nominated Person(s), is/are the assignee(s) of the actual inventor(s).

The Applicant(s)/Nominated Person(s) is/are the applicant(s) of the basic application(s) listed on the Patent Request. The basic application(s) listed on the Patent Request is/are the first application(s) made in a Convention Country in respect of the invention.

DATED this 6th day of April 1995

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The invention relates to communication equipment which uses a battery (8) as the power supply. When a controller (7) increases the transmission power at a transmitter (6) corresponding to a drop in the electric field intensity, another controller (18) lowers, accompanying that operation, a reference voltage from a reference voltage source (12) which is used for comparison with the battery (8) voltage for the purpose of detecting a drop in the battery capacity. Therefore, even when the battery (8) voltage is dropped due to an increase in the transmission output, the reference voltage is also lowered correspondingly, so that an erroneous detection of drop in the battery capacity due to the drop in the battery voltage will not occur.

**Claim**

1. A battery capacity detector comprising:
   a detector for detecting a battery voltage;
   a comparator for comparing a detected battery voltage with one of a plurality of reference values; and
   a selector for selecting said one of said plurality of reference values as a selected reference value in response to a load on a battery.
7. A communication device comprising:
   power supply means;
   detection means for detecting a supply voltage of
   said power supply means;
   comparison means for comparing said supply voltage
   with a reference value; and
   varying means for varying said reference value in
   response to a load on said power supply means.
BATTERY CAPACITY DETECTOR

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a battery capacity detector, and more particularly to a device for accurately detecting a capacity drop in the power supply batteries used for communication equipment.

Description of the Related Art

In a portable equipment for mobile communication such as a portable telephone, batteries are generally used for its power supply. Therefore, the normal operation of the equipment cannot be secured if the battery power is deteriorated. For that reason, there have been proposed devices which urge the user the replacement or recharging of the batteries by issuing an alarm when the battery power, for example, the battery voltage, dropped to below a specified voltage level.

A cordless telephone system having such an alarm function is disclosed in, for example, Japanese Patent Laid-Open Application No. 354230/1992 (JP-A-H04-354230). This cordless telephone system includes a master set and a slave set which is carried for use. In the slave set, a battery capacity detector detects the voltage of the batteries which supply power to a communication part.
which includes a radio part, a modem, a control part, and the like. When the detected battery voltage drops to below a value prescribed in advance, the control part displays in a display part a signal that indicates the drop of the remaining capacity, and notifies the information to the master set via a communication part. Upon receipt of this signal the master set issues an alarm.

Now, a radio data transmitter, such as a teleterminal, has a function of controlling the voltage of transmission signals in response to the communication circumstances. For example, the radio data transmitter has a function of monitoring the electric field intensity of a received radio signal. When the electric field intensity is dropped, the transmission voltage is increased successively in accordance with the electric field intensity in order to perform all the time a suitable data transmission corresponding to the electric field intensity. However, when the detector for detecting the drop of the battery voltage as described in the above is installed in the radio data transmitter, the load in the circuit supplied with the power is increased with the increase in the transmission power, causing a drop in the battery voltage. Because of this, in a type of device which detects the battery capacity based on the battery voltage, a drop in the battery voltage is detected when the transmission
power is increased, and an alarm is issued sometimes in spite of the fact that a sufficient battery capacity is remaining.

Similarly, if one attempts to equip the above-mentioned cordless telephone system with a function which, for example, controls the transmission power in response to the electric field intensity of the received signal, the battery voltage is dropped temporarily due to the increase in the transmission power. Therefore, the system judges the situation as a drop in the battery capacity, which results in a problem of erroneous display or alarm issuance.

Furthermore, when the battery voltage is dropped temporarily due not only to a change in the transmission power, but also to a variation in the battery load during communication, a similar erroneous detection of the battery capacity may happen.

SUMMARY OF THE INVENTION

It is therefore an object of this invention to provide a battery capacity detector capable of detecting the drop in the battery capacity more accurately irrespective of the variations in the battery load.

Another object of this invention is to provide a battery capacity detector capable of detecting accurately the drop in the battery capacity irrespective of the changes in the transmission power of a transmitter.
In a communication device, it is desirable to have a function of detecting the battery capacity based on the battery voltage, and of urging the user to replace or recharge the battery when the battery voltage dropped to below a voltage where the communication device begins to fail to perform the normal operation. Therefore, it is desirable to designate a voltage value at which the communication device no longer performs its normal operation as the reference value, and compare the detected battery voltage with this reference value.

However, the battery voltage drops temporarily due to changes in the communication circumstances, for example, an increase in the transmission power or the battery load. Therefore, the comparison of the battery voltage with the reference value results in the indication of a drop of the battery voltage to be low the reference value, giving rise to the notification of this information to the user.

In view of such problems, the battery capacity detector according to the present invention includes a detector which detects the battery voltage, a comparator which compares a detected battery voltage with a predetermined reference, and a controller which varies the predetermined reference value in response to a battery load.

In a communication equipment in which the transmission power is controlled according to the communication
circumstances, it is preferable to provide the communication equipment with a means of detecting the transmission power and a means of varying the reference voltage value in response to the detected transmission power.

For example, a change in the transmission power may be detected by a change in the electric field intensity of the received signal. Or, the transmission power may be controlled based on the AGC signal in the receiving system of the communication equipment.

According to this invention, when the battery voltage drops due to an increase in the battery load, the reference voltage is arranged to drop also in response to the drop in the battery voltage, so that there will not occur an erroneous detection of the battery capacity drop.

Moreover, even when the battery voltage drops due to an increase in the transmission power at the time of drop in the electric field intensity of the received signal, the drop in the battery voltage is arranged not to be detected as a voltage drop, by lowering the reference voltage accompanying the increase in the transmission power. Therefore, the erroneous detection of the battery capacity drop can be prevented.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, features and advantages
of this invention will become more apparent from the following detailed description taken with the accompanying drawings in which:

FIG. 1 is a block diagram of a communication device which is a preferred embodiment of a battery capacity detector according to the present invention;

FIG. 2 is a block diagram of a preferred embodiment of the controller shown in FIG. 1;

FIG. 3 is a block diagram of another preferred embodiment of the controller shown in FIG. 1;

FIG. 4 is a block diagram of another embodiment of the present invention; and

FIG. 5 is a block diagram of yet another embodiment of the present invention.

In the drawings, the same reference numerals denote the same structural elements.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 is a block diagram of a communication device, preferably a portable telephone, which has a first preferred embodiment of a battery capacity detector according to the present invention.

During reception, a receiver 2 converts a radio signal received by an antenna 1 to a received intermediate frequency (IF) signal. An automatic gain controller (AGC) 3 controls the level of the received IF signal
to a predetermined level and supplies a level-controlled IF signal to an amplifier 4. The amplifier 4 amplifies the level-controlled IF signal to obtain an amplified received IF signal, and outputs the amplified received IF signal to an IF part (not shown). On the other hand, during transmission, an amplifier 5 amplifies a transmitting IF signal which is input from the IF part. A transmitter 6 transmits a transmitting radio frequency (RF) signal, obtained by converting an amplified transmitting IF signal, via the antenna 1. The transmitter 6 has the function of varying the transmission power of the transmitting RF signal. A controller 7 is supplied from the AGC 3 with an AGC signal which is closely related to the electric field of the received signal, and outputs a transmission power control signal which varies the transmission power at the transmitter 6.

A battery 8 is a power supply for driving the various parts within the telephone set. The voltage of the battery 8 is converted in an A/D converter 9 to a digital signal that corresponds to the voltage. This digital signal is input to a controller 18. The controller 18 compares the input battery voltage with a reference voltage. When the battery voltage dropped to below the reference voltage, the controller 18 causes a battery capacity display 10 to display the drop of the battery capacity, or an alarm 11 to issue an alarm. As will be
described later, the reference voltage is made variable corresponding to the level of the AGC signal.

FIG. 2 is a block diagram of a preferred embodiment of the controller 18 shown in FIG. 1.

A reference voltage source 12 is connected in series with a plurality of resistors R1 to Rn. A plurality of voltages V1 to Vn obtained by dividing the reference voltage are taken out from the junctions of the resistors R1 to Rn, and the plurality of voltages V1 to Vn are input to a selector 13. A decision circuit 19 inputs an AGC signal from the AGC 3, and outputs a select signal which selects one out of the plurality of voltages in response to the level of the AGC signal. The selector 13 selects one out of the plurality of different voltages V1 to Vn in response to the select signal as described later. One of the voltages selected by the selector 13 is converted to a digital signal in an A/D converter 14, and is supplied to one of the input nodes of a comparator 15. To the other input node of the comparator 15 is input the output of the A/D converter 9 connected to the battery 8. The comparison output of the comparator 15 is supplied to a driving circuit 16 which drives the battery capacity display 10 and the alarm 11.

In the portable telephone shown in FIG. 1, when the communication state is deteriorated by, for example, the drop of the electric field intensity of the received signal,
the reception level at the receiver 2 goes down, so that
the level of the AGC signal from the AGC 3 goes up.
Therefore, upon receipt of the AGC signal, the controller 7
sends the transmission power control signal to the
transmitter 6 to execute the control of the increase
in the transmission power of the transmitting RF signal
from the transmitter 6. Then, the load of the battery 8
is raised due to the increase in the transmission power,
and the voltage of the battery 8 goes down.

On the other hand, in the controller 18, the selector
13 selects one of the plurality of divided voltages Vl to
Vn of the reference voltage source 12 based on the level
of the AGC signal. In other words, the selection is
carried out, based on the electric field intensity, or
on the transmission power which is closely related to
the electric field intensity. Preferably, a voltage,
which is roughly inversely proportional to the transmission
power, is selected in the selector 13 and is output as a
reference voltage. The selected reference voltage, i.e.,
one of the divided voltages, is input to the comparator 15
after being converted to the digital signal by the A/D
converter 14. This signal is compared in the comparator 15
with the voltage of the battery 8 which is converted to a
digital signal by the A/D converter 9. As a result, if
the voltage of the battery 8 is found to be lower than
the selected reference voltage, a driving signal which
drives the battery capacity display 10 and the alarm 11 is supplied to the driving circuit 16 to display and issue an alarm that the battery capacity has dropped.

Since, the battery load is raised accompanying the increase in the transmission power, the voltage of the battery 8 goes down temporarily. However, at the same time, a voltage power than the original reference voltage is also selected as the selected reference voltage, as a result of the increase in the transmission power.

Therefore, even when the battery voltage drops due to the increase in the transmission power, the battery voltage in the comparator 15 does not go to a level below the selected reference voltage, avoiding the erroneous detection of the drop in the battery capacity.

Moreover, the selector 13 selects a voltage which corresponds to the extent of increase in the transmission power as the selected reference voltage so that it is possible to vary the reference voltage by following the change in the transmission power. Therefore, a temporary drop in the battery voltage will not be judged as a drop in the battery capacity, and it is possible to accurately detect the battery capacity and issue a correct alarm all the time.

FIG. 3 is a block diagram of another embodiment of the controller 18. In FIG. 3, a plurality of values TH1 to THn of the reference voltage corresponding to
a plurality of different transmission powers are stored in advance in a memory 17. Either one of these stored reference values TH1 to THn is selected based on the level of the AGC signal in the selector 13, and supplied to one of the input nodes of the comparator 15. The value of the digital signal obtained in a manner similar to the above embodiment by converting the voltage of the battery 8 with the A/D converter 9 is supplied to the other input node of the comparator 15.

Therefore, also in this embodiment, the controller 7 recognizes the electric field intensity based on the AGC signal, and accordingly controls the transmission power. At the same time, the selector 13 in the controller 18 reads from the memory one of the reference values corresponding to the transmission power based on the AGC signal, and uses the selected reference voltage as the reference voltage in the comparator 15. Consequently, even when the battery voltage drops temporarily due to an increase in the transmission power, the reference voltage value is reduced simultaneous with the drop, so that erroneous detection of this state as a drop in the battery capacity and an erroneous issuance of alarm will not take place.

In the first embodiment of the controller 18, the reference voltage is selected by the selector in a step-wise manner. However, a constitution may be adopted by
which a continuously varying reference voltage is output, and supplied to the comparator. For example, the plurality of resistors R1 to Rn may be replaced by a variable resistor, and may control the resistance of the variable resistor in response to the select signal which is based on the AGC signal.

Moreover, in the above embodiments, the transmission power is controlled in response to the electric field intensity, so that the reference voltage is varied by utilizing the AGC signal which is closely related to the transmission power. However, when the transmission power is controlled by some other factor, for example, in a device whose transmission power is controlled based on the error rate or the like, the system may be constituted so as to change and control the reference voltage by directly utilizing the transmission power information.

For example, as shown in FIG. 4, the reference voltage may be controlled based on a transmission power control signal from the controller 7. In that case, the transmission power control signal instead of the AGC signal is supplied to the decision circuit 19 shown in FIG. 2 or 3. Since the remaining configuration and operation of the device shown in FIG. 4 are the same as those of the device shown in FIG. 1, a further description will be omitted. Here, the controller 7 controls the
transmitter 6 in response to the AGC signal, but the
controller 7 may independently control the transmitter 6
without responding to the AGC signal.

Furthermore, when the battery load is varied by some
other factor regardless of the transmission power, this
invention may be provided with a detector for detecting
the load, and the device may be constructed so as to
vary and control the reference voltage in response to
the extent of the load.

For example, as shown in FIG. 5, a resistor R is
inserted between the battery 8 and the A/D converter 9,
and the current flowing in the resistor R is detected
by an ammeter 20, a current value detector, or the like.
The detected current value is supplied to the decision
circuit 19 shown in FIG. 2 or 3. The decision circuit 19
stores in advance several threshold values, and the
detected current value is compared with these threshold
values. According to the result of the comparison, the
decision circuit 19 sends a select signal to the selector
indicating to select an adequate reference voltage.

As in the above, by varying the reference voltage
in response to the load on the battery, in a receiver
having the battery saving function, it is possible to
prevent an erroneous battery capacity detection.

As described in the above, according to the present
invention, in detecting the battery capacity by comparing
the voltage of the battery used as a power supply with a
reference voltage, the reference voltage with which the
detected battery voltage is compared is made to vary in
response to the battery load. Since the communication
device is so arranged as to lower the reference voltage
in response to a drop in the battery voltage caused by
an increase in the battery load, the comparison of these
voltages will not lead to the judgment of a drop in the
battery capacity, and hence an erroneous detection of
the battery capacity can be prevented.

In addition, in a communication equipment whose
transmission power is varied and controlled in response
to the communication circumstances, according to the
present invention in which the reference voltage is
varied in response to the transmission power, even when
the battery voltage is dropped due to an increase in the
transmission power, the reference voltage is lowered
accompanying the increase in the transmission power.
Therefore, a detection result indicating that the battery
capacity is dropped will not be output, and an erroneous
detection of the drop in the battery capacity can be
prevented.

In this way, erroneous detection of the battery
capacity due to variations in the load, operating
conditions, or the like can be avoided, so that an
accurate grasping of the remaining capacity of the
battery is made possible, giving rise to an effect which ensures an accurate issuance of the battery alarm.

While the invention has been described with reference to specific embodiments thereof, it will be appreciated by those skilled in the art that numerous variations, modifications, and embodiments are possible, and accordingly, all such variations, modifications, and embodiments are to be regarded as being within the spirit and scope of the invention.
what is claimed is:
The claims defining the invention are as follows:

1. A battery capacity detector comprising:
   a detector for detecting a battery voltage;
   a comparator for comparing a detected battery voltage with one of a plurality of reference values; and
   a selector for selecting said one of said plurality of reference values as a selected reference value in response to a load on a battery.

2. The battery capacity detector as claimed in claim 1, wherein said selector comprises:
   a generator for generating said plurality of reference values.

3. The battery capacity detector as claimed in claim 2, wherein said generator comprises:
   a reference voltage source; and
   a plurality of resistors connected in series with said reference voltage source which supply said plurality of reference values to be supplied to said selector by dividing a reference voltage of said reference voltage source.

4. The battery capacity detector as claimed in claim 2, wherein said generator comprises a memory which stores said plurality of reference values.
5. The battery capacity detector as claimed in claim 1, wherein said selector selects lower reference value and higher reference value in response to an increase and a decrease in said load on said battery, respectively.

6. The battery capacity detector as claimed in claim 1, further comprising:
   information means; and
   driving means for driving said informing means when said battery voltage is lower than said selected reference value.

7. A communication device comprising:
   power supply means;
   detection means for detecting a supply voltage of said power supply means;
   comparison means for comparing said supply voltage with a reference value; and
   varying means for varying said reference value in response to a load on said power supply means.

8. The communication device as claimed in claim 7, wherein said varying means increases and decreases said reference value in response to an increase or a decrease in said load.
9. The communication device as claimed in claim 7, wherein said varying means comprises:
   generating means for generating a plurality of reference values; and
   selection means for selecting one of said plurality of reference values as said reference value in response to said load.

10. The communication device as claimed in claim 7, further comprising:
   transmission means for transmitting a transmitting signal; and
   a first control means for controlling an output level of said transmitting signal.

11. The communication device as claimed in claim 10, wherein said varying means utilizes said output level of said transmitting signal as said load on said power supply means.

12. The communication device as claimed in claim 10, further comprising:
   reception means for receiving a receiving signal; and
   a second control means for controlling a level of said receiving signal and for supplying a control signal to said first control means.
13. The communication device as claimed in claim 12, wherein said alteration means utilizes said control signal as the load on said power supply.

14. The communication device as claimed in claim 7, further comprising:
   informing means; and
   driving means for driving said informing means when said power supply voltage is lower than said reference value.

15. The communication device as claimed in claim 12, wherein said second control means comprises an automatic gain controller.

16. A method for controlling a detection of a remaining capacity of a battery, the method comprising the steps of:
   detecting a battery voltage of said battery;
   selecting a reference value in response to a load on said battery; and
   comparing said battery voltage with a selected reference value.

17. The method as claimed in claim 16, the method further comprising the step of:
   informing a user about status when said battery voltage is lower than said selected reference value.
18. A method for controlling a detection of a capacity of a battery, the method comprising the step of:
   detecting a battery voltage of said battery;
   supplying a plurality of reference values;
   selecting one of said plurality of reference values;
   supplying a selected reference value; and
   comparing said battery voltage with said selected reference value.

19. The method as claimed in claim 18, wherein said selecting step selects said one of said plurality of reference values based on a load on said battery.

DATED this THIRTY-FIRST day of JANUARY 1995
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Battery Capacity Detector

ABSTRACT

The invention relates to communication equipment which uses a battery (8) as the power supply. When a controller (7) increases the transmission power at a transmitter (6) corresponding to a drop in the electric field intensity, another controller (18) lowers, accompanying that operation, a reference voltage from a reference voltage source (12) which is used for comparison with the battery (8) voltage for the purpose of detecting a drop in the battery capacity. Therefore, even when the battery (8) voltage is dropped due to an increase in the transmission output, the reference voltage is also lowered correspondingly, so that an erroneous detection of drop in the battery capacity due to the drop in the battery voltage will not occur.

Figure 1
FIG. 1
FIG. 4